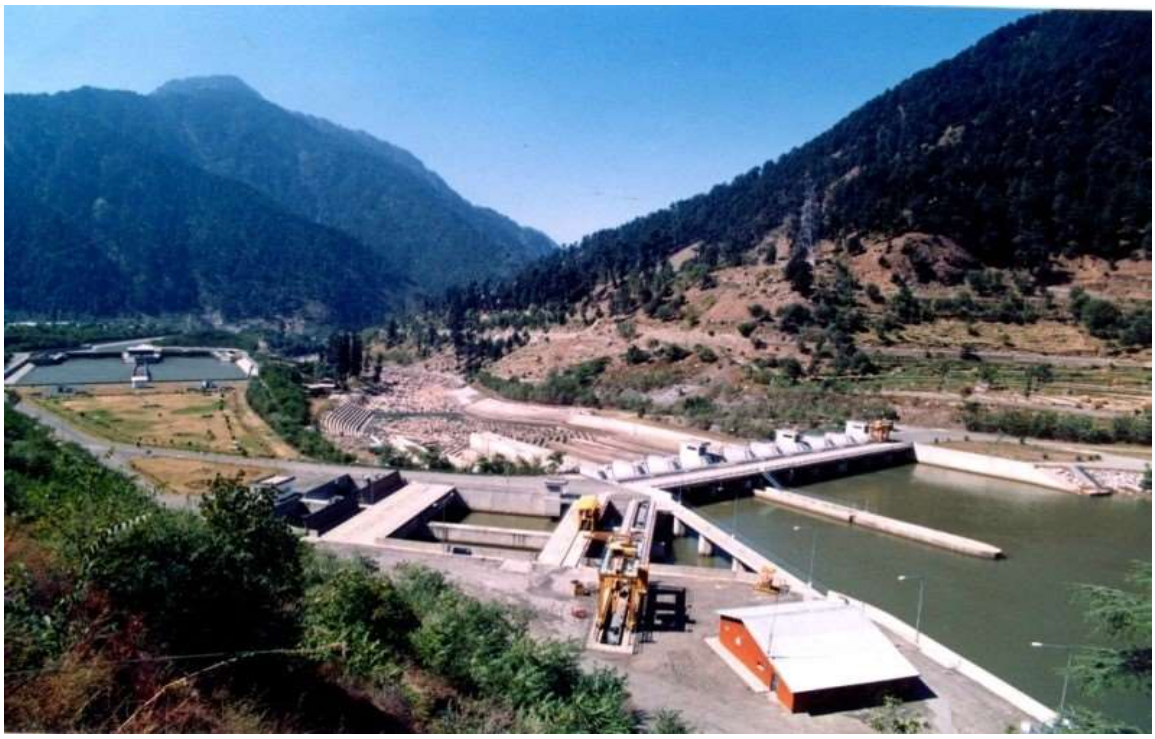
NHPC LIMITED

(A GOVT. OF INDIA ENTERPRISE)

URI-I (STAGE-II) H.E. PROJECT

JAMMU & KASHMIR (UT)

(2 X 120 = 240 MW)



UPDATED DETAILED PROJECT REPORT

VOLUME - I

CHAPTER-I TO VIII

FARIDABAD **MARCH-2023**

FOREWORD

URI I Stage II Hydroelectric Project (240 MW)

UT of JAMMU & KASHMIR

FOREWORD

Updated Detailed Project Report of Uri-I (Stage-II) Hydroelectric Project has been prepared by NHPC Limited in 21 chapters as per the "Guidelines for formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence (2015)". These 21 chapters have been compiled in four volumes of DPR as under:

Volume - I	**Chapter- I**	**:**	**Introduction**
	Chapter- II	**:**	**Justification of project from power supply angle**
	Chapter- III	**:**	**Basin Development**
	Chapter- IV	**:**	**Inter-State/ Inter-National Aspects**
	Chapter- V	**:**	**Survey & Investigation**
	Chapter- VI	**:**	**Hydrology**
	Chapter- VII	**:**	**Reservoir**
	Chapter- VIII	**:**	**Power Potential Studies & Installed Capacity**
Volume - II	**Chapter- IX**	**:**	**Design of Civil Structures**
	Chapter- X	**:**	**Electrical and Mechanical Designs**
Volume - III	**Chapter- XI**	**:**	**Transmission of Power and Communication facilities**
	Chapter- XII	**:**	**Construction Programme and Plant Planning**
	Chapter - XIII	**:**	**Project Organization**
	Chapter - XIV	**:**	**Infrastructural Facilities**
	Chapter - XV	**:**	**Environmental and Ecological Aspects**
Volume - IV	**Chapter - XVI**	**:**	**Cost Estimates**
	Chapter - XVII	**:**	**Allocation of Cost**
	Chapter - XVIII	**:**	**Economic Evaluation**
	Chapter - XIX	**:**	**Future Utilization of Buildings**
	Chapter - XX	**:**	**Recommendations**
	Chapter -XXI	**:**	**Clearances / Inputs**

In addition to above Four (4) volumes I, II, III & IV, additional information regarding Hydrology, Geological and Construction Material Aspects has been compiled in following Annexure Volumes of the DPR.

Volume - V	**:**	**Annexure Volume: Hydrology**
Volume – VI	**:**	**Annexure Volume: Geological Aspects**
Volume – VI-A	**:**	**Annexure Volume: Geological Aspects**
Volume - VII	**:**	**Annexure Volume: Construction Materials**

Volume - I Comprises of Chapters I to VIII, viz. Introduction, Justification of Project from Power supply angle, Basin Development, Inter-state / Inter-national aspects, Survey & investigation, Hydrology, Reservoir and Power potential studies & Installed capacity.

Volume - II Comprises of Chapters IX and X, viz. Design of Civil Structures & Electrical and mechanical designs.

Volume - III Comprises of Chapters XI to XV, i.e. Transmission of Power & Communication facilities, Construction Programme and Plant Planning, Project Organization, Infrastructural facilities and Environmental & Ecological Aspects.

Volume - IV Comprises of Chapters XVI to XXI, Viz. Cost Estimates, Allocation of Cost, Economic Evaluation, Future Utilization of Buildings, Recommendations and Clearances/Inputs.

Volume - V **Annexure of Hydrology -** Annexure volume to **Chapter VI i.e. Hydrology** of the DPR. The volume comprises of detailed study on Water Availability study, River System & Basin Characteristics, Design Flood, Hydraulic Transient study for water conductor system, Reservoir Sedimentation etc.

Volume – VI **Annexure of Geological Aspects –** Annexure Volume to **Sub-Chapter-5.6 (Geology and Geotechnical Features) of Chapter-V (Survey and Investigations) of the DPR.** The volume comprises of detailed study on Regional Geology,

Surface & Sub-surface Investigations (Geological mapping, Geophysical survey, Exploratory Drilling, Drifting, Laboratory & In-situ Rock Mechanic Testing etc.) Geology / Geo-technical evaluation of Project Components, Seismicity, Conclusions & Recommendations.

Volume – VI A **Annexure Volume to Geological Aspects.** The Volume comprises of reports on Laboratory Rock Mechanic Testing, Geophysical Studies i.e. Resistivity Imaging, Seismic Refraction Tomography, Wedge / Kinematic Analysis of Discontinuities vis-a-vis Proposed Structures, Drill Hole logs along with Test Reports of In-situ Rock Mechanic Tests & Drift Logs of Stage-I Power House & TRT area previously carried out for Uri-I Power Station.

Volume - VII **Construction Material - Annexure to Sub-Chapter-5.9 (Construction Material Investigation)** of Chapter-V (Survey and Investigations) of DPR. The Volume details about the previous investigations, Requirement of Construction materials, Details of Quarry & Borrow areas including River borne material and Conclusions.

After signing of Memorandum of Understanding (MOU) between NHPC & Govt. of J&K on 3rd January 2021 for implementation of Uri-I Stage-II HE Project (240 MW) HE Project on Build, Own, Operate & Transfer (BOOT) basis for the period of 40 years, NHPC in consultation with CEA submitted all six (6) no of Preliminary chapters to CEACWC/GSI/CSMRS etc. in January 2021 followed by 1st consultation meeting on 15th Feb'21, wherein CEA had given go-ahead for carrying out of survey & Investigation activities for preparation of DPR. The minutes of the meeting (MoM) for the said meeting was issued by CEA on 22nd Feb'21.

Accordingly, NHPC started the survey & investigation works i.e. Topographical Survey, Exploratory Core drilling, Geophysical survey, Construction material survey works etc. at site as per the agreed exploration plan. Subsequent to obtaining of clearances on Preliminary chapters from CEA/CWC/GSI/CSMRS etc.

and completion of all requisite survey & investigation works at site, NHPC submitted all 9 no of Pre-DPR chapters to concerned directorates of CEA/CWC/GSI/CSMRS in the month of October & November 2021 as advised by CEA. Accordingly, all Pre-DPR clearances except clearance on International aspect on Indus Treaty Angle have been obtained.

Regarding clearance on International aspect on Indus Treaty Angle, DC Indus, Ministry of Jal Shakti (MoJS) vide E-mail dated: 03.12.2021 informed that the clearance related to Indus Water Treaty 1960 will be issued only after finalization of all salient features & concerned agency should apply the same under Appendix-II to Appendix-D. Subsequent to accord of Pre-DPR clearances, NHPC prepared the DPR as per the CEA Guidelines for formulation of DPR 2015 & submitted the DPR in CEA/CWC/GSI/CSMRS on 18th May, 2022. Further DPR acceptance meeting was held in CEA on 20th June'22 along with all its stakeholders CWC, GSI, CSMRS etc to check the adequacy of investigations & its contents.
Now after accord of all clearances from concerned apprising groups of CEA/CWC/GSI/CSMRS etc. and optimisation of time schedule to 44 months with zero date of the project as 01.12.2023, revision of layout of power house, updation of cost estimate at December 2022 PL, revision of design energy of the project to 932.60 MU from 929.13 MU considering approval of head losses, Turbine Generator (TG) efficiency, inflows and other suggestions received from appraising agencies during Clearance process and followed by Concurrence meeting held on 16th Feb, 2023, the updated DPR is being submitted to CEA for accord of TEC.

The support and Co-operation extended by Govt. of Jammu & Kashmir, Central Electricity Authority Central Water Commission, Geological Survey of India, Survey of India, Central Soil and Material Research Station etc. during preparation of Preliminary, Pre-DPR & DPR chapters is duly acknowledged.

CHECK LISTS-ANNEX- 2(a) & 2(b)

URI-I STAGE-II HYDROELECTRIC PROJECT (240 MW)

JAMMU& KASHMIR

Check Lists Annex –2(a)

List of relevant Documents/ References

1. The Electricity Act, 2003.
2. Indian Companies Act, 1956.
3. Forest Conservation Act, 1980 and Notifications/Resolutions by MOE&F.
4. "Guidelines for preparation of DPRs of Irrigation and Multipurpose Projects" issued by CWC.
5. "Guidelines for preparation of project estimates for major irrigation and multipurpose project" issued by CWC.
6. National Electricity Plan notified by CEA.
7. Indian Electricity Sector – Widening Scope for Private Participation- Issued by Ministry of Power
8. Policy on Hydro Power Development issued by Ministry of Power.
9. Guidelines for "Investigation of major irrigation and hydro-electric projects" issued by CWC.
10. Guidelines for Investigations and Explorations required at Detailed Project Report stage of Proposed Hydroelectric Project in Himalayan Terrain.
11. CBIP – Technical Report No.19 "Life of Reservoir (1977)".
12. IS 5497: Guide for topographical surveys for river valley projects.
13. IS 4890: Method for measurement of suspended sediment in open rivers.
14. IS 13216: Code of practice for geological explorations for reservoir sites.
15. IS 4186: Guide for preparation of project report for river valley projects.

16. IS 4877: Guide for preparation of Estimate for River Valley Projects.
17. IS 5477: Methods for fixing the capacities of reservoirs. (Part 1-4)
18. IS 7323: Method for determining evaporation from reservoirs.
19. IS 7323: Guidelines for operation of reservoirs.
20. IS 13028: Guidelines for overall planning of river basin.
21. IS 7560: Guidelines for allocation of cost among different purposes of river valley projects.
22. IS 4247: Code of practice for structural design of surface Hydel Power stations.
23. IS 12837: Guidelines for selection of hydraulic turbines for medium and large hydro-electric power houses.
24. IS 12800: Guidelines for selection of turbines preliminary dimensioning & layout of surface hydro-electric power houses.

ANNEX-2(b)

Abstract of Cost Estimates

Present Price level: December2022
Zero Date : Dec -2023
Construction Period: 44 Months
FE Rate: NA

i). Cost estimates at Present Price Level:

Item	Indian Component	Foreign Component		Total (Rs in Cr)
	(Rs Cr)	fc	(Eqvt. in Rs Lakhs)	
1.Cost of Civil Works	1410.53		NA	1410.53
2.Cost of Electro-Mechanical	500.65			500.65
3.Cost of Miscellaneous	58.67			58.67
Total Cost of Works (Hard Cost) (1+2+3)	**1969.85**			**1969.85**
IDC & FC				**219.76**
Total Project Cost including IDC & FC				**2189.61**

Fc: Foreign Currency

ii). Cost estimates at Completion Level:

Item	Indian Component	Foreign Component		Total
	(Rs Lakhs)	fc	(Eqvt. in Rs Lakhs)	
1.Cost of Civil Works	1643.81			1643.81
2.Cost of Electro-Mechanical Works	562.82		NA	562.82
3.Cost of Miscellaneous Works	70.71			70.71
Total Cost of Works (Hard Cost) (1+2+3)	**2277.34**			**2277.34**
IDC & FC				**249.45**
Total Project Cost including IDC & FC				**2526.79**

fc: Foreign Currency

APPENDIX-3(a) – Checklist-1

APPENDIX–3 (a) Checklist-1

(To be examined in the office of Secretary, CEA)

Sr. No.	ITEM	REMARKS
1	Name of the Project	Uri-I Stage-II Hydroelectric Project (240MW)
2	Location	
(a)	State (s)	Jammu & Kashmir
(b)	District(s)	Baramula
(c)	Taluka(s) / Tehsil(s)	Uri
(d)	Basin	Jhelum, Sub Basin of Indus Basin
(e)	River	Jhelum
(f)	Longitude	Barrage $74^0$11'00" E Power House 74^0 03'00" E
	Latitude	Barrage $34^0$08'00"N Power House $34^0$05'00"N
(g)	Survey of India Topographical Map reference No.(s)	43 J/4
(h)	Earthquake Zone Number	Seismic Zone-IV
(i)	Complete address for along with pin code/telephone no./Fax//e-mail.	Uri Power Station, Gingle, P.O. - Mohura Distt.-Baramulla (UT of J&K) PIN-193122 Tel/fax : 01956-253211/ 253213 E-mail : **hop-uri-i@nhpc.nic.in**
3	Whether the scheme is included in the National Electricity Plan. If so, whether the capacity and type of scheme are same as given in the NEP.	Not included in NEP.
4	Category of the Project	Power Project
(a)	Power Project	
(b)	Power Project having reservoir for flood moderation.	
(c)	Multipurpose Project	
5	In case of category (4(c)) above weather the clearance of Technical Advisory Committee of Ministry of Water Resources is available.	Not Applicable

Sr. No.	ITEM	REMARKS
6	Mode of formation of the Generating Company in terms of Clause-2(28) of Electricity Act, 2003.	Project to be executed by NHPC Ltd. (A company registered under the Companies Act, 1956). NHPC limited was entrusted with the execution of Uri-I Stage-II Hydroelectric Project as per Memorandum of Understanding (MoU) signed between NHPC Limited & Govt. of J&K on 3rd January 2021. **Enclosed as Annexure-1(a)**
7	Whether the Generating Company is Registered with the Registrar of the Company. Whether Article of Association has Generation as one of the objectives of the Company.	Registered on 07-11-1975. **Enclosed as Annexure-1(b)**
8	What is the mode of allocation of the scheme whether through	A Memorandum of Understanding (MoU) has been signed between NHPC Limited & Govt. of J&K on 3rd January 2021 for execution of Project on Build, Own, Operate and Transfer Basis for a period of 40 (Forty) years. Enclosed as **Annexure-2.**
(i)	MOU route upto 100 MW	
(ii)	Tariff based bidding	
(iii)	MOU route with equity participation of State Govt. If so % age of State Govt. equity.	
(iv)	Any other mode.	
9	Whether authorization of Competent Government in favour of the company to establish, operate and maintain specific Power Station available.	Yes
10	Whether land availability Certificate from State Government available.	Regarding NOC for Land availability, NHPC had submitted a letter to Principal Secretary, Revenue (J&K) on 12.10.2021. The State land identified by the Revenue Deptt., Baramulla for

Sr. No.	ITEM	REMARKS
		carrying out Compensatory Afforestation measuring 17 Ha. in lieu of diversion of the underground forest land to be utilized for Uri-I Stage-II was jointly inspected by both Forest Deptt and user agency NHPC Ltd on 14th & 15th Feb'23. Subsequent to Joint Inspection, Field Range Officer, Uri in its letter Dated: 27.02.23 to DFO, Baramulla has intimated that the inspected land was found to be suitable for Compensatory Afforestation. The status of same has also been shared with the local Sarapanch & they have also expressed their eagerness & positive response for carrying out the planation under Compensatory Afforestation.
11	Whether State Govt. authorized the company to utilize water of that stretch of river.	Yes, NOC for Water availability obtained from Govt. of J&K on 09.02.2023. **The same is enclosed in Chapter-21**
12	Whether power/energy benefits have been estimated on the updated hydrological series.	Yes
13	Whether Cost Estimates enclosed	Yes
(a)	Completed Cost–For private generating companies.	
(b)	Present Day Cost-For SEB's & State power Utilities.	
(c)	Present and Completed Cost–For Generating Companies in Public Sector.	
14	How the Project is going to be financed.	With debt equity ratio 70:30

Sr. No.	ITEM	REMARKS
15	Whether arrangement for absorption / dispatch of power made.	NHPC will approach to CEA and Central Transmission Utility (CTU) for finalization of Power Evacuation System for Uri-I H.E. Project Stage-II and accordingly, Power Evacuation system shall be finalized. NHPC shall apply for the Connectivity in due course time as per CERC's (Connectivity and General Network Access to ISTS) Regulations 2022.
	Whether arrangements for wheeling/evacuation of power made	Agreement to be signed later on.
17	Whether, any agreement with the transmission company to provide evacuation system made. If so details of the agreement.	Agreement to be signed later on
18	Whether Consent of STU/State Govt. for availability of off peak power/energy (for pumped storage scheme) is obtained.	Not Applicable
19	Whether salient features of the Project filled up in the prescribed format.	Yes
20	Status of CWC/other affected states clearance from inter-state angle, if applicable	Clearance on Interstate was obtained from ISM, Directorate CWC. **Enclosed in Chapter-21**
21	Status of Defence clearance, if required	Yes obtained from Ministry of Defence**. Enclosed in Chapter-21**
22	Whether the area is likely to	No, This scheme is parallel to

Sr. No.	ITEM	REMARKS
	have any Environmental and Ecological problems due to the altered surface water pattern. If yes, whether preventive measures have been discussed.	another operational scheme of Uri-I Power Station (480 MW). Both scheme shall utilize water from same Barrage
23	Statusof MOEF Clearance from Environment/Forest angle	**Environmental Clearance:** TOR for EIA/ EMP studies was approved by MoEF & CC on 10.06.2021. The work for conducting EIA / EMP study was awarded on 09.08.2021 and is under progress. Other steps in the process of Environment Clearance will be followed in due course of time as per the prevailing provisions of EIA Notification, 2006 and its subsequent amendments. **Forest Clearance:** Regarding Forest Clearance, proposal for diversion of 17 ha Forest land was uploaded on Parivesh Portal of MoEF & CC on 29.07.2021. District administration vide its letter No. SDM/Uri/23/341-42 dated 11.02.2023 has provided the revenue extracts of the state land proposed for Compensatory Afforestation for forest clearance of Uri-I Stage-II. The identified land was jointly inspected by both

Sr. No.	ITEM	REMARKS
		Forest Deptt and user agency NHPC Ltd on 14th & 15th Feb'23. Subsequent to Joint Inspection, Field Range Officer, Uri in its letter Dated: 27.02.23 to DFO, Baramulla has intimated that the inspected land was found to be suitable for Compensatory Afforestation. The status of same has also been shared with the local Sarapanch & they have also expressed their eagerness & positive response for carrying out the planation under Compensatory Afforestation. **(Enclosed in Chapter-21)**. Further action by State Forest Department is in progress as per the provisions of Forest (Conservation) Act, 1980 and prevailing Rules. Gram Sabha meetings under FRA, 2006 have been conducted for all four Panchayats.
24	Status of clearance from Indian Board of Wild-Life	Not applicable.
25	Status of clearance from Ministry of Social Justice & Enforcement / Tribal Affairs (In case Scheduled Tribe population is affected)	Clearance from Ministry of Social Justice & Empowerment shall be required if any Scheduled tribe Families are getting affected, which could be ascertained after Social Impact Assessment (SIA) study

Sr. No.	ITEM	REMARKS
		and finalization of Resettlement & Rehabilitation(R&R) plan as a part of land acquisition process to be initiated as per provisions of RFCTLARR Act,2013.
26	Whether Rehabilitation and Resettlement Plan from State Revenue Department enclosed.	Rehabilitation and Resettlement Plan shall be framed by the administrator appointed by State Govt. at the time of acquisition of land after conducting Social Impact Assessment (SIA) studies as per RFCTLARR ACT, 2013.

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CHAPTER – I

INTRODUCTION

CHAPTER - I

INTRODUCTION

1.0 GENERAL

Jammu and Kashmir has many lakes, rivers, and glaciers. Significant rivers that flow through Jammu & Kashmir from the Himalayas are Jhelum, Chenab, Sutlej, Ravi and Indus. These river basins are located at a higher elevation facilitating huge hydro power potential. Major lakes include Manasbal Lake, Dal Lake, Wular Lake, Nageen Lake. There are around 1230 water bodies in Jammu & Kashmir.
The Union Territory, Jammu and Kashmir has vast Hydro Power potential. Power Development in Jammu and Kashmir has a long and distinguished history. 9MW Mohra Hydro-electric Plant, among the first of its kind in the subcontinent, was developed as early as 1905. The estimated hydro-power potential of Jammu and Kashmir is 20,000 Megawatts (MW), of which about 16,475 MW have been identified. "This comprises 11,283 MW in Chenab basin, 3,084 MW in Jhelum basin, 500 MW in Ravi Basin and 1608 MW in Indus basin. These projects are techno-economically viable, besides being eco-friendly and socially beneficial.
Uri I Stage II Hydroelectric Project envisages harnessing the potential of River Jhelum in Uri Tehsil of District Baramula, UT of Jammu & Kashmir, India.

The river Jhelum rises from Verinag Spring situated at the foot of the Pir Panjal in the southeastern part of the Kashmir Valley administered by India. It is joined by its tributaries Lidder River near village Mirgund at Khanabal, Veshaw River at Sangam in Anantnag, Sind River at Shadipora and Pohru River at Doabgah in Sopore in Jammu and Kashmir. It flows through Srinagar and Wular Lake before entering Pakistan-administred Kashmir through a deep narrow gorge. The Neelum River, the largest tributary of the Jhelum, joins it at Domel Muzaffarabad, as does the next largest, the Kunhar River of Kaghan Valley. It is then joined by the Poonch River, and flows into the Mangla Dam reservoir in the Mirpur District. The Jhelum enters Pakistani Punjab in the Jhelum District. From there, it flows through the plains of Pakistan's Punjab,

forming the boundary between the Jech and Sindh Sagar Doabs. It ends in a confluence with the Chenab River at Trimmu in the Jhang District. The Chenab merges with the Sutlej to form the Panjnad River, which joins the Indus River at Mithankot.

Most of the villages and important cities in Kashmir valley are situated on the banks of Jhelum.

The Uri Hydroelectric Project was conceived by the Power Development Department (PDD) of the Government of Jammu and Kashmir, who submitted a Detailed Project Report (DPR) to the Central Water and Power Commission in 1974. Following modifications to the project, it was cleared by the Central Electricity Authority (CEA) in March 1980. Responsibility for development of the project was transferred to the National Hydroelectric Power Corporation of India (NHPC) in 1981. NHPC carried out the preliminary design and obtained Forest Department clearance for the project in 1986, and commenced pre-construction work in 1987.

In the early 1980s the Government of India and NHPC began soliciting funds from international agencies with the objective of implementing the project on an Engineering Procurement and Construction (EPC) basis with bilateral support.

The Swedish company, Skanska, promoted the project, seeking support from Swedish Government agencies including Sida. Following an indication of bilateral support in 1988, the Swedish-British URICO consortium led by Skanska participated in a limited tender held by NHPC for finance and construction of the project. NHPC and GoI. formally approached Sida for financing in June 1989.

The consortium was successful in the tender, and following confirmation of the funding support by the bilateral agencies, URICO was awarded the contract on 18th October 1989. The Order to Commence was given by NHPC on 22nd November 1989, and construction of the project started in early 1990. Generation of electricity from the first unit commenced in February 1997.

NHPC Limited, now, has signed a Memorandum of Understanding with the Government of Jammu and Kashmir on January 03, 2021 for execution of URI-I Stage-II HE Project (240 MW) on Build, Own, Operate & Transfer (BOOT) basis for the period of 40 years on the River Jhelum, in Uri Tehsil of Baramulla district in Jammu and Kashmir.

The General layout of the Project, size and dimensions of various components/ structures have been adopted based upon built in structures of URI-I Power Station. The separate underground water conveyance structures and separate Power house complex structures are proposed to be constructed for URI-I Stage-II H.E. Project.

The main components of the project are as follows:

A. **Constructed structures (URI-I Power Station)**

- Uri-I Power station Barrage 95m long and 21.5m high from its deepest foundation level. The full supply water level upstream of the barrage is EL 1491.00 M and barrage top is at EL 1495.50 M.
- Spillway consisting of 6 bays of 8.0m (width) x 7.5m (height) and 3 No. under sluice bays 8m(width) x 8.25m (height)
- A fish way is provided between bay No. 6 and bay No. 7. It is about 150 m long with the inlet at El 1489.0 M and the outlet at El 1475.50 M.
- Head regulator of 34m length, four bays of cut and cover culvert, 44 m to 66m wide desilting basin with two bays of 300m length
- Headrace canal of about 470m length and 12m width and side slopes 1V:1.5 H.
- Intake forebay at the downstream end of the canal of 195m.
- A siphon type surplus escape at a water level of El 1491.30 M
- The Buniyar Nalla intake, culvert and tunnel intake of total length about 250m.

B. **Proposed structures (URI-I Stage-II H.E. Project)**

- 1 No HRT of size 6.5m Horse shoe shape in left bank and parallel in valley side to existing HRT.
- 1 no. 5 m dia Steel lined pressure tunnels/shafts and 2 no. 3.25m dia Steel lined pressure tunnel for auxiliary units.
- Underground power house cavern housing 2 no. main units of 120 MW each.
- Transformer cavern located d/s of power house cavern.
- Draft Tube gate operation cavern further d/s of Transformer cavern
- 1 no. main TRT of size 6.5m Horse shoe shape having tailrace surge galleries

- To facilitate the construction and operation of the project components, suitable adits and Access tunnels have been proposed

Salient features of the project have been given below: -

1.1 SALIENT FEATURES

PROJECT LOCATION			
1	State	:	Jammu & Kashmir
2	District	:	Baramulla
3	River	:	Jhelum
4	Latitude	:	Barrage $34^0$08'00"N Power House $34^0$05'00"N
5	Longitude	:	Barrage $74^0$11'00" E and Power House 74^0 03'00" E
6	Nearest rail head	:	Udhampur
7	Nearest Airport	:	Srinagar
HYDROLOGY			
1	Catchment area up to Barrage site	:	12,750 Km^2
2	Annual rainfall in the catchment area	:	1104 mm (1992-2019)
3	Reservoir Capacity	:	23.71 Ham
4	Minimum average 10-daily in-flow in 90% dependable year.	:	41.3 Cumecs
5	Max. observed discharge at Barrage	:	1675 Cumecs
6	Design Flood :	:	2264 Cumecs
RESERVOIR			
1	Full Reservoir Level (FRL)	:	EL 1491.0 M
2	Maximum Water Level (MWL)	:	EL 1491.0 M
3	MDDL	:	EL 1491.0 M
4	Gross Storage at FRL	:	23.71 Ham
5	Live Storage	:	Nil (ROR Scheme)
6	Reservoir area at FRL	:	6.19 Ham
7	Length of Reservoir at FRL	:	950m
8	Annual Sediment Load	:	3.11 Million tons per year
DIVERSION TUNNEL			
1	No., Diameter & Shape	:	
2	Length	:	Not Applicable.

3	Diversion Discharge	:	
4	Invert Level at Entry	:	
5	Invert Level at Exit	:	
6	Diversion Tunnel Gate (Type of Gate)	:	
7	Size of Opening	:	
8	Design Head (m)	:	
COFFER DAMS			Not Applicable.
1	Type of u/s Coffer Dam / d/s coffer Dam	:	
2	Height of u/s coffer dam	:	
3	Height of d/s coffer dam	:	
ALREADY CONSTRUCTED STRUCTURES			
DAM / BARRAGE			
1	Type	:	Barrage
2	Dam Top Elevation / Barrage	:	EL.1495.50 M
3	FRL Elevation / Pond Level	:	EL 1491.0 M
4	Dam/Barrage height (above river bed level/deepest foundation level)	:	14.5m / 21.5 m
5	Length of dam at top	:	95.0 m
6	Type of Foundation cut-off	:	Concrete cut off at u/s floor of barrage, Barrage foundation and in stilling basin.
SPILLWAY			
1	Design Flood/ Check Flood	:	2264 cumecs
2	Type	:	Gated, Crest Spillway
3	Crest Elevation	:	
a	Lower Level	:	EL.1483.00 M
b	Upper Level	:	EL.1483.75 M
4	Number & Size of Spillway Opening	:	
	Lower Level		
a	Number	:	3 nos
b	Size (W x H)	:	8m(W) x 8.25m(H)
	Upper Level		
a	Number	:	6 nos

b	Size (W x H)	:	8m(W) x 7.5m(H)
5	Energy Dissipation Type	:	Stilling Basins
6	Total Length of Spillway Blocks	:	112.5m including stilling basin.
Construction Sluices / River Sluices/Under sluices/ Silt excluder			
1	Numbers	:	6 Nos
2	Size	:	4 Nos 1m x1.6m & 2Nos 0.8m X 1.6m
3	Invert Level/Cistern Level	:	Basin 1 to 6 Bottom EL.1471.0 m Basin 7 to 9 Bottom EL.1470.0 m
4	Stilling Basins	:	63m length (total floor length up to end of sill 78m)
5	Type of Gate	:	Radial
Head Regulator			
1	Nos of bays	:	2
2	Width	:	16m each
3	Design discharge	:	521 cumecs
Cut and cover section			
1	Length of culverts	:	188/207 m
2	No. of barrels	:	4 nos
3	Design Discharge	:	521 cumecs
4	Type of Gate	:	Radial
5	Design Head (m)	:	5.6m
DESILTING CHAMBERS / BASINS			
1	Number	:	2
2	Size	:	Length of desilting basin 300 m Width of basins varies from 44 to 66m Side slope 1V: 1.5H
3	Inlet Discharge	:	521 Cumecs
4	Normal flushing discharge	:	68 Cumecs
Surplus Escape			
1	Syphon	:	6 nos 8m(W)
2	Crest level	:	EL 1491.0 M
3	Capacity	:	500 cumecs at EL.1491.3 M
Head race canal			
1	Length of canal, including forebay	:	665m
2	Width of invert	:	12.0m
3	Side slope	:	1V:1.5H
4	Elevation of invert	:	EL.1483.0 M
5	Design Discharge	:	453 Cumecs

POWER INTAKE			
BUNIYAR NALA INTAKE STRUCTURE			
1	Size of intake gate	:	7.0 (W)x 9.0m(H)
2	Sill Level	:	EL 1469.5m
3	Trash Rack	:	
a	Dimension (W x H)	:	33.4m(W) x 15.8m(H)
b	Number	:	1
4	Length of Culvert	:	177m
5	Shape of Culvert	:	Octagonal
6	Cross Sectional area	:	104 sqm.
7	Design Discharge	:	453 Cumecs
8	Type of Gate	:	Vertical lift fixed wheel type
9	Design Head (m)	:	21.5 m
HRT INTAKE STRUCTURE			
1	Number	:	02 (One no for URI-I PS & other for URI-I Stage-II)
2	Size of intake gate	:	7.0 (W)x 9.0m(H)
3	Invert Level	:	EL 1462.5 M
4	Design Discharge	:	453 Cumecs
5	Design Discharge (per intake)	:	226.5 cumecs
6	Invert Level	:	EL 1462.5 M
7	C/L of Intake	:	1465.75m
8	Type of Gate	:	Vertical lift fixed wheel type
9	Design Head (m)	:	28.5 m
PROPOSED STRUCTURES			
HEAD RACE TUNNEL			
1	Number & Type	:	1 No., Horse shoe
2	Size (Dia.)	:	6.5m
3	Length	:	10472m
4	Design Discharge	:	117.15 cumecs
5	Velocity	:	3.34 m/s
6	Bed Slope	:	0.2817% (1 in 355)
HRT ADITS			
1	Nos	:	4
2	Size	:	6.5 m D-shape
3	Length		
a	Adit 1A length	:	330m
b	Adit 2A length	:	550m
c	Adit 3A length	:	450m

d	Adit4A length	:	150m
SURGE ARRANGEMENT IN U/S OF PH			
1	Type & Numbers	:	1 no. Surge shaft , Underground
2	Size	:	17m
3	Height	:	93.5m(From operating floor level)
4	Top Level	:	EL. 1532.5M
5	Bottom level	:	EL. 1439 M
6	HRT invert below surge shaft	:	EL 1433 M
7	Maximum Up-surge Level	:	EL. 1531.0 M
8	Minimum down-surge Level	:	EL.1444.0 M
9	Adit to Surge shaft top (Adit-4B)		
a	Size	:	7.0 m D-shape
b	Length	:	175m
10	Surge Gallery Details	:	nil
a	Type of Gate	:	Vertical lift fixed wheel type of Size 6mx6m (WXH),01 Number
b	Design Head (m)	:	58 m
BUTTERFLY VALVE CHAMBER			Not Applicable
1	Type	:	
2	Chamber Size	:	
3	Valve number, Size	:	
PRESSURE SHAFT/PENSTOCK			
PRESSURE SHAFT			
1	Number & Type	:	1 No. ,circular steel lined
2	Diameter	:	5m
3	Length	:	Length (top Horizontal) 230m, Vertical shaft 220m
4	Design Discharge (excluding vertical)	:	117.15 cumecs
5	Velocity (Penstock)	:	5.97 m/s
PENSTOCK			
1	Numbers & Type	:	2 nos., Underground circular steel lined
2	Diameter	:	3.25m dia
3	Length	:	PS-1=30m, PS-2=40m
4	Design Discharge (each Penstock)	:	58.58cumec
5	Velocity (Penstock)	:	7.06 m/s

ADIT TO PRESSURE SHAFT TOP			
1	Size & Length	:	7.0 m D-shape, 170m
Adit to Pressure shaft Bottom			
1	Size & Length	:	7.0 m D-shape, 332m
POWERHOUSE			
1	Type, Size	:	Underground 91m(L) x 20m(W) x 42.8m(H)
2	Number of Units	:	2 Nos
3	Type of Turbine	:	Francis
4	Unit Installed Capacity	:	240MW (2x120MW)
5	Unit Discharge	:	58.57 cumecs
6	Net Head/ Rated Head	:	227m
7	Head loss (all units/ one unit)	:	23m
8	Normal TWL	:	EL 1241.00 M
9	Minimum TWL	:	EL 1241.00 M
10	Maximum TWL	:	EL 1241.00 M
TRANSFORMER CAVERN			
1	Type & Size	:	Underground 109m (L) x 16.6m (W) x 26.5m(D)
2	Number	:	1
3	Transformer details	:	52 MVA, 13.8/400/√3 kV, Single Phase, 50 Hz
DRAFT TUBE GATE HALL			
1	SIZE	:	50m(L) x 7.5m (W) x 19m (D)
2	Type of Gate	:	Vertical lift fixed wheel type Size 6mx 6m (WXH), 02 Numbers.
3	Design Head (m)	:	40 m with increased stresses
SURGE ARRANGEMENT D/S PH			
1	Number & Type	:	2 nos., Surge tunnels
2	Size (L x W x H)	:	7m dia. Horse shoe shape each
3	Surge Gallery Details	:	1no. 7m dia. Horse shoe inclined gallery with invert at EL 1224.0m to EL 1264.0m in slope 1in 11 &1no. 7m dia. Horse shoe horizontal gallery of length 260m with invert at El.1233m
4	Max. Upsurge level at gate shaft	:	EL.1264.0 M
5	Max. Upsurge level at Surge gallery	:	EL.1264.0 M

6	Min. down-surge level at gate shaft	:	EL. 1233.5 M
TAILRACE TUNNEL			
1	Number & Type	:	1no. , underground
2	Diameter & Shape	:	6.5m Horse shoe
3	Design Discharge	:	117.15cumec
4	Length	:	2280m
5	Adit to TRT	:	6.5 m D-Shape, 340m
6	No. of Gates and their size	:	1No. , 6.0 (W) x 6.0 m (H)
7	Type of Gate	:	Vertical lift fixed wheel type
8	Sill Level	:	EL.1232 M
9	Design Head (m)		9m
TAIL RACE OUTLET STRUCTURE			
1	Nos	:	1 no.
2	Invert Level	:	EL 1235.00 M
2	Normal TWL	:	EL 1241.00 M

Project Cost			
1	Total Project cost at Dec' 2022 PL	:	**Rs. 2189.61 Cr**
2	1st year Tariff (Completion Level)	:	Rs. 3.46 per KWH (Combined Tariff)
3	Levellised Tariff (Completion Level)	:	Rs. 3.96 per KWH (Combined Tariff)
4	1st year Tariff (As per CERC)	:	Rs. 6.15 per KWH (Standalone Tariff)
5	Levellised Tariff (As per CERC)	:	Rs. 5.99 per KWH (Standalone Tariff)

1.2 PROJECT LOCATION & ACCESS

Uri-I Stage II Hydroelectric Project envisages harnessing the potential of River Jhelum in Uri Tehsil of District Baramula, UT of Jammu & Kashmir, India. The Project is located about 30 km from District Baramula, UT of Jammu & Kashmir. Project is located in Jhelum Valley. It is 347 Km away from Jammu and 85 Km away from Srinagar. It is situated on NH – 1.

The Baramula district is spread from Srinagar district and Ganderbal district in the east to the line of control in the west, and from Kupwara district in the north

and Bandipore district in the northwest to Poonch district in the south and Badgam district in the southwest.

Project site is stretched from Barrage complex at Boniyar to TRT Outlet near Village Bandi in Uri Tehsil in District Baramula. Boniyar is about 30 Km from Baramula. The stretch between Boniyar to Baramula is around 19 Km on National Highway NH – 1. The NH – 1 Highway is only all season route which connects Project to Srinagar in Kashmir Valley via Baramula.

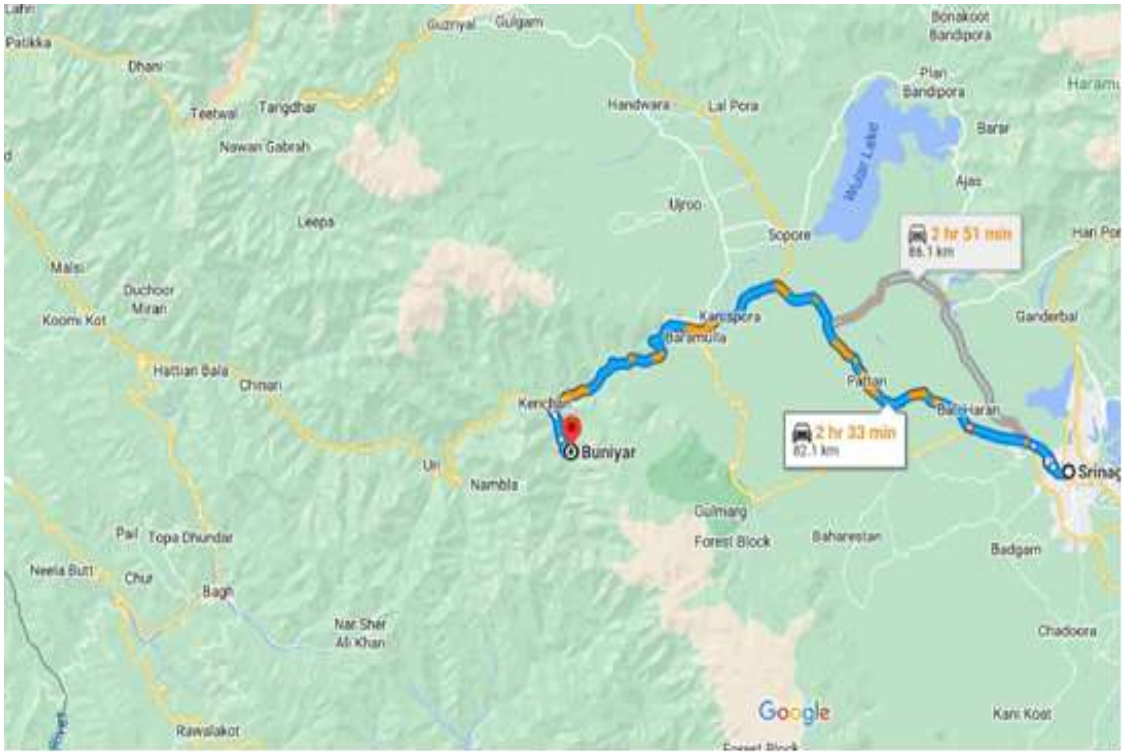


Figure 1.1: Project Location Map

1.3 ACCESS TO PROJECT AREA

Airport at Srinagar is an International Airport nearest to Project. Udhampur is nearest Railway station connected to rest of India. The Jammu–Baramulla line is a railway track being laid to connect the Kashmir Valley in the Indian union territory of Jammu and Kashmir with Jammu railway station and thence to the rest of the country. The 356 km railway track will start from Jammu and end at

Baramulla. The 359 m (1,178 ft) tall Chenab Bridge lies on this line, which once completed will be the tallest railway bridge in the world.

1.4 CLIMATIC CONDITIONS

The Kashmir valley is situated at the northern extreme of the tropical circulation. The air stream is shallow and ascent of air with accompanying rainfall often controlled by overlying subsiding continental air masses. Rainfall is normally connected with disturbances in the monsoon. Rainfall is normally connected with disturbances in the monsoon. The climatic seasons are divided into four seasons. i.e. Winter (December-March), summer or Pre-monsoon (April-June), South West Monsoon (July-September) & autumn or Post-monsoon (October-November). As per IMD data (Data base: 1951-2000) the normal annual rainfall of Jhelum basin within Indian catchment is 890.1 mm. Average annual rainfall observed at Barrage site is around 1104 mm. At the Barrage site, the winter temperature is reported to drop a few degrees below zero on occasion and some ice formation can occur, while conditions at lower elevation in the river valley can be expected to be less strenuous. The river has maximum dominant discharge in April, May & June when the snow melts. Maximum and minimum temperatures are 40^{o}C and -6.4^{o}C respectively at barrage site. Maximum and minimum relative humidity has been observed as 100% and 2.6% respectively at Barrage site.

1.5 GENERAL DESCRIPTION OF TOPOGRAPHY, PHYSIOGRAPHY AND GEOLOGY OF THE PROJECT AREA

1.5.1 TOPOGRAPHY & PHYSIOGRAPHY

The state of Jammu & Kashmir covers the extreme Western sector of Himalayas in the northern most state of India. It lies between latitude 32-30N and 37-05N and longitude 72-40E and 80-30E. The valley is approximately 150km long and 50km wide, with an average elevation of 1700m and surrounded by high hills like "Pir Panjal" on the southern side and “Hindukush" on Northern side. Jhelum River originates from Verinag Spring near Banihal hills & it drains the main Kashmir valley, which forms an elongated depression between the great Himalayas in the north east and Pirpanjal range in the south west. The lowest part of the Kashmir depression makes the shallow Wular Lake, which has a highly variable surface area of average 80 sq.km. The Jhelum river flows gently over the valley plain from southeast to northwest for some 100 km and is joined by several mountain streams both from the Himalayas and the Pirpanjal range and reaching the Wullar Lake at an elevation of about 1580m and leaves the valley near Baramulla town. This river is very sluggish before it re-enters the hilly region with a steep gradient. From the Wullar Lake the river changes to a west south westerly direction still with a very gentle slope, until it breaks through the Pirpanjal range forming a steep and narrow gorge.

The Uri barrage site is situated about 50 km downstream of the lake. The elevation of the river at the dam site is about 1480m. The total catchment area is 12750 sq.km. The highest places within the catchment area reach altitudes of more than 5500m. and the median elevation is about 2400m. The gradient of the river in the main valley is less than 0.20% for a total river course of more than 140 km.

1.5.2 GEOLOGY

1.5.2.1 Regional Geology

Geologically, the project area falls on the eastern part of the Kashmir syntaxial bend of the northwest Himalaya where the arcuate ridges are aligned nearly along NE-SW. The project area lies in the Survey of India Toposheet No. 43 J/4 and is bounded between latitude 34º06' to 34º09' and longitude 74º03' to 74º12'.

1.5.2.2 Seismicity

The project area falls in seismic zone IV as per seismic zoning map of India BIS-1893 part I, 2016. The seismic design parameters for the Uri H E project stage-I were evaluated by DEQ-IIT Roorkee and the project was constructed as per the recommended seismic design parameters for the various structures and the barrage could withstand the effects of devastating Muzaffarabad earthquake of 2005 without any damage. Since, same diversion structures such as barrage and intake are used for stage-II project and all proposed structures are within the same regime of existing stage-I structure, FE&SA directorate vide letter no. CWC I,D.No.11/45/TE/2021/FE&SA/214-216 dated 06/08/21 and ID No. 11/45/TE/2021/FE&SA/260-262 dated 14/09/21 has stated that "It may not be prudent to get the site specific parameter re-established for construction of additional power house only. The directorate further conveyed it's no objection for use of seismic design parameters recommended by DEQ-IITR and used for design of head works of Uri-I, Stage I in further planning and design of project components of Stage II of Uri-I project also". The detail discussion on seismicity aspects is provided in Chapter VI and NOC accorded by FE & SA directorate is appended in Annexure Volume of Geological & Geotechnical aspects of Uri-I Stage-II H E Project DPR.

Further, FE&SA directorate vide their letter no. CWC. I.D. No. 11/45/TE/2021/FE&SA/288-290 dated 15.07.2022 approved the Foundation Engineering & Seismic Aspects of Uri-I (Stage-II) HE project & the clearance is appended in Appendix – XI of Volume – VIA of DPR.

1.5.2.3 Project Geology

The project area comprises variety of rock formation ranging in age from pre-Cambrian to recent alluvium. The layout of Uri-I stage-II project is confined within folded and thrusted sequence of Tanawal schists, Panjal Volcanics, Lime stones and Nummulitic shales. The stratigraphic succession around project area (After D.N. Wadia) and progress report no. 1 of the preliminary geological investigations for Uri Hydel Project, Baramulla Dist. J &K, Field Season 1973-74, which is given as under.

Table: 3.1 Stratigraphic Succession of Kashmir Valley.

Formation	Litho-units	Age
Jhelum fill	Silt, sand, riverine / Fluvio glacial deposits	Quarternary
Murree Group	Interbedded sandstone, siltstone and shales	Oligo-Miocene
----------Murree Thrust ----------		
Nummulitic Group	Shale, Limestone	Eocene
----------Panjal Thrust ----------		
Wuyah/khrew Khunamuh Group	Limestone outlier	Triassic
----------Sheared/Faulted contact (CT) ----------		
Panjal volcanics	Vesicular & compact basalt	Permian
----------Sheared/Faulted contact (CT) ----------		
Tanawal Group	Quartzitic Schist, Quartzite, Phyllite	Proterozoic

1.5.2.4 Dam complex

The barrage complex is situated immediately downstream of the confluence between the River Jhelum and the Limber or Warrikah Nalla. The Full reservoir level/ full supply water level upstream of the barrage is EL 1491.00 M. It is 95m

long and 21.5m high from the deepest foundation level. The Top level of the Barrage is fixed as EL 1495.5m to provide free board and to accommodate additional space for removal of logs and floating debris over the radial gate top.

The barrage consists of three major parts, viz. A spillway with six bays with a sill level at EL 1483.75m has total width 48m and a lower spillway/ under sluice with three bays with a sill level at EL 1483.00m of total width 24m and a head regulator with two bays with a sill level at EL 1485.40m each of width 16m. A fish way is placed between the two spillway parts.

1.5.2.5 Water conductor arrangement

The existing surface water conductor system of URI-I power station are Head regulator of 34m length, four bays of cut and cover culvert, 44 m to 66m wide desilting basin with two bays of 300m length ,Headrace canal of about 470m length and 12m width with side slopes 1V:1.5 H. The Buniyar Nalla intake, culvert and tunnel intake of total length about 250m is already constructed.

All the components of surface water conductor system of URI-I Power station is designed and constructed for 453 cumecs. Design discharge of URI-I Power station is 226.5 cumecs as per approved DPR and design discharge for URI-I stage-II H.E. Project is proposed as 117.15 cumecs.

As per current power potential study, design discharge of URI-I Power Station is considered as 239.03 cumecs. The combined discharge for Uri PS and Uri-I stage-II works out to be 356.18 cumecs. Hence design discharge of 453 cumecs for the existing surface water conveyance system of URI-I power station is more than adequate.

1.6 HISTORICAL BACKGROUND OF THE PROJECT

1.6.1 PRE-FEASIBILITY STUDY:

Uri-I (Stage-II) H. E. project is the second stage of already commissioned 480 MW of Uri-I Power Station. Uri-I HE project was commissioned in the year 1997.

This project is planned as per provision kept in the DPR of URI-I Power Station. The provision for second stage has been kept in the design of surface water conveyance system from head regulator and up to the Intake of HRT keeping the diversion structure of URI-I Power Station i.e. Barrage is same for URI-I (Stage –II) H.E. Project.

The investigation of Uri-I H.E Project was started in 1972 by Power Development Department of J&K State. The Project was handed-over to NHPC for execution in 1981. NHPC also carried out some pre-construction stage investigations during and after 1987. Thereafter the construction of entire project was awarded for execution on turnkey basis including financing to a Swedish British Consortium. The Consortium contractors did balance pre-construction investigation also & the project was commissioned in 1997 & since operating successfully.

