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हिमाचल प्रदेश के केंद्रीय विश्वविद्यालय परिसर, धर्मशाला, जनपद कांगड़ा, हिमाचल प्रदेश के लिए प्रस्तावित भूमि की व्यवहार्यता चरण भूवैज्ञानिक / भू-तकनीकी जांच

FEASIBILITY STAGE GEOLOGICAL/ GEOTECHNICAL INVESTIGATION OF PROPOSED SITE FOR THE CENTRAL UNIVERSITY OF HIMACHAL PRADESH CAMPUS, DHARAMSHALA, DISTRICT DHARAMSHALA HIMACHAL PRADESH

टोपोशीट सं./ Toposheet No.: 52D/8

कार्य सत्र **2021-22** का प्रतिवेदन
Report for Field Season 2021-22

रमेश लाइश्रम, **अधीक्षक भूवैज्ञानिक/** Ramesh Laishram, Superintending Geologist
प्रदाप जगन आर,**भूवैज्ञानिक**/ Pradap Jagan R, Geologist

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उत्तरीक्षेत्र, चंडीगढ़ / Northern Region, Chandigarh

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हिमाचल प्रदेशके केंद्रीय विश्वविद्यालय परिसर, धर्मशाला, जनपद कांगड़ा, हिमाचल प्रदेश के लिए प्रस्तावित भूमि की व्यवहार्यता चरण भूवैज्ञानिक / भू-तकनीकी जांच

Feasibility stage geological/ geotechnical investigation of proposed site for the Central University of Himachal Pradesh Campus, Dharamshala, District Kangra, Himachal Pradesh

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Feasibility stage geological/ geotechnical investigation of proposed site for the Central University of Himachal Pradesh Campus, Dharamshala, District Kangra, Himachal Pradesh

द्वारा/ By:
रमेश लाइश्रम, अधीक्षक भूवैज्ञानिक/ Ramesh Laishram, Superintending Geologist
प्रदाप जगन आर, भूवैज्ञानिक/ Pradap Jagan R, Geologist

CHAPTER – 1

INTRODUCTION

The Central University of Himachal Pradesh (CUHP) has proposed for setting up their campus near Dharmashala, district Kangra, H.P. Around 100 acres of land has been identified by the officials of the CUHP near Tang and Jadrangal on Dharmashala – Palampur road. The SDO (Civil) cum Nodal Officer, CUHP, Dharamshala requested the Director-General vide letter No…. SDK/Central University of Himachal Pradesh dated 27-07-2021 for a detailed geological/geotechnical study of the area proposed for the CUHP campus. On the subsequent direction from the Director General to the office of GSI, SU: P, H & HP, Chandigarh, through DyDG & HoD, GSI NR via mail dated 30.07.2021, a team of officers headed by Dr. G.S. Tiwari, Dy. Director General, SU: PH & HP visited the proposed site from 26th to 28th September 2021. The main purpose of the visit was to assess the nature & quantum of work and to prepare the MoU for carrying out detailed geological and geotechnical evaluation of land for the campus of CUHP. Accordingly, a MoU was signed between GSI and District Administration of Kangra, HP on 11.11.2021 in the office of Deputy Commissioner, district Kangra, Himachal Pradesh. The first phase of field work was undertaken between 18th and 28th November 2021. Subsequently, the work was continued between 29th and December 2021 and 06th January 2022 and was concluded during 12th to 15th January 2022.

1.1 Location and Accessibility:

The proposed area for Central University of Himachal Pradesh (CUHP) is located southeast of Dharamsala Town, situated in the foothills of Dhauldhar Hills. The proposed site is located near villages Narwana, Tang, Jadrangal and is accessible by a motorable metal road. The proposed campus area is divided into 15 polygons distributed at different locations and accessible through the village roads (Fig. 1). Since the proposed area categorized into private, forest, non-forest and revenue lands, the local administration classified it into different polygons distributed at different locations. These polygons / land shown by the officials of the CUHP fall under non-forest / forest lands. The proposed area falls under Survey of India Toposheet No. 52D/8 bounded by geographical coordinates Lat 32°09'17.2", 32°11'20.1"; Long 76°24'1.9", Long 76°26'1.4". The elevation of the proposed campus area ranges between approximately 1000 m to 1800 m. The proposed site for CUHP is covered by forest, settlement and barren land. The area is accessible through State Highway 17 from Dharamshala. The nearest rail head is Kangra and the nearest airport is Gaggal at a distance of 24 km and 20.5 km respectively.

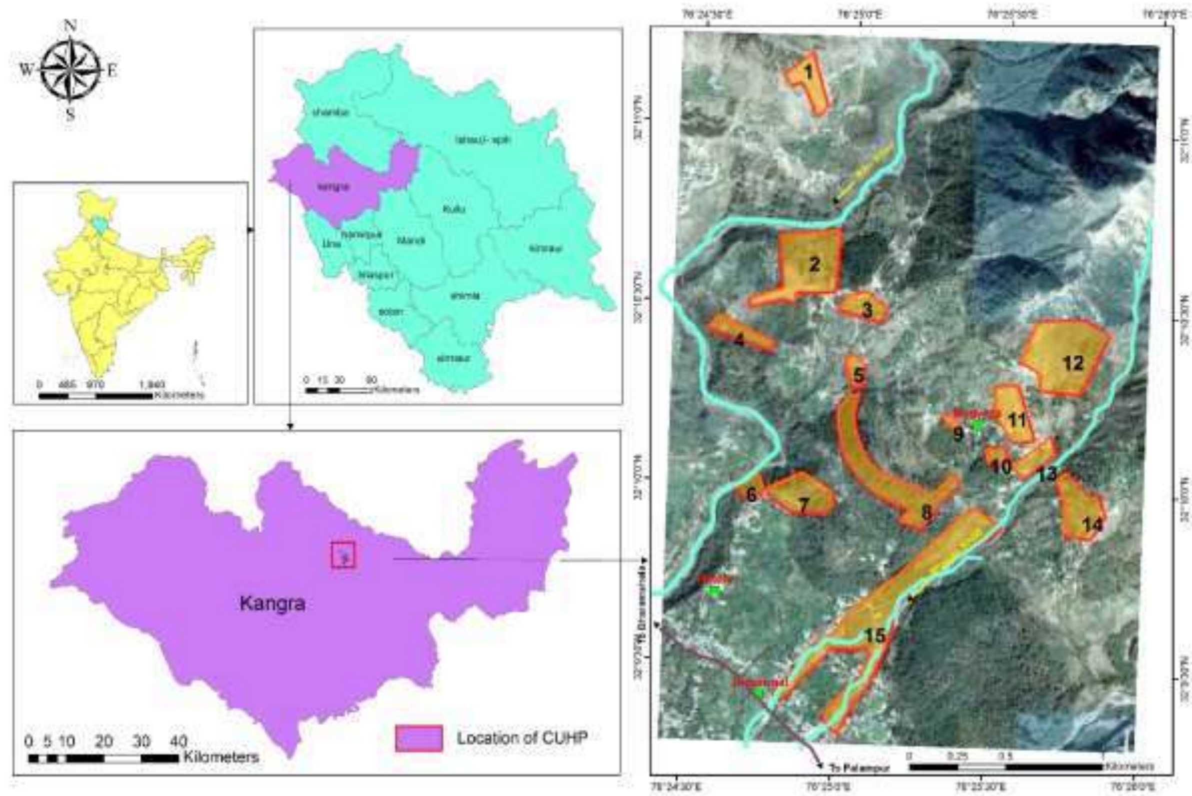


Fig.1: Location map of CUHP.

1.2 Climate:

Overall, climate of the area is quite pleasant throughout the year, although the winters tend to be a bit cold (sometimes dropping down to -1°C in the night). Summers are hot reaching a temperature of 36°C. The temperature during summers ranges from 19°C to 31°C degrees Celsius. Monsoon season in the valley brings a good amount of rainfall. The monsoon last from June to September and temperatures during monsoon range from 17°C-27°C and sometimes get even colder due to continuous rainfall. The district is one of the wettest parts of Himachal Pradesh recording more than 150- 590 mm of rainfall (Fig.-2). Autumn temperatures average around 16–17°C.

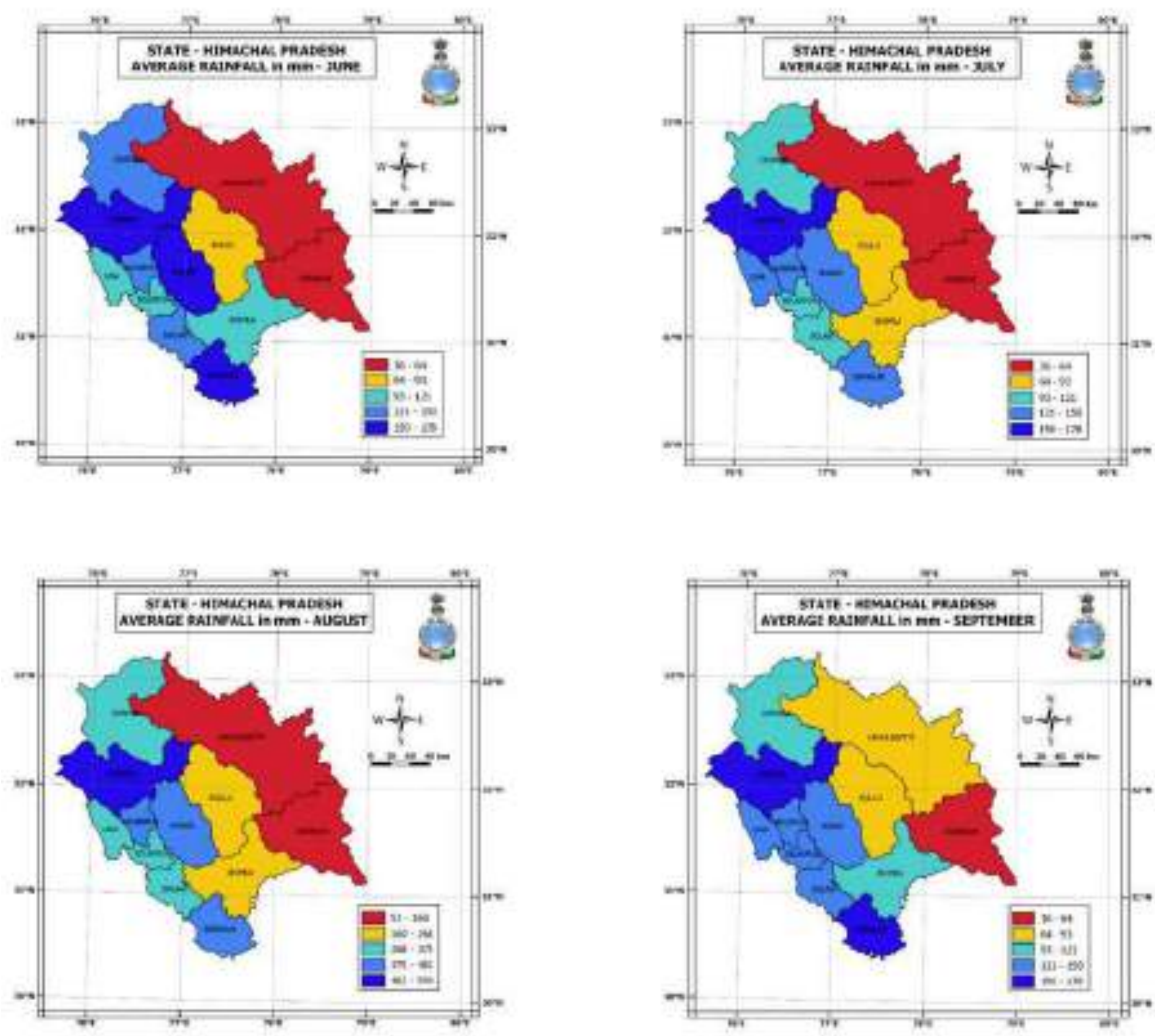
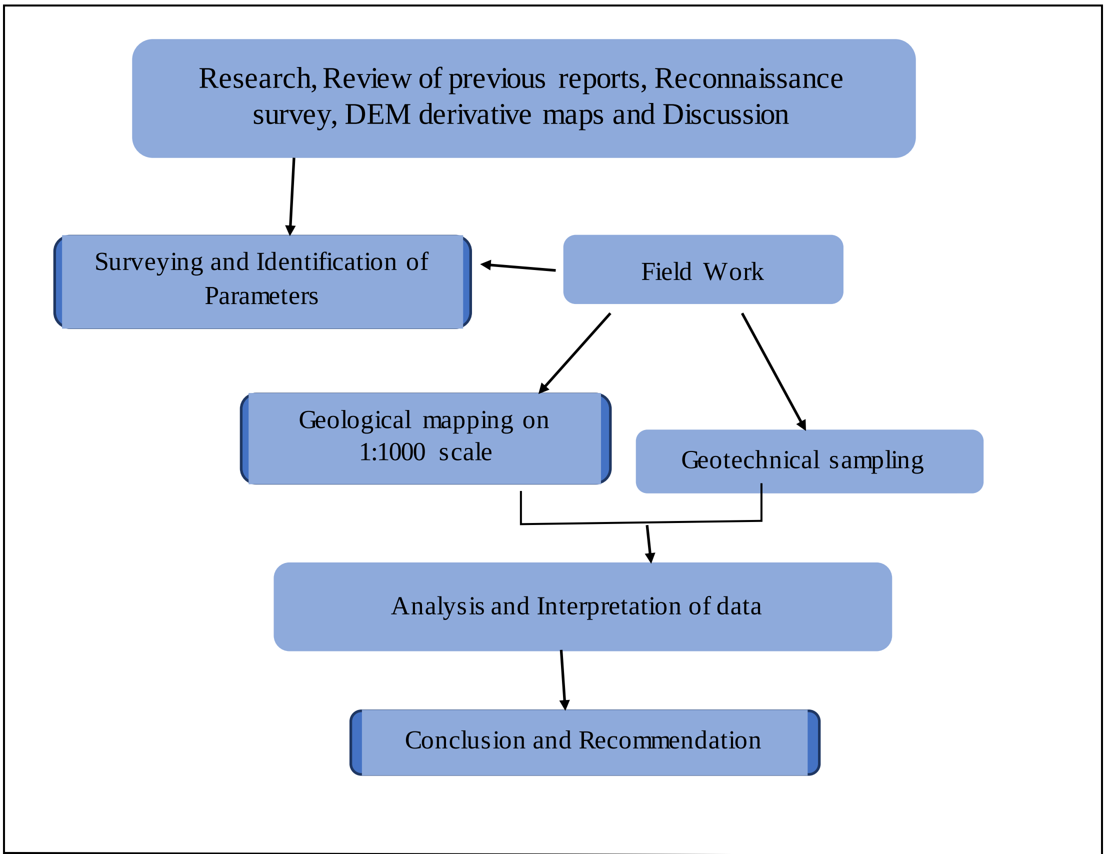


Fig. 2: Mean rainfall pattern over districts of Himachal Pradesh (Source: Met Monograph No.: ESSO/IMD/HS/Rainfall Variability/10(2020)/34 of IMD)

1.3 Methodology:

The methodology in the current investigation involves review of previous work and reports of the area, reconnaissance survey of the area, preparation and studies of various geo-factor maps derived from ALOS PALSAR Digital Elevation Model. This was followed by the field work and geological mapping on 1:1000 scale. Disturbed soil and undisturbed soil samples along with rock samples was collected systematically from all the polygons for studies of geotechnical properties. Finally, all this data was collated, interpreted and analyzed to the conclusion and recommendation. The flowchart of the work carried out is given below.



Flowchart showing the methodology

1.4 Acknowledgement:

The authors are thankful to Dr. G.S. Tiwari, Deputy Director General, State Unit: Punjab, Haryana and Himachal Pradesh for his constant support and suggestions during the work. They are also indebted to Sh. Prashant T. Ilamkar, Director, Engineering Geology Division, State Unit: Punjab, Haryana and Himachal Pradesh for his valuable advices and technical input during the field work and preparation of the report. The authors would like to express their sincere gratitude towards Dr. Nipun Jindal, IAS & DC, Kangra for his initiation and encouragement during the course of investigation. The constant logistic supports provided by Smt. Shilpi Goyat, HAS, Sub- Divisional Officer (Civil)- cum Nodal officer of CUHP is also duly acknowledged. Dr. A. K. Mahajan, Dean & Secy. to VC, CUHP is also thanked for his help during the field work and technical discussions in the course of the work help in bringing out a good exhaustive report. The ground water data provided by CGWB, Dharmashala and GWO, Jal Shakti Vibhag, Una, HP is also highly appreciated.

CHAPTER – 2

REGIONAL GEOLOGY

The oldest rock in the area belongs to the Kulu Group of Palaeoproterozoic age and is subdivided into Khamrada, Gahr and Khokhan formations. The Khamrada Formation comprises of carbonaceous slate, phyllite, limestone and quartzite. The Gahr Formation overlies the Khamrada Formation and is mainly made up of streaky and banded gniesses. The Khokhan Formation is the topmost unit of this Group and is made up of schist and quartzite. This Group is thrusted over the Sundernagar Group of rocks along the Kulu Thrust. The Sundernagar Group is further subdivided into Mandi Volcanics and Maloh Formation in the area, they are of Palaeo to Mesoproterozoic in age. The Mandi Volcanics is composed mainly of tholelitic basalt with minor quartz arenite and shale. The overlying Maloh Formation is mainly composed of quartzite, shale, slate and few basic flows. The Sundernagar Group is thrusted over the Sirmur Group along the Shali Thrust in the area. The Sirmur Group belonging to early Miocene to Late Palaeocene age and comprises mainly of Dagshai Formation and Kasauli Formation in the area. The Dagshai Formation is made up of red shale, claystone and sandstone. The sandstone is grey in colour and often medium to fine grained. The Dagshai Formation is overlain by Kasauli Formation and comprises of greenish grey micaceous sandstone and subordinate shale. The Siwalik Group of rocks are represented by Lower and Middle Siwalik in the area and has a thrusted contact with the Dagshai Formation in the north which is called as Main Boundary Thrust (MBT) locally known as the Palampur Thrust. The Lower Siwalik comprises sandstone, pebbly sandstone and sandy clay alternations and belongs to Miocene age. The Middle Siwalik comprising of grey micaceous sandstone, gravel, beds, shale and clay are of Mio-Pliocene age. They are overlain by the Channel Alluvium of Holocene age and is made up of sand, silt and gravel. The topmost formation in the area are composed of glacio-fluvial sediments, alluvium and hill wash material belonging to the Undifferentiated Quaternary (Table 1, Fig. 4). In recent times, systematic geological mapping of the Siwalik Group of rocks in the area were undertaken by Shyam Sundar et al, in 2012 and they have delineated the lithostratigraphic units of Siwalik.

Table 1: Regional Geology of the area *(Source: Geoinformatics, GSI, Chandigarh)*

Group	**Formation**	**Lithology**	**Age**
	Quaternary (undiff)	Glacio-fluvial sediments, alluvium and hill wash material	Quaternary
Newer Alluvium	Channel Alluvium	Sand, silt and gravel	Holocene
Siwalik	Middle Siwalik	Grey micaceous sandstone,	Mio-Pliocene

		gravel beds, shale and clay	
	Lower Siwalik	Sandstone, pebbly sandstone and sandy clay alternations	Miocene
Palampur Thrust (MBT)			
Sirmur	Dagshai	Red shale, claystone and sandstone	Early Miocene to Late Palaeocene
	Kasauli	Greenish grey micaceous sandstone and subordinate shale	
Shali Thrust			
Sundernagar	Maloh	quartzite, shale, slate and few basic flows	Palaeo to Meso Proterozoic
	Mandi Volcanics	Tholelitic basalt with minor quartzarenite and shale	
Kulu Thrust			
Kulu	Khokhan	Schist and quartzite	Palaeoproterozoic
	Gahr	Streaky and banded gniesses	
	Khamrada	Carbonaceous slate, phyllie, limestone and quartzite	

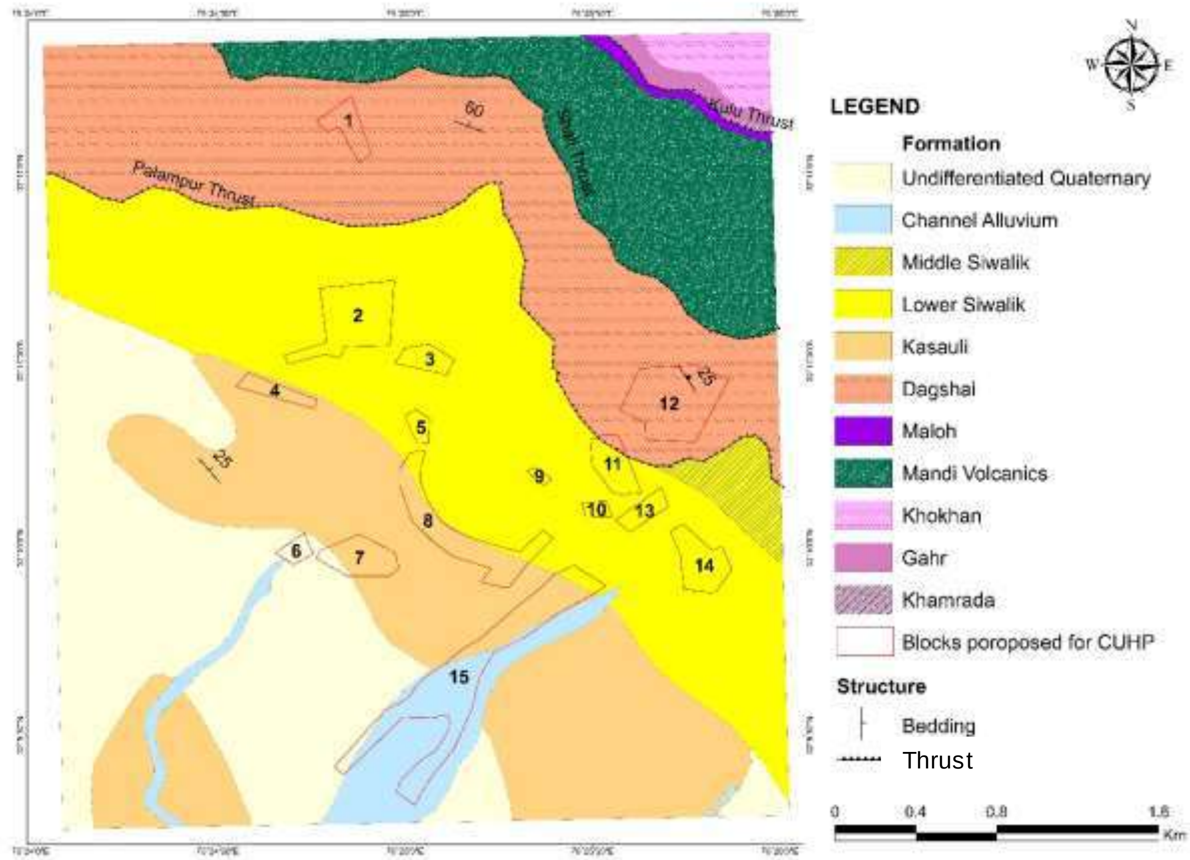


Fig. 3: Regional Geological Map (1:50,000 scale) of the area proposed for CUHP

CHAPTER – 3

GEO-FACTOR THEMES

Six relevant geo-factor themes have been taken into account in the Geotechnical investigation of study *viz*, slope, curvature, landuse/ land-cover, geomorphology, aspect and Stream power index. These factors have varying degree of influence on slope stability. Some of the geo-factor themes are categorical (e.g., geomorphology, aspect etc.) and others represent continuous data (e.g., slope, elevation etc.). These spatial geo-factor maps are prepared using ALOS PALAR data and employing different mapping techniques which are detailed below.

3.1 Slope angle:

The outward or downward movement of material takes place necessarily through certain angle of slope and hence, the slope factor is invariably associated with slope stability. This inherent causal relationship of slope in inducing slope instability makes it the most important and effective parameter to consider. ALOS PALSAR DEM of 12.5 m resolution data has been used to derive slope angle for the study area using ArcGIS 10.3 (Fig. 4). The slope map so derived is reclassified for analysis into 9 classes with 9 percentile distribution. In the study area slope angle varies between 0° and 66° with steeper slopes concentrated in northeastern corner of the study area. It can be observed from the slope angle map of the area that majority of the area i.e. 89.52% of the area falls under slope angle and range between 0° to 35°. And very little area of 2.12% falls in the area with high slope angle of >40° (Fig. 5). Most of the polygons proposed for CUHP is falling in slope angle between 0° to 35° angle.

However, a small portion in the northeast corner of Polygon-4 and northern corner of Polygon 12 falls in the steep slope category i.e between 30° and 45°. Due care needs to be taken for this part while disturbing the slope for any construction.

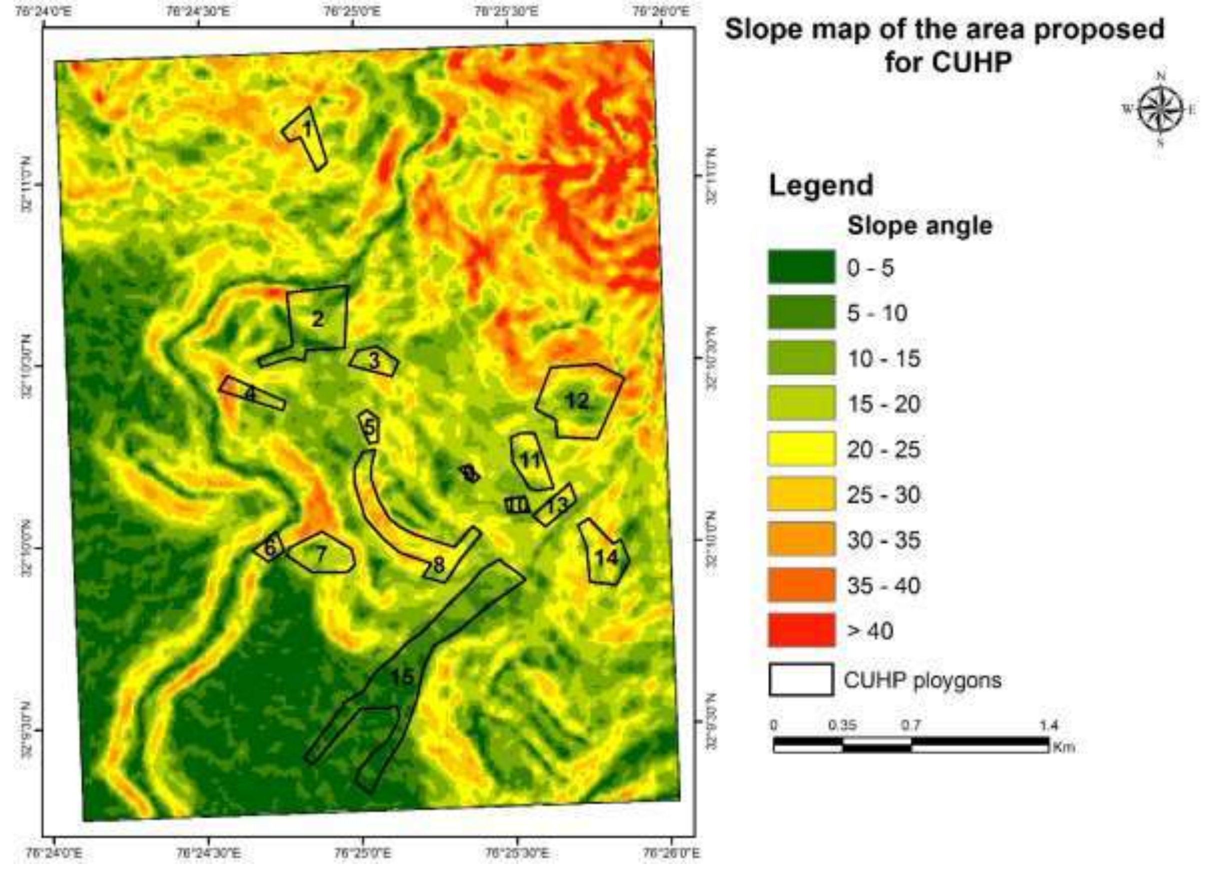


Fig. 4: Slope map of the area proposed for CUHP

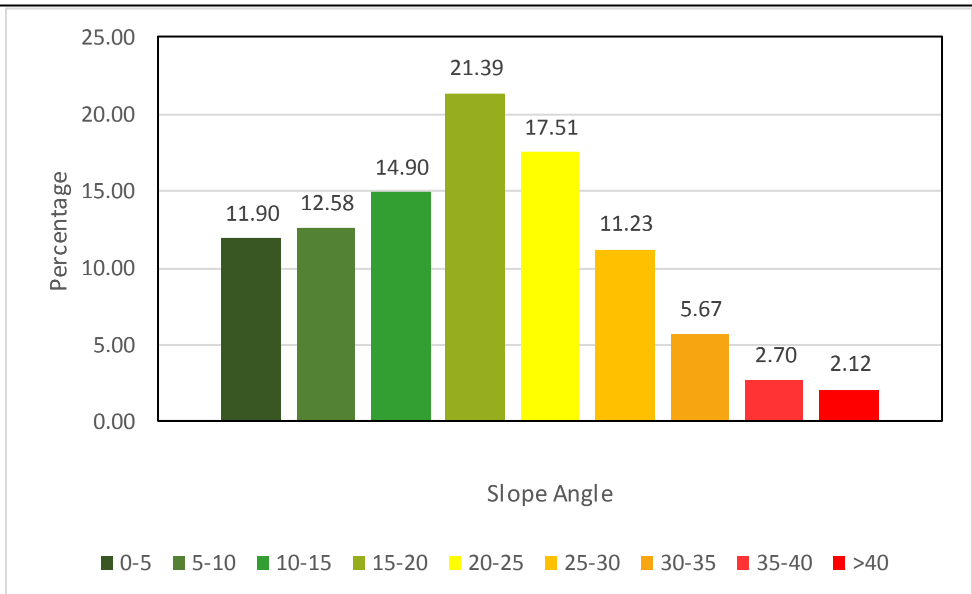


Fig.5: Bar diagram showing spatial distribution of slope classes in percentage

3.2 Slope curvature:

Another derivative map used in the analysis is a curvature map of slope. This is basically the slope shape or profile curvature and is derived from 12.5 m resolution ALOS PALSAR DEM. A positive curvature represents upwardly convex surface while a negative curvature indicates that the surface is upwardly concave at a given pixel. It can be seen from the figures below that the concave curvature is shown by 39% of the area, followed by 38% of convex curvature slopes and the remaining 23% of the area is flat (Fig. 6 and 7). Hill slope with concave profile are more susceptible to failure as they have more pore water pressure and thus increasing the chances of more water saturation as compared to convex hill slopes. The flat curvature profile is the most stable. Increase in curvature in either direction is the most significant factor in decreasing the overall stability of a hill slope, *Sharma, 2013*. In the polygons proposed for CUHP the polygons are dominated by concave slope curvatures followed by convex and flat in descending order. Due care needs to be taken in the area with concave slope curvatures during construction.

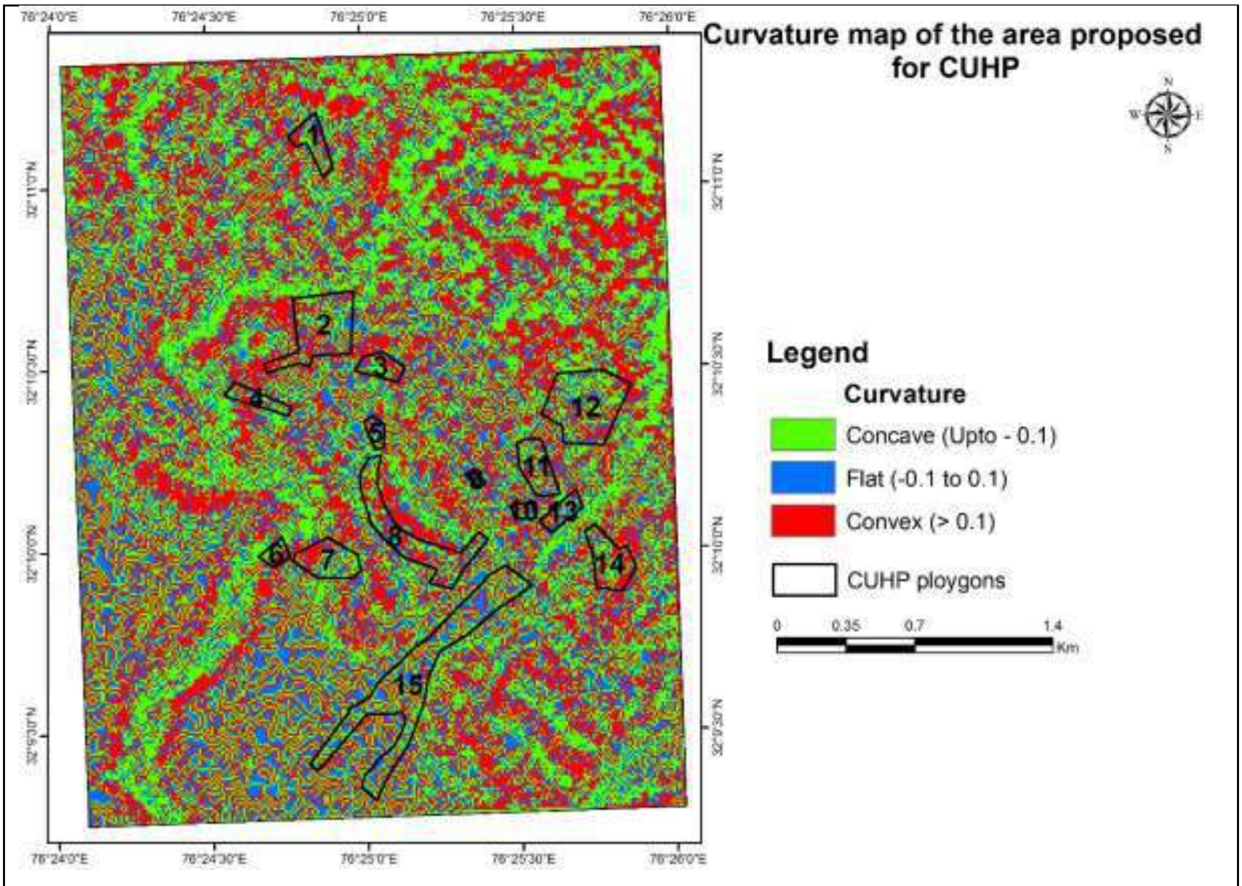


Fig. 6: Slope curvature map of the area proposed for CUHP

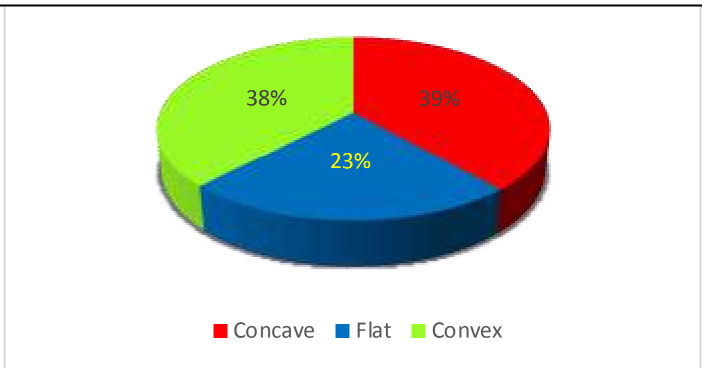


Fig.7: Pie diagram showing spatial distribution of slope curvature classes in percentage

3.3 Slope aspect:

Another derivative map used in the analysis is a slope aspect map which has been derived from 12.5 m resolution ALOS PALSAR DEM (Fig. 8). It can be seen from the figures below that the slope facing S and SW constitute the largest portion, 52.52% in the area, followed by 17.25% facing W direction. The SE facing slope constitutes 14.31% of the area. The NW facing slope make up 8.65% of the area the remaining 7.27% is facing E, NE and N in descending order (Fig. 9).

The major reason for this is that those areas are under the influence of other parameters. Therefore, it is wrong to evaluate the aspect, alone. Since it is a part of the system, it should be evaluated together with other conditioning factors.

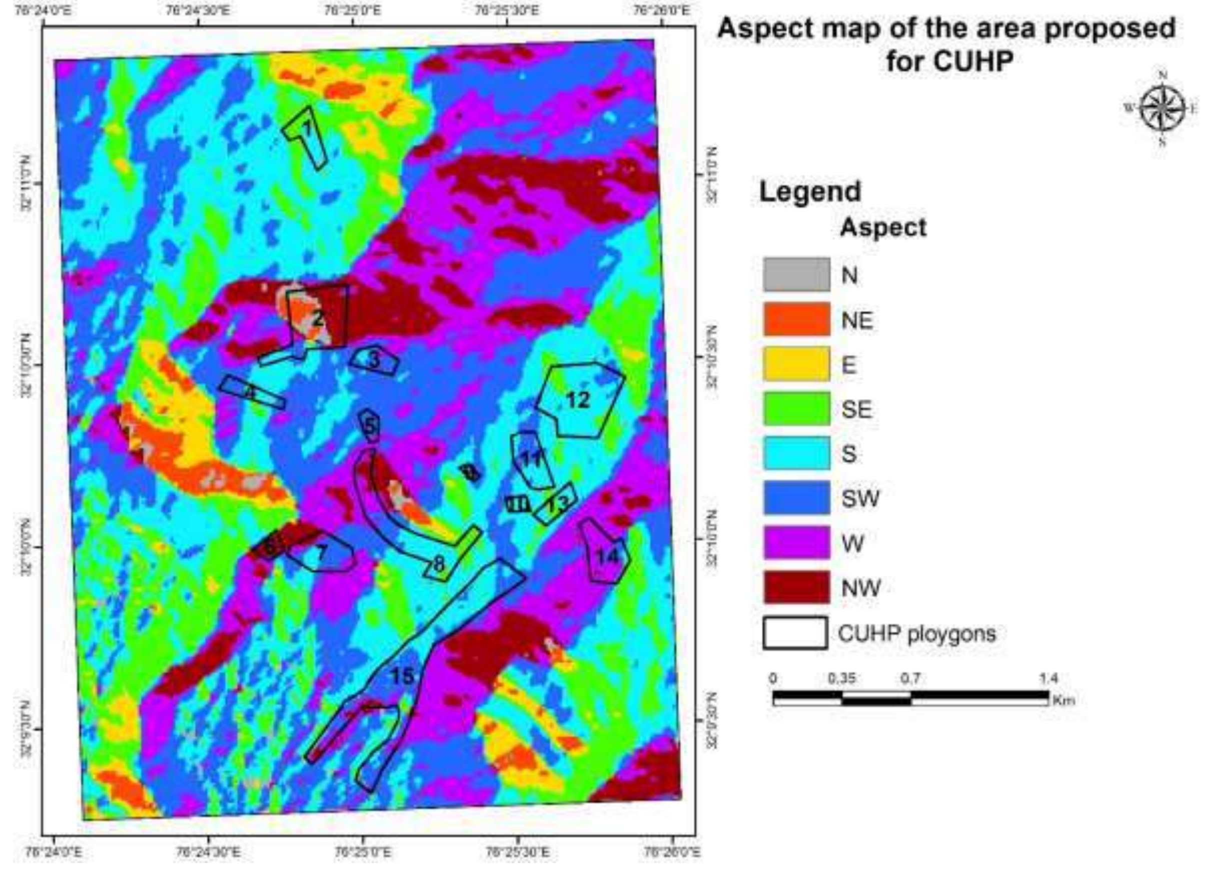


Fig. 8: Slope curvature map of the area proposed for CUHP

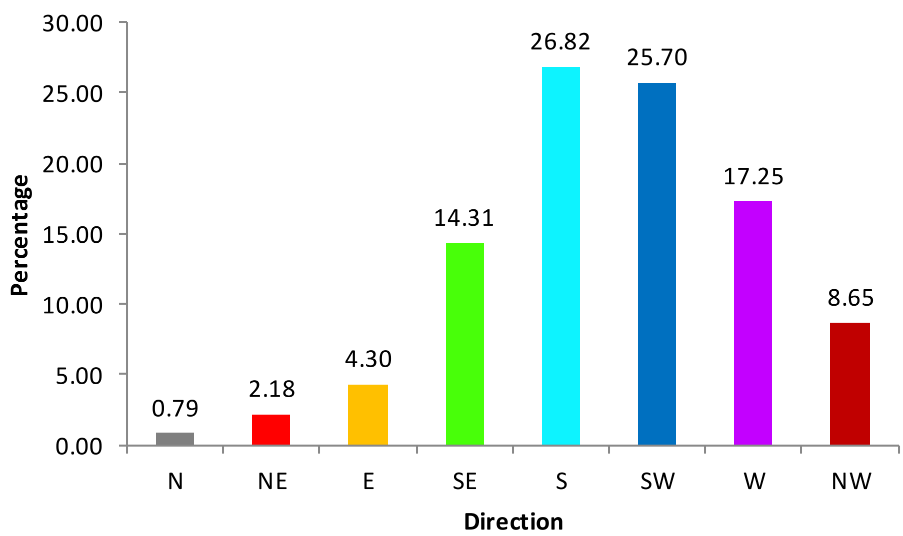


Fig.9: Bar diagram showing spatial distribution of slope aspect classes in percentage

3.4 Drainage:

Another derivative map used in the analysis is a drainage map. This is basically the stream order map of the area and is derived from 12.5 m resolution ALOS PALSAR DEM data. It can be seen from the figure (Fig.10) below that the area is drained by Ikku River and its tributaries of various order. The 4^{th} order stream passing through the non-revenue land of CUHP is perennial and the other smaller order stream is seasonal and is dry throughout the year except for monsoon season (Fig.12). The presence of first order streams in the polygons can be a problem particularly during the monsoon season. So, proper channelization of the streams needs to be addressed during construction.

