BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

Appeal No. 23 of 2016

In the matter of:
Dr. Vijay Verma ... Appellant

Versus

Uttrakhand Forest Development Corporation & Ors. ... Respondents

INDEX

N.D.O.H.: 19.11.2018

FILED BY:

SANJAY KATYAL
Advocate for the Respondent No. 4
A-53, Ashok Vihar Phase-III,
Delhi-110052
Mob. 9350023553

New Delhi
Dated: 16.11.2018

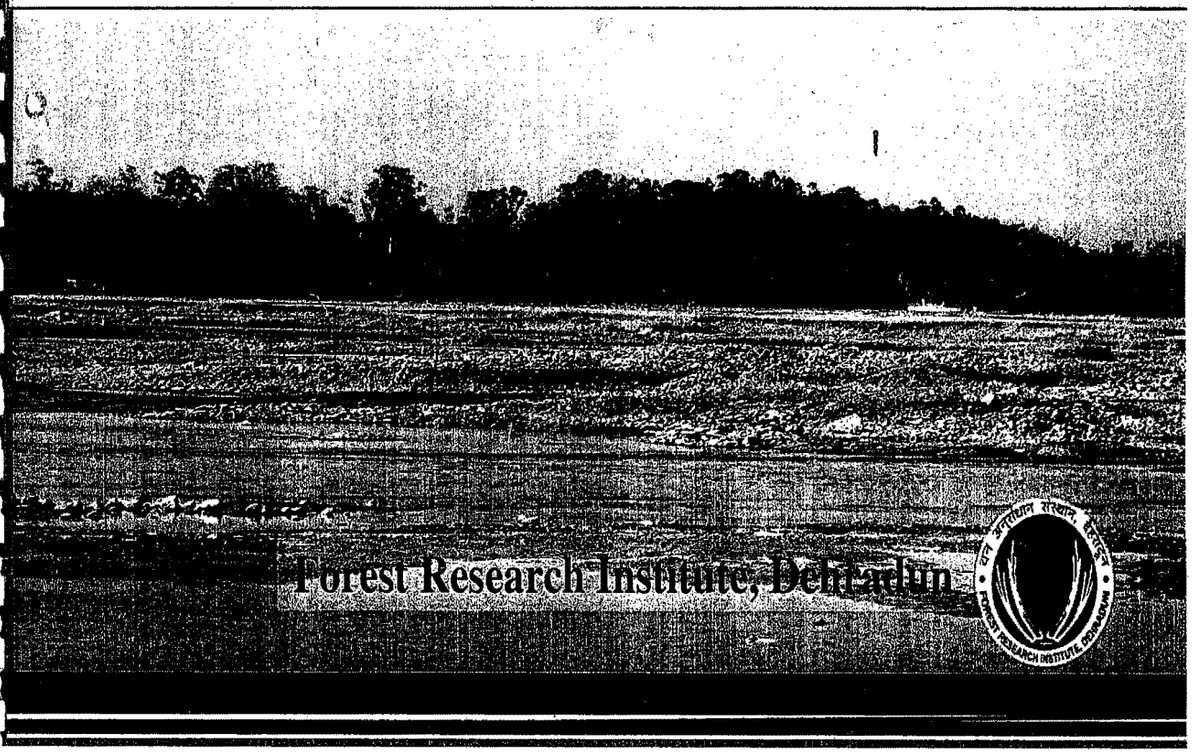
461

Interim Report on Deposition of River Bed Material

(Study conducted in 2018)

Under the project

REPLENISHMENT STUDY OF RIVERBED MATERIAL FOR GANGA RIVER AND ITS TRIBUTARIES



Forest Research Institute, Dehradun

462

GENERAL INFORMATION

1.	**Project Title**	:	Replenishment study of river bed material for Ganga river and its tributaries
2.	**Name of the Institute**	:	Forest Research Institute, Dehradun
3.	**Project Adviser**	:	Dr Savita, *IFS*, Director, Forest Research Institute, Dehradun
4.	**Project Coordinator**	:	Dr Parmanand Kumar, Scientist- C, FRI, Dehradun
5.	**Team Members**	:	Mr. N. Bala, Scientist-F, FRI, Dehradun Dr Mridula Negi, Scientist-D, FRI, Dehradun Dr Tara Chand, Scientist-D, FRI, Dehradun Shri Rajesh Bhandari, Scientist-F, FRI, Dehradun Shri R. S. Topwal, Scientist-E, FRI, Dehradun Dr Hukum Singh, Scientist-B, FRI, Dehradun Mr. S.K. Kamboj, Senior Technical Officer, FRI, Dehradun Mr. Arun Kandwal, Technical Officer, FRI, Dehradun
6.	**External Expert**	:	Dr Rajeev Tiwari, *IFS*, Secretary, ICFRE, Dehradun Mr. Raman Nautiyal, Head & Scientist- E, Division of Forestry Statistics, ICFRE, Dehradun Dr Sumit Sen, Department of Hydrology, IIT Roorkee
7.	**Duration**	:	3 years (initiation of the project)*
8.	**Total Cost (Rs.)**	:	62.18 lakhs
12.	**Address**	:	Forest Ecology & Climate Change Division, Forest Research Institute, P.O. New Forest, Dehradun- 246008 Email : pkumar@icfre.org Phone : 0135-2224482

**However under unavoidable circumstances such as erratic monsoon (drought or flood), when data is not justifiable the project may be extended for consecutive one or two years with extra cost if required.*

1. Background

In Appeal No. 23 of 2016 and 49 of 2016 in the matter of Dr. Vijay Verma vs Uttarakhand Forest Development Corporation & Ors., the Hon'ble NGT restrained the mining activity on seven rivers viz. Bishanpur, Bhogpur, Chidiyapur, Kotwali, Rawasan I, Rawasan II and Shyampur for which Environment clearances were granted to UFDC. The Hon'ble NGT observed that the previous reports provide insufficient insight on whether mining can be allowed to continue or not because the data of the River Bed Material given was based on one time data collection. Also, The Hon'ble NGT directed Forest Research Institute on 26-02-2018 to conduct the replenishment study for the seven rivers and restrained the mining licenses till the study report is received.

