CHAPTER 17. ALTERNATIVE DEVELOPMENT PLAN

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CHAPTER 17. ALTERNATIVE DEVELOPMENT PLAN

17.1 Alternative Development Plan

A study was made in "9.1.5 (1) Comparative Study of Alternative Layouts" of the four alternative plans to develop a head between the Goktas and Kavsak Reservoirs. As a result of this study, Plan I -- which is to develop a head in one stage -- was selected as the fundamental development plan.

Plan III, on the other hand, was chosen as an alternative to Plan I. The main features and general layout of Plan III are shown in Table 17-1 and DWG. 17-1.

The No. 1 Powerhouse is connected to the Goktas Reservoir by a short, 880 m pressure tunnel in this plan. The discharged water (maximum 108 m^3/s) from the No. 1 Powerhouse is directly induced and conducted to the No. 2 Powerhouse through a 10.5 km non-pressure tunnel. The discharged water from No. 2 Powerhouse and the river runoff (maximum 111 m^3/s) is induced into an intake and conducted to the No. 3 Powerhouse through a 5.4 km non-pressure tunnel.

In this study, the energy calculation for each development stage was redone employing the reservoir operational rule for maintaining a high water level.

It is feasible to prepare tunnel work adits for the tunnel of the No. 2 power plant, because the tunnel can be routed along the river. These adits, moreover, will make it possible to shorten the construction period and to cope promptly and easily with such accidents as sudden emissions of water.

The characteristics of the project are described below.

o Because the investment cost of each project can be reduced by dividing one project into three, the development patterns -- such as simultaneous triple-project development, simultaneous double-project development, and series development -- are feasible considering the possible amount of funds procured.

- The economic benefits of the Nos. 2 and 3 power plant are achieved through their control of the Goktas Reservoir. The development of the No. 2 and/or No. 3 power plant without the Goktas Dam would bring about minimal economic effects in the projects, along with excessive installed capacity.

- Tunnel work adits can be prepared for the No. 2 power plant's tunnel, but a disposal area can hardly be found for the material expressed from these adits.

17.2 Transmission Plan

Total power output of the No. 1, No. 2 and the No. 3 power plants is 264,500 kW.

Because the transmission line route from the Goktas switchyard to Adana has already described at Chapter 10, it will be mentioned here the power transmission scheme from the No. 1 power station to the No. 3 power station which locates at the most downstream of Zamanti River.

(1) Transmission Route

While all three power stations are planned to develop at the right-bank side of Zamanti River, it is preferable from the topographic reason, to construct the each transmission line and switchyard at the left-bank side. Each power station and switchyard is connected by tie-transmission. The 154 kV transmission line will be two route from reliability aspect.

(2) Conductor and line length

- The No. 1 - The No. 2 Switchyard

  154 kV ACSR, 477 MCM, 2 circuits, 10 km
  Thermal capacity: 125 MW for 1 circuit

o The No. 2 - The No. 3 Switchyard

154 kV, ACSR, 1,272 MCM, 2 circuits, 7 km
Thermal capacity: 250 MW for 1 circuit

Fig. 17-1 Transmission Line for Alternative Plan

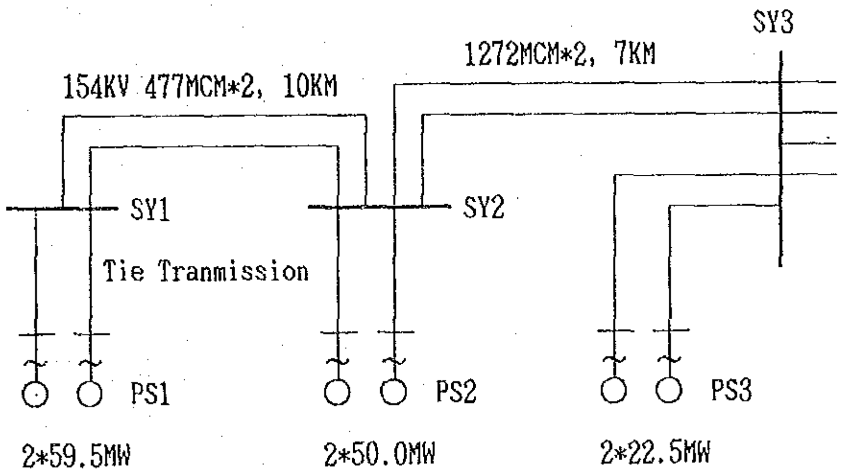


Table 17-1 Main Feature of the Alternative Plan

Item	Unit	No. 1 PS			No. 2 PS			No. 3 PS			Total		
High Water Level	m	630.0			496.0			378.0					
Low Water Level	m	620.0											
Available Drawdown	m	10.0											
Grass Storage Capacity	10^6 m^3	109.3											
Effective Storage Capacity	10^6 m^3	24.7											
Tunnel Length	m	880			10,500			5,250					
Tunnel Diameter	m	6.8			6.7			6.9					
Tunnel Gradient		1/100			1/1,500			1/1,500					
Tunnel Type		Pressure			Pressureless			Pressureless					
Maximum Discharge	m^3/s	108			108			111					
Standard Intake Water Level	m	626.7			488.7			374.5					
Tail Water Level	m	496.0			378.0			321.8					
Gross Head	m	130.7			110.7			52.7					
Effective Head	m	124.9			105.9			48.2			279.0		
Installed Capacity	MW	119.0			100.5			45.0			264.5		
Stage		I	II	III	I	II	III	I	II	III	I	II	III
Annual Inflow	10^6 m^3	1,704	1,852	1,416	1,704	1,852	1,416	1,798	1,946	1,511	–	–	–
Annual Power Discharge	10^6 m^3	1,646	1,805	1,408	1,646	1,805	1,408	1,702	1,866	1,456	–	–	–
Firm Peak Power	MW	116.9	119.0	109.4	98.3	98.3	93.2	44.4	44.3	41.8	259.6	261.6	244.4
Annual Energy Production	GWh	516.9	567.5	441.0	427.2	468.8	365.6	193.9	212.8	165.9	1,138.0	1,249.1	972.5
Plant Factor	%	49.6	54.4	42.3	48.5	53.2	41.5	49.2	54.0	42.1	49.1	53.9	42.0

17.3 Outline of Geology

This project site for development of the head from Goktas Dam to the end of Kavsak Reservoir, as shown in Fig. 17-2, similarly to the headrace tunnel route in the previously-mentioned single-stage development proposal, is composed of sedimentary rocks mainly consisting of Paleozoic to Mesozoic limestone and Mesozoic peridotite. The geologies of the principal structure sites are described below.

17.3.1 No. 1 Power Development Site

(1) Dam Site

This dam site coincides with the dam site in the previously-mentioned single-stage development scheme. The geological properties of this site which has peridotite as the base have already been described in Chapter 7, "Geology and Materials."

(2) Headrace Tunnel Route

The headrace tunnel route 880 m in length consists of peridotite. The peridotite distributed along this route, according to the surface geological reconnaissance along the Zamanti River, is tight and hard, while it is expected there are no large-scale faults along the route.

(3) Penstock and Powerhouse Sites

The right bank of the Zamanti River where the penstock and powerhouse are planned has a steep slope of average gradient 40 deg from EL. 600 m to the bed of the Zamanti River. At this slope, other than for gullies cutting in deeply and talus deposits at parts immediately below the steep slope, there is fresh, tight, and hard peridotite exposed. Although a possibility for surface-layer bedrock spalling off and falling exists, it is judged there is little possibility for large-scale collapses occurring at this slope as seen from the standpoint of geological structure.

17.3.2 No. 2 Power Development Site

(1) Intake Site

Water discharged from the No.1 Power Station would pass through a culvert and be drawn in intact at the No.2 Intake. As confirmed by Drillhole SSK-1, there is a distribution of talus deposits approximately 36 m in thickness with peridotite as the base in the section from the outlet of the No.1 Power Station to the No.2 Intake. The talus deposits consist mainly of cobble-size or boulder-size angular gravels and although the amount of fines is small in general, weathered soil and small gravels are predominant in an approximately 1-m thickness of the surface layer.

Slopes where talus deposits are distributed are generally gentle and stable, but at places next to the Zamanti River there are cliffs of specific height difference 5 to 10 m.

(2) Headrace Tunnel Route

At the headrace tunnel route of length 10.5 km, it is assumed that the distribution from the intake side is in the order of peridotite (Of), Mesozoic limestone (Jkr), Paleozoic limestone, sandy limestone, etc. (Pk). It is estimated from surface geological reconnaissances that weathered layers at the ground surface are thin at all of these rocks so that the headrace tunnel will pass through fresh parts of the various bedrocks. However, as confirmed by Drillhole TB-1, there are thin oxidized solution cracks in the limestone.

There are numerous faults beside a thrust fault at the boundary between peridotite (Of) and Mesozoic limestone (Jkr) at the headrace tunnel route. However, as stated previously in Chapter 7, it is assumed that the widths of the sheared zones and altered zones of these faults are small and it is judged that there is little possibility of tunnel excavation being made extremely difficult over a long distance.

(3) Penstock and Powerhouse Sites

The right-bank slope of the Zamanti River where the penstock and the powerhouses are planned has a steep gradient of 35 to 40 deg. At this slope, other than for a slight amount of talus deposits in the vicinity of the river bed, most consists of exposed fresh Paleozoic limestone (Pk).

Bedding planes are recognized in the limestone at intervals of 50 to 200 cm, with the direction dipping to the south, or into the mountain at 0 to 30 deg. With such a geological structure, although there is a possibility for spalling and collapse of the surface layer rock occurring at this slope, it is judged there is little chance of a large-scale collapse occurring.

