Annexure II

APPRAISAL OF WORK DONE BY THE DIRECTORATE OF GEOLOGY AND MINING, DIMAPUR, NAGALAND DURING 2020-2021

I. MINERAL INVESTIGATION

1. G-4 Level Exploration of Ni-Co-Cr-Magnetite in Mollen-Jopi-Ziphu Ridge and adjoining Areas, Naga Hills Ophiolite, Phek District, Nagaland

The G-4 Level Exploration of Ni-Co-Cr-Magnetite was carried out in Mollen-Jopi-Ziphu (MJZ) Ridge and adjoining Areas, Naga Hills Ophiolite, Phek District, Nagaland which falls within the geo-coordinates from latitudes 25°28'46.08"N to 25°38'35.81"N and longitudes 94°41'33.87"E to 94°46'53.94"E in Survey of India Toposheet number 83K/10, 11, 14 & 15. The Geological Report was completed and had been submitted to the National Minerals Exploration Trust (NMET), Ministry of Mines, GoI.

The major quantum of works comprised geological mapping of an area of 103 sq.km, 25 Cu.m pitting, geochemical sampling and analysis of 200 Nos of samples mainly for 6-radicals (Ni, Co, Cr, Fe, Ti& V) along with few petrological and mineralogical studies. PGE analysis was carried out for 25 Nos of samples.

Based on present work (1) the different types of iron ores identified in the present block are (i) Magnetite ores (ii)Laterites/Lateritic soils, (iii) besides mineralisation of chromites associated with or without magnetites in the form of pods, lens etc spread sparsely in the ultramafic rocks throughout the study area. (2) Six mineralized areas/zones were demarcated namely (i) Thewati Magnetite depositmagnetites (ii) Reguri Magnetite magnetites (iii)Northern Ziphu magnetites (iv) Southern Ziphu pod-magnetites& laterites (v) Mollen Laterites (vi) Reguri Lateritic soil. Out of these mineralized areas, the two magnetite ore deposits with commercial potentials were delineated for resources estimaton namely (i) Thewati Magnetite deposit and (ii) Reguri Magnetite Deposit.

These two zones/deposits were considered for both ≥45% to <55% and ≥30% to <45%Fe cut off grades separately by using cross section method for estimating the multi-metal magnetite resources (334) of the MJZ block/areas as:

Sl.No	Features	Details			
1	**Quantity of Minerals**				
	Ni-Co-Cr Magnetite (334)	Grade	Thewati (MT)	Reguri (MT)	Total
		≥45% to <55% Fe cut off	2.84	0.81	**3.65**
		≥30% to <45% Fe cut off	1.68	0.05	**1.73**
		Total Quantity (MT)	4.52	0.86	**5.38**
	Average Grade	≥45% to <55% Fe cut off	≥30% to <45% Fe cut off	PGE (PPB)	
		Fe. 47.21%	Fe. 32.28%	Ru. 216.875-533.476	
		Ni. 0.64%	Ni. 0.865%	Rh. 33.053-56.294	
		Cr. 1.246%	Cr. 1.01%	Pd. 32.296-224.602	
		Co. 0.058%	Co. 0.06%	Os. 21.475-188.531	
		Ti. 0.194	Ti. 0.105	Ir. 89.424-290.185	

		V. 0.017	V. 0.019	Pt. 122.143-391.666
			$\sum PGE$	***681.262-1550.369***
2	**Mineralised Zones**			
	Number of Mineral Zones	1		
	Trend (Dip and Strike)	Strike: NW-SE Dip: 25° - >80 (westerly)		
	Total Thickness	4.0 m		

2. G3 Level Exploration of Limestone in Salumi Block, Kiphire district, Nagaland.

The G3 exploration of Limestone in Salumi Block, Kiphire district has been completed and geological report submitted to NMET. The exploratory work comprised drilling 5 boreholes with total meterage of 224.75 m, geological mapping and laboratory studiescarried out with the objective to assess the disposition of limestone deposit and to estimate the in-situ limestone resource and quality.

The present exploration has revealed that the Salumi limestone block comprises of five lensoidal pockets/ deposits of varying dimensions spread over an area of approx 0.79 sq.km. The limestone occurs as rootless, lenticular deposits/pockets associated with the volcanic rocks of the NHO Complex. Pocket I located on the southern side of the block is the main deposit which extends for strike length of about 800 m trending almost N-S direction. The other 4 limestone pockets occur as isolated pockets towards the northern part of the block and are of relatively smaller dimensions.

Based on the present exploratory drilling it is concluded that the limestone is not persistent with depth as reported by earlier workers where limestone was envisaged to be continuing upto the Likimro river. The limestone is affected intensely by silicification and its quality deteriorates with increase in SiO_2 % with depth as evident from the individual borehole logs.

The chemical analysis shows variation in quality within the block. Limestone with very high silica enrichment falling below the cement grade cut off and threshold value has been classified as siliceous limestone. Resources has been estimated for the low grade limestone, provided they are processed for beneficiation to the required level. The limestone quality of Salumi is as:

i. Cement grade: CaO 48.63 %, MgO 0.75 %, Fe_2O_3 0.75 %, SiO_2 3.31, Al_2O_3 0.48 % & LOI 40.56 %.
ii. Siliceous limestone: CaO 33.97 %, MgO 1.31 %, Fe_2O_3 2.45 % , SiO_2 28.35 %, Al_2O_3 2.90 % & LOI 28.20 %.

The total limestone resource potential of Salumi block is 7.59 MT of which0.99 MT indicated (332), 5.55 MT inferred (333) and 1.05 MT reconnaissance resource (334).

