

GOVT. OF BIHAR
WATER RESOURCES DEPARTMENT
National Hydrology Project (NHP)



Terms of Reference

CONSULTANCY SERVICES

**Development of Sone Canal Asset Management
System for Irrigation Management (Using Online
Web Based Monitoring System and GIS
Techniques) and as a Decision Support tool**

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Consultancy Services

Development of Sone Canal Asset Management System for Irrigation Management (Using Online Web Based Monitoring System and GIS Techniques) and as a Decision Support tool

1. Introduction

The history of the utilization of Sone river water with a canal system dates back to the nineteenth century when an anicut was constructed on the river at Dehri in Bihar for Irrigation. Being one of the oldest and important irrigation system in the country, the Sone river has been serving the area to great extent. However, in the current times, the unlined canal in the Sone Canal System, absence of field channels beyond outlets and lack of any control structure & gates etc. in the canal is causing considerable loss of water resource, resulting in low field application efficiency. Non-existence of proper land shaping, land leveling and fragmented land holdings have escalated the problems. This is further aggravated by the absence of proper legislation and canal management system. The implementation of efficient and scientific irrigation system through the development of a Canal Asset Management System (CAMS) will help in modernization of Sone Canal network. This will be of great benefit to farmers, who have a long experience of irrigated cultivation in the Sone command and are now facing a situation of crisis and distress.

The World Bank funded Hydrology Project Phase I (IDA US\$94.95 million and Phase II (IBRD US\$91.58 million) have supported the establishment of a hydrological information system in a number of States mainly in South India. Based on the successful outcome of past two phases of Hydrology Project, Government of India requested World Bank assistance for a follow on project – National Hydrology Project (NHP) – Approach towards Integrated Water Resources Management’ (<http://nhp.mowr.gov.in>). With the funding of USD 350 million, the National Hydrology Project (NHP) would be implemented in eight years (2017-2024). The project aims to improve the extent, quality, and accessibility of water resources information and strengthen the capacity of targeted water resource management institutions in India.

2. Background

The Sone river is one of the main tributaries of Ganga flowing through Madhya Pradesh (MP), Uttar Pradesh (UP), Jharkhand and Bihar. The anicut constructed at Dehri in Bihar for irrigation in 1874 was later abandoned with the construction of Barrage at Indrapuri about 10 km upstream of the old anicut. Thereafter a dam on river Rihand, a tributary of Sone, was constructed in UP to store 7.3 MAF water, mainly for hydel generation in 1962. This was followed by construction of Bansagar dam on the Sone main river in the Rewa District of

M.P. Bansagar Agreement was formulated for the use of Sone river water for irrigation purpose, which was signed in 1973 with MP, UP and Bihar States as Signatories. Under this project, a storage of 1 MAF was allocated for the state of Bihar for Kharif and Rabi irrigation.

3. Objective of the Consultancy

The objective of the consultancy is to develop a web-enabled GIS based Canal Asset Management System (CAMS) for the Sone Canal Network. This is a decision support tool for Sone Canal System envisaged to be developed with the objective of :

- Monitoring of water flow to be released from canal as per the demand assessed for irrigation in the command area
- Finding, identifying and maintaining the infrastructure asset
- Updating and distributing information mapped with the tool
- Recording & retrieving maintenance information of the system
- Identifying & issuing notification for future maintenance needs.
- Providing support in Feasibility assessment on inclusion of a power generation component on the existing canal network such as mini hydel power schemes with low head turbines and/or Canal Rooftop Solar panels.

The CAMS will support irrigation management functions such as maintenance and strengthening of existing canal; generation of alerts for anticipated irrigation related hazards, planning of new control structures and irrigation management works; development of community participation for canal surveillance for discharge of water as per demand in the canal system; assessment of irrigated land in the command area and updating canal safety information in the CAMS. The information database in CAMS will also help in collection of revenue from the farmers on the basis of irrigated land.

