National Highways of Infrastructure Development Corporation Ltd

Specialised Consultancy Services for **'Good for Tender'** design based on detailed investigations, costing and preparation of Technical Schedules of EPC documents of (i) Construction of Additional Bridge adjacent to the existing bridge at Km 52.100 on NH-10 at Rangpo at the border of West Bengal and Sikkim State(ii) Construction of Chisopani Traffic Tunnel at Km 67.24 on NH-10 in East Dist., Sikkim"

NIT No. NHIDCL/DPR/Sikkim/Rangpo Bridge-Chisopani Tunnel/2015, Dated: 10.03.2016

Main Report

CM ENGINEERING & SOLUTION

Engineering, Planning And Project Management

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CHAPTER - 1

INTRODUCTION

1.1 INTRODUCTION

Sikkim is the youngest and small hill state of India having an area of 7096 Sq.km and lies between 27° to 28° north latitude and 88° to 80° east longitudes. The altitude above mean sea level varies from 213 m in the south to over 8500 m in the North West. It is surrounded by important mountain ranges. The chola range of mountains on its east forms the watershed between it and Bhutan on one side and Chumbi valley of Tibet on the other. It is bordered on the west by Nepal, on the north by Tibet, on the east by Bhutan and the south by Darjeeling district of West Bengal. Sikkim is drained by number of perennial rivers. Three main river systems are Teesta, Rangpo and Rangit. Rangpo River joins Teesta River just near the border between Sikkim and West Bengal at Rangpo. Climate of the study area is of Tropical Monsoon type, with moderate to hot summer, long rainy season and a short spell of cold weather. The maximum and minimum temperatures are 37.4°c and 7.8°c respectively. Maximum and minimum humidity at 8.30 hrs and 17.30 hrs are 89.74% and 58.19% respectively. The total annual rainfall is around 3200 mm.

NH 10, originating from junction of NH -27 & Hill cart Road at Siliguri and terminate at Burtuk , Gangtok , Sikkim . This is an important NH and life line for the Defense/ Civilians of the Sikkim & Darjeeling District in West Bangal for their social and economic development. This route is also one of important international trade route via Nathula pass in between two Giants of Asia.

1.2 BACKGROUND

NHIDCL has been assigned the work by the Ministry of Road Transport & Highways, Govt. of India for Construction of Additional Bridge adjacent to the existing bridge at Km 52.100 on NH-10 at Rangpo at the border of West Bengal and Sikkim States and Construction of Chisopani Traffic Tunnel at Km 67.24 on NH-10 in East Distt., Sikkim.

NHIDCL has awarded the contract vide LOA letter No. NHIDCL/DPR/Sikkim/Rangpo Bridge –Chisopani Tunnel/2015 dated 23rd May 2016 to CM Engineering and Solution, Gurgaon for detailed investigations, costing and preparation of Technical Schedules of EPC documents.

1.3 OBJECTIVE OF THE PROJECT

There is an existing week steel bridge at Km 52.10 of Sevoke Gangtok Section of NH-10 was constructed more than 30 years ago. The existing bridge is 40R loading having width 6.5 m and entry point of Sikkim Commercial Check post resulting in frequent traffic jams & vehicle congestion. Therefore it is proposed to construct new bridge parallel to existing bridge.

There is an existing tunnel at Km 67.24 of Sevoke Gangtok Section of NH-10 having length 62.0 m & carriage way width of 4.25 m .The existing tunnel entry point is blind curve and exit point is very narrow road with very steep hill on both sides resulting in frequent traffic jams. At present only one way traffic (unidirectional) can pass through this tunnel. The widening of existing tunnel is not possible. The Defense vehicle movement towards China Border is also catered by this stretch of NH-10.Thus it is proposed to construct new tunnel parallel to this tunnel or construct an open cut Highway

1.4 SCOPE OF WORK

The Scope of Work is specified in Para 2 of the Terms of Reference. The phases of implementation are highlighted as under:

- **Stage-I (Preliminary Stage)-Providing three options each for location**
- **Stage-II (Investigation report and GAD)**
- **Stage-III (Technical Schedules design and drawings)**
- **Stage-IV (Review of Environmental Study Report & Land Acquisition Plans)**

CHAPTER – 2: RECONNAINCE SURVEY

2.1 REVIEW OF DATA & DOCUMENTS

The Team identified the data, documents and information requiring study and review. In addition, the data is procured and collected about likely constraints in execution of the project like existence of structures along the road, which would require interaction with the local authorities for their relocation and removal. The data as collected has been studied and reviewed.

The teams made in depth study of data/information, as available, about the project sites. The inter alias includes:

- Topographical sheets, geological and meteorological maps etc.
- Detailed of on – going works.
- Details of works already proposed on the project road.
- Study reports/ investigation reports of specialized agencies for trouble spots/ other problems on the project site.

2.2 FURTHER STUDIES & INVESTIGATIONS

Based on this study/review, the team has identified the data and investigation gaps, so that, further data collection and investigations, as required, are carried out during the detailed surveys and investigations proposed for the project.

2.3 GROUND RECONNAISSANCE:

In addition to the discussion and study of maps, report and available data, the consultant conducted the ground reconnaissance and general survey of the proposed bridges and tunnel sites. It included:

(a) Data Collection
(b) Compilation of salient feature
(c) Evaluation of bridge and tunnel condition
(d) Major problems on the proposed bridge site & tunnel site / approach, if any

2.4 LOCATION SURVEY

General

Based on the reconnaissance survey of the bridge & tunnel by the consultant staff, the location study is summarized in the matrix as attached.
The data collected helps the consultants to appreciate the requirement of the project, the challenges to be faces on the ground and the thrust area to be covered in the study, engineering and design of the project bridge.
We carried out the following studies as part of the Preliminary Stage (Siting of the proposed bridge and tunnel alignment / orientation)

- Location
- General physical feature
- Geophysical features
- Hydrological features
- Environmental
- Derivation

THE DATA OF LOCATION STUDY ARE AS UNDER:

Location study of Bridge At River Rangpo at 52.10 Km of NH - 10		
Sn	**Study Item**	**Location Study**
1	Proposed Bridge	Permanent Bridge (Double Lane)
2	Location	On River Rangpo at Sikkim – West Bengal border.
3	Topography of the area	Hilly
4	Existing facility	Steel Truss Bridge
5	Bridging requirement	Permanent bridge
6	Geometric approach	Curve at starting & Straight at end
7	Traffic	Very High
8	Terrain and soil condition	Hilly
9	Geology	Rock/ banks with soil mixed with rocks
10	Cliff & Gorges	Deep Gorge
11	Drainage characteristic	Perennial stream
12	Veg. Extent	Low
13	Temperature	30°C Daytime
14	Rainfall	3200 mm per year
15	Snowfall	Nil
16	Wind direction / Velocity	Moderate
17	Visibility	Clear
18	Exposure to sun	Sunny
19	History of Cloud burst	No cloud burst
20	Ecology	Natural and undisturbed
21	Slope stability of approaches	Stable
22	Scour condition of stream	Normal scour condition
23	Stream Reach (Straight or meandering)	Meandering on downstream site & Straight on upstream site

THE DATA OF LOCATION STUDY ARE AS UNDER:

Location study of Chisopani Tunnel at 67.24 Km of NH - 10		
Sn	**Study Item**	**Location Study**
1	Proposed Tunnel	Tunnel (Double Lane)
2	Location	Chisopani , Singtam
3	Topography of the area	Hilly
4	Existing facility	Existing lane Single
5	Tunnel requirement	Permanent Tunnel
6	Geometric approach	Curve at starting & Straight at end
7	Traffic	Very High
8	Terrain and soil condition	Hilly
9	Geology	Rock types of the area are mostly Phyllite - Quartzite intercalations and they have been traversed by Quartzite veins.
10	Cliff & Gorges	Deep Gorge
11	Drainage characteristic	Perennial stream
12	Veg. Extent	Very high
13	Temperature	30°C Daytime
14	Rainfall	3200 mm per year
15	Snowfall	Nil
16	Wind direction / Velocity	Moderate
17	Visibility	Clear
18	Exposure to sun	Sunny
19	History of Cloud burst	No cloud burst
20	Ecology	Natural and undisturbed
21	Slope stability of approaches	Stable

2.4.1 PROBLEMS AND CHALLENGES AREAS

Based on the ground study, reconnaissance survey and the data collected from PWD Sikkim & BRO, the consultants have gained appreciation of the technical and project management problems and have insight of the challenge areas of the project. In addition, each project road sector has its own local challenges. The general appreciation of the thrust areas is described in the following paragraphs.

Approach to the bridge site: Presently all types of vehicle cross the location of the bridge through an existing Steel Truss Bridge. However, the bridge is weak and for limited traffic.

Approach to the tunnel site: Presently all types of vehicle passing through the existing single lane tunnel.

Plantation: There is little growth of vegetations on both sides of the bridge and very high vegetation growth on both sides of tunnel

Sand and stones for Bridge & Tunnel construction: Good quality sand is available in the Teesta River. Good quality stones have been identified in the vicinity of the proposed bridge & Tunnel site. Alternatively, the good quality stone can be transported from identified quarries. While extracting stones from concrete works, the quality materials should be selectively chosen.

Water: Generally, water available in the area has been found suitable for use in the bridge & tunnel construction work.

Work force: Most of the local people are engaged in agriculture. Bridge & Tunnel construction requires tradesmen of sort, skilled labourers and unskilled labourers. Manpower may need to be brought from other part of the country. It requires planning and organization for recruitment, training, induction and maintenance including provision of campage, food supplies, medical welfare activities, etc. Independent facilities are necessitated to cater for the increased workforce**.**

Contractor: Though small supply of Contractor are available in Sikkim, the bulk of the requirement is initially to be augmented from outside. The stone crushers have to be installed for meeting the project requirement for major bridge.

Approach road for bridge

Based on the reconnaissance survey, review of the available data and the desk study, we have arrived at the conclusion to approach the problem of siting of the bridge by a comprehensive study and the survey of the project influence area and thereafter to decide the siting of the bridge.

Approach road for tunnel

Based on the reconnaissance survey, review of the available data and the desk study, we have arrived at the conclusion that widening of existing tunnel is not possible. Therefore we need to realign the existing stretch of the road either by complete new alignment or by new two lane tunnel.

CHAPTER – 3: SURVEY AND INVESTIGATION FOR BRIDGE

3.1 TOPOGRAPHICAL SURVEY OF BRIDGE SITE

Objective

The Topographical Survey is carried out to map the topographical features of the approach road and bridge location on the abutting land and abutting areas. It is aimed at preparation of the Base map of the area, to facilitate review of alignment layout and preparation of plan for the bridge.

The objectives of the survey are :

- Enable a definitive design to be made for the bridge
- Enable a definitive influence to be made for the profile of the approach road.
- Define clearly and contractually the extent of the bridge work to be done.
- Enable quantity estimate to be prepared.
- Provide record of work that will serve maintenance planning needs.
- Surveyed corridor is suitably extended for overall view of the area.

Resource Input

The detailed survey is carried out using Total Station. Other Survey equipment may also be used. The work of verification is carried out by deploying survey Expert and survey Assistant along with the bridge Engineer.

Control Points

For mapping we have the control points as follows:

P-1 Sikkim side on Concrete pillar (X=651548.295 Y = 3006493.232 Z = 308.560)

P-2 Sikkim side on Concrete pillar (X=651536.037 Y=3006505.732 Z=308.380)

P-3 West Bengal side on Concrete pillar (X =651545.192 Y =3006405.515 Z =318.666)

P-4 Opposite side on Concrete pillar (X=651537.792 Y=3006399.897 Z= 319.383)

Cross Section of the River Regime

Seven number cross sections have been taken to capture complete profile of the river. These are shown in the sketch attached and are as under.

Sl. No	Nomenclature of the Section	Location	Remark
1	CS – 1	Down stream	CMES/NHIDCL/RANGPO BR/CS/01
2	CS – 2	Down stream	
3	CS-P	At proposed bridge	
4	CS – 3	Up stream	
5	CS – 4	Up stream	
6	CS – 5	Up stream	
7	CS – 6	Up stream	

Water level

Base on the local survey, the water level has been established as under:

HFL	309.35

Survey data

The approach road to the bridge site has also been surveyed in order to have overall appreciation of the bridge project. The survey data is also attached for reference.

- Chainage
- Approach to Rangpo on West Bengal side
- Approach to Rangpo on West Bengal side
- Cross sections
- Record of GPS control point
- Record of water level

3.2 PRELIMINARY HYDROLOGICAL SURVEY AND ASSESSMENT

General

This includes the general enquiry, visual inspection, analysis of available data, and historical background in order to make assessment of hydrological behavior and design parameters. It is to lead to the conclusion with respect to:

- Terrain
- Rainfall and runoff
- Cloud burst or such factor
- Gorge/ Cliff
- Discharge
- Velocity of flow
- Scour condition
- Bed slope
- Stream configuration
- Stability of banks
- Factor with negative impact

The hydrological and hydraulic study has been carried out in accordance with IRC Special Publication No 13 (Guidelines for the design of small bridges and culverts). IRC: 5 – 1998 (Standard Specification & Code of Practice for Road bridges, Section 1: General Feature of design), etc.

We have carried out our visual examination and evaluate the data made available by the client as well as data collected by local enquiry that the design parameter arrived at are appropriate. The investigation is also carried out for other drainage structures(s) along the section under study.

We undertook a desk study of available data on topography, storm duration, rainfall statistics, top soil characteristic, vegetation cover etc., so as to assess the catchments area and hydraulic parameters for all existing and proposed drainage provision. The finding of the desk study is further supplemented and augmented by a reconnaissance along the area. All important features are noted during field reconnaissance.

It is carried out on the basis of the following items:

- Location study
- Stream condition
- Peak flood condition
- Deck level / adequacy
- Adequacy of span
- Road, Geometric of the approaches
- Adequacy of design for smooth and comfort to the traffic
- Bridge / Road width matching to the traffic requirement and futuristic assessment
- Protection work.

Base on the above, the parameters have been identified for carrying out the hydraulic study for aiming at the design parameter of the bridge.

Location of the Bridge:

- The proposed bridge is on the NH -10 at Rangpo River
- Take off point on West Bengal Rangpo
- Approach road upto bridge point is being upgraded
- The area is in seismic zone of India (Zone – IV)
- Rainy season in mostly May – September
- Flood is normally during July

River Condition

- The bridge is about Km 52.10 on NH-10
- The road alignment is already marked and defined on the ground
- Siting of the bridge is already defined on the ground. We have considered proposals while carrying out the option study
- Presently the river is negotiable by existing steel truss bridge
- Upstream side river meandering is more toward Sikkim side bank.
- The stream in the peak flood condition more attracted toward Sikkim side , therefore spurs wall and toe walls are constructed on river bank to avoid the bank erosion
- The river in the low water level condition flows more towards Sikkim side
- Sikkim side river bank very shallow and a part of the river bed are having vegetation on slope.
- West Bengal side river bank is steep and less vegetation on the bank slope.
- There is an out crop of rock on west Bengal side and jetting toward towards low water level. It is indicative of rock formation underneath. Whereas on Sikkim side river bed material deposited.

Peak flood condition

- In the peak flood conditions, the depth of the water is to the tune of 2 to 3m
- We have done the contouring of the entire area up – stream and downstream and also have marked the higher flood level. It indicated a defined flood line of the river during peak flow condition.
- Location enquires indicates that the velocity of the flow in peak flood condition is high. There is no historical data to confirm the exact velocity of the river peak flow condition.

Adequacy of deck level

- The level of the approach on either side decides the deck level of the proposed bridge
- There is no flooding of the approaches by the river
- The river remains at a distance from the toe line of the approaches.
- There is sufficient clearance between the deck level and the high flood level

Adequacy of Span

- The length of the existing bridge is 62meters
- The span of the bridge has been provided for the complete regime width during the peak flood condition.
- There is no provision of contraction in the design of bridge span
- The existing abutments are also placed on the banks, which do not obstruct the regime width of the river.
- The level of the span is calculated base in the regime width and of the deck level.

- It is considered that the bridge of around 70 - 80 meters length would be meeting the requirement

Foundation Condition

- Based on the preliminary study and the initial inspection, it is found that the deep gorge at the proposed site may have the rock formation.
- The upper layer of the sand/ soil deposit appears to be due to siltation
- The foundation and the pier will be based on the detailed geo – tech investigations and test result obtained therein. At this point of time, we contemplate to have founding on rock formation.

Road Geometric of the Approaches

- The approaches have been constructed
- There is no indication of any toe scour of the approaches.
- West Bengal side approach is curve & Sikkim side approach is straight.
- Our proposal indicates the modification to the existing approaches. However, it being of minimal nature, it is not included in bridge proposal and would be taken care in the up gradation road programme in hand.

Comfort level

- The proposed bridge is expected to meet the design level of comfort to the traffic.
- Since the traffic is in smooth flow situation, there will be no un-comfort in the commuters.

Bridge width

- It is proposed to construct a double lane bridge. The 2 – lane will match with the assessed traffic requirement

3.3 PRELIMINARY GEO – TECH ASSESSMENT SURVEY

General

It include general enquiry, foundation inspection, analysis of available data and historical background in order to make assessment and geo – technical behavior of the design parameters. The activities involved under the task are as under:

- Location study
- Conduct analysis of design operation
- Select Option
- Working out soil investigation requirement
- Define parameter, level of investigation and deliveries
- Assess requirement of bore holes
- Organize drilling of the bore holes
- Prepare characteristic and test on samples

Location Study

- The official inspection indicates that ample possibility of rock formation at this location. There is out crop of rock on West Bengal side & river bed material deposited on Sikkim side
- The out crop of rock shows possibility of good foundation on rock of the bridge
- The situation of the soil on the surface in the river bed appears to be false and consequence of siltation.

Design Foundation

- The design option available would be pier and abutment on rock and to cater for scour depth upto hard rock / strata.
- Alternative is to take foundation deep to cover for its scour in case the subsoil survey indicates soil/ soil mixed with bolder condition

Requirement of sub – soil investigation

- It is proposed to carry out the soil investigation up to the rock level and depth to meet codal requirement.
- Sub – soil is proposed to be carried out by a own firm
- The drilling of the bore hole would be carried out to meet the Codal requirement
- The soil characteristic will be based on test of samples
- Detailed Geo – physical investigation will ultimately decide the foundation design

3.4 PRELIMINARY MATERIAL ASSESSMENT SURVEY

General

- Soil and materials survey is carried out for resource input for the construction activity
- Good quality sand is available.
- Approved stone is available.
- Alternatively, good quality stone can be transported from other areas
- Water is available in the area

3.5 INITIAL ENVIRONMENTAL EXAMINATION

General

Initial environment screening has been carried out in accordance with government of India Guidelines, as applicable.

