

INDIA

MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

DEPARTMENT OF AREA DEVELOPMENT
STATE GOVERNMENT OF UTTAR PRADESH

**FEASIBILITY STUDY
ON
IRRIGATION AND DRAINAGE
DEVELOPMENT OF
SHARDA CANAL CAD PROJECT**

VOLUME II - 1

ANNEXES


NOVEMBER 1991

Japan International Cooperation Agency

INDIA
FEASIBILITY STUDY ON
IRRIGATION AND DRAINAGE DEVELOPMENT OF
SHARDA CANAL CAD PROJECT

VOLUME II - 1
ANNEXES

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ABBREVIATIONS

BOR	Board of Revenue, UP
CAD	Command Area Development
CADA	Command Area Development Authority
CCA	Culturable Command Area
CGWB	Central Ground Water Board
FAO	Food and Agriculture Organization, United Nations
GDP	Gross Domestic Product
GNP	Gross National Product
GOI	Government of India
GOJ	Government of Japan
GSI	Geological Survey of India (Central)
GWB	Ground Water Board
GWD	Ground Water Department
ID	Irrigation Department, UP
IMD	India Meteorological Department (Central)
IWC	Irrigation Work Circle
JICA	Japan International Cooperation Agency
OFD	On-Farm Development
RSAC	Remote Sensing Application Center, UP
SI	Survey of India
UNDP	United Nation Development Programme
UP	Uttar Pradesh
USDA	United States, Department of Agriculture

ABBREVIATIONS OF MEASUREMENT

Length

cm	=	Centimeter
m	=	Meter
km	=	Kilometer
ft	=	Foot
yd	=	Yard

Area

cm ²	=	sq.cm	=	Square centimeter
m ²	=	sq.m	=	Square meter
ha	=		=	Hectare
km ²	=	sq.km	=	Square kilometer

Volume

cm ³	=	cu.cm	=	Cubic centimeter
l	=	lit	=	liter
kl	=		=	Kiloliter
m ³	=	cu.m	=	Cubic meter
gal.	=		=	Gallon
MCM	=		=	Million Cubic Meters

Weight

mg	=	Milligram
g	=	Gram
kg	=	Kilogram
ton	=	Metric ton
lb	=	Pound

Time

sec	=	s	=	Second
min	=		=	Minute
hr	=		=	Hour
d	=		=	Day
yr	=		=	Year

Electrical Measures

V	=	Volt
A	=	Ampere
Hz	=	Hertz (cycle)
W	=	Watt
kW	=	Kilowatt
MW	=	Megawatt
GW	=	Gigawatt

Other Measures

%	=	Percent
PS	=	Horsepower
°	=	Degree
'	=	Minute
"	=	Second
°C	=	Degree centigrade
10 ³	=	Thousand
10 ⁵	=	Lakh
10 ⁶	=	Million
10 ⁷	=	Crore
10 ⁹	=	Billion (milliard)

Derived Measures

m ³ /s	=	m ³ /sec	=	Cubic meter per second
cusec	=		=	Cubic feet per second
mgd	=		=	Million gallon per day
kWh	=		=	Kilowatt hour
MWh	=		=	Megawatt hour
GWh	=		=	Gigawatt hour
kWh/yr	=		=	Kilowatt hour per year
kVA	=		=	Kilovolt ampere
BTU	=		=	British thermal unit

Money

Rs.	=	Indian Rupees
US\$	=	US dollar
Yen	=	Japanese Yen

CONVERSION FACTORS

	From Metric System		To Metric System	
Length	1 cm	=	0.394 inch	
	1 m	=	3.28 ft = 1.094 yd	
	1 km	=	0.621 mile	
				1 inch = 2.54 cm
				1 ft = 30.48 cm
			1 yd = 91.44 cm	
			1 mile = 8 furlongs	
			= 5,280 feet	
			= 1.609 km	
			1 furlong = 201.17 m	
Area	1 cm ²	=	0.155 sq.in	
	1 m ²	=	10.76 sq.ft.	
	1 ha	=	2.471 acres	
	1 km ²	=	0.386 sq.mile	
			1 sq.ft = 0.0929 m ²	
			1 sq.yd = 0.835 m ²	
			1 acre = 0.4047 ha	
			1 sq.mile = 2.59 km ²	
Volume	1 cm ³	=	0.0610 cu.in	
	1 lit	=	0.220 gal. (imp.)	
	1 kl	=	6.29 barrels	
	1 m ³	=	35.3 cu.ft	
	10 ⁶ m ³	=	811 acre-ft	
			1 cu.ft = 28.32 lit	
			1 cu.yd = 0.765 m ³	
			1 gal. (imp.) = 4.55 lit	
			1 gal. (US) = 3.79 lit	
			1 acre-ft = 1,233.5 m ³	
Energy	1 kWh	=	3,413 BTU	
			1 BTU = 0.293 Wh	
Temperature	°C	=	(°F-32) 5/9	
			°F = 1.8°C + 32	
Derived Measures				
	1 m ³ /s	=	35.3 cusec	
	1 kg/cm ²	=	14.2 psi	
	1 ton/ha	=	891 lb/acre	
	10 ⁶ m ³	=	810.7 acre-ft	
	1 m ³ /s	=	19.0 mgd	
			1 cusec = 0.0283 m ³ /s	
			1 psi = 0.703 kg/cm ²	
			1 lb/acre = 1.12 kg/ha	
			1 acre-ft = 1,233.5 m ³	
			1 mgd = 0.0526 m ³ /s	

ANNEX-A
METEOROLOGY AND
HYDROLOGY

FEASIBILITY STUDY ON
IRRIGATION AND DRAINAGE IMPROVEMENT OF
SHARDA CANAL CAD PROJECT

ANNEX - A
METEOROLOGY AND HYDROLOGY

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ANNEX-A METEOROLOGY AND HYDROLOGY

1. Introduction

The objective of meteorological and hydro logical study is the compilation of meteorological data and assessment of surface water resources for the use in the agricultural study, irrigation water demand study, flood damage study, water supply and demand balance analysis and other engineering studies.

In Chapter 2, general characteristics of weather in Uttar Pradesh were mentioned. Agro-climatic season and weather in relation to crops were described in particular.

In Chapter 3, general climate of the Sharda Canal Command Area was discussed in relation with general climatic characteristics of India with special attention to agro-climate. Rainfall characteristics in the Sharda Canal Command Area were also analyzed in this Chapter.

In Chapter 4, characteristics of water sources of the Sharda Canal Irrigation System were described. Outline, discharge characteristics, probable discharge both in terms of flood and availability (low flow) were discussed. Availability of water from ponds/lakes was examined and water quality of those sources were checked and discussed as well.

In Chapter 5, hydrological condition and characteristics of the Sharda Canal Command Area were described. A hydrologic model was introduced for explaining hydrological characteristics and/or constraints for the four Representative Areas, viz., Sarojini Nagar Study Area in Lucknow District, Sataon Study Area in Rae Bareli District, Sursa Study Area in Hardoi District and Purwa Study Area in Unnao District.

Balance of water demand and supply for the Sharda Main Canal System was examined using actual discharge record of latest five years not only for the total volume but also weekly distribution of water. Some operational losses were pointed out and countermeasures were also discussed. Simulation of water balance under with-project condition and without-project condition were examined and potential of water sources of the Sharda Canal Command Area including ground water was estimated.

2. General - Season and Weather of Uttar Pradesh State -

2.1 Season

From agricultural point of view, the year is divided into two seasons, Rabi and Kharif. Nominally, Rabi starts on 1st of October and ends on 31st March while Kharif starts on 1st of April and ends on 30th September. Actually, of course, there is overlapping of crops of the two seasons to an appreciable extent.

Kharif crops are sown from early June to early July depending on rainfall. Kharif season opens earliest in the eastern part of the state and progresses westward as the monsoon advances. The harvest, however, matures earlier in the western parts and later in the eastern parts as dry season comes earlier in the former. As the monsoon recedes, western parts becomes ready earlier for Rabi sowing which is carried out from late September to November. The harvesting of Rabi crops takes place from March to April.

Sugarcane, the most important cash crop of the state is an year round crop and covers both seasons. It is sown from February to March and harvested from November to March next year. A variety of sugarcane is also sown in October but it is not widely planted.

2.2 Weather in Relation to Crops

The annual average rainfall in the plains varies from about 25 cms in south western parts to about 150 cms in the sub-Himalayan belt. Almost 75% or more of this rainfall is concentrated during the monsoon months, the balance occurring during the winter. There is thus no arid part of the state which may be wholly dependent on artificial irrigation. From the cultivator's point of view, the distribution of rainfall is more important than its total annual magnitude. Rainfall at the wrong time may actually do a great deal of harm. The ideal weather conditions of two seasons are described below:

(1) Kharif

There should be some rainfall at the end of May or the beginning of June so that ploughing can be started as soon as possible. Heavier rainfall is required later in June to get the land thoroughly wetted, followed by a period of fine weather for tillage and sowing.

During July and August, there should be considerable rain broken by bright intervals lasting not more than seven to ten days at a stretch. Similar weather with lesser rainfall is

required in September for Kharif crops. A few showers at the end of September are, however, essential for the preparation of land for Rabi.

In areas where late rice is sown this distribution is slightly modified. Generally more rain and less sunshine are required. A very heavy rainfall is necessary towards the end of July for transplantation. August and September should be wet and rainfall in early October would also be required.

(2) Rabi

Assuming that September rainfall has left sufficient moisture in the soil, the next requirement is that the air should cool down rapidly so that the soil temperature falls to that suitable for Rabi germination. This takes place when the sky is clear and there is a steady west wind. During November and early December weather should remain clear and get steadily cooler. About the middle of December a light fall of rain is beneficial. A second fall is desirable in the first half of January and a further light fall in February will benefit the crops. It is extremely important that winter rain should be broken by clear weather as continuously drizzling or cloudy weather results in wide spread plant diseases. The rest of the season should be dry and free from hailstorms. In March the west wind should blow steadily to ripen the grains but should not be too strong otherwise they would not attain their maximum size and weight. As soon as Rabi crops are threshed, rainfall will again be good for young sugarcane plants and for preparation of land for Kharif.

(3) Effect of abnormal or scanty rainfall

Kharif crops can usually stand up to three weeks of dry weather without very serious damage. The actual duration would vary with the type of crop, type of soil, moisture present in the soil at the beginning of the dry spell, preparation of field and maturing. Excessive rain is most harmful just after sowing and when the crop is flowering. In the middle of the season it is generally not particularly harmful to Kharif crops.

The most serious danger for Rabi crops is that the soil may be too dry for sowing as a result of a dry and hot September. "Paleo" irrigation (i.e. irrigation of a field prior to the sowing of a crop) is then the only means of preparing land for sowing. With all the irrigation facilities available, Rabi crops are not likely to be good in such an year. Without the extensive irrigation facilities available it would result in famine. On the other hand, continuation of rainfall late into November may also be harmful as it delays Rabi sowing and may make it too late for the sowing of some of the crops.

The effect of failure of winter rains is not so serious. Yield is reduced in all areas but total failure would result in dry higher lands only. Rainfall soon after germination is undesirable as it weakens plant growth. Continuous drizzling or cloudy weather in December, January, is harmful as it leads to wide spread plant diseases, particularly "rust" which attacks wheat grain.

Premature dry winds or too strong winds shrivel up the grain and reduce yield. Frost usually occurs in early January and is not very harmful except for arhar, poppy and tobacco, while gram and a few other crops may also suffer to some extent. A late frost in late January or early February may however cause widespread damage. This is, fortunately not a destruction of the crop after the grain has formed. Usually, the occurrence of a hail storm is localized and though causing considerable local distress, is seldom a wide spread calamity.

3. Meteorology

3.1 Data

3.1.1 Rainfall Data

Several kinds of Rainfall data in/around Sharda Canal Command were collected during Phase I and II Field Work. Rainfall data of eleven Districts viz., Nainital, Pilibhit, Bareilly, Shahjahanpur, Kheri, Hardoi, Sitapur, Barabanki, Unnao, Lucknow and Rae Bareilly were collected. Additionally, rainfall data of five more districts adjacent to the Command Area were collected. They were Pithoragarh, Pratapgarh, Faizabad, Sultanpur and Allahabad. The former consists of daily, monthly data for 25 years and monthly normal which is average monthly rainfall of latest 50 years, while the latter is composed of only normal rainfall.

Rainfall data of major observatories in UP which are distributed three to five numbers per District are compiled by Board of Revenue, UP in Lucknow. Some other Departments keep their own observatories for specific purposes and they can be utilized as well. Contents of rainfall data are shown in Table A.1.

3.1.2 Meteorological Data

Meteorological data are observed and compiled by India Meteorological Department(IMD). In the Sharda Command Area, IMD has three meteorological observatories, i.e., Lucknow, Shahjahanpur and Hardoi. Data from Kanpur which is located

closely in the west of Unnao can be used to represent climatic conditions of lower and western reach of the Command Area. These data were collected for period of 1986 to 1990.

Meteorological data are composed of temperature(maximum, minimum, average), relative humidity(-do -), wind speed, wind direction, sunshine hours and evaporation. Data of sunshine hours themselves are available only for Lucknow. Oktas which expresses cloudiness by eight degrees are observed in place of sunshine hours in other observatories. Evaporation data are available only for Lucknow too. However evapotranspiration can be estimated by some empirical equations such as Penman Method, Braney-Criddle Method, etc. which are introduced in FAO Irrigation and Drainage Paper No.24, "Crop Water Requirement". These estimated evapotranspiration will be used to calculate water requirements for irrigation. Contents of meteorological data are summarized in Table A.2.

3.2 Climate in the Sharda Canal Command Area

The State of UP lies under semi-arid climate zone of semi-tropical area, characterized by four distinctive season as follows;

- i) dry winter season from January to February,
- ii) comparatively dry but hot season from March to May,
- iii) monsoon season from June to September, and
- iv) post monsoon season from October to December.

No major difference by place is seen in climate of the Sharda Command Area as a whole. The climatic characteristics are mentioned below.

January is usually the coldest month of the year when atmospheric temperature goes below 10°C. Then the minimum temperature gradually rises up to 25 to 27°C in May, and then is stabilized till September, which means that heat balance between atmosphere and soil is kept stable during these five months.

The maximum temperature rises over 40°C in May, the hottest month of the year. Also the variation of temperature in a day is the biggest in this month which causes the lowest relative humidity of 20% and the maximum wind speed of 4 to 5 m/sec which forms dry and dusty condition of the Area. Such a low relative humidity is caused by low content of soil moisture, which is almost exhausted by evaporation during long dry season.

According to the soil survey conducted on fallow land during the first Field Work period (1990 October), a surface layer up to 80cm showed dried-up condition, which explains that almost all the capillary water in the root zone is evaporated during dry season.

In June, rainfall begins to grow and relative humidity goes up accordingly, which suppress the maximum temperature. During cold season, north-westerly wind prevails, on the other hand, easterly winds prevail during the hottest season. Annual evaporation in Lucknow is about 1,500mm which is 1.5 to 2 times as much as annual rainfall. Average minimum evaporation of 1 to 2 mm/day is observed in January to February, and average maximum evaporation of 9mm/day is observed in April to May. Climatic information of the past 4 to 5 years at 4 stations is shown in Table A.3 and illustrated in Fig. A.1 and Fig. A.2.

3.3 Rainfall

3.3.1 Rainfall Characteristics

In India rainfall is generally erratic and ill distributed. About 70% of annual rainfall in most part of the country is provided by southeast monsoon. The normal rainfall in/around the Sharda Command Area is shown in Table A.4 and Fig. A.3. The maximum annual rainfall in the Area is 1,556 mm observed in Nainital, while the minimum is 838 mm in Unnao.

Generally, rainfall in the Area is concentratedly distributed in Kharif up to 90% of annual rainfall. The peak of rainfall distribution is seen in July and August in which 60% annual rainfall is observed. Such a concentrated distribution of rainfall brings about difficulty for irrigation practice and achieving high crop intensity, in other words, productivity. The minimum rainfall of the year is observed in April and November.

Total rainfall by season is summarized in Table A.5. According to this table, dry/wet season and its probability can be known. Also dependable rainfall by season calculated by Thomas Method is tabulated in Table A.6.

Since the Sharda Canal has vast command area, rainfall distribution is different by location. Table A.7 shows drought year by district for latest 25 years. 1965 Kharif, 1968/69 Rabi and 1987 Kharif are considered the most severe drought years when both rainfall over the Area and discharge of the Sharda River are insufficient. 1972 Kharif, 1972/73 Rabi, 1975 Rabi, 1979 Kharif and 1984/85 Rabi are also drought years in view of rainfall on to the Area.

3.3.2 Rainfall Intensity

(1) Probable rainfall

Considering provision of proper drainage system or flood control system, assessment of rainstorm which is expressed by some parameters such as rainfall intensity, depth-duration curve, etc is indispensable. Using rainfall data collected in this Study, probable maximum rainfall of 1 in 5 year and 1 in 10 year by duration were calculated by Thomas Method which is popular method for determining probable rainfall by normal distribution. Results related to four Representative Areas are as follows:

<u>24 hours rainfall</u>	<u>1 in 5 year (80%)</u>	<u>1 in 10 year (90%)</u>
Hardoi (Sursa Area)	158 mm	200 mm
Lucknow(Sarojini Nagar Area)	120 mm	148 mm
Purwa(Purwa Area)	140 mm	167 mm
Rae Bareli(Sataon Area)	160 mm	205 mm

<u>48 hours rainfall</u>	<u>1 in 5 year (80%)</u>	<u>1 in 10 year (90%)</u>
Hardoi (Sursa Area)	210 mm	265 mm
Lucknow(Sarojini Nagar Area)	165 mm	210 mm
Purwa(Purwa Area)	200 mm	228 mm
Rae Bareli(Sataon Area)	270 mm	350 mm

<u>72 hours rainfall</u>	<u>1 in 5 year (80%)</u>	<u>1 in 10 year (90%)</u>
Hardoi (Sursa Area)	250 mm	310 mm
Lucknow(Sarojini Nagar Area)	207 mm	260 mm
Purwa(Purwa Area)	220 mm	275 mm
Rae Bareli(Sataon Area)	270 mm	350 mm

(2) Rainfall Intensity

Maximum t-hour rainfall can be estimated by Sherman's equation using 24-hour rainfall:

$$R_t = R_T (t/T)^k$$

- where, R_t : maximum t-hour rainfall
 R_T : Maximum T-hour rainfall as standard. Here, 24-hour maximum rainfall is adopted.
 k : constant, normally 0.5 is adopted.

According to this formulae, t-hour rainfall in mm for the Study Areas was calculated as shown below:

	Hardoi	Lucknow	Purwa	Rae Bareli
1 hour	32 (41)	24 (30)	29 (34)	33 (42)
4 hour	65 (82)	49 (60)	57 (68)	65 (84)
12 hour	112 (141)	85 (105)	99 (118)	113 (148)
24 hour	158 (200)	120 (148)	140 (167)	160 (205)

Remarks: 1 in 5 year(1 in 10 year) unit; mm

4. Hydrology

4.1 Data

4.1.1 Sharda River

Discharge data of the Sharda River at Banbassa were collected during Field Work. Measurement of river discharge is conducted by Irrigation Department of UP every day. Daily discharge is calculated to weekly average which is utilized as basis of rostering. Accordingly, probable discharge for irrigation planning is obtained by week.

In this Study, weekly discharge from 1960 to 1990 and daily discharge from 1986 to 1990 were collected from Irrigation Department.

4.1.2 Other Rivers

The Sai River and the Loni Nadi ("Nadi" means small rivers or big drains in Hindi) are major rivers in the Study Areas other than the Sharda River. The Sai River is the main drainage river covering Districts in the south from Hardoi.

The Sai River flows near Sursa Study Area, Sarojini Nagar Study Area and Sataon Study Area. There are a few gauging stations along the Sai River. The first one is located at Auras in northern Unnao District operated by Irrigation Department from 1985. The second and the third station are located in Rae Bareli and in Jaunpur both of which are under control of Central Water Commission (CWC).

The Loni river flows near Purwa Study Area as the main drainage river. There is a gauging station operated by Irrigation Department in Peralipur in Rae Bareli District.

Daily discharge data of the Sai River at Auras were collected during this Study covering six years from 1985, while discharge data of Peralipur were collected for four years from 1987 for the Loni Nadi. Discharge data for stations under CWC Have not been obtained. Some probability analysis was reported by Irrigation Department as "Hydrological Report of Sai River" (1983) in which ten-day discharge from 1971 to 1980 at Rae Bareli and Jaunpur are available. These data can be used for estimating available water and flood in conjunction with discharge data at Auras.

4.2 Sharda River Discharge

4.2.1 Outline of the Sharda River

The Sharda River flows down along the international boundary of India and Nepal, and irrigation water is diverted for the Sharda Canal Irrigation System at Banbassa Headworks in Nainital District. Catchment area of the Sharda River at Banbassa is 14,960 km², half of which is located in Nepal. The Sharda River originates from the Himalayan Range and joins the Ghaghara River in the east of Sitapur.

4.2.2 Discharge Characteristics

Annual distribution of discharge from the Sharda River resembles annual rainfall distribution. The peak discharge is recorded in August. Average weekly discharge of the past 30 years at Banbassa is illustrated in Fig. A.4. The Sharda River discharges most of annual discharge within four months from July to October. The average discharge is 20,000 cusec (566 cumec) and the base flow is estimated 4,500 cusec (127 cumec) from the lowest discharge recorded in February. Fluctuation of annual discharge by year is shown in Fig.A.5. Tendency of fluctuation is similar to dry/wet year by rainfall distribution. As for recent Kharif seasons, year of 1987 and 1989 were drought years of 1 in 33 years and 1 in 7 years respectively. On the other hand, year of 1988 was wet year of 1 in 7 years. In Rabi

season, 1987/88 was drought year of 1 in 10 years and 1985/86 was wet year of 1 in 44 years. Probability of actual discharge from 1960 to 1990 by season is summarized in Table A.8.

4.2.3 Probable Discharge

In India, 75% probable discharge (dependable discharge in three years out of four years) is regarded as "available water" (proposed discharge) for irrigation planning. As for the Sharda Canal Project, irrigation water distribution schedule i.e., Roster which is revised every year by Irrigation Department of UP is based on 75% probable discharge calculated from observed discharges of latest 10 years.

75% probable discharge calculated by Thomas Method based on weekly discharge data from 1960 to 1990 and proposed discharge mentioned in Roster are compared in Fig. A.6. Judging from the results, the peak discharge of Roster is a bit bigger than calculated value, but almost coincides in dry season. It can be said that the proposed discharge (available water) mentioned in Roster is proper as a whole.

4.3 Other River Discharge

4.3.1 Outline of Other Rivers

(1) Sai River

The Sai River is one of the major tributaries of the Gomti River. It originates near the adjoining boundaries of Kheri and Hardoi District. It travels in District of Hardoi, Unnao, Lucknow, Rae Bareli, Pratapgarh and Jaunpur. Total length of the river is 760km and the catchment area of the basin is 12,850 km² at the confluence in the Gomti River covering 14 blocks fully and 50 blocks partially. Because of gentle topography of the basin, the river course meanders and frequent floods hit the surrounding area.

(2) Loni Nadi

Total length of Loni Nadi is 156km. It originates near Makhi in Unnao District and joins the Ganges River in Rae Bareli. Total catchment area of the basin comprises 1,180 km². Improvement has been done for some parts by Irrigation Department of UP.

4.3.2 Available Discharge from the Sai River for Irrigation

Available water for irrigation can be estimated by probability analysis of actual discharge. From locational condition, water from the Sai River can be utilized to some extent of Sarojini Nagar Study Area and Sataon Study Area. Catchment area of the Sai River at proposed intake point is 4,030 km² for Sarojini Narga (crossing point of Mohanlalganj-Maurawan Road) and 5,080 km² for Sataon (crossing point of Gurbuxganj-Bachhiowan Road).