After signing of Memorandum of Understanding (MOU) between NHPC & Government of Jammu and Kashmir for execution of URI-I Stage-II HE Project (240 MW) on Build, Own, Operate & Transfer (BOOT) basis for the period of 40 years on 3rd January 2021, NHPC in consultation with CEA submitted all six(6) no of Preliminary chapters on Hydrology, General layout, Power Potential, Foundation Engineering & Seismic, Geology & Construction material aspects to CEACWC/GSI/CSMRS etc. in January 2021.

So no Pre-Feasibility study was carried out by NHPC for Uri-I (Stage-II) H. E. Project.

1.6.2 DETAILED PROJECT REPORT:

Following submission of all Six (6) no of Preliminary chapters on Hydrology, General layout, Power Potential, Foundation Engineering & Seismic Aspects, Geology & Construction Material Aspects to CEACWC/GSI/CSMRS etc. in January 2022, 1st Consultation meeting was held with CEA/CWC/GSI/CSMRS on

15th Feb'21 & go ahead Permission was conveyed to NHPC for preparation of DPR. The Minutes of Meeting (MoM) of 1st Consultation meeting was issued by CEA on 22nd Feb'21.

Accordingly, the survey & investigation works of the project i.e Topographical Survey, Exploratory Core Drilling works, Construction material survey etc. were carried out as per the site exploration plans. After completion of site survey & investigation works & obtaining of Preliminary clearances, Pre-DPR chapters on Hydrology, General layout, Geology, Construction material, Inter-state, International aspects, Storage-ROR conversion etc. were prepared & submitted to concerned divisions of CEA/CWC/GSI/CSMRS etc. in the month of October & November 2021. Pre-DPR clearances on Hydrology, General Layout, Geology, Construction Material, Inter-state, Storage-ROR conversion etc. were obtained from concerned directorates / divisions of CEA/CWC/GSI/CSMRS upto Feb 2022.

Regarding Clearance on International aspect on Indus treaty angle, DC Indus, Ministry of Jal Shakti (MoJS) informed that the clearance related to Indus Water Treaty 1960 will be issued only after finalization of all salient features & concerned agency should apply the same under Appendix-II to Appendix-D of the treaty vide E-mail dated: 03.12.2021. The copy of E-mail is enclosed at Chapter-21.

1.6.3 Present Proposal

Further regarding Environmental Clearance, TOR for EIA/ EMP studies was approved by MoEF & CC on 10.06.2021. The work for conducting EIA / EMP study was awarded on 09.08.2021 and so far the data for three season reports have been collected by the Consultant. The draft EIA & EMP report has also been submitted by the Consultant & is under finalization. Other steps in the process of Environment Clearance will be followed in due course of time as per the prevailing provisions of EIA Notification, 2006 and its subsequent amendments.

Regarding Forest Clearance, proposal for diversion of 17 ha Forest land was uploaded on Parivesh Portal of MoEF & CC on 29.07.2021, further action by State Forest Department is in progress as per the provisions of Forest (Conservation) Act, 1980 and prevailing Rules.

The details of NOC & Clearances and their present status have been mentioned in Chapter No:21.

1.7 NEED OF THE PROJECT

India has been facing electricity shortages in spite of appreciable growth in electricity generation. The demand for electrical energy has been growing at a much faster rate and is expected to increase further to match with the projected growth of Indian economy. The per capita electricity consumption which was 18.17 kWh during 1950 has increased to approx. 1208 kWh during the year 2019-20 in India according to the data released by Ministry of Power.

The Northern Region includes the states of Punjab, Haryana, Himachal Pradesh, Delhi, UP, Uttarakhand, Rajasthan, UT of Chandigarh, UT of J&K and UT of Laddakh. The Northern grid consists of power system controlled by various Electricity Boards/ GENCOS/ TRANSCOS/ DISCOMS located in the above states.

The Northern Region has been experiencing acute power shortage especially the peaking power, during the last decade, due to rapid industrialization, developing irrigation network & urbanization. Electrical energy being the basic ingredient for economic upliftment through industrial and agricultural development, power shortage had slowed down the wheels of progress and put a curb on all development activities in the region. Thermal and nuclear generation of power, being base power, is not the right solution for meeting peaking power deficit in this region. Further, there are limitations imposed by inadequate availability of coal and nuclear fuel, long distances over which fuel has to be transported through an overloaded railway system and higher cost of power generation.

Moreover, our country is committed to focus on decarbonisation and promote zero carbon emission, hence adding non fossil sources of power generation to reduce the adverse impact of fossil fuels on environment. Therefore, endeavour should be adoption of cleaner fuels, increasing share of RE, phasing out of old & inefficient polluting power plants etc.

One side, the demand is increasing due to rapid industrialization, urbanization, electric transportation, modernization of agriculture etc. and on the other side generation from thermal power stations will go on decreasing due to retirement of old/ inefficient plants. Though, renewable energy sources like solar and wind are added rapidly to meet the energy demand, but the peak demand (morning and evening peak demand) cannot be met with the addition of solar based power plants without storage. Hence, advance planning and implementation of new hydro projects is extremely beneficial to meet the peak demand as well as grid balancing requirement expected to arise due to addition of other renewable energy sources in the grid.

The proposed Uri-I Stage-II HE Project is a run of the river project and would form an integral part of the Northern Grid to contribute in projected energy requirement. This project is proposed to be commissioned by the end of 2027-28 and envisages utilization of surplus water of Jhelum River after full utilization by Uri-I Stage-I Power Station & additional water from of Kishanganga HE Project will be released through turbine outlets into Wular lake and subsequently to the Jhelum river. Besides, to an extent, it will also contribute peak capacity to the grid, grid balancing power in the aftermath of rapid augmentation of seasonal and intermittent renewable energy like solar and wind.

1.8 ALTERNATIVE STUDY

Diversion structure of URI-I Power station i.e. Barrage, Head regulator, desilting basin, power channel, Surplus escape , Buniyar Intake structure, Buniyar nala culvert structure and Power intake structures which is already constructed and

are utilized for URI-I Stage –II H.E. Project , hence no Alternative study for diversion structure is required for URI-I Stage-II H.E. Project .

Intake Structure

Power intakes structure for URI-I Stage-II are already constructed hence alternative studies are not required.

Dam

Barrage of URI-I PS is already constructed which is also utilized for diversion structure of URI-I Stage-II and hence alternative studies are not required

River Diversion Arrangements

Barrage of URI-I PS is already constructed which is also utilized for diversion structure of URI-I Stage-II hence alternative studies for river diversion arrangement is not required.

Head race Tunnel

All the surface water conveyance system for URI-I Stage–II Project from Head regulator to the Intake of HRT has been already constructed. A separate HRT parallel to existing HRT of URI-I Power Station has been proposed to be constructed. URI-I Power Station HRT shall be in continuous operation. Hence proposed HRT for URI-I Stage –II H.E is located in valley side with sufficient lateral cover from existing HRT as well as adequate vertical and lateral rock cover in valley side. Experience gained from the construction of existing HRT shall be valuable during construction of proposed HRT.

In view of the above, no other Alternative alignment study is envisaged for HRT.

Size of HRT is proposed to be 6.5m finished Horseshoe considering the alternative studies for different sizes of HRT and study of economical dia of HRT.

Surge Shaft

Underground surge shaft is propsed similar in line with the existing underground surge shaft of URI-I Power Station. Construction Adit/ Access tunnels at surge shaft top and bottom can be constructed as on extension to the existing construction adits of URI-I Power station and these Adits are of short length (about100-150m) . In addition, the proposed Surge shaft is in the same geological setup as existing underground surge shaft which is functioning well since commissioning

Alternatively surface (open to sky) Surge shaft is considered by shifting the surge shaft d/s where ground level is approximately same as top of surge shaft. However road to surge shaft is not available for construction of Surge shaft. Road shall be required to be constructed from the the ground level of EL 300 to EL 1550 approx which require about 2-3 km road length . In addition to that the area below surge shaft is habitated and construction of road involves greater difficulty considering the blasting of rock mass near vicinity besides other socioeconomic issues.

In view of the above underground surge shaft is proposed for URI-I Stage-II H.E.Project .

Power House and Transformer Cavern

Underground Power house caverns are proposed similar in line with the existing underground power house of URI-I Power station as the existing topography is suitable for underground structures. Seperate Power house caverns are proposed near by the existing power house cavern keeping the optimum rock cover considering the constructibility of the new structure

along with the continuous operation of the existing structures. Access tunnels / Adits constructed for URI-I are also available and short extension to these Adits / Access tunnels can be constructed which shall also optimize the cost of the project.

In view of the above underground powerhouse and transformer cavern is proposed for URI-I Stage-II H.E.Project

Tail Race Tunnel

Considering the Project layout plan with underground power house as mentioned above and for optimum utilization of head for power generation, TRT is proposed in parallel to existing TRT with TRT outlet portal just u/s of existing TRT outlet of URI-I PS.

1.9 NATURAL RESOURCES

The site has ample water resources and construction materials in the local vicinity of the construction site.

1.10 SOCIO-ECONOMIC ASPECTS

The aim of the socio-economic study is to assess the overall impact on various facets of socio-economic environment due to establishment of the project in the Study Area Villages. The Private land required for the project (85 Ha) is already in possession of NHPC. Hence no private land acquisition is required for construction of this project. Therefore, construction of this project does not involve any displacement of local population. However, social and local area development plan will be suggested as part of the EMP. The work for conducting EIA/EMP study was awarded to M/s R S Envirolink Technologies on 09.08.2021 & so far the data for three season reports have been collected by the consultant. The draft EIA & EMP report has already been submitted by the Consultant & is under finalization. Gram Sabha meetings under FRA, 2006 have been conducted for all four Panchayats.

1.11 LAND REQUIREMENT

Total land required for various project components, quarry sites, submergence area is about 102 ha; out of which 17 ha is forest land, 85 ha is private land, which has been already been mutated in the name of NHPC and therefore is in possession with Uri-I Power Station.

1.12 POPULATION AFFECTED

No Population of any kind will be affected by the construction of this project.

1.13 ENVIRONMENTAL ASPECTS

Based on the findings of the Environmental Impact Assessment studies, following broad Environmental Management Plans shall be implemented to mitigate adverse impacts and maximize positive impacts of the project:

- Biodiversity Conservation & Management Plan
- Catchment Area Treatment Plan
- Fish Management Plan
- Green Belt Development Plan
- Muck Disposal Plan
- Restoration Plan for Quarry/ Borrow Areas
- Landscaping & Restoration of Construction Areas
- Health Delivery System
- Waste Management Plan & Sanitation Facilities
- Energy Conservation Measures
- Community and Social Development Plan
- Maintenance of Water, Air and Noise Quality
- Disaster Management Plan
- Environmental Monitoring Programme
- Compensatory Afforestation Scheme

Some of the above plans may be modified or some more may be added depending upon final decision of MoEF & CC while according Environment Clearance to the Project.

1.14 INTERSTATE, INTERNATIONAL OR DEFENCE ASPECT

Uri-I Stage-II Hydroelectric Project, a run- of the river scheme, is situated on river Jhelum in Uri Tehsil of Baramulla district UT of Jammu and Kashmir. Jhelum

river has its source from a spring called Verinag in Anantnag district. The river is entirely flows in Jammu & Kashmir state up to Uri-I Barrage.

Clearance on Inter-state aspect has been accorded by ISM-2 directorate of CWC vide letter no: 2/8/ISM-2/2017/510 Dated: 23.12.2021. The copy of same is enclosed at Chapter-21.

Regarding Clearance on International aspect on Indus Treaty Angle (IWT), DC Indus, Ministry of Jal Shakti (MoJS) informed that the clearance related to Indus Water Treaty 1960 will be issued only after finalization of all Salient features & concerned agency should apply the same under Appendix-II to Appendix-D of the treaty vide E-mail dated: 03.12.2021. **The copy of E-mail is enclosed at Chapter-21.**

1.15 DEFENCE ANGLE

Defence Clearance for construction of project has been obtained from Ministry of Defence vide F.NO 22 (23)/2021/D (Coord) on 25.02.2022. **Copy of NOC is enclosed at Chapter-21.**

1.16 COST & BENEFITS OF THE PROJECT

An estimate of cost of the entire Project comprising both Civil and Electrical Works on the basis of the prices as prevalent in December 2022 has been worked out as under:

Sl. No.	Details	Present Day Cost (Dec' 22 PL)	Completion Cost (Zero Date Dec' 23)
a)	Hard cost (Civil & HM)	Rs. 1410.53 Cr	Rs. 1643.81 Cr
b)	Hard cost (Miscellaneous)	Rs. 58.67 Cr	Rs. 70.71 Cr
c)	Hard cost (E& M works)	Rs. 500.65 Cr	Rs. 562.82 Cr
A	Total Hard Cost (a+ b+ c)	Rs 1969.85 Cr	Rs. 2277.34 Cr
B	IDC & FC @ 8% p. a.	Rs. 219.76 Cr	Rs. 249.45 Cr
C	Total Project Cost	Rs. 2189.61 Cr	Rs. 2526.79 Cr
D	Grant against Enabling Infra	Rs. 22.00 Cr	Rs. 26.20 Cr

As no separate dam/barrage is proposed for Uri-1 stage –II HE project, barrage of Uri Power station shall be used as common barrage for both the plants. As such, on considering the revised installed capacity of the plant as 720 MW (480 MW for Uri PS and 240 MW for its second stage i.e. Uri-1 Stage-II HE Project), revised Annual Plant Load Factor (PLF) has been found as 54.65 %. Annual Plant Load Factor (PLF) for lean period has been found as 19.60%. Since, 54.65%. PLF value is satisfactory for a ROR project, the combined installed capacity of both the project as 720 MW (480 MW for Uri PS and 240 MW for second stage of Uri-I HE project) is found suitable. Accordingly, 240 MW has been considered as installed capacity of Uri-I stage-II HE Project. At 240 MW, the Annual Load Factor of Uri-I Stage-II has been found as 45.33%.

Based on the water series of 90% dependable year for Uri-I Power Station in year 2007-08 and for Kishanganga Power Station in year 2001-02 respectively, the annual energy with 95% machine availability for 720MW capacity of Uri-I has been calculated as 3376.20 MU. After considering mandatory E-flow release, the revised Design Energy of Uri PS for 480 MW is 2443.60 MU at rated head of

222.5m and overall efficiency 92%. Hence the balance energy may be considered on account of Uri-I stage II which works out as 932.60 MU with respect to rated head of 227m and overall efficiency 92.59%.

The Combined 1st year and Levellised Tariff for Uri-I, Stage-II HEP at completion level are Rs. 3.46 & Rs. 3.96 respectively. As per CERC Guidelines, the Standalone 1st year and Levellised Tariff are Rs. 6.15 and Rs. 5.99 respectively. The above tariffs are inclusive of water charges.

1.17 CONSTRUTION PROGRAMME

It is proposed to complete the project and commission the two units of 120 MW within a period of 44 months i.e. 3 years 8 months excluding preconstruction period. Preconstruction period of 24months is estimated for the construction of infrastructure works mainly strengthening of roads & bridge to start the main construction works.

1.18 PRESENT REPORT

The present report is part of Detailed Project Report, which consists of following:

CHAPTER 1 INTRODUCTION
CHAPTER 2 JUSTIFICATION OF PROJECT FROM POWER SUPPLY ANGLE
CHAPTER 3 BASIN DEVELOPMENT
CHAPTER 4 INTER-STATE / INTER-NATIONAL ASPECTS
CHAPTER 5 SURVEY & INVESTIGATIONS
CHAPTER 6 HYDROLOGY
CHAPTER 7 RESERVOIR
CHAPTER 8 POWER POTENTIAL STUDIES & INSTALLED CAPACITY
CHAPTER 9 DESIGN OF CIVIL STRUCTURES
CHAPTER 10 ELECTRICAL & MECHANICAL DESIGNS
CHAPTER11 TRANSMISSION OF POWER & COMMUNICATION FACILITIES
CHAPTER 12 CONSTRUCTION PROGRAMME & PLANT PLANNING
CHAPTER 13 PROJECT ORGANISATION
CHAPTER 14 INFRASTUCTURAL FACILITIES
CHAPTER 15 ENVIRONMENTAL & ECOLOGICAL ASPECTS
CHAPTER 16 COST ESTIMATES
CHAPTER 17 ALLOCATION OF COST
CHAPTER 18 ECONOMIC EVALUATION
CHAPTER 19 FUTURE UTILISATION OF BUILDING
CHAPTER 20 RECOMMENDATIONS
CHAPTER 21 CLEARANCES/INPUTS

CHAPTER – II

JUSTIFICATION OF PROJECT FROM POWER SUPPLY ANGLE

CHAPTER-II

JUSTIFICATION OF PROJECT FROM POWER SUPPLY ANGLE

2.1 POWER- SUPPLY DEMAND

2.1.1 On All India Basis

The Power System in India has grown from small, isolated stations, serving limited consumers in and around large cities, into large Regional Power Grids and further interlinked to one National Grid. As per monthly report of CEA for All India Installed Capacity (In MW) of Power stations, total installed capacity in the country has already grown to 395607.86 MW (As on 28.02.2022).

For the purpose of efficient power system planning and operation, the power system of the country has been divided into the five geopolitical regions: Northern, Western, Southern, Eastern and North-Eastern regional grids and the regional grids have been inter-connected to make the national grid.

The objective of the system development is to evolve self-sufficient regional grid catering to the individual regional power demands. It is also aimed at achieving the maximum benefits from integrated operation, through a proper mix of thermal, hydro and other renewable energy sources. The actual power position in the five Regional Grids for the year 2020-21, as per “Load Generation Balance Reports (LGBR) “2020-2021” published by CEA has been shown in table 2.1 (Annexure - I).

2.1.2 On Regional Basis

The Northern Region includes the states of Punjab, Haryana, Himachal Pradesh, Delhi, UP, Uttarakhand, Rajasthan, UT of Chandigarh, UT of J&K and UT of Laddakh. The Northern grid consists of power system controlled by various Electricity Boards/ GENCOS/ TRANSCOS/ DISCOMS located in the above states.

The Northern Region has been experiencing acute power shortage especially the peaking power, during the last decade, due to rapid industrialization,

developing irrigation network & urbanization. Electrical energy being the basic ingredient for economic upliftment through industrial and agricultural development, power shortage had slowed down the wheels of progress and put a curb on all development activities in the region. Thermal and nuclear generation of power, being base power, is not the right solution for meeting peaking power deficit in this region. Further, there are limitations imposed by inadequate availability of coal and nuclear fuel, long distances over which fuel has to be transported through an overloaded railway system and higher cost of power generation. Moreover, our country is committed to focus on decarbonisation and promote zero carbon emission, hence adding non fossil sources of power generation to reduce the adverse impact of fossil fuels on environment. Therefore, endeavour should be adoption of cleaner fuels, increasing share of RE, phasing out of old & inefficient polluting power plants etc.

One side, the demand is increasing due to rapid industrialization, urbanization, electric transportation, modernization of agriculture etc. and on the other side generation from thermal power stations will go on decreasing due to retirement of old/ inefficient plants. Though, renewable energy sources like solar and wind are added rapidly to meet the energy demand, but the peak demand (morning and evening peak demand) cannot be met with the addition of solar based power plants without storage. Hence, advance planning and implementation of new hydro projects is extremely beneficial to meet the peak demand as well as grid balancing requirement expected to arise due to addition of other renewable energy sources in the grid.

2.1.3 JUSTIFICATION FOR THE PROJECT

From the Table 2.1 a for the year 2020-21, it is observed that the North Region has deficit in peak capacity of 0.7% and energy deficit of 1.0%. The proposed Uri-I Stage-II HE Project is a run of the river project and would form an integral part of the Northern Grid to contribute in projected energy requirement. This project is proposed to be commissioned by the end of 2027-28 and envisages utilization of surplus water of Jhelum River after full

utilization by Uri-I Stage-I Power Station & additional water from Kishanganga HE Project released through turbine outlets into Wular lake and subsequently to the Jhelum river. Besides, to an extent, it will also contribute peak capacity to the grid, grid balancing power in the aftermath of rapid augmentation of seasonal and intermittent renewable energy like solar and wind.

2.2 SCHEME FOR WHEELING EVACUATING POWER

Power from Uri-I Stage-II HE Project is proposed to be evacuated through existing 400kV transmission lines (Line-1 & Line-2 to 400/220kV Substation at Amargarh and Line-3 to 400/220kV Substation at Wagoora via Uri-II Power station) through inter connecting of 400kV GIS of Uri-I Power Station and Uri-1 Stage-II HEP.

2.3 AVAILABLE GENERATING CAPACITY IN REGION

As per monthly report of CEA for All India Installed Capacity (In MW) of Power stations, total installed capacity in Northern Region as on 28th Feb 2022 is 110456.05 MW. Out of this, capacity of thermal & nuclear is 65048.57 MW, capacity of Hydro plant is 20433.77 MW and capacity of RES plants (Solar, Wind, SHPs and Bio Mass etc.) is 24973.71MW.

2.4 FUTURE ENERGY REQUIREMENTS IN REGION

As per draft National Electricity Plan'2022 circulated by CEA in Feb-2022, the projected available energy, total energy requirement and peak demand during the year 2026-27 has tentatively been assessed as 1967 BU, 1874 BU and 272 GW respectively. However, the projected available energy, total energy requirement and peak demand during the year 2031-32 has been assessed tentatively as 2655 BU, 2538 BU and 363 GW respectively.

2.5 POWER SUPPLY POSITION WITHOUT & WITH PROJECT

The Power supply position with and without Uri-I Stage-II project has been assessed and indicated at table 2.2 & 2.3 (Annexure-II &III).From table 2.2,

the power scenario in All India Level without Uri-I Stage-II Project by the end of 2027-28 is summarized as under:-

Region	Position of Peaking Power (MW) (Deficit/ Surplus)	Peaking Power (%) (Deficit/ Surplus)	Energy(MU) (Deficit/ Surplus)	Energy (%) (Deficit/ Surplus)
National Grid	-25988	-9.0%	+232528	+11.58%

Note: Surplus denoted by (+)
Deficit denoted by (-)

Uri-I Stage-II Project having installed capacity of 240 MW, is one of the potential schemes in UT of J&K and, as such, merits clearance at an early date so as to be taken up for execution immediately to obtain benefits by 2027-28. The need for Uri-I Stage-II Project has, therefore, been considered in the national interest for providing environmental friendly clean energy, boosting thrust on decarbonisation and energy requirements of Northern region apart from other considerations like grid balancing on account of expected huge capacity addition of Solar and wind power in the grid.

From the perusal of table 2.3, the power scenario in all India level with Uri-I Stage-II Project by the end of 2027-28 is summarized as follows:

Region	Position of Peaking Power (MW) (Deficit/ Surplus)	Peaking Power (%) (Deficit/ Surplus)	Energy(MU) (Deficit/ Surplus)	Energy (%) (Deficit/ Surplus)
National Grid	-25804	-8.9%	+233264	+11.62%

Note: Surplus denoted by (+)
Deficit denoted by (-)

It is observed that in National Grid, by the end of 2027-28, the peaking deficit after addition of Uri-I Stage-II HE Project (240MW) would improve from 9% to 8.9% and Energy surplus would be approx. 11.6%.

The power from this project would be fully absorbed in the Northern grid/National Grid. As such, Uri-I Stage-II H.E. Project is being proposed for immediate implementation.

Annexure-I

Table: 2.1

Actual Power Position for Year 2020-21

	Energy				Peak			
Region	**Requirement**	**Availability**	**Surplus/ Deficit (-)**		**Demand**	**Met**	**Surplus/ Deficit (-)**	
	(MU)	**(MU)**	**(MU)**	**(%)**	**(MW)**	**(MW)**	**(MW)**	**(%)**
Northern	396151	392323	-3828	-1.0%	68288	67806	-482	-0.7%
Western	388013	387975	-38	0.0%	61778	61692	-86	-0.1%
Southern	326885	326836	-49	0.0%	58395	58395	0	0.0%
Eastern	147530	146999	-531	-0.4%	24016	24016	0	0.0%
North-Eastern	16995	16531	-464	-2.7%	3294	3107	-187	-5.7%
All India	1275574	1270664	-4910	-0.4%	215771	215016	-755	-0.3%

The data for the year 2020-2021 tabulated above is as per 'Load generation balance report (LGBR) Published by CEA on the website www.cea.nic.in

Annexure-II

Table 2.2

POWER SUPPLY POSITION ALL INDIA

WITHOUT URI-I STAGE-II H.E. PROJECT

	Unit	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28
Installed Capacity (Up to 28.02.2022)	MW	395607	451608	507609	563609	619610	675611	720007
Installed capacity excl renewables	MW	289232	298053	306874	315695	324515	333336	343249
Peak availability	MW	222665	229456	236246	243037	249827	256618	264250
Peak requirement	MW	205873	219098	232324	245549	258775	272000	290238
Peak Surplus(Deficit)	MW	16792	10357	3922	-2512	-8947	-15382	-25988
Peak Surplus(Deficit)	%	8.2%	4.7%	1.7%	-1.0%	-3.5%	-5.7%	-9.0%
Energy availability	MU	1568247	1637911	1762276	1886640	2011004	1967000	2239419
Energy requirement	MU	1474025	1554020	1634015	1714010	1794005	1874000	2006892
Energy Surplus(Deficit)	MU	94222	83891	128261	172630	172630	93000	232528

Energy Surplus(Deficit)	%	6.4%	5.4%	7.8%	10.1%	9.6%	5.0%	11.58%
Fuel Type Installed capacity:								
Thermal (Coal, Lignite, Diesel)	MW	211029 MW	215786 MW	220542 MW	225298 MW	230055 MW	234811 MW	238431 MW
Gas	MW	24900 MW	24913 MW	24927 MW	24941 MW	24954 MW	24968 MW	24968 MW
Nuclear	MW	6780 MW	8180 MW	9580 MW	10980 MW	12380 MW	13780 MW	15520 MW
Hydro & PSP	MW	46525 MW	49175 MW	51826 MW	54476 MW	57127 MW	59777 MW	64330 MW
Renewables (solar, wind, small hydro, biomass)	MW	106375 MW	153555 MW	200735 MW	247915 MW	295095 MW	342275 MW	376758 MW
Total	MW	395608 MW	451608 MW	507609 MW	563610 MW	619610 MW	675611 MW	720007 MW
1.The Peak/Energy availability & requirement data for the year 2021-22 has been taken from 'Load generation balance report 2021-22' Published by CEA on the website www.cea.nic.in. Installed capacity of 395607.86 MW as on 28.02.2022 has been taken from CEA website.								
2. Projected total Installed capacity for the 2026-27 has been taken from Draft National Electricity Plan for calculation.								

3. Projected total Installed capacity for all other years been calculated on pro rata basis from total Installed capacity for the year 2021-22 and Projected Installed capacity 2026-27 has been taken from Draft National Electricity Plan.
4. Peak availability for all the years has been estimated on the basis of ratio of Peak availability to Installed capacity (excluding renewables) considering year 2021-22 as reference.
5. Energy availability for the year 2026-27 is as per Draft National Electricity Plan (page no 5.23). Energy availability for the all other years, has been calculated on projected Installed capacity and considering PLF of 59.94% for Thermal, 16% for Gas, 70% for Nuclear, 35% for Hydro and CUF of 20% for Renewables. (Energy available MU = IC (MW) x365*24*PLF/CUF/1000)
6. Energy requirement and peak requirement for the year 2026-27 & 2031-32 taken for calculation purpose based on Draft National Electricity Plan (page no 4.3) and for other all years calculated on pro rata basis
7. Uri-I Stage-II HE Project with installed capacity of 240 MW and Design Energy of 932.60 MU is likely to be commissioned during year 2027-28
This is a statistical analysis based on various publications mentioned above and meant for study and planning purposes only.

Annexure-III

Table 2.3

POWER SUPPLY POSITION ALL INDIA

WITH URI-I STAGE-II H.E. PROJECT

	Unit	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28
Installed Capacity (Up to 28.02.2022)	**MW**	395608	451608	507609	563610	619610	675611	720247
Installed capacity excl renewables	**MW**	289233	298054	306874	315695	324515	333336	343489
Peak availability	**MW**	222665	229456	236247	243037	249827	256618	264434
Peak requirement	**MW**	205873	219098	232324	245549	258775	272000	290238
Peak Surplus(Deficit)	**MW**	16792	10358	3923	-2512	-8948	-15382	-25804
Peak Surplus(Deficit)	**%**	**8.2%**	**4.7%**	**1.7%**	**-1.0%**	**-3.5%**	**-5.7%**	**-8.9%**
Energy availability	**MU**	1568247	1637911	1762276	1886640	2011004	1967000	2240155
Energy requirement	**MU**	1474025	1554020	1634015	1714010	1794005	1874000	2006892
Energy Surplus(Deficit)	**MU**	94222	83891	128261	172630	172630	93000	233264

Energy Surplus(Deficit)	**%**	**6.4%**	**5.4%**	**7.8%**	**10.1%**	**9.6%**	**5.0%**	**11.62%**
Fuel Type Installed capacity:								
Thermal (Coal, Lignite, Diesel)	**MW**	211029 MW	215786 MW	220542 MW	225298 MW	230055 MW	234811 MW	238431 MW
Gas	**MW**	24900 MW	24913 MW	24927 MW	24941 MW	24954 MW	24968 MW	24968 MW
Nuclear	**MW**	6780 MW	8180 MW	9580 MW	10980 MW	12380 MW	13780 MW	15520 MW
Hydro & PSP	**MW**	46525 MW	49175 MW	51826 MW	54476 MW	57127 MW	59777 MW	64570 MW
Renewables (solar, wind, small hydro, biomass)	**MW**	106375 MW	153555 MW	200735 MW	247915 MW	295095 MW	342275 MW	376758 MW
Total	**MW**	**395608 MW**	**451608 MW**	**507609 MW**	**563610 MW**	**619610 MW**	**675611 MW**	**720247 MW**
1.The Peak/Energy availability & requirement data for the year 2021-22 has been taken from 'Load generation balance report 2021-22' Published by CEA on the website www.cea.nic.in. Installed capacity of 395607.86 MW as on 28.02.2022 has been taken from CEA website.								
2. Projected total Installed capacity for the 2026-27 has been taken from Draft National Electricity Plan for calculation.								

3. Projected total Installed capacity for all other years been taken calculated on pro rata basis from total Installed capacity for the year 2021-22 and Projected Installed capacity 2026-27 has been taken from Draft National Electricity Plan .
4. Peak availability for all the years has been estimated on the basis of ratio of Peak availability to Installed capacity (excluding renewables) considering year 2021-22 as reference.
5. Energy availability for the year 2026-27 is as per Draft National Electricity Plan (page no 5.23). Energy availability for the all other years, has been calculated on projected Installed capacity and considering PLF of 59.94% for Thermal, 16% for Gas, 70% for Nuclear, 35% for Hydro and CUF of 20% for Renewables. (Energy available MU = IC (MW) x365*24*PLF/CUF/1000)
6. Energy requirement and peak requirement for the year 2026-27 & 2031-32 taken for calculation purpose based on Draft National Electricity Plan (Page no 4.3) and for other all years calculated on pro rata basis
7.Uri-I Stage-II HE Project with installed capacity of 240 MW and Design Energy of 932.60 MU is likely to be commissioned during year 2027-28
This is a statistical analysis based on various publications mentioned above and meant for study and planning purposes only.

CHAPTER – III

BASIN DEVELOPMENT

CHAPTER-III

BASIN DEVELOPMENT

3.0 INTRODUCTION

Jammu and Kashmir has many lakes, rivers, and glaciers. Significant rivers that flow through Jammu & Kashmir from the Himalayas are Jhelum, Chenab, Sutlej, Ravi and Indus. These river basins are located at a higher elevation facilitating huge hydro power potential. Major lakes include Manasbal Lake, Dal Lake, Wular Lake, Nageen Lake. There are around 1230 water bodies in Jammu & Kashmir.

The Union Territory, Jammu and Kashmir has vast Hydro Power potential. Power Development in Jammu and Kashmir has a long and distinguished history. 9MW Mohra Hydro-electric Plant, among the first of its kind in the subcontinent, was developed as early as 1905. The estimated hydro-power potential of Jammu and Kashmir is 20,000 Megawatts (MW), of which about 16,475 MW have been identified. "This comprises 11,283 MW in Chenab basin, 3,084 MW in Jhelum basin, 500 MW in Ravi Basin and 1608 MW in Indus basin. These projects are techno-economically viable, besides being eco-friendly and socially beneficial.

Uri 1 Stage II Hydroelectric Project envisages harnessing the potential of River Jhelum in Uri Tehsil of District Baramulla, UT of Jammu & Kashmir, India.

The river Jhelum rises from Verinag Spring situated at the foot of the Pir Panjal in the south-eastern part of the Kashmir Valley administered by India. It is joined by its tributaries Lidder River near village Mirgund at Khanabal, Veshaw River at Sangam in Anantnag, Sind River at Shadipora and Pohru River at Doabgah in Sopore in Jammu and Kashmir. It flows through Srinagar and Wular Lake before entering Pakistan-administered Kashmir through a deep narrow gorge. The Neelum River, the largest tributary of the Jhelum, joins it at Domel Muzaffarabad, as does the next largest, the Kunhar River of Kaghan Valley. It is then joined by the Poonch

River, and flows into the Mangla Dam reservoir in the Mirpur District. The Jhelum enters Pakistani Punjab in the Jhelum District. From there, it flows through the plains of Pakistan's Punjab, forming the boundary between the Jech and Sindh Sagar Doabs. It ends in a confluence with the Chenab River at Trimmu in the Jhang District. The Chenab merges with the Sutlej to form the Panjnad River, which joins the Indus River at Mithankot.

Most of the villages and important cities in Kashmir valley are situated on the banks of Jhelum.

The Uri Hydroelectric Project was conceived by the Power Development Department (PDD) of the Government of Jammu and Kashmir, who submitted a Detailed Project Report (DPR) to the Central Water and Power Commission in 1974. Following modifications to the project, it was cleared by the Central Electricity Authority (CEA) in March 1980. Responsibility for development of the project was transferred to the National Hydroelectric Power Corporation of India (NHPC) in 1981. NHPC carried out the preliminary design and obtained Forest Department clearance for the project in 1986, and commenced pre-construction work in 1987.

In the early 1980s, the Government of India and NHPC began soliciting funds from international agencies with the objective of implementing the project on an Engineering Procurement and Construction (EPC) basis with bilateral support.

The Swedish company, Skanska, promoted the project, seeking support from Swedish Government agencies including Sida. Following an indication of bilateral support in 1988, the Swedish-British URICO consortium led by Skanska participated in a limited tender held by NHPC for finance and construction of the project. NHPC and GoI formally approached Sida for financing in June 1989.

The consortium was successful in the tender, and following confirmation of the funding support by the bilateral agencies, URICO was awarded the contract on 18th October 1989. The Order to Commence was given by NHPC

on 22nd November 1989, and construction of the project started in early 1990. Generation of electricity from the first unit commenced in February 1997.

NHPC Limited, now, has signed a Memorandum of Understanding with the Government of Jammu and Kashmir on January 03, 2021 for execution of URI-I Stage-II HE Project (240 MW) on Build, Own, Operate & Transfer (BOOT) basis for the period of 40 years on the River Jhelum, in Uri Tehsil of Baramulla district in Jammu and Kashmir.

3.1 THE COURSE OF THE RIVER

The Jhelum is the principal water-way of Kashmir. It has its source from a spring called Verinag. The Jhelum is joined by numerous small mountain streams from the Pir Panjal Range separating the Kashmir valley from the plains in the southwest and by some tributaries from the Great Himalayas in the northeast. From Sangam to Srinagar, the Romshi draining western ranges & Watalara & Arapal tributaries draining eastern ranges join river Jhelum. Downstream of Srinagar, the Sindh flowing from the east joins river Jhelum on its right bank opposite Shadipur. The Sindh River drains the north-eastern ranges of Pir Panjal from Amarnath Cave to Zojila and Ganderbal. Doodh Ganga & Shali Ganga drain the western ranges south of Gulmarg. They also drain partially through supplementary flood channel to river Jhelum downstream of Srinagar. Finally these nallahs drain into Wular Lake. Ningli nallah drains the hill side to the north of Gulmarg. It meets river Jhelum on the left bank after it emerges from Wular Lake.

From its junction with the Sindh river, the Jhelum river continues its north-easterly course upto the Wular lake situated towards the north end of the valley of Kashmir about 34 km north-west of Srinagar. Wular Lake lying between Bandipora and Sopore is the largest fresh water lake in India. It is an elliptical form with a surface area of lake varies between about 175 km^2 at highest water stage (EL 1580M) down to 60 km^2 at low-water stage in winter time and makes a sharp left turns to break through the Pir Panjal. The lake is an important feature of the hydrographic system of Kashmir. Acting as a flood reservoir, its dimensions vary in different times of the year. The elevation of

Wular Lake water level ranges from 1574 to 1580 m. After leaving Wular Lake, the Jhelum River flows in a south-westerly direction to Baramula, receiving midway the waters of Pohru river, the drainage of the north Kashmir valley. From Baramula to Muzafarabad, the valley is narrow and confined by the spurs of two mountain ranges. The river Jhelum follows a westerly course and at Domel near Muzafarabad, the Kishanganga, a large river from the snowy mountains to the north, falls into it.

3.2 Power Potential of Jhelum sub basin and Stages of Development

The UT of Jammu and Kashmir comprises of the extreme western sector of Himalayas in the Northern most part of India. The J&K region can be divided into six natural regions namely south west planes South West plains, Pir Panjal range, Kashmir valley, great Himalayas, Karakorum and Ladakh Plateau. The major part J&K region slopes to North West. The directional flow of river is governed by Pir panjal, the Himalayas and Karakorum mountain ranges. Rivers in the region are snow fed and perennial.

The Jhelum River is a sub basin of the Great Indus river system. It is the principal water-way of Kashmir. It has its source from a spring called Verinag and after flowing downstream of Srinagar, it continues its north easterly course up to Wular lake situated towards the north end of the valley of Kashmir. After leaving Wular Lake, the Jhelum River flows in a south-westerly direction to Baramula, receiving midway the waters of Pohru river, the drainage of the north Kashmir valley. From Baramula to Muzafarabad, the valley is narrow and confined by the spurs of two mountain ranges. The river Jhelum follows a westerly course and at Domel near Muzafarabad, the Kishanganga, a large river from the snowy mountains to the north, falls into it. Moreover, after commissioning of Kishanganga HE Project, the additional water from of the Project released through turbine outlets into Wular lake and subsequently to the Jhelum river. The major portion of the River Jhelum and its tributaries receives a considerable amount of snowfall and most of the part of upper reaches remains under snow cover throughout the year. The main

river as well as various tributaries is fed from number of glaciers which make these rivers perennial. The catchment receives rainfall during monsoon as well as during winter periods. Major part of the valley experiences cold climate.

Out of 190 schemes in the Great Indus basin with probable installed capacity of 33,832 MW, 33 schemes are identified Jhelum river sub basin with a hydroelectric potential of 1607.65 MW. Uri-I Stage-II project is an extension scheme utilizing existing structure of Uri-I Stage-I e.g. Barrage, Power Intake & Desilting chambers and the Jhelum discharge beyond 8000 cusecs (226 cumecs) shall be utilized. Major hydropower projects constructed/ planned on Jhelum river sub basin are listed below:

TABLE 3.1

S. No.	Name of Scheme	Installed Capacity (MW)	Status
1	Ganderbal	15	Commissioned
2	Kishanganga	330	Commissioned
3	Lower Jhelum	105	Commissioned
4	Upper Sindh-I	22.6	Commissioned
5	Upper Sindh-II	105	Commissioned
6	Uri-I	480	Commissioned
7	Uri-II	240	Commissioned
8	Uri-I Stage-II	240	New scheme
8	New Ganderbal	93	New Scheme
9	Parnai	37.5	New scheme

3.3 WHETHER TRANS-BASIN DIVERSION OF WATERS INVOLVED

No trans-basin diversion of water is proposed. However, Uri-I (Stage-II) H. E. project also utilizes diverted (additional) waters available after generation of Kishanganga Power station. Kishanganga Power station is a run of the river

scheme which involves transfer of water of Kishanganga River (tributary of Jhelum) in Gurez valley to Bonar nallah, which is tributary of Jhelum River in Kashmir valley. Bonar Nallah joins Madhumati nallah D/s of tail race outlet of the power house of KGHP. Madhumati nallah discharges into Wullar lake located on main Jhelum River. Kishanganga Power station was commissioned during the month of May-2018. The project utilizes water coming from Lower Jhelum H.E. Project (just upstream of Uri-I Reservoir) for power generation after releasing mandated e-flow and remaining water spills over the barrage as there is no live capacity in the reservoir. The water drawn for power generation is discharged back to Jhelum River through TRT.

3.4 FITMENT OF THE SCHEME IN OVERALL BASIN DEVELOPMENT

URI-I Stage-II H.E. Project, an extension of URI-I Stage –I H.E. Project, now URI-I Power station (480MW) is a run off the river scheme situated on river Jhelum in Uri Tehsil of Baramulla district of UT Jammu and Kashmir. The existing 21.5 m high barrage and surface water conveyance system of URI-I stage-I is also used for URI-I Stage-II H.E. Project. Underground water conveyance system and power house is proposed to be constructed for URI-I Stage-II H.E. Project. The Barrage and other civil structure of the URI-I Stage-I project was constructed in 1997 and since under operation.

URI-I stage-I H.E. Project FRL is at EL1491.0M and reservoir is extending about 950m along river Jhelum. URI-I stage-I H.E. Project lies in between Lower Jhelum HE Project in Upstream and Uri-II Power Station in the downstream. The TWL of Lower Jhelum HE Project is EL 1492.0M and FRL of Uri-II Power Station is at EL 1491.0M, which means the plants running in tandem will not have any negative effect on their performance and there will be no interference with upstream or downstream projects. Uri-I Stage-II H.E. Project an extension of Uri-I Power Station fits well in the Jhelum basin between these two projects and Inter-basin transfer is not involved in.

3.5 FITMENT OF THE SCHEME IN THE POWER POTENTIAL ASSESSMENT STUDIES CARRIED OUT BY CEA

The details of above has been assessed in Chapter No: 2 i.e. (Justification of Project from Power Supply Angle)

3.6 EFFECT OF FUTURE UPSTREAM/DOWNSTREAM DEVELOPMENT ON THE POTENTIAL OF THE PROPOSED SCHEME

All the projects identified and proposed by CEA on Jhelum River are run of the river projects. There is no trans–basin water diversion proposed in the upstream projects. As such, the effect of upcoming upstream and downstream projects on Uri-I Stage-II Hydroelectric Project shall be insignificant.

3.7 CONVERSION OF STORAGE SCHEME TO RoR, IF ANY (AS PER ALREADY APPROVED CHAPTER/ASPECT AS REFERRED UNDER PARA 2.3 ABOVE)

Uri-I Stage-II Hydroelectric Project is the extension of URI-I Stage–I H.E. Project, now Uri-I Power Station, a run off the river scheme. Uri-I Power Station was constructed in 1997 and since under operation. Hence in the URI-I Stage-II H.E. Project, there is no conversion of storage scheme to ROR.

CHAPTER – IV

INTER-STATE / INTER-NATIONAL ASPECTS

CHAPTER IV
INTER-STATE / INTER- NATIONAL ASPECTS

4.0 INRODUCTION

The “Interstate / International Aspects” of URI-I Stage-II H.E. Project has been prepared in accordance with “Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence, Jan 2015”. This chapter is prepared considering the International aspect of the project mainly Indus Water Treaty (IWT).

URI-I Stage-II H.E. Project is the extension of URI-I H.E.Project (480MW) on river Jhelum in Baramula district of Jammu & Kashmir. Stage-I of URI H.E. Project a purely run–off-the river scheme which was allotted to NHPC Limited and was commissioned in 1997 and since then operating successfully. URI-I Stage –II H.E. Project is planned as per provision kept in the DPR of URI-I H.E Project. This project also utilizes diverted (additional) waters available after generation of Kishanganga Power station.

URI-I Stage-II H.E. Project is panned as purely run-off the river scheme similar to URI-1 Stage-I (Now URI-I Power Station) in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II as per the provisions as mentioned in Annexure- D & E of The Indus Water treaty, 1960.

4.1 States Countries Traversed by the River

Uri-I (stage-II) Hydroelectric Project, a run off the river scheme, is situated on river Jhelum in Uri Tehsil of Baramulla district UT of Jammu and Kashmir. Jhelum river has its source from a spring called Verinag in Anantnag district. The river is entirely flows in Jammu & Kashmir state up to Uri-I Barrage. Uri and Kishanganga Catchment plans with district & state boundaries are prepared based on information available on internet are shown in **Figure-4.1 & 4.2** respectively.

4.2 Distribution of catchment in states /countries and yields from the catchment of state /countries concerned

Entire catchment of the Jhelum river upto Uri-I Barrage site lies in UT of Jammu & Kashmir of India. The catchment area of Jhelum is 12750 km^2 upto Uri-I Barrage. The average annual yield for the series Jun-94 to May-20 is computed as 8080 MCM (i.e. 633.7 mm) at Uri-I Barrage.

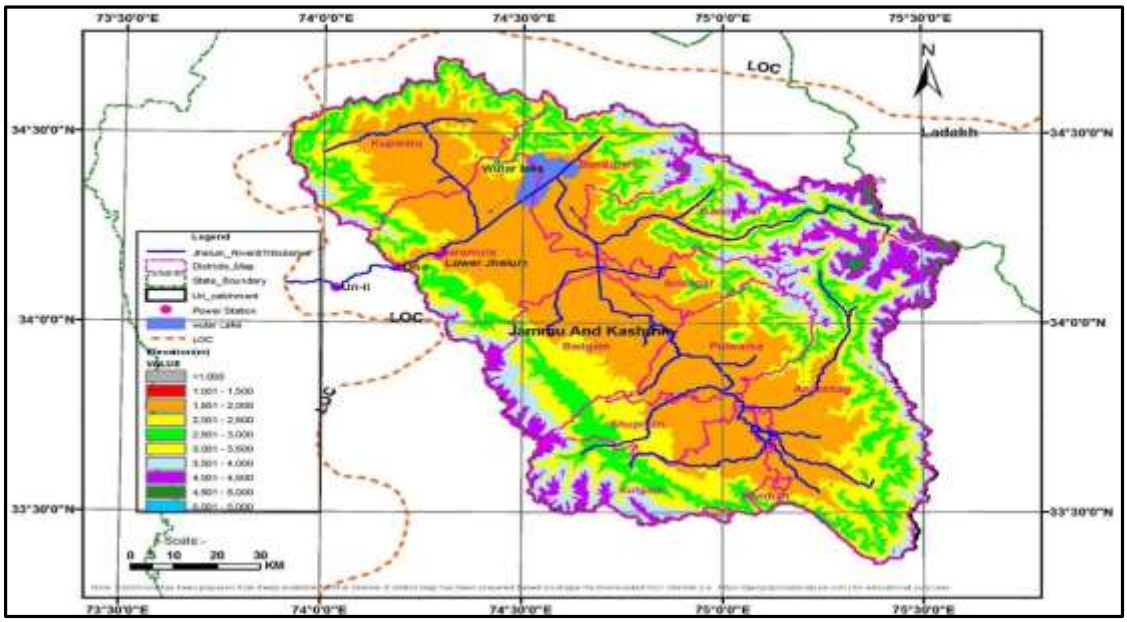


Figure-4.1: Uri Catchment with district & state boundaries

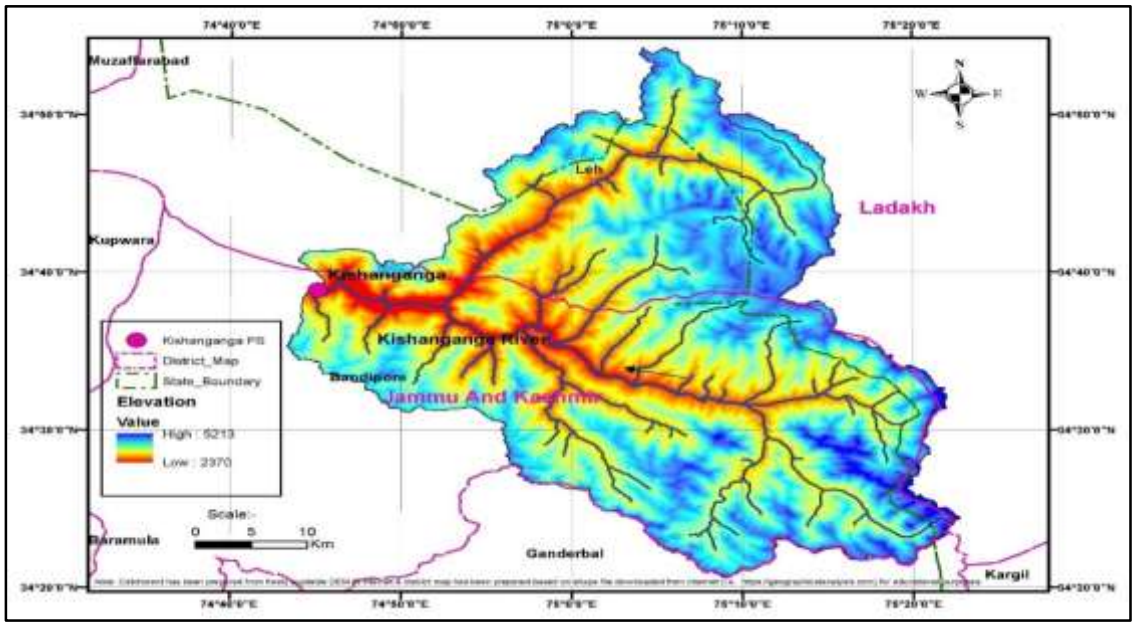


Figure-4.2: Kishanganga Catchment with district & state boundaries

Clearance on Inter-state aspect has been accorded by ISM-2 directorate of CWC vide letter no: 2/8/ISM-2/2017/510 Dated: 23.12.2021. The copy of same is enclosed at Chapter-21.

4.3 INTERNATIONAL ASPECTS

The Indus system of rivers comprises of three Eastern Rivers (Ravi, Beas and Sutlej and their tributaries) and three Western Rivers (Indus, Jhelum and Chenab and their tributaries).The Jhelum is one of the principal rivers forming part of the Indus basin. The waters of this basin are shared between India and Pakistan in accordance with the provisions of "The Indus Water Treaty, 1960".

