8.5.3 Potential Route of Interceptor Sewer for Each Sewerage Zone

(1) Left Bank Area of Tau Hu, Ben Nghe Canal

The area has been developed as the center of Ho Chi Minh City since French era. Combined sewer system was developed along the roads. In the east part of this area covering District 1, 3 and 5 is fully developed with an adequate road networks. And interceptor sewer can be installed in some potential roads along and parallel to the canals. While, in the west part of this area covering District 6, 10 and 11 is very congested area. Only Tran Van Kieu road along Tau Hu canal is recognized as the potential route of the interceptor sewer.

(2) Island Area between Tau Hu - Ben Nghe and Doi - Te Canals

In this area, roads are existed along both canals of Tau Hu - Ben Nghe and Doi - Te. There are no alternative routes for installation of the interceptor sewer except the roads along the canals.

(3) Right Bank Area of Doi - Te Canal :

This area is not fully developed yet. Road networks are not sufficient to develop the sewer system. This area will be developed in future. The sewerage system will be also developed harmonized with the land development. The Vietnamese standards stipulates that the sewerage development for newly developed area must be covered by separate sewer system. Hence the separate sewer system is proposed in this right bank area of Doi - Te canal.

8.5.4 Alternative Study of Interceptor Route for East Area of Left Bank of Tau Hu - Ben Nghe Canal

(1) Selection of Alternative Route

There are two (2) alternative routes for the interceptor sewer; one is Ton Duc Thang - Ham Nghi - Tran Hung Doa roads and second one is Ton Duc Thang - Ben Chuong Duong roads. Based on these two (2) alternative routes, following three (3) options of the interceptor sewer are considered as shown in Fig. 8.20.

(2) Alternative Plan A

Two (2) lines of interceptor sewer are proposed. The main interceptor sewer runs along Ton Duc Thang - Ham Nghi - Tran Hung Dao streets to collect the wastewater from the sub-zones of No.1, 2, 3, 5, 7 and 9. The secondary interceptor sewer is along Ben Chuong Duong Street to collect the wastewater from the sub-zones of No.4, 6, 8 and 10.

The main features of the interceptor sewer are shown as follows.

Length	:	Total: 9,710 m
		Main : 5,480 m
		Secondary : 4,230 m
Interceptor Diameter	:	Main : ϕ 700 mm ~ ϕ 1,500 mm
	:	Secondary : ϕ 600 mm ~ ϕ 800 mm
Earth Covering Depth	:	Main : 3.7 ~ 10.4 m
		Secondary : 1.2 ~ 8.3 m
Construction Method	:	Open Cut Method : 7,070 m
		Pipe Jacking Method: 2,640 m

(3) Alternative Plan B

The route B is proposed under Ton Duc Thang – Ben Chuong Duong streets located along Saigon river and Tau Hu – Ben Nghe canal to collect the dry weather flow from the sub-zones of No.1, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

The main features of the interceptor sewer are shown as follows.

Length	:	Main : 5,405 m
Interceptor Diameter	:	Main : ϕ 700 mm ~ ϕ 1,500 mm
Earth Covering Depth	:	Main : 3.7 ~ 10.3 m
Construction Method	:	Open Cut Method : 2,525 m
		Pipe Jacking Method: 2,880 m

(4) Alternative Plan C

The main interceptor sewer runs along Ton Duc Thang – Ham Nghi – Tran Hung Dao streets to collect the wastewater from the sub-zones of No. 1, 2, 3, 5, 7 and 9 as same as Alternative Plan A.

For collection of wastewater from sub-zones of 4, 6, 8 and 10, the secondary interceptor sewer is proposed along the roads, which are perpendicular to Ben Chuong Duong street and conveys it to the main interceptor sewer.

The main features of the interceptors are shown as follows.

Length	:	Main 5,480 m
Interceptor Diameter	:	Main : ϕ 700 mm ~ ϕ 1,500 mm
Earth Covering Depth	:	Main : 3.7 ~ 10.3 m
Construction Method	:	Open Cut Method : 2,640 m

Pipe Jacking Method: 2,840 m

(5) Comparative Evaluation

From the economical point of view, there is no significant difference among three (3) alternative routes.

Alternative Route	Construction Cost
A	166 billion VND
B	168 billion VND
C	168 billion VND

Basically, interceptor sewer is installed along rivers and canals to intercept the wastewater before it discharges to those water bodies. From this concept, Alternative Plan B is the most appropriate one. While the Ben Chuong Duong street along Ben Nghe canal has a plan to connect Thu Thiem area crossing Saigon River by tunnel. Access road of about 1,000 m to Saigon River crossing tunnel is required to construct under the Ben Chuong Duong street. This access road, which will be constructed by the diaphragm wall much affects the existing drainage system along the Ben Chuong Duong street. The existing drainage sewers to Ben Nghe canal will be affected by the diaphragm wall and required to construct by-pass sewer to Saigon River or upstream reaches of Ben Nghe canal. Hence, **Alternative Plan C** is proposed as the optimum interceptor route to avoid the congestion of drainage and interceptor sewers under the Ben Chuong Duong street.

8.5.5 Proposed Plan

(1) Eastern Part of Left Bank Area of Tau Hu, Ben Nghe Canal

Alternative Plan C is selected as the optimum interceptor sewer route. The proposed alignment and longitudinal profile are shown in Fig. 8.21 and 8.22.

(2) Western Part of Left Bank Area of Tau Hu, Ben Nghe Canal

The interceptor sewer will be installed along Tran Van Kieu and Ben Ham Tu roads harmonizing with the canal side road expansion project.

The proposed alignment and longitudinal profile are shown in Fig. 8. 21 and 8.23.

The main features of the interceptor sewer are as follows:

Total length	:	4,990 m
Interceptor Diameter	:	ϕ 700 mm - ϕ 1,500mm
Earth Covering Depth	:	1.2m - 7.4 m

Construction Method	:	Open Cut Method : 4,240 m
	:	Pipe Jacking Method : 750 m

(3) Khanh Hoi Sub-Zone

Two (2) lines of interceptor sewer are proposed under Ben Van Don and Ton That Thuyet roads running along the Ben Nghe and Te canals, respectively. The interceptor sewer along the Ben Van Don road joins the other one running along Tong That Thuyet road and the merged interceptor sewer finally joins the main sewer installed in Rach Ong sub-zone after crossing Te canal. The route and the longitudinal profile of the interceptor sewer are shown in Fig. 8.24 and 8.25, respectively.

Main Features

Total Length	: 6,513 m (include canal crossing)	
Interceptor Diameter	: ϕ 450 mm ~ ϕ 1,200 mm	
Earth Covering Depth	: 1.2 ~ 5.45 m	
Construction Method	: Open Cut Method	
Canal Crossing	: Canal Name	: Te Canal
	Length	: 179 m
	Construction Method	: Shield Tunneling
	System	: Siphon with ϕ 900 mm x 2 lines

(4) Hung Phu Sub-zone

Two (2) lines of interceptor sewer are proposed under the Ben Ba Dinh and Ben Nguyen Duy roads on both sides of sub-zone along the canals. After joining both interceptor sewers, the merged interceptor sewer crosses the Doi canal at the intersection of Chanh Hung and Ben Nguyen Duy roads and connects to the main sewer installed in Pham The Hien sub-zone. The route and the longitudinal profile of the interceptor sewer are shown in Fig. F.8.24 and 8.26, respectively.

Main Features

Total Length	: 4,543 m (include canal crossing)	
Interceptor Diameter	: ϕ 400 mm ~ ϕ 500 mm	
Earth Covering Depth	: 1.2 ~ 4.35 m	
Construction Method	: Open Cut Method	
Canal Crossing	: Canal Name	: Doi Canal
	Length	: 160 m
	Construction Method	: Pipe Jacking Method
	System	: Siphon with ϕ 600 mm x 2 lines

(5) Tung Thien Vuong Sub-zone

Two (2) lines of interceptor sewer are proposed under the Ben Binh Dong and Ben Nguyen Duy roads on both sides of sub-zone along the canals. After joining both interceptor sewers, the merged interceptor sewer crosses Doi canal beside the Nhi Thien Duong bridge and reaches to the main sewer installed in Binh Dang sub-zone. The route and the longitudinal profile of the interceptor sewer are shown in Fig. 8.24 and 8.27, respectively.

Main Features

Total Length	: 4,870 m (include canal crossing)		
Interceptor Diameter	: ϕ 400 mm ~ ϕ 700 mm		
Earth Covering Depth	: 1.2 ~ 5.01 m		
Construction Method	: Open Cut Method		
Canal Crossing	: Canal Name	: Doi Canal	
	Length	: 150 m	
	Construction Method	: Pipe Jacking Method	
	System	: Siphon with ϕ 500 mm x 2 lines	

(6) Binh Dong Sub-Zone

Interceptor sewers are proposed under roads surrounding Binh Dong sub-zone. Collected wastewater by the interceptor sewers is transferred to the main sewer in Tung Thien Vuong sub-zone. Crossing under Ngang No.1 canal by pipe jacking method is proposed near by the bridge. The route and the longitudinal profile of the interceptor sewer are shown in Fig. 8.24 and 8.27, respectively.

Main Features

Total Length	: 2,543 m (include canal crossing)	
Interceptor Diameter	: ϕ 400 mm ~ ϕ 450 mm	
Earth Covering Depth	: 1.2 m ~ 4.23 m	
Construction Method	: Open Cut Method	
Canal Crossing	: Canal Name	: Ngang 1 Canal
	Length	: 42 m
	Construction Method	: Open Cut Method
	System	: Siphon with ϕ 350 mm x 2 lines

8.5.6 Diversion Chamber

All existing combined sewers are affected by tide. Hence, designing diversion chamber, high water level of the receiving water bodies should be taken into consideration. The following four (4) conditions are considered for designing diversion chamber.

Case	Flow Condition	Water level of Down Stream
A	Dry weather flow	Low tide
B	Wet weather flow	Low tide
C	Dry weather flow	High tide
D	Wet weather flow	High tide

The proposed typical diversion chamber is shown in Fig. 8.28. The orifice is designed to divert the wastewater to the interceptor sewer. The weir with a flap gate is installed at the center of the diversion chamber. From the maintenance reason, typical plane internal dimension of 2.0m x 2.2m is proposed.

103 units of outlet of combined sewer exist in the priority project area. The location is shown in Fig. 8.29.

8.6 Conveyance Sewer

8.6.1 Alternative Study of Conveyance Sewer Route

Based on the potential Tau Hu, Ben Nghe and Doi, Te canals crossing routes and potential locations of intermediate pumping station, three (3) alternative routes of conveyance sewer are selected as shown in Fig. 8.30. The outline of three (3) alternative routes are described as shown below.

Alternative Route	Characteristics
(A) Nguyen Bieu	Nearest to the city center Two (2) canals of Tau Hu, Ban Nghe and Doi, Te intersecting point is potential canal crossing route Potential site of pumping station is Da Nam Park
(B) Tran Tuan Khal	Largest open space for Pumping Station Shortest length of canal crossing
(C) Nguyen Tri Phuong	Potential Pumping Station site faces main road Tennis court space of district office to be used for work yard for construction

These three (3) alternative routes of conveyance sewer are evaluated under the following aspects:

- Facility of potential site acquisition for canal crossing work yard
- Required length of canal crossing
- Facility of potential site acquisition for pumping station and their circumstances
- Facility to access to pumping station
- Required land acquisition for conveyance sewer installation

Alternative route (B) Tran Tuan Khal is selected as the optimum conveyance sewer route with the lowest construction cost of VND349.2 billion.

The detailed evaluation is described in Supporting Report Appendix F, Table F.13.1.

(2) Comparison between Gravity Flow and Pressured Flow

Due to the proposed wastewater treatment plant site located far from the sewerage development area, conveyance sewer with a total length of 5.4 km is required. Then the earth covering depth of conveyance sewer of gravity flow system becomes deep. And its construction cost becomes high. Hence the pressure flow conveyance sewer is compared with gravity flow conveyance sewer.

Advantage and disadvantage of pressure flow system are listed below:

Advantage:

- Installation of conveyance sewer with earth covering depth of about 1 m
- Bending in the vertical alignment
- River and canal crossing by bridge with easier maintenance
- Unnecessary of inflow pump at treatment plant

Disadvantage:

- Requirement of additional pipe with same diameter running parallel for maintenance and emergency
- More frequent maintenance required for sediment removal
- No experience of large scale pressure flow sewer system in Japan

The construction costs of both gravity and pressure flow systems are estimated at same amount of VND 447 billion. While the annual O/M costs of both systems are estimated at VND 18.9 billion for gravity system and at VND 19.5 billion for pressure system.

8.6.2 Proposed Plan

Alternative route B of gravity flow is recommended as the optimum conveyance sewer from the following reasons:

- No significant difference of their construction costs between gravity flow and pressure flow
- Gravity flow is more economical than pressure flow in O/M cost
- Gravity flow has higher reliability in operation than pressure flow

Proposed alignment and longitudinal profile of conveyance sewer are shown in

Fig. 8.31and 8.32 and its main features are shown below.

Main Features

Total Length	: 5,400 m (including canal crossing)		
Interceptor Diameter	: φ 2,000 mm ~ φ 2,500mm		
Earth Covering Depth	: 1.2m ~8.6m		
Construction Method	: Open Cut Method (3,850m)		
	Shield Tunneling Method (1,500m)		
	Pipe Jacking Method (50m)		
River/Canal Crossing (1)	: Canal Name	: unknown	
	Length	: 50m	
	Construction Method	: Pipe Jacking	
	System	: Gravity with φ 2,500mm x 1 line	
(2)	: Canal Name	: Tac Ben Ra	
	Length	: 100m	
	Construction Method	: Shield Tunneling	
	System	: Gravity with φ 2,500mm x 1 line	

8.7 Intermediate Sewage Pumping Station

Sewage intermediate pumping station is proposed at Ward 4 in District 8. The area of about 0.6 ha is located in the swampy area enclosed by Dong Dien road and Ong Nho canal.

Design capacity of intermediate sewage pumping station is 640,000 m^3/day (445.0 m^3/min.). Five (5) units of axial flow vertical type pump with a design capacity of 133.3 m^3/min./unit (2 units) and 105.0 m^3/min./unit (3 units) are installed. Grit chamber and screen are proposed after the pumping up.

The proposed location and layout of intermediate sewage pumping station is shown in Fig. 8.33 and Fig. 8.34.

8.8 Wastewater and Sludge Treatment Plant

8.8.1 Introduction

Modified activated sludge treatment plant will be constructed at the swampy area in Phuoc Loc ward in District Nha Be. The proposed treatment site is enclosed by Cay kho canal to the east and Go Nai river to the west. The existing land elevation of this area ranges from +0.3 m to +1.3 m above mean sea level. The soil condition of the top layer of this treatment plant site is rather soft. The base layer is not found until a depth of 30 meters from ground surface.

The treatment plant will treat daily average dry weather discharge plus ground water infiltration. The design flow of 469,000 m^3/day consisting wastewater of 426,500 m^3/day and ground water of 42,500 m^3/day is applied as dry weather flow in 2010. Design influent and effluent water qualities are 180 mg/l and 50 mg/l in terms of BOD_5 respectively.

8.8.2 Preliminary Design

The proposed wastewater treatment plant includes inflow pumping station, primary sedimentation basin, aeration tank, secondary sedimentation basin and disinfection tank. Sludge treatment plant consists of gravity thickener, centrifugal thickener, belt filter press and composting.

The proposed layout of wastewater and sludge treatment plant is shown in Fig. 8.35.

(1) Inflow Pumping Station

A pump station with a capacity of 445 m^3/min. will be installed by the year 2010. Additional pump with a total capacity of 40 m^3/min. will further be provided by 2020. 5 units including one stand-by of axial flow vertical pump with a hydraulic head of 20 m will be installed.

(2) Primary Sedimentation Basin

Rectangular type primary sedimentation basin of 48 units will be constructed with an effective depth of 3.75 m. Dimension of one basin is 7 m width, 51 m length and 4.5 m depth. One unit of flight chain type sludge collector will be installed in each basin. 36 units of sludge drawing pump including 12 units of stand-by with 15 m hydraulic head will be installed.

Hydraulic detention time is 3.75 hours with an overflow rate of 27.4 m^3/m^2/day. Proposed primary sedimentation basin is shown in Fig. 8.36.

(3) Aeration Tank

Rectangular type aeration tank of 48 units will be installed with an effective depth of 5 m. Dimension of one (1) unit of tank is 7 m width, 63 m length and 6 m depth. 5 units of blower including 1 stand-by with 6.3 mAq x 800 kw will be installed. Hydraulic detention time is 6.2 hours with sludge recirculation ratio of 54 %. Diffused type aeration will be installed. Proposed aeration tank is shown in Fig. 8.37.

(4) Secondary Sedimentation Basin

Rectangular type secondary sedimentation basin of 48 units with an effective depth of 4.5 m will be installed. Dimension of one (1) unit of basin is 7 m width, 76.5 m length and 5.25 m depth. One (1) unit of flight chain type sludge collector will be installed in each basin. Sludge drawing pump of 36 units including 12 units stand-by with hydraulic head of 10 m will be installed. Hydraulic detention time is 6.75 hours with an overflow rate of 18.2 m^3/m^2/day. Proposed primary sedimentation basin is shown in Fig. 8.38.

(5) Disinfection Tank

Salient features of disinfection tank are as follows:

Effective depth: 4 m
Dimension of tank : 25 m (W) x 67 m (L) x 4.5 m (D)

Hydraulic detention time is 18.8 minutes. Chlorine injection rate of 3 mg/l is proposed.

(6) Gravity Thickener

Gravity thickener for primary sludge treatment consists of storage tank and thickener. Salient feature of storage tank and thickener are as follows:

Storage tank	: 5m (W) x 5 m (L) x 3.5 m (D)
	: Agitator of 5.5 kw capacity will be installed.
Thickener	: 24 m (ϕ) x 4 m (H) x 2 units

Proposed gravity thickener is shown in Fig. 8.39.

(7) Centrifugal Thickener

Decanter type centrifugal thickener with a capacity of 1,067 kg/hr/unit is proposed. Four (4) units including one (1) unit will be installed to treat secondary sludge. Proposed layout of centrifugal thickener is shown in Fig. 8.40.

(8) Sludge Dewatering

Belt filter press of 17 units including one (1) stand-by with a capacity of 157 m^3/day/unit will be installed. Thickened both primary and secondary sludge will be dewatered from 4 % to 20 % of solid concentration. The proposed layout is shown in Fig. 8.40.

(9) Composting

In this project, land disposal is proposed as the ultimate disposal of sludge, thus it is necessary to stabilize the sludge before disposal so as to reduce pathogens and odor.

EPA established criteria for the use of processed sludge on agricultural land. After the sludge is treated by the treatment process to significantly reduce pathogens it can be applied to the agricultural land. The composting process is included in the category of the treatment process to significant reduce pathogens, hence is proposed as an appropriate process for applying sludge of domestic wastewater to the agricultural land.

Proposed composting process consists of (1) preconditioning and (2) fermentation.

8.9 Sewerage Collection System Development

The right bank area of Doi – Te canal is proposed to be developed by separate sewer system as mention above. Hence secondary/tertiary and main sanitary sewers will be installed in this area. The area consists of 3 sub-zones, which are Rach Ong, Pham The Hien and Binh Dang areas and the total amounts to 537 ha (refer to Fig, 8.18).

The interceptors planned for the area isolated by Tau Hu – Ben Nghe and Doi – Te Canal are proposed to be installed along the roads in the 3 sub-zones. Consequently, the main sanitary sewers for these sub-zones will be connected to the interceptor running along the canal.

The total length of the secondary/tertiary and the main sanitary sewers are 26 km and 35 km, respectively. The pipe diameter ranges from ϕ 300 mm to ϕ 600 mm and the main features of the new drainage pipe by each sub-zone are presented in the table below.

Sewer	Diameter (mm)	Rach Ong (133 ha)	Pham The Hien (196 ha)	Binh Dang (208 ha)	Total
Secondary /Tertiary	300	6,384	9,398	9,984	25,766
Main	300	7,161	18,747	5,289	31,197
	400	782	287	920	1,989
	500	995	-	647	1,642
	600	-	-	250	250
Total		15,322	28,432	17,090	60,844
No. of House Connection		67,480	42,796	41,562	151,838
No. of Manhole		279	388	391	1,058

8.10 Implementation Program of Priority Project for Sewerage Development

8.10.1 Project Phasing

The total project cost for the Priority Project of Sewerage Development for Tau Hu, Ben Nghe – Doi, Te Basin is estimated at 4,490.5 VND billion as shown in Appendix J. From the budgetary constraints, the Priority Project should be divided into two (2) phases.

8.10.2 Selection of the Priority Area

Sewerage development area is proposed to divide into 24 sub-zones. And 24 sub-zones are classified into four (4) integrated zones from their wastewater collection system. Eastern part of left bank of Ben Nghe canal consists of 10 sub-zones of No. 1,2,3,4,5,6,7,8,9 and 10. And Western part of left bank of Tau Hu canal consists of six (6) sub-zones of No. 11,12,13,14,15 and 16. Isolated area by both canals of Tau Hu, Ben Nghe and Doi, Te consists of five (5) sub-zones of Khanh Hoi, Ong Kieu, Hung Phu, Tung Thien Vuong and Binh. And Southern part of Doi, Te canals consists of three (3) sub-zones of Rach Ong, Pham The Hien and Binh Dang. Delineation of sewerage sub-zones into four (4) integrated zones are shown in Fig. F.8.41.

Priority sequences for implementation of the priority sewerage development are determined based on the aspects of demand/benefits and constraints of the respective zones.

Demand/benefits consists of population density, public land use and pollution load generation. Constraints consist of affordability of sewerage development and existing combined sewer coverage rate.

These five (5) items are evaluated for the respective zones. Integrated evaluation is obtained assigning marks ranging from 1 to 5 on each item summing up the given marks.

The highest priority is given to Eastern part and Western part of left bank area of Tau Hu, Ben Nghe canal, followed by Isolated zone and Southern part of Doi, Te canal.

While, Western part of left bank area of Tau Hu canal has only one (1) potential route of Tran Van Kieu and Ben Ham Tu roads along Tau Hu canal for interceptor sewer installation. These Tran Van Kieu and Ben Ham Tu roads will be expanded by the canal side roads expansion project after the relocation program along canals will be completed. Then, interceptor sewer of Western part of left bank area of Tau Hu canal should be constructed simultaneous with the canal side road expansion project. While the interceptor sewer for Eastern part of left bank area of Tau Hu, Ben Nghe canal can be constructed independently without any affection by other projects schedule. From this point of view, Eastern part of left bank area of Ben Nghe canal is selected as the Phase I Project area.

8.11 Selection of Appropriate Wastewater Treatment Process for The Phase I Project

8.11.1 General

In the Interim Report, JICA Study Team has conducted detailed comparison of various wastewater treatment processes for the Priority Project with the target year of 2020 and has proposed conventional activated sludge process as the most appropriate wastewater treatment process. The Priority Project is proposed to be implemented in two (2) phases. The Phase I with the target year of 2005 will improve the environmental condition of THBNDT zone immediately. Design conditions of Phase I Project are different from that of those studied at Master Plan Stage and about 50 ha of land is available for treatment plant. Hence, options for treatment process are reviewed again but keeping in mind that process chosen at Phase I could be smoothly switched to conventional activated sludge process proposed for the year of 2020.

8.11.2 Optimum Wastewater Treatment Process

The design conditions for Phase I Project are described below comparing with the ultimate design condition:

Item	Phase I Project	Priority Project (2020)
Population Served	425,830	1,390,282
Design flow	141,000 m^3/d	512,000 m^3/d
Influent quality	BOD_5 = 180 mg/l	BOD_5 = 180 – 250 mg/l
Design effluent quality	BOD_5 = 50 mg/l	BOD_5 = 20 mg/l

With due consideration to the hot weather of Ho Chi Minh City and scale of treatment plant required, processes which satisfy the above mentioned criteria are selected for evaluation and mentioned below.

- Stabilization pond
- Aerated lagoon
- Primary sedimentation + Stabilization pond
- Modified activated sludge

The above-mentioned four (4) alternatives are evaluated under the following criteria:

- Construction cost/Removal BOD_5
- Facility maintenance

- Operation technology
- Maintenance cost
- Required area
- Excess sludge generation
- Adaptability to variation in quality and quantity of inflow
- Effluent quality
- Environmental aspects
- Initial performance
- Smoothness of switching to conventional activated sludge process with bigger capacity in the Final Stage

Pond processes are more economical compared with modified activated sludge process. It is not easy to convert pond process to conventional activated sludge process, which means dual investment will be necessary. Pond processes have quite often smell problem. Furthermore in case of process failure, pond processes need 2-3 months to recover with comparison to 2 weeks for modified activated sludge process.

Modified activated sludge process which has cost efficiency to BOD_5 removal quite close to pond processes, high tolerance to variation of inflow quality and quantity, easy convertibility to Final Stage Process and effluent conforming to Vietnamese standards, is recommended for the Phase I Project.

Proposed interceptor sewer and conveyance sewer in Phase I Project are shown in Fig. 8.42. And proposed layout of wastewater and sludge treatment plant is shown in Fig. 8.43.

