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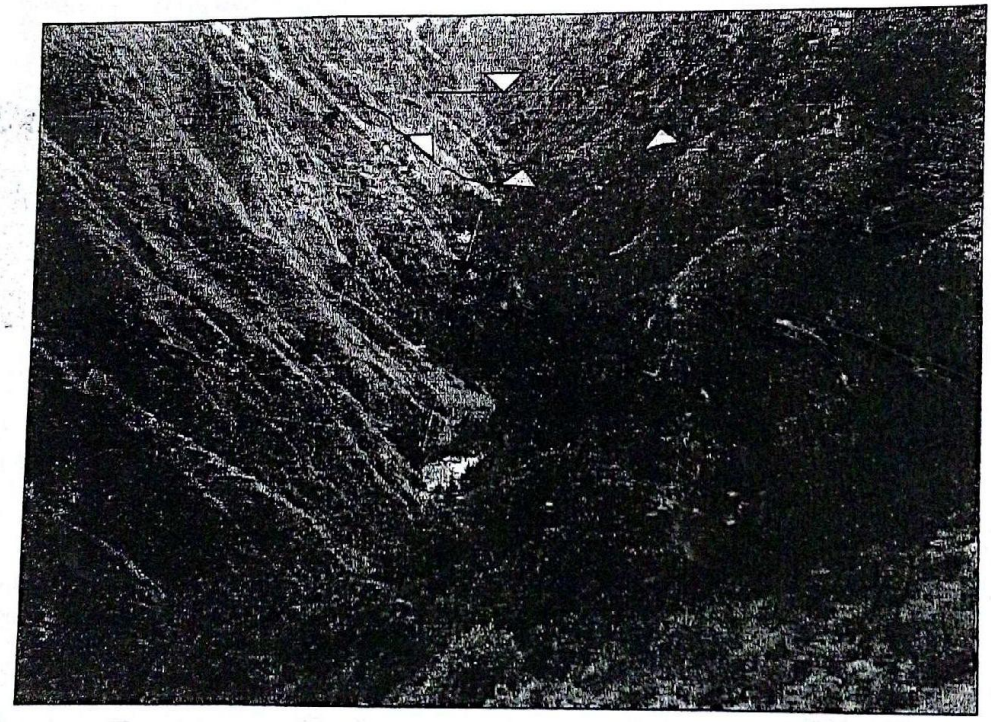
STUDY NOTE NO 8 ON THE GEOTECHNICAL INVESTIGATION OF THE JAKHOL-SANKRI HYDROELECTRIC PROJECT, DISTRICT UTTARKASHI, UTTARAKHAND