3. Regional Coal Exploration Melak –Tzurang Valley Coalfield, Mokokchung district, Nagaland

i. Changki Coal Block B (CCBB): The physical components of work in Changki Coal Block B has been completed which involves 21 boreholes with total meterage of 3791.05m, geological mapping on 1:5000 scale in 13.70 sq.km and Channel sampling

of all mineable coal seams. The analytical results of core and channel samples are awaited from CSIR-NEIST, Jorhat and CMPDIL, Ranchi laboratories. The preparation of geological report is in progress.

ii. Mongchen-Dibuia Coal Block (MDCB): The present block is the northern strike continuation of Northern Khar coal clock where regional exploration has been completed. The G2 exploration activities in MDCB commenced from February 2021. The work achievement since commencement is summarized below as-

1	Geological Mapping on 1:5000 scale	1.30 sq.km
2	Borehole	3 (1 completed, 2 running BH)
3	Total meter drilled	305 m

iii. Yimchenkimong-Molungyimsen Coal Block (YMCB): The G4 exploration activities in YMCB commenced from March 2021. The work achievement since commencement is summarized below as-

1	Geological Mapping on 1:12500 scale	1.10 sq.km
2	Borehole	3 (1 completed, 2 running BH)
3	Total meter drilled	317.20

4. G4 exploration of coal resource along Khar Thrust between New Camp and Tuli, Mokokchung district.

G4 level investigation of coal resource was carried out along Khar Thrust between New Camp and Tuli, Mokokchung district. The area of investigation falls under SoI toposheet No 83 J/7 & J/10 and lies between latitude 26°25'8.90"N to 26°40'32.32"N and longitude 94°24'51.92"E to 94°40'50.03"E. Geological mapping on 1:12,500 scale was carried out to assess the coal bearing strata, nature of occurrence of coal seams, qualitative potential and its prospect for future exploration.

The Baragoloi Formation of Barail Group is the coal bearing formation in the study area, sandwiched between Khar and Disang thrust in the west and east respectively. The Baragoloi Formation is thrusted over the underlying Tipam rocks along the Khar thrust on the lower margin while towards the upper margin the Disang rocks are thrusted over the Baragoloi along the Disang thrust. The general rock trend is NE-SW with average dip ranging from 40º to 50º due southeast.

The coal bearing Formation in the study area is characterized by alternations of sandstone, sandy shale, carbonaceous shale, sandy clay, clay and coal. The Baragoloi Formation comprises of two (2) coal and their regional correlation has been established along strike extension from Tuli in the northeast to New Camp in the southwest during the present investigation.

Seam 1 is approx. 1.20 m thick and Seam 2 is approx. 1.55 m thick. The parting between the two seams is about 70 – 80 m characterized by thin bedded sandstone and shale alternations, clay with sandy laminations and clay. The coal is hard and shows variable lustre but they are dominantly bright to moderately bright in appearance. Coal samples has been sent to CSIR-NEIST Jorhat for analysis, the results of which are still awaited.

5. Brief report on Preliminary Geological investigation for Semi-Precious Stone (Chalcedony and Agate) downstream of Layoti nallah, Phek district, Nagaland.

Geological investigation for Chalcedony and Agate was carried out from Layoti nallah confluence to downstream of Layoti nallah west of Shilloi Lake located at latitude N25°35'51.1'' and longitude E94°47'35.0'' in part of toposheet no. 83 K/14. The area was investigated and mapped on 1:10000 scale by tape and compass and GPS covering an area of about 4.2 sq. km. It is observed that the Chalcedony and Agate are found in small and large boulders along the stretch of the nallah. It appears to be deposited by river and are not found in-situ. Probably, their source of origin may have been from quartzitic terrain at the water heads of New Thewati area.

Boulder size ranging from 1 feet square to almost 3-meter square was observed along the nallah with colour varying from grey, greyish blue, greenish blue and pale green. Higher grade transparent variety was not seen, only translucent and opaque varieties were observed. As huge in-situ deposit was not found, it cannot be utilized commercially. However, the villagers can locally utilize it for making small artifacts, potteries and gift items.

6. Mineral Resources Mapping of Kiphire District.

Kiphire District of Nagaland occupies parts of Survey of India toposheet No. 83K/9, 83K/13 and 83K/14. The main mineral resources of Kiphire District having economic potential are Magnetite, Limestone, Sandstone and other building materials.

1. Magnetite:

Magnetite deposits with their total resources are:

Sl. No	Location/Block	Resource in million tonnes
1	Pokphur (S & N Block)	5.087 (333)
2	Pokphur (Extreme NNW Block)	7.10 (334)
3	Thongsonyu Block	0.26 (334)

2. Limestone:

Limestone deposits with their total resources are:

Sl. No	Location/Block	Resource in million tonnes
1	Longpotrop	14.175 (333)
2	Mimi-Pyakatsu	167.77 (332)
3	Mimi kheti	19.073 (334)
4	Thongsonyu	48.60 (334)
5	Salumi village	7.59 (333)
6	Kamku	9.11 (334)

3. Building material

Sl. No	Location	Rock type
1	Zaonger village	Spilite
2	Kiphire town	Sandstone
3	Changchor	Sandstone
4	Longkang	Sandstone
5	New Mongre	Sandstone
6	Old Seyochung	Sandstone
7	Kisetong	Sandstone
8	New Risethsi	Sandstone
9	Iponger	Granite

4. **Sand and gravel:**
   Sand and gravel are mined at Zunki River near Kiphire town.
5. **Brick plant**
   A mini brick plant is located below Tutheyo village.

