C.1.4. Existing Water Supply Systems

(1) Water Production Facilities

a. Transition of Water Production

- Islamabad

There are three kind of water production facilities to water supply for Islamabad proper area, namely reservoir dam, head works and tube wells. The average daily water production and its capacity as of 1986 are 200,800 cmd (44.2 MGD) and 225,100 cmd (49.6 MGD) respectively, as shown in Table C-1-24.

Table C-1-24. Daily Water Production in 1986

(Unit: MLD (MGD))

Name of Source	Average Daily Production	Production Capacity
Simly-Filtration Plant	95.0 (20.9)	109.1 (24.0)
Kurang H.W.	-	11.3 (2.5) 1/
Shahdara H.W.	3.3 (0.7)	11.3 (2.5)
Nurpur H.W.	3.2 (0.7)	3.2 (0.7)
Saidpur H.W.	3.6 (0.8)	3.6 (0.8)
Golf Course H.W. (New)	12.3 (2.7)	12.3 (2.7)
Golf Course H.W. (Old)	10.0 (2.2)	10.0 (2.2)
G-10 H.W.	9.1 (2.0)	11.3 (2.5)
Tuble Wells in National Park Area	34.0 (7.5)	34.0 (7.5)
Tube Wells in Sectoral Area	30.3 (6.7)	30.3 (6.7)
Total:	200.8 (44.2)	225.1 (49.6)

Source: CDA

Note: 1/: Not in operation since 1983 for the preparation of the future expansion.

H.W.: Head Works

Water production in Islamabad Proper Area at present and in past eleven years is shown in Table C-1-25 and Figure C-1-7, respectively.

Table C-1-25. Annual and Average Daily Water Production in Islamabad

Year	Annual Water Production (cum)				Average Daily Production	
	Simly Dam	Tube Wells	Head Works	Total	(cmd)	(mgd)
1976	5,296,700	8,089,215	13,084,390	26,470,305	72,323	(15.91)
1977	5,447,715	8,958,950	13,253,695	27,660,360	75,781	(16.67)
1978	5,964,595	8,801,065	13,366,670	28,132,330	77,075	(16.95)
1979	5,270,720	9,400,755	13,872,950	28,544,425	78,204	(17.20)
1980	8,006,635	12,114,190	14,499,165	34,619,990	94,590	(20.81)
1981	11,991,980	16,032,380	16,391,830	44,416,190	121,688	(26.77)
1982	13,190,905	17,115,735	16,527,420	86,834,060	128,312	(28.23)
1983	15,775,760	17,072,965	16,788,135	49,636,860	135,991	(29.92)
1984	18,268,250	17,902,885	16,735,355	52,906,490	144,553	(31.80)
1985	23,634,520	21,500,155	16,087,890	61,222,565	167,733	(36.90)
1986	34,701,030	23,465,715	15,137,850	73,304,595	200,834	(44.18)

Source: CDA

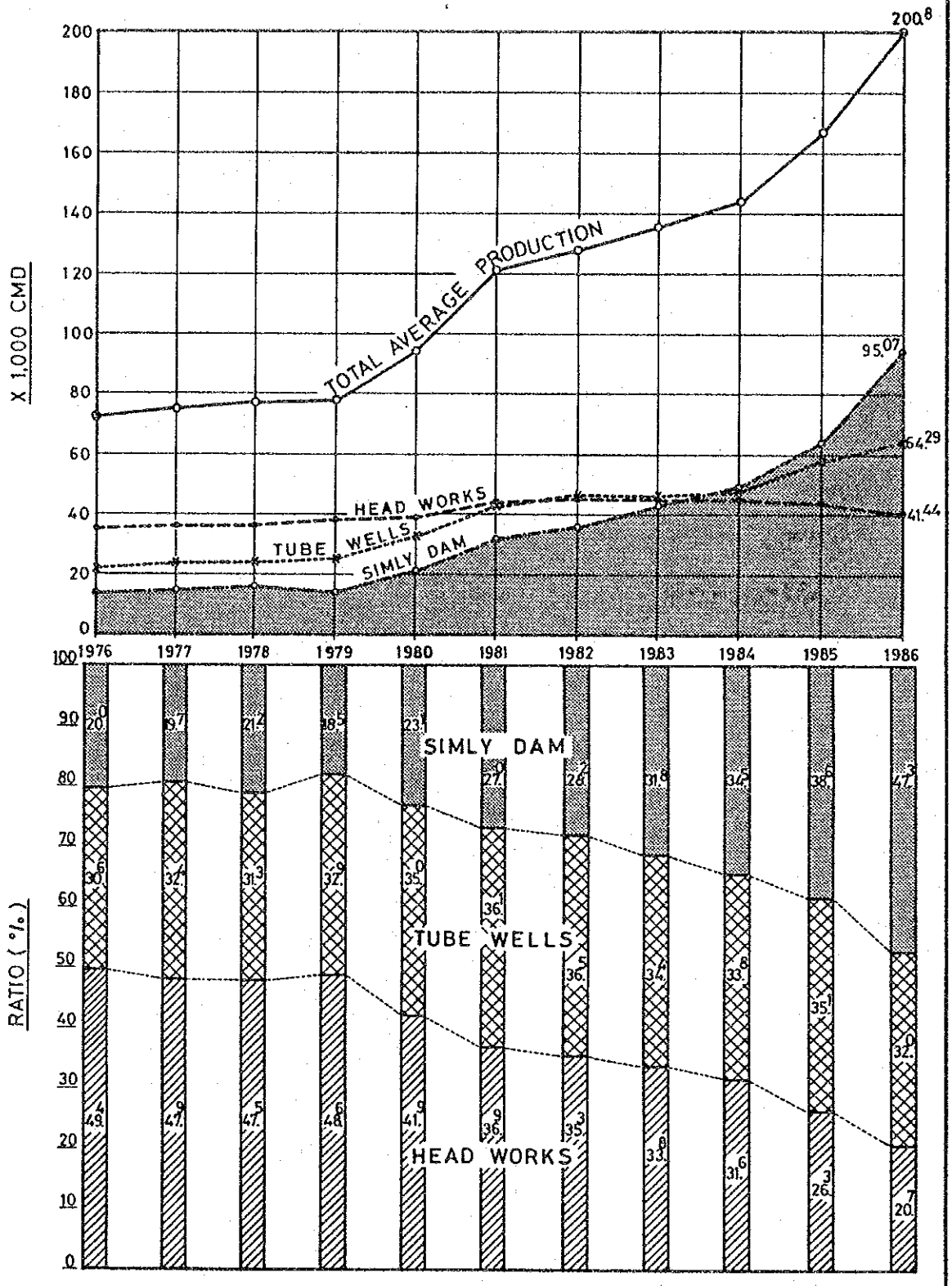
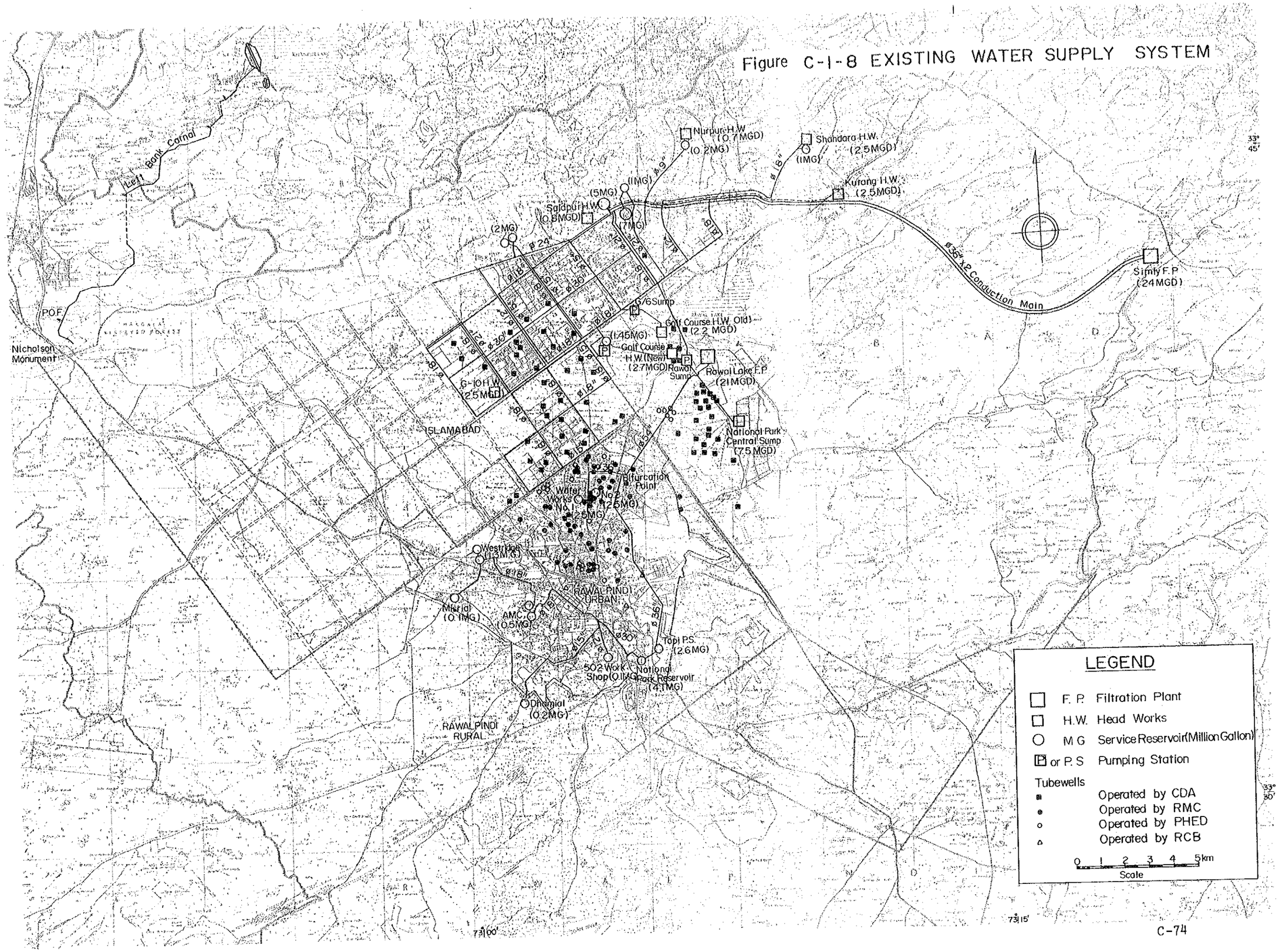


FIGURE C-1-7 **AVERAGE DAILY WATER PRODUCTION BY VARIOUS SOURCES (ISLAMABAD, 1976 - 1986)**

Figure C-I-8 EXISTING WATER SUPPLY SYSTEM



- Rawalpindi

There are two kind of water production facilities to water supply for Rawalpindi urban area, namely reservoir dam and tube wells.

The average daily water production and its capacity as of 1986 are 178,300 cmd (39.2 MGD) and 192,200 cmd (42.2 MGD) respectively, as shown in Table C-1-26.

Table C-1-26. Daily Water Production in 1986 (Rawalpindi Urban)

(Unit: MLD (MGD))

Name of Source	Average Daily Production	Production Capacity
Rawal Lake Filtration Plant	81.7 (18.0)	95.6 (21.0)
Sohan Camp Tube Wells	11.3 (2.5)	11.3 (2.5)
PHED Tube Wells	17.8 (3.9)	17.8 (3.9)
RMC Tube Wells	47.1 (10.4)	47.1 (10.4)
CB Tube Wells	19.3 (4.2)	19.3 (4.2)
MES (Army) Tube Wells	1.1 (0.2)	1.1 (0.2)
Total:	178.3 (39.2)	192.2 (45.2)

Source: PHED, RMC AND MES

Water production in Rawalpindi urban area at present and in past eleven years is shown in Table C-1-27.

Table C-1-27 Annual and Average Daily Water Production for Rawalpindi Urban Area

Year	Water Production (cum)					Average Daily Production	
	Rawal Dam	T/W by PHED	T/W by RMC	T/W by CANTT	Total	(cmd)	(mgd)
1976	23,314,200	3,330,600	8,336,500	2,364,725	37,346,025	102,038	(22.45)
1977	23,250,500	4,151,875	9,915,990	2,358,265	39,676,630	108,703	(23.91)
1978	23,250,500	4,151,875	9,915,990	2,358,265	39,676,630	108,703	(23.91)
1979	25,125,825	4,151,875	10,480,645	2,358,265	42,116,610	115,387	(25.38)
1980	31,136,740	4,163,250	10,518,045	2,364,725	48,182,760	131,646	(28.96)
1981	30,347,090	4,151,875	10,762,970	2,358,265	47,620,200	130,466	(28.70)
1982	29,177,010	4,151,875	12,955,160	2,358,265	48,642,310	133,266	(29.32)
1983	28,936,680	4,151,875	19,780,845	2,574,160	55,443,560	151,900	(33.41)
1984	31,643,745	4,163,250	22,241,755	2,747,745	60,796,495	166,110	(36.54)
1985	31,906,055	4,151,875	22,670,550	3,371,320	62,099,800	170,136	(37.43)
1986	29,820,470	4,151,875	27,735,835	3,371,320	65,079,500	178,300	(39.22)

b. Water Treatment Plant

- Islamabad

There are eight treatment plants including one filtration plant and seven head works out of which one plant is now suspending operation for further expansion of the facilities. The summary of the treatment plants of Islamabad is presented in Table C-1-28 indicating water sources, production capacities, year of construction, etc.

- Simly Filtration Plant

The Simly Filtration Plant, located near by the Simly dam, takes raw water directly from the reservoir through ϕ900 mm transmission mains (two lines). The production capacity of the plant is 24 MGD and the major facilities are distribution wells, flocculation and sedimentation basins, rapid sand filters. The details of the plant facilities is presented in Table C-1-29. Raw water quality shows higher values than normal in pH, total solids, hardness and alkalinity. Such high alkalinity of water is considered to be caused by the geological conditions as limestone strata of mountains extend behind the reservoir. According to CDA, turbidity of raw water ranges 50 to 200 units (JTU). Treated water quality obtained from CDA shows normal turbidity, odor, colour, etc., indicating that purification works are carried out smoothly and satisfactorily.

- Head Works

Head works take raw water from surface water or river-bed water of various streams originated from the Margala range except those at Golf Course Head Works for which raw water

are taken from tube wells and Rawal Lake. A total production capacity of the head works at present is 10.1 MGD. Major facilities of the head works are sedimentation basins and slow sand filters.

- Rawalpindi

Rawal Leake Filtration Plant is only the treatment plant of Rawalpindi. The plant, located near by Rawal dam, takes water from the lake through open canal with the length of about 600 m. The production capacity of the plant is 21 MGD and the major facilities of the plant are similar to the Simly plant. The details of the facilities is also presented in Table C-1-29.

As for the current practice of chemical application, solid Alum and liquid chlorine or bleaching powder are used for coagulant purpose and for disinfection in every treatment plant in both cities.

The prices of solid Alum and liquid chlorine in the project area are Rs. 3,800 to 4,500 per metric ton and Rs.3,000 to 3,500 per 900 kg, respectively. Those chemicals are locally produced within Pakistan and are available from Karachi and Lahore.

Laboratory is provided in Simly and Rawal Lake filtration plants, in which raw water and treated water are analyzed and their data are registered. In addition, CDA has a laboratory at the sewerage plant in Sector I-9.