4.3.1 INTERNATIONAL AGREEMENT

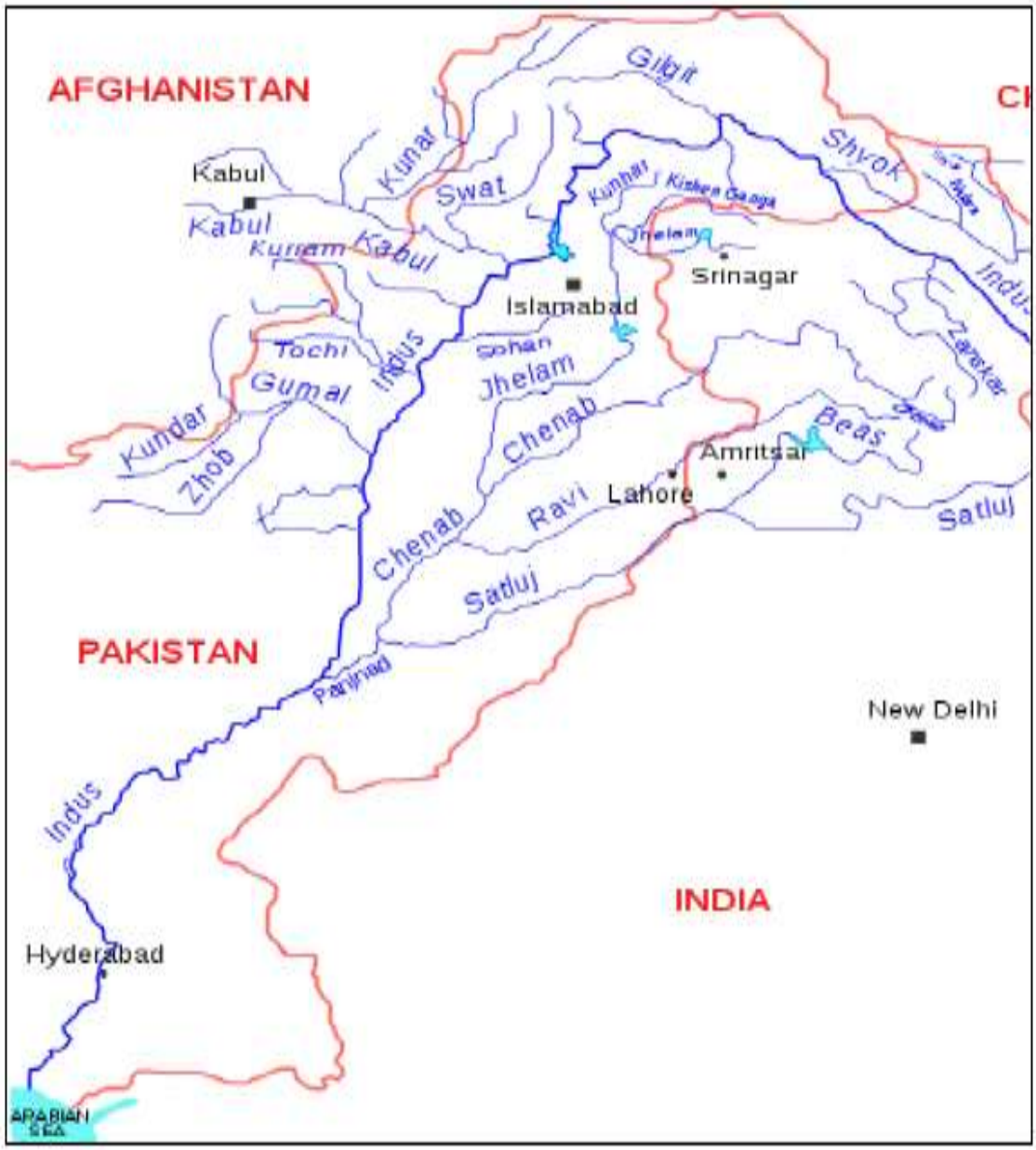
The Government of India and the Government of Pakistan, being equally desirous of attaining the most complete and satisfactory utilization of waters of the Indus system of rivers and recognising the need, therefore, of fixing and delimiting, in a spirit of goodwill and friendship, the rights and obligations of each in relation to the other concerning the use of these waters and of making provision for the settlement, in a cooperative spirit, of all such questions as may hereafter arise in regard to the interpretation or application of the provisions agreed upon herein, have resolved to conclude a Treaty in furtherance of these objectives, namely "The Indus Water Treaty, 1960".

URI-I Stage-II H.E. Project is planned as purely run-of river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating as per the provisions of The Indus Water treaty, 1960.

Uri-I (Stage-II) H. E. project also utilizes diverted (additional) waters available after generation of Kishanganga Power station. Kishanganga Power station is a run-of the river scheme which involves transfer of water of Kishanganga River in Gurez valley to Bonar nallah, which is tributary of Jhelum River in Kashmir valley. Bonar Nallah joins Madhumati nallah D/s of tail race outlet of

the power house of KGHP. Madhumati nallah discharges into Wullar lake located on main Jhelum River.

The parameters of the project have been planned in accordance with the provision of the Treaty (Annexure-D- Generation of Hydro-Electric Power by



India on the Western Rivers & Annexure E: Storage of the Western Rivers).

Figure 4.3: Rivers of Indus Water System

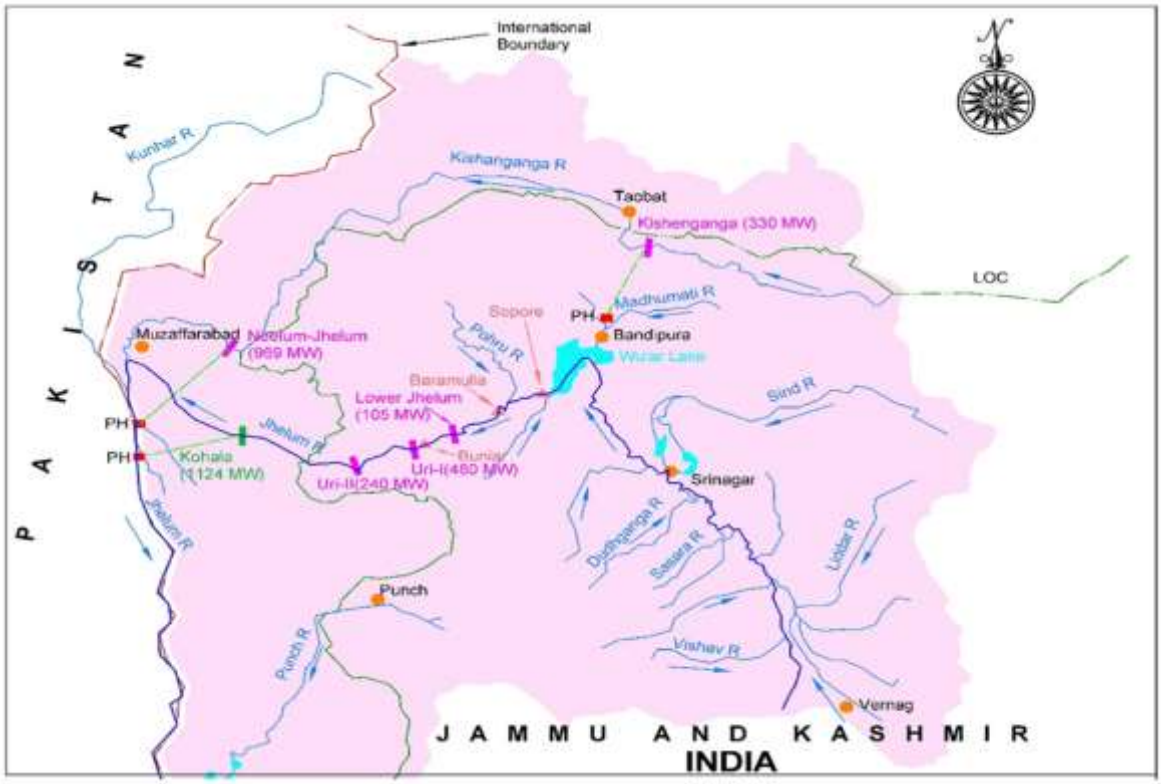


FIG 4.4 River map of Jhelum and Kishanganga

4.3.2 Storage Provision as per IWT

According to Indus water Treaty 1960, no storage as well as Power storage is provided on the main Jhelum river. URI-I PS is constructed and operating as per provision of IWT and URI-I Stage –II H.E. Project is the extension of URI-I PS.

The relevant extracts from the treaty relating to the use of waters of Jhelum and its tributaries are enclosed as Annexure 4.1.

4.3.3 Hydroelectric Projects on Western Rivers

"Annexure-D" of the Treaty stipulates the provisions and design considerations of establishing a hydroelectric power plant by India on Western Rivers. As per Paragraph 1 of the Annexure D, use of waters of Westerns Rivers for generation shall be unrestricted, provided that the design, construction and operation of new hydro-electric plants are in accordance with the provisions contained in Annexure D.

4.3.4 Design Considerations

URI-I Stage-II HEP is a new Project but it is an extension of the URI-I Power Station a Run-of-River power station and qualifies the definition of "Run-of-River Plant", therefore, Part- 3 of the Annexure D applies for the URI-I Stage-II HEP.

Part- 3 of the Annexure D has 16 Paragraphs from "8" to "23". Design Considerations for Run-of-River plants are given in Paragraph 8. As per Paragraph 8 the Run-of-River plant shall conform to the following criteria

a. **The works themselves shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design.**

URI-I Stage-II H.E. Project is planned as purely run-of river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating since 1997 as per the provisions of The Indus Water treaty, 1960.

b. The design of the works shall take due account of the requirements of Surcharge Storage and of Secondary Power.

There is no surcharge storage in URI-I Stage-II H.E. Project / URI-I Power station

c. **The maximum Pondage in the Operating Pool shall not exceed twice the Pondage required for Firm Power.**

URI-I Stage-II H.E. Project is planned as purely run-of river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating since 1997 as per the provisions of The Indus Water treaty, 1960. There is no Pondage in the Uri-I barrage.

d. There shall be no outlets below the Dead Storage Level, unless necessary for sediment control or any other technical purpose; any such outlet shall be of the minimum size, and located at the highest

level, consistent with sound and economical design and with satisfactory operation of the works.

URI-I Stage-II H.E. Project is planned as purely run-of river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating since 1997 as per the provisions of The Indus Water treaty, 1960.

e. If the conditions at the site of a Plant make a gated spillway necessary, the bottom level of the gates in normal closed position shall be located at the highest level consistent with sound and economical design and satisfactory construction and operation of the works.

URI-I Stage-II H.E. Project is planned as purely run-off the river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating since 1997 as per the provisions of The Indus Water treaty, 1960.

f. The intakes for the turbines shall be located at the highest level consistent with satisfactory and economical construction and operation of the Plant as a Run-of-River Plant and with customary and accepted practice of design for the designated range of the Plant's operation.

URI-I Stage-II H.E. Project is planned as purely run-off the river scheme as an extension of URI-I Power Station in which water of Jhelum river shall be utilized both for URI-I PS and URI-I Stage-II with existing diversion structure (Barrage) of URI-I Power Station which is operating since 1997 as per the provisions of The Indus Water treaty, 1960.

Regarding Clearance on International aspect on Indus Treaty Angle (IWT), DC Indus, Ministry of Jal Shakti (MoJS) informed that the clearance related to Indus Water Treaty 1960 will be issued only after finalization of all Salient features & concerned agency should apply the same under Appendix-II to Appendix-D of the treaty vide E-mail dated: 03.12.2021. **The copy of E-mail is enclosed at Chapter-21**

ANNEXURE – 4.1

EXTRACT OF THE INDUS WATER TREATY (1960)

The relevant extracts from The Indus Water Treaty, 1960 relating to the use of waters of Chenab and its tributaries are given below:

ARTICLE-I: Definitions as used in this Treaty:

1. XXXXX
2. The term "Tributary" of a river means any surface channel, whether in continuous or intermittent flow and by whatever name called, whose waters in the natural course would fall into that river, e.g. a tributary, a torrent, a natural drainage, an artificial drainage, a nadi, a nallah, a nai, a khad, a cho. The term also includes any sub-tributary or branch or subsidiary channel, by whatever name called, whose waters, in the natural course, would directly or otherwise flow into that surface channel.
3. The term "The Indus," "The Jhelum," "The Chenab," "The Ravi," "The Beas" or "The Sutlej" means the named river (including Connecting Lakes, if any) and all its Tributaries: provided that

   i) None of the rivers named above shall be deemed to be a tributary;

   ii) The Chenab shall be deemed to include the river Panjnad; and

   iii) The river Chandra and the river Bhaga shall be deemed to be Tributaries of the Chenab.

4. The term *"Main"* added after Indus, Jhelum, Chenab, Sutlej, Beas or Ravi means the main stem of the named river excluding its Tributaries, but including all channels and creeks of the main stem of that river and such connecting lakes as form part of the main stem itself. The Jhelum main shall be deemed to extend up to Verinag, and the Chenab Main up to the confluence of the river Chandra and the river Bhaga.
5. XXXXX

6. The term “Western Rivers” means The Indus, The Jhelum and The Chenab taken altogether.
7. The term “The Rivers” means all the rivers, The Sutlej, The Beas, The Ravi, The Indus, The Jhelum and The Chenab.
8. XXXXX
9. The term “Agricultural Use” means the use of water for irrigation, except for irrigation of household gardens and public recreational gardens.
10. The term “Domestic Use” means the use of water for:

    (a) Drinking, washing, bathing, recreation, sanitation (including the conveyance and dilution of sewage and of industrial and other wastes), stock and poultry, and other like purposes;

    (b) Household and municipal purposes (including use for household gardens and public recreational gardens); and

    (c) Industrial purposes (including mining, milling and other like purposes);

    but the term does not include Agricultural Use or use for the generation of hydro-electric power.

11. The term **“*Non-Consumptive Use*”** means any control or use of water for navigation, floating or timber or other property, flood protection or flood control, fishing or fish culture, wild life or other like beneficial purposes, provided that, exclusive of seepage and evaporation of water incidental to the control or use, the water (undiminished in volume within the practical range of measurement) remains in, or is returned to, the same river or its Tributaries; but the term does not include Agricultural Use or use for the generation of hydro-electric power.

12. And 13. XXXXX

14. The term “Commissioner” means either of the Commissioners appointed under the provisions of Article VIII(1) and the term

"Commission" means the Permanent Indus Commission constituted in accordance with Article VIII(3).

15. The term "interference with the waters" means:

(a) Any act of withdrawal therefrom; or

(b) Any man-made obstruction to their flow which causes a change in the volume (within the practical range of measurement) of the daily flow of the waters: Provided however that an obstruction which involves only an insignificant and incidental change in the volume of the daily flow, for example, fluctuations due to afflux caused by bridge piers or a temporary by-pass, etc., shall not be deemed to be an interference with the waters.

16. The term *"Effective date"* means the date on which this treaty takes effect in accordance with the provisions of Article XII, that is, the first of April, 1960.

ARTICLE-II: Provisions regarding Eastern Rivers XXXXX

ARTICLE-III: Provisions regarding Western Rivers

1. XXXXX
2. India is under obligation to let flow all the waters of the Western Rivers, and shall not permit any interference with these waters, except for the following uses, restricted (except as provided in item (c)(ii) of Paragraph 5 of Annexure C) in the case of each of the rivers, The Indus, The Jhelum and The Chenab, to the drainage basin thereof:

   (a) Domestic Use,

   (b) Non-consumptive use,

   (c) Agricultural use as specified in IWT Annexure-C,

(d) Generation of hydro-electric power as specified in IWT Annexure-D.

3. XXXXX
4. Except as provided in Annexure-D & E, India shall not store any water of, or construct any storage works on, the Western rivers.

ARTICLE-IV: Provisions regarding Eastern and Western Rivers

1. XXXXX
2. Each party agrees that any Non-consumptive use made by it shall be so made as not to materially change, on account of such use, the flow in any channel to the prejudice of the uses on that channel by the other party under the provisions of this Treaty. In executing any scheme of flood protection or flood control each party will avoid, as far as practicable, any material damage to other party, and any such scheme carried out by India on the Western rivers shall not involve any use of water or any storage in addition to that provided under Article III.
3. To 5. XXXXX
6. Each party will use its best endeavours to maintain the natural channels of the rivers, as on the effective date, in such condition as will avoid, as far as practicable, any obstruction to the flow in these channels likely to cause material damage to the other party.
7. XXXXX
8. The use of the natural channels of the rivers for the discharge of flood or other excess waters shall be free and not subject to limitation by either party, or neither party shall have any claim against the other in respect of any damage caused by such use. Each party agrees to communicate to the other party, as far in advance as practicable, any information it may have in regard to such extraordinary discharges of water from reservoirs and flood flows as may affect the other party.
9. Each party declares its intention to operate its storage dams, barrages and irrigation canals in such manner, consistent with the

normal operations of its hydraulic systems, as to avoid, as far as feasible, material damage to the other party.

10. To 11. XXXXX

12. The use of water for "industrial purposes" under Articles II(2), II(3) and II(2) shall not exceed:

(a) in the case of an industrial process known on the Effective date i.e, 01.04.1960, such quantum of use as was customary in that process on the Effective date;

(b) in the case of an industrial process not known on the Effective date:

(i) such quantum of use as was customary on the Effective date is similar or in any way comparable industrial processes; or

(ii) if there was no industrial process on the Effective date similar or in any way comparable to the new process, such quantum of use as would not have a substantially adverse effect on the other party.

13. To 15. XXXXX

ANNEXURE-C: Agricultural use by India from the Western rivers

1. The provisions of this Annexure shall apply with respect to the Agricultural use by India from the Western rivers under the provisions of Article III (2) (c) and, subject to the provisions of this Annexure, such use shall be unrestricted.
2. As used in this Annexure, the term "Irrigated Cropped Area" means the total area under irrigated crops in a year, the same area being counted twice if it bears different crops in kharif and rabi. The term shall be deemed to exclude small blocks of ghair mumkin lands in an irrigated field, lands on which cultivation is dependent on rain or snow and to which no irrigation water is applied, areas naturally inundated by river flow and cultivated on sailab thereafter, any area under floating gardens or demb lands in and along any lakes, and

any area under water- plants growing within the water-spread of any lake or in standing water in a natural depression.

3. India may withdraw from the Chenab Main such waters as India may need for Agricultural Use on the following canals limited to the maximum withdrawals

	Name of Canal	*Maximum Withdrawals for Agricultural Use*
(a)	*Ranbir Canal*	*1000 cusecs from 15th April to 14th October, and 350 cusecs from 15th October to 14th April.*
(b)	*Pratap Canal*	*400 cusecs from 15th April to 14th October, and 100 cusecs from 15th October to 14th April.*

Provided that

(i) The maximum withdrawals shown above shall be exclusive of any withdrawals which may be made through these canals for purposes of silt extraction on condition that the waters withdrawn for silt extraction are returned to The Chenab.

(ii) India may make **additional withdrawals** through the **Ranbir Canal** up to **250 cusecs** for hydro-electric generation on condition that the waters so with - drawn are returned to The Chenab.

(iii) If India should construct a barrage across the Chenab Main below the head regulators of these two canals, the withdrawals to be then made, limited to the amounts specified in (a) and (b) above, during each 10-day period or sub-period thereof, shall be as determined by the Commission in accordance with sound irrigation practice and, in the absence of agreement between the Commissioners, by a Neutral Expert in accordance with the provisions of Annexure F.

4. Apart from the irrigation from the Ranbir and Pratap Canals, **India may continue to irrigate from the Western Rivers those areas which were so irrigated as on the Effective Date.**

5. **In addition to such withdrawals** as may be made in accordance with the provisions of Paragraph 3 and 4, India may, subject to the provisions of Paragraph 6, 7, 8 and 9, make further withdrawals from the Western Rivers to the extent India may consider necessary to meet the irrigation needs of the areas specified below:-

	Particulars	*Maximum Irrigated Cropped Area (over and above the cropped area irrigated under the provisions of Paragraph 3 and 4)(acres)*
(a)	*From The Indus, in its drainage basin*	*70,000*
(b)	*From The Jhelum, in its drainage basin*	*400,000*
(c)	*From The Chenab,*	
	(i) in its drainage basin	*225,000 of which not more than 100,000 acres will be in the Jammu District.*
	(ii) outside its drainage basin in the area west of the Deg Nadi (also called Devak River), the aggregate capacity of irrigating channels leading out of the drainage basin of The Chenab to this area not to exceed 120 cusecs…	*6,000*

Provided that

(i) in addition to the maximum Irrigated Cropped Area specified above, India may irrigate road-side trees from any source whatever;

(ii) the maximum Irrigated Cropped Area shown against items (a), (b) and (c) (i) above shall be deemed to include cropped areas, if any, irrigated from an open well, a tube-well, a spring, a lake (other than a Connecting Lake) or a tank, in excess of the areas so irrigated as on the Effective Date; and

(iii) the aggregate of the areas specified against items (a), (b) and (c) (i) above may be re-distributed among the three drainage basins in such manner as may be agreed upon between the Commissioners.

6. (a) Within the limits of the maximum Irrigated Cropped Areas specified against items (b) and (c) (i) in Paragraph 5, there shall be no restriction on the development of such of these areas as may be irrigated from an open well, a tube-well, a spring, a lake (other than a Connecting Lake) or a tank.

(b) Within the limits of the maximum Irrigated Cropped Areas specified against items (b) and (c) in Paragraph 5, there shall be no restriction on the development of such of these areas as may be irrigated from General Storage (as defined in Annexure E): the areas irrigated from General Storage may, however, receive irrigation from river flow also, but, unless the Commissioners otherwise agree, only in the following periods:

(i) from The Jhelum : 21st June to 20th August

(ii) from The Chenab : 21st June to 31st August:

Provided that withdrawals for such irrigation, whether from General Storage or from river flow, are controlled by Government.

7. Within the limits of the maximum Irrigated Cropped Areas specified against items (b) and (c) in Paragraph 5, the development of these areas by withdrawals from river flow (as distinct from withdrawals

from General Storage *cum* river flow in accordance with Paragraph 6(b)) shall be regulated as follows:-

(a) **Until India can release water from Conservation Storage** (as defined in Annexure E) in accordance with sub-paragraphs (b) and (c) below, the new area developed shall not exceed the following:

(i) from The Jhelum : 150,000 acres

(ii) from The Chenab : 25,000 acres during the Transition Period and 50,000 acres after the end of the Transition Period.

(b) **In addition to the areas specified in (a) above, there may be developed from The Jhelum or The Chenab an aggregate area of *150,000 acres* if there is released annually from Conservation Storage, in accordance with Paragraph 8, a *volume of 0.2 MAF into The Jhelum* and a *volume of 0.1 MAF into The Chenab*; provided that India shall have the option to store on and release into The Chenab the whole or a part of the *volume of 0.2 MAF* specified above for release into *The Jhelum*.**

(c) **Any additional areas over and above those specified in (a) and (b) above may be developed if there is released annually from Conservation Storage a volume of 0.2 MAF into The Jhelum or The Chenab, in accordance with Paragraph 8, in addition to the releases specified in (b) above.**

8. **The releases from Conservation Storage, as specified in Paragraphs 7(b) and 7(c), shall be made in accordance with a schedule to be determined by the Commission which shall keep in view, first, the effect, if any, on Agricultural Use by Pakistan consequent on the reduction in supplies available to Pakistan as a result of the withdrawals made by India under the provisions of Paragraph 7 and, then, the requirements, if any,**

of hydro-electric power to be developed by India from these releases.

In the absence of agreement between the Commissioners, the matter may be referred under the provisions of Article IX (2) (a) for decision to a Neutral Expert.

9. On those Tributaries of The Jhelum on which there is any Agricultural Use or hydro-electric use by Pakistan, any new Agricultural Use by India shall be so made as not to affect adversely the then existing Agricultural Use or hydro-electric use by Pakistan on those Tributaries

10. XXXXX

11. (a) As soon as the statistics for each crop year (commencing with the beginning of kharif and ending with the end of the following rabi) have been compiled at the District Headquarters, but not later than the 30th November following the end of that crop year, India shall furnish to Pakistan a statement showing for each of the Districts and Tehsils irrigated from the Western rivers, the total Irrigated Cropped Areas (excluding the area irrigated under the provisions of Paragraph 3) arranged in accordance with items (a), (b), (c)(i) and (c)(ii) of Paragraph 5: Provided that, in the case of areas in the Punjab, the 30th November date specified above may be extended to the following 30th June in the event of failure of communications.

(b) If the limits specified in Paragraph 7(a) and 7(b) are exceeded for any crop year, the statement shall also show the figures for Irrigated Cropped Areas falling under Paragraph 6(a) and 6(b) respectively, unless appropriate releases from Conservation Storage under the provisions of Paragraph 8 have already begun to be made.

ANNEXURE-D: Generation of Hydro-Electric Power by India on the Western Rivers (Article III(2)(d)

1. The provisions of this Annexure shall apply with respect to the use by India of the waters on the Western rivers for the generation of

hydro-electric power under the provisions of Article II (2)(d) and subject, to the provisions of this Annexure, such use shall be unrestricted: Provided that the design, construction and operation of new hydro-electric plants which are incorporated in a Storage Work (as defined in Annexure E) shall be governed by the relevant provisions of Annexure E.

Part 1 - Definitions

2. As used in this Annexure:

(a) "Dead Storage" means that portion of the storage which is not used for operational purposes and "Dead Storage Level" means the level corresponding to Dead Storage.

(b) "Live Storage" means all storage above Dead Storage.

(c) "Pondage" means Live Storage of only sufficient magnitude to meet the fluctuations in the discharge of the turbines arising from variations in the daily and the weekly loads of the plant.

(d) "Full Pondage Level" means the level corresponding to the maximum Pondage provided in the design in accordance with Paragraph 8(c).

(e) "Surcharge Storage" means uncontrolled storage occupying space above the Full Pondage Level.

(f) "Operating Pool" means the storage capacity between Dead Storage Level and Full Pondage Level.

(g) "Run-of-River Plant" means a hydro-electric plant that develops power without Live Storage as an integral part of the plant, except for Pondage and Surcharge Storage.

(h) "Regulating Basin" means the basin whose only purpose is to even out fluctuations in the discharge from the turbines arising from variations in the daily and the weekly loads of the plant.

(i) "Firm Power" means the hydro-electric power corresponding to the minimum mean discharge at the site of a plant, the minimum mean discharge being calculated as follows:

The average discharge for each 10-day period (1st to 10th, 11th to 20th and 21st to end of the month) will be worked out for each year for which discharge data, whether observed or estimated, are proposed to be studied for purposes of design. The mean of the yearly values for each 10-day period will then be worked out. The lowest of the mean values thus obtained will be taken as the minimum mean discharge. The studies will be based on data for as long a period as available but may be limited to the latest 5 years in the case of Small Plants (as defined in Paragraph 18) and to the latest 25 years in the case of other plants (as defined in Paragraph 8).

(j) "Secondary Power" means the power, other than Firm Power, available only during certain periods of the year.

Part 2 – Hydro-Electric Plants in Operation, or under Construction, as on the Effective Date. XXXXX

Part 3 – New Run-of-River Plants

8. Except as provided in Paragraph 18, the design of any new Run-of-River Plant (hereinafter in this Part referred to as a Plant) shall conform to the following criteria:

(a) The works themselves shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design.

(b) The design of the works shall take due account of the requirements of Surcharge Storage and of Secondary Power.

(c) The maximum Pondage in the Operating Pool shall not exceed twice the Pondage required for Firm Power.

(d) There shall be no outlets below the Dead Storage Level, unless necessary for sediment control or any other technical purpose; any such outlet shall be of the minimum size, and located at the highest

level, consistent with sound and economical design and with satisfactory operation of the works.

(e) If the conditions at the site of a Plant make a gated spillway necessary, the bottom level of the gates in normal closed position shall be located at the highest level consistent with sound and economical design and satisfactory construction and operation of the works.

(f) The intakes for the turbines shall be located at the highest level consistent with satisfactory and economical construction and operation of the Plant as a Run-of-River Plant and with customary and accepted practice of design for the designated range of the Plant's operation.

(g) If any Plant is constructed on the Chenab Main at a site below Kotru (Longitude 74° - 59' East and Latitude 33° - 09' North), a Regulating Basin shall be incorporated.

9. to 23. XXXXX

Part 4 – New Plants on Irrigation Channels XXXXX

Part 5 – General XXXXX

ANNEXURE-E: Storage of waters by India on the Western Rivers (Article III(4)

1. The provisions of this Annexure shall apply with respect to storage of water on the Western rivers, and to the construction and operation of Storage works thereon, by India under the provisions of Article III (4).

2. As used in this Annexure:

(a) “Storage work” means a work constructed for the purpose of impounding the waters of a stream, but excludes

(i) a Small Tank,

(ii) the works specified in Paragraphs 3 and 4 of Annexure D, and

(iii) a new work constructed in accordance with the provisions of Annexure D.

(b) "Reservoir Capacity" means the gross volume of water which can be stored in the reservoir.

(c) "Dead Storage Capacity" means that portion of the Reservoir Capacity which is not used for operational purposes, and "Dead Storage" means the corresponding volume of water.

(d) **"Live Storage Capacity"** means the Reservoir Capacity excluding Dead Storage Capacity, and "Live Storage" means the corresponding volume of water.

(e) **"Flood Storage Capacity"** means the portion of the Reservoir Capacity which is reserved for the temporary storage of flood waters in order to regulate downstream flows, and "Flood Storage" means the corresponding volume of water.

(f) "Surcharge Storage Capacity" means the Reservoir Capacity between the crest of an uncontrolled spillway or the top of the crest gates in normal closed position and the maximum water elevation above this level for which the dam is designed, and "Surcharge Storage" means the corresponding volume of water.

(g) **"Conservation Storage capacity"** means the reservoir capacity excluding Flood storage capacity, Dead storage capacity and Surcharge storage capacity, and "Conservation storage" means the corresponding volume of water.

(h) **"Power Storage Capacity"** means that portion of the Conservation Storage Capacity which is designated to be used for generating electric energy, and "Power Storage" means the corresponding volume of water.

(i) **"General Storage Capacity"** means the Conservation Storage Capacity excluding Power Storage Capacity, and "General Storage" means the corresponding volume of water.

(j) "Dead Storage Level" means the level of water in the reservoir corresponding to Dead Storage Capacity, below which level reservoir does not operate.

(k) "Full Reservoir Level" means the level of water in the reservoir corresponding to Conservation Storage Capacity.

(l) "Multi-purpose Reservoir" means a reservoir capable of and intended for use for more than one purpose.

(m)"Single-purpose Reservoir" means a reservoir capable of and intended for use for only one purpose.

(n) "Small Tank" means a tank having a Live Storage of less than 700 acre-feet and fed only from a non-perennial small stream: Provided that the Dead Storage does not exceed 50 acre-feet.

3. There shall be no restriction on the operation as heretofore by India of those Storage works which were in operation as on the Effective date or on the construction and operation of Small Tanks.
4. to 6. XXXXX
7. **The aggregate storage capacity of all Single-purpose and Multi-purpose Reservoirs** which may be constructed by India after the Effective Date on each of the River Systems specified in Column (2) of the following table shall not exceed, for each of the categories shown in Columns (3), (4) and (5), the quantities specified therein :

	River System	*Conservation Storage Capacity*		
		General Storage Capacity	*Power Storage Capacity*	*Flood Storage Capacity*
(1)	(2)	(3)	(4)	(5)
		…… million acre- feet ……		
(a)	The Indus	0.25	0.15	Nil

(b)	The Jhelum (excluding the Jhelum Main)	0.50	**0.25**	0.75
(c)	The Jhelum Main	Nil	Nil	As provided in Paragraph 9
(d)	The Chenab(excluding the Chenab Main)	**0.50**	**0.60**	Nil
(e)	The Chenab Main	Nil	**0.60**	Nil

Provided that

(i) **The storage specified in Column (3) above may be used for any purpose whatever, including the generation of electric energy;**

(ii) **The storage specified in Column (4) above may also be put to Non-Consumptive Use (other than flood protection or flood control) or to Domestic Use;**

(iii) **India shall have the option to increase the Power Storage Capacity specified against item (d) above by making a reduction by an equal amount in the Power Storage Capacity specified against items (b) or (e) above ; and**

(iv) Storage Works to provide the Power Storage Capacity on the Chenab Main specified against item (e) above shall not be constructed at a point below Naunut (Latitude 33° 19' N. and Longitude 75° 59' E.).

8. The figures specified in Paragraph 7 shall be exclusive of the following:

(a) Storage in any Small Tank.

(b) Any natural storage in a Connecting Lake, that is to say, storage not resulting from any man-made works.

(c) Waters which, without any man-made channel or works, spill into natural depressions or borrow-pits during floods.

(d) Dead Storage.

(e) The volume of Pondage for hydro-electric plants under Annexure D and under Paragraph 21(a).

(f) Surcharge Storage.

(g) Storage in a Regulating Basin (as defined in Annexure D).

(h) Storage incidental to a barrage on the Jhelum Main or on the Chenab Main not exceeding 10,000 acre-feet.

9. to 10. XXXXX

11. The **design of any Storage Work** (other than a Storage Work falling under Paragraph 3) shall conform to the following criteria:

(a) The Storage Work shall not be capable of raising artificially the water level in the reservoir higher than the designed Full Reservoir Level except to the extent necessary for Flood Storage, if any, specified in the design.

(b) The design of the works shall take due account of the requirements of Surcharge Storage.

(c) The volume between the Full Reservoir Level and the Dead Storage Level of any reservoir shall not exceed the Conservation Storage Capacity specified in the design.

(d) With respect to the Flood Storage mentioned in Paragraph 9, the design of the works on the Jhelum Main shall be such that no water can spill from the Jhelum Main into the off-channel storage except when the water level in the Jhelum Main rises above the low flood stage.

(e) Outlets or other works of sufficient capacity shall be provided to deliver into the river downstream the flow of the river received upstream of the Storage Work, except during freshets or floods. These outlets or works shall be located at the highest level consistent with sound and economical design and with satisfactory operation of the Storage Work.

(f) Any outlets below the Dead Storage Level necessary for sediment control or any other technical purpose shall be of the minimum size, and located at the highest level, consistent with sound and

economical design and with satisfactory operation of the Storage Work.

(g) If a power plant is incorporated in the Storage Work, the intakes for the turbines shall be located at the highest level consistent with satisfactory and economical construction and operation of the plant and with customary and accepted practice of design for the designated range of the plant's operation.

12. To enable Pakistan to satisfy itself that the design of a storage work (other than a storage work falling under Paragraph 3) conforms to the criteria mentioned in Paragraph 11, India shall, at least six months in advance of the beginning of construction of the Storage work, communicate to Pakistan in writing the information specified in the Appendix to this Annexure; if any such information is not available or is not pertinent to the design of the Storage work or to the conditions at the site, it will be so stated:

    Provided that, in the case of a Storage work falling under Paragraph 9,

    (i) XXXXX

    (ii) XXXXX

13. Within three months (or two months, in the case of a Storage Work specified in Paragraph 9) of the receipt by Pakistan of the information specified in Paragraph 12, Pakistan shall communicate to India in writing any objection that it may have with regard to the proposed design on the ground that the design does not confirm to the criteria mentioned in Paragraph 11. If no objection is received by India from Pakistan within the specified period of three months (or two months, in the case of a Storage work specified in Paragraph 9), then Pakistan shall be deemed to have no objection.

14. If a question arises as to whether or not the design of a Storage work (other than a Storage work falling under Paragraph 3) conforms to the criteria set out in Paragraph 11, then either Party

may proceed to have the question resolved in accordance with the provisions of Article IX(1) and (2).

15. (a) If any alteration proposed in the design of a Storage work (other than a Storage work falling under Paragraph 3) before it comes into operation would result in a material change in the information furnished to Pakistan under the provisions of Paragraph 12, India shall immediately communicate particulars of the change to Pakistan in writing and the provisions of Paragraph 13 and 14 shall then apply, but where a period of three months is specified in Paragraph 13, that period shall be reduced to two months.

    (b) If any alteration proposed in the design of a Storage work (other than a Storage work falling under Paragraph 3) after it comes into operation would result in a material change in the information furnished to Pakistan under the provisions of Paragraph 12, India shall, at least four months in advance of making the alteration, communicate particulars of the change to Pakistan in writing and the provisions of Paragraph 13 and 14 shall then apply, but where a period of three months is specified in Paragraph 13, that period shall be reduced to two months.

16. In the event of an emergency arising which requires repairs to be undertaken to protect the integrity of a Storage work (other than a Storage work falling under Paragraph 3), India may undertake immediately the necessary repairs or alterations; if these repairs or alterations result in a change in the information furnished to Pakistan under the provisions of Paragraph 12, India shall, as soon as possible, communicate particulars of the change to Pakistan in writing to enable Pakistan to satisfy itself that after such change the design of the work conforms to the criteria specified in Paragraph 11. The provisions of Paragraph 13 and 14 shall then apply.

17. The Flood Storage specified against item (b) in Paragraph 7 may be effected only during floods when the discharge of the river exceeds

the amount specified for this purpose in the design of the work; the storage above Full Reservoir Level shall be released as quickly as possible after the flood recedes.

18. **The annual filling of Conservation Storage and the initial filling below the Dead Storage Level, at any site, shall be carried out at such times and in accordance with such rules as may be agreed upon between the Commissioners. In case the Commissioners are unable to reach agreement, India may carry out the filling as follows:**

(a) XXXXX

(b) XXXXX

(c) **if the site is on The Chenab, between 21st June and 31st August at such rate as not to reduce, on account of this filling, the flow in the Chenab Main above Merala to less than 55,000 cusecs.**

19. The Dead Storage shall not be depleted except in an unforeseen emergency. If so depleted, it will be refilled in accordance with the conditions of its initial filling.

20. **Subject to the provisions of Paragraph 8 of Annexure C, India may make releases from Conservation Storage in any manner it may determine.**

21. If a hydro-electric power plant is incorporated in a Storage Work (other than a Storage Work falling under Paragraph 3), the plant shall be so operated that:

(a) the maximum Pondage (as defined in Annexure D) shall not exceed the Pondage required for the firm power of the plant, and the water-level in the reservoir corresponding to maximum Pondage shall not, on account of this Pondage, exceed the Full Reservoir Level at any time; and

(b) except during the period in which a filling is being, carried out in accordance with the provisions of Paragraph 18 or 19, the volume of water delivered into the river below the work during any period of

seven consecutive days shall not be less than the volume of water received in the river upstream of the work in that seven-day period.

22. In applying the provisions of Paragraph 21(b):

(a) the period of seven consecutive days shall commence at 8 A.M . on every Saturday and the time shall be Indian Standard Time ;

(b) a tolerance of 10% in volume shall be permissible and adjusted as soon as possible; and

(c) any temporary uncontrollable retention of water due to variation in river supply will be accounted for.

23. When the Live Storage Capacity of a Storage Work is reduced by sedimentation, India may, in accordance with the relevant provisions of this Annexure, construct new Storage Works or modify existing Storage Works so as to make up the storage capacity lost by sedimentation.

24. XXXXX

25. If the change referred to in Paragraph 5(a) or 15 is not material, India shall communicate particulars of the change to Pakistan, in writing, as soon as the alteration has been made or the repairs have been undertaken. The provisions of Paragraph 6 or Paragraphs 13 and 14, as the case may be, shall then apply.

CHAPTER – V

SURVEY & INVESTIGATION

CHAPTER-V

SURVEY AND INVESTIGATIONS

5.0 INTRODUCTION

Uri-I stage-II Hydroelectric project with an installed capacity of 2 x 120 = 240 MW is an extension of Uri-I Stage-I Hydroelectric project (Uri Power station / Uri H E Project). Uri Power station, a Run-off the River scheme is located (Plate 5.1) on river Jhelum in Uri Tehsil of Baramulla district in UT of Jammu and Kashmir was commissioned in May' 1997, with an installed capacity of 4 x 120 = 480MW. The project area lies in Survey of India Toposheet No. 43 J/4 and is bounded between latitude 34°06' to 34°09' and longitude 74°03' to 74°12'. The present scheme (Uri-I Stage-II H.E. Project) is planned as per provision kept in the DPR of Uri H E Project. Thus, in addition to barrage, the surface water conveyance system consisting of Head regulator to HRT intake of Uri power station shall also be utilized for stage-II project. Accordingly, the general layout of the project, size and dimensions of various components/ structures has been adopted based upon built in structures of Uri-I Power Station. As such, one 6.5m dia, 10.5Km long HRT, an underground Powerhouse complex and one 6.5m dia, 2.3Km long TRT are envisaged in the current proposal.

Background:

The Geotechnical investigation of Uri Hydroelectric project was started in 1972 by Power Development Department of J&K State (JKPDD). Various alternatives / layouts were examined during DPR stage and project was planned to be developed in two stages. Accordingly, the detailed project report of Uri H E Project (stage-I) was submitted by JKPDD in 1974, with provision of stage-II at later stage. In the stage-I a common diversion arrangement of Barrage complex for both stage-I & II and construction of water conductor system for stage-I with an installed capacity of 480MW was planned. For utilizing the infrastructure and Access Adits constructed during the stage-I for the development of stage-II extension at later date, all the structures of stage-I were aligned on hill side.

It is worthwhile to mention here that despite difficulties of Himalayan terrain, complex geological conditions and their encounterance during the construction of project structures, stage-I project was completed successfully and in operation since 1997. It is also pertinent to mention here that the construction of intake and excavation of HRT of about 30m length for stage-II has already been completed during the stage-I construction. The geological details collected during investigation and construction stage of Uri Power Station provide very useful geological data for the structures envisaged in the stage-II project as well. The gamut of geological data and experience gained from stage-I construction provides great help in evaluation of geological conditions of proposed structures.

5.1 TOPOGRAPHICAL SURVEY

Topographical survey of the project area is carried out with the objective of preparing grid maps, establishing ground control points etc for all proposed structures of Uri-I stage-II project. Detailed topographic survey was carried out with the help of two nos high precision Total Station of Leica Make TC-1201 for collecting filed survey data. The field data has been processed with the help of softwares like Autodesk, Liscad etc and finally contour plans/ topographical maps has been developed with required scale and contour interval for various project components.

5.2 ARCHEOLOGICAL SURVEYS IN THE RESERVOIR AREA

Uri reservoir is common for both stage-I and stage-II schemes. Existing reservoir is in operation since 1997 and no site of national importance was notified by Archaeological survey of India in the reservoir area. Further, Archaeological Survey of India, Srinagar circle vide letter no. DAMA/957-59/ AMA-203/NHPC dated 06.10.2021 has forwarded the application for grant of NOC along with Form I and II duly filled and inspection report with other relevant documents to competent authority i.e Chairman, National Monument Authority, New Delhi. Subsequently, final NOC has been received vide letter no. DOAAM-AMA/1/2021-02/918-19 dated 20.07.2022. Copy of above-mentioned letter is enclosed in Appendix-XI of Volume-VIA of DPR.

5.3 MINERALOGICAL SURVEYS IN THE CATCHMENT AREA

Uri reservoir is common for both stage-I and stage-II schemes. No change in existing reservoir level is envisaged. It is pertinent to mention here that no minerals of economic significance were observed within the submergence area of the reservoir. Directorate of Geology & Mining, Govt. of J&K UT vide letter JDK/DGM/SGR/F-79/4306-08 dated 28.07.2021 issued NOC for Uri-I Stage-II Project. Copy of NOC is enclosed in Appendix - XI of Volume-VIA of DPR.

5.4 RIGHT OF WAY SURVEYS FOR THE RESERVOIR

Since the existing reservoir to be utilised, no additional road or other infrastructures works are envisaged. In the immediate upstream of Uri reservoir another hydel power station named Lower Jhelum Project (LJP) is exist. The access to right bank villages is provided in the upstream of LJP through a bridge. On the left bank of Uri barrage and reservoir, NH - 1 exists connecting Srinagar to Muzaffarabad in POK. It is also pertinent to mention here that no family is affected due to construction of Uri-I stage-II H E Project.

COMMUNICATION SURVEYS

The Uri-I stage-II Hydroelectric Project is well connected by Road i.e located on NH –1 connecting Uri, District Baramulla, J&K to rest of India via Jammu and Srinagar. The nearest airport is located in Srinagar, capital of UT of Jammu & Kashmir. The nearest rail head is Baramulla located about 30Km from Barrage complex near Boniyar village, district Baramulla. However, as on date operational rail network is up to Katra from Jammu and from Banihal to Baramulla. The construction work of train route from Katra to Banihal is in progress and expected to be completed by 2022. The Jammu–Baramulla line railway track is being laid to connect the Kashmir Valley in the Indian union territory of Jammu and Kashmir with Jammu railway station and thence to the rest of the country. The 356 km railway track will start from Jammu and end at Baramulla. No additional infrastructure is required for the construction of the project. A good amount of residential, field hostels, transit camps of Uri

Power station are available and shall be utilised for the required NHPC staff for the project. A well-established Kendriya Vidyalay is also located within the colony area up to Class XII standard which can be used for both NHPC and contractor staff. Brief details of road network, telephone connectivity and power supply is elaborated below:

5.5.1 Road Communication Networks

Uri-I stage-II project is located at about 90Km from Srinagar and connected by NH - 1. All the project components are located on left bank adjacent to NH–1. The access Adits constructed for stage-I shall be utilised for stage-II scheme as well and as such no additional portal is required and hence any disturbance to public traffic is not posed due to construction of the project.

Public goods including construction material like cement & steel are being supplied to the ***Baramulla*** town which is about 30Km from Project area. The road is all weather National Highway. People commute through local bus / taxi service. The project area receives heavy snow during the months January and February, however, there is a system to clear snow within few hours. So the road is operational throughout the year.

5.5.2 Telephone Lines

Presently, telecommunication facilities at Project area are very good. Multiple operators such as BSNL, Airtel, Vodafone, Jio are providing telephone / mobile services (up to 4G) in the project area. Apart from these, EPBX facility and walkie talkie are also available in the project area.

5.5.3 Power supply

Very good Power supply system is available in the project area. The project area falls in very cool climate during winter season i.e from November to March and hence domestic power consumption is high.

5.6 GEOLOGY AND GEOTECHNICAL FEATURES

5.6.1 Regional Geology

Uri-I Stage-II Hydroelectric Power project is an extension of Uri-I Power station is located on the eastern part of the Kashmir syntaxial bend of the northwest Himalaya where the arcuate ridges are aligned nearly along NE-SW. The project area lies in Survey of India Toposheet No. 43 J/4 and is bounded between latitude 34°06' to 34°09' and longitude 74°03' to 74°12'. Regional geological map of project area has been prepared from the Geological survey of India online portal **"bhokosh.gsi.gov.in"** and appended as Plate 5.1. Description of regional geology for Toposheet No. 43 J/4 collected from GSI, Lucknow as under.

Regional Geology of Toposheet No. 43J/04: (Source: GSI, Lucknow)

The area forms parts of Muzaffarabad, Punch and Kashmir North (Baramula) districts of Jammu and Kashmir State, India. The important locations of the area are well connected by metalled and unmetalled roads. Kazinag Dhar, Lain Dori, Kala Pahar, Garaja gali, Sidh Kanu Shah gali and Uruskhan gali are some of the famous ridges and passes which, at times, are being used for commutation.

Physiographically, the area shows rugged and undulating topography with high ridges and deep valleys, which range in elevation from 1237 m to 4399 m above the msl. The Jhelum river with its tributaries like Islamabad *nala*, Dachhawar *nala*, Salamabad *nala* and Hapat Khai *nala* drain the area. Numerous perennial springs are also present in the area.

Geologically, the area exposes rocks of Salkhala Formation, Dogra Group, Pir Panjal Group, Kazinag Granite, Palaeozoic basics, Subathu Formation, Murree Group, Karewa Group and undifferentiated Quaternary deposit. The Salkhala Formation of undifferentiated Proterozoic age is exposed in the north of Jhelum river flanked on either side by the rocks of Dogra (≡ Buniyar) Group with faulted contact in the north and thrusted contact (Chhulan Thrust) the in south, which is concealed under Quaternary sediments. Further eastwards, the rocks are unfossiliferous and comprise garnetiferous sericite phyllite, quartz-chlorite schist, calc schist, graphitic limestone, marble with gypsum

and graphite. The rocks of the Dogra Group (≡ Buniyar Group) of Meso-Proterozoic age occur on both sides of Jhelum river and is divisible into three formations namely Tirkanjan (≡ Bafliaz), Baren (≡ Chandimar) and Chananwari (≡ Kalamund) formations. The Tirkanjan Formation comprises grey sericite phyllite and chlorite phyllite with penecontemporaneous lava flows. The overlying Baren Formation is exposed on the both sides of the Jhelum river. It extends from Dachhawar in the west to Chitrakot in the east. It consists of grey quartz sericite phyllite, quartz-chlorite phyllite and basic lava flows. A thick sequence of basic lava flow is encountered below this formation between Dachhi and Nambla, which is considered the north-western extension of Bafliaz volcanics. The unconformably overlying Chananwari Formation comprises grey massive unfossiliferous arenite. The Panjal Volcanics of Early Permian age of Pir Panjal Group is exposed around Dachhi, Garhkot and Nambla. It comprises light to dark green amygdaloidal andesitic to basaltic lava flows. Dogra Group is intruded by the Kazinag Granite of Palaeozoic age. It comprises medium to coarse-grained biotite granite, porphyritic granite, tourmaline granite, pegmatite and quartz veins. Dogra Group is also intruded by Palaeozoic basic to ultra-basic dykes. The Subathu Formation (≡ Nummulitic Limestone) of Palaeocene to Eocene age comprises grey limestone and shale sequence with Nummulites. The Lower Murree Formation of Murree Group of Late Eocene to Early Miocene age is exposed in the southwestern part around Uri. It comprises grey coloured sandstone, shale and siltstone. A small outcrop of Karewa Group of Pliocene to Pleistocene age, represented by the Hirpur Formation, is exposed in the north-eastern part. It consists of sandy clay, clay stone and gravel. The undifferentiated Quaternary deposit is represented by alluvium, moraines, talus and scree. These are un-assorted deposits located generally along the major streams and foothills.

During the investigation and construction stage of Stage-I Project rock types of quartzitic schist, metavolcanics, limestone & shale intercalations have been encountered in HRT, TRT & Powerhouse area. The present proposal is an extension of the existing Stage-I project in the same geological regime.

5.6.2 Geological and geotechnical investigations at Project area

Detailed geological appraisal along with all the Geological and Geotechnical investigations are documented in Volume – VI (Geological Aspects) and Volume – VIA (Annexure Volume) of DPR. Brief details of various geotechnical investigations and geotechnical evaluation of proposed project components is summarised in succeeding paragraphs.