Dependable low flow at these two points can be interpolated from those at Auras (CA=1,950 km²) for which discharge data of six years from 1985 to 1990 are available and Rae Bareli (CA=6,201 km²), for which 75% (3 in 4 years) dependable discharge for 1971 to 1980 is available. As for low flow at Auras, the minimum of five years can be regarded as 75% to 80% dependable low flow. Table A.10 shows approximate low flow of 75% to 80% at Sarojini Nagar and Sataon which is interpolated proportionally to catchment area. Judging from the results, the lowest low flow of 75 to 80% dependability is about 2 cumec at Sarojini Nagar and Sataon Study Area.

4.3.3 Flood Discharges

Flood discharge of the Sai River can be estimated from Table A.9 where the maximum flow during 1985 to 1990 is listed for Sarojini Nagar and Sataon Study Area. The maximum flow is usually recorded in September and October when discharges of 150 to 200 cumec were observed at Auras. Proportionally to the catchment area at Sarojini Nagar and Sataon, flood discharge there can be extrapolated to be 400 to 500 cumec.

The Loni Nadi has only one gauging station at Peralipur which started measurement in 1985 only and actual discharge data are available from 1987. Out of four years from 1987 up to 1990, the maximum flow (101 cumec) was recorded in August of 1990. Maximum discharges in cumec by month are written below:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.8	7.6	3.8	3.7	1.5	12.9	54.3	101.0	69.1	16.0	4.3	4.4

4.4 Other Water Sources for Irrigation - Lakes and Ponds -

(1) Applicability

Other than irrigation water from canal, ground water, and river water, possibility of development of supplemental water resources were re-examined. Water from lakes or natural ponds has been utilized by place where the above-mentioned irrigation facilities are not available.

Generally, irrigation by water of lakes/ponds is conducted in small scale because of; their i)low dependability, ii)uneasiness of application. Quantity of available water depends on rainfall itself, which leaves this kind of irrigation unreliable and supplemental.

Lakes/ponds are normally formed along perished river course or in depression and their water depth is shallow. The edge of surface of water moves continuously according to weather condition, and suction point is not stable, which brings about uneasiness of application of irrigation.

(2) Limitation of development

Water from lakes and ponds can be applied to certain extent. As mentioned before, 90% of annual rainfall is observed during rainy season(June to September). On the other hand, annual evaporation comes 1.5 to 2 times of annual rainfall, out of which 60% is observed in dry season, viz., from October to May. Potential evaporation rate (ETO) estimated by Modified Penman Method is 1,500mm to 1,600mm in Sharda Command Area, of which 900 mm is estimated to be evaporated by beginning of next rainy season. Seepage rate from lakes/ponds is 500 mm/year which is adopted by Ground Water Department UP in course of estimation of ground water recharge. Seepage from lakes/ponds during dry season (8 months) is thus estimated 300mm. As a result, standing water is estimated to be reduced by 1,200mm during dry season. If water depth of a pond at the beginning of dry season is more than 1,200mm, the pond is supposed to be perennial.

Accordingly, total volume of water below 1.2 m deep can be regarded as supplemental water source. Further extraction of water will damage ecological balance and should not be done. Topographic survey is required to estimate this volume and irrigated area. From qualitative point of view, water from lakes/ponds is applicable for irrigation use both in terms of salinity and alkalinity.

(3) Utilization of lakes/ponds water in Representative Areas

Irrigated area and other features about lakes/ponds irrigation are mentioned in Milan Khasra of 1989/90, which are summarized below:

Study Area	Irrigated Area by Lakes/Ponds (ha)	Total Irrigated Area (ha)	Area of Lakes & Ponds (ha)	No. of Lakes & Ponds (nos.)
Sarojini Nagar	483	13,117	102	116
Sataon	601	9,934	450	48
Sursa	139	15,313	411	350
Purwa	534	10,355	460	115

Irrigated Area by lakes/ponds becomes the largest value in Sataon Study Area which suffers from severe shortage of irrigation water. Ratio of Irrigated area to Area of lakes/ponds (herein after I/P ratio) indicates dependency on lakes/ponds as irrigation water source.

In Sarojini Nagar Area, I/P ratio is 4.7 which shows high dependency on water of lakes/ponds, while those of Sataon, Sursa and Purwa are 1.3, 0.3 and 1.2 respectively.

Based on 1 in 50,000 topographical maps, catchment area of lakes/ponds is approximately five times as large as themselves. Rainfall in the Study Areas during dry season is from 700mm to 1,000 mm. If rainfall of 700mm gathers into a pond from catchment of five times as large as the pond, water of 4,200 mm in depth is stored and 1,200 mm is diminished naturally as a loss. Taking application loss of 20% into account, about 2,400mm depth of irrigation water can be utilized from this pond, which is nearly three times as much as irrigation requirement of Rabi crops (400 mm).

Judging from these, proposed irrigated area (P.I.A.) by lakes/ponds is estimated to be six times as large the area as perennial lakes/ponds themselves, which is equivalent to I/P ratio of 6.0 Thus it can be said that possibility of utilization of lakes/ponds water is very low in Sarojini Nagar Study Area. Proposed irrigated area by lakes/ponds in 1990/91 Rabi season is shown below:

Study Area	PIA (ha)
Sarojini Nagar	600
Sataon	2,700
Sursa	2,500
Purwa	2,800

4.5 Water Quality

(1) Adopted criteria

In view of adverse effect of irrigation on crop growth, water quality should be assessed particularly on alkalinity (pH) and salinity indicated by electric conductivity (EC). The tolerance against salinity or alkalinity depends on the soil characteristics with respect to drainage, the cations present in water and soil and also on the crop grown. Water quality can be tested in accordance with the procedures listed in FAO Irrigation and Drainage Paper-29 "Water Quality for Agriculture" which is referred in "The Water Management Manual" by Ministry of Water Resources, GOI. It shows that water whose EC is less than 0.7 micro mho brings about no reduction in crop yield even for the most sensitive crops against salinity.

pH is an indicator of the acidity or basicity of a water, but is seldom a problem by itself. The main use of pH in a water analysis is for detecting an abnormal water. According to the FAO Paper No.29, the normal pH range for irrigation is from 6.5 to 8.4.

(2) Quality of Sharda Canal Water

Water quality of Sharda Canal was checked during Phase I & II Field Work. Results are shown in Table A.10. Average EC is 0.255 mmho and pH is 8.4 both of which can be judged normal value and applicable for irrigation purpose.

(3) Water quality in Representative Areas

During Phase II Field Work, water quality survey was conducted in four Representative Area including river water, pond water and drainage canal water (table in the next page). Ground water quality was also tested by Hydro-geologist, the results of which are compiled in Annex B.

Study Area	Date	Lakes/Ponds		Drainage Canal		Distributary		Sai River	
		pH	EC	pH	EC	pH	EC	pH	EC
Sarojini Nagar	04/02/91	8.5	0.25	8.5	0.51	8.5	0.24	8.8	0.53
Sataon	05/02/91	8.6	0.36	8.3	0.61	8.7*	0.25	8.7	0.54
Sursa	06/02/91	8.6	0.24	8.1	0.81	9.1*	0.21	9.2*	0.36
Purwa	08/02/91	8.6	0.35	8.3	0.61	8.4	0.24	-	-

Remarks: * Stagnant water

Judging from the above, water quality of sources in Study Areas can be said normal to slight alkaline, but applicable for irrigation, excluding stagnant water. In Rabi season, all kinds of water tends to stagnate due to low discharge. Stagnant water is apt to be contaminated by accumulation of toxic ions, which results in high pH. Marginal or small farmers who can not afford wells are forced to utilize these high pH water, which makes their farmland deteriorate with alkaline soils.

5. Water Balance Study

5.1 Basic Conditions

It is indispensable to consider hydrologic balance to clarify the process of water logging or salinity/alkalinity.

Water balance within a certain area is generally composed of water movement on the surface and that below ground level. The former consists of precipitation, irrigation water from canal and natural run-off from upper reach as "Input", and percolation, evapotranspiration and run-off outside the area as "Output". The latter is composed of recharge (deep percolation) and ground water flow inside the area as "Input", and draft of ground water and ground water outflow as "Output".

Figure in next page shows the hydrological balance within a certain segment of land. Each component is explained below:

P: Precipitation

SFin: Surface flow into the area

where, $SFin = NFin + Iin$

NFin: Natural inflow

Iin: Irrigation water supply

SFout: Surface flow outside

where, $SFout = NFout + Dout$

NFout: Natural outflow

Dout: Drainage outside the area

ET: Evapotranspiration

where, $ET = ET0 + ETcrop$

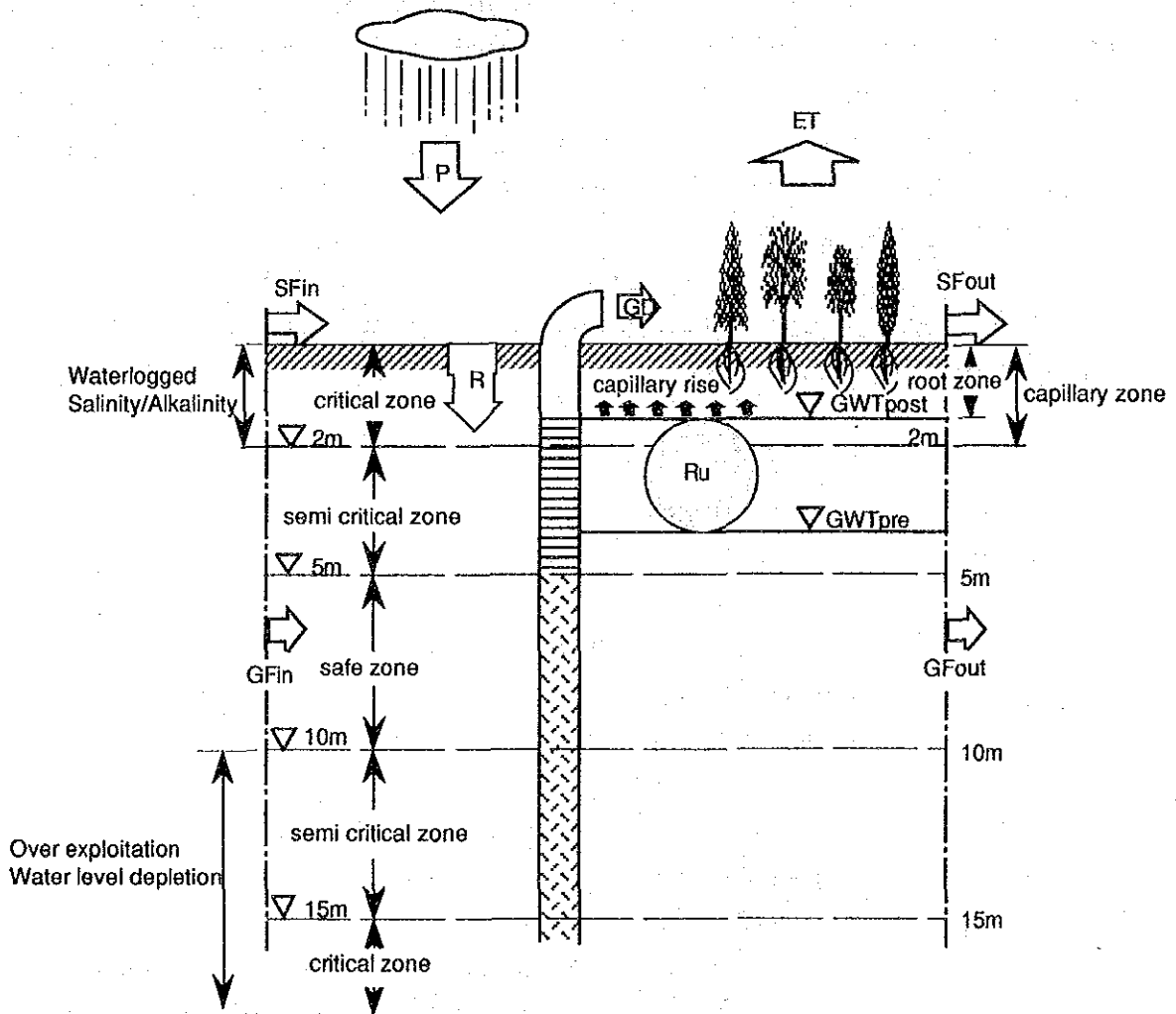
ET0: Evapotranspiration from non-agricultural land

ETcrop: Evaporation from agricultural land or crop
consumptive use

GD: Gross draft of ground water
R: Gross recharge or deep percolation
 where, $R = R_r + R_c + R_i + R_t + R_p$

- R_r : Recharge from rainfall
- R_c : Seepage from irrigation canal
- R_i : Recharge from surface irrigation
- R_t : Recharge from tanks
- R_p : Potential recharge from flood prone area and shallow water table area

GFin Ground water inflow
GFout Ground water outflow
GWTpost Post-monsoon ground water table
GWTpre Pre-monsoon ground water table



According to the hydrologic model mentioned above, present condition of Study Area can be explained and appropriate countermeasures for overcoming constraints against high crop productivity will be given.

As for rainfall (P) and evapotranspiration (ET), difference in the Study Area is not distinguished. Also horizontal movement within shallow aquifer is almost negligible because of flat topography in/around the Area. The present condition or constraints against agricultural development can be clarified through evaluation of rate of ground water exploitation (GD), usable recharge(Ru), surface water inflow(SFin) and surface water outflow (SFout). These parameters have close correlation with soil salinity and "water logging" which means saturated soil condition within root zone by capillary rise from shallow ground water table.

From ecological point of view, shallow ground water table is classified into five zones as follows:

- i) Upper critical zone (0 to 2 m); water logging and/or salinity problem occurs due to capillary rise of ground water,
- ii) Upper semi-critical zone (2 m to 5 m),
- iii) Safe zone (5 m to 10 m); as far as ground water table is maintained within this zone, no water logging and/or salinity problem occurs,
- iv) Lower semi-critical zone (10 m to 15 m), and
- v) Lower critical zone (below 15 m); ground water cannot pumped up even if a pump-set were installed below ground level.

Hydrological characteristics and countermeasures against constraints by Representative Area are mentioned in sub-section 5.3.

5.2 Sharda Canal System

5.2.1 General Features of the Main Canal System

The Sharda Irrigation System covers about 1,600 thousand ha of CCA and proposed irrigation area of 384 thousand ha (24% of CCA) in Kharif and 400 thousand ha (25% of CCA) in Rabi season with the maximum design discharge of 11,500 cusec (325 cumec). The Main Canal diverts water directly to four Branches, four Feeders and two channels along its total length of 43 km. During Kharif season, flows are suitably regulated so as to utilize

an average flow of around 10,000 cusec for irrigation and the balance for filling Sharda Sagar Reservoir. In Rabi season when supplies in river are low, the available supplies in Sharda Sagar, Nanak Sagar and Baigul reservoirs are suitably utilized to regulate the canal system. The Sharda Main System is illustrated in Fig. 7 with location of Representative Areas.

5.2.2 Rostering of Main Canal

In Kharif season, the canal system starts functioning from April to the end of June, the supplies in the river are not sufficient to meet the requirements of Main Canal and the canal system runs with reduced supplies. In this period, no supplies are diverted either to fill Sharda Sagar or to feed the Old Sharda Deoha Feeder. With this adjustment, it becomes possible to meet the requirements at bifurcation point, i.e., tail end of the Main Canal. During the period from the beginning of June to the end of September, the supplies in the river are sufficient to maintain the design flow and satisfy the envisaged requirements.

Rabi season starts from October and the river flows are normally sufficient to maintain design head discharge in Sharda Main Canal up to the third week of October. From the last week of October, river flows are less sufficient but the system is able to run efficiently with the support of additional supplies from Sharda Sagar Reservoir through outlet channel. In the period from November to the end of Rabi, when supplies in the Sharda River is very low, optimal and judicious plans are drawn with the play of following flexibilities.

- i) No supplies are drawn from Main Canal either for feeding Sharda Sagar or serving D.B. Feeder or both, thereby drastically reducing the load on Main Canal.
- ii) Suitable supplies are drawn from Sharda Sagar through outlet channel to serve the areas allocated to Hardoi Branch.
- iii) D.B. Feeder System is served through allocated supplies of Nanak Sagar.
- iv) Shahjahanpur System is suitably supplemented through Baigul Reservoir.

Ultimately, well balanced supplies are maintained in both seasons for the Main Canal System. Similarly, well balanced Rosters are prepared for functioning of Branch systems.

5.2.3 Actual Water Supply of Main Canal System

(1) Main Canal

Total supplied volume through the Main Canal System up to the bifurcation is summarized in Table A.11, where actual supply and proposed supply in Roster are compared for five Kharif seasons and four Rabi seasons. As mentioned before, 1987 Kharif, 1987/88 Rabi and 1989 Kharif season are drought year and actual discharge of the Sharda River did not meet Roster. However the water was extracted sufficiently to the Main Canal in total volume.

Achievement rate of water supply in 1990 Kharif and 1989/90 Rabi are summarized by canal in Table A.12 to Table A.13, where fluctuation of water supply is shown by week. It is noted that actual loss along the Main Canal (shown in Table A.12 (7/8) and Table A.13 (7/8), "Loss up to Bifurcation") is estimated 150% to 300% of the Roster for latest five years, which largely depended on the discharge through Nagra Escape as described later on.

(2) Sharda Sagar Reservoir

Sharda Sagar Reservoir comprises an earthen dam of height 16.15 metres with live capacity of 365MCM which is equivalent to total volume for four weeks of peak discharge of Hardoi Branch in October. In addition to run-off from its own catchment of 127 km², it is also fed from Sharda Main Canal through Old Sharda Sagar Feeder and New Sharda Sagar Feeder.

The water from the reservoir is carried at 13.4 mile (21.4 km) of Hardoi Branch through outlet channel with head discharge capacity of 3,500 cusec. The inflows and outflows from the reservoir are monitored by Irrigation Department of UP according to Roster. Comparison of actual water level of the reservoir and that in Roster for latest three seasons is illustrated in Fig. 8. Storage volume of the reservoir tends to be larger than that in Roster at the end of Roster period due to intensive rainfall on to the catchment. According to actual discharge record of latest five years, Sharda Sagar Reservoir supplied 27% of requirement of Hardoi Branch in Kharif and 23% in Rabi.

Judging from fluctuations of water level from 1985 to 1990 shown in Fig. 9, it can be said that storage capacity of the reservoir is controlled well as a whole.

(3) Nagra Escape

Nagra Escape discharges excessive water of the Main Canal to the Sharda River. Discharge of Nagra Escape is not estimated in Roster and it can be regarded as loss of the Main Canal System. New Sharda Sagar Feeder branches off the Nagra Escape in the north of the Sagar Reservoir. Water to Sagar Reservoir is estimated via Escape when the storage volume is more than that in Roster. This operational loss can be reduced by introducing more effective water management system such as wireless communication system distributing eliminated water to Hardoi Branch from outlet channel of Sagar Reservoir or to Kheri Branch via the Main Canal. Table A.14 shows an example of simulation of re-distributing eliminated water through Nagra Escape to Hardoi and Kheri Branch under condition of 1989/90 Rabi.

The tables in next page show the changes in achievement of water supply against Roster for latest five years in case eliminated water through Nagra Escape is re-distributed to Hardoi and Kheri Branch.

	Nagra Escape (loss %)	Outlet Channel (Actual/Roster %)	Hardoi (max.) (Actual/Roster %)	Kheri (Actual/Roster %)
Kharif				
1986	2.9 → 2.4	114 → 115	103 → 103	98 → 98
1987	2.1 → 0.0	114 → 115	107 → 108	96 → 96
1988	6.9 → 3.4	132 → 150	108 → 111	97 → 102
1989	1.0 → 0.6	110 → 111	N.A. → N.A.	92 → 93
1990	8.6 → 5.4	115 → 129	N.A. → N.A.	N.A. → N.A.
Average	4.5 → 2.4	117 → 124	105 → 107	96 → 97
Rabi				
1985/86	N.A. → N.A.	N.A. → N.A.	N.A. → N.A.	N.A. → N.A.
1986/87	12.3 → 1.0	144 → 192	102 → 115	109 → 138
1987/88	N.A. → N.A.	N.A. → N.A.	N.A. → N.A.	N.A. → N.A.
1988/89	9.7 → 1.5	157 → 200	105 → 117	99 → 111
1989/90	7.3 → 0.3	112 → 143	105 → 113	87 → 99
Average	9.8 → 0.9	138 → 178	104 → 115	98 → 116

Remarks: Calculated based upon Roster and actual discharge records by Irrigation Department of UP

As for Kharif season, no major changes can be seen. However in Rabi season, operational loss on Nagra Escape is reduced by 9% of total discharge of the Main Canal and achievement rates for Hardoi Branch and Kheri Branch are enhanced by 10% and 20% respectively. Needless to say, these saved water can be utilized for other irrigation system as per requirements and capacity of canals.

5.2.4 Simulation of Water Supply of the Sharda Canal

Present irrigation system of the Sharda Canal is not good enough to supply sufficient water for crop growth to tail end of canals. A number of constraints are pointed out in this Study such as malfunctioned irrigation facilities, lack of regulators, conventional inequity on water distribution and so on. Following simulation was conducted in order to clarify present condition and constraints on irrigation system of the Sharda CAD Area.

(1) Irrigation Requirement

Irrigation requirements are calculated based upon crop consumptive use. Procedures of determining irrigation requirements are described in Annex-F. Diversion requirements for the Hardoi Canal System reviewed in this Study (IRrev) and those mentioned in Roster (IRros) are compared below.

	IR rev		IR ros	
	Kharif	Rabi	Kharif	Rabi
1. Hardoi Branch (0 to 53 mile)	1740	1460	1200	790
2. Hardoi Branch (53 mile to tail)	1590	1080	1050	670
3. Lucknow Branch	1260	1100	1130	670
4. Purwa, Unnao, Asiwani Branch	1180	1010	780	500

Remarks: Unit is mm. IRrev was calculated using estimated present irrigation efficiency.

Judging from above table, it can be said that diversion requirements themselves listed in Roster do not satisfy crop consumptive use under present condition of irrigation system, which results in low productivity in the Command Area.

(2) Irrigation Efficiency

Irrigation efficiency was estimated based upon field measurement, discharge record of irrigation canals, reports of other projects and documents widely quoted for irrigation project. Table 16 shows irrigation efficiency of with-project and without-project. Introduction of wireless communication system for water management will improve operation efficiency and conveyance efficiency. Complete or partial lining will enhance conveyance efficiency and modernized facilities and/or on-farm development works will improve application efficiency.

(3) Present Condition

Table A.16 shows present condition of the irrigation system. Actual discharge records of five years by Irrigation Department were used for this simulation. Actual irrigated area (AIA), actual supplied volume (ASV, in other words, actual diverted volume) were calculated to average. According to these figures, field supplied volume (FSV) was estimated. Comparing FSV with field irrigation requirement (FIR), irrigation sufficiency, i.e. achievement rate of water supply against crop water requirements which were estimated based upon crop consumptive use by Modified Penman Method, can be examined. If Irrigation sufficiency is 50%, it means that only half of present irrigated area can be irrigated in full sufficiency.

Irrigation sufficiency for the whole Sharda system is 66% in Kharif and 55% in Rabi. In Kharif season, Hardoi Branch System supplies irrigation water better than Kheri Branch and other systems judging from higher irrigation sufficiency. Actual irrigated area is 80% of proposed area which shows along with irrigation sufficiency that supplied volume covers only 45 to 55% of necessary volume against PIA. Among branch systems under Hardoi Branch, Asiwani Branch and Unnao Branch shows low irrigation sufficiency and low achievement of irrigation area. As a whole, it can be said that lower reach of the system is subject to shortage of irrigation water.