TABLE 8.1 PROPOSED LONGITUDINAL PROFILE OF TAU HU - BEN NGHE CANAL

Station	Distance (m)	Accumu-late Distance (m)	Existing			Design		
			Bed Elevation EL1 (m)	Left Bank Elevation EL2 (m)	Right Bank Elevation EL3 (m)	Canal Bed Elevation EL4 (m)	High Water Level EL5 (m)	Dike Crown Elevation EL6(m)
No.0	0	0				-3.45	1.32	
No.1	60	60	-2.55	2.07	1.53	-3.45	1.32	2.00
No.2	120	180	-2.72	2.69	1.61	-3.44	1.32	2.00
No.3	215	395	-2.51	2.19	2.49	-3.43	1.33	2.00
No.4	220	615	-2.21	1.93	2.03	-3.42	1.34	2.00
No.5	185	800	-2.01	2.15	2.00	-3.41	1.34	2.00
No.6	180	980	-2.36	1.83	1.85	-3.40	1.34	2.00
No.7	200	1,180	-2.12	2.10	1.74	-3.39	1.35	2.00
No.8	190	1,370	-1.99	1.97	1.85	-3.38	1.35	2.00
No.9	195	1,565	-2.02	1.72	2.09	-3.37	1.36	2.00
No.10	180	1,745	-2.06	2.04	2.89	-3.36	1.36	2.00
No.11	220	1,965	-1.82	2.10	1.83	-3.35	1.37	2.00
No.12	205	2,170	-2.09	2.97	2.13	-3.34	1.37	2.00
No.13	180	2,350	-2.33	2.14	2.02	-3.33	1.38	2.00
No.14	195	2,545	-2.26	1.73	1.89	-3.32	1.38	2.00
No.15	190	2,735	-2.55	1.77	1.57	-3.31	1.39	2.00
No.16+40	265	3,000	-3.53	2.14	1.88	-3.30	1.40	2.00
No.17	140	3,140	-7.87	1.90	1.83	-3.39	1.40	2.00
No.18	90	3,230	-10.50	1.99	1.86	-3.45	1.40	2.00
No.19+45	90	3,320	-2.98	1.98	1.57	-3.50	1.40	2.00
No.20	250	3,570	-2.93	2.34	1.63	-3.49	1.41	2.00
No.21	225	3,795	-2.66	2.10	1.63	-3.48	1.41	2.00
No.22	195	3,990	-2.84	2.06	1.48	-3.47	1.42	2.00
No.23	175	4,165	-2.75	2.37	1.44	-3.46	1.42	2.00
No.24	205	4,370	-2.69	1.97	1.40	-3.45	1.43	2.00
No.25	170	4,540	-2.74	2.15	1.67	-3.44	1.43	2.00
No.26	210	4,750	-1.91	2.32	1.65	-3.43	1.44	2.00
No.27	190	4,940	-2.03	1.67	1.66	-3.42	1.44	2.00
No.28	195	5,135	-1.73	1.24	1.44	-3.41	1.45	2.00
No.29	190	5,325	-1.71	1.44	1.41	-3.40	1.45	2.00
No.30	190	5,515	-1.40	2.09	1.75	-3.39	1.46	2.00
No.31	180	5,695	-1.58	1.98	1.79	-3.38	1.46	2.00
No.32	185	5,880	-1.71	1.75	1.49	-3.37	1.47	2.00
No.33	200	6,080	-1.85	1.77	1.89	-3.36	1.47	2.00
No.34	85	6,165	-1.52	2.94	2.40	-3.36	1.47	2.00
No.35	110	6,275	-1.50	2.14	1.99	-3.35	1.48	2.00
No.36	245	6,520	-1.49	2.05	1.84	-3.34	1.48	2.00
No.37	185	6,705	-1.63	2.50	1.77	-3.33	1.49	2.00
No.38	195	6,900	-1.63	1.86	1.94	-3.32	1.49	2.00
No.39	145	7,045	-1.71	1.79	1.75	-3.32	1.50	2.00
No.40	110	7,155	-1.84	2.13	1.78	-3.31	1.50	2.00
No.41+90	205	7,360	-2.07	1.73	1.95	-3.30	1.50	2.00
No.41+90	0	7,360	-2.07	1.73	1.95	-4.54	1.50	2.00
No.42	100	7,460	-2.69	1.86	1.79	-4.54	1.51	2.00
No.43	200	7,660	-3.16	1.81	1.78	-4.53	1.51	2.00
No.44	190	7,850	-2.81	1.54	1.64	-4.52	1.52	2.00
No.45	210	8,060	-3.27	1.66	1.31	-4.51	1.52	2.00
No.46	200	8,260	-2.72	1.62	1.55	-4.50	1.53	2.00
No.47	230	8,490	-3.25	1.46	1.45	-4.48	1.53	2.00
No.48	170	8,660	-3.69	1.41	1.34	-4.48	1.54	2.00
No.49	175	8,835	-3.76	1.37	1.47	-4.47	1.54	2.00
No.50	95	8,930	-3.81	1.62	1.47	-4.46	1.54	2.00
No.51	100	9,030	-3.08	1.49	1.40	-4.46	1.55	2.00
No.52	100	9,130	-3.02	1.45	1.49	-4.45	1.55	2.00
No.53	100	9,230	-3.00	1.55	1.43	-4.45	1.55	2.00
No.54	105	9,335	-2.97	1.41	1.63	-4.44	1.55	2.00
No.55	100	9,435	-2.84	1.27	1.53	-4.44	1.56	2.00
No.56	235	9,670	-1.84	1.40	1.14	-4.43	1.56	2.00
No.57	205	9,875	-1.93	1.58	0.95	-4.41	1.57	2.00
No.58	205	10,080	-1.79	1.37	1.17	-4.40	1.57	2.00
No.59	220	10,300	-2.06	1.20	1.16	-4.39	1.58	2.00
No.60	180	10,480	-2.37	1.44	1.12	-4.38	1.58	2.00
No.61	220	10,700	-3.60	1.35	0.70	-4.37	1.59	2.00
No.62	190	10,890	-3.62	1.02	1.10	-4.36	1.59	2.00
No.63	180	11,070	-3.96	1.28	1.06	-4.36	1.60	2.00
No.64	210	11,280	-2.97	0.92	0.86	-4.34	1.60	2.00
No.65	190	11,470	-3.66	1.4	0.97	-4.34	1.61	2.00
No.66	250	11,720	-2.9	1.19	1.17	-4.32	1.61	2.00
No.67	180	11,900	-3.56	1.17	0.92	-4.31	1.62	2.00
No.68	190	12,090	-3.98	1.38	1.61	-4.30	1.62	2.00
No.69	80	12,170				-4.30	1.62	2.00

TABLE 8.2 DESIGN CROSS SECTION OF TAU HU-BEN NGHE CANAL

Name of Canal	Section		Length (L) (m)	Bed Elevation (m above MSL)		Dike Elevation (m above MSL)		Type of Cross Section	Canal Width (m)						Bank Slope		Depth	
	Start	End		Start	End	Start	End		Bottom (B1)	Middle (B2)	Top (B3)	O/M Road (B4) Left	O/M Road (B4) Right	Total (B5)	Left (S1)	Right (S2)	Start (H1) (m)	End (H2) (m)
Ben Nghe	No.0	No.2 + 20	200	-3.45	-3.44	2.00	2.00	Existing	21.0	70.0 - 100.0	90.0 - 120.0	None	None	90.0 - 120.0	1 : 3	1 : 3	5.45	5.44
	No.2 + 20	No.2 + 110	90	-3.44	-3.44	2.00	2.00	A1	21.0	58.0 - 78.0	70.0 - 90.0	5.0	5.0	80.0 - 100.0	1 : 1.5	1 : 1.5	5.44	5.44
	No.2 + 110	No.5 +40	550	-3.44	-3.41	2.00	2.00	A1	21.0	58.0	70.0	5.0	5.0	80.0	1 : 1.5	1 : 1.5	5.44	5.41
	No.5 + 40	No.5 + 140	100	-3.41	-3.40	2.00	2.00	A1	21.0	48.0 - 58.0	60.0 - 70.0	5.0	5.0	70.0 - 80.0	1 : 1.5	1 : 1.5	5.41	5.40
	No.5 + 140	No.15 + 105	1,900	-3.40	-3.31	2.00	2.00	A1	21.0	48.0	60.0	5.0	5.0	70.0	1 : 1.5	1 : 1.5	5.40	5.31
	No.15 + 105	No.16 + 40	160	-3.31	-3.30	2.00	2.00	A1	21.0	48.0 - 72.5	60.0 - 84.5	5.0	5.0	70.0 - 94.5	1 : 1.5	1 : 1.5	5.31	5.30
	No.16 + 40	No.17	140	-3.30	-3.48	2.00	2.00	A2	21 - 35	56.0 - 72.5	84.5 - 100.0	5.0	None	89.5 - 105.0	1 : 1.5	Existing	5.30	5.48
Tau Hu (Down-stream)	No.17	No.19 - 45	180	-3.48	-3.48	2.00	2.00	A2	21 - 30	38.0 - 54.0	50.0 - 96.0	5.0	None	55.0 - 101.0	1 : 1.5	Existing	5.48	5.48
	No.19 - 45	No.21 - 40	435	-3.48	-3.45	2.00	2.00	A1	21.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	5.48	5.45
	No.21 - 40	No.21 + 90	130	-3.45	-3.45	2.00	2.00	C1	21.0	40.0 - 50.0	40.0 - 50.0	5.0	5.0	50.0 - 60.0	Vertical	Vertical	5.45	5.45
	No.21 + 90	No.23 + 30	310	-3.45	-3.43	2.00	2.00	C1	21.0	40.0	40.0	5.0	5.0	50.0	Vertical	Vertical	5.45	5.43
	No.23 + 30	No.24 - 90	85	-3.43	-3.43	2.00	2.00	C1	21.0	40.0 - 50.0	40.0 - 50.0	5.0	5.0	50.0 - 60.0	Vertical	Vertical	5.43	5.43
	No.24 - 90	No.24 + 50	140	-3.43	-3.43	2.00	2.00	A1	21.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	5.43	5.43
	No.24 + 50	No.25 + 100	220	-3.43	-3.42	2.00	2.00	A4	21.0	44.0	50.0	5.0	5.0	60.0	1 : 1.5	Vertical	5.43	5.42
	No.25 + 100	No.26 + 10	120	-3.42	-3.42	2.00	2.00	A1	21.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	5.42	5.42
	No.26 + 10	No.27 - 15	165	-3.42	-3.41	2.00	2.00	A1	21.0	38.0 - 48.0	50.0 - 60.0	5.0	5.0	60.0 - 70.0	1 : 1.5	1 : 1.5	5.42	5.41
	No.27 - 15	No.29 + 70	470	-3.41	-3.38	2.00	2.00	A1	21.0	48.0	60.0	5.0	5.0	70.0	1 : 1.5	1 : 1.5	5.41	5.38
	No.29 + 70	No.30 + 10	130	-3.38	-3.38	2.00	2.00	A1	21.0	38.0 - 48.0	50.0 - 60.0	5.0	5.0	60.0 - 70.0	1 : 1.5	1 : 1.5	5.38	5.38
	No.30 + 10	No. 32	355	-3.38	-3.37	2.00	2.00	A1	21.0	48.0	60.0	5.0	5.0	70.0	1 : 1.5	1 : 1.5	5.38	5.37
	No.32	No.33 + 75	275	-3.37	-3.36	2.00	2.00	A3	21.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	5.37	5.36
	No.33 + 75	No.38	745	-3.36	-3.32	2.00	2.00	B1	21.0	41.0	45.0	5.0	5.0	55.0	1 : 0.5	1 : 0.5	5.36	5.32
	No.38	No.41 + 90	460	-3.32	-3.30	2.00	2.00	B2	21.0	37.0	45.0	5.0	5.0	55.0	1 : 0.5	1 : 1.5	5.32	5.30
Tau Hu (Upstream)	No.41 + 90	No.44 + 80	570	-4.54	-4.51	2.00	2.00	A4	22.0	44.0	50.0	5.0	5.0	60.0	1 : 1.5	Vertical	6.54	6.51
	No.44 + 80	No.44 + 110	30	-4.51	-4.51	2.00	2.00	B3	22.0	43.0 - 44.0	45.0 - 50.0	5.0	5.0	55.0 - 60.0	1 : 0.5	Vertical	6.51	6.51
	No.44 + 110	No.47 + 35	565	-4.51	-4.48	2.00	2.00	B3	22.0	43.0	45.0	5.0	5.0	55.0	1 : 0.5	Vertical	6.51	6.48
	No.47 + 35	No.56 -110	1,035	-4.48	-4.43	2.00	2.00	A2	22.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	6.48	6.43
	No.56 - 110	No.60 + 30	950	-4.43	-4.38	2.00	2.00	A1	22.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	6.43	6.38
	No.60 + 30	No.68 + 80	1,660	-4.38	-4.30	2.00	2.00	A1	22.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	6.38	6.30
Ngang No.1	No.1	No.1 + 80	80	-4.54	-4.54	2.00	2.00	A1	22.0	41.0	45.0	5.0	5.0	55.0	1 : 0.5	1 : 0.5	6.54	6.54
	No.1 +80	No.2 - 40	20	-4.54	-4.54	2.00	2.00	A1	22.0	41.0 - 48.0	45.0 - 60.0	5.0	5.0	55.0 - 70.0	1 : 1.5	1 : 1.5	6.54	6.54
	No.2 - 40	No.4 + 15	290	-4.54	-4.54	2.00	2.00	A1	22.0	48.0	60.0	5.0	5.0	70.0	1 : 1.5	1 : 1.5	6.54	6.54
Ngang No.2	No.1	No.4 + 20	420	-4.48	-4.38	2.00	2.00	Existing	22.0	39.0	45.0	5.0	5.0	55.0	1 : 1.5	1 : 1.5	6.48	6.38
Ngang No.3	No.1 - 10	No.2	120	-4.38	-4.38	2.00	2.00	A1	22.0	38.0	50.0	5.0	5.0	60.0	1 : 1.5	1 : 1.5	6.38	6.38
	No.2	No.2 + 20	20	-4.38	-4.38	2.00	2.00	A1	22.0	38.0 - 48.0	50.0 - 60.0	5.0	5.0	60.0 - 70.0	1 : 1.5	1 : 1.5	6.38	6.38
	No.2 + 20	No.4 + 40	260	-4.38	-4.38	2.00	2.00	A1	22.0	48.0	60.0	5.0	5.0	70.0	1 : 1.5	1 : 1.5	6.38	6.38

TABLE 8.3 RESULTS OF HYDRODYNAMIC SIMULATION : EXISTING CONDITION

Canal	ID	From Mouth (km)	A -Q (m3/s)	A +Q (m3/s)	A W.L. (EL.m)	2A -Q (m3/s)	2A +Q (m3/s)	2A W.L. (EL.m)	2B -Q (m3/s)	2B +Q (m3/s)	2B W.L. (EL.m)	C -Q (m3/s)	C +Q (m3/s)	C W.L. (EL.m)
Tau Hu	T1	12.175	-32	1	1.73	-31	12	1.66	-33	12	1.72	-37	12	1.50
	T2	11.120	-26	2	1.74	-28	7	1.68	-25	7	1.73	-27	7	1.50
	T3	9.935	-86	1	1.82	-86	5	1.76	-84	5	1.80	-83	5	1.57
	T4	8.930		111	1.83	-32	110	1.76	-32	114	1.80	-32	117	1.58
	T5	7.930	-5	40	1.69	-16	39	1.62	-16	44	1.66	-16	43	1.47
	T6	6.650	-40	10	1.72	-41	14	1.63	-40	13	1.71	-40	13	1.51
	T7	6.260	-14	16	1.74	-15	19	1.65	-14	18	1.73	-14	13	1.55
	T8	5.155	-5	54	1.71	-24	51	1.61	-24	58	1.70	-24	58	1.52
	T9	3.320	-6	120	1.50	-47	113	1.45	-47	124	1.48	-47	102	1.39
Ben Nghe	B1	3.000	-17	14	1.46	-23	18	1.41	-22	18	1.44	-24	18	1.37
	B2	1.970	-14	22	1.45	-30	24	1.41	-30	28	1.43	-30	26	1.36
	B3	0.940	-13	59	1.39	-40	53	1.36	-40	67	1.37	-40	64	1.34
	B4	0.000	-13	94	1.32	-55	86	1.32	-55	107	1.32	-55	108	1.32
Doi - Te	D1	12.756	-1	3	1.73	-6	5	1.66	-5	6	1.72	-5	6	1.50
	D2	12.450	-1	35	1.73	-22	33	1.66	-22	39	1.72	-22	43	1.50
	D3	11.450	-2	40	1.73	-43	42	1.66	-43	51	1.71	-43	53	1.49
	D4	10.285	-3	108	1.71	-79	101	1.64	-79	124	1.69	-79	128	1.47
	D5	9.270	-4	146	1.69	-98	144	1.62	-97	171	1.66	-98	174	1.46
	D6	8.550	-1	233	1.67	-146	221	1.61	-146	262	1.64	-146	275	1.46
	D7	7.560	-4	317	1.64	-199	299	1.57	-199	356	1.61	-199	377	1.43
	D8	6.040	-4	321	1.56	-230	301	1.50	-230	369	1.53	-230	393	1.41
	D9	4.250	-4	422	1.48	-310	387	1.43	-310	486	1.46	-310	522	1.38
	D10	3.900	-4	438	1.48	-308	403	1.43	-308	501	1.46	-308	550	1.37
	D11	2.055	-4	439	1.37	-362	400	1.35	-361	527	1.36	-361	581	1.34
	D12	0.000	-4	440	1.32	-428	418	1.32	-427	562	1.32	-427	614	1.32
Connecting Canals	N1	0.210	-4	96	1.66	-28	91	1.60	-28	99	1.64	-28	105	1.45
	N2	0.215	-4	92	1.69	-28	92	1.62	-28	94	1.66	-28	98	1.47
	N3	0.215	-4	66	1.73	-10	63	1.67	-10	70	1.72	-10	67	1.49
x J c			1.			1.			1. 7			1.		

Canal	ID	From Mouth (km)	A -Q (m3/s)	A +Q (m3/s)	A W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	4A -Q (m3/s)	4A +Q (m3/s)	4A W.L. (EL.m)	4B -Q (m3/s)	4B +Q (m3/s)	4B W.L. (EL.m)	4C -Q (m3/s)	4C +Q (m3/s)	4C W.L. (EL.m)
Tau Hu	T1	12.175	-47	13	1.45	-51		1.35	-50	19	1.38	-49	19	1.43	-53	19	1.41
	T2	11.120	-39	13	1.49	-43		1.40	-46	17	1.38	-42	17	1.47	-40	17	1.44
	T3	9.935	-89	9	1.61	-89		1.53	-89	12	1.49	-88	12	1.59	-89	12	1.54
	T4	8.930		107	1.63	-10	108	1.56	-19	106	1.52	-19	109	1.61	-19	112	1.56
	T5	7.930		28	1.49	-9	27	1.41	-10	26	1.38	-10	30	1.48	-10	31	1.45
	T6	6.405	-29	9	1.63	-30		1.57	-28	17	1.48	-29	16	1.61	-28	16	1.58
	T7	4.880		57	1.61	-14	57	1.55	-24	53	1.45	-24	60	1.58	-24	65	1.55
	T8	3.320		117	1.41	-11	117	1.34	-39	107	1.34	-41	120	1.38	-40	130	1.35
Ben Nghe	B1	3.000	-36	32	1.39	-56		1.33	-67	49	1.34	-56	49	1.37	-49	49	1.35
	B2	1.520		32	1.39	-29	1	1.35	-62	62	1.34	-62	57	1.36	-62	58	1.33
	B3	0.000		78	1.32	-33	57	1.32	-76	83	1.32	-76	112	1.32	-76	123	1.32
Doi - Te	D1	12.756	-42	112	1.42		135	1.31	-57	142	1.39	-57	130	1.40	-57	133	1.40
	D2	12.450	-65	30	1.45	-84		1.35	-93	36	1.38	-82	37	1.43	-76	37	1.41
	D3	11.450	-65	30	1.47	-84		1.38	-98	41	1.37	-83	42	1.45	-69	42	1.42
	D4	10.285	-11	34	1.47	-45		1.39	-81	58	1.37	-69	58	1.46	-48	58	1.43
	D5	9.270		48	1.47	-36	23	1.39	-84	88	1.37	-70	76	1.46	-70	72	1.44
	D6	8.550		133	1.47	-33	116	1.39	-108	119	1.37	-108	159	1.45	-108	177	1.43
	D7	7.560	-10	223	1.45	-32	206	1.37	-152	173	1.36	-158	237	1.43	-157	280	1.40
	D8	6.040		163	1.42	-73	116	1.35	-221	211	1.35	-221	225	1.40	-221	242	1.37
	D9	4.250	-26	266	1.40	-83	214	1.33	-290	274	1.34	-290	309	1.37	-290	373	1.35
	D10	3.900		303	1.40	-52	271	1.33	-257	237	1.34	-265	312	1.37	-264	389	1.34
	D11	2.055		305	1.34	-225		1.33	-640	599	1.33	-640	617	1.34	-640	658	1.33
	D12	0.000		305	1.32	-225		1.32	-689	632	1.32	-689	650	1.32	-689	691	1.32
Connecting Canals	N1	0.210	-11	97	1.47		97	1.39	-22	90	1.37	-25	100	1.45	-25	108	1.43
	N2	0.215		101	1.48	-3	102	1.40	-20	100	1.37	-25	102	1.46	-24	106	1.44
	N3	0.215		58	1.49	-2	55	1.40	-5	50	1.38	-7	60	1.47	-7	62	1.44
Southern Canals	XC	0.615	-43	67	1.41		100	1.31	-73	119	1.36	-73	100	1.38	-73	66	1.39
	OL	0.550	-178	2	1.39		297	1.30	-365	389	1.33	-344	349	1.35	-344	349	1.33
x J c			1.70			1.			1. 0			1.			1. 2		

TABLE 8.4 RESULTS OF HYDRODYNAMIC SIMULATION : PROPOSED CONDITION

Canal	ID	From Mouth (km)	Maximum Discharges and Water Levels for Different Cases (Closed Canal System without any Southern Canal)														
						B			2A			2B					
			-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)
Tau Hu	T1	12.175	-17	1	1.66	-17	1	1.65	-20	7	1.61	-19	8	1.65	-19	8	1.44
	T2	11.120	-17	1	1.66	-17	1	1.65	-36	14	1.61	-36	17	1.65	-36	17	1.44
	T3	9.935	-77	17	1.67	-77	18	1.65	-82	20	1.61	-76	19	1.66	-68	19	1.44
	T4	8.930		121	1.64		122	1.63	-72	119	1.58	-72	130	1.63	-72	135	1.42
	T5	7.930	-18	85	1.62	-19	91	1.60	-74	81	1.56	-74	97	1.61	-74	102	1.41
	T6	6.650	-24	43	1.60	-9	59	1.58	-55	55	1.54	-55	65	1.59	-55	59	1.41
	T7	6.260	-4	53	1.60	-7	71	1.58	-60	62	1.53	-60	74	1.58	-60	70	1.41
	T8	5.155	-4	91	1.57	-6	111	1.55	-76	86	1.50	-76	108	1.56	-76	112	1.41
	T9	3.320	-6	142	1.47	-6	161	1.47	-101	127	1.42	-101	156	1.45	-101	168	1.37
Ben Nghe	B1	3.000	-6	65	1.42	-6	66	1.42	-98	68	1.38	-98	90	1.41	-98	89	1.36
	B2	1.970	-6	99	1.39	-5	100	1.39	-113	92	1.36	-113	125	1.39	-113	129	1.35
	B3	0.940	-5	137	1.34	-4	138	1.34	-122	124	1.33	-122	164	1.34	-122	175	1.33
	B4	0.000	-5	172	1.32	-4	173	1.32	-137	157	1.32	-137	203	1.32	-137	220	1.32
Doi - Te	D1	12.756	-1	5	1.66	-1	5	1.65	-11	5	1.61	-11	6	1.66	-11	6	1.44
	D2	12.450		18	1.66		18	1.65	-8	16	1.61	-8	18	1.65	-8	17	1.44
	D3	11.450	-1	24	1.66		24	1.65	-33	23	1.61	-33	26	1.65	-33	25	1.44
	D4	10.285	-16	100	1.65	-16	100	1.63	-68	96	1.59	-68	114	1.63	-68	118	1.42
	D5	9.270	-16	139	1.63	-15	139	1.61	-88	133	1.57	-88	159	1.61	-88	164	1.41
	D6	8.550		196	1.62		191	1.60	-122	190	1.56	-122	221	1.60	-122	232	1.41
	D7	7.560	-10	292	1.59	-8	273	1.57	-197	277	1.53	-197	326	1.57	-197	345	1.40
	D8	6.040	-9	294	1.52	-7	275	1.52	-238	278	1.47	-237	338	1.50	-237	362	1.38
	D9	4.250	-13	433	1.45	-12	435	1.45	-379	401	1.40	-378	508	1.43	-377	548	1.36
	D10	3.900	-24	371	1.44	-23	372	1.44	-296	344	1.40	-295	427	1.42	-295	466	1.36
	D11	2.055	-29	372	1.36	-30	374	1.36	-360	342	1.34	-359	449	1.35	-359	499	1.34
	D12	0.000	-36	373	1.32	-34	374	1.32	-424	355	1.32	-423	484	1.32	-423	533	1.32
Connecting Canals	N1	0.210	-19	108	1.61	-17	95	1.59	-42	101	1.55	-42	109	1.59	-42	116	1.40
	N2	0.215	-7	63	1.63	-10	59	1.61	-17	65	1.57	-17	65	1.61	-17	65	1.42
	N3	0.215	-29	79	1.66	-29	79	1.65	-5	75	1.61	-5	80	1.65	-5	81	1.43
			1.69			1.67			1.63			1.67			1.44		