In compliance with the NGT order dated on 26-02-2018, Forest Research Institute submitted a proposal to UFDC for carrying out Replenishment Study of River Bed Material in River Ganga and its tributaries ~~study~~ which was approved on 21st June 2018. It was proposed to study the replenishment of RBM for three years. This report being submitted includes the study of deposition for the first year for three rivers i.e. Kotawali, Rawasan-I, and Rawasan-II. In remaining four rivers, it was not possible to conduct study at present as the rivers were flooded after monsoon. The study in these rivers will be conducted once the water recedes and conditions become favorable to conduct it.

2. Introduction

The state of Uttarakhand has great importance in the local, regional, national and international perspectives due to its distinct physiographic conditions i.e. Himalayas, Shivalik and planes having altitudinal variation ranging from 300 to 3500 meters. It is endowed with diverse vegetation types, ranging from tropical to subtropical, temperate and alpine including riverine, grasslands and wetlands. The state has 64.79% of its total geographical area as forest area against India's forest and tree cover of 23.4% of the total geographical area. Many rivers originate from Himalayan and Shivalik regions which supply water in down streams. The greatest sediment yields are generally associated with rivers draining areas of intensive tectonic activity therefore,

Himalayan rivers causes' tremendous erosion and carries large amount of sediment. The sediment load of a river commonly considered to be a pollutant that is aesthetically displeasing and environmentally degrading. Sediment load can be divided into bed load and suspended load based on the mode of transport. Bed load is transported close to the bed where particles move by rolling, sliding, or jumping (Adegbola, 2012). Xlaoqing (2003) explained that bed load transport in natural rivers is a complicated phenomenon. Its movement is quite uneven in both the transverse and longitudinal directions, which varies considerably. Some sediment particles roll or slide along the bed intermittently and some others saltate (hopping or bouncing along the bed). The material transported in one or both of these modes is called 'bed load' (Figure 1). Finer particles (with low fall velocities) are entrained in suspension by the fluid turbulence and transported along the channel in suspension. This mode of transport is called 'suspended load'. Sometimes finer particles from upland catchment (sizes which are not present in the bed material), called 'wash load', are also transported in suspension. The combined bed material and wash load is called 'total load'. A summary of mode of sediment transport is given in Figure 1&2 (Nalluri & Featherstone, 2001). Bed load ranges from a few percent of total load in lowland rivers to perhaps 15% in Mountain Rivers to over 60% in some arid catchments. Although a relatively small part of the total sediment load, the arrangement of bed load sediment constitutes the architecture of sand bed and gravel-bed channels. The rate of sediment transport typically increases as a power function of flow; that is, a doubling of flow typically produces more than a doubling in sediment transport and most sediment transport occurs during floods (Kondolf, 1997).

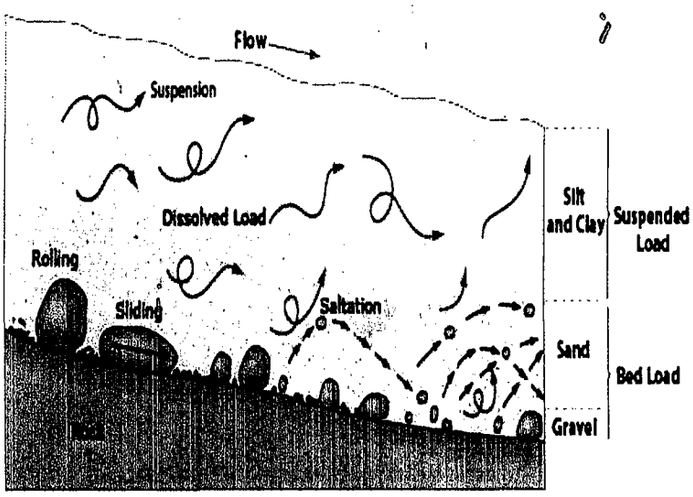


Figure 1: Sediment Load in Rivers

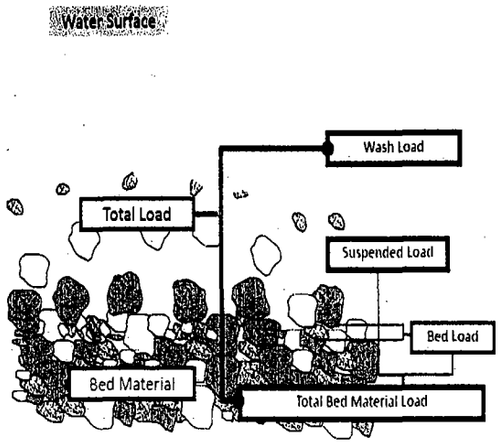


Figure 2. Pattern of Sediment Transport in River

2.1 Significance of study:

Sediment load (sand and gravel) in the river water as valuable natural resource for use, by the society. The potential usefulness of the sediment is enhanced when it is composed of different particle sizes, found in deposits on the riverbed (Figure 2). Replenishment of river bed material takes place is the deposition of the sediments of different size carried by the stream. Many factors such as topography, soil type, bedrock type, climate and vegetation cover influence input, output and transport of sediment and water in a drainage basin (Charlton, 2008). Sediment transport knowledge is important in river restoration, ecosystem protection, navigation, watershed studies and reservoir management. These factors also influence the natural pattern and carrying capacity of water bodies (Twidale, 2004). Di-siltation (removal of excess sand and

stone from river bed) of the river helps to maintain the carrying capacity and provides protection from flooding during monsoon season. However, in the subsequent rainy season grain/particle size distribution analysis of bed load samples must be done to define the size composition of the material in transit.

