Annexure: 2.28

परियोजना का नाम :– जनपद चमोली के थराली ब्लॉक मे थराली घाट मोटर मार्ग के किमी0–3 में क्रोनिक स्लिप जोन के सुरक्षात्मक कार्य हेतु वनभूमि प्रस्ताव।

भू–वैज्ञानिक की आख्या

संलग्न है।

अमिन	कनिष्ठ अभियन्ता	सहायक अभियन्ता	अधिशासी अभियन्ता अधिशासी अभियन्ता निर्माण खण्ड लो0 नि0 वि0 थराली (चमोली)

CONSOLIDATED CONSULTANTS GROUP

Ref. No. CCEE-JSV/UDRP-WB/DSC/RP/01/2018-19/0151 Date: 05 Dec, 2018

To,

Executive Engineer
World Bank Division,
PWD, Karnprayag,Gochar,
District Chamoli
(Uttrakhand

SUB: - Design and Supervision Consultant - Road Protection Works (Pkg No. UDRP/R&B/AF/DSC/RP/01: **Regarding submission Draft Geotechnical Investigation Report GSCC Appendices (Times Based) TOR Sl No 7 Deliverables for supervision of Road Protection Work Table 2 Sl No 3**

Ref: Our Agreement No UDRP/R&B/AF/DSC/RP/01 dt 18/08/2018

Dear Sir,

In continuation of aforesaid submission of **Draft_Geotechnical Investigation Report,** GCC Appendices (Times Based) TOR Sl. No 7 Deliverables for Supervision of Road Protection Work Table 2 Sl No 3.

1. **Tharali Ghat Motor Road at km 3**

This is for your kind information and necessary review please.

Thanking You

M/S. CCEE Group India Pvt. Ltd.,
In Association with JSV Technocrats LLP

TEAM LEADER DSC-01
SC (ROAD PROTECTION)
CCEE GROUP-JSV TECHNOCRATS LLP

Team Leader
Ram Parwesh Prasad

CC:
1. CHE, Procurement, UDRP-AF, PWD,WB, Dehradun
2. DPM,UDRP-AF, PWD, WB, Dehradun,
3. EE, PWD, World Bank Division, Karnprayag, Gochar
4. SE,PWD, World Bank Division, Karnprayag, Gochar

Encl: 2 Copies of Geotechnical Investigation Report

Head Office: F-201, Arboria Apartment, TarlaNagal, Mussoorie Bypass, Dehradun-248 001
Registered Office: 570/8-B, Nakul Gali, Vishwash Nagar, Shahdara, Delhi-110 032 India
Contact No.: +91-99108 75109; +91-93100 79226
Email: India@group-cc.com; jsvtechnocrats@gmail.com
Subsidiary of Consolidated Consultants Group, Jordan; www.group-cc.com
DESIGN MANAGEMENT SERVICES SPECIALIZED STUDIES

ECON Laboratory and Consultancy

Vill.: Khabarwala, P.O.: Jaintanwla, NearGarhi Cantt.,
Dehradun, Uttarakhand-248003
Contact No: +91-8534957815, 8126534344, Web: www.econlaboratory.com,
Email: uk@econlaboratory.com, econlab.consultancy@yahoo.in

Date: 26/11/2018 **Place: Dehradun**

To,

The Team Leader

M/s CCEE Group India Pvt. Ltd.,

in Association with JSV Technocrates LLP.

F-201, Arboria Apartment, Tarai Nagal,

Mussorie bypass, Dehradun-248001.

Subject: Submission of Final Geotechnical Investigation Report for existing hill road slope protection work at TharaliGhat motor road at Km-03, Dist. Chamoli Garhwal.

Sir,

We are herewith submitting the Final Geotechnical Investigation Report for existing hill road slope protection work at TharaliGhat motor road at Km-03, Chamoli Garhwal.

Thanking you!

Yours Sincerely,

Dr. Mahadev Semwal

ECON Laboratory and Consultancy
Vill.: Khabarwala, P.O.: Jaintanwala,
Near Garhi Cantt. Dehradun-248003

GEO-TECHNICAL INVESTIGATION REPORT FOR EXISTING HILL ROAD SLOPE PROTECTION WORK AT THARALI GHAT MOTOR ROAD KM-3, DIST. CHAMOLI, UTTARAKHAND, INDIA

REPORT FOR

DETERMINATION OF SAFE BEARING CAPACITY & NATURE OF STRATA

SUBMITTED TO

M/S CCEE GROUP INDIA PVT.LTD.
IN ASSOCIATION WITH
JSV TECHNOCRATS L.L P.
JAIPUR, RAJASTHAN

NOVEMBER, 2018

PREPARED BY

ECON LABORATORY AND CONSULTANCY
(ISO 9001, ISO 14001 Certified & NABL Accredited Laboratory)
Vill. Khabarwala, P.O.: Jaintanwala, Near Garhi Cantt.,
Dehradun, Uttarakhand-248003
Web: www.econlaboratory.com, email: uk@econlaboratory.com,
econlab.consultancy@yahoo.in,
Contact No:+91- 8126534344, 8534957815

