land acquisition cost. While, the treated water at Serpong WTP where land for extension of treatment plant for additional water of 3 m^3/s is already available is sent to the distribution centers by pipeline system.

As for material of the pipeline, pre-cast reinforced concrete pipe was selected as the pipeline material because construction of steel or ductile iron pipes was considered to require higher cost than that in case of concrete one referring to the cost comparison of pipeline system in the Definitive Plan Report for Pejopongan Pipeline Project in 1987, which indicated that a steel pipeline system needs 40 % higher cost than that of concrete type under the condition that design discharge of 6.2 m^3/sec and length of 11 km.

The adopted type of raw and treated water conveyance system is drawn in Figure 9 and longitudinal profile to R.4 DC is illustrated in Figures 10 and 11.

(3) Land acquisition cost

Referring to the land cost of Rp. 50,000 /m^2 to Rp.1,500,000 /m^2 in DKI Jakarta and Rp. 1,500 /m^2 to Rp. 500,000 /m^2 in other area in the JWRMS, the following land cost was adopted.

- Rural area between Parungpanjang and Serpong	15,000 Rp./m^2
- Rural area between Serpong and Lebakbulus	100,000 Rp./m^2
- Urban and new town area	500,000 Rp./m^2

2.3.4 Cost comparison

Cost comparison was made on the total cost of; 1) the construction cost of water conveyance system, 2) land acquisition cost, 3) replacement cost, and 4) operation and maintenance cost for water conveyance system and pumping station. In the cost comparison, the water treatment cost at Parungpanjang and Serpong WTPs was not included since the water amount of 6 m^3/s comes from the same water source and therefore the treatment cost in all the alternative routes was assumed to be same.

The total of pipeline construction cost and operation and maintenance cost for each alternative route was estimated by selecting an optimum diameter of pipes minimizing the total cost. Evaluation of cost of each alternative was made by the present value basis with the discount rate of 12 % per annum.

The cost for the alternative routes is shown in Table 2. As indicated in the table, the cost for conveyance system between Parungpanjang and Serpong WTPs was evaluated firstly and as a result, the route 1S is cheaper than the route 1N in both cases of design discharge of 3 m^3/s and 6 m^3/s because the route 1N requires construction method using steel sheet pile and higher land acquisition cost due to its alignment in the BSD area.

The cost for alternatives to R.4 DC, then, was compared combining with the route 1S connecting Parungpanjang and Serpong WTPs. The alternative 1, which is aligned along the pipeline under construction to Lebakbulus and R.4 DC, indicates the least cost among the alternatives as summarized below since most of the route in this alternative passes through comparatively less developed area and needs excavation works without steel sheet piling. While, the highest cost was derived for the alternative 4 because of high land acquisition cost in the new town and urban areas.

	Alt. Route	Construction (bill. Rp.)	Land (bill. Rp.)	Replacement (bill. Rp.)	O & M (bill. Rp./yr.)	Total (bill. Rp.)
(1)	1S + 0 + 1	104.5	21.7	4.4	3.7	115.6
(2)	1S + 0 + 2	117.3	22.0	5.2	4.4	128.9
(3)	1S + 0 + 3	123.1	19.2	5.2	4.4	131.7
(4)	1S + 0 + 4	124.6	82.7	4.6	4.1	179.6
(5)	1S + 0 + 5	141.8	23.5	5.2	4.6	150.6

2.3.5 Proposed route between Parungpanjang and DKI Jakarta

The cost comparison indicated that the routes through Serpong WTP needs less cost than those directly connected between Parungpanjang and R.4 DC due to the acquired land in the Serpong WTP for water treatment plant for the additional discharge, the shorter total length of water conveyance system and less possibility of occurrence of land acquisition problem.

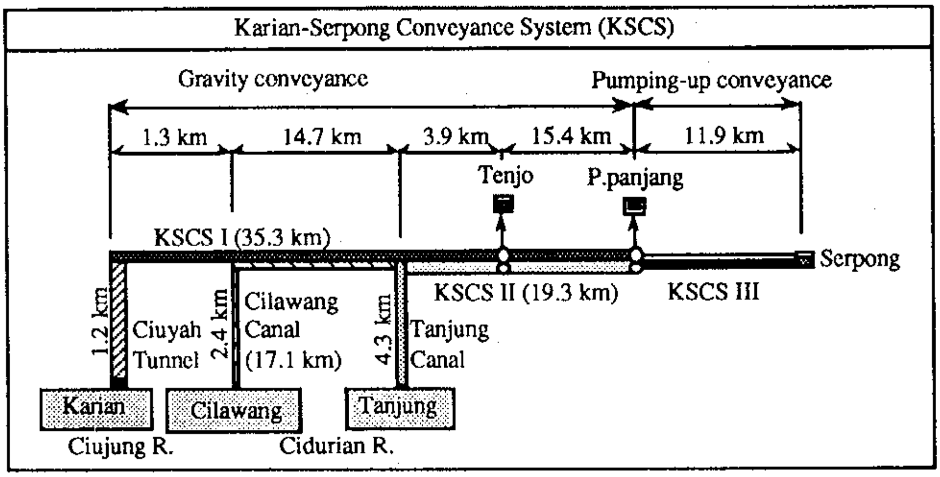
From the above, it is proposed that the envisaged raw water conveyance system from the western water resources is designated to Serpong WTP as described in the S/W for this Study and that treated water conveyance route from Serpong WTP to Lebakbulus and R.4 DC is aligned by using the site of the pipeline system under construction or existing/planned roads as much as possible.

However, twenty (20) years till the year of 2015, when the raw water conveyance system between Parungpanjang and Serpong WTP will be introduced, is rather long time span and economic and social situation along the conveyance system for this stretch may change from the present situation. Therefore, it is recommended to review this result, especially degree of difficulty of land acquisition along the route together with review on future water demand in Jabotabek area.

3. PROPOSED KARIAN-SERPONG CONVEYANCE SYSTEM

3.1 Proposed KSCS

The optimum route and conveyance method based on the above result are determined as follows:



The final route setting of Karian-Serpong Conveyance System (KSCS) was made based on the detailed field investigation along the route of N-2, paying special attention to; 1) the existing villages and towns, 2) the existing residential and industrial areas, 3) on-going new town areas such as housing development at Tenjo, Tigaraksa and Serpong, and 4) socio-cultural places such as graves and religiously important places.

The general layout plan of the KSCS with a total length of 55.1 km including the Cilawang and Tanjung canals are shown in Figure 12, which is based on the topographic map with a scale of 1: 5,000 prepared by this study.

The KSCS is planned to be implemented by applying phasing development together with the water resources development by provision of the envisaged dam and reservoirs as shown in Figure 13. Therefore, the KSCS is divided into five waterways as illustrated in the mentioned figure; 1) KSCS I from the Ciuyah tunnel to Parungpanjang; 2) KSCS II from the confluence with Tanjung canal to Parungpanjang; 3) KSCS III from Parungpanjang to Serpong WTP; 4) Tanjung canal; and 5) Cilawang canals.

Taking into account the mentioned phasing development plan, the structural features of major structures were finalized based on the following flow capacities:

Waterway	Flow Capacity (m3/s)			
	Phase I	Phase IIA	Phase IIC-a	Phase IIC-b
Ciuyah Tunnel	12.40	-	-	-
KSCS I				
a) Sec.1 (Upstream section of Tenjo WTP)	12.40	-	-	-
b) Sec.2 (Downstream section of Tenjo WTP)	6.20	-	-	-
KSCS II				
a) Sec.1 (Upstream section of Tenjo WTP)	-	4.10	13.80	-
b) Sec.2 (Downstream section of Tenjo WTP)	-	5.05	9.90	-
KSCS III	-	6.00	6.00	-
Cilawang Canal	-	4.10	-	4.10
Tanjung Canal	-	-	9.70	-

3.2 Major Structures

(1) KSCS I, II and III

The waterway bed slope of KSCS I and II between the Karian reservoir and Parungpanjang including the Ciuyah tunnel was studied with the cross section data at 100 m intervals on the topographic map with a scale of 1: 5,000. The optimal longitudinal profile of the waterway was determined through the cost comparison of the several gradient of bed slopes. In the comparison, construction costs for all the structures such as the Ciuyah tunnel, waterway of KSCS and the Cilawang and Tanjung canals, pumping stations at Parungpanjang and Serpong WTP, and operation and maintenance costs were taken into account in the optimization study of the waterway bed slope.

In order to find out an optimum bed slope of waterway giving the least cost, the following bed slopes and water level at the beginning point of KSCS shown Figure 14 were assumed taking into account the head loss at the intake and in the Ciuyah tunnel:

Bed Slope	1/2500	1/5000	1/7500	1/10000	1/15000
WL. at BP (El.m)	45.30	45.60	45.70	45.75	45.80

The cost of each alternative was estimated for the following design discharge corresponding to the M&I water demands given in the scenario C/5:

(unit : m^3/s)

Section	Section 0	Section 1	Section 2	Section 3	Section 4
Phase I	12.4	12.4	12.4	6.2	-
Phase II-a	12.4	12.4	12.4+13.8	6.2+9.9	6.0
Phase II-b	12.4	12.4+4.1	12.4+13.8	6.2+9.9	6.0

The estimated costs for construction, operation and maintenance are given in Table 3 and summarized below.

Waterway Bed Slope	Investment Cost		Total Present Value (billion Rp.)
	Construction Cost (billion Rp.)	O & M Cost (billion Rp./yr.)	
1/2500	247.5	9.9	258.5
1/5000	253.8	8.3	254.2 (Least)
1/7500	286.5	8.0	279.9
1/10000	305.0	7.9	294.8
1/15000	353.5	8.0	335.6

The cost comparison indicated that the waterway slope of 1: 5,000 attains the least cost among the alternative slopes. Based on the aforesaid result, the proposed longitudinal profile of the waterway between the Karian reservoir and Serpong WTP is shown in Figure 15. The cross sections of KSCS with the bed slope of 1:5,000 are shown in Figure 16.

The KSCS III between Parungpanjang pump station and Serpong WTP consists of steel pipe and pre-cast reinforced concrete pipe with an internal diameter of 2.2 m. The steel pipeline is applied for river and road crossing portions and aqueduct in the Cisadane river. The length of steel and pre-cast concrete pipes are 2.5 km and 9.4 km, respectively.

(2) Cilawang Canal

The applied connection type between the Karian reservoir and KSCS I was also adopted for the Cilawang reservoir and the Cilawang canal. Hollow jet valve was selected as a discharge control facility by the comparison of the total cost of civil and metal works with sleeve valve and its diameter was designed at 0.9 m for design discharge of 4.1 m^3/s to the Cilawang canal.

Since there is sufficient hydraulic head of around 25 m between the LWL 66.50 m of the Cilawang reservoir and the water level of EL. 45.43 m in the Cilawang canal at the meeting point with KSCS I as shown in Figure 17, two (2) waterway types were examined; one is the pipeline type and the other is concrete canal. As a result, the rectangular reinforced concrete canal is a cheaper type of the waterway than concrete pipeline type for the design discharge of 4.1 m^3/s as shown below.

Type	Dimensions of Pipe Diameter (m) or Canal Width and Height (m)	Pipeline/ Canal Bed Slope	Construction Cost (million Rp.)
Pipe	1.65	1/300	7,407
	1.65	1/400	4,317
	1.65	1/500	4,279
Canal	1.85 x 1.40	1/250	3,566
	2.10 x 1.50	1/500	3,092 (Least)
	2.25 x 1.60	1/750	3,203
	2.35 x 1.65	1/1000	3,314
	2.55 x 1.75	1/1500	3,675
	2.70 x 1.80	1/2000	3,783
	3.30 x 2.05	1/5000	4,421

By the above cost comparison, the rectangular canal of 2.10 m wide and 1.50 m high with the bed slope of 1: 500 is adopted for the Cilawang canal. The adopted waterway profile and sections are shown in Figures 16 and 17.

(3) Tanjung Canal

In the Cisadane river basin development study, a high level intake for irrigation water supply was proposed on the right bank of the Tanjung dam at EL. 40.00 m taking into account the design water levels of the Tanjung reservoir of FWL 59.50 m, FSL 56.50 m and MOL 50.00 m. The proposed intake site on the right bank of around EL. 62.5 m is insufficient earth covering for the construction of tunnel of around EL. 50 m, so that open excavation type intake is proposed in this study. The intake equipped with two sets of slide gate of 1.5 m wide and 2.0 m high for the design discharge of 9.7 m^3/s will be directly connected with the Tanjung canal at the weir elevation of EL. 48.50 m.

The Tanjung canal between Tanjung reservoir and KSCS II is designed as reinforced rectangular canal since pipeline system is not applicable due to low hydraulic head between the LWL 50.00 m of the Tanjung reservoir and the water level of EL. 42.42 m of KSCS II and comparatively large design discharge of 9.7 m^3/s. The design bed slope of the Tanjung canal, therefore, is set at 1: 600 based on the LWL in the Tanjung reservoir and the water level in KSCS II in order to maximize the bed slope so as to minimize the construction cost thereby. Consequently, the Tanjung canal is designed at reinforced rectangular canal with a width of 3.00 m, a height of 1.95 m and bed slope of 1/600 as shown in Figures 16 and 17.

(4) River crossing structure

River crossing structures are required to cross the rivers of the Cibeureum, Cidurian, Cicinta, Payaheum, Cimatuk, Cibunar, Cimanceuri and Cisadane. Structure type, that is syphon or aqueduct types, were examined based on the following criteria:

a) Syphon type is applied in case that the river water level with a return period of 100 years is higher than the design structure level of KSCS.

b) In case that the river water level with a return period of 100 years is lower than the design water level of KSCS and that difference between the river water level and design structure level is larger than free board of 0.6 m, both types are applicable and therefore, comparison of construction cost selects a type giving less cost.

Among the aforesaid rivers, the river crossing structure with syphon type was applied for the rivers of the Cibeureum, Cicinta, Payaheum, Cimatuk, Cibunar, and Cimanceuri in accordance with selection criteria (a).

The river crossing sturucture in the Cidurian river was studied by comparing between aqueduct and syphon types as shown in Figures 18 to 21. As a result, the syphon type giving the least cost was selected for the KSCS I as shown in Table 4 and summarized below.

Alternative	Cost (billion Rp.)
Alt.-1 R.C. Aqueduct	3.91
Alt.-2 Syphon	2.08

The river crossing in the Cisadane river was also examined among syphon type and two kinds of aqueduct types as shown in Figures 22 to 27. Steel pipe aqueduct type was recommended to be provided for the KSCS III in consideration of not only the least cost as given in Table 4 but also the advantage on its easy maintenance and construction works. The total cost for the alternatives are summarized as follows:

Alternative	Cost (billion Rp.)
Alt.-1 Steel pipe aqueduct with concrete girder	5.65
Alt.-2 Steel pipe aqueduct	5.62
Alt.-3 Syphon	5.65

(5) Railway and road crossing structures

The KSCS I, II and III and Tanjung and Cilawang canals were identified to cross the existing railway and roads or foot paths as follows:

Description	KSCS I	KSCS II	KSCS III	Tanjung Canal	Cilawang Canal
Railway crossing	1	-	1	-	-
Road crossing					
Road	36	17	16	4	16
Foot path	22	14	8	3	12
Total	58	31	24	7	28

(6) Cross drains

Cross drains are necessary at 92 locations at the streams and rivers where the waterway is constructed. The structure size is determined at a capacity draining out 5-year probable flood peak discharge and its width is designed to be same as that of the existing stream or river channels.

(7) Pump Station

Because of the much cost difference between gravity flow canal and pressured pipeline due to the hilly area between Parungpanjang and Serpong WTP, the provision of a pump station is proposed on the left and right banks of the Cimanceuri river at Parungpanjang. The pump station is planned to convey raw water to Serpong WTP and Parungpanjang WTP proposed by the water supply master plan established by JWRMS. The pump facility to Parungpanjang WTP is suggested to be designed taking into account the supply capacity of the water treatment plant to be decided by the water treatment authority. While, the pump facilities for raw water conveyance to Serpong WTP is involved in the Karian-Serpong conveyance system.

4. PRELIMINARY DESIGN OF WATER CONVEYANCE SYSTEM

4.1 Intake Structures in the Envisaged Reservoirs

4.1.1 Karian reservoir

The Ciuyah tunnel is planned to release the stored water in the Karian reservoir to KSCS I at the location shown in Figure 28. The intake for KSCS I is placed in the Ciuyah tunnel in the Karian reservoir as shown in Figures 29 to 33 for the design discharge of 12.4 m^3/s. The Ciuyah tunnel consists of inlet of 10.0 m long, intake shaft of 14.5 m in diameter and 45.4 m deep, tunnel of 1,164.8 m long and 4.0 m in diameter and outlet of 5.0 m long.

The inlet is connected with the Karian reservoir by the approach channel of 7.0 m in bottom width, 3.2 m deep and 203 m long which is provided because the original ground surface of EL. 45.5 m serves insufficient flow depth in the inlet in case of the reservoir water level at LWL 46.00 m. The channel will be trapezoid shape and its slope will be protected with concrete surfacing of 0.30 m thick.

The inlet is divided to two channels of 3.0 m wide so as to make head loss at intake small and arrangement of trash rack and stoplogs easy.

The Ciuyah tunnel between the inlet and intake shaft is designed to be pressure flow in case of the reservoir water level equal to or higher than EL. 46.80 m and free flow lower in case of water level lower than EL. 46.80 m. The downstream section of tunnel of the intake shaft is designed to be free flow in any case. The design capacity of the tunnel is 12. 4 m^3/s and its freeboard of the downstream section is 0.8 m corresponding to the 20 % of the tunnel internal diameter. The estimated Manning's roughness coefficient of the tunnel is 0.014 taking into consideration the concrete lining with a sliding steel form. The flow velocity of the design discharge is estimated at 1.15 m/s.

The intake shaft was designed to be located in the downstream hill at 110.4 m from the inlet in order to control the discharge from the reservoir to KSCS I. Dimensions of the shaft was determined at an internal diameter of 14.50 m and depth of 45.42 m and a set of sleeve valve and guard valve of 1.40 m in diameter and a set of slide gate and stoplog is to be installed.

The two kinds of discharge facility are arranged aiming at discharging the water with head as high as possible so as to minimize the construction cost and the pump-up cost at the proposed water treatments. The valve type is changed from the hollow jet valve proposed in the Feasibility Study to the sleeve valve because the former type will require a large cavern in the horizontal direction to arrange a stilling basin and make the underground construction work difficult comparing the latter type which requires a vertical stilling basin. The sleeve valve is provided to discharge the water between the normal high water level (NHWL) of 67.50 m and the design low water level for sleeve valve (DLWL) 52.50 m. The slide gate is provided to discharge the water between DLWL 52.50 m and LWL 46.00 m in which water level the sleeve valve cannot discharge the design discharge of 12.4 m^3/s.

4.1.2 Cilawang reservoir

The intake structure in the Cilawang reservoir was designed to release the design discharge of 4.4 m^3/s, consisting of 4.1 m^3/s for the Cilawang canal and 0.3 m^3/s for the flushing water in the Cibeureum river and its layout was decided referring that proposed in the previous study as shown in Figures 34 and 35.

The steel pipe line of 1.20 m in diameter and 240m long is aligned along the right guide wall of spillway. At the end of the pipe line a set of guard valve and hollow jet valve of 0.90 m in diameter is provided to control the discharge. The dimensions of steel pipe line/valve and valve type are determined by comparison of total cost of civil and metal works between a hollow jet valve and a sleeve valve.

A stilling basin of 21. 80 m long, 3.85 m wide and 7.80 m high to still the remaining energy of the flow discharged from the follow jet valve is located between the valve house and the Cilawang canal. A slide gate of 1.00 m wide and 0.50 m high is arranged on the left wall of the Cilawang canal as a river outlet for the flushing water in the Cibeureum river.

4.1.3 Tanjung reservoir

The intake of Tanjung dam is located at the right bank of dam as shown in Figures 36 and 36. The intake will discharge the water of 9.7 m3/s between the water level of HWL 57.50 m and LWL 50.00 m from the Tanjung reservoir to the Tanjung canal. The intake will be equipped with two sets of slide gate of 1.50 m wide and 2.00 m high and one set of stoplogs. A stilling basin of 26.0 m long and 4.00 m wide is located between the gates and the Cilawang canal to still the remaining energy of discharged water through the gates.

4.2 Water Conveyance System

4.2.1 KSCS I

The KSCS I is planned to have a reinforced rectangular concrete channel with a length of 35.3 km, syphon structures at 7 rivers, railway crossing near Tenjo, division structures and spillways at Tenjo and Parungpanjang, road crossings at 58 locations, and cross drains for 63 streams. The waterway was designed for the design discharge of 12.4 m^3/s between the Ciuyah tunnel and the division structure at Tenjo and 6.2 m^3/s between the division structure at Tenjo and Parungpanjang pump station. The locations of major structure sites are shown in Figure 28.

(1) Waterway

The waterway was designed with the following conditions:

a) Manning's roughness coefficient : 0.015 assuming the concrete placing method with wooden/steel plate form

b) Effective flow area : flow depth corresponding to half of canal width to attain hydraulically optimum flow

c) Freeboard : 0.60 m to avoid the overflow of water from the canal due to the accidental over-discharge, wave, roughing canal surface

d) Canal side wall : 1.2 m higher than the surrounding ground surface to protect inhabitant and livestock from dropping into the canal

e) Inspection road : width of 3.0 m and gravel metalling

The proposed alignment, profile and cross sections of the waterway are shown in Figures 38 to 59. The coordinates of the intersection points and dimensions of curvatures of KSCS are shown in Tables 5 and 6. The internal dimensions of the waterway section are tabulated below.

No.	Section	Length (km)	Q (m^3/s)	Width (m)	Height (m)
1.	Ciuyah tunnel outlet toTenjo Division structure	19.9	12.4	4.85	2.45
2.	Tenjo Division Structure to Parungpanjang Pump Station	15.4	6.2	3.75	1.90

The water levels at the main structures in the Ciuyah tunnel and KSCS I are estimated on the above design conditions as shown in Table 7 and Figures 53 to 55 and summarized below.

No.	Location	Accumulated Length (m)	Water level (EL.m)
1.	Karian Reservoir		
	FWL		69.90
	NHWL		67.00
	LWL		46.00
2.	Ciuyah Tunnel		
	Inlet at LWL	-1,179.8	46.00
3.	Outlet of Tunnel /BP of KSCS I	0.0	45.60
4.	Division Pool at Tenjo	24,138.5	40.27
5.	EP of KSCS I	35,385.8	37.85

As shown in Figure 58, high excavation and embankment such as about 15 to 20 m high will be required at some sections. Expected problem relating with them is the settlement of the high embankment which will cause crack of concrete waterway due to uneven settlement of embankment below the waterway. So as to avoid the uneven settlement, the waterway in embankment shall be constructed after the settlement of embankment for around two years and with cut-and-backfill method of embankment. The stability of slope of the high embankment is confirmed by the stability analysis. Problem in the high excavation will be slope failure due to the weathering of rock with rainfall and underground water. It may be protected with the shotcrete slope protection.

The main construction works of KSCS I is earth and concrete works of large amount as tabulated below.

Item	Unit	Quantity
1. Earth Work		
a) Excavation	m^3	3,420,000
b) Embankment	m^3	1,340,000
c) Disposal	m^3	1,930,000
2. Concrete Work		
a) Concrete	m^3	161,000
b) Re-bar	ton	14,400

(3) Syphon structure

To cross the rivers in the route of KSCS I, seven syphon are proposed to be constructed as tabulated below and shown in Figures 60 to 74.

No.	River	Length (m)	Internal Size(m)
1.	Cibeureum	98.3	Dia. 3.2
2.	Cicinta	91.0	Dia. 3.2
3.	Cisadane	259.7	Dia. 3.2
4.	Payaheum	62.8	Dia. 3.2
5.	Cimatuk	126.6	Dia. 3.2
6.	Cibunar	75.8	Dia. 3.2
7.	Cimanceuri	61.0	2.2 x 2.2

The syphon are designed on the following conditions:

a) Flow velocity in the syphon : 1.5 times faster than that in the canal,

b) Water covering (seal) : 0.3 m or more at the entrance of syphon,

c) Earth covering : 2.0 m or more on the syphon in the river (specially 1.0 m in hard rock riverbed),

d) Gradient of syphon : 25 degrees or gentler from the points of view of construction and stability against sliding, and

e) Manhole and drain pit in the syphon : provided in case of syphon length more than 200 m or with complicated longitudinal profile.

A box culvert type is adopted to the syphon No. 7 in the Cimanceuri river because the easy connection with the Parungpanjang pump station which will be constructed by the water treatment agency.

The details of proposed manhole are shown in Figure 75. Manhole Type A is applied to the manhole to be constructed in the river channel in which a pump is arranged to drain the water in the syphon. Type B is applied to the syphon in which water can be drained by gravity.

Revetment with concrete block is provided on the slopes of existing river bank and embankment in the flood plain. Gabion mattress are proposed to be put on the riverbed above the syphon protecting them from scouring.

(4) Railway crossing

The waterway and existing railway will cross near Tenjo. The waterway will pass in the underground 7.2 m below the railway of ground level of EL. 50.47 m as shown in Figure 76. Because the covering above the waterway is not sufficient to excavate the earth with the conventional tunneling method under operation of railway and insufficient space is available for the construction method by the temporary relocation of railway, a front jack method is applied to this construction. The box culvert of waterway is 2.94 m high, 4.85 m wide and 90.00 m long.

(5) Division structure

Two division structures shown in Figures 77 to 81 are required to connect KSCS I and KSCS II/Cilawang canal and divide the water to KSCS I, KSCS II and Tenjo WTP at Tenjo, and connect KSCS I and KSCS II and divide the water to the pump stations for Parungpanjang in Phases I and II, and KSCS III for Serpong WTP at Parungpanjang.

The division structure at Tenjo is 76.40 m long and 11.65 m wide and equipped with two sets of gate and stoplogs for operation of KSCS I and waterway to Parungpanjang WTP in Phase I and three sets of stoplogs are provided for the construction of KSCS II/Cilawang canal and canal to Parungpanjang WTP. One set of gate and stoplog slots will be constructed in KSCS I in Phase I for the provision of one set of gate and stoplogs in Phase II for the maintenance of upstream section of KSCS I.

The division structure at Parungpanjang is 32.00 m long and 14.50 m wide. Two sets of gate and stoplog slots will be constructed in KSCS I in Phase I for the provision of two sets of gate and stoplogs in Phase II for the maintenance and operation of KSCS I and three sets of stoplogs will be provided for the construction of KSCS II and canals to Parungpanjang pump stations.

(6) Spillway

Two spillways are proposed in Phase I at the entrance of syphon No.1 at the Cicinta river and in the division structure at Tenjo so as to discharge the extra water more than the design discharge.

The spillway at Cicinta (called Cicinta spillway) shown in Figures 62 and 64 has the following functions:

- releasing the extra water in normal operation,

- draining out the water in KSCS I at the time of maintenance/repair of KSCS I,

- diversion of the water in KSCS I in case of the failure of canal by accident between the syphon No.1 at Cicinta and division structure at Tenjo because of existence of large structures such as two syphon, high embankment and a railway crossing.

The Cicinta spillway of 12.4 m^3/s in capacity consists of chute, stilling basin and connection channel of 4.85 m wide and 73.17 m long in total to discharge the water in the Cicinta river. Two sets of gate and one set of stoplog are provided for the spillway.

The spillway at the division structure at Tenjo (called Tenjo spillway) shown in Figures 77 and 78 has the function to discharge the extra water from the Karian reservoir at the Cicinta river and sudden mal-operation of Tenjo WTP. The syphon type spillway of 6.2 m^3/s in capacity is adopted because of its large discharge capacity and lower cost than over flow type. Syphon of precast steel type is proposed because of easy construction.

The Tenjo spillway is connected with the trapezoid shape spillway canal of 2.0 m bottom wide, 1.5 m high and 895.0 m long in total to discharge the water to the Cilaku river as shown in Figure 78. The canal will be constructed with wet cobble masonry.

To drain KSCS I between the Cicinta spillway and the Tenjo division structure, a drainage gate of 1.0 m wide and high and drainage canal connected with the spillway canal is planned as shown in Figure 77.

Spillway and drainage facility at the end of KSCS I at the Parungpanjang will be designed relating with the arrangement of pump station for the Parungpanjang WTP to be constructed by the water treatment authority.

(7) Road crossing structures and foot paths

Road crossing structures are planned to be constructed at 36 locations where the waterway and public roads cross. Foot paths are proposed to be constructed to serve the inhabitant to pass the waterway at 22 locations of existing foot path. Their locations are shown in Figure 82. Typical design of the road crossing is shown in Figures 83 to 88. The road crossing will be two types; embankment type on the box culvert waterway and box culvert type in embankment below the waterway. The road will be paved with asphalt of 5.0 to 6.0 m wide depending on the existing road pavement width.

The footpath will be box culvert type of 3.0 m wide which will be constructed by providing a concrete slab on the waterway.

(8) Cross drains

Cross drains will be constructed below or above the waterway to drain the water at 63 locations shown in Figures 92 and 93 where the streams or lower land are barred by the waterway. Four types of cross drain; namely, box culvert, pipe culvert of horizontal and syphon types and open channel are proposed as shown in Figures 94 to 97. Among 63 cross drains, three cross drains in the Cipanggang, Ciruruh and Cikasungka rivers are shown in Figures 98 to 103.

The cross drains are proposed to be constructed with the length of Phase II so as to avoid the demolishing of structures constructed in Phase I at the inlet construction work. The cross drains are designed to have the flow capacity against 5-year flood.

(9) Spoil banks

Spoil banks at 26 locations shown in Figures 104 and 105 are proposed to dispose the excavated earth from the waterway. The estimated area of spoil bank and disposal earth volume are 83.5 ha and 2.6 million m3 in total including those for Phase II.

4.2.2 KSCS II

KSCS II is planned to have a reinforced rectangular concrete channel with a length of 19.3 km, syphons at 3 rivers in the scenario A or 4 rivers in the scenario C, railway crossing at Tenjo, road crossings at 31 locations. The waterway was designed for the design discharge of 4.10 m^3/s and 5.05 m^3/s in Phase IIA and 13.80 m^3/s and 9.90 m^3/s IIC-a, respectively, between the confluence of Cilawang and Tanjung canals and Parungpanjang pump stations for the Parungpanjang and Serpong WTP. The locations of major structure sites are shown in Figure 28.

(1) Waterway

The canal is aligned along KSCS I in the hill side and designed with the same design conditions as KSCS I. The canal bed slope is the same as KSCS I of 1/5,000. The alignment, profile and cross sections of the canal are shown in Figures 45 to 59. The internal sectional dimensions of the canal are tabulated below and shown in Figure 16.

		Length	Phase IIA			Phase IIC-a		
No.	Section	(km)	Q(m^3/s)	B (m)	H (m)	Q(m^3/s)	B (m)	H (m)
1.	Confluence of Cilawang and Tanjung canals to Tenjo Division structure	3.9	4.10	2.20	3.05	13.80	5.30	3.05
2.	Tenjo Division Structure to Parungpanjang Pump Station	15.4	5.05	3.20	3.05	9.90	5.40	3.05

(3) Syphon structure

To cross the rivers in the route of KSCS II, three and four syphon in Phases IIA and IIC-a, respectively, are proposed to be constructed as tabulated as follows.

No.	River	Length (m)	Size in Phase IIA (m)	Size in Phase IIC-a (m)
1.	Payaheum	62.8	Dia. 2.2	Dia. 3.0
2.	Cimatuk	126.6	Dia. 2.2	Dia. 3.0
3.	Cibunar	75.8	Dia. 2.2	Dia. 3.0
4.	Cimanceuri	61.0	-	1.8 x 1.8

The syphon are designed on the same design conditions as those for KSCS I. The dimensions of the syphon are shown in Figures 67 to 74.

(4) Railway crossing

The waterway and existing railway will cross near Tenjo in parallel with and at the same location as KSCS I as shown in Figure 76. The front jack method is also applied to KSCS II with the same reason as KSCS I. The box culvert of waterway to be constructed is 2.94 m high, 5.30 m wide and 2.20 m wide in Phases IIA and IIC-a, respectively, and 90.00 m long.

(5) Division structure

KSCS II will be connected with the two division structures shown in Figures 77 to 81 at Tenjo at Parungpanjang which will be constructed in Phase I. Four sets of gate will be provided to the Tenjo division structure in Phase II. Five sets of gate and two/three sets of stoplogs will be supplied in Phase II.

(6) Spillway

Syphon spillway of discharge capacity of 5.05 m^3/s and 9.9 m^3/s for Phases IIA and IIC, respectively, will be added to discharge the extra water from KSCS II in Phase II in the Tanjung division structure shown in Figure 77 and 78.

Spillway and drainage facility at the end of KSCS II at the Parungpanjang pump station shown in Figures 79 to 81 will be constructed to discharge the extra water in KSCS II and the water of 6.0 m^3/s not pumped up for the Serpong WTP.