Table C-1-28 Existing Water Treatment Plants in Islamabad/Rawalpindi

Water Treatment Plant	Water Source	Production Capacity (MGD)	Year of Construction	Treatment Process	Operated By	Expansion Programe
Islamabad						
1. Simly Filtration Plant	Simly Reservoir	24.0	1965 - 7	Sedimentation & rapid sand filtration	CDA	12 MGD by 2000
2. Kurang Head Works	Riverbed Water	2.5 (Not in operation)	1966	Sedimentation & slow sand filtration	CDA	1.5 MGD by 2000
3. Shahdara Head Works	Surface water from stream	2.5	1967	Sedimentation & slow sand filtration	CDA	0.5 MGD by 2000
4. Nurpur Head Works	Riverbed water	0.7	1963	Sedimentation & slow sand filtration	CDA	0.3 MGD by 2000
5. Saidpur Head Works	Spring water	0.8	1963	Sedimentation & slow sand filtration	CDA	
6. Golf Course Head Works (New)	3 tube wells & Rawal Lake	2.7		Sedimentation & slow sand filtration	CDA	
7. Golf Course Head Works (Old)	8 tube wells & Surface water from stream	2.2	1966	Sedimentation & slow sand filtration	CDA	
8. G-10 Head Works	Surface water from stream	2.5	1970	Sedimentation & slow sand filtration	CDA	
Rawalpindi						
9. Rawal Lake Filtration Plant	Rawal Lake	21	1962-14 mg/d 1979 - 7 mg/d	Sedimentation & rapid sand filtration	PHED	7 MGD by 1990

Table C-1-29. Plant Facility

Item	Simly Filtration Plant	Rawal Lake Filtration Plant
Capacity	24 mgd (109,100 m^3/d)	21 mgd (95,500 m^3/d)
Flocculation time	20 min	12 min
Sedimentation time	3 hrs	1.5 hrs
Filtration rate	120 $m^3/m^2/d$	140 $m^3/m^2/d$
Coagulant used	Alum	Alum
Sterilizing agent	Chlorine	Chlorine
Backwash system	Compressed air + water	Compressed air + water
No. of clarifiers	4 (6 mgd each)	3 (7 mgd each)
No. of filter beds	12 units	12 units
Filter Bed area	76 m^2	69 m^2

(2) Intake, Conduction Main and Service Reservoir

a. Intake of Khanpur Reservoir

Intake facility of water to be diverted from Khanpur Reservoir has been constructed at under the right bank saddle embankment of the Dam. Design diversion capacity of the intake is approximately 15.6 cu.m/sec with conduit elevation of 580.11 m (RL 1,902 ft) at the inlet. Diameter of the conduit is about 2.0 m (6.5 ft) with RCC structures.

b. Left Bank Canal

The Left Bank Canal has been completed stretching over 19 km (11.8 miles) as the conduction main of Khanpur Project between the dam site and near Nicholson Monument. Water derived from the dam at the irrigation outlet structure flows through 80 m long Main Canal and 65 m long head regulator into the Left Bank Canal.

The Left Bank Canal was constructed by WAPDA during years from 1973 to 1978 to convey Khanpur water for water supply to both the cities of Islamabad and Rawalpindi, for industrial water supply to POF (Wah) and PIDC (Taxila) and for irrigation to agricultural land extending on the left bank of the Haro river. Irrigation water is diverted from the canal between the points 0.0 km and 8.8 km, and the canal section downword is allocated for municipal and industrial waters allowing water diversion for PIDC at the point of 15.6 km. Downstream portions of the canal are assigned only for water supply.

Design capacity of the canal varies from 12.5 to 7.9 cu.m/sec (440 to 278 cusec). Since the canal passes

undulating terrain of northwest foot of the Margala range of hills, many appurtenant structures such as tunnels, syphons and aqueducts are accompained, and the canal is lined with concrete block on its all faces for about 80 % of total length. The majority of canal portions is situated on the rock foundation with fine limestone and alternations of limestone and shale or marl. However, sedimentary loam has been found at the limited portions near the beginning point of the Left Bank Canal, outlet of the Mohra Muradu Tunnel and inlet of Margala Tunnel.

It is investigated that the Canal has been designed employing design procedures prepared for irrigation purposes, consists of many deep-cut portions without protection works of side slopes allowing sediment inflows during heavy rains, and that operation and maintenance works are laborious.

c. Conduction Main to Islamabad

Major Conduction Mains Islamabad are briefly explained as follows:

- Simly Conduction Main

This is to convey treated water at the Simly Filtration Plant to the service reservoir located in Sectors F-5 and F-6 of Islamabad, and the major dimensions are as under;

Length	:	L = 28.0 km (92,000 ft)
Pipe	:	PRCC with steel core, 900 mm (36") Dia. 2 lines
Discharge	:	Q = 0.632 cu.m/sec (12.0 MGD) each line

Elevation :

Simly Clear Water Res.	HWL 629.4 m (2,065 ft)
(5 M.G.)	LWL 623.3 m (2,045 ft),
	HWL 627.9 m (2,060 ft)
	LWL 621.8 m (2,040 ft),
	HWL 626.4 m (2,055 ft)
	LWL 620.3 m (2,035 ft)
Islamabad Service Res.	HWL 618.7 m (2,030 ft)
(7 M.G.)	LWL 612.6 m (2,010 ft)

Two conduction lines of 900 mm diameter (36") have already been completed and at present two lines are being operated, as the second phase of the scheme, to make fully yield of 24 MGD of Simly dam available.

- Conduction Line from National park Area

Waters produced from tube wells in the National Park Area are gathered in the Central Sump and then conveyed to the Rawal Sump by means of pumping up. Water is boosted at Rawal Sump and sent to the service reservoirs situated at F-5 and north of F-6.

Length	:	Central Sump to Rawal Sump, L = 3.7 km (12,000 ft)
		Rawal Sump to F-6 Service Reservoir, L = 7.9 km (26,000 ft)
Pipe	:	PRCC with steel core, Dia. 500 mm (21") x 2 lines
Capacity	:	34,000 cmd (7.5 MGD)

- Other Conduction Lines

The majority of conduction mains are provided with PRCC pipes of diameters 450 mm to 225 mm (18" to 9"), with

exception of 18" mild steel pipe which forms a part of conduction line from the Golf Course Head Works and G-10 Head Works.

d. Conduction Main to Rawalpindi

Water, treated at the Rawal Filtration Plant and from tube wells in the National Park Area, is conveyed to RMC and CB through RC pipes of 1,350 mm (54") diameter. The conduction main branches off, before it reaches distribution block of RMC, in two directions for RMC and CB, and then water is conveyed through respective lines of 900 mm (36") RC pipes.

e. Service Reservoir

Service reservoirs are categorized into two types; namely elevated reservoir and ground reservoir. Elevated reservoirs are of small scale and those recently constructed are, mostly, of reinforced concrete, excluding some of old type which are made of brick masonry or steel. Although most of service reservoirs in Islamabad are of gravity flow type providing large capacities, those in Rawalpindi are of small capacity and considerable number of direct pumping distribution systems are found.

Scales and dimensions of major service reservoirs are as tabulated below;

Table C-1-30. Data of Reservoir Tanks

Reservoir Site	Type	Capacity (cum)	Capacity (MG)	Overflow Elevation (m)	Overflow Elevation (feet)	Structure
Islamabad Existing						
F-5	Ground	31,800	7	618.7	2030	RC
F-6	Ground	22,700	5	629.4	2065	RC
				627.9	2060	RC
				626.4	2055	RC
Shahdara	Ground	4,500	1	666.0	2185	RC
Nurpur	Ground	900	0.2	634.0	2080	RC
North of F-5	Elevated	4,500	1	676.7	2220	RC
Saidpur	Ground	4,500	1	621.8	2040	RC
Faisal Mosque	Ground	9,100	2	614.2	2015	RC
G-10	Ground	9,100	2			RC
Golf Course (New)	Ground	6,600	1.45	579.4	1901	RC
Under Construction						
E-10	Elevated	22,700	5	634.0	2080	RC
"	Ground	36,400	8	603.5	1980	RC
Rawalpindi (Existing)						
Water Works No.1	Elevated	11,370	2.5	509.6	1672	RC
Water Works No.2	"	11,370	2.5	509.6	1672	RC
Topi P/S	Ground	11,820	2.6	496.8	1630	RC
National Park	Elevated	11,640	4.1	533.1	1749	RC
AMC Center	"	2,270	0.5	534.0	1752	RC
Westridge	"	5,900	1.3	566.0	1857	RC
Misrial	"	450	0.1			RC
502 Work Shop	"	450	0.1			RC
Dhanial	"	900	0.2			RC

Source: CDA, PHED, MES
Note: RC --- Reinforced Concrete, P/S --- Pumping Station

(3) Water Supply System

Figure C-1-8 show the relative positions and distribution systems of such water works facilities as filtration plant, head works, conduction main and distribution pipe line.

As outline of the existing water treatment plant in Islamabad/Rawalpindi is summarized in Table C-1-28. As shown, water

in Islamabad is supplied from the Simly Filtration plant, seven head works and tube wells to each sector where distribution pipes are provided completely. The other hand, the PHED is in charge of bulk water supply from Rawal Filtration Plant to Water Works No. 1 and No. 2 where located beside Saidpur Road. The RMC is responsible for operation and maintenance of water distribution systems from Water Works No. 1 and No. 2 to each sub-area where distribution pipes are provided in RMC area. From the bifurcation point the MES and RCB are responsible for operation and maintenance of water supply facilities to the cantonment areas under their jurisdiction.

The present water supply systems in the twin cities have inherent factors which tend to disturb the efforts toward achievement of technical success, institutional success and financial success, respectively. They are listed below;

1. Intermittent supply services of water
2. Low quality of product and faulty fixing technique
3. Prevalence of unmetered connections
4. Indifferent leave water running
5. Predominance of flat rate water tariff system

All the above factors interrelate with each other, creating a vicious circle situation.

C.1.5. Countermeasures on the Reduction of Wastage and Leakage Losses from Water Supply Systems

(1) General Concept

"Water is one of God given blessings like air and sunshine." and, therefore "It will be used and consumed for free." This is the belief rooted in Islamism and firmly held by the people of the country. It has a great deal to do with the existing state for leakages and wastages in the Project Area. However, it should be it

called to our attention that air and sunshine exist virtually boundlessly, whereas water (especially urban water) is limited and produced.

Water sustains life like the other two; it is at the same time an economic good. Religion puts the light on one side and modern economics stresses the other side. Accommodation of the two sides is possible through tariff structures where the rate will be nominal up to a level of consumption enough to meet basic human need.

It is a stark fact that whenever you overlook or ignore a leaking or wasting of water you are throwing away money. And to improve and rectify such a situation not only meets the requirements of economics, but also follows the precepts of ethics and religion. (Refer to Table C-1-31)

(2) Modernization of Technical/Institutional Aspects

This is to reduce to the minimum the leakages from all sorts of pipelines due to technical/physical insufficiencies. It, first of all, involves the enhancement/standardization of quality and quantity in respect of maintenance force and equipment. It, at the same time, involves the enhancement/standardization of quality and quantity in respect of all kinds of related products as well as in respect of all aspects of fixing techniques.

(3) Modernization of Moral/Mental Aspects

Reduction of losses through modernization of technical/institutional aspects can never proceed in any way if the consumers have the mentality where they do not mind or care about the wastages by leaving taps open.

They must change their moral/mental attitudes toward water. It is an economic good like oil, wheat, cloth or anything; it accompanies huge cost to produce it and therefore they must pay for it.

To motivate and promote the transformation of their attitudes a big campaign shall be launched on a long-term basis through mass communication media.

(4) Modernization of Financial Aspects

All the preceding measures are bound to fail, however, unless people concerned are forced and compelled toward the improvement of *status quo*.

We must create the circumstances where a trickling of water lost through leakages will entail a loss of revenue on the part of the authorities and also a dripping of water lost through wastages and leakages will demand an expenditure on the part of consumers.

That is to say, the exact quantity including wastages and leakages a user has consumed shall be automatically recorded by the metering system and he shall pay in accordance with it. Also, the authorities shall be managed on the self-financing basis with leakages jeopardizing their financial health.

The system rests on a fair measure of the modernization of technical, institutional and moral/mental aspects. In other words, it shall be introduced at an appropriate phase of that modernization. In order that the authorities may stand on their own feet they must gradually reorganize their tariff systems into those enabling them to make both ends meet.

Self-sufficiency on the part of authorities will facilitate and accelerate the introduction of perfect metering since they can financially assist consumers in fixing metering systems.

Immediately after the introduction of perfect metering, quantity tariff systems shall be completely established.

The combined attainment of all day service, perfect metering and quantity tariff systems is the crux of the modernization of financial aspects. It also holds the key for the modernization of other aspects. After that things may evolve further toward a mature level of modern water supply service.

Table C-1-31. Table of Countermeasures on the Reduction of Wastage and Leakage Loss

ITEM / YEAR	Technical Aspect	Moral/Mental Aspect	Institutional Aspect	Financial Aspect
Existing Conditions	**Responsibility of Authority** Conduction Main, Service Reservoir, Distribution Pipe Line, Service Pipe Line → Leakage from Joints & Fittings **Responsibility of Users** Underground Water Tank → Leakage Overhead Tank → Overflow (Islamabad) All Taps → Leakage from Joints & Fittings and Tap itself Intermittent Service	→ Leave Water Running (Carelessness)	Low Quality of Product Faulty Fixing Technique	**Status of Metering** Islamabad: Nos. of Connections 22,103; Nos. of Meters 3,990; Ratio 18% Rawalpindi RMC: 41,750; 837; 2% CANTT: 9,334; 3,267; 35% MES: 3,346; 1,338; 40% Sub-Total: 54,430; 5,442; 10% Total: 76,533; 9,432; 12% **Status of Finance** Islamabad: Unit Cost of Water Rs.1.64/m³; Unit Revenue of Water Rs.0.23/m³; Ratio 14% Rawalpindi RMC: Rs.0.50/m³; 0.19/m³; 38% **Reasons for financial laxity** 1. Flat Rates 2. Too Low Rates 3. Inperfect Billing & Collection
1990	INVESTIGATIONS BY CONSULTANTS REINFORCEMENT OF MAINTENANCE/REPAIR DEPT. ·Personnel Reinforcement ·Training/Education	MORAL/MENTAL MEASURES "Water is a precious, limited resource. Launch a big "Save Water" campaign to boost moral standard through mass communication media.	STANDARDIZATION OF PRODUCT QUALITY INTRODUCTION OF LICENSE SYSTEM FOR PLUMBERS	REORGANIZATION OF TARIFF SYSTEMS ·Elevate Flat Rates ·Reduce Quantity Rates ·Tariffs Recovering All Costs
2000	·Repairing Equipment ·Systematic & Rapid Actions in Urgency. (Establishment of Training Center)			TOWARD PERFECT METERING ·Toward All Day Service (Self-Financing)
2010	TOWARD PERFECT METERING Toward All Day Service			(Attainment of All Day Service & Perfect Metering) (Complete Transfer to Quantity Tariffs)
2020				
2030	(Achievement of Technical Success)	(Achievement of Moral/Mental Success)	(Achievement of Institutional Success)	(Achievement of Financial Success)

C.2. Irrigation Water

C.2.1. Land Use and Soils

(1) Haro River Lef Bank Command Area

(a) Present Land Use

Present land use is prepared based on the topographical maps with scale 1 to 50,000 published by Survey of Pakistan and detail field investigations. Present land use can be classified into the following forms.

Uncultivable	
° Residential Area	3,000 ha (Including Wah, Texila Cantonment)
° River, Road	8,000 ha (Including gullied erosion)
° Forest and stony mountain	2,700 ha
Cultivated Area	
° Cultivated Area (Including current fallow)	17,800 ha
Total Area	31,500 ha

(b) Soil and Land Capability

The soils are alluvial in the north eastern area and medium texured with a fair propotion of silty clay in the south western area.

Soil and land classification is shown in Table C-2-1, Figure C-2-1 and C-2-2 prepared by referring "Reconnaisance soil survey by Soil Survey of Pakistan in 1967 (Rawalpindi), 1970 (Attock).

