CHAPTER 5 BASIC DEVELOPMENT PLAN

5.1 Agriculture Development Plan

5.1.1 Land Use Plan

(1) Intensive Land Use Plan

According to the basic concept of agricultural development described in Chapter 4 and the Seventh Five Years Development Plan of Turkey, following direction will be the fundamentals of agricultural land use.

- Increasing of the irrigated farm land by the development of water resources.
- Increasing of the productivity of irrigated farm land by the introduction of high productive crops.
- Rising up the land use intensity by the rotational cropping with summer and winter crops.
- Decrease of fallow and improvement soil fertility by the introduction of leguminous crops.
- Development of animal husbandry and integrated agriculture by the matter cycle between crop production and livestock breeding section.
- Control of salification of cultivable land, degradation of soil fertility and soil erosion.

Among upper directions, development of water resources and effective use of water, developing the irrigation facilities, diffusion of water-saving irrigation system will be the basic ways in every regions. Introduction of high productive and promising crops into the irrigation area must also be promoted to enhance the effect of irrigation. However, practical ways for intensive agricultural land use will differ by regions. So, the practical direction of each agro-ecological regions is shown in Annex Table C-18, and recommended ways to promote the intensive land use in regions will be shown as follows ;

- In Aegean and Mediterranean Sea Coast regions, double cropping system with winter cereals and summer fodder crops which do not take the longer days for their growing and maturing than other summer crops.
- In Marmara, Aegean and Mediterranean Sea Coast regions, spring rainfall and soil moisture can be utilized for crop growth, and it will support the stable germination and growth. It also enables to introduce the double cropping system by the spring, summer and autumn crops.
- In Black Sea Coast region, expansion of planted area of summer cereals such as maize and rice are planned by utilizing the summer rainfall. Pulses, industrial crops and tuber crops should also be introduced progressively to improve the agricultural land use.
- In Anatolia Highland, the area of fallow can be reduced largely by the introduction of some kind of pulses and soiling crops. Pulses will make the soil fertility improve and contribute to rise the crop yields in the regions.

(2) Irrigation Plan

There are over 4,200,000 ha of irrigated area in Turkey. These projects were carried out by General Directorate of State Hydraulic Works (DSI), by General Directorate of Rural Services (GDRS) and by farmers themselves.

Proposed irrigation area by the small scale irrigation projects in the study area are shown in Table 5.5.1 conforming to the plans and projects of GDRS in the study area. Irrigation area of crops, vegetables and fruits are also allocated by the cropping plans in irrigation area in the projects (Proposed irrigation areas to field crops and vegetables in each region are shown in Annex Table C-18).

Table 5.1.1 Proposed Irrigation Area by Small Scale Irrigation Projects (Unit: ha)

	Regions	Ex./Prop.	Crops	Vegetables	Fruits	Total
1-1	Marmara Sea	Existing	126,691	53,638	47,592	227,919
		Proposed	2,650	150	326	3,126
1-2	Aegean Sea	Existing	430,862	99,276	134,360	664,499
		Proposed	7,683	3,900	5,200	16,783
1-3	Mediterranean	Existing	364,377	82,389	96,921	543,686
		Proposed	10,320	1,726	3,050	15,096
2	Black Sea	Existing	100,624	30,443	16,864	147,929
		Proposed	12,500	4,770	255	17,525
3-1	Cent. North	Existing	260,553	60,782	62,745	384,081
		Proposed	11,261	6,200	500	17,961
3-2	Cent. South	Existing	476,535	38,825	83,936	599,293
		Proposed	25,336	5,600	7,400	38,336
3-3	Cent. East	Existing	132,265	15,846	37,102	185,214
		Proposed	11,020	3,500	500	15,020
	Study Area Total	Existing	1,891,907	381,199	479,520	2,752,621
		Proposed	80,770	25,846	17,231	123,847

Source : Existing irrigation area is areas in 1991, quoted from "Statistical Year Book of Turkey, 1995."

The irrigated cultivation area of crops in each region which are shown in upper Table will be given by the conversion of non-irrigated cultivation area of crops, fallow and conversion of the area of low benefit crops

5.1.2 Cropping Pattern and Farming Plan

(1) Promising Crops and Cropping Pattern

1) Promising Crops

To develop the agriculture of the regions, promising crops should be selected at first in accordance with the climatic and soil condition of the regions and demand of markets. Cropping patterns will be improved gradually by the introduction of the productive and promising crops. Selection of promising crops which enable to heighten the effect of irrigation will contribute to the improvement of the productivity of agricultural land and also bring the benefit and higher incomes to farmers.

Examples of promising crops in regions are shown in Table 5.1.2.

Table 5.1.2 Examples of Promising Crops in the Regions

Regions	Field Crops	Vegetables	Fruits
Marmara Sea	Sunflower, Maize, Sugar beet	Tomato, Green pepper, Melon	Pome fruits, Stone fruits, Grape
Aegean Sea	Sunflower, Cotton, Pulses	Tomato, Water melon, Melon	Citrus fruits, Grape
Mediterranean	Maize, Pulses, Cotton	Cucumber, Green pepper, Pumpkin	Citrus fruits, Pome fruits
Black Sea	Maize, Potato, Rice	Cabbage, Fresh beans, Egg plant	Pome fruits, Nuts, Cherry
Anatolia Highland	Pulses, Sugar beet, Potatoes	Carrot, Fresh beans, Cabbage	Pome fruits, Stone fruits,

2) Cropping Plans and Pattern in the Regions

Existing rate of planted area to the cultivable area are 91~98 % in Sea Coast regions, and 78~81 % in Anatolia Highland.

To advance the rate of planted area to 100~110 % is possible in Marmara, Aegean and Mediterranean Sea Coast regions. Advancement of the rate of planted area will be achieved by the expansion of cultivated area of vegetables and industrial crops. The area of vegetables and industrial crops will be extended by early sowing of crops to utilize the rain water and soil moisture in early spring.

Harvesting time of wheat and barley in these area is earlier than central Anatolia. So, soiling crops must be introduced after harvesting the winter cereals. It can supply green fodder to livestock and will improve the soil fertility.

In Black Sea Region, as the region has much rainfall in summer season comparing with other regions, so, extension of the area of rice, maize, pulses and potato can be achieved and average yields of the crops will be improved by the intensive cultivation techniques.

In Anatolia Highland, existing rates of planted area to the cultivable area are 78~81 %, and fallow occupies 19~22 % of the cultivable area. The reason will be caused by the long days for growing and maturing of winter cereals and scarce rainfall in summer season. The average existing yield of winter cereals are remaining in levels of 1,950~2,200 kg/ha. Feed for livestock are also under insufficient condition. Expansion of planted area of pulses such as chick pea, dry beans and lentil should be planned at first to solve these situations. The rate of planted area will be raised to over 90 % by increasing the area of leguminous crops.

Cropping plans in the regions is shown in Table 5.1.3 and cropping plans in seven agro-ecological regions and existing and proposed cropping patterns are also shown in Annex Table C-19 and Fig. C-6.

Table 5.1.3 Cropping Plans in the Seven Agro-Ecological Regions (%)

Regions	Ex/Pr	Wheat	Barley	Winter C	Summer C	Pulses	Indust.	Oil	Tuber	Pastur.	Veget.	Fruit	Fallow	Total
Marmara	Ex	45.1	4.9	1.8	5.7	1.5	2.4	19.7	1.6	1.0	4.8	9.5	2.0	100
	Pr	43.0	5.0	2.0	8.0	3.0	4.0	20.0	4.0	2.0	8.0	11.0	0.0	110
Aegean	Ex	28.6	8.0	1.1	1.7	6.5	15.9	3.3	1.1	1.0	6.5	21.6	4.8	100
	Pr	30.0	8.5	1.5	4.0	8.0	18.0	5.0	2.0	3.0	8.0	22.0	2.0	112
Mediter.	Ex	44.5	5.7	0.6	4.1	4.7	10.5	3.6	0.7	0.1	6.7	9.4	9.3	100
	Pr	45.0	6.0	1.0	6.0	8.0	12.0	4.0	3.0	2.0	10.0	13.0	4.0	114
Black Sea	Ex	24.8	7.1	2.0	14.7	3.3	2.7	1.0	2.2	1.5	2.8	29.7	8.2	100
	Pr	27.0	8.0	2.0	17.0	5.0	4.0	2.0	4.0	4.0	5.0	31.0	4.0	113
Cent. N.	Ex	43.5	15.4	0.9	0.6	9.1	2.4	1.5	0.8	0.7	2.2	3.2	19.5	100
	Pr	42.0	15.0	1.0	2.0	14.0	3.0	2.0	1.0	2.0	4.0	4.0	10.0	100
Cent. S.	Ex	42.0	20.7	2.6	0.1	5.1	3.3	0.6	1.7	0.5	0.9	3.1	19.4	100
	Pr	42.0	19.0	2.3	1.0	9.0	4.0	2.0	3.0	2.0	1.7	4.0	10.0	100
Cent. E	Ex	46.2	10.4	1.3	0.8	6.0	3.9	1.5	2.0	1.1	1.9	3.3	21.7	100
	Pr	45.0	10.5	1.5	2.0	11.0	6.0	2.0	3.0	2.0	3.0	4.0	10.0	100
Total	Ex	39.6	12.5	1.5	2.8	5.9	5.5	3.5	1.3	0.8	3.2	9.6	13.7	100
Total	Pr	39.2	12.0	1.5	4.4	9.3	6.7	4.4	2.5	2.6	5.3	10.7	6.7	105.3

Note : Ex means existing cultivated area (%), Pr means proposed cultivation area (%). Existing cultivated area are statistics in 1994.

(2) Farming Plans

1) Cultivation Techniques and Target Yield of Main Crops

The average existing yields of crops are low in general, except some crops such as maize, sugar beet and dry onion. Low yields may be caused by the insufficient supply of water for the growth of crops, regression of soil fertility, low level of introduction of new varieties and cultivation by local varieties. Fertilizers are also used in low level.

Following techniques should be introduced to improve such a low productive conditions.

- Water-saved irrigation: Expansion of irrigated area and stable crop production by irrigation will be achieved by water-saved irrigation.
- Adequate use of chemical fertilizers: In irrigated area, adequate amount of chemical fertilizers are requested to get high and stable production.
- Improvement of soil fertility: Introduction of leguminous crops, use of organic matter, compost, by-product and inorganic soil amendment
- Introduction of new varieties: Increasing the area of resistant varieties for coldness and drought, high quality varieties, F-1 varieties

Target yields of main field crops under irrigated conditions and new techniques are shown in Table 5.1.4 with means for acquiring the high yields and existing and target yields of main crops in the Seven Agro-Ecological Regions are shown in Annex Table C-20.

Table 5.1.4 Target Yields and Means for High Production of Main Crops

Crops	Means for High Yields	Target Yields (kg/ha)
Wheat	Irrigation, Soil fertility, New varieties for high quality	3,500~4,300
Barley	Early sowing, Selection of variety	3,700~4,300
Maize	Selection of variety, Irrigation, Fertilization	4,500~7,500
Pulses	Early sowing, Extension of area as summer crops	1,200~2,000
Sugar beet	Irrigation and Fertilization	55,000~70,000
Sunflower	Irrigation and Fertilization in Marmara Region	1,500~2,500
Tuber Crops	Spring & Autumn Cropping, Fertilizing of potassium	25,000~40,000
Vegetables	Selection of high qualitative varieties, Irrigation, Classification of products by freshness, size and quality	
Fruits	Production of high quality fruits by introducing new varieties, Irrigation	
Pasture	Mix sowing of alfalfa with grasses to reduce the harvesting loss, High yield by irrigation	20,000~25,000

2) Value Adding of Agricultural Products

The sales value of agricultural products can be added by careful selection and classification of products by freshness, size and quality especially in vegetables and fruits.

Processing of agricultural products will also heighten the value of products and it makes the products possible to store for long period, and can utilize the labors in the country.

3) Promoting the Integrated Agriculture

For the development of small scale farm household, integrated agriculture should be promoted. It means to change their cultivation from the single cropping of winter cereals such as wheat and barley to diversified cropping systems by the effective use of summer field with high productive and high income crops. It also means to progress the matter cycle among crops production and animal breeding section. It can utilize the by-products of both sections and can reduce the cost of production.

4) Development of Livestock Husbandry

Produced meat in Turkey are insufficiently supplied to the nation and meat are imported from other countries in recent years. The development of livestock husbandry is very important for the stable supply of animal products to the nation. Many problems such as breeding of livestock, increase of artificial insemination, increase of production of fodder crops should be dealt successfully with livestock and feed.

On the feed problems, followings should be developed for the stable supply of fodder crops to livestock ;

- Increase of the yield of fodder cereals such as barley, oats, rye and maize by sowing in optimum season and high yielding varieties.
- Increase of yield of alfalfa by irrigation.
- Grazing capacity of natural grassland should be heightened effectively by the control of over grazing and grazing in sprouting time of young leaves.

- Introduction of soiling crops after harvesting the winter cereals and early harvested vegetables.

5) Development of Horticulture

There are over 2,000 ha of green houses and over 6,700 ha of vinyl houses in Marmara, Aegean and Mediterranean Sea Coast regions in 1991. Main products are fruit vegetables such as tomatoes, egg plant, cucumber and green pepper. The cultivation by houses are increasing by years and also will be increased in future in mainly in the Sea Coast regions.

Vegetables are sufficiently produced for the nation. For the development of export of vegetables, improvement of quality by the introduction of new varieties and careful selection and classification of products by quality, size and freshness will be requested.

For the development of fruit production, improvement of varieties, introduction of new varieties and irrigation facilities should be proposed to get high productivity and high quality of fruits.

Ornamental crops are planted mainly in Aegean and Mediterranean Sea Coast regions. Planted area must be enlarged both in green house and field with irrigation facilities.

5.1.3 Strengthening of Agricultural Supporting Services

(1) Strengthening of Agricultural Extension Service

For the development of irrigation project, it is necessary to strengthen the agricultural extension service to farmers. Crop production could be increased by irrigation and intensive management to crops. Water-saved irrigation, irrigation in suitable stage of crops and selection of promising crops for irrigation are requested to rise the effect of irrigation and to enforce the irrigation projects in the study area.

(2) Strengthening of Farmer's Organization

Irrigation projects should be carried out under the organization of farmers relating with irrigation. Farmer's organization must be strengthened especially in the newly developed irrigation projects.

5.2 Irrigation Plan

A master plan related to small-scale irrigation is formulated in line with the agricultural development plan mentioned above in Chapter 5.1. The formulation starts with estimation of crop water requirement, calculated by Modified Penman method, to realize the cropping patterns and cropping intensities programmed. The estimation refers to the cropping patters of 7 agro-ecological zones and is made on a provincial basis since rainfall consumed by crop varies widely.

Net required irrigation water would be estimated, based on the crop water requirement, by undertaking the amount of effective rainfall. The estimation is to be made on a monthly basis and such droughts with probability of one in 5 and 10 years will also be taken into consideration. The net irrigation water will then be converted into gross requirement taking into consideration the losses incurred in delivering of irrigation water and its on-farm application. The gross requirement will be summarized in accordance with the prospected water sources such as dam reservoir, surface (weir) and groundwater, and the development will be formulated within the framework of the implementation schedule.

An improvement of irrigation practice will also be presented with respect to delivering of irrigation water, application of modern irrigation method where practical, reduction of irrigation losses, and introducing night storage reservoir to regulate lags between water demand and its supply. Water users association, composed of the beneficiaries, will play a key role in utilizing scarce water source as well as practicing effective irrigation. The role and responsibility are clarified and the organizational set-up are presented with regard to the present practice in groundwater irrigation.

5.2.1 Crop Water Requirement

(1) Reference Crop Evapotranspiration

For calculation of crop water requirement, the modified Penman method usually gives the most satisfactory results under the condition that such measured data are available as temperature, humidity, wind and sunshine duration, compared to other methods such as Blaney-Criddle method, Radiation method and Pan evaporation method.

Though Blaney-Criddle had been mostly used in Turkey, the method is now being replaced by the modified Penman method. In this Study, the modified Penman method is used in estimating reference crop evapotranspiration (ETo) with reference to the past mean data given by General Directorate of State Meteorology. The equation is shown below, and the calculation is made on a provincial basis.

$$ETo = C\,[\,W \times Rn + (1-W) \times f(u) \times (ea-ed)\,]$$

Where:
- ETo = reference crop evapotranspiration, mm/day
- W = temperature related weighting factor
- Rn = net radiation in an equivalent evaporation, mm/day
- f(u) = wind related function
- (ea-ed) = difference between the saturation vapour pressure and the mean actual vapour pressure, mbar
- C = adjustment factor for day/night weather condition

The provincial based reference crop evapotranspirations (ETo) are detailed in ANNEX E-5. Table 5.2.1 shows summarized annual ETos based on the 7 agro-ecological zones:

Table 5.2.1 Agro-Ecological Zone Based Annual ETo

Agro-Eco. Zone	Min ETo, mm	Max ETo, mm	Average*, mm	No. of Provinces
Marmara	874	1072	974	8
Aegean	1069	1402	1226	9
Mediterranean	1175	1430	1306	5
Black Sea	737	952	858	13
Central Northern	809	1129	984	11
Central Southern	987	1238	1123	7
Central Eastern	923	1035	936	3

*: Weighted by service area of each province.

Minimum annual ETo shows up in Black Sea zone with 737mm, while the maximum in Mediterranean zone with 1430mm. The average ETo, weighted by service are of each province, ranges between 846 and 1300 mm, and tends to increase from north to south due to warm climate and long sunshine duration.

(2) Crop Evapotranspiration

Crop evapotranspiration (ETcrop) is calculated by multiplying crop coefficients (Kc) by the ETo. The crop coefficients (Kc), correspondent to the crops presented in Chapter 5.1, are decided as shown in Table 5.2.2 with regard to the ones used in Turkey and in FAO Irrigation and Drainage paper No. 24:

ETcrop = Kc x ETo

Where: ETcrop = crop evapotranspiration, mm/day
Kc = crop coefficient
ETo = reference crop evapotranspiration, mm/day

Table 5.2.2 Representative Crop Coefficients Kc

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
Wheat	1.20	1.21	1.25	1.38	1.45	1.05	0.36			0.37	0.85	0.94	
Barley	1.20	1.21	1.25	1.38	1.45	1.05	0.36			0.37	0.85	0.94	
Maize					0.56	0.80	0.91	0.92	0.68				
Paddy					2.11	2.35	2.87	2.61	2.14				
Beans				0.34	0.54	0.55	0.77	0.60					
Sugarbeet				0.44	0.48	1.35	1.25	1.25	1.22	1.00			
Sunflower				0.30	0.31	0.38	1.19	0.43	0.32				
Cotton					0.76	0.88	1.27	1.16	0.44	0.35			
Vegetable				0.42	0.64	0.82	0.76	0.52	0.64	0.82	0.76		
Orchard				0.68	0.72	0.80	0.81	0.79	0.74	0.68			
Cloverfeed					0.87	0.96	0.96	0.94	0.78	0.62			
Others				0.79	0.83	1.09	1.10	1.16	0.79				Ex. Tobacco

The crop evapotranspiration (ETcrop) is calculated crop by crop with regard to the Kc (summarized in ANNEX E-7 on basis of 7 agro-ecological zones).