TABLE OF CONTENTS

Consultancy
P.O.: Jaintanwala,
Dehradun-248003

sumesh.consultancy@yahoo.in

1.0 INTRODUCTION

The work on detailed geotechnical investigation for existing hill road slope protection work at Tharali ghat motor road km-3, Dist. Chamoli in the state of Uttarakhand, India.

The work of detailed geotechnical investigation work of location of hill side section was taken up to explore the construction site by subsurface exploratory drilling in order to understand the subsurface geological conditions at locations and to assess the foundations competency & nature of sub soil strata.

This report includes the safe gross bearing pressure for location. Geological borehole log, soil profile / rock profile table with the test results for Boreholes at locations is presented at the end of this report in Appendixes

PURPOSE OF STUDY

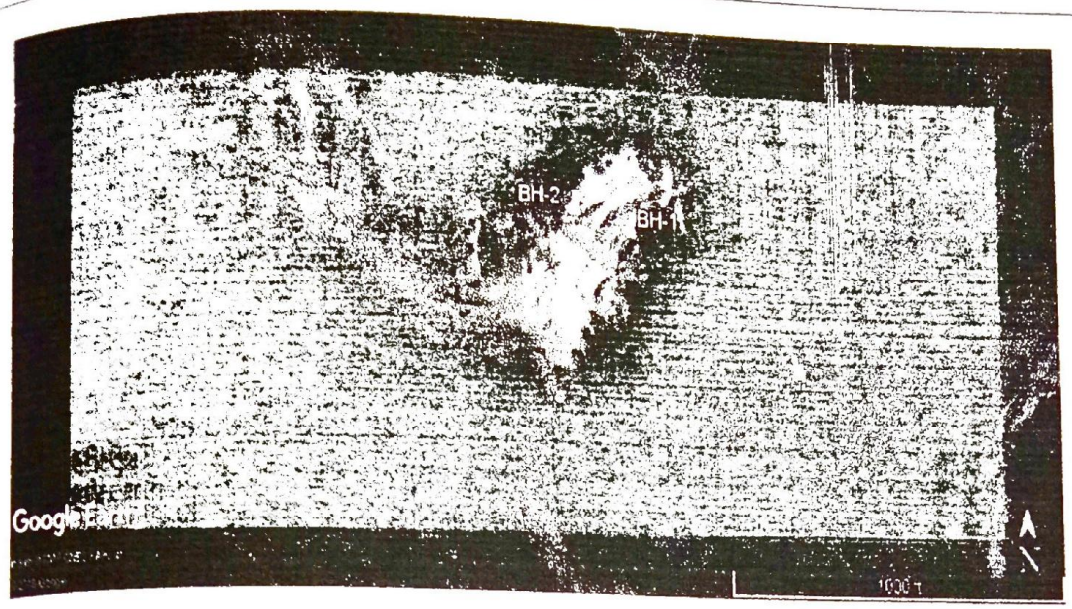
The purpose of the study was to evaluate the sub surface litho-logy up to a depth of 15.0 m from ground level at the proposed locations, so as to develop recommendations for foundation design. To accomplish this purpose, the study was conducted in following phases.

- Drilling of two number boreholes at the proposed locations to determine subsoil condition as well as to obtain representative samples for laboratory testing.
- Testing of representative subsoil/rock samples in the laboratory to evaluate their index and engineering properties.
- Performing engineering analysis of all the field and laboratory data to arrive at the safe bearing capacity & nature of sub soil/rock strata.

3.0 SCOPE OF WORK

Details of boreholes drilled on site are as follows:

	Borehole Designation	Location	Coordinates
1	BH-1	Tharali Ghat Dist. Chamoli	N=30□07'37.40 " E=79□30'57.73 "
2	BH-2	Tharali Ghat Dist. Chamoli	N=30□07'37.73 " E=78□30'53.25 "



(LOCATION MAP OF DRILLED BOREHOLE)

4.0 FIELD INVESTIGATION

The scope of work includes mainly drilling of NX size exploratory boreholes at locations Borehole 1 & 2 and the drilling was done up to 15.3 m depth for location Borehole-1 & 2 at Tharali Ghat Dist. Chamoli in the state of Uttarakhand, India.

After analysis of boreholes data, field observations, as well as lab test data, final geotechnical investigation report prepared.

This report includes the safe gross bearing pressure for design for BH-1 & 2.