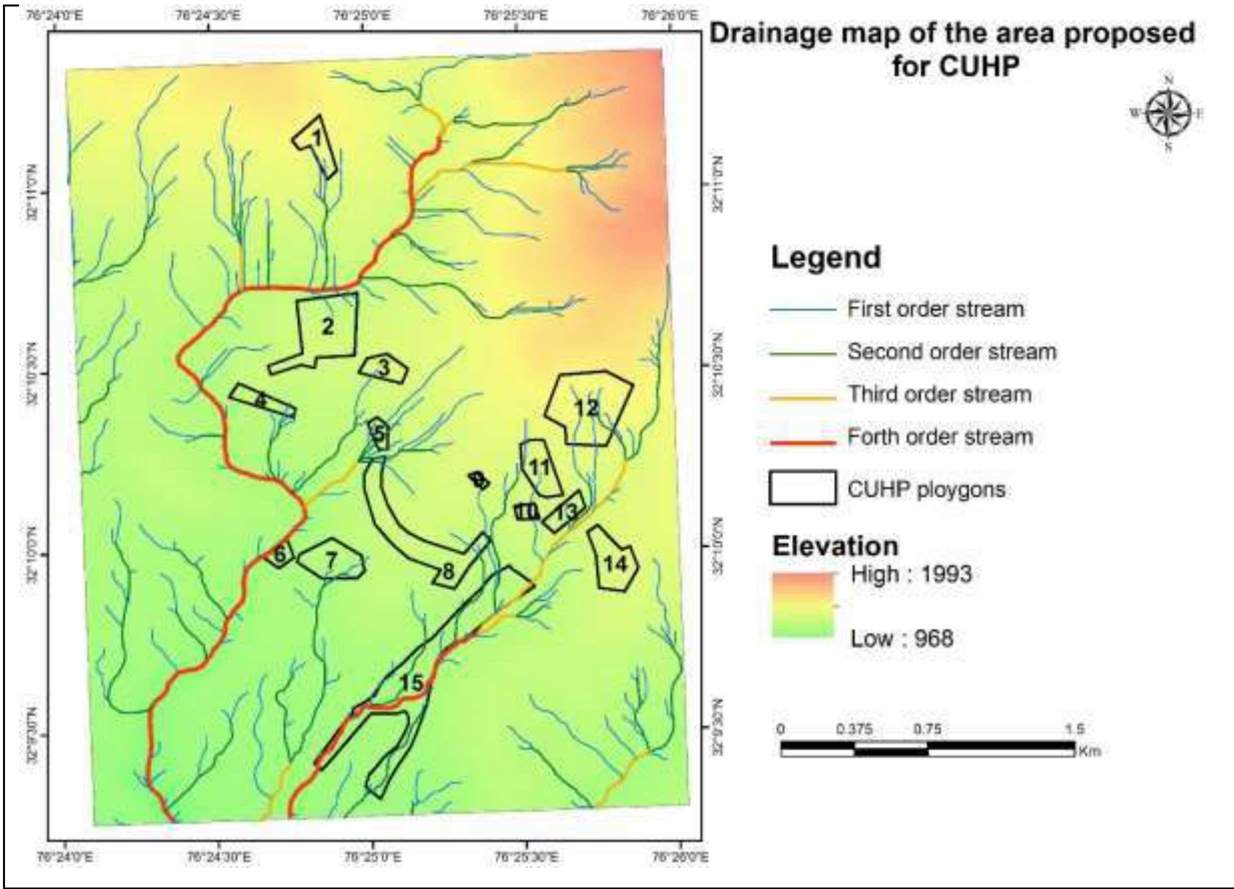


Fig. 10: Drainage map of the area proposed for CUHP

3.5 Stream Power Index:

Another derivative map used in the analysis is a Stream Power Index map. This is basically the erosive power of the stream in the area and is derived from 12.5 m resolution ALOS PALSAR DEM data. It can be seen from the figures below that the forth order streams with the highest erosive power of 5 to 8.4 constitute only 1.44% of the area. The majority of the area falls under moderate erosive power streams with SPI range of -2.1 to 1.8 which accounts for 65.67% of the area (Fig, 10 and 11). Due care needs to be taken of all the streams and depressions present in the polygons.

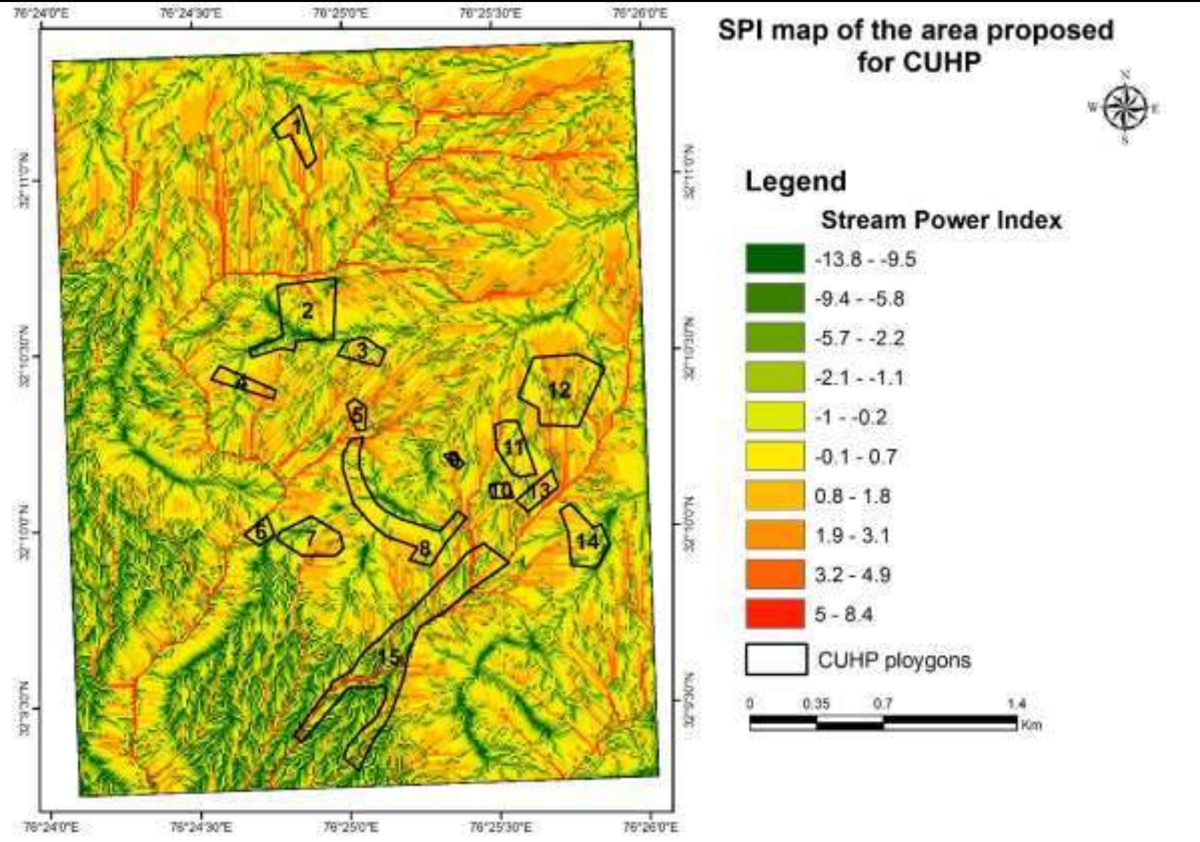


Fig. 11: Stream Power Index map of the area proposed for CUHP

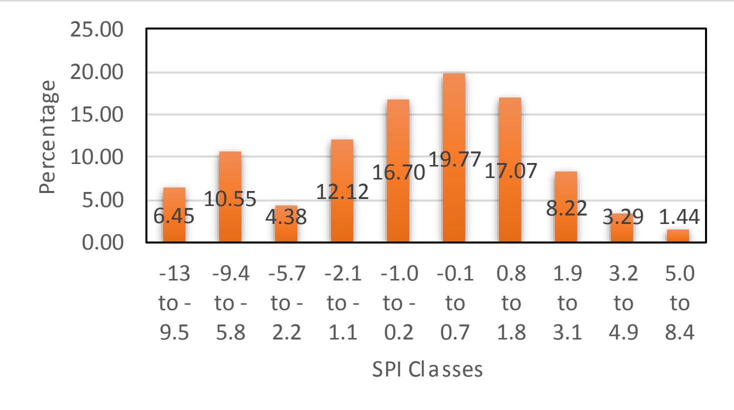


Fig.12: Bar diagram showing spatial distribution of SPI in percentage

3.6 Hydrology:

The groundwater condition plays a critical role in the slope instability. The infiltration of water drastically changes the shear strength of the slope forming materials. In the current study, in addition to combined erosion-stream power index theme, the hydro geological conditions of the area were collected from Central Ground Water Board (CGWB), Dharamshala and Ground Water Organization (GWO), Jal Shakti Vibhag, Una, Himachal Pradesh. The condition of groundwater can change with season and under adverse meteoric events. The qualitative observations on groundwater considered in the current study are based solely on the data provided by the above two departments. The water table depth from the log sheets of hand pumps provided by GWO indicate that the water table range between 45 to 54 meters below ground level in the area (Annexure - I). As per the data from the Exploratory Tube Well of CGWB, located on link road to Central University, Jadrangal, they encountered aquifers in 5 levels, viz. i) 50.0-52.50m, ii) 58-60m, iii) 72-76m, iv) 84-90m and v) 94-98m. The shallowest aquifer is at a depth of 50.0-52.50m below ground level. As per the hand pump data received from GWO the solid rock encountered at a depth of 86 meters below ground level (Annexure - II).

3.7 Land use and Land cover:

Land use land cover map (Fig. 13) of the study area is prepared using the imagery from open source google earth data. The imagery data of the area is taken from the 2021 in the preparation of LULC map. The .kml file received from the Nodal Officer, CUHP is imported to Google Earth. The different classes of LULC theme are identified and marked or digitized using polylines. The same are saved in .kml and in ArcGIS the features are converted into polygons and then again exported to Google Earth through layer to kml conversion. Each polygon is named as per its LULC class and reconverted into a shape file through .kml to layer conversion. Scrubs constitute about 37.5% of the area followed by barren land which occupies 28.41% of the area. Forested area occupies 25.61% of the area and the remaining area is made up of Cultivation, River bed material, extensive cut slope and quarry (Fig. 14). In the area, the extensive cut slopes are confined mainly along the road. The barren land is more susceptible to slope failures and shows sinking zones and palaeo-slides.

Table 2: Landuse/ land-cover area statistics:

Landuse classification	Area (sq. km.)	Area percentage
Barren	0.309	29.41
Cultivation	0.060	5.72
ECS	0.003	0.28
Dense vegetation	0.269	25.61
Quarry	0.001	0.08
RBM	0.015	1.40
Scrubs	0.394	37.50

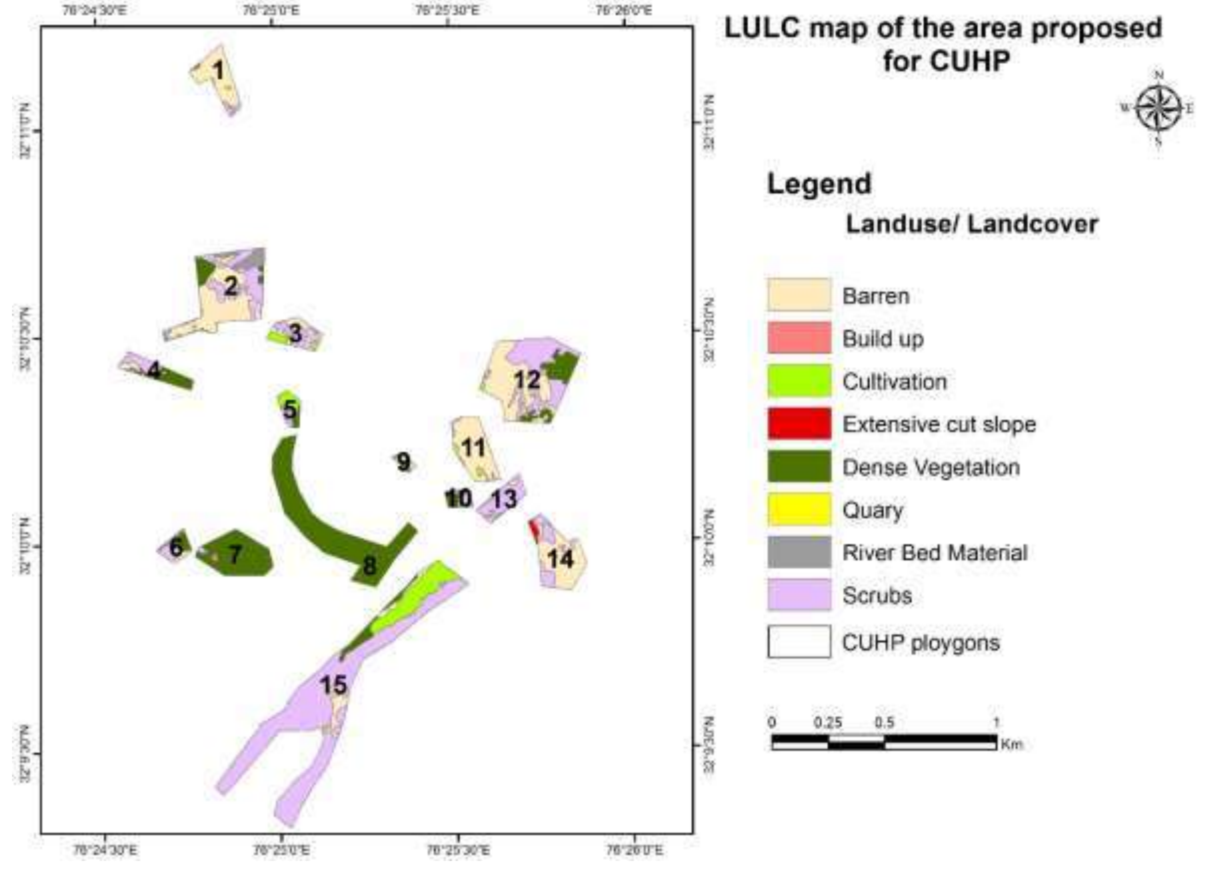


Fig. 13: Landuse/ Landcover map of the area proposed for CUHP

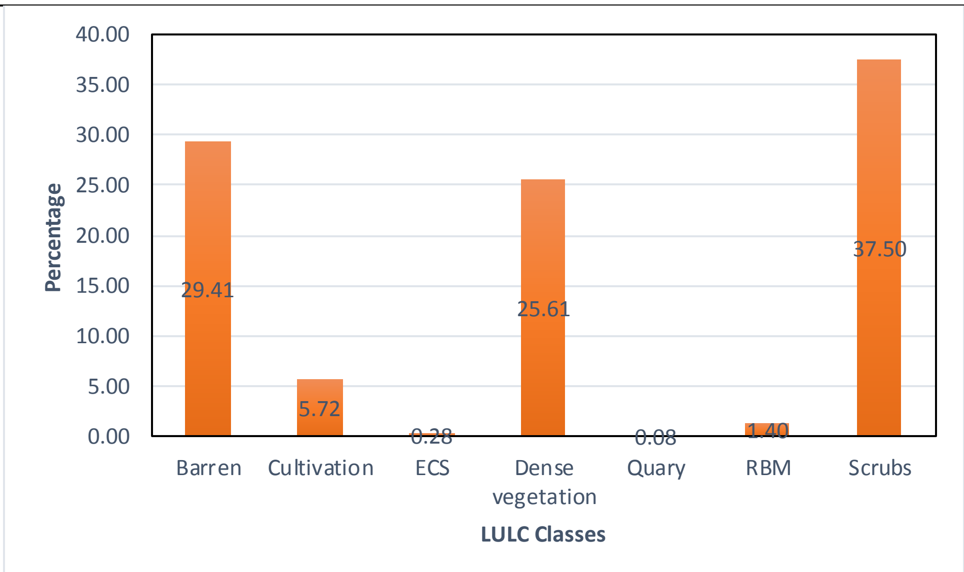


Fig. 14: Bar diagram showing distribution of LULC classes in the area

3.8 Seismicity of the area:

The state of Himachal Pradesh located in the Western Himalaya has experienced major earthquakes because it is seismically a very active region and falls in the zone of continental collision of the Indian and Eurasian plates. As per BIS: 1893:2002: Part-I, the area

(Dharamshala Region) falls in the Seismic Zone V of the Seismic Zonation Map of India. This region experienced around 476 earthquakes during last 30 years as per records available at Indian Metrological Department. In Dharamshala region, the earthquakes activity occurred in the last 3 years is scattered near MBT spans about 45 km in width and extended below from 10 km to 40 km down in the crust. Tectonically the project area belongs to the Cover rock of frontal belt affected by fold and thrust Zone which is bounded by a major tectonic plane namely Palampur Thrust (MBT) in the north. The other important tectonic surfaces in this zone include Jwalamukhi Thrust and Kullu Thrust. The Palampur Thrust (MBT), in fact, passes in the proximity of area in the northern part of the Polygon 11, but no surface manifestation is found. The thrust is suspected to be responsible for a shallow (0-23km) Dharamshala earthquake of M=5.5 reported from east of the project site on 26.04.1986. The project area is falling in Seismic Zone-V as per IS 1894:1975 (Fig. 15).

Considering its geographical location and its past seismic history, suitable provision of seismic coefficient factor may be made in the design of civil engineering structures to make them earthquake resistant. The structure in the region are designed and must be constructed as per guidelines laid down by Bureau of Indian Standards (BIS) to minimize the losses due to earthquakes.

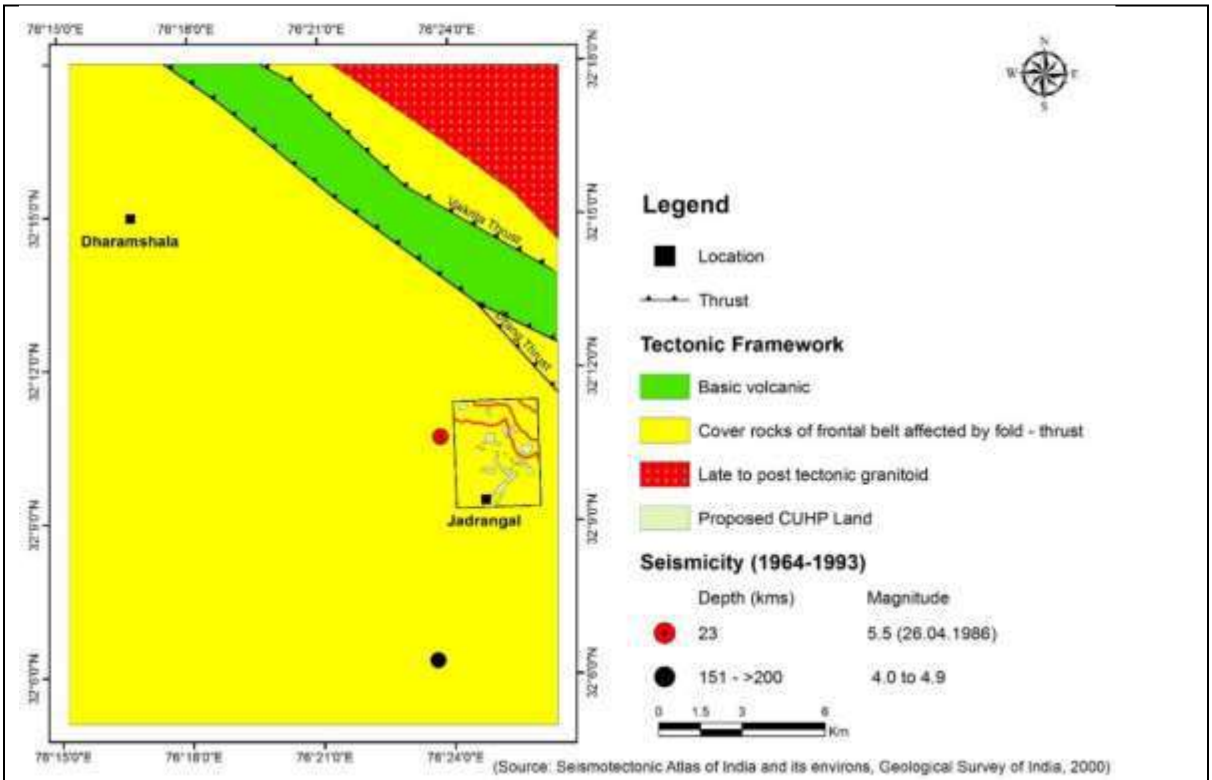


Fig. 15: Seismotectonic map (1:2,50000 scale) of the area porposed for CUHP.

CHAPTER – 4

GEOLOGY OF THE AREA

The study area is mainly covered with overburden material with very scanty rock exposures. The study area has been divided into 15 polygonsand are marked from 1 to 15 from North to South (Fig. 1). During the course of investigation, a detailed geological mapping of the Polygons along with surveyor and total station was carried out on 1:1000 scale in the area.

4.1 Polygon 1:

The proposed site for the Transit hostel - II is located on the northernmost part of the area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 30013 Sqm of land is being developed in this area for the purpose of constructing transit hostel buildings. The proposed site is located on a rugged terrain, along a spur. The trend of the spur is NNW-SSE. The northern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1511m, and flows south-ward down the hill slope. The depression forms a first order dry stream with angular big boulders indicative of some past flash flood. The area around Dharamshala is dominated by Quaternary alluvial fan deposits at the foothills of high ranges which may be of fluvio-glacial origin. Excepting a few isolated rock exposures on the slope face (R.L. 1432 m.), the slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with large size angular boulders strewn along the slope and embedded in the above type of debris (Fig. 17). Dark grey silicified sandstone is the rock type exposed in isolated pockets belonging to the Dagshai Formation and they often show spheroidal weathering and trace fossils (Fig. 18). A study of the contour plan provided by CUHP shows that there is a maximum level difference of 100m between the lowest (1410m) and highest (1410m) RL in the polygon. The slope is comparatively steeper towards the northern periphery than the southern side. The steepness of slope is more pronounced in the portion immediately below the forest in the northern portion. The overall slope condition appears to be stable in the absence of any large scale slide features (Fig. 16). Two samples of disturbed soil (DS14) and undisturbed soil (UDS14) were collected from this polygon and sent for analysis.

This Polygon is drained by the seasonal *nala* which are very rigorous, and has the evidence of flash flood. The protection of the *nala* from the flash flood is needed by means of improvement of gully catchments to reduce and regulate the run-off volume and peak rates, diversion of runoff water upstream of the gully area and construction of suitable structure to reduce bank erosion, if any.

Fig. 16: Geological map of Polygon 1

Fig. 17: Panoramic view of Polygon 1

Fig. 18a: Spheroidal weathering in silicified sandstone of Dagshai Formation.

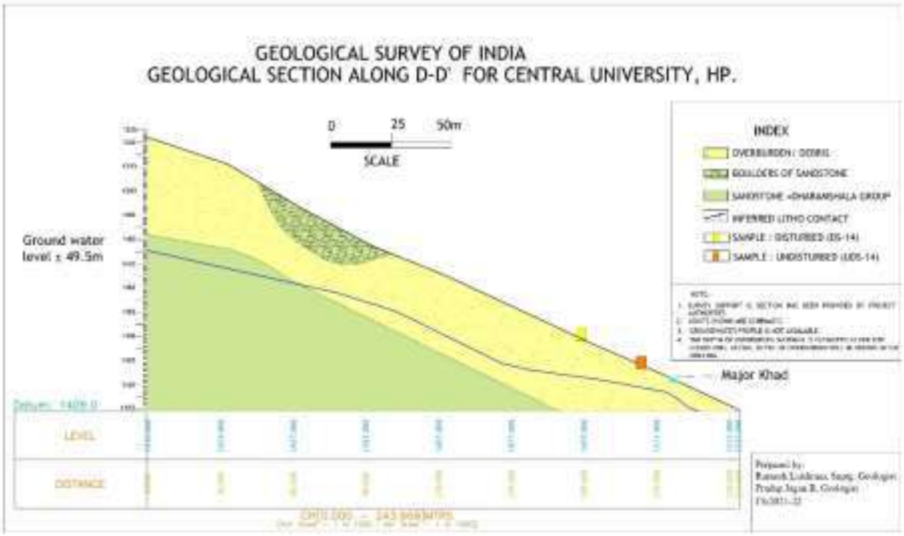


Fig. 18b: Geological cross section along the line DD' in polygon 1

4.2 Polygon 2:

The proposed site for the Administration Block, College Buildings and Parking is located on the northern part of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 100096 Sqm of land is being developed in this area for the purpose of constructing Administration Block, College Buildings and Parking. The proposed site is located on left bank of the Ikku River. The northern periphery of the proposed site is marked by a prominent forth order Ikku River, which flows south-west down the hill slope. Excepting a few isolated rock exposures on the slope face in the southern part of the polygon, the slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. Light brown sandstone belonging to the Lower Siwalik Group is exposed in isolated pockets. They are soft, friable and cross bedded and at places shows spheroidal weathering (Fig.19) having NW-SE bedding strike and 10° northeasterly dip. The prominent joints in the rock types are: - (i) WNW-ESE strike, dip 65° towards N and (ii) NW-SE strike, dip 35° towards SW. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 133 m between the lowest (1214m) and highest (1347m) RL in the polygon. The slope is comparatively steeper towards the southeastern periphery than the northern side. The overall slope condition appears to be stable in the absence of any large scale slide features (Fig. 19). Three samples of disturbed soil (DS1), undisturbed soil (UDS1) and a rock sample (R1) were collected from this polygon. UCS dry and wet saturated data shows 45.37MPa and 43.50MPa respectively which fall in moderate category as per ISRM. As per BIS classification (IS:1498-1970), the soil sample DS1 falls in non-cohesive soil, silty sand which means the fine particles have little or no plasticity (P.I is 6.92%). The Natural Moisture Content (NMC) is low (6.00%). The dry density and wet density of the sample is 1.63 kg/m^3 and 1.73 kg/m^3 respectively. The grain size distribution curve also supports the data that the soil is coarse grained with no fine content. The SPI in this polygon ranges from low to moderate (-13.8 to 3.1).

A suitable remedial measures by means of improvement of gully catchments to reduce and regulate the run-off volume and peak rates to be taken during the construction activity along the bank of Ikku River. Since, the erosion will take place on the convex slopes, a properly designed retaining structure to be erected to avoid the bank erosion, as it happened in the year 2018 in Neogal Khad, near Palampur, H.P.

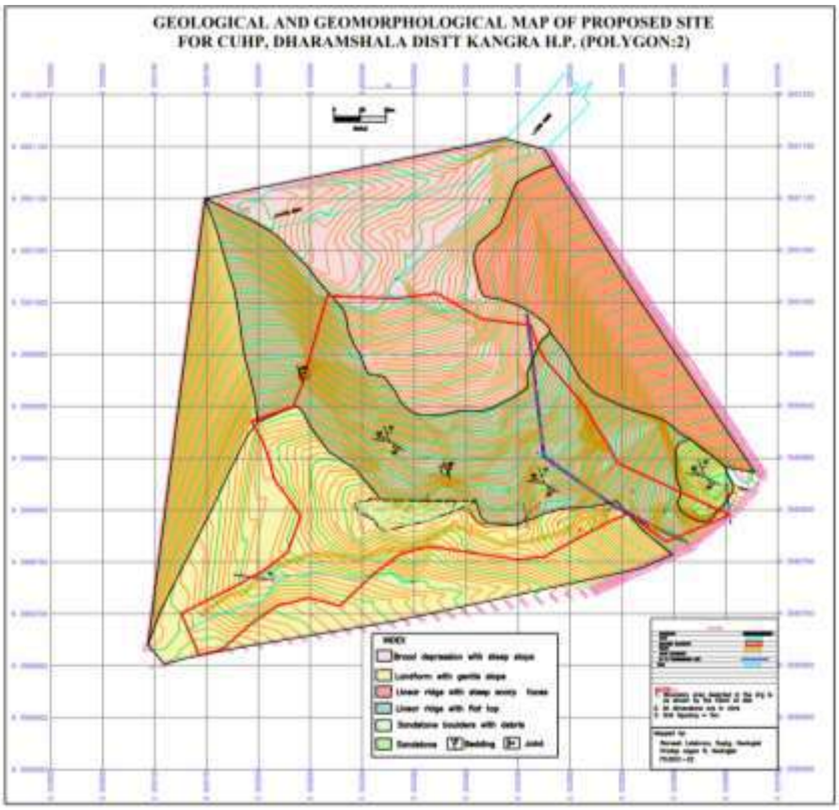


Fig. 19: Geological map of Polygon 2

	
Fig. 20: Panaromic view of polygon 2	Fig. 21: Spheroidal weathering in sandstone of polygon 2

4.3 Polygon 3:

The proposed site for the Gymnasium and parking is located on the northern proximity of the area put forward for CUHP and is approachable from Jadrangal and Tang by a motorable road. About 23050 Sq. m. of land is being developed in this area for the purpose of constructing Gymnasium and parking. The proposed site is located on relatively flat hill side facing SW. The southern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1367m, and flows south-west down the hill slope. The depression forms a first order stream and is dry. The northeastern periphery is marked by a slide scars with the crown of the slide resting at R.L. 1367m just below the upper road level (Plate-3). The development of ground cracks in the crown portions was also observed. Excepting a few isolated rock exposures on the slope face (R.L. 1357m.), the slopes are entirely covered by overburden of slope debris. Light brown sandstone is the rock type exposed in isolated pockets belonging to the Lower Siwalik Group and they are soft, friable and cross bedded having NNW-SSE bedding strike and 10° westerly dip. The prominent joints in the rock types are: - (i) WNW-ESE strike, dip 65° towards NNE and (ii) NW-SE strike, dip 35° towards SW. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 74 m between the lowest (1295m) and highest (1369m) RL in the polygon. The slope is comparatively steeper towards the northeastern periphery than the southern side. A suitable designed retaining wall to be constructed to protect the landslide and improvement of gully catchments to reduce and regulate the run-off volume is suggested. To stabilize the land-slipped slopes in Polygon 3, the measures are suggested like (i) Four strand barbed wire fencing should be erected around the affected area, (ii) Stone retaining walls along contour should be constructed to with-hold and help in stabilizing the land slip. (iii) Vegetative measures: Slip area should be planted and well covered with quick establishing species of trees and shrubs e.g. Alnus nepalensis (a coloniser), Populas ciliata, Salix, Agave, Wendlandia, Vitex, Ipomea etc. (iv) Covering with netting: Wherever possible land slipped slopes should be provided with cover of wire netting, rope netting or sack (coarse Jute fabric) etc. including wattling and mulching.

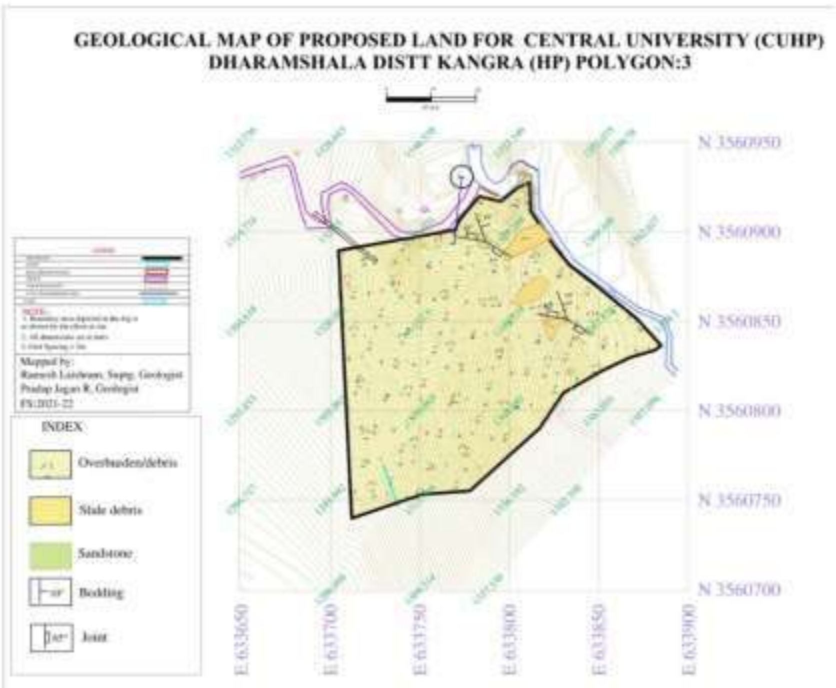


Fig. 22: Geological Map of Polygon 3

Fig. 23: Panoramic view of polygon 3

Fig. 24: Ground cracks developed in the slide of polygon 3

4.4 Polygon 4:

The proposed site for the school buildings is located on the northeastern proximity of the area proposed for CUHP and is approachable from Jadrangal and Tang by a motorable road upto Bagyara village then by foot track. About 21531 Sq. m. of land is being developed in this area for the purpose of constructing school buildings. This polygon 4 is located on relatively flat spur trending N - S. The slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 75 m between the lowest (1175m) and highest (1250m) RL in the polygon. The slope is comparatively steeper towards the northwestern periphery where it takes a sudden dip due to the erosion of the 4th order stream Ikku River. The overall slope condition appears to be stable in the absence of any large scale slide features.

Though the area appears to be stable, the slopes more than 45˚ became unstable, when disturbed. It is recommended to cut the slope not more than 45˚ during the construction activities.

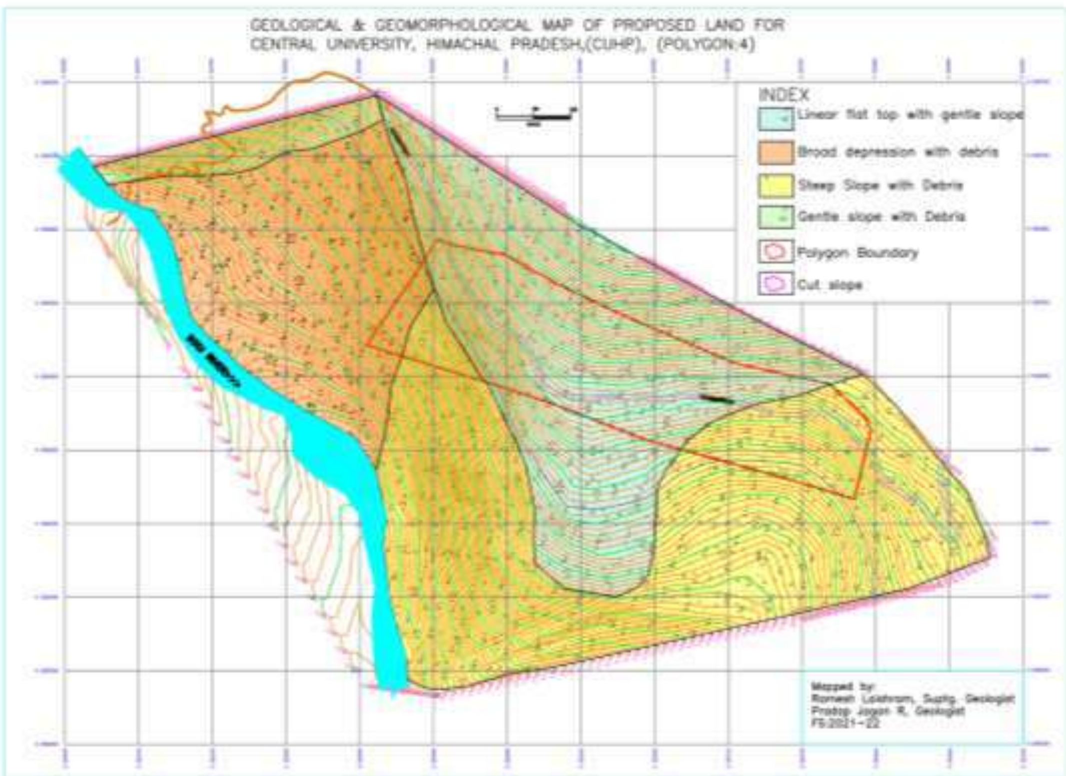


Fig. 25: Geological Map of Polygon 4

Fig. 26: Panoramic view of polygon 4

4.5 Polygon 5:

The proposed site for the CUHP is located on the central part of the area proposed for CUHP and is approachable from Jadrangal and Tang by a motorable road upto Bagyara village then by foot track. About 11570Ssq. m. of land is being developed in this area for the purpose of various construction of CUHP. The proposed site is located on relatively flat spur trending NW - SE. The slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with big angular boulders strewn along the slope and embedded in the above type of debris. The eastern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1285m, and flows south-west down the hill slope. The depression forms a second order stream and merges with another first order stream flowing ESE to WNW in the southern proximity of the polygon and is wet with flowing water. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 44 m between the lowest (1240m) and highest (1284m) RL in the polygon. The slope is comparatively steeper towards the north western then the southeastern part. The overall slope condition appears to be stable in the absence of any large scale slide features. Major portion of the northern part of the polygon is under cultivation.

