ANNEX D

Environment

THE STUDY
ON
THE LINING OF DISTRIBUTARIES AND MINORS
IN
PUNJAB
IN
THE ISLAMIC REPUBLIC OF PAKISTAN

VOLUME II

ANNEX D ENVIRONMENT

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D.1 Legal Frame work on Environment in Punjab, Pakistan

1.1 Environmental Laws

Environmental protection has always been a part of the legislation in Pakistan which are embodied in some 23 different legislation's that relate to environmental concerns since 1870's.

In 1983 'The Pakistan Environmental Protection Ordinance' was declared and this made provision for the formation of a high powered 'Pakistan Environmental Protection Council' to be chaired by the President of Pakistan. This council was empowered among others to:

(a) ensure enforcement of the ordinance
(b) establish comprehensive national environmental policy
(c) give appropriate direction to conserve the renewable and expandable resources
(d) ensure that environmental considerations are inter-weaved into National Development Plans and Policies
(e) ensure the enforcement of the National Environmental Quality Standards
(f) give directions to any Government agency, a body or a person requiring it to take measures to control pollution being caused and to refrain from carrying out any particular activity prejudicial to public interest..

Pakistan Environmental Protection Agency (EPA) formed under the 'The Pakistan Environmental Protection Ordinance of 1983', perform the functions assigned to it under the Ordinance and the formation of rules and regulations.

1.2 Environmental Impact Assessment and regulatory process.

Among the functions of the EPA was the provision of Environmental Impact Assessment Statements. To implement the ordinance, the Punjab EPA was formed in 1987. It has among its objectives, the adoption of EIA procedures, creating awareness, enforcement and monitoring. However the major areas of concentration at present appear to be in the fields of urban pollution, vehicle emissions, solid waste and sewerage management in the urban areas. The Pakistan Environmental Protection Agency has published National Environmental Quality Control Standards for the following categories.

(1) Municipal and liquid industrial effluents
(2) Industrial gaseous emissions
(3) Motor vehicle exhaust and noise

All newly establishing industries are required by law to obtain 'No Objection Certificates' (NOC) from EPA after submission of their Environmental Impact statements. After approval of the Environmental Quality Control Standards, it has now become imperative for all newly industrial units with effect from July 1994 to arrange for effective pollution control devices or measures. All existing units were required to undertake similar steps by 1st July 1996.

As regards the agricultural and irrigation projects, at the time of the JICA Study there were no guidelines published by the Punjab EPA. There are no environmental standards fixed for irrigation water or for most of the other irrigation related activities. Certain international guidelines are followed in some cases where there is none fixed, as in drinking water, the WHO standards are adopted by the Public Health Engineering Department. Major infrastructure projects funded by Donor agencies have carried out environmental studies as a requirement of the project. It was seen that in some of the Donor assisted projects, the environmental procedures of such agencies were followed by them. The Planning and Development Board gives approval for provincial projects to go ahead.

1.3 National Policy

The on going Eighth five year plan of the Government of Pakistan has given a strong commitment to environmental issues of management and institutional aspects. From the fourteen core programmes of the 'National Conservation Strategy' which are supported by the five year plan, Maintaining Soils in Croplands and Increasing Irrigation Efficiency are given the two highest priorities. A beneficial impact of the proposed canal lining project is expected to be the same. The Eighth five year plan also has one of its targets as the elimination of water logging in the 1.40 million hectares of disaster areas of Pakistan. Hence the canal lining project is in keeping to the objectives of the National Policy framework on environment.

D.2 Description of the Project

The project for the study on 'Lining of Distributaries and Minors in Punjab' is to conduct a Feasibility in the Lower Jhelum Canal, Lower Chenab Canal and the Central Bari Doab Canal systems, in the Punjab province in Pakistan covering an area of 24,500 km^2. and

(i) to select priority project area comprising approximately 500 km of distributaries and minors from a total length of 6,600 km. in the above three canal systems from the areas where the salinity hazard are deemed to be serious

(ii) to formulate canal lining projects for the selected priority distributary systems including O&M system in line with GOP's institutional reforms and

(iii) to evaluate the feasibility of the proposed project.

D.3 Objective of Environment study

The objective of the environment study was to carry out a preliminary environmental review through an IEE and to assess whether an EIA is necessary or not for the project. Major study components of the IEE include present environmental conditions of the study area, preliminary assessment of environmental impacts and evaluation of whether an EIA is necessary or not

D.4 The present environmental conditions in the study area.

4.1 Study area

The study area is in the Indus Basin in Pakistan, and as indicated on the location map consists of the three Irrigation systems of (1). Lower Jhelum Canal Circle in the Chaj Doab (2) Lower Chenab Canal Circle in the Rechna Doab and (3) Central Bari Doab Canal in the Bari Doab. It lies in Punjab province in the upper Indus Plains and lies between north latitudes 30° 40' and 32° 40' and east longitudes 72° 00' and 74° 40'

The total study area is 27,247 km2 with a gross command area of 2.4 million hectares and cultivable command area of 2.1 million ha. It extends approximately 250 km in the east - west direction and about 240 km.in the north - south direction. The land is almost flat and its elevation varies from 140 m. to 220 meters above sea level. The Punjab province is divided into four (4) Agro Ecological Zones, namely Rice zone, Central mixed zone, Cotton zone and Barani (Rainfed) zone. The greater part of the study area is located in the Central mixed zone.

This existing irrigation system construction commenced during the latter half of the 19th century and continued in the 20th century by the British colonial government. It forms part of

the worlds largest irrigation systems. 90% of the geographical area under the three canal systems is under their command.

The study area receives an annual average rainfall varying from 600 mm in the northern parts to 200 mm in the southern area. Hence the project area is classified as an arid to semi-arid region. This arid and semi arid land has been made productive by the provision of irrigation water through a vast network of diversions and a canal system. The provision of canal irrigation systems have changed the environmental conditions in the doabs. In the last four decades the agricultural production has increased and in the 1980's kept up with the high population growth, but over the years of irrigation, certain major adverse environmental impacts have occurred. After nearly a century of irrigation, the lands are now prone to typical environmental problems associated with irrigated lands in arid and semi arid regions, such as waterlogging, salinity and soil salinisation. The project area has undergone vast changes since irrigation was introduced, that its physical environmental conditions have completely changed and taken the present state.

4.2 Population

The population in the study area has been estimated at 21.1 million based on the 1981 census data and the trend during 1972 to 1981. This is equivalent to 25.7% of the population of Punjab. The density of population is highest in CBDC with 1,922 / km^2 while LCC and LJC were with 616 and 451 km^2. Of the total population 52% were in the urban area while 48% lived in rural areas. The number of households is estimated at 2,120,000 giving a unit size of 6.6.

The farm survey carried out during phase 1 of the study indicated that the literacy rate in the study area was 45% with more than half of them coming from small and marginal farms. The literacy rate for women was 25.5% while it was 61% for men.

4.3 Land use

The total area of study is 27,247 km2 with a gross command area of 2.4 million hectares and the cultivable command area of 2.1 million ha. The land is mainly used for crop production, range lands, forest, barren land and residential area depending on the geographical position, soil properties and irrigation water availability. Irrigated cultivated area is the dominant land use in the area, which spreads along the irrigation canals. The table below gives the major land use in Punjab.

Land Use Class	Area (1,000 ha)
Agricultural Land	
Irrigated	10,743
Rainfed	1,316
Rangelands	
Degraded	4,466
Non-degraded	1,293
Forest/Trees	608
Barren Land	
Rock, gravel	337
Desertic	1,324
Water bodies	477
Urban	62
Total	20,626

Source: Punjab Forestry Sector Master Plan (1992)
Agricultural Research Phase-II Project (1995)

The Agriculture depends on irrigation and the system has been built to accommodate a cropping intensity of 68% whereas at present it has a cropping intensity of 128%. Wheat is the major Rabi (October - April) crop. The Kharif (April - October) crops depends on the natural and social conditions. The main ones are cotton, rice, maize and sugarcane. The average land holding size under irrigation ranged between 3.89 to 23.3 acres in four categories. Their distribution is as follows: marginal; 3.9 acres, small; 7.0 acres, medium; 12.3 acres and large; 23.3 acres.

Farmers in the study area, particularly the marginal and small farmers engage themselves in livestock farming. The landless tend to have greater proportions of goats and sheep which can make the most of free grazing, while owner farmers and tenant farmers have buffaloes and cattle. The estimated number of livestock are, Cattle 2 million, Buffaloes 3.9 million, Goats 3.3 million and Sheep 1.2 million.

4.4 Health and sanitation

The health and sanitation conditions in the study area is very poor. The survey carried out in the study area revealed that more than 50% of the families are regularly affected by illness. Flu/fever, malaria, dysentry and typhoid were the major causes. There are the minimum infrastructure facilities provided but the treatment sought at government hospitals were by about 27% of the population. The lack of doctors, medical supplies or expensive medicines were the reasons for not attending.

Health statistics of the Department for 1995 indicate the high incidence of the water re;related diseases.

	Population	Diarrhoea	Dysentry	Malaria	Typhoid
Lahore	5,835,000	149,202	90,313	46,253	18,199
Kasur	2,302,000	10,428	8,569	118	
Faisalabad	4,307,000	113,941	64,100	16,634	14,286
TT Singh	1,191,000	27,508	16,660	761	1,348
Jhang	3,011,000	69,259	34,301	11,056	3,907
Sargodha	2,628,000	52,871	34,897	979	6,022
		423,209	248,840	75,801	43,762

Source; Health Department, Punjab

The source of drinking water in 87% of the study area was from hand or motor pump. Only a small number, less than 1% use river or canal water directly. The practice of boiling water is almost non existent. 25% of the population were dissatisfied with the water quality stating it was the salinity that they objected to. The survey in the study area showed that in LJC 72% of the households had toilets while in LCC it is 38% and in CBDC it is 37%. The incidence of some water related diseases could be connected to the quality of drinking water and sanitation. The present health and sanitation conditions in the project area, with the high incidence of diseases would be indicated in the lower productivity of the farmers.

4.5 Forests and Forestry Plantations

The extent of forests in Punjab is about 2.5% of its land area. In the study area it is even lesser and is estimated at less than 1%. Forestry is thus a very limited resource in the area. The forests directly supply the requirements of timber, firewood, resin, industrial and other forest products, while indirectly it provides many other environmental requirements. Some of the larger forests in the study area also provides as sanctuaries to the wild life and also as recreational areas. Fuelwood still plays an important role in overall energy needs of the people. The Farm survey carried out within the project area indicated that 88% of the households in the study area obtained their energy requirements from firewood while only 10% had animal dung as the energy source. This resource thus have to partly be providing over 21 million population in the project area with there fuelwood requirements.

The study area has four types of forests maintained by the Forest Department. They are, by the type of vegetation (a) Linear plantations (b) Irrigated plantations (c) Riverain forests (d) Range lands. In addition to the forests maintained by the Forest Department, there are private forest plantations in the project area varying in extent from .4 ha. to 40 ha.

(a) Linear Plantations

These are avenues of trees planted along the roadside, canalside and railside. In Punjab there are 7,175 kms. of roadside, 762 kms. of railside and 5,263 kilometers of canalside plantations.

An important forest in relation to this project in the study area are the forest plantations along canal reservations. These plantations were carried out by the PID under its programme after the canals were constructed and were maintained by them until the early 1990's when they were handed over to the Forest Department. The Forest Department presently maintains canalside plantations in the study area in about 14% of the canal lengths. The canalside plantations are mainly Kikar and Shisham. The Forest Department under its programme intends carrying out further plantations on the blank lengths along the canalsides when possible. Canal side linear plantations also serve as wind breaks in addition to providing timber and fuelwood.

(b) Irrigated plantations

These are man made forests in the shape of blocks of tree plantations in the canal irrigated tract which were raised originally to cater to the fuelwood requirements of the railway steam engines. The first artificial forest of this type was established at Changa Manga in the CBDC area in 1866.

The study area has 16,633 hectares of such forest plantations that are irrigated mainly in the summer by the canal waters. These are in the CBDC and LCC areas. The largest of the plantations is the Changa Manga forest which is also classified as a sanctuary. The irrigated forest plantations in the project area, extents and their water requirements are as follows:

Name of Plantation	Canal System	Area (Hectares)		Discharge (cusecs)	
		Total	Commandable	Sanctioned	Actual
Changa Manga	CBDC	5066	4433	150	120
Gatwala	LCC	50	40	2.6	2.6
Shorkot	LCC	4081	3295	38.5	38.5
Chak 178/JB	LCC	198	198	2.2	2.2
Chak Bahadar	LCC	397	397	6.0	2.0
Kamalia	LCC	4345	3623	128	37.5
Chak155/RB	LCC	184	183	2.5	2.5
Bhagat reservoir	LCC	279	240	3.5	3.3
Bhagat	LCC	251	201	3.0	3.0
Chak no. 160/GB	LCC	72	64	0.7	0.7
Chak no 300/GB	LCC	596	531	1.0	0.1
Chak no 324/GB	LCC	142	126	0.5	0.5
Chakku Rakh	LCC	156	131	2.0	1.9
Chaku reservoir	LCC	376	247	2.2	2.2
Chak no. 363/GB	LCC	122	123	1.0	0.3
Chak no. 367/GB	LCC	238	235	1.0.	0.3
TOTAL		16633			

Changa Manga is an important plantation which is 5,066 hectares in extent and comprises of plantations of deciduous trees that require irrigation during summer only, and a sanctioned discharge of 150 cusecs. although the actual available according to the Forest Department is only 95 cusecs. There are two other major forest plantations in the Sargodha Forest circle in the project area. They are the Shorkot plantation of extent 4,081 hectares with a sanctioned irrigation capacity of 38.5 cusecs and Kamalia plantation of 4,398 hectares with a sanctioned capacity of 128 cusecs. According to the forest department the actual available irrigation discharge at Kamalia is 38 cusecs with a shortfall of 90 cusecs. All the other plantations in the project area is less than 700 hectares in extent.

The general composition of the crop in irrigated plantations is a mixture of Shisham, Bakian, Kikar, Mulberry, Simal, Hybrid poplar and Eucalyptus. It has been estimated that about 10% of the firewood needs are met by these forests.

Changa Manga is considered the most well known of these plantations. In addition to it being a forest plantation it is also a wild life sanctuary and has a recreational area. The main species in this sanctuary are Nilgai, Cheetal, hog deer, jungle cat, wild boar,. wild hare, flying fox, grey partridge, black partridge, doves, babblers, horn bill, pea fowl and song birds.

(c) Riverain forests

The riverain or Bela forests occur along different rivers of the Punjab where Shisam is the predominant species. Traditionally they lined the river banks of the major rivers, with the annual flooding bringing in a fresh deposit of silt which fertilized their growth. With the development of the large reservoirs and the diversion of water through the canal system, the annual floods reduced and with it the riverin forests started shrinking and in some areas has disappeared. The Punjab Forest department statistics indicate that out of a total of 55,931 hectares of riverain forests in Punjab there is 2,646 hectares in the departments Sargodha Forest Circle. The present position is that there is only a small extent of riverine forest in the project area.

(d) Range lands

Range lands are normally considered to be any naturally vegetated land in the project area grazed mainly by domestic livestock and game animals. These are uncultivated lands where due to adverse conditions of soil, topography and water deficiency neither agriculture nor forestry is economically possible. The range lands are presently in an overgrazed state by the livestock.

(e) Other related projects

Presently there is a Forest Sector Development Project funded by the World Bank which has recently commenced with the emphasis on social forestry. Its main components are Farm forestry, Range management, Seed production and Research and Training. In the project area at present there are no major projects under this programme underway but it can be expected in the future.

4.6 Wild life

The Study area has wildlife sanctuaries at the forest plantations of Changa Manga in CBDC and Bhaget at TT Singh in LCC. The Gatwala forest plantation at Faisalabad in LCC is a game reserve. The wildlife species in these reserves are the jungle cat, jackal, wild boar, wild hare, grey and black partridges, doves, babblers and song birds. The variety at Changa manga is more than in other reserves and include Nilgal, Cheetal, Hog deer, Horn bill and Pea fowl. An 8 kilometer wide Boarder Belt along the Indo - Pakistan border is also a Game Reserve. There are no wetlands within the project area.

4.7 Groundwater table and Waterlogging

The ground water in the study area was initially formed out of seepage from rainfall, rivers or streams. In summer with the melting of the snow in the Himalayas and the regular floods, the natural streams and rivers overflowed their banks spreading water over large areas. By this process large quantities of high quality fresh water seeped into the underground aquifers. A natural balance of water and salt was maintained in this process. With the introduction of the canal irrigation system in the early 19th century and the construction of main, branch, distributaries and minors irrigating the agricultural fields all over the doabs, increased the seepage area. The ground water level in the study area has been gradually increasing from the time of the introduction of the canal irrigation system. By the 1960's waterlogging had become a severe problem. **Fig. D-1** shows the ground water table contours prior to the irrigation system and the post irrigation ground water contours.

In the early 1960's, a massive effort to control waterlogging and salinity was undertaken and the planning and programming studies culminated in an 'Action Plan' covering ten years period. These studies were supplemented by later studies under the changing circumstances, and to draw up investment plans to cover various period. To overcome the problems of the rising ground water table, salinisation and poor drainage, SCARPS programmes were implemented. In the study area 12 SCARPS programmes have been implemented or are ongoing. These are indicated in **fig. D-2**

The introduction of the SCARPS tube wells by WAPDA brought this rising ground water table and the associated water logging problems under limited control at that time. The SMO of WAPDA records the depth of the water table in June and October of each year. The table below gives the water table condition in the study area under each command in June 1959 at the commencement of the SCARP and in June 1989 after 30 years of implementation and also the results of the JICA study team survey of June 1996. The extents of land in LJC, LCC and CBDC areas where the water table was less than 5', between 5' to 10' and greater than 10' are indicated. The extents are indicated as a percent of the total extents.

Extent of land with Watertable depths less than 5', between 5' - 10' and over 10' indicated as % of total during June (1959 - 1996)

	CBDC			LCC			LJC		
	<5'	5'-10'	>10'	<5'	5'-10'	>10'	<5'	5'-10'	>10'
June 1959*	6	16	78	6	30	64	9	66	25
June 1989*	2	7	91	2	16	82	4	35	61
June 1996**	0	11	89	1	17	82	5	43	52

* SMO/WAPDA
** JICA study survey

Fig. D-3 shows the watertable depths in June 1996

With the onset of the monsoon, the water table rises and by October it almost reaches the highest levels during the year. The similar water table data for October 1959 and 1989 and also the latest available information for October 1995 are given below It has been observed that during the years with heavy rainfall the extents that get affected by waterlogging, which are the lands with the water table less than 5' increases more than in a dry year.

Extent of land with Watertable depths less than 5', between 5' - 10' and over 10' indicated as % of total during October (1959 - 1989)

	CBDC			LCC			LJC		
	<5'	5'-10'	>10'	<5'	5'-10'	>10'	<5'	5'-10'	>10'
Oct 1959*	10	24	65	6	23	71	24	33	44
Oct 1989*	0	32	68	4	22	75	11	34	55
Oct 1995*	1	12	87	2	20	78	10	29	61

* SMO/WAPDA

The above data indicates that the worst affected area by waterlogging was the Lower Jhelum Canal Circle with nearly 24% of its extent with the water table within the hazardous zone of less than 5' in October 1959. The position has improved by October 1995 to a reduction of 10% of the land getting waterlogged. This yet remains at too high a level to be considered as having solved the problem of waterlogging. The other very badly affected area which was CBDC has presently got a much reduced problem. In October the problem is very minor though there are in a few areas localized problems which are mainly due to flooding and poor surface drainage. In general in the CBDC area, it appears as if the water table is getting too lowered. Fig D-4 indicates the water table depths during October 1995.

From the above it is seen that the ground water table has improved in the danger zone of less than 5' in almost all the areas during the last 35 year period. Although the rising ground water table and the associated water logging problem has reduced from the very severe conditions of the early 1960's, it is yet a very major problem and require to be further improved with the

changing circumstances. The eighth five year plan of the Government of Pakistan has one of its major objectives for the physical infrastructure, as the elimination of water logging in the 1.40 million hectares of the disaster areas. During this Plan period it is proposed to complete the Left Bank Outfall Drain and to commence work on the Right Bank Outfall Drain under the National Drainage Programme. It is thus seen that the improvement of the waterlogging problem is of the highest priority in Government Policy.