- The Consultant carried out the preliminary environmental screening to assess the direct and induced impacts due to the project
- The Consultant ensured to document baseline conditions relevant to the project with the objectives to established the benchmarks
- The Consultants assessed the potential significant impacts and identify the mitigate measures to address these impact adequately
- The Consultants carried out the analysis incorporating environmental concerns. This would include with and without scenario and modification incorporated in the proposed project due to environment considerations

Special Features of the Project

- Name of the Project : Construction of Double lane Bridge over River Rangpo
- Length of the bridge : Approximately 70 to 80 m.
- Location : On NH-10 at Km 52.10
- Nature of terrain : Hilly
- Nature of Soil : Hard rock and on surface soil or soil mix with soil and rock

The Project

The project is for the construction of the bridge. The project is for bridging the gap in the road on the existing route alignment

Present Facility

Presently there is existing steel truss bridge at this location

Environmental grading

Factors affecting environmental resources and values and their IEE grading level is given in the Table given below

Beneficial Impact of the Bridge Project

The project will have several beneficial impacts as given in the table attached

Negative impact

We do not contemplate any negative impact of this project on the environmental aspect

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

Actions affecting environmental resources and values		Recommended feasible mitigate measures	IEE grading (suggestive)
(A)	**Environmental Impacts Due to Project Location**		
(i)	Disruption to Hydrology	There will be no disruption to flow of stream as the bridge is planned for full require width	D1
(ii)	Resettlement	No resettlement involved	-
(iii)	Environmental aesthetics degradation	Care shall be taken to avoid/ minimize effect	D1
(iv)	Inequitable locations for rural roads	Cross roads suitable clubbed for access to the road. For the purpose, suitable connectors are planned and under implementation NHIDCL	D1
(v)	Loss of terrestrial ecology including forest and wildlife	Not involved	-
(vi)	Loss of swamp ecology	Not involved	-
(B)	**Impacts during construction phase**		
(i)	Site runoff from cut and fill area	Suitable measures to be adopted during construction	D1
(ii)	Safety of works from accidents	All safety measures to be incorporated in tender document	D1
(iii)	Slum creation hazards	Appropriate planning for housing of construction workers to be made	D1
(iv)	Cultural difference hazards	It is to be avoided and public learning be made and considered	-
(v)	Escape of hazardous materials	Strict monitoring the movement of hazardous materials	D1
(vi)	Escape of air pollution (including dusts)	Suitable measures to be adopted to prevent/ minimize	D1
(vii)	Noise and vibrations	Effects shall be assessed and measures taken based on significance	D1
(viii)	Quarrying hazards(including use of explosives)	Appropriate planning operation of blasting and use of operating quarries	D1
(ix)	Disruption of utilities along route	Not involved	
(x)	Disruption of traffic along route	Alternative	
(C)	**Impacts from Project Operations**		
(i)	Noise disturbance	Not involved	D1
(ii)	Vibration disturbance	Appropriate planning and post construction monitoring may be made	D1
(iii)	Air Pollution	Appropriate planning and post construction monitoring will be made	D1
(iv)	Continuing erosion	Protective vegetation and other methods shall be adopted	D1
(v)	Highway runoff contamination	Appropriate planning and post construction monitoring to take care	D1
(vi)	Highway spills of hazardous materials	Appropriate spills control program and post construction monitoring to take care	D1
(vii)	Escape of sanitary wastes	Appropriate planning/ post construction monitoring to be considered	D1
(viii)	Congestion at access/ exit points	Not involved	-
(ix)	Inadequate highway maintenance	Not involved	-

Note IEE grading Scale:

D1 - Not significant
D2 - Small significant effects
D3 - Moderate significant effect
D4 - Major significant effect

Beneficial Impacts of Bridge Project

- Employment opportunity to people
- Enhancement of local industry, agriculture and handicrafts
- Income from visitors and taxes
- Enhancement of rural development through quick and easy transportation of building materials
- Transporting, processing and marketing of agricultural products
- Opening up of opportunities for new occupations
- Approach to quick services and safety
- Improved quality of life for people and so on

CHAPTER – 4: OPTION STUDY FOR SELECTION OF LOCATION OF THE BRIDGE

General

In order to carry out the option study for the siting of the bridge, we have carried out survey of the possible locations and the influence area.

All the surveys and investigations have already been described in Chapter-2 and 3.

The route alignment of NH-10 is already fixed and is in place. The road is being upgraded and it is in the final stages of development. Apart from this, the route forms approach from either side of the proposed bridge. The siting of the bridge is more or less fixed and decided. However, revalidation of the sitting has been conducted with an understanding to find alternative site which may be more economical, stable, comfortable and cost effective.

Options

Seven number cross sections have been taken to capture the profile of the river at various locations. There are two possible locations for sitting the bridge within the constraints of the road alignment. The brief analyses of these options are given as under:

Option No.	Nomenclature of Section	Location (U/S OR D/S)	Remark
1.	CS – 2	Downstream side	This option is unfeasible for the reason (a) the river is wide, (b) the river banks are built up , (d) Lose boulders indicates unwanted siltation/ deposits
2.	CS-P	Near existing Bridge site	This is the most feasible location of the proposed site. The merits are: (a) it falls on the route alignment of the road, (b) banks are well defined, (c) river reach is straight, (d) rock formation on banks offers good foundation conditions (e) no extra expense on road approaches.
3.	CS – 3	Upstream side	This location is at the upstream side (a) new approach road is required, (b) is at the curvature of the stream, (c) there is a siltation at the Sikkim side, (d) the Sikkim side is erodible, (e) the approach at West Bengal side is at the steep hill & rock fall

In view of the above, the siting of the bridge at a location at CP has been considered as the select option. Details are:

- The bridge is proposed to be kept at 15.40 m center to center of the existing bridge.
- West Bengal side abutment is kept backward 11.0 m to have good foundation condition on rock
- Sikkim side abutment will be at line with the existing abutment

The option recommended by the Consultant based on the technical, economic, ease in construction, suitability and constructability.

CHAPTER – 5: OPTION STUDY OF SPAN ARRANGEMENT

Based on the site conditions of the bridge site, various span arrangement options have been proposed and are summarized as under:

S/N	Item	Option-1	Option-2	Option-3
1	Span Arrangement	1x20+1x48+1x20	1x72	1x80
2	Structural System	RCC T-Beam & PSC I girder	PSC Single cell box girder with strut	Tied arch Bridge.
3	Depth of Structure	2.0m for 20 m span & 3.431m for 48 m span	4.0 m	Height of Tied arch 13.5 m
4	Material	20 m span RCC & 48 m span PSC	PSC	Steel arch & RCC Deck slab
5	Width of bridge	14.9m	14.9 m	15.5 m
6	Carriage width	10.5 m	10.5 m	10.5 m
7	Substructure	Abutment at both ends & Pier at edge of river bank	Abutment at ends	Abutment at ends
8	Foundation	Pile	Pile	Pile
9	Waterway	Affecting	Not affecting	Not affecting
10	Formwork	Simple	Comparatively difficulty & costly from option-1	Very simple
11	Span launching	Simple and easier	Comparatively difficulty from option-1	Comparatively difficulty from option-1 &2
12	Constructability	Simple and conventional	Comparatively more skilled from option-1	Needs very high technical skilled required.
13	Construction period	More	Less compare to option-1	Less compare to Option -1 & 2 but depend up the availability of hanger. As hanger need to be import from France / China
14	Aesthetic	Simple	Good	Very good
15	Durability & Maintenance	Very less	Very less	High
16	Approx. cost	15 cr	13Cr.	20 Cr.

Select option:

Option no: 2 – Single cell Box Girder is recommended select option

CHAPTER – 6: SURVEY AND INVESTIGATION FOR CHISOPANI TUNNEL

6.1 TOPOGRAPHICAL SURVEY

Objective

The Topographical Survey is carried out to map the topographical features of the approach road, existing tunnel location & proposed alignment. It is aimed at preparation of the Base map of the area, to facilitate review of alignment layout and preparation of plan for the proposed alignment.

The objectives of the survey are:

- The alignment should meet the geometric standards, particularly the gradients and curvature.
- It should be as directional as possible i.e. least distance.
- It should facilitate smooth traffic dispersal.
- It should avoid acquisition of commercial and residential establishments.
- It should avoid costly land acquisition.
- It should be environment friendly.
- Enable a definitive influence to be made for the profile of the approach road.
- Enable quantity estimate to be prepared.
- Provide record of work that will serve maintenance planning needs.
- Surveyed corridor is suitably extended for overall view of the area.

Resource Input

The detailed survey is carried out using Total Station. Other Survey equipment may also be used. The work of verification is carried out by deploying survey Expert and survey Assistant along with the Tunnel Engineer, Geologist & Bridge Engineer.

Control Points

For mapping we have the control points as follows:

PILLAR-G1	**(X=650578.994**	**Y=3014042.997**	**Z= 470.996)**
PILLAR-G2	**(X=650594.161**	**Y=3014048.522**	**Z= 471.480)**
PILLAR-G3	**(X=650889.110**	**Y=3014429.117**	**Z= 472.770)**
PILLAR-G4	**(X=650896.408**	**Y=3014445.098**	**Z= 473.225)**
P=K1	**(X=650505.302**	**Y=3014337.846**	**Z= 656.701)**
P=K2	**(X=650507.591**	**Y=3014318.487**	**Z= 655.433)**

6.2 PRELIMINARY GEO – TECH ASSESSMENT SURVEY

General

It include general enquiry, foundation inspection, analysis of available data and historical background in order to make assessment and geo – technical behavior of the design parameters. The activities involved under the task are as under:

- Location study
- Conduct analysis of design operation
- Select Option
- Working out soil investigation requirement
- Define parameter, level of investigation and deliveries
- Assess requirement of bore holes
- Organize drilling of the bore holes
- Prepare characteristic and test on samples

Location Study

- The official inspection indicates that ample possibility of rock formation at this location. There is out crop of rock on West Bengal side & river bed material deposited on Sikkim side
- The out crop of rock shows possibility of good foundation on rock of the bridge
- The situation of the soil on the surface in the river bed appears to be false and consequence of siltation.

Design Foundation

- The design option available would be pier and abutment on rock and to cater for scour depth upto hard rock / strata.
- Alternative is to take foundation deep to cover for its scour in case the subsoil survey indicates soil/ soil mixed with bolder condition

Requirement of sub – soil investigation

- It is proposed to carry out the soil investigation up to the rock level and depth to meet codal requirement.
- Sub – soil is proposed to be carried out by a own firm
- The drilling of the bore hole would be carried out to meet the Codal requirement
- The soil characteristic will be based on test of samples
- Detailed Geo – physical investigation will ultimately decide the foundation design

On the basis of preliminary field investigation following field observation have been made

Rock types of the area are mostly Phyllite - Quartzite intercalations and they have been traversed by Quartzite veins at places of thickness varying from a mm to 6-7 cm. Due to shearing at places these Quartz veins have taken lampzoidal shape . At inlet portion Quartzite content is more, at places it is 70% or more whereas near outlet portion Quartzite contents more and going upto 70-75.

The general trend of rock type is N30W-S30E to N50W-S50E however it has been observed to swing either way due to structural deformation .Mostly they are dipping 30-60 degree in N-E direction N-S, E-W shears also have noted. Four sets of prominent joints have been observed of

which bedding Joint is most prominent. At places they are filled with siliceous material. Other joints are N-S, W45E, S45W, E-W with varying dips.

6.3 PRELIMINARY MATERIAL ASSESSMENT SURVEY

General

- Soil and materials survey is carried out for resource input for the construction activity
- Good quality sand is available.
- Approved stone is available.
- Alternatively, good quality stone can be transported from other areas
- Water is available in the area

6.4 INITIAL ENVIRONMENTAL EXAMINATION

General

Initial environment screening has been carried out in accordance with government of India Guidelines, as applicable.

- The Consultant carried out the preliminary environmental screening to assess the direct and induced impacts due to the project
- The Consultant ensured to document baseline conditions relevant to the project with the objectives to established the benchmarks
- The Consultants assessed the potential significant impacts and identify the mitigate measures to address these impact adequately
- The Consultants carried out the analysis incorporating environmental concerns. This would include with and without scenario and modification incorporated in the proposed project due to environment considerations

Special Features of the Project

- Name of the Project : Construction of Double lane Bridge over River Rangpo
- Length of the bridge : Approximately 70 to 80 m.
- Location : On NH-10 at Km 52.10
- Nature of terrain : Hilly
- Nature of Soil : Hard rock and on surface soil or soil mix with soil and rock

The Project

The project is for the construction of the bridge. The project is for bridging the gap in the road on the existing route alignment

Present Facility

Presently there is existing steel truss bridge at this location

Environmental grading

Factors affecting environmental resources and values and their IEE grading level is given in the Table given below

Beneficial Impact of the Bridge Project

The project will have several beneficial impacts as given in the table attached

Negative impact

We do not contemplate any negative impact of this project on the environmental aspect

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

Actions affecting environmental resources and values		Recommended feasible mitigate measures	IEE grading (suggestive)
(A)	**Environmental Impacts Due to Project Location**		
(i)	Disruption to Hydrology	There will be no disruption to flow of stream	D1
(ii)	Resettlement	No resettlement involved	-
(iii)	Environmental aesthetics degradation	Care shall be taken to avoid/ minimize effect	D1
(iv)	Inequitable locations for rural roads	Cross roads suitable clubbed for access to the road. For the purpose, suitable connectors are planned and under implementation NHIDCL	D1
(v)	Loss of terrestrial ecology including forest and wildlife	Not involved	-
(vi)	Loss of swamp ecology	Not involved	-
(B)	**Impacts during construction phase**		
(i)	Site runoff from cut and fill area	Suitable measures to be adopted during construction	D1
(ii)	Safety of works from accidents	All safety measures to be incorporated in tender document	D1
(iii)	Slum creation hazards	Appropriate planning for housing of construction workers to be made	D1
(iv)	Cultural difference hazards	It is to be avoided and public learning be made and considered	-
(v)	Escape of hazardous materials	Strict monitoring the movement of hazardous materials	D1
(vi)	Escape of air pollution (including dusts)	Suitable measures to be adopted to prevent/ minimize	D1
(vii)	Noise and vibrations	Effects shall be assessed and measures taken based on significance	D1
(viii)	Quarrying hazards(including use of explosives)	Appropriate planning operation of blasting and use of operating quarries	D1
(ix)	Disruption of utilities along route	Not involved	
(x)	Disruption of traffic along route	Alternative	
(C)	**Impacts from Project Operations**		
(i)	Noise disturbance	Not involved	D1
(ii)	Vibration disturbance	Appropriate planning and post construction monitoring may be made	D1
(iii)	Air Pollution	Appropriate planning and post construction monitoring will be made	D1
(iv)	Continuing erosion	Protective vegetation and other methods shall be adopted	D1
(v)	Highway runoff contamination	Appropriate planning and post construction monitoring to take care	D1
(vi)	Highway spills of hazardous materials	Appropriate spills control program and post construction monitoring to take care	D1
(vii)	Escape of sanitary wastes	Appropriate planning/ post construction monitoring to be considered	D1
(viii)	Congestion at access/ exit points	Not involved	-
(ix)	Inadequate highway maintenance	Not involved	-

Note IEE grading Scale:

D1 - Not significant
D2 - Small significant effects
D3 - Moderate significant effect
D4 - Major significant effect

Beneficial Impacts of Project

- Employment opportunity to people
- Enhancement of local industry, agriculture and handicrafts
- Income from visitors and taxes
- Enhancement of rural development through quick and easy transportation of building materials
- Transporting, processing and marketing of agricultural products
- Opening up of opportunities for new occupations
- Approach to quick services and safety
- Improved quality of life for people and so on

CHAPTER – 7: OPTION STUDY OF ALIGNMENT

General

In order to carry out the option study of alignment near the existing tunnel site, as widening of existing tunnel is not possible, we have carried out survey of the possible locations and the influence area.

The objective of the Route alignment study is to determine various alternative alignment options and to identify relative acceptable and preferable alignment. With a view to appreciate the feasibility and relative strength, weakness of the alternative proposals marked on the topo sheets, and site evaluation of the same have been carried out. This was manifested through identifying the problems, shortcomings along with probable route.

CRITICAL FACTORS IN ALIGNMENT SELECTION

The critical factors to be considered in the selection of the alignment are as follows:

- The alignment should meet the geometric standards, particularly the gradients and curvature.
- It should avoid acquisition of commercial and residential establishments.
- It should avoid costly land acquisition.
- It should be as directional as possible, i.e. least distance.
- It should facilitate smooth traffic dispersal.
- It should be environment friendly.
- It should have minimum provision of structures.

During the detailed topographical survey, the trace-cut has been marked on the ground and survey details have been obtained on the trace-cut. However, in hard rock and hazardous areas the trace-cut is serving as reference line only.

THE METHODOLOGY ADOPTED IS DESCRIBED AS FOLLOWS :

Step – 1: Contour Map Study

Contour sheets are very important for fixing the alignment of the road and to design the road geometric, particularly in the hill road. Based on the contours, approximate alignment options have been studied taking into account the level difference between take-off and the terminal points. This exercise was done with a view to have an approximate understanding of the alignment options. The alignment marked on the contour sheets are planned to achieve the required length

Step-2: Satellite image study

Satellite image is very useful for fixing of the new alignment. Satellite image gives three dimension picture of the project area. Based on the contours, clear view of water channel & terrain condition, approximate alignment option has been studied. This exercise was done with a view to have a better understanding of the alignment option.