7. Geo-morphological study of Dhansiri & Chathe River for sand, gravel/boulder mining in Dimapur district, Nagaland

Investigation was carried out along Dhansiri and Chathe River to determine the source of sand/gravel deposit, their impact on environment and other parameters required. The findings of the study are briefly described below: -

1. *Chathe River:*

   Chathe River originates from the hills area of Medziphema, passes through Chumukedima and Dimapur and joined Dhansiri. In fact, it is one of the main tributaries of Dhansiri River. Chathe river is covered by toposheet No 83 G/13,14 of Survey of India. About 10.6 km of Chathe River was investigated from Maova Village Bridge to Old Kukidolong Bridge. Investigation could not proceed further due to ongoing Four-lane road construction.

   Chathe River under investigation forms a part of the foothills region of the Naga Hills. Boulders and gravels are extracted from this river and used in civil construction, building construction, road construction. Bigger sizes are employed in retaining wall, fencing etc.

   The source of boulders and gravels are derived from disang, barial and dihing/recent formations where the river cuts through it. Accumulation of boulders and gravels takes many thousands of years.

   The width of the river varies from 30m to 80 m. At Maova village area, the stream had boulders of 2ft to 3ft square mixed with 1.5ft to 1 ft square and pebbles sizes. The consistency of boulder sizes gradually decreases as we go downstream.

2. *Dhansiri River:*

   Dhansiri River under investigation is covered by toposheet No 83(G)/9, 10 & 13 of the survey of India. 27.5 km length of the river from Dhansiripar town near railway overhead bridge to Full Nagarjan Bridge was investigated.

   Dhansiri River is the perennial river of Dimapur district of Nagaland. It originates from Laisang peak of Peren district of Nagaland. It flows through a distance of 352 km from south to North before joining Brahmaputra on its south bank. Its catchment area is 1220 square km, while flowing as the boundary between Karbi Anglong (Assam) and Nagaland.

   The area under study forms a part of foothill region of the Naga Hills. Since, it falls in the plain sector, the topography is not conspicuous and rather monotonous. Except for a few elevations in the Rangapahar areas, the rest is more or less of uniform elevation with gentle slope.

   Source of Deposition:

   Along the Dhansiri River and its flood plain, the soil is made fertile due to fluvial deposit made by the river. Therefore, it is well sorted in according with their size and specific gravity of their constituent grains.

During summer, when Dhansiri overflows its bank, deposit of silt and clay known as natural levees, are seen along the fringes of the flooded channels. When the flood recedes, we find well sorted deposit of sand especially in the inner curve of the river. Sufficient amount of sands is deposited in the river bed from the upstream and from the flooded plains of the river bank. Most of the sands sources are from Barail formation. The sediment of various sizes in mixed forms is predominantly deposited in the river bed.

Dhansiri Railway Bridge-

The area within the co-ordinate at N25°.47', 535" E 93° 37' 16.8 with elevation of 145 m amsl near the railway head bridge, the sand is being extracted from the river bed up to the depth of 1m and 20 m width with JCB since October 2020, minimum of 6 trips of dumper 10 wheels per day are being supplied to 4 lane construction site @ Rs 100-200 per trip by Sinplex Company without having any mining permit/licence. So many sand mining activities are going on most parts of the Dhansiri River.

Kiyeto Village Junction Area:

It lies within the co-ordinate of N25° 48', 01.6'' E93°37'52.3'' with the elevation of 139 m. amsl. The sand mining activities is ongoing since 2012. Stock yard also located near the main road sells sand @Rs. 300/- per 350 cft without any mining permit/license.

Bade Village area:

It lies within the co-ordinate N25°49', 06.7" E 93° 38', 32.7''. Huge amount of deposit of sand are found in these area having 1 to 2m thickness, 718m length and 40m width in some part. Sand is being mined in this area for the past 30 years.

Murise & Thsithrongse Village area:

It lies within the co-ordinate of N25° 50'41.2'' N93°42' 00.8''. Sand in extracted with pumping machines installed in some location on the Assam side, which is supplied to Nagaland. Few deposit of boulders are also seen on both side of the river just before Sangtamtilla area.

Sangtamtilla Area:

It lies within the co-ordinate of N 25°42'54.8' E 93°42'47.11''. Boulders ranging in size from 2" – 6" in size are extracted in this area near Logdrum School Sangtamtila. Gravels are also extracted from the river bed with heavy machineries in disorganized manner.

Thahekhu Village Area:

It lies within the co-ordinates of N25° 52', 01.3" E 93° 43'00.1'', sand mining activities with heavy machineries is being carried out in this area.

The Chathe and Dhansiri rivers are endowed with abundant boulders/gravel and sand deposit all along its river bed and banks. Unregulated and rampant sand and boulder mining have adverse impact on the environment. The collapse of a bridge in the recent past is due to uncontrolled/rampant/unscientific sand and gravel mining. The Government of Nagaland has already passed the "Minor Mineral Concession Rule 2004" which is already enforced. Most public and even Government Departments may not be aware of the Act, which is sidelined again due to the State enjoying special constitutional provision of Article 371 b. Therefore, it would be proper, if the "ACT" is

publicized through Govt. Machineries and media. Stakeholders should be advised to approach the concerned department for sand/gravel mining permit / license and for proper guidance of mineral extraction, so that environments are protected and sustainability of gravels/sand maintain.

