CHAPTER 2

GEOLOGY AND CONSTRUCTION MATERIALS

CHAPTER 2 GEOLOGY AND CONSTRUCTION MATERIALS

LIST OF FIGURE

LIST OF TABLES

LIST OF DRAWINGS

CHAPTER 2 GEOLOGY AND CONSTRUCTION MATERIALS

2.1 PREVIOUS STUDIES

From 1958 to 1960, geological explorations and investigation works summarized in Table IV-2-1 were carried out, and a report compiling the results was published in March 1962.

Table IV-2-1 List of Geological Investigation in Boyabat Dam Site

Drill Holes

Item		Total holes	Total length	Water pressure test	Permeability test
			m		
Rock fill dam site		26	1,272.40	256	58
Spillway		5	307.18	20	-
Spillway shute canal		2	127.08	35	-
	1	8	285.10	55	-
Power house site	2	2	60.55	24	-
	3	2	59.90	16	-
	4	6	357.09	69	-
Downstream coffer dam		5	190.78	-	24
Upstream coffer dam		8	257.53	18	43
Diversion and power tunnel		6	438.64	38	-
Gravity dam site		6	301.24	38	-
Total		76	3,657.49	575	125

Test Pits

Gravel material sites		10 pits	32.15 m
Clay material sites		26 pits	46.90 m
	Total	36 pits	79.05 m

Laboratory Test

Compression test	14
Shear test	13
Soil test	

2.2 GEOLOGY

2.2.1 Topography

The Boyabat dam site is situated at a bend in the Kızılırmak and the river flows in a S-N direction in the vicinity of the dam axis. The elevation of the river bed in the vicinity of the dam axis is approximately 200 m, the valley width approximately 270 m, and the ratio between height at normal water level of 330 m and the valley width is approximately 1:4. The average slope gradient at the dam axis is approximately 40° and steep, but with the width of both banks of the river being broad, the topography on the whole is spread out.

The dam abutment at the left-bank side is a relatively large mountain mass, but that at the right-bank side is a scraggy ridge with its width at El. 330 m in the vicinity of the intake 80 to 100 m. There are numerous small gullies developed cutting sharply into the left-bank slope, whereas at the right-bank side there are wide, shallow gullies formed.

2.2.2 Geology

At the Boyabat dam site, green schist and calcareous schist belonging to a Paleozoic metamorphic series are distributed as the old basement rock. Covering these is limestone belonging to the Karımca Formation of the Tertiary Period in the Cenozoic Era. Overlying these new and old basal rocks are distributed slope wash, an fan deposite and alluvium of the Quaternary Period of the Cenozoic Era.

Slope Wash : This is distributed at mountain skirts. The layer thickness is several meters, but at the right bank downstream of the dam axis the thickness is more than 10 m, the slope wash being combined with terrace deposits.

Fan Deposits : This is widely developed at a gully on the left-bank side where Kışla Village is located. The fan consists principally of breccia of green schist, calcareous schist and limestone.

Alluvium : This is developed along the Kızılırmak River and the layer thickness is around 40 m. It is a clay-bearing sand-gravel layer, and sizes and proportions of gravel differ greatly depending on location.

Karımca Formation Limestone : This is a yellowish-gray, hard and massive rock. Cracks frequently contain weathered material, while there are numerous cavities formed along lines of weakness. The limestone is distributed at the left-bank of the dam site above an elevation of approximately 400 m and is not directly related to the dam structure.

Green Schist : This is widely distributed at the left-bank upstream of the dam axis and from the river bed to the right-bank slope. According to the results of petrological studies made by ELE, this rock is considered to belong to green schist facies such as chlorite-albite schist and epidote-chlorite-albite schist.

Regarding schistosity, the rock is tight and bedding is indistinct. The schistosity has a strike and dip roughly of E-W, 70-90°S or N. Microfolding is developed at localized areas.

When weathered, the schistosity becomes revealed and the rock is exfoliated in the form of thin leaves to thin plates. Parts up to 10 m from the ground surface, 20 to 30 m at places, are weathered and comprise brittle portions.

Fresh parts are hard and there is no problem as a foundation for a rockfill dam.

Calcareous Schist : This is distributed at the left-bank downstream of the vicinity of the dam axis and at part of the right-bank. According to the published report, it consists of schistose limestone and phyllonitic marble. At parts, there are intercalations of thin layers of green schist, and locally, there are fine alternations of calcareous schist and green schist.

Fresh parts are hard and although schistosity is developed the rock is tight and there is adequate strength as a foundation for a rockfill dam.

The rock at the part near the ground surface is hard but is weathered and easily exfoliated due to the weathering.

Caves have been formed along some of the seams. The cave with an opening of 80 cm and depth of 200 cm along a seam in the N15°E, 40°SE direction at the left-bank downstream of the dam axis is the largest. Dissolution marks are also recognized on drill cores and there is somewhat of a problem regarding watertightness.

Bedding and predominant schistosity coincide, and the strike and dip are generally E-W and 70-90°S or N. This coincides also with the schistosity of green schist. The small gullies cutting sharply into the left-bank side were formed along predominant schistosity lines.

On the whole, the geological structure of this site has a strike of E-W and a dip close to vertical and the green schist and calcareous schist comprise a harmonious structure. At the boundary between the two the green schist is crushed for a width of several meters and exfoliated.

Faults are mostly parallel to bedding and the sheared widths are 100 cm or less. The directions are parallel to the dam axis or diagonally cross it at a gentle angle. Besides the above, there is a fault of N35°W, 55°N along the right-bank of the river. A fault is estimated to exist crossing Drill Hole 104 at the right-bank side.

2.2.3 Engineering Geology

(1) Rock Soundness

The foundation rock of the impervious core zone and the filter zones of the

rockfill dam is calcareous schist at the left-bank slope and green schist from the river bed to the right-bank slope.

Both the green schist and the calcareous schist are deeply weathered, but fresh portions are considered to have adequate strength to serve as the foundation for the impervious core zone and filter zones of a rockfill dam.

There is no special problem with regard to the foundation parts of rockfill zones.

The ridge at which the intake and spillway gates would be located is scraggy, and weathered and the creep zone are deep.

(2) Watertightness

According to the results of water pressure tests, very high lugeon values are indicated as a whole and the rock body is fairly permeable.

The part showing prominent lugeon values is that at high elevation at the left-bank side and the majority of test results are higher than 25 lugeous, and moreover, there are many sections where pressure does not attain the specified 10 kg/cm^2. The cause is considered to be creep of the calcareous schist or cavities due to dissolution.

Since the depths of drilling are around 50 m, it is unknown what the conditions are at greater depths, it is surmised that it is fairly permeable at greater depth also.

2.3 CONSTRUCTION MATERIALS

Construction materials for the rockfill dam will mainly be described in outline below.

2.3.1 Impervious Material

As the borrow area for impervious material, the vicinity of Fakılı Village at a point 5 km upstream of the dam site as indicated in DWG. IV-4-1 was selected as a result of field reconnaissance. This borrow area consists of deposits of weathered green schist washed down, and it is expected that the quantity available will be more than 5.0 x 10^6 m^3. The results of tests on samples taken from this borrow area are indicated in Table IV-2-2 and Fig. IV-2-1. Judging from these tests results, permeability of the order of 1 x 10^{-7} cm/sec can be expected and this can be amply used as impervious material for the rockfill dam.

Fig. Ⅳ-2-1 Distribution Curve of Impervious Material

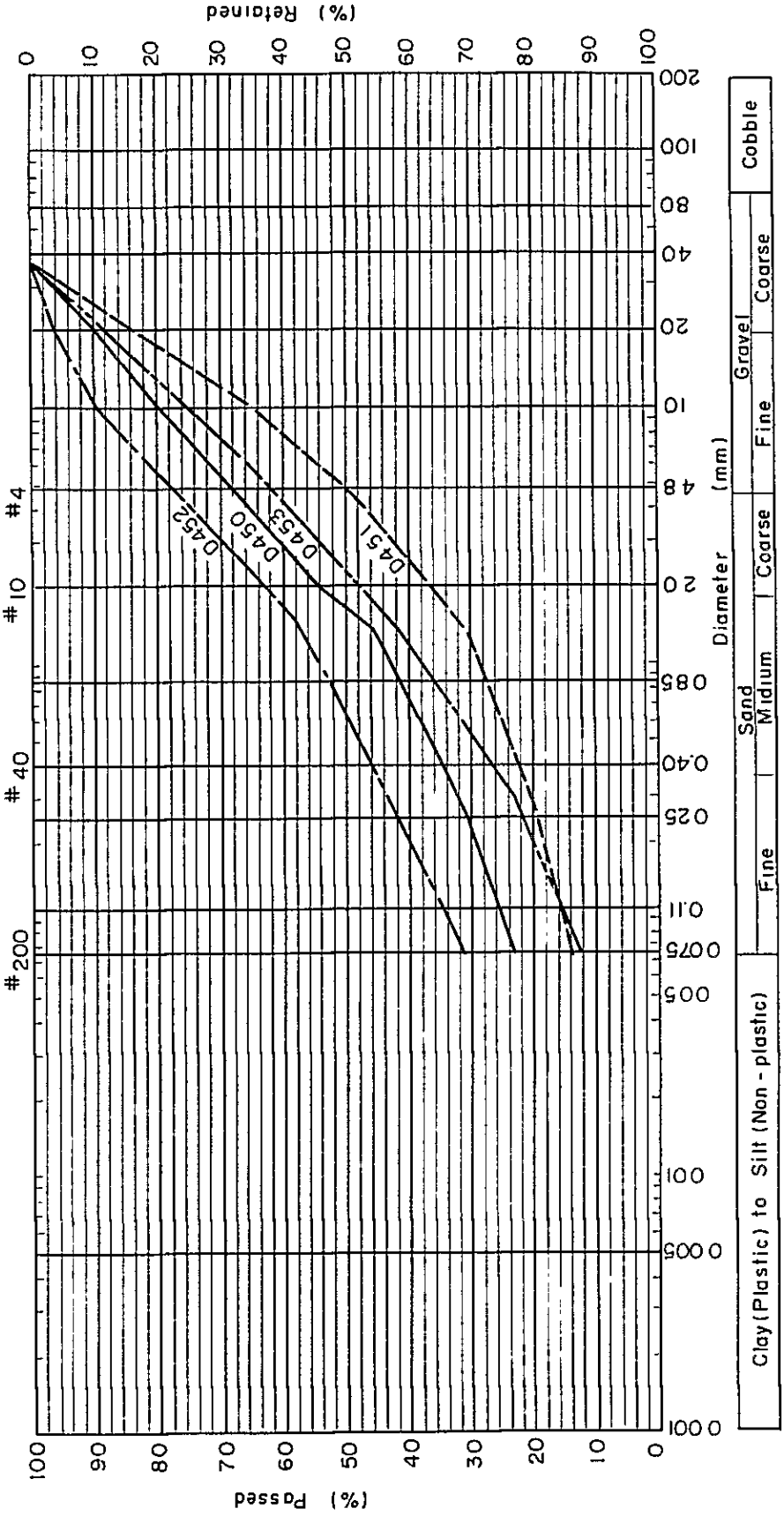


Table IV-2-2 Test Result of Impervious Material

Group Symbol	Spec. Grav.	Compaction Test		Atterberg Limits			Natural Moisture Content (%)
		t/m^3	W_{opt}	LL	PL	PI	
CL-GC	2.67 ~2.73	1.90 ~2.09	8.6(%) ~13.4	25~31	15~18	8~14	2.0~11.3

2.3.2 Filter Materials and Concrete Aggregates

The design volume of filter material will be 1.0×10^6 m^3 of fine filter and 1.45×10^6 m^3 of coarse filter, a total of 2.45×10^6 m^3. These filter materials are to be secured by temporarily stockpiling downstream of the dam site the 3.0×10^6 m^3 excavated from the river-bed for the dam, with any shortage collected from the river-bed sand-gravel deposit downstream of the dam The physical properties of river-bed sand-gravel deposits in this vicinity are as described in Chapter 4 of Part III. Fine filter material is to be used classifying the above river-bed sand-gravel deposits.

Concrete aggregates are to be produced crushing and classifying the above river-bed sand-gravel at an aggregate plant.

2.3.3 Rock Material

The rock material required will amount to 14.5×10^6 m^3. Of this rock material the inner rock material will consist of material excavated for the spillway and other structures and temporarily stockpiled. This volume is estimated to be 4.1×10^6 m^3. The remaining 10.4×10^6 m^3 is to be collected and hauled from a calcareous schist quarry at the left-bank 0.5 to 1.0 km downstream of the dam for embankment. The relatively smaller-block rock materials collected from the above quarry are to be used for the inner rock zone and the larger-block materials for the outer rock zone.

2.4 CONCLUSION

(1) Rock Soundness

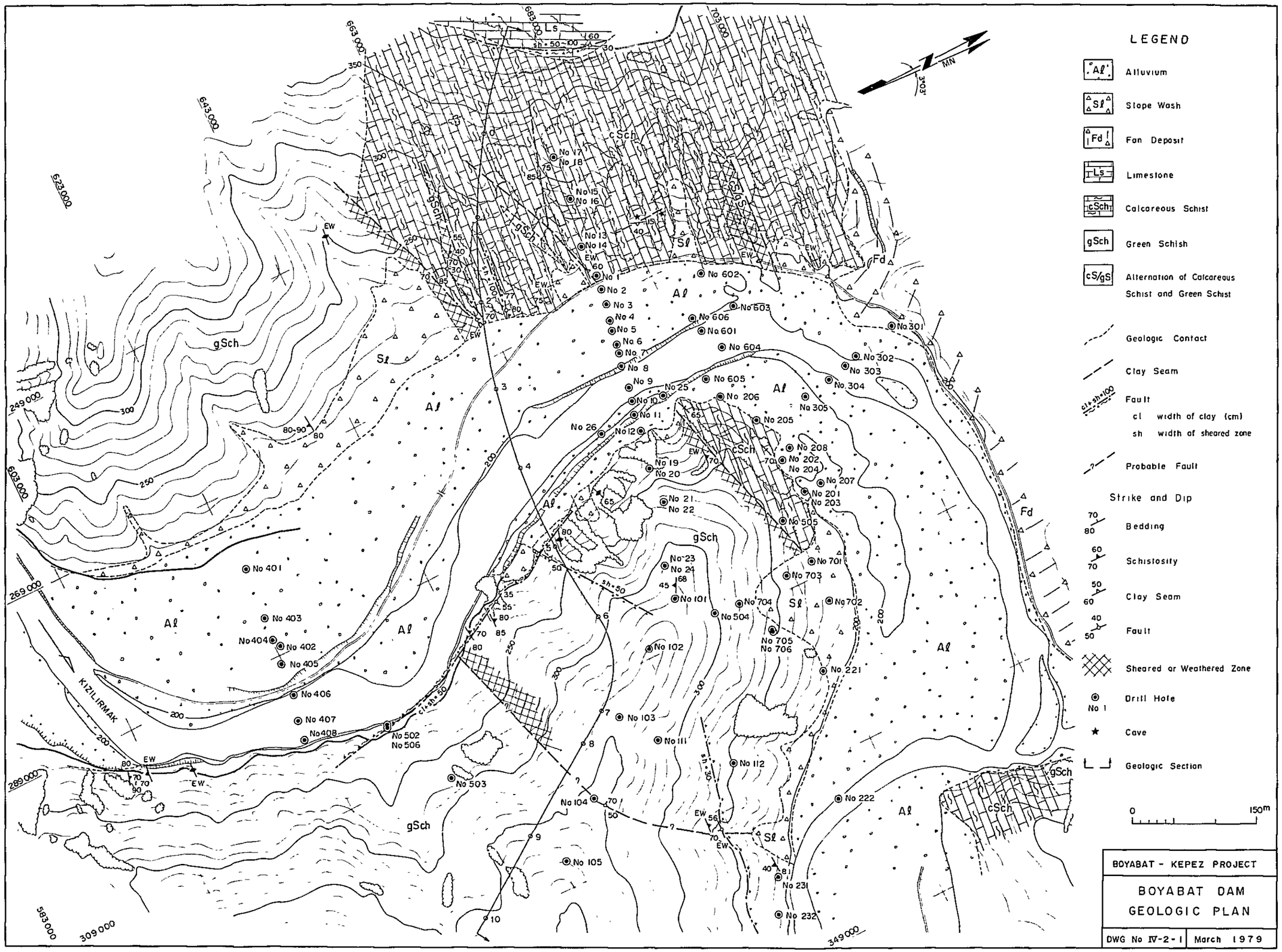
Both calcareous schist and green schist have sufficient strength as foundation rock for the impervious core zone and filter zones. However, the boundary portion between the two rocks and the green schist intercalated in the calcareous schist will require special attention.

(2) Watertightness

With the exception of a small part there is permeable on the whole. In particular, permeability of the calcareous schist at the left-bank is extreme and the causes of this are considered to be creep and cavities. Since depth of boring was only about 50 m, the details of watertightness at greater depths are unknown, but water cut-off treatment should be necessary to depths greater than 50 m.

(3) Construction Materials

Impervious material for the rockfill dam will be collected from a borrow area at the left-bank 5 km upstream from the dam site. The excavated material from the river-bed at the dam site and alluvium downstream of the dam will be used as filter material and concrete aggregates. The material to be embanked as rock material will be material excavated for the spillway and other structures and material collected from a quarry on the left-bank downstream of the dam. These materials have been found to be amply usable as a result of field investigations and laboratory tests.