Canal	Location ID	From Mouth (km)	Maximum Discharges and Water Levels for Different Cases (Open Canal System Linked with Southern Canals)														
						B			4A			4B			4C		
			-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)	-Q (m3/s)	+Q (m3/s)	W.L. (EL.m)
Tau Hu	T1	12.175	-61	31	1.46	-78		1.36	-87	41	1.38	-76	41	1.44	-68	41	1.41
	T2	11.120	-54	31	1.47	-70		1.38	-82	45	1.37	-70	46	1.45	-55	46	1.42
	T3	9.935	-98	31	1.48	-100		1.40	-104	42	1.37	-95	42	1.47	-96	42	1.44
	T4	8.938		100	1.48	-24	98	1.40	-68	96	1.37	-68	106	1.47	-68	106	1.44
	T5	7.930		48	1.47	-26	42	1.29	-67	55	1.37	-67	63	1.45	-67	66	1.43
	T6	6.405	-35	29	1.48	-41		1.41	-67	61	1.36	-67	57	1.46	-67	52	1.43
	T7	4.880		56	1.47	-28	50	1.40	-80	73	1.35	-80	79	1.44	-80	83	1.41
	T8	3.320		115	1.40	-27	110	1.34	-93	95	1.34	-93	122	1.37	-93	150	1.35
Ben Nghe	B1	3.000		91	1.39	-79		1.33	-194	191	1.34	-194	175	1.36	-194	175	1.34
	B2	1.520		96	1.36	-79	2	1.33	-208	204	1.33	-208	201	1.34	-208	203	1.33
	B3	0.000		149	1.32	-78	59	1.32	-226	224	1.32	-226	250	1.32	-226	275	1.32
Doi - Te	D1	12.756	-58	114	1.43		143	1.31	-80	156	1.38	-80	137	1.40	-80	129	1.40
	D2	12.450	-53	31	1.46	-64		1.36	-69	39	1.38	-61	40	1.44	-60	40	1.41
	D3	11.450	-53	32	1.46	-64		1.38	-73	45	1.38	-65	45	1.45	-53	45	1.42
	D4	10.285	-2	33	1.47	-39		1.39	-72	65	1.37	-60	63	1.45	-52	63	1.43
	D5	9.270		54	1.47	-32	28	1.39	-79	97	1.37	-79	95	1.45	-79	90	1.43
	D6	8.550		114	1.46	-33	97	1.39	-111	116	1.37	-111	143	1.44	-111	158	1.42
	D7	7.560	-9	219	1.45	-33	203	1.38	-147	166	1.36	-148	229	1.43	-148	277	1.40
	D8	6.040		158	1.42	-78	113	1.37	-239	217	1.35	-239	233	1.40	-239	249	1.37
	D9	4.250	-31	265	1.40	-103	211	1.33	-361	324	1.34	-361	356	1.37	-361	465	1.35
	D10	3.900		231	1.39	-26	265	1.33	-193	211	1.34	-192	265	1.37	-192	271	1.34
	D11	2.055		291	1.34	-212		1.33	-620	567	1.33	-620	584	1.34	-620	621	1.33
	D12	0.000		292	1.32	-213		1.32	-662	596	1.32	-662	617	1.32	-662	654	1.32
Connecting Canals	N1	0.210	-28	113	1.46	-4	113	1.38	-31	100	1.36	-31	112	1.44	-31	120	1.42
	N2	0.215	-3	76	1.47	-8	80	1.39	-17	81	1.37	-17	81	1.45	-17	74	1.43
	N3	0.215	-7	53	1.47	-8	40	1.39	-2	32	1.37	-2	55	1.45	-2	61	1.43
Southern Canals	XC	0.615	-48	65	1.41		98	1.31	-81	121	1.35	-80	103	1.38	-80	71	1.38
	OL	0.550	-204		1.39		296	1.30	-420	411	1.33	-392	399	1.35	-392	399	1.33
Max. W.L. at Junction with Lo Gom (EL. m)			1.51			1.43			1.39			1.50			1.47		

TABLE 8.5 HYDRODYNAMIC SIMULATION RESULTS OF PUMP DRAINAGE SYSTEMS

Model Cases		Drainage Systems				Pump Characteristics				Reservoir Characteristics		
Case	Sub-Case	Name	Category	Area Sub-Drainage (ha)	Area Total (ha)	Capacity (m3/s)	Start Level* (EL. m)	Stop Level** (EL. m)	Operation Time (hr:mm)	Area (m2)	Initial (Low) Water Level (EL. m)	Maximum (High) Water Level (EL. m)
1	1	Thanh Da	Phase I	15.37	15.37	0.35	-0.80	0.80	3:55	4,050	-1.00	0.90
2	2A	Ben Me Coc 1 - East	Phase I	32.57	70.92	0.70	0.00	0.80	3:57	19,000	-0.20	0.83
	2B	Ben Me Coc 1 - East + West	Phase II (including Phase I)	70.92		1.50	-0.80	0.80	4:03	19,000	-1.00	0.95
3	3	Ben Me Coc 2 - North + South	Phase I	45.95	45.95	1.05	-0.80	0.80	4:12	12,375	-1.00	0.85

* : Refers to internal water level at reservoir.
** : Refers to external water level at outlet.

Note :
- For all cases, 5-year rainfall as derived from Mass Curve analysis has been applied.
- For Thanh Da, at the outlets, dynamic water level with crest level of EL. +1.32 m has been applied.
- For Ben Me Coc 1 and 2, at the outlets, dynamic water level with crest level of EL. +1.50 m has been applied.
- Flap gates (non-return valves) have been set up at all the outlets.

TABLE 8.6 (1/2) COMPARISON OF DRAINAGE PUMP TYPE ALTERNATIVES

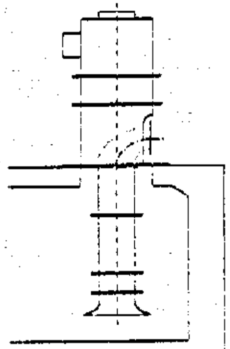
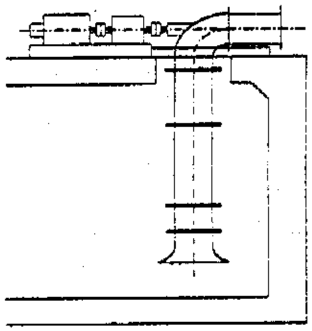
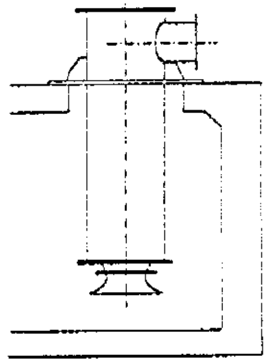
ITEM \ PUMP TYPE	Alternative 1 Vertical Shaft Axial Flow Pump		Alternative 2 Horizontal Shaft Axial Flow Pump		Alternative 3 Submersible Motor Pump	
1. Pump Specifications Main Pump Bore x Capacity x Head Quantity Revolution Efficiency Motor Weight per Unit		Vertical Shaft Axial Flow Pump ϕ 400 x 0.35 [m^3/s] x 3.5 [m] 1 980 [rpm] 80 [%] 18.5 [kW] 2500 [kgf]		Horizontal Shaft Axial Flow Pump ϕ 500 x 0.35 [m^3/s] x 3.5 [m] 1 700[rpm] 81 [%] 18.5 [kW] 1000 [kgf]		Submersible Motor Pump ϕ 400 x 0.35 [m^3/s] x 3.5 [m] 1 970 [rpm] 80 [%] 18.5 [kW] 600 [kgf] (pump & motor)
2. Installation Layout						
3. Other Equipment Discharge Valve Flap Valve Pipe Electrical Equipment Crane Aux. Equipment		1 (ϕ 400 Motor-driven Butterfly) ϕ 500 ϕ 500, ϕ 600 1 Set (Electrical Panels) 1 (Manual, 5 ton) None		1 (ϕ 500 Motor-driven Butterfly) ϕ 600 ϕ 500, ϕ 600 1 Set (Electrical Panels) 1 (Manual, 3 ton) 2 Vacuum Pumps & piping		None ϕ 500 ϕ 400, ϕ 500 1 Set (Electrical Panels) 1 (Manual, 1 ton) None
4. Area of Civil and Superstructure	2	Area of pump room is little smaller than Horizontal shaft model. However, the superstructure is much higher than other types.	3	Pump room is little larger than others' because of the motor installation. The height of the building is less than half of Vertical shaft pump's.	4	Both the area of pump room and the height of superstructure is smallest among three.
5. Weight of Pump Facilities	2	Due to the largest weight of pump itself, the total facility is the heaviest among three.	3	Intermediate weight.	4	Although the pump itself is very light comparing others, civil work weight is little less than others
6. Installation of Equipment	1	The installation requires well trained technicians with special pump installation skills for leveling and shaft alignment.	2	The installation is easier than vertical type. However, it still requires well trained technicians with special pump installation skills for leveling and shaft alignment.	5	The installation is the easiest among those three.
7. Operation	4	Pump can be easily started because impeller is always submerged in the water.	2	Priming by vacuum pump is necessary when the main pump is started. The starting process, however, can be automated to ease the operation complexity.	4	Pump can be easily started because impeller is always submerged in the water.
8. Vibration and Noise	3	Higher vibration and noise are expected than submergible motor pump whose motor is installed under water. The environmental effects are acceptable because the motor is installed on fixed foundation in a closed concrete building while pump is under water.	2	Higher level of vibration and noise are expected than submergible motor pump whose motor is installed under water. The level is acceptable level because both pump and motor are installed on the fixed foundation in a closed concrete building.	5	Vibration and noise are the lowest among three because all main components are placed under water.

TABLE 8.6 (2/2) COMPARISON OF DRAINAGE PUMP TYPE ALTERNATIVES

ITEM \ PUMP TYPE	Alternative 1 Vertical Shaft Axial Flow Pump		Alternative 2 Horizontal Shaft Axial Flow Pump		Alternative 3 Submersible Motor Pump	
9. Daily Maintenance	2	Operating condition is hardly checked directly because most of rotating parts such as pump bearing are submerged in water.	4	Operating condition can be checked directly because all the rotating components, including the motor, are above the water.	2	Operating condition cannot be checked directly because all the components, including the motor, are submerged in water.
10. Overhaul	1	Overhaul is difficult because vertical shaft with some submerged baring requires special skill and well-trained technicians. Lifting up the pump itself is a lot of work.	4	The easiest maintenance ability is expected because both motor and pump is above the water level. Overhaul is easily performed with its horizontal-separate casing structure.	3	Overhaul is easy by lifting up the pump and motor unit.
11. Life Span	4	Longer device life, comparing with submergible pumps, can be expected because the motor unit is free from suction water contact. By employing some anti-erosion and or non-metal materials, the pump life can be enhanced.	5	The longest life among three is expected because both the motor unit and pump itself are always above the suction water level.	2	A long life span cannot be expected. Submergible pumps are generally used for short-time or temporally stations. Leakage may occur because motor unit and pump itself are always in the suction water.
12. Reliability	4	If the periodically check and maintenance are carried out, long life operation and higher reliability are expected.	4	If the periodically check and maintenance are carried out, long life operation and higher reliability are expected.	2	Because of possible leakage into the motor unit due to the temperature changes caused by intermittent operation, it has the lowest reliability.
13. Achievements for the Same Type	5	There are many cases of adoptions in the past for same type of projects.	5	There are many cases of adoptions in the past for same type of projects.	4	Although there are some cases of adoption of submersible motor pump for the long-term or permanent pumping stations, there are no or very few examples of the pumping stations with the large-size submersible motor pump treating seawater contamination.
14. Initial Cost 1) Pump and Mechanical Equipment	2	Most expensive because of the heaviest and the most complicated pump structure.	3	Intermediate. Vacuum pump must be installed in order to prime the main pump when it is started.	5	Lowest price.
2) Electrical Equipment	4	Same as others'	3	Same as others' (Strictly speaking, it costs a couple of percent higher than others because of extra electrical facilities for the priming vacuum pump.)	4	Same as Plan 1.
3) Civil and Superstructure	2	Most expensive. To reserve enough lift for a crane for maintenance, the superstructure is much higher than others'.	3	Intermediate. Due to the motor installation, the superstructure has to be a little larger in longitudinal dimension.	4	Least expensive. Thanks for much lighter weight of pump unit, civil cost is reduced comparing with other pumps.
15. Running Cost	4	Intermediate energy cost.	5	Most efficient in electric energy consumption due to the highest pump efficiency.	4	Same as Plan 1.
16. Maintenance Cost	2	The highest maintenance cost is predicted because there are many consumable parts.	4	The lowest maintenance cost is expected because both motor and pump is above the water level. Overhaul is easily performed with its horizontal-separate casing structure.	3	Intermediate maintenance cost.
17. Evaluation	42	**Not recommended.** Due to the highest initial cost, this type of pomp is not strongly recommended for a project with limited budget.	52	**Not recommended.** With higher reliability, longer life expectancy, and high efficiency in the long run, however initial cost is high including civil cost.	55	**Most Recommended.** Although low reliability and short life expectancy, initial cost is lowest. This type should be considered as the first choice for this project.

TABLE 8.7 MAJOR EQUIPMENT LIST OF PUMPING STATION

Item \ Pumping Station	Thanh Da P.S.		Ben Me Coc (1) (East) P.S.		Ben Me Coc (1) (West) P.S.		Ben Me Coc (2) P.S.	
Pump ①	0.35m3/s×3.5m 400DSZ3(18.5kw)	1	0.35m3/s×3.7m 400DSZ3(18.5kw)	2	0.80m3/s×3.7m 600DSZ3(37kw)	1	0.70m3/s×3.7m 600DSZ3(37kw)	1
Pump ②							0.35m3/s×3.7m 400DSZ3(18.5kw)	1
Flap valve ①	φ500mm	1	φ500mm	2	φ900mm	1	φ750mm	1
Flap valve ②							φ500mm	1
Pipe	φ400mm	1	φ400mm	1	φ750mm	1	φ600mm φ400mm	1 1
Crane	1 ton	1	1 ton	1	2 ton	1	1 ton	1
Panels etc.								
*H.V. incoming panel		1		1		1		1
*H.V. receiving panel		1		1		1		1
*Transformer Panel		1		1		1		1
*L.V. Motor Panel		1		2		1		1
*Aux. Panel		1		1		1		1
*Local Control Panel		1		1		1		1
*Instruments		1		1		1		1
Stop log for discharge pit	W1.4 m x H3.1 m	1	W2.6 m x H3.8 m	1	W2.1 m x H3.8 m	1	W3.6 m x H3.2 m	1
Stop log for suction pit	W1.5 m x H3.1 m	1	W2.6 m x H3.6 m	1	W2.1 m x H3.6 m	1	W3.6 m x H3.2 m W2.0 m x H3.2 m	1 1
Bar screen	W1.5 m x H3.1 m	1	W2.6 m x H3.6 m	1	W2.1 m x H3.6 m	1	W3.6 m x H3.2 m	1
Gate for gravity flow	W1.0 m x H1.0 m W1.2 m x H1.2 m W1.4 m x H1.4 m	1 1 2	W1.5 m x H1.5 m W2.0 m x H2.0 m (W1.4 m x H1.8 m) (W1.2 m x H1.2 m) (W1.3 m x H1.3 m)	1 1 (2) (1) (1)	W1.6 m x H1.6 m W2.0 m x H2.0 m	1 1	W1.3 m x H1.3 m W1.5 m x H1.5 m W1.8 m x H1.8 m	1 1 2
Outdoor space for power receiving panels	W 4.7 m x D 4.7 m	1	W4.7 m x D4.7 m	1	W4.7 m x D4.7 m	1	W4.7 m x D4.7 m	1

Table 8.8 Covered Population and Population Density by 24 Sub-zones

Sub-zone	1997		2010		2020	
	Covered Population	Population Density (person/ha)	Covered Population	Population Density (person/ha)	Covered Population	Population Density (person/ha)
(1) Tan Hu - Ben Nghe Canal Left Bank Area						
1. Sub-zone 1	19,933	151	19,871	150	19,823	150
2. Sub-zone 2	44,971	318	44,688	316	44,470	315
3. Sub-zone 3	12,543	570	12,428	565	12,340	561
4. Sub-zone 4	51,513	707	48,331	663	46,034	631
5. Sub-zone 5	32,333	450	32,041	446	31,820	443
6. Sub-zone 6	38,341	816	36,044	767	34,374	731
7. Sub-zone 7	163,247	703	159,187	686	156,189	673
8. Sub-zone 8	31,366	699	28,425	633	26,355	587
9. Sub-zone 9	25,949	642	25,038	620	24,363	603
10.Sub-zone 10	21,874	923	19,777	834	18,303	772
11.Sub-zone 11	62,892	801	61,771	787	60,936	776
12.Sub-zone 12	10,679	703	9,310	613	8,377	551
13.Sub-zone 13	153,275	553	147,211	531	142,958	516
14.Sub-zone 14	132,401	617	129,482	604	126,901	592
15.Sub-zone 14	88,578	525	89,250	529	89,308	530
16.Sub-zone 14	69,864	629	68,795	619	68,083	613
Sub total	959,759	567	931,649	550	910,634	538
(2) Island Area between Tan Hu - Ben Nghe and Doi - Te Canals						
17.Khanh Hoi	219,217	626	213,228	609	209,134	597
18.Ong Kieu	1,434	372	1,077	279	864	224
19.Hung Phu	67,220	876	59,739	779	54,806	714
20.Tung Thien Vuong	51,588	629	44,295	540	40,847	498
21.Binh Dong	21,369	440	19,952	411	18,926	390
Sub total	360,828	643	338,291	603	324,577	578
(3) Doi - Te Canal Right Bank Area						
22.Rach Ong	68,615	523	67,480	515	66,778	509
23.Pham The Hien	40,361	219	42,796	232	44,768	243
24.Binh Dang	39,140	202	41,562	215	43,525	225
Sub total	148,116	288	151,838	295	155,071	302

Table 8.9 Design Wastewater Discharge of 24 Sub-zones

Sub-zone	Design Wastewater Discharge (m^3/day) (2020)		
	Wastewater	Groundwater	Total
(1) Tau Hu – Ben Nghe Canal Left Bank			
1. Sub-zone 1	9,297	664	9,961
2. Sub-zone 2	20,856	1,490	22,346
3. Sub-zone 3	5,788	413	6,201
4. Sub-zone 4	21,589	1,542	23,131
5. Sub-zone 5	14,924	1,066	15,990
6. Sub-zone 6	16,121	1,152	17,273
7. Sub-zone 7	73,252	5,232	78,484
8. Sub-zone 8	12,361	883	13,244
9. Sub-zone 9	11,427	816	12,243
10. Sub-zone 10	8,585	613	9,198
11. Sub-zone 11	28,580	2,041	30,621
12. Sub-zone 12	3,928	281	4,209
13. Sub-zone 13	67,047	4,789	71,836
14. Sub-zone 14	59,517	4,251	63,768
15. Sub-zone 15	41,885	2,992	44,877
16. Sub-zone 16	31,931	2,281	34,212
Sub Total	427,088	30,506	457,594
(2) Islands between Tau Hu – Ben Nghe and Doi – Te Canals			
17. Khanh Hoi	98,084	7,006	105,090
18. Ong Kieu	405	29	434
19. Hung Phu	25,704	1,836	27,540
20. Tung Thien Vuong	19,158	1,368	20,526
21. Binh Dong	8,876	634	9,510
Sub Total	152,227	10,873	163,100
(3) Doi – Te Canal Right Bank			
22. Rach Ong	31,319	2,237	33,556
23. Pham The Hien	20,996	1,500	22,496
24. Binh Dang	20,413	1,458	21,871
Sub Total	72,728	5,195	77,923
Total	652,043	46,574	698,617