Step-3: Fly Level Survey

After the detailed study of the contour sheets and the available data, fly level survey of the entire road was carried out by using Auto Levels and the support instruments in order to generate the road profile. The gradients of various alignment options were generated in the shape of strip plan showing gradient of proposed road

ALIGNMENT OPTIONS

Two (2) alignment options have been studies. The details of each option is given below

S/N.	Option-1	Option-2
1	Take of Point 90m backward from existing tunnel inlet & merging point 200 m away from existing tunnel outlet.	Take of point 850 m backward from existing tunnel inlet & merging point 350 m away from existing tunnel outlet.
2	Proposed alignment on RHS of the Ranikhola.	Proposed alignment on LHS of the Ranikhola
3	Proposed alignment passing through New tunnel parallel to the existing tunnel.	Proposed alignment cross the Ranikhola at two places i.e. one at starting of the alignment & other at end of the alignment.
4	Proposed alignment Length 400 m including 250 m tunnel	Proposed alignment length is 2.4 Km including 3 Nos of bridges. Length of Br. No-01 -70m, Br.No.-02-50m & Br.No.-03 -07m.
5		Proposed alignment needs three Nos of bridges. Two bridges over the Ranikhola & one bridge over Rongou Khola.
6	Entire stretch passing through the Burung Reserve forest.	About 70% of proposed alignment passing through the built-up area , cultivated portion and remaining passing through Sumin reserve forest
7	Proposed alignment needs forest clearance. Forest land required about 0.50 Ha.	Proposed alignment needs private Land acquisition and forest clearance. Proposed alignment needs about 6.5 Ha private lands & 0.50 Ha forest land.
8	Proposed alignment having better road geometry & shorten the length of road.	Proposed alignment geometry is comparatively poor than option-01 & lengthen the length of existing road.
9	Approx. cost of the project is Rs.25.00 Cr.	Approx. cost of the project is Rs..33.20 Cr.

Select option:

Option no: 1 – Tunnel

Detailed Cost Estimate

General

The cost estimate presented in this Section is based on the detailed proposals given in Vol-I. It is envisaged that the project would involve site clearance, construction of formation in cutting, slope protection works, pavement work, bridge work and road furniture etc. The detailed cost estimate presented in this report has been worked out using quantities of different items of works derived from the detailed design, drawing and unit rates.

Estimation of Quantities

In arriving at the quantities, the following items of civil works have been computed for the total length of the road :

* Earthwork
* Slope Protection Works
* Bridge Work
* Pavement Work
* Road appurtenances

Detailed estimate of quantities and costs are presented in "Volume – II: Cost Estimate" of the report. Methodology followed for various items are based on Technical Specifications of Ministry of Road Transport and Highways (MoRTH) for material laying, its quality, measurements, etc. and it has been illustrated in brief in the subsequent paragraphs.

a) Earthwork :

Earthwork qualities in cutting and small quantities of filling are calculated by highway design software Mx-Road for the entire length of the project road. The formation cutting consists of earth cutting to get a formation width of double lane standard. Through cutting has also been proposed in some locations especially in curves where the existing alignment has been followed to ease the curves while going round spurs. Embankment s has also been proposed at some stretches.

The classification of soil in cutting has been made in three categories :

Soil : includes ordinary soil, hard, soil mixed with boulder
Ordinary Rock not requiring blasting
Hard Rock requiring blasting.

Locations along the road alignment passing along the above given three were noted down during field surveys and total quantities of earthwork in cutting has been worked out accordingly.

b) Slope Protection Works :

Quantities for retaining walls, breast walls, parapet walls, toe walls, etc. have been worked out based on the design proposals. Gabion walls have also been proposed at specified locations and quantities have been worked out.

c) Bridge & Tunnel :

Quantities of bridges have been worked out for all the stretches of the road based on the structure proposed at each location of cross-stream or river.

d) Pavement :

The provision for pavement includes different layers of sub-base, base, and surfacing course as appropriate throughout the whole stretch of the road.

Granular Sub-base (GSB): 250mm thick sub-base layer of crushed stone aggregate has been proposed. The sub-base course has been extended up to full width of the formation.

Extra quantities for widening at curves, major and minor junction locations are calculated separately and final quantities are worked out.

#Wet Mix Macadam Base (WMM): 250mm thick base layer of Wet Mix Macadam is proposed for 10.0m width.

#Dense Bituminous Macadam of 60 mm thick and 40mm thick of Bituminous Concrete as surfacing course has been proposed.

e) **Road Appurtenances**

Road appurtenances include provision for road signs and markings, etc.

Unit Rates

The unit rates for arriving at cost of different components of works are based on SIKKIM PWD Schedule of Rates 2012 (for National Highways). For those items of works which are not available in the SOR, separate Analysis of Rates have been carried out and incorporated in this DPR.

- Bitumen (60-70 grade) (Ex-Singtam) (Basic rate = Rs 23976/ MT + 2% CST, Rs 479.5+4% SKVAT, Rs 959.0 + 1% Env Cess (Cost +VAT) Rs. 249.4 +transportation from Barauni to Singtam (462Km xRs.11) Rs.5082.0= Rs 30745.9)

- Emulsion (Ex-Singtam) (Basic rate = Rs 19636.0/ MT + 2% CST, Rs 392.7+4% SKVAT, Rs 785.40 + 1% Env Cess (Cost +VAT) Rs. 204.2 +transportation from Haldia to Singtam (740Km xRs.11) Rs.8140.0= Rs 29158.3)

- Cement (43 grade) (Ex-Singtam) (Basic rate = Rs 4200.00/ MT + 2% CST, Rs 84.0+14.5% SKVAT, Rs 609.0 + 12.5 Rs. ED 525.00 + 1% Env Cess (Cost +VAT) Rs. 48.1 +transportation from Murshidbad to Singtam (467Km xRs.5.6) Rs.2615.2= Rs 8081.3)

- Cold twisted bars (HYSD Fe 500 Bars)(Basic rate = Rs 32000.00/ MT + 2% CST, Rs 640.0+4% SKVAT, Rs 1280.0 + 1% Env Cess (Cost +VAT) Rs. 332.8 +transportation from Siliguri to Singtam (90Km xRs.5.6) Rs.504.0= Rs 34756.8)

- Sand & Aggregate from Teesta River.

During analysis of unit rates for Tunnel work items an overhead component of 20% has been considered to account for the establishment cost and cost of financing to the contractor. In addition, a contractor's profit of 10% has been included. In all cases, fully mechanised construction techniques have been assumed.

CONSTRUCTION OF ADDITIONAL BRIDGE ADJACENT TO THE EXISTING BRIDGE AT KM 52.100 ON NH-10 AT RANGPO AT THE BORDER OF WEST BENGAL AND SIKKIM STATE.

Name of Road :NH- 10 (Sevoka -Gangtok Section)

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ABSTRACT OF COST ESTIMATE FOR BRIDGE

Sr.No.	Items of work	Total quantity	Unit	Amount (Rs)
A.	**CONSTRUCTION COST**			
1	Formation Cutting			
2	Dismantling			35,010.00
3	Jungle Clearance etc			3,716.10
4	Formation Works	2147.02	Cum	1,016,649.53
	Road Side drain	200.00	Rm	252,762.00
5	Protection Works	200.00	Rm	18,087,900.00
6	Pavement Works			4,105,861.40
7	Road Signs , Road Safety & Light			3,071,076.00
8	Bridge Work		LS	81,822,007.47
		TOTAL OF (1 to 8)	**Rs**	**108,394,982.50**
B	Escalation for 4 years @ 5%		Rs.	21,678,996.50
C	**Civil Cost**		**Rs.**	**130,073,979.00**
D	Contingency (2.8% of C)		Rs.	3,642,071.41
E	**TOTAL (C+D)**		**Rs.**	**133,716,050.41**
F	Construction Supervision Charge (6 % of C)		Rs.	7,804,438.74
G	Quality Control Charge (1.0% of C)		Rs.	1,300,739.79
H	Road Safety Audit Charge (1.0% of C)		Rs.	1,300,739.79
I	Maintenance for 4Years (0.25%+0.5%x3=1.75% of C)		Rs.	2,276,294.63
J	Escalation (10 % of C)		Rs.	13,007,397.90
K	Agency (NHIDCL) Charge (3 % of C)		Rs.	3,902,219.37
	TOTAL PROJECT COST		**Rs.**	**163,307,880.63**
	Say		**Rs.**	**163,300,000.00**

CONSTRUCTION OF CHISOPANI TRAFFIC TUNNEL AT KM 67.24 ON NH-10 IN EAST DIST., SIKKIM

Name of Road :NH-10 within Sikkim

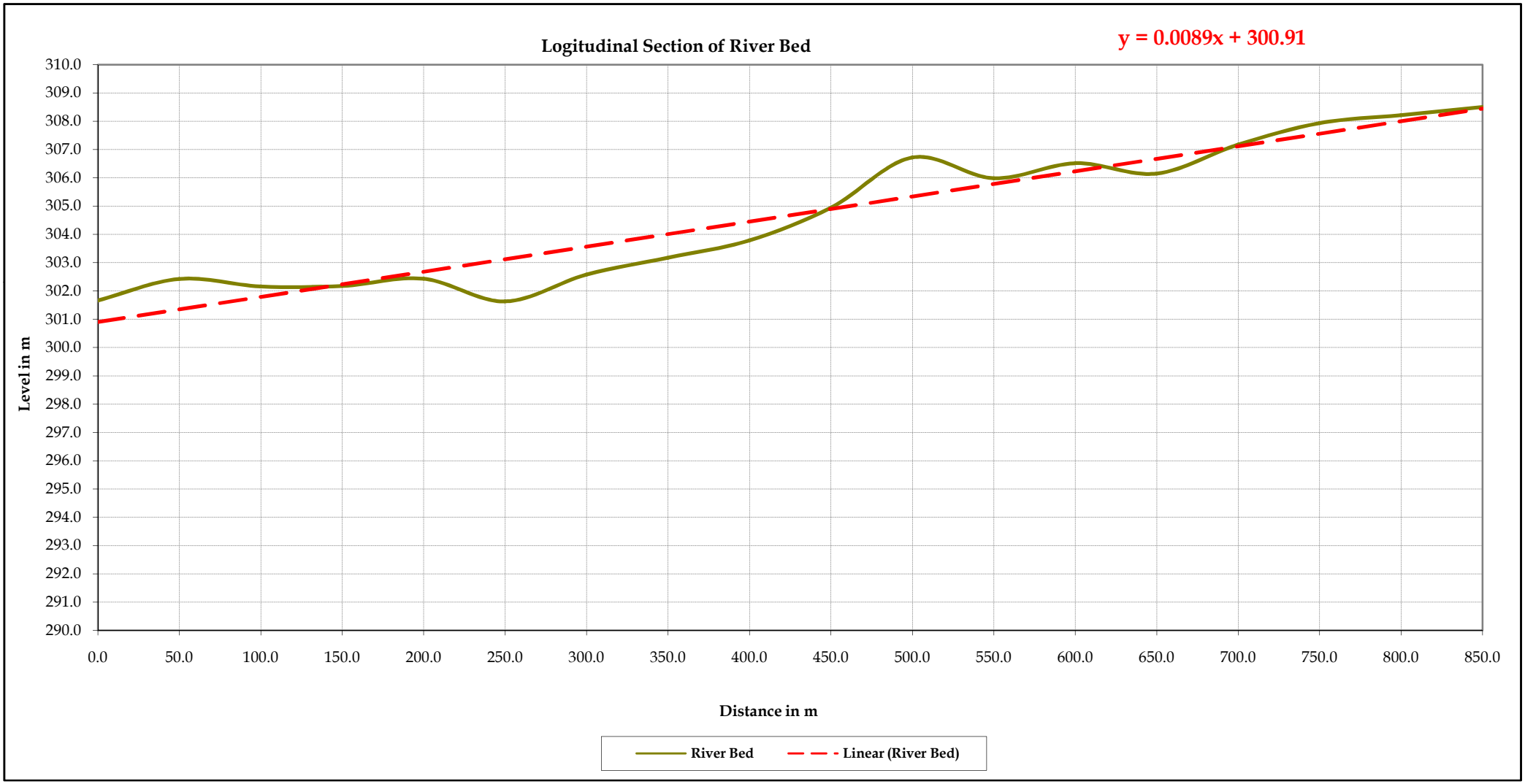
ABSTRACT OF COST ESTIMATE FOR TUNNEL

Sr.No.	Items of work	Total quantity	Unit	Amount (Rs)	Share
A.	**CONSTRUCTION COST**				
1	Formation Cutting				
2	Dismantling			65,022.00	0.03%
3	Jungle Clearance etc			9,031.80	0.00%
4	Formation Works	3498.82	Cum	316,793.10	0.14%
5	Protection Works	150.00	Rm	2,411,100.00	1.05%
6	Pavement Works			5,479,741.90	2.39%
7	Road Signs			2,135,083.00	0.93%
8	Tunnel Work		LS	218,712,000.00	95.45%
		TOTAL OF (1 to 8)	**Rs**	**229,128,771.80**	100.0%
B	Escalation for 4 years @ 5%		Rs.	45,825,754.36	
C	**Civil Cost**		**Rs.**	**274,954,526.16**	
D	Contingency (2.8% of C)		Rs.	7,698,726.73	
E	**TOTAL (C+D)**		**Rs.**	**282,653,252.89**	
F	Construction Supervision Charge (6 % of C)		Rs.	16,497,271.57	
G	Quality Control Charge (1.0% of C)		Rs.	2,749,545.26	
H	Road Safety Audit Charge (1.0% of C)		Rs.	2,749,545.26	
I	Maintenance for 4Years (0.25%+0.5%x3=1.75% of C)		Rs.	4,811,704.21	
J	Escalation (10 % of C)		Rs.	27,495,452.62	
K	Agency (NHIDCL) Charge (3 % of C)		Rs.	8,248,635.78	
	TOTAL PROJECT COST		**Rs.**	**345,205,407.59**	
	Say		**Rs.**	**345,200,000.00**	

Hydraulic Calculations for Bridge over River Rangpo Chu at Rangpo

1 Longitudinal Section of River Bed From U/S to D/S

X= Dis	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850
Y=Lvl	301.667	302.424	302.158	302.18	302.434	301.631	302.581	303.175	303.786	304.947	306.721	305.99	306.519	306.153	307.173	307.936	308.221	308.508



L Section of River

2.0 Hydraulic Calculations for Bridge over River Rangpo Chu at Rangpo

2 General details

At Proposed bridge site **Rangpo**

Chainage of Proposed bridge centre line **NH-10** **52+100 Km**

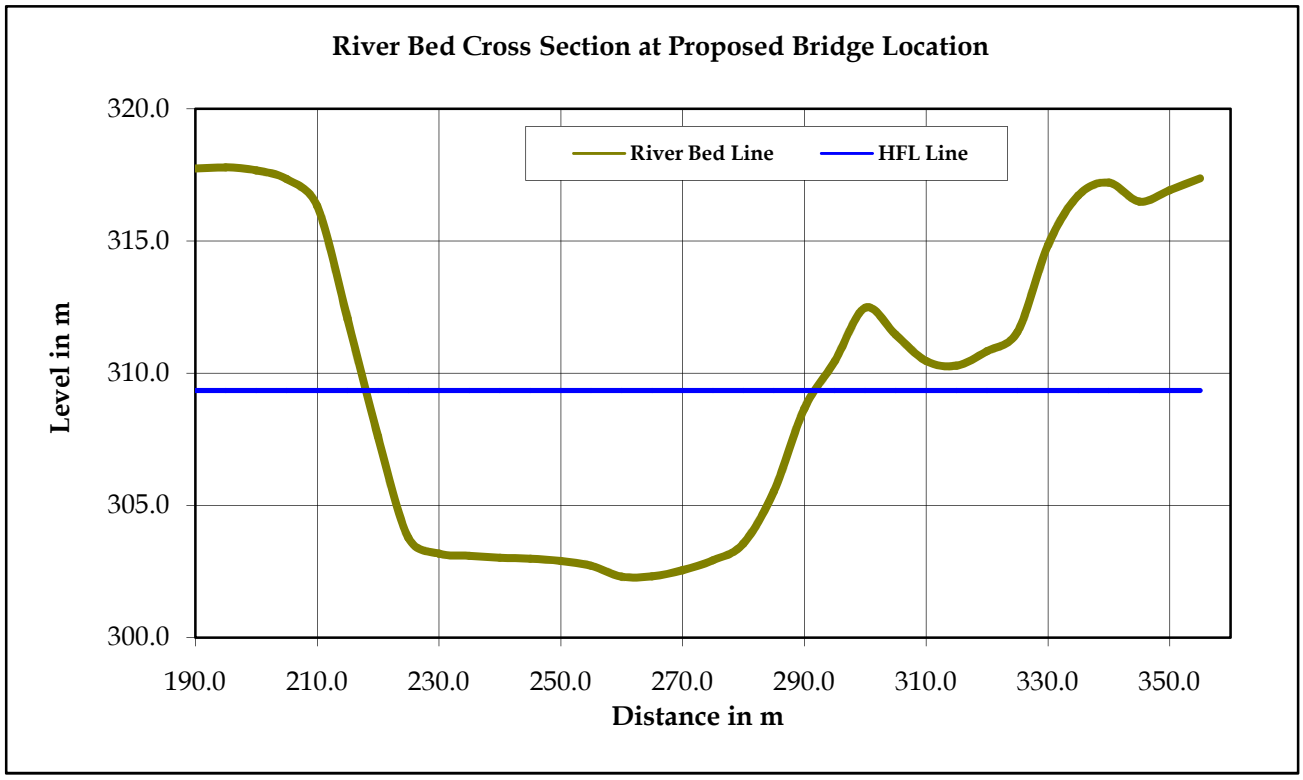
HFL at proposed bridge **(As per Local enquiry)** 309.350 m

Longitudinal slope of the River as per Survey 0.0089 m per m

3 Discharge by Manning's Formula

Cross-sectional area of River at Proposed bridge site is as follows:

S/N	Distance (m)	Level (m)	HFL (m)	Depth (m)	Av depth (m)	Area (sqm)	Perimeter (m)	Top width of flow (m)
1	190.00	317.74	309.35					
2	195.00	317.79	309.35					
3	200.00	317.68	309.35					
4	205.00	317.35	309.35					
5	210.00	316.33	309.35					
6	215.00	312.06	309.35					
7	220.00	307.60	309.35	1.748				
8	225.00	303.77	309.35	5.577	3.663	18.313	6.298	5.000
9	230.00	303.18	309.35	6.175	5.876	29.380	5.036	5.000
10	235.00	303.09	309.35	6.264	6.220	31.098	5.001	5.000
11	240.00	303.02	309.35	6.334	6.299	31.495	5.000	5.000
12	245.00	302.98	309.35	6.367	6.351	31.753	5.000	5.000
13	250.00	302.90	309.35	6.448	6.408	32.038	5.001	5.000
14	255.00	302.71	309.35	6.640	6.544	32.720	5.004	5.000
15	260.00	302.31	309.35	7.045	6.843	34.213	5.016	5.000
16	265.00	302.32	309.35	7.030	7.038	35.188	5.000	5.000
17	270.00	302.55	309.35	6.801	6.916	34.578	5.005	5.000
18	275.00	302.92	309.35	6.433	6.617	33.085	5.014	5.000
19	280.00	303.54	309.35	5.806	6.120	30.598	5.039	5.000
20	285.00	305.53	309.35	3.818	4.812	24.060	5.381	5.000
21	290.00	308.66	309.35	0.690	2.254	11.270	5.898	5.000
22	295.00	310.45	309.35					
23	300.00	312.48	309.35					
24	305.00	311.46	309.35					
25	310.00	310.47	309.35					
26	315.00	310.28	309.35					
27	320.00	310.83	309.35					
28	325.00	311.57	309.35					
29	330.00	314.83	309.35					
30	335.00	316.72	309.35					
31	340.00	317.21	309.35					
32	345.00	316.49	309.35					
33	350.00	316.92	309.35					
34	355.00	317.37	309.35					
	Total					**409.79**	**72.69**	**70.00**