LEGEND
Alluvium
Slope Wash
Fan Deposit
Limestone
Calcareous Schist
Green Schish
Alternation of Calcareous Schist and Green Schist
Geologic Contact
Clay Seam
Fault
cl width of clay (cm)
sh width of sheared zone
Probable Fault
Strike and Dip
Bedding
Schistosity
Clay Seam
Fault
Sheared or Weathered Zone
Drill Hole
Cave
Geologic Section
0
150m
BOYABAT - KEPEZ PROJECT
BOYABAT DAM
GEOLOGIC PLAN
DWG No IV-2-1
March 1979
KIZILIRMAK
MN
3°03'
663 000
683 000
703 000
643 000
623 000
603 000
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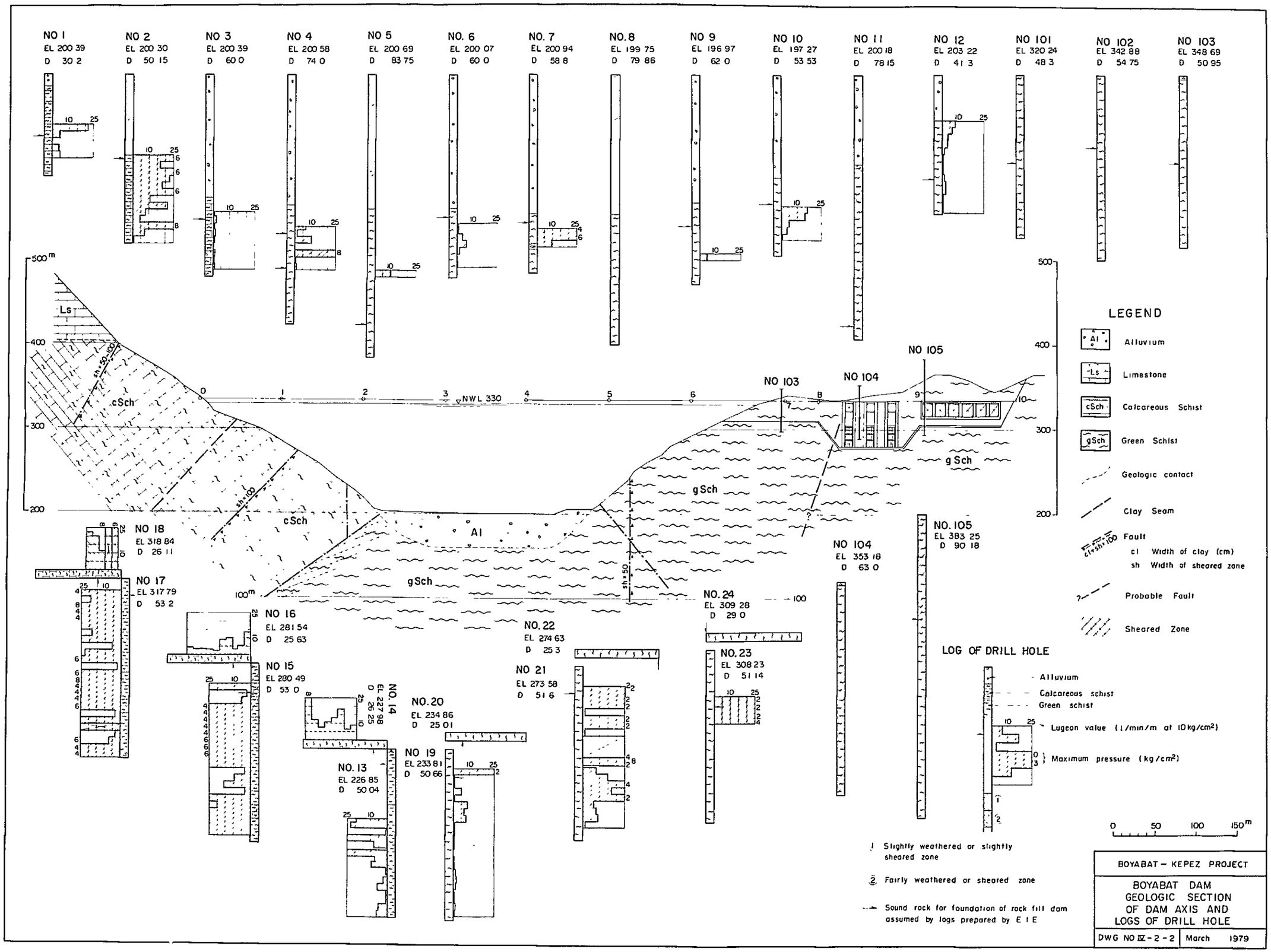


BOYABAT – KEPEZ PROJECT

BOYABAT DAM
GEOLOGIC SECTION
OF DAM AXIS AND
LOGS OF DRILL HOLE

DWG NO IV-2-2 | March 1979

CHAPTER 3

ELECTRIC POWER DEVELOPMENT PLAN

CHAPTER 3 ELECTRIC POWER DEVELOPMENT PLAN

LIST OF FIGURE

LIST OF TABLES

CHAPTER 3 ELECTRIC POWER DEVELOPMENT PLAN

3.1 BASIC CONSIDERATIONS

As stated in Part III, the catchment area of the Boyabat site is 99.92% compared with the Kepez site, and it is considered there is no difference between the two, and the run-off at the Kepez site is to be used as the run-off at the Boyabat site.

Comparing the Boyabat site with the Kepez site, the major differences between the two from the standpoint of power generation are described below.

(1) The tailrace water level at the Boyabat site will be El. 200.5 m and 10.5 m higher than the El. 190 m at the Kepez site so that the effective head will be reduced. Taking account of that the normal water level of Altınkaya Reservoir will be 190 m, the Kepez site is more desirable from the standpoint of effective utilization of the river also.

(2) The storage capacity of the reservoir will be reduced with the gross storage capacity at El. 330 m 85%, and the regulating capacity of the reservoir will be reduced. The storage capacity and reservoir area curve of the Boyabat site is indicated in Fig. IV-3-1.

3.2 OPERATION PLAN OF RESERVOIR

Operation rules for Boyabat Reservoir are to be established taking the following points into consideration:

(1) Operation is to be done storing run-offs of wet years for supplementing in dry years to make the amount of firm discharge as large as possible.

(2) During a single year, operation is to be done storing the run-off of the wet season for supplementing in the dry season.

(3) Operation is to be done in a manner to minimize over-flow from the reservoir as less as possible.

(4) Operation is to be done in a manner making it possible for stable output to be secured over a long term and in a manner to make energy production large.

Calculations are to be made by computer using monthly average inflows. Variations in efficiencies of turbines and generators due to water level are to be taken into consideration and the maximum available diacharge is to be held down to match maximum output when the water level is higher than the standard design water level.

Further, the firm discharge is to be determined to maximize through 37 years on estimating evaporation losses from the present run-off mass curve at the Boyabat dam site and deducting these losses. The evaporation per unit area is to be

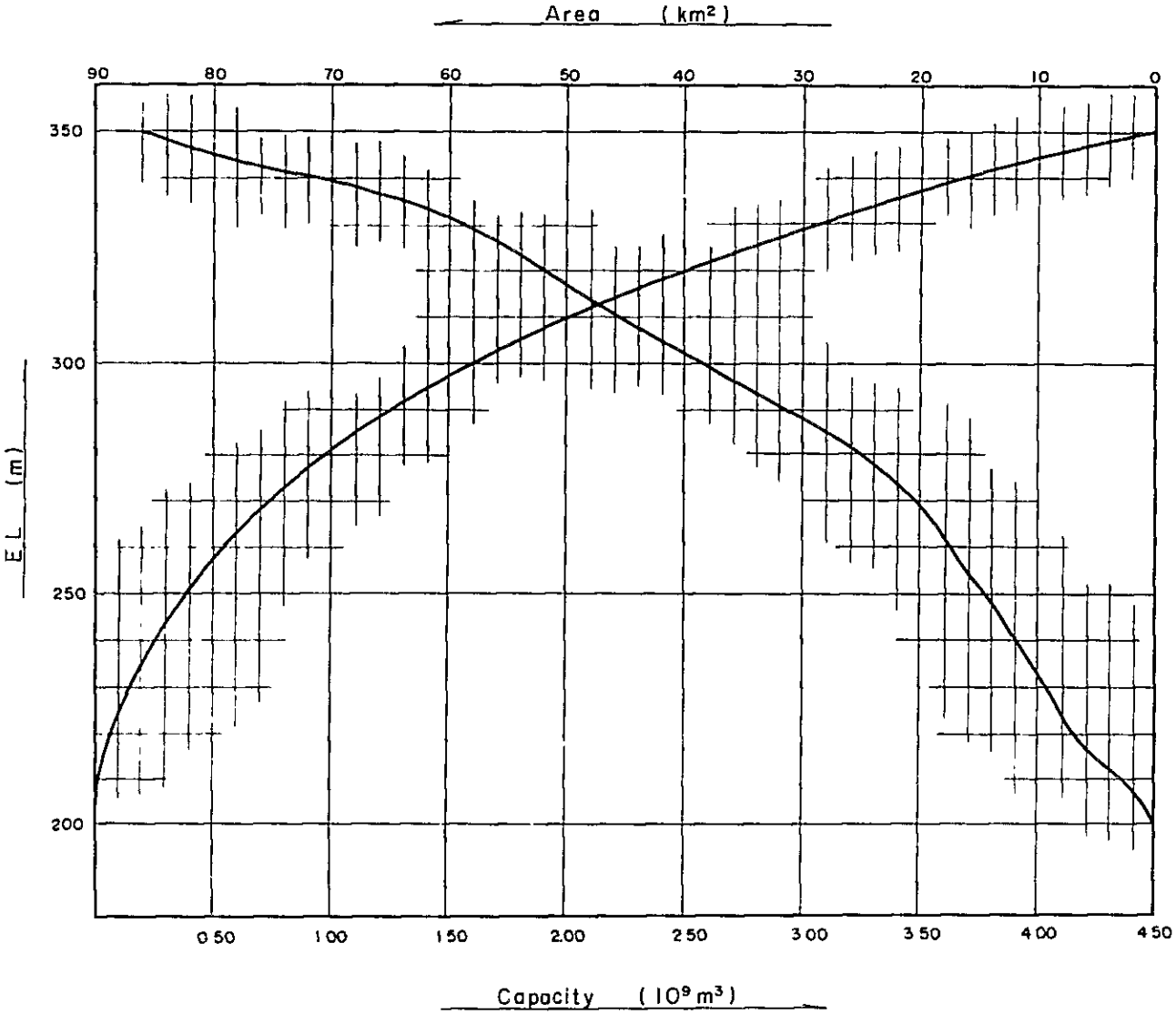
considered equal to that from Kepez Reservoir.

3.3 DEVELOPMENT SCALE

Examinations are made based on the results of the various comparison studies made for the Kepez site in II. 5.3, and an effective capacity of 1,410 x 10^6 m^3, normal water level of 330.0 m, and maximum output of 459 MW is taken to be the optimum case. The reservoir will be operated according to the operation rules described in 3.2, and the results of electric energy calculations for the 37-year period from 1939 through 1975 are as indicated in Table IV-3-1. The 37-year annual average energy production will be 1,341.5 x 10^6 kWh and 91% of the optimum case for the Kepez site.

The benefit-cost calculation for Boyabat Power Station is indicated in Table IV-3-2. The additional benefit at the downstream Altınkaya Power Station is equal to that of the optimum case for the Kepez site. As for effective power, effective electric energy and costs, they will be the same as in III. 5.3. The benefit-cost ratio for Boyabat project will be 0.768.

Fig.Ⅳ-3-1 Boyabat Reservoir Capacity and Area Curve



EL (m)	Capacity ($10^6 m^3$)	Area (km^2)
199	—	0
200	0	01
210	15	30
220	65	69
230	145	92
240	249	118
250	380	144
260	539	174
270	728	203
280	953	247
290	1 233	314
300	1 582	383
310	2 000	454
320	2 487	519
330	3 040	587
340	3 690	714
350	4 476	858

Table IV-3-1 Energy Production at Boyabat P.S.

Unit : GWh

Year	Jan.	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1939	98.7	89.9	78 7	116.8	139.8	79.5	82.0	81 3	78 1	80 1	77.1	79.3	1081.3
1940	101.0	125.9	95.1	330.5	263.3	146.4	82.1	81 8	78.6	80.8	104.2	123.9	1616.8
1941	172.9	219.7	341.5	330.5	303.8	87.9	82.1	81.9	81.5	93.0	103.3	95.1	1993.0
1942	116 1	157.7	195.9	330.5	341.5	129.7	81.8	81.3	78.3	81.1	110.5	202.3	1896.9
1943	160.3	142.1	78.9	322.0	341.5	154.8	82.2	81.9	82.5	91.5	95.9	104.5	1738.3
1944	138.2	159.2	253 0	236.9	229.8	138 1	82.0	81.6	78.4	80.6	90.4	101.9	1670.1
1945	101.2	106.2	78 4	162.2	295.5	87.9	82.0	81.4	78.2	80.3	77.4	94.0	1324.7
1946	95.4	87.8	78.9	152.6	341.5	146.4	82.2	81.7	78.6	85.5	90.0	94.2	1416.9
1947	101.8	142.9	232.3	171.0	98.7	87.9	82.1	81.6	78.4	80 5	84.2	106.6	1347.9
1948	108.7	134.4	78.6	284.1	341 5	230.1	82.1	81.8	78.7	91 3	90.5	96.2	1698.0
1949	91.6	106.2	79 0	318.0	341.5	129.7	81.9	81.5	78.5	85.5	96.0	101.0	1590.3
1950	95.5	111.0	193 1	330.5	341.5	154.8	82.2	85.9	85.0	95.5	94.8	99.0	1771.7
1951	128.2	115.6	79.0	78.0	107.7	121.3	82.1	81.8	78.6	87.8	95.5	103 5	1159.1
1952	101.4	141.5	78.9	321.9	228.2	96.2	81.8	81.0	77.5	79.1	75.8	77.8	1441.1
1953	77.4	69.8	77.8	182.1	237.5	113.0	82.1	81.6	78.2	80.1	77.0	79.1	1235.7
1954	87 1	109.9	164.8	330.5	341.5	146.4	90.5	89.0	85.5	91.2	92.2	103.8	1732.6
1955	115.8	128.3	79.0	78.2	109.5	79.5	81.6	80.7	77.0	78.5	75.1	77.0	1060.2
1956	76.6	71.8	77.7	138.9	168.5	87.9	81.9	81.4	78.2	80 3	77.3	82.5	1103.0
1957	90.2	86.7	137.3	106.6	179.5	146.4	90.5	81.9	78 6	80.3	76.6	78.5	1233.1
1958	78.2	79 2	86.0	78.6	82.0	87.8	81.8	80 9	77.5	79.2	75.3	76.5	963.0
1959	75.7	68.0	75.9	74.7	77.2	74.5	76.3	74.9	71.2	72.8	69.9	71.8	882.9
1960	71.5	66.8	71 9	70.7	75.1	73.8	75.7	74.7	71.5	72.8	68.3	68.9	861.7
1961	68.0	62.0	71.2	72.1	76.2	74.3	77.0	76.1	72.7	74.2	70.9	72.7	867.6
1962	72.2	65.5	74.8	74.2	75.3	72.3	73.0	70.9	66.5	66.8	63 4	65.7	841.6
1963	67.8	65.0	76.1	76.0	166.2	196.6	81.7	80.6	76.6	77.8	74.1	75.9	1114.4
1964	75.1	70.0	76.4	75.4	77.4	74.9	77.5	76.0	71.7	72.2	68.4	70.2	885.2
1965	69 9	64.1	107 7	128.5	114.9	79.5	81.5	80.5	76.9	78 3	74.0	76.3	1032.5
1966	239.4	273.0	166.0	214.7	138.3	79 2	81.4	80.8	77.6	79.6	76.3	78.5	1584.8
1967	94.2	92.4	155.7	330.5	341.5	96.2	81.9	81.1	77.5	79.6	76.8	98 7	1606.0
1968	197.3	226.7	341 5	330.5	267.5	171.5	81 9	81.5	81.1	93.1	95.5	144.4	2112.5
1969	187 5	189.7	340 3	330.5	341.5	104.6	82.0	81.4	78.2	92.4	109.3	171.3	2108.5
1970	199.4	308.4	233.5	116.7	81.8	78.7	80.6	79.7	76.4	78.6	76.1	96.0	1506.1
1971	143.2	103.6	93.4	142.3	126.2	129.7	81 7	80.6	77.4	79.9	78 0	136.9	1272.9
1972	97.2	103.3	83.6	78.5	143.1	96.2	82.1	81.6	87.1	100.7	99.0	87.5	1139.7
1973	95.4	104.6	86.8	85.6	82.1	79.4	81.3	80.0	76.3	78.0	71.7	76.8	1001.0
1974	76.5	68.7	76.2	73 8	76.0	72.9	73.9	72.1	68.1	68.8	64.8	65.7	857.3
1975	65.3	58.8	67 3	68.1	76.5	78 7	81.1	80.0	76.3	78.5	76.0	78.7	885 5
Average	109.1	118.4	128.4	182.2	193.8	110.4	81.3	80.4	77.5	81.8	83.1	94.9	1341.5

Table IV-3-2 Estimation of Economic Evaluation

Item	Unit	Description
Firm Peak Output	MW	402.8
Losses	%	7.8
Effective Output	MW	371.4
Unit Price per kW	TL/kW	2,830
kW Value	10^6TL	1,051
Annual Energy	10^6 kWh	1,341.5
Losses	%	7.8
Effective Energy	10^6 kWh	1,236.9
Unit Price per kWh	TL/kWh	0.57
kWh Value	10^6TL	705
Annual Benefit (B)	10^6TL	1,756
Construction Cost	10^6TL	19,874
Annual Cost (C)	"	2,286
Surplus Benefit (B/C)	10^6TL	-530
Benefit-Cost Ratio (B/C)		0.768

CHAPTER 4

PRELIMINARY DESIGN

CHAPTER 4 PRELIMINARY DESIGN

LIST OF DRAWINGS

CHAPTER 4 PRELIMINARY DESIGN

4.1 CIVIL ENGINEERING STRUCTURES

4.1.1 Selection of Layout

The dam site is selected to be at a location indicated in DWG. IV-4-1 where the Kızılırmak River bends sweepingly to the right considering the layout relations of the spillway and other structures, geological conditions, economic effect, etc. This site has a river-bed width as much as 270 m for a width-height ratio of 1 : 4 and dam types other than rockfill are considered to be uneconomical. Regarding the spillway and power station, an ideal layout is conceivable through utilization of the peninsular ridge at the right-bank side as indicated in DWG. IV-4-2, but because of the reasons described previously and the thickness of alluvial deposits which reach 45 m, the dam volume will be as much as 20.6×10^6 m^3 to greatly impair the economics.

The spillway is located on the mountain side of the powerhouse in consideration of accessibility to the powerhouse and effect on the tailrace by the dissipated water. As for the center line of the spillway, it is located in parallel with the center line of the power station in view of aesthetics and reduction in construction cost. For the dissipator, a roller bucket type is adopted considering the topographical and geological conditions (deep alluvial deposit).

The powerhouse is located at the river side of the spillway, while regarding the intake and penstock line, it is judged more economical to provide 3 unit lines than branching a penstock pipe into 3 lines. It will be conceivable for the penstock lines to be of tunnel type, but in consideration of the depth of overburden and the relation with the spillway, they are made to be of open type. A normal semi-outdoor type is adopted for the powerhouse.

The switchyard, as a matter of course, is planned so that the broad river-bed between the dam and the powerhouse is utilized. As for transformers, outdoor types are provided at the upstream side of the powerhouse.

For the access road, the road going from Akbelen Village to Fakılı Village is to be improved up to the vicinity of the high water level of the reservoir from where a new road is built at the left-bank side to the dam crest. Regarding the access road to the powerhouse, it goes down the left-bank side from the dam crest to the elevation of the erection bay of the powerhouse, and reach the latter crossing the river at the downstream end of the dam.

The diversion tunnels are to be utilized as the outlet works and valve chambers are to be provided on the dam axis. Access to these valve chambers is provided by utilizing a tunnel crossing under the spillway, and the diversion tunnels.

The preliminary drawings for this site are DWG. IV-4-2 and DWG. IV-4-3.

4.1.2 Design Criteria

(1) The crest elevation of the dam is determined by the same technique as used for Kepez Dam.

The dam foundation rock-bed consists of relatively permeable calcareous schist at the left-bank slope and relatively impermeable green schist from the river-bed to the right-bank slope as described in Chapter 2. Accordingly, the dam foundation is to be treated with grouting and a grouting gallery is to be provided at the dam crest elevation for 60 m of grouting at the left-bank and a grouting is to be 90 m at the left-bank side river-bed. As for the river-bed to the right-bank slope, standard grouting is to be performed, but since the base parts of the intake and spillway are at a narrow ridge it is planned for somewhat deep grouting to be done there.