The decrease in the ground water table has been due mainly to the operation of the SCARP tube wells and has been later on assisted by the installation and operation of farmer's tube wells in the fresh water zones. There are presently about 400,000 farmers tube wells in Punjab. The tube wells in the study area is estimated at about 75,000. The large number of private tube wells by the farmers have contributed to increased agricultural production while indirectly lowering the ground water table by extracting water for irrigation from the fresh water zones. The private tube wells extraction of irrigation water is limited mainly to the fresh water zone. However there is a limit foi the installation of such tube wells which depend on the availability of fresh ground water in the underground aquifer.

4,8 Water quantity

The average annual offtake through the Lower Jhelum Canal, Lower Chenab Canal and Central Bari Doab Canal are 2.99, 7.51 and 1.45 MAF respectively. The water available in the canal irrigation system has been constant over the years, although the cropping intensity has almost doubled. In addition, poor maintenance of the system and theft of water has caused a severe shortage of water. The perennial Canal system itself has been designed during the British regime to maximize the cropped area and settle maximum number with a view to avoiding famine, and not for the purpose of maximizing agricultural production.

In the last few decades the canal irrigation water has been supplemented by tube well water. Initially SCARP tube well water with marginal quality water was mixed with canal water and used for irrigation. The same practice is adopted presently by some of the farmers . The major aim is to increase the quantity of water available for irrigation, overlooking the quality with possible secondary salinisation and degradation of the land.

4.9 Ground Water Quality and Salinity

Generally the quality of the water available in the study area is of three basic types. The canal irrigation water is of good quality at around of 150-200 PPM. The ground water in the freshwater zone is of medium quality with the salt level going up to around 1000 PPM. In the

saline zone the water quality is over 1000 PPM with many areas being even higher than 5000 PPM. The canal water that is carried through the saline zone looses a certain amount of water due to seepage. This fresh water that is so lost is not usable again for irrigation due to water getting mixed up with the saline water. Such water is 'lost' to the system and the proposed project envisages using such water that could be saved.

SCARPS programmes have monitored the water quality over the years in the projects implemented and the data on the water quality changes that have occurred in the projects in the study area are given below.

CHANGES IN THE GROUND WATER QUALITY IN THE SCARPS PROJECTS WITHIN THE STUDY AREA

Canal Circle	PROJECT	No. of common Tube wells	Year	Category of Water quality (% of land)		
				Usable	Marginal	Hazardous
LJC	SCARP II (non saline)	1070	1975-76	59	29	12
			1982-84	52	31	17
	SCARP II Saline zone (4 zones)					
	(i) T/W along drain	179	1979-83	2	4	94
			1984-86	2	2	96
	(ii) T/W along canal	59	1980-81	63	18	18
			1982-86	68	18	14
	(iii) T/W along watercourse	379	1980-81	73	19	9
			1982-86	70	15	15
	(iv) P.A.F. Base	24	1974-83	0	0	100
			1984-86	0	0	100
	Shahpur	175	1978-79	92	6	2
			1984-86	95	4	1
LCC	SCARP I	1547	1962-63	41	37	21
			1984-86	32	44	24
	SCARP IV	827	1970-74	82	17	1
			1983-85	72	27	1
	SCARP V	60	1979-81	33	8	58
	(Satiana P.P)		1985-86	31	7	62
	SCARP V	87	1976-78	87	12	1
	(Shorkot - Kamalia P.P)		1985-86	81	18	1
	Lower Rechna	35	1985-87	0	3	97
	(Khairwala unit)		1987-88	0	3	97
C.B.D.C	C.B.D.C.	83	1983-86	27	22	51
	(Sukh Beas)		1986-87	25	13	62

(Source: WAPDA/SMO, 1993, Publication SM-141)

Water quality criteria adopted by SMO for categorizing Irigation water.

ater quality	Limiting values of parameters		
Category	Electrical conductivity (EC) micro-mhos/cm at 25 C	Residual Sodium Carbonate (RSC) in meq/l	Sodium Adsorbtion Ratio (SAR)
Usable wat	<1500	<2.5	<10
Marginal	1500 - 2700	2.5 - 5.0	10.0 - 18.0
Hazardous	> 2700	>5.0	>18.0

From the analysis it could be seen that the availability of water of usable quality has generally been reducing over the years. The amount of tube wells producing hazardous water is increasing in all projects except Shahpur and along canals in LJC. The water quality of the tube wells along the canals are improving, probably as a result of the seepage from the canals.

As indicated the groundwater in the study area consist of both fresh as well as saline water. The Salinity Monitoring Organization (SMO) of WAPDA carries out water quality tests under

the various SCARPS programmes of the tube well water on a regular basis. The various agencies involved in carrying out different aspects in the irrigation system adopt slightly varying criteria for the water quality standards. For the purpose of this Study, it is assumed that the area of concern, as to where the groundwater has Total Dissolved Solids (TDS) greater than 1000 ppm.

The present study carried out water quality tests of the study area by sampling at 700 locations based on a grid drawn on topo sheets at 6x6 kilometers. The extent of saline and non saline water areas were determined on the basis of fresh water areas being those areas where the ground water has less than 1000 ppm of TDS. On this basis LJC, LCC and CBDC had 60.2%, 59.8% and 48.5% of fresh water areas. The details of the fresh and saline water areas are given in the table below.

Canal Command	Area	Fresh water area TDS < 1000 ppm	Saline water area TDS > 1000 ppm
LJC	7189	60.2 %	39.8 %
LCC	16157	59.8 %	40.2 %
CBDC	3901	48.5 %	51.5 %
TOTAL	27247	58.3%	41.7 %

The extent where the saline groundwater has different qualities between 1000 - 1500 ppm, between 1500 - 3000 ppm and greater than 3000 ppm was found to be as follows. These are given as a percentage of the total extent in each of the canal commands of LJC, LCC and CBDC

Canal Command	Total saline area TDS> 1000 ppm	TDS 1000 - 1500 ppm	TDS 1500 - 3000 ppm	TDS > 3000 ppm
LJC	39.8 %	24.0 %	11.7 %	4.0 %
LCC	40.2 %	19.4 %	16.1 %	4.6 %
CBDC	51.5 %	22.3 %	24.0 %	5.2 %
TOTAL	41.7 %	21.0%	16.1%	4.6 %

Fig.D-5 indicates the salinity in the area during the study period of May - June 1996.

Water quality survey carried out by the study team classified samples taken according to USDA Handbook # 60, which uses Electrical Conductivity (EC) and Sodium Adsorption Ratio (SAR)* as the two important parameters. This gave the percent area of LJC, LCC and CBDC having different water quality in the major categories as follows.

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* Sodium Absorption Ratio (SAR) is defined as
SAR = $[Na^+] / [Ca^{++} + Mg^{++}]^{1/2}$ (ion concentrations are expressed in millimoles per liter)

Class	% LJC	% LCC	% CBDC	Remarks
C1 - S1	5			Low salinity and low sodium level could be used for irrigating almost in all soils with little likelihood of developing salinity.
C2 - S1	19	16	14	Groundwater of this class contains medium concentration of salts and can be used for irrigation without the need of any special measures.
C3 - S1	31	36	19	Ground water contains high salt contents and cannot be used in soil with limited drainage. Even with adequate drainage system, special management for salinity control may be required and plants with good salts tolerance have to be adopted in these areas.
C3 - S2	22	19	18	The water samples belonging to this class contains medium level of Sodium. These waters when used for irrigation can create Sodium hazard and as such should be used with precaution.
C3 - S3		6	8	High salinity water and high sodium contents may produce harmful levels of exchangeable sodium in most soils. Will require good drainage and high leaching. Not to be used on soil with inadequate drainage.
C4 - S3		5		Very high salinity and may produce harmful levels of exchangeable sodium in most soils and would require special management, good drainage and high leaching
C4 - S4	13	12	30	Groundwater of this class contains very high salinity as well as very high sodium and is totally unfit for agricultural purposes.

Diagram given in **Fig. D-6** indicates this water quality classification

The ground water quality in the Study area which was determined by sampling 700 locations on a grid of 6km x 6 km and averaged for each parameter in the three canal systems is given below.

Parameter	LJC	LCC	CBDC
pH	7.7	7.9	8.0
EC (microsiemens/cm)	1854	1722	2390
Ca + Mg (meq/l)	6.2	5.5	5.0
Na (meq/l)	13.8	12.8	20.4
K (meq/l)	0.3	0.4	0.6
CO_3 (meq/l)	2.1	0.9	1.2
HCO_3 (meq/l)	5.9	6.2	6.8
Cl (meq/l)	11.4	9.7	12.2
SO_4 (meq/l)	2.9	2.7	6.8
NO_3 (meq/l)	0.3	0.3	0.2
RSC	2.2	2.3	4.2
SAR	7.0	7.6	13.0
TDS (ppm)	1187	1102	1530

The water quality survey results indicated the following behavior of HCO_3, Cl and SO_4 anions with electrical conductivity. Bicarbonate anions in the fresh water have been found to be higher even upto 85%, but shows sharp decline trend with increasing salinity upto EC value of 5,000

microsiemens/cm. Thereafter a reduction in HCO_3 becomes gradual and almost asymptotic to a value of 10%, with further increase in the ground water salt content. The pattern of anionic variations in all three canal systems is more or less similar. Chloride concentration in the groundwater is quite reverse to their HCO_3 anions. These are low, about 6%, in the fresh groundwater, show a rapid increase upto EC of 5,000 microsiemens/cm and then to a level of about 40% with further increase in the groundwater salts. Sulphate concentration is low in the areas of good quality waters. It increases to a peak against an EC of 1,500 microsiemens/cm and then drops rather rapidly to a constant level of about 4 to 6% in highly mineralized groundwater. The initial increase in the SO_4 concentration appears to be due to the application of gypsum by the farmers in the areas of poor quality groundwater.

In the Lower Jhelum Canal Circle, the ground water quality survey indicated the location of highly concentrated brackish water mostly in the central, north south axis of the project area. A few pockets of saline groundwater also exist along the left bank of Jhelum river on its western boundary. Groundwater having TDS less than 1000 ppm covers 60.2% of the area whereas the groundwater containing TDS in the range of 1000-1500 ppm constitutes 24% of the total area. The remaining 15.8% is occupied by highly mineralized water in scattered patches specially in the center of canal system along north east to south west direction.

Sodium Adsorption Ratio of the groundwater in LJC varies from 2 to 67. Sodium Adsorption Ratio of water less than 15 makes up 89 % of the area. As such majority of the samples have SAR well within the permissible range. Only 11 % of the area has high SAR and is confined to those areas which are occupied by highly mineralized groundwater.

The water quality survey also indicated that the groundwater of low salinity and low sodacity mostly covers south eastern portion of the LJC area along the right bank of Chenab river. The groundwater within the main central body and along the right bank of Lower Jhelum Canal is well mixed from low salinity to high salinity and low Sodium to high Sodium waters. The groundwater at the deeper depth in the upper half portion of the project area and along the western part is very saline. The deep percolation and recharge from the irrigation fields, supplied with canal irrigation water have improved the quality of shallow groundwater. The area where the deep percolation losses are high, groundwater has shown marked improvement and where the percolation is of low order, the salinity/sodacity of groundwater is comparatively much higher.

In the Lower Chenab Canal Circle the extent with groundwater having TDS less than 1000 ppm covers 59.8% of the area whereas the groundwater containing TDS in the range of 1000-1500 ppm constitutes 19.4.% while 20.7% has TDS level higher than 1500. Examination of the

water quality test data reveals that highly mineralized groundwater with nearly 6400 ppm TDS exists along the central line from north east corner to south west tip of the project area. A wide strip of groundwater along the left bank of Chenab river and right bank of Ravi river contains comparatively less salts and is acceptable for irrigation with or without mixing. Highly concentrated saline groundwater occupies central zone of the project. Groundwater along the main canals, rivers and in southern tip extending upto the confluence of Chenab and Ravi rivers is quite fresh and fit for irrigation.

SAR indicates the same trend as that of groundwater quality. In fact, higher the concentration of the salts in the groundwater, higher is the sodium contents and hence the SAR.

In the Central Bari Doab the water quality survey indicated the existence of mineralized water near Pattoki town in the south western zone of the project area. This pocket appears to have been extended downward upto B.S. Link Canal and towards upward in north eastern direction along the Central Bari Doab Canal. The groundwater close to the main canal has considerably improved as a result of seepage.

Another pocket of mineralized groundwater exists below Kasur towards southern direction. A comparison of SAR of the former pocket located within the southern tip of the project area with that of south eastern corner, reveals a wide difference. This is explained from the fact that inherent or natural mineralized groundwater always contains high sodium contents as compared to calcium & magnesium. As such the natural groundwater posses high SAR. The SAR of the mineralized groundwater occupying the south eastern portion of the project area is much lower as compared to the SAR of the mineralized groundwater in the south western tip of the project area. This reflects that mineralized groundwater of south eastern portion is of different origin. The evident source of this pollution is the huge amount of contaminated water having disposed off from a large number of tanneries established in the Kasur area. The water quality in a large strip of land between river Ravi and CBDC, excluding southern portion is excellent to good and fit for agriculture.

The water quality survey revealed that about 48.5% of the total area is occupied by groundwater having TDS less than 1000 PPM ,whereas 22.3% has a groundwater quality varying from 1000 to 1500 PPM. The balanced 29.2% of gross area contains highly mineralized water. having TDS above 1500 PPM.

About 32.9% of the water samples collected from the area are of low sodium contents, of course the salinity varies upto 2250 microsiemens/cm. Groundwater of this class can be used

for irrigation without any arrangement of special techniques usually employed for saline water utilization.

Around 38.3% of samples belong to highly saline and high sodium classes. Use of these waters may provide harmful levels of exchangeable sodium in most of the soils . As such special soil management, good drainage, high leaching and other measures are needed to maintain appropriate level of physical as well as chemical status of soils.

4.10 Surface Water quality

The quality of the canal water was found to be of excellent quality for irrigation. The TDS of canal water varied between 90 ppm to 202 ppm. The sodium adsorption ratio (SAR) of all samples were less than 1. These being categorized as low salinity low sodacity (C1-S1) class water. River water also is of excellent quality for irrigation. However the suspended solids in the river water and canal water is very high varying between 1214 ppm to 3041 ppm in LCC and 373 to 1465 ppm in LJC. During the rainy seasons these values increase many fold. Though the surface water quality is chemically suitable for irrigation and human use, they are unfit for human consumption due to the very high bacteriological contamination.

Drainage effluent was also of poor quality with extremely high electrical conductivity and high SAR.

4.11 Soils and Land Capability

The soils in the LJC area is composed of the alluvium carried by the Chenab and Jhelum rivers from the Himalayan ranges. The soils are young and pronounced development of soil profile structure is not yet visible. The process of sediment deposition and erosion is still continuing. About 55% of the area is predominantly medium textured silt loam and loamy soils which have excellent drainage characteristics and very productive for major and minor crops and orchards. About 32% of the area is sandy clay loam and clay loams which also has good physical properties and are fertile. Coarse textured loamy sand and loams cover about 7% of the LJC area and occur mostly in the form of discontinuous belts along the beds of old river channels. The pH of the soil in this area varies between 7.2 and 9.5. Of this, 99% of the area has a pH below 9 while the higher values are at locations where the surface salinity and ESP are high.

The soils in the LCC area has been derived from the alluvial deposits of Chenab and Ravi rivers. These soils are also young and the pronounced development of soil profiles are not yet exhibited. Coarse textured soils including sand to loamy sand and sandy loam constitute about

21% of the area and are found mostly along the bed of old braided and bifurcated channels. Medium textured soils such as loam and silty loam cover 53% of the LCC area while the remaining 26% comprises of sandy clay loam, silty clay, clay loam and silty clay loam. The fine textured soils are concentrated in the south western tip of the doab and medium textured soils are mostly located in the north western portion of LCC. The pH of the soil in this area varies between 7.46 and 9.7. Of this 97% of the area has a pH below 8.5 while the higher 3% is scattered in various spots.

In the CBDC area the soils are formed from the alluvium laid by the rivers Ravi, Bias and Sutlej. Half the area is covered by loam soils while the other half is of silt loam texture. The area covered by silt loams has higher content of finer silt particles and is situated along the left bank of Ravi river, CBDC canal and BS - link canal. The pH of the soil in this area varies between 8.0 and 8.9.

The status of the soil in the master plan area was determined by the JICA study team through the survey carried out by the IRI, from 350 representative soil samples selected based on a grid of 12 x 12 kilometers The values of the various parameters that were determined, averaged for each of the canal systems is given below.

Parameter	LJC	LCC	CBDC
pH 1:2.5 H_2O	8.8	8.6	8.7
pH 1:2.5 KCl	8.1	8.0	8.1
Saturated. paste	8.1	8.1	8.5
ECx 10^6 Sat. extract	7834	3090	3103
Carbo. efferv	3.4	2.8	2.1
Ca + Mg (meq/100g)	7.9	7.2	9.47
Na (meq/100g)	3.8	1.9	1.05
K (meq/100g)	1.0	0.9	0.86
C.E.C. (meq/100g)	12.7	9.9	11.0
CO_3 (meq/l)	1.7	1.4	1.4
HCO_3 (meq/l)	10.8	9.7	9.0
Cl (meq/l)	61.6	18.4	19.0
SO_4 (meq/l)	22.9	8.7	3.8
NO_3 (meq/l)	1.2	0.6	0.7
SAR	54.9	29.3	8.4
ESP.	30.2	21.3	9.5
C %	0.4	0.5	0.5
N %	0.02	0.02	0.01
C/N ratio	32.1	34.5	43.0
Organic matter %	0.7	0.9	0.8
P (ppm)	4.9	2.9	3.1
B (ppm)	1.2	0.8	1.2

The soils in the area are mostly calcareous, with 97%, 93% and 64% being moderately to very strongly calcerous in LCC, LJC and CBDC areas respectively. Section 3.1.4 indicated the present condition of the soil in the study area.

The Land Capability map, **Fig. D-7** shows the present soil and land capability conditions of the study area. The different grades of soils in the three canal command areas are as follows.

Grade	LJC	LCC	CBDC
Grade I	21.3%	41.7%	60.1%
Grade II	26.0%	33.8%	30.8%
Grade III	26.0%	11.8%	8.8%
Grade IV	20.0%	8.8%	0.3%
Grade V	5.6%	3.9%	
Grade VI	1.1%	0.1%	

Land capability is a dynamic parameter and depending on the rating adopted, it can vary. The properties of the soils in the study area has also been changing over the years, following irrigation. The use of saline ground water for irrigation has converted non saline - non sodic soils to saline soils and this process is continuing.

4.12 Salinity and Sodacity status in the study area

The soils are classified into four categories of Non saline - Non sodic, Non saline - Sodic, Saline - Non sodic and Saline - Sodic soils depending on their conductivity of saturated extract and Exchangeable Sodium Percentage. Non saline - non sodic soils are excellent and offer no problems associated with soil salinity or sodacity. Non saline - sodic soils has problems of phosphate fixation, non availability of micro nutrients and low permeability and infiltration rates. Saline - non sodic soils has excessive salts which if removed would become more productive. Saline - sodic soils has similar appearance and properties of saline salts, where if the excess soluble salts are leached these soils may become similar to non-saline sodic soils.

The soil survey carried out by the study obtained the following status of the soil in the project area as regarding its condition of Salinity and Sodacity. The Table below indicates the percentage area in each of the areas of Lower Jhelum, Lower Chenab and Central Bari Doab areas falling into these classes.

Soil classification of LJC, LCC and CBDC given as a percentage of total extent.

Soil Classification	LJC	LCC	CBDC
1. Non saline - Non sodic (NS-NS)	27%	42%	62%
2. Non saline - Sodic soils (NS-S)	5%	24%	19%
3. Saline - Non sodic (S-NS)		8%	19%
4. Saline - Sodic (S-S)	68%	26%	
TOTAL	100%	100%	100%

In LJC area, the non saline - non sodic soils are in the lower half and occurs along the right bank of the Chenab river. Problems of soil salinisation or sodacity is not encountered in this zone. NS-S soils are confined to a small area along the north eastern boundary bounded by the northern branch of the Lower Jhelum canal. The large extent of 68% of the area is saline - sodic and occurs in the upper half and extends upto the confluence of the rivers in the south west. The high ESP and the salt content in these soils are injurious to plant growth and crop productivity. In most of these areas farmers have been indiscriminately using saline water for supplemental irrigation.