II. GEO-ENGINEERING ACTIVITIES

1. Seismic Microzonation of Greater Dimapur City, Nagaland *(December 2020 - February 2021) - A collaborative program of the NEIST, Govt. of India, SDMA and DGM, Nagaland.*

Geological field activities, geotechnical investigations and geophysical investigation could not be carried out efficiently during the period under review due to the Covid-19 lockdown. The quantum of physical work carried out during December 2020 - February 2021 is given below as:

1. Boring carried out at 10 locations for collection of subsurface data upto 50 m depth so as to generate data on lithology and structure of the study area. A total of 1540 ft of boring was carried out in 10 locations involving litho-logging and sample collection for analysis. The boring locations are given below as:

Sl.No	Location	Depth (Ft)
1	Lengrijan	190
2	Burma Camp	180
3	Purana Bazaar	170
4	CRC, 2 1/2 mile	40
5	Toluvi	150
6	Burma Camp (Miya colony)	150
7	City College of Commerce	180
8	Kushiabil	150
9	Zani Village	160
10	LRC colony	170
Total		**1540**

2. Collection of soil samples from locations where boring could not be carried out. A total number of 75 samples both subsurface and surface samples has been collected. The samples have been sent to PWD laboratory, Dimapur for analysis results of which is awaited.
3. GPR profiling and Seismic site amplification was carried out by NEIST, Jorhat in all the 10 locations in February 2021.
4. Seismic ambient noise acquisition was conducted at 134 sites in greater Dimapur in several field sessions.
5. All the acquired seismic ambient noise data are processed, analyzed and site amplification ratio of each site with corresponding fundamental frequency estimated.
6. Estimated Seismic Vulnerability Index for greater Dimapur.
7. Prepared Seismic Site Amplification map, Fundamental Frequency map and Seismic Vulnerability Index map.

8. Conducted Ground Penetrating Radar (GPR) profiling covering the entire greater Dimapur. Total 57 Nos. of GPR profiling was done to understand the shallow subsurface geology. Processing and analysis of GPR data is in progress.
9. Recorded a few earthquakes using accelerographs installed at DGM office, Dimapur and estimated the strong ground motion parameters for the events.

Works to be completed:

1. Correlation of borewell data and integration of seismic data for preparation of final thematic map layers.
2. Analysis of all the thematic maps for appropriate weight value and integration in GIS platform along with seismic data.
3. Integration of seismic data, GPR data and litholog data of borewells is in progress.
4. Compilation of completion SMZ Project report.

2. Geological Investigation Landslides at Peraciezie, Kohima and Old KMC Damping Site (Dzuchie) along NH-29.

Sl. No	Particulars	Peraciezie Landslide	Old Dumping site/Dzuchie Landslide,
1	Location Co-ordinates	Latitudes N25°41'23.81" & Longitudes E94°05'49.60"	Latitudes N25°40'42.01"N to N25°41'24.35" N Longitudes E94°03'52.17" E to E94°04'23.17"E
2	Location Area	High School Colony, Kohima	Along NH-29 between Ms-175 and 176
3	Years of occurrence	2017	2018 & 2019
4	Damages	16 houses mostly Assam type removed, Colony road affected, Settlements at its periphery at risk	About 1 km length in NH-29 affected, 2 houses,1one four-grid post & power line removed, and I multi-storeyed building at risk and unlivable.
5	Affected Area	7 Acres	91.43 Acres
6	Types	Complex-Slumping+earthflow	Complex-Slumping+earthflow
7	State of Activity	Active in the form of subsidence by 2-$2^{1/2}$´	Active in the form of subsidence and minor slump
8	Pitting	2 Nos:18´depth;Water saturation at 3-8 ´	3 Nos: 28´ depth; Water wet after 12´
9	Trenching (LxWxD)	360´x 8´x 3´to 20´; Soil thickness 3´ to 15´	NA
10	Slope angle of failure	17˚ -23˚	26-28˚
11	Causative Factors	i) Water permeable material cover of weathered shale rocks and soil mantle ii) Dominant shale rocks with few meters units of sandy shale and thin sandstone beds iii) Synformal structure with axis gently plunging NNE opposite to slide direction. Its limbs dip 15° to 60° towards westerly or easterly. It is associated with minor folding and minor reverse	i) It falls in Disang-Barail Transition zone where water rich permeable Barail rocks overlain the impermeable Disang rocks. ii) Three litho-units - Shale-sandstone, Sandstone-shale and Shale with sandy lamination occurred dominated by shale unit. iii) Highly disturbed structurally when localized tight minor folding and few reverse faults trending NW-SE and dipping SW along with its lithological conditions control the hydrological conditions and stability

		faults iv) Lithological and structural conditions promotes hydrological condition n of shallow perched aquifers in the area. v) Capillary action raises the water saturation level in the soil where it is high or near surface even in dry season. vi) Anthropogenic activities of random construction of roads and houses in such unstable area vii)No proper surface drains.	of the area. iv) Random road earthworks and heavy traffics without any proper drains especially above and below the road. v) Lack of sub-surface data hinders proper geological condition of the area
12	Recommendation of Remedial measures	i) Proper geotechnical mitigation measures – both surface and sub-surface draining along with retention walls wherever necessary.	i. Detailed systematic investigation of the landslides in the area measures. ii. Proper draining of surface water and constructions vertical drains.

3. Installation of Subsurface Drain to control the movement of the landslides at Peraciezie, High School Colony, Kohima.

DGM, Nagaland has ventured to undertake installation of Subsurface Drain to arrest/control the landslide at Peraciezie, High Colony, Kohima which subsides few feet every year during rainy season. It is almost to monitor the effectiveness of this method of remedial measure in controlling this typical landslide type, common in Nagaland. The techniques and methodology adopted for the present work of sub-surface drain installation as:

Sl. No	Features	Details
1	Materials	1. Geo-textiles- Non-woven fabrics 2. Perforated PVC 6´´ 3. Infilling materials – stone chips 35mm to 75mm
2	Machineries	Excavator and Truck carriers (Hired)
4	Manpower	2 Skilled workers and 6 unskilled workers
3	Dimensions of Earthwork trench upto the depth of water saturated level	1. Length – 360 feet, 2. Width- 8 to 9 feet 3. Depth- 6 to 15feet
4	Dimensions of the actual sub-surface drains	1. Length -360 feet 2. Width – 2.5 to 4 ft 3. Depth – 4 to 6 ft The perforated PVC pipes and permeable infills/chips area wrapped by non-woven geo-textiles fabric
5	Backfill materials	1. The rest of the trenches above the sub-drains were backfilled by dug-out earth materials
6	Water Catch-Drain and Manholes	1. Water catch-drains are installed the two exit end of the of the sub-surface drain and is taped by the locals for household utility 2. One Manhole was installed on the left flank of the sub-drain where perforated is linked with

		non-perforated drain pipe.
7	Water Analysis result from both Right and Left flank of the Sub-surface drains	1. The iron content of the water from the left flank side and the potassium content from both Left and right flank of the sub-drain are above permissibility as per BIS for drinking water. 2. The other 14 parameters analyzed, are within permissible limit

- *Courtesy to Chemical Section, DGM, Nagaland for analyzing the water samples.*

4. Brief report on Geotechnical and landslide study along NH-2 Mokokchung-Amguri road section and NH-702D Mokokchung-Mariani road section, Mokokchung district.

Geotechnical and landslide study was carried out from Tuli to Mokokchung town along NH-2 part of toposheet no. 83 J/10 and 83 J/11 to investigate the occurrences of landslide at Merankong, Unger, Mongsenyemti and Minkong areas. The causes of the landslide are mainly due to anthropogenic agents caused by road cutting (for the two lane), stone quarry mining activities in the tectonic litho Contact.

Study was also carried out from Tzutapela Nagaland Gate to Mokokchung town along NH-702D where the occurrences of landslide at Changki, Chungtia and Mekuli areas in Toposheet no. 83J/7 were investigated.

Changki landslide is due to coal mining activities above and below road section. Road sinking and subsidence occur.

Chungtia landslide occurred due to stone mining activities above road section and toe erosion of nallah occurs below road section. Road sinking and subsidence occur.

Mekuli landslide is due to toe erosion of nallah below the road and link road construction. Road subsidence and sinking occur.

5. Brief report on Soil Stability test for Foundation study in urban areas of Chumukedima, Dimapur District.

Chumukedima town is a low lying area on the western side and high altitude area on the eastern side with elevation varying from 156 m to 213 m above mean sea level. Drainage pattern is parallel to sub-dendritic type and originate from hill slope and flows towards south west.

Geologically, the area consists of sandstone boulders, pebbles, clay, sandy silt, alluvium and terrace deposits. The eastern side consist of bedded sandstone, shale, siltstone and conglomerate of the Surma Formation. The rocks show the general trend of NE-SW. The Naga Thrust trending NE-SW cut across southern and south eastern part of the area.

Soil investigation and geological mapping was carried out on 1:10000 scale covering an area of about 8.6 sq.km. Pits of 1m X 1m X 2m were dug out for visual inspection of soil profile and stratum. 14 nos. of unconsolidated undrained soil samples were collected at specific locations and tested with tri-axial shear soil test for soil bearing / load bearing capacity.

6. Geo-environment impact assessment studies along Kohima-Dimapur route section (NH29) due to road cutting & widening.

Geological traverses and mapping along the new four lane road section (NH29) from Naga Hospital, Kohima to Chumukedima old check-gate were undertaken for preliminary appraisal of the geostratigraphy, geotechnical and geo-environment aspects with the help of tape and compass on 1:25,000 scale. The area under study is a part of the tertiary group of rocks where almost complete sequence is exposed along the road section. It may be pertinent to mention here that the repeated tectonic activities that were and are still active, are responsible for the highly disturbed rock formations prevalent in the area under study.

The area under investigation lies roughly between 25 37'30" N and 25 48'03" N latitudes and 94 04'40" E and 93 44'56" E longitude. The area of study along NH-39 from Naga Hospital, Kohima to Pherima falls under Kohima District and from Medziphema to Chumukedima lies under Dimapur District. It forms a part of India Toposheet Nos. 83 G/13 and 14 and 83 K/2. Traverses along NH-29 taking Dimapur as '0' point touches Chumukedima – 16 Km; Kukidolong – 23 Km; Ghaspani/ Medziphema – 30 Km; Pherima – 38 m; Piphema – 46 Km; and Kohima – 74 Km.

During the field work, apart from the normal geological investigation, geotechnical investigation was also attempted. The purpose of this investigation was to identify the landslide prone area along the NH-29 between Kohima and Chumukedima for future references and studies.

Four-lane NH-29 expansion has cleared away many present and paleo-landslide heads. Major landslide that occurs near Faith Theological Seminary in 2018-19, may re-activate again with onset of Monsoon. A building on the site of the highway has been badly affected. Paleo-slide zone is also notice between Essar petrol pump and Peducha village.

In some areas along the highway, manmade slides were generated due to cutting and scooping away of hills and blasting of rocks. Rocks slides especially along Pakala Pahar has disrupted traffics and many accidents had occurred with loss of life too.

The area understudy and the resultant reports cover only the road section along NH-29. Extensive coverage of the area may help in understanding the geology and geotechnical better. The Schuppen belt is another area that needs more attention. Almost all the oil bearing zone in the north east falls along this belt. As the north east falls under active earthquake zone (Zone 5), the Schuppen belt may be an indicator for signalling future impending catastrophe.

III. MINERAL DEVELOPMENT

1. Coal

Report on activities undertaken under Coal Policy Implementation:

The Department of Geology and Mining is implementing the Nagaland Coal Policy and Rules, 2006(First Amendment, 2014). For expeditious disposal of mining lease applications, the Mining Section of the Department of Geology and Mining is supervising, monitoring and administering the grant of Coal Prospecting License(CPL), Coal Mining Lease(CML), monitoring the mines and collecting coal royalty from the licensees, firms, coal operators, transporters etc.