(7) Road crossing structures and foot paths

Road crossing structures at 17 locations and foot paths at 14 locations is planned to be provided at the same location and of the same structure for KSCS I as shown in Figure 82.

(8) Cross drains

Cross drains in KSCS II will not be constructed in Phase II because all of them are constructed in Phase I.

4.2.3 KSCS III

KSCS III consists of a pump station at Parungpanjang, steel pipeline with a length of 1.7 km, precast concrete pipeline with a length of 10.2 km and an aqueduct of steel pipe with a length of 140 m, railway crossing near the Cisadane river, road crossings at 24 locations and cross drains at 15 locations. The pipeline of 2.20 m in internal diameter is applied under the design discharge of 6.0 m^3/s between Parungpanjang pump station and Serpong WTP. The locations of major structure sites are shown in Figure 28. Alignment of pipeline is shown in Figures 49 to 52. Its profile and typical cross section are shown in Figures 56 and 57. Cross sections are shown in Figure 59. The coordinates of the intersection points and dimensions of curvatures of KSCS III are shown in Table 8.

(1) Pump station

Parungpanjang pump station is proposed to pump up the water conveyed by KSCS I and II from the reservoirs to the Serpong WTP from which the treated water will be supplied to Jakarta. The required pump-up height at Parungpanjang pump station is estimated at 26.5 m by the calculation as given in Table 9. The general layout of the pump station is shown in Figure 79 and its details is in Figure 106.

The pump house of 14.50 m wide, 42.6 m long and 12.60 m high will be equipped with three sets of pump of the capacity of 3.0 m^3/s each among which one set is arranged for a stand-by pump for the time of maintenance and repair. The pump house will be constructed on the pile foundation as shown in Figure 106.

(2) Pipeline

The pipe line diameter is optimized by the least total cost of the pipeline construction and operation cost of pump-up tabulated below and determined at 2.20 m.

Item	Pipe Diameter (m)			
	1.80	2.00	2.20	2.40
Construction cost (bill. Rp.)	28.18	29.71	32.87	36.82
Replacement cost (bill. Rp.)	6.81	4.58	3.41	2.75
Operation cost (bill. Rp./year)	4.16	2.8	2.08	1.68
Present value (bill. Rp.)	45.28	39.17	37.85	38.87

Note : The above construction cost covers the cost for construction of pipe line, pump station and land acquisition.

Steel pipeline was designed to be used for the following locations and as a result, a length of steel pipeline is 1.69 km:

- topographically complicated area where concrete pipeline is not applicable,
- stream crossing where the stream elevation is at similar level as that of pipeline,
- aqueduct at the Cisadane river, and
- urbanized area in order to minimize scale of land acquisition.

Typical and actual sections of the pipeline are shown in Figures 57 and 59.

(3) Aqueduct

A steel pipe aqueduct is proposed to cross the Cisadane river. The aqueduct consists of steel pipe of 2.2 m in diameter and 140 m long supported by abutments and three piers with concrete pile foundation as shown in Figures 25 and 26.

(4) Railway crossing

To cross the railway near Parungpanjang, a construction method by the relocation of railway is adopted because of sufficient space around the construction site and lower construction cost than other methods. The plan and sections of pipeline at the railway crossing site are shown in Figure 107.

(5) Road crossing structures and foot paths

Road crossing structures at 16 locations and foot paths at 8 locations will be constructed at the location shown in Figure 82. Among them, road crossing at BRS-11 and BRS-16 is shown in Figures 89 to 91 as typical design.

(8) Cross drains

Cross drains at 15 locations shown in Figure 93 is planned as same as KSCS I. They consists of one box culvert type, one pipe culvert type and 13 open channel types.

4.2.4 Cilawang canal

The waterway for the discharge of 4.1 m^3/s is proposed to supply the water of the Cilawang reservoir to KSCS II on the right bank along the Cibeureum river and along KSCS I as shown in Figures 38 to 43. The length of the Cilawang canal is 17.1 km consisting of the canal along the Cibeureum river for 2.4 km and along KSCS I for 14.7 km till the confluence of the Tanjung canal. Syphon structures at 2 rivers, road crossings at 28 locations and cross drains for 7 streams are required to be constructed. The coordinates of the intersection points and dimensions of curvatures of Cilawang canal between the Cilawang dam and the meeting point with KSCS I are shown in Table 10.

(1) Waterway

The canal consists of two types as tabulated below and shown in Figure 15. The dimensions of Type A is determined in accordance with the design conditions given in the section 4.2.1 and adopting the freeboard of 0.45m. Those of Type B is determined to be the same water level as that of KSCS I in order to make the waterways stable by constructing the new one in

Phase II on the same elevation as Phase I. The profile of canal is shown in Figures 16, 53 and 54.

Type	Section	Length (km)	Gradient	Width (m)	Height (m)
A	Cilawang Dam - KSCS I	2.4	1/500	2.10	1.50
B	Along KSCS I	14.7	1/5,000	2.20	3.05

(2) Syphon

Two syphon will be constructed in parallel with KSCS I in the Cicinta river and Cidurian river with the following dimensions shown in Figures 62 to 66.

No.	River	Length (m)	Size(m)
1	Cicinta	91.0	Dia. 2.2
2	Cisadane	259.7	Dia. 2.2

(3) Spillway

A spillway is planned to be provided at the same location as KSCS I in front of the syphon No. 2 in the Cicinta river.

(4) Road crossing structures and foot paths

Road crossing structures at 16 locations and foot paths at 12 locations will be constructed at the location shown in Figure 82.

(5) Cross drains

Cross drains at 7 locations shown in Figure 92 will be constructed in the section between the Cilawang dam and KSCS I. Those in other sections will be constructed in Phase I. They consists of six pipe culvert types and one open channel type.

4.2.5 Tanjung canal

(1) Waterway

The Tanjung canal will be constructed to convey the water of 9.7 m^3/s from the Tanjung reservoir to KSCS II as shown in Figure 2. The waterway is planned to have a reinforced concrete open canal with a width of 3.0 m, a height of 1.95 m, a length of 4.3 km and bed slope of 1/600 as shown in Figures 15, 16 and 59. The alignment of waterway is shown in Figures 43 and 44. The coordinates of the intersection points and dimensions of curvatures of Tanjung canal between the Tanjung dam and the meeting point with KSCS I are shown in Table 11.

(2) Road crossing structures and foot paths

Road crossing structures at four locations and foot paths at three locations will be constructed the location shown in Figure 82.

(3) Cross drains

Cross drains at 8 locations shown in Figure 92 will be constructed consisting of one box culvert type, five pipe culvert types and two open channel types.

TABLES

Table 1 OVERALL COMPARISON OF CONVEYANCE TYPES

Item	Trapezoidal Channel Unlined (ALT-1)	Trapezoidal Channel Masonry (ALT-2)	Trapezoidal Channel Concrete (ALT-3)	Rectangular Channel Masonry (ALT-4)	Rectangular Channel Concrete (ALT-5)	Box Culvert (ALT-6)	Pipeline Steel (ALT-7)	Pipeline Concrete (ALT-8)
1) Hydraulic Aspect								
Roughness	Large	Middle (+)	Small (++)	Middle (+)	Small (++)	Small (++)	Small (+++)	Small (++)
Head loss	Large	Middle (+)	Small (++)	Middle (+)	Small (++)	Small (++)	Large	Large
2) Construction								
Method	Easy	Normal (-)	Normal (-)	Normal (-)	Normal (-)	Normal (-)	Normal (-)	Normal (-)
Quality control	Easy	Normal (- -)	Normal (-)	Normal (- -)	Normal (-)	Normal (- -)	Normal (- -)	Normal (- -)
Period	Short	Normal (-)	Normal (-)	Normal (-)	Normal (-)	Long (- -)	Normal (-)	Normal (-)
Cost	V. Low	Low (- 3)	High (- 7)	Middle (- 4)	High (- 14)	High (- 17)	V. High (- 25)	V. High (- 20)
3) Repair and Maintenance								
Sustanability of structure	Difficult	Normal (+)	Easy (++)	Normal (+)	Easy (+++)	Easy (+++)	Easy (+++)	Easy (+++)
Work frequency	Frequent	Rare (+)	Rare (+)	Rare (+)	Nil (++)	Nil (++)	Nil (++)	Nil (++)
Scale	Large	Small (+)	Small (+)	Small (+)	Nil (++)	Nil (++)	Nil (++)	Nil (++)
Cost	High	Low (+)	Low (+)	Low (+)	Nil (++)	Nil (++)	Nil (++)	Nil (++)
4) Water Conveyance Loss(%)	High	Middle (++)	Middle (++)	Middle (++)	Low (++++)	Low (++++)	Low (++++)	Low (++++)
5) Water Pollution								
Severeness	High	Low (+)	Low (+)	Low (+)	Nil (++)	Nil (+++)	Nil (+++)	Nil (+++)
Intrusion of rain drainage	High	Low (+)	Low (+)	Low (+)	Nil (++)	Nil (+++)	Nil (+++)	Nil (+++)
By inhabitant and livestock	High	High (+)	High (+)	Low (+)	Nil (++)	Nil (+++)	Nil (+++)	Nil (+++)
6) Dangerness of Drowning of Inhabitant and Livestock	Low	Low (-)	Low (-)	N. Low (-)	N. Low (-)	Nil (+)	Nil (+)	Nil (+)
7) Enviromental Impact								
Resettlement of inhabitant	Many	Many (+)	Many (+)	N. many (+)	N. many (+)	N. many (+)	N. many (+)	N. many (+)
Comparison Alt-1								
Possitive		+12	+15	+12	+24	+24	+23	+22
Negative		-8	-11	-9	-19	-20	-28	-23
Total		+4	+4	+3	+5	+5	-5	-1

Note ; V : Very
N : Not
+ : More benefitial than ALT-1
- : less benefitial than ALT-1

Table 2 COST COMPARISON OF ALTERNATIVE ROUTES BETWEEN PARUNGPANJANG AND DKI JAKARTA

Alternative Routes			Distance (km)	Discharge (m3/s)	Pipe Diam. (m)	Land Acquisition		Cost (bill. Rp.)						
						Area (1000 m2)	Unit Price (1000 Rp. /m2)	Const-ruction	Land Acquist.	Replace-ment	Mainte-nance (/year)	Opera-tion (/year)	Present Value	System Total
	1N	Sec.4 In BSD	10.31	3.00	1.80	3.1	500	39.30	1.55	1.42	0.39	0.87	37.72	
	1S	Sec.4	11.07	3.00	1.80	128.0	15	22.21	1.92	1.46	0.23	0.89	24.31	
	1N	Sec.4 In BSD	10.31	6.00	2.20	3.1	500	52.30	1.55	3.29	0.52	2.01	54.41	
	1S	Sec.4	11.07	6.00	2.20	130.7	15	32.22	1.96	3.41	0.33	2.08	38.88	
Alt-1	1S	Sec.4	11.07	6.00	2.20	130.7	15	32.22	1.96	3.41	0.33	2.08	38.88	
	0	Along Exist. Pipeline	10.55	6.00	2.20	155.0	100	31.03	15.50	0.94	0.31	0.58	40.04	
	0	Along Exist. Pipeline	1.75	3.00	1.50	1.1	500	5.15	0.55	0.00	0.05	0.00	4.58	
	1	Along Exist. Pipeline	12.30	3.00	1.50	7.4	500	36.08	3.70	0.00	0.36	0.00	32.05	
		Total	35.67					104.48	21.71	4.35	1.05	2.66	115.55	115.55
Alt-2	1S	Sec.4	11.07	6.00	2.20	130.7	15	32.22	1.96	3.41	0.33	2.08	38.88	
	0	Along Exist. Pipeline	12.30	3.00	1.50	139.1	100	24.65	13.91	1.07	0.25	0.66	34.11	
	2	Along Toll Road	20.25	3.00	1.50	12.2	500	60.44	6.10	0.68	0.61	0.42	55.92	
		Total	43.62					117.31	21.97	5.16	1.19	3.16	128.91	128.91
Alt-3	1S	Sec.4	11.07	6.00	2.20	130.7	15	32.22	1.96	3.41	0.33	2.08	38.88	
	0	Along Exist. Pipeline	12.30	3.00	1.50	139.1	100	24.65	13.91	1.07	0.25	0.66	34.11	
	3	Along Existing Road	22.20	3.00	1.50	6.7	500	66.24	3.35	0.75	0.66	0.46	58.72	
		Total	45.57					123.11	19.22	5.23	1.24	3.20	131.70	131.70
Alt-4	1S	Sec.4	11.07	3.00	1.80	128.0	15	22.21	1.92	1.45	0.23	0.89	24.31	
	0	Along Exist. Pipeline	12.30	3.00	1.50	139.1	100	24.65	13.91	1.07	0.25	0.66	34.11	
	4	Direct Connection	25.55	3.00	1.50	127.8	500	77.75	63.90	2.03	0.78	1.24	118.18	
	-	Parungpanjang WTP	-	-	-	30.0	100	-	3.00	-	-	-	3.00	
		Total	48.92					124.61	82.73	4.55	1.26	2.79	179.60	179.60
Alt-5	1S	Sec.4	11.07	3.00	1.80	128.0	15	22.21	1.92	1.45	0.23	0.89	24.31	
	0	Along Exist. Pipeline	12.30	3.00	1.50	139.1	100	24.65	13.91	1.07	0.25	0.66	34.11	
	5	Along Existing Road	31.20	3.00	1.50	9.4	500	94.89	4.70	2.64	0.95	1.61	89.19	
	-	Parungpanjang WTP	-	-	-	30.0	100	-	3.00	-	-	-	3.00	
		Total	54.57					141.75	23.53	5.16	1.43	3.16	150.61	150.61

Table 3 COST COMPARISON FOR OPTIMIZATION OF WATERWAY BED SLOPE

(1) Cost

Cost Item	Bed Slope	1/2,500	1/5,000	1/7,500	1/10,000	1/15,000
Construction	Waterway	222,293	234,028	268,497	287,914	337,348
(mill.Rp.)	Pump Station	16,971	13,607	12,479	11,913	11,346
	Replacement	8,232	6,194	5,515	5,175	4,836
	(Total)	(247,496)	(253,829)	(286,490)	(305,002)	(353,529)
O & M	Operation	2,164	2,220	2,511	2,678	3,100
(mill.Rp./yr)	Maintenance	7,761	6,052	5,483	5,198	4,913
	(Total)	(9,926)	(8,272)	(7,994)	(7,876)	(8,014)

(2) Present Value

(unit : mill.Rp.)

Cost Item	Bed Slope	1/2,500	1/5,000	1/7,500	1/10,000	1/15,000
Construction	Waterway	187,021	195,942	224,509	240,696	281,495
	Pump Station	13,937	11,163	10,232	9,766	9,298
	Replacement	6,882	5,179	4,611	4,327	4,043
	(Sub-Total)	(207,840)	(212,284)	(239,352)	(254,788)	(294,835)
O & M	Operation	13,151	13,096	14,656	15,588	17,754
	Maintenance	37,491	28,786	25,884	24,433	22,982
	(Sub-Total)	(50,641)	(41,881)	(40,540)	(40,021)	(40,736)
Total		258,482	254,165	279,892	294,810	335,571

Note ; Discount Rate : 12 %

Pump : Parungpanjang for Parunpanjang Water Treatment Plant
Parungpanjang for Pipe Line to Serpong Water Treatment Plant
Serpong for Serpong Water Treatment Plant

Waterway : Ciuyah Tunnel, KSCS, Cilawang and Tanjung Canals

Table 4 COST COMPARISON OF RIVER CROSSING STRUCTURES

(1) The Cidurian River

No. Work item	Unit	Unit price (Rp.)	Quantity Aqueduct	Quantity Syphon	Amount (million Rp.) Aqueduct	Amount (million Rp.) Syphon
(1) Coffering and dewatering	L.S.				338	331
(2) Cleaning and stripping	m2	1,900	800	11,100	1.52	21.09
(3) Excavation,common	m3	7,050	5,000	20,000	35.25	141.00
(4) Backfill	m3	6,400	3,500	11,000	22.40	70.40
(5) Embankment	m3	5,950	0	30,700	0.00	182.67
(6) Gravel bedding	m3	28,610	60	42	1.72	1.20
(7) Concrete pile including piling (D=0.4m)	m	178,800	4,600	0	822.48	0.00
(8) Structural concrete (210 kg/cm2)	m3	161,310	5,200	2,200	838.81	354.88
(9) Levelling concrete (150 kg/cm2)	m3	153,500	80	150	12.28	23.03
(10) Form	m2	28,060	15,600	6,500	437.74	182.39
(11) Reinforcing bar	ton	1,756,010	530	220	930.69	386.32
(12) PVC waterstop (B=20cm)	m	31,690	110	380	3.49	12.04
(13) Miscellaneous metal work (screen and etc.)	ton	10,273,630	1	1	10.27	10.27
(14) Revetment with concrete block	m2	128,960	2,000	2,000	257.92	257.92
(15) Gabion mattress	m3	50,610	120	190	6.07	9.62
(16) Others (5 %)	L.S.				185.93	99.17
Sub-total					3,905	2,083

(2) The Cisadane River

No. Work item	Unit	Unit price (Rp.)	Quantity Aqueduct PC	Quantity Aqueduct Steel Pipe	Quantity Syphon	Amount (million Rp.) Aqueduct PC	Amount (million Rp.) Aqueduct Steel Pipe	Amount (million Rp.) Syphon
(1) Clearing and stripping	m2	1,900	1,400	1300	1,600	2.66	2.47	3.04
(2) Steel sheet pile coffering and dewatering	L.S	420,000	650	600	2,500	273.00	252.00	1,050.00
(3) Excavation, common	m3	7,050	5,300	4100	6,250	37.37	28.91	44.06
(4) Backfill	m3	6,400	4,500	3500	4,700	28.80	22.40	30.08
(5) Sand bedding	m3	28,610	0	0	900	0.00	0.00	25.75
(6) Gravel bedding	m3	28,610	80	70	0	2.29	2.00	0.00
(7) PC girder	m	1,500,000	280	0	0	420.00	0.00	0.00
(8) Structural concrete (210 kg/cm2)	m3	161,310	1,100	750	70	177.44	120.98	11.29
(9) Levelling concrete (150 kg/cm2)	m3	153,500	40	40	2	6.14	6.14	0.31
(10) Form	m2	28,060	1,648	870	290	46.23	24.41	8.14
(11) Reinforcing bar	ton	1,756,010	110	67	10	193.16	117.65	17.56
(12) Gabion mattress	m3	50,610	50	50	750	2.53	2.53	37.96
(13) Concrete pile including piling (D=0.5m)	m	178,800	1,330	980	0	237.80	175.22	0.00
(14) Steel pipe	ton	10,701,700	100	190	160	1,070.17	2,033.32	1,712.27
(15) Miscellaneous metal work	ton	17,122,720	10	23	16	171.23	393.82	273.96
(16) Temporary bridge	L.S.					2,710.45	2,168.36	2,168.36
(17) Others (5 %)	L.S.					269	268	269
Total						5,648	5,618	5,652

Table 5 COORDINATES OF KSCS I (1/2)

No.	IP X	IP Y	IP Distance (m)	Azimuth (deg)	IA (deg)	IA (deg)	IA (min)	IA (sec)	Element of Curve R (m)	Element of Curve TL (m)	Element of Curve CL (m)	Accumulative distance BC (km)	Accumulative distance EC (km)
(1) BP of KSCS I to Tenjo Division Structure													
BP of KSCS I	648,292.327	291,447.437										0 km 0.000 m	0 km 0.000 m
			625.893	66.201311									
IP- 2	648,865.000	291,700.000			42.238877	42	14	20.0	50.0	19.313	36.860	0 km 606.580 m	0 km 643.441 m
			196.977	23.962433									
IP- 3	648,945.000	291,880.000			67.870408	67	52	13.5	50.0	33.643	59.228	0 km 787.462 m	0 km 846.690 m
			375.192	91.832841									
IP- 4	649,320.000	291,868.000			58.444375	58	26	39.8	250.0	139.847	255.011	1 km 48.391 m	1 km 303.403 m
			526.972	33.388466									
IP- 5	649,610.000	292,308.000			7.047863	7	2	52.3	500.0	30.791	61.504	1 km 659.737 m	1 km 721.241 m
			685.136	26.340603									
IP- 6	649,914.000	292,922.000			99.299237	99	17	57.3	100.0	117.706	173.310	2 km 257.881 m	2 km 431.191 m
			260.860	125.639839									
IP- 7	650,126.000	292,770.000			46.378745	46	22	43.5	200.0	85.676	161.892	2 km 488.669 m	2 km 650.561 m
			590.339	79.261094									
IP- 8	650,706.000	292,880.000			76.566883	76	34	0.8	200.0	157.856	267.269	2 km 997.368 m	3 km 264.636 m
			340.376	2.694211									
IP- 9	650,722.000	293,220.000			23.522708	23	31	21.7	500.0	104.103	205.274	3 km 343.053 m	3 km 548.327 m
			393.731	339.171503									
IP- 10	650,582.000	293,588.000			16.507127	16	30	25.7	500.0	72.528	144.052	3 km 765.426 m	3 km 909.478 m
			398.132	355.678630									
IP- 11	650,552.000	293,985.000			63.172763	63	10	21.9	150.0	92.231	165.386	4 km 142.850 m	4 km 308.236 m
			318.989	58.851393									
IP- 12	650,825.000	294,150.000			93.629177	93	37	45.0	50.0	53.272	81.707	4 km 481.722 m	4 km 563.429 m
			306.804	325.222215									
IP- 13	650,650.000	294,402.000			62.912138	62	54	43.7	100.0	61.175	109.802	4 km 755.787 m	4 km 865.589 m
			326.588	28.134354									
IP- 14	650,804.000	294,690.000			19.936354	19	56	10.9	500.0	87.877	173.977	5 km 43.126 m	5 km 217.103 m
			476.873	8.198000									
IP- 15	650,872.000	295,162.000			34.919757	34	55	11.1	200.0	62.906	121.893	5 km 543.193 m	5 km 665.086 m
			326.914	333.278243									
IP- 16	650,725.000	295,454.000			77.243980	77	14	38.3	200.0	159.783	269.632	5 km 769.311 m	6 km 38.944 m
			984.620	50.522222									
IP- 17	651,485.000	296,080.000			39.590738	39	35	26.7	200.0	71.986	138.198	6 km 791.794 m	6 km 929.991 m
			564.238	10.931484									
IP- 18	651,592.000	296,634.000			22.071081	22	4	15.9	500.0	97.512	192.606	7 km 324.732 m	7 km 517.338 m
			527.947	348.860403									
IP- 19	651,490.000	297,152.000			29.559306	29	33	33.5	200.0	52.766	103.181	7 km 895.007 m	7 km 998.188 m
			254.568	319.301098									
IP- 20	651,324.000	297,345.000			64.661335	64	39	40.8	200.0	126.585	225.710	8 km 73.406 m	8 km 299.116 m
			295.466	23.962433									
IP- 21	651,444.000	297,615.000			24.730253	24	43	48.9	500.0	109.613	215.812	8 km 358.384 m	8 km 574.196 m
			977.129	48.692686									
IP- 22	652,178.000	298,260.000			27.183361	27	11	0.1	500.0	120.886	237.219	9 km 320.826 m	9 km 558.046 m
			950.741	75.876047									
IP- 23	653,100.000	298,492.000			19.693576	19	41	36.9	500.0	86.785	171.859	10 km 301.115 m	10 km 472.974 m
			1,617.637	95.569623									
IP- 24	654,710.000	298,335.000			10.452387	10	27	8.6	1,000.0	91.468	182.428	11 km 912.357 m	12 km 94.786 m
			998.624	85.117236									
IP- 25	655,705.000	298,420.000			23.553525	23	33	12.7	500.0	104.244	205.543	12 km 897.698 m	13 km 103.241 m
			315.006	61.563711									
IP- 26	655,982.000	298,570.000			28.944517	28	56	40.3	200.0	51.620	101.035	13 km 262.384 m	13 km 363.419 m
			623.315	32.619195									
IP- 27	656,318.000	299,095.000			76.319826	76	19	11.4	125.0	98.224	166.504	13 km 836.890 m	14 km 3.394 m
			754.865	108.939020									
IP- 28	657,032.000	298,850.000			38.376523	38	22	35.5	200.0	69.601	133.959	14 km 590.434 m	14 km 724.393 m
			1,247.077	70.562497									
IP- 29	658,208.000	299,265.000			63.743087	63	44	35.1	150.0	93.263	166.879	15 km 808.605 m	15 km 975.484 m
			488.456	6.819410									
IP- 30	658,266.000	299,750.000			19.707693	19	42	27.7	500.0	86.849	171.982	16 km 283.827 m	16 km 455.809 m
			676.187	26.527104									
IP- 31	658,568.000	300,355.000			26.233608	26	14	1.0	500.0	116.508	228.931	16 km 928.639 m	17 km 157.571 m
			1,171.015	0.293495									
IP- 32	658,574.000	301,526.000			60.912479	60	54	44.9	400.0	235.206	425.249	17 km 976.871 m	18 km 402.120 m
			597.930	61.205974									
IP- 33	659,098.000	301,814.000			19.926951	19	55	37.0	500.0	87.835	173.895	18 km 677.009 m	18 km 850.904 m
			1,032.350	81.132926									
EP (Tenjo division structure)	660,118.012	301,973.129										19 km 795.419 m	19 km 795.419 m

Table 6 COORDINATES OF KSCS I (2/2)

No.	IP X	IP Y	IP Distance (m)	Azimuth (deg)	IA (deg)	IA (deg)	IA (min)	IA (sec)	Element of Curve R (m)	Element of Curve TL (m)	Element of Curve CL (m)	Accumulative distance BC (km)		Accumulative distance EC (km)	
(2) Tenjo Division Structurew to EP of KSCS I															
BP (Tenjo division structure)	660,194.150	301,980.730												19 km	871.819 m
			215.000	81.132811											
IP- 34	660,406.580	302,013.871			9.146146	9	8	46.1	1,000.0	79.985	159.630	20 km	6.834 m	20 km	166.464 m
			2,027.444	90.278957											
IP- 35	662,434.000	302,004.000			40.350409	40	21	1.5	500.0	183.718	352.123	21 km	930.204 m	22 km	282.328 m
			1,994.893	130.629366											
IP- 36	663,948.000	300,705.000			51.462422	51	27	44.7	500.0	240.969	449.094	23 km	852.533 m	24 km	301.627 m
			824.697	79.166944											
IP- 37	664,758.000	300,860.000			16.905517	16	54	19.9	1,000.0	148.608	295.057	24 km	736.747 m	25 km	31.804 m
			850.774	96.072462											
IP- 38	665,604.000	300,770.000			35.430986	35	25	51.6	100.0	31.944	61.839	25 km	702.026 m	25 km	763.864 m
			2,376.768	131.503448											
IP- 39	667,384.000	299,195.000			47.033421	47	2	0.3	500.0	217.579	410.444	27 km	891.109 m	28 km	301.552 m
			757.526	84.470027											
IP- 40	668,138.000	299,268.000			38.032468	38	1	56.9	500.0	172.322	331.896	28 km	669.176 m	29 km	1.072 m
			1,686.096	122.502495											
IP- 41	669,560.000	298,362.000			43.863321	43	51	48.0	250.0	100.660	191.390	30 km	414.186 m	30 km	605.576 m
			883.307	78.639174											
IP- 42	670,426.000	298,536.000			56.837822	56	50	16.2	250.0	135.281	248.002	31 km	252.943 m	31 km	500.944 m
			301.569	21.801352											
IP- 43	670,538.000	298,816.000			59.925776	59	55	32.8	150.0	86.473	156.885	31 km	580.759 m	31 km	737.645 m
			340.544	81.727127											
IP- 44	670,875.000	298,865.000			22.096498	22	5	47.4	500.0	97.627	192.828	31 km	894.088 m	32 km	86.916 m
			849.608	103.823625											
IP- 45	671,700.000	298,662.000			15.974132	15	58	26.9	1,000.0	140.311	278.801	32 km	698.587 m	32 km	977.388 m
			1,225.863	87.849494											
IP- 46	672,925.000	298,708.000			50.210616	50	12	38.2	500.0	234.273	438.170	33 km	828.667 m	34 km	266.837 m
			447.040	37.638878											
IP- 47	673,198.000	299,062.000			74.162550	74	9	45.2	150.0	113.367	194.157	34 km	366.237 m	34 km	560.394 m
			420.043	111.801428											
IP- 48	673,588.000	298,906.000			29.213081	29	12	47.1	250.0	65.151	127.466	34 km	801.920 m	34 km	929.386 m
			282.105	82.586659											
BP.of div. structure	673,867.747	298,942.399												35 km	146.340 m
EP.of div. structure	673,899.311	298,947.817												35 km	178.340 m
			15.000	82.588347											
IP- 49	673,914.186	298,949.752			25.732113	25	43	55.6	50.0	11.420	22.455	35 km	181.920 m	35 km	204.376 m
			207.334	56.856234											
EP of KSCS I	674,087.787	299,063.110												35 km	400.289 m

Table 7 WATER LEVELS IN CIUYAH TUNNEL AND KSCS I

(1) Design Condition

Design discharge	12.40 m3/s
Waterway slope	1/5,000
Manning's roughness coefficient	
Tunnel	0.014
Canal and Syphon	0.015

(2) Water Level

No.	Location		Acc. Length (m)	Length (m)	Loss (m)	Water level (EL.m)
1. Karian reservoir						
	FWL					69.90
	NHWL					67.00
	LWL					46.00
2. Ciuyah Tunnel						
	Inlet at LWL		-1,179.8			46.00
	Tunnel				0.40	
	Outlet/BP of KSCS I		0.0			45.60
3. KSCS I						
	BP-Syphon No.1		750.0			
	Syphon No.1	BP	680.7	680.7	0.14	45.46
		EP	819.4		0.13	45.33
	Syphon No.1-No.2		11,920.0			
		BP	11,867.7	11,048.3	2.21	43.12
		EP	11,999.3		0.14	42.98
	Syphon No.2-No.3		13,250.0			
		BP	13,156.4	1,157.1	0.24	42.74
		EP	13,457.4		0.26	42.48
	Syphon No.3-Division Pool		19,900.0			
		BP	19,858.6	6,401.2	1.29	41.19
		EP	19,900.0		0.07	41.12
	Division Pool-Syphon No.4		24,190.0			
		BP	24,138.5	4,238.5	0.85	40.27
		EP	24,242.0		0.05	40.22
	Syphon No.4-No.5		30,100.0			
		BP	30,026.5	5,784.5	1.16	39.06
		EP	30,195.0		0.09	38.97
	Syphon No.5-No.6		32,440.0			
		BP	32,383.7	2,188.7	0.44	38.53
		EP	32,500.7		0.06	38.47
	Syphon No.7-No.7		35,350.0			
		BP	35,303.8	2,803.1	0.57	37.90
		EP	35,385.8		0.05	37.85
Total					8.15	37.85

Energy at EP of KSCSS I	v=6.2/3.75/1.9=	0.87 m/s
	hv=v^2/2g=	0.04 m
	E=WL+hv=	37.89 m (=38.00 m)

