



भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
जल विद्युत परियोजना प्रबोधन प्रभाग
Hydro Projects Monitoring Division

सं० CEA/ HPM/129 /1/2022 /38

दिनांक : 25-02-2022

Subject: Report of the visit of Sh. Manoj Tripathi, Chief Engineer (HPM), CEA, to Parbati St-II HE Project (4x200 MW = 800 MW), Himachal Pradesh being executed by M/s NHPC Limited on 14th & 15th February, 2022 for review of status of works

The Parbati St-II HE Project was visited by the undersigned on 14th & 15th Feb, 2022 to review the progress of works. Head of Project, Parbati-II HEP and other senior officers of the project also accompanied me during the visit. Discussions were also held with the Officers / Site Engineers and Contractors of the project on various aspects of the on-going works, problem areas and measures taken/necessary to accelerate the pace of works with the aim of timely commissioning of the units as per present schedule i.e by March, 2023. The status of various works, critical areas, observations during the visit and assessment of completion of the project are as under:

1.0 Introduction:

Parbati H.E. Project Stage-II is located in Kullu District of Himachal Pradesh and envisages **inter-basin diversion of waters** of Parbati River (a tributary of river Beas/ Indus) into Sainj river (also a tributary of river Beas/ Indus), thereby utilizing head available to generate power in Parbati-II Power House and also augment generation of Parbati-III HEP. The Parbati river flow which is tapped at Dam site through Intakes is augmented by adding water from Jigrai nallah in the upstream of Dam at Pulga. Further the discharges of Manihar, Pancha, Hurla, and Jiwa nallahs, through two feeder tunnels, are dropped into the head race tunnel of project.

All the four major Civil & HM work packages were allotted during the month of September, 2002. Contract for E&M works were awarded on 21.12.2002. As per the CCEA the project was to be commissioned within 7 year of CCEA i.e by September, 2009. The CCEA approved cost is Rs. 3919.59 cr (12/2001 PL) and Latest estimated cost is Rs. 9897.59 cr (04/2020 PL). The total expenditure till Jan, 22 is about Rs. 9676 crores. ***The current programme of completion of the project is by March, 2023.*** The project has mainly been delayed due to tunneling issues (adverse geological conditions, frequent water/silt seepage issues, intermittent shear/weak zones, frequent TBM cutter replacement issues in negotiating Manikaran Quartzite ,frequent breakdown of TBM, etc.) between

Adit-I and Adit-II (Face-3 and Face-4) which covers a distance of about 13.1 km, termination of two contracts for HRT and delays in re-award of these contract due to high bids and poor response of the contractors. Other reasons for delay are delay in forest clearance, 3 times back slope failure of Power House, flash floods/ cloud bursts, impact of Covid, funds constraints with present civil contractors, etc.

2.0 Present status of works:

All the major components of the project are completed except part HRT (between Adit 1 and 2) and project is generating infirm power from water of various nallhas. The critical balance works is excavation of about 900 m HRT and lining of HRT at Face-3/4. The present schedule of completion of balance works is by Feb,23 and commissioning of the project by March,23.

3.0 Conclusion, observations, main critical areas & assessment of completion of project:

- The execution of TBM in Himalayan Geology had been a success only in two hydro projects viz. Kishanganga HEP (HRT excavation using double shielded TBM of M/s SELI with progress of more than 400 m per month) and Parbati-II HEPs (inclined pressure shafts excavation using Mitsubishi double shielded TBM), whereas the experience in Dulhasti HRT (HRT excavation using Gripper type TBM of M/s Robbins had to be abandoned), Tapovan Vishnugad HRT (faced contractual issues and thrice struck up in poor geology using Robbins make double shielded TBM being operated by M/s Alpine), Parbati-II HRT (refurbished Robbins make gripper type TBM) and Vishnugad Pipalkoti HRT (double shielded TBM being manufactured and operated by M/s SELI Spa, Italy) had not been encouraging. Further, TBM's are now being deployed in Pakal Dul HEP due to site constraints.
- TBMs are often considered the only viable option for the excavation of long tunnels with high overburden, due to the impracticability of opening several faces via adits to enable the application of traditional tunneling methods. It is suggested that, use of TBM may preferably be resorted only if DBM is not feasible or proper S&I (using geophysical as well as geotechnical methods) is possible, which is practically possible in low cover reaches with accessibility of survey/ investigation instruments along HRT alignment. Further, TBM purchased may be new with all features to address various geological conditions and contract documents may include geological baseline report with risk register and proper risk sharing mechanism. The CPSU's (NHPC/ NTPC/ THDC) may share the lesson learnt in execution of TBM and pool their knowledge for future execution of projects using TBM.
- It is also suggested that in future projects with anticipated EGO occurrences, the main civil contractor may be supplemented with provision of a specialized sub-contractor for taking care of EGO conditions. Also, PCC mud-mat may be provided during excavation of long stretches of HRT by DBM method, where ever practical, so that the movement of heavy machinery and other vehicles is smooth and wear and tear of the vehicles will also be less.
- The Parbati-II HEP has been identified as a project vulnerable to flash floods as it is the upper most project in the main Parbati river. The project authorities have taken short term measures for the EWS by setting up a G&D site on Tosh river about 3 km

