THE REPUBLIC OF TURKEY

FEASIBILITY STUDY ON ZAMANTI GÖKTAŞ HYDROELECTRIC POWER DEVELOPMENT PROJECT

OCTOBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Republic of Turkey, the Japanese Government decided to conduct a survey on Zamanti Göktaş Hydroelectric Power Development Project and entrusted the survey to Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Turkey survey teams headed by Mr. Mamoru Takaichi, the Electric Power Development Co., Ltd., from November, 1987 to August, 1989.

The teams exchanged views with the officials concerned of the Government of Turkey, and conducted field surveys. After the teams returned to Japan, further studies were made and the present report was prepared.

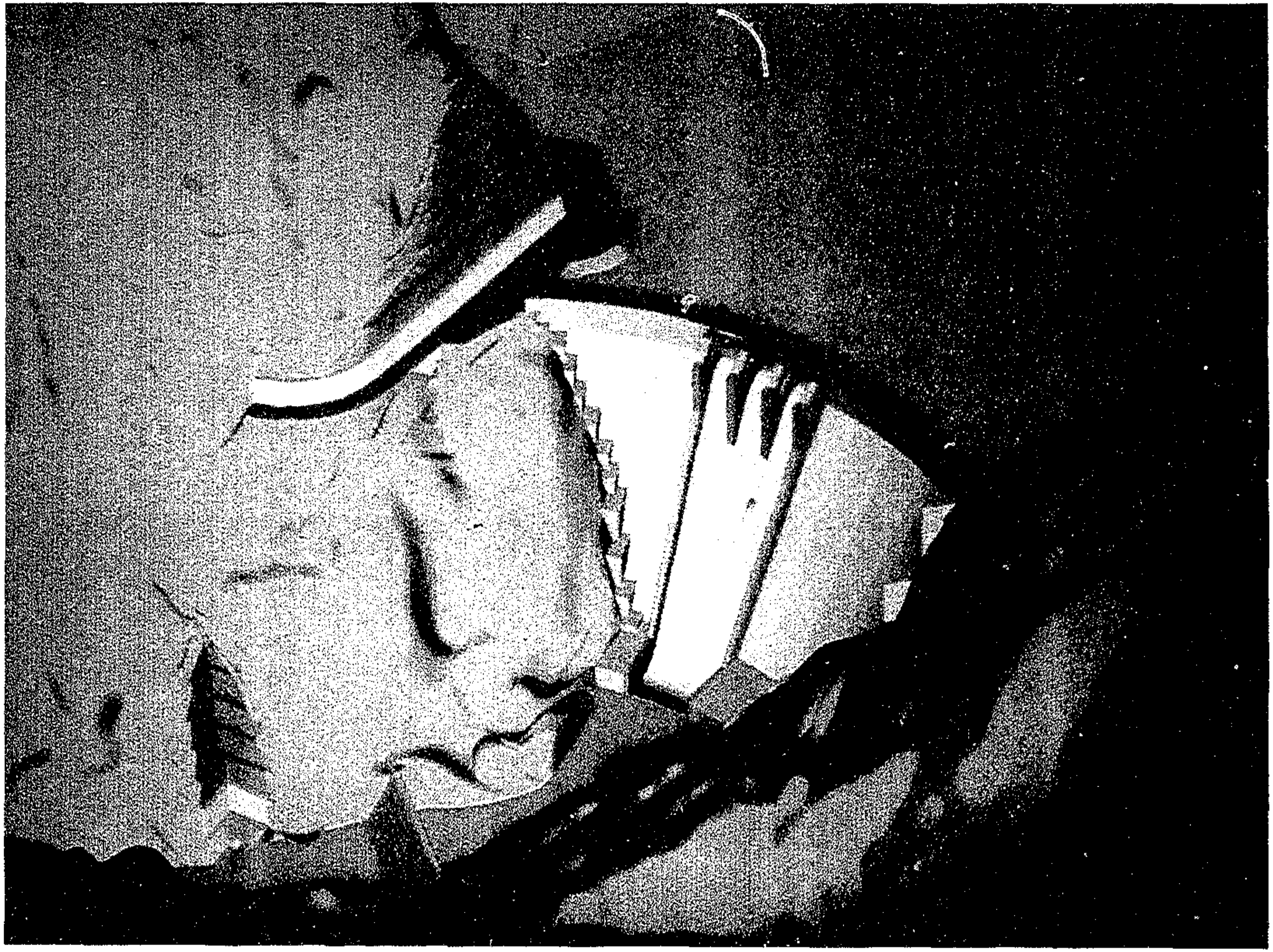
I hope that this report will contribute to the development of the Project and to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Turkey for their close cooperation extended to the team.

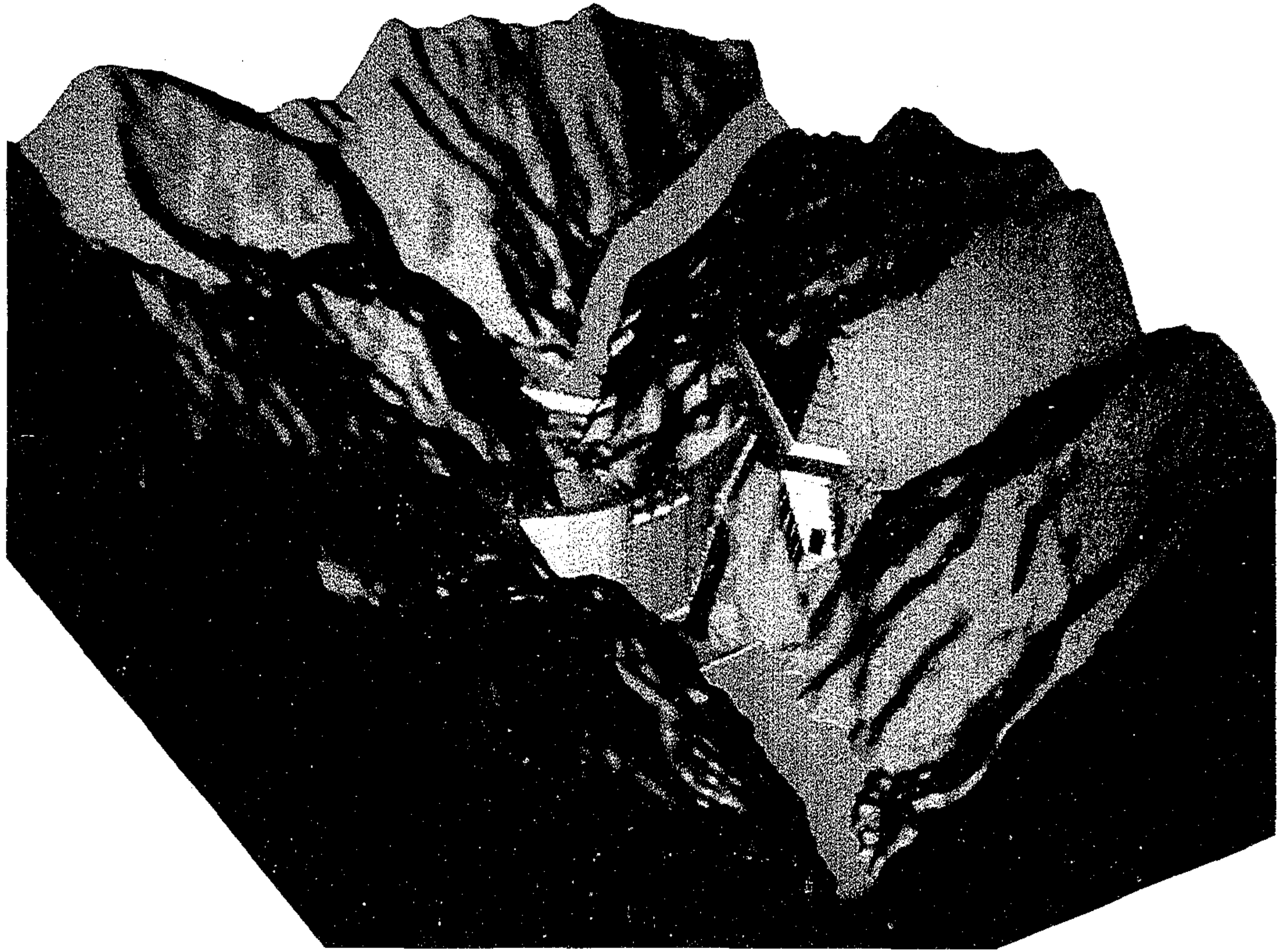
October, 1989

Kensuke Yanagiya

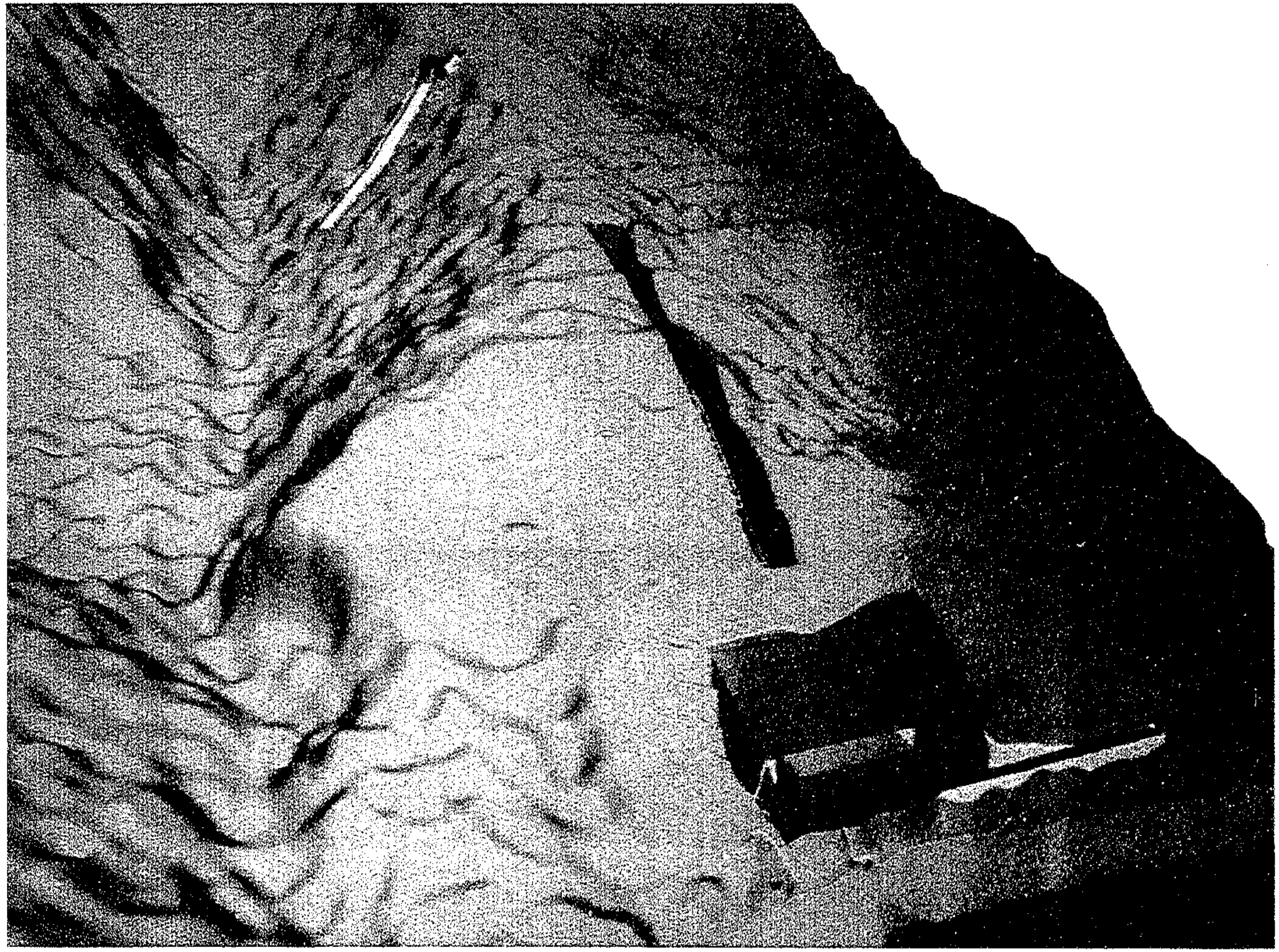
Kensuke Yanagiya
President
Japan International Cooperation Agency



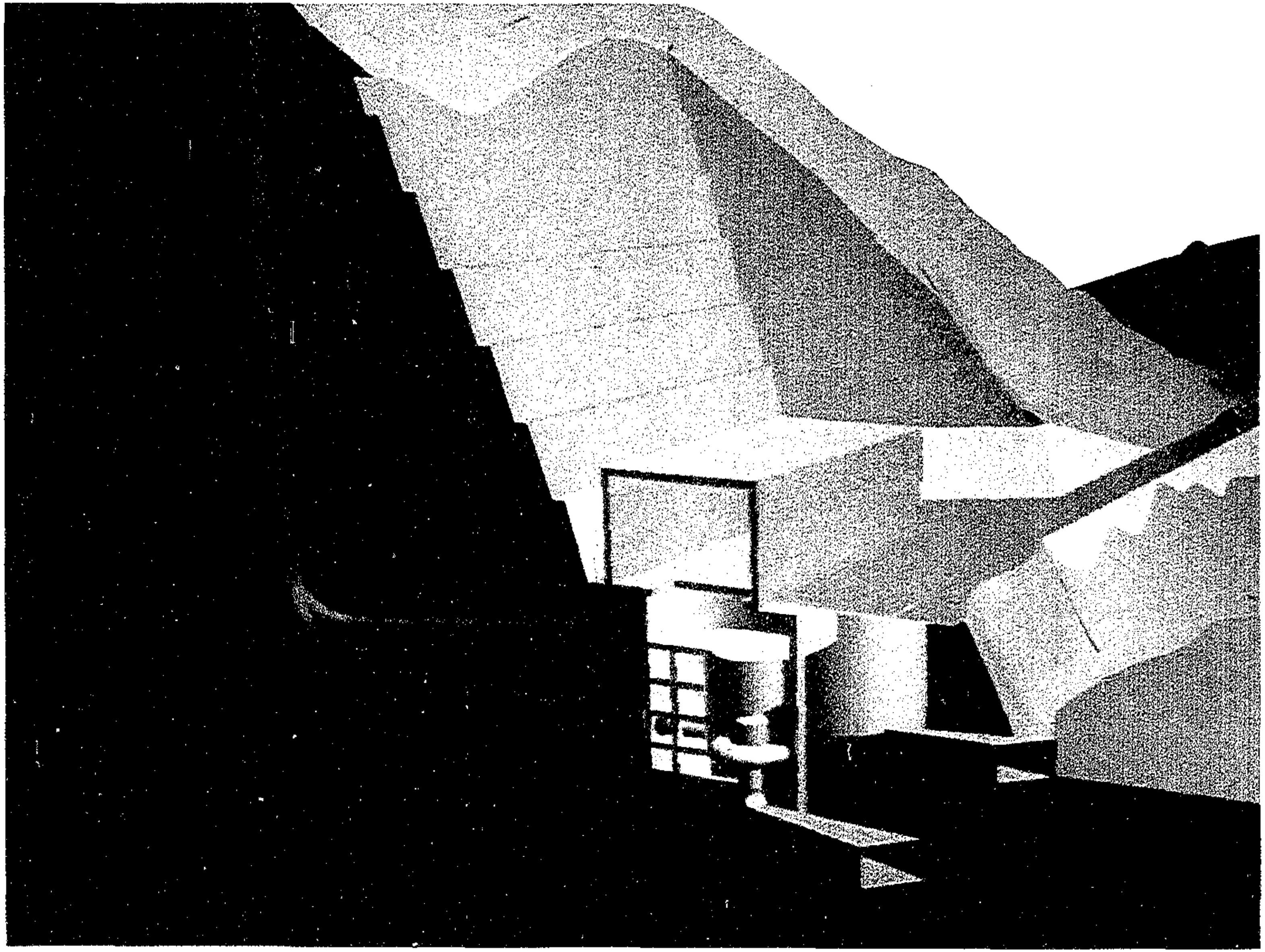
Downstream view of dam [Drawn with CAD]