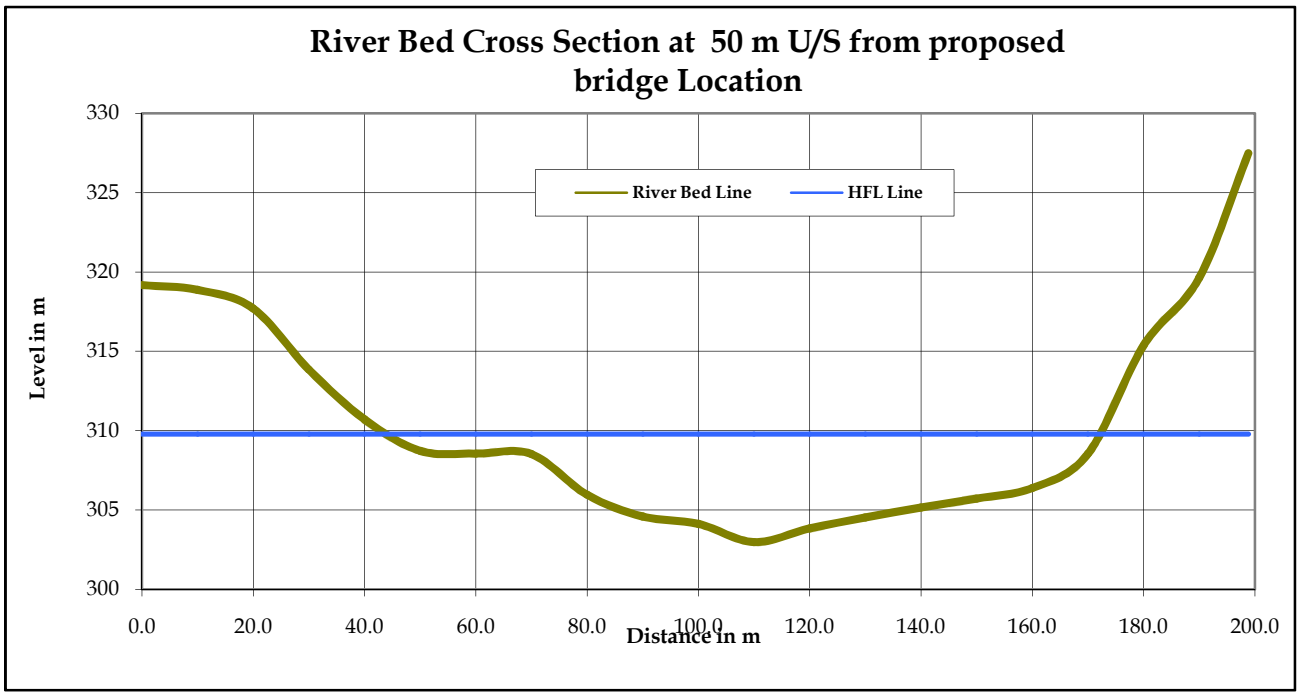


Cross-sectional area of River at the U/S of Proposed bridge is as follows:

Distance from Proposed bridge 50 m

HFL at this location 309.795 m

S/N	Distance (m)	Level (m)	HFL (m)	Depth (m)	Av depth (m)	Area (sqm)	Perimeter (m)	Top width of flow (m)
1	0.00	319.18	309.80					
2	10.00	318.88	309.80					
3	20.00	317.71	309.80					
4	30.00	313.86	309.80					
5	40.00	310.70	309.80					
6	50.00	308.73	309.80	1.067				
7	60.00	308.56	309.80	1.236	1.152	11.515	10.001	10.000
8	70.00	308.54	309.80	1.260	1.248	12.480	10.000	10.000
9	80.00	305.97	309.80	3.830	2.545	25.450	10.325	10.000
10	90.00	304.60	309.80	5.193	4.512	45.115	10.092	10.000
11	100.00	304.13	309.80	5.667	5.430	54.300	10.011	10.000
12	110.00	302.99	309.80	6.806	6.237	62.365	10.065	10.000
13	120.00	303.85	309.80	5.943	6.375	63.745	10.037	10.000
14	130.00	304.53	309.80	5.263	5.603	56.030	10.023	10.000
15	140.00	305.16	309.80	4.637	4.950	49.500	10.020	10.000
16	150.00	305.73	309.80	4.063	4.350	43.500	10.016	10.000
17	160.00	306.40	309.80	3.394	3.729	37.285	10.022	10.000
18	170.00	308.55	309.80	1.247	2.321	23.205	10.228	10.000
19	180.00	315.38	309.80					
20	190.00	319.62	309.80					
21	198.86	327.49	309.80					
	Total					**484.49**	**120.84**	**120.00**

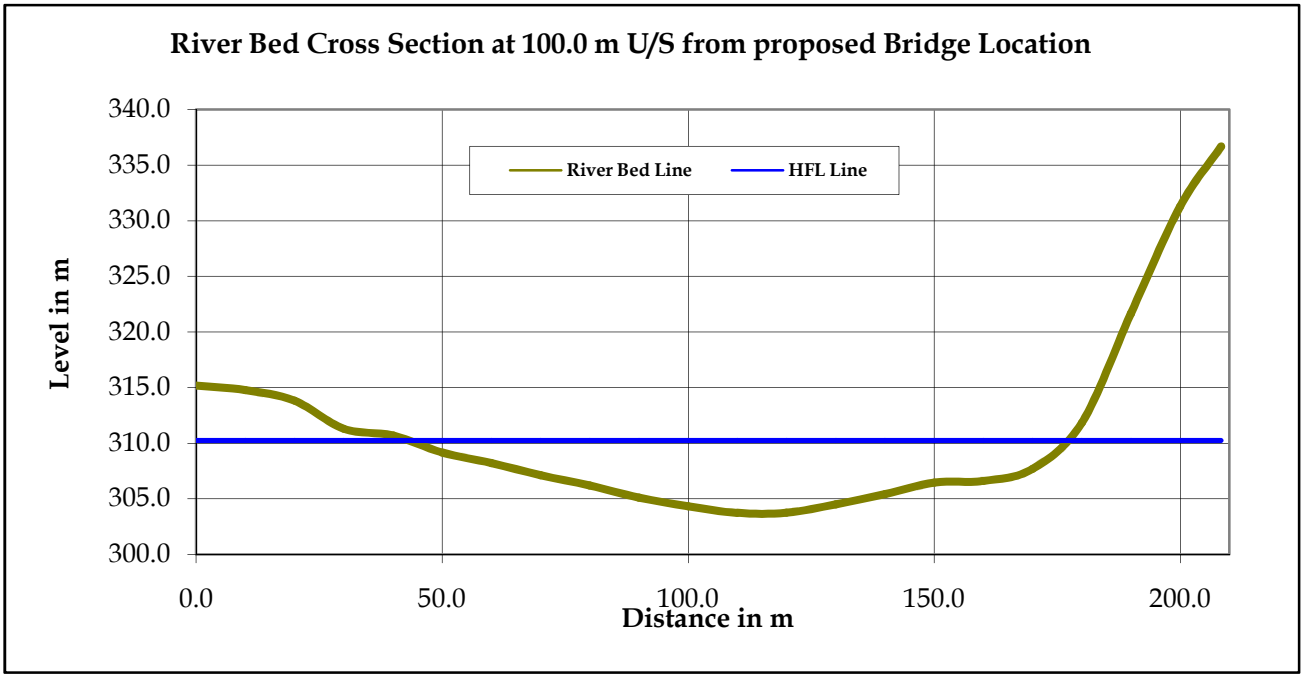


Cross-sectional area of River at the U/S of Proposed bridge is as follows:

Distance from Proposed bridge 100 m

HFL at this location 310.240 m

S/N	Distance (m)	Level (m)	HFL (m)	Depth (m)	Av depth (m)	Area (sqm)	Perimeter (m)	Top width of flow (m)
1	0.000	315.192	310.240					
2	10.000	314.782	310.240					
3	20.000	313.815	310.240					
4	30.000	311.309	310.240					
5	40.000	310.679	310.240					
6	50.000	309.161	310.240	1.079				
7	60.000	308.213	310.240	2.027	1.553	15.530	10.045	10.000
8	70.000	307.110	310.240	3.130	2.578	25.785	10.061	10.000
9	80.000	306.210	310.240	4.030	3.580	35.800	10.040	10.000
10	90.000	305.102	310.240	5.138	4.584	45.840	10.061	10.000
11	100.000	304.325	310.240	5.915	5.527	55.265	10.030	10.000
12	110.000	303.731	310.240	6.509	6.212	62.120	10.018	10.000
13	120.000	303.743	310.240	6.497	6.503	65.030	10.000	10.000
14	130.000	304.494	310.240	5.746	6.122	61.215	10.028	10.000
15	140.000	305.438	310.240	4.802	5.274	52.740	10.044	10.000
16	150.000	306.463	310.240	3.777	4.290	42.895	10.052	10.000
17	160.000	306.618	310.240	3.622	3.700	36.995	10.001	10.000
18	170.000	307.685	310.240	2.555	3.089	30.885	10.057	10.000
19	180.000	311.847	310.240					
20	190.000	321.640	310.240					
21	200.000	331.291	310.240					
22	208.300	336.664	310.240					
	Total					**530.10**	**120.44**	**120.00**

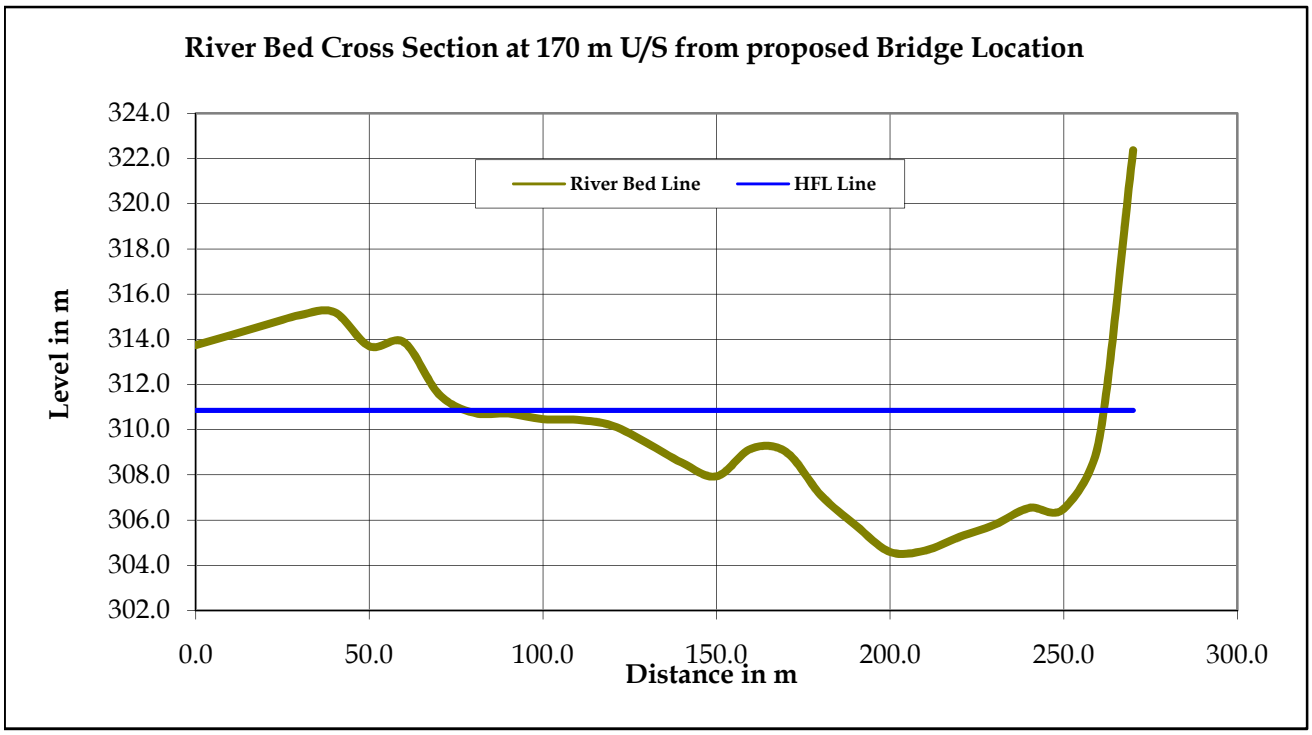


Cross-sectional area of River at the U/S of Proposed bridge is as follows:

Distance from Proposed bridge 170 m

HFL at this location 310.863 m

S/N	Distance (m)	Level (m)	HFL (m)	Depth (m)	Av depth (m)	Area (sqm)	Perimeter (m)	Top width of flow (m)
1	0.000	313.753	310.863					
2	10.000	314.193	310.863					
3	20.000	314.633	310.863					
4	30.000	315.072	310.863					
5	40.000	315.196	310.863					
6	50.000	313.693	310.863					
7	60.000	313.868	310.863					
8	70.000	311.577	310.863					
9	80.000	310.753	310.863	0.110				
10	90.000	310.719	310.863	0.144	0.127	1.270	10.000	10.000
11	100.000	310.474	310.863	0.389	0.267	2.665	10.003	10.000
12	110.000	310.440	310.863	0.423	0.406	4.060	10.000	10.000
13	120.000	310.183	310.863	0.680	0.552	5.515	10.003	10.000
14	130.000	309.409	310.863	1.454	1.067	10.670	10.030	10.000
15	140.000	308.546	310.863	2.317	1.886	18.855	10.037	10.000
16	150.000	307.941	310.863	2.922	2.620	26.195	10.018	10.000
17	160.000	309.168	310.863	1.695	2.309	23.085	10.075	10.000
18	170.000	309.024	310.863	1.839	1.767	17.670	10.001	10.000
19	180.000	307.118	310.863	3.745	2.792	27.920	10.180	10.000
20	190.000	305.784	310.863	5.079	4.412	44.120	10.089	10.000
21	200.000	304.596	310.863	6.267	5.673	56.730	10.070	10.000
22	210.000	304.659	310.863	6.204	6.236	62.355	10.000	10.000
23	220.000	305.265	310.863	5.598	5.901	59.010	10.018	10.000
24	230.000	305.796	310.863	5.067	5.333	53.325	10.014	10.000
25	240.000	306.542	310.863	4.321	4.694	46.940	10.028	10.000
26	250.000	306.508	310.863	4.355	4.338	43.380	10.000	10.000
27	260.000	309.398	310.863	1.465	2.910	29.100	10.409	10.000
28	270.000	322.364	310.863					
	Total					**532.87**	**180.98**	**180.00**

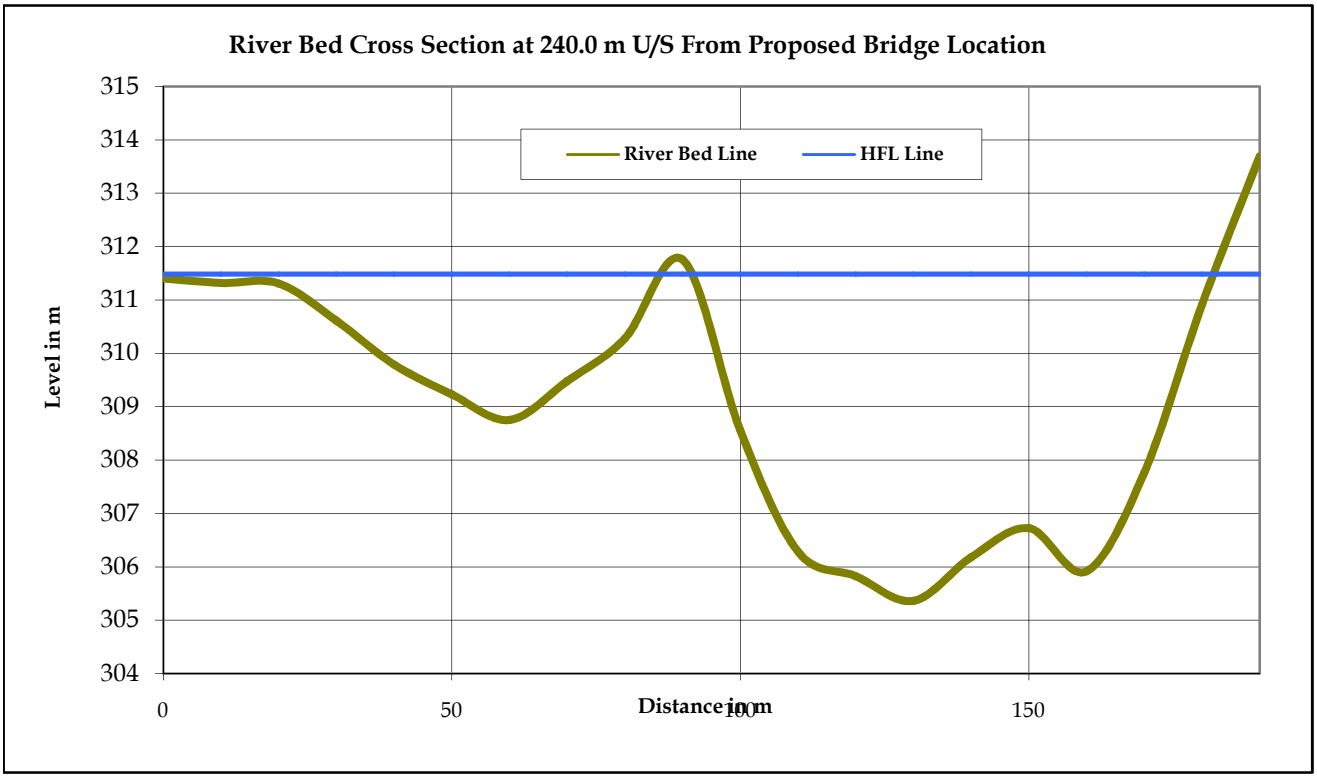


Cross-sectional area of River at the U/S of Proposed bridge is as follows:

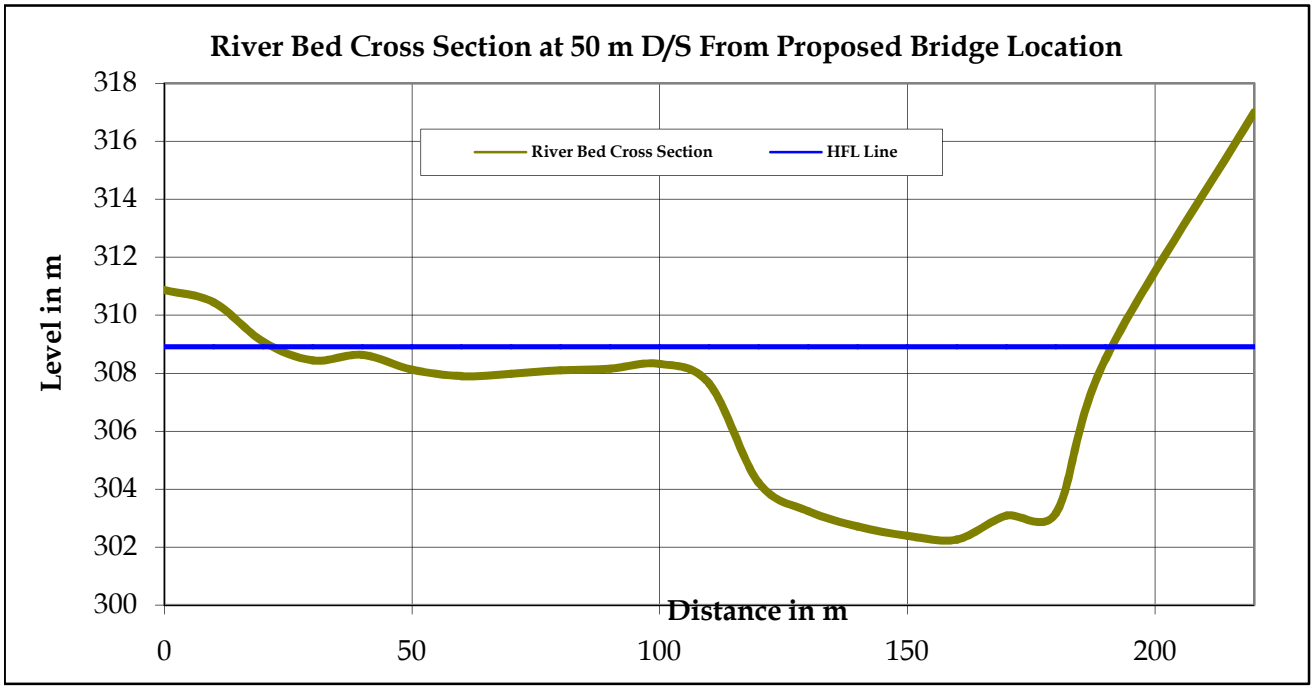
Distance from Proposed bridge 240 m

HFL at this location 311.486 m

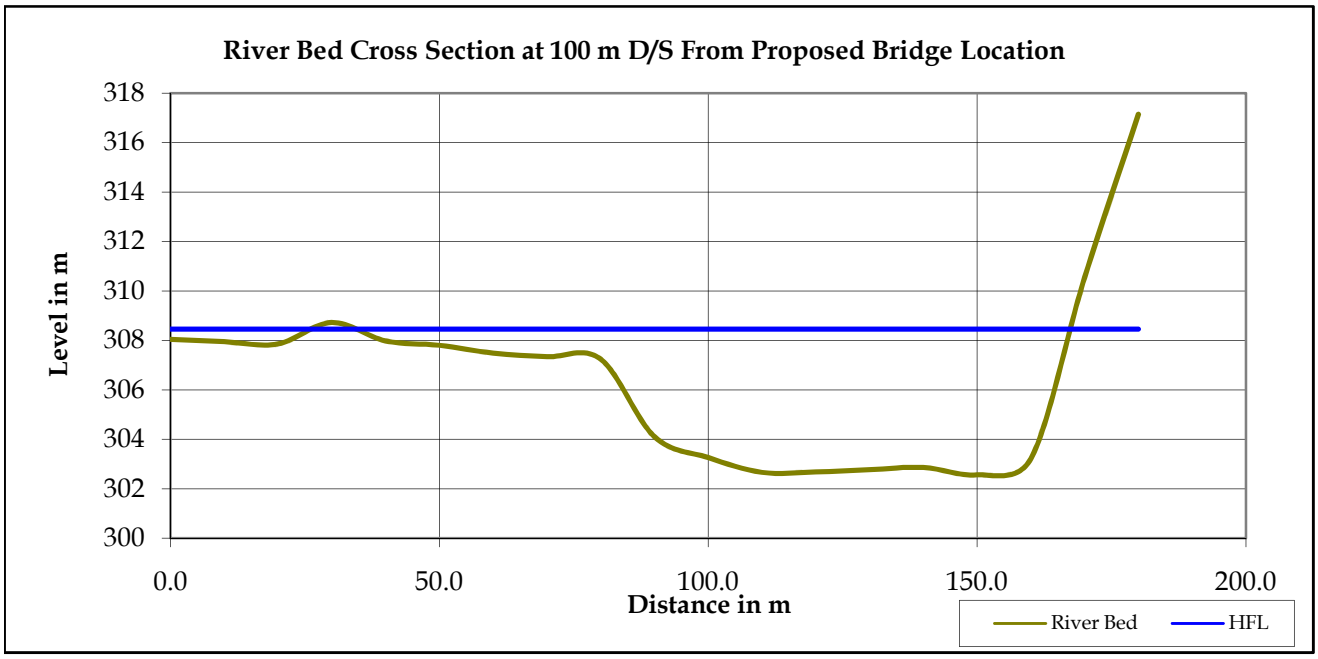
S/N	Distance (m)	Level (m)	HFL (m)	Depth (m)	Av depth (m)	Area (sqm)	Perimeter (m)	Top width of flow (m)
1	0.000	311.404	311.486	0.082				
2	10.000	311.320	311.486	0.166	0.124	1.240	10.000	10.000
3	20.000	311.310	311.486	0.176	0.171	1.710	10.000	10.000
4	30.000	310.611	311.486	0.875	0.526	5.255	10.024	10.000
5	40.000	309.793	311.486	1.693	1.284	12.840	10.033	10.000
6	50.000	309.236	311.486	2.250	1.972	19.715	10.016	10.000
7	60.000	308.754	311.486	2.732	2.491	24.910	10.012	10.000
8	70.000	309.478	311.486	2.008	2.370	23.700	10.026	10.000
9	80.000	310.277	311.486	1.209	1.609	16.085	10.032	10.000
10	90.000	311.756	311.486					
11	100.000	308.554	311.486	2.932				
12	110.000	306.286	311.486	5.200	4.066	40.660	10.254	10.000
13	120.000	305.828	311.486	5.658	5.429	54.290	10.010	10.000
14	130.000	305.364	311.486	6.122	5.890	58.900	10.011	10.000
15	140.000	306.177	311.486	5.309	5.716	57.155	10.033	10.000
16	150.000	306.725	311.486	4.761	5.035	50.350	10.015	10.000
17	160.000	305.913	311.486	5.573	5.167	51.670	10.033	10.000
18	170.000	307.764	311.486	3.722	4.648	46.475	10.170	10.000
19	180.000	310.908	311.486	0.578	2.150	21.500	10.483	10.000
20	190.000	313.689	311.486					
						486.46	**161.15**	**160.00**



	Cross-sectional area of River at the D/S of Proposed bridge is as follows:							
	Distance from Proposed bridge						50	m
	HFL at this location						308.905	m
S/N	**Distance**	**Level (m)**	**HFL (m)**	**Depth (m)**	**Av depth**	**Area (sqm)**	**Perimeter**	**Top width**
1	0.000	310.865	308.905					
2	10.000	310.441	308.905					
3	20.000	309.076	308.905					
4	30.000	308.438	308.905	0.467				
5	40.000	308.625	308.905	0.280	0.374	3.735	10.002	10.000
6	50.000	308.117	308.905	0.788	0.534	5.340	10.013	10.000
7	60.000	307.893	308.905	1.012	0.900	9.000	10.003	10.000
8	70.000	307.977	308.905	0.928	0.970	9.700	10.000	10.000
9	80.000	308.093	308.905	0.812	0.870	8.700	10.001	10.000
10	90.000	308.154	308.905	0.751	0.782	7.815	10.000	10.000
11	100.000	308.316	308.905	0.589	0.670	6.700	10.001	10.000
12	110.000	307.631	308.905	1.274	0.932	9.315	10.023	10.000
13	120.000	304.225	308.905	4.680	2.977	29.770	10.564	10.000
14	130.000	303.237	308.905	5.668	5.174	51.740	10.049	10.000
15	140.000	302.707	308.905	6.198	5.933	59.330	10.014	10.000
16	150.000	302.392	308.905	6.513	6.356	63.555	10.005	10.000
17	160.000	302.258	308.905	6.647	6.580	65.800	10.001	10.000
18	170.000	303.084	308.905	5.821	6.234	62.340	10.034	10.000
19	180.000	303.173	308.905	5.732	5.777	57.765	10.000	10.000
20	190.000	308.494	308.905	0.411	3.072	30.715	11.328	10.000
23	220.000	316.996	308.905					
						481.32	**162.04**	**160.00**



	Cross-sectional area of River at the D/S of Proposed bridge is as follows:							
	Distance from Proposed bridge						100	m
	HFL at this location						308.460	m
S/N	**Distance**	**Level (m)**	**HFL (m)**	**Depth (m)**	**Av depth**	**Area (sqm)**	**Perimeter**	**Top width**
1	0.000	308.045	308.460	0.415				
2	10.000	307.948	308.460	0.512	0.464	4.635	10.000	10.000
3	20.000	307.860	308.460	0.600	0.556	5.560	10.000	10.000
4	30.000	308.727	308.460					
5	40.000	307.983	308.460	0.477				
6	50.000	307.805	308.460	0.655	0.566	5.660	10.002	10.000
7	60.000	307.489	308.460	0.971	0.813	8.130	10.005	10.000
8	70.000	307.344	308.460	1.116	1.044	10.435	10.001	10.000
9	80.000	307.247	308.460	1.213	1.165	11.645	10.000	10.000
10	90.000	304.105	308.460	4.355	2.784	27.840	10.482	10.000
11	100.000	303.263	308.460	5.197	4.776	47.760	10.035	10.000
12	110.000	302.663	308.460	5.797	5.497	54.970	10.018	10.000
13	120.000	302.682	308.460	5.778	5.788	57.875	10.000	10.000
14	130.000	302.772	308.460	5.688	5.733	57.330	10.000	10.000
15	140.000	302.861	308.460	5.599	5.644	56.435	10.000	10.000
16	150.000	302.558	308.460	5.902	5.751	57.505	10.005	10.000
17	160.000	303.212	308.460	5.248	5.575	55.750	10.021	10.000
18	170.000	310.549	308.460					
19	180.000	317.153	308.460					
	Total					**461.53**	**140.57**	**140.00**



Summary of cross-sections

Cross-section at	Area (sqm)	Perimeter	Top width
Proposed bridge location	409.79	72.69	70.00
U/S side 50.0 m from Proposed bridge location	484.49	120.84	120.00
U/S side 100.0 m from Proposed bridge location	530.10	120.44	120.00
U/S side 170.0 m from Proposed bridge location	532.87	180.98	180.00
U/S side 240.0 m from Proposed bridge location	486.46	161.15	160.00
D/S side 50 m from Proposed bridge location	481.32	162.04	160.00
D/S side 100 m from Proposed bridge location	461.53	140.57	140.00
At proposed location	**409.79**	**72.69**	**70.00**

Hydraulic mean radius R=A/P

Longitudinal slope as calculated 0.0089 m per m

Velocity by Manning's formula

$V=1/n\ R^{2/3}\ S^{1/2}$ (refer SP-13, page 18)

For winding ,some pools & shoals ,clean ,lower stages more ineffective slope & sections

n= 0.05

Discharge Q=A*V

Summary of Velocity & Discharge

Cross-section at	R	V	Q
Proposed bridge location	5.64	5.98	2449.03
U/S side 50.0 m from Proposed bridge location	4.01	4.76	2307.05
U/S side 100.0 m from Proposed bridge location	4.40	5.07	2686.25
U/S side 170.0 m from Proposed bridge location	2.94	3.88	2065.41
U/S side 240.0 m from Proposed bridge location	3.02	3.94	1917.08
D/S side 50 m from Proposed bridge location	2.97	3.90	1876.60
D/S side 100 m from Proposed bridge location	3.28	4.17	1923.66
At proposed location	**5.64**	**5.98**	**2449.03**

Cross-sectional area of flow at proposed location 409.79 sqm

Width of flow 70.00 m

Wetted perimeter perpendicular to direction of flow 72.69 m

Velocity V= 5.98 m/s

Discharge Q=A*V 2449.03 cum/s

4 Discharge by Rational Formulae

Discharge as per Rational formula formula (refer SP-2004-,page 12

The distance from the critical point to the structure L		45.96	Km
The fall in level from the critical point to the structure H		3697.7	m
The concentration time =	$t_c = (0.87 \times L^3/H)^{0.385}$	3.34	
One hour rain fall I_o		8.12	cm/h
The critical intensity I_c	$I_o(2/(t_c+1))$	3.75	

$Q=.028PAI_C$

P=Co-efficient of run-off for the catchment characteristics	0.40	
(Loam , lightly cultivated or covered)		
A=Catchment area	49670.00	hectares
IC=critical intensity of rainfall in cm per hour	3.75	cm/h
Q=	2084.00	cum/sec

5 Discharge by Dicken's Formula

Discharge as per Dicken's formula (refer SP-13, page 7)

$Q=CM^{3/4}$

C=300-320 cm in Sikkim	22	

Annual rain fall , which is about 300cm to 320 cm .Therefore C value is taken as 22.

M=catchment area	496.70	sqkm
Q=	2314.69	cum/s

6 Discharge by Ryve's Formula

Discharge as per Ryve's Formula (refer SP-13, page 7)

$Q=CM^{2/3}$

C=Limited area near the hill	10	
M=catchment area	496.70	sqkm
Q=	627.19	cum/s

7 Discharge by Ingli's Formula

Discharge by Ingli's Formula (refer SP-13, page 7)

Q=125M/SQRT(M+10)

M=catchment area	496.70	sqkm
Q=	2758.22	cum/s

8 Design Discharge

(Refer SP-13, page 21)

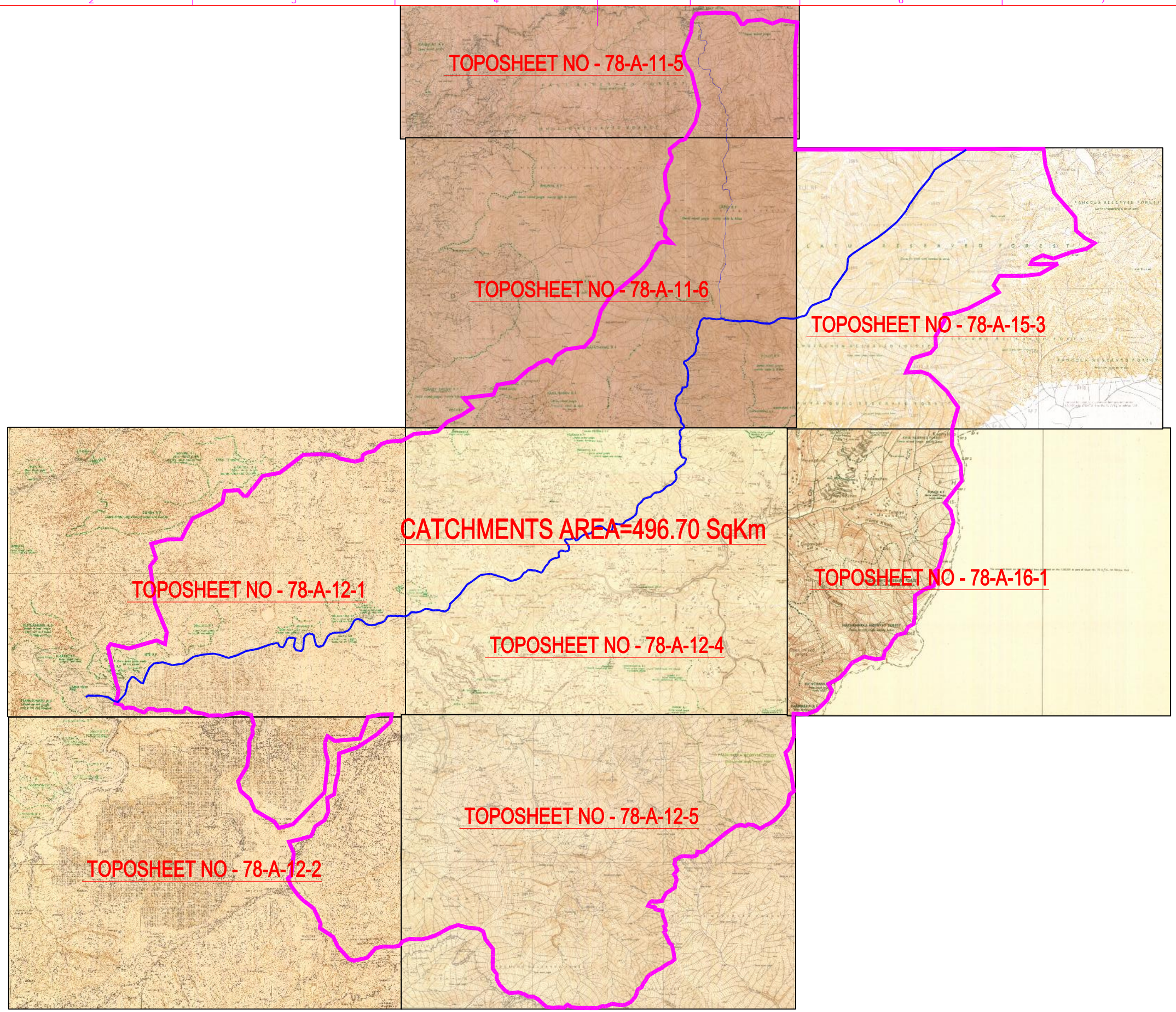
Discharge by Manning's Formula	2449.03	cum/sec
Discharge by Rational Formula	2084.00	cum/sec
Discharge by Dicken's Formula	2314.69	cum/sec
Discharge by Ingli's Formula	2758.22	cum/sec
Discharge as per Ryve's Formula	627.19	cum/sec
Maximum discharge	2758.22	cum/sec
Next maximum discharge	2449.03	cum/sec
The difference is within 50% of the next maximum discharge		
Maximum design discharge	**2758.22**	cum/sec
Bhasmey Hydroelectric Project is located in the East District of Sikkim on the Rangpo River, about 6 km upstream of Rangpo Bazar .Spillway Design Discharge:	1570	cum/sec
Hence design discharge	1570	cum/sec