upstream of Dam and further HPPCL G&D sites are also in the upstream reaches. NHPC is in the process of establishing the AWS based G&D sites, level sensors and establishment of the control room for EWS with all requisite facilities.

- The project is an example of many unique features like longest HRT in India (31.5 km), longest inclined pressure shafts (1.5 km each), large network of project roads (about 90 km) & bridges, diversion of 5 nallah's into Dam/ HRT for augmenting generation, large spread of project components over 4 valleys, unique slope protection work in Power House back slope, etc.
- NHPC has presently programmed to commission the project by March,23. It was observed that ,presently part HRT works are only balance and therefore critical for commissioning of the units by March'23 and excavation completion will depend on the geology & seepage of water in the balance HRT length of about 900m. It has been assessed that under optimistic conditions, the project can be commissioned by Feb,23; however, keeping in view the issues being faced and average geological conditions during excavation, the most likely estimate is Aug'23. The detailed estimation of completion of the project has been worked out at para 4.2. ***It is further assessed that if the tunnel day-lighting is completed by July,22 , then the commissioning is possible during the year 2022-23 under best efforts, since the level of uncertainty in balance works of lining, grouting, cleaning, plugging, etc. is quite less compared to excavation works.***
- Though, it was observed that all out efforts are being put up by NHPC in expediting the works, still it is advised that the all out efforts should continue along with timely decision making till COD of the project as the timely diversion of Parbati water will also help in augmenting generation of the already constructed Parbati-III Power Station apart from containing the IDC component of Parbati-II HEP.

The tour report is enclosed herewith for kind perusal please.

संलग्न : ऊपरोक्त अनुसार

मनोज
25/2/22
(मनोज त्रिपाठी)
मुख्य अभियंता

अध्यक्ष और प्रबंध निदेशक (एनएचपीसी लिमिटेड)

प्रतिलिपि:

1. संयुक्त सचिव (हाइड्रो), एमओपी
2. SA to सदस्य (हाइड्रो), सीईए

**Central Electricity Authority
Hydro Project Monitoring Division**

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1.0 Introduction:

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All the four major Civil & HM work packages were allotted during the month of September, 2002. Contract for E&M works were awarded on 21.12.2002. As per the CCEA the project was to be commissioned within 7 year of CCEA i.e by September, 2009. The CCEA approved cost is Rs. 3919.59 cr (12/2001 PL) and Latest estimated cost is Rs. 9897.59 cr (04/2020 PL). The total expenditure till Jan, 22 is about Rs. 9676 crores. ***The current programme of completion of the project is by March, 2023.*** The project has mainly been delayed due to tunneling issues (adverse geological conditions, frequent water/silt seepage issues, intermittent shear/weak zones, frequent TBM cutter replacement issues in negotiating Manikaran Quartzite ,frequent breakdown of TBM, etc.) between Adit-I and Adit-II (Face-3 and Face-4) which covers a distance of about 13.1 km, termination of two contracts for HRT and delays in re-award of these contract due to high bids and poor response of the contractors. Other reasons for delay are delay in forest clearance, 3 times back slope failure of Power House, flash floods/ cloud bursts, impact of Covid, funds constraints with present civil contractors, etc.