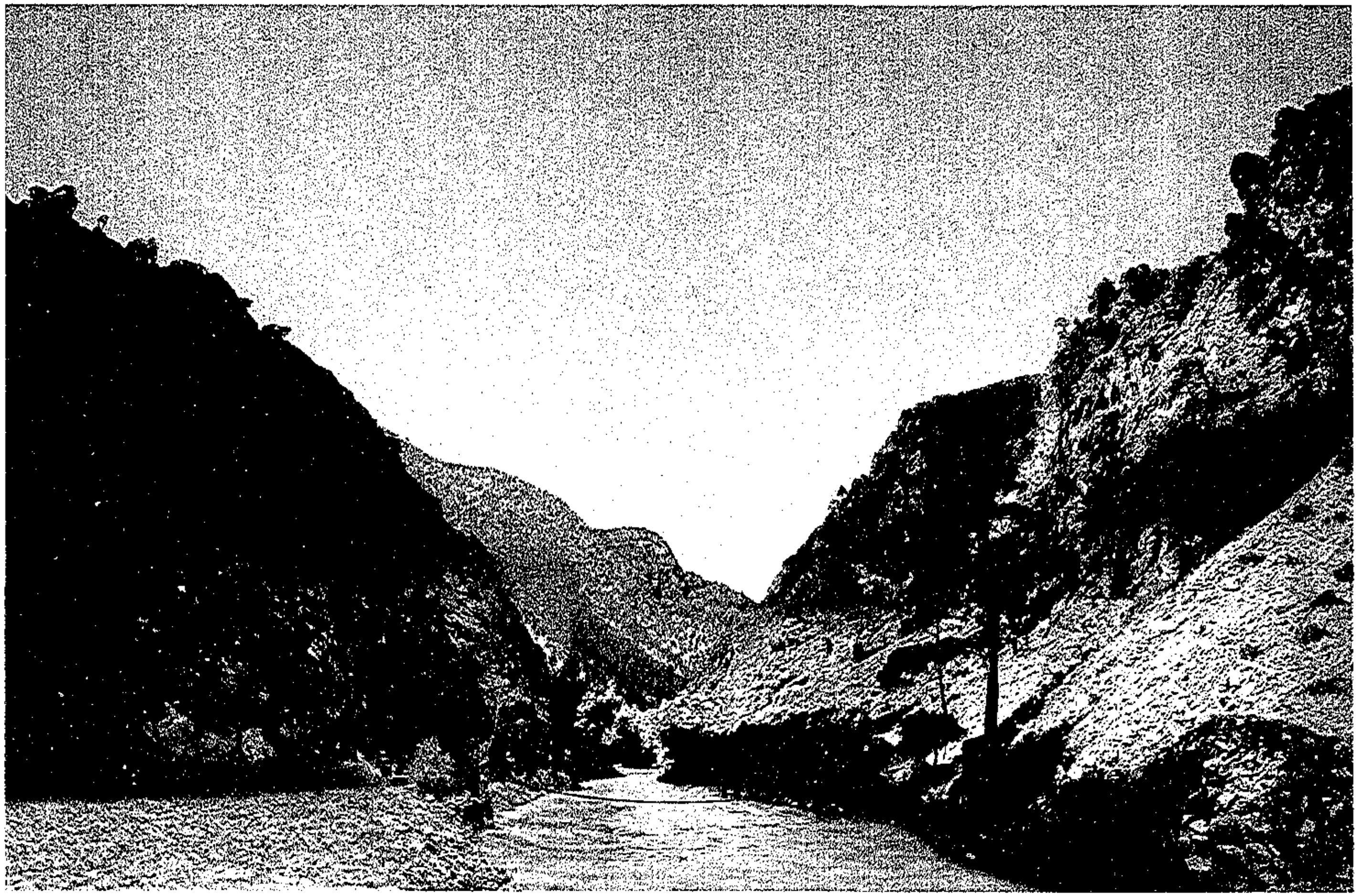
Upstream view of dam (Drawn with CAD)



Bird eye view of powerhouse (Drawn with CAD)



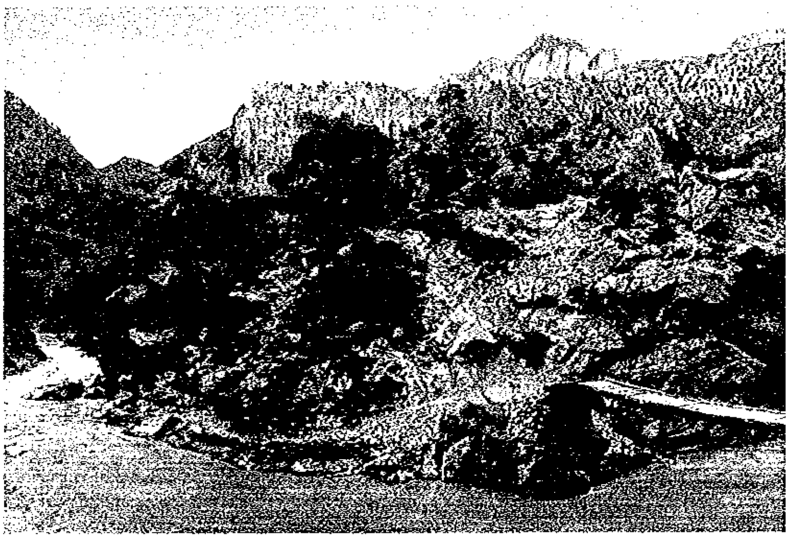
Transverse section of powerhouse (Drawn with CAD)



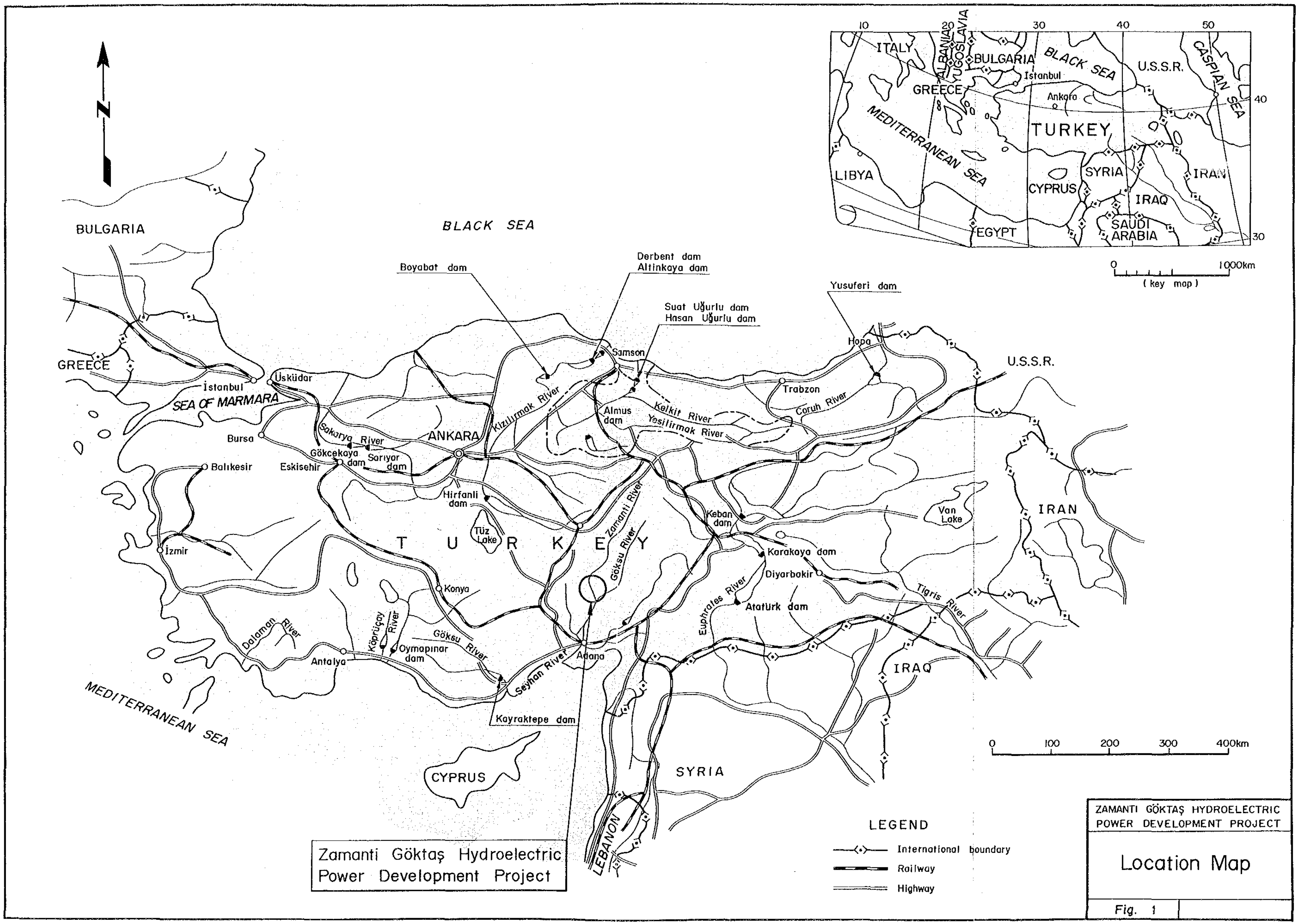
Göktaş Dam Site

—Looking from the Downstream Side—

Powerhouse Site



Quarry Site



N
BULGARIA
BLACK SEA
GREECE
İstanbul
Üsküdar
SEA OF MARMARA
Bursa
Balıkesir
Eskisehir
İzmir
Sakarya River
Gökçekaya dam
Sarıyar dam
ANKARA
Kizilirmak River
Hirfanli dam
Tüz Lake
T U R K E Y
Konya
Dalaman River
Antalya
Köprüçay River
Oymapınar dam
Göksu River
Kayraktepe dam
Seyhan River
Adana
Zamanti River
Göksu River
MEDITERRANEAN SEA
CYPRUS
Boyabat dam
Derbent dam
Altinkaya dam
Suat Uğurlu dam
Hasan Uğurlu dam
Samson
Almus dam
Kelkit River
Yesilirmak River
Yusuferi dam
Hopa
Trabzon
Coruh River
U.S.S.R.
Keban dam
Karakaya dam
Diyarbakir
Euphrates River
Atatürk dam
Tigris River
Van Lake
IRAN
IRAQ
SYRIA
LEBANON
0 100 200 300 400km
ITALY
ALBANIA
YUGOSLAVIA
BULGARIA
BLACK SEA
U.S.S.R.
CASPIAN SEA
İstanbul
GREECE
Ankara
TURKEY
MEDITERRANEAN SEA
LIBYA
CYPRUS
SYRIA
IRAN
IRAQ
SAUDI ARABIA
EGYPT
10 20 30 40 50
40
30
0 1000km
(key map)
Zamanti Göktaş Hydroelectric Power Development Project
LEGEND
International boundary
Railway
Highway
ZAMANTI GÖKTAŞ HYDROELECTRIC POWER DEVELOPMENT PROJECT
Location Map
Fig. 1

