Chapter 3

TAU HU - BEN NGHE CANAL IMPROVEMENT

CHAPTER 3 TAU HU - BEN NGHE CANAL IMPROVEMENT

3.1 Present Condition of the Canal

3.1.1 Hydraulic Characteristics

Tau Hu - Ben Nghe canal lies along southern edge of the central business area of HCM City and drains the rainwater, domestic and industrial wastewater from District 1, 4, 5, 6, 8, 10, 11 and Binh Chanh District into Saigon River. The canal having a total length of about 12.1 km connects with Ben Luc River to the west and Saigon River to the east. Its present hydraulic characteristics (canal bed and bank elevations, width, depth, maximum flow area, wetted perimeter, average hydraulic gradient, velocity and discharge capacity) are updated in the previous JICA feasibility study. These are shown in Table 3.1 and Fig. 3.1 and summarized below.

(1) Canal Bed and Dike Crown Elevation

Bed elevation of Ben Nghe canal, which varies from EL.-1.82 to EL.-2.72 m above MSL, is very shallow due to much sedimentation consisting of dumped soil, garbage, solid waste, debris and organic materials. Tau Hu downstream reaches of about 4.2 km long from Chu Y Bridge to T-junction with Ngang No.1 canal are also very shallow. The bed elevation from EL.-1,50 to EL.-2.98 m is almost the same variation as that of Ben Nghe canal. Upstream reaches of Tau Hu canal including Lo Gom canal with elevation from EL.-3.06 to EL.-3.82 m are relatively deep, however, still shallow for navigation of the boat with 300 tons during low tide.

Bank elevations of Ben Nghe and Tau Hu downstream reaches vary from EL.+1.3 to EL.+1.9 m, which is almost the same as or higher than the design high water level (DHWL) of EL.+1.32 to EL.+1.50m. However, existing dikes in some sections of Tau Hu upstream reaches are lower than DHWL of EL.+1.50 to EL.+1.6 m. Accordingly, during high tide, flood waters have overflowed from low banks to the low-lying inland.

(2) Canal Width

Average canal width of Ben Nghe may be originally about 60 m and 70 m in upstream and downstream reaches respectively, according to the old topographic map with 1:5000. However, due to the encroachment of more than 7,800 illegal houses and buildings constructed on and along the canal, the present width from midstream to upstream reaches of Ben Nghe have become narrowed from 30 m to 40 m, resulting in a greater hindrance to the drainage and smooth navigation.

The original width of Tau Hu upstream and downstream reaches may be 45 m to 50 m and 40 m to 60 m respectively. Due to the encroachment of illegal houses and buildings to the watercourse of Tau Hu upstream, the width of some sections are reduced to about 30 m. Execution of the relocation program is expected for the improvement of storm water drainage, waterway transportation and water environment including landscape.

(3) Velocity and Discharge Capacity

Tau Hu - Ben Nghe canal has always strongly affected by tidal influence from the East Sea. The tide amplitudes are quite high. The average tide amplitudes at Phu An station near the mouth of Ben Nghe canal ranges from 1.7 to 2.5 m. Therefore, flow direction and velocity of the canal always vary based on the water levels of surrounding rivers, especially Saigon and Nha Be rivers. Maximum and minimum velocity is surveyed at about 0.5 and 0 m/sec respectively, which are evaluated by the hydraulic dynamic simulation. The existing discharge capacities of Tau Hu - Ben Nghe canals during the high tide are estimated at 30 to 150 m^3/sec under the steady flow condition.

3.1.2 Water Environment

Tau Hu - Ben Nghe canal receives untreated domestic and industrial wastewater with about 300,000 m^3/day from the surrounding districts excluding Tan Hoa - Lo Gom basin. Water quality of the canal has been deteriorated to an alarming level. The canal water is black in color and emanates offensive odor. At Chu Y Bridge, Tau Hu canal has BOD as high as 150-250 mg/l and Fecal Coliforms is of the order of 2.1 E+0.5 MPN/100ml. Water quality is comparatively better in Ben Nghe downstream reaches due to dilution by Saigon River. BOD is about 100-150 mg/l but still quality of canal is similar to wastewater. The fecal contamination has already led to higher incidence of water-borne diseases in District 5,6 and 8. Sludge accumulated at the bottom of canal is undergoing an aerobic degradation and emanates offensive odor of CH_4 and H_2S. Investigation of sludge shows that heavy metals are present but still sludge can pass EU regulations and Japanese standards for heavy metals in the sludge to be disposed on land. Present water quality condition of Tau Hu - Ben Nghe is shown in Table 3.2.

3.1.3 Encroachment by Illegal House and Building

According to the 1996 survey data by the Department of Land and Housing (DLH), the number of residents on and along Tau Hu - Ben Nghe canal including the tributaries is reported about 65,000 with 7,800 households as shown in the table below. Among them, illegal houses account for 80% and most of them encroach on the canal water. Almost half of them have been living in the low level or temporary houses of this area without electricity and water supply services for more than 20 years. Many houses can be seen constructed on the accumulated garbage in the canal and disturb the storm water drainage and navigation. The part of Tau Hu canal in District 5 has the highest density of houses followed by the Ben Nghe canal on the side of District 1. There are many boats floating on the lower part of Ben Nghe canal of the District 1 and on the side of District 5 of Tau

Hu canal. Compared with Ben Nghe canal, Tau Hu canal has more warehouses, small workshop, markets and unloading stations of the shipment. Action plan for relocation and resettlement of illegal houses along left (north) and right (south) banks of Tau Hu – Ben Nghe canal has being prepared by both PMU of East-West Highway Project and Water Environment Improvement Project respectively.

SUMMARY OF RESIDENTS ALONG TAU HU - BEN NGHE CANALS

Item	Number
Total Residents (persons)	65,218
Total Households (households)	7,832
Share of Illegal Households (%)	80.8
Houses located in less than 5 m from the bank (houses)	5,921 (80.2%)
Houses constructed before 1975 (houses)	3,679 (49.8%)

Source: Survey of Households along Canals in Inner City of HCM City, 1996,DLH

3.1.4 Related Structures

There are four (4) relevant structures on and along the canal. These are electric cable, bridge, quay and bank protection. Location of related structures is shown in Fig. 3.2.

(1) Electric Wire

Fourteen (14) power lines in total have been installed over and/or under Tau Hu - Ben Nghe canal including Ngang No.1 to No.3 canals. These are as follows:

Canal	Number of Line	Voltage	Location
Ben Nghe	4	Medium	Over the canal (2 lines) Underground (2 lines)
Tau Hu	7	2 lines: High 2 lines: Medium	Over the canal
Ngang No.1	1	Medium	Over the canal
Ngang No.2	1	Medium	Over the canal
Ngang No.3	1	Medium	Over the canal

(2) Bridge

There are fifteen (15) existing and one (1) under constructing bridges on the Tau Hu - Ben Nghe and Ngang No.1 to No.3 canals. Out of these bridges, seven (7) bridges were constructed by reinforced or pre-stressed concrete. The remaining nine (9) bridges are steel one. Mon and Ong Lanh bridges are not in use, because the superstructure has been damaged. Mon Bridge is being rehabilitated as a historical structure. Main structural features of the existing bridges are shown in Table 3.3. Replacement of eight (8) bridges, Khanh Hoi, Mong, Calmette, Chu Y, Cha Va, Binh Tay, Chu U and Nha May Ruou bridges is included in East-West Highway Project.

(3) Quay Structure

According to OWM, seven (7) quays are operating along Tau Hu - Ben Nghe canal, in which two (2) quays is in Ben Nghe canal and the remaining five (5) are along Tau Hu canal. Name, location, length and loading/unloading goods of each quay are summarized in the table below.

SUMMARY OF QUAY ALONG TAU HU - BEN NGHE CANALS

No.	Name	Location	Length (m)	Loading/Unloading Good
Q.1	No.5	Ben Nghe	70	foodstuff, agricultural product
Q.2	No.6	ditto	100	ditto
Q.3	No Name	Tau Hu	30	construction material (sand)
Q.4	No Name	ditto	30	ditto
Q.5	No.2	ditto	120	
Q.6	Tran Van Kieu	ditto	2,000	foodstuff, agricultural product, fertilizer, construction materials
Q.7	Ben Binh Dong	ditto	2,200	ditto

(4) Bank Protection/Revetment

Ben Nghe canal has no existing sufficient bank protection or revetment except near confluence with Saigon River. These were constructed by stone masonry with the slope of 1:3, of which length is about 60 and 160 m for the left and right bank respectively.

Some kinds of bank protection or revetment are fund out along Tau Hu, Lo Gom and Ngang No.2 canals. These facilities have been rehabilitated and newly constructed by OMW based on the navigation requirements. Location of the existing bank protection and revetment are summarized below and shown in Fig. 3.2.

(a) right bank of downstream reaches from Cha Va Bridge: about 400 m
(b) right bank of downstream reaches from Ngang No.1 canal: about 450 m
(c) both banks of downstream reaches from Chu U Bridge: about 600 m
(d) right bank from the confluence of Ngang No.2 canal to Chu U Bridge: about 550 m
(e) right bank from the confluence of Lo Gom to Ngang No. 2 canals: 1,000 m
(f) both banks near the confluence of Doi canal: about 200 m

Some sections of these facilities are, however, eroded, damaged and collapsed due to their long use, some poor quality, and collide with boats. These are needed to rehabilitated or replaced to new one. Table 3.4 shows the summary of existing bank protection and revetment and their structural evaluation.

(5) Landscape

General landscape overview has three sections of characteristic feature through Tau Hu - Ben Nghe canal system. These are (i) Ben Nghe canal from Khanh Hoi Bridge to Chu Y Bridge, (ii) Tau Hu (Downstream) canal between Chu Y Bridge and T-junction with Ngang No.1, (iii) Tau Hu (Upstream) canal from T-junction with Ngang No.1 to confluence with Doi canal.

The existing characteristic landscape impression sketches for the above three sections are shown in Figs. 3.3(1/3) to (3/3) and summarized below:

(a) Ben Nghe canal

- Old-fashioned steel frame bridge is to be a focal point. View from the Khanh Hoi Bridge.
- Squatter settlement houses on the water fringe at Calmette Bridge west
- Rich of tree vegetation is dominated and made amicable scenery at south bank area nearby Khanh Hoi Bridge.
- Loading and unloading activities with small boats are observed nearby Cau Muoi market. View from Ong Lanh Bridge
- Line of canal revetment continues and no squatter settlement can be seen at Nguen Van Cu transport facility
- Open view stretching on the Ben Nghe canal at Nguyen Kieu bridge at south bank

(b) Tau Hu (Downstream) canal

- Low quality settlement houses densely congested has been occupied on the water margin along Tau Hu canal. View from Chug Y Bridge
- Group of small boats are tying on the bank at the area of canal wound.
- Raw of the old French style warehouses and anchored rice grain loading boats on the left (north) bank of the canal
- Cha Va Bridge and the canal bank, squatter settlements are jammed at the north bank area.
- Variety of small boats is crowded near by Cho Lon market, and existing bank protection is sometimes discontinued by settlement houses on the north bank.
- Newly improved stone masonry revetment at the right (south) bank of the canal and canopy trees has been planted along top of the revetment.
- Newly constructed RC bridge is crossing over the canal No.1.

(c) Tau Hu (Upstream) canal including Lo Gom canal

- Group of old French style warehouses are remained along the north bank of the Tau Hu canal.

- Linear stretched river port is allocated with small boats and barges at the confluence of Tau Hu and Tan Hoa canals.
- Along the south bank of the Lo Gom canal, some houses are allocated at the water margin and small boats are tying there.
- No revetment is recognized and irregular formulated along the canal fringe, bamboo stockpiles are often observed on the bank.
- Canal confluence point at Lo Gom and Doi canal meeting, their Industrial warehouses are facilitated.

3.2 Related On-going Project

There are three (3) related on-going project for preparation of Tau Hu - Ben Nghe canals improvement plan. These are summarized as follows:

3.2.1 Dredge and Rehabilitation Project on Ben Nghe - Tau Hu - Lo Gom for Navigation

Office of Waterway Management (OWM) has completed the feasibility study on the Project to Dredge and Rehabilitate Ben Nghe - Tau Hu - Lo Gom for Navigation in December 1995. The main objectives of the project are as follows:

- to dredge the canal in order to recover the enough draft for the navigation
- to contribute as much as possible for the improvement of urban drainage condition in the central parts of the city

The proposed project is summarized below:

(a) Name of Project: Improvement if Ben Nghe - Tau Hu - Lo Gom canal
(b) Implementation Agency: Waterway Unit under the management of Transportation and Public Works Service
(c) Location of the Project: District 1, 4, 5, 6 and 8
(d) Main Construction Item

- Length to be Dredged:

Ben Nghe canal	: L =	3.45 km
Tau Hu canal	: L =	6.30 km
Lo Gom canal	: L =	2.75 km
Ngang No. 1, 2 and 3	: L =	1.35 km
Total	: L =	13.85 km

- Minimum Width of Canal to be Dredged
  - * Ben Nghe canal (Saigon River – Chu Y Bridge) : W = 21.0 m
  - * Tau Hu canal (Chu Y Bridge – Ngang No. 1) : W = 21.0 m
  - * Tau Hu/Lo Gom canal (Ngang No.1 – Phu Dinh) : W = 22.0 m
- Design Water Level : H = -1.20 m
- Minimum Draft for Boat Navigation : H = 2.1 m and 3.1 m
- Design Canal Bed Elevation

* Ben Nghe canal (Saigon River – Chu Y Bridge) : EL = -3.30 m
* Tau Hu canal (Chu Y Bridge – Ngang No. 1) : EL = -3.30 m
* Tau Hu/Lo Gom canal (Ngang No.1 – Phu Dinh) : EL =-4.30 m

- Total Dredging Volume : V = 1,043,513 m^3

(e) Project Implementation Period : T = 2 years
(f) Project Cost: Construction Cost : C1 =33,246 million VND
Contingency and Others : C2 = 3,200 million VND
Total : C3 =36,446 million VND
(g) Source of Fund: PCHCM City

The project was approved on April 1998 by PCHCMC, however, any dredging has never been executed up to now due to local budgetary constrain. OWM states that the tender of Ben Nghe Canal Dredging Project is executed in May 2000 and dredging work will be commenced from the end of June 2000 as periodical dredging work.

3.2.2 Rehabilitation of Ben Chuong Duong – Ben Ham Tu – Tran Van Kieu Road

In 1995, Department of Transportation and Public Works (DTPW) conducted the feasibility study on the rehabilitation and widening project of Ben Chuong Duong - Ben Ham Tu - Tran Van Kieu Road. The existing road of 9.92 km in length runs along and close to Tau Hu - Ben Nghe canal through the District 1, 5, 6, 8 and Binh Chanh District and mainly functions as a regional road. These roads, of which width is very narrow of 6 to 10 m, were constructed in the French colonial time. DTPW proposed to rehabilitate and widen these roads in order to create a new urban road, to meet with the transport requirement for the communication between Northeast and Southwest regions of the city and to contribute the improvement of city traffic condition.

The proposed project as shown in Fig. 3.4 is summarized as follows:

(a) Name of Project: Rehabilitation and Widening of Ben Chuong Duong - Ben Ham Tu - Tran Van Kieu - Ben Nghe - Ham Tu Road Across Lo Gom Canal Linking With N.H.1A
(b) Implementation Agency: DTPW, PCHCM
(c) Location of the Project: District 1, 5, 6,8, and Binh Chang District
(d) Main Construction Item:

- Length to be improved: Ben Chuong Duong Road : L = 2.675 km
Ben Ham Tu Road : L = 2.795 km
Tran Van Kieu Road : L = 3.622 km
Lo Gom Bridge – National Road-1 : L = 4.258 km
Total : L = 13.350 km
- Proposed width Ben Chuong Duong Road : W = 35.5 – 42.5 m
Ben Ham Tu Road : W = 35.5 – 36.5 m
Tran Van Kieu Road : W = 23.5 – 42.0 m

Lo Gom Bridge – National Road-1 : W = 40.0 m

- Bridge Construction: Five bridges

(e) Relocation and Resettlement Program

- Number of house to be removed: 4,650 houses
- Number of house to be resettled: 3,745 houses

(f) Project Cost:

Project Cost:	Construction Cost:	373,600 billion VND
	Compensation and Removal Cost:	538,452 billion VND
	Total Cost:	912,052 billion VND

Special Assistance for Project Formation (SAPROF) for this project has been conducted by Japan Bank for International Cooperation (JBIC), which is described below.

3.2.3 SAPROF Study for Transport Infrastructure Development Project in HCMC

SAPROF Study for the Transport Infrastructure Development Project in HCMC, which consists of two phases, has been conducted from January to September 1999 by JBIC.

In 1st Phase study, (i) clarification of the consistency for 25 candidate subprojects with the Master Plan 2020 of the HCMC, (ii) evaluation of a priority order of these subprojects and (iii) selection of the high priority project to be covered in 2nd Phase study were carried out. As a result, "Ben Chuong Duong - Ham To - Tran Van Kieu Road (Canal Side Road) Improvement Project" mentioned in the previous section and "Saigon River Crossing Tunnel Project" were identified as the high priority projects.

2nd Phase study was conducted to define the project scope and to confirm the technical and economical feasibility, measures to be taken for compensation and resettlement, and environmental soundness of these two (2) Project. Relevant matters for Tau Hu - Ben Nghe canal improvement in 2nd Phase study is summarized as follows:

(1) Design Concept

Geometric design standards of the Canal Side Road and Tunnel are as follows:

Item	Canal Side Road	Tunnel Section
1. Number of lane (two ways)	6	6
2. Cross section elements		
(1) Lane width (m)	3.50	3.25
(2) Raised median (m)	1.00	1.50
(3) Left and Right shoulder (m)	2.00 & 0.25	0.50 & 0.50
3. Alignment elements		
(1) Design speed (km/hr)	60	60
(2) Min. horizontal curve (m)	120	120
(3) Min. vertical curve of sag/crest (m)	1,000 &1,400	1,000 & 1,400

(4)	Vertical clearance	4.50	4.50

Typical cross sections of Canal Side Road and Tunnel are shown in Figs. 3.5.

(2) Preliminary Design of Alignment

The alignment of Package-1 (Canal Side Road) from National Highway No.1 to Calmette Bridge is divided into the following two (2) sections:

(a) Section-1: 5 km from National Highway No.1 to the eastern end of Tran Van Kieu street: unrelated section to Tau Hu - Ben Nghe canal improvement
(b) Section-2: 8.05 km from Tran Van Kieu street to Calmette Bridge along Ben Chong Duong street: related section to Tau Hu - Ben Nghe canal improvement

The proposed alignment of Canal Side Road along Tau Hu - Ben Nghe canal is almost the same as that of the previous pre-feasibility study as shown in Fig. 3.4, except the section of about 2.5 km between Cha Va Bridge and Cho Quan Hospital. The alignment of this section was revised to minimize the affected housed and buildings. Applied radii for Section-2 road range from 80 to 400 m. PMU of this Project note that the minimum radius is expected to change from 120 to 200 m.

The right-of-way width for the Canal Side Road is as follows:

(a) Section-1: 41.5 m (Left and right 20.75 m from the road center)
(b) Section 2: 36.5 m – 41.5 m (refer to Fig. 3.5)

The alignment of Package-2 starts from Calmette Bridge and underpasses the Saigon River by immersed and cut & covered tunnel, which connects with Thu Thiem Road to be designed and constructed by PCHCMC. Applied radii for Package-2 varies from 500 to 1,000 m.

(3) Preliminary Planning of Interchanges

Along Tau Hu – Ben Nghe canal, the following three interchanges are proposed to construct under this project:

(a) Fly-over with Cha Va Bridge (Project road overpass the crossing road)
(b) Fly-over with Chu Y Bridge (Project road underpasses the crossing road)
(c) Diamond with Calmette Bridge (Project road underpasses the crossing road)

Other interchanges at Nguyen Tri Phuong Bridge/Street (S/N No.8), Nguyen Van Cu Bridge to Binh Tuang Road (S/N No.17) and North-south Axis Road (S/N No.6) are proposed to construct in future.

(4) Improvement of Existing Bridges

The following five existing bridges across the Tau Hu - Ben Nghe canal are proposed to re-constructed under the Project.

(a) Cha Va Bridge: Cha Va Bridge is proposed to be widen in order to obtain the turning lanes for traffic coming in and out the Project Road
(b) Chu Y Bridge: Chu Y Bridge in the section of Tau Hu canal is proposed to re-construct in order to obtain at least 4.7 m of vertical clearance.
(c) Calmette Bridge: Existing bridge is proposed to reconstruct and widen considering the heavy traffic from Saigon Port to the entrance of Tunnel.
(d) Mong Bridge: Approach road of the bridge is proposed to reconstruct.
(e) Khanh Hoi Bridge: Existing bridge is proposed to reconstruct at the same place and temporary bridge shall be provided during the construction.

(5) Other Facilities

Other road facilities related to the canal improvement are as follows:

(a) Retaining Wall: Reinforced concrete retaining wall may be employed for the left (north) bank of Ben Nghe canal between Calmette to Mong bridges, if necessary, in order to keep the required right-of-way.

(b) Pedestrian and Bicycle Bridge: The existing pedestrian bridges across Tau Hu – Ben Nghe canal should be improved to maintain properly the traffic from the pedestrian bridge into the project road. These bridges are as follows:

- Binh Tay Bridge: 3 m in width
- May Ruou Bridge: 3 m in width
- Chu U Bridge: 4 m in width

(6) Relocation

Affected houses of 4,454 units on and along left (north) bank of Tau Hu - Ben Nghe canal is planned to relocated and resettled in this project. Therefore, any land acquisition and house compensation along left bank of Tau Hu - Ben Nghe canal is not necessary to consider in preparation of canal improvement plan.

3.3 Planning Concept and Design Criteria

Planning concept and design criteria which aim to propose more practical, economical and sustainable canal improvement project are established as follows:

(1) Target Year

Target completion year of the canal improvement project is set at 2010 on the premises that the proposed project implementation will be taken up at least 10 years. However, all the plans are to be prepared to meet the city development plan in 2020.

(2) Design Scale

Design scale for Tau Hu - Ben Nghe canal improvement is 10-year frequency flood, which is applied for the canal with total catchment area of more than 30 km^2. This design criteria was established in the Master Plan.

(3) Design Rainfall

The following rainfall intensity-duration formula is to be employed as a design rainfall for Tau Hu - Ben Nghe canal improvement.

(a) $I = 29{,}125/(t^{1.25} + 154)$: $t < 3$ hours
(b) $I = 1{,}669/(t^{0.80} - 16)$: 3 hours $< t <$ 24 hours

where, I: Point rainfall intensity (mm/hour)
t: Duration (minutes)

For flood run-off analysis, the area reduction factor prepared in the Master Plan Study is applied to convert the basin design rainfall intensity.

(4) Design High Water Level

Design High Water Level (DHWL) at the mouth of Ben Nghe canal is applied at EL.+1.32 m above MSL, which is the average of monthly maximum water levels during August and November. Design 24 hours consecutive water level variation prepared in Master Plan Study is employed in hydraulic evaluation of the canal improvement by hydrodynamic simulation model.

(5) Navigation Requirement

The canal improvement plan of Tau Hu - Ben Nghe have to meet the following waterway transportation requirements proposed by OMW.

NAVIGATION REQUIREMENTS FOR TAU HU - BEN NGHE CANALS

Canal	Section Start	Section End	Min. Canal Width (m)	Design Water Level (m)	Proposed Canal Bed Elevation (m)	Boat Size (ton)
Ben Nghe	Saigon River	Chu Y Bridge	21.0	- 1.20	- 3.30	100 - 200
Tau Hu (Downstream)	Chu Y Bridge	Ngang No.1	21.0	- 1.20	- 3.30	100 – 200
Tau Hu (Upstream)	Ngang No.1	Phu Dinh Port	22.0	- 1.20	- 4.30	300
Ngang No.1 to No.3	Tau Hu Canal	Doi Canal	22.0	- 1.20	- 4.30	300

Note: DWL of –1.20 m corresponding to 90% frequency for the navigation possibility was determined based on the alternative study conducted by OMW.

(6) Other Criteria

Other criteria, such as run-off formula, Manning's roughness coefficient, freeboard, are the same as those of Master Plan Study.

3.4 Alternative Study

According to the navigation requirements prepared by OMW, the bed elevation of Tau Hu downstream reaches from Chu Y Bridge to Ngang No.1 is proposed to be 1.0 m higher than that of upstream reaches. Considering more steady flow of the downstream reaches, the following alternative study has been carried out.

(a) Alternative I.A:
Minimum bed elevation of Tau Hu downstream reaches is to be -3.30 m, which is proposed by the navigation requirements. Bed slope of Tau Hu - Ben Nghe canal is designed to be unidirectional. Bed level of Ben Nghe canal varies from EL. -3.30 m at confluence with Te canal to -3.45 m at Saigon river mouth. Bed level of Tau Hu canal varies from EL. -3.30 m at confluence with Ngang 1 canal to -3.50 m at confluence with Doi canal and from EL. -4.30 m at confluence with Doi canal / Ben Luc river to -4.54 m at confluence with Ngang 1 canal. The rise in bed level from upstream to downstream of Tau Hu canal at confluence with Ngang 1 canal is 1.24 m.

(b) Alternative I.B:
Bed slope of Tau Hu - Ben Nghe canal is designed to follow flood flow direction (bi-directional). From confluence of Tau Hu canal with Ngang 1 canal to Saigon river mouth, bed levels of Tau Hu - Ben Nghe canals are the same as that of for Alternative IA. But from confluence of Tau Hu canal with Lo Gom canal to

confluence with Ngang 1 canal and to confluence with Ben Luc river / Doi canal, bed level varies from EL. -4.30 m to -4.41 m and from -4.30 m to -4.43 m. The rise in bed level from u/s to d/s of Tau Hu canal at confluence with Ngang 1 canal is 1.11 m

(c) Alternative II:
Minimum bed elevation of Tau Hu downstream reaches is to be - 4.30 m, which is the same as that of the upstream reaches. Bed slope of Tau Hu - Ben Nghe canal is the same as Alternative IA (unidirectional). Bed level of Ben Nghe canal and Tau Hu canal from confluence with Ben Luc river / Doi canal to Ngang 1 canal are the same as that of for Alternative IA. But bed level of Tau Hu canal from confluence with Ngang 1 canal to Doi canal is lower than that of Alternative IA or IB.

Longitudinal profile of each alternative is shown in Table 3.8. Alternative study has been conducted under the following hydrological and hydraulic conditions:

(a) Canal Network: Ben Nghe - Tau Hu - Lo Gom - Doi - Te canal network including Ngang No.1 to No.3
(b) Catchment Area: Independent catchment with total area of 61.72 km^2 including Tan Hoa - Lo Gom basin
(c) DHWL : 1.32 m at the mouth of Ben Nghe and Te canals
(d) Design Rainfall: 10-year return period
(d) Status of Canal: Ben Nghe, Tau Hu, Ngang: after improvement, Doi, Te: existing
(f) Calculation Method: Hydrodynamic simulation model of MIKE 11

Comparative studies of the above Alternatives mentioned in Section 6 conclude that Alternative IB is more feasible option. Because, the construction cost of Alternative II is estimated at 11.96 billion VND higher than that of Alternative IA and IB, even if hydraulic effect of Alternative II can be expected only 5 cm lower water level than that of Alternative IA and IB as shown in Table. 3.8. Moreover, Alternative IB follows natural flow/flood flow direction and is inferred to be more efficient in conveying flood water than Alternative IA.

COST COMPARISON OF ALTERNATIVES I and II

(unit of cost: billion VND)

Alternative / Item	Alternative IA and IB		Alternative II	
	Quantity	Cost	Quantity	Cost
1. Dredging	335,830 m^3	45.34	424,450 m^3	57.30
2. Bank Protection (Type A)	29,709 m^2	16.56	29,709 m^2	16.56
(Type B)	8,720 m^2	12.55	8,720 m^2	12.55
(Type C)	4,200 m^2	15.50	4,200 m^2	15.50
Total		89.95		101.91

Note: Bill of quantities of Alternative IA and IB are almost same.

3.5 Proposed Definitive Plan

3.5.1 Alignment

The alignment of the courses of Tau Hu - Ben Nghe canal proposed in the Feasibility Study has been fully reviewed based on the topographic map with scale of 1:1,000 and the following technical point of view:

(a) To coincide with the existing channel alignment to minimize land acquisition and house evacuation

(b) To ensure the curve within the radius from 100 to 200 m for Ben Nghe and Tau Hu (Downstream) canals, and 200 to 300 m for Tau Hu (Upstream) canal including Lo Gom canal taking into consideration of navigation criteria

(c) Principally, to maintain the original canal width as much as possible

(d) To coincide with the road alignment proposed in the SAPROF Study on HCMC East-West Highway Project and to ensure the horizontal curve with minimum radius of 200 m indicated by PMU East-West Highway Project.

Through a series of meeting with PMU East-West Highway Project and OWM, the proposed alignment of Tau Hu - Ben Nghe canal has been revised and finalized as shown in Fig. 3.6.

Main revised alignments are as follows:

(a) Total number of curve of the watercourse was reduced from 38 to 29. As a result, total length of canal improvement was little bit shorten from 12.170 to 12.098 km. Its breakdown is as follows:

Name of Canal	Improvement Length (m)		
	F/S Study	De/P Study	Difference
Ben Nghe	3,140	3,158	+ 18
Tau Hu (Downstream)	4,220	4,130	- 90
Tau Hu (Upstream)	4,810	4,809	- 1
Ngang No. 1	390	390	0
Ngang No. 2	420	420	0
Ngang No. 3	400	400	0
Total	13,380	13307	73

(b) Alignment between Khan Hoi and Mong bridges was shifted about 10 m to the south to acquire the land for reconstruction of access road of Mong Bridge.

(c) Radii of S-curve section of Tau Hu canal nearby Cho Quan Hospital was revised from 100 and 175 m to 160 and 250 m in order to keep minimum radius of 200 m proposed in East-West Highway Project.

3.5.2 Longitudinal Profile

The proposed canal bed has to be designed principally to meet the requirements of waterway transportation, which was mentioned in Section 3 "Planning Concept and Design Criteria". The canal bed slope is planned at 1:20,000 to maintain the canal bed and to be more gentle hydraulic gradient of DHWL, which is nearly equal to or lower than the existing ground level in principle so as not create drainage problems inside the embankment.

The proposed longitudinal profile of Tau Hu – Ben Nghe canal is shown in Table 3.5 and Fig. 3.7.