This report has been prepared based on borehole data to decipher the bed soil/rock profile, subsurface ground conditions along with necessary recommendations.

SPT (Standard Penetration Test)

is conducted as per IS :2131 in a borehole using split-spoon sampler of 0.45 m length when the borehole has been drilled to the desired depth, the drilling tools are removed and the sampler is lowered to the bottom of the bore hole. The sampler is driven into the sediments by dropping a hammer of 63.5 kg from the top. Weight falling through a height of 75cm. SPT is the measure of number of blows required to drive the SPT sampler every 15 cm at a prescribed depth. The same process is repeated thrice. The number of blows recorded for the first 15 cm

Sharma Consultancy
P.O.: Jaintanwala,
Dehradun-248003

consultancy@yahoo.in

is disregarded or considered as "Seating Value". The number of blows recorded for the last two 15 cm intervals are added to give Standard Penetration Test ('N' value) and are regarded as the "Penetration Value".

5.0 REGIONAL GEOLOGY

Geologically the area belong to the Lesser Himalayas and lies in a tectonic foredeep. The Lesser Himalayas are comprised of fanglomerates followed by bedded quartzites, slates, phyllites and low-grade schists. The rock types are ranging from green schist to lower amphibolite facies. The main rock types are schists, phyllites and quartzites.

The generalized geological succession in the district is given below:

Granite (1100 Ma)	----------	
(iii) Vaikrita Group (part)/Jaunsar Group	Undifferentiated Vaikrita/Mandhali-Chandpur-Nagthat formations	Purple, grey quartzite, grits and conglomerate, thin bedded limestone-phyllite/slate, laminated greenish grey phyllite/slate with lenticular greywacke, purple green quartzite, grit, conglomerate
(ii) Garhwal Group	----------	
	Granite (1900 Ma & 1600 Ma)	
	Berinag Formation	Quartzite with penecontemporaneous mafic volcanics
	----------Disconformity ----------	
	Deoban Formation	Limestone-dolomite, shale
	Rautgara Formation	Quartzite with penecontemporaneous mafic volcanics
	Granite (2200-2100 Ma)	
	Uttarkashi Formation	Quartzite with penecontemporaneous mafic volcanic, dolomite-limestone, shale
(i) Central Crystalline Group	Granite (2500 Ma)	
	Badrinath Formation	Garnet, sillimanite, muscovite, kyanite - bearing gneiss, mica schist, migmatite, calcsilicate
	Pandukeshwar Formation	Banded quartzite gneiss, para-amphibolites
	Joshimath Formation	Garnet-mica-schist, sillimanite-kyanite schist
	Bhimgora Quartzite	White quartzite
	Ragsi Formation	Kyanite-mica schist, gneiss, para-amphibolite

(Geological Map Of Area)

6.0 SITE STRATIGRAPHY

The strata primarily consists of fractured Phyllite Metamorphic rock upto the depth of investigation. The startum from on an average depth of 0.0m to 0.60m is top soil cover/ Residual matenal. The layer below 0.60 to 4.5m is weak & weathered Phyllite rock. The layer further followed by highly fractured to broken Phyllite rock up to average depth of 10.80m. The stratum from 10.80m to 15.0m is fractured &moderately strong phyllite metamorphic rock up to the depth of investigation.

The ground water table at the proposed location is not encountered during the drilling upto the depth of 15.0m below existing ground level.

The stratigraphy encountered at the Borehole-1 & 2 at Tharali ghat Dist. Chamoli in the state of Uttarakhand is tabulated below:

(LITHOLOGY OF BH-1)

DEPTH, m		LITHOLOGY
From	To	
0.00	0.40	Top Soil cover/ Residual Soil Material
0.40	5.00	Weak & weathered Fractured Metamorphic rock
5.00	11.00	Highly Fractured to Broken Phyllite Metamorphic rock
11.00	15.00	Moderately Strong Fractured Metamorphic Rock

(LITHOLOGY OF BH-2)

DEPTH, m		LITHOLOGY
From	To	
0.00	0.70	Top Soil cover/ Residual Soil Material
0.70	4.50	Weak & weathered Fractured Metamorphic rock
4.50	10.50	Highly Fractured to Broken Phyllite Metamorphic rock
10.50	15.00	Moderately Strong Fractured Metamorphic Rock

Geological borehole log for BH-1 & 2 is presented at the end of this report in Appendix B.

Consultancy
P.O.: Jaintanwala,
Dehradun-248003

ENGINEERING PROPERTIES OF THE ROCK MASS

The representative rock samples collected during drilling were subjected to different lab tests for the purpose of determining rock-mass characteristics as well as for other relevant engineering properties. The tests comprised of the following which were conducted as per standard codal practice.

