WATER USE EFFICIENCY Of EASTERN SONE CANAL SYSTEM

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1. INTRODUCTION

Sone basin is facing most significant water crises because it has many aspects and consequences. Reduced water supplies and a growing population are worsening the effects. Climate change is reducing our storage and increasing the frequency and intensity of floods and drought. Increasing up - stream utilisation and new regulations have resulted in the reduction of water deliveries in the eastern Sone canal command. The current financial crisis will make it even more difficult to invest in solutions. We must act now to provide integrated, reliable, sustainable, secure water resources management systems for our health, economy and ecosystems and must take action to promote water efficiency to preserve our limited water supply.

The whole project of Sone Canal System consists of

1. River Sone
2. Anicut across river Sone at Dehri-on-Sone now defunct.
3. Canal System on Eastern and Western Side.
4. After 1966, a barrage across river Sone at Indrapuri.
5. Two Link Canals – One on Eastern side and the other on Western side which connect the original canal systems.
6. Two high level canals taking off from the Link Canals on Eastern and Western side.

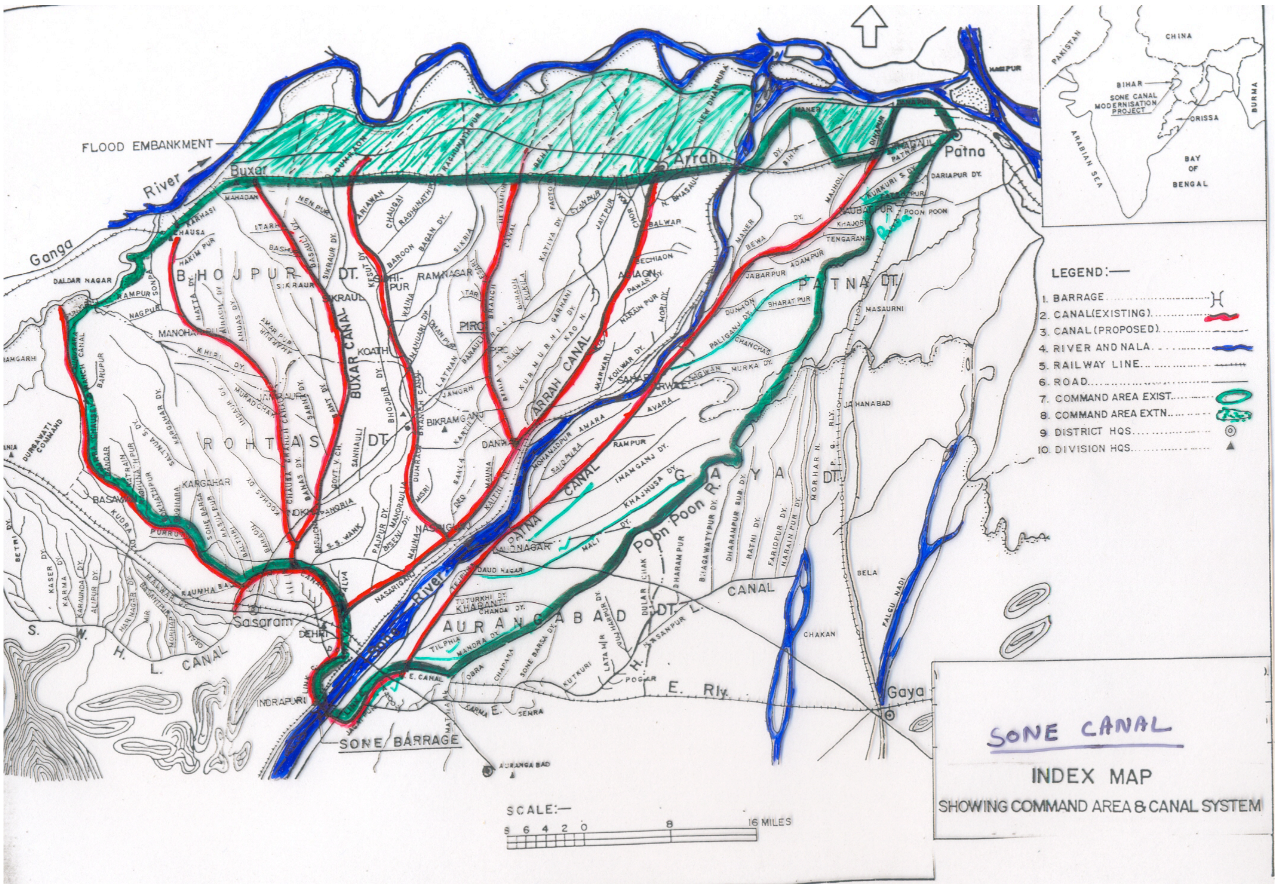
EASTERN SONE CANALS

The Eastern Sone Canal System comprises of the following canals

1) Eastern Link Canal
2) Eastern High Level Canal
3) Patna Canal

The Eastern Link Canal starts from Eastern Head Regulator and runs almost parallel to the Sone river. It has following features