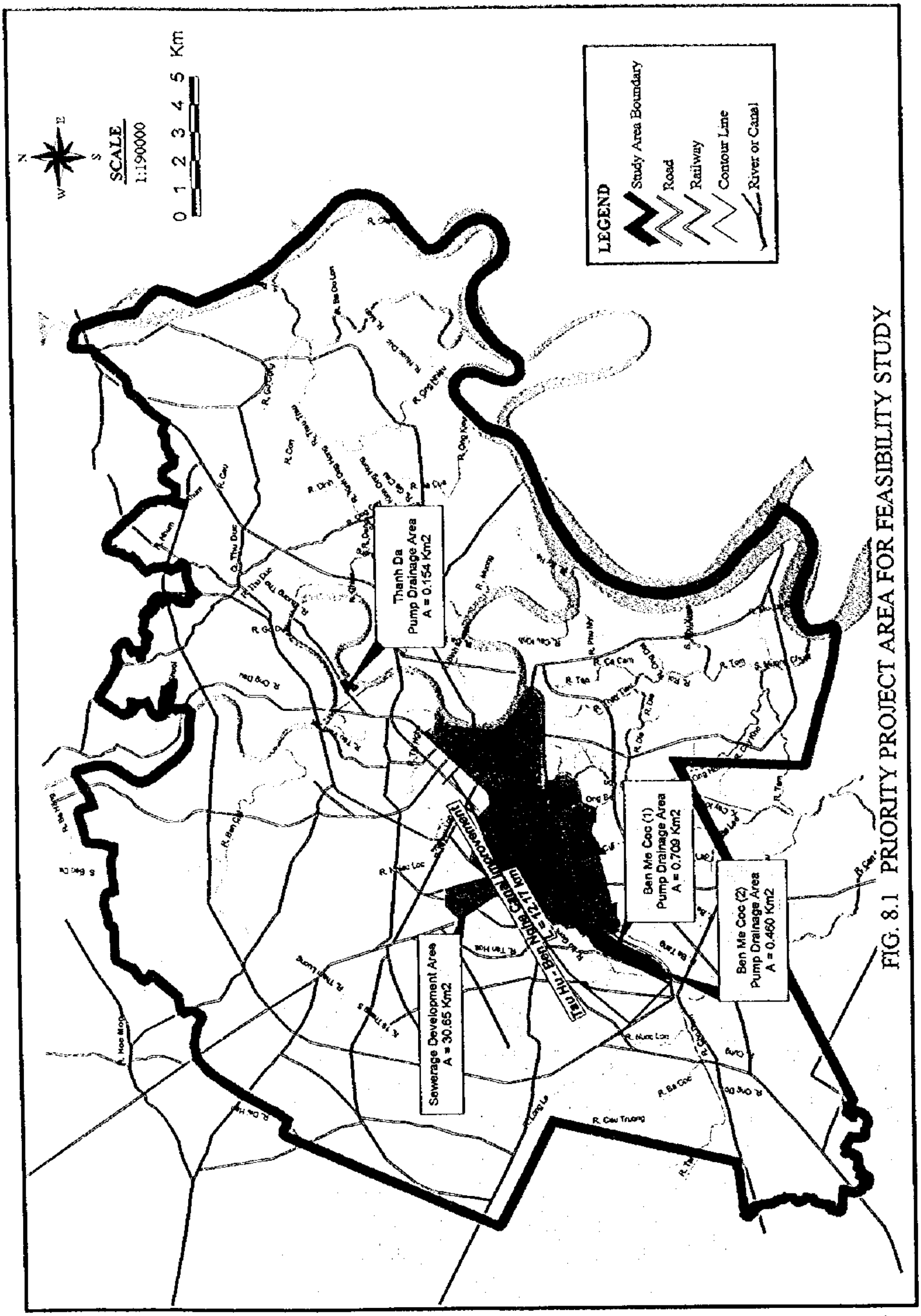


FIG. 8.1 PRIORITY PROJECT AREA FOR FEASIBILITY STUDY

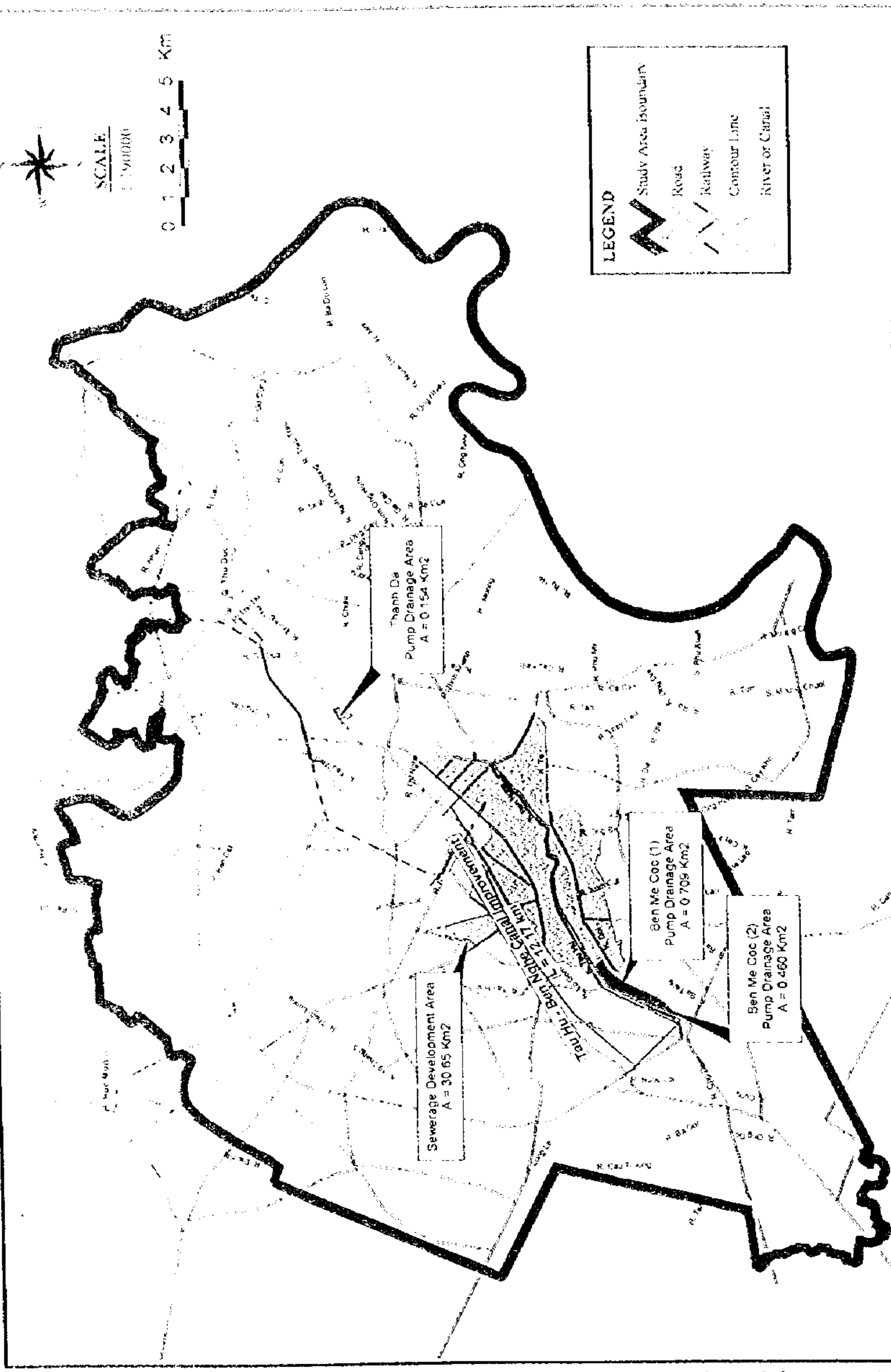


FIG. 8.1 PRIORITY PROJECT AREA FOR FEASIBILITY STUDY

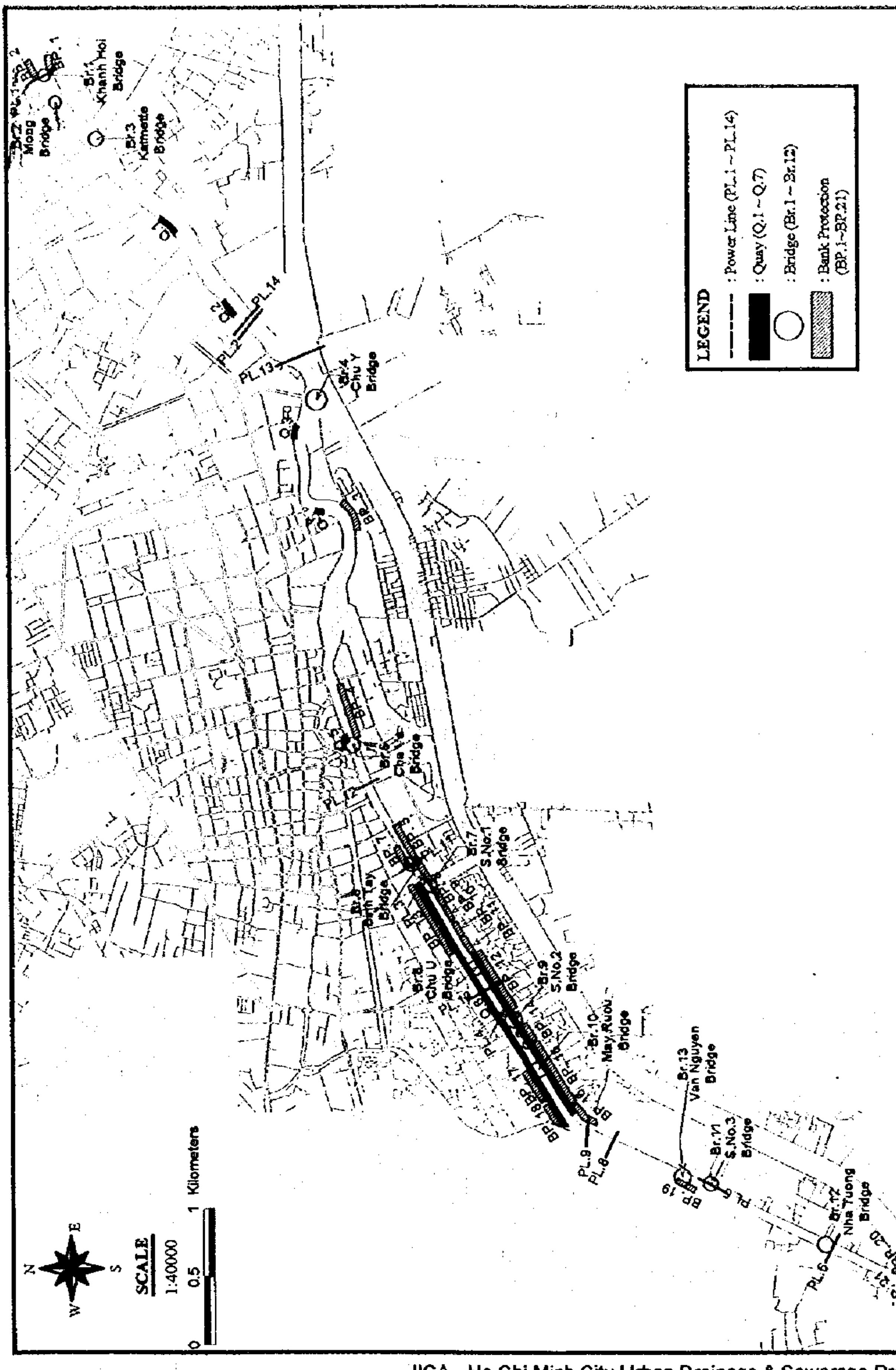


FIG. 8.2 LOCATION OF RELATED STRUCTURES

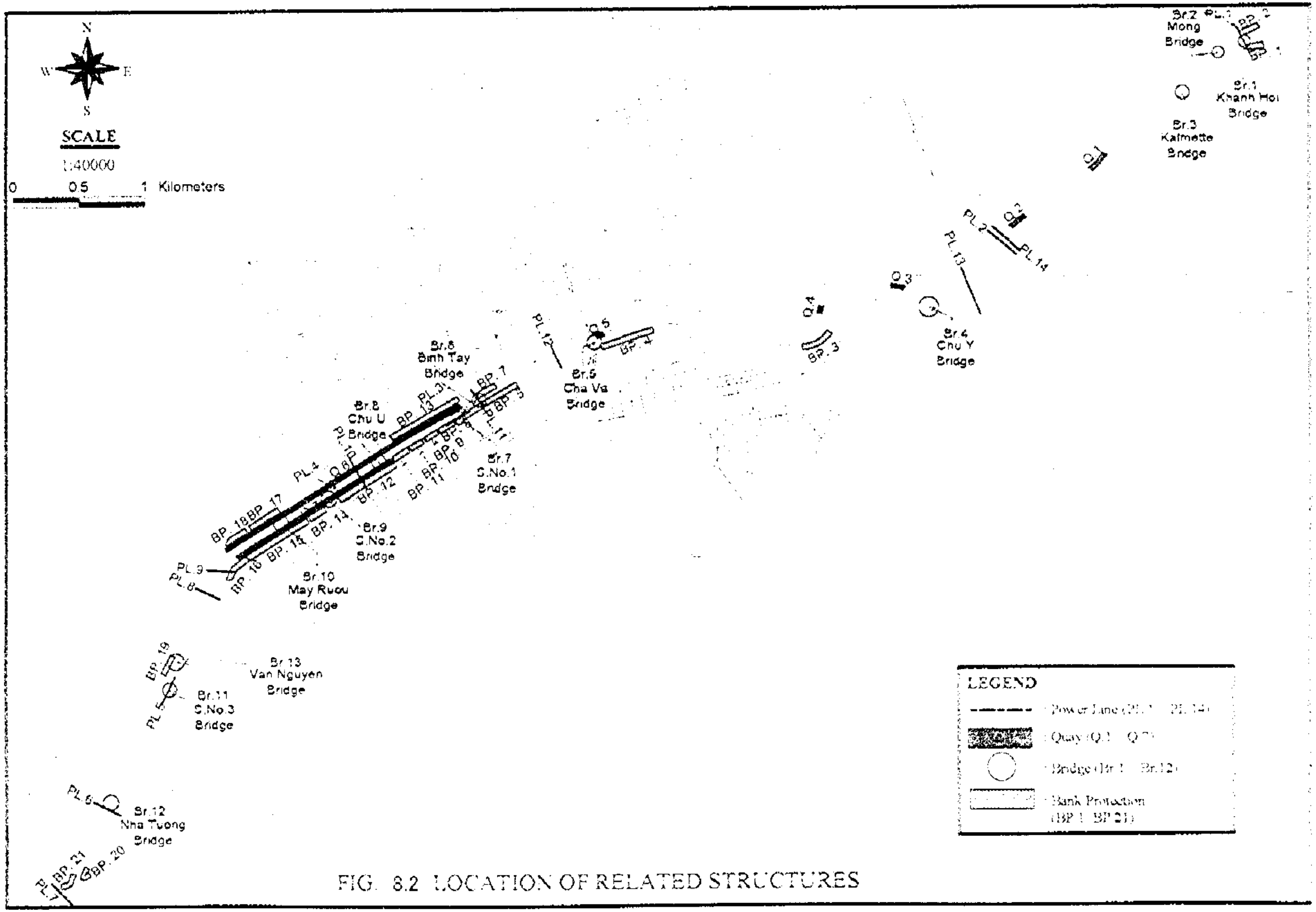


FIG. 8.2 LOCATION OF RELATED STRUCTURES

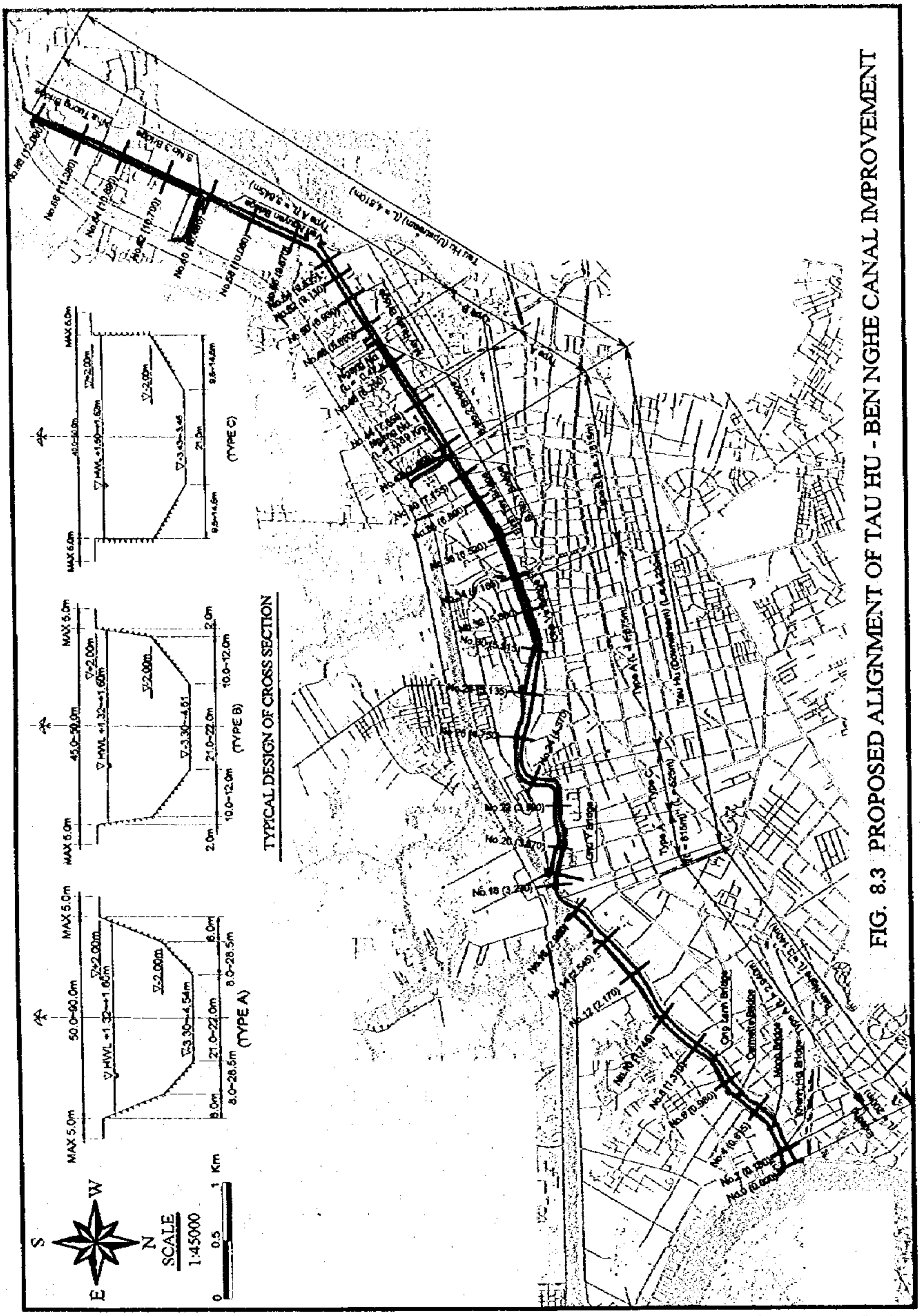


FIG. 8.3 PROPOSED ALIGNMENT OF TAU HU - BEN NGHE CANAL IMPROVEMENT

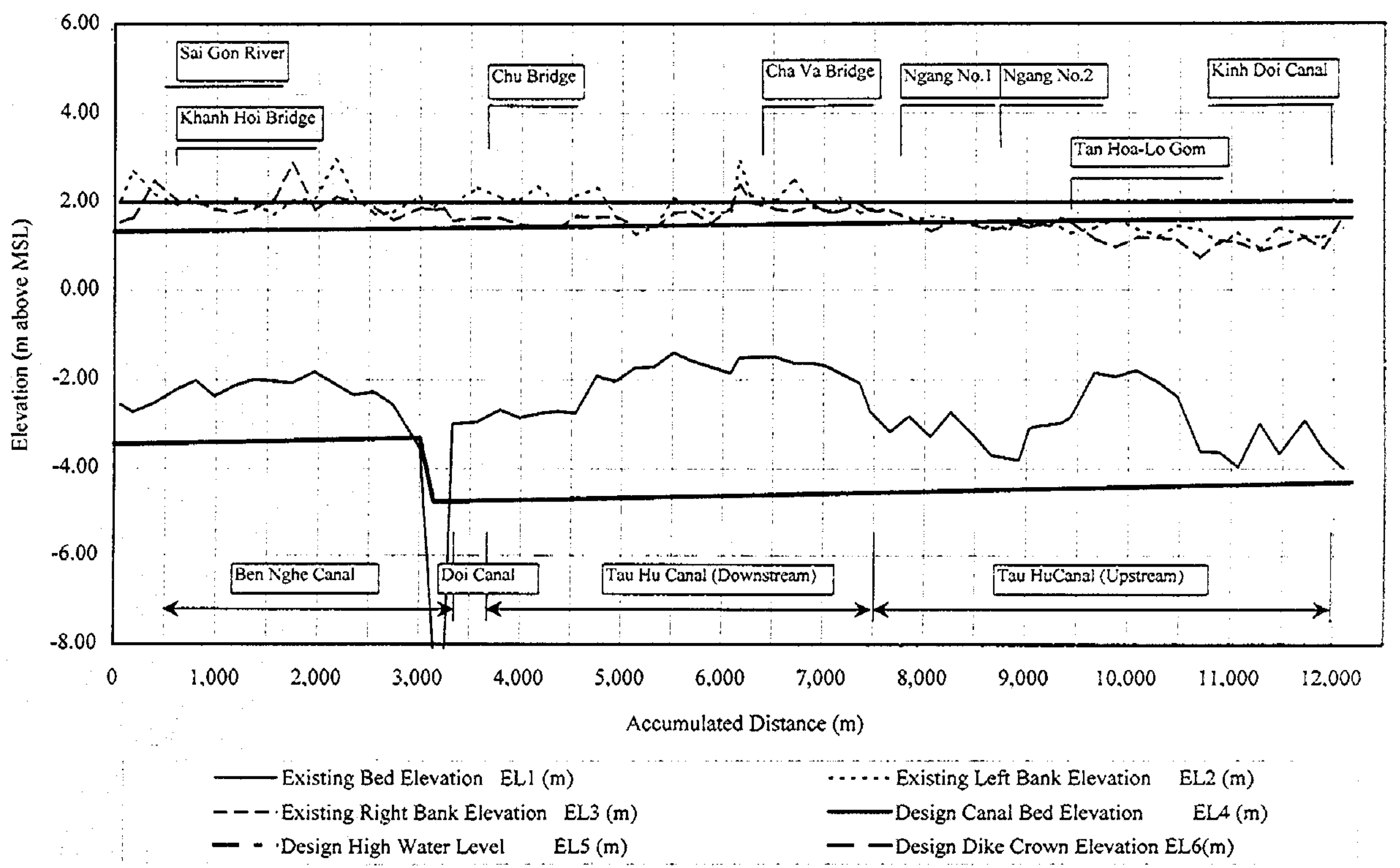


FIG. 8.4 PROPOSED LONGITUDINAL PROFILE OF TAU HU - BEN NGHE CANAL IMPROVEMENT

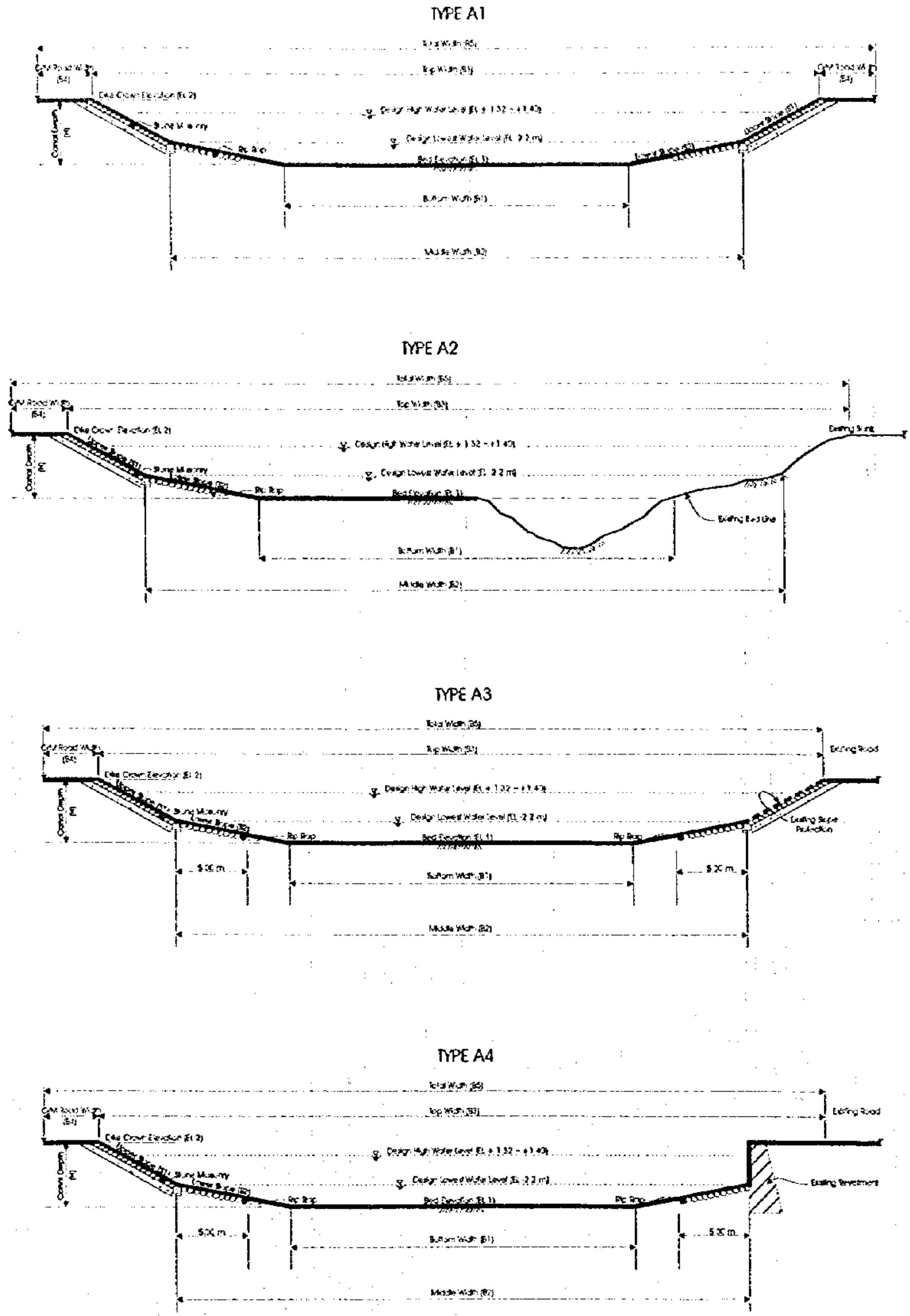


FIG. 8.5(1/2) TYPICAL DESIGN CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT (1)

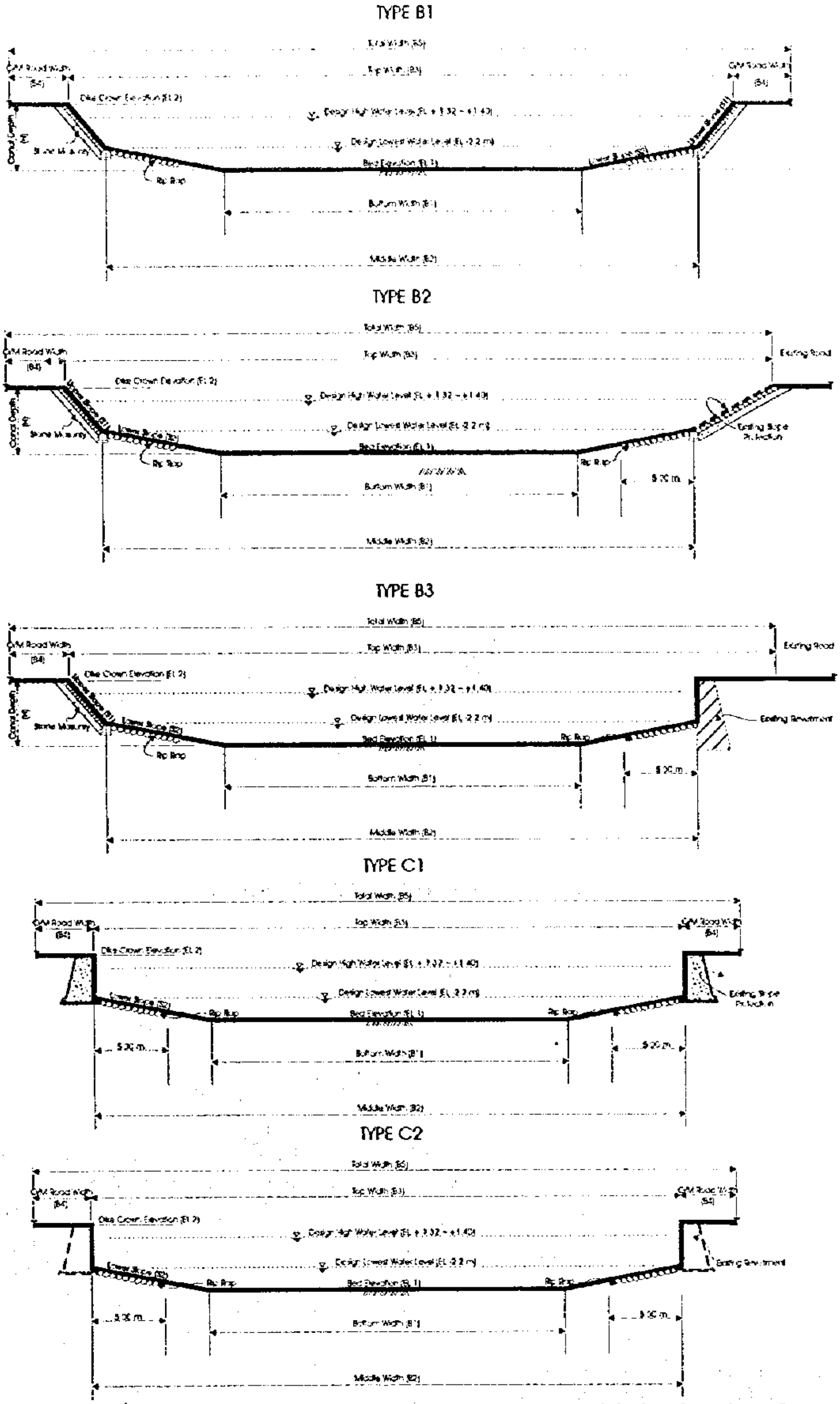
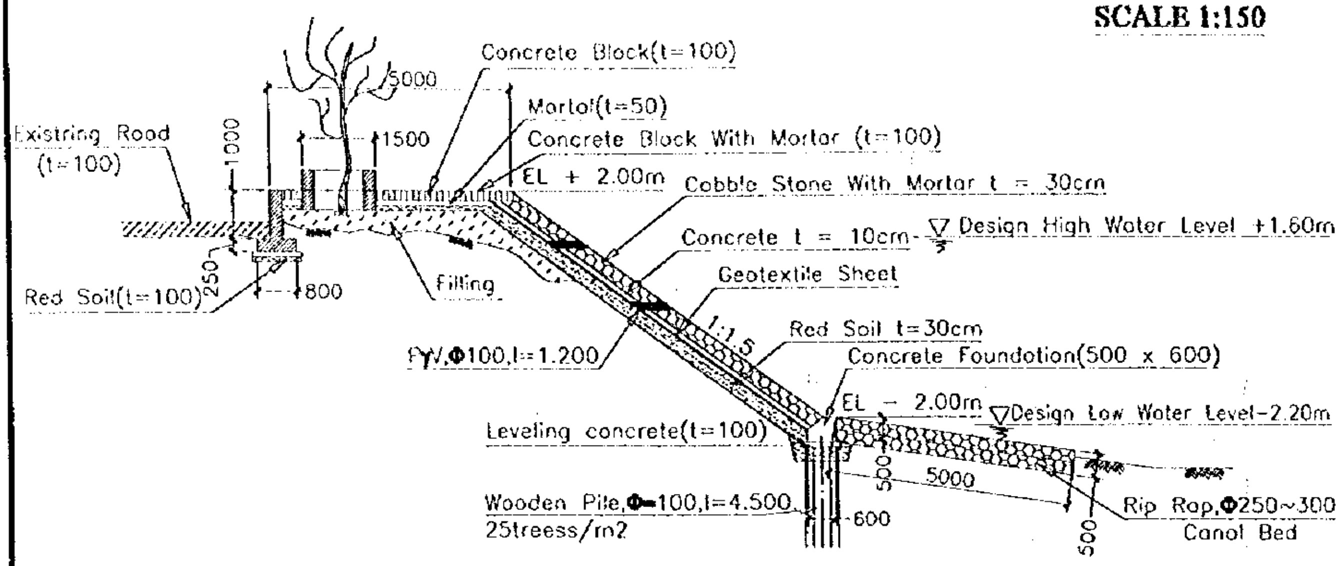
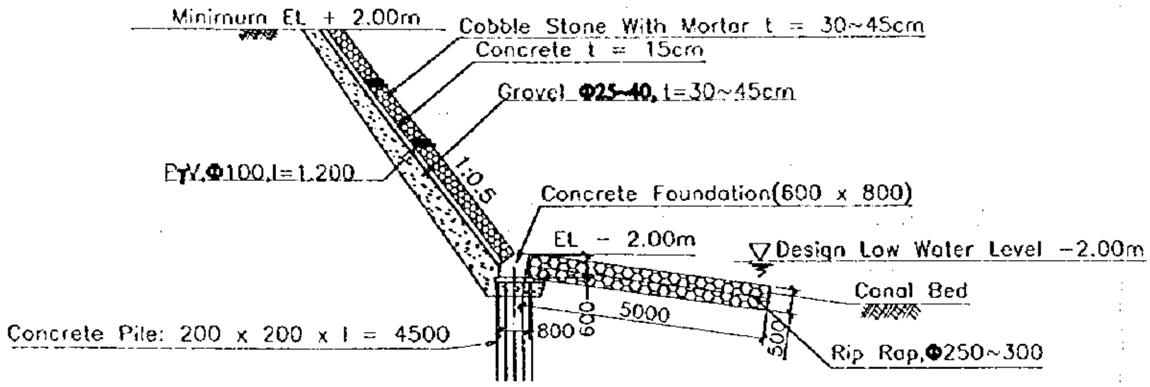