5.6.2.1 Alternative Studies

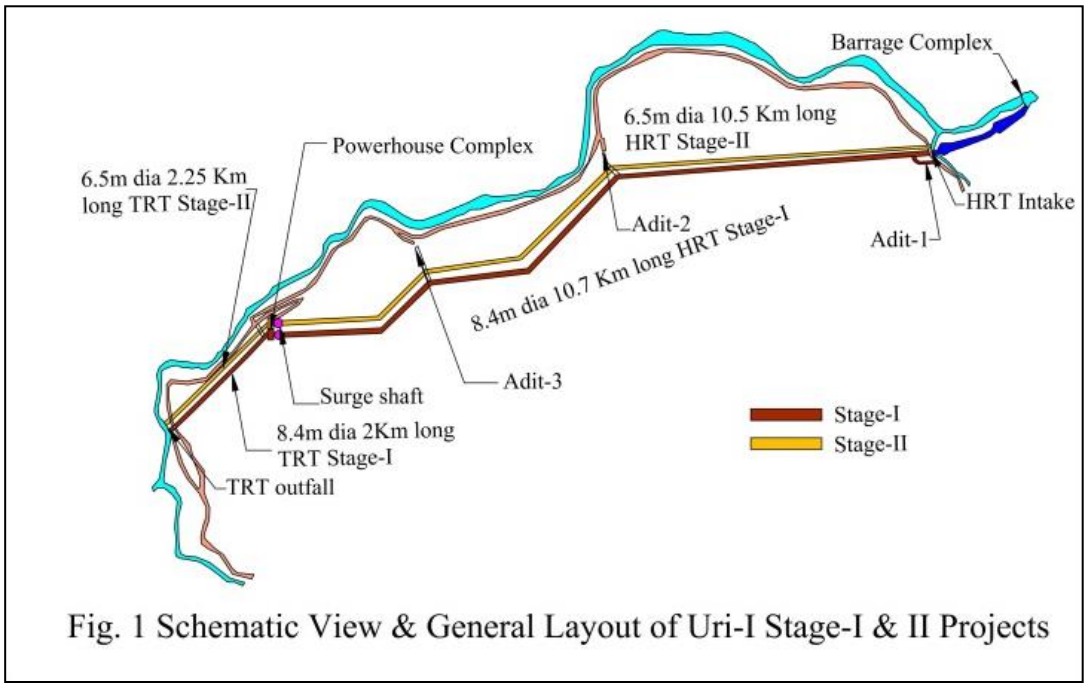


Fig. 1 Schematic View & General Layout of Uri-I Stage-I & II Projects

Uri-I Stage-II H E Project is an extension scheme of Uri-I Stage-I H E Project named as Uri Power Station which is in operation since 1997. The provisions for stage-II were laid in the DPR of Uri Power Station and accordingly HRT intake, an initial reach of about 30m HRT and part of powerhouse central gullet have already been excavated during the construction of stage-I project. Accordingly, keeping in view the topographical conditions and available geological data, existing structures, proposed layout (Fig.1) of the Stage-II scheme was reviewed and the new layout of said scheme was finalized and no further alternative studies are required. The major structures envisaged in the present proposal are as under:

- The 6.5m dia,10.5Km long HRT is aligned parallel towards valley side of existing stage-I HRT and having lateral distance of approx. 200m in the major length and about 125m apart near Adit-2 / Adit-3.
- The 6.5m dia, 2.3 Km long TRT is aligned parallel towards valley side of existing stage-I TRT and having lateral distance of approx. 200m in the major length and about 35m apart near TRT outfall.
- The Powerhouse complex is an extension of similar structure of stage-I and necessary adit arrangements are already taken care during its construction.

5.6.2.2 Previous surface & subsurface Investigations:

Investigations of Uri H E Project as a combined scheme were started by J&K Power Development Department in 1972. The geological studies were conducted in association with Geological Survey of India during 1973-1977. Further, detailed project report (Geology volume) was submitted in 1977 for development of stage-I project with a provision to develop stage-II at later date. TEC of the said project was accorded in 1979. Further, the project was handed over to NHPC in 1981. Subsequent to allotment of the project, NHPC had carried out preconstruction stage investigation from 1981 to 1989. After award of work on turnkey basis to Swedish and British consortium (SWECO) few more additional investigation were also carried for firming up the layout. As per the provisions kept in DPR and clearance from CWC/CEA, construction of Uri-I stage-I project was completed along with construction of intake and 30m long HRT for stage-II project. Proposed structures of HRT, TRT and Powerhouse complex are located within the same geological regime that was encountered during the construction of similar structures of stage-I project.

During the DPR stage and construction stage of Uri-I Power station geotechnical investigation were carried out that include topographical survey, detailed geological mapping of project area covering all the components including reservoir area, petrographic studies, exploratory drilling, exploratory drifting, geophysical survey, in-situ rock mechanic testing and construction

material survey works. The geology encountered along HRT & TRT during the construction stage is documented in the form of geological strip logs.

5.6.2.3 Field Investigations of Uri-I Stage-II H E Project

Surface and subsurface geotechnical investigations were carried out for proposed project components of Uri-I Stage-II H. E. Project. The same are discussed as under.

5.6.2.3.1 Geological Mapping:

Detailed geological mapping of HRT, TRT and Powerhouse Complex has been carried out on available topographical plan with an objective to delineate various lithological units and their geotechnical properties. The geological details collected during the construction of stage-I project were also used for relevant structures of stage-II. Summary of extent of geological mapping carried out for stage-II project is given in Table 5.1.

Table 5.1: Details of Geological Mapping

S.No.	Component/ Structure	Scale
1	Barrage Complex (As built)	-
2	Intake & Adits	1:1000
3	Head Race Tunnel (HRT)	1: 10000
4	Powerhouse Complex (including surge shaft)	1: 1000
5	Tail Race Tunnel (TRT)	1 : 5000
6	TRT Outfall	1: 500

5.6.2.3.2 Discontinuity Survey

The rock mass in the project area comprised of three major rock formations viz quarzitic schists, metavolcanics and variegated shales with intercalation of limestones. The quartzitic schist and metavolcanics are metamorphosed with well-formed foliation planes as Joint Set-1. The rocks are steeply dipping at 65º to 85º and also show reversal of dips at places.

In case of quarzitic schist, several sets of joints are observed with local variations. Apart from the major discontinuities few random sub horizontal joints are also present. In quarzitic schist, mostly joints are rough and occasionally filled with clay or gouge. In metavolcanics, the joints are slightly rough and at times slicken sided. In metavolcanics numerous calcite and quartz veins of varying thickness has been found both along and across the foliation planes. In general, shale intercalated with limestone are thinly foliated and with few irregular sets of joints and due to intense folding and warping of beds due to Panjal thrust. Summary of major discontinuity characteristics are given in table 5.2 to 5.4.

Table 5.2 Discontinuity characteristics in Quartzitic Schist

Joint set	Av. Orientation	Persistence (m)	Spacing (cm)	Aperture/ Filling
S-1	340-035/70-85º	3 to >10	6-20	Tight to 20mm
S-1A	250-270/70-85º	2 to 8	6-20	Tight to 20mm
S-2	220-240/50-80º	2 to 7	20-60	Tight
S-3	060-080/70º	2 to 10	60-200	Tight
S-4	130-150/25-35º	2 to 7	60-200	Tight

Table 5.3 Discontinuity characteristics in Metavolcanics

Joint set	Av. Orientation	Persistence (m)	Spacing (cm)	Aperture/ Filling
S-1	340-035/70-85º	3 to >10	6-20	Tight to 20mm
S-2	220-240/50-80º	2 to 7	20-60	Tight
S-3	135-160/15-25	2 to 7	20-200	Tight
S-4	060-080/15-35º	2 to 10	60-200	Tight
R-1	300/80º	0.5 to 2	60-200	Tight
R-2	060/80	0.5 to 2	60-200	Tight

5.4 Discontinuity characteristics in Shales / Limestone

Joint set	Av. Orientation	Persistence (m)	Spacing (cm)	Aperture/ Filling
S-1	350-020/35-70º	3 to >10	6-20	Tight to 20mm
S-2	220-240/50-80º	2 to 7	20-60	Tight
S-3	135-150/60-80º	2 to 7	20-60	Tight
S-4	060-080/15-35º	2 to 10	60-200	Tight

5.6.2.3.3 Exploratory Drilling

As per available data, total 20 no. drill holes were drilled in the project area covering HRT, Surge shaft, Power House complex and TRT. Out of these 20 holes, 16 holes were drilled during investigation and construction phase of stage-I project. NHPC has also investigated the HRT and surge shaft area by two drill holes viz DH-1(80m) & DH3 (85m) respectively in year 2011-12. Further, one drill hole named DH-5 (80m) at HRT Kandarban Nala crossing at RD 7600m and another drill hole at proposed surge shaft location named DH-3A (210m) were also completed in 2021. Summary of structure wise drill holes are given in Table 5.5 to 5.7 and location of holes has been shown in geological plan of relevant structures. Geological logs of drill holes have been appended in Appendix - X of Volume-VIA of DPR.

Table 5.5 Summary of Exploratory Drilling in HRT Area

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type & Geotechnical characteristics
1	SHT-2	Nala crossing of Stage-II HRT d/s of Chandanwari RD ± 5550M	1506.9	105.2	11.4 / 1495.5	Light grey coloured fine grained schistose quartzite from depth 11.4 to end of the hole. RQD, in general of the order of 50 to 85%.

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type & Geotechnical characteristics
2	SHT-5	Nala Crossing of stage-II HRT, upstream of Mohura near near RD ± 5950M	1543.1	146.3	5 / 1538.07	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. RQD, in general of the order of 50 to 92%.
3	HRT-5	Kalas Nala Crossing of Stage-II HRT near RD ± 6660M	1520.0	88.4	9.5 / 1510.5	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. RQD, in general of the order of 25 to 75%.
4	DH-1	Mohura Nala Crossing of Stage-II HRT RD ± 6850M	1508.1	80.0	Entirely in Rock	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. RQD, in general of the order of 50 to 85% with few sections of poor RQD due to fractured rock mass. Permeability of bedrock is < 4 Lugeon.

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type & Geotechnical characteristics
5	DH-5	Kandarban Nala Crossing of Stage-II HRT RD ± 7660M	1523.1	80.0	9.5 / 1513.6	Light grey coloured fine grained schistose quartzite from depth 11.4 to end of the hole. In general poor RQD of less than 50%, due to fractured rock mass. Permeability of bedrock is less than < 4Lugeon

Table 5.6 Summary of Exploratory Drilling in Powerhouse Area

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type
1	SSS 1	Stage-I Surge shaft	1627.57	177.2	7.4m / 1620.2m	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. RQD, in general of the order of > 85% with few sections of poor RQD due to fractured rock mass.
2	DH-3	Pressure shaft alignment (Stage-II)	1549.13	85.0	24 m / 1525.1m	
3	DH-3A	Proposed surge shaft of stage-II	1638.5	210.0	24m / 1614.5m	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. Poor RQD <50% due to fractured rock mass.

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type
4	RLCC 1	Stage –I Power house Drift (Cavern Area)	± 1272.0	45.72	Entirely rock	Dark grey to greenish, thinly foliated metavolcanics with numerous quartz and calcite veins. RQD, in general of the order of > 85% with few sections of poor RQD due to fractured rock mass.
5	RRCC 5		± 1272.0	50.3		
6	SPH 1		1272.2	82.9		
7	SPH 2		1272.0	74.2		
8	SPH 3		1272.0	126.9		
9	SPH 4		1271.7	80.1		
10	SPH 5		1272.9	89.3		

Table 5.7 Sumary of Explorator Drilling at TRT area:

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type and Geotechnical characteristics
1	STT-3	TRT Stage-I Alignment	1531.2	108.2	21.7 / 1509.4	Thinly foliated, sheared and fractured metavolcanics with poor RQD.
2	SOL 1	TRT outfall	1265.0	85.6	68.9 / 1196.05	Thinly foliated, weak to medium strong, puckered variegated shales with intercalated limestone bands.
3	SOL 2	TRT outfall	1277.2	93.1	62.8 / 1214.4	

S. No.	Drill hole No	Location	Ground Elevation (M)	Total depth (m)	Bed rock depth(m) / Level(M)	Rock Type and Geotechnical characteristics
4	TRT 7	Left Bank, Jhelum upstream of TRT outfall	1310	67	39.6 / 1270.4	
5	TRT 8	Left Bank, Jhelum upstream of TRT outfall	1285	73.2	51.4 / 1233.6	

5.6.2.3.4 Exploratory Drifting:

Stage-I powerhouse was explored by excavating a drift (approx... 543.5m) having portal near Rajarwani village downstream of Adit-IV on NH-1 of drift along with cross cuts. Further, the existing stage-I TRT area was also explored by 3 no. drifts with cumulative length of 193m. In addition to the above, 3D geological logging central gullet of proposed stage-II powerhouse excavated during stage-I has been carried out. Summary of exploratory drifting data used for stage-II project is given in Table 5.8 and geological logs of same are appended in Appendix VIII & IX of Volume – VIA of DPR.

Table 5.8: Summary of Exploratory Drifting

S.No.	Name of Drift	Location	Length	Geological Description
1	Rajarwani Main Powerhouse Drift	Powerhouse (EL 1322 M)	405m	Moderately to closely foliated, grayish-green to green coloured schistose metavolcanics encountered. The moderately foliated rock mass are of rock class –II and thinly foliated bands are assessed of rock class-III.
2	Powerhouse Right Cross Cut	Powerhouse (EL 1322 M)	113.5m	
3	Powerhouse Left Cross	Powerhouse	25m	

S.No.	Name of Drift	Location	Length	Geological Description
	Cut	(EL 1322 M)		
4	UTRDR-5	TRT area (Near Cherian Nala) EL ±1350	105m	The drift is located on road side near Cherian Nala (Valley side of Stage-II TRT). In the initial 65m of drift thinly foliated, moderately to intensely jointed shales encountered of rock class – IV and followed by competent metavolcanics of rock class –III.
5	UPDR-2	TRT area (Near Bandy) EL ±1440 M	57m	The drift is located on hillside of stage-I TRT near Bandy Village. Moderately to thinly foliated, weak to medium strong, variegated (purple / green shales) of rock class – III & IV encountered.
6	UPDR-4	TRT area (Near Bandy) EL ±1410 M	31m	The drift is located between stage-I and stage-II TRT alignment at EL ± 1410M. Moderately to thinly foliated, weak to medium strong Variegated shales and limestone intercalations of rock class – III & IV encountered.

5.6.2.3.5 Geophysical Survey (Resistivity Imaging & Seismic Refraction)

Detailed high resolution geophysical resistivity imaging survey has been carried out to delineate the nature of rock mass and assessing major weak zones in TRT, HRT and Powerhouse areas. Resistivity imaging survey has been carried out utilizing Terrameter LS2 Imaging System (Guideline Geo, Sweden). Due to site limitations, few accessible areas have been utilized for laying resistivity imaging profiles.

Field Technique & Profile Layout:

Two-dimensional (2D) resistivity surveys are usually carried out using large number of electrodes connected to multi-core cables connected to the instruments (Fig.5.2). Data is collected by the instrument automatically for several datum points through a computerized switching system as per the selected electrode configurations (Fig. 5.3). An artificial source of current is injected into the subsurface through point electrodes and the resulting potential difference is measured at other electrodes positions in the neighbourhood of the current flow (Photo 5.1). Resistivity imaging was carried out utilizing Dipole-Dipole and Schlumberger protocols. The electrode spacing of 10m has been kept for profiles keeping in view the required depth as well as subsurface resolution. In order to ensure ground contact of electrodes for current penetration, electrodes of 1.0 m length of steel and 20mm diameter were utilized. Further, to increase the contact surface area of electrodes, these were driven with hammer in a small pit filled with clay, salt water mixture.

Depth of penetration of the resistivity imaging profiles varying from few meters to 190m depending upon the length of the profile. Data has been collected utilizing both dipole-dipole and Schlumberger protocols. However, after checking of consistency and error levels, data of suitable protocol has been selected for further processing & interpretation. Data has been processed with RES2DINV software for determination of two dimensional resistivity distribution of subsurface below the profiles.

Photo 5.1 Electrode placement with clay, salt water mixture for better connectivity

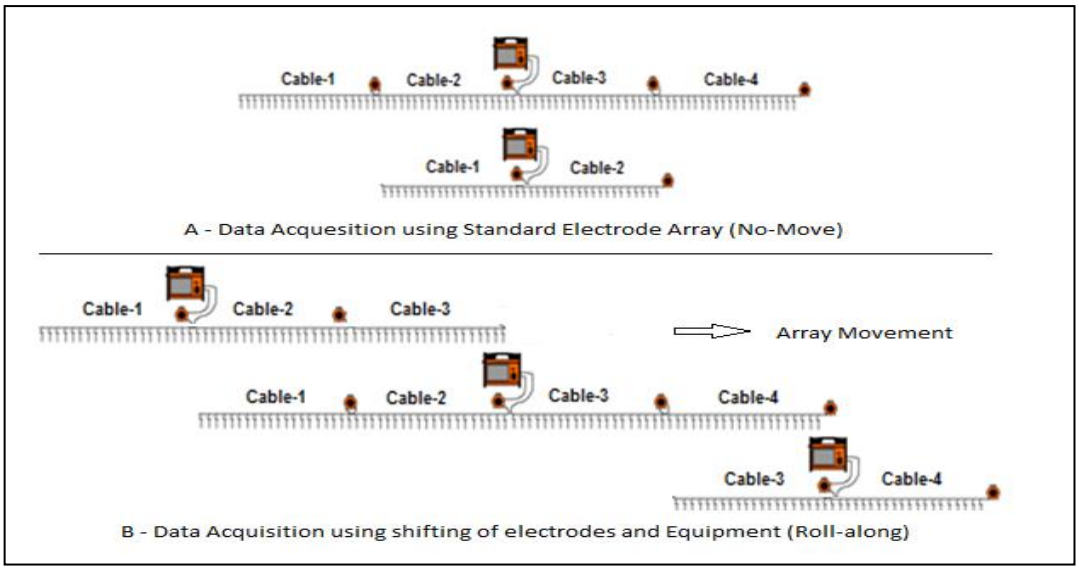


Fig 5.2. Schematic Diagram Showing Cables & Instrument

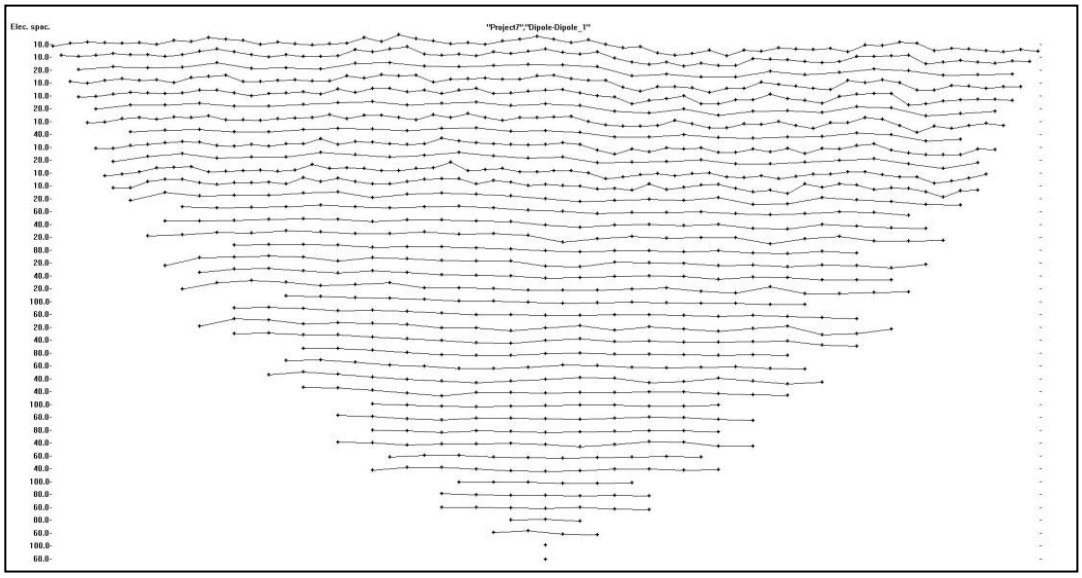


Fig 5.3. Actual Datum points collected along profile

Results:

The results of resistivity imaging at the project have revealed the subsurface geology. In all 9 profiles having cumulative length of 4456m were carried out covering HRT intake, three locations of low cover reaches of HRT, powerhouse central gullet and major length of TRT area. One test profile (Fig. 5.4) was also carried out for assessment of resistivity of variants of rock type within same geohydrological environment.

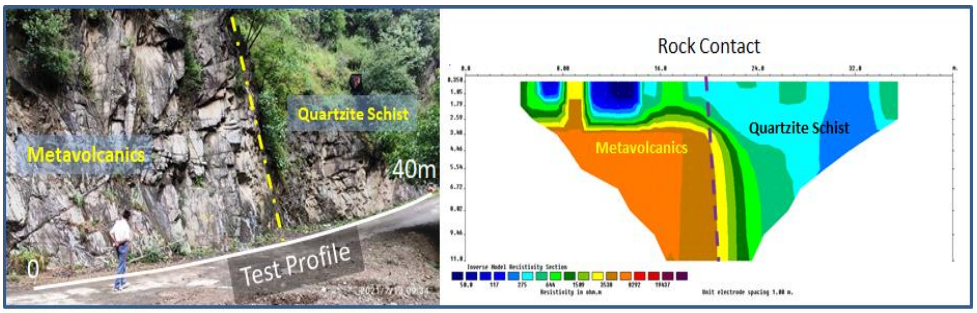


Fig. 5.4 Resistivity Imaging Test Profile showing Rock mass vis-à-vis Resistivity

One seismic refraction profile was also carried at Powerhouse central gullet to study the subsurface geology, especially under charged condition of existing powerhouse in the immediate vicinity. Study report on above geophysical survey is appended in Appendix – II of Volume – VIA of DPR. Summarized data of the said studies is given in Table 5.9.

Table 5.9 Geophysical Resistivity Imaging / Seismic Refraction Results

S.No	Profile No	Location	Length	Remarks
1	RI-1	HRT Intake	400m	The profile is laid above HRT intake. High resistivity values of >4000ohm-m indicates very strong competent rock mass.
2	RI-2	HRT Kandarban Nala Crossing	400m	The profile is laid across Nala at HRT alignment that has indicated moderate to fair rock mass having resistivity values >2000 ohm-m.
3	RI-3	HRT area, near Mohura village	400m	The profile is laid along HRT alignment at an offset of 100m on valley side corresponding to HRT RD 6850-7240M. The variation in resistivity values indicating two distinct lithology comprised of fair rock mass of

S.No	Profile No	Location	Length	Remarks
				weathered and fractured quarzitic schist and on upstream & downstream end and presence of fair to good rock mass of competent metavolcanics in the middle reach of profile.
4	RI-4	HRT area, Chandanwari Nala	400m	The profile is laid along left bank of Chandanwari nala across existing stage-I HRT and present HRT. The variation in resistivity values indicate two distinct lithology comprised of fair rock mass of quarzitic schist from Ch. 0-190m and beyond that fair to good rock mass of competent metavolcanics.
5	RI-PH	Powerhouse Central Gullet	56m	Results indicated fair to good rock mass of metavolcanics having resistivity values of the order of 5600 ohm-m.
6	RI-5	TRT Area near Bandy Village		The survey covers TRT alignment from RD± 500m to 2100M. In general, metavolcanic rocks are interpreted having resistivity values > 6000ohm-m. However, the fractured and sheared metavolcanics and massive limestone are having moderate resistivity in the order of 2500-
7	RI - 6	TRT Area near Bandy Village		

S.No	Profile No	Location	Length	Remarks
8	RI-7	TRT area near Rajarwani Village		4000 ohm-m. The water saturated zones of rock mass are interpreted to have resistivity values 300-500ohm-m. RI-5 & RI-6 were laid at EL ± 1420M and at El 1375M respectively near downstream end of TRT. These two profiles have clearly demarcated Panjal Thrust and also subsurface geology of TRT area depicted by clear contrast of resistivity images along the profile. These profiles also confirmed and identified the extent of saturation around existing stage-I TRT. RI-7 & RI-8 were laid along the TRT alignment revealed 3 zones of weak / jointed rock mass inferred by low resistivity values.
9	RI-8	TRT area downstream of Rajarwani Village		
10	P-1	Powerhouse Central Gullet	56m	As per seismic refraction profile, the seismic compressional wave velocity of the competent rock mass is approximately 4000m/sec. The blast induced disturbed zone extends up to 3-5m having average P-wave velocity of 2500m/sec. For competent rock mass, S-wave velocity has been observed as 2200m/s.

5.6.2.3.6 Rock Mechanic Testing

In-situ Rock Mechanic Tests

Stress Measurement in Power house Cavern: Rock stress measurements by over coring method were conducted in SPH-1 and SPH-4 bore holes in powerhouse cavern. The mean principle stress values are given below.

Sigma1 = 14 Mpa bearing 310°

Sigma2 = 5 Mpa bearing 120°

Sigma3 = 3 Mpa bearing 50°

In addition, In-situ rock mechanic testing for were also carried out in the powerhouse drift by CSMRS, New Delhi during 1980-1983 for determination of engineering properties of rock mass such as deformability and shear parameters. The summary of test results are given table in 5.10 and 5.11 and test reports are appended in Appendix – IV, V & VI of Volume – VIA of DPR.

Table 5.10 In-situ Shear Tests (Concrete to Rock)

S.No.	Location	Normal Stress (Kg/Cm^2)	Shear Stress (Kg/Cm^2)	Shear strength parameters
1	Left Cross Cut	4.34	6.31	C = 0.8 Kg/Cm^2 Ø = 38º
2	Left Cross Cut	6.64	11.83	
3	Left Cross Cut	3.25	4.53	
4	Right Cross Cut	8.1	14.94	

Table 5.11 Test Results of In-situ Deformation by Flat Jack Tests

S.No.	Location	Mean Modulus of Deformation in GPa	Mean Elastic Modulus in GPa	Direction	Stress Level in Kg/Cm^2
1	Power House Drift	1.5 to 13.4	3 to 19	Vertical	33-39
				Horizontal	43-46

Laboratory Rock Mechanic Tests

Laboratory rock mechanic tests were conducted in July-August 2021 on variants of rock types in HRT, Powerhouse and TRT area. The tests were conducted on core and rock samples of metavolcanics, quarzitic Schist / schistose quartzite and purple shales. The above tests results indicate that in general quartzitic schist & metavolcanics rocks are competent whereas shales are relatively weaker rock mass. Summarized test results are given in Table 5.12 and study report is appended in Appendix – I of Volume – VIA of DPR.

Table 5.12 Laboratory Rock Mechanic Test Results

S.No	Test / Physical Property	Rock Type		
		Quartzitic Schist	Metavolcanics	Shale
1	Bulk Density (g/cc)	2.65	2.91	2.74
2	Water absorption (%)	0.24	0.16	0.47
3	Porosity (%)	0.64	0.46	1.28
4	Slake Durability index (%)	99.3	98.74	98.11
5	UCS (Mpa) – Dry	192	76	-
6	UCS (Mpa) – Saturated	176	70	30
7	Tensile Strength (Mpa) - Dry	13.7	-	-
8	Tensile Strength (Mpa) – Saturated	13.2	9.49	-
9	Young's Modulus (GPa)	60.2	21.8	9.27
10	Cohesion (C) - Mpa	10.19	8.4	-
11	Friction Angle Ø (in degree)	63.36	62.5	-

5.6.3 GEOTECHNICAL APPRAISAL OF MAIN CIVIL STRUCTURES

5.6.3.1 Project Components

Uri-I Stage-II H E Project is an extension of existing Uri Power station. There is common barrage and diversion structure for both the schemes. In addition, HRT intake, a 30m long HRT and part of powerhouse central gullet for Uri-I stage-II have already been excavated during the construction of Uri Power station. Hence, present scheme proposes for construction of HRT, TRT and Underground Powerhouse Complex. All these structures are aligned in valley side and parallel to existing similar structures (Photo-5.2). The geotechnical evaluation of proposed project components is discussed here under.

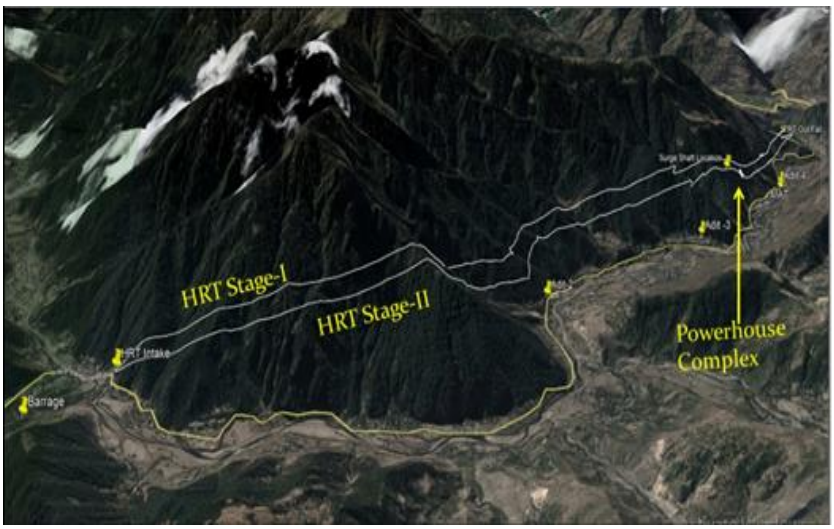


Photo 5.2 : Google Map View of Project Layout

5.6.3.2 Geotechnical Appraisal of Barrage Complex:

The barrage complex is situated immediately downstream of the confluence of River Jhelum and Limber or Warrikah Nalla. The barrage complex (Photo-5.3 & 5.4) is comprised of barrage, cut and cover culvert, desilting basins, head regulator, surplus escape and head race channel (Forebay). In addition, HRT intake and Buniyar nala training works were also completed. The Full reservoir level/ full supply water level upstream of the barrage is EL 1491.00 M. It is 95m long and 21.5m high from the deepest foundation level. The Top level of the Barrage is fixed as EL 1495.5m to provide free board and to

accommodate additional space for removal of logs and floating debris over the radial gate top.

Photo 5.3: Bird Eye View of Barrage Complex

5.6.3.2.1 Barrage Foundation:

The entire foundation of barrage and its appurtenant structures such as cut and cover culvert, desilting basin, head regulator, surplus escape and half portion of head race channel (forebay) were laid on overburden comprised of fluvioglacial material keeping in view of availability of rock at deeper elevation i.e EL ± 1450M. The spillway bays S-1 to S-6 were laid on right bank terrace deposit by excavating the river section. The under-sluice bays S-7 to S-9 were laid on undisturbed overburden material. The head regulator, desilting basin, surplus escape and cut & cover culvert were laid on undisturbed river borne material. A drainage gallery was also provided 13m downstream of barrage axis at EL 1478.9M and extended below the head regulator at EL 1477M. The natural riverbed coincides almost with the foundation level in the head regulator. The upstream part of the head regulator is founded on undisturbed soil and well compacted fill at EL1479.0 m. The downstream part is founded on a filter layer. Four concrete cutoff beams aligned parallel to the axis of barrage are provided at its base. The first one is 5 m deep and is located 30m upstream of the axis and second one is also 5 m deep along axis of the barrage. The remaining two are located 47.89m and 112.5m downstream of the axis respectively and are about 3.0 m & 9,5 m deep. To control seepage, multi-row grout curtain was carried out.

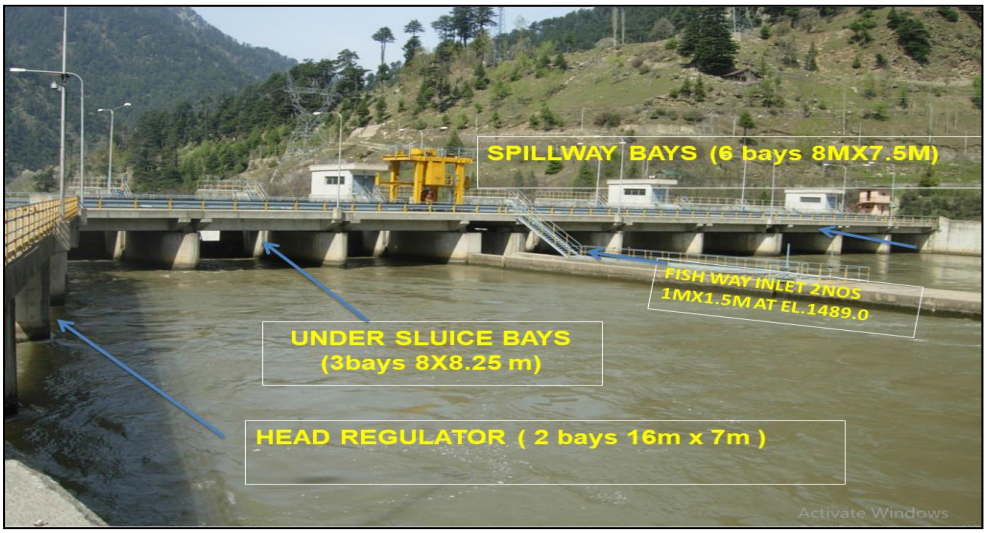


Photo 5.4 : View of Uri Barrage and Diversion Structure

5.6.3.2.2 Cut / Cover Culvert, Desilting Basins, Surplus Escape and Open Channel:

The diversion of water from barrage to the water conductor system has been routed **through** cut and cover culverts, desilting basins, head regulator and head race channel. A surplus escape channel was also provided in the downstream of desilting basin. The foundation was laid on the undisturbed fluvio glacial material of large sized boulders, pebbles and cobbles mixed in silty sand matrix.

5.6.3.2.3 Buniyar Nala Culvert and Head Race Tunnel Intake:

Photo 5.5: View of Existing HRT Intake / Buniyar Culvert Area

The Buniyar nalla is a perennial nala flowing across the alignment of Head Race Channel (Forebay) enroute to HRT intake. As such, a cut and cover culvert has been constructed below the nala (Photo-5.5). The culvert is 184m long and octagonal in shape having cross sectional area of 104 m^2. A bridge on NH - 44 was also provided on this culvert. Foundation of Culvert was laid at EL 1460M after excavation of nalla bed for about 10-12m depth. Bed rock was encountered near HRT intake and half of the length of culvert at foundation grade. HRT intake portal has been supported by 6m long grouted rock anchors / dowels at 2m C/C , 50mm shotcrete and pressure relief holes.

5.6.3.2.4 Reservoir:

The 21.5 m high barrage is a run-off the river scheme having reservoir extending about 0.9Km along river Jhelum. The reservoir capacity is 23.71Ha.m at FRL 1491M. The reservoir is under operation since 1997 and no changes are envisaged dur to construction of stage-II project. In the reservoir area, river Jhelum flows generally in NE-SW direction. The immediate slopes on both banks of the reservoir are gentle to moderate and occupied by thick pile of riverine / fluvioglacial material and slopewash material. However, the upper slopes are steep with rock cliffs. Bedrock of quartzitic schist, schistose quartzite are exposed in the vicinity of reservoir periphery.

Landslides

In general, the reservoir rim appears to be stable. There are no landslides in the reservoir area and has no implication of any kind whatsoever on the competency of the already operating reservoir.

Expectency of Leakage from Reservoir

Any leakage from the reservoir is not reported or observed since 1997.

5.6.3.2.5 Review of Safety and Stability of Barrage:

DAM Safety Review Panel (DSRP) for Uri–I barrage constituted for Review of Safety and Stability of Barrage had submitted its report in October 2020 with conclusion that “The Uri-I Barrage and its appurtenant structures are well

maintained and in good condition. All safety norms as applicable to dam/barrage safety are adhered and applied to keep the dam/barrage and its appurtenant works in safe condition. The condition of the Uri– I barrage is satisfactory and over all safety category of dam falls under CATEGORY –III".

5.6.3.3 Geotechnical Evaluation of HRT including Adits:

5.6.3.3.1 Layout :

A 6.5 dia, 10.5 Km long horse shoe shape HRT is envisaged from HRT intake near Buniyar Nala and joining underground surge shaft below Rajarwani ridge. For facilitating construction activities, the existing Adits namely Adit-I near HRT intake, Adit-2 near Chandanwadi Nala, Adit-3 near Mohura Nala and Adit-IV near powerhouse complex shall be used by extending them and aligning suitably. Geological Plan & Section of HRT is appended as Plate 5.2 & 5.3 respectively depicting surface and subsurface exploration data of proposed structures.

5.6.3.3.2 Constructed Adits :

For facilitiating construction of HRT for Stage-I, Four (04) nos D shaped 6.5m dia and 7m high Adits namely Adit-1, 2, 3 & 4 were constructed having length 373m, 514m, 611m and 2397m respectively. The adit-4 further provides access to surge shaft bottom, surge shaft top, pressure tunnel, penstocks and surge galleries. In general during the construction of adits, major problems were not encountered. However, in some reaches wet to flowing conditions were encountered that were dealt with timely support and grouting.

5.6.3.3.3 Proposed Adits for Stage-II HRT:

For facilitiating the construction of HRT of stage-II, the existing 4 Adits will be utilised in the intitial reach so that no additional portal developemnt is envisaged in the present proposal. However, branch out of Adits from the existing Adits is planned to intersect the HRT of stage-II at HRT RD ± 330, ±5245, ±7975 and ±10450M respectively. The branch adits will be named as Adit-1A, Adit-2A, Adit-3A and Adit-4A having lengths ±330m, ±550, ±450m and ±150m respectively. All adits will be D shaped having 6.5m dia and 7m height.

Adit-1A :

Adit -1A is located near HRT intake. Adit portal (Photo 5.6) already exists and is laid in strong to very strong, fine to medium grained, thinly foliated to blocky quartzitic schist. During the construction of Adit-1, the branch adit for Adit-1A was also excavated for a length of 10m. The proposed Adit-1A is passing ± 20m above stage-I HRT. There is superincumbent cover of about 60m near Adit-1 junction and rises thereafter up to ±300m near Stage-II HRT junction.

Photo 5.6 View of Adit-I Portal

In addition to geological mapping of Adit-1 / 1A area, one geophysical resistivity imaging profile named RI – 1 (Fig. 5.5) having a length of 400m has also been carried out above the tunnel portal which has indicated saturation of water around existing HRT area, otherwise indicating competent hard rock mass in the vicinity of Adit.

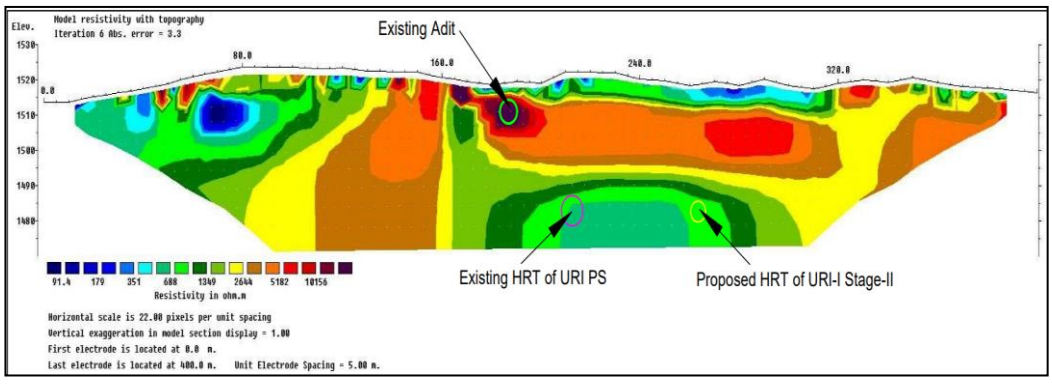


Fig. 5.5 Resistivity Imaging Profile RI-1 showing Rock mass vis-à-vis Resistivity

For assessment of geological conditions along tunnel alignment, geological plan and section along Adit has been prepared and appended as plate 5.5 & 5.5a in Volume – VI of DPR. Based on available surface & subsurface geological data, the proposed ±330m length of adit-1A will be negotiated by entirely one rock type i.e quartzitic schist. The rock mass is dissected by four joint sets viz. S1:260/80º, S2: 340º/80º S3: 070º/25º and S42: 355/50º and Random joint set 140/25º. Stereographic projection of discontinuities vis-à-vis tunnel alignment indicated stable rock mass with concurrent rock support. Upper right wedge formed due to intersection of joint sets S-1, S-2 & S-3 and roof wedges are formed due to intersection of S-1, S-2 & S-4 and S-1, S-4 & Random joint (140/25). All these three wedges are falling wedges having apex height varying from 0.20m to 0.82m which are stable with concurrent rock support. The report on stereoplot / wedge analysis is appended in Appendix – III of Volume – VIA of DPR. The rock mass rating has been assessed based on rock exposures near Adit-1 area and rock exposures along the road cut from boniyar to Uri. The geology encountered in the stage-I HRT and Adit-1 was also considered for evaluation of anticipated rock classes in the proposed Adit-1A. Based on the above geological data 15%, 65% and 20% length of adit-1A is expected to negotiate in class –II, III & IV respectively. At the location of HRT crossing, moderately to blocky quartzitic schist having RMR 41-50 indicating fair rock mass was encountered. Since, the branching of adit would be passing above the existing HRT, suitable protection measures / control blasting may be taken up during the excavation.

Adit - 2A :

Proposed 6.5m dia, D shaped, Adit - 2A is having about 546m length which is bifurcating from existing Adit-2 of stage-I at RD ± 210M. As such there is no requirement for development of portal for this Adit. Adit-2 (Photo 5.7) is located near Chandanwadi Nalla, a major tributary of Jhelum River on its left bank. Adit-2 has been laid in medium strong to strong, fine to medium grained, thinly foliated quartzitic schist. The proposed adit-2A is aligned almost perpendicular to existing Adit on downstream side up to RD ± 425M having driving direction varies from N 224º to N 205º and then taking

rightangle turn towarads HRT junction (RD ± 5356M) of stage-II having driving direction N 130. There is superincumbent cover varies between 55m and 155m along the tunnel alignment. Geological plan and section of Adit-2A have been prepared for assessment of geological condition along the tunnel alignment and are appended as plate 5.6 & 5.6a in Volume – VI of DPR.

Photo 5.7 View of Adit-2 Portal

Based on geological mapping, entire length of proposed Adit-2A will be negotiated by quartzitic schist. One geophysical resistivity imaging profile named RI-4 (Fig. 5.6) having length of 400m has been carried out along Chandanwani Nala near HRT confluence RD 4570M depicted fair to good rock mass of metavolcanics on hill side and quartzitic schist on valley side.

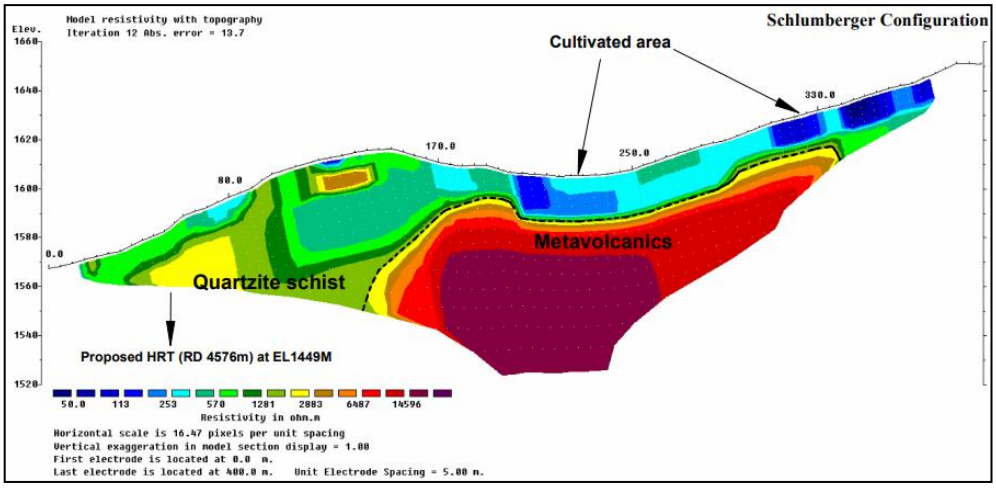


Fig. 5.6 Resistivity Imaging Profile RI-4 showing Rock mass vis-à-vis Resistivity

As such the entire length of Adit would be negotiating thinly to moderately foliated / blocky quartzitic schist. The rock mass is dissected by four joint sets S1:340/80º, S2: 245/45-70º, S3: 170º/50º, S4: 080º/45º, Random Joint 070/80. Stereographic projection of discontinuities vis-à-vis tunnel alignment indicated stable rock mass with concurrent rock support. Roof wedges having apex height varying between 0.37m to 1.29m are formed due to inetersection S-1 with S-2, S-3, S-4 & Random joint set. On the otherhand, upper left wedge is formed due to intersection of S-1, S-2 & S-3 and upper right wedge is formed due to intersection of S-2, S-3 & S-5 joints having apex height of wedge 0.36m and 0.29m respectively. Thus no major unstability is anticipated. The report on stereoplot / wedge analysis is appended in Appendix – III of Volume – VIA of DPR.

The rock mass rating has been assessed based on rock exposures near Adit-2 area and rock exposures near Chandanwari nala. The geology encountered in HRT stage-I and Adit- 2 are also considered for evaluation of anticipated rock classes for the proposed Adit-2A. In the initial reaches of Adit-2 thinly foliated, moderately jointed quartzitic schist with slightly to moderately weathered was encountered with presence of few shear seams and seepage conditions. The entire Adit 2 was negotiated by 85% class-III rock and 9% class-IV rock, balance in class-II. The Stage-I HRT in this area near adit-2 junction was also excavated in class-III rock without any major issues. Based on available surface and subsurface geological data, nature of rock mass vis-à-vis rock cover above the tunnel, it is anticipated that 20% , 65% and 15% length of adit-2A is expected to negotiate in class –II, III & IV respectively. Cautious approach may be taken during construction of Adit-2A bifurcation from the existing Adit by installing concurrent rock support with adequate provisions.

Adit - 3A :

Proposed 6.5m dia, D shaped, Adit - 3A is having about 450m length which is bifurcating from existing Adit-3 of stage-I at RD ± 350M. As such there is no requirement for development of portal for this Adit. Adit - 3A is located near Mohura Village. Adit portal (Photo 5.8) already exists and is laid in medium

strong to very strong, fine to medium grained, thinly foliated quartzitic schist. The proposed Adit-3A is aligned almost perpendicular to existing Adit on upstream side up to RD ± 105M having driving direction of N 058º and takes a turn to N 097º and aligned up to RD 390M before taking rightangle turn toward HRT junction (RD 7974). There is superincumbent cover varies between ± 100m and ±170m along the tunnel alignment. For assessement of geological conditions of tunnel, geological plan and section along Adit-3A has been prepared and appended as plate 5.7 & 5.7a in Volume-VI of DPR.

Photo 5.8 View of Adit-3 portal

The proposed 450m length of Adit-3A will be negotiated by entirely one rock type i.e quartzitic schist. Laboratory testing of rock sample (Quartzitic schist) collected near Adit-3 has been carried out and indicated very strong rock with UCS value of 176 MPa. In general, the rock mass in this area is thinly to moderately bedded, slightly weathered in nature with presence of saturated water conditions. The rock mass is dissected by four joint sets S1:350/75º, S2: 240/65º, S3: 060-70º/80º, S4: 150º/25º. Stereographic projection of discontinuities vis-à-vis tunnel alignment indicated stable rock mass with

concurrent rock support. The most probabilitic wedge is upper left wedge formed due to intersction of S-1, S-2 & S-3 (apex height 0.51m) and roof wedge formed due to intersection of S-1, S-2 & S-4 joints (apex height 0.62m). The report on stereoplot / wedge analysis is appended in Appendix-III of Volume – VIA of DPR. The rock mass rating (RMR) has been assessed based on rock exposures near Adit-3 area and rock exposures along the road cut from Adit-3 to Mohura Village. Geology encountered in the stage-I HRT and Adit-3 was also considered for evaluation of anticipated rock classes in the proposed Adit-3A. Adit-3 in major length of about 90% negotiated higher rock class-III indicating fair to competent rock with subordinate rock classes – II & IV of 2% and 8% respectively. Similarly, in the vicinity of proposed Adit, HRT of stage-I was also negotiated through rock class-III. As such, based on available surface and subsurface geological data, it is anticipated that 10% , 80% and 10% length of Adit-2A will be negotiated in class –II, III & IV respectively.

Adit-4A :

Proposed Adit - 4A is about 159m extended from existing Adit- 4 (Photo 5.9) at RD ± 1200M located in powerhouse complex, which will meet HRT at RD± 10450M just in the upstream of surge shaft bottom.

Photo 5.9 View of Adit-4 Portal

The location of tunnel alignment is marked in the geological plan of powerhouse complex appended as Plate 5.4. Geological section along Adit -4A is prepared for rock mass assessment and appended as plate 5.9 in Vol-VI of DPR. In the vicinity of proposed Adit-4A, the Adit-4 excavated during stage-I project negotiated rock class-III through thinly to moderately foliated metavolcanics with presence of few thin bands of graphitic schist / schist bands. It was observed that few zones of sheared and fractured rock also encountered in Adit-4 in the nearby area. As such, based on available surface and subsurface geological data, it is anticipated that 85% and 15% length of adit-4A will be expected to negotiate in class –III & IV respectively. A few sections of Adit, especially near the branching junction are expected to be in class IV rock mass and may be protected by initial rock support comprise of shotcrete and rock bolts and followed by permanent steel rib support.

5.6.3.3.4 Geotechncial Evaluation of HRT

Tunnelling Media: Based on available geological data and latest investigation results it is expected that in the initial reaches up to RD ± 6000 M, bedrock of predominantly quartzitic schist with metavolcanics sills will be negotiated. From RD ± 6000M onwards up to Surge shaft, the entire HRT will be negotiated through bedrock of metavolcanics in fair to good rock mass. Few stress related issues are expected between RD± 1200M to 4000M during the tunnel excavation where the super incumbent cover varies from more than ± 500m to maximum ± 760m. The rocks of quartzitic schist at places are highly fractured and intensely jointed and hence excessive ground water flow conditions in the tunnel cannot be ruled out being closely located water charged HRT of Uri-I stage-I. As such, to tackle the seepage issues, adequate provision will be kept for ground improvement measures. The tunnel would be passing below a number of valleys and ridges from RD 4500m onwards until Rajarwani ridge at RD 9000M. The rock cover is about 66m at RD ± 9140M. Further, the HRT would be negotiating such low cover zone through fractured and sheared rock mass near Kandarban Nala Crossing between RD 7700M to 8000M as inferred from Resistivity Imaging profile RI 2 and drill hole DH-5 which will be taken care off through adequate support measures. In the

balance reach the tunnel would be negotiating fair to good rock.

Rock Mass Classification along tunnel alignment: Based on the surface/subsurface investigations, it is expected that that the HRT would be negotiating quartzitic schist comprising of quarzitic schist, quartzite, phyllitic quartzite, graphitic schist intercalations and metavolcanics. (Plate 5.2 & 5.3) The quarzitic schists are thinly to moderately foliated whereas metavolcanics are thinly foliated in nature (Photo 5.10 to 13). The rock mass is dissected by four joint sets viz S1:350/80º, S1A:270/80º, S2: 220-240/70º, S3: 060º/70º, S4: 130-150º/25º and few random joints. The tunnel has five kinks along its alignment. In general, roof weges are formed due to intersection of S-1 joint with combination of S-2, S-3, S-4 having apex height varying between 0.20m to 1.63m. In addition, upper right and upper left wedges having sighnificantly very low apex height (falling wedges) are also formed due o intersection of various joint sets. As such no major instability is anticiapted during the construction of HRT. The report on stereoplot / wedge analysis is appended in Appendix-III of Volume-VIA of DPR.Based on the exploratory drilling, surface geological mapping, geological data available from the logs of stage-I HRT, the rock classes that would be negotiated at the proposed alignment of HRT have been assessed (Plate 5.4). It is anticipated that HRT will be negotiated through 20% class II, 70%Class III and 10% class IV rock mass.