In LCC area 42% of the land is non saline - non sodic. If the electrical conductivity of the soil is considered upto 8 ds/m where salt tolerant crops could be grown, then the area of cropble land could reach upto about 80% of the LCC area. The saline - sodic soils in LCC are mostly concentrated in two areas. One is located towards the Khanki Headworks bounded by the Lower Chenab Canal and the Chenab river. This area has excessive seepage from Qadirabad - Balloki Link canal and the Lower Chenab Canal. The second area is near the tails of the canals passing through the center of the doab. Due to insufficient water in the canals, the farmers are using saline groundwater resources for supplemental irrigation causing this secondary salinisation.

In the CBDC area 62% of the extent consists of non saline -non sodic soils which are excellent for crop production. Most of these soils are located between the Ravi river and the Central Bari Doab Canal. Non saline - sodic soils are 19% in extent and is mainly confined to a portion in the south eastern corner of the CBDC area. The soils have a high pH and sodacity impairing crop growth due to problems of permeability, infiltration and availability of plant nutrients. A further 19% of the land in CBDC area consist of saline - non sodic soils. These can be found closer to the BS link canal and in the south western portion of the CBDC system. The seepage water from the link canal causes a high water table and the use of underground water which is moderately saline by the farmers for supplemental irrigation has been partly the causes for this.

The Land Reclamation Directorate of the Irrigation and Power Department of Punjab carries out annual surface salinity surveys. These surveys are carried out through the Patawaries. The survey categorizes the saline soils into 5 different types. They are:

(1) Thur Kohna - Ultra alkaline or Non Saline Alkali soils. These saline lands has never been cultivated since the advent of canal irrigation. They are high in salt content & alkalinity or low salt content & high alkali.

(2) Thur Panjsala - Highly saline or saline alkali soils. These are lands excluded from cultivation for more than 5 years due to salinity. They show advance stage of deterioration. pH is 9.0 to 10.0

(3) Thur Nau - Highly saline or saline alkali soils. These lands have been excluded from cultivation within 5 years due to salinity. These are mostly saline alkali soils in the northern part of the Indus plains.

(4) Thur Juzvi - Saline or saline alkali soils. These saline lands under cultivation bearing visible patches of salts to the extent of above high salinity in patches and alkalinity show progressively increasing.

(5) Thur Tirk - Lands where salts present in root zone hamper opening of cotton balls. Accumulation of salts is well below in the root zone and salts are not visible over the soil surface.

Table D-1 shows the extent of the soils affected by the above categories within the Study area. These extents are for each Engineer's division of the three canal command areas. Sargodha Division has 27% of its land affected by salinisation while Lower Gojra has 23%, Kirana and Khanki divisions have 17% of their lands and Burala 15%, Hafizabad 14%, Rasool 13%, and Faisalabad 10%. Lahore and Shahpur has the lowest rates of soil deterioration with 3% and 2% respectively. The overall picture within the study area show that in almost all the divisions barring Shahpur and Lahore the condition of its soil to be very poor and with a tendency to degrade.

D.5 Initial Environmental Examination

An Initial Environmental Examination (IEE) of the Study area was carried out to assess whether an Environmental Impact Assessment (EIA) was necessary or not, having taking into consideration 19 items listed below that could cause impacts.

1. Canal Right of Way and Land requirements
2. Distribution of inequities (Restoration of equitable water rights)
3. Canal closure and loss of labour opportunity
4. Institutional changes

5. Down stream settlements
6. Impairment of transportation
7. Impediment to livestock
8. Farmers income and living standards
9. Changes in farming practice
10.. Increase use of agro chemicals
11. Health and sanitation.
12. Drinking water quality
13. Forestry
14. Wild life
15. Ground water table (Waterlogging)
16. Groundwater quality
17. Water quantity
18. Soil salinisation
19. Salt balance

The results of the preliminary evaluation is given in **Table D-2.** It indicated that there will not be any major significant environmental impacts envisaged due to the project and that an EIA was not necessary. Further study on some of the items and the impacts on the selected canals command areas due to certain project activities was carried out.

The findings on the issues arising on these are described as follows.

5.1 Canal Right of Way and Land requirements

The Right of Way (reservation) of the canals are under the purview of the PID. It maintains land plans indicating the widths available on all sections of the canal system and under the regulations it can be made use of at any time for any works. The complete reservation widths which were obtained from the Land Plans of the PID indicates the available right of way along the selected canals is given in **Tables D-3, D-4 and D-5.** This reservation is to be made use of to the maximum for the construction work in order to avoid acquiring private land. Land will mainly be required for (a) construction of diversion canals, (b) borrow areas and (c) other temporary works.

The table below gives a summary of the maximum and minimum reservation widths available on any single side from the center line of distributaries and minors in each of the canal systems.

	LJC	LCC	CBDC
Minimum width on Distributary Canals	49'	40'	27'
Maximum width on the Distributary Canals	110'	112'	50'
Minimum width on the Minor	15'	30'	10'
Maximum width on the Minors	77'	50'	20'

The right of way data indicate that the average available reservation width on canals is highest in LJC and lowest in CBDC. The highest requirement for extra land would thus be in CBDC and least in LJC.

The proposed procedure for the construction of the diversion canals is not to make use of the narrower reservation on the side of the existing O&M road but to use the other side. In almost all the cases, this will give additional land to work with and thus will reduce the requirement for extra land. However in many instances the reservation will not be sufficient and in such cases the adjoining land will have to be obtained from the land owners. The average width of extra land required for construction has been estimated as 5.53m. in CBDC, 2.24m in LCC and 1.40m. in LJC. The total extent of land required for constructing diversion canals and other temporary works is estimated at 136 hectares.

The reservation presently being encroached and cultivated will initially be obtained by the PID after giving due notice. PID has informed that no compensation is required for this purpose. Those who are cultivating this land would loose the income that they got from cultivating it, as they will not be getting this land back for cultivation after the lining is completed. On completion of lining, the canals are expected to be handed over to the FO. The canal reservations that are so handed over should be free from encumbrances.

In instances where the width of the reservation is not sufficient for the construction of diversion canals, land has to be acquired. Land acquisition is a long time consuming procedure and it has to be done under the Land acquisition Act 1894, under sections 4, 5, 6, 11 and 16. The time it would require to take possession of land free of encumbrances under this Act would vary from a year to many years. **Fig. D-8** indicates in the flow chart, the activities for land acquisition and the time required. In actual practice, on projects the time taken to acquire land has been very much more. As such these procedures should best be avoided. Where land is required from outside the reservation, direct procurement from the owners should be resorted to. Land that will have to be obtained from owners for the construction of the diversion canals could be returned to them after lining and as such it will not be necessary to acquire. It is suggested that the use of this land be negotiated on some reasonable basis such as crop loss and damages. The land should be returned in a similar condition to what it was before being taking over.

The use of the land adjoining the canal being used as a borrow area is to be discouraged, as it will be difficult to be leveled and brought back to the original condition. Such land would end up being an environmental hazard as they could get waterlogged with no proper drainage and be the breeding grounds for disease carrying vectors such as mosquitoes

The canal reservation also has forest plantations which are managed by the Forest Department. Removal of forest plantations on canal reservations because of the lining works should be best avoided. However it is inevitable that the proposed construction procedure would entail the almost complete clearing at least one side of the canal for the construction of temporary canals. The land required for the construction of temporary canals will have to be obtained from the Forest Department who would have to clear the plantations according to the present rules and regulations. This item is discussed in section 5.13

The project will not nessitate any major resettlement. Certain encroachments on the canal reservation will have to be removed. These encroaches are mostly who have got permission on a temporary basis to occupy the canal reservations. PID has informed that they will leave when the land is required.

5.2 Distribution of inequities (Restoration of equitable water rights)

At present the distribution of water is not equitable though water rates are uniformly charged. The inequitable distribution of water in terms of location of distributary and minor has been taken for granted by the farmers. The study having carried out field measurements has concluded that the inequality of water is prevailing in the project area. The project anticipates that this inequity in distribution of water could be corrected which will be a very highly beneficial impact. The field survey carried out indicated that the majority of the farmers, both at the head and the tail end felt the insufficiency of water in the whole system as the major problem while 37% indicating that lining of distributaries and minors could increase their supply.

The project is expected to make a significant redistribution of water, with those presently having water shortages, which are mainly at the tail end benefiting. Those who are mostly at the head and have been getting excess will be able to receive there fair share. There will be an additional quantity of water made available for irrigation, after completion of the lining, and with the reduction of seepage. This combined with the new canal design and the proposed institutional changes is expected to make the restoration of equitable water rights a reality. The

benefit that would occur is almost totally dependent on the success of the implementation of the institutional changes proposed.

It will be necessary to have a proper monitoring plan developed to assess impacts after completion of project.

5.3 Canal closure and loss of Labour opportunity

For the construction work, the canals will have to be closed for some short length of time. The farmers have indicated that they are prepared for an extra canal closure ranging from a minimum of 5 to a maximum of 33 days, with 21 days as the average. Farmers do not appear accepting long periods of closure due to loss of income from farming and labour. The longer closures will mean a loss of income for the farmers and also for many of the farm labour which is a negative impact. Labour opportunities would however arise for some in the construction works. Longer closures would entail in the provision of essential water for the daily needs to the farmers.

The construction methodology to be introduced have taken this fact into consideration and is proposing constructing diversion canals within the reservation. This will allow irrigation to be carried out with minimum of interruptions. There will be no nessacity for canals to be closed for long periods that would cause hardship to the farmers.

5.4 Institutional changes

The proposed Institutional changes were given in section 5.4. The farmer organizations taking over responsibility for the irrigation system are to be the most far reaching changes that would be occurring in the irrigation management, down stream of the distributary system in Punjab since its introduction over a century ago. The existing system created during the colonial times mainly for its interests, have served its purpose and outlived it with little modifications but has not met the requirements of the changing political, economic and social order. Little or no attempt has been made in participatory management. The existing system continues to deteriorate in all aspects of management at the distributary level, which eventually would result in environmental degradation. The proposed institutional changes would be attempting to arrest this deterioration by the involvement of participatory management on a pilot basis. Changing of a management system built on old colonial traditions would bring in conflicts and resentment from interested parties who would prefer to continue the present system.

The success of the Institutional changes would bring in many benefits, both environmentally and socio economically. The failure of the pilot scheme would cause the reverting back to the existing system.

5.5 Downstream settlements.

The proposed project is conceived within the confines of the study area. The impacts this could cause on the downstream settlements which are outside the study area is not determinable on the present scope of work and could be stated as unknown.

5.6 Impairment of Transportation

The existing O & M road that is maintained by the PID is used extensively by the farmers and other settlers in the project area. During the construction period, there will be interruptions to its use. Suitable alternatives or crossings will be required only during the construction period.

Following construction, the O&M road is expected to be brought upto a higher standard. At present there are 229 vehicular crossings on the selected canals, giving an average of a bridge for every 2.53 kms. In the proposed design there will be 442 bridges giving a crossing every 1.3 kms. The additional road crossings across the distributaries will be a very beneficial impact of the project

The canal O &M road which had been constructed for the purpose of canal maintenance is used by the public due to its convenience. The PID continues to maintain that it is an illegal use as the regulations do not allow such a facility. However with the farmer organizations taking over of maintenance of the distributaries and minors, the affect on the O & M road could be a process of legalizing this usage. The ability and capacity of FO to maintain such roads should be addressed at the appropriate time.

5.7 Impediment to livestock

Livestock constitute an important item in the lives of the farmers with the tail end farmers being more dependent on them than others. On the average there are about 20 animals in a single farm. They provide many services to the farmers including transportation and add to economic and nutritional benefits. The possession of livestock also increases the wealth of the farmers and forms an easily disposable asset in case of an emergency. The present unlined canal system provides a very convenient passage for livestock crossings. The canals are used extensively by buffaloes for bathing particularly during summer. Much damage is being done

by livestock trespassing on the canals by way of damaging its banks. These damaged banks would become weak points in the canals and at time of floods breaches have occurred at these same locations.

The proposed lining project would stop the livestock's free access into the canal and there by eliminate the damages caused by them on the embankments. The design has provided for water for bathing by providing ponds on the watercourses, which are outside the lined distributaries and minors. The alternative would have been to provide steps at selected locations on either bank so as to provide as a crossing as well, but this could cause damages to lined canals as well as add to pollution. The drinking water quality tests that were carried out on canal water indicated that all samples tested were unfit due to their not meeting the bacteriological requirements. The livestock's direct use of the canals would only add to the pollution and when considering the fact, that in the future the canal water will be the main source of drinking water in the saline zone, it is desirable to reduce this contamination. During earlier periods, ponds had been provided in chaks to meet the requirements of water of the livestock. These have mostly disappeared due to encroachments or by conversion for other purposes.

In the proposed design, the number of crossings over the distributaries and minors has increased appreciably and is on the average 1.3 kms. apart. This is considered a sufficient spacing for livestock crossings as well.

The locations, numbers and the sizes of such newly designed ponds will have to take into consideration the livestock population under each canal command and their requirement. This will have to be taken into consideration in the detail design stage.

5.8 Farmers income and living standards

The overall objective of the project is to improve the agricultural productivity by saving of water that gets seeped into the saline ground water. A major benefit of the project would be the increase in farmers income following improved farming practices and greater agricultural productivity. The additional water would be giving extra production through a higher yield. The anticipated incomes with and without the project are given in Annex F. The highest percentage increase in disposable incomes in each of the canal systems are for the marginal farmers and lowest for the large farmers. The increase in disposable incomes vary from a high of 21.5% for the marginal farmers in LJC to a low of 4% for the large farmers in CBDC. The institutional changes would cause a positive impact on the social environment.

A higher disposable income realized through greater productivity, would produce a better living standard for the farmers.

5.9 Changes in farming practice

It is anticipated that with the increase in quantity of water available and more equitable water distribution under the proposed implementation of Institutional changes, that there will be minor changes to the present practices in the long term. The proposed institutional changes could bring about a greater impact to the farming practice. The farmer organizations would be able to reach all the farmers at grass root level and improve dissemination of information among them. However changes that would bring major changes to the farming practices are not anticipated. Significant environmental impacts are not anticipated from changes of farming practices.

5.10 Increase use of agro chemicals

It is anticipated that the increase in agricultural productivity caused by the project would result in a minor increase in the use of agro chemicals. This increased use of more agro chemicals would not make any significant changes to the present state of the environment. The lining of canals and resulting small increase use of agro chemicals would not be harmful to humans and livestock more than at present. No significant impacts are anticipated on this parameter.

5.11 Health and sanitation

The health and sanitation conditions in the project area are very poor. A sample survey carried out in the study area reveled that over 50% of the population were affected by frequent illnesses. This survey indicated that during the previous year, 83% of the families were affected by flu or fever while 51% by malaria 47% with dysentery and 15% by typhoid as the main causes of illnesses. Although there are the basic infrastructure facilities provided, the treatment sought at government hospitals, dispensaries, basic health units and rural health centers was only 27% of those surveyed. The majority preferred private treatment or some other treatment at home, by Hakim or by Pir/Fakir. 78% of those surveyed indicated that the health facilities were inadequate with absence of treatment center/doctor, lack of medical supplies and expensive medicines as the major problems.

An analysis of the data obtained from the Punjab Health Department on the number of cases that were treated in the project area at Government health institutions for the major water related diseases are given below on a district basis for the year 1995.

	Population	Diarrhoea	Dysentry	Malaria	Typhoid
Lahore	5,835,000	149,202	90,313	46,253	18,199
Kasur	2,302,000	10,428	8,569	118	
Faisalabad	4,307,000	113,941	64,100	16,634	14,286
TT Singh	1,191,000	27,508	16,660	761	1,348
Jhang	3,011,000	69,259	34,301	11,056	3,907
Sargodha	2,628,000	52,871	34,897	979	6,022
Total		423,209	248,840	75,801	43,762

Source; Health Department, Punjab

The above number of cases has to be considered in relation to the population in each district. On this basis the incidence of each of the diseases (population per reported case) is given below.

District	Diarrhoea	Dysentery	Malaria	Typhoid
Lahore	39	64	126	320
Kasur	220	268	19508	
Faisalabad	38	68	258	301
TT Singh	43	71	1,565	883
Jhang	43	88	272	770
Sargoda	49	75	2,684	436
Average	46	77	254	440

The incidence of malaria in the Jhang, Faisalabad and Lahore areas appears to be much higher than in others. The incidence of Typhoid in Faisalabad and Lahore appear very high. This could be because of the better health facilities like teaching hospital being available in Faisalabad and patients preferring to come to this hospital for treatment. Overall the incidence of water related diseases are high when one considers the fact that every patient does not go to the hospital for treatment. The high incidence of these diseases could be indicative of poor quality drinking water and lack of sanitation facilities in the project area. Of the households surveyed 72% in LJC, 37% in LCC and 38% in CBDC had toilets in them. Overall 23% had sewerage systems.

The present health and sanitation conditions in the project area, with the high incidence of diseases would be indicated in the lower productivity of the farmers. The proposed project of lining of canals could have a significant impact by reducing the seepage of water and thereby reduce the waterlogging and surface water stagnating ponds which would be the breeding grounds for the various vectors such as the malaria mosquitoes. The impact of the lining project would thus be a positive impact on the health sector.

5.12 Drinking water supplies

The canals selected for lining are in the saline zone and hence the chemical quality of the ground water available for drinking is generally lower than the desirable standard. The drinking water quality survey carried out by the study team on 30 chaks within the 12 selected priority canals reveled that only 4 out of the 30 samples were fit for human consumption. Even these 4 had there chemical parameters above the WHO desirable level but below the maximum permissible level. The standards adopted in Punjab for the drinking water quality is given in **Table D-6.** 24 out of 30 tested were bacteriologically unfit for consumption, while in addition many of the samples had their chemical parameters such as magnesium, sulphate, chloride and the total hardness above the WHO permissible level. This indicates a very poor condition in the availability of drinking water. The details of the drinking water quality results for the 30 Chaks are given in **Table D-6A.** The average values of the water quality of the 30 samples are as follows.

Parameter	Average value	WHO Desirable level	Parameter	Average value	WHO Desirable level
pH	7.86	7.0 - 8.5	Sulfate	498 mg/l	200
TDS	2,009 mg/l	500	Chloride	445 mg/l	200
Calcium	69 mg/l	75	Fluoride	0.34 mg/l	
Magnesium	62mg/l	50	Iron	0.13 mg/l	.1
Total Hardness	390 mg/l	100	Conductivity	2732 us/cm	
Total Alkalinity	630 mg/l		Nitrate	0 mg/l	
Nitrite	0 mg/l		Bacteriological Test	20% of samples acceptable	

The Public Health Engineering Department (PHED) has solved this problem of non availability of suitable quality drinking water in the very saline zones such as Kirana, Hujjan and Nasrana distributaries by installing tube wells in close proximity to the distributary canals and drawing out the 'sweet' water from the underground aquifer. This fresh water aquifer is dependent mostly on the seepage water from the distributary canals. Some other water schemes in the saline zone has its source as canal water, which is taken directly and treated due to such water being bacteriologically contaminated. PHED then distributes the drinking water by pipelines to the Chaks. There are 32 such schemes in Kirana serving 37 chaks, 3 in Hujjian and on Nasrana 17 schemes are from tube wells with another 2 as a direct canal source, are to be installed. The present population of the Chaks receiving drinking water from the above schemes is estimated at 180,000. The Chaks served by these water supply schemes are given in **Table D-7.** The PHED also plans more such schemes in the saline zone, as funds become available. The priority is presently a political matter. In addition there are 190 Hand pumps installed within the canal reservation, in closer proximity to the canal embankment, that draws from the shallow fresh water. These are indicated in **Table D-8.**

The impact of the canal lining project would be a reduction in the amount of fresh water made available for these tubewells following the lining. The quantity required by most of these tube wells is less than 100,000 gallons per day and there is a slight probability, that there might be sufficient fresh water that would seep after lining, although the projects aim is to reduce the fresh canal water to be lost by seepage to the saline groundwater. The hand pumps installed mostly on the canal embankments tap the shallow fresh water unlike the tubewells. These hand pumps would firstly be affected by the construction work as they have to be removed. Re-fixing of these hand pumps is to be done by the project, but there will be no guarantee that they will have suitable water after lining. The lining project would thus directly affect much of the population in the saline zone who now depend on the seepage water from the distributaries and minors for their drinking water. With the reduction of canal water seepage into the fresh water aquifer, the possibility of the saline ground water intrusion into the present fresh water aquifer could occur over a long period of time. This would be a major negative impact that could occur. The monitoring programme is to include this item as part of its activities.