(4) Improved Condition by CAD Works and Wireless Communication System

Table A.17 shows improved condition of the Area by means of on-farm development by CAD (OFD Works), partial lining of Distributary/Minor and introduction of wireless communication system. In Kharif season, irrigation sufficiency will be enhanced up to 100% except Unnao Branch System. Field application efficiency is estimated to increase by 20% by OFD Works, which contributes to the results much. In fact, shortage of water at further farmland from kulabas was observed during field inspection in spite of enough water supply to kulabas. Even in the area after completion of OFD Works, such a condition was seen due to partial lining of watercourse and deterioration of farmland.

In Rabi season shortage of nearly 10% remains at head of the Main Canal and 20 to 30% at head of Branches, which suggests necessity of utilization of other water sources such as ground water. Particularly in Asiwani Branch System, only half of requirements can be satisfied even after completion of improvement. Conjunctive use of canal water and ground water and/or other sources is indispensable for lower reach of the system.

(5) Conjunctive Use of Ground Water

In lower reach of the canal system, ground water has been developed to large extent due to shortage of irrigation water through canals. Supposedly ground water potential in such areas seems to be low and further exploitation is limited. However, command area of a shallow tubewell is only 2.5 to 4 hectares and 40 hectares for a deep tubewell. Therefore, ground water exploitation in CCA and non-CCA do not intervene each other. If water supply through irrigation canal recovers after improvement, farmers will extract water from canals and water from their tubewell can be used to enhance reliability or quantity of irrigation, which will be followed by high yield. Suppose that 50% is the higher limit of ground water development, 30 to 35% is considered to be lower limit of development in order to maintain ground water table within safe zone between three to ten metres. As far as ground water table is kept in safe zone, no capillary rise will reach root zone and no waterlogging will occur.

Table A.18 and Table A.19 shows water balance of conjunctive use of surface water and ground water in CCA. If 50% of usable recharge is exploited, irrigation sufficiency will be fulfilled both in Rabi and Kharif even for proposed irrigation area. In case of ground water development of 35%, PIA is also covered in full sufficiency. Especially in Rabi season, nearly 200% of PIA which is 250% of present irrigated area can be irrigated by 50% of usable recharge of ground water in CCA.

5.3 Water Balance by Representative Area

5.3.1 Hydrological Condition by Study Area

Hydrological characteristics of the four Study Areas based upon the model introduced in sub-section 4.1 are mentioned below:

(1) Sarojini Nagar Study Area

Table 20 and Table 21 show comparison of Roster discharge and actual discharge by irrigation canals of Study Areas for 1989/90 Rabi and 1990 Kharif. Judging from these, Roster discharge was almost satisfied at the head and 72 mile point of Lucknow Branch. However, only 85% of Roster discharge was supplied at the head of Amausi Distributary in Kharif 1990. On the other hand, in Rabi 1989/90, 130% of Roster discharge was supplied at the head of Amausi Distributary, but irrigation water from canal was not still sufficient in lower reach due to low conveyance efficiency of the canal.

Sarojini Nagar Study Area can be divided into three portions according to condition of surface water inflow (SFin) particularly in irrigation water (Iin) and drainage condition (SFout or GD). They are; i) upper reach of Amausi Distributary and Gehru Distributary; ii) left bank of middle reach of Amausi Distributary; and iii) right bank of middle reach and lower reach of Amausi Distributary.

i) Upper reach of Amausi Distributary and Gehru Distributary

Surface water inflow (SFin) viz., irrigation supply(Iin) is small due to higher elevation of farmland and deterioration of canal. Shallow ground water table remains upper "safe zone".

ii) Left bank of middle reach of Amausi Distributary

Irrigation supply (SFin, Iin) is very small and drainage condition (SFout) is also poor. Shallow ground water table exists in upper "semi-critical zone" to "safe zone".

iii) Right bank of middle reach and lower reach

Irrigation supply (SFin, Iin) is small and shallow ground water table is within middle to lower "safe zone".

Judging from above, Sarojini Nagar Area is characterized by low availability of surface irrigation water as a whole. Particularly in middle reach, drainage and usar problem occurs due to its topographic condition, viz., "flat Midland" where ground water table is shallow. In lower reach, surface drainage is applicable in "Upland" adjacent to the Sai River and Quila Mohammad Drain, but ground water potential which is expressed by ratio of Net recharge (85% of Ru) to net draft(70% of GD) shown in Table A.28 is low as well as surface water availability. General hydrological condition is shown in Fig. A.10.

(2) Sataon Study Area

Sataon Study Area is characterized by its low surface water availability(Iin) and also low ground water potentiality (higher Ru/GD). Table A.22 and Table A.23 shows extremely low availability of surface water from irrigation canals which can provide only 20% of required water in 1989/1990 Rabi and 1% in 1990 Kharif. Low potentiality of ground water means less water logging and soil salinity problem. In addition, sandy soils are predominant

in this Area, which restrains capillary rise to the surface of soil profile and no waterlogging is seen here. This Area was selected as "Irrigation Problem Area" along with Sarojini Nagar Study Area. The difference between the two is quantity of "net recharge" shown in Table 25 which is entirely low in this Area, while upper or middle reach of Sarojini Nagar Study Area still have feasible potential of further ground water exploitation. Typical hydrological condition of the area is shown in Fig. A.11.

(3) Sursa Study Area

This Area was selected as "Drainage Problem Area". Poor drainage condition is observed along Hardoi Branch, lower reach of Badaicha Distributary and along Marsa Distributary. Most part of this Area lies in midland, which is characterized by scatteringly distributed ox-bow lakes and ponds.

Judging from the actual discharge data of Badaicha Distributary and Marsa Distributary from 1989 to 1990 shown in Table A.24 and Table A.25, irrigation supply(Iin) proposed in Roster was satisfied in this Area, while surface drainage is poor due to gentle ground slope in lower reach. On the other hand, ground water potential is very high, which causes water logging and soil salinity problem.

Sandy soils are distributed in the middle reach of Badaicha Distributary, which suggests possibility of improvement of surface drainage. Hydrological condition of the Area is illustrated in Fig. A.12.

(4) Purwa Study Area

Purwa Study Area was selected as representative area in view of "Salinity/alkalinity and waterlogging problem".

Characteristics of soil profile explain constraints of this Area. Thick heavy clayey layer exists up to 25m to 30m depth here which causes brisk capillary rise from shallow ground water table. Irrigation water supply proposed in Roster(Iin) is satisfied as a whole as shown in Table A.26 and Table A.27, but not on the sufficient level. Low permeability of soil causes water logging by the same amount of supplied water which does not bring about such a problem to high-permeable soils distributed in Sataon or Sursa Study Area.

Typical hydrological condition of Purwa Study Area is shown in Fig. A.13.

TABLES

Table A.1 List of Rainfall Data

District	Station	Contents	Available period
Pithoragarh	Pithoragarh	Monthly	1965-1989
		Daily	1965-1982,1989
		Normal	
	Dharchula	Monthly	1979-1989
	Askote	Monthly	1965-1978
		Daily	1965-1978
Chaukuri	Monthly	1965-1978	
	Daily	1965-1978	
Nainital	Haldwani	Normal	
Bareilly	Bareilly	Normal	
Pilibhit	Puranpur	Monthly	1965-1989
		Daily	1965-1989
	Pilibhit	Monthly	1965-1989
Shahjahanpur	Shahjahanpur	Monthly	1965-1989
		Daily	1965-1989
		Normal	
Kheri	Kheri	Monthly	1965-1989
		Daily	1965-1989
		Normal	
Sitapur	Sitapur	Monthly	1965-1989
		Daily	1965-1989
		Normal	
Hardoi	Hardoi	Monthly	1965-1990
		Daily	
		Normal	
Barabanki	Nawabganj	Monthly	1965-1989
		Daily	1965-1989
		Normal	
Lucknow	Lucknow	Monthly	1965-1990
		Normal	
	Mohanolganj	Monthly	1965-1990
		Daily	1965-1990
		Normal	
Unnao	Unnao	Monthly	1965-1990
		Daily	1965-1990
		Normal	
Rae Bareli	Rae Bareli	Monthly	1965-1990
		Daily	1965-1990
		Normal	
Pratapgarh	Pratapgarh	Normal	
Faizabad	Faizabad	Normal	
Sultanpur	Sultanpur	Normal	
Allahabad	Allahabad	Normal	

Source: Compiled Data by Board of Revenue, UP.

Table A.2 List of Meteorological Data

District	Station	Data	Available period
Lucknow	Lucknow	Daily data for; Temperture Relative Humidity Wind speed wind direction Evaporation Sunshine hours	1986-1989
Hardoi	Hardoi	Daily data for; Temperture Relative Humidity Wind speed wind direction	1985-1989
Shahjahanpur	Shahjahanpur	Daily data for; Temperture Relative Humidity Wind speed wind direction	1985-1989
Kanpur	Kanpur	Daily data for; Temperture Relative Humidity Wind speed wind direction	1986-1989

Source: India Meteorological Department, Lucknow

Table A.3 (1/4)

Climate of Lucknow (1986 - 1989)

Month	Temperature (°C)			Relative Humidity (%)			W.S. 3/	ETpan 4/	ET0 5/	S.Hrs 6/
	max	min	mean	8:30 1/	17:30 2/	mean				
Jan	22.6	7.8	15.2	85.2	59.2	72.2	1.4	1.6	2.5	7.7
Feb	26.1	10.7	18.4	70.2	45.2	57.7	2.0	2.8	3.9	8.7
Mar	32.0	11.7	21.9	59.6	32.9	46.3	2.7	5.0	5.6	8.7
Apr	38.2	20.4	29.3	38.3	21.8	30.1	3.5	5.0	7.8	8.9
May	39.4	24.8	32.1	47.6	28.4	38.0	3.9	7.4	8.6	8.6
Jun	38.4	26.9	32.7	60.1	42.8	51.5	3.3	7.4	7.7	7.4
Jul	33.7	26.3	30.0	83.9	73.3	78.6	2.5	3.7	4.8	4.3
Aug	33.8	25.9	29.9	82.4	71.8	77.1	2.9	3.7	5.2	5.7
Sep	33.6	24.6	29.1	82.6	71.8	77.2	2.1	3.5	4.6	5.7
Oct	32.6	19.1	25.9	75.8	66.6	71.2	1.0	2.7	4.2	8.4
Nov	29.4	12.7	21.1	73.8	63.0	68.4	0.6	1.9	3.0	8.2
Dec	24.1	9.0	16.6	86.8	68.4	77.6	0.9	1.5	2.0	6.2
Annual	32.0	18.3	25.2	70.5	53.8	62.1	2.2	3.9	5.0	7.4

Remarks: 1/ Measured at 8:30
 2/ Measured at 17:30
 3/ Wind speed in meter/sec
 4/ Pan Evaporation in mm
 5/ Evapotranspiration estimated by Modified Penman Method
 6/ Sunshine hours in hours

Source : Aquired from India Meteorological Department, UP

Table A.3 (2/4)

Climate of Shahjahanpur (1986 - 1989)

Month	Temperature (°C)			Relative Humidity (%)			W.S. 3/	Oktas 4/	ET0 5/
	max	min	mean	8:30 1/	17:30 2/	mean			
Jan	21.9	7.6	14.8	84.4	63.8	74.1	1.6	5.3	1.8
Feb	25.4	9.3	17.4	75.7	50.2	63.0	2.6	4.1	2.8
Mar	30.6	14.3	22.5	64.3	39.4	51.9	3.7	5.6	3.7
Apr	36.8	19.8	28.3	47.7	29.2	38.5	5.7	4.5	5.7
May	38.5	23.7	31.1	51.4	33.6	42.5	5.5	6.2	5.5
Jun	27.3	26.3	26.8	63.7	46.9	55.3	4.5	6.2	5.3
Jul	33.3	25.4	29.4	83.0	71.7	77.4	3.2	6.0	4.5
Aug	33.1	25.5	29.3	83.1	73.6	78.4	3.0	5.7	4.4
Sep	32.6	24.0	28.3	83.3	72.7	78.0	2.5	6.3	3.6
Oct	31.6	18.3	25.0	77.8	64.2	71.0	1.1	4.3	3.4
Nov	28.5	11.7	20.1	75.1	62.9	69.0	0.6	3.1	2.5
Dec	23.5	8.9	16.2	84.1	71.2	77.7	1.5	5.6	1.7
Annual	30.3	17.9	24.1	72.8	56.6	64.7	3.0	5.2	3.7

Remarks: 1/ Measured at 8:30
 2/ Measured at 17:30
 3/ Wind speed in meter/sec
 4/ Oktas (Cloud cover expressed by 8 degrees. ex. full cover -> 8)
 5/ Evapotranspiration estimated by Modified Penman Method

Source : Aquired from India Meteorological Department, UP

Table A.3 (3/4)

Climate of Hardoi (1986 - 1989)

Month	Temperature (°C)			Relative Humidity (%)			W.S. 3/	Oktas 4/	ETO 5/
	max	min	mean	8:30 1/	17:30 2/	mean			
Jan	21.4	8.6	15.0	86.0	63.3	74.7	0.2	3.6	1.9
Feb	25.1	11.5	18.3	79.9	54.9	67.4	0.3	4.3	2.8
Mar	31.0	15.4	23.2	67.1	39.8	53.5	0.4	2.3	4.2
Apr	37.3	21.8	29.6	44.1	30.2	37.2	0.5	3.2	5.7
May	38.8	25.2	32.0	51.4	32.6	42.0	0.4	4.0	6.1
Jun	37.9	27.4	32.7	60.0	44.7	52.4	0.4	4.0	6.4
Jul	33.6	26.0	29.8	81.9	71.2	76.6	0.4	4.8	5.1
Aug	33.5	26.2	29.9	82.7	72.5	77.6	0.4	4.4	4.9
Sep	33.2	25.2	29.2	80.9	68.8	74.9	0.3	4.6	4.3
Oct	32.3	20.3	26.3	75.0	59.9	67.5	0.1	3.0	3.6
Nov	28.7	13.8	21.3	74.7	54.3	64.5	0.1	3.7	2.9
Dec	22.9	9.8	16.4	86.3	63.5	74.9	0.1	3.2	1.8
Annual	31.3	19.3	25.3	72.5	54.6	63.6	0.3	3.8	4.1

Remarks: 1/ Measured at 8:30
 2/ Measured at 17:30
 3/ Wind speed in meter/sec
 4/ Oktas (Cloud cover expressed by 8 degrees. ex. full cover -> 8)
 5/ Evapotranspiration estimated by Modified Penman Method

Source : Aquired from India Meteorological Department, UP

Table A.3 (4/4)

Climate of Kanpur (1986 - 1989)

Month	Temperature (°C)			Relative Humidity (%)			W.S. 3/	Oktas 4/	ETO 5/
	max	min	mean	8:30 1/	17:30 2/	mean			
Jan	22.1	7.9	15.0	83.8	62.0	72.9	1.1	2.2	2.4
Feb	26.2	10.6	18.4	74.3	51.1	62.7	1.1	2.2	3.4
Mar	31.4	15.4	23.4	61.1	39.0	50.1	1.2	2.0	5.0
Apr	37.9	20.9	29.4	39.9	25.9	32.9	1.2	2.1	6.5
May	40.4	25.8	33.1	48.5	33.6	41.1	1.3	2.1	7.4
Jun	39.1	27.8	33.5	59.2	44.3	51.8	1.2	2.3	7.4
Jul	34.1	27.7	30.9	80.7	71.4	76.1	1.1	2.6	6.5
Aug	33.7	26.4	30.1	81.7	71.8	76.8	1.1	2.6	6.1
Sep	32.6	23.7	28.2	81.6	72.5	77.1	1.3	2.5	5.3
Oct	32.4	17.4	24.9	69.9	59.2	64.6	1.1	2.2	4.4
Nov	29.1	11.1	20.1	67.8	59.2	63.5	1.0	1.7	3.1
Dec	23.3	7.8	15.6	81.3	65.1	73.2	1.1	2.3	2.2
Annual	31.9	18.5	25.2	69.2	54.6	61.9	1.2	2.2	5.0

Remarks: 1/ Measured at 8:30
 2/ Measured at 17:30
 3/ Wind speed in meter/sec
 4/ Oktas (Cloud cover expressed by 8 degrees. ex. full cover -> 8)
 5/ Evapotranspiration estimated by Modified Penman Method

Source : Aquired from India Meteorological Department, UP

Table A.4 Normal Rainfall in/around the Sharda Canal Command Area

District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pithoragarh	44.2	66.1	23.9	29.2	51.8	188.9	319.4	287.6	173.7	38.6	9.8	23.6	1256.8
* Nainital	36.6	40.3	16.9	10.4	27.3	190.0	485.6	468.3	242.4	31.5	3.0	3.6	1555.9
* Pilibhit	26.6	31.4	16.0	8.4	23.4	152.4	379.5	314.9	211.6	34.6	5.0	11.1	1214.9
* Bareilly	26.3	30.5	13.9	8.6	19.1	125.4	326.3	312.0	196.0	34.1	4.0	10.4	1106.6
* Shahjahanpur	16.5	22.2	11.9	8.1	17.2	119.7	300.0	284.0	127.0	41.0	3.6	8.2	959.42
* Kheri	20.8	24.3	12.3	8.6	26.4	139.5	297.5	289.7	195.1	41.8	5.3	8.4	1069.7
* Barabanki	15.9	20.6	7.9	5.7	14.3	98.4	299.7	281.6	203.6	43.6	4.7	6.5	1002.5
* Sitapur	17.8	19.9	9.9	8.7	15.6	108.5	285.1	267.7	188.5	40.9	3.9	7.5	974.0
* Hardoi	16.0	16.5	9.1	6.1	13.4	83.5	271.5	249.9	167.0	35.3	2.8	7.7	878.8
* Lucknow	16.2	18.5	8.4	7.7	13.9	86.8	295.4	271.8	194.5	34.6	5.2	6.3	959.3
* Unnao	13.8	16.7	7.7	6.6	9.7	67.8	262.1	247.3	165.1	30.3	4.8	5.9	837.8
* Rae-Bareli	16.3	19.2	8.3	6.2	9.0	80.5	291.3	277.2	176.7	32.5	4.5	6.5	928.2
Pratapgarh	14.6	19.3	8.4	6.2	10.1	82.2	303.6	298.0	184.9	38.6	5.1	6.9	977.9
Faizabad	13.5	19.2	8.1	6.5	14.2	106.5	306.1	282.0	196.7	46.7	4.6	5.5	1009.6
Sultanpur	14.7	18.7	7.3	7.0	10.7	27.3	307.1	289.7	202.8	44.4	4.0	6.5	940.2
Allahabad	17.2	19.8	8.2	5.4	8.0	80.7	303.4	300.2	181.1	38.6	7.1	6.7	976.4
* Average	20.3	23.6	11.1	7.7	17.2	113.9	317.6	296.8	188.0	36.4	4.3	7.5	1044.3
						941.2	90.1%				103.1	9.9%	
							Kharif					Rabi	
Average	20.4	25.2	11.1	8.7	17.8	108.6	314.6	295.1	187.9	37.9	4.8	8.2	1040.5
						932.7	89.6%				107.8	10.4%	
							Kharif					Rabi	

Remarks: * ; Station located in the Sharda Canal Command Area

Source: Board of Revenue, UP

Table A.5 Probability of Rainfall in the Past (1/5)

Station: Fiihibhit							Station: Kheri								
Kharif				Rabi			Kharif				Rabi				
Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)
1960	N.A			1960/61	N.A			1960	N.A			1960/61	N.A		
1961	N.A			1961/62	N.A			1961	N.A			1961/62	N.A		
1962	N.A			1962/63	N.A			1962	N.A			1962/63	N.A		
1963	N.A			1963/64	N.A			1963	N.A			1963/64	N.A		
1964	N.A			1964/65	N.A			1964	N.A			1964/65	N.A		
1965	366		31.2	1965/66	30		59	1965	603		7.7	1965/66	128	normal	
1966	N.A			1966/67	N.A			1966	714		4.3	1966/67	74	normal	
1967	1,000	normal		1967/68	103	normal		1967	801	normal		1967/68	60	normal	
1968	1,676	7.1		1968/69	44	normal		1968	1,239	normal		1968/69	54	normal	
1969	1,465	normal		1969/70	117	normal		1969	1,381	5.3		1969/70	74	normal	
1970	1,229	normal		1970/71	116	normal		1970	855	normal		1970/71	126	normal	
1971	1,766	16.7		1971/72	228	7.1		1971	1,610	9.1		1971/72	153	4.5	
1972	765	normal		1972/73	63	normal		1972	908	normal		1972/73	53		4.0
1973	1,473	4.0		1973/74	247	8.3		1973	1,299	4.0		1973/74	221	10.0	
1974	N.A			1974/75	N.A			1974	N.A			1974/75	N.A		
1975	N.A			1975/76	25		8.0	1975	N.A			1975/76	N.A		
1976	1,634	6.7		1976/77	N.A			1976	789	normal		1976/77	N.A		
1977	N.A			1977/78	N.A			1977	700		4.8	1977/78	178	6.7	
1978	1,036	normal		1978/79	N.A			1978	927	normal		1978/79	120	normal	
1979	638		5.9	1979/80	40	normal		1979	565		10.0	1979/80	58	normal	
1980	831	normal		1980/81	38		4.2	1980	1,704	11.1		1980/81	76	normal	
1981	399		25.0	1981/82	61	normal		1981	N.A			1981/82	N.A		
1982	753		4.0	1982/83	N.A			1982	1,195	normal		1982/83	72	normal	
1983	1,711	11.1		1983/84	366	18.2		1983	1,504	6.7		1983/84	315	25.0	
1984	1,046	normal		1984/85	15		19.2	1984	963	normal		1984/85	33		11.1
1985	1,254	normal		1985/86	297	11.9		1985	1,098	normal		1985/86	179	6.3	
1986	1,592	5.3		1986/87	78	normal		1986	796	normal		1986/87	83	normal	
1987	751		4.3	1987/88	36		4.5	1987	424		40.0	1987/88	57	normal	
1988	1,198	normal		1988/89	105	normal		1988	1,300	4.0		1988/89	53	normal	4.0
1989	1,191	normal		1989/90				1989	1,341	4.5		1989/90			
1990								1990							
Average	1,132			Average	112			Average	1,033			Average	108		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP. The season whose return period of rainfall is less than four years was regarded as normal.

Table A.5 Probability of Rainfall in the Past (2/5)

Station: Shahjahanpur							Station: Sitapur								
Kharif				Rabi			Kharif				Rabi				
Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)	Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)	Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)	Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)
1960	N.A.			1960/61	N.A.			1960/61	N.A.			1960/61	N.A.		
1961	N.A.			1961/62	N.A.			1961/62	N.A.			1961/62	N.A.		
1962	N.A.			1962/63	N.A.			1962/63	N.A.			1962/63	N.A.		
1963	N.A.			1963/64	N.A.			1963/64	N.A.			1963/64	N.A.		
1964	N.A.			1964/65	N.A.			1964/65	N.A.			1964/65	N.A.		
1965	638		5.9	1965/66	73	normal		1965/66	659		9.1	1965/66	117	4.0	
1966	N.A.			1966/67	N.A.			1966/67	669		7.5	1966/67	45	normal	
1967	956	normal		1967/68	65	normal		1967/68	821	normal		1967/68	41	normal	
1968	646	normal		1968/69	27			1968/69	1,187	normal		1968/69	19	normal	5.6
1969	1,121	5.9		1969/70	127	normal	4.8	1969/70	974	normal		1969/70	82	normal	
1970	939	normal		1970/71	84	normal		1970/71	1,132	normal		1970/71	N.A.		
1971	849	normal		1971/72	162	normal		1971/72	1,655	15.4		1971/72	167	6.3	
1972	467		25.0	1972/73	17		8.2	1972/73	712		6.3	1972/73	57	normal	
1973	975	4.3		1973/74	191			1973/74	888	normal		1973/74	247	11.1	
1974	N.A.			1974/75	N.A.		7.7	1974/75	N.A.			1974/75	N.A.		
1975	N.A.			1975/76	51	normal		1975/76	N.A.			1975/76	16		7.1
1976	679	normal		1976/77	N.A.			1976/77	823	normal		1976/77	N.A.		
1977	915	normal		1977/78	116	normal		1977/78	986	normal		1977/78	N.A.		
1978	N.A.			1978/79	70	normal		1978/79	1,026	normal		1978/79	N.A.		
1979	643		5.3	1979/80	N.A.			1979/80	N.A.			1979/80	27	normal	
1980	1,314	9.5		1980/81	55	normal		1980/81	1,830	28.6		1980/81	31		4.8
1981	645	normal		1981/82	139	normal		1981/82	1,237	normal		1981/82	N.A.		
1982	1,251	6.7		1982/83	N.A.			1982/83	N.A.			1982/83	N.A.		
1983	1,405	14.3		1983/84	164	5.3		1983/84	N.A.			1983/84	N.A.		
1984	1,083	5.3		1984/85	11		14.3	1984/85	N.A.			1984/85	N.A.		
1985	1,290	8.3		1985/86	270	22.2		1985/86	N.A.			1985/86	N.A.		
1986	676	normal		1986/87	8		20.0	1986/87	N.A.			1986/87	N.A.		
1987	513		14.3	1987/88	41	normal		1987/88	N.A.			1987/88	N.A.		
1988	1,173	6.3		1988/89	149	4.2		1988/89	N.A.			1988/89	N.A.		
1989	701	normal		1989/90				1989/90	N.A.			1989/90			
1990															
Average	898			Average	96			Average	1,043			Average	77		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP.
The season whose return period of rainfall is less than 4 year was regarded as normal.