CAMS would integrate and provide on-line access through web based portal to all the relevant information needed on Sone Canal System for efficient irrigation monitoring through canal operation and maintenance. These information are currently in different forms and scattered across different offices. CAMS will help in tracking asset location, cataloging routine maintenance activities and highlighting future service needs. It will support development of a Canal Safety Programme by periodically monitoring physical status of canal. It will integrate operational use of past and current canal data whenever required. It will assist Headquarter office at WRD Secretariat, Patna in monitoring the flow in canal system, irrigation in the command area, identifying vulnerable reaches from hydraulic and structural aspects and store relevant data for subsequent detailed design at field level. The GIS based system will provide a decision making support tool on alternatives for power generation such as mini hydel project and/or Canal Rooftop Solar panels on the existing canal network. Canal Rooftop Solar panels will aid in reducing evaporation losses in canals.

4. **Scope of the Consultancy**

The consultant will work in close coordination with engineers, specialist and staff of concerned WRD offices. The Consultant will provide the services as below:

- Obtain all relevant data of canal such as design capacity, command area, actual flow, irrigation capacity and the assets from the concerned offices of Sone Canal System,
- Collect data and information on current maintenance, planning and approval, inspection and surveillance processes including annual expenditure on physical works from relevant office.
- Prepare inventory of the assets and their classification.
- Assess the desired maintenance plan for the assets.
- Design and develop a GIS-based Canal Asset Management System with user friendly functional modules for various functions in canal asset management with an aim of planning and implementation of the objectives as discussed in para 3.0 above.
- Prepare and integrate database and management functional modules to the CAMS.
- Make recommendations for sustainable and effective use of Sone Canal Asset Management System (SCAMS).
- Provide on-the-job training to field engineers on the development and management of CAMS.
- Develop User Manual, Technical Reference and Training Modules.

The consultancy services would inter-alia include enterprise database design and planning and providing functionalities for spatial and non-spatial analysis. The design of the Enterprise Oracle/ArcGIS geo-database would support maintenance and inspection works of WRD. The consultant would develop standard protocols and formats for field office inspection and reporting.

Data such as legacy and new construction drawings and plans, maintenance reports, inspection reports, operation and maintenance manuals, models, and technical studies would need to be catalogued and linked through the CAMS, allowing users to search documents for specific canal segments. Database management functions would provide alerts and reports. The consultancy will also include the establishment of administrative protocols for data input and editing to maintain data integrity and quality control. To support long term management and maintenance of this database, the consultant will develop GIS standards and a comprehensive data management plan.

Following tasks have been identified in the consultancy work:

Task-1: Review of Current Practices, Data Availability & User Need Survey

- A. Study of International practices and review of current practices used for maintaining database of main canal & assets and identify possible approach for integration in CAMS
- B. Review current practices of canal operation & maintenance and recommend appropriate approach for integration in CAMS. The consultant will review samples of various field reports and suggest modalities for integration in CAMS.
- C. Prepare inventory of existing and expected future data of canal & assets to design the database.
- D. Conduct “User Need” survey to define functional requirement of Canal Asset Management System.

Output:

Inception Report covering Task-1 findings, proposed development approach, activity schedule and expected outputs etc.(Deliverable - At the end of 2nd month)

Task-2: Design of Canal Asset Management System (CAMS)

- A. The design and development of the Canal Asset Management system (CAMS) piloted for the Sone Canal System will be conducted in coordination with the staff of the concerned WRD offices.

The inventory of existing and expected future data and ‘user needs’ survey of the stakeholders in this region will provide the ‘basis’ of conceptualization and design of the database and management functions. Recognizing the allocation of roles and responsibilities at various levels and locations, the CAMS will be designed in standard user-node template. The general design concept of Canal Asset Management System (CAMS) will be finalized in consultation and approval of WRD and will include features as given below:
- B. System Requirement Specifications (SRS) detailing the structure of CAMS, input-output, interfaces etc.
- C. Develop a generic master module structure of CAMS for all canal system of Bihar and subsequently develop for Sone canal system as a module of CAMS
- D. Data viewer to display (graphically and numerically) and generate summary statistics on various user-selected database
- E. Generate spatial maps of hydraulic data, engineering data and field reports. This may include colour markers reflecting critical canal management

parameters.