17.3.3 No. 3 Power Development Site

(1) Intake Dam Site

The intake dam site is composed of alluvial deposits and basement rock consisting of the Devonian (D) and the Permian (Pk) strata which are mainly Paleozoic limestone. The slopes at both sides have steep gradients of approximately 45 deg with mostly fresh bedrock exposed and there are practically no talus deposits. It is assumed there is distribution of thick alluvium at the river bed. The thickness is estimated to be about 20 m judging by the results of geological investigations at the dam site of the No.1 Power Generation Project and the topography at this site.

(2) Headrace Tunnel Route

The headrace tunnel route of length of 5.25 km is composed of Paleozoic limestone, sandy limestone, etc. (Pk). According to surface geological reconnaissances, the weathered layer at the ground surface is thin, and therefore, it is estimated that the headrace tunnel will pass through fresh rock. However, as has been confirmed by Drillhole TB-2, there are thin oxidized solution cracks developed in the limestone.

It is assumed that numerous faults are distributed along the headrace tunnel route. However, as mentioned previously in Chapter

7, the widths of the sheared zones of these faults are estimated to be small, and it is judged that there is little possibility of tunnel excavation being made greatly difficult over a long distance.

(3) Penstock and Powerhouse Sites

The projected locations of these structures coincide with those in the single-stage proposal. The geologies of these sites have been described in Chapter 7.

17.4 Conceptional Design

17.4.1 Dam and Appurtenant Structures

Since the dam site and particulars of the No. 1 Power Plant are the same as in the Basic Plan, structural types the same as in the Basic Plan will be optimum for the dam and appurtenant structures of the No. 1 Power Plant (see 11.2). That is, the dam body would be an arch-gravity type with three spillway gates provided.

From the viewpoint of economy, the No. 2 Power Plant will not have an intake dam, with direct conduction done through a culvert from the tailrace of the No. 1 Power Plant to the intake of the No. 2 Power Plant. This is because the residual catchment area between the dam of the No. 1 Power Plant and the intake of the No. 2 Power Plant is small and hardly any increase in available discharge of the No. 2 Power Plant can be looked forward to even if an intake dam were to be constructed.

The intake dam for the No. 3 Power Plant is planned at a site where the river is narrow approximately 13 km downstream from the No. 1 Power Plant dam. Since the flood water level will rise much higher than the High Water Level at the intake dam site during a flood, the dam is to be a concrete gravity type with no spillway gate, allowing flood water to overtop the dam body.

The features of the dams of power plants and of appurtenant structures are given in Table 17-2.

Table 17-2 Features of Dam and the Appurtenant

	No. 1	No. 2	No. 3
<u>Dam</u>			
Type	Arch gravity	-	Gravity
Height	148 m	-	25 m
Slope	1:0.6	-	1:0.8
Concrete Volume	8.0×10^5 m^3	-	0.1×10^5 m^3
<u>Spillway</u>			
Type	Gated Chute	-	Overtoppable Type
Design Discharge	3,900 m^3/s	-	4,100 m^3/s
<u>Care of River</u>			
Type	Diversion Tunnel	-	Diversion Canal
Design Discharge	530 m^3/s	-	550 m^3/s

17.4.2 Waterway and Powerhouse

(1) No. 1 Power Plant

For the intake and headrace tunnel, it is judged that a gated vertical shaft type and a pressure tunnel of inside diameter 6.80 m, respectively, the same as in the Basic Plan, will be optimum. A simple surge tank is to be provided in order to cope with load fluctuations of generators. The penstock is to be a inclined shaft type in consideration of the topography with water conducted to the powerhouse branched into two lines immediately upstream of the powerhouse.

The topography in the vicinity of the powerhouse is not very steeply sloped so that excavation volume would not be excessive even with a exposed type, and so a exposed type powerhouse excelling in economics and constructability is to be adopted.

Since the outer peripheral wall must be made high in order to escape inundation even at time of Provable Maximum Flood (PMF), a building will be omitted, selecting a structure where equipment would be delivered to the election bay by a gantry crane installed at the powerhouse. The height of the peripheral wall at the tailrace was designed so that the waterway would not be buried by sediment even with a 100-year return period flood. When there is outage of the No. 2 Power Plant, discharge from the No. 1 Power Plant would flow into the Zamanti River overtopping the peripheral wall of the tailrace.

(2) No. 2 Power Plant

As mentioned in 17.4.1, the No. 2 Power Plant would draw water directly from the tailrace of the No. 1 Power Plant, cross the Burukboz Gully with a non-pressure culvert, and then conduct the water to a surge tank by a non-pressure tunnel (inside diameter 6.70 m, standard horseshoe shape) 10.5 km in length.

Since the vicinity of the surge tank and powerhouse is of especially rugged topography, it is thought reasonable for water to be conducted by a penstock of vertical-shaft type to a semi-underground powerhouse of double vertical-shaft type similarly to the Basic Plan.

(3) No. 3 Power Plant

Although a Tyrolean type is conceivable for the method of intake from the intake dam, since there would be concern about screen damage due to boulders, it is thought a side inflow type intake provided at the side of the dam will be less affected by the river and match the characteristics of the site. The intake would be a structure of large width since the type is for intake of 111 m^3/s of power discharge water from a small depth.

The type of headrace tunnel, surge tank, penstock, and powerhouse would be the same as for the No. 2 Power Plant.

17.4.3 Electro-mechanical Equipment

In selection and conceptional design of the electro-mechanical equipment for the three power plants, the numbers of units of main equipment were decided to be two units each for the same reasons as the basic proposal, while the main transformers, 154 kV switchyards and tie transmission lines are to be of the same compositions as in the basic proposal because of topographical constraints. The specifications for electro-mechanical equipment of the three power plants for the alternative proposal such as type of turbine determined by available discharge and normal effective head are given below.

(1) No. 1 Power Plant

Type	Vertical Francis
Number of units	2 units
Normal effective head	124.9 m
Available discharge	54 m^3/sec.
Output	60.8 MW
Speed	250 rpm

Generator

Type	3-phase, AC, synchronous
Number of units	2 units
Capacity	66 MVA
Power factor	0.9 lagging
Speed	250 rpm
Frequency	50 Hz
Voltage	13.8 kV

Main Transformer

Type	Outdoor, single-phase
Number of units	7 units (incl. 1 reserve)
Capacity	22 MVA
Voltage	13.8 kV : $154/\sqrt{3}$ kV

Switchyard

Bus system	Main bus + transfer bus
Bus	Self-supporting type aluminum pipe bus
Number of connections	4 bays
Voltage	154 kV

Tie Transmission Line

Number of circuits	2 circuits
Number of towers	3 sets (double-circuit type steel tower)
Voltage	154 kV
Type of conductor	ACSR 477 MCM
Section	Powerhouse - switchyard

(2) No. 2 Power Plant

Turbine

Type	Vertical Francis
Number of units	2 units
Normal effective head	105.9 m
Available discharge	54 m^3/sec.
Output	50.25 MW
Speed	250 rpm

Generator

Type	3-phase, AC, synchronous
Number of units	2 units
Capacity	56 MVA
Power factor	0.9 lagging
Speed	250 rpm
Frequency	50 Hz
Voltage	13.8 kV

Main Transformer

Type	Outdoor, single-phase
Number of units	7 units (incl. 1 reserve)
Capacity	18.7 MVA
Voltage	13.8 kV : $154/\sqrt{3}$ kV

Switchyard

Bus system	Main bus + transfer bus
Bus	Self-supporting type aluminum pipe bus
Number of connections	6 bays
Voltage	154 kV

Tie Transmission Line

Number of circuits	2 circuits
Number of towers	3 sets (double-circuit type steel tower)
Voltage	154 kV
Type of conductor	ACSR 477 MCM
Section	Powerhouse - switchyard

(3) No. 3 Power Plant

Turbine

Type	Vertical Francis
Number of units	2 units
Normal effective head	48.2 m
Available discharge	55.5 m^3/sec.
Output	23.2 MW
Speed	250 rpm

Generator

Type	3-phase, AC, synchronous
Number of units	2 units
Capacity	25 MVA
Power factor	0.9 lagging
Speed	250 rpm
Frequency	50 Hz
Voltage	11.0 kV

Main Transformer

Type	Outdoor, single-phase
Number of units	7 units (incl. 1 reserve)
Capacity	8.3 MVA
Voltage	11.0 kV : $154/\sqrt{3}$ kV