5.2.2 Effective Rainfall

The water, needed for the proposed crops, is partially provided by rainfalls. The crops do not use all the rainfalls provided since part of the rainfalls become surface runoff and infiltrate down below the root zone. The rainfalls, consumed by the crops, are therefore called effective rainfalls. There are several methods for estimating the effective rainfall, among which the following USBR method is very conventional in computer calculation and is used in Turkey. The method described below is applied in this Study:

RFeff = RF x (125 - 0.25・RF) / 125 .... RF less than or equal to 250mm

Where: RFeff = effective rainfall, mm
RF = rainfall, mm

Rainfall probability should also be taken into consideration. Meteorological data usually tend to have a bias in their distribution, therefore Log-Pearson Type III Distribution is employed in calculating such probabilities as 50 % (once in every 2 years), 80 % (once in every 5 years), and 90 % (once in 10 years). The rainfall is firstly calculated on a provincial basis, and then weight-averaged in the 7 agro-ecological zones by the service areas of the provinces. ANNEX E-6 details the provincially based result, and an example with 50 % probability in Ankara is presented in the following Figure 5.2.1. Also, illustrated in Table 5.2.3 to 5.2.5 below are the agro-ecological zones based on annual rainfalls with the weight-averaged ones by those service areas:

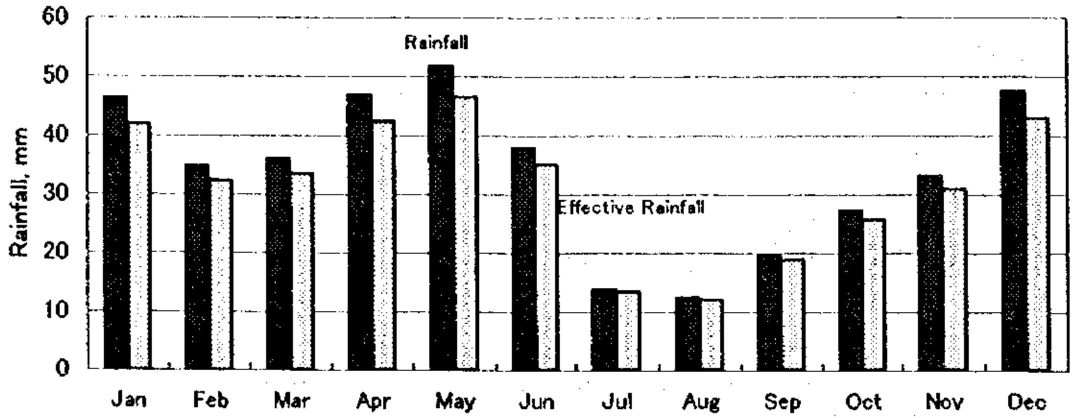


Figure 5.2.1 Rainfall in Ankara with 50% Probability

Table 5.2.3 Agro-Ecological Zone Based Rainfall with 50% Probability

Agro-Eco. Zone	Annual Rainfall, mm			Annual Effect. Rainfall, mm			No. of Provinces
	Min.	Max.	Average	Min.	Max.	Average	
Marmara	562	820	611	499	700	535	8
Aegean	403	1179	613	370	792	505	9
Mediterranean	572	1113	766	479	828	600	5
Black Sea	380	2150	685	351	1333	586	13
Central Northern	368	617	470	341	511	420	11
Central Southern	325	412	342	304	377	318	7
Central Eastern	414	450	418	379	410	383	3

Table 5.2.4 Agro-Ecological Zone Based Rainfall with 80% Probability

Agro-Eco. Zone	Annual Rainfall, mm			Annual Effect. Rainfall, mm			No. of Provinces
	Min.	Max.	Average	Min.	Max.	Average	
Marmara	479	729	525	435	634	468	8
Aegean	340	962	511	316	684	434	9
Mediterranean	447	893	592	391	709	495	5
Black Sea	318	1954	593	298	1257	518	13
Central Northern	303	516	402	285	443	366	11
Central Southern	255	353	282	241	328	265	7
Central Eastern	357	388	361	331	359	335	3

Table 5.2.5 Agro-Ecological Zone Based Rainfall with 90% Probability

Agro-Eco. Zone	Annual Rainfall, mm			Annual Effect. Rainfall, mm			No. of Provinces
	Min.	Max.	Average	Min.	Max.	Average	
Marmara	429	685	484	395	602	436	8
Aegean	313	869	467	292	643	403	9
Mediterranean	396	804	525	352	655	446	5
Black Sea	290	1866	550	273	1230	485	13
Central Northern	275	471	371	260	419	341	11
Central Southern	220	327	255	210	305	242	7
Central Eastern	333	356	336	311	332	314	3

5.2.3 Irrigation Efficiency

Irrigation efficiency should be accounted in calculating the total irrigation water requirement of the Project. The efficiency is normally sub-divided into three stages as follows:

- ***Conveyance efficiency (Ec):***
  Ratio between water received at the inlet of an irrigation block and that in-taken at the Project headwork; namely, conveyance efficiency subject to the main canal starting at the water source(s) and the branch canals within the Project area but excluding on-farm canals.

- ***Field distribution efficiency (Ed):***
  Ratio between water received at the inlet of an irrigation block and that received at the outlet usually installed at a sub-divided irrigation block; namely, distribution efficiency subject to on-farm canal or distribution pipe in the irrigation block.

- ***Field application efficiency (Ea):***
  Ratio between water directly available to the crops and that received at the outlet of the sub-divided irrigation block, depending upon irrigation scheme to be applied, experience of the farmers, soil condition and climate.

In this Study, each efficiency is studied with reference to the field condition, and project efficiencies, corresponded to irrigation type, will be proposed. The project efficiency will be applied to individual irrigation project, and a comprehensive efficiency is to be proposed for the purpose of estimating the total irrigation water in the Master Plan.

(1) Conveyance Efficiency

FAO Irrigation and Drainage Paper No. 24 indicates the efficiency to be 0.9 in case of continuous supply with no substantial changes in flow. Canals undertaken in this Study are to be concrete-lined, and night storage of water will be introduced as required in order to reduce the irrigation losses. The conveyance efficiency, applied to open canal with surface or dam project, can therefore be expected to be high, thus 0.90 is applied as suggested by FAO.

There are some cases in which closed pipeline system is employed, starting at the outlet of the project headwork, even for dam or surface irrigation project. This system usually applies to closed irrigation systems such as sprinkler and drip irrigation but not to basin and furrow irrigation. In this case, efficiency is expected to be higher than open canal's, and efficiency 0.95 is applied.

Since conveyance canals for groundwater are of relatively short length compared to other surface or dam related projects, higher efficiency can be reasonably expected. This Study adopts 0.95 of conveyance efficiency in case of lined open canal associated with groundwater irrigation, and no loss is accounted, namely 1.00 efficiency, in such case that the groundwater is directly provided to crop through piped system.

(2) Field Distribution Efficiency

While FAO Paper No. 24 suggests an efficiency of 0.90 in both cases of lined and piped irrigation, higher efficiency has been mostly applied to the latter case of piped irrigation. With the complete set of distribution pipeline network in the field, the field distribution losses are supposed not to be high, therefore an efficiency of 0.95 is employed in case of sprinkler and drip irrigation. The efficiency of lined distribution canal remains as suggested by FAO; namely, 0.90.

(3) Field Irrigation Efficiency

Field irrigation efficiency largely depends on the irrigation schemes practiced by farmers. There are schemes several as basin (flood) irrigation, furrow irrigation, sprinkler and drip irrigation. The first two schemes, categorized into surface irrigation, usually undertake lower efficiency than the last two. The following table presents efficiencies commonly adopted in many of the irrigation related studies.

Table 5.2.6 Field Irrigation Efficiencies

Scheme	Efficiency	Remarks
Basin irrigation	0.60 - 0.80	FAO No.24 Paper
Furrow irrigation	0.55 - 0.70	FAO No.24 Paper
Sprinkler irrigation	0.75 - 0.85	Commonly employed
Drip irrigation	0.85 - 0.90	Commonly employed

In case of basin irrigation, the lowest efficiency of 0.60 among the above range of 0.60 to 0.80 is to be applied since the Study area's fields fall mostly in hilly areas, thus making difficult to attain high efficiency. Furrow irrigation's efficiency is to be 0.65 with reference to the range indicated above.

With strict water application and management, such efficiencies are known to be attainable as high as 0.85 for automated sprinkler and 0.90 for drip irrigation. However, farmers concerned in this Study are not familiar to the schemes and also the sprinkler is to be mostly hand-move type. Therefore efficiencies of 0.75 and 0.85 are applied in cases of sprinkler and drip irrigation respectively.

(4) Project Irrigation Efficiency (Ep)

Project irrigation efficiency means the ratio between water made directly available to the crops and that in-taken at the Project headwork; namely, the ratio is calculated by multiplying the aforementioned three efficiencies as Ep = Ec x Ed x Ea. The project efficiencies are calculated and summarized as follows:

Surface and Dam Irrigation with open canal conveyance:

Basin:	Ep = 0.90 x 0.90 x 0.60 = 0.49
Furrow:	Ep = 0.90 x 0.90 x 0.65 = 0.53
Sprinkler:	Ep = 0.90 x 0.95 x 0.75 = 0.64
Drip:	Ep = 0.90 x 0.95 x 0.85 = 0.73

Surface and Dam Irrigation with closed pipeline conveyance:

Sprinkler:	Ep = 0.95 x 0.95 x 0.75 = 0.68
Drip:	Ep = 0.95 x 0.95 x 0.85 = 0.77

Groundwater Irrigation:

Basin:	Ep = 0.95 x 0.90 x 0.60 = 0.51
Furrow:	Ep = 0.95 x 0.90 x 0.65 = 0.56
Sprinkler:	Ep = 1.00 x 0.95 x 0.75 = 0.71
Drip:	Ep = 1.00 x 0.95 x 0.85 = 0.81

Table 5.2.7 Summary of Irrigation Efficiencies

Project Scheme	Basin	Furrow	Sprinkler	Drip	Remarks
Surface/Dam	0.49	0.53	0.64	0.73	Open Canal
Surface/Dam			0.68	0.77	Closed Pipeline
Groundwater	0.51	0.56	0.71	0.81	
Overall	0.60				For Master Plan

The efficiencies presented above will be applied to individual projects with reference to the irrigation type, and a conventional mean is applied in formulating the Master Plan since it is not practical to estimate each irrigation requirement for the long and short listed all projects. The Master Plan employs 0.60 as the overall efficiency since sprinkler system, currently only 5 % being employed, is becoming popular thereby leading to better efficiency.

5.2.4 Diversion Requirement

Net diversion requirement is estimated by subtracting the effective rainfall from the crop evapotranspiration. ANNEX E-7 presents the requirement corespondent to each crop, and an example, vegetables in North Central Zone under rainfall probability of 50%, is illustrated below:

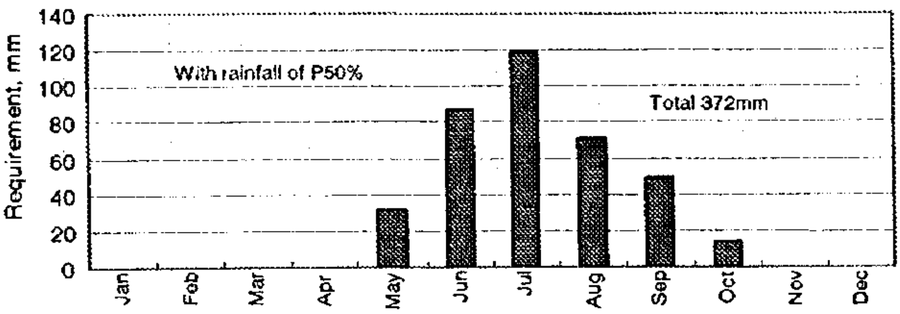


Figure 5.2.2 Diversion Requirement for Vegetables in C. Northern

Taking into consideration the area to be planted, total net diversion requirement is estimated and then gross diversion requirement with the irrigation efficiency of 0.6. These calculations are in ANNEX E-7 and summarized in Table 5.2.8 below for the annual amount:

Table 5.2.8 Diversion Water Requirement in '000CUM & mm

Agro-ecological Zone	Crop Area Gross ha	Probability 50%, '000CUM		Probability 80%, '000CUM		Probability 90%, '000CUM	
		Net	Gross	Net	Gross	Net	Gross
Marmara	3,126	12,148	20,246	12,699	21,166	12,980	21,633
Groundwater	546	2,122	3,536	2,218	3,697	2,267	3,779
Surface	794	3,086	5,143	3,226	5,376	3,297	5,495
Dam	1,786	6,940	11,567	7,256	12,093	7,416	12,360
Aegean	16,783	90,748	151,247	93,989	156,648	95,445	159,075
Groundwater	6,167	33,346	55,576	34,537	57,561	35,072	58,453
Surface	5,871	31,745	52,909	32,879	54,798	33,388	55,647
Dam	4,745	25,657	42,761	26,573	44,288	26,985	44,975
Mediterranean	15,096	77,798	129,663	81,072	135,120	82,537	137,561
Groundwater	1,286	6,627	11,045	6,906	11,510	7,031	11,718
Surface	6,820	35,145	58,575	36,624	61,040	37,286	62,143
Dam	6,991	36,026	60,043	37,542	62,570	38,220	63,701
Black Sea	17,526	41,910	69,850	45,504	75,841	47,255	78,758
Groundwater	3,177	7,598	12,663	8,249	13,749	8,567	14,278
Surface	13,676	32,705	54,509	35,510	59,184	36,876	61,461
Dam	672	1,607	2,678	1,745	2,908	1,812	3,020
Central Northern	17,961	70,904	118,173	73,968	123,280	75,486	125,810
Groundwater	2,180	8,606	14,343	8,978	14,963	9,162	15,270
Surface	11,660	46,030	76,716	48,019	80,032	49,004	81,674
Dam	4,121	16,268	27,114	16,971	28,286	17,320	28,866
Central Southern	38,336	199,240	332,067	208,179	346,966	212,560	354,267
Groundwater	16,053	83,431	139,051	87,174	145,290	89,008	148,347
Surface	14,927	77,579	129,298	81,059	135,099	82,765	137,942
Dam	7,356	38,231	63,718	39,946	66,577	40,787	67,978
Central Eastern	15,020	59,547	99,245	61,886	103,144	62,946	104,910
Groundwater	774	3,069	5,114	3,189	5,315	3,244	5,406
Surface	13,064	51,792	86,320	53,827	89,712	54,749	91,248
Dam	1,182	4,686	7,810	4,870	8,117	4,954	8,256
Total in '000CUM	123,847	552,294	920,490	577,298	962,164	589,209	982,015
Total in mm		446	743	466	777	476	793
Percent to P50%		100	100	105	105	107	107

In summary, all of the long and short term listed projects, which total service area is 123,847ha, require a total diversion requirement of 920MCM (743mm), 962MCM (777mm), and 982MCM (793mm) in gross under the condition of rainfall probability of 50%, 80%, and 90% respectively. Although the requirement increases as rainfall becomes less, the requirement does not increase much, showing 105% for P80% and 107% for P90% to P50% requirement. This can be explained by that the requirement shows up mostly during dry season (summer season), the rainfall of which is very limited, thereby less affecting the requirement despite the probability.

5.2.5 Diversion Potential

Diversion potential is assessed in each agro-ecological zone, with which potential if the diversion requirement, estimated in Chapter 5.2.4, can be secured well or not is confirmed. The diversion potential is assessed by river runoff discharge derived from the catchment area given in the long list and rainfall. However, since the long list often lacks the data, this assessment is to be preliminary and should give a comprehensive estimation whether the diversion requirement could be secured or not in terms of the agro-ecological zone based overall balance. The methodology is briefed in the following:

(1) To calculate total catchment area of each agro-ecological zone and weight-averaged rainfall in the zone, and to work out the runoff discharge taking into account weight-averaged runoff coefficient,

(2) To calculate the balance between the runoff discharge and gross diversion requirement on monthly basis,

(3) In case of surface irrigation, to calculate the irrigable percent based on the runoff discharge, regarded as available diversion water for irrigation, on monthly basis, and takes the lowest percent as the critical irrigable percent which would mostly show up in July or August,

(4) In case of reservoir irrigation, to sum up all monthly minus balances calculated in item2 above, total of which is supposed to be provided by the reservoir, and to divide the total by the probable stored-water in the reservoir, regarded as the irrigable percent, the water of which is calculated by summing up the plus-balances calculated in item2 above and maximum of which should be the dam capacity,

(5) In case of groundwater irrigation, the irrigable percent is to be regarded 100% since irrigation areas have been sized taking into consideration the availability and the yield of groundwater.

Calculation based on the procedure above is shown in ANNEX E-7, and Table 5.2.9 summarizes the critical irrigable percents, showing up during summer season, with rainfall probabilities:

Table 5.2.9 Summary of Irrigable Percent in terms of Water Availability

Agro-ecological Zone	Crop Area Gross ha	Probability 50% Irrigable %	Probability 80% Irrigable %	Probability 90% Irrigable %	Remarks
Marmara	3,126	100	100	100	
Groundwater	546	100	100	100	
Surface	794	100	100	100	
Dam	1,786	100	100	100	
Aegean	16,783	92	91	90	
Groundwater	6,167	100	100	100	
Surface	5,871	100	100	100	
Dam	4,745	73	67	65	
Mediterranean	15,096	64	56	53	
Groundwater	1,286	100	100	100	
Surface	6,820	52	40	35	See note
Dam	6,991	69	63	61	
Black Sea	17,526	100	100	100	
Groundwater	3,177	100	100	100	
Surface	13,676	100	100	100	
Dam	672	100	100	100	
Central Northern	17,961	97	84	78	
Groundwater	2,180	100	100	100	
Surface	11,660	100	89	82	See note
Dam	4,121	86	63	54	
Central Southern	38,336	64	62	60	
Groundwater	16,053	100	100	100	
Surface	14,927	12	10	9	See note
Dam	7,356	91	85	79	
Central Eastern	15,020	22	20	19	
Groundwater	774	100	100	100	
Surface	13,064	10	9	8	See note
Dam	1,182	100	92	80	
Overall Percent	123,847	73	70	68	
Percent to P50%		100	95	92	

Note: Because of lack of catchment areas' data, these are not precise.

Table above reveals: 1) only Marmara and Black Sea zones yield enough diversion water throughout year to irrigate all service areas planned in the long and short listed projects, 2) surface irrigation hardly meets the required diversion water during summer season in such zones as Mediterranean (52-35%), Central Southern (12-9%), and Central Eastern (10-8%), and 3) the overall percents are 73%, 70% and 68% corresponding to rainfall probability of 50%, 80% and 90% respectively.

5.2.6 Improved Irrigation Practice

(1) Application of Sprinkler and Drip Irrigation System

The choice of appropriate irrigation system is very important from the viewpoint of not only making efficient use of irrigation water but also having economical irrigation facilities. In choosing the systems, consideration should be given to the type of crops, type of soils, topographic condition, operating labor requirement, available energy, farm size, investment and O&M costs, domestic marketability, and familiarity to the farmers.

There are such sprinkler systems as hand-move sprinkler called half-fixed sprinkler, hose-pull sprinkler, fixed sprinkler, side roll, center pivot and liner move. The following are the description of those systems including drip irrigation:

-Hand-move Sprinkler:

This type of sprinkler has been introduced in a number of irrigation project areas, and it is the most popular in Turkey. The laterals, on which sprinklers with intervals from 9 to 14 meters are mounted, are manually placed on the farm with interval from 9 to 14 meters. The laterals are manually connected to a buried pipeline, through which irrigation water is supplied. This system can be employed in a wide variety of soils and crops, and capital investment is low but it needs a high labor requirement. The high labor requirement leads to an application for restricted to small-scale farms and soils with relatively high moisture retention.

-Hose-pull Sprinkler:

It was recently developed in the Middle East in cooperation with FAO. A flexible hose has a riser pipe with the height of about 40 cm at its end, on which sprinkler is mounted. The sprinkler is manually moved from one place to next place by pulling the hose with an interval of required sprinkling hours. The system's applicability seems almost the same as hand-move sprinkler but probably less labor will be required. This system has not yet been experimented in Turkey, and therefore an experimental farm may be required before introducing it to Turkey.

-Fixed Sprinkler:

Fixed sprinkler system is composed of buried main and sub-main pipelines and complete set of laterals placed on the farm. Following land preparation of the farm, the laterals are placed, covering all farm areas, and will have been operated until harvesting season comes. This system requires the highest capital investment per area and fairly number of temporary labor forces for laying down and removing the laterals.

-Side Roll Sprinkler:

Side roll sprinkler has a lateral that is moved by large diameter wheels. When moving in a farm from one position to the next position, the lateral must be once disconnected from the pressurized pipeline, and then again connected to the next outlet of the pipeline. The roll is usually powered by small engine mounted in the center of the roll. This system requires less labor force comparing to hand-move and hose-pull sprinklers, and is applicable to a middle scale farm. However the limited ground clearance, which is usually only between 1.2 and 1.5m, restricts irrigation of toll crops like maize.

-Center Pivot Sprinkler:

Center pivot is an automated irrigation system and one of the most attractive systems for large-scale farms. The lateral system is moved by rotating its line in a circle about one end as the pivot. The application rate is adjusted to compensate for different rates of travel along the line. The wheels are usually powered by small motors mounted on each wheel, and designed to produce a rate of travel proportional to the distance from the pivot.

-Linear Move Sprinkler:

The structure of linear move sprinkler system is very similar to that of center pivot, but the lateral is not fixed to a pivot. The lateral moves in a straight line over rectangulary shaped land parcels. The system can cover the entire parcel by moving the lateral without leaving the corners as in the case of center pivot. The irrigation water is usually lifted from an open field channel by mounted feeding machine and boosted into the lateral. This open channel restricts the application of the system to a land with slope exceeding 1 %.