3.5.3 Cross Section

Three types of single cross sections were proposed in the previous Feasibility Study. These are as follows:

(c) Type A: Trapezoidal in shape channel with 1:1.5 slope lined by stone masonry
(d) Type B: Trapezoidal in shape channel with 1:0.5 slope lined by stone masonry
(e) Type C: Rectangular in shape channel lined by concrete retaining wall or concrete pile revetment.

Among of these types, Type A and B are more typical one than Type C, which was proposed to employ for only S-curve channel improvement of about 525 m in length near by Cha Quan Hospital along Tau Hu canal.

In parallel with review of canal alignment through several meetings with PMU East-West Highway Project and OWM, cross-sections have been also reviewed and revised as the need arises. These revised sections are as follows:

(a) S-curve section of 525 m long near by Cha Quan Hospital along Tau Hu canal: Proposed cross section was changed from Type C to Type A, which is the same as that of up and downstream reaches. Because, it can keep better condition for smooth navigation, and land acquisition along right bank should be made in order to acquire the required land along left bank for East-West Highway Project. Land acquisition and house compensation cost for the area of 1,600 m^2 increased by changing from Type C to A was lower than difference of their construction cost.

(b) Downstream stretch of about 120 m from Cha Va Bridge:
Type A was revised to Type B, because of narrow width between two existing roads along both banks.

(c) Tau Hu (Upstream) canal of about 700 m between T-junction of Ngang No.1 to Chu U Bridge:
Type A was revised to Type B due to the same reason of above item (b).

(d) Ngang No.2:
Canal improvement by only dredging was revised to Type A improvement.

Revised length of Tau Hu - Bhen Nghe canal improvement by cross section type is shown in the table below:

Name of Canal	Type A		Type B		Type C		Existing		Total	
	F/S	D/P	F/S	D/P	F/S	D/P	F/S	D/P	F/S	D/P
Ben Nghe	5.74	5.59	0	0	0	0	0.40	0.38	6.28	5.97
Tau Hu (Down)	4.31	6.03	1.95	2.40	1.05	0	0.96	0	8.27	8.43
Tau Hu (Up)	6.83	6.96	0.60	2.18	0	0	2.20	0.49	9.63	9.63
Ngang No.1	0.78	0.70	0	0.14	0	0	0	0	0.78	0.84
Ngang No.2	0	0.87	0	0	0	0	0.82	0	0.82	0.87
Ngang No.3	0.80	0.79	0	0	0	0	0	0	0.80	0.79
Total	18.46	20.94	2.55	4.72	1.05	0	4.38	0.87	26.58	26.50

Note: F/S: Feasibility Study, D/P: Definitive Plan Study

Table 3.6 and Figs. 3.8(1/5) to (5/5) show the proposed design cross section. Details of the design cross section are compiled in Appendix “Drawings”.

3.5.4 Slope Protection and Revetment Facility

Many types of slope protection/revetment have been developed by means of brushwood, wood, stone, concrete block, reinforced concrete, etc. These revetments are structures to protect a bank slope from scouring by discharge flow, sliding by earth pressure and infiltrating discharge flow. These are also functioning to decrease a coefficient of roughness of bank. Generally, slope protection work consists of covering of bank slope, foundation of covering and foot protection, which is constructed to protect a foundation from scouring of canal bed in front of foundation of covering and to keep its stability.

The slope protection and revetment should be designed in consideration of the following aspect:

- Structural and economical conditions

- Easiness of land acquisition and house evacuation
- Easiness of construction
- Beautification

From these points of view, the following two types of slope protection and revetment were preliminarily designed.

(a) Type A: As shown in Fig. 3.9(1/4), this is the slope protection lined stone masonry with 1:1.5 slope, which is the most typical type in HCMC and applied for the channels having no land acquisition and house evacuation problems. Stone with mortar having a thickness of 30 cm is supported with concrete of 10 cm in thickness. Geo-textile sheet is provided to protect outflow of filling materials (red soil) with a thickness of 30 cm. In order to drain out groundwater, PVC pipe with 100mm diameter is provided at interval of 1.2m. The foundation of slope protection is constructed by concrete block with cross section of 600mm W x 400mm H and 4.0m long, which is fabricated beforehand on-site or factory. The concrete block foundation is supported by wooden pile with 100mm in diameter and 4.5m long, and with the density of 25 trees/m^2. Riprap with 3.0 m in width and 50 cm in thickness is provided to cope with scouring around the concrete block foundation.

(b) Type B: This is the slope protection lined stone masonry with slope of 1: 0.5, as shown in Fig. 3.9(2/4). This type is applied for channel improvement from Cha Va Bridge to the junction of Ngang No.2 (about 2.49 km), which have a restriction of land. The structure of this type is basically the same as that of Type A except the following changes:

- Thickness of stone masonry is 45 cm.
- Backfill materials is to be change from red soil to gravel layer with 300 to 375 mm thick
- Cross section of concrete block foundation is 800mm W x 600mm H.
- Length of wooden pile is to be changed from 4.5 m to 6.0 m.

Thickness of rip rap is 60 cm.

These slope protection types are popular and easy to construct in low cost. However, for structural and beautification requirements at some sections along Tau Hu - Ben Nghe canal, other two types of slope protection are proposed.

(c) Type A1: This is slope protection using pre-fabricated concrete blocks with slope of 1:1.5. As shown in Fig. 3.9(3/4), this structure is basically the same as that of slope protection Type A except concrete block of 500mm in width, 500mm in height and 120mm in thickness, and backfill concrete layer of 280 mm thick.

(d) Type B1: This type is alternative one of slope protection Type B. As shown in Fig.

3.9(4/4), instead of stone masonry with thickness of 450mm in Type A, pre-fabricated concrete block of 400mm in width, 300 in height and 350mm in thickness and filling concrete of 250 mm thick are used.

Construction cost per 1.0 meter of each type shown in Figs. 3.9(1/4) to (4/4) is preliminary estimated as shown in the table below.

Unit: x1000 VND

Type	Material Cost	Labor Cost	Machinary Cost	Total Cost
A	2,885.3	234.9	12.9	3,133.2
B	3,395.8	233.7	15.3	3,644.9
A1	4,401.7	203.8	39.7	4,645.2
B1	5,005.8	203.0	40.2	5,248.9

Note: Temporary cofferdam and dewatering costs is excluding.

As shown in the above table, construction costs of slope protection Type A1 and B1 is almost 1.5 times of Type A and B respectively.

3.5.5 Operation and Maintenance Road (O/M Road)

Generally, O/M road has to be provided along the river/canal to supervise and maintain the channels. The existing roads along both banks of Tau Hu - Ben Nghe canal has sufficient structural features for using as public road and also O/M road, even though some sections are slightly narrow. Consequently, it is not necessary to provide newly O/M road along the canal.

However, Tau Hu - Ben Nghe canal improvement aims to improve not only urban drainage and waterway transportation, but also water body environment and landscape of the city. So, in order to maintain the amenity of water body environment it is proposed to provide principally open space of maximum 5.0 m in width along both banks of the canal, in which tree planting and installation of some facilities for recreation/relaxation are recommended. Utilization for open space of 5.0 m is described later.

According to the SAPROF report of East-West Highway Project, the proposed boundary line between near Chu Y Bridge to the junction with Tan Hoa - Lo Gom canal is mostly touched with existing edge of the canal. Therefore, in detailed design stage, it will be necessary to coordinate the boundary lines proposed by both projects.

3.5.6 Landscape Study

(1) Landscape resource potential identification

Existing landscape along the canal has been disturbed by disordered mass of squatter settlements on the canal fringe even they hang over the watercourse. These obstacles caused by the existence of squatter settlements always choke such valuable scenic and vista potential of landscape of canal stretch and expansion.

On the other hands there are many points to recognize the canal feature landscape resource, such as bridge sections, small open vacant spaces on the bank and some revetment space of which resettlement program has been done. Followings are major points of landscape resource potential points to be identified and Fig. 3.10 shows each of their distribution through the canal sections. These are summarized below:

- Historical asset, Mast of the ship at the north corner of the Saigon River confluence
- Riverside Park, plaza and garden at the left (north) bank nearby Mong Bridge as the classic style steel structured bridge
- Cultural facility and garden, HCM museum at south corner of the Saigon River confluence
- Morphological variation of water margin and geographic feature
- Panoramic view to the CBD skyscrapers and view to Pagoda as a landmark at Calmette Bridge.
- Water expansion view of the canal confluence and Chu Y Bridge as a landmark of the vicinity, panoramic view point.
- Wound waterfront scape of the canal and future additional open space area due to improvement of river revetment project and highway, road project. Space for urban plaza, park and greenery are going to be established.
- Raw of classic French style warehouse as historic alley at north bank and as distinctive focal points, bridges and canal confluences are recognized

(2) Canal improvement and Landscape Development

As one of the canal improvement components landscape development is a quite essential element for enhancement of the canal side scenery as well as establishment of waterfront Cornish way, in which is identified an urban greenery system along the watercourse also utilized recreational access way to the strategic parks and gardens location in future scheme. Length of the canal landscaping is to be 12.2 km in Tau Hu - Ben Nghe canal including Lo Gom canal. Such long continuous and expanded canal bank side landscaping would become a distinctive spine of the urban greenery together with watercourse in the urban area of Ho Chi Ming City.

(a) Planting of canopy trees along the canal

Medium size canopy trees are planted along top space of both banks. Interval of each planting tree location is 8.0 m in general for consideration of future growth of the planted trees. 1.8m x 1.8m planting square shall be applied for each planting location. Each interval of 24.0m rectangular formed planting areas is applied as for a visual accent of greenery belt, and there are planted turf grass, flowering lower shrubs within the planting area.

In the center of this planting space, street lighting pole with 6 to 8m in height shall be installed for safety pedestrian's walk in the evening time and also for an aesthetic point of view along the canal water frontage.

(b) Related project of the East-West Highway and the canal improvement

In accordance with PMU East-West Highway Project, typical section of Tau Hu - Ben Nghe canal together with future development scheme of the East-West Highway and South Bank Road is shown in Fig. 3.11. Pavement shall have a width of 5.0 m for maintenance space on the top of the canal bank, and this space shall be used for pedestrian walk as well as sidewalk of the both canal side of the Highway and the Road. The top space of the bank shall be furnished with concrete block paving and planting of canopy trees for shadow provision and installation of street lightings.

(c) Jetty as a temporary work on the revetment

Jetty and pontoon may be facilitated at some priority locations of the canal side for supporting tourism activities and also for various type of loading and unloading commercial activities in time to time. In some strategic points the canal revetment may be equipped jetty and pontoon system for meeting with proposed future diversified activity demand of navigation. Samples of the proposed jetty and pontoon are shown in Fig. 3.11 and 3.12.

(d) Landscaping of some spaces born along Tau Hu – Ben Nghe canal

(i) Water Front Park

Area with length from 400m to 500m and width of maximum 40m could be established as a Cornish style waterfront park along the Tau Hu canal. The proposed waterfront park may be formed long expanded area in shape and the park may have multipurpose open space, in which seasonal events and exhibitions would be generated. Also urban forest as focal arborous core is to be born for a temporary use of reserved space for future canal side road and green open space.

Vicinity citizens may wish to have some spaces for enjoying static recreation activities. Longer expanded park area could share such spaces of generated multiple recreational activities. Some strategic reserved space along the canal side road may be utilized for provision of small urban plaza as community assembly core or enjoying relaxation.

(ii) Canal Cornish way as urban water front corridor

Linear greenery, which is composed with raw of canopy trees, turf green belt, will become a waterfront corridor and the open space system with continuous planted trees will be creating strategic bouquet or urban forest along the canal watercourse.

Fig. 3.12 shows proposed waterfront park scheme in relation to the East-West Highway Project.

3.6 Evaluation of Proposed Canal Improvement Plan by Hydrodynamic Model

The objectives of hydrodynamic simulation are to:

(a) Carry out comparative study on three alternatives canal improvement plans from hydraulic viewpoint
(b) Evaluate the optimum canal improvement plan from hydraulic viewpoint

Compared to Feasibility Study, some modifications have been made in proposed width, length, bed elevation, slope and alignment of Tau Hu - Ben Nghe canal. Also, most recent existing cross-section data of Doi - Te, Ong Lon and Xom Cui canals have been collected from Sub-Institute for Water Resources Planning (WRP) and water level boundary conditions have been updated based on continuous one week (May 30 to June 6, 200) hourly discharge and water level measurement survey by JICA. Applying updated cross-sections and boundary conditions, the proposed (modified) canal improvement plan has been evaluated by hydrodynamic as described below.

(1) Model Set Up

Hydrodynamic simulation has been carried out to evaluate the proposed canal improvement plan against 10-year return period rainfall event and design flood level condition. Danish Hydraulic Institute's "MIKE 11" software has been used. The canal network for hydrodynamic model is shown in Fig. 3.13. The hydrodynamic model has been set up for seven canals. They are: Tau Hu - Ben Nghe, Doi - Te, Ngang 1, Ngang 2, Ngang 3, Xom Cui and Ong Lon canals.

(2) Model Cases

Hydrodynamic simulation has been carried out for three alternatives. They are:

Alt. IA: Bed slope of Tau Hu - Ben Nghe canal is designed to be unidirectional. Bed level of Ben Nghe canal varies from EL. -3.30 m at confluence with Te canal to -3.45 m at Saigon river mouth. Bed level of Tau Hu canal varies from EL. -3.30 m at confluence with Ngang 1 canal to -3.50 m at confluence with Doi canal and from EL. -4.30 m at confluence with Doi canal / Ben Luc river to -4.54 m at confluence with Ngang 1 canal. The rise in bed level from u/s to d/s of Tau Hu canal at confluence with Ngang 1 canal is 1.24 m.

Alt. IB: Bed slope of Tau Hu - Ben Nghe canal is designed to follow flood flow direction (bi-directional). From confluence of Tau Hu canal with Ngang 1 canal to Saigon river mouth, bed levels of Tau Hu - Ben Nghe canals are the same as that of for Alt. IA. But from confluence of Tau Hu canal with Lo Gom canal to confluence with Ngang 1 canal and to confluence with Ben Luc river / Doi canal, bed level varies from EL. -4.30 m to -4.41 m and from -4.30 m to –4.43 m. The rise in bed level from u/s to d/s of Tau Hu canal at confluence with Ngang 1 canal is 1.11 m

Alt. II: Bed slope of Tau Hu – Ben Nghe canal is the same as Alt. IA (unidirectional). Bed level of Ben Nghe canal and Tau Hu canal from confluence with Ben Luc river / Doi canal to Ngang 1 canal are the same as that of for Alt. IA. But bed level of Tau Hu canal from confluence with Ngang 1 canal to Doi canal is lower than that for Alt. IA or IB.

(3) Cross-Section

Hydraulic evaluation has been made on proposed canal improvement plan. A combination of existing and proposed canal sections has been used. For Tau Hu - Ben Nghe, Ngang 1, Ngang 2 and Ngang 3 canals, cross-sections according to proposed canal improvement plan have been applied. For the rest of the canals, existing cross-sections have been used.

Compared to Feasibility Study cross-section (1993) data, existing cross-section data of Doi - Te, Xom Cui and Ong Lon canals have been updated using the most recent (1999) data collected from Sub-Institute for Water Resources Planning (WRP). A comparison for hydraulic properties of Doi - Te canal between years 1993 and 1999 is presented in Fig. 3.14. As can be seen, in 1999 compared to 1993, canal bed has been raised, top width as well as flow area has been reduced, due to sedimentation and garbage deposition.

(4) Boundary Conditions

Two types of boundary conditions have been applied for all three alternative cases. One is constant maximum water level boundary condition and the other is design 24-hour dynamic water level boundary condition. Based on hourly discharge and water level measurement survey along the canals carried out by JICA during the period May 30 to June 6, 2000, boundary conditions at Ben Luc river, Xom Cui and Ong Lon canals have been updated from Feasibility Study. The dynamic boundary conditions are presented in Fig. 3.15.

Design maximum and minimum water levels at the boundaries of Saigon and Ben Luc rivers, Ong Lon and Xom Cui canals are applied to be EL. +1.32, +1.14, +1.34, +1.40 m and EL. -1.98, -1.08, -2.15, -2.23 m respectively. Relative to Saigon river, phase lags for design maximum and minimum water levels at Ben Luc river, Ong Lon and Xom Cui canals are applied to be +1, 0, 0 hour and 0, -1, 0 hour respectively.

(5) Runoff Hydrographs

Design 10-year rainfall hyetograph with total rainfall amount of about 128 mm and maximum rainfall intensity of about 91 mm/hr has been applied for runoff hydrograph generation. The rainfall hyetograph is shown in Fig. 3.15.

Nine runoff hydrographs with total catchment area of 61.72 km^2 have been applied. Details of the sub-catchments with runoff hydrographs are presented in Table 3.7. Symmetric triangular unit hydrograph with base time of 2*time of concentration which produces peak runoff same as calculated by Rational method has been applied for runoff hydrograph generation. Average specific runoff is calculated to be about 10 $m^3/s/km^2$.

(6) Model Parameters

Manning's roughness co-efficient of 0.035 and 0.025 have been applied for existing and proposed canal sections. A space step of 50 m and a time step of 15 seconds have been applied for hydrodynamic simulation.

(7) Simulation Results

(a) Optimum Canal Improvement Plan

A comparison for maximum water levels among the three alternative cases for both constant and dynamic water level boundary conditions are presented in Table 3.8. It is found that maximum water levels along Tau Hu – Ben Nghe canal for Alt. IA and IB are almost the same for both constant water level boundary condition (EL. +1.426) and dynamic water level boundary condition (EL. +1.429 and +1.427 m respectively. Even though, maximum water level for Alt. II is about 5 cm lower than Alt. IA and IB, but Alt. II has lower bed elevation than Alt. IA and IB requiring more excavation and more cost. Therefore, Alternative II has been discarded from the optimum canal improvement plan. Between Alt. IA and IB, bed slope of Alt. IB follows natural flow / flood flow direction (as shown in Fig. 3.19, high tide) and is inferred to be more efficient in conveying flood water. Therefore, Alt. IB is proposed as the optimum canal improvement plan.

(b) Design Water Level, Discharge and Velocity

Results for the optimum canal improvement plan, i.e. for Alt. IB under dynamic water level boundary condition is presented. Maximum water level (EL. +1.43) is found to be at the junction of Tau Hu canal with Lo Gom canal. Therefore, a free board of about 60 cm can be maintained even at the most critical location of Tau Hu - Ben Nghe canal. Design water level, discharge and velocity distributions at selected locations along Tau Hu - Ben Nghe, Ngang 1, Ngang 2 and Ngang 3 canals which are proposed to be improved are shown in Fig. 3.16. The numbers represent maximum and minimum values, occurred at different times of 24-hr simulation period. Discharge and velocity hydrographs at selected locations are shown in Figs. 3.17 and 3.18.

Design maximum water level is calculated to be EL. +1.43 m at the junction of Tau Hu canal with Lo Gom canal. Design discharges along Tau Hu - Ben Nghe and connecting canals vary from 41 to 154 m^3/s and from 2 to 100 m^3/s respectively. Design velocities along Tau Hu - Ben Nghe and connecting canals vary from 0.27 to 0.82 m/s and from 0.01 to 0.43 m/s respectively.

(c) Flow Direction during High and Low Tides

Fig. 3.19 shows water level, discharge and velocity distributions during high and low tides (values are taken at the same high and low tide times of 24-hr simulation period). It can be seen that the flow direction during high tide coincides with the proposed canal alignment of Alt. IB.

3.7 Bill of Quantities

Bill of quantities of Tau Hu – Ben Nghe Canal Improvement is summarized in Table 3.9 (1/3) to (3/3).

follows natural flow / flood flow direction (as shown in Fig. 3.19, high tide) and is inferred to be more efficient in conveying flood water. Therefore, Alt. IB is proposed as the optimum canal improvement plan.

(b) Design Water Level, Discharge and Velocity

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3.7 Bill of Quantities

Bill of quantities of Tau Hu – Ben Nghe Canal Improvement is summarized in Table 3.9 (1/3) to (3/3).

TABLE 3.1 HYDRAULIC FEATURES OF EXISTING TAU HU - BEN NGHE CANAL

Station	Accumu-late Distance (m)	Canal Bed Elevation E1 (m)	Left Bank Elevation E2 (m)	Right Bank Elevation E3 (m)	Top Width B (m)	Depth H (m)	Maximum Flow Area A (m2)	Weted Perimeter P (m)	Hydraulic Radius R (m)	Average Gradiant I	Average Velocity V (m/s)	Discharge Capacity Q (m3/s)
No.0	0					0.0						
No.1	60	-2.55	2.07	1.53	112.6	4.1	306.06	113.12	2.71	0.00003	0.28	85
No.2	180	-2.72	2.69	1.64	95.0	4.4	262.19	96.28	2.72	0.00003	0.28	73
No.3	395	-2.51	2.19	2.49	64.4	4.7	222.94	66.25	3.37	0.00003	0.32	72
No.4	615	-2.21	1.93	2.03	68.9	4.1	215.70	70.54	3.06	0.00003	0.30	65
No.5	800	-2.01	2.15	2.00	59.9	4.0	163.07	61.58	2.65	0.00003	0.27	45
No.6	980	-2.36	1.83	1.85	39.0	4.2	114.44	41.36	2.77	0.00003	0.28	32
No.7	1,180	-2.12	2.10	1.74	67.7	3.9	180.12	69.02	2.61	0.00003	0.27	49
No.8	1,370	-1.99	1.97	1.85	38.0	3.8	121.58	41.62	2.92	0.00003	0.29	35
No.9	1,565	-2.02	1.72	2.09	55.9	3.7	159.87	57.92	2.76	0.00003	0.28	45
No.10	1,745	-2.06	2.04	2.89	52.8	4.1	169.81	55.34	3.07	0.00003	0.30	51
No.11	1,965	-1.82	2.10	1.83	53.8	3.7	152.07	55.19	2.76	0.00003	0.28	43
No.12	2,170	-2.09	2.97	2.13	64.9	4.2	204.57	66.73	3.07	0.00003	0.30	62
No.13	2,350	-2.33	2.14	2.02	44.9	4.4	152.77	46.93	3.26	0.00003	0.31	48
No.14	2,545	-2.26	1.73	1.89	47.8	4.0	153.33	49.90	3.07	0.00003	0.30	46
No.15	2,735	-2.55	1.77	1.57	58.8	4.1	193.87	60.68	3.19	0.00003	0.31	60
No.16	2,960	-3.53	2.14	1.88	94.7	5.4	349.24	96.00	3.64	0.00003	0.34	118
No.17	3,140	-7.87	1.90	1.83	101.9	9.7	552.51	105.79	5.22	0.00003	0.43	238
No.18	3,230	-10.50	1.99	1.86	99.7	12.4	693.67	103.58	6.70	0.00003	0.51	352
No.19	3,365	-2.98	1.98	1.57	68.9	4.6	175.36	70.27	2.50	0.00003	0.26	46
No.20	3,570	-2.93	2.34	1.63	55.1	4.6	175.92	57.14	3.08	0.00003	0.30	53
No.21	3,795	-2.66	2.10	1.63	46.0	4.3	142.36	47.85	2.98	0.00003	0.30	42
No.22	3,990	-2.84	2.06	1.48	37.2	4.3	119.18	39.81	2.99	0.00003	0.30	35
No.23	4,165	-2.75	2.37	1.44	43.4	4.2	139.38	45.96	3.03	0.00003	0.30	42
No.24	4,370	-2.69	1.97	1.40	57.7	4.1	131.18	59.91	2.19	0.00003	0.24	32
No.25	4,540	-2.74	2.15	1.67	54.0	4.4	166.18	56.61	2.94	0.00003	0.29	49
No.26	4,750	-1.91	2.32	1.65	59.8	3.6	153.13	61.15	2.50	0.00003	0.26	40
No.27	4,940	-2.03	1.67	1.66	62.0	3.7	168.49	64.13	2.63	0.00003	0.27	46
No.28	5,135	-1.73	1.24	1.44	73.4	3.0	161.46	74.08	2.18	0.00003	0.24	39
No.29	5,325	-1.71	1.44	1.41	81.9	3.1	169.47	82.73	2.05	0.00003	0.23	39
No.30	5,515	-1.40	2.09	1.75	43.4	3.2	100.38	44.54	2.25	0.00003	0.25	25
No.31	5,695	-1.58	1.98	1.79	47.9	3.4	125.92	50.00	2.52	0.00003	0.26	33
No.32	5,880	-1.71	1.75	1.49	49.0	3.2	132.02	51.36	2.57	0.00003	0.27	35
No.33	6,080	-1.85	1.77	1.89	45.6	3.6	123.48	47.44	2.60	0.00003	0.27	33
No.34	6,165	-1.52	2.94	2.40	45.8	3.9	123.70	47.63	2.60	0.00003	0.27	33
No.35	6,275	-1.50	2.14	1.99	42.8	3.5	111.59	44.19	2.53	0.00003	0.26	30
No.36	6,520	-1.49	2.05	1.84	39.5	3.3	96.20	40.66	2.37	0.00003	0.25	24
No.37	6,705	-1.63	2.50	1.77	37.3	3.4	93.94	39.32	2.39	0.00003	0.26	24
No.38	6,900	-1.63	1.86	1.94	35.9	3.5	97.55	37.60	2.59	0.00003	0.27	26
No.39	7,045	-1.71	1.79	1.75	44.3	3.5	112.14	45.60	2.46	0.00003	0.26	29
No.40	7,155	-1.84	2.13	1.78	33.2	3.6	84.92	34.98	2.43	0.00003	0.26	22
No.41	7,270	-2.07	1.73	1.95	46.6	3.8	110.45	48.35	2.28	0.00003	0.25	27
No.42	7,460	-2.69	1.86	1.79	53.5	4.5	173.40	55.20	3.14	0.00003	0.31	53
No.43	7,660	-3.16	1.81	1.78	49.8	4.9	176.30	52.01	3.39	0.00003	0.32	57
No.44	7,850	-2.81	1.54	1.64	51.61	4.4	156.31	53.06	2.95	0.00003	0.29	46
No.45	8,060	-3.27	1.66	1.31	32.58	4.6	96.73	35.06	2.76	0.00003	0.28	27
No.46	8,260	-2.72	1.62	1.55	37.29	4.3	120.42	39.94	3.02	0.00003	0.30	36
No.47	8,490	-3.25	1.46	1.45	30.98	4.7	79.17	32.83	2.41	0.00003	0.26	20
No.48	8,660	-3.69	1.41	1.34	40.97	5.0	132.92	44.27	3.00	0.00003	0.30	40
No.49	8,835	-3.76	1.37	1.47	54.19	5.1	200.86	56.42	3.56	0.00003	0.33	67
No.50	8,930	-3.81	1.62	1.47	56.67	5.3	188.80	58.04	3.25	0.00003	0.31	59
No.51	9,030	-3.08	1.49	1.40	56.68	4.5	200.68	58.38	3.44	0.00003	0.33	65
No.52	9,130	-3.02	1.45	1.49	54.57	4.5	172.99	56.25	3.08	0.00003	0.30	52
No.53	9,230	-3.00	1.55	1.43	51.48	4.4	170.84	53.48	3.19	0.00003	0.31	53
No.54	9,335	-2.97	1.41	1.63	59.25	4.4	181.84	60.67	3.00	0.00003	0.30	54
No.55	9,435	-2.84	1.27	1.53	57.61	4.1	169.93	58.96	2.88	0.00003	0.29	49
No.56	9,670	-1.84	1.40	1.14	52.96	3.0	108.16	53.66	2.02	0.00003	0.23	25
No.57	9,875	-1.93	1.58	0.95	56.22	2.9	105.50	56.81	1.86	0.00003	0.22	23
No.58	10,080	-1.79	1.37	1.17	51.69	3.0	113.15	52.46	2.16	0.00003	0.24	27
No.59	10,300	-2.06	1.20	1.16	43.93	3.2	97.00	44.83	2.16	0.00003	0.24	23
No.60	10,480	-2.37	1.44	1.12	50.09	3.5	111.93	50.83	2.20	0.00003	0.24	27
No.61	10,700	-3.60	1.35	0.70	52.00	4.3	138.40	53.09	2.61	0.00003	0.27	37
No.62	10,890	-3.62	1.02	1.10	49.80	4.6	139.03	51.2	2.72	0.00003	0.28	39
No.63	11,070	-3.96	1.28	1.06	50.28	5.0	138.73	51.63	2.69	0.00003	0.28	38
No.64	11,280	-2.97	0.92	0.86	49.78	3.8	98.33	50.68	1.94	0.00003	0.22	22
No.65	11,470	-3.66	1.40	0.97	51.00	4.6	102.40	52.37	1.96	0.00003	0.22	23
No.66	11,720	-2.90	1.19	1.17	46.97	4.1	119.95	48.29	2.48	0.00003	0.26	31
No.67	11,900	-3.56	1.17	0.92	46.84	4.5	111.82	48.09	2.33	0.00003	0.25	28
No.68	12,090	-3.98	1.38	1.61	47.68	5.4	141.56	50.07	2.83	0.00003	0.29	40
No.68+80	12,170	-	-	-	-	-	-	-	-	-	-	-

TABLE 3.2 WATER QUALITY OF BEN NGHE – TAU HU CANAL

Parameter / Location	Y Bridge (Tau Hu Canal)		Khanh Hoi Bridge (Ben Nghe Canal)	
	High Tide	Low Tide	High Tide	Low Tide
Temperature, C	28.4 (16.3)	29.9 (28.0)	27.9 (26.0)	29.9 (28.5)
PH	6.7 (6.8)	6.6 (6.8)	6.1 (6.7)	6.4 (6.9)
DO, mg/l	2.8 (4.6)	0.0 (1.9)	2.6 (3.4)	0.2 (0.6)
Conductivity, mS/m	306.0 (41.0)	331.0 (64.0)	38.0 (30.0)	214.0 (57.0)
BOD5, mg/l	151.0 (84.0)	251.0 (124.0)	81.0 (50.0)	157.0 (104.0)
COD, mg/l	249.0 (125.0)	400.0 (200.0)	200.0 (98.0)	211.0 (176.0)
Total Solids, mg/l	70.0 (67.0)	216.0 (92.0)	11.0 (33.0)	41.0 (38.0)
Total Nitrogen (T-N), mg/l	2.0 (1.9)	11.2 (3.1)	1.6 (1.5)	10.4 (8.0)
Total Phosphorus (T-P), mg/l	0.1 (1.1)	0.6 (2.5)	0.1 (1.6)	0.9 (6.2)
Total Coliform, MPN/100ml	1.50E+0.6 (1.10E0.6)	2.10E+0.6 (1.50E0.6)	9.0E+0.2 (1.10E+0.6)	9.3E+0.3 (1.10E+0.6)
Fecal Coliform, MPN/100ml	9.30E+0.4 (2.00E+0.4)	9.30E+0.4 (5.70E+0.5)	2.1E+0.2 (5.70E+0.4)	5.7E+0.3 (1.50E+0.5)
$SO_4^{(-2)}$, mg/l	81.1 (25.0)	97.4 (43.1)	26.9 (219.0)	317.3 (22.1)
Chloride (Cl^-), mg/l	769.6 (78.0)	782.1 (120.6)	123.1 (49.0)	520.4 (74.3)
Cadmium, µg/l	<1 (2.9)	<1 (2.1)	2.7 (3.7)	3.8 (4.1)
Lead, µg/l	<2 (<2)	<2 (<2)	<2 (<2)	2.2 (<2)
Hexavelent Chromium (Cr^{+6}), µg/l	<0.04 (<0.04)	<0.04 (<0.04)	<0.04 (<0.04)	<0.04 (<0.04)
Arsenic (As), µg/l	0.9 (0.9)	0.3 (0.3)	0.6 (0.6)	2.8 (2.8)
Total Mercury (Hg), µg/l	<2.5 (<2.5)	<2.5 (<2.5)	<2.5 (<2.5)	<2.5 (<2.5)

Note: The upper and lower figures in the table mean the water quality in rainy season and the early dry season respectively.