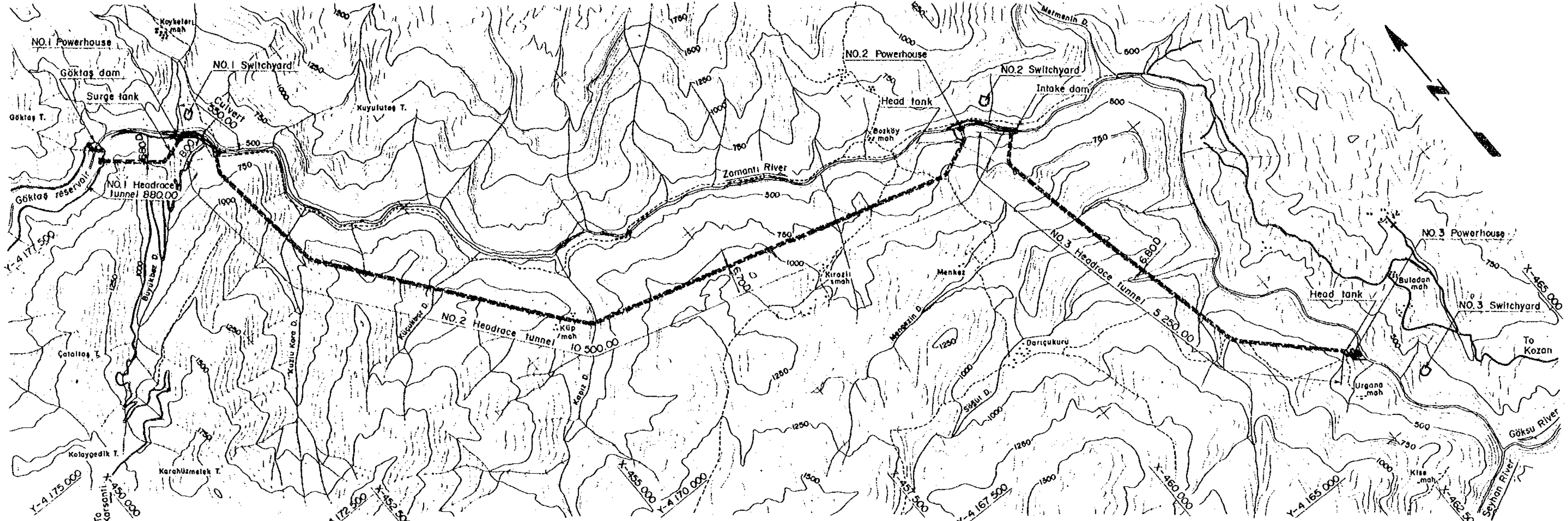
Switchyard

Bus system	Main bus + transfer bus
Bus	Self-supporting type aluminum pipe bus
Number of connections	7 bays
Voltage	154 kV

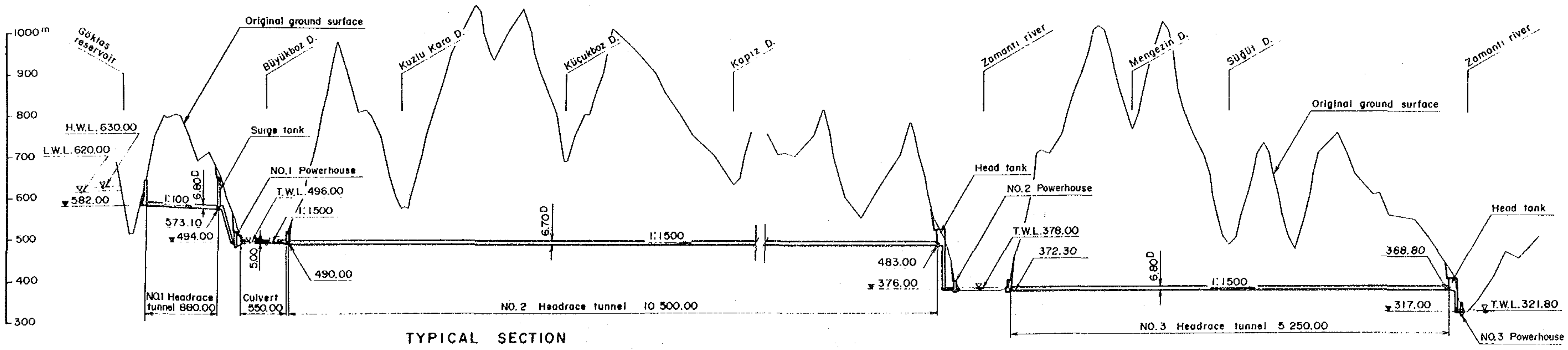
Tie Transmission Line

Number of circuits	2 circuits
Number of towers	3 sets (double-circuit type steel tower)
Voltage	154 kV
Type of conductor	ACSR 477 MCM
Section	Powerhouse - switchyard