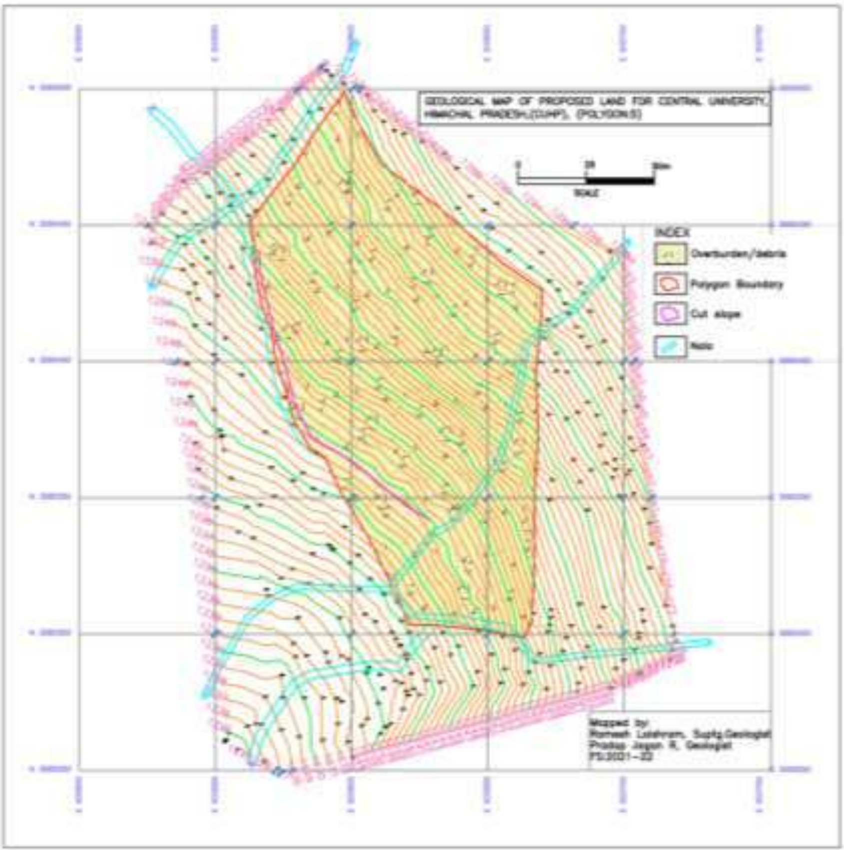


Fig. 27: Geological Map of Polygon 5

Fig. 28: River bed material in polygon 5

4.6 Polygon 6:

The polygon is located on the western proximity of the overall area proposed for CUHP and is approachable from Jadrangal to Patola village by a motorable road. About 12509 Sq. m. of land is being developed in this area for the purpose various constructions of

CUHP (Fig.30). The proposed site is located on river bank of the Ikku River and its slope is very steep. The northern and northwestern periphery of the proposed site is marked by a prominent 4^{th} order stream Ikku River which flows from NE to SW. This river brings many boulders of the granites of the Dalhousie Granite from the upper reaches of the Dauladhar ranges and the polygon is marked by scattered deposition of these boulders of different shape and sizes. Excepting a few isolated rock exposures on the slope face (R.L. 1100m.), the slopes are entirely covered by overburden of slope debris. The debris is predominantly River bed material type with rounded big boulders varying in size from few cm to 2 meters strewn along the slope and embedded in the above type of debris (Fig.31). Dark grey sandstone is the rock type exposed in isolated pockets belonging to the Kasauli Formation of Sirmur Group and they are cross bedded (Fig 29) having NW-SE bedding strike and 65° southwesterly dip. The prominent joints in the rock types are: - (i) NE-SW strike, vertical dip and (ii) NW-SE strike, dip 15° towards NE. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 45 m between the lowest (1092m) and highest (1137m) RL in the polygon. The slope is comparatively steeper towards the southeastern periphery than the northeastern side.

The overall slope condition appears to be a little disturbed due to the presence of highly erosive fourth order Ikku River in the NE corner of the polygon. The water table depth from the log sheets of hand pumps in Patola village provided by GWO indicate that the water table range between 45 to 54 meters below ground level in the area.

The area falling in the Polygon-6 is having moderate to steep slope towards the Ikku River, where the overburden is mixed with very big boulders of granite varying in size 1-3m height. In fact, the slope is not stable due to susceptible erosion of fragile, loose overburden sandy material due to vigorous flowing of seasonal nalas. The general issues hindering the course of the work are as follows. (i) The toe erosion from the major khad, (ii) erosion by the seasonal nalas, (iii)removal of gigantic granitic boulders, (iv) modification in the slope geometry, (v) protection from the slope failure and (vi)safe foundation etc.

Since, the erosion will take place on the convex slopes, a properly designed retaining structure (gabion wall) to be erected to avoid the bank erosion because of the presence of Ikku River. A suitable remedial measures in the form of diversion of channel and use of vegetation is also recommended since the river bank that have vegetation erode slower than those without.

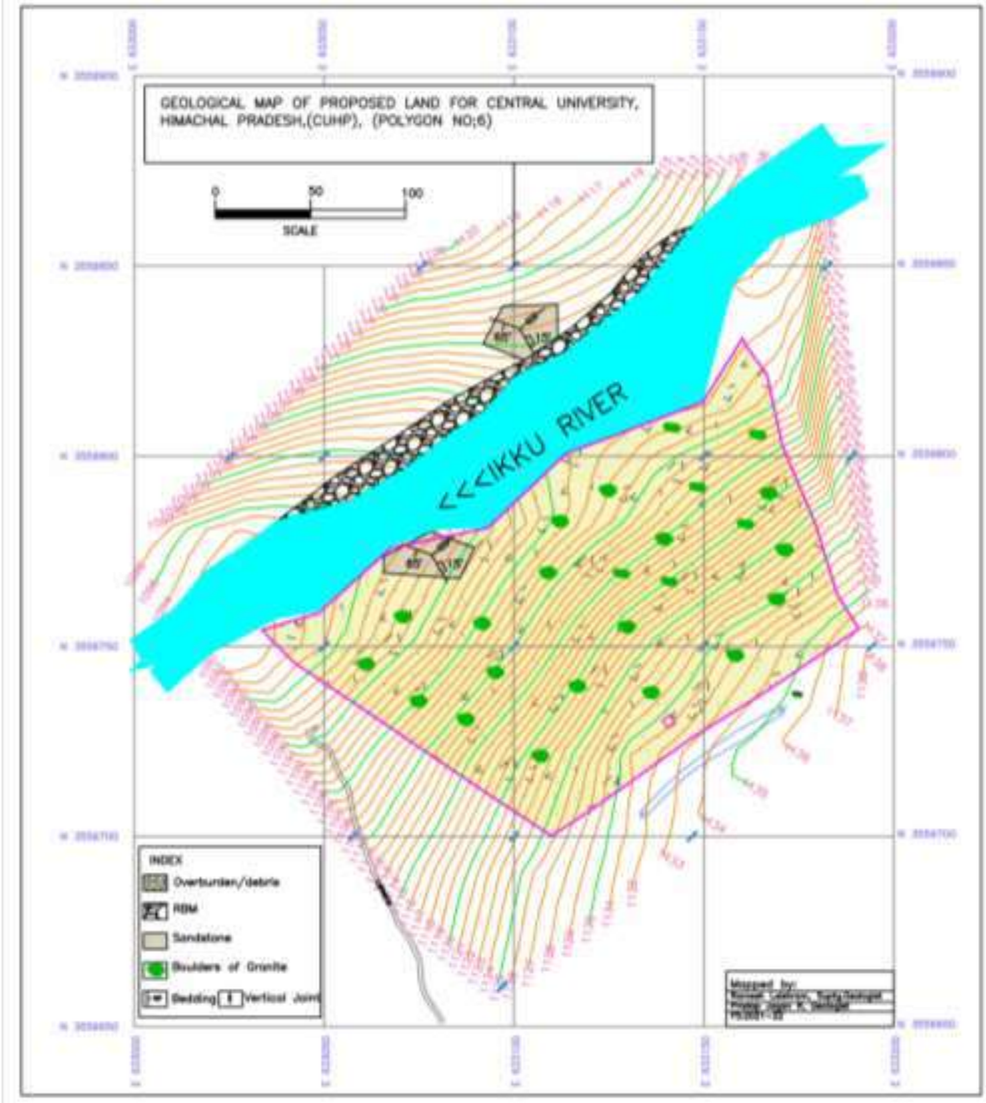


Fig. 29: Geological map of Polygon 6

Fig. 30: Panoramic view of polygon 6

Fig. 31: River Borne Material in polygon 6

4.7 Polygon 7

The proposed site for the school building and community center is located on the western proximity of the overall area proposed for CUHP and is approachable from Jadrangal to Patola village by a motorable road. About 23050 Sq. m. of land is being developed in this area for the purpose of constructing school building and community center. The proposed site is located on a spur trending NE-SW. The eastern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1205m, and flows south-west down the hill slope. The depression forms a first order stream and is dry. The stream is scattered with angular boulders of sandstone. The northwestern part of the polygon has rock exposures on the slope face (from R.L. 1150 to 1173m.), the slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. Dark grey sandstone alternating with purple color mudstone is the rock type exposed in isolated pockets belonging to the Kasauli Formation of Sirmur Group and they are cross bedded (Fig.32) having NW-SE bedding strike and 65° southwesterly dip. The prominent joints in the rock types are: - (i) NE-SW strike, vertical dip and (ii) NW-SE strike, dip 15° towards NE. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 72m between the lowest (1140m) and highest (1212m) RL in the polygon. The slope is comparatively steeper towards the northeastern periphery than the southwestern side. The overall slope condition appears to be stable in the absence of any large scale slide features. The water table depth from the log sheets of hand pumps in Patola village provided by GWO indicate that the water table range between 45 to 54 meters below ground level in the area.

Fig. 32: Panoramic view of polygon 7

Fig. 33: Scar of slide in polygon 7

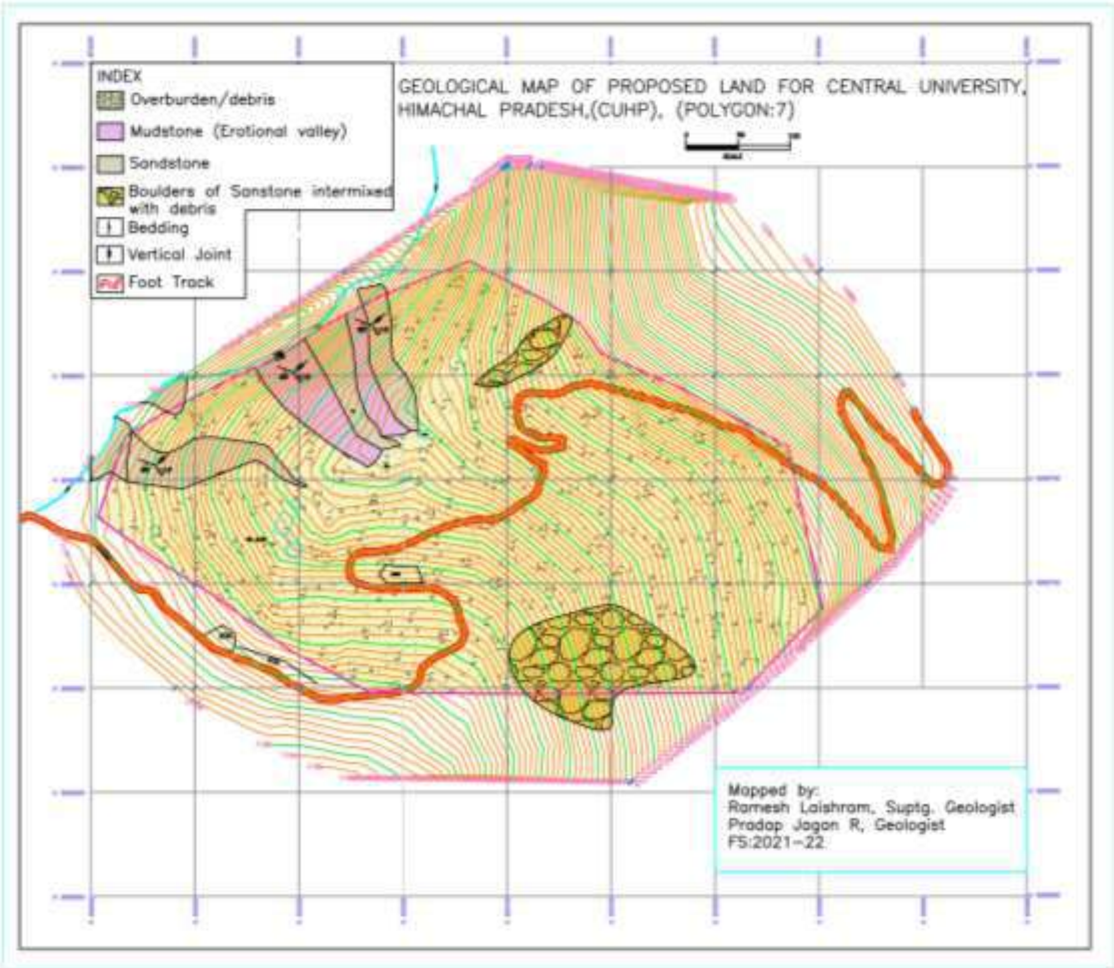


Fig.34: Geological Map of Polygon 7

4.8 Polygon 8

Due to the thick pine forest in the polygon, the surveyor informed that contour plan could not be prepared. The proposed site for the University Schools, Faculty Club & Transit Hostels is located on the central part of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 100000 Sq. m. of land is being developed in this area for the purpose of constructing University Schools, Faculty Club & Transit Hostels. The proposed site is located on a ridge trending NW-SE. The NW-SE trending ridge has rock exposures all along the ridge and both the slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. Development of hockey stick bending in the pine trees were observed in this polygon are indication soil creep (Fig.35) Dark grey sandstone is the rock type exposed in ridge belonging to the Kasauli Formation of

Sirmur Group and they are cross bedded and shows hexagonal cracks (Fig.36) having NW-SE bedding strike and 65° northeasterly dip. The prominent joints in the rock types are: - (i) NE-SW strike, vertical dip and (ii) NW-SE strike, dip 40° towards NE. The slope is comparatively steeper towards the central portion of the polygon. The overall slope condition appears to be stable in the absence of any large scale slide features and considering the huge rock outcrop (solid foundation of shallow level) in this polygon. Three samples of disturbed soil (DS9), undisturbed soil (UDS9) and a rock sample (R4) were collected from this polygon and the results are discussed as below. UCS value falls in moderate 49.78 and 46.00 in dry and saturated respectively as per ISRM. Other parameters like wet density and dry density are 2.41 and 2.2 kg/m3 respectively and specific gravity is 2.69. The friction angle is 26.93, appears to be stable area. UCS is 37Mpa falling in Moderate category. The soil is having low permeability value and all parameters indicate a stable area. Uniformity coefficient is 17.72 which indicate that the soil is well graded.

The soil creep in this Polygon must be taken care of while designing any civil structures and can be kept under monitoring by constructing observation pillars in the area of polygon and regularly monitoring for any movement or rule out any creep movement.

Fig. 35: Hockey stick bending of the pine tree due to soil creep, Polygon 8

Fig. 36: Hexagonal cracks developed in the Sandstone of Kasauli Formation, Polygon 8

4.9 Polygon 9

The proposed site for the Library & Information Technology Centre is located on the central part of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 4009 Sq. m. of land is being developed in this area for the purpose of constructing Library & Information Technology Centre. The proposed site is located on relatively flat spur trending NE - SW. The slopes are entirely covered by overburden of slope debris (Fig.37). The debris is predominantly sandy loam type strewn along the slope. Two prominent depression marking first order stream was recorded in the polygon, the first one from a higher elevation of 1350m in the NW flowing downhill towards SE and the other flowing from North to south from an elevation of 1342m and taking a sharp turn at 1338m towards SW. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 28 m between the lowest (1322m) and highest (1350m) RL in the polygon. The slope is comparatively steeper towards the northwestern then the southeastern part of the polygon. The overall slope condition appears to be stable in the absence of any large scale slide features (Fig.38a&b). Two samples of disturbed soil (DS13), undisturbed soil (UDS13) were collected from this polygon and the results are discussed. UDS13 shows 16.42 uniformity coefficients which indicate a well graded soil. Plasticity chart shows sample DS 4 falls in MI category indicating inorganic silts, clayey silt with medium plasticity (liquid limit is >50%). Friction angle is high that is 36.0; However, UCS falls in moderate category. DS13 shows CL/ML indicating inorganic silt and clay with low plasticity. Friction angle is low (30.65) and UCS values show 38.32 which falls in moderate category.

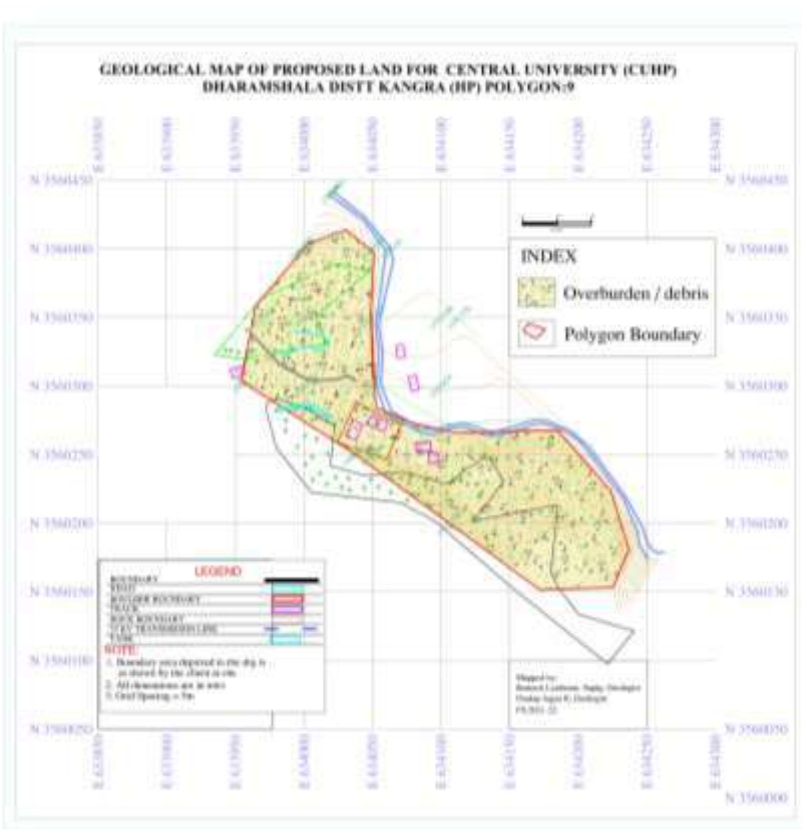


Fig. 37: Geological Map of Polygon 9

	
Fig. 38a: Panoramic view of polygon 9	Fig. 38b: Panoramic view of polygon 9

4.10 Polygon 10

The proposed site for the Transit boys hostel is located on the central part of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. Contour plan of only half of the area was provided as the other half is covered with thick pine forest and contour plan could not be prepared as conveyed by surveyor (Fig.39). About 8005 Sqm. of land is being developed in this area for the purpose of constructing Transit boys hostel. The proposed site is located on relatively flat spur trending NE - SW. The slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type strewn along the slope. A prominent depression marking first order stream was recorded in the polygon, flowing from North to south in the downhill. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 25 m between the lowest (1312m) and highest (1337m) RL in the polygon. The slope is comparatively steeper towards the northern then the southern part. The overall slope condition appears to be stable in the absence of any large scale slide features.

Sample UDS 8 shows CL-ML category designating inorganic silt and clay of low plasticity, as per the plasticity chart. However, the soil has been classified as poorly graded sand/ sandy soil with little or no fine particles (SP). Fiction angle is also high 32.85 and UCS value falls in moderate category. Uniformity coefficient (Cu) of sample UDS8 shows 9.65 values indicating poorly grades soil.

Since, the friction angle of the soil appears to be high and poorly graded, a nala or streamlets are to be properly lined or retaining structures to be given in this u/s part for drainage to avoid any erosion activity in the Polygon area.

Fig. 39: Panoramic view of polygon 10

4.11 Polygon 11:

The proposed site for the Transit Boys Hostel is located on the eastern part of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 0.040095 sq. km. of land is being developed in this area for the purpose of constructing Transit Boys Hostel. The proposed site is located on spur trending NE – SW (Fig.40). The northwestern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1397m, and flows south-west down the hill slope. The depression forms a first order stream and is dry during the field work. The central part is marked by a slide scar with the crown of the slide resting at R.L. 1402m just below the upper road level (Fig.41, Plate-II). Though there is no surface indication, according to compiled geological map of the area from 50K compiled map of GSI, the Palampur Thrust (MBT) (where rocks of Dagshai Formation override the Lower Siwalik Group of rocks) passes through the polygon in the northern portion. The slide scar maybe the ground signature appeared because of this thrust. The slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 44 m between the lowest (1358m) and highest (1402m) RL in the polygon. The slope is comparatively steeper towards the northern periphery than the southern side. The overall slope condition appears to be a little disturbed due to the presence of slides. Two samples were collected from this polygon. one disturbed soil (DS5) and one undisturbed soil sample (UDS5). DS5 shows MI/OI as per plasticity that indicating inorganic/ organic silt, clay silt with medium plasticity. Friction angle shows 32.20 and UCS value falls in moderate category 38.22MPa. Uniformity coefficient (Cu) shows high value that is 24.55.

Diversion of the channel well above the landslide can check rain water coming to fragile site and divert it to safe natural course nearby and suitably designed retaining wall is recommended to protect the landslide from the construction site. The Polygon 11 needs to be monitoring by erecting pillars and monitoring their movement periodically over a longer time.

	
Fig. 40: Panoramic view of Polygon 11	Fig.41: Slide in Polygon 11

4.12 Polygon 12:

The proposed site for the Transit Boys Hostel is located on the eastern proximity of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 12004 Sq. m. of land is being developed in this area for the purpose of constructing Transit Boys Hostel. The proposed site is located on spur trending NE - SW. The southwestern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of the polygon R.L. 1462m, and flows south-west down the hill slope. The depression forms a first order stream and is dry. The slopes are entirely covered by overburden of slope debris (Fig.42). The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 134m between the lowest (1434m) and highest (1568m) RL in the polygon. The slope is comparatively steeper towards the northeastern periphery than the southwestern side. The overall slope condition appears to be stable in the absence of any large scale slide features.

Though the area appears to be stable, due care to be taken during disturbing the natural slope.

Fig. 42: Panoramic view of Polygon 12

Fig. 43: Geological Map of Polygon 10, 11, 12, 13 and 14

4.13 Polygon 13:

The proposed site for the Transit Boys Hostel is located on the eastern proximity of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 20019 Sq m of land is being developed in this area for the purpose of constructing Transit Boys Hostel. The proposed site is located on spur trending NE - SW. The central part of the proposed site is marked by a prominent depression, which originates from the highest level of R.L. 1330m, and flows south-west down the hill slope. The depression forms a first order stream and is dry. The slopes are entirely covered by overburden of slope debris (Fig.43 & 44). The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 49m between the lowest (1295m) and highest (1344m) RL in the polygon. The slope is comparatively steeper towards the northeastern periphery than the southwestern side. The overall slope condition appears to be stable in the absence of any large scale slide features.

Fig. 44: Panoramic view of polygon 13

4.14 Polygon 14:

The proposed site for the Transit Boys Hostel is located on the eastern proximity of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 50012 Sq. m of land is being developed in this area for the purpose of constructing Transit Boys Hostel. The proposed site is located on hill side of a NE – SW trending spur and on the left bank of the Bhagan Khad (Fig.45). The eastern periphery of the proposed site is marked by a prominent depression, which originates from the highest level of R.L. 1384m, and flows north-west down the hill slope. The depression forms a first order stream and is dry during the field work. The southwestern and southeastern periphery is marked by a slide scars. The slides are because of the disturbance of slope for road cuts. Excepting a few isolated rock exposures on the slope face, the slopes are entirely covered by overburden of slope debris. The debris is predominantly sandy loam type with boulders strewn along the slope and embedded in the above type of debris. Light brown sandstone is the rock type exposed in isolated pockets belonging to the Lower Siwalik Group and they are soft, friable and cross bedded (Fig 46) having NW-SE bedding strike and 40° northeasterly dip. The prominent joints in the rock types are: - (i) NE-SW strike, vertical dip and (ii) NW-SE strike, dip 15° towards NE. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 95 m between the lowest (1300m) and highest (1395m) RL in the polygon. The slope is comparatively steeper towards the southeastern periphery than the northwestern side. The overall slope condition appears to be a little disturbed due to the presence of slides and construction of road in the SW and SE corner of the polygon. The sample of disturbed soil (DS2) falls in CL-ML category indicating inorganic silt and clay of low plasticity. C and ø value also show low while UCS values shows 32.21mPA indicating moderate category.

Fig. 45: Panoramic view of Polygon 14

Fig. 46: Sandstone of Lower Siwalik Group, Polygon 14

4.15 Polygon 15:

The proposed site for the various construction of CUHP is located on the southern proximity of the overall area proposed for CUHP and is approachable from Jadrangal by a motorable road. About 22105 Sq m of land is being developed in this area for the purpose of various constructions. The proposed site is located on the valley fill of the Bhagan Khad. The eastern and western periphery is flanked by two nalas. The eastern flank is marked by the Bhagan Khad which is a forth order stream and flows south-west down the hill slope.

The nala on the western flank is a second order stream and is dry. Excepting a few isolated rock exposures on the nala sections, the slopes are entirely covered by overburden of slope debris and River bed material (Fig.47). The debris is predominantly river bed material with boulders strewn along the slope and embedded in the above type of debris. These river bed materials are also being quarried locally for construction purposes (Fig.48). Dark grey sandstone is the rock type exposed in isolated pockets belonging to the Kasauli Formation of the Sirmur Group and they are hard and cross bedded (Fig.49) having NW-SE bedding strike and 50° northeasterly dip. The prominent joints in the rock types are: - (i) NE-SW strike, dip 45° towards SE and (ii) NW-SE strike, dip 50° towards SW. A study of the contour plan provided by CUHP shows that there is a maximum level difference of 151m between the lowest (1082m) and highest (1233m) RL in the polygon. The slope is comparatively steeper towards the northeastern periphery than the southwestern side. The overall slope condition appears to be a little disturbed due to the presence of two big nala on both the flanks of the polygon. As per the data from the Exploratory Tube Well of CGWB, located on link road to Central University, Jadrangal, they encountered aquifers in 5 levels, viz. i) 50.0-52.50m, ii) 58-60m, iii) 72-76m, iv) 84-90m and V) 94-98m. The shallowest aquifer is at a depth of 50.0-52.50m below ground level. They encountered solid rock at a depth of 86 meters below ground level. Two samples were collected from this polygon. UDS10 and DS10 show inorganic silt and clay of low plasticity (CL-ML category). C and ø value is low indicating poorly graded soil. Uniformity coefficient value (Cu) shows 8.64 also indicating poorly graded soil. A properly designed retaining structure (gabion wall) to be erected to avoid the bank erosion. A suitable remedial measures in the form of diversion of channel is also suggested.

	
Fig. 47: Panoramic view of polygon 15	Fig. 48: Sand quarry in Polygon 14

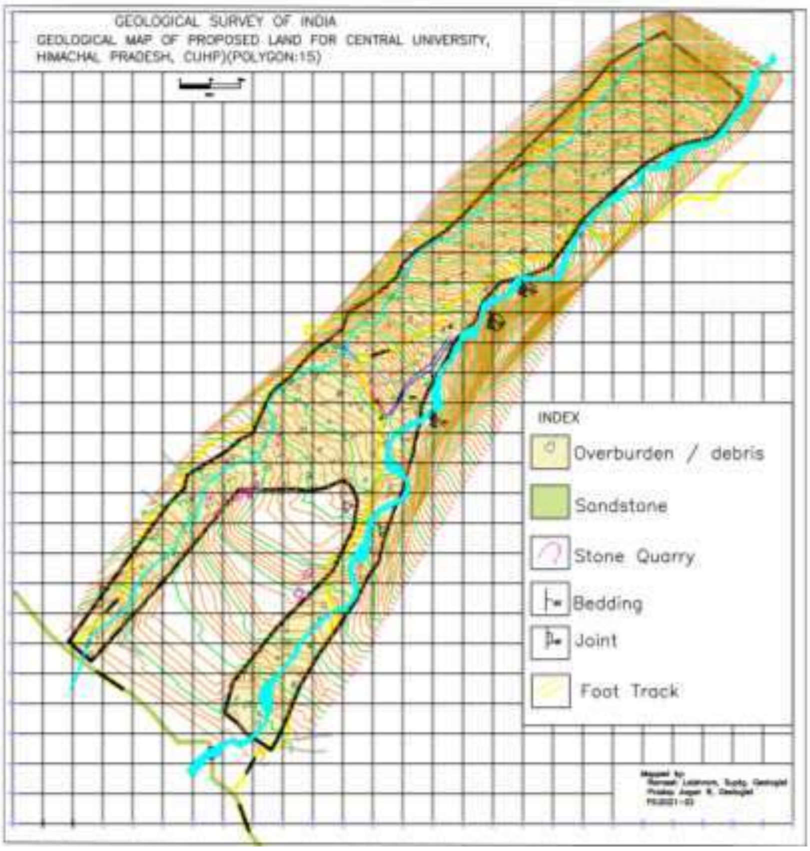


Fig. 49: Geological map of Polygon 15

4.16 Summary of the discontinuities:

The rock exposures in the allotted campus are very limited. The bedding/ bedding parallel joint is not much differing in the overall area. The details of the joints present at the study area are given in Table -3.

Table-3: Nature of the joints present at the study area.

Set	Dip Amount	Dip Direction	Spacing (m)	Aperture (mm)	Roughness		Filling
S0/J1 Bedding	12°-20°	040°-070°	0.2-0.5	2 to10	RP-SP		Nil to coating Mud fill
J2	35°-50°	190°-210°	0.3- widely spaced	Tight to 10	RP-SU		NIL to coating & minor clay infilling
J3	65°-80°	010°-015°	0.5 - widely spaced	Open to 10	RP-SU		NIL to coating & minor clay infilling
J4	Sub vertical	130°-150°	1 -widely spaced	Tight to 20	RP-SU		NIL to coating & minor clay infilling

CHAPTER – 5

GEOTECHNICAL INVESTIGATIONS

Geotechnical analysis includes the physical and mechanical properties of soil and rock and their strength. In addition, soils are good materials used in engineering projects. soil foundation, use of soil in constructions and industrial applications is another dimension. The objective of studying this module is to know about the engineering properties of soils and their significance.

5.1 Rock Mass Rating:

Bieniawski (1976) published the details of a rock mass classification called the Geomechanics Classification or the Rock Mass Rating (RMR) system. Over the years, this system has been successively refined as more case records have been examined and the reader should be aware that Bieniawski has made significant changes in the ratings assigned to different parameters. The discussion which follows is based upon the 1989 version of the classification (Bieniawski, 1989). Both this version and the 1976 version deal with estimating the strength of rock masses. The following six parameters are used to classify a rock mass using the RMR system:

1. Uniaxial compressive strength of rock material.
2. Rock Quality Designation (RQD).
3. Spacing of discontinuities.
4. Condition of discontinuities.
5. Groundwater conditions.
6. Orientation of discontinuities.

The basic RMR is to be calculating addition of five parameters except orientation of discontinuities. The uniaxial compressive strength has been calculated by the geological hammer and also the UCS value is obtained from the test results of the rock samples. The UCS value obtained from rock samples in dry condition for R1, R2 and R3 is 45.37, 53.94 and 49.78mpa respectively. The UCS value obtained in saturated conditions is 43.50, 50.01 and 46.99mpa for the R1, R2 and R3. The RQD has been calculated by using Palmstrom (1995) method from volumetric join count.

Based on the field evaluation the Rock Mass Rating (RMR) has been calculated in and around **Polygon 2** area as follows.

Table 4: RMR calculation

Sl.No	Item	Value	Rating
1	Point load index	48Mpa	4
2	RQD (very poor)	<25%	05
3	Spacing of discontinuities	60-200mm	08
4	Condition of discontinuities	*	13
5	Ground water condition	Dry	0
6	Orientation of discontinuities	(Not applicable)	-0
		RMR	**30**

*** Considering all the parameters**

The RMR is value 30 indicates the rock mass is on the boundary between 'Poor rock' category. Guidelines for excavation and support of 10m span rock tunnels in accordance with the *RMR* system (After Bieniawski 1989) is given below.

Table 5: Guidelines for excavation

Rock mass class	Excavation	Rock bolts (20 mm diameter, fully grouted)	Shot crete	Steel sets
IV - Poor rock *RMR*: 21-40	Top heading and bench 1.0-1.5m advance in top heading. Commence support each blast. Complete support 10m face.	Systematic bolts 4-5 m long, spaced 1-1.5 m in crown and walls with wire mesh.	100-150 mm in crown and 100 mm in sides.	Light to medium ribs spaced 1.5 m where required.

Safe cut slope (^{o}) for the poor RMR category is **<40** (Waltham, 2002). The allowable bearing pressure is **45 -50 (T/m2) (**After Bieniawski 1993).

5.2 SAMPLE COLLECTION AND INTERPRETATION:

A total of 19 representative soil samples were collected (table-5) from the various pockets of Central University (CUHP), mainly from a geotechnical database point of view (Fig.50 & 51). Three bed rock samples were collected from three different levels. Similarly, eight disturbed and eight undisturbed soil samples were collected. Each was collected in a poly bag except undisturbed soil samples which was collected through 40cm length and 2.5cm dia. steel tube. The samples were submitted to DC, Dharamshala, Dist. Kangra, H.P.

for estimation of geotechnical parameters [Cohesion (C), Angle of Internal Friction (ϕ), Dry Density, Natural Moisture Content (NMC), Optimum Moisture Content (OMC), Void ratio at OMC, Specific Gravity, Liquid Limit (LL) and Plastic Limit (PL) and Grain Size Analysis]. The following 19 (3 - rock sample and 8 each of disturbed and undisturbed) samples which have been collected from the proposed site for CUHP near at Jadrangal, Dist. Kangra, H.P.

Table: 6 Details of the sample collected from the CUHP campus

Box No.	**Sample No.**	**Sample Type**	**Remark**	**Polygon**
1	R-01	Rock	Sandstone	2
2	R-02	Rock	Sandstone	14
3	R-04	Rock	Sandstone	8
4	DS-1	Debris/ Soil	Disturbed sand/debris sample.	2
5	DS-2	Debris/ Soil	Disturbed sand/debris sample.	14
6	DS-4	Debris/ Soil	Disturbed sand/debris sample.	9
7	DS-5	Debris/ Soil	Disturbed sand/debris sample.	11
8	DS-8	Debris/ Soil	Disturbed sand/debris sample.	10
9	DS-9	Debris/ Soil	Disturbed sand/debris sample.	8
10	DS-10	Debris/ Soil	Disturbed sand/debris sample.	15
11	DS-13	Debris/ Soil	Disturbed sand/debris sample.	Polygon clubbed in 9
12	UDS-1	Debris/ Soil	Undisturbed soil/debris sample	2
13	UDS-2	Debris/ Soil	Undisturbed soil/debris sample	14
14	UDS-4	Debris/ Soil	Undisturbed soil/debris sample	9
15	UDS-5	Debris/ Soil	Undisturbed soil/debris sample	11
16	UDS-8	Debris/ Soil	Undisturbed soil/debris sample	10
17	UDS-9	Debris/ Soil	Undisturbed soil/debris sample	8
18	UDS-10	Debris/ Soil	Undisturbed soil/debris sample	15
19	UDS-13	Debris/ Soil	Undisturbed soil/debris sample	Polygon clubbed in 9

Fig. 50: Disturbed sample collection from proposed land for CUHP

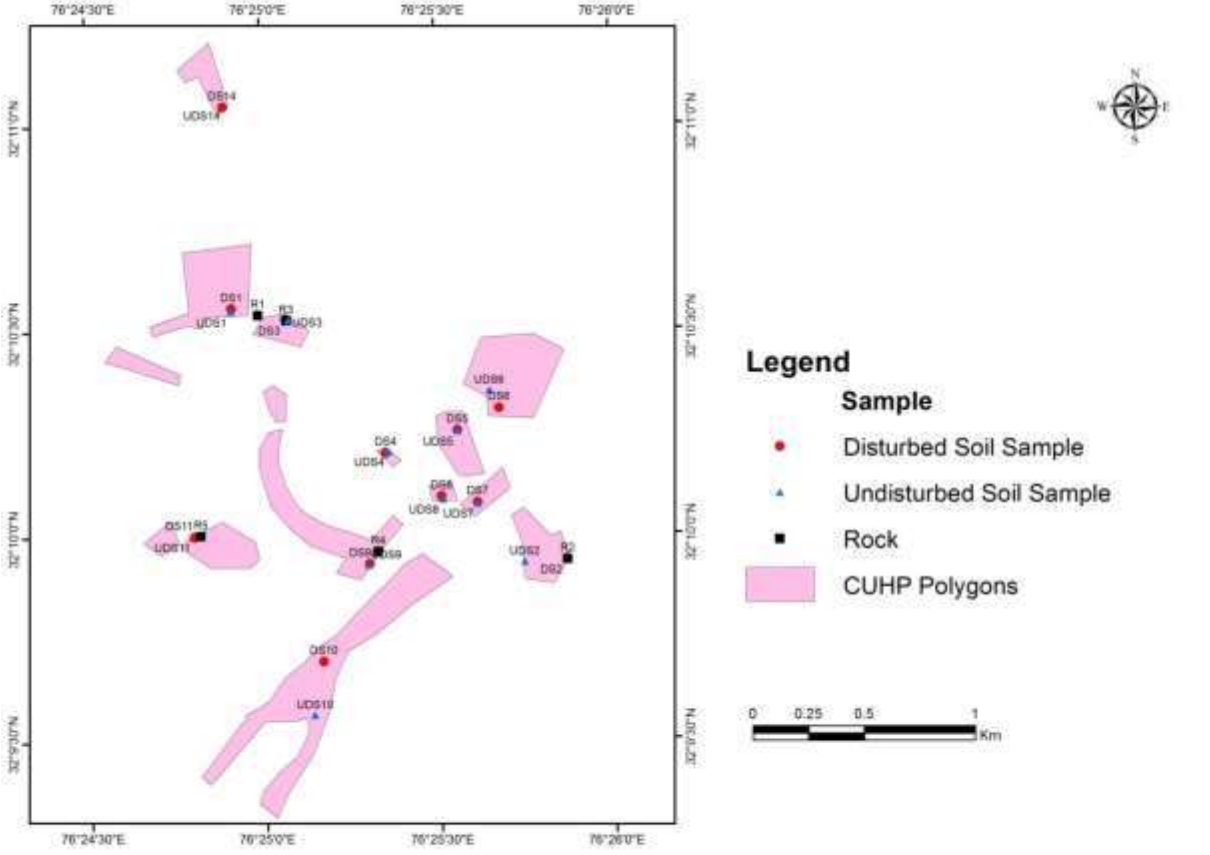


Fig. 51: Sample location map of the polygons of CUHP

Table-7: Results of Geotechnical Parameters of disturbed soil samples

S.No.	Parameters	Unit	DS- 1	DS- 2	DS- 4	DS-5	DS- 8	DS- 9	DS- 10	DS- 13
1	**Porosity**	(%)	0.38	0.37	0.37	0.35	0.36	0.37	0.38	0.38
2	**Dry Density**	kg/m3	1.63	1.55	1.50	1.65	1.50	1.60	1.49	1.84
3	**Wet Density**	kg/m3	1.75	1.68	1.60	1.74	1.61	1.74	1.58	1.98
4	**Specific Gravity**	Unit less	2.70	2.71	2.72	2.70	2.73	2.71	2.75	2.71
5	**Liquid Limit**	Unit less	50.76	34.82	47.59	41.38	26.16	47.27	36.83	32.51
6	**Plastic Limit**	Unit less	43.84	29.02	42.65	34.59	20.46	40.28	30.59	26.54
7	**Plasticity Index**	(%)	6.92	5.80	4.94	6.79	5.70	6.99	6.24	5.97
8	**Natural Moisture Content**	(%)	6.00	7.00	5.50	6.50	7.00	8.50	2.80	3.50
9	**Dry Unit Weight**	kN/m3	16.55	16.83	16.78	17.20	17.06	16.72	16.65	16.62
10	**Void Ratio**	Unit less	0.60	0.58	0.59	0.54	0.57	0.59	0.62	0.60
11	**Triaxial Cohesion**	KPa	14.65	27.54	15.48	28.87	25.42	36.51	33.67	35.87
12	**Friction Angle**	Deg	35.00	32.50	36.00	32.20	35.10	28.40	31.90	30.65
13	**U.C.S.**	KPa	32.48	37.21	32.52	38.22	35.10	38.25	36.45	38.32
14	**Water Absorption**	(%)	0.22	0.21	0.22	0.20	0.21	0.22	0.23	0.22
15	**Tensile Strength**	MPa	2.10	2.20	2.40	2.30	2.40	2.00	2.40	2.30
16	**Soil Classification**		**SM**	**SP**	**SM**	**SP-SM**	**SP**	**SP-SM**	**SP-SM**	**SP-SM**

Table-8: Results of Geotechnical Parameters of undisturbed soil samples

S.No.	Parameters	Unit	UDS- 1	UDS-2	UDS-4	UDS- 5	UDS-8	UDS- 9	UDS-10	UDS-13
1	**Porosity**	(%)	0.35	0.31	0.33	0.29	0.32	0.34	0.32	0.33
2	**Dry Density**	kg/m3	1.73	1.62	1.60	1.73	1.56	1.84	1.60	1.97
3	**Wet Density**	kg/m3	1.82	1.71	1.68	1.82	1.64	1.94	1.68	2.07
4	**Specific Gravity**	Unit less	2.69	2.70	2.69	2.71	2.72	2.70	2.73	2.69
5	**Liquid Limit**	Unit less	49.64	35.53	52.00	39.58	29.75	43.38	37.67	35.89

6	**Plastic Limit**	Unit less	42.84	30.02	44.65	35.46	23.12	36.87	31.60	29.86
7	**Plasticity Index**	(%)	6.80	5.51	7.35	4.12	6.63	6.51	6.07	6.03
8	**Natural Moisture Content**	(%)	7.00	8.00	6.00	7.00	8.00	10.00	3.00	4.00
9	**Dry Unit Weight**	kN/m3	17.25	18.27	17.59	18.99	18.15	17.54	18.34	17.71
10	**Void Ratio**	Unit less	0.53	0.45	0.50	0.40	0.47	0.51	0.46	0.49
11	**Triaxial Cohesion**	KPa	15.68	29.53	16.54	27.59	29.76	34.59	30.58	37.26
12	**Friction Angle**	Deg	33.80	31.95	34.67	31.15	32.85	26.93	30.04	29.20
13	**U.C.S.**	KPa	31.25	32.00	36.54	37.85	31.52	37.00	35.21	37.81
14	**Water Absorption**	(%)	0.20	0.17	0.19	0.15	0.17	0.19	0.17	0.18
15	**Tensile Strength**	MPa	1.90	2.10	2.50	2.30	2.40	2.40	2.10	2.50
16	**Soil Classification**		SM	SP	SM	SP-SM	SP	SP-SM	SP-SM	SP-SM

Table-9: Results of Geotechnical Parameters of Rock samples

Parameters	**Unit**	**R-01**	**R-02**	**R-04**
UCS Dry	MPa	45.37	53.94	49.78
UCS Saturated	MPa	43.50	50.01	46.99
Wet Density	kg/m3	2.31	2.52	2.41
Dry Density	kg/m3	2.29	2.38	2.28
Specific Gravity	Unit less	2.67	2.72	2.69

5.2.1 Atterberg limit:

The values of Atterberg limit of the disturbed soil samples available for the entire sample. The LL values ranges from 26.16% to 50.76% in disturbed samples and 29.75% to 52.00% in undisturbed samples. Similarly, the PL values ranges from 20.46% to 43.84% in disturbed samples and 23.12 to 44.65% in undisturbed samples. The overall values of the PI (PI = LL-PL) varies from 4.94% to 6.99% in disturbed samples and 4.12% to 7.35% in undisturbed samples. So the soil description based on PI is slightly plastic to medium plastic. The amount of water in the soil controls deformation behavior for that soil. This behavior is called Soil Consistency. This property is characteristic on fine grained soil only in the presence of water. Due to presence of clay or fine silt in the overburden/debris material in the allotted pockets, PI value is increasing from slightly plastic to medium plastic. Soil with low plasticity index can change from a solid to liquid with little change in moisture content. These soils may be prone to mass movements (Hicks 2007).