- Specific Gravity
- Moisture absorption
- Uni-axial compressive strength of rock cores
- Point load strength index of rock lumps
- Brazilian test for tensile Strength Of Rock
- Porosity

SPECIFIC GRAVITY (IS: 2720 (PART-3)-1980)

A few representative rock samples from the investigated locations were tested for their specific gravity. The specific gravity of the samples tested varies from 2.63 to 2.71.

MOISTURE ABSORPTION. (IS: 13030-1991)

The representative rock samples from the boreholes were also tested for their moisture absorption. The moisture absorption percentages are seen to vary from 0.38% to 0.53%.

UNI-AXIAL COMPRESSIVE STRENGTH & POINT LOAD STRENGTH (IS: 9143-1979 & IS: 8764-1998)

Uni-axial compressive strength tests have been carried out on rock core sample with length to diameter ratio as 2.0. For rock samples, where this ratio could not be maintained because of short length and irregular shaped core pieces, point load strength index test was carried out and an empirical correlation used to estimate the uni-axial compressive strength. Recommendations outlined in IS 10785 1983 were adhered to while arriving at the results. The uni-axial compressive strength varies from 55.2 kg/cm^2 to 92.0 kg/cm^2.

...consultancy@yahoo.in

TENSILE STRENGTH BY BAZILLION TEST (IS: 10082-1981)

Determination of tensile strength of rocks by indirect tests on rock specimens, namely, Brazilian Test have carried out. The tensile strength varies from 19.3 kg/cm^2 to 26.9 kg/cm^2

POROSITY (IS: 13030-1981)

The representative rock samples from the boreholes were also tested for their porosity. The porosity percentages are seen to vary from 11.0% to 22.7%.

8.0 FOUNDATION TYPE AND DETAILS

A shallow foundation transmits the load to the strata at shallow depths. A foundation is termed as shallow if it is laid at a depth equal to or less than its width. The satisfactory performance of the shallow foundation involves following criteria that must be satisfied.

We understand that the open foundation. The details of foundation are follows:

Foundation Width Range (m)	Foundation Type
2.0 - 4.0	Open Foundation (Strip foundation)

Our recommended bearing capacities the foundation bearing on soil is presented in Section 11.0 of this report.

CONCEPTS FOR FOUNDATION ANALYSIS

Foundation Bearing on Rock formation

Bearing Capacity Analysis for Well Foundations on Rock has been done by following methods.

(i) Presumptive values as published in IS: 12070.
(ii) Based on rock mass rating (RMR values) as per IS: 12070.
(iii) Estimate of safe bearing pressure from the core IS: 12070.

Rock quality based on RQD recorded for the boreholes for majority of the drilling runs is 'Very Poor'. The estimate of the quality of rock based on RQD can then be used to estimate, rock mass quality index Q. Rock mass quality index Q is read from the reference values given by Hoek and Brown 1980 and by also giving due consideration to the relation that exists between RQD and Q (Refer Barton et el. 1974). Rock mass quality index 'Q' reference values given by Hoek and Brown 1980 are tabulated below:

Quality of Rock	Rock Mass Quality Index 'Q'
Exceptionally good	1000 - 400
Extremely good	400 - 100
Very good	100 - 40
Good	40 - 10
Fair	10 - 4
Poor	4 - 1
Very Poor	1 - 0.1
Extremely poor	0.1 - 0.01
Exceptionally poor	0.01 - 0.001

We now have a complete sequence for estimating RMR of the stratum below foundation level. The table below gives net safe bearing pressures based on RMR and is adopted from (IS: 12070 1987) Table 3.0:

Classification No.	I	II	III	IV	V
Description of Rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100- 81	80 - 61	60 - 41	40 - 21	20 - 0
Qns (t/m^2)	600 - 448	440 - 288	280 - 151	145 - 90 -58	55 - 45 - 40

The safe bearing capacity table attached at the end of this report gives safe allowable bearing pressures based on the results of uni-axial compressive strength and rock mass rating calculations. The value of Rock Quality Index "Q" based on results obtained from drilling of the borehole and study of rock quality designation has been taken as 0.01 and rock mass rating calculated is 2.55.Based on this value safe allowable bearing pressure according to the table above is 44.0t/m^2 and can be adopted as a representative value for the investigated locations.

econlab.consultancy@yahoo.in

Estimation of safe bearing pressure from Rock Core Strength

Uni-axial compressive strength test, for determination of safe bearing capacity, has been carried out on rock core sample with length to diameter ratio 2.0. At depths where RQD was low, the samples collected during drilling were of shorter length, these samples had to be cut and reshaped so as to have length to diameter ratio 2.0. The safe bearing pressure is estimated from the equation (IS: 12070 1987):

$$qs = qc \times Nj$$

qs = Safe bearing pressure (gross)

qc = Average compressive strength of the rock core

Nj =Empirical coefficient depending upon the spacing of discontinuities

In the present case the value of Nj has been taken as 0.1. This is because the discontinuities are closely spaced.