Photo 5.10 Thinly Bedded Quartzitic Schist

Photo 5.11. Blocky Quartzite Schist near Adit-2

Photo 5.12 : Metavolcanics rock at Datta Mandir Nala

Photo 5.13 Contact of Quartzitic Schist with Metavolcanics

5.6.3.4 Geotechnical Evaluation of Powerhouse Complex

5.6.3.4.1 Layout:

The underground powerhouse complex comprises Machine Hall (about 55m central gullet already excavated), Transformer Cavern, Draft Tube Gate Hall, underground Surge shaft, Pressure shaft and other associated structures. For geological and geotechnical assessment of structures in powerhouse complex detailed geological mapping, exploratory drilling, drifting and rock mechanic tests have been carried out. For assessment of geological conditions of powerhouse complex, geological plan (Plate 5.4) and geological X section of powerhouse (Plate 5.5) has also been prepared.

5.6.3.4.2 **Powerhouse Cavern** (91m x 20m x 42.8m)**:**

The underground powerhouse complex comprises of Machine Hall (91m x 20m x 42.8m, (about 55m central gullet already excavated), Transformer Cavern (109m x 16.6m x 26.5m), Draft Tube Gate Hall (50m x 7.5m x 19m), Surge shaft (17m dia, 93.5 high), Pressure shaft and other associated structures. For assessment of various structures within powerhouse complex geological sections of powerhouse cavern, transformer cavern, surge gallery etc has been prepared and appended as plate 5.9 to 5.13 in Annexure Vol.VI of DPR.

Main powerhouse cavern (Machine Hall) is proposed adjacent to existing stage-I Powerhouse at distance of 40m. The average vertical cover above the proposed and existing cavern is 275m. Access to power house is through 185 m long Main Access Tunnel (MAT) bifurcating from existing MAT of Uri-I PS. Entire cavern will be excavated in hard and competent bedrock of metavolcanics. The bedrock is moderately jointed and strong to very strong in nature. The rock mass is dissected by predominantly foliation planes and three other joints sets. Major foliation plane (S-1) observed in the powerhouse area is 350°/65-80°, while other joint sets observed were S-2: 220-240°/65-80°, S-3: 155°/25°, S-4: 060-080/25, and other random joints viz. 060/70, 300/80 210°/30°. The longer axis of the cavern (N 347°) has been oriented orthogonally (88°) with respect to the strike of foliation (Fig 5.7) and has been

kept at a reasonably low angle (37°) w.r.t the direction of maximum principal stress direction (N 310°).

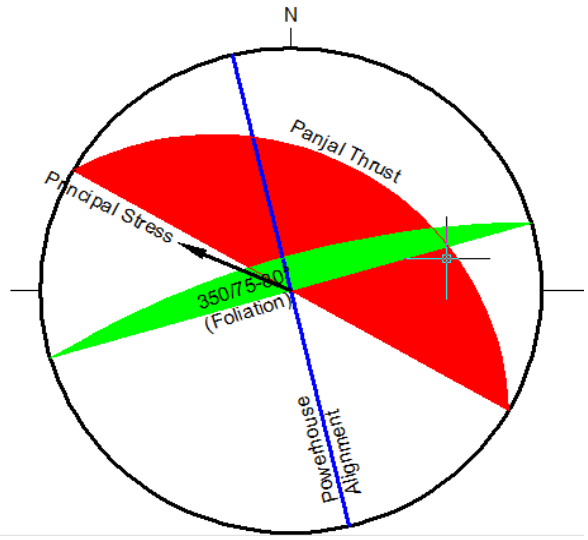


Fig. 5.7 Orientation of Longer Axis of Powerhouse w.r.t Foliation

Preliminary cavern support requirement has been derived, making the best use of empirical approach available; based on rock mass classification. This has been followed by an integrated design methodology proposed in Indian Standard IS: 15026. After that, stability analysis (Unwedge analysis), incorporating the rock-rock joint characteristics, cavern geometry and orientation, has been conducted for finalizing the length and spacing of rock bolts. Numerical modelling using Phase2 – a two dimensional elasto plastic finite element stress analysis programme (by incorporating the field stress values, rock mass strength and deformation properties as derived from insitu rock mechanics testing carried out inside powerhouse drift) have been used for estimating adequacy of rock pillar between the cavern, estimating deformation and stress. Three caverns are modelled in Phase2 and analysis has been carried out based on the excavation sequence to check the adequacy of spacing of the caverns. As a result of Phase2 stress analysis it is concluded that the spacing between power house cavern, transformer cavern and Draft tube gate operation chamber is adequate and safe. Plastic zone formed around the tunnel when strength of the material surrounding the excavation is less than

the induced stress, has been determined using the software, is also within the rock reinforcement provided.

Based on investigation results, it is expected that excavation of machine hall will be carried out in fair to good quality rock mass. However, due to charging of surge shaft and operation of stage-I powerhouse, occurrence of seepage / water ingress in the proposed PH cavern during its excavation cannot be ruled out. Accordingly, adequate drainage arrangements during the construction need to be provisioned. It is suggested that for measuring and monitoring of inherent stresses, piezometric gauges be installed prior to start of excavation at the existing powerhouse and adits.

5.6.3.4.3 Transformer Cavern (109m x 16.6m x 26.5m):

The Transformer Cavern cum GIS is located 40 m downstream of power house cavern. The overall dimensions of transformer cavern are 109m (L) x 16.6m (W) x 26.5 m (H). Similar rock conditions are anticipated as in case of Machine Hall as mentioned above. It is pertinent to mention here that in the present proposal the side slashing and benching of the existing central gullet of transformer cavern for stage-II is envisaged.

5.6.3.4.4 Drafttube Gate Hall & Draft Tube Tunnels:

Draft tube gate operation cavern of size 50 m x 7.5 m x 19 m is located 30 m downstream of Transformer cavern. Two numbers draft tube tunnels of finished size 6m (W) X 6m (H) are proposed starting from the downstream of power house up to draft tube gate operation chamber. The length of each draft tube tunnel is 95 m. The draft tube gate hall and tunnels would be housed in bedrock of metavolcanics. Based on available surface and subsurface geological data, rock classes are estimated in general that in the excavation of these structures is 20% class –II, 65% class-III and 15% class-IV are anticipated. As such adequate measures are required for timely support and seepage control.

Surge Shaft / Pressure Tunnel / Penstocks :

17m dia, 93.5 high underground Surge shaft is housed inside Rajarwani ridge in thinly foliated metavolcanic rocks. The surge shaft of stage-II is located

about 175m distance from the surge shaft of stage-I project. The area was explopred by means of 3 drill holes. The drill hole SSS-1 was drilled down to depth of 177m at location of stage-I surge shaft. Drill hole DH-3 was drilled down to depth of 85m at alternative location of stage-II power house. Drill hole DH-3A (210m) has also been completed at the proposed location of stage-II. In these 3 drill holes bedrock is of thinly foliated metavolcanic rock is deciphered with presence of fractured and sheared rock mass conditions in between. Due to intersection of closely foliated subvertical foliation planes and subhorizontal joints, poor recovery and RQD was recorded in the drill holes in the area. Keeping in view of the size of the surge shaft, it is apprehended that during the excavation of surge shaft few wedge formation are expected formed by the intersection of S-1, S-2 joints and random subhorizontal joints. As such adequate support measures be taken for stability of roof and side walls of the surge shaft during construction. It is pertinent to mention here that in the above mentioned similar geological condition, construction of surge shaft of stage-1 was completed without any major geological problems. However, suitable support measures be taken including rock support, grouting and monitoring the stability of the surge shaft and pressure tunnels / penstocks through intsrumentation. Like PH cavern, the surge shaft and pressure tunnel / penstocks are to be laid entirely in competent bedrock of metavolcanics.

Downstream Surge Gallery:

In addition to 17m dia 93.5 high surge shaft, 7m dia 625m long inclined horse shoe shaped inclined surge gallery and 7m dia 260m long horizontal surge gallery are enviasged for surge arrangement. The inclined surge gallery is to be laid having invert EL 1224M to 1264M whereas the invert of horizontal surge gallery is kept at EL 1233M. The entire surge arrangement is to be laid in thinly foliated greyish green metavolcanic rocks. For assessment of rock mass, geological section along downstream surge gallery is prepared based on geology encountered in adjacent tunnels constructed during stage-I and appended as plate 5.11 & 5.11a in Volume VI of DPR. Based on avialbale geological data rock classes along surge gallery of total length of ± 885m is

expected to negotiate 15%, 50%, 25% and 10% in rock class –II, III, IV & V respectively.

5.6.3.5 Geotechnical Evaluation of TRT & Associated Adits:

5.6.3.5.1 Layout :

A 6.5 dia, 2.3 Km long horse shoe shaped TRT of stage-II is aligned on valley side and running parallel to the existing stage-I TRT. The TRT is located on left bank of Jhelum River with TRT out fall near Bandi Village. For geological and geotechnical assessment of TRT alignment detailed geological mapping has been carried out on 1: 5000 scale along TRT area. In addition to the available geological data of previous investigation through exploratory drilling, drifting, a high resolution resistivity imaging in a major length of TRT alignment has also been carried out.

Proposed Adits for Stage-II TRT :

For facilitiating construction of TRT of stage-II, Adit-6A having length of 240m is proposed branching out from existing Adit-6 near TRT outlet. Access for construction of TRT is also planned from powerhouse side through TRT surge gallery. Thus total 3 faces will be available for construction of 2.25 Km long TRT. For assessment of geological conditions of Adit-6A, geological section along Adit has been prepared and appended as Plate 5.17 in Volume – VI of DPR. Adit-6A is expected to negotiate moderately to highly weathered variegated shales with intermittent limestone bands and graphitic schist / phyllite bands. The rock mass is generally fair, however becomes poor with water charged conditions.. Based on avialble geological data, the Adit-6A would be expected to negotiate 10% class -II, 50% class-III and 40% class IV rock mass.

5.6.3.5.2 Geotechncial Evaluation of TRT of Stage-II:

As per exploration results, TRT would be negotiating rock types like metavolcanics, limestone, phyllites/schists, graphitic schist and variegated shales. The rock mass is dissected by four joint sets viz. S1:010/35-70º, S2: 240/70º, S3: 060º/80º, S4: 300º/80º. However, in general, stereographic projection of discontinuities vis-à-vis tunnel alignment indicated stable rock

mass with concurrent rock support. The most probabilitic wedge are roof wedges formed due to intersection of S-1 with combination of S-2, S-3, S-4 and random joints. The report on stereoplot / wedge analysis is appended in Appendix – III of Volume -VIA of DPR. For assessing the nature of subsurface geology in addition to the geological mapping, drill hole data and geology of stage-I TRT, a high-resolution resistivity imaging has been carried out along TRT alignment. In all 4 resistivity imaging profiles have been studied, which revealed subsurface geology as below.

Two Resistivity Imaging Profiles namely RI-5 (Fig. 5.8) having length 600m and RI-6 (Fig. 5.9) having length 800m were laid in upstream of Bandi village across the hill slope, at an average elevation of EL ±1420M and EL ± 1375M respectively to decipher subsurface geology near TRT outfall area / Panjal thrust contact. Due to steep slopes, the profiles were laid oblique to the tunnel alignment and have deciphered the lithological interface of limestone intercalated with schist bands with variegated shales.

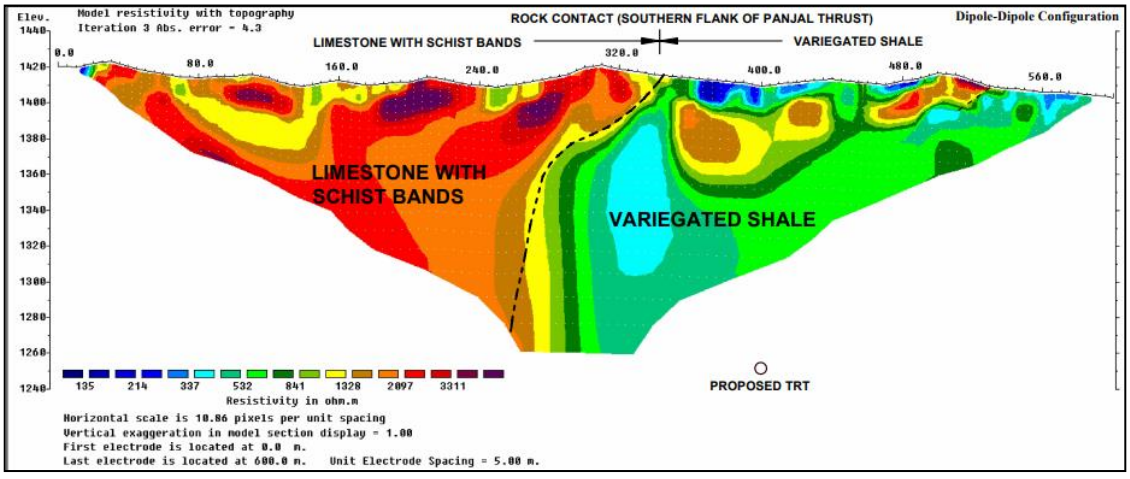


Fig. 5.8 View of Resistivity Imaging Profile RI-5

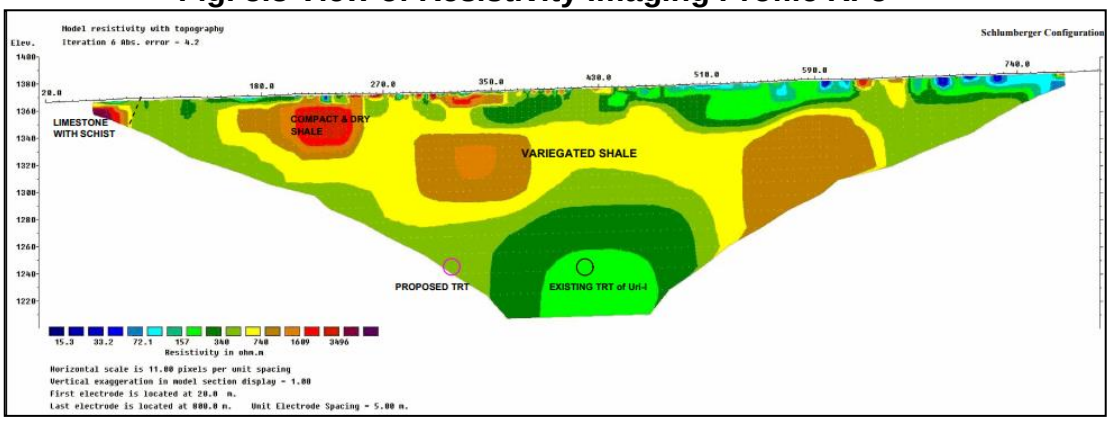


Fig. 5.9 View of Resistivity Imaging Profile RI-6

The subsurface geology depicted through these two profiles was found to be in line with geology encountered in stage-I TRT and collaborated with surface geological mapping. The data from these two profiles is useful for the interpretation of geology of TRT between RD 1500 M and TRT oufall (about 750m).

Another two resistivity imaging profiles namely RI-7 (Fig. 5.10) having length 800m and RI-8 (Fig. 5.11) having length 600m were laid which provide subsurface geological data between RD ± 490M and ±1400M. As per results of profiles RI-7, effect of Cherian nallah is evident in the deeper section of the profile in terms of weathering/fracturing and water saturation condition. These profiles further also able to identify three weak zones viz RD 510M - 820M, RD 1160 – 1240M and RD 1140M – 1390M respectively wherein few pockets of saturation and weathered / fractured rock is interpreted.

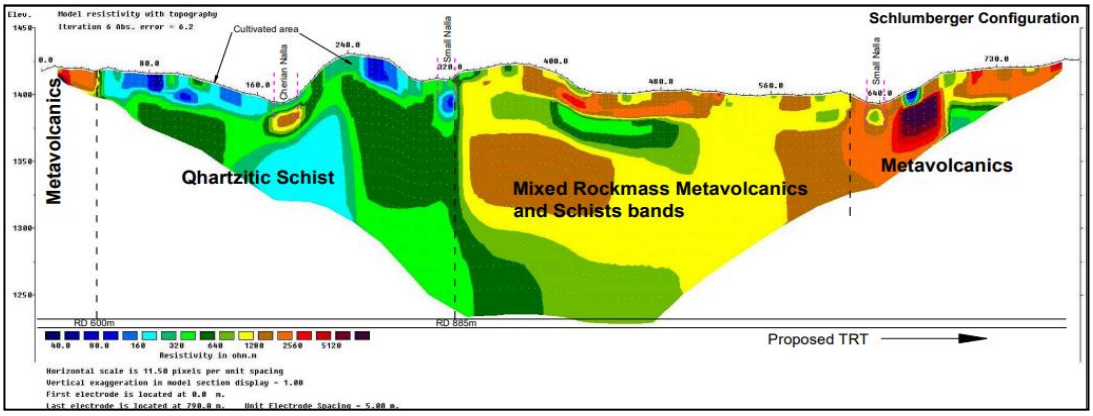


Fig. 5.10 View of Resistivity Imaging Profile RI-7

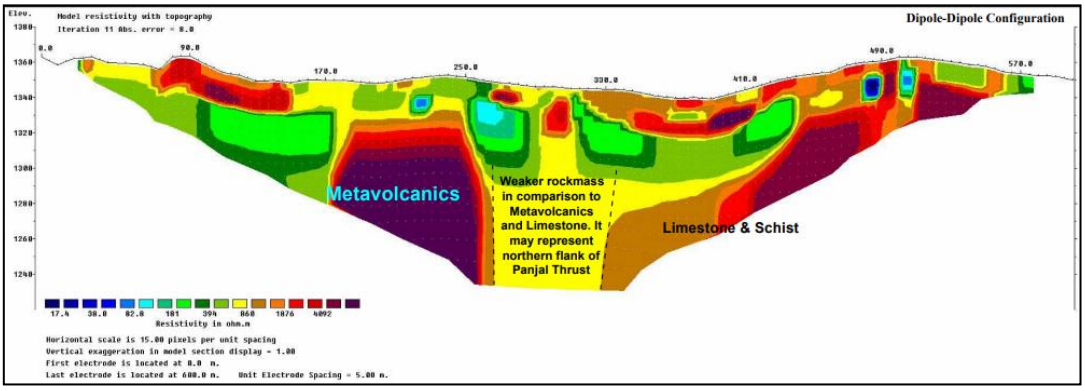


Fig. 5.11 View of Resistivity Imaging Profile RI-8

Based on geology encountered in stage-I TRT, surface geological mapping, available drill hole data and resistivity imaging carried out geological plan of TRT and geological section of TRT has been prepared and given as Plate 5.6 and 5.7 respectively for assessment of rock mass along TRT alignment. As per geological section along TRT alignment, sufficient superincumbent cover of the order of about 160 - 440m exists above the tunnel grade. The excavation of TRT has been planned in three faces. Two faces will be from Adit-6A and one face from powerhouse end. In the initial stretch from RD 0M to RD ± 500M, strong to very strong thinly foliated metavolcanics rock will be encountered. The reach from RD ± 500M to ± 800M will negotiate weathered rock mass of graphitic schist with intermittent bands of metavolcanics. The rock mass relatively improves from RD ± 800m to RD ±1150m with the occurrence of mainly metavolcanics rocks with intermittent bands of schist. The strong competent rock mass of metavolcanics is interpreted from RD ±1150m to RD ±1500m. From RD ±1500m to RD ±1800m the tunnel would be expected to negotiate the fractured and sheared rock mass of metavolcanics and limestone /schist / shale intercalations (Photo 5.14 to 5.16). Beyond ±1800 m, the tunnel will be negotiating entirely in weak to medium strong, weathered rock mass of variegated shales.

Photo 5.14 : Thinly bedded Limestone outcrop near Bandi Village

Photo 5.15 View of Limestone and Variegated Shales near Bandi Village

Photo 5.16 Rock outcrop of variegated shales near TRT outfall

Rock Mass Classification: Based on the detailed geologiclal explorations carried out for present proposal and data of stage-I TRT the rock mass rating along the tunnel has been assessed. It is anticipated that the tunnel will negotiate 50% in rock class -III, 35% in rock class -IV and 15% in rock class –V.

5.6.3.5.3 TRT Outlet

TRT Outlet portal would be accommodated in sub vertical rocky slope consisting of shales and lime stone intercalations (Photo-5.17). Geological mapping of outfall area has been carried out on 1: 500 scale. For assessment of geology around outfall area, geological plan and section

outfall portal area has been prepared and appended as plate 5.8 and 5.9 respectively. The right bank of River Jhelum at TRT outfall location is comprised of terrace deposits consisting of riverine / fluvio glacial material of pebbles, cobbles and boulders mixed in sandy silty matrix. The exploratory drilling carried out near TRT out fall through SOL-1 & 2during stage-I indicated deep overburden in the river bed. However bedrock is exposed all along left bank slope. As such for construction of TRT outfall portal, a temporary river diversion may be required that can be taken up during lean season and the diversion channel may be laid on right bank lower terrace deposit. Cautious approach shall be taken during the excavation of TRT outfall portal with concurrent suitable slope protection and rock support measures.

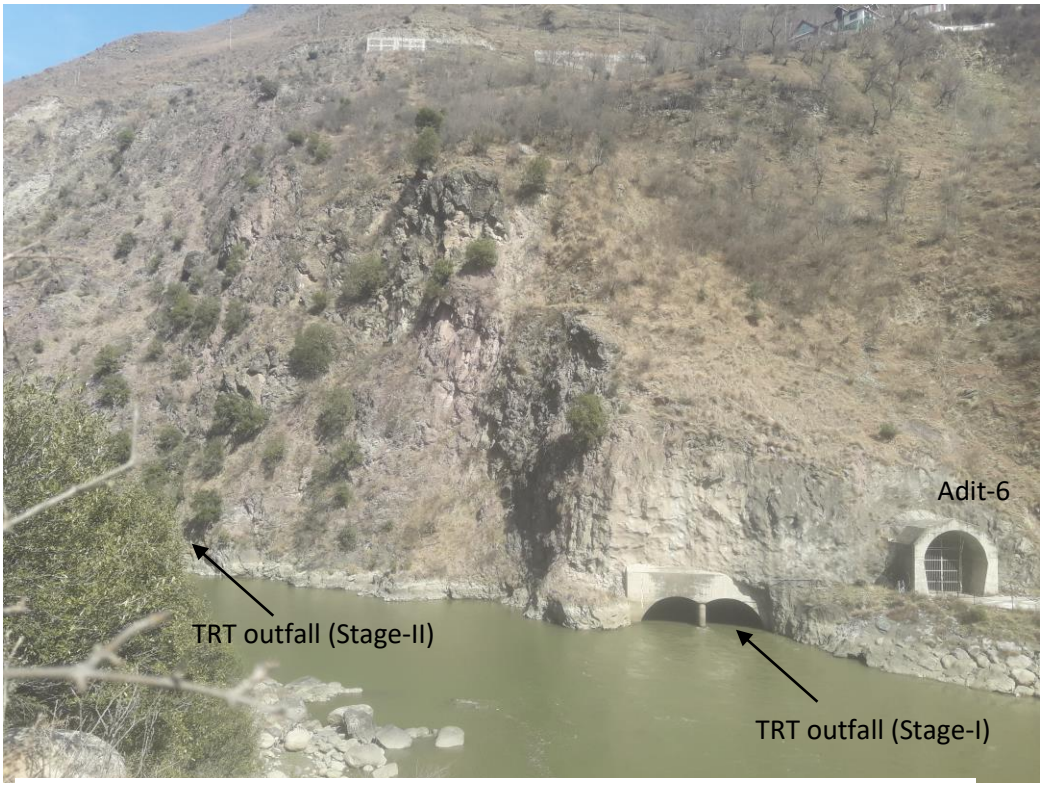


Photo 5.17 Rock outcrop of variegated shales near TRT outfall

5.7 SEISMICITY

Project area falls in seismic zone IV as per seismic zoning map of India BIS-1893 part I, 2016. Seismic design parameters for the Uri Power station were evaluated by DEQ-IIT Roorkee and the project was constructed as per the recommended seismic design parameters. In the current proposal existing

diversion structures of Barrage complex and already built HRT intake will be used for stage-II also and the proposed HRT, TRT and powerhouse are located within the same regime of existing similar structures commissioned in 1997. Hence, further additional studies are not required. Details are given in chapter –VI of Volume -VI of DPR.

5.8 FOUNDATION ENGINEERING & SEISMIC ASPECTS

The FE&SA directorate vide their letter no. CWC.I.D.No. 11/45/TE/2021/FE&SA/260-262 dated 14.09.2021 issued NOC to utilize the same seismic design parameters for stage-II project also and the letter is appended in Appendix – XI of Volume – VIA of DPR. Further, FE&SA directorate vide their letter no.CWC. I.D.No. 11/45/TE/2021/FE&SA/288-290

dated 15.07.2022 approved the FE&SA aspects of Uri-I (Stage-II) HE project & the clearance is appended in Appendix – XI of Volume – VIA of DPR.

5.9 CONSTRUCTION MATERIAL SURVEY & INVESTIGATIONS

5.9.1 Construction Material Requirement & Source:

Total estimated requirement of coarse & fine aggregate for the construction of project is about 3.60 lakh cum and 1.80 lakh cum respectively (Table 5.13).

Availability of construction material has been studied giving due consideration to the impact of the same on environment. Accordingly, based on experience from existing Uri Power station and field investigations carried out during current season 2020-21, three (03) prospective shoal deposits namely a) Sheeri shoal deposit (Photo 5.18), b) Mohra power house terrace deposit (Photo 5.19) and c) Salamabad shoal (Photo 5.20) deposit have been identified and found to cater sufficient quantity of natural aggregate required for construction of the project. Further, three (03) rock quarries were also identified namely a) Naushera rock quarry site (Photo 5.21) b) Hajipeer nala rock outcrops (Photo 5.22) and c) Excavated material from HRT & Power House (Photo 5.23) as potential sources of material for the construction of Uri-I Stage-II H E Project.

Table 5.13 Estimated Required Quantities of Construction Material

Sl. No.	Material	Quantity as per BOQ (lakh Cum)	Quantity considering wastage of 38% (lakh Cum)
1.	Coarse Aggregate		
	a) Non-wearing Surface Concrete	3.10	4.30
	b) Wearing Surface Concrete	0.50	0.70
2.	Fine Aggregate.	1.80	2.50
	Total	5.40	7.50

5.9.2 Field Investigation for Construction Material:

River bed / shoal deposits were explored by pitting and gradation analysis of pit run material at site followed by collection of representative samples for testing of coarse and fine aggregate. In addition to these, crushed coarse and fine aggregate samples were also collected from Naushera & Hajipeer rock quarries and excavated material of HRT & power house cavern by making small drifts. Coarse aggregate samples were tested for Specific gravity, Water absorption, Impact value, Los-Angeles abrasion value, Crushing value, Soundness loss, Flakiness index, Elongation index whereas fine aggregate samples were tested for Specific gravity, Fineness modulus, Silt & Clay content, Organic impurities & Soundness loss. Additionally petrography examination, Alkali Aggregate Reactivity (AAR) by accelerated mortar bar and detailed mortar bar methods have also been conducted. Entire testing has been carried out at National Council for Cement and Building Material (NCCBM), Ballabgarh.

Topographical surveys of borrow areas / rock quarries were also carried out for estimating the quantity of material available in each of the borrow area/quarry and index pan of borrow areas / rock quarries has also been prepared and

appended as plate 5.10. A detail account on construction material sampling, testing and discussion are given in Volume – VII (Construction Material Volume) of DPR.

Photo 5.19 View of Mohra Powerhouse Terrace (River Jhelum) Deposit

Photo 5.20 View of Salamabad Nala Shoal Deposit

Photo 5.21 View of Naushera Rock Quarry & Nature of Excavated Material

Photo. 5.18 View of Sheeri Nala Shoal Deposit

Photo 5.22 View of Hajipeer Rock Quarry & Nature of Excavated Material

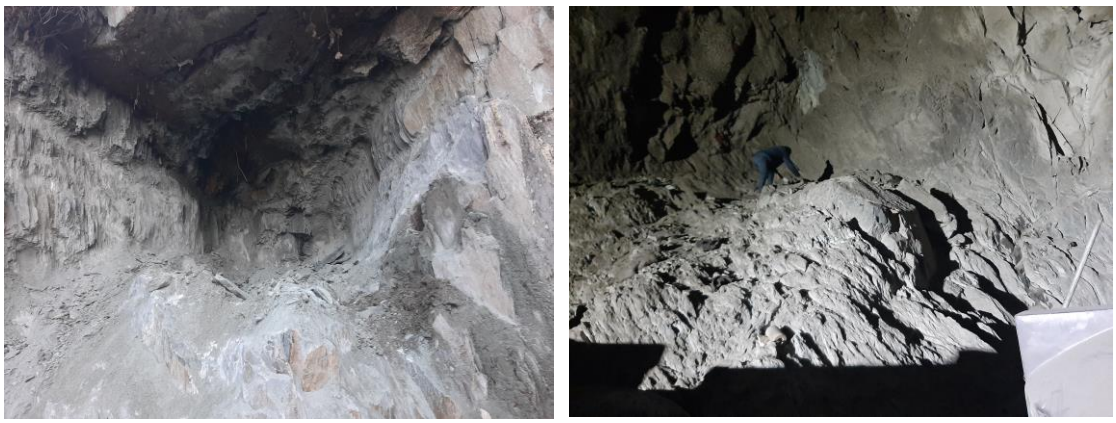


Photo 5.23 Exploratory Drift in HRT area (Left) and Powerhouse (Right) for sample collection of construction material

5.9.3 Shortlisted Suitable Construction Material Resources:

Shortlisted deposits / quarries for the recommended usable material are given in table 5.14.

Table 5.14 - Shortlisted River Shoal Deposit & Rock quarries.

Sl. No.	Name of Deposit	Index No.	Distance from Site (km)		Total Available Quantity (Lakh cum)	Remarks
			HRT Intake	PH		
1.	Sheeri shoal Deposit	UR-I St-II G-1	15	35	1.80	Proposed to be quarried
2.	Salamabad nala shoal Deposit	UR-I St-II G-2	21	10	1.60	Proposed to be quarried
3.	Naushera Rock Quarry	UR-I St-II R-1	8	24	7.0	Proposed to be quarried
4.	Excavated Muck Material of HRT	UR-I St-II R-3	10	5	1.5	Usable
5	Excavated Muck Material of Power House Cavern	UR-I St-II R-4	10	0	1.5	Usable
				Total	**13.4**	
6.	Mohra P/H Terrace Deposit	UR-I St-II G-3	10	8	1.25	Kept reserved
7.	Hajipeer Rock Quarry	UR-I St-II R-2	25	10	5.0	Kept reserved
				Total	**6.25**	

5.9.4 Conclusion:

Sufficient and suitable quantities of construction material are available for the construction of dam and other structures of the project.

Against the total requirement of 7.5 lakh cum coarse & fine aggregate, about 3.40 lakh cum usable suitable aggregate material is available from river shoal deposits i.e., UR-I St-II G1 (Sheeri Village Shoal Deposit), UR-I St-II G 2 (Salamabad Shoal Deposit) and about 10.0 lakh cum usable suitable material is available from rock quarries i.e. UR-I St-II R 1 (Naushera Rock Quarry), UR-I St-II R 3 (Excavated Material from HRT) & UR-I St-II R 4 (Excavated Material of Power House Cavern).

However, UR-I St-II G 3 (Mohra P/H Terrace Deposit) & UR-I St-II R 2 (Salamabad Rock Quarry) sites are kept reserved.

Clearance of pre DPR chapters of construction material has been received from CSMRS vide letter no. U. No:29/36 Uri-I Stage-II/RM-I/CSMRS/2021/ dated 10.02.2021. Subsequent to submission of DPR in May 2022, final clearance from CSMRS has been received vide letter no. U. No:29/36 Uri-I Stage-II/RM-I/CSMRS/2021/ dated 15.06.2022. Nevertheless, sufficient quantity of material is available to cater to the additional concrete requirements from the sources approved by CSMRS.

5.10 HYDROLOGICAL AND METEOROLOGICAL INVESTIGATIONS

5.10.1 Rain Gauge Stations/ Snow data:

Rainfall data is being observed by NHPC at **Uri-I barrage site** since 1992 and average annual rainfall at this site is worked out as around 1104 mm. Meteorological data was also procured from IMD Pune for Jhelum River Basin from the year 1976 onwards. The precipitation data collected from IMD consists of 46 rainfall stations and 5 snowfall stations covering the entire Jhelum basin in the upstream of Uri HE project stage-I&II. The rainfall and snowfall data availability and their average annual rainfall based on average monthly rainfall in Jhelum basin as collected from IMD are shown in **Table-5.15.**

Table-5.15: Monthly Rainfall Data Availability Status of Jhelum River Basin (IMD)

S.No.	Name of Station	Data Available	Average Annual Rainfall (mm)	S.No.	Name of Station	Data Available	Average Annual Rainfall (mm)
1	Amarnath Holy CA	2012-2018 (June	193	24	Tangmarg	1976-1994	1198
2	Anantnag	1976-1994	510	25	Arizal	1976-1994	1235
3	Anantnag-AWS	2012-2018	748	26	Badgam	1976-1994	1081
4	Anantnag-Hydro	1994-2018	725	27	Chari Sharif	1976-2006	1225
5	Chandanwari AWS	2013-2018	765	28	Harran-AWS	2012-2018	870
6	Dachigam	1976-1994	695	29	Awantipur IAF	1993-2018	735
7	Durroo	1996	866	30	Babapura	1976-1982	410
8	Kukernagh	1976-1982	795	31	Kanibal	2009-2017	745
9	Kukernagh Obsy	1978-2018	1073	32	Manlangpura-AWS	2012-2018	590
10	Kulgam	1976-2005	959	33	Malashahibag	1976-2004	1087
11	Pahalgam	1976-1982	1180	34	Prang	1976-1982	1278
12	Pahalgam-AWS	2013-2018	879	35	Rambag AWS	2012-2018	647
13	Pahalgam Obsy	1978-2018	1316	36	Shalimar Agro	2003-2018	858
14	Panchtarni AWS	2013-2018	1158	37	sonemarg Obsy	2003-2018	993
15	Seshnag AWS	2013-2018	1095	38	Srinagar Obsy	1976-2018	737
16	Verinagh	1976-1994	1317	39	Srinagar AeroIAF Obsy	1993-2018	694
17	Baramulla	1976-1994	1052	40	Srinagar Agro AWS	2012-2018	720
18	Baramulla-AWS	2012-2018	917	41	Shopian	1976-1996	784
19	Baramulla-Obsy	1981-95	957	42	Shopian AWS	2012-2018	690
20	Gulmarg AWS	2012-2018	951	43	Kulgam AWS	2012-2018	558
21	Gulmarg Obsy	1977-2004	1120	44	Quzigund Obsy	1976-2018	1217
22	Gulmarg R.S. Obsy	1976-2018	1421	45	Baltal	2013-2018	1041
23	Sopore	1976-1982	700	46	Gund Obsy	1976-2018	1177

The average monthly snowfall of five stations in Jhelum basin as collected from IMD are shown in **Table-5.16**

Table-5.16: Status of Annual Snowfall of Jhelum River Basin (IMD)

S.No.	Name of Station	Data Base	Annual Snowfall (mm)
1	Pahalgam	2000-2016	369.9
2	Srinagar	1998-2016	129.8
3	Qazigund	1998-2016	269.5
4	Gulmarg	2000-2016	540.3
5	Kupwara	2000-2016	196.1

5.10.2 Temperature:

NHPC has established meteorological station at Barrage site (w.e.f 1997). Based on that, maximum and minimum temperatures at barrage site are 40^{o}C

and -6.4ºC respectively. Maximum and minimum relative humidity has been observed as 100% and 2.6% respectively at Barrage site.

5.10.3 Gauge and Discharge Observation

The discharge at Uri-I Barrage is being measured by control structure/ Barrage on hourly basis. The data status of discharge sites available with NHPC is shown in **Table-5.17.** Discharge data of Kishenganga Power Station since May 2018 has also been used for water availability studies of Uri-I stage-II H E Project.

Table-5.17 Data status of Discharge Sites

G&D Site	Data Availability	Location
Uri I Barrage	1997 to till now	At Uri I Barrage
Baramulla	Jun 1976 to 1987, 1991 to 2020	15 km upstream of Uri I Barrage
LJHP	1988 to 2020	Upstream of Uri Barrage
Buniyar	1991-1996	500 m u/s of Uri Barrage
Sopore	1991- 2000	D/S of Wular Lake

5.10.4 Sediment Observations:

The sediment observation site has been established at Uri I Barrage.
Sediment data is available from 2003 to till date.

5.11 SUMMARY AND RECOMMENDATIONS

Uri-I Stage-II Hydroelectric Power project is an extension of Uri-I Stage-I (Uri-I Power station) planned as per provision kept during DPR and construction of Uri-I Power station with an installed capacity of 2 x 120 = 240 MW. The Uri-I Power station, a Run-off the River scheme, is situated on river Jhelum in Uri Tehsil of Baramulla district in UT of Jammu and Kashmir with an installed capacity of 4 x 120 MW = 480 MW. Thus there will be an increase in

generation of 240 MW electricity from stage-II while utilizing the additional water from the common reservoir.

NHPC Limited has signed a Memorandum of Understanding with the Government of Jammu and Kashmir on January 03 2021 for execution of URI-I Stage-II HE Project (240 MW) on Build, Own, Operate & Transfer (BOOT) basis for the period of 40 years on the River Jhelum in Uri Tehsil of Baramulla district in Jammu and Kashmir.

Based on the geological & geotechnical, seismological, foundation engineering, construction material and hydrology & meteorological studies carried out, following conclusions are drawn:

1. Geological and Geotechnical aspects

a) Geologically the area around project falls on the eastern part of the Kashmir syntaxial bend of the northwest Himalaya where the arcuate ridges are aligned nearly along NE-SW. The layout of Uri-I stage-II is confined within folded and thrusted sequence of Tanawal schists, Panjal volcanics and Nummulitic shales.

b) The barrage and reservoir area are completely located in the Tanawal Schist and Jhelum fill material. These structures are already exist and no diversion structure is proposed in the present scheme.

c) Adequate geological investigations are carried out for geotechnical evaluation of proposed structures. Moreover, the construction experience and geological data of Uri – I Stage-I Project are of great help and used for Uri-I Stage-II Project.

d) Additional investigation comprising 2 no drill holes, one at HRT low cover zone near Kandarban Nala and one hole at proposed Surge shaft location has been carried out.

e) In addition, Resistivity Imaging survey has been carried out for major length of TRT area through 4 nos profiles having cumulative profile length of 2800m. one profile at HRT intake and 3 profiles at different locations along HRT alignment having cumulative length of 1600m (Each profile length 400m) were

also laid. These studies are helpful to decipher Panjal thrust, major weak zones and nature of rock mass successfully.

f) Laboratory rock mechanic testing of three rock variants on total 77 samples was carried out for determination of their Physico Mechanical properties.

g) Based on surface geological mapping, geophysical survey, exploratory drilling of Uri- I stage-II and exploratory drifting and geological data of Uri-I stage-I project, geotechnical evaluation of proposed project components has been assessed.

Geotechnical Evaluation of HRT:

- Around 10.5 km long, 6.5m dia HRT will pass through folded sequence of quarzitic schist and metavolcanics.
- There is sufficient incumbent rock cover above HRT. The maximum cover above the tunnel grade is ± 760m and minimum cover is about 66m near RD ± 9140m.
- In general, fair to good rock mass is anticipated in the HRT alignment with some reaches of poor geological conditions at low reach near Nala crossing of HRT.
- It is anticipated that HRT will be negotiated through 20% class II, 70%Class III and 10% class IV rock mass.

Geotechnical Evaluation of Powerhouse Complex:

- The underground powerhouse complex (2 x 120 MW) is an extension of existing stage-I powerhouse already in operation with installed capacity of 4 x 120 = 480 MW.
- The underground Powerhouse complex will be laid in hard and competent metavolcanics. It comprises Machine hall, Transformer cavern, draft tubes, surge shaft, pressure tunnels / penstocks, draft tube gate hall, bus ducts and other associated adits / tunnels.
- In general, the bedrock exposed in the powerhouse area comprises of fine grained, grey-green coloured thinly foliated, slightly weathered to fresh, dissected by two major joints and few random sub horizontal joints. However,

at few locations, the bedrock of moderately to highly weathered nature was also seen.

- Major foliation plane observed in the powerhouse area is 345°/70-75°, while other joint sets observed were 245°/65°, 210°/30° & 155°/25°. The longer axis of the cavern (N 347°) has been oriented orthogonally (88°) with respect to the strike of the foliation and has been kept at a reasonably low angle (37°) w.r.t the direction of maximum principal stress direction (N 310°).
- It is expected that excavation of machine hall will be carried out in fair to good rock mass. Due to charging of Surge shaft & operation of stage-I powerhouse, occurrence of seepage / water ingress during the excavation of PH and other associated cavern cannot be ruled out. Accordingly, adequate drainage arrangements during the construction need to be provisioned.

Geotechnical Evaluation of TRT:

- A 6.5 dia, 2.3 Km long modified horse shoe shape TRT of stage-II is aligned on valley side and running parallel to the existing stage-I TRT starting from Powerhouse and joins Jhelum river near Bandy Village.
- Geologically the TRT area lies in complex geological environment with occurrence of Quartzitic Schists, Metavolcanics, Limestones / schist /phyllite and Shale intercalations.
- In general, poor to fair rock mass conditions are anticpated along the TRT.
- Around 50% of tunnelling is expected through class-III (Fair) rock dominated by hard massive metavolcanics and rest 50% through class-IV/V (Poor) rock comprising of moderately to highly jointed, intercalated fractured and sheared rock mass of metavolcanics, limestone and shale intercalations. The Panjal thrust zone is estimated to be about 300m.
- As such adequate support measures are required during the construction.

h) Seismotectonic Aspects:

- The project area falls in seismic zone IV as per seismic zoning map of India BIS-1893 part I, 2016.

- The FE&SA directorate vide letter no. CWC.I.D.No. 11/45/TE/2021/FE&SA/139-141 dated 03.06.2021 has issued NOC to utilize the seismic design parameters of Uri-I stage-I for proposed components of stage-II also.
- Clearance of Pre-DPR chapters of Geological Aspects of Uri-I Stage-II H E Project has been received from GSI vide letter no. 183/Uri-I Stage-II HEP/EPE/DGCO/GSI/2021/1372 dated 18.02.2022.
- Clearance of DPR chapters of Geological Aspects of Uri-I Stage-II H E Project has been received from GSI vide letter no. 183/Uri-I Stage-II HEP / EPE / DGCO / GSI / 2021 / 344 to 349 dated 10.06.2022.

2. Construction Material Aspects

- 3 nos of rock quarries and 3 nos of borrow areas have been identified and suitability of construction material has been assessed in laboratory. Based on results it is concluded that sufficient quantity of aggregates is available within economical distance from the project.
- Clearance of pre DPR chapters of construction material has been received from CSMRS vide letter no. U. No:29/36 Uri-I Stage-II/RM-I/CSMRS/2021/ dated 10.02.2021.
- Subsequent to submission of DPR in May 2022, final clearance from CSMRS has been received vide letter no. U. No:29/36 Uri-I Stage-II/RM-I/CSMRS/2021/ dated 15.06.2022.
- Nevertheless, sufficient quantity of material is available to cater to the additional concrete requirements from the sources approved by CSMRS.

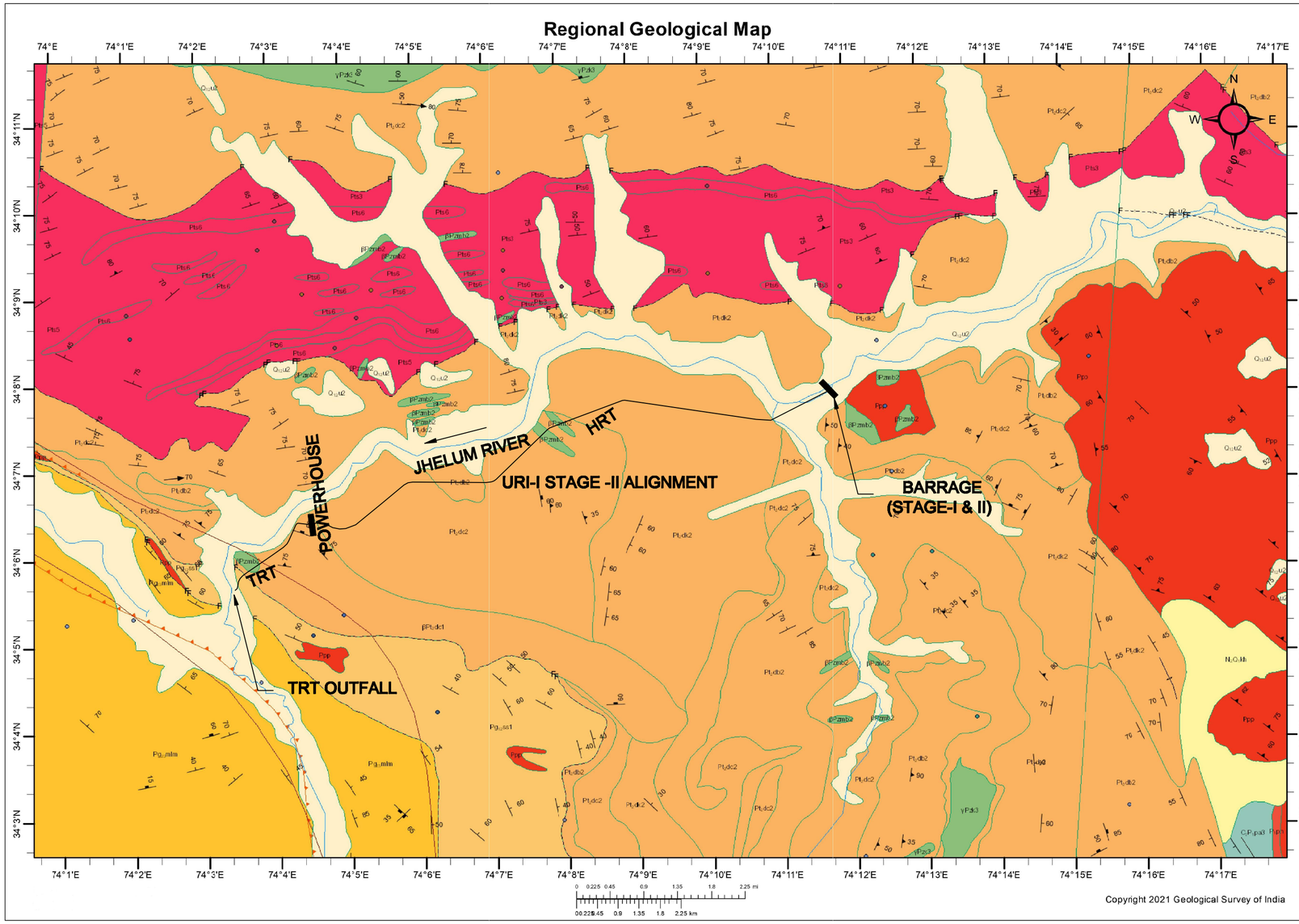
3. Hydrological and Meteorological Aspects

- Rain gauge stations are located within project basin and long-term rainfall /snow fall data is available.
- Temperature data, gauge and daily discharge data of Jhelum river for varying periods are available in the region.
- The sediment data since year 2003 till now is available at Uri-I Barrage.

ANNEXURES

Plate 5.1

Regional Geological Map



LEGEND

Lithology

- PLEISTOCENE - HOLOCENE , ALLUVIUM, MORAINES, HILLWASH & SCREE - Q12u2
- PLIOCENE - PLEISTOCENE , CLAY, SANDY CLAY, CONGLOMERATE WITH LIGNITE - N2Q1kh
- EOCENE - MIOCENE , SHALE, SANDSTONE AND SILTSTONE - Pg23mlm
- PALAEOCENE - EOCENE , SPLINTERY SHALE WITH NUMMULITIC LIMESTONE - Pg12ss1
- PERMIAN , ANDESITIC AND BASALTIC LAVA FLOWS - Ppp
- PALAEOZOIC , DOLERITE / META-DOLERITE - βPzmb2
- PALAEOZOIC , LEUCOCRATIC TO MESOCRATIC BIOTITE GRANITE - γPzk3
- MESOPROTEROZOIC , SCHISTOSE QUARTZITE, SLATE AND GRITTY QUARTZITE - Pt2dk2
- MESOPROTEROZOIC , BASIC VOLCANICS - βPt2dc1
- MESOPROTEROZOIC , PHYLLITE, QUARTZITE, DIAMICTITE AND LAVA FLOWS - Pt2dc2
- MESOPROTEROZOIC , PHYLLITE, QUARTZITE, LIMESTONE AND LAVA FLOWS - Pt2db2
- PROTEROZOIC (UNDIFF) , CARBONACEOUS PHYLLITE, SCHIST, LST AND DOLOMITE - Pts3
- PROTEROZOIC (UNDIFF) , CARBONACEOUS PHYLLITE WITH MARBLE AND QUARTZITE - Pts5
- PROTEROZOIC (UNDIFF) , CARBONACEOUS PHYLLITE SCHIST WITH GRAPHITE - Pts6
- PROTEROZOIC (UNDIFF) , CARBONACEOUS PHYLLITE, SCHIST WITH GRAPHITE - Pts6

State Boundary

Oriented_Structure_Line

- FOLD AXIS

Oriented_Structure_Plane

- BEDDING
- CLEAVAGE/FOLIATION/SCHISTOSITY (S1)
- JOINT

Fault

- FF FAULT INFERRED
- FF FAULT INTERPRETED

Fold

- ANTICLINE

Boundary

Waterways

Thrust 2M

Thrust Tectonic

NOTE:Reproduced from Geological Map of Himalayas (GSI)/ Bhukosh.GSI (1:50000 MAP)

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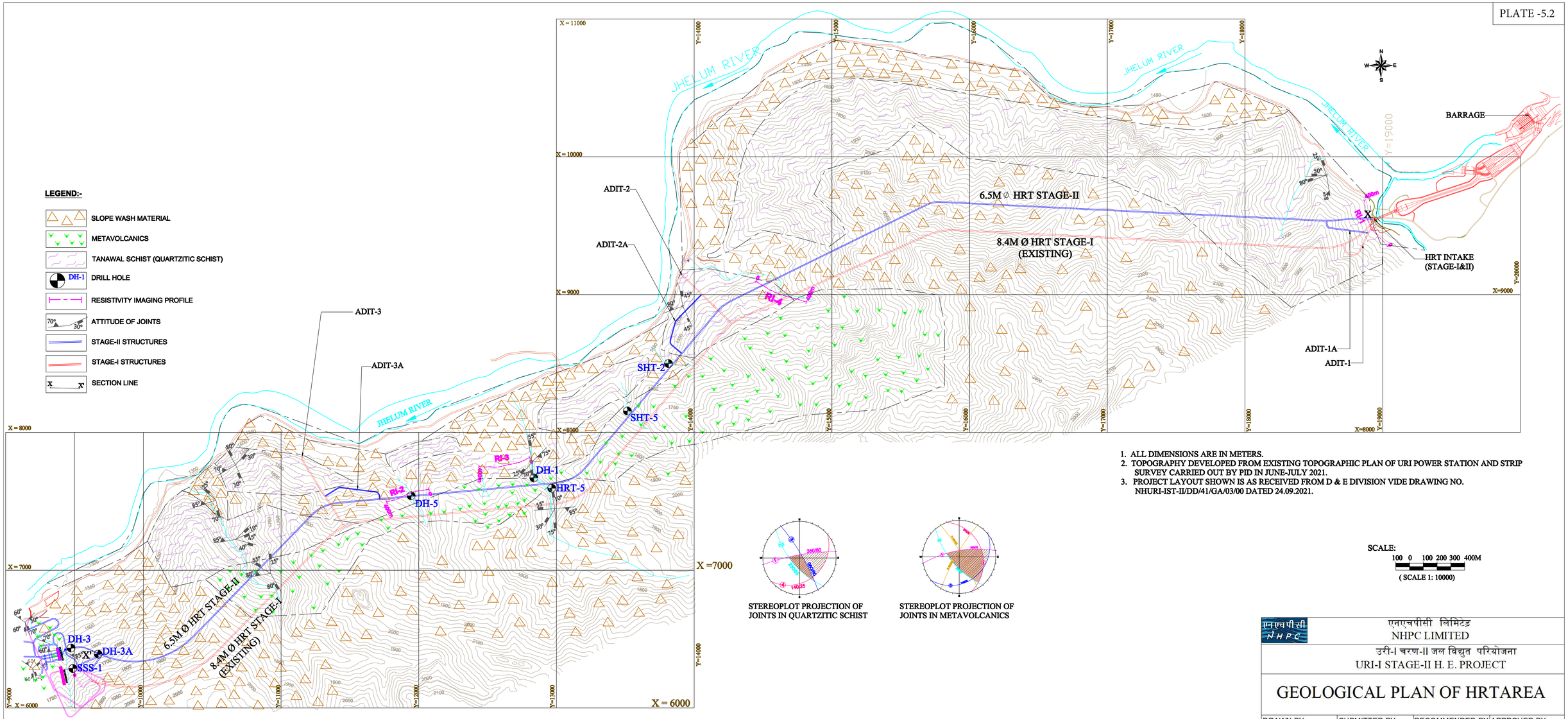
URI-I STAGE-II H. E. PROJECT

REGIONAL GEOLOGICAL PLAN

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
Sushil Almadi Manaer(ED)	BNS Naveen Kumar Sr.Manager (Geo)	Ajay Singh DGM (Geo)	S L Kapil ED (Geo-tech)

DATE: October 2021 | DRG.No.