FIG. 8.5(2/2) TYPICAL DESIGN CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT (2)

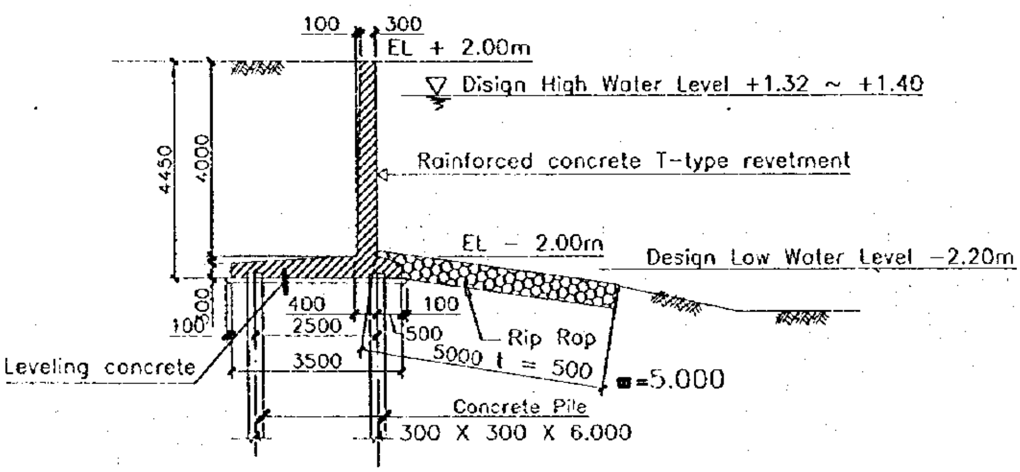
SCALE 1:150



TYPE-A (STONE MASONRY WITH 1:1.5 SLOPE)



TYPE-B (STONE MASONRY WITH 1:0.5 SLOPE)



TYPE-C (RAINFORCED CONCRETE REVETMENT)

FIG. 8.6 TYPICAL DESIGN OF SLOPE PROTECTION AND REVETMENT

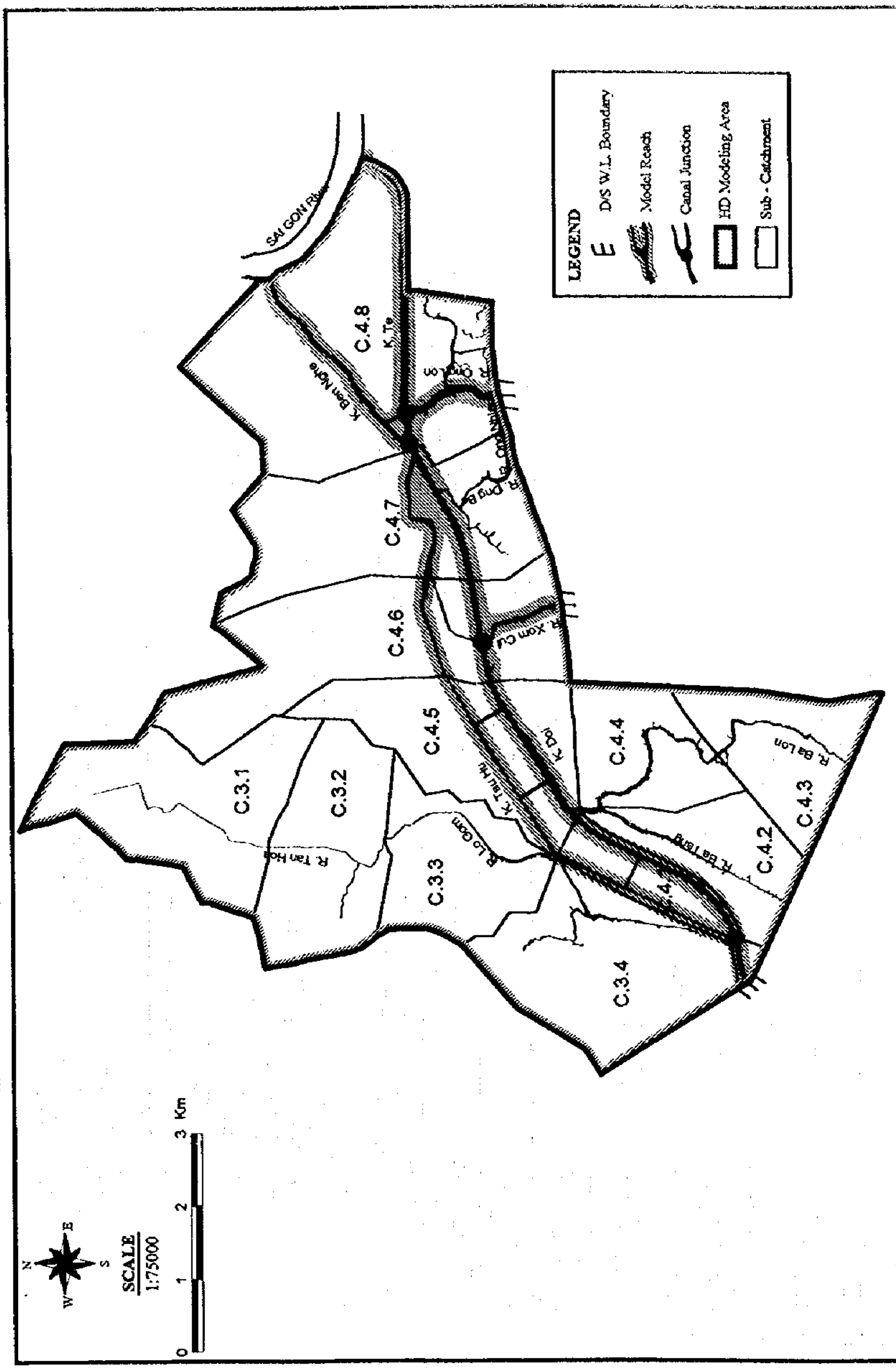


FIG. 8.7 MODEL NETWORK FOR HYDRODYNAMIC SIMULATION

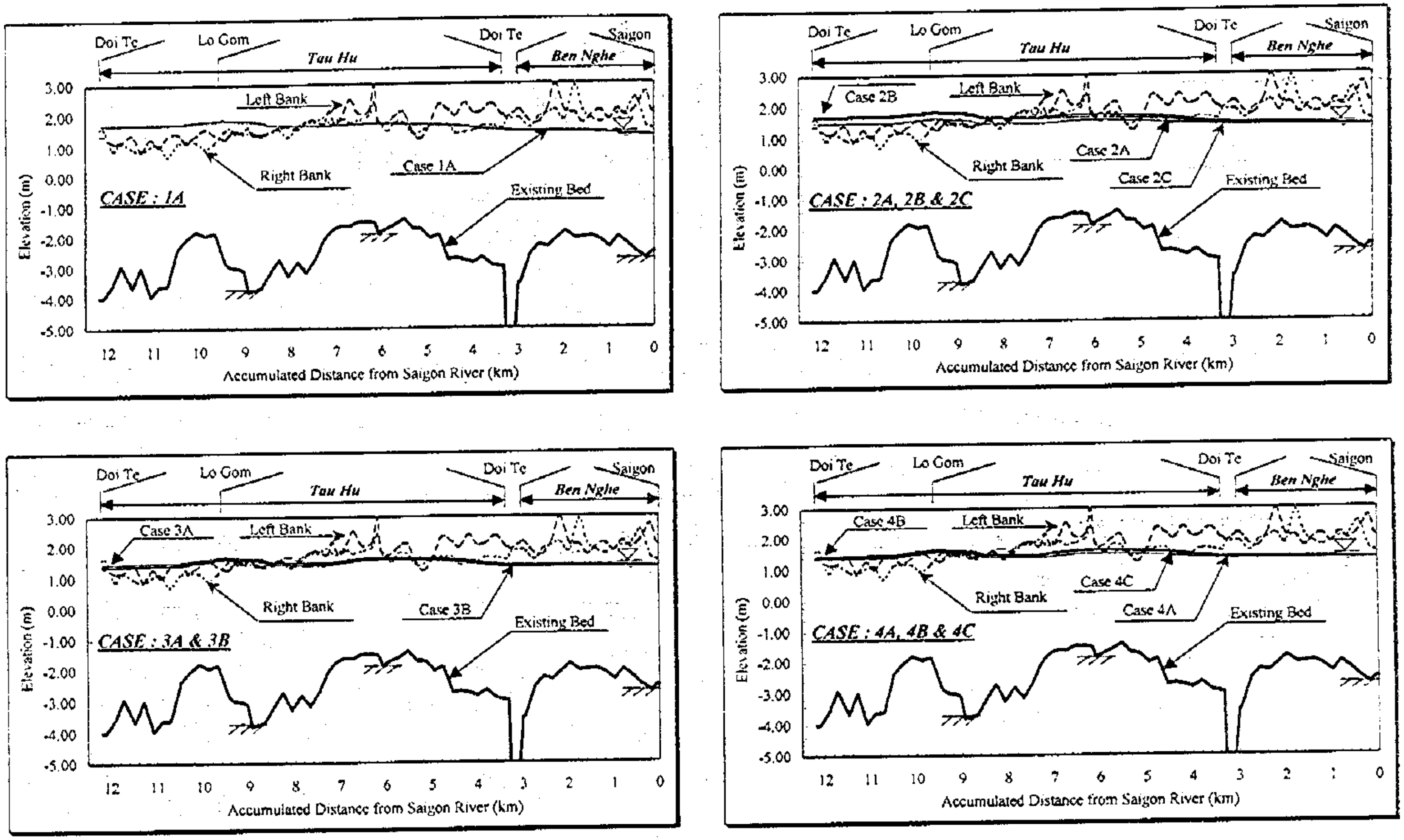


FIG. 8.8 LONGITUDINAL PROFILES OF WATER LEVELS : EXISTING CONDITION

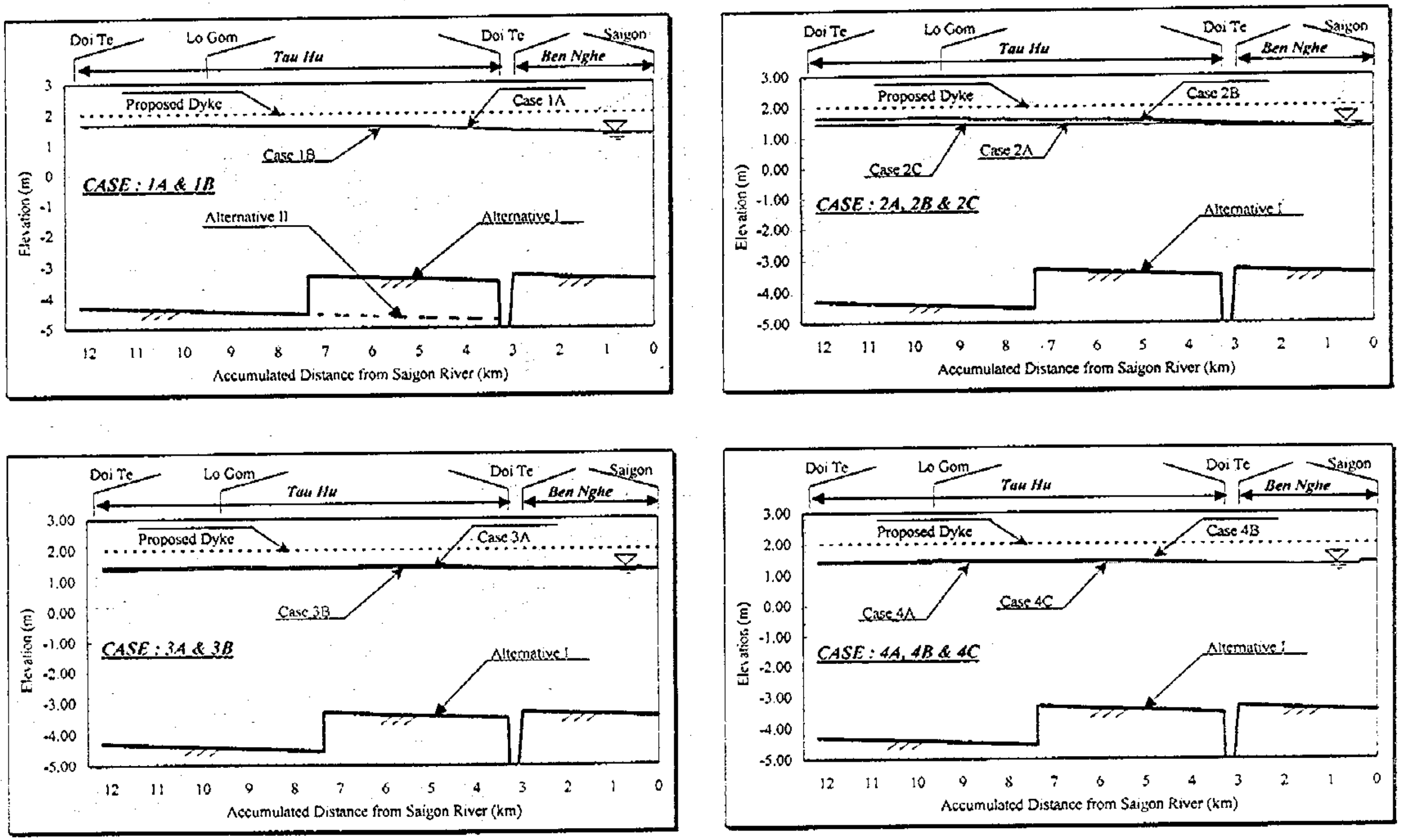


FIG. 8.9 LONGITUDINAL PROFILES OF WATER LEVELS : PROPOSED CONDITION

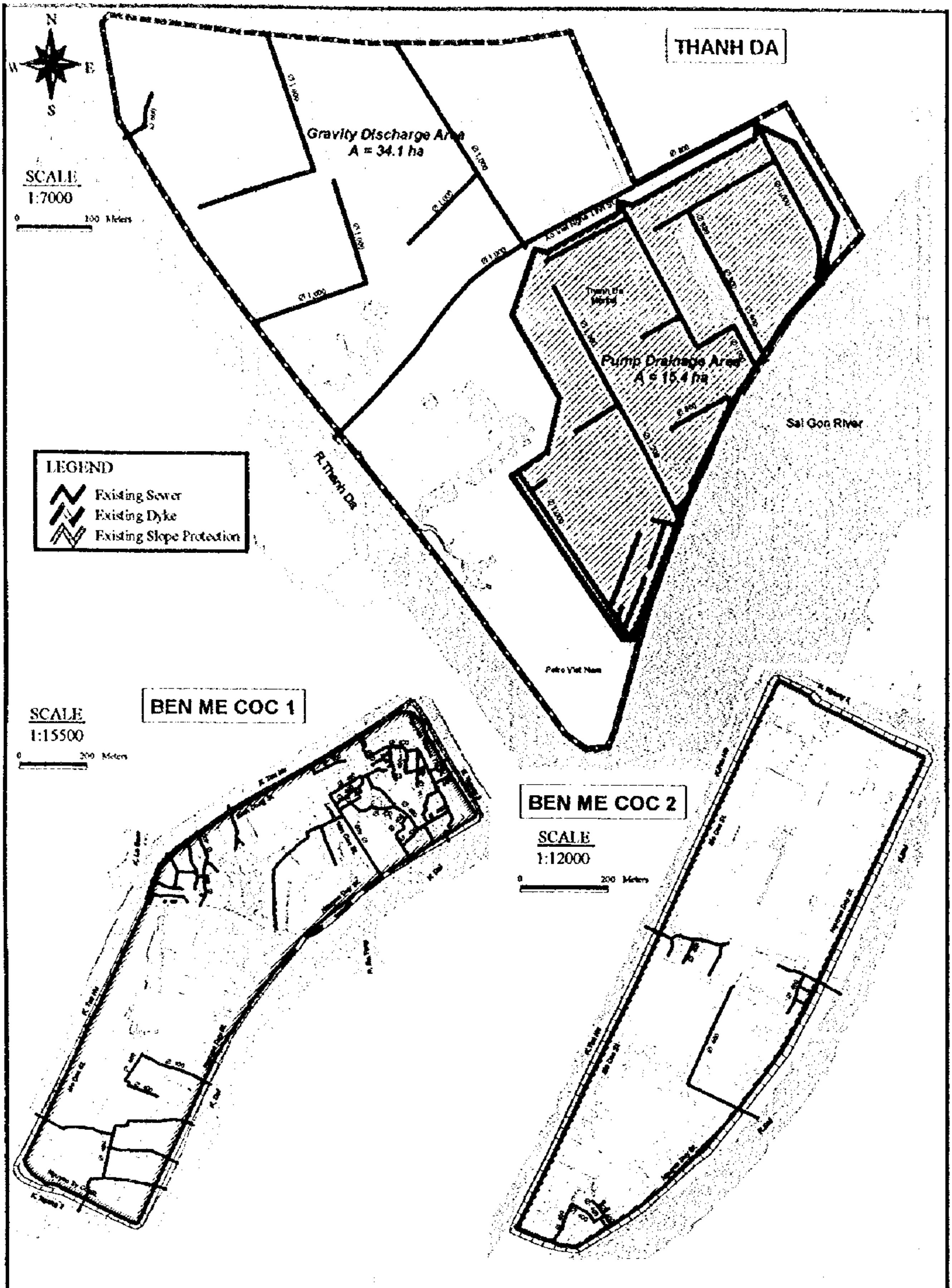
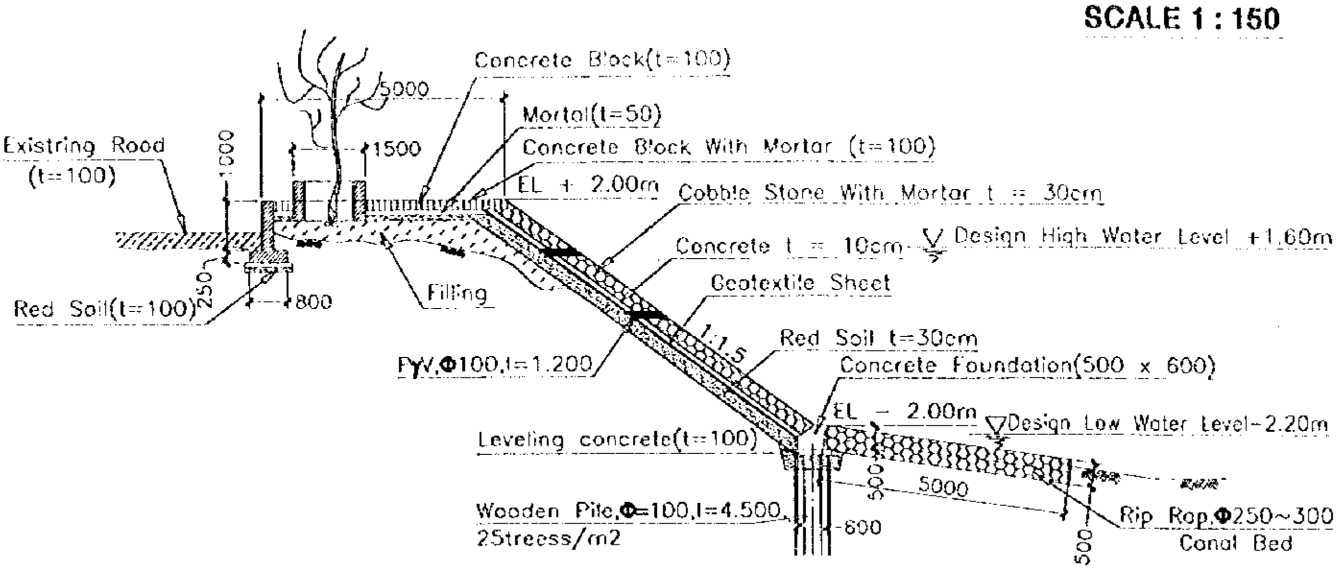
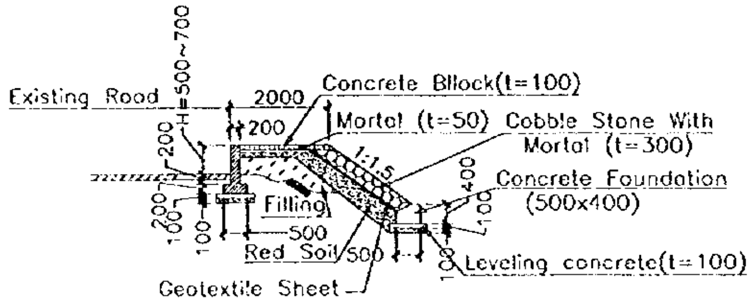


FIG. 8.10 EXISTING SEWER NETWORKS IN THE PROPOSED PUMP DRAINAGE

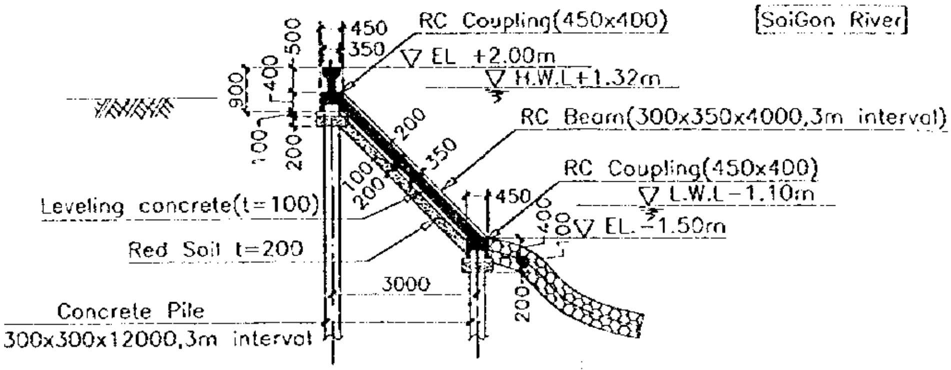
SCALE 1 : 150



PROPOSED DIKE ALONG TAU HU, LO GOM AND NGANG NO.1&3 CANAL IN BEN ME COC (1) & (2)



PROPOSED DIKE ALONG DOI CANAL IN BEN ME COC (1) & (2)