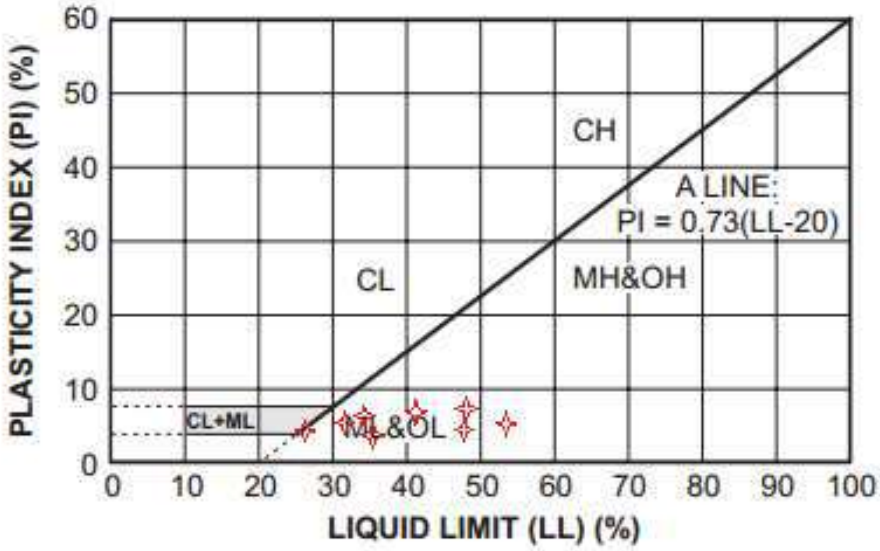
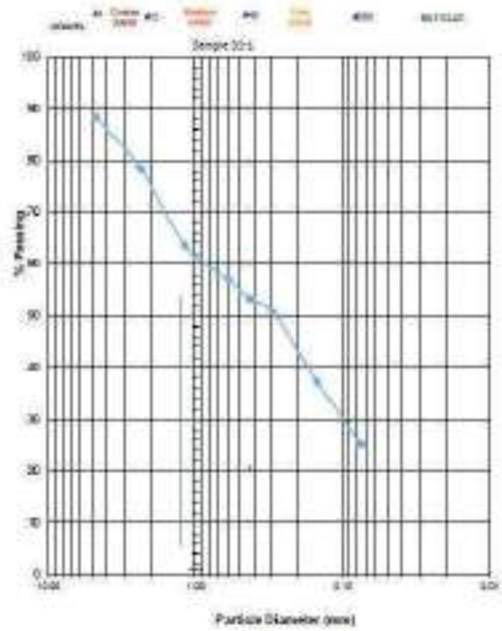


Fig:52 Plasticity chart for disturbed soil samples

The samples are falling below the A-line. One sample (DS-8) among the eight samples falling in the **CL+ML** ***(CL: Clay with low plasticity, ML: Silt with low plasticity)*** while remaining samples are falling below A-line categorized into **ML or OL** ***(ML: Medium plastic silt, OL: Medium plastic organic soil)*** category (Fig.52)**.** The samples distribution in the plasticity shows the liquid limit of the most of the samples are less than 50% which indicates **low plasticity** and also falling in the ***Silty sand*****s** category as per the BIS soil classification.

5.2.2 Grain Size Analysis:

Grain size analysis of the samples was done by Sieve Analysis Method. Sieves with 4.75mm, 2.36mm, 1.18mm, 0.60mm, 0.43mm, 0.300mm, 0.150mm and 0.075mm openings (U.S. Standards) were used for this purpose. A total 1000gm has been used for the sieve analysis for each sample. From the grain size analyses, it is observed the most of the soil samples area passing through the 2.36mm to 0.300mm and some amount of the soil is passing below the 0.075mm size so it can be categorized ***Medium Grained Soil*** which has small amount of **silt** and **clay** (Fig.53).



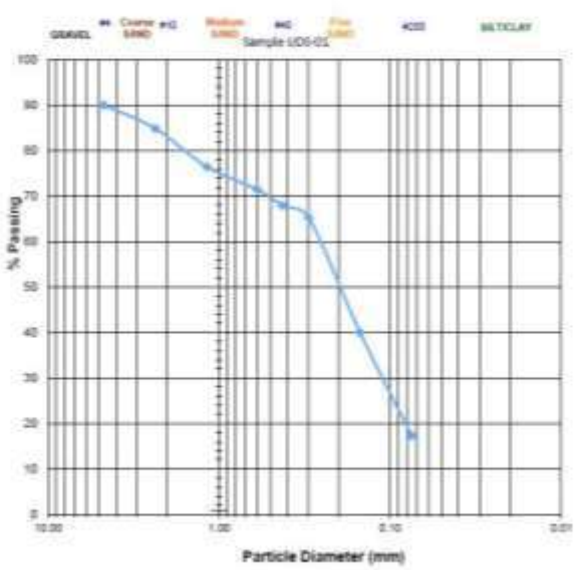


Fig. 53: Grain size analysis of disturbed and undisturbed soil samples for Polygon-1

5.2.3 Density:

In case of Dry Density (DD), the overall values vary from 1.49Kg/m3 to 1.84Kg/m3 in the disturbed soil sample and 1.56 Kg/m3 to 1.97 Kg/m3 undisturbed soil samples. The maximum value is obtained in the samples No-13 representing polygon No-10, and the minimum value obtained in the sample No-10 representing polygon No-15. The values reflect that there is not much of differences in values of dry density and wet density of the soil samples collected from all the polygons.

5.2.4 Moisture Content/ Natural Moisture Content:

The Moisture Content (MC)/ Natural Moisture Content (NMC) vary in general from 2.80% to 8.50% in disturbed soil samples and 4.0% to 10.0%, in undisturbed soil samples which is slightly higher range than disturbed soil samples. The maximum dry density is almost 2 kg/m^3which is having the moisture content of 4% (Fig.54)

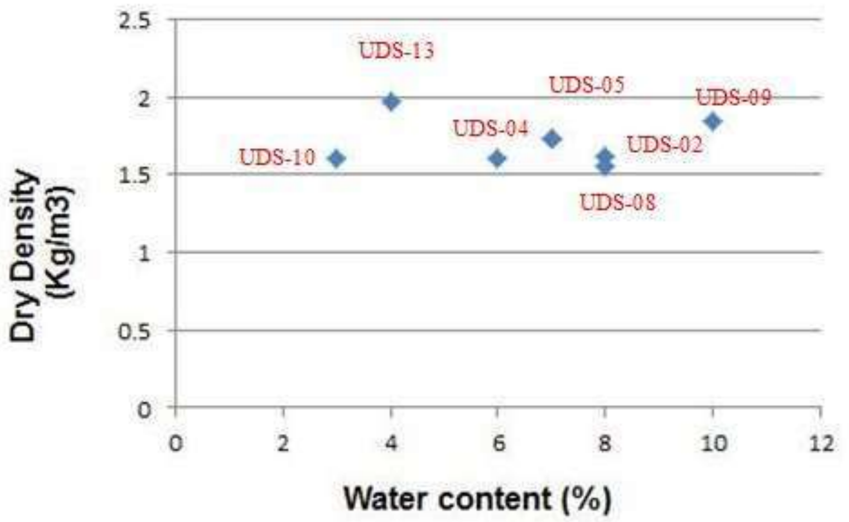


Fig:54 Water content (Moisture content) - dry density relationship

5.2.5 Specific Gravity:

Specific gravity is the ratio of the mass of soil solids to the mass of an equal volume of water. It is an important index property of soils that is closely linked with mineralogy or chemical composition and also reflects the history of weathering. It is relatively important as far as the qualitative behavior of the soil is concerned and useful in soil mineral classification. Typical values of specific gravity are given in the table below.

Table 10: Typical values of specific gravity (Bowles, 2012)

Type of soil	**Specific gravity**
Sand	2.65 – 2.67
Silty sand	2.67 – 2.70
Inorganic clay	2.70 – 2.80
Soil with mica or iron	2.75 – 3.00
Organic soil	1.00 – 2.60

Based on the result we obtained for the disturbed soil sample, the specific gravity of the samples ranges from 2.70 to 2.75 which fall in the Inorganic clay or soil with mica and iron category of Table. 1. Whereas the result of the undisturbed soil sample range from 2.69 to 2.73 which falls in the silty sand to inorganic clay category of soil.

5.2.6 Shear Strength Parameters:

Soil strength of soil may be defined as the resistance to shearing stresses and a consequent tendency for shear deformation. It is expressed by two parameters viz. Cohesion (C) and Angle of Internal Friction (**Φ**). Cohesion (C) may be defined as tendency of constituent particles to stick together by virtue of molecular and electrostatic forces of particles. Similarly, Angle of Internal Friction (**Φ**) may be defined as the innate resistance offered as a result of interactions between individual particles constituting the plane of separation.

The values of shear strength parameters (Cohesion, C and Angle of Internal Friction, ϕ) were also estimated from the samples collected. The cohesion value ranges from 14.65 to 35.87kpa. The cohesion value for the pure sand is 0. Angle of Internal Friction (ϕ) theoretically pure clay would have a value of 0° and ϕ would rise with increasing sand content and density to approximately 40° for a compact sandy loam soil. Similarly, ϕ, value ranges from 26.93^0 to 34.67^0 for the undisturbed soil sample.

The Cohesion (C)and Angle of Internal Friction (ϕ) values are likely reduce drastically in actual site condition and fully saturated.

5.2.7: Slope stability modeling:

The slope stability analysis was done for the polygon-2 by using the Soilworks software model. The factor of the safety has been calculated from the profile of the slope and the geotechnical parameters of the samples collected from the corresponding slope. The factor of the safety for the admin block i.e polygon-2 is estimated the value of 1.3 for the dry condition (Annexure – IV). The factor of safety for the slope has been calculated by the following data.

Table 11: The data used in the FS

Section	Wet unit weight (kN/m³)	Saturated unit weight (kN/m³)	Cohesion (kN/m²)	Internal friction angle ([deg])	Modulus of elasticity (kN/m²)	Poisson's ratio
DS1	16.55	21.00	14.6	35.00	-	-
UDS1	17.25	21.00	15.7	33.80	-	-

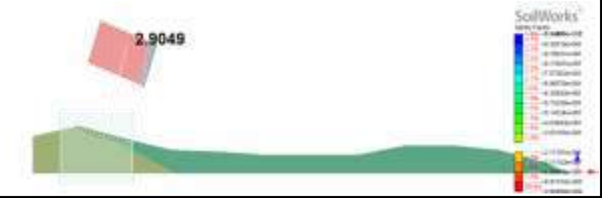
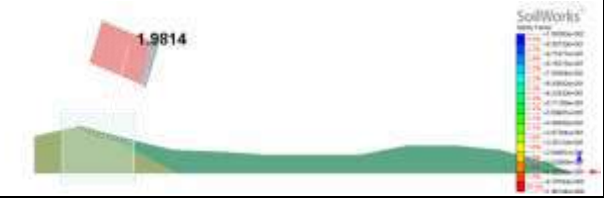
static slope			seismic slope		
					
Standard safety factor	1.300	Evaluation	Standard safety factor	1.300	Evaluation
Analysis safety factor	2.905	**OK**	Analysis safety factor	1.981	**OK**

Fig.55 Model generated from Soil Works

If the value of FS < 1, the slope is unstable. If the FS is higher than 1.5, it is acceptable for the design of the stable slope. The most of the slope profile has been falling in mid portion of the polygon where area is marked as ***linear ridge with flat top*** in the geological/geomorphological map of the Polygon-2 (Refer. Plate-2)

CHAPTER – 6

CONCLUSSIONS AND RECOMMENDATIONS

- Geotechnical investigation of the land proposed for CUHP was undertaken by Geological Survey of India during November 2021 to January 2022. Investigation was carried out to assess the stability of slope and feasibility of the construction of various building for the campus of CUHP.
- The proposed site is mostly rugged topography in the form of ridges and broad valleys. The area forms part of Siwalik foothill belt toward the southwest, and the Lesser Himalayan zone toward southeast occupied by southwestern slope of the NW - SE trending Dhauladhar Range.
- On regional scale, the minimum elevation of 493 m lies to the southwest and maximum elevation of +1800m falls on the ridge top of the Dhauladhar Range in the northeast. The area is drained by number of tributaries originating from southwestern slope of Dhauladhar Range.
- Geologically, the area is occupied by the sandstone of Lower Siwalik Group and Kasauli Formation and mostly covered by debris/ overburden material. The sandstone of Lower Siwalik Group exposed in this area is very fragile and highly weathered in nature. However, the sandstone of Kasauli Formation appears to be hard rock mass at some Polygons.
- A detailed geological mapping on 1:1,000 scale of the proposed area was carried out with the help of Surveyor along with total station provided by the local administration.
- The average rock mass condition of the area is very poor. However, the thickness of the bedrock in the area varies from 45 to 52m as per the ground water data received from CGWB.
- Most of the proposed / allotted area except the NE corner and center of the Polygon 4 are highly undulated and having gentle to moderate slope.
- Tilting of the trees, crack, paleo slide scar was common in the allotted polygons (i.e Polygon No-8, 11 and 14). This shows the sign of the creeping/ sinking movement of the land.
- The study of LU/LC classification is necessary for the planning of natural resource management. Land-use refers to people's activities in land for various uses which are carried out on land etc. Land-cover depicts the natural vegetation, water bodies, rocks, etc., that resulted due to land transformation. As per the data received from the different

agencies and field work, the bed rock is not available at shallow depth and in most of the polygons the building foundations has to be suitably designed over the heterogenous overburden material containing large sized boulders.

- As per the investigation and the grain size analyses the soil is classified as well graded sand with substantial amount of gravel with some fines, low-plastic, less cohesive.
- The Plasticity Index ranges from 4.74 to 6.99 in disturbed soil samples and 4.12 to 6.80 in undisturbed soil samples. The soil is cohesive and low-medium plastic since the area mainly comprises clay or fine silt particles as the overburden/ debris material.
- The UCS (Uniaxial Compressive Strength) value obtained in the soil samples ranging from 31.25 to 38.32 KPa which is falling in 'Soft' soil category. The UCS value for rock samples shows the value from 45.37 to 53.94 KPa under dry condition which is into medium strength category.
- Steep hill slopes abruptly ending against flat land with numerous gullies, slump zones and cracked surfaces are the main morphologic characteristic of this terrain. The area is full of big boulders and variable thicknesses of slope-wash material which is pervious in nature. Cutting this slope wash product, there flows several small streamlets fed by springs and rain water.
- Regionally, the allotted land is in (especially the Polygons -11 and 13) close proximity of the Main Boundary Thrust (Locally Palampur Thrust) and Main Central Thrust i.e Kullu thrust and also falling in the seismic active Zone-V. Moreover, the area is in the vicinity of catastrophic Kangra earthquake (7.8M, 1905).

Based on the above conclusion drawn based on field work, analysis and interpretation of the results, the following recommendations have been suggested to the Authorities of Central University of Himachal Pradesh.

- In general, Dharamshala and nearby area is recording maximum rainfall in state during the monsoon season also witnessed flash floods in the recent times. It has been observed that many of the allotted land is drained by the seasonal *nalas* which are very rigorous, and has the evidence of flash flood. The protection of the *nala* from the flash flood is needed wherever it is required.
- The availability of suitable area is limited in view of the available flat space and is likely to extend onto the sloping surface with a gradient of the order of upto 40°. In spite of presence of paleo landslide scars in some polygons, it can be said from geo-technical

point of view, that the slope is stable for construction of light structures provided the design takes into account the slope condition and construction is carried out with necessary precautions.

- Some gullies and streamlets are to be properly lined in this part for drainage and some remedial measures are to be undertaken in case this area is selected for building structures. The following three methods must be applied in order of priority: (a) Improvement of gully catchments to reduce and regulate the run-off volume and peak rates; (b) Diversion of runoff water upstream of the gully area; (c) Stabilization of gullies by structural measures and accompanying re-vegetation. Cutoff drains and waterways are drainage management structures.
- In gully control, temporary physical structural measures such as gully reshaping, brushwood, sandbag, loose stone, gabion and arc-weir check-dams are used to dissipate the energy of runoff and to keep the stability of the gully.
- Light structures are preferable where the structure will be founded on cohesion less material or in highly weathered foundation rock. Weathered/shear portion be removed and treated by use of a thick mat of reinforced concrete or by providing thick cement base on fresh surface.
- The design of earthquake-resistant base and foundation includes a solid reinforced concrete foundation slab with crisscross strips, freely supported on an intermediate sandy cushion, which separates the soils from the foundation slab, and the channels around the foundation. So, cast in situ construction is the technique of choice for earthquake-resistant concrete structures, especially buildings; besides, monolithic construction is the quintessential use of concrete Shear walls, cross braces, diaphragms, and moment-resisting frames are central to reinforcing a building. Shear walls are a useful building technology that helps to transfer earthquake forces. Made of panels, these walls help a building keep its shape during movement.
- The site characterization, if required may be carried out to rule out any liquefaction potential of the area. If the site is susceptible to liquefaction, either ground improvement must be undertaken or the foundation must be carefully designed, such that it can carry the load even after the vulnerable soil layers have liquefied.
- All the civil structures to be constructed as per the National Building Code of India, 2016.
- The bearing capacity of the soil is unknown. The safe/allowable bearing will give the permissible limit of the settlement in the natural conditions of the soil to design the safer

foundation. The safe bearing capacity shall be checked for safe bearing pressure for settlement criteria as per required permissible settlement.

- In most cases, coarse grained soils usually undergo immediate settlement under the working loads and doesn't impose much problem, however, soils with consolidation problem like soft and saturated clayey soil, the settlement criteria may be more critical and safe bearing pressure shall be considered for the design of foundations.
- Since the foundation is likely to be set in the very soft silty sand or sandy clay loam, the soft foundation design may be preferred or adapted.
- Buildings up to 2 or 3 storied may be easily constructed in these areas (Polygon 2, part of 6, 7, 9, 13, 14 & part of 15) where thin soil cover or rocks are exposed. In other areas (Polygon 1,3, 4, 5, 8, 10, 11, 12,) where the soil has **bearing capacity of the order of 2 Kg/cm (ultimate) or as suggested by design engineer**, single storied building may have constructed.
- The overall area is present with very thick debris/overburden cover comprising mostly sandy silt with organic soil. It should be ensured that foundation in the soft ground do not undergo shear failure during or under the loading the structure especially in the saturated wet conditions. SPT 'N' for the subsurface will be useful to know strength of the foundation strata.\
- The sewerage disposable and drainage system must be provisioned since the local soak pits and unplanned sewerage disposal may aggravate the existing stable slopes by their long term continuous sub surface saturation. A suitable muck disposal site/s may be identified.
- The factor of the safety for the slope stability has been calculated by using the modeling, the FS=1.3 is estimated for the poygon-2. The FS for the remaining polygons is unknown. Most of the polygon area is very steep, stable to unstable slope, modification in slope geometry is required.
- The office of GSI, SU: P, H & HP, Chandigarh may please be contacted further during the construction activities, in case of any slope stability problem, if required.

--------------------------§§§-----------------------------§§§-------------------------------------

Pradap Gagan R
Geologist

Ramesh Laishram
Supdtg. Geologist

Locality Index

Place	Latitude	Longitute
Dharmashala	32° 13' 8.5" N	76° 19' 24.2" E
Kangra	32° 5' 59.2" N	76° 16' 8.7" E
Tang	32° 9' 48.3" N	76° 24' 4.7" E
Jadrangal	32° 9' 33.3" N	76° 24' 34" E
Palampur	32° 6' 37.9" N	76° 32' 10.4" E
Narwana	32°10'40.9"N	76°23'38.4"E
Gaggal	32° 9'50.0"N	76°15'44.4"E
Una	31° 28' 6.3" N	76° 16' 14.9" E
Bagyara	32°10'12.1"N	76°25'26.1"E
Patola	32° 9'53.4"N	76°24'42.1"E

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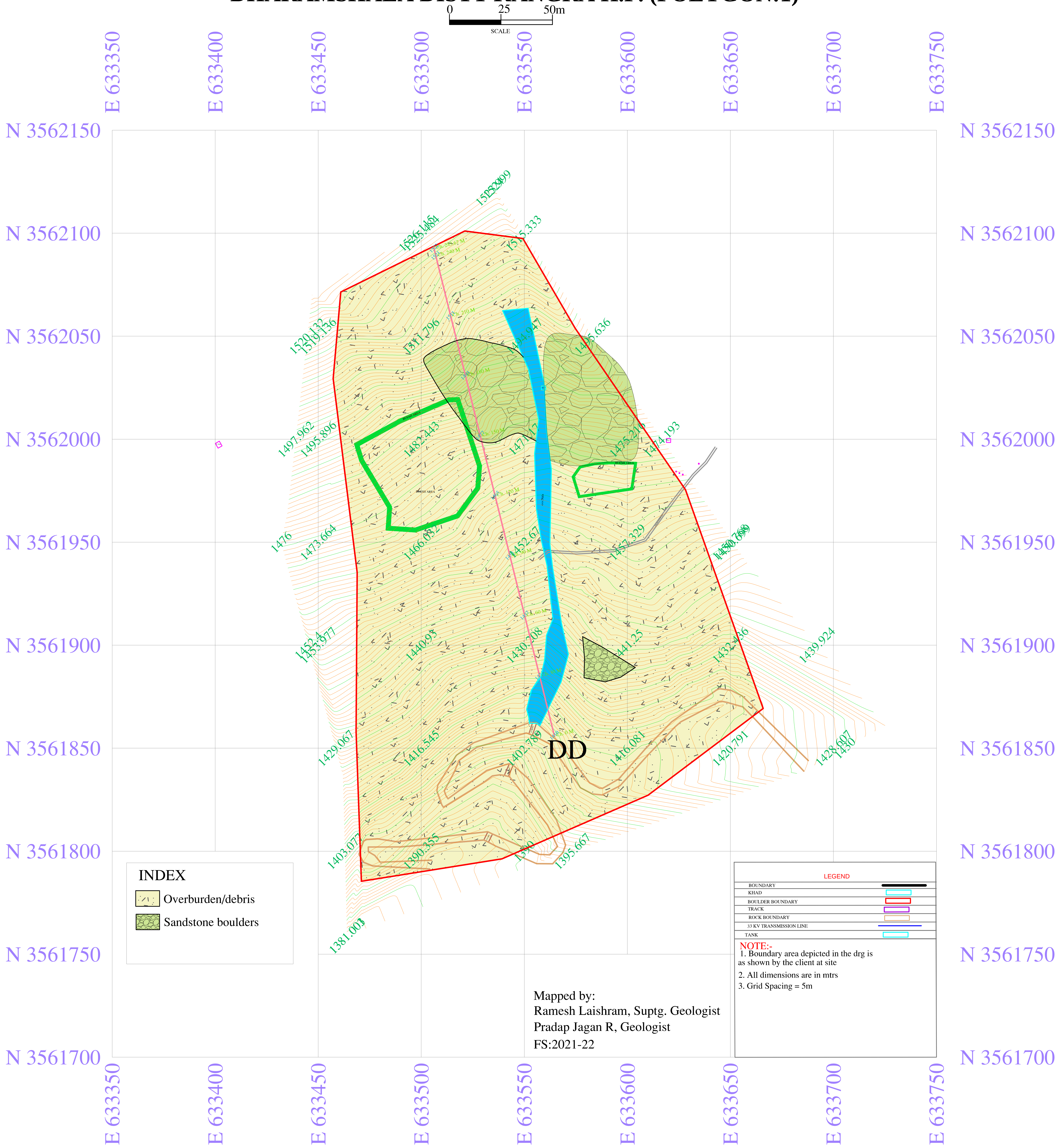
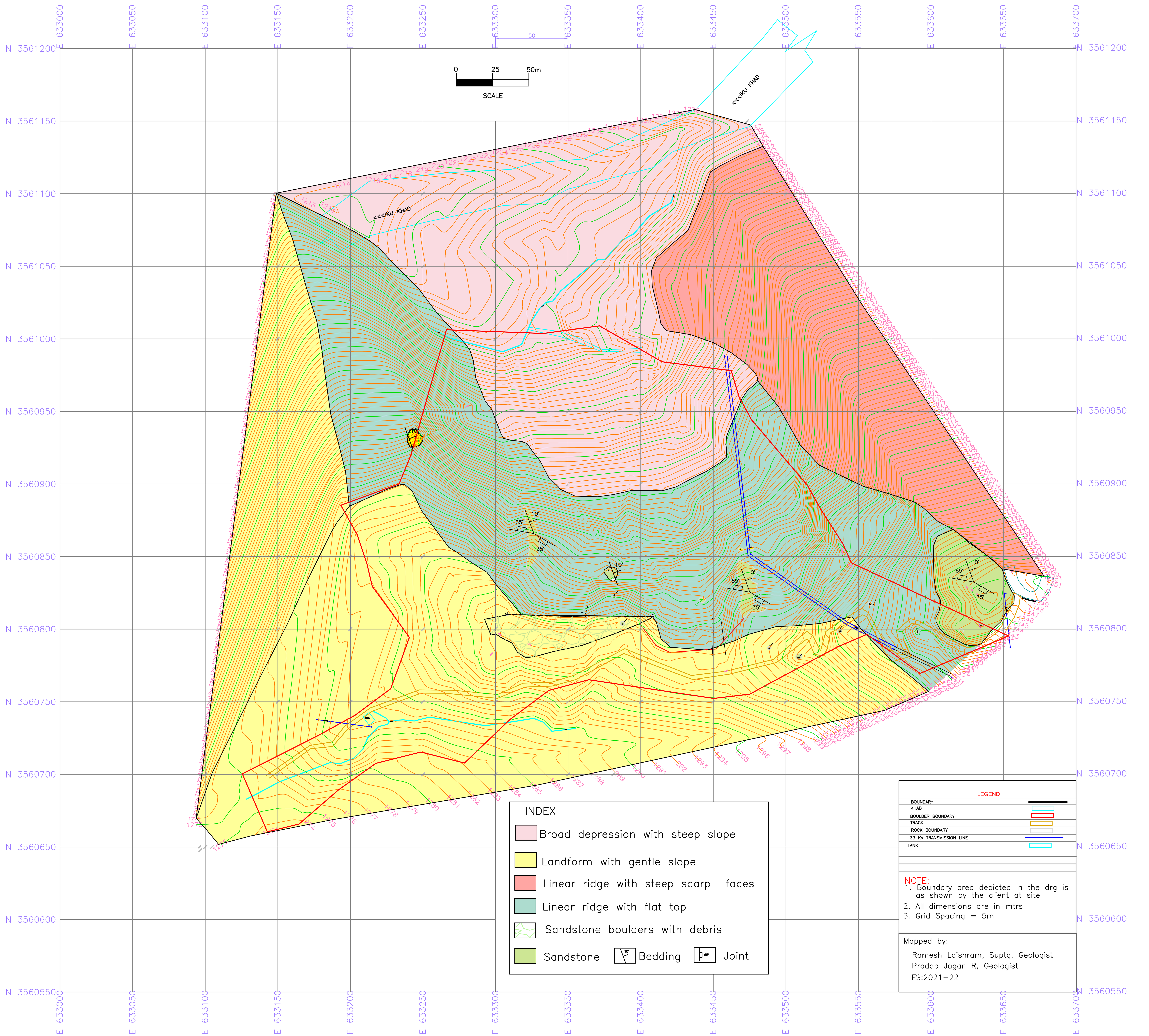
PLATE-1

GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY (CUHP) DHARAMSHALA DISTT KANGRA H.P. (POLYGON:1)



PLATE–2

GEOLOGICAL AND GEOMORPHOLOGICAL MAP OF PROPOSED SITE FOR CUHP, DHARAMSHALA DISTT KANGRA H.P. (POLYGON:2)

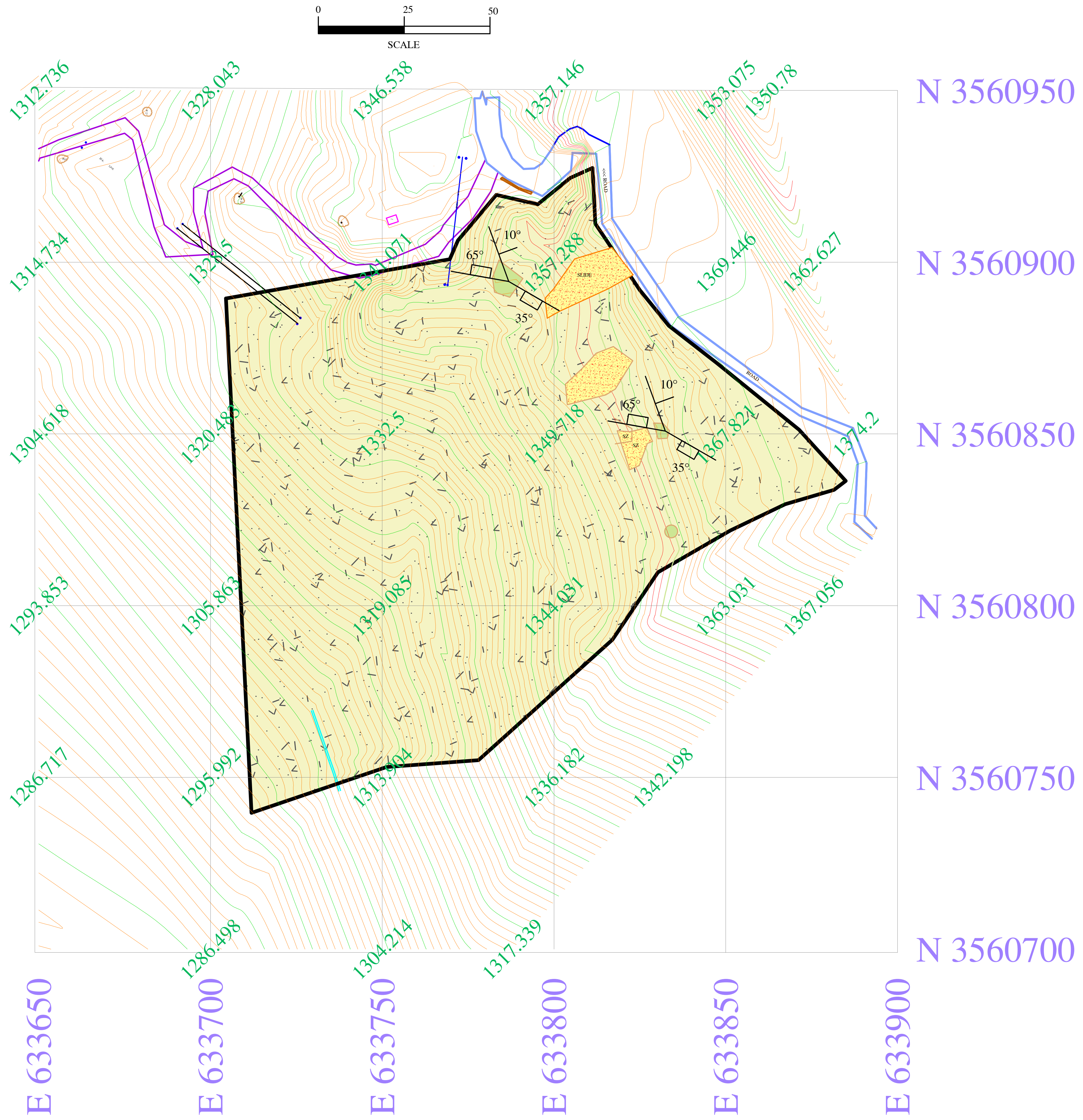


NOTE:–
1. Boundary area depicted in the drg is as shown by the client at site
2. All dimensions are in mtrs
3. Grid Spacing = 5m

Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021–22

PLATE-3

GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY (CUHP) DHARAMSHALA DISTT KANGRA H.P. (POLYGON:3)



LEGEND

BOUNDARY	
KHAD	
BOULDER BOUNDARY	
TRACK	
ROCK BOUNDARY	
33 KV TRANSMISSION LINE	
TANK	

NOTE:-
1. Boundary area depicted in the drg is as shown by the client at site
2. All dimensions are in mtrs
3. Grid Spacing = 5m

Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22

INDEX

- Overburden/debris
- Slide debris
- Sandstone
- 10° Bedding
- 65° Joint

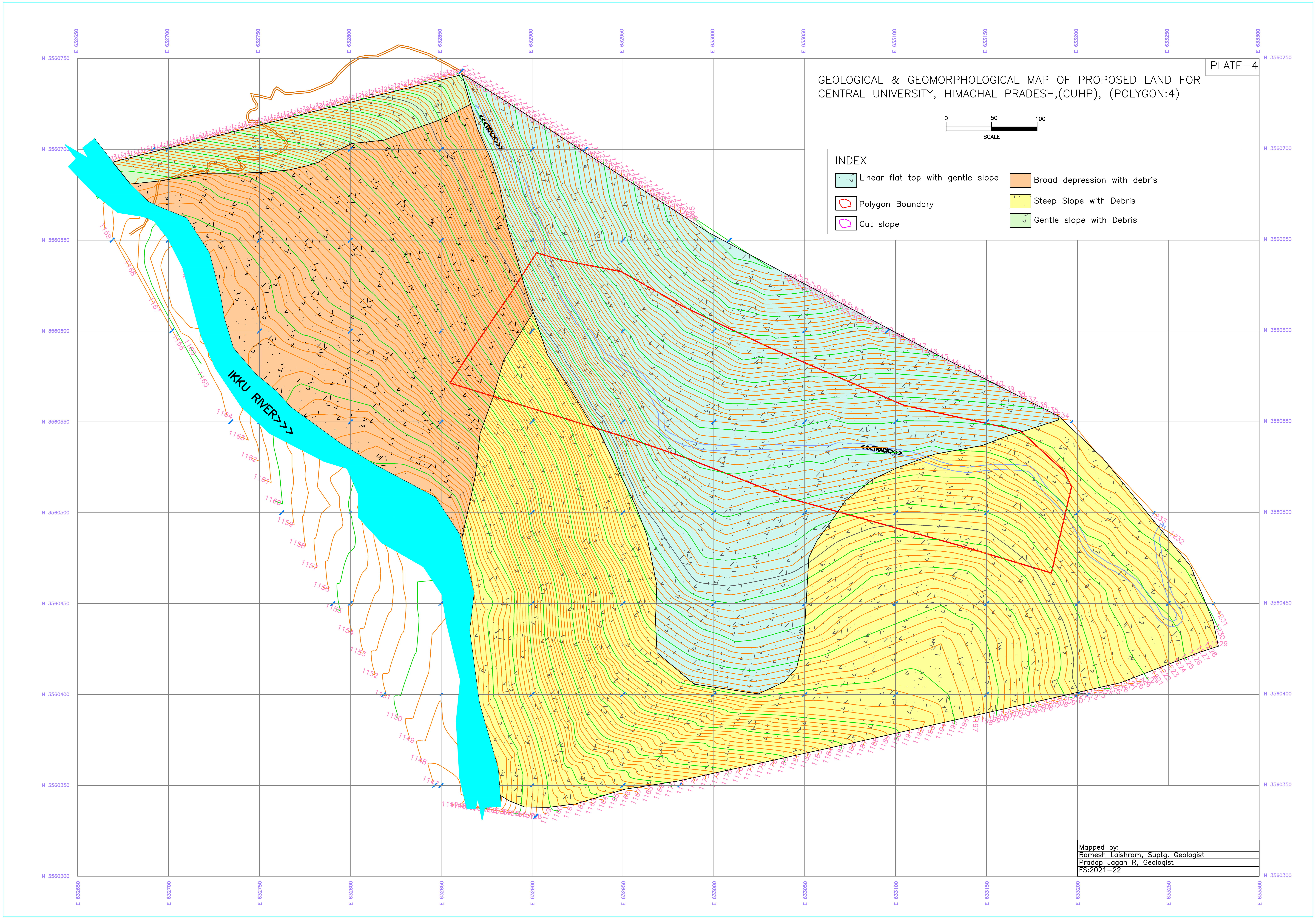
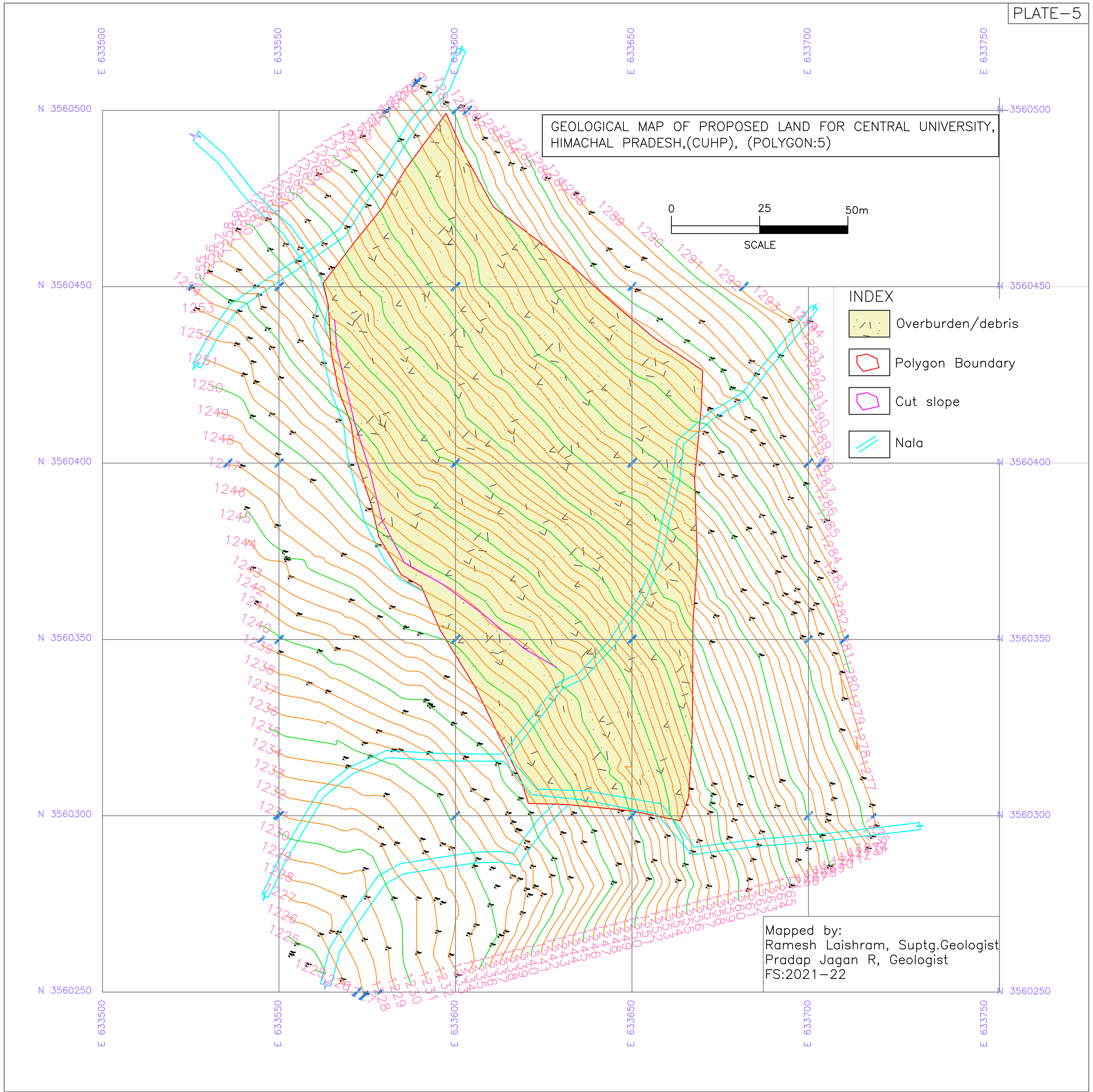