During 2021-22, the following activities were carried out: -

(i) <u>Grant of Coal Prospecting License(CPL) and Coal Mining Lease(CML) :</u>

The Department has granted 13(thirteen) Coal Prospecting License(CPL) to private firms/individuals for coal exploration and prospecting works in Mon, Longleng, Mokokchung and Wokha Districts and 3(three) Coal Mining Lease (CML) for extraction of coal to individuals/firms granted 1(one) CML in Mon District and 2(two) CML in Mokokchung District.

(ii) <u>Revenue Outsource cum Coal depot license:</u>

The Department has outsourced coal royalty collection cum coal depot License to 6(six) firms namely; M/s. Nagaland Minerals and Mines, M/s. Apongsashi and M/s. Manshak Phom in Mokokchung District, M/s. Mosa Phom in Longleng District, M/s. Methlow Konyak and M/s. MCJ & Company in Mon District.

(iii)<u>Revenue Collection:</u>

The Department has generated revenue to the tune of Rs. 218.89 lakhs and credited the same to Govt. treasury from coal sector during 2020-21 fiscal year.

(iv)<u>Petroleum and Natural Gas:</u>

Petroleum and natural gas exploration and development is being regulated under the State own legal framework i.e, the Nagaland Petroleum and Natural Gas Regulations and Rules, 2012. The direction, regulation and control in relation to all operations of Nagaland Petroleum and Natural Gas is vested in a 3(three) level organizational structure namely; a group of ministers(GoM), Nagaland Petroleum and Natural Gas Board(NPNGB) and Operational Wing(OW). The Department of Geology and Mining extend technical and logistic supports as and when called for. Presently, all activities of P&NG in the State is under suspension as the matter is subjudiced. Meanwhile, the State Govt. is having discussion with the Central Govt. to resolve the issue on tax/royalty sharing basis.

2. Minor Minerals

Report on activities undertaken by Minor Mineral section:

The Department is implementing the Nagaland Minor Mineral Concession Rules (NMMCR) 2004, which was framed under Section 17 of the Nagaland (Ownership & Transfer of Land and its resources) Act, 1990 (Act 1 of 1993) under the special provision of Article 371-A in respect of Land and its resources of the State.

However, the regulatory mechanism (State legal framework) which is already in place could not be effectively implemented on the ground due to overlapping of jurisdiction with the Forest Department. Presently the Department is granting mining leases and mineral concessions to private firms/parties/individuals under the statutory provisions of the aforesaid Acts and Rules. The Department as an initial phase of implementation of the NMMCR, 2004 has started in Dimapur District. The Deputy Commissioner in his order has directed both the Forest and Geology & Mining Departments to collect mineral royalty on turn basis till the issue of overlapping of jurisdiction is resolved by the State Govt.

During 2020-21 the Department has carried out the following activities:

1. Royalty collection in all designated check gates and mines under Dimapur District and its adjoining areas.
2. Detail Study of Minor Mineral deposits and identification of stone quarries in the districts of Mon, Wokha, Longleng and Peren.
3. Grant of mineral concession and mining leases to various firms and agencies.
4. Prepared Sand mining and gravel management guidelines for effective control of illegal sand mining in the State.
5. Installation of CCTV in all designated check gates in Dimapur.
6. Field investigation on the extraction of boulders and sand-gravels was carried out along Chathe River. During the investigation, it was found that the concerned village councils are auctioning the mineral deposit areas to the private parties or firms on realization of royalty. As a result, the rampant extraction of boulders and sand-gravels are being carried out without following systematic and scientific method of mining plan. The village councils are collecting royalty at the source and Forest Department at the transit points. Since boulders and sand are being extracted and regulated by multiple departments such as; Forest, Local administration, police, village council etc. it is practically difficult to bring those illegal mines under the regulatory mechanism, unless the State government clearly authorize one department to regulate and monitor the mineral resource of the State. As per the study report, it was found that, once the boulders and sand mining extracted along Chathe and Dhansiri Rivers are brought under the regulation of Geology & Mining, it can control the illegal mining and generate a substantial amount of revenue to the State's exchequer.

IV. GROUNDWATER SECTION

1. Construction and development of tube wells.

One of the core objectives of Groundwater section is sustainable development of groundwater resources on scientific lines for long term planning and management. Basing on this, the Department regularly undertakes exploration of groundwater in the form of water tube wells to establish the hydrogeology of a particular area which includes lithologging, monitoring water levels and Pump test to determine the aquifer characteristics, largely in unexplored areas of the State. During 2020-2021, 12(Twelve) nos of exploratory tube wells and 2 nos of tube wells under deposit works have been successfully constructed, developed and handed over to user agencies.

Given in the table below are the list of wells constructed on exploratory and deposit basis during the financial year 2020-2021:

i. Detailed work carried out on *Exploratory basis* during 2020-2021.