9 Water Way

Regime width	$W=4.8Q^{1/2}$	190.19	m
(Refer IRC:5-1998, cl 104.3 or SP-13, page 25)			
Width of flow at HFL condition		70.00	m
However ,for proposed bridge provided clear span		72	m
no. of spans		1	no.

		total waterway provided L	70.50	m
		Thickness of pier	1.50	m
10	**Scour depth**			
	Increase in design discharge, as per IRC:78-2000, cl 703.1.1		30%	
	Increased design discharge		2041.00	cum/sec
	Mean depth of scour, as per IRC:78-2000, cl 703.2			
		$d_{sf} = 1.34\ (D_b^2/K_{sf})^{1/3}$		
		Db = Design discharge per metre width	28.95	cum/sec/m
		Weighted mean diameter	0.11	mm
		K_{sf} = Silt factor	0.58	
		d_{sf} =	15.12	m
	without any floor protection			
	Maximum scour depth, as per IRC:78-2000, cl 703.3	$= 2*d_{sf}$ =	30.23	m
	The maximum depth of scour below the HFL for pier having individual foundation without any floor protection			
	Maximum scour depth, as per IRC:78-2000, cl 703.3	$= 1.27*d_{sf}$ =	19.20	m
11	**Foundation depth**			
	Depth of foundation below max. scour, as per IRC:78-2000, cl 705.2		1.50	m
	Max. Scour level at abutment location		290.15	m
	Bed level at site		302.305	m
12	**Deck level**			m
	HFL at Proposed bridge site		309.350	m
	Minimum vertical clearance		1.500	m
	Depth of super structure		4.000	m
	Wearing coat		0.056	m
	Minimum deck level required		314.906	m

Main govering condition for bridge deck is approach road either side of river bank



DATE	ISSUED AND/OR REFERENCES	DEALT	CHECKED

REVISIONS

LEGEND

CLIENT: NATIONAL HIGHWAY & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.
3rd FLOOR PTI BUILDING, 4 PARLIAMENT STREET, NEW DELHI-110001

MINISTRY OF ROAD, TRANSPORT & HIGHWAYS, GOVERNMENT OF INDIA

Manager (NHIDCL) Gangtok,Sikkim | Genaral Manager (NHIDCL) Gangtok,Sikkim

CONSULTANT: CM ENGINEERING & SOLUTION
MARUTI VIHAR, HOUSE NO. 1473A,
GURGAON,HARYANA -122002
Email - cmesconsultancy@gmail.com
Phone: 9811406386, 9911052266, 01244255138

SM	ASK	DK
DEALT	CHECKED	APPROVED

PROJECT: Specialised Consultancy Services for 'Good for Tender' design based on detailed investigations, costing and preparation of Technical Schedules of RFC documents of (i) Construction of Additional Bridge adjacent to the existing bridge at Km 52.100 on NH-10 at Rangpo at the border of West Bengal and Sikkim State (ii) Construction of Chisopani Traffic Tunnel at Km 67.24 on NH-10 in East Dist., Sikkim

TITLE: RANGPO BRIDGE
CATCHMENT AREA

STATUS: PROJECT DRAWING | DATE: 08.08.16 | SCALE: NTS | A3

CMES/NHIDCL/RANGPO BR/ CA/01

REV. R0 | SHEET 1 of 1

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH- 01**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 317.05**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 10-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 16-Aug-16**
Cordinates	**: X = 651526.090,Y = 3006415.624**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
10-Aug-16	317.050	0.5	0	1	1					0.16	Nil	9		Nil	50	0.8	white	Grey silicified Phylitie & fine grain Quartzite with thin quartz veins
10-Aug-16	316.050	2	1	2	1					0.32	Nil	6		Nil	60	0.8	white	Grey fine grain Phylitie & Quartzite with occasional Quartz veins
10-Aug-16	315.050	2	2	3	1					Nil	Nil			Nil	50	0.9	white	Coarse sand from sludge water
11-Aug-16	314.050	2	3	4	1					0.25	Nil	11	314.05	Nil	55	0.8	white	Fine grain grey Quartzite & Phylite with iron stains on weak planes
11-Aug-16	313.050	2	4	5	1					Nil	Nil			Nil	30	0.9	white	Grey coarse sand from sludge water
12-Aug-16	312.050	2	5	6	1					0.15	Nil	2		Nil	50	0.6	white	Grey phylitic Quartzite
12-Aug-16	311.050	2	6	7	1					0.24	Nil	6		Nil	17	1.0	white	Grey silicified Phylite & Quartzite with Quartz veins of 1.5 cm
13-Aug-16	310.050	2	7	8	1					Nil	Nil	1	309.05	Nil	50	1.4	white	Coarse grey sand from sludge water & only one pieces of 1/2 cm
13-Aug-16	309.050	2	8	9	1					0.26	Nil	13		Nil	101	1.0	white	Silicified phyllitic quartzite traversed by Quartz veins of 1.5 cm
14-Aug-16	308.050	2	9	10	1					0.21	Nil	7	307.05	Nil	105	1.0	white	Grey Phyllite
14-Aug-16	307.050	2	10	11	1					Nil	Nil	Nil		Nil	40	0.9	white	Grey Phyllite with very thin Quartz veins
14-Aug-16	306.050	2	11	12	1					0.23	14	2		Nil	42	0.9	white	Grey Phyllite traversed by thin Quartz veins
14-Aug-16	305.050	2	12	13	1					0.23	Nil	3		Nil	70	1.0	white	Grey Phyllite traversed by thin Quartz veins of 0.1-1.0 cm

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH- 01**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 317.05**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 10-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 16-Aug-16**
Cordinates	**: X = 651526.090,Y = 3006415.624**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
15-Aug-16	304.050	2	13	14	1					Nil	Nil	Nil	306.75	Nil	50	0.9	white	Only coarse sand from sludge water
15-Aug-16	303.050	2	14	15	1					0.24	Nil	12		Nil	20	1.3	white	Grey Phyllitic & Phyllitic Quartzite
15-Aug-16	302.050	2	15	16	1					0.32	Nil	7		Nil	15	0.9	white	Grey Phyllitic & Phyllitic Quartzite traversed by Quartz veins
15-Aug-16	301.050	2	16	17	1					0.30	Nil	13		Nil	110	1.0	white	Small pieces of Phyllite & Phylitiuc Quartzite traversed by Quartz veins
16-Aug-16	300.050	2	17	18	1					0.33	Nil	10	306.75	Nil	50	1.0	white	Grey Phyllitic rock
16-Aug-16	299.050	2	18	19	1					0.30	Nil	11		Nil	50	1.0	white	Phyllite & Phillitic Quartzite traversed by Quartz veins
16-Aug-16	298.050	2	19	20	1					0.40	Nil	15		Nil	100	1.0	white	Small pieces of phyllite phylitiuc quartzite traversed by quartz veins

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-02**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 317.700**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 17-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 24-Aug-16**
Cordinates	**: X = 651520.133,Y = 3006418.049**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	Water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
17-Aug-16	317.7	0.5	0	1	1					0.15	Nil	4		Nil		1.00	white	Grey Phyllite Quartzite
17-Aug-16	316.7	2	1	2	1					0.20	Nil	10		Nil		1.75	white	Grey Phyllite Quartzite Traversed by Quartz veins at places
18-Aug-16	315.7	3	2	3	1					0.23	Nil	3		Nil		1.67	white	Coarse fine grain Quartzite hard
19-Aug-16	314.7	4	3	4	1					0.18	Nil	5	314.70	Nil		1.70	white	Coarse fine grain Quartzite hard occassionally traversed by Quartz veins
20-Aug-16	313.7	5	4	5	1					0.22	Nil	6		Nil		1.70	white	Coarse fine grain Quartzite hard occassionally traversed by Quartz veins of 1cm
20-Aug-16	312.7	5	5	6	1					0.36	Nil	10		Nil		1.77	white	Coarse fine grain Quartzite hard along with their Phyllite band
21-Aug-16	311.7	6	6	7	1					0.30	Nil	12	310.70	Nil		1.83	white	Grey Phyllitic Quartzite with thin (two) Quartz veins
21-Aug-16	310.7	7	7	8	1					Nil	Nil	Nil5		Nil		0.98	white	Grey Phyllitic quartzite without Quartz veins
21-Aug-16	309.7	8	8	9	1					0.21	Nil	10		Nil		0.83	white	Grey Phyllitic Quartzite
22-Aug-16	308.7	8	9	10	1					Nil	Nil	Nil	309.70	Nil	53	0.75	white	Grey fine grain powdary material recovered form sludge water
22-Aug-16	307.7	8	10	11	1					Nil	Nil			Nil	43	0.72	white	Grey fine grain powdary material recovered form sludge water
22-Aug-16	306.7	8	11	12	1					0.30	Nil	16		Nil	45	0.73	white	Fine grain grey Phyllite Quartzite
22-Aug-16	305.7	8	12	13	1					0.21	Nil	5		Nil	60	0.68	white	Fine grain grey Phyllite Quartzite traversed by one Quartz veins of 2 mm

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-02**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 317.700**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 17-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 24-Aug-16**
Cordinates	**: X = 651520.133,Y = 3006418.049**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	Water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
22-Aug-16	304.7	8	13	14	1					0.3	Nil	2		Nil	20	0.77	white	Fine grain grey Phyllite Quartzite traversed by two Quartz veins of 1-1.5 mm
22-Aug-16	303.7	8	14	15	1					0.40	Nil	9		Nil	32	0.80	white	Fine grain phyllitie Quartize with thin bands of Phyllite
23-Aug-16	302.7	8	15	16	1					0.22	Nil	3	306.70	Nil	60	1.58	white	Fine grain Phyllitie Quartize traversed by one Quartz veins of 3 mm
23-Aug-16	301.7	8	16	17	1					0.33	Nil	4		Nil	50	2.00	white	Fine grain Phyllitic Quartzite without Quartz veins
23-Aug-16	300.7	8	17	18	1					Nil	Nil	Nil		Nil	40	2.50	white	Fine grain Powdary sand from sludge water
24-Aug-16	299.7	8	18	19	1					0.35	Nil	7	307.70	Nil	90	1.67	white	Fine grain grey Phyllitic Quartzite traversed by one Quartz veins of 2 mm
24-Aug-16	298.7	8	19	20	1					0.40	Nil	13		Nil	50	1.54	white	Fine grey phyllitic Quartzite along with thin Phyllitic bands

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-03**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 311.677**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 26-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 31-Aug-16**
Cordinates	**: X=651522.931,Y=3006426.916**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
26-Aug-16	311.677	0.5	0	1	1					0.15	Nil	14		Nil	122	0.80	white	14 pieces of fine grain Silicified Quartzite at places traversed by Quartz veins
26-Aug-16	310.677	1	1	2	1					0.17	Nil	2	310.68	Nil	102	1.00	white	2 pieces of conglo meratic mate probably with cementing material
26-Aug-16	309.677	2	2	3	1					0.16	Nil	8		Nil	54	0.97	white	8 pieces of silified qreenish phyllitic & one pieces of conglo type.
26-Aug-16	308.677	2	3	4	1					0.18	Nil	3		Nil	104	1.69	white	Silicified Phyllitic rock with Quartz veins
27-Aug-16	307.677	3	4	5	1					0.24	Nil	5	309.68	Nil	107	0.96	white	Conglomeratic and aplitic fine grain rock hard
27-Aug-16	306.677	3	5	6	1					0.19	Nil	4		Nil	106	0.94	white	Hard aplitic conglo rock
27-Aug-16	305.677	4	6	7	1					0.18	Nil	3		Nil	110	0.91	white	Foliated Quartzitic type rock
28-Aug-16	304.677	7	7	8	1					0.22	Nil	9	308.58	Nil	115	0.87	white	Nine pieces Quartzitic queiss type rock
28-Aug-16	303.677	7	8	9	1					0.25	Nil	3		Nil	110	0.91	white	Silicified hard fine grain sericitic Quartzite
29-Aug-16	302.677	7	9	10	1					0.21	Nil	3	306.53	Nil	110	0.92	white	Fine grain silisified grey Quartzite traversed by thin Quartz veins
29-Aug-16	301.677	7	10	11	1					Nil	Nil	Nil		Nil	100	1.00	white	Fine grain powderly material collected from water sludge
29-Aug-16	300.677	7	11	12	1					0.18	Nil	9		Nil	113	0.89	white	Seven pieces of grey fine grain sericitic Quartzite material .
29-Aug-16	299.677	7	12	13	1					0.19	Nil	5		Nil	116	0.86	white	Silicified phyllitic Quartzite with thin Quartz veins

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-03**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 311.677**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 26-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 31-Aug-16**
Cordinates	**: X=651522.931,Y=3006426.916**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
30-Aug-16	298.677	7	13	14	1					Nil	Nil	Nil		Nil	110	1.00	white	Fine grain grey powdery grey material collected from sludge water
30-Aug-16	297.677	7	14	15	1					0.19	Nil	4	304.68	Nil	100	0.91	white	4 pieces of toliated Granite fine grain Quartzite grey Phyllitic
30-Aug-16	296.677	7	15	16	1					0.30	Nil	5		Nil	101	0.99	white	Fine grain hard grey Quarzite
31-Aug-16	295.677	7	16	17	1					Nil	Nil	Nil	304.53	Nil	100	0.98	white	Fine grain grey powdery material collected from sludge water
31-Aug-16	294.677	7	17	18	1					0.32	Nil	14		Nil	100	1.00	white	Silicified phyllitic rock with Quartz veins in total 14 pieces
31-Aug-16	293.677	7	18	19	1					0.25	Nil	7		Nil	103	0.97	white	Grey phyllitic rock
31-Aug-16	292.677	7	19	20	1					0.49	33	8		Nil	100	0.95	white	Fine grain Quartzite (Grey) at places with thin Quartz veins

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-04**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 304.722**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 5-Sep-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 11-Sep-16**
Cordinates	**: X=651529.126,Y=3006432.428**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
5-Sep-16	304.72	0.5	0	1	1					0.10		8		Loss		1.00		Grey silicified Phylitie
5-Sep-16	303.72	1	1	2	1					0.11		3		Loss		0.91		Granitic material with secondary silica
5-Sep-16	302.72	1	2	3	1					0.23	23	2	303.72	Loss		1.00		Grey Silicified Phylitie
6-Sep-16	301.72	2	3	4	1					0.25		4	303.22	Loss		0.98		11.6 & 6.8 cm pieces of granitic material & 2.5 cm fine grain grey Quarzite
6-Sep-16	300.72	3	4	5	1					0.27		13		Loss		0.97		Ten pieces granitic material with secondary silica
6-Sep-16	299.72	5	5	6	1					0.28		13		Loss		0.96		Fine grained grey Quartzite
6-Sep-16	298.72	5	6	7	1					0.22		4		Loss		0.91		4 pieces of fine grained Silicified rock
7-Sep-16	297.72	7	7	8	1					0.17		3		Loss		0.87		3 pieces of silicified phyllitic
7-Sep-16	296.72	7	8	9	1					0.23	15	2		Loss		0.89		Silicite quartzite with thin bending
8-Sep-16	295.72	7	9	10	1					0.20		5		Partly loss	104	0.77	White	Fine grained Phyllitic Quartzite , fine grain mica creep Quarzite one pieces
8-Sep-16	294.72	7	10	11	1					0.16		7		Partly loss	100	0.99	White	Folicated pieces of biotite Quartzite two pieces 3.5 cm ,8.5 cm fine grain Phyllitic Quartizite.
8-Sep-16	293.72	7	11	12	1					0.21		28		Partly loss	111	0.98	White	Fine grain granite pieces of 17.5 & 6.3 cm, 27 pieces of greenish sercilic quartzite

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-04**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,WB site**	Ground Elevation	**: 304.722**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 5-Sep-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 11-Sep-16**
Cordinates	**: X=651529.126,Y=3006432.428**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
9-Sep-16	292.72	7	12	13	1					0.24	11	4	299.72	Partly loss	118	1.00	White	Fine grain sericite Quartzite
9-Sep-16	291.72	7	13	14	1					0.14		3		Partly loss	150	0.97	White	Greenish sericite Quartzite
10-Sep-16	290.72	7	14	15	1					0.15		8		Partly loss	100	0.94	White	Phyllitic quartzite with iron leaching
10-Sep-16	289.72	7	15	16	1					0.17	12	2		Partly loss	120	0.96	White	Sericite Quartzite
11-Sep-16	288.72	7	16	17	1					0.18		5		Partly loss	100	0.94	White	Sericite Quartzite with thin Silica
11-Sep-16	287.72	7	17	18	1					0.19	12	2	292.72	Partly loss	150	0.99	White	Sericite Quartzite
11-Sep-16	286.72	7	18	19	1					0.25		6		Partly loss	150	1.10	White	Fine grain silicified Phylliite
11-Sep-16	285.72	7	19	20	1					0.28		7		Partly loss	150	0.98	White	Fine grain silicified greenish Quartzite.