Table 8 COORDINATE OF KSCS III

No.	IP X	IP Y	IP Distance (m)	Azimuth (deg)	IA (deg)	IA (deg)	IA (min)	IA (sec)	Element of Curve R (m)	Element of Curve TL (m)	Element of Curve CL (m)	Accumulative distance BC (km)		Accumulative distance EC (km)	
BP of KSCS III	674,027.632	298,976.655												35 km	302.948 m
			51.002	56.853610											
IP- 50	674,070.335	299,004.542			22.406163	22	24	22.2	11.0	2.179	4.302	35 km	351.772 m	35 km	356.073 m
			38.101	34.447447											
IP- 51	674,091.887	299,035.962			22.546035	22	32	45.7	11.0	2.193	4.329	35 km	389.803 m	35 km	394.132 m
			64.000	56.993481											
IP- 52	674,145.558	299,070.825			25.070087	25	4	12.3	11.0	2.446	4.813	35 km	453.493 m	35 km	458.307 m
			58.999	31.923395											
IP- 53	674,176.756	299,120.901			25.069899	25	4	11.6	11.0	2.446	4.813	35 km	512.415 m	35 km	517.228 m
			585.786	56.993294											
IP- 54	674,668.000	299,440.000			33.006706	33	0	24.1	250.0	74.069	144.019	36 km	26.498 m	36 km	170.517 m
			554.000	90.000000											
IP- 55	675,222.000	299,440.000			63.030296	63	1	49.1	200.0	122.633	220.017	36 km	527.815 m	36 km	747.832 m
			886.399	153.030296											
IP- 56	675,624.000	298,650.000			56.518650	56	31	7.1	250.0	134.382	246.609	37 km	377.217 m	37 km	623.826 m
			1,992.856	96.511646											
IP- 57	677,604.000	298,424.000			23.903851	23	54	13.9	1,000.0	211.680	417.201	39 km	270.620 m	39 km	687.821 m
			2,328.454	72.607795											
IP- 58	679,826.000	299,120.000			9.734574	9	44	4.5	2,500.0	212.888	424.751	41 km	591.708 m	42 km	16.459 m
			912.360	62.873221											
IP- 59	680,638.000	299,536.000			20.378354	20	22	42.1	1,000.0	179.733	355.669	42 km	536.197 m	42 km	891.866 m
			905.962	42.494867											
IP- 60	681,250.000	300,204.000			53.923925	53	55	26.1	50.0	25.434	47.057	43 km	592.661 m	43 km	639.719 m
			161.009	96.418792											
IP- 61	681,410.000	300,186.000			82.761214	82	45	40.4	50.0	44.051	72.223	43 km	731.243 m	43 km	803.465 m
			220.227	13.657578											
IP- 62	681,462.000	300,400.000			73.394833	73	23	41.4	75.0	55.898	96.074	43 km	923.744 m	44 km	19.817 m
			738.978	87.052411											
IP- 63	682,200.000	300,438.000			16.879591	16	52	46.5	1,000.0	148.377	294.604	44 km	554.520 m	44 km	849.124 m
			1,067.268	70.172821											
IP- 64	683,204.000	300,800.000			12.405996	12	24	21.6	1,000.0	108.688	216.525	45 km	659.327 m	45 km	875.853 m
			479.971	57.766825											
IP- 65	683,610.000	301,056.000			81.833313	81	49	59.9	100.0	86.674	142.826	46 km	160.462 m	46 km	303.288 m
			246.868	139.600138											
IP- 66	683,770.000	300,868.000			41.206717	41	12	24.2	100.0	37.594	71.919	46 km	425.889 m	46 km	497.808 m
			142.014	180.806854											
IP- 67	683,768.000	300,726.000			63.378090	63	22	41.1	25.0	15.434	27.654	46 km	586.795 m	46 km	614.448 m
			178.011	117.428764											
IP- 68	683,926.000	300,644.000			10.660041	10	39	36.1	250.0	23.324	46.513	46 km	753.702 m	46 km	800.215 m
			94.021	128.088805											
IP- 69	684,000.000	300,586.000			26.021026	26	1	15.7	75.0	17.330	34.061	46 km	853.583 m	46 km	887.644 m
			296.554	102.067779											
EP of KSCS III	684,290.000	300,524.000			102.067779	102	4	4.0				47 km	166.868 m	47 km	166.868 m

Table 9 HYDRAULIC CALCULATION FOR KSCS III

(1) Design Condition

Design discharge	6.00 m3/s
Internal Dianeter	2.20 m
Manning's roughness coefficient	
Steel Pipe	0.012
Concrete Pipe	0.014
Flow area	3.80 m2
Verocity	1.58 m/s

(2) Pipe Length and Head Loss

No.	Horiz. Dis (m)	El. (m)	Actual Dis.(m)	Steel Pipe (m)	R. C. Pipe (m)	Bending (nos.)	Fliction loss(m)	Bending loss(m)	Head (El. m)
0		36.64							64.500
1	50	29.20	50.6	50.6		2	0.040	0.014	64.445
2	150	48.50	151.2	151.2		6	0.121	0.043	64.282
3	50	48.50	50.0	50.0			0.040	0.000	64.242
4	440	48.50	440.0		440.00	1	0.477	0.007	63.758
5	20	45.00	20.3		20.30	1	0.022	0.007	63.729
6	1,260	45.00	1,260.0		1260.00	1	1.367	0.007	62.354
7	150	51.00	150.1		150.12	1	0.163	0.007	62.184
8	420	53.00	420.0		420.00	1	0.456	0.007	61.721
9	880	53.00	880.0		880.00	1	0.955	0.007	60.759
10	340	60.00	340.1		340.07	1	0.369	0.007	60.383
11	840	60.00	840.0		840.00	1	0.912	0.007	59.464
12	1,070	59.50	1,070.0		1070.00	1	1.161	0.007	58.296
13	30	62.50	30.1		30.15	2	0.033	0.014	58.249
14	30	59.50	30.1	30.1		1	0.024	0.007	58.218
15	350	59.50	350.0		350.00	1	0.380	0.007	57.831
16	30	62.50	30.1		30.15	2	0.033	0.014	57.784
17	30	59.50	30.1	30.1		1	0.024	0.007	57.753
18	970	59.50	970.0		970.00	1	1.053	0.007	56.693
19	200	40.00	200.9		200.95	1	0.218	0.007	56.468
20	860	37.00	860.0		860.01	1	0.933	0.007	55.528
21	70	43.00	70.3		70.26	1	0.076	0.007	55.444
22	360	43.00	360.0		360.00	1	0.391	0.007	55.047
23	30	46.00	30.1		30.15	2	0.033	0.014	55.000
24	30	43.00	30.1	30.1		1	0.024	0.007	54.969
25	300	43.00	300.0		300.00	1	0.326	0.007	54.636
26	30	46.00	30.1		30.15	2	0.033	0.014	54.589
27	30	43.00	30.1	30.1		1	0.024	0.007	54.558
28	420	43.00	420.0		420.00	1	0.456	0.007	54.095
29	30	46.00	30.1		30.15	2	0.033	0.014	54.048
30	30	43.00	30.1	30.1		1	0.024	0.007	54.017
31	980	43.00	980.0		980.00	1	1.063	0.007	52.946
32	80	30.00	81.0		81.05	1	0.088	0.007	52.851
33	200	30.00	200.0	200.0		1	0.159	0.007	52.685
34	50	37.00	50.5	50.5		1	0.040	0.007	52.637
35	140	37.00	140.0	140.0		1	0.112	0.007	52.518
36	300	33.50	300.0	300.0		1	0.239	0.007	52.272
37	120	33.50	120.0	120.0		1	0.096	0.007	52.169
38	130	42.50	130.3	130.3		1	0.104	0.007	52.058
39	350	46.00	350.0	350.0			0.279	0.000	51.779
Total	11,850		11,857	1,693	10,164		12.379	0.342	

(3) Required Pumpup Height

Pipe center at Serpong WTP	46.0 El. m
Design water level at Serpong WTP	50.0 El. m
Head loss=(12.38 + 0.34)*1.1=12.72 *1.1 =	14.0 m
Velocity head at Serpong WTP	0.1 m
Required head by pumpup	64.1 El. m
Water level at EP of KSCS II	38.0 El. m
Required pumpup height	26.1 m
Design pumpup height	**26.5** m
Design head	**64.5** El. m

Table 10 COORDINATE OF CILAWANG CANAL

No.	IP X	IP Y	IP Distance (m)	Azimuth (deg)	IA (deg)	IA (deg)	IA (min)	IA (sec)	Element of Curve R (m)	TL (m)	CL (m)	Accumulative distance BC (km)		EC (km)	
BP of CWG cana	650,714.937	290,953.925												0 km	0.000 m
			197.000	5.552944											
IP- C1	650,734.000	291,150.000			91.285047	91	17	6.2	50.0	51.134	79.661	0 km	145.865 m	0 km	225.527 m
			134.373	274.267897											
IP- C2	650,600.000	291,160.000			71.797332	71	47	50.4	75.0	54.288	93.982	0 km	254.477 m	0 km	348.459 m
			274.066	346.065229											
IP- C3	650,534.000	291,426.000			27.970950	27	58	15.4	200.0	49.812	97.637	0 km	518.425 m	0 km	616.062 m
			148.432	14.036179											
IP- C4	650,570.000	291,570.000			59.036141	59	2	10.1	100.0	56.619	103.037	0 km	658.063 m	0 km	761.101 m
			246.073	315.000038											
IP- C5	650,396.000	291,744.000			90.666277	90	39	58.6	100.0	101.170	158.242	0 km	849.385 m	1 km	7.628 m
			243.261	224.333761											
IP- C6	650,226.000	291,570.000			64.460420	64	27	37.5	100.0	63.047	112.505	1 km	86.672 m	1 km	199.177 m
			403.515	288.794181											
IP- C7	649,844.000	291,700.000			64.662271	64	39	44.2	75.0	47.470	84.643	1 km	492.175 m	1 km	576.817 m
			186.698	224.131910											
IP- C8	649,714.000	291,566.000			76.770331	76	46	13.2	100.0	79.217	133.989	1 km	636.828 m	1 km	770.817 m
			319.331	300.902240											
IP- C9	649,440.000	291,730.000			49.708712	49	42	31.4	200.0	92.643	173.516	1 km	918.288 m	2 km	91.804 m
			252.834	350.610952											
IP- C10	649,398.753	291,979.447			42.777208	42	46	37.9	100.0	39.167	74.660	2 km	212.828 m	2 km	287.488 m
			39.167	33.388160											
Confluence with KSCS I	649,420.307	292,012.150							100.0			2 km	287.489 m	2 km	287.489 m

Table 11 COORDINATE OF TANJUNG CANAL

No.	IP X	IP Y	IP Distance (m)	Azimuth (deg)	IA (deg)	IA (deg)	IA (min)	IA (sec)	Element of Curve R (m)	TL (m)	CL (m)	Accumulative distance BC (km)		EC (km)	
BP of TJG canal	660,071.000	296,146.000												0 km	0.000 m
			92.962	328.190660											
IP- T1	660,022.000	296,225.000			51.991263	51	59	28.5	100.0	48.764	90.742	0 km	44.199 m	0 km	134.940 m
			248.798	20.181923											
IP- T2	660,107.836	296,458.522			17.218334	17	13	6.0	200.0	30.280	60.103	0 km	304.695 m	0 km	364.798 m
			390.000	2.963590											
IP- T3	660,128.000	296,848.000			10.307819	10	18	28.1	1,000.0	90.196	179.905	0 km	634.322 m	0 km	814.227 m
			453.722	352.655771											
IP- T4	660,070.000	297,298.000			82.655771	82	39	20.8	150.0	131.907	216.392	1 km	45.846 m	1 km	262.238 m
			384.000	270.000000											
IP- T5	659,686.000	297,298.000			79.037979	79	2	16.7	200.0	164.978	275.894	1 km	349.352 m	1 km	625.246 m
			452.252	349.037979											
IP- T6	659,600.000	297,742.000			19.872233	19	52	20.0	500.0	87.589	173.418	1 km	824.931 m	1 km	998.349 m
			477.766	8.910212											
IP- T7	659,674.000	298,214.000			58.791363	58	47	28.9	200.0	112.674	205.220	2 km	275.852 m	2 km	481.072 m
			515.228	310.118849											
IP- T8	659,280.000	298,546.000			16.081509	16	4	53.4	1,000.0	141.266	280.675	2 km	742.360 m	3 km	23.035 m
			932.901	294.037340											
IP- T9	658,428.000	298,926.000			39.827698	39	49	39.7	250.0	90.567	173.781	3 km	724.103 m	3 km	897.884 m
			464.585	333.865038											
IP- T10	658,223.356	299,343.085			32.954047	32	57	14.6	100.0	29.578	57.516	4 km	242.324 m	4 km	299.839 m
			29.578	6.819085											
Confluence with KSCS I	658,226.868	299,372.454										4 km	299.840 m	4 km	299.840 m