Sl. No	District	Location of well	Depth of well (m)	Static water level (m)	Draw Down (m)	Discharge (lph)
1	Pherima Village	N25°46′33.6″ E93°54′56.4″	82.00	59.00	2.00	3000
2	DGM Office Complex	N25°54′20.47″ E93°41′46.16″	106.00	57.91	6.09	2772
3	Merangkong Town	N 26°36′33.7″ E94 °40′0.4″	100.00	68.42	7.62	1800
4	Church Colony Changtongya Town	N 26°32′2.71″ E94 °40′40.13″	94.48	68.88	10.36	1500
5	Imrongkumden's Residence, Changtongya Town	N26°32′10.95″ E94 °40′52.15″	57.00	25.10	0.06	3500
6	Imsuyanger's Residence, Sunrise Ward Changtongya	N26°32′2.52″ E94 °40′42.95″	67.00	46.02	2.10	2500
7	ABAM Centre, Impur	N26°23′22.80″ E94 °32′25.87″	45.72	18.28	4.50	3000
8	Imkongliba Memorial District Hospital Mokokchung Town	N26°19′22.05″ E94 °31′15.97″	64.08	42.21	6.70	2700
9	North Point Colony (Old Playground) Akuluto Town	N 26°10′43.4″ E 94°29′ 58.3″	46.00	5.40	10.00	3600
10	Nsunyu Village-1, Kohima		116	Abandoned due to caving		
11	Nsunyu Village (Tseminyu)	N25°58'47.7″ E94°14′15.7″	46.00	12.50	4.20	3200
12	Tseminyu Town, Ngvuphen village (Tourist Lodge)	N25°55'45.7″ E94°13′01.0″	49.00	20.80	3.60	3400

ii. Detailed work carried out on *Deposit basis* during 2020-2021:

Sl. No	District	Location of well	Depth of well (m)	Static water level (m)	Draw Down (m)	Discharge (lph)	Revenue
1	NIT Chumukedima, Dimapur (3rd Pilot hole)		137.16	Abandoned due to caving at the bottom			Nil
2	BIET Centre Akuluto	N 26°11′12″ E 94°29′ 57″	61.00	29.00	3.00	3200	` 44,469
3	Shri. Mughalu Residence, DC Hill, Zunheboto	N 26°00′36.6″ E 94°31′ 24.8″	61.00	38.30	0.00	3200	` 44,469
4	Akuluto Town near GHSS	Abandoned due to caving					` 45,683

Total Revenue generated = ` 1, 34, 621/-

(One Lakh Thirty Four Thousand Six Hundred Twenty One) only

Total meterage drilled (Sl. No. i & ii) = 1132.44

2. Feasibility Studies & site selection

Hydrogeological investigation and site selection for construction of tube wells as per the demand of the user agencies is being continuously carried out by the Department.

3. Periodic water level monitoring from national hydrographic network stations (NHNS) in Nagaland.

Collection of water level data from NHNS covering Dimapur, Peren, Kohima, Wokha, Mokokchung, Tuensang and Mon districts in Nagaland is a continuous field item since 1999, a collaborative work with CGWB NER Guwahati. Monitoring of wells is done periodically four times a year in the month of Jan, March, August and Nov. There are presently 33 monitoring stations set up by CGWB and DGM within the state. The data so collected is being sent to CGWB NER Guwahati periodically.

In addition to NHNS, there are 9 monitoring stations in the state covering Dimapur, Kohima, Wokha and Mon districts for monthly collection of water level data which are also sent to CGWB NER Guwahati.

4. Groundwater Quality studies of streams and wells for Agricultural and Industrial waste contamination in Peren, Dimapur and Wokha districts.

Collection of GW Samples and selection of stations for periodic monitoring were carried out at foothill areas of Peren, Wokha & Dimapur districts. Accordingly, samples from Ponds, Wells and Streams were collected and analyzed from the Chemical lab of the Department.

Observation from the analyzed GW samples indicated no immediate hazard of contaminants from agriculture activities with use of pesticides, fungicides or other chemicals etc., as no traces of lead, nitrate, copper, chlorine, mercury, etc.

However, in Peren & Wokha districts, most of the samples has Pottasium (K) more than the permissible limit which is 10mg/l and few cases of Sodium (Na) and Iron (Fe) which are slightly above the permissible limit. In Dimapur district, the

samples were collected from Streams and rivers. One characteristic of Dhansiri river water samples collected from Burma camp area indicates high presence of Iron (Fe) ranging between .30 mg/l to 1.88 mg/l, high content of Pottasium (K) ranging from 16.95 mg/l to 49.33 mg/l; presence of Flouride (F) upto 1.82 mg/l is also observed near Burma Camp, Sunrise colony which is attributed to the sewage from municipal dumping.

It is also observed that most of the ring wells and bore wells in Dimapur valley has Iron content above 0.3 mg/l, which can be easily treated by traditional, sand, charcoal and gravel based filtration method to make it potable.

5. Survey of Geological potentiality and geomorphic setting of Baghty valley

Baghty valley represents an intermontane valley covering an area of approx. 30 sq.km, lies between 26°14′3.00″ & 26°17′ 51.00″ latitudes and 94°09′40.00″ & 94°14′ 5.00″ longitudes with an elevation of about 300m amsl, consists of four administrative units viz Baghty town, Soku village, Makharong village and upper Baghty village under Wokha district. As per 2011 census, the total population stood at 2697.

The western part of the valley is marked by denudational low lying hills dominated by surma sandstones, the central part is mainly depositional in nature with the formation of alluvial fans type deposits characterized by occurrence of boulder beds at its upper reaches and alluvial clay deposits at its lower part where terrace cultivation is mostly done. The valley is dissected by tributaries of Baghty River which flows southwest parallel to the Doyang River and ultimately confluence together at the foothills.

The eastern fringe of the valley is demarcated by high rise Tipam sandstone trending north-south direction and dipping eastward with elevation reaching to a height of more than 900m amsl. Rat hole Coal mining activity is observed along its foothills, west of Yunchucho village. Analysis reports of water samples collected in streams adjacent to coal mine shows high acidity with very low ph value, high Ca, Fe, Mn, Na & K content clearly indicating contamination of the tributaries of Baghty river by the mining activity.

Much of the valley area is covered by shrubs in addition to plantations of rubber, areca nut, lichi, coconut, etc, in patches.