PLATE-4
GEOLOGICAL & GEOMORPHOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY, HIMACHAL PRADESH,(CUHP), (POLYGON:4)
0
50
100
SCALE
INDEX
Linear flat top with gentle slope
Broad depression with debris
Polygon Boundary
Steep Slope with Debris
Cut slope
Gentle slope with Debris
IKKU RIVER>>>
<<<TRACK>>>
Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22


GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY, HIMACHAL PRADESH,(CUHP), (POLYGON:5)
0
25
50m
SCALE
INDEX
Overburden/debris
Polygon Boundary
Cut slope
Nala
Mapped by:
Ramesh Laishram, Suptg.Geologist
Pradap Jagan R, Geologist
FS:2021-22
E 633500
E 633550
E 633600
E 633650
E 633700
E 633750
N 3560500
N 3560450
N 3560400
N 3560350
N 3560300
N 3560250

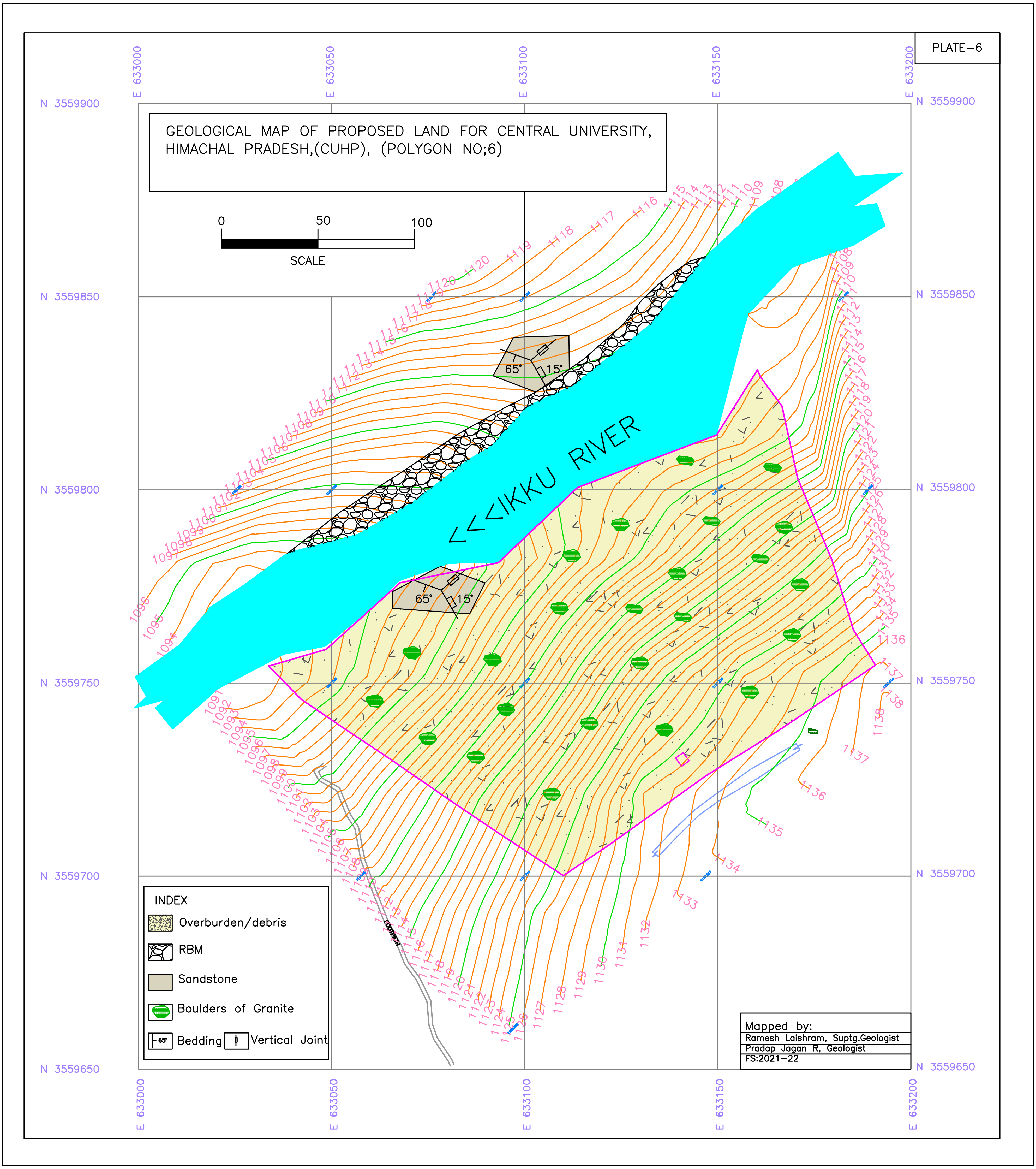


PLATE-6
GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY, HIMACHAL PRADESH,(CUHP), (POLYGON NO;6)
0
50
100
SCALE
<<<IKKU RIVER
65°
15°
INDEX
Overburden/debris
RBM
Sandstone
Boulders of Granite
Bedding
Vertical Joint
Mapped by:
Ramesh Laishram, Suptg.Geologist
Pradap Jagan R, Geologist
FS:2021-22
N 3559900
N 3559850
N 3559800
N 3559750
N 3559700
N 3559650
E 633000
E 633050
E 633100
E 633150
E 633200

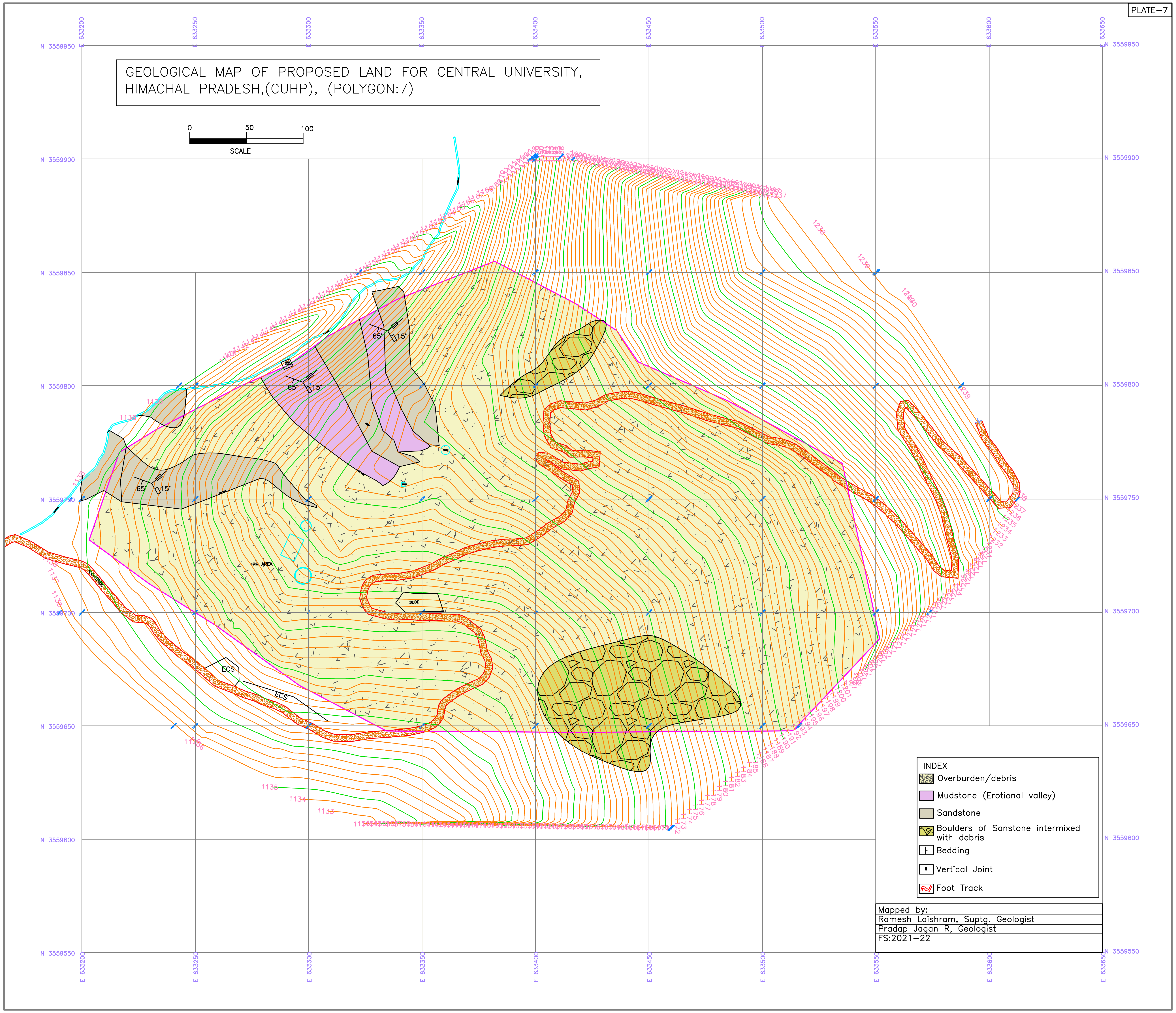
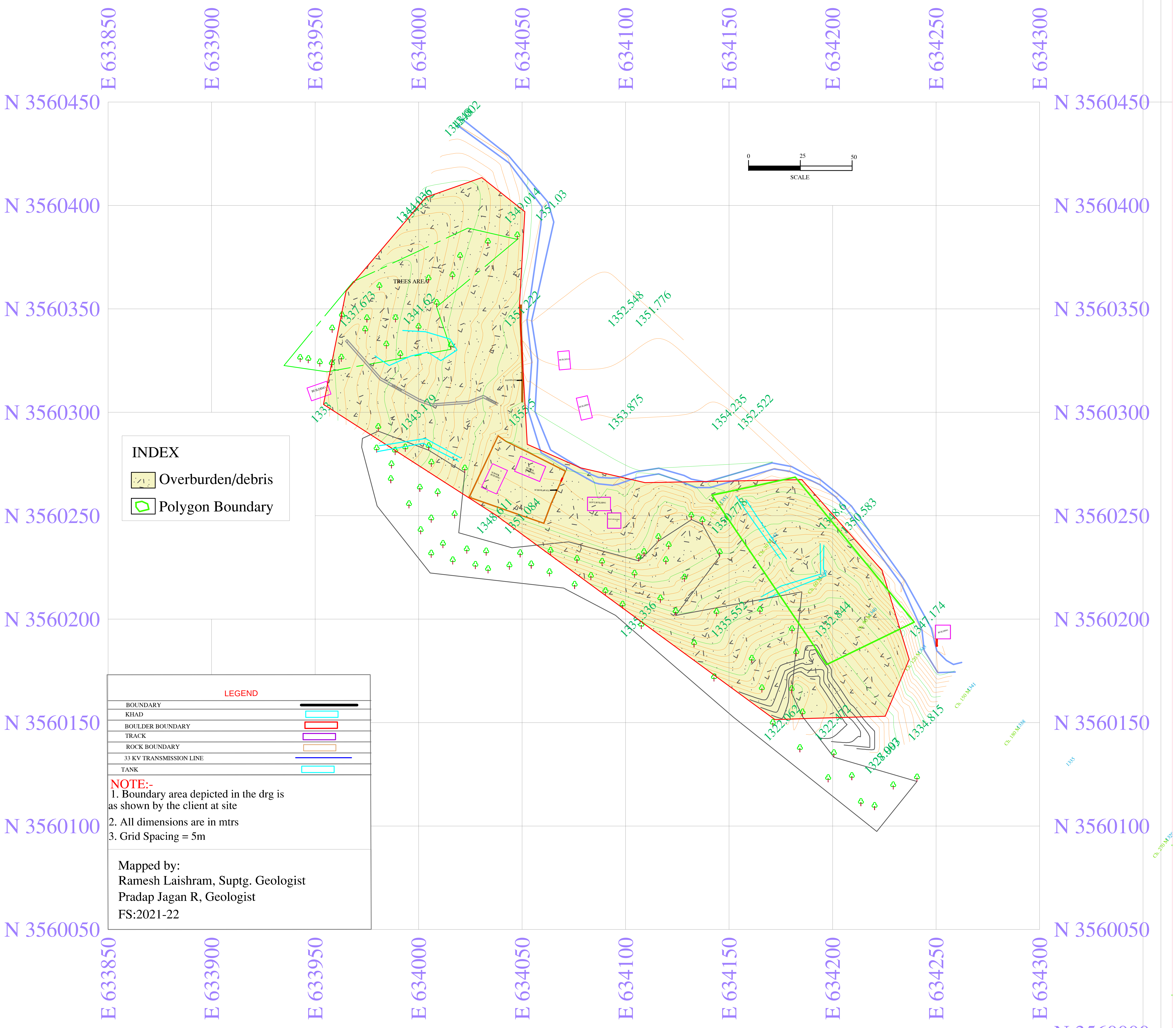


PLATE-7
GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY, HIMACHAL PRADESH,(CUHP), (POLYGON:7)
0
50
100
SCALE
IPH AREA
SLIDE
ECS
ECS
INDEX
Overburden/debris
Mudstone (Erotional valley)
Sandstone
Boulders of Sanstone intermixed with debris
Bedding
Vertical Joint
Foot Track
Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22

PLATE-8

GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY (CUHP) DHARAMSHALA DISTT KANGRA (HP) POLYGON:9




GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY (CUHP) DHARAMSHALA DISTT KANGRA,H.P.(POLYGON:10,11,12,13 & 14)
PLATE-9
0 25 50m
HILL ROCKY
BARREN ROCKY
PVT LAND
AA
INDEX
Overburden/debris
Slide debris
Sandstone boulders
Moderate slope with Sandstone boulders
Sandstone
Bedding
Joint
Sinking zone
Road cut/ Cut slope
LEGEND
BOUNDARY
KHAD
BOULDER BOUNDARY
TRACK
ROCK BOUNDARY
33 KV TRANSMISSION LINE
TANK
KML BOUNDARY
NOTE:-
1. Boundary area depicted in the drg is as shown by the client at site
2. All dimensions are in mtrs
3. Grid Spacing = 5m
Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22

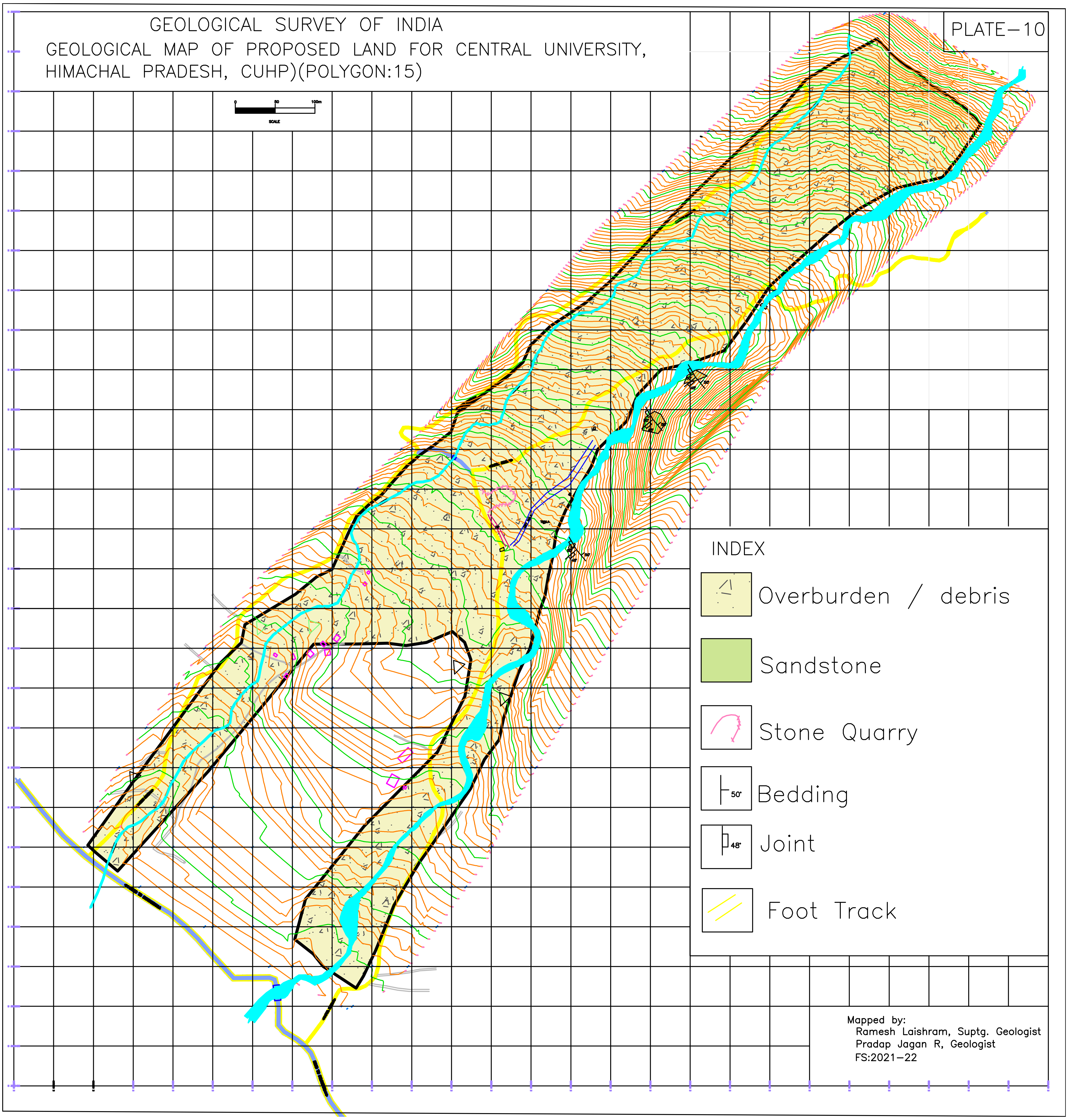
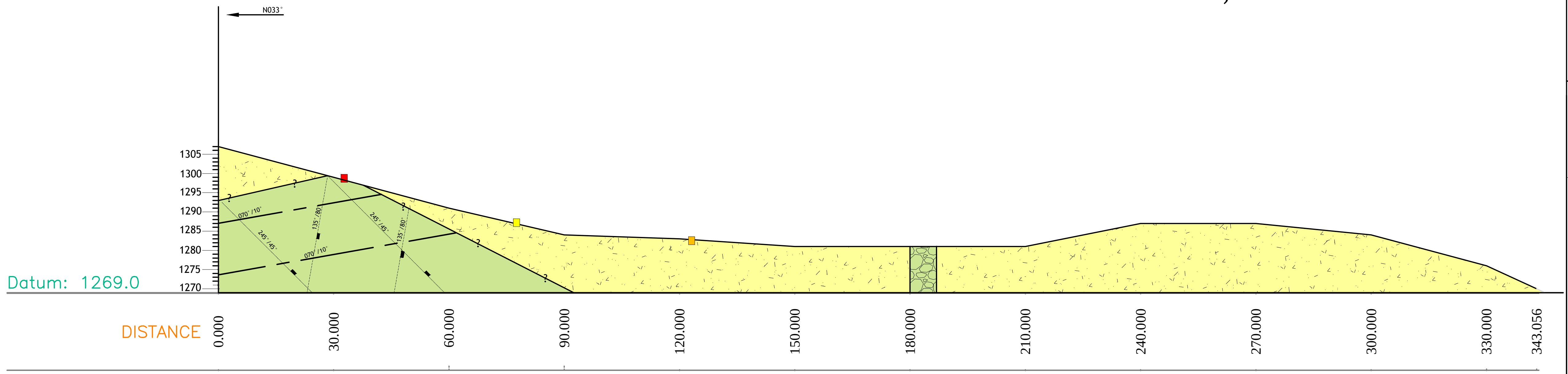

GEOLOGICAL SURVEY OF INDIA
GEOLOGICAL MAP OF PROPOSED LAND FOR CENTRAL UNIVERSITY, HIMACHAL PRADESH, CUHP)(POLYGON:15)
PLATE-10
INDEX
Overburden / debris
Sandstone
Stone Quarry
Bedding
Joint
Foot Track
Mapped by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22

PLATE-11

GEOLOGICAL SURVEY OF INDIA
GEOLOGICAL SECTION ALONG C-C' FOR CENTRAL UNIVERSITY, HP.



CH[0.000 – 343.056]MTRS
[Hor Scale – 1 in 1000 : Ver Scale – 1 in 1000]

SCALE :

0 25 50m

INDEX

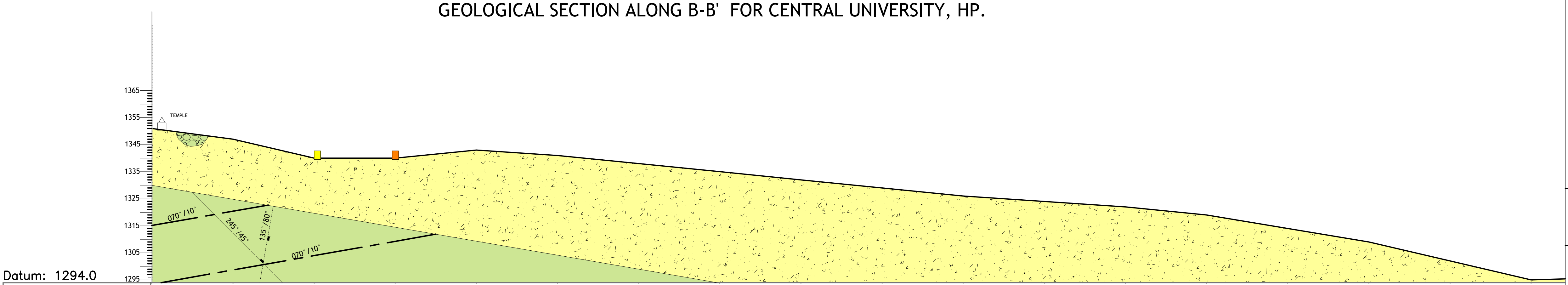
- OVERBURDEN/ DEBRIS
- BOULDERS OF SANDSTONE
- SANDSTONE =DHARAMSHALA GROUP
- INFERRED LITHO CONTACT
- 070°/10° TRACE OF FOLIATION SHOWN ARE SCHEMATIC
- 135°/80° TRACE OF JOINTS SHOWN ARE SCHEMATIC
- SAMPLE : ROCK (RS-1)
- SAMPLE : DISTURBED SOIL (DS-1)
- SAMPLE : UNDISTURBED SOIL (UDS-2)

NOTE:-

1. SURVEY SUPPORT & SECTION HAS BEEN PROVIDED BY PROJECT AUTHORTIES.
2. JOINTS SHOWN ARE SCHEMATIC.
3. GROUNDWATER PROFILE IS NOT AVAILABLE.
4. THE DEPTH OF OVERBURDEN MATERIAL IS ESTIMATED AS PER SITE CONDITIONS. ACTUAL DEPTH OF OVERBURDEN WILL BE KNOWN AFTER DRILLING.

PLATE-12

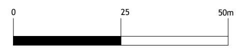
GEOLOGICAL SURVEY OF INDIA
GEOLOGICAL SECTION ALONG B-B' FOR CENTRAL UNIVERSITY, HP.



LEVEL	1351.000	1347.000	1340.000	1340.000	1343.000	1341.000	1338.000	1335.000	1332.000	1329.000	1326.000	1324.000	1322.000	1319.000	1314.000	1309.000	1302.000	1295.000
Chainage	0.000	30.000	60.000	90.000	120.000	150.000	180.000	210.000	240.000	270.000	300.000	330.000	360.000	390.000	420.000	450.000	480.000	510.000

CH[0.000 – 951.907]MTRS
[Hor Scale – 1 in 1000 : Ver Scale – 1 in 1000]

SCALE :



INDEX

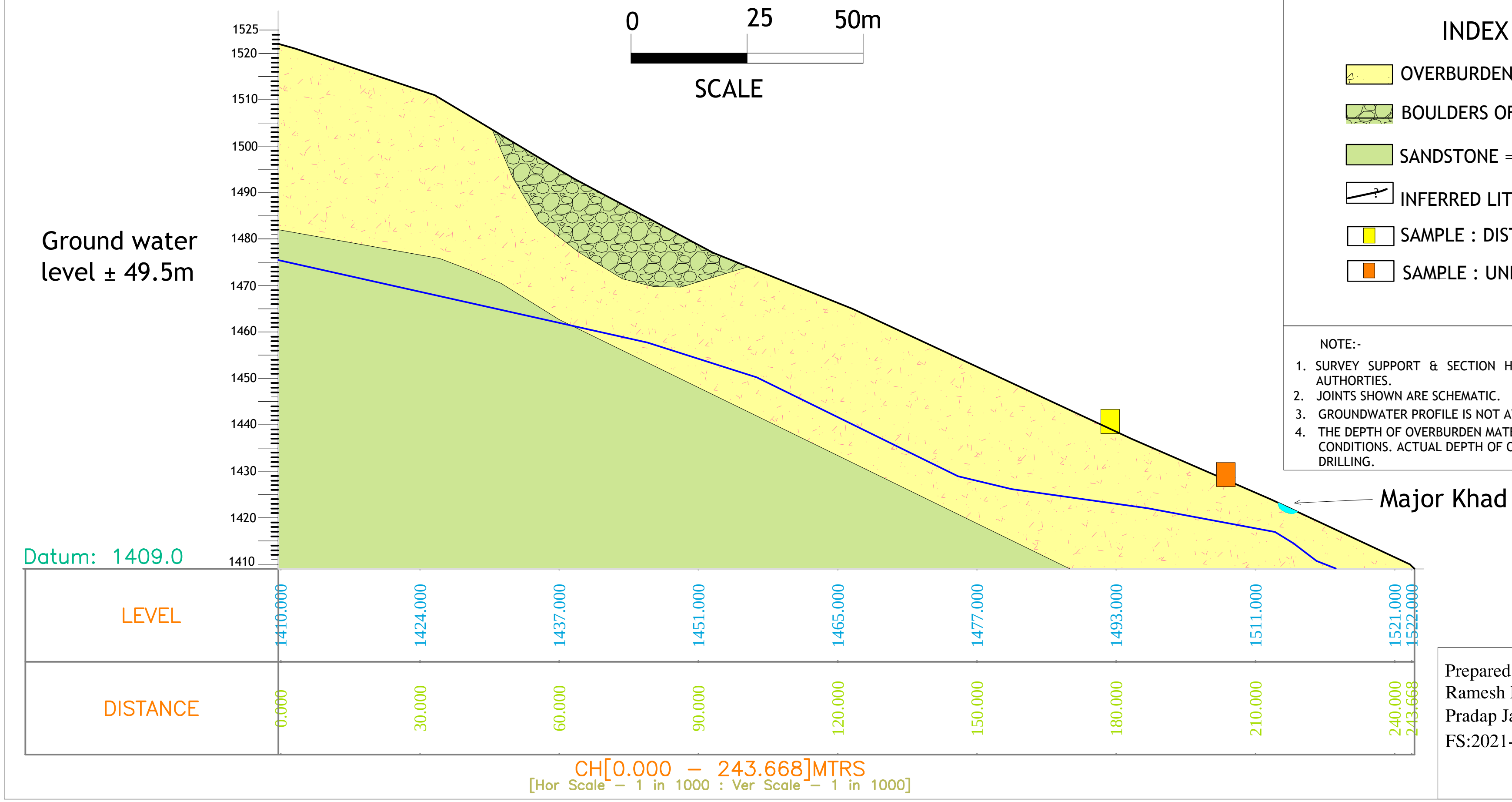
- OVERBURDEN/ DEBRIS
- BOULDERS OF SANDSTONE
- SANDSTONE =DHARAMSHALA GROUP
- INFERRED LITHO CONTACT
- 070°/10° TRACE OF FOLIATION SHOWN ARE SCHEMATIC
- 135°/80° TRACE OF JOINTS SHOWN ARE SCHEMATIC
- SAMPLE : DISTURBED SOIL (DS-1)
- SAMPLE : UNDISTURBED SOIL (UDS-2)

NOTE:-

1. SURVEY SUPPORT & SECTION HAS BEEN PROVIDED BY PROJECT AUTHORTIES.
2. JOINTS SHOWN ARE SCHEMATIC.
3. GROUNDWATER PROFILE IS NOT AVAILABLE.
4. THE DEPTH OF OVERBURDEN MATERIAL IS ESTIMATED AS PER SITE CONDITIONS. ACTUAL DEPTH OF OVERBURDEN WILL BE KNOWN AFTER DRILLING.

PLATE-13

GEOLOGICAL SURVEY OF INDIA
GEOLOGICAL SECTION ALONG D-D' FOR CENTRAL UNIVERSITY, HP.



INDEX

- OVERBURDEN/ DEBRIS
- BOULDERS OF SANDSTONE
- SANDSTONE =DHARAMSHALA GROUP
- INFERRED LITHO CONTACT
- SAMPLE : DISTURBED (DS-14)
- SAMPLE : UNDISTURBED (UDS-14)

NOTE:-

1. SURVEY SUPPORT & SECTION HAS BEEN PROVIDED BY PROJECT AUTHORTIES.
2. JOINTS SHOWN ARE SCHEMATIC.
3. GROUNDWATER PROFILE IS NOT AVAILABLE.
4. THE DEPTH OF OVERBURDEN MATERIAL IS ESTIMATED AS PER SITE CONDITIONS. ACTUAL DEPTH OF OVERBURDEN WILL BE KNOWN AFTER DRILLING.

Prepared by:
Ramesh Laishram, Suptg. Geologist
Pradap Jagan R, Geologist
FS:2021-22

LOG SHEET OF HAND PUMP

1. Name of the firm executing the work : M/s Shri Sai Bore well.
2. Agreement No. & Date :
3. Location of hand pump : Jandrangal (W.No-2) Nr. Shiv Temple
4. Coordinate : Latitude : N 32° 09' 37.0"
   Longitude : E 76° 24' 26.5"
5. Date of drilling : 17/9/17
6. Bore well size:
   a). 165 mm dia DTH
   b). 152 mm dia ODEX 299 feet
   c). 115 mm dia DTH
7. Mode of drilling : ODEX
8. Final depth of bore well : 299 feet only.
9. Detail of water table :
   (i) 150' (ii) 260'
10. 90° V-notch measurement in one hour : 1½"
11. Details of casing pipe :
    i) Length of blind 125mm dia MSERW Fin Cut pipe used: 300 feet only.
    ii) Length of blind 125mm dia GI / PVC pipe used:
12. Number of slots :
13. Length of riser pipe :
    a). 65 mm dia GMS
    b). 50 mm dia GMS
    c). 32 mm dia GMS
14. Length of connecting rods 12 mm dia :
15. Make and type of hand pump :
16. Date of installation of hand pump :
17. Discharge in 40 strokes / minute : N-A
18. Static water level :

Remarks:

Submitted to the Executive Engineer, I&PH Division D/Shala. for information and further necessary action.

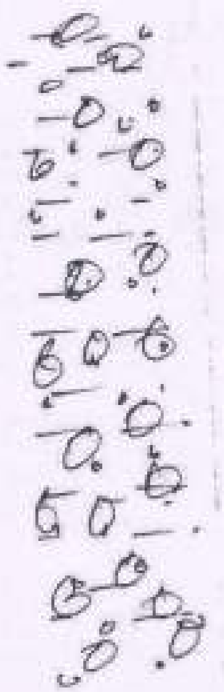
Sr. Technical Assistant
G.W.O. I.P.H UNA
H.Q. I.P.H. Divn., Shahpur

Contractor J.E. A.E. E.E.

LITHOLOG AND HAND PUMP ASSEMBLY

Location of Hand Pump: Jandrangal. Division: D/shala
Sub-Division: D/shala

LITHOLOG:



Sandy clay gravels boulder.

299 feet

HAND PUMP ASSEMBLY

Casing 125 mm (black): 300
Casing mm (slotted): –
Static water level: –
Riser pipe: –
Connecting rods: –
Cylinder depth: –

Sr. Technical Assistant
G.W.O. I.P.H. UNA
H.Q. I.P.H. Divn. Shahpur

LOG SHEET OF HAND PUMP E 76° 24' 28.4"

E 76° 24' 28-4"
N 32° 09' 06-3"

1. Name of the firm executing the work M/s Shri Sai Borewell
2. Agreement No. & Date :
3. Location of hand pump : Balla Jandrangal (W.No -4) Nr. Ram 147 Lr. house.
4. Date of drilling : 29/6/17
E 76° 24' 28.4"
N 32° 09' 06.3"
5. Bore well size:
   a). 165 mm dia DTH —
   b). 152 mm dia ODEX 299 feet -
   c). 115 mm dia DTH —
6. Mode of drilling: ODEX
7. Final depth of bore well : 299 feet - only.
8. Detail of water table :
   (i) 180' (ii) 260'
9. 90° V-notch measurement in one hour : 1"
10. Details of casing pipe :
   i) Length of blind 125mm dia MSERW Fin Cut pipe used: 300 feet - only.
   ii) Length of blind 125mm dia GI / PVC pipe used:
11. Number of slots : —
12. Length of riser pipe :
   a). 65 mm dia GMS
   b). 50 mm dia GMS
   c). 32 mm dia GMS
13. Length of connecting rods 12 mm dia :
14. Make and type of hand pump :
15. Date of installation of hand pump :
16. Discharge in 40 strokes / minute :
17. Static water level :

Remarks:

Submitted to the Executive Engineer, I&PH Division D/Shala for information and further necessary action.

Sr. Technical Assistant
G.W.O. I.P.H UNA
H.Q. I.P.H. Divn., Shahpur

Contractor J.E. A.E. E.E

LITHOLOG AND HAND PUMP ASSEMBLY

Location of Hand Pump: Balla Jadrangal (U-No-4) Nr.

Sub-Division: D/shala

Division: Kr-House D/shala.

LITHOLOG:

Not to Scale

Sandy clay.
gravels, pebbles

299 feet

HAND PUMP ASSEMBLY

Casing 125 mm (blind): 300 feet

Casing mm (slotted): —

Static water level: —

Riser pipe : G.I

Connecting rods: —

Cylinder depth: —

Sr. Technical Assistant
G.W.O. I.P.H. UNA
H.Q. I.P.H. Divn, Shahpur

GOVERNMENT OF INDIA

MINISTRY OF JAL SHAKTI

CENTRAL GROUND WATER BOARD

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVINATION

BASIC DATA REPORT OF EXPLORATORY TUBE WELL AT JADRANGAL , DISTRICT KANGRA

NORTH WESTERN HIMALAYAN REGION

DHARAMSHALA

2020

BASIC DATA REPORT
EXPLORATORY TUBE WELL, JADRANGAL
DISTRICT KANGRA

CONTENTS

FIGURES

BASIC DATA REPORT
EXPLORATORY TUBE WELL AT JADRANGAL, DISTRICT KANGRA

PROJECT	: GROUND WATER EXPLORATION IN H.P UNDER NAQUIM (AAP 2017-18)
LOCATION	: JADRANGAL
DISTRICT	: KANGRA
TEHSIL	: DHARAMSHALA
CO-ORDINATES	: N 32.15994, E 76.4164
TOPOSHEET NO.	: (52 D/12)
HYDROGEOLOGY	: Smt Rachna Bhatti, AHG
CHEMICAL ANALYSIS	: Chemical Lab, NWHR, Jammu
SITE PLAN & LITHOLOG	: Anju Devi, Draughtsman, NHR, Dharamshala
DRILLING RIG UNIT	: DTH/KLR-12/124, CGWB, Div XVII, Dharamshala

BASIC DATA REPORT OF EXPLORATORY WELL AT JADRANGAL, TEH. DHARAMSHALA, DISTRICT KANGRA

1.0 INTRODUCTION

During AAP 2012-13 of CGWB, NHR, Dharamsala, NAQUIM area of "Parts of Kangra-Chamba area" was taken. In Year 2018-19, exploratory wells were envisaged to be drilled as per EFC data gap and in order to understand the aquifer geometry and ground water potentialities of the morainic deposits of the Kangra district.

1.1 LOCATION

The Exploratory Tube Well site is located at about 200 m before of Shri Chamunda Devi shrine, on link road to Central University. The location as shown on the site plan is given in fig.1.

2.0 HISTORY OF DRILLING OPERATIONS

The rig unit DTH/KLR 12/124, Div.XVII, was shifted to Jadrangal site.