TABLE 3.3 MAIN STRUCTURAL FEATURES OF EXISTING BRIDGES

No.	Name of Bridge	Name of Canal	Bridge Length (m)	Width (m)	No. of Span	Type of Super-stru cture	Complet -ion Year	Clearance for Naviga-ti on (m)	Allow-a ble Load (ton)
1	Khanh Hoi	Ben Nghe	91.8	17.0	4	PC	Before 1975	0.5	25
2	Mong	-do-	96.0	5.0	6	Steel	-do-	6.0	-
3	Calme-tte	-do-	84.4	15.3	4	PC	-do-	0.5	17
4	Ong Lanh	-do-	50.4	7.0	3	RC	-do-	4.0	-
5	Chu Y	Tau Hu	512.0	12.0	24	RC	-do-	3.5	30
6	Cha Va	-do-	62.7	26.4	5	PC	1997	-do-	-do-
7	Binh Tay	-do-	47.6	3.0	1	Steel	Before 1975	3.5	-
8	Chu U	-do-	204.2	4.0	-do-	-do-	-do-	-do-	-
9	Nha May Ruou	-do-	79.8	3.0	-do-	-do	-do-	-do-	-
10	Van Nguyen	Lo Gom	48.8	2.5	3	-do	-do-	4.32	-
11	Nha Thuong	-do-	75.0	3.0	1	-do-	-do-	3.5	-
12	S. No.1	Ngang No.1	74.9	11.0	3	PC	1993	3.5	30
13	S. No.1	-do-	116.0	4.0	-	Steel	Before 1975	2.5	-
14	S. No.2	Ngang No.2	116.0	4.0	7	Steel	-do-	2.5	1.5
15	S. No.2	-do-	-	-	-	PC	Under Constru ction	-	-
16	S. No.3	Ngang No.3	146.0	4.0	9	Steel	Before 1975	5.0	1.0

TABLE 3.4 MAIN FEATURES OF EXISTING BANK PROTECTION ALONG TAU HU - BEN NGHE CANAL

No.	Canal	Location	Length (m)	Structure				Completion Year	Structural Drawings	Existing Condition
				Type	Slope	Depth of Foundation	Main Materials			
BP.1	Ben Nghe	0.00 - 0.16 (R)	160	I	1:3	-1.5	stone and mortar	before 1985	None	old, no crack & erosion, good
BP.2	do	0.00 - 0.16 (L)	60	I	1:3	-1.5	ditto	ditto		ditto
BP.3	Tau Hu	4.50 - 4.74 (R)	240	III	vertical	-	ditto	before 1955		relatively new, good
BP.4	do	5.85 - 6.25 (R)	400	I	1:1.5	-1.5	ditto			new one, good
BP.5	do	6.95 - 7.24 (R)	310	I	1:1.5	-1.5	ditto	before 1990		relatively new, good
BP.6	do	7.24 - 7.42 (R)	180	II	vertical	-1.5		before 1993		new one, good
BP.7	do	7.14 - 7.24 (L)	75	I	1:1.5	-1.5	stone and mortar	-		relatively old, to be replaced
BP.8	do	7.45 - 7.60 (R)	150	III	vertical	-		before 1996		relatively old, but good condition
BP.9	do	7.60 - 7.75 (R)	31	I	1:1.5	-1.5	stone and mortar	before 1993		ditto
BP.10	do	7.75 - 7.90 (R)	150	III	vertical	-1.5		before 1956		ditto
BP.11	do	7.90 - 8.00 (R)	100	I	1:1.5	-1.5	stone and mortar	before 1993		little bit old, but good condition
BP.12	do	8.00 - 8.55 (R)	550	II	vertical	-1.5		before 1955		new one, good
BP.13	do	7.35 - 7.98 (L)	630	I	1:1.5	-1.5	stone and mortar	before 1990		old, partly eroded, to be replaced
BP.14	do	8.65 - 8.85 (R)	200	III	vertical	-		before 1956		under construction
BP.15	do	8.85 - 9.45 (R)	600	I	1:1.5	-1.5		before 1997		new one, good condition
BP.16	do	9.45 - 9.65 (R)	200	III	vertical	-1.5	stone and mortar	before 1956	old, dirty	new one, good condition
BP.17	do	8.95 - 9.28 (L)	330	I	1:1.5	-1.5		-		relatively old, to be replaced
BP.18	do	9.40 - 9.53 (L)	130	I	ditto	-1.5	stone and mortar	-		ditto
BP.19	Lo Gom	10.20 - 10.40 (L)	200	I	ditto	-1.5	ditto	-		old, partly eroded, to be replaced
BP.20	do	12.05 - 12 25 (R)	200	I	ditto	-1.5	ditto	1997		new, partly eroded, to be replaced
BP.21	do	12.05 - 12.35 (L)	300	I	ditto	-1.5	ditto	1998		new, good condition

Note: 1. (R) and (L) mean the right and left bank respectively.
2. Type I: Stone masonry with the slope of 1:1.5 - 1:2 shown in Fig. 8.3 (a)
3. Type II: Stone masonry with the vertical slope (Gravity Type Revetment) shown in Fig. 8.3.(b)
4. Type III: Concrete pile fixed by reinforced concrete top beam on the stone masonry bank protection shown in Fig. 8.3 (c)

TABLE 3.5 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	0.0				-3.45	1.32	
No.1	60.0	60.0	-2.55	2.07	1.53	-3.45	1.32	2.00
No.2	119.9	179.9	-2.72	2.69	1.64	-3.44	1.32	2.00
No.3	216.5	396.4	-2.51	2.19	2.49	-3.43	1.33	2.00
No.4	213.9	610.3	-2.21	1.93	2.03	-3.42	1.34	2.00
No.5	184.3	794.6	-2.01	2.15	2.00	-3.41	1.34	2.00
No.6	180.5	975.1	-2.36	1.83	1.85	-3.40	1.34	2.00
No.7	204.8	1,179.9	-2.12	2.10	1.74	-3.39	1.35	2.00
No.8	188.0	1,367.9	-1.99	1.97	1.85	-3.38	1.35	2.00
No.9	194.0	1,561.9	-2.02	1.72	2.09	-3.37	1.36	2.00
No.10	180.8	1,742.7	-2.06	2.04	2.89	-3.36	1.36	2.00
No.11	222.0	1,964.7	-1.82	2.10	1.83	-3.35	1.37	2.00
No.12	207.2	2,171.8	-2.09	2.97	2.13	-3.34	1.37	2.00
No.13	176.2	2,348.0	-2.33	2.14	2.02	-3.33	1.38	2.00
No.14	193.0	2,541.0	-2.26	1.73	1.89	-3.32	1.38	2.00
No.15	192.6	2,733.6	-2.55	1.77	1.57	-3.31	1.39	2.00
No.16+13.86	243.1	2,976.7	-3.53	2.14	1.88	-3.30	1.39	2.00
No.17+27	181.7	3,158.4	-7.87	1.90	1.83	-3.40	1.40	2.00
No.18	55.0	3,213.4	-10.50	1.99	1.86	-3.43	1.40	2.00
No.19-10	126.7	3,340.1	-2.98	1.98	1.57	-3.50	1.40	2.00
No.20	214.0	3,554.1	-2.93	2.34	1.63	-3.49	1.41	2.00
No.21	223.9	3,778.0	-2.66	2.10	1.63	-3.48	1.41	2.00
No.22	197.4	3,975.3	-2.84	2.06	1.48	-3.47	1.42	2.00
No.23	144.9	4,120.3	-2.75	2.37	1.44	-3.46	1.42	2.00
No.24	193.5	4,313.8	-2.69	1.97	1.40	-3.45	1.43	2.00
No.25	154.0	4,467.8	-2.74	2.15	1.67	-3.44	1.43	2.00
No.26	208.0	4,675.8	-1.91	2.32	1.65	-3.43	1.44	2.00
No.27	191.0	4,866.8	-2.03	1.67	1.66	-3.42	1.44	2.00
No.28	197.1	5,063.9	-1.73	1.24	1.44	-3.41	1.45	2.00
No.29	190.0	5,253.9	-1.71	1.44	1.41	-3.40	1.45	2.00
No.30	186.4	5,440.4	-1.40	2.09	1.75	-3.39	1.46	2.00
No.31	179.7	5,620.1	-1.58	1.98	1.79	-3.38	1.46	2.00
No.32	189.0	5,809.1	-1.71	1.75	1.49	-3.37	1.47	2.00
No.33	198.0	6,007.1	-1.85	1.77	1.89	-3.36	1.47	2.00
No.34	86.9	6,094.0	-1.52	2.94	2.40	-3.36	1.47	2.00
No.35	109.0	6,203.0	-1.50	2.14	1.99	-3.35	1.48	2.00
No.36	245.9	6,449.0	-1.49	2.05	1.84	-3.34	1.48	2.00
No.37	182.8	6,631.7	-1.63	2.50	1.77	-3.33	1.49	2.00
No.38	195.0	6,826.7	-1.63	1.86	1.94	-3.32	1.49	2.00
No.39	145.0	6,971.7	-1.71	1.79	1.75	-3.32	1.49	2.00
No.40	110.0	7,081.7	-1.84	2.13	1.78	-3.31	1.50	2.00
No.41+90	206.9	7,288.6	-2.07	1.73	1.95	-3.30	1.50	2.00
No.41+90	0.0	7,288.6	-2.07	1.73	1.95	-4.41	1.50	2.00
No.42	100.8	7,389.4	-2.69	1.86	1.79	-4.40	1.50	2.00
No.43	200.0	7,589.4	-3.16	1.81	1.78	-4.39	1.51	2.00
No.44	187.0	7,776.4	-2.81	1.54	1.64	-4.38	1.51	2.00
No.45	208.0	7,984.4	-3.27	1.66	1.31	-4.37	1.52	2.00
No.46	200.0	8,184.4	-2.72	1.62	1.55	-4.36	1.52	2.00
No.47	232.9	8,417.3	-3.25	1.46	1.45	-4.35	1.53	2.00
No.48	170.0	8,587.3	-3.69	1.41	1.34	-4.34	1.53	2.00
No.49	170.0	8,757.3	-3.76	1.37	1.47	-4.33	1.54	2.00
No.50	100.0	8,857.3	-3.81	1.62	1.47	-4.33	1.54	2.00
No.51	100.0	8,957.3	-3.08	1.49	1.40	-4.32	1.54	2.00
No.52	100.0	9,057.3	-3.02	1.45	1.49	-4.32	1.55	2.00
No.53	100.0	9,157.3	-3.00	1.55	1.43	-4.31	1.55	2.00
No.54	103.0	9,260.3	-2.97	1.41	1.63	-4.31	1.55	2.00
No.55+79	180.2	9,440.4	-2.84	1.27	1.53	-4.30	1.56	2.00
No.56	158.0	9,598.4	-1.84	1.40	1.14	-4.31	1.56	2.00
No.57	205.0	9,803.4	-1.93	1.58	0.95	-4.32	1.57	2.00
No.58	205.0	10,008.4	-1.79	1.37	1.17	-4.33	1.57	2.00
No.59	220.0	10,228.4	-2.06	1.20	1.16	-4.34	1.58	2.00
No.60	178.0	10,406.5	-2.37	1.44	1.12	-4.35	1.58	2.00
No.61	220.0	10,626.5	-3.60	1.35	0.70	-4.36	1.59	2.00
No.62	190.0	10,816.5	-3.62	1.02	1.10	-4.37	1.59	2.00
No.63	180.0	10,996.5	-3.96	1.28	1.06	-4.38	1.59	2.00
No.64	210.0	11,206.5	-2.97	0.92	0.86	-4.39	1.60	2.00
No.65	190.0	11,396.5	-3.66	1.4	0.97	-4.40	1.60	2.00
No.66	245.0	11,641.5	-2.9	1.19	1.17	-4.41	1.61	2.00
No.67	185.0	11,826.5	-3.56	1.17	0.92	-4.42	1.62	2.00
No.68	192.3	12,018.8	-3.98	1.38	1.61	-4.43	1.62	2.00
No.69	79.3	12,098.1				-4.43	1.62	2.00

TABLE 3.6 (1/4) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT

Name of Canal	Section	Length	Accumulate Length	Type of Cross Section	Elevation (m above MSL)							Canal Width						Bank Slope				Depth			
					Left		Channel			Right		Channel			O/M Road		Total	Left		Right		Left		Right	
					Bank	Crown	L-Bed	C-Bed	R-Bed	Crown	Bank	Bottom	Middle	Top	Left	Right		Upper	Lower	Lower	Upper	Upper	Lower	Lower	Upper
					EL.1	EL.2	EL.3	EL4	EL5	EL.6	EL.7	Bi	B2	B3	B4	B5	B	S1	S2	S2'	S1'	H1	H2	H2'	H1'
		(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(1: S1)	(1: S2)	(1: S2')	(1: S1')	(m)	(m)	(m)	(m)
Ben Nghe	No. 0 (SP)	0.00	0.00	Existing	2.07	2.07	0.20	-3.45	-0.20	1.94	1.94	30.0	99.0	119.0	0.0	0.0	119.0	3.0	10.0	10.0	3.0	1.87	3.65	3.25	2.14
	No. 1	60.00	60.00	Existing	2.07	2.07	-0.20	-3.45	-0.20	1.94	1.94	30.0	95.0	115.0	0.0	0.0	115.0	3.0	10.0	10.0	3.0	2.27	3.25	3.25	2.14
	No.2 + 10 (IP1)	129.85	189.85	Existing	2.69	2.00	-2.00	-3.44	-2.00	2.00	2.13	30.0	78.9	90.9	5.0	5.0	100.9	3.0	17.0	17.0	3.0	4.00	1.44	1.44	4.00
	No. 2 + 110	100.00	289.85	A	2.69	2.00	-2.00	-3.43	-2.00	2.00	2.13	30.0	58.7	70.7	5.0	5.0	80.7	1.5	10.0	10.0	1.5	4.00	1.43	1.43	4.00
	No. 3 + 35 (BC2)	141.54	431.39	A	2.19	2.00	-2.00	-3.43	-2.00	2.00	2.49	30.0	58.5	70.5	5.0	5.0	80.5	1.5	10.0	10.0	1.5	4.00	1.43	1.43	4.00
	No. 4 - 42 (EC2)	136.93	568.32	A	2.00	2.00	-2.00	-3.42	-2.00	2.00	2.03	30.0	58.4	70.4	5.0	5.0	80.4	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 4	42.00	610.32	A	2.00	2.00	-2.00	-3.42	-2.00	2.00	2.03	30.0	58.4	70.4	5.0	5.0	80.4	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 5 - 23 (BC3)	161.26	771.58	A	1.93	2.00	-2.00	-3.41	-2.00	2.00	2.00	30.0	58.2	70.2	5.0	5.0	80.2	1.5	10.0	10.0	1.5	4.00	1.41	1.41	4.00
	No. 5 + 47.21 (EC3)	70.21	841.79	A	1.93	2.00	-2.00	-3.41	-2.00	2.00	2.00	30.0	58.1	70.1	5.0	5.0	80.1	1.5	10.0	10.0	1.5	4.00	1.41	1.41	4.00
	No. 6 - 34 (BC4)	99.30	941.09	A	1.83	2.00	-2.00	-3.40	-2.00	2.00	1.85	21.0	49.0	61.0	5.0	5.0	71.0	1.5	10.0	10.0	1.5	4.00	1.40	1.40	4.00
	No. 6 + 19.05 (EC4)	53.05	994.14	A	1.83	2.00	-2.00	-3.40	-2.00	2.00	1.85	21.0	49.0	61.0	5.0	5.0	71.0	1.5	10.0	10.0	1.5	4.00	1.40	1.40	4.00
	No. 7 - 108.45 (BC5)	77.28	1,071.42	A	1.87	2.00	-2.00	-3.40	-2.00	2.00	1.74	21.0	48.9	60.9	5.0	5.0	70.9	1.5	10.0	10.0	1.5	4.00	1.40	1.40	4.00
	No. 7 +13 (EC5)	121.45	1,192.87	A	1.87	2.00	-2.00	-3.39	-2.00	2.00	1.74	21.0	48.8	60.8	5.0	5.0	70.8	1.5	10.0	10.0	1.5	4.00	1.39	1.39	4.00
	No. 8	175.00	1,367.87	A	1.97	2.00	-2.00	-3.38	-2.00	2.00	1.85	21.0	48.6	60.6	5.0	5.0	70.6	1.5	10.0	10.0	1.5	4.00	1.38	1.38	4.00
	No. 9	194.00	1,561.87	A	1.72	2.00	-2.00	-3.37	-2.00	2.00	2.09	21.0	48.4	60.4	5.0	5.0	70.4	1.5	10.0	10.0	1.5	4.00	1.37	1.37	4.00
	No. 9 + 38 (BC6)	38.00	1,599.87	A	1.72	2.00	-2.00	-3.37	-2.00	2.00	2.09	21.0	48.4	60.4	5.0	5.0	70.4	1.5	10.0	10.0	1.5	4.00	1.37	1.37	4.00
	No. 10 - 28 (EC6)	114.82	1,714.69	A	2.04	2.00	-2.00	-3.36	-2.00	2.00	2.77	21.0	48.3	60.3	5.0	5.0	70.3	1.5	10.0	10.0	1.5	4.00	1.36	1.36	4.00
	No. 11	250.00	1,964.69	A	1.73	2.00	-2.00	-3.35	-2.00	2.00	1.83	21.0	48.0	60.0	5.0	5.0	70.0	1.5	10.0	10.0	1.5	4.00	1.35	1.35	4.00
	No. 12 - 61 (BC7)	146.24	2,110.93	A	2.00	2.00	-2.00	-3.34	-2.00	2.00	2.13	21.0	47.9	59.9	5.0	5.0	69.9	1.5	10.0	10.0	1.5	4.00	1.34	1.34	4.00
	No. 12 - 18.94 (EC7)	42.06	2,152.99	A	2.00	2.00	-2.00	-3.34	-2.00	2.00	2.13	21.0	47.8	59.8	5.0	5.0	69.8	1.5	10.0	10.0	1.5	4.00	1.34	1.34	4.00
	No. 13	195.00	2,347.99	A	1.93	2.00	-2.00	-3.33	-2.00	2.00	2.02	21.0	47.6	59.6	5.0	5.0	69.6	1.5	10.0	10.0	1.5	4.00	1.33	1.33	4.00
	No. 14 - 75 (BC8)	117.96	2,465.95	A	1.63	2.00	-2.00	-3.33	-2.00	2.00	1.89	21.0	47.5	59.5	5.0	5.0	69.5	1.5	10.0	10.0	1.5	4.00	1.33	1.33	4.00
	No. 14 - 43.28 (EC8)	31.72	2,497.67	A	1.63	2.00	-2.00	-3.32	-2.00	2.00	1.89	21.0	47.5	59.5	5.0	5.0	69.5	1.5	10.0	10.0	1.5	4.00	1.32	1.32	4.00
	No. 14 + 30.62 (BC9)	73.90	2,571.57	A	1.73	2.00	-2.00	-3.32	-2.00	2.00	1.89	21.0	47.4	59.4	5.0	5.0	69.4	1.5	10.0	10.0	1.5	4.00	1.32	1.32	4.00
	No. 15 - 50 (EC9')	112.01	2,683.58	A	1.85	2.00	-2.00	-3.31	-2.00	2.00	1.59	21.0	47.3	59.3	5.0	5.0	69.3	1.5	10.0	10.0	1.5	4.00	1.31	1.31	4.00
	No. 15 - 15.66 (BC10	34.34	2,717.92	A	1.85	2.00	-2.00	-3.31	-2.00	2.00	1.59	21.0	47.3	59.3	5.0	5.0	69.3	1.5	10.0	10.0	1.5	4.00	1.31	1.31	4.00
	No. 15 + 3.89 (EC10)	19.55	2,737.47	A	1.85	2.00	-2.00	-3.31	-2.00	2.00	1.44	21.0	47.2	59.2	5.0	5.0	69.2	1.5	10.0	10.0	1.5	4.00	1.31	1.31	4.00
	No. 16 - 100 (BC11)	124.94	2,862.41	A	2.14	2.00	-2.00	-3.31	-2.00	2.00	1.50	21.0	47.1	59.1	5.0	5.0	69.1	1.5	10.0	10.0	1.5	4.00	1.31	1.31	4.00
	No. 16 + 5.06 (EC11)	105.06	2,967.47	A	2.14	2.00	-2.00	-3.30	-2.00	2.00	1.50	33.0	68.0	80.0	5.0	0.0	85.0	1.5	10.0	10.0	1.5	4.00	1.30	1.30	4.00
	No. 16 + 13.86 (BC12	9.23	2,976.70	A	2.14	2.00	-2.00	-3.30	-2.00	2.00	1.50	40.0	75.0	87.0	5.0	0.0	92.0	1.5	10.0	10.0	1.5	4.00	1.30	1.30	4.00
	No. 17 + 27 (EP)	181.68	3,158.38	A	1.90	2.00	-2.00	-7.87	-1.57	1.83	1.83	35.0	62.0	100.0	5.0	0.0	105.0					4.00	5.87	6.30	3.41

TABLE 3.6 (2/4) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT

Name of Canal	Section	Length	Accumulate Length	Type of Cross Section	Elevation (m above MSL)							Canal Width						Bank Slope				Depth			
					Left		Channel			Right		Channel			O/M Road		Total	Left		Right		Left		Right	
					Bank	Crown	L-Bed	C-Bed	R-Bed	Crown	Bank	Bottom	Middle	Top	Left	Right		Upper	Lower	Lower	Upper	Upper	Lower	Lower	Upper
					EL.1	EL.2	EL.3	EL4	EL5	EL.6	EL.7	Bi	B2	B3	B4	B5	B	S1	S2	S2'	S1'	H1	H2	H2'	H1'
		(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(1: S1)	(1: S2)	(1: S2')	(1: S1')	(m)	(m)	(m)	(m)
	No. 17 + 27 (SP)	0.00	3,158.38	A	1.90	2.00	-2.00	-7.87	-1.57	1.83	1.83	35.0	62.0	100.0	5.0	0.0	105.0					4.00	5.87	6.30	3.41
	No. 18	55.00	3,213.38	A	1.99	2.00	-2.00	-10.50	-2.70	1.86	1.86	0.0	73.0	100.0	5.0	0.0	105.0	1.5			1.5	4.00	8.50	7.81	4.55
	No. 19 - 10 (EC12)	126.68	3,340.06	A	1.61	2.00	-2.00	-3.50	-2.00	2.00	1.57	21.0	39.0	51.0	5.0	5.0	61.0	1.5	6.0	6.0	1.5	4.00	1.50	1.50	4.00
	No. 20	214.00	3,554.06	A	0.87	2.00	-2.00	-3.49	-2.00	2.00	1.63	21.0	38.8	50.8	5.0	5.0	60.8	1.5	6.0	6.0	1.5	4.00	1.49	1.49	4.00
	No. 20 + 34.86 (BC13	34.86	3,588.92	A	0.87	2.00	-2.00	-3.48	-2.00	2.00	1.63	21.0	38.8	50.8	5.0	5.0	60.8	1.5	6.0	6.0	1.5	4.00	1.48	1.48	4.00
	No. 21 - 77 (EC13)	112.05	3,700.97	A	1.42	2.00	-2.00	-3.48	-2.00	2.00	1.63	21.0	38.8	50.8	5.0	5.0	60.8	1.5	6.0	6.0	1.5	4.00	1.48	1.48	4.00
	No. 21	77.00	3,777.97	A	1.42	2.00	-2.00	-3.48	-2.00	2.00	1.63	21.0	38.7	50.7	5.0	5.0	60.7	1.5	6.0	6.0	1.5	4.00	1.48	1.48	4.00
	No. 21 + 91.28 (BC14	91.28	3,869.25	A	1.42	2.00	-2.00	-3.47	-2.00	2.00	1.63	21.0	38.7	50.7	5.0	5.0	60.7	1.5	6.0	6.0	1.5	4.00	1.47	1.47	4.00
	No. 22 - 60 (EC14)	46.08	3,915.33	A	2.13	2.00	-2.00	-3.47	-2.00	2.00	1.33	21.0	38.6	50.6	5.0	5.0	60.6	1.5	6.0	6.0	1.5	4.00	1.47	1.47	4.00
	No. 22 - 2.27 (BC15)	57.73	3,973.06	A	2.13	2.00	-2.00	-3.47	-2.00	2.00	1.33	21.0	38.6	50.6	5.0	5.0	60.6	1.5	6.0	6.0	1.5	4.00	1.47	1.47	4.00
	No. 23	147.19	4,120.25	A	2.37	2.00	-2.00	-3.46	-2.00	2.00	1.40	21.0	38.5	50.5	5.0	5.0	60.5	1.5	6.0	6.0	1.5	4.00	1.46	1.46	4.00
	No. 23 + 70 (EC15)	70.00	4,190.25	A	2.37	2.00	-2.00	-3.45	-2.00	2.00	1.40	21.0	38.5	50.5	5.0	5.0	60.5	1.5	6.0	6.0	1.5	4.00	1.45	1.45	4.00
	No. 24 - 105 (BC16)	18.54	4,208.79	A	1.44	2.00	-2.00	-3.45	-2.00	2.00	1.40	21.0	38.4	50.4	5.0	5.0	60.4	1.5	6.0	6.0	1.5	4.00	1.45	1.45	4.00
	No. 24	105.00	4,313.79	A	1.44	2.00	-2.00	-3.45	-2.00	2.00	1.40	21.0	38.4	50.4	5.0	5.0	60.4	1.5	6.0	6.0	1.5	4.00	1.45	1.45	4.00
	No. 25 + 70 (EC16)	224.00	4,537.79	A	2.20	2.00	-2.00	-3.44	-2.00	2.00	1.31	21.0	38.3	50.3	5.0	5.0	60.3	1.5	6.0	6.0	1.5	4.00	1.44	1.44	4.00
Tau Hu (Down-stream)	No. 26 - 71.23 (BC17)	66.78	4,604.57	A	2.32	2.00	-2.00	-3.43	-2.00	2.00	1.65	21.0	38.2	50.2	5.0	5.0	60.2	1.5	6.0	6.0	1.5	4.00	1.43	1.43	4.00
	No. 26 + 13 (EC17)	84.23	4,688.80	A	2.32	2.00	-2.00	-3.43	-2.00	2.00	1.65	21.0	38.2	50.2	5.0	5.0	60.2	1.5	6.0	6.0	1.5	4.00	1.43	1.43	4.00
	No. 27 - 78.0	100.00	4,788.80	A	1.22	2.00	-2.00	-3.42	-2.00	2.00	1.39	21.0	49.5	61.5	5.0	5.0	71.5	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 27 - 16.43 (BC18)	61.57	4,850.37	A	1.22	2.00	-2.00	-3.42	-2.00	2.00	1.39	21.0	49.4	61.4	5.0	5.0	71.4	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 27 + 54.74 (EC18	71.08	4,921.45	A	1.22	2.00	-2.00	-3.42	-2.00	2.00	1.39	21.0	49.4	61.4	5.0	5.0	71.4	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 27 + 98.05 (BC19	43.31	4,964.76	A	1.22	2.00	-2.00	-3.42	-2.00	2.00	1.66	21.0	49.3	61.3	5.0	5.0	71.3	1.5	10.0	10.0	1.5	4.00	1.42	1.42	4.00
	No. 28 - 59 (EC19)	40.18	5,004.94	A	1.42	2.00	-2.00	-3.41	-2.00	2.00	1.25	21.0	49.3	61.3	5.0	5.0	71.3	1.5	10.0	10.0	1.5	4.00	1.41	1.41	4.00
	No. 28	59.00	5,063.94	A	1.54	2.00	-2.00	-3.41	-2.00	2.00	1.25	21.0	49.2	61.2	5.0	5.0	71.2	1.5	10.0	10.0	1.5	4.00	1.41	1.41	4.00
	No. 29	190.00	5,253.94	A	1.44	2.00	-2.00	-3.40	-2.00	2.00	1.44	21.0	49.0	61.0	5.0	5.0	71.0	1.5	10.0	10.0	1.5	4.00	1.40	1.40	4.00
	No. 30 - 82	104.41	5,358.35	A	1.93	2.00	-2.00	-3.40	-2.00	2.00	1.75	21.0	48.9	60.9	5.0	5.0	70.9	1.5	10.0	10.0	1.5	4.00	1.40	1.40	4.00
	No. 30 +18 (BC21)	100.00	5,458.35	A	1.93	2.00	-2.00	-3.39	-2.00	2.00	1.75	21.0	37.7	49.7	5.0	5.0	59.7	1.5	6.0	6.0	1.5	4.00	1.39	1.39	4.00
	No. 31 - 32 (EC21)	129.74	5,588.09	A	1.98	2.00	-2.00	-3.39	-2.00	2.00	1.63	21.0	37.6	49.6	5.0	5.0	59.6	1.5	6.0	6.0	1.5	4.00	1.39	1.39	4.00
	No. 31	32.00	5,620.09	A	1.98	2.00	-2.00	-3.38	-2.00	2.00	1.63	21.0	37.6	49.6	5.0	5.0	59.6	1.5	6.0	6.0	1.5	4.00	1.38	1.38	4.00
	No. 32	189.00	5,809.09	A	2.14	2.00	-2.00	-3.37	-2.00	2.00	1.73	21.0	37.5	49.5	5.0	5.0	59.5	1.5	6.0	6.0	1.5	4.00	1.37	1.37	4.00
	No. 33 - 43	155.00	5,964.09	A	2.11	2.00	-2.00	-3.37	-2.00	2.00	1.70	21.0	37.4	49.4	5.0	5.0	59.4	1.5	6.0	6.0	1.5	4.00	1.37	1.37	4.00
	No. 33 - 43	0.00	5,964.09	B	2.11	2.00	-2.00	-3.37	-2.00	2.00	1.70	21.0	41.5	45.5	5.0	5.0	55.5	0.5	7.5	7.5	0.5	4.00	1.37	1.37	4.00
	No. 33	43.00	6,007.09	B	2.11	2.00	-2.00	-3.36	-2.00	2.00	1.70	21.0	41.5	45.5	5.0	5.0	55.5	0.5	7.5	7.5	0.5	4.00	1.36	1.36	4.00