Table A.5 Probability of Rainfall in the Past (3/5)

Station: Hardoi							Station: Mohanlalganj(Lucknow)								
Kharif				Rabi			Kharif				Rabi				
Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)
1960	N.A			1960/61	N.A			1960	N.A			1960/61	N.A		
1961	N.A			1961/62	N.A			1961	N.A			1961/62	N.A		
1962	N.A			1962/63	N.A			1962	N.A			1962/63	N.A		
1963	N.A			1963/64	N.A			1963	N.A			1963/64	N.A		
1964	N.A			1964/65	N.A			1964	N.A			1964/65	N.A		
1965	590	normal		1965/66	39	normal		1965	387		9.1	1965/66	39	normal	
1966	686	normal		1966/67	39	normal		1966	600	normal		1966/67	46	normal	
1967	667	normal		1967/68	67	normal		1967	961	4.0		1967/68	52	normal	
1968	898	normal		1968/69	11		37.0	1968	650	normal		1968/69	15		17.5
1969	852	normal		1969/70	255	12.5		1969	771	normal		1969/70	89	4.0	
1970	N.A			1970/71	65	normal		1970	1,194	9.1		1970/71	52	normal	
1971	783	normal		1971/72	35		4.3	1971	658	normal		1971/72	62	normal	
1972	423		5.9	1972/73	25	6.3		1972	N.A			1972/73	23		6.7
1973	325		14.3	1973/74	175		7.6	1973	829	normal		1973/74	24		6.3
1974	N.A			1974/75	N.A			1974	N.A			1974/75	N.A		
1975	N.A			1975/76	31		5.0	1975	N.A			1975/76	N.A		
1976	832	normal		1976/77	N.A			1976	N.A			1976/77	N.A		
1977	1,204	7.7		1977/78	199	7.4		1977	N.A			1977/78	42	normal	
1978	1,267	12.5		1978/79	81	normal		1978	1,063	5.6		1978/79	85	normal	
1979	369		9.1	1979/80	52	normal		1979	401		8.3	1979/80	40	normal	
1980	1,364	22.2		1980/81	62	normal		1980	1,386	16.7		1980/81	36	normal	
1981	843	normal		1981/82	126	normal		1981	765	normal		1981/82	127	7.7	
1982	724	normal		1982/83	0	normal		1982	653	normal		1982/83	57	normal	
1983	414		6.7	1983/84	128	4.0		1983	694	normal		1983/84	83	normal	
1984	496	normal		1984/85	13		25.0	1984	553	normal		1984/85	36	normal	
1985	1,023	5.7		1985/86	312	normal		1985	951	4.3		1985/86	272	38.8	
1986	594	normal		1986/87	58	normal		1986	541	normal		1986/87	76	normal	
1987	341		11.8	1987/88	92	normal		1987	327		16.9	1987/88	89	4.0	
1988	899	4.5		1988/89	108	normal		1988	1,120	normal		1988/89	134	8.4	
1989	622	normal		1989/90				1989	650	normal		1989/90			
1990								1990							
Average	734			Average	90			Average	758			Average	70		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP.
The season whose return period of rainfall is less than four years was regarded as normal.

Table A.5 Probability of Rainfall in the Past (4/5)

Station: Unnao							Station: Rae Bareilly								
Kharif				Rabi			Kharif				Rabi				
Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)
1960	N.A			1960/61	N.A			1960/61	N.A			1960/61	N.A		
1961	N.A			1961/62	N.A			1961/62	N.A			1961/62	N.A		
1962	N.A			1962/63	N.A			1962/63	N.A			1962/63	N.A		
1963	N.A			1963/64	N.A			1963/64	N.A			1963/64	N.A		
1964	N.A			1964/65	N.A			1964/65	N.A			1964/65	N.A		
1965	548		5.0	1965/66	146	6.3		1965/66	357	7.9		1965/66	72	normal	
1966	N.A			1966/67	33		6.3	1966/67	N.A			1966/67	N.A		
1967	738	normal		1967/68	97	normal		1967/68	1,051	normal		1967/68	111	normal	
1968	778	normal		1968/69	10	normal	285.7	1968/69	767	normal		1968/69	14	normal	17.5
1969	656	normal		1969/70	102	normal		1969/70	1,050	normal		1969/70	77	normal	
1970	887	normal		1970/71	38	normal	4.8	1970/71	1,149	4.0		1970/71	51	normal	
1971	1,071	7.1		1971/72	97	normal		1971/72	1,285	6.3		1971/72	118	normal	
1972	760	normal		1972/73	59	normal		1972/73	439		6.3	1972/73	97	normal	
1973	724	normal		1973/74	27		9.5	1973/74	1,368	7.7		1973/74	157	7.7	
1974	N.A			1974/75	N.A			1974/75	N.A			1974/75	N.A		
1975	N.A			1975/76	71	normal		1975/76	N.A			1975/76	17		14.3
1976	582		4.0	1976/77	N.A			1976/77	747	normal		1976/77	N.A		
1977	746	normal		1977/78	83	normal		1977/78	343	normal	9.0	1977/78	91	normal	
1978	N.A			1978/79	N.A			1978/79	1,152	4.2		1978/79	25		6.3
1979	498		6.7	1979/80	N.A			1979/80	410	normal	6.7	1979/80	101	normal	
1980	N.A			1980/81	N.A			1980/81	1,777	25.0		1980/81	50	normal	
1981	N.A			1981/82	N.A			1981/82	851	normal		1981/82	N.A		
1982	1,286	20.0		1982/83	79	normal		1982/83	N.A			1982/83	41	normal	
1983	1,137	10.0		1983/84	149	6.7		1983/84	1,118	normal		1983/84	178	8.4	
1984	727	normal		1984/85	36		5.6	1984/85	795	normal		1984/85	78	normal	
1985	917	4.2		1985/86	N.A			1985/86	1,105	normal		1985/86	244	58.8	
1986	793	normal		1986/87	55	normal		1986/87	979	normal		1986/87	132	4.0	
1987	419	18.2		1987/88	123	4.3		1987/88	99		66.7	1987/88	24		6.7
1988	808	normal		1988/89	57	normal		1988/89	794	normal		1988/89	70	normal	
1989	473		10.0	1989/90				1989/90	720	normal		1989/90			
1990															
Average	766			Average	74			Average	870			Average	87		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP.
The season whose return period of rainfall is less than four years was regarded as normal.

Table A.5 Probability of Rainfall in the Past (S/S)

Station: Barabanki

Kharif		Rabi		Average			
Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)	Year	Discharge (MCM)	Wet Year (Year)	Dry Year (Year)
1960	N.A			1960/61	N.A		
1961	N.A			1961/62	N.A		
1962	N.A			1962/63	N.A		
1963	N.A			1963/64	N.A		
1964	N.A			1964/65	N.A		
1965	399		7.7	1965/66	59	normal	
1966	N.A			1966/67	N.A		
1967	992	normal		1967/68	73	normal	
1968	465		5.3	1968/69	N.A		
1969	945	normal		1969/70	76	normal	
1970	1,390	5.0		1970/71	56	normal	
1971	N.A			1971/72	75	normal	
1972	465		5.3	1972/73	61	normal	
1973	1,093	normal		1973/74	125	6.7	
1974	N.A			1974/75	N.A		
1975	N.A			1975/76	23		14.3
1976	N.A			1976/77	N.A		
1977	751	normal		1977/78	162	12.5	
1978	1,165	normal		1978/79	104	4.5	
1979	455		5.6	1979/80	28		7.7
1980	1,915	11.1		1980/81	48	normal	
1981	1,183	normal		1981/82	N.A		
1982	N.A			1982/83	71	normal	
1983	N.A			1983/84	N.A		
1984	N.A			1984/85	N.A		
1985	N.A			1985/86	N.A		
1986	N.A			1986/87	N.A		
1987	N.A			1987/88	N.A		
1988	N.A			1988/89	N.A		
1989	N.A			1989/90	N.A		
1990	N.A						
Average	950			Average	74		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP.
The season whose return period of rainfall is less than four years was regarded as normal.

Table A.6 Dependable Annual Rainfall by District

unit: mm

Station	Kharif			Rabi		
	90%	80%	75%	90%	80%	75%
Pilibhit	520	680	780	22	34	40
Shahjahanpur	550	640	680	14	26	32
Kheri	560	680	740	33	46	52
Hardoi	360	460	500	21	32	36
Sitapur	640	740	780	13	21	25
Barabanki	360	470	530	25	34	38
Lucknow	380	460	500	19	27	31
Unnao	470	550	580	27	38	43
Rae Bareli	300	520	640	18	32	39

Source: Board of Revenue, UP

Table A.7 Drought Year by District

	1965		1966		1967		1968		1969		1970		1971		1972		1973		1974		1975		1976		1977	
	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R
Sharda River	⊙	⊙																								
Pilibhit	⊙	⊙																								
Kheri	⊙	⊙																								
Shahjahanpur	⊙	⊙																								
Hardoi																										
Sitapur	⊙	⊙																								
Barabanki	⊙	⊙																								
Lucknow	⊙	⊙																								
Unnao	⊙	⊙																								
RaeBareli	⊙	⊙																								

	1978		1979		1980		1981		1982		1983		1984		1985		1986		1987		1988		1989		
	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	
Sharda River																									
Pilibhit																									
Kheri																									
Shahjahanpur																									
Hardoi																									
Sitapur																									
Barabanki																									
Lucknow																									
Unnao																									
RaeBareli																									

Remarks
 ○ Drought of once in 4 to 10 years
 ⊙ Drought of less than once in 10 years
 K: Kharif
 R: Rabi

Table A.8 Probability of Discharge of the Sharda River

Kharif				Rabi			
Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)	Year	Discharge (MCM)	Wet Year (year)	Dry Year (year)
1960	13,139	normal		1960/61	4,149	5.3	
1961	16,687	14.3		1961/62	5,126	10.5	
1962	16,084	9.1		1962/63	3,741	normal	
1963	12,891	normal		1963/64	3,397	normal	
1964	14,829	4.5		1964/65	3,823	normal	
1965	8,996		50.0	1965/66	2,469		33.3
1966	13,314	normal		1966/67	2,610		15.4
1967	13,895	normal		1967/68	3,196	normal	
1968	14,192	normal		1968/69	3,028		4.0
1969	11,971	normal		1969/70	3,654	normal	
1970	11,762	normal		1970/71	3,164	normal	
1971	17,861	33.3		1971/72	4,346	6.3	
1972	11,873	normal		1972/73	3,468	normal	
1973	15,959	8.3		1973/74	4,470	6.7	
1974	10,791		7.7	1974/75	5,211	11.8	
1975	16,796	16.7		1975/76	3,596	normal	
1976	14,729	4.0		1976/77	3,044	normal	
1977	13,179	normal		1977/78	3,407	normal	
1978	12,098	normal		1978/79	3,576	normal	
1979	12,781	normal		1979/80	2,680		10.5
1980	11,424		4.8	1980/81	3,601	normal	
1981	14,516	normal		1981/82	3,270	normal	
1982	13,346	normal		1982/83	3,013		4.2
1983	11,607		4.5	1983/84	4,053	4.8	
1984	13,497	normal		1984/85	2,933	normal	
1985	12,902	normal		1985/86	6,988	43.5	
1986	13,708	normal		1986/87	3,516	normal	
1987	9,430		33.3	1987/88	2,684		10.0
1988	15,817	7.7		1988/89	3,255	normal	
1989	10,911		7.1	1989/90	3,355	normal	
1990	13,641	normal					
Average	13,375			Average	3,627		

Remarks: Total discharge was calculated based upon weekly discharge observed by Irrigation Department of UP.
The season whose return period of discharge is less than four years was regarded as normal.

Table A.9 Estimation of Low Flow and Flood of the Sai River

unit : cumec

Station		Auras (CA=1,950sq.km)						Sarojini Nagar	Sataon	Rae Bareli
Year		1985	1986	1987	1988	1989	1990	(CA=4,030 sq.km)	(CA=5,080 sq.km)	(CA=6,201 sq.km)
January	Ave		5.1	4.8	2.0	1.4	1.5			
	Max		8.5	6.0	2.0	1.6	1.7	17.6	22.1	
	Min		3.8	4.0	1.9	1.3	1.4	3.2	4.2	5.2
February	Ave		4.3	3.9	2.0	1.4	1.4			
	Max		5.6	4.0	2.1	1.4	1.4	11.6	14.6	
	Min		3.0	3.7	1.5	1.4	1.4	3.0	3.8	4.7
March	Ave		2.9	3.4	2.0	1.8	1.5			
	Max		3.1	3.5	2.2	2.6	1.9	7.2	9.1	
	Min		2.7	3.2	1.9	1.3	1.4	2.3	2.8	3.3
April	Ave		2.7	2.8	2.1	1.4	2.3			
	Max		2.9	3.2	2.2	1.5	3.0	6.5	8.3	
	Min		2.0	2.5	1.9	1.3	1.9	1.9	2.3	2.6
May	Ave		1.9	2.3	1.9	1.5	2.3			
	Max		2.0	2.6	2.0	1.9	2.9	6.0	7.6	
	Min		1.8	2.0	1.8	1.3	1.8	2.0	2.3	2.7
June	Ave		2.3	2.0	2.2	2.0	2.7			
	Max		6.5	2.6	2.8	2.1	3.1	13.4	16.9	
	Min		0.5	1.9	1.8	1.9	0.7	2.1	2.9	3.8
July	Ave		29.5	1.9	9.7	4.2	3.8			
	Max		64.0	2.1	20.3	4.9	5.8	132.3	166.7	
	Min		8.1	1.6	2.1	3.6	1.9	13.7	19.9	26.4
August	Ave	28.4	20.0	1.8	21.7	3.1	3.8			
	Max	35.0	29.2	2.0	22.9	3.7	5.6	60.3	76.1	
	Min	25.8	11.8	1.7	20.4	2.9	1.9	17.4	25.3	33.8
September	Ave	88.2	14.9	2.0	20.6	3.3				
	Max	158.6	119.3	2.2	23.5	3.5		327.8	413.2	
	Min	24.0	7.4	1.7	16.4	3.0		21.1	30.9	41.3
October	Ave	105.6	7.8	2.4	15.2	2.9				
	Max	182.2	8.7	4.3	19.8	4.2		376.4	474.5	
	Min	38.7	7.4	1.1	7.4	2.2		10.9	15.9	21.2
November	Ave	22.9	4.3	1.8	6.9	2.0				
	Max	50.5	4.8	2.0	7.6	6.1		104.4	131.6	
	Min	8.3	4.0	1.8	4.3	1.0		4.3	5.9	7.7
December	Ave	10.8	5.1	1.9	3.8	1.9				
	Max	14.5	6.0	2.1	4.1	1.9		30.0	37.8	
	Min	6.3	4.3	1.8	1.6	1.8		3.6	4.6	5.7

Remarks: J1 Minimum Values for Sarojini Nagar and Sataon are interpolated from those of Auras and Rae Bareli. by catchment area.

J2 Maximum Values for Sarojini Nagar and Sataon are extrapolated from Auras by catchment area.

J3 Values for Rae Bareli are 75% dependable discharge reported in "Hydrological Report of Sai River" (1983) by Irrigation Department of UP.

J4 Outlined values are the maximum during period of measurement.

J5 Bold-faced values are the minimum during period of measurement.

Table A.10 Water Quality in the Sharda Irrigation System

Point of Measurement	Date	EC (mmho)	pH
Sharda River	20/10/90	0.185	8.5
Main Canal (BP)	20/10/90	0.230	8.5
Main Canal (EP)	20/10/90	0.240	8.3
Outlet from Sagar Dam	21/10/90	0.240	8.3
Hardoi Branch (BP)	21/10/90	0.230	8.4
Hardoi Branch (56mile)	07/02/91	0.380	8.6
Hardoi Branch (70mile)	07/02/91	0.310	8.7
Hardoi Branch (99mile)	21/10/90	0.240	8.4
do	07/02/91	0.310	8.6
Hardoi Branch (EP)	22/10/90	0.240	8.4
Lucknow Branch (BP)	21/10/90	0.240	8.5
Lucknow Branch (Lucknow)	22/10/90	0.260	7.8
Unnao Branch (Unnao)	22/10/90	0.250	8.3
Unnao Branch (near EP)	22/10/90	0.250	8.5
Purwa Branch (Unnao)	22/10/90	0.240	8.4
Purwa Branch (near EP)	22/10/90	0.240	8.6
Average		0.255	8.4

Remarks: Results of field measurement

Table A.11 Comparison of Roster and Actual Discharge of the Main Canal System

Unit: MCM

	1990 Kharif		1989/90 Rabi		1989 Kharif		1988/89 Rabi		1988 Kharif		1987/88 Rabi		1987 Kharif		1986/87 Rabi		1986 Kharif		
	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	Roster	Actual	
1	14.497	15.976	2,855	3,292	14,599	12,226	2,855	3,219	14,548	17,057	2,663	11,553	2,855	3,537	2,855	11,553	2,855	3,537	16,611
2	104	90*	64	N.A.	96	N.A.	64	49*	100	N.A.	N.A.	97*	64	N.A.	64	N.A.	64	N.A.	100
3	4,535	3,993	2,774	3,010	4,346	4,154	2,774	2,986	4,443	4,545	2,599	4,597	2,774	3,358	2,774	3,358	2,774	3,358	4,441
4	31	11*	15	N.A.	29	N.A.	15	N.A.	30	N.A.	15	24*	15	N.A.	15	N.A.	15	N.A.	30
5	233	249	96	147	301	286	96	118	267	222	92*	270*	96	102	96	102	96	102	267
6	315	164*	96	N.A.	260	N.A.	96	85	288	N.A.	N.A.	286*	96	N.A.	96	N.A.	96	N.A.	288
7	0	413*	0	236	0	40	0	288	0	318	0	3*	0	3*	0	3*	0	3*	140*
8	472	209	268	268	452	396	268	301	462	525	246	487*	268	320	268	320	268	320	462
9	114	103	62	50	110	102	62	60	112	92	54*	128*	62	50	62	128*	62	50	112
10	163	110*	97	100	154	142	97	79	159	132	81*	128*	97	87	97	128*	97	87	159
11	185	199*	171	N.A.	164	N.A.	171	N.A.	175	N.A.	171	377	171	N.A.	171	N.A.	171	N.A.	175
12	3,022	2,535*	1,964	2,045	2,887	2,616	1,964	1,928	2,955	3,116	2,055*	2,959	2,955	2,174*	2,955	2,174*	2,955	2,955	
13	390	259*	305	432	322	238	305	415	356	514	401	297	305	474	305	474	305	474	
14	996	927*	570	517	1,017	919	570	602	1,007	942	647*	985	570	735*	570	735*	570	735*	
15	1,636	1,349	1,089	1,096	1,548	1,459	1,089	911	1,592	1,660	1,007	1,677	1,089	967	1,089	967	1,089	967	
i	576	769*	401	473	648	694	401	660	612	784	481*	689	401	706*	401	706*	401	706*	
ii	2,212	2,118*	1,490	1,569	2,196	2,158	1,490	1,571	2,204	2,444	1,488*	2,586	1,490	1,673*	1,490	1,673*	1,490	1,673*	
iii	58	27	31	23	56	46	31	29	57	45	23*	44	31	N.A.	31	N.A.	31	N.A.	
iv	77	54*	58	29	53	117	58	77	65	278	217*	169	58	N.A.	58	N.A.	58	N.A.	
v	2,076	2,037	1,401	1,517	2,085	1,990	1,401	1,465	2,081	2,121	1,248	2,153	1,401	1,466	1,401	1,466	1,401	1,466	
vi	334	405	265	296	242	439	265	298	288	387	222	288	265	138	265	138	265	138	
vii	1,741	1,632	1,136	1,221	1,844	1,551	1,136	1,167	1,793	1,734	1,026	1,803	1,136	1,328	1,136	1,328	1,136	1,328	
viii	73	N.A.	48	N.A.	94	N.A.	48	N.A.	84	N.A.	48	N.A.	48	N.A.	48	N.A.	48	N.A.	
ix	47	-261	0	106	-25	-170	0	-127	11	-48	12	-122	0	-130	0	-130	0	-130	
16	82	336*	143	346	59	206	143	351	71	218	269*	225	143	257*	143	257*	143	257*	
17	135	323*	277	353	169	221	277	361	152	225	343*	235	277	335*	277	335*	277	335*	
18	56	242*	4	168	4	127	4	166	30	150	129*	137	130	130	130	130	130	130	
i	609.3	616.5*	611.9	617.4	607.6	609.2	611.9	617.4	608.4	610.6	612.9*	610.2	611.9	615.9*	611.9	615.9*	611.9	615.9*	
ii	612.5	620.0*	621.1	622.0	613.3	613.0	621.1	622.5	612.9	613.3	621.3*	614.0	621.1	622.1*	621.1	622.1*	621.1	622.1*	
iii	607.6	614.3*	603.3	609.1	603.4	603.4	603.3	609.0	605.5	607.6	603.3	606.4	603.3	605.7*	603.3	605.7*	603.3	605.5	

Remarks: Parenthesized values are average of discharge mentioned in available Roster. Values with (*) are averaged or modified values of available data

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (1/8)