The purpose of carrying out this study is to understand the behavior and quantity of deposition in the River Ganga and its tributaries. In these rivers river bed material extraction activities have been carried out. In this scenario it is important to study the replenishable material and amount of deposition taking place before and after monsoon. This study will help in determining the deposition at the mining sites and also the extent of extractable amount of river bed material from the river if any. Further, continuous flow of river is essential for ecological and economical needs such as irrigation and biodiversity etc. Therefore, replenishment study of the river helps to understand potential carrying capacity of water during monsoon season.

2.2 General Description:

The study was undertaken to investigate the quality and quantity of river bed material in 7 different rivers distributed in Haridwar district of Uttarakhand (Figure 3). These rivers are tributaries of River Ganga (i.e. ***Kotawali, Rawasan-I, Rawasan-II, Ganga Shyampur, Ganga Chiryapur, Ganga Bisanpur and Ganga Bhogpur***) which confluence in Ganga at Haridwar. The overall catchment area of the study site is 2281.34sq km with a perimeter of 201.196 km. The catchment consists of both plains and steep slopes which vary up to 66 degrees (Figure 4). The elevation range of the catchment is from 182 m to 2232 m. Geographically, the area lies in between 78° 1'00" E to 78° 29'30" E longitude and 30° 18'13" N to 29° 41'00" N latitude. The geomorphological patterns such as stream orders were delineated using ArcGIS tool. The area poses streams with the six level of stream order (Figure 5).

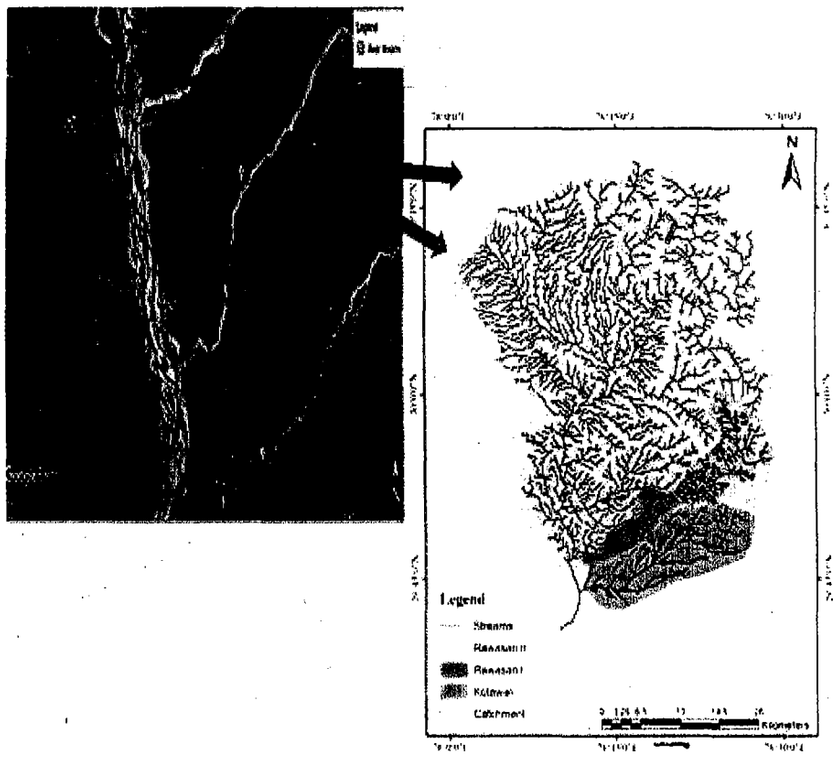


Figure 3 Drainage network of the catchment area of Ganga River and its tributaries