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-05**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 17 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 303.890**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 13-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 31-Aug-16**
Cordinates	**: X=651567.272,Y=3006481.696**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run(m)															
			From	To														
13-Aug-16	303.890	0.5	0	0.5	0.5	100			100	25	Nil	4		No	65	0.63	White	Granitic aplitie folitated rock
13-Aug-16	302.89	0.5	1	2	1					28	14	6		No	65	1.19	White	Hard foliated aplitic rock Quartz veins with greenish Phyllitie
14-Aug-16	301.89	1	2	3	1					30	10	4		No	70	1.43	White	Mainly Quartz veins traversing greenish rock
14-Aug-16	300.89	1.5	3	4	1					16	Nil	9		No	70	1.11	White	Pieces of granitic and aplitic rock
18-Aug-16	299.89	2	4	5	1					17	Nil	6		No	75	2.27	White	Pieces of granitic and aplitic rock
18-Aug-16	298.89	3	5	6	1					25	Nil	9		No	55	2.17	White	Fine grain Quartzite Aplitic rock
18-Aug-16	297.89	4	6	7	1					24	Nil	4		No	55	1.82	White	Fine grain hard Sericite Quartzite with minor Phyllitic
19-Aug-16	296.89	6	7	8	1					Nil	Nil	Nil		No	50	2.86	White	Poweder clayey material from pit water
19-Aug-16	295.89	8	8	9	1					16	Nil	4		No	50	1.49	White	Clayey white core pieces
19-Aug-16	294.89	9	9	10	1					Nil	Nil	Nil		No	40	3.13	White	Powder material slump of return water
19-Aug-16	293.89	9	10	11	1					20	Nil	30		No	40	3.33	White	Fine grain grey Quartzite with phyllitic rock
19-Aug-16	292.89	9	11	12	1					21	Nil	6		No	40	2.78	White	Fine grain grey Quartzite with Quartz veins of places
20-Aug-16	291.89	9	12	13	1					Nil	Nil	Nil		No	38	2.94	White	Coarse sand with light and dark grains
20-Aug-16	290.89	9	13	14	1					25	Nil	23		No	35	2.70	White	Pieces of small greenish Phyllitic rock
21-Aug-16	289.89	9	14	15	1					Nil	Nil	Nil		No	35	2.63	White	Coarse sand with light and dark grains

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-05**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 17 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 303.890**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 13-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 31-Aug-16**
Cordinates	**: X=651567.272,Y=3006481.696**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run(m)															
			From	To														
21-Aug-16	288.89	9	15	16	1					22	Nil	19		No	30	2.44	White	Fine grain pieces of Sericite Quartzite with Quartz veins at places
21-Aug-16	287.89	9	16	17	1					38	10	5		No	25	2.27	White	Fine grain grey Sericite Quartzite with one Quartz veins of 2 mm

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-06**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 308.771**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 22-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 27-Aug-16**
Cordinates	**: X = 651573.888,Y = 3006488.814**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run(m)															
			From	To														
22-Aug-16	308.77	0.5	0	1	1	100			100	15	Nil	4		Light loss	110	2.27	Grey	Granitic folitated rock
22-Aug-16	307.77	1	1	2	1					17	Nil	10		Light loss	110	2.17	Grey	Pieces of granite fine grain Sericite Quartzite
23-Aug-16	306.77	2	2	3	1					20	Nil	20	306.77	Light loss	115	2.78	Grey	Pieces of granite fine grain Sericite Quartzite
23-Aug-16	305.77	3	3	4	1					30	Nil	4		Light loss	120	2.63	Grey	Fine grain Quartzite with Mica
24-Aug-16	304.77	4	4	5	1					38	19	23	305.77	Light loss	130	2.70	Grey	Granite rock pieces with fine grain grey Quartzite pieces
24-Aug-16	303.77	5	5	6	1					25	11	5		Light loss	130	1.52	Grey	Granite rock pieces without Quartzite
25-Aug-16	302.77	6	6	7	1					47	24	7	303.77	Light loss	130	1.25	Grey	Fine grain grey Quartzite & Granitic foliated
25-Aug-16	301.77	7	7	8	1					44	20	4		Light loss	100	1.19	Grey	Foliated Granite
26-Aug-16	300.77	8	8	9	1					45	20	7		Light loss	80	1.18	Grey	Fine grain grey Quartzite foliated
26-Aug-16	299.77	8	9	10	1					32	Nil	6	302.77	Light loss	70	1.54	Grey	Fine grain grey Quartzite & Granite
26-Aug-16	298.77	8	10	11	1					47		6		No loss	80	1.54	Grey	Fine grain grey Quartzite & Granite
26-Aug-16	297.77	8	11	12	1					50		6		No loss	40	1.30	Grey	Granite with fine grain grey quartzite

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-06**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 308.771**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 22-Aug-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 27-Aug-16**
Cordinates	**: X = 651573.888,Y = 3006488.814**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run(m)															
			From	To														
26-Aug-16	296.77	8	12	13	1					21		6		No loss	40	1.25	Grey	Fine grain grey to greenish Quartzite pieces
26-Aug-16	295.77	8	13	14	1					Nil		Nil		No loss	35	1.22	Grey	Medium grained sand with light & dark sand grains from sump
26-Aug-16	294.77	8	14	15	1					20		7		No loss	35	1.52	Grey	Fine grain grey to greenish Quartzite
27-Aug-16	293.77	8	15	16	1					Nil		Nil	302.27	No loss	30	1.56	Grey	Sand of light & dark sand pices from slump
27-Aug-16	292.77	8	16	17	1					24		7		No loss	30	1.30	Grey	Fine grain greyish Quartzite with one micaceous granite type
27-Aug-16	291.77	8	17	18	1					Nil		Nil		No loss	25	7.14	Grey	Sand of light & dark sand grains
27-Aug-16	290.77	8	18	19	1					32		8		No loss	25	1.54	Grey	Fine grain quartzite with Quartz veins of 1-2 mm
27-Aug-16	289.77	8	19	20	1					30		21		No loss	20	1.82	Grey	Fine grain quartzite with Quartz veins of 1-2 mm

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-07**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 308.159**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 4-Sep-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 7-Sep-16**
Cordinates	**: X = 651580.278,Y = 3006505.455**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
4-Sep-16	307.659	0	0.5	1	1					15	Nil	21		No	50	3.13	Grey	Small rounded to subrounded pieces of different rock type.
4-Sep-16	307.159	0.5	1	2	1					21	Nil	7		No	50	2.94	Grey	Pieces of granite Quartzite quartz veins etc.
4-Sep-16	306.159	1	2	3	1					20	Nil	5		No	55	2.50	Grey	Sericite Quartzite
4-Sep-16	305.159	2	3	4	1					17	Nil	5		No	55	2.17	Grey	Grey Quartzite & one granaite piece.
4-Sep-16	304.159	3	4	5	1					21	Nil	7		No	60	2.08	Grey	Pieces of Quartzaitic Granite
5-Sep-16	303.159	4	5	6	1					24	Nil	2	304.159	No	60	2.13	Grey	Foliated Granite
5-Sep-16	302.159	6	6	7	1					22	Nil	3		No	60	1.82	Grey	Foliated Granite
6-Sep-16	301.159	7	7	8	1					23	Nil	6	303.159	No	45	1.92	Grey	Foliated Granite
6-Sep-16	300.159	8	8	9	1					21	Nil	6		No	45	1.96	Grey	Foliated Granite
6-Sep-16	299.159	9	9	10	1					19	Nil	3		No	40	2.27	Grey	Quartz vein & grey Quartzite
6-Sep-16	298.159	9	10	11	1					Nil		Nil		No	40	2.22	Grey	Coarse sand from sludge
6-Sep-16	297.159	9	11	12	1					20		9		No	38	2.17	Grey	Granitic rock greenish Quartzite with quartz vein

Project	**RANGPO BRIDGE**	Bore Hole No.	**: BH-07**
Type of Core Barrel	**: NX Double core barrel**	Depth of hole	**: 20 m**
Location	**: Rangpo Bridge ,Sikkim site**	Ground Elevation	**: 308.159**
Method of Boring/Drilling	**: Shell/RMC**	Date of Start	**: 4-Sep-16**
Boring /Driling Equipment	**: Geo Rig with Diamond bit**	Date of Completion	**: 7-Sep-16**
Cordinates	**: X = 651580.278,Y = 3006505.455**	Operator Name	**: SK KARIM**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
6-Sep-16	296.159	9	12	13	1					12		4		No	35	2.13	Grey	Clayey core with pieces of Phyllitic
7-Sep-16	295.159	9	13	14	1					14		4	302.659	No	35	2.04	Grey	Clayey with pieces of phyllite
7-Sep-16	294.159	9	14	15	1					11		3		No	30	1.82	Grey	Clayey altered phyllities
7-Sep-16	293.159	9	15	16	1					24		9		No	30	1.72	Grey	Clay with phyllitic traversed by Quartz veins
7-Sep-16	292.159	9	16	17	1					Nil		Nil		No	30	1.72	Grey	Sandy material from sludge water
7-Sep-16	291.159	9	17	18	1					15		5		No	30	2.04	Grey	Greenish Quartzite with Quartz vein
7-Sep-16	290.159	9	18	19	1					22		5		No	25	1.82	Grey	Greenish Quartzite with Quartz vein
7-Sep-16	289.159	9	19	20	1					24		5		No	20	1.75	Grey	Quartzite & Phyllitic Quartzite

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	:	**RANGPO BRIDGE**	Bore Hole No.	:	**BH-08**
Type of Core Barrel	:	**NX Double Core barrel**	Depth of hole	:	**20 m**
Location	:	**Rangpo Bridge ,Sikkim site**	Ground Elevation	:	**308.217**
Method of Boring/Drilling	:	**Shell/RMC**	Date of Commencemer	:	**8-Sep-16**
Boring /Driling Equipment	:	**Geo rig Diamond bit**	Date of Completion	:	**12-Sep-16**
Cordinates	:	**X = 651587.152, Y = 3006512.475**	Operator Name	:	

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
8-Sep-16	308.217	0.50	0	1	1					10	Nil	7		Loss	100	2.13		Small pieces of Granite Phyllitic Quartzite Phyllile
8-Sep-16	307.217	1.00	1	2	1					15	Nil	5		Loss	100	2.08		Small pieces of Granite Phyllitic Quartzite Phyllile
9-Sep-16	306.217	1.50	2	3	1					19	Nil	6		Loss	125	2.08		Biolite granite ,Quartzite, phylletic Quartzite
9-Sep-16	305.217	2.50	3	4	1					10	Nil	8		Loss	125	2.04		Small pieces of granite ,phyllitic Quartzite traversed by Quartz vein
9-Sep-16	304.217	3.50	4	5	1					17	Nil	3		Loss	150	1.82		Quartzite & Sericite Quartzite
10-Sep-16	303.217	5.00	5	6	1					19	Nil	10	301.717	Loss	160	1.64		Granitic rock with minor phyllitic Quartize pieces
10-Sep-16	302.217	6.50	6	7	1					38	38	1		Loss	160	1.54		Single core of foliated Granaite
10-Sep-16	301.217	6.50	7	8	1					22	Nil	4		NO	75	1.75	Grey	Granitc rock
11-Sep-16	300.217	6.50	8	9	1					17	10	2	301.717	NO	50	1.72	Grey	Granitc rock foliated with Quartz veins
11-Sep-16	299.217	6.50	9	10	1					16	Nil	3		NO	40	1.75	Grey	Granitc rock foliated with Quartz veins
11-Sep-16	298.217	6.50	10	11	1					17	Nil	5		NO	50	1.82	Grey	Foliated coarse biolite Granite
11-Sep-16	297.217	6.50	11	12	1					21	Nil	4		NO	50	1.96	Grey	Foliated biotite Granite with quartz veins

Project	:	**RANGPO BRIDGE**	Bore Hole No.	:	**BH-08**
Type of Core Barrel	:	**NX Double Core barrel**	Depth of hole	:	**20 m**
Location	:	**Rangpo Bridge ,Sikkim site**	Ground Elevation	:	**308.217**
Method of Boring/Drilling	:	**Shell/RMC**	Date of Commencemer	:	**8-Sep-16**
Boring /Driling Equipment	:	**Geo rig Diamond bit**	Date of Completion	:	**12-Sep-16**
Cordinates	:	**X = 651587.152, Y = 3006512.475**	Operator Name	:	

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
11-Sep-16	296.217	6.50	12	13	1					22	Nil	3		NO	55	2.17	Grey	Foliated biotite granite with quartz veins medium to coarse grained
11-Sep-16	295.217	6.50	13	14	1					24	Nil	3		NO	55	2.08	Grey	Phyllitic Quartzite with quartz veins
12-Sep-16	294.217	6.50	14	15	1					18	Nil	4	301.717	NO	55	1.92	Grey	Coarse biotite Granite foilited
12-Sep-16	293.217	6.50	15	16	1					24	10	3		NO	60	1.82	Grey	Coarse biotite Granite foilited
12-Sep-16	292.217	6.50	16	17	1					17	Nil	3		NO	60	2.17	Grey	Fine granite & Quartzite
12-Sep-16	291.217	6.50	17	18	1					18	Nil	3		NO	70	2.27	Grey	Greenish Quartzite traversed by Quartz veins of 1/2 cm
12-Sep-16	290.217	6.50	18	19	1					20	Nil	2		NO	70	2.00	Grey	One pieces of basic rock & Quartzite 1 pieces
12-Sep-16	289.217	6.50	19	20	1					22	Nil	3		NO	75	1.85	Grey	Greenish Quartzite traversed by Quartz veins of 1/2 cm

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project : **CHISOPANI TUNNEL**
Type of Core Barrel : **NX Double core barrel**
Location : **TUNNEL INLET**
Method of Boring/Drilling : **Shell/RMC**
Boring /Driling Equipment : **Geo rig with Diamond bit**
Cordinates : **X=650535.678 ,Y=3014099.881**

Bore Hole No. : **BH-01**
Depth of hole : **45 m**
Ground Elevation : **503.442**
Date of Start : **22-Aug-16**
Date of Completion : **4-Sep-16**
Operator Name : **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	To														
22-Aug-16	503.442	0.5	0	1	1					0.18	Nil	5	0	Loss	250	1.389		Thinly sedded Phylletic partly altered Quartzite
22-Aug-16	502.442	1.5	1	2	1					0.19	Nil	3	0	Loss	300	1.333		Phyllitic Quartzite
23-Aug-16	501.442	2.5	2	3	1					Nil	Nil	Nil	0	Loss	300	2.500		Coarse sand recovered from sludge water
23-Aug-16	500.442	3.5	3	4	1					0.14	Nil	10	0	Loss	350	1.471		Partly altered phyllitic with Quartzite
23-Aug-16	499.442	4.5	4	5	1					0.2		4	0	Loss	400	1.429		Phyllitic quartzite with iron leaching on weak planes
23-Aug-16	498.442	5.0	5	6	1					0.14		4		Loss	400	1.370		Phyllitic quartzite with iron leaching on weak planes
24-Aug-16	497.442	6.5	6	7	1					0.21		7	497.9	Loss	300	1.351		Altered phyllitic Quartzite
24-Aug-16	496.442	7.5	7	8	1					0.2		5		Loss	300	1.176		Grey phyllitic Quartzite with visible joint planes
25-Aug-16	495.442	7.5	8	9	1					0.22		5	495.94	Loss	300	1.190		Phylletic Quartzite silisified with thin quartz veins
25-Aug-16	494.442	7.5	9	10	1					0.28		8		Loss	350	0.800		Grey phyllitic rock traversed by quartz veins (2-3 cm thick)
26-Aug-16	493.442	7.5	10	11	1					0.2		5	495.24	Loss	350	1.176		Phyllite & Phyllitic Quartzite traversed by thin quartz veins

Project	: **CHISOPANI TUNNEL**	Bore Hole No.	: **BH-01**
Type of Core Barrel	: **NX Double core barrel**	Depth of hole	: **45 m**
Location	: **TUNNEL INLET**	Ground Elevation	: **503.442**
Method of Boring/Drilling	: **Shell/RMC**	Date of Start	: **22-Aug-16**
Boring /Driling Equipment	: **Geo rig with Diamond bit**	Date of Completion	: **4-Sep-16**
Cordinates	: **X=650535.678 ,Y=3014099.881**	Operator Name	: **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	To														
26-Aug-16	492.442	7.5	11	12	1					0.2		6		Loss	350	1.220		Pieces of phyllites
26-Aug-16	491.442	7.5	12	13	1					0.22		11		Loss	400	1.163		Phyllite & phylletic quartzite pieces at places with quartz veins
27-Aug-16	490.442	7.5	13	14	1					0.21		7	494.94	Loss	400	1.136		Phyllite & Phyllitic Quartzite
27-Aug-16	489.442	7.5	14	15	1					0.24		6		Loss	450	1.087		Mainly pieces of grey quartzitie with very little Phyllite
27-Aug-16	488.442	7.5	15	16	1					0.2		7		Loss	450	1.220		Pieces of quartzite
27-Aug-16	487.442	7.5	16	17	1					0.31		11		Loss	500	1.075		Mainly small pieces of grey Phyllite with two pieces of Phyllite Quartzite
28-Aug-16	486.442	7.5	17	18	1					0.28		13	494.44	Loss	2000	0.952		Small pieces of grey phyllite one pieces of quartz veins (1 cm)
28-Aug-16	485.442	7.5	18	19	1					0.22	Nil	3		Loss	2000	0.971		Phyllite & Phyllitic Quartzite traversed by thin quartz veins
28-Aug-16	484.442	7.5	19	20	1					0.23		4		Loss	2000	1.064		Grey Phyllite traversed by quartz veins
28-Aug-16	483.442	7.5	20	21	1					0.3		4		Loss	2000	1.042		Grey Phyllite traversed by quartz veins
29-Aug-16	482.442	7.5	21	22	1					0.25		5	494.44	Loss	2200	1.190		Grey Phyllite traversed by quartz veins
29-Aug-16	481.442	7.5	22	23	1					0.28		6		Loss	2200	1.220		Grey Phyllite traversed by quartz veins

Project	: **CHISOPANI TUNNEL**	Bore Hole No.	: **BH-01**
Type of Core Barrel	: **NX Double core barrel**	Depth of hole	: **45 m**
Location	: **TUNNEL INLET**	Ground Elevation	: **503.442**
Method of Boring/Drilling	: **Shell/RMC**	Date of Start	: **22-Aug-16**
Boring /Driling Equipment	: **Geo rig with Diamond bit**	Date of Completion	: **4-Sep-16**
Cordinates	: **X=650535.678 ,Y=3014099.881**	Operator Name	: **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
29-Aug-16	480.442	7.5	23	24	1					0.21		4		Loss	2200	1.149		Grey Quartzite with Phyllite traversed by Quartz veins
29-Aug-16	479.442	7.5	24	25	1					0.29		5		Loss	2300	0.909		Grey Quartzite with Phyllite traversed by Quartz veins
30-Aug-16	478.442	7.5	25	26	1					0.22		6	494.44	Loss	2300	1.205		Mainly grey Phyllite with Phyllitic quartz band
30-Aug-16	477.442	7.5	26	27	1					0.23		4		Loss	2300	1.220		Phyllitic Quartzite traversed by thin quartz veins
30-Aug-16	476.442	7.5	27	28	1					0.29		5		Loss	2300	0.855		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
30-Aug-16	475.442	7.5	28	29	1					0.23		4		Loss	2350	1.042		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
31-Aug-16	474.442	7.5	29	30	1					0.28		5	494.44	Loss	2350	1.064		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
31-Aug-16	473.442	7.5	30	31	1					0.31		6		Loss	2350	1.087		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
31-Aug-16	472.442	7.5	31	32	1					0.28		5		Loss	2400	1.149		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
1-Sep-16	471.442	7.5	32	33	1					0.21		5	494.44	Loss	2400	1.190		Phyllitic Quartzite with rare Phyllite traversed by quartz vein
1-Sep-16	470.442	7.5	33	34	1					0.3		9		Loss	2400	1.205		Phyllitic Quartzite & Phyllitic traversed by quartz veins have Phyllite content increased 20%
1-Sep-16	469.442	7.5	34	35	1					0.26		8		Loss	2400	1.235		Phyllite & Phyllitic quartzite traversed by quartz veins 60 :40%