Soil associations comprising the area are as follows

Soil Associations	Area (ha)	Percent (%)
1. Bahter Association	9,260	29.4
2. Chakwal Association	770	2.5
3. Guliana Association	740	2.3
4. Misa Association	3,620	11.5
5. Rajar Complex	4,840	15.5
6. Shahdra Association	110	0.3
7. Qutbal Complex	160	0.5
8. Qutbal Guloied Land complex	5,360	19.0
9. Qullied Land	3,080	9.7
10. Rough Mountainous and Study Land	1,410	4.5
11. Urban Land	2,150	6.8
Total	31,500	100.0

Bahtar association, Missa association, Rajar Complex and Qutbal complex occupies 74% of the whole area, most of the cultivated area. Those four associations are the main soils which describe characteristic of the area.

(2) Soan River Right Bank Suburban Area

(a) Present Land Use

Present land use is prepared based on the topographical maps with scale 1 to 50,000 published by Survey of Pakistan and detail field investigations.

Present land use can be classified into the following forms;

- Uncultivable
  - ° Residental area 100 ha
  - ° River, road (including gullied erosion) 590 ha
  - ° Forest and stoney hills 1,160 ha
- Cultivable
  - ° Cultivated Area (Including current fallow) 1,150 ha
- Total Area 3,000 ha

(b) Soil and Land Capability

Soil and land classification is shown in Table C-2-2 Figure C-2-3 and C-2-4 prepared by referring "reconnaissance Soil Survey by Soil Survey of Pakistan in 1967 (Rawalpindi).

Soil associations comprising the area are as follows;

	Soil Associations	Area (ha)	Percent (%)
1.	Argan Complex	810	27.0
2.	Shadara Association	60	2.0
3.	Missa Association	160	5.3
4.	Rough Broken and Stony Land	1,970	65.7
	Total:	3,000	100.0

C.2.2. Selection of Crops and its Cropping Pattern

(1) Crops and Cropping Pattern

(a) Proposed Crops

On the basis of present cropping pattern and intensity described in Figure F-2-1, suitable cropping pattern can be established in due consideration of the following view points.

(i) Former's demand

According to the finding of socio economic survey (refer to Table C-2-3), most of the farmers desire to grow cash crops like sugarcane and oilseeds, vegetables and orchards. (Refer to Table C-2-8)

(ii) National Policy for Agriculture

According to the sixth five year plan by the government of Pakistan (refer to Table C-2-4, 5), great emphases are placed on oilseed and vegetables.

(iii) Barani Development Plan

According to the report titled "Barani Forming Systems of the Punjab prepared by National Agricultural Research Centre (NARC), it is recommended that more high value crops such as vegetables should be introduced in order to increase productivity.

(iv) Soil

According to "Crop Suitability for Irrigation" in the Reconnaissance soil survey refer to Table C-2-6), most of the crops except rice are well or moderately suited to the prevailing soil associations.

In due considerations of the above, suitable crops to be introduced are shown in below.

Rabi	Kharif	Parennial
Wheat	Maiz	Orchard
Oilseeds	Soybean	Sugarcane
Fodders	Fodders	
Vegtetables/Fruits	Vegetables/Fruits	

(b) Cropping Intensity

It may be beneficial that cropping intensity is as high as possible. But the intensity is limited by availability of water source.

- Intensity achieved under irrigation (Refer to Table C-2-7).

  Rawlapindi district ..... 111 - 157 %
  Attock district ..... 109 - 171 %

- Intensity applied by Irrigation Department of the Punjab.

  Small Dams Organization ..... 130 - 150 %

Therefore, cropping intensity to be adopted will be 130 % to 140 %. Highter intensity will be applied according to availability of water source calculated by water balance simulation.

that is,

Rabi ..... 70 - 75 %
Kharif ..... 60 - 65 %
Total ..... 130 - 140 %

Figure C-2-1 Soil Map

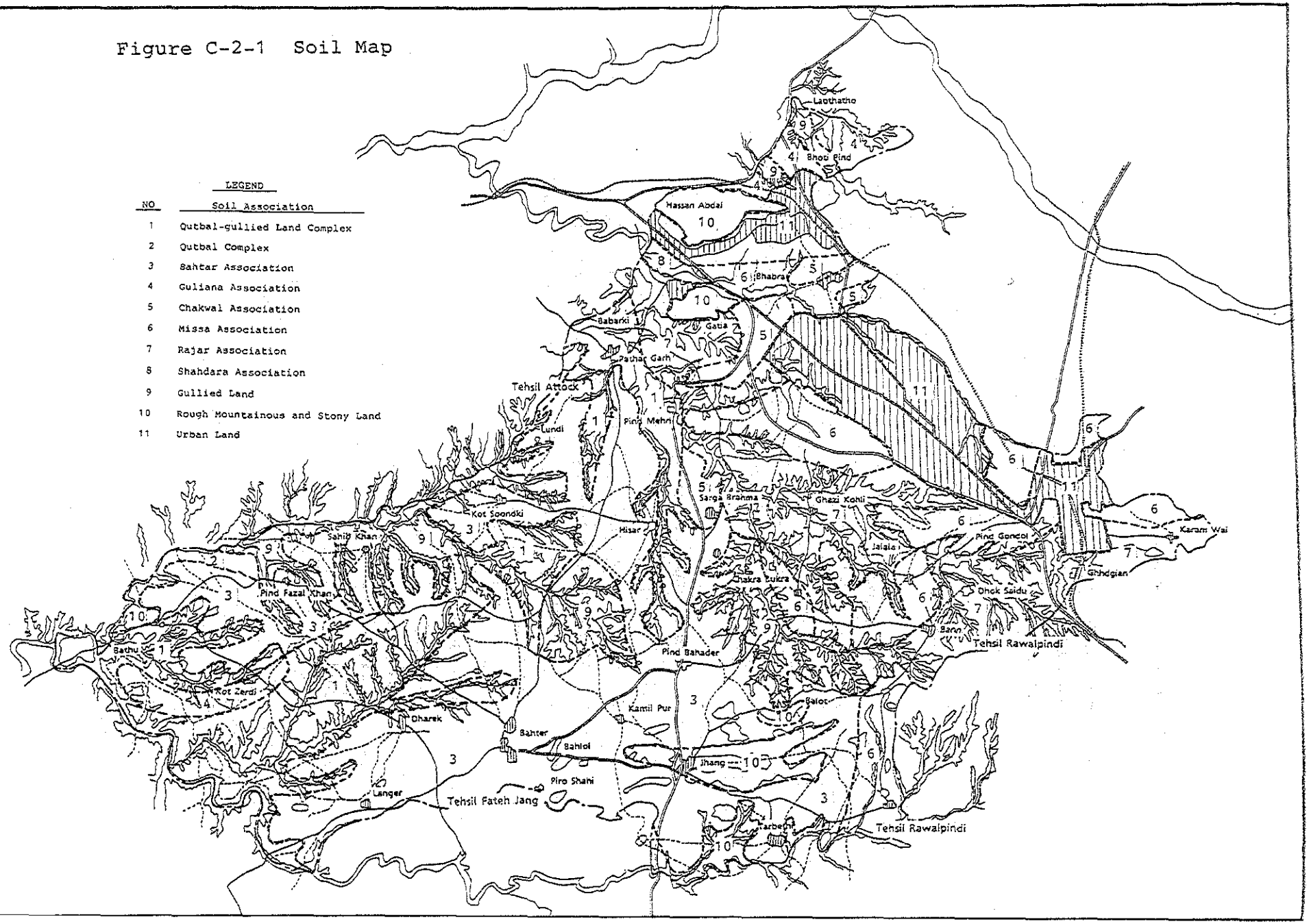


Figure C-2-2 Land Classification Map

LEGEND

NO	Class	Land Features
1	irI	Very good irrigable land
2	irIIs	Good irrigated land
3	dIIIc-dIIIe	Moderate dry-farmed land
4	dIIIe-dIVs	Moderate with little poor dry-farmed land
5	dIIIc-dVIIe	Moderate and poor dry-farmed land and some land with poor grazing potential
6	dIVc-dIVs	Poor dry-farmed land
7	dIVc-dIVs	Poor dry-farmed land and little land with fair grazing potential
8	VIs	Land with fair grazing or good land potential
9	VIIs-VIs-dIVs	Land with poor and fair grazing potential with little poor dry-farmed land
10	VIIe-VIIs	Land with poor grazing potential
11	VIIIe-VIIIs	Agriculturally unproductive land
12		Open water
13		River bed
14		Urban land

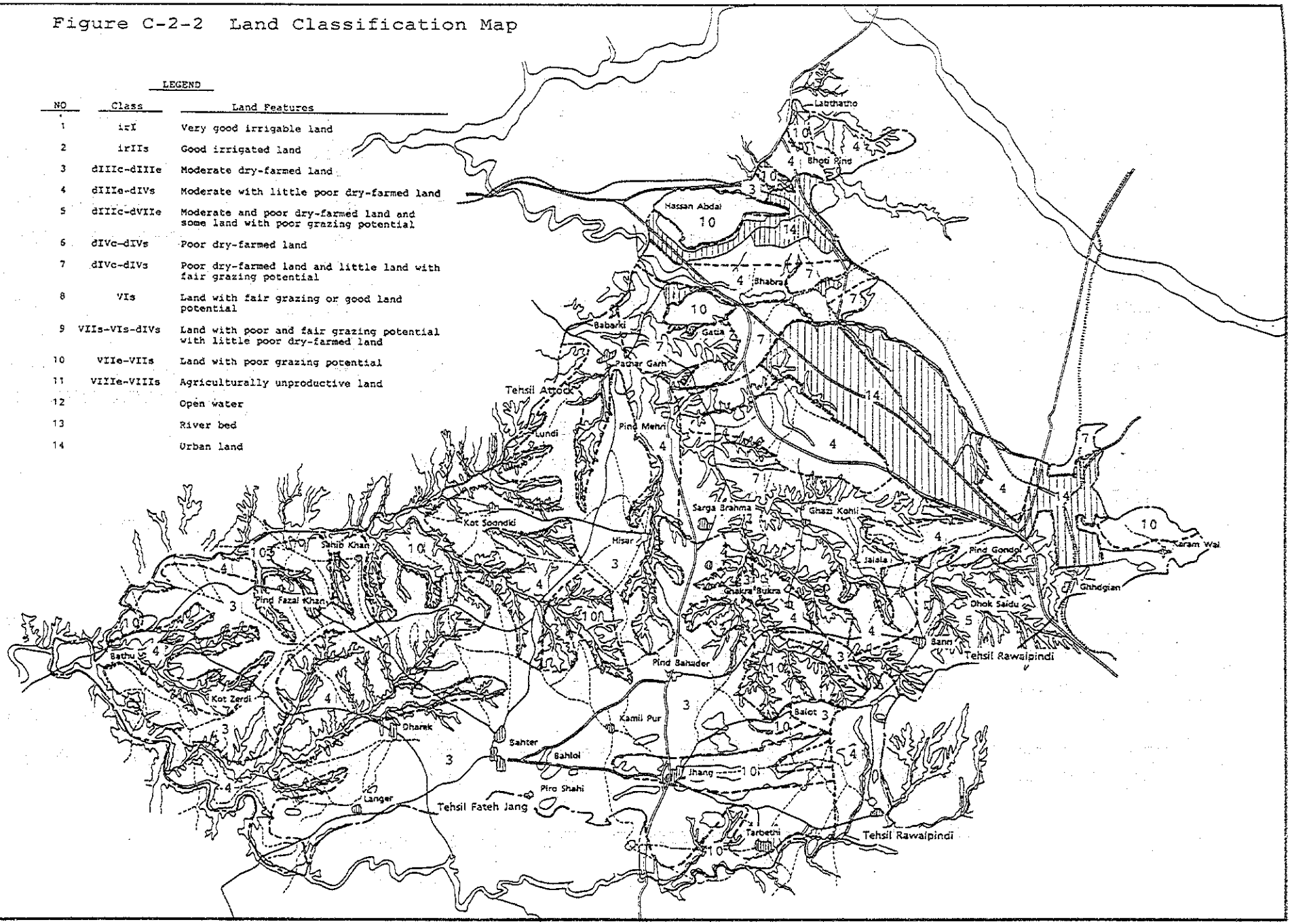


Table C-2-1(1) Soils and Land Capability

Soil Association/series	Slop (%)	Soil Depth	Soil Texture	Structure	Limitation/ Hazard	Land capability W.O 1/	W 2/
1. Bahtar Association					3/		
· Bahtar	1-3	moderate	SiCL	Weak	M.S.Clayey	dIIIc	-
· Qutbal	4-8	Deep	SiCL	Massive	-do-	dIIIe	-
· Domel	1-2	Shallow	SiC	Weak	M.S	dIIIc	-
· Guliana	0-2	Shallow	SiL	Moderate	M.S.Clayey	dIIIc	-
2. Chakwal Association							
· Chakwal	level	-	SiCL	calcareous	Drought	dIVs	irIIs
· Guiliana	0-2	Shallow	SiCL	non-calcareous	-do-	dIIIc	irIIs
3. Guiliana Association							
· Gulana	level	Shallow	SiCL	no-calcareous	Drought	dIIIc	irIIs
· Chakwal subhumid	1-3	-	SiCL	calcareous	Drought,erosion	dIIIc	irI
· Missa	1-3	-	Sil	-do-	-d-	dIIIe	irIIe
4. Missa Association							
· Missa sloping	1-3	-	SiL	calcareous	Slope Drought,erosion	dIIIe	irIIIe
· Rajar	Steep	-	SiL	-do-	Minor Drought,erosion	dIIIe	4/ N.A.
· Misa gently sloping	1-3	-	SiL	-do-	-do-	dIIIe	irIIe
· Gullied land	steep	-	-	-	Steep Slopes	VII	N.A.