Period	I.Sharda River				2.Nepal Channel				3.Sharda Main Canal			
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	Roster (4)	(3)/(4)	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	Roster (4)	(3)/(4)
08/29/90	6,736	4,500	150%	115	77	150%	6,499	4,350	149%	111	74	149%
04/05/90	5,926	5,000	119%	217	163	133%	5,906	4,850	122%	212	157	135%
04/12/90	6,039	5,500	110%	320	257	125%	6,019	5,350	113%	315	249	127%
04/19/90	5,862	6,000	98%	420	359	117%	6,613	5,850	113%	428	349	123%
04/26/90	6,265	6,500	96%	528	471	112%	6,245	6,350	98%	535	458	117%
05/03/90	6,286	7,000	90%	635	590	108%	6,981	6,850	102%	655	575	114%
05/10/90	13,735	8,000	172%	870	727	120%	5,661	7,850	72%	752	709	106%
05/17/90	16,080	9,000	179%	1,146	881	130%	10,117	8,750	116%	925	859	108%
05/24/90	14,388	10,000	144%	1,392	1,053	132%	10,252	9,750	105%	1,700	1,026	107%
05/31/90	17,523	10,500	167%	1,692	1,232	137%	10,655	10,250	104%	1,283	1,202	107%
06/07/90	13,916	11,000	127%	1,950	1,421	136%	11,004	10,750	102%	1,471	1,386	106%
06/14/90	12,709	12,000	106%	2,147	1,626	132%	11,004	11,500	96%	1,659	1,382	105%
06/21/90	20,505	15,000	137%	2,498	1,883	133%	10,574	11,500	92%	1,840	1,779	103%
06/28/90	28,739	27,000	106%	2,990	2,345	128%	9,443	11,500	82%	2,002	1,976	101%
07/05/90	90,628	40,000	227%	4,541	3,030	150%	6,127	11,500	53%	2,107	2,173	97%
07/12/90	74,574	45,000	166%	5,818	3,800	153%	1,507	11,500	13%	2,133	2,370	90%
07/19/90	55,617	60,000	93%	6,770	4,827	140%	9,042	11,500	79%	2,287	2,367	89%
07/26/90	59,176	70,000	85%	7,783	6,025	129%	10,185	11,500	89%	2,462	2,753	89%
08/02/90	55,497	80,000	69%	8,733	7,394	118%	10,534	11,500	92%	2,642	2,960	89%
08/09/90	88,528	80,000	111%	10,248	8,763	117%	10,534	11,500	92%	2,822	3,157	89%
08/16/90	84,700	80,000	106%	11,697	10,133	115%	10,534	11,500	92%	3,003	3,354	90%
08/23/90	55,469	70,000	79%	12,647	11,331	112%	10,668	11,500	93%	3,185	3,551	90%
08/30/90	54,370	60,000	91%	13,577	12,338	110%	10,534	11,500	92%	3,366	3,748	90%
09/06/90	50,270	50,000	101%	14,438	13,213	109%	10,883	11,500	95%	3,552	3,944	90%
09/13/90	42,243	30,000	141%	15,161	13,727	110%	11,273	11,500	98%	3,745	4,141	90%
09/20/90	37,738	25,000	151%	15,807	14,155	112%	10,023	11,500	87%	3,916	4,338	90%
09/27/90	38,463	20,000	192%	16,465	14,497	114%	14,453	11,500	126%	4,164	4,535	92%
Average	35,630	31,370	114%				9,010	9,813	92%			
Maximum	90,628	80,000	113%				14,453	11,500	126%			

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (2/8)

Period	4.Khatuma Channel				5.New Sharda Sagar Feeder				6.Old Sharda Deoha Feeder				
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		
	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	Roster (4)	(3)/(4)	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	Roster (4)	(3)/(4)	
03/29/90	N.A.	0	N.A.	N.A.	0	N.A.	0	0	0	0	0	0	
04/05/90	0	0	N.A.	N.A.	11	0	0	0	0	0	0	0	
04/12/90	0	50	0%	N.A.	1	N.A.	0	684.0	800	85%	12	14	85%
04/19/90	0	80	0%	N.A.	2	N.A.	0	798.0	800	100%	25	27	95%
04/26/90	N.A.	0	N.A.	N.A.	2	N.A.	0	114.0	0	0	27	27	100%
05/03/90	N.A.	0	N.A.	N.A.	2	N.A.	0	0.0	0	0	27	27	100%
05/10/90	N.A.	80	N.A.	N.A.	4	N.A.	0	0.0	800	0%	27	41	66%
05/17/90	N.A.	80	N.A.	N.A.	5	N.A.	0	684.0	800	85%	39	55	71%
05/24/90	N.A.	80	N.A.	N.A.	6	N.A.	0	684.0	800	85%	51	68	74%
05/31/90	N.A.	80	N.A.	N.A.	8	N.A.	0	471.9	800	59%	59	82	72%
06/07/90	74	80	93%	N.A.	9	N.A.	0	799.0	800	100%	72	96	76%
06/14/90	77	80	96%	N.A.	10	N.A.	0	543.4	800	68%	82	110	75%
06/21/90	80	80	100%	N.A.	12	N.A.	0	501.0	800	63%	90	123	73%
06/28/90	69	80	86%	N.A.	13	N.A.	0	641.6	800	80%	101	137	74%
07/05/90	0	80	0%	N.A.	15	N.A.	0	228.0	800	28%	105	151	70%
07/12/90	0	80	0%	N.A.	16	N.A.	0	0.0	800	0%	105	164	64%
07/19/90	0	80	0%	N.A.	17	N.A.	0	0.0	800	0%	105	178	59%
07/26/90	0	80	0%	N.A.	19	N.A.	0	0.0	800	0%	105	192	55%
08/02/90	0	80	0%	N.A.	20	N.A.	0	0.0	800	0%	105	205	51%
08/09/90	0	80	0%	N.A.	21	N.A.	0	0.0	800	0%	105	219	48%
08/16/90	0	80	0%	N.A.	23	N.A.	0	0.0	800	0%	105	233	45%
08/23/90	40	80	50%	N.A.	24	N.A.	0	0.0	800	0%	105	246	43%
08/30/90	80	80	100%	N.A.	26	N.A.	0	0.0	800	0%	105	260	40%
09/06/90	0	80	0%	N.A.	27	N.A.	0	391.0	800	49%	112	274	41%
09/13/90	69	80	86%	N.A.	28	N.A.	0	850.1	800	106%	126	288	44%
09/20/90	0	80	0%	N.A.	30	N.A.	0	429.4	800	54%	134	301	44%
09/27/90	0	80	0%	N.A.	31	N.A.	0	433.0	800	54%	141	315	45%
Average	N.A.	67	N.A.	N.A.	562	504	111%	306	681	45%	306	681	45%
Maximum	N.A.	80	N.A.	N.A.	1,098	800	137%	850	800	106%	850	800	106%

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (3/8)

Period	7.Nagra Escape				8.New Sharda Deofia Feeder				9.Bisalpur Branch								
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)						
	Actual (1)	Roster (2)	(1)/(2)	(3)	(4)	(1)	(2)	(1)/(2)	(3)	(4)	(1)	(2)	(1)/(2)	(3)	(4)	(3)/(4)	
03/29/90	1,118	0		19	0	280	0		5	0	0	0	0	0			
04/05/90	360	0		25	0	661	0		16	0	0	0	0	0			
04/12/90	742	0		38	0	828	1,200	69%	30	21	147%	116	300	39%	5	39%	
04/19/90	71	0		39	0	1,098	1,200	92%	49	41	119%	159	300	53%	5	10	46%
04/26/90	0	0		39	0	1,182	0		69	41	169%	304	0		10	10	96%
05/03/90	0	0		39	0	172	0		72	41	176%	304	0		15	10	147%
05/10/90	0	0		39	0	1,029	1,200	86%	90	82	109%	174	300	58%	18	15	117%
05/17/90	0	0		39	0	858	1,200	71%	103	103	102%	346	350	99%	24	21	112%
05/24/90	0	0		39	0	882	1,200	74%	120	123	97%	252	300	84%	28	27	107%
05/31/90	N.A.	0		N.A.	0	1,172	1,200	98%	140	144	97%	359	300	120%	34	32	109%
06/07/90	43	0		N.A.	0	1,024	1,200	85%	157	164	96%	324	300	108%	40	37	109%
06/14/90	0	0		N.A.	0	853	1,200	71%	172	185	93%	353	300	118%	46	42	110%
06/21/90	0	0		N.A.	0	485	1,200	40%	180	203	88%	303	300	101%	51	47	109%
06/28/90	0	0		N.A.	0	515	1,200	43%	189	226	84%	230	300	77%	55	52	106%
07/05/90	0	0		N.A.	0	0	1,200	0%	189	246	77%	130	300	43%	57	57	100%
07/12/90	0	0		N.A.	0	0	1,200	0%	189	267	71%	43	300	14%	57	62	92%
07/19/90	599	0		N.A.	0	0	1,200	0%	189	288	66%	290	300	97%	58	68	86%
07/26/90	1,071	0		N.A.	0	0	1,200	0%	189	308	61%	204	300	68%	63	73	87%
08/02/90	1,662	0		N.A.	0	460	1,200	38%	197	329	60%	204	300	68%	67	78	86%
08/09/90	2,464	0		N.A.	0	690	1,200	57%	209	370	56%	204	300	68%	70	83	84%
08/16/90	3,735	0		N.A.	0	230	1,200	19%	213	390	54%	244	300	81%	74	88	84%
08/23/90	1,377	0		N.A.	0	0	1,200	0%	213	411	52%	251	250	100%	79	92	85%
08/30/90	883	0		N.A.	0	0	1,200	0%	213	431	49%	304	250	122%	84	97	87%
09/06/90	1,189	0		N.A.	0	0	1,200	0%	213	452	47%	346	250	138%	90	101	89%
09/13/90	3,237	0		N.A.	0	0	1,200	0%	213	472	45%	353	250	141%	96	105	91%
09/20/90	1,544	0		N.A.	0	0	1,200	0%	213	472	45%	266	250	106%	100	110	92%
09/27/90	963	0		N.A.	0	0	1,200	0%	213	472	45%	335	250	134%	106	114	93%
Average	810	0				460	1,022	45%				229	246	95%			
Maximum	3,735	0				1,182	1,200	99%				359	350	103%			

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (4/8)

10. Nigohi Branch									
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)	(4)	(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)					
03/29/90	0	0	0	0					
04/05/90	298	0	5	0					
04/12/90	393	400	12	7	98%	12	7	173%	
04/19/90	401	400	19	14	100%	19	14	137%	
04/26/90	57	0	20	14		20	14	144%	
05/03/90	0	0	20	14		20	14	144%	
05/10/90	57	400	21	21	14%	21	21	101%	
05/17/90	387	450	27	28	86%	27	28	97%	
05/24/90	422	400	35	35	106%	35	35	98%	
05/31/90	0	400	35	42	0%	35	42	82%	
06/07/90	0	400	35	49	0%	35	49	71%	
06/14/90	29	400	35	56	7%	35	56	63%	
06/21/90	286	400	40	62	72%	40	62	64%	
06/28/90	N.A.	400	N.A.	69	N.A.	N.A.	69	N.A.	
07/05/90	N.A.	400	N.A.	76	N.A.	N.A.	76	N.A.	
07/12/90	N.A.	400	N.A.	83	N.A.	N.A.	83	N.A.	
07/19/90	N.A.	400	N.A.	90	N.A.	N.A.	90	N.A.	
07/26/90	N.A.	400	N.A.	97	N.A.	N.A.	97	N.A.	
08/02/90	371	400	104	104	93%	104	104	N.A.	
08/09/90	258	400	110	110	65%	110	110	N.A.	
08/16/90	188	400	117	117	47%	117	117	N.A.	
08/23/90	303	450	125	125	67%	125	125	N.A.	
08/30/90	437	450	133	133	97%	133	133	N.A.	
09/06/90	422	450	140	140	94%	140	140	N.A.	
09/13/90	185	450	148	148	41%	148	148	N.A.	
09/20/90	401	450	156	156	89%	156	156	N.A.	
09/27/90	555	450	163	163	119%	163	163	N.A.	
Average	N.A.	354	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
Maximum	N.A.	450	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	

11. Loss up to Birlurcation									
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)	(4)	(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)					
	N.A.	400	N.A.	7					
	-114	400	-28%	14					
	-585	400	-146%	21					
	-779	400	-195%	27					
	N.A.	400	N.A.	34					
	N.A.	400	N.A.	41					
	N.A.	400	N.A.	48					
	N.A.	400	N.A.	55					
	N.A.	400	N.A.	62					
	N.A.	400	N.A.	68					
	2,462	400	616%	75					
	1,784	400	446%	82					
	2,250	400	562%	89					
	N.A.	400	N.A.	96					
	N.A.	400	N.A.	103					
	N.A.	400	N.A.	110					
	N.A.	400	N.A.	116					
	N.A.	400	N.A.	123					
	1,529	400	382%	130					
	32	400	8%	137					
	703	400	176%	144					
	1,607	400	402%	151					
	775	400	194%	157					
	407	400	102%	164					
	-507	400	-127%	171					
	-302	400	-76%	178					
	1,053	400	263%	185					
Average	N.A.	400	N.A.	N.A.					
Maximum	N.A.	400	N.A.	N.A.					

12. Birlurcation									
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)	(4)	(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)					
	4,458	3,950	113%	76					
	4,150	4,450	93%	147					
	3,012	2,200	137%	199					
	3,767	2,670	141%	263					
	N.A.	5,950	N.A.	N.A.					
	N.A.	6,450	N.A.	N.A.					
	N.A.	4,670	N.A.	N.A.					
	N.A.	5,470	N.A.	N.A.					
	N.A.	6,570	N.A.	N.A.					
	5,220	7,070	74%	N.A.					
	5,925	6,770	79%	N.A.					
	6,388	7,520	85%	N.A.					
	5,611	7,520	75%	N.A.					
	N.A.	7,520	N.A.	N.A.					
	N.A.	7,520	N.A.	N.A.					
	N.A.	7,520	N.A.	N.A.					
	N.A.	7,520	N.A.	N.A.					
	N.A.	7,520	N.A.	N.A.					
	6,768	7,520	90%	N.A.					
	6,655	7,520	89%	N.A.					
	5,664	7,520	75%	N.A.					
	5,710	7,520	76%	N.A.					
	7,020	7,520	93%	N.A.					
	7,323	7,520	97%	N.A.					
	6,282	7,520	84%	N.A.					
	6,995	7,520	93%	N.A.					
	10,062	7,520	134%	N.A.					
Average	N.A.	6,539	N.A.	N.A.					
Maximum	N.A.	7,520	N.A.	N.A.					

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (5/8)

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)
03/29/90	743	0	13	0
04/05/90	947	0	29	0
04/12/90	687	0	41	0
04/19/90	495	270	49	5
04/26/90	N.A.	1,930	N.A.	38
05/03/90	N.A.	2,450	N.A.	80
05/10/90	N.A.	2,470	N.A.	122
05/17/90	N.A.	70	N.A.	123
05/24/90	N.A.	370	N.A.	130
05/31/90	487	870	N.A.	145
06/07/90	516	0	N.A.	145
06/14/90	778	720	N.A.	157
06/21/90	420	720	N.A.	169
06/28/90	513	720	N.A.	182
07/05/90	499	720	N.A.	194
07/12/90	376	720	N.A.	206
07/19/90	885	720	N.A.	219
07/26/90	1,451	720	N.A.	231
08/02/90	487	720	N.A.	243
08/09/90	516	720	N.A.	256
08/16/90	778	3,520	N.A.	316
08/23/90	420	720	N.A.	328
08/30/90	513	720	N.A.	340
09/06/90	499	720	N.A.	353
09/13/90	376	720	N.A.	365
09/20/90	885	720	N.A.	377
09/27/90	1,451	720	N.A.	390
Average	N.A.	843	N.A.	N.A.
Maximum	N.A.	3,520	N.A.	N.A.

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)
03/29/90	686	0	12	0
04/05/90	114	0	14	0
04/12/90	1,894	2,200	46	38
04/19/90	2,346	2,400	86	79
04/26/90	1,869	0	118	79
05/03/90	286	0	123	79
05/10/90	1,864	2,200	155	116
05/17/90	2,210	2,200	193	154
05/24/90	2,174	2,200	230	192
05/31/90	2,295	2,200	269	229
06/07/90	2,404	2,800	311	277
06/14/90	2,805	2,800	359	325
06/21/90	2,596	2,800	403	373
06/28/90	N.A.	2,800	N.A.	421
07/05/90	N.A.	2,800	N.A.	459
07/12/90	N.A.	2,800	N.A.	517
07/19/90	N.A.	2,800	N.A.	565
07/26/90	N.A.	2,800	N.A.	613
08/02/90	2,451	2,800	N.A.	661
08/09/90	2,380	2,800	N.A.	709
08/16/90	1,694	0	N.A.	709
08/23/90	1,983	2,800	N.A.	757
08/30/90	2,720	2,800	N.A.	804
09/06/90	2,805	2,800	N.A.	852
09/13/90	2,465	2,800	N.A.	900
09/20/90	2,210	2,800	N.A.	948
09/27/90	3,542	2,800	N.A.	996
Average	N.A.	2,156	N.A.	N.A.
Maximum	N.A.	2,800	N.A.	N.A.

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)
03/29/90	3,029	3,950	52	68
04/05/90	3,088	4,450	105	144
04/12/90	431	0	112	144
04/19/90	925	0	128	144
04/26/90	2,857	4,000	177	212
05/03/90	3,497	4,000	237	281
05/10/90	1,635	0	265	281
05/17/90	2,869	3,200	314	335
05/24/90	3,052	4,000	366	404
05/31/90	2,437	4,000	408	472
06/07/90	2,404	3,970	449	540
06/14/90	2,805	4,000	497	609
06/21/90	2,596	4,000	541	677
06/28/90	N.A.	4,000	N.A.	746
07/05/90	N.A.	4,000	N.A.	814
07/12/90	N.A.	4,000	N.A.	883
07/19/90	N.A.	4,000	N.A.	951
07/26/90	N.A.	4,000	N.A.	1,020
08/02/90	3,829	4,000	N.A.	1,088
08/09/90	3,759	4,000	N.A.	1,157
08/16/90	3,192	4,000	N.A.	1,225
08/23/90	3,305	4,000	N.A.	1,293
08/30/90	3,787	4,000	N.A.	1,362
09/06/90	4,019	4,000	N.A.	1,430
09/13/90	3,440	4,000	N.A.	1,499
09/20/90	3,900	4,000	N.A.	1,567
09/27/90	5,069	4,000	N.A.	1,636
Average	N.A.	3,540	N.A.	N.A.
Maximum	N.A.	4,450	N.A.	N.A.

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (6/8)

Period	Periodical Discharge (cusec)				Accumulated Discharge (MCM)			
	Roster		(1)/(2)		Actual		(3)/(4)	
	(1)	(2)	(1)/(2)	(3)	(4)	(3)/(4)	(3)/(4)	
03/29/90	1,041	0		18	0			
04/05/90	1,362	0		41	0			
04/12/90	406	0		48	0			
04/19/90	1,020	0		66	0			
04/26/90	2,247	1,600	140%	104	27	380%		
05/03/90	2,073	1,600	130%	139	55	255%		
05/10/90	1,784	0		170	55	310%		
05/17/90	2,495	0		213	55	388%		
05/24/90	2,425	1,600	152%	254	82	309%		
05/31/90	2,257	1,600	141%	293	110	267%		
06/07/90	2,217	1,630	136%	331	137	241%		
06/14/90	2,138	1,600	134%	367	165	223%		
06/21/90	1,078	1,600	67%	386	192	201%		
06/28/90	N.A.	1,600	N.A.	N.A.	220	N.A.		
07/05/90	N.A.	1,600	N.A.	N.A.	247	N.A.		
07/12/90	N.A.	1,600	N.A.	N.A.	274	N.A.		
07/19/90	N.A.	1,600	N.A.	N.A.	302	N.A.		
07/26/90	N.A.	1,600	N.A.	N.A.	329	N.A.		
08/02/90	1,514	1,600	95%	N.A.	357	N.A.		
08/09/90	1,654	1,600	103%	N.A.	384	N.A.		
08/16/90	2,003	1,600	125%	N.A.	411	N.A.		
08/23/90	2,018	1,600	126%	N.A.	439	N.A.		
08/30/90	1,773	1,600	111%	N.A.	466	N.A.		
09/06/90	1,601	1,600	100%	N.A.	493	N.A.		
09/13/90	1,953	1,600	122%	N.A.	521	N.A.		
09/20/90	1,601	1,600	100%	N.A.	548	N.A.		
09/27/90	2,135	1,600	133%	N.A.	576	N.A.		
Average	N.A.	1,246	N.A.	N.A.	4,785	N.A.	N.A.	
Maximum	N.A.	1,630	N.A.	N.A.	5,600	N.A.	N.A.	

15ii. 15i + 15ii								
Period	Periodical Discharge (cusec)				Accumulated Discharge (MCM)			
	Roster		(1)/(2)		Actual		(3)/(4)	
	(1)	(2)	(1)/(2)	(3)	(4)	(3)/(4)	(3)/(4)	
03/29/90	4,070	3,950	103%	70	68	103%		
04/05/90	4,451	4,450	100%	146	144	101%		
04/12/90	837	0		160	144	111%		
04/19/90	1,945	0		193	144	135%		
04/26/90	5,105	5,600	91%	281	240	117%		
05/03/90	5,570	5,600	99%	376	335	112%		
05/10/90	3,419	0		435	335	130%		
05/17/90	5,364	3,200	168%	526	390	135%		
05/24/90	5,477	5,600	98%	620	486	128%		
05/31/90	4,654	5,600	84%	701	582	120%		
06/07/90	4,621	5,600	83%	780	678	115%		
06/14/90	4,943	5,600	88%	864	774	112%		
06/21/90	3,674	5,600	66%	927	869	107%		
06/28/90	N.A.	5,600	N.A.	N.A.	965	N.A.		
07/05/90	N.A.	5,600	N.A.	N.A.	1,061	N.A.		
07/12/90	N.A.	5,600	N.A.	N.A.	1,157	N.A.		
07/19/90	N.A.	5,600	N.A.	N.A.	1,253	N.A.		
07/26/90	N.A.	5,600	N.A.	N.A.	1,349	N.A.		
08/02/90	5,343	5,600	95%	N.A.	1,445	N.A.		
08/09/90	5,413	5,600	97%	N.A.	1,540	N.A.		
08/16/90	5,195	5,600	93%	N.A.	1,636	N.A.		
08/23/90	5,323	5,600	95%	N.A.	1,732	N.A.		
08/30/90	5,560	5,600	99%	N.A.	1,828	N.A.		
09/06/90	5,620	5,600	100%	N.A.	1,924	N.A.		
09/13/90	5,393	5,600	96%	N.A.	2,020	N.A.		
09/20/90	5,501	5,600	98%	N.A.	2,116	N.A.		
09/27/90	7,204	5,600	129%	N.A.	2,211	N.A.		
Average	N.A.	4,785	N.A.	N.A.	4,785	N.A.	N.A.	
Maximum	N.A.	5,600	N.A.	N.A.	5,600	N.A.	N.A.	

15iv. Madhroanda Distributary								
Period	Periodical Discharge (cusec)				Accumulated Discharge (MCM)			
	Roster		(1)/(2)		Actual		(3)/(4)	
	(1)	(2)	(1)/(2)	(3)	(4)	(3)/(4)	(3)/(4)	
03/29/90	0	100	0%	0	2	0%		
04/05/90	0	150	0%	0	4	0%		
04/12/90	0	0		0	4	0%		
04/19/90	36	0		1	4	15%		
04/26/90	107	150	71%	2	7	36%		
05/03/90	146	150	97%	5	9	53%		
05/10/90	21	0		5	9	56%		
05/17/90	0	0		5	9	56%		
05/24/90	90	150	60%	7	12	57%		
05/31/90	141	150	94%	9	15	64%		
06/07/90	150	150	100%	12	17	69%		
06/14/90	113	150	75%	14	20	70%		
06/21/90	126	150	84%	16	22	72%		
06/28/90	N.A.	150	N.A.	N.A.	25	N.A.		
07/05/90	N.A.	150	N.A.	N.A.	27	N.A.		
07/12/90	N.A.	150	N.A.	N.A.	30	N.A.		
07/19/90	N.A.	150	N.A.	N.A.	33	N.A.		
07/26/90	N.A.	150	N.A.	N.A.	35	N.A.		
08/02/90	0	150	0%	N.A.	38	N.A.		
08/09/90	39	150	26%	N.A.	40	N.A.		
08/16/90	0	150	0%	N.A.	43	N.A.		
08/23/90	103	150	69%	N.A.	45	N.A.		
08/30/90	150	150	100%	N.A.	48	N.A.		
09/06/90	150	150	100%	N.A.	50	N.A.		
09/13/90	61	150	40%	N.A.	53	N.A.		
09/20/90	105	150	70%	N.A.	56	N.A.		
09/27/90	0	150	0%	N.A.	58	N.A.		
Average	N.A.	126	N.A.	N.A.	126	N.A.	N.A.	
Maximum	N.A.	150	N.A.	N.A.	150	N.A.	N.A.	