- F. Ability to upload and download various datasets

Output:

Design Report covering design of Canal Asset Management System including input and output data format, internal & external interfaces.
(Deliverable - At the end of 6th month)

Task-3: Preparation of Database, Management Functional Modules and Integration in CAMS

Database:

The database will integrate all the legacy and current data related to Sone Canal System. The system will be able to retrieve technical details or documents at any specified location of canal. The indicative list of spatial and non-spatial data to be collected from respective WRD field offices and other departments are:

- a) Administrative Data :
- Name of the Canal / Branch Canal
 - Section wise Start and end point of the Main Canal,
 - Name of Branch Canal and its origin at Main Canal
 - Name of the village, Thana and block.
 - Name and location of offices of Chief Engineer(CE), Superintending Engineer(SE), Executive Engineer(EI), Sub-Divisional Officer (SDO) and Junior Engineer(JE) under whom the different Canals under Sone Canal System is maintained.
 - Location and inventory of stores and mechanical divisions.
- b) Engineering Data:
- Cross Section of the Main Canal at different locations,
 - Longitudinal Section of the Main Canal,
 - Bed Level, Full Supply Level (FSL), and Freeboard etc.
 - Structural Information – Structures existing along main canal, such as aqueducts, syphon, head regulator, gates and bridges etc. and cross regulator at branch canal,
 - Current physical status of canal
 - Maintenance history – Past and current data on inspection, certification

and maintenance of all works on or along the canal

- Breach/cut history – for last ten years
- Inspection report generated at various levels of WRD including different committees
- Geo-technical / Geological Survey Data along main canal

c) Spatial Data:

- Location and alignment of all the canals, branch canals, structures etc.
- Main Canal with road-crossings, branch canals and details of junctions
- Photographs of vulnerable locations taken at different time using GPS camera. The photo dataset will include field for comments, reference datum/ coordinate system, longitude, latitude and comments to be entered by photographer. Photograph details will be imported as a GIS layer so that they can be associated with the specific location on a canal.

Functional Modules:

a) Inspection Module

A web-based Inspection module for canal inspection will be prepared in line with the Operation & Maintenance Guidelines. This module will assist the decision makers to formulate the alarm instructions for canal operation in the event of occurrence of extreme events such as flood or earthquake.

b) Operation & Maintenance Log:

The module will integrate all records of operation & maintenance activities of the main canal and other structures. This module will store legacy data and information on performance of the canal such as seepage, embankment settlement, stability, repairs, maintenance etc. and will be valuable for conducting safety inspection and evaluations of the Sone canal system.

c) Alerts:

The system will have tools for 2D visualization of canals and retrieving technical details or documents of any specified location of canal. CAMS shall generate various alerts for operation & maintenance of canals & structures, generate maps and tabular data based on standard and customized user queries and provide support in the preparation of Report.

Data Viewer:

Design and develop a database Viewer, a web-based tool, as part of the CAMS that will provide authorized users with direct access to the canal database.

The Viewer will be hosted by WRD, Bihar web portal. The online application will be supported by a fully specified and documented API (Application Programming Interface) to allow modular replacement and expandability. The Viewer will also enable users to search documents associated with canal by the name, type, and geographic location. The ArcGIS supported database created for the Viewer will allow detailed geospatial analysis, to be conducted in consultation with the WRD.

Protocol & Formats:

The Consultant will develop protocols for operation, maintenance and updating at Head Office. Updating protocols may cover data flow in specified formats from field offices to head office and downstream upgrading may be required in the field offices for data exchange with CAMS.

Output:

Beta version of Canal Asset Management System including Reporting Protocol and Formats (Deliverable – End of 10th month).

Task-4: Development of User Manual, Technical Reference, Operation Manual and Training Schedule:

The sustainable and effective use of CAMS will be ensured through User Manual, Technical Reference, Operation Manual, Training programmes and development of protocols for operation, maintenance and updating at Head Office.

The User Manual shall include step-by-step, easily comprehensible instructions and support to the users in operating the various modules of the CAMS.