PLATE -5.2



1. ALL DIMENSIONS ARE IN METERS.
2. TOPOGRAPHY DEVELOPED FROM EXISTING TOPOGRAPHIC PLAN OF URI POWER STATION AND STRIP SURVEY CARRIED OUT BY PID IN JUNE-JULY 2021.
3. PROJECT LAYOUT SHOWN IS AS RECEIVED FROM D & E DIVISION VIDE DRAWING NO. NHURI-IST-II/DD/41/GA/03/00 DATED 24.09.2021.

STEREOPLOT PROJECTION OF JOINTS IN QUARTZITIC SCHIST

STEREOPLOT PROJECTION OF JOINTS IN METAVOLCANICS

SCALE:

100 0 100 200 300 400M

(SCALE 1: 10000)

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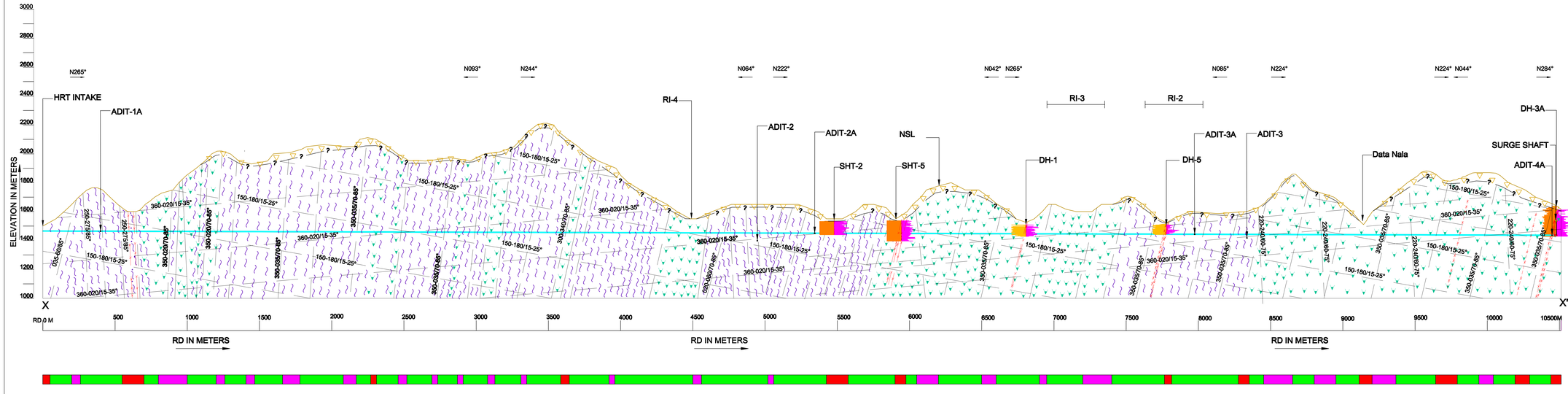
URI-I STAGE-II H. E. PROJECT

GEOLOGICAL PLAN OF HRTAREA

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
Sushil Almadi Manager(ED)	BNS Naveen Kumar Sr.Manager (Geo)	Ajay Singh DGM (Geo)	S.L Kapil ED (Geo-tech)

DATE March 2022 DRG. NO.: NHURI-I/ST-II//EG/2021/

PLATE - 5.3



INDEX

- SLOPEWASH MATERIAL
- GRAPHITIC SCHIST
- METAVOLCANICS
- QUARTZITIC SCHIST
- RECOVERY / RQD
- RESISTIVITY IMAGING LINE (RI-3)
- ROCK CLASS IV / V
- ROCK CLSS III
- ROCK CLSS II

NOTES: -

1. ALL DIMESIONS ARE IN METERS.
2. DISCONTINUITIES ARE SCHEMATICALLY SHOWN.
3. ANTICIPATED ROCK CLASSES IN HRT : 20% - CLASS-II, 70% - CLASS-III & 10% - CLASS-IV/V, ARE SHOWN TENTATIVE AND MAY VARY DURING ACTUAL CONSTRUCTION..

SCALE:-

100 0 100 200 300 400M

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NHPC Limited

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URI-I STAGE-II HYDROELECTRIC PROJECT

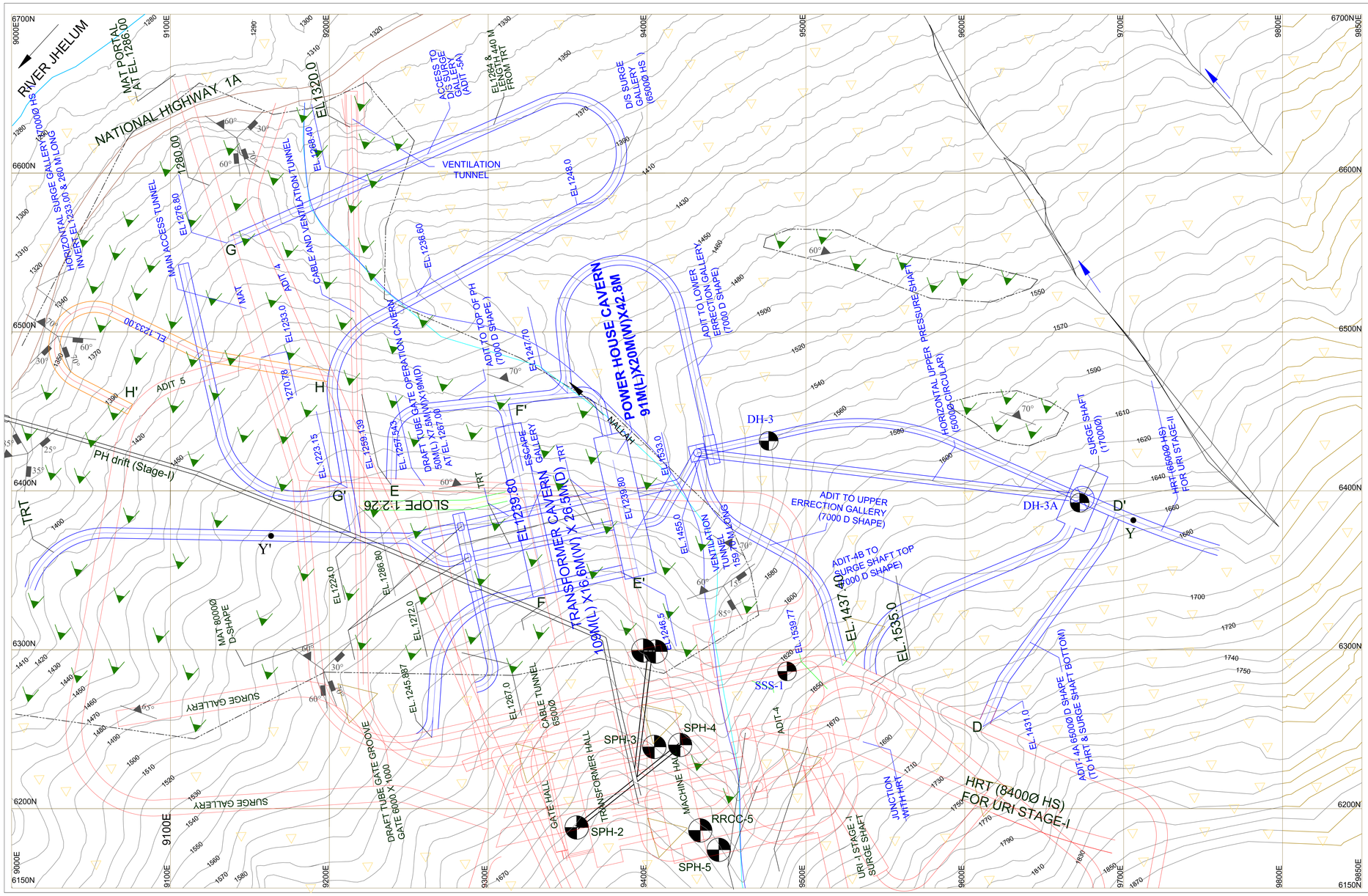
GEOLOGICAL SECTION ALONG HEAD RACE TUNNEL (INTERPRETED)

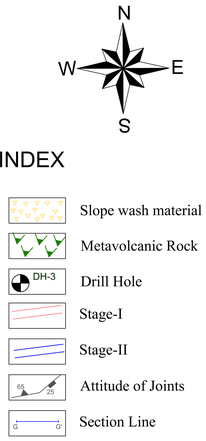
Drawn By	Submitted By	Recommended By	Approved By
	BNS Naveen Kumar SM(Geo)	Ajay Singh DGM(Geo)	S L Kapil ED(Geotech)

Date October 2021

DRG. NO.:/ NHURI-I/ST-II/EG/2021/

PLATE - 5.4





INDEX

- Slope wash material
- Metavolcanic Rock
- DH-3 — Drill Hole
- Stage-I
- Stage-II
- Attitude of Joints
- Section Line

LIST OF CONTROL POINT

POINT	EASTING	NORTHING	ELEVATION	REMARKS
PH-1	9229.319	6656.440	1333.766	Existig survey point (Cylindrical with plate) situated hillside of the road adjacent to Adit-IV area
PH-2	9073.023	6832.150	1327.185	Bolt & Concrete Pillar at R/B of River Jhelum, riverside of road, opposite of Adit-IV area.

LEGEND

- NALLA
- ROAD
- RIVER
- HOUSE
- CONTROL POINT

NOTES:

1. ALL DIMENSIONS ARE IN METERS.
2. THE MAP HAS BEEN DEVELOPED ON URI-I POWER STATION GRID SYSTEM.
3. REFERENCE LEVEL HAS BEEN TAKEN FROM URI-I POWER STATION.
4. THIS DRAWING HAS BEEN DEVELOPED BASED ON SURVEY DATA COLLECTED IN THE MONTHS OF MAY-JUNE 2011 BY PID.
5. THERE MIGHT BE A SLIGHT DEVIATION IN CONTOUR VALUE IN AREAS HAVING DENSE VEGETATION AT HIGHER ELEVATIONS.
6. VALIDATION SURVEY HAS BEEN DONE IN THE MONTH OF FEB' 2021 BY PID.

SCALE 0 20 40 60 80 100M

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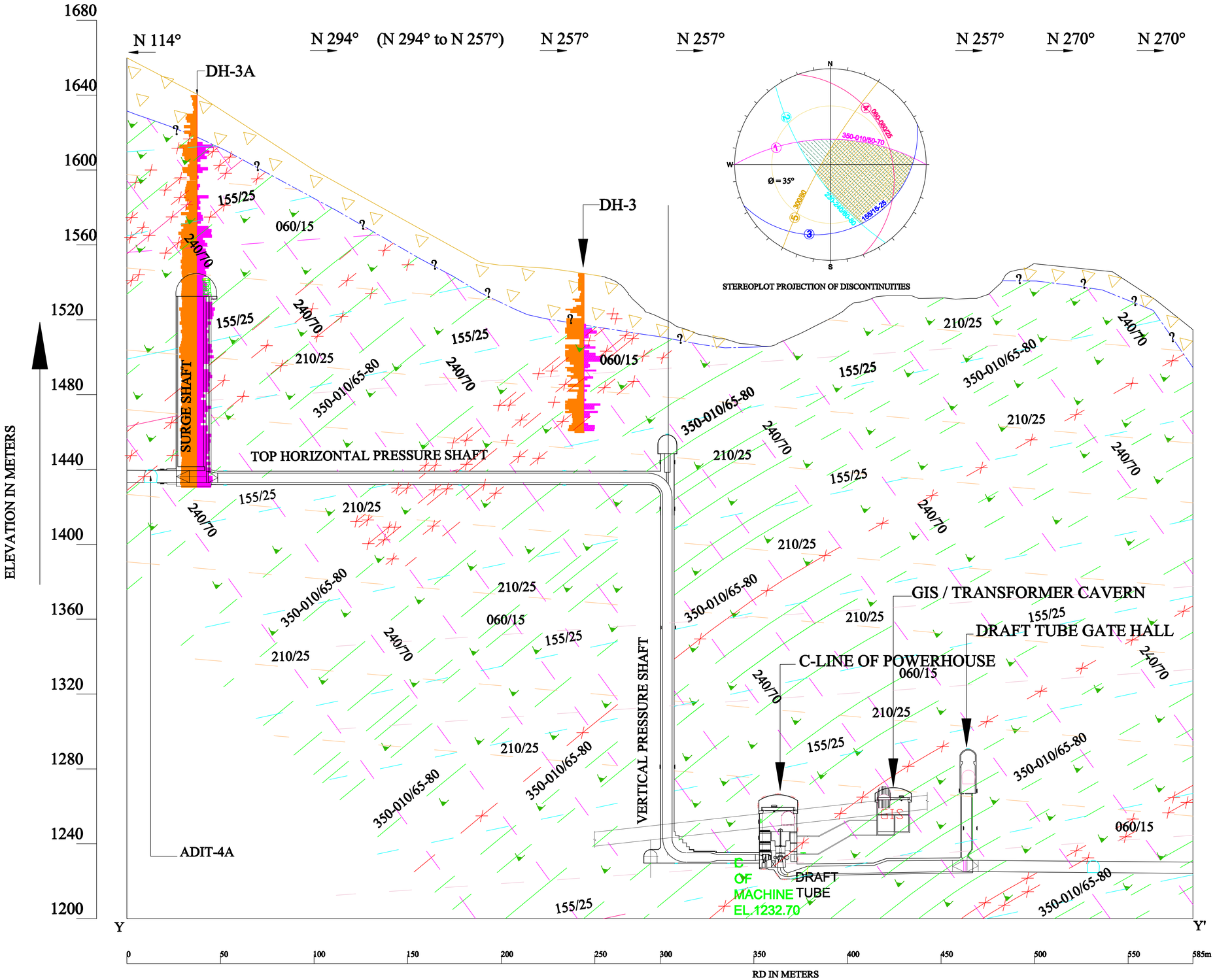
N H P C LIMITED

उरी–I चरण-II जल वदियुत परयोजना
URI-I STAGE II H.E.PROJECT

GEOLOGICAL PLAN OF POWER HOUSE AREA

	Submitted By	Recommended By	Approved By
	BNS Naveen Kumar SM(Geo)	Ajay Singh DGM(Geo)	S L Kapil ED(Geotech)
Date : Oct 2021			

PLATE - 5.5



STEREOPLOT PROJECTION OF DISCONTINUITIES

LEGEND:-

- SLOPE WASH MATERIAL
- METAVOLCANICS
- SHEAR SEAM (5-10CM)
- 010/70 — FOLIATION JOINT (S-1)
- 240/70 — JOINT SET (S-2)
- 155/25 — JOINT SET (S-3)
- JOINT SET (S-4)
- RECOVERY / RQD (100% 0 100%)

NOTES: -

1. ALL DIMESIONS ARE IN METERS.
2. NSL AS RECEIVED FROM D & E DIVISION VIDE DRAWING NO. NHURI-IST-II/DD/41/ GA/03 DATED 24.09.2021.
3. JOINTS ARE SCHEMATICALLY SHOWN.

20 0 20 40 60m

SCALE :

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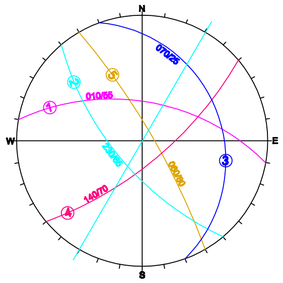
URI-I STAGE-II H. E. PROJECT

GEOLOGICAL X- SECTION OF POWERHOUSE

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
Sushil Almadi Manager(ED)	BNS Naveen Kumar Sr.Manager (Geo)	Ajay Singh DGM (Geo)	S.L.Kapil ED (Geo-tech)

DATE Oct 2021 DRG.No.

PLATE - 5.6



STEREOPLOT PROJECTION OF JOINTS IN TRT AREA

X = 6750
X = 6500
X = 6250
X = 6000
X = 5750
X = 5500
X = 5250
X = 5000
X = 4750
X = 4500
Y=9750
Y=10000
Y=9500
Y=9250
Y=9000
Y=7750
Y=8000
Y=8250
Y=8500
Y=8750

P-1
RI-PH
DH-3
DH-3A
SSS-1
Z
Z'
UTDR - 5
STT-3
RI-7
RI-8
RI-6
RI-5
6.5M ϕ TRT STAGE-II
8.4M ϕ TRT STAGE-I (EXISTING)
800m
UPDR 4
ADIT-6A
UPDR - 2
ADIT-6
TRT OUTLET (STAGE-II)
SOL-1
SOL-2
TRT OUTLET (STAGE-I)

LEGEND:-

- RIVERBORNE MATERIAL
- SLOPEWASH MATERIAL
- SLUMPED ROCK
- VARIEGATED SHALE
- LIMESTONE / MARBLE
- GRAPHITIC SCHIST
- METAVOLCANICS
- STT-3 — DRILL HOLE
- RESISTIVITY IMAGING PROFILE
- UPDR - 2 — DRIFT
- 60 / 80° — ATTITUDE OF DISCONTINUITIES
- THRUST
- Z Z'

NOTES:-

1. ALL DIMENSIONS ARE IN METERS.
2. TOPOGRAPHY DEVELOPED FROM EXISTING TOPOGRAPHIC PLAN OF URI POWER STATION AND STRIP SURVEY CARRIED OUT BY PID IN JUNE-JULY 2021.
3. PROJECT LAYOUT SHOWN IS AS RECEIVED FROM D & E DIVISION VIDE DRAWING NO. NHURI-IST-II/DD/41/GA/03/00 DATED 24.09.2021.

SCALE:- 50 0 50 100 150 200 250M

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उरी-I चरण-II जल विद्युत परियोजना
URI-I STAGE-II H. E. PROJECT

GEOLOGICAL PLAN OF TRT

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
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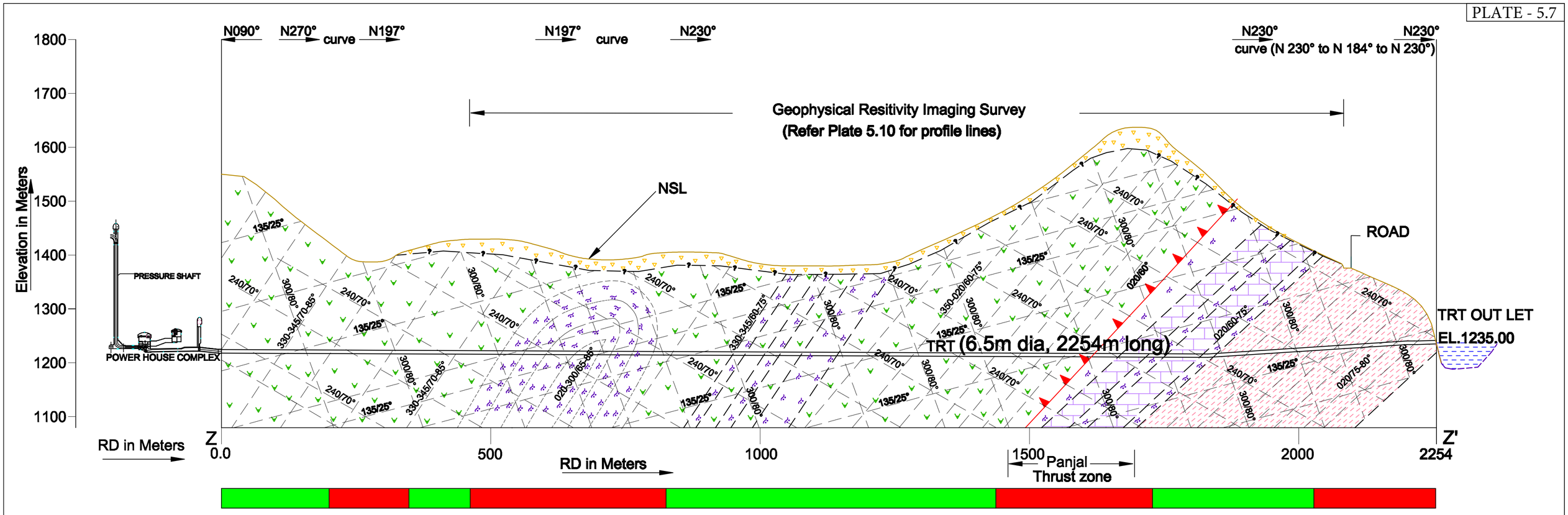
DATE Oct 2021		DRG.No.	

PLATE - 5.7



INDEX

- SLOPE WASH MATERIAL
- VARIEGATED SHALE
- LIMESTONE
- GRAPHITIC SCHIST
- METAVOLCANICS
- THRUST
- ROCK CLASS -IV / V
- ROCK CLASS -III

SCALE 0 50 100 150 200 250M

NOTES: -

1. ALL DIMESIONS ARE IN METERS.
2. NSL AS RECEIVED FROM D & E DIVISION VIDE DRAWING NO. NHURI-IST-II/DD/41/GA/03 DATED 24.09.2021.
3. DISCONTINUITIES ARE SCHEMATICALLY SHOWN.
4. ROCK CLASSES SHOWN ARE TENTATIVE (FOR INDICATION PURPOSE ONLY) AND MAY VARY DURING ACTUAL CONSTRUCTION.
5. ANTICIPATED ROCK CLASSES IN TRT : 50% - CLASS-III & 35% - CLASS-IV & 15% CLASS - V.

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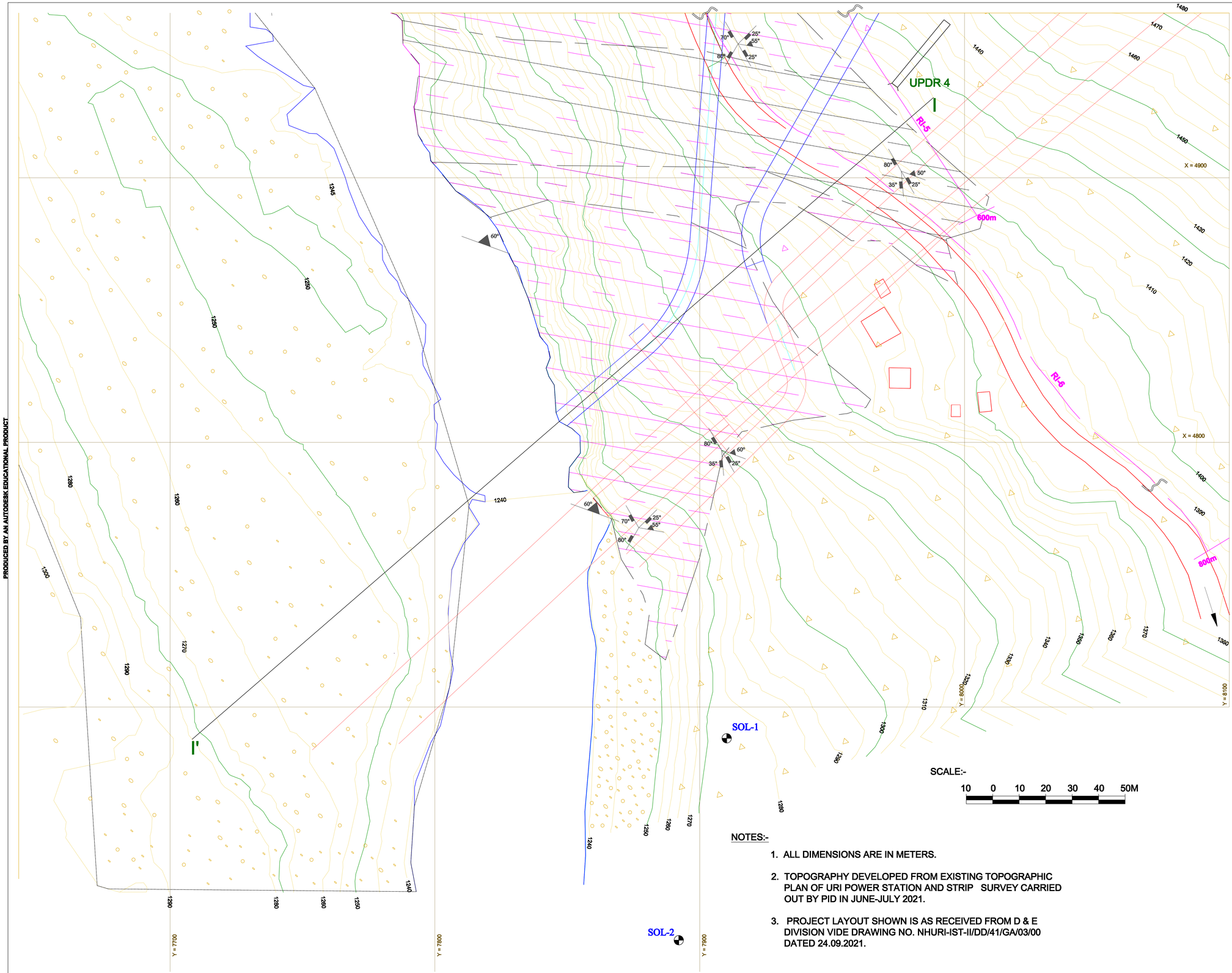
URI-I STAGE-II HYDROELECTRIC PROJECT

GEOLOGICAL SECTION OF TRT
(Interpreted)

DRAWN By	Submitted by	Recommended by	Approved by
Sushil Almadi Manager (ED)	BNS Naveen Kumar SM(Geo)	Ajay Singh DGM(Geo)	S. L. Kapil E.D. (Geo-Tech)
DATE: Oct-2021		DRG. NO.:	

PLATE - 5.8



SCALE:-

10 0 10 20 30 40 50M

LEGEND:-

- RIVERBORNE MATERIAL
- SLOPE WASH MATERIAL
- VARIEGATED SHALE
- Sol-2 DRILL HOLE
- RI-2 RESISTIVITY IMAGING PROFILE
- UPDR - 2 DRIFT
- 60 / 80 ATTITUDE OF JOINTS

NOTES:-

1. ALL DIMENSIONS ARE IN METERS.
2. TOPOGRAPHY DEVELOPED FROM EXISTING TOPOGRAPHIC PLAN OF URI POWER STATION AND STRIP SURVEY CARRIED OUT BY PID IN JUNE-JULY 2021.
3. PROJECT LAYOUT SHOWN IS AS RECEIVED FROM D & E DIVISION VIDE DRAWING NO. NHURI-IST-II/DD/41/GA/03/00 DATED 24.09.2021.

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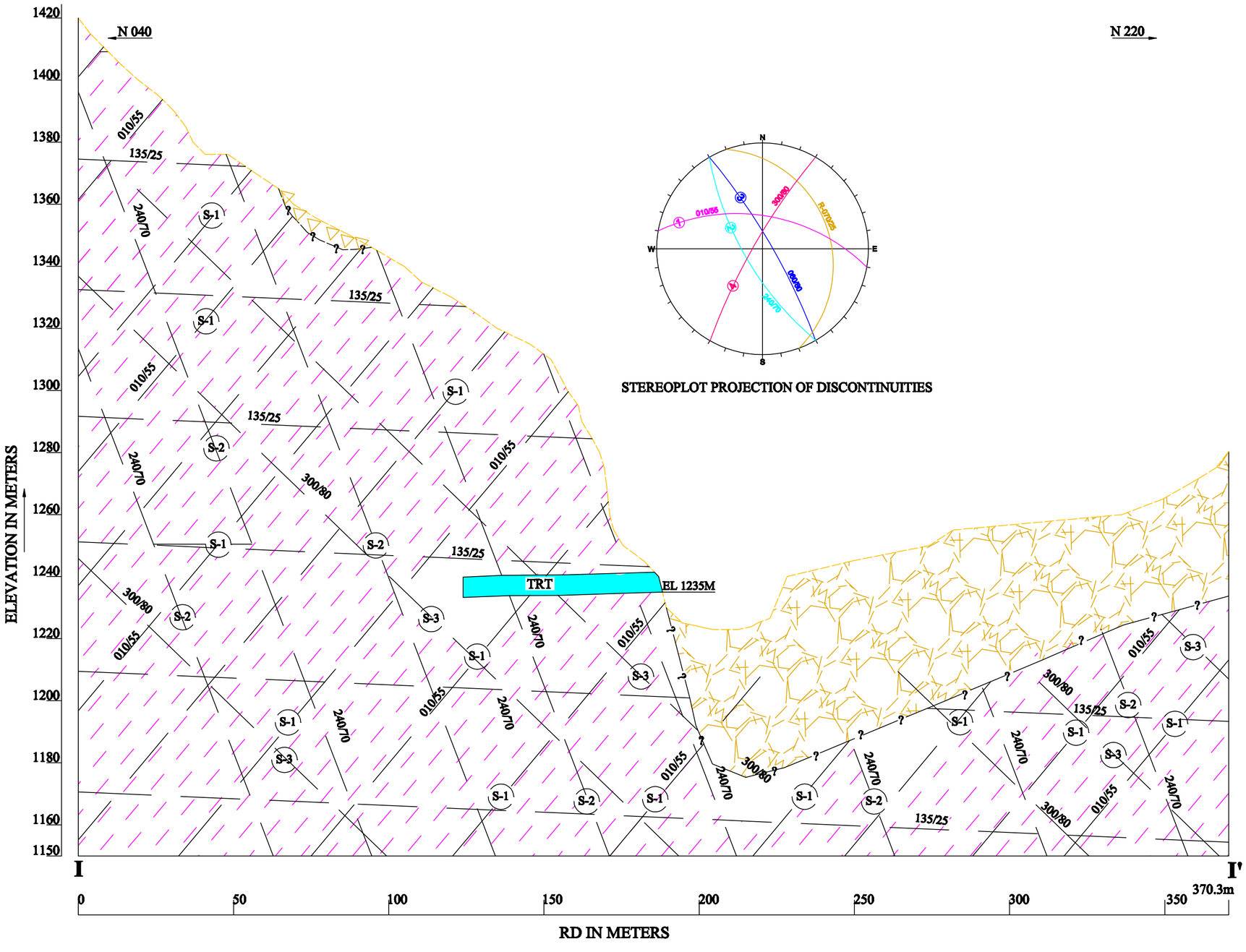
उरी-I चरण-II जल विद्युत परियोजना
URI-I STAGE-II H. E. PROJECT

GEOLOGICAL PLAN OF TRT OUTLET

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
Sushil Almadi Manager(ED)	BNS Naveen Kumar Sr.Manager (Geo)	Ajay Singh DGM (Geo)	S.L.Kapil ED (Geo-tech)

DATE Oct. 2021 DRG.No.

PLATE - 5.9



STEREOPLOT PROJECTION OF DISCONTINUITIES

LEGEND

- RIVERBORNE MATERIAL
- SLOPEWASH MATERIAL
- VARIEGATED SHALE
- S-1 — JOINT SET (SCHEMATIC)

NOTE:
1. JOINTS ARE SCHEMATICALLY SHOWN.

15 0 15 30 45 60m

SCALE :

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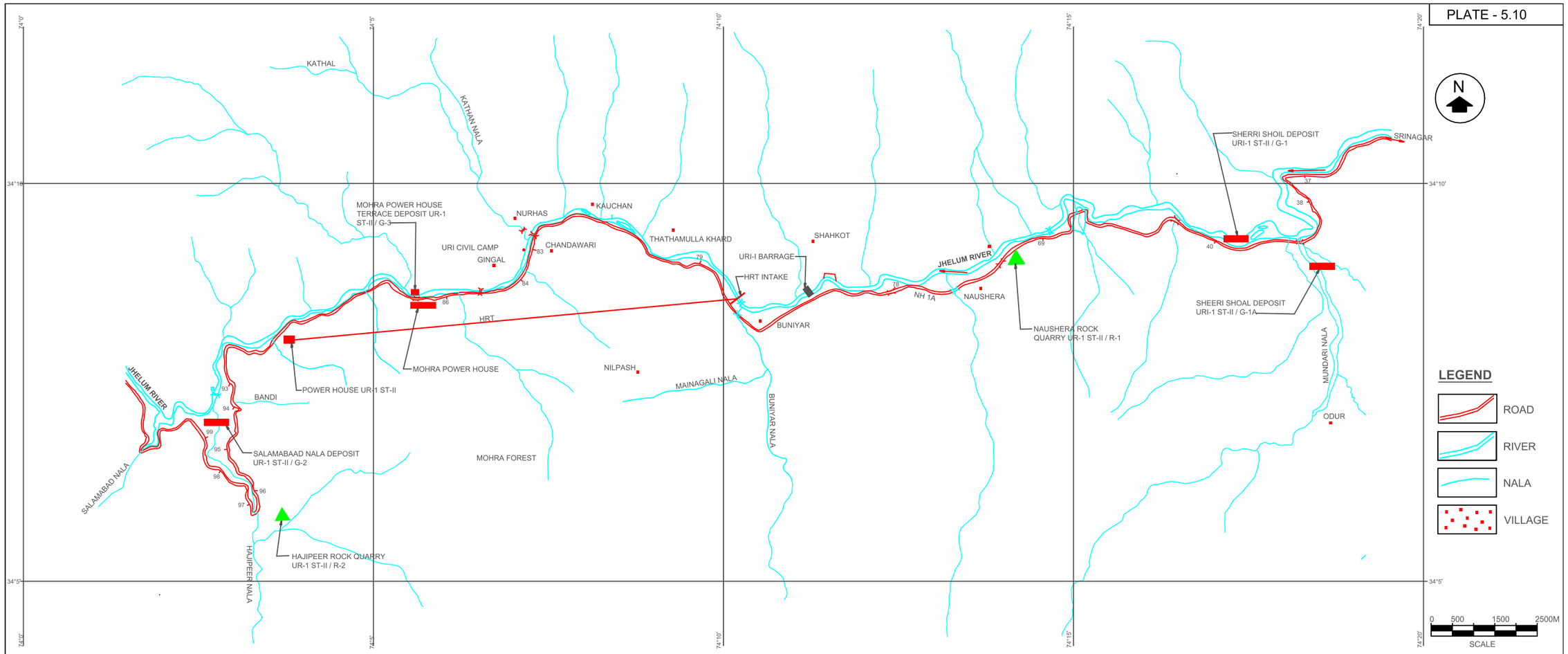
URI-I STAGE-II HYDROELECTRIC PROJECT

GEOLOGICAL SECTION OF TRT OUTFALL (I-I')

DRAWN BY	SUBMITTED BY	RECOMMENDED BY	APPROVED BY
Sushil Almadi Manager (ED)	BNS NAVEEN KUMAR SM (GEO)	AJAY SINGH DGM (GEO)	S. L. Kapil E.D. (Geo-Tech)
DATE: Oct 2021		DRG. NO.: NHURI-I/ST-II//EG/2021/	

PLATE - 5.10



S.No.	NAME OF BORROW AREAS AND ROCK QUARRIES	LEGEND	INDEX NO.	DISTANCE FROM		AVIALABLE QUANTITY (lakh cum)	REQURED QUANTITY (lakh cum)	REMARKS
				INTAKE (KM)	P.H. (KM.)			
1.	SHEERI SHOAL DEPOSIT		UR- 1ST-II/G-1	15.0	35.0	1.35	Coarse Aggregate = 3.60 (A) Non-wearing Surface = 3.10 (B) Wearing Surface = 0.50 Fine Aggregate = 1.80 **Total = 5.40** **Add 38% Wastage as per CWC Guidelines** Coarse Aggregate = 5.00 Fine Aggregate = 2.50 **Total = 7.50**	PROPOSED TO BE QUARRIED
	SHEERI SHOAL DEPOSIT (MUNDRI NALA)		UR- 1ST-II/G-1A	18.0	38.0	0.45		
2.	SALAMABAD SHOAL DEPOSIT		UR- 1ST-II/G-2	21.0	10.0	1.60		
3.	MOHRA POWER HOUSE TERRACE DEPOSIT		UR- 1ST-II/G-3	10.0	8.0	1.25		KEPT RESERVED
4.	NAUSHERA ROCK QUARRY		UR- 1ST-II/R-1	8.0	24.0	7.00		PROPOSED TO BE QUARRIED
5.	HAJIPEER NALA ROCK QUARRY		UR- 1ST-II/R-2	25.0	10.0	5.00		KEPT RESERVED
6.	EXCAVATED ROCK MATERIAL FROM HRT		UR- 1ST-II/R-3	10.0	10.0	1.50		PROPOSED TO BE QUARRIED
7.	EXCAVATED ROCK MATERIAL FROM POWER HOUSE		UR- 1ST-II/R-4	10.0	0.0	1.50		

NHPC LIMITED

URI - I H E PROJECT STAGE- II

INDEX PLAN OF BORROW AREAS AND ROCK QUARRIES

DRN.	PRE	CKD	APP
N S SIDHU	AK MISHRA MGR(GEO)	SK DUTTA DGM (R)	S L KAPIL ED(GEO)

DRG. NO. NH/EG/CSM-67/1 DATE: SEPT. 2021

CHAPTER – VI

HYDROLOGY

CHAPTER-VI

HYDROLOGY

6.1 HYDROLOGICAL INPUTS FOR THE PROJECT PLANNING

Uri-I (Stage-II) H. E. project is the second stage of already commissioned 480 MW (in the year-1997) at Uri-I Power Station. This project is planned as per provision kept in the DPR of URI-I Power Station. Uri-I Power station, a run-off the river scheme, is situated on river Jhelum in Uri Tehsil of Baramulla district in UT of Jammu and Kashmir. The provision for second stage has been kept in the design of surface water conveyance system from head regulator and up to the Intake of HRT keeping the diversion structure of URI-I Power Station i.e. Barrage is same for URI-I (Stage –II) H.E. Project. The catchment area of Jhelum at Uri-I Power Station lies between Longitude $73^{o}55'$ E to $75^{o}35'$ E and Latitude $33^{o}25'$ N to $34^{o}40'$ N with an area of 12,750 km^2. The present gross storage capacity of Uri-I reservoir is 23.71 Ham at FSL i.e. EL 1491 M as per latest reservoir survey. Various Hydrological inputs for Project planning are given below:

6.1.1 Water Availability Series

The average 10-daily water availability series at Uri-I from Jun1976 to May 2011 was approved by CWC, vide letter no.7/36/96/Hyd (N)/757, dated 12.12.2011. Following the same methodology/approach, average 10-daily water availability series is updated from Jun 2011 to May 2020 based on the discharge data observed at control structure of Uri-I Barrage after deduction of turbine release from Kishanganga Hydroelectric Project from observed series at Uri-I Barrage. Average water availability series from 1994-1995 to 2019-2020 (26 years) has been approved by CWC Hydrology (N) Directorate vide their file no. T-11025/1//2021-HYD (N) Dte, dated 15-03-2021. The average annual yield for the series Jun-94 to May-20 is computed as 8080 M cum (i.e. 633.7 mm).

6.1.2 Reservoir Area Elevation Capacity Curve

Full Supply Level (FSL) of the reservoir is at EL 1491 m. The initial gross storage capacity and surface area of reservoir were 35.97 Ham & 8.69 Ha. at

FSL. The present gross storage capacity & surface area of reservoir are 23.71 Ham & 6.19 Ham at FSL as per latest post monsoon 2018 reservoir survey. The live capacity of the reservoir is Nil. The reservoir of Uri-I power station is around 950 m long at FSL.

6.1.3 Design Flood

A design flood value of 80000 Cusecs (2264 cumec) was adopted for Uri-I Barrage during the construction of the Barrage. The same shall be valid for Uri-I (Stage-II) project also, as existing Uri-I Barrage, will also be diversion structure for Uri-I (Stage-II) project.

6.1.4 Diversion Flood

The diversion flood is not proposed as no works are proposed at diversion site on river.

6.1.5 Reservoir Sedimentation

The sediment load at barrage site has also been calculated on the basis of observed sediment data from 2003-2020. Based on this data the average annual sediment (including 8% bed load) works out to be (suspended load of 2.88 + Bed load of 0.23) 3.11 Million tons per year.

6.1.6 Hydraulic Transient Study

The hydraulic transient study for Uri-I (Stage-II) H.E. Project has been carried out to ascertain the transient conditions in occurring during operation of the power plant and especially to satisfy those stipulated in CEA guidelines and Indian Standards for total closing and/or opening of the turbine valves. Transient conditions have been analyzed using the computer programme WHAMO (Water Hammer and Mass Oscillations) developed by US Army corps of Engineers (details in Annexure Volume – Hydrology of DPR).

6.2 EFFECT OF PROJECT DEVELOPMENT ON HYDROLOGIC REGIME

Uri-I (Stage-II) H.E. Project is the extension of Uri-I Power station (480 MW). Uri-I power station a purely run–of-the river scheme which was allotted to NHPC Limited and was commissioned in 1997 and since then operating

successfully on River Jhelum. The Project has a power house with TRT outlets proposed at about 16 Km d/s of the Barrage. Hon'ble NGT vide OA no-425/2019 had ordered to maintain 15% of average discharge of lean period as an e-flow i.e. 14.2 cumecs. Barrage is equipped with a fish pass between bay No.6 and bay No. 7 to release discharge of 2.5 cumecs continuously. Balance e-flow is provisioned to pass through the Silt excluder gate. The project utilizes water coming from Lower Jhelum H.E. Project for power generation after releasing mandated e-flow and remaining water spills over the barrage as there is no live capacity in the reservoir. Hence, this project development has no significant effect on hydrological regime of the river.

6.3 HYDROLOGICAL STUDIES:

The hydrological studies have been explained in detail in Volume-V (Annexure Volume: Hydrology). They are explained in brief in subsequent paragraphs.

6.3.1 Water Availability study

6.3.1.1 Previous studies

The water availability series at Uri-I project was earlier approved by CWC for the period 1922-1978, which was used for the power potential studies of Uri-I Power station. During the DPR stage of Uri-II H.E. Project, the water availability series was updated by using the control structure data of Uri-Barrage and water availability series from Jun1976 to May 2002 was approved by CWC, vide letter no. CWC U.O. No. 7/36/96/HYD-N/39 dated 23.01.04.

During the year 2011, water availability series was updated by using the control structure data of Uri-Barrage. The consistency of the observed discharge data at Uri-I Barrage was validated with respect to discharge observed at upstream locations on Jhelum River such as Lower Jhelum HE project, Baramulla & Sopore. Average 10-daily water availability series was updated from Jun 2002 to May 2011 based on the discharge data observed on hourly basis at control structure of Uri-I Barrage. The earlier approved series from Jun 1976 to May 2002 was extended up to 2011 by clubbing the additional data and thus water availability series developed at Uri-I barrage for

the purpose of Uri-I (stage-II) H.E. Project from Jun1976 to May 2011 was approved by CWC, vide letter no. 7/36/96/Hyd (N)/757, dated 12.12.2011.

6.3.1.2 Present study - Extension of Series up to Water Year 2019-20

Following the same methodology/approach, average 10-daily water availability series was updated from Jun 2011 to May 2020 based on the discharge data observed at control structure of Uri-I Barrage after deduction of turbine release from Kishanganga Hydroelectric Project from observed series at Uri-I Barrage.

6.3.1.2.1 Water Availability Series at Uri-I Barrage after deduction of Kishanganga machine discharge flows

Kishanganga Hydroelectric Project (KGHEP) was commissioned in May-2018. This project is a inter basin transfer river and after commission of KGHEP its water will come to Uri-I Barrage site through Bonar Nallah - Madhumati Nallah - Wular Lake - Jhelum. It is understood that after commissioning of KGHP, i.e. May 2018 onwards the flow utilized by machines after generation will be released in the Bonar Nallah / Wullar Lake, which will ultimately reach to Uri-I Power Station. The 10-daily average values of machine discharge after May 2018 has been computed and attached at **Annexure-6.1.** Water availability series at Uri-I barrage has been developed in two parts from June-11 to April 2018 as it is and from May-2018 to May 2020 after deduction of KGHEP machine discharge flows. Necessary correction in the series of Uri-I have been made so that the inflow series of Uri-I & KGHP are being used, separately. The corrected water availability at Uri-I series from Jun-1976 to May-2020 is enclosed as **Annexure-6.2.**

6.3.1.2.2 Curtailment of Length of Period of Water Availability Series after Observations of CWC (Feb-2021)

The updated water availability series (i.e. from Jun 1976 to May 2020) after deduction of Kishanganga machine discharge flows was sent to CWC for clearance/appraisal of the series. During the examination of the above said series, it was observed by CWC that “yields of water availability for the period 1988-89 to 1996-97 series on annual basis for the period is abnormally high

considering LJHP data and series failed in F-test/t-test from 1976-77 to 2011-12 and there is clear kink in the mass curve also". Subsequently, daily discharge data at LJHP from January-2011 to January-2021 and Baramula G&D site data on Jhelum River from Jan-2011 to Dec-2020 have been collected from project locations. The data status of discharge sites after collection of discharges from various agencies is shown in Table-6.1.

Table-6.1 Data status of Discharge sites

G&D Site	Data Availability	Location
Uri-I Barrage	1997 to till now	At Uri I Barrage
Buniyar	1991-1996	500 m u/s of Uri Barrage
Lower Jhelum HE Project	1988 to 2020	Upstream of Uri Barrage @ LJHP
Baramulla	Jun 1976 to 1987, 1991 to 2020	15 km upstream of Uri I Barrage
Sopore	1991- 2000	D/S of Wular Lake

Average monthly discharges at Uri-I PS, LJHP and Baramula G&D sites from Jan-2011 to Dec-2020 has been plotted and found that discharge measured at these locations are consistent w.r.t. that measured in Uri-I PS. After establishing that the discharge data at Uri-I PS is consistent with upstream projects on Jhelum River, rainfall run-off consistency check has been performed. However, the water availability series (i.e. June-1976 to May-2020) was passed in the F-test but failed in t-test. To make water series consistent and homogeneous as suggested by CWC, the original water availability series has been curtailed to the year 1994-95 to year 2019-2020 (**26 years**), so that the series passes both F-Test and T-test. The water availability series from 1994-95 to 2019-20 (26 years) has been approved by CWC Hydrology (N) Directorate vide their file no. T-11025/1//2021-HYD(N) Dte, dated 15-03-2021. The copy of same is enclosed as **Annexure-6.3.** The

average annual yield for the series Jun-94 to May-20 is computed as 8080 MCM (i.e. 633.7 mm).

CWC has been again approached for reconsideration of long term flow series (1976-77 to 2019-20) after receiving the long term rainfall and snowfall data from IMD Pune. An attempt has again been made to establish the consistency of long term water availability series at Uri-I Barrage for Jhelum River Basin from the year 1976 onwards. The precipitation data consists of 46 rainfall stations and 5 snowfall stations covering the entire Jhelum basin upstream of project.

In response to above request for reconsideration of long term series by NHPC Limited HYD (N) Dte. of CWC sent their view after re-examination of submitted information vide their file no. T-11025/1/2021-HYD (N) DTE, dated 16-04-2021. CWC in its letter stated that, "*the water availability series approved of Uri-I (stage-II) for the period from 1994-95 to 2019-20 have been again re-examined in totally considering the available consistent hydrological data and the Indus Water treaty provisions and it is observed that the water availability series approved earlier (i.e. vide file no. T-11025/1//2021-HYD (N) Dte, dated 15-03-2021) is in order*".

6.3.1.2.3 Water Availability Series used in Power Potential Studies

Considering actual generation data, on the request of NHPC Limited, CEA agreed to consider long term Water Availability series from 1976-77 to 2019-20 (44 years) for Jhelum River and water availability series from 1971-72 to 2019-20 (49 yrs) for Kishanganga River for Power Potential studies. The water availability series used in power potential studies (enclosed in **Annexure-6.2)** is same as proposed earlier.