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (7/8)

Period	15v. Loss up to 13.4 Mile				15vi. Hardoi Branch 13.4 Mile				15vii. Loss between 13.4 to 53 Mile						
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)				
	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	(3)/(4)	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	(3)/(4)	Actual (1)	Roster (4)	(1)/(2)	Actual (3)	(3)/(4)
03/29/90	254	135	188%	4	2	188%	4	2	188%	557	815	68%	10	14	68%
04/05/90	39	135	29%	5	5	108%	141	135	104%	967	815	119%	26	28	94%
04/12/90	194	0		8	5	180%	152	135	113%	415	0		19	28	68%
04/19/90	64	0		9	5	204%	183	135	136%	964	0		35	28	127%
04/26/90	142	195	73%	12	8	149%	267	225	119%	1,233	815	151%	57	42	135%
05/03/90	-36	195	-19%	11	11	99%	360	315	114%	1,283	815	157%	79	56	141%
05/10/90	-10	0		11	11	98%	418	315	133%	653	0		90	56	161%
05/17/90	606	135	449%	21	14	158%	500	367	136%	1,147	815	141%	109	70	157%
05/24/90	131	195	67%	24	17	140%	590	457	129%	1,145	815	141%	129	84	154%
05/31/90	-881	195	-452%	9	20	42%	683	547	125%	1,075	815	132%	147	98	151%
06/07/90	-963	195	-494%	-8	24	-33%	776	637	122%	1,095	815	134%	166	112	149%
06/14/90	-604	195	-310%	-18	27	-68%	869	727	119%	1,011	815	124%	183	126	146%
06/21/90	-580	195	-297%	-28	30	-93%	939	817	115%	373	815	46%	190	139	136%
06/28/90	N.A.	195	N.A.	N.A.	34	N.A.	1,009	907	111%	817	815	100%	204	153	133%
07/05/90	N.A.	195	N.A.	N.A.	37	N.A.	1,092	997	110%	1,176	815	144%	224	167	134%
07/12/90	N.A.	195	N.A.	N.A.	40	N.A.	1,107	1,087	102%	-369	815	-45%	218	181	120%
07/19/90	N.A.	195	N.A.	N.A.	44	N.A.	1,181	1,177	100%	972	815	119%	234	195	120%
07/26/90	N.A.	195	N.A.	N.A.	47	N.A.	1,274	1,267	101%	1,168	815	143%	254	209	121%
08/02/90	-91	195	-46%	N.A.	50	N.A.	1,367	1,357	101%	1,235	815	152%	275	223	123%
08/09/90	107	195	55%	N.A.	54	N.A.	1,457	1,447	101%	924	815	113%	291	237	123%
08/16/90	-158	195	-81%	N.A.	57	N.A.	1,548	1,536	101%	986	815	121%	308	251	123%
08/23/90	-85	195	-44%	N.A.	60	N.A.	1,639	1,626	101%	1,012	815	124%	325	265	123%
08/30/90	99	195	51%	N.A.	64	N.A.	1,730	1,716	101%	1,064	815	131%	344	279	123%
09/06/90	208	195	107%	N.A.	67	N.A.	1,820	1,806	101%	817	815	100%	358	293	122%
09/13/90	71	195	36%	N.A.	70	N.A.	1,910	1,896	101%	1,090	815	134%	376	307	123%
09/20/90	134	195	69%	N.A.	74	N.A.	2,000	1,986	101%	1,452	815	178%	401	321	125%
09/27/90	188	195	96%	N.A.	77	N.A.	2,120	2,076	102%	1,035	815	127%	419	335	125%
Average	N.A.	167	N.A.	N.A.			4,588	4,495	102%	906	724	125%			
Maximum	N.A.	195	N.A.	N.A.			7,016	5,255	134%	1,452	815	178%			

Table A.12 Weekly Comparison of Actual & Roster Discharge - 1990 Kharif (8/8)

15viii. Hardoi Branch 53 Mile										
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)/(4)	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)			Roster (2)	Actual (3)	Roster (4)	(3)/(4)
03/29/90	3,259	2,900	56	50	112%	112%	0	0	0	0%
04/05/90	3,445	3,350	115	107	103%	107%	65	0%	1	0%
04/12/90	1,058	0	133	107	0	124%	0	0	1	0%
04/19/90	880	0	148	107	0	138%	0	0	1	0%
04/26/90	3,623	4,440	210	183	82%	115%	322	0%	7	0%
05/03/90	4,178	4,440	281	259	94%	109%	315	0%	12	0%
05/10/90	2,754	0	329	259	0	127%	0	0	12	0%
05/17/90	3,612	2,250	390	297	161%	131%	0	0	12	0%
05/24/90	4,111	4,440	461	373	93%	123%	322	0%	18	0%
05/31/90	4,359	4,440	535	449	98%	119%	315	0%	23	0%
06/07/90	4,339	4,440	610	525	96%	116%	322	0%	28	0%
06/14/90	4,423	4,440	685	601	100%	114%	65	0%	30	0%
06/21/90	3,754	4,440	750	677	85%	111%	322	0%	35	0%
06/28/90	3,230	4,440	805	753	73%	107%	315	0%	40	0%
07/05/90	3,724	4,440	869	829	84%	105%	322	0%	46	0%
07/12/90	1,193	4,440	889	905	27%	98%	65	0%	47	0%
07/19/90	3,559	4,440	946	981	76%	96%	322	0%	53	0%
07/26/90	4,266	4,440	1,019	1,057	96%	96%	315	0%	58	0%
08/02/90	4,199	4,440	1,091	1,133	95%	96%	322	0%	63	0%
08/09/90	4,342	4,440	1,166	1,209	98%	96%	65	0%	65	0%
08/16/90	4,368	4,440	1,240	1,285	98%	97%	322	0%	70	0%
08/23/90	4,293	4,440	1,314	1,361	97%	97%	315	0%	75	0%
08/30/90	4,247	4,440	1,387	1,437	96%	96%	322	0%	81	0%
09/06/90	4,445	4,440	1,463	1,513	100%	97%	65	0%	82	0%
09/13/90	4,172	4,440	1,534	1,589	94%	97%	322	0%	88	0%
09/20/90	3,810	4,440	1,599	1,665	86%	96%	315	0%	93	0%
09/27/90	5,981	4,440	1,702	1,741	135%	98%	322	0%	99	0%
Average	3,682	3,768			98%				213	
Maximum	5,981	4,440			135%				322	

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (1/8)

Period	1.Sharda River				2.Nepal Channel				3.Sharda Main Canal			
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	(1)/(2)	(3)	Roster (4)	(3)/(4)	Actual (1)	Roster (2)	(1)/(2)	Actual (3)	Roster (4)	(3)/(4)
10/05/89	14,841	12,500	119%	254	214	119%	264	150	176%	5	3	176%
10/12/89	12,688	11,800	108%	471	416	113%	264	150	176%	9	5	176%
10/19/89	11,952	10,400	115%	676	594	114%	N.A.	150	176%	14	8	176%
10/26/89	11,014	10,400	106%	864	772	112%	N.A.	150	N.A.	N.A.	10	N.A.
11/02/89	9,948	9,000	111%	1,035	926	112%	N.A.	150	N.A.	N.A.	13	N.A.
11/09/89	9,122	8,500	107%	1,191	1,071	111%	N.A.	150	N.A.	N.A.	15	N.A.
11/16/89	8,497	8,000	106%	1,336	1,208	111%	N.A.	150	N.A.	N.A.	18	N.A.
11/23/89	7,487	7,000	107%	1,476	1,337	110%	N.A.	150	N.A.	N.A.	21	N.A.
11/30/89	6,992	6,500	108%	1,724	1,568	110%	N.A.	150	N.A.	N.A.	26	N.A.
12/14/89	6,226	6,000	104%	1,831	1,671	110%	N.A.	150	N.A.	N.A.	28	N.A.
12/21/89	6,151	5,800	106%	1,936	1,770	109%	N.A.	150	N.A.	N.A.	31	N.A.
12/28/89	5,747	5,400	106%	2,034	1,862	109%	N.A.	150	N.A.	N.A.	33	N.A.
01/04/90	5,354	5,200	103%	2,126	1,951	109%	N.A.	150	N.A.	N.A.	36	N.A.
01/11/90	4,973	5,000	99%	2,211	2,037	109%	N.A.	150	N.A.	N.A.	39	N.A.
01/18/90	4,706	5,000	94%	2,292	2,122	108%	N.A.	150	N.A.	N.A.	41	N.A.
01/25/90	4,529	5,000	91%	2,369	2,208	107%	N.A.	150	N.A.	N.A.	44	N.A.
02/01/90	4,341	4,900	89%	2,443	2,292	107%	N.A.	150	N.A.	N.A.	46	N.A.
02/08/90	5,284	4,900	108%	2,534	2,376	107%	N.A.	150	N.A.	N.A.	49	N.A.
02/15/90	6,052	4,900	124%	2,637	2,460	107%	N.A.	150	N.A.	N.A.	51	N.A.
02/22/90	5,406	4,700	115%	2,730	2,540	107%	N.A.	150	N.A.	N.A.	54	N.A.
03/01/90	14,503	4,600	315%	2,978	2,619	114%	N.A.	150	N.A.	N.A.	56	N.A.
03/08/90	5,964	4,600	130%	3,080	2,697	114%	N.A.	150	N.A.	N.A.	59	N.A.
03/15/90	6,352	4,600	138%	3,189	2,776	115%	N.A.	150	N.A.	N.A.	62	N.A.
03/22/90	7,406	4,600	161%	3,316	2,855	116%	N.A.	150	N.A.	N.A.	64	N.A.
Average	7,749	6,672	116%				N.A.	150	N.A.			
Maximum	14,841	12,500	119%				N.A.	150	N.A.			

7,084 6,482 109%
11,471 11,500 100%

N.A. 150 N.A.
N.A. 150 N.A.

7,749 6,672 116%
14,841 12,500 119%

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (2/8)

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
10/05/89	0	80	0%	0	1	0%
10/12/89	23	80	29%	0	3	14%
10/19/89	0	80	0%	N.A.	4	N.A.
10/26/89	N.A.	0	N.A.	N.A.	4	N.A.
11/02/89	N.A.	0	N.A.	N.A.	4	N.A.
11/09/89	N.A.	80	N.A.	N.A.	5	N.A.
11/16/89	N.A.	80	N.A.	N.A.	7	N.A.
11/23/89	N.A.	0	N.A.	N.A.	7	N.A.
11/30/89	N.A.	0	N.A.	N.A.	7	N.A.
12/07/89	N.A.	0	N.A.	N.A.	7	N.A.
12/14/89	N.A.	60	N.A.	N.A.	8	N.A.
12/21/89	N.A.	60	N.A.	N.A.	9	N.A.
12/28/89	N.A.	60	N.A.	N.A.	10	N.A.
01/04/90	N.A.	0	N.A.	N.A.	10	N.A.
01/11/90	N.A.	0	N.A.	N.A.	10	N.A.
01/18/90	N.A.	0	N.A.	N.A.	10	N.A.
01/25/90	N.A.	50	N.A.	N.A.	11	N.A.
02/01/90	N.A.	50	N.A.	N.A.	12	N.A.
02/08/90	N.A.	50	N.A.	N.A.	12	N.A.
02/15/90	N.A.	0	N.A.	N.A.	12	N.A.
02/22/90	N.A.	0	N.A.	N.A.	12	N.A.
03/01/90	N.A.	50	N.A.	N.A.	13	N.A.
03/08/90	N.A.	50	N.A.	N.A.	14	N.A.
03/15/90	N.A.	50	N.A.	N.A.	15	N.A.
03/22/90	N.A.	0	N.A.	N.A.	15	N.A.

Average	N.A.	35	N.A.	N.A.
Maximum	N.A.	80	N.A.	N.A.

4. Khauria Channel						
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
10/05/89	805	800	101%	14	14	101%
10/12/89	345	800	43%	20	27	72%
10/19/89	345	800	43%	26	41	62%
10/26/89	799	800	100%	39	55	72%
11/02/89	839	800	107%	54	68	79%
11/09/89	569	800	71%	64	82	77%
11/16/89	426	800	53%	71	96	74%
11/23/89	0	0		71	96	74%
11/30/89	0	0		71	96	74%
12/07/89	0	0		71	96	74%
12/14/89	0	0		71	96	74%
12/21/89	470	0		79	96	82%
12/28/89	1,096	0		98	96	102%
01/04/90	1,096	0		116	96	121%
01/11/90	157	0		119	96	124%
01/18/90	0	0		119	96	124%
01/25/90	0	0		119	96	124%
02/01/90	0	0		119	96	124%
02/08/90	0	0		119	96	124%
02/15/90	115	0		121	96	126%
02/22/90	805	0		135	96	141%
03/01/90	230	0		139	96	145%
03/08/90	0	0		139	96	145%
03/15/90	0	0		139	96	145%
03/22/90	0	0		139	96	145%

Average	324	224	145%
Maximum	1,096	800	137%

5. New Sharda Sagar Feeder						
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
10/05/89	888.6	1,000	89%	15	17	89%
10/12/89	905.0	1,000	90%	31	34	90%
10/19/89	905.0	1,000	90%	46	51	90%
10/26/89	N.A.	1,000	N.A.	N.A.	68	N.A.
11/02/89	N.A.	0	N.A.	N.A.	68	N.A.
11/09/89	N.A.	0	N.A.	N.A.	68	N.A.
11/16/89	N.A.	0	N.A.	N.A.	68	N.A.
11/23/89	N.A.	800	N.A.	N.A.	82	N.A.
11/30/89	N.A.	800	N.A.	N.A.	96	N.A.
12/07/89	N.A.	0	N.A.	N.A.	96	N.A.
12/14/89	N.A.	0	N.A.	N.A.	96	N.A.
12/21/89	N.A.	0	N.A.	N.A.	96	N.A.
12/28/89	N.A.	0	N.A.	N.A.	96	N.A.
01/04/90	N.A.	0	N.A.	N.A.	96	N.A.
01/11/90	N.A.	0	N.A.	N.A.	96	N.A.
01/18/90	N.A.	0	N.A.	N.A.	96	N.A.
01/25/90	N.A.	0	N.A.	N.A.	96	N.A.
02/01/90	N.A.	0	N.A.	N.A.	96	N.A.
02/08/90	N.A.	0	N.A.	N.A.	96	N.A.
02/15/90	N.A.	0	N.A.	N.A.	96	N.A.
02/22/90	N.A.	0	N.A.	N.A.	96	N.A.
03/01/90	N.A.	0	N.A.	N.A.	96	N.A.
03/08/90	N.A.	0	N.A.	N.A.	96	N.A.
03/15/90	N.A.	0	N.A.	N.A.	96	N.A.
03/22/90	N.A.	0	N.A.	N.A.	96	N.A.

Average	N.A.	224	N.A.
Maximum	N.A.	1,000	N.A.

6. Old Sharda Deoha Feeder						
Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
10/05/89	888.6	1,000	89%	15	17	89%
10/12/89	905.0	1,000	90%	31	34	90%
10/19/89	905.0	1,000	90%	46	51	90%
10/26/89	N.A.	1,000	N.A.	N.A.	68	N.A.
11/02/89	N.A.	0	N.A.	N.A.	68	N.A.
11/09/89	N.A.	0	N.A.	N.A.	68	N.A.
11/16/89	N.A.	0	N.A.	N.A.	68	N.A.
11/23/89	N.A.	800	N.A.	N.A.	82	N.A.
11/30/89	N.A.	800	N.A.	N.A.	96	N.A.
12/07/89	N.A.	0	N.A.	N.A.	96	N.A.
12/14/89	N.A.	0	N.A.	N.A.	96	N.A.
12/21/89	N.A.	0	N.A.	N.A.	96	N.A.
12/28/89	N.A.	0	N.A.	N.A.	96	N.A.
01/04/90	N.A.	0	N.A.	N.A.	96	N.A.
01/11/90	N.A.	0	N.A.	N.A.	96	N.A.
01/18/90	N.A.	0	N.A.	N.A.	96	N.A.
01/25/90	N.A.	0	N.A.	N.A.	96	N.A.
02/01/90	N.A.	0	N.A.	N.A.	96	N.A.
02/08/90	N.A.	0	N.A.	N.A.	96	N.A.
02/15/90	N.A.	0	N.A.	N.A.	96	N.A.
02/22/90	N.A.	0	N.A.	N.A.	96	N.A.
03/01/90	N.A.	0	N.A.	N.A.	96	N.A.
03/08/90	N.A.	0	N.A.	N.A.	96	N.A.
03/15/90	N.A.	0	N.A.	N.A.	96	N.A.
03/22/90	N.A.	0	N.A.	N.A.	96	N.A.

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (3/8)

Period	7.Nagra Escape				8.New Sharda Deoha Feeder				9.Bisalpur Branch						
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)				
	Actual (1)	Roster (2)	(1)/(2)	(3)	(4)	Actual (1)	Roster (2)	(1)/(2)	(3)	(4)	Actual (1)	Roster (2)	(1)/(2)	(3)/(4)	
10/05/89	374	0		6	0	1,201	1,200	100%	21	21	304	350	87%	5	6
10/12/89	3,037	0		58	0	1,201	1,200	100%	41	41	304	350	87%	10	12
10/19/89	753	0		71	0	1,201	1,200	100%	62	62	245	350	70%	15	18
10/26/89	186	0		74	0	1,201	1,200	100%	82	82	29	0		15	18
11/02/89	143	0		77	0	1,037	0		100	82	79	0		16	18
11/09/89	557	0		86	0	853	0		115	82	0	0		16	18
11/16/89	1,708	0		116	0	583	1,200	49%	125	103	0	300	0%	16	23
11/23/89	132	0		118	0	515	1,200	43%	133	123	253	300	84%	21	28
11/30/89	0	0		118	0	1,201	1,200	100%	154	144	72	250	29%	22	33
12/07/89	0	0		118	0	142	0		156	144	0	0		22	33
12/14/89	0	0		118	0	398	0		156	144	36	0		23	33
12/21/89	898	0		133	0	810	1,100	74%	177	163	136	0		25	33
12/28/89	627	0		144	0	1,096	1,100	100%	196	181	215	250	86%	29	37
01/04/90	0	0		144	0	1,096	1,000	110%	215	199	251	250	100%	33	41
01/11/90	0	0		144	0	157	0		217	199	36	0		37	45
01/18/90	0	0		144	0	0	0		217	199	0	0		38	45
01/25/90	0	0		144	0	0	0		217	199	0	0		38	45
02/01/90	0	0		144	0	736	1,100	67%	230	217	175	0		41	45
02/08/90	0	0		144	0	920	1,100	84%	246	236	244	250	98%	45	50
02/15/90	0	0		144	0	157	0		248	236	130	250	52%	47	54
02/22/90	0	0		144	0	0	0		248	236	0	0		47	54
03/01/90	878	0		159	0	0	0		248	236	0	0		47	54
03/08/90	132	0		161	0	0	0		248	236	0	0		47	54
03/15/90	1,150	0		181	0	0	850	0%	248	251	0	250	0%	47	58
03/22/90	2,362	0		221	0	263	900	29%	253	266	0	250	0%	47	62
Average	517	0				591	622	95%			110	146	76%		
Maximum	3,037	0				1,201	1,200	100%			304	350	87%		

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (4/8)

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
10/05/89	441	500	88%	8	9	88%
10/12/89	401	500	80%	14	17	84%
10/19/89	401	500	80%	21	26	83%
10/26/89	401	0		28	26	110%
11/02/89	251	0		32	26	126%
11/09/89	122	0		35	26	138%
11/16/89	122	450	27%	37	33	112%
11/23/89	322	450	72%	43	41	105%
11/30/89	451	450	100%	51	49	104%
12/07/89	64	0		52	49	106%
12/14/89	0	0		52	49	106%
12/21/89	286	0		57	49	116%
12/28/89	401	400	100%	64	56	114%
01/04/90	401	400	100%	70	62	113%
01/11/90	401	400	100%	77	69	111%
01/18/90	57	0		78	69	113%
01/25/90	0	0		78	69	113%
02/01/90	217	0		82	69	118%
02/08/90	387	400	97%	89	76	116%
02/15/90	344	400	86%	94	83	114%
02/22/90	0	0		94	83	114%
03/01/90	0	0		94	83	114%
03/08/90	0	0		94	83	114%
03/15/90	0	400	0%	94	90	105%
03/22/90	87	400	22%	96	97	99%
Average	224	226	99%			
Maximum	451	500	90%			

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
	97	400	24%	2	7	24%
	388	400	97%	8	14	61%
	1,077	400	269%	27	21	130%
	N.A.	670	N.A.	N.A.	32	N.A.
	N.A.	400	N.A.	N.A.	39	N.A.
	N.A.	400	N.A.	N.A.	46	N.A.
	N.A.	400	N.A.	N.A.	53	N.A.
	N.A.	400	N.A.	N.A.	59	N.A.
	N.A.	400	N.A.	N.A.	66	N.A.
	N.A.	400	N.A.	N.A.	73	N.A.
	N.A.	400	N.A.	N.A.	80	N.A.
	N.A.	400	N.A.	N.A.	87	N.A.
	N.A.	400	N.A.	N.A.	94	N.A.
	N.A.	400	N.A.	N.A.	100	N.A.
	N.A.	500	N.A.	N.A.	109	N.A.
	N.A.	400	N.A.	N.A.	116	N.A.
	N.A.	400	N.A.	N.A.	123	N.A.
	N.A.	400	N.A.	N.A.	130	N.A.
	N.A.	400	N.A.	N.A.	136	N.A.
	N.A.	400	N.A.	N.A.	143	N.A.
	N.A.	400	N.A.	N.A.	150	N.A.
	N.A.	400	N.A.	N.A.	157	N.A.
	N.A.	400	N.A.	N.A.	164	N.A.
	N.A.	400	N.A.	N.A.	171	N.A.
	N.A.	400	N.A.	N.A.	177	N.A.
Average	N.A.	415	N.A.			
Maximum	N.A.	670	N.A.			