–Drip Irrigation:

Drip irrigation, also referred to as trickle irrigation, consists of an extensive network of pipes usually of small diameter that deliver filtered water directly to the soil near the plant. With this system, irrigation water can be applied very efficiently, often with 90% application efficiency, to small trees and widely spaced plants, where adequate water can be placed in the root zone without wetting the soil where no roots exist. It is also well known that using drip irrigation produces greater crop yields and better quality. Fruits containing considerable moisture when harvested respond well to drip irrigation. However, there are such potential problems as clogging of the emitters, requiring well-designed filter system.

According to the stated above, this Study proposes hand-move sprinkler for the improved irrigation system. The system requires the least initial cost affordable for small-scale farmers. Also recommended is drip irrigation where valuable fruits are grown. It should be stressed that economic and financial aspects should be evaluated before introducing these systems to any project.

(2) Night Storage

Water delivery system is usually operated for 24 hours a day to convey the required water, while on-farm irrigation is limited to less than 24 hours. Farmers are generally said to practice their farming between 8 and 20 hours a day with its maximum in peak periods.

Therefore, storing facility would be required in order to reduce unexpected runoff occurring during nighttime. The storage is proposed in a reservoir, made of concrete lining or impervious soil material, to be placed at each irrigation unit with the capacity of a couple of hours storage. The storage capacity is calculated as follows in a case of 20 hours working, and the application will be studied in each case taking into consideration the delivering system and its size, available land for the storage, and farmers' practice:

$$V = ETcrop / (Ed \times Ea) \times 10 \times A \times 4/24$$

Where:
- V = capacity of storage reservoir, cum
- ETcrop = crop water requirement, mm/day
- Ed = field distribution efficiency
- Ea = field irrigation efficiency
- A = command area of storage reservoir, ha
- 4/24 = eight hours storage a day

(3) Rotational Irrigation Practice

Rotational irrigation must be employed for conventional sprinkler in order to economize the irrigation facilities. An interval of four to seven days, in general, has mostly been practiced depending upon season, crops and available workforce.

1) Estimation of TRAM

Design irrigation interval is calculated based on the total readily available moisture, so-called TRAM. TRAM is obtained by dividing the available moisture in the important soil layer by the value of soil moisture extraction pattern (SMEP) in that layer, and is given as follows:

TRAM = (fe - Ml) D / Cp

Where: fe = field water holding capacity in volume ratio, %
Ml = wilting point in volume ratio, %
D = thickness of important soil layer, mm
Cp = SMEP in the important soil layer, %

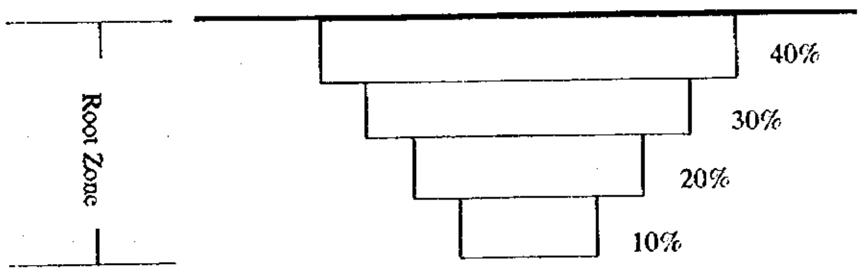
Field water holding capacity represents the water content at which the moisture level in the soil begins to remain relatively constant. The capacity is therefore defined as the water that remains in the soil after the soil has drained to a deeper water table.

Wilting point has been the moisture content at which plants permanently started wilting. It was usually defined as the water content at a capillary pressure of pF 4.2. However, the wilting point is now often regarded as the depletion of moisture content against optimum growth than that of starting permanent wilting in order to achieve not only optimum yield but also with good quality. The pF value of affecting the yield as well as quality is said to start at 3.5 to 3.8.

The moisture difference between fe and M1 is defined as available moisture content, and this is usually decided by a pF curve test. However, this Study refers to the values quoted in Table 5.2.10 below, which are commonly used over the world, since no specific test has been carried out in this Study.

Important soil layer is included in effective soil layer, and dominates moisture consumption of crops. In other words, moisture condition in this layer directly influences the growth of crops, yield and quality. Therefore, it is the layer with the smallest TRAM to be calculated from the available moisture and SMEP. If the soil is formed with layers, the important layer can be estimated by observing the layer, while in case the soil within root-zone is homogeneous, the important layer lies as low as 20 cm from the surface in most cases. The latter case is applied to this Study for presenting representative TRAM.

The moisture decrease in effective soil layer is not uniform, and generally follows the model on the figure below. SMEP is the ratio of moisture decrease in each layer to the whole effective soil layers. Although SMEP varies with crops, soils and growing stages, Shockley suggested a conventional pattern of 40, 30, 20, and 10 % in a descending order from the surface layer. This Study refers to the pattern and Cp is therefore 40 %.



The following table calculates the TRAM which corresponds to a soil condition represented by the texture. The TRAM calculated varies between 20 mm and 115 mm, and this should be taken as an example since this was estimated based on general usage:

Table 5.2.10 Calculation of TRAM

Texture	Available Water, %	SMEP, %	D, mm	TRAM, mm
Sandy	8 (6-10)	40	100, 200	20 - 40
Sandy Loam	12 (9-15)	40	100, 200	30 - 60
Loam	17 (14-20)	40	100, 200	43 - 85
Clay Loam	19 (16-22)	40	100, 200	48 - 95
Silty Clay	21 (18-23)	40	100, 200	53 - 105
Clay	23 (20-25)	40	100, 200	58 - 115

Note: Figure in ( ) means the range.

2) Irrigation Interval

Design irrigation interval is calculated by dividing TRAM by maximum daily consumption of irrigation water. The maximum daily consumption appears in summer with about 6 to 9 mm/day. Therefore, irrigation interval is calculated in the following:

Table 5.2.11 Calculation of Irrigation Interval

TRAM, mm	Max. Consump.,	Interval, days	Remarks
20 - 40	6 - 9	3 - 7	Sandy
30 - 60	6 - 9	3 - 10	Sandy Loam
43 - 85	6 - 9	5 - 14	Loam
48 - 95	6 - 9	5 - 16	Clay Loam
53 - 105	6 - 9	6 - 17	Silty Clay
58 - 115	6 - 9	6 - 19	Clay

With reference to the above table, an interval of once or twice a week would be recommended in practicing sprinkler irrigation, depending upon the soil condition. Also notified is that the intervals have to be studied based on a pF test result when designing individual project.

5.2.7 Water Users Association

(1) Irrigation Advisory Services

Farmers are expected to establish water users association (WUA) in order to well-maintain the irrigation system and to practice their farming on a cooperative basis. In organizing and legalizing WUA, an orientation shall be given to the farmers. Also, an advice and training for operating the on-farm irrigation facilities will be called by the farmers, as needs arise, since they are little familiar to irrigation agriculture.

Those tasks will require new section within GDRS offering such major services:1) to facilitate and assist WUAs in establishing, maintaining and managing their own organizations for improving irrigation system performance, and 2) to assist WUAs in planning, designing, implementing, operating, maintaining and managing the improved irrigation technology and the adoption of improved water management technologies.

The new organization is temporary called "Irrigation Advisory Services (IAS)" which will be under the Department of Irrigation or otherwise newly established as a department. The conceptual structure of IAS is proposed below:

Irrigation Advisory Services

- Section 1: Formation of WUA
- Section 2: Training of WUA
- Section 3: Monitoring & Evaluation

The Services is composed of three sections; namely, 1) Formation of WUA, 2) Training and 3) Monitoring & Evaluation. "Formation of WUA" gives orientation of the procedure of forming WUA and help WUA to be legalized. "Training" gives farmers technical assistance relating to sprinkler and drip irrigation. "Monitoring & Evaluation" monitors and evaluates farmers' improved irrigation and feedbacks the outcome in collaboration with "Training" section. The Services is headed by the Head and three section directors.

Same function of this Services will be established in each Regional Office. A Regional Office supervises a district office that will be in charge of contacting farmers. Contact with farmers is to be made by district officers, dealing with irrigation or field agents who are employed and trained by the officers.

(2) Water Users Association

A group shall be formed in operating and maintaining the irrigation system. The group, called Water Users Association (WUA), will be established at each irrigation system, mostly at village level, comprising of farmers who will benefit. Besides operating and maintaining the irrigation system, the following major roles are assigned to WUA:

- To develop and implement operational plans for irrigation schedule and regular facilities maintenance,
- To improve water use management through improved irrigation schedule and other useful irrigation practices,
- To develop roles and responsibilities of the WUA's members and local rules for resolving water-related conflicts,
- To develop and maintain close coordination and good working relationships with organizations for essential services such as banks, equipment firms, public and private lessor, local village councils, and GDRS as well as agriculture extension services, and
- To develop and maintain an official and functional information linkage with GDRS.

In order to give financial arrangement to WUA and other inducements to the formation of WUA, a specific legislation may be required. The legislation would specify the rights, roles and responsibilities as well as limitation of both GDRS and WUA, thereby enabling WUA to buy and sell goods and property, to make contracts, to mobilize resources, to obtain credit from financial institutions as a legal entity and to enter into their own business activities.

The WUA, proposed in this Study, is firstly referred to the associations currently operated, and then some new arrangements are to be introduced. These new arrangements are to 1) assign women representative(s) and 2) invite scheme manager from GDRS provincial office. The organizational structure is illustrated below:

Chairman

Vice Chairman

Treasurer **General Meeting**

Members (2)

Women Representative (newly proposed)

Scheme Manager (newly proposed)

The Chairman is responsible for his/her irrigation system and is to supervise the members' water use, rotational irrigation practice among the members, and be responsible for inspecting the irrigation system in collaboration with the vice chairman. The Vice chairman is responsible for performing administrative works related to the association, recording the works and resolutions of the meeting, and notifying the irrigation-related-authority with the resolutions of the meeting. The Treasurer is responsible for collecting and bookkeeping such fees as maintenance of the system, replacement cost to be required in future, and so on.

Since women are not tending to stand for committee members, a women representative(s) is to be especially appointed, expecting future women's own initiative. The scheme manager is an advisor from GDRS district office and invited by the committee. This manager will work for the sake of the farmers in terms of irrigation practices, and should not have any right in any voting.

A pump attendant is required in case of pump irrigation system. Although it is desirable that the attendant is from the members, it may be difficult to find out a person with certain mechanical knowledge. In case the attendant can not be found among the members, the association will make necessary arrangement to train a member in coordination with Irrigation Advisory Services.

The general meeting, with the presence of all members, will be convened annually or as required in order to elect the representatives, audit the account, decide the fees required, discuss and fix cropping patterns within a year, and rule rotational irrigation among the members. There is a unit, which is currently practiced, called Control Unit that oversees the activities of the representatives of WUA. This unit should remain unchanged with the same structure composed of a Head and two members.

5.3 Drainage Plan

5.3.1 Future Drainage Work by GDRS

Long and short lists had identified 51 drainage projects with a total service area of 26,890ha. The lists indicate that drainage projects are relatively large in scale with the area reaching to more than 1,000ha as represented by ones in Adana, Samsun and Antalya regions. Table 5.3.1 below is a summary of drainage projects shown in the lists (For more detail, see ANNEX E-12).

Table 5.3.1 Summary of Drainage Projects

Region	No. of Project	Service Area, ha	No. of Farmers	Cost MTL	Area per Project	Area per Farmer	Cost per ha, MTL
Ankara	15	2,927	1,394	501,201	195	2.10	171.26
Konya	2	639	NA	5,435	320	NA	8.51
Adana	2	2,504	6,580	12,780	1,252	0.38	5.10
Sivas	17	6,089	220	4,262	358	27.68	0.70
Trabzon	1	24	60	1,368	24	0.39	58.21
Samsun	4	8,779	16,012	363,108	2,195	0.55	41.36
Kastamonu	7	553	464	218,844	79	1.19	395.74
Antalya	3	5,376	3,550	1,039,143	1,792	1.51	193.31
Total	51	26,890	28,280	2,146,141	527	0.95	79.81

Those drainage works are usually associated with reclamation projects which are to be implemented in wet and marsh areas, or otherwise planed in already opened areas by DSI. The drainage projects, planned in DSI opened areas, had been assisted by the World Bank under "A Core Program of Drainage and On-farm Development", which new phase is now under negotiation with the WB.

5.3.2 GDRS Drainage Work Implementation

Table 5.3.2 below summarizes past five years performance of drainage works by GDRS. The table shows GDRS has carried out a total of 318,756ha over the country as of the end of 1995, and the average annual opened area for the country is 2,784ha and the area for the Study area is estimated at about 2,200ha.

Taking into consideration the average annual opened area, the total project area of 26,890ha identified in short and long list would need about 12 years to complete. However, excluding the large scale drainage projects in Adana, Samsun and Antalya regions which could be assisted by the World Bank as were the case previously arranged, the remaining about 10,000ha could need four to five years only to be completed.

Table 5.3.2 Past Drainage Performance by GDRS

Year	1991	1992	1993	1994	1995	Remarks
Total Area, ha	308,466	309,822	316,300	317,163	318,756	For the State
Implemented Area, ha	3,634	1,353	6,478	863	1,593	For the State
Aver' Imp. Area, ha	2,784					For the State
For the Study Area	2,200					About 80% to the State

5.3.3 Drainage Design

This section presents general ideas of planning and designing drainage facilities. Drainage should be, at first, open-typed as was the case previously practiced, and buried pipe drainage system may be required in case of reclamation projects of wet lands and marsh areas in order to get water table lowered. There also may be a case for which water clogging problem appears associated with excessive seepage water incurred by irrigation, requiring not only open type drainage but also a buried pipe irrigation system.

Main drainage system, exclusively open drainage, will be aligned beside and in parallel to irrigation canal in case that the irrigation canal is aligned along counter line. The drainage will have one side command area. In case that irrigation canal is aligned perpendicular to the counter line, the open drainage will be aligned in the middle of the two irrigation canals.

Although on-farm drainage system can be open, piped or otherwise both types, the piped system should be constructed after recognizing that the open drainage only does not work enough for draining.

Open type drainage should be constructed in a form of unlined trench enough for draining of excessive groundwater, and have enough section for discharging not only drainage water but also excessive irrigation water which will be discharged into drain mostly during night time. The section, which can discharge the designed excessive groundwater, can usually be secured by setting the bottom deep enough for drawing groundwater. The amount of excessive irrigation water, which is discharged into drainage canal, is often designed to be about 20% of the total irrigation water.

In designing piped system, steady state flow equation, based on the following, is usually employed:

$$q = (8 \cdot K \cdot d \cdot h)/S/S + (4 \cdot K \cdot h \cdot h)/S/S$$

Where: q = discharge rate per unit surface area, m/day
h = hydraulic head above drain level midway between the drains, m
K = hydraulic conductivity, m/day
S = drain spacing
d = thickness of the so-called Hooghoudt's equivalent layer

In practical application, a limitation should be imposed on maximum and minimum drain spacing despite the theoretical spacing. A minimum spacing of 20-30m has mostly been employed in terms of economical point of view, and a maximum of 50-60m has been often claimed as a practical upper limit.

Concerning drain depth, groundwater table should be, in principal, kept below certain depth in order to keep aeration to the root zone. FAO Irrigation and Drainage paper No.38 suggests the following water table depth in meter below ground surface:

Field Crops:	1.0 m
Vegetables:	1.0 m
Tree Crops:	1.2 m

Drain depth is usually calculated by summing the design water table above, half the water table rise by the maximum individual recharge, and a residual hydraulic head of 0.1m. Assuming that the water table rise is 0.50 m, following drainage depths are worked out, and these are referred to as a reference in this Study:

Field Crops:	1.0 + 0.25 + 0.1 = 1.35 m
Vegetables:	1.0 + 0.25 + 0.1 = 1.35 m
Tree Crops:	1.2 + 0.25 + 0.1 = 1.55 m

Material for piped drain system is usually the corrugated perforated PVC pipe enveloped with synthetic filter if locally available, having about 80 mm diameter.

Collector drains are usually constructed with plain concrete pipes for inside diameters varying between 15cm and 40cm, and with reinforced concrete pipes for diameters of more than 40cm. In deciding the drainable area in accordance with the pipe diameter and slope, Wesseling worked out following equation taking into consideration 25 % reduction in area in order to allow for light sedimentation in the pipe (FAO Irrigation and Drainage Paper No. 9):

$$A = (1.91/q \times d)^{2.714} \times S^{0.57}$$

Where: A = drainable area under effective transport (ha)
q = discharge rate per unit surface area, mm/day
d = pipe inner diameter, cm
S = slope, %

5.4 Agricultural Infrastructure Plan

(1) Development Policy of Agricultural Infrastructure

According to the Seventh 5-year Development plan (1996~2000), development policy for rural infrastructure in the agricultural rural area is as mentioned below;

- To execute proper management and effective use of soil and water resources .
- To promote participation by the beneficiaries in public services to ensure improvement, operation, maintenance and management of investments.
- To accelerate land consolidation and on-farm development for increase in irrigation efficiency.
- To implement irrigation dams, power, drinking water supply and flood prevention measures.

Based on the above policy, following agricultural infrastructure development projects are being executed by GDRS with special considerations undermentioned.

- Giving Priority to the projects to contribute to the rural economy in short periods.
- Maximizing benefits from the area under irrigation, on-farm development and land consolidation.

1) Enlargement of irrigation land and to increase efficiency in irrigated area.

- Construction of Small dams, effective utilization of surface and ground water sources available, should be realized, especially, terminal irrigation systems by ground water, where wells are already constructed by DSI, should be developed in the early stage.
- Development of pipeline canal network to secure high water supply efficiency, and wide use of spray irrigation systems for water saving should be realized.
- Tendency of enlargement of irrigation land rendered by GDRS is 16,500ha in the last 5 years average, while 1,146,000ha of land is under irrigated in the whole country basis, of which 814,000ha is in the study area. Same or more quick program pace will be applied within the proposed budget.

2) On-farm Development

On-farm Development projects(OFD) are composed of several works and facilities such as land leveling, quaternary canals, drainage, reparcelling of farms plot and farm roads.

The works are either implemented independently or as integratedly with other works.

Developed area in the whole country and study area are 82,300ha and 70,400ha, respectively, while annual average of on-farm development area during the current 5-year period is 25,000ha.

3) Land Consolidation

Land consolidation includes rearrangement of farmland, improvement of irrigation and drainage, soil improvement, farm road construction and consolidation of farm plots as well as transfer of rights.

The development marked a sharp increase. About 70% of land are consolidated during the latest five years, and the total is 192,000ha in area. According to future plan by GDRS Irrigation Department, 280,000ha of land will be developed in the next decade from 1996.

4) Soil Conservation

Soil conservation project will be implemented for adequate management and utilization of soil resources.

Annual average conserved area in the country basis is 4,400ha in the latest 5 years. The project components are extension of afforestation and vegetation area, contour farming and construction of terracing to prevent soil erosion. Terracing work include to provide terrace land with irrigation and drainage canals and farm roads. All of soil conservation project in the long list have a same components as mentioned above.

5) Drainage Improvement

Drainage project is implemented for improvement of poor drainage condition in the irrigated area.

The area to be improved by the drainage project in future, is extended widely to the irrigated area without drainage system.

The subject area is estimated about 510,000ha.

6) Other Project

- Drinking water is so essential factor for village life. State and regional administration body gives priority to the project for drinking water. However, in the study area 17,000units are provided with unstable water sources. It is equivalent to 32% of the total village drinking water units of 54,000. High priority is given to the cities along the Black Sea drinking water facilities.

- Sewerage
  Sewerage problem is highlighted recently with following needs mentioned below.

- to maintain the quality of water sources for drinking and irrigation.
- to maintain the environment of River and Lakes from viewpoint of tourism and wild life.

It is not emerged as serious problems, because, most of villages are located far in a vast country area, but sewerage is concentrated along the River and Lakes. Sewerage will be taken place important problems in future.

- Village Road

  Village roads to be improved are tracks, and it is estimated 39,000km in length. Implementation priority will be given to the village roads in the underdeveloped regions such as Northern and Southeastern area of the country.

(2) Agricultural Infrastructure Development

Based on the results of long list analysis and 7th Five-year plan, the following projects and works will be implemented in the early stage. The works listed reflects the policy of 5-year plan, namely;

- The works contribute to well utilization of soil and water resources.
- The works contribute to upgrading of the village productivity and activities in the rural area through irrigated farming and on-farm development.

Same work types and share of project in the long list will be extended to building up the middle-term agricultural infrastructure development plan.

5.5 Maintenance and Management plan

(1) Soil and water Source Management

Soil and water resources developed by human beings is limited.

Due to the topographical, climatic and precipitation characteristics in Turkey, regional partialness of resource takes place. On the other hand, modern societies and industries want to use resources at marginal level of amount, unbalanced utilization of resource in water caused unusual phenomenon such as serious lowering of ground water table and deterioration of water quality. In order to avoid inadequate use of resources, following measures should be realized.