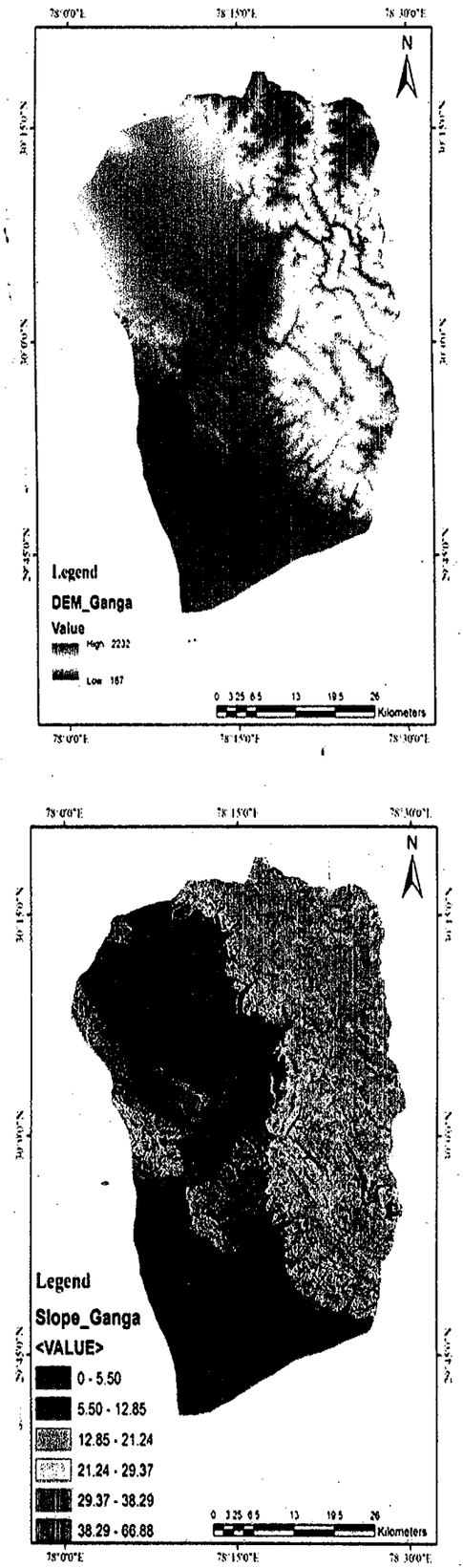


Figure 4 Slope and DEM of catchment area of Ganga and its tributaries

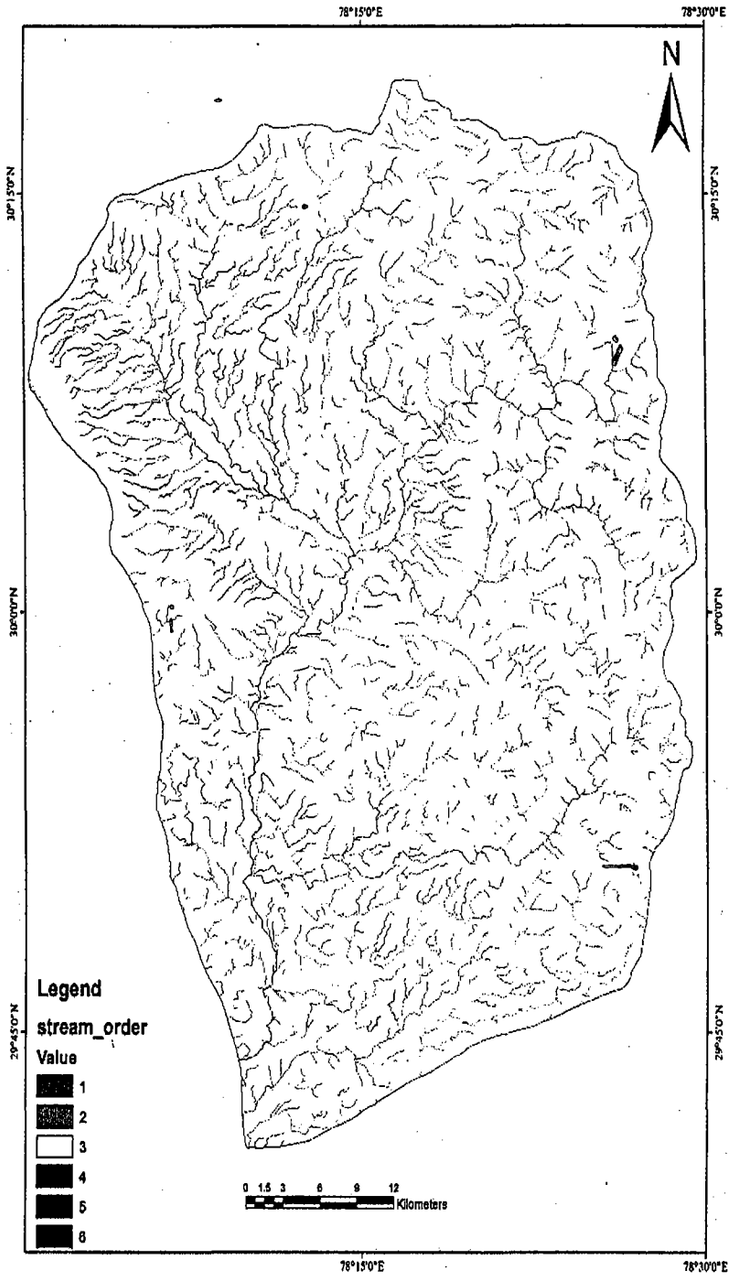


Figure 5 Stream order in the catchment area of River Ganga and its Tributaries

3. Study site:

3.1 Kotawali

The Kotawali River, a tributary of Ganga River comes under Haridwar Forest Division. The basin length is 27.30 km. Geographically, the River lies between 78° 11.5' 30"E and 78° 20'00"E longitude and 29° 52'30"N to 29° 46.5' 00" N latitude. The overall catchment area of the Kotawali River is 207.96 sq. km and perimeter is 65.51km (Figure 6). The catchment consists of both plains and steep slopes up to 66 degrees. The elevation range of the catchment is from 187m to 2232m above msl. The area posesses streams upto the fourth level of stream orders. The stretch of mining area is 1.68km (Figure7) in the tributary.