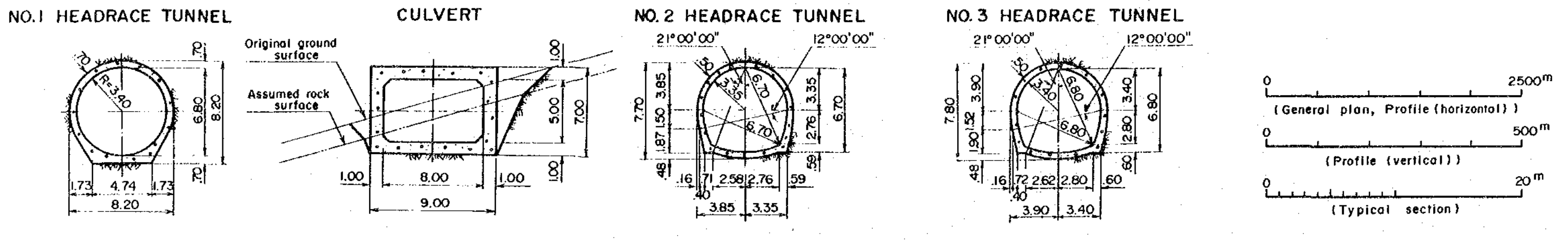
GENERAL PLAN



PROFILE



TYPICAL SECTION

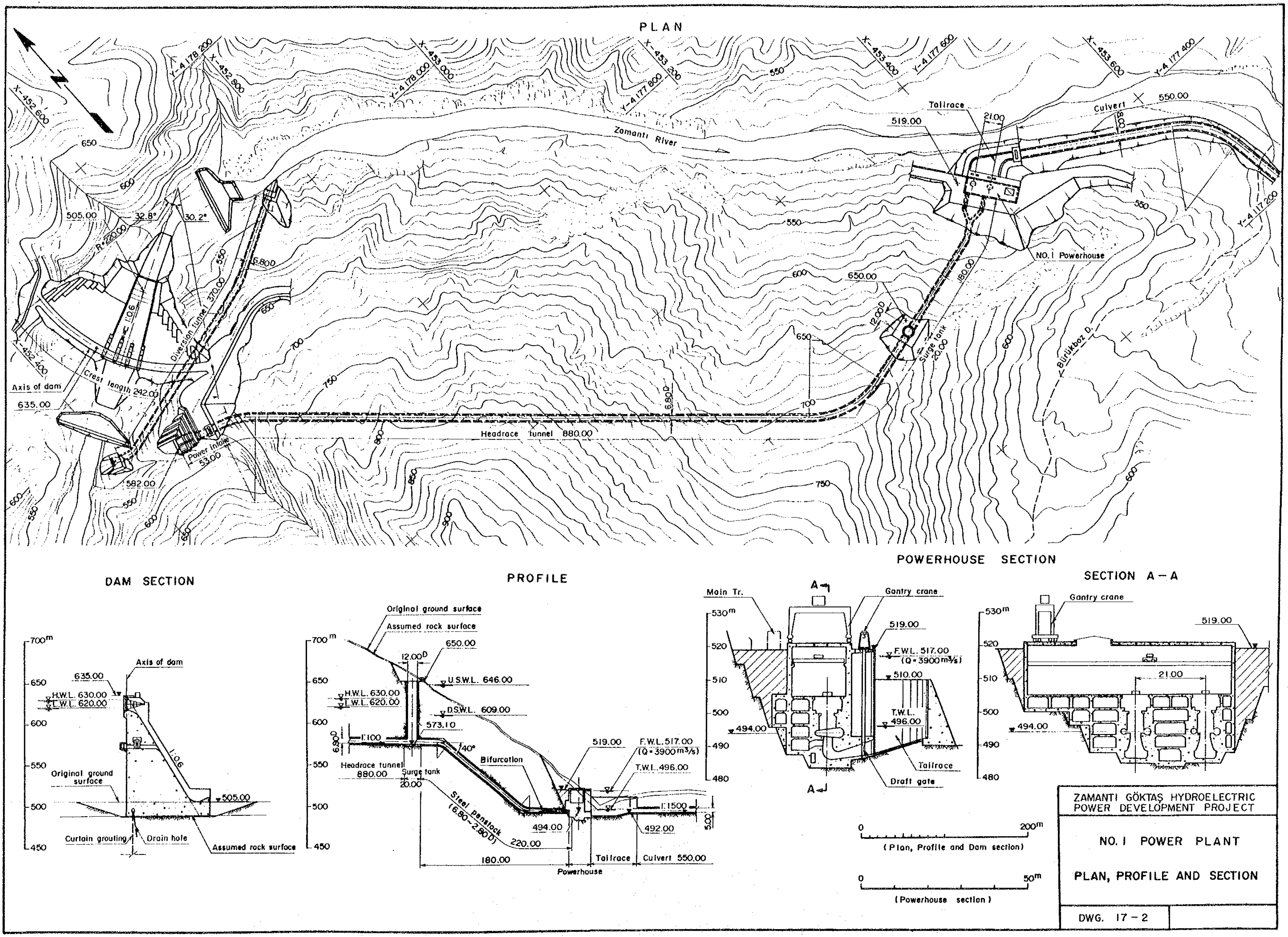


ZAMANTI GÖKTAŞ HYDROELECTRIC
POWER DEVELOPMENT PROJECT

ALTERNATIVE PLAN

GENERAL PLAN, PROFILE
AND TYPICAL SECTION

DWG 17 - 1



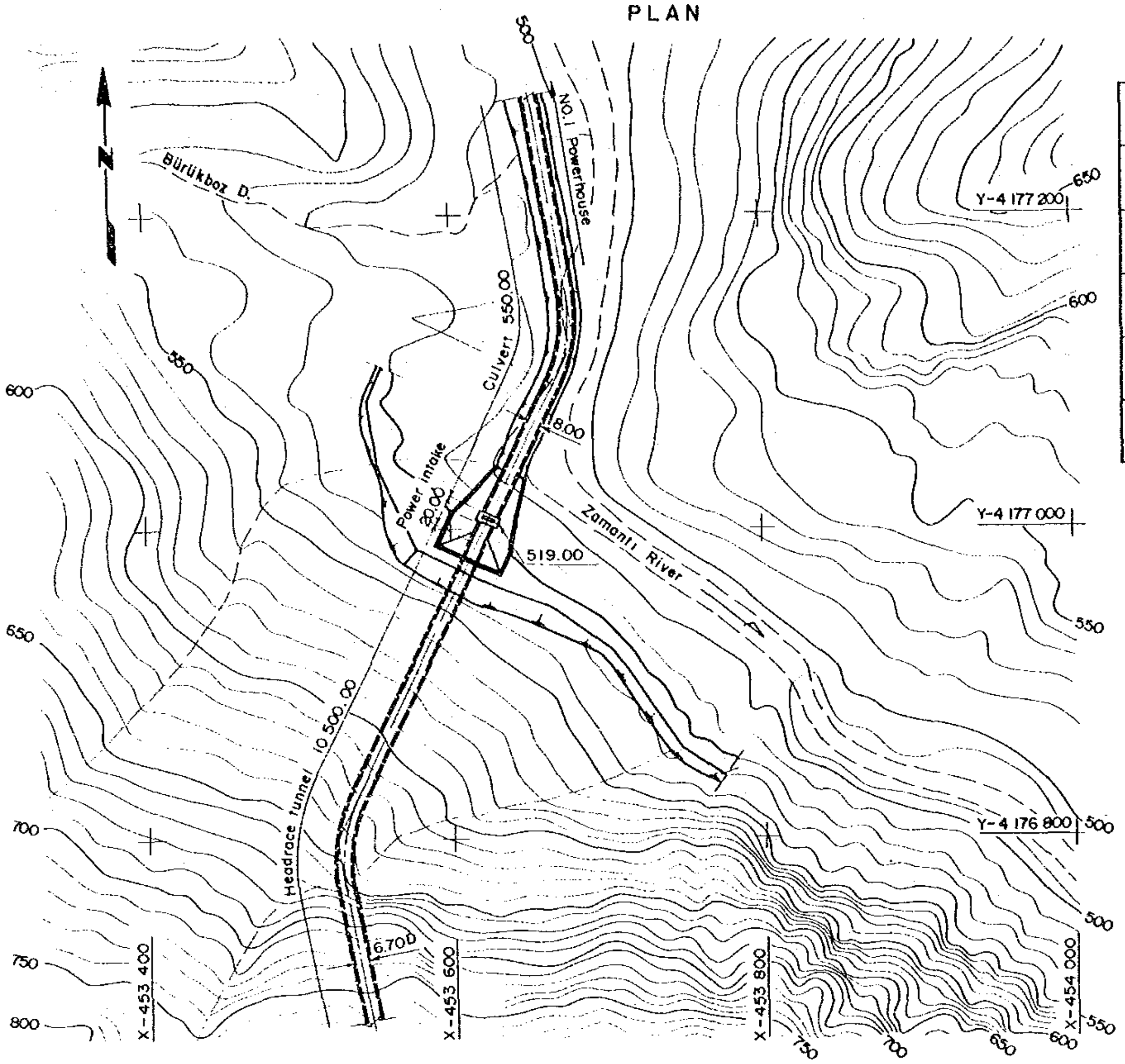
ZAMANTI GÖKTAŞ HYDROELECTRIC
POWER DEVELOPMENT PROJECT