Details are as follows:

Name of Site	Jadrangal, District Kangra
Coordinates	N 32.15994, E 76.4164, elevation 1108m amsl.
Drilling Rig Unit	DTH/KLR 12/124, Div.XVII, CGWB, Dharamshala
Drilling date	From 08.03.2018 to 20.04.2018
Bore Hole dimensions	0.00-25.00=254mm 25.00-71.00=203 mm 71.00-104.00=165 mm
Depth of bore hole (m)	104 m
Depth of Assembly (m)	101.00 m
Dia of Assembly	8" 6" 4"
Aquifer tapped (m bgl)	50.0-52.50,58-60,72-76, 84-90,94-98
Discharge (LPM)	60
Static Water Level (m bgl)	37.58

The well was developed with air compressor for 10 hours and later by Vertical Turbine Pump for 4 hours.

3.0 GEOLOGY

The area Jadrangal is a is situated near Chamunda shrine on Dhauladhar mountains in Kangra district having N 32.15994, E 76.4164, elevation 1108m amsl..

During the course of drilling, drill cuttings of the formation encountered were collected at regular intervals of 1.0m or whenever a change of lithology was observed. The collected samples were washed and on the basis of their examination, the following lithological log was prepared (figure 2).

Litholog of Exploratory Tube Well at Jadrangal

Depth Range (m bgl)	Thickness (m)	Major Lithology
0.00-10.00	10	Hard Stone
10.00-48.00	38	Clay
48.00-54.00	6	Clay mixed with sand
54.00-65.00	11	Clay
65.00-78.00	13	Clay
78.00-83.00	5	Clay
83.00-86.00	3	Sand Clay
86.00-92.00	6	Sand
92.00-101.00	8	Sand Clay

4.0 WELL DESIGN

Keeping in view the hydrogeological set up of the area and lithology, following well assembly was lowered in the Exploratory Tube Well, after geophysical logging. The details of the well assembly are shown in fig.2.

Well Assembly Lowered at Jadrangal, district Kangra

Depth range	Thickness	Diameter	Description
00.50 to 00.00 m agl	0.50 m	203 mm	Blank pipe 8”
0.00 mbgl-22 mbgl	22 m	203 mm	Blank pipe 8”
22 mbgl-23 mbgl	1 m		Reducer
23 mbgl -50.50 mbgl	27.50 m	152 mm	Blank pipe 6”
50.50 to 52.50 m bgl	**2 m**	**152 mm**	**Slotted pipe (Slot Size=1/16 inch)**
52.50 mbgl-58.00 mbgl	5.50 m	152 mm	Blank pipe 8”
58.00 mbgl-60.00 mbgl	**2 m**	**152 mm**	**Slotted pipe (Slot Size =1/16 inch)**
60.00 mbgl-70.00 mbgl	10 m	152 mm	Blank pipe 6”
70.00 mbgl-71.00 mbgl	1 m		Reducer
71.00 mbgl-72.00 mbgl	1 m	**101 mm**	Blank pipe 4”
72.00 mbgl-76.00 mbgl	**4.00 m**	**101 mm**	**Slotted pipe (Slot Size =1/16 inch)**
76.00 mbgl-84.00 mbgl	8.00 m	101 mm	Blank pipe 4”
84.00 mbgl-90.00 mbgl	**6.00 m**	**101 mm**	**Slotted pipe (Slot Size =1/16 inch)**
90.00 mbgl-94.00 mbgl	4.00 m	101 mm	Blank pipe 4”
94.00 mbgl-98.00 mbgl	**4.00 m**	**101 mm**	**Slotted pipe (Slot Size =1/16 inch)**
98.00 mbgl-101.00 mbgl	3.00m	101 mm	Blank Pipe with bail plug

The well was initially developed with air compressor, followed by a vertical turbine pump.

5.0 WELL HYDRAULICS

Due to less discharge, pumping test was not conducted.

6.0 GROUND WATER QUALITY

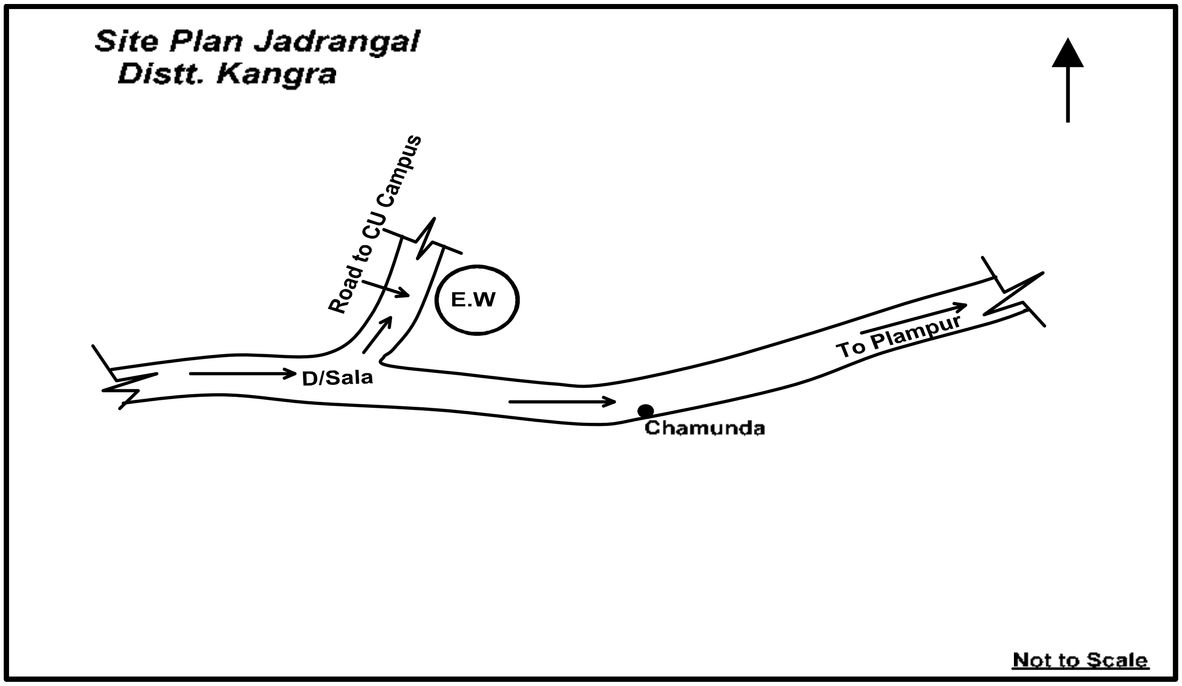
Pumping test was not conducted due to low discharge of well. However one water samples were collected, from nearby hand pump and subjected for complete chemical analysis in the Chemical Lab, NWHR, Jammu to know the water quality. The water quality is fresh and portable.

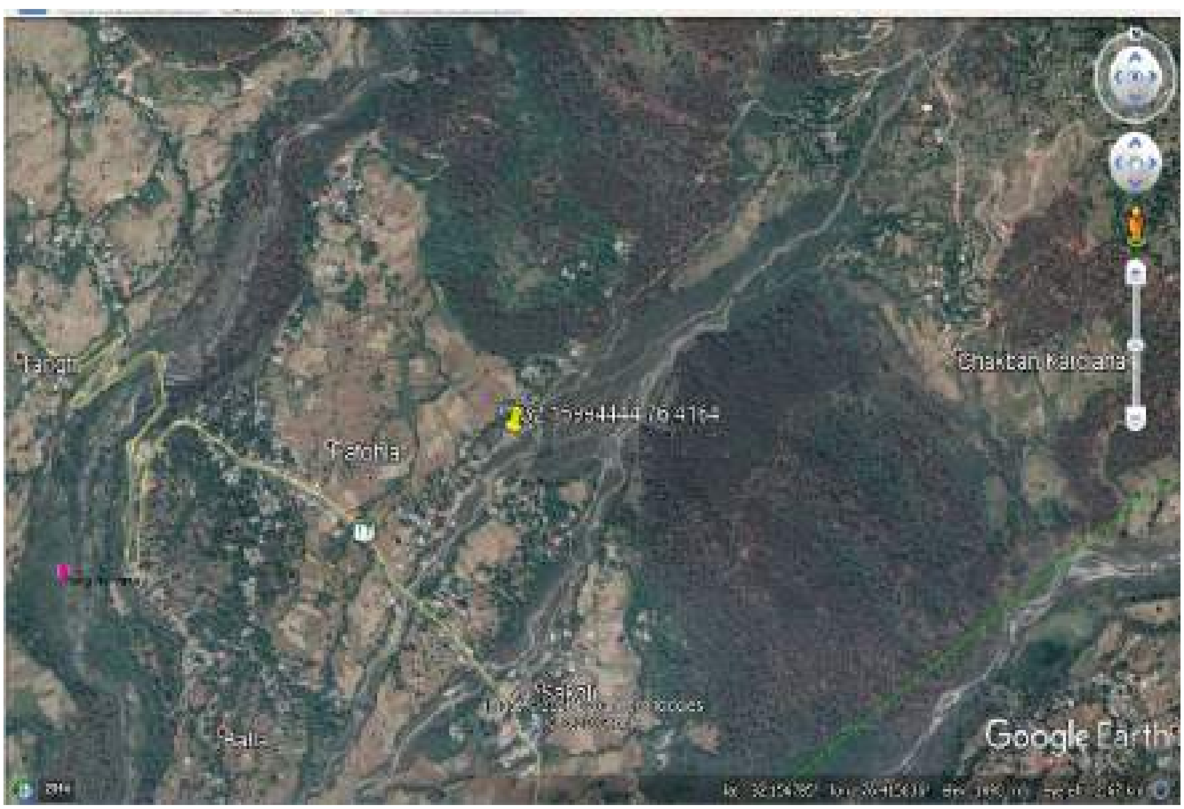
Results of chemical analysis of water samples of near by hand pump

Sample no.	1
Date of collection	May 2017
pH	7.83
EC (µS/cm) at 25^0C	210
CO_3 mg/l	0
HCO_3 mg/l	90
Cl mg/l	7.0
SO_4 mg/l	18
NO_3 mg/l	0.0
F mg/l	0.3
Ca mg/l	26
Mg mg/l	10
Na mg/l	6.0
K mg/l	0.4
TH as $CaCO_3$ mg/l	105

On the basis of chemical analysis data as above, it is inferred that the water is potable and fit for human consumption as far as chemical constituents are concern ed. However it recommended the water samples from the well may be subjected to pathogenic and other bacteriological tests before the same is used as a source of water supply.

Fig1: Site Plan & Location map





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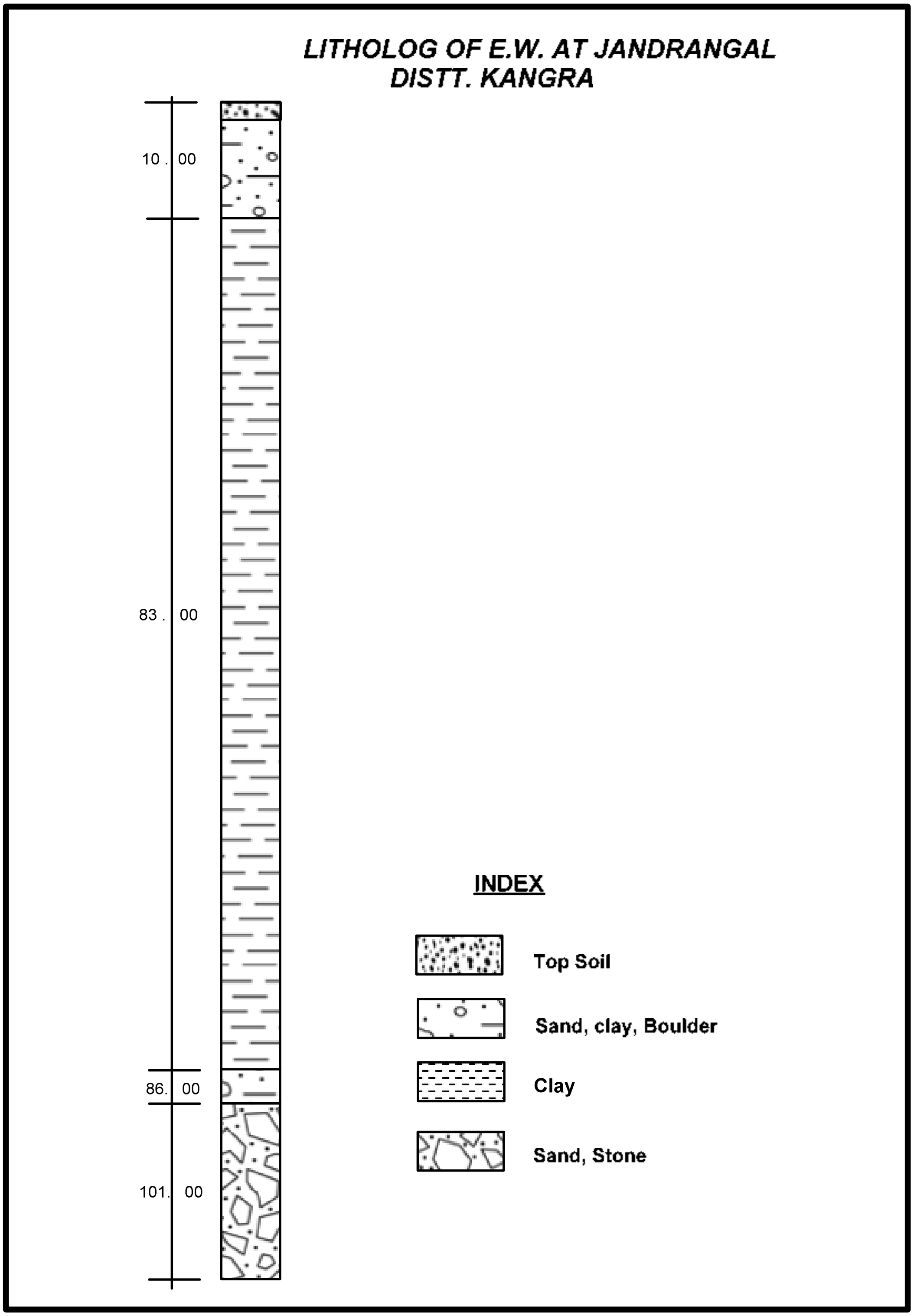
LITHOLOG OF E.W. AT JANDRANGAL
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101. 00
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Top Soil
Sand, clay, Boulder
Clay
Sand, Stone

Result report of disturbed soil sample

	Physical/ Shear Properties of Disturbed Soil Sample Results									
S.No.	**Parameters**	**Unit**	**DS- 1**	**DS- 2**	**DS- 4**	**DS-5**	**DS- 8**	**DS- 9**	**DS- 10**	**DS- 13**
1	**Porosity**	(%)	0.38	0.37	0.37	0.35	0.36	0.37	0.38	0.38
2	**Dry Density**	kg/m3	1.63	1.55	1.50	1.65	1.50	1.60	1.49	1.84
3	**Wet Density**	kg/m3	1.75	1.68	1.60	1.74	1.61	1.74	1.58	1.98
4	**Specific Gravity**	Unit less	2.70	2.71	2.72	2.70	2.73	2.71	2.75	2.71
5	**Liquid Limit**	Unit less	50.76	34.82	47.59	41.38	26.16	47.27	36.83	32.51
6	**Plastic Limit**	Unit less	43.84	29.02	42.65	34.59	20.46	40.28	30.59	26.54
7	**Plasticity Index**	(%)	6.92	5.80	4.94	6.79	5.70	6.99	6.24	5.97
8	**Natural Moisture Content**	(%)	6.00	7.00	5.50	6.50	7.00	8.50	2.80	3.50
9	**Dry Unit Weight**	kN/m3	16.55	16.83	16.78	17.20	17.06	16.72	16.65	16.62
10	**Void Ratio**	Unit less	0.60	0.58	0.59	0.54	0.57	0.59	0.62	0.60
11	**Triaxial Cohesion**	KPa	14.65	27.54	15.48	28.87	25.42	36.51	33.67	35.87
12	**Friction Angle**	Degree	35.00	32.50	36.00	32.20	35.10	28.40	31.90	30.65
13	**U.C.S.**	kpa	32.48	37.21	32.52	38.22	35.10	38.25	36.45	38.32
14	**Water Absorption**	(%)	0.22	0.21	0.22	0.20	0.21	0.22	0.23	0.22
15	**Tensile Strength**	mpa	2.10	2.20	2.40	2.30	2.40	2.00	2.40	2.30
16	**Soil Classification**		SM	SP	SM	SP-SM	SP	SP-SM	SP-SM	SP-SM

Result report of undisturbed soil sample

	Physical / Shear Properties of Undisturbed Soil Sample Results									
S.No.	**Parameters**	**Unit**	**UDS- 1**	**UDS-2**	**UDS-4**	**UDS- 5**	**UDS- 8**	**UDS- 9**	**UDS- 10**	**UDS- 13**
1	**Porosity**	(%)	0.35	0.31	0.33	0.29	0.32	0.34	0.32	0.33
2	**Dry Density**	kg/m3	1.73	1.62	1.60	1.73	1.56	1.84	1.60	1.97
3	**Wet Density**	kg/m3	1.82	1.71	1.68	1.82	1.64	1.94	1.68	2.07
4	**Specific Gravity**	Unit less	2.69	2.70	2.69	2.71	2.72	2.70	2.73	2.69
5	**Liquid Limit**	Unit less	49.64	35.53	52.00	39.58	29.75	43.38	37.67	35.89
6	**Plastic Limit**	Unit less	42.84	30.02	44.65	35.46	23.12	36.87	31.60	29.86
7	**Plasticity Index**	(%)	6.80	5.51	7.35	4.12	6.63	6.51	6.07	6.03
8	**Natural Moisture Content**	(%)	7.00	8.00	6.00	7.00	8.00	10.00	3.00	4.00
9	**Dry Unit Weight**	kN/m3	17.25	18.27	17.59	18.99	18.15	17.54	18.34	17.71
10	**Void Ratio**	Unit less	0.53	0.45	0.50	0.40	0.47	0.51	0.46	0.49
11	**Triaxial Cohesion**	KPa	15.68	29.53	16.54	27.59	29.76	34.59	30.58	37.26
12	**Friction Angle**	Degree	33.80	31.95	34.67	31.15	32.85	26.93	30.04	29.20
13	**U.C.S.**	kpa	31.25	32.00	36.54	37.85	31.52	37.00	35.21	37.81
14	**Water Absorption**	(%)	0.20	0.17	0.19	0.15	0.17	0.19	0.17	0.18
15	**Tensile Strength**	mpa	1.90	2.10	2.50	2.30	2.40	2.40	2.10	2.50
16	**Soil Classification**		SM	SP	SM	SP-SM	SP	SP-SM	SP-SM	SP-SM

Result report of rock sample

Physical Properties of Rock Sample				
Parameters	**Unit**	**R-01**	**R-02**	**R-04**
UCS Dry	mpa	45.37	53.94	49.78
UCS Saturated	mpa	43.50	50.01	46.99
Wet Density	kg/m3	2.31	2.52	2.41
Dry Density	kg/m3	2.29	2.38	2.28
Specific Gravity	Unit less	2.67	2.72	2.69

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हमीरपुर (हि.प्र.) – 177 005 (भारत)
NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
HAMIRPUR (H.P.) - 177 005 (INDIA)
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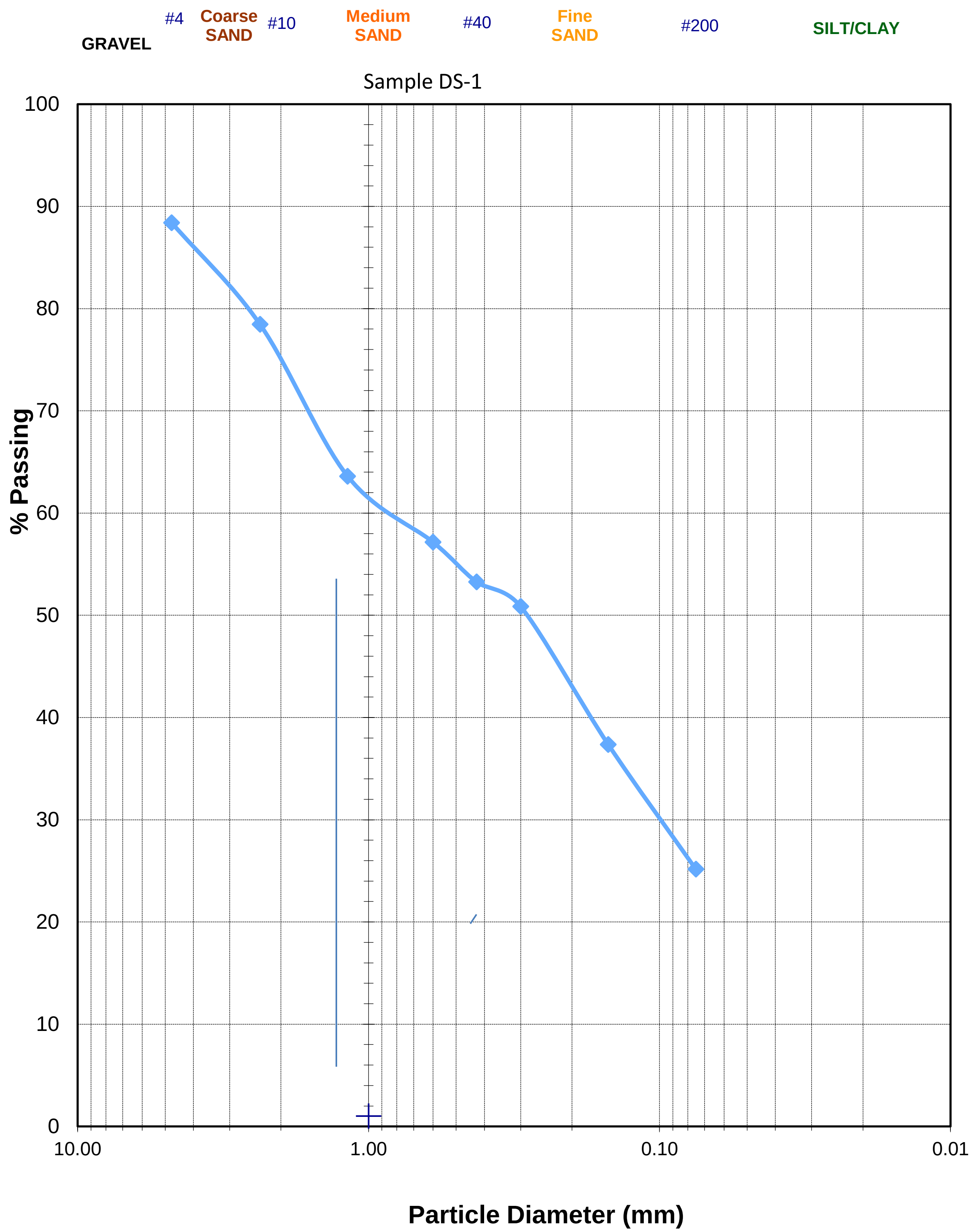
Sample DS-1 Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	551	116	11.6	88.4
2	2.36	393	492.5	99.5	10.0	78.5
3	1.18	376	524.5	148.5	14.9	63.6
4	0.60	468	532.5	64.5	6.5	57.2
5	0.43	326	365	39	3.9	53.3
6	0.300	330	354	24	2.4	50.9
7	0.150	349	484	135	13.5	37.4
8	0.075	264	386	122	12.2	25.2
Pan	0	321	572.5	251.5	25.2	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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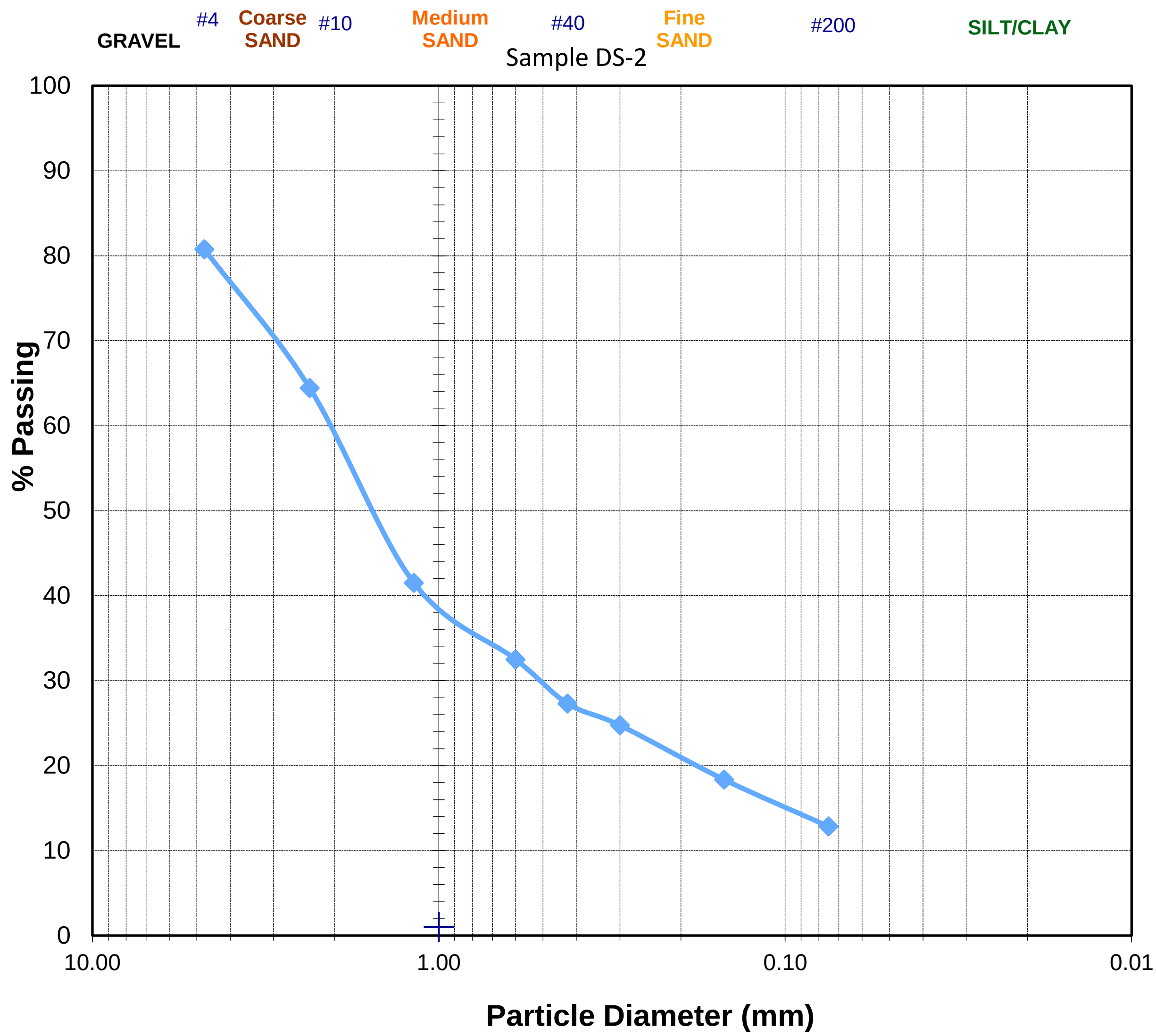
Sample DS- 2

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	627.5	192.5	19.3	80.8
2	2.36	393	556	163	16.3	64.5
3	1.18	376	605.5	229.5	23.0	41.5
4	0.60	468	558	90	9.0	32.5
5	0.43	326	378	52	5.2	27.3
6	0.300	330	355.5	25.5	2.6	24.8
7	0.150	349	413	64	6.4	18.4
8	0.075	264	319	55	5.5	12.9
Pan	0	321	449.5	128.5	12.9	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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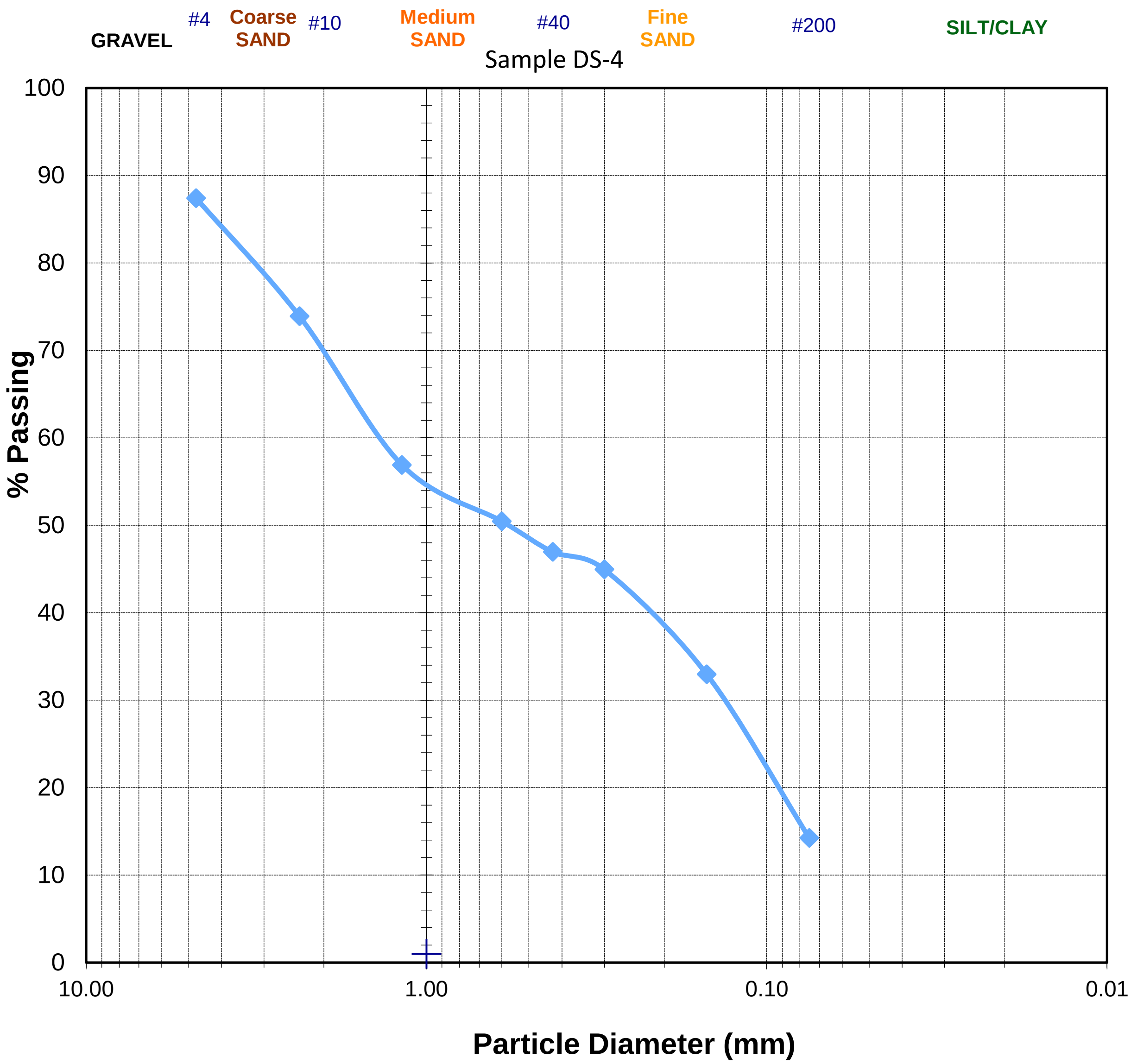
Sample DS-4

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	561	126	12.6	87.4
2	2.36	393	528	135	13.5	73.9
3	1.18	376	546	170	17.0	56.9
4	0.60	468	532.5	64.5	6.5	50.5
5	0.43	326	361	35	3.5	47.0
6	0.300	330	350	20	2.0	45.0
7	0.150	349	469	120	12.0	33.0
8	0.075	264	451	187	18.7	14.3
Pan	0	321	463.5	142.5	14.3	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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हमीरपुर (हि.प्र.) – 177 005 (भारत)
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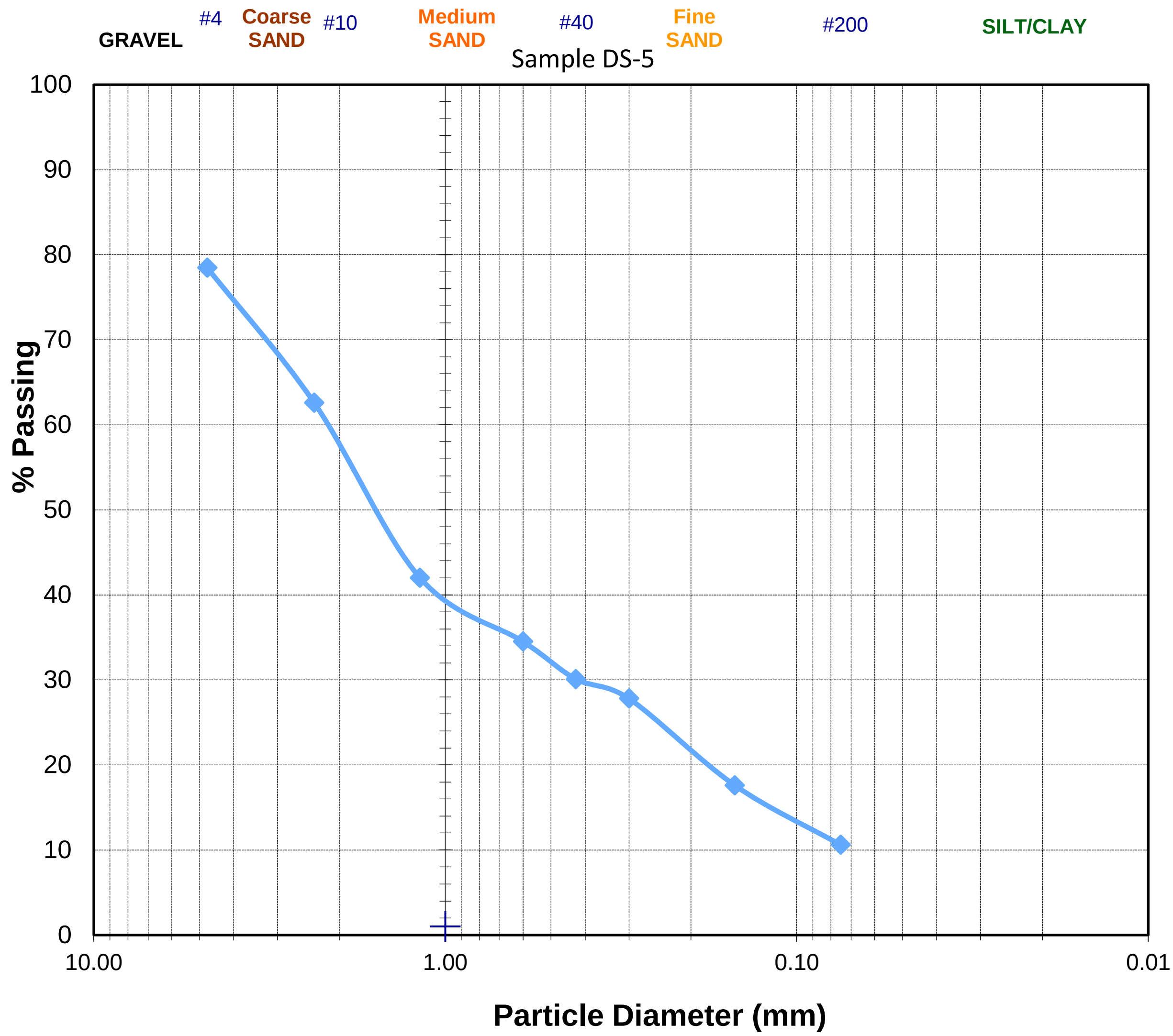
Sample DS-5

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	650.5	215.5	21.6	78.5
2	2.36	393	551.5	158.5	15.9	62.6
3	1.18	376	582	206	20.6	42.0
4	0.60	468	543	75	7.5	34.5
5	0.43	326	370	44	4.4	30.1
6	0.300	330	353	23	2.3	27.8
7	0.150	349	451	102	10.2	17.6
8	0.075	264	334	70	7.0	10.6
Pan	0	321	427	106	10.6	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
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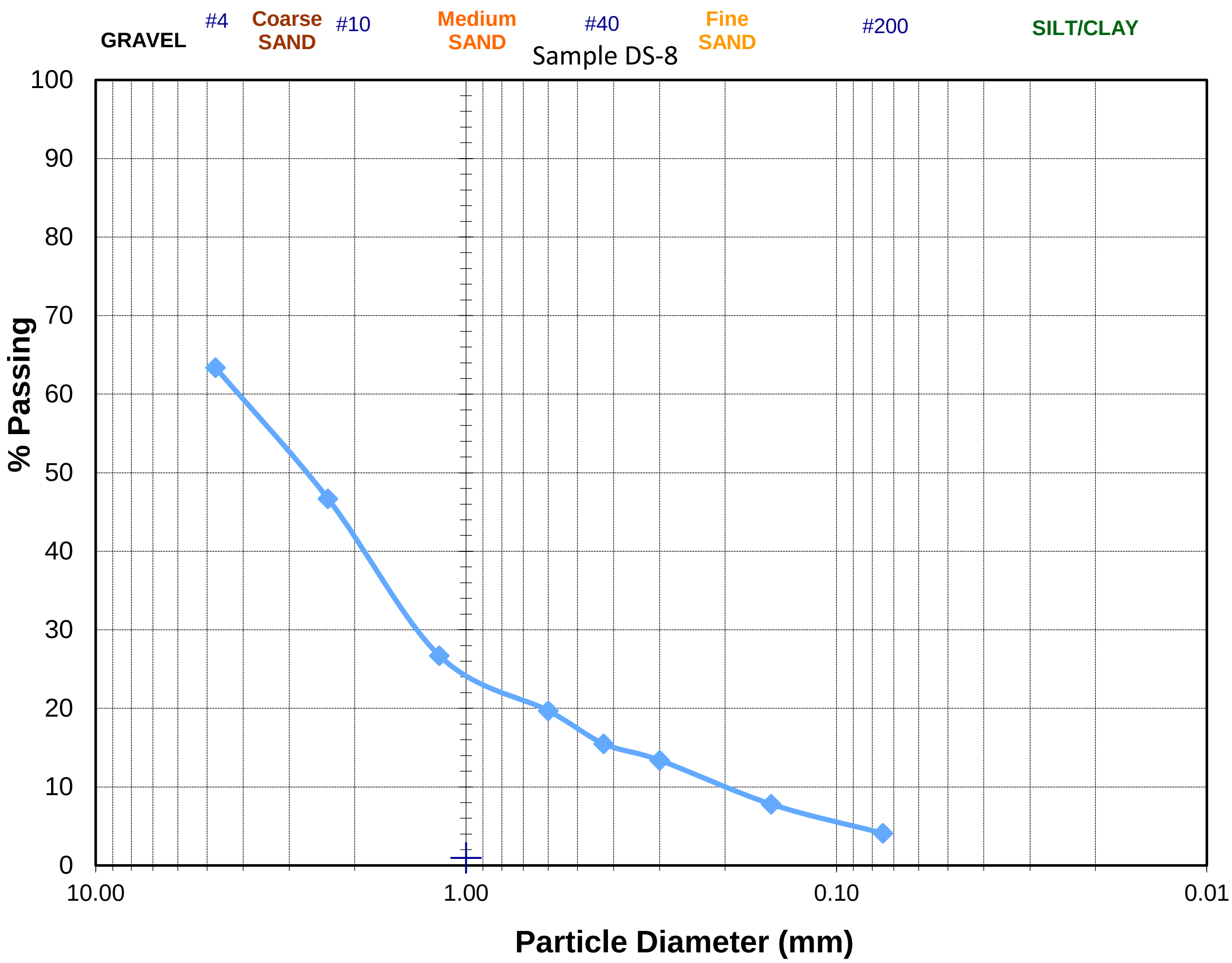
Sample DS- 8