FIGURES

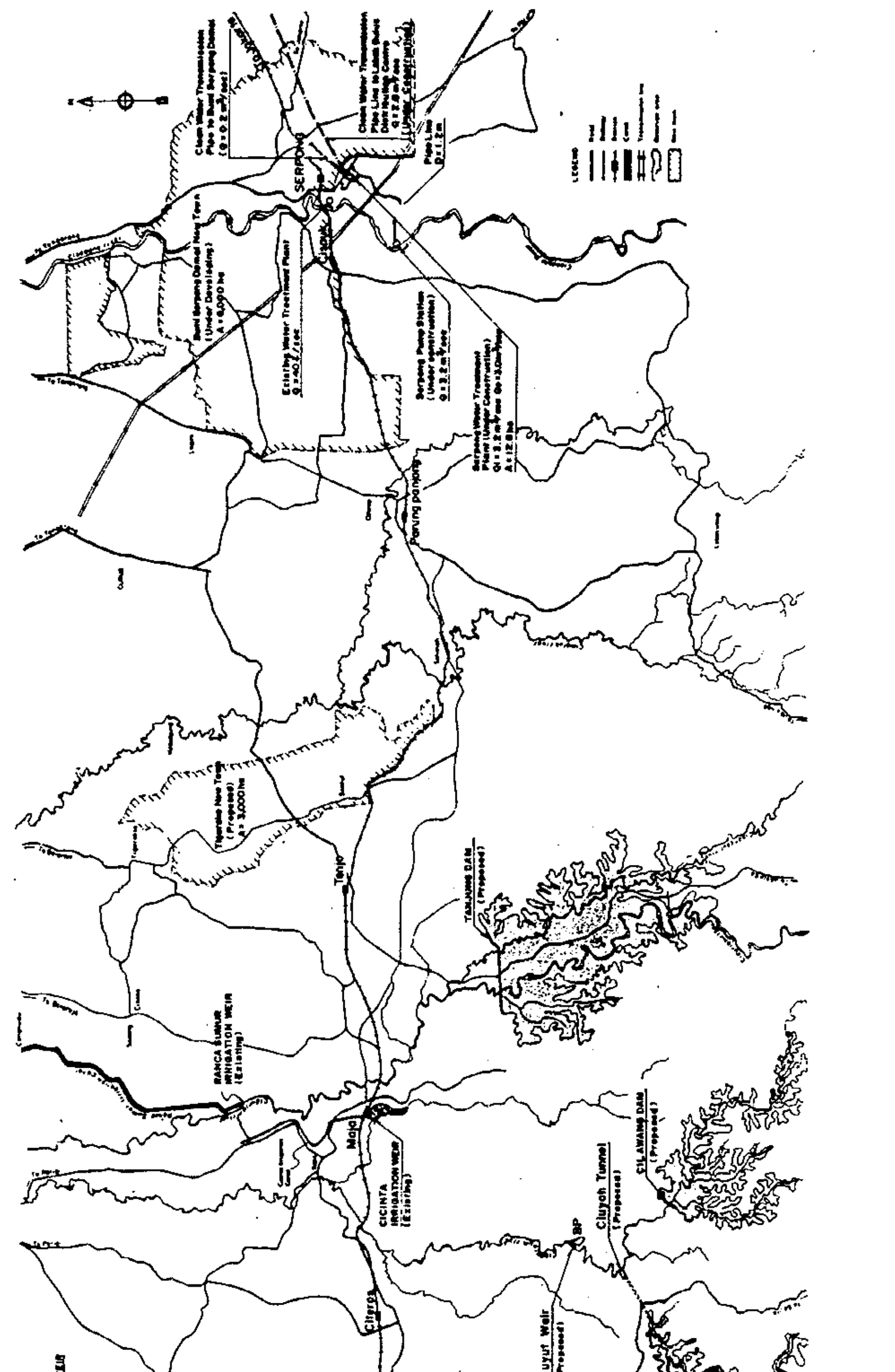


Figure 1 LOCATION MAP OF ENVISAGED WATER RESOURCES

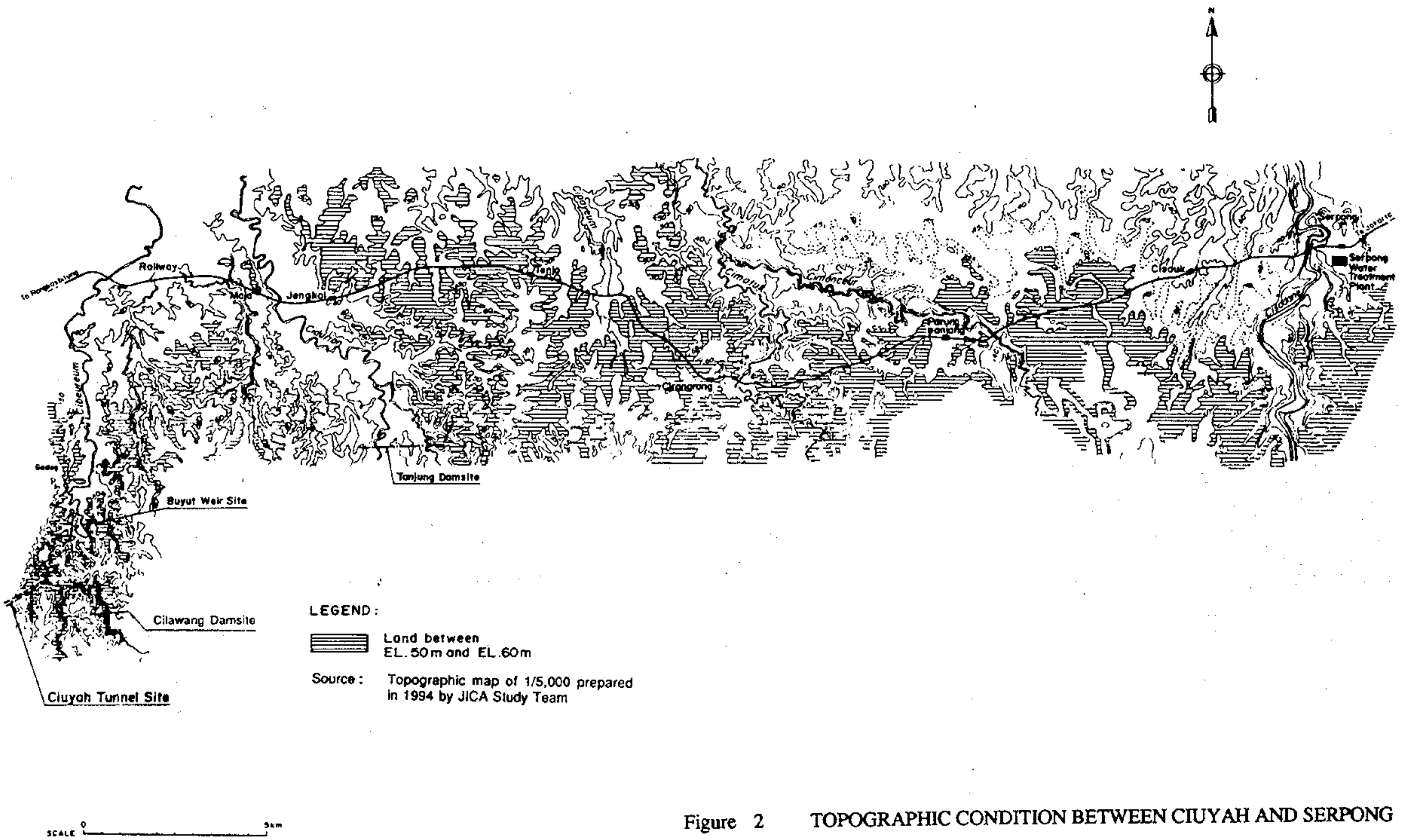


Figure 2 TOPOGRAPHIC CONDITION BETWEEN CIUYAH AND SERPONG

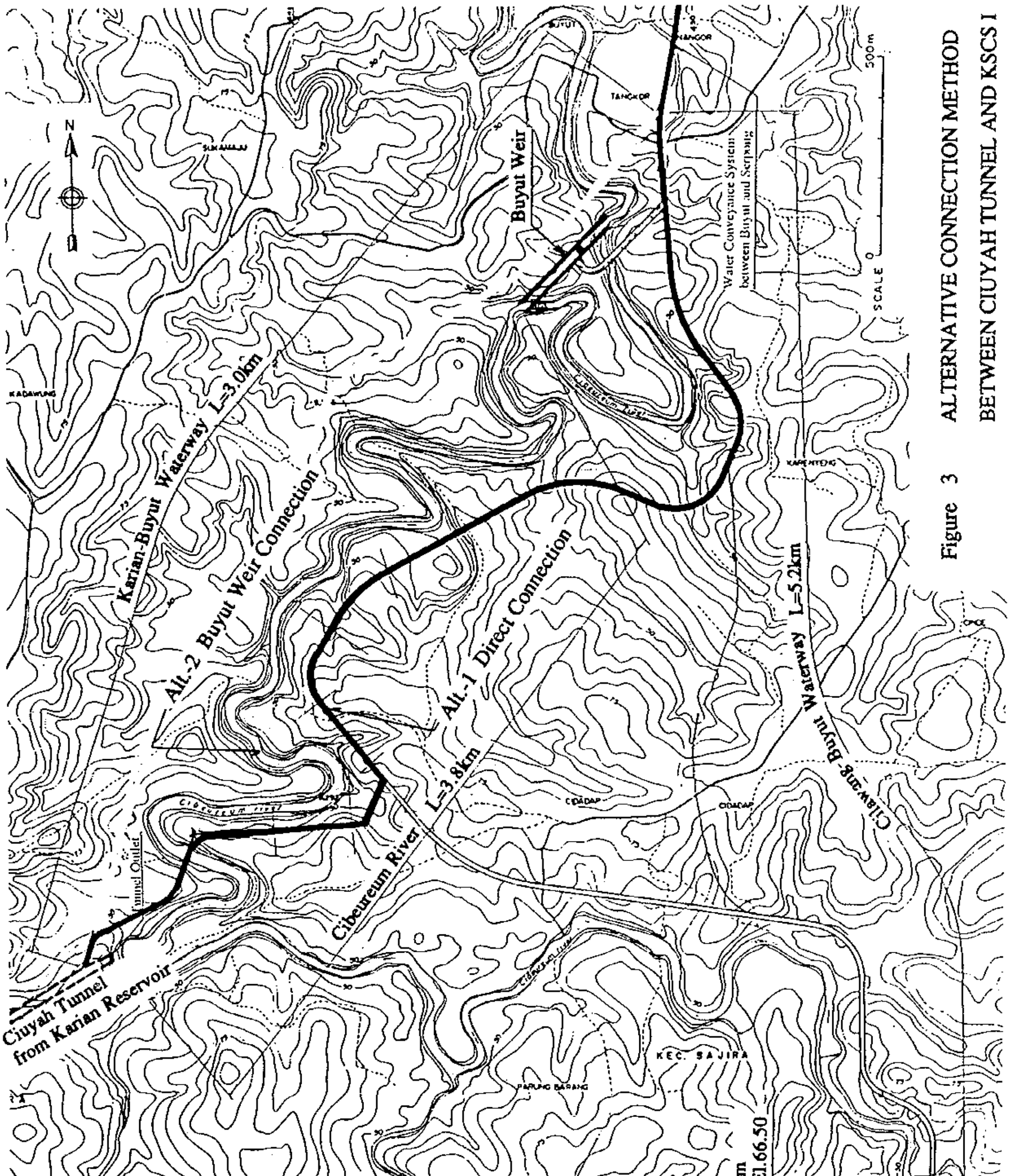


Figure 3 ALTERNATIVE CONNECTION METHOD BETWEEN CIUYAH TUNNEL AND KSCS I

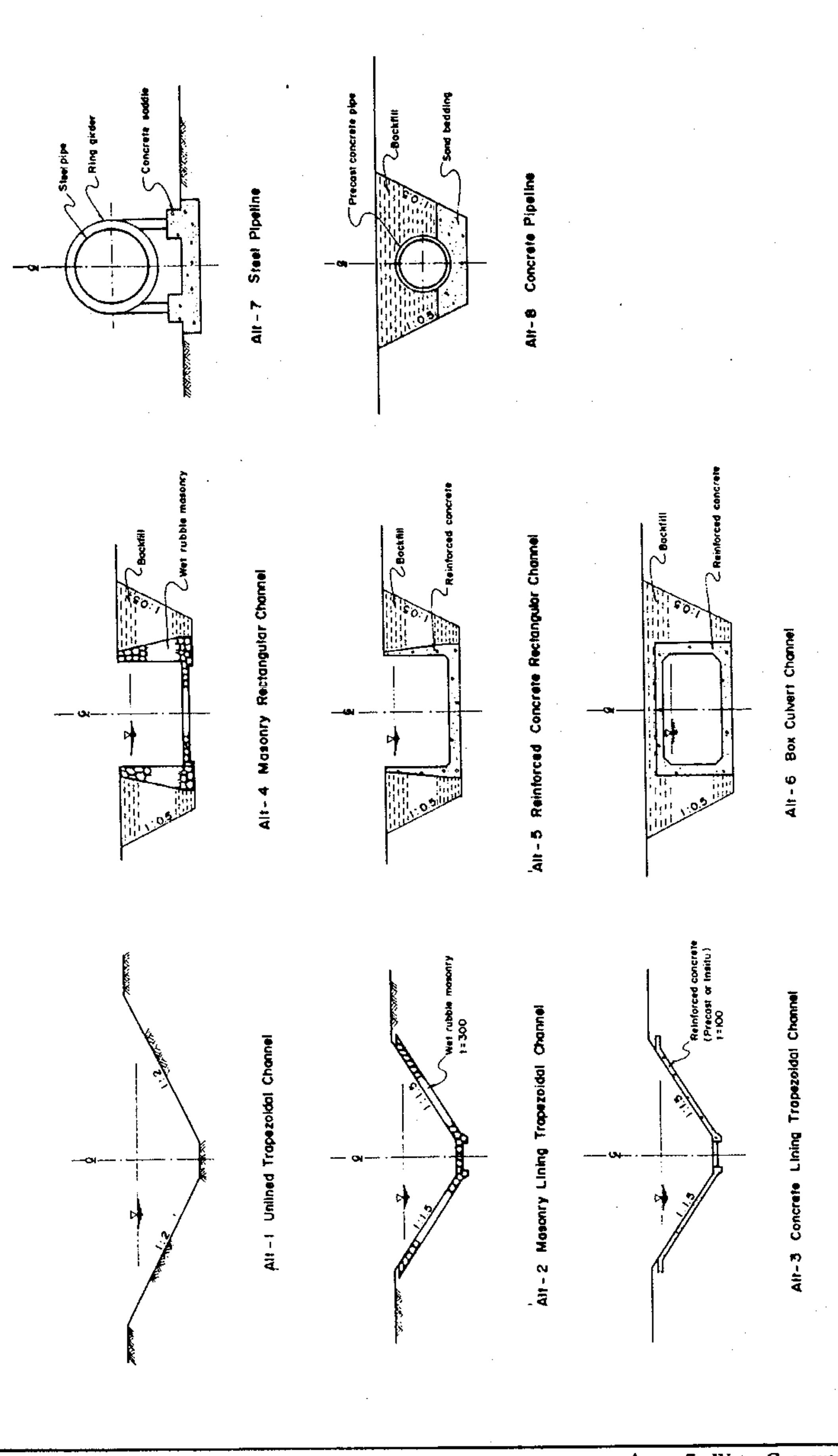


Figure 4 OPTIONS FOR WATER CONVEYANCE TYPES

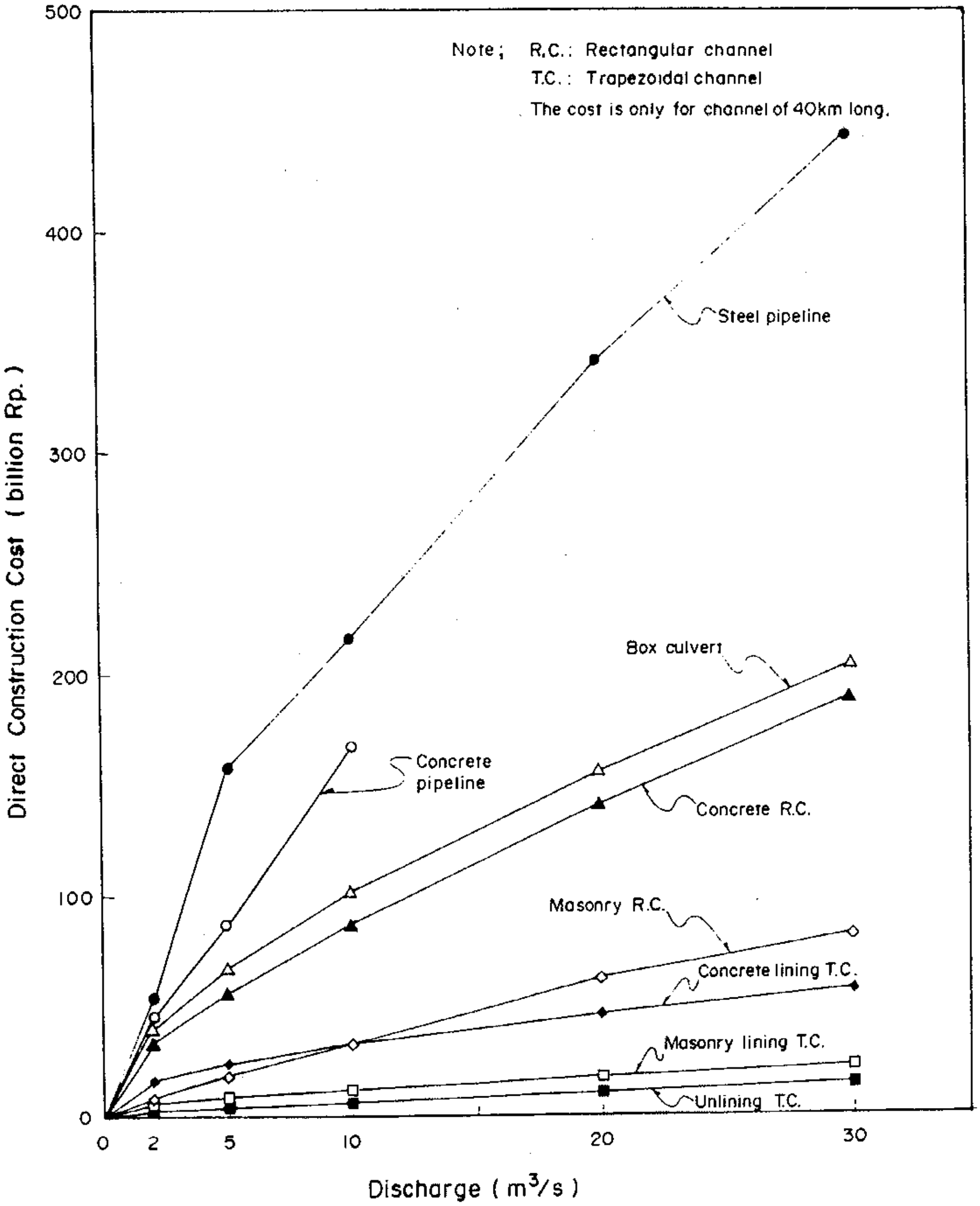


Figure 5 CONSTRUCTION COST COMPARISON AMONG WATERWAY TYPES

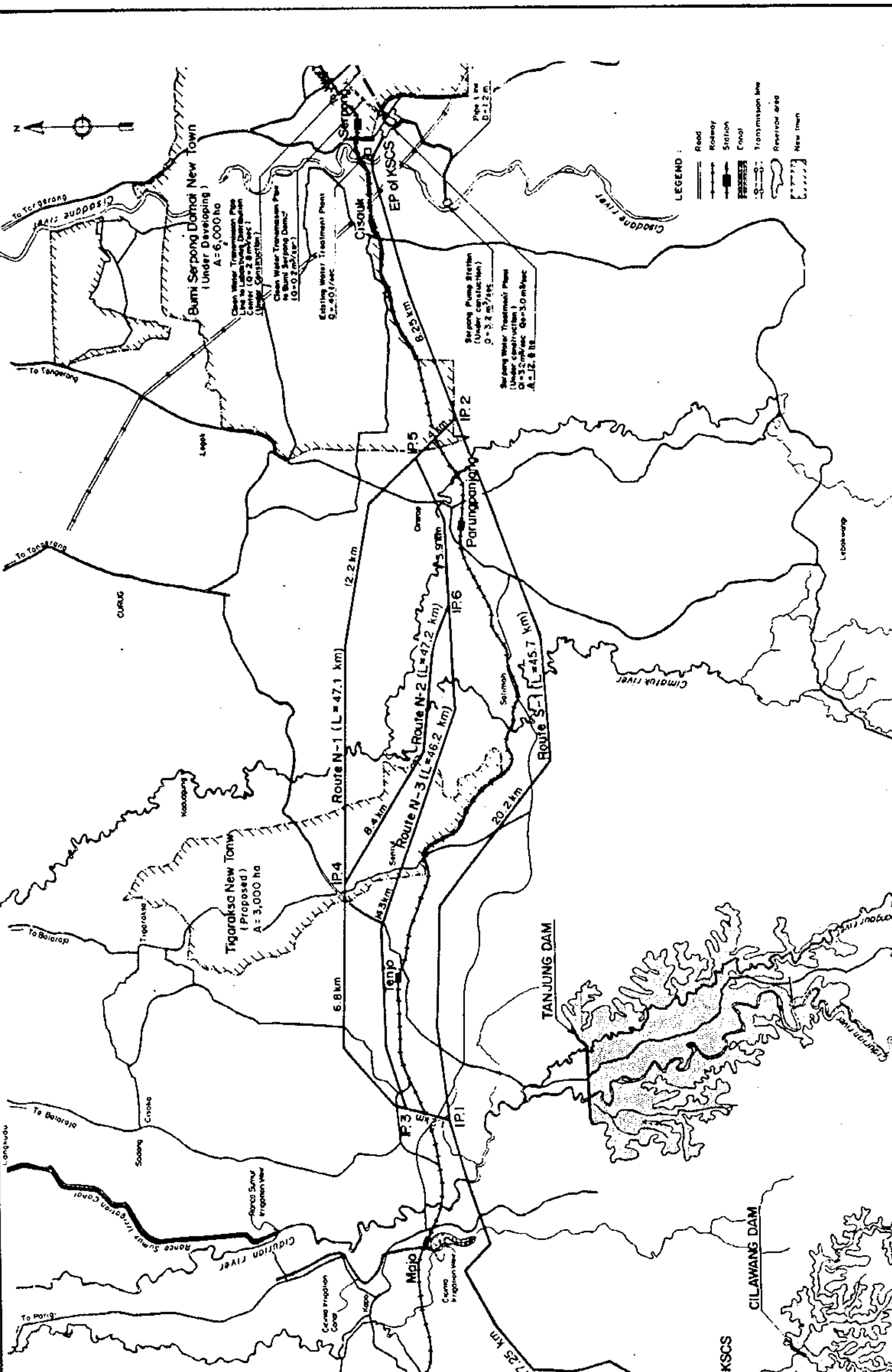


Figure 6 ALTERNATIVE ROUTES OF KARIAN SERPONG CONVEYANCE SYSTEM

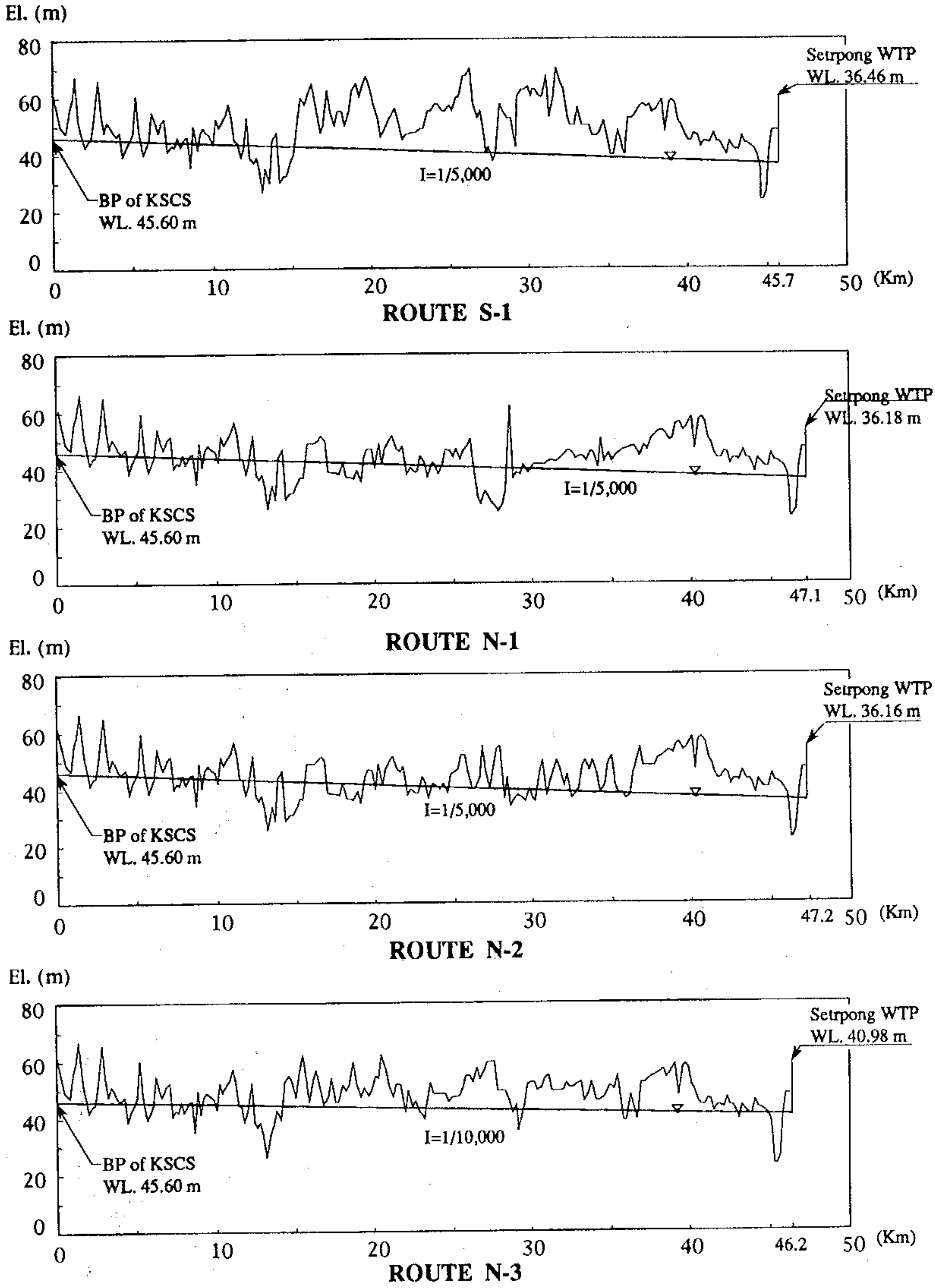


Figure 7 LONGITUDINAL PROFILE OF ALTERNATIVE ROUTES FOR KARIAN-SERPONG CONVEYANCE SYSTEM

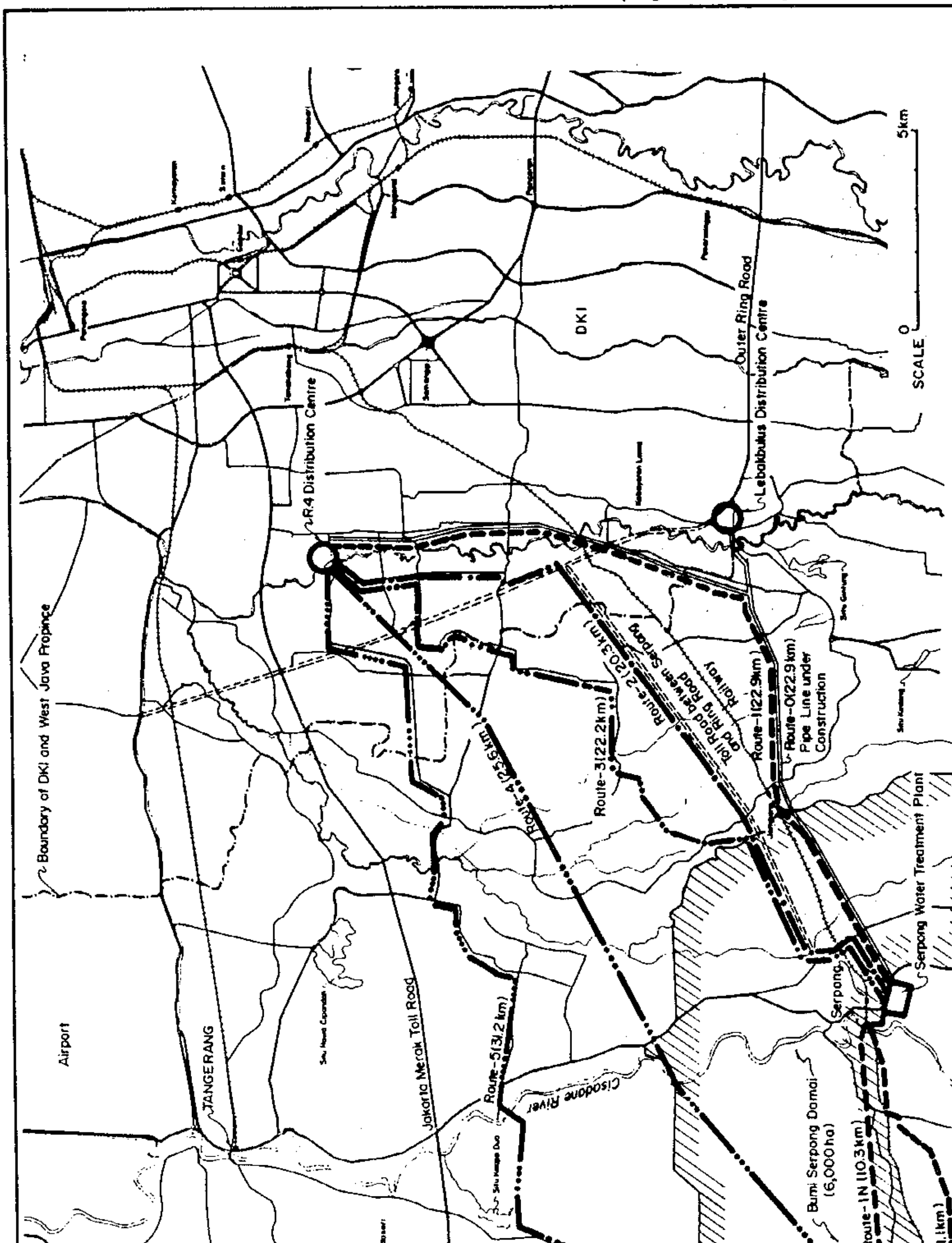
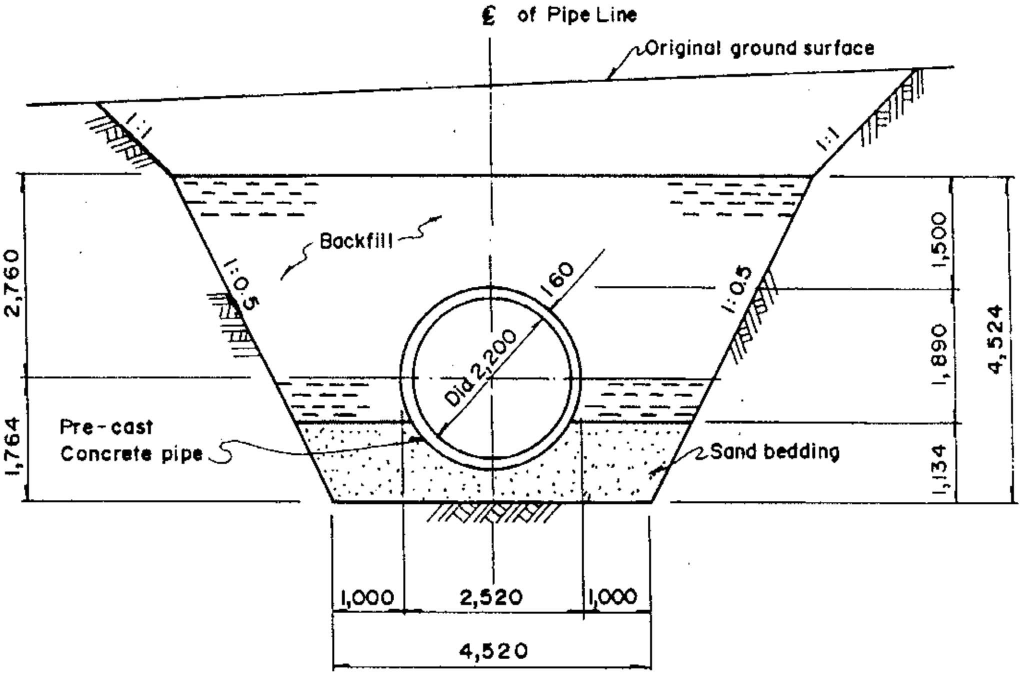
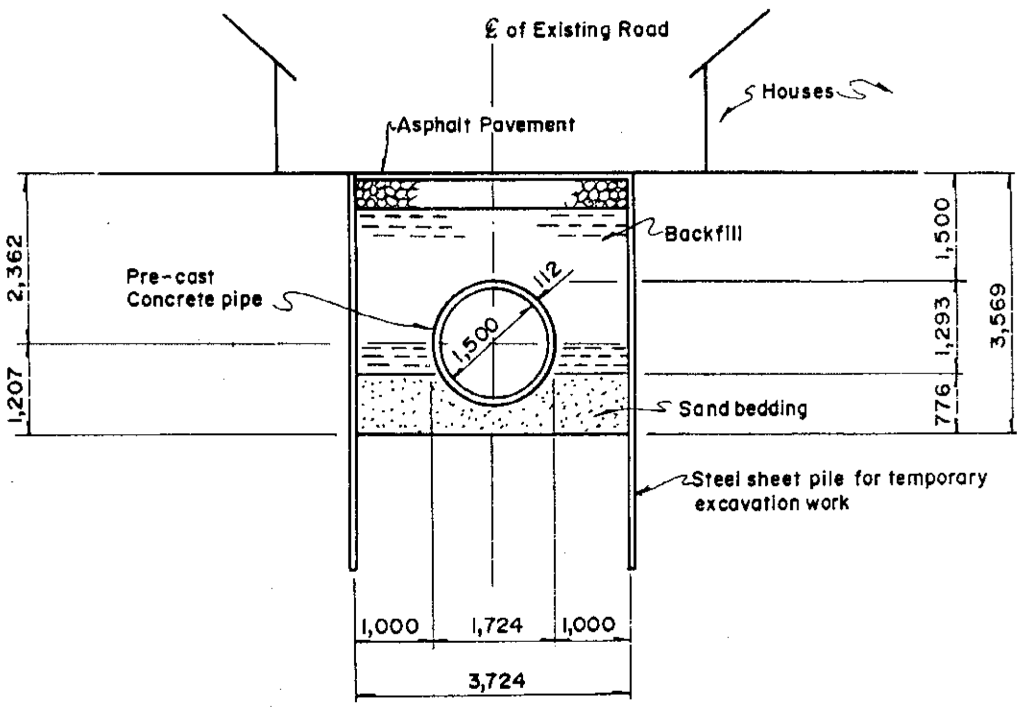


Figure 8 ALTERNATIVE WATERWAY ROUTES BETWEEN PARUNGPANJANG AND DKI JAKARTA



PIPE LINE BETWEEN PARUNGPANJANG AND SERPONG WTP ($Q=6\ m^3/sec$)



PIPE LINE TO BE CONSTRUCTED IN EXISTING ROADS ($Q=3\ m^3/sec$)

Figure 9 TYPICAL CROSS SECTION OF PIPELINE FOR PARUNGPANJANG AND DKI JAKARTA

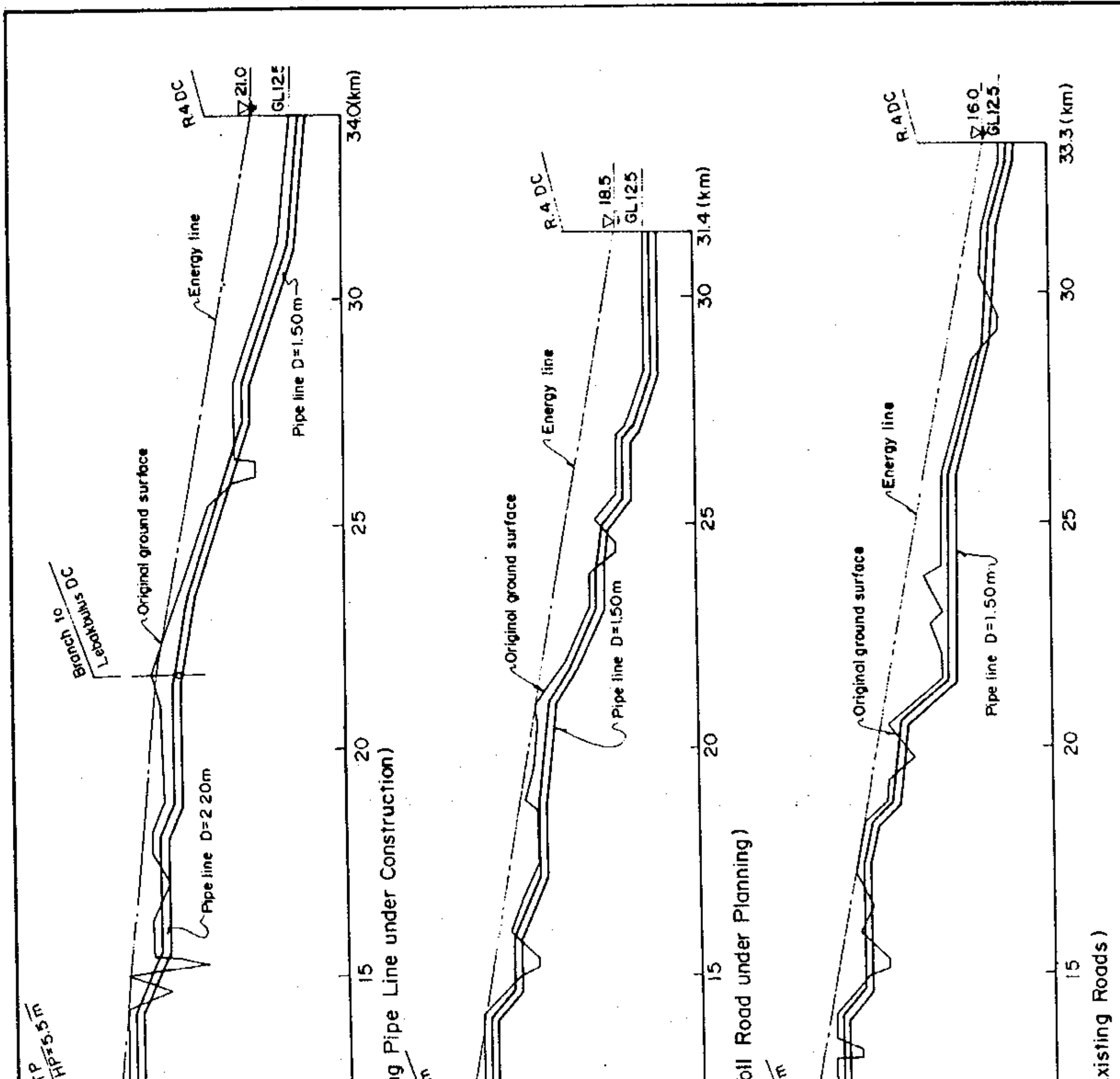


Figure 10 PIPELINE PROFILES BETWEEN PARUNGPANJANG AND DKI JAKARTA (1/2)

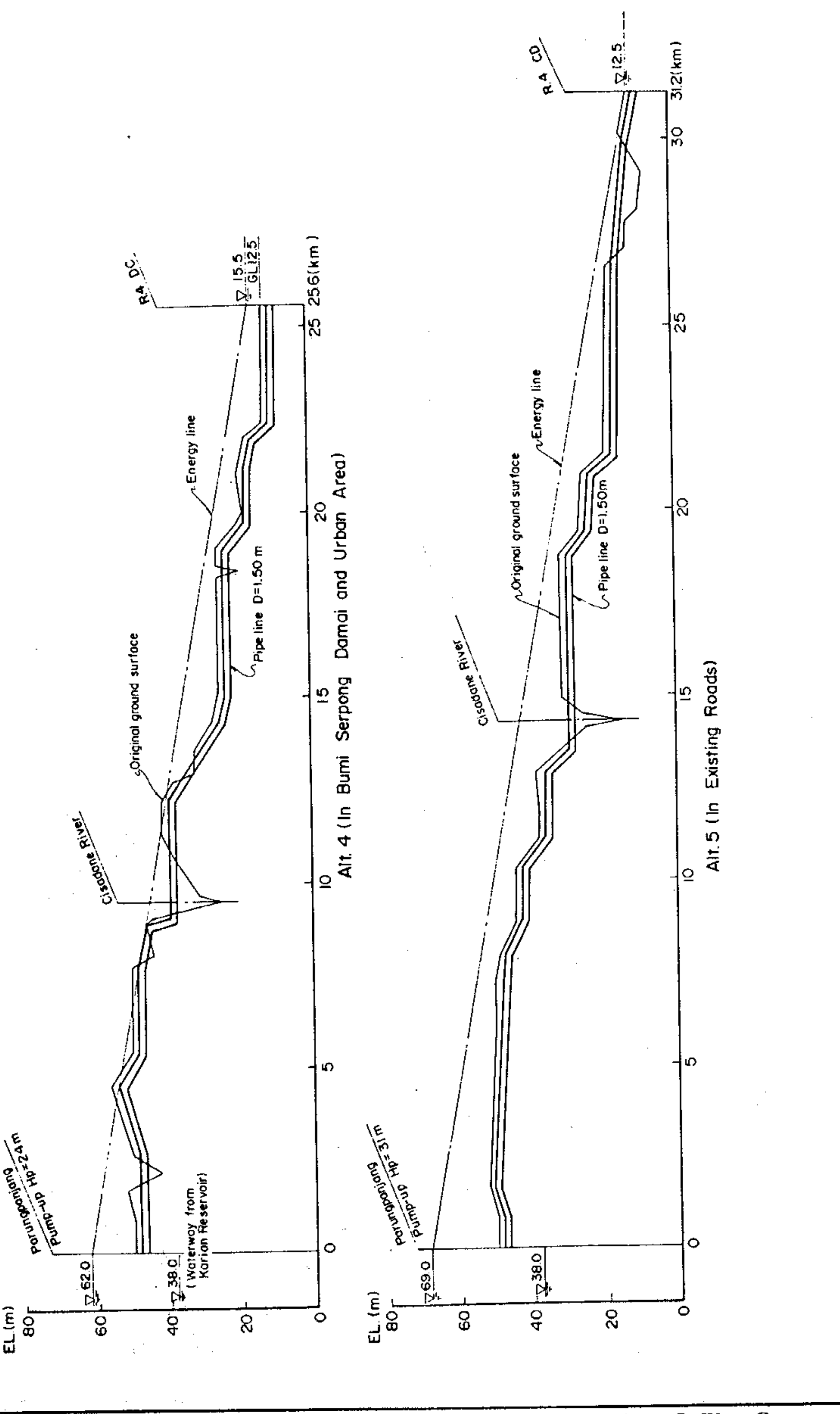


Figure 11 PIPELINE PROFILES BETWEEN PARUNGPANJANG AND DKI JAKARTA (2/2)