As a mitigative measure, provision of drinking water to the affected persons during the construction period will be necessary. All hand pumps that will be removed for the construction work will have to be reinstalled by the project. Monitoring of the other tube well schemes after construction will be required and suitable action has to be taken in the event of non availability of suitable drinking water.

Eventually if the tubewells have to be discarded, an alternative means of providing drinking water to the chaks will have to be made. The tube wells are about 80 feet deep and the seepage water that is extracted are of an acceptable standard for distribution with almost no bacteriological contamination due to the filtering action. The canal water, though less in salinity than ground water, is almost always contaminated and not upto the acceptable bacteriological standards. If canal water has to be used a more expensive type of scheme involving sedimentation tanks and treatment will have to be adopted. This type of scheme would require over an acre of land for its construction. The canal reservation does not have such land and hence they will have to be acquired. The maintenance of these schemes also require special attention.

The average present costs involved by the Public Health Engineering Department on these schemes are as follows:

1.	Construction of tube well scheme	Rs.	500/= per capita
2.	Construction using canal water directly	Rs.	1,200/= per capita

3.	Maintenance of tube well scheme	Rs. 120,000/= per annum
4.	Maintenance of canal schemes	Rs. 400,000/= per annum

The above costs for the canal schemes does not include any payments for the supply of canal water by the PID or costs of land acquisition. The average population served by these schemes is about 5,000 and the designed per capita water requirement is a low 10 -15 gallons per day

5.13 Forest plantations

All selected priority canals have forest plantations on either side of it. The details of the available canalside plantations are given in **Table D-9**. These consist mainly of Shisham and Kikar with much lesser distribution of Poplar, Eucalyptus and other varieties. The canal lining project would necessitate the cutting down most of these trees for the construction of diversion canals and other temporary works. These forest plantations which were with the PID was handed over to the Forest Department in 1994, who presently maintains and have afforestation and regeneration programmes to fill in the blank areas in them. To implement the canal lining project it would be necessary to clear the canalside plantations according to the detail design requirements. In Punjab, an order has been issued by the Chief Minister in 1994, totally banning the cutting, sale or felling of canalside plantations. Permission will have to obtained for this and the procedure is outlined in **figure D-8.** The procedure to obtain this land would approximately take 6 months including the clearing operations.

The project would have to take mitigative action and provide for canalside plantations at the completion of the construction. The plantations proposed are Shisham, Kikar and faster growing trees such as Eucalyptus. The selection and planting of trees would have to take into consideration the fact that canal lining should not be damaged or interfered by its root system.

The cost of planting an avenue mile of trees (500 trees at 10' X 10' spacing) is as follows

1.	Cost of planting	Rs. 8,100/=	per avenue mile
2.	1st Year maintenance	Rs. 5,000/=	do
3.	2nd Year maintenance	Rs. 4,000/=	do
4.	3rd Year maintenance	Rs. 3,500/=	do

On completion of replanting the plantations would be given back to the Forest Department for maintenance. However with the implementation of the institutional reforms and the formation of Farmer organizations the viability of maintenance of these canalside plantations by them may be explored.

5.14 Wild Life

The proposed project will have no impacts on the wildlife resources.

5.15 Groundwater table (Waterlogging)

The condition of the ground water table and waterlogging in the project area was indicated in section **4.7.** The implementation of the SCARPS programmes which have so far numbered 12 in the project area was indicated in **figure D-2.** The waterlogging problem has improved over the years but has not been solved. In LJC area, around 10% of the extent is yet waterlogged following the monsoons. Waterlogging is now generally recognized as an outcome of intensive irrigation in arid and semi arid lands. As already indicated in section 1.3, the solution to this problem is of the highest priority in Pakistan and included in the eighth five year plan to be eliminated.

The environmental impacts of Waterlogging are many fold. A high water table, generally less than 5' causes yield losses in crops. The yield loss increases with the rising water table. The percentage yield reduction due to high water tables is given in the following table.

Percentage yield reduction due to high water tables.

Water table depth (feet)	Mango	Cotton	Sugar cane	Wheat	Fodder
0.0' - 0.8'	100	98	91	79	80
0.8' - 1.6'	100	57	66	49	27
1.6' - 2.5'	100	35	46	28	0
2.5' - 3.2'	87	21	29	13	0
3.2' - 4.1'	63	12	14	5	0
4.1' - 4.9'	38	5	5	1	0
4.9' - 5.7'	14	1	1	0	0
>.5.7'	0	0	0	0	0

Source: Water Sector Investment Plan

From the above it can be seen that depending on the crop, waterlogging problems severity is felt more. The reduction of yield would initially lower the incomes of the farmers. The reduction of yield at around 3' will be that severe for the cultivation to be uneconomic. The environmental impact will be that the waterlogged land degrades to that level and finally becomes unproductive. The impact on the farmers would be lost income, land and livelihood.

Waterlogging and salinity were referred very commonly as the "twin" menaces. Waterlogging is said to have accentuated and accelerated the development of such soils. In that sense too, waterlogging causes land degradation. The impact of such lands will be that even after reduction of the waterlogging problem, further corrective measures will be required for salinity.

The project to line distributaries and minors in the saline zone seeks to eliminate or reduce the seepage of fresh canal water to the saline ground water. The fresh water seepage to the saline water aquifer when mixed up are not reused as in the case of the freshwater zones. This causes a build up of the water table and thereby increase the extent of waterlogging. The major impact of the reduction of the seepage of water in the saline zone would be to reduce the build up of the water table in this zone and there by reduce the waterlogging problem. The proposed project has a high significant environmental impact which is on the positive side

The impact of the reduction of seepage on the water table following construction will have to be assessed by a monitoring plan that should be developed.

5.16 Groundwater quality

The ground water quality in 39.8% of LJC, 40.2% of LCC and 51.5% of CBDC are saline with TDS of over 1000 ppm. In the 12 selected command areas, the saline area is 81%. The ground water in the saline zone is not generally used for irrigation while in the fresh water zone it is heavily extracted by farmers tube wells for supplementary irrigation.

The projected changes on the quality of ground water due to the lining project will arise from:

(a) increase use of agro chemicals

(b) reduction of seepage of fresh canal water from the canals in the saline zone

The affects on the project by the above will be;

(a) There will be no increase in the extent of land or in cropping intensity than at present which would cause an increase use of agro chemicals. However the present cultivated extents would see a change in farming practice and a small increase in the use of agro chemicals. This would not contribute towards any appreciable changes in the groundwater quality.

(b) As indicated earlier, in the fresh water zone the watertable is falling at an excessively high level. The reduction of fresh canal water seepage to the ground water aquifer combined with over extraction of fresh water by tube wells for irrigation purposes could cause the saline water intruding unto the fresh water zone. This would result in a greater area becoming saline than at present. This can be a very adverse impact that could occur by the project.

The overall impact of lining of canals on the quality of groundwater is not expected to be adverse, but it is very necessary that constant monitoring of the water quality as well as the fresh water extraction by tube wells is done, to ascertain whether such an intrusion is

occurring. Further studies on this parameter such as solute transport modelling should be undertaken.

The impact of the proposed project of lining the canals in the saline zone by preventing the seepage of fresh water into the saline zone would be an increase in the quantity of canal water available and thereby an improvement in the quality of the total irrigation water that will be available from saving of seepage water. Simultaneously there could be a slight decrease in quality of the unused water in the saline zone.

A plan should be developed to monitor the water quality during project implementation.

5.17 Water Quantity

The proposed project to line distributaries and minors in the saline ground water zone would reduce the seepage of fresh canal water to the saline ground water aquifer. It is agreed by almost all concerned that the loss of this fresh water to the saline zone makes it an unusable commodity. Canal losses in the fresh ground water zone is not a complete loss as they are reused by pumping from the ground water aquifer. The present study has after carrying out field tests of the canals in the saline zone and having considered the seepage losses have selected those with the highest losses. The average losses of the canals selected is about 10%. It may be assumed that the water quantity available in these canals can increase upto 10% of the present flows. This together with the new design and better water management through institutional reform will maximize the use of the water resources and in turn will bring the greatest benefits that could be had from the project.

The impact on this item is beneficial and is of high significance.

5.18 Soil Salinisation

The soils in the study area are already badly affected by soil salinity with 13% of the total area affected. In the project area the dominant salt tends to be Sodium bicarbonate. Section 4.12 indicated the present state of the soil salinisation in the study area. According to Thur Gadawari surveys which are carried out annually by the PID, 17% of the land in LJC, 13% in LCC and 5% in CBDC areas are affected and are in various stages of salinisation. The major area affected is Sargodha division with 27% and Lower Gojra with 23% of its land extent. This indicates an alarming loss of productive lands and is a very major environmental problem as much as waterlogging. It should be noted that Sargodha has 5% 'Thur Kohna' which are lands that were ultra alkaline and never cultivated even before the advent of irrigation.

The major salinisation issue of high environmental concern will be 'Thur Juzvi' which are lands presently in cultivation but showing patches of salts and progressively increasing salinisation. In LJC, Sargodha and Kirana divisions are very badly affected with 17% and 15% of such lands being affected while Shahpur has relatively very little with 2%. It appears from the analysis of 5 year data of Thur Gadawari surveys that the salinisation has reached a constant figure of around 13% . In other words, as lands are reclaimed more lands are being degraded.

In the selected canal command areas of the project, 9% of the land is affected by soil salinisation as indicated in **Table D-10**. The most affected are Pir Mahal distribuary and its minors, in Hujjan minors of Jaspal and Kot raja and in the minors of Kirana, Hadda, Malkana and Sarubi. In all these canals over 20% of the land has been affected by soil salinisation.

The use of moderately saline ground water for irrigation in the fresh water zone has converted non saline - non sodic soils to saline soils and this process is continuing. In the saline zone the seepage of fresh canal water to the saline water aquifer builds up the watertable, thereby increasing the evaporation and causing accumalation of salt in the soil. It must also be emphasized that the saline soils could become non saline soils, if the excess soluble salts are leached. The water that is saved by the proposed project, which amounts to 163 MCM annually could be used to reclaim 'lost land'. This would amount to creation of new land for cultivation.

The land reclamation that is being carried out mainly by leaching of saline soils with water to wash the excessive salinity under well drained conditions, is a technique of general applicability and hence this has been adopted. According to the Land Reclamation Directorate, so far about one million acres has been reclaimed in Punjab at an average rate of 16,000 acres per year. For this purpose additional water supply over the normal supplies that has been made available to irrigation has to be committed. The extra water supplies required for reclamation are at the rate of one cusec for 45 acres in perennial canals and for 60 acres for non perennial canals. This process is continued for 3 years. According to the Directorate of Land Reclamation a delta of about 250" to 300" is required to leach down salts from the root zone under well drained conditions. Divided into 3 years this amounts to 80" to 100" for each year. This delta of water is envisaged to be utilized during the Khariff season, in the shape of 24 irrigations of 4" each.

The impact of salinisation is somewhat similar to those caused by waterlogging. As salinity increases, yields decrease. The environmental impact will be that the salinity causes land degradation progressively until it becomes unproductive. The impact on the farmers would be lost income, land and livelihood.

The following table gives the Salinity - Yield relationship for different crops

	Threshold tolerance (TT) EC	Percent For unit increase above TT EC	Yield EC-8	Decrease Ec-15
Cotton	7.7	5.2	2	38
Wheat	6.0	7.1	14	64
Rice	3.0	12.0	60	100
Sugar Cane	1.7	5.9	37	78
Rabi fodder	1.5	5.7	37	77
Kharif fodder	1.8	7.4	46	98

Source: Mass and Hoffman

The impact of the elimination of fresh water seepage from canals being added to the saline water would be to decrease the water table and reduction of evaporation which results in salt accumulation in soil, which is a beneficial impact. The net saving of water would enhance the possibilities of making more water made available for leaching under the reclamation programme. The impact of a more saline ground water without suitable drainage would be to enhance the possibility of soil salinisation with the rise of the water table.

The development of a plan to monitor the soil salinisation following implementation of the project is essential.

5.19 Salt balance

Salt balances that have been carried out by various agencies indicate a build up of salts within Punjab. A recent study has indicated that there is an addition of 4.5 tons/ha/year to the soils in the fresh water zones of Punjab and 1.25 tons/ha/year in the saline zone.

The present study on the salt balance in the study area has indicated that there is a salt accumulation in the soils of both, the fresh water zones (average 4.7 tons /hectare) and the saline zones (average 3.1 tones /hectare). In the ground water of the fresh water zones and in the saline zones there is a reduction of salts. The annual salt addition to the soil in the fresh groundwater zones (FGW) and saline ground water zones (SGW) of all 3 canal systems is given below.

Area	LJC/SGW	LJC/FGW	LCC/FGW	LCC/SGW	CBD/FGW	CBD/SGW
Salt addition to soil (tons/ha)	2.5	1.4	5.5	3.8	5.3	3.0
Salt added to ground water (million tons))	-0.8	-0.9	-4.4	-2.2	-0.8	-0.7

The results indicate that through continuous irrigation that both in the fresh and saline ground water zones, salt moves to and accumulates in the soil and less salt remain in the ground water. The soils in the fresh water zones are more vulnerable for secondary salinisation than those in the saline zones. In the fresh water zones the higher salt accumulation is apparently caused by the tube well water being pumped for irrigation. In the saline area, capillary movement of water in evaporation is the cause for salt accumulation in soil. If the present condition continues, salt accumulation in the soil will be detrimental to irrigated agriculture in the study area. Considering the long term affects would be creation of waterlogging which is an environmental hazard.

From the salt balance study it is indicated that as far as the canal lining project is concerned the effects are:

(1) canal losses through fresh water zones assist in off setting tube well pumping and there by dampen aquifer mining,

(2) canal losses through saline zone has a negative impact, in that the water is lost forever for irrigation when it mixes with the saline water, and then it goes on to contribute towards water logging.

Canal lining in the saline zone would have a positive impact. The salts in the saline zone that have already accumulated cannot now be removed, without proper drainage and considerable leaching. Canal lining would contribute towards the lowering of the water table, and reduction of evaporation would reduce the salts accumulation. Though canal lining will not remove the salts completely it will reduce it from getting worsened.

D.6 Environmental Management Plan

Based on the results of the Initial Environmental Examination and further study, the environmental management plan and monitoring plan is drawn up for future reference. The environmental management plan is given in **Table D-11.** The inter departmental coordination between the PID, the implementing agency and the other related organizations such as Agriculture Department, Public Health Engineers Department, Forest Department, Health Department, WAPDA and others are very vital for this project and should be enhanced. Each of the activities that have been dealt with, require follow up action from pre commencement to completion and post completion. The table indicates the requirements. Detail implementation plan of the project should incorporate these recommendations into such plans. Certain mitigative actions that have to be carried out as a result of the project during the implementation, will have to be done from the miscellaneous item of the cost estimate.

D.7 Environmental Monitoring plan

The environmental monitoring plan is given in **Table D-12** A committee should be formed within PIDA to implement the monitoring programme. The other related institutions should be co-opted to this committee. The main functions of this committee will be to:

(a) prepare a detail monitoring plan based on the recommendations given in this study
(b) to carryout through the various government agencies, research organizations, independent consultants and FO the required activities and to supervise the actual monitoring programme
(c) analyze the data, take mitigative actions and to decimate this information to others concerned
(d) to maintain a data base including all baseline data on the project
(e) to recommend any special studies that are required to be done

The monitoring items include drinking water quality, ground water quality, water table, extraction of ground water by tubewells, soil salinisation, restoration of equal water rights, canal seepage, farmers living standards, health conditions and issues raised by the farmers during the construction period regarding any unexpected changes occurring. The monitoring of drinking water quality should be carried out in the 30 chaks, at the same locations as given in **Table D-13**. This sampling carried out during this study will be used as the baseline data to ascertain the impacts on the drinking water quality in the chaks.

The monitoring and evaluation results should be considered for the future direction of the pilot project.

D.8 Conclusions

The project has environmentally beneficial as well as adverse impacts. The main benefit will arise from the improvement to the irrigation system with the lining, in better water management and the institutional reforms. This will result in a higher income for the farmers through higher productivity and a better standard of living. Certain negative impacts that arise due to the project could be overcome by the implementation of the mitigative actions proposed. These are to be carried out from the miscellaneous item, in the cost estimate. The shortage of good quality drinking water is a major problem faced presently by the people living in the saline zone. The canal lining project could cause a further decrease in the availability of drinking water and this has to be closely monitored. Impacts on environmental parameters such as water quality, water table, salt balance are dependent on many factors. Some are dependent on other

programmes such as the drainage programme while some are outside the present scope of work and would require further study including modelling. The probability exists for saline water intrusion into the fresh water zone and for loss of aquifer potential due to reduced recharge following the lining of canals. These can be possible adverse impacts in the long term and require close monitoring. Overall, the project would have more beneficial impacts compared to the adverse impacts

D.9 Recommendation

The project has more beneficial impacts than adverse impacts and possible adverse impacts that could occur. It is recommended that the project be implemented with the following mitigative actions taken.

1. Forest plantations removed for the construction work should be reforested after the completion of the project.

2. Drinking water supply should be continued during the construction stage and shallow hand pumps disturbed be reinstalled at suitable locations. Tube well schemes should be monitored for loss in fresh water aquifer potential. If they are affected, alternate schemes to be provided.

3. Model studies be undertaken to determine salt water intrusion into the fresh water zone and loss in aquifer potential.

4 The formation of a committee in PIDA to implement the Monitoring plan and take corrective action

TABLES

Table D-1 Extent of Salinity during1995 in the project area

All extents in acres

Canal Circle	Division	Area surveyed	(1) Thur Kohna	(2) Thur Punjasala	(3) Thur Nau	(4) Thur Juzvi	(5) Thur Tirk	Thur Recl	Total Saline area	Saline area
		(Acres)							(Acres)	%
Lower Jehlum	Sargodha	511.690	26.473	10.808	11.195	88.095	176	404	137.151	26.8
	Kirana	589.250	5.207	1.817	4.563	88.473	22	393	100.475	17.1
	Shahpur	235.351	3.045	365	459	4.160	26	0	8.055	3.4
	Rasool	238.149	5.336	1.735	1.932	19.650	0	1.125	29.778	12.5
	Sub total	1.574.440	40.061	14.725	18.149	200.378	224	1.922	275.459	17.5
Lower Chenab	Faisalabad	387.735	4.037	3.103	2.815	28.276	260	1.224	39.715	10.2
	Hifzabad	412.606	9.136	10.223	447	34.419	285	1.551	56.061	13.6
	Jhang	692.270	6.489	2.290	1.234	34.871	166	1.671	46.721	6.7
	Khanki	296.181	2.335	32.715	786	12.393	0	1.685	49.914	16.9
	Upper Gojra	701.133	11.701	10.058	2.816	30.316	0	267	55.158	7.9
	Lower Gojra	566.512	5.550	16.173	14.920	92.244	494	2.687	132.068	23.3
	Burala	588.923	10.971	10.221	3.724	58.986	224	4.426	88.552	15.0
	Sub total	3.645.360	50.219	84.783	26.742	291.505	1.429	13.511	468.189	12.8
CBDC	Lahore	703.013	15.467	3.803	3.586	12.583	633	0	36.072	5.1
	Sub total	703.013	15.467	3.803	3.586	12.583	633	0	36.072	5.1
	TOTAL	5.922.813	105.747	103.311	48.477	504.466	2.286	15.433	779.720	13.2

Explanation of terminology used in salinity surveys

(1) Thur Kohna - Ultra alkaline or Non Saline Alkali soils. Never cultivated saline land since the advent of canal irrigation. High in salt content & alkanality or low salt content & high alkali.

(2) Thur Panjsala - Highly saline or saline alkali soils. Lands excluded from cultivated for more than 5 years due to salinity. Advance stage of deterioration. pH is 9.0 to 10.0

(3) Thur Nau - Highly saline or saline alkali soils. Lands excluded from cultivation within 5 years due to salinity. These are mostly saline alkali soils in the northern part of the Indus plains.