Hydrogeologically, Baghty valley is a marshy area where the groundwater table is at the surface and groundwater development is almost negligible. Foul smell of water in dug/ring wells has been reported by the residents which may attributed to contamination of groundwater by rotting vegetation. Analysis of Water samples collected from dug wells shows high levels of K (37.84 mg/l) and Fe (3.71mg/l). Drinking Water supply in the valley is mainly tapped and piped from streams originating in the surrounding hills, east of the valley.

6. Identification of Flood prone areas for mitigation measures.

The area in and around Dimapur city is vulnerable to natural disaster such as flood and extreme temperature due to its geographic location and topography. In the recent years the area has witnessed floods at unprecedented level, leaving many families homeless, damaging agriculture land, and disrupting the normal activities of the

people to a large extent. The objective of the study is to identify such locations in and around Dimapur town that are vulnerable to flooding and to suggest remedial measures for disaster risk reduction.

The study shows that generally flood-prone areas are distributed in low land, around major river flows both in the middle and downstream of rivers, and generally in areas with extensive settlements and agricultural land. Overflowing of Dhansiri River and Chathe River due to incessant rainfall during monsoon is one of the major factor of inundation in most of the low lying areas along the river. Poor artificial drainage system and lack of regulation for infrastructure development are some of the factors causing inundation in densely populated urban areas. Human activities like unregulated sand mining alters the river bed, forcing the river to change its course and erode banks is also one of the factors contributing to flooding during monsoon. In urban areas, rapid and unplanned urbanization without any regulations have led to encroachment and disappearance of water bodies and water carrying channels. Ideally, natural drains should have been widened to accommodate the higher flows of storm water. But, on the contrary, there have been large scale encroachments on the natural drains and the river flood plains. Consequently, the capacity of natural drains has decreased, resulting in flooding.

Pic: A view of Dhansiri River. Overflowing of Dhansiri River during monsoon is one of major cause of inundation in low lying areas.

Pic: Unregulated sand mining altering river course and eroding banks causing flooding in low lying areas.

Some of the identified areas vulnerable to flooding and which has been affected by flood in the recent years are Toulazoma, Sangtamtilla, Bade, Tsithrongse Village; Selouphe Village, Naharbari, Darogajan, Purana Bazar Model Colony, Khushiabil, Thahekhu Village block – 7. Urban areas such as Namgailong (Burma Camp), Supermarket area, Dhobinalla, Zeliangrong colony are also susceptible to flooding during intense rainfall due to poor artificial drainage.

Floods are natural phenomenon and one cannot entirely get rid of them but their impact can be minimized with preventive measures adopted by the government and stakeholders and with the use of human's technological and engineering skill. Some of the flood mitigation measures that could be adopted to mitigate the adverse impacts of severe floods and to prevent normal floods are: -

i. Flood walls: The construction of floodwalls and embankments has been the traditional means of protecting low lying communities and infrastructure against flooding. Steel & concrete flood walls may be constructed at identified vulnerable areas in order to control the flow of flood waters and prevent the flooding.
ii. Levees: Levees can be constructed with the use of material such as earth and stone in order to prevent the flooding from a free flowing body of water.
iii. Reducing Bed Roughness and Altering Stream Channels wherever necessary: Smoothening and reducing the river bed's roughness allows the river to flow faster reduces the likelihood of a flood.
iv. Proper urban planning, Land use planning and Zoning: Local municipalities or authorities should come up with strict laws or guidelines in order to regulate development of residential and commercial properties in high risk flood prone areas. This planning can further restrict where buildings can be constructed, as well as if these buildings must be flood-proofed.
v. Floodplain mapping using GIS and participatory approach: A comprehensive Flood mapping using GIS tools and community participation is crucial to flood risk management and risk reduction
vi. Creating Awareness: Flood risk management cannot be treated in isolation, rather it should be a part of community development. It is therefore essential to build a community's capacity to understand their vulnerabilities, strategies, activities and the role they could play in managing flood risks without relying on external entities.

Pics: Clogged drains, absences of proper drainage system, encroachment of natural drainage and water bodies is contributing to inundation in urban areas.

V. CHEMICAL LABORATORY

1. Water Sample Analysis:

A total of 298 samples were analyzed in the DGM Chemical Laboratory during the period. A brief account of the sample analyzed is stated below: -

i. Water collected by the DGM Chemical Laboratory from in and around Dimapur for quality test = 211 samples.
Out of the 211 samples, the following parameters were detected which is above the permissibility as per Bureau of Indian Standard for drinking water.

a) Iron = 77 samples
b) Fluoride = 9 samples
c) Manganese = 56 samples

ii. Water samples received from DGM field officers for quality test= 86 samples.
The following parameters were detected which is above the permissibility limit of the Bureau of Indian Standard for drinking water.

a) Iron = 20 samples
b) Manganese= 32 samples

iii. Water samples received from private parties = 1 sample.

a) Presence of Iron which is above the permissibility of Bureau of Indian Standard for drinking water was detected.

2. Limestone sample analysis:

The Laboratory received 3 (three) limestone samples from DGM field officer during the period.

The content of CaO (Calcium Oxide) and MgO (Magnesium Oxide) in the samples analyzed is given below:

a) Sample I - CaO= 50.96%, MgO = 0.8%
b) Sample II - CaO= 55.44%. MgO = 1.2%
c) Sample III - CaO= 54.32%. MgO= 5.2 %

3. Coal sample analysis:

5 samples of Coal (from Nagaland) were received and analyzed in the Laboratory during the period.

Out of the 5 samples, 1 (one) sample was found to be of Lignite quality and the remaining 4(four) samples were found to be of Bituminous quality.

4. Other Samples:

2 (two) quartz samples were received for silica test. The content of SiO2 was found to be 53%.