

**BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI
ORIGINAL APPLICATION NO. 463/2022**

IN THE MATTER OF: -

Vipin Nayyar

.... Applicant

Vs

Union of India & Ors

.... Respondents

INDEX

Sr. No	Particulars	Pg. No
1.	Response by way of affidavit on behalf of Chief Engineer , Irrigation Department, Dehradun, Uttarakhand, against the additional affidavit filed by the applicant dated 21.04.2025 before the Hon'ble Court.	1-6
2.	ANNEXURE A: ESDD Report of Virbhadra Barrage as submitted in the Dam Rehabilitation and Improvement Project (DRIP) phase II.	7-46
3.	ANNEXURE B: Criteria for design of lined canals and guidance for selection of type of lining, BIS IS 9429/10430:2002 (Page 10 4.1.5)	47-65



Filed By

DEEPAK BORA

Counsel for the State of Uttarakhand

17, New Lawyers Chambers,

Setalvad Block,

Supreme Court of India

New Delhi-110001

Mobile No. 9971578987

BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI
ORIGINAL APPLICATION NO. 463/2022

IN THE MATTER OF: -

Vipin Nayyar

.... Applicant

Vs

Union of India & Ors

.... Respondents

RESPONSE BY WAY OF AFFIDAVIT ON BEHALF OF CHIEF ENGINEER,
IRRIGATION DEPARTMENT, DEHRADUN, UTTARAKHAND, AGAINST THE
ADDITIONAL AFFIDAVIT FILED BY THE APPLICANT DATED 21.04.2025
BEFORE THE HON'BLE COURT.

I, SHANKAR KUMAR SAHA, aged 57 years, working as Chief Engineer, Irrigation
Department, Dehradun, Uttarakhand do hereby solemnly affirm and state as
follows:

1. That in my above-mentioned official capacity, I am acquainted with the facts
and circumstances of the present case and fully conversant with the present
Original Application and the Additional Affidavit of Vipin Nayyar dated
21/04/2025. I am fully competent to file this Response Affidavit.
2. The Applicant has filed Additional Affidavit dated 21/04/25 raising
objections to the report made by the Chief Engineer with respect to the
Virbhadra Barrage, challenging the report on the basis of erroneous



representation of facts and legality of the verification given to the hotels clearing them of violation in the report by the chief engineer, basis of these objections, apart from insinuating coercion or undue influence, being,

- i. The length of the Virbhadra bridge,
 - ii. The embankment composition,
 - iii. The legality of hotels constructed at elevation 335.99m AMSL and the positioning of the hotels with respect to the width of floodplain zone in the area.
3. After careful perusal of the Applicant's contentions and the Report, these issues require demonstration of factual accuracy of the report, compliance with all statutory and regulatory norms, and proper technical basis for dam dimensions, embankment design and ancillary constructions.
4. The Applicant's Additional Affidavit is founded on erroneous factual premises and misapprehension of law, accordingly :
- i. Length of the barrage is 312m and there is no contention or fact which says that it is of 1.73 km in length.
 - ii. The filter materials present in the embankment are standard safety features and not violation and it can only be present in the cross-sectional area and only amounts up to 20% and never 50% as contended by the applicant.
 - iii. No statute prohibits hotels at 335.99 m ASML so long as hazard-zone norms are met.
 - iv. The Report was prepared under the due norm made by the irrigation department.



[Handwritten signature]

5. The content of para 7, page 760 is rejected in total as the Applicant has contended that the length of barrage given in the report is contradictory in para 3 and para 6 of the report vide page no 737 wherein the length of barrage was mentioned as 312 metres in para 3, page 736 and 1.73 km in para 6. However, this contention was based on a factual misstatement wherein the report explicitly mentions that the length of the barrage is indeed 312 m and 1.73 km in approximate is the length of the reservoir and not the barrage as mentioned in the report in para 6, page 737. The Applicant has misrepresented these facts to argue on the basis of contradiction of length of barrage in the report. The same fact can be corroborated by referring to page no. 7 of the ESDD Report of Virbhadra Barrage as submitted in the Dam Rehabilitation and Improvement Project (DRIP) phase II, wherein the length of the barrage is calculated to be of 312 metres. The copy of the same is annexed herewith and marked as **Annexure A**.
6. The contention made by Applicant in para 10-11 is also responded, alleging that the report has purposefully hidden a material fact that the 50% of the embankment is filter material, implying structural risk or regulatory breach to the hotel Ganga Forest View built above. Zoned embankment design under BIS IS 9429/10430:2002 (adopted by CWC) mandates filter and drainage zones to prevent internal erosion. These filters comprise a designed proportion of cross-section and are integral to dam stability. The Report confirms adherence to CWC-approved zonal designs, no deviation or over-use of filter material occurred. Thus, the Applicant's claim mischaracterizes standard engineering practice, besides the filter material will only comprise



[Handwritten signature]

up to a maximum of 20% and never 50% as contended by the Applicant. The filter content in the Virbhadra barrage embankment would have been engineered for stability. The ESDD report had also not cited any embankment composition violation. If anything, claims of "50% filter" exaggerate a routine design feature. Any inference of illegality is incorrect. The CWC's dam-safety guidelines implicitly accept such filters, and Uttarakhand dam regulations do not forbid them. A copy of the report is annexed herewith and marked as **Annexure B**.

7. Applicant in para 12 contends that the hotel at 335.99 m AMSL contravene dam safety/ floodplain rules. The FRL is 336.50 m AMSL, hotels at 335.99 m lie 0.51 m below FRL, but outside the direct embankment footprint and behind the mandated chain-link fencing and afflux bund works as stated in the report. There is sufficient structural protection that negates that slight difference in length. The ESDD report's inundation mapping for the Revised Spillway Design Flood (23,530 m³/s) shows the hotel sites remain outside the 100-year flood envelope.
8. The Applicant's contention in para 16, page no: 763 is rejected in toto that width of the flood plain zone in the area near hide out café is not provided. The also contend that the Hide Out Café is exposed to flood risk according to the width of the river. The width of the flood plain zone near the area of the hideout Café is provided in para 14: page no: 740 to be calculated as 1200 metres approximately. Para 13 has cited hydrological studies 100-year return period flood level of the river Ganga has been calculated the data



provided herewith in the report is satisfactory to conclude that the café is located safely.

- 9. Contention made by the Applicant in paras 13 to 16 is also rejected as claims of contradictory flood plain widths as 550m and 1.73km in the report, again suggests a technical confusion as the 500m refers to channel width during monsoon seasons, whereas the 1.73 km was the length of the reservoir and it is a misconstruction of combined channel plus temporary spill bench widths under extreme flood. The Report clearly delineates these parameters in separate sections, with no contradiction.
- 10. The citation made in para 13, page no 762 is misconstrued wherein the applicant has cited M C Mehta v. Union of India O.A NO. 200 of 2014, however the 30 metre Highest Flood rule wherein commercial establishments are built 30 metres away will not be applicable here as this rule applies only when Costal Regulation Zone (CRZ)/ Eco Sensitive Zone (ESZ) notifications cover the particular area.

[Handwritten Signature]

DEPONENT

Jain
I identify the Executant/Deponent who has signed in my presence.



Sworn before me on this Vipin Nayyar
day of at Delhi by
Shri/Smt
R.o. Delhi who has been identified
by Shri/Smt. [Signature]
Advocate Delhi

9 JUL 2025

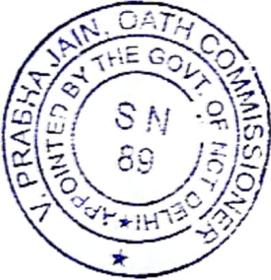
VERIFICATION

I, the deponent above named, do hereby verify and say that the contents of my above report by way of the affidavit are true and correct to my knowledge based on the record, no part of it is false, and nothing material has been concealed therefrom. The legal submissions are further true as per legal advice received and believed to be true and correct.

Verified by me at P. H. Comd on this 19th day of July 2025.

**DEPONENT****SHANKAR KUMAR SAHA,**

Chief Engineer,
Irrigation Department,
Dehradun,
Uttarakhand

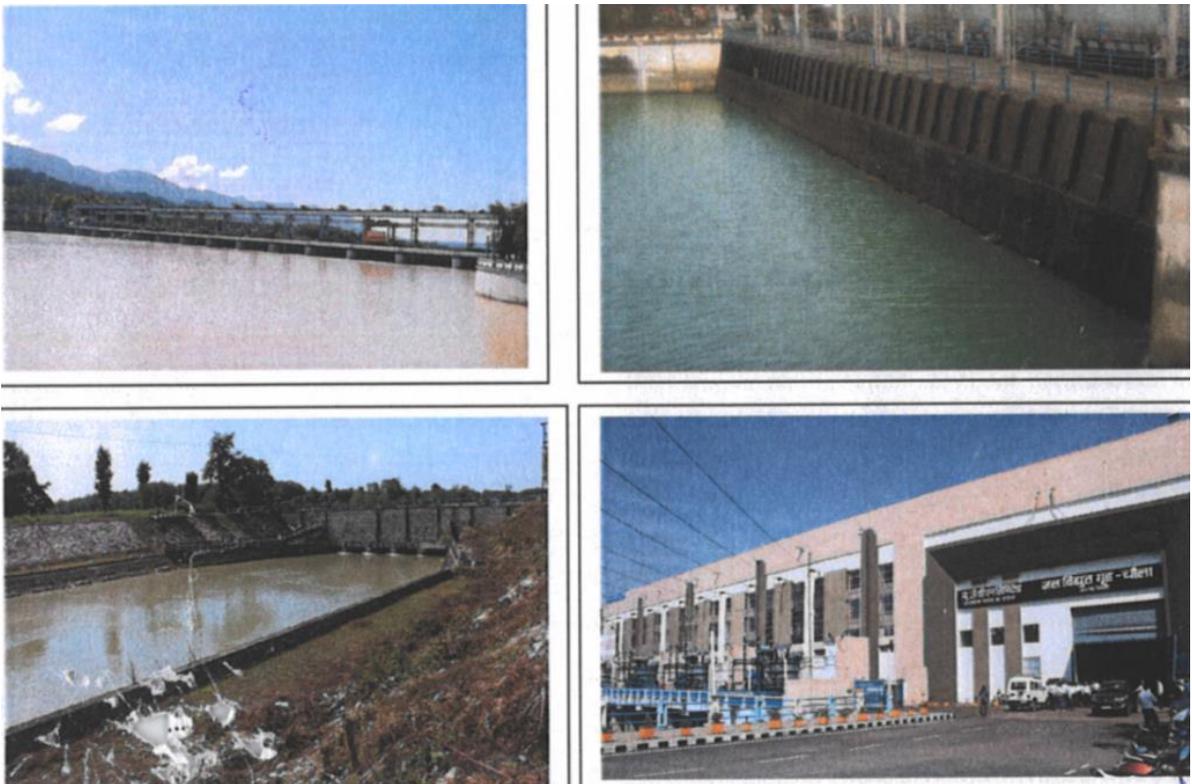
 **Filed By****DEEPAK BORA,**

Counsel for the State of Uttarakhand
17, New Lawyers Chambers,
Setalvad Block,
Supreme Court of India
New Delhi-110001
Mobile No. 9971578987

**DAM REHABILITATION AND IMPROVEMENT PROJECT (DRIP)
Phase II
(Funded by World Bank)**

**VIRBHADRA BARRAGE
(PIC: GENUAWA003)**

ENVIRONMENT AND SOCIAL DUE DILIGENCE REPORT



FEBRUARY 2021

**Office of Executive Engineer (E&M)
Virbhadra Barrage
UJVN Limited
Rishikesh, Uttarakhand**

CONTENTS

EXECUTIVE SUMMARY	4
INTRODUCTION	6
1.1 PROJECT OVERVIEW	6
1.2 SUB-PROJECT DESCRIPTION – VIRBHADRA BARRAGE	6
1.3 PROPOSED INTERVENTIONS/ACTIVITIES AND INTENDED OUTCOMES	8
1.4 IMPLEMENTATION ARRANGEMENT AND SCHEDULE	16
1.5 PURPOSE OF ESDD.....	16
1.6 APPROACH AND METHODOLOGY OF ESDD.....	17
INSTITUTIONAL FRAMEWORK AND CAPACITY ASSESSMENT	18
2.1 POLICY AND LEGAL FRAMEWORK	18
2.2 DESCRIPTION OF INSTITUTIONAL FRAMEWORK	19
ASSESSMENT OF ENVIRONMENTAL AND SOCIAL CONDITIONS.....	20
3.1 PHYSICAL ENVIRONMENT	20
3.2 PROTECTED AREA.....	21
3.3 SOCIAL ENVIRONMENT	22
3.4 CULTURAL ENVIRONMENT.....	24
ACTIVITY WISE ENVIRONMENT & SOCIAL SCREENING, RISK AND IMPACTS IDENTIFICATION	25
4.1 SUB-PROJECT SCREENING	25
4.2 STAKEHOLDER CONSULTATION	29
4.3 DESCRIPTIVE SUMMARY OF RISKS AND IMPACTS FROM ACTIVITIES BASED ON SCREENING	29
CONCLUSIONS AND RECOMMENDATIONS	31
5.1 CONCLUSIONS.....	31
5.1.1 <i>Risk Classification</i>	31
5.1.2 <i>National Legislation and WB ESS Applicability Screening</i>	31
5.2 RECOMMENDATIONS	32
5.2.1 <i>Mitigation and Management of Risks and Impacts</i>	32
5.2.2 <i>Institutional Management, Monitoring and Reporting</i>	33

TABLES

TABLE 4.1: SUMMARY OF IDENTIFIED RISKS/IMPACTS IN FORM SF-3.....	28
TABLE 5.1: WB ESF STANDARDS APPLICABLE TO THE SUB-PROJECT	31
TABLE 5.2: LIST OF MITIGATION PLANS WITH RESPONSIBILITY AND TIMELINES.....	32

FIGURES

FIGURE 1.1: SELECTED PHOTOGRAPHS OF IMPROVEMENT/INTERVENTION AREA.....	12
FIGURE 1.2: PROJECT AREA SHOWING MAJOR INTERVENTION LOCATIONS	13
FIGURE 3.1: LAND USE AND LAND COVER MAP OF 5 KM RADIUS AROUND BARRAGE SITE.....	20
FIGURE 3.2: PROTECTED AREAS VIS-À-VIS BARRAGE LOCATION.....	22

ANNEXURES

ANNEXURE I: FORM SF1	35
ANNEXURE II: FORM SF2	37

ABBREVIATIONS AND ACRONYMS

AIDS	:	Acquired Immunodeficiency Syndrome
CA	:	Conservation Area
CCA	:	Culturable Command Area
COVID	:	Coronavirus Disease
CSS	:	Compact Secondary Substation
CWC	:	Central Water Commission
DRIP	:	Dam Rehabilitation and Improvement Project
DSRP	:	Dam Safety Review Panel
E&S	:	Environment & Social
EAP	:	Emergency Action Plan
ESDD	:	Environmental and Social Due Diligence
ESF	:	Environmental and Social Framework
ESIA	:	Environmental and Social Impact Assessment
ESMF	:	Environment and Social Management Framework
ESMP	:	Environment and Social Management Plan
ESS	:	Environmental and Social Standard
GBV	:	Gender Based Violence
GIS	:	Geographic Information System
GRM	:	Grievance Redressal Mechanism
HIV	:	Human Immunodeficiency Virus
HR	:	Head regulator
IA	:	Implementation Agency
IPF	:	Investment Project Financing
MCM	:	Million Cubic Meters
OHS	:	Occupational Health & Safety
PA	:	Protected Area
PDO	:	Project Development Objective
PPE	:	Personal Protective Equipment
PST	:	Project Screening Template
RET	:	Rare Endangered and Threatened
SC	:	Scheduled Castes
SCADA	:	Supervisory Control and Data Acquisition
SEA	:	Sexual Exploitation and Abuse
SEAH	:	Sexual Exploitation Abuse and Harassment
SEP	:	Stakeholder Engagement Plan
SF	:	Screening Format
SH	:	Sexual Harassment
SITC	:	Supply, installation, testing & commissioning
SPF	:	Standard Project Flood
SPMU	:	State Project Management Unit
ST	:	Scheduled Tribes
TRC	:	Tailrace channel
WB	:	World Bank
WQ	:	Water Quality

EXECUTIVE SUMMARY

Virbhadra barrage is located at Virbhadra about 5 km d/s of Rishikesh in Dehradun District of Uttarakhand on the river Ganga. The barrage serves to divert water to the power channel for generation of electricity at Chilla Power House (144 MW). The gross storage of the reservoir is 8.1 MCM.

It has been proposed to undertake rehabilitation measures (structural civil & hydro-mechanical remedial works, electrical works and basic facility enhancement) under the proposed Dam Rehabilitation and Improvement Project (DRIP II) with a view to increase the safety and to strengthen dam safety management.