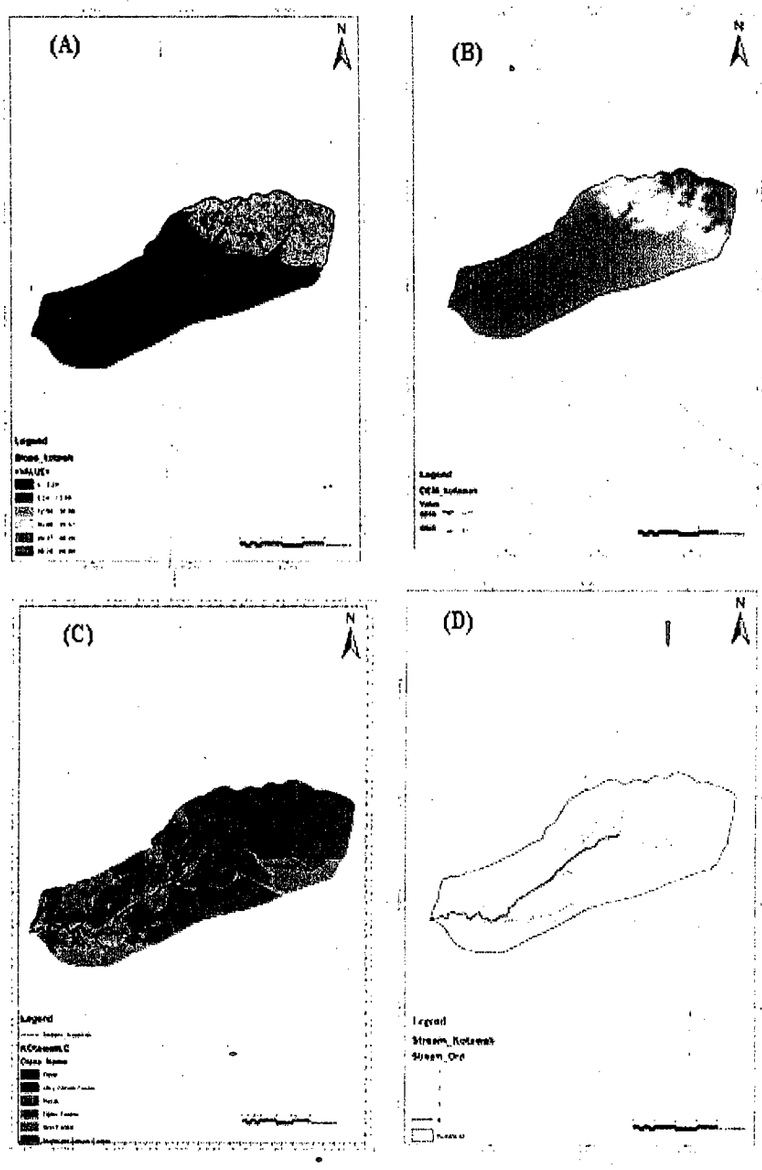


Figure 6 A) Slope map B) DEM C) Land Cover D) Stream order of river Kotawali

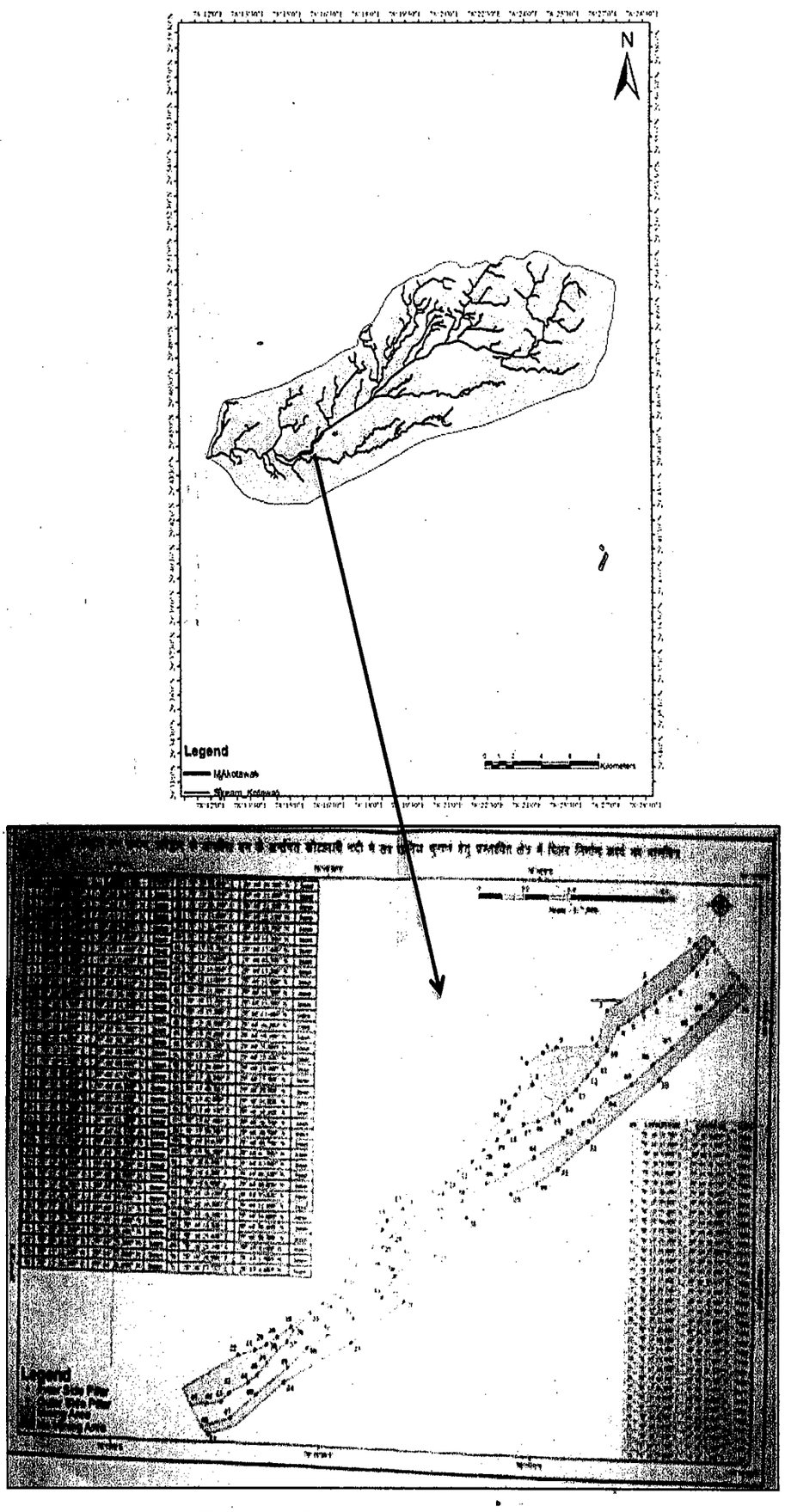


Figure 7. Mining area of Kotawali River

3.2 River Rawasan-I

The Rawasan-I River, a tributary of Ganga River flows through Haridwar Forest Division. The basin length is 15.07 km. Geographically, the River lies between 78° 12' 30"E and 78° 20'00"E longitude and 29° 52'30"N to 29° 46.5' 00" N latitude. The overall catchment area of the Kotawali river is 20.44 sq. km and perimeter is 24.86 km (Figure 8). The catchment consists of both plains and steep slopes up to 21.82 degrees. The elevation range of the catchment is from 214m to 325m above msl. The area posesses streams upto the fourth level of stream orders. The stretch of mining area is 4.15km (Figure 9) in the tributary.