PROPOSED DIKE OF THANH DA

FIG. 8.11 TYPICAL DESIGN OF PROPOSED DIKE

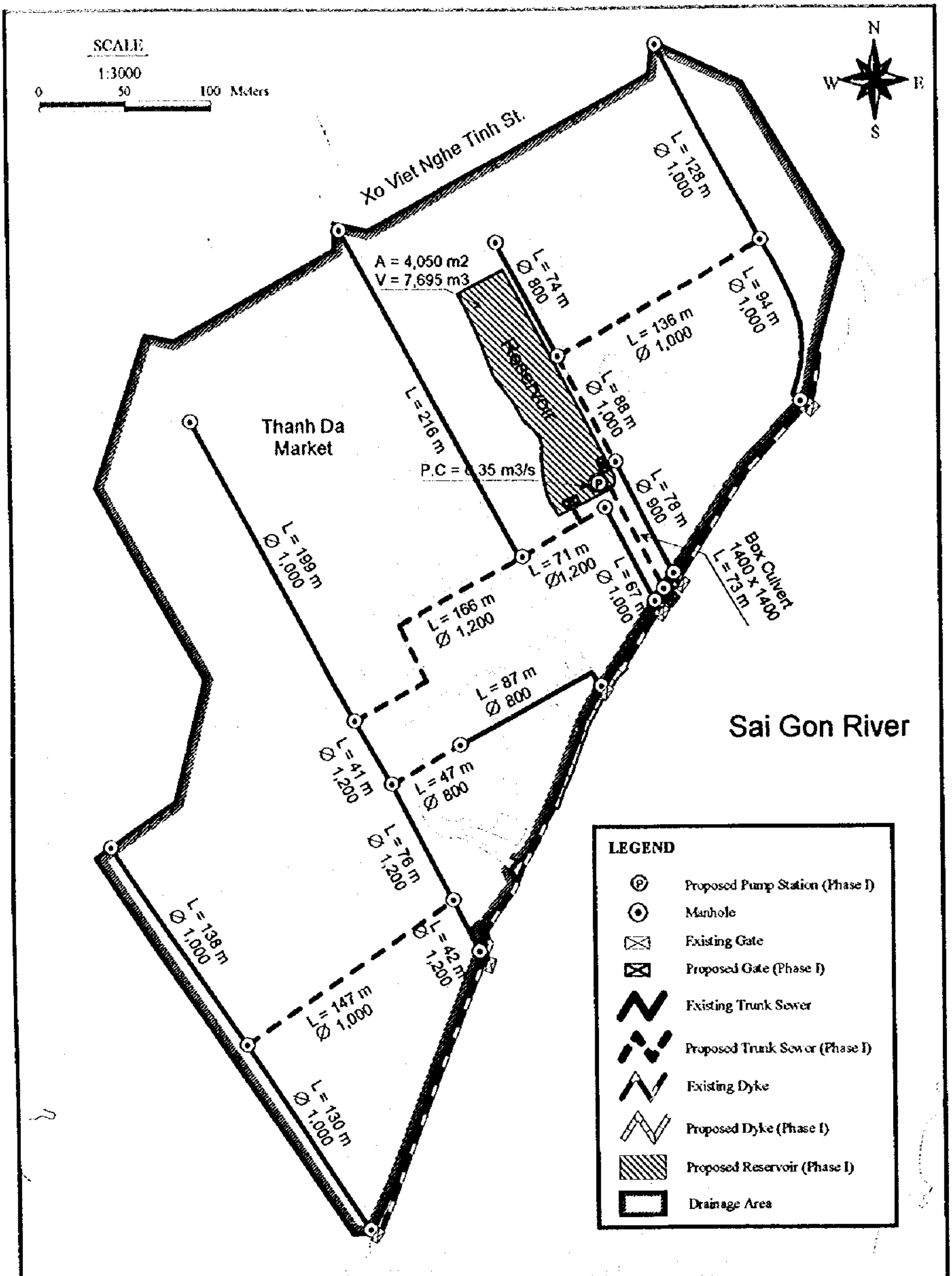


FIG. 8.12 PROPOSED DRAINAGE SYSTEM FOR THANH DA AREA

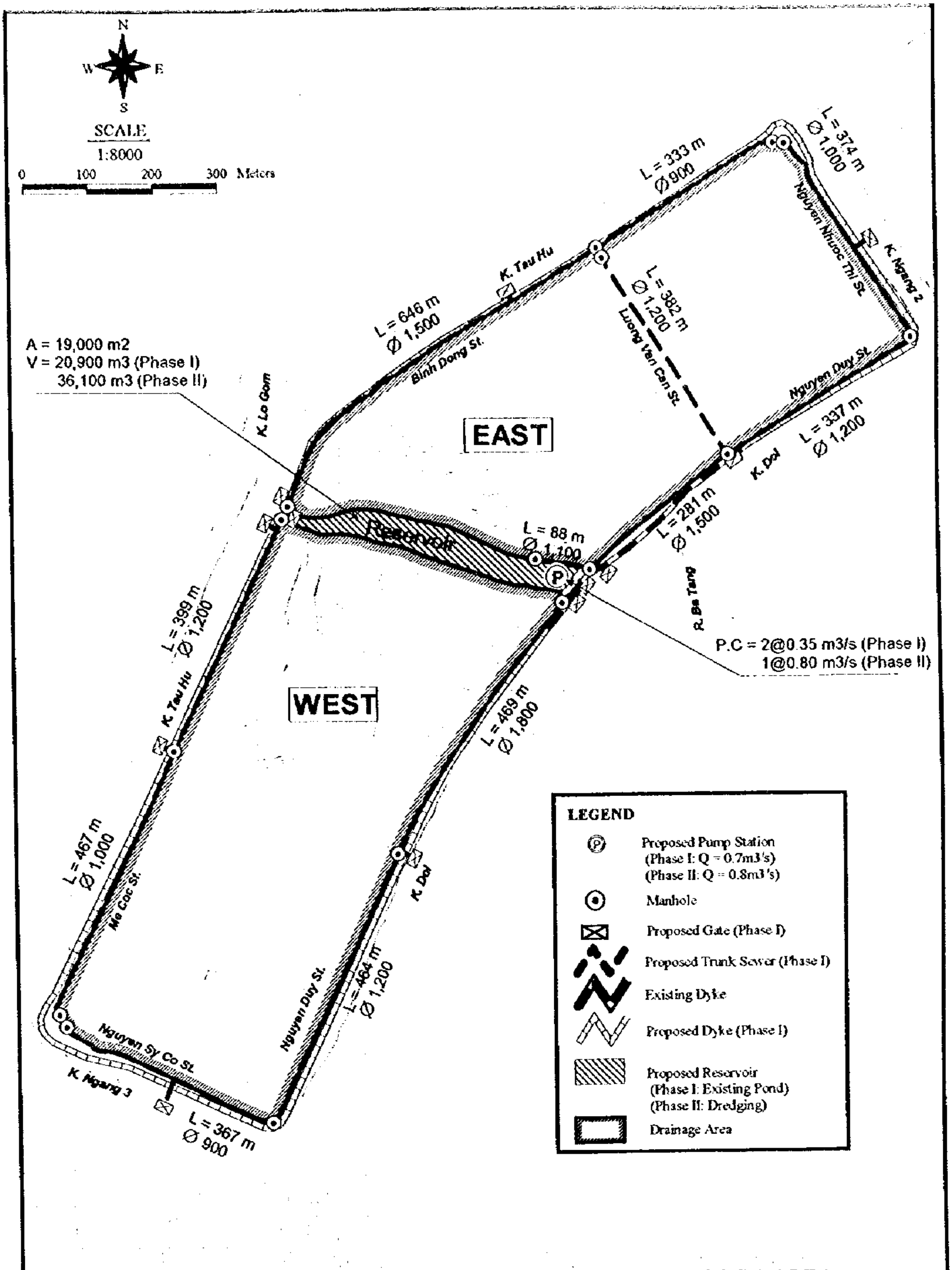


FIG. 8.13 PROPOSED DRAINAGE SYSTEM FOR BEN ME COC 1 AREA

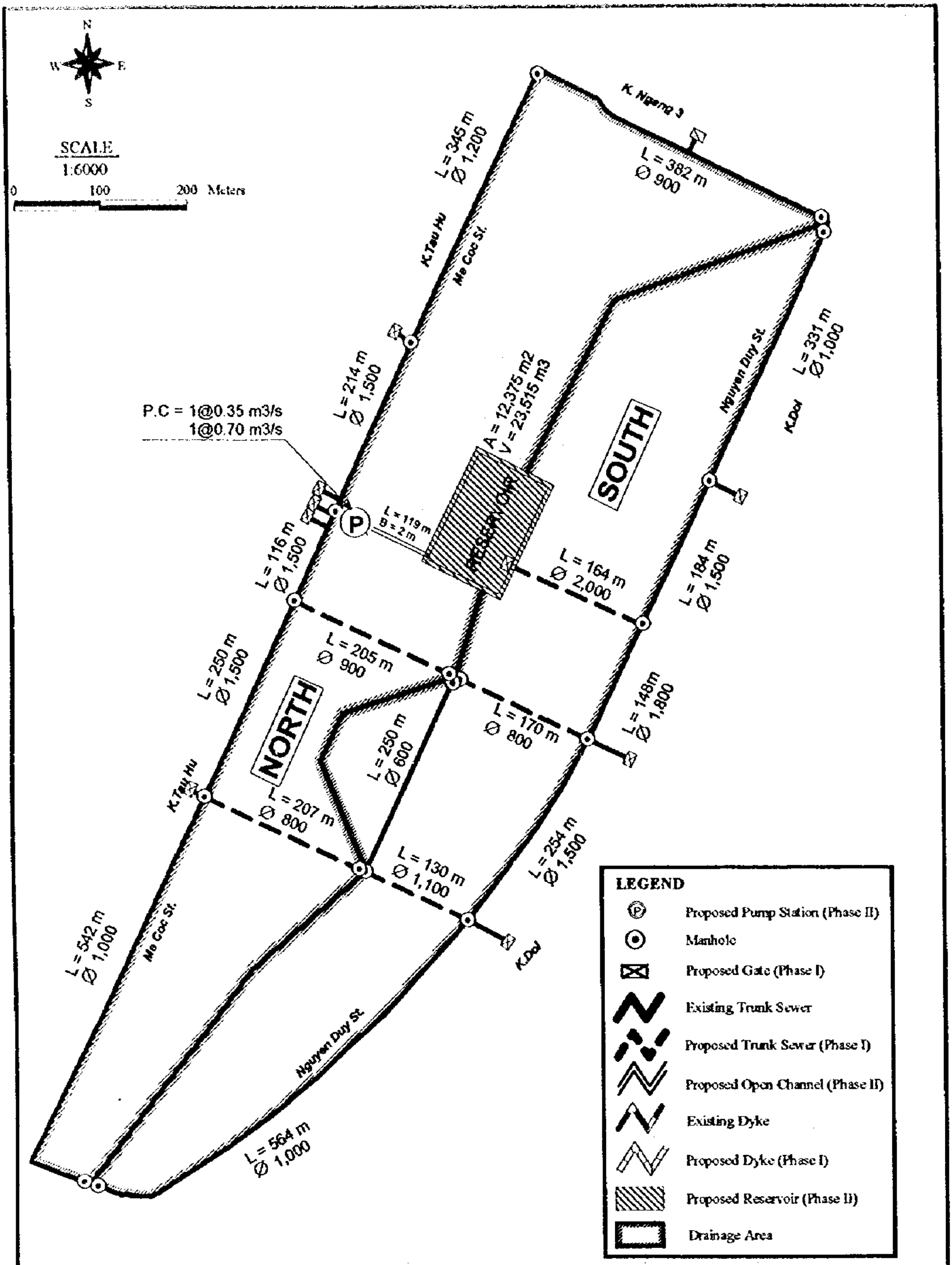


FIG. 8.14 PROPOSED DRAINAGE SYSTEM FOR BEN ME COC 2 AREA

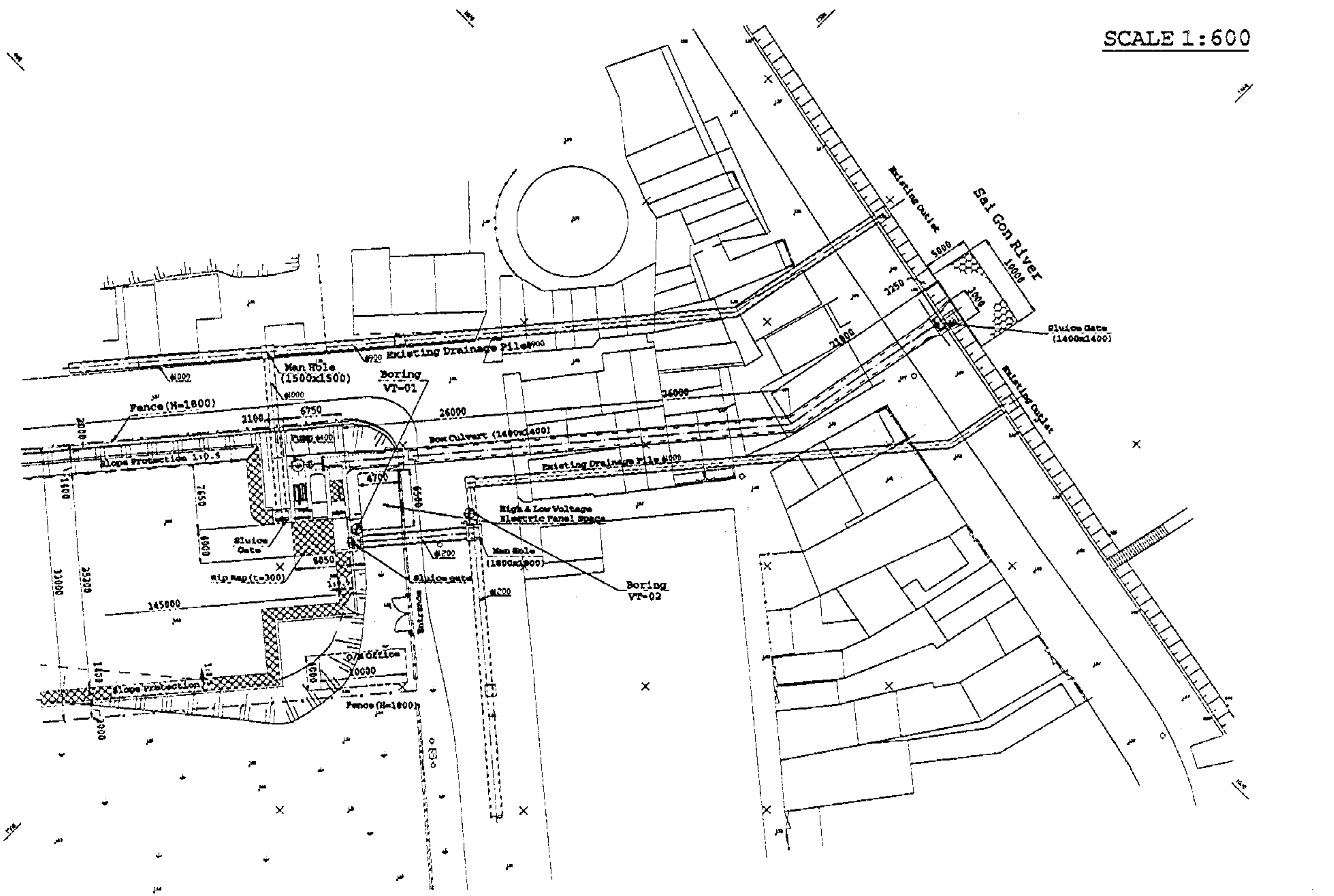


FIG. 8.15 LAYOUT OF PROPOSED THANH DA PUMPING STATION

SCALE 1:350

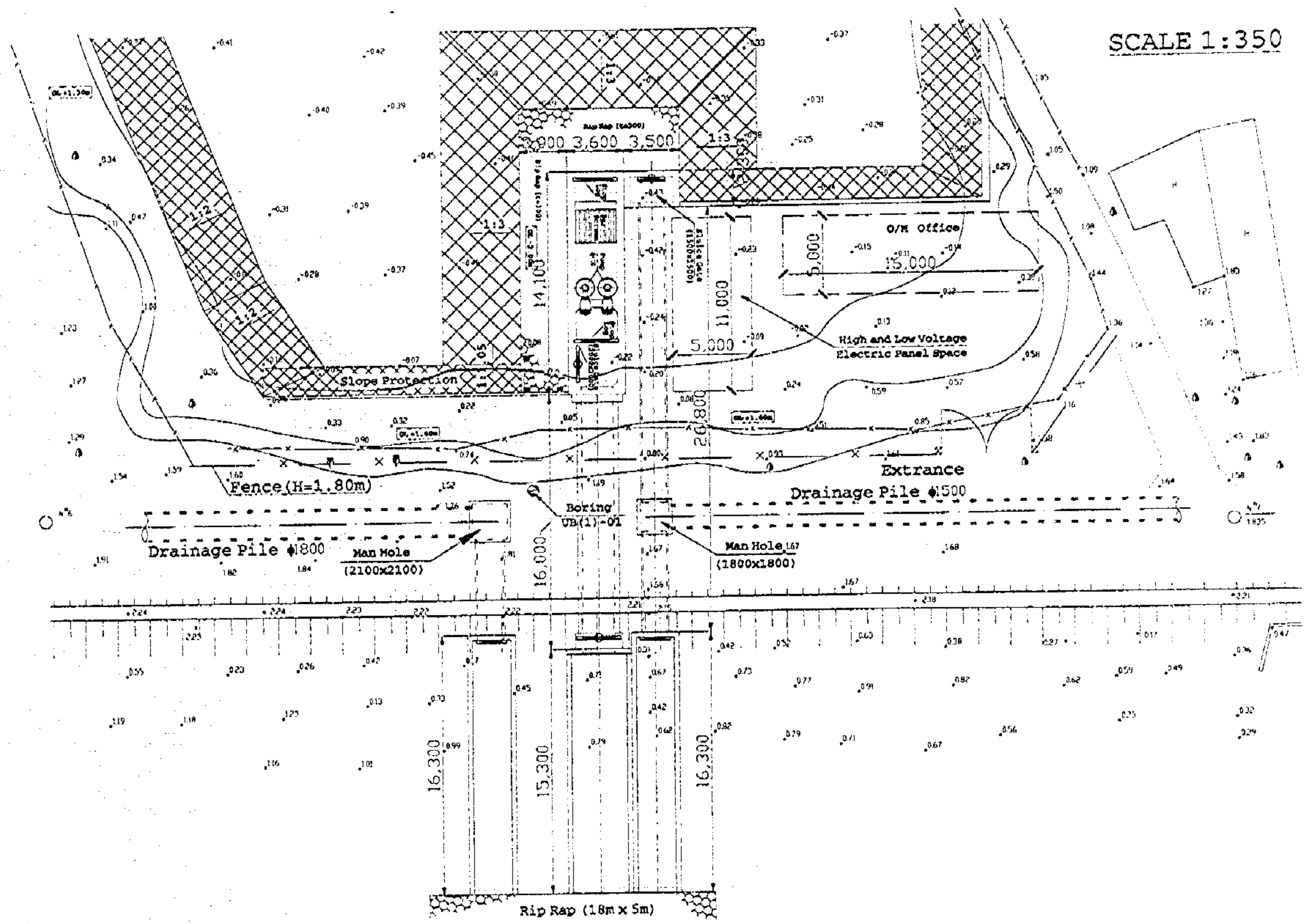


FIG. 8.16(1/2) LAYOUT OF PROPOSED BEN ME COC (1) PUMPING STATION (phase-1)

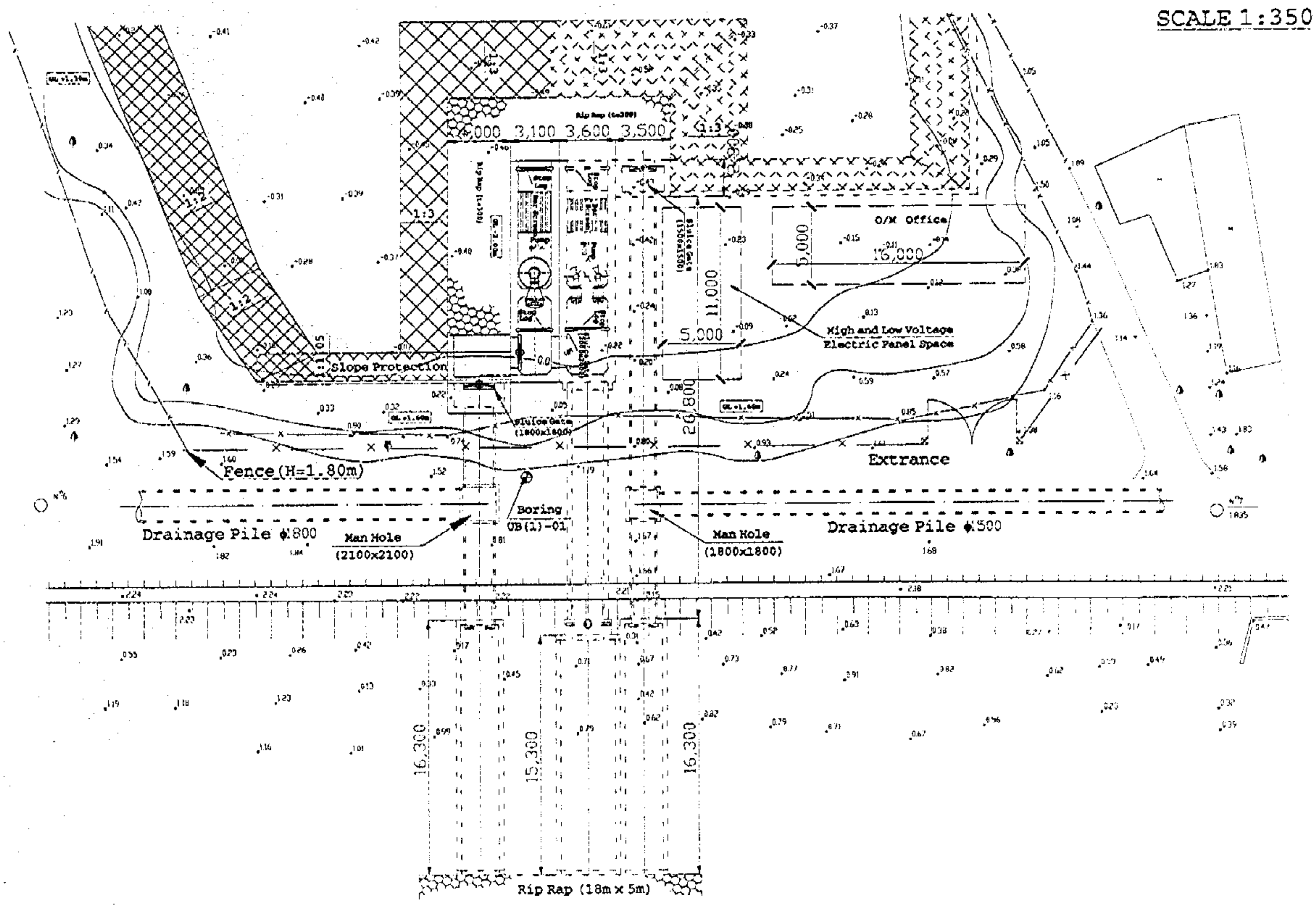


FIG. 8.16(2/2) LAYOUT OF PROPOSED BEN ME COC (2) PUMPING STATION (phase-2)

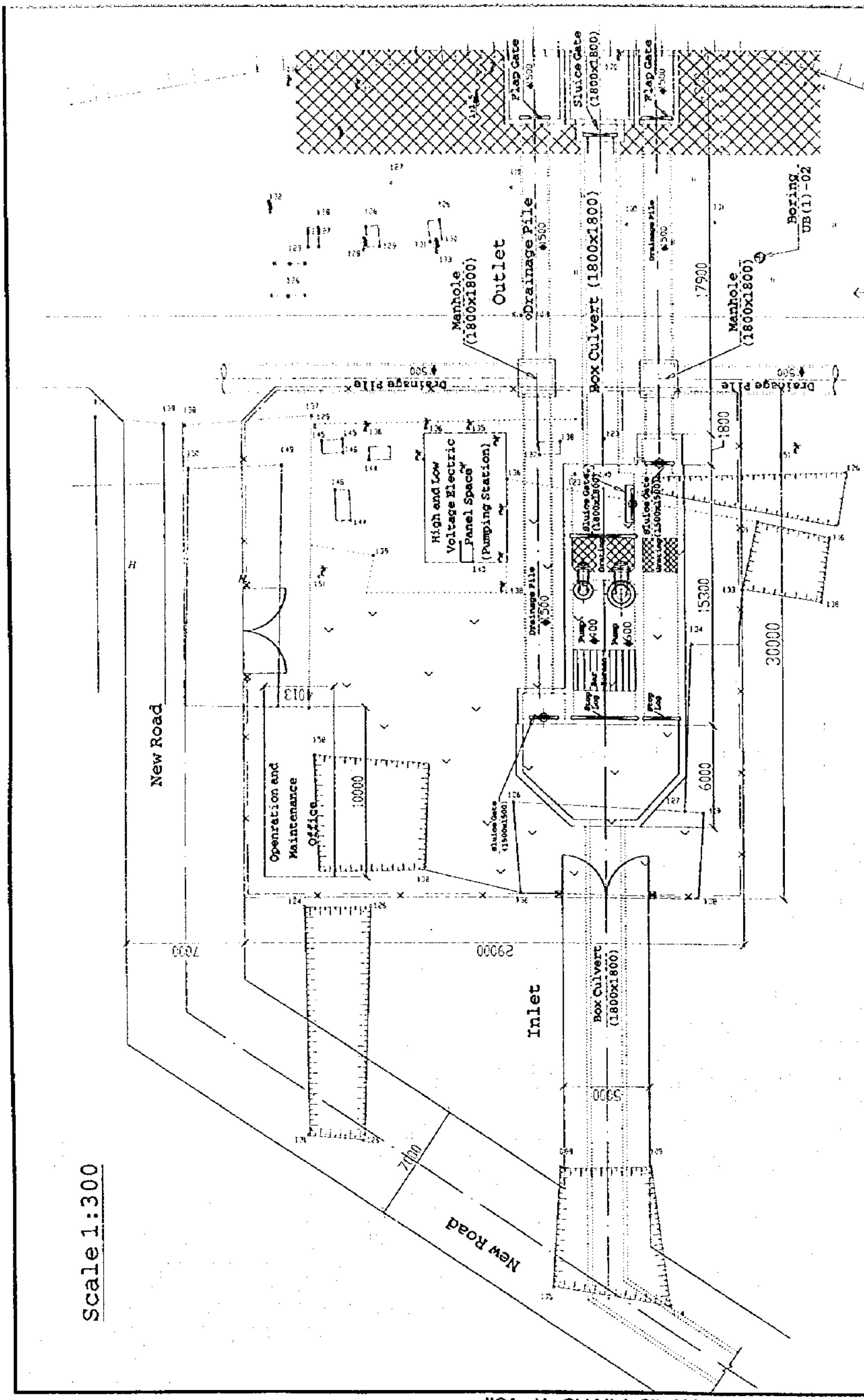
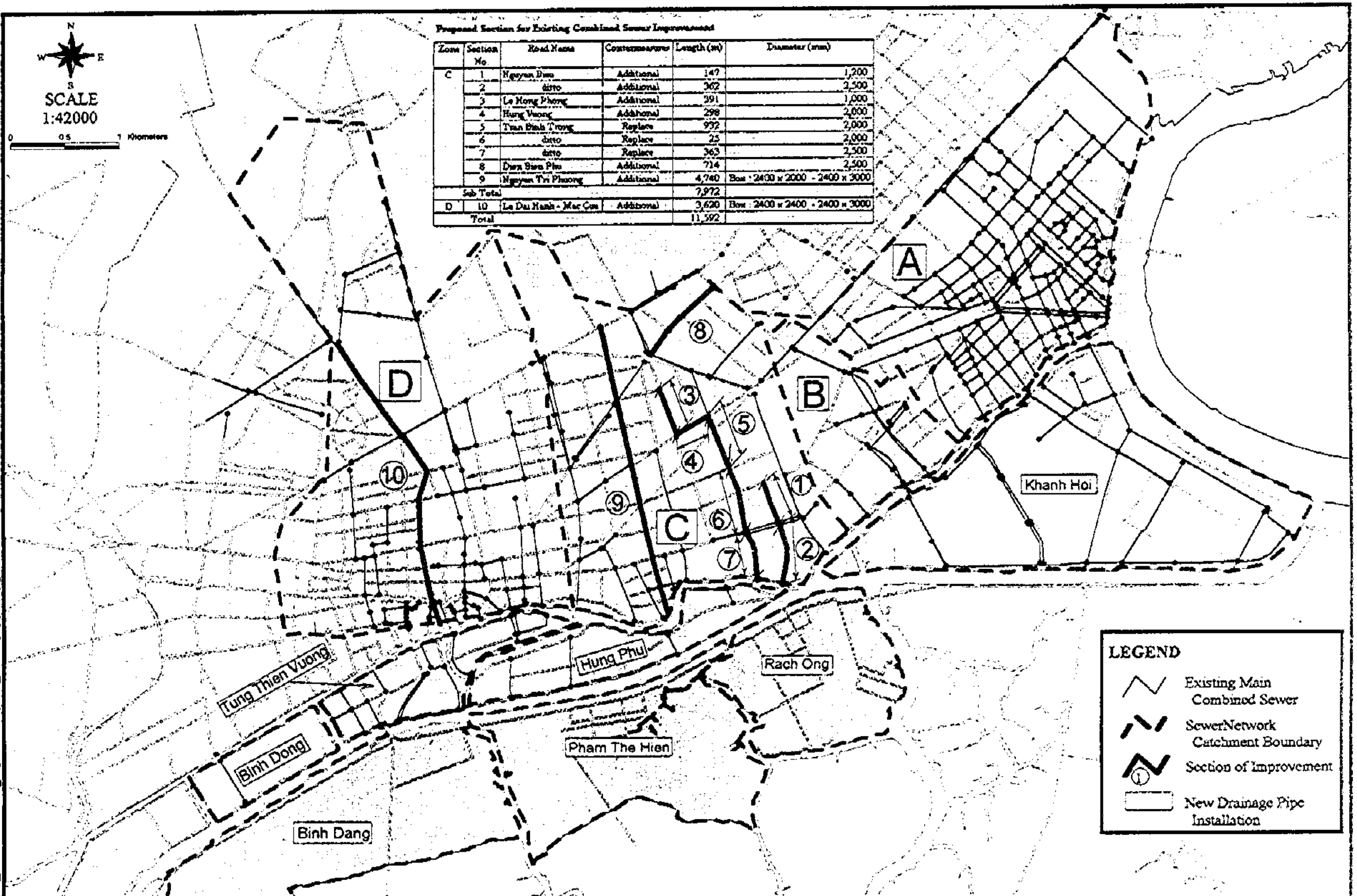