- Long term landuse plan and balanced wateruse plan.
- Sustainable development and operation plan from environmental aspect.
- Application of feed back process to establish reuse plans for resources by monitoring the flows of resources.

(2) Management Plan for Developed Facilities

1) Operation and maintenance of agricultural infrastructure

Agricultural infrastructures are comprised of various works and facilities such as water source facilities, irrigation/drainage canals, farm roads and terracing, etc. These are classified into two type of works from the managerial aspect; function management type and Operation management type.

Canal systems, roads and terracing belong to the former, while dams, weirs and pumps are operation management type.

The subjects of management for agricultural infrastructure are as follows;

- Maintenance program and collection of maintenance fee.
  Inspection and repair of facilities should be practiced with the maintenance program.
  Maintenance fee is comprised of repairing cost and repayment cost.
  Insufficient inspection and repairing result shortening of facilities life.
- Operation program and collection of O/M fee.
  The tasks for good operation of facilities are summarized below;
  a) To collect information needed for operation such as water levels, discharges, irrigation area etc.
  b) Employment of operators and inspectors and training of operational engineering technologies.
  c) To collect operation fee such as fuel expenses and electricity charges.

These management works should be carried out by beneficiaries themselves.

2) Management Organization

In order to Promote the participation by the beneficiaries into the public services, management organizations mainly composed of farmers should be established under the leadership of GDRS.

CHAPTER 6 IMPLEMENTATION PLAN

6.1 Project Target Year

Target years should be set up in implementing the projects identified in the long and short lists. The target years are to be designed with reference to the Seventh Five-Year Development Plan, as well as spanning medium and long run. This Study proposes the Years as below:

- Short-term target year (3 years): 1998 to 2000 (set within current Five-Year Plan)
- Medium-term target year (5 years): 2001 to 2005 (spanning next Five-Year Plan)
- Long-term target year (5 years): 2006 to 2010 (over the next Five-Year Plan)

Short-term covers three years; viz., starting in 1998, the following year of this Study's completion, and finishing at 2000 corresponding to the end of current Five-Year Plan. During this term, high-prioritized projects, mostly short-listed-projects, will be implemented. Medium-term is set over next Five-Year Plan (2001-2005), during which long-listed-projects will be put into the implementation according to those priorities. Long-term is also proposed, covering the following five years of 2006 - 2010, to accomplish the probable remaining long-listed-projects and to prepare for the new projects which would be showing up during the short and medium terms.

Though the target yeas above specify a term spanning certain period, it is proposed that the implementation program shall be of rolling plan especially after the completion of the short-term. Rolling plan moves, as an example, the medium-term from the original 2001-2005 to 2002-2006 upon completion and evaluation of the projects set during 2001, and the same is repeatedly conducted over again. This could facilitate the implementation of a project which at present is not applied by any farmers, thus neither long- nor short-listed, but would be applied with high priority during the implementation of originally programmed projects.

6.2 Project Prioritization

A criteria stipulating project prioritization should be prepared for implementing numerous projects in line with a budget ceiling within the framework of the target years. The projects are categorized into two; namely, short-listed and only long listed. In this Study, short-listed projects has exclusively higher priority than long listed ones, and the following are the criteria to be applied in prioritizing those listed projects:

(1) 30% weight to the project investment cost per area in case of long listed projects (EIRR, B/C ratio or net incremental benefit are not available), to the less of which the higher priority is given, or otherwise in case of short listed projects 20 % weight to the B/C ratio and 10 % weight to the net incremental benefit, to the higher of which the higher priority is given,

(2) 15 % weight to migration rate, substituted by population change, from the province where the project is located to other areas, to the higher rate of which the higher priority is given,

(3) 15 % weight to GDP per capita of the province where the project is located, to the less of which the higher priority is given,

(4) 10 % weight to the average size of farm holdings in the irrigation area, to the less of which (average farm size) the higher priority is given,

(5) 10 % weight to the year the project was planned, to the older of which the higher priority is given,

(6) 10 % weight to the year programmed for the implementation, to the earlier of which the higher priority is given, and

(7) 10 % weight to the willingness of the farmers, to the higher of which the higher priority is given.

Criterion 1 above refers to the project performance, while criteria 2 and 3 refers to a poverty level, those of which, consisting of 60 % weight, are the major issues. Criterion 4 could reflect the number of farmers to be benefited by the projects. The period, farmers are waiting, is considered in criterion 5. Criterion 6 takes into consideration the implementation year programmed. The last, criterion 7, refers to the farmers' willingness given by the long list. This was not directly asked to the farmers but was given by GDRS staff, therefore the weight is to be just 10 %.

Exceptional prioritization applies to such groundwater projects that the wells have been already opened by DSI but on-farm irrigation system has not yet done, leaving the farmers waiting. In this case, the priority will have additional 100 % weight to initiate such projects with greater importance than any other projects, or otherwise the implementation is programmed by the year of 2000 at the latest.

6.3 Project Ceiling

Budgetary ceiling is an important factor in programming the implementation of any project. The implementation schedule of small-scale irrigation projects should be worked out with reference to the budget availability, including the possibility of external funds, and in accordance with the projects' priorities quoted above. The projection of the project ceiling is proposed below:

(1) To calculate the average investment growth rate, relating to small scale irrigation projects implemented by GDRS, at constant price over the last five years (1992-1996),

(2) To compare between the average investment growth rate above and the 1.4 to 3.8 % of fixed capital investment growth rate in public agricultural sector, which were calculated on basis of the sector's public investment indexes of 107.1 (5.5% GDP growth) and 120.7 (7.1% GDP growth) projected in the current Five-Year Development Plan, and

(3) To adopt the highest growth rate, either the average investment growth rate or 3.8 %, and to project the investment ceiling in years of 2000, 2005 and 2010, starting with the investment budget already earmarked in 1997 for the 13 regions.

The highest growth rate, proposed above, is justified on condition that enough domestic budget or external funds or the both could be available as the result the Turkish Government recognize the importance of small scale irrigation projects as mentioned in "4.2 Necessity of Small Scale Irrigation and Rural Development Program".

Summarizing in the following the past performance such as allocated cost, actually invested amount as well as planed and opened areas, relating to irrigation, observed are 1) the allocated amount to the Study area consists of a share from 74 % to 84 % of the total amounts which were allocated to the State, 2) The ratio of actually invested amount to the allocated ranges from 82 % and 102 %, 3) The invested amount, inflation adjusted, varies widely, reflecting the then-economic-condition, from 1,194,676 MTL in 1995 to 2,740,793 MTL in 1993, 4) The average growth rate over the period from 1992 to 1996 is calculated at 2.2 % as the growth spanning 1,973,047 MTL in 1992 and 2,196,267 MTL in 1996, 5) GDRS had planned to open about 10,000 to 14,000 ha per year but actually opened about 6,300 to 13,000 ha annually, and 6) Both the allocated amount and planned area in 1997 well surpass the past performance:

Table 6.3.1 Past Performance in terms of Cost and Area by GDRS and 1997's Plan

	Year	1997	1996	1995	1994	1993	1992	Remarks
Study Area	Allocated, MTL	4,954,046	2,163,710	708,944	738,259	489,510	181,476	
	Share, %	78	78	74	84	77	77	to the State
	Invested, MTL		2,196,267	663,709	606,151	414,643	180,023	
	Ratio, %		102	94	82	85	99	to the allocated
	Inf. Adj'td, MTL		2,196,267	1,194,676	2,400,358	2,740,793	1,973,047	to the invested
	Inf. Factor		1.00	1.80	3.96	6.61	10.96	
	Aver' Growth, %		2.2					
The State	Allocated, MTL	6,317,740	2,788,106	953,012	881,320	634,099	235,311	
	Invested, MTL		2,818,615	957,450	767,894	523,558	229,858	
Study Area	Planned, ha	19,347	10,822	12,154	13,833	14,232	12,074	
	Opened, ha		10,316	6,295	9,006	13,493	10,865	
The State	Planned, ha	25,782	13,005	17,042	19,839	19,710	15,378	
	Opened, ha		11,880	8,757	11,535	15,470	14,221	

Note: For more detail information, see ANNEX E-8. Inf. means inflation, and Adj'td is adjusted.

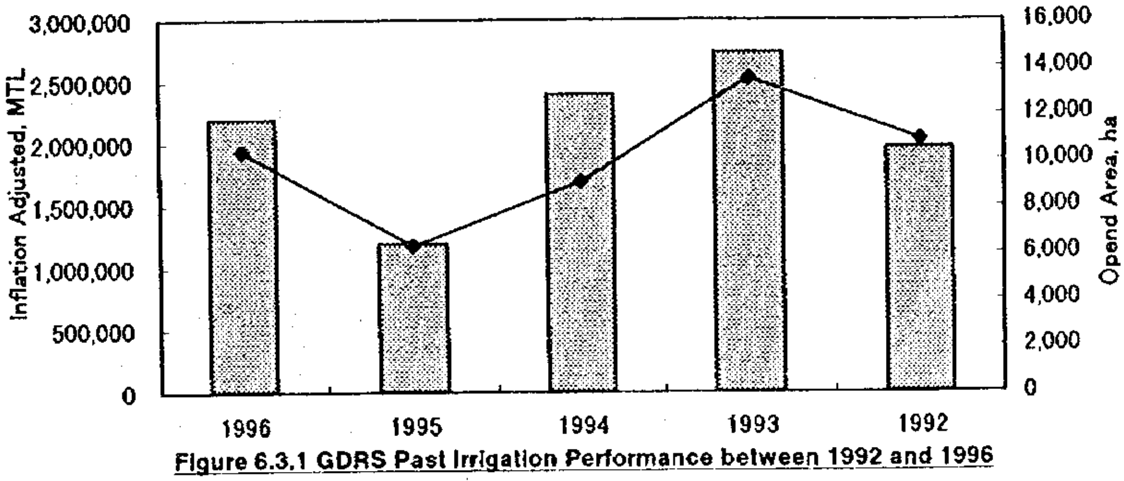


Figure 6.3.1 GDRS Past Irrigation Performance between 1992 and 1996

Regarding the past five years' average growth rates of 2.2 % and 3.8 % derived from the current Five-Year Development Plan, this Study takes the 3.8 % growth rate to project future investment over current 1997. Following are the projected investments correspondent to the years to come:

Table 6.3.2 Projected Budgets correspondent to the Years

Year	Budget, MTL	Summed, MTL	Remarks
1997	4,954,046		Already allocated
1998	5,142,300	5,142,300	Project to be started
1999	5,337,707	10,480,007	
2000	5,540,540	16,020,547	Short-term Target
2001	5,751,081	21,771,627	
2002	5,969,622	27,741,249	
2003	6,196,467	33,937,716	
2004	6,431,933	40,369,649	
2005	6,676,346	47,045,996	Middle-term Target
2006	6,930,048	53,976,043	
2007	7,193,389	61,169,433	
2008	7,466,738	68,636,171	
2009	7,750,474	76,386,645	
2010	8,044,992	84,431,637	Long-term Target

Note: All regarded as 1997 constant price.

6.4 Relevant Levels of Investment

Because the projects inevitably incur financial burden of beneficiary farm households, reasonable range of the cost should be fixed from their capacity of bearing investment. The reasonable levels of project cost are estimated by type of the projects corresponded to the benefits generated from the implementation of the projects. Economic evaluation is based on this amount for the evaluation by project. The benefit comprises two types, namely direct one and indirect one, and these are totaled in a cumulative way during the project life, subtracting production cost to obtain net gain of reasonable investment levels by financial price.

The reasonable investment cost per hectare for the implementation vary with regions reflecting local characters such as farming plans and local conditions for farming. In order to minimize the influence by price escalation, it is necessary to unify the base, for example value in 1996. Then, as an indicative cost level for constructing facilities of land improvement projects, the maximum level is estimated for judging the initial investment by type of project. At any rate, the estimation serves nothing but a reference figure since the figure does not reflect social side-effect of the projects. As the share of financial burden met by beneficiary farmers in Turkey comes to considerable rate, viable cost by financial price is rather more important than that based on relevant levels of national investment by economic price.

It is proposed that the indicative standard for estimating reasonable amount of capital to be invested to land improvement projects lies at around the value of benefit increment per unit area multiplied with a weighted average of project life and acreage of the beneficiary concerned. It is also assumed that the most stable and reliable water source constitutes ground-water, followed by reservoirs, and the most risky one is stream water taken by weirs. The extent of risk of water depletion, interviewed among farmers is found at 0% for wells, 5% for reservoirs and 15% for canal water from weirs. Employing these figures and setting a desirable benefit-cost ratio at 2.5, the reasonable levels of investment can be derived from the cumulative net benefit estimated for the entire project life, viz. 30 years. Crop benefits are given in Chapter 7.

Table 6.4.1 indicates the estimated viable per hectare cost for agricultural infrastructure improvement the based on crop profitability in different agro-ecological zones (1,2 and 3) assuming the typical crop compositions in each zone. The per hectare cost of an irrigation project is derived as the mean of GDRS project costs in 13 regions in the study area in January

1995 and January in 1996, converted to the cost price in mid-1996, while that of land consolidation is derived from the unit price in the long listed projects. Also, the operation and maintenance costs stem from on-going managing cost of GDRS projects, as a cumulative total for 30 years. As a result of comparison, the relevant level of investment per ha is estimated at about 3 thousand US$ as of mid 1996. Provided that the average area of planned projects, 120 ha is deemed as the standard, the standard project cost amounts to 360 thousand US$/project, without regarding so-called economy of the scale. If this standard is tried to compare with the planned project costs, it is identified that current cost levels for the project with weir and ground-water come to inexpensive, but those for reservoirs and land consolidation happen to be considerably more expensive than the proposed investment standard.

Table 6.4.1 Estimated Relevant Investment Cost Levels (million TTL/ha)

Project Type	Construction		O & M	Total
Weir	166		10	176
Reservoir	284		14	298
Groundwater	118		32	150
Land Consolid.	320		5	325
Agro-Eco. Zone	1	2	3	average
	Annual Average Cross Project Benefit			
Weir	882	776	1,084	913
Reservoir	985	868	1,211	1,021
Groundwater	1,037	913	1,274	1,075
Land Consolid.	1,192	1,049	1,465	1,237
	Annual Average Net Project Benefit			
Weir	565	459	767	597
Reservoir	448	331	675	485
Groundwater	767	643	1,004	805
Land Consolid.	607	464	880	650
	Relevant per hectare Investment Cost			
Weir	353	310	433	366
Reservoir	394	347	485	408
Groundwater	415	365	510	430
Land Consolid.	477	420	586	494

Note: the cost estimation date assumes mid 1997
Base of Estimation: Interior Statistical Data, GDRS

6.5 Project Implementation Schedule

The implementation is to start in 1998, which is the following year of this Study's completion. The short and long listed projects are prioritized in accordance with the criteria mentioned in "6.2 Project Prioritization" and put in order starting with the highest priority. ANNEX E-9 presents a list, following which the implementation should be made (the project costs in the list were converted into 1997 price with inflation rate of 80% from 1996 price).

The budgetary ceiling, shown in Table 6.3.2, specifies the number of the projects which can be implemented in a year. Figure 6.5.1 illustrates the number and service areas which are put into implementation each year, and Table 6.5.1 summarizes the project implementation, on a basis of province, in terms of project number, service area, and required cost (converted into 1997 price with inflation rate of 80% from 1996 price available). It reveals that short-listed projects are to be completed by the year of 2000 and all projects be completed by the year of 2006.