Regarding the standard section of the dam, rockfill dams under construction or being planned in the DSİ VII Region are taken into consideration and the preliminary design is made for an upstream slope of 1 : 2.5 and a downstream slope of 1 : 2.0.

(2) The same design flood as for the Kepez site is adopted for the spillway. The width of the spillway is determined considering the standard section of gates, the spillway discharge per unit meter, and the dissipating capacity of the roller bucket.

(3) With regard to the design flood of the diversion tunnels, the fact that the dam is to be a rockfill type is taken into account and 1,630 m^3/sec corresponding to a 25-years return period of statistic flood is adopted. The diameter of the diversion tunnels is determined by the same method as for the Kepez site.

(4) The diameter of the penstock pipe is determined by the same manner as for the Kepez site.

(5) The fundamental dimensions of the powerhouse and switchyard are selected in consideration of the layouts of mechanical and electrical equipment.

4.2 ELECTRICAL MACHINERY

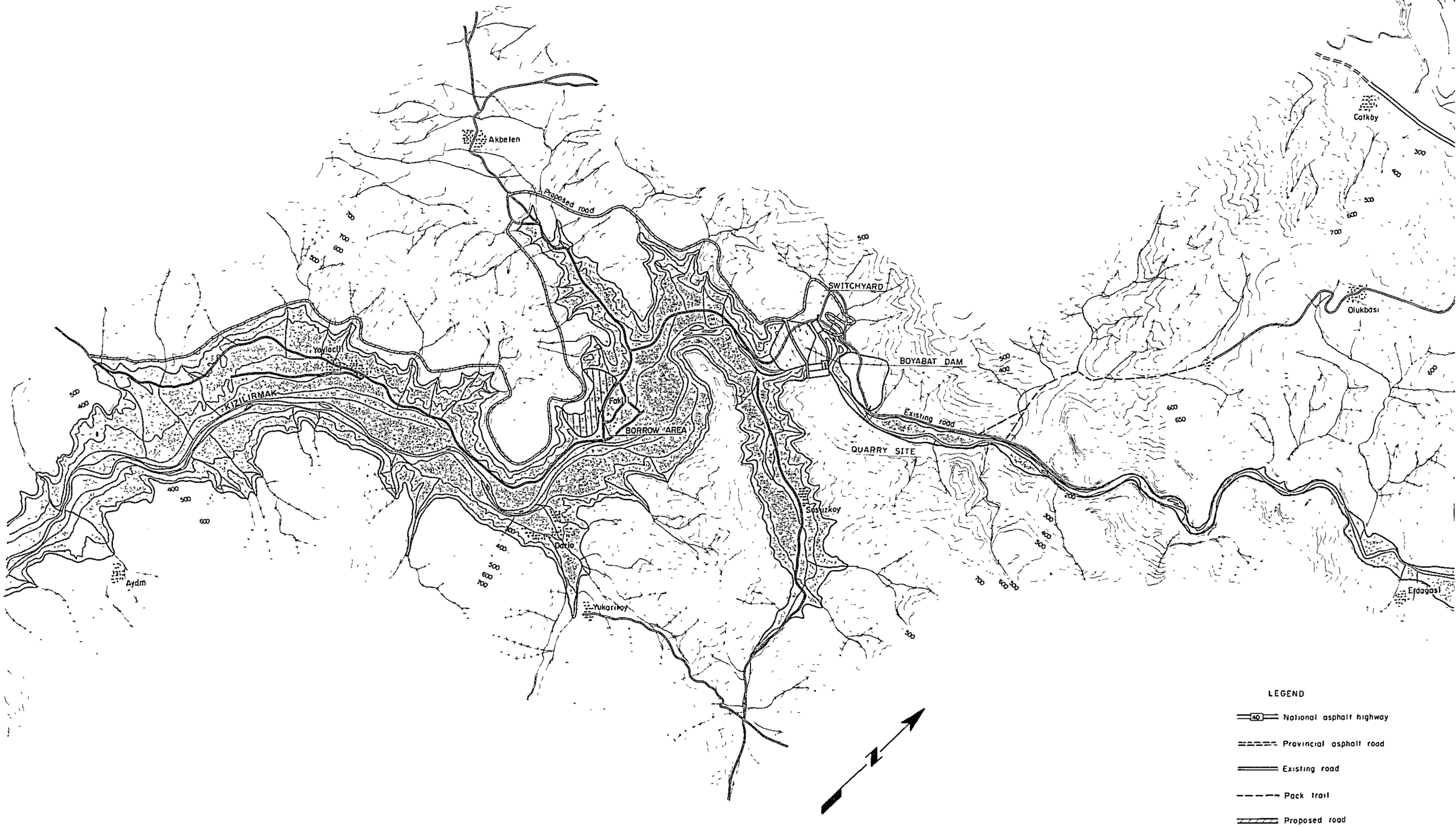
The optimum development scale for Boyabat Power Station would be a normal effective head of 112.9 m and power station output of 459 MW.

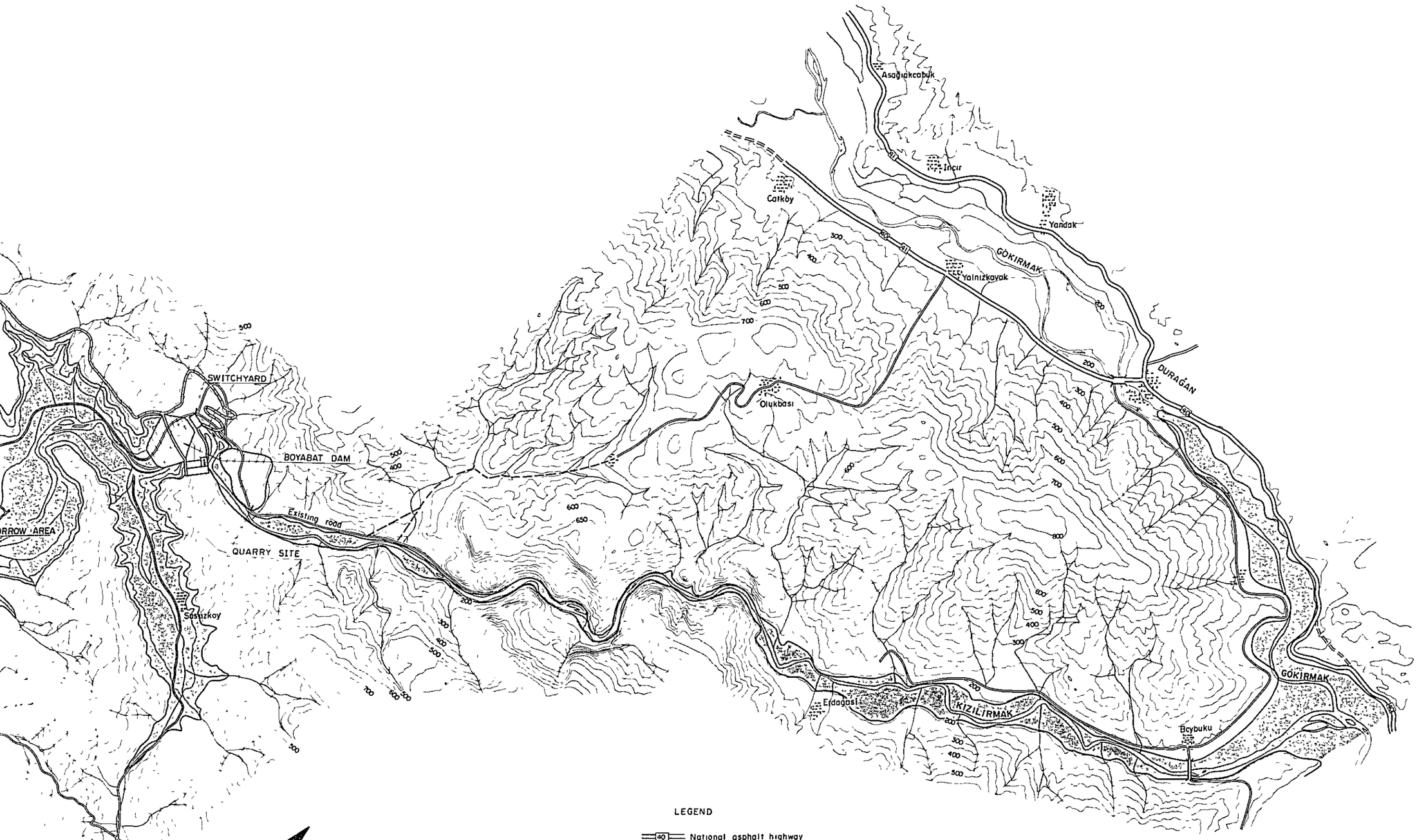
It would be suitable from both the standpoints of economy and operation for three 153-MW units to be selected as main equipment.

The powerhouse is to be located at the right-bank side downstream of the dam, and 3 main transformers of outdoor type are to be installed at the upstream side of the powerhouse.

Interconnection of the main transformers and the 380-kV switchyard is to be achieved by 3 circuits of OF cable 500 m in length.

It was considered that the main circuits and the switchyard would be of exactly the same compositions as in the Kepez Power Station plan described in III.6.1.2.

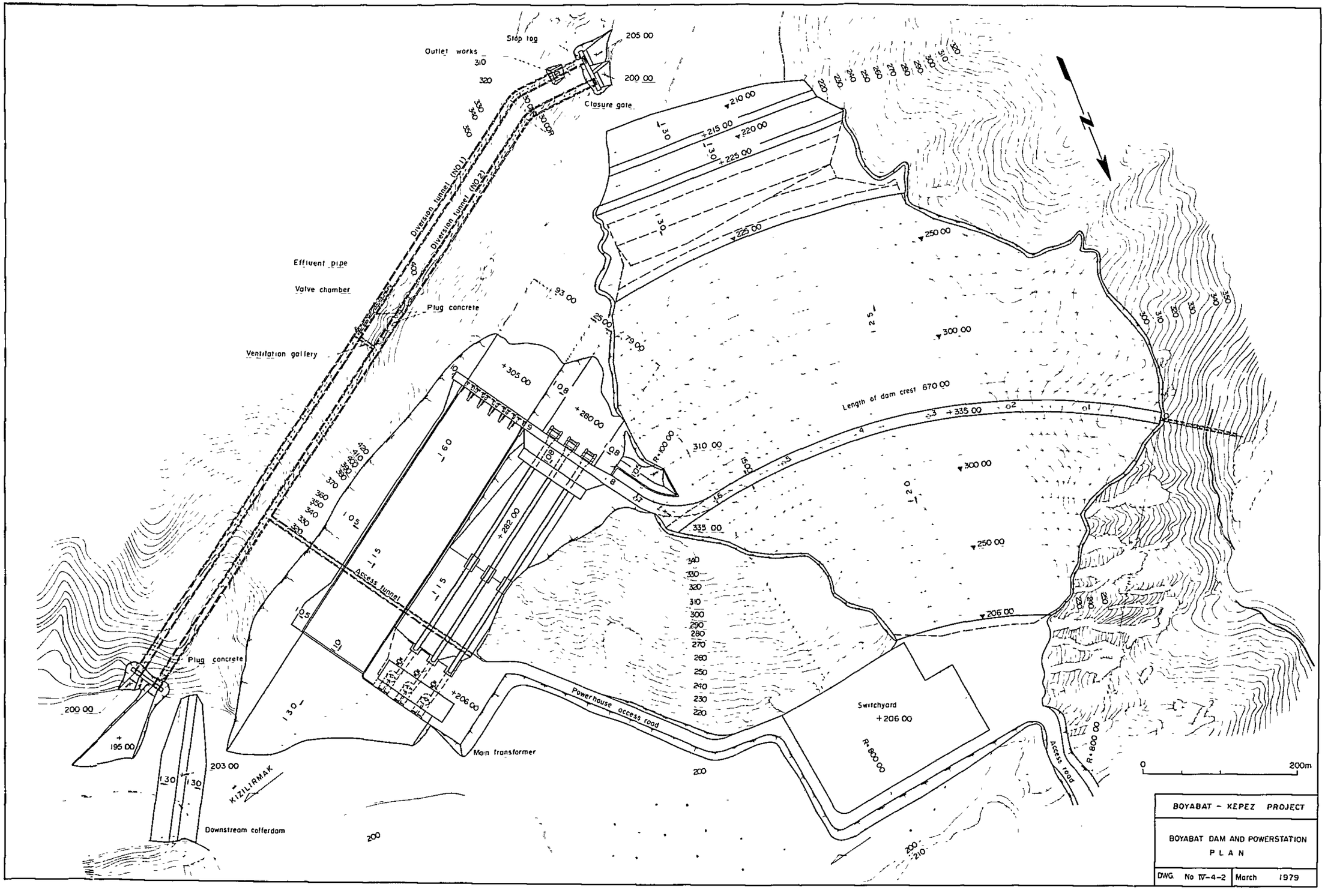

Akbelen
Proposed road
SWITCHYARD
BOYABAT DAM
Yaylacik
KIZILIRMAK
Fakil
BORROW AREA
Existing road
QUARRY SITE
Catkoy
Olukbasi
Susuzkoy
Dario
Aydin
Yukarikoy
Erdogasi
LEGEND
National asphalt highway
Provincial asphalt road
Existing road
Pack trail
Proposed road



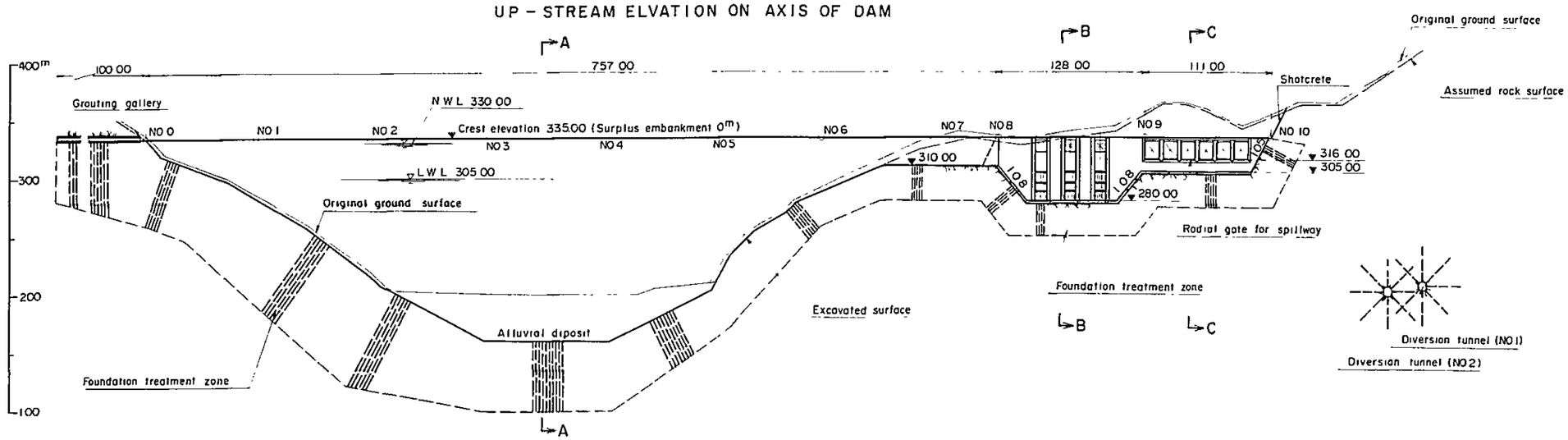
BOYABAT – KEPEZ PROJECT

GENERAL LAYOUT
BOYABAT DAM AND POWERSTATION

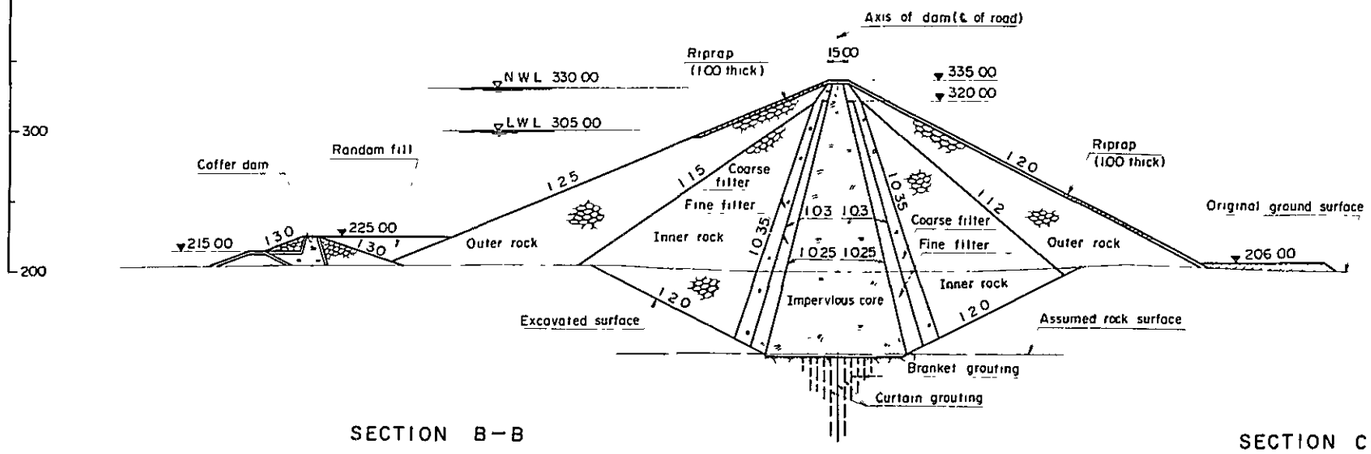
DWG No IV-4-1 | March 1979


Stop log
Outlet works
205 00
200 00
Closure gate
Diversion tunnel (NO.1)
Diversion tunnel (NO.2)
Effluent pipe
Valve chamber
Plug concrete
Ventilation gallery
93 00
79 00
+305 00
+280 00
+282 00
+206 00
Access tunnel
Plug concrete
200 00
195 00
203 00
KIZILIRMAK
Downstream cofferdam
Main transformer
Powerhouse access road
Switchyard
+206 00
R=800 00
Access road
R=100 00
310 00
335 00
Length of dam crest 670 00
+335 00
+215 00
220 00
+225 00
225 00
250 00
300 00
250 00
206 00
0
200m
BOYABAT - KEPEZ PROJECT
BOYABAT DAM AND POWERSTATION
PLAN
DWG No IV-4-2
March 1979