Sl. No.	Name of Canal	Reach No.	Length	Bed Width	Bed Slope	FSD	Design Discharge	n
1	2	3	4	5	6	7	8	9
1.	Eastern Link Canal	Reach I (River Portion)	7600 ft (2.30 km)	148’ (45.12 m)	$\frac{1}{7700}$	8’ (2.44 m)	4400 cusecs (124.71cumecs)	0.02
		Reach II (On Bank)	17,200 ft (5.27 km)	148’ (45.12 m)	$\frac{1}{7700}$	8’ (2.44 m)	4250 cusecs (120.46 cumecs)	
		Reach III	9000 ft (2.73 km)	105’ (32.01 m)	$\frac{1}{7700}$	8’ (2.44 m)	2915 cusecs (82.62 cumecs)	
2.	Eastern High Level Canal	Off taking at 24.8 RD of Link Canal	-	-	-	-	1450 cusecs (41.09 cumecs)	
3.	Patna Canal	Starting at 33.80 RD of Link Canal i.e. End of Link Canal	78 miles (124.8 km)	134’ (40.85 m)	$\frac{1}{5500}$	7.5’ (2.29 m)	2960 cusecs (83.90 cumecs)	



SONE CANAL SYSTEM
Fig. 1.1

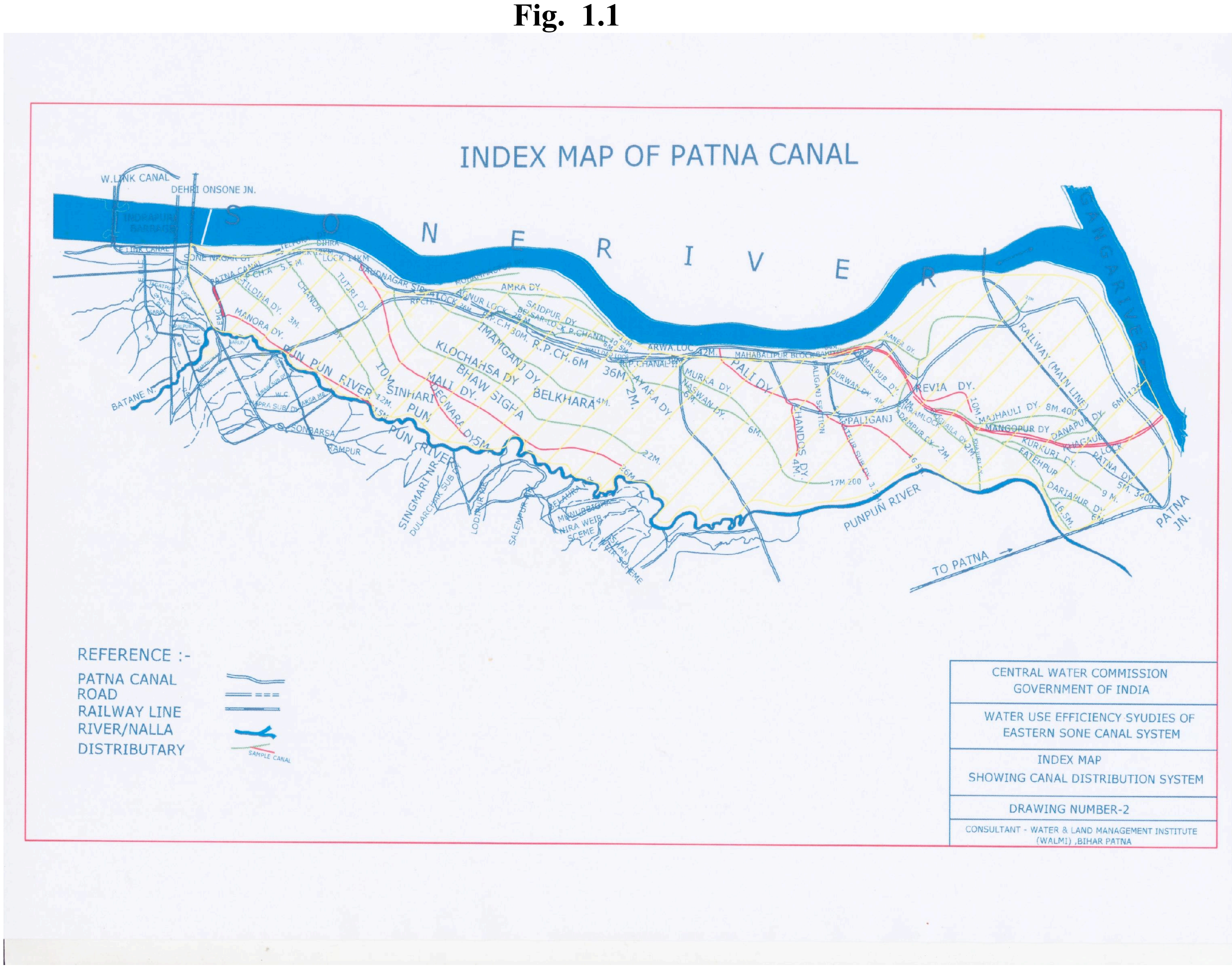


Fig. 1.2

2.0 OBJECTIVE

The targeted command area of Eastern Sone Canal hereafter called Patna Canal is 97595 Ha. in Kharif & 39507 Ha. in Rabi. There has been continued deterioration in the system due to various reasons affecting the efficiency of the whole network right from head of the canal up to the outlet level as well as field / farm . The objective of this study is to analyse the various reasons for shortfall in the target and to suggest remedial measures. The study is based on collection of secondary and primary data. The time schedule for completion of the study being short, the analysis and evaluation is mostly based on secondary data, however, for carrying out analysis in some of the activities, field visits is done and primary data is collected as far as practicable. To fulfill this objective within the time frame, appropriate methodology is adopted. The objectives laid down are as follows:

1. **Barrage and River Delivery Efficiency**
2. **Delivery System (Conveyance) Efficiency**
3. **On Farm Application and Operational Efficiency**
4. **Drainage Efficiency**
5. **Comparison of Irrigation Potential created and utilised for proper evaluation of overall Command Area Efficiency.**

3.0 SCOPE OF STUDIES

The scope of studies covers the conveyance system of Patna Canal up to outlet level. The scope also emphasizes collection of data, analysis, evaluation related to surface flow as well as ground water availability in the command area.

The scope does not include conducting any topographical survey, fixing gauges and discharge observation but will rely on the secondary data.

The evaluation study is based on available data up to 10 years. The scope of work includes the evaluation of

(i) Study of delivery system efficiency by considering two samples, one in the main canal and other in any distributary carrying discharges more than 150 cusecs in a suitable reach. Study of delivery system for distribution network by taking two samples one in distributary and other in minor having discharge less than 150 cusecs.

(ii) For determining the extent of Irrigation Potential utilised for a period of 10 years, four samples covering an area of 40 Ha. or below is selected which include such areas where water is reported to be partially available.

(iii) For evaluation of efficiency of the drainage system, the drainage network system as contemplated at the project stage, its actual construction, extent of damages and its siltation, lack of structures is relied upon and field visit made for one such system in the command area.

4.0 METHODOLOGY

The purpose of providing irrigation to the field / farms is to obtain optimum crop growth and the sustainable yields with least operation and maintenance hazards. The irrigation is always associated with agronomy i.e. the crops and the output may be defined as irrigated agricultural yields. The system includes the aspects of design, physical construction, proper management, upkeep with proper operation to have an equitable distribution of water to the crops as and when needed for the growth. The result of over irrigation is harmful and it creates water logging, deposition of salts and minerals in the root zone. The irrigation system will not deliver the desired result if the drainage network is not equally efficient.

The object of this evaluation study for bringing up the overall efficiency of the system is oriented towards the above purposes so that the money spent on creation of potential is fully utilised by achieving the target. Indication of regular follow up and the methodology for such creative and positive management and operation system is made in the report.

(i) Correct assessment of GCA & CCA with the help of the latest land census report of the command area.
(ii) Study of existing cropping pattern and crop water requirement with suitable amendment, if necessary.
(iii) To check the design discharge of the main canal and at distributary heads.
(iv) Study of the physical condition of canal, distributary etc. with respect to their existing carrying capacity.
(v) Study of behavior of structures up to outlets.
(vi) Study of seepage loss by adopting one or two methods and to work out conveyance efficiency. Proposed method is given in detail.
(vii) Study and analysis of effective rainfall in the selected model command area.
(viii) Study of records of discharge observation at heads of various distributaries and minors and comparing with the discharge needed in the command area.
(ix) Study of the sample areas during kharif irrigation period to assess the irrigation potential utilised and the farm application efficiency. One of the methods to find out on-farm efficiency is given in detail.
x) Visit to one drainage system of the command area and study the extent of efficiency.
(xi) Study the fluctuation in the Ground Water Table under the model command area and the possibilities of conjunctive use.
(xii) Study of water logged areas, visit of one such area and to suggest remedial measures for the improvement.

The efficiency of the irrigation system depends on the following physical aspects apart from those mentioned in the objectives of the studies.

(a) Physical condition of the canal system to carry the design discharge.
(b) Capacity of the head regulators to take the design discharge at designed FSL of the parent channel.
(c) Condition of banks and their susceptibility to breaches.
(d) Areas of command which are frequently subjected to flooding having inadequate drainage system.

5.0 SAMPLE CANAL

The model areas for observing seepage, evaporation loss in the main and distributary is located after the discussion with the project authorities in such lengths and reaches which represents the average condition regarding cutting / filling, nature *of* soil ground water level, lining or unlined lengths.

Four model farm areas has been selected in command areas each covering a farm area of about 40 hectares with and without turn outs and water courses mainly for kharif crop (paddy).