The Technical References shall include technical description of technologies, modules and objects used in the CAMS. The technical references shall also include data dictionary, system architecture, hardware and software specifications, maintenance information, etc.

Output:

- A. Draft Final Report including User Manual, Technical Reference, Operation Manual & Reporting Protocols and formats
 - B. Operational CAMS
 - C. Training Schedule
- (Deliverable - At the end of 13th Month)

Task-5: Capacity Building and Training:

The Consultants shall implement an effective training programme to include on-the-job training as well as training at the Consultant's office for relevant officials of the department at headquarters and field offices on the maintenance, basic updating and use of CAMS. Orientation training will be provided to the top management on the benefits and use of CAMS. An exhaustive training will be provided to WRD officers, engineers & staff involved in hardware, software and network system maintenance, database and GIS development, operations and management of CAMS. (To be completed by end of 14th month)

Output:

- A. Training to Field Officers for the effective use of CAMS
- B. Training to top management on the benefit & use of CAMS
- C. Training to engineers involved in maintenance & operation of CAMS

Task-6: Final Report :

The Consultant shall submit the final report to the client in requisite number of copies incorporating all comments of Draft Final Reports and Final Version of CAMS along with accompanying computer data files generated as part of the project background documentation (At the end of 15th month).

5. Responsibilities of Client:

- Provide authority letter for procuring data and other related works.
- Provide available office data and thematic GIS data i.e. administrative data, engineering data etc of canal with assets.
- Facilitate access to H.O. and field offices for data collection and field visits.
- Facilitate access to other staff (Remote sensing/GIS/Database specialist, Webmaster) as needed by the Consultant.
- Nominate counter-part engineers and specialist including database/GIS&RS specialists to liaise with the Consultant.

6. Responsibilities of Consultant:

- The Consultant shall conduct and complete the Project as per the agreed scope and objectives of the ToR . He will have his own hardware (Laptop) and required software.
- Convert all source data supplied by WRD, Bihar as needed for integration in CAMS.

- The Consultant shall deploy necessary resources to collect all canal related data proposed in CAMS from concerned agencies of WRD, Bihar and populate the database.
- Conduct field visits for data collection and ground verification.

7. Reporting and Review

The activities described earlier and the outputs described below shall be completed within a period of 15 months. Key reporting requirements follow:

Reports	Covering	Time / Month
Inception Report	Findings of Task-1, analysis of data availability, draft concept of design of CAMS, proposed Development Approach, Activity Schedule & identification of data input and outputs expected.	By end of 2 nd Month
Quarterly Progress Report	Progress of the Project covering all the aspects as provided in the scope of work during the Quarter	By last week of next month ending each quarter
Design Report	Detail Concept of Design of Canal Asset Management System including input & output data formats, internal & external interfaces as mentioned in the scope and objectives of this consultancy	By end of 6 th Month
Beta Version of CAMS	Prototype model of CAMS including Reporting Protocols and Formats for approval	By end of 10 th Month
Draft Final Report	Draft Final Report including User & Operational Manuals Operational CAMS Training Schedule	By end of 13 th Month
Training	Training on developed CAMS	During 14 months
Final Report	Incorporating all comments of Draft Final Reports Final Version of CAMS	By end of 15 months

The reports except quarterly progress report will be reviewed by NHP Standing Review committee (NHP SRC) already set up by WRD, Bihar. The Consultant will present different deliverables to the client. The Client will facilitate to present the reports to NHP- SRC for its review within 15 days of the submission of the report. The SRC will then accord its approval after satisfactory compliance of SRC observations , if any.

8. Professional Key Staff Requirements

The indicative list of Key Staff and man months are listed below. The Consultant may propose alternative team composition and skill mix in order to carry out its roles and responsibilities efficiently for successful completion of the assignment.