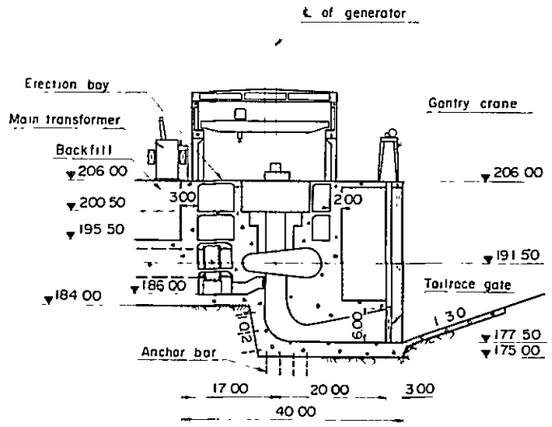
UP - STREAM ELVATION ON AXIS OF DAM



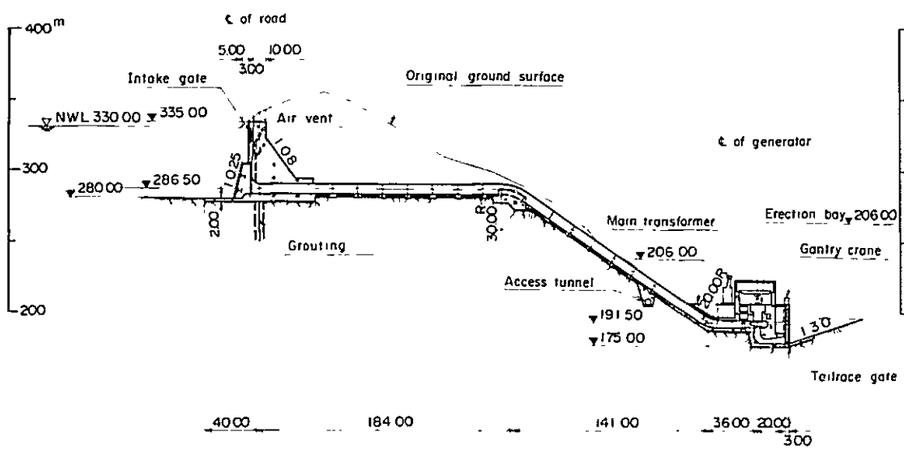
TYPICAL CROSS SECTION (SECTION A-A)



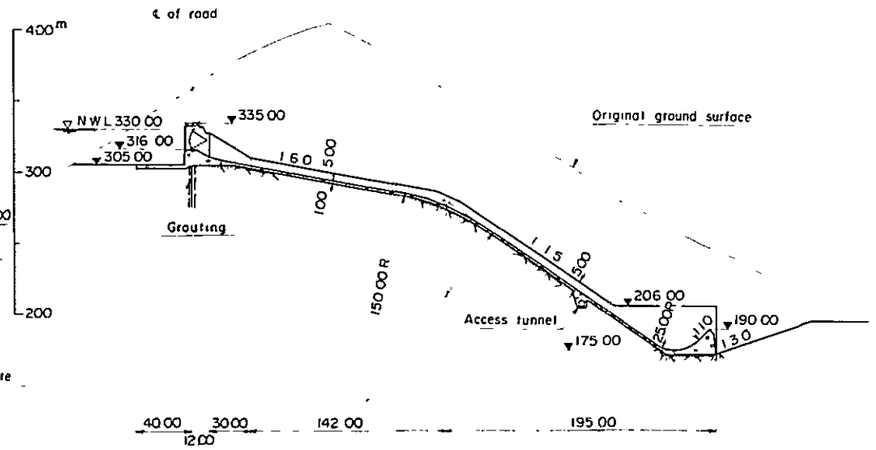
POWERHOUSE SECTION



SECTION B-B



SECTION C-C



0 200m (UP STREAM ELEVATION SECTION A-A,B-B,C-C)

0 50m (POWERHOUSE SECTION)

BOYABAT - KEPEZ PROJECT

BOYABAT DAM AND POWERSTATION
PROFILE AND SECTION

DWG No IV-4-3 | March 1979

CHAPTER 5

CONSTRUCTION COST

LIST OF TABLE

CHAPTER 5 CONSTRUCTION COST

The basic terms for calculating the construction cost were taken to be the same as for the case of the Kepez site.

The total construction cost for the Boyabat Project is indicated in Table IV-5-1.

Table IV-5-1 Estimated Construction Cost

Unit : 1,000 TL

Item	
Civil Works	
Cofferdam	195,200
Diversion Tunnel	336,500
Dam	4,220,100
Spillway	1,707,900
Outlet Works	25,600
Intake	109,300
Penstock	613,800
Powerhouse	252,600
Switchyard	27,300
Access road	154,600
Cement	117,000
Tailrace	11,200
Subtotal	7,771,100
Contingency (15%)	1,165,400
Total	8,936,500
Hydraulic Works	708,800
Mechanic and Electric Equipment	1,960,000
Transmission Line	1,000,000
Camp Facility	60,000
Relocation of Road	150,000
Project Controlling	1,922,000
Land Acquisition	961,000
Total	15,698,300
Interest during Construction Period (9.5%)	4,175,700
Grand Total	19,874,000

APPENDIX

A-1 DATA PROVIDED BY DSİ

List of Data Provided by DSİ

The obtained foundmental data to study this project are as follows;

1.1 Power Demand/Supply and Electric Item

1. Installed Generating Capacity
2. Energy Generated
3. Net Consumption
4. Number of Ultimate Customers and Population

   (Except number of ultimate customers)
5. Monthly Maximum Demand
6. Typical Actual Load Demand Curve in 1977
7. Annual and Monthly Load Duration Curve Estimated in 1978
8. Gross Economical Potential of River Basin in Turkey
9. Total of Hydroelectric Power Stations Project in Turkey
10. Total of Hydroelectric Power Potential in Turkey
11. Electrical Energy and Power Estimates of Turkey (1978-2000 years)
12. Planning Data of Transmission Line
13. Construction Cost of Transmission Line in Turkey
14. Configuration of TEK's Standard Transmission Tower
15. Single Line Diagram for Osmanca Substation
16. Data of Tosköprü Substation
17. 800 KV and 400 KV Alternatives in Transmission Planning for Long Period
18. Electrification Map of Turkey (1977)
19. Karakaya Hydroelectric Power Development Supplementary Information to the Loan Application Report
20. Catalan-Kavsak Hydroelectric Power Plant Project Equivalent Fill-Oil and Gas Turbine Power Plant Cost
21. Hydroelectric Potential Energy in Turkey
22. Report of Energy Production for Long Term in Turkey (1982-2002)
23. TEK's Energy Generated Analysis in 1976
24. TEK's Energy Balance (1972-1977)

1.2 Economic Evaluation Data

1. Translation of Harsit Project
2. Facility Life and Replacement and Amortisation Factors
3. Table belonging to Calculation of Operation and Maintenance Costs
4. Data for Economic Evaluation

1.3 Geology and Construction Materials

A. KEPEZ

1. Seismic Map and General Plan
2. Stereographical Projection of Joint
3. Dam Axis Geological Section I. II.
4. Geological Section of Explanatory Adit 1~8
5. DENEY RAPORU 27, 9, 1978
   KIZILIRMAK-KEPEZ BENT YERI MÜHENDISLIK JEOLOJISI
   ÇALIŞMALARI CILT 2 (KUYU LOGLARI)
6. Test Result of Aggregate

REPORTS

(1) KIZILIRMAK-KEPEZ REZERVUARI JEOLOJI RAPORU 8, 1974
(2) KIZILIRMAK-KEPEZ BENT YERI JEOLOJI ÖN RAPORU 7, 1972
(3) KIZILIRMAK-KEPEZ BENT YERI VE CIVARININ
JEOLOJI RAPORU 1968

B. BOYABAT

1. Topographic Map (EK-12/1~4) 1/1000
2. Geological Plan (EK-11) 1/5000
3. Geological Section of Dam Axis (EK-13) 1/500
4. Geological Section of Spillway (EK-14) 1/500
5. Borehele Diagrams 1~148
6. Borehele Diagrams of Material Investigation 1~36
7. Test Result of Impervious Material

REPORTS

(1) KIZILIRMAK-BOYABAT BARAJ YERI JEOLOJIK SONUÇ RAPORU 3, 1962

(2) KIZILIRMAK-BOYABAT BARAJ YERI CILT 2 3, 1962

1.4 Planning Data

1. Storage and Spillway Characteristics of Hirfanlı Dam
2. Storage and Spillway Characteristics of Kesikköprü Dam
3. Typical Cross Section and the Characteristics of Kızılırmak between Devres R. and Duragan
4. Storage Curve at Boyabat Dam
5. Storage Curve at Kepez Dam
6. Kızılırmak Power Development
7. Dimension of Hirfanlı Dam and Power Plant
8. Rating Curve at Kepez
9. Rating Curve at Boyabat
10. Key Plans of Developing Plan of Kızılırmak River
11. Catchment Area at the Appointed Places

1.5 Topographical Map

1. Topographical Map Covered Project Area
   Scale 1/100,000
2. Topographical Map Covered Project Area
   Scale 1/25,000
3. Topographical Map at Project Site
   Scale 1/1,000

1.6 Hydrological and Meteorological Data

1. Run-off Data

(1) Hydrometric Stations and Measured Discharges in Kızılırmak River Basin

(2) Monthly Flow at Kızılırmak gauging Stations

Inözü	1. '61～9. '76	Şahinkaya	10. '38～9. '73
Yahşian	10. '73～9. '76	Gülşehir	10. '73～9. '76
Kuyluş	12. '53～9. '76 (10. '60～9. '61)		
Durağan	10. '38～9. '73		
Yamula	10. '73～9. '76	Sarmısaklı	10. '53～9. '72 (10. '60～9. '61)

(3) Gauging Stations for which Measured Flow is Given

(4) Discharge at Hirfanlı Dam

1. '60～9. '72

(5) Subareas of Kızılırmak River Basin

(6) Measured Flow at Kızılırmak Gauging Stations

Inözü	10. '66～9. '68	10. '70～9. '76
Şahinkaya	10. '66～9. '67	10. '71～9. '72
Yahşihan	10. '66～9. '68	10. '70～9. '76
Gülsehir	10. '66～9. '68	10. '70～9. '76
Kuyluş	10. '66～9. '68	10. '70～9. '76
Durağan	10. '67～9. '68	10. '70～4. '76
Yamula	10. '66～9. '68	10. '70～9. '76
Sarmısaklı	10. '66～9. '68	10. '70～9. '76

2. Flood Flow Data

(1) Isohyetal Pattern of Project Storm Rainfall

(2) Time Distribution of 36 Hours Mean Rainfall for Major Storms

(3) Derivation of Time Distribution of 36 Hour Rainfall

(4) Determination of Run-off Curve Numbers according to Observed Rainfall and Run-off Values

(5) Unit Hydrograph Characteristics of 8 Subbasins

(6) Superposition of Run-off Hydrographs of 8 Subbasins Resulted from Project Design Storm

(7) Max. Probable Temperatures and Snowmelt Rate

(8) Elevation Area Curve and Snowmelt Run-off Hydrograph for 1000 km^2

(9) Maximum Probable Flood Hydrograph for Altınkaya Dam

(10) Maximum Probable Flood Hydrograph for Kepez Dam

(11) Statistic Flood for Kepez Dam

3. Sedimentation Data

(1) Sediment Rating Curve of Kızılırmak Çetinkaya Gauging Station

Monthly Oct.～May

(2) Sediment Rating Curve of Kızılırmak Çetinkaya Gauging Station

Monthly Jun.～Sep., total

(3) Flow Duration Curves at Altınkaya

'61～'73

4. Evaporation Data

(1) Evaporation-Capacity Curves for Altınkaya, Derbent Hirfanlı and Kesikköprü Reservoirs

(2) Evaporation at Altınkaya and Hirfanlı

Altınkaya '62～'73 Hirfanlı '52～'73

(3) Evaporation at Kastamonu

'62～'76

(4) Evaporation-Temperature Correlation Curve at Kastamonu

5. Precipitation Data

(1) Isohyetal Map of Mean Annual Precipitation

(2) Rain Gauging Stations and Measured Yearly Precipitations in Kızılırmak River Basin

(3) Areal Distribution of Storm Rainfall

27th. Jan. 1959, 16th. Jun. 1964, 4th. Feb. 1965, 4th. Apr. 1967, 13th. Mar. 1968, 29th. Nov. 1969, 5th. Jul. 1972.

(4) Depth Area Relation of 24 Hour P.M.P.

(5) Monthly Precipitation at Gauging Stations

Osmancık	'53～'76	Kastamonu	'30～'76
Kargı	'50～'76	Boyabat	'50～'76

6. Weather Data

(1) Monthly Maximum Temperature at Gauging Stations

Osmancık	7. '65~12. '76	Boyabat	1. '64~12. '76
Kargı	12. '64~12. '76	Kastamonu	1. '30~12. '76

(2) Monthly Minimum Temperature at Gauging Stations

Osmancık	7. '65~12. '76	Boyabat	1. '64~12. '76
Kargı	1. '65~12. '76	Kastamonu	1. '30~12. '76

(3) Monthly Average Temperature at Gauging Stations

Osmancık	7. '65~12. '76	Boyabat	1. '64~12. '76
Kargı	12. '64~12. '76	Kastamonu	1. '31~12. '76

1.7 Inland Transportation Data

1. Transportation Fee
2. Crane Facilities at Samsun Harbour
3. Highway Bridges between Havza and Duragan
4. Road Map of Transportation Route
   1/50,000

1.8 Cost Estimation Data

1. Land Acquisition and Compensation
2. Agricultural Loss
3. Road Relocation Cost

A-2 RUN-OFF DATA AT GAUGING STATIONS APPLIED TO ESTIMATION OF RUN-OFF AT PROJECT SITE

Monthly Flow at Yamula Gauging Station

Catchment Area 15362 km^2 (10^6 m^3)

Year	Jan	Feb	Mar	Apr	May	Jun.	Jul.	Aug	Sep	Oct	Nov	Dec	Total
1938										55 7	63 0	86 4	-
1939	90.6	87 8	238 3	491 3	272.2	125.7	62 3	53 1	52 6	63 2	56 9	79 0	1673 0
1940	108 6	198 8	373 7	884.1	315.7	190.6	92.5	53 1	44.8	68 1	94.0	128 1	2552 1
1941	137 6	270 6	754 5	847.3	362 9	114.8	83.1	60 9	49 8	62.5	81.3	62.5	2887.8
1942	85 9	120 2	436 1	923 4	440 7	149 8	65.2	45 6	45.5	67 0	124 3	212 5	2715.4
1943	127.5	111 4	209 7	1007.0	546 9	199 5	89 7	58.5	51.4	56 2	71 7	81.2	2610.7
1944	95.8	144.2	571 9	486.4	331 0	203 7	74 4	47 2	42.8	49 5	75 4	72.0	2197.3
1945	59 6	58.1	105 5	608.5	418 5	132.7	50.6	34.4	30.1	52.6	45.2	50 1	1645 9
1946	47 3	58 0	224.3	499.2	471.1	171.6	68.9	39 2	35 7	61 4	46 7	44.8	1763 2
1947	69.4	109 3	318 7	353.6	144.5	96.2	51.6	31.6	31 1	71 5	51.9	73 9	1554 3
1948	102 2	129.3	148 4	677.4	526.6	247 3	64.0	40.0	35 9	39.9	38 7	39 6	2089 3
1949	59 8	48 3	166 6	635.9	355 0	123 6	45.0	32 8	35 7	41 9	44.3	44 6	1853.5
1950	42 7	57 3	423 2	771.4	601 8	159 3	66.5	40 3	33.9	44 4	41.6	41.2	2322 6
1951	45.5	46.0	195 5	166.9	201 9	175 1	85.7	63 9	69.3	94 1	91 7	103.3	1339 4
1952	99.7	181.9	322.8	918 3	317.2	141.8	69.9	43.1	34.2	37 2	46 8	62.9	2274 9
1953	58.4	90.1	138 1	732.6	415.7	189.0	77.0	37.8	41.7	42 2	45 3	17 7	1885 6
1954	12.7	106.2	539.2	1143.8	686.9	218 0	93.8	65.7	52.2	52.8	57.5	71.2	3100.0
1955	101 4	124.0	224 0	224.2	223 3	65.7	27.4	26 1	28.8	29 4	34.1	63 1	1171 5
1956	79 2	150.2	282 7	659.0	357.4	130.4	42.5	26 8	28.6	3..9	39 4	43 5	1871 6
1957	42.6	75 0	452 3	316.1	408.5	265 4	81.8	32 5	31.0	40.9	52.3	50.4	1848 8
1958	63 3	92.1	287 0	506 8	287 1	227 7	52 0	28 4	25.4	30.8	33.4	51 5	1685 5
1959	70.7	61.9	258.6	472.6	293 4	196 3	56 7	36.7	33.0	44.0	55 3	56 1	1635.3
1960	66.7	123.2	303.9	795.5	392 9	134.1	64.3	35.1	33.0	41 7	45.7	49 1	2085 2
1961	54 1	62.3	130.5	346.3	128.3	100.4	38.0	32.7	33.5	29.7	39 1	88.8	1083.7
1962	106.6	128 4	627.2	356.5	198.7	82.3	32.2	24.4	22.4	34.5	39.4	93 9	1746.5
1963	276.1	381 1	476 8	661.6	481 6	447.8	131.9	67 1	64.9	70.6	80.6	83.9	3224.0
1964	61 7	68 6	389.5	433.0	218.6	196.7	54.1	27.4	33.6	35.6	42 8	60 5	1622.1
1965	74 4	67 2	364.0	575.5	387.0	143.1	61.7	31 8	28.7	46.9	64.2	118 2	1962.7
1966	403 5	391 0	480.1	554.6	291.8	139.5	69.6	42.5	45.4	52.6	53.2	97.0	2620.8
1967	107.1	93 2	240 3	1071 1	616.3	196.5	101.1	54.9	57.7	66 4	95.3	137.5	2837.4
1968	133 8	188.8	885.3	1140 4	507.3	278.3	99.5	72 1	70.5	92 3	119.6	153 1	3741.0
1969	158 1	131.7	741.9	963.8	638.6	207.1	117.3	68 4	51.3	73.4	72.9	110.4	3334.9
1970	120.8	202 1	437 1	404.9	161 2	84 0	44.8	34.8	32.6	46.9	60 1	103.6	1732.9
1971	191.0	73.3	208 2	401.0	254.5	171.1	42 4	54.0	40 1	42.7	55.3	106 3	1549.9
1972	80.4	93 7	344.7	589 2	522.0	316.6	111.1	55.0	52 5	61.6	62.3	53.0	2342 1
1973	49.4	58.5	119.6	300 4	237 5	108.4	49.0	22 2	21.5	24.8	28.4	42.3	1062.0
1974	40 2	56.9	288.2	271.5	258 5	63 0	20.9	19 1	36.7	22 2	50 3	50.4	1177.9
1975	58.0	58.4	391 0	617.9	720.8	184.6	72 8	38.6	34 7	44.0	49.1	52.6	2322 5
1976	61 7	63 4	702 7	1213 2	539 0	195.8	67.1	43 9	43.0				-
Average	93 3	120 1	358.0	632.7	387 7	172.9	67.7	42.7	40.4	49.6	59.2	77.3	2081.4

Monthly Flow at Boğazköy Gauging Station

Catchment Area 2339 km^2 (10^6 m^3)