Following canal of the system have been selected as sample for study. Their hydraulic particulars are noted against them in Table No. –5.1

TABLE NO.-5.1

Sl. No.	Canal Name	Design Discharge (cusecs)	Bed Width (ft)	Bed Slope	FSD	Nature of Construction

	Canal					Filling
2.	Mali Distributary	325	22	1:4000	5'	Filling
3.	Paliganj Distributary	180	20	1:8000	4.6"	Cutting & Filling
4.	Rewa Distributary	85	13	1:5000	3.6"	Cutting & Filling Near off-take crosses a nala

6.0 EFFICIENCY OF BARRAGE

The design discharge of Western H. R. is 8000 cusecs and that of Eastern H.R. is 4,400 cusecs. During analysis of discharges at Barrage, it is seen that discharges more than design discharge of link canals have been thrust in both the canals. For e.g.- Table No.-6.1

TABLE NO. – 6.1

Unit - cusecs

Year	Date	Indent		Supply	
		ELC	WLC	ELC	WLC
1	2	3	4	5	6
2000	4.10.2000	4,250	9,600	4,250	12,034
	10.10.2000	4,550	10,000	4,550	12,200
2001	3.10.2001	3,850	10,000	3,850	9,885

This shows that the barrage is 100% efficient in diverting the design discharges through the HR in Link canals. However, the efficiency for every year for 1st-10th Oct. is presented in Tabular Form with respect to indent and also with respect to design capacity of HRs.

TABLE NO. – 6.2

Barrage Efficiency Year Wise for 1st – 10th Oct.

Volume figures in million Acft.

Year	Indent ELC + WLC	Supply ELC + WLC	Efficiency (3) ÷ (2)	Design Capacity of HRs ELC + WLC	Supply ELC + WLC	Efficiency (6) ÷ (5)	Remarks
1	2	3	4	5	6	7	8
1995	0.239	0.239	1.00	0.246	0.239	0.972	Column 4 & 7 are Efficiency of Barrage
1996	0.260	0.260	1.00	0.246	0.260	1.057	
1997	0.275	0.275	1.00	0.246	0.275	1.118	
1998	0.246	0.246	1.00	0.246	0.246	1.000	
1999	0.246	0.246	1.00	0.246	0.246	1.000	
2000	0.275	0.312	1.13	0.246	0.312	1.268	
2001	0.247	0.246	0.99	0.246	0.246	1.000	
2002	0.242	0.222	0.92	0.246	0.217	0.882	
2003	0.246	0.246	1.00	0.246	0.246	1.000	
2004	0.288	0.287	0.99	0.246	0.287	1.167	

Thus, the Sone Barrage at Indrapuri is 100% efficient and even more in diverting the required discharges through the H. R. in Link Canal.

6.1 River Delivery Efficiency

This is ratio of Water Supply and Water Demand. Water Supply and Demand at both the H. R. has been shown for critical drought years and river delivery efficiency has been worked out in Table No.- 6.3

TABLE 6.3

River Delivery Efficiency for drought years at Indrapuri Barrage From Oct. to Sept.

Year	Demand MAf	Supply MAf	$\frac{\text{Supply}}{\text{Demand}} \left(\frac{\text{Col. 3}}{\text{Col. 2}}\right)$
1	**2**	**3**	**4**
2008	2.59	1.185	.45
2009	2.59	1.1	.42
2010	2.59	1.12	.43

The above table shows that **River Delivery Efficiency at Indrapuri Barrage** is **43** percent only for certain critical drought years, so it is possible to increase the supply by increasing river delivery efficiency. The governance challenge of water resource management, allocation, use and compliance is delivered through using better real time river management tools based on river hydraulics, on regulated systems. By better managing releases to more accurately match timed demands, operational surplus is minimised improving river delivery efficiency and providing 'more space in the river'. Accurate river flow measurement along the system and metering based on telemetry is essential linked to water ordering system. This will also enable water options trading in the future again 'making efficiency improvements' based on the natural capacity of the system. This is called Computer Aided River Management

7.0 CONVEYANCE EFFICIENCY

The irrigation water conductor system (the system) conveys water by gravity from the source, to the irrigation fields. It has to pass through soil strata of various nature and texture. It has to meet variable ground water levels. The system includes carrier channels (canal) e.g. main canal, distribution system e.g. distributaries/minors, structures, farm outlets, water courses for each farm chak area. The channel passes either in cutting or in filling zones. The soil condition, nature and extent of recharge of ground water 'conditions, attracts the canal flow within the soil zones by gravitation action and this phenomena is called "seepage". The water surface is also subjected to heat, humidity, sunshine, winds etc. and is liable to undergo evaporation losses. The functioning of regulators, outlets also lead to some water loss. The spreading of water on the field through outlets in absence of water courses /turnouts involves considerable loss of water. All these phenomena are related to water loss and the discharge delivered at the head reduces gradually along the track till it reaches the field.

All the losses summed up together indicate the water efficiency of the system. It is expressed in percentage of water loss to the water delivered at the beginning (head).

Broadly the losses are classified in some specific categories and the efficiency *of* different major components are divided as follows.

1. Conveyance Efficiency *of* Main Canal.
2. Conveyance Efficiency *of* Distribution System (distributaries/minors)
3. Outlet Efficiency or Farm Output Efficiency.

The crop water requirement varies during the crop period depending upon nature *of* crop, stage *of* crop development, effective rainfall, rate *of* percolation *of* water in the ground. This requirement is called N.I.R i.e. Net Irrigation Requirement. This amount *of* water is needed to be delivered to the fields for growth *of* crops. But for delivering this much amount *of* water the system has to undergo low to high water losses during transit and the efficiency *of* system affects the irrigated area.