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July 2010

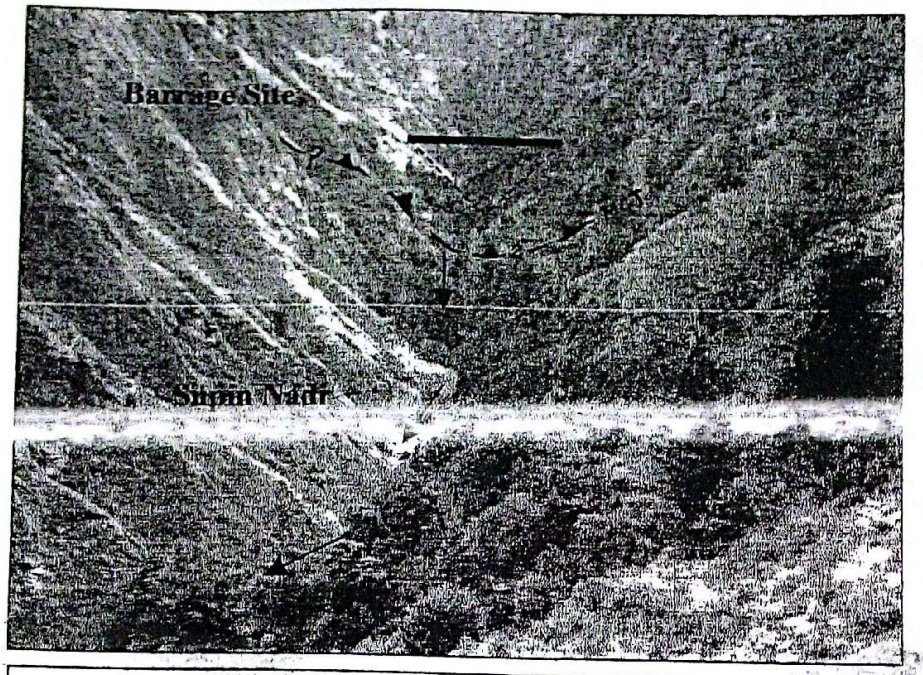

Photo: 1 A distant upstream view of The Jakhol Barrage Site

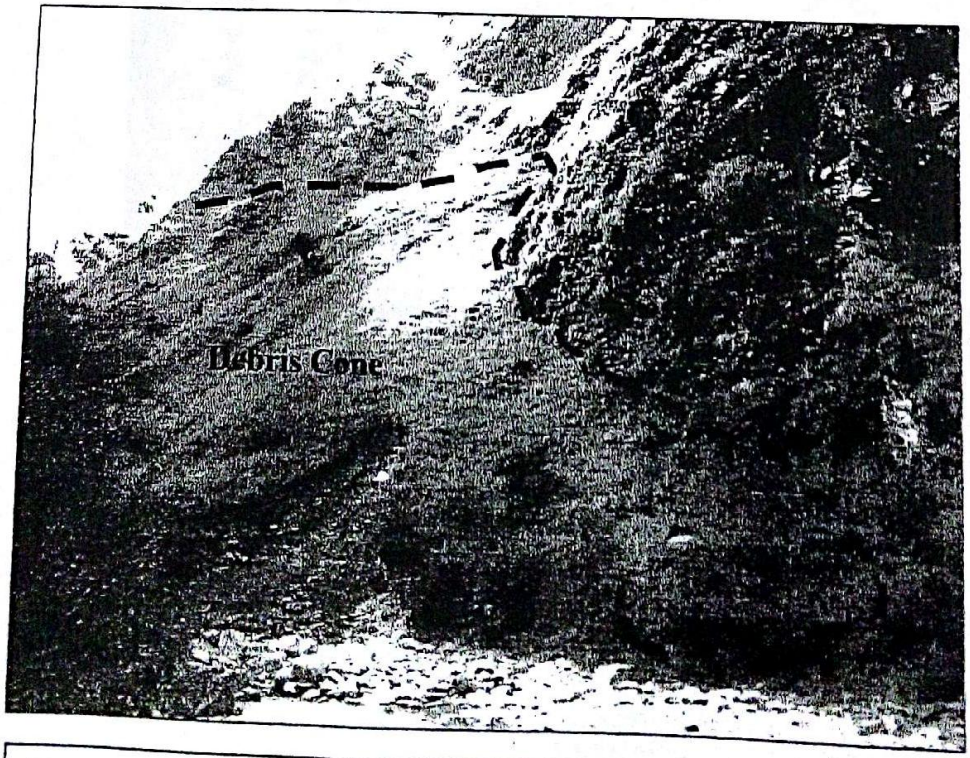

Photo: 2 Unstable Debris Cone Structure immediately downstream of the Jakhol Barrage Site