(4) Thur Juzvi - Saline or saline alkali. Saline lands under cultivation bearing visible patches of salts to the extent of above high salinity in patches & alkalinity show progressively increasing.

(5) Thur Tirk - Lands where salts presnt in root zone hamper opening of cotton balls. Accumalation of salts is well below in the root zone & salts are not visible over the soil surface.

Source: DLR/PID

Table D-2 Preliminary evaluation of the magnitude of Impact on items by the project and the importance of the item in the project

Item	Magnitude of impact on item (Note 1)	Magnitude of importance of item in project (Note 2)	Remarks
1. Land acquisition	- B	D	Construction methods to minimize land acquisition
2. Distribution of inequities	+ A	A	Depends on sucess of implementation
3. Canal closure	- A	C	Depends on the construction methodology
4. Institutional changes	+A / -A	A	Depends on sucess of implementation
5. Down stream settlements	- U	E	
6. Impairment of transportation	- C	D	
7. Framers income & living standards	+A	A	
8. Impediment to Livestock	- A	B	
9. Changes in farming practice	- C	C	
10. Increase use of agrochemicals	- C	B	
11. Health and sanitation	+ C	C	
12. Drinking water quality	A	A	Drinking water quality survry to be carried out
13. Forestry	- A	D	Further details are necessary at next stage
14. Wild life	D	E	
15. Groundwater table/waterlogging	+ B	A	Further details and monitoring plan is necessary
16. Groundwater quality	- B	A	Further details and monitoring plan is necessary
17. Water quantity	+ A	A	Monitoring plan is neccessary
18. Soil salanisation	+B / -B	B	Further details and monitoring plan is necessary
19. Salt balance	+C	B	Further study is necessary

Note 1. Magnitude of levels of Impact on the Induvidual item by the Project

A : Relative high magnitude of Impact is expected
B : Relative medium magnitude of Impact is expected
C : Relative low magnitude of Impact is expected
D : No effect is expected
U : Impact is unknown
+ : Positive Impact is expected
- : Negative Impact is expected

Note 2. Magnitude of the importane of the item in the overall project

A : Very high importance in the overall project.
B : High importance in the overall project.
C : Medium importance on the overall project.
D : Low importance in the overall project.
E : No importance in the overall project.

Table D-3 Reservation Widths along canals selected for lining in LJC

Distributory	Minor	Length	Command	Canal section		* Reservation		Remarks
		km	area (ha)	From - RD	To - RD	Left	Right	
Pindi		6.86	2,164	0	248			Within the reservation of Northern Branch
				248	22,500	55	55	Crown waste land on right side
Hujjan		34	11,358	0	21,000	57.75	57.75	
				21,000	23,500	79.75	79.75	
				23,500	43,113	57.75	57.75	
				43,113	69,000	55	55	
				69,000	70,000	77	77	
				70,000	79,500	55	55	
				79,500	81,000	77	77	
				81,000	83,225	55	55	
				83,225	85,500	49.5	49.5	
				85,500	86,000	71.5	49.5	
				86,000	87,500	71.5	71.5	
				87,500	105,000	49.5	49.5	
				105,000	107,500	71.5	71.5	
				107,500	111,492	49.5	49.4	
	Arrian	5.43	1,392	0	5,000	33	33	
				5,000	18,000	30.25	30.25	
	Bhikhi	6.79	1,911	0	5,000	35.75	35.75	
				5,000	14,000	33	33	
				14,000	22,540	30.25	30.25	
	Jaspal	8.33	2,724	0	3,000	41.25	41.25	
				3,000	7,000	52.25	52.25	
				7,000	12,500	41.25	41.25	
				12,500	16,000	49.5	49.5	
				16,000	25,100	35.75	35.75	
	Kot Momin	6.79	2,380	0	22,000	33	33	
	Kot Raja	2.81	534	0	15,000	30.25	30.25	
	M. Wala	5.77	1,406	0	1,300	33	33	
				13,000	20,000	30.25	30.25	
	Sahowal	6.34	1,600	0	5,000	32.25	17.25	
				5,000	11,500	30.95	15.95	
				11,500	15,000	41.37	26.37	
				15,000	18,700	30.95	15.95	
	Tangu	5.87	1,784	0	14,823	30.25	30.25	
Kirana		64.11	22,358	0	9,500	101.75	101.75	RD 2800 to 16700 : Crown waste land
				9,500	27,000	99	99	RD 28200 to 76639 : Crown waste land
				27,000	58,000	110	110	RD 82264 to 146000: Crown waste land
				58,000	84,500	88	88	
				84,500	126,000	82.5	82.5	
				126,000	132,250	77	77	
				132,250	146,000	57.75	57.75	
				146,000	210,972			
	Dhabian	7.89	1,909	0	11,000	60.5	60.5	Crown waste land
				11,000	26,700	55	55	"
	Hadda	4.1	1,639	0	Tail	Not available		"
	Hunda	4.91	1,778	0	17,000	55	55	"
	Killa	4.09	1,317	0	13,700	55	55	"
	Malkana	10.14	3,548	0	15,000	77	77	"
				15,000	24,000	66	66	"
				24,000	40,300	60.5	60.5	"
	Rodian	6.02	2,220	0	13,000	46.75	46.75	"
				13,000	19,500	66	66	"
	Saruli	1.58	606	0	9,300	55	55	"
	Wasuana	6.87	1731	0	15870	60.5	60.5	Crown waste land
	Tandlian	3.95	1,309	0	12,929	14.5	29.5	

* Note: The reservation widths to the Left and Right is from the centerline of canal and given in feet

Table D-4 Reservation widths along canals selected for lining in LCC

Distributory	Minor	Length Kms.	Command area (ha)	Canal section From - RD	Canal section To - RD	Reservation width Left (ft)	Reservation width Right (ft)	Remarks
Nasrana		54.67	23,910	0	50,000	65	65	Government Waste land on right hand side
				50,000	100,000	60	60	do
				100,000	125,000	55	55	do
				125,000	150,000	50	50	do
				150,000	170,000	45	45	do
				170,000	175,000	40	40	do
	Doomra	3.65	2,604	0	21,000	35	35	do
	Khilliana	2.94	838	0	14,565	35	35	do
	Narwala	3.86	2,139	0	19,200	40	40	
	Natheri	3.04	1,270					Data not available at Xen office
	Saiduana	1.82	720	0	7,900	38.5	38.5	
	Satiana	2.42	1,136	0	12,000	30	30	Government Waste land on right hand side
Pir Mahal		47.61	6,237	0	18,150			Data not available
				18,150	27,500	64	64	Bhagat Reservoir plantation
				27,500	29,500	47	86	do
				29,500	32,500	59	59	do
				32,500	36,000	58	58	do
				36,000	36,500	58	87	
				36,500	39,000	47	87	
				39,000	46,000	46	80	
				46,000	61,410	48	83	
				61,410	66,000	86	44	Crown waste land on both sides begin at 62,000
				66,000	69,000	65	65	Crown waste land on both sides of canal reservation
				69,000	70,500	64	64	do
				70,500	78,000	61	61	do
				78,000	81,000	60	60	do
				81,000	90,000	58	58	do
				90,000	130,000	52	52	Crown waste land on right hand side
				130,000	137,500	49	49	do
				137,500	156,000	42.5	42.5	do
	Jandwala	3.75	513	0	10,000	40	40	
				10,000	18,000	38	38	
	Junejwala	37.21	7,539	0	11,500	44	44	
				11,500	18,000	39	39	
				18,000	40,000	40	40	
				40,000	60,457	41	41	
	Magneja	9.90	1,741	0	20,000	40	40	Crown waste land on both sides
				20,000	33,500	41	40	
	Thera	4.85	1,012	0	9,000	41	41	
				9,000	15,600	36	36	
Mungi		37.00	15,109	0	1,500	80	80	
				1,500	51,820	60	60	
				51,820	108,260	55	55	
				108,260	123,000	40	40	
	Mungi	2.64	1,624	0	14,000	40	40	
Sarangwala		25.03	9,901	0	43,700	50	50	
				43,700	79,260	45	45	
Janiwala		10.57	4,343	0	42,060	40	40	
	Amirwala	7.63	2,077	0	25,301	40	40	
Kilianwala		46.09	23,112	0	8,000	60.5	60.5	
				8,000	18,000	66	66	
				18,000	43,000	69.5	68	
				43,000	49,000	67	65	
				49,000	51,000	62	59	
				51,000	63,000	66	66	
				63,000	73,000	65	62	
				73,000	75,000	72	60+52	
				75,000	82,000	60.5	60.5+52	
				82,000	92,000	47.5	96	
				92,000	96,000	52	94.5	
				96,000	118,760	43.5	94.5	
				118,760	126,674	48	87	
				126,674	140,275	44	44	
				140,275	150,910	41	41.5	
	Minor #3	6.66	2,019	0	21,480	50	50	
	Zeera	2.71	1,109	0	20,000	40	40	

Table D-5 Reservation widths along canals selected for lining in CBDC

Distributory	Minor	Length	Command	Canal section		Reservation		Remarks
		Kms.	area (ha)	From - RD	To - RD	Left	Right	
Thaman		30.61	8,726	0	1,800	50	50	
				1,800	3,400	50	47	
				3,400	6,000	50	44	
				6,000	10,000	50	40	
				10,000	10,200	47	40	
				10,200	13,600	40	38	
				13,600	16,000	43	36	
				16,000	17,500	40	39	
				17,500	26,000	45	40	
				26,000	29,500	40	29	
				29,500	41,000	45	35	
				41,000	43,500	39	29	
				43,500	51,000	39	31	
				51,000	60,000	36	31	RD 56 to 66 is Brick Lined
				60,000	68,500	36	28.5	
				68,500	79,000	33.5	28.5	
				79,000	80,000	32	27	
				80,000	97,000	32	27	Tail at 97000 RD.
China		25.48	14,128	0	2,730	44	42	
				2,730	19,760	44	35	
				19,760	20,000	45	32.5	
				20,000	23,750	40	32.5	
				50,000	75,000	35	35	
				75,000	79,000	32.5	32.5	
				79,000	85,000	36.5	32.5	
				85,000	99,000	34	32.5	
				99,000	100,600	32	32.5	
	Kala Minor	7.82	2,610	0	500	20	20	
				500	6,550	17.5	17.5	
				6,550	7,100	17.5	22.5	
				7,100	8,000	17.5	17.5	
				8,000	11,500	20	20	
				11,500	18,075	15	15	
				18,075	21,500	17.5	17.5	
				21,500	23,000	15	15	
				23,000	24,746	10	10	

* Note: The reservation widths to the Left and Right is from the centerline of canal

Table D-6 Standards adopted for Drinking Water Quality in Punjab

Parameter	Units	Highest Desirable Level	Maximum Permissible Level
Physical			
Temperature			
Odour		Unobjectionable	Unobjectionable
Colour		5 units	50 units
Taste		Unobjectionable	Unobjectionable
Turbidity	N.T.U.	5 units	25 units
Chemical			
pH		7.0 - 8.5	6.5 - 9.2
Total Dissolved Solids	mg/l	100	500
Calcium	mg/l	75	200
Magnesium	mg/l	50	150
Total Hardness	mg/l	100	500
Sulfate	mg/l	200	400
Chloride	mg/l	200	600
Total Iron	mg/l	0.1	1
Conductivity	mg/l		0.05
Arsenic	mg/l		0.05
Cadmium	mg/l		0.005
Chromium	mg/l		0.05
Cynaide	mg/l		0.1
Fluoride	mg/l		1.5
Lead	mg/l		0.05
Manganese	mg/l		0.1
Mercury	mg/l		0.001
Selenium	mg/l		0.01
Zinc	mg/l		5
Copper	mg/l	0.05	1.5
Anionic detergents	mg/l	0.2	1
Mineral oil	mg/l	0.01	0.3
Phenolic compounds	mg/l	0.001	0.002
Bacteriological			
Residual Chlorine			
Coliform	MF/100ml		
E. Coli	MPN/100 ml		

Table D-6A Results of the drinking water quality tests

No.	Canal	Chak	pH	TDS ppm	Ca ppm	Mg ppm	Total Hardness	Total Alkalinity	SO4 ppm	Cl ppm	F ppm	Fe ppm	Conduct (Us/cm)	Nitrate ppm	Nitrite ppm	Bacterological Result
			W.H.O. maximum permissible level (adopted by Public Health Engineering Department, Punjab)													
			6.5-9.2	1500	200	150	500		400	600		1				
1	Tamman	Jeevan singh	8	966	60	22	240	410	260	74	0.4	Nil	1,380	Nil	Nil	Fit
2	Kala Minor	Kot Shajoo Kahn	8.7	1,610	24	Nil	60	670	580	92	0.3	Nil	2,300	Nil	Nil	Fit
3	Kala Minor	Kot Shajoo Kahn	8.6	2,380	84	35	340	340	615	111	0.3	Nil	3,400	Nil	Nil	Unfit
4	Chinna Dy	Haveli Jhanger	8.2	1,190	28	2	80	760	340	225	0.2	Nil	1,700	Nil	Nil	Fit
5	Pir Mahal Dy.	261/GB	7.6	1,232	28	45	250	540	410	167	0.4	Nil	1,760	Nil	Nil	Unfit
6	Pir Mahal Dy.	688-28	7.5	1,085	52	30	250	540	230	108	0.4	Nil	1,550	Nil	Nil	Unfit
7	Junejwala M	681-22 GB	7.3	371	52	18	200	290	98	27	0.5	Nil	530	Nil	Nil	Unfit
8	Megneja M	665/5	7.4	679	40	30	220	440	178	40	0.5	Nil	970	Nil	Nil	Unfit
9	Sarangwala Dy	107/GB	7.6	1,435	100	138	860	800	418	236	0.4	Nil	2,050	Nil	Nil	Unfit
10	Mungi Dy	245/GB	7.6	5,250	132	Nil	140	800	1,320	1,190	0.3	Nil	7,500	Nil	Nil	Unfit
11	Gojra Dy	366/JB	7.8	9,100	104	153	870	710	1,980	1,203	0.3	1	13,000	Nil	Nil	Unfit
12	Janiwala Dy.	162/GB	7.3	420	100	138	800	760	120	113	0.3	Nil	600	Nil	Nil	Unfit
13	Amirwala M	157/GB	7.5	917	80	165	860	620	200	140	0.3	Nil	1,310	Nil	Nil	Unfit
14	Killianwala D	441/GB	7.7	1,470	48	42	290	680	210	117	0.4	Nil	2,100	Nil	Nil	Unfit
15	Killianwala D	458/GB	7.7	1,085	100	58	470	680	245	167	0.3	3	1,550	Nil	Nil	Unfit
16	Minor #3	445/GB	7.8	1,085	16	10	80	740	240	59	0.3	Nil	1,550	Nil	Nil	Unfit
17	Nasrana Dy.	51/JB	7.7	1,295	152	80	700	940	300	232	0.2	Nil	1,850	Nil	Nil	Unfit
18	Nasrana Dy.	81/JB	7.9	2,240	88	25	320	610	545	481	0.4	Nil	3,200	Nil	Nil	Unfit
19	Doomra M	87/JB	7.6	1,855	84	53	420	630	450	345	0.3	Nil	2,650	Nil	Nil	Unfit
20	Narwala M	67/JB	7.9	2,660	36	25	190	780	660	490	0.5	Nil	3,800	Nil	Nil	Unfit
21	Dherma Dy	68/NB	8.2	1,200	80	Nil	130	550	321	120	0.3	Nil	1,500	Nil	Nil	Unfit
22	Hujjian Dy.	Liliani	8.5	840	64	67	430	450	230	115	0.4	Nil	1,050	Nil	Nil	Unfit
23	Jaspal M	16/SB	7.9	1,400	56	85	480	560	360	225	0.4	Nil	1,750	Nil	Nil	Fit
24	Kot Momin M	Kot Momin	8.2	1,160	48	60	360	460	291	115	0.3	Nil	1,450	Nil	Nil	Unfit
25	M'wala M	M'wala	8.1	1,520	32	40	240	650	386	198	0.4	Nil	1,900	Nil	Nil	Fit
26	Kirana Dy.	25/SB	7.9	800	36	58	320	280	198	69	0.3	Nil	1,000	Nil	Nil	Fit
27	Kirana Dy.	137/SB	8.2	1,280	36	12	140	410	329	239	0.4	Nil	1,600	Nil	Nil	Unfit
28	Malkana M	104/SB	7.8	6,400	80	175	900	810	1,600	3,028	0.3	Nil	8,000	Nil	Nil	Unfit
29	Rodion M	121/SB	7.5	1,920	128	75	620	130	480	248	0.3	Nil	2,400	Nil	Nil	Unfit
30	Wasuna M	114/SB	7.9	4,000	116	72	580	870	970	2,254	0.1	Nil	5,000	Nil	Nil	Unfit
31	Pindi Dy	91/NB	8.2	3,440	56	25	240	1,630	865	1,564	0.4	Nil	4,300	Nil	Nil	Unfit
32	Killianwala Dy	Killianwala Dy	7.6	208	28	20	150	140	Nil	23	0.4	Nil	260	Nil	Nil	Unfit
33	Nasrana Dy.	Nasrana Dy.	7.5	192	36	15	150	130	Nil	18	0.5	Nil	240	Nil	Nil	Unfit
34	Mungi Dy.	Mungi Dy.	7.5	200	36	15	150	160	Nil	36	0.5	Nil	250	Nil	Nil	Unfit

Note: Shaded values indicates the items which are higher than the maximum permissible level for that parameter.