TABLE 3.6 (3/4) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT

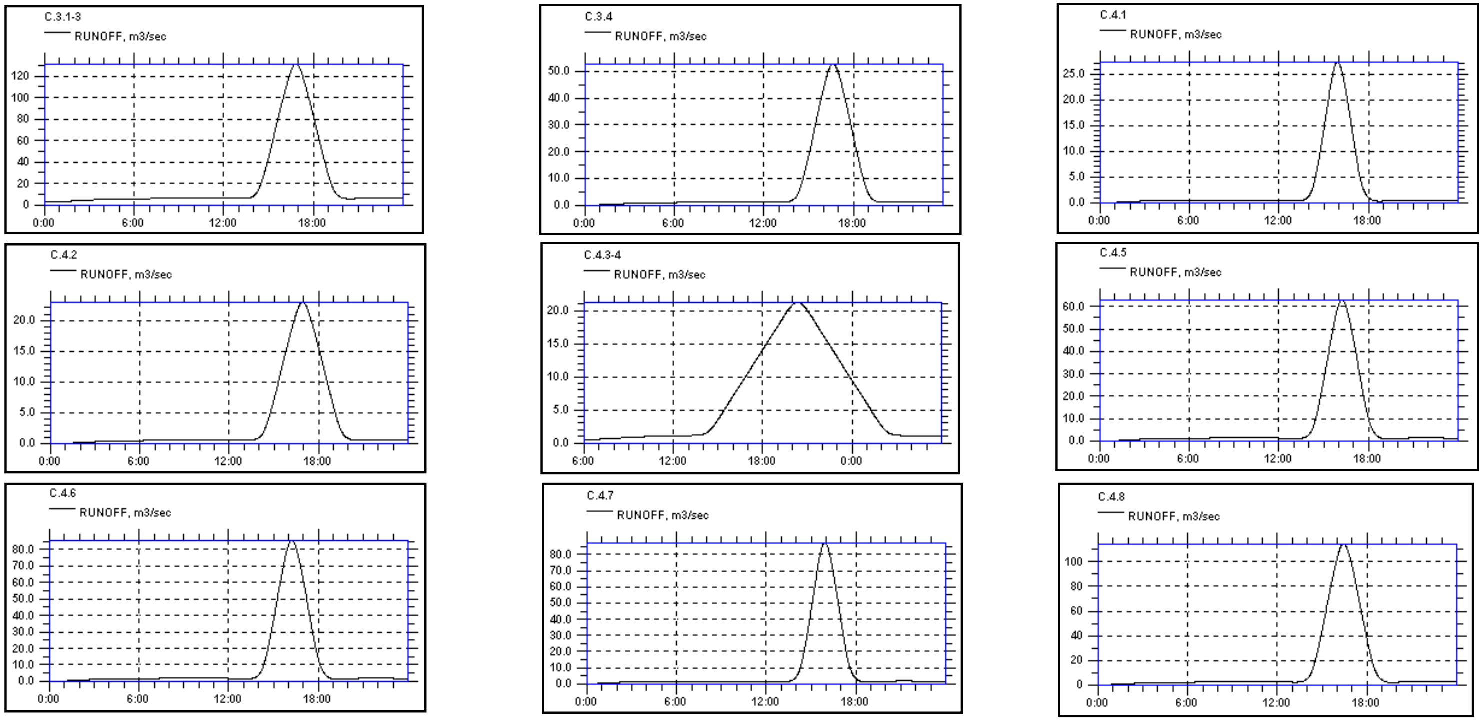
Name of Canal	Section	Length	Accumulate Length	Type of Cross Section	Elevation (m above MSL)							Canal Width						Bank Slope				Depth			
					Left		Channel			Right		Channel			O/M Road		Total	Left		Right		Left		Right	
					Bank	Crown	L-Bed	C-Bed	R-Bed	Crown	Bank	Bottom	Middle	Top	Left	Right		Upper	Lower	Lower	Upper	Upper	Lower	Lower	Upper
					EL.1	EL.2	EL.3	EL4	EL5	EL.6	EL.7	Bi	B2	B3	B4	B5	B	S1	S2	S2'	S1'	H1	H2	H2'	H1'
		(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(1: S1)	(1: S2)	(1: S2')	(1: S1')	(m)	(m)	(m)	(m)
Tau Hu (Down-stream)	No. 34 - 9 (IP22)	77.93	6,085.02	B	2.84	2.00	-2.00	-3.36	-2.00	2.00	2.35	21.0	41.4	45.4	5.0	5.0	55.4	0.5	7.5	7.5	0.5	4.00	1.36	1.36	4.00
	No. 35	118.00	6,203.02	B	2.14	2.00	-2.00	-3.35	-2.00	2.00	2.24	21.0	41.3	45.3	5.0	3.5	53.8	0.5	7.5	7.5	0.5	4.00	1.35	1.35	4.00
	No. 36 - 77 (IP23)	168.93	6,371.95	B	2.05	2.00	-2.00	-3.35	-2.00	2.00	1.84	21.0	41.2	45.2	5.0	5.0	55.2	0.5	7.5	7.5	0.5	4.00	1.35	1.35	4.00
	No. 36	77.00	6,448.95	B	2.05	2.00	-2.00	-3.34	-2.00	2.00	1.84	21.0	41.1	45.1	5.0	5.0	55.1	0.5	7.5	7.5	0.5	4.00	1.34	1.34	4.00
	No. 36 + 61.5 (BC24)	61.50	6,510.45	B	2.05	2.00	-2.00	-3.34	-2.00	2.00	1.84	21.0	41.1	45.1	5.0	5.0	55.1	0.5	7.5	7.5	0.5	4.00	1.34	1.34	4.00
	No. 36 + 94.77 (EC24	33.27	6,543.72	B	2.05	2.00	-2.00	-3.34	-2.00	2.00	1.84	21.0	41.1	45.1	5.0	5.0	55.1	0.5	7.5	7.5	0.5	4.00	1.34	1.34	4.00
	No. 37	88.00	6,631.72	B	2.05	2.00	-2.00	-3.33	-2.00	2.00	1.77	21.0	41.0	45.0	5.0	3.5	53.5	0.5	7.5	7.5	0.5	4.00	1.33	1.33	4.00
	No. 38	195.00	6,826.72	B	1.88	2.00	-2.00	-3.32	-2.00	2.00	1.78	21.0	40.8	44.8	3.0	3.5	51.3	0.5	7.5	7.5	0.5	4.00	1.32	1.32	4.00
	No. 39	145.00	6,971.72	B	1.83	2.00	-2.00	-3.32	-2.00	2.00	1.84	21.0	40.7	44.7	2.5	5.0	52.2	0.5	7.5	7.5	0.5	4.00	1.32	1.32	4.00
	No. 40	110.00	7,081.72	B	1.92	2.00	-2.00	-3.31	-2.00	2.00	1.63	21.0	40.7	44.7	2.5	3.5	50.7	0.5	7.5	7.5	0.5	4.00	1.31	1.31	4.00
	No. 41	117.00	7,198.72	B	1.87	2.00	-2.00	-3.30	-2.00	2.00	2.08	21.0	40.6	44.6	2.5	5.0	52.1	0.5	7.5	7.5	0.5	4.00	1.30	1.30	4.00
	No. 41 + 89.66 (IP25)	89.86	7,288.58	B	1.87	2.00	-2.00	-3.30	-2.00	2.00	2.08	21.0	40.5	44.5	2.5	5.0	52.0	0.5	7.5	7.5	0.5	4.00	1.30	1.30	4.00
Tau Hu (Up-stream)	No. 41 + 89.66 (IP25)	0.00	7,288.58	B	1.87	2.00	-2.00	-4.41	-2.00	2.00	2.08	22.0	41.3	45.3	2.0	5.0	52.3	0.5	7.5	7.5	0.5	4.00	2.41	2.41	4.00
	No. 42	100.82	7,389.40	B	1.76	2.00	-2.00	-4.40	-2.00	2.00	1.95	22.0	41.2	45.2	3.5	5.0	53.7	0.5	7.5	7.5	0.5	4.00	2.40	2.40	4.00
	No. 43	200.00	7,589.40	B	1.85	2.00	-2.00	-4.39	-2.00	2.00	1.85	22.0	41.1	45.1	5.0	5.0	55.1	0.5	7.5	7.5	0.5	4.00	2.39	2.39	4.00
	No. 44	187.00	7,776.40	B	1.51	2.00	-2.00	-4.38	-2.00	2.00	1.68	22.0	41.1	45.1	5.0	5.0	55.1	0.5	7.5	7.5	0.5	4.00	2.38	2.38	4.00
	No. 45 - 95 (IP27)	113.00	7,889.40	B	1.50	2.00	-2.00	-4.38	-2.00	2.00	1.60	22.0	41.0	45.0	3.0	5.0	53.0	0.5	7.5	7.5	0.5	4.00	2.38	2.38	4.00
	No. 45	95.00	7,984.40	B	1.50	2.00	-2.00	-4.37	-2.00	2.00	1.60	22.0	41.0	45.0	3.0	5.0	53.0	0.5	7.5	7.5	0.5	4.00	2.37	2.37	4.00
	No. 46	200.00	8,184.40	B	1.62	2.00	-2.00	-4.36	-2.00	2.00	1.62	22.0	40.9	44.9	3.0	3.0	50.9	0.5	7.5	7.5	0.5	4.00	2.36	2.36	4.00
	No. 47	232.90	8,417.30	B	1.46	2.00	-2.00	-4.35	-2.00	2.00	1.68	22.0	40.8	44.8	5.0	3.0	52.8	0.5	7.5	7.5	0.5	4.00	2.35	2.35	4.00
	No. 47 + 40 (IP28)	40.00	8,457.30	B	1.41	2.00	-2.00	-4.35	-2.00	2.00	1.34	22.0	40.8	44.8	3.0	5.0	52.8	0.5	7.5	7.5	0.5	4.00	2.35	2.35	4.00
	No. 47 + 40 (IP28)	0.00	8,457.30	A	1.41	2.00	-2.00	-4.35	-2.00	2.00	1.36	22.0	38.4	50.4	1.0	2.0	53.4	1.5	3.5	3.5	1.5	4.00	2.35	2.35	4.00
	No. 48	130.00	8,587.30	A	1.34	2.00	-2.00	-4.34	-2.00	2.00	1.30	22.0	38.4	50.4	2.5	5.0	57.9	1.5	3.5	3.5	1.5	4.00	2.34	2.34	4.00
	No. 49	170.00	8,757.30	A	1.35	2.00	-2.00	-4.33	-2.00	2.00	1.47	22.0	38.3	50.3	3.0	5.0	58.3	1.5	3.5	3.5	1.5	4.00	2.33	2.33	4.00
	No. 50	100.00	8,857.30	A	1.57	2.00	-2.00	-4.33	-2.00	2.00	1.50	22.0	38.3	50.3	3.0	5.0	58.3	1.5	3.5	3.5	1.5	4.00	2.33	2.33	4.00
	No. 51	100.00	8,957.30	A	1.51	2.00	-2.00	-4.32	-2.00	2.00	1.45	22.0	38.3	50.3	3.0	5.0	58.3	1.5	3.5	3.5	1.5	4.00	2.32	2.32	4.00
	No. 52	100.00	9,057.30	A	1.48	2.00	-2.00	-4.32	-2.00	2.00	1.50	22.0	38.2	50.2	3.0	3.0	56.2	1.5	3.5	3.5	1.5	4.00	2.32	2.32	4.00
	No. 53	100.00	9,157.30	A	1.39	2.00	-2.00	-4.31	-2.00	2.00	1.47	22.0	38.2	50.2	3.0	3.0	56.2	1.5	3.5	3.5	1.5	4.00	2.31	2.31	4.00
	No. 54 + 22 (BC30)	124.96	9,282.26	A	1.41	2.00	-2.00	-4.31	-2.00	2.00	1.63	22.0	38.2	50.2	3.0	5.0	58.2	1.5	3.5	3.5	1.5	4.00	2.31	2.31	4.00
	No. 55	79.00	9,361.26	A	1.42	2.00	-2.00	-4.30	-2.00	2.00	1.62	22.0	38.1	50.1	5.0	5.0	60.1	1.5	3.5	3.5	1.5	4.00	2.30	2.30	4.00
	No. 55 + 79.15 (EC30	79.15	9,440.41	A	1.34	2.00	-2.00	-4.30	-2.00	2.00	1.62	22.0	38.1	50.1	5.0	5.0	60.1	1.5	3.5	3.5	1.5	4.00	2.30	2.30	4.00
	No. 55 + 79 (EC30)	0.00	9,440.41	A	1.34	2.00	-2.00	-4.30	-2.00	2.00	1.26	22.0	38.1	50.1	5.0	5.0	60.1	1.5	3.5	3.5	1.5	4.00	2.30	2.30	4.00

TABLE 3.6 (4/4) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL IMPROVEMENT

Name of Canal	Section	Length	Accumulate Length	Type of Cross Section	Elevation (m above MSL)							Canal Width						Bank Slope				Depth			
					Left		Channel			Right		Channel			O/M Road		Total	Left		Right		Left		Right	
					Bank	Crown	L-Bed	C-Bed	R-Bed	Crown	Bank	Bottom	Middle	Top	Left	Right		Upper	Lower	Lower	Upper	Upper	Lower	Lower	Upper
					EL.1	EL.2	EL.3	EL4	EL5	EL.6	EL.7	Bi	B2	B3	B4	B5	B	S1	S2	S2'	S1'	H1	H2	H2'	H1'
		(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(1: S1)	(1: S2)	(1: S2')	(1: S1')	(m)	(m)	(m)	(m)
Tau Hu (Up-stream)	No. 56 - 55 (IP33)	103.02	9,543.43	A	1.45	2.00	-2.00	-4.30	-2.00	2.00	1.05	22.0	38.1	50.1	5.0	5.0	60.1	1.5	3.5	3.5	1.5	4.00	2.30	2.30	4.00
	No. 56	55.00	9,598.43	A	1.45	2.00	-2.00	-4.31	-2.00	2.00	1.05	22.0	38.2	50.2	5.0	5.0	60.2	1.5	3.5	3.5	1.5	4.00	2.31	2.31	4.00
	No. 57	205.00	9,803.43	A	1.58	2.00	-2.00	-4.32	-2.00	2.00	1.04	22.0	38.2	50.2	5.0	5.0	60.2	1.5	3.5	3.5	1.5	4.00	2.32	2.32	4.00
	No. 58	205.00	10,008.43	A	1.42	2.00	-2.00	-4.33	-2.00	2.00	1.04	22.0	38.3	50.3	4.5	4.5	59.3	1.5	3.5	3.5	1.5	4.00	2.33	2.33	4.00
	No. 59	220.00	10,228.43	A	1.39	2.00	-2.00	-4.34	-2.00	2.00	1.13	22.0	38.4	50.4	1.0	5.0	56.4	1.5	3.5	3.5	1.5	4.00	2.34	2.34	4.00
	No. 60 + 30 (IP34)	208.05	10,436.48	A	1.44	2.00	-2.00	-4.35	-2.00	2.00	1.70	22.0	38.4	50.4	3.5	5.0	58.9	1.5	3.5	3.5	1.5	4.00	2.35	2.35	4.00
	No. 61	190.00	10,626.48	A	1.58	2.00	-2.00	-4.36	-2.00	2.00	1.09	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.36	2.36	4.00
	No. 62	190.00	10,816.48	A	1.52	2.00	-2.00	-4.37	-2.00	2.00	1.00	22.0	38.6	50.6	5.0	5.0	60.6	1.5	3.5	3.5	1.5	4.00	2.37	2.37	4.00
	No. 63	180.00	10,996.48	A	1.40	2.00	-2.00	-4.38	-2.00	2.00	1.05	22.0	38.6	50.6	5.0	5.0	60.6	1.5	3.5	3.5	1.5	4.00	2.38	2.38	4.00
	No. 64	210.00	11,206.48	A	1.19	2.00	-2.00	-4.39	-2.00	2.00	1.02	22.0	38.7	50.7	5.0	5.0	60.7	1.5	3.5	3.5	1.5	4.00	2.39	2.39	4.00
	No. 65	190.00	11,396.48	A	2.75	2.00	-2.00	-4.40	-2.00	2.00	1.02	22.0	38.8	50.8	5.0	5.0	60.8	1.5	3.5	3.5	1.5	4.00	2.40	2.40	4.00
	No. 66	245.00	11,641.48	A	1.31	2.00	-2.00	-4.41	-2.00	2.00	1.17	22.0	38.9	50.9	5.0	5.0	60.9	1.5	3.5	3.5	1.5	4.00	2.41	2.41	4.00
	No. 67	185.00	11,826.48	A	1.35	2.00	-2.00	-4.42	-2.00	2.00	1.19	22.0	38.9	50.9	5.0	5.0	60.9	1.5	3.5	3.5	1.5	4.00	2.42	2.42	4.00
	No.67 + 54.28 (BC36)	54.28	11,880.76	A	1.35	2.00	-2.00	-4.42	-2.00	2.00	1.19	22.0	39.0	51.0	5.0	5.0	61.0	1.5	3.5	3.5	1.5	4.00	2.42	2.42	4.00
	No. 67 + 89.31 (EC36	35.03	11,915.79	A	1.35	2.00	-2.00	-4.42	-2.00	2.00	1.19	22.0	39.0	51.0	5.0	5.0	61.0	1.5	3.5	3.5	1.5	4.00	2.42	2.42	4.00
	No. 68	103.00	12,018.79	A	0.76	2.00	-2.00	-4.43	-2.00	2.00	1.22	22.0	39.0	51.0	1.0	1.0	53.0	1.5	3.5	3.5	1.5	4.00	2.43	2.43	4.00
	No. 68 + 80	79.33	12,098.12		-	-	-	-4.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ngang No.1	No. 1 - 5	0.00	0.00	B	2.07	2.00	-2.00	-4.41	-2.00	2.00	2.43	22.0	41.3	45.3	5.0	5.0	55.3	0.5	4.0	4.0	0.5	4.00	2.41	2.41	4.00
	No. 1 + 80	80.00	80.00	B	2.07	2.00	-2.00	-4.41	-2.00	2.00	2.43	22.0	41.3	45.3	5.0	5.0	55.3	0.5	4.0	4.0	0.5	4.00	2.41	2.41	4.00
	No. 2 - 40	20.00	100.00	A	1.72	2.00	-2.00	-4.42	-2.00	2.00	1.84	22.0	48.6	60.6	5.0	5.0	70.6	1.5	5.5	5.5	1.5	4.00	2.42	2.42	4.00
	No. 2	40.00	140.00	A	1.72	2.00	-2.00	-4.42	-2.00	2.00	1.84	22.0	48.6	60.6	5.0	5.0	70.6	1.5	5.5	5.5	1.5	4.00	2.42	2.42	4.00
	No. 3	90.00	230.00	A	1.94	2.00	-2.00	-4.42	-2.00	2.00	2.13	22.0	48.6	60.6	5.0	5.0	70.6	1.5	5.5	5.5	1.5	4.00	2.42	2.42	4.00
	No. 4 + 5	165.00	395.00	A	2.04	2.00	-2.00	-4.43	-2.00	2.00	2.18	22.0	48.7	60.7	5.0	5.0	70.7	1.5	5.5	5.5	1.5	4.00	2.43	2.43	4.00
Ngang No.2	No. 1 - 10	0.00	0.00	A	38.82	2.00	-2.00	-4.35	-2.00	2.00	0.00	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.35	2.35	4.00
	No. 2	115.00	115.00	A	51.11	2.00	-2.00	-4.36	-2.00	2.00	0.00	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.36	2.36	4.00
	No. 3	105.00	220.00	A	60.32	2.00	-2.00	-4.36	-2.00	2.00	0.00	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.36	2.36	4.00
	No. 4	90.00	310.00	A	54.27	2.00	-2.00	-4.37	-2.00	2.00	0.00	22.0	38.6	50.6	5.0	5.0	60.6	1.5	3.5	3.5	1.5	4.00	2.37	2.37	4.00
	No. 5 + 20	95.00	405.00	A	33.27	2.00	-2.00	-4.37	-2.00	2.00	0.00	22.0	38.6	50.6	5.0	5.0	60.6	1.5	3.5	3.5	1.5	4.00	2.37	2.37	4.00
Ngang No.3	No. 1 - 10	0.00	0.00	A	118.91	2.00	-2.00	-4.35	-2.00	2.00	0.00	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.35	2.35	4.00
	No. 2	120.00	120.00	A	149.55	2.00	-2.00	-4.36	-2.00	2.00	0.00	22.0	38.5	50.5	5.0	5.0	60.5	1.5	3.5	3.5	1.5	4.00	2.36	2.36	4.00
	No. 2 + 20	20.00	140.00	A	149.55	2.00	-2.00	-4.36	-2.00	2.00	0.00	22.0	47.9	59.9	5.0	5.0	69.9	1.5	5.5	5.5	1.5	4.00	2.36	2.36	4.00
	No. 3	90.00	230.00	A	134.93	2.00	-2.00	-4.36	-2.00	2.00	0.00	22.0	48.0	60.0	5.0	5.0	70.0	1.5	5.5	5.5	1.5	4.00	2.36	2.36	4.00
	No. 4 + 25	170.00	400.00	A	152.42	2.00	-2.00	-4.37	-2.00	2.00	0.00	22.0	48.1	60.1	5.0	5.0	70.1	1.5	5.5	5.5	1.5	4.00	2.37	2.37	4.00

TABLE 3.7 SUB-CATCHMENTS FOR RUNOFF HYDROGRAPHS

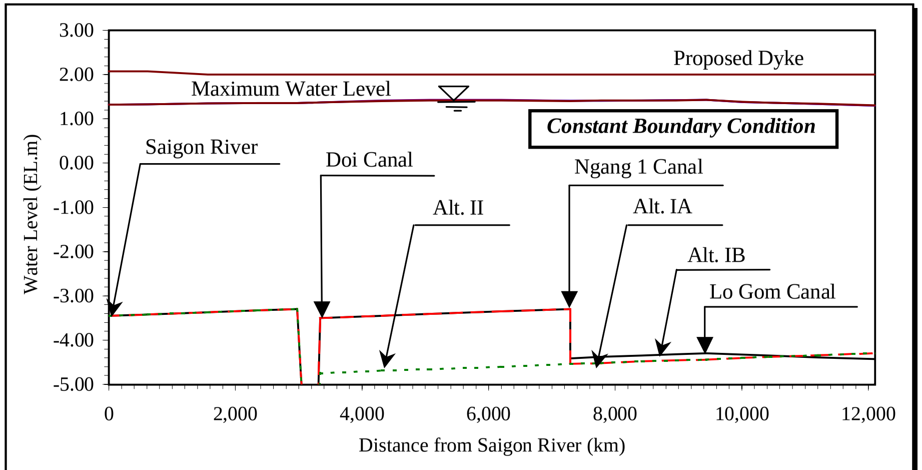
Catchment				Inlet		Flow		Time of Concentration (minutes)	Areal Reduction Factor	10-Year Rainfall Intensity (mm/hr)	10-Year Peak Runoff (Future Landuse) (m3/s)	Specific Runoff (m3/s/km2)
Catchment	Sub-Catchment	Area (km2)	Runoff Coefficient (Future Landuse)	Length (km)	Time (minutes)	Length (km)	Time (minutes)					
C.3	C.3.1 + C.3.2 + C.3.3	14.35	0.76	1.80	45	7.07	97	143	0.95	45	131	9
	C.3.4	5.88	0.69	2.00	72	1.50	63	135	0.98	48	53	9
C.4	C.4.1	1.84	0.85	0.59	19	3.34	80	98	0.99	63	27	15
	C.4.2	2.88	0.67	1.60	72	3.33	79	151	0.99	43	23	8
	C.4.3 + C.4.4	6.52	0.58	1.51	84	5.75	240	323	0.98	19	20	3
	C.4.5	5.24	0.79	2.60	63	2.06	49	112	0.98	56	63	12
	C.4.6	7.51	0.75	4.10	97	0.79	19	115	0.98	55	84	11
	C.4.7	6.64	0.76	3.00	72	1.00	24	96	0.98	64	88	13
	C.4.8	10.86	0.76	2.00	50	4.25	71	121	0.97	53	116	11
	Total	61.72									Average	10



Note : Represents runoff hydrographs for the sub-catchments for 10-year rainfall with peak intensity occurring at 12th hour.

TABLE 3.8 COMPARISON AMONG DIFFERENT ALTERNATIVES FOR MAXIMUM WATER LEVEL

Canal Name	Section No.	Chainage (km)	Lowest Bed Level (EL. m) Bed - Alt. IA	Bed - Alt. IB	Bed - Alt. II	Constant W. L. Boundary Condition CWL - Alt. IA	CWL - Alt. IB	CWL - Alt. II	Dynamic W.L. Boundary Condition DWL - Alt. IA	DWL - Alt. IB	DWL - Alt. II	Proposed Dyke (EL.m)
Ben Nghe	No. 0	0	-3.450	-3.450	-3.450	1.320	1.320	1.320	1.320	1.320	1.320	2.070
	No. 4	610	-3.420	-3.420	-3.420	1.328	1.330	1.328	1.328	1.329	1.323	2.070
	No. 9	1,562	-3.370	-3.370	-3.370	1.348	1.348	1.347	1.346	1.346	1.328	2.000
	No. 13	2,348	-3.330	-3.330	-3.330	1.357	1.357	1.356	1.354	1.354	1.334	2.000
	No. 16 + 14	2,976	-3.300	-3.300	-3.300	1.358	1.358	1.358	1.356	1.355	1.339	2.000
Doi Te	No. 17 + 27	3,158	-7.870	-7.870	-7.870	1.362	1.362	1.362	1.359	1.358	1.340	2.000
	No. 18	3,213	-10.500	-10.500	-10.500	1.367	1.367	1.367	1.362	1.361	1.341	2.000
Tau Hu Downstream	No. 19 - 10	3,340	-3.500	-3.500	-4.750	1.368	1.368	1.368	1.363	1.362	1.341	2.000
	No. 24	4,313	-3.450	-3.450	-4.690	1.416	1.410	1.401	1.412	1.422	1.365	2.000
	No. 28	5,064	-3.410	-3.410	-4.660	1.431	1.422	1.414	1.432	1.422	1.377	2.000
	No. 35	6,203	-3.350	-3.350	-4.600	1.432	1.423	1.416	1.433	1.424	1.376	2.000
	No. 41 + 90	7,288	-3.300	-3.300	-4.540	1.407	1.406	1.403	1.406	1.405	1.362	2.000
Tau Hu Upstream	No. 41 + 90	7,288	-4.540	-4.410	-4.540	1.407	1.406	1.403	1.406	1.405	1.362	2.000
	No. 44	7,776	-4.520	-4.380	-4.520	1.418	1.409	1.414	1.422	1.410	1.363	2.000
	No. 47	8,417	-4.480	-4.350	-4.480	1.418	1.411	1.414	1.422	1.414	1.365	2.000
	No. 51	8,957	-4.460	-4.320	-4.460	1.419	1.421	1.415	1.423	1.424	1.366	2.000
	No. 55 + 79	9,440	-4.440	-4.300	-4.440	1.429	1.426	1.426	1.429	1.427	1.368	2.000
Lo Gom	No. 55 + 79	9,440	-4.440	-4.300	-4.440	1.429	1.426	1.426	1.429	1.427	1.368	2.000
	No. 58	10,008	-4.400	-4.330	-4.400	1.379	1.381	1.383	1.373	1.376	1.338	2.000
	No. 60 + 30	10,436	-4.380	-4.350	-4.380	1.363	1.364	1.366	1.355	1.356	1.324	2.000
	No. 64	11,206	-4.340	-4.390	-4.340	1.334	1.338	1.340	1.322	1.327	1.299	2.000
	No. 68 + 80	12,098	-4.300	-4.430	-4.300	1.300	1.302	1.309	1.287	1.289	1.269	2.000



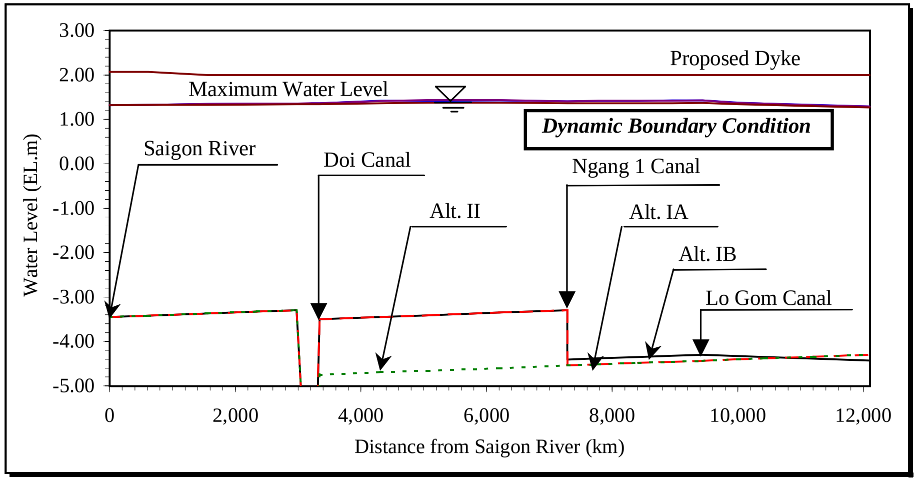


TABLE 3.9 (1/3) BILL OF QUANTITIES FOR TAU HU - BEN NGHE CANAL IMPROVEMENT (DREDGING AND FILLING)