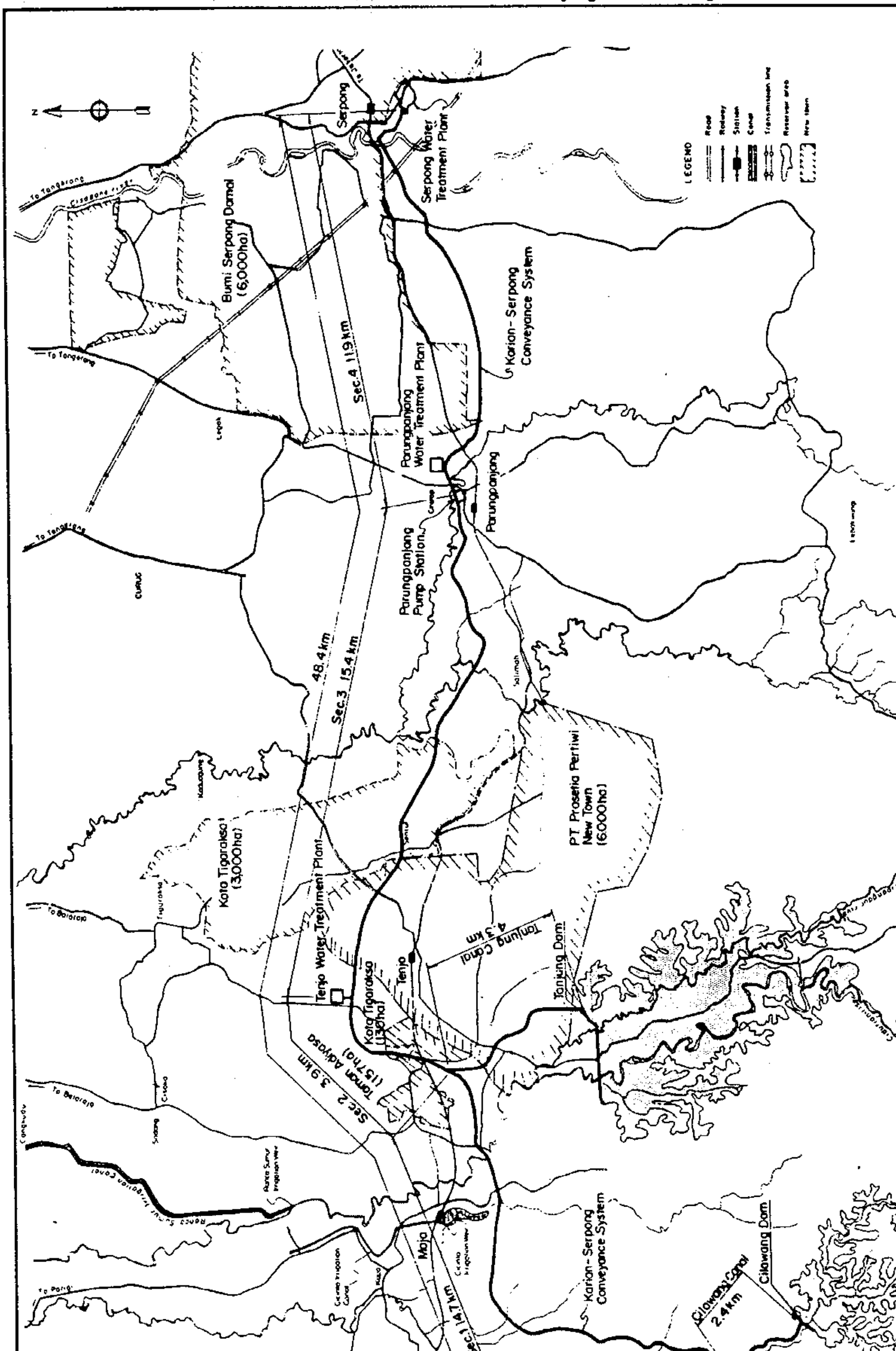


Figure 12 OPTIMUM ROUTE OF KARIAN SERPONG CONVEYANCE SYSTEM

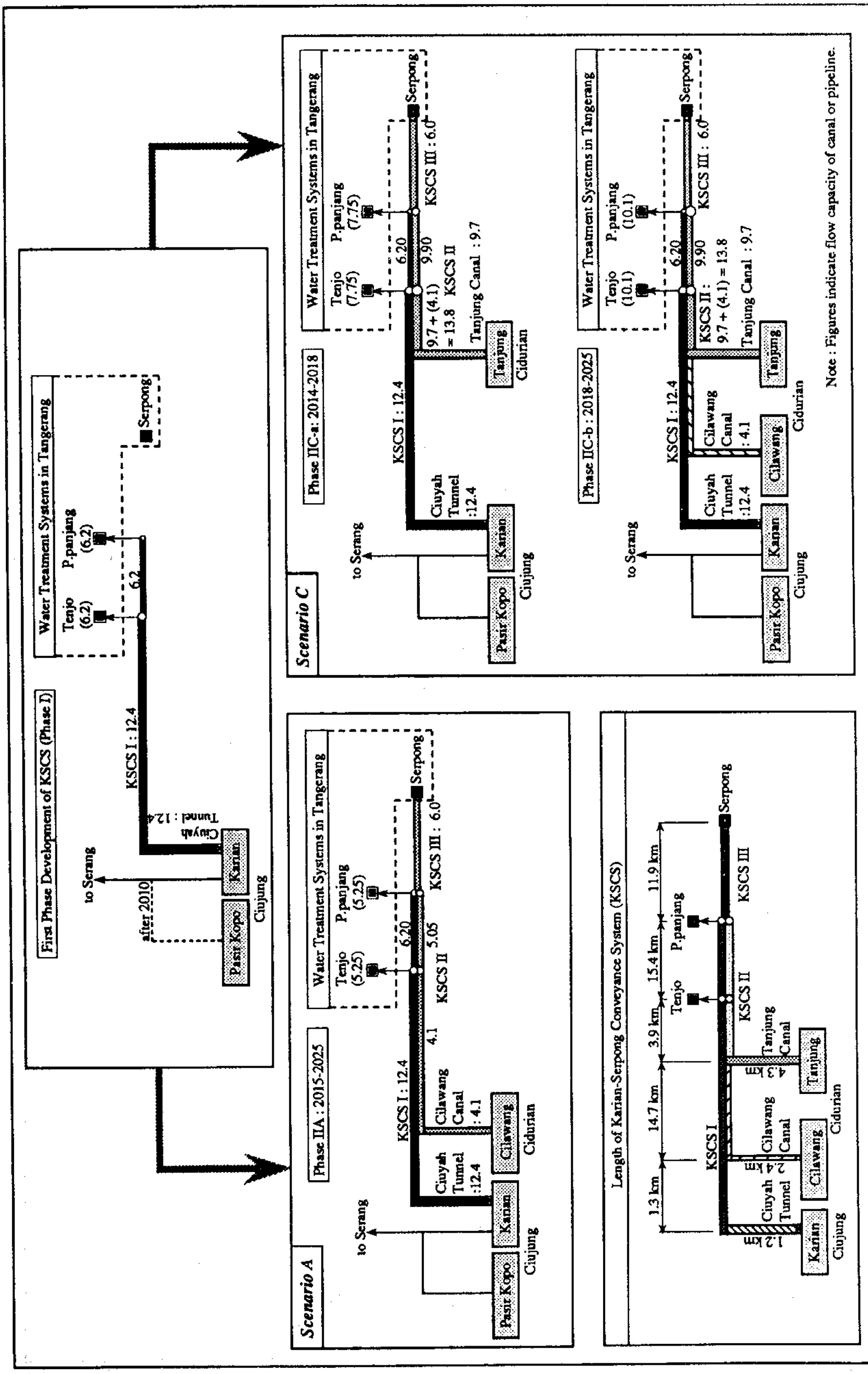


Figure 13 PROPOSED PHASING DEVELOPMENT PLAN OF KSCS

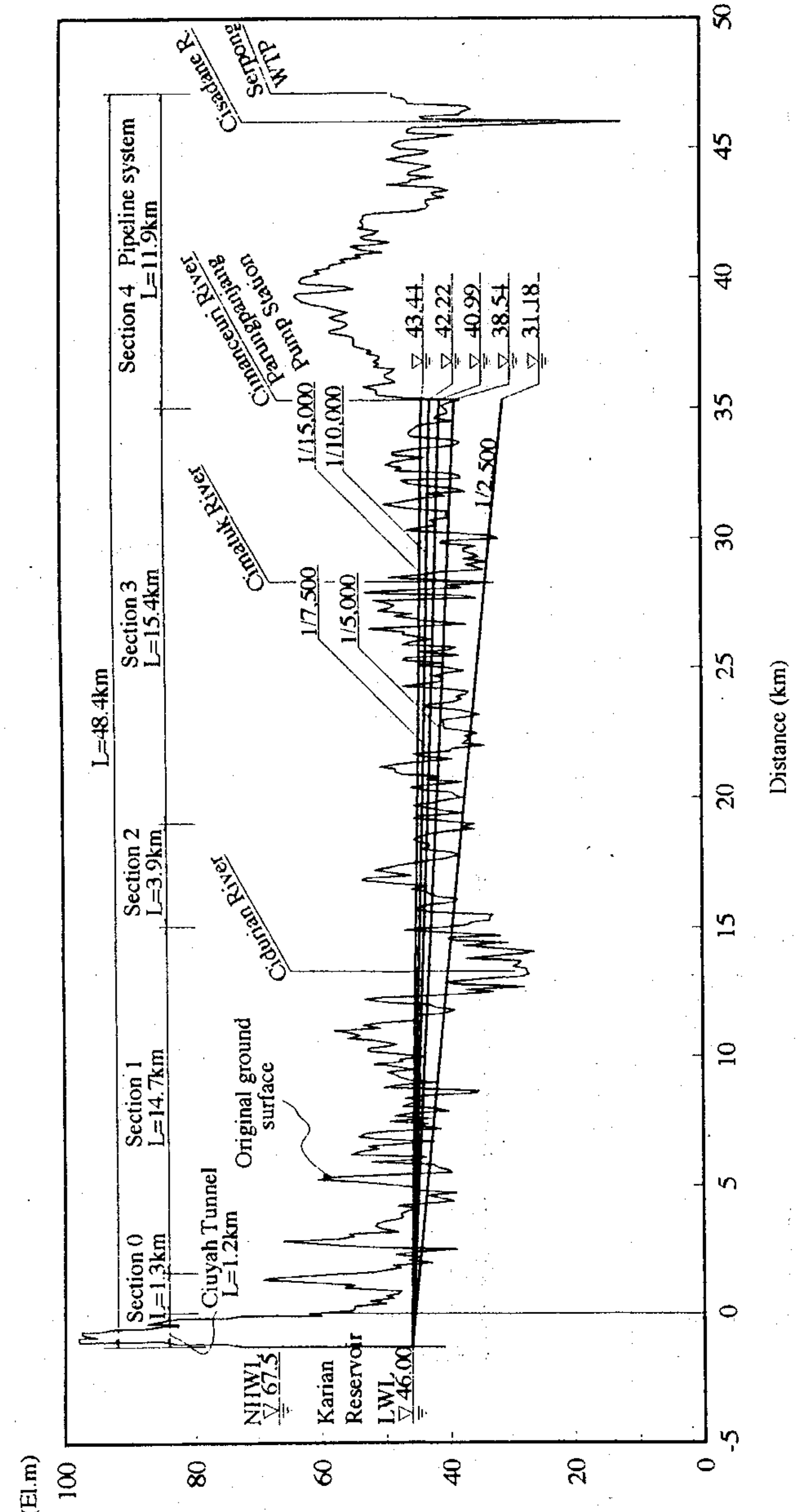


Figure 14 ALTERNATIVE WATERWAY BED SLOPE

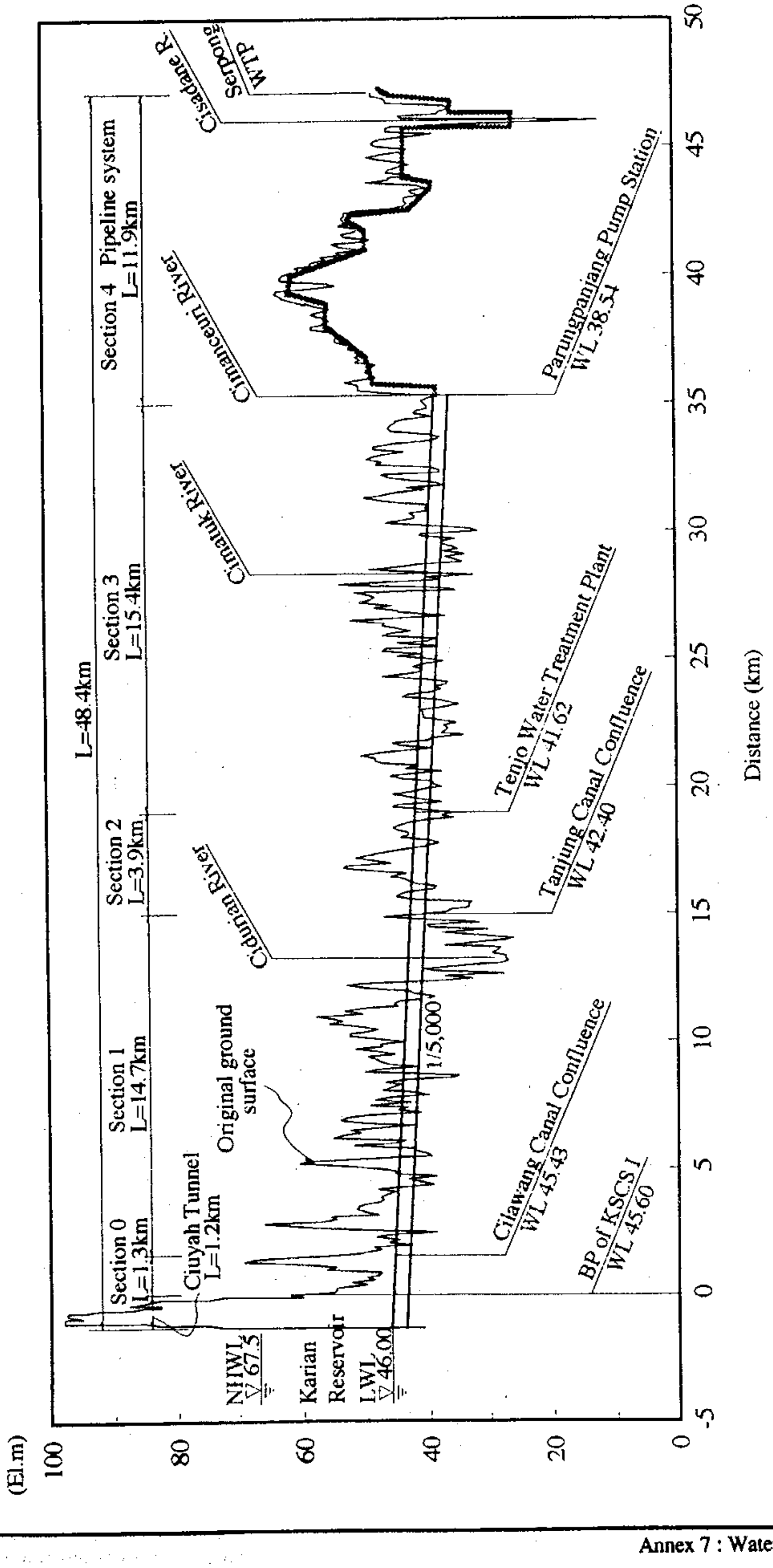


Figure 15 PROPOSED LONGITUDINAL PROFILE OF KSCS

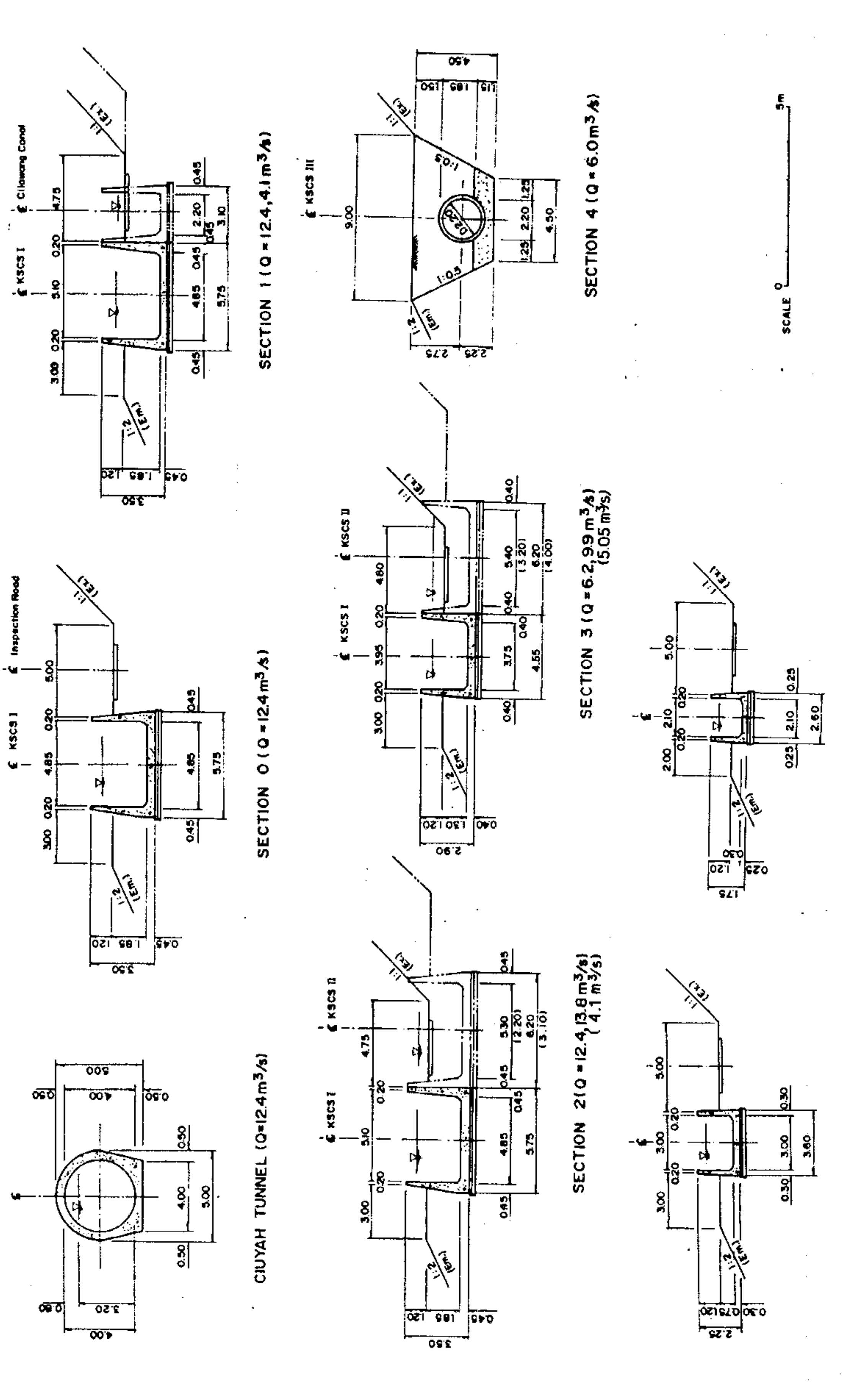


Figure 16 TYPICAL CROSS SECTIONS OF KSCS

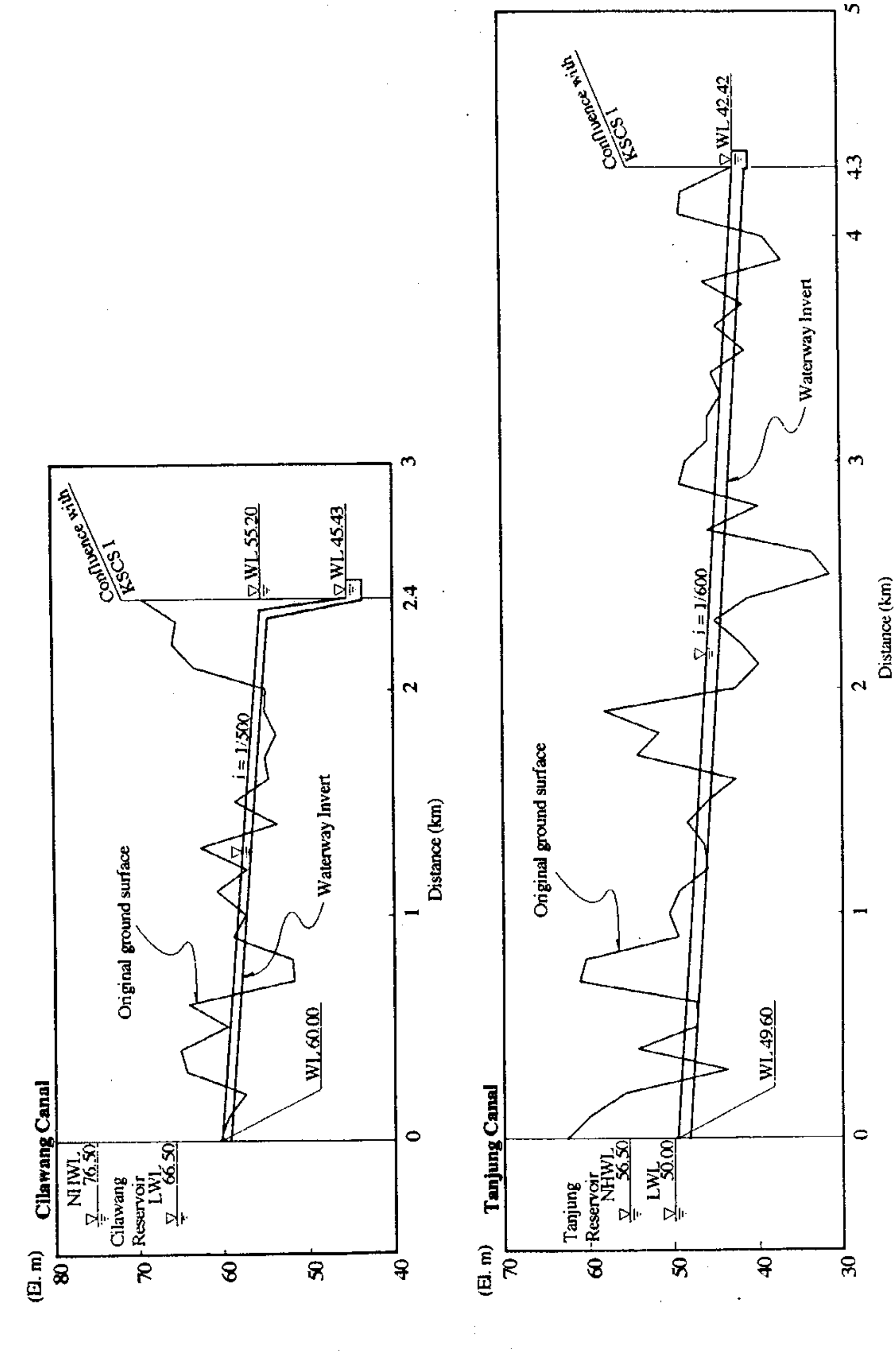


Figure 17 PROPOSED LONGITUDINAL PROFILE OF TANJUNG AND CILAWANG CANALS

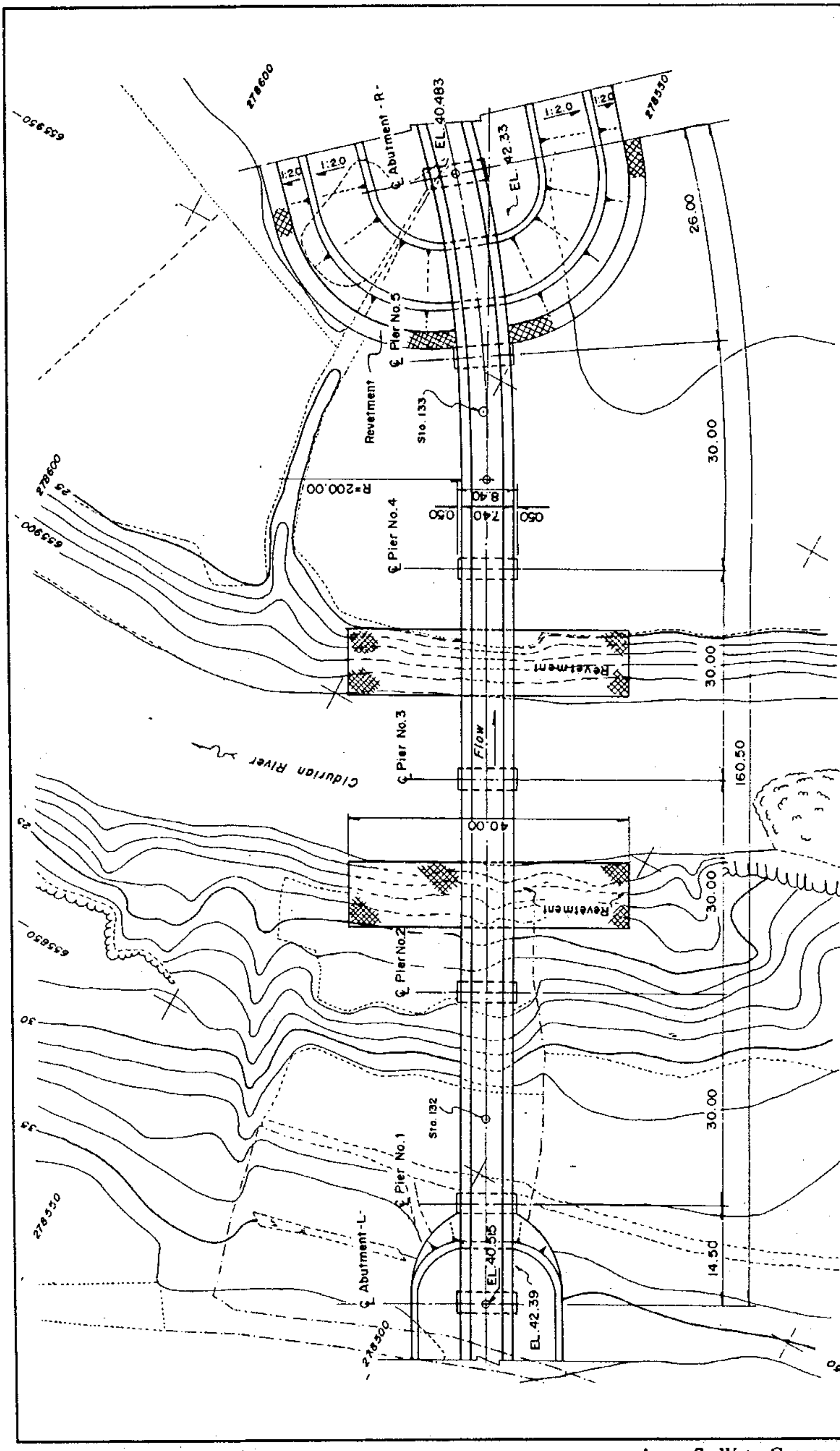


Figure 18 ALTERNATIVE 1 AQUEDUCT IN THE CIDURIAN RIVER (1/2)

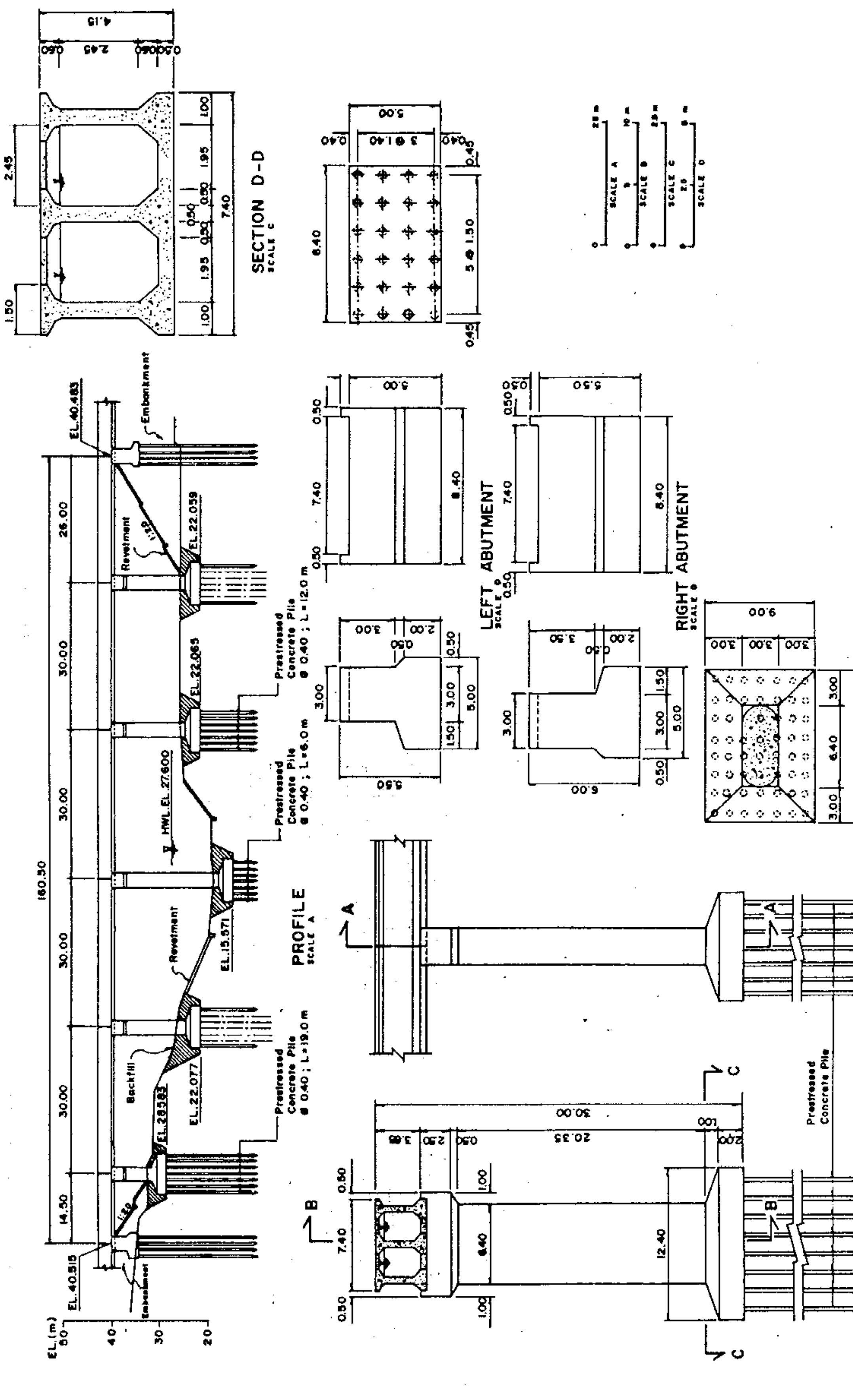


Figure 19 ALTERNATIVE 1 AQUEDUCT IN THE CIDURIAN RIVER (2/2)

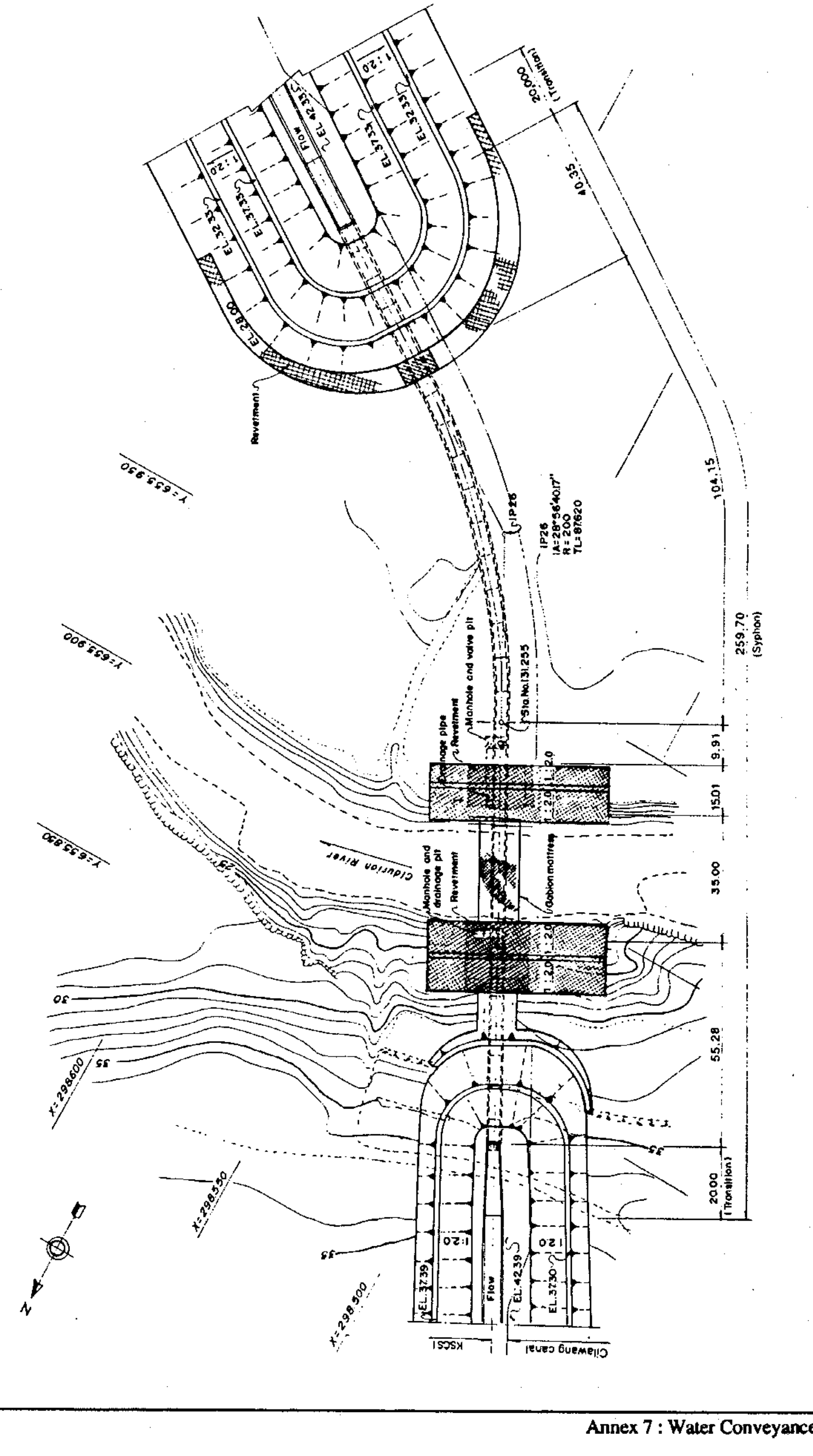


Figure 20 ALTERNATIVE 2 SYPHON IN THE CIDURIAN RIVER (1/2)

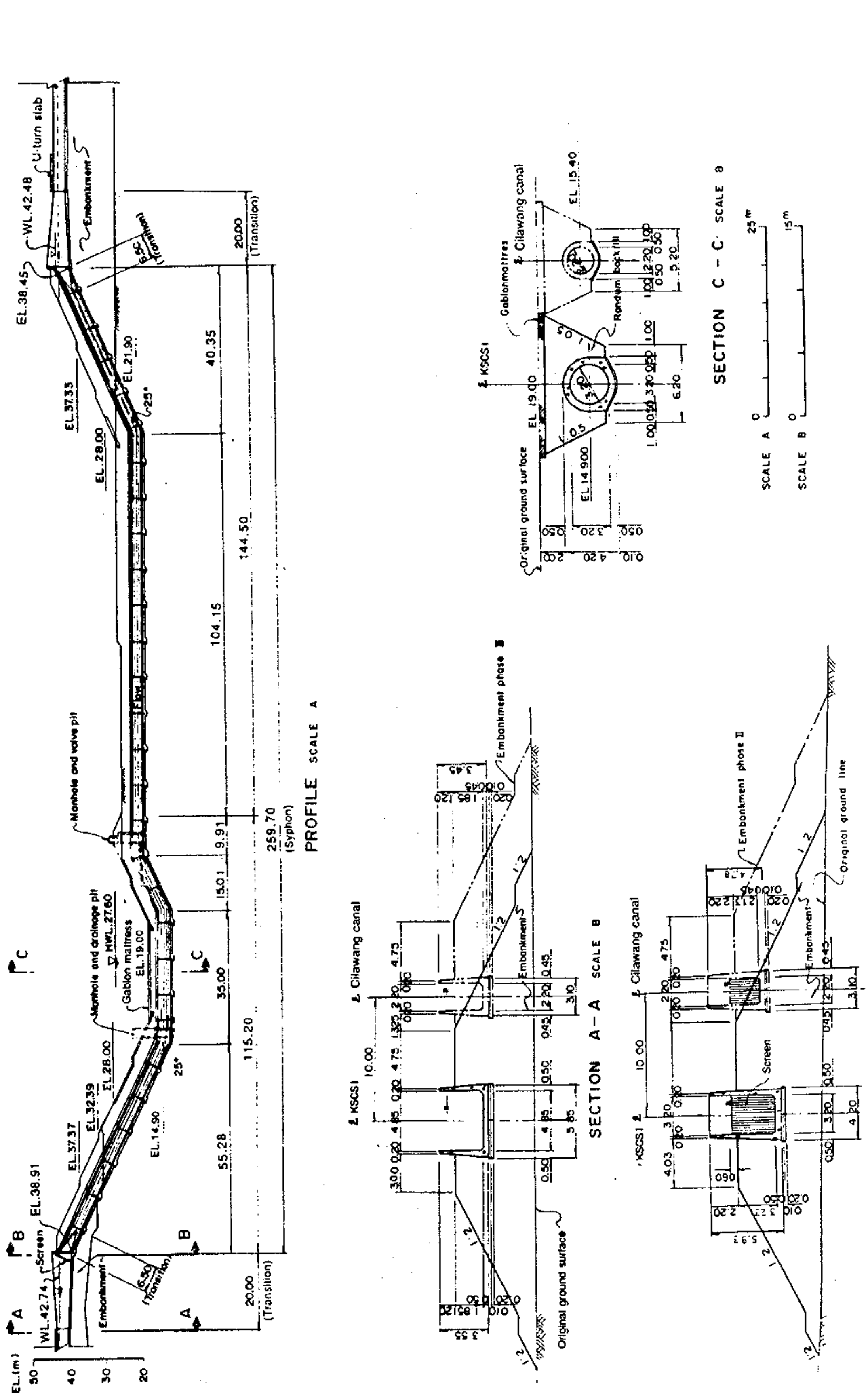


Figure 21 ALTERNATIVE 2 SYPHON IN THE CIDURIAN RIVER (2/2)

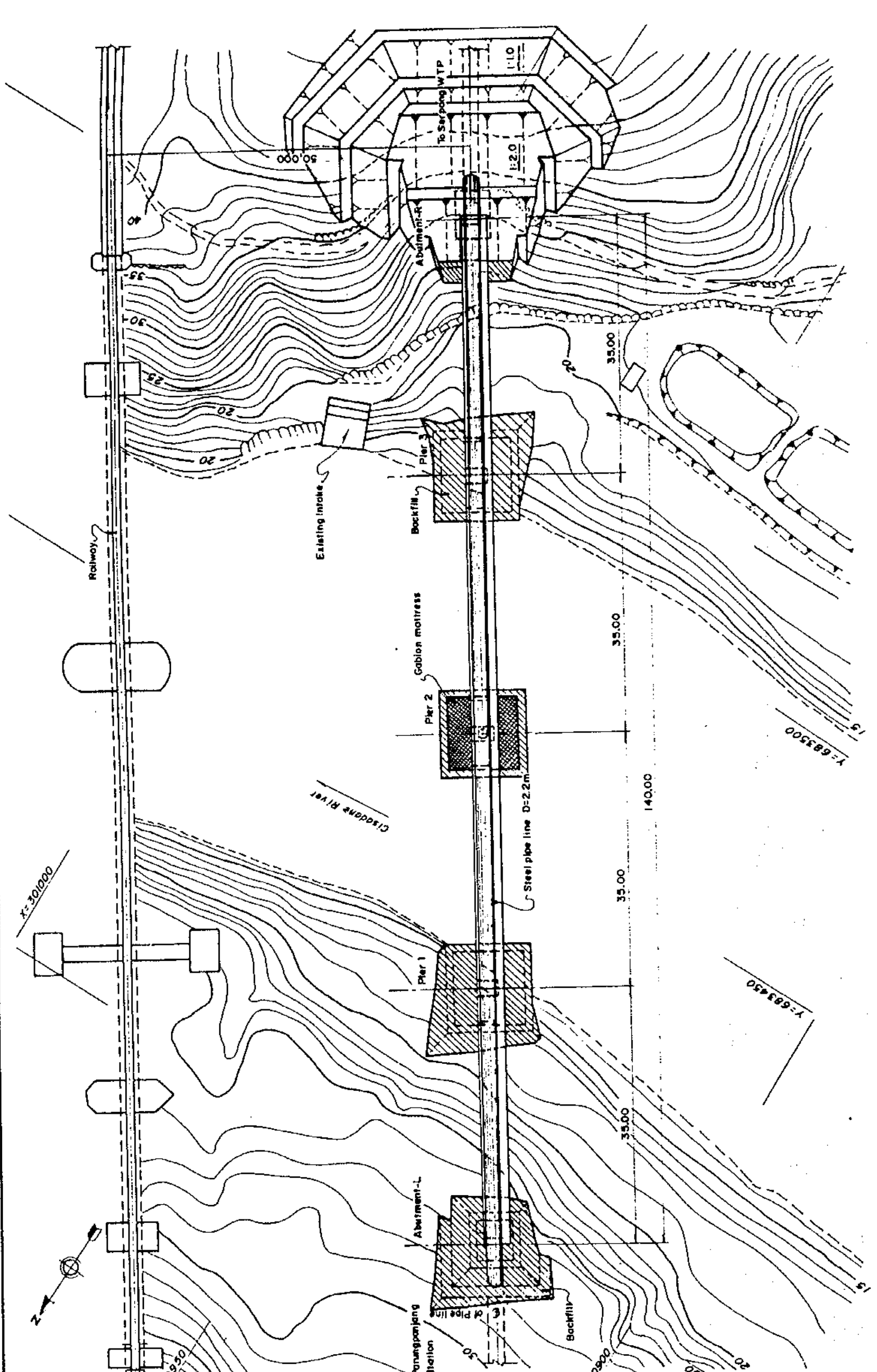


Figure 22 ALTERNATIVE 1 CONCRETE GIRDER AQUEDUCT IN THE CISADANE RIVER (1/2)