NO. I POWER PLANT

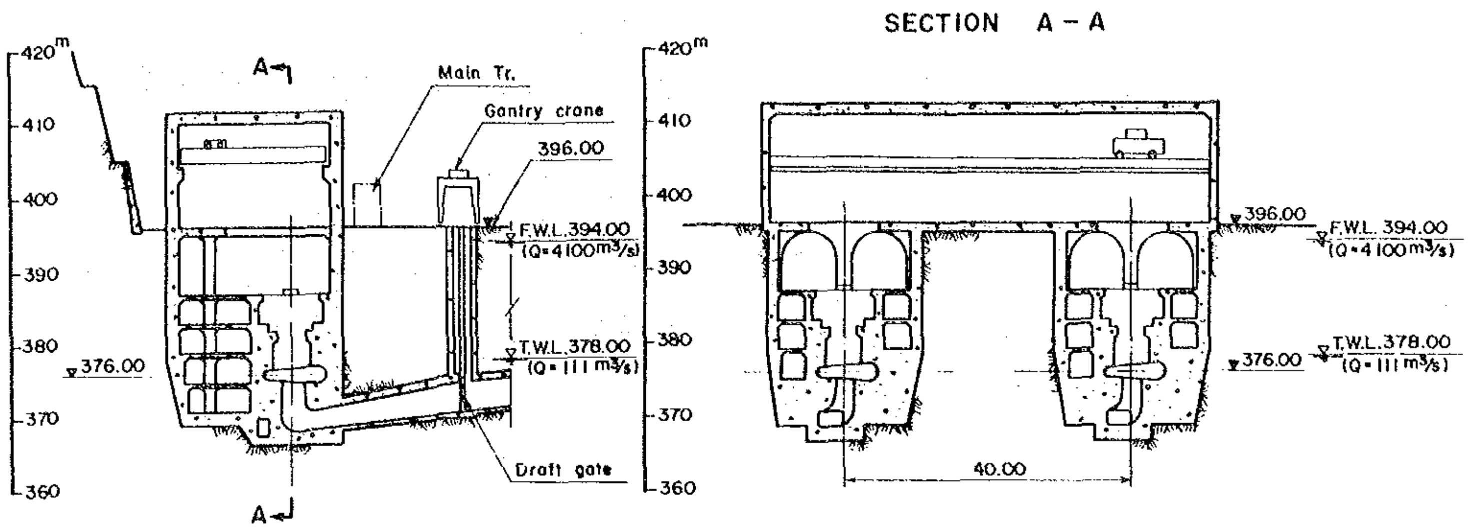
PLAN, PROFILE AND SECTION

DWG. 17 – 2

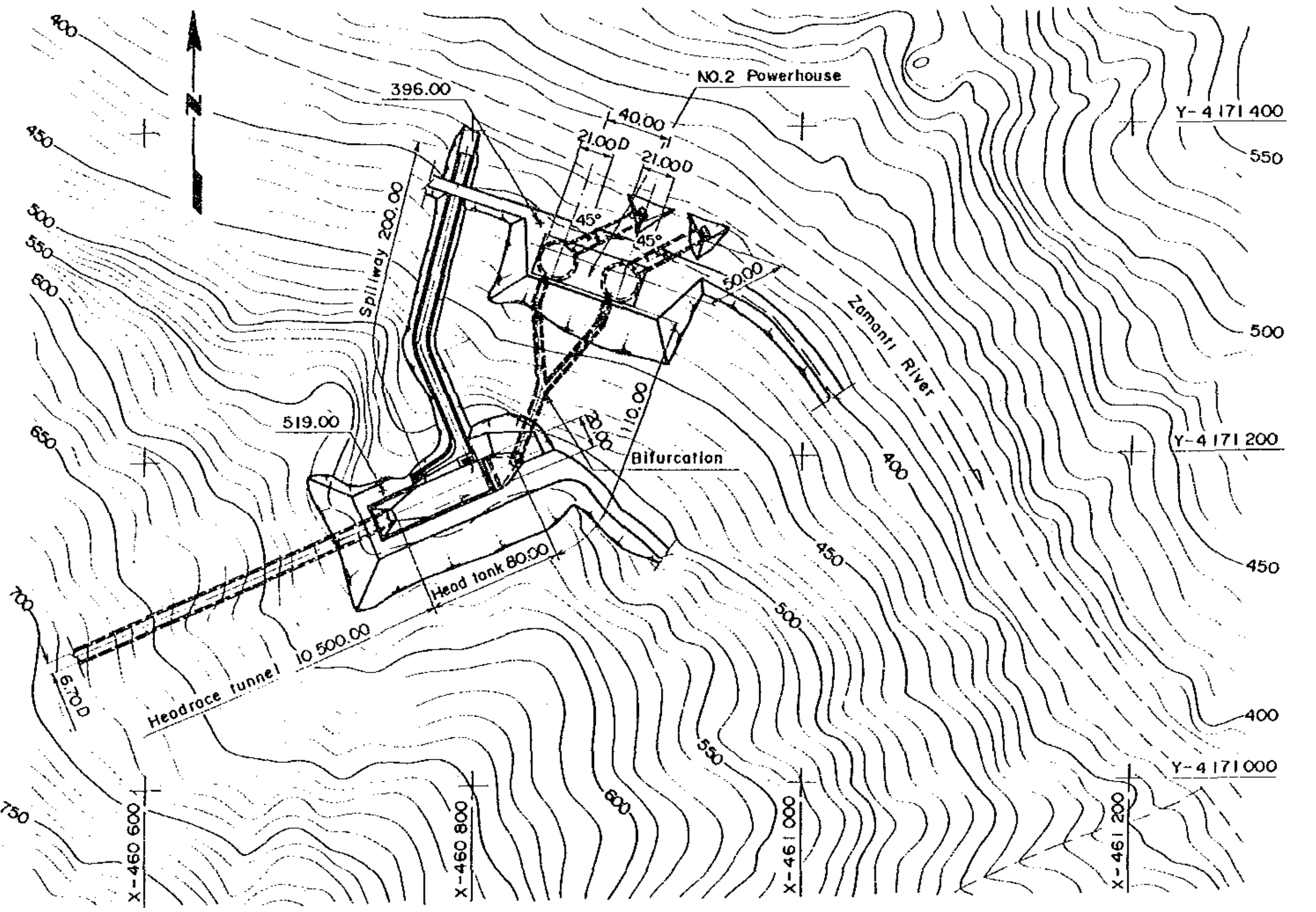
PLAN



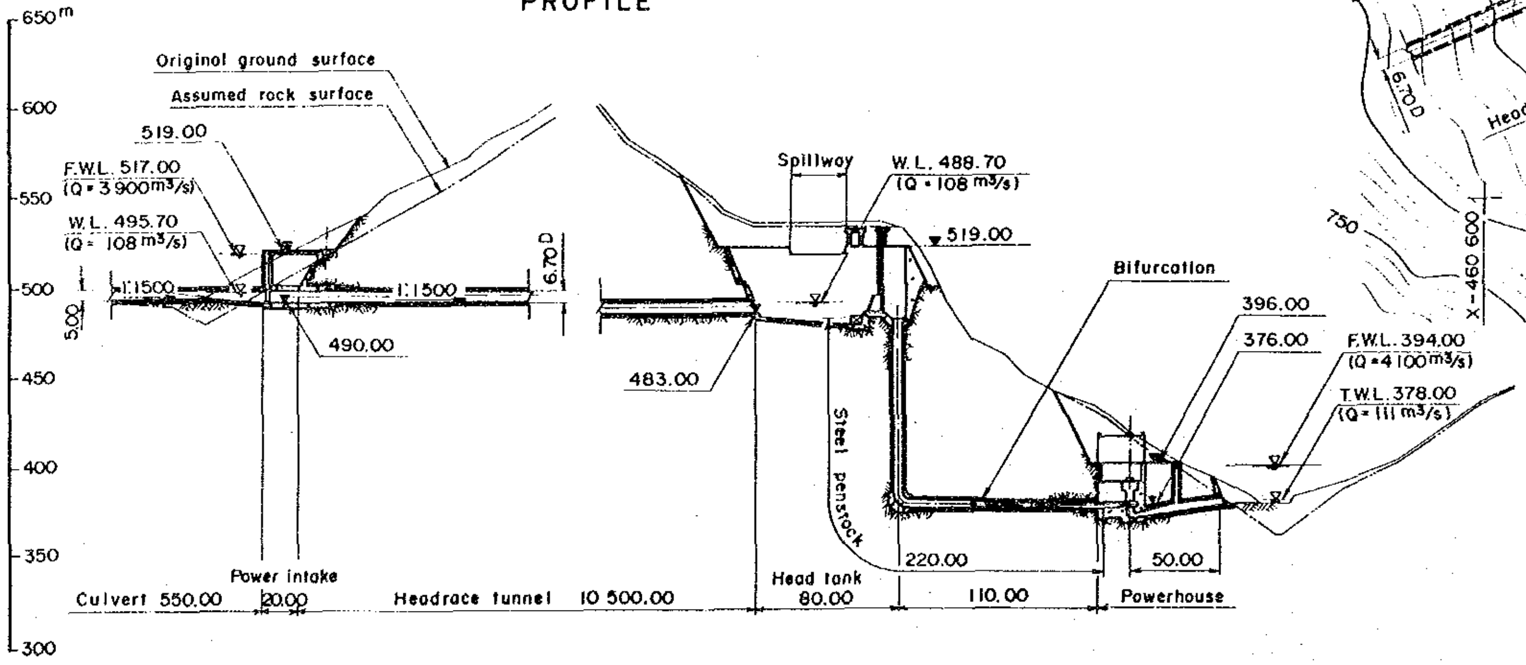
POWERHOUSE SECTION


SECTION A – A

PLAN



PROFILE



0 200m
(Plan, Profile)

0 50m
(Section)

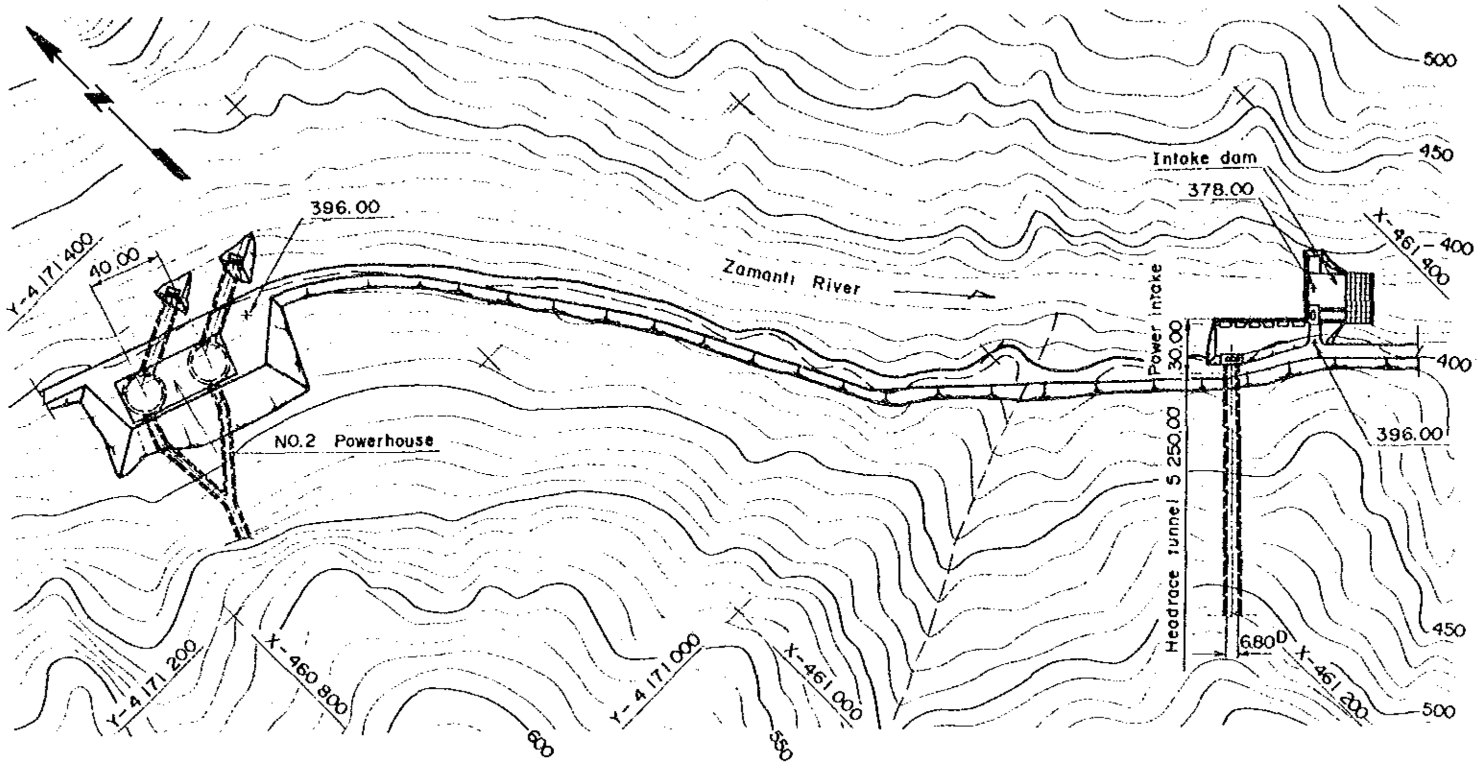
ZAMANTI GÖKTAŞ HYDROELECTRIC
POWER DEVELOPMENT PROJECT