Some vertical as well as inclined cracks in the rock mass have been observed. As a result a few rock cores recovered from the bore hole were split into two pieces. Correction factor of 0.50 on account of orientation of continuous joints in the slope of the stratum has been applied

RECOMMENDATION FOR FOUNDATION

The following table presents our recommended values of gross bearing pressure for the foundations:

- Foundation Bearing on rock stratum

Depth of Foundation Below EGL, m	Bearing Capacity Based On Presumptive value, T/m^2	Bearing Capacity Based On RMR value, T/m^2	Bearing capacity based on Core Strength, T/m^2	Recommended Gross Bearing Pressure, T/m^2
2.0 m	62.1	44.0	41.3	41.3
3.0 m	62.1	44.0	41.7	41.7
4.0 m	62.1	44.0	42.0	42.0

ecolab.consultancy@yahoo.in

Ecolab Consultancy
P.O.: Jaintanwala,
Dehradun-248003

The above recommendations are based on the field data collected from the various limited test locations and results of laboratory test carried out on the soil/rock samples recovered from test bore holes.

In case the proposed structure are located away from the test locations and/or the actual subsoil conditions varied during the excavation for various foundation are found to be different from what has been reported above, the consultants are to be referred for further advice prior to taking up to actual construction work at site.

The bearing capacity estimates for foundations have been made at foundation depth below 2.0m, 3.0m and 4.0m from the existing ground level (Ground level at the time of investigation). The table below gives recommended bearing capacity at the above mentioned depths.

The typical calculation for foundation bearing for Borehole is presented on Annexure-A.

PREVENTIVE MEASURES & MITIGATION STRATGY FOR LANSLIDE

The observation made in the field indicates those phyllites are highly susceptible to landslide. The flaky and brittle nature of the phyllite makes it prone to sliding induced by triggering factors like cloudburst, blasting, road, construction etc. The slides over phyllite, as encountered along the approach roads, leave a pile of clay and mica in powdered form over these roads and render the approach very sticky and slippery after a downpour.

There are a number of techniques adopted to control the landslide singly or in combination depending on the nature of slide, terrain conditions (slope etc.) climate (rainfall/ snow) and geological conditions. For the surfacial and deep sheeted landslide following techniques are most effective.

a) **Vegetative Turfing:**
it is the most effective and most important corrective measures particularly for the fresh exposed surface produced by road cutting and mining. Planting fast growing grasses and bushes in the landslide area is the first step in this direction.

b) **Bio-Engineering:**
It is the very economical means to control landslide and soil erosion using live plants and plant parts. Through plantation of grasses, shrubs, tree and bamboo, lining of grasses and shrub cuttings, applying jut net or vegetated stone pitching. c) Spraying: Certain spray is used to cut down the surfacial erosion and to improve the moisture condition of soil to facilitate the vegetal Turfing.

c) **Channelizing the surface and sub-surface runoff:** In order to reduce the

Surface run off and percolation surface drainage is constructed in unstable high gradient hill slopes. The small stair cases and artificial rapids are made to reduce the velocity of water. To reduce the pore water pressure the subsurface, percolated or perched water should be drained out through constructing the tunnels across the deep sheet sliding mass and perforated pipe is shallow sliding mass. In slide areas this method reduces the hydrostatic and hydrodynamic pressure of ground water.

E) **Retaining walls and Buttresses**: In areas of restricted space and those close to other structure retaining walls and buttresses are used. This is particularly use full to stop the movement of freshly cut slopes during road and building construction sites. Low walls are used to fasten the toe of existing slide. This method also reduces the artificially generated dynamic forces like blasting, Vehicle vibrations.

h) **Treatment of Shape of Slope:** the reduction of load of rock and soil at the head of the slide through removing the material and changing the geometry of the hill slope by trimming of slide mass.

I) **Grouting:** Filling of fissures and cracks or blanketing the landslide by Portland cement in order to reduce or eliminate the chemical and physical processes that increase the volume of slide mass.

CLOSURE

We appreciate the opportunity to perform this investigation for you and have pleasure in submitting this report. Please feel free to contact us in case of any clarification.

Readers are requested to send their comments, corrections, criticism, and suggestions. These contributions will help us in improving our reports in future. We thank you once again and assure you of our best services in future.

For Econ Laboratory & Consultancy.