FIG. 8.17 LAYOUT OF PROPOSED BEN ME COC (2) PUMPING STATION



Proposed Section for Existing Combined Sewer Improvement

Zone	Section No.	Road Name	Countermeasures	Length (m)	Diameter (mm)
C	1	Nguyen Bien	Additional	147	1,200
	2	ditto	Additional	362	2,500
	3	Le Hong Phong	Additional	391	1,000
	4	Hung Vuong	Additional	298	2,000
	5	Tran Binh Trong	Replace	932	2,000
	6	ditto	Replace	25	2,000
	7	ditto	Replace	363	2,500
	8	Dien Bien Phu	Additional	714	2,500
	9	Nguyen Tri Phuong	Additional	4,740	Box : 2400 x 2000 - 2400 x 3000
Sub Total				7,972	
D	10	Le Dai Hanh - Mac Cuu	Additional	3,620	Box : 2400 x 2400 - 2400 x 3000
Total				11,592	

FIG. 8.18 PROPOSED DRAINAGE PIPE SYSTEM IMPROVEMENT

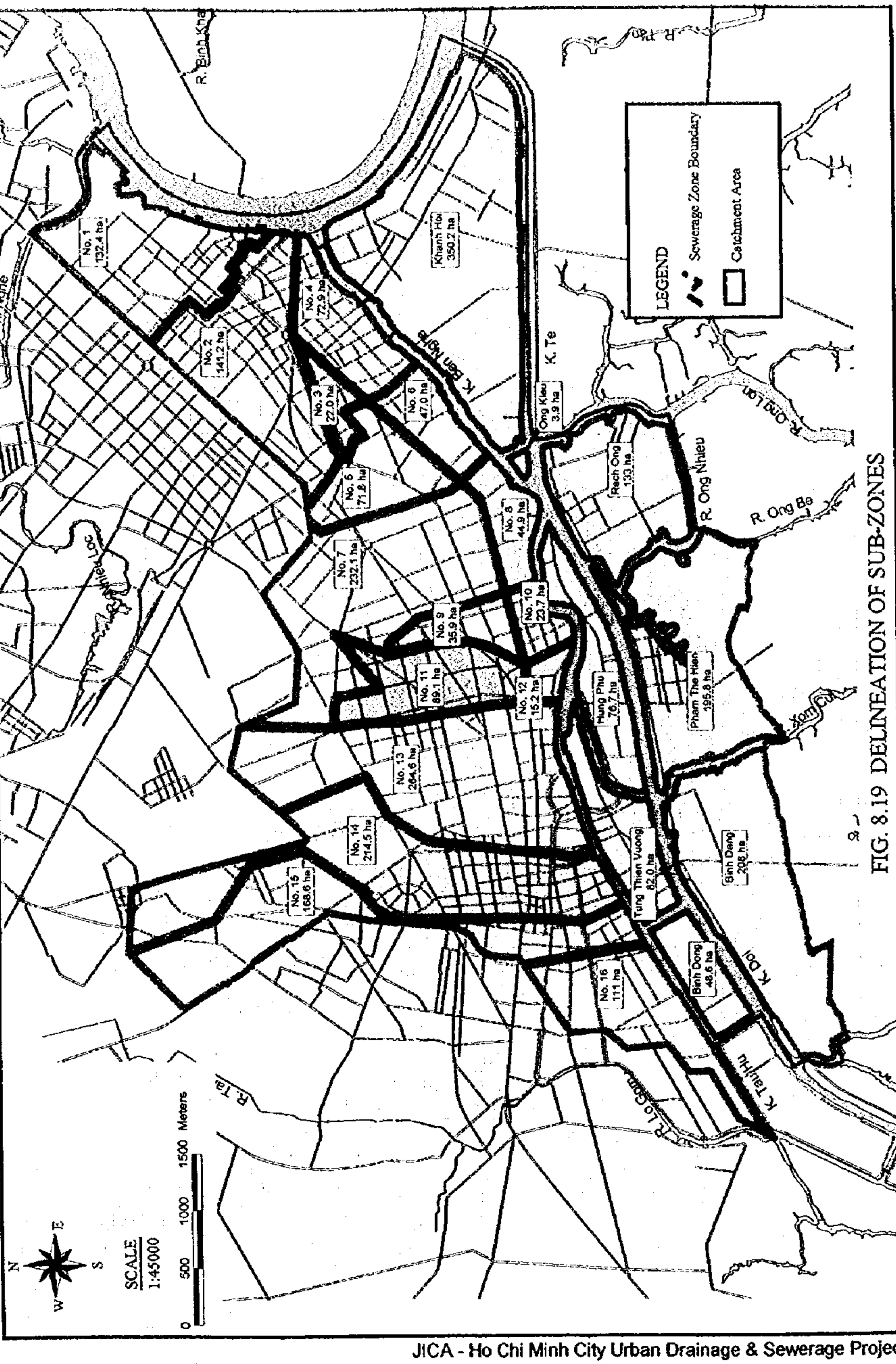


FIG. 8.19 DELINEATION OF SUB-ZONES

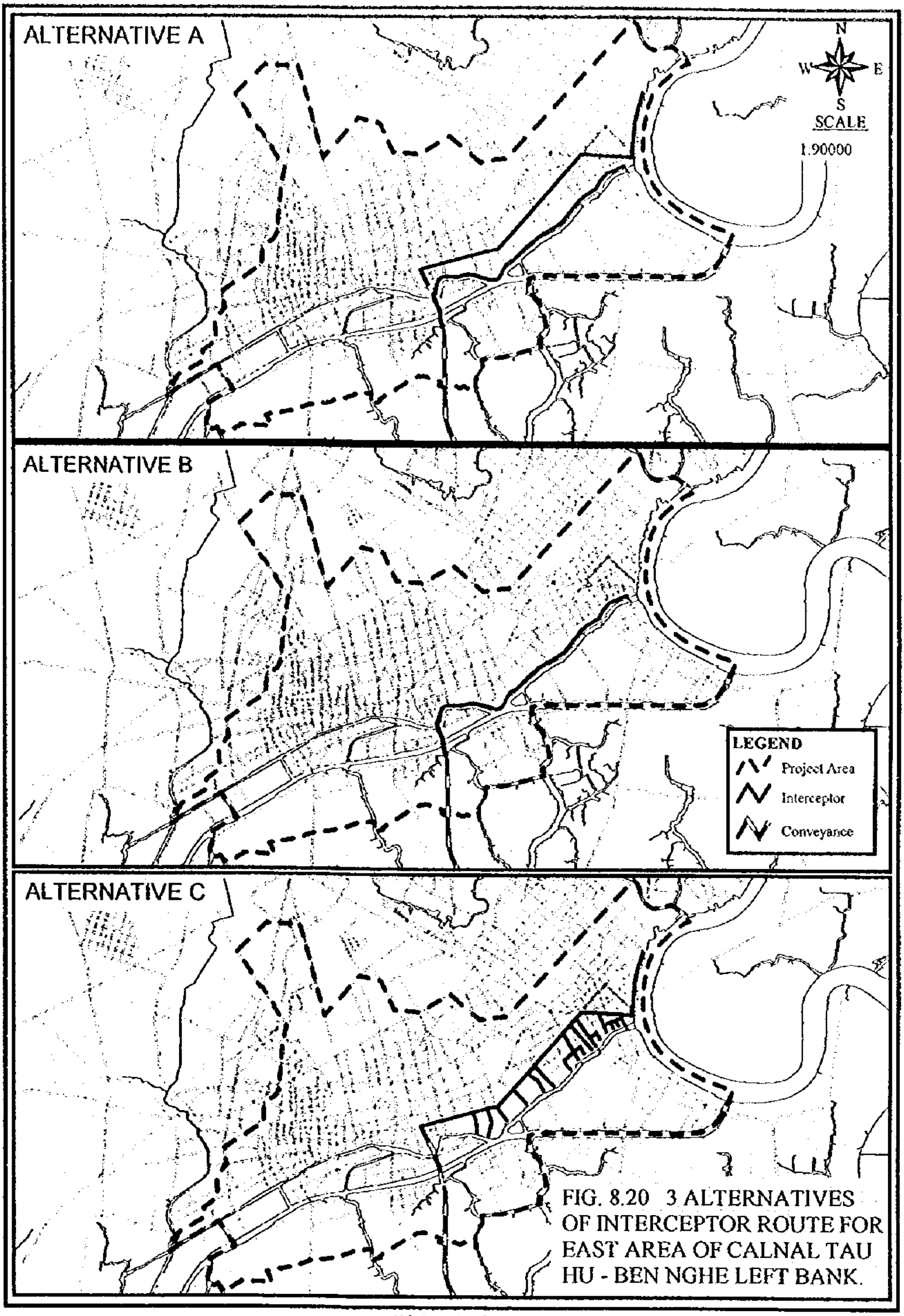


FIG. 8.20 3 ALTERNATIVES OF INTERCEPTOR ROUTE FOR EAST AREA OF CALNAL TAU HU - BEN NGHE LEFT BANK.

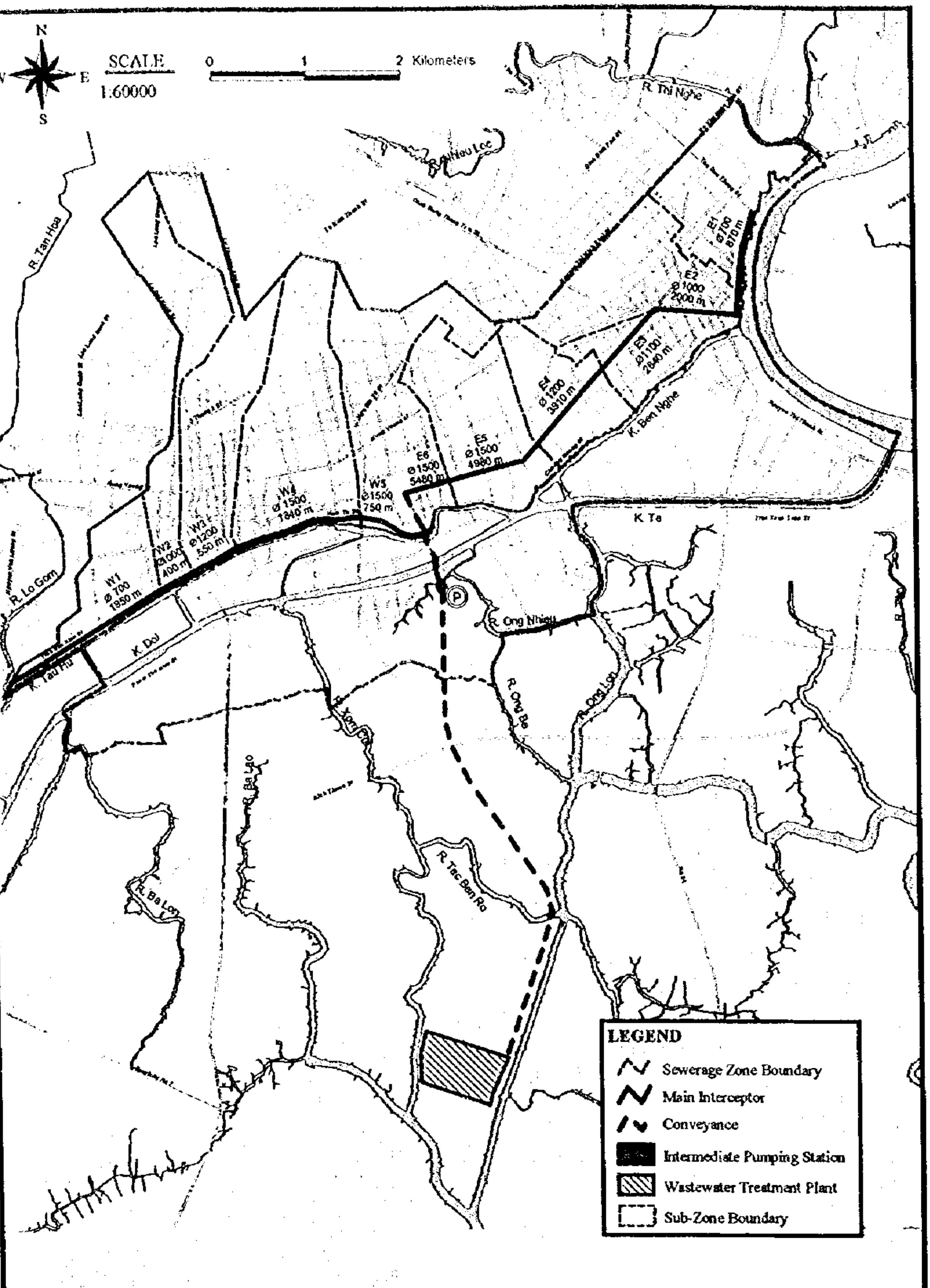
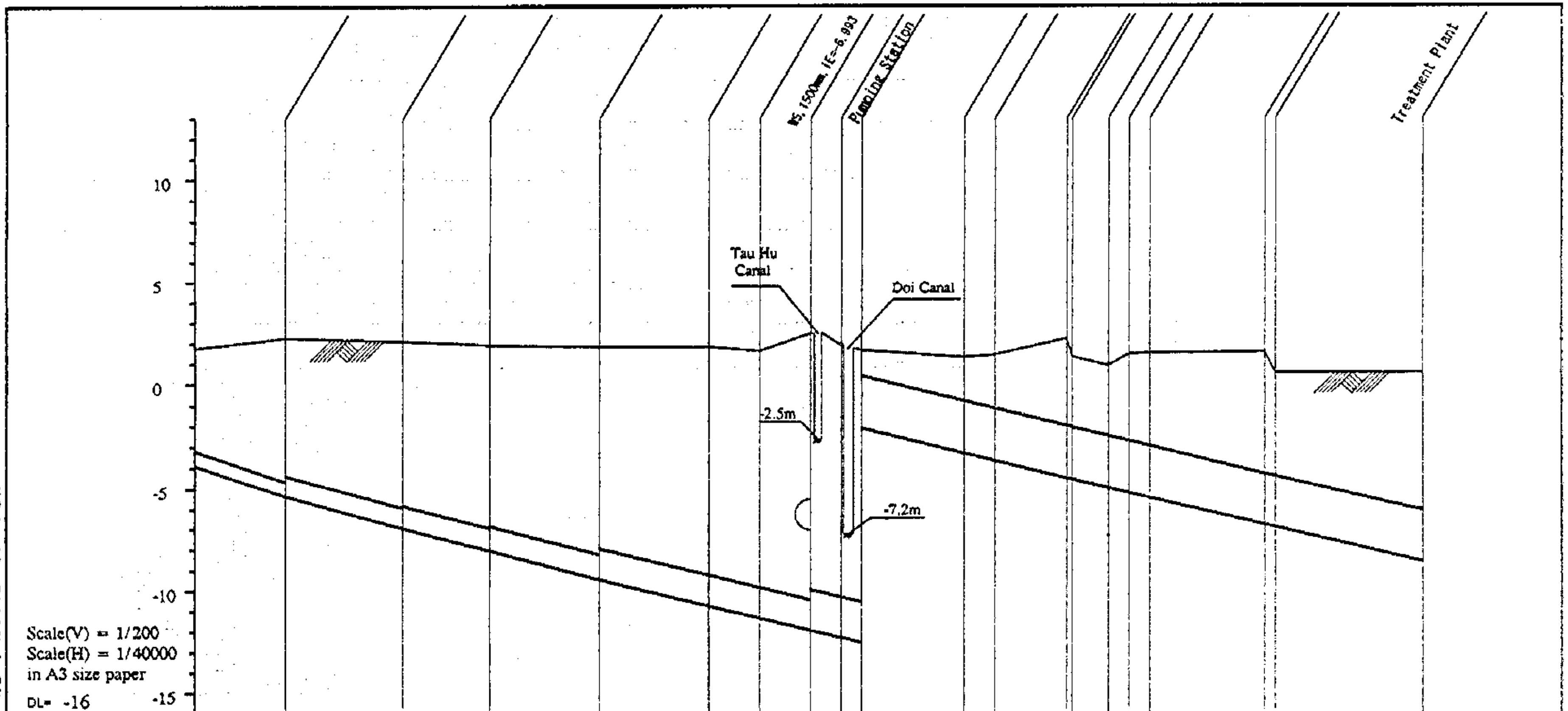


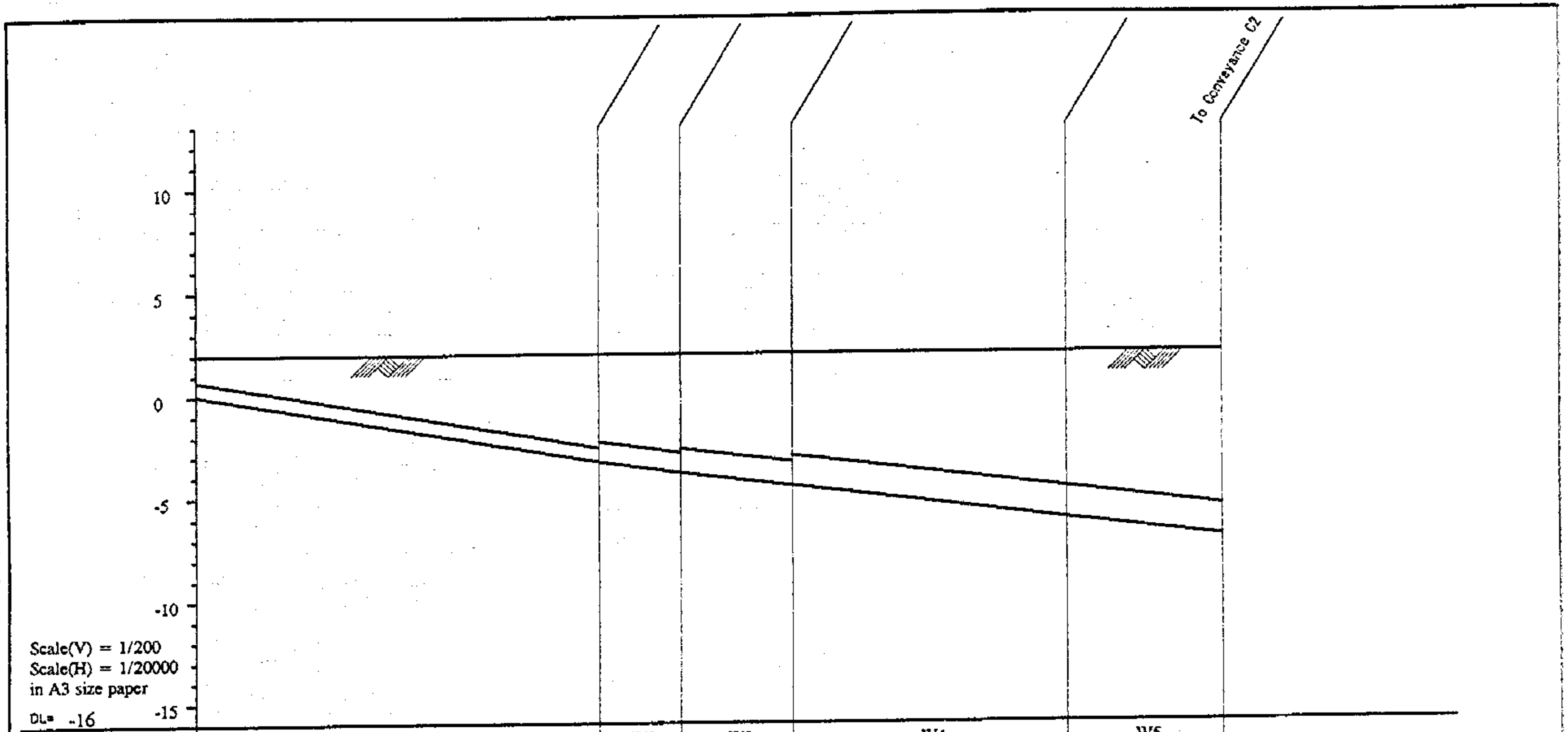
FIG. 8.21 PROPOSED ALIGNMENTS OF INTERCEPTOR SEWERS FOR TAU HU, BEN NGHE CANAL LEFT BANK



Line Number	E1	E2	E3	E4	E5	E6	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
Diameter (mm)	700	1000	1100	1200	1500	1500	1500	2000	2000	2500	2500	2500	2500	[illegible]	2500	2500	2500	2500	2500
Gradient (o/oo)	1.7	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Length (m)	870	1130	840	1070	1070	500	500	300	200	1000	300	700	50	350	200	200	1100	100	1400

Total Length (m)	Ground Elevation (m)	Earth Covering (m)	Invert Elevation (m)
0	1.76	4.88	-3.87
870	2.28	6.88 / 6.58	-5.35 / -5.35
2000	2.12	8.00 / 7.90	-6.93 / -6.93
2840	1.92	8.80 / 8.70	-8.03 / -8.03
3910	1.85	10.02 / 9.72	-9.42 / -9.42
4980	1.84	10.99 / 10.99	-10.70 / -10.70
5480	1.64	11.39 / 11.39	-11.30 / -11.30
5980	1.61	11.96 / 11.46	-11.90 / -11.90
6280	1.92	12.13 / 12.13	-12.26 / -12.26
6480	1.68	12.13 / 1.20	-12.50 / -2.07
7480	1.34	2.06 / 2.06	-3.27 / -3.27
7780	1.45	2.33 / 2.33	-3.63 / -3.63
8480	2.23	[illegible]	[illegible]
8530	1.33	[illegible]	[illegible]
8880	0.93	[illegible]	[illegible]
9080	1.48	[illegible]	[illegible]
9280	1.52	[illegible] / 4.40	[illegible] / -5.43
10380	1.58	5.78 / 5.78	-6.75 / -6.75
10480	0.57	5.89 / 4.89	-6.87 / -6.87
11880	0.57	8.60	-8.55

Fig. 8.22 Longitudinal Profile of Interceptor and Conveyance Sewers



Line Number	W1	W2	W3	W4	W5
Diameter (mm)	700	1000	1200	1500	1500
Gradient (o/oo)	1.7	1.4	1.2	1.2	1.2
Length (m)	1950	400	550	1340	750

Total Length (m)	0	1950	2350	2900	4240	4990
Ground Elevation (m)	2	2	2	2	2	2
Earth Covering (m)	1.2	4.52 / 4.22	4.78 / 4.58	5.24 / 4.94	6.54 / 6.54	7.44
Invert Elevation (m)	0.05	3.265 / 3.265	3.835 / 3.835	4.485 / 4.485	6.093 / 6.093	6.993