6.3.1.2.4 Submission of Pre-DPR Chapters

Pre-DPR chapters on hydrological aspects has been prepared and submitted to Central Water Commission (CWC) during the month of October-2021. The comments and response of CWC on hydrological aspects has been received vide their file no. T-11025/1/2021-HYD (N) DTE, dated 17-11-2021. The copy of the same is enclosed as **Annexure-6.4.**

Annexure-6.1

Kishanganga Power Station, Jammu & Kashmir

DAILY AVERAGE DISCHARGE THROUGH MACHINE AT KGHEP DAM (Based on 24-hourly)

Station: Kishanganga Dam **Unit: Cumec**

YR/MONTH	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
2018					0.0	7.4	15.2	6.4	24.9	13.7	14.4	6.5
					7.5	16.1	8.0	13.8	24.9	14.0	0.0	9.8
					24.0	27.3	28.2	8.6	19.0	12.3	0.0	8.0
2019	5.3	6.4	7.0	34.5	20.2	24.2	29.1	26.6	30.5	19.1	5.6	10.4
	5.4	5.2	5.6	31.0	25.9	26.6	32.8	15.7	24.4	13.2	12.2	9.6
	6.7	7.2	17.4	22.6	26.3	35.9	32.0	15.1	22.3	10.6	13.3	6.5
2020	5.1	2.8	19.2	0.0	36.7	23.0	39.4	39.6	38.1	20.0	12.2	
	2.3	2.7	2.0	0.0	39.2	38.8	39.5	39.7	38.6	17.2	12.8	
	4.3	5.8	0.0	6.5	23.2	39.4	39.4	39.1	26.8	13.6	12.5	

Annexure-6.2(1)

URI-I (STAGE-II) HYDROELECTRIC PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After reduction of Kishanganga machine flows)

YEAR	JUN			JUL			AUG			SEP			OCT			NOV		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	482.5	435.2	348.6	397.3	397.2	279.2	673.5	823.4	522.8	438.1	396.0	459.6	136.5	111.9	99.1	84.2	76.1	68.0
1977-78	386.9	302.5	306.3	359.4	357.7	302.5	207.8	199.0	220.3	168.9	170.8	161.4	122.8	82.1	80.2	103.2	97.6	80.8
1978-79	483.1	350.2	298.8	321.1	360.9	336.4	137.1	310.9	289.3	168.4	105.9	119.5	117.9	70.6	49.4	70.6	86.8	85.2
1979-80	447.2	354.3	345.2	340.0	299.9	266.7	168.1	139.6	145.0	110.4	76.3	124.8	119.1	88.7	72.7	63.4	79.4	101.0
1980-81	452.5	493.9	510.6	499.3	469.6	425.2	388.3	334.1	220.3	184.2	329.6	251.8	158.4	117.1	87.6	91.7	84.0	96.5
1981-82	603.4	448.6	378.5	399.4	371.5	424.7	466.7	350.6	232.4	159.6	124.2	118.3	118.3	99.3	88.5	89.7	92.1	80.8
1982-83	533.9	504.6	425.2	422.5	372.0	313.4	281.1	345.0	255.1	152.1	102.9	118.8	130.2	104.7	114.0	153.1	159.7	155.7
1983-84	786.9	685.9	597.4	745.6	682.0	639.4	671.2	637.6	550.6	524.7	370.3	268.6	182.0	150.9	138.2	118.1	111.4	99.3
1984-85	555.6	447.0	370.3	295.5	216.9	243.8	238.9	252.6	326.9	421.9	363.8	225.7	107.1	55.4	40.2	39.1	42.8	66.2
1985-86	473.0	438.1	427.0	221.6	231.0	557.1	349.3	320.2	289.1	109.1	72.6	66.6	153.0	122.1	112.4	103.0	92.6	87.0
1986-87	456.4	503.4	658.8	683.8	592.7	523.7	575.0	492.3	381.5	224.5	131.7	112.3	131.5	120.1	153.8	105.5	161.5	223.2
1987-88	473.6	452.7	427.5	407.3	397.5	377.5	349.3	320.2	289.1	266.8	230.5	189.0	153.9	122.8	113.0	103.6	93.1	87.5
1988-89	430.4	283.4	268.4	301.1	476.0	593.1	612.4	402.9	269.2	183.1	111.0	220.0	480.0	237.2	120.5	111.2	54.3	53.8
1989-90	794.1	686.0	354.7	344.2	305.4	393.0	653.7	368.3	214.8	221.7	130.0	83.1	103.6	115.2	129.0	146.3	101.9	98.0
1990-91	581.8	367.2	353.1	463.4	389.6	223.4	178.7	275.9	233.3	210.2	186.7	147.3	112.7	85.8	74.1	76.7	61.7	54.4
1991-92	988.6	990.0	884.3	670.6	652.9	626.4	431.5	383.1	313.9	313.9	298.3	294.9	258.5	158.0	117.3	85.2	59.2	72.2
1992-93	869.0	765.8	709.4	716.5	636.0	436.4	407.6	544.4	419.6	402.5	1428.6	933.2	366.6	244.9	176.3	147.4	121.5	143.9
1993-94	771.0	533.1	699.3	713.5	1083.7	1221.4	519.7	301.1	165.4	145.8	197.3	206.0	201.4	157.2	110.9	124.5	149.3	115.1
1994-95	707.4	713.2	600.3	590.0	548.9	605.1	448.0	448.3	550.7	542.0	524.0	280.9	391.9	325.8	345.7	83.3	72.5	60.6
1995-96	728.3	570.8	523.9	442.9	351.1	964.7	1245.2	1042.1	738.4	328.4	265.2	157.8	166.2	179.9	140.3	150.7	155.1	86.5
1996-97	925.4	986.1	1426.8	1371.6	976.1	567.5	460.5	396.3	938.4	972.6	286.0	187.6	196.9	185.7	164.5	122.2	81.0	87.2
1997-98	472.3	431.6	429.6	421.1	262.1	224.3	238.7	185.5	319.7	702.1	398.1	177.2	125.9	120.4	121.0	121.7	114.1	107.4

URI-I (STAGE-II) HYDROELECTRIC PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After Reduction of Kishanganga machineflows)

YEAR	DEC			JAN.			FEB			MAR			APR			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	64.2	58.7	56.2	53.1	73.5	80.7	99.5	100.5	108.1	114.5	126.6	148.0	206.3	369.0	233.8	432.0	373.2	408.9
1977-78	68.9	66.2	82.7	76.1	63.7	77.3	69.6	77.2	86.1	158.3	239.0	277.4	262.0	406.8	537.5	522.6	521.8	567.9
1978-79	68.2	56.9	46.2	41.3	44.2	51.4	47.2	57.0	99.6	175.3	252.8	260.2	344.4	392.9	383.8	374.5	426.3	625.9
1979-80	110.0	91.4	88.8	109.1	95.5	103.2	126.9	204.0	301.9	360.0	354.7	426.4	419.7	454.2	486.2	491.5	522.6	491.2
1980-81	103.9	84.9	79.5	89.7	80.4	103.4	164.0	232.1	321.9	399.0	399.0	482.7	717.3	748.8	815.0	796.8	739.9	674.8
1981-82	74.3	69.3	64.2	61.8	59.2	71.6	83.6	104.6	128.2	181.9	233.7	402.9	432.4	490.4	560.6	581.7	515.9	503.6
1982-83	161.7	185.0	137.1	132.6	123.0	129.1	139.0	122.2	141.3	290.6	491.9	613.0	584.7	683.6	647.7	782.1	820.7	824.8
1983-84	92.2	88.7	88.3	82.3	82.3	82.9	84.9	101.9	120.0	126.6	206.6	322.5	364.2	425.8	470.0	455.0	552.4	548.9
1984-85	59.4	64.8	45.2	66.9	56.7	74.8	67.7	72.8	74.2	84.8	74.8	139.3	224.8	311.8	286.4	554.3	525.0	426.0
1985-86	44.7	67.1	119.2	78.8	80.8	84.6	99.1	123.8	149.4	201.0	261.2	324.5	554.6	687.1	977.0	983.3	852.9	656.5
1986-87	226.5	281.6	262.7	181.6	150.4	151.9	196.4	241.9	337.1	433.2	442.1	542.1	658.8	591.8	771.3	498.9	504.6	504.9
1987-88	81.9	83.5	81.6	57.2	65.7	99.9	116.1	145.0	182.6	267.1	674.1	574.0	571.1	596.1	661.6	649.4	552.1	484.7
1988-89	53.8	54.9	78.3	97.1	82.3	56.9	71.1	68.2	92.7	120.7	216.2	332.2	494.8	432.1	372.2	601.4	605.8	743.7
1989-90	74.8	74.5	106.3	77.6	71.9	126.1	224.3	232.9	190.0	180.5	340.8	922.6	612.3	614.9	635.3	717.3	815.7	765.8
1990-91	49.0	48.7	96.4	182.0	157.4	144.2	198.2	325.6	321.4	437.1	526.8	637.4	1236.9	1340.7	838.6	834.4	809.1	1059.4
1991-92	63.8	66.6	72.8	74.8	73.5	111.1	276.1	214.6	176.3	236.4	318.1	824.1	772.5	679.4	979.2	1017.8	992.7	894.5
1992-93	128.3	120.3	124.6	196.6	185.5	169.3	155.2	271.9	318.7	295.7	560.5	907.0	658.5	624.8	639.2	869.3	1110.4	990.9
1993-94	115.2	100.7	95.9	103.2	94.0	121.7	196.2	153.5	201.4	356.7	399.3	492.8	830.1	553.8	403.9	670.6	893.4	895.2
1994-95	86.1	137.6	98.1	149.0	104.2	93.7	101.4	300.5	274.7	256.5	249.5	695.6	628.1	606.0	729.2	749.0	787.2	895.2
1995-96	34.8	97.8	116.6	111.5	121.3	104.8	102.7	248.6	311.4	321.1	699.8	895.6	667.7	576.2	624.3	727.9	712.2	892.0
1996-97	88.0	79.7	73.5	78.1	61.9	66.7	70.8	40.0	78.4	116.5	190.4	266.7	299.2	405.5	430.6	573.5	522.6	464.4
1997-98	127.9	123.1	99.1	84.4	118.9	110.9	122.7	183.4	199.9	327.1	307.9	431.7	666.2	761.0	883.7	883.2	651.8	631.4

Annexure-6.2 (2)

URI-I (STAGE-II) HYDROELECTRIC PROJECT																		URI-I (STAGE-II) HYDROELECTRIC PROJECT																	
AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After reduction of Kishanganga machine flows)																		AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After Reduction of Kishanganga machineflows)																	
YEAR	JUN			JUL			AUG			SEP			OCT			NOV			DEC			JAN.			FEB			MAR			APR			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1998-99	582.8	441.8	386.9	444.4	402.9	302.5	157.9	147.7	145.5	118.9	130.4	154.1	145.2	91.7	86.5	68.1	60.1	54.2	53.5	48.4	48.3	46.9	49.2	76.4	87.0	124.9	134.9	206.0	214.9	188.5	251.6	329.5	308.4	363.4	364.3	278.2
1999-00	155.8	99.5	106.3	86.2	88.5	94.1	125.7	164.3	125.2	105.9	85.5	84.3	80.2	59.7	42.5	62.1	80.2	62.1	47.5	57.3	82.6	40.5	52.9	62.2	76.1	83.7	66.0	94.2	122.2	138.7	220.6	222.2	287.2	275.3	361.3	305.2
2000-01	181.0	105.5	93.5	264.0	335.5	291.3	105.1	85.3	175.6	293.3	191.9	119.0	98.2	85.8	97.7	38.7	39.5	41.9	40.8	45.0	47.1	40.9	36.4	37.1	34.5	31.3	48.6	47.5	58.0	82.6	118.9	173.7	192.2	261.1	346.1	253.6
2001-02	126.9	114.7	149.3	114.2	104.0	116.8	152.3	115.6	105.5	79.8	77.8	78.5	56.3	50.8	45.7	86.3	66.2	56.4	48.7	51.0	50.8	43.9	77.7	72.6	64.6	88.7	181.6	153.2	204.0	378.5	451.4	487.1	548.8	435.6	523.7	517.3
2002-03	318.0	214.3	287.0	234.8	129.1	85.9	64.2	154.4	142.6	152.0	156.3	156.5	105.6	72.3	61.5	51.6	46.6	43.0	42.5	42.3	46.5	40.5	36.6	35.8	40.4	70.2	218.4	428.4	435.0	447.5	485.3	720.0	768.6	1000.9	851.0	786.8
2003-04	713.4	603.6	386.1	297.1	253.9	178.3	169.2	142.8	143.3	153.5	170.1	157.7	175.9	126.8	85.6	58.9	55.1	61.4	54.2	91.8	80.7	77.4	82.9	123.7	118.1	157.3	174.9	192.1	243.5	215.6	203.6	261.9	327.6	608.3	547.0	435.0
2004-05	275.0	186.4	200.8	174.3	171.6	109.7	95.4	95.6	103.2	94.5	66.9	83.6	77.1	94.1	86.0	67.7	51.9	48.1	57.9	48.0	50.7	104.0	80.1	72.1	93.3	173.2	161.7	266.3	555.9	628.1	492.7	444.4	539.1	552.2	570.1	467.9
2005-06	466.1	458.7	488.4	563.7	599.6	505.8	298.0	209.9	140.6	110.2	122.0	125.3	93.2	85.2	79.3	58.9	53.4	49.5	52.8	47.0	41.5	57.7	77.1	121.1	129.9	201.0	235.5	281.6	197.0	241.9	313.1	432.5	371.5	466.3	580.4	529.0
2006-07	340.5	190.6	171.5	182.2	307.4	223.2	307.4	399.9	176.6	464.6	479.2	177.5	131.1	81.2	78.9	69.3	110.1	118.5	103.8	110.1	112.7	98.1	82.3	72.2	90.5	112.6	118.7	142.5	204.4	570.2	589.0	559.4	531.7	462.7	436.2	378.3
2007-08	216.0	226.7	258.1	431.8	317.2	216.8	150.1	180.2	179.7	121.5	121.8	121.2	97.7	51.8	44.7	42.0	42.2	41.3	41.5	44.1	41.3	47.7	82.2	78.4	65.5	89.0	167.6	223.7	243.2	213.9	219.7	343.1	339.7	320.1	368.3	507.5
2008-09	418.8	368.9	322.1	253.2	230.8	190.5	117.1	185.6	193.6	121.4	158.5	114.5	76.8	74.5	79.6	63.3	89.2	79.9	83.0	137.4	161.4	101.6	111.9	176.4	178.2	178.9	198.2	233.5	230.1	237.0	357.4	478.6	469.5	521.8	475.5	508.0
2009-10	498.1	357.0	339.6	322.3	261.8	227.3	236.7	177.5	133.7	142.2	125.8	81.4	74.7	67.3	52.6	48.6	64.7	61.4	57.8	59.5	55.3	45.9	45.7	45.3	70.2	176.4	170.3	225.7	212.0	224.4	227.0	257.0	371.4	557.0	639.9	702.6
2010-11	789.8	532.4	505.8	392.8	321.5	436.6	699.3	600.5	521.1	289.5	200.3	197.1	138.7	88.6	95.8	93.7	75.8	72.1	65.1	58.4	57.0	59.9	60.9	67.1	156.4	280.2	210.0	248.0	262.6	458.7	434.9	562.0	650.5	663.7	622.4	599.8
2011-12	445.1	329.2	296.0	263.2	176.5	144.3	117.8	120.0	121.8	140.5	197.3	273.7	128.6	86.3	73.8	70.1	76.3	61.8	52.7	60.7	55.2	49.9	49.4	57.8	79.0	98.1	155.7	193.1	160.7	241.6	316.5	389.5	411.4	370.1	391.4	414.6
2012-13	451.2	347.9	331.6	317.4	307.8	226.1	186.1	187.0	184.3	183.7	410.8	374.3	169.4	98.7	87.4	69.1	55.8	56.7	57.8	61.3	65.1	64.0	67.5	90.9	122.3	122.3	157.3	227.8	249.1	329.6	286.0	307.8	385.4	372.5	395.9	564.5
2013-14	564.2	517.0	428.5	332.1	214.3	134.8	118.3	254.8	396.0	218.9	162.9	130.9	94.5	83.2	67.7	67.8	52.7	55.4	52.7	47.6	43.7	44.9	48.3	59.2	85.9	105.8	93.2	121.6	371.8	535.0	540.9	582.9	554.2	643.4	718.1	615.0
2014-15	633.1	570.3	492.3	550.6	453.2	337.9	220.5	162.9	203.2	697.1	1139.8	691.0	358.6	201.6	136.8	122.5	114.4	92.3	77.8	65.6	59.5	53.2	51.8	51.8	67.4	103.4	278.4	392.6	441.0	612.2	962.5	774.3	982.1	863.9	853.0	766.9
2015-16	587.4	506.3	634.8	669.1	696.1	671.5	528.4	323.5	189.8	129.4	101.1	265.4	223.1	126.4	231.7	259.0	250.8	159.4	115.1	145.7	105.5	117.6	102.5	92.7	102.3	131.4	207.8	153.0	403.7	576.7	656.2	614.6	538.9	470.4	528.9	553.4
2016-17	436.8	361.8	333.9	270.3	201.5	196.5	238.5	240.5	186.6	287.1	165.7	112.0	81.1	56.5	49.5	47.0	44.7	45.0	43.5	43.1	43.3	51.7	58.3	97.7	201.6	270.0	313.7	247.2	219.5	329.2	735.1	812.5	844.0	645.5	625.1	631.4
2017-18	563.4	508.1	455.3	477.2	390.6	313.9	265.5	203.3	136.5	140.5	129.5	86.5	59.2	44.0	41.3	37.8	41.8	47.4	42.8	55.7	51.9	46.0	42.7	38.4	39.1	45.1	58.6	113.0	121.0	121.0	170.0	330.6	398.0	297.1	322.4	288.2
2018-19	293.4	242.6	166.1	448.3	344.7	334.2	285.6	248.6	175.7	98.9	103.8	110.2	92.1	87.8	74.6	113.9	159.0	114.3	89.1	83.9	67.3	63.6	75.6	113.1	124.2	199.9	270.8	235.0	254.4	337.4	486.7	601.8	574.5	515.4	439.2	481.1
2019-20	479.6	615.0	505.2	433.7	426.4	391.0	439.8	422.1	299.3	179.9	113.1	87.4	102.8	104.2	83.3	120.5	222.4	292.2	246.2	173.6	152.4	119.4	161.6	204.4	179.3	176.5	225.5	275.7	287.1	349.0	417.4	457.6	462.6	521.8	560.4	482.1
Average	**521.4**	**446.4**	**424.6**	**423.9**	**390.1**	**369.9**	**335.9**	**311.3**	**274.2**	**256.2**	**248.0**	**197.4**	**152.1**	**113.1**	**100.7**	**91.2**	**90.9**	**86.9**	**79.6**	**83.6**	**82.6**	**81.8**	**81.4**	**92.3**	**114.1**	**151.0**	**183.2**	**230.5**	**301.3**	**417.6**	**480.5**	**520.4**	**550.6**	**589.9**	**598.4**	**591.3**

Annexure-6.3(1)

File No.T-11025/1/2021-HYD(N) DTE

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग
केंद्रीय जल आयोग
जल विज्ञान (उत्तर) निदेशालय

सत्यमेव जयते

Government of India
Ministry of Jal Shakti
Department of Water Resources, RD&GR
Central Water Commission
Hydrology (North) Directorate

Sub : - Allotment of URI -1 (Stage –II) to NHPC Ltd – Water Availability Study reg.

Ref : - This office letter No. T-11025/1/2021-HYD(N) DTE dated 15.03.2021

Please refer to the letter cited above forwarding therewith a copy of report of water availability study of Uri-1 (Stage-II) along with finalized water availability series at Uri-I for the period from 1994-95 to 2019-2020. In this regard, in the report some typographical errors need to be corrected as under:

1. In Para 2.1, in table at Sl No. 1, 2 & 4; 'May 2011' be read as 'Dec 2020'.
2. In Para 3.3, in 3rd and 5th line from bottom; '1995-96' may be read as '1994-95'

Signature valid
Digitally signed by GOVERDHAN PRASAD
Date: 2021.03.17 10:29:10 IST

(गोवर्धन प्रसाद Goverdhan Prasad)
निदेशक /Director

The General Manager (PID), NHPC Ltd, NHPC Office Complex, Sector-33, Faridabad, Haryana

Copy to:

The Chief Engineer, HPP&I, CEA, Sewa Bhawan, New Delhi

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♦Conserve Water- Save Life♦

Annexure-6.3 (2)

File No.T-11025/1/2021-HYD(N) DTE

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग
केंद्रीय जल आयोग
जल विज्ञान (उत्तर) निदेशालय

सत्यमेव जयते

Government of India
Ministry of Jal Shakti
Department of Water Resources, RD&GR
Central Water Commission
Hydrology (North) Directorate

Sub : - Allotment of URI -1 (Stage –II) to NHPC Ltd – Water Availability Study reg.

Ref : - 1. NHPC letter No. - NH/PID/Dugar/2020/968 dated 20.01.2021
2. This office letter No. 7/36/96/HYD(N)/757 dated 12.12.2011
3. This office letter No. T-11025/1/2021-HYD(N) DTE dated 15.02.2021

Please refer to the letter cited above at Sl No. 1 forwarding therewith a copy of report of water availability study of Uri-1 (Stage-II). Subsequently, some additional data / information was also provided through emails dated 05.02.2021 and dated 10.02.2021. In this regard, Updated water availability study of Uri-1 (Stage-II) was also provided vide e- mail dated 05.03.2021.

The aforesaid updated water availability series of Uri-1 (Stage-II) has been examined and generally in order. A report in this regard along with finalized water availability series at Uri-I for the period from 1994-95 to 2019-2020 is enclosed herewith.

This is issued with the approval of Chief Engineer (HSO), CWC, New Delhi.

Signature Not Verified
Digitally signed by GOVERDHAN PRASAD
Date: 2021.03.15 11:51:26 IST

Encl : As above

(गोवर्धन प्रसाद Goverdhan Prasad)
निदेशक /Director

The General Manager (PID), NHPC Ltd, NHPC Office Complex, Sector-33, Faridabad, Haryana

Copy to:

The Chief Engineer, HPP&I, CEA, Sewa Bhawan, New Delhi

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Annexure-6.3 (3)

Water Availability Study Report of URI – 1 (Stage – II)

1.1 Introduction

Uri-I Hydroelectric Project is an existing project on river Jhelum in Baramula district of Jammu & Kashmir commissioned in 1997. Uri-I (Stage-II) Hydroelectric Project Uri-I is planned to use existing structure/ barrage of Uri-I by providing an additional HRT and power house. The present gross storage capacity of Uri-I reservoir is 23.71 Ha.m. The Jhelum is joined by numerous small mountain streams from the Pir Panjal Range separating the Kashmir valley from the plains in the southwest and by some tributaries from the Great Himalayas in the northeast. As per information provided by the project authorities, the catchment area of the Jhelum river at the Uri-I barrage is 12,750 km^2 and is fan shaped. The catchment areas of some important stations in Jhelum basin are as under:

2.1 Data availability

The 10 average daily discharges of sites as per details given below are used for establishing consistency and establishing water availability series at Uri-I site.

S. No.	G&D Station	Catchment Area (km^2)	Period of Availability	Location/Remark
1	Baramula	10455	Jun 1976 to 1987	15 km upstream of Uri-1 Barrage
			1991 to 1999	
			2000 to May 2011	
2	LJHP	12700	1988 to 1997	Upstream of Uri-I Barrage
			1998 to May 2011	
3	Buniyar		1991 to 1996	500 m upstream of Uri-I Barrage
4	Uri-I Barrage	12750	1997 to May 2011	At Uri-I Barrage after commissioning of Uri-I Power station
5	Sopore	10455	1991 to 2000	Downstream of Wular lake

3.0 WATER AVAILABILITY STUDIES

3.1 Year-2003 studies

The water availability series at Uri-I project was earlier approved by CWC for the period 1922-1978, which was used for the power potential studies of Uri-I Power station. Subsequently, for DPR stage of Uri-II H.E. Project, the discharge series developed from 1976 to 2002 was formulated using discharges of Baramula from Jun 1976 to Dec-1987, Lower Jhelum hydroelectric Project from 1988 to 1996 and Uri-I barrage site from 1997 to 2002. This water availability series for Uri-II HEP from Jun 1976 to May 2002 was approved by CWC vide letter No. CWC U.O. No. 7/36/96/HYD-N/39 dated 23.01.2004

Annexure-6.3 (4)

3.2 Year-2011

Subsequently, water availability series of Uri-II was updated using the data of Uri Barrage (post 1997) upto 2011. However, the series failed in t-test and thus not homogeneous. It was suggested that the series may be further reviewed with coming 2-3 years data. It was also suggested the extended series from 1976-2011 may be used for preliminary project planning vide CWC letter no. 7/36/96/Hyd(N)/757, dated 12.12.2011.

3.3 Present study - Extension of Series up to Water Year 2019-20

Water availability series has now been updated from Jun 2011 to May 2020 (i.e. from Jun 1976 to May 2020) based on the discharge data observed at Uri-I Barrage. During the examination of the above said series, it was observed that yields of water availability for the period 1988-89 to 1996-97 series on annual basis for the period is abnormally high considering LJHP data and series failed in F-test / t-test from 1976-77 to 2011-12 and there is clear kink in the mass curve also. Thus consistency and homogeneity of whole series could not be established. To make series homogeneous, the annual flow series of Uri-I have been tried considering different durations from 1976-77 to 2019-20 by truncating the series so as to pass in t-test/F-test. The water availability series of Uri-I from 1995-96 to 2019-20 (26 years) passes t-test and F-test. Further, mass curve of this series is fairly straight without any major kink and can be considered homogeneous. Accordingly, water availability series of Uri-I for the period from 1995-96 to 2019-20 (26 years) can be used for preliminary project planning and enclosed as Annexure -1. E-flows as per statutory norms may also be maintained.

Annexure-6.3 (5)

AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After reduction of Kishenganga machine flows) Unit-cumec Annexure-I

YEAR	JUN			JUL			AUG			SEP			OCT			NOV			DEC			JAN.			FEB			MAR			APR			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1994-95	707.4	713.2	600.3	590.0	548.9	605.1	448.0	448.3	550.7	542.0	524.0	280.9	391.9	325.8	345.7	83.3	72.5	60.6	86.1	137.6	98.1	149.0	104.2	93.7	101.4	300.5	274.7	256.5	249.5	695.6	628.1	606.0	729.2	749.0	787.2	895.2
1995-96	728.3	570.8	523.9	442.9	351.1	964.7	1245.2	1042.1	738.4	328.4	265.2	157.8	166.2	179.9	140.3	150.7	155.1	86.5	34.8	97.8	116.6	111.5	121.3	104.8	102.7	248.6	311.4	321.1	699.8	895.6	667.7	576.2	624.3	727.9	712.2	892.0
1996-97	925.4	986.1	1426.8	1371.6	976.1	567.5	460.5	396.3	938.4	972.6	286.0	187.6	196.9	185.7	164.5	122.2	81.0	87.2	88.0	79.7	73.5	78.1	61.9	66.7	70.8	40.0	78.4	116.5	190.4	266.7	299.2	405.5	430.6	573.5	522.6	464.4
1997-98	472.3	431.6	429.6	421.1	262.1	224.3	238.7	185.5	319.7	702.1	398.1	177.2	125.9	120.4	121.0	121.7	114.1	107.4	127.9	123.1	99.1	84.4	118.9	110.9	122.7	183.4	199.9	327.1	307.9	431.7	666.2	761.0	883.7	883.2	651.8	631.4
1998-99	582.8	441.8	386.9	444.4	402.9	302.5	157.9	147.7	145.5	118.9	130.4	154.1	145.2	91.7	86.5	68.1	60.1	54.2	53.5	48.4	48.3	46.9	49.2	76.4	87.0	124.9	134.9	206.0	214.9	188.5	251.6	329.5	308.4	363.4	364.3	278.2
1999-00	155.8	99.5	106.3	86.2	88.5	94.1	125.7	164.3	125.2	105.9	85.5	84.3	80.2	59.7	42.5	62.1	80.2	62.1	47.5	57.3	82.6	40.5	52.9	62.2	76.1	83.7	66.0	94.2	122.2	138.7	220.6	222.2	287.2	275.3	361.3	305.2
2000-01	181.0	105.5	93.5	264.0	335.5	291.3	105.1	85.3	175.6	293.3	191.9	119.0	98.2	85.8	97.7	38.7	39.5	41.9	40.8	45.0	47.1	40.9	36.4	37.1	34.5	31.3	48.6	47.5	58.0	82.6	118.9	173.7	192.2	261.1	346.1	253.6
2001-02	126.9	114.7	149.3	114.2	104.0	116.8	152.3	115.6	105.5	79.8	77.8	78.5	56.3	50.8	45.7	86.3	66.2	56.4	48.7	51.0	50.8	43.9	77.7	72.6	64.6	88.7	181.6	153.2	204.0	378.5	451.4	487.1	548.8	435.6	523.7	517.3
2002-03	318.0	214.3	287.0	234.8	129.1	85.9	64.2	154.4	142.6	152.0	156.3	156.5	105.6	72.3	61.5	51.6	46.6	43.0	42.5	42.3	46.5	40.5	36.6	35.8	40.4	70.2	218.4	428.4	435.0	447.5	485.3	720.0	768.6	1000.9	851.0	786.8
2003-04	713.4	603.6	386.1	297.1	253.9	178.3	169.2	142.8	143.3	153.5	170.1	157.7	175.9	126.8	85.6	58.9	55.1	61.4	54.2	91.8	80.7	77.4	82.9	123.7	118.1	157.3	174.9	192.1	243.5	215.6	203.6	261.9	327.6	608.3	547.0	435.0
2004-05	275.0	186.4	200.8	174.3	171.6	109.7	95.4	95.6	103.2	94.5	66.9	83.6	77.1	94.1	86.0	67.7	51.9	48.1	57.9	48.0	50.7	104.0	80.1	72.1	93.3	173.2	161.7	266.3	555.9	628.1	492.7	444.4	539.1	552.2	570.1	467.9
2005-06	466.1	458.7	488.4	563.7	599.6	505.8	298.0	209.9	140.6	110.2	122.0	125.3	93.2	85.2	79.3	58.9	53.4	49.5	52.8	47.0	41.5	57.7	77.1	121.1	129.9	201.0	235.5	281.6	197.0	241.9	313.1	432.5	371.5	466.3	580.4	529.0
2006-07	340.5	190.6	171.5	182.2	307.4	223.2	307.4	399.9	176.6	464.6	479.2	177.5	131.1	81.2	78.9	69.3	110.1	118.5	103.8	110.1	112.7	98.1	82.3	72.2	90.5	112.6	118.7	142.5	204.4	570.2	589.0	559.4	531.7	462.7	436.2	378.3
2007-08	216.0	226.7	258.1	431.8	317.2	216.8	150.1	180.2	179.7	121.5	121.8	121.2	97.7	51.8	44.7	42.0	42.2	41.3	41.5	44.1	41.3	47.7	82.2	78.4	65.5	89.0	167.6	223.7	243.2	213.9	219.7	343.1	339.7	320.1	368.3	307.5
2008-09	418.8	368.9	322.1	253.2	230.8	190.5	117.1	185.6	193.6	121.4	158.5	114.5	76.8	74.5	79.6	63.3	89.2	79.9	83.0	137.4	161.4	101.6	111.9	176.4	178.2	178.9	198.2	233.5	230.1	237.0	357.4	478.6	469.5	521.8	475.5	508.0
2009-10	498.1	357.0	339.6	322.3	261.8	227.3	236.7	177.5	133.7	142.2	125.8	81.4	74.7	67.3	52.6	48.6	64.7	61.4	57.8	59.5	55.3	45.9	45.7	45.3	70.2	176.4	170.3	225.7	212.0	224.4	227.0	257.0	371.4	557.0	639.9	702.6
2010-11	789.8	532.4	505.8	392.8	321.5	436.6	699.3	600.5	521.1	289.5	200.3	197.1	138.7	88.6	95.8	93.7	75.8	72.1	65.1	58.4	57.0	59.9	60.9	67.1	156.4	280.2	210.0	248.0	262.6	458.7	434.9	562.0	650.5	663.7	622.4	599.8
2011-12	445.1	329.2	296.0	263.2	176.5	144.3	117.8	120.0	121.8	140.5	197.3	273.7	128.6	86.3	73.8	70.1	76.3	61.8	52.7	60.7	55.2	49.9	49.4	57.8	79.0	98.1	155.7	193.1	160.7	241.6	316.5	389.5	411.4	370.1	391.4	414.6
2012-13	451.2	347.9	331.6	317.4	307.8	226.1	186.1	187.0	184.3	183.7	410.8	374.3	169.4	98.7	87.4	69.1	55.8	56.7	57.8	61.3	65.1	64.0	67.5	90.9	122.3	122.3	157.3	227.8	249.1	329.6	286.0	307.8	385.4	372.5	395.9	564.5
2013-14	564.2	517.0	428.5	332.1	214.3	134.8	118.3	254.8	396.0	218.9	162.9	130.9	94.5	83.2	67.7	67.8	52.7	55.4	52.7	47.6	43.7	44.9	48.3	59.2	85.9	105.8	93.2	121.6	371.8	535.0	540.9	582.9	554.2	643.4	718.1	615.0
2014-15	633.1	570.3	492.3	550.6	453.2	337.9	220.5	162.9	203.2	697.1	1139.8	691.0	358.6	201.6	136.8	122.5	114.4	92.3	77.8	65.6	59.5	53.2	51.8	51.8	67.4	103.4	278.4	392.6	441.0	612.2	962.5	774.3	982.1	863.9	853.0	766.9
2015-16	587.4	506.3	634.8	669.1	696.1	671.5	528.4	323.5	189.8	129.4	101.1	265.4	223.1	126.4	231.7	259.0	250.8	159.4	115.1	145.7	105.5	117.6	102.5	92.7	102.3	131.4	207.8	153.0	403.7	576.7	656.2	614.6	538.9	470.4	528.9	553.4
2016-17	436.8	361.8	333.9	270.3	201.5	196.5	238.5	240.5	186.6	287.1	165.7	112.0	81.1	56.5	49.5	47.0	44.7	45.0	43.5	43.1	43.3	51.7	58.3	97.7	201.6	270.0	313.7	247.2	219.5	329.2	735.1	812.5	844.0	645.5	625.1	631.4
2017-18	563.4	508.1	455.3	477.2	390.6	313.9	265.5	203.3	136.5	140.5	129.5	86.5	59.2	44.0	41.3	37.8	41.8	47.4	42.8	55.7	51.9	46.0	42.7	38.4	39.1	45.1	58.6	113.0	121.0	121.0	170.0	330.6	398.0	297.1	322.4	288.2
2018-19	293.4	242.6	166.1	448.3	344.7	334.2	285.6	248.6	175.7	98.9	103.8	110.2	92.1	87.8	74.6	113.9	159.0	114.3	89.1	83.9	67.3	63.6	75.6	113.1	124.2	199.9	270.8	235.0	254.4	337.4	486.7	601.8	574.5	515.4	439.2	481.1
2019-20	479.6	615.0	505.2	433.7	426.4	391.0	439.8	422.1	299.3	179.9	113.1	87.4	102.8	104.2	83.3	120.5	222.4	292.2	246.2	173.6	152.4	119.4	161.6	204.4	179.3	176.5	225.5	275.7	287.1	349.0	417.4	457.6	462.6	521.8	560.4	482.1

Annexure-6.4

File No.T-11025/1/2021-HYD(N) DTE

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग
केंद्रीय जल आयोग
जल विज्ञान (उत्तर) निदेशालय

सत्यमेव जयते

Government of India
Ministry of Jal Shakti
Department of Water Resources, RD&GR
Central Water Commission
Hydrology (North) Directorate

विषय Sub: Uri-I Stage II, HEP, J&K- Submission of Pre-DPR Chapter - reg.

संदर्भ Ref: No. NH/PID/Uri-I (Stg-II)/2021/1132 dated 18.10.2021

Please refer to NHPC letter dated 18.10.2021 cited above on the subject attaching therewith a copy of Pre- DPR hydrological studies of Uri-I (Stage-II) for evaluation /examination. It is further stated in the letter that preliminary chapter of hydrological studies have already been cleared by Hydrology (N) Directorate, CWC on 15.03.2021.

The aforesaid pre- DPR hydrological chapter of Uri-I (Stage-II) has been examined and it is observed that at Annexures 3.8(1) to 3.8(5), letters and 10 daily water availability series for the period from 1994-95 to 2019-20 (26 years) approved vide this office letter dated 15.03.2021 have been appended. Further vide this office letter dated 16.04.2021 (Annexure 3.9), it has been conveyed that aforesaid series of Uri-I (Stage-II) was again re-examined in totality considering consistent hydrological data and Indus Treaty provisions and is in order.

However, it has been mentioned in Pre DPR hydrology chapter that as per CEA letter No. CEA/HY-12-20/3/2021-HPA Division dated 03.09.2021 (Annexure 3.10), CEA has decided to approve the power potential studies of Uri-I (Stage-II) considering old water availability series from 1976-77 to 2019-20 (44 years) for Jhelum river and from 1971-72 to 2019-20 (49 years) for Kishenganga river.

This office does not have expertise in power potential studies and CEA has decided to use the water availability series of 44 years for Uri-I (Stage-II) and 49 years for Kishanganaga in variance to this office approval letters dated 15.03.2021 (Annexure 3.8(2)) and 17.05.2016 (Annexure 3.11) vide which series for the period from 1994-95 to 2019-20 (26 years) & from 1971 to 2004 (34 years) respectively were approved.

In view of above, it is stated that CEA has already finalized power potential studies based on 44 years series of Uri-I (Stage II) in variance to 26 years series approved by this office and no new fresh study / data vis-à-vis earlier approval dated 15.03.2021 have been provided in pre DPR hydrology chapter of Uri-I (Stage-II) submitted vide letter dated 18.10.2021, this office has nothing to examine further as far hydrological aspects are concerned.

This issues with the approval of Chief Engineer (HSO), CWC, New Delhi.

Signed by Goverdhan Prasad
Date: 17-11-2021 09:46:09
Reason: Approved

(गोवर्धन प्रसाद Goverdhan Prasad)
निदेशक Director

The Executive Director (PID), NHPC Ltd, Faridabad – 121003

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6.3.2 Design Flood

Uri-I Barrage is 95 m long and 21.5 m high from the deepest foundation level. The full supply water level upstream of the barrage is EL 1491 m. The initial gross storage capacity of reservoir is 35.97 Ha.m and live storage capacity is nil at FSL. The present gross storage capacity of reservoir is 23.71 Ha.m at FSL as per latest post monsoon 2018 reservoir survey.

A design flood value of 80000 Cusecs (2264 cumec) was adopted for Uri-I Barrage during the construction of the Barrage based on the flood frequency analysis and upstream Lower Jhelum H.E. Project. The maximum observed flood discharge at Barrage site was 1675 Cumec on 02-Jul-1996. Hence, design flood of 80000 Cusecs (2264 cumec) adopted for Uri-I Barrage is maintained as existing Uri-I Barrage, which will also be diversion structure for Uri-I (Stage-II) project.

6.3.3 Reservoir Sedimentation

Full Supply Level (FSL) of the reservoir is at EL 1491 m. The initial gross storage capacity and surface area of reservoir were 35.97 Ha.m & 8.69 Ha. at FSL. The present gross storage capacity & surface area of reservoir are 23.71 Ha.m & 6.19 Ha. at FSL as per latest post Monsoon 2018 reservoir survey. The reservoir of Uri power station is around 950 m length at FSL as per latest PM-2018 survey. The present sediment load at barrage site has also been calculated on the basis of observed sediment data from 2003-2020. Based on this data the average annual sediment (including 8% bed load) works out to be (suspended load of 2.88 + Bed load of 0.23) 3.11 Million tons per year.

6.3.4 Transient Studies

Transient conditions have been analysed using the computer program WHAMO (Water Hammer and Mass Oscillations) developed by US Army corps of Engineers. Main features of water conductor system are as follows:

Plant features:

- No. of pressure tunnel/shaft - 1
- Design discharge for pressure tunnel – 117.15 Cumecs.
- HRT Diameter, Shape & Length – 6.5 m dia ,HS & 10472 m.
- Surge shaft Diameter– 17 m
- Orifice area – 11 m^2
- TRT Diameter, Shape & Length – 6.5 m dia, HS & 2280 m
- Centre line of machines – 1232.7 m
- No. of units - 2
- Gate shaft area of 21.1 m^2 up to EL 1237 m & 35.5 m^2 above EL 1237 m
- Orifice area of each Gate shaft -5.75 m^2

The water conductor system of the project was analyzed as per the conditions as specified in IS: 7396 (Part-I) & Part-II. The criteria used for the transient analysis with respect to reservoir levels was that the maximum level of reservoir is FRL (EL 1491 m), minimum level is MDDL (EL 1491 m) for upstream WCS. The criteria used for the transient analysis with respect to maximum tail water level is taken as EL 1247.49 m corresponding to discharge of 2264 cumec and minimum tail water level is taken as EL 1241.06 m for two units running. For one unit running condition minimum tail water level has been considered as EL 1241.01 m.

As per the studies the following conclusion were made:

For Upstream Water Conductor System

- It is proposed to provide the restricted orifice type surge tank; the size of surge tank is 17 m diameter, the encroachment area has been taken as 19.5 m^2 thus net equivalent area is 207.4 m^2. Orifice area has been taken as 11 m^2.
- For the given acceptance and rejection curve of machines is shown in load diagrams. In upstream surge tank the maximum upsurge water level is computed as EL 1531 m and the minimum down surge water level is computed as EL 1444 m.

For Downstream Water Conductor System

- For the given acceptance and rejection timing of machines with two units of equal design discharge (58.58 cumec each) as shown in load diagrams.
- Surge gallery of 7 m ø HS shape & inclined with invert @ EL 1224 m to EL 1264 m in the slope of 1 in 11 and 7 m ø HS shape horizontal gallery of length 260 m with invert @ EL 1233 m has been provided.
- The maximum upsurge and minimum down surge water level in gate shaft chamber & surge gallery is computed as EL 1264 m and EL 1233.5 m respectively.

CHAPTER – VII

RESERVOIR

CHAPTER-VII
RESERVOIR

7.1 CATCHMENT AREA AND ANNUAL RUNOFF

7.1.1 Catchment Area:

Uri-I Hydroelectric Project, a run- off the river scheme, is situated on river Jhelum in Uri Tehsil of Baramulla district of UT Jammu and Kashmir. The Jhelum is the principal water-way of Kashmir. It has its source from a spring called Verinag. The Jhelum is joined by numerous small mountain streams from the Pir Panjal Range separating the Kashmir valley from the plains in the southwest and by some tributaries from the Great Himalayas in the northeast. From Sangam to Srinagar, the Romshi draining western ranges & Watalara & Arapal tributaries draining eastern ranges join river Jhelum. Downstream of Srinagar, the Sindh flowing from the east joins river Jhelum on its right bank opposite Shadipur. The Sindh River drains the north-eastern ranges of Pir Panjal from Amarnath Cave to Zojila and Ganderbal. Doodh Ganga & Shali Ganga drain the western ranges south of Gulmarg. They also drain partially through supplementary flood channel to river Jhelum downstream of Srinagar. Finally these nallahs drain into Wular Lake. Ningli nallah drains the hill side to the north of Gulmarg. It meets river Jhelum on the left bank after it emerges from Wular Lake.

From its junction with the Sindh river, the Jhelum river continues its north-easterly course upto the Wular lake situated towards the north end of the valley of Kashmir about 34 km north-west of Srinagar. Wular Lake lying between Bandipora and Sopore is the largest fresh water lake in India. It is an elliptical form with a surface area of lake varies between about 175 km^2 at highest water stage (EL 1580 m) down to 60 km^2 at low-water stage in winter time and makes a sharp left turns to break through the Pir Panjal. The lake is an important feature of the hydrographic system of Kashmir. Acting as a flood reservoir, its dimensions vary in different times of the year. The elevation of Wular Lake water level ranges from 1574 to 1580 m. After leaving Wular Lake, the Jhelum River flows in a south-westerly direction to Baramulla, receiving midway the waters of

Pohru river, the drainage of the north Kashmir valley. From Baramula to Muzafarabad, the valley is narrow and confined by the spurs of two mountain ranges. The river Jhelum follows a westerly course and at Domel near Muzafarabad, the Kishanganga, a large river from the snowy mountains to the north, falls into it.

The catchment area of the Jhelum river at the Uri-I Barrage is fan shaped and has an area of 12,750 km^2. About 20 percent of the catchment lies downstream of Wular Lake. Upto Baramulla, the catchment area is nearly fan shaped. This local catchment is primarily drained by the Pohru River which has its sources in the mountain ranges and flows with a moderate slope through the western part of the Kashmir valley for some 60 km before joining the Jhelum River some 10 km downstream of Wular Lake. The catchment area of Jhelum at Uri-I Power Station lies between Longitude 73^{o}55' E to 75^{o}35' E and Latitude 33^{o}25' N to 34^{o}40' N. Catchment Map of Jhelum Basin up to Uri-I Barrage Site has been placed as **Figure-7.1.** Catchment areas some of the important stations and its estimated catchments areas are given in **Table-7.1**.

Table-7.1 Catchment areas some of the Important Stations

S. No.	Station	Catchment Area (Km^2)
1	Wular Lake Outlet	10200
2	Sopore	10455
3	Baramula	12490
4	LJHP	12700
5	Uri-I Barrage	12750

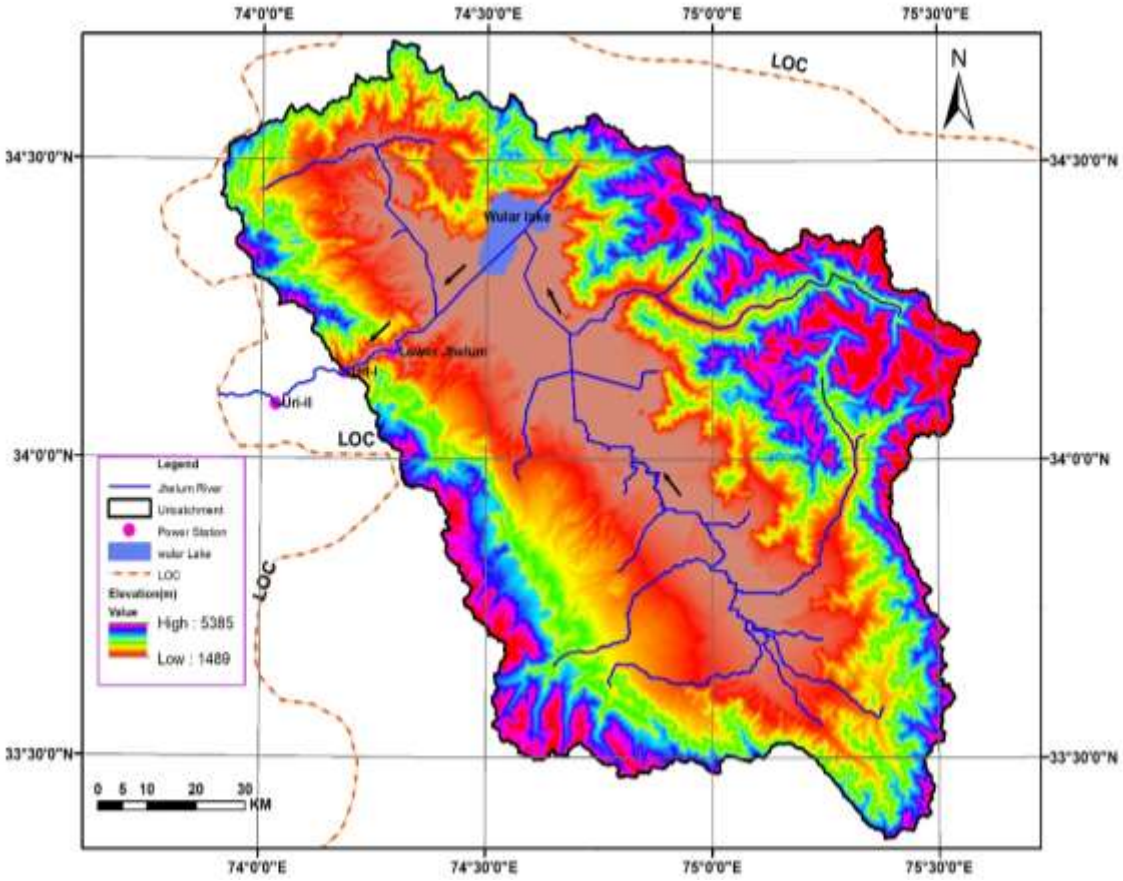

Figure-7.1 Catchment plan of Jhelum Basin up to Uri-I Barrage

The highest peaks in the Jhelum catchment reach above 5000 m, but most of the area is located between elevation 1400 and 4000 m. The Kashmir valley is situated at the northern extreme of the tropical circulation. NHPC has established meteorological station at Barrage site (w.e.f 1997). Based on that, maximum and minimum temperatures are 40^{o}C and -6.4^{o}C respectively at Barrage site. Maximum and minimum relative humidity has been observed as 100% and 2.6% respectively at Barrage site. At the Barrage site, the winter temperature is reported to drop a few degrees below zero on occasion and some ice formation can occur, while conditions at lower elevation in the river valley can be expected to be less strenuous. As per IMD data (Data base: 1951-2000) the normal annual rainfall of Jhelum basin within Indian catchment is 890.1 mm. As

observed by NHPC, average annual rainfall is worked out around 1104 mm at Uri-I Barrage site.

7.1.2 Annual Runoff

The water availability series from 1994-95 to 2019-20 (26 years) has been approved by CWC Hydrology (N) Directorate vide their file no. T-11025/1//2021-HYD(N) Dte, dated 15-03-2021. The average annual yield for the series Jun-94 to May-20 is computed as 8080 MCM (i.e. 633.7 mm).

7.1.3 Submergence

The 21.5 m high barrage is a run-off the river scheme having reservoir extending about 950m along river Jhelum. The present gross storage capacity & surface area of reservoir are 23.71 Ham & 6.19 Ha. at FSL after 22 years of operation as per latest post Monsoon 2018 reservoir survey. The reservoir is under operation since 1997 and no changes are envisaged due to construction of stage-II project. In the reservoir area, river Jhelum flows generally in NE-SW direction. The immediate slopes on both banks of the reservoir are gentle to moderate and occupied by thick pile of riverine / fluvioglacial material and slope wash material. However, the upper slopes are steep with rock cliffs. Bedrock of quartzitic schist, schistose quartzite are exposed in the vicinity of reservoir periphery.

7.2 SEDIMENTATION DATA AND STUDIES

The total sediment load including (8%) bed load at the Uri Barrage site has been estimated as 3.11 Million tons per year based on observed sediment data at Uri-I Barrage from year 2003 to 2020. The distribution of coarse, medium and fine fractions of sediment has been calculated as 3.6 %, 2.4% and 94 % respectively. The percentage of sediment load from March to July months is about 77.7%.

7.3 FIXATION OF STORAGE LEVELS (MAXIMUM WATER LEVEL, FULL RESERVOIR LEVEL, MINIMUM DRAWDOWN LEVEL), FLOOD CUSHION ETC.

7.3.1 MAXIMUM WATER LEVEL, FULL RESERVOIR LEVEL, MINIMUM DRAWDOWN LEVEL

Uri-I PS was designed and constructed as purely run-off-river scheme with Full Supply Level (FSL) at EL 1491 m with no live storage capacity.

7.3.2 FLOOD CUSHION

No flood storage envisaged in this project.