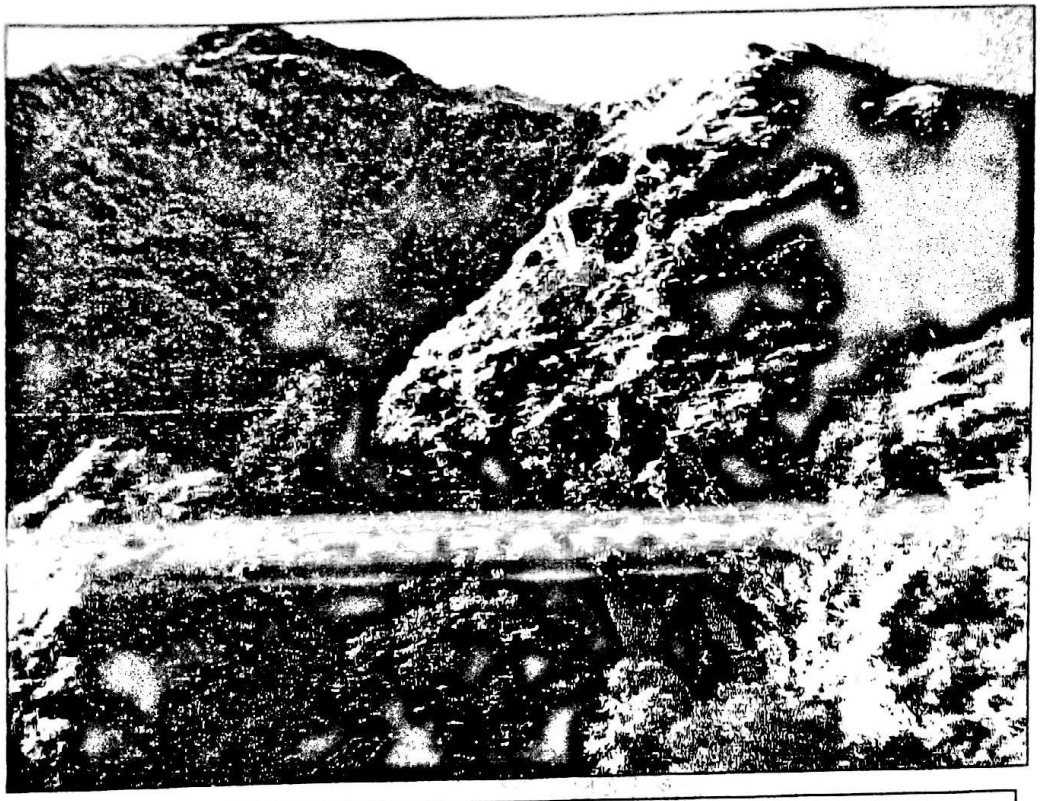

Photo 3: Gneisses exposed on the right abutment near Barrage

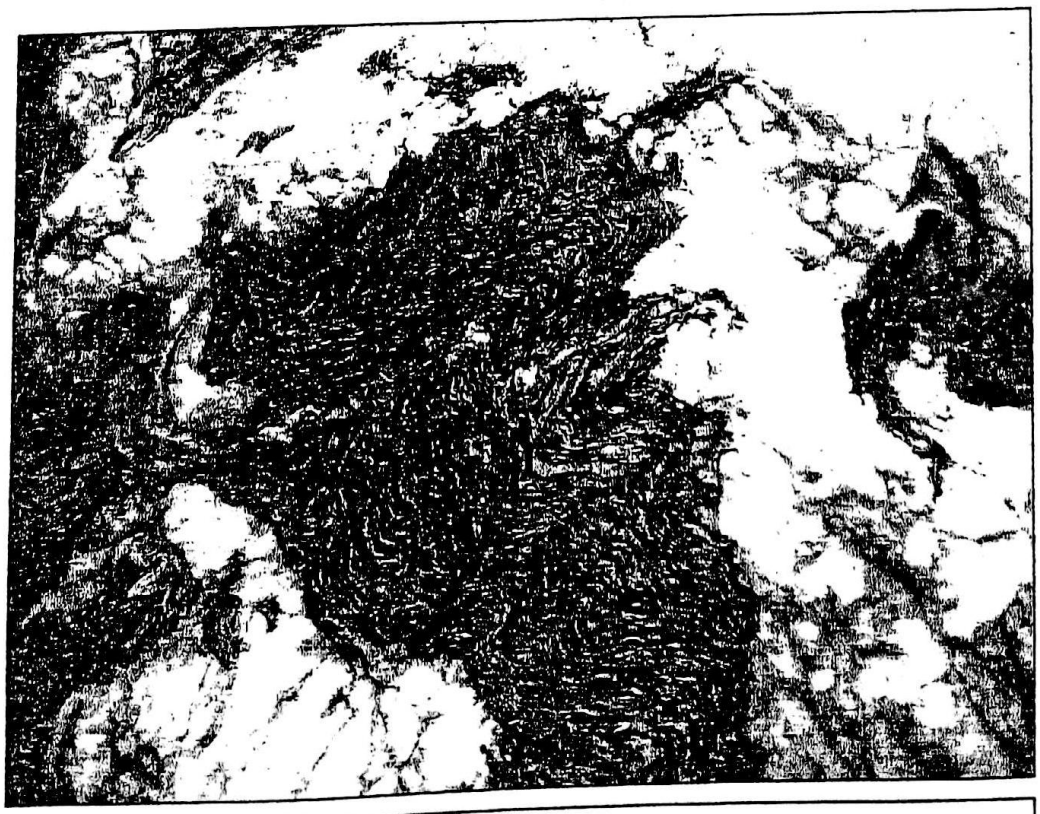

Photo 4: Crenulations and micro folding observed within quartz veins in Gneisses around Jakhol barrage site.

Government of India
F.S 2009-10

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Study note no 8 on the Geotechnical Investigation of the Jakhol-Sankri Hydroelectric Project, District Uttarkashi, Uttarakhand

Akhouri Bishwapriya, Senior Geologist
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Study Note no 8 on the Geotechnical Investigation of the Jakhol- Sankri Hydroelectric Project, district Uttarkashi, Uttarakhand

Akhouri Bishwapriya, Senior Geologist
B. P Rawat, Junior Geologist

Introduction

At the instance of the project authorities, the DPR stage geotechnical investigation of the Jakhol - Sankri Hydroelectric project was carried out by the authors in the company of Shri G.S Pundir, Deputy Manager (Geology), SJVNL during 30 September – 13 October 2009.

The authors carried out detailed geological mapping of the area around proposed barrage site (1:1000), detailed geological mapping of the area around portal location of proposed construction adit no 2 (1:200), and detailed geological mapping of the area around proposed powerhouse site (1:1000). A surveyor with a total station devise was provided by the project to facilitate mapping. A total area of 5,34,586m^2 was covered by detailed geological mapping. The contour plan along the HRT layout was made available by the project. The investigations were later dovetailed by the inspection visit of Shri Kumud Sharma, Director, Engineering Geology who subsequently issued an inspection note in this regard. *(Annexure I)*.

It is worth mentioning here that the aforesaid mentioned sites have been identified and referred by SJVNL. The work carried out is discussed in the following paragraphs.