Name of Canal	Length (m)	Dredging					Filling				
		Total Area (m2)				Total Volume (m3)	Total Area (m2)				Total Volume (m3)
		Left Bank	Channel	Right Bank	Total		Left Bank	Channel	Right Bank	Total	
Ben Nghe	3,158.4	0.2	2,626.8	0.0	2,627.0	277,986	557.2	0.0	606.4	1,163.6	129,572
Tau Hu	4,130.2	1.0	3,800.9	0.0	3,802.0	376,003	755.1	0.0	477.2	1,232.3	126,202
Sub-total of Phase 1	7,288.6	1.3	6,427.7	0.0	6,428.9	653,989	1,312.2	0.0	1,083.7	2,395.9	255,774
Tau Hu (Upstream)	4,809.5	0.0	3,538.8	1.6	3,540.4	423,768	200.0	0.0	287.8	487.8	65,341
Ngang No.1	395.0	0.0	582.1	0.0	582.1	34,142	26.7	0.0	41.5	68.2	4,669
Ngang No.2	405.0	0.0	396.7	0.0	396.7	33,972	26.1	0.0	31.0	57.2	4,734
Ngang No.3	405.0	0.0	678.9	0.0	678.9	56,626	75.3	0.0	83.2	158.5	14,407
Sub-total of Phase 2	6,014.5	0.0	5,196.5	1.6	5,198.1	548,508	328.1	0.0	443.5	771.7	89,151
Total	13,303.1	1.3	11,624.1	1.6	11,627.0	1,202,497	1,640.4	0.0	1,527.2	3,167.6	344,925

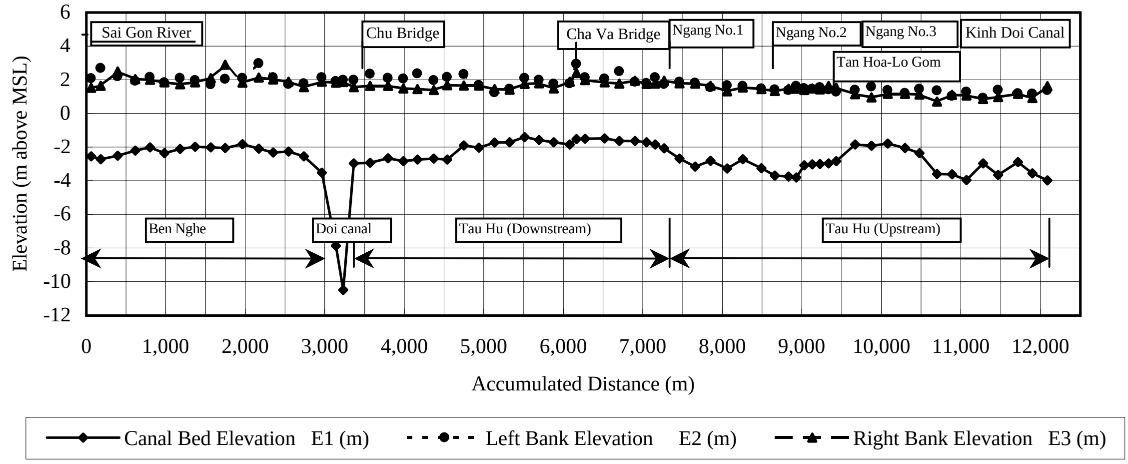
TABLE 3.9 (2/3) BILL OF QUANTITIES FOR TAU HU - BEN NGHE CANAL IMPROVEMENT (SLOPE PROTECTION)

Name of Canal	Length (m)	Type A						Type B					
		Length (m)			Area (m2)			Length (m)			Area (m2)		
		Left Bank	Right Bank	Total	Left Bank	Right Bank	Total	Left Bank	Right Bank	Total	Left Bank	Right Bank	Total
Ben Nghe	3,158.4	2,949.0	2,464.6	5,413.6	21,265	17,772	39,037	0.0	0.0	0.0	0	0	0
Tau Hu	4,130.2	2,921.6	2,857.2	5,778.8	21,068	20,603	41,671	1,327.3	1,321.3	2,648.6	5,936	5,909	11,845
Sub-total of Phase 1	7,288.6	5,870.6	5,321.8	11,192.4	42,333	38,375	80,708	1,327.3	1,321.3	2,648.6	5,936	5,909	11,845
Tau Hu (Upstream)	4,809.5	3,683.4	3,274.0	6,957.4	26,561	23,609	50,170	1,167.8	864.0	2,031.8	5,222	3,864	9,086
Ngang No.1	395.0	348.3	348.3	696.6	2,512	2,512	5,024	70.0	70.0	140.0	0	0	0
Ngang No.2	405.0	433.3	433.3	866.6	3,125	3,125	6,250	0.0	0.0	0.0	0	0	0
Ngang No.3	405.0	403.3	403.3	806.6	2,908	2,908	5,816	0.0	0.0	0.0	0	0	0
Sub-total of Phase 2	6,014.5	4,868.3	4,458.9	9,327.2	35,106	32,154	67,260	1,237.8	934.0	2,171.8	5,222	3,864	9,086
Total	13,303.1	10,738.9	9,780.7	20,519.6	77,439	70,529	147,968	2,565.1	2,255.3	4,820.4	11,158	9,773	20,931

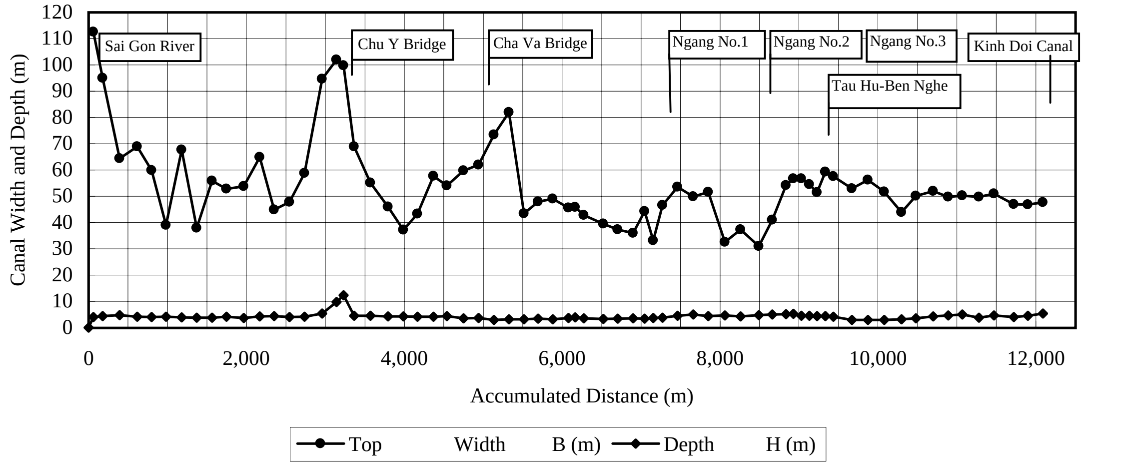
TABLE 3.9 (3/3) BILL OF QUANTITIES FOR TAU HU - BEN NGHE CANAL IMPROVEMENT (RIP RAP AND O/M ROAD)

Name of Canal	Length (m)	Rip Rap							Pavement of O/M Road				
		Length (m)		Area (m2)			Thickness (m3)	Volume (m3)	Width (m)		Area (m2)		
		Left Bank	Right Bank	Left Bank	Right Bank	Total			Left Bank	Right Bank	Left Bank	Right Bank	Total
Ben Nghe	3,158.4	2,949.0	2,464.6	8,847	7,394	16,241	0.5	8,120	5.0	5.0	14,745.0	12,147.9	26,893
Tau Hu	4,130.2	4,248.8	4,178.4	12,747	12,535	25,282	0.5	12,641	2.5 - 5.0	3.5 - 5.0	19,700	20,126	39,826
Sub-total of Phase 1	7,288.6	7,197.8	6,643.0	21,594	19,929	41,523	0.5	20,761	2.5 - 5.0	3.5 - 5.0	34,445	32,274	66,719
Tau Hu (Upstream)	4,809.5	4,851.2	4,629.8	14,554	13,890	28,443	0.5	14,222	1.0 - 5.0	1.0 - 5.0	19,284	21,076	40,360
Ngang No.1	395.0	348.3	348.3	1,045	1,045	2,090	0.5	1,045	5.0	5.0	1,742	1,742	3,483
Ngang No.2	405.0	433.3	433.3	1,300	1,300	2,600	0.5	1,300	5.0	5.0	2,167	2,167	4,333
Ngang No.3	405.0	403.3	403.3	1,210	1,210	2,420	0.5	1,210	5.0	5.0	2,017	2,017	4,034
Sub-total of Phase 2	6,014.5	6,036.1	5,814.7	18,108	17,444	35,553	2.0	17,776	1.0 - 5.0	1.0 - 5.0	25,209	27,001	52,210
Total	13,303.1	13,233.9	12,457.7	39,702	37,373	77,075	2.5	38,538	1.0 - 5.0	1.0 - 5.0	59,654	59,274	118,929

LONGITUDINAL PROFILE



CANAL WIDTH AND DEPTH



DISCHARGE CAPACITY

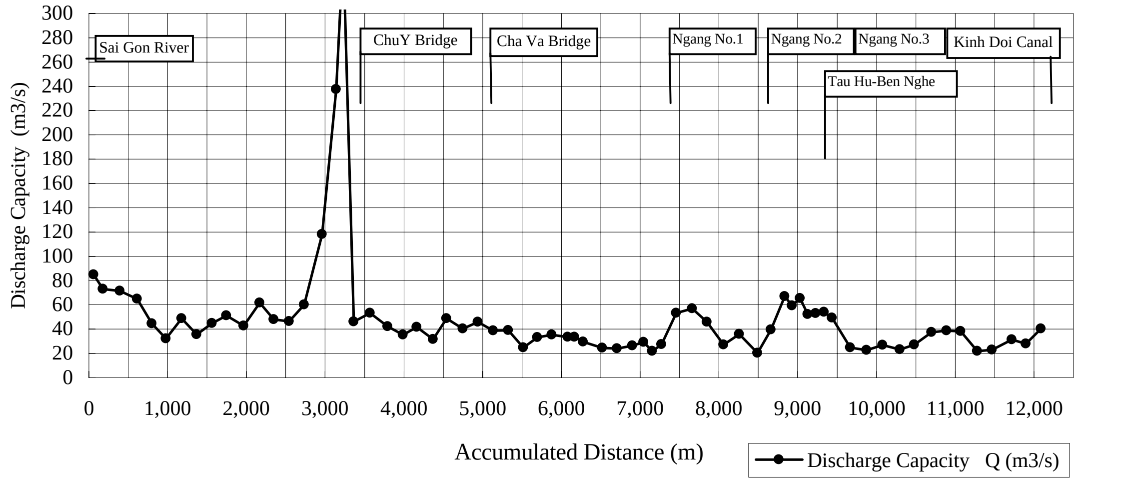


FIG. 3.1 HYDRAULIC CHARACTERISTIC AND DISCHARGE CAPACITY OF EXISTING TAU HU - BEN NGHE CANAL

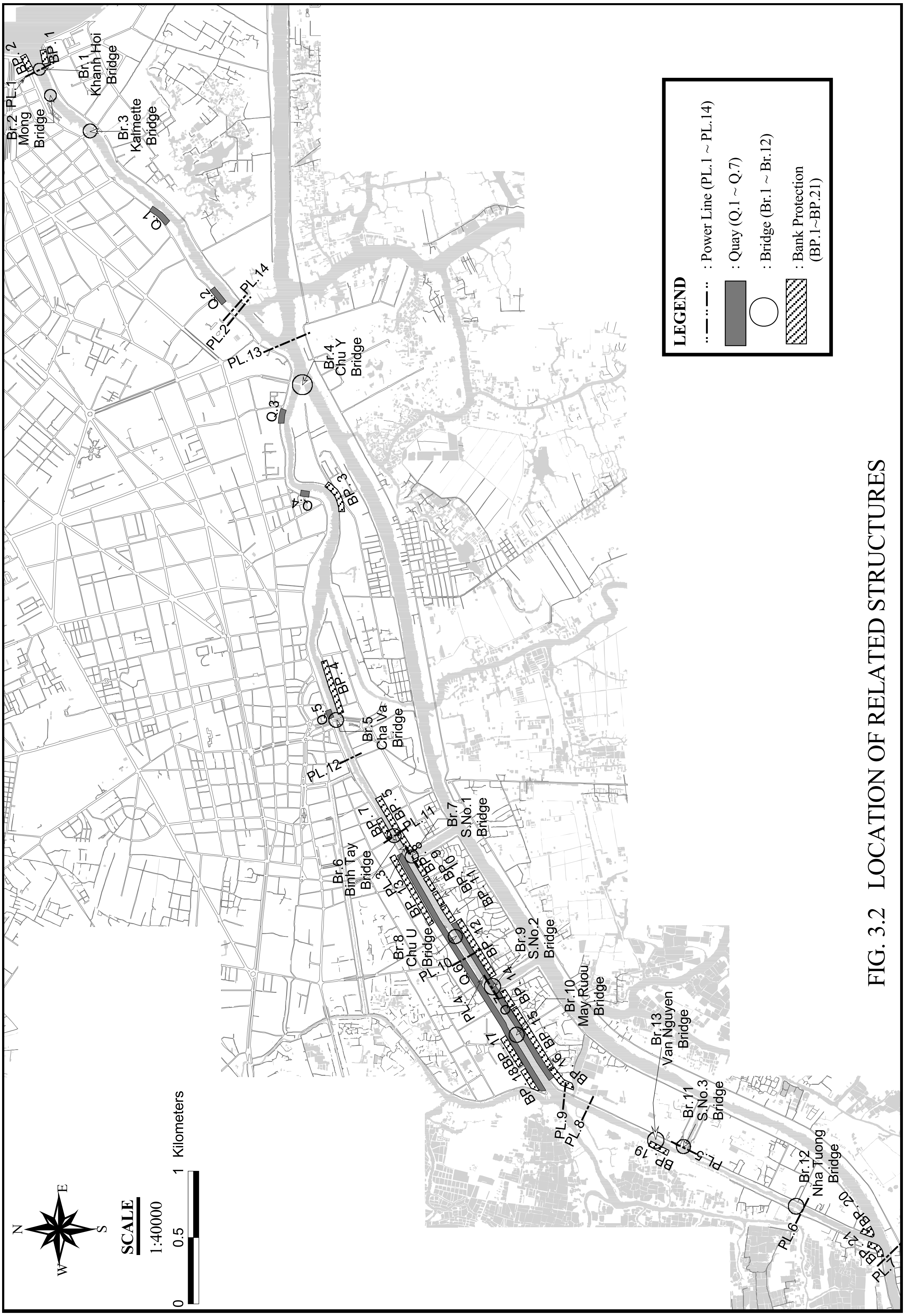


FIG. 3.2 LOCATION OF RELATED STRUCTURES

EXISTING LANDSCAPE OVERVIEW ALONG BEN NGHE CANAL (KHANH HOI BRIDGE TO CHU Y BRIDGE)

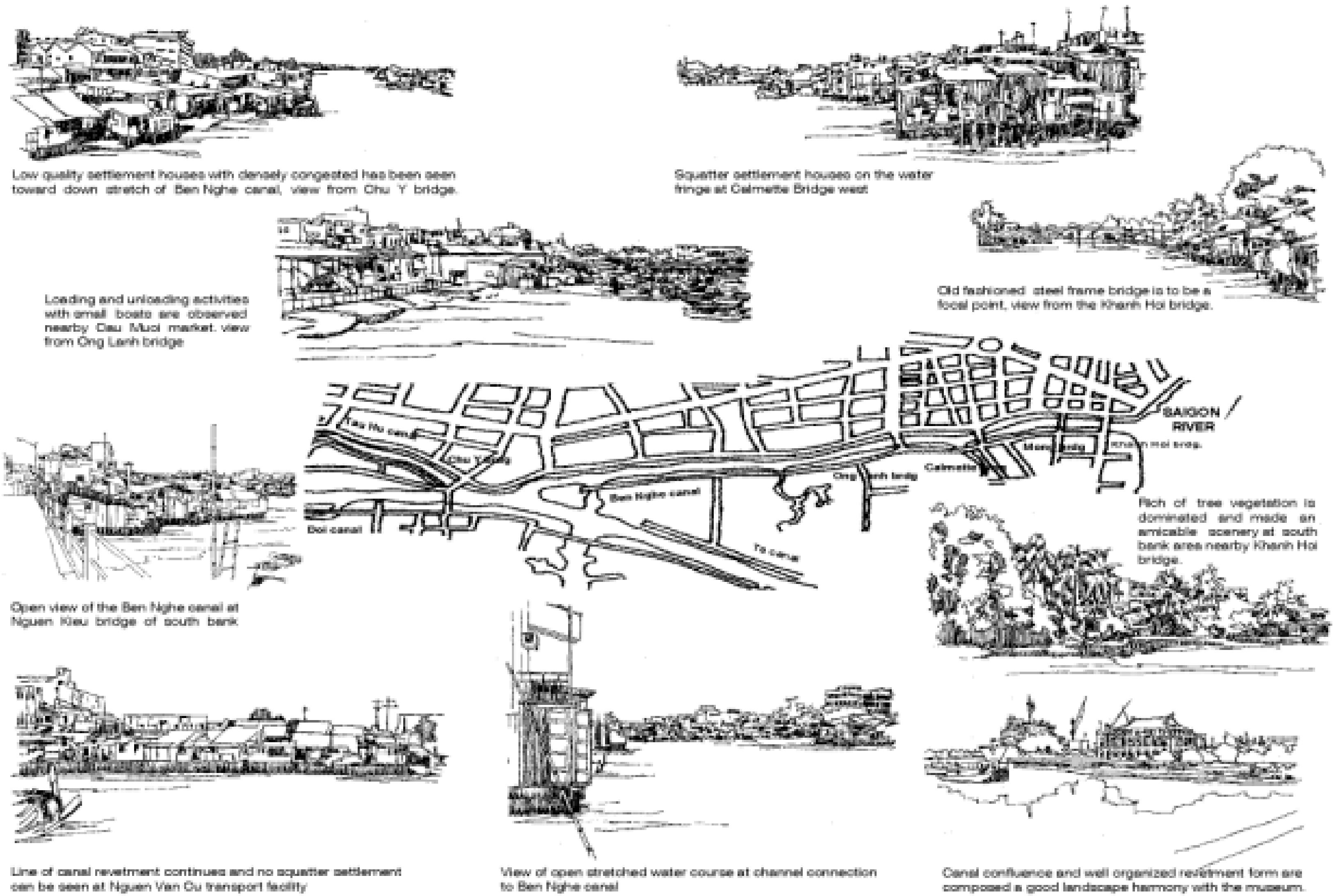


FIG. 3.3(1/3) EXISTING LANDSCAPE OVERVIEW ALONG BEN NGHE CANAL

EXISTING LANDSCAPE OVERVIEW ALONG TAU HU CANAL (CHU Y BRIDGE TO No.1 CANAL)

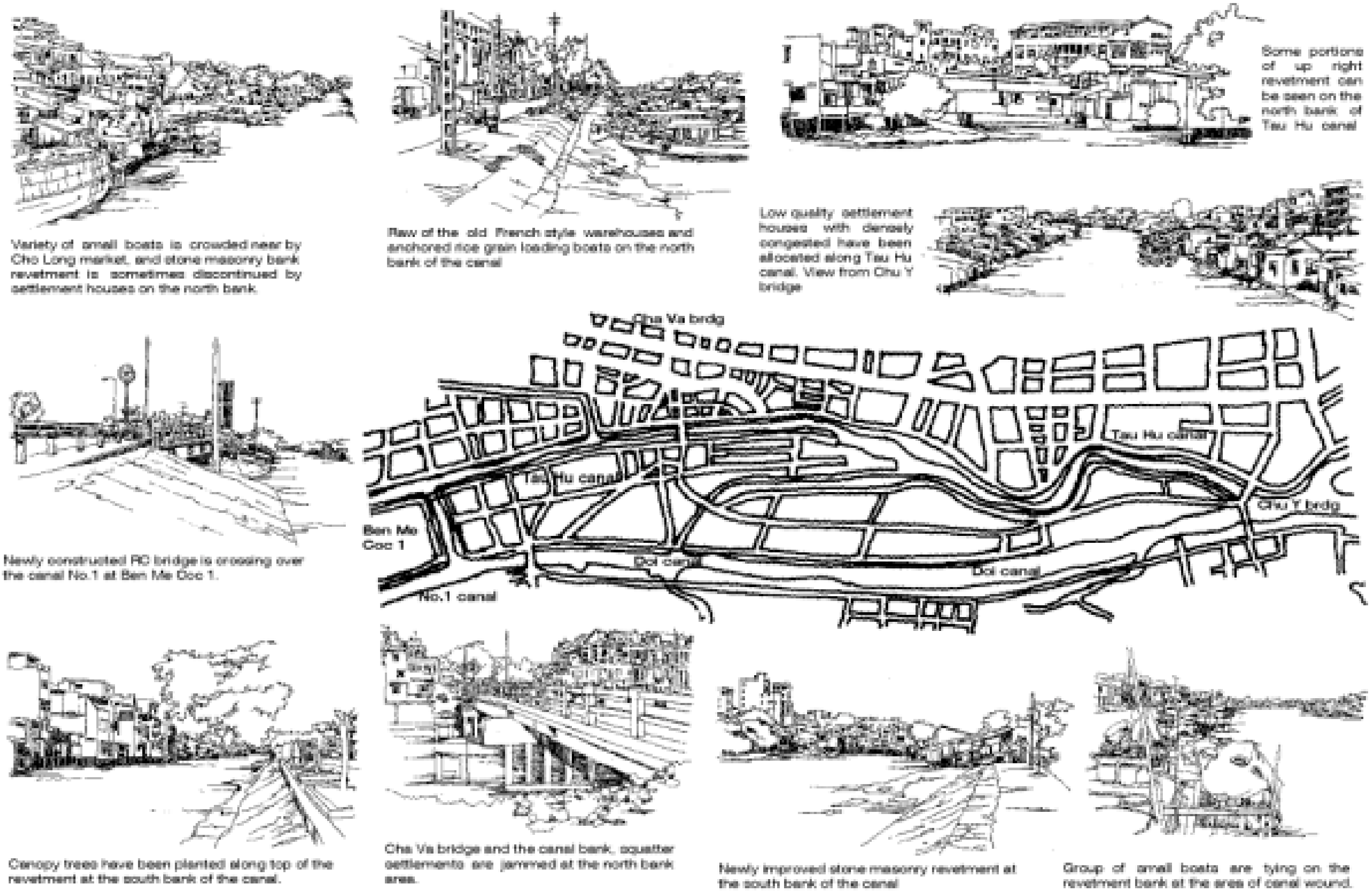


FIG. 3.3(2/3) EXISTING LANDSCAPE OVERVIEW ALONG BEN NGHE CANAL

EXISTING LANDSCAPE OVERVIEW ALONG TAU HU - LO GOM CANAL (CANAL No.1 TO DOI CANAL CONFLUENCE)

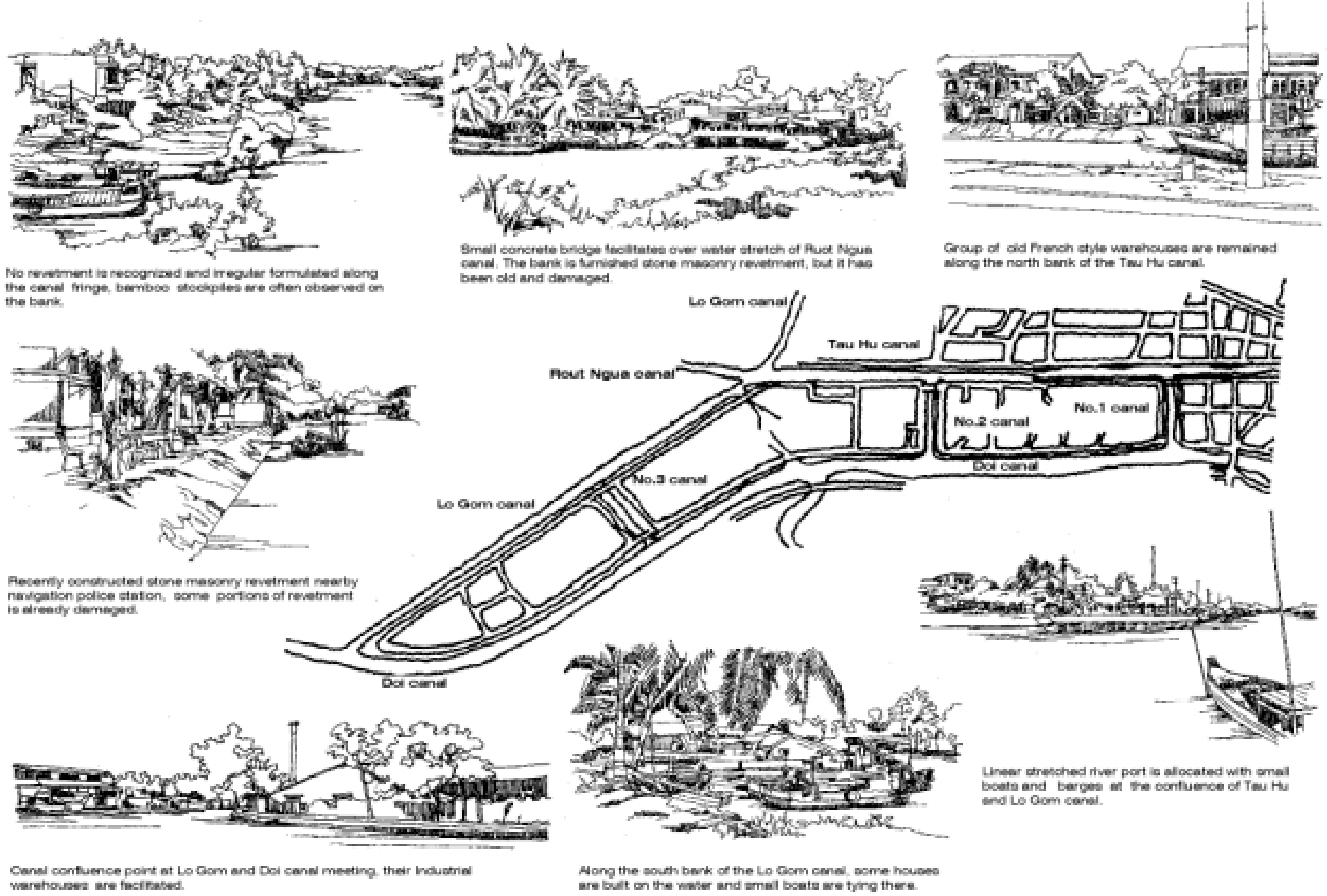


FIG. 3.3(3/3) EXISTING LANDSCAPE OVERVIEW ALONG BEN NGHE CANAL

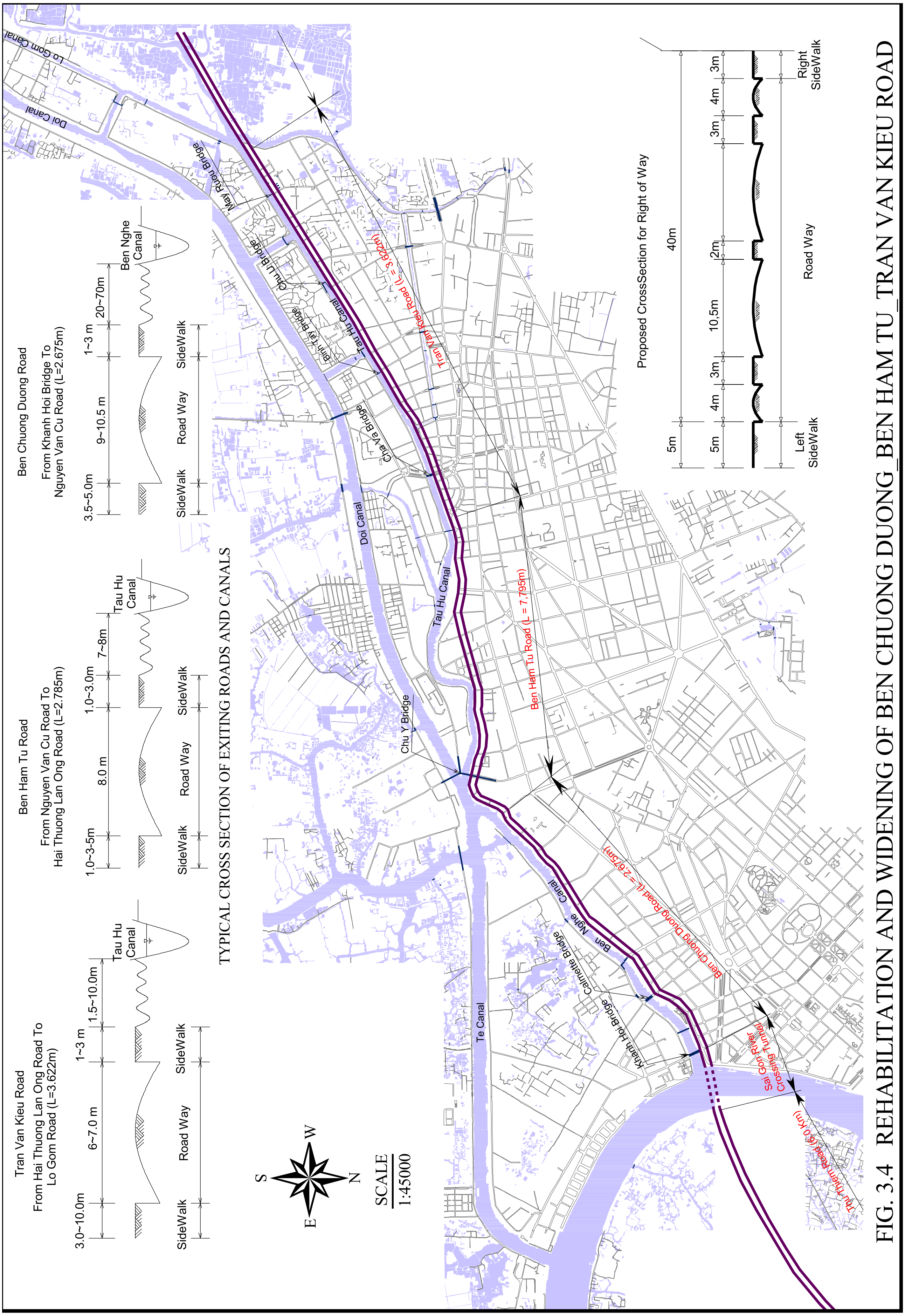
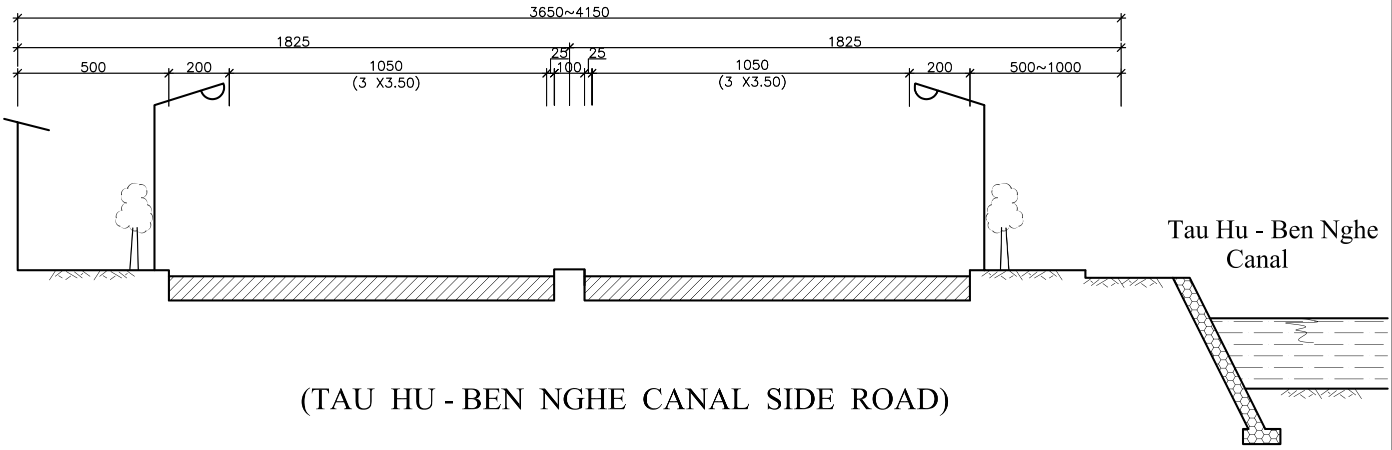
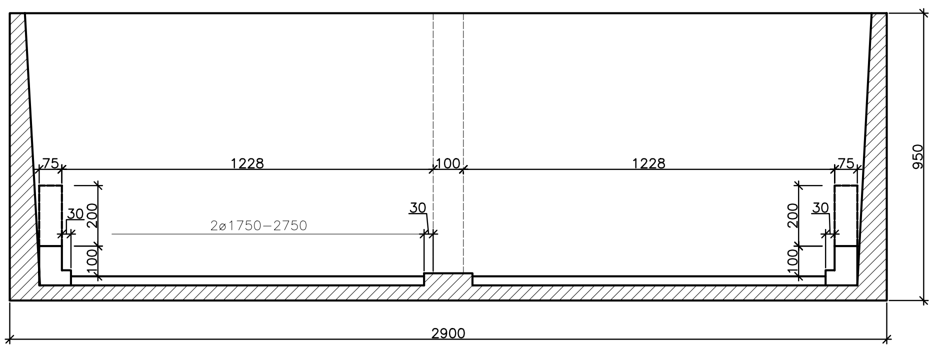