NO. 2 POWER PLANT

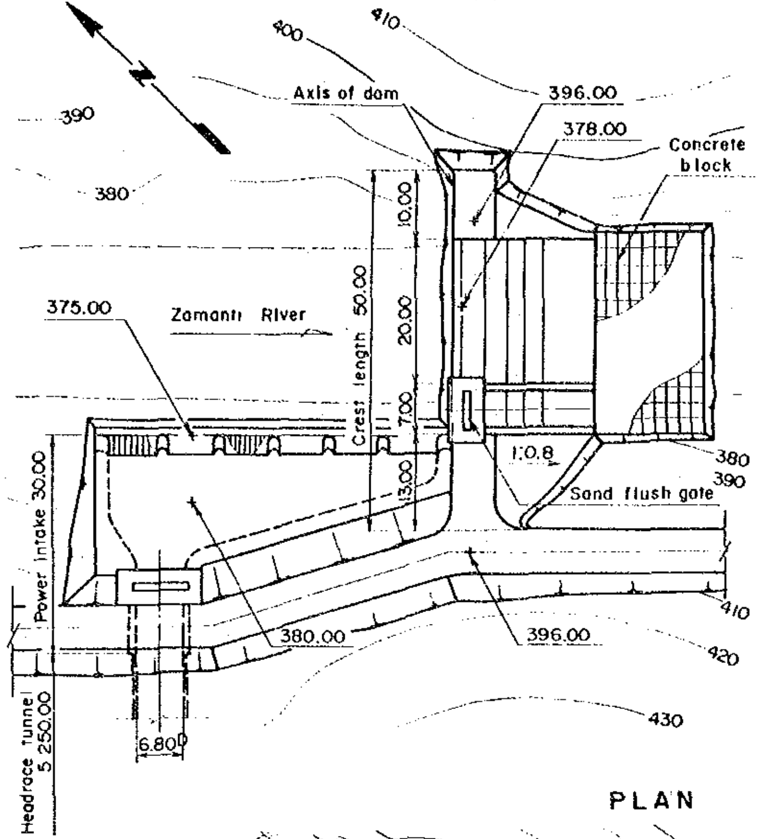
PLAN, PROFILE AND SECTION

DWG. 17-3

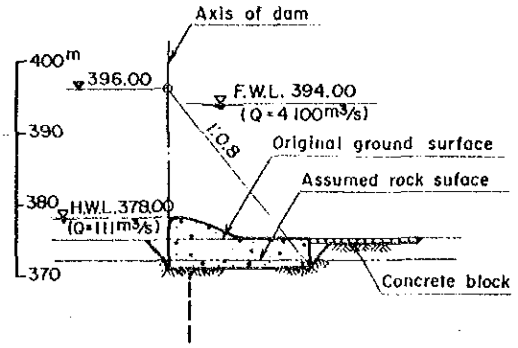
PLAN



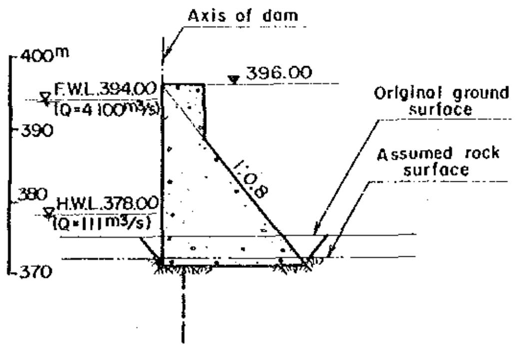
DETAIL OF INTAKE DAM



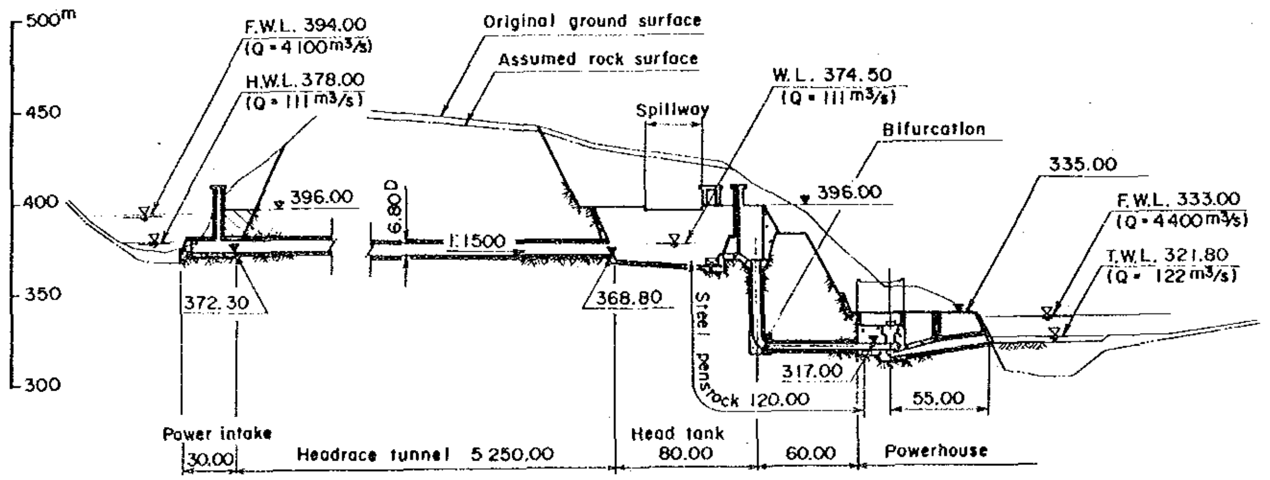
OVERFLOW SECTION



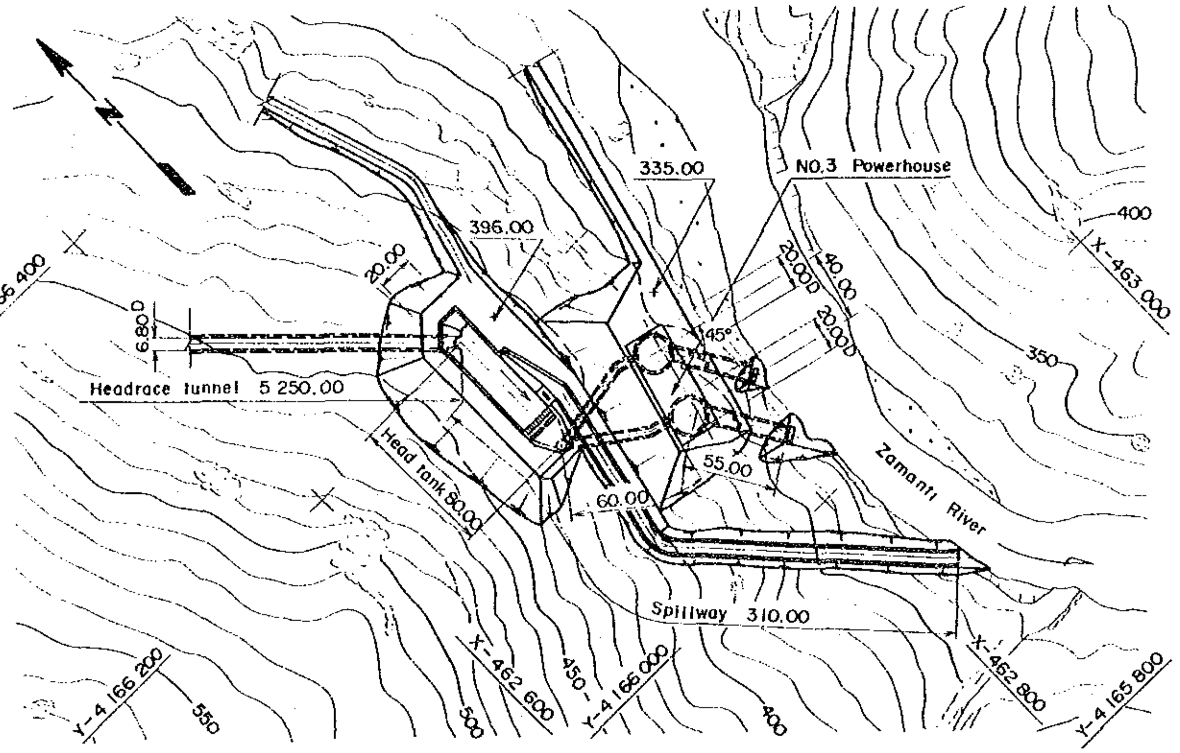
NON- OVERFLOW SECTION



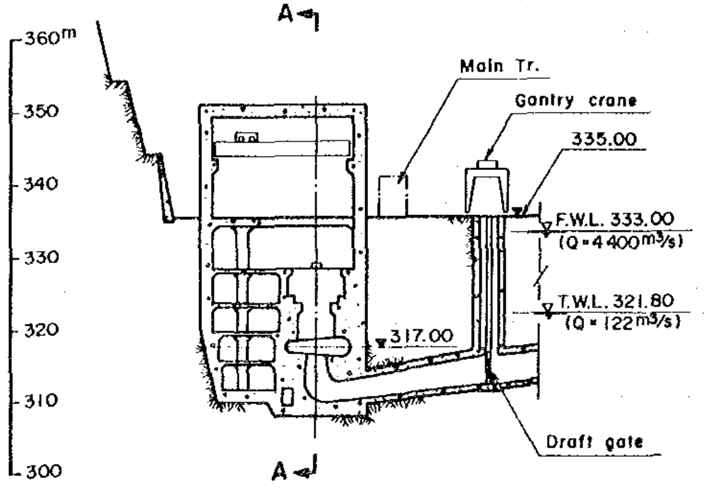
PROFILE



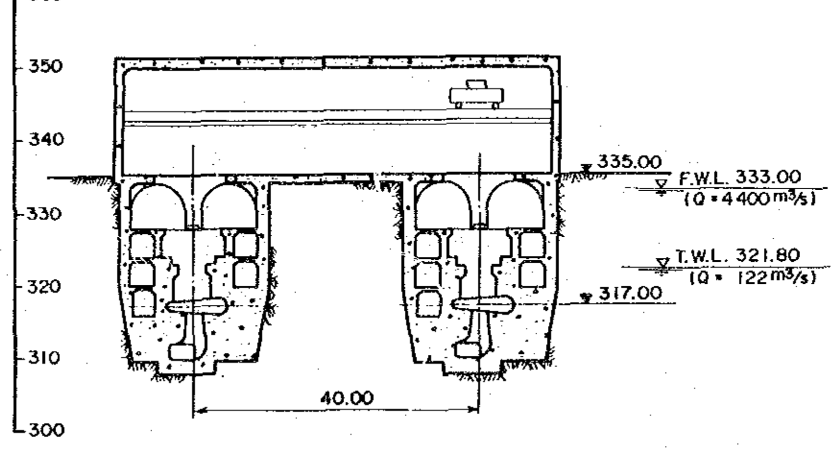
PLAN

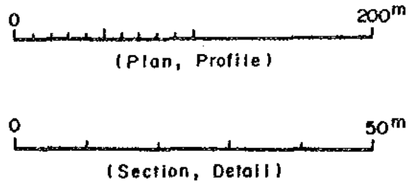


POWERHOUSE SECTION



SECTION A-A



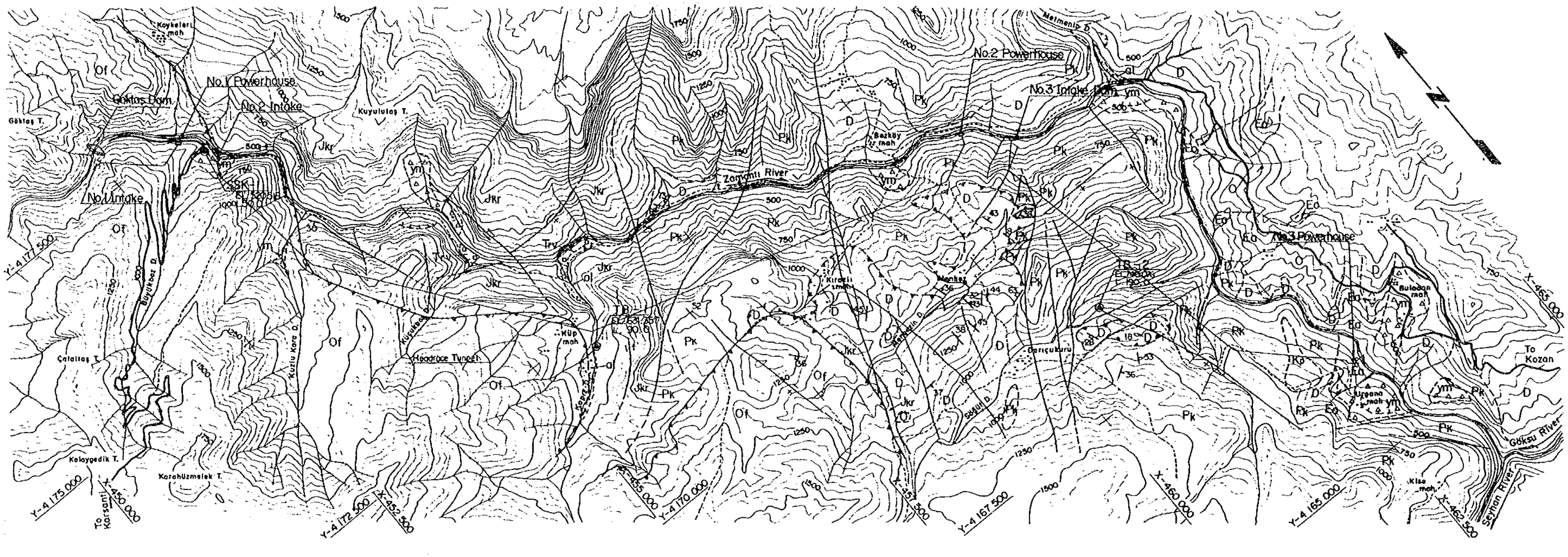


ZAMANTI GÖKTAŞ HYDROELECTRIC
POWER DEVELOPMENT PROJECT

NO. 3 POWER PLANT

PLAN, PROFILE AND SECTION

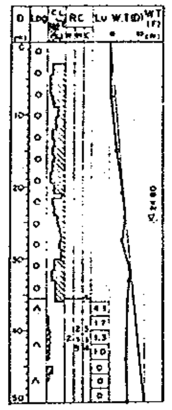
DWG. 17-4



Hole No.SSK-1

Elevation: 520.34 m

Depth of Hole: 50.00 m Angle from Horizontal: Vertical



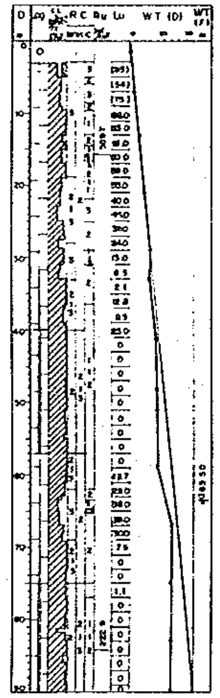
Legend of Geological Log

- ⊙ Alluvium
- ^ Peridotite
- Limestone
- Limestone (Bituminous)
- Sandy limestone
- Dolomitic limestone
- Sandstone

Hole No.TB-1

Elevation: 631.787 m

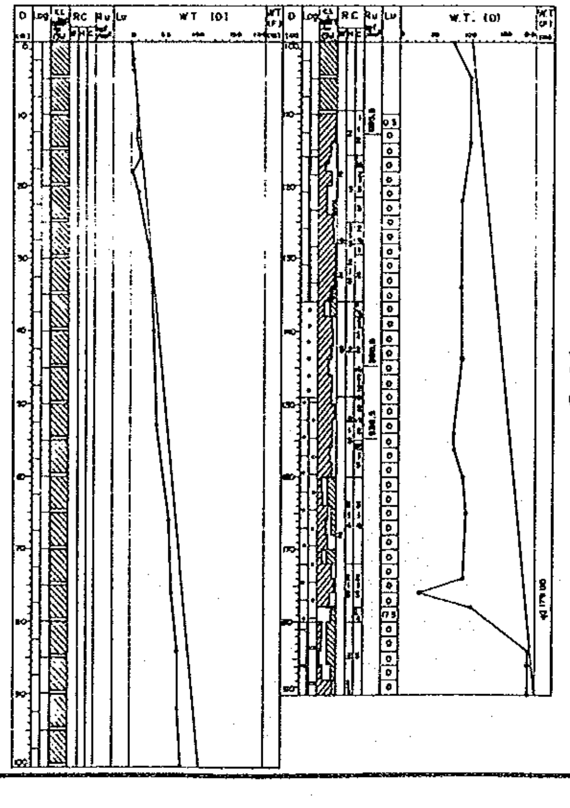
Depth of Hole: 90.00 m Angle from Horizontal: Vertical



Hole No.TB-2

Elevation: 740.07 m

Depth of Hole: 190.00 m Angle from Horizontal: Vertical

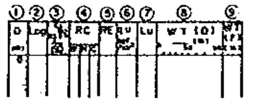


LEGEND

	Symbol	
Quaternary	al	Alluvium
	ym	Slope Wash
	Trv	Travertine
Cretaceous	Of	Ophiolite (Peridotite)
	Kp	Sandstone, Siltstone, Shale
Jurassic Cretaceous	Jkr	Limestone
Carboniferous ~Permian	Pk	Limestone, Sandstone
Devonian	D	Limestone, Dolomitic limestone, Shale, Sandstone
Ordovician	O	Shale, Siltstone
Cambrian	Eo	Limestone
	Eo	Standstone, Shale, Quartzite, Limestone

- Geologic Boundary
- 20 Strike and Dip of Strata
- 80 Strike and Dip of Joint
- Fault and Direction of Movement
- Overthrust
- Fault (assumed)
- Rock Slide Surface
- Spring Through Limestone Cave
- ◉ Drillhole

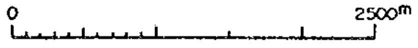
DRILLING LOGS



① Depth of Drillhole (m)
② Geological Log
③ R.Q.D.=Rock Quality Designation (%)
C.L. =Core Loss (%)
④ R.C. =Rock Classification
W: Weathering 1 (Very Fresh) ~ 5 (Strongly Weathered)
H: Hardness 1 (Very Hard) ~ 5 (Soft)