Table C-2-1(2) Soils and Land Capability

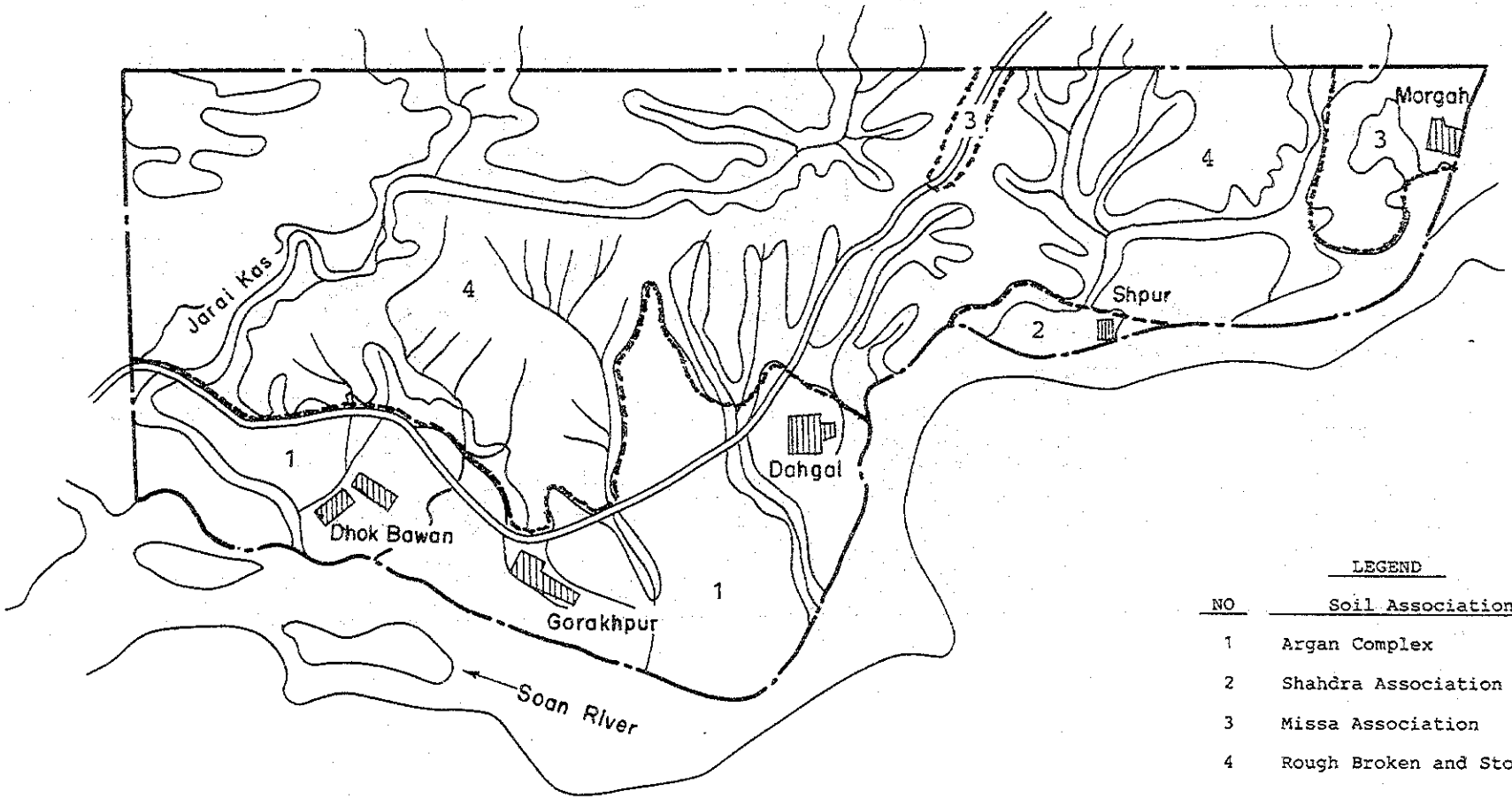
Soil Association/series	Slop (%)	Soil Depth	Soil Texture	Structure	Limitation/ Hazard	Land capability W.O 1/	W 2/
5. Rajar Complex							
· Rajar	Steep	-	SiL	calcareous	Drought,slope erosion	VIIe	N.A.
· Gullied land	-do-	-	SiL	-No-	Steep erosion	dIVe	N.A.
· Missa gently sloping	1-3	-	SiL	-do-	Drought,slope erosion	dIIIs	irIIe
6. Shahdara Association							
· Shahdara	0-2	Shallow	SiL,L	-	Drought	dIIIc	irI
· Khair	0-2	-	SL	-	-do=	dIIIc	irIIs
· River Wash	-	-	-	-	unproductive	VIII	N.A.
7. Qutbal Complex							
· Qutbal	4-5	Moderate	SiCL	Massive	Slope M.S,erosion	dIIIe	-
· Basal	2-3	Shallow	SiL	-	M.S.	dIVc	-
· Gullied land	Steep	-	-	-	Water Steep erosion,slope	VIIe	N.A.
8. Qutbal Gullied Land Complex							
· Qutbal	4-8	Moderate	SiCL	Massive	M.S,Water erosion	dIIIe	-
· Gullied land	Steep	-	-	-	Water erosion	VIIe	N.A.
· Basal	2-3	-	SiC	-	M.S,clayey	dIVs	-
· Rajar	4-8	-	SiL	Massive	M.S,Water erosion	dIIIe	-

Table C-2-1(3) Soils and Land Capability

Soil Association/series	Slop (%)	Soil Depth	Soil Texture	Structure	Limitation/ Hazard	Land capability W.O 1/	W 2/
9. Gullied land							
· Gullied land	Steep	-	-	-	Steep Slopes	VIIe	N.A.
· Chamba	2-3	-	Stony	-	Stones,erosion	dIVs	N.A.
· Misa Sloping	2-3	-	SiL	calcareous	erosion	dIIIe	irIIIe
· Mehsehra	2-3	-	SiCL	non-calcareous	-do-	dIIIe	irIIIc
· Unidentified Soils	-	-	-	-	-do-	-	-
10. Rough Mountainous and Stony land							
11. Urban Land							

Note; 1/ Not Irrigated
2/ Irrigated
3/ Moisture Shortage
4/ Not Applicable
Source; IR-2

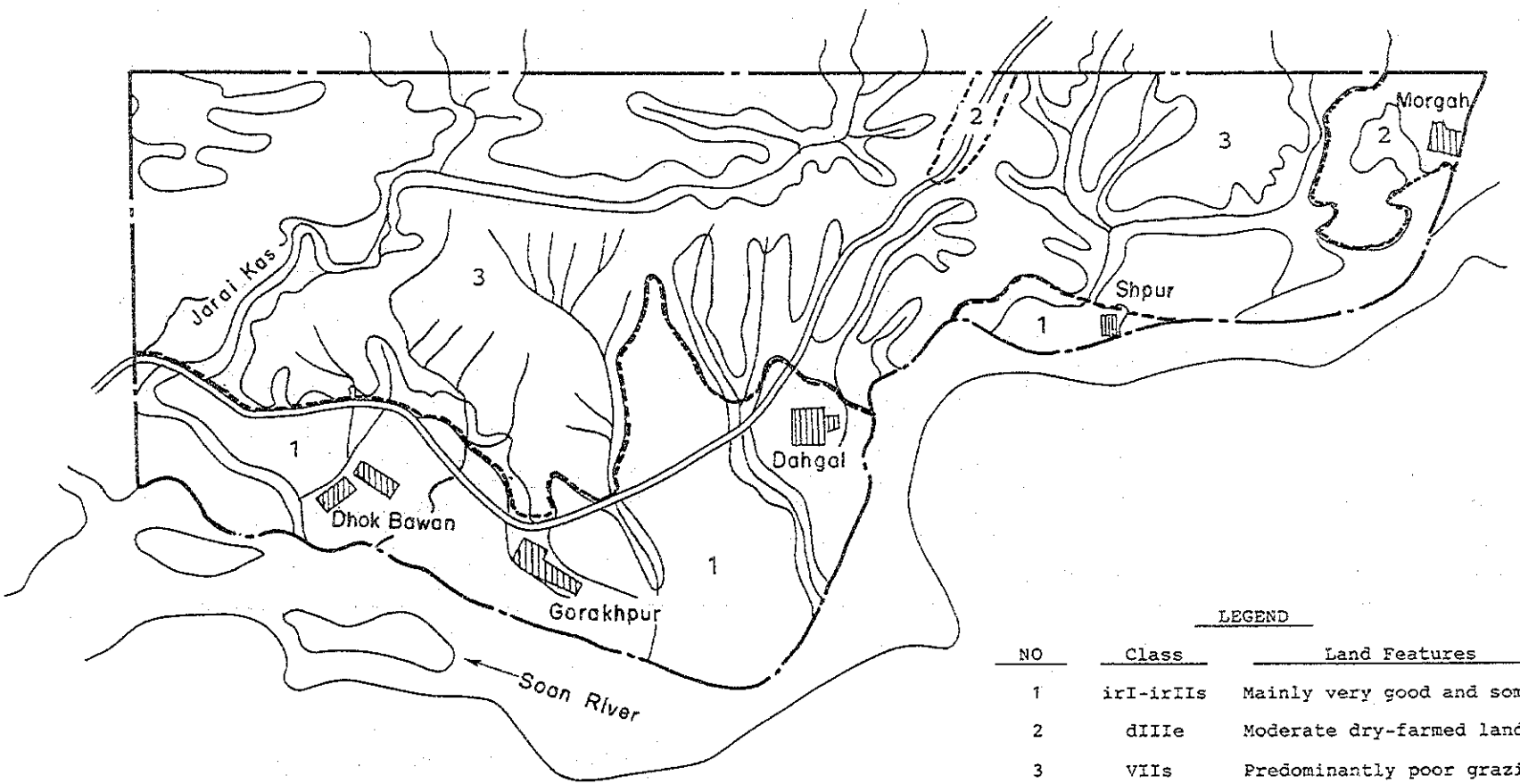
Figure C-2-3 Soil Map



LEGEND

NO	Soil Association
1	Argan Complex
2	Shahdra Association
3	Missa Association
4	Rough Broken and Stony Land

Figure C-2-4 Land Classification Map



LEGEND

NO	Class	Land Features
1	irI-irIIs	Mainly very good and some irrigable land
2	dIIIe	Moderate dry-farmed land,gently sloping
3	VIIs	Predominantly poor grazing land

Table C-2-2 Soils and Land Capability

Soil Association/series	Slop (%)	Soil Depth	Soil Texture	Structure	Limitation/ Hazard	Land capability W.O 1/	W 2/
1. Argan Complex							
· Argan	-	-	L,SiL	-	Drought	dIIIc	irl
· Jhahdara	-	-	L,SiL	-	-do-	dIIIc	irl
· Khair	-	-	SL	-	-do-	dIIIc	irIIs
2. Missa Association							
· Shahdara	0-2	Shallow	SiL,L	-	Drought	dIIIc	irI
· Khair	0-2	-	SL	-	-do-	dIIIc	irIIs
· Riverwash	-	-	-	-	Unproductive	dIIIe	N.A.3/
3. Missa Association							
· Missa Sloping	1-3	-	SiL	Calcareous	Slope Drought,erosion	dIIIe	irIVe
· Rajar	Steep	-	SiL	-do-	Minor Drought,erosion	dIIIe	N.A.
· Missa gently sloping	1-3	-	SiL	-do-	-do-	dIIIe	irIIe
4. Rough broken and stony Land							

Source ; IR-2

Note ; 1/ Not Irrigated
2/ Irrigated
3/ Not Applicable

Table C-2-3. Major Crops to be Sown

Major crops to be sown

Tehsil	No. of Famers Interview	Wheat	Coarse 1/ Grain	Cash 2/ Crops	Vegetable/Orchard
- Attack	141	7	9	62	63
- Feteh Jang	231	21	6	93	111
- Rawalpindi (Taxila)	238	14	6	75	143
- Rawalpindi	50	2	-	31	17

Note; 1/ Mainly Maize, Millet
2/ Mainly Sugarcan, Oilseed

Table C-2-4. Change of Cropping Pattern During Sixth Plan

Crops	Percentage Share in Cropped Area (%) Benchmarks	1987-88	Additional Area (x1,000 ha)	Percentage of additional Area (%)
- Grains	55.79	54.69	498	38.0
° Wheat	36.25	35.13	240	18.3
° Rice	9.95	10.02	146	11.1
° Other Grains	9.59	9.52	112	8.6
- Cotton	11.51	10.78	-	30.0
- Oil seeds excluding Cotton Seed	2.85	4.56	393	30.0
- Pulses	7.38	7.33	86	6.6
- Vegetables, Spices and Fruits	2.68	3.69	248	18.9
- Sugarcane	4.29	4.02	-	-
- Other including Fodder	15.50	14.95	85	6.5
Total	100.00	100.00	1,310	100.00

Source; IR-1

Table C-2-5. Crop Production Targets

Crops	Computed Benchmarks	Estimato 1982-83	Targets 1987-88	Percentage Increase Over Benchmarks Overall	Annual
	Million tonnes			%	
- Grains	16.72	(17.39)	21.80	30	5.5
° Wheat	11.80	(12.34)	15.50	31	5.6
° Rice	3.31	(3.44)	4.20	27	4.9
° Maize	0.97	(1.01)	1.38	43	7.3
° Others	0.64	(0.60)	0.72	12	2.4
- Cash Crops	35.89	(33.42)	42.07	17	3.2
° Cotton (Lint)	0.82	(0.82)	1.03	26	4.7
° Sugarcane	35.00	(32.53)	40.94	17	3.2
° Tobacco	0.07	(0.07)	0.10	47	8.0
- Oil seeds	2.00	(2.08)	2.86	42	7.3
° Cotton Seed	1.64	(1.64)	2.07	26	4.7
° Traditional	0.33	(0.42)	0.44	42	5.6
° Non-traditional	0.03	(0.02)	0.35	1,029	64.4
- Pulses	0.70	(0.71)	0.79	15	2.8
° Gram	0.50	(0.50)	0.58	18	3.3
° Others	0.20	(0.21)	0.21	7	1.4
- Vegetables and Spices	2.61	(2.73)	5.11	96	14.4
° Onion	0.45	(0.48)	0.80	77	12.1
° Potatoes	0.46	(0.52)	0.85	85	13.1
° Others	1.70	(1.73)	3.46	104	15.3
- Fruits	2.20	(2.68)	3.59	63	10.2

Souce; IR-1

Table C-2-6. Crop Suitability for Irritation

Soil Association/Series	Wheat	Gram	Barley	Vegitable	Maize	Millests	Rice	Groundnut	Sugar Cane	Improved Pasture
1. Haro River Left Bank										
° Chakwal	1	3	-	2	1	1	1	3	1	1
° Guliana	1	3	-	2	1	1	1	3	1	1
° Khair (Subhumid)	2	1	-	1	2	2	3	1	3	1
° Missa gently sloping	2	2	-	2	2	2	3	2	2	1
° Shahdara (Subumid)	1	1	-	1	1	2	3	1	1	1
2. Soan River Right Bank										
° Argan	1	1	-	1	1	1	3	1	1	1
° Missa gently sloping	2	2	-	2	2	2	3	2	2	1
° Shahdara (Subhumid)	1	1	-	1	1	2	3	1	1	1

Source: IR-2

Note: 1 ..... Well suited, 2 ..... Moderately suited
3 ..... Poorly suited, 4 ..... Not suited

Table C-2-7. Cropping Intensity on Irrigated and Unirrigated Farms

Area: Acres

District/Size of Farm	All Farms	Average Intensity of Farms with Irrigated Area				Average Intensity of Unirrigated Farms
		Under 51%	51% to 75%	76% to 99%	Over 100%	
- Rawalpindi						
under 1.0	16,688	157	108	-	157	170
° 1.0 to under 2.0	35,571	141	85	100	163	153
° 2.5 to under 5.0	27,381	129	124	141	180	136
° 5.0 to under 7.5	19,687	118	179	107	185	124
° 7.5 to under 12.5	17,663	114	166	-	179	116
° 12.5 to under 25.5	10,169	112	126	168	147	111
° 25.0 to under 50.0	3,752	112	57	158	156	106
° 50.0 to under 150.0	983	112	-	103	135	105
° 150.0 to above	78	70	112	182	168	98
Total	131,972	111	135	149	157	122
- Attock						
under 1.0	5,309	143	150	100	196	126
° 1.0 to under 2.0	13,063	130	159	170	187	117
° 2.5 to under 5.0	14,739	121	151	167	175	109
° 5.0 to under 7.5	15,450	113	142	124	167	104
° 7.5 to under 12.5	20,999	110	125	172	165	104
° 12.5 to under 25.5	20,670	106	125	179	125	103
° 25.0 to under 50.0	8,408	100	105	-	141	102
° 50.0 to under 150.0	2,413	103	121	103	132	101
° 150.0 to above	296	108	94	135	101	102
Total	101,347	109	133	163	171	103

Source: IR-3

Table C-2-8. (1) Land Use Plan by Socio-Economic Survey

Sr.No.	Tehail	No. of farmers interview	1 Future Dev. of Area		2 Inconvenient Social Aspects		3 Made of Irrigation			4 Major Grops to be Sown				5 Extented of Income Per Acre		6 Extent of Water Charges			7 Protection of Gully Erosion	
			A	B	A	B	A	B	C	A	B	C	D	A	B	A	B	C	A	B
1.	Attock	141	32	109	61	80	69	11	61	7	9	62	63	52	89	6	7	128	53	88
2.	Fateh Jang	231	9	222	37	194	117	3	111	21	6	93	111	33	198	16	17	198	61	170
3.	Rawalpindi (Taxila)	238	7	231	25	213	107	13	118	14	6	75	145	47	191	21	13	204	29	209
4.	Rawalpindi (II)	50	-	50	6	44	23	3	24	2	-	31	17	11	39	1	3	46	17	33
	Total	660	48	612	129	531	316	30	314	44	21	261	334	143	517	44	40	576	160	500

Codes:

1. A. Barani Area
   B. Irrigated Area
2. A. Irrigation System
   B. Farm Machinery
3. A. Canal
   B. Mini Dam
   C. Tubewell
4. A. Wheat
   B. Coarse Grain
   C. Cash Crops
   D. Vegetable & Orcharde
5. A. Rs.2000 to Rs.2999 per acre
   B. Rs.3000 to Rs.3999 per acre
6. A. 1.00 to 4.9%
   B. 5% and above
   C. As fixed by Government
7. A. Soil Conservation Practices
   B. Afforestation

Table C-2-8. (2) Land Use Plan by Socio-Economic Survey

8			9			10			11			12	
Utilazation of Cultivable Waste			Utilization of Un-cultivable Waste			Kind of Idvestock to be fed			Additional Job/Cottage Industry			Type of Occuposion	
A	B	C	A	B	C	A	B	C	A	B	C	A	B
53	88	-	120	-	21	92	14	35	40	91	10	138	3
67	164	-	104	6	121	151	17	63	43	-	188	214	17
29	209	-	89	15	134	123	27	88	164	33	41	230	8
16	34	-	21	7	22	31	-	19	21	-	9	50	-
165	395	-	334	28	298	397	58	205	288	124	248	632	28

8. A. Farm Land
   B. Afforestation
   C. Pastures

9. A. Park or Garden
   B. Grazing
   C. Farm Land

10. A. Buffaloes
    B. Cows/Bullocks
    C. Sheep & Goats

11. A. Poultry
    B. Bee Keeping
    C. Sericulture

12. A. Full time farmer
    B. Part time farmer

C.2.3. Computation of Unit Irrigation Water Requirement

(1) Reference Crop Evapotranspiration

Table C-2-9. Reference Crop Evapotranspiration

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Tmean (c)		10.0	12.3	17.2	22.7	27.7	31.6	29.9	28.8	27.3	22.6	16.5	11.6	
RM mean (%)		70.7	68.8	64.1	53.6	41.0	41.3	66.1	74.7	68.7	63.0	66.5	70.8	
Wind Speed (m/s)		1.1	1.5	1.8	1.8	1.8	1.8	1.6	1.2	1.0	0.9	0.8	0.9	
Sunshine Hourse (h)		6.4	6.8	6.8	8.5	10.1	10.2	14.2	8.5	8.6	9.0	8.1	6.5	
	Blanny Criddle	1.6	2.3	3.5	4.8	7.5	8.3	6.5	5.5	5.2	3.8	2.5	1.7	
ETo (mm/day)	Radiation	2.0	2.9	4.0	5.9	7.4	8.2	6.4	6.0	5.8	4.8	3.1	2.0	
	Penman	1.8	2.5	3.7	5.5	7.4	8.4	6.7	5.7	5.0	3.8	2.4	1.6	
	Penman (mm/mmth)	56	70	115	165	229	252	208	177	150	118	72	50	1662
	Pan Evap	61.0	82.6	152.4	208.8	309.1	347.4	268.8	208.8	171.2	139.7	85.9	58.9	2,093.7
	Pan Evap x 0.8	49	66	122	167	247	278	215	167	137	112	69	47	1,676

(2) Crop Coefficient

Table C-2-10. (1) Crop Coefficient (Kc) (Rabi Season)

Crop Growing Stage (%)		10	20	30	40	50	60	70	80	90	100
	1	0.60	0.94	1.25	1.40	1.46	1.40	1.25	1.00	0.80	0.65
Wheat	2	0.43	0.54	0.66	0.83	0.90	0.97	1.03	0.97	0.49	0.08
	3	0.38	-	-	-	-	-	1.05	-	-	0.25
	4	0.43	0.54	0.66	0.83	0.90	0.97	1.03	0.97	0.49	0.25
	1	-	-	-	-	-	-	-	-	-	-
Oilseed	2	0.38	0.44	0.52	0.61	0.75	0.87	0.90	0.89	0.71	0.35
	3	-	-	-	-	-	-	-	-	-	-
	4	0.38	0.44	0.52	0.61	0.75	0.87	0.90	0.89	0.71	0.35
	1	0.36	0.60	0.87	1.05	1.14	1.18	1.20	1.20	1.18	1.10
Fodders	2	0.40	0.48	0.57	0.70	0.92	0.98	0.92	0.62	0.25	0.03
	3	0.33	-	-	-	-	1.00	1.05	-	-	0.55
	4	0.40	0.48	0.57	0.70	0.82	0.99	1.05	0.98	0.75	0.55
	1	0.27	0.36	0.52	0.73	0.96	1.08	1.10	1.03	0.92	0.79
Vegetables	2	0.39	0.50	0.63	0.78	0.92	0.98	0.92	0.62	0.25	0.03
	3	0.33	-	-	-	-	-	1.05	-	-	0.75
	4	0.39	0.50	0.63	0.78	0.92	1.00	1.05	0.95	0.85	0.75

Note: 1 ..... On Farm Water Management Field Manual, 2 ..... Irrigation Requirements of Crops in Punjab,
3 ..... FAO Technical Paper No. 24, 4 ..... Adjusted

Table C-2-10. (2) Crop Coefficient (Kc) (Kharif Season)

Crop Growing Stage (%)		10	20	30	40	50	60	70	80	90	100
	1	0.46	0.65	0.86	1.06	1.19	1.27	1.29	1.25	1.18	1.08
Maize	2	0.50	0.53	0.56	0.60	0.65	0.24	0.85	0.91	0.77	0.56
	3	0.28	-	-	-	-	-	1.05	-	-	0.55
	4	0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55
	1	0.32	0.55	0.80	0.98	1.12	1.20	1.23	1.19	1.08	0.91
Soybean	2	-	-	-	-	-	-	-	-	-	-
	3	0.35	-	-	-	-	-	1.00	-	-	0.45
	4	0.35	0.45	0.65	0.79	0.91	0.97	1.00	0.82	0.64	0.45
	1	-	-	-	-	-	-	-	-	-	-
Fodders	2	0.37	0.40	0.44	0.49	0.56	0.63	0.71	0.78	0.77	0.69
	3	0.38	-	-	-	0.85	-	1.00	1.05	-	0.50
	4	0.40	0.48	0.57	0.70	0.85	0.92	1.00	1.05	0.80	0.50
	1	0.27	0.36	0.52	0.73	0.96	1.08	1.10	1.03	0.92	0.79
Vegetables	2	0.39	0.50	0.63	0.78	0.92	0.98	0.92	0.62	0.25	0.03
	3	0.53	-	-	-	-	-	1.05	-	-	0.60
	4	0.39	0.50	0.63	0.78	0.92	1.00	1.05	0.95	0.85	0.60

Note: 1 ..... On Farm Water Management Field Manual, 2 ..... Irrigation Requirements of Crops in Punjab,
3 ..... FAO Technical Paper No. 24, 4 ..... Adjusted

Table C-2-10. (3) Crop Coefficient (Kc) (Pernnial)

Crop Growing Stage (%)		10	20	30	40	50	60	70	80	90	100
	1	0.60	0.82	1.00	1.10	1.11	1.05	0.94	0.78	0.60	0.47
Suger cone	2	0.66	0.92	0.89	0.80	0.79	0.93	0.84	0.63	0.49	0.35
	3	0.53	-	-	-	-	-	1.05	-	-	0.95
	4	0.66	0.74	0.82	0.95	1.05	1.05	1.05	1.00	1.00	0.95
	1	-	-	-	-	-	-	-	-	-	-
Orchard	2	-	-	-	-	-	-	-	-	-	-
	3	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.90	0.90	0.85
	4	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.90	0.90	0.85

Note: 1 ..... On Farm Water Management Field Manual, 2 ..... Irrigation Requirements of Crops in Punjab,
3 ..... FAO Technical Paper No. 24, 4 ..... Adjusted

(3) Consumptive Use of Crops

Table C-2-11(1) Field Irrigation Requirement(Wheat)

MONTH	OCT			NOV			DEC			JAN			FEB			MAR			APR			MAY			JUN		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN													Wheat (Rabi)														
1. ELEMENT % OF GROWING SEASON			6	12	18	24	30	35	41	47	53	59	65	71	77	82	88	94	100								
CROP COEFFICIENT (kc)			0.40	0.45	0.52	0.59	0.66	0.76	0.84	0.88	0.92	0.96	1.00	1.04	1.05	0.92	0.63	0.44	0.25								
				0.40	0.45	0.52	0.59	0.66	0.76	0.84	0.88	0.92	0.96	1.00	1.04	1.05	0.92	0.63	0.44	0.25							
					0.40	0.45	0.52	0.59	0.66	0.76	0.84	0.88	0.92	0.96	1.00	1.04	1.05	0.92	0.63	0.44	0.25						
						0.40	0.45	0.52	0.59	0.66	0.76	0.84	0.88	0.92	0.96	1.00	1.04	1.05	0.92	0.63	0.44	0.25					
							0.40	0.45	0.52	0.59	0.66	0.76	0.84	0.88	0.92	0.96	1.00	1.04	1.05	0.92	0.63	0.44	0.25				
Kc AVERAGE			0.40	0.43	0.46	0.49	0.52	0.60	0.67	0.75	0.81	0.87	0.92	0.96	0.99	0.99	0.93	0.82	0.66	0.56	0.44	0.35	0.25				
ETo (MM/DAY)	3.8			2.4			1.6			1.8			2.5			3.7			5.5			7.4					
ET (MM/DAY)			1.5	1.0	1.1	1.2	0.8	1.0	1.1	1.4	1.5	1.6	2.3	2.4	2.5	3.7	3.4	3.0	3.6	3.1	2.4	2.6	1.9				
SOIL SATURATION (MM)	50			50																							
2. EQUATION LAND SOAKING		1/5	1/5	1/5	1/5	1/5																					
NORMAL IRRIGATION			1/5	2/5	3/5	4/5	5/5												5/5	4/5	3/5	2/5	1/5				
3. WATER REQUIREMENT LAND SOAKING (MM)		10	10	10	10	10																					
NORMAL IRRIGATION (MM/DAY)			0.3	0.4	0.7	1.0	0.8	1.0	1.1	1.4	1.5	1.6	2.3	2.4	2.5	3.7	3.4	3.0	3.6	2.5	1.4	1.0	0.4				
MM / 10 DAYS		10	13	14	17	20	8	10	11	14	15	16	23	24	25	37	34	30	36	25	14	10	4				
MM / MONTH	23			51			29			45			72			101			75			14					

Table C-2-11(2) Field Irrigation Requirement(Oilseed)

MONTH	OCT			NOV			DEC			JAN			FEB			MAR			APR			MAY		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN												Oilseeds (Rabi)												
1. ELEMENT % OF GROWING SEASON					7	14	21	29	36	43	50	57	64	71	79	86	93	100						
CROP COEFFICIENT (kc)					0.37	0.40	0.45	0.51	0.57	0.65	0.75	0.83	0.88	0.90	0.89	0.78	0.60	0.35						
						0.37	0.40	0.45	0.51	0.57	0.65	0.75	0.83	0.88	0.90	0.89	0.78	0.60	0.35					
							0.37	0.40	0.45	0.51	0.57	0.65	0.75	0.83	0.88	0.90	0.89	0.78	0.60	0.35				
								0.37	0.40	0.45	0.51	0.57	0.65	0.75	0.83	0.88	0.90	0.89	0.78	0.60	0.35			
Kc AVERAGE					0.37	0.39	0.41	0.43	0.48	0.54	0.62	0.70	0.79	0.85	0.89	0.88	0.81	0.67	0.59	0.48	0.35			
ETo (MM/DAY)				2.4			1.6			1.8			2.5			3.7			5.5					
ET (MM/DAY)					0.9	0.9	0.7	0.7	0.8	1.0	1.1	1.3	2.0	2.1	2.2	3.3	3.0	2.5	3.2	2.6	1.9			
SOIL SATURATION (MM)				50			50																	
2. EQUATION LAND SOAKING				1/4	1/4	1/4	1/4																	
NORMAL IRRIGATION					1/4	2/4	3/4	4/4										4/4	3/4	2/4	1/4			
3. WATER REQUIREMENT LAND SOAKING (MM)				13	13	12	12																	
NORMAL IRRIGATION (MM/DAY)					0.2	0.5	0.5	0.7	0.8	1.0	1.1	1.3	2.0	2.1	2.2	3.3	3.0	2.5	2.4	1.3	0.5			
MM / 10 DAYS				13	15	17	17	7	8	10	11	13	20	21	22	33	30	25	24	13	5			
MM / MONTH				45			32			34			63			88			42					

Table C-2-11(3) Field Irrigation Requirement(Fodder)

MONTH	SEP			OCT			NOV			DEC			JAN			FEB			MAR			APR			MAY		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN											Fodder (Rabi)																
1. ELEMENT % OF GROWING SEASON			5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100					
CROP COEFFICIENT (kc)			0.36	0.40	0.44	0.48	0.50	0.57	0.62	0.70	0.75	0.82	0.90	0.99	1.03	1.05	1.03	0.98	0.88	0.75	0.65	0.55					
				0.38	0.40	0.44	0.48	0.50	0.57	0.62	0.70	0.75	0.82	0.90	0.99	1.03	1.05	1.03	0.98	0.88	0.75	0.65	0.55					
					0.38	0.40	0.44	0.48	0.50	0.57	0.62	0.70	0.75	0.82	0.90	0.99	1.03	1.05	1.03	0.98	0.88	0.75	0.65	0.55					
						0.38	0.40	0.44	0.48	0.50	0.57	0.62	0.70	0.75	0.82	0.90	0.99	1.03	1.05	1.03	0.98	0.88	0.75	0.65	0.55			
Kc AVERAGE			0.38	0.39	0.41	0.43	0.46	0.50	0.54	0.60	0.66	0.72	0.79	0.87	0.94	0.99	1.03	1.02	0.98	0.91	0.81	0.70	0.65	0.60	0.55		
ETo (MM/DAY)	5.0			3.8			2.4			1.6			1.8			2.5			3.7			5.5			7.4		
ET (MM/DAY)			1.9	1.5	1.6	1.6	1.1	1.2	1.3	1.0	1.1	1.2	1.4	1.6	1.7	2.5	2.6	2.6	3.6	3.4	3.0	3.9	2.8	2.3	4.1		
SOIL SATURATION (MM)	50																										
2. EQUATION LAND SOAKING		1/4	1/4	1/4	1/4																						
NORMAL IRRIGATION			1/4	2/4	3/4	4/4																4/4	3/4	2/4	1/4		
3. WATER REQUIREMENT LAND SOAKING (MM)		12	12	13	13																						
NORMAL IRRIGATION (MM/DAY)			0.5	0.8	1.2	1.6	1.1	1.2	1.3	1.0	1.1	1.2	1.4	1.6	1.7	2.5	2.6	2.6	3.6	3.4	3.0	3.9	2.7	1.7	1.0		
MM / 10 DAYS		12	17	21	25	16	11	12	13	10	11	12	14	16	17	25	26	26	36	34	30	39	27	17	10		
MM / MONTH	29			62			36			33			47			77			100			83			10		

Table C-2-11(4) Field Irrigation Requirement(Vegetable)