The Environment and Social Due Diligence has been conducted for decision-making on the sub-project with a view to identify, evaluate and manage the environment and social risks and impacts in a manner consistent with the World Bank ESF. ESDD has been carried out by studying the sub-project information and proposed interventions, assessing the magnitude of E&S risk and impacts with respect to key baseline data in immediate vicinity area. Stakeholder consultations with communities living downstream/vicinity of the barrage, could not be held in the current circumstances due to COVID19 and these shall be held as soon as situation is conducive for holding such consultations.

Activity wise environment and social screening has been carried out to identify risks and impacts to classify the sub-project based on risk level (low, moderate or substantial and high) and recommend commensurate plans/measures to meet identified risks and impacts.

As per the ESDD exercise, risk/impacts that have been identified relate to Water Quality, Physical Environment, labour and SEAH/GBV. Environment risks of air, water, noise, land use, soil and resource use for repair & restoration of spillway glacis and downstream protection work from gate Numbers 5 to 15 of barrage, construction of coffer dam / ring bandha and repair & strengthening of boulder excluder tunnel of under sluice gate 1 are considered moderate. Similarly, environment and social risk of labour camp and disposal of debris has also been identified as moderate. Due to location of barrage on boundary of "Rajaji National Park", impact of rehabilitation work on protected area has also been considered moderate. Risk of all other activities has been identified as Low. These risks are low to moderate and localised, short term and temporary in nature which can be managed with standard ESMP and guidelines. OHS is a substantial risk activity and is being treated separately through OHS plan in accordance with WB ESHS guidelines.

Since risks and impacts are low to moderate, a standard ESMP customised to sub-project will be prepared in accordance with the ESMF. The customised ESMP will address the following:

- Gender Based Violence or SEA/SH related actions (ESS1)
- Labour Management Procedure (ESS2)

- Resource Efficiency and Pollution Prevention (ESS3)
- Community Health and Safety (ESS4)
- Bio-diversity Conservation Plan (ESS6)
- Stakeholders Engagement Plan (ESS10)

Overall, the proposed activities within this sub-project have low to moderate risks resulting in the sub-project to be categorized as Moderate risk category. These risks and impacts can be effectively mitigated with effective implementation of mitigation plans by SPMU/IA, Contractors and monitoring by EMC, SPMU and CWC.

1.1 PROJECT OVERVIEW

The proposed Dam Rehabilitation and Improvement Project (DRIP II) would complement the suite of ongoing and pipeline operations supporting India's dam safety program. The project development objective (PDO) is to increase the safety of selected dams in participating States and to strengthen dam safety management in India. Project Components include:

- Component 1: Rehabilitation and Improvement of Dams and Associated Appurtenances (US\$ 577.14 million);
- Component 2: Dam Safety Institutional Strengthening (US\$45.74 million);
- Component 3: Incidental Revenue Generation for sustainable operation and maintenance of dams (US\$26.84million);
- Component 4: Project Management (US\$68.13 million).
- Component 5: Contingency Emergency Response Component (US\$0 million).

The project is likely to be implemented for 300 dams in 18 states across the country. The primary beneficiaries of the project are the communities that live in dam breach flood inundation areas and the communities that depend on water, irrigation and electricity services provided by the dams that could be compromised by poor dam performance or failure. In addition to saving lives, improved dam safety will avoid potential flood damage to houses, farm areas, infrastructure (roads, bridges, other public and private infrastructure) and industrial and commercial facilities. Improved dam safety will also reduce the likelihood of service interruptions due to dam failure as well as potentially improving dam service provision, overall efficiency and storage capacity, including during drought periods.

1.2 SUB-PROJECT DESCRIPTION – VIRBHADRA BARRAGE

Virbhadra barrage is located at Virbhadra about 5 km d/s of Rishikesh in Dehradun District of Uttarakhand on the river Ganga. It was constructed between 1973-74 and 1980-81 and the barrage serves to divert water to the power channel for generation of electricity at Chilla Power House (144 MW). The gross storage of the reservoir is 8.1 MCM.

Salient features of the Virbhadra barrageproject are reported below:

Project Name	Virbhadra Barrage
River Basin	Ganga
River/Stream	Ganga
District	Dehradun
Latitude/Longitude	30 ⁰ 04' 27" / 78 ⁰ 17' 18"
Type of Project	Run off the river hydro project
Gross Command Area (GCA)	NA

Cultivable Command Area (CCA)	NA
Hydro Power Installed Capacity	144 MW
Average Annual Energy Generation (MU):	720 MU
Domestic/Municipal/Industrial Water Supply (Annual)	NA
Dam	
Type	Concrete barrage
Total length of the Main dam	312 m
Length of Embankment dam	NA
Length of Masonry/Concrete dam	312 m
Top width of Embankment Dam	NA
Top width of Masonry/Concrete Dam	7.5 m
Elevation of top of Embankment Dam	NA
Elevation of top of Masonry/Concrete Dam	338.50 m
Elevation of top of Upstream Solid Parapet Wall	NA
Height of Embankment Dam above Lowest River Bed Level	NA
Height of Masonry/Concrete Dam above deepest foundation level	22.15 m
Lowest River Bed Elevation	322.50 m
Deepest Foundation Elevation	321.50m
Saddle Dam	NA
Spillway	
Type of Spillway	Broad crested
Length of Spillway	312m
Location of Spillway	Main barrage on right of under sluices
Spillway Crest Level	326.50 m
Number of bays	11
Total Discharging Capacity at MWL	10,560cumec
Spillway Gate	Vertical lift
Spillway gate size	18 m width & 10.15 m height
Type of Hoist for Spillway Gates	Rope drum
Type of Energy Dissipation Arrangement	Dentated sill
Hoist capacity of spillway gates	30 MT
Under Sluice Arrangement	
No of sluices	4
Size of sluice	18 m width & 11.15 m height
Discharging capacity of sluice at FRL	4280 cumec
Crest level	325.50 m
Head regulator	
Location	Left bank
Number	5
Sill level	326.50 m
Size	11 m width & 7.2 m height
Discharging capacity	665 cumec
Reservoir	
Catchment Area at barrage site	21,400 sq km
Maximum Water Level	336.50 m
Full Reservoir Level	336.50m

Minimum Draw Down Level	333.00m
Gross Storage Capacity at FRL	8.10 MCM
Live Storage Capacity	5.11 MCM
Date of Starting the Construction	1973-74
Date of Completion	1980 – 81
Date of first full impoundment	07/11/1980
Original Inflow Design Peak Flood	14,750cumec
Maximum observed flood peak and date	13,600 cumec on 17/06/2013
Revised Inflow Design Peak Flood	23,5330cumec

1.3 PROPOSED INTERVENTIONS/ACTIVITIES AND INTENDED OUTCOMES

The Dam Safety Review Panel (DSRP), constituted by CWC, Government of India for the purpose of inspection of the those projects which are planned to be undertaken for the repair, rehabilitation and modernization work under World Bank funded DRIP-II schemes, made a visit to Virbhadra barrage on 17/11/2019 for inspection purpose and recommended measure to improve the safety and performance of barrage and associated appurtenances in a sustainable manner, and also to strengthen the dam safety institutional set-up.

The objectives of the project are to be achieved through investments for physical and technological improvement activities, managerial upgrading of barrage operations, management and maintenance, with accompanying institutional reforms. The project will improve the safety and operational performance of barrage and mitigate risks to ensure safety of downstream population and property. The following rehabilitation proposals as described in the PST PART A have been formulated based on DSRP recommendations and these proposals form the basis for preparation of present ESDD report. All rehabilitation proposals listed under Part B in PST, are not being taken up at the present time and therefore are not considered as part of the ESDD.

Structural Rehabilitation Works

- Works related to chain link fencing along right afflux bund road of barrage
- Weather coat painting & other related works over civil structures with in barrage premises
- Protection & refurbishment work from spillway work from Spillway glacis to end sill of gate no 5 to 15 of barrage
- Works related to repair of damaged railing at barrage bridge & H.R. bridge
- Construction of coffer dam / ring bandha

Structural Measures for ensuring hydrological safety

- Replacement of S. S. plate on track guide of gate groove of barrage gates
- Replacement of sill beams
- Replacement of wheels, bearing of under sluice gates and other bay gates
- Procurement of bearing of spillway gates & head regulator
- SITC of package substation of 500 KVA, 11 KV/415 V CSS
- Providing and fixing of chequered plates at barrage gates, HR gates and gantry crane platform at barrage structure
- Epoxy on under sluice gates, otherway gates at barrage
- Replacement of rubber seal of HR gate, otherway gate, under sluice gate at barrage

- Repair & strengthening of boulder excluder tunnel of under sluice gate 1
- Providing and fixing of new pre-fabricated cabin above hoisting equipment of under sluice gate 1 to 4, other bay gate 5 to 15, head regulator gate 1 to 5

Basic Facilities Improvement

- Construction of new control room building
- Construction of training center/transit camp building N
- Construction of guest house building near police chowki*
- Construction of residential building at hydel colony

Si.No.	Name of Work	location	Land Ownership	Land Requirement
1	Construction of new control room building	Photographs Attached as Figures 1.3 and 1.4	UJVN Ltd.	812.95 Sqm
2	Construction of guest house building near police chowki		UJVN Ltd.	445.00 Sqm
3	Construction of residential building at Hydrel Colony.		UJVN Ltd.	1514.00 Sqm
4	Construction of training center/transit camp building at Rishikesh.		UJVN Ltd.	1160.00 Sqm

Instrumentation, SCADA, Surveillance system, etc.

- Design, supply, installation, commissioning and testing of early warning system & public address system
- SITC of solid waste disposal system
- Engineering, design, supply, installation, testing and commissioning of solar power panel for power backup*
- Procurement of 4 vehicles
- Procurement of furniture for office/training center at Chilla

Others

- Consultancy works related to supervision of design for structures and supervision of civil & basic facilities works
- Hydrographic Survey of Virbhadra Barrage, pashulok, Rishikesh..

** These activities have not been recommended for inclusion under rehabilitation works and hence have not been considered in present ESDD.*

Figures 1.1 and 1.2 provide photographs of key infrastructure proposed for rehabilitation works and also major interventions locations.