Authorized Signatory
Mobile: 01265343 44, 8534957015
Econlab.consultancy@yahoo.in

Shrimad Consultancy
P.O.: Jaintanwala,
Dehradun-248003

ANNEXURES – A

TYPICAL CALCULATIONS

BEARING CAPACITY ANALYSIS FOR FOUNDATIONS ON ROCK

Analysis as per IS 12070-1987 (Including Amendment No. 1 Nov 2008) & International Practice

BEARING CAPACITY ANALYSIS FOR OPEN FOUNDATIONS BEARING ON ROCK HAS BEEN DONE BY THREE DIFFERENT METHODS AS GIVEN BELOW:

1) Presumptive Values of safe bearing capacity as per Clause 5.2 of IS 12070-1987
2) Based on RMR value as per Clause 5.3 of IS 1270-1987

Rock Type: Phyllite

Foundation Depth: 3 m Below Founding Level :

Rock Core Recovery: 20 % RQD value 6.8 %

Presumptive Values: Clause 5.2 of IS 12070-1987

$$q_{net\ safe} = q_s * c_{sub} * c_c * c_s$$

where:

$q_{net\ safe}$ = safe net bearing capacity

q_s = safe bearing capacity

c_{sub} = correction for saturation / submerged condition

c_s = correction for orientation of joints

c_c = correction for solution cavities (in limestone)

Net safe Bearing Pressure based on rock classification:

Material	$q_{net\ safe}$, T/m^2
Massive crystalline bed rock including granite ,diorite,gneiss,trap rock	1000
Foliated rocks such as schists or slate in sound condition	400
Bedded limestone in sound condition	400
Sedimentary rock,including hard shales and sandstones	250
Soft or broken bed rock (excluding shale)and soft limestone	100
Soft shale	30

Presumptive Value of safe bearing capacity for design: q_s = 100 T/m^2

Correction for saturation/submergence: c_{sub} = 1

Correction for orientation of joints c_c = 0.50

Correction for solution cavities (in limestone) c_c = 1.00

$q_{net\ safe}$ = **50.0** T/m^2

$q_{gross\ safe}$ = **62.1** T/m^2

Based on RMR value: Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
$q_{net\ safe}$ (T/m^2)	600-448	440-288	280-151	145-90-58	55-45-40

RMR value for design = 2.55 Class of Rock: V Rock Description: Very Poor

Interpolating linearly between the values of $q_{net\ safe}$ given above,

$q_{net\ safe}$ = 31.9 T/m^2

$q_{gross\ safe}$ = **44.0** T/m^2

Sharma Soil Consultancy
Khasmanda, P.O.: Jaintanwala,
Distt. Garh. Dehradun-248003

ANNEXURES – B

GEOLOGICAL BOREHOLE LOG

Shubham Consultancy
P.O.: Jakhanwala,
Dehradun-248005

shubham.consultancy@yahoo.in

GEOLOGICAL LOG OF DRILL HOLE

PROJECT NAME:- GEO-TECHNICAL INVESTIGATION FOR EXISTING HILL ROAD SLOPE PROTECTION WORK AT THARALI GHAT MOTOR ROAD KM-3, DIST. CHAMOLI, UTTARAKHAND, INDIA

BOREHOLE NUMBER	BH- 2				
BEARING OF HOLE	VERTICAL	CHAINAGE.-	-	SHEET NO.	01 of 01
COLLAR ELEVATION	12.00 cm	CO-ORDINATES:-	30° 7' 37.87" N 79° 30' 57.76" E	FEATURE	-
GROUNDWATER TABLE	NOT ENCOUNTERED	INCLINATION	VERTICAL	TOTAL DEPTH	15.0 m
STARTED DATE	8.11.2018	GROUND ELEVATION	-	TYPE(S) OF CORE BARREL	DOUBLE TUBE
		COMPLETED DATE	12.11.2018	DRILLING AGENCY	ECON LABORATORY AND CONSULTANCY