Table D-7 Rural Water Supply Schemes of the Public Health Engineers Department Located on Canal Reservations

No.	Distrbutory	RD	Chak served	Population	Source
1	Nasrana	59.7, 60.28	230/RB	6,000	2 tubewells
2	Nasrana	55.97,56.47,56.97	61/JB	12,500	3tubewells
3	Nasrana	63.86, 64.74	62/JB	5,300	2 tubewells
4	Nasrana	68,69	63/JB	5,300	2 tubewells
5	Nasrana	32,35	08/JB	6,265	2 tubewells
6	Nasrana	90.5	67/JB	12,783	2 tubewells
7	Nasrana	93.79	71/JB	8,700	1tubewell
8	Nasrana	54.32	217/RB	7,125	1 tubewell
9	Nasrana	52.82, 53.32	57/RB	5,870	2 tubewells
10	Nasrana	62.38, 62.88	66/JB	16,669	2 tubewells
11	Nasrana	54.47	60/JB	7,175	1 tubewell
12	Nasrana	70.79,80.85	68/JB	6,426	2 tubewells
13	Nasrana	97.24	77/JB	7,276	1tubewell
14	Nasrana	104.98	76/JB	5,500	1tubewell
15	Nasrana	113.092	80/JB	4,432	1tubewell
16	Nasrana	121.552	89/JB	5,580	1tubewell
17	Nasrana	113.10, 115.9	84/JB	5,580	2 tubewells
18	Nasrana	*Yet to b e installed	86/JB	4,464	Canal source
19	Nasrana	*Yet to b e installed	85/JB	6,100	Canal source
20	Kirana	RD data not available	89/SB	4,415	Tubewells
21	Kirana	RD data not available	128/SB	4,408	Tubewells
22	Kirana	RD data not available	107/SB	9,240	Tubewells
23	Kirana	RD data not available	113/SB	7,432	Tubewells
24	Kirana	RD data not available	127/SB	7,432	Tubewells
25	Kirana	RD data not available	126/SB	8,612	Tubewells
26	Kirana	RD data not available	131/SB	4,410	Tubewells
27	Kirana	RD data not available	90/SB	5,508	Tubewells
28	Kirana	RD data not available	105/SB	3,321	Tubewells
29	Kirana	RD data not available	94/SB	1,810	Tubewells
30	Kirana	RD data not available	98/SB	4,429	Tubewells
31	Kirana	RD data not available	100/SB	3,687	Tubewells
32	Kirana	RD data not available	116/SB,119/SB	5,848	Tubewells
33	Kirana	RD data not available	103/SB	4,097	Tubewells
34	Kirana	RD data not available	112/SB	2,135	Tubewells
35	Kirana	RD data not available	114/SB	3,306	Tubewells
36	Kirana	RD data not available	130/SB	4,140	Tubewells
37	Kirana	RD data not available	84/SB	4,445	Tubewells
38	Kirana	RD data not available	102/SB	4,225	Tubewells
39	Kirana	RD data not available	123/SB, 124/SB	7,078	Tubewells
40	Kirana	RD data not available	110/SB	3,743	Tubewells
41	Kirana	RD data not available	40/SB	4,767	Tubewells
42	Kirana	RD data not available	121/SB	4,390	Tubewells
43	Kirana	RD data not available	129/SB	4,843	Tubewells
44	Kirana	RD data not available	132/SB	5,069	Tubewells
45	Kirana	RD data not available	135/SB	5,463	Tubewells
46	Kirana	RD data not available	92/SB, 93/SB	5,477	Tubewells
47	Kirana	RD data not available	39/SB	3,768	Tubewells
48	Kirana	RD data not available	35/SB	2,836	Tubewells
49	Kirana	RD data not available	95/SB	2,402	Tubewells
50	Kirana	RD data not available	85,88,91/SB, Sadeona	11,785	Tubewells
51	Kirana	RD data not available	101/SB	2,140	Tubewells
52	Hujjan	RD data not available	65/SB	7,171	Tubewells
53	Hujjan	RD data not available	17/SB	5,811	Tubewells
54	Hujjan	RD data not available	13-A/SB	5,477	Tubewells

Table D-8 Hand Pumps located along the selected canals (1/2)

S.No.	Distributory Name	Minor Name	No. of Hand Pumps			Remarks
			I/S	R/S	Total	
1.	Pindi		3	3	6	
2.	Hujjan		21	26	47	
3.	Hujjan	Arlan	1	--	1	
4.	Hujjan	Kot Moman	1	1	2	
5.	Hujjan	Kot Raja	2	1	3	
6.	Hujjan	Bhiki	1	1	2	
7.	Hujjan	Sahowal	2	1	3	
8.	Hujjan	Marulianwala	–	1	1	
9.	Hujjan	Tangu	1	1	2	
10.	Hujjan	Jaspal	1	2	3	
11.	Kirana		2	4	6	
12.	Kirana	Saruli	--	4	4	
13.	Kirana	Hadda	1	1	2	
14.	Kirana	Malkana	–	1	1	
15.	Kirana	Wasuana	1	1	2	
16.	Kirana	Tandalian	1	–	1	
17.	Kirana	Rodian	2	1	3	
18.	Kirana	Hunde	–	–	–	
19.	Kirana	Killa	1	1	2	
20.	Kirana	Dhablan	1	1	2	
21.	Sarangwala		10	9	19	
22.	Nasrana		20	10	30	
23.	Nasrana	Saduana	1	–	1	
24.	Nasrana	Khilliana	1	–	1	
25.	Nasrana	Narwala	–	2	2	
26.	Nasrana	Saliana	1	1	2	
27.	Nasrana	Natheri	1	–	1	

Hand Pumps located along the selected canals (2/2)

S.No.	Distributory Name	Minor Name	No. of Hand Pumps			Remarks
			L/S	H/S	Total	
28.	Nasrana	Domra	–	1	1	
29.	Gojra		3	3	6	
30.	Gojra	Zeera	1	1	2	
31.	Mungi		4	5	9	
32.	Mungi	Mungi	1	–	1	
33.	Janiwala/Amirwala		–	2	2	
34.	Janiwala/Hamza		–	1	1	
35.	Janiwala	Amirwala	1	1	2	
36.	Pirmahal		2	2	4	
37.	Pirmahal	Thera	1	–	1	
38.	Pirmahal	Magneja	1	–	1	
39.	Pirmahal	Junejwala	–	1	1	
40.	Pirmahal	Jandwala	1	1	2	
41.	Killianwala		3	2	5	
42.	Killianwala	Minor #3	1	–	1	
43.	Thamman		1	–	1	
44.	Thamman	Saharan	1	2	3	
45.	China		1	2	3	
46.	China	Kale	–	1	1	

Ref C:\No 102\A\Punjab\IP-Sum.W

Table D-9 Canalside Forest Plantations - Number of trees on the selected canals

Disributory	Minor	Length	Number of Trees on canal length	
		kms.	Number	Remarks
Thamman		30.64	3669	Total on full length on both sides
Chiona		25.48	2085	"
Chinna	Kala Minor	7.82	728	"
Nasrana		54.67	8471	"
Nasrana	Doomra	3.65	481	"
Nasrana	Khilliana	2.94	278	"
Nasrana	Narwala	3.86	414	"
Nasrana	Natheri	3.04	472	"
Nasrana	Saiduana	1.82	105	"
Nasrana	Satiana	2.42	139	"
Pir Mahal		47.61	8722	"
Pir Mahal	Jandwala	3.75	1084	"
Pir Mahal	Junejwala	37.21	2798	"
Pir Mahal	Magneja	9.90	904	"
Pir Mahal	Thera	4.85	0	Not available
Mungi		37.00	4358	Total on full length on both sides
Mungi	Mungi	2.64		Not available
Sarangwala		25.04	2628	Total on full length on both sides
Janiwala		10.57	803	"
Janiwala	Amirwala	7.63	1272	"
Kilianwala		46.09	5806	"
Kilianwala	Minor #3	6.66	645	"
Kilianwala	Minor #7	4.17	982	"
Kilianwala	Minor #8	2.62	374	"
Gojra		15.07	794	"
Gojra	Zeera	2.71	208	"
Hujjan		34.00	5114	"
Hujjan	Arianwala	5.43	950	"
Hujjan	Bhikhi	6.79	1027	"
Hujjan	Jaspal	8.33	834	"
Hujjan	Kot Momin	6.79	699	"
Hujjan	Kot Raja	2.81		Not available
Hujjan	Mianwala	5.77	1240	Total on full length on both sides
Hujjan	Sahawai	6.34	562	"
Hujjan	Tangu	5.87	960	"
Kirana		64.11	7630	"
Kirana	Dhabian	7.89	396	"
Kirana	Hadda	4.10	531	"
Kirana	Hunde	4.91	105	"
Kirana	Killa	4.09	73	"
Kirana	Malkana	10.14	1085	"
Kirana	Rodian	6.02	1430	"
Kirana	Sarubi	1.58	343	"
Kirana	Tandallan	3.95		"
Kirana	Wasuana	6.87	902	"
Pindi		6.86	1017	"
Total		602.51	73148	

Table D-10 Extent of surface salinity in each of the command areas of the selected canals for lining during 1995

Distributory	Minor	Length	Command	Extent (acres) with surface salinity level							Total saline
		Kms.	area (acres)	Thur Kohna	Thur Punjasala	Thur Nau	Thur Jozvi	Thur Tirk	Thur Rect	Total saline	%
Thamman		30.61	21,815	1026	289	144	582	18		2059	9%
Chinna		25.48	35,320	315	199	138	510	32		1194	3%
Nasrana		53.67	59,775	810	131	192	800			1933	3%
Nasrana	Doomra	3.65	6,510	50	19	24	247			340	5%
Nasrana	Khilliana	2.94	2,095	6	3	24	318			351	17%
Nasrana	Narwala	3.86	5,348	16		298	169			483	9%
Nasrana	Natheri	3.04	4,425			6	113			119	3%
Nasrana	Saiduana	1.82	1,800				26			26	1%
Nasrana	Satiana	2.42	2,830	6		5	123			134	5%
Pir Mahal		47.61	15,593	79	351	414	4067			4911	31%
Pir Mahal	Jandwala	3.75	1,283	10	65	25	450			550	43%
Pir Mahal	Junejwala	37.21	18,818	45	567	169	2270			3051	16%
Pir Mahal	Magneja	9.90	4,353		641	183	960			1784	41%
Pir Mahal	Thera	4.85	2,530	3	294	92	1098			1487	59%
Mungi		37.00	37,773	11	71	105	2057	7		2251	6%
Mungi	Mungi	2.64	4,060		23		221			244	6%
Sarangwala		25.04	24,753	26		450	2478			2954	12%
Janiwala		10.57	10,858	99	120	72	1746			2037	19%
Kilianwala		46.09	57,780	335	84	82	1181	224	305	2211	4%
Kilianwala	Minor #3	6.66	5,048		67	44	307			418	8%
Gojra		15.07	15,868	12	12	5	1118		141	1288	8%
Gojra	Zeera	2.74	2,773		2	5	363			370	13%
Hujjan		34.00	28,395	59		25	2038			2122	7%
Hujjan	Arianwala	5.43	3,480	47			111			158	5%
Hujjan	Bhikhi	6.79	4,778	57			55			112	2%
Hujjan	Jaspal	8.33	6,835	211		657	958			1826	27%
Hujjan	Kot Momin	6.79	5,950				57			57	1%
Hujjan	Kot Taja	2.81	1,335				284			284	21%
Hujjan	Mianwala	5.77	3,515		120					120	3%
Hujjan	Sahawal	6.34	4,000				147			147	4%
Hujjan	Tangu	5.87	4,460	155	20	164	405			744	17%
Kirana		64.11	55,895	280	17	33	2314			2644	5%
Kirana	Dhabian	7.89	4,773		4		234			238	5%
Kirana	Hadda	4.10	4,098	3	4	12	1307			1326	32%
Kirana	Hunde	4.91	4,445				26			26	1%
Kirana	Killa	4.09	3,293	135		1	184			320	10%
Kirana	Malkana	10.14	8,870	240	435	237	2793			3705	42%
Kirana	Rodian	6.02	5,550		7	7	47			56	1%
Kirana	Sarubi	1.58	1,515				393			393	26%
Kirana	Tandallan	3.95	3,273	67		21	444			532	16%
Kirana	Wasuana	6.87	4,328	98			377			475	11%
Pindi		6.86	5,410	343	18	160	308			829	15%
TOTAL		580.27	505,638	4541	3563	3791	33686	281	446	46309	9%

Explanation of terminology used in salinity surveys

(1) Thur Kohna - Ultra alkaline or Non Saline Alkali soils. Never cultivated saline land since the advent of canal irrigation. High in salt content & alkanolity or low salt content & high alkali.

(2) Thur Punjsala - Highly saline or saline alkali soils. Lands excluded from cultivated for more than 5 years due to salinity. Advance stage of deterioration. pH is 9.0 to 10.0

(3) Thur Nau - Highly saline or saline alkali soils. Lands excluded from cultivation within 5 years due to salinity. These are mostly saline alkali soils in the northern part of the Indus plains

(4) Thur Jozvi - Saline or saline alkali. Saline lands under cultivation bearing visible patches of salts to the extent of above high salinity in patches & alkalinity show progressively increasing

(5) Thur Tirk - Lands where salts present in root zone hamper opening of cotton balls. Accumulation of salts is well below in the root zone & salts are not visible over the soil surface

Source: DLR

Table D-11 Environmental Management Plan (1/2)

Item	Activity / Parameter	Measures to be taken	Timing	Execution	Super vison	Related Institution
1. Land requirements						
1.1 Fixing of Right of Way & Clearing						
(a)	Translate Land Plans to ground	Inform public of project and the requirement of the R-O-W	Detail design stage	P.O. /CE	PID	
(b)	Removal of farmer encroachers	Inform farmers not to cultivate next season and to move out of R-O-W	One season before construction	CE	PID	
(c)	Removal of other encroachers	Notice to move out of reservation and give any support necessary	One year before construction	CE	PID	Commissioner
(d)	Removal of other structures	Instruct encroachers to find alternate accomadation	One year before construction	CE	PID	Commissioner
1.2 Private Land required for construction						
(a)	Land for diversion canals	(i) Negotiate compensation for useage on crop loss basis & damages	Before construction	P.O. / CE	PID	
		(ii) Land to be returned in simmilar condition as original	Within 3 months of completion	CE	PID	
(b)	Land for borrow areas	(i) Negotiate compensation on the basis of purchase of land	One year before construction	CE	PID	
	(If required from outside the	(The land not to be an environmental hazard after construction)				
	reservation only)	(ii) If all posible negotiations fail to acquire under Acquistion Act	18 months required for activity	CE	PID	LAC/DC
(c)	Land for water supply schemes	Negotiate to purchase land or on failing only to acquire	Detail design stage	PHED	PHED	LAC/DC
2. Restoration of equitable water rights						
(a)	Shortage of water towards the tail	Equitible distribution of water to all to be made by design and	Detail design	P.O.	PIDA	
		institutional changes. Redistribution of 'lost water'	With implementation of FO	PIDA	Consultant	Ag. Dept.
3. Institutional changes						
(a)	Taking over of canals by FO	Training of farmers in all aspects of canal maintenance	Before and after formation of FO	PIDA	PIDA	
(b)	Improved canal maintenance	Training of farmers and FO employees	After formation of FO	Consultant	PIDA	
(c)	Allowing FOs to undertake other	Dessimation of information	After formation of FO and this	PIDA	PIDA	
	activities including marketing		to be a continous process			
4. Farmers income and living standards						
(a)	Improved cropping pattern	Introduction of proper farming systems	After construction	FO/Ag. Dp.		
(b)	Higher disposable income	Monitoring of agricultural and socio economic conditions	Regularly after construction	Consultant	PIDA	P&D/Ag. Dp.
		Periodic evaluation	Every 2 years after construction	Consultant	PIDA	P&D/Ag. Dp.

Environmental Management Plan (2/2)

Item	Activity / Parameter	Measures to be taken	Timing	Execution	Super-vison	Related Institution
5. Canalside plantations						
	(a) Removal of plantations	Follow procedure to obtain permission from Chief Minister	9 months before construction	P.O./CE/CF	F/D	Chief Minister
	(b) Replanting	Reforestation of full width of ROW, tree selection by Forset Dept.	After construction	F/D, FO	PIDA	FO
	(c) Handing over plantation to FO	FO to maintain plantations	After handing over of canals to FO	PIDA/FO	PIDA	FD
6. Drinking water supply						
	(a) Shortage of drinking water due to seepage not reaching Tube wells	(i) Provide drinking water to affected population	During construction	CE	PID	Commissioner
		(ii) Provide new schemes to replace affected ones	Construction period	PHED	PHED	PHED
	(b) Loss of quality of drinking water	(i) Where canal water is used, it should be treated and supplied	During water scheme construction	PHED	PHED	PHED
		(ii) Monitoring of drinking water quality	During and after construction	Consultant	PHED	
7. Impediment to Livestock						
	(a) Reduction of Livestock crossings	Provision of livestock crossings at suitable locations	Detail design	PID	PID	FO
	(b) Elimination of bathing in canal	Provision of sufficient number of ponds on watercourses	Discuss with FO for locations	PID	PID/Ag. Dp	FO/Ag. Dept.
8. Groundwater table						
	Changes of water table	Monitor ground water table at observation wells	June and October	PID/WAPDA	PIDA	WAPDA
		Monitor reduction of seepage from canals lined in the saline zone	After construction	IRI	PIDA	
9. Groundwater quality						
	(a) Increase use of agro chemicals	Introduction of proper farming systems to reduce water pollution	After construction	Ag. Dp./ FO	Ag. Dept.	
	(b) Changes in water quality	Monitor water quality with baseline data of Study	After construction annually	Consultant	PIDA	
10. Water quantity						
	(a) Loss by seepage to saline zone	Monitor quantities available	After construction	PIDA	PIDA	FO
	(b) Excess use of water at head	Monitoring programmes to de deveolped	After construction	PIDA	PIDA	FO
11. Soil salanisation						
	(a) Use of saline water for irrigation	Discourage use of saline water by providing additional saved water	After construction	PIDA	PIDA	Ag. Dept.
	(b) Insufficient water for leaching	Provide an allocation of saved water for leaching and reclamation	After construction	PIDA	PIDA	DLR/PIDA

Table D-12 Environmental Monitoring Plan

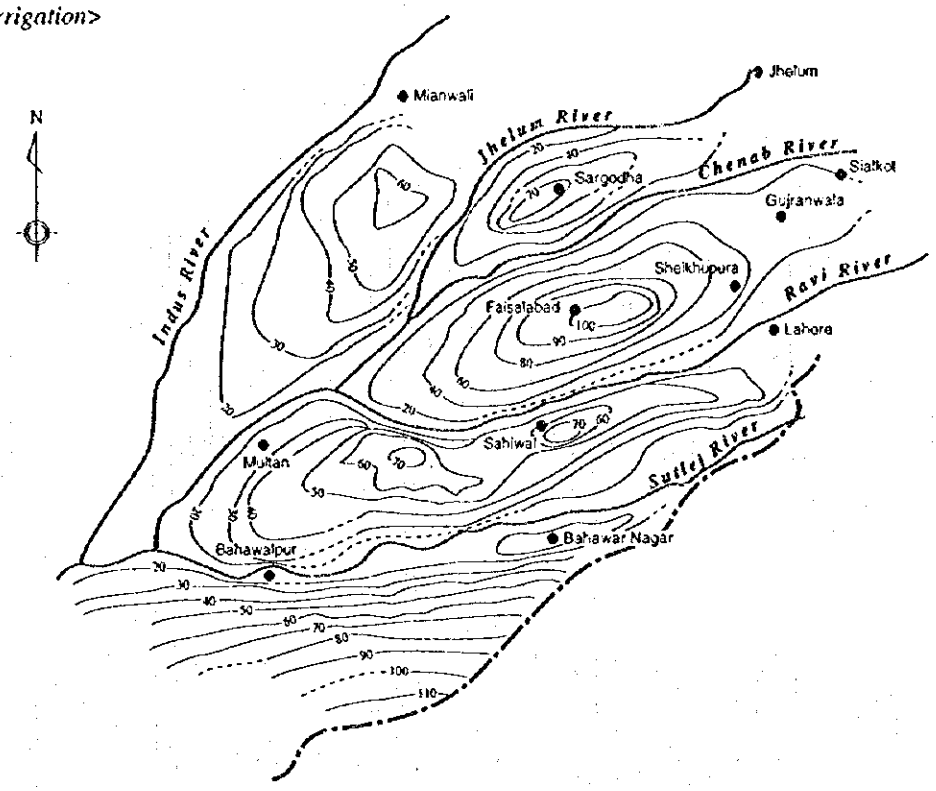
Description of Impact	Environmental issue	Methodology	Sampling regime	Frequency	Monitoring agency	Related Institution
1. Deterioration of Water quality						
(A) Drinking Water						
	(a) Drinking water quality	Direct observation /Sampling	pH, Odour, Colour, Taste,Turbidity,TDS Ca, Mg, Na, SO4, Cl,Hardness,Alkalinity E. Coli, Coliform on sampling locations fixed for baseline data in study	Half yearly	Consultant/PHED	PHED
	(b) Availability of drinking water	Interviews	Inspection	Monthly during construction	PIDA/PHED	PHED
(B) Ground Water						
	(a) Ground water quality	Direct observation /Sampling	pH, EC, Na, Ca, Mg, K, CO3, HCO3, Cl, SO4, NO3, on same locations	Yearly	IRI	WAPDA
	(b) Loss of aquifer potential due to reduced recharge	Solute transport modelling		Once	Consultant/PIDA	
	(c) Salanisation of fresh water zones due to saline water intrusion	Solute transport modelling / Observation		Once	Consultant/PIDA	
	(d) Farming practice /Agro chemical use	Interviews / observations		Yearly	PIDA	Agri. Dp.
2. Changes in Water table						
	(a) Water table depth	Direct observation	Water table depth at observation wells	June and October	SMO/WAPDA	
	(b) Ground water extraction by tube wells	Direct observation	Numbers operating and pumpage	Half yearly	PIDA	Agri. Dp.
3. Soil Salanisation						
	(a) Surface salinity	Direct observation	pH, EC, Na, Ca, Mg, K, CO3, HCO3	Yearly	DLR	IRI/Agri. Dp.
4. Increase in availbility of canal irrigation water						
	(a) Reduction in seepage	Direct observation	Seepage volume on selected canals	Yearly	IRI	
5. Restoration of equal water rights						
	(a) Ensuring availability of fair share of water	Direct observation / interviews	Quantity of water received	Half yearly	Consultant/PIDA	FO
6. Farmers living standards						
	(a) Socio - economic conditions	Data collection /interview	Disposable income	Two years	Consultant/PIDA	FO
7. Others						
	(a) Water related diseases	Data collection	Number treated in hospitals for water related diseases	Yearly	PIDA	Health Dp.
	(b) Issues raised by local people	Interviews	Any constraints	Quarterly	PIDA	
	(c) Other issues	As required	As required	When required	PIDA	