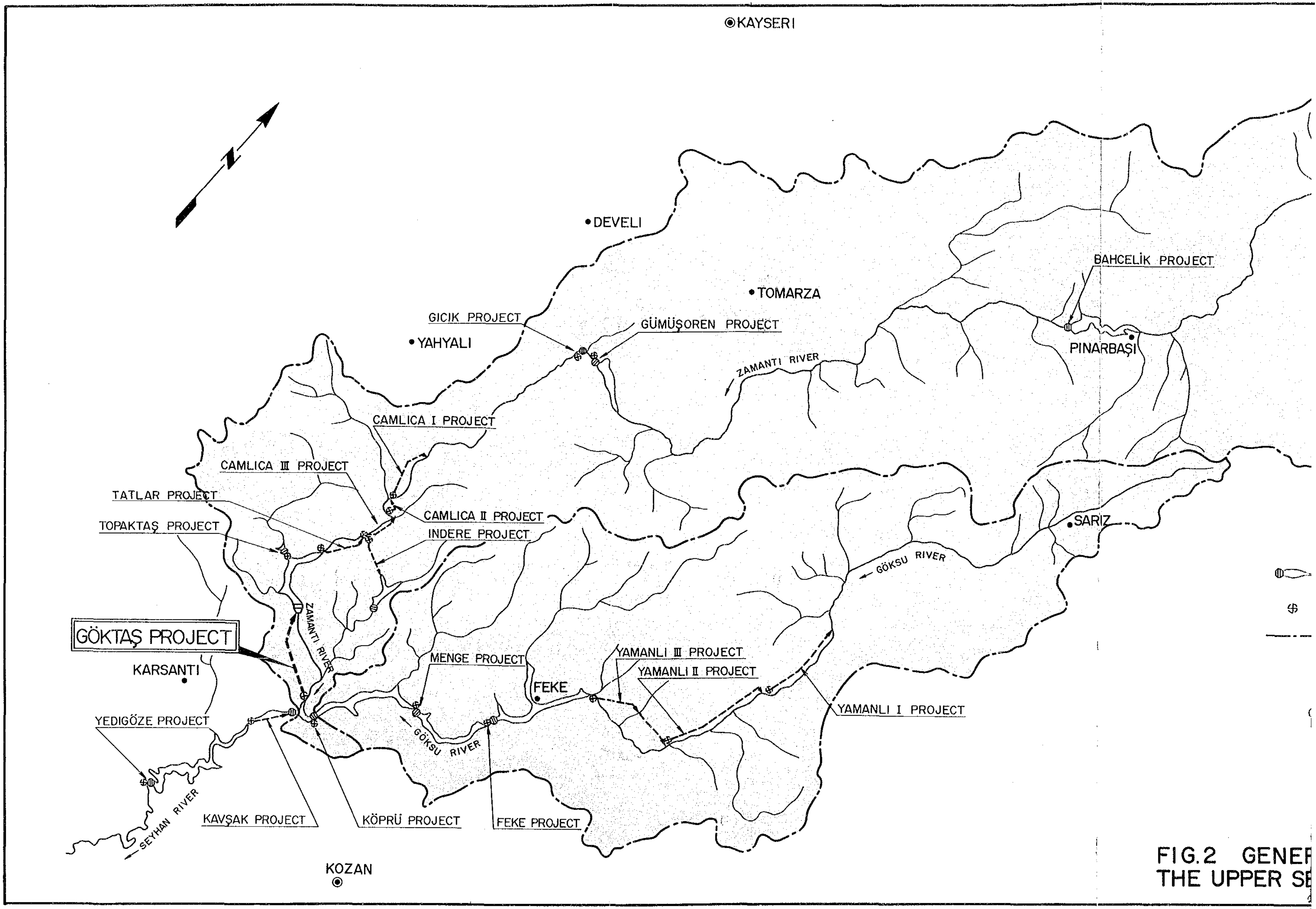


FIG.2 GENEF
THE UPPER SE

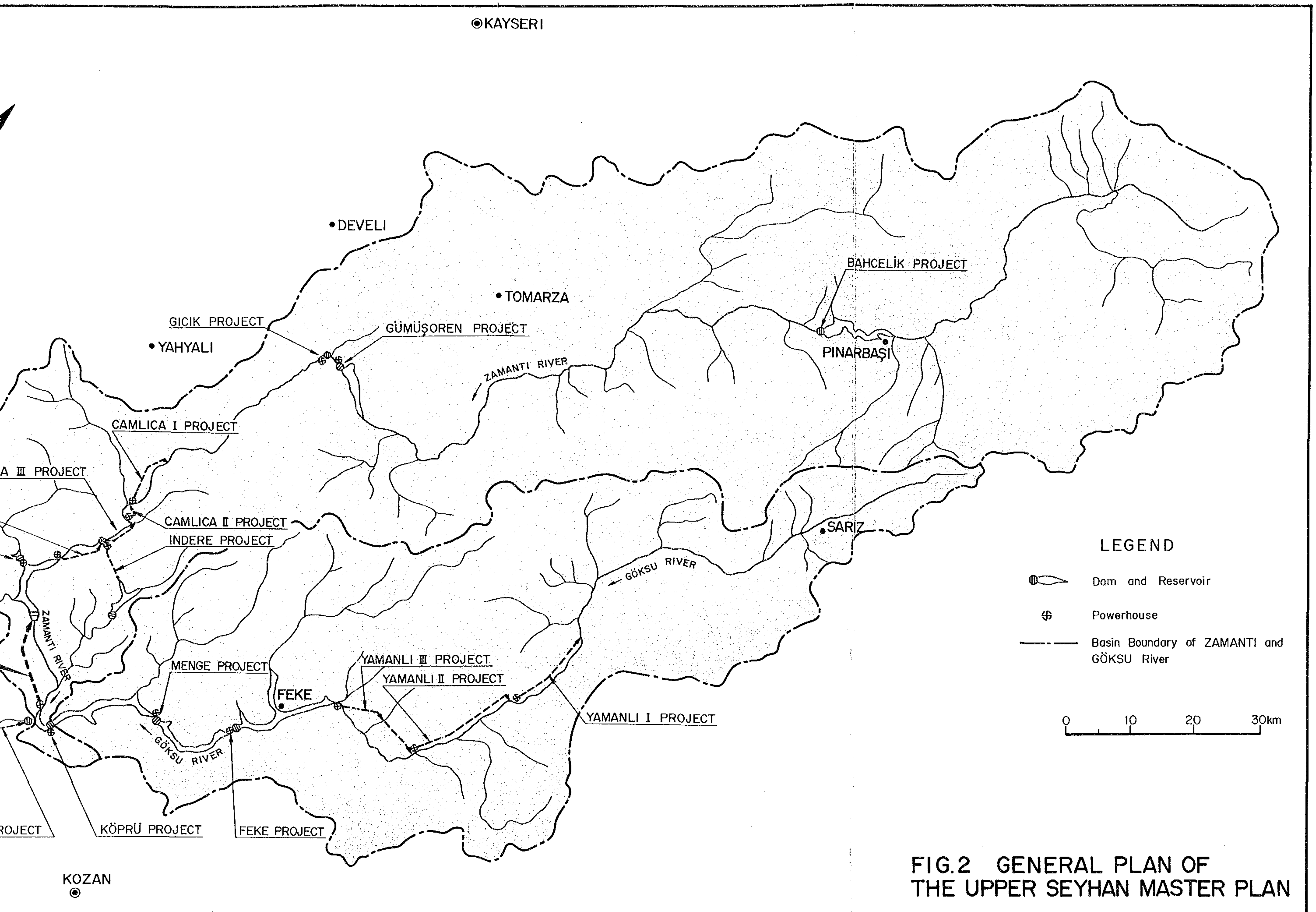
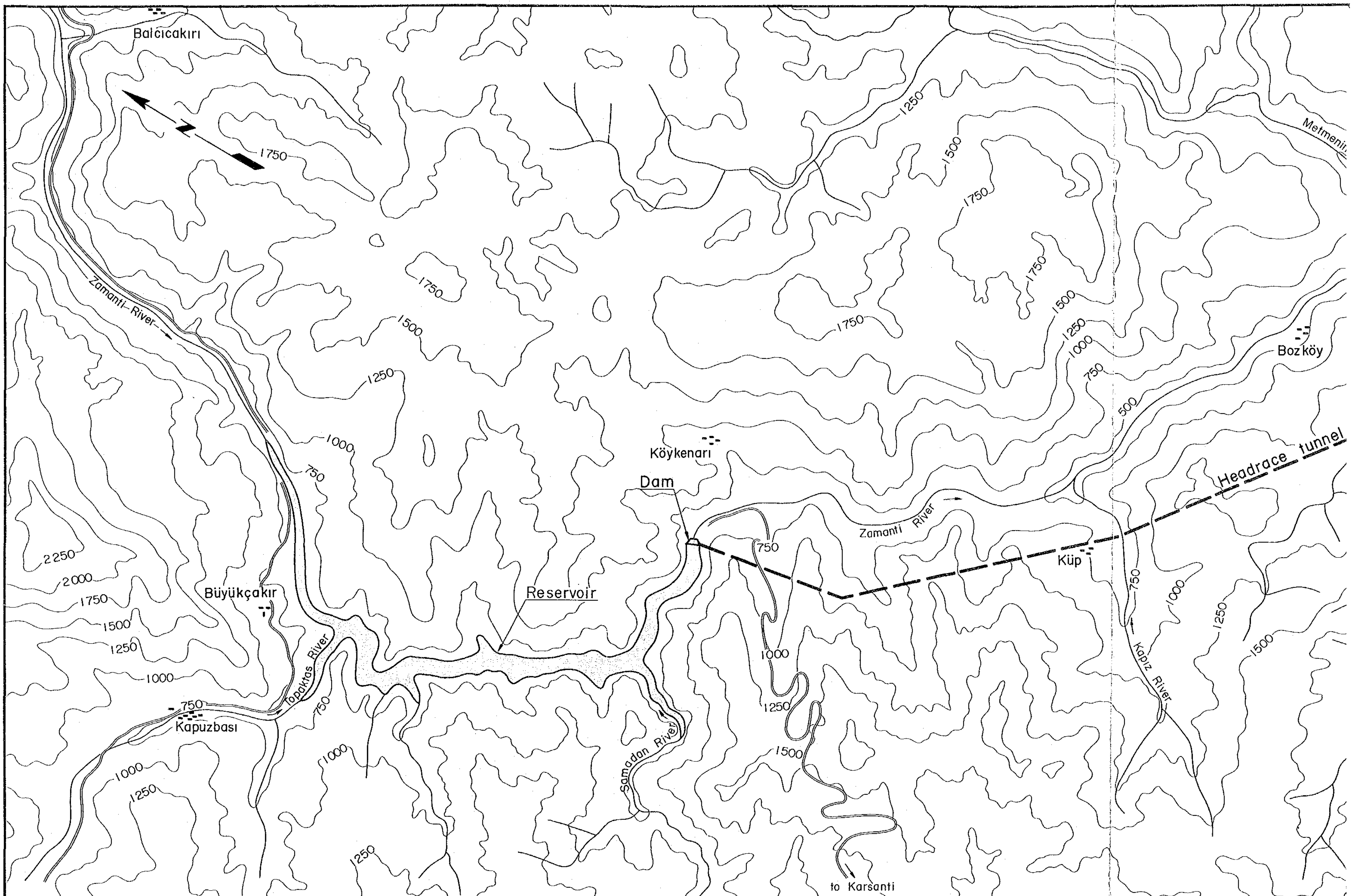


FIG.2 GENERAL PLAN OF THE UPPER SEYHAN MASTER PLAN



Balcıcakırı
1750
Zamanti River
1750
1500
1250
1000
750
1250
1500
1750
1750
1750
1500
1250
1000
750
500
Metmeni
Bozköy
Köykenari
Dam
Headrace tunnel
Zamanti River
750
Küp
750
1000
1250
1500
Kapız River
2250
2000
1750
1500
1250
1000
Büyükçakır
Reservoir
Topaktaş River
750
Kapuzbası
750
1000
1250
1000
1250
Samadan River
1000
1250
1500
to Karsanti

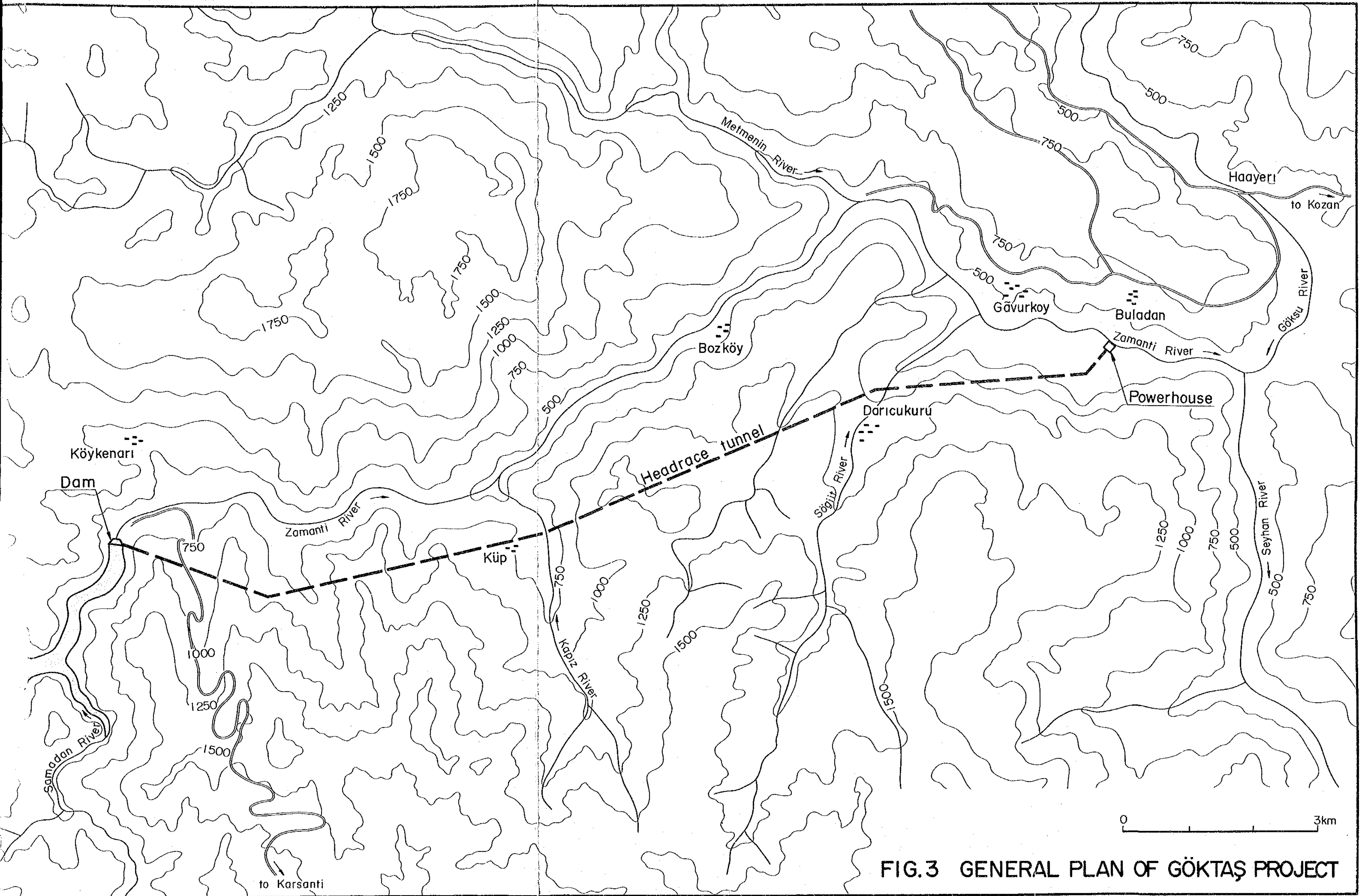


FIG. 3 GENERAL PLAN OF GÖKTAŞ PROJECT

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CHAPTER 16. FURTHER INVESTIGATIONS

CHAPTER 17. ALTERNATIVE DEVELOPMENT PLAN

SUMMARY

SUMMARY

This report concerns the feasibility study of the Zamanti Goktas Hydroelectric Power Development Project of the Republic of Turkey. The feasibility study has been conducted from 1987 to 1989 by the Japan International Cooperation Agency (JICA) under a technical cooperation program of the Government of Japan.

This report is submitted by JICA, through the Ministry of Foreign Affairs of the Japanese Government, to the General Directorate of State Hydraulic Works (DSI) of the Government of Turkey.

A brief summary of the results of the feasibility study is presented in the following part of this section.

(1) Features of the Project

The Zamanti Goktas Hydroelectric Power Development Project described in this Report consists of a power generation project including a dam, waterway, and powerhouse, and a transmission line construction from Goktas Power Station to the entrance of Adana Substation.

The Seyhan River has the two large tributaries of the Zamanti River and the Goksu River for a total catchment area of approximately 20,730 km^2 and a length of approximately 506 km, the annual average runoff being approximately 7,100 x 10^6 m^3.

There are as many as 20 projected development sites on the Seyhan River including this Goktas project site for a total output of 1,849.5 MW (including the existing Seyhan 54 MW, and Catalan 156 MW under construction).

Among these, there are nine projected development sites on the Zamanti River for a total output of 593.5 MW, the Goktas site being of the largest scale among these. This project site is located at the most downstream part of the Zamanti River, and it is looked forward to that development will be carried out at an early time.

There are three power plants planned downstream of this Project, while there is also one each of an existing power plant and a power plant under construction.

Consequently, runoff regulation to be achieved with this Project will make possible increased utilization efficiency of these five downstream power plant.

(2) Rationale for the Development

The electric power generating facilities of the Republic of Turkey amount to 12,492 MW (44,353 GWh) with the ratio between hydroelectric power plants (5,003 MW) and thermal power plants (7,489 MW) being 40:60. Meanwhile, importation of electric power from the Soviet Union was started in 1979 and from Iraq in 1988, both of which are still going on today. On the other hand, imports from Bulgaria which were started in 1975 were terminated in 1986. Importation of electric power which recorded a peak of 2,653 GWh in 1984 has decreased since then, but the Turkish Government is planning to continue importing 1,600 GWh annually until 1996.

The power demands for the future (1989 - 2008) as forecast by Turkish Electricity Authority (TEK) and by the macroscopic method are as shown below.

	TEK Forecast		Macro Method Forecast	
	(GWh)	(MW)	(GWh)	(MW)
1989	57,925	9,250	56,520	9,249
1990	64,910	10,370	63,049	10,317
1995	105,930	17,060	95,981	15,934
2000	166,830	26,955	142,453	23,997
2005	231,530	37,700	205,663	35,161
2008	283,170	46,110	252,861	43,231

In order to cope with these power demands, Altinkaya Hydro (175 MW x 4 = 700 MW) started operation from 1987 to 1988, while Karakaya Hydro (300 MW x 6 = 1,800 MW) with its first unit having started operation in 1987 will continue with operation starts until 1989. Elbistan Thermal (4,200 MW), Ataturk Hydro (2,400 MW), and Catalan Hydro (156 MW) are under construction. Furthermore, Kayraktepe Hydro (420 MW), Ilisu Hydro (1,200 MW), Boyabat Hydro (510 MW), Birecik Hydro (670 MW), and Yedigoze Hydro (300 MW) are being prepared for start of construction in immediate years in the future.

Cukurova Electric Power Company is a private electric power sector supplying electric power to three provinces around Adana. The Cukurova Power System is interconnected with the power system of TEK and power shortages are being filled with purchases from TEK.

Since this Project will be located in the service area of Cukurova Electric Power, there is a high probability that the electricity produced will be allocated to meet the power demand of the Cukurova Region.

Considering the physical development schedule, it is thought the commissioning of the Goktas Hydro Power Plant will be achieved around the year 2000. This will be a time when the proportion of hydro among the power generating facilities of Turkey as a whole will temporarily decline. Consequently, it is desirable for the Goktas Hydro to be commissioned as early as possible in the 2000s. The development of the Goktas hydro will also contribute to economic development of the Region.

(3) Meteorology and Hydrology

The basin of the Zamanti River in which the Goktas project site is located is divided into an area of Central Anatolian climate on the upstream side and an area of Mediterranean climate on the downstream side by the Toros Mountain Range cutting across the southern part of the basin, with most of the basin in the area of Central Anatolian climate. The characteristics of the respective areas are listed below:

- Central Anatolian Climate Area
  - Annual precipitation is low at about 400 mm.
  - The average elevation is high at 1,700 m with snow cover occurring in the winter.
  - The topography is comparatively gentle with gentle river gradients.

- Mediterranean Climate Area
  - The annual precipitation is fairly high at 800 to 1,200 mm to constitute an area of high precipitation. There are some places where ground water is seen springing from limestone distributed in the basin and a sharp increase in river discharge occurs.

- The rainy season is from November to May while there is a fairly large amount of snowfall in January-February.
- The topography is rugged as this area is on the southern slopes of the Toros Mountain Range and the river gradient is also steep.