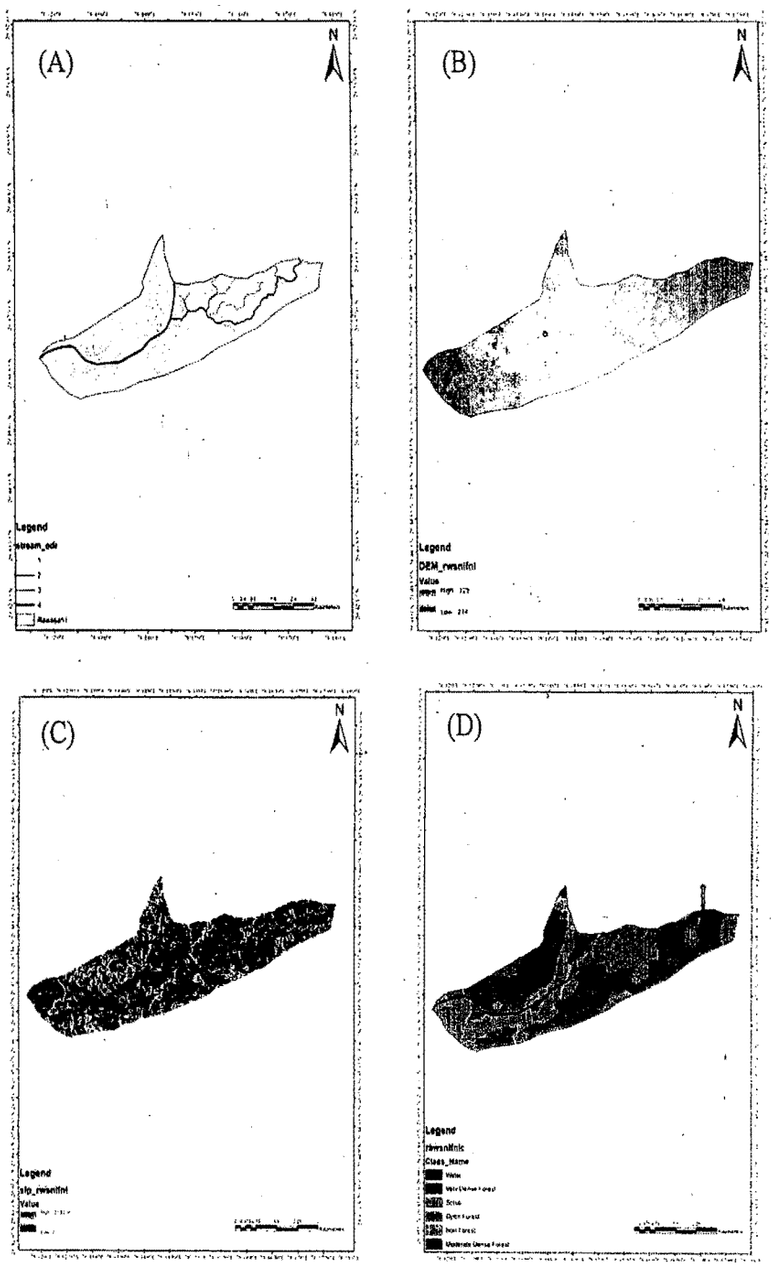


Figure 8. A) Stream Order (B) DEM (C) Slope map (D) Land of RawasanI River

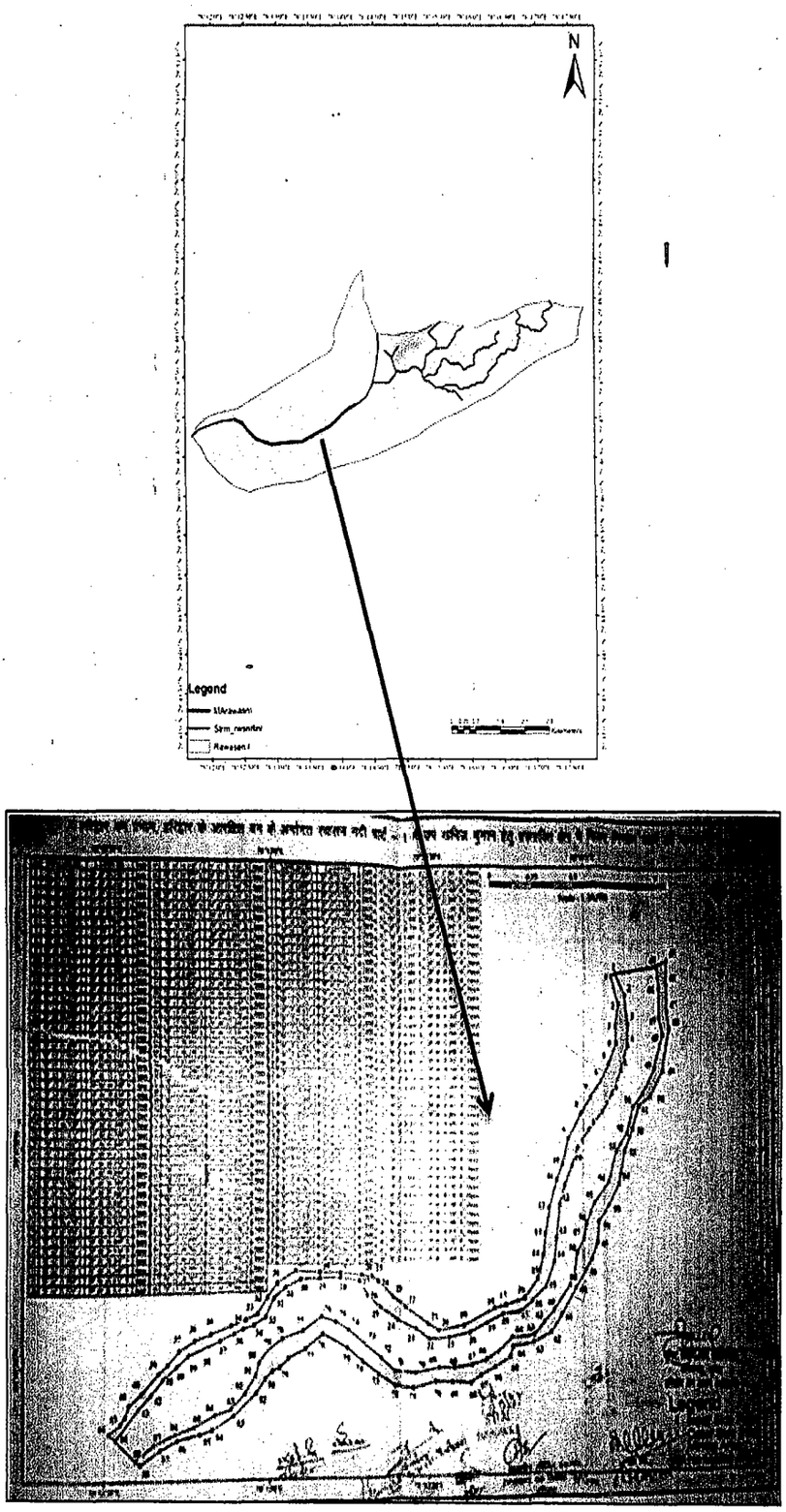


Figure 9. Mining Area of Rawasan-II river

3.3 River Rawasan-II

The Rawasan-II River, a tributary of Ganga River flows through Haridwar Forest Division. The basin length is 18.18 km. Geographically, the River lies between 78° 14' 37"E and 78° 16'31"E longitude and 29° 48' 37"N to 29° 49' 34" N latitude. The overall catchment