Table D-13 DRINKING WATER QUALITY SAMPLING LOCATIONS FIXED FOR MONITORING

No.	Canal	Distributory	Minor	Chak	House owner	Source
1	CBDC	Thaman		Jevan Singh	Sagir Ahmad s/o Rahim Khan	Hand Pump
2	CBDC	Chhina		Haveli Jhangraweli	Muhammad Khalil s/o Insyat	Hand Pump
3	CBDC	Chhina	Kala Minor	Kot Chhaju Khan	Muhammad Ishaq s/o Shabir Khan	Hand Pump
4	CBDC	Chhina	Kala Minor	Kot Chhaju Khan	Amjad Ali s/o Chango Khan	Donkey Pump
5	LCC	Pir Mahal	Megneja	665/6	Ghulam Sarwar s/o Sultan Ali	Hand Pump
6	LCC	Pir Mahal	Junejwala	681-22 GB	Sardar Ali s/o Sher Muhammad	Hand Pump
7	LCC	Pir Mahal	Megneja	688-28, Darbar Baba Akbar	Muhammad Boota s/o Sube Khan Muhammad	Hand Pump
8	LCC	Kilianwala		445/GB, Naiabadi	Muhammad Akram s/o Muhammad Yousaf	Donkey Pump
9	LCC	Kilianwala		458/GB, Jhok Manak	Ali sher s/o Lal Muhammad	Hand Pump
10	LCC	Kilianwala		441/GB, Sadanwala	Haji Naamat Ali Shah s/o Muhammad Ishaq	Hand Pump
11	LCC	Nasrana		81/JB, Pindori	Haji Muhammad Ragi s/o Wali Mohammad	Donkey Pump
12	LCC	Nasrana	Narwala Minor	67/JB, Sidhan	Abdul Ghafoor s/o Muhammad Ismail	Hand Pump
13	LCC	Nasrana	Doomra	87/JB, Gobindair	Nazir Ahamad s/o Allah Buckash	Donley Pump
14	LCC	Gojra		366/JB,Didapur	Muhammad Sardar s/o Ghulam Muhammad	Hand Pump
15	LCC	Janiwala		162/GB	Muhammad Rafiqque s/o Taj Din	Hand Pump
16	LCC	Janiwala	Amirwala	152/JB, Jite	Muhammad Akram s/o Ghulam Muhammad	Donkey pump
17	LCC	Mungi		245/JB, Talwandi	Abdul Sattar s/o Muhammad Yaqub	Hand Pump
18	LCC	Nasrana		51/JB, Sajjadwala	Muhammad Yoonis s/o Hussain Buckash	Hand Pump
19	LCC	Sarangwala		107/JB, Paharang	Ghulam Muhammad s/o Rahim Buckhash	Hand Pump
20	LJC	Kirana		137/SB	Muhammad Khan s/o Mehtab Khan	Hand Pump
21	LJC	Kirana		25/SB	Ihsan -ul Haq s/o Ch. Muhammad Ali	Hand Pump
22	LJC	Kirana	Malkana	104/SB	Muhammad Saleem ex councillor	Hand Pump
23	LJC	Kirana	Wasuana	114/SB, Wasan Wala	Syad Abid s/o Syad Anwar Abbas	Hand Pump
24	LJC	Kirana	Rodion	121/SB, Pathanwala	Muhammad Aslam s/o Fazal Din Muhammad	Hand Pump
25	LJC	Pindi		91/NB	Haji Rahim Din s/o Sharif Din	Hand Pump
26	LJC	Dherma		68/NB	Muhammad Mumtaz s/o Rana Bogga	Hand Pump
27	LJC	Hujjan		Lillani	Hafiz Shams-ud-Din s/o Ghulam Nabi Gondal	Hand Pump
28	LJC	Hujjan	Kot Momin	Kot Momin	Hotie of Muhammad Asia s/o Ahamad Ali	Hand Pump
29	LJC	Hujjan	M'wala	Maraulian Wala	Allah Ditta s/o Bahadar Khan	Hand Pump
30	LJC	Hujjan	Jaspal	16/SB	Muhammad Asghar s/o Allh Ditta	Hand Pump

FIGURES

< Pre Irrigation>



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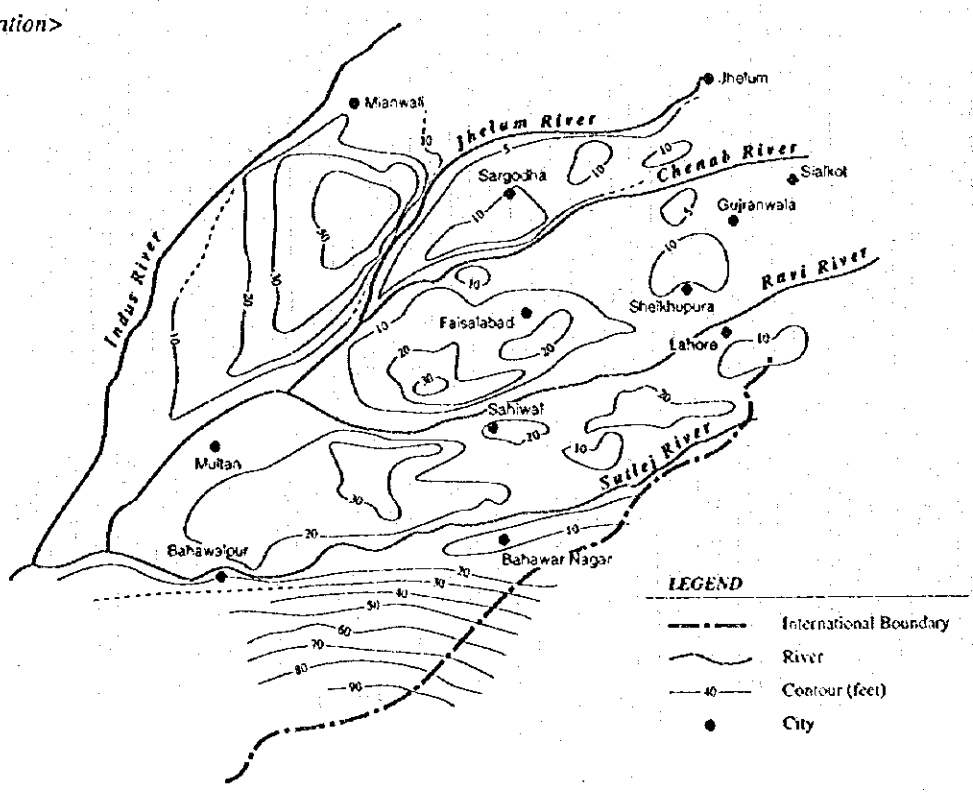


Fig. D-1 Ground Water Depth Contours for Pre Irrigation and Post Irrigation Period (1960) in Punjab

Source: Ground Water Resources of Pakistan - Dr. Nazir Ahmad

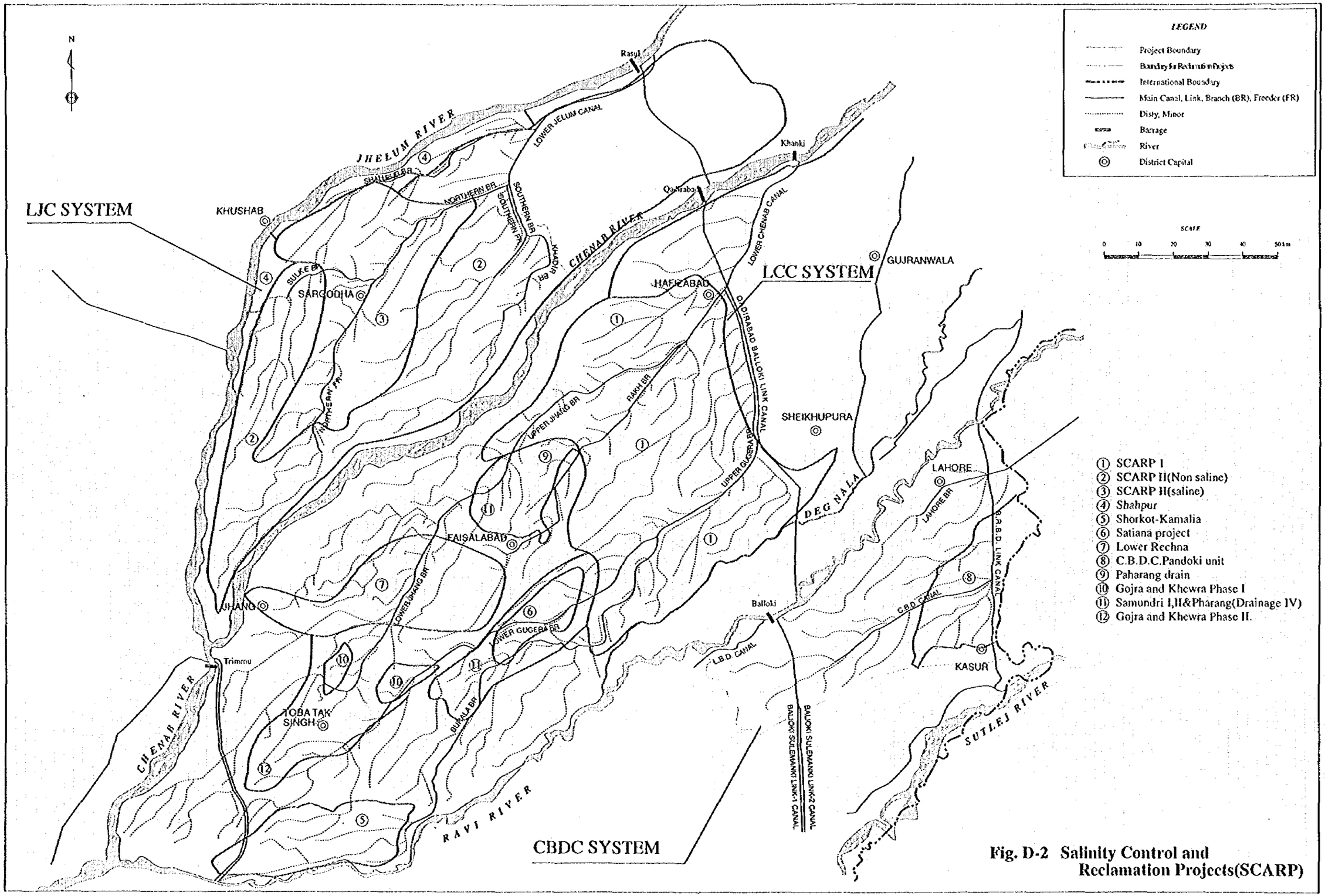


Fig. D-2 Salinity Control and Reclamation Projects(SCARP)