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	801	366	36.6	63.4
2	2.36	393	560	167	16.7	46.7
3	1.18	376	576	200	20.0	26.7
4	0.60	468	538	70	7.0	19.7
5	0.43	326	368	42	4.2	15.5
6	0.300	330	351	21	2.1	13.4
7	0.150	349	405	56	5.6	7.8
8	0.075	264	301	37	3.7	4.1
Pan	0	321	362	41	4.1	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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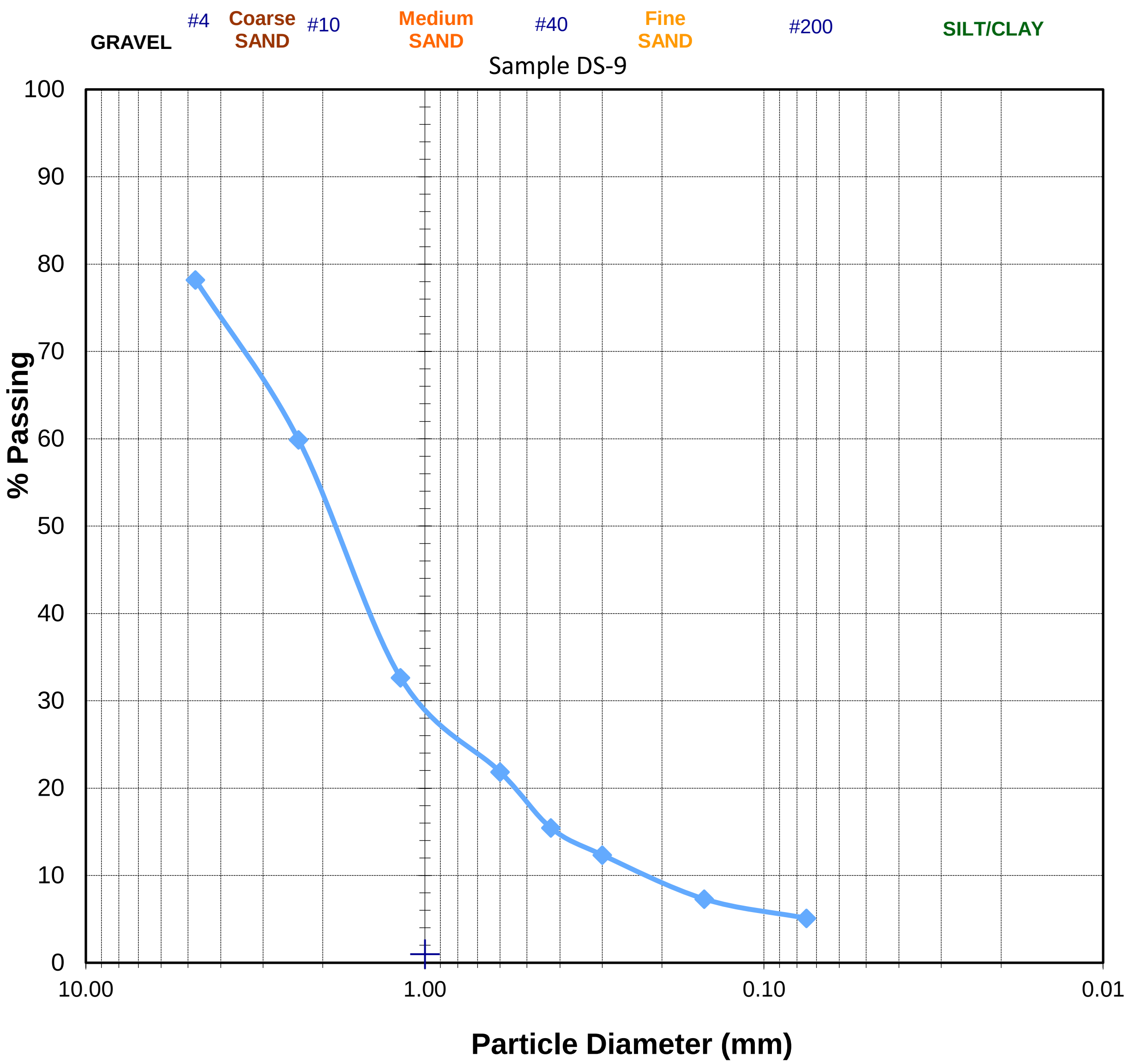
Sample DS- 9

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	653	218	21.8	78.2
2	2.36	393	576	183	18.3	59.9
3	1.18	376	648.5	272.5	27.3	32.7
4	0.60	468	576	108	10.8	21.9
5	0.43	326	390	64	6.4	15.5
6	0.300	330	361	31	3.1	12.4
7	0.150	349	399.5	50.5	5.1	7.3
8	0.075	264	286	22	2.2	5.1
Pan	0	321	372	51	5.1	0.0
			TOTAL:	**1000**	**100.0**	



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Associate Prof
CED, NIT Hamirpur

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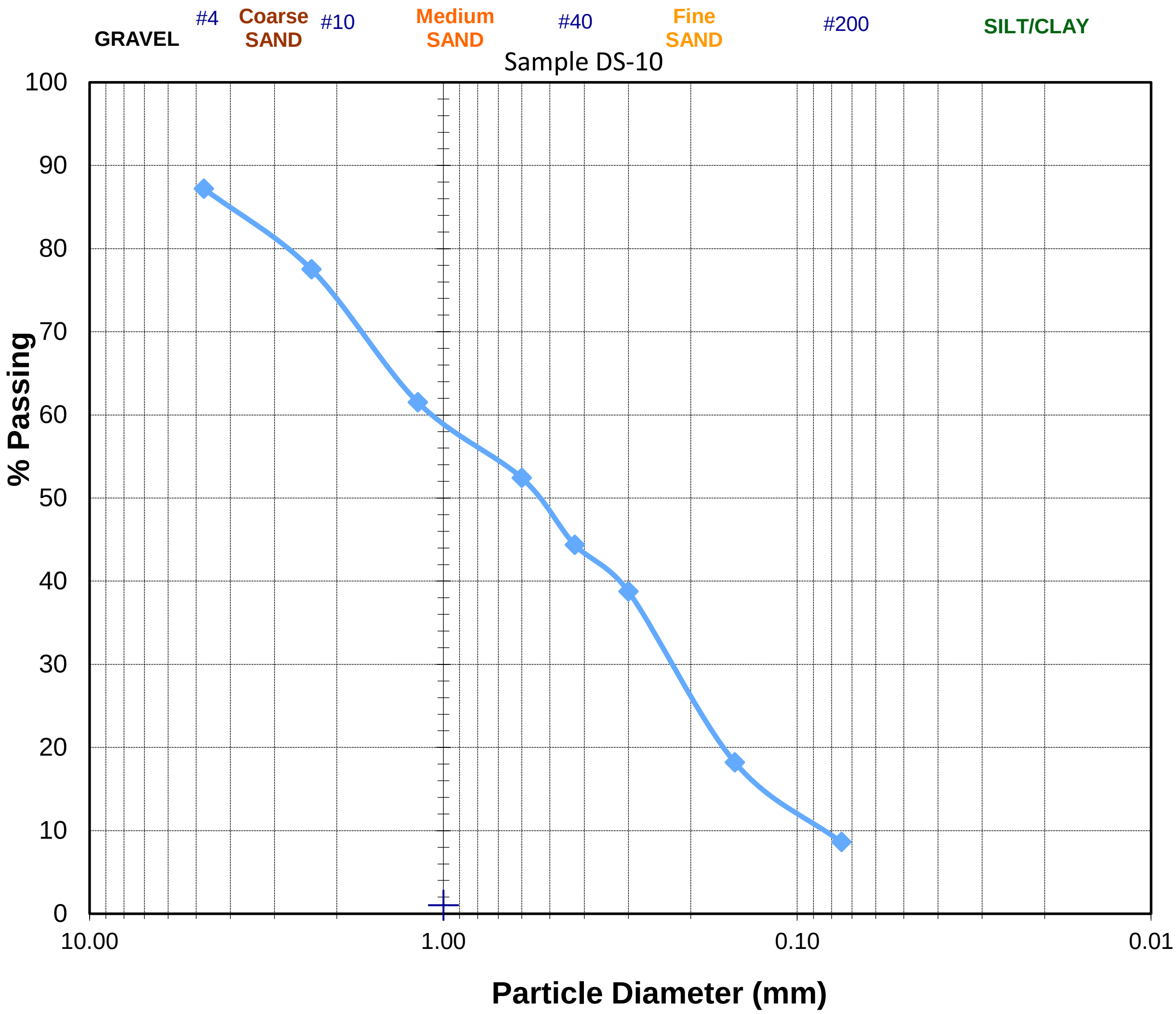
Sample DS-10 Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	563	128	12.8	87.2
2	2.36	393	490	97	9.7	77.5
3	1.18	376	536	160	16.0	61.5
4	0.60	468	559	91	9.1	52.4
5	0.43	326	406.5	80.5	8.1	44.4
6	0.300	330	386	56	5.6	38.8
7	0.150	349	554.5	205.5	20.6	18.2
8	0.075	264	360	96	9.6	8.6
Pan	0	321	407	86	8.6	0.0
			TOTAL:	**1000**	**100.0**	



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Associate Prof
CED, NIT Hamirpur

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NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
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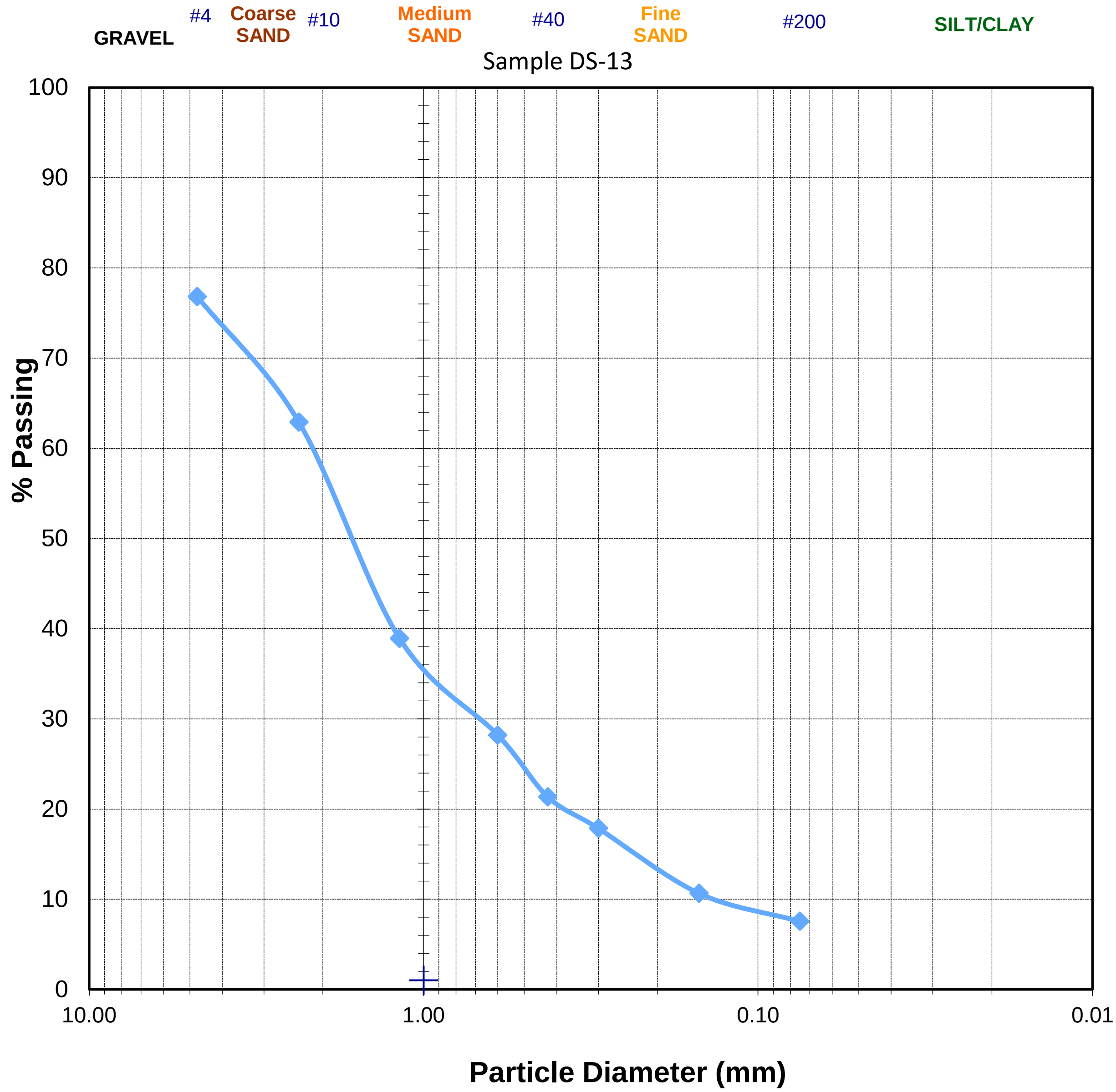
Sample DS-13

Grain Size Analysis

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	667	232	23.2	76.8
2	2.36	393	532	139	13.9	62.9
3	1.18	376	616	240	24.0	38.9
4	0.60	468	575	107	10.7	28.2
5	0.43	326	394.5	68.5	6.9	21.4
6	0.300	330	365	35	3.5	17.9
7	0.150	349	421	72	7.2	10.7
8	0.075	264	295	31	3.1	7.5
Pan	0	321	396.5	75.5	7.6	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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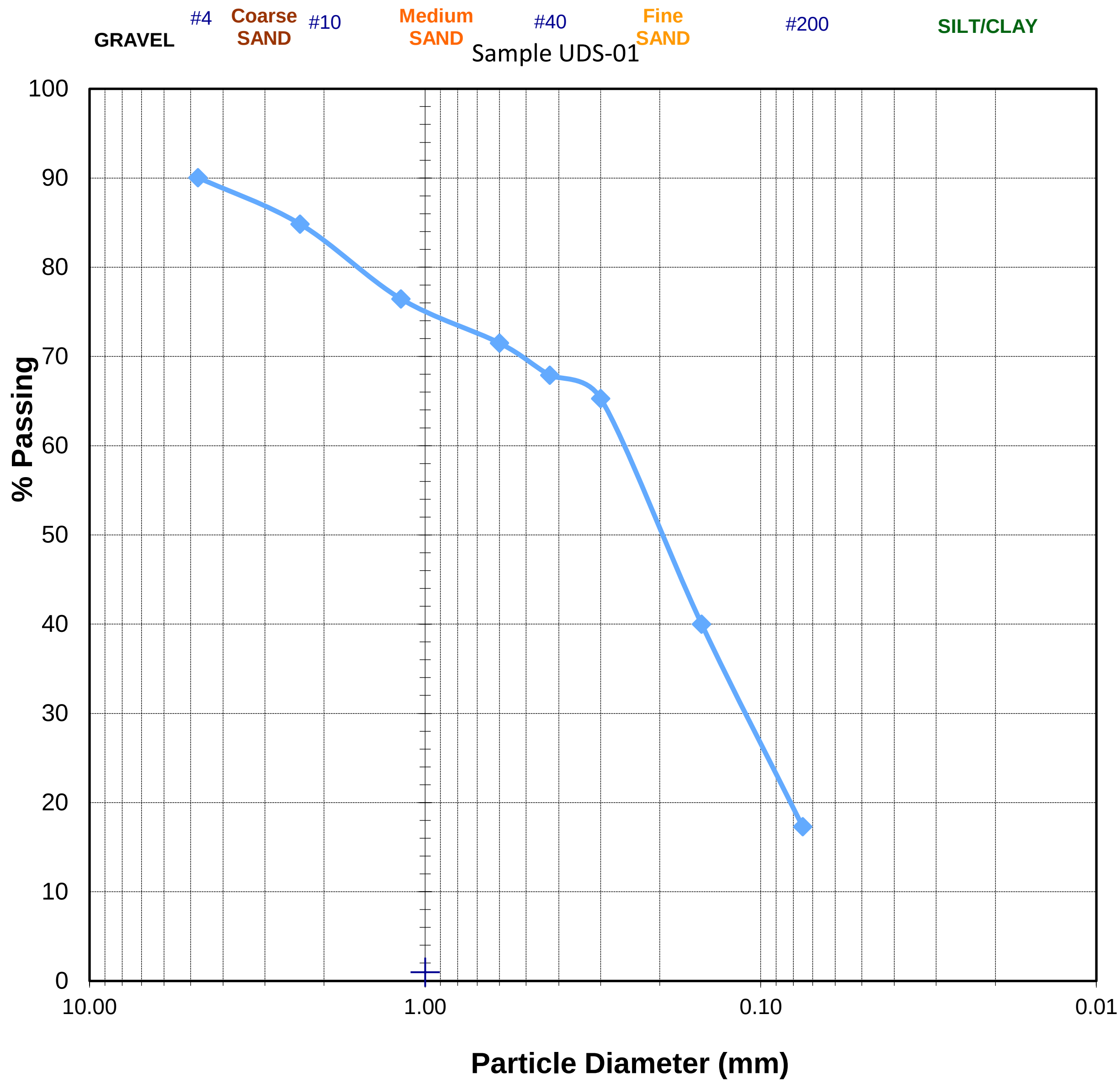
Sample UDS-1

Weight of Dry Sample (g): 1000.0 **Grain Size Analysis**

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	534.5	99.5	10.0	90.1
2	2.36	393	445	52	5.2	84.9
3	1.18	376	460	84	8.4	76.5
4	0.60	468	517.5	49.5	5.0	71.5
5	0.43	326	362	36	3.6	67.9
6	0.300	330	356	26	2.6	65.3
7	0.150	349	602	253	25.3	40.0
8	0.075	264	491	227	22.7	17.3
Pan	0	321	494	173	17.3	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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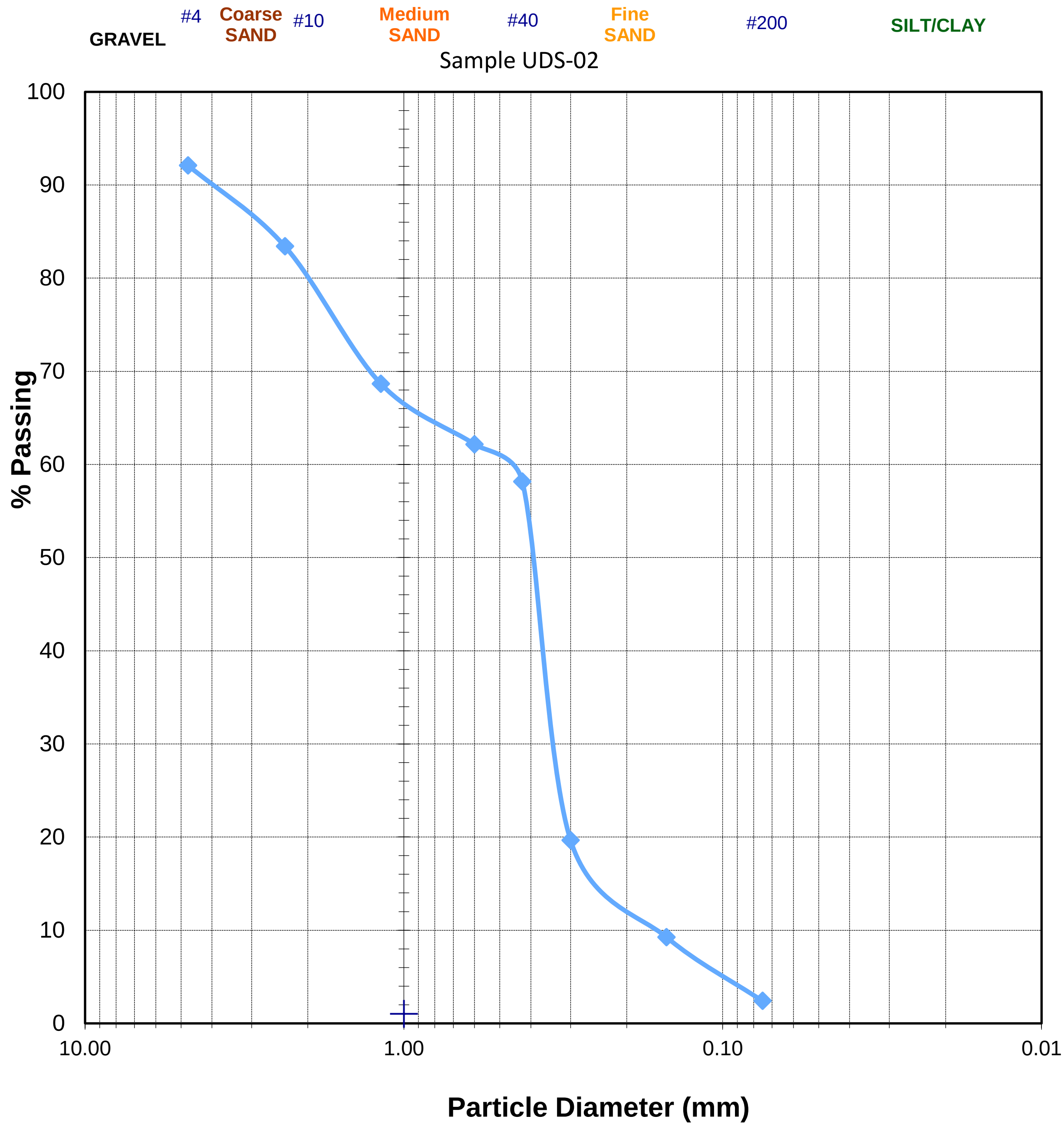
Sample UDS- 2 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	514	79	7.9	92.1
2	2.36	393	480	87	8.7	83.4
3	1.18	376	523.5	147.5	14.8	68.7
4	0.60	468	533	65	6.5	62.2
5	0.43	326	366	40	4.0	58.2
6	0.300	330	715	385	38.5	19.7
7	0.150	349	453	104	10.4	9.2
8	0.075	264	332.5	68.5	6.9	2.4
Pan	0	321	345	24	2.4	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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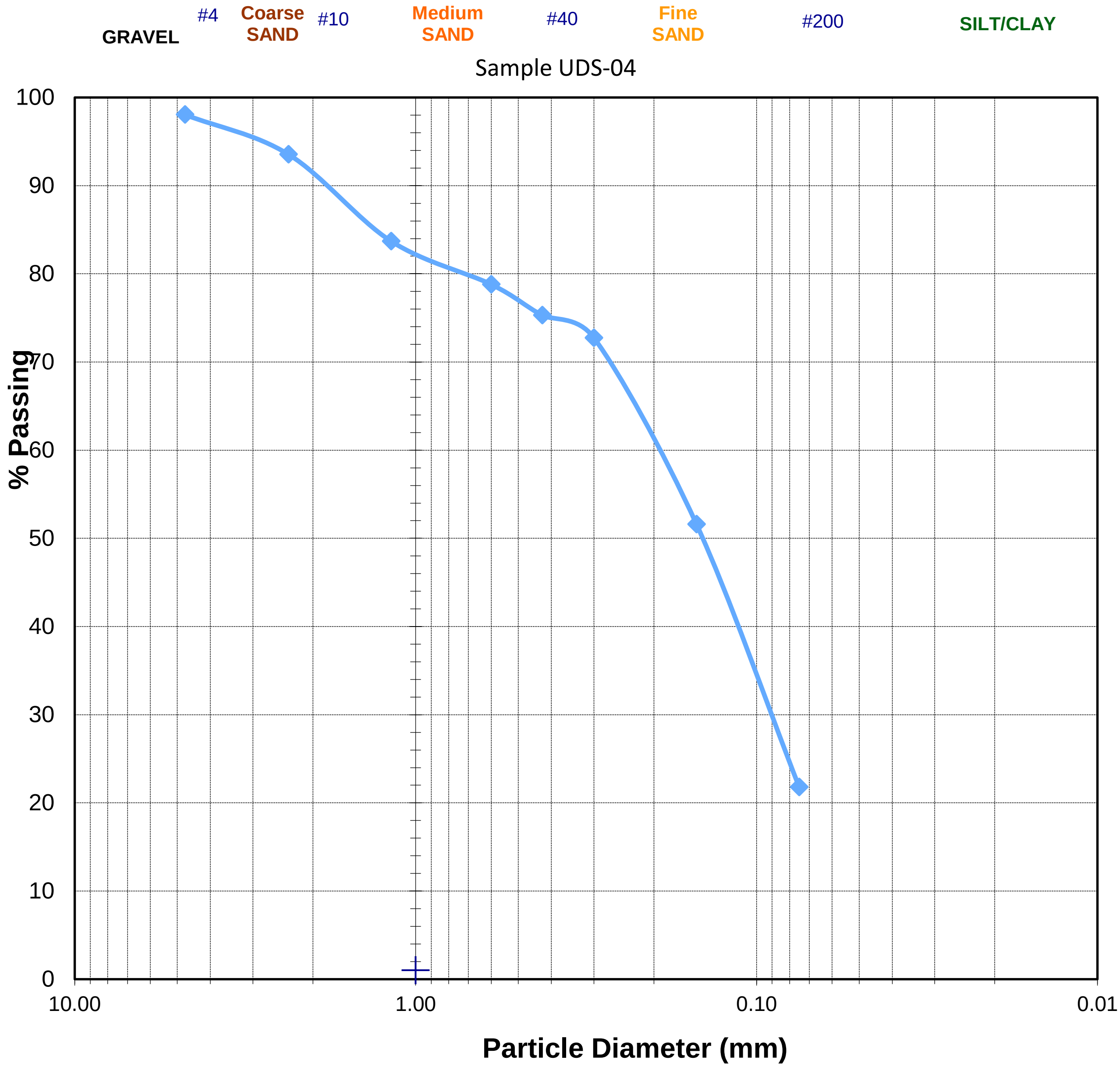
Sample UDS- 4 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	454.5	19.5	2.0	98.1
2	2.36	393	438	45	4.5	93.6
3	1.18	376	474.5	98.5	9.9	83.7
4	0.60	468	517	49	4.9	78.8
5	0.43	326	361	35	3.5	75.3
6	0.300	330	355.5	25.5	2.6	72.8
7	0.150	349	560.5	211.5	21.2	51.6
8	0.075	264	562	298	29.8	21.8
Pan	0	321	539	218	21.8	0.0
			TOTAL:	**1000**	**100.0**	



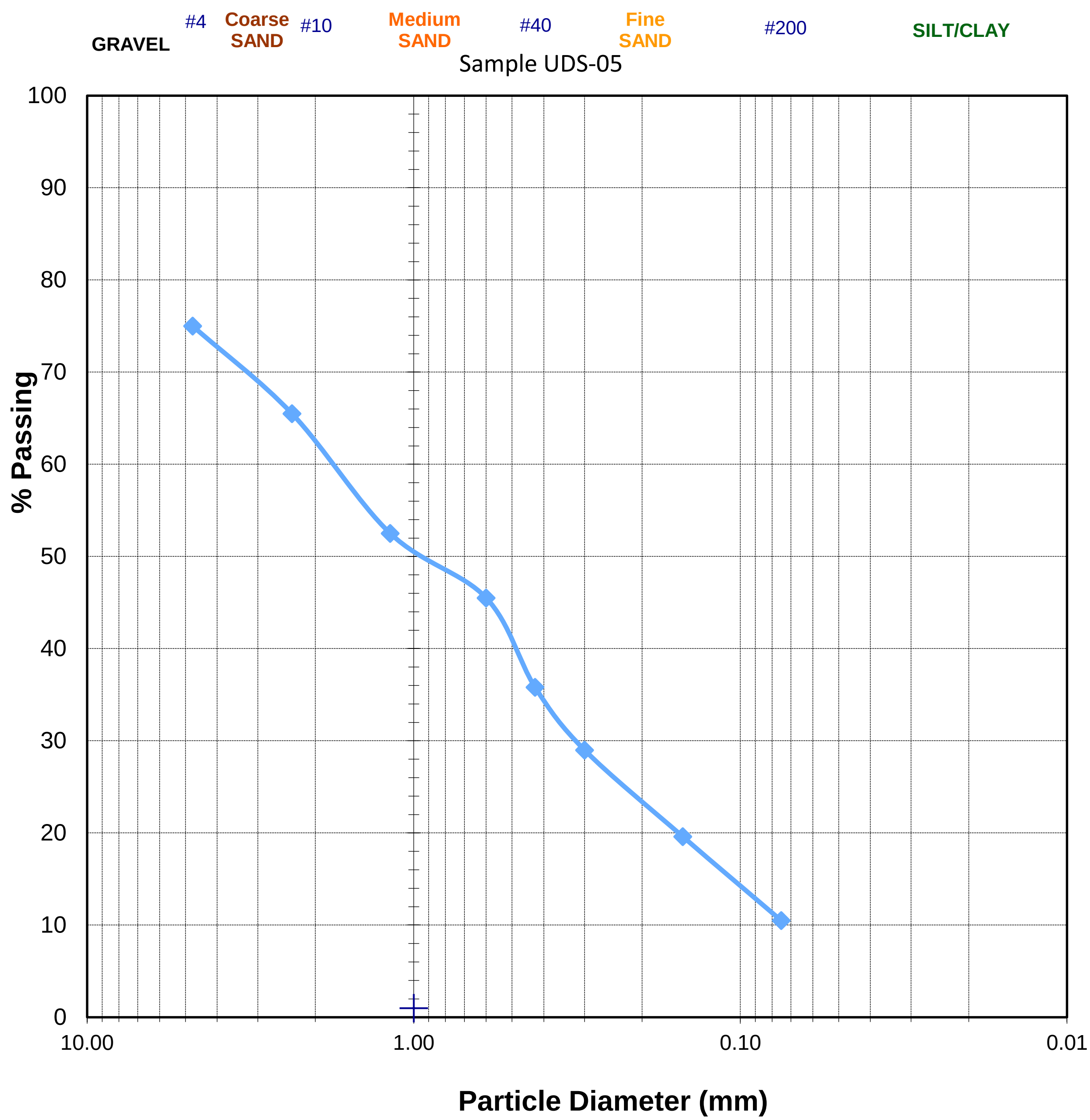
Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

Soil sample supplied by Ms. Shilpi Beakta , H.A.S , Sub Divisional officer(Civil) –cum nodel officer central university of Himachal Pradesh Dharamshala vide office letter no. 4494/SDK-CUHP dated 16.12.2021.

Sample UDS-5 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	685	250	25.0	75.0
2	2.36	393	488	95	9.5	65.5
3	1.18	376	506	130	13.0	52.5
4	0.60	468	538	70	7.0	45.5
5	0.43	326	423	97	9.7	35.8
6	0.300	330	398	68	6.8	29.0
7	0.150	349	443	94	9.4	19.6
8	0.075	264	355	91	9.1	10.5
Pan	0	321	426	105	10.5	0.0
			TOTAL:	**1000**	**100.0**	



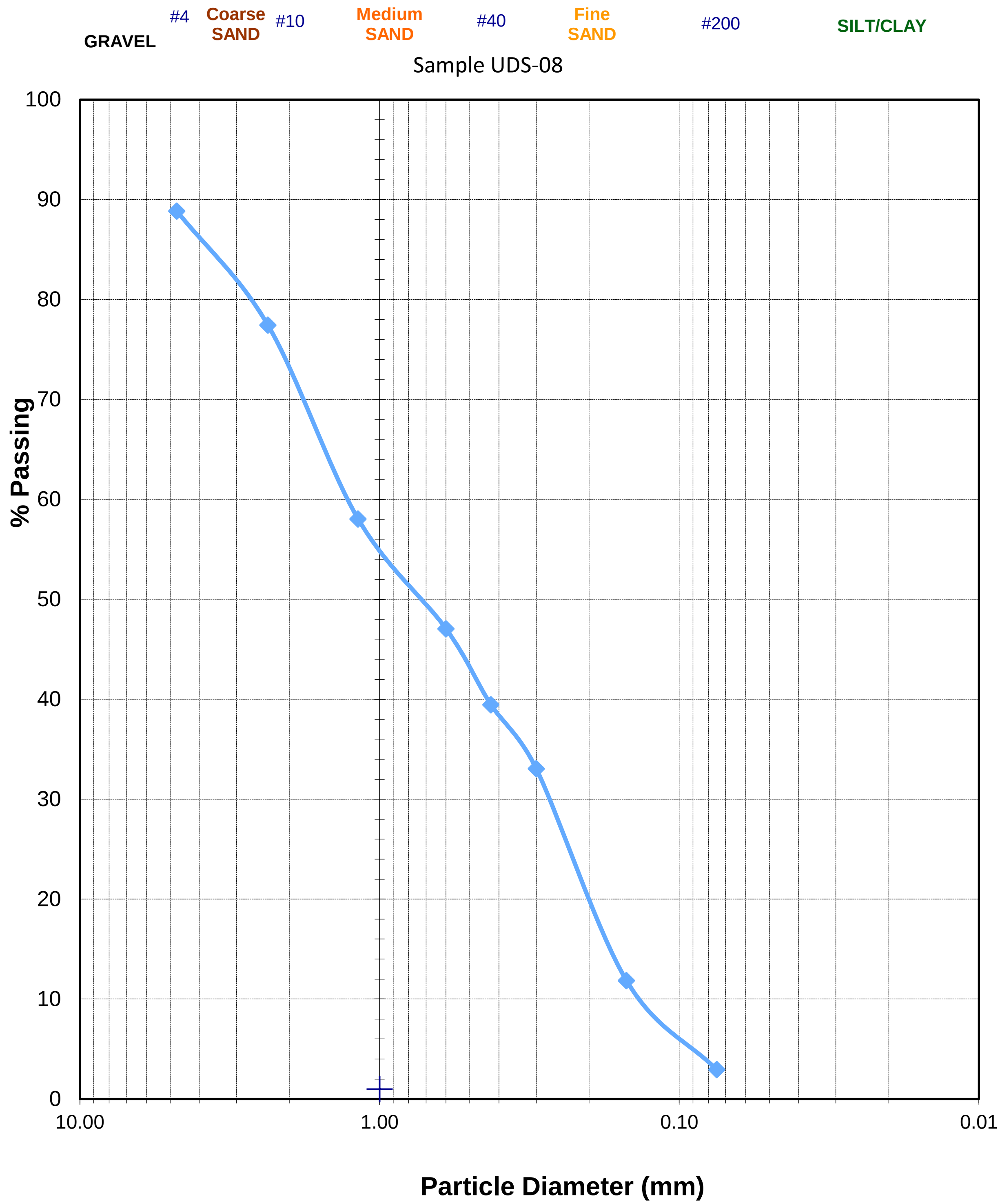
Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

Soil sample supplied by Ms. Shilpi Beakta , H.A.S , Sub Divisional officer(Civil) –cum nodel officer central university of Himachal Pradesh Dharamshala vide office letter no. 4494/SDK-CUHP dated 16.12.2021.

Sample UDS-8 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	546.5	111.5	11.2	88.9
2	2.36	393	507	114	11.4	77.5
3	1.18	376	570	194	19.4	58.1
4	0.60	468	578	110	11.0	47.1
5	0.43	326	402	76	7.6	39.5
6	0.300	330	394	64	6.4	33.1
7	0.150	349	561	212	21.2	11.9
8	0.075	264	353	89	8.9	2.9
Pan	0	321	350.5	29.5	3.0	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

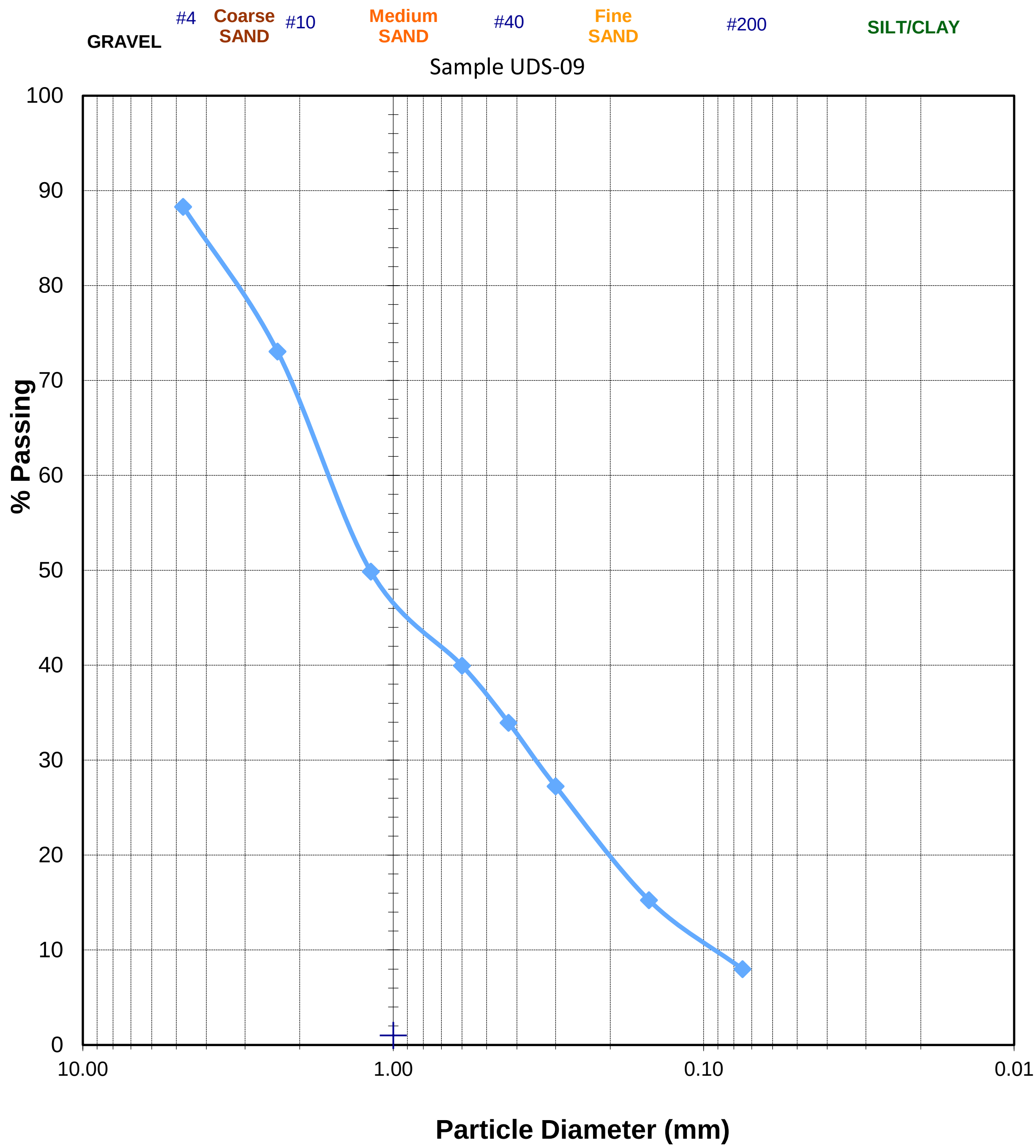
राष्ट्रीय प्रौद्योगिकी संस्थान हमीरपुर
हमीरपुर (हि.प्र.) – 177 005 (भारत)
NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
HAMIRPUR (H.P.) - 177 005 (INDIA)
(An Institute of National Importance under Ministry of HRD)

Soil sample supplied by Ms. Shilpi Beakta , H.A.S , Sub Divisional officer(Civil) –cum nodel officer central university of Himachal Pradesh Dharamshala vide office letter no. 4494/SDK-CUHP dated 16.12.2021.