2.0 ***Project Components:***

The major project components are:

- ❖ **Dam:** 83.7 m high from deepest foundation, 110 m long, concrete gravity dam at village Pulga. Reservoir to have live storage capacity of 3.09 Mcum with gross storage capacity as 6.83 Mcum.
- ❖ **Spillway:** 3 nos. Orifice type to pass maximum probable flood of 1850cumec with 6m x 9m Radial gates with breast wall.
- ❖ **HRT:** 31.526 Km long (horse shoe shape for DBM portion – 22.476 Km long and in circular shape for TBM portion – 9.05 Km long) of 6 m diameter. The construction of tunnel is from six construction Adits and twelve faces. ***This HRT is also the longest HRT in India.***
- ❖ **Nallah Diversions:** Jagri Nallah: 11.6 m long trench weir, 813 m long feeder tunnel; Manihar Nallah: 15 m long trench weir, 2252 m long feeder tunnel; Pancha Nallah: 10 m long trench weir, 770 m long feeder tunnel; Hurla Nallah: 12 m long trench weir, 114 m long feeder tunnel and Jiwa Nallah: 14m long trench weir, 5200 m long feeder tunnel.
- ❖ **Surge Shaft:** Restricted orifice type with 17 m diameter, 130 m high.
- ❖ **Pressure Shaft:** 2 nos. inclined steel lined of diameter 3.5 m, 2121 m and 2149 m long.
- ❖ **Valve House:** size 69m x 8m x 12.5m to accommodate Butterfly valves for each Pressure Shaft.
- ❖ **Power House:** Surface type of size 123m x 36.25m x 23.5m located on the right bank of river Sainj. Installation four Pelton turbines with generator of capacity 200 MW each (total 800 MW).
- ❖ **Tail Race Channels:** 4 nos., 60m long and 5m x 4.5 m each to discharge the water from Power House to river Sainj.

The schematic diagram is at **Annex-I** and some photographs taken during the site visit are at **Annex-II**. The Memorandum of Changes from the concurred DPR have been issued by CEA vide letter dated 15th June, 2018.

3.0 ***Brief details of Contracts:***

(i) **Lot PB-1:** Works awarded on 11.09.2002 to M/s Patel – SEW JV, Mumbai for contract Value of Rs.322.90 Crores with completion by 10.09.2007. Works related to PB-1 are Construction of Diversion Tunnel, Cofferdams, Main Dam, Power Intake, Desilting Chambers, Silt Flushing Tunnels, Gate Operation Chambers, associated Adits, approach Adit to the Main tunnel, Jigrai Nallah Trench Weir and Feeder tunnel and HRT (RD 00-3500 M)

(ii) **Lot PB-2:** Works awarded on 11.09.2002 to M/s Himachal JV, Bangalore for contract value of Rs.419.89 Crores with completion by 10.09.2007. Works are Adit 1, Adit 2, Adit 2a, Adit 3 and HRT (RD 3500 to 24733 M), Hurla Nallah trench weir, Pancha Nallah trench weir, Manihar Nallah trench weir and their Feeder tunnels.

On account of non-performance, M/s HJV contract was terminated during March'2012. In year 2013, leftover works of M/s HJV were awarded to two agencies namely M/s Gammon-CMC JV (by TBM for **Lot-PB-2A**) in August' 2013 and M/s Valecha Engineering Limited (VEL) (by

DBM **Lot- PB-2B**) in Nov'2013 to take up the works of HRT in parallel, from available Tunnel faces at the risk and cost of M/s HJV. The Lot-PB-2B was also terminated on 22.12.2018 due to non-performance and re-awarded to M/s GECPL as **Lot-PB-2C** on 2.6.2020 with completion by 01.03.2023.

(iii) **Lot PB-3:** Works awarded on 13.09.2002 to M/s Gammon India Ltd., Mumbai, for contract value 603.69 Crores with completion by 13.03.2007. Works are Power House, Surge Shaft, Pressure Shaft, Penstocks, Adit-IV & Adit-V, Valve house, Tail race channel.

(iv) **Lot PB-4:** Works awarded on 11.09.2002 to M/s BJ – Techno – HAS (JV), New Delhi for contract value Rs.56.47 crores with completion by 10.09.2007. Works are Jiwa Nallah Trench Weir, feeder tunnel, Desilting Basin, Silt Flushing tunnel, Gate operation tunnel and Adit to the above works, Jiwa Nallah, Feeder tunnel, and Gate operation chamber. The works were terminated and later awarded during 2011 to M/s Coastal Projects.

(v) **LOT PB-5:** Works for E&M works awarded on 24.12.2002 to M/s Bharat Heavy Electricals Limited (BHEL), India for contract value Rs.353.98 crores with completion by April, 2007.