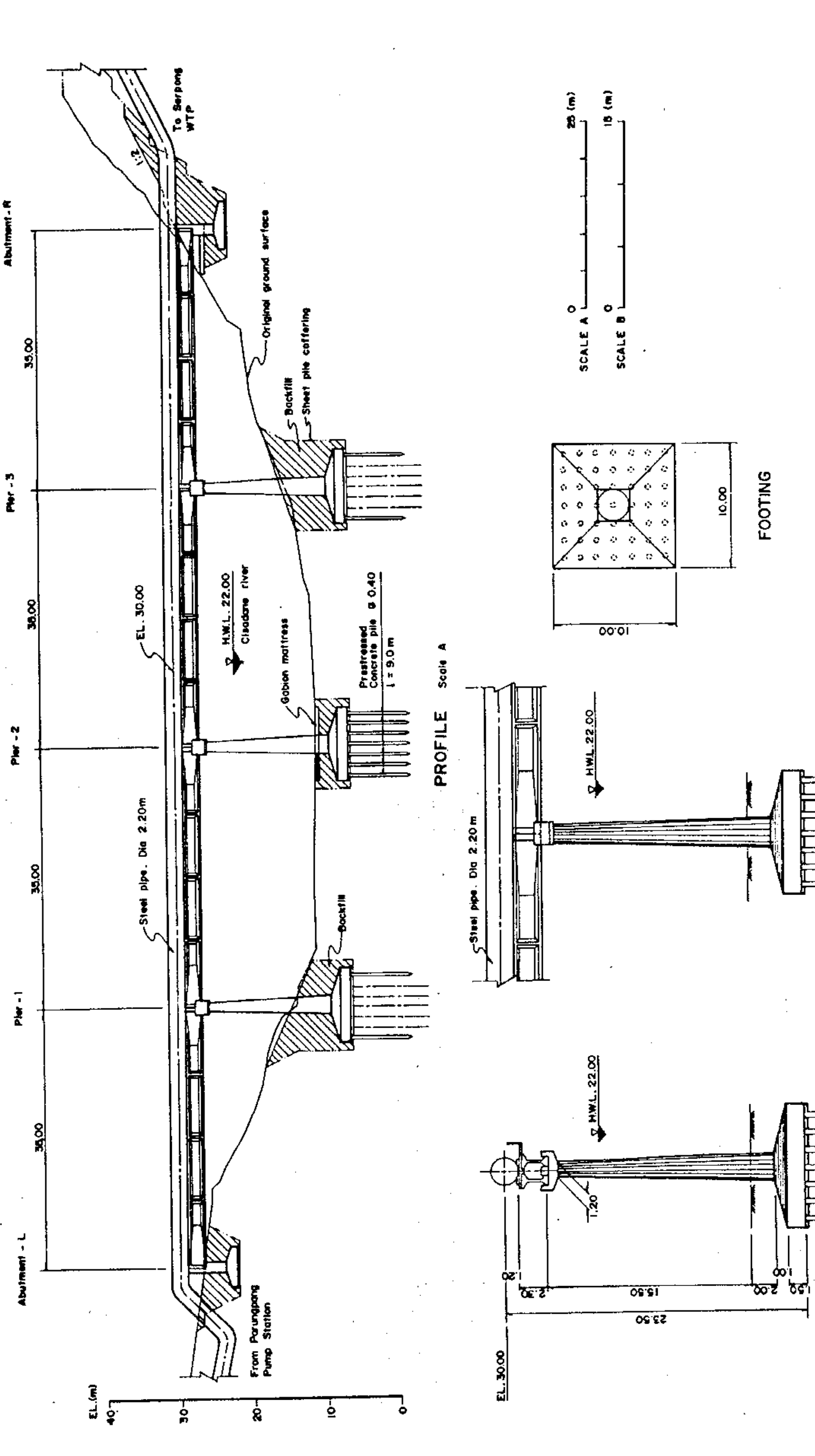


Figure 23 ALTERNATIVE 1 CONCRETE GIRDER AQUEDUCT IN THE CISADANE RIVER (2/2)

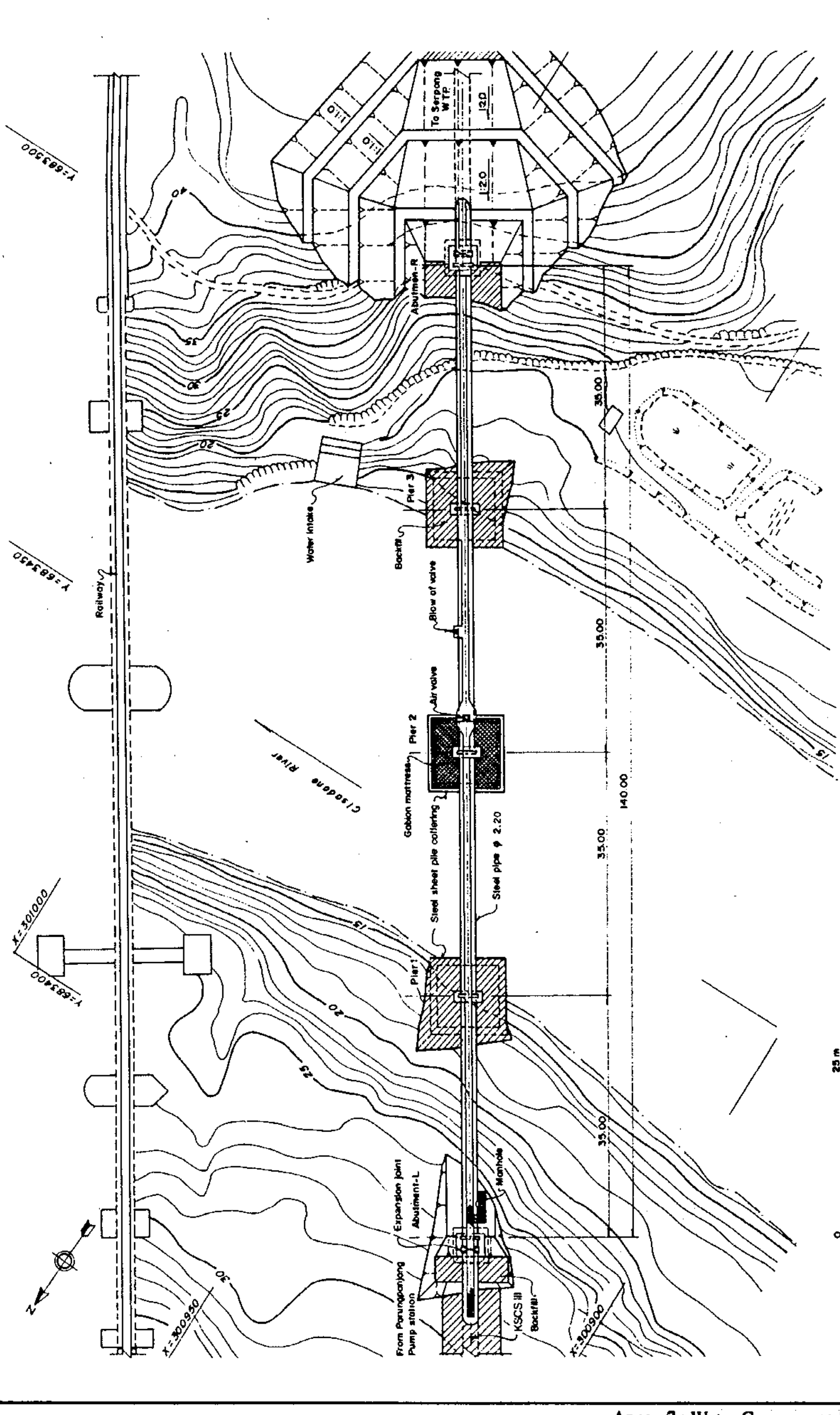


Figure 24 ALTERNATIVE 2 STEEL PIPE AQUEDUCT IN THE CISADANE RIVER (1/2)

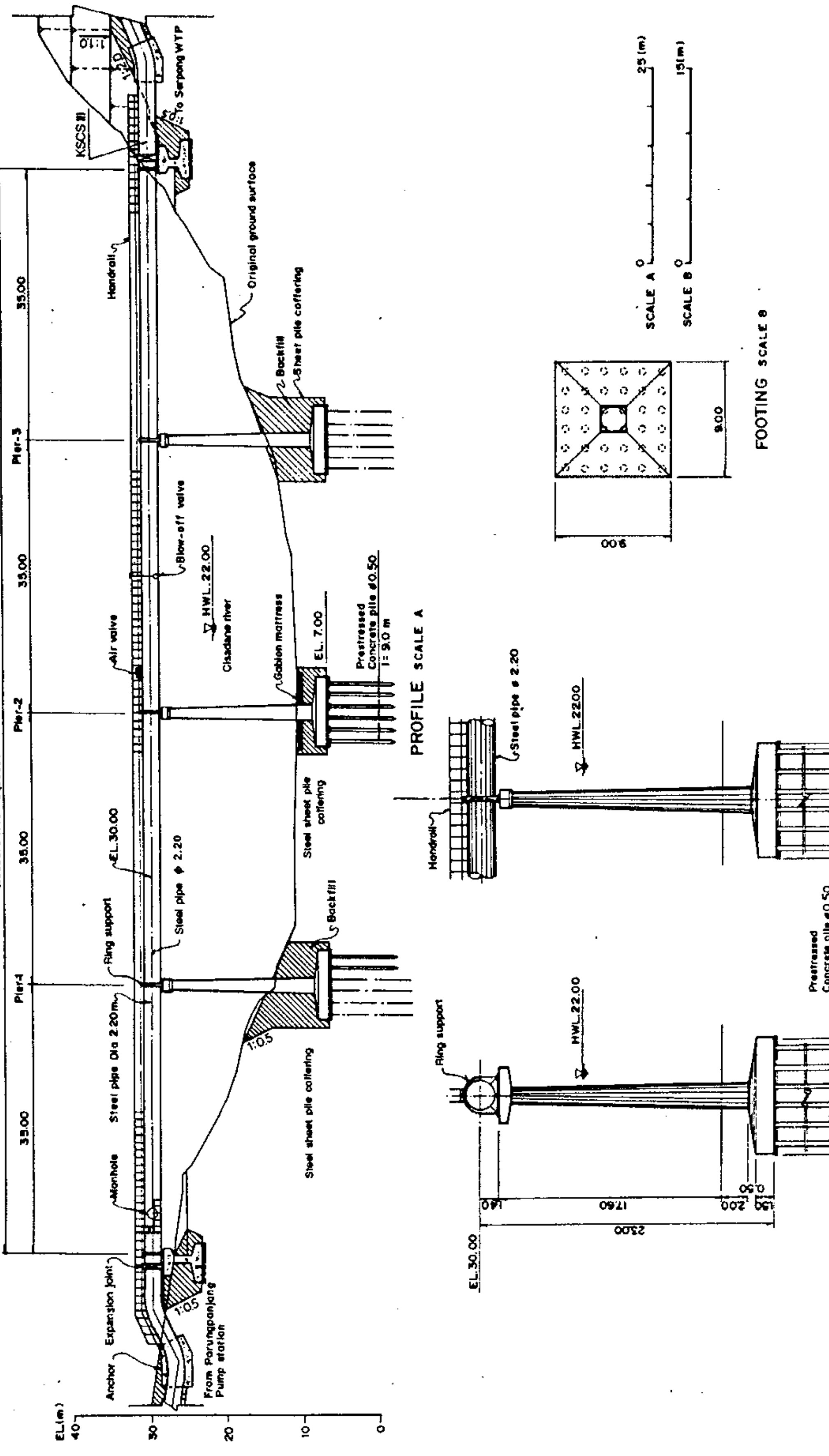


Figure 25 ALTERNATIVE 2 STEEL PIPE AQUEDUCT IN THE CISADANE RIVER (2/2)

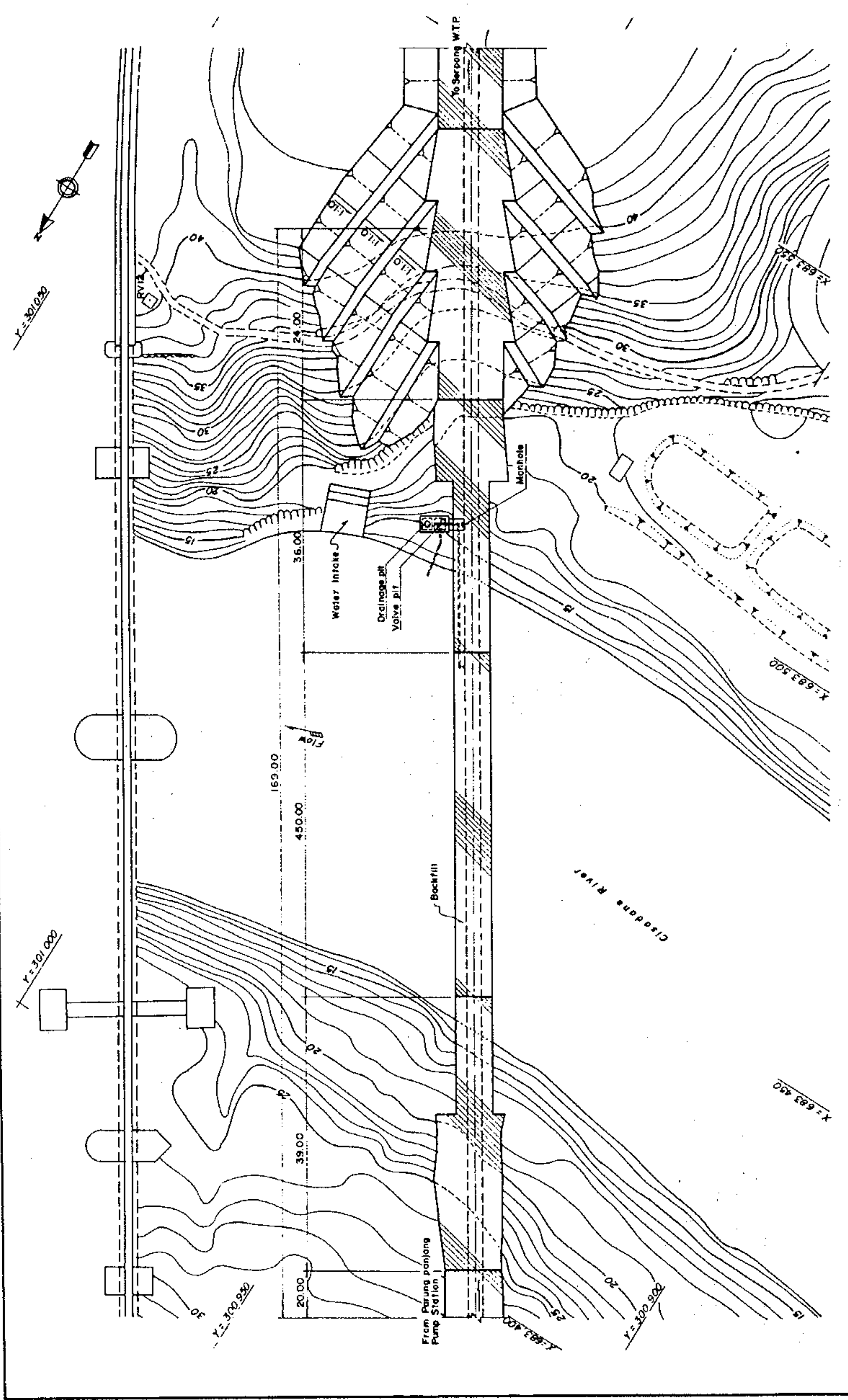


Figure 26 ALTERNATIVE 3 SYPHON IN THE CISADANE RIVER (1/2)

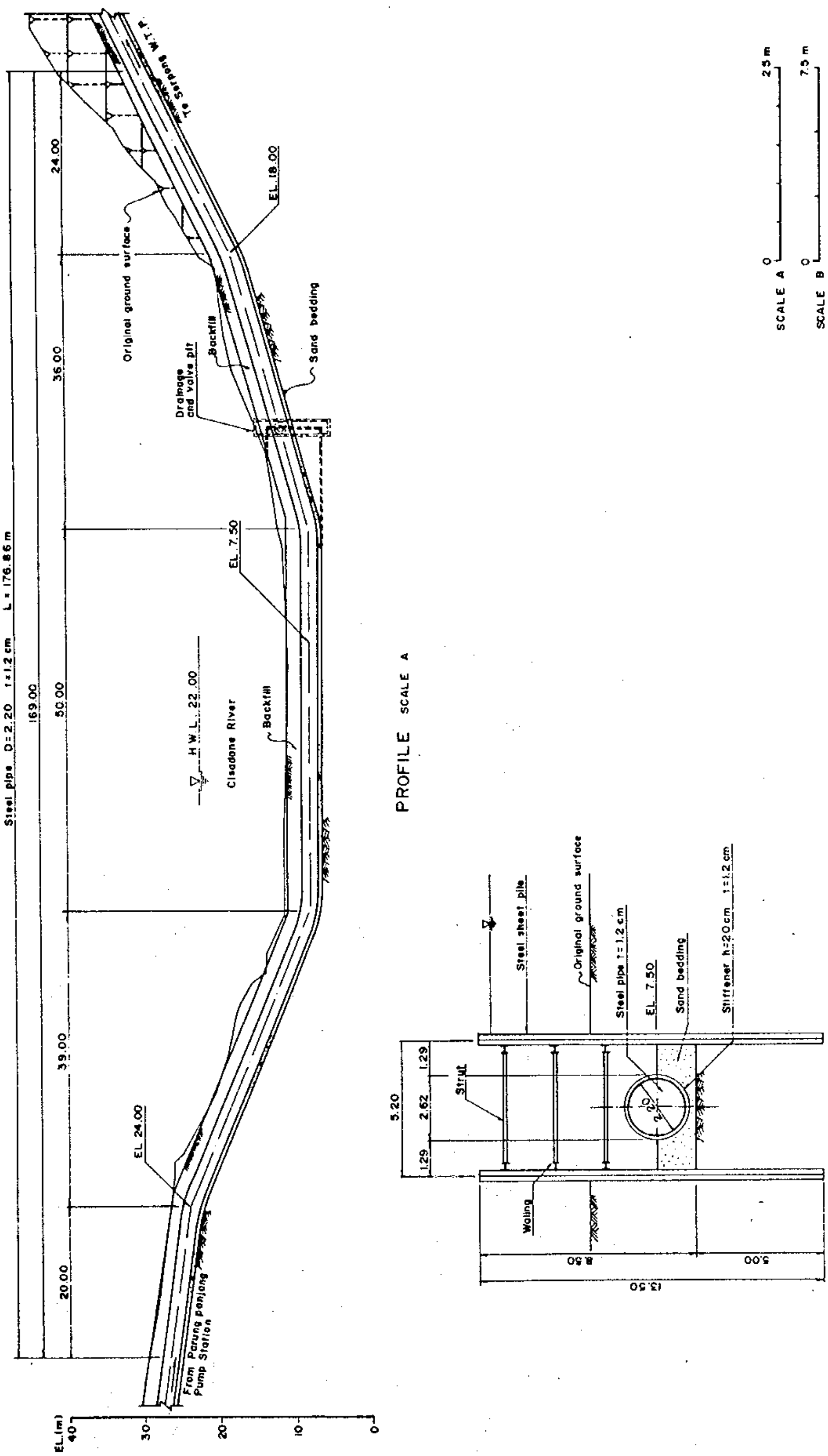


Figure 27 ALTERNATIVE 3 SYPHON IN THE CISADANE RIVER (2/2)