These losses are generally assured in design *of* canal on observations made for different projects.

As it involves major variations it is a better proposition to measure such losses and work out efficiency *of* various major components *of* the water conductor system especially for major projects.

The measurement of water loss has to be derived form secondary sources depending upon achievements *of* irrigation vis a vis water delivered at source. The primary sources involve actual measurement *of* discharges in the system at various points under variable conditions. The discharge needed at the outlet head is denoted as F.I.R (Field Irrigation Requirement)

Which is

$$\frac{\text{N.I.R.}}{\text{Efficiency at Outlet}}$$

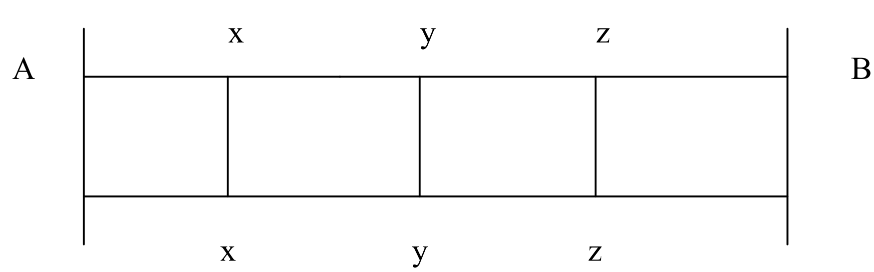
The discharge needed at the head *of* main canal is denoted as G.I.R (Gross Irrigation Requirement) and it is denoted as

$$\text{G.I.R} = \frac{\text{F.I.R}}{\text{Efficiency of distributary and main canal}}$$

7.1 Determination of Seepage Loss

In order to determine the seepage loss *of* canal, following measures are to be taken:

1. Sample lengths in main canal and distributary is selected in consultation with the project authority.
2. For measuring velocity in the canal, current meter is used and thereafter knowing the cross section of the canal, discharge will be calculated.
3. About 2 Km length of sample canal, preferably between two bridges, is fixed. Then this sample length is divided into equal segments as shown in the figure below:



2 K m

(i) Cross-sections is taken at points A, B, x-x, y-y and z-z.
(ii) A constant discharge is ensured at entry point "A" for 8 hrs. keeping all the outlets closed between point A & B.
(iii) Then hourly discharges observed at point A, B, x-x, y-y & z-z by knowing the

velocity at these points by current meter and the cross-sections as in (i) above.
(iv) Reduction in the discharge observed show the seepage loss.

4. Now open all the outlets and observe hourly discharge also at outlet heads to know the Water released through outlets. This observation' has been compared with the design discharge of outlet. Accordingly, losses at outlets is calculated.

7.2 Canal Conveyance Efficiency

Canal Conveyance Efficiency is defined as the ratio of total volume of water delivered at the outlets for field irrigation (Vo) over total volume of water released at the head of the canal (V_H) during base period of the crop. Mathematically canal conveyance efficiency

$$Ec = \frac{Vo}{V_H}$$

This indicates water loss in the system to the extent V_H-V_o. The losses in system are two types

(i) Seepage loss in to bed and bank of the canal and
(ii) Evaporation loss to atmosphere from water surface of canal

MEC & MANORA DISTRIBUTARY

The year wise seepage loss, evaporation loss and conveyance efficiency has been computed Abstract of the computation is presented in Table No.-7.1

TABLE NO.-7.1

Abstract of Computation of Conveyance Efficiency of MEC & Manora Distributary

Year	Total Water released at head (V_H) Acft	Losses in Conveyance (Acft)		Conveyance Efficiency = $(V_H - (Vs + Ve))/V_H$
		Seepage (Vs)	Evaporation (Ve)	
1	2	3	4	5
1997	27768.595	2622.624	39.916	0.904
2003	23276.031	1913.48	33.01	0.916
2004	31725.6	3180.32	57.71	0.898
2005	21391.7	1893.6	30.07	0.91
Average	**26040.4815**	**2402.506**	**40.7165**	**0.907**

MALI DISTRIBUTARY

The year wise seepage loss, evaporation loss and conveyance efficiency has been computed. Abstract of the computation is presented here in Table No.-7.2

TABLE NO.-7.2

Abstract of Computation of Conveyance Efficiency of Mali Distributary

	Total Water Released at Head (V_H) Acft	Losses in Conveyance (Acft)		Conveyance Efficiency = $(V_H - (Vs + Ve))/V_H$
		Seepage (Vs)	Evaporation (Ve)	
1	2	3	4	5
Average/year	**56885.074**	**11693.335**	**128.701**	**0.791**

PALIGANJ DISTRIBUTARY

The year wise seepage loss, evaporation loss and conveyance efficiency has been computed. Abstract of the computation is presented here in Table No.-7.3