area of the Kotawali river is 192.53 sq. km and perimeter is 82.91 km (Figure 10). The catchment consists of both plains and steep slopes up to 61degrees. The elevation range of the catchment is from 269m to 1707m above msl. The area posesses streams upto the fourth level of stream orders. The stretch of mining area is 3.35km (Figure 11) in the tributary.

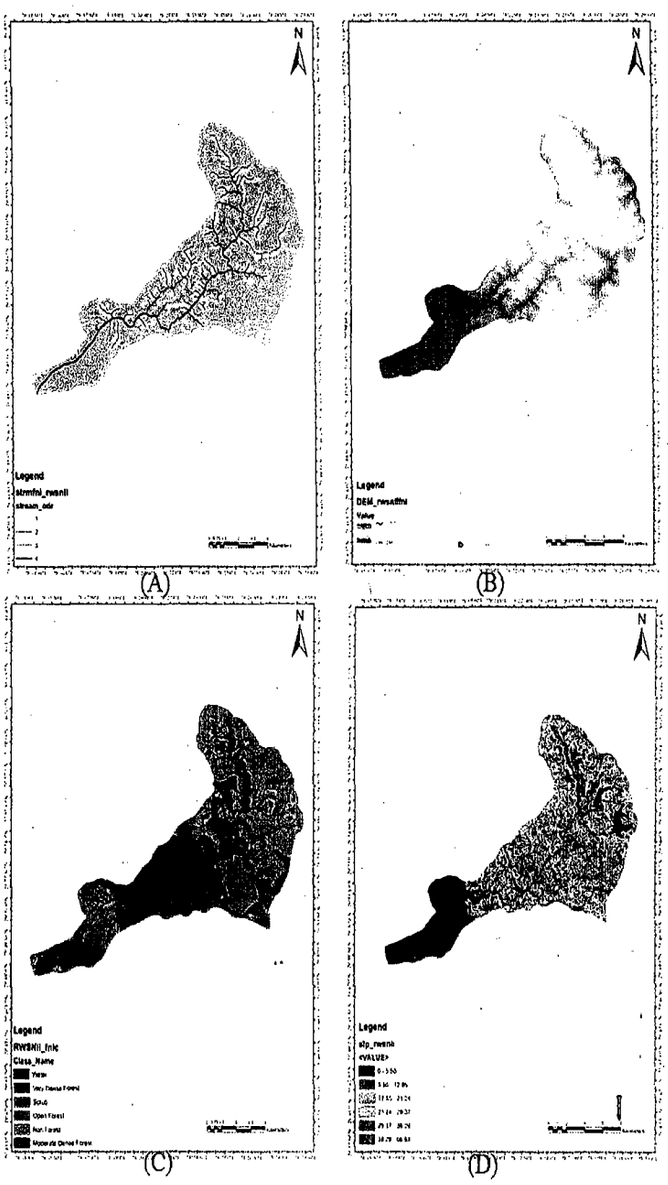


Figure 10. A) Stream Order (B) DEM (C) Land cover (D) Slope map of Rawasan-I River