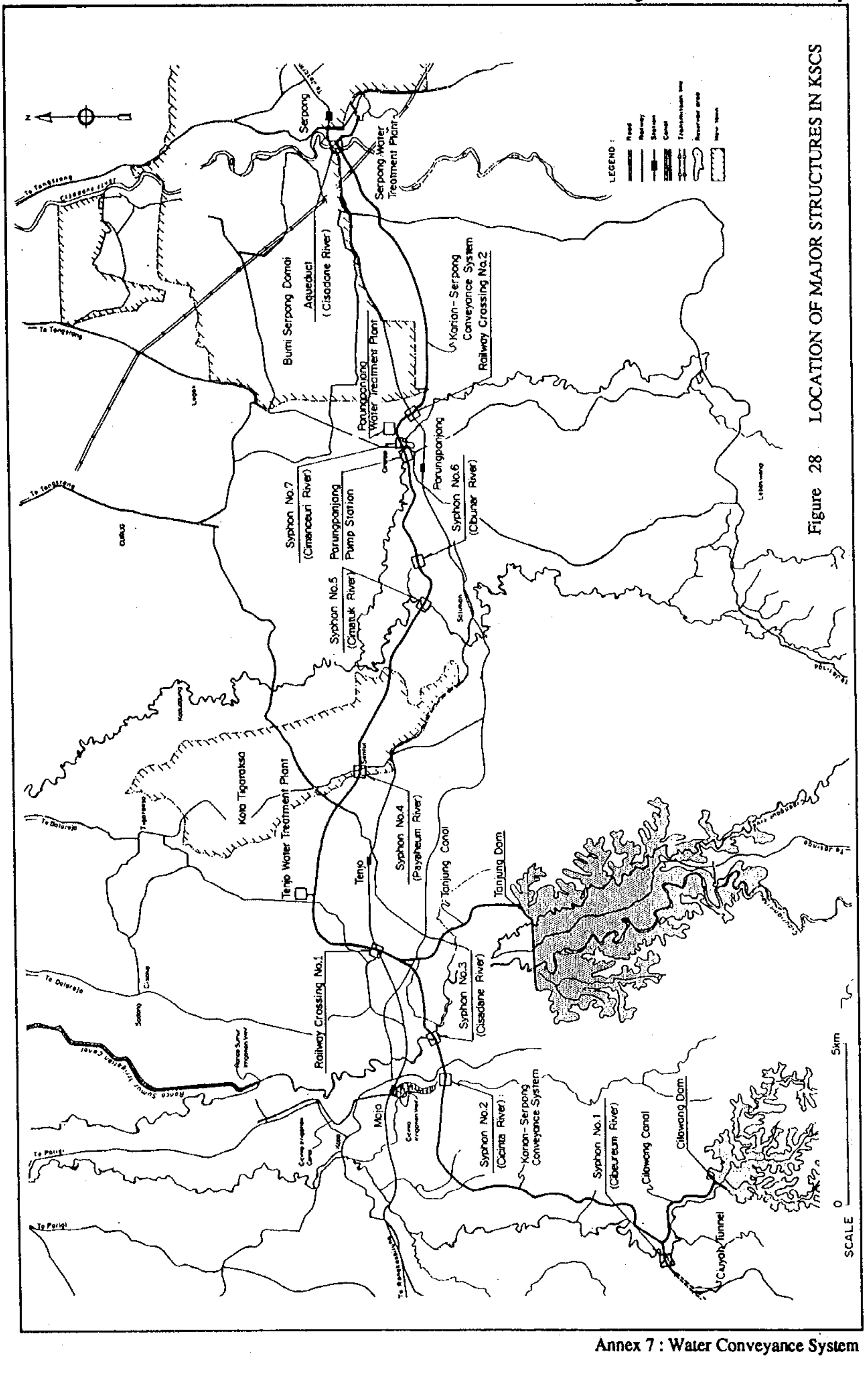


Figure 28 LOCATION OF MAJOR STRUCTURES IN KSCS

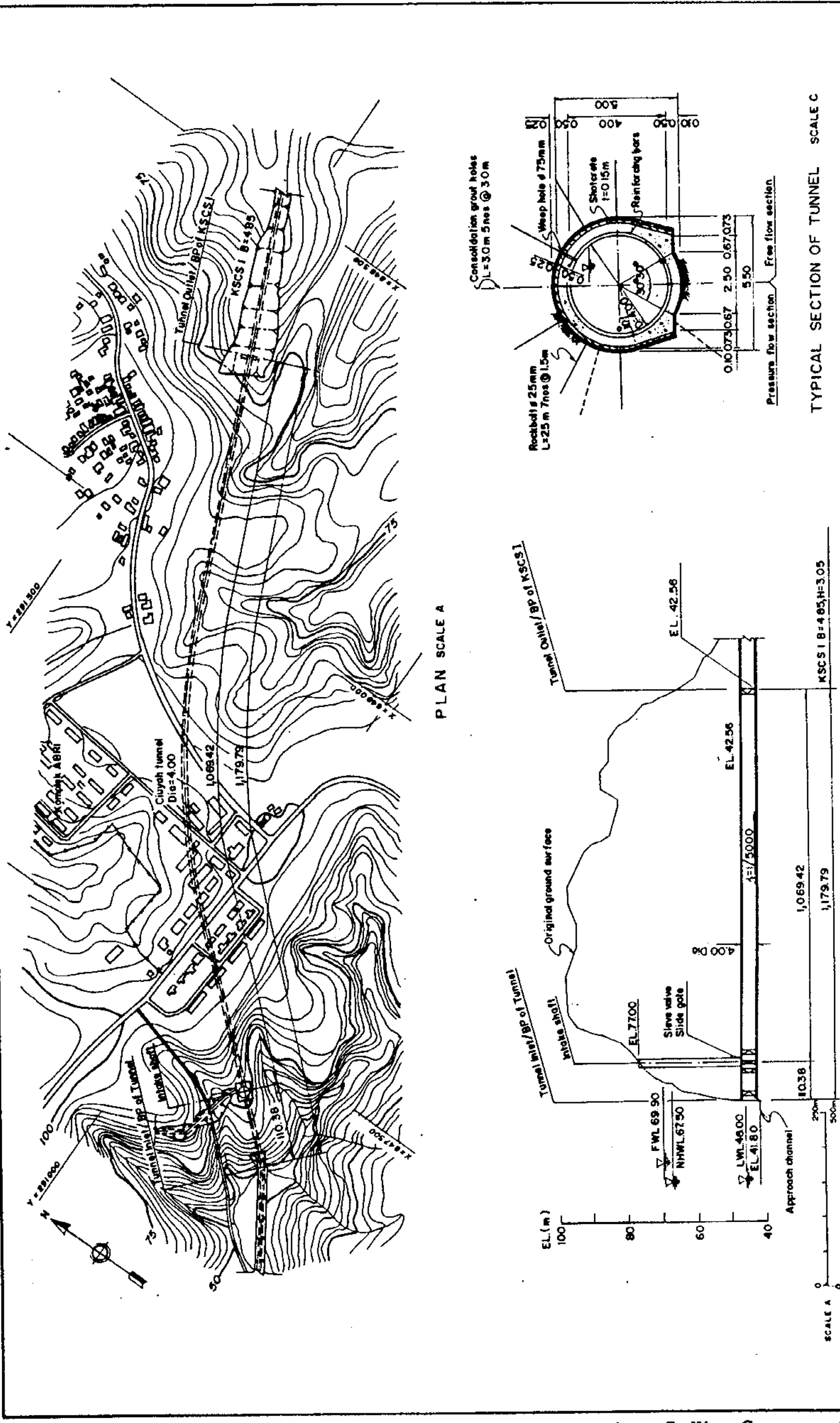


Figure 29 GENERAL PLAN, PROFILE AND SECTION OF CIUYAH TUNNEL

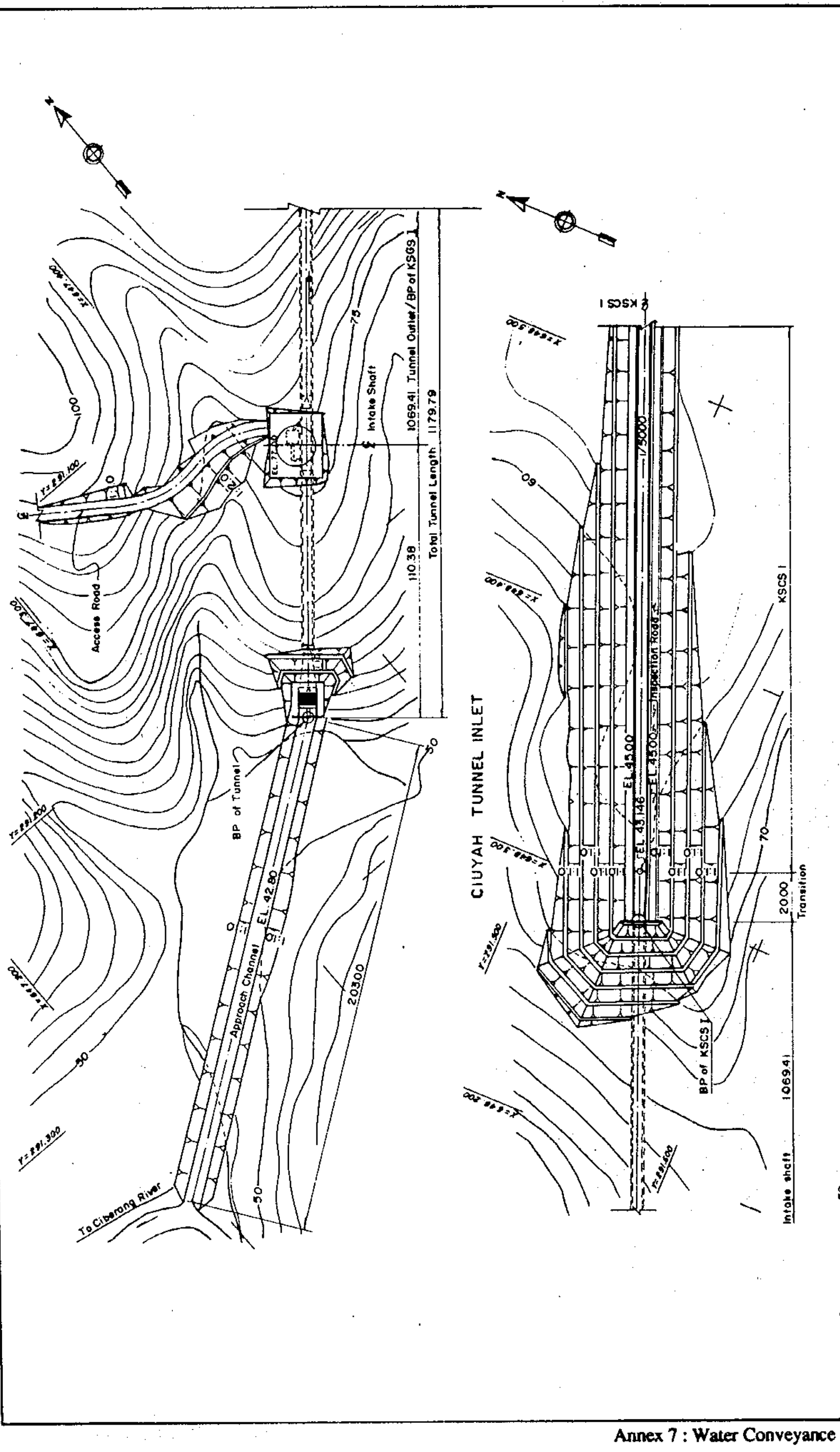


Figure 30 INLET AND OUTLET OF CIUYAH TUNNEL

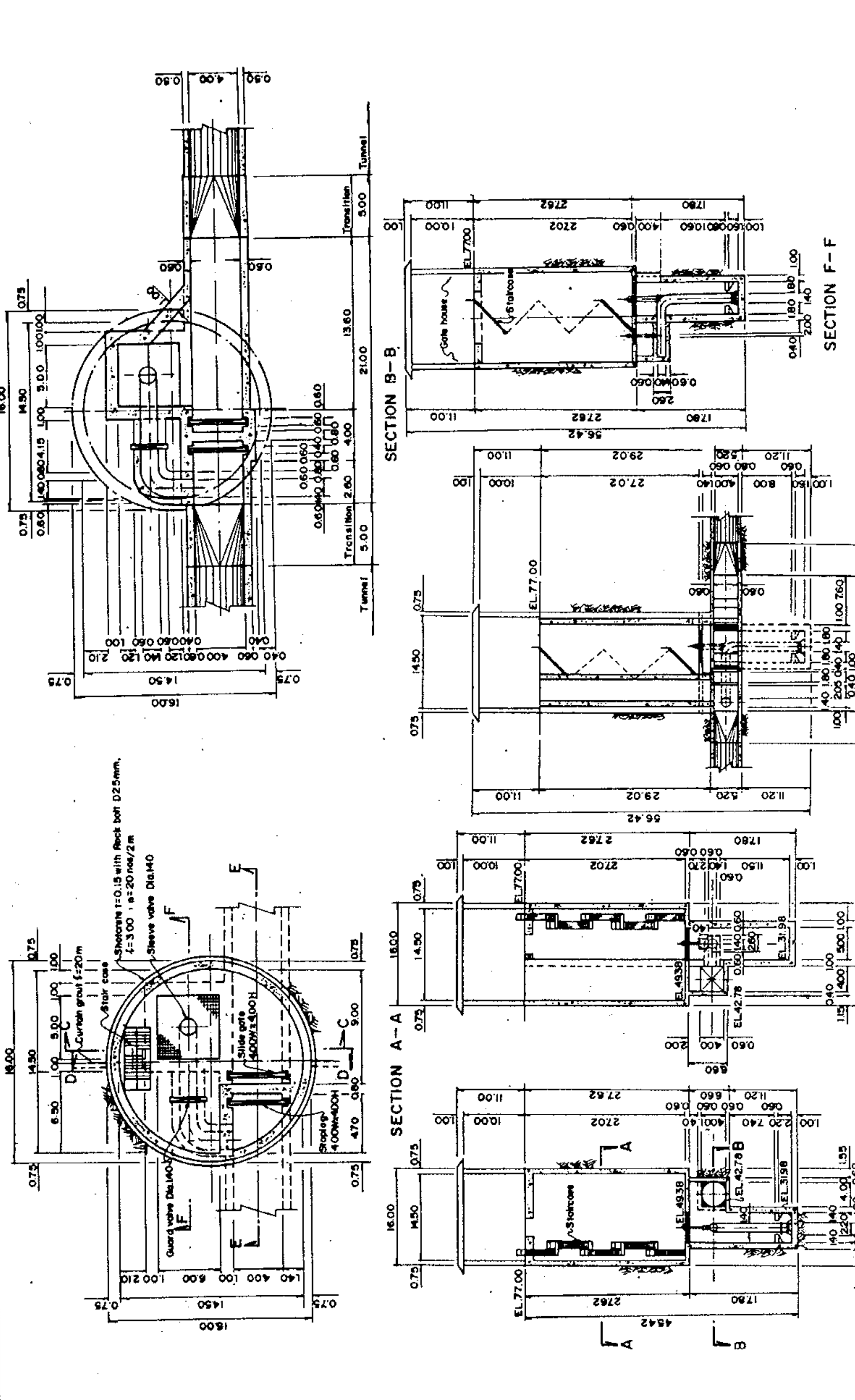


Figure 31 INTAKE SHAFT OF CIUYAH TUNNEL

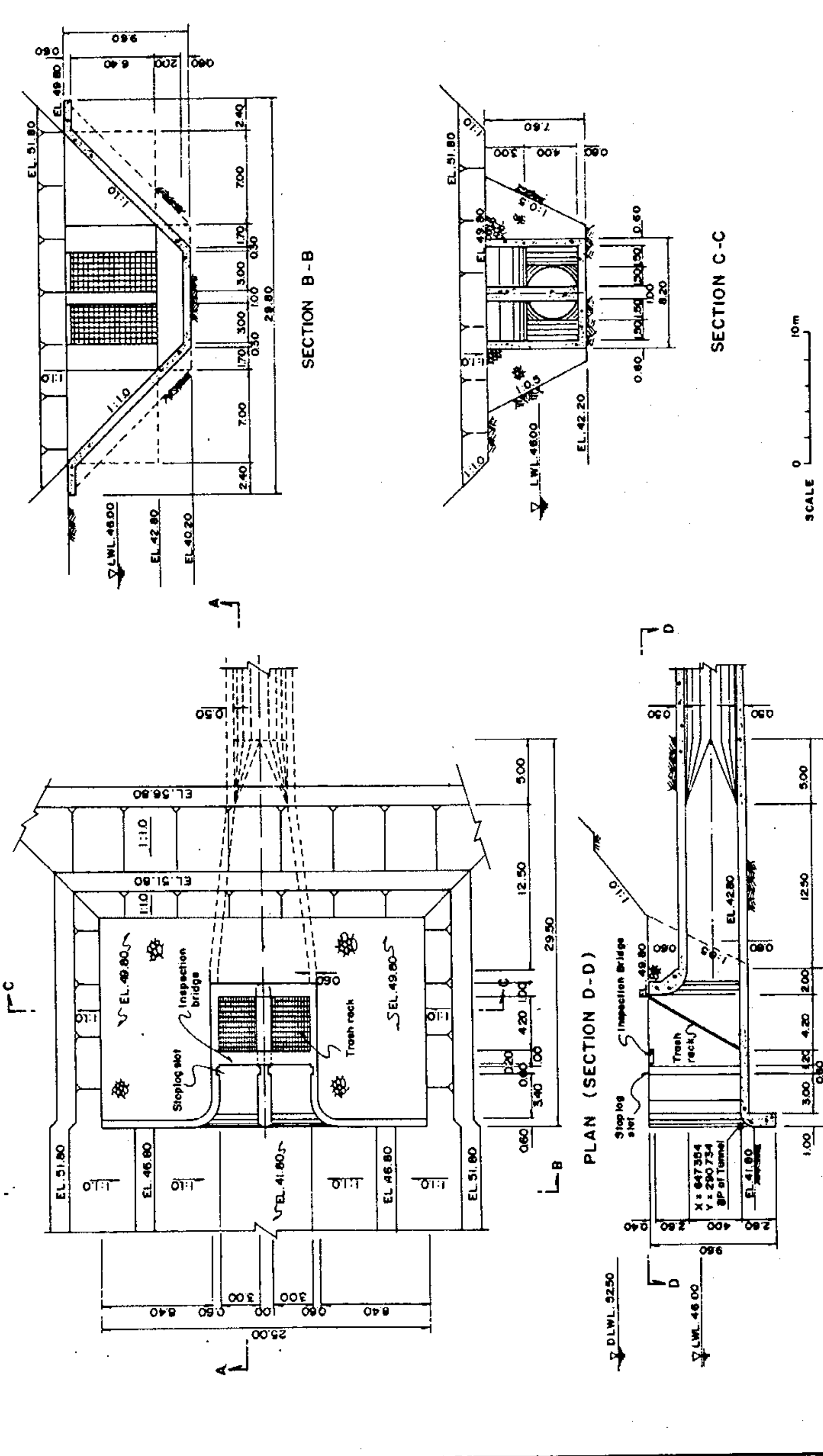


Figure 32 INLET OF CIUYAH TUNNEL

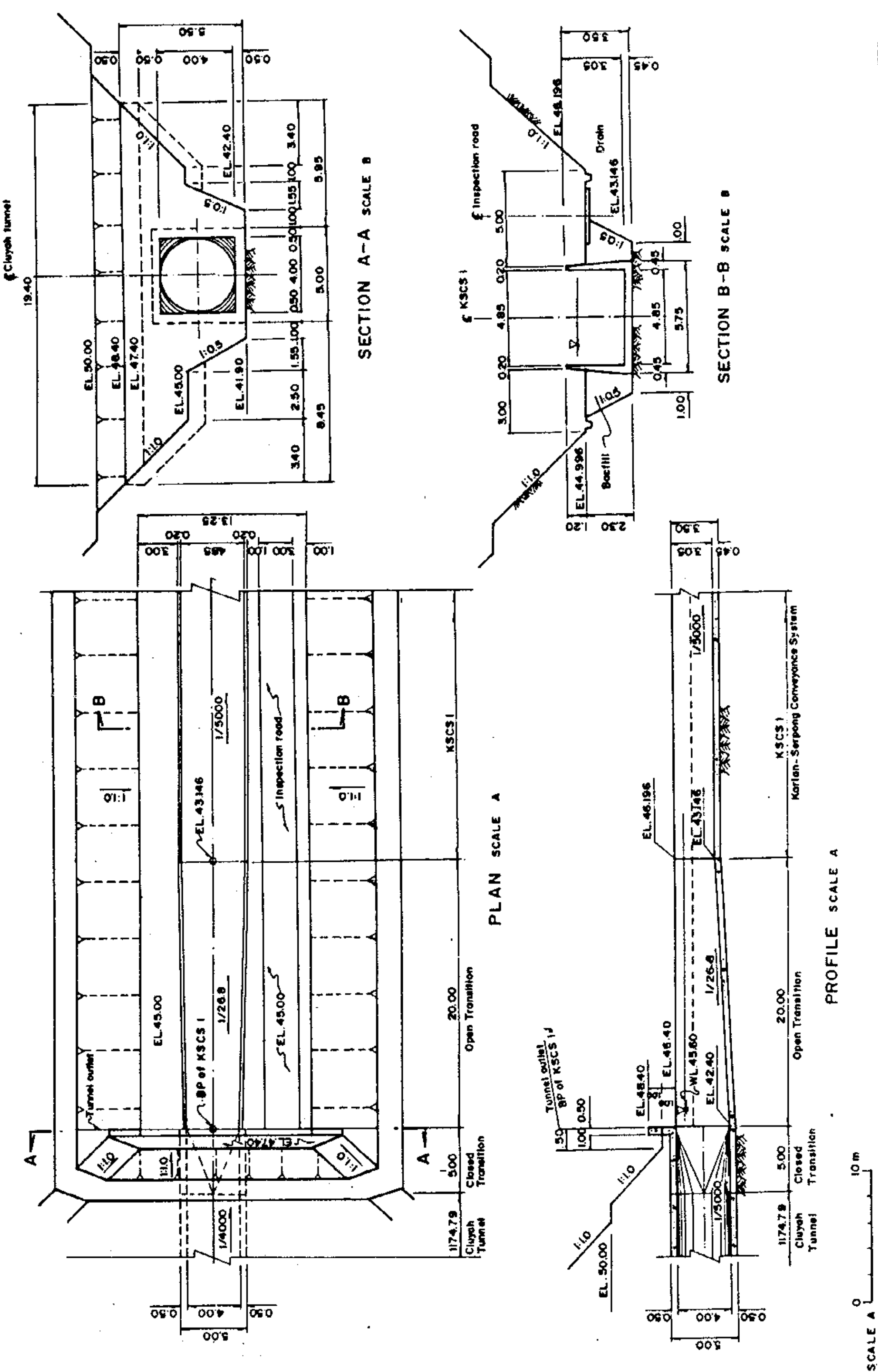


Figure 33 OUTLET OF CIUYAH TUNNEL

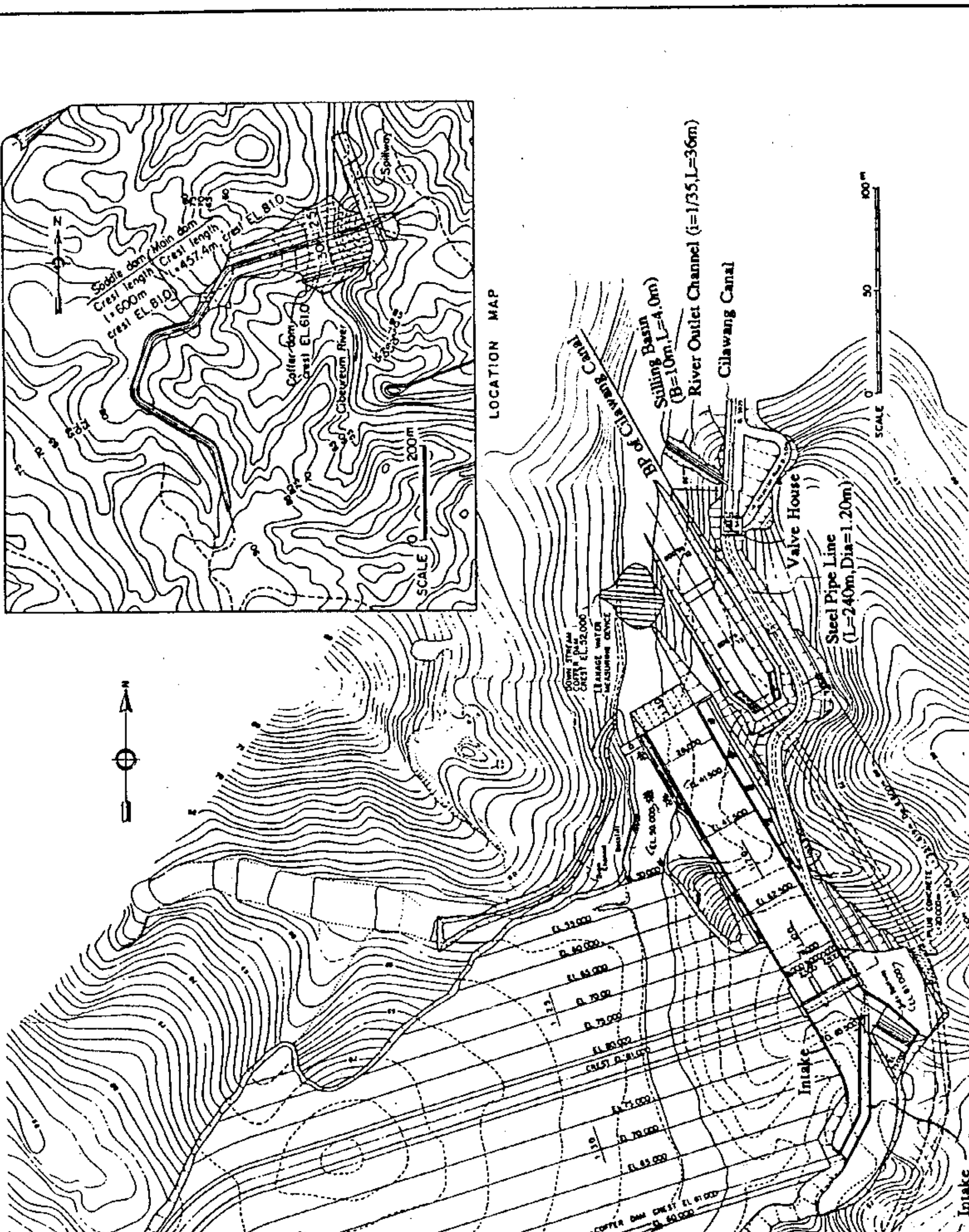


Figure 34 GENERAL PLAN OF INTAKE OF CILAWANG CANAL

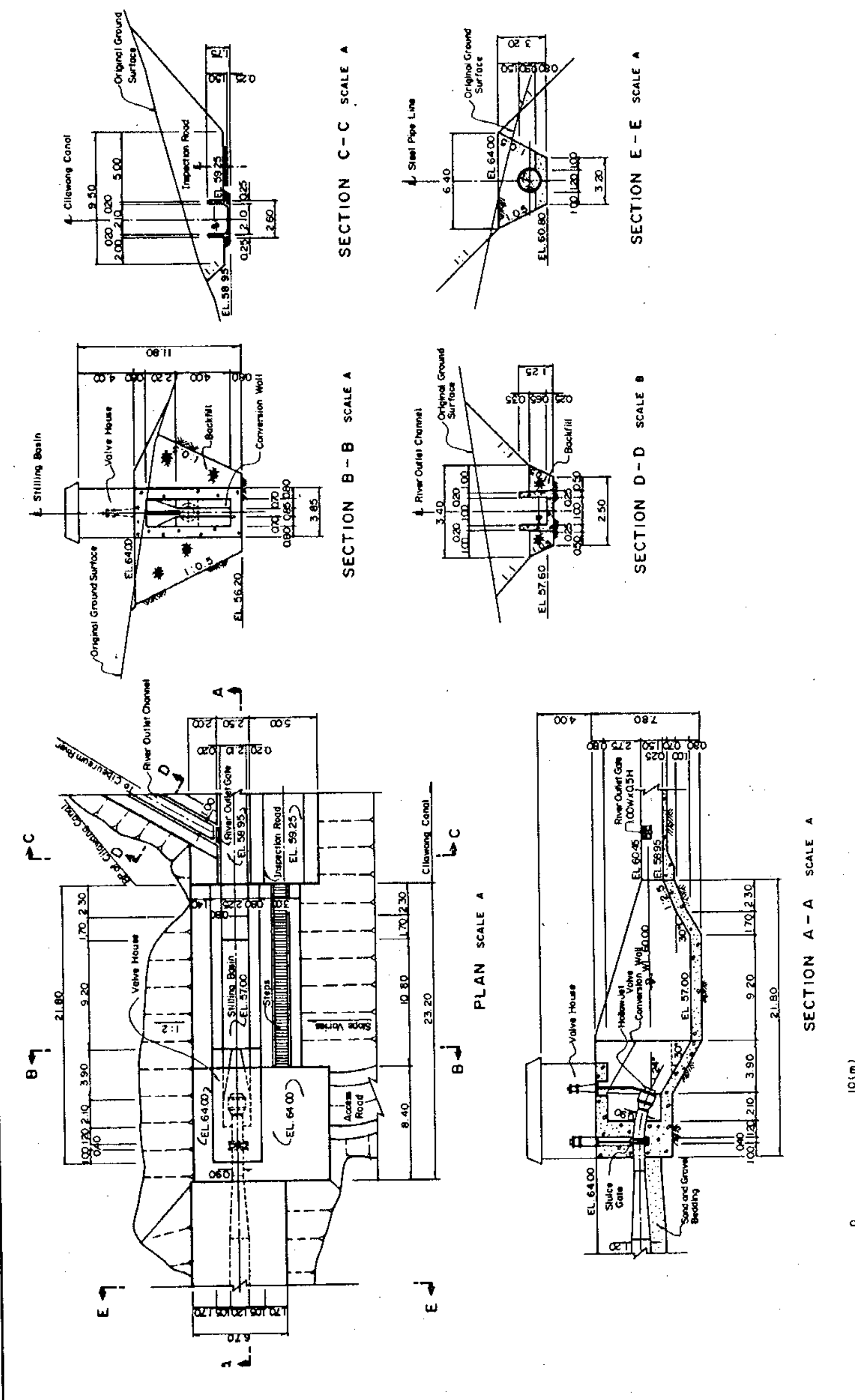


Figure 35 INTAKE OF CILAWANG CANAL

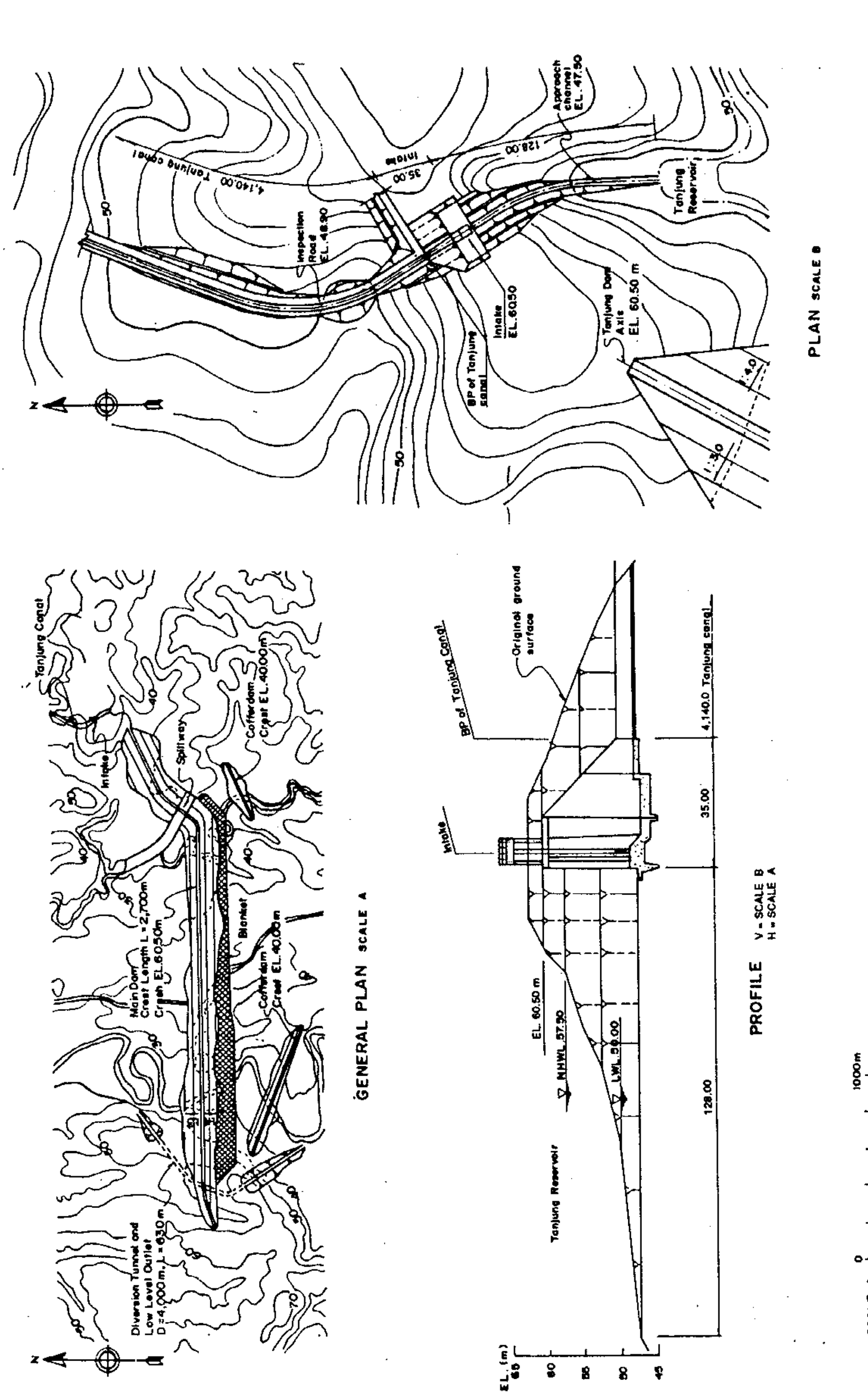


Figure 36 GENERAL PLAN OF INTAKE OF TANJUNG CANAL

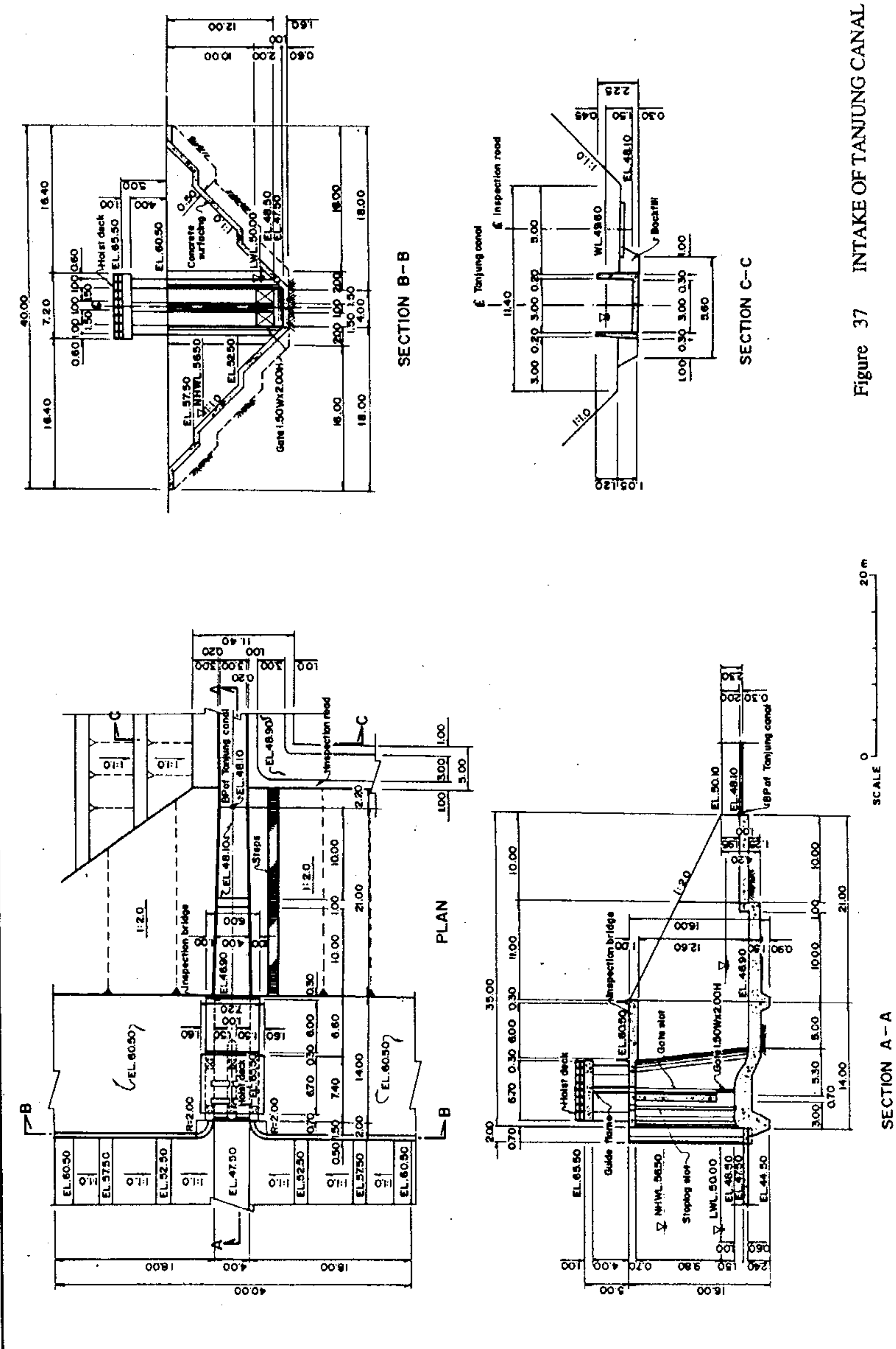


Figure 37 INTAKE OF TANJUNG CANAL

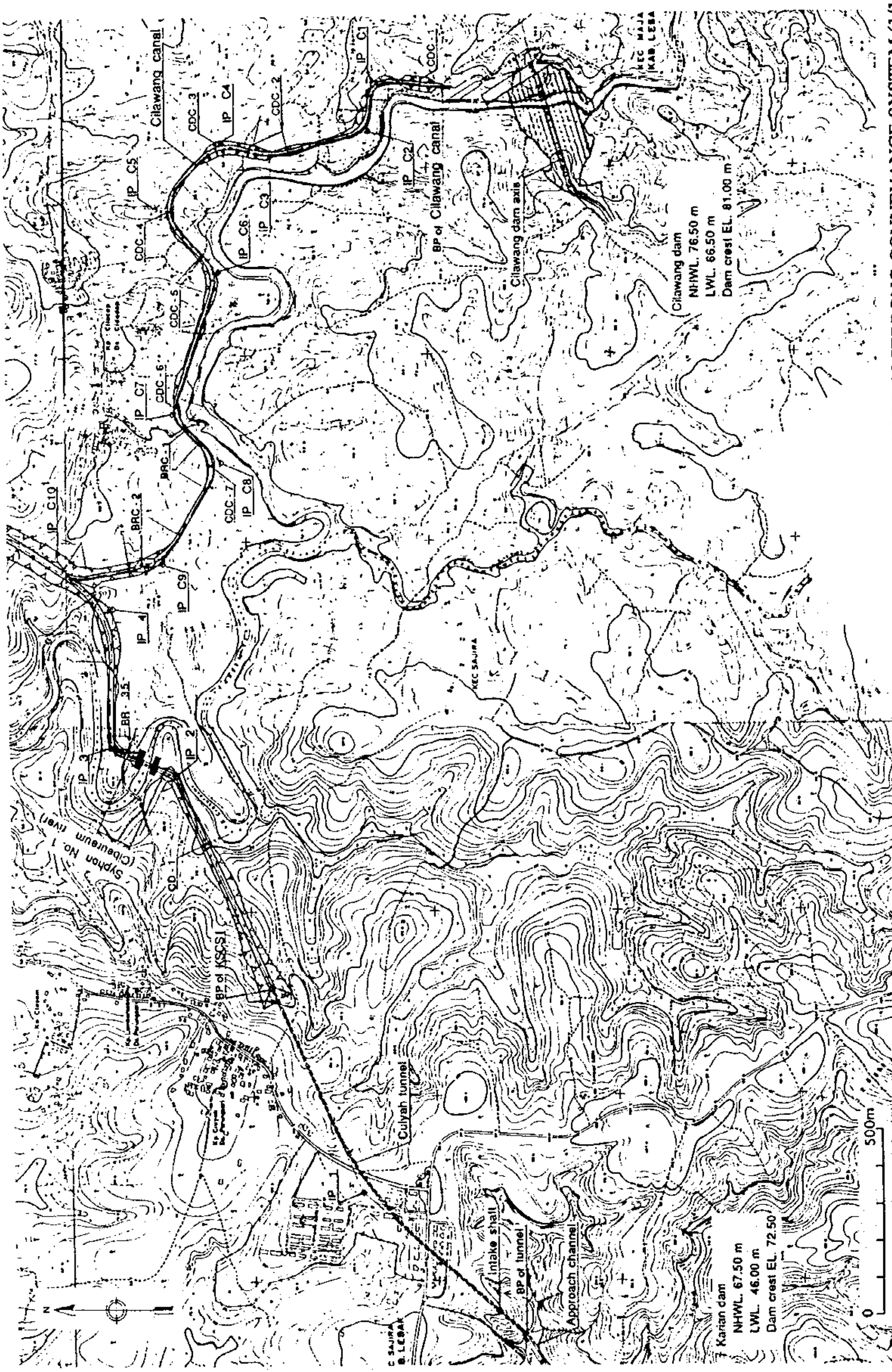


Figure 38 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (1/15)

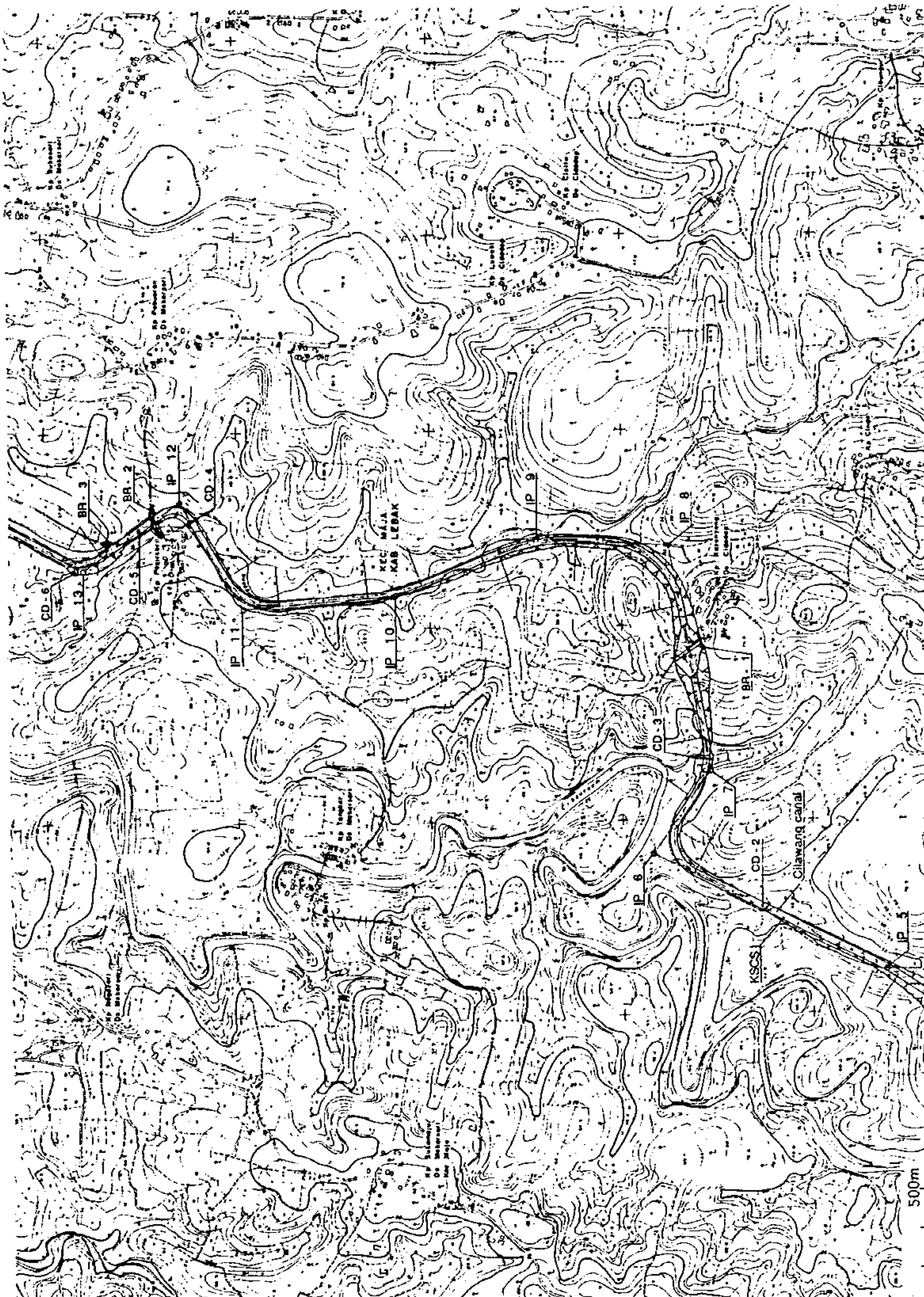


Figure 39 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (2/15)