1. Jakhol Barrage Site

The detailed geological mapping of the proposed diversion was carried out. The site is located on river Supin downstream of the bridge connecting Jakhol and Fitari villages near a prominent cave location. The site is also about 300m beyond the MCT located well within the rocks of Central Crystallines represented by gneisses with interbedded schist bands (Photo 1).

The right bank has dominant rock cover even upto higher elevations (Photo 3) barring a small RBM/ overburden patch of about 12-15m separating the water level and rock exposure towards the hill, along the barrage axis. Just upstream of barrage axis, a rock debris zone has been observed which apparently looks like a slided mass. It however may have resulted from a detached rock zone along higher contour elevations, the debris of which has spread along the slopes (Plate I).

About 20-25m downstream of the barrage axis, there is prominent debris cone, the top of which lies at an approximate elevation of 2055m (Photo 2). The basal width of the

debris cone is ~160m and the bulge in concavity lies towards the lower side. There is a manifestation in form of a small debris slide near its upstream edge with the river, which is not alarming.

There is a lensoidal sand bar in the middle of the river across which the barrage axis is proposed. It's a raised depositional portion of the river, which the river water has not been able to capsize. This sand bar and the riverine material towards the left bank has resulted the water flow to remain confined towards the right bank. This could well be a temporary feature and during high floods the river water may cover the entire span of the river. Another sand bar of smaller dimension has been observed immediately d/s of this feature.

The left bank through which the intake is proposed may have to be accommodated through limited exposures of rock. Moving downstream from slightly u/s of barrage axis, there is a rock exposure of 28-30m followed by RBM/ overburden patch of ~50-60m, followed by a lensoidal rock exposure of 8-10m. This is followed by overburden cover of 35-40m and then by continued rock exposure. These observations were made close to the river, adjacent to a mule track. The higher reaches are heavily forested and mostly inaccessible. It is understood that the first exposure of 28-30m may have to be used for intake. The room for intake is thus limited however it is expected that the rock exposure is continuous moving into the hill. The depth and continuity may have to be investigated by detailed exploration.

The predominant rock type is gneiss with interbedded schist bands. The rock is hard, compact and thickly foliated. Quartz veins within the host rock at some places is extremely crenulated (Photo 4). The dip of the formation is in upstream direction (N20° to 49°E/ 35-48°). In general the rocks have been dissected by three prominent sets of joints.

No	Joints	Dip Direction / Amt	Spacing	Continuity	Nature
1	S1//J1	N020°-050°/35°-50°	10cm-150cm	Long 5-20m; BC +25m	MSP*; usually tight, at places opening in mm.
2	J2	N210°-240°/40°-65°	20cm-120cm	2-5m; BC+5m	MSP to MSU**, usually tight, at places opening in mm to 2cm, filled with rock fragments.
3	J3	N290°-310°/70°- 82°	10-50cm	2-4m	MSP to SP***, Generally tight

* Moderately Smooth Planar ** Moderately Smooth Undulating
** Smooth Planar

Geotechnical Discussions

The site faces limitations in view of the major debris cone on the right bank and availibility of limited outcrop (±30m) on the left abutment. The spillway discharge would be hitting the toe of the debris cone directly and would call for elaborate slope stabilization measures along with a heavily reinforced toe wall.

The diversion structure may have to be a structure, which needn't intercept the run off so as to avoid flooding and disturb the debris cone structure downstream of the

diversion structure axis. As such, a choice of diversion structure may have to be taken in the light of this aspect. As there is limited room for intake on the left bank abutment a choice of surface desilting chamber may need to be considered as per site conditions.

There is a prominent left bank cross drainage ~50-55m upstream of the barrage axis which is reported to carry enormous discharge along its course. The drainage may be appropriately tamed in the higher reaches to prevent any problem to the overburden covered left bank of Supin nadi. Boulder crate wall arrangement may be provided to arrest the movement of big sized particles downward along with water. However the discharge of the nala would only contribute to the discharge potential of Supin nadi.

The MCT is interpreted to be located ~250 -300m downstream of the site. This may have implications on the engineering structure being designed in the near vicinity of a major tectonic plane. Aseismic designing of the structure may have to be done in view of this.

In view of the extensive wild life coverage in the area, a very good diversion site located in the upstream had to be forfeited resulting in shifting of site to a geologically inferior site, which is now under consideration.

Due to thick vegetation cover on the left bank particularly in the higher reaches and inaccessibility, ground observations are practically impossible to make.

2. Portal Location of Construction Adit no 2

The site lies close to Sunkundi village and falls exactly along the motorable road section connecting Jakhol and Sankri villages. The site has been proposed by the project authorities.