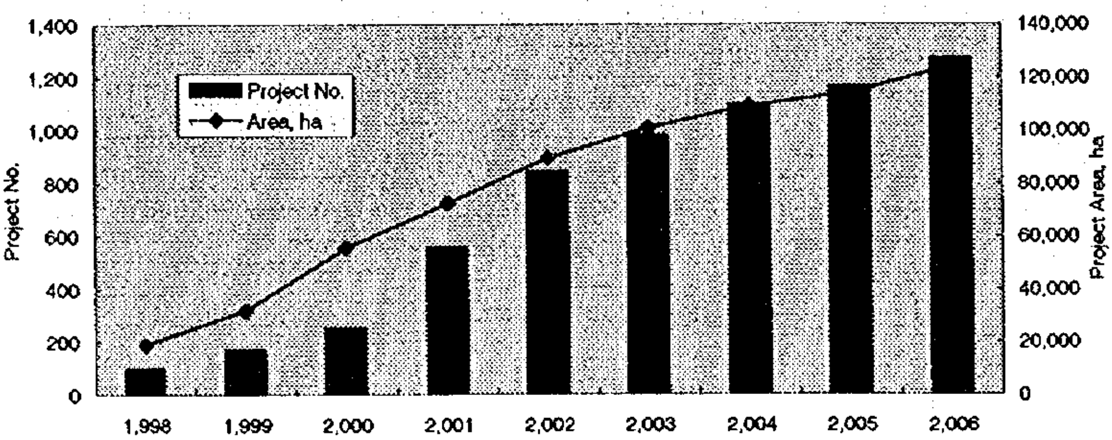


Figure 6.5.1 Project Implementation Program

Table 6.5.1 Summary of Project Implementation

No.	Regional Office	City No.	Province	1998			1999			2000			2001			2002			2003			2004			2005			2006			Total		
				No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)	No	Area(ha)	Cost(MTL)
1	ANKARA	06	ANKARA	1	150	2,533	1	60	8,048	2	250	73,675	7	247	48,582	30	1,021	477,585	14	1,331	2,117,470	20	1,120	323,931	8	409	74,914	13	847	440,606	96	5,435	3,573,343
		14	BOLU	0	0	0	0	0	0	1	2,050	440,042	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2,050	440,042
		18	CANKIRI	0	0	0	1	200	11,865	1	90	5,033	4	278	20,796	10	670	74,150	3	157	14,469	7	417	314,697	7	166	45,556	14	750	225,501	47	2,728	712,067
		71	KIRIKKALE	0	0	0	0	0	0	5	1,597	1,018,402	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1,597	1,018,402
	Total			1	150	2,533	2	260	19,912	9	3,987	1,537,152	11	525	69,378	40	1,691	551,735	17	1,488	2,131,939	27	1,536	638,628	15	575	120,470	27	1,597	672,107	149	11,809	5,743,854
2	KONYA	42	KONYA	12	4,155	316,610	2	462	146,552	13	5,230	328,367	14	1,356	114,670	0	0	0	1	537	38,066	3	175	223,218	0	0	0	9	2,842	70,659	54	14,757	1,238,143
		68	AKSARAY	2	470	39,603	1	141	17,289	6	4,268	160,274	3	274	28,000	0	0	0	2	108	79,266	9	405	62,714	5	628	114,411	0	0	0	28	6,294	501,556
		70	KARAMAN	1	371	152,592	1	50	80,640	6	936	227,250	3	450	58,446	0	0	0	0	0	0	1	50	8,028	13	555	220,181	9	387	323,203	34	2,799	1,070,339
		51	NIGDE	5	982	297,702	2	467	165,600	0	0	0	13	1,196	538,012	1	27	16,200	14	1,846	1,115,611	2	916	972,000	3	880	2,509,560	2	0	21,060	42	6,312	5,635,745
	Total			20	5,978	806,507	6	1,120	410,081	25	10,434	715,890	33	3,275	739,127	1	27	16,200	17	2,490	1,232,943	15	1,546	1,265,961	21	2,063	2,844,152	20	3,229	414,922	158	30,162	8,445,783
3	ADANA	01	ADANA	3	594	22,608	3	1,005	51,424	2	415	26,424	2	155	95,402	23	1,559	464,628	15	1,951	780,394	7	907	421,104	4	243	364,779	2	60	0	61	6,888	2,226,762
		33	ICEL	1	1,813	198,479	3	831	263,790	2	515	232,668	0	0	0	1	65	15,552	8	264	81,463	2	61	225,000	0	0	0	0	0	0	17	3,549	1,016,952
		31	HATAY	3	480	135,454	1	175	6,455	0	0	0	7	702	179,440	3	869	299,224	1	18	2,385	0	0	0	1	9	3,879	2	20	7,200	18	2,273	634,036
	Total			7	2,887	356,541	7	2,011	321,669	4	930	259,092	9	857	274,841	27	2,493	779,404	24	2,233	864,241	9	967	646,104	5	252	368,658	4	80	7,200	96	12,710	3,877,750
4	KAYSERI	38	KAYSERI	1	90	27,540	7	1,141	325,529	0	0	0	3	156	174,163	24	1,214	863,857	2	186	240,770	11	1,288	2,223,260	2	87	543,460	11	817	4,153,127	61	4,978	8,551,706
		40	KIRSEHIR	1	211	570,240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	211	570,240
		50	NEVSEHIR	1	128	11,899	0	0	0	1	228	33,829	2	150	60,027	0	0	0	0	0	0	3	458	317,397	1	200	2,000,160	0	0	0	8	1,164	2,423,313
	Total			3	429	609,679	7	1,141	325,529	1	228	33,829	5	306	234,191	24	1,214	863,857	2	186	240,770	14	1,745	2,540,657	3	287	2,543,620	11	817	4,153,127	70	6,352	11,545,259
5	SIVAS	58	SIVAS	20	2,889	739,076	4	441	79,711	5	573	80,596	133	6,134	1,714,699	34	2,699	605,710	3	109	79,889	0	0	0	0	0	0	7	0	336,033	206	12,845	3,635,713
		60	TOKAT	1	202	19,440	1	201	16,290	1	100	46,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	503	82,530
	Total			21	3,091	758,516	5	642	96,001	6	673	127,396	133	6,134	1,714,699	34	2,699	605,710	3	109	79,889	0	0	0	0	0	0	7	0	336,033	209	13,348	3,718,243
11	TRABZON	61	TRABZON	0	0	0	0	0	0	0	0	0	9	146	40,409	2	46	6,358	0	0	0	0	0	0	0	0	0	0	0	0	11	192	46,767
		08	ARTVIN	5	517	354,571	1	61	12,060	1	213	368,582	12	604	374,774	15	474	173,030	14	355	110,799	12	440	305,237	0	0	0	1	30	12,636	61	2,694	1,711,689
		69	BAYBURT	2	148	16,740	1	80	17,267	1	80	38,254	0	0	0	3	142	86,997	4	130	101,060	6	110	58,595	3	28	82,606	9	289	156,046	29	1,008	557,565
		28	GIRESUN	1	66	12,612	2	109	15,838	0	0	0	20	471	129,758	7	187	34,797	5	213	32,463	2	26	7,645	1	13	13,300	1	7	2,974	39	1,091	249,387
		29	GUMUSHANE	2	52	16,087	0	0	0	0	0	0	11	508	184,456	11	401	185,177	14	373	74,707	14	359	272,508	2	68	12,510	0	0	0	54	1,760	745,446
	Total			10	783	400,010	4	250	45,166	2	293	406,836	52	1,730	729,398	38	1,250	486,359	37	1,071	319,029	34	934	643,985	6	108	108,416	11	326	171,655	194	6,745	3,310,854
12	SAMSUN	55	SAMSUN	2	843	1,355,605	1	85	67,110	0	0	0	0	0	0	1	48	6,697	0	0	0	0	0	0	0	0	0	0	0	0	4	976	1,429,412
		05	AMASYA	7	828	108,385	3	524	96,338	1	320	61,084	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1,672	265,807
		19	CORUM	8	904	92,823	1	93	12,350	0	0	0	15	724	75,107	27	1,040	137,437	3	99	26,303	2	281	238,666	0	0	0	1	21	2,525	57	3,162	585,210
	Total			17	2,575	1,556,813	5	702	175,797	1	320	61,084	15	724	75,107	28	1,087	144,133	3	99	26,303	2	281	238,666	0	0	0	1	21	2,525	72	5,809	2,280,429
13	KASTAMONU	37	KASTAMONU	0	0	0	2	275	308,304	2	263	75,327	2	237	458,550	8	761	282,168	2	65	91,724	0	0	0	0	0	0	0	0	0	16	1,602	1,216,073
		67	ZONGULDAK	1	98	13,680	0	0	0	0	0	0	3	81	74,612	17	787	536,456	1	125	7,740	0	0	0	0	0	0	0	0	0	22	1,091	632,487
		57	SINOP	1	50	3,600	1	53	46,402	0	0	0	21	679	189,355	23	1,511	238,911	1	244	16,848	1	105	15,091	0	0	0	3	236		51	2,878	510,207
		78	KARABUK	0	0	0	0	0	0	2	146	57,970	0	0	0	0	0	0	1	34	5,288	8	407	121,178	11	964	89,775	2	194	9,844	24	1,745	284,055
		74	BARTIN	0	0	0	0	0	0	2	280	132,192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	2,210	744,156	14	2,490	876,348
	Total			2	148	17,280	3	329	354,706	6	689	265,489	26	997	722,517	48	3,059	1,057,535	5	468	121,600	9	512	136,270	11	964	89,775	17	2,640	754,000	127	9,806	3,519,171
14	ESKISEHIR	26	ESKISEHIR	1	79	11,104	5	775	332,044	2	371	180,630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1,225	523,778
		03	AFYON	3	390	42,664	2	200	13,162	4	458	72,731	10	986	348,343	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	2,033	476,899
		43	KUTAHYA	0	0	0	2	145	56,520	0	0	0	2	169	72,000	1	247	64,800	4	427	374,040	0	0	0	0	0	0	0	0	0	9	988	567,360
		64	USAK	0	0	0	1	55	13,464	0	0	0	0	0	0	2	38	20,446	2	391	111,136	0	0	0	0	0	0	0	0	0	5	483	145,045
	Total			4	469	53,768	10	1,174	415,190	6	829	253,361	12	1,155	420,343	3	285	85,246	6	818	485,176	0	0	0	0	0	0	0	0	0	41	4,729	1,713,082
15	ANTALYA	07	ANTALYA	4	515	171,659	4	469	324,360	0	0	0	1	40	57,024	29	941	456,301	5	338	38,930	2	38	13,469	0	0	0	1	45	0	46	2,386	1,061,743
		15	BURDUR	3	1,315	238,731	4	659	154,868	0	0	0	2	197	90,072	6	1,665	627,048	0	0	0	0	0	0	0	0	0	1	350	0	16	4,185	1,110,719
		32	ISPARTA	1	88	42,352	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	88	42,352
	Total			8	1,918	452,742	8	1,128	479,228	0	0	0	3	237	147,096	35	2,606	1,083,349	5	338	38,930	2	38	13,469	0	0	0	2	395	0	63	6,659	2,214,814
16	IZMIR	35	IZMIR	2	215	58,162	2	444	306,653	3	513	97,927	3	618	588,508	4	336	229,713	11	1,422	328,128	2	514	134,141	0	0	0	0	0	0	27	4,061	1,743,233
		09	AYDIN	0	0	0	0	0	0	3	503	50,760	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	503	50,760
		20	DENIZLI	1	145	23,652	4	1,312	301,218	0	0	0	0	0	0	1	194	113,400	0	0	0	0	0	0	0	0	0	3	580	0	9	2,231	438,270
		45	MANISA	0	0	0	3	190	172,669	1	15	73,566	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	205	246,235
		48	MUGLA	0	0	0	4	978	730,972	1	138	0	3	78	34,689	1	18	8,332	5	316	199,984	1	45	16,848	0	0	0	1	30	12,960	16	1,603	1,003,785
	Total			3	360	81,814	13	2,924	1,511,512	8	1,170	222,253	6	696	623,196	6	548	351,445	16	1,738	528,113	3	559	150,989	0	0	0	4	610	12,960	59	8,604	3,482,283
17	BURSA	16	BURSA	0	0	0	0	0	0	5	959	700,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	959	700,200
		10	BALIKESIR	0	0	0	2	1,096	648,000	5	2,893	1,365,805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3,989	2,013,805
		11	BILECIK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		17	CANAKKALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		77	YALOVA	0	0	0	0	0	0	2	207	62,730	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	207	62,730
	Total			0	0	0	2	1,096	648,000	12	4,059	2,128,735	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	5,155	2,776,735
18	ISTANBUL	39	KIRKLARELI	1	120	9,450	2	315	31,932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	435	41,382
		59	TEKIRDAG	0	0	0	0	0	0	0	0	0	1	111	17,672	2	177	91,880	2	213	113,555	1	63	32,059	4	620	256,601	5	342	174,646	15	1,525	686,413
	Total			1	120	9,450	2	315	31,932	0	0	0	1	111	17,672	2	177	91,880	2	213	113,555	1	63	32,059	4	620	256,601	5	342	174,646	18	1,960	727,795
	Short List Grand Total			97	18,908	5,105,652	74	13,091	4,834,724	74	23,096	5,900,046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	245	55,095	15,840,422
	Long List Grand Total			0	0	0	0	0	0	6	515	111,071	306	16,746	5,767,566	286	17,134	6,116,853	137	11,248	6,182,487	116	8,183	6,306,788	65	4,869	6,331,692	109	10,057	6,699,175	1,025	68,752	37,515,631
	Grand Total			97	18,908	5,105,652	74	13,091	4,834,724	80	23,611	6,011,117	306	16,746	5,767,566	286	17,134	6,116,853	137	11,248	6,182,487	116	8,183	6,306,788	65	4,869	6,331,692	109	10,057	6,699,175	1,270	123,847	53,356,053
	Accumulated Total			97	18,908	5,105,652	171	31,999	9,940,376	251	55,610	15,951,493	557	72,357	21,719,059	843	89,491	27,835,912	980	100,739	34,018,399	1,096	108,921	40,325,187	1,161	113,790	46,656,878	1,270	123,847	53,356,053			

Note: Project costs are at 1997 constant price, converted with 80% inflation from 1996 price

6.6 Project Amount at Target Years

6.6.1 Project Amount for the Study Area

Based on the project implementation mentioned in "6.5 Project Implementation Schedule", a projection is made at the year of 2010, which is long term target, over the short and medium target years. An area which can be opened annually would decrease, since at the latter year a project is implemented, the less the project performance becomes. Therefore, in projecting the annual project area over 2006, until the year of which all short and long listed projects are to be completed, progressively decreased areas are applied based on an average annual decrease between 1999 and 2006.

Table 6.6.1 below presents a projection, from which the following are viewed: 1) an annual decrease of about 1,100ha would appear despite increasing budget with annual 3.8% growth due mainly to project performance becoming less, and 2) the area to be opened by the year of 2010 could be about 153,000ha and the required budget is to be 83,800,000 MTL at 1997 constant price:

Table 6.6.1 Projection of Project Area and Budget for the Study Area

Year	Scheduled Area, ha	Decrease ha	Average ha	Accumulated Area, ha	Annual Bud't MTL	Accumulated Bud't, MTL	Remarks
1998	18,908			18,908	5,105,652	5,105,652	
1999	13,091	-5,817		31,999	4,834,724	9,940,376	
2000	23,611	10,520		55,610	6,011,117	15,951,493	
2001	16,746	-6,865		72,356	5,767,566	21,719,059	
2002	17,134	388		89,490	6,116,853	27,835,912	
2003	11,248	-5,886		100,738	6,182,487	34,018,399	
2004	8,183	-3,065		108,921	6,306,788	40,325,187	
2005	4,869	-3,314		113,790	6,331,692	46,656,879	
2006	10,057	5,188	-1,106	123,847	6,699,175	53,356,054	
2007	8,951			132,798	7,193,389	60,549,443	Projected
2008	7,844			140,642	7,466,738	68,016,181	-do-
2009	6,738			147,380	7,750,474	75,766,655	-do-
2010	5,632			153,011	8,044,992	83,811,647	-do-

6.6.2 Contribution to the National Irrigation Development

With regard to the projection for the Study Area made above, the contribution of GDRS irrigation projects to the national irrigation development is studied. Table 6.6.2 below shows GDRS state level project areas at the target years, the estimation of which was made based on the areas calculated for the Study Area. GDRS had already opened 13% of the state potential as of end of 1995 and is to open 14.8%, 15.7% and 16.3% at the years of 2000, 2005 and 2010 respectively.

Table 6.6.2 Contribution to the National Irrigation Development

	State	Study Area	Surface	G.W.	Remarks
State Potential, ha	8,500,000		7,900,000	600,000	
Already Developed, ha	4,100,000		3,700,000	400,000	as of 1995
Already Developed, %	48%		47%	67%	
State Developed, ha	3,032,468		2,695,827	336,641	as of 1995
GDRS Development					
As of end of 1995	1,146,389		897,416	248,973	
Percent to the State	38%		33%	74%	as of 1995
Percent to the Potential	13%		11%	41%	
Developed in 1996	11,880		9,965	1,915	
Planed in 1997	25,782		19,825	5,957	
Total as of 1997	**1,184,052**		**927,206**	**256,846**	
Projection at 2000	74,147	55,610			S.A./0.75=State
Projection at 2005	151,720	113,790			
Projection at 2010	204,015	153,011			
Total at 2000	**1,258,198**		**924,776**	**333,423**	
Total at 2005	**1,335,772**		**981,792**	**353,979**	
Total at 2010	**1,388,067**		**1,020,229**	**367,838**	
Percent to the Potential	**14.8%**		**11.7%**	**55.6%**	at 2000
Percent to the Potential	**15.7%**		**12.4%**	**59.0%**	at 2005
Percent to the Potential	**16.3%**		**12.9%**	**61.3%**	at 2010

CHAPTER 7 PROJECT EVALUATION

7.1 Project Cost

GDRS has two types of works, i.e., so-called public work such as securing tap water the benefit of which the entire communities can enjoy, and official investment programs the advantage of which is offered to certain beneficiaries like farm households within the communities concerned. Institutional loans from Agricultural Bank (Z.B.) are granted to a part of the latter, the limited beneficiaries, so that purchase of inputs and equipment and cost of implementing works are met by these loans, eventually paid by the beneficiaries.

In general, GDRS is responsible for both additional, final works to the major works implemented by DSI, for example implementation of the terminal parts of large scale water supply facility by DSI, and self-sponsored works which GDRS can initiate and complete within its capacity. Of water source development projects, those depending on ground water are exclusively implemented by DSI, regardless of the size, as far as drilling, installation of pumps and electricity feeding system are concerned. Hence it is required that the sunk costs, namely cost already expensed for the construction of existing water source which GDRS is to make use of in its projects must be estimated or traced for counting and reflecting them into the project evaluation.

The projects GDRS has implemented up till now have components that are essential for meeting basic needs of living like facility of potable water supply, with an exigency without needing any appraisal for economic viability. This is the reason why the prioritization of projects for deciding the order of implementation according to the result of economic analysis has not necessarily been made. However, standards for prioritization of project implementation will become more and more important from now onward, as free economy develops throughout the state, so that selection of priority projects can be made based on relevant evaluation.

In Turkey the rate of price escalation has been so fast that the estimated costs and benefits tends to become erroneous or obsolete unless they are both investigated and up-dated simultaneously. Judging from data availability for prices and other officially announced data, it would be the most convenient to employ the price as of mid-1996. Since there exists wide disparity of price and wages among regions, some difficulty would arise, given the evaluation is made by a single unit cost trying to represent all the state for a commodity, except for public intervention prices.

With respect of the estimated project cost for so far planned projects by GDRS, it has been summarized in a table in Annex. Usually, the unit (per ha) project costs of ground-water development are cheaper and those of reservoirs tend to be higher. Those of land consolidation and soil conservation are highly variable but their average come to comparable levels to irrigation projects. Those of drainage projects are apt to have lowest unit cost because they cover vast beneficiary areas. The grand average of unit cost as of 1996 of GDRS projects comes to 157 million TL/ha, and this is equivalent to per farm household burden of 284 million TL/ha assuming that all the cost is met by the beneficiary farmers. As some lucrative cash crops can bring annual net return of 300 million TL/ha or so, this cost level seems quite reasonable to those who live in peri-urban horticultural zones within commercial sphere. However, it would become burdensome for those who inhabit remote countryside where self-supply economy predominates and the rate of grains in their cropping is higher bringing only 30 million TL/ha per annum as net return, if the cost must fully met from their surplus of household expenditure.

7.2 Project Benefit

As to methodology of benefit calculation, the project life is determined from the life of facilities, and it is proposed that the period of benefit generation be set at 30 years for small scale irrigation projects in Turkey. Assuming that the implementation period lasts for 1 - 3 years except for the facilities already constructed, the unit yield development of crops and cropping of the proposed rotation is estimated to follow gradual increase after their construction, and cumulative benefits are estimated from the difference between "with project" basis and "without project" basis. Also, as regards livestock, from in view of the fact that livestock is commonly kept by most farm households, the evaluation should include value-added benefits from such by-products as cereal straw and other crop residuals, processing by-products and feed-crops through the conversion to meat or milk. The benefits likely generated from unit area on "with-project" basis will be fairly variable among regions, attributable to difference in quality, yields and unit wholesale prices.

7.3 Economic Evaluation

By the reasons that the study area extends to major part of the state, and GDRS projects are implemented as national policy measures, the economic evaluation desirably is based on the project benefit measurements through economic prices as the evaluation for national investment. Similarly, since the same types of work are in parallel implemented through GDRS projects at the finance of farmers own fund or credits, incurring considerable financial burden on them, the evaluation by financial price provides an important judging criterion to assess the viability of the credit repaying capacity of farm households. In the stage of interim report, the overall appraisal is made exclusively by evaluation on financial price basis, but that on economic price basis is scheduled on the feasibility stage by setting border prices for tradable commodities.

In financial evaluation, the core of evaluation is focused on how the proposed project can raise farm income contributing to improvement in livelihood as the project beneficiary, a member of local communities enjoys benefits through the project implementation. For the classification of economic zones to be applied to the evaluation, it is considered sufficient to divide the study area into three zones, i.e., central Anatolian plateau, southern and western coastal and northern/eastern or Black Sea coastal zones. This division seems rough, but it will do for the tentative purpose of simplifying financial analysis because prices of farm products, labor wage and living cost expenditure show similar levels within each of the classified zone though inter-zonal differences are fairly remarkable.

The result of financial evaluation based on farm economy is summarized in Table 7.3.1. The profitability of crop components evaluated from production costs, crop yield and the levels of farm-gate price shows that pulses and industrial crops have sparingly profitable, sometimes dropped into negative net-return when self supplied farm labor is evaluated as an input cost. However, they are inevitably incorporated into the fixed rotation system in land use with grass-land and fallow area, regardless of whether they are profitable or not.

In this respect mere conversion to, or concentration into more profitable crops will lead to negligence of "sustainable farming" that can maintain soil fertility, prevention of hazards from successive cropping of the same crop and reasonable production regarding security of marketing outlet. Moreover, sweeping away of animal husbandry and minor crops as supplying sources of plant proteins would threaten proper soil management or nutritional balance, since the farming in remote areas has character of self-supply.