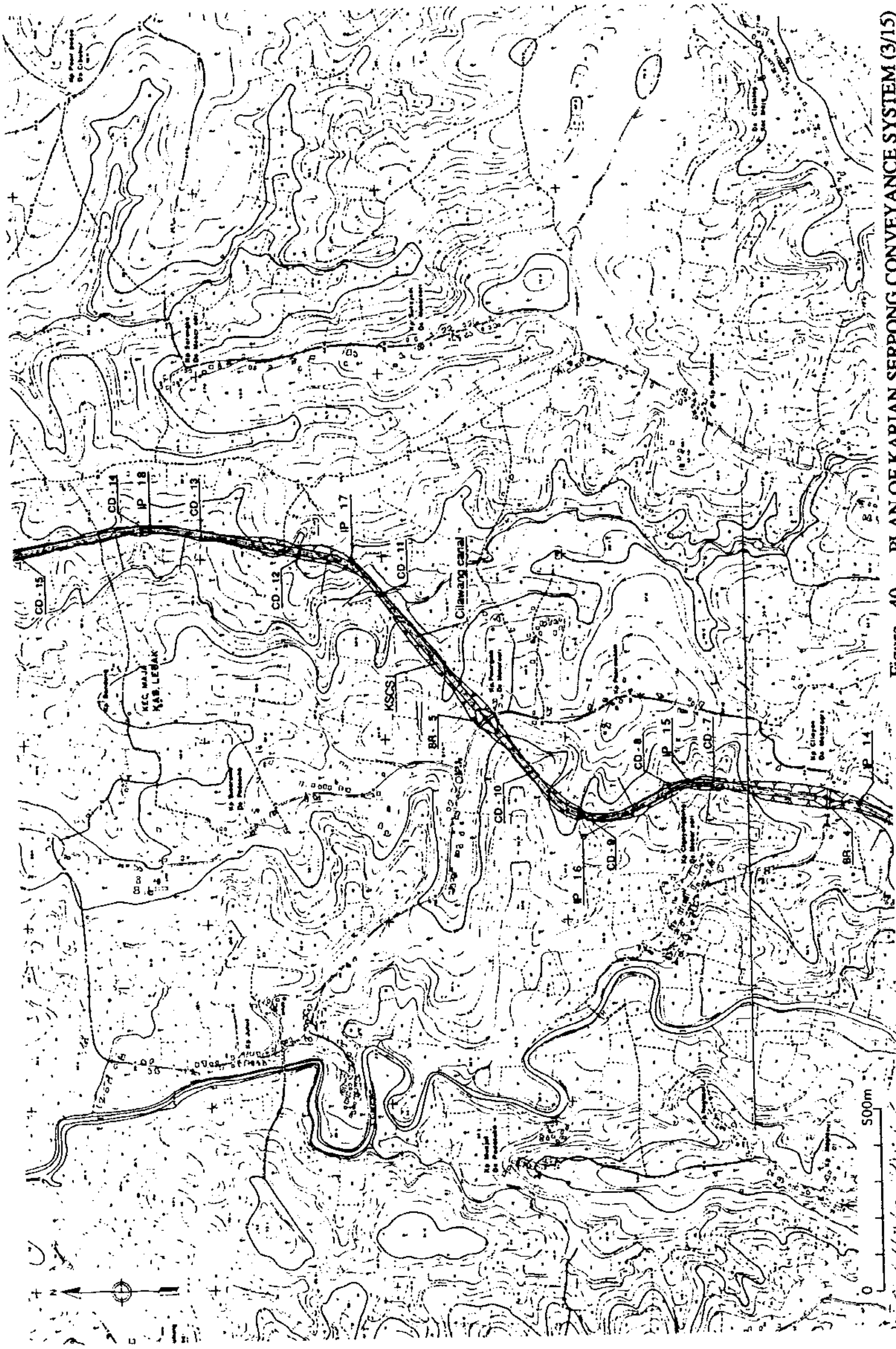


Figure 40 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (3/15)

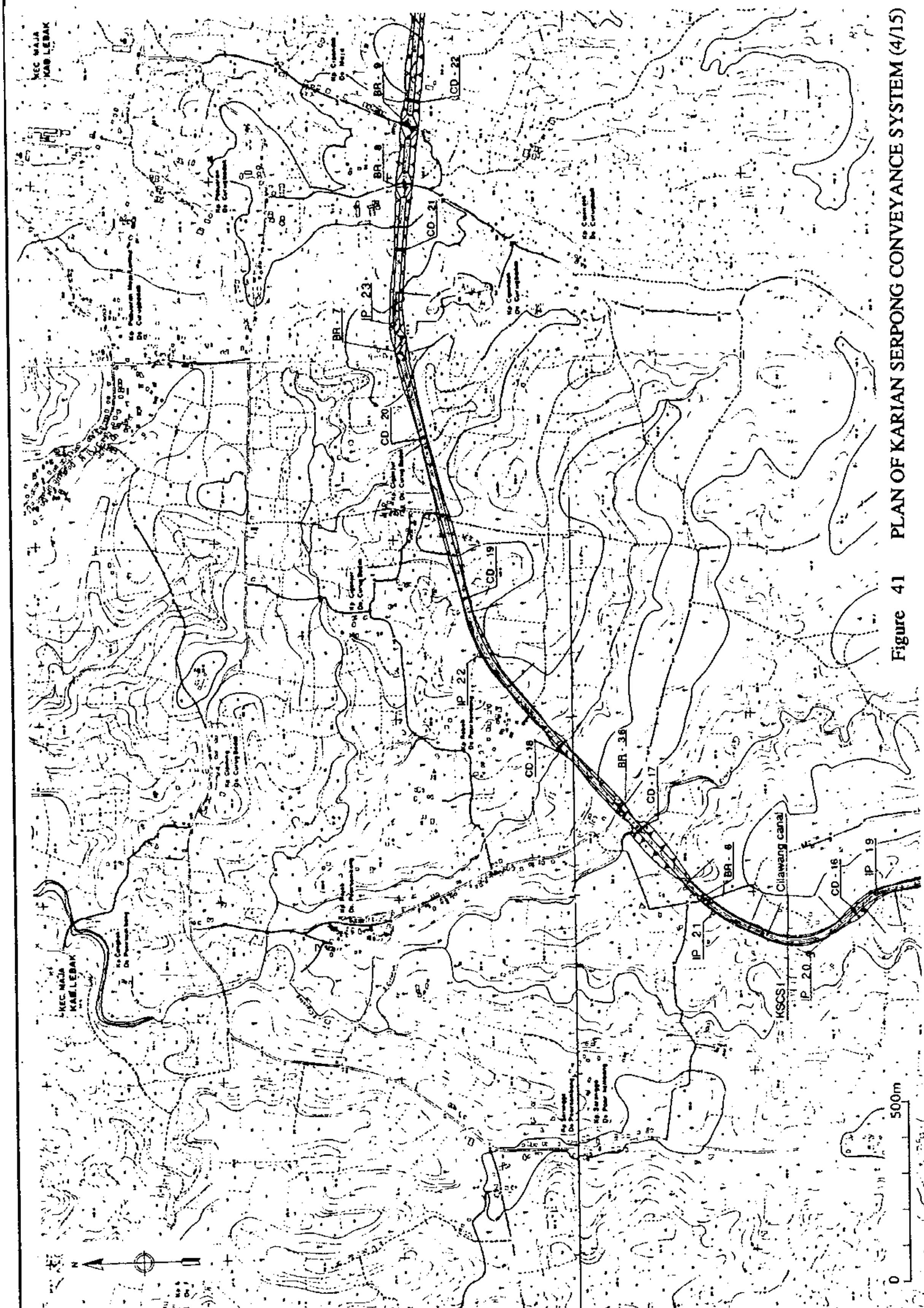


Figure 41 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (4/15)

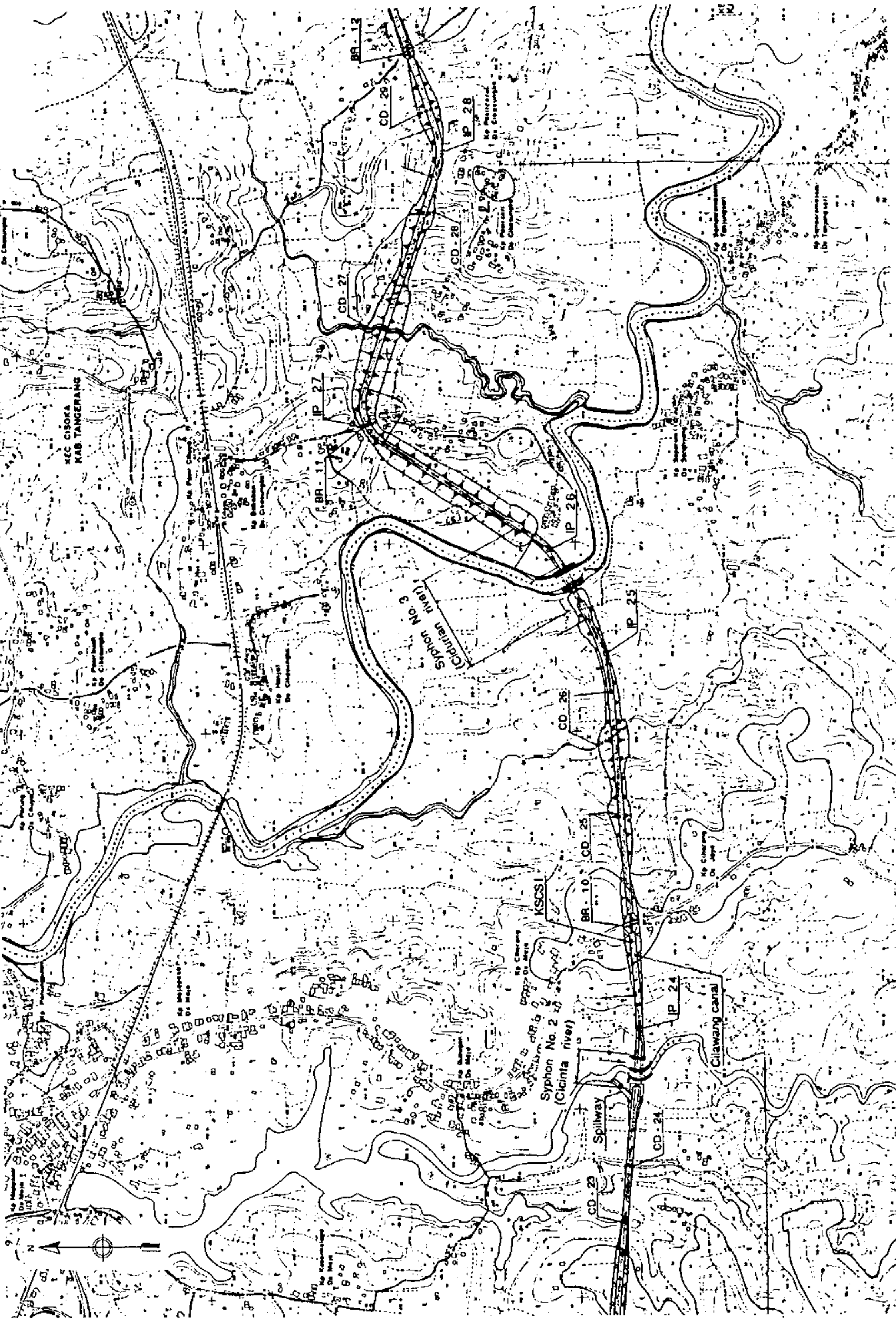


Figure 42 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (5/15)

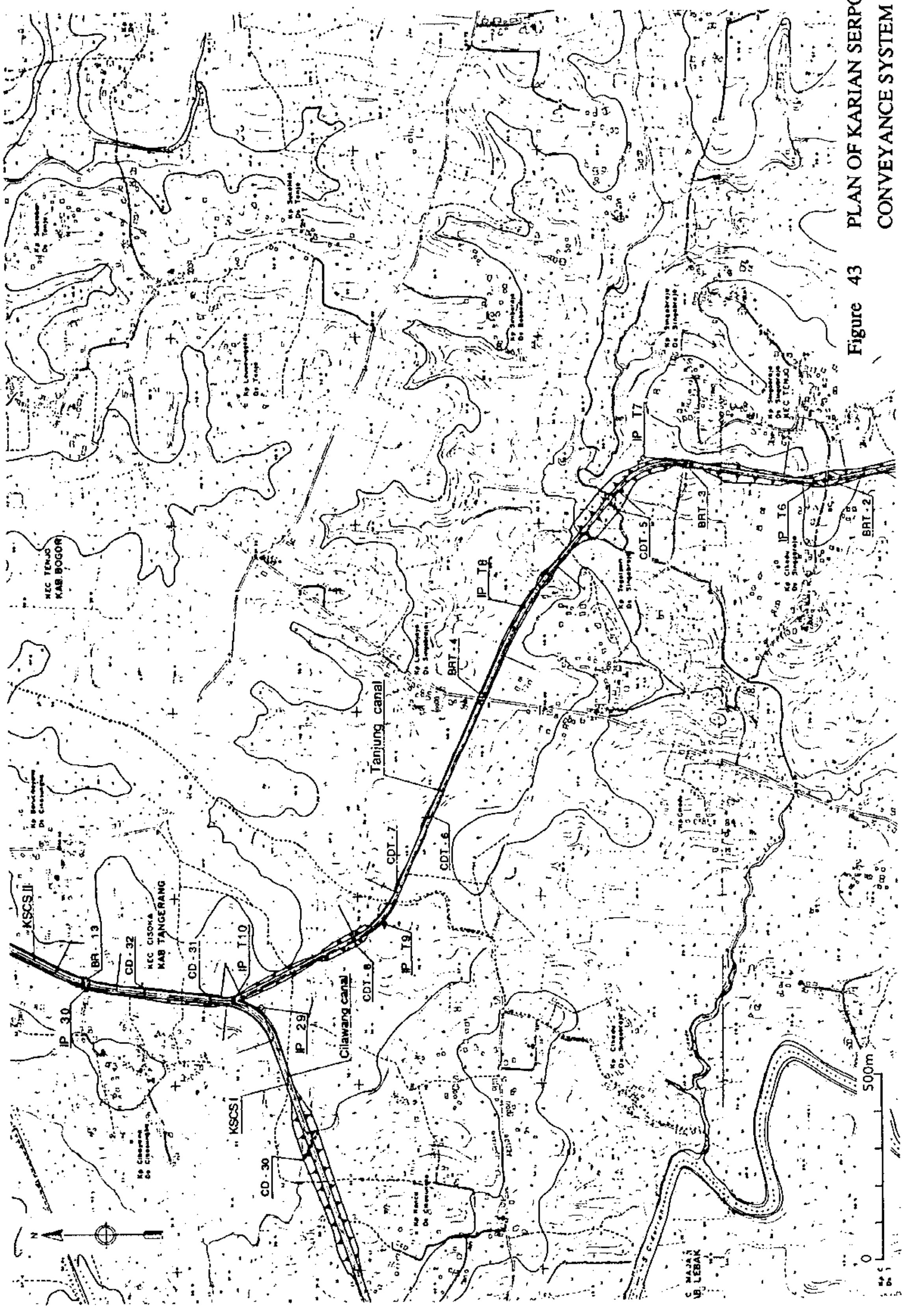


Figure 43 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (6/15)

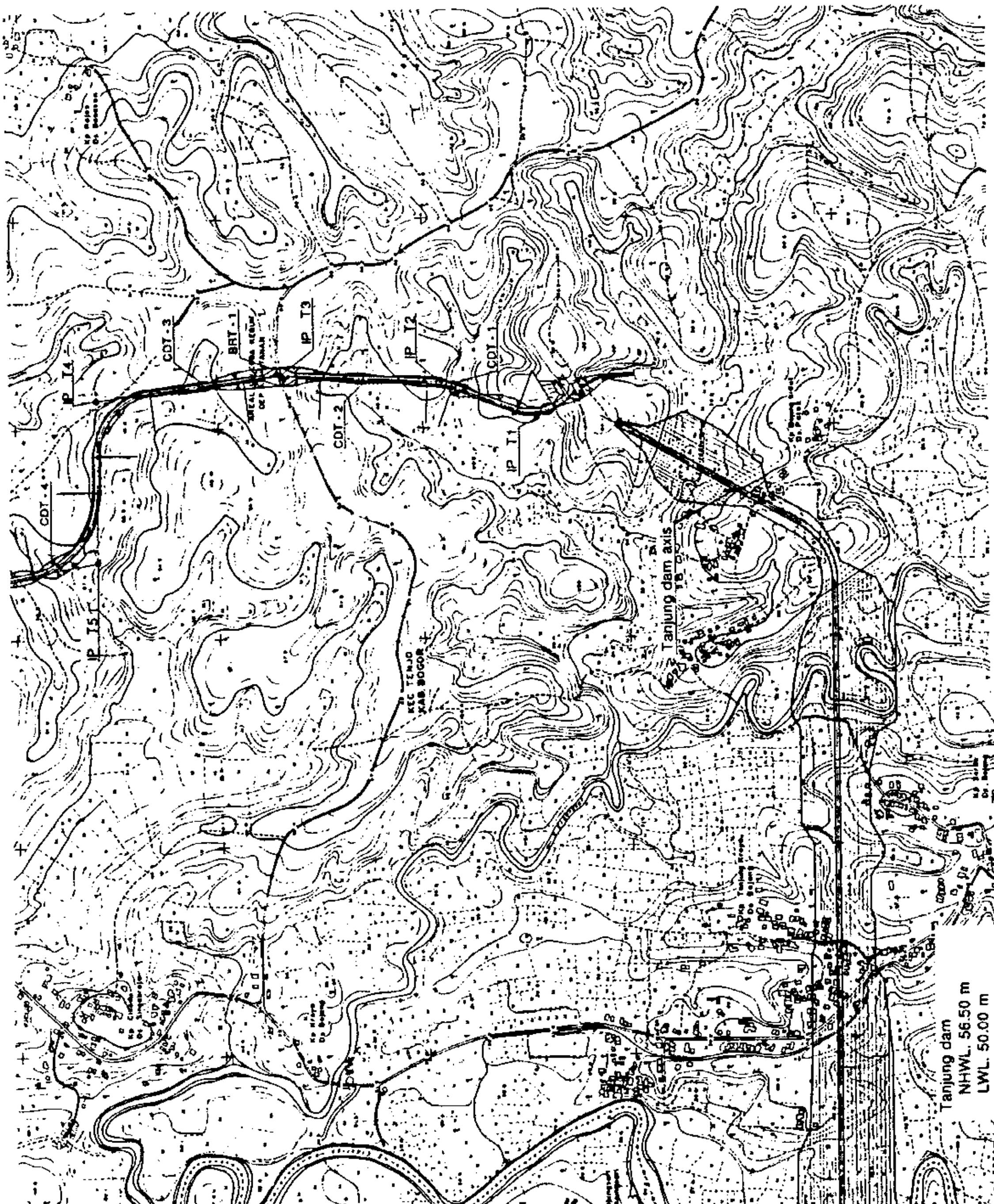


Figure 44 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (7/15)

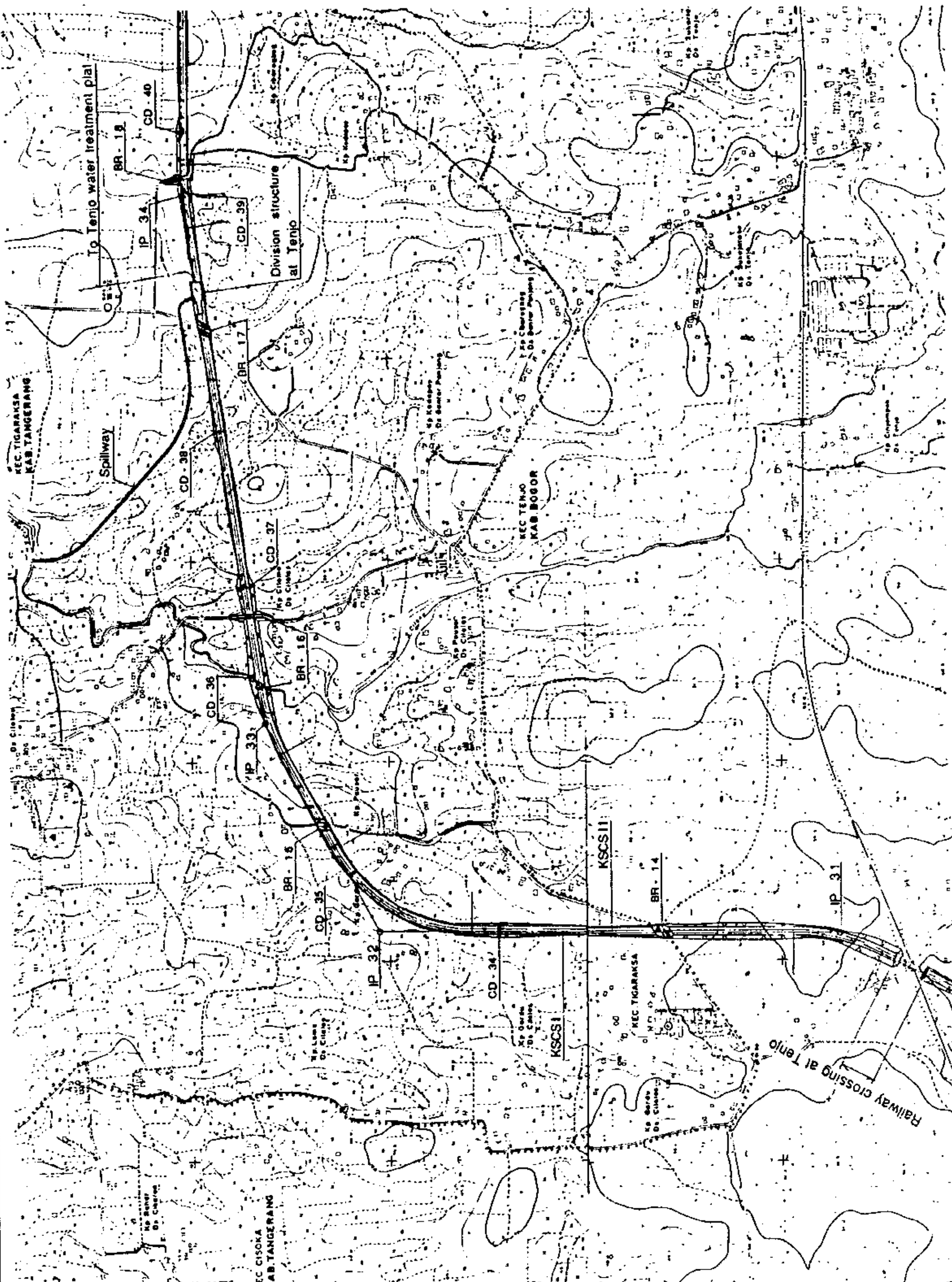


Figure 45 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (8/15)

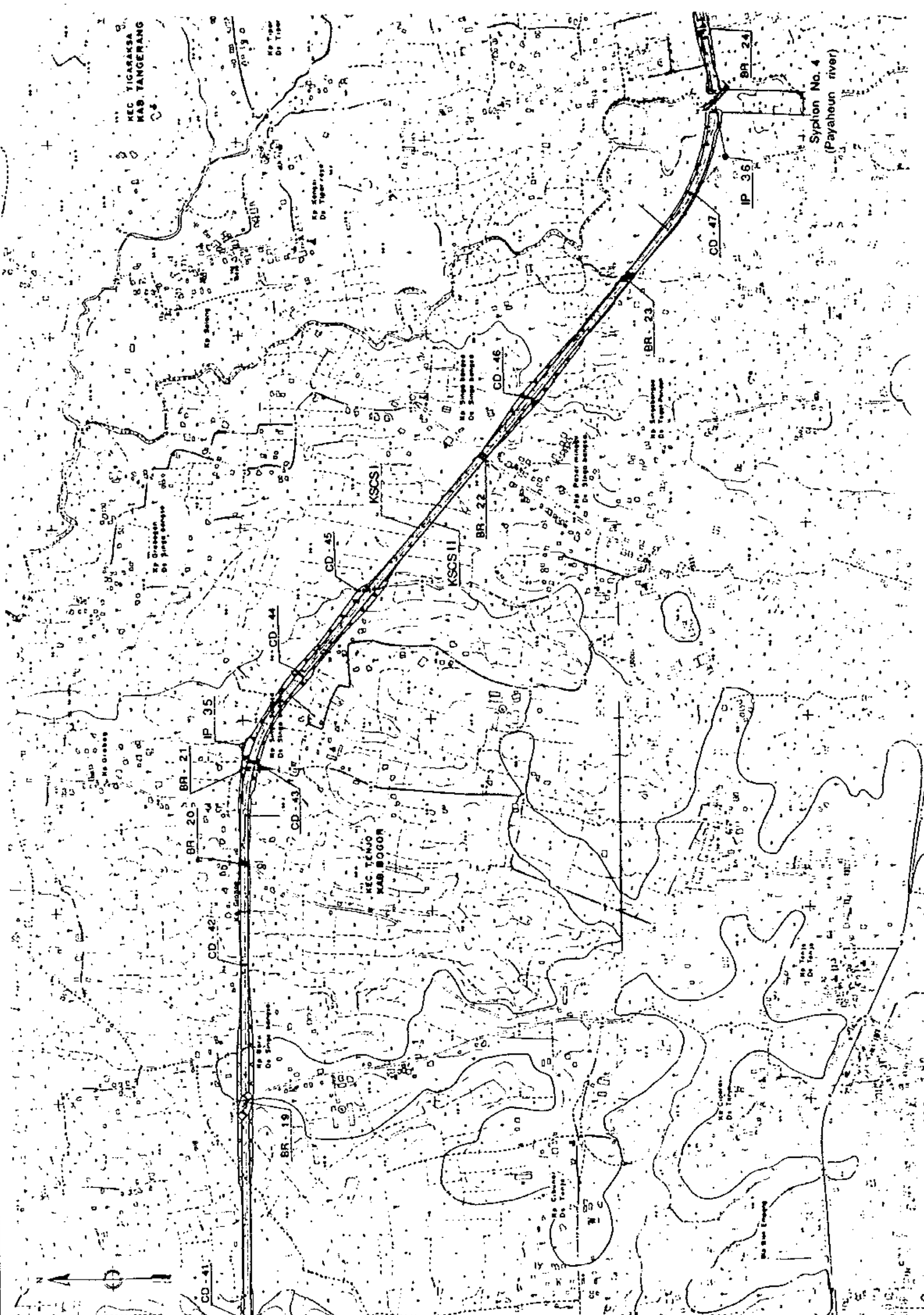


Figure 46 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (9/15)

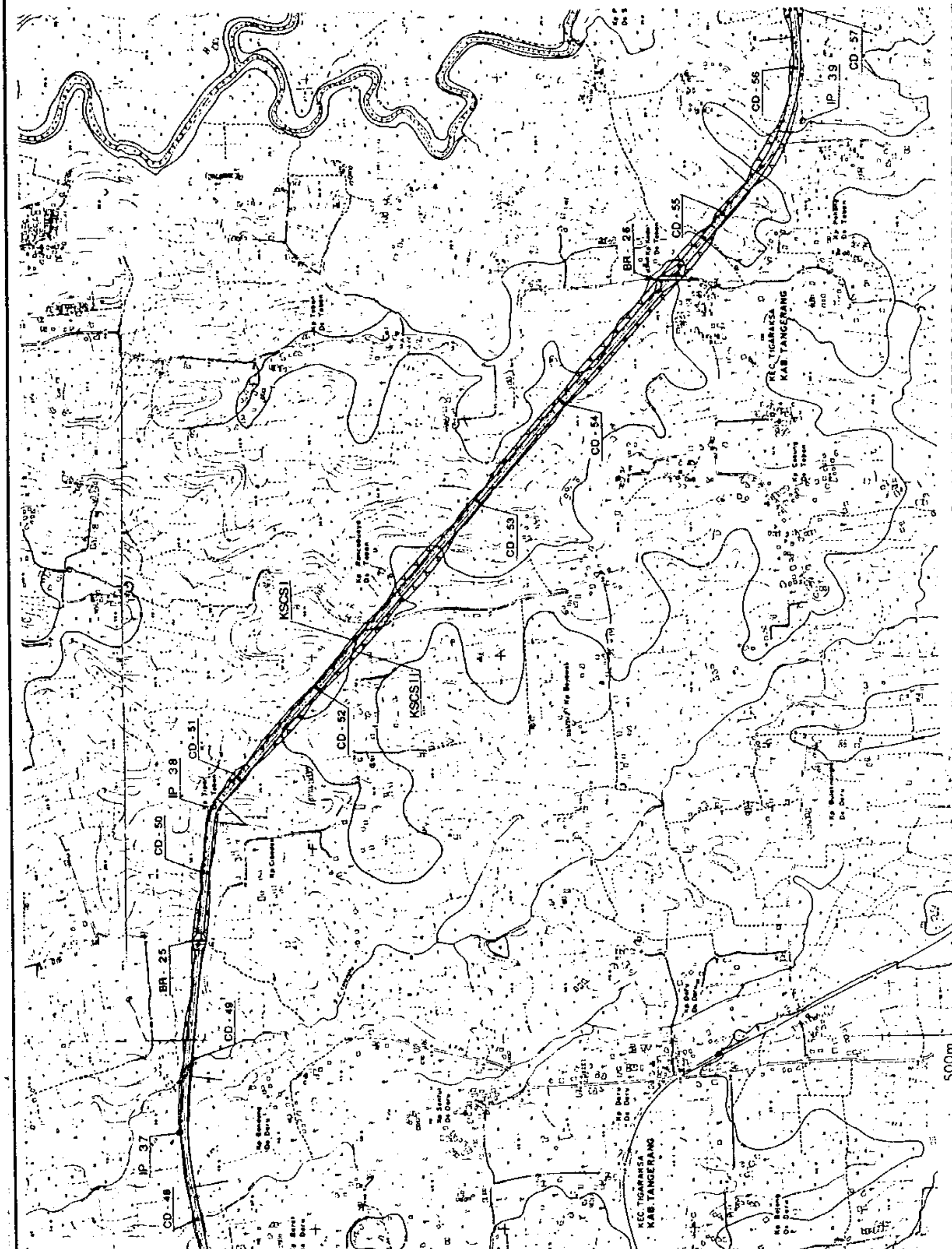


Figure 47 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (10/15)

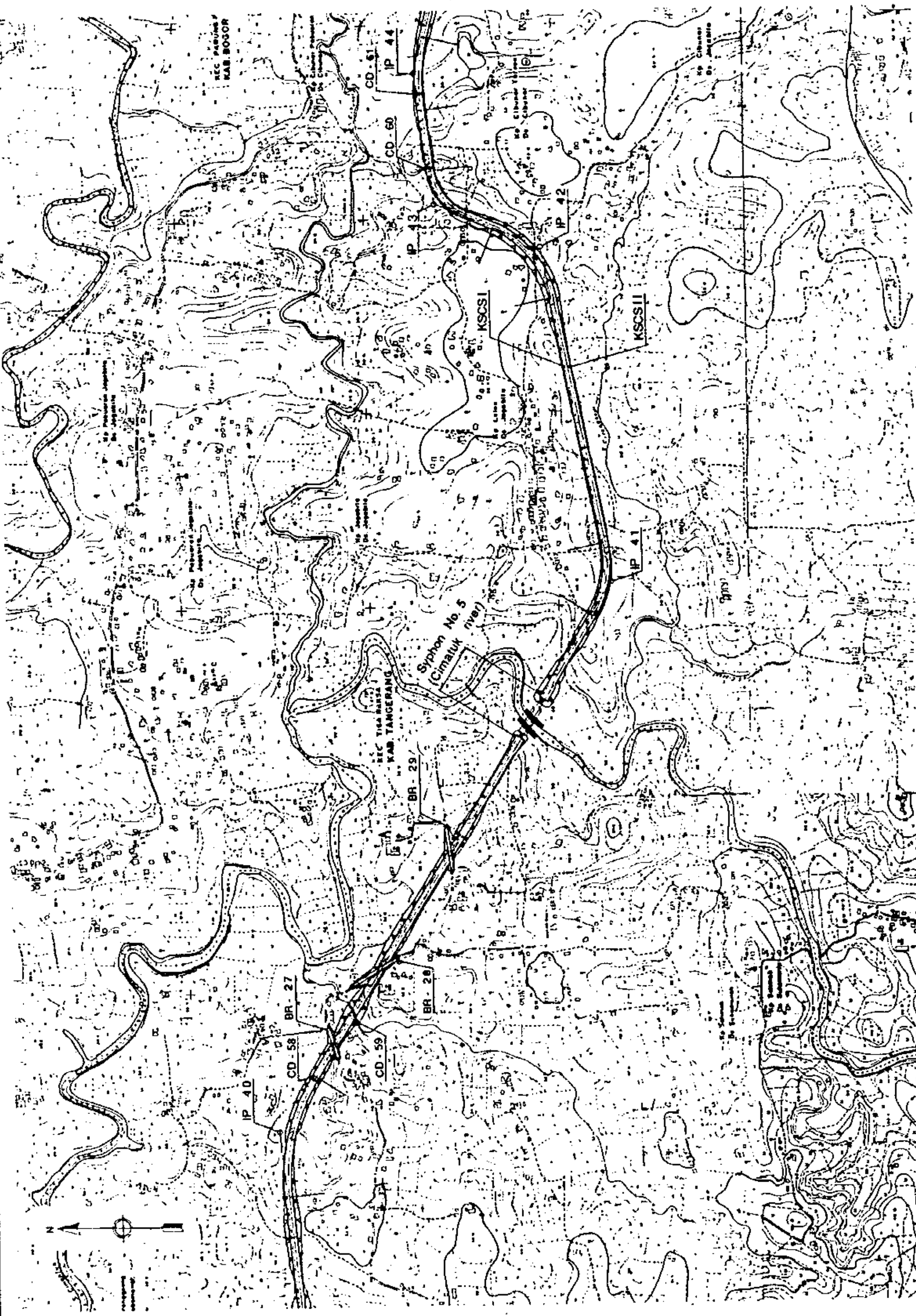


Figure 48 PLAN OF KARIAN SERPONG CONVEYANCE SYSTEM (11/15)