As the exact location had not been specified, a wide area of exposure has been mapped on 1:200 scale (Plate 3 and 4). From the area mapped, the desired elevation of ~1947m may be worked out as per rock exposures and topographic constraints. Hard and compact gneisses with thin schistose bands are present at the portal site. The rock in general is hard and compact having WO-W2 grade of weathering. The dip of the foliation is N07°E –N30°E/23-28°. There is another steeper foliation joint dipping 45-52°. The other sets of joint include

No	Joints	Dip Direction/ Amount	Spacing	Continuity	Nature
1	J1	N030°-050°/35°-52°	20cm-100cm	Long; 4-10m	MSP* to Usaually Tight
2	J2	N210°-245°/60°- 80°	40cm-180cm	2-4 m	MSP to Tight; usually tight, at places opening in mm to 2cm, filled with rock fragments.
3	J3	N290°-310°/75-85°	20-50cm	2-5m	MSP to SP**, Tight

* Moderately Smooth Planar *** Smooth planar

The entire exposure mapped may be taken as a rock unit, the top of which is defined by the rock-overburden boundary as depicted in the geological map (Plate III). The major portion of the ex[illegible]beneath the motorable road continuing downwards and which is mostly inacc[illegible]

The adit portal location may be governed by two minor nalas towards the upstream and downstream end through which mild to moderate water flow has been observed. The water of the nala is guided by the plane of the foliation as observed in the nala towards downstream end.

Geotechnical Discussions

Citing of adit portal may have to be taken in view of the minor nalas in the area and may have to be kept sufficiently away from them or keeping them somewhere in between the two nalas. These may also be tamed and properly lined.

The face of the adit portal is expected to proceed either parallel or slightly eskew to the strike of the foliation thus exposing the dip of the foliation from the right wall of the adit being excavated. This aspect may thus be considered in view of the safety of the adit cavern and therefore the orientation may be planned perpendicular to the strike of the formation, to the extent possible.

There are two big sized isolated boulders in the area mapped, which are in a critical state of equilibrium and may have to be removed.

In view of the adjoining nalas and a general wet appearance of the exposed rock strata, possibility of encountering water in the adit may not be ruled out.

3. Powerhouse Site

An underground powerhouse has been proposed for the scheme. The powerhouse area lies near Sankri village, next to the Tons- Supin river confluence on the left bank of Supin nadi.

The area around powerhouse site comprises rocks of Purola Crystallines and Jaunsar Group. While the Purola Cystallines are represented by medium grained quartz biotite gneiss with interbedded schist, the Jaunsar Group of rocks are represented by a thick sequence of quartzite interspersed with thinner bands of chlorite mica schist and fine to medium grained greenish coloured rocks rich in mafics. The rocks of these two groups are reportedly seperated by Purola Thrust that appears to have an arcuate disposition at site.

The quartzite schist sequence, found very well exposed in a ~250m high section on the right bank of the Tons river and Supin Nadi, is remarkably uniform dipping. The powerhouse cavern is likely to be located within the ~150m thick quartzite- schist sequence comprising a ~15-25m thick schist band sandwiched between an underlying ~100m thick bed of thickly bedded quartzite and an overlying ~35m thick bed of thinly bedded quartzite. Prima-facie, the 100m thick underlying sequence of quartzite appears favourable for citing the powerhouse cavern.

The area around proposed surge shaft and the penstock location has also been mapped and geotechnically observed. Large tracts of the area is under cover of overburden barring a few isolated lenses of rock outcrop. Thus the ground location of Purola Thrust is also somewhat conjectural, as there isn't any sharp contact zone differentiating the Crystallines from the Jaunsars due to thick overburden.

The dip of the bedding within quartzites and foliation within fine to medium grained rock sequence is N335°/30-35°.Other prominent sets of joint in the area include

No	Joints	Dip Direction/ Amount	Spacing	Continuity	Nature
1	S1/So /J1	N325°-355°/25-40°	5cm-150cm	Long, 3-25m broken +30m.	MSP* to SP**, Tight Open at places, few mm, filled with rock fragments of gougy/clay material
2	J2	N120°-150°/45°-70°	10cm-120cm	10-20 m, long; BC +25m	MSP; Usually tight, at places opening in few mm to 1.5cm. Filled with rock fragments
3	J3	N210°-240°/70°-83°	20cm -80cm	20-80cm	MSP to SP, Tight

* Moderately Smooth Planar

**** Smooth planar

The underlying quartzite sequence has some minor bedding parallel shears, which have been observed, along the motorable road section. These include a shear zone (8-10cm thick; continuity 10-20m filled with clayey material), (5-7cm thick filled with rock fragments) and (5-60 cm; cont 15-20m filled with weathered schistose rock).

The quartzite in general form very steep inaccessible slopes due to which a closer examination is difficult.

Geotechnical Discussions

An interpreted geological section around the powerhouse area perpendicular to the strike of the formation was developed to see the disposition of bed and where the powerhouse cavern was falling as per the present layout. As per available powerhouse elevation at 1530m, the powerhouse cavern is falling into the ~100 thick underlying quartzite sequence.