According to discharge data of runoff gaging stations upstream and downstream of the Goktas dam site, the increase in discharge between the two gaging stations is larger than the amount of precipitation in the downstream catchment area of the Zamanti River. The reliability of discharge data was questioned because of this. However, the appropriateness of discharge data was confirmed by the results of hydrologic data analyses and runoff surveys made by the DSI and General Directorate of Electrical Power Resources Survey and Development Administration (EIE) in 1988. This increase in discharge is considered to be due to rain and snow falling inside and outside the basin supplied in the form of ground water through limestone veins with this water being discharged in the downstream basin of the Zamanti River.

The meteorological and hydrological quantities at the Goktas dam site obtained through analyses of meteorology and hydrology data are as follows:

∘ Temperature	:	Maximum 39.7°C Minimum -4.9°C Mean 15.3°C
∘ Annual evaporation from reservoir surface	:	767 mm
∘ Annual inflow	:	1,704 x 10^6 m^3
∘ Annual average discharge	:	54 m^3/s
∘ Suspended Load	:	152 ton/yr/km^2
∘ Design sedimentation	:	22,020 x 10^3 m^3/50 yr (in case of Gumusoren Dam existing upstream) 57,820 x 10^3 m^3/50 yr (in case of no dam upstream)
∘ 10-year return period flood	:	525 m^3/s (according to Gumbel distribution)
∘ Probable maximum flood (PMF)	:	3,900 m^3/s

(4) Geology and Materials

(4)-1 Geology

The site of the Goktas Project is mainly composed of Paleozoic sedimentary rocks such as sandstone and shale containing limestone, Mesozoic limestone, and also Mesozoic ophiolite (peridotite). The basement rocks of the various principal structures planned are roughly as listed below:

Uppermost reaches of reservoir	- Mesozoic limestone
Reservoir, dam	- Mesozoic ophiolite (peridotite)
Headrace tunnel	- Mesozoic ophiolite (peridotite) and limestone, paleozoic limestone, sandstone, shale, etc.
Powerhouse	- Paleozoic sandstone, shale, limestone, etc.

In the area of the reservoir (normal high water level 630 m), limestone is distributed close to the reservoir backwater level only above 610 m, with ophiolite (peridotite) widely distributed elsewhere. There is no landslide location in the reservoir area and it is judged there will be no problem about stability of the reservoir slopes. With regard to watertightness of the reservoir, even though there is distribution of limestone at the uppermost reaches, geological or hydrogeological data to indicate large amounts of leakage from this part have not been obtained as a result of surface reconnaissances and it is judged possible for water to be impounded up to EL. 630 m. For the sake of safety, however, it is thought necessary for supplementary investigations to be made such as drilling in the limestone distribution area and continuous measurements of groundwater levels utilizing drillholes.

The dam site is composed of ophiolite (peridotite), and although slight serpentinization can be observed along cracks, construction of an arch-gravity concrete dam of 150 m height class is recommendable.

As for the sites of other principal structures such as the headrace tunnel, penstock, and powerhouse, no geological defect that could be fatal to the Project is recognizable.

(4)-2 Materials

For concrete aggregates, it is considered optimum to use crushed rock made from limestone widely distributed at the left bank of the Zamanti River approximately 1.5 km downstream from the dam site. This limestone possesses a suitable character for concrete aggregate in the aspects of both quality and quantity.

(5) Results of In-situ Tests and Evaluations

(5)-1 In-situ Rock Tests at Dam Site

(a) Plate Bearing Tests

Coefficients of deformation are 107,700 to 132,100 kgf/cm^2 for Class ⓑ rock with predominant distribution within the exploratory adits, and 39,900 to 103,000 kgf/cm^2 for Class ⓒ rock with slightly more cracking than Class ⓑ, to indicate that the bedrock has little deformability.

Tangential moduli of elasticity are 189,200 to 239,600 kgf/cm^2 for Class ⓑ rock and 57,500 to 167,700 kgf/cm^2 for Class ⓒ, which are very high moduli of elasticity, so that the characteristics are those of good, hard bedrock.

(b) Block Shear Tests

Although it was not possible for shear strengths to be measured directly for reasons of strengths of concrete blocks and loosening of bedrock, the following estimated shear strengths were obtained from the correlations of coefficients of deformation and moduli of elasticity with shear strengths:

	Internal Angle of Friction (ø)	Cohesion (C)
Class (b) rock	60°	50 kgf/cm^2
Class (c) rock	55°	40 kgf/cm^2

(5)-2 Seismic Prospecting at Powerhouse Site

The following velocity layers were obtained by 3-traverse-line seismic prospecting (diffraction method) as elastic wave velocities (P waves) of the bedrock comprising the powerhouse site.

	Velocity (km/s)	Layer Thickness (m)	Estimated Geological Properties
1st Layer	0.35	0 - 5	Talus deposit
2nd Layer	(0.80	0 - 5	Weathered rock
	2.20)	23 - 50	Slightly weathered rock
3rd Layer	3.70	-	Fresh rock

(6) Seismicity

The estimation of the maximum ground acceleration at Goktas site by probability analysis was performed to determine the design seismic coefficient. The seismicity data used in this study are those compiled by NOAA (National Oceanic and atmospheric Administration Environmental Data Service) and are 5,980 in number during the period 1901 - 1985.

The Zamanti Goktas Project site is located in the 4th degree zone, but near the 3rd degree zone delineated in the Seismic Risk Map for Turkey (IMAR ve ISKAN BAKANLIGI, 1972). The design seismic coefficient 0.10 can be applied for the Project.

However, it is necessary that the long return period expectancy should be checked, taking the uncertainties of the earthquake occurrence into account.

Therefore, 0.12 is to be adopted as the design seismic coefficient of Goktas site in the light of the probability analysis results.

(7) Environmental Evaluations

Based on the field survey and literature study carried out by DSI for the natural and social environments of the Goktas project area and it's surroundings, the effects of the Goktas project on it's environments are qualitatively evaluated.

(7)-1 Natural Environmental Conditions

There are no national parks, environment conservation areas, or wild life protection areas in the Project area. Therefore, all such protection areas are outside the project area and are not affected thereby.

- Natural Scenery

Most of the area around the reservoir is forest and remaining part is rocky abondoned land and small farm land. Most of the forest consists of the pine tree. River stream is rapid.

The existence of dam and reservoir seems to make a new natural scenery.

- Vegetation

Most of the forest around the reservoir is pine tree and there is no forest tree to be protected. Forest will be felled for setting up the Power Plant structure, but impacts can be reduced by utmost minimizing the felling forest area, tree planting after the construction, etc.

- Animals

Land animals that inhabit the reservoir area are boars, foxes, hawks, snakes, frogs and dragonflys, etc., but there is no rare animal to be designated for protection.

Aquatic animals that inhabit the reservoir area are trouts, carps and crabs, etc. However, there is no rare aquatic animal species conserved in the reservoir area.

◦ Water Quality

Major sources of impact on the water quality during construction are concrete plant, water discharging and excavation from the temporary plants such as spray plant, etc., water discharging from concrete production. Impacts of discharged water can be reduced by water treatment before discharging.

It is considered that frequency of water exchange in the reservoir after starting operation is very much and there is no remarkable contamination source coming into the flow. Therefore, there are no possibilities for changing water temperature, long term discharging of turbid water and entrophication.

Accordingly, creation of new environment for aquatic animals is expected by the existence of the reservoir.

◦ Noise and Air Pollution

Major sound and air pollution sources are construction equipment and trucks for transporting materials; but for enforcement of construction, these impacts can be reduced by using equipments of low noise type.

As there is little equipment generating sound and there is no equipment causing air pollution after starting operation, no impact is expected.

(7)-2 Social Environmental Conditions

◦ Industrial Activities and Land Use

Total cultivated area submerged by the reservoir is 43 da, 29 da of which is farm land and 14 da vineyard.

For enforcement of the Project, it is desirable to deliberate fully with the persons concerned and to make optimum compensation.

There are only small commercial activities at the reservoir area, but it is expected that traffic will become busy and commerce will be in full activity during construction and after starting operation.

- Transportation and Public Facilities

New construction road is expected to be made along a river from the powerhouse to dam site, to transport main materials for construction. The existing road might be used under enforcement of the construction.

Although the traffic volume is temporarily expected to increase, there is no serious impact on the general traffic, as recent traffic volume is not so high.

There is no major public facility except a primary school in each village center around the reservoir. These primary schools are located far from the dam site and roads for construction.

There is no serious impact on public facilities under construction.

- Water Utilization

Water consumption in the surroundings of reservoir is not in question. There is no expected requirement for water consumption in surrounding areas in the future except the up-river part of the reservoir. There are three mills working with water power located at Kopuzbasi Springs. Two of them are between elevations 640 and 650 m, the other is at a higher elevation. These mills are releasing the water back to the bed after using it.

As shown above, there is no serious impact on recent water utilization for enforcement of the Project. It is expected to fish newly by existence of the reservoir.

- Cultural Assets and Recreational Facilities

There are no relics, cultural assets and recreational facilities around the reservoir area.

After starting operation, dam site, powerhouse and their surrounding areas are expected to be used for recreational facilities.

(7)-3 Evaluation Results

According to evaluation results, there is no serious impact on natural and social environments, except impact on the people whose farm lands are submerged by the reservoir.

(8) OUTLINE OF OPTIMUM DEVELOPMENT PLAN

(8)-1 Outline of the Project

An outline of the Goktas Project is as given below.

This Project is situated on the downstream part of the Zamanti River, a tributary of the Seyhan River. It is planned for a concrete arch-gravity dam 148 m in height and 800,000 m^3 in volume to be constructed at a point approximately 22 km upstream from the confluence with the Goksu River to obtain a gross storage capacity of 109.3 x 10^6 m^3 and effective storage capacity of 24.7 x 10^6 m^3. An annual average inflow of 1,704 x 10^6 m^3 is to be regulated by means of this reservoir.

A maximum available discharge of 108 m3/s is to be drawn from an intake provided at the right-bank side immediately upstream of the dam, this water being conducted to a powerhouse provided at the right bank through a headrace tunnel and penstock approximately 16.3 km in length to obtain a maximum output of 270 MW and annual energy production of 1,160 GWh. The electric power generated by Goktas Power Plant is to be sent to Yedigoze Substation via Akarca Substation by means of a 154-kV and 380-kV transmission line. The power is to be transmitted further from Yedigoze Substation to Adana Substation.

(8)-2 Construction Cost and Economic Evaluation

The construction cost of this Project will be 583,315 x 10^6 TL (US$448.7 x 10^6) and the period required for construction will be approximately 6 years.

The construction costs per kW and kWh at the generating end will be 2,084.4 x 10^3 TL (US$1,603.4) and 485.3 TL (US$0.37), respectively. Also, energy cost is 52.2 TL/kWh (0.04 $/kWh) (at the entrance of Yedigoze Substation).

The net present value (B - C) and benefit-cost ratio (B/C) of this Project in case of using an imported-coal thermal as the alternative power generating facility will be 227,476 x 10^6 TL (US$174.98 x 10^6) and 1.69, respectively.

The financial internal rate of return (FIRR) and the economic internal rate of return (EIRR) of the Project are 14.02 percent and 14.38 percent, respectively.

(9) CONSTRUCTION SCHEDULE AND CONSTRUCTION COST

(9)-1 Construction Schedule

Considering the year of commissioning of the Project as 2001 A.D., it will be necessary for preparations to start construction to be made roughly according to the schedule below.

Nov. 1987 - Oct. 1989	Feasibility Study (2 years)
Jan. 1990 - Dec. 1990	Provision and Award of Final Design (1 year)
Jan. 1991 - Dec. 1992	Final Design (2 years)
Jan. 1993 - Jun. 1994	Financing Formalities (1.5 years)
Jul. 1994 - Dec. 1995	Bidding and Award of Contract for Construction (1.5 years)
Jan. 1996	Start of Construction
- Dec. 2001	End of Construction

The construction work of the Project will require a period of approximately 6 years as a result of studying the scale of construction, layout of structures, preparatory works, etc. The work schedule of the Project is given in Fig. 12-3.

(9)-2 Construction Cost

It was assumed for the construction cost of the Project that designs and construction methods, and materials and products of the levels that can be expected at this time would be used. Furthermore, estimates were made giving consideration to geological conditions, topographical conditions, and project scale. The time of estimation was taken to be June 1988. (The exchange rate used was US$1.00 = 1,300 TL)

With the construction cost as 583,315 x 10^6 TL (US$448.7 x 10^6) the breakdown of local and foreign currency requirements is as follows:

Local currency : 329,458 x 10^6 TL (US$253.4 x 10^6)
Foreign currency: 253,857 x 10^6 TL (US$195.3 x 10^6)

Summary of Zamanti Goktas Hydroelectric Power Development Project

Item	Unit	Description
Location	-	Zamanti River
Catchment Area	km^2	8,290
Annual Inflow	10^6 m^3	1,703.92
Design Flood	m^3/sec	3,900
Reservoir		
Normal High Water Level	m	630
Low Water Level	m	620
Available Drawdown	m	10
Sedimentation Level	m	607
Reservoir Area	km^2	2.67
Gross Storage Capacity	10^6 m^3	109
Effective Storage Capacity	10^6 m^3	25
Diversion Tunnel		
Diameter	m	6.8
Length	m	370
Design Flood	m^3/sec	530
Number	-	1
Dam		
Type	-	Concrete-arch gravity
Elevation of Crest	m	635
Height of Dam	m	148
Length of Crest	m	242
Volume of Dam	10^3 m^3	800

Item	Unit	Description
Spillway		
Type	-	Chute
Capacity	m^3/sec	3,900
Number of Gate	set	3
Size of Gate	m	14 x 13
Power Intake		
Type	-	Vertical shaft with gate
Number of Gates	set	Roller gate. 1.
Headrace Tunnel		
Type		Circle (Pressure)
Length	m	15,680
Diameter	m	6.8
Surge Tank		
Type	-	Lower Portion: Chamber Upper Portion: Overflow
Penstock		
Type	-	Lower Portion: Embedded Upper Portion: Exposed
Length	m	600
Diameter	m	6.8 - 2.6
Number	-	1 (2 bifurcated at end)
Powerhouse		
Type	-	Semi-underground
Size	m	∅22 m Depth 29 m

Item	Unit	Description
Power Generation Facilities		
Number of Units	unit	2
Unit Capacity	MW	135
Installed Capacity	MW	270
Turbine		
Number	unit	2
Type	-	Vertical Shaft Francis Turbine
Rated Intake Water Level	m	626.7
Rated Tail Water Level	m	321.8
Gross Head	m	304.9
Normal Effective Head	m	284.4
Maximum Discharge	m^3/sec/unit	54.0
Standard Output	MW	137.5
Revolving Speed	rpm	300
Generator		
Number of Units	unit	2
Type	-	AC 3-phase Synchronous Generator
Output	MVA	150
Voltage	kV	14.4
Power Factor	-	0.9 (lagging)
Frequency	Hz	50
Revolving Speed	rpm	300
Main Transformer		
Number of Units	unit	7 (including one set for spare use)

Item	Unit	Description
Type	-	Outdoor type single phase Transformer
Capacity	MVA	50
Voltage	kV	14.4 : 154 / 3
Switchyard		
Bus System	-	Main Bus and Transfer Bus
Normal Voltage	kV	154
Type of Circuit Breaker	-	Gas Circuit Breaker
Tie Transmission Line		
Section	-	Powerhouse - Switchyard
Number of Circuit	cct	2
Nominal Voltage	kV	154
Transmission Line		
Section	-	Switchyard to entrance of Yedigoze Substation
Number of Circuit and Nominal Voltage	cct x kV	3 x 154 and 1 x 380
Construction Period	years	6
Annual Energy Production		
Total Energy	GWh	1,159.7
Firm Energy	GWh	586.0
Secondary Energy	GWh	573.7
Project Cost		
Dam and Power Facility	10^6 T.L	562,788 (US$432.9 x 10^6 $)
Transmission Line (Goktas P.P to Yedigoze S.S)	"	20,527 (US$15.8 x 10^6 $)
Total	"	583,315 (US$448.7 x 10^6 $)

Item	Unit	Description	
Construction Cost at Sending End			
Per kW	10^3 T.L/kW	2,084.4	(1,603 US$/kW)
Per kWh	T.L/kWh	485.3	(0.37 US$/kWh)
Net Present Value (B-C)	10^6 T.L	227,476	(US$174.98 x 10^6)
Benefit Cost Ratio (B/C)	-	1.69	
Financial Internal Rate of Return (FIRR)	%	14.02	
Economic Internal Rate of Return (EIRR)	%	14.38	
Equalized Discount Rate (EDR)	%	23.82	
Exchange Rate		1 US$ = 1,300 T.L (as of June, 1988)	

CONCLUSION AND RECOMMENDATION

CONCLUSION AND RECOMMENDATION

The Project is the Zamanti Goktas Hydroelectric Power Development Project to be constructed at the downstreammost part of the Zamanti River, a tributary of the Seyhan River in the southeastern part of the Republic of Turkey which empties into the Mediterranean Sea.