Fig. 8.23 : Longitudinal Profile of Interceptor Sewer for West Side of Left Bank

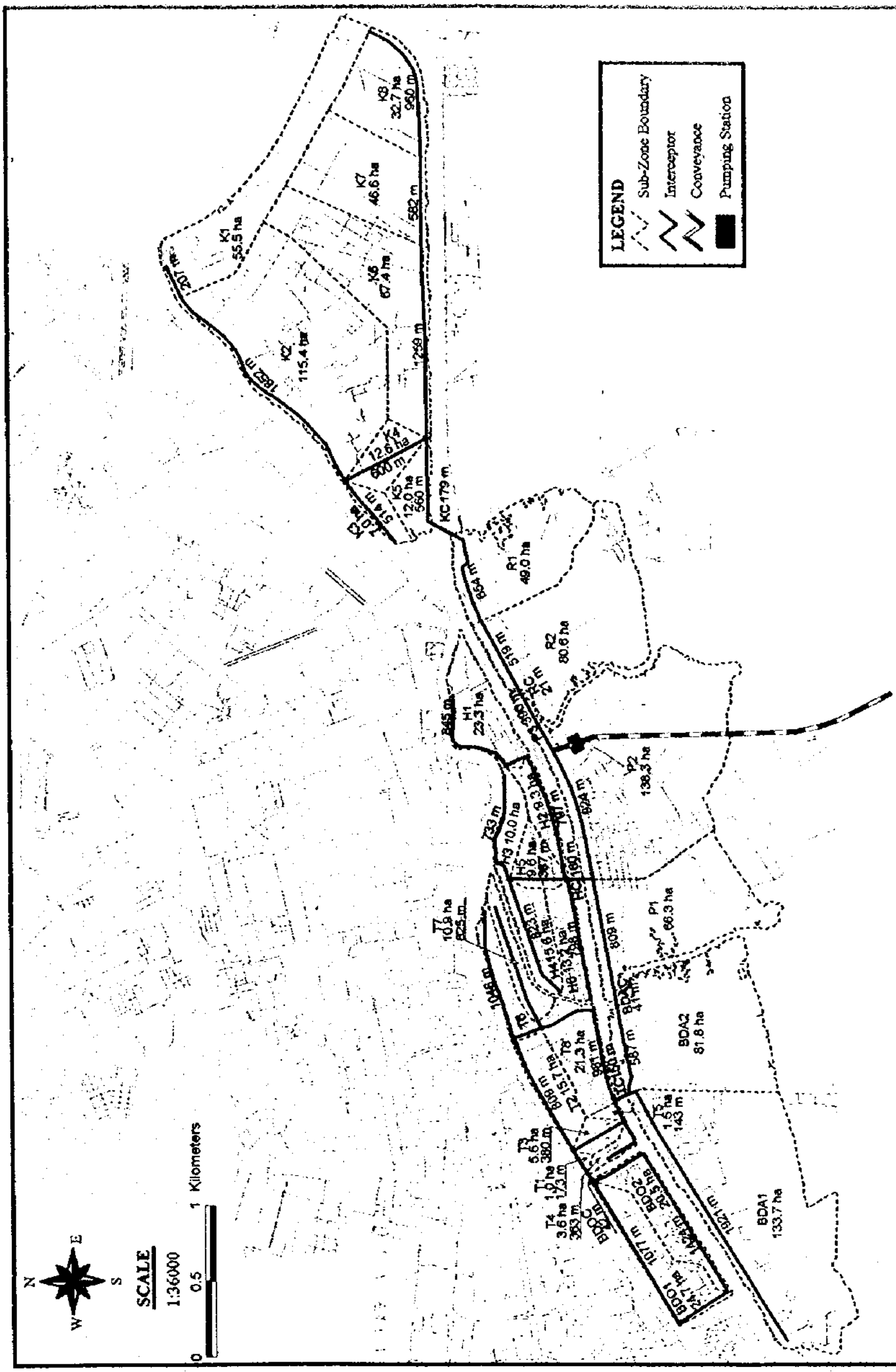


FIG. 8.24 SUB-ZONE AND INTERCEPTOR ROUTE FOR ISLANDS AND SOUTHERN AREAS

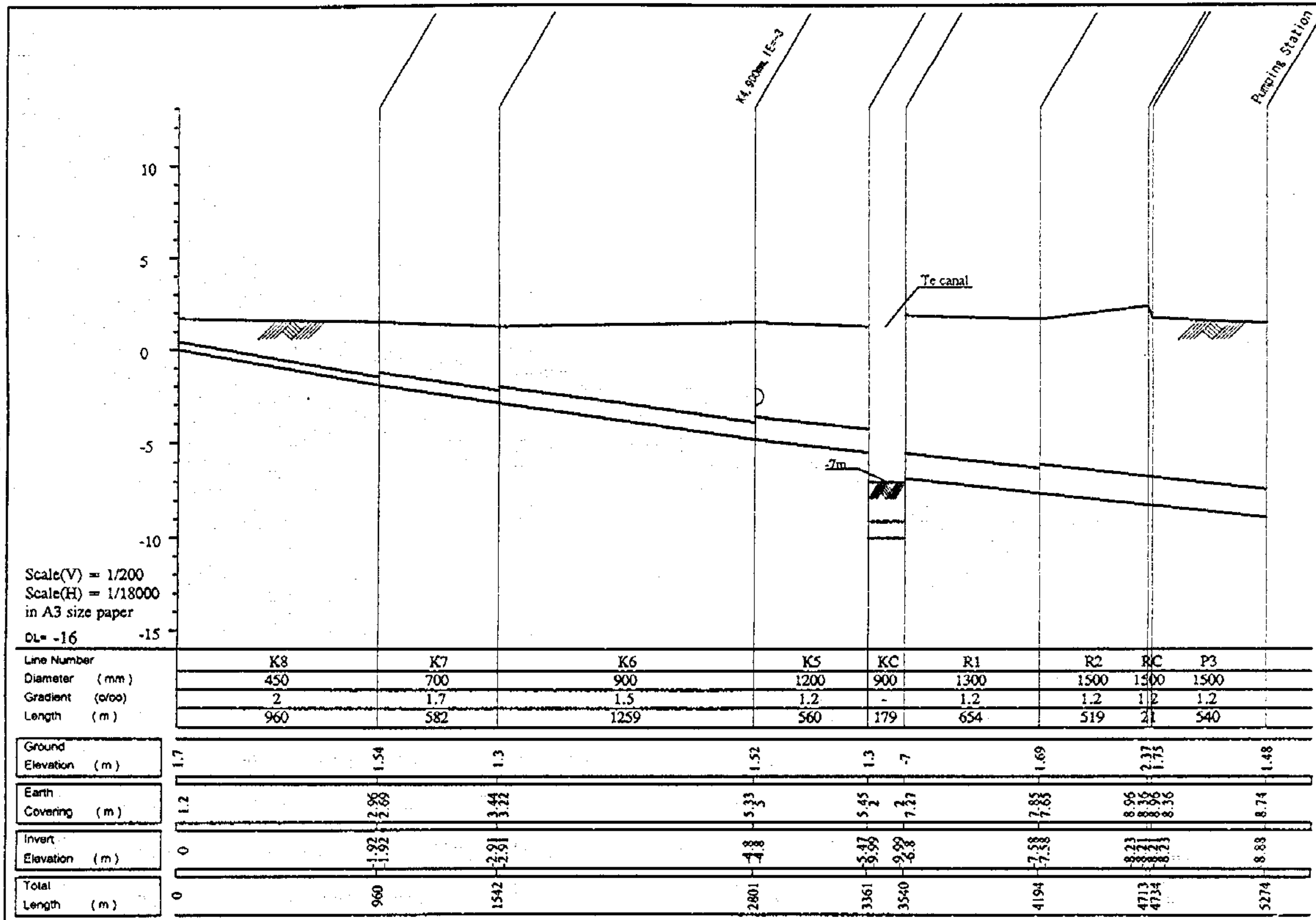


FIG. 8.25 LONGITUDINAL PROILE OF INTERCEPTOR FOR KHANH HOI AND RACH ONG SUB-ZONES

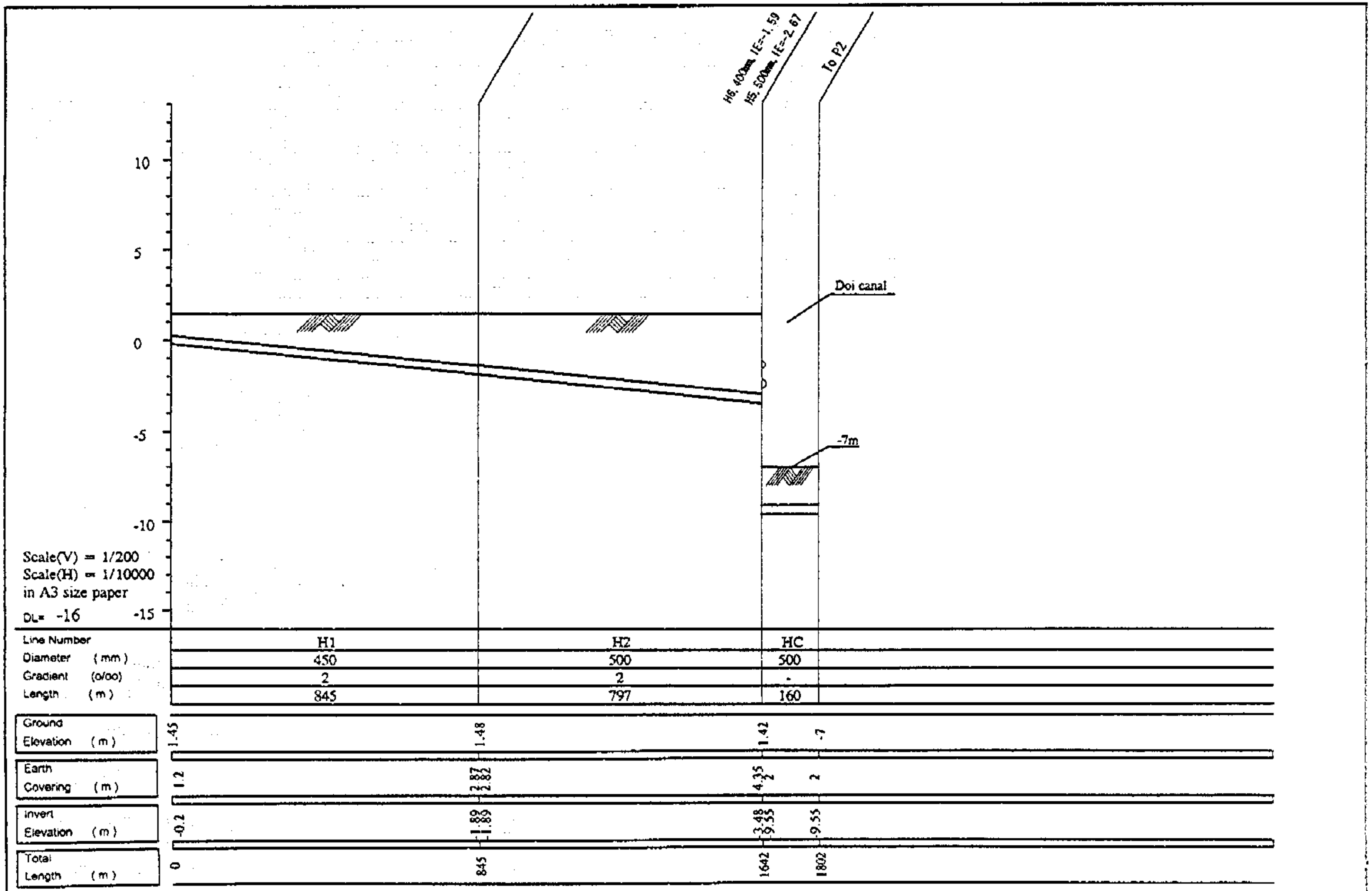


FIG. 8.26 LONGITUDINAL PROILE OF INTERCEPTOR FOR HUNG PHU SUB-ZONES

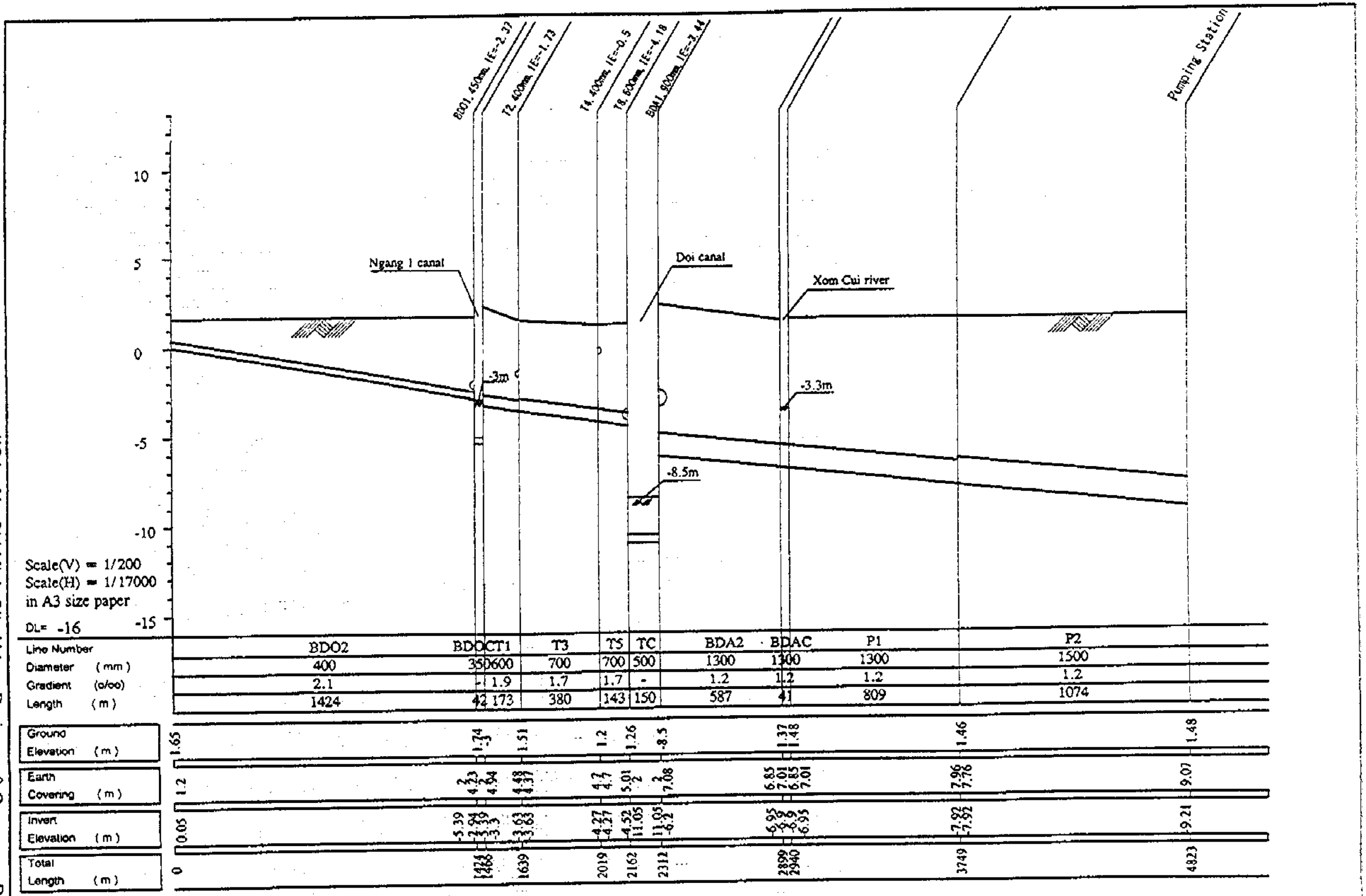


FIG. 8.27 LONGITUDINAL PROILE OF INTERCEPTOR FOR BINH DONG, TUNG THIEN VUONG, BINH DANG AND PHAM THE HIEN SUB-ZONES

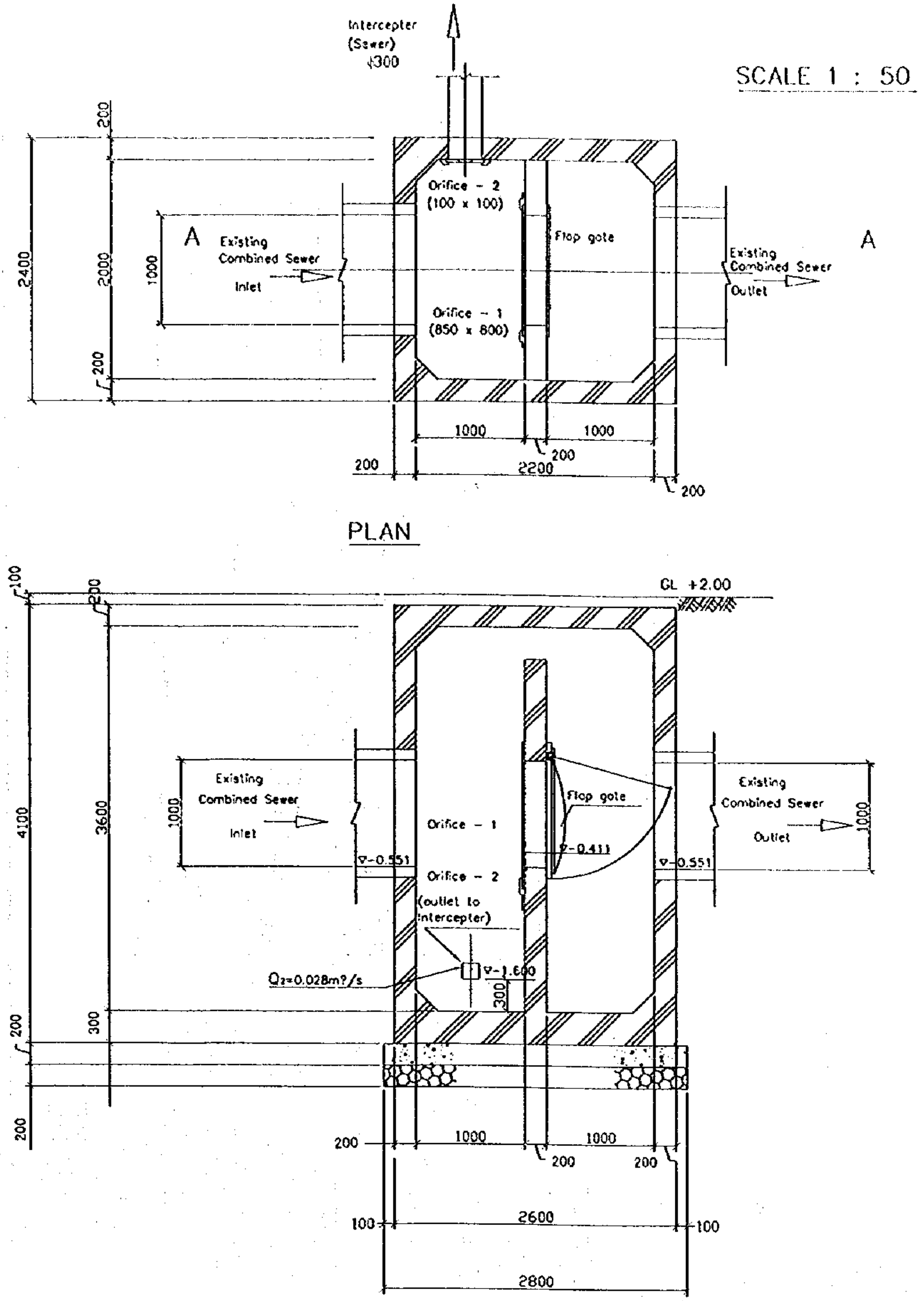


FIG. 8.28 PROPOSED TYPICAL SECTION DIVERSION CHAMBER

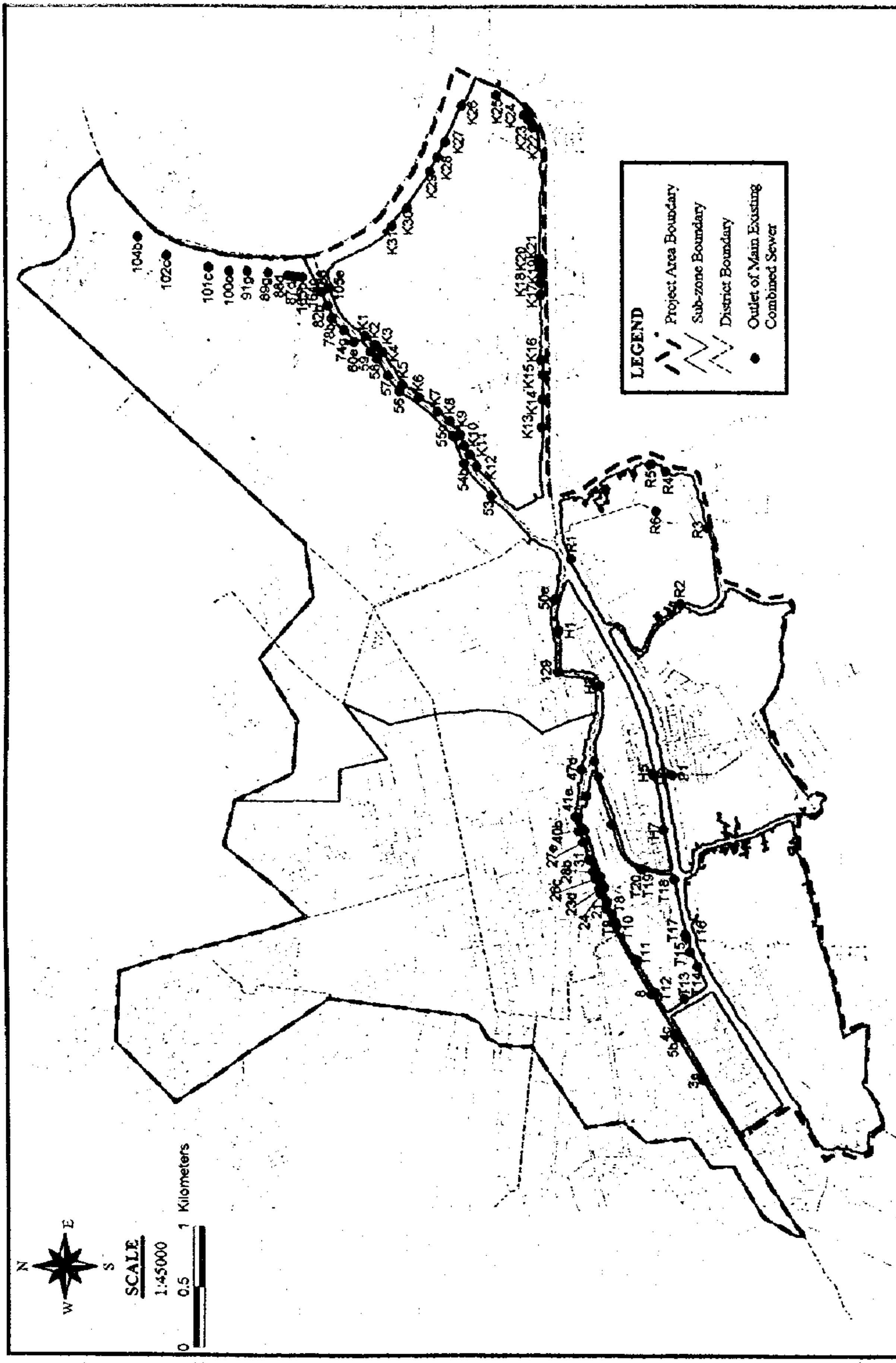


FIG. 8.29 LOCATION OF OUTLET OF MAIN EXISTING COMBINED SEWER

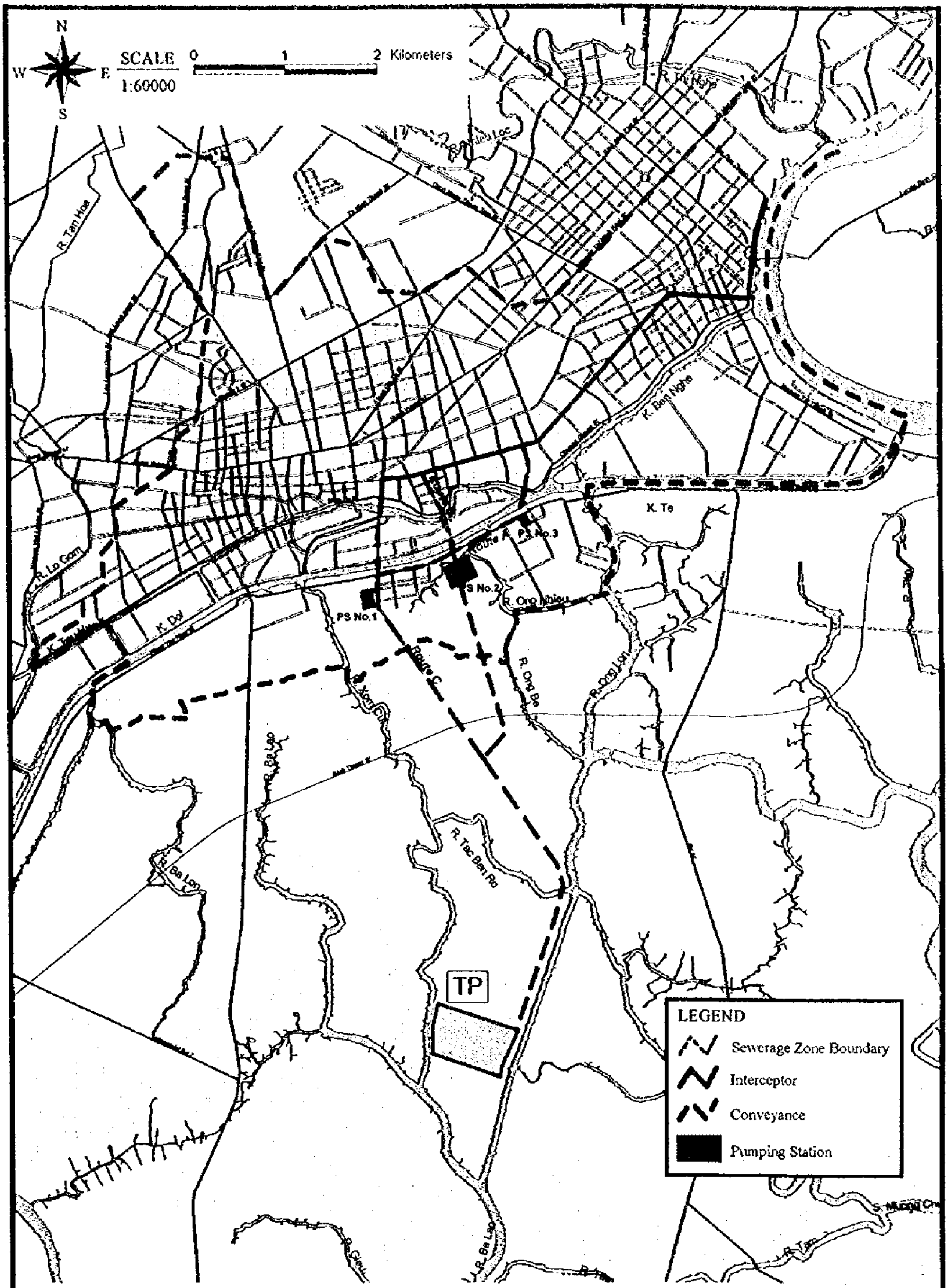


FIG. 8.30 ALTERNATIVE STUDY ON CONVEYANCE ROUTE

JICA - Ho Chi Minh City Urban Drainage & Sewerage Project