Table 7.3.1 Estimated Financial Cost Based Benefits (Unit: ha t/ha million TL L.U (livestock unit))

Zone in the Study Area	average holdings per farm	planned irrigation area (ha)	Current Area (upper) under crop & yield (lower column)						Planned Area (upper) under crop & yield (lower column)						1996 crop prices, production cost *				
			Cereals	Pulses /Tubers	Industrial Cr.	Orchard Trees	Vegetables	Grass / Fallow	irrigated Cereals	Pulses /Tubers	Industrial Cr.	Orchard Trees	Vegetables	Grass / Fallow	Grain/ Cereals	Pulses /Tubers	Industrial Cr.	Orchard Trees	Vegetables
Southern / Western																			
Coastal 5 regions	5.8	0.7	2.8	0.0	1.6	0.5	0.1	0.8			0.5	0.1	0.1		19.7	65.0	4.5	16.0	14.0
(agroecological zone1)			1.7	0.0	17.8	14.5	20.8	5.0			42.7	29.0	43.7		51.0	78.0	85.0	120.0	257.4
Central Plateau				(tubers)												(tubers)			
Anatolian 5 regions	9.2	1.6	3.9	2.2	0.4	0.2	0.2	2.3	0.3	0.2	0.4	0.2	0.2	0.3	19.7	16.0	4.5	15.0	12.5
(agroecological zone3)			2.4	8.5	11.2	12.6	35.4	2.8	5.0	13.6	25.8	20.2	63.7	5.9	47.0	135.0	85.0	110.0	244.5
Northern / Eastern																	sunflower		
Coastal 3 regions	2.5	0.8	0.8	0.3	0.2	0.0	0.4	0.8	0.2		0.2		0.4		19.7	58.5	35.5	-	9.5
(agroecological zone2)			3.5	0.8	1.8	0.0	20.7	3.5	4.9		2.7		33.1		45.0	78.0	57.0	-	225.0
Zone in the Study Area	per farm mean livestock unit	Planned farm livestock unit	Current Production Cost/Gross/Net Benefit						Planned Production Cost/Gross/Net Benefit						per Farm (upper) / per ha (lower column) net profit increment by GDRS projects				
			Cereals	Pulses /Tubers	Industrial Cr.	Orchard Trees	Vegetables	Live Stock	Cereals	Pulses /Tubers	Industrial Cr.	Orchard Trees	Vegetables	Live Stock	Crops		Livestock		Total
Southern / Western			47.9		122.4	57.3	24.9	22.8	47.9		126.7	57.8	25.7	26.0					
Coastal 5 regions	3.5	4.0	93.8	0.0	128.2	116.0	29.1	61.3	93.8	0.0	184.2	139.2	61.2	70.0	105.7		5.5		111.2
(agroecological zone1)			45.9		5.8	58.8	4.2	38.5	45.9		57.6	81.4	35.4	44.0	21.13		6.9		19.2
Central Plateau			169.7	284.9	30.6	20.9	47.2	12.4	170.7	286.0	34.0	22.0	48.9	19.5					
Anatolian 5 regions	1.9	3.0	184.4	299.2	20.2	37.8	88.5	33.3	200.0	315.5	46.4	60.5	159.3	52.5	143.3		12.1		155.4
(agroecological zone3)			14.7	14.3	-10.4	16.9	41.3	20.9	29.3	29.5	12.4	38.5	110.4	33.0	20.762		5.3		16.9
Northern / Eastern			34.0	21.8	9.7		86.6	19.5	34.5	21.8	11.4		90.0	22.8					
Coastal 3 regions	3.0	3.5	55.2	14.0	12.8	0.0	78.7	52.5	60.7	14.0	19.2	0.0	125.8	61.3	53.4		5.5		58.9
(agroecological zone2)			21.2	-7.7	3.1		-7.9	33.0	26.2	-7.7	7.8		35.8	38.5	31.427		6.9		23.0

Remarks: [illegible]

* : [illegible]

The increment of per household income by irrigation projects has been roughly estimated at 1996 price as annual value at 59 - 155 million TL (equivalent to 70 - 180 US$), while the benefit increment per ha amounts to 17 - 24 million TL per annum (20 - 28 US$). Among zones, central plateau has the lowest increment, south-western part shows medium increase, whereas north eastern part gives the highest increment. This is because there is a tendency in base levels staying higher as the producing areas are located further in southern and western sides. Another reason may lie in the fact that there is less zonal disparity in the effect of irrigation on yield increment. The project cost as converted in 1997 price as measured per hectare of irrigated field as listed in the Long List is summarized as below:

Table 7.3.2 Representative Construction Costs in the Long List (Unit : 1997 (July) price, million TL/ha)

Type of Works	Weir	Reservoir	Groundwater	Soil conservation	Land consolidation	Drainage
Costlier examples	857	682	320	900	684	360
Cheaper examples	69	35	135	67	94	44
Average O&M cost	17	42	62	15	27	45

In summary, in the case of ground-water irrigation 197 - 382 million TL/ha at 1997 price (hereinafter the same unit is employed for costs and benefits), for weir 85 - 873 and in the case of reservoir 76 - 724 or in between the former two cases are required in addition to farming cost. On the other hand, the mean benefit increment during the same period is estimated at 1,037 in south-western zones, 913 in the central, and 1,275 in north eastern zones. If the difference can be interpreted as a milestone of benefit brought about by the GDRS projects, then the benefits amounting 531 - 1,078 for ground-water projects, 189 - 1,199 for reservoirs and 40 - 1,192 for weir irrigation can be envisaged during the project life. However, cost gaps found in the different cases of the same type by far outweigh the zonal differences in benefit generation even per annum basis, resulting that the difference in the cumulative benefit between lower example and higher one reaches several ten times depending on the sites.

7.4 Environmental Impact

(1) Implementation of Initial Environmental Examination (IEE)

The purpose of this IEE is to ensure environmentally sound and sustainable development through the timely incorporation of environmental issues into the project design. This study was carried out based on the " Guideline of Environmental Assessment" prepared by JICA. The check list was composed by 47 items of social and natural environment.

(2) Method of Initial Environmental Examination

IEE was carried out on the 285 areas which was candidates for the short listed the 205 project areas. Summary of the study area showed in ANNEX G. During this study, Study Team discussed with GDRS about 47 items of check list, and excluded the unnecessary items from the list.

(3) Result of Initial Environmental Examination

As the results of investigation, several points were point out (refer to Table 7.4.1, 7.4.2 and ANNEX G).

- Regional areas where the significant environment impact is unquestionably induced by the project (evaluated class A), were recognized only in Izmir and Bursa. The item of the problem is only one item about " increased use of agrochemicals".
- Regional areas where the environment impact is likely to be induced by the project (evaluated class B), recognized in Ankara, Konya, Adana, Samsun, Antalya, Izumir, Bursa, and Istanbul. The environmental problem are mainly three items about "increase use of agrochemicals", "residual toxicity of agrochemicals", and "soil contamination by agrochemicals and others".
- On the other hand, the total items that the positive impacted items by project (evaluated class D) and excluded items by discussion with GDRS, were occupied 91.4 % of entirety.

(4) Negative Environmental Impacts

Irrigation projects manage water supplies for the purpose of agricultural production. There is a wide variety of irrigation types depending upon the source of water, means of water storage, conveyance and distribution systems, and methods of delivery. Therefore, environmental impacts by implementation are mainly water-related problems and large quantities investment of fertilizers and agrochemicals.

Waterlogging and salinization of soils are common problems associated with surface irrigation. Waterlogging results primarily from canals and ditches. Waterlogging concentrates salts, drawn up from lower in the soil profile, in the plants' rooting zone. The soils have a natural tendency toward salinization, many of soil-related problems could be minimized by installing adequate drainage systems. Waterlogging and salinization can also be reduced or minimized by using sprinkler or drip irrigation which apply water more precisely and can more easily limit quantities to no more than the crop needs.

Agrochemicals are used predominantly in Turkey. Agrochemicals are used DDT, BHC, parathion, and malathion as insecticide, machine oil emulsion as acaricide, 2,4-D as herbicide. Chlorinated hydrocarbon agrochemicals, such as DDT and BHC are not metabolised but accumulate in fatty tissue in the body. They are inactive when stored but at times of poor nutrition, fats are readily metabolised and chlorinated agrochemicals are released into the blood stream, with the possibility of toxic effects.

Overdosing of fertilizer on agricultural land can result in high levels of nutrients in the drainage water causing eutrophication and salinization of soil. High nutrient concentrations will result in stimulation of aquatic weed and algae growth in the drainage canals.

Table 7.4.1 Summary of Initial Environmental Examination (IEE)

Regional Area	Number of Evaluation*					Total	Number of Survey Area**
	A	B	C	D	Excluded		
Ankara	0	2	37	529	90	658	14
% of evaluation	0	tr	6	80	14	100	
Konya	0	190	306	1,948	470	2,914	62
% of evaluation	0	7	11	67	15	100	
Adana	0	60	99	641	140	930	20
% of evaluation	0	6	11	69	14	100	
Kayseri	0	0	47	422	142	611	13
% of evaluation	0	0	8	69	23	100	
Sivas	0	0	67	881	227	1,175	25
% of evaluation	0	0	6	75	19	100	
Trabzon	0	0	9	756	34	799	17
% of evaluation	0	0	1	95	4	100	
Samsun	0	8	16	1,191	54	1,269	27
% of evaluation	0	tr	1	95	4	100	
Kastamonu	0	0	12	618	28	658	14
% of evaluation	0	0	2	94	4	100	
Eskisehir	0	0	112	936	174	1,222	26
% of evaluation	0	0	9	77	14	100	
Antalya	0	54	51	603	138	846	18
% of evaluation	0	6	6	71	17	100	
Izmir	18	13	12	1,208	253	1,504	32
% of evaluation	1	1	1	80	17	00	
Bursa	7	10	18	520	103	658	14
% of evaluation	1	2	3	79	15	100	
Istanbul	0	3	3	112	23	141	3
% of evaluation	0	2	2	80	16	100	

Note: * A: The subject significant environment impact is unquestionably induced by the project.
B: The subject significant environment impact is likely to be induced by the project.
C: The subject significant environment impact is not fully known.
D: There is no possibility that the subject significant environment impact is likely to be induced by the project.

** IEE was conducted on the 285 area which was candidates for the short listed area.

Table 7.4.2 Total Amount of Initial Environmental Examination (IEE) on the Every Environmental Item

Environmental Item	Number of Evaluation ※					Total
	A	B	C	D	Excluded	
1. Planned residential settlement	0	0	0	285	0	285
2. Involuntary resettlement	0	0	0	285	0	285
3. Substantial changes in the way of life	0	0	65	220	0	285
4. Conflict among communities and people	0	1	98	186	0	285
5. Impact on native people	0	0	49	186	50	285
6. Population increase	0	5	100	180	0	285
7. Drastic change in population composition	0	0	1	284	0	285
8. Changes in bases of economic activities	0	1	18	266	0	285
9. Occupational change and loss of job opportunities	0	0	7	278	0	285
10. Increase in income disparities	0	0	0	285	0	285
11. Adjustment & regulation of water or fishing rights	0	4	6	230	45	285
12. Changes in social and institutional structures	0	0	77	208	0	285
13. Changes in existing institutions and customs	0	0	32	253	0	285
14. Increased use of agrochemicals	25	112	87	61	0	285
15. Outbreak of endemic diseases	0	0	0	285	0	285
16. Spreading of endemic diseases	0	0	0	285	0	285
17. Residual toxicity of agrochemicals	0	98	10	177	0	285
18. Increase in domestic and other human wastes	0	0	56	229	0	285
19. Impairment of historic remains and cultural assets	0	0	0	237	48	285
20. Damage to aesthetic sites	0	0	0	285	0	285
21. Impairment of buried assets	0	0	1	236	48	285
22. Changes in vegetation	0	1	3	281	0	285
23. Negative impact on important fauna and flora	0	0	0	247	38	285
24. Degradation of ecosystems with biological diversity	0	1	0	284	0	285
25. Proliferation of exotic and/or hazardous species	0	0	67	218	0	285
26. Destruction of wetlands and peat lands	0	8	0	214	63	285
27. Decrease of tropical rain forest and wild lands	0	0	0	0	285	285
28. Destruction or degradation of mangrove forests	0	0	0	0	285	285
29. Degradation of coral reefs	0	0	0	115	170	285
30. Soil erosion	0	1	23	261	0	285
31. Soil salinization	0	0	1	284	0	285
32. Deterioration of soil fertility	0	0	0	285	0	285
33. Soil contamination by agrochemicals and others	0	97	5	183	0	285
34. Devastation or desertification of land	0	0	0	285	0	285
35. Devastation of hinterland	0	0	1	284	0	285
36. Ground subsidence	0	0	0	264	21	285
37. Change in surface water hydrology	0	6	5	245	29	285
38. Change in ground water hydrology	0	0	32	253	0	285
39. Inundation and flooding	0	0	0	285	0	285
40. Sedimentation	0	0	0	213	72	285
41. Riverbed degradation	0	0	0	167	118	285
42. Impediment of inland navigation	0	0	0	65	220	285
43. Water contamination and deterioration of water quality	0	0	2	282	1	285
44. Water eutrophication	0	0	17	187	81	285
45. Sea water intrusion	0	0	0	67	218	285
46. Change in temperature of water	0	6	21	237	21	285
47. Air pollution	0	0	5	224	56	285
Total	25	341	789	10,371	1,869	13,395
% of total	0.2	2.5	5.9	77.4	14.0	100.0

※ SEI: Significant Environmental Impact

A: The subject SEI is unquestionably induced by the Project.

B: The subject SEI is likely to be induced by the Project.

C: The SEI is not fully known.

D: There is no possibility that the subject SEI is likely to be induced by the Project.

CHAPTER 8 SELECTION OF THE PRIORITY PROJECTS FOR FEASIBILITY STUDY

8.1 Criteria of Selection

The 10 priority projects for feasibility study is to be selected from short list inventory. The following criteria are employed in choosing these.

(1) Beneficiary Area: Sizable projects are selected taking account that representative nature of the priority projects should constitute a pilot one for each area. In practice, for irrigation projects consisting of such water source as weir, small scale dam and groundwater those with the beneficiary area larger than 120ha or the average size should be selected. In soil conservation projects, the main work of which is actually terracing with limited tract of field, a range size is proposed as a criterion as 80ha at the minimum and 200ha at the maximum, so that the planning can avoid cumbersome works. As for land consolidation, that actually and basically constitutes the terminal consolidation of irrigation facilities for large scale DSI irrigation projects with larger beneficiary area. Taking these into account, and in the light of the term of this study to select small scale irrigation schemes, a criterion of selecting those with 200 ha at least but 1,200ha at the maximum is proposed. In the total, the following criteria for area coverage for priority projects are employed:

	Irrigation			Soil	Land
	Weir	Dam	Groundwater		
Beneficiary (ha)	$120<A$			$80<A<200$	$200<A<1,200$

(2) Beneficiary Household: It is considered important for prioritizing the projects that the projects have sizable number of beneficiary households. Here, the minimum numbers of beneficiary households are proposed as follows, as a condition for employing priority projects:

	Irrigation			Soil	Land
	Weir	Dam	Groundwater		
Minimum Household	50			30	80

(3) Year Planning: Those planned quite a few years ago have possibility of accompanying such problems as a drastic change in the background socio-economic status or some development has been made in a part of the planned area. Therefore, these are subject to a radical review. In the light of this possibility, obsolete project plans established before 1990 should not be employed.

(4) Willingness of the Project Implementation: Selecting those with acute needs and willingness of the project implementation of beneficiary farmers and GDRS.

(5) Availability of Basic Data: Those for which data (covering natural conditions, socio-economic status, topography maps etc.) are provided for site survey are selected. It means

that data are to a fairly detailed extent accumulated in the target projects by thorough investigations.

(6) Inception Environment Impact Assessment (EIA): Those should be selected for which initial EIA has been conducted and the result guarantees no serious environmental impact is arisen from the project implementation.

(7) Type of Project: They should include various types of projects covering those with reservoir, weir, ground water, land consolidation, soil conservation etc., so that the selected projects can represent these diverse types found in the original inventory.

(8) Agro-ecological Zone: They should cover all the agro-ecological zones, or at least one from each of the seven different agro-ecological zones should be chosen.

(9) Regional Offices of GDRS: To keep equitable distribution, it is avoided to select more than two projects from the same jurisdiction under particular regional GDRS office.

8.2 Candidate Priority Projects

With a view to selecting 10 priority projects for feasibility study, the following process is followed one after another based upon the criteria as stated in 8.2.1.

Process No.1 :As the result of applying the criterion of beneficiary area (1) 90 projects fail to meet the criterion and eliminated. 115 projects are passed. (205 projects to 115)

Process No.2 :Applying the criteria of household (2) to the remaining 115 projects, it is found that 13 projects fail to satisfy it, and 102 survive. (115 projects to 102)

Process No.3 :After the application of the criterion o plan age, 14 drops failing to meet the requirement and 88 are selected. (102 projects to 88)

Process No.4 :Thorough review is made for the selected 88 projects up to the procedure 3 on the willingness of project implementation, the 19 projects as shown in Table 8.2.1 has been found greatest willing to the implementation.

Process No.5 :Further examination is imposed on the candidate projects selected through the process shown above, checking the criterion (4) or the data availability, to have identified that all the candidates have provided the basic data for feasibility study, then requirement of the criterion (5) or the result of environmental assessment is also cleared.

Process No.6 :Taking account of the number of projects with different types, as well as the exigency needs of ground water development, the following distribution is proposed to cover as many kinds of projects as possible:

Project Type	S.S.Weir	S.S.Dam	Ground water	Soil Conservation	Land Consolidation	Total
Proposed Number	3	2	3	1	1	10

(s.s. stands for small scale)

Process No.7 : Finally, these 10 projects are proposed so that these meet the requirement of the criterion (7) or the coverage of agro-ecological zones and the criterion (8) or pursuing equity among regional GDRS offices.

Figure 8.2.1 Procedure of Selection of Priority Project for Feasibility Study

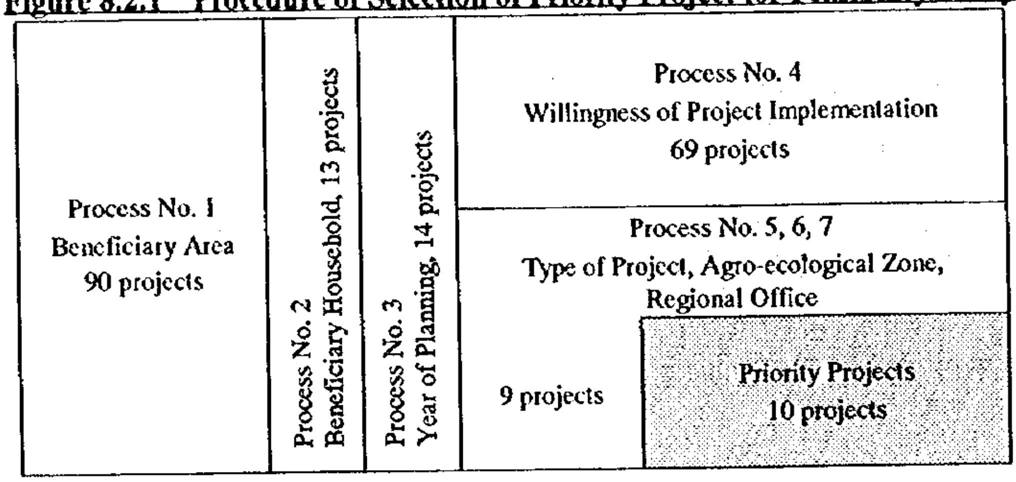


Table 8.2.1 Outline of 19 Candidate Priority Projects

Name of Project	Region	Province	District	Village	Agro-Ecological Zone	Study Stage	Beneficiary Area (ha)	Beneficiary Household	Project Type
URUNLU	KONYA	KONYA	CUMRA	URUNLU	3 - 2	DD	465	50	Ground water
ASLANLAR	IZMIR	IZMIR	TORBALI	ASLANLAR	1 - 2	PR	244	350	Ground water
K.KARISTIRAN	ISTANBUL	KIRKLARELI	LULEBURGAZ	K KARISTIRAN	1 - 1	DD	120	84	Ground water
MULATLAR	ESKISEHIR	AFYON	IHSANIYE	MURATLAR	3 - 2	PR	139	103	Ground water
S.KOYLERI	ANKARA	BOLU	SEBEN	KOYLERI	3 - 1	PR	2,050	450	Small Dam
KALESEKISI	ADANA	ADANA	SAIMBEYLI	KALESEKISI	1 - 3	PR	210	250	Small Scale I.
HACILAR	ANKARA	KIRIKKALE	KESKI	HACILAR	3 - 1	PR	200	500	Small Scale I.
AYDINLAR	BURSA	BURSA	IZNIK	AYDINLAR	1 - 1	DD	250	80	Small Scale I.
KOZLUK-KUSCA	SAMSUN	SAMSUN	TERME	KOZLUK	2	PR	862	640	Small Scale I.
KUSKARA	KASTAMONU	KASTAMONU	MERKEZ	KUSKARA	2	PR	80	35	Soil Conservation
ESENKOY	IZMIR	MUGLA	FETHIYE	ESENKOY	1 - 2	DD	250	120	Soil Conservation
TASCILI	ADANA	ICEL	MERKEZ	TASCILI	1 - 3	DD	260	200	Small Scale Dam
INCESU	KASTAMONU	KASTAMONU	TASKOPRU	INCESU	2	DD	150	140	Small Scale Dam
OZDENK	ESKISEHIR	ESKISEHIR	ALPU	OZDENK	3 - 1	PR	172	75	Small Scale Dam
YUKARI YAPICI	BURSA	BALIKESIR	ERDEK	YUKARIYAPICI	1 - 2	DD	620	380	Small Scale Dam
ASAGICAVAS	BURSA	CANAKKALE	YENICE	ASAGICAVAS	1 - 2	PR	240	445	Small Scale Dam
ILYASKOY	BURSA	YALOVA	CIFTLIKKOY	ILYASKOY	1 - 1	PR	137	120	Small Scale Dam
CAYDIBI	SAMSUN	AMASYA	TASOVA	CAYDIBI	3 - 3	DD	231	500	Small Scale Dam
CAMLIBEL	SIVAS	TOKAT	MERKEZ	CAMLIBEL	3 - 3	PR	1,100	177	Land Consolid.