Year	Jan	Feb	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1953										12.42	13.78	14 60	-
1954	18 65	29 29	29 05	32.18	19.76	9.55	10.43	10 05	9.87	11 70	11.91	16.05	208.49
1955	18.85	16 17	17.64	13.17	13.05	8.02	9.99	10 13	9.48	11 01	10.15	13 18	150 84
1956	15.85	17 72	18.49	15.65	10.36	8 47	10.08	10 69	10.88	12 77	12.77	14 09	157 82
1957	15.55	23 57	24 60	16 44	18.47	17.43	10.67	10.11	10.21	13.27	14.11	14.86	189 29
1958	18.58	16.30	18 08	19.62	13.82	16.97	9.85	9.76	10.75	13.18	12.63	14.15	173.69
1959	18 55	15.23	24.48	18.58	14.76	14.07	10.17	10.59	10.84	13.74	15.91	18.35	185.27
1960	18 00	19.03	20.54	23.39	14.14	11.24	10.14	10.03	10.79	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	11.30	11.60	14 00	-
1962	15.00	13.80	17.30	12.90	10.60	6.89	7.79	7.82	9.04	10.10	9.19	12 10	132 53
1963	15 90	15.60	19.00	18.70	17.60	18.50	8 97	8.56	11.00	14.20	15.30	15 80	179 13
1964	15.80	18.00	22 00	16.80	11.70	13 20	8.14	8.64	9.92	13.30	12.00	14.70	164 20
1965	16.50	12.20	16.40	20.70	13.30	10.70	9. 9	8.45	9.37	12.10	14.90	14.80	158 91
1966	24 80	20 70	22.10	20.00	12.00	10.00	8.47	8.75	9.76	12.20	9.55	17.10	175 43
1967	18.50	16.60	22.00	25.90	17 70	6.50	8.67	10.40	11.60	18.20	15.10	16 40	187.57
1968	14.80	16 20	25.60	27.70	14.70	18.40	9.35	10.20	11.80	16.20	15.30	15 10	195.35
1969	16.50	18 70	21.80	22.90	16.70	12 40	14.50	14.70	14.10	18.20	15.20	16.50	202 20
1970	17.60	15 30	18 10	12.70	10.50	11.30	9.66	8.64	10.40	16.00	15.70	15.80	161.70
1971	15 70	14.40	16.30	18.80	14.20	12.10	8.60	10.60	15.40	15.20	14.00	15 10	170.40
1972	14.00	16.00	19.80	17.20	19.30	18.60	14.60	12.50	15.70	15.00	16.40	11.40	190 50
1973	16.90	16.10	16.10	19.10	18.70	17.10	11.40	12.40	11.80	14.30	18.60	12.10	184 60
1974	11.20	19.00	16 90	18.60	14.80	11.00	9.30	9.24	12.30	14.00	13.20	11.10	160 64
1975	12.70	16.50	17.70	21 80	31.00	13.70	8.28	7.69	12.10	15.40	16.10	16 70	189 67
1976	15.80	14.60	19.20	30.00	22.30	12.80	10.40	10.30	12 50	-	-	-	-
Average	16.60	17.30	20.10	20.10	15.90	12.70	10.00	10.00	11.30	13.80	13.80	14 70	175.90

Monthly Flow at Gülşehir Gauging Station

Catchment Area 20368 km^2 (10^6 m^3)

Year	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec	Total
1959												151.2	-
1960	162 5	234 3	453 3	884 9	472.2	203 5	97.2	46.6	46.2	59.2	69.6	76.4	2806.4
1961	72 8	90 6	156.8	364 0	137.3	131.2	45.3	28.3	35.1	45.0	51.3	105.8	1263.5
1962	116 4	136 9	601.6	401.7	231 3	104.9	40.4	32.6	33.5	46 9	54.9	102.4	1903.5
1963	281.6	379 1	485.3	702.5	538 0	516 2	160.0	78.7	78.9	95 2	103.5	116.2	3535.2
1964	79.2	87.8	443.1	462.7	229.8	214 4	64.8	36.8	45.3	53 7	58 7	74 4	1850.7
1965	81 9	76.2	376.4	586.1	391.0	158.5	70.9	42.7	41.6	64.1	77.1	121.8	2088.3
1966	430 4	442.6	533.3	613.5	322.7	148.9	79.1	55.1	58.5	74.7	75 1	127.9	2961 8
1967	130.3	113 3	287.4	1055.7	627.4	205.2	115.6	68.0	70.6	87.0	110.0	154.6	3025.1
1968	166.7	208 6	968 6	1216 3	600.5	340 1	108.8	84.0	89.7	107.7	140 5	177.0	4208.5
1969	183.6	152.2	759 1	919.6	635 7	295.1	131.4	82.2	76.7	98.7	91 5	140.5	3476 3
1670	153 1	238.9	442.5	404.9	164.1	96.7	57.2	43.2	41.7	62 2	75.6	120.6	1900.7
1971	118 5	90.0	220.8	438.7	278 5	191.4	58.6	71.4	55.4	58.2	69 6	116.8	1767.9
1972	72.9	98.9	322.5	582.7	530.5	344 5	133.0	70.7	71.5	87.3	88.4	66.3	2469.2
1973	65 4	85 8	159 9	323 3	268.5	147.5	55.7	35.2	74.3	40.4	47.8	59.9	1324 2
1974	50.4	75.1	344 6	308 4	292.1	82.2	36.1	31.7	53 8	42.6	70.6	65.5	1453 1
1975	67.3	78 4	454 6	732 8	811.0	253.2	99.9	51.5	43 3	56.7	68.9	70.6	2788 2
1976	85.9	93.7	334.0	1153.0	536 4	214.0	86.3	60.4	58 4				-
Average	136.5	157.8	432.0	656.0	415.7	209.3	84.7	54.1	55.0	67.5	78.3	108.7	2426.4

Monthly Flow at Yahşihan Gauging Station

Catchment Area 30023 km^2 (10^6 m^3)

Year	Jan.	Feb	Mar.	Apr	May	Jun	Jul.	Aug	Sep	Oct.	Nov.	Dec	Total
1938										85 7	97.2	116 6	-
1939	135.8	128 0	450.2	524.4	321 6	145.1	74.1	65.7	70.1	86.3	78.3	113.1	1996 7
1940	163 4	218.2	401 7	1115 3	449 9	278 8	133.7	77.7	69 6	95.0	156.4	197 3	4387 0
1941	231 3	323.2	1002 1	1057.2	515.8	169 2	122 3	94.9	88.3	110 5	153.2	121.3	3989. 1
1942	160.2	215.0	570.9	1170 8	604.6	224.9	97.2	75.3	93 5	121 7	177.4	319 4	3830 9
1943	209.8	187 7	289.2	1200 7	772.8	283 3	124.5	92 5	88.1	105 8	128.2	153.2	3635 8
1944	178.6	217.8	686.9	634.6	442.1	264 5	119.3	74.1	75.8	93 9	126.0	144.3	3057.9
1945	144.4	128 7	193 9	701.5	556 4	173 1	81.0	70.0	68.5	97.6	101.7	124.5	2444. 1
1946	124 7	127 7	286 4	607.1	679.8	270.6	110 1	76 6	80 8	108.2	108.4	118.2	2698 6
1947	146 4	202.7	651 1	523.7	204.2	158 9	96 4	76 3	78 3	83 5	115.2	160.3	2497 0
1948	170.1	224.5	237.4	853 3	823.1	406 2	124 1	84 2	85 9	109.6	110.1	125 0	3381 5
1949	111.4	137.9	296 5	962 2	349 2	231 2	104.5	79.9	97.5	113.9	128.5	141 1	3254 1
1950	119.0	138.6	583 4	1031.2	935 0	271 7	142.7	104.7	90 3	119 0	124.3	134.6	1796 5
1951	155 6	141.5	301.0	273.6	104.6	248.8	136 5	75.5	79 1	116 8	126.8	149.9	2109 7
1952	145.0	259.9	289.3	1119.2	386.2	191.1	74 6	45 1	33.6	43.7	63.2	97.7	2749.0
1953	101 1	129.5	199.4	847 3	494.2	253 6	108 4	53.2	60 4	71 6	83.9	72.9	2455 5
1954	113.4	177.8	589.9	1450.7	819.3	273 7	131 2	93.8	78.3	86.5	95.6	125 0	4035 2
1955	139.9	156.0	257.0	261.1	244 1	87.9	40 9	35 9	40 6	48.2	53.8	86 8	1472 2
1956	108.0	171.9	310 0	658.6	395 2	167 8	86.7	53.7	57 2	64 9	77 7	79.3	2231.0
1957	83 3	101.9	448.3	322 1	464 2	314.2	129.2	59.9	54 5	69.4	62 3	20.3	2129.6
1958	19.4	16.5	21.9	22 2	21 4	21.6	19.8	22 4	23 8	22 3	21.8	21 7	254.8
1959	25 9	19.4	22 3	20.6	19.7	23.3	13 7	40 5	22.5	19 9	18 7	31 1	283 6
1960	33 5	7 9	14 1	17 8	62.0	46 0	68 5	100 3	116 7	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	218 6	84 5	96.9	-
1963	88.0	80 1	168.0	238 9	205 3	302 1	312 6	185.9	187.9	305.6	322 1	287 3	2883 8
1964	347.7	358.0	260.2	198.3	236 3	235.7	159.2	96.3	189 3	216 1	263 9	179.7	2740 7
1965	165.4	119 4	62 3	54.2	108 0	97 9	201.3	173.6	292 2	311 5	267.9	197.1	2050 8
1966	23 5	69.6	142 7	178 1	229 6	142 5	179 1	148 4	199.9	253 0	247.8	248.3	2064 5
1967	238 2	270.1	188 9	230.7	403.3	231 4	250 8	210.7	203 6	273 6	263 7	309.4	3174 4
1968	209.8	91.4	203 8	648 0	767 8	535 1	308.6	301.7	254 5	366.6	419.0	347.9	4457.2
1969	286.7	311 6	325.5	520 9	530 3	400 9	263.5	278.8	272 8	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	181.7	294 7	272 9	-
1971	297.8	215.8	211 8	107.8	88.1	79.0	92.9	133.7	138.6	194.7	53 9	51.2	1665.3
1972	66.7	144.1	184.2	228 2	276 6	245 1	209.8	246 3	296.4	326.2	284 9	336 2	2841 7
1973	317.4	242 5	218 1	100 9	84 7	95.8	153 7	130.0	186 2	160.4	170.3	84.4	1944 4
1974	70.0	56 1	44.9	23 0	91 2	137.4	169.5	169.2	114.0	118.2	151.8	101 5	1246.8
1975	91.7	88 0	29 2	71.3	55 1	98.6	83.7	132 1	172.0	124 0	288 0	314 2	1547 9
1976	209 3	282.1	265 7	238.2	240 9	185.9	225.9	263.3	231 1				-
Average	150.1	165.5	291.7	522.7	391.0	214 9	136.0	115.0	122 6	140.7	152.0	156.6	2372 3

Monthly Flow at Küylus Gauging Stations

Catchment Area 4189 km^2 (10^6 m^3)

Year	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec	Total
1953										-	-	11.34	-
1954	9.95	22.07	107 30	74 34	79.21	60.25	13.53	6.63	10.29	9.18	9.11	10.31	412.17
1955	10.20	11 72	13.21	38.52	10.09	8.73	6.38	12.35	29.78	13.29	13.69	19.92	186.88
1956	20.28	50.51	75 08	106 01	54.46	44.58	11.26	2 66	3.95	5.17	7.36	6.02	387.34
1957	5.26	12.83	16.29	11.88	83.33	28.75	7.43	5 57	15.92	13.53	14.19	20.52	235.50
1958	21.10	31.53	85 60	143 11	62.21	80.36	16.48	13.52	19.84	13.36	13.26	16.03	516.60
1959	18.66	15.77	117.85	135.38	85.11	106.36	17.60	22.04	15 58	13.25	15.43	14.85	577.88
1960	13.13	20.37	24 79	101 68	46.19	35.88	11.44	8.85	9.08	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	10 30	10 40	16.50	-
1962	15.60	29.80	109.40	70 20	40.10	13.80	1.43	0.32	19.00	13 70	9.54	40.20	363.09
1963	77.20	115.50	118.90	132.00	171.10	90.10	26.40	5.88	11.60	17.10	15.00	20.10	800.88
1964	12.40	23.90	78.80	50.80	83 80	138.10	24.30	12.30	14.20	10.90	14 20	40.60	504.30
1965	28.20	44.50	167.10	168.70	105.50	58.10	9.76	8.20	12.00	11.50	14.70	27.90	656.16
1966	76.50	61.60	73.10	183.30	82.90	49.00	8 30	7.57	7.57	9.59	10.10	11.60	581.51
1967	12 00	9.75	47.70	162.10	133.50	103.90	23.80	70.20	22.10	15.60	12.30	32.10	645.05
1968	46.90	78.70	138.80	142.80	57.20	19.20	9.01	17.10	38.70	24.10	19.80	20.00	612.31
1969	22.50	51.80	114.40	159.00	145.20	55.10	18.20	5.58	11.80	11.90	12.50	22.40	630.38
1970	30.50	51.10	76.70	66.60	35.40	34.60	3.71	2.46	3.49	6.56	8.43	11.90	331.45
1971	29.00	16.10	72.70	101.60	131.90	93 60	11.30	8.22	12 80	10.40	12.10	19.30	519.22
1972	21.20	27.80	80.00	118.30	133.20	48.48	65.10	31.40	21.40	46.90	45.00	29.00	667.78
1973	22.50	54.80	103.30	113.90	59.60	45.80	76.30	3.78	7.58	10.60	14.60	22.00	534.76
1974	14.90	16.60	54.70	41.00	58.40	13.40	7.45	5.47	4 74	4.65	7.05	9.03	237.39
1975	14.80	16.60	76.70	91.50	168.30	53.90	7.49	5.37	5.43	8.40	9 95	10.50	468.94
1976	14.50	13.70	108.20	90.40	34 60	28.20	7.13	5.72	5.56				-
Average	24.42	35.32	84.58	104.71	84.61	55.06	17.45	11.87	13.74	13.33	13.75	19.64	493.58

Monthly Flow at Şahinkaya Gauging Station

Catchment Area 72936 km^2 (10^6 m^3)

Year	Jan.	Feb	Mar	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec	Total
1957										101.3	110.7	138.4	-
1958	166.7	206.5	545 1	573.5	230.6	352 4	95.4	75.3	120.3	41.2	44.0	67.0	2518.0
1959	149.6	114.3	500 9	440.0	245.5	330.3	64.7	87.1	91.1	124.6	124.6	152.7	2425.4
1960	174.6	164.3	253.4	442.6	258.9	184.3	145.9	155.0	216.7	175.0	200.0	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	368 2	263.3	386 5	-
1966	945 0	624 3	682 0	1017.3	589.6	282 2	239.0	226.6	263.1	336.1	352.0	432.3	5989.7
1967	496 8	438 3	813 8	1342.2	1233.8	567 3	387.0	268.3	294.6	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	503.5	567.5	620.6	-
1969	640.0	764 2	1422.0	1447.1	1312.9	643.4	325 7	339.2	423.5	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	305.0	202.1	319.7	-
1972	215 1	327 5	657.3	663 5	779.8	488.9	407.8	344.6	462.3				-
Aberage	398.3	377 1	700.6	846.6	664.4	407.0	237.9	213.8	267.4	244 4	233.0	302.5	3644.4

Monthly Flow at Inözü Gauging Station

Catchment Area 72992 km^2 (10^6 m^3)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1960												319.3	-
1961	272.7	435.8	611.7	645.3	346.2	398.7	291.5	275.6	148.1	120.1	137.8	197.9	3881.4
1962	175.4	392.5	737.9	335.2	115 9	83.1	87.2	83.1	160.5	271.0	154.5	376 8	2973.1
1963	523.4	793.0	735.4	802.5	943.5	826.3	399.8	178.1	200.4	341.7	374.1	422 1	6540.3
1964	396 0	546.0	684.5	381.6	380.7	709.5	214.9	105.5	170.0	240.0	314.2	385.6	4528.5
1965	289.3	500 4	1273.6	822.2	508.9	297 0	232.1	231.2	319.6	351.3	285.8	381 3	5492.7
1966	945.5	614 1	698.9	1031.3	595.5	309.2	264.8	232.4	278 6	328.3	317.0	398.6	6017.2
1967	452 3	421 6	898.0	1472.3	1258.3	570 1	377.9	244.3	288 5	405.5	383.2	565.1	7337.1
1968	717.6	676.5	1496.1	1[illegible]6.4	1147.0	830.4	423.2	398.3	456.0	513.5	576.4	620.7	9314 1
1969	643.3	780.4	1429.5	15[illegible]8.1	1326.5	660 6	370.5	338.1	384 7	571.2	623.8	709.3	9376 0
1970	639.1	985.0	1038.3	702.9	297.9	394.9	309.6	266.0	222.2	316 9	433.2	542.4	6118.4
1971	638 5	417.7	737.3	810.2	594.0	535.5	143.6	160.4	279.4	320.0	216.8	349.6	5203.0
1972	228.4	359.1	689.1	715.2	880 8	322.5	412.7	359.6	482.1	536.2	494 6	473.4	6151.0
1973	474.7	511.0	768.7	622.9	315.0	283 9	169.9	120 2	242.6	229 2	249.0	238.4	4225.5
1974	178.6	166.8	314 4	191.3	297.5	195.2	177.3	141.4	138.8	145.2	153.2	223 8	2323.5
1975	215.8	232.2	557.2	496 2	1,318 1	378.5	121.3	140.1	225 5	273.5	430 0	484.9	4873.3
1976	385.3	491.2	1,026 7	976.8	536.5	350.4	278.3	301.1	327.8				-
Average	448.5	520.2	856.1	812.8	678.9	459.1	267.2	223.5	270 3	310.2	321.5	418 1	5625.9