TABLE NO.-7.3

Abstract of Computation of Conveyance Efficiency of Paliganj Distributary

	Total Water released at head (V_H) Acft	Losses in Conveyance (Acft)		Conveyance Efficiency = (V_k – (Vs + Ve))/V_H
		Seepage (Vs)	Evaporation (Ve)	
1	2	3	4	5
Average/year	25271.149	14768.229	82.890	0.80425

REWA DISTRIBUTARY

The year wise seepage loss, evaporation loss and conveyance efficiency has been computed. Abstract of the computation is presented here in Table No.-7.4

TABLE NO.- 7.4

Abstract of Computation of Conveyance Efficiency of Rewa Distributary

	Total Water Released at Head (V_H) Acft	Losses in Conveyance (Acft)		Conveyance Efficiency = (V_H– (Vs + Ve))/V_H
		Seepage (Vs)	Evaporation (Ve)	
1	2	3	4	5
Average/year	10995.802	2103.742	25.682	0.801

8.0 Determination of On-Farm and Operational Efficiency

In order to determine On-Farm Efficiency, following measures are to be taken:

1. Model areas fully covered and partially covered is selected in consultation with project authority.
2. Nature of soil and its permeability is assessed.
3. Discharge at the beginning and end of water course is observed.
4. No. of hours to fill the model area for irrigation purpose is observed.
5. Initial depth of water in the model area and depth at every six-hour is observed.

Difference in the quantity of water supplied and quantity of water standing in the field determine the on-farm efficiency.

On farm application efficiency is defined as the ratio of actual water delivered to the field to water requirement of the crops considering effective rainfall in the command, when water supply is abundant.

TABLE NO.- 8.1

Computation of On-farm Application Efficiency of MEC & Manora Distributary for Kharif Paddy Irrigation

	Volume of water reaching the outlet Acft.	Net Irrigation Requirement			On farm Application Efficiency Col.(5) / Col. (2)
		NIR in mm	Area irrigated Ha.	Volume of NIR in Acft.	
1	2	3	4	5	6
Avg./year	24974.39	545.54	4867	14722.402	0.5895

TABLE NO.- 8.2

Computation of On-farm Application Efficiency of Mali Distributary for Kharif Paddy Irrigation

	Volume of water	Net Irrigation Requirement	On farm Application

	reaching the outlet Acft.	NIR in mm	Area irrigated Ha.	Volume of NIR in Acft.	Efficiency Col.(5) Col. (2)
1	2	3	4	5	6
Avg./year	45063.03		7896.11	33629.95	0.753

TABLE NO.- 8.3

Computation of On-farm Application Efficiency of Paliganj Distributary for Kharif Paddy Irrigation

	Volume of water reaching the outlet Acft.	Net Irrigation Requirement			On farm Application Efficiency Col.(5) Col. (2)
		NIR in mm	Area irrigated Ha.	Volume of NIR in Acft.	
1	2	3	4	5	6
Avg./year	19441.7		3880.3	16594.4	0.8789

TABLE NO.- 8.4

Computation of On-farm Application Efficiency of Rewa Distributary for Kharif Paddy Irrigation

	Volume of water reaching the outlet	Net Irrigation Requirement			On farm Application Efficiency Col.(5) Col. (2)
		NIR in mm	Area irrigated Ha.	Volume of NIR in Acft.	
1	2	3	4	5	6
Avg./year	9488.66		1953.33	6442.8	0.6790

There are technologies and management strategies available that conserve water while maintaining yield and production standards. These technologies and management strategies like improved irrigation scheduling and crop specific irrigation management often not only conserve water, but also save energy and decrease grower's costs. Below is a list of commonly used agricultural water conservation methods for on-farm level implementation.

Irrigation Scheduling

Deciding when and how much water to apply to a field has a significant impact on the total amount of water used by the crop water use efficiency and irrigation efficiency. A number of different scheduling systems should be developed that can use either soil- plant or atmosphere-based measurements to determine when to irrigate. Using a more scientific approach to scheduling has generally been shown to decrease the amount of water applied while improving yield.

Tailwater Return Systems

To provide adequate water to the low end of the field, surface irrigation requires that a certain amount of water be spilled or drained off as tail water. Tail water return systems catch this runoff and pump the water back to the top of the field for reuse.

Irrigation System Improvements

Irrigation system improvement involves modifying the irrigation method or use of hardware and software to properly apply water to the field while minimizing water losses. For example improved furrows, combination of furrow and sprinkler, and changing from surface irrigation (flood, furrow and border check) to pressurized systems. Changing from surface irrigation to pressurized systems (sprinkler, drip, microirrigation) generally increases irrigation distribution uniformity and decreases applied water, although with certain soil types and applications, surface irrigation can be very efficient.

8.1 Operational efficiency

This is ratio of actual operation done and operation required. There is no gate at outlet therefore operational efficiency is zero

9.0 Drainage Efficiencv

For the evaluation of drainage efficiency, the drainage network system as envisaged in the initial project report, its actual execution, the extent of damages and its siltation, if any, is relied upon. The field visit is made for one such system in the command area with the project authority.

Drainage Efficiency is defined as ratio of total annual water drained from the system to total annual water delivered to the system plus effective annual rainfall minus water consumed by the crops.