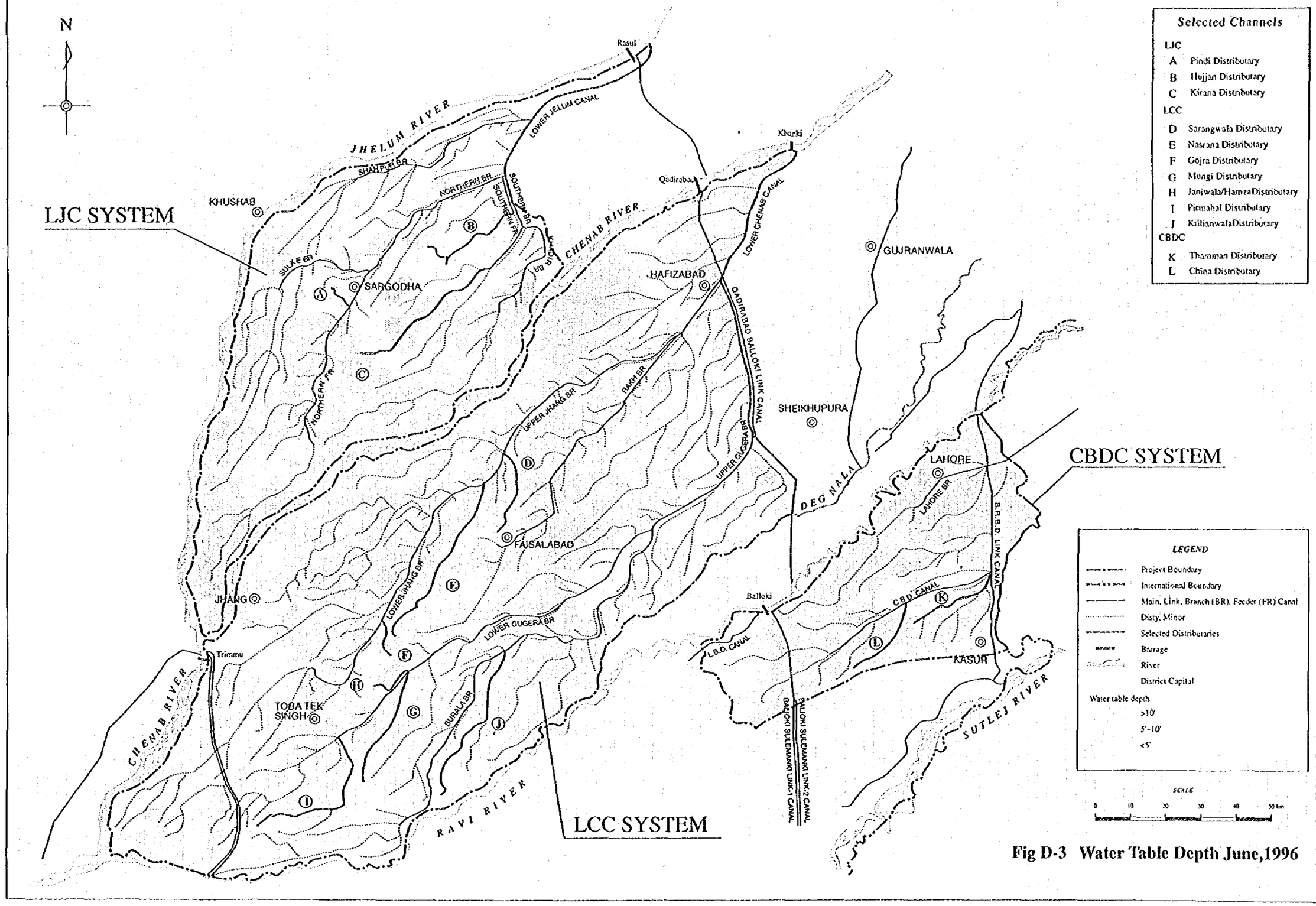


Fig D-3 Water Table Depth June,1996

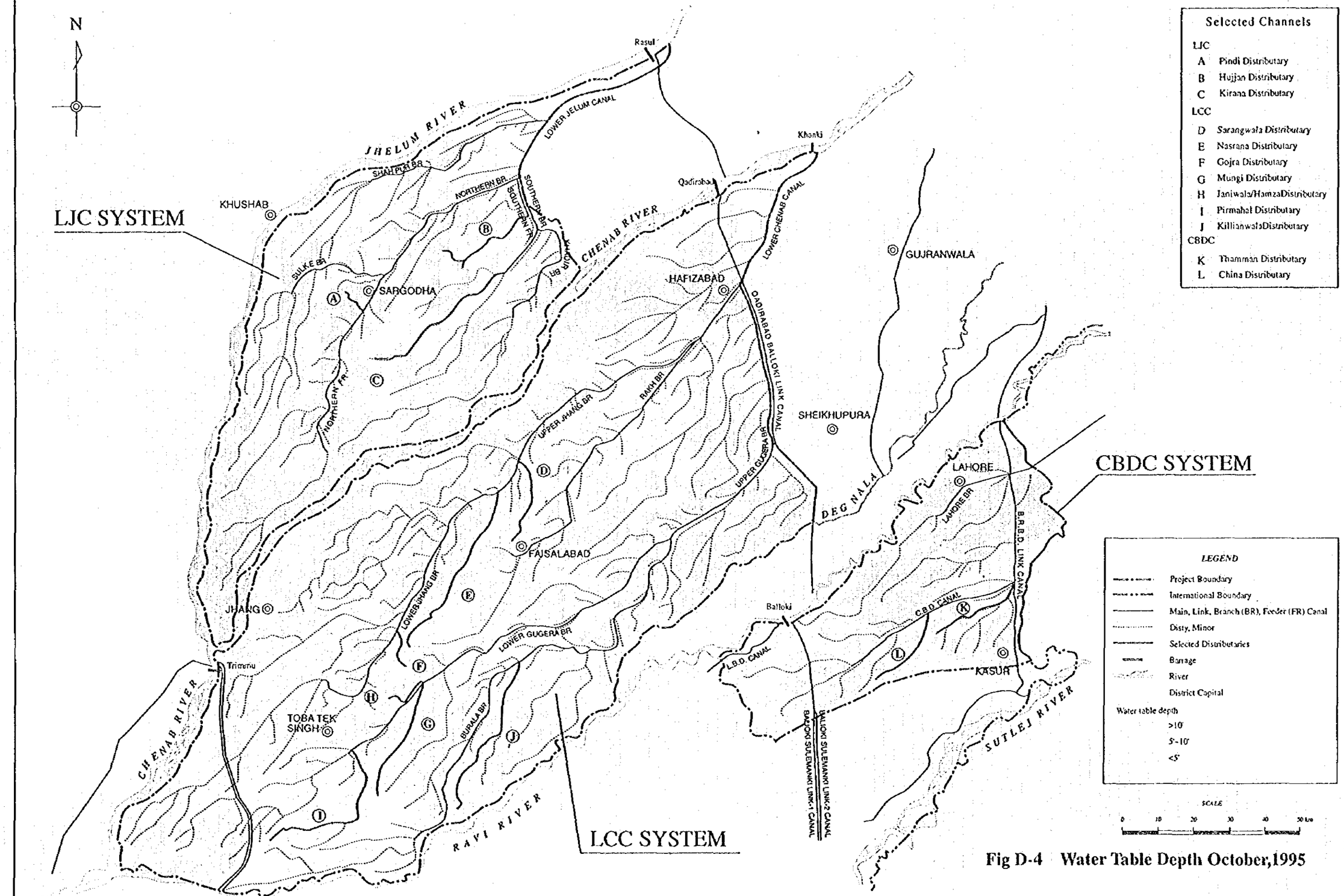


Fig D-4 Water Table Depth October,1995

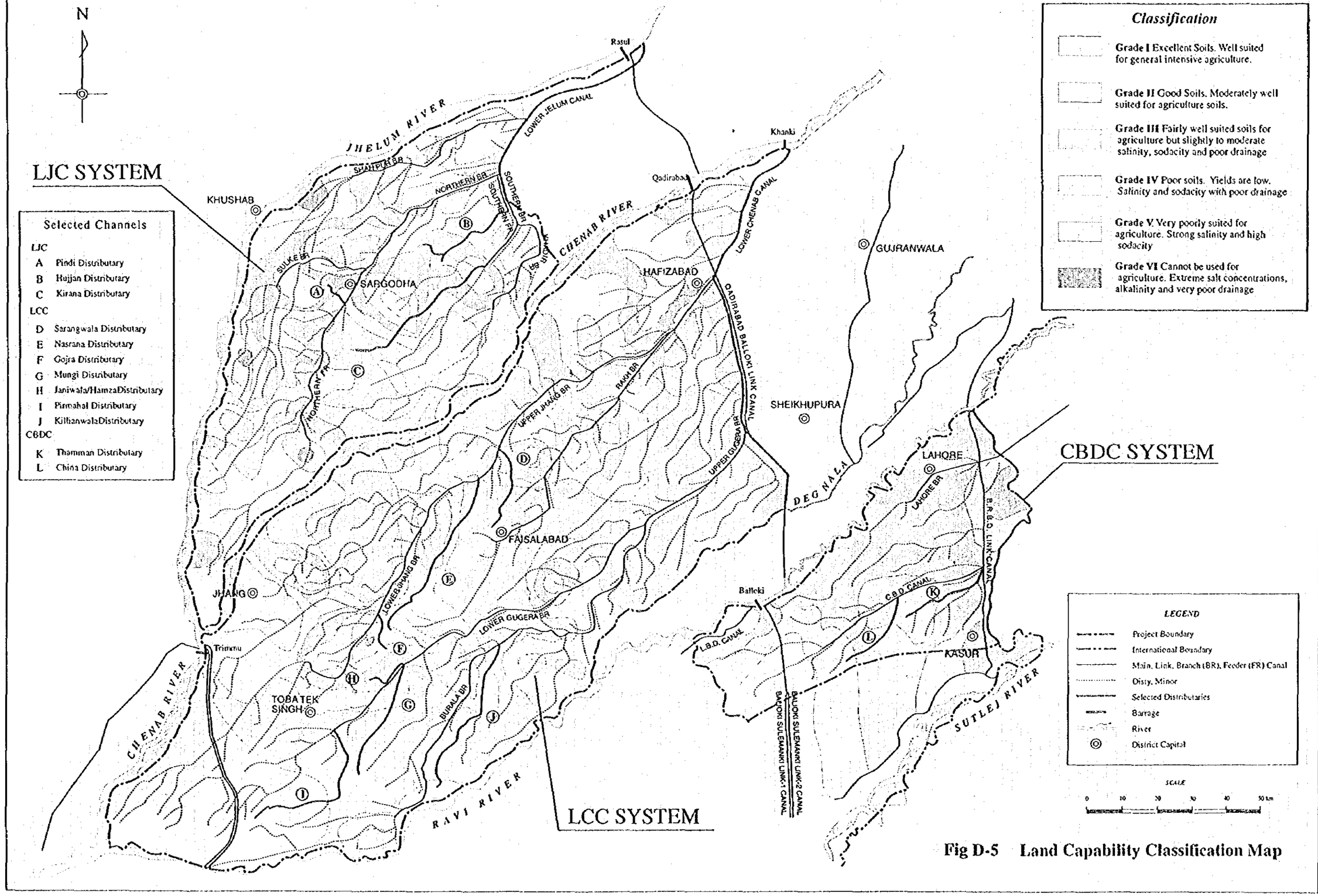


Fig D-5 Land Capability Classification Map

Fig. D-6 Water Quality Classification

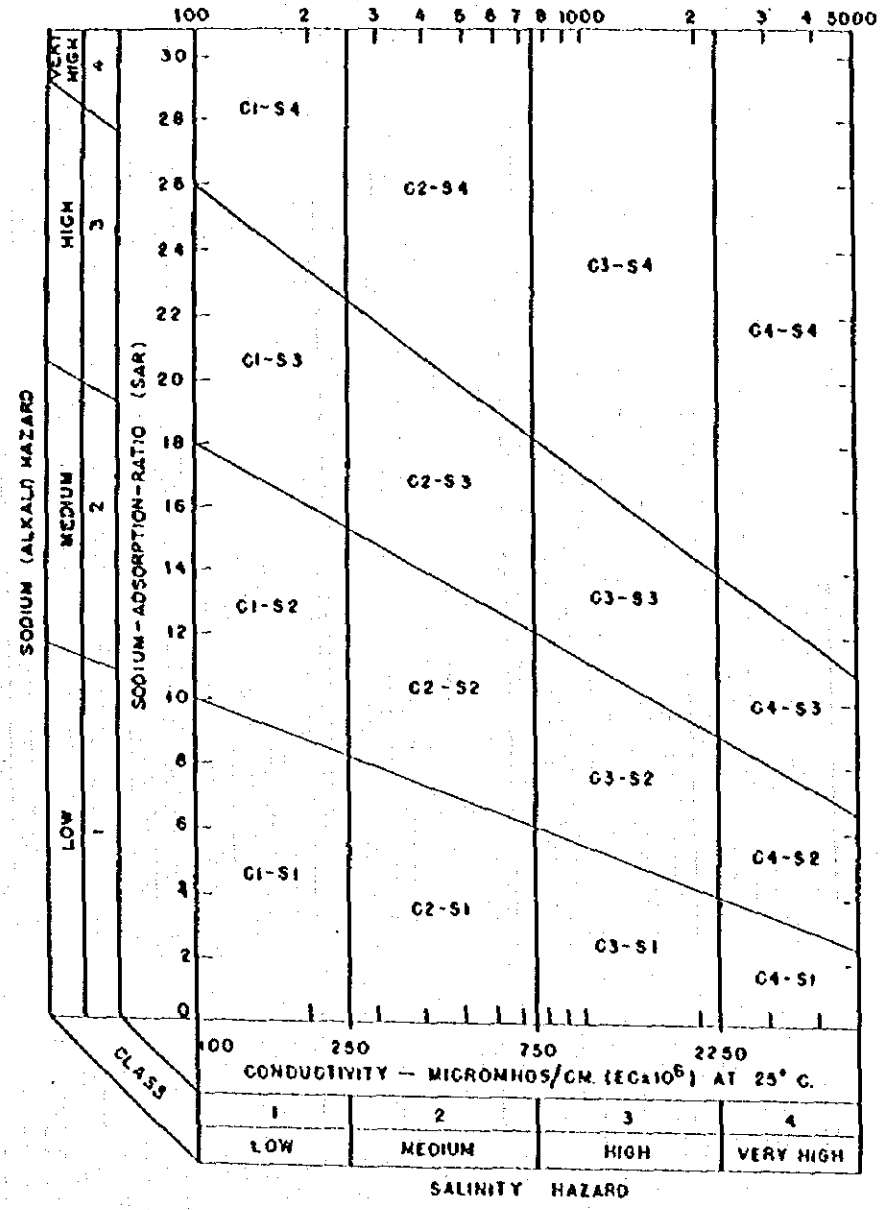


Diagram for the classification of irrigation waters. (U.S. Salinity Laboratory Staff 1954)

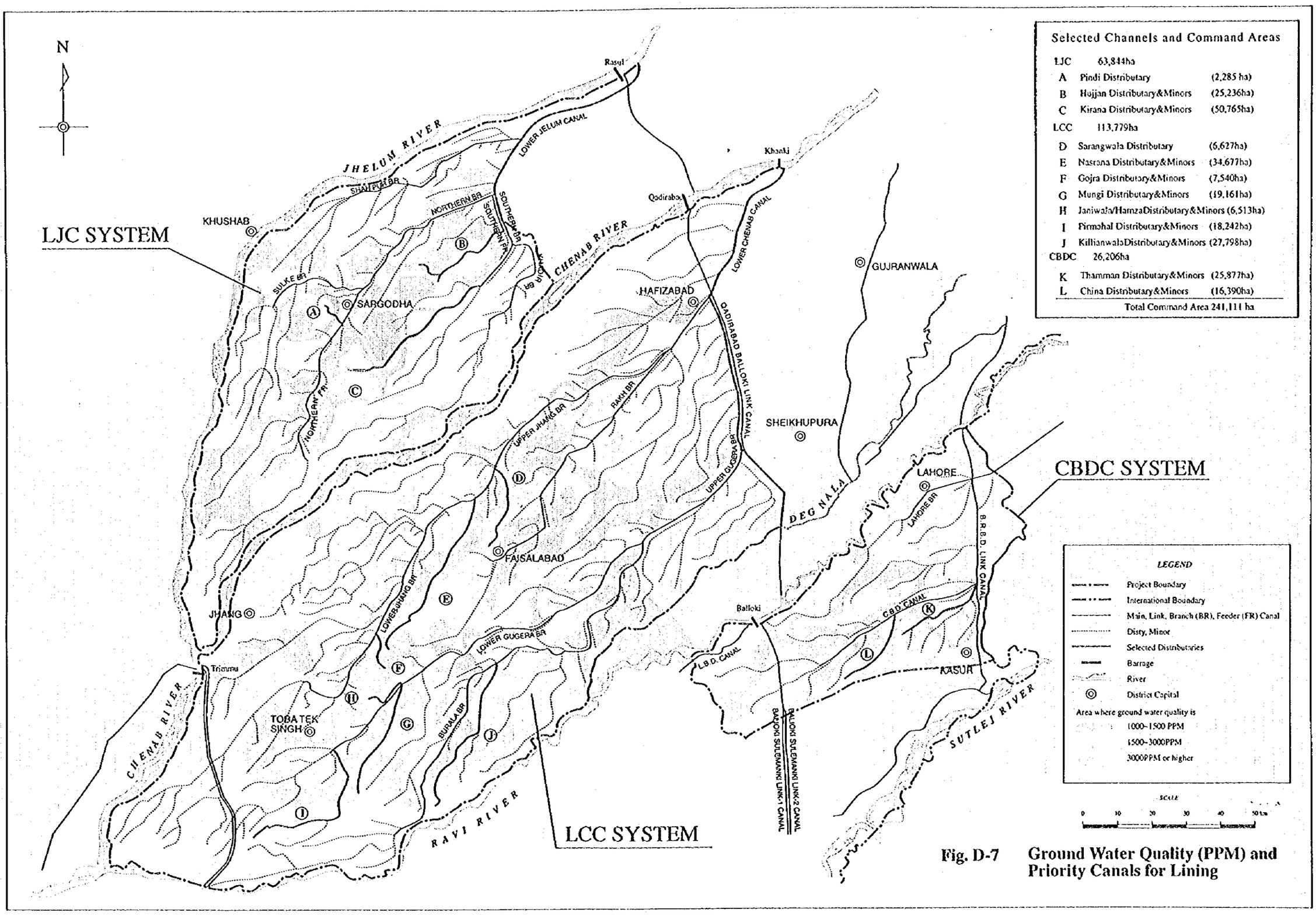
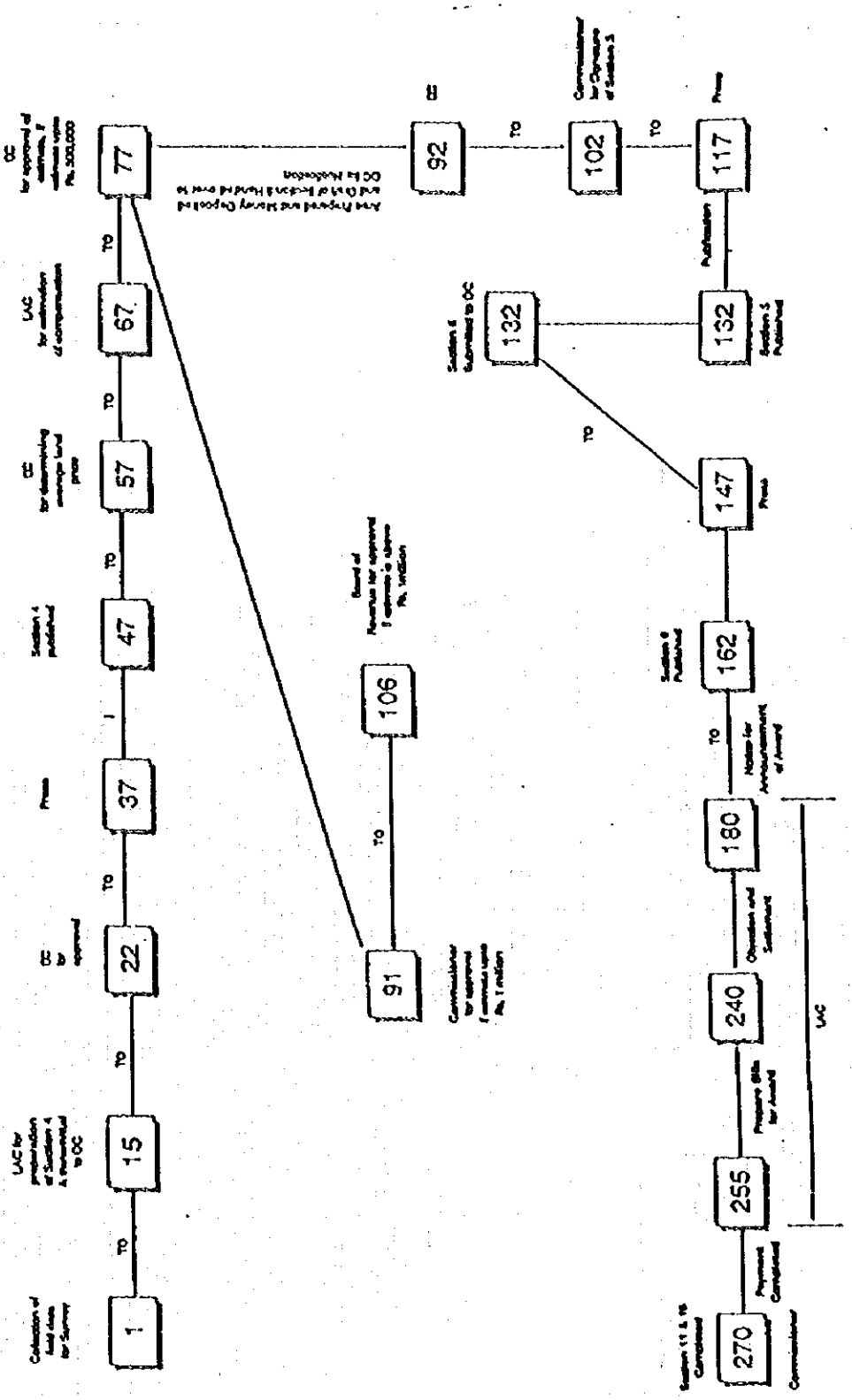


Fig. D-7 Ground Water Quality (PPM) and Priority Canals for Lining

Fig. D-8 Flow Chart for Land Acquisitioning Activities

(Figures inside ☐ indicate Calendar Days)



ATTACHMENTS

Attachment I

C.M's Directive
Top Priority

NO. NO. SO FT(EX-I) VI I I-9/93
GOVERNMENT OF THE PUNJAB
FORESTRY, WILDLIFE, FISHERIES, TOURISM
AND YOUTH AFFAIRS DEPARTMENT

Dated Lahore the 26th July, 1994.

Mr. Muhammad Akram Malik,
Secretary,
Government of the Punjab,
Forestry, Wildlife, Fisheries, Tourism
and Youth Affairs Department.

To

1. All the Chief Conservators of Forests in Punjab.
2. Director General, Murree Kahuta Development Authority, Rawalpindi.
3. All the Conservators of Forests in Punjab.
4. All the Divisional Forests Officers in Punjab.

SUBJECT:- BAN ON TREE CUTTING.

The Chief Minister Punjab has ordered a total ban on tree cutting/sale/fellings in all Canalside Plantations, Roadside Plantations and entire M.K.D.A. area including Guzara Forests.

2. Any violation would attract severe action.

3. Please convey instructions personally to your subordinate officers both in writing and verbally.

(MUHAMMAD AKRAM MALIK)
SECRETARY

NO. & DATE EVEN.

A copy is forwarded to the Secretary, Implementation and Coordination, SGA&I Department for similar necessary action in respect of all Canalside or compact Plantation not yet handed over to the Forest Department.

DA - 1

Technical Specification
for
Soil Survey

1. Objectives

The main objectives of the Soil Survey and Analysis are to identify major soil groups, grasp their characteristics, demarcate the saline soil area and cross-check the existing soil map covering the existing irrigation area for the Study on the Lining of Distributaries and Minors in Punjab. The data and information are fully incorporated in establishment of the development framework of the Project.

2. Survey Area

The survey area is located in the Lower Chenab Canal System, Lower Jhelum Canal System and C. B. D. Canal System in Punjab province, which is approximately 23,500km^2 (Command Area). All the survey area will be indicated by the JICA study team.

3. Plan of operation

1) Type of works : Soil sampling
(350 sites)

: Soil analysis
1 sample per 1 sampling site
(350 samples)

2) Items of test

These samples should be taken by the Contractor at the pits specified by the JICA Study Team. The analysis shall be performed in accordance with the methods specified in the following standards or their equivalents as approved by the JICA Team.

Item	Method/Remarks
Soil Texture	Hydrometer method
pH (1 : 2.5 H_2O)	Glass electrode method for 1:2.5 soil water suspension
pH (1 : 2.5 KCl) 1N KCl pH of saturated paste	Glass electrode method for 1:2.5 soil KCl suspension
EC (1 : 5) EC (saturated extract)	Electric conductivity meter method for extracts from saturated soil pastes and 1:5 soil-water mixtures
Total Nitrogen	Micro-Kjeldhl method (converting Nitrogen to NH_4 by Kjeldhl digestion, and measuring the amount of NH_4 by back titration after addition of acid solution)
Organic Carbon	Walkley-Black method
Available Phosphorous	Olsen method
Cation Exchange Capacity (CEC)	N-ammonium acetate centrifuge method at pH 7.0
Exchangeable Ca	Sodium Nitrate extraction method
Exchangeable Mg	Sodium Nitrate extraction method
Exchangeable Na	Flame-photometer method with leaching extraction by N-ammonium acetate
Exchangeable K	Flame-photometer method with leaching extraction by N-ammonium acetate
Anions: NO_3, Cl, SO_4	Ion exchange spectrophotometer method
Anions: CO_3, HCO_3	Alk:meq method
ESP, RSC & SAR	By calculation
Boron	Selected samples

4. Outputs to be Submitted

The Contractor shall submit reports on analysis of survey data consisting of :

(a) Procedure and performance of survey
(b) Report concerning soil classification, present land use, saline soil area, water logging area, and land capability including soil chemical analysis.
(c) Present land use map, soil map and land capability map (all maps including sampling spots)

5. Work period

All the works shall be completed during two (2) months

APPENDIX - A

Technical Specification for Water Quality Test

1. Objective

The objectives of the water quality test are to assess the suitability of water in the existing wells, canals, drains and rivers for irrigation use. The results are fully incorporated in establishment of the development framework of the Project.

2. Sampling Sites

The survey area is located in the Lower Chenab Canal System, Lower Jhelum Canal System and C. B. D. Canal System in Punjab province, which is approximately 23,500km^2 (Command Area). All the survey area will be indicated by the JICA study team. All the sampling areas will be indicated by the JICA study team.

3. Survey Items

1)Type of works	: Water Sampling and Analysis
2) Number of water samples	: seven hundred (700) samples
3) Items of test	: water temperature, water level pH Electric conductivity (EC) Suspended solids (SS) Total dissolved solids (TDS) Chemical analysis - Cations (Ca, Mg, Na, K) - Anions (CO_3, HCO_3, Cl, SO_4, NO_3)

4. Plan of Operation

The survey works shall be carried out by full-use of technical knowledge of the Contractor under the supervision and frequent monitoring of the JICA Study Team.

(1) The works comprise (i) preparatory work, (ii) sampling, (iii) laboratory test, and (iv) data analysis. The Contractor shall be responsible for the employment of field surveyors, arrangement of accommodation, transportation and others which may be required for execution of the works.

(2) The sampling sites will be indicated by JICA Study Team.

5. Outputs to be Submitted

The Contractor shall submit the Report on the water quality test including the procedure and performance of survey, location map of samplings, and results and analysis of water quality test.

6. Cost estimation

The estimated costs shall be deemed to cover all the costs necessary for completion of the Water Quality Analysis. The Contractor is requested to show the unit cost (per sample) and the breakdown of the estimated costs.

7. Work period

All the works shall be completed during two (2) months of April through June 1996.

APPENDIX - A

Technical Specification for Drinking Water Quality Test

1. Objective

The objectives of water quality analysis are to assess the suitability of water in the existing wells, canals, drains and rivers for irrigation use for the Study on the Lining of Distributaries and Minors in Punjab. The data and information are fully incorporated in establishment of the development framework of the Project.

2. Sampling Sites

The survey area is located in the Lower Chenab Canal System, Lower Jhelum Canal System and C. B. D. Canal System in Punjab province, which is approximately 23,500km^2 (Command Area). All the survey area will be indicated by the JICA study team. All the sampling areas will be indicated by the JICA study team.

3. Survey Items

1)Type of works	: Drinking Water Sampling and Analysis
2) Number of water samples	: thirty (30) samples
3) Items of test	: water temperature, water level, color, odour, taste, turbidity pH Electric conductivity (EC) Suspended solids (SS) Total dissolved solids (TDS) Chemical analysis - Cations (Ca, Mg, Na, K) - Anions (CO_3, HCO_3, Cl, SO_4, NO_3) DO, COD, BOD Coliform count, E. Coli

4. Plan of Operation

The survey works shall be carried out by full-use of technical knowledge of the Contractor under the supervision and frequent monitoring of the JICA Study Team.

(1) The analysis works comprise (i) preparatory work, (ii) sampling, and (iii) data analysis. The Contractor shall be responsible for employment of field surveyors, arrangement of accommodation and transportation required for the survey work.

(2) The sampling sites will be selected by JICA Study Team.

5. Outputs to be Submitted

The Contractor shall submit the Report resulting of analysis of water samples consisting of procedure and performance of survey, location map of samples and results of analysis of samples

6. Cost estimation

The estimated costs shall be deemed to cover all the costs necessary for completion of the Water Quality Analysis. The Contractor is requested to show the unit cost (per sample) and the breakdown of the estimated costs.

7. Work period

All the works shall be completed in one and half (1.5) months.