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
Team Leader [1]	- Degree in Civil Engineering from reputed University. Post Graduate Degree and higher degree in Civil Engineering / Water Resources - He should have at least 15 years of experience in planning, operation & maintenance / management of canal. - Knowledge for the development of enterprise level database & information system, asset management and working experience with multi-disciplinary teams will be preferred.	- Responsible for all aspects of overall project management, planning, design, development, coordination, reporting and to liaison with the Client. - Provide advice, lead and co-ordinate the project team. - Attending meeting as and when required by WRD. - Ensure that all the work are done as per the scope and objective as mentioned in the TOR	15 months

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
Canal Maintenance cum Data Liason Expert [1]	- Degree in Civil Engineering from reputed University. Post Graduate Degree in Civil Engineering / Water Resources will be preferred. - He should have at least 12 years of working experience in planning, operation & maintenance / management of canal. - He should be aware of existing protocols & reporting process for canal management.	- Review current protocols and reporting process during operation & maintenance of canals - Conduct 'user needs survey' for CAMS - Liaise with client and central agencies for data collection - Assist system analyst in defining the functional requirements during conceptualizing/designing CAMS - Recommend improvement in current reporting and planning process, and Integration in CAMS - Assist training of SSNNL staff in the use of CAMS	10 Months

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
System Analyst [1]	• B Tech in Computer Engineering/IT/MCA/Bachelor Degree in Civil Engineering with Post Graduate certified course in ICT or similar discipline. • Should have at least 10 years of experience in the field of Water Resources related works. • Experience in system design, use of GIS and RS technology; experience in asset management information system will be preferred.	• Analyze the functional requirements and data availability. • Developing functional & technical specifications of the system. • Prepare detailed flow charts & diagrams outlining systems capabilities & processes. • Preparing system documentation. • Developing plan & procedures for testing & debugging • Design and develop the CAMS.	10 Months

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
Database Specialist [1]	• B Tech in computer science /IT/ MCA, or equivalent degree from a recognized university of India or abroad / Bachelor Degree in Civil Engineering with Post Graduate degree in ICT or similar discipline. • Should have at least 10 years of experience with experience in development of application integrating GIS & database and other information systems. Experience in asset management information system will be preferred.	• Analyze the existing physical (hardcopy) / electronic database • Identify the data required for the system • Assist System Analyst to design and develop the CAMS • Installation & configuration of the database. • Performance tuning of the database. • Design and development of Metadata. • Recommending & implementing database standards, the security & integrity of the database. • Finalize data communication protocol.	13 Months

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
GIS Expert [1]	• Post Graduate Degree in Geography / Science / Geo informatics with at least 10 years working experience in GIS / RS applications for resource mapping, preparation & integration of GIS database. • Working experience in Water Resources and asset management information system will be preferred.	• Analyze the requirement of GIS applications in CAMS • Identify required GIS data • Guide and monitor the activities to implement GIS applications • Ensure the quality of application software, reports and documents • Prepare Geo-database and link to the database and other information systems • Plan and design the analysis of different layers of spatial data and presentation of the results for better interpretations.	13 Months
Software Programmer [1]	• Degree in computer science /IT/ MCA, or equivalent degree from a recognized university of India or abroad / Bachelor Degree in Civil Engineering with Post Graduate degree in ICT or similar discipline. • Should have at least 10 years of experience with experience in development web based application, integration GIS application with web. Experience in asset management information system will be preferred.	• Analyze the existing physical (hardcopy) / electronic database • Planning & design of various web based module • Installation & configuration of the web based application to GIS & database. • Recommending & implementing web based application for the security & integrity of the CAMS.	13 Months

Proposed Position [No of Persons]	Qualification	Responsibility	Total Person-months
Technician [1]	• Minimum of bachelor degree with at least 2-3 years' experience in digitizing maps, exporting to GIS platform, entering and attaching attribute data, assist in the GIS specialist and database specialist. • Experience in GPS survey and asset management information system will be preferred.	• Conducting GPS survey, processing surveyed data, digitizing, data editing and exporting it to GIS platform. • Preparation & validation of attribute data.	10 Months

Support Staff

Position	Qualification	Person-months
Assistant Software Programmer [Two]	Degree in computer science / BCA, or equivalent degree from a recognized university of India or abroad or similar discipline. Working experience in Water Resources and asset management information system will be preferred	20 months