ASSESSMENT OF DRAINAGE REQUIREMENT

Natural flow of water is from high contour to low contour. Main problem of drainage is in monsoon months during Kharif season. In this period, storm water as well as surplus irrigation water is to be drained.

The command is so steep and has so many natural drainages; there is no need of additional drains at the moment.

However a few drains may be needed to be excavated to join the existing ones. But it is a matter detail investigation and study.

10.0 Irrigation Potential Created & Utilised

The corrected assessment of the Gross Command Area and Culturable Command Area will be made with the help of latest land census report of the command area. The study of the sample area during kharif irrigation period will be made to assess the irrigation potential utilized

POTENTIAL UTILIZED IN SAMPLE CANALS

Potential utilized in sample canals are given in the Table No.-10.1 to 10.4

TABLE NO.- 10.1

Irrigation Potential Created (Design) & Utilized in ME Canal & Manora Distributary Command

Unit Ha.

Year	Design Potential		Potential Utilized	
	Kharif	Rabi	Kharif	Rabi
1	2	3	4	5
1996-97	3521	2113	4900	-
97-98	3521	2113	4800	425
98-99	3521	2113	4820	394
99-00	3521	2113	4800	-
00-01	3521	2113	4900	670
01-02	3521	2113	5205	200
02-03	3521	2113	4950	420
03-04	3521	2113	5000	640
04-05	3521	2113	4800	700
05-06	3521	2113	5276	800

TABLE NO.- 10.2

Irrigation Potential Created (Designed) & Utilized in Mali Distributary Command

Unit Ha.

Year	Design Potential		Potential Utilized	
	Kharif	Rabi	Kharif	Rabi
1	2	3	4	5
1996-97	9183	595	3800	-
97-98	9183	595	7400	1273
98-99	9183	595	6900	1400
99-00	9183	595	7015	-
00-01	9183	595	7155	1347
01-02	9183	595	8145	-
02-03	9183	595	8145	1214
03-04	9183	595	8145	5799
04-05	9183	595	9000	2000
05-06	9183	595	9160	2051

TABLE NO. 10.3

Irrigation Potential Created (Designed) & Utilized in Paliganj Distributary Command

Unit Ha.

Year	Design Potential		Potential Utilized	
	Kharif	Rabi	Kharif	Rabi
1	2	3	4	5
1996-97	4200	2520	3852	971.27
97-98	4200	2520	3537	1240.81
98-99	4200	2520	3890	1273.21
99-00	4200	2520	3891	NIL
00-01	4200	2520	4077	709.04
01-02	4200	2520	4058	788.25
02-03	4200	2520	4099	1157.49
03-04	4200	2520	4090	1112.90
04-05	4200	2520	3807	1152.00
05-06	4200	2520		1169.60

TABLE NO.- 10.4

Irrigation Potential Created (Designed) & Utilized in Rewa Distributary Command

Unit Ha.

Year	Design Potential		Potential Utilized	
	Kharif	Rabi	Kharif	Rabi
1	2	3	4	5
1996-97	2100	1260	1970	1200
97-98	2100	1260	2000	970
98-99	2100	1260	2000	-
99-00	2100	1260	1953	-
00-01	2100	1260	1846	1200
01-02	2100	1260	1850	-
02-03	2100	1260	2021	328
03-04	2100	1260	2023	-
04-05	2100	1260	1886	-
05-06	2100	1260		

ANALYSIS

The data of design potential, potential created and utilized in case of four sample commands have been examined and it is found that potential utilized in case of Kharif is more than the design potential and also more than the potential created in some years.

In case of Rabi, the utilization figure is much behind the created potential. On field enquiry, it has come to notice that the farmers are inclined to Dalhan crops like chana, matar, masur etc. which do not require irrigation and gives good return in terms of money than irrigated rabi crop of wheat.

The remote sensing study was carried out for the Eastern Sone Canal Irrigation Project for the Rabi and Kharif cropping seasons. For the Eastern Sone Canal Project command area, the satellite remote sensing imagery of LISS III from IRS-P6 was acquired for the dates 23rd February 2007 and 14th November 2007 having path-row 104-054, to estimate the crop coverage and cropping pattern in the irrigation command during Rabi and Kharif season respectively. The Eastern Sone Canal Irrigation Project Command Area is bounded by latitude 25^0 39’ N to 24^0 49.8’ N and longitude 84^0 13.2’ to 85^0 10.8’E.

The boundary of the command area developed through digitization of the map yielded an area of 2,25,532 hectares. This area derived from GIS analysis can be considered as the gross command area for the Eastern Sone Canal Irrigation Project. Through the supervised classification technique of the satellite imagery and NDVI analysis, three types of crops have been classified, namely wheat, pulses and oil seed during the Rabi cropping period. The areas occupied by wheat, pulses and oil seed are 78860, 13888 and 2736 hectares respectively, for the Eastern Sone Canal Irrigation Project during the Rabi period against targeted command area of Eastern Sone Canal is 39507 Ha. in Rabi.