8.3 Priority Project for Feasibility Study

Ten priority projects for feasibility study, which have been selected from the candidates as stated in 8.2, are shown in Table 8.3.1. Each of these projects are selected from the different regions, all types of projects except drainage are represented by these ten projects, covering all agro-ecological zones found in the study area, all the selected ones are recently planned, in 1992 or later and the beneficiaries of which have expressed willingness to project implementation. Besides, in these projects all types of major target crops for irrigation with all irrigation systems have been designed. The distribution of the proposed priority projects among agro-ecological zones concerned are as below:

Agro-Ecological Zone		Number of Proposed Priority Projects
1 - 1	Marmara Sea Zone	2
1 - 2	Aegean Sea Zone	1
1 - 3	Mediterranean Sea Zone	1
2	Black Sea Zone	2
3 - 1	Central Anatolian Zone	2
3 - 2	Central-South Anatolian Zone	1
3 - 3	Central-East Anatolian Zone	1

Table 8.3.1 Ten Proposed Priority Projects for Feasibility Study

Name of Project	Region	Province	District	Village	Agro-Economic Zone	Study Stage	Beneficial Area (ha)	Project Type
HACILAR	ANKARA	KIRIKKALE	KESKI	HACILAR	3-1	PR	862	Small Scale I.
URUNLU	KONYA	KONYA	CUMRA	URUNLU	3-2	DD	465	Ground water
KALESEKISI	ADANA	ADANA	SAIMBEYLI	KALESEKISI	1-3	PR	210	Small Scale I.
CAMLIBEL	SIVAS	TOKAT	MERKEZ	KYARABANSARAY	3-3	PR	1,100	Land Consolid.
KOZLUK	SAMSUN	SAMSUN	TERME	KOZLUK	2	PR	550	Small Scale I.
KUSKARA	KASTAMONU	KASTAMONU	MERKEZ	KUSKARA	2	PR	80	Soil Conserv.
OZDENK	ESKISEHIR	ESKISEHIR	ALPU	OZDENK	3-1	PR	172	Small Dam
ASLANLARK	IZMIR	IZMIR	TORBALI	ASLANLAR	1-2	PR	244	Ground water
ILYASKOY	BURSA	YALOVA	CIFTLIKK	ILYASKOY	1-1	PR	137	Small Dam
K.KARISTIRAN	ISTANBUL	KIRLARELI	LULUBURGAZ	K.KARISTIRAN	1-1	DD	120	Ground water

PART II FEASIBILITY STUDY

CHAPTER 1 THE STUDY AREA

1.1 Physical Features

1.1.1 Location and Topography

(1) Hacilar Project (Pump)

Hacilar town, in which the project site is included, is connected to the center of Kýrýkkale province with 17 km asphalt road. The project site is accessible throughout year. The project area's latitude is N39°40' and longitude is E33°30'. The topography of the project area can be defined as undulating. The major surface water source of the Hacilar town is Kapulukaya Dam which has been in operation since 1989.

The place, at which the pumping station is to be installed, is just beside the reservoir of Kapulukaya Dam. The place is located about 3km upstream from the dam body, and the elevation is about 720m. The slope of the abutment is very steep, giving approximately 40% inclination. The highest elevation of the hill, at the foot of which the pumping station is to be constructed, is 857.21m.

The altitude of the project area is changing between 724-800m. The irrigable area is divided into six categories in terms of agricultural usage. The first class land is nearly flat with an inclination of 2-3 %, and the area is as small as about 60ha. The second class land is nearly flat with an inclination of 2-6%, occupying large area of about 510ha, and the third class land has an inclination of 6-8 % with approximately 550ha.

(2) Urunlu Project (Groundwater)

The project area, which is to be irrigated by groundwater, is approximately 55 km away from the center of Konya province. Ürünlü village is connected to Çumra administrative district center with 10 km conventional asphalt road. The highest altitude in the project area is 1012m and the lowest is 1005m. Latitude of the project area is N37°40' and the longitude is E32°50'.

The land is mostly flat with an inclination changing gradually between 0 to as much as 2%. Also, observed are parts in deferent areas being slightly undulating with about 1% inclination.

(3) Kalesekisi Project (Pump)

The project area is located, with a coordinate of N37°50' and E36°10', at a distance of 156 km from the center of Adana province. Though the road connecting Adana and Saimbeyli, in which Kalesekisi villagers live, is asphalt paved, it takes more than three hours by an automobile because the road is of mountainous one. The road between Saimbeyli and the irrigation area is unpaved, and the inclination is steep since the irrigation area is located on a steep slope.

The area, at which pumping station is to be constructed, is just beside Kirkok river flowing throughout year. There are small plots, having relatively flat topographic condition, at both sides of the river. The pumping station will be constructed on such small flat plot.

The irrigation area is located on the eastern side slope of a valley stretching towards south. The elevation starts with as low as 800m and reaches as high as 1300m, giving fairly steep inclination. The irrigation area is broadly divided into two parts, both of which are separated by a ridge, and the parcels, to which the irrigation is introduced, are scattered on the parts.

(4) Çamlibel Project (Land Consolidation)

The project site is located alongside the Fineze river in Çamlibel plain. The latitude of the project area is approximately N40°05' and the longitude is E36°29'. Regarding the topography of the project site, about 90 % of the area is plain with an inclination changing between 0 to 2%, while 10% of the area is a little sloppy with small undulating. The average altitude is approximately 1130m. The highest hill is Gürcütepe (1951m) that is included in the Güzelce dam basin.

As to transportation to the village, any difficulty is not found. The village is connected to Tokat province with asphalt road, and nearly all roads between districts and towns, and between towns and Tokat province are asphalt. However, the village roads are just stabilized ones and become muddy during winter season due to snowfalls.

(5) Kozluk Project (Weir)

The project site is located near Black Sea, and about 80km away from Samsun towards east. Latitude of the project area is N41°07' and the longitude is E37°07'. The transportation is well kept throughout year between the village and other areas. The main road leading to Samsun is asphalt paved, and the road connecting the main road and the village is also conventionally paved. However, the condition of the road is not well kept, therefore maintenance work is required.

The irrigation area is in an elevation range between 50m to as low as 1m. The topographic condition in lower elevation area is very flat, suitable for paddy cultivation, and it becomes relatively steep and undulating as one goes to higher elevation. The weir is to be constructed in a place about 7km upstream from Black Sea. Fairly hard foundation shows up at the both sides of the river, and western downstream side of the river is characterized with very steep slope, giving difficulty of constructing canal.

(6) Kuskara Project (Land Conservation)

The project area is the land of Kastamonu-Merkez-Kuskara village at a coordinate of N41°30' and E34°00'. The village is connected to the center of the province with a 13 km of asphalt paved way, and accessible throughout year. The project area is located south of the village with the elevation between 670 and 700m.

The village has a total land of 250 ha, 81 ha of which had been opened for irrigation between the years 1992 to 1994, and a total of 117ha, including this 81ha, is the project area. The 117 ha, land conservation area, is categorized into two such as Class II (37%) and III (63%) in terms of land classification. The slope of Class II land is about 5 to 6% and there are uneven topographic condition. Class III's slope is about 8% to as steep as 9%, causing land erosion with irrigation water applied.

(7) Ozdenk Project (Dam)

The project site is located, with a coordinate of N39°50' and E31°00', about 3km away from Ozdenk village that is the beneficiary. The village is connected to Eskisehir with 53km asphalt-paved-road and 13km with conventionally paved-road. The accessibility, to the village and the dam site, is kept throughout year.

The elevation of the dam site is about 1000m at its river bed, and the both abutments are relatively steep, about 1 vertical to 2 horizontal slope, giving good topographic condition as a dam site. The river branches into two at its upstream of 400m from the dam axis. The catchment area extends towards NNE, occupying 8.612 km^2. The southern part of the catchment area is characterized with poor vegetation, which requires terrace and/or reforestation, while the northern part is covered with good vegetation like trees.

The irrigation area starts at just downstream of the dam, and runs along the river-sides. The irrigation land is composed of alluvial and terraces deposit, originating in river sedimentation. The topography is gentle, and the elevation goes down as one goes to downstream. The lowest elevation in the irrigation area is about 890m. The slope is nearly flat in the central part of the irrigation area, which runs along the river, and changes up to about 8% inclination beside the foothills.

(8) Aslanlar Project (Groundwater)

Aslanlar village is connected to the center of Izmir-Torbali district with a distance of 7 km, and 45 km to the center of Izmir province via an asphalt road with good condition. The latitude of the project area is N38°10', and longitude is E27°27'. To the east of the project area, there is Taþkesik village and Balýk mountain (97m), while there is Fetrek stream to the west. There is mountain named Burgur with the elevation of 392m in north and Pehitler village is located in south of the project area.

The project area is located in a plain, however the topography varies in different parts. The altitude is about 60m in the north of the project area, and is about 30m in the south of the project area, giving about 30m elevation difference between the highest and the lowest of the project area. Accordingly, the inclination is about 0.2% from north to south.

(9) Ilyaskoy Project (Dam)

Latitude of the project area is N40°35' and the longitude is E29°26'. Ilyaskoy village is connected to the center of Yalova province with 24 km asphalt road. The village is accessible every season. The dam is located about 1 km from Ilyaskoy village. The road is conventional asphalt paved and the accessibility is available throughout year. The irrigation area is located on the hills downstream from the dam, and the topography is undulating specially for the north-eastern area.

The elevation of the dam site is about 225m. The slope of the abutments is 1 vertical to 8 horizontal for the northern side and 1 to 7 for the southern side, giving relatively gentle slope as a dam site. The catchment area is 4.3 km^2, stretching towards ESE, and mostly covered with forest.

(10) K. Karistiran Project (Groundwater)

The project area is located between Luleburgaz and Çorlu, 5 km to the north of E-5 Highway. Regarding transportation, the accessibility is kept throughout year from the highway to the village. However, there may be a need for road improvement in the project area since the farm road becomes muddy during rainy season.

The latitude of the project area is N41°19' to N41°30' and the longitude is E27°31' to E27°34'. Altitude of the project area is approximately 117m, and the lowest spot height is 90m. The land in the project area is nearly flat with an inclination of 1-2 %. There are places gently sloping or depleting with a slope changing between 2% to as steep as 4 %.

1.1.2 Meteorology and Hydrology

(1) Hacylar Project (Pump)

Central Anatolian Continental Climate prevails around the project area. Summarized below are such climatic data as precipitation, temperature, relative humidity, wind velocity, and sunshine duration, those of which have been observed at Keskin station (No. 730):

Table 1.1.1 Summary of Meteorological Records at Keskin (No.730)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	225.0 (1956)	596.7 (1990)	401.5	1956-1994 (n=39)
Monthly Average Temp., °C	-3.1 (Jan)	18.7 (Jul)	7.9	
Monthly Minimum Temp., °C	-5.0 (Jan)	14.7 (Jul)	5.1	
Monthly Maximum Temp., °C	2.4 (Jan)	27.8 (Jul)	15.9	
Monthly Relative Humidity, %	50 (Aug)	76 (Dec)	62	
Monthly Wind Velocity, m/s	2.2 (Nov)	4.2 (Jul)	2.9	
Monthly Sunshine Duration, hr/day	2.9 (Dec)	12.2 (Jul)	7.2	

Annual precipitation ranges from 225 to 597mm with its average of 402mm. Summer season's monthly rainfalls are 29mm (Jun.), 9mm (Jul.), 6mm (Aug.), and 16mm (Sep.) only, requiring supplemental water for crop growing. Mean monthly average temperature is 7.9°C with its minimum of -3.1°C and maximum of 18.7°C. Relative humidity varies in a small range and the mean is 62%. Mean monthly wind velocity is 2.9m/s and sunshine duration ranges widely between 2.9 hours/day and 12.2 hours/day with its mean of 7.2 hours/day.

(2) Urunlu Project (Groundwater)

The project site has the characteristics of the Central Anatolian Continental Climate. Shown below are the annual precipitation and other major climatic records at Cumra station (No. 900) except sunshine duration. The sunshine duration was taken from Konya station (No.244):

Table 1.1.2 Summary of Meteorological Records at Cumra (No. 900)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	118.4 (1941)	502.1 (1976)	301.9	1929-1994 (n=27)
Monthly Average Temp., °C	-3.4 (Jan)	17.8 (Jul)	6.8	
Monthly Minimum Temp., °C	-4.8 (Jan)	14.3 (Jul)	4.8	
Monthly Maximum Temp., °C	3.9 (Jan)	29.6 (Jul)	17.7	
Monthly Relative Humidity, %	54 (Aug)	79 (Dec)	66	
Monthly Wind Velocity, m/s	0.7 (Sep)	1.4 (Apr)	1.0	
Monthly Sunshine Duration, hr/day	3.2 (Dec)	12.0 (Jul)	7.5	Konya Station (244)

Small amount of rainfall predominates the area, ranging from 118mm to 502 mm annual rainfall with the mean of 302mm only. Summer season's rainfalls are very little such as 19mm (Jun.), 4mm (Jul.), 2mm (Aug.), and 6mm (Sep.), totaling to about 30mm only. Mean monthly average temperature is 6.8°C with its minimum of -3.4°C and maximum of 17.8°C. Relative humidity is between 54 to 79% with the mean of 66%. Mean monthly wind velocity is 1.0m/s and sunshine duration ranges widely between 3.2 hours/day and 12.0 hours/day with its mean of 7.5 hours/day.

(3) Kalesekisi Project (Pump)

This project area is located in a climatic zone of Mediterranean. Table 1.1.3 below summarizes precipitation recorded at Saimbeyli (No.1880) and others at Goksun (No.866):

Table 1.1.3 Summary of Meteorological Records

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	556.6 (1964)	1446.4 (1976)	890.8	1957-1994 (n=38)
Monthly Average Temp., °C	-4.1 (Jan)	21.2 (Jul)	8.9	
Monthly Minimum Temp., °C	-9.1 (Jan)	11.3 (Jul)	2.0	
Monthly Maximum Temp., °C	1.0 (Jan)	29.1 (Aug)	15.7	
Monthly Relative Humidity, %	55 (Jul)	80 (Dec)	69	
Monthly Wind Velocity, m/s	1.8 (Jan)	2.8 (Jul)	2.2	
Monthly Sunshine Duration, hr/day	3.4 (Jan)	12.6 (Jul)	7.7	

The rainfall is more than that of Central Anatolian Continental Climate, giving annual precipitation between 557 to 1446mm with its average of 891mm. Summer season's rainfall from June to September is about 74mm, which could consist of a part of crop water requirement. Mean monthly average temperature is 8.9°C with its minimum of -4.1°C and maximum of 21.2°C. This temperature is low for Mediterranean climate, since the elevation is high of 1344m. Relative humidity ranges from 55 to 80%, and the mean is 69%. Mean monthly wind velocity is 2.2m/s and sunshine duration varies widely between 3.4 hours/day and 12.6 hours/day with its mean of 7.7 hours/day.

The source of this project is Kirkok River, from which water is taken by means of pump. Although no flow measurement has been conducted, it is well-known that the river flows throughout year and the runoff even during summer season could be more than hundreds litters per second. The water comes from Karst geological formation and this gives relatively stable flow throughout year. The catchment area at the planed pumping station is 42.7 km^2. According to the villagers, April usually has maximum discharge, the depth of which is about 0.7 to 1.0m only.

(4) Camlibel Project (Land Consolidation)

Central Anatolian Continental Climate is prevailing at and around the project area. Summarized below are such climatic data as precipitation recorded at Camlibel (No.1290), and temperature, relative humidity, wind velocity, and sunshine duration, those of which have been observed at Tokat station (No. 86):

Table 1.1.4 Summary of Meteorological Records

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	300.2 (1965)	568.9 (1958)	390.2	1956-1976 (n=15)
Monthly Average Temp., °C	1.8 (Jan)	21.8 (Jul)	12.3	
Monthly Minimum Temp., °C	-1.6 (Jan)	15.2 (Jul)	7.0	
Monthly Maximum Temp., °C	5.9 (Jan)	28.7 (Aug)	18.2	
Monthly Relative Humidity, %	57 (Aug)	70 (Dec)	62	
Monthly Wind Velocity, m/s	2.0 (Oct)	2.9 (Mar)	2.4	
Monthly Sunshine Duration, hr/day	2.3 (Dec)	9.2 (Aug)	5.9	

The amount of annual rainfall in this area is small as expected for Central Anatolian Continental Climate, showing the mean of 390mm only. Summer season's rainfalls are very little such as 42mm (Jun.), 5mm (Jul.), 4mm (Aug.), and 16mm (Sep.), which are almost negligible for crop growing. Mean monthly average temperature is 12.3°C with its minimum of 1.8°C and maximum of 21.8°C. Relative humidity is in a small range of between 57 to 70% with the mean of 62%. Mean monthly wind velocity is 2.4m/s and sunshine duration shows wide range of between 2.3 hours/day in winter and 9.2 hours/day in summer. The mean is 5.9 hours/day.

(5) Kozluk Project (Weir)

This project site falls in coastal area of Black Sea, and enjoys warm temperature and considerable rainfall throughout year. Shown below are the annual precipitation and other major climatic records at Unye station (No. 624):

Table 1.1.5 Summary of Meteorological Records at Unye (No.624)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	731.3 (1955)	1731.8 (1967)	1116.3	
Monthly Average Temp., °C	5.8 (Feb)	21.5 (Jul)	13.1	
Monthly Minimum Temp., °C	4.1 (Jan)	19.4 (Aug)	11.2	
Monthly Maximum Temp., °C	10.2 (Feb)	25.5 (Aug)	17.3	
Monthly Relative Humidity, %	68 (Dec)	82 (May)	76	
Monthly Wind Velocity, m/s	1.9 (May)	2.4 (Jan)	2.2	
Monthly Sunshine Duration, hr/day	2.8 (Dec)	8.6 (Jun)	5.2	

Annual precipitation ranges from 731 to as much as 1731mm, and the mean is 1116mm. The rain falls more during winter season and less during summer season. Summer season's monthly rainfalls are 66mm (Jun.), 68mm (Jul.), 93mm (Aug.), and 82mm (Sep.), totaling as much as 309mm. This consists of considerable amount for crop growing. Mean monthly average temperature is 13.1°C with its minimum of 5.8°C and maximum of 21.5°C. Mean relative humidity is 76% and mean monthly wind velocity is 2.2m/s. Sunshine duration ranges between 2.8 hours/day and 8.6 hours/day with its mean of 5.2 hours/day, which is shorter than those of other project areas.

The irrigation water is taken from Akcay river which flows throughout year. The catchment area at the weir site is 220 km^2, and the main river channel's length is 42 km with a average slope of 2.2%. Since this project came up in 1978, the runoff of Akcay River had been periodically measured until 1992, in which Planning Report was prepared by GDRS. The measurement had been done at times when the river gave little discharge mostly during dry season corespondent to the irrigation period. Total 16 measurements had been done in 8 years, and these are shown below with dry season's and annual rainfall corespondent to the year. The minimum runoff among the measured and minimum in July, requiring peak irrigation water requirement, are 470 l/s and 850 l/s respectively, as indicated below:

Table 1.1.6 Measured Runoffs, l/s

Date	Runoff, l/s	Dry Season Rain	Annual Rain	Remarks
7 Nov. 1978	470	513.6	1136.4	Minimum
30 Jan. 1979	2400	347.6	1044.5	
18 Aug. 1979	750			
20 Jul. 1981	1000	644.3	1272.8	
2 Nov. 1981	550			
5 Aug. 1982	800	417.5	979.0	
11 Aug. 1983	700	443.9	1099.2	
30 Sep. 1983	650			
30 Jul. 1984	900	554.0	1038.4	
25 Jun. 1991	1700	556.0	1244.6	
19 Jul. 1991	850			Mini. in July
20 Aug. 1991	650			Mini. in August
30 Oct. 1991	500			
3 Jul. 1992	1500	433.0	1287.1	
10 Aug. 1992	700			
10 Sep. 1992	600			

Note: The rainfall is at Unye (No. 624), and dry season is between May and October.

(6) Kuskara Project (Land Conservation)

The project site falls in the Central Anatolian Continental Climate. Shown below are the annual precipitation and other major climatic records at Kastamonu station (No. 74):

Table 1.1.7 Summary of Meteorological Records at Kastamonu (No. 74)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	307.7 (1957)	641.0 (1931)	461.7	1930-1994 (n=65)
Monthly Average Temp., °C	-3.3 (Jan)	15.8 (Jul)	6.1	
Monthly Minimum Temp., °C	-5.0 (Jan)	12.0 (Jul)	3.9	
Monthly Maximum Temp., °C	3.0 (Jan)	27.6 (Aug)	16.1	
Monthly Relative Humidity, %	59 (Jul)	81 (Dec)	70	
Monthly Wind Velocity, m/s	1.1 (Oct)	1.7 (Apr)	1.4	
Monthly Sunshine Duration, hr/day	2.3 (Dec)	10.4 (Jul)	6.2	

The amount of annual rainfall in this area is small as shown in the table, ranging between 308mm and 641mm with its mean of 462mm. Summer season's rainfalls are very little such as 67mm (Jun.), 30mm (Jul.), 27mm (Aug.), and 25mm (Sep.), which are almost negligible for crop growing. The temperature is cold: mean monthly average temperature of 6.1°C with its minimum of -3.3°C and maximum of 15.8°C. Relative humidity ranges between 59 to 81% with the mean of 70%. Mean monthly wind velocity is 1.4m/s and sunshine duration shows wide range of between 2.3 hours/day in winter and 10.4 hours/day in summer. The mean is 6.2 hours/day.