According to the results of studies based on data obtained up to the present time, it may be concluded that the Project is feasible from technical and economic points of view. The contents of the conclusions are described below.

CONCLUSIONS

(1) The objective of the Project is to construct a large-scale hydroelectric power plant effectively utilizing water power, which is one of the domestic resources of Turkey, to supply plentiful and stable electric power to satisfy demand.

By carrying out the Project, it will be possible also to contribute to the economic development of the region.

(2) The growth of power demand in the Republic of Turkey was blunted by scheduled load shedding from 1980 to around 1983 because of the insufficiency of power supply capability. However, a growth at the 12-percent level was indicated in 1984 as a result of increase in supply capacity and imports of electric power from foreign countries.

Since then, power demand had increased steadily every year and since 1986 double-digit growth rates have been recorded. The installed capacity as of 1987 was 12,493 MW (44,353 GWh, imports not included). The Turkish Government is presently proceeding with construction of large-scale power plants utilizing domestic resources.

According to the load forecast made by TEK under the Turkish Government using the MAED (Model of Analysis of the Energy Demand) Method, it is calculated that the demands will be 10,370 MW (64,910 GWh) in 1990, 26,955 MW (166,830 GWh) in 2000, and 52,730 MW (323,850 GWh) in 2010.

(3) Regarding the timing for commissioning of the Project in the national power system, it is judged reasonable for operation to be started around the year 2000 considering the period required for further investigations, definite design, and construction.

(4) The Project is situated at the downstreammost part of the Zamanti River proposed in the Upper Seyhan Master Plan, the river gradient being steep and the river banks on both sides also steep in the area. Accordingly, the site characteristics are advantageous for dam-and-conduit type schemes combining medium-scale reservoirs and tunnels.

Two routes are conceivable for transportation from Adana to the dam site. One is a route starting from Adana and going through Imamoglu and the powerhouse site to reach the dam site going upstream along the Zamanti River. The other is a route from Adana which goes through Catalan and Karsanti to reach the dam site going over a pass of EL. 1,500 m. Studies were made of the two routes. On consideration of the economics, construction planning, and future maintenance and administration of the dam and the powerhouse will be more suitable.

(5) With regard to the development of the effective head from the Goktas dam site to the end of Kavsak Reservoir, the four alternatives of single-stage, two-stage, and three-stage (two proposals) were studied and the single-stage development which is the best in economics was selected as the basic development plan.

(6) For the high water level of Goktas Reservoir, comparison studies were made of the three cases of elevation 630 m, 620 m, and 610 m giving consideration to geology in the reservoir area, sedimentation, and effective storage capacity.

For the effective storage capacity, comparison studies were made of available drawdowns of 40 m, 30 m, 20 m, 10 m, and 0 m, a total of five cases.

As a result of these comparison studies, and taking into overall account the economic, topographic and geologic conditions, it was judged optimum for the reservoir high water level to be 630 m and available drawdown 10 m. The gross storage capacity and the effective storage capacity of the reservoir in this case will be 109.33 x 10^6 m^3 and 24.7 x 10^6 m^3, respectively.

(7) For the optimum scale of the Goktas Power Plant comparison studies were made of the three cases of peak durations of 6, 8, and 10 hours, and five cases of maximum power discharge varied between 81 m^3/s and 162 m^3/s. As a result of the studies, a maximum power discharge of 108 m^3/s and installed capacity of 270 MW (annual energy production: 1,160 GWh) will be the most advantageous.

(8) It is considered there will be no problem about the watertightness of the reservoir from the fact that ophiolite (peridotite) and melange making up most of the reservoir area except for the upstreammost part of the reservoir are impermeable and groundwater levels are high. There is distribution of limestone at the end of the reservoir, upstream from the river-bed water level of EL. 610 m. For high water level of the reservoir at EL. 630 m, a maximum of 20 m in water depth and approximately 600 m in length will be a limestone distribution area. Signs that leakage would occur from the limestone distribution area of this part have not been discovered in surface geological explorations. However, for the sake of safety, it will be necessary for additional investigations to be made to confirm the watertightness of the upstreammost part of the reservoir.

(9) The geology of the Goktas dam site is composed of hard peridotite. There are small-scale faults at the surface layer, while cracks are developed and serpentinization can be seen to have occurred in parts, but all of these are discontinuous and would not extend deep underground.

The topography of the dam site is one of a V-shaped gorge with continuous steep slopes close to perpendicular, while the river width is narrow at only about 40 m.

(10) Regarding the type of Goktas Dam, a comprehensive study was made taking into consideration topography, geology, meteorology, availability of concrete aggregates, rock and soil materials, etc., and as a result it was judged that a concrete gravity dam or a concrete arch-

gravity dam would be suitable. Since these two dam types were thought to be promising, feasibility designs were made of the two, and a comparison study was carried out. As a result of examination it was judged that a concrete arch-gravity type would be desirable from economic and technical points of view. The height and volume of the dam selected were 148 m and 800,000 m^3, respectively.

The spillway would be located at roughly the middle of the dam body with three radial gates 14.0 m in width and 13.0 m in height installed.

(11) The intake is to be installed at the right-bank side approximately 100 m upstream from the dam and is to be a gated vertical shaft. The headrace tunnel route was selected to connect the intake site and the surge tank site by the shortest distance within limits of satisfying the condition that there would be adequate rock cover and work adits could be easily provided. The length and inside diameter of the headrace would be 15.7 km and 6.8 m, respectively. An overflow type was adopted for the surge tank. The penstock is to be a surface type at the upper part with the lower part below EL. 410 m an embedded type in consideration of workability and economy. The penstock would be 600 m in length with the end portion bifurcated.

(12) For the powerhouse type, a comparison study was made of a surface type and a semi-underground type taking into consideration topography, geology, constructibility, and economy. As a result of the study, a semi-underground type was selected. The number of main electro-mechanical equipment units is to be two with vertical-shaft Francis turbines (137.5 MW) and 3-phase alternating-current synchronous generators (150 MVA).

(13) The switchyard is to be provided at a terrace on the opposite bank from the powerhouse in consideration of topography and geology. The powerhouse and the switchyard are to be connected by a 154-kV x 2-cct tie tranmission line.

(14) The electric power generated at Goktas Power Plant is to be sent from Goktas Switchyard to Yedigoze Substation via ..karca Substation by means of a 154-kV and 380-kV transmission line (length approximately

35 km). The electric power is to be transmitted further from Yedigoze Substation to Adana Substation.

(15) Environments survey is qualitatively performed based on the limited field survey and collected materials.

According to evaluation results, there is no serious impact on natural and social environments, except impact on the people whose farm lands are submerged by the reservoir.

It is necessary to accomplish the Project successfully, lest the environment should be affected unexpectedly, and the fundamental living rights of the people concerned be violated by executing the Project.

Therefore, impacts on the natural environment during construction have to be reduced. In addition, it is desirable to perform optimum monitoring mainly for the water quality during construction and after starting operations.

(16) The initial investment required as of June 1988 will be 583,315 x 10^6 TL (US$448.7 x 10^6), the breakdown being as follows:

Dam, powerhouse and appurtenant facilities		
Local currency	320,872 x 10^6 TL	(US$246.8 x 10^6)
Foreign currency	241,916 x 10^6 TL	(US$186.1 x 10^6)
Subtotal	562,788 x 10^6 TL	(US$432.9 x 10^6)
Transmission line facilities		
Local currency	8,586 x 10^6 TL	(US$6.6 x 10^6)
Foreign currency	11,941 x 10^6 TL	(US$9.2 x 10^6)
Subtotal	20,527 x 10^6 TL	(US$15.8 x 10^6)
Total		
Local currency	329,458 x 10^6 TL	(US$253.4 x 10^6)
Foreign currency	253,857 x 10^6 TL	(US$195.3 x 10^6)
Total	583,315 x 10^6 TL	(US$448.7 x 10^6)

The construction costs per kW and kWh at the generating end for Goktas Power Plant are 2,084.4 x 10^3 TL (US$1,603.4) and 485.3 TL (US$0.37), respectively. The construction period for the Project was assumed to be 6 years.

(17) For the purpose of benefit-cost analysis, an imported-coal fired thermal power plant capable of substituting the Project was assumed, and the costs compared. The result of the study indicated that the net present value (B - C) and the benefit cost ratio (B/C) are 227,476 x 10^6 TL (US$174.98 x 10^6) and 1.69 respectively.

(18) The financial soundness of the Project was evaluated by comparing the financial internal rate of return (FIRR) based on the market prices with the borrowing interest rate expected for the Project. The financial internal rate of return of the Project is 14.02%, exceeding the expected borrowing interest rate of 9.5%.

Next the economic internal rate of return (EIRR) was calculated by the modification market price (conversion to border price), which were obtained by modifying the market price used in the FIRR. Then this economic internal rate of return was compared to the opportunity cost of capital within the Republic of Turkey to evaluate the economic value of the Project. the economic internal rate of return of the Project is 14.38%, exceeding the capital opportunity cost in Turkey of 12%. Thus it can be concluded that the Project is feasible from both financial and economic points of view.

(19) The Project described above (hereafter referred to as "Basic Development Plan") was selected as the optimum plan from the viewpoint of the economics. Meanwhile, an alternative plan next best to this Basic Development Plan is described in Chapter 17, "Studies on Alternative Development Plans." The alternative Plan is for construction of Goktas Dam and Reservoir (the same as the Basic Development Plan) and three power Plants (total output 264.5 MW). This alternative, in contrast to the Basic Development Plan, makes it possible for individual power Plants to be developed in order from the upstream side in accordance with the amount of funds procurable, but the technical and economical condition will be inferior.

RECOMMENDATIONS

The Zamanti Goktas Hydroelectric Power Development Project is feasible both technically and economically, and it is recommended that the Project be implemented.

It is necessary for the following to be done in order to carry out the Project:

(1) Preparations required for construction such as definite design and composition of bid documents.

(2) Additional investigations and tests on the items cited in Chapter 16, "Further Investigations" of the Report in order to proceed with definite design, the results of the investigations to be thoroughly reflected in the definite design.

(3) Although adoption of the alternative plan in place of the Project (Basic Development Plan) is not desirable from an economic standpoint, in case of implementing the alternative, further field investigations and technical studies will be necessary before proceeding with definite design.

CHAPTER 1. INTRODUCTION

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CONTENTS

CHAPTER 1. INTRODUCTION

In the Republic of Turkey, efforts are being continued to achieve economic growth through industrialization by changing the industrial structure which had been based mainly on agriculture. Securing energy is an indispensable factor for this purpose, and with limited petroleum resources, the development of domestic energy resources has been given very high priority in order to achieve the established target of economic growth.

A growth rate in GNP of 8 percent was the target in the Fourth Five-Year Plan (1979-1983), but the result was far below it. In the current Fifth Five-Year Plan (1985-1989) which started in 1985, the target GNP growth rate is 6.3 percent. The growth rates in GNP from 1979 to 1987 and the growth rates in electric energy supply during those years are as shown below.

	1979	1980	1981	1982	1983	1984	1985	1986	1987
GNP (%)	-0.4	-1.1	4.1	4.6	3.2	5.9	5.1	8.1	7.4
Electric Energy supply growth (%)	5.5	4.5	6.8	7.7	4.4	12.5	9.3	11.3	11.0

This low growth rate in electric energy supply was due to the shortage of capital for investment in economic activity because of the second oil crisis which occurred in 1978 so that supply capability became insufficient in spite of the existence of latent demand, and this was manifested by the load shedding carried out from 1980 to 1983.

As an emergency measure against immediate electric power shortages, the Turkish Government imported from Bulgaria from 1975 to 1986, while since 1979 it has been importing from the Soviet Union, and since 1988 from Iraq. The quantity had been increasing yearly, and in 1984 it was 2,653 GWh, as much as 8.7 percent of the total energy production of 30,614 GWh. However, the quantity imported has decreased since 1985, it having been 572 GWh in 1987, approximately 1.3 percent of the total energy production of 45,000 GWh.

The installed electric power capacity of the Republic of Turkey in 1987 was 12,492 MW (5,003 MW hydro, 7,489 MW thermal). As a result of the recovery of the world economy after the second oil crisis there has been an increase in investment in the electric power sector. The Turkish Government, in order to meet the increasing power demand, has been implementing the construction of largescale hydro and thermal projects such as Elbistan Thermal Power Plant (4,200 MW), Karakaya Hydroelectric Power Plant (1,800 MW), Altinkaya Hydroelectric Power Plant (700 MW), Ataturk Hydroelectric Power Plant (2,400 MW) and Catalan Hydroelectric Power Plant (153 MW), and these are scheduled to be successively commissioned in the electric power system from 1987 to around 1990. Of these, Altinkaya Hydroelectric Power Plant went into operation in 1987 with Unit No. 1 of 175 MW, and with Unit No. 2 to Unit No. 4 each of 175 MW added in 1988. Regarding Karakaya Hydroelectric Power Plant, operation was started in 1987 with Unit No. 1 to Unit No. 3 each of 300 MW, and with Unit No. 4 and Unit No. 5 each of 300 MW added in 1988. Further, Unit No. 6 of 300 MW is scheduled to be commissioned in 1989. It is thought that the chronic shortage of electric power will be gradually eliminated if these projects are developed as planned.

1.1 Background

As an outlook from a long-range point of view, the Turkish Government has predicted that it will be necessary to additionally construct capacity of 64,400 MW (annual average growth rate 8.0 percent) and electric energy of 343,000 GWh (annual average growth rate 8.6 percent) according to the demand forecast for the 22-year period from 1989 to 2001. Of this amount, it is proposed to develop approximately 27,000 MW and 99,000 GWh, respectively, of hydro power.

It has been published in the Annual Report of 1983 that the energy resources of Turkey are 57 x 10^6 tons of petroleum, 12,900 x 10^6 tons of coal, and 30,800 MW of hydroelectric potential. The production of oil would supply only about 10 to 20 percent of domestic demand. The production of coal is about 20 million tons annually, but there is little hard coal, with most of the production consisting of lignite which is not of very good quality, making it difficult to use this for purposes other than fuel. Therefore, hard coal is being used for industrial purposes and lignite for heating and for thermal power generation.

On the other hand, with regard to hydro, although Turkey is situated in a dry area, since the country as a whole is in the form of a plateau, the hydroelectric potential is fairly large, and from the viewpoint that it is a purely domestic energy resource, the Turkish Government has been actively promoting its development. From the standpoint of effective utilization of domestic energy, the Government plans to continue to aggressively develop hydro in the future to bring the ratio of hydro versus thermal to 50:50 or 45:55. In addition to the large-scale hydros previously mentioned, preparations are underway to start construction of Kayraktepe Hydroelectric Power Plant (420 MW), Ilisu Hydroelectric Power Plant (1,200 MW), Boyabat Hydroelectric Power Plant (510 MW), Birecik Hydroelectric Power Plant (670 MW), Yedigoze Hydroelectric Power Plant (300 MW), etc., in the very near future, and plans are ready for development of new sites following these projects. The hydroelectric potential of Turkey is concentrated in the eastern part of the country. Hydroelectric power development at sites near Istanbul and load centers in the west has reached a stage of completion, and development is shifting to the eastern region which is far away from load centers.