4.0 Status of works under Contracts:

4.1 LoT PB-1: Works related to PB-1 are Construction of Diversion Tunnel, Coffor Dams, Main Dam, Power Intake, Desilting Chambers, Silt Flushing Tunnels, Gate Operation Chambers, associated Adits, approach Adit to the Main tunnel, Jigrai Nallah Trench Weir and Feeder tunnel and HRT (RD 00-3500 M).

- a) **River Diversion works:** River was diverted on 31.10.2003.
- b) **Dam, Intake, Desilting Chambers and part HRT (RD 0 to 3500 m):** All major works completed and substantial completion achieved on 29-08-17. The river is presently flowing through the spillway gates as HRT portion related to Lot PB-2 is not yet complete.

4.2 LoT PB-2/ 2A/2B/2C: Works related to PB-2 are Adit 1, Adit 2, Adit 3 and HRT (RD 3500 to 24733 M), Hurla Nallah trench weir, Pancha Nallah trench weir, Manihar Nallah trench weir and their Feeder tunnels.

The Sheelagarh Diversion works which include diversion of Manihar, Pancha and Hurla nallahs has been completed and water diverted to HRT, and units generating power from these nallahs including Jiwa nallah. The Head Race Tunnel works between Adit-2 and Adit-3 (a distance of about 13.1 kms) are presently under execution. The details are as under-

Head Race Tunnel:

- (a) **HRT Excavation:** Six adits (12 faces) were used for excavating the 31.5 km long HRT. Excavation from all faces except Face-3 and Face-4 completed. A small portion

of HRT viz Face-5 of length 60 m will be excavated after completion of Face-4 excavation, as it is acting as a rock plug since the HRT downstream is charged with water from various nallhas through drop shafts.. Face-3 is being excavated using traditional drilling and blasting (DBM) technique and Face-4 is being excavated using Tunnel Boring Machine (TBM). A total length of about 917 m (90 m from Face-4-TBM and 827 m by DBM) is balance. **The Works of HRT from Face-3 &4 are on critical path.**

- (b) **Excavation/ Lining from Face 4 (PB2A-Gammon-CMC JV):** This face is being excavated using Tunnel Boring Machine (TBM); a refurbished machine of the Open Shield hard rock type, Robbins make. The average progress under the current contract (PB2A-Gammon-CMC JV) has been about 40m/ month and maximum progress had been 106 m/ month during April'16. Presently about 90 m reach under this contract is balance and 3036 m has been completed in about 75 months. The scope of excavation is likely to be completed by March'22 and thereafter, it is planned to extend the scope of tunneling under this contract further till day-lighting is achieved. The reasons for slow progress of TBM had been adverse geological conditions, frequent water/silt seepage issues, intermittent shear/weak zones, frequent TBM cutter replacement issues while negotiating Manikaran Quartzite ,frequent breakdown of TBM, rock bursting in high rock cover reaches, etc. Concrete lining is also been done concurrently and presently 6406 m lining has been completed and now only 838 m lining is balance out of total of 7244 m. The maximum progress of lining had been 312 m per month during Sept'15.
- (c) **Excavation/ Lining from Face-3 (PB-2C-GECPL):** The remaining works were awarded during June,2020 which included about 1519m excavation , 2708 m lining and grouting works of Face2/3.. Under excavation scope, 692 m has been completed since start of works during Jan'21 and 827 m is balance. Lining will be done after day-lighting of the tunnel. A maximum progress of 132 m excavation has been achieved during May'21 and average progress has been about 52 m per month. Considering the large lead distance of about 5 km, which is unusual in DBM, the progress of excavation had been very good till July'21, however, the progress was first hindered due to water ingress during July,21 and thereafter the HRT alignment was detoured and again water ingress was there during Dec,21. Presently the tunnel is negotiating a weak zone and pipe-roofing/ fore-poling is being implemented during excavation alongwith rib support. Keeping in view the reverse slope of this Face, number of submersible pumps and six pipes are being deployed to throw water out of the adit-1.
- (d) **Assessment of Completion of HRT Works:** The only major/ critical work is day-lighting of the tunnel & subsequent lining/ grouting works of the tunnel. At present about 900 m excavation through Face3/4 is balance in order to achieve day-lighting. Because of the geological uncertainties two scenario had been worked out to assess the completion of the project as under:

Optimistic Scenario: The maximum progress achieved under the present contracts has been used to work out the optimistic estimate. Details are as under:

- a) Completion of excavation: About 4.5 months i.e by Mid-June,2022, keeping an estimated rate of excavation of about 100 m per month by DBM and 100 m per month by TBM.
- b) Completion of Lining (Face-3): 2708 m balance lining @ 700 m per month assuming working at multiple gantry/stretchers & using continuous gantry will take about 4 months i.e by Mid-Oct'22.
- c) Dismantling of TBM & balance lining of Face-4 : Dismantling and demobilization of TBM will take about 3 month and balance lining may take about 1.5 months i.e by Mid-Oct'22.
- d) Grouting: 1.5 months i.e by Dec,22.
- e) Cleaning & Inspection of part HRT & Plugging/ Gating of adits: 1.5 months i.e by Mid-Jan'23.
- f) Charging of water conductor system: 1 month i.e by Mid-Feb, 2023.
- g) Commissioning of units-0.5 month i.e by Feb,23. .

Note- i)b & c are parallel activities in Face-3 and 4 after day-lighting of the tunnel.
ii)The excavation of the rock plug at Face-5 (60 m length), lining and other associated activities will be parallel to d) & e) activity.

Most Likley Scenario: The average progress achieved under the present contracts has been used to work out the most likely estimate. Details are as under:

- a) Completion of excavation: About 9 months i.e by Oct,2022, keeping an estimated rate of excavation of about 50 m per month by DBM and 50 m per month by TBM.
- b) Completion of Lining (Face-3): 2708 m balance lining @ 500 m per month assuming working at multiple gantry/stretchers & using continuous gantry will take about 6 months i.e by April'23.
- c) Dismantling of TBM & balance lining of Face-4 : Dismantling and demobilization of TBM will take about 3 month and balance lining may take about 2 months i.e by March'23.
- d) Grouting: 2 months i.e by June,23.
- e) Cleaning & Inspection of part HRT & Plugging/ Gating of adits: 1.5 months i.e by Mid-July'23.
- f) Charging of water conductor system: 1 month i.e by Mid-Aug, 2023.
- g) Commissioning of units-0.5 month i.e by Aug ,23.

Note- i)b & c are parallel activities in Face-3 and 4 after day-lighting of the tunnel.
ii)The excavation of the rock plug at Face-5 (60 m length), lining and other associated activities will be parallel to d) & e) activity.

4.3 Lot PB-3: The scope of works included part HRT (6.79 KM), surge shaft, pressure shaft , Power House, TRT, etc. The works stands completed during the year 2015.

4.4 Lot PB-4: The Jiwa nallha works under this contract stands completed and generation was started in the project since Sept,18 by diversion of Jiwa waters into HRT.

4.5 Lot PB-5: (E&M Works) The units 1 to 4 were synchronized on 14.09.2018, 22.09.2018, 28.09.2019 and 28.09.2019 respectively. A fire incident took place at Power House on 29.07.2020 and thereafter two unit were restored during the year 2020 and rest 2 units are programmed to be restored by July,22. The total generation utilizing water of various nallahs during the current year (till date) is about 340 MU.