Depth (m)	SPT - N Value	Lithology Description	<10	10 to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Weathering	Structural Condition Log	Percent Core Recovery (in figures)	Type of Bit	RQD(%)	Depth of Water Level (m)	Drill Water Loss	Drilling Rate (cm/hour)	Special Observations
0.0–0.7		Top Soil Cover														
0.7–1.5	Refusal(100)	Slightly weathered, highly fractured, black Phyllite Metamorphic Rock		3	2	1		N A	Weak Fractured Foliated Phyllite Rock	24	DIAMOND	0	NOT ENCOUNTERED	PARTIAL	124	Bedrock- 0.70m-15.0m
1.5–3.0	Refusal(100)	Slightly weathered, highly fractured, black Phyllite Metamorphic Rock		3	4	3		N A	Weak Fractured Foliated Phyllite Rock	20	DIAMOND	0.0	NOT ENCOUNTERED	PARTIAL	110	
3.0–4.5	-	Slightly weathered, highly fractured, black Phyllite Metamorphic Rock		2	4			N A	Weak Fractured Foliated Phyllite Rock	22	DIAMOND	7.2	NOT ENCOUNTERED	PARTIAL	108	The bedrock has been encountered from 0.70m upto the hole depth(i.e 15.0m) which from 0.0m - 0.70m is top soil cover/ residual soils. From 0.70-4.5 m is fractured metamorphic rock. The stratum from 4.5m to 10.5m is broken to highly fractured, black Phyllite Metamorphic Rock. starata from 10.5m - 15.0m is Moderately strong fractured Phyllite Metamorphic rock.
4.5–6.0	-	Slightly weathered, jointed, broken to highly fractured, black Phyllite Metamorphic Rock		2	5				Broken to Highly Fractured	20	DIAMOND	0	NOT ENCOUNTERED	PARTIAL	102	
6.0–7.5	-	Slightly weathered, jointed, broken to highly fractured, black Phyllite Metamorphic Rock		2	6	3			Broken to Highly Fractured	24	DIAMOND	0	NOT ENCOUNTERED	PARTIAL	104	
7.5–9.0	-	Slightly weathered, jointed, broken to highly fractured, black Phyllite Metamorphic Rock		2	5	2		N A	Broken to Highly Fractured	20	DIAMOND	3	NOT ENCOUNTERED	PARTIAL	110	The core recovery percentage in bedrock varies between 18% to 26% with RQD varies from is 0.0 to 11.7%.
9.0–10.5	-	Slightly weathered, jointed, broken to highly fractured, black Phyllite Metamorphic Rock		2	4	3		N A	Broken to Highly Fractured	20	DIAMOND	7.6	NOT ENCOUNTERED		115	The Rock is weathered & fractured. The Core recovery & RQD seems very poor
10.5–12.0	-	Moderately strong fractured, black Phyllite Metamorphic Rock		2	4	2		N A	Fractured Metamorphic Rock	25	DIAMOND	11.2	NOT ENCOUNTERED		118	The ground water level has not been observed in this bore hole
12.0–13.5	-	Moderately strong fractured, black Phyllite Metamorphic Rock		1	5	2		N A	Fractured Metamorphic Rock	26	DIAMOND	8.2	NOT ENCOUNTERED		103	Drak grey to black medium to coarse grained wash were collected in Borehole
13.5–15.0	-	Moderately strong fractured, black Phyllite Metamorphic Rock		2	6	2		N A	Fractured Metamorphic Rock	22	DIAMOND	8.4	NOT ENCOUNTERED		105	The Penetration rate varies from 102cm/hour to 124cm/hour

Legend: Top Soil Cover; WEAK PHYLLITE ROCK; Broken to Highly Fractured Phyllite Rock; Moderately strong fractured phyllite Rock

ECON Laboratory and Consultancy

ANNEXURES – C

SOIL/ ROCK PROFILE TABLE

Borehole No.: -1	Coordinates	30° 7' 37.22" N 79° 30' 59.19" E

Particulars					Rock Properties					Shear Test		Chemical Properties		Symbolic Representation	Visual Description
Depth of Run (in m)	SPT "N" Value	Type of Sample	Bulk Density gm/cc	Sp. Gravity	Void Ratio,%	Porosity,%	Uniaxial Compressive Strength, Kg/cm^2	Water Absorption %	Tensile Strength, kg/cm2	Cohesion (kg/cm^2)	Angle of Friction	pH	ELECTRICAL CONDUCTIVITY (Microsiemens/cm)		
1.5	<100	CORE	2.41	2.63	0.09	18.3	68.6	0.52	20.7	0.22	26.1	7.92	44.2		TOP SOIL LITTER RESIDUAL SOIL (0.0M - 1.4M)
3.0	<100	CORE	2.42	2.64	0.09	18.2	71.4	0.50	21.3	0.24	25.4	7.85	45.8		WEAK & WEATHERED ROCK FRACTURED PHYLLITE ROCK (1.4M -5.0M)
4.5	-	CORE	2.43	2.66	0.09	18.9	69.4	0.51	22.1	0.22	26.1	7.84	51.0		
6.0	-	CORE	2.43	2.66	0.09	18.9	77.8	0.48	22.8	0.20	26.8	7.82	51.7		
7.5	-	CORE	2.48	2.66	0.07	14.5	67.5	0.50	19.8	-	-	-	-		WEAK & WATHERED HIGHLY FRACTURED PHYLLITE ROCK WITH BROKEN ROCK FRAGMENTS (5.0M- 11.0M)
9.0	-	CORE	2.51	2.67	0.06	12.7	61.1	0.52	20.2	-	-	-	-		
10.5	-	CORE	2.52	2.67	0.06	11.9	70.1	0.46	19.4	-	-	-	-		
12.0	-	CORE	2.54	2.68	0.06	11.0	94.1	0.44	26.4	-	-	-	-		MODERATELY STRONG FRACTURED PHYLLITIE METAMORPHIC ROCK (11.0M - 15.0M)
13.5	-	CORE	2.55	2.70	0.06	11.8	81.4	0.41	27.2	-	-	-	-		
15.0	-	CORE	2.55	2.70	0.06	11.8	88.2	0.38	26.9	-	-	-	-		