It was under such circumstances that the Turkish Government selected the Seyhan River for large-scale development of the next generation, and prepared a Lower Seyhan Basin Master Plan in 1981 and an upper Seyhan Basin Master Plan in 1984 for an integrated development scheme for the river in anticipation of its development.

The Seyhan River has approximately 6 percent (1,850 MW) of the hydroelectric potential in the country. The river basin is surrounded by steep mountains, while the runoff is on the large side compared with other rivers in Turkey, and so the river is ideal for hydroelectric power development.

According to the Master Plan, the Goktas Hydroelectric Power Development Project planned on the Zamanti River, a major tributary of the Seyhan River, is promising as part of the Seyhan River Development Plan. The project site is at a short distance from Adana City in Adana Province. In recent years, the demand for electric power has increased in the southwestern part of Turkey with Adana City at the center, the demand which in 1987 was 1,700 GWh/yr expected to increase approximately tenfold to 17,750 GWh/yr in the year 2000.

Under such circumstances, in order for the Goktas Hydroelectric Power Development Project to be realized, the Government of Turkey requested the Government of Japan for technical cooperation to conduct a feasibility study of the Project. The Government of Japan, responding to the request, commissioned the Japan International Cooperation Agency in August 1987 to conduct the study, and a preliminary survey team headed by Mr. Masatake Kitajima of the Public Utilities Department, Agency of Natural Resources and Energy, Ministry of International Trade and Industry, was dispatched to Turkey for exchanges of opinions with the Government of Turkey and to carry out a general reconnaissance in the field.

Based on the results of the above, an agreement was reached in August 1987 between the General Directorate of State Hydraulic Works (DSI), Republic of Turkey and the Japan International Cooperation Agency (JICA), under the title of "Scope of Works for the Feasibility Study on the Zamanti Goktas Hydroelectric Power Development Project in the Republic of Turkey".

1.2 Scope of Study and Field Investigation

The objective of the Study is to study and assess the feasibility in technical, economical and financial points of view, of the Zamanti Goktas Hydroelectric Power Development Project (hereinafter referred to as the Project) located in the lower reaches of the Zamanti River, the tributary of the Seyhan River which flows into the Mediterranean Sea through Adana City located southeastern part of Turkey, using the collected data and the result of field investigation. The study results will be summarized as the Feasibility Report.

The study consists of three stages: Preliminary Investigations Stage, Detailed Investigations Stage, and Feasibility Design Stage. The preliminary investigations of the first stage may be divided into the three parts of preliminary preparations in Japan, field investigations, and analysis work in Japan. In Turkey, field reconnaissances, data collection, and analyses and evaluations will be done. In Japan, analysis work will be performed and the basic concept of development of this Project formulated. The detailed investigation Program and technical specifications will be prepared based on this basic development concept.

The detailed investigations of the second stage will be carried out for making the feasibility design based on the results of the preliminary investigations, and will consist of field investigations, analysis work in Japan, and field investigation works. The investigation work will be carried out by the DSI, and will consist of topographical surveying, geological investigation works, and various tests.

The third stage will consist of feasibility design, cost estimating, and economic and financial evaluation based on the results of the preliminary and detailed investigations.

In October 1987, JICA began the work based on the beforementioned "Scope of Works." JICA next dispatched the following survey teams for field investigations concerning the Project.

November 14 - December 28, 1987:	First Preliminary Investigation
March 14 - March 28, 1988:	Second Preliminary Investigation
June 18 - July 17, 1988:	First Detailed Investigation
September 6 - November 4, 1988:	Second Detailed Investigation
March 18 - March 31, 1989:	Discussion on Interim Report
August 19 - September 2, 1989:	Discussion on Final Draft Report

During this time, the Survey Team submitted the following reports to the DSI.

November 1987:	Inception Report
March 1988:	First Progress Report, Detailed Investigation Program, and Technical Specifications
November 1988:	Second Progress Report
March 1989:	Interim Report

June 1989: Third Progress Report

August 1989: Draft Final Report

From April 1988 to December 1988, the DSI carried out field investigations and investigation works based on the abovementioned Detailed Investigation Program. The outlines of the field investigations and investigation works are as shown Table 1-1.

The members of the Survey Team and the persons of the Turkish Government who cooperated with the investigation are listed below.

Table 1-1 Investigation Works

Items		Description
Topographic Survey		
Powerplant Site	:	1/1,000 (3.68 km^2)
Area A	:	" (1.24 km^2)
Area B	:	" (2.44 km^2)
Geological Investigation and Material Tests		
Drilling Work and Permeability Tests		
Dam Site	:	450 m
Powerplant Site	:	141 m
Tunnel Route	:	280 m
Exploratory Adits		
Dam Site	:	100 m
In-Situ Tests		
Dam Site		
Plate Bearing	:	7 Points
Rock Shear	:	8 Points
Seismic Prospecting		
Powerplant Site	:	865 m
Field/Laboratory Test for Material		
Quarry Site	:	8 Samples
River Deposit Sites	:	22 Samples
Social and Environmental Aspect		
Investigation for Compensation		

JICA Survey Team

Name	Assignment	Period
Mamoru TAKAICHI	Team Leader (Civil Engineer)	Nov. 14 - Dec. 28, 1987 Mar. 14 - Mar. 28, 1988 Oct. 1 - Oct. 15, 1988 Mar. 18 - Mar. 31, 1989 Aug. 19 - Sep. 2, 1989
Kunio KITAMURA	Design (Civil Engineer)	Ditto
Junichi ASANO	Planning (Civil Engineer)	Nov. 14 - Dec. 28, 1987 Mar. 14 - Mar. 28, 1988 Mar. 18 - Mar. 31, 1989
Takeshi WASHIZAWA	Cost Estimation (Civil Engineer)	Jun. 18 - Jul. 17, 1988
Shigeru NAKAMURA	Hydrology (Civil Engineer)	Nov. 14 - Dec. 28, 1987
Kazuhiko FUSHIMI	Rock Test (Civil Engineer)	Sep. 6 - Oct. 20, 1988
Ken NIIMI	General Geology (Geologist)	Nov. 14 - Dec. 28, 1987 Sep. 6 - Nov. 4, 1988 Mar. 18 - Mar. 31, 1989
Eijiro KOCHI	Seismic Exploration (Geologist)	Sep. 6 - Oct. 20, 1988
Takumi MIYAKO	Power Plant (Electrical Engineer)	Jun. 18 - Jul. 17, 1988
Akio SUZUKI	Power System (Electrical Engineer)	Jun. 18 - Jul. 17, 1988
Takashi HIGURASHI	Environment (Civil Engineer)	Oct. 1 - Oct. 15, 1988
Takanobu KITAKIDO	Economy (Economist)	Jun. 18 - Jul. 2, 1988

Turkish Government and Relevant Agency

First Stage Preliminary Investigation (Nov. 14 – Dec. 28, 1987)

DSI (Ankara)

Mr. Erol ENACAR	General Director

Mr. Ahmet F. UNVER	Assistant General Director	
Mr. Ozden BILEN	Chairman:	Dept. of Planning & Investigation
Mr. Yuksel SAYINER	Deputy Head:	"
Mr. Savas USKAY. CE	Deputy Head:	"
Mr. Tuncay SOYSAL	Planning Manager:	Dept. of Planning & Investigation
Mr. Hasan ERKE	Head of Energy Section	"
Mr. Ramazan KOSDERE	Manager: (Survey Section)	
Mr. Namik AKCANBAS	Deputy Director:	Dept. Geotechnical Service & Underground Water
Mr. Yigit AYASLIOGLU	Manager:	"
Mr. Yildiray PAGDA	Geological Engineer:	"
Mr. Mehmet AKPINAR	Geological Engineer:	"
Mr. Serapettin CANAZ	Civil Engineer:	Dept. of Planning & Investigation
Mrs. Zekiye KULGA	Meteorologist:	"
Mrs. Lale CVLFU	Hydrologist:	"
Mr. Yalcin SENCER	Meteorologist:	"

DSI 6th (Adana)

Mr. Yulmaz YAPICI	Regional Director	
Mr. Suleyman BOZKURT	Deputy Director	
Mr. Hasan MERT	Manager:	Planning Section
Mr. Adil AKYATAN	Civil Engineer:	"
Mr. Cabbar YORDEM	Geological Engineer	
Mr. Ugur Cemal OGUZBERK	Geological Engineer	
Mr. Halil ALTINOK	Hydrologist	

DSI 12th (Kayseri)

Mr. Naci BEKTAS	Retional Director

Mr. Efhem GOGER	Geological Engineer
Mr. Yakup BASOGLU	Civil Engieern
Mr. Sahap YILMAZ	Civil Engineer

EIE

Mr. Nezih SAYAN	Head of Project Design Department
Mr. Sukru KARABIBER	Section Manager of Project Design Department
Mr. Vildirim VARLIK	Project Design Department

TEK

Mr. Faruk EREN	Ast. Director of Planning and Coordination Division

Second Stage Preliminary Investigation (Mar. 14 – Mar. 28, 1988)

DSI (Ankara)

Mr. Ferruh ANIK	General Director	
Mr. Ozden BILEN	Chairman :	Dept. of Planning & Investigation
Mr. Savas USKAY. CE	Deputy Head:	"
Mr. Yuksel SAYINER	Deputy Head:	"
Mr. Tuncay SOYSAL	Planning Manager :	"
Mr. Hasan ERKE	Head (Energy Section) :	"
Mr. Sadat SAMSUNLU	Planning Engineer:	"
Mr. Ramazan KOSDERE	Manager (Survey Section) :	"
Mr. Zekiye KULGA	Meteorologist :	"
Mr. Turan AKLAN	Chairman :	Dept. of Geological Service & Underground Water
Mr. Muammer YARALIOGLU	Deputy Head :	"
Mr. Yigit AYASLIOGLU	Manager :	"
Mr. Yildiray PAGDA	Geological Engineer:	"

Mr. Mehmet AKPINAR	Geological Engineer: Dept. of Geological Service & Underground Water
Ms. Ayla ALTUG	Chief Engineer (Carst Investigation Section): "
Mr. Mahmud SOZEN	Geological Engineer (Geophisical Investigation Section): "
Mr. Museyin EDOGAN	Geological Engineer (Rocks and Soil Mechanics Section) : "
Mr. Cetin HIZLI	Geological Engineer (Borrow Material Section): "
Mr. Erden DEMIREL	Geological Engineer (Drilling Section) : "
Mr. Ergun DEMIROZ	Deputy Director: Technical Research and Quality Control Dept.

<u>DSI 6th (Adana)</u>

Mr. Yulmaz YAPICI	Regional Director
Mr. Suleyman BOZKURT	Deputy Director
Mr. Hamit OZASLAN	Deputy Director
Mr. Hasan MERT	Manager
Mr. Cabbar YORDEM	Geological Engineer

First Stage Detailed Investigation (Jun. 18 – Jul. 17, 1988)

DSI (Ankara)

Mr. Ozden BILEN	Chairman :	Dept. of Planning & Investigation
Mr. Savas USKAY	Deputy Head:	" "
Mr. Tuncay SOYSAL	Planning Manager :	Dept. of Planning & Investigation
Mr. Hasan ERKE	Head of Energy Section:	"
Mr. A. Sedat SAMSUNLU	civil Engineer :	"
Mr. Mehmet AKPINAR	Geological engineer :	Dept. of Geotechnical Survey & Underground Water
Mr. Mehmet SOYTURK	Geological Engineer :	"
Mr. Suat PASIN	Deputy Director :	Dam and Hydroelectric Power Plants Dept.
Mr. Ismail H. ALTUN	Electrical Engineer	

DSI 6th (Adana)

Mr. Yilmaz YAPICI	Regional Director
Mr. Suleyman BOZKURT	Deputy Director
Mr. Hamit OZASLAN	Deputy Director
Mr. Mustafa KANALCI	Deputy Director
Mr. Hasan MERT	Manager: Planning Section
Mr. Cabbar YORDEM	Geological Engineer
Mr. Ugur Cemal OGUZBERK	Geological Engineer
Mr. Ihsan CANGUVEN	Agricultural Economist
Mr. Cahit SUGUCUK	" "
Mr. Mahmut CETIN	Agricultural Engineer
Mr. Vedat TURAN	Electrical Engineer

DSI (Karakaya)

Mr. Ilker OZEL	Regional Director
Mr. Avni BUYUKKAYA	Electrical Engineer

DSI (Ataturk)

Mr. Erdogan BASMACI	Regional Director

MERSIN PORT

Mr. Unkur GURSES	Port Director
Mr. Ugur OZUS	Ass. Port Manager (Technical)
Mr. Gurol TOYKAN	Ass. Port Manager (Administer)

TEK (Ankara)

Mr. Faruk EREN	Assistant Director of Planning and Coordination Division
Mr. Suat KIZILYALLI	Qhiel of Transmission Planning and Coordination
Mr. Metin GUNYOL	Ass. Director of Follow up and Evaluation Section
Mr. Zehra SENER	Statistical Department
Mr. Teoman ALPTURK	director of Load Dispatching Department
Mr. Ilhami OZSAHIN	Ass. Director of Load Dispatching Center

CUKUROVA ELEKTRIK A.S. (Adana)

Mr. Vakif ACUNSAL	General Manager
Mr. Hikmet YANAR	Ass. General Manager
Mr. Yaman AKAR	Ass. General Manager
Mr. Akkan TANER	Director of Load Dispatching Control Center
Mr. Ogur KANIBIR	Ass. Director of Load dispatching Center

Second Stage Detailed Investigation (Sep. 6 – Nov. 4, 1988)

DSI (Ankara)

Mr. Ozden BILEN	chairman of Planning & Investigation Dept.
Mr. Savas USKAY	Deputy Head of "
Mr. Tuncay SOYSAL	Manager of "
Mr. Yigit AYASLIOGLU	Manager of Geotechnic Services & Underground Water Dept.
Mr. Yildiray PAGDA	Geotechnic Services & Underground Water Dept.
Mr. Eray OZGULER	"
Mr. Mohmet SOYTURK	"
Mr. Ercin TURKEL	"
Mr. Mufit GUVEN	"
Mr. Umit ERDEM	"
Mr. Ertugrui ADA	"
Mr. Cengiz Kaptan	"
Mr. Cetin HIZLI	Chief of Geotechnic Services & Underground Water Dept.
Mr. Serafettin CANAZ	Planning & Investigation Dept.
Mr. O. L. UZUN	Geotechnic Services & Underground Water Dept.

DSI 6th (Adana)

Mr. Yilmaz YAPICI	Regional Director
Mr. suleyman BOZKURT	Deputy Director
Mr. Hasan MERT	Manager of Planning Section
Mr. Ugur Cemal OGUZBERK	Planning Section
Mr. Cabbar YORDEM	"
Mr. Hasan MULAYIN	"
Mr. Ilgun TOKSUK	"
Mr. Ihsan CANGUVEN	Chief of Planning Section

Mr. Orhan EMRE	Head of Drilling Section		
Mr. Idris YARDIM	Deputy Head of Drilling Section		
Mr. Erdem ERSOZLUOGLU	Drilling Section		
Mr. Mohmet	Planning Section		

First Stage Feasibility Design (Mar. 18 – Mar. 31, 1989)

DSI (Ankara)

Mr. Ozden BILEN	Assistant General Director		
Mr. Ahmet F. UNVER	Assistant General Director		
Mr. Suleyman BOZKURT	chairman	:	Dept. of Planning & Investigation
Mr. Savas USKAY. CE	Deputy Head:		"
Mr. Huseyin YAVUZ	Deputy Head:		"
Mr. Tuncay SOYSAL	Planning Manager	:	"
Mr. Semavi AKAY	Planning Manager	:	"
Ms. Sen SULUN	Planning Manager	:	"
Mr. Hasan ERKE	Head (Energy Section)	:	"
Ms. Lale CULTU	Hydrologist	:	"
Mr. Sadat SAMSUNLU	Civil Engineer	:	"
Mr. Turhan AKLAN	Chairman	:	Dept. of Geotechnical Service & Underground Water
Mr. Namik AKCANBAS	Deputy Director	:	"
Mr. Yigit AYASLIOGLU	Manager	"	"
Mr. Yildiray PAGDA	Geological Engineer:		"
Mr. Mufit GUVEN	Geological Engineer:		"
Mr. Ercin TURKEL	Geological Engineer:		"
Mr. Eray OZGULER	Geological Engineer:		"
Mr. Cetin HIZLI	Geological Engineer:		"
Mr. O. Lutfu UZUN	Geological Engineer:		"

Mr. Cengiz KAPTAN	Geological Engineer:	Dept. of Geotechnical Service & Underground Water
Mr. Huseyin ERDOGAN	Mining Engineer :	"
Ms. Ayla ALTUG	Geological Engineer: (Karst Investigation Section)	"

DSI 6th (Adana)

Mr. Yilmaz YAPICI	Regional Director	
Mr. Hasan MERT	Manager :	Planning Section
Mr. Ilgun TOKSUK	Civil Engineer:	"
Mr. Cabbar YORDEM	Geological Engineer	
Mr. Ugur Cemal OGUZBERK	Geological Engineer	

1.3 Information and Data

The project studies were conducted with existing information and data mainly made available by DSI, and information and data obtained through field investigations and investigation works.