It appears that due to bed thickness limitations, it may not be possible to accommodate the powerhouse cavern in the overlying quartzite, which may be more appropriate from the point of view of Main Access Tunnel. Locating the complex within the underlying thick quartzite bed may be geologically a better option but pushes the cavern deeper into the hill and may render the layout very complex. Further, the penstock is almost certain to cut across the chlorite mica schist zone with accompanying excavation problems.

It is important to note that the present layout intersects the Purola Thrust probably in the pressure shaft area and may pose obvious construction and stabilization problems depending upon its nature.

These features reveal that the Sankri Powerhouse complex is expected to be located in a heterogeneous lithological complex between wildlife protected area boundary on the western side and Purola Thrust on the eastern side being subject to problems associated with it.

An alternative to powerhouse location keeping it on the other side of Purola Thrust in a more homogeneous sequence of the rocks of Purola Crystallines has already been communicated. (Inspection Note of Shri Yogendra Deva, Ex Director, GSI; 9-11 October 2008)

A decision to siting of powerhouse cavern may be taken in light of these geotechnical conside

Conclusions and Recommendations

Barrage site:

1. It is understood that the present site under consideration is a fallout of a very good diversion site ~300m upstream due to wild life considerations. As such, wild life constraints play a very important role in citing of engineering structures.
2. Gneisses with interbedded schist bands representing Central Crystallines is exposed at the diversion site. While the right bank has good rock exposures, the left bank has limited rock exposures at river level.
3. The present site faces limitations in view of the major debris cone on the right bank. The spillway discharge would be hitting the toe of the debris cone directly and would call for elaborate slope stabilization measures along with a boulder / reinforced concrete wall.
4. The diversion structure may have to be a structure, which needn't intercept the run off so as to avoid flooding and disturb the debris cone structure downstream of the diversion structure axis. As such, a choice of diversion structure may have to be taken in the light of this aspect.
5. There is limited availibility of rock (±28m) for intake on the left abutment. However it is expected that the rock exposure is continuous moving into the hill. The depth and continuity may have to be investigated by detailed exploration.
6. The MCT is interpreted to be located ~250 -300m downstream of the site. This may have implications on the engineering structure being designed in the near vicinity of a major tectonic plane. Aseismic designing of the structure may have to be done in view of this.
7. There is a prominent left bank cross drainage ~50-55m upstream of the barrage axis which is reported to carry enormous discharge along its course. The drainage may be appropriately tamed around its confluence with Supin nadi to prevent any problem to the overburden covered left bank of Supin nadi.
8. Geophysical studies at the barrage site is necessary to corroborate surface geological observations.

Portal Location of Construction Adit No 2:

1. Hard and compact gneisses with thin schistose bands are present at the portal site. The rock in general is hard and compact having WO-W2 grade of weathering.
2. Citing of adit portal may have to be taken in view of the minor nalas in the area and may have to be kept sufficiently away from them or keeping them somewhere in between the two nalas. These may also be tamed and properly lined.
3. The face of the adit portal is expected to proceed either parallel or slightly eskew to the strike of the foliation thus exposing the dip of the foliation from the right wall of the adit being excavated. This aspect may thus be considered in view of the safety of the adit cavern and therefore the orientation may be planned perpendicular to the strike of the formation, to the extent possible.
4. In view of the adjoining nalas and a general wet appearance of the exposed rock strata, possibility of encountering water in the adit may not be ruled out.

5. As the portal lies exactly on the road head, this may lead to realigning of the existing road.

Powerhouse site:

1. The area around powerhouse site comprises rocks of Purola Crystallines and Jaunsar Group. The rocks of these two groups are reportedly seperated by Purola Thrust that appears to have an arcuate disposition at site.
2. It appears that due to bed thickness limitations, it may not be possible to accommodate the powerhouse cavern in the overlying quartzite, which may be more appropriate from the point of view of Main Access Tunnel. Locating the complex within the underlying thick quartzite bed may be geologically a better option but [illegible] hill and may render the layout very complex. Further, the penstock is almost certain to cut across the chlorite mica schist zone with accompanying excavation problems.
3. It is important to note that the present layout intersects the Purola Thrust probably in the pressure shaft area and may pose obvious construction and stabilization problems depending upon its nature.
4. The ground location of Purola Thrust is also somewhat conjectural, as there isn't any sharp contact zone differentiating the Crystallines from the Jaunsars due to thick overburden.
5. These features reveal that the Sankri Powerhouse complex is expected to be located in a heterogeneous lithological complex between wildlife protected area boundary on the western side and Purola Thrust on the eastern side being subject to problems associated with it. Orientation of the powerhouse cavern may be done perpendicular to the strike of the formation.
6. The quartzite in general form very steep inaccessible slopes due to which a closer examination is difficult.