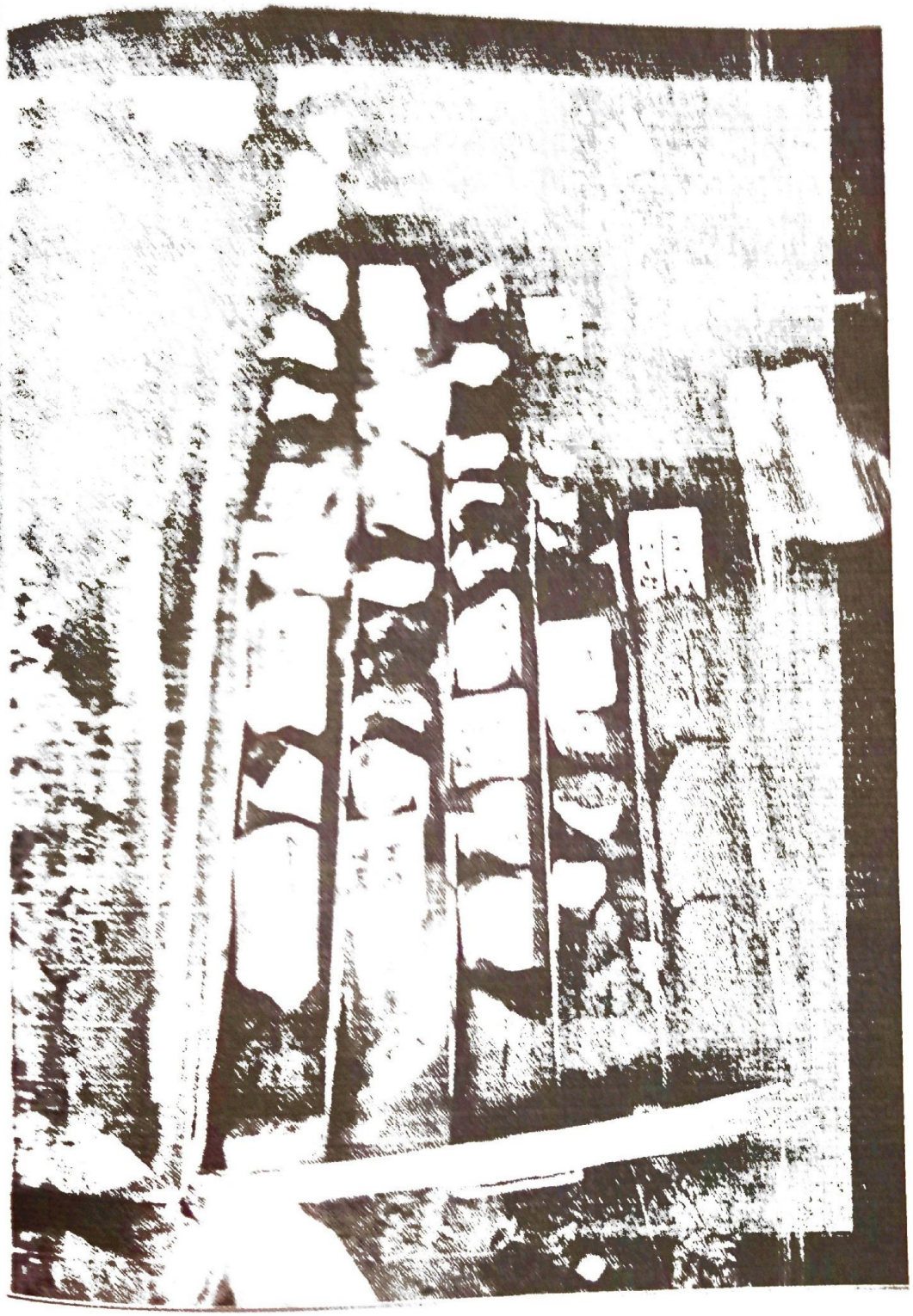
ANNEXURES – D

CORE BOX PHOTOGRAPHS

econlab.consultancy@yahoo.in

Bore Hall No-1

Consultancy
P.O.: Jaintanwala,
Dehradun-248003



Bore Hall No-2