Topographic maps, hydrologic data, cost estimate data, power supply and demand data, economic and financial data, etc. which were used in the studies are listed in Appendix A-7.

CHAPTER 2. GENERAL SITUATION IN THE REPUBLIC OF TURKEY

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CHAPTER 2. GENERAL SITUATION IN THE REPUBLIC OF TURKEY

2.1 Geography

The Republic of Turkey is geographically located between north latitudes 42°06' and 35°51', and east longitudes 44°48' and 25°40', and is situated at the connecting point between the European and Asian continents.

The country is in the shape of a rectangle, 650 km wide and 1,565 km long having a total area of 779,452 km^2. 97% of this area belongs to the Anatolian Peninsula at the westernmost tip of Asia called Asia Minor, with the remaining 3% being the Thrace Region in the southeastern part of the Balkan Peninsula located at the eastern tip of the European continent.

The land is bounded on the south by the Mediterranean Sea, on the west by the Aegean Sea and Bulgaria and Greece, on the north by the Black Sea, and on the east by the Soviet Union, Iraq, Iran and Syria.

Broadly dividing the land geographically, it consists of the Aegean-Mediterranean Region, Black Sea Coast Region, Eastern and Central Anatolia Region, and the Southern Anatolia Region. 96% of the land belongs to a steppe type climate zone called the Anatolian Plateau, and only 30% of the land is cultivated.

The mean elevation of the land is 1,132 m with no more than 20% of the land being below elevation 500 m. The mean elevation of Ankara, the capital city, is 902 m.

Representative rivers are the Kizilirmak River (1,355 km), the longest in Turkey, the Sakarya River (825 km), the Seyhan River (560 km) and the Yesilirmak River (520 km), besides these, there are the famous Tigris and Euphrates which are international rivers that rise within the boundaries of Turkey.

Lake Van (3,700 km^2) in Eastern Anatolia, and Lake Tuz (1,500 km^2) in Central Anatolia are representative lakes, and both are salt water lakes. Artificial lakes are Lake Keban (675 km^2) on the Euphrates River and Lake Hirfanli (263 km^2) on the Kizilirmak River which are well-known, and both are playing important roles as reservoirs for hydroelectric power generation, namely, as water power energy resources.

Most of the mountain areas are situated in the Eastern Anatolia Region bounded by the Soviet Union and Iran. Mt. Ararat (5,165 m) is the most famous mountain, besides which there are peaks such as Mt. Suphan (4,434 m), Mt. Kackar (3,932 m), and Mt. Erciyes (3,916 m), and this region comprises the greatest hydroelectric potential area of Turkey.

Vegetation differs according to the climate and topographical conditions, but the country can be broadly divided into the following regions.

Black Sea Coast Region	:	Forest zones are distributed at mountain slopes facing the shoreline, with oak, elm and birch being the predominant species.
Aegean-Mediterranean Coast Region	:	Olive, citrus, and pine are the predominant species along the mountain areas.
Anatolian Plateau Area	:	The vegetation consists of natural forage and scattered forests.

2.2 Climate

In spite of the fact that three sides - north, west, south - of Turkey are bonded by sea (Black Sea, Aegean Sea and Mediterranean Sea, total coast-line 8,400 km), the mean elevation of the country is 1,132 m. The climate differs greatly according to region due to the influence of the mountain ranges running parallel to the coast line from north to south.

2.2.1 Temperature

The annual mean temperature in the Black Sea Coast Region is a mild 14°C to 15°C, while in midsummer of July and August, temperatures are from 22°C to 24°C which is relatively comfortable, and in the cold season of January and February the temperature is from 5°C to 7°C and the climate is not very severe.

The annual mean temperature of the Aegean-Mediterranean Region is a warm 18°C to 20°C, a so-called Mediterranean climate. The temperature climbs higher than 27°C in summer, but it is mild from 8°C to 12°C in winter.

On the other hand, annual mean temperatures in inland areas differ greatly between 4°C and 18°C depending on altitude, a continental climate with extremes of hot and cold. In midsummer it becomes burning hot, while in mid-winter warm winds are shut off by mountain ranges running parallel to the coast line and many areas are hit by cold waves of 0°C to -10°C.

2.2.2 Precipitation

Turkey is subject both to a continental type climate characterized by rainy weather throughout the year and also to a subtropical climate distinguished by dry summers. Rainfalls are generally observed on the slopes of the mountains facing the seas. But moving towards the interior areas, the rainfall gradually becomes less. Thus there is a substantial variation in precipitation from region to region.

In the Agean-Mediterranean Region the rainy season continues from autumn to late spring, while in the Black Sea Coast Region there is rainfall throughout the year. The precipitation in the inland areas consists mainly of snowfall in the wintertime succeeded by rainfall in the early spring, with almost no precipitation in the other periods.

The climates of the main cities are shown in Table 2-1.

Table 2-1 Climate in the Main Cities

Selected Cities	Regions	Altitude above Sea (m)	Temperature (°C)			Average Humidity (%)	Average Precipitation (mm)
			Average	Lowest	Highest		
Istanbul	Mar.	39	14.0	-16.1	40.5	75	673.4
Ankara	Cent.A.	902	11.7	-24.9	40.0	60	367.0
Izmir	Aegean	25	17.6	-8.2	42.7	65	700.2
Adana	Medit.	20	18.7	-8.4	45.6	66	646.8
Edirne	Thrace	48	13.5	-22.2	41.5	70	599.3
Bursa	Mar.	100	14.4	-25.7	42.6	69	713.1
Antalya	Medit.	42	18.6	-4.6	44.6	69	1,067.2
Urfa	S.East A.	547	18.1	-12.4	46.5	48	473.1
Zonguldak	W.Black S.	136	13.5	-8.0	40.5	73	1,242.9
Rize	E.Black S.	4	14.1	-7.0	38.2	77	2,357.0
Van	East A.	1,725	6.6	-28.7	37.5	60	384.0
Agri	N.East A.	1,632	6.1	-43.2	38.0	67	528.5
Mugla	Aegean	646	14.9	-12.6	41.2	61	1,220.9

Source: General Directorate of Meteorology
Statistical Yearbook of Turkey 1987

2.3 Population

The total population as of the end of 1987 was 51,350,000, the ratio between urban and rural areas being 53:47.

2.4 Economy

The economy in the Republic of Turkey is a mixed system (established in the early 1930's) where private enterprises coexist with public enterprises set up with state capital. Today, approximately 55% of industrial production is by the public sector.

In 1960 the State Planning Organization was established and a Long-Range Fifteen-Year Economic Development Plan was formulated to start from 1963. Since 1963, a planned economy has been implemented, the objective being to attain an annual average economic growth rate of a 7% level.

This target is to be realized through promoting industrialization and absorbing surplus labor of agriculture into the industrial sector.

At present, the Fifth Five-Year Development Plan (1985-1989) is being implemented. In the Fourth Five-Year Development Plan (1979-1983), it was planned to attain an economic growth of 8% annually by investing 10,595 x 10^9 TL (1983 prices), but the actual performance was as shown in Table 2-2, and the growth rate was approximately 2.0%, considerably below the planned level.

Table 2-2 Growth Rates during Planned Development Periods by Sectors

% Increase (at 1968 Factor Prices)

	1st Plan Average (1963-1967)	IInd Plan Average (1968-1972)	IIIrd Plan Average (1973-1977)	1978 Average	IVth Plan Average (1979-1983)
1. Agriculture					
a. Target	4.2	4.1	4.6	4.1	5.3
b. Realisation	3.1	3.5	3.5	2.4	2.2
2. Industry					
a. Target	12.3	12.0	11.2	8.0	9.9
b. Realisation	10.8	7.8	9.8	3.7	1.7
3. Services					
b. Realisation	7.3	7.9	7.9	4.1	2.5
4. Gross Domestic Product					
b. Realisation	6.4	6.8	7.3	3.6	2.3
5. Gross National Product					
a. Target	7.0	7.0	7.9	6.1	8.0
b. Realisation	6.6	7.1	6.5	3.0	2.0

Source: Economic Report (Turkey) 1984
Publication No. 1984/13

In the Fifth Five-Year Development Plan, it is planned to invest a total of 14,413 x 10^9 TL (1983 prices), the breakdown of which is 57% for the public sector, and 43% for the private sector. By category, the investment is to be 27.04% for manufacturing industries, 18.57% for transportation and communications, 15.20% for housing, 11.37% for agriculture, 14.89% for energy, and 12.93% for others, with which it is planned to achieve an annual average growth of 6.3%. The major economic activities during the 5-year period of 1983-1987 (with estimtes partially included) are indicated in Table 2-3.

Table 2-3 Economic Activity

Item	Unit	1983	1984	1985	1986	1987
GNP (Current Price)	10^9TL	11,551.9	18,374.8	27,789.4	39,177.2	55,757.2
Foreign Deficit	10^9TL	409.5	513.3	525.0	1,023.0	818.9
Total Resources	10^9TL	11,961.4	18,888.2	28,314.0	40,200.2	56,596.1
Growth Rate 1/	%	3.3	5.9	5.1	8.1	7.4
Total Investment	10^9TL	2,311.0	3,549.9	5,795.7	9,654.8	13,947.4
Fixed Capital Investment	10^9TL	2,182.0	3,285.7	5,554.1	9,120.7	13,886.2
Stock Changes	10^9TL	128.9	263.2	241.7	534.2	61.2
Total Consumption	10^9TL	9,650.4	15,339.3	22,512.7	30,545.4	42,628.7
GNP by Origin						
Agriculture	%	21.4	21.0	18.8	18.2	17.9
Industry	%	26.4	27.1	31.6	32.0	32.1
Services	%	52.2	51.9	49.6	49.8	50.0
Per Capita GNP 2/	T.L.	241,347.0	374,462.0	550,407.0	762,612.0	1,094,845.0

1/ : Producers' VALVES at 1968 prices
2/ : Current Producers' Prices

Source: The Turkish Economy 88 (TUSIAD)
Economic Report 88

The rates of increase in wholesale price indices and unemployment rates in the latest 5 years are as follows:

	Wholesale price index (Yearly average, percent change) (%)	Unemployment rate (%)
1983	30.6	16.1
1984	50.3	16.5
1985	38.2	16.3
1986	24.6	15.8
1987	48.9	15.2

The exchange rate between the U.S. dollar and the Turkish Lira had been revised annually or monthly as necessary, but since May 1981, the adjustments have been made daily. The recent record is as shown below.

TL/$ (Year-end)	TL/$ (Year-end)
1976 - 16.50	1982 - 184.90
1977 - 19.25	1983 - 280.00
1978 - 25.00	1984 - 443.30
1979 - 35.00	1985 - 574.00
1980 - 89.25	1986 - 757.79
1981 - 132.30	1987 - 1,020.90

The recent state of foreign trade of Turkey is as shown in Table 2-4.

Table 2-4 Foreign Trade

Unit: 10^6 $ (%)

	1983	1984	1985	1986	1987
Exports : Total (FOB)	5,728	7,134	7,958	7,457	10,190
Agricultural Products	1,881 (32.84)	1,749 (24.52)	1,719 (21.60)	1,886 (25.29)	1,853 (18.18)
Processed and Manufactured Products	3,658 (63.86)	5,145 (72.12)	5,995 (75.33)	5,324 (71.40)	8,065 (79.15)
Mining and Quarrying Products	189 (3.30)	240 (3.36)	244 (3.07)	247 (3.31)	272 (2.67)
Imports : Total (CIF)	9,235	10,757	11,613	11,105	14,163
Agricuture and Livestock	138 (1.49)	417 (3.88)	375 (3.23)	457 (4.12)	782 (5.52)
Mining and Quarrying	3,864 (41.84)	3,908 (36.33)	3,626 (31.22)	2,146 (19.32)	3,034 (21.42)
Industrial Products	5,177 (56.06)	6,338 (58.92)	7,342 (63.22)	8,502 (76.56)	10,347 (73.06)

Source: The Turkish Economy 88 (TUSIAD)

Exports in 1987 consisted mostly of textiles, processed foodstuffs, agricultural products such as grain and leaf tobacco, leather goods, and metal products. On the other hand, the principal items of imports were crude oil, machinery, chemical products, and steel. Of the amount of imports, crude oil took up 19%, followed by machinery at 15%.

The main trading partners in 1987 were as follows:

Export
West Germany, Iraq, Iran, Italy, Saudi Arabia

Import
Iran, West Germany, U.S.A., Iraq, Libya

Approximately 63% of both exports and imports are with OECD countries, and almost all of the remainder being barter with the Soviet Union, West European countries and OPEC countries based on bilateral trade agreements.

The balance of trade is constantly that of a deficit, and in 1987, exports amounted to $\$10,190 \times 10^6$ and imports to $\$14,163 \times 10^6$ recording a deficit of approximately $\$3,973 \times 10^6$. The main reason for the deficit was the dependency of import of crude oil and other forms of petroleum, amounting to $\$2,771 \times 10^6$, making up about 19% of total imports.

The Turkish Government is encouraging laborers in the country to emigrate to oil-producing countries and is making efforts to promote tourism to increase foreign exchange income, and the recent balances of emigration and tourism revenues are as follows:

Table 2-5 Emigration and Tourism

	Worker's Remittance (10^6\$)	Tourism Revenue (10^6\$)
1982	2,186.7	370.3
1983	1,553.6	411.1
1984	1,881.3	726.2
1985	1,774.2	1,481.6
1986	1,696.0	1,215.1
1987	2,102.0	1,721.1

The international balance of trade in 1987 in terms of current balance and overall balance were minus \$984 x 10^6 and \$571 x 10^6, respectively (source: Central Bank, tentative figures).

2.5 Energy Resources

Securing energy is an extremely important matter for Turkey which is attempting to transform the industrial structure of the country from mainly agriculture to an industry oriented economy by pursuing an economic development plan spread over a number of years. However, the demand and supply balance of electric power in Turkey has been constantly facing of a shortage in power supply capability, and this situtaion is being tide over by imports of electric power from the Soviet Union and Iraq. Therefore, development of electric power is a problem of urgent nature for the country. The present production of electrical energy in the country is as shown in Table 2-6.

Table 2-6 Electric Energy Production by Energy Resources

Unit: GWh

Kind	1983	1984	1985	1986	1987
Coal	787	706	710	773	632
Lignite	7,790	9,413	14,318	18,664	17,053
Fuel	7,427	7,047	7,082	7,000	5,496
Geo-Thermal and Natural Gas	-	22	64	1,385	2,586
Thermal	16,004	17,188	22,174	27,822	25,767
Hydraulic	11,343	13,426	12,045	11,872	18,600
Total	27,347	30,614	34,219	39,694	44,367

Source: SPO
Economic Report (Turkey) 1988

The electric power supply facilities as of 1987 was 12,493 MW (44,353 GWh) and the ratio of hydroelectric power generating facilities (5,003 MW) to thermal power generating facilities (7,489 MW) was 40% : 60%.