MONTH	SEP			OCT			NOV			DEC			JAN			FEB			MAR			APR		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN										Vegetable (Rabi)														
1. ELEMENT % OF GROWING SEASON			8	16	25	33	41	50	58	66	74	83	91	100										
CROP COEFFICIENT (kc)			0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75										
				0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75									
					0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75								
						0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75							
							0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75						
								0.38	0.46	0.57	0.61	0.72	0.92	0.98	1.03	1.01	0.92	0.84	0.75					
Kc AVERAGE			0.38	0.42	0.47	0.51	0.55	0.61	0.38 0.66	0.46 0.76	0.57 0.83	0.61 0.88	0.72 0.92	0.92 0.92	0.98 0.92	1.03 0.91	1.01 0.88	0.92 0.84	0.84 0.80	0.75 0.75				
ETo (MM/DAY)	5.0			3.8			2.4			1.6			1.8			2.5			3.7					
ET (MM/DAY)			1.9	1.8	1.8	1.9	1.3	1.5	1.6	1.2	1.3	1.4	1.7	1.7	1.7	2.3	2.2	2.1	3.0	2.8				
SOIL SATURATION (MM)	50			50																				
2. EQUATION LAND SOAKING		1/7	1/7	1/7	1/7	1/7	1/7	1/7																
NORMAL IRRIGATION			1/7	2/7	3/7	4/7	5/7	6/7	7/7					7/7	6/7	5/7	4/7	3/7	2/7	1/7				
3. WATER REQUIREMENT LAND SOAKING (MM)		7	7	7	7	7	7	8																
NORMAL IRRIGATION (MM/DAY)			0.3	0.5	0.8	1.1	0.9	1.3	1.6	1.2	1.3	1.4	1.7	1.7	1.5	1.6	1.3	0.9	0.9	0.4				
MM / 10 DAYS		7	10	12	15	18	16	21	16	12	13	14	17	17	15	16	13	9	9	4				
MM / MONTH	17			45			53			39			49			38			13					

Table C-2-11(5) Field Irrigation Requirement(Maize)

MONTH	APR			MAY			JUN			JUL			AUG			SEP			OCT		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN										Maize (kharif)											
1. ELEMENT % OF GROWING SEASON					10	20	30	40	50	60	70	80	90	100							
CROP COEFFICIENT (kc)					0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55							
						0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55						
							0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55					
								0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55				
									0.50	0.53	0.56	0.60	0.65	0.74	1.05	1.00	0.80	0.55			
Kc AVERAGE					0.50	0.52	0.53	0.55	0.57	0.62	0.72	0.81	0.85	0.83	0.85	0.78	0.68	0.55			
ETo (MM/DAY)				8.4			6.7			5.7			5.0			3.8					
ET (MM/DAY)					4.2	4.4	3.6	3.7	3.8	3.5	4.1	4.6	4.3	4.2	4.3	3.0	2.8	2.1			
SOIL SATURATION (MM)																					
2. EQUATION LAND SOAKING				1/5	1/5	1/5	1/5	1/5													
NORMAL IRRIGATION					1/5	2/5	3/5	4/5	5/5					5/5	4/5	3/5	2/5	1/5			
3. WATER REQUIREMENT LAND SOAKING (MM)																					
NORMAL IRRIGATION (MM/DAY)					0.8	1.8	2.2	3.0	3.8	3.5	4.1	4.6	4.3	4.2	3.4	1.8	1.0	0.4			
MM / 10 DAYS					8	18	22	30	38	35	41	46	43	42	34	18	10	4			
MM / MONTH				26			90			122			119			32					

Table C-2-11(6) Field Irrigation Requirement(Soybean)

MONTH	MAY			JUN			JUL			AUG			SEP			OCT			NOV		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN									Soybean (Kharif)												
1. ELEMENT % OF GROWING SEASON				10	20	30	40	50	60	70	80	90	100								
CROP COEFFICIENT (kc)				0.35	0.45	0.65	0.79	0.91	0.97	1.00	0.82	0.64	0.45								
					0.35	0.45	0.65	0.79	0.91	0.97	1.00	0.82	0.64	0.45							
						0.35	0.45	0.65	0.79	0.91	0.97	1.00	0.82	0.64	0.45						
							0.35	0.45	0.65	0.79	0.91	0.97	1.00	0.82	0.64	0.45					
Kc AVERAGE				0.35	0.40	0.48	0.56	0.70	0.83	0.92	0.93	0.86	0.73	0.64	0.55	0.45					
ETo (MM/DAY)	7.4			8.4			6.7			5.7			5.0			3.8					
ET (MM/DAY)				2.9	3.4	4.0	3.8	4.7	5.6	5.2	5.3	4.9	3.7	3.2	2.8	1.7					
SOIL SATURATION (MM)	0			0																	
2. EQUATION LAND SOAKING			1/4	1/4	1/4	1/4															
NORMAL IRRIGATION				1/4	2/4	3/4	4/4						4/4	3/4	2/4	1/4					
3. WATER REQUIREMENT LAND SOAKING (MM)			0	0	0	0															
NORMAL IRRIGATION (MM/DAY)				0.7	1.7	3.0	3.8	4.7	5.6	5.2	5.3	4.9	3.7	2.4	1.4	0.4					
MM / 10 DAYS				7	17	30	38	47	56	52	53	49	37	24	14	4					
MM / MONTH				54			141			154			75			4					

Table C-2-11(7) Field Irrigation Requirement(Fodder)

MONTH	APR			MAY			JUN			JUL			AUG			SEP			OCT			NOV			DEC		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN										Fodders (Kharif)																	
1. ELEMENT % OF GROWING SEASON		11	22	33	44	56	67	78	89	100																	
CROP COEFFICIENT (kc)		0.41	0.50	0.61	0.79	0.97	1.00	1.04	0.83	0.55																	
													0.41	0.50	0.81													
Kc AVERAGE		0.41	0.46	0.51	0.58	0.66	0.71	0.76	0.77	0.74	0.74	0.74	0.74	0.74	0.79	0.83	0.86	0.88	0.86	0.81	0.69	0.55					
ETo (MM/DAY)	3.7			5.5			7.4			8.4			6.7			5.7			5.0			3.8					
ET (MM/DAY)		1.5	1.7	2.8	3.2	3.6	5.3	5.6	5.7	6.2	6.2	6.2	5.0	5.0	5.3	4.7	4.9	5.0	4.3	4.1	3.5	2.1					
SOIL SATURATION (MM)	50			50			50			50																	
2. EQUATION LAND SOAKING	1/13																										
NORMAL IRRIGATION		1/13	2/13	3/13	4/13	5/13	6/13	7/13	8/13	9/13	10/13	11/13	10/13	9/13	8/13	7/13	6/13	5/13	4/13	3/13	2/13	1/13					
3. WATER REQUIREMENT LAND SOAKING (MM)	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1															
NORMAL IRRIGATION (MM/DAY)		0.1	0.3	0.6	1.0	1.4	2.4	3.0	3.5	4.3	4.8	5.2	3.8	3.5	3.3	2.5	2.3	1.9	1.3	0.9	0.5	0.2					
MM / 10 DAYS	4	5	7	10	14	18	28	34	39	47	52	56	38	35	33	25	23	19	13	9	5	2					
MM / MONTH	16			42			101			155			106			67			27			2					

Table C-2-11(8) Field Irrigation Requirement(Vegetable)

MONTH	FEB			MAR			APR			MAY			JUN			JUL			AUG			SEP			OCT		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN											Vegetable (Kharif)																
1. ELEMENT % OF GROWING SEASON			8 0.38	17 0.47	25 0.57	33 0.68	42 0.81	50 0.92	58 0.98	67 1.04	75 1.00	83 0.92	92 0.83	100 0.75														
CROP COEFFICIENT (kc)				0.38	0.47 0.38	0.57 0.47	0.68 0.57	0.81 0.68	0.92 0.81	0.98 0.92	1.04 0.98	1.00 1.04	0.92 1.00	0.83 0.92	0.75 0.83	0.75											
						0.38	0.47 0.38	0.57 0.47	0.68 0.57	0.81 0.68	0.92 0.81	0.98 0.92	1.04 0.98	1.00 1.04	0.92 1.00	0.83 0.92	0.75 0.83	0.75									
								0.38	0.47 0.38	0.57 0.47	0.68 0.57	0.81 0.68	0.92 0.81	0.98 0.92	1.04 0.98	1.00 1.04	0.92 1.00	0.83 0.92	0.75 0.83	0.75							
										0.38	0.47 0.38	0.57 0.47	0.68 0.57	0.81 0.68	0.92 0.81	0.98 0.92	1.04 0.96	1.00 1.04	0.92 1.00	0.83 0.92	0.75 0.83	0.75					
												0.38	0.47	0.57	0.68	0.81	0.92	0.96	1.04	1.00	0.92	0.83	0.75				
Kc AVERAGE			0.38	0.42	0.47	0.53	0.58	0.64	0.69	0.73	0.76	0.78	0.82	0.85	0.88	0.91	0.92	0.92	0.90	0.87	0.83	0.78	0.75				
ETo (MM/DAY)	2.5			3.7			5.5			7.4			8.4			6.7			5.7			5.0					
ET (MM/DAY)			1.0	1.6	1.7	2.0	3.2	3.5	3.8	5.4	5.6	5.8	6.9	7.1	7.4	6.1	6.2	6.2	5.1	5.0	4.7	3.9	3.7				
SOIL SATURATION (MM)	50			50			50			50																	
2. EQUATION LAND SOAKING		1/10																									
NORMAL IRRIGATION			1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10		10/10	9/10	8/10	7/10	6/10	5/10	4/10	3/10	2/10	1/10				
3. WATER REQUIREMENT LAND SOAKING (MM)		5	5	5	5	5	5	5	5	5	5																
NORMAL IRRIGATION (MM/DAY)			0.1	0.3	0.5	0.8	1.6	2.1	2.7	4.3	5.0	5.8	6.9	7.1	6.7	4.9	4.3	3.7	2.6	2.0	1.4	0.8	0.4				
MM / 10 DAYS		5	6	8	10	13	21	26	32	48	55	58	69	71	67	49	43	37	26	20	14	8	4				
MM / MONTH	11			31			79			161			207			123			60			12					

Table C-2-11(9) Field Irrigation Requirement(Orchard)

MONTH	APR			MAY			JUN			JUL			AUG			SEP		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN									Orchard									
1. ELEMENT % OF GROWING SEASON																		
CROP COEFFICIENT (kc)																		
Kc AVERAGE	0.85																	0.85
ETo (MM/DAY)	5.5			7.4			8.4			6.7			5.7			5.0		
ET (MM/DAY)	4.7	4.7	4.7	6.3	6.3	6.3	7.1	7.1	7.1	5.7	5.7	5.7	4.8	4.8	4.8	4.3	4.3	4.3
SOIL SATURATION (MM)																		
2. EQUATION LAND SOAKING																		
NORMAL IRRIGATION																		
3. WATER REQUIREMENT LAND SOAKING (MM)																		
NORMAL IRRIGATION (MM/DAY)	4.7	4.7	4.7	6.3	6.3	6.3	7.1	7.1	7.1	5.7	5.7	5.7	4.8	4.8	4.8	4.3	4.3	4.3
MM / 10 DAYS	47	47	47	63	63	63	71	71	71	57	57	57	48	48	48	43	43	43
MM / MONTH	141			189			213			171			144			129		

Table C-2-11(10) Field Irrigation Requirement(Orchard)

MONTH	OCT			NOV			DEC			JAN			FEB			MAR		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN									Orchard									
1. ELEMENT % OF GROWING SEASON																		
CROP COEFFICIENT (kc)																		
Kc AVERAGE	0.85								0.85	0.9					0.9	0.85	0.85	0.85
ETo (MM/DAY)	3.8			2.4			1.8			1.8			2.5			3.7		
ET (MM/DAY)	3.2	3.2	3.2	2.0	2.0	2.0	1.4	1.4	1.4	1.6	1.6	1.6	2.3	2.3	2.3	3.1	3.1	3.1
SOIL SATURATION (MM)																		
2. EQUATION LAND SOAKING																		
NORMAL IRRIGATION																		
3. WATER REQUIREMENT LAND SOAKING (MM)																		
NORMAL IRRIGATION (MM/DAY)	3.2	3.2	3.2	2.0	2.0	2.0	1.4	1.4	1.4	1.6	1.6	1.6	2.3	2.3	2.3	3.1	3.1	3.1
MM / 10 DAYS	32	32	32	20	20	20	14	14	14	16	16	16	23	23	23	31	31	31
MM / MONTH	96			60			42			48			69			93		

Table C-2-11(11) Field Irrigation Requirement(Sugarcane)

MONTH	MAR			APR			MAY			JUN			JUL			AUG		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN									Sugar Cane									
1. ELEMENT % OF GROWING SEASON	3	6	8	11	14	17	19	22	25	28	31	33	36	39	42	44	47	50
CROP COEFFICIENT (kc)	0.66	0.66	0.66	0.67	0.69	0.70	0.73	0.76	0.78	0.80	0.83	0.86	0.90	0.94	0.97	0.99	1.02	1.05
Kc AVERAGE																		
ETo (MM/DAY)	3.7			5.5			7.4			8.4			8.7			5.7		
ET (MM/DAY)	2.4	2.4	2.4	3.7	3.8	3.9	5.4	5.8	5.8	6.7	7.0	7.2	6.0	6.3	6.5	5.8	5.8	6.0
SOIL SATURATION (MM)																		
2. EQUATION LAND SOAKING																		
NORMAL IRRIGATION																		
3. WATER REQUIREMENT LAND SOAKING (MM)																		
NORMAL IRRIGATION (MM/DAY)	2.4	2.4	2.4	3.7	3.8	3.9	5.4	5.6	5.8	6.7	7.0	7.2	6.0	6.3	6.5	5.6	5.8	6.0
MM / 10 DAYS	24	24	24	37	38	39	54	56	58	67	70	72	60	63	65	56	58	60
MM / MONTH	72			114			168			209			188			174		

Table C-2-11(12) Field Irrigation Requirement(Sugarcane)

MONTH	SEP			OCT			NOV			DEC			JAN			FEB		
10 DAY	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CROPPING PATTERN									Sugar Cane									
1. ELEMENT % OF GROWING SEASON	53	56	58	61	64	67	69	72	75	78	81	83	86	89	92	94	97	100
CROP COEFFICIENT (kc)	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.04	1.02	1.01	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.95
Kc AVERAGE																		
ETo (MM/DAY)	5.0			3.8			2.4			1.6			1.8			2.5		
ET (MM/DAY)	5.3	5.3	5.3	4.0	4.0	4.0	2.5	2.5	2.6	1.6	1.6	1.6	1.8	1.8	1.8	2.5	2.4	2.4
SOIL SATURATION (MM)																		
2. EQUATION LAND SOAKING																		
NORMAL IRRIGATION																		
3. WATER REQUIREMENT LAND SOAKING (MM)																		
NORMAL IRRIGATION (MM/DAY)	5.3	5.3	5.3	4.0	4.0	4.0	2.5	2.5	2.6	1.6	1.6	1.6	1.8	1.8	1.8	2.5	2.4	2.4
MM / 10 DAYS	53	53	53	40	40	40	25	25	26	16	16	16	18	18	18	25	24	24
MM / MONTH	159			120			76			48			54			73		

(4) Irrigation Efficiency

Table C-2-12. Irrigation Efficiency

			ICID or ILRI
a. Conveyance Efficiency (Ec)			
° Continuous water supply and small variation of discharge			0.9
° Project area 3,000 - 7,000 ha, Rotative irrigation (Rotation block 700 - 300 ha well maintained)			0.8
° Large Scale (10,000 ha) and small scale (1,000 ha) Project, Rotative irrigation (poorly-maintained)			0.6 to 0.70
b. Canal Efficiency (Eb)			
° On-farm (20 ha)		no lining	0.8
		lining, piped	0.9
° On-farm (20 ha)		no lining	0.7
		lining, piped	0.8
c. Distribution Efficiency (Ed = Ec x Eb)			
° Average value in rotative irrigation			
- Operation and maintenance		(Excellent)	0.65
"		(Good)	0.55
"		(fair)	0.40
"		(Bad)	0.30
d. Application Efficiency (Ea)	US (SCS)		
° Surface irrigation			
- Slop furrow irrigation	0.60 - 0.75		0.53
- Basin irrigation, level irrigation	0.60 - 0.80		0.58
- Contour irrigation	0.50 - 0.55		
- Border irrigation	0.55 - 0.70		0.57
- Wavy irrigation	0.50 - 0.70		