C: Interval of Cracks 1 (Over 30cm) ~ 5 (Under 1 cm)
⑤ R.E. =Rock Evaluation
ⓐ Very Good
ⓔ Very Bad
⑥ q_u =Unconfined Compression Strength of Core (kgf/cm^2)
⑦ Lu =Lugeon Value ($\ell/m/min/10kgf/cm^2$)
( ): Converted Lugeon Value
⑧ W.T.(O) =Water Table in Drillhole during Drilling
⑨ W.T.(F) =Final Water Table (m)

Note: This map is compiled on the basis of data as follows:

1. Geological Map of Dam, Tunnel Route and Powerplant sites (Scale : 1/25,000) DSI, 1988
2. Results of aerialphoto interpretation (1988) and geological mapping (1987, 1988) by JICA



ZAMANTI GÖKTAŞ HYDROELECTRIC
POWER DEVELOPMENT PROJECT

GEOLOGICAL MAP OF ALTERNATIVE DEVELOPMENT PLAN AREA

Fig. 17 – 2

17.5 Cost Estimation

The estimate of the construction cost of the alternative plan was based on 12.1.1 and 12.2.1, "Fundamental Matters" in Chapter 12, "Construction Planning and Cost Estimation". The construction costs of transmission lines, roads and transmission lines for construction, and camp facilities were calculated allocating to the three power plants as shown below.

Transmission Lines and Substations

Section	Allocation
No. 1 Switchyard - No. 2 Switchyard	No. 1 Power Plant
No. 2 Switchyard - No. 3 Switchyard	No. 1 and No. 2 Power Plant by capacity ratio
No. 3 Switchyard - Yedigoze Substation	No. 1, No. 2, No. 3 Power Plant by capacity ratios

Roads and Transmission Lines for Construction (Preparation Works)

Section	Allocation
Goktas Dam - No. 2 Intake	No. 1 Power Plant
No. 2 Intake - No. 3 Intake	No. 1 and No. 2 Power Plant by capacity ratio
No. 3 Intake - Postkabasakal or Kozan	No. 1, No. 2, No. 3 Power Plant by capacity ratios

Camp Facilities

According to No. 1, No. 2 and No. 3 Power plant capacity ratios.

The construction costs of the individual power plant are given in Table 17-3.

17.6 Economic Evaluation

The economic condition of the alternative development plan was studied adopting the method in which the cost of the alternative thermal powerplant is used as the benefit of the project as mentioned in "9.1.3 Basic Condition for the Study". The main feature and value adopted of the alternative thermal power plant is shown in Table 17-4.