9. Payment Schedule

All payment should be made on deliverables as given below:

- 20 percent after submission and approval of Inception Report by NHP-SRC
- 10 percent after submission and approval of Design Report by NHP-SRC
- 20 percent after submission approval of Beta Version by NHP-SRC
- 15 percent after submission and approval of Draft Final Report by NHP-SRC

- 15 percent after successfully completion of training plan and submission and approval of training report by NHP-SRC
- 20 percent after submission and approval of final Report incorporating all the suggestions / comments by NHP-SRC

10. Duration of consultancy

Duration of the consultancy works shall be 15 months.

11. Mode of Procurement

Quality and cost based selection (QCBS) method.

12. Project Appreciation

12.1 Project Area

The Sone command is spread over seven districts in South Bihar namely Rohtas, Bhojpur, Buxar, Kaimur, Patna, Gaya and Aurangabad. The GCA of Sone low level Canal (SLLC) after construction of Indrapuri Barrage and remodeling of Canal is 6.88 Lakh Hectares. While CCA is 5.60 Lakh Hectares, annual irrigation is being done in 6.95 Lakh Hectares. Sone High Level Canal has a GCA of 1.84 Lakh Hectares and its CCA is 1.392 Lakh Hectares. The SLLC is divided into two systems viz. the Western Canal System (old) or Western Low Level Canal (WLLC) System and the Eastern Canal System (old) or Eastern Low Level Canal (ELLC) System. The present CCA is spread work 44 blocks in the seven districts mentioned above. WLLC System covers four districts of Rohtas, Bhojpur, Buxar and Kaimur while ELLC System covers the remaining three districts of Patna, Gaya and Aurangabad. Some of the blocks are fully covered and others are only partially covered by canal irrigation.

12.2 Climate in the Project Area

Climate in the command area is subtropical monsoon type characterized by hot summer, high humidity and dry winter. The three seasons are summer (March to Mid June), rainy season (Mid June to Mid October) and winter season (Mid October to February). Most of the rainfall occurs during the period of four months, between mid June to mid October from South West Monsoon.