Photo – 1 Virbhadra Barrage Pond



Photo – 2 Barrage View from D/S



Photo – 3 Position of Barrage Gates



Photo – 4 Position of Gate Pulley



Photo – 5 Damaged SS Plate of Wheel Track of Spilway Gate



Photo – 06 Damaged Rubber Seal of Head Regulator Gate



Photo – 7Rusted Chequered Plate at Highest Platform



Photo – 8Damaged SS Sill Plate

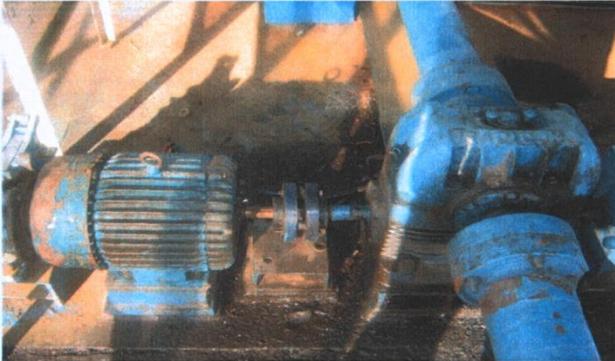


Photo – 9Hoisting Motors



Photo – 10Barrage Gate Motor



Photo – 11Trash Rack

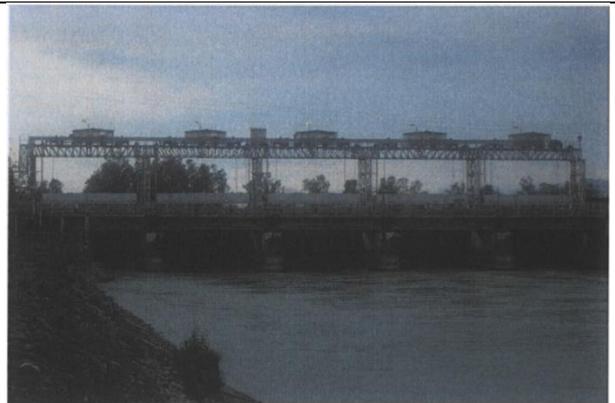


Photo – 12Head Regulator Gates



Photo – 13Distress Condition of Piers



Photo – 14 Distress Condition of Piers

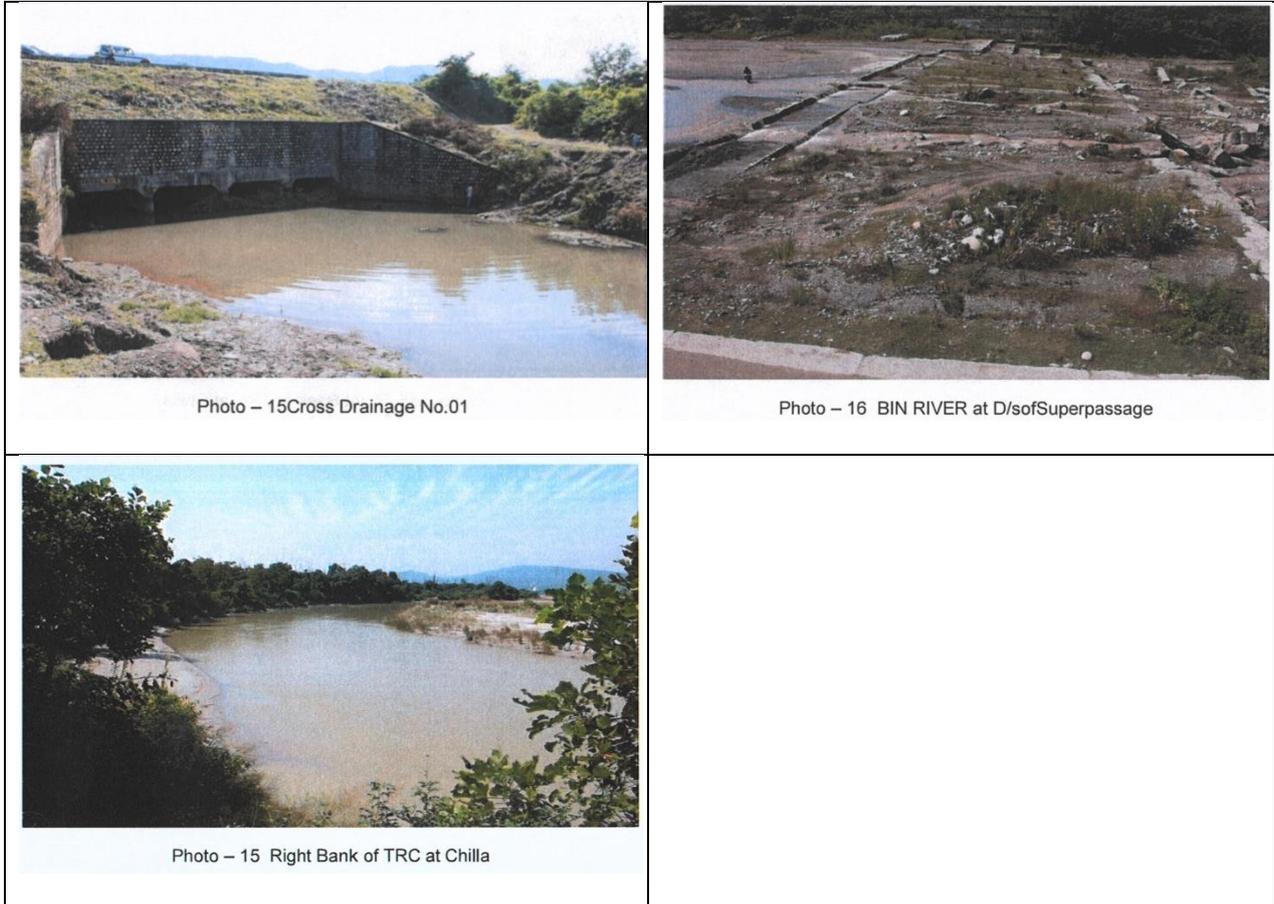


Figure 1.1: Selected Photographs of Improvement/Intervention area

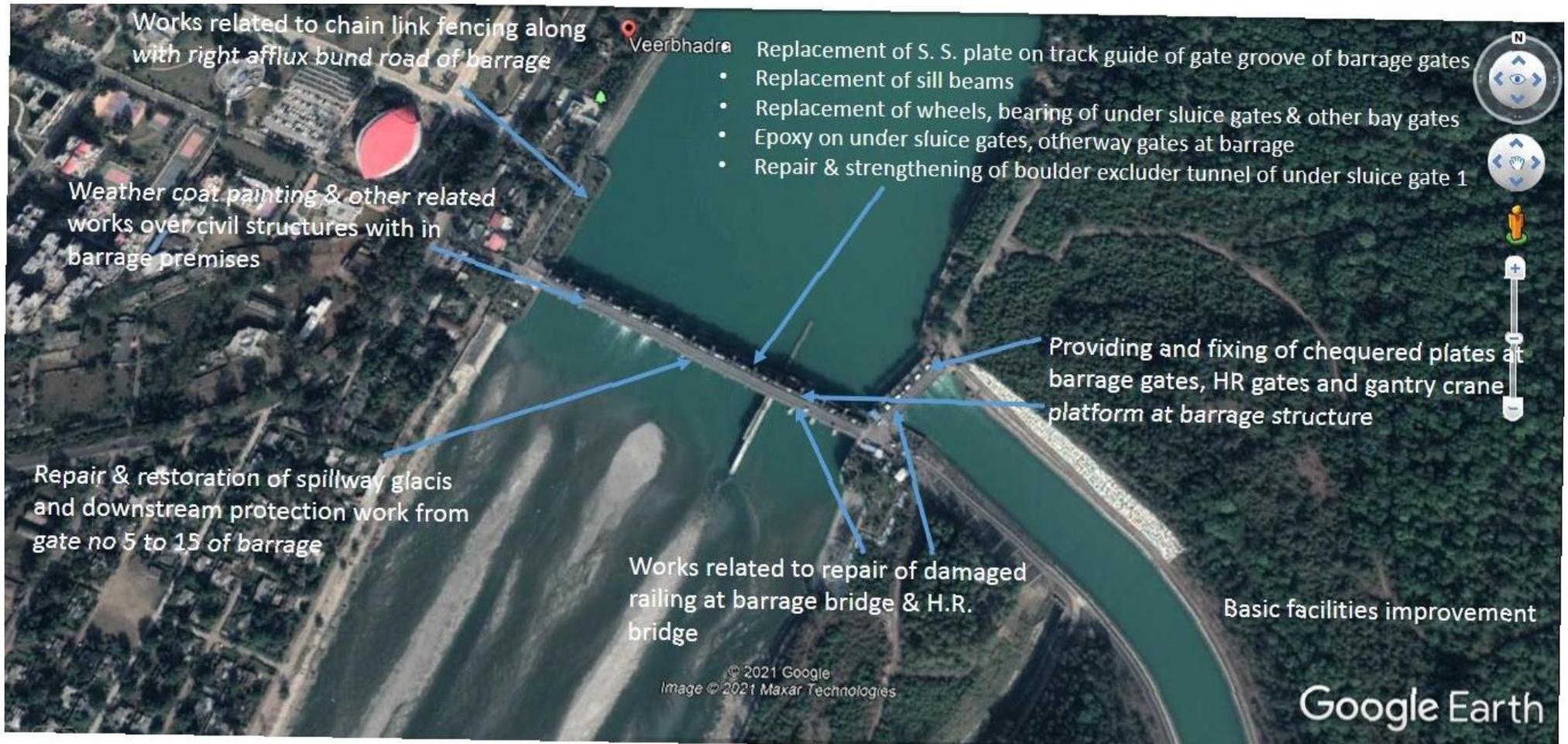


Figure 1.2: Project Area showing major intervention locations

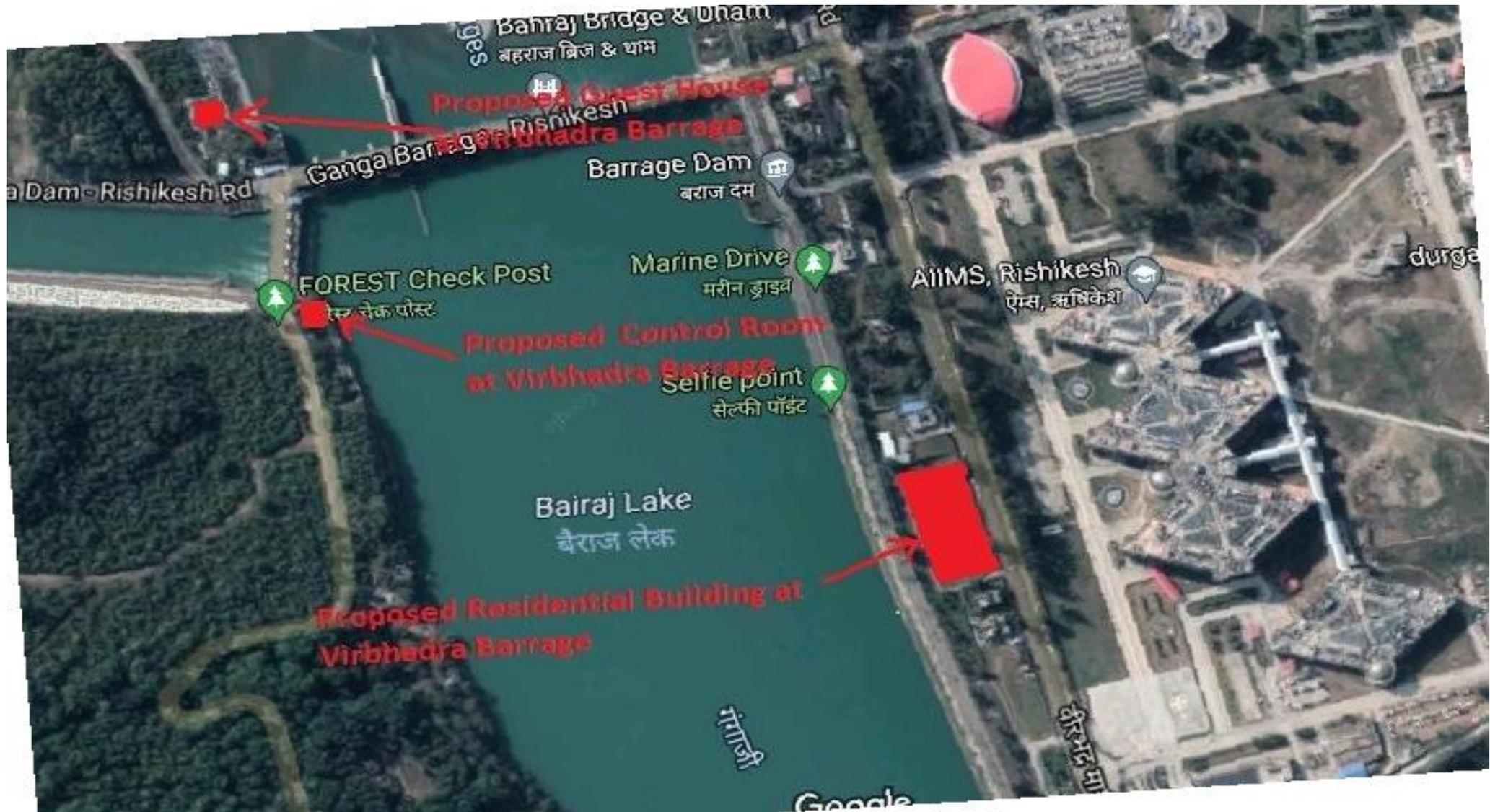


Figure 1.3: Showing Proposed Structure locations at Virbhadra Barrage

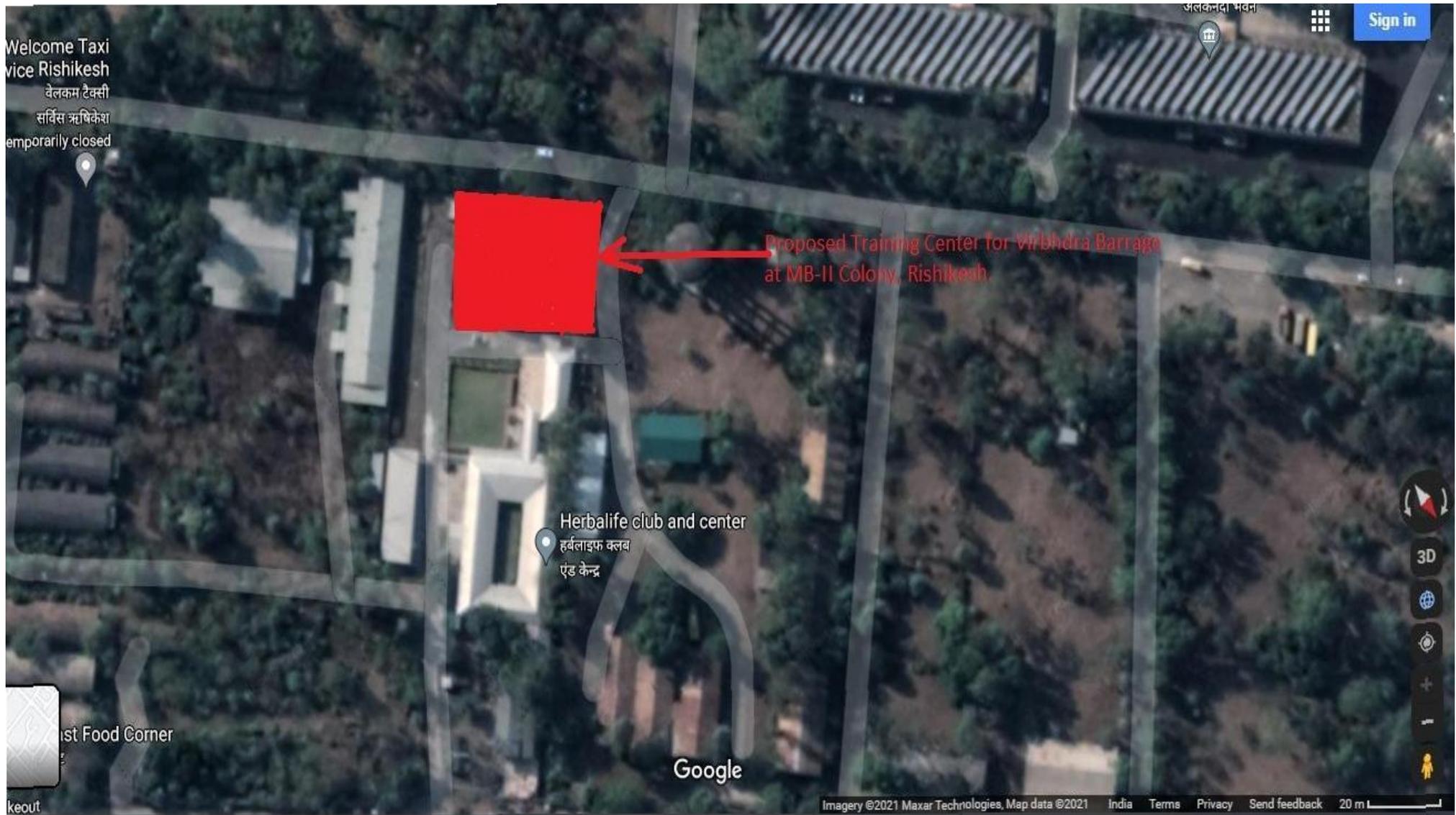


Figure 1.4: Showing Proposed Training Center locations at MB-II Colony, Rishikesh.

1.4 IMPLEMENTATION ARRANGEMENT AND SCHEDULE

As can be seen from the list of activities proposed under dam rehabilitation project; these activities can be divided into civil works main package, other package and instrumentation. Civil work will be carried out by contractor(s) as these are labour intensive activities and would be completed over a period of 36months. Project Authority will hire contractor(s) based on national open competitive procurement using a Request for Bids(RFB) as specified in the World Bank's-Procurement Regulations for IPF Borrowers, July 2016, Revised August 2018 Procurement Regulations), and is open total Bidders as defined in the Procurement Regulations. Following is the overall implementation and procurement schedule:

a) Overall Phasing of Project Implementation:

Proposed Starting of implementation (MM/DD/YYYY) : 01/01/2021

Proposed Ending of implementation (MM/DD/YYYY) : 31/01/2024

Implementation Duration (months) (MM) : 36months

b) Timeline phasing of implementation:

Sl. No.	Description	From (month/year)	To (month/year)	Status of Procurement Process
1	Civil Work – Main Package	01/01/2021	31/01/2024	Procurement process will be initiated after obtaining approval of the PST from World Bank.
2	Other Packages	01/01/2021	31/01/2024	
3	Procurement – instrumentation, goods, inspection vehicles	01/01/2021 – 31/01/2024		

1.5 PURPOSE OF ESDD

The overall project (DRIP II) was categorized as **High Risk** as per the internal Environment and Social Risk Classification of the Bank. The Environment and Social Due Diligence has been conducted to use it as a tool for decision-making on the sub-project with the following specific objectives:

- i. To identify, evaluate and manage the environment and social risks and impacts of the sub-project in a manner consistent with the ESSs;
- ii. To adopt a mitigation hierarchy approach to the project's E&S risks i.e. a) anticipate and avoid risks and impacts; b) minimize or reduce risks and impacts to acceptable levels, if not avoidable; c) once risks and impacts have been minimized or reduced, mitigate; and (d) where significant residual impacts remain, compensate for or offset them, where technically and financially feasible;
- iii. To help identify differentiated impacts on the disadvantaged or vulnerable, if any, and to identify differentiated measures to mitigate such impacts, wherever applicable;

- iv. To assess the relevance and applicability of environmental and social institutions, systems, laws, regulations and procedures in the assessment, development and implementation of projects, whenever appropriate; identify gaps, if any exist, and
- v. To assess borrower's existing capacity, gaps therein, and identify areas for enhanced capacity towards management of E&S risks.
- vi. Based on the categorization of Environment and Social risks and impacts of the barrage sub-project, to determine whether ESIA is to be carried out using independent third- party agency or a standard ESMP customized to mitigate E&S risks and impacts will suffice.

1.6 APPROACH AND METHODOLOGY OF ESDD

The following approach has been adopted for ESDD:

- i. Study sub-project information, proposed interventions, their magnitude and locations and carry out assessment of each proposed intervention to identify the magnitude of E&S risk and impacts;
- ii. Review relevance and applicability of national and state legal requirements and Bank's ESF policy, standards and directives and preliminary assessment of applicability of legal requirement and ESS framework (2-8)
- iii. Conduct site visit to understand baseline environment and social settings, proposed activities under the sub-project, their location and sensitivity, if any.
- iv. present key baseline data essential for impact assessment in immediate vicinity area of proposed interventions from secondary sources, such as land-use, protected areas in vicinity, ascertain presence of indigenous (schedule tribe)/vulnerable people, etc.
- v. Undertake institutional assessment to identify existing capacities & relevant gaps to manage E&S risks and impacts
- vi. Conduct preliminary stakeholder consultations to help identify potential stakeholders; to provide information on the proposed interventions; to identify issues and concerns; and ascertain appropriate mechanisms for continued engagement
- vii. Carry out activity wise environment and social screening and identify risks and impacts. Classify the sub-project based on risk level (low, moderate or substantial and high) and recommend commensurate plans/measures to meet identified risks and impacts.

Stakeholder consultations with communities living downstream/vicinity of the barrage, could not be held in the current circumstances due to COVID and these shall held as soon as situation is conducive for holding such consultations.

2.1 POLICY AND LEGAL FRAMEWORK

India has well defined environmental and social regulatory framework. The regulation applicability depends on nature of work and location of work. Broadly legislation can be divided into four categories viz environmental, forests, wildlife conservation and social. The applicability analysis of regulations pertaining to all the above four categories was carried out. The applicability of World Bank ESF comprising, 10 ESSs (ESS1 to ESS10) to the proposed rehabilitation proposals and Standard specific requirements were analysed. Further, a comparison of national environmental and social regulations versus World Bank's ESS has been carried out along with the gap analysis. Applicability of Indian regulations, World Bank's ESS along with comparison and gap analysis is discussed in ESMF.

Central Water Commission, Ministry of Jal Shakti, Government of India has prepared "Operational Procedures for Assessing and Managing Environmental Impacts in Existing Dam Projects" and is under publication as a guiding document for the dam owners to systematically address in advance the environmental safeguard requirements and have discussed in detail all applicable legal requirement. Reference has been drawn from this document as well, while carrying out applicability analysis.

Indian environmental regulations requiring environment clearance is for new dam projects specifically for the purpose of hydropower generation and/or irrigation projects and vary with generation capacity for hydropower projects and culturable command area served by irrigation projects. Forest related clearances become applicable, if new or any modification in any existing project requires diversion of forest land for non-forestry purposes. Wildlife Clearance process gets triggered if the project is in proximity to protected area or activities are proposed within protected areas (PA).

For the proposed rehabilitation activities at Virbhadrha barrage, environment and forest clearances will not be applicable as neither it is a new barrage project nor any forest land required for the rehabilitation work. River Ganga on its left bank forms boundary of the Raja ji National Park. Most project appurtenant like head regulator, power channel, powerhouse etc are located within Rajaji National Park. Rehabilitation work is proposed on the existing barrage structures only, bordering/inside the protected area, therefore, permission from wildlife department should be taken for any proposed activity falling within national park. Project authorities will intimate the wildlife department/park authorities before start of rehabilitation work and follow their guidelines for rehabilitation work and transportation of man and material on the routes passing through the Rajaji National Park. Other applicable regulatory requirements are discussed in ESMF.

2.2 DESCRIPTION OF INSTITUTIONAL FRAMEWORK

The sub-project will be implemented by Uttarakhand Jal Vidyut Nigam Limited (UJVNL). UJVNL has in-house expertise to address E&S issues. As per the suggestions of CPMU/CWC, if required specific consultancy services of Environmental and Social experts to assist the department in resolving E & S issues shall be outsourced.