(7) Ozdenk Project (Dam)

The project site has the characteristics of the Central Anatolian Continental Climate. Shown below are the annual precipitation recorded at Alpu station (No. 1386) and other major climatic records at Eskisehir station (No. 706):

Table 1.1.8 Summary of Meteorology Records

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	281.5(1955)	511.8(1991)	368.9	1954-1996 (n=35)
Monthly Average Temp., °C	-0.4 (Jan)	21.3 (Jul)	10.7	
Monthly Minimum Temp., °C	-4.4 (Jan)	12.6 (Jul)	3.9	
Monthly Maximum Temp., °C	4.0 (Jan)	29.0 (Jul)	17.4	
Monthly Relative Humidity, %	53 (Jul)	77 (Dec)	64	
Monthly Wind Velocity, m/s	1.2 (Oct)	2.3 (Mar)	1.8	
Monthly Sunshine Duration, hr/day	2.4 (Dec)	11.9 (Jul)	6.8	

Annual precipitation ranges from 282 to 512mm with its average of 368mm. Summer season's monthly rainfalls are 24mm (Jun.), 11mm (Jul.), 11mm (Aug.), and 12mm (Sep.) only, requiring supplemental water for crop growing. Mean monthly average temperature is 10.7°C with its minimum of -0.4°C and maximum of 21.3°C. Relative humidity varies in a small range and the mean is 64%. Mean monthly wind velocity is 1.8m/s and sunshine duration ranges widely between 2.4 hours/day and 11.9 hours/day with its mean of 6.8 hours/day.

The source of the irrigation is Ozdenk River which is seasonally flowing. The river usually starts flowing at the beginning of November and the flow peak shows up in March. The flow, then, becomes less and finally stops flowing in June. Periodical runoff measurement has not been done, however GDRS once carried out the measurement throughout the rainy season in 1995 to 1996. According to the measurement, the discharge between November in 1995 and May in 1996 was 808,000 m^3, arriving at 93.8 mm taking into the catchment area of 8.612 km^2.

(8) Aslanlar Project (Groundwater)

This project area is located in a climatic zone of Mediterranean. Table 1.1.9 below summarizes precipitation recorded at Torboli (No.1663) and others at Selcuk (No.854):

Table 1.1.9 Summary of Meteorological Records

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	393.7 (1992)	1024.2 (1978)	682.0	1953-1994 (n=34)
Monthly Average Temp., °C	7.8 (Jan)	26.1 (Jul)	16.2	
Monthly Minimum Temp., °C	3.2 (Jan)	16.6 (Jul)	9.3	
Monthly Maximum Temp., °C	13.3 (Jan)	33.1 (Jul)	23.1	
Monthly Relative Humidity, %	53 (Jul)	71 (Dec)	64	
Monthly Wind Velocity, m/s	1.7 (Oct)	2.4 (Feb)	2.1	
Monthly Sunshine Duration, hr/day	4.1 (Dec)	11.9 (Jul)	7.8	

Annual precipitation is between 394mm and 1024mm with its mean of 682mm. Summer season's monthly rainfalls are 10mm (Jun.), 3mm (Jul.), 1mm (Aug.), and 11mm (Sep.), those of which are negligible for crop growing. Temperature in this area is relatively warm, and the mean monthly average temperature is 16.2°C with its minimum of 7.8°C and maximum of 26.1°C. Relative humidity varies in a small range and the mean is 64%. Mean monthly wind velocity is 2.1m/s and sunshine duration ranges between 4.1 hours/day and 11.9 hours/day with its mean of 7.8 hours/day.

(9) Ilyaskoy Project (Dam)

The project site has the characteristics of the Central Anatolian Continental Climate. Shown below are the annual precipitation and other major climatic records summarized based on the data at Yaloba station (No. 660):

Table 1.1.10 Summary of Meteorological Records at Yaloba (No. 660)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	463.9 (1934)	1146.0 (1981)	732.9	1930-1994 (n=51)
Monthly Average Temp., °C	3.3 (Feb)	23.0 (Jul)	14.0	
Monthly Minimum Temp., °C	2.9 (Jan)	17.4 (Jul)	10.0	
Monthly Maximum Temp., °C	9.6 (Jan)	27.4 (Jul)	18.5	
Monthly Relative Humidity, %	75 (Jul)	78 (Nov)	76	
Monthly Wind Velocity, m/s	1.4 (May)	2.3 (Dec)	1.8	
Monthly sunshine Duration, hours	1.8 (Dec)	9.7 (Jul)	5.7	

Annual precipitation is in a range of 464mm to 1146mm with its mean of 733mm. Summer season's monthly rainfalls are 37mm (Jun.), 24mm (Jul.), 24mm (Aug.), and 50mm (Sep.), totaling to 135mm. This area's temperature is relatively warm comparing to other Central Anatolian Continental zones. The mean monthly average temperature is 14.0°C with its minimum of 3.3°C and maximum of 23.0°C. Mean relative humidity is 76% and mean monthly wind velocity is 1.8m/s. Sunshine duration ranges between 1.8 hours/day and 9.7 hours/day with its mean of 5.7 hours/day.

The source of the irrigation is Orencik River. There is a continuous flow throughout year though summer season's flow is very little amount often less than 1 l/s. This is probably because the catchment area is well covered with forest and could arrest rainfall in the ground. There is no other river flowing throughout year around Ilyaskoy. The Orencik River has no any runoff measurement. Based on the interview to the villagers, the maximum water depth during rainy season reaches to as high as about 1m, just overflowing the river channel of approximately 0.6m (depth) x 2.0m (width).

(10) K. Karistiran Project (Groundwater)

This project area falls in a climatic zone of Mediterranean. Summarized are annual precipitation, temperature, relative humidity, and wind velocity recorded at Lureburgaz (No.3002), and sunshine duration recorded at Goztepe (No.62):

Table 1.1.11 Summary of Meteorological Records at Lureburgaz (No. 3002)

	Minimum	Maximum	Mean	Remarks
Annual Precipitation, mm	324.6 (1948)	877.8 (1940)	591.8	1930-1994 (n=60)
Monthly Average Temp., °C	3.0 (Jan)	23.0 (Jul)	12.9	
Monthly Minimum Temp., °C	-0.8 (Jan)	14.4 (Jul)	6.7	
Monthly Maximum Temp., °C	6.9 (Jan)	30.3 (Jul)	19.1	
Monthly Relative Humidity, %	60 (Jul)	83 (Dec)	73	
Monthly Wind Velocity, m/s	1.4 (Aug)	2.1 (Mar)	1.6	
Monthly Sunshine Duration, hr/day	2.4 (Jan)	11.1 (Jul)	6.4	Goztepe (No.62)

Annual precipitation varies from 325mm to 878mm, and the mean is 592mm. Summer season's monthly rainfalls are 47mm (Jun.), 26mm (Jul.), 16mm (Aug.), and 27mm (Sep.), totaling to 116mm. Mean monthly average temperature is 12.9°C with its minimum of 3.0°C and maximum of 23.0°C. Mean relative humidity is 73% and mean monthly wind velocity is 1.6m/s. Sunshine duration ranges between 2.4 hours/day and 11.1 hours/day with its mean of 6.4 hours/day.

1.1.3 Geology and Hydrogeology

Geology and hydrogeology is described for the three groundwater projects, the two dam projects, and one weir project in Samsun, those foundations of which require considerations:

(1) Urunlu Project (Groundwater)

Preceding this project, wells shown below were opened in and around the project area during the previous years:

Table 1.1.12 Summary of Previously Opened Wells in and around the Project Area

DSI Well No.	Depth, m	Static Level, m	Dynamic Level, m	Yield, l/s
21828	169	10	14	50
25481	164	15	21	33
39100	150	1	9	51

The typical lithology obtained for above wells is: surface soil with about 1m depth, clayey soil to the depth of about 15m, marl to the depth of 45m, limestone to the depth of 120m, and claystone downward. The aquifer, which has been identified in the light of the data above, is limestone. Taking into consideration the characteristics, the wells which had been required for this project were designed as shown below and already opened in 1996 & 1997:

Well depth:	150 m
Yield:	50 l/s
Average static level:	10 m
Average dynamic level:	20 m
Manometric head:	30 m

(2) Aslanlar Project (Groundwater)

In the general geological stratigraphy of the project area and its surroundings, the Paleozoic aged schist and marble formation form the foundation rock, belonging to the meander crytal massif. On top of the formation, Cenozoic aged formation come, and Neogenic limestone, marl, clay and conglomerate formation continue in this series. The Quaternary aged alluvium is at the top, and is usually very clayey and is little sandy and gravelly.

The project area has two formations, which can yield water, such as Neogenic aged conglomerates and Paleozoic aged marbles. Both formations, having a fissured, cracked, and cavernous geological structure, create a suitable aquifer for this project. There are two wells, which had been opened, for the purpose of researching the aquifers (These were undertaken in this project). The characteristics are as follows:

Table 1.1.13 Summary of Previously Opened Wells

DSI Well No.	26907	35493
Well depth, m	69.5	75.0
Yield, l/	50	40
Static level, m	4.4	10.5
Dynamic level, m	8.5	28.6
Transmissibility, m^3/day/m	7181	505
Year opened	1979	1986
Aquifer	Neogenic Conglomerate	Palezoic marble

For well No. 26907, the lithology is boulder aggregate up to 10m depth, and from 10m to the bottom it goes down in conglomerate. Well No.35493 has the lithology of aggregate up to 12m depth, and then marbles formation follows. Taking above into consideration, there are two aquifers that support this project.

(3) K. Karistiran Project (Groundwater)

In Ergene river basin and its around, there is Babaeski formation, belonging to Pliocene, which is composed of clay, silt and sand. The formation that usually consists of yellow clay, with silt and clay belt, reaches as thick as 100m. Corlu formation exists below the Babaeski formation. The Corlu formation is composed of fine sand, coarse sand, fine gravel, clay and silt in a form of layers.

The groundwater in and around the project area is found in the alluvium and in Corlu formation. There are tens of wells that had been opened around the project area, and those wells are not close to each other. The aquifers are all Corlu formation, and the characteristics of some wells are shown below:

Table 1.1.14 Summary of Previously Opened Wells around the Project Area

DSI Well No.	Depth, m	St. Level, m	Dy. Level, m	Yield, l/s	Remarks
39039	250			40	Kirikoy
39040	252			40	Kirikoy
39041	249			40	Kirikoy
39042	252			40	Kirikoy
3336-A	300	21.8	55.0	35	Ahmetbey
10773	200	12.4	25.0	39	Evrensokiz
34848	200	15.1	20.7	46	Pinarbasi
34844	200	20.1	30.5	48	Pinarbasi

(4) Ozdenk Project (Dam)

The oldest unit in the area is schist belonging to Palaeozoic era, and its outcrops can be seen at the upper heights of the catchment area. This geological formation bears the characteristics of micaceous schist, chlorite schist, and has a metamorphic structure. Advanced schistosity is observed. These shists have no relation with the dam and reservoir areas, giving no outcrops there. These bear the traces of tectonic effect and they have been exposed to the fractured.

Neocene sediments, which are widespread in the area, lays on the schists discordantly with its base conglomerate. Base conglomerate is represented with red clay, marl, and limestone with marl. However, there is no base conglomerate in the dam and reservoir area. Whole area of the dam and the reservoir is covered with gravel, sand, and silt. At the higher elevation (over the dam crest height), there are marl and limestone with marl. The correlation between upper alluvium and lower schist units and the Neocene sediments, having usually a horizontal shape, is discordant. The sediments, which are widespread in the area, have not been exposed to tectonic movements since they belong to Quaternary geological period. Generally they preserve their original position, and their layer inclinations are nearly horizontal with the direction of NW.

Alluvium belonging to Quaternary geological era is seen in the river-beds and the bottom of valleys. This spreads on the lower unit with discordance. The thickness is changing between

5 to 14m. The unit was formed as a result of the conveyance, erosion, and accumulation of the rocks, and composed of schist and quartz gravel.

Total seven number of drilling boreholes have been carried out, 5 of which in 1984, and 2 of which in 1989. The dam site geologically consists of red silt clay with sand and gravel belonging to Neocene period. The clay layer is very hard and consolidated and spreads as far as above crest height. At upper levels, transition to marl and limestone with marl is seen. There is alluvium having a thickness changing between 5 to 14m in the river-bed. With the boreholes drilled, permeability tests had also been carried out. The results were nearly impermeable, giving the permeability coefficients of $K=10^{-5}$cm/sec order except upper weathered zones and alluvium. The weathered and alluvium zones will be excavated off.

The geology of the reservoir area is the same as the dam site. Whole reservoir area is covered with Neocene sediments. Lower area consists of red colored sandy silt clay layer, and it will be in touch with the water in the whole reservoir area. Other lithology will not be in touch with the water. Minor erosion and collapse would occur with the effect of the water rising and lowering.

(5) Ilyaskoy Project (Dam)

Sarmaciene, including Pleocene aged deposits, outcrops in Armutlu peninsula, and it is formed with marl, clay, limestone, rarely conglomerate, and sand stone lithologies. Fossils are sometimes found. Terrestrial Pleocene can be distinguished in between Yalova - Cinarcik in southeast of Izmit Gulf, northeast and northwest of Iznik Lake. The formation is made with conglomerate, sandstone, clay, marl and lake limestone. Pleocene aged fossils are found in marled limestone in Yaloba-Orhangazi road.

Alps orogenic era activity has affected the formations distinguishably in the project area, which is considered to be the front of the Plate Tectonics. E-W and SW-NE directional movements are present in some fractured lineaments. Faults are present and probable faults could be found, intersecting each other in south of Yalova thermal springs which are close to the project area.

Total eight number of boreholes had been drilled along the planned dam axis in 1993, reaching a total length of 104m. Miocene aged half-terrestrial deposits are found in the dam site. Two distinct formations are recognized in the Miocene aged deposits. Clay stone and silt stone overlap and some sand and gravel stone are met in the places close to the surface. Marl had penetrated through under this section. In the river bed, there is Miocene aged deposits and over them there is Quaternary aged alluvium.

The clay stones and silt stones are seldom cemented. These formations are sometimes petrified and observed as hard clays and silts, in which cracks are often observed. The cracks are usually filled with clay and silt. In all the boreholes, marl was observed under clay stone and silt stone, except in the borehole No. SK.1 covering left abutment crest level. As can be seen from the boring results, sand stones and clay stones are located at 14m maximum depth in SK.2 numbered borehole covering middle of the left abutment.

With reference to the permeability test conducted in the boreholes, Miocene aged marls in the foundation shows impermeable or little permeable having values of 10^{-6} to 10^{-5} cm/s. The permeability of clay stone and silt stone overlap in Miocene aged deposits is: 10^{-4} to 10^{-5} cm/s indicating semi-permeable to impermeable at shallower places, and 10^{-5} to 10^{-8} cm/s of impermeable to little permeable at deeper location. Permeability in shallower places is explained with weathered condition. Quaternary aged alluvium shows 10^{-4} cm/s permeability, requiring excavation-off from the dam foundation.

The geology of the reservoir area is composed of almost same as dam site geological formation. Miocene aged deposits overlap with silt stone and clay stone outcrops in the observed area. Some gravel and sand deposits are also met, and few marl outcrops are present.

(6) Kozuluk Project (Weir)

Volcanic origin agglomerates form the foundation of the site at which Kozuluk weir to be constructed. Though geological mechanical test has not been done, the foundation seems to have enough bearing capacity for the planned weir. On the foundation, there is a series of volcano sediments which are found as mudstone, sandstone and tuff formations. The thickness of the volcano sediments is about 3 to 4m. Since these are not consolidated, they are continuously abraded in the vertical direction by the river. The foundation, originating in agglomerates, can be observed in some part of the riverbed.

1.1.4 Soil

Summary of soil and soil limiting factor was shown to Table 1.1.15. Summary of project areas are as following (details refer to ANNEX G.).

(1) Hacilar Project Area

The soils in this area are distributed into 2(two) types. Main soil group is Brown soils which sloping from 4 to 20%. Soil horizon had medium depth, and medium soil erosion. Soil limiting factors for crop growth aren't problem except soil alkalinity.

The other soil group is Colluvial soils which distributed in the flat area of the project area. Soil fertility is high, and soil limiting factor for crops is nothing.

(2) Urunlu Project Area

The soil in this area is same soil group as Alluvial soils. The topographic condition in almost area is flat, and soil has deep depth and high fertility. The soil presents with alkalinity, because of presence many calcium carbonate concretion in the soil layer. The parts of area contain many gravel on the ground.

(3) Kalesekisi Project Area

The soil in this area is same soil group as Non calcareous brown soils with severe eroded, giving low land capability class because of steep. The soil depth is shallow, having many gravel in the surface and subsurface horizons.

(4) Camlibel Project Area

The soil in this area is same soil group as Alluvial soils with deep soil horizon, and nearly flat topographic condition. The soil texture is loamy, and soil structure develops with comparatively high organic matter content. The salt accumulated soil is observed in the part of lower topographic condition, giving clayey and poor drainage.

(5) Kozluk Project Area

The soils in this area are distributed into 2(two) types, Brown forest soils and Alluvial soils, respectively. Brown soils distribute for gentle land form, having nothing soil limiting factors. And, Alluvial soils in the lower area is drainage problem, causing comparatively high ground water table.

(6) Kuskara Project Area

The soil in this area is same soil group as Brown forest soils with loamy texture, giving gentle land form. The land capability and soil erosion class is moderate, having nothing soil limiting factors.

(7) Ozdenk Project Area

The soil in this area is mainly Colluvial soils, which composed of colluvium from higher topographic area of the circumference, and the part of area distributes Brown soils. Colluvial soils are deep depth, having high land capability class, also soil erosion slightly. The other soil, Brown soils, distributes around of project area, and contains many concretions of calcium carbonate.

(8) Aslanlar Project Area

The soils in this area are distributed into 2(two) types, Alluvial soils and Colluvial soils, respectively. The topographic condition is nearly flat area, having deep soil depth with high land capability class, also soil erosion slightly. This project area hasn't soil limiting factors.

(9) Ilyaskoy Project Area

The soil in this area is Brown forest soils, giving relatively steep. The soil is moderately deep, and clayey texture. In case of dry season, there is fear which suffers damage to plant root, causing soil cracks.

(10) K. Karistiran Project Area

The soil in this area is Vertisole soils, sloping land form slightly. This soil has a characteristic in dark reddish soil color and clayey texture. The project area is high land capability class, and nothing soil limiting factors for crop growth.

Table 1.1.15 Summary of Soil and Soil Limiting Factor

Name of Project	Soil Group	Slope (%)	Land Capability	Soil Depth (cm)	Soil Erosion	Soil Limiting Factor			
						Alkalinity	Salinity	Drainage	Gravel
Hacilar	Brown Soil	4-20	Moderate	Moderate	Moderate	Slight	Nothing	Nothing	Nothing
	Colluvial Soil	0-3	well	Moderate	Slight, Moderate	Slight	Nothing	Nothing	Nothing
Urunlu	Alluvial Soil	2>	Well	Deep	Slight	Slight	Nothing	Nothing	Moderate
Kalesekisi	Non Calcareous Brown Soil	18-30	Severe	Moderate	Severe	Nothing	Nothing	Nothing	Moderate
Camlibel	Alluvial Soil	0-3	Well, Severe	Deep	Slight	Slight	Nothing	Slight	Nothing
Kozluk	Alluvial Soil	2>	Well	Deep	Nothing	Nothing	Nothing	Slight	Nothing
	Brown Forest Soil	10	Moderate	Moderate	Slight	Nothing	Nothing	Nothing	Nothing
Kuskara	Brown Forest Soil	5-9	Well, Moderate	Moderate	Moderate	Nothing	Nothing	Nothing	Slight
Ozdenk	Colluvial Soil	0-6	Well	Deep	Slight	Nothing	Nothing	Nothing	Slight
	Brown Soil	4+	Well, Moderate	Moderate	Moderate	Nothing	Nothing	Nothing	Moderate
Aslanlar	Alluvial Soil	2+	Well	Deep	Slight	Nothing	Nothing	Nothing	Nothing
	Colluvial Soil	2+	Well	Deep	Slight	Nothing	Nothing	Nothing	Slight
Ilyaskoy	Brown Forest Soil	4-15	Well, Moderate	Moderate	Moderate, Severe	Nothing	Nothing	Nothing	Slight
K. Karistiran	Vertisole soil	3-5	Well	Moderate	Moderate	Nothing	Nothing	Nothing	Slight

Note: Soil limiting factor is divided into four levels, nothing, slight, moderate and severe.