12.3 Topography

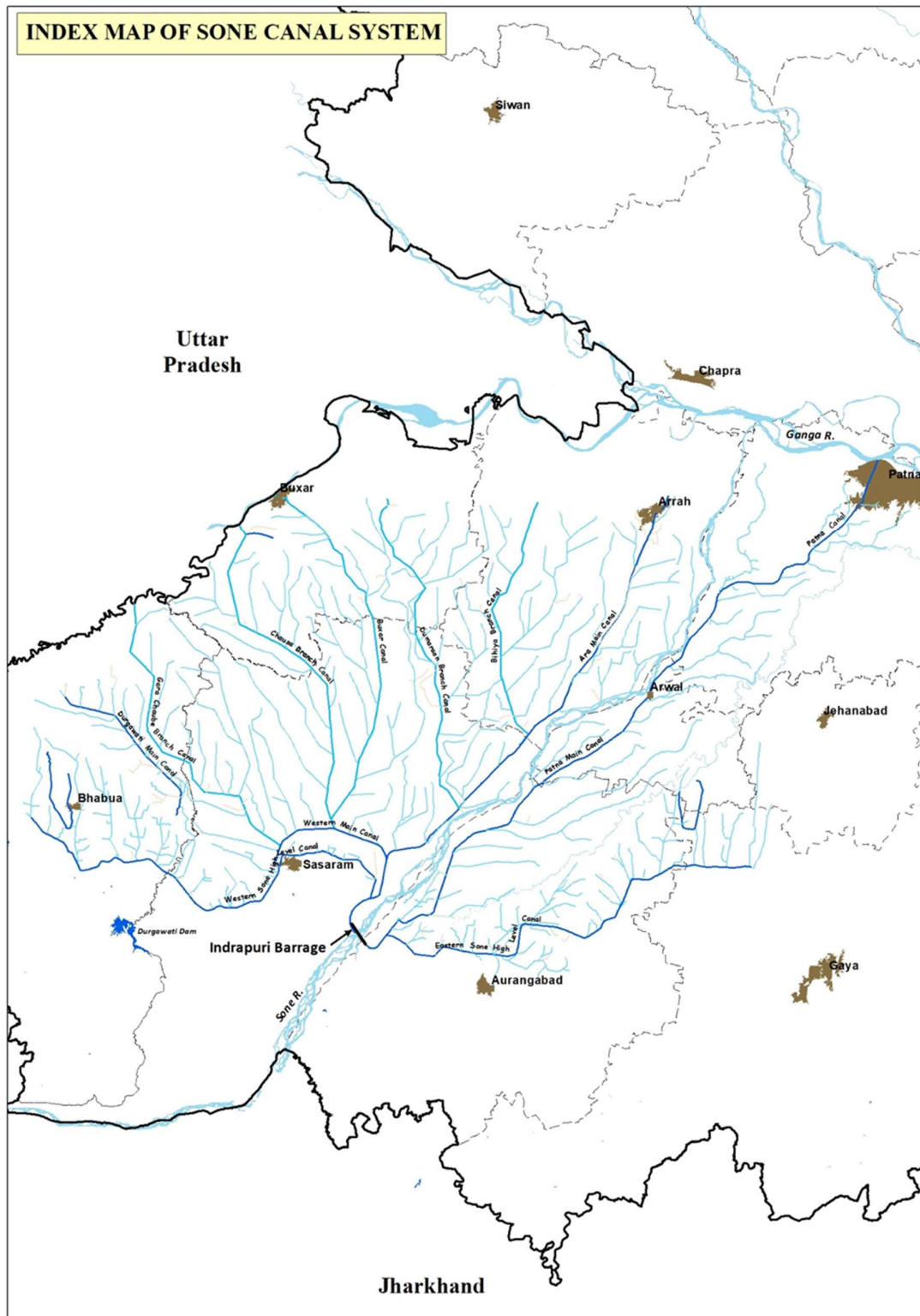
Topography of the command area is best suited to flow irrigation . The total cultivable area of Sone Command is spread over 7.04 Lakh Hectares on the southern side of Patna-Buxar Railway line and over 0.92 Lakh Hectares on its northern side upto Buxar, Koilwar flood embankments along river Ganga. The entire Sone Command stands divided by a series of North to South parallel ridges and valleys with the rivers flowing in the valleys and the canals on the ridges. This fan shaped command area is almost plain and sloping from South to North at a gentle slope of 1:2000. The rivers of the West command area flow in North-West direction, in the central Command, flow towards North and in the Eastern Command, they flow in the North-East direction, running almost parallel to each other and ultimately falling into river Ganga. River Sone flows along the highest valley.

12.4 High Level Canals

Construction of two High Level Canals taking off from the two link canals on either flanks are known as Sone Western High Level Canal and Sone Eastern High Level Canal. They were made to provide irrigation to upper areas which were outside the command of the old Canal System. With the above modification, the old Sone Canal System has come to be known as Sone Low Level Canal System. The Capacity originally designed in 1874 and those obtained after remodeling are as shown in the following table :

Name of Canal	Length in K.M	As originally designed (1874)		Post remodeling design (1968)	
		Cumecs	Cusecs	Cumecs	Cusecs
Western Canal System:-					
Western Link Canal	10.12	-	-	226.54	8000
Main Western Canal	32.50	123.96	4342	190.01	6710
Arrah Main Canal	84.50	56.640	2000	99.00	3496
Dumraon Branch Canal	64.80	9.94	351	29.86	1055
Bihyan Branch Canal	49.60	12.12	428	27.41	968
Buxar Branch Canal	69.80	34.72	1226	68.02	2402
Chausa Branch Canal	62.67	17.64	623	21.72	1120
Garachaube Branch Canal	61.20	18.24	644	18.24	644
Western Sone High Level Canal	80.42	-	-	39.65	1400
Eastern Canal System:-					
Eastern Link Canal	10.16	-	-	124.60	4400
Main Eastern Canal	10.60	45.68	1613	83.82	2960
Patna Main Canal	129.50	41.51	1466	79.38	2960
Eastern Sone High Level Canal	81.68	-	-	39.73	1403