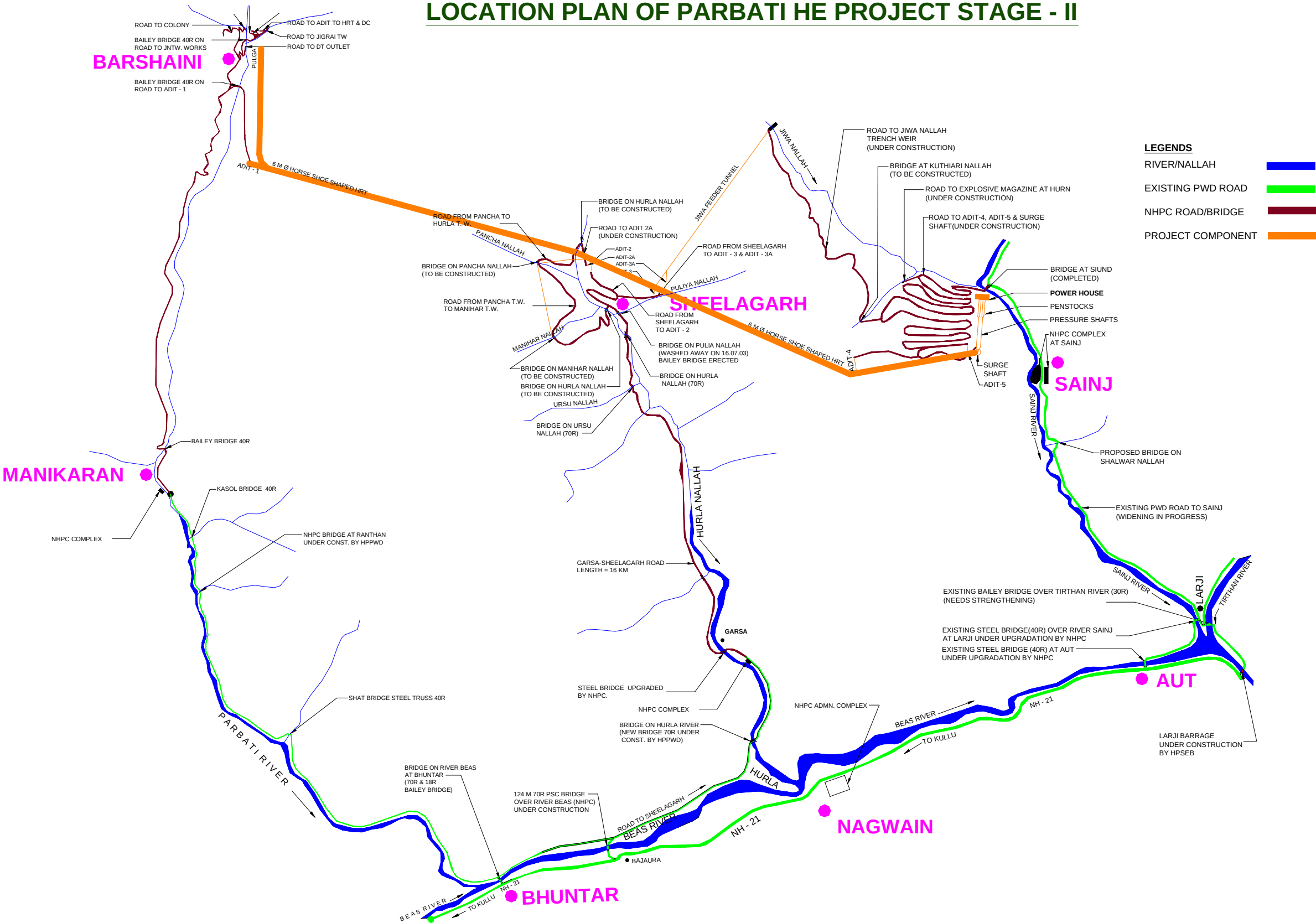
5.0 Conclusion, observations, main critical areas & assessment of completion of project:

- The execution of TBM in Himalayan Geology had been a success only in two hydro projects viz. Kishanganga HEP (HRT excavation using double shielded TBM of M/s SELI with progress of more than 400 m per month) and Parbati-II HEPs (inclined pressure shafts excavation using Mitsubishi double shielded TBM), whereas the experience in Dulhasti HRT (HRT excavation using Gripper type TBM of M/s Robbins had to be abandoned) , Tapovan Vishnugad HRT (faced contractual issues and thrice struck up in poor geology using Robbins make double shielded TBM being operated by M/s Alpine), Parbati-II HRT (refurbished Robbins make gripper type TBM) and Vishnugad Pipalkoti HRT (double shielded TBM being manufactured and operated by M/s SELI Spa, Italy) had not been encouraging. Further, TBM's are now being deployed in Pakal Dul HEP due to site constraints.
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measures for the EWS by setting up a G&D site on Tosh river about 3 km upstream of Dam and further HPPCL G&D sites are also in the upstream reaches. NHPC is in the process of establishing the AWS based G&D sites, level sensors and establishment of the control room for EWS with all requisite facilities.

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LOCATION PLAN OF PARBATI HE PROJECT STAGE - II



SITE PHOTOGRAPHS



UPSTREAM VIEW FROM DAM TOP



INSIDE DAM GALLERY



VIEW OF DAM FROM INTAKE SIDE



DRILL JUMBO- OUTSIDE ADIT 1 (FOR FACE-3 EXCAVATION BY DBM)



**FACE-3 ABANDONED STRETCH WHERE SEEPAGE WAS FIRST OBSERVED DURING JULY,21
(seepage been channelized through pipes/ dewatering pumps)**



OUTSIDE ADIT-2 (FACE 4 EXCAVATION BY TBM)



TBM CUTTERS



SURFACE POWER HOUSE BUILDING



PANCHA NALLAH TRENCH WEIR SITE



HURLA NALLAH TRENCH WEIR SITE