The economically developable hydroelectric potential of Turkey is estimated at 30,800 MW, and only about 16% of this had been developed as of 1987, and therefore this resource is anticipated for development in the future. Other domestic energy resources of Turkey are petroleum (estimated reserves 57 x 10^6 ton), hard coal, soft coal,and peat (estimated reserves 12.9 x 10^9 ton), and uranium. In 1984, although on a small scale (15 MW), geothermal power generation was started, while research was begun on the utilization of solar energy. According to Long Term Generation Planning by TEK, the first unit of nuclear power, 1,000 MW, is schedule to be commissioned in 2006.

2.6 Transportation and Communications

The means of transportation available in Turkey are highways, railways, watercraft, aircraft,and pipelines. Roads, combining national and provincial highways, were of a total length of approximately 58,915 km (1987), of which 92% was paved.

Highways play the most important role in the transportation system, and in 1986 accounted for 88% of passenger travel and 72% of freight transportation. The number of vehicles registered was approximately 1,973,670 (1987), 63% of which consisted of passenger cars.

The total length of railways is 10,186 km, of which trunk lines comprised 8,439 km (including 479 km of electrified lines), and branch lines 1,747 km (including 72 km electrified).

Turkey is a peninsula surrounded by the Black Sea, the Aegean Sea, and the Mediterranean Sea, so that ports and harbors have been developed from historical ages, and there are now 10 seaports for international trade and 65 others as well. Istanbul is an important port city which straddles two continents.

Airports include the three international airports of Istanbul, Ankara, and Izmir, besides which there are 10 others at major cities in the country and scheduled flights are operated.

The means of communications in Turkey are mail, telegraph, and telephone. The number of post offices as of 1986 were 986 main stations, 2,670 branch stations, and 24,427 agents.

Broadcasts of radio and television cover the entire country although the rates of receiving set ownership are still low.

CHAPTER 3. GENERAL DESCRIPTION IN PROJECT AREA AND SURROUNDINGS

CHAPTER 3. GENERAL DESCRIPTION IN PROJECT AREA AND SURROUNDINGS

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CHAPTER 3. GENERAL DESCRIPTION IN PROJECT AREA AND SURROUNDINGS

3.1 General Description in Surrounding of Project Area

3.1.1 General Description

The Seyhan River Basin in which this project area is located is within the bounds of 36°30' to 39°15' north latitude and 34°45' to 37°00' east longitude, and is situated at the southeast part of Turkey.

The Seyhan River Basin may be broadly divided topographically into upstream and downstream basins. The upstream basin is surrounded by the Toros Mountain Range and Kulmac Mountain Range at the northwest side and Dibek Mountain Range and the Tahtali Mountain Range at the southeast side and constitutes a highland area. The downstream basin consists mostly of a flat area called the Cukroba Plain.

The Seyhan River is formed by the tributary Zamanti and Goksu rivers and the mainstream Seyhan River.

The Zamanti River rises from Mt. Karaka (EL. 2,079 m) of the Kulmac Mountain Range and the Goksu River from Mt. Sandikdera (EL. 2,601 m) of the Tahtali Mountain Range. These two rivers flow approximately parallel to each other in the south-southwest direction and merge together at a point approximately 70 km north-northeast of the city of Adana to become the Seyhan River. The Seyhan River goes down past Seyhan Dam, passes nearby the urban area of Adana, and feeds into the Mediterranean Sea approximately 50 km further downstream.

The Seyhan River is one of the principal rivers of Turkey with a catchment area of approximately 20,730 km^2, length of approximately 506 km, and annual runoff of approximately 7,100 x 10^6 m^3.

The Seyhan River Basin is generally of a Central Anatolian climate in the upstream basin and a Mediterranean climate in the downstream area.

Annual precipitation is from 400 to 1,000 mm in the upstream basin and 800 to 1,000 mm in the downstream basin, the mean precipitation in the entire basin being approximately 590 mm annually. The annual mean temperatures in the basin are 8°C in the upstream basin and 18°C in the downstream basin.

The Seyhan River Basin straddles the provinces of Sivas, Kayseri, K. Maras, Nigde, and Adana, but is mainly in Kayseri Province (area 16,917.49 km^2) and Adana Province (area 17,252.67 km^2).

The city of Kayseri, the center of Kayseri Province, is situated outside the Seyhan River Basin. The catchment area of the Seyhan River Basin within the province is made up of the middle and upstream areas of the Zamanti River and is approximately 9,000 km^2. The residents in this area are chiefly engaged in agriculture and livestock raising. The agricultural products are mainly wheat, barley, rye, corn, lentil, and sugar beet. Although outside the basin, apple, cherry, and grape are grown at Develi and Yahyali.

As underground resources, chrome, iron, zinc, and lignite are being mined although in small scale.

The Seyhan River Basin in Adana Province consists of the Zamanti River Basin in which the Project is located, the Goksu River Basin, and the Seyhan River Mainstream Basin, the catchment area being approximately 11,700 km^2.

Adana Province is situated in the southeastern part of the Republic of Turkey and its southern side fronts on the Mediterranean Sea. The climate is that of the moderate Mediterranean climate zone. Agriculture has flourished from ancient times and even today it is a major industry of the province along with manufacturing. The province also has ancient relics and is favored with a natural environment of scenic beauty along the Mediterranean coast. The area of Adana Province is 17,252.67 km^2 (corresponding to approximately 2.2 percent of the entire Turkish territory). The total population is 1,725,940 (as of 1985) for a population density of 94 per square kilometer. The ratio of population between urban and rural areas is 2:1. Adana, the capital city of the province is located at a distance of 489 km (by road) from the national capital of Ankara, and is connected by regular air flights with Ankara and Istanbul.

Reilroads connect from Adana to the cities of Mersin and Gazintep. The major roles in transportation and trade within the province are played by regular long-distance buses and trucks. The principal roads in the province are a national highway running east-west along the Mediterranean Sea shoreline and centered at the city of Adana, and a national highway from Adana which passes through Kozan and Feke within the province and Pinarbasi in Kayseri Province to reach the cities of Kayseri and Malatya. To the southeast of Adana City there is the port of Iskenderun in Hatay Province and to the west the port of Mersin in Icel Province, which have cargo handling facilities for ocean-going freighters, where trade within the region and with other regions including foreign countries is being carried out. The city of Adana has a population of 777,554 (as of 1985) and is the fourth largest city of Turkey, being a center of tourism, agriculture, commerce, industry, and culture, and a residential center as well. There are various government agency offices, various bank offices, hospitals, schools, libraries, museums, theaters, hotels, communications and transport facilities, and shops, and all facilities indispensable for commercial activities and daily facilities are available.

Adana City and its surroundings have wheat flour, rice, cotton, sesame oil, soap, and macaroni as primary products, and textiles, brick, cement, cast iron products as secondary products. The main agricultural products are cotton, grains, peanut, olive, grape, and orange.

As underground resources, it is known that chrome, aluminum, asbestos, iron, coal, lead, gold, and silver exist in the Feke, Saimbeyli, Tufanbeyli, Kozan, and Karsanti districts.

3.1.2 Water Resources Development Project and their Present Status

There is a mini power plant at Pinarbasi in the upstream basin in the Seyhan River. In the upstream basin of the Zamanti River there are small-scale channels and dykes constructed for irrigation by the DSI and the RDA (Rural Development Agency). In the downstream basin of the Seyhan River there is Seyhan Multipurpose Dam completed in

1956 as a full-fledged development project for the Seyhan River with the purposes of power generation (54 MW), irrigation (186,000 ha), and flood control.

Upstream of Seyhan Dam there is Catalan Dam for the purposes of power generation (156 MW), irrigation, and flood control now under construction and scheduled for completion in 1989.

Upstream of Catalan Dam there is a plan for construction of Yedigoze Dam with detailed investigations already completed and preparations being made for start of construction.

The DSI formulated a Lower Seyhan Basin Master Plan in 1981 to promote development of the Seyhan River System, while in 1984 it set up an Upper Seyhan Basin Master Plan. The abovementioned Master Plan is an integrated plan for development in stepped form of 20 sites (total output 1,849.5 MW, including the existing Seyhan Power Plant, 54 MW, and Catalan Power Plant, 156 MW, now under construction) for hydroelectric power development. The breakdown of these sites is as given in Table 3-1.

Table 3-1 Hydroelectric Power Development on Seyhan River Basin

Project	Installed Capacity (MW)	Annual Energy Production (10^6 kWh)	Remarks
Seyhan River Upstream Basin			
Goksu River			
Yamanli-I	22.0	100.6	
Yamanli-II	120.0	393.0	
Yamanli-III	30.0	175.3	
Feke	170.0	426.3	
Zamanti River			
Gumusoren	5.0	23.8	
Gicik	1.0	4.8	
Camlica-I	140.0	521.1	
Camlica-II	50.0	132.1	
Camlica-III	25.0	121.2	
Tetlar	60.0	280.6	
Indere	62.0	236.5	
Topaktas	7.0	34.4	
Seyhan River Downstream Basin			
Zamanti River			
Goktas	263.5	1,281.2	
Goksu River			
Menge	33.0	113.5	
Kopru	189.0	480.9	
Seyhan River			
Kavsak	120.0	563.8	; Being prepared for start of construction
Yedigoze	300.0	968.8	
Imamoglu	62.0	196.0	
Catalan	156.0	491.1	; Irrigation, power generation. Under construction
Seyhan	54.0	268.5	; Irrigation, power generation, flood control. Existing
Total	1,849.5	6,813.3	

3.2 General Description of Project Area

3.2.1 Geography and Natural Conditions

(1) Geography

The project area is situated in the downstream basin of the Zamanti River, a tributary of the Seyhan River. The Zamanti is a river having a catchment area of 8,967 km^2, total length of 306 km, and an annual runoff of 2,143 x 10^6 m^3, which rises from Karaka Tepe (EL. 2,079 m) and merges with the Goksu River along the way to form the maintstream Seyhan River which empties into the Mediterranean Sea.

The Zamanti River has 18 major tributaries of which three are in the project area, Topaktas and Kucukdre at the right-bank side and Inderesi at the left-bank side.

The project area generally comprises a rugged mountainland. The principal mountains in the area are Demirkazik (EL. 3,756 m) and Tahtafirlatan (EL. 2,496 m), besides which there are mountains of 2,000-m class.

Consequently, there is extremely little plain area, and when limited to Goktas Reservoir and its surroundings, no plain areas can be seen.

(2) General Description of Natural Conditions

(a) Geology

Paleozoic and Mesozoic calcareous formations with interspersed rock masses of ophiolite are widely distributed in the Zamanti River Basin where the project site is located. Ophiolite is a general term for composites of mainly ultrabasic to basic rocks such as periodotite, gabbro, diabase, basalt, and chert.

Broadly divided, the project area from the upstream side is composed of a limestone zone, an ophiolite zone, a limestone zone again, and a sand-stone-shale zone. Limestone is distributed from near the end of the reservoir (EL. 610 m) to the upstream area. Most of the reservoir area and the dam site consists of ophiolite.

The ophiolite distributed from the reservoir to the dam site is made up of periodotite corresponding to an ultrabasic rock from among the beforementioned varieties of rock. Of the headrace tunnel route, the upstream part has ophiolite, and the midstream and downstream parts has limestone and limestone with intercalations of quartzite, shale, and sandstone. Limestone, sandstone, and shale are mainly distributed at the penstock and powerhouse sites.

(b) Seismicity

Turkey is situated at roughly the middle of the Alpine-Himalayan Orogenic Belt and comprises an area which has had severe crustal movements from ancient times. There are two prominent faults, the North Anatolian Fault which runs east-west in the northern part of the land, and the East Anatolian Fault which runs northeast-southeast in the eastern part. These are faults which constitute so-called plate boundaries.

Earthquake faults do not necessarily coincide with active faults, but earthquakes do tend to occur frequently in sheared zones caused by active faults or their neighborhoods. Most of the major earthquakes of M7 or stronger have occurred along the abovementioned two faults.

The project area is located approximately 500 to 600 km southwest of the point where the two faults intersect, and moreover, is not an area existing along a so-called active fault. There is no record of a major earthquake of M7 in the project area, and it is located at the fringe of a so-called earthquake zone. According to "the Map of Earthquake Regions by the Ministry of Civil Works dated 1972," this project area belongs to a fourth-degree zone.

(c) Meteorology

The Zamanti River Basin can be divided generally into zones having continental and Mediterranean climates. However, since the project area is in a mountainious zone, air temperature are closer, rather, to those of the Central or Eastern Anatolian regions. On the other hand, precipitation is of a condition close to Mediterranean with the annual mean being approximately 900 mm.

Consequently, the annual mean temperature of the area, although differing depending on elevation, is around 15°C, while the cold is severe in the winter with snowfall in January-March.

3.2.2 Natural and Social Environment

The natural and social environmental will be discussed in detail in Chapter 13, "Impact on Environment," and only an outline will be given here.

(1) Natural Environment

(a) Scenery

There is no place within the project area that can be said to be of especially scenic beauty. There are only springs in the vicinity of Kapuzbasi on the Topaktas River, a right-bank tributary at the backwater end of Goktas Reservoir which form waterfalls.

(b) Vegetation

Precious varieties of plant life have not been reported so far to exist in the project area. The forests in the reservoir area are of red pine, while there is platanus near the river bed. The vegetation at EL. 900 to 1,300 m is a virgin forest of black pine, while from EL. 1,300 to 2,000 m, the vegetation consists of juniper, ladin, chion, and turpentine. Above EL. 2,000 m, there is not vegetation. The dam site has steep cliffs at both banks with bare rock exposed, and there is no vegetation. The degree of vegetation at the powerhouse site is that of occasional shrubbery.

(c) Animals

Rare species of land and aquatic animals have not been reported so far to exist in the project area. The land animal species are boar, fox, rabbit, eagle, hawk, snake, frog, crab, etc. The aquatic animals are trout, dace, carp, etc.

(d) Water Quality

Investigations of water quality were made at the dam site from June to September 1988. According to the results, pH values range from 8.1 to 8.4. The results of analyses show that the water quality is of C_2S_1 class.

(2) Social Environment

(a) Residents

There are no cities or towns in the project area and only the villages named below are scattered about. On the left-bank side of the Zamanti River, there are the villages of Balcicakir, Cubukharmani, Koykeieri, Tetir, Bozkoy, Gavurkoy, and Buladan. On the right-bank side, there are Buyukcakir, Kopuzbasi, Kup, Kirazh, Menkez, Daricukuru, and Urgana.

Even if this Project were to be implemented, the residents of the abovementioned villages would not be directly affected. Of the villages, there are four around the reservoir, the populations in the census of 1985 having been as follows:

Buyukcakir	:	910
Kopuzbasi	:	366
Balcicakir	:	531
Cubukharmani	:	668

Cultivated land to be affected by the reservoir after construction of Goktas Dam belongs to Buyukcakir Village, the farmlands of the other three villages being located outside the reservoir area.

(b) Culture, Public Facilities

There are no public facilities in particular in the project area except for elementary schools and mosques in the larger villages. There are cultural and public facilities in Kozan (population 50,324 as of 1985), Karsanti (5,659 as of 1985), and Yahyali (17,875 as of 1985) located in the neighborhood of the project area.

(c) Transportation and Communications

The transportation to the dam site would be by national highway from Adana to Karsanti (approximately 105 km) and by forest road from Karsanti to the dam site (approximately 40 km). Transportation to the powerhouse site would be by national highway from Adana to Kozan via Imamoglu, by provincial highway from Kozan to Comluk, and by forest road from Comluk to the opposite bank from the powerhouse site. Forest roads connect to the various villages in the project area, but traffic may be closed in cases when there is snowfall in the winter or during the rainy season.

As communications facilities, there is a telephone exchange by PTT in Karsanti. There are also a number of telephones in the villages in the project area.

(d) Agriculture and Industry

The people living in the project area are mostly engaged in agriculture and livestock raising. Agricultural products are grape, fig., tomato, cucumber, pumpkin, and beans. Livestock are sheep, goat, and cattle. There is no industrial activity in particular in the project area. At most, it is of the degree of residents weaving rugs in their individual homes.

(e) Commerce and Tourism

There is no special commercial activity in the project area. Residents purchase necessary articles such as daily necessities at Yahyali, Karsanti, and Kozan.

Other than the Kopuzbasi Springs which constitute a tourism attraction, there are no important historical relics or facilities for tourism.