A formal GRM system has been established for dealing with external complaint at central level, which is connected to project site level. There is also an internal complaint committee as per Sexual Harassment Act at head office level and the same is used as platform for dam level.

As committed in ESCP, a Grievance Redress Mechanism (GRM) will be established and operated by the contracted agencies to address Project workers workplace concerns before start of work. SPMU will have oversight responsibility on the functioning of the GRM.

Chapter 3

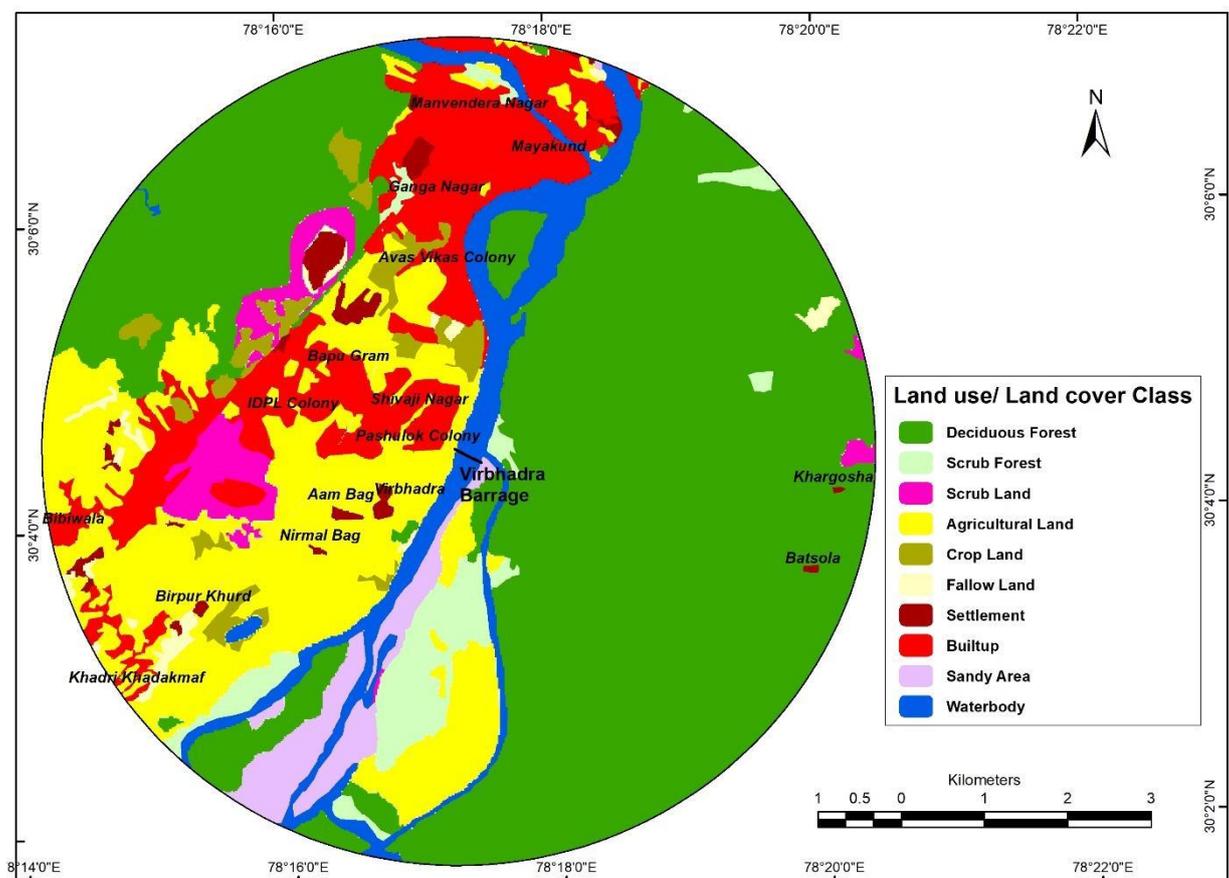
ASSESSMENT OF ENVIRONMENTAL AND SOCIAL CONDITIONS

Assessment of physical, ecological and socio-economic conditions at barrage site and immediate surrounding has been carried out based on secondary information and site observations; as discussed below.

3.1 PHYSICAL ENVIRONMENT

Land Use/Land Cover

The project surrounding area's land use and environmental sensitivity was analyzed using GIS techniques. Land use/ land cover map within 5 km radius of barrage is presented at **Figure 3.1**. Present land use is mainly deciduous forest and agriculture followed by scrub land and scrub forest, water bodies (mainly river and reservoir), settlement, fallow and sandy areas. There are 16 habitations or village falling in 5 km of radius of the Virbhadra barrage; they are Pashulok colony, Virbhadra, Shivaji Nagar, IDPL colony, Babu Gram, Aam bag, Nirmal bag, Avas Vikas colony, Ganga Nagar, Mayakund, Manvendera Nagar, Bibiwala, Birpur Khurd, Khadri Khadakmaf, Khargosha and Batsola.



[(Source: Digital data on land use/land cover maps using bhuvan prepared by National Remote Sensing Centre (NRSC) with Uttarakhand Space Application Centre along with further refinement using Google Earth]

Figure 3.1: Land Use and Land Cover Map of 5 km radius around barrage site

Natural Hazards

Potential of natural hazards such as flooding and earthquake have been assessed.

The design flood for barrage is 14,750 cumec. The revised hydrological studies have been carried out by CWC in 2017 and they worked out the revised design flood (SPF) as 23,530 cumec. It is proposed that the barrage and its appurtenant including afflux bunds, guide walls etc be checked for revised design flood and accordingly, appropriate measures (structural and non-structural) to be taken up to take care of increased design flood during concurrency of DRIP II.

Project falls in earthquake zone IV, and same was considered at the time of design and there is no need for seismic design review. The Bureau of Indian Standards [IS 1893 (Part I):2002], has grouped the country into four seismic zones, viz. Zone II, III, IV and V. Zone II is the least active and Zone V is the most active.

3.2 PROTECTED AREA

Virbhadra barrage is located on the boundary of Rajaji National Park which was notified as protected area on August 12, 1983 by merging Rajaji Wildlife Sanctuary with Motichur and Chilla wildlife sanctuaries. Rajaji National Park is spread over an area of 819.54 sq. kms and falls in three districts of Uttarakhand i.e. Dehradun, Haridwar and Pauri Garhwal. Rajaji National Park has been declared Rajaji Tiger Reserve vide notification dated 18th April 2015. A total area of 1075.17 sq. km. has been declared as Rajaji Tiger Reserve. The Core Zone comprises the whole of Rajaji National Park is 819.54 sq km. The Buffer Zone has an area of 255.63 sq km which comprises of a reserve forest block (Bijni Beat) under the administrative control of RNP, part of Shyampur Range of Haridwar Forest Division and Laldhang&Kotdwar ranges of Lansdowne Forest Division.

The National Park is rich in the diversity of flora with broadleaved deciduous forests, riverine vegetation, scrubland, grasslands and pine forests as well as of fauna with 23 species of mammals and 315 avifauna species found in the National Park. The river Ganga bifurcates the Park into two distinct parts: the eastern part comprising of Chilla and Gohri range and the western part comprising of Haridwar, Dhaultkhand, Beriwar, Chillawali, Motichur, Kansaru and Ramgarh ranges. The Park is renowned for its elephants population. The mountain goat, goral, chital, sambar, barking deer, hog deer, nilgai, wild pigs and sloth bears are also noteworthy resident. Tigers and leopards are the prime predators in Rajaji. The leopard cat, jungle cat, civet and yellow-throated marten are other carnivores. Mammals like the jackal and the Bengal fox scavenge in the park. The Himalayan black bear though uncommon, can be sighted in the higher reaches of the park. The rivers which flow through the park harbour species of fish such as trout and mahseer.

Location of the barrage w.r. t. to National Park is shown in Figure 3.2.

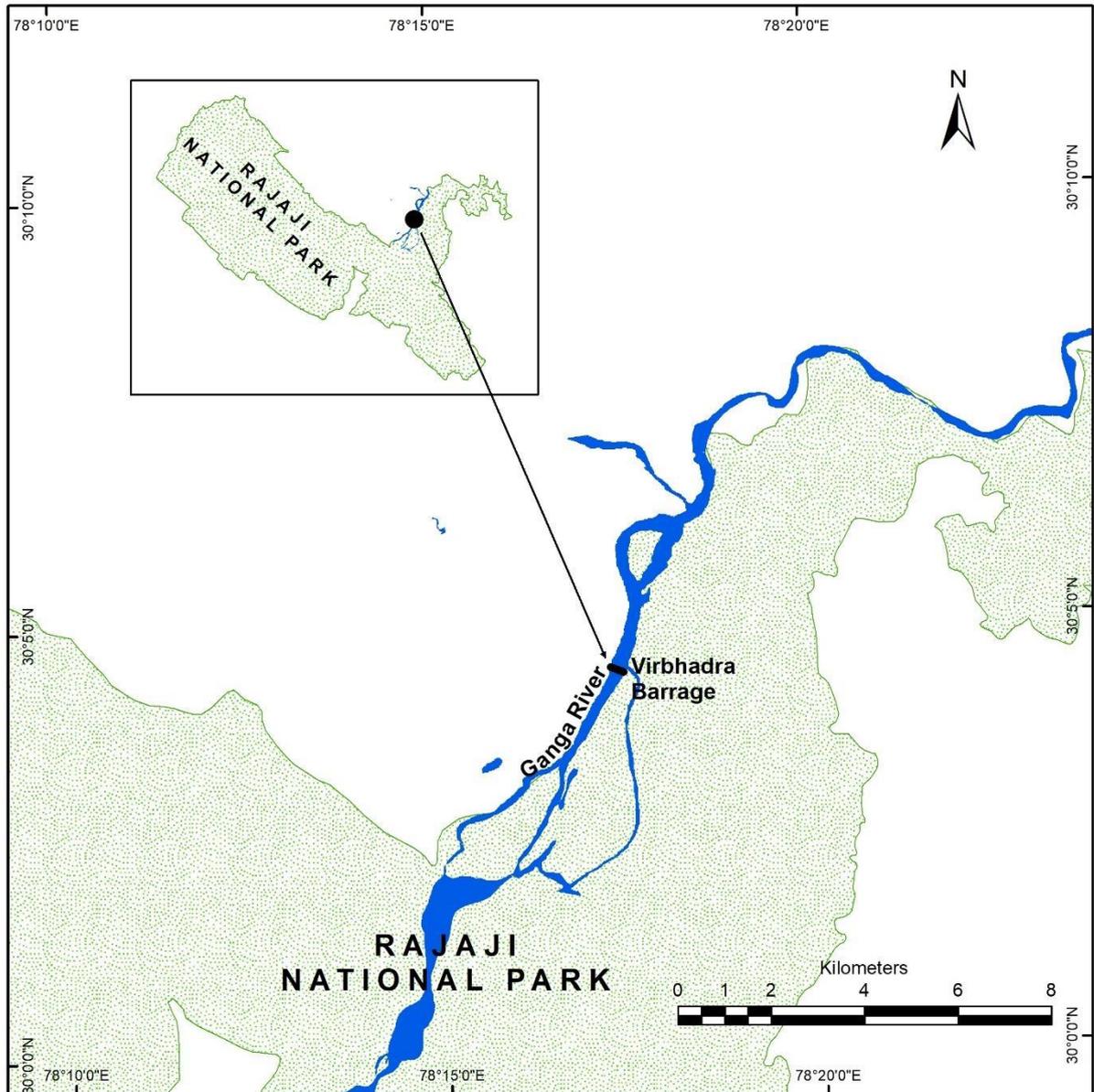


Figure 3.2: Location of Barrage wrt to Rajaji National Park

3.3 SOCIAL ENVIRONMENT

The Virbhadra Barrage project is located on the river Ganga in district Dehradun in the state of Uttarakhand. Uttarakhand state does not have any Schedule V¹ areas.

The district is located in the Shivalik range of Himalayas on the western border of the state. The district consists of six tehsils and six community development blocks for implementation and monitoring of development schemes at rural level. As per census 2011, there are 748 revenue villages, out of which 731 villages are inhabited and 17 villages are un-inhabited.

¹**Scheduled Areas** are areas in India with a preponderance of tribal population subject to a special governance mechanism wherein the central government plays a direct role in safeguarding cultural and economic interests of **scheduled** tribes in the **area**.

There are three sectors of the economy i.e., primary, secondary and tertiary which reflect the direction of growth of any region. In Dehradun district, the tertiary (services) sector contributed the maximum share of 69.38 percent to Gross District Domestic Product (GDDP) which is much higher than that of Uttarakhand's share of 51.9 percent to Gross State Domestic Product (GSDP) in 2013-14. The district's primary (agricultural) sector contributes just about 4.32 percent to GDDP while the secondary sector's contribution is 26.29 percent.

The brief demographic characteristic of the district is given in the table below:

Description	Number	Respective %	Description	Number	Respective %
No. of Households	3,47,001	--	Household Size	5	--
Total Population	16,96,694	--	Population (0-6 age)	2,01,652	11.88
Male	8,92,199	52.58	Boys (0-6 age)	1,06,746	52.94
Female	8,04,495	47.42	Girls (0-6 age)	94,906	47.06
Sex Ratio	902		Sex Ratio (0-6)	889	
Population (SC)	2,28,901	13.49	Population (ST)	1,11,663	6.58
Male	1,20,430	52.61	Male	58,264	52.18
Female	1,08,471	47.39	Female	53,399	47.82
Literates	12,59,506	74.23	Literacy Rate (in %)	--	84.25
Male	7,02,216	55.75	Male	--	89.40
Female	5,57,290	44.25	Female	--	78.54
No. of Workers	5,82,768	34.35	Cultivators	77,176	13.24
Male	4,58,834	78.73	Agricultural Labours	38,195	6.55
Female	1,23,934	21.27	Household Industrial Workers	22,992	3.95
No. of Main Workers	4,88,161	83.77	Other Workers	4,44,405	76.26
No. of Marginal Workers	94,607	16.23			

Source: Census of India, 2011 (District Handbook)

According to Census 2011, total population of the district is 16,96,694, out of which 52.58% are males and 47.42% are females with the sex ratio of 902. The population density is 549 persons per sq. km in the district. There are 11.88% population belongs to 0-6 age group, out of which 52.94% are boys and 47.06% are girls in the same age group with the sex ratio of 889.

The district has literacy rate of 84.25%.The male literacy rate in the district is 89.40% and that of female is 78.54%, thus a gender gap in literacy rate of 10.86% in the district.

In the district, the Scheduled Caste and Scheduled Tribe population is 13.49% and 6.58% respectively to the total population. The ST households will be taken into account during the implementation of Emergency Action Plan.

Work participation rate of the district has observed about 34.35%, out of which 78.73% are male workers and only 21.27% are female workers, thus a significant gender gap in work participation rate of 57.46%.

Among the total work force in the district, 83.77% are Main Workers and 16.23% are Marginal Workers. About 13.24% workers are cultivators and 6.55% are agricultural labourers. About 76.26% of work force is engaged in other than agricultural activities including 3.95% household industrial workers.

3.4 CULTURAL ENVIRONMENT

List of National Monuments in Uttarakhand and list of State Protected monuments in Uttarakhand have been reviewed. There are protected monuments identified by Archaeological Survey of India however none of them are in the vicinity of the project. Barrage is located 5 km d/s from holy town Rishikesh which is on Himalayan foothills beside the Ganges River. Rishikesh is renowned as a centre for studying yoga and meditation, temples and ashrams.

Chapter 4

ACTIVITY WISE ENVIRONMENT & SOCIAL SCREENING, RISK AND IMPACTS IDENTIFICATION

4.1 SUB-PROJECT SCREENING

The subproject screening is undertaken following a three step screening methodology as described in ESMF. Process of risk /impacts identification is done using screening process considering the proposed interventions at each dam as provided in the Project Screening Template using first screening format (SF-1). Applicable interventions are further classified based on their location i.e., within barrage area or outside the barrage area. Each activity is reviewed for the applicability under-sub project, location of applicable activity and likely risks and impacts. The SF-1 format is used to ascertain the types of E&S risks for each of the proposed rehabilitation activity e.g. Risk/Impact on Water Quality, Fisheries, Conservation Area, Protected Area, Ecology, Physical Environment, Cultural Environment, Tribal Presence, Private Land/Assets/Encroachers/Squatters, Labour, Migrant Labour and GBV risks – each of these corresponding to the ESS 2-8.

The second format (SF-2) is used to assess the extent of risk/impact intensity for each of the identified E&S risk and is used to categorize the risk level as Low/Moderate/Substantial/High. Finally, using a third E&S risk summary format (SF-3), the risk categories for all different types of E&S risk and impacts is summarized and the highest of the risk categories is assigned as overall risk category for the given barrage sub-project. Based on the above findings, the ESDD report recommends Risk category of the barrage sub-project – whether it is Low/Moderate/Substantial/High and types of instruments that need to be prepared as part of the ESMP along with the responsibilities and timelines.