The annual surplus benefit (B-C) and benefit cost ratio (B/C) at first stage, obtained from equalized annual cost (C) for the project life of the hydropower facility and the equalized annual cost (B) of the alternative thermal facility, is shown in Table 17-5. The construction cost of the transmission line from the No. 3 power station to the Yedigoze Switchyard and the Acarca Substation is distributed to three powerplants cost according to each installed capacity.

Energy calculation of No. 2 and No. 3 powerplants was carried out on condition that inflow is controlled in the No. 1 power plant reservoir. Therefore, the economic condition of No. 2 and No. 3 power plants will be lowered, when they are constructed before No. 1 powerplant.

Table 17-3 Estimated Construction Cost of Alternative Plan

(Unit: 10^6 T.L)

	Total	No. 1 Power Plant	No. 2 Power Plant	No. 3 Power Plant	Note
	264.5 MW	119.0 MW	100.5 MW	45.0 MW	
1. Civil Works					
(1) Care of River	6,796	6,163	0	633	Construction Period
(2) Dam	68,721	67,811	0	910	No. 1 Power Plant: 5 years
(3) Waterway	106,373	11,869	61,780	32,724	No. 2 Power Plant: 4.5 years
(4) Powerhouse & Switchyard	33,985	10,557	11,928	11,500	No. 3 Power Plant: 4.0 years
(5) Access Road	1,525	1,123	201	201	
(6) Camp Facilities	8,614	3,876	3,273	1,465	
(7) Preparation Works	29,901	15,002	11,953	2,946	
(8) Contingency	38,387	17,460	13,370	7,557	
(9) Sub-total	294,302	133,861	102,505	57,936	
2. Hydraulic Equipment	16,939	9,534	4,483	2,922	
3. Electromechanical Equipment	144,900	52,400	52,700	39,800	
4. Transmission Line	18,319	8,976	6,569	2,774	
5. Total (Direct Cost)	474,460	204,771	166,257	103,432	
6. Project Controlling	71,170	30,716	24,939	15,515	
7. Land Acquisition	250	250	0	0	
8. Total (Project Cost)	545,880	235,737	191,196	118,947	
9. Interest during Construction	116,308	53,748	39,960	22,600	
10. Grand Total	662,188	289,485	231,156	141,547	

Fig. 17-3 Construction Schedule of Alternative Plan

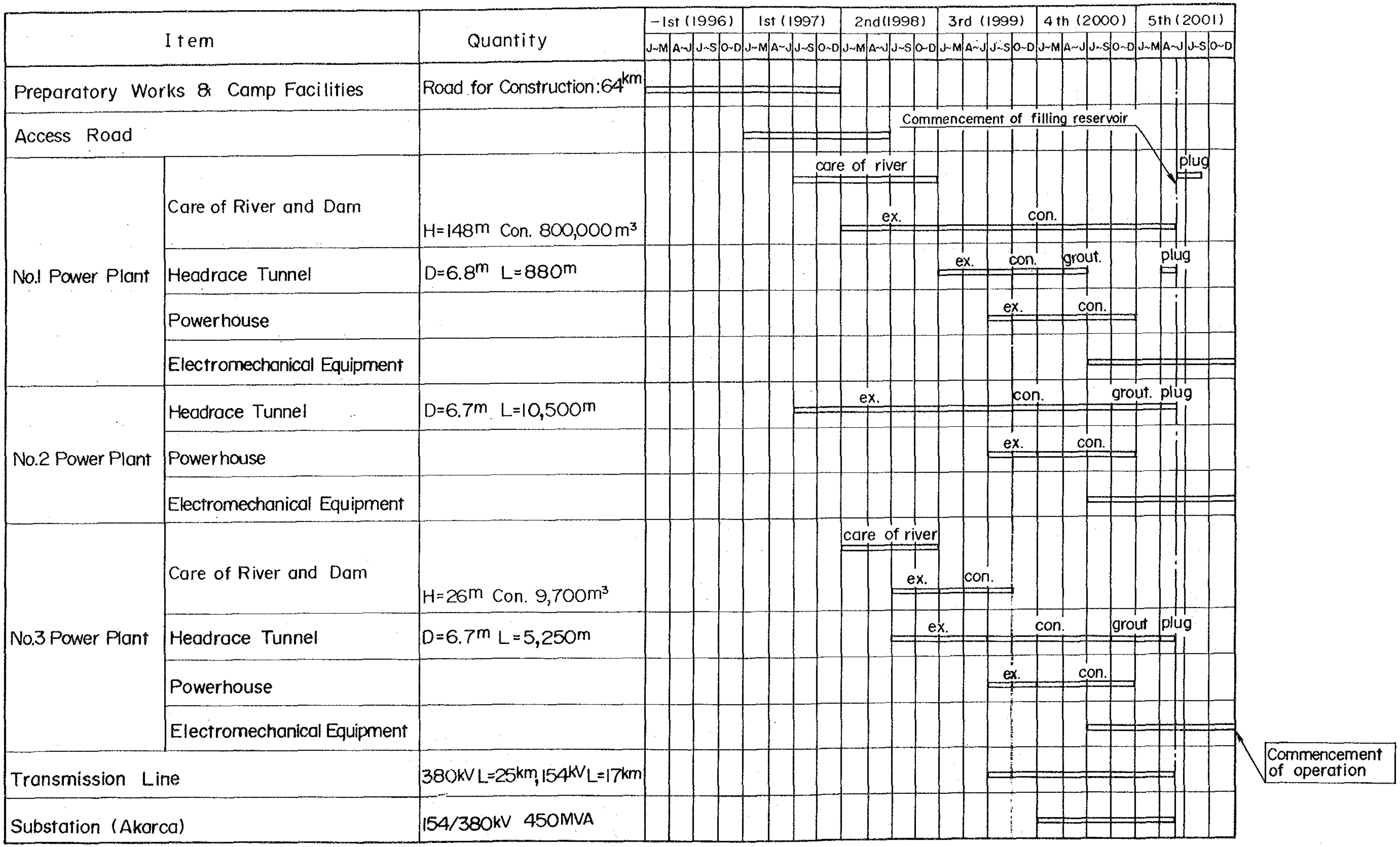


Table 17-4 Alternative Thermal Power Plant for Economic Evaluation

Interest Rate = 9.5%

Item	Unit	Description
Type		Coal Fired Power Plant
Installed Capacity	MW	300
Annual Plant Factor	%	70
Thermal Efficiency	%	38.3
Annual Energy Production	GWh	1,839.6
Investment Cost	10^6 TL	429,000
Service Life	Years	25
Construction Period	Years	4
Capital Recovery Factor		0.10596
Coal Calorific Value	Kcal/kg	6,500
Coal Surface Moisture	%	7
Oil Calorific Value	Kcal/kg	10,500
Fuel Consumption Rate (Coal 95%)	kg/kWh	0.353
Fuel Consumption Rate (Oil 5%)	kg/kWh	0.011
O & M Cost, Administration Cost	%	3.0
Unit Fuel Cost (Coal)	TL/kg	58.5
Unit Fuel Cost (Oil)	TL/kg	139.1
Transmission Line Investment Cost	10^6 TL	5,140

Annual Cost		Fixed Cost	Variable Cost
Capital Recovery	10^6 TL	45,966.4	-
O & M Cost, Administration Cost	10^6 TL	11,652.4	1,294.7
Fuel Cost	10^6 TL	-	40,803.4
Total	10^6 TL	57,618.8	42,098.1
Annual Cost at Receiving End			
kW Cost	TL/kW	1) 241,850	
kWh Cost	TL/kWh		2) 24.69

1) $$\frac{57,618.8 \times 10^6 \text{ TL}}{300,000 \text{ kW}} \times \overset{3)}{1.272} = 244,304$$

2) $$\frac{42,098.1 \times 10^6 \text{ TL}}{1,839.6 \times 10^6 \text{ kWh}} \times \overset{3)}{1.079} = 24.69$$

3) Adjustment Factor for kW & kWh

Item	kW	kWh
Transmission Loss Rate (%)	1.4	1.1
Station Service Rate (%)	5.6	6.3
Forced Outage Rate (%)	4.0	-
Scheduled Outage Rate (%)	12.0	-

$$\text{kW Adjustment Factor} = \frac{1}{(1 - 0.014) \times (1 - 0.056) \times (1 - 0.04) \times (1 - 0.12)}$$

$$= 1.272$$

$$\text{kWh Adjustment Factor} = \frac{1}{(1 - 0.011) \times (1 - 0.063)} = 1.079$$

Table 17-5 Economic Index of Alternative Plan

Item	Unit	No. 1 Powerplant	No. 2 Powerplant	No. 3 Powerplant	Total
High Water Level	m	630.0	496.0	378.0	
Low Water Level	m	620.0			
Grass Storage Capacity	10^6 m^3	109.3			
Effective Storage Capacity	10^6 m^3	24.7			
Maximum Discharge	m^3/s	108	108	111	
Effective Head	m	124.9	105.9	48.2	279.0
Installed Capacity	MW	119.0	100.5	45.0	264.5
Firm Peak Power	MW	116.9	98.3	44.4	259.6
Annual Energy Production	GWh	516.9	427.2	193.9	1,138.0
Investment Cost	10^6 TL	289,485	231,156	141,547	662,188
Annual Cost (C)	10^6 TL	29,527	23,578	14,438	67,543
Annual Benefit (B)	10^6 TL	39,782	33,271	15,051	88,104
Benefit Cost Ratio (B/C)		1.35	1.41	1.04	1.30
Surplus Benefit (B-C)	10^6 TL	10,255	9,639	613	20,561
Unit Cost of Energy	TL/kWh	58.1	56.1	75.7	60.4

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