Monthly Discharge from Hirfanlı Reservoir

Catchment Area 26499 km^2 (10^6 m^3)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.	Total
1960	22.4	-	7.73	13.3	68.1	68.4	89.3	114.9	122.5	104.5	170.6	218.6	-
1961	161.1	141.8	160.8	137.2	143.4	124 8	187.2	219.4	72.2	40.1	77 6	60 8	1526 4
1962	76.6	121.0	143.4	28 7	37.8	57.4	107.9	103 1	149.9	185.8	87.9	88 6	1188 1
1963	77.2	58.0	148.7	191.6	166 1	449.9	275 7	165.0	195.6	308 9	318 2	277.4	2632 3
1964	156.4	330.6	213.1	166.7	195 1	184.2	137.8	87.0	168.8	197 7	237.0	145 1	2219.5
1965	134.1	100 4	57.5	48.1	104.8	98.8	199.6	176.8	263.7	244.6	242 9	161.3	1832.6
1966	68.0	97 7	132.0	180.2	199.9	139.0	170.4	145.4	203.1	229 7	332.3	211 1	2108.8
1967	208.9	218 8	155.2	245.2	338.9	254.7	234.3	192.5	186.2	246.3	221.8	280.0	2782.8
1968	150.2	71.7	176.2	639.7	695.5	474.5	298.2	280.3	248.6	281.0	368.0	254.8	3938.7
1969	186.4	180.6	241.9	392.6	458.0	350.1	249.7	249.2	258.6	387.2	428 9	280.0	3663.2
1970	148.7	123.9	97.0	143.0	167.8	245.4	276.0	210.7	152.3	164 0	257.3	266.2	2252.3
1971	275.5	199.4	191.9	85.8	72.4	81.1	100.9	123.3	143.4	161 8	27.7	43.0	1506.2
1972	66.9	112.5	177.1	212.9	259.3	206.0	165.8	196.1	295 6	271.5	229 6	287.4	2480.7
1973	298.4	210.5	179.1	79.7	76.8	100.3	113.5	113.5	170.9	160.2	147.5	83.3	1733 3
1974	79 7	58.5	42.9	17.6	108.3	127.9	160.1	147.6	87.6	114.8	143.8	91 2	1180.0
1975	99.1	103.8	17.5	61.6	27.5	87.3	93.9	122.8	164.7	160.7	274.8	246 1	1459 8
1976	187.8	236.4	240.3	206.1	212 7	185.1	235.4	259.5	223.9	255 1	267.6	250 9	2760.8
Average	141.0	147.9	140 1	167.7	196.0	190.3	182.1	171.0	182 8	206.7	225.5	190.9	2204.1

A-3 PRCIPITATION DATA AT GAUGING STATIONS IN THE VICINITY OF PROJECT SITE

Monthly Total Precipitation at Kastamonu Meteorological Station

(mm)

month / year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1930	11.0	6.7	26.2	19.5	104.3	125.7	19.6	62.3	16.7	43.9	47.7	43.1	526.7
1931	27.5	37.1	40.6	84.0	197.8	79.9	14.7	25.5	32.4	24.2	47.4	29.9	641.0
1932	35.7	53.9	51.4	48.4	58.7	76.1	9.9	31.2	11.0	10.6	31.3	20.7	438.9
1933	4.9	57.1	26.8	73.2	80.2	82.3	62.1	23.8	12.2	40.0	39.5	57.9	560.0
1934	17.7	14.0	10.8	23.4	72.5	45.6	53.9	16.0	16.2	27.7	17.6	13.2	328.6
1935	46.5	36.0	37.3	50.5	21.2	11.5	21.6	0.6	27.6	18.2	17.5	27.8	316.3
1936	12.3	23.7	24.3	58.0	117.1	115.9	34.4	51.5	28.3	47.0	38.6	20.5	571.6
1937	23.0	21.2	13.0	63.2	37.9	19.7	15.2	64.7	16.3	16.5	37.4	34.7	362.8
1938	16.3	15.1	26.2	71.6	108.6	5.5	58.7	23.7	51.4	13.1	12.1	26.1	428.4
1939	10.2	21.9	42.6	17.5	96.7	77.4	65.5	66.0	33.5	26.9	48.4	45.6	554.2
1940	26.4	20.7	21.5	35.6	141.0	105.0	35.6	103.0	6.1	37.1	22.5	55.9	610.4
1941	58.8	17.1	40.9	25.4	21.9	55.9	47.8	17.3	16.7	20.5	42.1	28.2	392.6
1942	25.0	2.4	18.6	47.7	61.8	24.9	9.1	20.6	88.1	57.4	32.3	10.4	398.3
1943	42.4	9.7	5.7	65.0	66.6	57.3	22.7	2.4	38.9	37.2	49.1	16.4	413.6
1944	5.3	31.3	56.4	48.6	66.6	24.1	16.0	0.4	5.8	31.2	12.4	13.7	311.8
1945	32.6	26.0	6.9	21.2	12.3	61.3	56.0	5.2	9.1	72.6	41.1	33.6	377.9
1946	16.0	52.6	55.2	57.1	114.2	46.3	25.4	42.0	17.6	32.7	36.6	31.1	526.8
1947	36.0	14.1	27.2	5.6	49.6	59.6	32.2	12.2	13.5	32.1	64.0	59.4	405.5
1948	11.6	44.5	57.8	61.4	107.4	123.8	1.2	24.7	19.2	49.6	28.5	4.2	533.9
1949	28.1	25.8	30.3	38.7	72.0	69.1	37.5	0.0	48.5	23.0	9.8	44.0	426.8
1950	39.3	26.5	30.0	43.7	55.2	30.7	13.0	4.5	10.9	38.2	24.6	8.6	327.2
1951	12.6	11.3	44.8	91.0	34.2	83.3	20.0	49.0	8.2	33.7	30.2	41.3	459.6
1952	27.6	28.3	17.7	33.5	117.8	92.7	21.8	2.5	24.5	22.9	15.2	3.8	408.3
1953	37.8	46.3	24.5	46.4	233.0	98.9	4.8	8.7	17.6	57.4	15.8	15.3	606.5
1954	71.2	30.3	24.9	35.1	63.4	104.5	7.8	19.2	20.5	10.5	31.0	23.4	441.8
1955	14.5	25.1	27.3	36.5	34.0	54.9	61.8	26.2	36.5	55.3	13 4	38.1	423.6
1956	27.3	46.3	73.6	9.4	45.3	51.6	6.7	0.1	12.7	8.3	28.8	10.7	320.8
1957	8.5	16.1	20.3	26.2	111.0	3.0	17.3	1.7	39.4	17.0	19.5	23.7	303.7
1958	23.6	10.2	90.5	60.9	28.4	96.0	21.3	10.4	24.0	18.8	5.9	32.2	422.2
1959	54.1	18.6	18.6	27.7	84.1	60.4	19.0	39.5	19.6	3.7	19.8	4.4	369.5
1960	16.7	25.3	44.4	76.0	41.1	97.1	15.8	19.2	33.0	29.3	28.6	19.6	446.1
1961	24.3	34.9	30.0	54.2	38.1	143.2	11.1	0.6	43.0	11.4	7.1	28.7	426.6
1962	21.6	62.9	29.1	29.7	37.7	20.1	24.3	0.6	70.2	66.7	12.1	77.3	452.3
1963	91.8	42.3	32.5	49.8	99.1	36.1	16.0	0.1	21.3	22.2	9.5	18.7	439.4
1964	5.0	35.3	20.2	34.1	66.5	119.9	38.1	69.3	19.5	3.4	70.8	30.1	512.2
1965	20.5	78.0	41.7	38.8	62.2	135.6	17.3	41.4	1.1	13.2	44.2	20.3	514.3
1966	60.4	2.2	51.3	71.2	47.4	50.6	11.7	57.6	1.6	26.7	26.2	14.4	421.3
1967	19.0	18.2	44.3	65.3	103.1	129.2	17.1	6.9	28.2	52.7	28.3	48.6	560.9
1968	57.4	18.0	46.5	24.9	34.6	64.5	19.9	87.2	67.0	67.6	23.3	25.8	536.7
1969	46.3	48.1	51.7	66.7	53.3	103.5	31.5	3.2	60.1	11.3	40.0	32.8	568.5
1970	34.9	37.9	33.7	12.5	51.6	60.2	11.2	3.6	19.7	30.5	11.8	45.4	353.0
1971	12.2	13.8	50.9	81.0	99.5	48.7	13.7	40.6	28.1	21.2	17.5	50.0	477.2
1972	15.1	12.4	20.4	112.3	72.9	62.1	121.8	30.6	47.6	83.8	19.0	19.1	617.1
1973	10.2	25.9	30.4	65.8	10.9	92.7	15.6	9.3	14.3	18.8	40.6	34.5	369.0
1974	10.2	13.0	29.1	36.4	58.0	28.0	36.8	76.4	8.6	33.0	8.9	43.2	381.6
1975	41.3	20.9	26.2	82.4	53.6	40.7	47.1	25.9	5.3	37.2	29.5	47.1	459.2
1976	50.6	22.9	8.2	42.8	32.4	39.3	25.4	18.2	21.3	58.6	21.4	42.9	384.0
Average	28.5	27.7	33.7	48.7	71.9	68.4	27.8	26.5	25.8	32.2	28.1	30.1	449.5

Monthly Total Precipitation at Kargı Meteorological Station

(mm)

month / year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1950	25.2	20.1	42.6	41.8	29 3	19.1	-	4.3	-	9.5	-	17.5	-
1951	11.5	26.3	28.6	51.5	38.4	25.6	-	9.9	16.5	13.5	31.7	12.6	-
1952	33.1	31.0	15.1	23.7	76.8	86.4	3.2	-	21.5	12.7	42.4	2.4	-
1953	28.9	48.7	10.4	39.7	91.2	59.0	0.0	0.0	0 0	12.4	10.2	13.1	313.6
1954	78.0	40.9	14.5	28.8	48.4	57.6	-	8.3	35 0	14.2	28.0	23.4	-
1955	8.1	16.4	135.8	111.5	26.5	11.5	50.5	44.9	15.5	30.5	14.8	37.2	503.2
1956	7.0	59.6	47.0	6.0	48.7	39.5	-	-	50.0	4.0	11.0	22.3	-
1957	-	-	-	-	-	-	-	-	-	16.4	12.4	53.6	-
1958	36.1	32.1	100.1	43.4	7.6	65.7	4.4	1.7	33.0	20.8	3.0	26.3	374.2
1959	119.8	11.1	27.0	19.5	62.8	34.6	20.8	2.3	3.6	9.9	16.5	5.7	333.6
1960	30.0	19.2	43.0	47.4	32.7	42.8	34.2	10.9	8.6	13.9	9.6	13.9	306.2
1961	16.4	48.8	30.4	49.3	44.0	82.5	6.1	0.0	17.8	1.5	-	47.2	-
1962	14.7	51.3	23.4	12.7	27.6	25.8	8.0	-	19.8	42.0	7.4	77.5	-
1963	34.6	34.1	18.0	33.8	107.8	18.0	19.8	0.0	17.9	7.5	17.1	27.2	335.8
1964	2.5	17.6	15.0	8.4	66.5	68.0	16.3	69.3	1.6	0.0	45.2	20.0	330.4
1965	12.5	86.5	49.3	43.7	43.9	49.3	13.4	22.6	-	4.9	37.0	36.1	-
1966	72.2	3.9	31.0	36.6	67.9	15.1	12.7	40.0	8.9	0.0	17.1	25.2	330.6
1967	20.1	14.4	43.7	55.0	51.7	38.5	0.4	4.6	3.8	10.0	26.8	32.5	301.5
1968	13.8	66.8	93.3	47.1	46.1	113.8	35.7	99.7	96.8	370.9	93.5	195.8	1273.3
1969	41.6	79.0	42.9	97.2	64.0	57.3	6.3	0.0	8.9	0.7	53.8	57.1	508.8
1970	39.2	44.1	24.0	12.2	50.8	20.9	3.7	0.0	38.2	52.1	9.6	34.0	328.8
1971	4.0	20.2	44.0	45.2	71.2	47.8	17.1	14.4	23.5	9.8	31.9	61.6	390.7
1972	10.0	11.9	5.7	44.6	42.2	37.8	56.7	57.9	36.9	35.6	9.6	13.6	362.5
1973	7.8	21.3	34.2	68.2	30.3	38.7	13.8	2.2	14.7	13.4	29.9	13.9	288.4
1974	4.3	18.5	16.0	56.9	45.5	15.1	22.9	12.0	5.3	5.8	1.9	44.4	248.6
1975	40.4	8.1	22.8	98.6	102.0	30.4	28.5	11.9	4.3	13.5	13.5	28.5	402.5
1976	34.8	9.1	3.5	24.8	34.2	50.5	18.0	34.7	13.1	50.8	12.6	31.9	318.0
Average	28.7	32.3	37.0	44.1	52.2	44.3	17.8	19.6	20.7	28.8	23.5	36.1	549.1

Monthly Total Precipitation at Boyabat Meteorological Station

(mm)

month / year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug	Sep.	Oct.	Nov	Dec.	Total
1950	21.6	22.2	27.2	20.4	16.7	30.1	22.3	9.2	7.5	30 1	17.0	2.6	226.9
1951	12.7	-	36.9	56.2	33.9	53.0	3.5	14.9	9 6	20.6	31.1	33.8	-
1952	25.7	23.0	19.5	10.3	113.4	35.8	26.9	-	9.5	39.2	18.7	3.7	-
1953	17.7	40.2	20.4	28.3	119.9	64.9	39.9	2.8	15.3	20.8	11.5	13 6	395.3
1954	45.7	30.1	22.9	33.2	66.6	40.0	12.4	8.2	33 3	9.0	17.9	34.1	353.4
1955	6.1	17.7	36.4	34.9	60.8	18.1	55.1	45.3	53.4	42.0	20.6	25.4	415 8
1956	13.9	64.4	43.3	19.7	79.0	65.9	1.9	16.3	8.7	2 2	30.4	17.4	363.1
1957	7.9	15.3	12.5	25.8	111.4	3 7	9.7	-	62.0	20.4	12 1	35.5	-
1958	23.0	17.7	92.1	80.3	16.5	66.8	20.8	1.3	24.5	28.1	2.7	35 4	409.2
1959	82.1	23.0	35.2	50.7	71.5	56.2	40.6	49.1	21.6	11.1	10 1	6.9	458.1
1960	15.1	30.1	22.6	61.0	56.5	106 7	8.6	10.3	18.5	20.0	28.7	7.1	385.2
1961	15.1	34.4	27.1	58.9	60.2	94.7	6.1	4.9	32.7	3.5	13.2	25.4	376.2
1962	19.9	62.7	17.9	29.7	63.0	36.1	9.3	6.1	33.6	42.6	22.6	64.7	408.2
1963	58.6	24.0	34.0	71.9	75.5	27.6	24.9	0.4	37.8	12.6	12.1	19.8	399.2
1964	3.1	16.3	18.5	34.7	64.3	55.5	25.4	24.9	19.4	1.6	57.5	23.9	345.3
1965	3.6	46.4	48.3	51.2	55 0	49.5	44.8	31.4	0.0	16.9	40.6	15.2	402.9
1966	37.3	6.2	34.9	83.6	64.0	28.3	25.4	48.9	11.2	5.7	21.1	29.4	396.0
1967	12.0	7.8	42.9	69.0	30.6	109.0	2.8	3.5	33.7	33.2	20.9	32.1	397.5
1968	43.4	28.3	57.5	6.2	24.2	46.8	3.4	62.1	93.5	24.2	26.8	12.3	428 7
1969	42.2	51.8	63.8	99.6	26.5	49.8	17.6	-	38.4	4.5	64.2	36.2	-
1970	43.9	33.4	44.1	9.8	60.7	62.2	8.2	6.8	27.9	47.9	6 8	35.7	387.4
1971	4.4	21.6	58.8	53.4	101.9	60.0	24.1	39.1	38.0	17.5	23.7	41.1	483.6
1972	16.2	18.4	15.8	79.8	55.0	85.4	27.8	23.3	25.9	82.2	18.3	11.6	459.7
1973	6.6	21.3	44.6	80.0	28.1	20.0	38.9	0.3	9.8	13.8	53.0	18.9	335.3
1974	9.9	22.0	18.3	57.0	68.7	12.2	55.1	48.4	18.0	16.2	5.7	62.3	393.8
1975	38.7	11.1	15.7	82.3	88.7	11.4	36.2	10.4	10.8	31.5	31.5	32.3	400.6
1976	32.0	9.7	13.3	37.5	46.2	25.1	28.6	21.3	23.6	41.6	14.7	20.6	314.2
Average	24.4	26.9	34.2	49.1	61.4	48.7	23.0	20.4	26.6	23.7	23.5	25.8	388.5

Monthly Total Precipitation at Osmancık Meteorological Station

(mm)

month / year	Jan	Feb	Mar	Apr	May	Jun.	Jul	Aug	Sep.	Oct.	Nov	Dec	Total
1953	42 1	26 3	24.4	23 4	35 2	81 7	2.2	0.0	2 9	18.2	5.5	16 0	277.9
1954	75.7	34.2	21 1	15 7	22.4	9.0	1 2	14 0	-	0 0	14.9	42.8	-
1955	8 6	18 4	27 6	31.0	28.6	12 3	21.8	22.4	10 3	40 2	24 3	20.5	266 0
1956	12 8	50 5	59 1	14.8	34.5	25 5	0 4	2 6	8.9	10.9	7 4	7 8	235.2
1957	7 2	7 5	22 4	46 9	100.6	14 4	0 0	-	40.5	6.1	10.8	42 7	-
1958	-	-	-	28.3	17.8	56 4	5.7	2.1	13 7	17.3	2 5	31 1	-
1959	104.7	11 9	41 0	60.9	137.9	48 9	8.3	17 2	13.2	16.7	12.9	12 3	495.9
1960	28 6	34 1	34 6	52 7	54.5	50.5	33.6	41.2	13 9	14 8	17.6	14 5	390 6
1961	31 6	56 7	27.6	42 4	-	-	-	6.3	38 5	8.2	13 4	124.5	-
1962	66.9	70.1	40.8	26 6	51 3	30.1	17 3	4 1	23.1	68.9	8 8	122 3	530 3
1963	93 6	33 8	47.4	73 1	75 4	51 6	18 3	0 2	45 8	24 9	22 0	25 1	511.2
1964	7.1	79 7	31.8	50.0	50 8	106 7	19.2	8.2	11.5	0.2	60 6	45 1	470.9
1965	29.6	126.6	67 5	54.0	67.9	30.4	13.5	29 9	-	8.7	52 0	63.8	-
1966	104 6	15 1	47.5	76 1	85.8	68 1	19.7	47.6	2 4	1.0	25 5	-	-
1967	-	32 0	-	60 5	48.6	57.2	5.1	6.8	5 4	24.9	42 9	40.9	-
1968	60 7	21 4	46 0	17.8	27 3	34.2	33.8	17.4	64.6	39.2	20.2	24 3	406.9
1969	54.9	77.9	35 4	90 2	22.1	52 3	2.4	0.0	15.7	4.2	48 5	65 3	468.9
1970	45 6	56 2	27.3	12.4	27 7	46.7	0.0	0.0	38.0	75.9	16.9	39.4	386.1
1971	2 9	9 4	32 9	39.5	57.1	32.7	34.3	12 7	20.0	18 5	43.8	62.2	386 0
1972	11.6	15 9	11.3	55.9	85.5	35 6	48 1	21.8	40.6	37.5	10.4	16 8	391.0
1973	10 8	15.5	33 8	56 5	75 8	44.6	10 6	-	9.1	21.7	14.9	7.5	-
1974	7 9	17.2	7.8	56.6	60 5	15.5	34 1	6.4	1.8	0.8	0.0	63.6	272 2
1975	37 3	6.7	23 1	76 5	43.3	12.3	14.8	12.5	2 7	29.9	29.9	27 3	316.3
1976	39.0	5.8	7.9	25 8	28 8	23.2	10.7	11 9	15 4	38.0	15 6	22 9	245.0
Average	40.2	35 8	32 7	45.3	53.9	41.7	15 4	13.0	19.9	21.9	21.7	40 8	430.6