Project	: **CHISOPANI TUNNEL**	Bore Hole No.	: **BH-01**
Type of Core Barrel	: **NX Double core barrel**	Depth of hole	: **45 m**
Location	: **TUNNEL INLET**	Ground Elevation	: **503.442**
Method of Boring/Drilling	: **Shell/RMC**	Date of Start	: **22-Aug-16**
Boring /Driling Equipment	: **Geo rig with Diamond bit**	Date of Completion	: **4-Sep-16**
Cordinates	: **X=650535.678 ,Y=3014099.881**	Operator Name	: **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m) From	Depth/Run (m) To														
1-Sep-16	468.442	7.5	35	36	1					0.25		5		Loss	2450	1.163		Mainly Phyllite with Phyllitic quartzite traversed by quartz veins (80:20 %)
1-Sep-16	467.442	7.5	36	37	1					0.34		6		Loss	2450	0.935		Mainly Phyllite with Phyllitic quartzite traversed by quartz veins (90:10 %)
2-Sep-16	466.442	7.5	37	38	1					0.32		7	494.44	Loss	2450	0.820		Phyllite Quartzite with minor Phyllite traversed by quartz veins (1-1.5 cm thick)
2-Sep-16	465.442	7.5	38	39	1					0.4		5		Loss	2350	0.926		Phyllite Quartzite with minor Phyllite traversed by quartz veins (1-1.5 cm thick)
2-Sep-16	464.442	7.5	39	40	1					0.34		9		Loss	2000	0.943		Phyllite & phyllitic quartzite protusly traversed by quartz veins 80:20 %
3-Sep-16	463.442	7.5	40	41	1					0.27		6	494.44	Loss	700	1.220		Phyllitic Quartzite & Phyllitic traversed by quartz veins 50:50%
3-Sep-16	462.442	7.5	41	42	1					0.3	13%	8		Loss	700	1.351		Phyllitic Quartzite & Phyllitic traversed by quartz veins 60:40%
3-Sep-16	461.442	7.5	42	43	1					0.26		7		Loss	500	1.282		Phyllitic Quartzite & Phyllitic traversed by quartz veins 50:50%
3-Sep-16	460.442	7.5	43	44	1					0.36	15%	3		Loss	500	0.980		Phyllitic Quartzite & Phyllitic traversed by quartz veins 60:40%
4-Sep-16	459.442	7.5	44	45	1					0.35	35%	8	494.44	Loss	500	0.926		Phyllitic Quartzite & Phyllitic traversed by quartz veins 40:60%

GEOLOGICAL LOG OF BORE / DRILL HOLE

Project	:	**CHISOPANI TUNNEL**	Bore Hole No.	:	**BH-02**
Type of Core Barrel	:	**Nx Double Core barrel**	Depth of hole	:	**45 m**
Location	:	**TUNNEL OUTLET**	Ground Elevation	:	**503.76**
Method of Boring/Drilling	:	**Shell/RMC**	Date of Start	:	**9-Sep-16**
Boring /Driling Equipment	:	**Geo rig with Diamond bit**	Date of Completion	:	**21-Sep-16**
Cordinates	:	**X=650709.700, Y=3014239.899**	Operator Name	:	**Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
9-Sep-16	503.76	0.5	0	1	1					0.20	Nil	10		Loss	200	1.32	NA	Greenish Phyllite Quartzite with minor phillite
9-Sep-16	502.76	0.5	1	2	1					0.24	Nil	4		Loss	260	1.25		Mainly Phyllitic Quartzite with minor Phyllite 90:10 %
9-Sep-16	501.76	0.5	2	3	1					0.25	Nil	3		Loss	300	1.39		Mainly Phyllitic Quartzite with minor Phyllite 90:10 %
9-Sep-16	500.76	0.5	3	4	1					0.24	Nil	4		Loss	340	1.43		Mainly phyllitic quartzite with occassionaly thin quartz veins
9-Sep-16	499.76	0.5	4	5	1					0.20	Nil	3		Loss	375	1.33		Phyllitic quartzite with iron leaching on waeak planes
10-Sep-16	498.76	0.5	5	6	1					0.25	Nil	3		Loss	400	1.33		Good core but recovery poor.
10-Sep-16	497.76	0.5	6	7	1					0.25	Nil	4		Loss	380	1.25		Greenish Phyllitie with Phyllite Quartzite.
10-Sep-16	496.76	0.5	7	8	1					0.20	Nil	6		Loss	400	1.25		Greenish Phyllite traversed by quartz veins
10-Sep-16	495.76	0.5	8	9	1					0.25	Nil	4		Loss	400	1.11		Greenish Phyllite Quartzite with quartz veins.
10-Sep-16	494.76	0.5	9	10	1					0.26	Nil	5		Loss	1360	1.08		Greenish Phyllite Quartzite with quartz veins.
10-Sep-16	493.76	0.5	10	11	1					0.28	Nil	7		Loss	1360	1.05		Greenish Phyllite Quartzite with quartz veins.
11-Sep-16	492.76	0.5	11	12	1					0.25	Nil	6		Loss	1360	1.05		Phyllite & Phyllitic Quartzite traversed by quartz veins
11-Sep-16	491.76	0.5	12	13	1					0.27	Nil	5		Loss	1400	1.03		Phyllite & Phyllitic Quartzite pieces at places with quartz veins

Project	: **CHISOPANI TUNNEL**	Bore Hole No.	: **BH-02**
Type of Core Barrel	: **Nx Double Core barrel**	Depth of hole	: **45 m**
Location	: **TUNNEL OUTLET**	Ground Elevation	: **503.76**
Method of Boring/Drilling	: **Shell/RMC**	Date of Start	: **9-Sep-16**
Boring /Driling Equipment	: **Geo rig with Diamond bit**	Date of Completion	: **21-Sep-16**
Cordinates	: **X=650709.700, Y=3014239.899**	Operator Name	: **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
11-Sep-16	490.76	0.5	13	14	1					0.27	Nil	11		Loss	1400	1.14		Greenish Phyllitic Quartizite with minor Phyllite traversed by quartz veins 60:40%
11-Sep-16	489.76	0.5	14	15	1					0.29	Nil	7		Loss	1425	1.11		Greenish Phyllitic Quartizite with minor Phyllite traversed by quartz veins 60:40%
11-Sep-16	488.76	0.5	15	16	1					0.32	Nil	8		Loss	1425	1.11		Greenish Phyllitic Quartizite with minor Phyllite traversed by quartz veins 60:40%
12-Sep-16	487.76	0.5	16	17	1					0.34	Nil	8		Loss	1450	1.15		Banded Phyllite & Phyllitic Quartzite with occassionaly quartz veins
12-Sep-16	486.76	0.5	17	18	1					0.38	Nil	7		Loss	1700	1.11		Banded Phyllite & Phyllitic Quartzite with occassionaly quartz veins
13-Sep-16	485.76	0.5	18	19	1					0.42	Nil	11		Loss	2000	1.05		Greenish Phyllitic rock with minor Quartzite traversed by quartz veins with oxidation.
13-Sep-16	484.76	0.5	19	20	1					0.40	Nil	14		Loss	2000	1.03		Greenish Phyllitic rock with minor Quartzite traversed by quartz veins with oxidation.
13-Sep-16	483.76	0.5	20	21	1					0.41	Nil	8		Loss	2050	1.02		Banded Phyllite & Phillitic Quartzite with quartz veins
14-Sep-16	482.76	0.5	21	22	1					0.40	Nil	18		Loss	2100	1.05		Banded Phyllite & Phillitic Quartzite with quartz veins
14-Sep-16	481.76	0.5	22	23	1					0.48	Nil	7		Loss	2200	1.11		Banded Phyllite & Phillitic Quartzite with quartz veins
14-Sep-16	480.76	0.5	23	24	1					0.42	Nil	7		Loss	2200	1.15		Phyllite & Phillitic quartzite with quartz veins with profusion thin quartz veins along bedding plane
15-Sep-16	479.76	0.5	24	25	1					0.43	Nil	8		Loss	2250	1.25		Mainly Phyllitic Quartzite with few thin quartz veins
15-Sep-16	478.76	0.5	25	26	1					0.42	Nil	9		Loss	2300	1.18		Mainly Phyllitic Quartzite with few thin quartz veins
16-Sep-16	477.76	0.5	26	27	1					0.28	Nil	6		Loss	2300	1.18		Grey Quartzite with Phyllitic quartzite with quartz veins

Project	: **CHISOPANI TUNNEL**		Bore Hole No.	: **BH-02**	
Type of Core Barrel	: **Nx Double Core barrel**		Depth of hole	: **45 m**	
Location	: **TUNNEL OUTLET**		Ground Elevation	: **503.76**	
Method of Boring/Drilling	: **Shell/RMC**		Date of Start	: **9-Sep-16**	
Boring /Driling Equipment	: **Geo rig with Diamond bit**		Date of Completion	: **21-Sep-16**	
Cordinates	: **X=650709.700, Y=3014239.899**		Operator Name	: **Md.Qamrudin**	

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
16-Sep-16	476.76	0.5	27	28	1					0.36	Nil	10		Loss	2300	1.18		Phyllitic quartz with oxidation & quartz veins
16-Sep-16	475.76	0.5	28	29	1					0.32	Nil	8		Loss	2300	1.18		Phyllitic quartz with oxidation & quartz veins
18-Sep-16	474.76	0.5	29	30	1					0.51	Nil	10		Loss	2325	1.11		Phyllitic Quartize & Phylitie with quartz veins & iron leaching with Phyllite
18-Sep-16	473.76	0.5	30	31	1					0.40	Nil	6		Loss	2350	1.11		Phyllitic Quartzite with minor Phyllite traversed by quartz veins
19-Sep-16	472.76	0.5	31	32	1					0.36	Nil	11		Loss	2350	1.14		Phyllitic Quartzite with minor Phyllite traversed by quartz veins with oxidation.
19-Sep-16	471.76	0.5	32	33	1					0.35	Nil	8		Loss	2400	1.05		Phyllitic Quartzite with minor Phyllite traversed by quartz veins with oxidation.
19-Sep-16	470.76	0.5	33	34	1					0.43	Nil	13		Loss	2400	1.05		Phyllite with minor phyllitic quartzite traversed by quartz veins
19-Sep-16	469.76	0.5	34	35	1					0.41	Nil	6		Loss	2450	1.11		Phylite & Phyllitic quartzite 50:50% traversed by quartz veins
19-Sep-16	468.76	0.5	35	36	1					0.54	Nil	8		Loss	2500	1.09		Phylite & Phyllitic quartzite 50:50% traversed by quartz veins
20-Sep-16	467.76	0.5	36	37	1					0.58	Nil	7		Loss	2500	1.09		Phyllitic Quartzite with minor Phyllite traversed by quartz veins
20-Sep-16	466.76	0.5	37	38	1					0.58	Nil	4		Loss	2500	1.14		Phyllitic Quartzite with minor Phyllite traversed by quartz veins
20-Sep-16	465.76	0.5	38	39	1					0.58	Nil	6		Loss	2500	1.11		Phyllitic Quartzite with minor Phyllite traversed by quartz veins
20-Sep-16	464.76	0.5	39	40	1					0.50	Nil	7		Loss	2450	1.09		Phyllitic Quartzite with minor Phyllite traversed by quartz veins
20-Sep-16	463.76	0.5	40	41	1					0.52	Nil	6		Loss	2450	1.15		Phyllitic Quartzite with minor Phyllite traversed by quartz veins

Project	: **CHISOPANI TUNNEL**	Bore Hole No.	: **BH-02**
Type of Core Barrel	: **Nx Double Core barrel**	Depth of hole	: **45 m**
Location	: **TUNNEL OUTLET**	Ground Elevation	: **503.76**
Method of Boring/Drilling	: **Shell/RMC**	Date of Start	: **9-Sep-16**
Boring /Driling Equipment	: **Geo rig with Diamond bit**	Date of Completion	: **21-Sep-16**
Cordinates	: **X=650709.700, Y=3014239.899**	Operator Name	: **Md.Qamrudin**

Date	Elevation (m)	Sample and in situ Test			Depth (m)	* No. of Blows			N' Value	Core Recoverd (m)	R.Q.D. (%)	No. of Pieces	Depth of water levels from Grd	Water loss	water used in lit	Penetration rate cm/min	Colour of return water	Remarks
		Casing depth (m)	Depth/Run (m)															
			From	To														
21-Sep-16	462.76	0.5	41	42	1					0.47	Nil	5		Loss	2400	1.15		Phyllitic Quartzite with minor Phyllite traversed by quartz veinswith oxidized carries
21-Sep-16	461.76	0.5	42	43	1					0.45	Nil	3		Loss	2450	1.11		Banded Phyllite & Phyllitic Quartzite with quartz veins rock sheared
21-Sep-16	460.76	0.5	43	44	1					0.50	Nil	4		Loss	2500	1.05		Banded Phyllite & Phyllitic Quartzite with thick quartz veins
21-Sep-16	459.76	0.5	44	45	1					0.47	Nil	6		Loss	2400	1.05		Banded Phyllite & Phyllitic Quartzite with quartz veins rock sheared

BORE HOLE PHOTO FOR RANGPO BRIDGE SIDE

BORE HOLE NO-01

BORE HOLE NO-02 (PART-01)

BORE HOLE NO-02 (PART-02)

BORE HOLE NO-03

BORE HOLE NO-04

BORE HOLE NO-05

BORE HOLE NO-06 (PART-01)

BORE HOLE NO-06 (PART-02)

BORE HOLE NO-07

BORE HOLE NO-08

BORE HOLE PHOTO FOR CHISOPANI TUNNEL SIDE

BORE HOLE NO-01 INLET (PART-01) (FROM 0 TO 20)

BORE HOLE NO-01 INLET (PART-02) (FROM 20 TO 36)

BORE HOLE NO-01 INLET (PART-03) (FROM 36 TO 45)

BORE HOLE NO-02 OUTLET (PART-01) (FROM 0 TO 16)

BORE HOLE NO-02 OUTLET (PART-02) (FROM 16 TO 26)

BORE HOLE NO-02 OUTLET (PART-03) (FROM 26 TO 36)

BORE HOLE NO-02 OUTLET (PART-04) (FROM 36 TO 44)

BORE HOLE NO-02 OUTLET (PART-05) (FROM 44 TO 45)

TOPOGRAPHICAL SURVEY PILLAR AT RANGPO BRIDGE SITE

Sikkim side on Concrete pillar	Sikkim side on Concrete pillar
(X=651548.295 , Y = 3006493.232 ,Z = 308.560)	(X=651536.037, Y=3006505.732 , Z=308.380)

West Bengal side on Concrete pillar	West Bengal side on Concrete pillar
(X =651545.192 , Y =3006405.515 , Z =318.666)	(X=651537.792 , Y=3006399.897 , Z= 319.383)

TOPOGRAPHICAL SURVEY PILLAR AT CHISOPANI TUNNEL SITE

GPS PILLAR- G-01 Singtam Side	GPS PILLAR- G-02 Singtam Side
(X=650578.994 , Y=3014042.997 , Z= 470.996)	(X=650594.161,Y=3014048.522 ,Z= 471.480)

GPS PILLAR- G-03 Gangtok Side	GPS PILLAR- G-04 Gangtok Side
(X=650889.110,Y=3014429.117 ,Z= 472.770)	(X=650896.408,Y=3014445.098 ,Z= 473.225)

RANGPO BRIDGE PROJECT SITE PHOTO

Proposed Bridge site on West Bengal

Existing Bridge approach on Sikkim Side

Existing Bridge

Existing Bridge approach on West Bengal Side

Existing Bridge approach on West Bengal Side

Existing Bridge approach on West Bengal Side

Existing Bridge

Existing Bridge approach on West Bengal Side

Proposed Bridge Site on West Bengal

Sikkim Site existing bridge abutment wall footing

Existing Bridge from Downstream side on West Bengal

Existing bridge bottom view

Spurs wall on Sikkim side

Spurs wall on Sikkim side

Spurs wall on West Bengal side

Proposed Bridge Abutment site on Sikkim side

Proposed Bridge Abutment site on Sikkim side


Proposed Bridge site on Sikkim side


Geotechnical Investigation at bridge site


Topographical survey at bridge site

CHISOPANI TUNNEL PROJECT SITE PHOTO


Existing Tunnel Inlet


Existing Tunnel

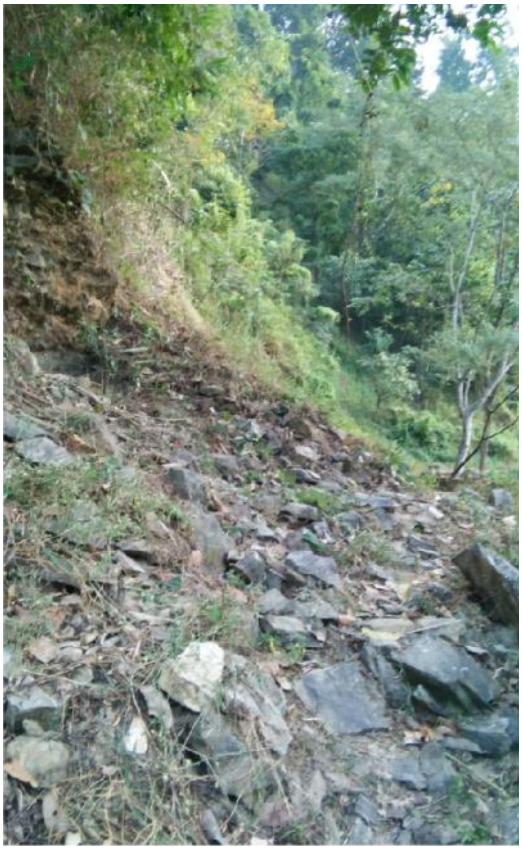

Existing Tunnel Outlet

Abandoned Open Chennel drain of small Hydal Power project on the Top of Existing Tunnel

Hill side & Valley side of Existing & Proposed Tunnel site

Proposed Tunnel Inlet & Outlet Approach


Proposed Tunnel Inlet Location

Proposed Tunnel Outlet Location