°	Sub - irrigation	0.80	
°	Spray irrigation (Arid, hot climate) ..	0.60	
	(Moderate ") ..	0.70	0.67
	(Lumid, cold ") ..	0.80	

Source; IR-4

TABLE C-2-13 GROSS IRRIGATION REQUIREMENT

CROPPING PATTERN WHEAT =0.400 OILSEEDS =0.050 FODDERS =0.050 VEGETABLE=0.150 MAIZE =0.300
SOYBEAN =0.050 FODDERS =0.050 VEGETABLE=0.150 ORCHARD =0.050 SUGARCANE=0.050

CROPPING INTENSITY = 140.0% IRRIGATION EFFICIENCY = 60.0%

(UNIT...MCM/1000HA)

YEAR	(JAN)	(FEB)	(MAR)	(APR)	(MAY)	(JUN)	(JUL)	(AUG)	(SEP)	(OCT)	(NOV)	(DEC)	ANNUAL
1952	0.230	0.257	0.668	0.886	0.899	0.773	0.295	0.201	0.755	0.624	0.629	0.458	6.674
1953	0.061	0.293	1.017	0.772	0.825	1.172	0.380	0.312	0.765	0.469	0.629	0.389	7.082
1954	0.093	0.000	0.606	0.919	0.851	1.164	0.469	0.288	0.445	0.302	0.625	0.372	6.135
1955	0.619	0.722	0.653	0.755	0.786	1.134	0.488	0.330	0.214	0.467	0.629	0.379	7.176
1956	0.355	0.812	0.266	0.792	0.910	0.760	0.133	0.052	0.745	0.304	0.600	0.458	6.189
1957	0.001	0.172	0.601	0.151	0.692	1.034	1.115	0.415	0.809	0.321	0.065	0.019	5.393
1958	0.171	0.825	0.412	0.840	0.882	1.180	0.351	0.259	0.506	0.450	0.546	0.163	6.586
1959	0.136	0.044	0.859	0.686	0.632	1.082	0.340	0.194	0.085	0.316	0.051	0.211	4.635
1960	0.112	0.573	0.567	0.631	0.858	1.187	0.374	0.309	0.467	0.482	0.629	0.405	6.592
1961	0.278	0.273	0.988	0.372	0.800	1.084	0.529	0.309	0.061	0.303	0.260	0.413	5.672
1962	0.182	0.552	0.528	0.812	0.826	0.928	0.455	0.149	0.419	0.648	0.429	0.199	6.127
1963	0.538	0.494	0.685	0.652	0.656	1.141	0.797	0.083	0.351	0.613	0.359	0.183	6.552
1964	0.099	0.455	0.975	0.651	0.766	1.071	0.274	0.494	0.702	0.641	0.629	0.458	7.217
1965	0.368	0.155	0.449	0.034	0.458	1.108	0.808	0.647	0.749	0.543	0.499	0.383	6.201
1966	0.612	0.309	0.362	0.525	0.737	0.818	0.529	0.320	0.411	0.449	0.555	0.402	6.030
1967	0.148	0.483	0.387	0.561	0.758	1.119	0.337	0.188	0.585	0.497	0.615	0.081	5.758
1968	0.298	0.210	0.527	0.551	0.744	1.150	0.429	0.101	0.747	0.441	0.266	0.148	5.611
1969	0.632	0.357	0.742	0.713	0.632	1.107	0.809	0.398	0.625	0.393	0.147	0.452	7.005
1970	0.464	0.304	0.300	0.778	0.856	1.014	0.504	0.215	0.122	0.342	0.609	0.391	5.899
1971	0.494	0.687	0.811	0.707	0.729	0.601	0.559	0.178	0.424	0.648	0.562	0.458	6.857
1972	0.204	0.152	0.410	0.438	0.836	0.931	1.115	0.848	0.286	0.271	0.408	0.108	6.008
1973	0.359	0.475	0.379	0.733	0.753	0.738	0.133	0.148	0.376	0.481	0.629	0.346	5.549
1974	0.632	0.768	0.867	0.785	0.838	0.689	0.288	0.378	0.724	0.518	0.629	0.258	7.372
1975	0.596	0.241	0.613	0.751	0.695	1.123	0.354	0.296	0.355	0.644	0.629	0.458	6.755
1976	0.232	0.008	0.232	0.403	0.876	1.028	0.506	0.091	0.444	0.333	0.599	0.458	5.212
1977	0.331	0.504	0.971	0.596	0.676	0.731	0.035	0.328	0.754	0.529	0.459	0.354	6.268
1978	0.609	0.590	0.442	0.790	0.879	1.054	0.282	0.055	0.288	0.267	0.052	0.379	5.687
1979	0.141	0.355	0.307	0.752	0.797	1.021	0.682	0.210	0.421	0.442	0.443	0.275	5.844
1980	0.014	0.317	0.344	0.630	0.837	0.821	0.142	0.308	0.397	0.421	0.590	0.365	5.186
1981	0.098	0.118	0.127	0.281	0.550	1.064	0.199	0.085	0.313	0.461	0.629	0.458	4.382
1982	0.308	0.160	0.039	0.332	0.481	1.055	1.015	0.147	0.603	0.408	0.320	0.136	5.006
1983	0.508	0.220	0.448	0.202	0.733	1.031	0.311	0.189	0.215	0.128	0.469	0.458	4.912
1984	0.631	0.479	0.497	0.582	0.870	0.867	0.201	0.172	0.331	0.644	0.629	0.320	6.222
1985	0.007	0.613	0.889	0.844	0.733	1.187	0.241	0.314	0.690	0.307	0.562	0.114	6.501
1986	0.451	0.263	0.375	0.663	0.706	0.854	0.525	0.329	0.659	0.136	0.270	0.058	5.288
MEAN	0.315	0.378	0.553	0.616	0.759	0.995	0.457	0.267	0.481	0.435	0.476	0.313	6.045

TABLE C-2-14 GROSS IRRIGATION REQUIREMENT

CROPPING PATTERN WHEAT =0.400 OILSEEDS =0.050 FODDERS =0.050 VEGETABLE=0.100 MAIZE =0.300
SOYBEAN =0.050 FODDERS =0.050 VEGETABLE=0.100 ORCHARD =0.050 SUGARCANE=0.050

CROPPING INTENSITY = 130.0% IRRIGATION EFFICIENCY = 60.0%

(UNIT...MCM/1000HA)

YEAR	(JAN)	(FEB)	(MAR)	(APR)	(MAY)	(JUN)	(JUL)	(AUG)	(SEP)	(OCT)	(NOV)	(DEC)	ANNUAL
1952	0.215	0.251	0.668	0.819	0.756	0.650	0.260	0.201	0.741	0.585	0.586	0.423	6.156
1953	0.055	0.293	0.996	0.710	0.694	1.008	0.348	0.312	0.749	0.442	0.586	0.358	6.549
1954	0.086	0.000	0.606	0.860	0.713	1.000	0.434	0.288	0.441	0.299	0.584	0.342	5.653
1955	0.578	0.693	0.650	0.696	0.656	0.972	0.448	0.323	0.212	0.459	0.586	0.348	6.622
1956	0.332	0.776	0.266	0.746	0.765	0.636	0.126	0.052	0.732	0.301	0.560	0.423	5.715
1957	0.001	0.167	0.597	0.144	0.570	0.887	1.027	0.407	0.797	0.304	0.064	0.018	4.982
1958	0.158	0.788	0.411	0.785	0.738	1.014	0.318	0.259	0.504	0.444	0.509	0.150	6.079
1959	0.125	0.044	0.849	0.632	0.526	0.926	0.307	0.194	0.080	0.315	0.049	0.190	4.237
1960	0.102	0.556	0.559	0.591	0.713	1.020	0.342	0.309	0.457	0.461	0.586	0.374	6.069
1961	0.259	0.264	0.965	0.346	0.661	0.928	0.482	0.309	0.058	0.303	0.245	0.382	5.202
1962	0.167	0.534	0.528	0.762	0.692	0.781	0.413	0.149	0.415	0.607	0.399	0.184	5.631
1963	0.501	0.476	0.685	0.608	0.542	0.978	0.733	0.083	0.347	0.578	0.335	0.167	6.033
1964	0.091	0.449	0.947	0.599	0.642	0.913	0.250	0.494	0.696	0.603	0.586	0.423	6.694
1965	0.342	0.153	0.449	0.034	0.377	0.951	0.742	0.635	0.736	0.509	0.465	0.353	5.746
1966	0.572	0.296	0.362	0.500	0.613	0.691	0.483	0.320	0.407	0.427	0.518	0.370	5.559
1967	0.137	0.462	0.387	0.525	0.629	0.958	0.306	0.188	0.585	0.473	0.574	0.072	5.294
1968	0.273	0.206	0.527	0.519	0.621	0.986	0.395	0.101	0.741	0.424	0.248	0.136	5.175
1969	0.590	0.352	0.736	0.661	0.522	0.947	0.743	0.388	0.619	0.371	0.138	0.416	6.482
1970	0.432	0.300	0.300	0.732	0.720	0.859	0.461	0.214	0.121	0.341	0.569	0.360	5.410
1971	0.461	0.659	0.802	0.661	0.602	0.504	0.510	0.178	0.413	0.607	0.524	0.423	6.345
1972	0.185	0.151	0.410	0.417	0.697	0.787	1.027	0.831	0.286	0.271	0.383	0.100	5.546
1973	0.333	0.460	0.379	0.685	0.632	0.612	0.118	0.148	0.372	0.455	0.586	0.318	5.099
1974	0.590	0.738	0.843	0.724	0.704	0.568	0.257	0.378	0.710	0.488	0.586	0.236	6.822
1975	0.556	0.240	0.609	0.704	0.575	0.961	0.318	0.296	0.348	0.604	0.586	0.423	6.220
1976	0.215	0.007	0.232	0.382	0.731	0.873	0.460	0.091	0.437	0.319	0.559	0.423	4.730
1977	0.307	0.492	0.947	0.548	0.560	0.605	0.034	0.328	0.744	0.502	0.428	0.325	5.820
1978	0.568	0.574	0.438	0.741	0.739	0.900	0.259	0.055	0.282	0.266	0.050	0.349	5.221
1979	0.129	0.344	0.307	0.708	0.667	0.868	0.630	0.209	0.420	0.435	0.413	0.252	5.380
1980	0.014	0.313	0.344	0.594	0.702	0.685	0.129	0.306	0.392	0.414	0.550	0.336	4.778
1981	0.090	0.116	0.127	0.279	0.454	0.912	0.178	0.085	0.309	0.445	0.586	0.423	4.003
1982	0.285	0.160	0.039	0.328	0.396	0.901	0.931	0.147	0.597	0.392	0.297	0.123	4.597
1983	0.473	0.214	0.448	0.197	0.604	0.879	0.279	0.189	0.215	0.128	0.445	0.423	4.494
1984	0.589	0.457	0.497	0.552	0.728	0.730	0.183	0.172	0.324	0.604	0.586	0.293	5.715
1985	0.006	0.589	0.865	0.779	0.612	1.020	0.221	0.314	0.673	0.297	0.524	0.103	6.004
1986	0.418	0.252	0.375	0.631	0.583	0.721	0.474	0.329	0.655	0.135	0.254	0.053	4.879
MEAN	0.292	0.366	0.547	0.577	0.632	0.847	0.418	0.265	0.475	0.417	0.444	0.288	5.570

TABLE C-2-15 GROSS IRRIGATION REQUIREMENT

CROPPING PATTERN WHEAT =0.400 OILSEEDS =0.050 FODDERS =0.050 VEGETABLE=0.050 MAIZE =0.300
SOYBEAN =0.050 FODDERS =0.050 VEGETABLE=0.050 ORCHARD =0.050 SUGARCANE=0.050

CROPPING INTENSITY = 120.0% IRRIGATION EFFICIENCY = 60.0%

(UNIT...MCM/1000HA)

YEAR	(JAN)	(FEB)	(MAR)	(APR)	(MAY)	(JUN)	(JUL)	(AUG)	(SEP)	(OCT)	(NOV)	(DEC)	ANNUAL
1952	0.200	0.245	0.668	0.752	0.612	0.528	0.226	0.201	0.727	0.547	0.543	0.387	5.637
1953	0.049	0.293	0.976	0.648	0.562	0.844	0.316	0.312	0.733	0.414	0.543	0.326	6.016
1954	0.079	0.000	0.606	0.801	0.574	0.837	0.398	0.287	0.436	0.297	0.542	0.312	5.170
1955	0.537	0.663	0.648	0.636	0.526	0.811	0.409	0.316	0.210	0.450	0.543	0.318	6.067
1956	0.309	0.740	0.266	0.699	0.620	0.512	0.119	0.052	0.719	0.298	0.520	0.387	5.241
1957	0.001	0.162	0.593	0.138	0.448	0.740	0.940	0.398	0.785	0.287	0.062	0.017	4.572
1958	0.144	0.752	0.409	0.730	0.595	0.848	0.285	0.259	0.502	0.438	0.472	0.137	5.572
1959	0.114	0.044	0.839	0.578	0.420	0.770	0.274	0.194	0.075	0.314	0.047	0.170	3.839
1960	0.092	0.540	0.550	0.550	0.568	0.853	0.310	0.309	0.447	0.441	0.543	0.342	5.547
1961	0.240	0.255	0.942	0.321	0.521	0.771	0.434	0.309	0.056	0.303	0.230	0.350	4.733
1962	0.153	0.515	0.528	0.712	0.558	0.633	0.371	0.149	0.412	0.567	0.370	0.168	5.136
1963	0.465	0.458	0.685	0.564	0.428	0.815	0.668	0.083	0.343	0.544	0.310	0.151	5.514
1964	0.084	0.444	0.920	0.547	0.518	0.754	0.227	0.494	0.689	0.565	0.543	0.387	6.172
1965	0.317	0.151	0.449	0.034	0.295	0.795	0.676	0.623	0.724	0.475	0.431	0.322	5.292
1966	0.532	0.282	0.362	0.476	0.489	0.565	0.437	0.320	0.403	0.404	0.480	0.338	5.088
1967	0.126	0.440	0.387	0.489	0.500	0.797	0.274	0.188	0.584	0.450	0.532	0.063	4.829
1968	0.248	0.202	0.527	0.487	0.498	0.823	0.360	0.101	0.734	0.406	0.229	0.124	4.739
1969	0.548	0.347	0.731	0.610	0.412	0.786	0.678	0.378	0.612	0.348	0.129	0.381	5.960
1970	0.399	0.295	0.300	0.686	0.584	0.704	0.418	0.214	0.121	0.340	0.530	0.329	4.921
1971	0.429	0.631	0.794	0.615	0.475	0.408	0.462	0.178	0.402	0.567	0.486	0.387	5.833
1972	0.166	0.151	0.410	0.395	0.558	0.644	0.938	0.814	0.286	0.271	0.359	0.091	5.084
1973	0.307	0.446	0.379	0.637	0.512	0.485	0.103	0.148	0.369	0.428	0.543	0.290	4.648
1974	0.548	0.708	0.820	0.664	0.571	0.448	0.225	0.378	0.695	0.459	0.543	0.214	6.272
1975	0.516	0.239	0.605	0.657	0.455	0.799	0.282	0.296	0.341	0.565	0.543	0.387	5.686
1976	0.197	0.006	0.232	0.362	0.587	0.718	0.413	0.091	0.429	0.305	0.519	0.387	4.248
1977	0.284	0.479	0.924	0.499	0.443	0.478	0.033	0.328	0.735	0.476	0.397	0.297	5.372
1978	0.528	0.557	0.435	0.693	0.599	0.745	0.235	0.055	0.277	0.265	0.048	0.318	4.755
1979	0.118	0.334	0.307	0.663	0.537	0.715	0.577	0.207	0.419	0.428	0.382	0.229	4.916
1980	0.013	0.309	0.344	0.558	0.568	0.548	0.116	0.305	0.386	0.407	0.509	0.306	4.370
1981	0.081	0.114	0.127	0.276	0.357	0.761	0.156	0.085	0.304	0.430	0.543	0.387	3.623
1982	0.263	0.160	0.039	0.324	0.312	0.746	0.847	0.147	0.592	0.376	0.273	0.109	4.188
1983	0.438	0.208	0.448	0.192	0.476	0.726	0.246	0.189	0.215	0.128	0.422	0.387	4.075
1984	0.548	0.435	0.497	0.521	0.585	0.592	0.166	0.172	0.317	0.564	0.543	0.267	5.207
1985	0.005	0.566	0.841	0.714	0.490	0.853	0.200	0.314	0.657	0.287	0.486	0.093	5.507
1986	0.384	0.242	0.375	0.598	0.460	0.587	0.424	0.329	0.651	0.135	0.238	0.048	4.469
MEAN	0.270	0.355	0.542	0.538	0.506	0.698	0.378	0.264	0.468	0.399	0.412	0.263	5.094