Outcome of three stage screening exercise is discussed below.

Step I Screening (using Form SF-1): Sub-Project Component, Construction Support Preparatory Intervention related vs Nature of Risk/Impact

Screening indicated that all project components related activities are limited to within the barrage area/premises. Due to nature of these activities, likely impacts will be on physical environment in terms of air pollution, noise pollution and waste generation. None of the proposed structural interventions involve acquisition of private land and/or private assets. These activities in no way cause restriction on access to land or use of resources by local communities and there is no economic displacement envisaged due to the sub-project. Activities interfacing with water bodies – river/reservoir will have risk of spillage of chemicals, construction material, and debris leading to water pollution and impacts on fishes.

Pre-construction and construction stage major auxiliary or preparatory intervention are within barrage area. Deployment and haulage of heavy machinery, setting up of workshop, operation of concrete mixture and heavy pumps will be within barrage area. Other activities such as labour camp and debris disposal will also be kept within the barrage area or on right bank because of left bank being the Raja ji National Park boundary. Activities involving machinery and equipment will have impacts on physical environment. Transportation of material, debris disposal and labour camp are likely to generate pollution and impact on physical environment. Due to its location vis-à-vis national park, risk of outside labour, transportation of man and material and noisy civil and hydro-mechanical works may have the potential to impact the habitat of fauna.

Project will involve project managers and supervisors, contracted workers – these would also include migrant workers as all the required labour will not be fully supplied locally for a number of reasons, such as worker's unavailability and lack of technical skills and capacity. Construction contractors are expected to stay at/near barrage or on right bank, set up construction equipment and machinery near work location at pre-determined/approved sites without impacting national park. Influx of skilled migrant labour, albeit few in numbers, for construction works is likely. The labour will stay with in/proximity the barrage premises; hence risk of SEA/SH is unlikely.

Output of this screening is enclosed as **Annexure I**.

Step II Screening (using Form SF-2): All applicable activities identified as having potential risks/impacts that were identified through Step I screening, are further screened for associated sub-activity and evaluated for the extent of risk. Sub-activity's Risk/Impact intensity is further categorised as Low (L), Moderate (M), Substantial (S) or High (H) based on following criteria:

Low	:	Localized, Temporary and Negligible
Moderate	:	Temporary, or short term and reversible under control
Substantial	:	Medium term, covering larger impact zone, partially reversible
High	:	Significant, non-reversible, long term and can only be contained/compensated

Each activity may have different type of risks/impacts and magnitude of separate risk may vary, as analysed under SF2. In SF2, each proposed rehabilitation activity is assessed for the nature of risk on various components of environment and social (based on SF1, Column 5) and then each one of these is separately evaluated for level of risk as Low, Moderate, Substantial or High; the highest risk level is recorded in column 5 of SF2 for each activity.

Occupational Health and safety: OHS is a substantial risk activity in almost all cases and is not being considered under screening criteria. Occupational health and safety is considered an important requirement of every project irrespective of size and type of the projects. It will be part of Contractor's ESMP.

Analysis of extent of risk/impact for sub-activities resulted in identification of following activities as having Moderate Risks/impacts.

- Protection & Refurbishment Work from Spillway Glacis to end-sill of Gate No. 05 to 15.
- Construction of coffer dam / ring bandha
- Repair & strengthening of boulder excluder tunnel of under sluice gate 1
- Labour Camps
- Major Debris Disposal

All other activities are categorized as low risk activities. E&S risks of none of the sub-activities for this sub-project is categorized as either Substantial or High risk. **The outcome of Screening is enclosed as Annexure II.** In case of GBV/SEAH, this site was assessed as Low risk. Based on consideration of all the above, summary of Risk/Impact (as per outcome of SF-2) is summarised for major sub-project activities under **Table 4.1 below.**

Table 4.1: Summary of Identified Risks/Impacts in Form SF-3

Project Activity	Environment Risks						Social Risks				
	Air, water, noise, land use, Soil, Resource use	Pollution downstream and upstream	General Ecology	Protected Area (Wild Life Sanctuaries, National Park and other natural habitat even if not protected)	Other RET species (flora and fauna) outside protected areas	Fish and Aquatic life within barrage water body	Land	Tribal	Labour	Cultural heritage	GBV/SEAH
Civil (within barrage Boundary)	M	M	L	M	None	L	M	L	M	None	L
Hydro Mechanical	M	M	L	M	None	L	L	L	M	None	L
Instrumental SCADA, surveillance	L	L	L	L	None	L	L	L	L	None	L
Painting	L	L	L	L	None	L	L	L	M	None	L
Road work	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Safety measures (Siren, Lighting)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Major Civil Work like Additional Spill Way	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Major Hydraulic Structure (tunnelling)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Major Civil Work extending beyond barrage Area Like training Structure	L	L	L	L	None	L	M	L	M	None	L
Additional activities for Tourism /Solar/Fisheries/ Water recreation enhancement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Criteria for Risk Evaluation:

Low: Localized, temporary and Negligible

Moderate: temporary, or short term and reversible under control

Substantial: medium term, covering larger impact zone, partially reversible

High: significant, non-reversible, long term and can only be contained/compensated

Occupational Health and safety: OHS is a substantial risk activity in almost all cases and is being treated separately through OHS plan in accordance with WB ESHS guidelines and shall be applicable to all sub-projects. Hence is not being considered under screening criteria.

4.2 STAKEHOLDER CONSULTATION

In light of the COVID 19 pandemic, that constrained holding of consultation meetings; stakeholder consultations could not be carried out. As soon as the situation becomes conducive, stakeholder consultations will be organized and report updated.

4.3 DESCRIPTIVE SUMMARY OF RISKS AND IMPACTS FROM ACTIVITIES BASED ON SCREENING

Based on the above screening analysis, potential impacts and risks from the sub-project are summarised below:

Environmental Impacts and Risks

1. Environment risks and impacts, as assessed above, for various project activities under this sub-project are categorised as Low and Moderate due to localised nature of proposed activities i.e. activities remain limited to barrage area except for labour camp and muck/debris disposal.
2. Execution of civil and hydro-mechanical work within barrage body will generate localised impacts on physical environment and resource use; pose risk of exposure of workers requiring personal protective equipment (PPE) use.
3. Civil works interfaced with water body especially like repair & restoration of spillway glacis and downstream protection work from gate no 5 to 15 of barrage, repair & strengthening of boulder excluder tunnel of under sluice gate 1 etc, may pose risk of water pollution and impact on fish fauna as well as impacts on land environment due to disposal of same on ground.
4. Construction waste, muck etc. from various above rehabilitation works and construction of control room, residential, training centre/transit camp buildings etc require careful disposal at pre-identified and approved site to minimise the risk of pollution on this count.
5. Since the project is on boundary of Rajaji National Park, which is home to several faunal species, there is risk of impact on ecology especially fauna due to civil and hydro-mechanical works. Therefore, there is a need to control noise generation from rehabilitation work, plan waste disposal sites outside the national park preferably on right bank and control the waste water discharge from construction sites.
6. Rehabilitation work would require labour to work on various sections of barrage involving working at height, working in confined spaces, working on reservoir side, etc; Further, workers will also be exposed to dust and noise and will have to handle chemicals/gases for some of the works; these will lead to occupational health and safety risks.

Social Impacts and Risks

1. As the interventions are within the barrage premises and on the barrage structure, there shall be no adverse impacts on land and assets due to any sub-component or sub-activities
2. The barrage is not located in the Schedule V area, though, there is about 6.58% scheduled tribe population in the district and there are scheduled tribe households in vicinity and downstream areas. These households shall not be directly impacted by

project in any manner. These ST households will be taken into account during the implementation of Emergency Action Plan.

3. Influx of migrant labour will be low as these works require only few but very skilled labour. Also, these workers will mostly operate from labour camps within the barrage premises/proximity and hence there would be minimal interface with communities and therefore significantly lower SEAH/GBV risks.
4. Waste generation from labour colony can pollute drinking water sources of community, risk is low and can be mitigated by providing adequate sanitation facilities.
5. No impacts are envisaged on cultural heritage as no such sites are identified in project vicinity.
6. Labour related risk would include:
 - Safety issues while at work like injuries/accidents/ fatalities leading to even death, while at work; Occupational health and safety risks due to exposure of workers to unsafe conditions while working at heights, working using lifts, handling of equipment and machinery, exposure to air and noise pollution etc. will be addressed through OHS guidelines.
 - Short term effects due to exposure to dust and noise levels, while at work
 - Long term effects on life due to exposure to chemical /hazardous wastes
 - Inadequate accommodation facilities at work force camp, including inadequate sanitation and health facilities
 - Sexual harassment at work
 - Absence or inadequate or inaccessible emergency response system for rescue of labour/workforce in situations of natural calamities.
 - Health risks of labour relating to HIV/AIDS and other sexually transmitted diseases
 - Non-payment of wages
 - Discrimination in Employment (e.g. abrupt termination of the employment, working conditions, wages or benefits etc.)
 - Unclear terms and conditions of employment
 - Discrimination and denial of equal opportunity in hiring and promotions/incentives/training opportunities
 - Denial for workers' rights to form worker's organizations, etc.
 - Absence of a grievance mechanism for labour to seek redressal of their grievances/issues

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 Risk Classification

As per the ESDD exercise, risk/impacts that have been identified relate to Water Quality, Physical Environment, labour and SEAH/GBV. The summarised environmental and social risks of identified activities with level of risk is presented in previous chapter. Environment risks of air, water, noise, land use, soil and resource use for repair & restoration of spillway glacis and downstream protection work from gate no 5 to 15 of barrage, construction of coffer dam / ring bandha and repair & strengthening of boulder excluder tunnel of under sluice gate 1 are considered moderate. Similarly, environment and social risk of labour camp and disposal of debris has also been identified as moderate. Due to location of barrage on boundary of "Rajaji National Park", impact of rehabilitation work on protected area has also been considered moderate. Risk of all other activities has been identified as Low. These risks are low to moderate and localised, short term and temporary in nature which can be managed with standard ESMP and guidelines.

Hence the overall risk of this sub-project barrage is categorized as Moderate. OHS is a substantial risk activity and is being treated separately through OHS plan in accordance with WB ESHS guidelines.

5.1.2 National Legislation and WB ESS Applicability Screening

The applicability analysis of GOI legal and regulatory framework indicates that while, there are various legislation which will have to be followed by the contractor for the protection of environment, occupational health and safety of workers and protection of workers and employment terms. None of Indian legislation is applicable warranting obtaining clearance prior to start of construction/improvement work.

In addition to overarching ESS1, four ESS standards are found relevant to this sub-project as per reasons given in **Table 5.1** below:

Table 5.2: WB ESF Standards applicable to the sub-project

Relevant ESS	Reasons for Applicability of the standard
ESS2: Labour and Working Conditions	Due to engagement of Direct worker, Contracted workers and Community workers (likely for EAP and other non-structural interventions) for rehabilitation work
ESS3: Resource Efficiency, Pollution Prevention and Management	Civil and hydro-mechanical work including resource consumption; requiring protection of physical environment and conservation of resources
ESS 4: Community Health and Safety	Rehabilitation work, although limited to barrage complex, can increase community exposure to risk and impacts; directly or indirectly.

Relevant ESS	Reasons for Applicability of the standard
ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural resources	Project components like left bank head regulator, power channel and power house etc fall within Raja ji National Park. All interventions are planned on barrage and head regulator, therefore to eliminate risks of impacts on protected habitat, Biodiversity Conservation Plan will be prepared.
ESS 10: Stakeholder Engagement Plan	For engagement of stakeholders in all structural and non-structural measures e.g. implementation of Early flood Warning system, siren systems, broadcasting facilities, Emergency Action Plan etc.

5.2 RECOMMENDATIONS

5.2.1 Mitigation and Management of Risks and Impacts

Since risks and impacts are low to moderate category, a standard ESMP customised to sub-project will be prepared in accordance with the ESMF. It shall cover the following aspects:

- a. SPMU shall customise the standard Environmental and Social Management plan (ESMP) that has been provided in the Environmental and Social Management Framework (ESMF) and make it part of bid document for effective adherence by contractors.
- b. ESMP will provide due measures for labour management and protection of environment quality and resource conservation (during handling of resources) in line with ESF standard ESS2 and ESS3 respectively. Likewise, due attention will be given to Occupational Health and Safety of workers and community in line with the requirements of ESS4 and World Bank Group guidelines on Occupational Health and Safety (OHS). SPMU/IA shall customise the standard ESMP in line with outline provided in the ESMF and ensure its adherence by contractor. The customised ESMP will address the following:
 - Gender Based Violence or SEA/SH related actions (ESS1)
 - Labour Management Procedure (ESS2)
 - Resource Efficiency and Pollution Prevention (ESS3)
 - Community Health and Safety (ESS4)
 - Bio-diversity Conservation Plan (ESS6)
 - Stakeholders Engagement Plan (ESS10)
- c. Contractor shall submit BOQ as per ESMP of the sub project.

Mitigation plans to meet requirements for relevant Standards with responsibility and stages are given in **Table 5.2** below:

Table 5.3: List of Mitigation Plans with responsibility and timelines

WB-ESS Triggered	Mitigation Instrument	Responsibility	Timelines
ESS1: Assessment and Management of Environmental and Social Risks and Impacts	<ul style="list-style-type: none"> • Gender Based Violence or SEA/SH related actions 	SPMU/IA	Before mobilization of contractor
ESS2: Labour and	<ul style="list-style-type: none"> • Labour Management 	SPMU/IA	Before mobilization of

WB-ESS Triggered	Mitigation Instrument	Responsibility	Timelines
Working Conditions	Procedure (LMP) including OHS management plan		contractor
ESS3: Resource Efficiency, Pollution Prevention and Management	<ul style="list-style-type: none"> Pollution Prevention and Environment Quality Management Plan (PPEQMP) 	SPMU/IA	Before mobilization of contractor
ESS 4: Community Health and Safety	<ul style="list-style-type: none"> Community Health and Safety Management Plan (CHSMP) 	SPMU/IA	Before mobilization of contractor
ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural resources	<ul style="list-style-type: none"> Biodiversity Conservation Plan 	SPMU/IA	Before mobilization of contractor
ESS 10: Stakeholder Engagement Plan	<ul style="list-style-type: none"> Stakeholder Engagement Plan 	SPMU/IA	By negotiation

ESDD and ESMP will be placed on the www.damsafety.in website as well as other accessible locations such as the office of Engineer in Charge at barrage site as well at SPMU for reference and record. These documents would be disclosed/disseminated through other appropriate means like project meetings, workshops etc. Each IA will translate these documents in their local language, if required, and will upload in their respective websites and also make available at other accessible locations.

5.2.2 Institutional Management, Monitoring and Reporting

ESMP will be customized for the sub project by SPMU/IA from standard ESMP included in ESMF and shall be shared with CWC by SPMU for their review/endorsement and approval before including in the bid document.

SPMU/IA will designate Nodal Officer(s) (full time in-house engineering staff with E&S expertise) to coordinate and supervise E&S activities. They shall be at the level of Executive Engineer/ Deputy Directors and shall provide commensurate time to comply with E&S related activities. Brief TORs for these Nodal E&S officers is included in ESMF. The SPMU, in case in-house expertise not available, will hire the qualified staffs on need basis to support management of E&S risks including Environmental and Social Experts for ensuring compliance with the Bank's ESF and ESS's and ensuring that these activities shall be implemented as per the procedures.

SPMU/IA shall advise contractors about applicable legislative requirements and ensure that contractors prepare its own ESMP (C-ESMP) as outlined in ESMP for this sub-project and submit compliance reports to SPMU/IA on quarterly basis. SPMUs will share regular implementation status of ESMPs to CWC and The World Bank in line with ESMF on quarterly basis.

SPMU/IA shall establish and operationalize a grievance mechanism to receive and facilitate resolution of complaints and grievances, from the communities and other stakeholders including implementation partners. GRM works within existing legal and cultural

frameworks and shall comprise project level and respective State level redressal mechanisms. Most Project related grievances could be minor and site-specific.

EMC (Engineering and Management Consultant) for the project will have sufficient staff with skills on Environment and Social aspects. Awareness raising and capacity building on the new Environmental and Social Framework (ESF) need to be carried out for the environment and social staff engaged and this will be an area of continued focus, with a view to generate awareness at to barrage level. EMC will develop formats for regular supervision and monitoring on E&S issues and undertake site visits/ inspections of the dam sites to monitor for compliance; collate and review QPRs and set up a monitoring and reporting system on E&S issues.

Overall, the proposed activities within this barrage sub-project have low to moderate risks resulting in the sub-project to be categorized as Moderate risk category. These risks and impacts can be effectively mitigated with effective implementation of mitigation plans by SPMU/IA, Contractors and monitoring by EMC, SPMU and CWC.