FIG. 3.4 REHABILITATION AND WIDENING OF BEN CHUONG DUONG_BEN HAM TU_TRAN VAN KIEU ROAD

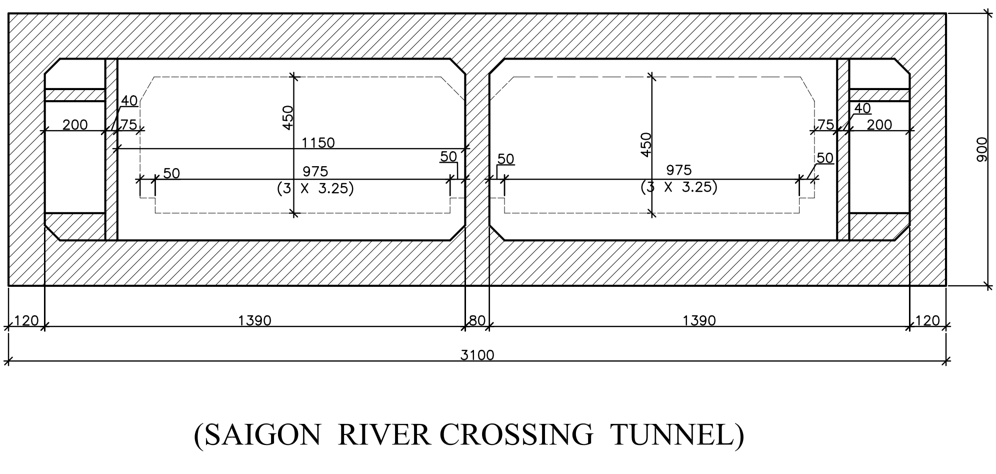
SCALE 1:250



(TAU HU - BEN NGHE CANAL SIDE ROAD)



(ENTRANCE TO SAIGON RIVER CROSSING TUNNEL)



(SAIGON RIVER CROSSING TUNNEL)

FIG. 3.5 TYPICAL CROSS SECTION OF CANAL SIDE ROAD AND SAIGON RIVER CROSSING TUNNEL

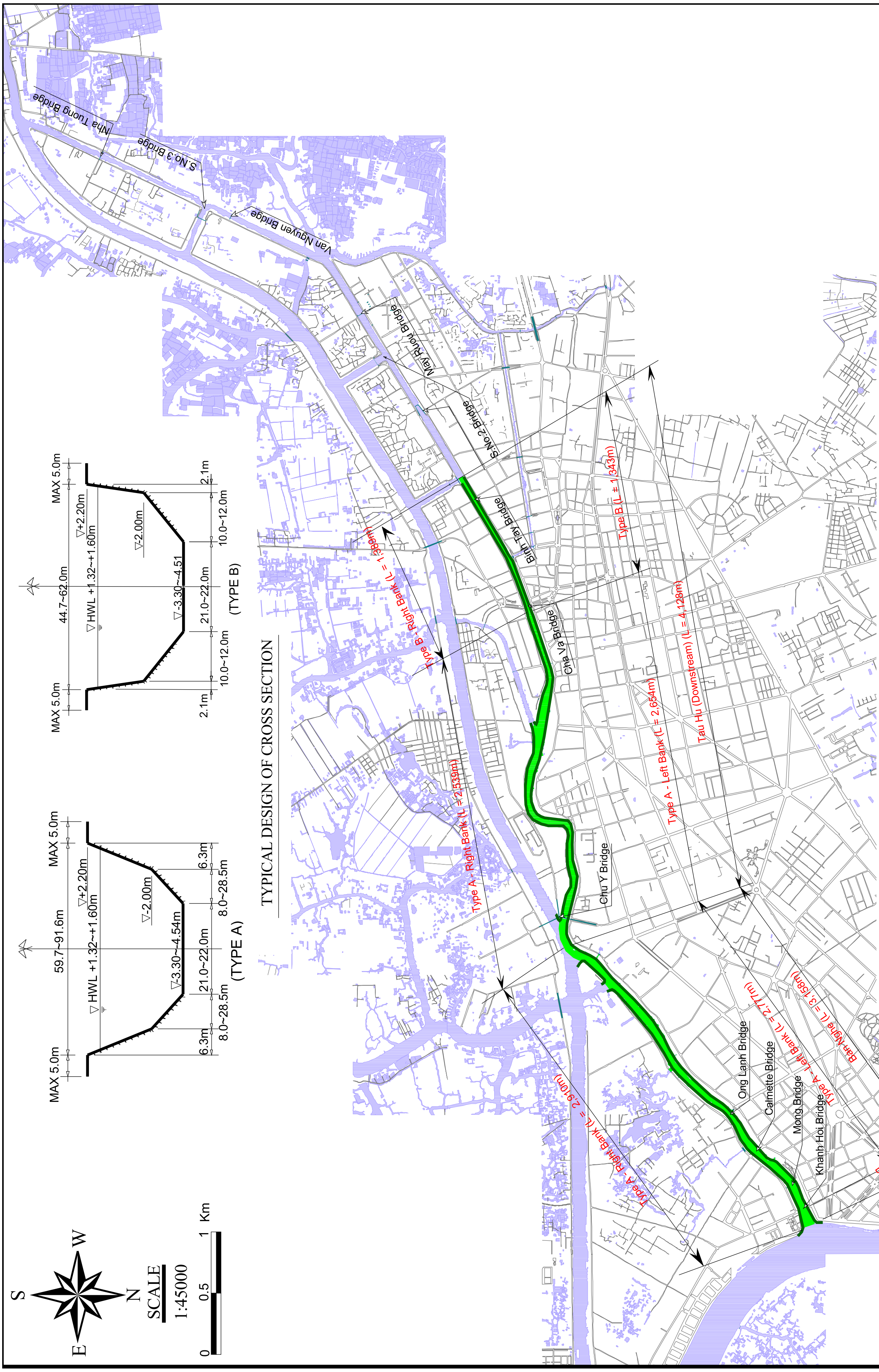
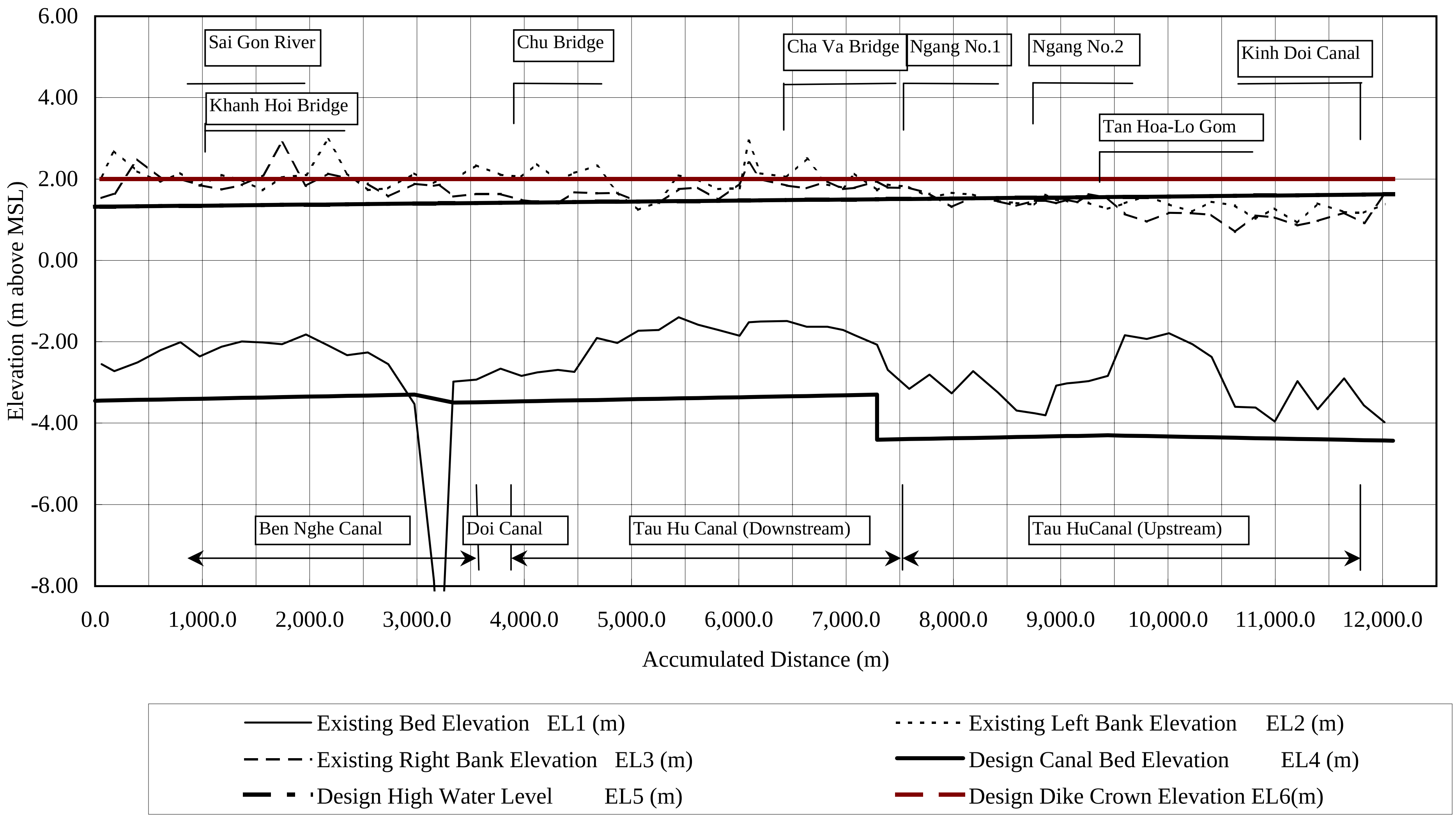


FIG. 3.6 TAU HU - BEN NGHE CANAL IMPROVEMENT FOR PHASE I PROJECT

FIG. 3.7 PROPOSED LONGITUDINAL PROFILE OF TAU HU - BEN NGHE CANAL IMPROVEMENT



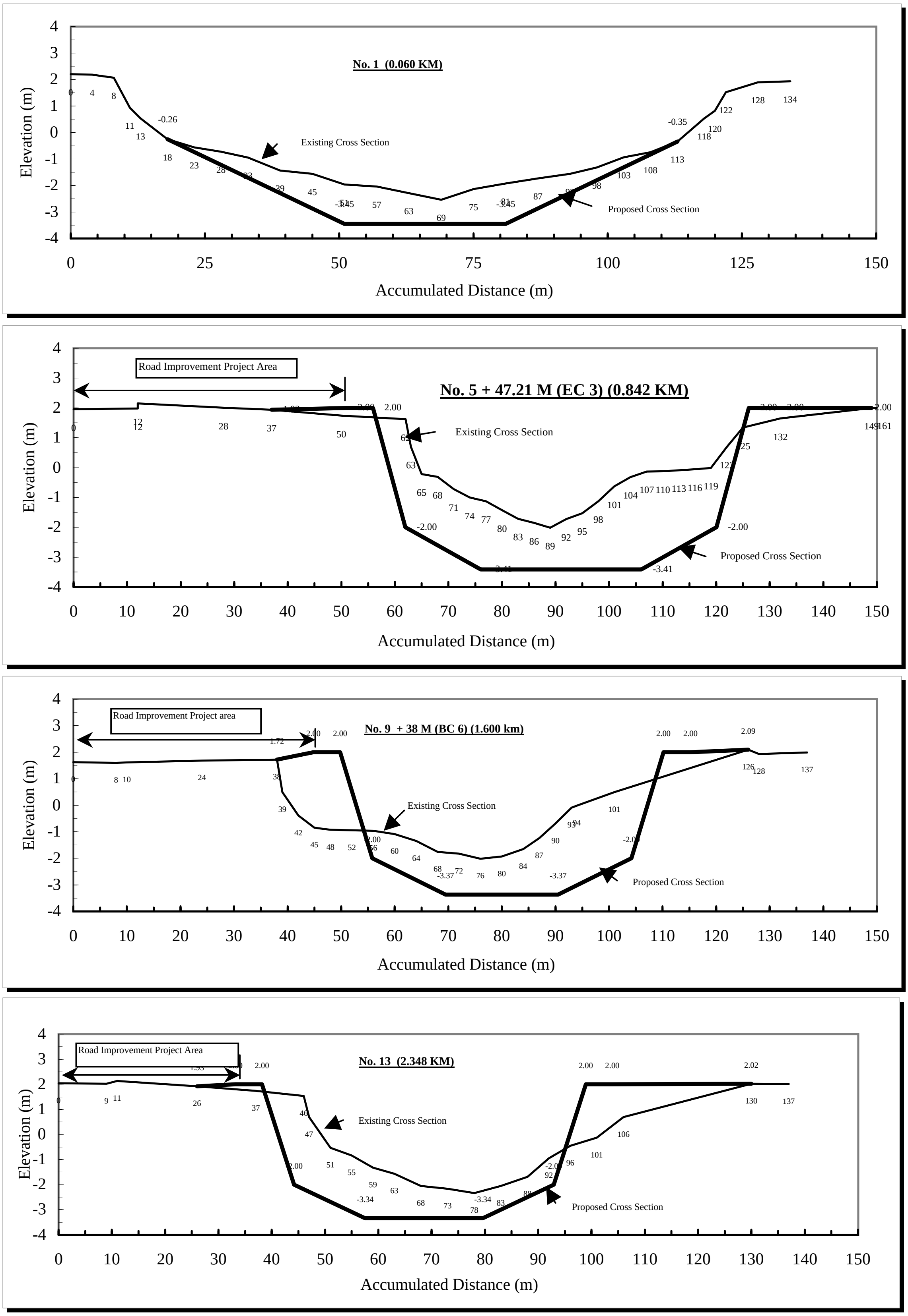


FIG. 3.8 (1/5) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL

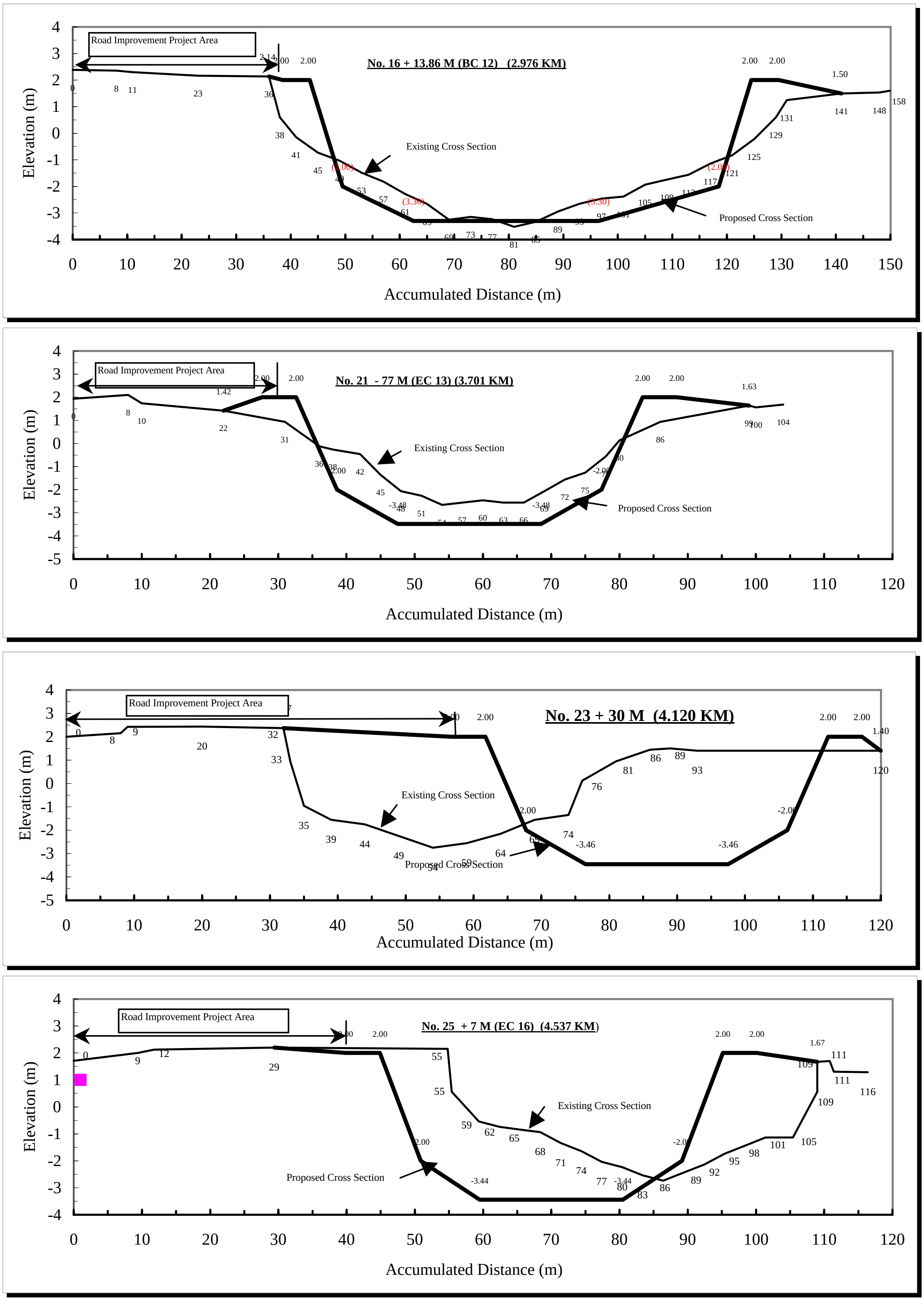
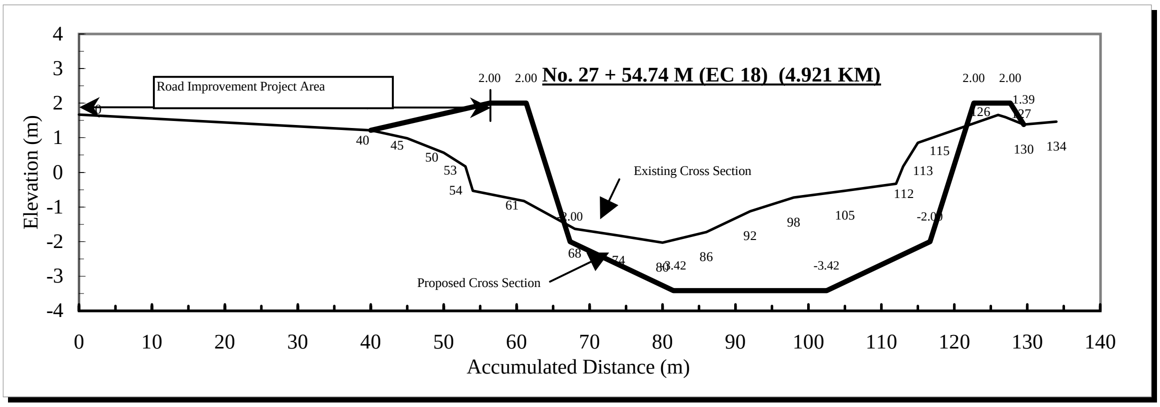
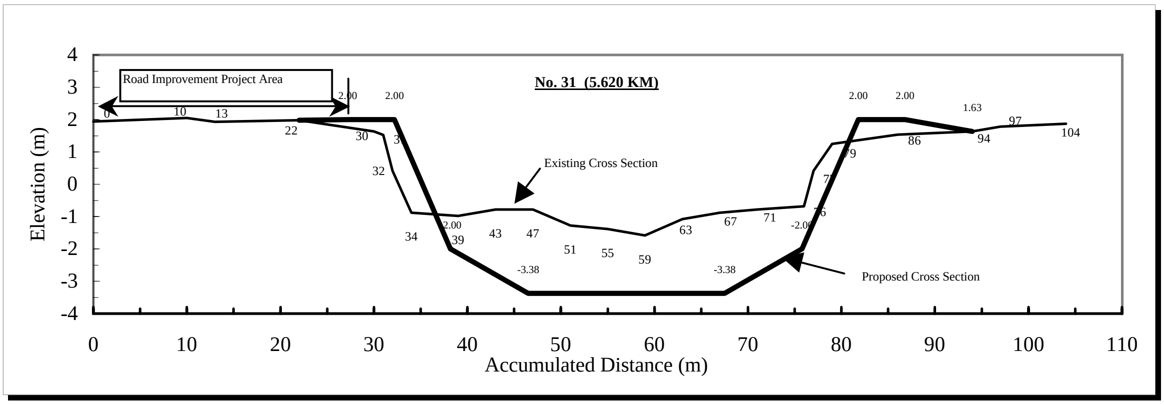
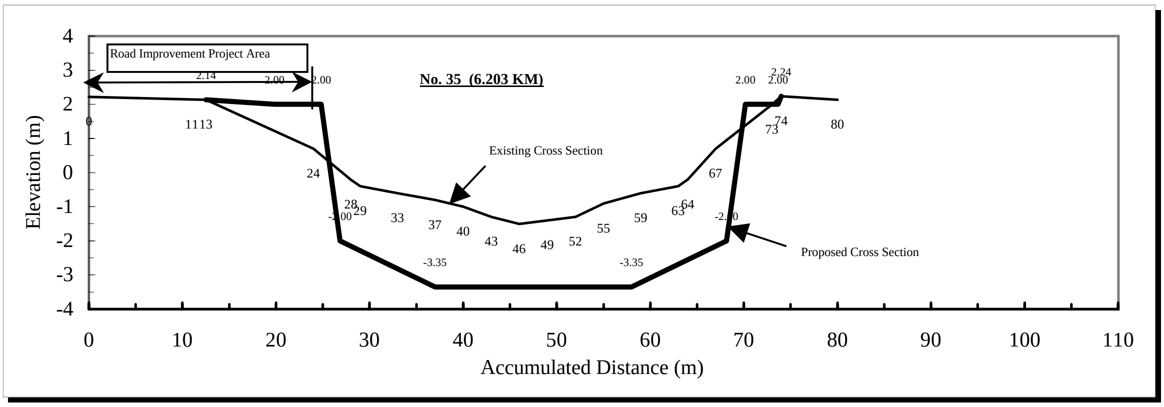