**** (As given by Irrigation Monitoring circle, WRD Bihar)**



Index Map of the Sone Canal System

12.5 Irrigation Management System for the Sone Canal

Sone Canal System is approximately 140 years old and irrigates Rohtas, Kaimur, Bhojpur, Buxar, Gaya, Aurangabad, Arwal and Patna districts of Bihar. A Barrage near Dehri, called Indrapuri Barrage on Sone river diverts water into left and right link canals of the Sone Canal System. At present the total design discharge of left and right Canal System is 351.15 cumec and the total CCA is 6,99,200 Ha.

After independence, a number of structures have been constructed on Sone river in the upstream of Indrapuri Barrage. This resulted in shortage of water for Sone Canal System. Ultimately Bansagar agreement among M.P, U.P and Bihar was signed to assure the demand of Sone Canal System. As per Bansagar Agreement, 7.75 million Acre feet (MAF) of water was allotted to Bihar for the Sone Canal System. The details of waters allocation is given below:-

#	Name of River in the catchment area of Sone river	Water allocation (MAF)		
		M.P.	U.P.	Bihar
1	Sone (U/S of Bansagar)	1.00	-	-
2	Sone (Bansagar Reservoir)	2.00	1.00	1.00
3	Banas	0.12	-	0.48
4	Gopad	0.55	-	0.65
5	Rihand	0.91	-	2.59
6	Kanhar	0.62	0.25	0.43
7	North Koel	-	-	2.10
8	Free catchment of Sone River	0.05	-	0.50
Total :-		5.25	1.25	7.75

At present Bihar is utilizing 1.00 MAF water stored in Bansagar Reservoir, discharge from free catchment and discharge released from Rihand Reservoir by U.P. according to their demand. Water released from Bansagar Reservoir takes approximately five days to reach Indrapuri Barrage for feeding the Sone Canal System. While there is shortage of water for the Sone Canal System, most of the share of water goes unutilized during the rainy season.

12.6 Salient Features Of Sone Barrage Project

A. Hydrology

Catchment	69,000 Sq. km
Average annual rainfall	139.8 cms (55 inches)
Observed maximum discharge	34.1 Th. cumecs
Design Discharge	41.3 Th. cumecs

B. Barrage

Length of Barrage	1410 m
Design H.F.L.	109.6 m
Afflux	1.22 m
Crest level of weir sluices	104.0 m
Crest level of under sluices	103.4 m
Average bed level	103.8 m
Pond level	108.3 m

C. Irrigation Canal System

Western Link Canal

Length	10.12 km
Full supply discharge	226.54 cumec
Gross command area	587.50 Th. ha

Eastern Link Canal

Length	10.16 km
Full supply discharge	124.61 cumec
Gross command area	284 Th. ha

D. Western and Eastern Canal Systems (Old) or Western and Eastern Low

Level Canal Systems

Gross Command area	688 Th. ha
Culturable Command area	560 Th. ha
Annual Irrigation	695 Th. ha

E. Sone Western and Eastern High Level Canals

Level Canal Systems

Gross Command area	184.2 Th. ha
Culturable Command area	139.2 Th. ha
Annual Irrigation	156.58 Th. ha

12.7 Details Of Canals

The details of Main Canals, Branch Canals and distribution system has been shown on the schematic drawing of these Canals attached herewith as **Annexure: 1.**

Length of Canals

Length of Main Canals	=	158 km
Length of Branch Canals	=	308 km
Length of Distributary/Minor Canals	=	2800 km
Total Length of Canals	=	3266 km

Total Culturable Command Area (CCA)

CCA of left (Western) main Canal	=	501839 ha
CCA of Right (Eastern) main Canal	=	197361 ha
Total CCA	=	699200 ha
Approximately Gross Command Area (GCA)	=	872200 ha

12.8 Details Of Structures

The details of different structures on the Canals can be obtained from the local Division offices of the Sone Canal System.