Sample UDS-9 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	552	117	11.7	88.3
2	2.36	393	545.5	152.5	15.3	73.1
3	1.18	376	608	232	23.2	49.9
4	0.60	468	567	99	9.9	40.0
5	0.43	326	386	60	6.0	34.0
6	0.300	330	397	67	6.7	27.3
7	0.150	349	469	120	12.0	15.3
8	0.075	264	336.5	72.5	7.3	8.0
Pan	0	321	401	80	8.0	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

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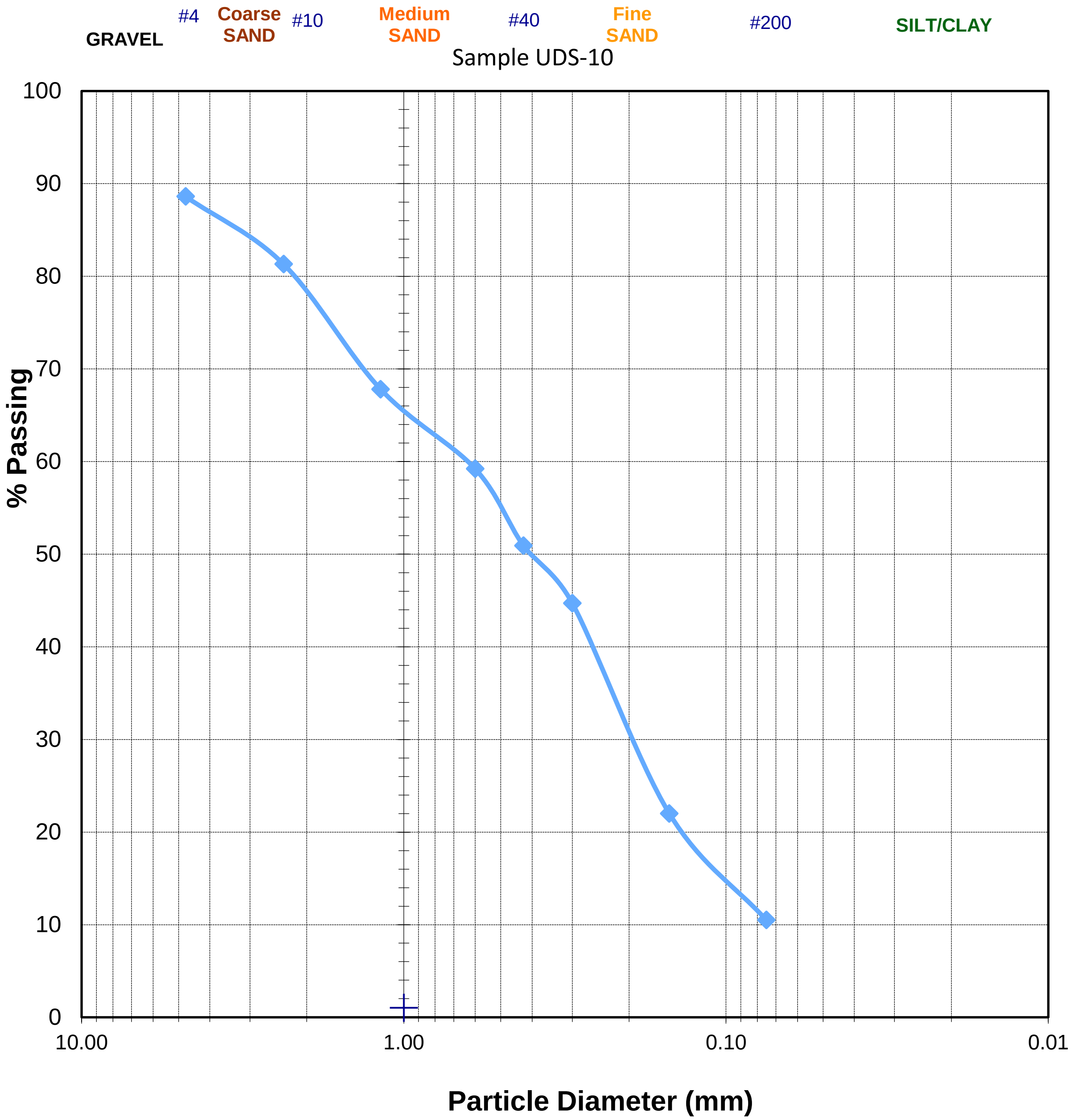
Soil sample supplied by Ms. Shilpi Beakta , H.A.S , Sub Divisional officer(Civil) –cum nodel officer central university of Himachal Pradesh Dharamshala vide office letter no. 4494/SDK-CUHP dated 16.12.2021.

Sample UDS-10 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	549	114	11.4	88.6
2	2.36	393	466	73	7.3	81.3
3	1.18	376	511	135	13.5	67.8
4	0.60	468	554	86	8.6	59.2
5	0.43	326	409	83	8.3	50.9
6	0.300	330	392	62	6.2	44.7
7	0.150	349	576	227	22.7	22.0
8	0.075	264	379	115	11.5	10.5
Pan	0	321	426	105	10.5	0.0
			TOTAL:	**1000**	**100.0**	



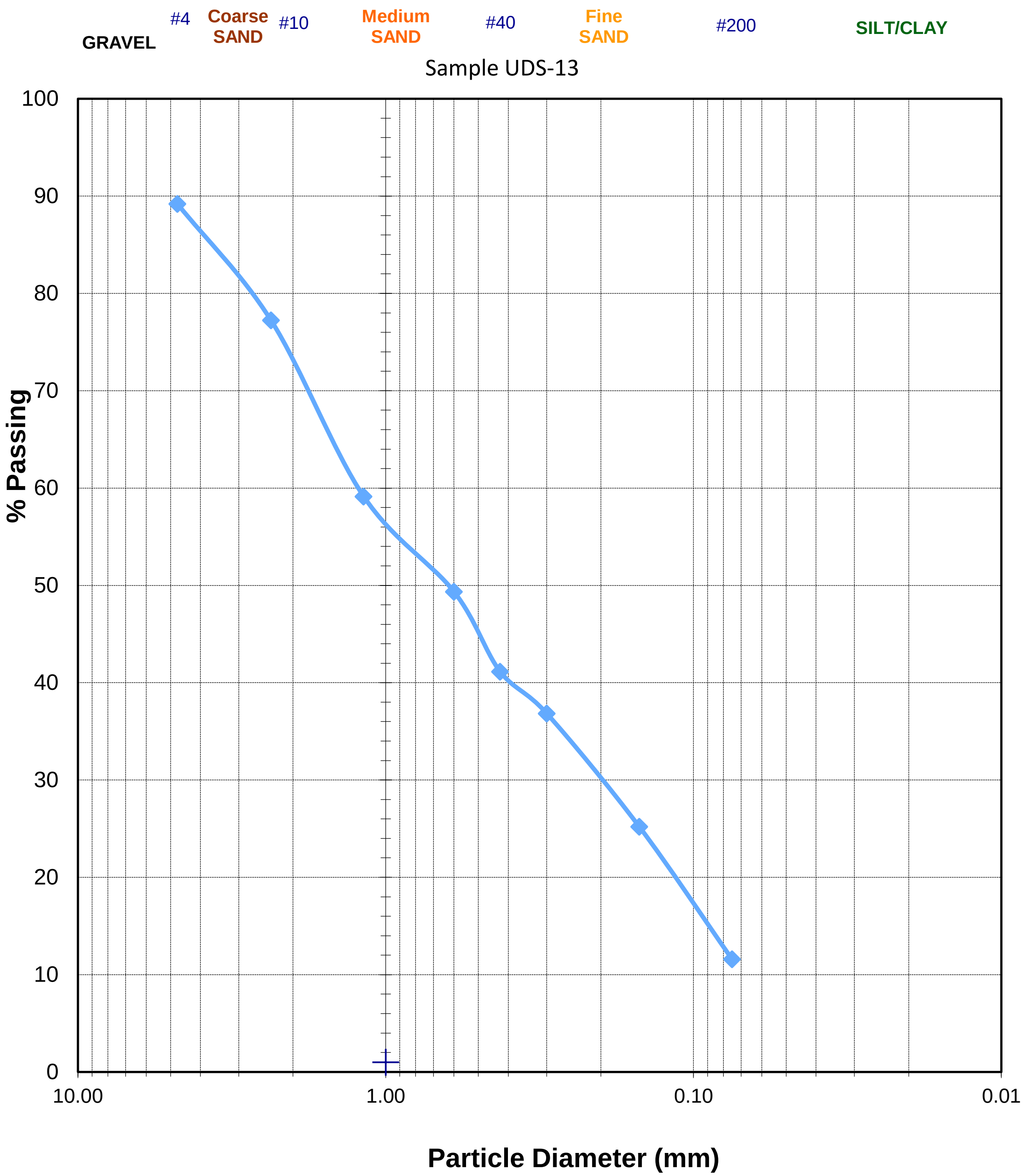
Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

Soil sample supplied by Ms. Shilpi Beakta , H.A.S , Sub Divisional officer(Civil) –cum nodel officer central university of Himachal Pradesh Dharamshala vide office letter no. 4494/SDK-CUHP dated 16.12.2021.

Sample UDS-13 **Grain Size Analysis**

Weight of Dry Sample (g): 1000.0

Sr/No	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
1	4.75	435	543	108	10.8	89.2
2	2.36	393	512.5	119.5	12.0	77.3
3	1.18	376	557	181	18.1	59.2
4	0.60	468	566	98	9.8	49.4
5	0.43	326	408	82	8.2	41.2
6	0.300	330	373	43	4.3	36.9
7	0.150	349	465.5	116.5	11.7	25.2
8	0.075	264	400	136	13.6	11.6
Pan	0	321	437	116	11.6	0.0
			TOTAL:	**1000**	**100.0**	



Dr. R.S. Banshtu
Associate Prof
CED, NIT Hamirpur

ANALYSIS OF GEOTECHNICAL PARAMETERS OF ROCK AND SOIL (DISTURBED & UNDISTURBED SAMPLES)

CLIENT:

Shilpi Beakta H.A.S.
Sub- Divisional Officer (Civil)- cum Nodal Officer
Central University of Himachal Pradesh, Dharamshala (H.P.)

SUBMITTED BY:

Department of Civil Engineering
National Institute of Technology
Hamirpur
Himachal Pradesh

Annexure – IV

I. Slope Stability Analysis

1. Review Objective

For slope stability check, the site conditions, constructability and economy need to be considered.

2. Applied Safety Factor

Section	Minimum safety factor	
Embankment region	User Defined	FS >= 1.3

II. Applied Properties

1. Soil Properties

Section	Wet unit weight (kN/m³)	Saturated unit weight (kN/m³)	Cohesion (kN/m²)	Internal friction angle ([deg])	Modulus of elasticity (kN/m²)	Poisson's ratio
DS1	16.55	21.00	14.6	35.00	-	-
UDS1	17.25	21.00	15.7	33.80	-	-

III. Analysis Results

1. Dry Season

static slope			seismic slope		
					
Standard safety factor	1.300	Evaluation	Standard safety factor	1.300	Evaluation
Analysis safety factor	2.905	**OK**	Analysis safety factor	1.981	**OK**

- Dry season's Embankment region slope stability check: In case of static slope,seismic slope allowable safety factor 1.3 has been satisfied. Determined to be safe.

A GEOLOGICAL NOTE ON RECONNOITORY TRAVERSE FOR ASSESSMENT OF NATURE AND QUANTUM OF WORK FOR GEOLOGICAL AND GEOTECHNICAL EVALUATION OF LAND FOR CENTRAL UNIVERSITY OF HIMACHAL PRADESH, DISTRICT KANGRA, H.P.

By

Manoj Kumar[1], Prashant T. Ilamkar[2], Dr. Atul Kohli[3], and Dr. Mukesh Verma[4]
1: Director, Tech. Coordination; 2: Director, Engineering Geology Division
3: Director, Project: Mesoscale LSM; 4: Sr. Geologist, EG and TC Divisions (P/T)
State Unit: Punjab, Haryana and Himachal Pradesh
Geological Survey of India, Chandigarh - 160 020

INTRODUCTION: -

The Central University of Himachal Pradesh (CUHP) has proposed for setting up the campus at or near Dharmashala, district Kangra, H.P. Around 100 acres of land has been identified by the officials of the CUHP near Tang and Jadrangal on Dharmashala – Palampur road. As per the request received from SDO (Civil) cum Nodal Officer, CUHP, Dharamshala to the Director-General vide letter No…. SDK/Central University of Himachal Pradesh dated 27-07-2021 with a request to conduct a detailed geological/geotechnical study of the area proposed for the CUHP campus. On the subsequent direction from the Director General to the office of GSI, SU: P,H&HP, Chandigarh, through DyDG & HOD, GSI NR via mail dated 30.07.2021, a team of officers headed by Dr. G.S. Tiwari, Dy. Director General, have visited the proposed site from 26th to 28th September 2021. The main purpose of the visit was to assess the nature and quantum of work for geological and geotechnical evaluation of land for the campus of CUHP. A joint field traverse was carried out by GSI team along with Faculty and Officers from CUHP and Officers from District Administration and Revenue & Forest Department on 27th Sept. 2021 after a brief meeting with Dr. Nipun Jindal, DC, Kangra, H.P in morning hours.

INTRODUCTION: -

The Central University of Himachal Pradesh (CUHP) proposed area is located southeast of Dharamsala Town, situated in the foothills of Dhauldhar Hills. The proposed site is located near villages Narwana, Tang, Jadrangal and is accessible by a motorized metal road. The proposed campus area is divided into 16 polygons distributed at different locations and accessible through the village roads. These polygons / land shown by the officials of the CUHP falls under non forest / forest lands. The proposed area falls under Survey of India Toposheet No.52D/8 having geographical coordinates are around Lat 32°09'39.7"; Long 76°25'12.9"). The elevation of the proposed campus area ranges from ±1000 m to ±1800 m. The proposed site for CUHP, on the day of visit was covered by forest, settlement and barren land without any forest cover at places.

GEOLOGICAL SETTINGS OF THE STUDY AREA: -

The general geology of the Dharmashala region is highly complex and shows great structural heterogeneity from south to north with distinct geological attributes. The study area exposes rocks of

Siwalik (Middle Siwalik Sub Group) and Sirmour Group (Dagshai Formation) of rocks comprising sandstone, red shale and siltstone. Structurally, tectonic stresses and movements as reflected by open folding and faulting in these, rocks have affected the entire Siwalik succession, developed in the outer belt. The rocks of the Murree/Dharamshala Group (mainly Lower Murree / Lower Dharamshala / Dagshai Formation) override the rocks of the Siwalik Group along the northerly dipping (>25˚) MBF or locally known as the Palampur Thrust.

The Jwalamukhi Thrust forms the southern limit of the Kangra re-entrant. It brings hanging wall comprising the upper part of the Lower Siwalik Subgroup (i.e Ramnagar/Nahan Formation) on the successive younger lithostratigraphic units (i.e Pinjor Formation). A small outcrop consists of gray sandstone with clay band was seen in the study area. The general bedding recorded is N24˚E/S24˚W dipping 44˚ towards N294. Two sets of joints other than bedding joint have also been recorded.

SEISMICITY OF THE STUDY AREA: -

The state of Himachal Pradesh located in the Western Himalaya has experienced major earthquakes because it is seismically a very active region and falls in the zone of continental collision of the Indian and Eurasian plates. As per BIS: 1893:2002: Part-I, the area (Dharamshala Region) falls in the Seismic Zone V of the Seismic Zonation Map of India. **The proposed study area falls in very high damage Risk Zone (MSK IX or more) (Source: BMTPC Vulnerability Atlas of Himachal Pradesh).** A highly devastating earthquake of magnitude 7.8 on the Richter scale occurred in 1905 within the study area. Around 19,727 people were killed and many of the fatalities were from Dharamshala, Kangra and neighboring towns and villages only.

GENERAL OBSERVATION OF THE STUDY AREA: -

The following observation made during the joint visit carried out in the proposed land to set up the campus of CUHP in Jagrandal and Bhagiyada area.

1) The proposed area forms a part of the southern outer Himalayan zone and situated in the lap of Dhauladhar Range with undulating topography.

2) A broad NW-SE trending flat bottomed Kangra valley between the Siwalik foothill belt towards southwest and the Dhauladhar Range in northeast, filled up with reworked morainic material is a prominent geomorphic feature of the area.

3) The most part of the proposed land area as shown by the officials exposes glacio-fluvial deposits comprising boulders varying is size from few cm to mts embedded in the silty clay matrix (Fig.1).

4) The outcrops comprising gray sandstone with thin bands of red clay have been observed in the study area falls in forest land comprising the polygons i.e. 1,2,4,5,6,7,8,10,11,12,13,14,15 and 16 (Fig.2, 3 and 4).

5) The some of the anomalous geomorphological features have been noticed during the field traverse which has to be mapped in detail to rule out any neo-tectonic activity in the proposed area.

6) Many glacial fed nala/streams have been observed in the proposed study area. The erosion powers of the stream/nalas in the form of Topographic Wetness Index (TPI) and SPI have to be calculated along with the field studies.

7) The slope instability problem, if any have to be studied in detail in the proposed land/area.

8) The area falls in the active tectonic zone and have received many earthquake events in the past, due to which the adverse geological / geomorphological features, if any have to be identified before finalization for setting up the campus of CUHP.

RECOMMENDATIONS: -

Based on the observation made during the joint visit, the following recommendation were drawn and briefed here.

1) The proposed land to set up the campus of Central University of Himachal Pradesh covers 75ha. Forest land and 24.5 ha of non-forest land of the land comprising thick glacio-fluvial material, colluvium and slope wash material having sporadic occurrence of the outcrops.

2) Slope instability/failure, if any have to be studied in details during the course of geological mapping.

3) The area being the part of the active tectonic zone, any adverse geological/geomorphological features have to be identified.

4) The erosion power of the streams/nala observed in the proposed area have to be studied and calculated along with field studies.

5) Prima-facie, the area appears to be suitable for the setting up of the campus for CUHP. However, it is recommended to carry out detail geological/geotechnical investigation in the study area before finalization of the project.

6) The geological/geotechnical investigation includes: -

- detailed geological mapping on 1:1,000 scale with total station,
- preparation of geological sections
- geotechnical analysis of the soil/rock samples
- pitting and trenching to obtain lithological, structural information in areas of shallow cover.
- auger drilling, at selected locations, if required, to ascertain the contact between overburden and rock.

7) A draft MoU (copy attached for Ref.) may be made between the GSI & District Administration, Kangra, H.P. for a common line of action to carry out further geological/geotechnical investigation as mentioned in point No.6. During the field visit, the same has been also communicated to Prof. Ambrish Mahajan, Geologist and Faculty from CUHP.

	
Fig.1 showing glacio-fluvial deposits comprising boulders varying is size from few cm to mts embedded in the silty clay matrix near Balla Jadrangal (Lat 32°09'39.7"; Long 76°25'12.9")	Fig.2 showing bed rock comprising sandstone with clay band exposed near Bhagiyada village (Lat 32°10'10.1"; Long 76°25'20.2")
	
Fig.3 A GSI team along with the officials from CUHP & Local Administration showing the location of polygon X. Outcrop can also be seen exposed on the surface.	Fig.4 Shows the location of one of the polygons VII with outcrop exposed at the surface.

Field Photographs

Report of the Site Selection Committee constituted by the Govt. of India vide MHRD F.No.42-24/2009-Desk (U) dated 17th May, 2013.

Constitution & Composition of the Committee:

1. Following the identification of additional land measuring 120 Hectare in contiguity of the previously identified 62.54.26 Hectare land by the Government of Himachal Pradesh, for the Dharamshala campus of the Central University of Himachal Pradesh, the Government of India vide MHRD F.No.42-24/2009-Desk (U) dated 17th May, 2013 constituted the Site Selection Committee. The composition of the Committee is as under:
    a. Prof. Abdul Wahid, Vice Chancellor, Central University of Kashmir
    b. Prof. Furqan Qamar, Vice Chancellor, Central University of Himachal Pradesh
    c. Shri Sanjay K. Murthy, Secretary (Higher Education), Govt. of Himachal Pradesh
    d. Dr. Akhilesh Gupta, Secretary, University Grants Commission
    e. Shri T.C. Nautiyal, AIG, Ministry of Environment & Forest, Govt. of India
    f. Shri Nand Lal Chauhan, Superintendent Engineer, CPWD, Chandigarh
    g. Shri Anant K. Singh, Joint Secretary, MHRD, (DoHE), GOI – **Convenor**

2. Visit of the Committee to the sites was undertaken on 12-13th June 2013 as fixed vide MHRD F.No.42-24/2009-Desk (U) dated 24th May, 2013. Prof. Abdul Wahid and Dr. Akhilesh Gupta could not make it convenient to undertake the visit due to some unavoidable reasons. In addition to the five members of the Committee, the officials from District Administration i.e. Deputy Commissioner, Additional District Magistrate, Sub Divisional Magistrate (Dehra), officials from the Departments of Revenue, Forests, PWD and IPH also accompanied the Committee to the Sites. Besides the Vice-Chancellor of Central University of Himachal Pradesh, who is the member of the Committee, the Pro-Vice-Chancellor and the Registrar of the University were also associated.

Background Details:

3. The Central Government vide MHRD letter No. F.42-24/2009-Desk(U) dated 23rd April 2010 approved the establishment of the Central University of Himachal Pradesh with its headquarters and temporary campus at Dharamshala and two distinct campuses on the sites offered by the Government of Himachal Pradesh in Dehra and Dharamshala in Kangra District. As per the approval, while the main campus of the University is to be located at Dehra, the other campus at Dharamshala is to have such of the school/Departments which do not require massive infrastructure. Further, the State Government was to ensure immediate handing over of the lands, free from all encumbrances for the two campuses simultaneously after obtaining due approvals/clearances from environmental angle **(Copy of the letter enclosed as Annexure 1).**

Recommendation of the first Site Selection Committee:

4. The reasons for and circumstances in which the decision to establish split/twin campuses of the Central University was taken are explained in detail in the reports of the Central Site Selection Committee constituted by the MHRD for the establishment of the Central University of Himachal Pradesh. During its visit on 15th-17th October 2008, the Central Site Selection Committee did not only visit the site offered by the State Government at Dehra but also explored all other possibilities and alternative sites that were indicated to them in the Kangra District of Himachal Pradesh. While State Government had proposed over 700 acres of land at Dehra, the Committee felt uncomfortable about the site on account of remoteness and lack of adequate supporting infrastructure. The possible sites indicated at Shahpur was found to be no more than 40 Acres whereas 200 Acres of land meant for HP Housing Board that was indicated as a possible site for the University at Dharamshala turned out to be private land requiring state government to invest a few hundred Crores of Rupees towards the cost of acquisition. The possibility of getting 500-600 Acres of Land out of the 1300 Acres in possession of the HP Agricultural University at Palampur was

also ruled out. **(Copy of the Minutes of the Central Site Selection Committee is enclosed as Annexure 2).**

Recommendation of the second Site Selection Committee:

5. Following the assumption of charge by the first Vice Chancellor of the Central University of Himachal Pradesh, he was also Co-opted as a member of the Site Selection Committee vide MHRD F.No.42-24/2009-Desk (U) dated 9.2.2010. The visit of the Site Selection Committee was organised once again on 19th-20th February 2010. This time the Government of Himachal Pradesh proposed two alternative sites, one at Dharamshala and another at Dehra. During its visit the Committee physically visited both the sites, perused land records and held detailed deliberations with the district officials. Having assessed both the sites, and taking an objective view, the committee felt that the topography that Himachal Pradesh had, it was well nigh impossible to find a single contiguous tract of land free from forest and vegetation for developing a campus at one single location and that it had no option but to consider recommending a split/twin campus facility for the Central University of Himachal Pradesh. The reasons for its recommendation are documented in details.

6. Even though the Committee had recommended for the twin/split campuses, it had clearly indicated Dharamshala to be better suited for the University when it observed that "The concerns for local development does make a case for setting up prestigious projects like this central university in relatively under-developed location so that the same could be developed in due course of time on the strength of the new development project. In case of higher educational projects, the foremost casualty of this approach would be excellence. It is important to understand that the need of the hour is not to set up just any institution of higher education. But the requirement is to set up institutions with the vision of achieving excellence in shortest possible period of time. Obviously, this could be achieved only if the university is located at a place that is developed enough to be able to attract talented and accomplished faculty and

the best students. Dharamshala has the added advantage of being not only the district head quarters but also in its accessibility to Gaggal Airport, thereby making it easier for visiting faculty, which would be needed in large numbers in the initial years of the university, to reach and return. In addition, Dharamshala is on the international tourist map, and therefore the university would start with an obvious advantage of not having to struggle to make its location known to scholars and faculty from anywhere. This would create a stronger academic and research profile for the university" **(A copy of the Report of the Central Site Selection Committee is enclosed as Annexure 3).**

Progress with regard to the transfer of land to the University:

7. After the decision of the Government of India dated 23.4.2010 to establish two campuses of the Central University, the State Government of Himachal Pradesh issued necessary directions to the District Administration to transfer 317.97.97 Hectares of land for the South/Beas Campus at Dehra and 62.54.26 Hectares for the North/Dhauladhar Campus at Dharamshala, for the establishment of Central University of Himachal Pradesh. Since the land identified and earmarked for both the campuses of the Central University of Himachal Pradesh was the forest land requiring clearance under Forest Conservation Act (FAC) 1980, the University took steps and prepared the cases in close collaboration with concerned Departments of State Govt. for getting FCA clearance.

8. The proposals for diversion of land of both the campuses of the Central University were sent by the Chief Conservator of Forests (FCA), O/O the Principal Chief Conservator of Forests, Himachal Pradesh to the Ministry of Environment & Forests, (FC Division), Government of India vide letter No. Ft.48-2089/2010(FCA) dated 26.11.2011.

9. The MoEF, Govt. of India vide their letter F. No. 8-120/2011 -FC dated 01.05. 2012 informed the Principal Secretary (Forest), Government of Himachal Pradesh as under:

   "the proposal appear to be non-site specific and requirement of forest land is very large and many non-essential items have been included in the requirements of forest land like provision for future expansion of many facilities and science, technology park. The Committee (Forest Advisory Committee) desired that the State Government may rationalise and minimise the forest land requirement and submit a detailed plan of land use for diversion may be provided. In view of the above, the State Government is requested to take appropriate action as per the observation of the FAC and submit a revised proposal" **(Copy of the letter enclosed at Annexure 4).**

10. The Chief Secretary, Government of Himachal Pradesh, in response to the above observations, wrote a Do letter No. D.O.No. EDN-A-Gha(8) 16/2006 dated 20th June 2012 explaining the reasons and justification for the proposal and urged the MoE&F) to reconsider the proposal and convey necessary approval. He further suggested that if required the MoE&F, Government of India may convene a meeting wherein the Chief Secretary and the Secretary, MHRD could attend to expedite the matter **(Copy of the letter enclosed at Annexure 5).** The matter was further followed up by a DO letter from the Chief Secretary on 10th December 2012. **(Copy of the letter enclosed at Annexure 6).**

11. Concerned about the delay in transfer of land to the Central University of Himachal Pradesh, Honourable Chief Minister of Himachal Pradesh, vide his letter No. EFE-B-F(2)-53/2009 dated 28-1-2013 requested the Honourable Union Minister of Environment & Forest to expedite necessary clearance so that the land could be transferred to the Central University at the earliest. Matter was followed up by the Nodal Officer-cum APCCF vide letter No. Ft.48-

2089/2010(FCA) dated 6th February 2013. **(Copy of the letter enclosed as Annexure 7).**

12. Honourable Union Minister of Human Resource Development too urged the Minister of Environment & Forest, Govt. of India vide letter D.O. No 42-24/2009 dated 5th March 2013 to facilitate an early decision in the matter so that the students of the State are not further deprived of the quality higher education for want of a permanent campus. **(Copy of the letter at Annexure 8).**

13. Honourable Minister of Environment & Forest wrote back to the Honourable Chief Minister vide her letter D.O. No...12/2011-FC dated 14th March 2013 reiterating the observations of the FAC and suggested, as earlier, that revised proposal be submitted after rationalising and minimising the requirement of forest land along with detailed plan of land use. She further informed in her letter that the Ministry of HRD has also been requested to constitute a joint committee to formulate guidelines for use of forest land for setting up of educational institutions with a focus to minimise loss of forest. **(Copy of the letter enclosed as Annexure 9).**

14. In the mean time, the State Government vide letter No. EDN-A-Gha(8)-16/2006 dated 26-02-2013 informed the University that the District Administration of Kangra has identified 120 hectare of additional government land contiguous to the earlier proposed land of 62 hectare in Dharamshala and required the University to confirm the suitability of the additional land to enable the Government to initiate the process for allotting the same to the Central University. **(Copy of the letter enclosed as Annexure 10).**

15. Accordingly the University approached the Ministry of Human Resource Development (MHRD) vide letter F.No. 2-1/CUHP/GA/2010-Vol II/1182 dated 8th March 2013 for constituted the Central Site Selection Committee to assess the suitability of additional land for the establishment of the Central University.

The Site Selection Committee was constituted by the MHRD vide letter F.NO. 42-24/2009-Desk (U) dated 17th May 2013 and visit of the Committee was fixed to be held on 12-13th June 2013 vide MHRD letter F. No. 42-24/2009-Desk (U) dated 24th may 2013.

Recommendations of the Site Selection Committee:

16. The Committee perused the reports of the Site Selection Committees of 2008 and 2010 along with the decision of the Government of India to familiarise itself with the concerns, constraints and issues involved in the identification of land for the establishment of permanent campuses of the Central University of Himachal Pradesh. It also considered the observations and insistence of the Ministry of Environment & Forest, Government of India to rationalise and minimise the requirement of land.

17. The Committee also perused the background papers presented by the University relating to the establishment of its campuses as approved by the Government of India including the reports of the geotechnical investigation, contour survey and the Master Plan that the University has got prepared for the construction and development of its permanent campuses, which was necessary to prepare and submit proposal for the FCA clearance. In the process the University spent Rs. 81.59 Lakhs on contour survey, geotechnical investigation, demarcation of boundary, preparation of the Master Plan, enumeration of trees and other associated work relating to the preparation of the FCA clearance proposal.

18. The Committee also considered the background papers placed by the University giving records of meetings that were held with the Chief Secretary, Government of Himachal Pradesh and also District Administration and noted that the issues of private land on the Dehra sites and contiguity of Dharamshala site still remain unsolved.

19. In order to take a holistic view on the matter, the Committee visited both the Dehra and Dharamshala sites including the additional land now identified by the State Govt. at Dharamshala. During the visits, the Committee also interacted and heard the local people who had gathered at Dehra and Dharamshala to get their view point. The Committee noted that there has hardly been any change in the views and passion of people about the location of the University as compared to the observation recorded in detail by the 2008 and 2010 Committee.

20. The Committee have had detailed deliberation with the local/district administration and perused in detail the record and revenue papers placed before it by the District Administration for both the sites and in particular with regard to the additional land identified at Dharamshala.

21. The Committee required the State Government and District Administration to furnish details of the additional land being proposed at Dharamshala and to get a geotechnical report in respect of the additional land. Based on the details furnished by the District Administration the area of the additional land proposed at Dharamshala worked out to be 97-45-74 Hectare only in addition to the already proposed 62-54-26 hectare. Thus the total land available for the Dharamshala site now worked out to be 160-00-00 Hectare. **(Details of the land enclosed as per Annexure 11).**

22. Geotechnical report of the site was received from the Geotechnical Wing, Directorate of Industries, Government of Himachal Pradesh on 20th June 2013 which mentions that by the surface observation made in the field that the proposed land is stable in most of the stretch. However, it considered certain recommendations absolutely essential for long-term safety of the sloping hill slope and proposed infrastructure **(Copy of the report enclosed as Annexure 12).**

23. After taking into account all relevant information vis-à-vis the observations of the Ministry of Environment and Forests, Govt. of India, for rationalizing and minimizing the requirement of forest land, the Committee makes the following recommendations:

a. Dharmshala being the District Headquarter and having air connectivity is better suited for establishing the Central University. With the additional land identified and proposed to be offered by the State Government at Dharamshala, the total land area becomes 160-00-00 hectare (62-54-26 hectare already proposed + 97-45-74 hectare of additional land). This works out to approximately 400 Acres and could be suitable for building a compact and cohesive main campus of the University. Given the topography and contour of land and considering the buildable portion, this site should be able to accommodate such requirements of the University which do not demand massive and heavy infrastructure.

b. As per MHRD norms about 500-600 Acres land is required for establishing a new Central University with Medical and Engineering Colleges. Availability of land area, its contour and topography may not permit the development of Schools requiring heavy infrastructure like the School of Medical Sciences, School of Health & Allied Sciences, School of Engineering Sciences & Technology and Research Park at the proposed site in Dharmshala. So, they may be developed at Dehra in the 2nd phase for which a contiguous land size of about 200 Acres on the right hand side of the Dharamshala – Hoshiarpur Road after excluding the private land and other land of common use such as the common charagah, shamshan ghat etc. should be sufficient.

c. Accordingly, the total land proposed for the establishment of the Central University of Himachal Pradesh shall come down from **380-52-23**

Hectares (62-54-26 Hectares at Dharamshala + 317-97-97 Hectares at Dehra) to **240-00-00 Hectares** only (160-00-00 Hectares at Dharamshala + 80-00-00 Hectares at Dehra) for the Main Campus at Dharmshala and the Satellite Campus at Dehra which is well within the norm of the MHRD.

d. The development of the two campuses should be taken up in phased manner. Out of the total proposed land, 160-00-00 Hectares at Dharmashala is the bare minimum and essential for the immediate development of the main campus of the University while 80-00-00 Hectares at Dehra may be taken up in the second phase subject to availability of funds from the MHRD/UGC. In case Ministry of Environment & Forest still has any reservation about the actual land requirement, it should keep the request for the proposed Dehra Campus in abeyance for detailed examination of the matter and grant clearance for the main campus at Dharmshala immediately as the matter has been delayed too much.

Prof. Furqan Qamar, Vice Chancellor, Central University of Himachal Pradesh	Sanjay K. Murthy, Secretary (Higher Education), Govt. of Himachal Pradesh	T.C. Nautiyal, AIG, Ministry of Environment & Forest, Govt. of India.	Nand Lal Chauhan, Superintendent Engineer, CPWD, Chandigarh

31.7.13
Anant Kumar Singh,
Joint Secretary, MHRD, (DoHE), GOI
Convenor

11C

Report of the Site Selection Committee for the establishment of Central University in the State of Himachal Pradesh.

Date of visit: 1st September, 2016

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The Government of Himachal Pradesh vide its letter dated 21.3.2016 has offered some additional land measuring 202 acres (82-82-73 hectares), making the total land about 748 acres (303-37-74 hectares), at revenue Villages - Sakoli, Patola, Kadiana, Kand, Bagiara, Up Mohal Kaswa and Salag, District: Kangra for North Campus of Central University of Himachal Pradesh.

2. Pursuant to the above proposal, the Ministry of Human Resources Development, Govt. of India, vide communication No. 42-24/2009-CU.III dated 8.8.2016 constituted a Site Selection Committee (SSC) with following members to inspect the above land offered by the Govt. of Himachal Pradesh and submit a report with its observations and recommendations for development of Campus of the Central University of Himachal Pradesh. The SSC visited the site offered by the State Government on 1.9.2016. The following were present during the visit:-

i. Shri Sukhbir Singh Sandhu, Joint Secretary (CU&L), MHRD, Government of India.
ii. Shri R.D. Dhiman, Principal Secretary (Education), Government of Himachal Pradesh.
iii. Prof. Kuldeep Chand Agnihorti, Vice Chancellor, Central University of Himachal Pradesh.
iv. Prof. Ashok Aima, Vice Chancellor, Central University of Jammu.
v. Shri Jitendra Kumar Tripathi, Joint Secretary, University Grants Commission (Representative of Secretary, UGC).
vi. Ms. Kamal Preet, Conservator of Forests, Regional Office, MoEF, Dehradun. (Representative of AIG, Ministry of Environment and Forests, Government of India)
vii. Shri P.K. Agrawal, Suptd. Engineer, CPWD, Shimla Central Circle, Shimla.

The following officials were also present:

1. Shri Ritesh Chauhan, Deputy Commissioner, District Kangra, Himachal Pradesh.
2. Registrar and Assistant Registrar, Central University of Himachal Pradesh.
3. Officials from Irrigation, PWD, Revenue and Water Supply Departments of the State Government.

3. The Vice Chancellor briefed the Committee about the present status, proposed developmental plans of Central University of Himachal Pradesh and the urgent need for developing its own Campus. Thereafter, the Site Selection Committee visited the proposed site situated at above mentioned revenue villages for physical inspection to ascertain the suitability of the land.

4. The total land offered is around 748 acres (303-37-74 hectare). It was informed by the Deputy Commissioner that out of it, around 686 acres (278-43-79 hectare) is forest land and around 60 acres (24-93-95 hectares) is government land.

5. The Site lies on Dharamshala - Palampur State Highway and is close to the periphery of Dharamshala town. The nearest point of the site is only 3 kms from Yol Army Cantt. The other end of the site is about 1 km from the famous Chamunda Devi Temple which is an important tourist spot of Himachal Pradesh.

6. Some part of the site, touching Dharamshala – Palampur road is almost at the level of the road, gradually rising to the hilly part where major portion of the site is located. Three relatively less sloppy chunks in the site were found more suitable for major construction. Many parts of the site are having trees. The site is interspersed with private land, which will have to be clearly demarcated and regulated by some 'land use master plan' to avoid haphazard development which may spoil the ambience and even create some undesirable situation in future. The State Government may be requested to acquire as much of this private land as possible to allow the University Campus to have a better planning and ambience.

7. The site is in close proximity to Dharamshala town which is well connected by road and air. Gaggal Airport is about 15 Kms from the site. Chamunda Marg Railway station (meter gauge) in only 5.5 kms from the site and the nearest Broad gauge Railway station is at Pathankot, about 100 kms from the site. Being in close physical proximity to Dharamshala town, this campus of the Central University of Himachal Pradesh will have access to all the amenities, facilities and services, including social infrastructure, requisite for its functioning and growth.

8. Good schooling facilities are available in Dharamshala town as good private schools as well as Kendriya Vidyalayas are available.

9. Dr. Rajendra Prasad Government Medical College and Hospital at Tanda near Kangra i about 12 kms from the site which offers good medical facilities apart from District Hospital ar many other private hospitals at Dharamshala.

10. Dharamshala, being a tourist town and District Headquarters, can offer reasonable job opportunities to the spouses of the faculty members of the Central University, a factor which has increasingly become important to attract and retain good faculty. Moreover, being a tourist town, along with McLeodganj, adds quality to life, which will again help in attracting good faculty.

11. The Committee was informed by the concerned departmental officers that there is no scarcity of potable water in the area and a gravity based water supply scheme can cater to the requirements of this campus which will have a sizeable student and employee strength in the years to come.

12. The Committee was also informed by the Irrigation Department officials that the site is not prone to floods and water logging.

13. In view of the fact that Central University of Himachal Pradesh is the only University established in 2009 where no land has been allotted so far for the establishment of its permanent campus, the Site Selection Committee is of the opinion that the site offered by the Government of Himachal Pradesh at Villages Sakoli, Patola, Kadiana, Kand, Bagiara, Up Mohal Kaswa, and Salag, District: Kangra is suitable for the establishment of the North campus of Central University of Himachal Pradesh due to its locational advantages. All the basic amenities like adequate water supply, electricity and adequately widened approach roads upto the university campus site shall be provided by the State Govt. at their own cost as per the policy of Govt. of India.

Sd/-

(S. S. Sandhu)
Joint Secretary(CU&L)
Dept. of Higher Education
MHRD

Sd/-

(R.D. Dhiman)
Principal Secretary (Edu.)
to the Govt. of HP

Sd/-

(J.K. Tripathi)
Joint Secretary
University Grants Commission

Sd/-

(Kuldeep Chand Agnihotri)
Vice Chancellor
Central University of HP

Sd/-

(Ashok Aima)
Vice Chancellor
Central University of Jammu

Sd/-

(P.K. Agrawal)
Suptd. Engineer
CPWD, Central Circle, Shimla

Sd/-

(Kamal Preet)
Conservator of Forests,
MoEF, Dehradun