Annexure I: Form SF1

Sl. No	Project Component	Applicable (A), Not Applicable (NA)	Environment and Social Risk Associated within dam area (DI), Beyond Dam Area (DE)	Likely Nature of Risk/Impact Water Quality (WQ), Fisheries (F), Conservation Area (CA), Protected Area (PA), Ecological (E), Physical Environment (PE), Cultural (C), Tribal Presence (T), Impact on private land/assets/encroachers/squatters (LA), Labour (L), GBV risks (G), (Write whichever is applicable)
1	2	3	4	5
A	Nature of Project Component and related sub activity Related			
1	Reservoir Desiltation	NA		
2	Major structural changes – Spillway construction (Improving ability to withstand higher floods including additional flood handling facilities as needed.)	NA		
3	Structural strengthening of dams to withstand higher earthquake loads	NA		
4	Structural Improvement/Repair work - upstream of Dam site (interfacing dam reservoir) (like u/s face treatment etc.)	A	DI	WQ, F, PA, PE, L, G
5	Structural Improvement/Repair work -Downstream of Dam site (with no interfacing with dam reservoir)	A	DI	WQ, F, PA, PE, L, G
6	Re-sectioning earth dams to safe, stable cross sections	NA		
7	Hydro-mechanical activities with interface with dam reservoir	A	DI	WQ, F, PA, PE, L, G
8	Hydro-mechanical activities Downstream of Dam site (with no interfacing with dam reservoir)	A	DI	WQ, F, PA, PE, L, G
9	Instrumentation, General lighting and SCADA systems	A	DI	PE, L
10	Basic Facilities (like access road improvement, renovation of office, etc)	A	DI/DE	PE, L
11	Utility installation like standby generator, or setting up solar power systems	NA		
12	Painting of dam u/s or d/s or both faces	A	DI	PE, L
13	Water recreation activities	NA		
14	Tourism Development	NA		
15	Installation of Solar power/floating solar	NA		
16	List any other component not listed above			
B	Pre-construction and construction stage major auxiliary or preparatory intervention			
1	Acquisition (diversion of forests land for non-forest purposes) of forest land	NA		

Sl. No	Project Component	Applicable (A), Not Applicable (NA)	Environment and Social Risk Associated within dam area (DI), Beyond Dam Area (DE)	Likely Nature of Risk/Impact Water Quality (WQ), Fisheries (F), Conservation Area (CA), Protected Area (PA), Ecological (E), Physical Environment (PE), Cultural (C), Tribal Presence (T), Impact on private land/assets/encroachers/squatters (LA), Labour (L), GBV risks (G), (Write whichever is applicable)
1	2	3	4	5
2	Acquisition of private land Resettlement and Rehabilitation (including physical or economic displacement/impact on livelihood;	NA		
3	Temporary loss of business or Damages to crops or trees or structures outside the ROW during Construction activities by Contractor	NA		
4	Borrowing earth to meet Borrow materials requirement	NA		
5	Sourcing of Quarry materials	NA		
6	Blasting	NA		
7	Setting up Labour Camps (location within dam premises or outside)	A	DI/DE	WQ, PA, PE, L, G
8	Heavy machinery deployment and setting up maintenance workshop	A	DI	PE, L, G
9	Setting up Hot mix plant	NA		
10	Deployment of Concrete mixture and heavy pumps	A	DI	PE, L, G
11	Temporary land acquisition	NA		
12	Need of Tree felling/ vegetation clearance	NA		
13	Disposal of large amount of Debris	A	DI/DE	PE, L
14	Transport of large construction material	A	DE	PA, PE, L
15	Utility shifting	NA		
16	Discharge of reservoir water (lowering of reservoir water involved)	NA		

Note: Occupational Health and Safety aspects / impacts/ risks are considered important part of any dam project and this risk is separately classified. It shall be managed as per defined OH&S plans in every project irrespective of size and type of project.

Annexure II: Form SF2

Sl. No	Applicable Sub-Project Component/ Construction preparatory Work-related Sub activity (As per SF-1)	Nature of Risk (Conforming to Column 5 of SF-1) and nature of sub activity	Elaborate cause (risk) and its effect (Impact) on environment /social	Risk/Impact intensity for each type of risk/impact Low (L) , Moderate (M), Substantial (S), High (H)
1	2	3	4	5
A	Project Component Related			
1.	Structural Strengthening /Improvement /Repair work -upstream of Dam site			
a	Construction of coffer dam / ring bandha	WQ, F, PA, PE, L, G	Air and noise pollution, Risk of increase in reservoir water turbidity, Impacts on fish, Impacts on fauna (national park) due to works/noise, Land contamination due to disposal of waste, Labour and GBV risk	M
b	Works related to repair of damaged railing at barrage bridge & H.R. bridge	PE, PA, L	Noise pollution, Impact of avi-fauna due to noise, Labour risk	L
2.	Structural Improvement/Repair work - Downstream of Dam site (with no interfacing with dam reservoir) (like repair of parapet walls, damage spillway crest, downstream training walls, etc.)			
a	Works related to chain link fencing along with right afflux bund road of barrage	PE, L	Generation of waste from packaging material, Dug up material generation and disposal due to fencing poles, Labour risk	L
b	Weather coat painting & other related works over civil structures with in barrage premises	PE, L	Land contamination due to paints, Labour risk	L
c	Protection & Refurbishment Work from Spillway Glacis to end-sill of Gate No. 05 to 15	WQ, F, PA, PE, L, G	Air and noise pollution, Risk of increase in river water turbidity, Impacts on fish, Impacts on fauna (national park) due to works/noise, Land contamination due to disposal of waste, Labour and GBV risk	M
3.	Hydro-Mechanical activities Down - stream of Dam Site (with no interfacing with dam			

Sl. No	Applicable Sub-Project Component/ Construction preparatory Work-related Sub activity (As per SF-1)	Nature of Risk (Conforming to Column 5 of SF-1) and nature of sub activity	Elaborate cause (risk) and its effect (Impact) on environment /social	Risk/Impact intensity for each type of risk/impact Low (L) , Moderate (M), Substantial (S), High (H)
1	2	3	4	5
	reservoir)			
a	Replacement of S. S. plate on track guide of gate groove of barrage gates	PE, L	Noise pollution, Labour risk	L
b	Replacement of sill beams	PE, L	Noise pollution, Labour risk	L
c	Replacement of wheels, bearing of under sluice gates and other bay gates	WQ, PE, L	Water pollution, Noise pollution, Generation of waste material from packaging etc Noise pollution, Labour risk	L
d	Procurement of bearing of spillway gates & head regulator	PE	Generation of waste material from packaging etc	L
e	SITC of package substation of 500 KVA, 11 KV/415 V CSS	PE	Air pollution	L
f	Providing and fixing of chequered plates at barrage gates, HR gates and gantry crane platform at barrage structure	PE, L	Noise pollution, Labour risk	L
g	Epoxy on under sluice gates, otherway gates at barrage	WQ, L	Water pollution, Labour risk	L
h	Replacement of rubber seal of HR gate, otherway gate, under sluice gate at barrage	PE	Generation of waste material from packaging etc	L
i	Repair & strengthening of boulder excluder tunnel of under sluice gate 1	WQ, F, PA, PE, L, G	Air and noise pollution, Risk of increase in river water turbidity, Impacts on fish, Impacts on fauna (national park) due to works/noise, Land contamination due to disposal of waste, Labour and GBV risk	M
j	Providing and fixing of new pre-fabricated cabin above hoisting equipment of under sluice gate 1 to 4, other bay gate 5 to 15, head regulator gate 1 to 5	PE, L	Noise pollution, Generation of waste material from packaging etc, Labour risk	L
4	Basic Facilities Improvement			
a	Construction of new control room building	PE, L, G	Air and noise pollution,	L

Sl. No	Applicable Sub-Project Component/ Construction preparatory Work-related Sub activity (As per SF-1)	Nature of Risk (Conforming to Column 5 of SF-1) and nature of sub activity	Elaborate cause (risk) and its effect (Impact) on environment /social	Risk/Impact intensity for each type of risk/impact Low (L) , Moderate (M), Substantial (S), High (H)
1	2	3	4	5
			Generation of construction waste/debris, Generation of waste material from packaging etc, Labour and GBV risk	
b	Construction of training center/transit camp building	PE, L, G	Air and noise pollution, Generation of construction waste/debris, Generation of waste material from packaging etc, Labour and GBV risk	L
c	Construction of residential building at hydel colony	PE, L, G	Air and noise pollution, Generation of construction waste/debris, Generation of waste material from packaging etc, Labour and GBV risk	L
5.	Instrumentation, SCADA, Surveillance system, etc.			
a	Design, supply, installation, commissioning and testing of early warning system & public address system	PE, L	Generation of waste material from packaging etc., Labour risk	L
b	SITC of solid waste disposal system	PE, L, G	Air pollution, Generation of waste material from packaging etc., Labour & GBV risk	L
c	Procurement of 4 vehicles	PE	Air pollution	L
d	Procurement of furniture for office/training center at Chilla	PE, L	Generation of waste material from packaging etc, Labour risk	L
B.	Pre-construction and construction stage major auxiliary or preparatory intervention			
1	Setting up Labour Camps (location within barrage premises or outside)	WQ, PE, G	Wastewater generation from domestic activities, waste generation, GBV risk within labour and involving community.	M
2	Heavy machinery deployment and setting up maintenance workshop	PE	Heavy machinery will be deployed for repair and	L

Sl. No	Applicable Sub-Project Component/ Construction preparatory Work-related Sub activity (As per SF-1)	Nature of Risk (Conforming to Column 5 of SF-1) and nature of sub activity	Elaborate cause (risk) and its effect (Impact) on environment /social	Risk/Impact intensity for each type of risk/impact Low (L) , Moderate (M), Substantial (S), High (H)
1	2	3	4	5
			maintenance of hoists and for other activities - risk due to machine handling, waste, wastewater and air emissions from machines operations, hazardous waste generation from oil waste	
3	Deployment of concrete mixture and heavy pumps	PE	Concrete mixture and pumps will be deployed for road repair and other civil works and dewatering - risk due to machine handling, waste generation, wastewater and air emissions from operations, hazardous waste generation from oil waste	L
4	Disposal of large amount of Debris	PE	Debris will be generated from various repair activities, risk during debris handling, air and noise emissions from debris handling and transportation, water pollution risk due to debris finding its way to water body	M
5	Transport of large construction material	PE, L	Material will be transported from various vendors and suppliers to site for civil, hydro- mechanical work and instrumentation, air and noise emissions from transportation	L

Criteria for Risk Evaluation:**Low:** Localized, temporary and Negligible**Moderate:** temporary, or short term and reversible under control**Substantial:** medium term, covering larger impact zone, partially reversible**High:** significant, non- reversible, long term and can only be contained/compensated**Occupational Health and safety:** OHS is a substantial risk activity in almost all cases and is being treated separately through OHS plan in accordance with WB ESHS guidelines and shall be applicable to all sub-projects. Hence is not being considered under screening criteria.

इंटरनेट

मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

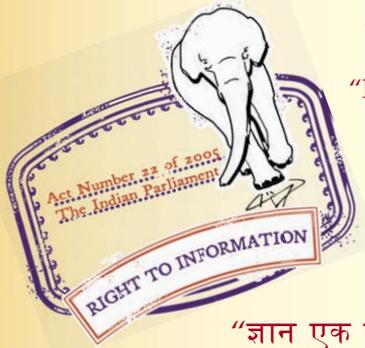
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 10430 (2000): Criteria for Design of Lined Canals and Guidance for Selection of Type of Lining [WRD 13: Canals and Cross Drainage Works]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



भारतीय मानक

अस्तर लगी नहरों की डिजाइन के माप दण्ड तथा
अस्तर प्रकार के चुनाव के मार्गदर्शी सिद्धांत
(पहला पुनरीक्षण)

Indian Standard

CRITERIA FOR DESIGN OF LINED CANALS AND
GUIDANCE FOR SELECTION OF TYPE OF LINING
(*First Revision*)

ICS 93.160

© BIS 2000

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

AMENDMENT NO. 1 AUGUST 2005
TO
IS 10430 : 2000 CRITERIA FOR DESIGN OF
LINED CANALS AND GUIDANCE FOR SELECTION OF
TYPE OF LINING

(First Revision)

[Page 1, clause 3(r)] — Substitute the following for the existing:

'r) Availability of suitable construction material within economic leads, such as:

- 1) Cement of requisite quality;
- 2) Building lime of requisite class;
- 3) Flyash for use as pozzolana;
- 4) Suitable clay for manufacture of calcined clay pozzolana;
- 5) Coarse and fine aggregates;
- 6) Soil of suitable quality for manufacture of burnt clay tiles/bricks;
- 7) Pulverized fuel ash-lime and/or clay flyash building bricks; and
- 8) Stones of required size and quality.'

[Page 3, clause 6(a)] — Substitute the following for the existing:

'a) **Rigid Lining**

- 1) Stone-pitched lining;
- 2) Burnt clay tile or brick lining;
- 3) Burnt bricks or pulverized fuel ash-lime bricks or burnt clay flyash building bricks lining;
- 4) Precast cement concrete/stone slab lining;
- 5) Cement concrete tile lining;
- 6) In situ cement/lime concrete lining;
- 7) Stone masonry lining;
- 8) Soil cement/soil cement and flyash lining;
- 9) Shotcrete lining;
- 10) Ferrocement lining; and
- 11) Asphaltic cement concrete lining.

Amend No. 1 to IS 10430 : 2000

[Page 4, clause 6(b)(1)] — Substitute the following for the existing:

- 1) Geomembrane like High Density Polyethylene (HDPE), Polvinyl chloride (PVC), Low Density Polyethylene (LDPE) with cover comprising layer of bentonite with adequate earth/burnt clay tile brick or pulverized fuel ash-lime brick or burnt clay flyash building brick/precast cement concrete.'

(WRD 13)

Reprography Unit, BIS, New Delhi, India

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Irrigation Canals and Canals Linings Sectional Committee had been approved by the Water Resources Division Council.

Lining of canals is an important feature of irrigation projects as it improves the flow characteristics and minimises the loss of water due to seepage. The water thus saved can be utilised for the extension and improvement of irrigation. Lining of water courses in the areas irrigated by tubewells assumes special significance as the pumped water supply is relatively more costly. The reduced seepage also prevents rise of the sub-soil water table and thus reduces the possibility of damage to the adjoining areas by water logging. Further, due to adoption of higher velocities in a lined canal there is a saving in the cross-sectional area of the canal and land width required, with corresponding saving in the cost of excavation and masonry works. It helps in retention of shape of the canal. Lining also results in improvement of command and larger working head for power generation.

This standard deals with design of lined canals. However, before lining of a canal is decided, techno-economic justification for the same should be established. Selection of a particular type of lining should be arrived at based on materials available and overall cost *vis-a-vis* saving in seepage and head. Performance data for various types of lining shall be collected and consulted before deciding on a particular type of lining.

Only general guidelines with regard to factors influencing the selection of the type of lining are given in this standard, for the assistance of the designer. But each project should be individually analysed taking into consideration its peculiar features.

This standard was first published in 1982. The first revision has been taken up in the light of the comments received from the Irrigation departments of various states. In this revision functions of lining and various types of lining have been included. Changes in side slopes, free board, etc, have also been incorporated.

There is no ISO standard on the subject. This standard has been prepared based on indigenous manufacturers' data/practices in the field in India.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard***CRITERIA FOR DESIGN OF LINED CANALS AND
GUIDANCE FOR SELECTION OF TYPE OF LINING***(First Revision)***1 SCOPE**

This standard lays down design criteria for lined canals and presents guidelines for selection of type of lining.

2 REFERENCES

The following Indian Standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
4558 : 1995	Code of practice for under drainage of lined canals (<i>second revision</i>)
9451 : 1994	Guidelines for lining of canals in expansive soils (<i>second revision</i>)

3 NECESSARY INFORMATION

For arriving at a suitable design of a lined canal and for selection of type of lining the following information is necessary for the entire length of the canal:

- a) **Capacity** — Capacity required for the canal to irrigate the command depends on the crop pattern, irrigation intensity, rotation period, water required during critical period, transmission losses, etc. For fixing the canal capacity, a design statement, or capacity statement should be separately prepared, reach by reach. The section of a particular reach should be designed for the maximum discharge in that reach.

NOTE — Suitable transmission loss (m^3/s per million square metre of wetted perimeter) for lined canal depending upon the type of lining, climatic conditions shall be assumed.