Annexure- I

Geological Survey of India
Lucknow, October 2009

Record Note on Inspection of Geological Investigation of Jakhol Sankri and Naitwar Mori HE Project, District Uttarkashi, Uttarakhand, on 11-13 October 2009

Kumud Sharma
Director

The undersigned inspected ongoing geological investigation of Jakhol Sankri and Naitwar Mori HE projects (JSHEP and NMHEP) in Uttarkashi District, Uttarakhand, on 11-12 October 2009. The work was in progress by S/ Shri Akhouri Bishwapriya, Geologist (Sr) and B.P Rawat, Geologist (Jr), Geological Survey of India, since 2nd instant and most of the job assigned had been accomplished at the time of visit. Besides detailed discussions with GSI officers at site and at camp, the work comprised general geological reconnaissance along the layout of the two projects under consideration, inspection of the powerhouse site, construction adit no 3 (portal site) of the JSHEP and barrage site of the NMHEP. While the Jakhol Sankri project reconnaissance was undertaken in the company of Shri Bhatnagar, Shri G S Pundir and Shri Negi, the Naitwar Mori Project reconnaissance was undertaken in the company of S/ Shri G. S Pundir, Shri Tomar and Shri Negi. The project officials thus dovetailed the inspection visit with a team of officers from SJVNL. Shri N R Bhattacharjee, Geologist (Sr) GSI also accompanied the undersigned during the visit.

The findings of the inspection visit are outlined in following paragraphs for information and necessary action of the project authorities.

1. The Jakhol Sankri Project lies largely within the Lesser Himalaya, transgressing into the Greater Himalaya as the diversion site is proposed about 300m beyond the MCT, within Central Crystallines. The underground powerhouse is proposed within interbedded quartzite and schist of Jaunsar Group, seperated by Purola Cystallines along the Purola Thrust. The project has landed up facing two important tectonic features- the Main Central Thrust and the Purola Thrust- across its layout besides environmental and wildlife restrictions which have had tremendous impact in governing the layout of the scheme.

2. As discussed with officers at site, the proposed barrage site faces limitations in view of a major debris cone on the right bank and a limited rock outcrop for intake on the left bank. The spill discharge would be hitting the toe of the debris cone directly and would call for elaborate slope stabilization measures along with a heavily reinforced toe wall. Decisions on the type of diversion structure may thus be taken in the light of this aspect.

3. Traverse along the road section connecting Jakhol and Sankri exhibits occurrence of lenticular pattern of rock outcrop with wide intermittent overburden exposures. The left bank HRT slopes in general are dominated by overburden. The overburden

dominated terrain around Jakhol and the appropriate crossing of the Bar Gad over HRT which is a deeply incised nala are the geological aspects of concern for HRT and may need to be explored properly.

4. The HRT in general is likely to cut across an undifferentiated sequence of gneisses and schist representing the Purola Crystallines, which in general are hard and competent.

5. The Intermediate Adit Portal location proposed by the project for which detailed geological mapping had been carried out by the officers from GSI was inspected. The site lies close to Sunkundi village and falls exactly along the road section. As the exact location had not been specified, a wide area of exposure has been mapped on 1:200 scale, [illegible] topographic constraints. Hard and compact gneisses with thin schistose bands are present at the portal site. The dip of the foliation is N07°E –N30°E/23-28°. There is another steeper foliation joint dipping 45-52°. There are two other sets of steeply dipping joint in south westerly and north westerly direction (valley side). The adit portal location may be governed by two minor nalas towards the upstream and downstream end. The rock in general is hard and compact having WO-W2 grade of weathering.

6. The powerhouse complex would be located between wildlife protected area boundary on the western side and Purola Thrust on the eastern side. During the investigation, the geological setting has been aptly defined by the officers and the best possible rock mass may have to be utilized for locating the powerhouse cavern.

7. The powerhouse area comprises rocks of Purola Crystallines and Jaunsar Group. While the Purola Cystallines are represented by medium grained quartz biotite gneiss with interbedded schist, the Jaunsar Group of rocks are represented by a thick sequence of quartzite interspersed with thinner bands of chlorite mica schist and fine to medium grained greenish coloured rocks rich in mafics (granulite?). The rocks of these two groups are reportedly seperated by Purola Thrust that appears to have an arcuate disposition at site. The quartzite schist sequence, found very well exposed in a ~250m high section on the right bank of the Tons river and Supin Nadi, is remarkably uniform dipping with a general attitude of N335°/30-35°. The powerhouse cavern is likely to be located within the ~150m thick quartzite- schist sequence comprising a ~15-20m thick schist band sandwiched between an underlying 100m thick bed of thickly bedded quartzite and an overlying 35m thick bed of thinly bedded quartzite. Prima-facie, the 100m thick underlying sequence of quartzite appears favourable for citing the powerhouse cavern.