FIG. 3.8 (2/5) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL







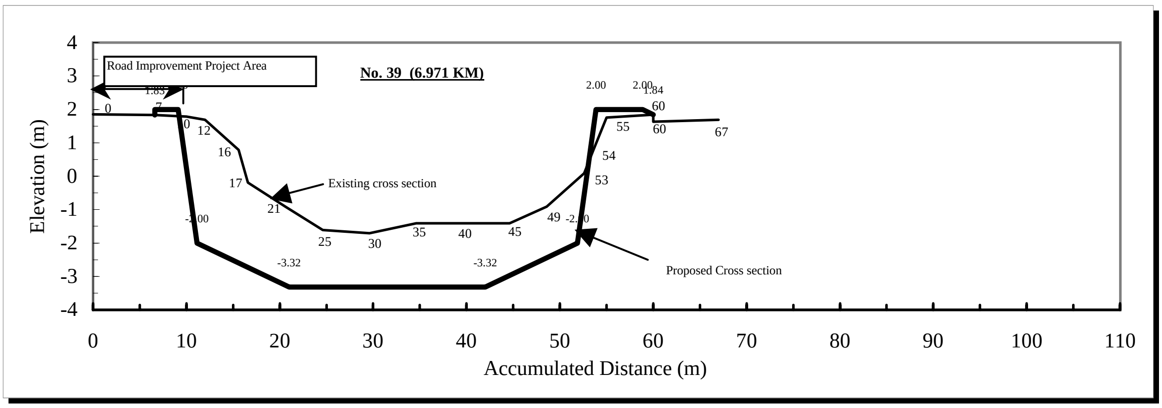


FIG. 3.8 (3/5) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL

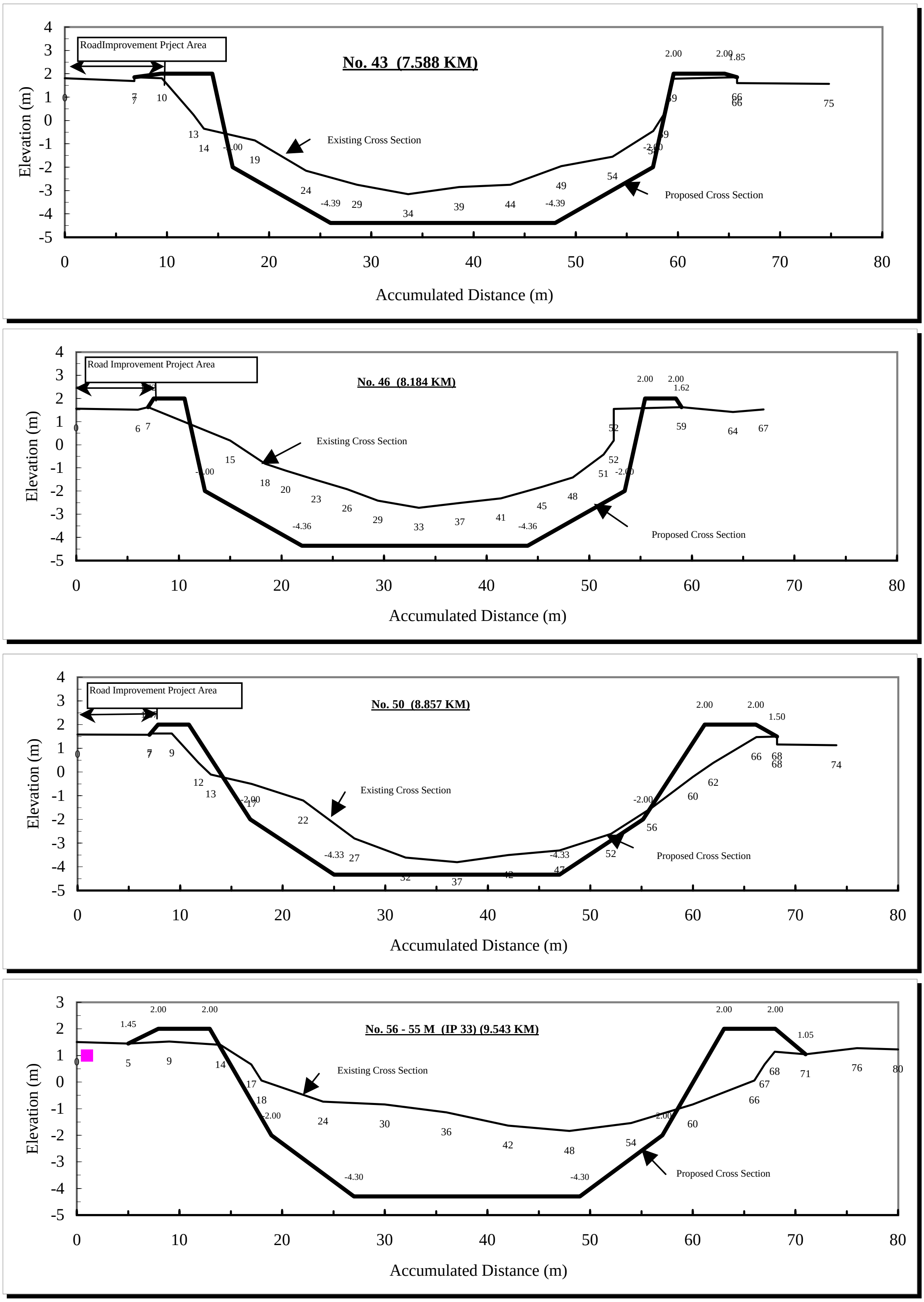


FIG. 3.8 (4/5) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL

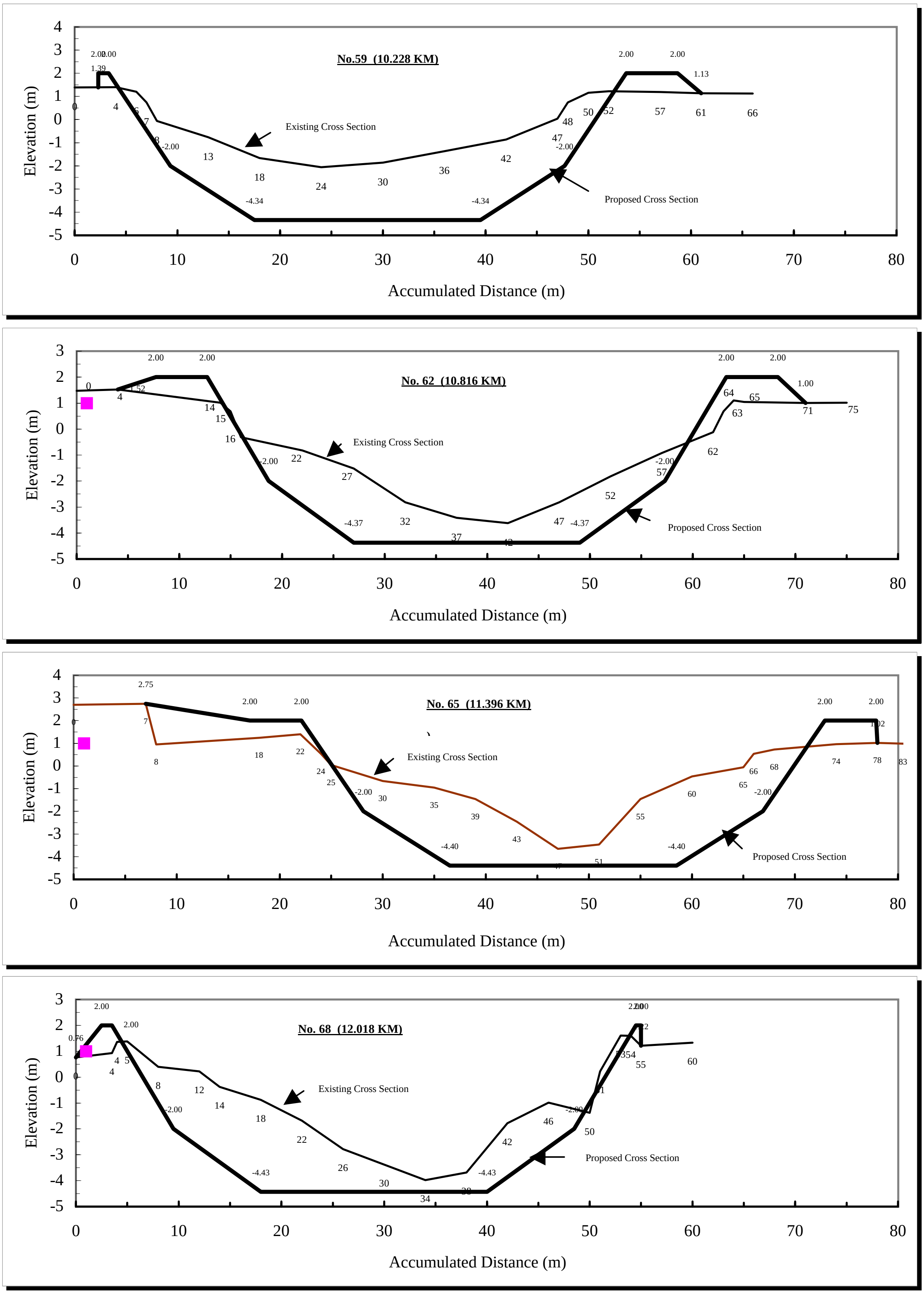


FIG. 3.8 (5/5) PROPOSED CROSS SECTION OF TAU HU - BEN NGHE CANAL

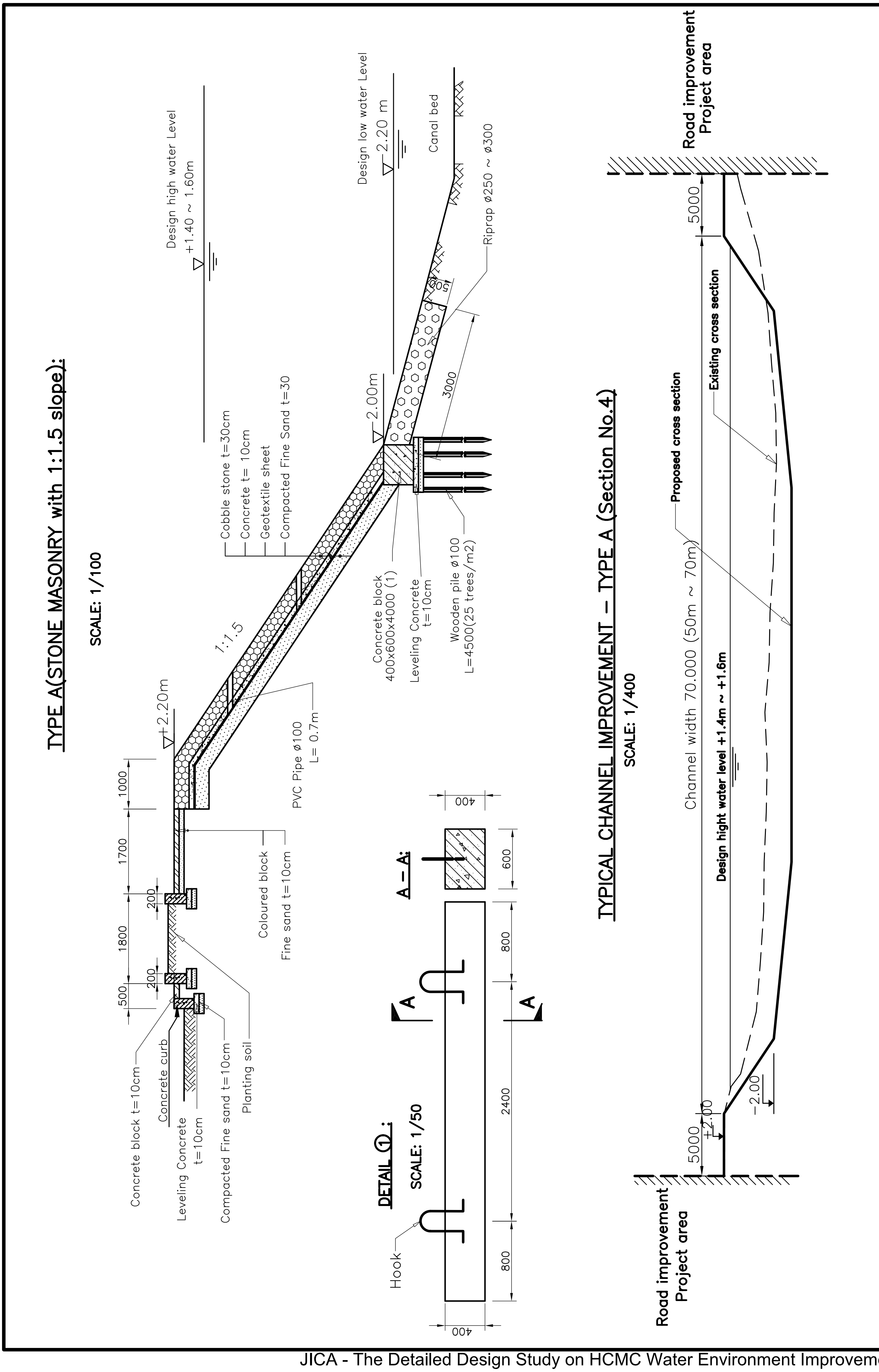


FIG. 3.9 (1/4) PROPOSED SLOPE PROTECTION (TYPE A)

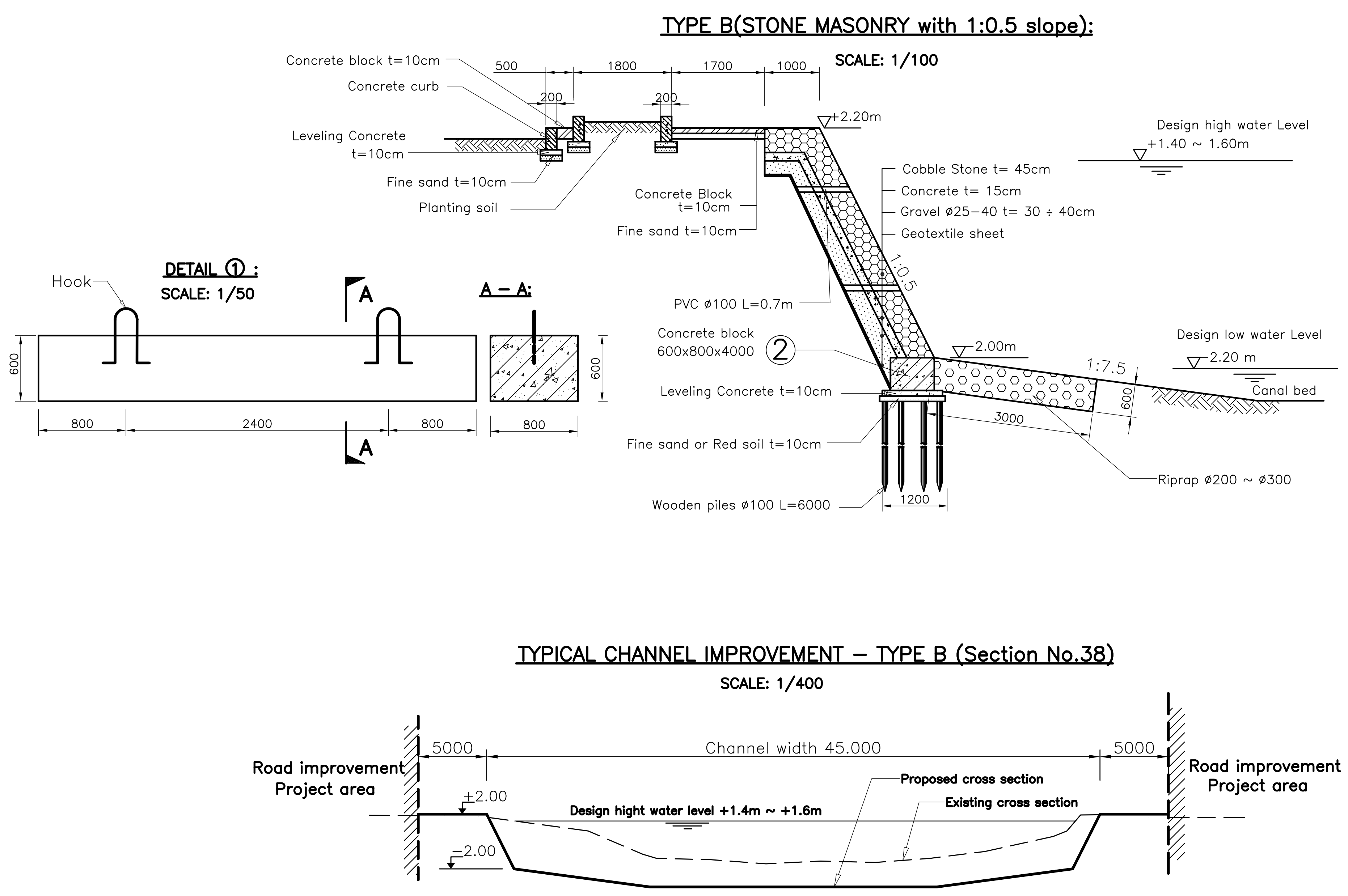
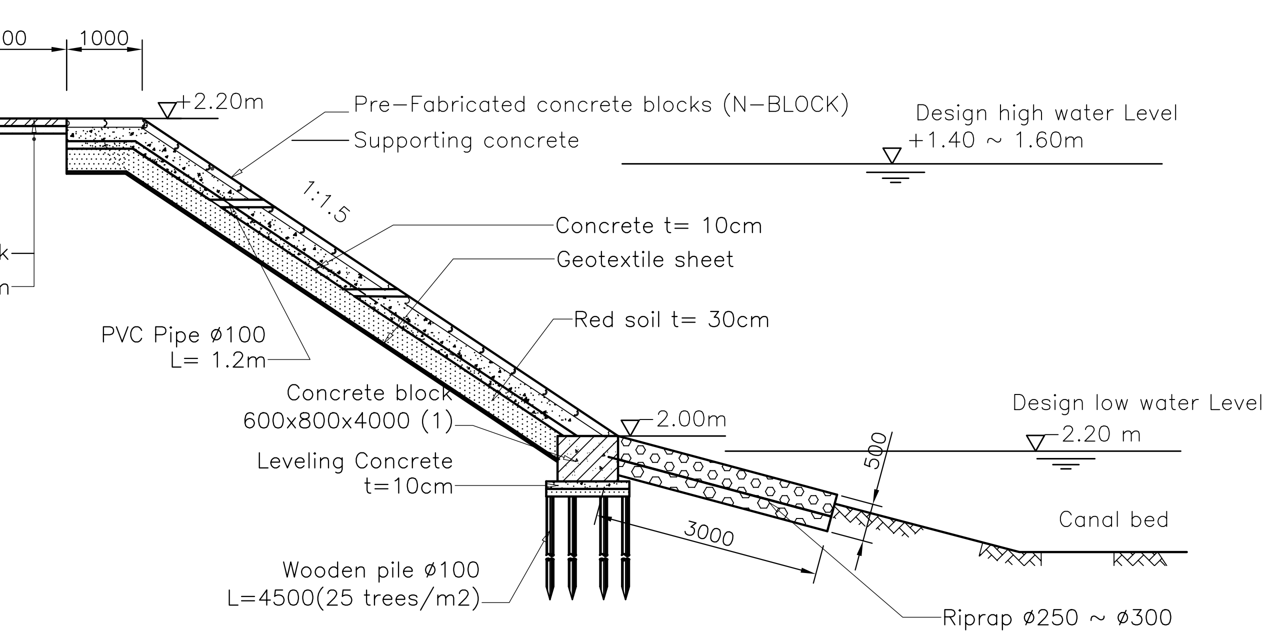


FIG. 3.9 (2/4) PROPOSED SLOPE PROTECTION (TYPE B)

TYPE A1(PRE – FABRICATED CONCRETE BLOCKS with 1:1.5 slope):

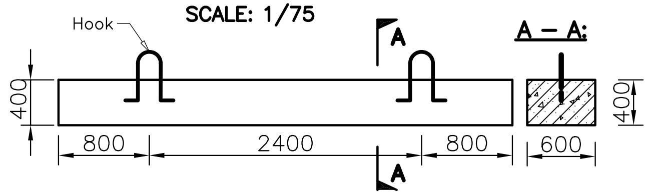
SCALE: 1/100



DETAIL ① :

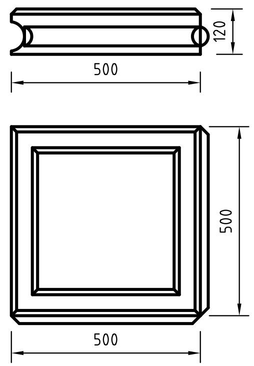
SCALE: 1/75

A – A:



N- BLOCK

SCALE: 1/20



A = 41,670m²

$n = \frac{41{,}670m^2}{0.250} = 166{,}700pcs$

STRENGTH: OVER 180kg/cm²
WEIGHT: 52kg/piece
VOLUME: 0.0226m³/piece

ALLOWABLE ERROR (mm)	
PLAIN	+ 3 - 3
LENGTH	+ 8 - 5

TYPICAL CHANNEL IMPROVEMENT – TYPE A (Section No.4)

SCALE: 1/500

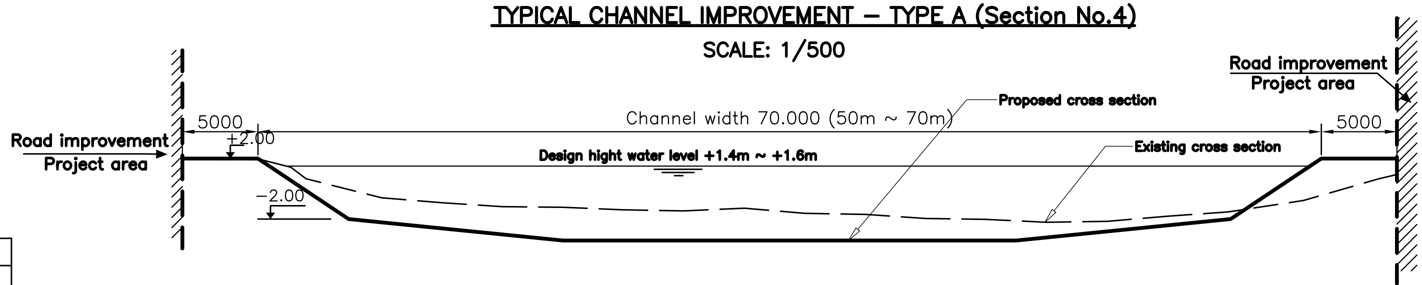
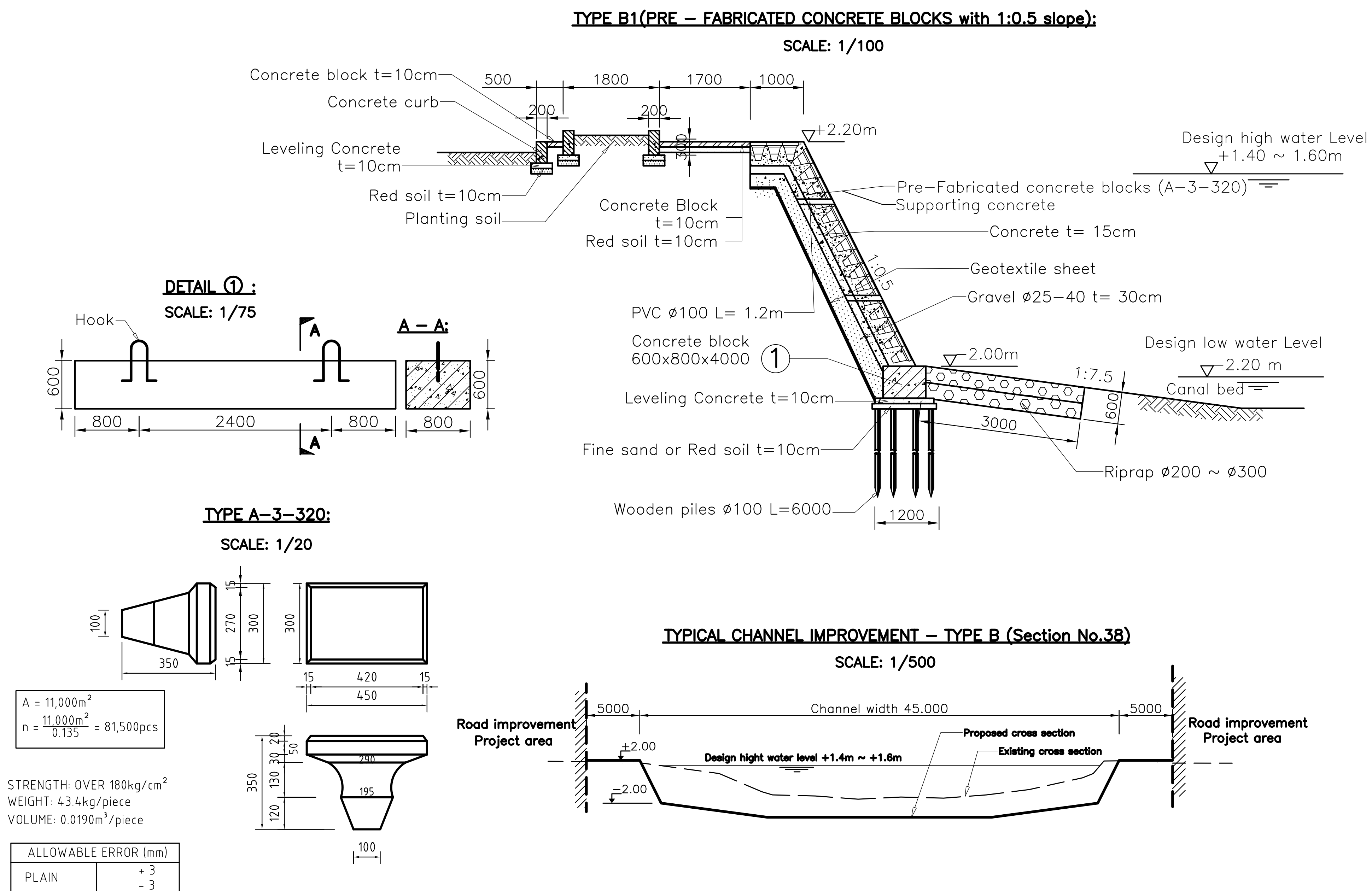


FIG. 3.9 (3/4) PROPOSED SLOPE PROTECTION (TYPE A1)



ALLOWABLE ERROR (mm)	
PLAIN	+ 3 – 3
LENGTH	+ 8 – 5

FIG. 3.9 (4/4) PROPOSED SLOPE PROTECTION (TYPE B1)