A-4 TEMPERATURE DATA AT GAUGING STATIONS IN THE VICINITY OF PROJECT SITE

Monthly Maximum Temperatures at Kastamonu Meteorological Station

(°C)

year \ month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Maximum
1930	12.6	13.7	24.0	25.2	28.8	30.0	35.6	37.6	31.0	27.0	18.5	12.4	37.6
1931	10.2	15.4	21.0	24.0	31.0	30.0	35.6	35.0	35.0	26.4	15.5	6.9	35.6
1932	9.1	9.2	23.6	27.6	31.8	34.3	37.6	35.7	30.2	31.0	23.0	11.4	37.6
1933	8.6	12.6	17.9	25.6	27.3	31.9	31.7	35.8	29.8	26.1	20.8	10.4	35.8
1934	9.9	9.9	24.2	28.6	29.3	31.0	36.1	35.1	35.7	26.8	19.5	10.7	36.1
1935	5.3	14.6	20.6	24.0	32.1	30.7	35.4	34.8	31.9	25.2	16.5	16.8	35.4
1936	10.8	14.9	18.8	27.4	25.6	27.7	30.4	34.6	29.8	28.2	20.0	13.7	34.6
1937	9.7	13.8	25.3	25.8	27.8	29.8	34.1	31.8	33.4	27.8	20.1	16.8	34.1
1938	10.4	12.3	18.7	23.5	29.0	31.5	33.9	33.6	33.8	24.1	21.0	12.0	33.9
1939	13.7	11.9	18.6	25.0	29.1	29.7	34.0	32.3	29.8	27.5	14.1	12.0	34.0
1940	10.8	13.4	26.0	24.7	27.3	29.9	34.6	32.9	29.3	29.7	20.2	17.9	34.6
1941	11.6	17.0	20.4	26.9	31.3	32.9	33.1	34.6	33.2	24.2	22.0	7.1	34.6
1942	7.2	11.2	18.4	25.4	31.1	34.8	33.4	35.5	27.2	22.5	18.5	11.0	35.5
1943	12.0	4.9	20.4	26.7	29.6	29.9	33.7	32.2	32.4	30.8	20.4	12.4	33.7
1944	7.8	15.4	21.3	27.2	26.9	29.6	33.9	34.0	30.8	27.8	18.8	14 0	34.0
1945	10.2	12.0	21.5	21.1	33.6	31.7	34.6	37.7	34.0	27.0	20 8	6 8	37.7
1946	12.7	13.2	16.4	22.6	29.0	29.9	32.4	34.0	33.9	25.6	22.0	13 1	34.0
1947	3.8	17.4	27.8	27.6	27.8	31.9	32.2	32.8	27.6	26.6	19 0	14 2	32.8
1948	14.2	12.9	15.0	24.3	28.0	31.0	34.5	36.3	27.1	22.7	20.2	6.4	36.3
1949	10.1	6.6	17.7	24.0	28.4	30.6	30.2	35.0	27.5	24.6	21.4	11.8	35.0
1950	5.4	8.3	18.4	29.2	29.9	30.1	32.8	34.7	33.2	28.1	18.7	12.4	34.7
1951	12.3	14.6	22.8	27.4	29.8	31.0	35.3	36.1	32.8	22.8	19.0	10.3	36.1
1952	11.9	13.2	27.6	30.6	26.6	29.6	30.9	35.2	34.7	30.4	20.5	16.6	35.2
1953	13.4	13.9	18.1	24.5	26.7	28.9	32.8	33.8	29.7	26.6	16.5	10.7	33.8
1954	9.1	7.4	20.9	25.7	27.9	30.7	36.7	37.6	31.5	26.4	19.1	14.4	37.6
1955	15.5	18.4	22.5	26.3	28.4	33.8	36.2	29.5	31.4	27.2	17.8	15.0	36.2
1956	13.1	14.3	16.3	27.7	24.2	31.6	32.7	34.2	30.4	28.1	20.9	15.8	34.2
1957	7.8	18.6	24.2	31.4	29.7	32.4	38.7	37.7	30.5	26.2	19.3	17.3	38.7
1958	12.9	20.6	22.0	23.4	31.3	34.7	34.1	36.9	27.4	25.4	20.6	14.6	36.9
1959	12.2	4.7	18.1	27.2	25.7	27.4	32.6	31.4	27.9	22.7	21.2	13.4	32.6
1960	14.3	17.9	19.3	22.2	31.6	29.4	34.2	36.7	33.8	25.7	21.5	15.4	36.7
1961	9.8	11.8	17.0	27.0	29.4	28.6	35.2	35.9	30.4	23.7	24.7	21.1	35.9
1962	10.9	12.6	22.1	22.7	32.0	31.8	38.9	35.4	34.3	26.3	21.8	12.7	38.9
1963	15.6	16.2	18.5	23.9	23.7	30.9	30.7	35.3	33.7	27.3	18.7	18.5	35.3
1964	5.7	10.7	22.6	25.9	28.3	28.4	32.3	31.6	29.3	28.8	18.5	15.0	32.3
1965	10.3	11.8	17.3	24.3	28.4	32.2	33.4	35.3	30.9	27.0	19.4	16.1	35.3
1966	15.4	18.7	19.3	28.4	25.6	31.8	35.3	33.3	29.2	26.9	22.2	15.1	35.3
1967	11.8	10.3	20.4	24.8	27.7	29.3	28.9	32.5	29.3	25.4	19.9	16.1	32.5
1968	10.4	15.2	18.3	26.2	28.0	31.0	35.5	32.7	32.4	20.8	15.9	15.3	35.5
1969	8.0	14.9	18.7	25.1	31.6	32.7	34.2	36.8	31.3	26.3	17.9	15.7	36.8
1970	10.6	15.0	22.4	29.4	30.7	30.6	35.0	35.5	29.2	25.6	21.3	10.3	35.5
1971	15.5	14.6	21.0	25.2	29.8	30.7	34.0	33.6	32.6	24.2	16.1	12.7	34.0
1972	5.0	9.5	18.4	26.4	28.7	31.6	33.4	35.5	30.6	24.7	16.1	9.6	35.5
1973	10.4	15.0	18.6	24.0	31.7	33.3	34.9	29.2	29.8	28.3	15.6	14.5	34.9
1974	4.6	12.4	20.4	23.8	26.6	33.3	34.3	32.2	28.2	29.3	21.4	10.4	34.3
1975	10.4	11.9	25.5	29.0	27.2	32.2	33.6	34.6	30.0	23.0	15.3	6.7	34.6
1976	9.5	7.1	19.7	26 6	24.7	27.9	33.1	33.6	30.3	27.9	18.1	17.2	33 6
Maximum	15.6	20.6	27.8	31.4	33.6	34.8	38.9	37.7	35.7	31.0	24.7	21.1	38.9

Monthly Maximum Temperatures at Kargı Meteorological Station

(°C)

year \ month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Maximum
1964												18.0	-
1965	13.5	12.6	21.3	25.8	32.3	36.7	36.2	39.4	35.0	30.0	21.5	15 7	39.4
1966	13.0	18.9	21.5	32.0	29.5	34.0	38.3	36.9	32.9	31.2	25.4	17.4	38.3
1967	12.3	12.0	23.0	30.0	32.0	34.4	32 8	36.9	33.5	28.8	23.8	16.0	36.9
1968	14.4	14.3	20.4	29.9	31.5	34.0	40.0	36.5	36.6	26.3	19.5	17.7	40.0
1969	11.9	16.2	20.0	27.5	35.1	36.0	38.0	40.8	34.0	30.6	18.0	14.6	40.8
1970	13.9	17.2	25.0	32.3	34.0	34.0	40.0	39.5	31.9	27.0	20.0	10.6	40.0
1971	16.4	17.8	22.5	33.4	32.2	36.0	37.4	37.1	36.6	28.0	16.3	14.5	37.4
1972	6.4	14.5	22.4	29.7	31.9	36.2	39.0	39.4	34.1	28.6	19.7	10.3	39.4
1973	10.1	18.2	20.8	26.3	33.9	38.5	39.4	32.8	33.9	29.0	18.6	17.1	39.4
1974	9.9	16.0	22.0	27.2	29.9	37.3	37.9	35.6	33.1	32.5	22.4	14.7	37.9
1975	10.0	14.9	25.3	31.9	29.3	35.9	37.0	39.0	34.2	27.0	18.3	9.5	39.0
1976	9.0	10.4	22.2	31.0	28.9	33.4	38.4	37.8	34.9	30.9	20.8	19.4	38.4
Maximum	16.4	18 9	25.3	33.4	35.1	38.5	40.0	40.8	36.6	32.5	25.4	19.4	40.8

Monthly Maximum Temperatures at Boyabat Meteorological Station

(°C)

year \ month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Maximum
1964	7.5	16.5	23.5	30.0	31.0	32.5	36.8	34.0	31.0	28.5	19.5	20.0	36.8
1965	13.5	13.0	22.6	26.5	31.5	38.0	36.0	37.0	32.5	29.0	20.8	19.5	38.0
1966	15.0	20.0	21.5	31.0	30.5	33.5	38.5	36.0	31.6	30.0	23.5	18.7	38.5
1967	14.0	13.5	22.2	27.0	33.0	32.3	31.8	34.2	33.0	27.4	22.5	20.5	34.2
1968	15.0	17.0	20.2	28.2	31.0	33.0	41.0	36.0	32.5	23.5	17.2	18.5	41.0
1969	9.5	16.4	20.6	28.2	34.2	36.5	39.8	40.0	32.5	26.5	19.4	13.0	40.0
1970	14.0	19.0	27.5	32.5	33.5	33.5	38.5	37.5	31.0	26.0	19.0	10.5	38.5
1971	18.5	18.0	23.0	28.0	31.5	32.0	37.0	35.0	35.0	26.4	19.0	11.0	37.0
1972	5.6	13.0	21.0	29.5	31.0	33.5	37.0	38.5	33.0	27.5	17 0	9.6	38.5
1973	11.0	19.5	20.0	27.8	32 5	38.0	40.0	31.0	32.5	27.5	17.0	13.5	40.0
1974	6.7	15.0	23.0	27.5	29.5	37.0	37.5	33.0	30.5	31.0	22.0	15.0	37.5
1975	13.0	15.0	25.0	31.5	29.0	36.0	36.5	38.0	33.5	27.0	18.0	8.5	38.0
1976	12.0	11.5	21.5	30.3	28.5	32.0	37.0	36.5	31.0	29.5	21.0	20.5	37.0
Maximum	18.5	20.0	27.5	32.5	34.2	38.0	41.0	40.0	35.0	31.0	23.5	20.5	41.0

Monthly Maximum Temperatures at Osmancık Meteorological Station

(°C)

month / year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug	Sep.	Oct	Nov	Dec.	Maximum
1965	-	-	-	-	-	-	37.0	39.0	34 0	31 0	21.9	17.9	39.0
1966	16.2	18.5	20.0	31.1	30.0	33.2	38 2	37 3	32 4	31.1	26.1	-	38 2
1967	-	-	-	27.5	33.4	34.1	32.4	36 5	30 6	27.6	24.1	18.0	36.5
1968	14.5	17.0	20.3	29.0	31.4	33.8	39.2	36 1	35.2	26 8	18 5	16 4	39.2
1969	12.0	14.9	19.9	28.1	34.6	35.4	38.9	40.4	36 1	29 8	19.9	15.1	40.4
1970	13.6	16.8	25.0	31.8	33.7	34.4	39.5	38.9	32.1	26.9	19.8	12 1	39 5
1971	17.8	19.0	22.9	27.4	32.2	33.1	37.3	37.0	36 4	27.4	17.9	14.1	37 3
1972	9.1	12.5	21.4	29.6	30.8	34.5	38.9	38.0	33.3	28 0	19 1	10.3	38.9
1973	9.6	19.1	20.0	26.1	32.9	37 9	38.8	32.8	33.2	28.5	17.5	15 1	38 8
1974	8 4	-	21.7	27.0	30 0	37.0	37.5	35.1	31.6	31.9	22.1	13 0	37.5
1975	13.0	13.6	22.3	31.3	29 2	36.2	37.5	38.5	34.5	27.1	17 2	8 1	38.5
1976	9.5	8.1	21.6	31.9	29.2	32 7	37.8	36.0	33 2	30 1	20 6	17.8	37.8
Maximum	17.8	19.1	25.0	31.9	34.6	37.9	39.5	40.4	36.4	31.9	26.1	19 0	40.1

Monthly Minimum Temperatures at Kastamonu Meteorological Station

(°C)

year \ month	Jan.	Feb	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Minimum
1930	-6 2	-8 2	-6 0	-1.3	2.3	5.6	10.7	9.9	5.0	2.3	-3.5	-5.4	-8.2
1931	-12 6	-5 2	-8 0	-7.2	3.4	8.4	9.9	10.5	0.6	0.2	-7.1	-10.3	-12.6
1932	-14 7	-13 2	-11.2	-3.0	1.7	6 7	6.7	7.6	4.0	4 5	-8.2	-8.2	-14.7
1933	-12 2	-11.2	-9.8	-5.0	2 3	4.5	9.4	8.9	4.8	-0 4	-4.7	-12.6	-12.6
1934	-12.1	-13.0	-3.5	-1.4	3.2	4.0	9.7	8.6	2.0	0.7	-2.0	-8.1	-13 0
1935	-26 9	-16.1	-11.7	-1.0	-0 4	3 0	5.2	7.9	2.6	1.0	-8.2	-13.6	-26.9
1936	-10 4	-14 4	-5 7	-2 6	-1.2	4.8	8.5	7.6	1.5	-0 1	-15.0	-14.4	-15.0
1937	-21 8	-12 1	-3.0	-4.4	0.6	3.0	8 5	9.2	7.5	-0.8	-1.6	-15 4	-21.8
1938	-15 6	-12 0	-10 6	-4.2	3.6	3 8	9 2	10.0	0.1	0.2	-5.8	-5.8	-15.6
1939	-13.6	-9 8	-10.0	-5 8	3.7	2 6	2.6	8 4	8.9	1.5	-7.4	-13.2	-13.6
1940	-20.9	-12 1	-14.6	-3 0	-1.9	5.1	9 6	8.0	2.4	-2.9	-4.6	-16.4	-20.9
1941	-20 0	-15 1	-14.3	-5.0	0.2	3.9	9.0	4.9	1.7	-4.8	-8.4	-23.7	-23.7
1942	-23 9	-9.9	-11 3	-5.6	1.3	2.8	5.6	4.9	3 0	-3.3	-5.7	-9.2	-23.9
1943	-12.7	-16 2	-13.2	-3.4	0.2	1.5	4 9	5.1	2.4	1.3	-3.1	-9.8	-16.2
1944	-12.7	-13 3	-7.1	-6.8	-0.3	4.1	7.0	0.9	0.7	0.4	-4 8	-7.1	-13 3
1945	-21.8	-16 6	-10.3	-6.6	-2.5	2.6	6.0	4 1	1.7	-1.8	-10 0	-17.7	-21.8
1946	-13 4	-12 3	-5 8	-3 4	2.3	5.2	6.8	7.2	1.0	-7.2	-3.2	-13.1	-13.4
1947	-20 6	-21.8	-7.8	-3 0	-0 5	6.1	8.5	5.9	2.4	-3.3	-3.8	-18.2	-21.8
1948	-7.8	-12 1	-10.4	-7.4	0.2	7.2	6.6	7.6	1.7	-3.9	-19 3	-14.1	-19.3
1949	-13.4	-14 4	-12.3	-5.2	-0.4	5 7	8.7	2.8	5.3	-1.9	-3.0	-13.0	-14.4
1950	-23 7	-21.9	5.6	0.6	0.8	0.2	6.1	6 1	5.1	-2.7	-7.9	-7.7	-23.7
1951	-7.8	-7.2	-3 0	-1.4	3.4	2.2	8.2	7.6	1.6	-4.9	-5.2	-9.6	-9.6
1952	-13.8	-8 9	-12.2	-2.5	0.3	3.9	6.6	7.9	3.9	0.9	-5 8	-5.1	-13.8
1953	-6.6	-12 3	-11.4	-2.4	3.0	6.3	7.0	8 0	2.1	-1.8	-12.5	-20.4	-20.4
1954	-19 5	-15 0	-9.1	-3 3	0.6	7.8	8.1	9.3	12.8	-0.4	-2.4	-4.5	-19.5
1955	-7.1	-7.5	-6 9	-2 6	0.2	5 5	9 2	7.8	2.4	3.0	-5.1	-9.0	-9.0
1956	-13.5	-15 9	-14.0	-4.7	1.5	2.7	6.2	6.8	-1.5	-4.6	-9.2	-11.6	-15.9
1957	-13.4	-9.0	-10.6	-5.4	2.7	4.2	5.2	8.4	8.7	-2.0	-7.4	-9 2	-13.4
1958	-10.4	-6 7	-5.9	-3.6	-0.2	2.5	6.3	6.2	2.4	-1.3	-8.5	-11.3	-11.3
1959	-9 0	-15.6	-12 5	-3.1	0.9	3.6	8.1	5.6	0 7	-4.6	-7.7	-8.0	-15.6
1960	-12 1	-22.3	-11.3	-0 3	1.4	5 6	6.7	8.5	1 3	-0.4	-2.6	-4.6	-22.3
1961	-19.6	-18 0	-11.5	-2.6	2 3	6 6	6.9	5.8	1.6	0.1	-3 4	-14.1	-19.6
1962	-7.3	-9 5	-7.9	-3 6	1.0	7.4	7 3	6 0	2 5	-0.3	-1.0	-7.0	-9.5
1963	-12 4	-10.5	-9.5	-4.5	1.2	6.3	7.8	5.7	2.0	-2 4	-4.7	-9.5	-12.4
1964	-20 6	-15 8	-6.8	-4.5	-1.9	6.7	5.5	7.3	2.7	-3.9	-10.4	-6.3	-20.6
1965	-11 6	-20.7	-6.6	-5 7	0.6	7.9	7 4	6.0	1.8	-4.6	-5 1	-3 5	-20.7
1966	-9 8	-10 1	-5 1	-3.6	-0.6	5 9	9 4	8.6	2.6	0.6	0.4	-12.4	-12 4
1967	-13.5	-16.0	-6.1	-6.8	2.0	0.8	7.9	7.3	2.6	1.4	-11.4	-8.6	-16.0
1968	-17 6	-11 7	-7.7	0 0	4.5	2.1	4.7	6.5	5.6	0.6	-1.6	-9.0	-17 6
1969	-16 1	-12 8	-5 6	-4 1	1.0	6.4	5 8	7.1	1.7	-4.3	-2.9	-4.1	-16 1
1970	-8.0	-6.2	-6.3	-2.3	3.0	6.4	8.8	3.2	1.8	-3.1	-2.9	-13.1	-13.1
1971	-10 1	-7.7	-7.2	-1.2	4 0	4.0	6 7	7 4	4.4	-2.8	-3.9	-14.0	-14.0
1972	-15 4	-16 6	-12 0	-4.6	3 3	9.1	8.0	11 0	4 7	-1.1	-6.0	-14.6	-18.4
1973	-16 0	-6 6	-10 0	-0.8	0.0	5.3	8 0	6.2	4.8	-7.5	-7 8	-11 6	-16.0
1974	-16 6	-15 0	-7.1	-3.5	1 6	6.0	7.7	6.4	1.0	0.8	-4.2	-13.2	-16.6
1975	-13 2	-10 4	-4 3	-0 8	3 8	7.0	9.8	5.5	3.7	-0.9	-5.9	-13.4	-13.4
1976	-18 9	-17.7	-9 5	-4.6	2.2	2 6	6 9	8.9	2 2	1 0	-1.0	-10.0	-18.9
Minimum	-26 9	-22	-14 6	-7 4	-2 5	0 2	2.6	0.9	-1.5	-7.5	-19.3	-23.7	-26 9