8. It is important to note that the present layout intersects the Purola Thrust probably in the pressure shaft area and may pose obvious construction and stabilization problems depending upon its nature. The ground location of Purola Thrust is also somewhat conjectural, as there isn't any sharp contact zone differentiating the Crystallines from the Jaunsars due to thick o[illegible]

9. The Naitwar Mori HE Project, which lies downstream of the Jakhol Sankri HE Project, across river Tons, immediately downstream of its confluence with Rupin Nadi was also inspected. The project on the right bank lies totally within the rocks of Purola Crystallines. The detailed investigation for the intake area, adit portal and right bank mapping had been carried out by Shri Akhouri Bishwapriya, during March 2009. These components were seen during the visit. Besides, the infamous Naitwar slide (subsidence zone) was also assessed.

10. The site for the proposed Naitwar Barrage falls downstream of the notorious Naitwar Slide zone though comfortably away of the affected region. The site area is located 730m downstream of the Tons- Rupin confluence and is occupied by schistose rock with frequent interbanding of porphyroblastic and banded gneiss. The left bank has [illegible] of valley dipping insitu rocks whereas the right abutment has favourable into the hill dip. The foliations have a general dip varying from N310-319°/ 28-37°.

11. The present site is about 400m downstream of the Naitwar slide zone, which is active. The phenomenally huge slide encompasses the Naitwar bazaar area. The present slide is located on the left bank of river Tons, exactly opposite to the location where Rupin nadi makes a confluence with river Tons. The width of the disturbed zone may be around ~325m extending upto an elevation of ~1459m. There are two fresh overburden slides within the realm of the affected zone. It may be interpreted that the upper old slide zone is marked by the presence of slided mass over which rests the whole of Naitwar bazaar area and the adjacent habitat. Evidence of sliding can be had from the birching and tilting of trees within the affected zone. Prominent gaping cracks, wide and deep within the settlements with deep subsidence can be observed in the area.

12. The proposed diversion site location may not be the best available site due to absense of surface rock exposures and may have to be founded completely on permeable foundation. A relatively better site lies about 100m downstream but may not hold good due to wild life restrictions as informed by the project. The structure may have to be erected by provision of construction joints, the long term efficacy of which must be assessed. The surface desilting chamber may have to be designed for terrace material for which enough room may be available for accomodating the structure. The intake location has been proposed by the project to be shifted ~125m downstream of its earlier location due to which the room for intake has been drastically cut down due to pinching of the rock exposure. A widening nala and predominance of overburden in the area next to intake may call for exploration to ascertain the depth to bedrock. A drill hole (10m into tunnel grade) in the region seems imperative to ascertain subsurface conditions.

13. The percentage of deleterious suspended quartz material may also be ascertained which may adversely affect the engineering components. Being designed in a seismically active region, the structure may be provisioned with suitable design parametres.

14. The intake portal site which had been mapped earlier was also assessed. Augen Gniesses with interbedded schist bands is available at the portal site. Two adjoining nalas

and a slight seepage zone around this location may have to kept in mind to safeguard against any possible avenues of seepage. Favourable into the hill dip of foliation may be suitable for the location.

15. In general, the HRT slopes appear favourable, the upper reaches of which are somewhat inaccessible.

Concerns

-Wild Life Sanctuary Area in both these projects is a major constraint in deciding the project layout. The wildlife authorities are not permitting even underground structures in the designated wild life protected areas. Some of the geologically good sites have been lost due to wildlife constraints

-The geological investigations are facing serious constraints due to uncalled for discrepancies in levels and physiographic features in the contour plans of sites. This has led to loss of time and unnecessary strain to the GSI party. In the absense of dependable contour plans of the sites, it may not be possible to make complete use of the geological data that has been collected. It's a different matter that DPR preparation itself would hang on dependable contour plans of the site.

- The trip in general had been planned well in advance and nothing augers better for the health of a project than collective discussions at site which helps arriving at many a critical decisions instantly. As a fresher to the projects, the undersigned would have appreciated a more fruitful interface with the geological counterparts to suggest constructive recommendations for future. Site inspection visits whenever applicable may be planned with proper representations from all organizations.

Discussions were also held with Shri Praveen Gupta, AGM (SJVNL) and in Charge of the Tons Valley Projects on 12 October 2009 at Mori revealed the following.

1. Wild Life sanctuary in the project area is a major constraint in deciding the project layout. This has led to several changes in arriving at optimal layout. Apparently, the layout has been governed more by wild life reasons than by geological reasons.
2. That geological recommendations from GSI may be adhered to arrive at best possible results. Any speculations in arriving at subsurface conditions may only lead to uncertainties thus affecting the health of the project at any stage.
3. That SJVNL would assist GSI monetarily in preparation and digitization of large maps and in processing of reports. This would facilitate better and improved final products in tune with modern times.
4. GSI may be a made a party to all communications, changes and decisions brought about in the project.

(Kumud Sharma)
Director