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(1)/(2)	(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)		
	7,360	7,170	103%	126	123	103%
	4,867	7,170	68%	209	245	85%
	6,543	5,920	111%	321	347	95%
	7,630	6,580	116%	452	459	98%
	7,144	7,650	93%	574	590	97%
	5,632	7,070	80%	671	711	94%
	4,337	4,620	94%	745	790	94%
	4,812	4,200	115%	827	862	96%
	4,154	3,750	111%	898	926	97%
	5,525	5,950	93%	993	1,028	97%
	5,810	5,990	108%	1,092	1,121	97%
	3,849	5,190	74%	1,158	1,209	96%
	2,430	3,040	80%	1,200	1,261	95%
	2,666	2,900	92%	1,245	1,311	95%
	2,892	2,700	107%	1,295	1,357	95%
	4,362	4,450	98%	1,370	1,433	96%
	4,185	4,400	95%	1,441	1,509	96%
	3,023	4,500	70%	1,495	1,882	94%
	2,569	2,550	101%	1,537	1,626	95%
	4,691	2,600	180%	1,617	1,671	97%
	4,752	4,150	115%	1,698	1,742	98%
	5,100	4,000	127%	1,786	1,810	99%
	5,339	4,000	133%	1,877	1,878	100%
	4,845	2,500	194%	1,960	1,921	102%
	3,633	2,500	146%	2,023	1,964	103%
Average	4,727	4,590	103%			
Maximum	7,630	7,650	100%			

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (5/8)

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)	
10/05/89	3,165	3,500	54	60	90%
10/12/89	1,217	3,500	75	120	63%
10/19/89	1,312	1,520	97	145	67%
10/26/89	1,608	180	125	149	84%
11/02/89	1,484	1,250	150	170	88%
11/09/89	750	970	173	187	87%
11/16/89	542	1,820	173	218	79%
11/23/89	732	0	185	218	85%
11/30/89	585	0	195	218	89%
12/07/89	578	0	205	218	94%
12/14/89	256	0	209	218	96%
12/21/89	1,978	2,590	243	262	93%
12/28/89	1,055	440	261	270	97%
01/04/90	127	0	263	270	98%
01/11/90	37	0	264	270	98%
01/18/90	0	0	264	270	98%
01/25/90	0	0	264	270	98%
02/01/90	206	1,900	268	302	88%
02/08/90	115	150	270	305	88%
02/15/90	1,102	0	288	305	95%
02/22/90	831	0	303	305	99%
03/01/90	3,142	0	356	305	117%
03/08/90	2,339	0	396	305	130%
03/15/90	664	0	408	305	134%
03/22/90	503	0	416	305	137%
Average	973	713			137%
Maximum	3,165	3,500			90%

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)	
229	0	0	4	0	
1,287	0	0	26	0	
1,930	2,000	96%	59	34	172%
2,001	2,000	100%	93	68	136%
2,180	2,800	78%	131	116	112%
2,210	2,800	79%	168	164	102%
316	0	0	174	164	106%
0	0	0	174	164	106%
1,429	2,000	71%	198	199	100%
2,001	2,000	100%	232	233	100%
1,401	2,600	54%	236	277	92%
1,375	2,600	53%	280	322	87%
229	0	0	284	322	88%
0	0	0	284	322	88%
1,551	1,800	86%	310	353	88%
2,318	2,400	97%	330	394	89%
2,574	2,400	107%	394	435	91%
2,281	2,400	95%	433	476	91%
343	0	0	439	476	92%
718	1,000	72%	451	493	92%
1,005	1,000	100%	469	510	92%
431	1,000	43%	476	527	90%
1,079	2,500	43%	494	570	87%
174	0	0	497	570	87%
1,162	1,332	87%			
2,574	2,800	92%			

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		(3)/(4)
	Actual (1)	Roster (2)	Actual (3)	Roster (4)	
3,966	3,670	108%	68	63	108%
3,650	3,670	99%	130	126	104%
3,944	4,400	90%	198	201	98%
4,093	4,400	93%	268	276	97%
3,659	4,400	83%	331	352	94%
2,702	3,300	82%	377	408	92%
1,585	0	0	404	408	99%
3,764	4,200	90%	468	480	98%
3,569	3,750	95%	529	544	97%
3,517	3,950	89%	590	612	96%
3,553	3,390	105%	650	670	97%
471	0	0	658	670	98%
0	0	0	658	670	98%
2,311	2,900	80%	698	719	97%
2,855	2,700	106%	747	766	98%
2,811	2,650	106%	795	811	98%
1,867	2,000	93%	827	845	98%
243	0	0	831	845	98%
173	0	0	834	845	99%
3,246	2,600	125%	890	890	100%
3,203	3,150	102%	944	944	100%
953	3,000	32%	961	995	97%
2,569	3,000	86%	1,005	1,046	96%
3,102	0	0	1,058	1,046	101%
2,976	2,500	119%	1,109	1,089	102%
2,591	2,545	102%			
4,093	4,400	93%			

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (6/8)

Period	Periodical Discharge (cusec)				Accumulated Discharge (MCM)			
	Roster		(1)/(2)		Actual		(3)/(4)	
	(1)	(2)	(1)/(2)	(3)	(4)	(3)/(4)		
10/05/89	859	0		15	0			
10/12/89	114	0		17	0			
10/19/89	879	1,300	68%	32	22	142%		
10/26/89	1,347	1,300	104%	55	45	123%		
11/02/89	1,347	1,300	104%	78	67	117%		
11/09/89	661	0		89	67	133%		
11/16/89	456	0		97	67	145%		
11/23/89	1,277	1,260	101%	119	88	134%		
11/30/89	1,844	1,910	97%	150	121	124%		
12/07/89	1,714	1,420	121%	180	145	124%		
12/14/89	1,546	2,370	65%	206	186	111%		
12/21/89	405	0		213	186	115%		
12/28/89	0	0		213	186	115%		
01/04/90	2,303	2,410	96%	252	227	111%		
01/11/90	2,805	2,810	100%	300	275	109%		
01/18/90	2,992	3,010	99%	352	327	108%		
01/25/90	2,992	3,250	92%	403	382	105%		
02/01/90	427	0		410	382	107%		
02/08/90	286	0		415	382	109%		
02/15/90	1,015	410	248%	432	389	111%		
02/22/90	160	0		435	389	112%		
03/01/90	0	660	0%	435	401	109%		
03/08/90	0	0		435	401	109%		
03/15/90	0	0		435	401	109%		
03/22/90	825	0		449	401	112%		
Average	1,050	956	112%					
Maximum	2,992	3,250	92%					

15ii. 15i + 15ii			
Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
Actual	Roster	Actual	Roster
(1)	(2)	(3)	(4)
4,825	3,670	83	63
3,763	3,670	147	126
4,823	5,700	230	223
5,440	5,700	323	321
5,006	5,700	408	418
3,363	3,300	466	475
2,041	0	501	475
5,041	5,460	587	568
5,413	5,660	680	665
5,231	5,370	769	757
5,099	5,760	857	856
876	0	872	856
0	0	872	856
4,613	5,310	950	947
5,660	5,510	1,047	1,041
5,803	5,660	1,147	1,138
4,859	5,250	1,230	1,228
670	0	1,241	1,228
459	0	1,249	1,228
4,261	3,010	1,322	1,279
3,563	3,150	1,580	1,533
953	3,660	1,396	1,396
2,569	3,000	1,440	1,447
3,102	0	1,493	1,447
3,800	2,500	1,558	1,490
3,641	3,482		
5,803	5,760		

15iv. Madhotanda Distributary			
Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
Actual	Roster	Actual	Roster
(1)	(2)	(3)	(4)
12	0	0	0
0	0	0	0
0	150	0	3
86	150	2	5
120	150	4	8
120	150	6	10
17	0	6	10
107	150	8	13
120	150	10	13
120	150	12	18
137	150	14	21
0	0	14	21
0	0	14	21
0	0	14	21
129	0	17	21
150	150	19	23
99	150	21	26
12	0	21	26
0	0	21	26
0	0	21	26
0	0	21	26
0	150	21	28
0	150	21	31
0	0	21	31
58	0	22	31
52	72		
150	150		

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (7/8)

Period	15v. Loss up to 13.4 Mile				15vi. Hardot Branch 13.4 Mile				15vii. Loss between 13.4 to 52 Mile			
	Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)		Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	(1)/(2)	(3)	Roster (4)	(3)/(4)	Actual (3)	Roster (4)	(3)/(4)	Actual (3)	Roster (4)	(3)/(4)
10/05/89	10	145	7%	0.2	2.5	7%	82	60	136%	769	805	96%
10/12/89	-124	135	-92%	-2	5	-41%	3,887	3,355	110%	935	815	117%
10/19/89	-318	195	-163%	-7	8	-91%	5,141	5,555	96%	1,179	815	145%
10/26/89	-62	195	-32%	-8	11	-74%	5,416	5,355	101%	1,083	815	133%
11/02/89	-41	195	-21%	-9	15	-62%	4,927	5,355	92%	1,105	815	136%
11/09/89	-349	135	-259%	-15	17	-88%	3,592	3,015	119%	847	815	104%
11/16/89	145	0		-13	17	-74%	1,878	0		323	0	
11/23/89	-64	195	-33%	-14	20	-67%	4,998	5,115	98%	1,271	815	156%
11/30/89	-185	195	-95%	-17	24	-71%	5,478	5,315	103%	1,339	815	164%
12/07/89	-47	205	-23%	-18	27	-65%	5,158	5,015	103%	1,065	815	131%
12/14/89	7	195	4%	-18	31	-57%	4,954	5,415	91%	1,052	815	129%
12/21/89	206	0		-14	31	-46%	670	0		-283	0	
12/28/89	0	0		-14	31	-46%	0	0		0	0	
01/04/90	N.A.	195	N.A.	N.A.	34	N.A.	4,115	5,115	80%	1,289	815	158%
01/11/90	N.A.	295	N.A.	N.A.	39	N.A.	5,256	5,215	101%	1,292	715	181%
01/18/90	N.A.	195	N.A.	N.A.	42	N.A.	5,300	5,315	100%	1,157	815	142%
01/25/90	N.A.	195	N.A.	N.A.	46	N.A.	4,527	4,905	92%	738	815	90%
02/01/90	N.A.	0	N.A.	N.A.	46	N.A.	643	0		-354	0	
02/08/90	21	0		N.A.	46	N.A.	438	0		438	0	
02/15/90	-106	195	-54%	N.A.	49	N.A.	4,367	2,815	155%	770	815	94%
02/22/90	23	135	17%	N.A.	51	N.A.	3,339	3,015	111%	631	815	77%
03/01/90	-514	195	-263%	N.A.	55	N.A.	1,467	3,315	44%	-258	815	-32%
03/08/90	359	135	266%	N.A.	57	N.A.	2,210	2,715	81%	567	815	70%
03/15/90	15	0		N.A.	57	N.A.	3,087	0		718	0	
03/22/90	110	135	81%	N.A.	59	N.A.	3,633	2,365	154%	910	815	112%
Average	N.A.	199	N.A.				3,571	3,271	109%	745	615	121%
Maximum	N.A.	295	N.A.				5,478	5,415	101%	1,339	815	164%

Table A.13 Weekly Comparison of Actual & Roster Discharge - 1989/90 Rabi (8/8)

15viii. Hardoi Branch 53 Mile

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)
10/05/89	4,034	2,720	69	47
10/12/89	2,935	2,720	119	93
10/19/89	3,962	4,540	187	171
10/26/89	4,333	4,540	261	249
11/02/89	3,822	4,540	327	326
11/09/89	2,744	2,200	374	364
11/16/89	1,556	0	400	364
11/23/89	3,727	4,300	464	437
11/30/89	4,140	4,500	535	515
12/07/89	4,093	4,200	603	586
12/14/89	3,903	4,600	672	665
12/21/89	953	0	688	665
12/28/89	0	0	688	665
01/04/90	2,826	4,300	736	739
01/11/90	3,964	4,500	804	816
01/18/90	4,143	4,500	875	893
01/25/90	3,790	4,050	940	963
02/01/90	977	0	957	963
02/08/90	0	0	957	963
02/15/90	3,597	2,000	1,018	997
02/22/90	2,709	2,200	1,065	1,035
03/01/90	1,725	2,500	1,094	1,077
03/08/90	1,643	1,900	1,122	1,110
03/15/90	2,368	0	1,163	1,110
03/22/90	2,722	1,550	1,209	1,136
Average	2,827	2,656	106%	
Maximum	4,333	4,600	94%	

15ix. Shambad Distributory etc

Period	Periodical Discharge (cusec)		Accumulated Discharge (MCM)	
	Actual (1)	Roster (2)	Actual (3)	Roster (4)
10/05/89	N.A.	200	N.A.	3
10/12/89	N.A.	200	N.A.	7
10/19/89	N.A.	365	N.A.	13
10/26/89	N.A.	372	N.A.	19
11/02/89	N.A.	265	N.A.	24
11/09/89	N.A.	0	N.A.	24
11/16/89	N.A.	0	N.A.	24
11/23/89	N.A.	75	N.A.	25
11/30/89	N.A.	272	N.A.	30
12/07/89	N.A.	262	N.A.	34
12/14/89	N.A.	265	N.A.	39
12/21/89	N.A.	0	N.A.	39
12/28/89	N.A.	0	N.A.	39
01/04/90	N.A.	76	N.A.	40
01/11/90	N.A.	265	N.A.	45
01/18/90	N.A.	272	N.A.	49
01/25/90	N.A.	272	N.A.	54
02/01/90	N.A.	10	N.A.	54
02/08/90	N.A.	0	N.A.	54
02/15/90	N.A.	200	N.A.	58
02/22/90	N.A.	200	N.A.	61
03/01/90	N.A.	0	N.A.	61
03/08/90	N.A.	0	N.A.	61
03/15/90	N.A.	0	N.A.	61
03/22/90	N.A.	0	N.A.	61
Average	N.A.	143	N.A.	
Maximum	N.A.	372	N.A.	

Table A.14 An Example of Re-distribution of water through Nagra Escape (1/2)

Present Condition

1989/90 Rabi

Period	Nagra (*1) (6,500)	S.S.Outlet (2,800)	Hardoi 13.4M (5,700)	Main (11,500)	Hardoi H (4,400)	Kheri H (2,800)
10/05/89	(*2) 374	(*3) 1,941	875	29	434	2,571
10/12/89	3,037	2,686	1,937	29	750	2,800
10/19/89	753	1,921	877	29	456	1,513
10/26/89	186	1,453	260	755	307	870
11/02/89	143	1,453	694	1,725	741	799
11/09/89	557	2,139	2,337	2,551	1,698	620
11/16/89	1,708	2,344	3,659	3,176	2,815	590
11/23/89	132	1,523	659	3,482	636	2,484
11/30/89	0	956	287	4,185	831	2,800
12/07/89	0	1,086	469	4,681	883	1,371
12/14/89	0	1,254	601	5,447	847	799
12/21/89	898	2,395	4,824	5,522	3,929	1,399
12/28/89	627	2,800	5,700	5,923	4,400	1,425
01/04/90	0	497	1,087	6,318	2,089	2,571
01/11/90	0	-5	40	6,700	1,545	2,800
01/18/90	0	-192	-103	6,967	1,589	1,249
01/25/90	0	-192	841	7,158	2,533	482
02/01/90	0	2,373	5,030	7,332	4,157	226
02/08/90	0	2,514	5,241	6,389	4,227	519
02/15/90	0	1,785	1,439	5,498	1,154	2,457
02/22/90	0	2,640	2,337	6,114	1,197	2,082
03/01/90	878	2,800	4,747	4,639	3,447	1,795
03/08/90	132	2,800	3,131	5,556	1,831	2,369
03/15/90	1,150	2,800	2,598	5,168	1,298	1,721
03/22/90	2,362	1,975	1,900	5,014	1,424	2,626

Remarks

*1: capacity of canal(cusec)

*2: actual discharge of Nagra Escape

*3: remaining capacity before re-distribution



: Roster discharge is zero

Table A.14 An Example of Re-distribution of water through Nagra Escape (2/2)
After redistribution

1989/90 Rabi

Period	Nagra (*1) (6,500)	S.S.Outlet (2,800)	Hardoi 13.4M (5,700)	Main (11,500)	Hardoi H (4,400)	Kheri H (2,800)
10/05/89	(*) (3) 0 374	374 (*4) (*5) 1,941	875	29	434	2,571
10/12/89	1,071 3,037	1,937 2,686	1,937	29	750	2,800
10/19/89	0 753	753 1,921	877	29	456	1,513
10/26/89	0 186	186 1,453	260	755	307	870
11/02/89	0 143	143 1,453	694	1,725	741	799
11/09/89	0 557	557 2,139	2,337	2,551	1,698	620
11/16/89	0 1,708	1,118 2,344	3,659	3,176	2,815	590
11/23/89	0 132	132 1,523	659	3,482	636	2,484
11/30/89	0	956	287	4,185	831	2,800
12/07/89	0	1,086	469	4,681	883	1,371
12/14/89	0	1,254	601	5,447	847	799
12/21/89	0 898	2,395	4,824	5,522	3,929	898
12/28/89	0 627	2,800	5,700	5,923	4,400	627
01/04/90	0	497	1,087	6,318	2,089	2,571
01/11/90	0	-5	40	6,700	1,545	2,800
01/18/90	0	-192	-103	6,967	1,589	1,249
01/25/90	0	-192	841	7,158	2,533	482
02/01/90	0	2,373	5,030	7,332	4,157	226
02/08/90	0	2,514	5,241	6,389	4,227	519
02/15/90	0	1,785	1,439	5,498	1,154	2,457
02/22/90	0	2,640	2,337	6,114	1,197	2,082
03/01/90	0 878	878 2,800	4,747	4,639	3,447	1,795
03/08/90	0 132	132 2,800	3,131	5,556	1,831	2,369
03/15/90	0 1,150	2,800	2,598	5,168	1,298	1,150
03/22/90	0 2,362	1,900 1,975	1,900	5,014	1,424	462
						2,626

Remarks

- *1: capacity of canal(cusec)
- *2: discharge of Nagra Esc. after re-distribution
- *3: actual discharge of Nagra Esc.
- *4: re-distributed water (cusec)
- *5: remaining capacity before re-distribution



: Roster Discharge is zero

Table A.15 Irrigation Efficiency by Canal System with/without Project

Canal System	Kharif		Rabi		Remarks
	Present	Improved	Present	Improved	
Main Canal (conveyance/operation efficiency)	0.95	0.97	0.92	0.95	Estimated from actual water distribution Efficiency will be improved by wireless communication system.
Hardoi Branch at Head (conveyance/operation efficiency)	0.70	0.75	0.75	0.77	do
Hardoi Branch at 23 mile (conveyance/operation efficiency)	0.73	0.78	0.78	0.80	do
Hardoi Branch at 53 mile (conveyance/operation efficiency)	0.75	0.80	0.80	0.82	do
Hardoi Branch at 99 mile (conveyance/operation efficiency)	0.78	0.83	0.83	0.85	do
Hardoi Branch at Tail (conveyance/operation efficiency)	0.80	0.85	0.85	0.87	do
Khert Branch at Head (conveyance/operation efficiency)	0.70	0.75	0.75	0.77	do
Lucknow Branch at Head (conveyance/operation efficiency)	0.75	0.80	0.80	0.82	do
Lucknow Branch at 72 mile (conveyance/operation efficiency)	0.80	0.85	0.85	0.87	do
Unnao, Purwa, Asawan Branch (conveyance/operation efficiency)	0.80	0.85	0.85	0.87	do
Distributary/Minor (conveyance/operation efficiency)	0.80	0.85	0.85	0.87	Estimated based upon field measurement. Partial lining and modernized facilities will enhance efficiency.
Watercourse (conveyance efficiency)	0.78	0.95	0.78	0.95	Estimated based upon the report on "Upper Ganga Project". Complete lining will enhance efficiency.
Farmland (application efficiency)	0.70	0.80	0.60	0.70	Estimated based upon the report on "Upper Ganga Project". On-farm works will improve efficiency.

Table A.16 Water Distribution under Present Condition (1/2) - Kharif

Canal System	Kharif(1986 - 1990)											
	CCA (1) (ha)	AIA (2) (ha)	PIA (3) (ha)	AIA/PIA (4) (%)	ASV (5) (MCM)	FAPE (6)	CON.EI (7)	CON.EI (8)	OVLE (9)	FSV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)
Sharda Main Canal at Head	1,612,633	301,365	387,032	78%	4,395	0.55	0.80	0.67	0.29	1,275	1,927	66%
at Bifurcation	1,080,886	(187,591)	259,413	72%	3,265	0.55	0.80	0.70	0.31	1,012	1,157	87%
Kheri Branch Canal	323,114	(60,383)	77,547	78%	960	0.55	0.80	0.70	0.31	298	403	74%
Hardoi Branch Canal at Head	757,772	127,208	181,865	70%	2,305	0.55	0.80	0.70	0.31	715	754	95%
at 23 miles	723,599	123,008	173,664	71%	2,043	0.55	0.80	0.73	0.32	654	726	90%
at 35 miles	668,895	109,628	160,535	68%	1,696	0.55	0.80	0.75	0.33	560	635	88%
Lucknow Branch Canal (55 miles) at 99 miles	308,771	48,733	74,105	66%	651	0.55	0.80	0.78	0.34	221	291	76%
Asiwan Branch Canal at Tail	152,379	25,669	36,571	70%	265	0.55	0.80	0.80	0.35	93	137	68%
Purwa, Unnao Branch Canal												
Lucknow Branch Canal at Head	281,443	44,961	67,546	67%	731	0.55	0.80	0.75	0.33	241	238	100%
Sandia Branch Canal (50 miles) at 72 miles	97,570	17,237	23,417	74%	256	0.55	0.80	0.80	0.35	90	91	99%
Sandia Branch Canal at Head	71,672	8,921	17,201	52%	154	0.55	0.80	0.80	0.35	54	47	100%
Asiwan Branch Canal at Head	85,511	11,535	20,523	56%	126	0.55	0.80	0.80	0.35	44	62	71%
Purwa Branch Canal at Head	74,565	14,922	17,896	83%	168	0.55	0.80	0.80	0.35	59	80	74%
at 30 miles	32,638	5,485	7,833	70%	87	0.55	0.80	0.80	0.35	30	29	100%
Unnao Branch Canal at Head	77,814	10,747	18,675	58%	96	0.55	0.80	0.80	0.35	34	57	60%
at 33 miles	31,465	3,327	7,552	44%	17	0.55	0.80	0.80	0.35	6	18	33%

Remarks: (1) Culturable commanded area
 (2) Actual irrigated area
 (3) Proposed Irrigated Area(24% of CCA)
 (4) Rate of AIA to PIA
 (5) Actual supplied volume
 (6) Application efficiency inclusive of conveyance efficiency of watercourse
 (7) Conveyance loss of Distributary/Minor
 (8) Conveyance loss of Main/Branch
 (9) Overall irrigation efficiency
 (10) Supplied volume to farmland
 (11) Field irrigation requirements
 (12) Irrigation sufficiency to crop water requirements

Source: Actual irrigation area and volume were collected from Irrigation Department of UP
 Irrigation efficiency was estimated based upon measurement and "Upper Ganges Project" and FAO Irrigation and Drainage Paper
 Ground water availability was estimated based upon Reports by Ground Water Department of UP

Table A.16 Water Distribution under Present Condition (2/2) - Rabi

Canal System	Rabi(1986/87 - 1989/90)											
	CCA (1) (ha)	AIA (2) (ha)	PIA (3) (ha)	ALA/PIA (4) (%)	ASV (5) (MCM)	FAPE (6)	CON.E2 (7)	CON.E1 (8)	OVIE (9)	FSV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)
Sharda Main Canal at Head	1,612,633	329,422	403,158	82%	2,982	0.47	0.80	0.69	0.26	775	1,415	55%
at Bifurcation	1,080,886	(228,243)	270,222	84%	1,906	0.47	0.80	0.75	0.28	534	911	59%
Khori Branch Canal	323,114	(66,004)	80,779	82%	561	0.47	0.80	0.75	0.28	157	257	61%
Hardoi Branch Canal at Head	757,772	162,239	189,443	86%	1,345	0.47	0.80	0.75	0.28	379	654	58%
at 23 miles	723,599	158,567	180,900	88%	1,226	0.47	0.80	0.78	0.29	360	636	57%
at 53 miles	668,895	145,756	167,224	87%	962	0.47	0.80	0.80	0.30	289	572	51%
Lucknow Branch Canal (55 miles) at 99 miles	308,771	65,419	77,193	85%	372	0.47	0.80	0.83	0.31	116	254	46%
Asiwan Branch Canal at Tail	152,379	32,650	38,095	86%	198	0.47	0.80	0.85	0.32	63	126	50%
Purwa, Unnao Branch Canal												
Lucknow Branch Canal at Head	281,443	62,806	70,361	89%	364	0.47	0.80	0.80	0.30	110	250	44%
Sandila Branch Canal (50 miles) at 72 miles	97,570	18,749	24,393	77%	135	0.47	0.80	0.85	0.32	43	75	58%
Sandila Branch Canal at Head	71,672	17,637	17,918	98%	86	0.47	0.80	0.85	0.32	27	70	39%
Asiwan Branch Canal at Head	85,511	16,423	21,378	77%	68	0.47	0.80	0.85	0.32	22	63	35%
Purwa Branch Canal at Head	74,565	17,932	18,641	96%	125	0.47	0.80	0.85	0.32	40	69	58%
at 30 miles	32,638	7,677	8,160	94%	72	0.47	0.80	0.85	0.32	23	30	76%
Unnao Branch Canal at Head	77,814	14,718	19,454	76%	73	0.47	0.80	0.85	0.32	23	57	41%
at 33 miles	31,465	4,683	7,866	60%	17	0.47	0.80	0.85	0.32	5	18	30%