7.4 LIFE OF A RESERVOIR IN YEARS AND WITH BASIS

Full Supply Level (FSL) of the reservoir is at EL 1491 M. The initial gross storage capacity and surface area of reservoir were 35.97 Ham & 8.69 Ha. at FSL during DPR stage in the year 1989. The present gross storage capacity & surface area of reservoir are 23.71 Ham & 6.19 Ha. at FSL as per latest post Monsoon 2018 reservoir survey. Reservoir elevation capacity curve/table as per Post Monsoon-2018 reservoir survey is given in **Figure-7.2** and **Table- 7.3**. It is a runoff the river scheme and project utilizes water coming from Lower Jhelum H.E. Project for power generation after releasing mandated e-flow and remaining water spills over the barrage as there is no live capacity in the reservoir. The reservoir has no significant changes over 22 years of operation (i.e. from 1997 onwards) as sediment laden water passes downstream through barrage spillway gates.

Figure-7.2 Reservoir Elevation Area Capacity Curve

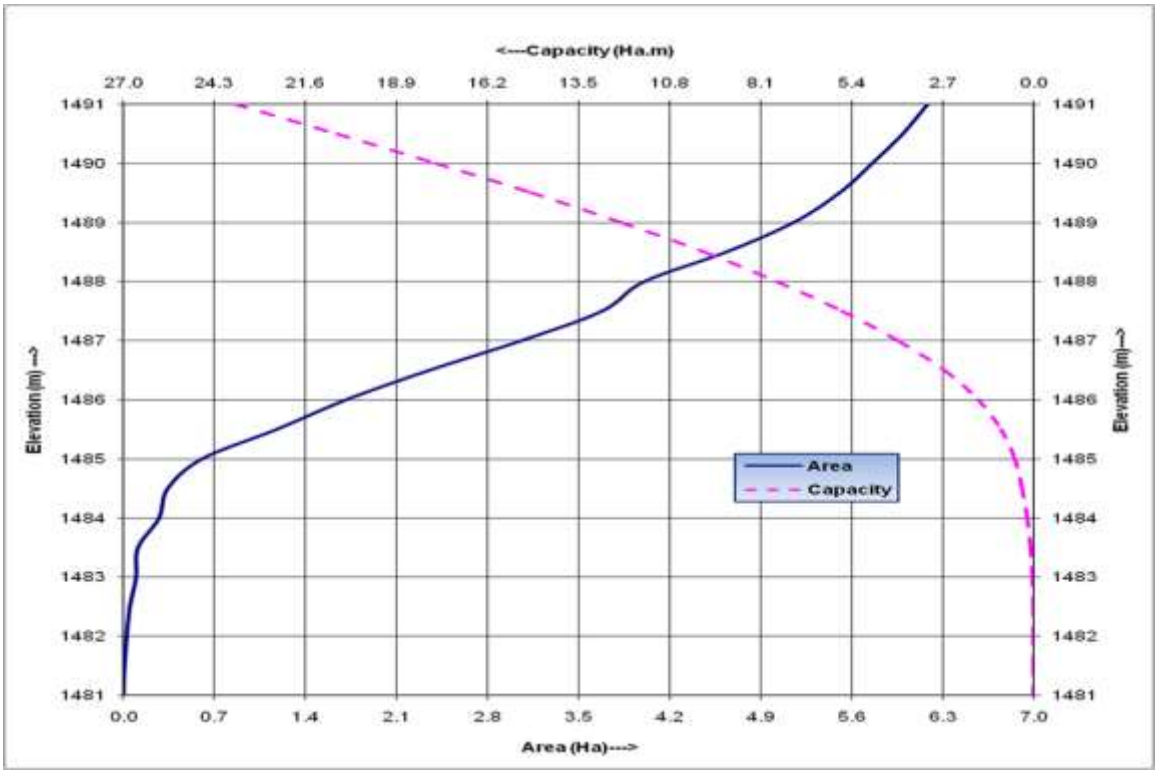

Table-7.2: Reservoir Elevation Area Capacity Table

Sl. No.	Elevation (m)	Area (Ha)	Capacity (Ha.m)
1	1491.0	6.19	23.71
2	1490.5	5.99	20.66
3	1490.0	5.76	17.74
4	1489.5	5.51	14.93
5	1489.0	5.15	12.26
6	1488.5	4.64	9.80
7	1488.0	4.00	7.62
8	1487.5	3.68	5.68
9	1487.0	3.05	4.02
10	1486.5	2.35	2.67
11	1486.0	1.72	1.66
12	1485.5	1.17	0.98
13	1485.0	0.61	0.57
14	1484.5	0.34	0.35
15	1484.0	0.27	0.19
16	1483.5	0.11	0.10
17	1483.0	0.10	0.06
18	1482.5	0.05	0.02
19	1482.0	0.02	0.01
20	1481.5	0.00	0.00
21	1481.0	0.00	0.00

7.5 CAPACITIES AT MWL, FRL, MDDL, ETC. AT PROJECT PLANNING STAGE AND AFTER DIFFERENT YEARS OF OPERATION:

Full Supply Level (FSL) of the reservoir is at EL 1491 M. The initial gross storage capacity and surface area of reservoir were 35.97 Ham & 8.69 Ha. at FSL during DPR stage in the year 1989. The present gross storage capacity & surface area of reservoir are 23.71 Ham & 6.19 Ha. at FSL after 22 years of operation as per latest post Monsoon 2018 reservoir survey.

7.6 WATER TIGHTNESS OF THE RESERVOIR

The reservoir is in operation since 1997 and any leakage from the reservoir is not reported or observed since then. So there is no loss of any kind from the under surface of reservoir in past.

7.7 ANNUAL LOSSES

7.7.1 Evaporation losses

The surface area of reservoir is small and it is a cold region as such evaporation losses are not relevant. However according to the project location the following monthly values of evaporation taken from evaporation Chart given in IS 5477 (Part-III), 1969 are given below in **Table-7.4**. According to the code, the charts are to be used with multiplication factor 0.845 for rainy period and 0.6 for dry period. The rainy period for Jhelum basin has been adopted as period from Jun to Sep and dry period from Oct to May to calculate actual evaporation from Uri-I reservoir. The computed monthly evaporation losses are given in **Table-7.4.**

Table-7.3: Evaporation losses

S. No.	Month	Evaporation as per IS 5477, 1969 Chart (mm)	Actual Evaporation (mm)
1	Jan	25	15.0
2	Feb	25	15.0
3	Mar	50	30.0
4	Apr	100	60.0
5	May	100	60.0
6	Jun	150	126.8
7	Jul	150	126.8
8	Aug	125	105.6
9	Sep	125	105.6
10	Oct	100	60.0
11	Nov	50	30.0
12	Dec	25	15.0
Total Annual Evaporation		**1025.0**	**749.8**

Surface area of Uri-I reservoir is 23.71 Ha at FSL. The same has been considered for computation of evaporation losses. The annual loss of water from Uri-I reservoir due to evaporation worked out to be 0.178 MCM (750.0 x 0.001 x 23.71 x 10000/1000000) which is negligible compared to annual runoff of 8080 MCM at Uri-I Barrage.

7.7.2 Seepage Losses:

The reservoir is in operation since 1997 and any leakage from the reservoir is not reported or observed since then.

7.8 FLOOD ADSORPTION ON REGULAR/FLASH FLOOD

No flood storage envisaged in this project.

7.9 Effect on sub-soil water tables in the adjoining areas upstream and downstream of the dam.

Any leakage from the reservoir is not reported or observed since 1997.

7.10 Seismic characteristics and effects due to construction of dam

Project area falls in seismic zone IV as per seismic zoning map of India BIS-1893 part I, 2016. Seismic design parameters for the Uri-I Power station were evaluated by DEQ-IIT Roorkee and the project was constructed as per the recommended seismic design parameters.

The reservoir is already under operation since 1997 and there are no adverse effects noticed.

7.11 Reservoir rim stability

In general, the reservoir rim appears to be stable. There are no landslides in the reservoir area and has no implication of any kind whatsoever on the competency of the already operating reservoir. The higher slopes are stabilized by contour drains /step drains suitably connected channelized to the river/reservoir. Both banks of the reservoir rim has also been stabilized by rip rap boulder pitching and other protection measures and are well maintained.

7.12 LENGTH OF THE RESERVOIR

The reservoir of Uri-I power station is around 950 m length at FSL as per latest Post Monsoon -2018 reservoir survey.

7.13 Land acquisition

The reservoir is in operation since 1997 and no further land acquisition is required.

7.14 Recreation facilities

A view point is already constructed on the upstream of the barrage on left bank and is well maintained. The dumping site on the downstream of barrage has

been developed as green belt zone, parks and gardens. Further adjacent to NH44, cut and cover section of head regulator and intake area is well developed as recreation park and is open for public and well maintained by NHPC.

7.15 PISCI culture

The reservoir is of small size capacity and environment flow is being maintained by releasing already provided fish pass in the barrage body & silt excluder near head regulator.

7.16 Need and recommendations for soil conservation measure in the catchment:

Catchment area around reservoir rim has been stabilized on the higher slopes by contour drains /step drains suitably connected channelized to the river/reservoir. Both banks of the reservoir rim has also been stabilized by rip rap boulder pitching and other protection measures and are well maintained. Further afforestation and soil conservation measures has been done during and after construction of Uri-I Stage-I Power station. Hence further need of soil conservation measures are not anticipated.

CHAPTER – VIII

POWER POTENTIAL & INSTALLED CAPACITY

CHAPTER-VIII

POWER POTENTIAL & INSTALLED CAPACITY

8.0 INTRODUCTION

480 (4x120) MW Uri Hydroelectric Project was commissioned by NHPC in February 1997 and is located on the Jhelum River in Baramulla District of Jammu & Kashmir. While planning for Uri Hydro Electric Project, provision of second stage was also kept in its barrage keeping in view the possibility of harnessing additional discharge from proposed Kishanganga HE project in future. Now, 330 MW (3 x110 MW) Kishanganga Hydroelectric Project has already been commissioned by NHPC on Kishanganga River by construction of a dam at Gurej area in Bandipora district of J&K during May 2018. The downstream discharge of Kishanganga Dam is flowing into Pakistan to merge with the River Neelum, however, the turbine outlet discharge at tail race of power house is flowing into Wular Lake and subsequently into River Jhelum. Water is spilling from the Uri barrage during monsoon as the existing installed capacity of Uri Power station is not adequate to harness the same. Additional discharge from tailrace outlet of Kishanganga shall also be available in Jhelum River. In this changed scenario, it is felt necessary to implement its stage-II to harness the additional inflow beyond the quantum of inflow utilized by installed capacity of Uri Power Station, without any further delay in the best interest of the nation.

It is pertinent to mention that the various civil structures of barrage complex of Uri Power Station stand designed for utilizing combined discharge of Uri Power Station and Uri-I Stage-II HE Project. The structures like HRT/ Pressure shaft, Surge shaft, Power house and TRT only are required to be designed and constructed.

The dam site is located in Boniyar village and powerhouse site is located on left bank of Jhelum River, about 10.56 km downstream of the dam axis. The Installed capacity of the Stage-II has been proposed as 240 MW consisting of the 2 units of 120 MW each. This chapter aims at determination of the power potential i.e. optimum Installed Capacity and Design Energy.

8.1 AVAILABLE INFLOW

The 10-daily inflow series was taken from 1976-77 to 2019-20 of Uri-I power station and for Kishanganga Power station, flow restricted to turbine discharge for the dependable year 2001-02 was taken for power potential study. The 10 daily water series from 1976-77 to 2019-20 (44 yrs.) for Jhelum River **has been considered and has been shown in Table 3.1.**

The turbine discharge of Kishanganga Power station has been considered which is being added to Wular Lake and further to Jhelum River, **has been shown in Table 3.2.**

8.2 ENVIRONMENTAL FLOW (E-FLOW)

For Uri-1 stage-II HE project, no separate dam/barrage is envisaged. Barrage of Uri Power station shall be common for both the project (Uri and Uri-1 stage-II). There is already a provision of 2.5 cumecs downstream discharge through fish ladder of barrage of Uri power station. However, in view of recent NGT order, provision of e-flow of 15% of average flows of Jhelum River in lean period of 90% dependable year (2007-08) comes out to be 8.19 Cumecs. As such, provision of additional downstream discharge of 5.69 Cumecs as e-flow, shall be made from the barrage of Uri Power station. As the reservoir of both stages (Stage-I & Stage-II) is same, no additional environmental release for stage-II is considered in power potential studies.

8.3 90% DEPENDABLE YEAR

This is the lower deciles of the series of the corresponding 10-daily period of the record i.e. (N+1) x 0.9^{th} year where N is the years for which hydrological data are available. The 90% dependable year of 44 yrs. water series of Jhelum River has been found as 2007-08 **(as shown in Table 3.3)** and 90% dependable year for Kishanganga River is 2001-02 **(as shown in Table 3.4)**.

Since, only turbine discharge of Kishanganga Power Station is adding to Jhelum River in the upstream of the Uri barrage, the inflow series of DY 2001-02 of Kishanganga river has been restricted up to Plant Discharge of Kishanganga Power Station i.e. 57.86 Cumecs. As the combined inflow is

available at the barrage of Uri Power station, hence the inflows considered for calculations for estimating the revised capacity and annual energy are as follows:

Uri-I Stage-I (under operation): Original discharge of River Jhelum after releasing mandatory 15% environmental release.

Uri-I Stage-II (Planned): Excess water of Uri Stage-I from Jhelum after releasing mandatory e-flows + Turbine discharge of Kishanganga HEP.

8.4 FULL RESERVOIR LEVEL (FRL)

Since the barrage is common for both Uri and Uri-I stage-II, FRL has been kept the same at EL 1491.0.

8.5 MINIMUM DRAWDOWN LEVEL (MDDL)

The MDDL has also been kept at EL 1491 M.

8.6 TAIL WATER LEVEL (TWL)

Min Tail Water Level of plant is EL 1241M and Normal (Max) TWL is also EL 1241M.

8.7 RATED NET HEAD AND HEAD LOSSES

The rated net head for turbines of Uri-I Stage-II has been calculated from the following formula:

Rated Net Head = MDDL+2/3*(FRL–MDDL)-Max. Tail Water level-Head Losses.

Based on the above mentioned formula, the rated net head works out to be 227 meter for plant. The head loss in water conductor system is considered as 23 m. (Head losses in water conductor system are yet to be approved by CWC), It is important to mention that the head loss and net head of Uri power station has been taken as 27.50m and 222.5m respectively.

8.8 INTERFERENCE OF UPSTREAM OR DOWNSTREAM PLANTS

The Uri-I stage-II is a run-of-river scheme with design discharge amounting 117.15 m^3/s. At present, one Lower Jhelum Hydro Power Station owned by JKSPDC of 105 MW (presently de-rated at 90 MW) is operational since 1978 in the upstream whose normal TWL is sufficiently above FRL of Uri Power Station. Further, in the Upstream of Lower Jhelum, 330 MW-Kishanganga Power Station owned by NHPC is also in operation and one Uri-II HE Power station owned by NHPC is in operation in the downstream. The upstream Power Station Kishanganga has TWL (max) at EL 1718.9 M.

The plant will have FRL at EL 1491.00 M and TWL at EL 1241.00 M and downstream Power station Uri-II has FRL at EL 1241.00 M. As such, the running of plants in tandem will not have any negative effect on their performance and there will be no interference with upstream or downstream projects.

8.9 INSTALLED CAPACITY

As no separate dam/barrage is proposed for Uri-1 stage –II HE project, barrage of Uri Power station shall be used as common barrage for both the plant. As such, on considering the revised installed capacity of the plant as 720MW (480 MW for Uri PS and 240 MW for its second stage i.e. Uri-1 Stage-II HE project), revised Annual Plant Load Factor (PLF) has been found as 45.33 %. Annual Plant Load Factor (PLF) for lean period has been found as 20.00 %. Since, 54.65 %. PLF value is satisfactory for a ROR project, the combined installed capacity of both the project as 720MW (480 MW for Uri PS and 240 MW for second stage of Uri-I HE project) is found suitable. Accordingly, 240 MW has been considered as installed capacity of Uri-I stage-II HE Project. At 240 MW, the Annual Load Factor of Uri-I Stage-II has been found as 45.33 %.

8.10 UNIT SIZE

The unit size has been selected based on the practice to opt for largest one compatible with parameters of power house width, economy, transport limitations, operating efficiency, maintenance, interchangeability, optimum utilization of available inflow etc. As the units of Uri-I Stage-II HE Project are

proposed to be installed at the same level as for units of Uri-I power station, the unit power rating is proposed to be kept as same as that of unit rating of Uri-I PS which is 120 MW. So, installed capacity may be considered in multiple of 120 MW i.e. 240 (2x120) MW.

8.11 ANNUAL ENERGY GENERATION IN 90% DEPENDABLE YEAR

Based on the water series of 90% dependable year for Uri-I Power Station in year 2007-08 and for Kishanganga Power Station in year 2001-02 respectively, the annual energy with 95% machine availability for 720MW capacity of Uri-I has been calculated as 3376.20 MU. After considering mandatory E-flow release, the revised Design Energy of Uri PS for 480 MW is 2443.60 MU at rated head of 222.5m and overall efficiency 92%. Hence the balance energy may be considered on account of Uri-I stage II which works out as 932.60 MU with respect to rated head of 227m and efficiency 92.59 %. **The same has been shown in the table 3.5.**

8.12 SUMMARY

- The power potential study carried out based on the 10-daily series indicates that an installed capacity of 240 MW comprising 2 nos generating units of 120 MW each is the best option for Uri-I stage-II HEP.
- Design energy of the project is 932.60 MU with annual load factor of 45.33% with peaking duration of less than 3 hrs. for three (3) 10-daily periods only. For all other thirty-three (33) 10-daily periods, peaking is more than 3 hours. Minimum peaking hours as per the study are 2.33 hrs.

ANNEXURES

Table 8.1

URI-I (STAGE-II) HYDROELECTRIC PROJECT

AVERAGE10-DAILYWATERAVAILABILITY SERIESATURI-IBARRAGE(Afterreductionof Kishanganga machine flows)

YEAR	JUN			JUL			AUG			SEP			OCT			NOV		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	482.5	435.2	348.6	397.3	397.2	279.2	673.5	823.4	522.8	438.1	396.0	459.6	136.5	111.9	99.1	84.2	76.1	68.0
1977-78	386.9	302.5	306.3	359.4	357.7	302.5	207.8	199.0	220.3	168.9	170.8	161.4	122.8	82.1	80.2	103.2	97.6	80.8
1978-79	483.1	350.2	298.8	321.1	360.9	336.4	137.1	310.9	289.3	168.4	105.9	119.5	117.9	70.6	49.4	70.6	86.8	85.2
1979-80	447.2	354.3	345.2	340.0	299.9	266.7	168.1	139.6	145.0	110.4	76.3	124.8	119.1	88.7	72.7	63.4	79.4	101.0
1980-81	452.5	493.9	510.6	499.3	469.6	425.2	388.3	334.1	220.3	184.2	329.6	251.8	158.4	117.1	87.6	91.7	84.0	96.5
1981-82	603.4	448.6	378.5	399.4	371.5	424.7	466.7	350.6	232.4	159.6	124.2	118.3	118.3	99.3	88.5	89.7	92.1	80.8
1982-83	533.9	504.6	425.2	422.5	372.0	313.4	281.1	345.0	255.1	152.1	102.9	118.8	130.2	104.7	114.0	153.1	159.7	155.7
1983-84	786.9	685.9	597.4	745.6	682.0	639.4	671.2	637.6	550.6	524.7	370.3	268.6	182.0	150.9	138.2	118.1	111.4	99.3
1984-85	555.6	447.0	370.3	295.5	216.9	243.8	238.9	252.6	326.9	421.9	363.8	225.7	107.1	55.4	40.2	39.1	42.8	66.2
1985-86	473.0	438.1	427.0	221.6	231.0	557.1	349.3	320.2	289.1	109.1	72.6	66.6	153.0	122.1	112.4	103.0	92.6	87.0
1986-87	456.4	503.4	658.8	683.8	592.7	523.7	575.0	492.3	381.5	224.5	131.7	112.3	131.5	120.1	153.8	105.5	161.5	223.2
1987-88	473.6	452.7	427.5	407.3	397.5	377.5	349.3	320.2	289.1	266.8	230.5	189.0	153.9	122.8	113.0	103.6	93.1	87.5
1988-89	430.4	283.4	268.4	301.1	476.0	593.1	612.4	402.9	269.2	183.1	111.0	220.0	480.0	237.2	120.5	111.2	54.3	53.8
1989-90	794.1	686.0	354.7	344.2	305.4	393.0	653.7	368.3	214.8	221.7	130.0	83.1	103.6	115.2	129.0	146.3	101.9	98.0
1990-91	581.8	367.2	353.1	463.4	389.6	223.4	178.7	275.9	233.3	210.2	186.7	147.3	112.7	85.8	74.1	76.7	61.7	54.4
1991-92	988.6	990.0	884.3	670.6	652.9	626.4	431.5	383.1	313.9	313.9	298.3	294.9	258.5	158.0	117.3	85.2	59.2	72.2
1992-93	869.0	765.8	709.4	716.5	636.0	436.4	407.6	544.4	419.6	402.5	1428.6	933.2	366.6	244.9	176.3	147.4	121.5	143.9
1993-94	771.0	533.1	699.3	713.5	1083.7	1221.4	519.7	301.1	165.4	145.8	197.3	206.0	201.4	157.2	110.9	124.5	149.3	115.1
1994-95	707.4	713.2	600.3	590.0	548.9	605.1	448.0	448.3	550.7	542.0	524.0	280.9	391.9	325.8	345.7	83.3	72.5	60.6
1995-96	728.3	570.8	523.9	442.9	351.1	964.7	1245.2	1042.1	738.4	328.4	265.2	157.8	166.2	179.9	140.3	150.7	155.1	86.5
1996-97	925.4	986.1	1426.8	1371.6	976.1	567.5	460.5	396.3	938.4	972.6	286.0	187.6	196.9	185.7	164.5	122.2	81.0	87.2
1997-98	472.3	431.6	429.6	421.1	262.1	224.3	238.7	185.5	319.7	702.1	398.1	177.2	125.9	120.4	121.0	121.7	114.1	107.4

URI-I (STAGE-II) HYDROELECTRIC PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After Reduction of Kishanganga machineflows)

YEAR	DEC			JAN.			FEB			MAR			APR			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	64.2	58.7	56.2	53.1	73.5	80.7	99.5	100.5	108.1	114.5	126.6	148.0	206.3	369.0	233.8	432.0	373.2	408.9
1977-78	68.9	66.2	82.7	76.1	63.7	77.3	69.6	77.2	86.1	158.3	239.0	277.4	262.0	406.8	537.5	522.6	521.8	567.9
1978-79	68.2	56.9	46.2	41.3	44.2	51.4	47.2	57.0	99.6	175.3	252.8	260.2	344.4	392.9	383.8	374.5	426.3	625.9
1979-80	110.0	91.4	88.8	109.1	95.5	103.2	126.9	204.0	301.9	360.0	354.7	426.4	419.7	454.2	486.2	491.5	522.6	491.2
1980-81	103.9	84.9	79.5	89.7	80.4	103.4	164.0	232.1	321.9	399.0	399.0	482.7	717.3	748.8	815.0	796.8	739.9	674.8
1981-82	74.3	69.3	64.2	61.8	59.2	71.6	83.6	104.6	128.2	181.9	233.7	402.9	432.4	490.4	560.6	581.7	515.9	503.6
1982-83	161.7	185.0	137.1	132.6	123.0	129.1	139.0	122.2	141.3	290.6	491.9	613.0	584.7	683.6	647.7	782.1	820.7	824.8
1983-84	92.2	88.7	88.3	82.3	82.3	82.9	84.9	101.9	120.0	126.6	206.6	322.5	364.2	425.8	470.0	455.0	552.4	548.9
1984-85	59.4	64.8	45.2	66.9	56.7	74.8	67.7	72.8	74.2	84.8	74.8	139.3	224.8	311.8	286.4	554.3	525.0	426.0
1985-86	44.7	67.1	119.2	78.8	80.8	84.6	99.1	123.8	149.4	201.0	261.2	324.5	554.6	687.1	977.0	983.3	852.9	656.5
1986-87	226.5	281.6	262.7	181.6	150.4	151.9	196.4	241.9	337.1	433.2	442.1	542.1	658.8	591.8	771.3	498.9	504.6	504.9
1987-88	81.9	83.5	81.6	57.2	65.7	99.9	116.1	145.0	182.6	267.1	674.1	574.0	571.1	596.1	661.6	649.4	552.1	484.7
1988-89	53.8	54.9	78.3	97.1	82.3	56.9	71.1	68.2	92.7	120.7	216.2	332.2	494.8	432.1	372.2	601.4	605.8	743.7
1989-90	74.8	74.5	106.3	77.6	71.9	126.1	224.3	232.9	190.0	180.5	340.8	922.6	612.3	614.9	635.3	717.3	815.7	765.8
1990-91	49.0	48.7	96.4	182.0	157.4	144.2	198.2	325.6	321.4	437.1	526.8	637.4	1236.9	1340.7	838.6	834.4	809.1	1059.4
1991-92	63.8	66.6	72.8	74.8	73.5	111.1	276.1	214.6	176.3	236.4	318.1	824.1	772.5	679.4	979.2	1017.8	992.7	894.5
1992-93	128.3	120.3	124.6	196.6	185.5	169.3	155.2	271.9	318.7	295.7	560.5	907.0	658.5	624.8	639.2	869.3	1110.4	990.9
1993-94	115.2	100.7	95.9	103.2	94.0	121.7	196.2	153.5	201.4	356.7	399.3	492.8	830.1	553.8	403.9	670.6	893.4	895.2
1994-95	86.1	137.6	98.1	149.0	104.2	93.7	101.4	300.5	274.7	256.5	249.5	695.6	628.1	606.0	729.2	749.0	787.2	895.2
1995-96	34.8	97.8	116.6	111.5	121.3	104.8	102.7	248.6	311.4	321.1	699.8	895.6	667.7	576.2	624.3	727.9	712.2	892.0
1996-97	88.0	79.7	73.5	78.1	61.9	66.7	70.8	40.0	78.4	116.5	190.4	266.7	299.2	405.5	430.6	573.5	522.6	464.4
1997-98	127.9	123.1	99.1	84.4	118.9	110.9	122.7	183.4	199.9	327.1	307.9	431.7	666.2	761.0	883.7	883.2	651.8	631.4

Table 8.1

URI-I (STAGE-II) HYDROELECTRIC PROJECT																																			
AVERAGE 10-DAILY WATER AVAILABILITY SERIES AT URI-I BARRAGE (After reduction of Kishanganga machine flows)																																			
YEAR	JUN			JUL			AUG			SEP			OCT			NOV			DEC			JAN.			FEB			MAR			APR			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1998-99	582.8	441.8	386.9	444.4	402.9	302.5	157.9	147.7	145.5	118.9	130.4	154.1	145.2	91.7	86.5	68.1	60.1	54.2	53.5	48.4	48.3	46.9	49.2	76.4	87.0	124.9	134.9	206.0	214.9	188.5	251.6	329.5	308.4	363.4	364.3	278.2
1999-00	155.8	99.5	106.3	86.2	88.5	94.1	125.7	164.3	125.2	105.9	85.5	84.3	80.2	59.7	42.5	62.1	80.2	62.1	47.5	57.3	82.6	40.5	52.9	62.2	76.1	83.7	66.0	94.2	122.2	138.7	220.6	222.2	287.2	275.3	361.3	305.2
2000-01	181.0	105.5	93.5	264.0	335.5	291.3	105.1	85.3	175.6	293.3	191.9	119.0	98.2	85.8	97.7	38.7	39.5	41.9	40.8	45.0	47.1	40.9	36.4	37.1	34.5	31.3	48.6	47.5	58.0	82.6	118.9	173.7	192.2	261.1	346.1	253.6
2001-02	126.9	114.7	149.3	114.2	104.0	116.8	152.3	115.6	105.5	79.8	77.8	78.5	56.3	50.8	45.7	86.3	66.2	56.4	48.7	51.0	50.8	43.9	77.7	72.6	64.6	88.7	181.6	153.2	204.0	378.5	451.4	487.1	548.8	435.6	523.7	517.3
2002-03	318.0	214.3	287.0	234.8	129.1	85.9	64.2	154.4	142.6	152.0	156.3	156.5	105.6	72.3	61.5	51.6	46.6	43.0	42.5	42.3	46.5	40.5	36.6	35.8	40.4	70.2	218.4	428.4	435.0	447.5	485.3	720.0	768.6	1000.9	851.0	786.8
2003-04	713.4	603.6	386.1	297.1	253.9	178.3	169.2	142.8	143.3	153.5	170.1	157.7	175.9	126.8	85.6	58.9	55.1	61.4	54.2	91.8	80.7	77.4	82.9	123.7	118.1	157.3	174.9	192.1	243.5	215.6	203.6	261.9	327.6	608.3	547.0	435.0
2004-05	275.0	186.4	200.8	174.3	171.6	109.7	95.4	95.6	103.2	94.5	66.9	83.6	77.1	94.1	86.0	67.7	51.9	48.1	57.9	48.0	50.7	104.0	80.1	72.1	93.3	173.2	161.7	266.3	555.9	628.1	492.7	444.4	539.1	552.2	570.1	467.9
2005-06	466.1	458.7	488.4	563.7	599.6	505.8	298.0	209.9	140.6	110.2	122.0	125.3	93.2	85.2	79.3	58.9	53.4	49.5	52.8	47.0	41.5	57.7	77.1	121.1	129.9	201.0	235.5	281.6	197.0	241.9	313.1	432.5	371.5	466.3	580.4	529.0
2006-07	340.5	190.6	171.5	182.2	307.4	223.2	307.4	399.9	176.6	464.6	479.2	177.5	131.1	81.2	78.9	69.3	110.1	118.5	103.8	110.1	112.7	98.1	82.3	72.2	90.5	112.6	118.7	142.5	204.4	570.2	589.0	559.4	531.7	462.7	436.2	378.3
2007-08	216.0	226.7	258.1	431.8	317.2	216.8	150.1	180.2	179.7	121.5	121.8	121.2	97.7	51.8	44.7	42.0	42.2	41.3	41.5	44.1	41.3	47.7	82.2	78.4	65.5	89.0	167.6	223.7	243.2	213.9	219.7	343.1	339.7	320.1	368.3	507.5
2008-09	418.8	368.9	322.1	253.2	230.8	190.5	117.1	185.6	193.6	121.4	158.5	114.5	76.8	74.5	79.6	63.3	89.2	79.9	83.0	137.4	161.4	101.6	111.9	176.4	178.2	178.9	198.2	233.5	230.1	237.0	357.4	478.6	469.5	521.8	475.5	508.0
2009-10	498.1	357.0	339.6	322.3	261.8	227.3	236.7	177.5	133.7	142.2	125.8	81.4	74.7	67.3	52.6	48.6	64.7	61.4	57.8	59.5	55.3	45.9	45.7	45.3	70.2	176.4	170.3	225.7	212.0	224.4	227.0	257.0	371.4	557.0	639.9	702.6
2010-11	789.8	532.4	505.8	392.8	321.5	436.6	699.3	600.5	521.1	289.5	200.3	197.1	138.7	88.6	95.8	93.7	75.8	72.1	65.1	58.4	57.0	59.9	60.9	67.1	156.4	280.2	210.0	248.0	262.6	458.7	434.9	562.0	650.5	663.7	622.4	599.8
2011-12	445.1	329.2	296.0	263.2	176.5	144.3	117.8	120.0	121.8	140.5	197.3	273.7	128.6	86.3	73.8	70.1	76.3	61.8	52.7	60.7	55.2	49.9	49.4	57.8	79.0	98.1	155.7	193.1	160.7	241.6	316.5	389.5	411.4	370.1	391.4	414.6
2012-13	451.2	347.9	331.6	317.4	307.8	226.1	186.1	187.0	184.3	183.7	410.8	374.3	169.4	98.7	87.4	69.1	55.8	56.7	57.8	61.3	65.1	64.0	67.5	90.9	122.3	122.3	157.3	227.8	249.1	329.6	286.0	307.8	385.4	372.5	395.9	564.5
2013-14	564.2	517.0	428.5	332.1	214.3	134.8	118.3	254.8	396.0	218.9	162.9	130.9	94.5	83.2	67.7	67.8	52.7	55.4	52.7	47.6	43.7	44.9	48.3	59.2	85.9	105.8	93.2	121.6	371.8	535.0	540.9	582.9	554.2	643.4	718.1	615.0
2014-15	633.1	570.3	492.3	550.6	453.2	337.9	220.5	162.9	203.2	697.1	1139.8	691.0	358.6	201.6	136.8	122.5	114.4	92.3	77.8	65.6	59.5	53.2	51.8	51.8	67.4	103.4	278.4	392.6	441.0	612.2	962.5	774.3	982.1	863.9	853.0	766.9
2015-16	587.4	506.3	634.8	669.1	696.1	671.5	528.4	323.5	189.8	129.4	101.1	265.4	223.1	126.4	231.7	259.0	250.8	159.4	115.1	145.7	105.5	117.6	102.5	92.7	102.3	131.4	207.8	153.0	403.7	576.7	656.2	614.6	538.9	470.4	528.9	553.4
2016-17	436.8	361.8	333.9	270.3	201.5	196.5	238.5	240.5	186.6	287.1	165.7	112.0	81.1	56.5	49.5	47.0	44.7	45.0	43.5	43.1	43.3	51.7	58.3	97.7	201.6	270.0	313.7	247.2	219.5	329.2	735.1	812.5	844.0	645.5	625.1	631.4
2017-18	563.4	508.1	455.3	477.2	390.6	313.9	265.5	203.3	136.5	140.5	129.5	86.5	59.2	44.0	41.3	37.8	41.8	47.4	42.8	55.7	51.9	46.0	42.7	38.4	39.1	45.1	58.6	113.0	121.0	121.0	170.0	330.6	398.0	297.1	322.4	288.2
2018-19	293.4	242.6	166.1	448.3	344.7	334.2	285.6	248.6	175.7	98.9	103.8	110.2	92.1	87.8	74.6	113.9	159.0	114.3	89.1	83.9	67.3	63.6	75.6	113.1	124.2	199.9	270.8	235.0	254.4	337.4	486.7	601.8	574.5	515.4	439.2	481.1
2019-20	479.6	615.0	505.2	433.7	426.4	391.0	439.8	422.1	299.3	179.9	113.1	87.4	102.8	104.2	83.3	120.5	222.4	292.2	246.2	173.6	152.4	119.4	161.6	204.4	179.3	176.5	225.5	275.7	287.1	349.0	417.4	457.6	462.6	521.8	560.4	482.1
Average	**521.4**	**446.4**	**424.6**	**423.9**	**390.1**	**369.9**	**335.9**	**311.3**	**274.2**	**256.2**	**248.0**	**197.4**	**152.1**	**113.1**	**100.7**	**91.2**	**90.9**	**86.9**	**79.6**	**83.6**	**82.6**	**81.8**	**81.4**	**92.3**	**114.1**	**151.0**	**183.2**	**230.5**	**301.3**	**417.6**	**480.5**	**520.4**	**550.6**	**589.9**	**598.4**	**591.3**

Table 8.2

Kishanganga inflow (Cumecs) Dependable Year 2001-02

Kishanganga PS Turbine Discharge: 57.86 Cumecs (Max)

PERIOD			Kishanganga inflow (Cumecs) Dependable Year 2001-02	Restricted Kishanganga river inflow (up to Kishanganga PS Turbine Discharge) to Uri barrage (Cumecs)
Jun-01	10	1-10	75.65	57.86
	10	11-20	75.48	57.86
	10	21-30	76.68	57.86
Jul-01	10	1-10	79.68	57.86
	10	11-20	68.79	57.86
	11	21-31	65.66	57.86
Aug-01	10	1-10	59.41	57.86
	10	11-20	56.77	56.77
	11	21-31	50.95	50.95
Sep-01	10	1-10	48.12	48.12
	10	11-20	47.70	47.70
	10	21-30	44.17	44.17
Oct-01	10	1-10	43.87	43.87
	10	11-20	45.32	45.32
	11	21-31	40.81	40.81
Nov-01	10	1-10	23.35	23.35
	10	11-20	21.68	21.68
	10	21-30	21.22	21.22
Dec-01	10	1-10	13.83	13.83
	10	11-20	12.27	12.27
	11	21-31	11.39	11.39
Jan-02	10	1-10	15.31	15.31
	10	11-20	15.36	15.36
	11	21-31	15.14	15.14
Feb-02	10	1-10	17.66	17.66
	10	11-20	18.66	18.66
	9	21-29	18.60	18.60
Mar-02	10	1-10	36.63	36.63
	10	11-20	43.26	43.26
	11	21-31	63.59	57.86
Apr-02	10	1-10	78.46	57.86
	10	11-20	111.53	57.86
	10	21-30	116.84	57.86
May-02	10	1-10	124.13	57.86
	10	11-20	217.20	57.86
	11	21-31	194.49	57.86

Table 8.3

Uri-I H.E. PROJECT

UNRESTRICTED ENERGY GENERATION

S.NO.	YEAR	UNRESTRICTED ENERGY GENERATION MU	REMARKS
1	1992-1993	8701.36	
2	1995-1996	7690.90	
3	1991-1992	7577.02	
4	1994-1995	7254.87	
5	2014-2015	7131.12	
6	1996-1997	6977.25	
7	1993-1994	6922.49	
8	1990-1991	6507.15	
9	1986-1987	6455.09	
10	1983-1984	6014.87	
11	2015-2016	5971.65	
12	1980-1981	5961.92	
13	1989-1990	5905.86	
14	1982-1983	5718.02	
15	1997-1998	5706.84	
16	2010-2011	5663.19	
17	1987-1988	5292.87	
18	2019-2020	5274.45	
19	1985-1986	5183.31	
20	1988-1989	4811.44	
21	2016-2017	4654.56	
22	1976-1977	4565.79	
23	1981-1982	***4539.75***	50 % DEPENDABLE YEAR
24	2013-2014	4493.85	
25	2002-2003	4380.67	
26	2005-2006	4339.36	
27	2006-2007	4300.22	
28	1979-1980	4196.72	
29	2018-2019	3990.99	
30	2012-2013	3901.68	
31	2008-2009	3899.76	
32	2003-2004	3873.42	
33	1977-1978	3862.80	
34	1978-1979	3689.84	75 % DEPENDABLE YEAR
35	1984-1985	3679.23	
36	2004-2005	3642.99	
37	2009-2010	3627.21	
38	1998-1999	3460.97	
39	2011-2012	3260.38	
40	2017-2018	3186.03	
41	2007-2008	***3088.74***	90 % DEPENDABLE YEAR
42	2001-2002	2972.97	
43	2000-2001	2230.05	
44	1999-2000	2111.89	

Table 8.4

KISHANGANGA H.E. PROJECT

UNRESTRICTED ENERGY GENERATION

S.NO.	YEAR	UNRESTRICTED ENERGY GENERATION MU	REMARKS
1	1992-1993	7158.53	
2	1987-1988	6707.94	
3	1972-1973	6541.90	
4	1986-1987	6481.80	
5	1989-1990	6359.85	
6	1983-1984	6020.83	
7	1991-1992	5985.76	
8	1993-1994	5875.12	
9	1994-1995	5463.36	
10	1975-1976	5392.56	
11	1977-1978	5385.37	
12	1990-1991	5368.39	
13	1980-1981	5297.37	
14	1976-1977	5195.27	
15	1998-1999	4931.32	
16	1973-1974	4927.93	
17	1978-1979	***4879.58***	50 % DEPENDABLE YEAR
18	1979-1980	4873.28	
19	1997-1998	4641.75	
20	1985-1986	4577.98	
21	1984-1985	4566.06	
22	1982-1983	4461.14	
23	1988-1989	4418.61	
24	1996-1997	4348.30	
25	1981-1982	4321.97	
26	2003-2004	4251.95	75 % DEPENDABLE YEAR
27	1974-1975	4019.24	
28	1971-1972	3932.33	
29	2002-2003	3881.11	
30	1995-1996	3880.54	
31	2001-2002	***2861.64***	90 % DEPENDABLE YEAR
32	2000-2001	2725.18	
33	1999-2000	2605.92	

Table 8.5

Revised Installed Capacity and Design Energy Calculation for Uri HE project considereing Uri-I stage-II as its extension

90% Dependable year 2007-08(Uri) & 2001-02 (Ksg)

Uri Plant														
FRL (m)	1491.00	MDDL (m)	1491	TWL (Max) m	1241.00	Rated Head (m)	222.50	Firm power (MW)	66.43	Avg Gross Head	250.00	Annual Load factor	80.29%	Design Energy(MU)	3376.20
Installed Capacity (MW)	480	Design Discharge (Cumec)	239.03	TWL (Min) m	1241.00	Overall Efficiency	92.00%	Min Full load ruunung hours	3.32	Head Loss	27.50	Type of Turbine	Francis	No. of units	4

Uri I St-II Project										
FRL (m)	1491.00	MDDL (m)	1491.00	TWL (Max) (m)	1241.00	Rated Head (m)	227.00	Avg Gross Head (m)	250.00	
Installed Capacity (MW)	240.00	Design Discharge (Cumec)	116.40	TWL (Min) (m)	1241.00	Overall Efficiency	92.59%	Head Loss(m)	23.00	

PERIOD		Uri-I (Cumec)-2007-08	Kishanganga inflow (Cumecs) 2001-02	Kishanganga Max Turbine discharge (Cumecs)	restricted kishanganga inflow to uri I (Cumecs)	Total inflow (Cumecs)	Total Inflow (MCuM)	E-flow (cumec)	Net inflow (Cumecs)	Unrestricted Power with E-flow (MW)	Unrestricted Energy with E-flow (MU)	Restricted Capacity (MW)	Restricted Energy (MU)	Resricted Energy with 95% M/c Availability (MU)	Full Load running hours	Spillage	Available Inflow (Cumec)	Unrestricted Power with Total inflow (MW)	Unrestricted Energy with Available inflow (MU)	Restricted Power (MW)	Restricted Energy with available inflow (MU)	Main Plant Energy with 95% M/c Availability (MU)	Plant Energy (MU) with 95% availability	Full Load running hours	Spillage	Remarks
Jun-07	1-10	216.00	75.65	57.86	57.86	216.00	186.63	8.19	207.81	417.31	100.15	480	100.15	100.15	20.87	0.00	57.86	119.30	28.63	240	28.63	28.63	128.79	11.93	0.00	
	11-20	226.73	75.48	57.86	57.86	226.73	195.89	8.19	218.54	438.85	105.32	480	105.32	105.32	21.94	0.00	57.86	119.30	28.63	240	28.63	28.63	133.96	11.93	0.00	Inflow of Uri-I Stage-I = Jhelum river flows - Env. release
	21-30	258.09	76.68	57.86	57.86	258.09	222.99	8.19	249.90	501.83	120.44	480	115.20	109.44	24.00	10.87	68.73	141.71	34.01	240	34.01	34.01	143.45	14.17	0.00	
Jul-07	1-10	431.81	79.68	57.86	57.86	431.81	373.09	8.19	423.62	850.68	204.16	480	115.20	109.44	24.00	184.59	242.45	499.90	119.98	240	57.60	54.72	164.16	24.00	126.05	
	11-20	317.23	68.79	57.86	57.86	317.23	274.09	8.19	309.04	620.59	148.94	480	115.20	109.44	24.00	70.01	127.87	263.65	63.28	240	57.60	54.72	164.16	24.00	11.47	
	21-31	216.83	65.66	57.86	57.86	216.83	206.08	8.19	208.64	418.97	110.61	480	110.61	110.61	20.95	0.00	57.86	119.30	31.49	240	31.49	31.49	142.10	11.93	0.00	
Aug-07	1-10	150.06	59.41	57.86	57.86	150.06	129.65	8.19	141.87	284.89	68.37	480	68.37	68.37	14.24	0.00	57.86	119.30	28.63	240	28.63	28.63	97.01	11.93	0.00	
	11-20	180.18	56.77	57.86	56.77	180.18	155.68	8.19	171.99	345.38	82.89	480	82.89	82.89	17.27	0.00	56.77	117.05	28.09	240	28.09	28.09	110.98	11.71	0.00	
	21-31	179.72	50.95	57.86	50.95	179.72	170.81	8.19	171.53	344.45	90.94	480	90.94	90.94	17.22	0.00	50.95	105.05	27.73	240	27.73	27.73	118.67	10.51	0.00	
Sep-07	1-10	121.53	48.12	57.86	48.12	121.53	105.00	8.19	113.34	227.59	54.62	480	54.62	54.62	11.38	0.00	48.12	99.22	23.81	240	23.81	23.81	78.43	9.92	0.00	
	11-20	121.84	47.70	57.86	47.70	121.84	105.27	8.19	113.65	228.22	54.77	480	54.77	54.77	11.41	0.00	47.70	98.35	23.60	240	23.60	23.60	78.38	9.84	0.00	
	21-30	121.24	44.17	57.86	44.17	121.24	104.75	8.19	113.05	227.02	54.48	480	54.48	54.48	11.35	0.00	44.17	91.07	21.86	240	21.86	21.86	76.34	9.11	0.00	
Oct-07	1-10	97.72	43.87	57.86	43.87	97.72	84.43	8.19	89.53	179.79	43.15	480	43.15	43.15	8.99	0.00	43.87	90.45	21.71	240	21.71	21.71	64.86	9.05	0.00	
	11-20	51.82	45.32	57.86	45.32	51.82	44.77	8.19	43.63	87.61	21.03	480	21.03	21.03	4.38	0.00	45.32	93.44	22.43	240	22.43	22.43	43.45	9.34	0.00	
	21-31	44.74	40.81	57.86	40.81	44.74	42.52	8.19	36.55	73.40	19.38	480	19.38	19.38	3.67	0.00	40.81	84.14	22.21	240	22.21	22.21	41.59	8.41	0.00	
Nov-07	1-10	42.02	23.35	57.86	23.35	42.02	36.30	8.19	33.83	67.93	16.30	480	16.30	16.30	3.40	0.00	23.35	48.14	11.55	240	11.55	11.55	27.86	4.81	0.00	
	11-20	42.22	21.68	57.86	21.68	42.22	36.48	8.19	34.03	68.33	16.40	480	16.40	16.40	3.42	0.00	21.68	44.70	10.73	240	10.73	10.73	27.13	4.47	0.00	
	21-30	41.27	21.22	57.86	21.22	41.27	35.66	8.19	33.08	66.43	15.94	480	15.94	15.94	3.32	0.00	21.22	43.75	10.50	240	10.50	10.50	26.44	4.38	0.00	
Dec-07	1-10	41.48	13.83	57.86	13.83	41.48	35.84	8.19	33.29	66.85	16.04	480	16.04	16.04	3.34	0.00	13.83	28.52	6.84	240	6.84	6.84	22.89	2.85	0.00	
	11-20	44.07	12.27	57.86	12.27	44.07	38.08	8.19	35.88	72.05	17.29	480	17.29	17.29	3.60	0.00	12.27	25.30	6.07	240	6.07	6.07	23.36	2.53	0.00	
	21-31	41.30	11.39	57.86	11.39	41.30	39.25	8.19	33.11	66.48	17.55	480	17.55	17.55	3.32	0.00	11.39	23.48	6.20	240	6.20	6.20	23.75	2.35	0.00	
Jan-08	1-10	47.65	15.31	57.86	15.31	47.65	41.17	8.19	39.46	79.24	19.02	480	19.02	19.02	3.96	0.00	15.31	31.57	7.58	240	7.58	7.58	26.59	3.16	0.00	
	11-20	82.18	15.36	57.86	15.36	82.18	71.00	8.19	73.99	148.57	35.66	480	35.66	35.66	7.43	0.00	15.36	31.67	7.60	240	7.60	7.60	43.26	3.17	0.00	
	21-31	78.37	15.14	57.86	15.14	78.37	74.48	8.19	70.18	140.93	37.21	480	37.21	37.21	7.05	0.00	15.14	31.22	8.24	240	8.24	8.24	45.45	3.12	0.00	
Feb-08	1-10	65.53	17.66	57.86	17.66	65.53	56.62	8.19	57.34	115.15	27.64	480	27.64	27.64	5.76	0.00	17.66	36.41	8.74	240	8.74	8.74	36.37	3.64	0.00	
	11-20	88.96	18.66	57.86	18.66	88.96	76.86	8.19	80.77	162.20	38.93	480	38.93	38.93	8.11	0.00	18.66	38.47	9.23	240	9.23	9.23	48.16	3.85	0.00	
	21-29	167.62	18.60	57.86	18.60	167.62	130.34	8.19	159.43	320.14	69.15	480	69.15	69.15	16.01	0.00	18.60	38.35	8.28	240	8.28	8.28	77.43	3.84	0.00	
Mar-08	1-10	223.74	36.63	57.86	36.63	223.74	193.31	8.19	215.55	432.85	103.88	480	103.88	103.88	21.64	0.00	36.63	75.53	18.13	240	18.13	18.13	122.01	7.55	0.00	
	11-20	243.24	43.26	57.86	43.26	243.24	210.16	8.19	235.05	472.01	113.28	480	113.28	109.44	23.60	0.00	43.26	89.20	21.41	240	21.41	21.41	130.85	8.92	0.00	
	21-31	213.89	63.59	57.86	57.86	213.89	203.28	8.19	205.70	413.06	109.05	480	109.05	109.05	20.65	0.00	57.86	119.30	31.49	240	31.49	31.49	140.54	11.93	0.00	
Apr-08	1-10	219.66	78.46	57.86	57.86	219.66	189.78	8.19	211.47	424.65	101.92	480	101.92	101.92	21.23	0.00	57.86	119.30	28.63	240	28.63	28.63	130.55	11.93	0.00	
	11-20	343.15	111.53	57.86	57.86	343.15	296.48	8.19	334.96	672.63	161.43	480	115.20	109.44	24.00	95.93	153.79	317.08	76.10	240	57.60	54.72	164.16	24.00	37.39	
	21-30	339.70	116.84	57.86	57.86	339.70	293.50	8.19	331.51	665.72	159.77	480	115.20	109.44	24.00	92.48	150.34	309.99	74.40	240	57.60	54.72	164.16	24.00	33.94	
May-08	1-10	320.06	124.13	57.86	57.86	320.06	276.53	8.19	311.87	626.27	150.30	480	115.20	109.44	24.00	72.84	130.70	269.48	64.68	240	57.60	54.72	164.16	24.00	14.30	
	11-20	368.29	217.20	57.86	57.86	368.29	318.20	8.19	360.10	723.12	173.55	480	115.20	109.44	24.00	121.07	178.93	368.93	88.54	240	57.60	54.72	164.16	24.00	62.53	
	21-31	507.49	194.49	57.86	57.86	507.49	482.32	8.19	499.30	1002.64	264.70	480	126.72	120.38	24.00	260.27	318.13	655.93	173.17	240	63.36	60.19	180.58	24.00	201.73	
Total													2494.10	**2443.60**							953.04	**932.60**	**3376.20**			

Notes:

(i) As per NGT recent order on hydro Power station, Eflow has been taken as 15% of average of 4 months of lean soeaon (Oct-Jan) equals 8.19 Cumecs