The main crop during the Kharif cropping period was identified as Paddy and other crops grown were millets, maize and vegetables. Distinction between crops during Kharif was not possible with single satellite imagery and also because the proportion of other crops as compared with paddy was insignificant. Therefore, the classification technique could extract the agricultural area which in turn was classified as paddy. The Kharif imagery of LISS III did not cover the full portion of the command area; therefore another imagery from ETM+ was used to analyze the missing portion. The total area under paddy cultivation in Eastern Sone Canal Irrigation Project Command during the Kharif cropping season was estimated to be 72,908 hectares against targeted command area of Eastern Sone Canal is 97595 Ha. in Kharif. Non-availability of temporal data spread over the cropping season and cloud coverage in remote sensing data hampered the effectiveness of

11.0 FINDINGS & RECOMMENDATION

FINDINGS

Following studies have been made:

1. **Efficiency of Barrage and River Delivery at Indrapuri** – It has been found 100%. **River Delivery Efficiency at Indrapuri Barrage** is **43** percent for critical drought years.

2. **Conveyance Efficiency of four sample canals namely (a) Main Eastern Canal & Manora Distributary, (b) Mali Distributary, (c) Paliganj Distributary & (d) Rewa Distributary. The average value of efficiency works out to 0.709,0.791, 0.80425 and 0.8014 respectively.**

3. **On-Farm Application Efficiencies in the command of the four sample canals work out to 0.5895, 0.753, 0.8789 & 0.6790 respectively and Operational Efficiency is Zero..**

4. **Potential Created & Utilized –. Average value of paddy / kharif irrigation potential created (design) and utilized for the command of the sample canal are presented below in Table No.-11.1.**

TABLE NO.-11.1

Potential Created (Design) & Utilized in the Command of Sample Canals

Sl. No.	Name of Sample Canal	CCA (Ha.)	Kharif Potential Created (Design)	Kharif Potential Utilized (Ha.)
1	2	3	4	5
1.	Main Eastern Canal & Manora Distributary	4695	3521	5269
2.	Mali Distributary	13118	9839	9200
3.	Paliganj Distributary	5600	4200	4099
4.	Rewa Distributary	2800	2100	2023

The remote sensing study show that:-

The areas occupied by wheat, pulses and oil seed are 78860, 13888 and 2736 hectares respectively, for the Eastern Sone Canal Irrigation Project during the Rabi period against targeted command area of Eastern Sone Canal is 39507 Ha. in Rabi.

The total area under paddy cultivation in Eastern Sone Canal Irrigation Project Command during the Kharif cropping season was estimated to be 72,908 hectares against targeted command area of Eastern Sone Canal is 97595 Ha. in Kharif

5. **Drainage Efficiency** – There is no drainage scheme executed in the command. But there has not been any problem of water logging and raising of ground water table in the Eastern Sone Canal System in its long functioning of more than 100 years.

RECOMMENDATIONS FOR IMPROVEMENT IN WATER USE EFFICIENCY

1. **Barrage and River Delivery Efficiency**

The Sone Barrage at Indrapuri is 100% efficient in diverting water in both the link canals as per indent. **River Delivery Efficiency at Indrapuri Barrage** is only **43** percent for certain critical drought years. To improve **River Delivery Efficiency** additional storage must be created through proposed **Indrapuri Dam**. For better governance of share water among co-basin state it is required to established **Computer Aided River Management System**

2. **Canal Conveyance Efficiency**

Four sample canals, two having discharge more than 150 cusecs and two having discharge less than 150 cusecs have been studied.

The conveyance efficiency depends on two losses, one is seepage loss and other is evaporation loss. Evaporation loss can not be minimized, but seepage loss can be minimized by seepage preventing measures in the canals like lining of canal in the reaches of more seepage loss.

3. **On-Farm Application and Operational Efficiency**

The command of the sample canals have been studied for on-farm application efficiency.

The low efficiency is attributed to absence of control structures in outlets and absence of water courses. A command of more than 100 acres are also being irrigated by field to field passage of water, which results in over irrigation and wastage of water by surface drainage.

There is a need to have control structures at outlets and provide authorised outlets at the places of unauthorised ones so that farmers' interference be minimized. And also every outlet should have water courses to check long run of field to field irrigation to avoid wastage of water. Now time has come to shift from surface irrigation to pressurized systems

4. **Drainage Efficiency**

The drainage arrangements as existing in the Eastern Sone Canal Command have worked efficiently and there has been no case of water logging and rise of ground water table. So, there is no need of planning a drainage system in the command. The existing drains leading to Punpun in the east and Sone in the west should be surveyed and improved in the reaches where required.

In a nut shell measures should be taken to improve the efficiencies are:-

(i) Improve water governance within co-basin States of Sone Basin through Computer Aided River Management System
(ii) Control Structures on outlets.
(iii) Construction of Water Courses & Field Channels.
(iv) To check the unauthorized outlets.
(v) To minimize seepage loss where necessary lining of canals.
(vi) Supervisory Control and Data Acquisition Systems (SCADA) allow Sone Command to improve operation and control. The Sone Irrigation Management Information System (SIMIS) should be established.
(vii) Create additional Storage through proposed Indrapuri Dam