Monthly Minimum Temperatures at Kargı Meteorological Station

(°C)

month / year	Jan	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Minimum
1965	-5.8	-13.7	-1.0	-1.0	7.3	12.2	13.7	12.0	10.5	-0 1	-0.4	0.5	-13 7
1966	-5.8	-3.6	0.2	2.3	5 9	11.0	15.5	12 6	10.9	5.7	4.3	-3.7	-5.8
1967	-6.7	-8.0	-2.5	0.2	7.9	7.2	14 7	15 0	9.9	6 5	-3.6	-6.4	-8.0
1968	-8.6	-3.8	-2.2	5.6	11.4	9.0	12.9	13.2	9.3	5 5	3.6	1.3	-8 6
1969	-7.2	-4.4	-1.5	0.9	9.1	14.3	13 4	14.0	8.4	0 7	1.1	0.0	-7.2
1970	-2.4	-2 2	-0 5	3.5	8.5	12.5	16.7	10.5	5.5	2.3	2.0	-4.5	-4.5
1971	-5.6	-6.0	-2 6	3.4	9.5	11.2	14.6	13.0	11.8	1.0	1 0	-5.2	-6 0
1972	-10.4	-11 0	-3.9	0 5	7.4	13.5	14.0	16.1	11.0	2.8	-2.6	-7 4	-11.0
1973	-12.5	-3 0	-3.5	5.0	6 5	11.0	13.5	11 6	9.5	-0.3	-2.5	-4.0	-12.5
1974	-8 0	-8 6	-1 2	1 9	7.8	13.0	13.2	13 6	7.7	5.9	-1.5	-3 0	-8 6
1975	-6 5	-5.6	-0.5	5.0	7 2	13.0	15.2	12.0	9.3	3 5	-2.7	-5 5	-6.5
1976	-15.0	-10.6	1)	0 0	8.3	9.0	12 5	13.4	8.3	9.0	0 9	-3.5	-15 0
Minimum	-15.0	-13 7	-3.9	-1.0	5 9	9.0	12.5	10.5	5.5	-0 J	-3.6	-7.4	-15.0

Monthly Minimum Temperatures at Boyabat Meteorological Station

(°C)

month / year	Jan.	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Minimum
1964	-10 0	-7.5	-1 5	0.0	5.0	13.0	12.4	11.0	9.0	0 5	-2.5	-3.3	-10.0
1965	-6.5	-10.5	-2.0	-2.5	5.0	11.5	13.5	10.5	9.0	-2.0	-2.0	-2 0	-10.5
1966	-4.5	-5 0	-2.0	0.5	4.0	8.0	14.0	13.0	9.5	3 5	3 5	-5.0	-5 0
1967	-6.5	-10.5	-4.0	-1.2	6.6	5.6	13.6	13 4	9.5	4.0	-4.5	-5.5	-10 5
1968	-9.5	-5.2	-4.2	3.0	11.0	7.5	11.4	12.5	7.0	3.0	1.0	-2.5	-9.5
1969	-8.5	-4.6	-2.0	-0.6	7.0	12.5	11.0	12.2	7.5	-2.0	-1.0	-1.5	-8.5
1970	-3 3	-2.0	-1.0	1.0	7.0	11.5	14.5	9.0	2 5	0 4	-0.5	-6.0	-6.0
1971	-7.0	-5.0	-3.7	3.2	7.5	9.0	12.6	8.0	10.0	-1.0	-2.0	-8.0	-8 0
1972	-13.5	-11 5	-5.2	-1.5	5.5	12.0	13.0	14.6	10.5	3.5	-4.0	-6 0	-13.5
1973	-10.6	-3.5	-5.0	3.5	4.5	9.0	12.5	11.0	7.6	-2.6	-3 5	-5.0	-10.6
1974	-10.5	-8 0	-2.6	-0 4	6.5	11.2	11.0	12.3	6.0	3 3	-3.5	-5.0	-10.5
1975	-5 7	-7.0	-3.0	1.5	8.0	13.5	14.0	11.5	7.5	0.5	-4.4	-11 0	-11.0
1976	-16.5	-10.5	-6.0	-1 0	6.5	8.0	11.6	13.0	7.3	1.5	-0 5	-9.4	-16.5
Minimum	-16.5	-11.5	-6.0	-2.5	4.0	5.6	11.0	8.0	2.5	-2.6	-4 5	-11.0	-16.5

Mo1 thly Minimum Temperatures at Osmancık Meteorological Station

(°C)

month / year	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Minimum
1965	-	-	-	-	-	-	13.1	21.0	6.0	-5.1	-5.8	0.4	-
1966	-8.4	-0.9	-1.4	4.5	7.0	14.0	17.4	14.0	10.0	4.0	4.0	-	-
1967	-	-	-	-0.9	4.6	7.4	12.4	14.0	5.6	1.9	5.6	-9.1	-9.1
1968	-12.4	-5.2	-4 0	1.3	8.4	4.4	12.3	9.9	6.8	1.7	-1.7	-4.5	-12.4
1969	-9.0	-7.5	-3.6	-1.7	4.4	13.0	12.4	11.9	4.0	-2.6	-2.4	-1.6	-9.0
1970	-3.3	-4.1	-2.4	0.4	6.4	10.0	14.8	8.8	5.4	0.4	-2.1	-5.5	-5.5
1971	-7.7	-9.6	-4.3	1.4	7.8	10.4	12.5	14.9	9.2	-1.8	-2.0	-6.6	-9.6
1972	-14.6	-18.1	-5.4	-1.1	7.4	11.8	13.4	14.9	9.4	-0.3	-5.0	-9.6	-18.1
1973	-16.6	-4.4	-4.1	3.3	4.4	10.0	11.5	10.4	6.5	-2.6	-5.6	-5.3	-16.1
1974	-12.0	-	-3.1	-0.4	7.6	11.5	12.1	12.4	5.4	3.2	-4.8	-4.2	-12.0
1975	-5.6	-9.4	-3.7	-3.2	6.6	12.5	14.8	10.3	7.3	1.2	-3.8	-6.9	-9.4
1976	-18.5	-10.7	-5.4	-1.4	6.7	8.5	11.4	11.6	5.8	2.8	0.4	-5.5	-18.5
Minimum	-18.5	-18.1	-5.4	-3.2	4.4	4.4	11.4	9.9	4.0	-5 1	-5.8	-9.6	-18.5

Monthly Average Temperatures at Kastamonu Meteorological Station

(°C)

year \ month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1931	0.3	4.2	6.4	8.7	15.4	18.9	22.3	21.5	18.1	12.0	3.4	-1 2	10.8
1932	-2.5	-2.5	5.0	9.9	15.0	19.4	20.9	20.0	17.4	16.3	5.8	0.9	10.5
1933	-1.7	1 3	3.2	6.9	14.5	16.2	19.5	20.3	14.9	11.7	8.5	-1.8	9.5
1934	-1 6	-1.3	8.7	11.6	15.9	18.0	21.2	20.5	16.9	12 1	7.3	1.4	10 9
1935	-6.3	0.1	2.6	9.5	15.6	18.7	19.5	20.6	16 6	11 9	4.5	2.2	9.6
1936	0.1	2.2	5.9	10.4	12.9	15.8	20.9	20.1	13.2	10.4	4.3	-1.9	9.5
1937	-4.6	2 1	8.3	10.1	14.3	16.7	22.0	20.2	18.8	11.1	6.6	2.1	10.6
1938	-1.5	-0.4	2.5	8.8	13.6	17.4	22.2	21.3	15.8	10.2	3.7	2.9	9.7
1939	1.6	0 2	2.6	9.9	15.4	17.3	19.9	19.3	15.1	12.6	3.4	1.9	9.9
1940	-3.5	2.0	2.8	10.1	12.2	17.4	21.1	19.1	14 6	11.5	5.3	2.4	9.6
1941	-1.1	3.1	3.1	11.0	15.1	18.4	20.4	18.7	13 9	8.0	2 5	-4 1	9.1
1942	-5.7	1.0	2.5	7.8	14.5	19.2	19.6	20 1	14.4	10.5	5.2	-1 0	9.0
1943	-2.2	-4.3	0.0	7.7	13.3	16.4	18.5	19.6	16.0	13.7	6.4	0.5	8.8
1944	-1.5	2.9	4.7	9.8	12.4	18.0	19.6	18.0	15.0	12.7	5.9	2.5	10.0
1945	-0.5	-2.5	1.4	7.0	15.6	16.5	19.5	20.9	16.0	9.2	4.5	-3.6	8.7
1946	-1.3	0.9	3.6	9.8	14 5	18.0	19.7	19.7	16.7	7 5	6.8	1.7	9.8
1947	-3.2	1.4	7.8	10.4	15.2	19.5	20.9	18.6	14.8	8.9	6.7	1 9	10.2
1948	3.3	0.2	-0.3	8.6	14.2	17.6	20.1	20 7	14.7	10.2	2.1	-2.4	9.1
1949	-3.0	-2.7	1.8	5.8	15.2	17.5	18.6	17.9	13.4	9.4	6.6	2.4	8.6
1950	-5.5	-4.2	3.1	13.7	15.1	16.7	19.3	18.7	17.8	9.0	5.0	1.5	9.2
1951	1.0	2.9	7.1	10.5	14.7	16.7	20.2	20 6	15.7	6.9	5.8	-1.2	10.1
1952	-0.3	2.1	4.0	10.1	12.7	15.7	19.3	21.0	18.4	12.2	6.5	3.9	10 5
1953	1.8	0.8	-0.2	9.5	13.7	18.0	20.1	20.0	14.5	10.6	2.3	-3.4	9.0
1954	-5.6	-2.9	4.9	7.3	14.4	18.1	21.5	21.4	16 2	11.9	7.4	2.8	9.8
1955	2.5	5.2	5.5	7.9	14.9	18.8	20.4	18.5	15.7	13 5	6.1	1.9	10.9
1956	0.6	-0.3	0.3	10.5	12.1	17.2	19.1	21.3	13.1	9 0	3 6	-1.6	8.7
1957	-2 4	2.8	3.9	11.0	13.8	19.4	22.1	22.3	18.3	11.4	6.1	2.0	10.9
1958	0.2	4.6	4.8	9.3	16 5	17.6	19.6	20.0	14.1	10.0	5.2	0.9	10.2
1959	1.2	-4.3	2.4	9.6	13 9	16.6	20.7	19.0	12.5	7.2	5.0	2.8	8.8
1960	1.8	-0.8	3.6	9.2	15.2	17.1	20.1	18.5	15.2	12.3	7.2	3.2	10.2
1961	-3.3	-0.3	3.5	11.3	14 8	17.6	19.7	19.7	13.0	10.3	7.4	2.7	9.7
1962	0.1	0.7	6.6	9.4	15.5	17.8	21.1	21.6	16.0	11.1	8.6	2.5	10.9
1963	0.4	2.8	2.8	8.8	13.6	17.5	19.7	20 3	16.8	11.3	5.8	1.8	10.1
1964	-4.7	-1.2	5.4	8.3	12.5	17.3	19.3	17.6	14.3	10.4	4.3	2.3	8.8
1965	-0.1	-2.5	5.2	8.2	13.6	17.7	19.2	19.0	15.7	7.3	5.8	3.6	9.4
1966	1.3	4.6	5.9	11.0	13.0	17.2	21 2	20.6	14.8	13.1	9.2	2.4	11.2
1967	1.8	-3.2	3.4	8.8	13.4	15.4	25.1	26.8	14.7	10.8	5.3	2.8	10.4
1968	-2.0	0.2	3.3	11.4	16.4	16 7	20.0	18.3	15 4	9.7	6.2	1.7	9.8
1969	-2 0	0.5	4.5	7.2	15.6	18.8	17.9	20.2	15.5	9.1	4.7	3.0	9.6
1970	1.7	3 3	6.1	12.2	13.2	16.9	21.2	18.7	14.7	9.2	5.4	-0 2	10.2
1971	1.1	1.2	5.6	9.1	14.1	16 7	20.1	19.4	16.3	8.2	6.1	0.0	9.8
1972	-2.8	3.5	2.7	9.5	13.9	15 7	20.0	18.3	16.1	10.9	3.0	-0.9	9.2
1973	-3.6	3 5	2.7	9 5	13.9	15.7	20.0	18.3	16.1	10.9	3.0	-0 9	9 1
1974	-3.6	1 3	6.0	7.3	13 8	18 6	19 3	18.6	11.2	11.6	5.0	0.1	9.5
1975	-1.5	0 6	6.6	11 7	13.6	19.2	21.1	19.9	15.4	10.2	1.7	-2.9	9.8
1976	-4.6	-3.1	3.4	9 6	13 9	16 5	19.4	18.3	14.5	11.6	5.9	0.9	8.8
Average	-1.3	0.6	4.0	9 1	14.1	17.5	20 3	19.9	15.5	10.7	5 1	0.8	

Monthly Average Temperatures at Kargı Meteorological Station

(°C)

year \ month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1964	-	-	-	-	-	-	-	-	-	-	-	6.1	-
1965	3.9	1.0	9.1	12.2	17.9	22.4	24.2	24.2	21.7	12.6	9.2	6.4	13.7
1966	4.0	8.3	9.7	14.9	17.6	21.9	25.9	25.3	20.3	18.8	12.9	5.8	15.5
1967	1.7	0.6	7.0	12.9	18.1	20.2	23.6	24.6	20.0	16.3	8.9	5.1	13.2
1968	1.1	4.0	7.7	15.9	21.1	21.9	25.1	23.7	20.6	14.4	10.7	5.2	14.3
1969	1.9	4.6	8.5	11.3	19.8	23.5	23.0	25.8	20.8	14.2	8.8	6.5	14.1
1970	5.5	6.8	10.2	16.9	17.7	21.9	26.1	23.9	20.2	13.2	9.1	3.5	14.6
1971	4.4	4.8	9.6	13.1	18.4	20.7	24.6	24.4	21.5	13.2	9.1	3.4	13.9
1972	-1.4	0.9	7.9	16.0	18.3	22.7	25.2	24.9	20.6	15.3	8.3	1.3	13.3
1973	-0.5	7.0	6.6	13.9	18.2	20.2	24.6	23.4	23.4	15.8	6.4	2.7	13.5
1974	0.5	4.7	10.1	11.2	18.0	23.6	24.2	23.6	19.8	19.0	9.3	2.6	13.9
1975	1.3	3.9	11.0	16.1	17.4	24.0	25.8	24.7	20.6	14.5	7.4	1.2	14.0
1976	-1 3	0.7	7.3	14.1	17.9	20.7	24.0	22.6	19.3	15.8	9.4	3.9	12.9
Average	1.8	3.9	8.7	14.0	18.4	22.0	24.7	24.3	20.7	15.3	9.1	4.1	

Monthly Average Temperatures at Boyabat Meteorological Station

(°C)

year \ month	Jan.	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1964	-0 9	3.5	9.2	12.2	15 9	21.6	23.1	21.7	18.8	15.8	7.6	5.4	12.8
1965	3.6	1.8	8.9	11.6	17.3	21.8	23.2	22.4	20.4	11.7	9.0	6.5	13.2
1966	4.5	8.2	9.6	14.4	16.5	20.8	25.1	24.6	13.0	17.7	12.5	5.5	14.4
1967	1.9	1.1	6.7	12.6	17.5	19.3	22.3	23.5	19.1	15.7	8.9	5 2	12.8
1968	1.2	4.0	7.0	14.9	20.2	20.7	23.8	21.9	19.2	15.6	9.6	4.5	13.6
1969	1.4	4.2	7.6	10.6	18.7	22 3	21.4	24.1	19.5	13.0	7.6	5.5	13.0
1970	4.8	6.6	9.6	15.8	16.8	20 2	24.7	22.4	18.8	12.7	8.3	2.8	13.6
1971	3.7	4.6	8.8	12.7	17.9	19.9	23.2	23.0	20.1	12.1	8.7	3.1	13.2
1972	-2.9	1.0	6.5	15.6	17.3	21.4	24.0	23.9	19.7	14.7	7.3	1.1	12.5
1973	0.0	6.6	6.0	12.9	15.7	19.5	22.9	21.7	19.6	14.3	5.5	2.7	12.3
1974	-0.2	4.5	8.7	10.3	16.9	22.0	21.8	21.6	18.4	17.6	8.7	2.5	12.7
1975	1.7	3 7	9.8	14.8	17.1	22 7	24.5	23.3	19.4	13.6	7.2	0.2	13.2
1976	-1.9	0.7	6.5	12.6	16.3	19 6	22.1	21.4	18.3	15.0	8.5	3.6	11.9
Average	1.3	3.9	8.1	13.2	17.2	20.9	23.2	22.7	18.8	14.6	8.4	3.7	

Monthly Average Temperatures at Osmancık Meteorological Station

(°C)

month / year	Jan.	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep	Oct	Nov.	Dec.	Average
1965	-	-	-	-	-	-	24.0	24.0	20.7	10.4	6.7	6.1	-
1966	4.1	6 8	6.2	13.1	18.4	22 0	27.2	26.2	19.6	15 5	10.5	-	-
1967	-	-	-	12 8	17.4	19.7	22.9	23.8	19.1	14.1	7.8	4.9	15.8
1968	0.8	3.2	6.7	14.8	20.4	21.1	24.1	22.7	19.4	12.8	8.8	4 5	13.3
1969	1.4	3 2	7.9	10.6	18.8	22.7	22.6	25.2	20.2	13.1	7.3	6 2	13.3
1970	5.1	6.5	9 4	16.1	17.5	21.4	26.1	23.6	19.5	12.4	8.1	6 0	14.3
1971	3.3	4.3	9.2	12 6	18.3	20 9	24.4	24.3	21.4	12.5	8.9	2.9	13.6
1972	-3.1	-1.7	7.1	15.8	18.0	22 3	25.4	25 2	15.0	20.4	7.2	3.1	12.9
1973	-2.0	6 1	5.7	14.0	17.9	20.9	24.9	23.4	21 1	15.6	6.3	2 4	13.0
1974	-1.1	-	9.4	11.1	17.9	23 3	23.5	23.3	19.1	18.2	8.4	2.3	-
1975	1.2	3.5	9 8	15.6	17.5	23 1	25.4	24.4	20.4	13.8	7.2	0.6	13.5
1976	-1 9	-0.7	6.0	12.9	17.3	20.3	23 5	22.3	18.8	15.6	8 4	3.7	12.2
Average	0.8	3.5	7.7	13.6	18.1	21.6	24.5	24.0	19.5	14.5	8 0	3.9