Remarks: (1) Culturable commanded area
 (2) Actual irrigated area
 (3) Proposed Irrigated Area(25% of CCA)
 (4) Rate of AIA to PIA
 (5) Actual supplied volume
 (6) Application efficiency inclusive of conveyance efficiency of watercourse
 (7) Conveyance loss of Distributary/Minor
 (8) Conveyance loss of Main/Branch
 (9) Overall irrigation efficiency
 (10) Supplied volume to farmland
 (11) Field irrigation requirements
 (12) Irrigation sufficiency to crop water requirements

Source: Actual irrigation area and volume were collected from Irrigation Department of UP
 Irrigation efficiency was estimated based upon measurement and "Upper Ganges Project" and FAO Irrigation and Drainage Paper
 Ground water availability was estimated based upon Reports by Ground Water Department of UP

Table A.17 Water Distribution under Improved Condition by CAD Works and Wireless Communication System (1/2)- Kharif

Canal System	Kharif(1986-1990)											
	CCA (1) (ha)	AIA (2) (ha)	PIA (3) (ha)	AIA/PIA (4) (%)	ASV (5) (MCM)	FAPE (6)	CON.EZ (7)	CON.EI (8)	O.V.I.E (9)	FSV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)
Sharda Main Canal at Head	1,612,633	301,365	387,032	78%	4,395	0.76	0.85	0.73	0.47	2,066	1,927	100%
at Bifurcation	1,080,886	(187,590)	259,413	72%	3,265	0.76	0.85	0.75	0.48	1,567	1,157	100%
Kheri Branch Canal	323,114	(60,383)	77,547	78%	960	0.76	0.85	0.75	0.48	461	403	100%
Hardoi Branch Canal at Head	757,772	127,208	181,865	70%	2,305	0.76	0.85	0.75	0.48	1,117	754	100%
at 23 miles	723,599	123,008	173,664	71%	2,043	0.76	0.85	0.78	0.50	1,029	726	100%
at 53 miles	669,895	109,628	160,535	68%	1,696	0.76	0.85	0.80	0.52	876	635	100%
Lucknow Branch Canal (55 miles) at 99 miles	308,771	48,733	74,105	66%	651	0.76	0.85	0.83	0.54	349	291	100%
Asiwan Branch Canal at Tail	152,379	25,669	36,571	70%	265	0.76	0.85	0.85	0.55	145	137	100%
Purwa, Unnao Branch Canal												
Lucknow Branch Canal at Head	281,443	44,961	67,546	67%	731	0.76	0.85	0.80	0.52	378	238	100%
Sandila Branch Canal (50 miles) at 72 miles	97,570	17,237	23,417	74%	256	0.76	0.85	0.85	0.55	140	91	100%
Sandila Branch Canal at Head	71,672	8,921	17,201	52%	154	0.76	0.85	0.85	0.55	84	47	100%
Asiwan Branch Canal at Head	85,511	11,535	20,523	56%	126	0.75	0.85	0.85	0.55	69	62	100%
Purwa Branch Canal at Head	74,565	14,922	17,896	83%	168	0.76	0.85	0.85	0.55	92	80	100%
at 30 miles	32,638	5,485	7,833	70%	87	0.76	0.85	0.85	0.55	47	29	100%
Unnao Branch Canal at Head	77,814	10,747	18,675	58%	96	0.76	0.85	0.85	0.55	53	57	93%
at 33 miles	31,465	3,327	7,552	44%	17	0.76	0.85	0.85	0.55	9	18	50%

Remarks: (1) Culturable commanded area
 (2) Actual irrigated area
 (3) Proposed Irrigated Area(24% of CCA)
 (4) Rate of AIA to PIA
 (5) Actual supplied volume
 (6) Application efficiency inclusive of conveyance efficiency of watercourse
 (7) Conveyance loss of Distributory/Minor
 (8) Conveyance loss of Main/Branch
 (9) Overall irrigation efficiency
 (10) Supplied volume to farmland
 (11) Field irrigation requirements
 (12) Irrigation sufficiency to crop water requirements

Source: Actual irrigation area and volume were collected from Irrigation Department of UP
 Irrigation efficiency was estimated based upon measurement and "Upper Ganges Project" and FAO Irrigation and Drainage Paper
 Ground water availability was estimated based upon Reports by Ground Water Department of UP

Table A.17 Improved Condition by CAD Works and Wireless Communication System (2/2) - Rabi

Canal System	Rabi(1986/87 - 1989/90)											
	CCA (1) (ha)	AIA (2) (ha)	PIA (3) (ha)	AIA/PIA (4) (%)	ASV (5) (MCM)	FAPE (6)	CON.E2 (7)	CON.E1 (8)	OV.I.E (9)	FSV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)
Sharda Main Canal at Head	1,612,633	329,422	403,158	82%	2,982	0.67	0.87	0.73	0.43	1,282	1,415	91%
at Bifurcation	1,080,886	(228,243)	270,222	84%	1,906	0.67	0.87	0.77	0.45	838	911	94%
Kheri Branch Canal	323,114	(66,004)	80,779	82%	561	0.67	0.87	0.77	0.45	252	257	98%
Hardoi Branch Canal at Head	757,772	162,239	189,443	86%	1,345	0.67	0.87	0.77	0.45	604	654	92%
at 23 miles	723,599	158,567	180,900	88%	1,226	0.67	0.87	0.80	0.47	572	636	90%
at 53 miles	668,895	145,756	167,224	87%	962	0.67	0.87	0.82	0.48	460	572	80%
Lucknow Branch Canal (55 miles) at 99 miles	308,771	65,419	77,193	85%	372	0.67	0.87	0.85	0.50	184	254	72%
Asiwan Branch Canal at Tail	152,379	32,650	38,095	86%	198	0.67	0.87	0.85	0.50	98	126	78%
Purwa, Unnao Branch Canal												
Lucknow Branch Canal at Head	281,443	62,806	70,361	89%	364	0.67	0.87	0.82	0.48	174	250	70%
Sandila Branch Canal (50 miles) at 72 miles	97,570	18,749	24,393	77%	135	0.67	0.87	0.85	0.50	67	75	89%
Sandila Branch Canal at Head	71,672	17,637	17,918	98%	86	0.67	0.87	0.85	0.50	42	70	61%
Asiwan Branch Canal at Head	85,511	16,423	21,378	77%	68	0.67	0.87	0.85	0.50	34	63	54%
Purwa Branch Canal at Head	74,565	17,932	18,641	96%	125	0.67	0.87	0.85	0.50	62	69	89%
at 30 miles	32,638	7,677	8,160	94%	72	0.67	0.87	0.85	0.50	36	30	100%
Unnao Branch Canal at Head	77,814	14,718	19,454	76%	73	0.67	0.87	0.85	0.50	36	57	63%
at 33 miles	31,465	4,683	7,866	60%	17	0.67	0.87	0.85	0.50	8	18	46%

Remarks: (1) Culturable commanded area
 (2) Actual irrigated area
 (3) Proposed Irrigated Area(25% of CCA)
 (4) Rate of AIA to PIA
 (5) Actual supplied volume
 (6) Application efficiency inclusive of conveyance efficiency of watercourse
 (7) Conveyance loss of Distributary/Minor
 (8) Conveyance loss of Main/Branch
 (9) Overall irrigation efficiency
 (10) Supplied volume to farmland
 (11) Field irrigation requirements
 (12) Irrigation sufficiency to crop water requirements

Source: Actual irrigation area and volume were collected from Irrigation Department of UP
 Irrigation efficiency was estimated based upon measurement and "Upper Ganges Project" and FAO Irrigation and Drainage Paper
 Ground water availability was estimated based upon Reports by Ground Water Department of UP

Table A.18 Water Distribution under Improved Condition and with Ground Water Development Rate of 35% (1/2) - Kharif

Canal System	Kharif (1986 - 1990)															
	CCA (1) (ha)	PIA (2) (ha)	AIA (3) (ha)	ASV (4) (MCM)	FAP.E (5)	COV.EZ (6)	CON.EI (7)	OV.I.E (8)	FSV (9) (MCM)	GWV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)	EIA (13) (ha)	EIIA/IA (14)	ETIA (15) (ha)	ETIIA/PIA (16)
Sharda Main Canal at Head	1,612,633	387,032	301,365	4,395	0.76	0.85	0.73	0.47	2,066	650	1,927	100%	123,330	41%	424,695	110%
at Bifurcation	1,080,886	259,413	(187,591)	3,265	0.76	0.85	0.75	0.48	1,567	245	1,157	100%	106,199	57%	293,790	113%
Kheri Branch Canal	323,114	77,547	(60,383)	960	0.76	0.85	0.75	0.48	461	49	403	100%	16,032	27%	76,415	99%
Hardoi Branch Canal at Head	757,772	166,917	127,208	2,305	0.76	0.85	0.75	0.48	1,106	196	754	100%	92,454	73%	219,662	132%
at 23 miles	723,599	156,665	123,008	2,043	0.76	0.85	0.78	0.30	1,022	198	726	100%	83,717	68%	206,725	132%
at 53 miles	668,895	143,576	109,628	1,696	0.76	0.85	0.80	0.52	882	181	635	100%	73,943	67%	183,571	128%
Lucknow Branch Canal (55 miles) at 99 miles	308,771	74,105	48,793	651	0.76	0.85	0.83	0.54	352	81	291	100%	23,814	49%	72,547	98%
Asiwan Branch Canal at Tail	152,379	36,551	25,669	265	0.76	0.85	0.85	0.55	146	36	137	100%	8,375	33%	34,044	93%
Purwa, Utnao Branch Canal																
Lucknow Branch Canal at Head	281,443	67,547	44,961	751	0.76	0.85	0.80	0.52	380	75	238	100%	40,975	91%	85,936	127%
Sandila Branch Canal (50 miles) at 72 miles	97,570	23,418	17,237	256	0.76	0.85	0.85	0.55	141	22	91	100%	13,581	79%	30,818	132%
Sandila Branch Canal at Head	71,672	17,201	8,921	154	0.76	0.85	0.85	0.55	85	20	47	100%	11,066	124%	19,987	116%
Asiwan Branch Canal at Head	85,511	20,542	11,535	126	0.76	0.85	0.85	0.55	69	22	62	100%	5,470	47%	17,005	83%
Purwa Branch Canal at Head	74,565	17,894	14,922	168	0.76	0.85	0.85	0.55	92	19	80	100%	5,764	39%	20,686	116%
at 30 miles	32,638	10,062	5,485	87	0.76	0.85	0.85	0.55	48	7	29	100%	4,918	90%	10,403	103%
Utnao Branch Canal at Head	77,814	18,657	10,747	96	0.76	0.85	0.85	0.55	53	17	57	100%	2,413	22%	13,160	71%
at 33 miles	31,465	11,124	3,327	17	0.76	0.85	0.85	0.55	9	7	18	89%	0	0%	3,327	30%

Remarks: (1) Culturable commanded area
 (2) Proposed irrigated area (24% of CCA)
 (3) Actual irrigated area
 (4) Actual supplied volume
 (5) Application efficiency inclusive of conveyance loss of watercourse
 (6) Conveyance efficiency of Distributary/Minor
 (7) Conveyance efficiency of Main/Branch
 (8) Overall irrigation efficiency
 (9) Field supplied volume
 (10) Ground water development
 (11) Field water requirements
 (12) Irrigation sufficiency to field requirements
 (13) Estimated increased irrigated area by improvement
 (14) Rate of increased irrigated area to actual irrigated area
 (15) Estimated total irrigated area
 (16) Rate of irrigated area to PIA

Source: Data were collected from Irrigation Department, Ground Water Department of UP

Table A.18 Water Distribution under Improved Condition and with Ground Water Development Rate of 35% (2/2) - Rabi

Canal System	Rabi (1986/87 - 1989/90)																
	CCA (1) (ha)	PIA (2) (ha)	AIA (3) (ha)	ASV (4) (MCM)	FAPE (5) (ha)	COVEZ (6)	CON/EI (7)	OV/E (8)	FSV (9) (MCM)	GWV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)	EIA (13) (ha)	EIIA/AIA (14) (ha)	ETIA (15) (ha)	ETIA/PIA (16)	
Sharda Main Canal																	
at Head	1,612,633	403,158	329,422	2,982	0.67	0.87	0.73	0.43	1,282	1,949	1,415	100%	422,731	128%	752,153	187%	
at Bifurcation	1,080,886	270,222	(255,446)	1,906	0.67	0.87	0.77	0.45	838	736	911	100%	191,627	75%	447,073	165%	
Kheri Branch Canal	323,114	80,779	(66,004)	561	0.67	0.87	0.77	0.45	252	148	257	100%	96,649	56%	102,654	127%	
Hardoi Branch Canal																	
at Head	757,772	189,442	162,239	1,345	0.67	0.87	0.77	0.45	605	589	654	100%	133,884	83%	296,123	156%	
at 23 miles	723,599	180,899	158,567	1,226	0.67	0.87	0.80	0.47	576	595	636	100%	133,386	84%	291,952	161%	
at 53 miles	668,895	167,224	145,756	962	0.67	0.87	0.82	0.48	462	545	572	100%	110,744	76%	256,500	133%	
Lucknow Branch Canal (55 miles)																	
at 99 miles	308,771	77,194	65,419	572	0.67	0.87	0.85	0.50	186	244	254	100%	45,407	69%	110,826	144%	
Asiwan Branch Canal																	
at Tail	152,379	38,096	32,650	198	0.67	0.87	0.85	0.50	99	107	126	100%	20,756	64%	53,406	140%	
Purwa, Unnao Branch Canal																	
Lucknow Branch Canal																	
at Head	281,443	70,360	62,806	364	0.67	0.87	0.82	0.48	175	225	250	100%	37,608	60%	100,414	143%	
Sandila Branch Canal (50 miles)																	
at 72 miles	97,570	24,392	18,749	135	0.67	0.87	0.85	0.50	68	66	75	100%	14,699	78%	33,448	137%	
Sandila Branch Canal																	
at Head	71,672	17,918	17,637	36	0.67	0.87	0.85	0.50	43	61	70	100%	8,541	48%	26,178	146%	
Asiwan Branch Canal																	
at Head	85,511	21,378	16,423	68	0.67	0.87	0.85	0.50	34	67	63	100%	9,776	60%	26,199	123%	
Purwa Branch Canal																	
at Head	74,565	18,643	17,992	81	0.67	0.87	0.85	0.50	41	57	69	100%	7,459	42%	25,391	136%	
at 30 miles	32,638	10,482	7,677	72	0.67	0.87	0.85	0.50	36	22	30	100%	7,088	92%	14,765	141%	
Unnao Branch Canal																	
at Head	77,814	19,453	14,718	73	0.67	0.87	0.85	0.50	37	50	57	100%	7,849	53%	22,567	116%	
at 33 miles	31,465	11,587	4,683	17	0.67	0.87	0.85	0.50	8	22	18	100%	3,044	65%	7,727	67%	

Remarks: (1) Culturable commanded area
 (2) Proposed irrigated area (25% of CCA)
 (3) Actual irrigated area
 (4) Actual supplied volume
 (5) Application efficiency inclusive of conveyance loss of watercourse
 (6) Conveyance efficiency of Distributory/Minor
 (7) Conveyance efficiency of Main/Branch
 (8) Overall irrigation efficiency
 (9) Field supplied volume
 (10) Ground water development
 (11) Field water requirements
 (12) Irrigation sufficiency to field requirements
 (13) Estimated increased irrigated area by improvement
 (14) Rate of increased irrigated area to actual irrigated area
 (15) Estimated total irrigated area
 (16) Rate of irrigated area to FIA

Source: Data were collected from Irrigation Department, Ground Water Department of UP

Table A.19 Water Distribution under Improved Condition and with Ground Water Development Rate of 50% (1/2) - Kharif

Canal System	Kharif (1986 - 1990)															
	CCA (1) (ha)	PIA (2) (ha)	AIA (3) (ha)	ASV (4) (MCM)	FAPE (5)	COV.E2 (6)	CON.E1 (7)	OVLE (8)	FSV (9) (MCM)	GWV (10) (MCM)	FIR (11) (MCM)	IS (12) (%)	EIIA (13) (ha)	EIIA/ALA (14)	ETIA (15) (ha)	ETIA/PIA (16)
Sharda Main Canal at Head	1,612,633	387,032	301,365	4,395	0.76	0.85	0.73	0.47	2,066	928	1,927	100%	166,869	55%	468,234	121%
at Bifurcation	1,080,886	259,413	(187,591)	3,265	0.76	0.85	0.75	0.48	1,567	350	1,157	100%	123,223	66%	310,814	120%
Kheri Branch Canal Hardoi Branch Canal at Head	323,114	77,547	(60,383)	960	0.76	0.85	0.75	0.48	461	70	403	100%	19,179	32%	79,561	103%
at 23 miles	757,772	166,917	127,208	2,305	0.76	0.85	0.75	0.48	1,106	280	754	100%	106,625	84%	233,833	140%
at 53 miles	723,599	156,665	123,008	2,043	0.76	0.85	0.78	0.50	1,022	283	726	100%	98,101	80%	221,109	141%
Lucknow Branch Canal (55 miles) at 99 miles	668,895	143,576	109,628	1,696	0.76	0.85	0.80	0.52	882	259	635	100%	87,357	80%	196,985	137%
Asiwan Branch Canal at Tail	308,771	74,105	48,733	651	0.76	0.85	0.83	0.54	352	116	291	100%	29,642	61%	78,375	106%
Purwa, Unnao Branch Canal at Head	152,379	36,551	25,669	265	0.76	0.85	0.85	0.55	146	51	137	100%	11,242	44%	36,911	101%
Lucknow Branch Canal at Head	281,443	67,547	44,961	731	0.76	0.85	0.80	0.52	380	107	238	100%	47,039	105%	92,000	136%
Sandila Branch Canal (50 miles) at 72 miles	97,570	23,418	17,237	256	0.76	0.85	0.85	0.55	141	31	91	100%	15,343	89%	32,580	139%
Sandila Branch Canal at Head	71,672	17,201	8,921	154	0.76	0.85	0.85	0.55	85	29	47	100%	12,717	143%	21,638	126%
Asiwan Branch Canal at Head	85,511	20,542	11,595	126	0.76	0.85	0.85	0.55	69	32	62	100%	7,256	63%	18,791	91%
Purwa Branch Canal at Head	74,565	17,894	14,922	168	0.76	0.85	0.85	0.55	92	27	80	100%	7,274	49%	22,196	124%
at 30 miles	32,638	10,062	5,485	87	0.76	0.85	0.85	0.55	48	10	29	100%	5,485	100%	10,970	109%
Unnao Branch Canal at Head	77,814	18,657	10,747	96	0.76	0.85	0.85	0.55	53	24	57	100%	3,771	35%	14,518	78%
at 33 miles	31,465	11,124	3,327	17	0.76	0.85	0.85	0.55	9	10	18	100%	185	6%	3,512	32%

Remarks: (1) Culturable commanded area
 (2) Proposed irrigated area (24% of CCA)
 (3) Actual irrigated area
 (4) Actual supplied volume
 (5) Application efficiency inclusive of conveyance loss of watercourse
 (6) Conveyance efficiency of Distributary/Minor
 (7) Conveyance efficiency of Main/Branch
 (8) Overall irrigation efficiency
 (9) Field supplied volume
 (10) Ground water development
 (11) Field water requirements
 (12) Irrigation sufficiency to field requirements
 (13) Estimated increased irrigated area by improvement
 (14) Rate of increased irrigated area to actual irrigated area
 (15) Estimated total irrigated area
 (16) Rate of irrigated area to PIA

Source: Data were collected from Irrigation Department, Ground Water Department of UP

Table A.19 Water Distribution under Improved Condition and with Ground Water Development Rate of 50% (2/2) - Rabi

Canal System	Rabi(1986/87 - 1989/90)															
	CCA (1) (ha)	PIA (2) (ha)	AIA (3) (ha)	ASV (4) (MCM)	FAP/E (5)	COV/E2 (6)	CON/E1 (7)	OV/LE (8)	FSV (9) (MCM)	GWV (10) (MCM)	FR (11) (MCM)	IS (12) (%)	E/IA (13) (ha)	E/IA/A/IA (14)	E/IA (15) (ha)	E/IA/PIA (16)
Sharda Main Canal at Head	1,612,633	403,158	329,422	2,982	0.67	0.87	0.73	0.43	1,282	2,784	1,415	100%	617,172	187%	946,594	235%
at Bifurcation	1,080,886	270,222	(255,446)	1,906	0.67	0.87	0.77	0.45	858	1,052	911	100%	280,122	110%	595,568	198%
Kheri Branch Canal Hardoi Branch Canal at Head	323,114	80,779	(66,004)	561	0.67	0.87	0.77	0.45	252	211	257	100%	52,906	80%	118,911	147%
at 23 miles	757,772	189,442	162,239	1,345	0.67	0.87	0.77	0.45	605	841	654	100%	196,473	121%	358,712	189%
at 53 miles	723,599	180,899	158,567	1,226	0.67	0.87	0.80	0.47	576	850	636	100%	196,962	124%	355,529	197%
Lucknow Branch Canal (55 miles) at 99 miles	668,895	167,224	145,756	962	0.67	0.87	0.82	0.48	462	778	572	100%	170,219	117%	315,975	189%
Asiwan Branch Canal at Tail	308,771	77,194	65,419	372	0.67	0.87	0.85	0.50	186	349	254	100%	72,373	111%	137,791	179%
Purwa, Unnao Branch Canal at Head	152,379	38,096	32,650	198	0.67	0.87	0.85	0.50	99	153	126	100%	32,650	100%	65,300	171%
Lucknow Branch Canal at Head	281,443	70,360	62,806	364	0.67	0.87	0.82	0.48	175	321	250	100%	61,801	98%	124,607	177%
Sandila Branch Canal (50 miles) at 72 miles	97,570	24,392	18,749	135	0.67	0.87	0.85	0.50	68	94	75	100%	21,749	116%	40,498	166%
Sandila Branch Canal at Head	71,672	17,918	17,637	86	0.67	0.87	0.85	0.50	43	87	70	100%	15,117	86%	32,754	183%
Asiwan Branch Canal at Head	85,511	21,378	16,423	68	0.67	0.87	0.85	0.50	34	95	63	100%	17,205	105%	33,628	157%
Purwa Branch Canal at Head	74,565	18,643	17,932	81	0.67	0.87	0.85	0.50	41	81	69	100%	13,774	77%	31,706	170%
at 30 miles	32,638	10,482	7,677	72	0.67	0.87	0.85	0.50	36	31	30	100%	9,468	123%	17,145	164%
Unnao Branch Canal at Head	77,814	19,453	14,718	73	0.67	0.87	0.85	0.50	37	72	57	100%	13,427	91%	28,144	145%
at 33 miles	31,465	11,587	4,683	17	0.67	0.87	0.85	0.50	8	31	18	100%	5,463	117%	10,146	88%

Remarks: (1) Culturable commanded area
(2) Proposed irrigated area (25% of CCA)
(3) Actual irrigated area
(4) Actual supplied volume
(5) Application Efficiency inclusive of conveyance loss of watercourse
(6) Conveyance efficiency of Distributory/Minor
(7) Conveyance efficiency of Main/Branch
(8) Overall irrigation efficiency
(9) Field supplied volume
(10) Ground water development
(11) Field water requirements
(12) Irrigation sufficiency to field requirements
(13) Estimated increased irrigated area by improvement
(14) Rate of increased irrigated area to actual irrigated area
(15) Estimated total irrigated area
(16) Rate of irrigated area to PIA

Source: Data were collected from Irrigation Department, Ground Water Department of UP