LANDSCAPE RESOURCE POTENTIALS IDENTIFICATION ALONG TAU HU - BEN NGHE CANAL

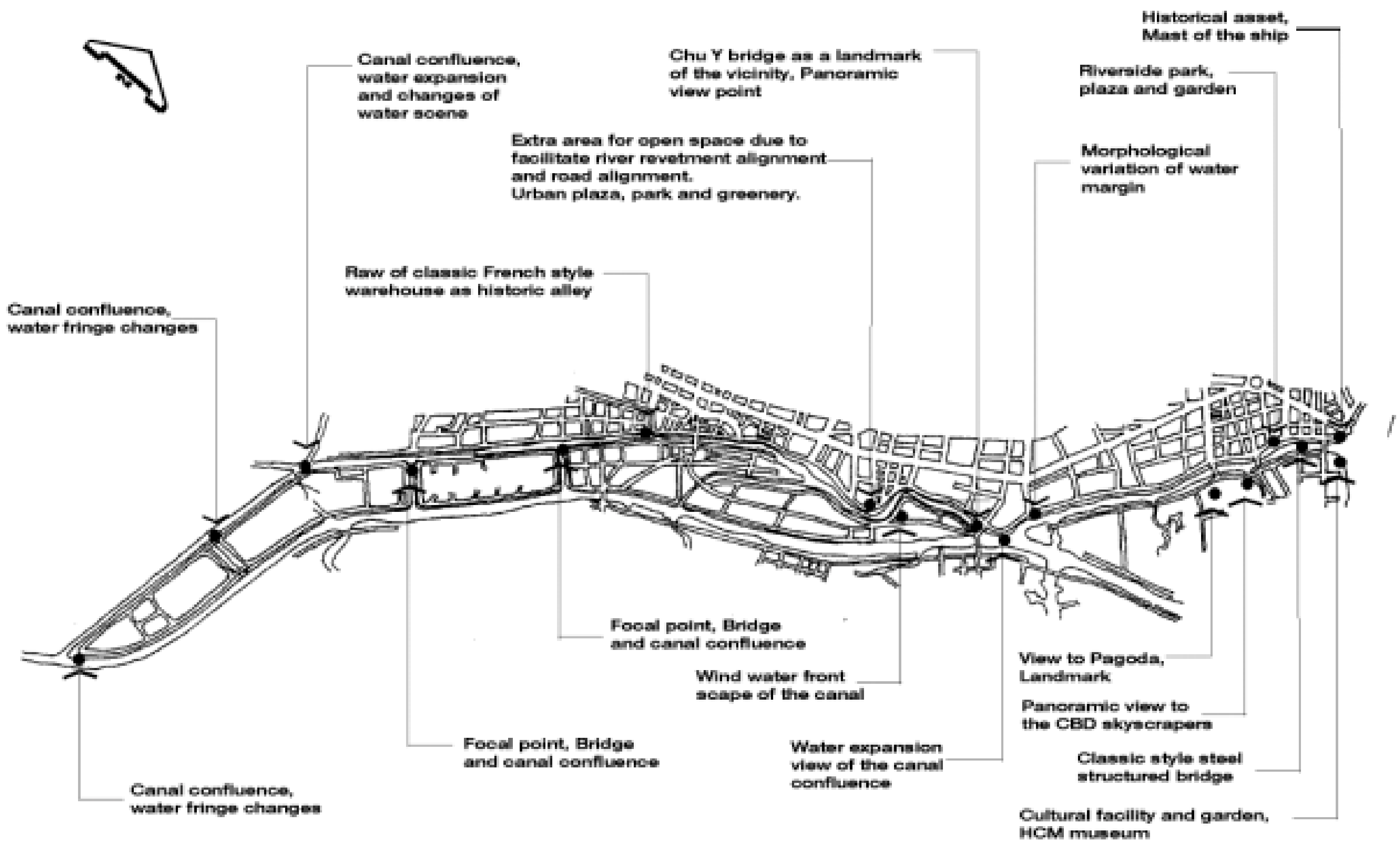


FIG. 3.10 LANDSCAPE RESOURCES POTENTIALS IDENTIFICATION MAP

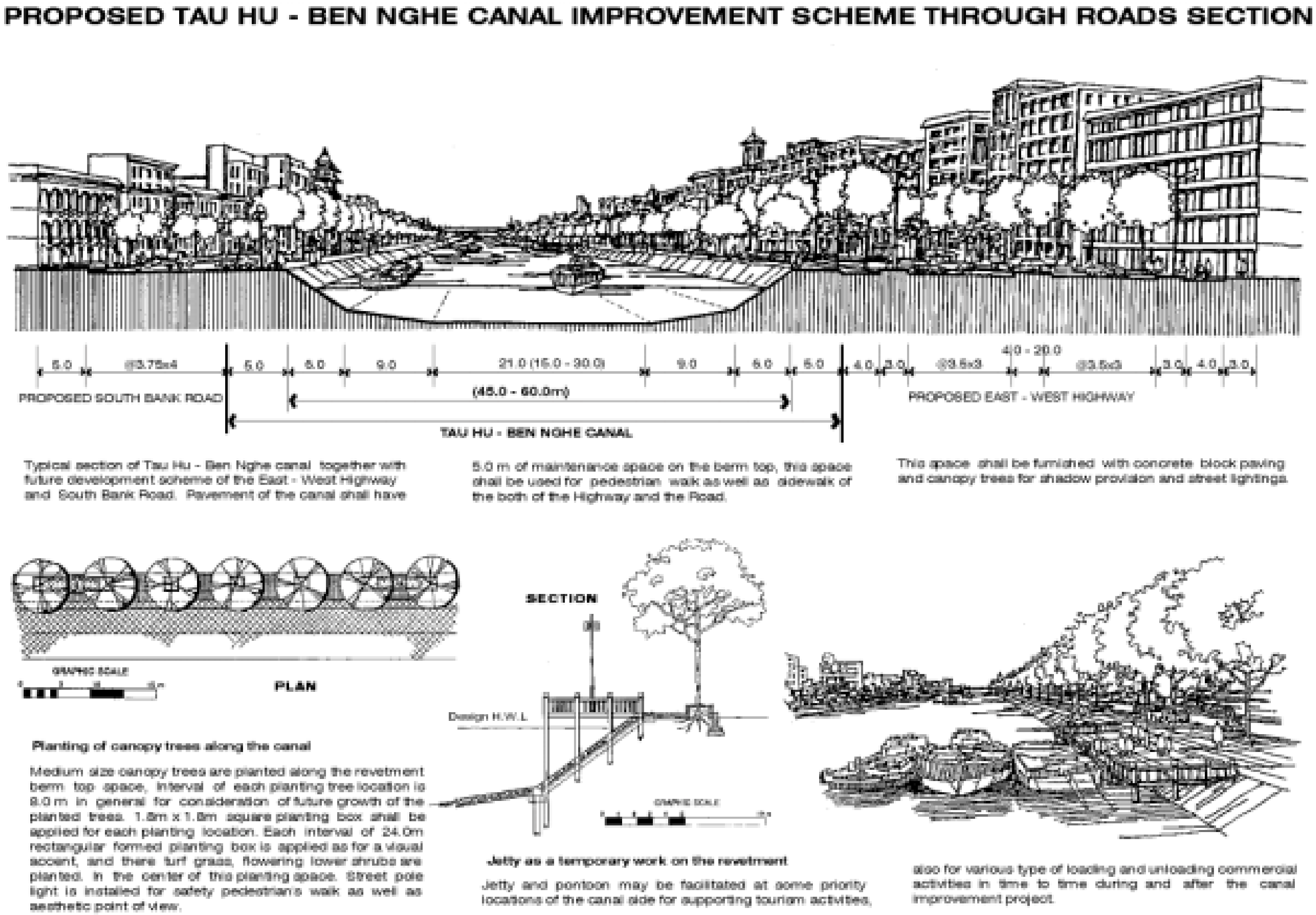


FIG. 3.11 PROPOSED TAU HU - BEN NGHE CANAL IMPROVEMENT SCHEME THROUGH ROAD SECTION

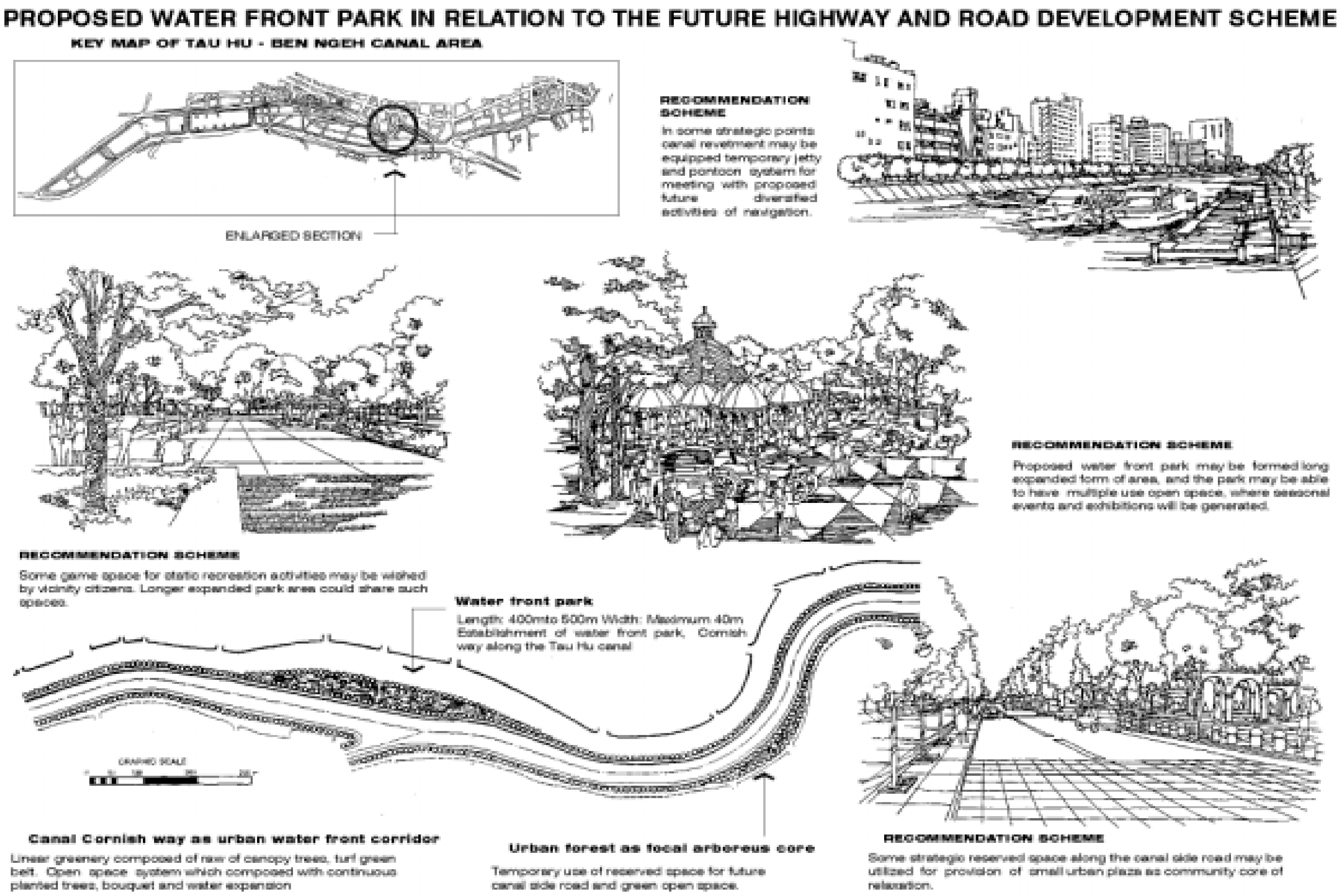


FIG. 3.12 PROPOSED WATER FRONT PARK IN RELATION TO THE FUTURE HIGHWAY AND ROAD DEVELOPMENT

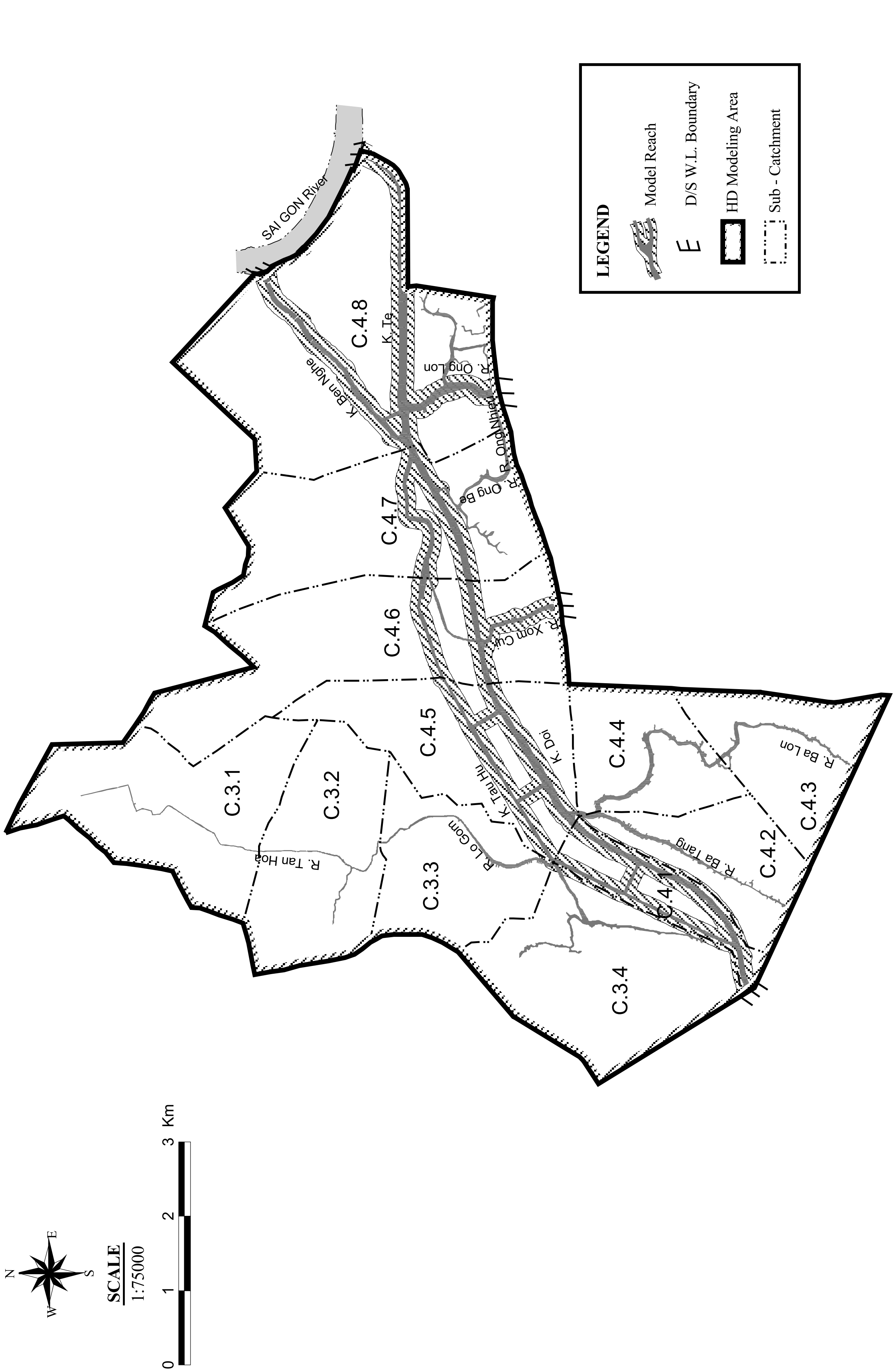
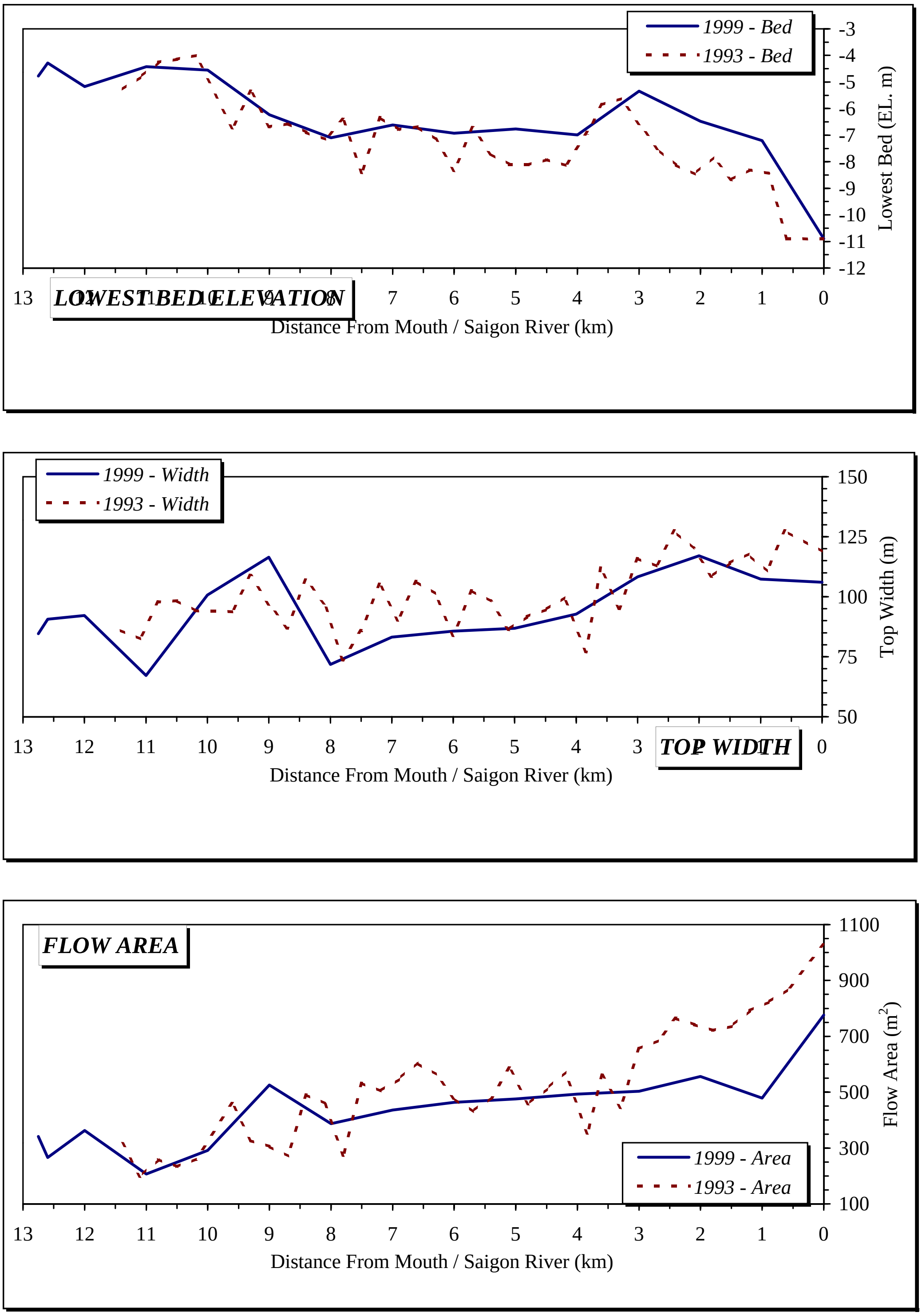


FIG. 3.13 MODEL NETWORK FOR HYDRODYNAMIC SIMULATION OF CANAL SYSTEM



Source of Cross-Section Data : 1999 => Sub-Institute for Water Resources Planning, HCM
1993 => Urban Drainage Company, HCM

FIG. 3.14 COMPARISON OF HYDRAULIC PROPERTIES OF DOI - TE CANAL BETWEEN YEARS 1999 AND 1993

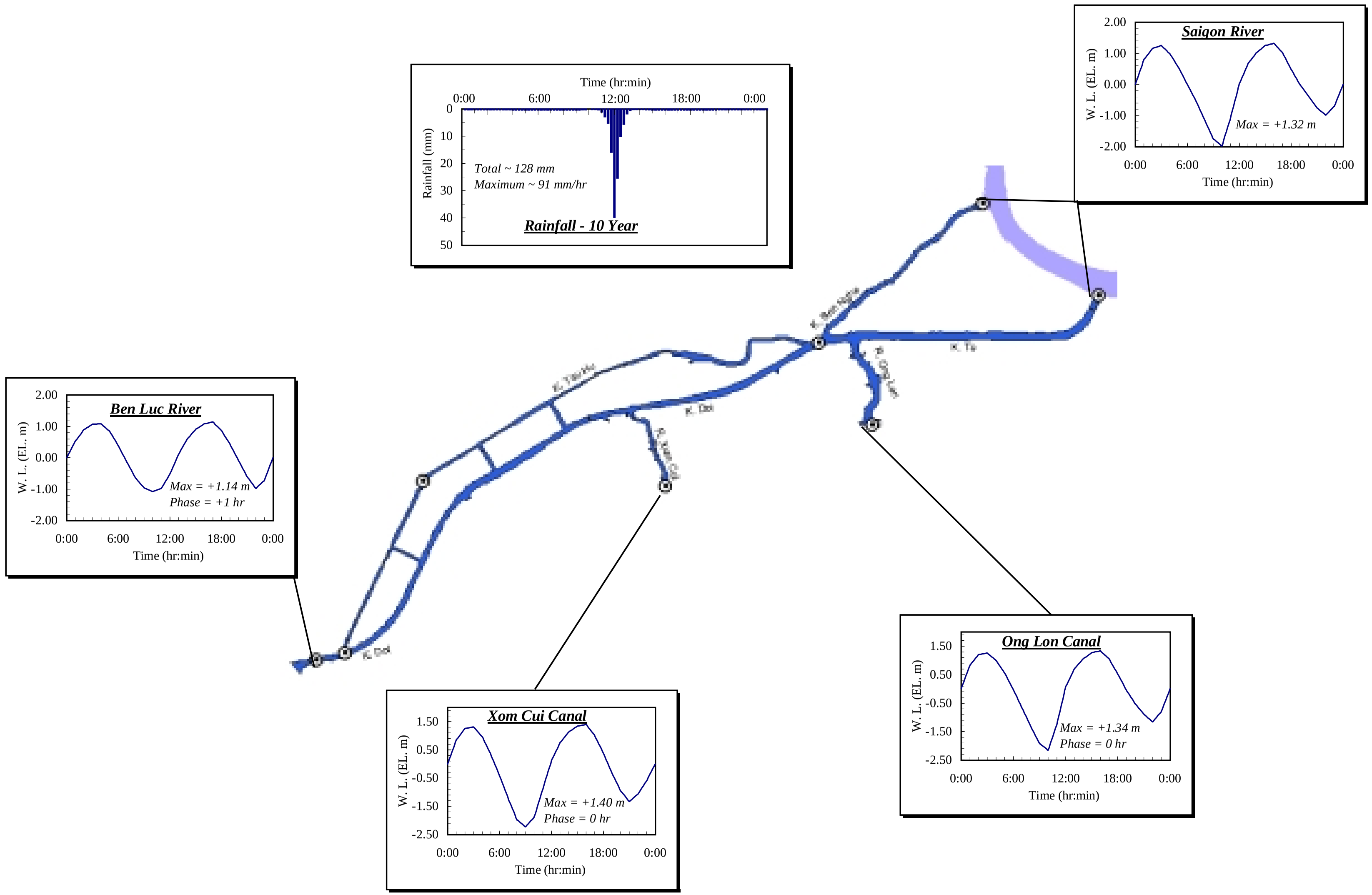


FIG. 3.15 DYNAMIC WATER LEVEL BOUNDARY CONDITIONS AND RAINFALL

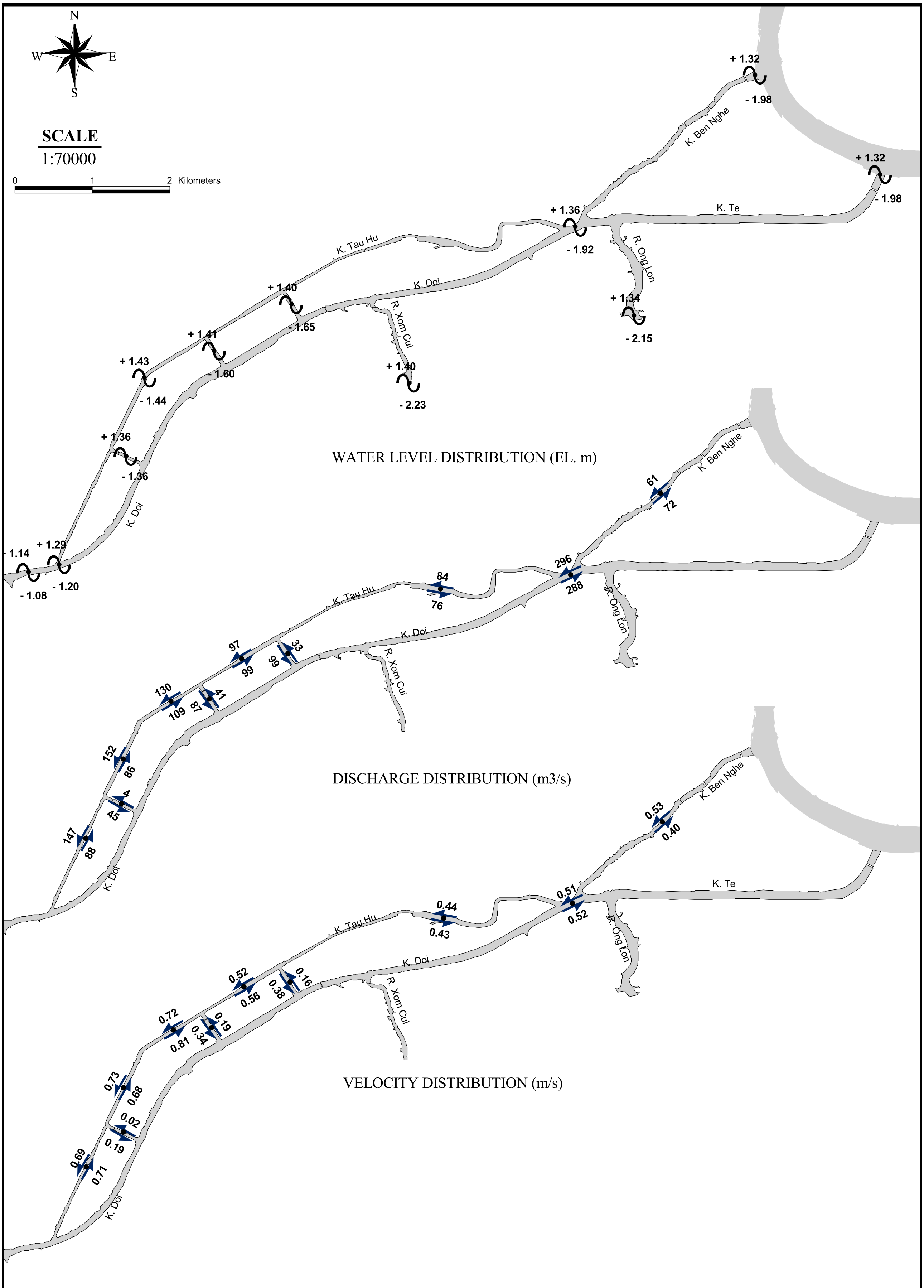


FIG. 3.16 DESIGN DISCHARGE, VELOCITY & WATER LEVEL DISTRIBUTIONS

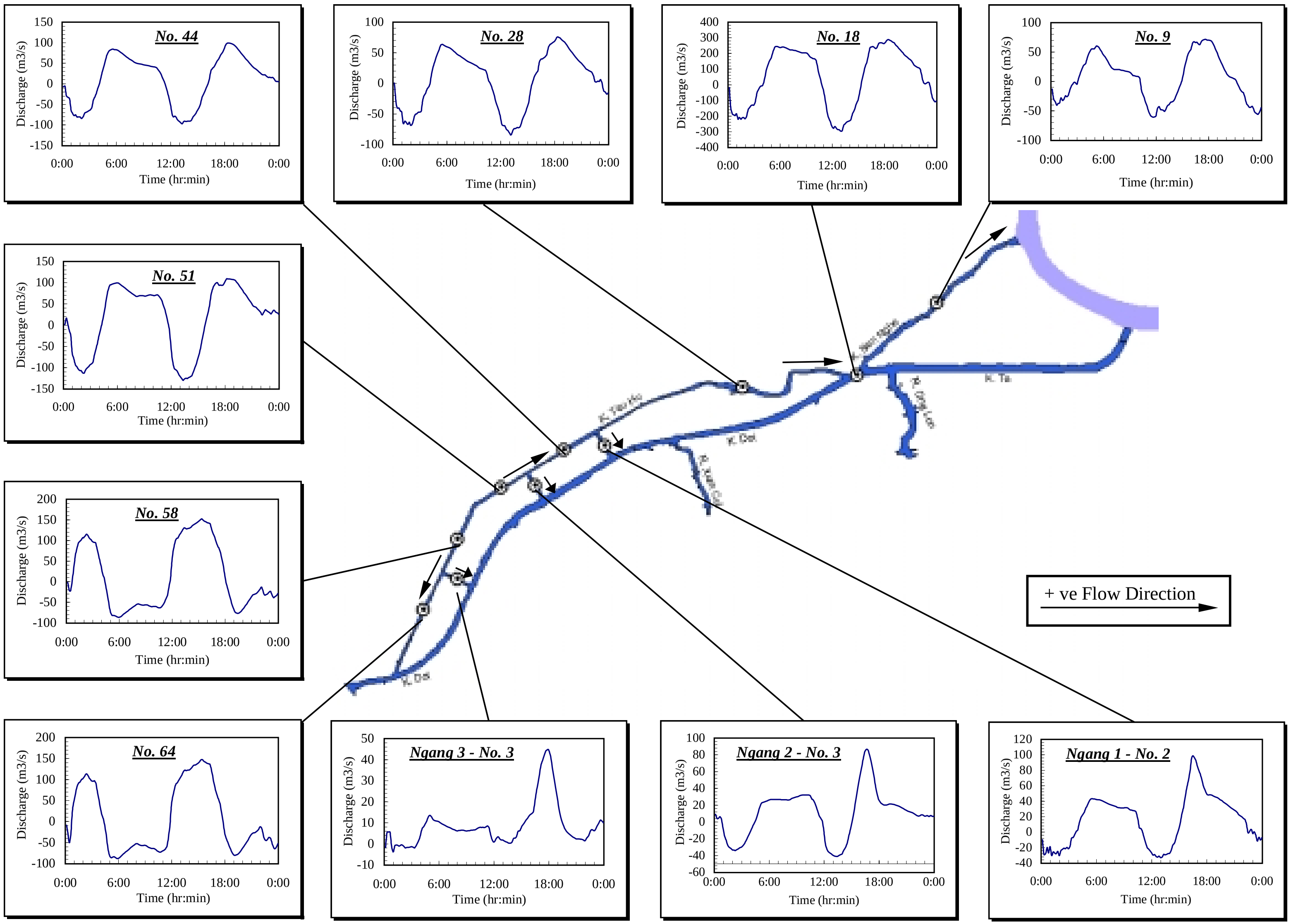


FIG. 3.17 DISCHARGE HYDROGRAPHS FROM HYDRODYNAMIC MODEL RESULT

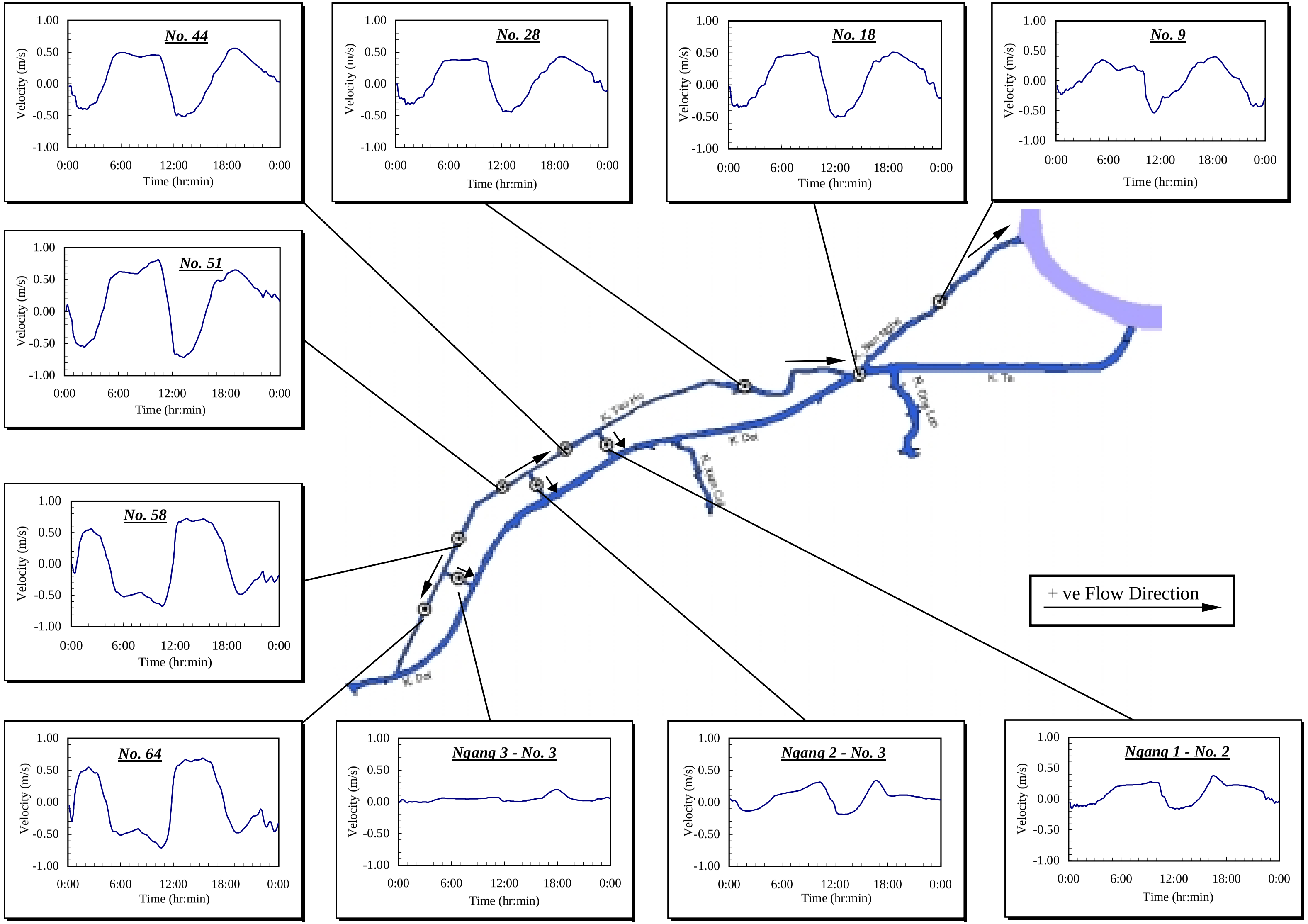


FIG. 3.18 VELOCITY HYDROGRAPHS FROM HYDRODYNAMIC MODEL RESULT

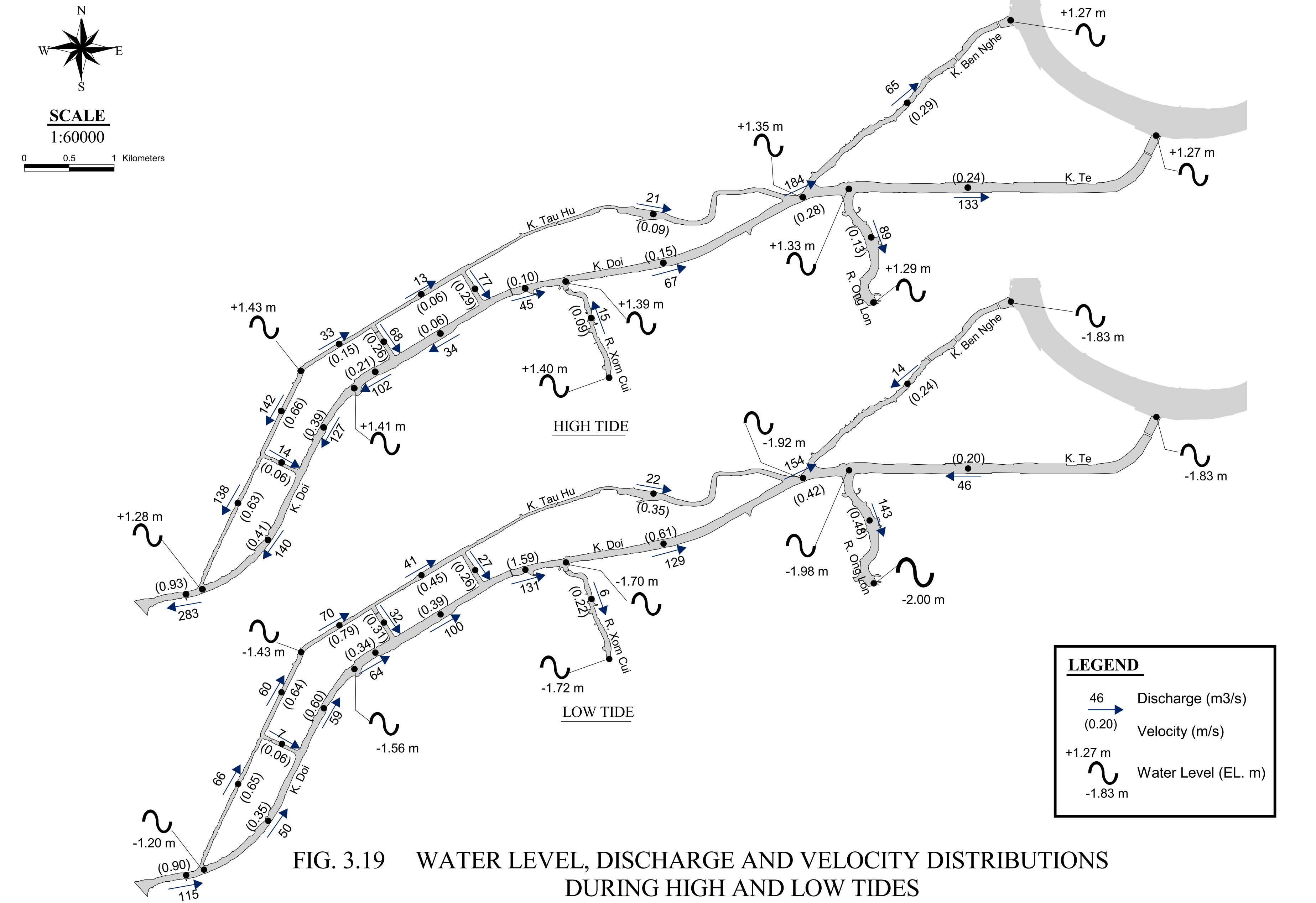


FIG. 3.19 WATER LEVEL, DISCHARGE AND VELOCITY DISTRIBUTIONS DURING HIGH AND LOW TIDES