- b) Longitudinal-section along the canal alignment plotted generally to a horizontal scale of 1 in 10 000 and a vertical scale of 1 in 100. Vertical scale may be changed, if desired, depending upon the drop in the ground levels;
- c) Full supply level (FSL), bank level and the bed level of the parent canal (if any);

- d) Cross-sections along the canal alignment at intervals not more than 300 m for a uniform terrain and at closer intervals for undulating terrain. The cross-sections should extend at least 10 metres beyond the limits of canal section on both sides;
- e) Road and railway crossings, cart/pedestrian tracks, drainage crossings, etc;
- f) Nature and quantity of sediment likely to be transported;
- g) Profile of soil up to at least half the full supply depth or 1 m whichever is more, below the canal bed level along the canal alignment at 500 m intervals. However, if any variation in soil strata is found, the spacing shall be at shorter intervals. Soil samples should be tested for usual soil properties including permeability, swelling pressures, and dispersive properties;
- h) Salt content of the soil, specially presence of sulphates, to be determined at suitable intervals;
- j) Sub-soil water level and its quality along the canal alignment;
- k) Availability of skilled and unskilled labour;
- m) Availability of construction machinery;
- n) Cattle traffic;
- p) Climatic and other local conditions;
- q) Thickness of ice formation (if applicable);
- r) Availability of suitable construction materials within economic leads, such as:
- 1) Coarse and fine aggregate for canal lining;
 - 2) Soil for making tiles/bricks; and
 - 3) Stones of required size, specific gravity and soundness for stone lining.

4 FUNCTIONS OF LINING**4.1 The functions of lining are:**

- a) Seepage control,
- b) Prevention of water logging,
- c) Increased hydraulic efficiency,
- d) Increased resistance to erosion/abraision,

IS 10430 : 2000

- e) Reduction in cross-section area and consequential smaller structures, and
- f) Low operation and maintenance cost.

4.1.1 Seepage Control

The seepage control mainly depends on the soundness and impermeability of lining. Seepage losses also depend on nature and permeability of soil, depth of water in the canal and position of sub-soil water table below the bed level. The permissible seepage losses depend on the local conditions such as value of water and any likely damage to land and other property by water loggings, etc.

Generally canal reaches of sufficient length having permeability of 1×10^{-6} cm/s or less need not be lined when the velocity in the canal does not exceed the permissible velocity. However, reaches of permeability 1×10^{-6} cm/s or less may be lined, particularly in power channels, for hydraulic efficiency and erosion resistance. Canal reaches of greater permeability may be lined with suitable material.

4.1.2 Increased Hydraulic Efficiency

The discharge carrying capacity of a canal varies inversely with the value of rugosity coefficient of a particular type of lining. It may, however, undergo changes with passage of time, it may decrease with the lining undergoing deterioration and consequent increase in roughness.

4.1.2.1 The values of rugosity coefficient (n) to be used in Manning's formula for various types of linings are given in Table 1.

4.1.2.2 Effective rugosity coefficient

An effective rugosity co-efficient is possible to be derived in such situation where the sides and bed are having different types of lining. For such channels the equivalent manning's ' n ' can be calculated by the following formula:

$$n = \frac{N \left[\sum_{i=1}^N (n_i^{3/2} p_i) \right]^{2/3}}{p^{2/3}}$$

where

- p_i = lengths of different portion of perimeter with corresponding roughness;
- n_i = roughness of portion p_i ; and
- p = $\sum p_i$.

Co-efficients as given in SI No. (v) and (vi) of Table 1 are suggested for some cases, where an analytical derivation, as above, is not feasible.

Table 1 Values of Rugosity Coefficient (n) for Lined Canals with Straight Alignment
(Clauses 4.1.2.1 and 4.1.2.2)

SI No.	Surface Characteristics	Value of ' n '
(1)	(2)	(3)
i)	Concrete with surface as indicated below:	
	a) Formed, no finish/PCC tiles or slabs	0.018-0.020
	b) Trowel float finish	0.015-0.018
	c) Guniting finish	0.018-0.022
ii)	Brick/tile lining	0.018-0.020
iii)	U.C.R./Random rubble masonry with pointing	0.024-0.026
iv)	Asphalt	
	a) Smooth	0.013-0.015
	b) Rough	0.016-0.018
v)	Concrete bed trowel/float finish and slopes as indicated below:	
	a) Hammer dressed stone masonry	0.019-0.021
	b) Coursed rubble masonry	0.018-0.020
	c) Random rubble masonry	0.020-0.025
	d) Masonry plastered	0.015-0.017
	e) Stone pitched lining	0.020-0.030
vi)	Gravel bed with side slope characteristics as given below:	
	a) Formed concrete	0.02-0.022
	b) Random rubble in mortar	0.017-0.023
	c) Dry rubble (rip-rap)	0.023-0.033

NOTES

1 For canals with an alignment other than the straight, a small increase in the value of ' n ' may be made or alternatively bend losses may be accounted for. In case of canals with relatively higher discharges in straight reaches, lower values of ' n ' indicated may be adopted.

2 The ' n ' value shall be decided in view of the age of lining, surface roughness, weed growth, channel irregularities, canal alignment, silting, suspended material and bed load, etc.

4.1.3 Increased Resistance to Erosion

Sometimes the canal transports considerable amount of sediment which can damage the lining by abrasion. The lining shall, therefore, be able to withstand such abrasion.

NOTE — Cement concrete and stone masonry linings provide better abrasion resistance as compared to brick tile lining.

4.1.4 Prevention of Water Logging

There is increase in ground water level if the canals remain unlined. This condition, if unchecked, brings alkali salt to the surface rendering land unfit for

cultivation. Lining of canals reduces the seepage appreciably and thus prevents the occurrence of water logging condition.

4.1.5 Reduction in Cross-Sectional Area

With the increase in efficiency of canal due to lining and higher velocity, reduced areas of cross-section is required to pass same discharge. Consequently, there is large saving in the cost of land acquisition and also of canal structures.

4.1.6 Low Operation and Maintenance Cost

Unlined canals require considerably increased operation and maintenance cost for periodical removal of silt, minor repairs, removal of weeds and water plants. The provision of lining reduce these costs considerably.

5 REQUIREMENTS OF LINING

5.1 General

The following are the important requirements for the selection of type of canal lining:

- a) Economy;
- b) Structural stability;
- c) Strength and durability;
- d) Repairability and easy maintenance;
- e) Maximum hydraulic efficiency;
- f) Impermeability;
- g) Resistance to erosion;
- h) Ability to prevent weed growth;
- j) Resistance against burrowing animals; and
- k) Reasonable flexibility.

The lining material shall be so selected that it should meet most of the requirements for the specific site.

5.1.1 Economy

The selection of suitable type of lining for any project is mainly a question of economics and availability of:

- a) material available within economical leads;
- b) skilled and unskilled labour;
- c) construction machinery and equipment; and
- d) time required during which the work should be completed.

The type of lining selected should not only be economical in initial costs, but also in repair and maintenance in the long run.

5.1.2 Structural Stability

The sides of the canal to be lined should preferably be kept at the stable slope of the soil so that there is no

earth pressure or any other external pressure against the lining. Pressure due to saturated backfill and the differential water head across lining should be avoided. Arrangements like weep holes, graded filter behind weep holes shall be made so that no water gets behind the lining from an external sources.

Where the side slopes are made steeper than the stable slopes of the soil, or where external pressures cannot be avoided, the lining will have to be designed accordingly in such special case.

To provide relief from differential pressure, adequate sub-soil drainage arrangements and pressure release arrangements (*see* IS 4558) shall be provided wherever necessary.

5.1.3 Strength and Durability

The canal lining shall be able to withstand the effect of velocity of water, rain, sunshine, frost, freezing and thawing (where applicable), temperature and moisture changes, chemical action of salts, etc. With suitable treatment, lining should be able to withstand the effect of gypsum, black cotton soil/bentonite. It should also be able to withstand the damaging effect caused by abrasions, cattle traffic, rodents and weed growth.

5.1.3.1 For the purpose of economic analysis, the life expectancy of concrete, brick/tile and stone pitched lining may be assumed to be of the order of 60 years. However, experience gained from data on lined canal in the vicinity can be utilized to review the life expectancy of lining.

5.1.4 Repairability/Easy Maintenance

Since with lapse of time the lining may get damaged, it should be such that it can be repaired easily and economically.

5.1.4.1 Brick/tile, stone-pitched and precast slab linings are more easily repairable or replaceable than *in-situ* concrete lining.

5.1.5 General

Other factors indicated in 5.1 (e) to 5.1 (h) are achieved to different extent by various options available for lining.

The multi-dimensional effect of choice on the various parameters affecting the requirements thus require a judicious evaluations before a final choice.

6 DIFFERENT TYPES OF LININGS

a) Rigid Lining

- 1) Stone-pitched lining;
- 2) Burnt clay tile or brick lining;
- 3) Precast cement concrete/stone slab lining;
- 4) *In-situ* cement lime/concrete lining;

IS 10430 : 2000

- 5) Stone masonry lining;
- 6) Soil cement lining;
- 7) Shotcrete lining; and
- 8) Asphaltic cement/concrete.

b) Flexible Lining

- 1) Geomembrane like High Density Polyethylene (HDPE), Polyvinyl chloride (PVC,) Low Density polyethylene (LDPE) cover comprising layer of bentonite with adequate/earth/burnt clay tile brick/precast cement concrete,
- 2) Bituminous or bituminous/asphaltic felt lining,
- 3) Fibre reinforced plastic tissue as phallic membrane, and
- 4) Composite membrane/rubber lining.

c) Combination Lining (membrane in the bed and brick/tile or concrete lining on sides)**7 SELECTION OF LINING****7.1 Considerations for Selection**

Taking into consideration all the above factors, suitable types of lining for different sizes of canals will be selected on the basis of type of subgrade, position of water table, climatic conditions, availability of materials, speed of construction, time schedule, performance of lining in the existing canals in the adjoining areas. Adoption of a particular type of lining will require careful consideration of all these factors.

7.2 After collecting necessary information as given in 3.1, the entire canal or specific reaches to be lined, may be decided as per 4.1.1. The types of lining

generally suitable for the site condition may be listed in the light of 5 and 6. The most economical of the linings selected from amongst the suitable linings may be evaluated as per Annex A for economical viability. To select type of lining to keep seepage within desirable limits, reference may also be made to performance data of existing canals. There may be other intangible factors like presence of high population intensity, aesthetics, limitations of land availability, etc, which may influence the final selection of type of lining.

8 PARAMETER FOR DESIGN OF LINED CANALS**8.1 Side Slopes****8.1.1 Inner Slopes of Lined Canals**

Lining is usually made to rest on stable slopes of the natural soil; so slopes should be such that no earth pressure or any other external pressure is exerted over the back of the lining. Sudden drawdown of water level in the lined canal should be controlled by strict operation rules and regulations to avoid external pressure on the lining. However where chance of sudden drawdown in the canal is considerable, the canal slopes should be checked for stability using slip circle analysis as given in IS 7894. In addition, other suitable measures like adequate drainage should be provided before lining work commences. As a rule, steeper slopes are economical but stable slopes depending on type of soil are preferred. For general guidance, the following side slopes as given in Table 2 are recommended.

8.1.2 Outer Slopes of Lined Canal

Suggested outer slopes for lined canals are seen in some of the typical sections such as given in Fig. 1A, 1B, 2A, 2B, etc. However, engineering properties of

Table 2 Recommended Side Slopes*(Clause 8.1.1)*

Sl No.	Type of Soil	Side Slopes (Horizontal : Vertical)
i)	Very light loose sand to average sandy soil	2 : 1 to 3 : 1
ii)	Sandy loam	1.5 : 1 to 2 : 1 (in cutting) 2 : 1 (in embankment)
iii)	Sandy gravel/murum	1.5 : 1 (in cutting) 1.5 : 1 to 2 : 1 (in embankment)
iv)	Black cotton	1.5 : 1 to 2.5 : 1 (in cutting) 2 : 1 to 3.5 : 1 (in embankment)
v)	Clayey soils	1.5 : 1 to 2 : 1 (in cutting) 1.5 : 1 to 2.5 : 1 (in embankment)
vi)	Rock	0.25 : 1 to 0.5 : 1

NOTE — The above slopes are recommended for depth of cutting/height of embankment up to 6 m. For depth/height in excess of the above, special studies for the stability of slopes are recommended.

soil shall govern the design of outer slopes giving due consideration to stability of slopes for functional situations (like moist conditions of fill, etc.) The need for introduction of berms will also be kept in view where the fill height is in excess of 6 m.

8.2 Free Board

Free board shall be measured from the full supply level to the top of lining. Minimum free boards for various canal discharge-are given below:

Canal Discharge	Free Board
More than 10 cumecs	0.75 m
Between 3 to 10 cumecs	0.60 m
1 to 3 cumecs	0.50 m
Less than 1 cumec	0.30 m
Less than 0.1 cumec (Water Course)	0.15 m

8.3 Berm

In deep cut reaches of canals with discharge capacity exceeding 10 cumecs, it is desirable to provide berms of 3 m to 5 m width on each side for stability, facility of maintenance, silt clearance, etc (see Fig. 1C). In such sections, the inner sides above the berms may be provided with turfing.

8.4 Bank Top Width

The width of the banks may vary according to the importance and capacity of the canal. In case of distributaries, service road should be provided on one bank for inspection and maintenance purpose. However, in case of main and branch canals service road should be provided on both the banks. The minimum values recommended for top width of the bank are as follows:

Discharge (m ³ /s)	Minimum Bank Top Width	
	Inspection Bank/ Wider Bank m	Non Inspection Bank/Other Bank m
0.15 to 1.5	4.0	1.5
1.5 to 3.0	4.0	2.0
3.0 to 10.0	4.0 + dowel	2.5
10.0 to 30.0	5.0 + dowel	4.0
30.0 and above	6.0 + dowel	5.0

NOTES

1 Bank widths given above may be altered when justified by specific conditions.

2 For distributary canals carrying less than 3.0 cumecs and minor canals, it is generally not economical to construct a service road on top of bank as this usually requires more materials than the excavation provides. In such cases, service road suitably lowered below top of lining may be

provided on natural ground surface and adjacent to the bank; however, the importance of providing adequate service roads where they are needed should always be kept in view. The service road should be above normally encountered high flood level (HFL) with some free board.

3 Where the stability of the embankment is required, wider bank widths can be provided. Turfing should be provided on the outer slopes.

4 In hilly terrain where it is not possible to provide above bank widths, the bank widths may be suitably reduced.

5 When the bank widths are reduced on exceptional ground, refuges after every 100 m should be provided for passing and sheltering of opposing traffic.

8.5 Dowla (Dowel 'Dwarf Bund')

Suitable dowels may be provided on the canal side of the service road, on one or both the banks depending upon the type and size of the lined canal. From economic consideration, dowels may be replaced by parapets particularly in case of high embankments. However, the parapet should not be considered additional free board. To check the ingress of rain water behind the lining of the side slopes of the canals, horizontal cement concrete coping 100 mm to 150 mm thick, depending upon size of canal should be provided at the top of lining. The width of coping at the top shall not be less than 225 mm for discharge up to 3 cumecs, 350 mm for discharge more than 3 cumecs and 550 mm for discharge more than 10 cumecs.

8.6 Roadway and Drainage

Wherever additional spoil banks are to be provided on the land side of the embankment, adequate drainage channels shall be provided with suitable slope on the roadway sloping away from the canal side. No rain water shall be allowed to flow or percolate towards the canal slope behind the linings.

8.7 Typical Cross-Sections

Typical cross-sections of the lined canals in cutting and filling are given in Fig.1 and 2. Three typical cross-sections of lined canals in rock cutting are shown in Fig. 3. Depending upon the quality of rock, full supply discharge, velocity, depth of flow and bed width, similar arrangements may be adopted.

8.8 Cross-Section, Discharge and Velocity

8.8.1 The cross-section of lined canal may be

- trapezoidal with or without rounded corners (see Fig. 1). This section can be used for all types of lined canals.
- cup shaped (see Fig. 2). It may be used for distributaries/minors for discharge up to 3m³/s as far as possible.

IS 10430 : 2000

8.8.2 The discharge that can pass through a canal section is calculated by

$$Q = A \times V_{\text{mean}} \text{ (m}^3\text{/s)}$$

where

A = area of cross-section in m^2 , and

V_{mean} = mean velocity in m/s .

8.8.3 The mean velocity V_{mean} is given by :

$$V_{\text{mean}} = \frac{R_h^{2/3} S^{1/2}}{n} \text{ (m/s)}$$

where

R_h = hydraulic mean depth ($= A/P$) (m);

A = cross sectional area (m^2);

P = wetted perimeter (m);

S = longitudinal slope of water surface (m/m); and

n = rugosity coefficient as given in Table 1.

8.8.4 The critical velocity ratio should be aimed at higher than unity or by any other method, it should be ensured that silting will not take place in the lined canal.