TABLE C-2-16 GROSS IRRIGATION REQUIREMENT

CROPPING PATTERN WHEAT =0.350 OILSEEDS =0.050 FODDERS =0.050 VEGETABLE=0.050 MAIZE =0.250
SOYBEAN =0.050 FODDERS =0.050 VEGETABLE=0.050 ORCHARD =0.050 SUGARCANE=0.050

CROPPING INTENSITY = 110.0% IRRIGATION EFFICIENCY = 60.0%

(UNIT...MCM/1000HA)

YEAR	(JAN)	(FEB)	(MAR)	(APR)	(MAY)	(JUN)	(JUL)	(AUG)	(SEP)	(OCT)	(NOV)	(DEC)	ANNUAL
1952	0.185	0.223	0.609	0.704	0.604	0.516	0.224	0.181	0.653	0.507	0.503	0.360	5.270
1953	0.046	0.267	0.893	0.608	0.555	0.817	0.297	0.279	0.660	0.388	0.503	0.303	5.617
1954	0.073	0.000	0.553	0.748	0.569	0.810	0.377	0.261	0.391	0.275	0.502	0.291	4.850
1955	0.496	0.609	0.589	0.596	0.522	0.787	0.390	0.287	0.188	0.416	0.503	0.296	5.679
1956	0.285	0.681	0.243	0.652	0.612	0.503	0.118	0.046	0.644	0.278	0.481	0.360	4.902
1957	0.001	0.147	0.538	0.134	0.448	0.713	0.873	0.360	0.705	0.268	0.062	0.017	4.266
1958	0.133	0.691	0.372	0.679	0.589	0.821	0.271	0.235	0.449	0.405	0.437	0.128	5.212
1959	0.105	0.040	0.767	0.544	0.417	0.747	0.264	0.176	0.068	0.292	0.044	0.159	3.624
1960	0.086	0.494	0.502	0.514	0.565	0.826	0.296	0.281	0.401	0.411	0.503	0.318	5.198
1961	0.221	0.233	0.863	0.302	0.521	0.749	0.409	0.280	0.051	0.282	0.214	0.326	4.451
1962	0.142	0.472	0.482	0.664	0.552	0.625	0.352	0.133	0.370	0.525	0.343	0.157	4.817
1963	0.429	0.420	0.625	0.529	0.428	0.791	0.624	0.075	0.309	0.503	0.288	0.142	5.164
1964	0.077	0.405	0.843	0.514	0.512	0.737	0.218	0.448	0.618	0.523	0.503	0.360	5.758
1965	0.292	0.138	0.409	0.034	0.295	0.768	0.631	0.565	0.649	0.443	0.399	0.300	4.924
1966	0.491	0.260	0.329	0.445	0.486	0.554	0.414	0.288	0.363	0.375	0.446	0.315	4.766
1967	0.116	0.405	0.351	0.459	0.498	0.774	0.266	0.169	0.523	0.419	0.493	0.060	4.532
1968	0.230	0.185	0.480	0.455	0.494	0.798	0.342	0.090	0.658	0.376	0.214	0.116	4.437
1969	0.506	0.317	0.666	0.571	0.411	0.765	0.636	0.341	0.549	0.326	0.125	0.353	5.568
1970	0.369	0.269	0.274	0.639	0.576	0.691	0.399	0.192	0.110	0.316	0.491	0.306	4.632
1971	0.396	0.579	0.725	0.573	0.475	0.396	0.439	0.159	0.363	0.525	0.451	0.360	5.441
1972	0.155	0.137	0.371	0.373	0.553	0.631	0.872	0.736	0.258	0.250	0.336	0.086	4.757
1973	0.284	0.409	0.345	0.595	0.505	0.483	0.103	0.134	0.330	0.401	0.503	0.270	4.361
1974	0.506	0.650	0.748	0.623	0.563	0.447	0.220	0.342	0.625	0.428	0.503	0.200	5.854
1975	0.477	0.218	0.553	0.611	0.455	0.778	0.272	0.272	0.307	0.523	0.503	0.360	5.328
1976	0.183	0.006	0.210	0.341	0.581	0.703	0.388	0.082	0.385	0.286	0.481	0.360	4.006
1977	0.262	0.439	0.845	0.471	0.442	0.478	0.032	0.299	0.658	0.443	0.368	0.276	5.014
1978	0.487	0.511	0.395	0.645	0.591	0.726	0.227	0.050	0.248	0.245	0.046	0.296	4.467
1979	0.109	0.306	0.278	0.618	0.532	0.699	0.542	0.187	0.376	0.395	0.354	0.214	4.611
1980	0.012	0.282	0.312	0.522	0.561	0.545	0.115	0.278	0.348	0.374	0.472	0.285	4.104
1981	0.076	0.103	0.114	0.254	0.357	0.737	0.151	0.075	0.273	0.400	0.503	0.360	3.403
1982	0.243	0.146	0.035	0.299	0.312	0.727	0.787	0.134	0.532	0.352	0.253	0.104	3.922
1983	0.404	0.190	0.407	0.179	0.476	0.708	0.240	0.170	0.191	0.123	0.393	0.360	3.840
1984	0.505	0.400	0.451	0.487	0.580	0.584	0.164	0.155	0.285	0.522	0.503	0.249	4.887
1985	0.004	0.519	0.768	0.669	0.486	0.826	0.192	0.287	0.591	0.268	0.451	0.088	5.151
1986	0.356	0.222	0.341	0.554	0.460	0.577	0.411	0.298	0.583	0.130	0.223	0.046	4.200
MEAN	0.250	0.325	0.494	0.503	0.502	0.681	0.359	0.238	0.420	0.371	0.383	0.245	4.772

C.3. Water Demand for New International Airport

C.3.1 Background of New Airport and its Location

(1) Background

In order to cope with the increasing air traffic requirements as well as with international standards to be recommended for the capital city of Pakistan, new facilities including expansion of the existing it in Chaklala Cantonment area are absolutely necessary. Consequently, following options were considered by Civil Aviation Authority (CAA):

- Expansion Plan: Expansion of the existing facilities; or construction of facilities on the north side of the existing runway.

- New Plan: Shifting of the airport to a new site. Expansion plan was rejected, because the existing site does not have any further potential for expansion of parking aprons and terminal facilities. The area on the north side of the existing runway was studied for the construction of aprons and terminal facilities, but it was concluded that the many environmental and physical constraints render it unsuitable.

The CAA during its 7th board meeting on July 1983 has decided to study the feasibility of a new airport, its location was further decided to be near the village Rakh Pind Ranjha in Rawalpindi Tehsil. Master plan and preliminary study for new airport was completed on June 1986.

(2) Location and Main Facilities

The new airport will be located south west of Islamabad at 25 km from the center of the city, at about 15 km east of Fatehjang

town and about 18 km south of Sang Jani railway station. The present airport will be reserved for the exclusive use of PAF. Total area is about 1,060 hectares, and land acquisition works has been proceeding by CAA.

The airport will include a runway of 3,800 x 45 m. South of this runway a land reservation will allow the construction of a future second runway if needed as well as an industrial area of 120 ha. All buildings related to the airport operations are situated north of the runway on the direct access from a city, and the planned buildings are:

- the passenger terminal with a total area of building bout 38,600 sq.m.
- the control tower and the operation building,
- the fire station
- the cargo terminal
- the CAA office building
- the airport maintenance area with a vehicle maintenance building, facilities maintenance building, warehouse, etc,
- the power plant
- the flight kitchen
- the mosque
- agricultural - horticultural building
- various ancillary buildings.

C.3.2. Traffic Projection

The statistics of passenger traffic, cargo traffic and aircraft traffic edited by the CAA and long term projections of each traffic were recommended by the Master Plan of new airport.

(1) Passenger Traffic

Year	Domestic	Transit	International	Transit	Total	Growth Rate (%)
1979-80	680	2	205	4	891	
1980-81	703	2	206	6	917	1.53
1981-82	714	1	211	5	931	6.66
1982-83	722	1	266	4	993	11.78
1983-84	781	4	320	5	1,110	5.73
1990	1,189	2	559	100	1,850	8.89
1995	1,394	2	832	270	2,498	6.19
2000	1,599	2	1,178	270	3,049	4.07

The average increase over the period of total traffic is 6.03 %, domestic value is 4.15 % and 9.66 is for international traffic. It is evident that international traffic will be increased year by year.

(2) Cargo Traffic

(metric ton)

Year	Domestic	International	Total	Growth Rate (%)
1979-80	6,207	4,522	10,729	
1980-81	7,482	4,860	12,702	18.39
1981-82	8,182	4,853	13,035	2.62
1982-83	8,276	7,208	15,484	18.78
1983-84	8,270	6,742	15,012	-0.15
1990	16,700	16,400	33,100	14.09
1995	20,300	25,000	45,300	6.48
2000	24,100	36,100	60,200	5.85

The average annual growth of cargo traffic is 8.56 % over the period.

(3) Aircraft Traffic

Year	Domestic	International	Total	Growth Rate (%)
1979-80	13,809	1,382	15,191	
1980-81	12,380	1,421	13,801	-9.15
1981-82	11,506	1,179	12,685	-8.09
1982-83	11,074	1,274	12,348	-2.66
1983-84	10,774	1,685	12,459	0.90
1990	13,500	2,800	16,700	5.00
1995	14,000	4,900	18,900	2.51
2000	14,500	5,900	20,400	1.54

The average increase of aircraft traffic is only 1.41 % due to the fast growth of the average payload of commercial aircraft.

(4) Passenger Peak Hour Traffic

Peak passenger traffic (arriving and departing) as shown below will be considered for water demand.

Year	Peak Hour Passenger Flow
1990	1,006
1995	1,159
2000	1,369

C.3.3. Water Demand Projection

The water requirement of new international airport was evaluated about 0.5 MGD (2300 cmd) at the target year of 2000 tentatively. This value came from new airport master plan report, which issued by CAA, and discussion between CAA and JICA study team. Since this projection is only considered new airport facilities requirement, total water demand for the target year 2030 will be reached about 1.50 MGD (6,800 cmd). This value includes requirement of airport facilities and relative industry/commerce.

APPENDIX D.

PRELIMINARY DESIGN OF THE FACILITIES

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D.1 Existing Water Resources Facilities

D.1.1 Existing Storage Dams

Major water sources undertaking at present and near future supply of water requested in the cities of Islamabad and Rawalpindi are surface water drained by the Haro, Kurang and Soan rivers, supported by the storage function of the Rawal, Khanpur, and Simly reservoirs.

The salient features of the three existing dams are shown in Table D-1-1.

(1) Rawal Dam

The Rawal Dam Project was conceived to meet chronic shortage of water supply having been experienced in Rawalpindi and Cantonment, and was formally inaugurated by the President of Pakistan on 17th May, 1962. In the original plan of the dam, the reservoir was proposed so as to provide 29.0 MGD of water to Rawalpindi and Cantonment, but the Project was revised due to the drought during the years 1972-73 with the conclusion that the supply of water be reduced to 21.0 MGD and the filtration plant was completed in 1979 with design capacity of 21.0 MGD.

In addition to supplying domestic water, the canal system was designed to irrigate a net CCA of 8390 acres (comprising 5010 acres on the right bank and 3300 acres on the left) and maturing 12,000 crop acres annually.

(2) Khanpur Dam

Originally the Khanpur Dam Project was approved in 1963 envisaging construction of 41.8 m (137 ft) high earth-fill dam and a canal system to irrigate 31,150 ha (77,000 acres) of agricultural land situated both on the left and right bank of the river including some area on the eastern side of the Margala range of hills, and the construction work was started in the beginning of 1967.

Due to growing need for municipal and industrial water supply in the terrain, irrigation water in the vicinity of twin city of Islamabad and Rawalpindi, heavy industrial complexes at Taxila and Wah, the Project was revised in 1973 converting the primary objective of the scheme from irrigation to water supply.

Consequently, the Khanpur Reservoir was designed with the raising of dam height to 50.9 m (167 ft), which is the maximum allowable from technical, geographic and geologic point of view, to supply 33.0 MGD of water to Islamabad and 69.37 MGD of water to Rawalpindi for domestic purposes, 28.5 MGD to the various industries at Wah and Taxila, and irrigation water for 14,770 ha (36,470 acres) of culturable command area of both the Left and Right Bank Canal.

(3) Simly Dam

The Simly Dam Project is recognized as an essential constituent of bulk water supply scheme for Islamabad. The reservoir stores not only the perennial low flows but also a considerable part of flood water of the Soan river. Water released from the reservoir is conveyed to Islamabad through twin conduction main pipes after treatment and the reservoir is expected to provide 24.0 MGD of water for drinking and domestic uses to the Federal Capital of Islamabad.

In the original design, it has been mentioned that the normal conservation level of the reservoir will be raised from 2,295 ft to 2,315 ft level in order to increase the live storage of the reservoir after abut 21 years of operation when almost all of the dead storage is lost due to sediment deposit. This will be done by providing three 7.62 m (25 ft) high gate, and may result an additional live storage of 11.8 MCM (9,600 acre ft) obtainable. It has become realized that the installation of gates can be advantageously progressed in near future to raise the conservation level to 2,315 ft thereby increasing live storage by 11.8 MCM resulting in gain of a substantial safe yield from the catchment.

Table D-1-1 Salient Features of Existing Dams

Name of Dam		Khanpur	Rawal	Simly
Catchment Area (sq. miles)		308	106	59
Reservoir				
High Water Level	(ft)	1,982	1,761	2,320
Retention Water Level	(ft)	1,982	1,752	2,295
Low Water Level	(ft)	1,902	1,708	2,233
Gross Storage	(AF)	107,000	45,500	28,750
Live Storage	(AF)	91,500	43,000	20,000
Dead Storage	(AF)	15,500	4,500	8,750
Main Dam				
Type of Dam		Earthfill	Gravity	Earthfill
Dam Top Elevation	(ft)	1,992	1763.5	2,330
Maximum Height	(ft)	167	133.5	263
Length of Dam	(ft)	1,546	700	1,010
Freeboard above HWL	(ft)	10	2.5	10
Width of Dam Top	(ft)	35	14	30
U/S Slope of Dam		1:3.5	1:0.04	1:3.0 & 2.25
D/S Slope of Dam		1:2.5	1:0.675	1:1.75 & 1.5
Spillway				
Type		Ogee Type Weir	Ogee Type Weir	Ogee Type Weir
Capacity	(cusec)	166,000	82,000	45,000
Crest Elevation	(ft)	1,947	1,742	2,300
Gates (W x H)	(ft)	5-Radial 40'x35'	8-Radial 30'x10.2'	No
Overflow Depth	(ft)	35	19	20
Overflow Length	(ft)	200	240	96(110)
Max. Probable Flood	(cusec)	182,000	120,000	90,684
Construction				
Commenced Year		1967	1959	1972
Completion Year		1983	1962	1982

D.1.2. Existing Water Supply System

Detailed descriptions of existing water supply systems were sifted to C.1.4 of Appendix C.