8.8.5 Limiting Velocities in Different Types of Lining

The maximum permissible velocities for guidance for

some types of lining are given below:

- | | |
|------------------------------------|---------|
| a) Stone-pitched lining | 1.5 m/s |
| b) Burnt clay tile or brick lining | 1.8 m/s |
| c) Cement concrete lining | 2.7 m/s |

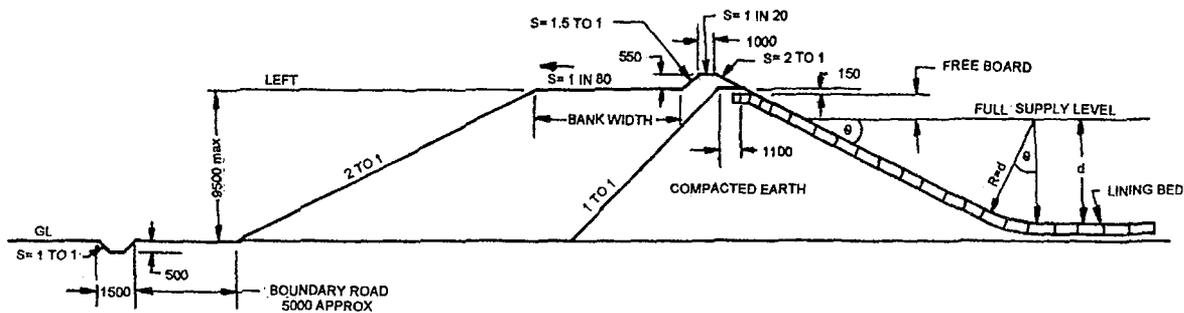
9 UNDER DRAINAGE

9.1 Embankments of relatively permeable soil do not need drainage measures behind the lining. However, the following conditions require suitable under drainage measures to be provided to protect the canal lining in accordance with IS 4558.

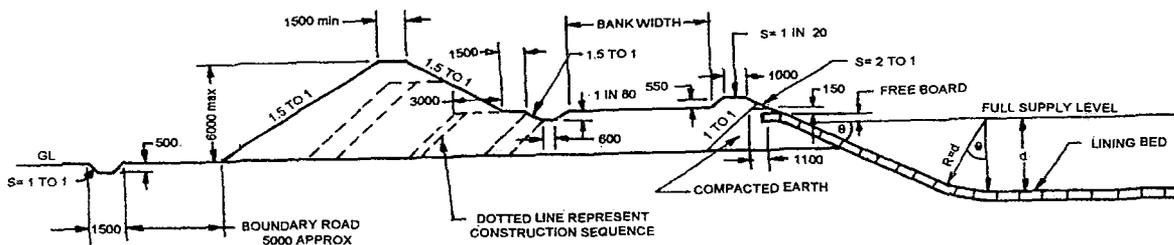
- i) Where the lined canal passes through an area with seasonal ground water level higher likely to be higher than the water level inside the canal,
- ii) Where sub grade is sufficiently impermeable to prevent the free drainage of seepage or leakage from the canal, and
- iii) Where there is built up pressure due to time lag between drainage of the sub-grade following drawdown of canal.

10 EXPANSIVE SOIL

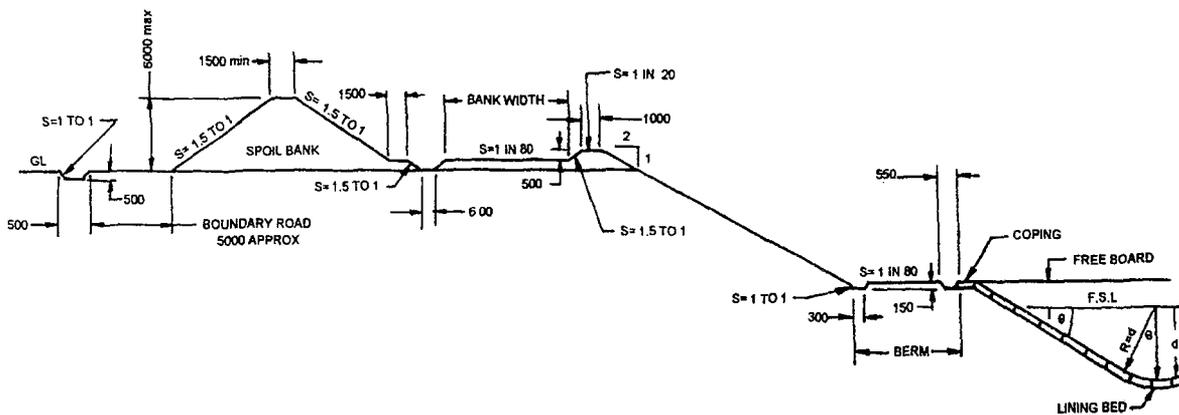
10.1 In reaches of expansive soil where swelling pressure is more than 50 kN/m^2 reference may be made to IS 9451.



All dimensions in millimetres.
FIG. 1A NATURAL GROUND BELOW BED

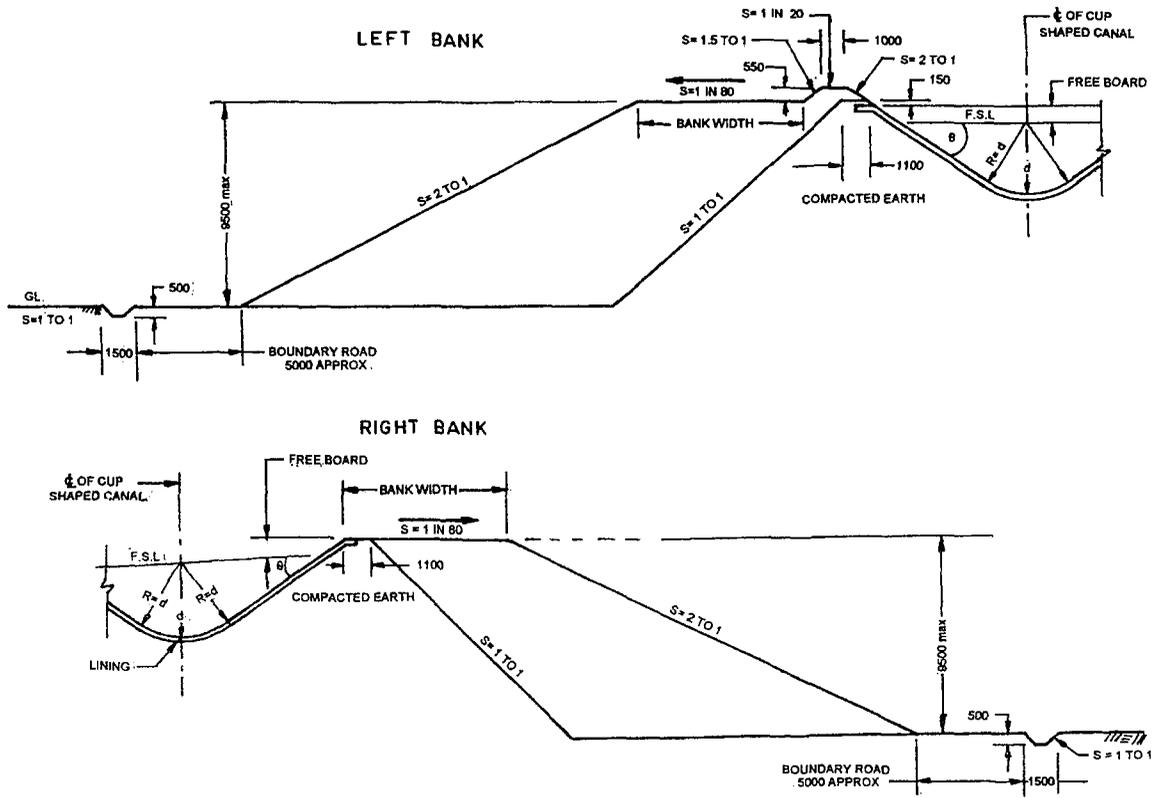


All dimensions in millimetres.
FIG. 1B NATURAL GROUND BETWEEN BED AND FULL SUPPLY LEVEL

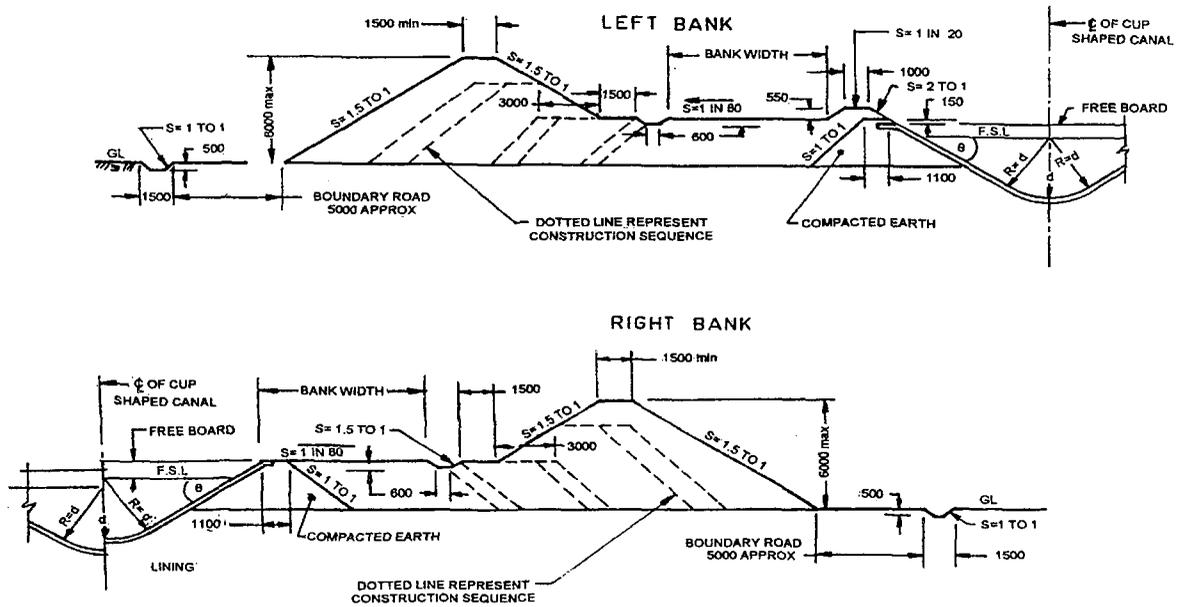


All dimensions in millimetres.
FIG. 1C NATURAL GROUND IS ABOVE TOP OF LINING

IS 10430 : 2000

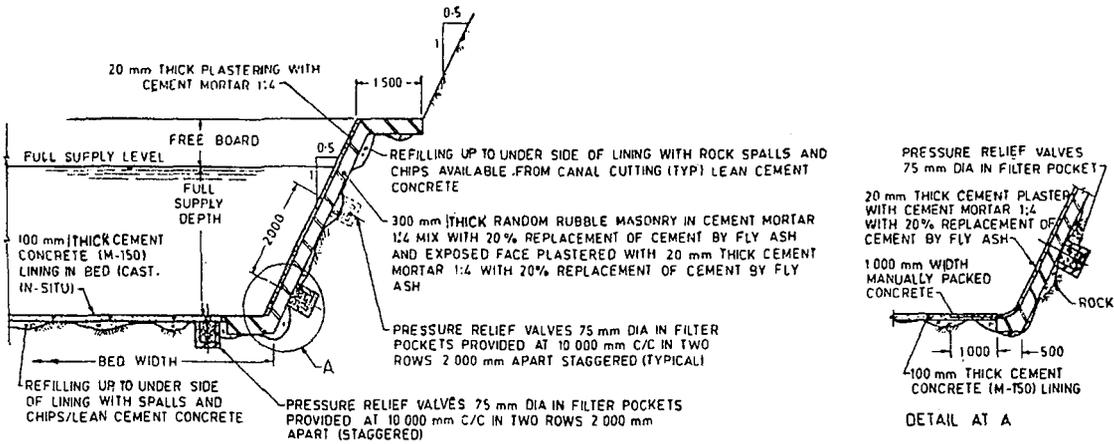


All dimensions in millimetres.
FIG. 2A NATURAL GROUND BELOW BED

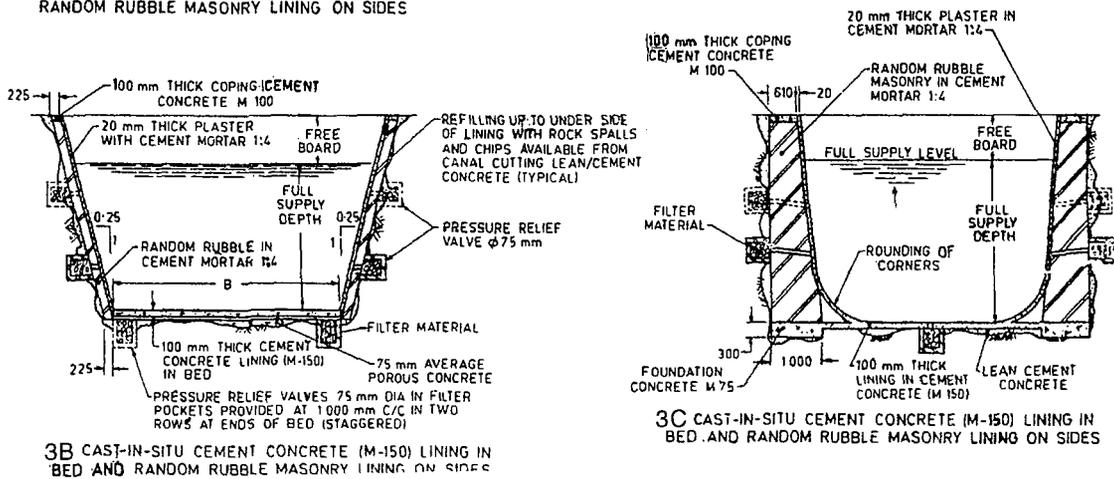


All dimensions in millimetres.
FIG. 2B NATURAL GROUND BETWEEN BED AND FULL SUPPLY LEVEL

IS 10430 : 2000



3A CAST-IN-SITU CEMENT CONCRETE LINING IN BED AND RANDOM RUBBLE MASONRY LINING ON SIDES



3B CAST-IN-SITU CEMENT CONCRETE (M-150) LINING IN BED AND RANDOM RUBBLE MASONRY LINING ON SIDES

NOTES

- 1 In case of sound rock, cement concrete lining may be provided in bed and sides. On sides, the lining may be anchored suitably to the rock behind.
- 2 All the dimensions are in millimetres unless otherwise specified.

FIG. 3 TYPICAL CROSS-SECTIONS OF LINED CANALS IN ROCK CUTTING

ANNEX A

(Clause 7.2)

ECONOMICS OF CANAL LINING

A-1 NOTATIONS

A-1.1 For the purpose of analysis for determining the maximum rate of expenditure on lining that is economically justifiable, the following notations should apply:

- C : Cost of lining in rupees per square metre including the additional cost of dressing the banks for lining.
- C' : Saving in the land, earthwork and structures (bridges, cross drainage works, etc) due to reduced section on account of lining, in rupees.
- s and S : Seepage losses in unlined and lined canal respectively in cubic metres per square metre of wetted surface per day.
- p and P : Wetted perimeter in metres of unlined and lined sections respectively.
- T = Total perimeter of lining in metres.
- d = Number of running days of the canal per year.
- W = Value of water saved in rupees per cum.
- L = Length of the canal in metres.
- Y = Life of the canal in years.
- M = Annual saving in rupees in operation and maintenance due to lining.
- B = Annual estimated value in rupees of other benefit for the length of canal under consideration. These will include prevention of water logging, reduced cost of drainage for adjoining lands, reduced risk of breaching, etc.

- X = Percent rate of interest per year.
- a = Total annual benefits resulting from the lining of canals.

A-2 METHOD

A-2.1 The annual value of water lost by seepage from the unlined section = $p L s d W$ rupees

The annual saving by lining in value of water otherwise lost by seepage if unlined = $(p L s d W - P L S d W)$ Rs
= $\{L d W (p s - P S)\}$ Rs

Total annual benefits resulting from the lining of canals, a = $\{L d w (p s - P S) + B + M\}$ Rs(1)

A-2.1.1 Additional capital expenditure on construction of lined canal = Rs $T L C C'$. If the prevalent rate of interest is X , the net present worth (NPW) of the total annual benefits a , over the life of the canal (Y years) is determined from the following formula:

$$NPW = a \frac{(1 + X)^Y - 1}{X (1 + X)^Y} \dots\dots\dots(2)$$

For the lining to be economically feasible the additional initial cost of the lined canal should be equal to or less than Net Present Worth of savings.

that is, $T L C - C' \leq NPW$

NOTE—In the above analysis it may be noted that the actual evaluation of benefits grouped under item B and M is very difficult to ascertain particularly on a new project. It can only be approximately estimated on the basis of experience on similar existing projects.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc : No. WRD 13 (45).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 323 01 31, 323 33 75, 323 94 02

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :

	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110 002	{ 323 76 17 323 38 41
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi CALCUTTA 700 054	{ 337 84 99, 337 85 61 337 86 26, 337 91 20
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160 022	{ 60 38 43 60 20 25
Southern : C. I. T. Campus, IV Cross Road, CHENNAI 600 113	{ 235 02 16, 235 04 42 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400 093	{ 832 92 95, 832 78 58 832 78 91, 832 78 92
Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM.	