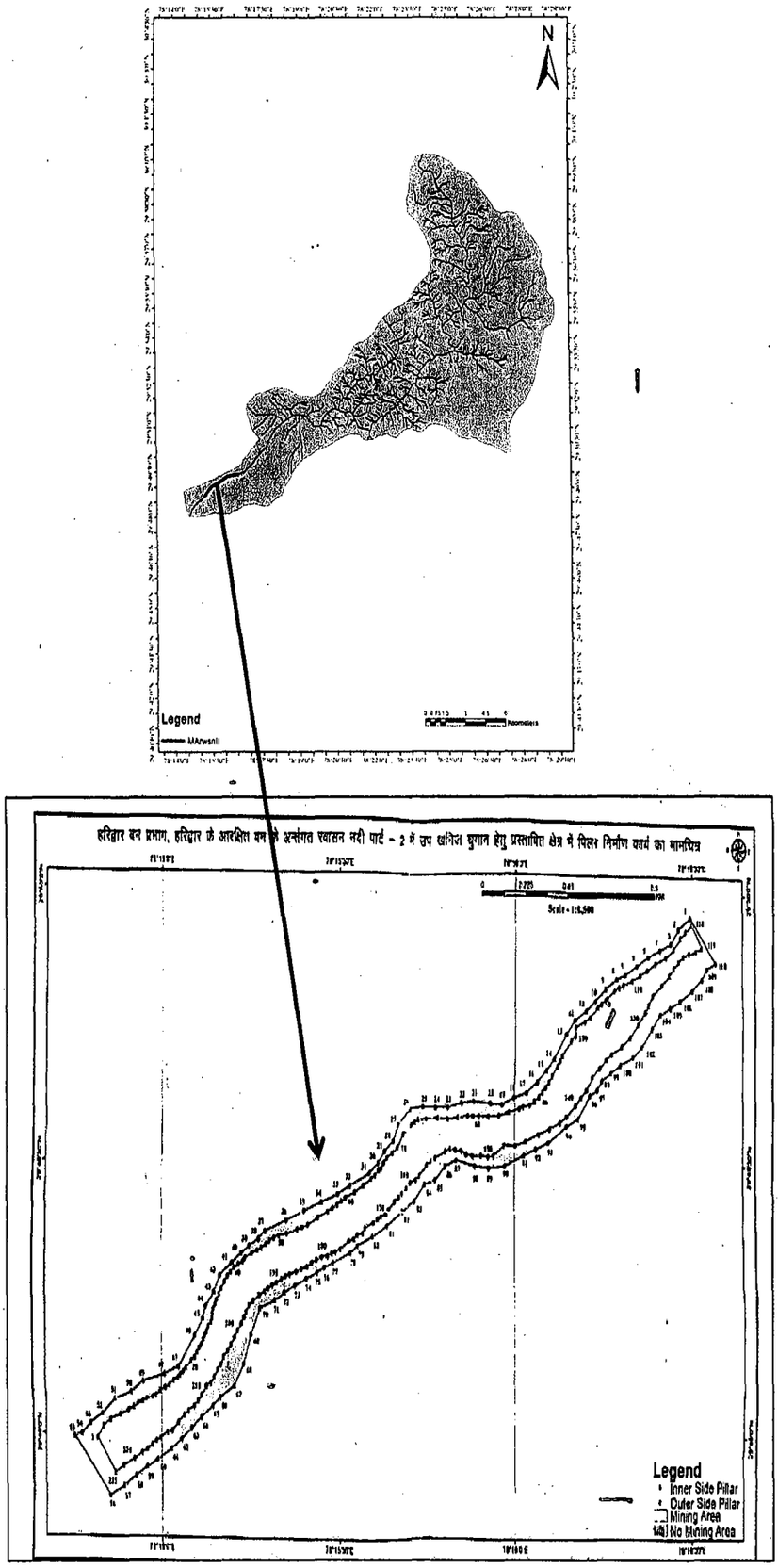


Figure11. Mining Area of Rawasan-II River

4. Activities:

The river usually transform to wide river and transport high sediment and bed load during high flow events in the monsoon season after reaching a plane drainage course. Quantification and estimation of River Bed Material (RBM) to establish safe limit for extraction/ removal of deposited (RBM) available in the selected rivers was carried out by adotping two pronged scientific approach *viz., mapping of watersheds by using ArcGIS software, grain size distribution* and survey using total station at the river beds for estimating the total deposition in the river and understanding grain size distribution of River Bed Material. The river bed material was measured during pre/post monsoon. Overall, the major and minor components of this study which will lead to estimate deposition of RBM generated on the river bed are mentioned below (Table 1, Figure 12). The activities carried out for conducting the study are morphometric analysis, grain size distribution study and analysis of deposition of RBM before and after monsoon.

Table 1: Component of study

Major component	Study of deposition in river stream annually
Minor component	Mapping of catchment area
	Study of morphological parameters of the river
	Study of grain size distribution
	Meteorological data acquisition

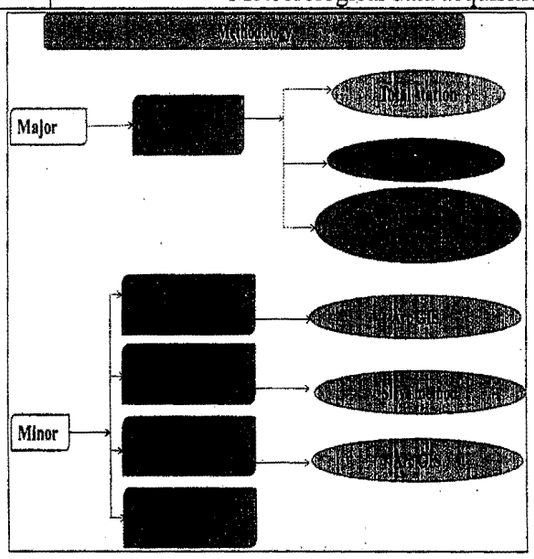


Figure 12. Schematic diagram showing methodology

4.1 Morphometric Analysis

The catchment area of the river is estimated by using spatial analysis tool of ArcGIS 10.3software for the river Rawasan-I, Rawasan-II and Kotawali. The total catchment area of the river, its stream order, morphological parameters are quantified using tool kit of ArcGIS software 10.3 as well as by adopting conventional ground-based survey. The geometric as well as morphometric parameters such as area, perimeter, length, mean width, length area relation, form factor ratio, elongation ratio, stream frequency, drainage density, drainage intensity etc. were determined using ArcGIS tool by adopting the suggested methods. The forest density cover in the study area has been mapped using the satellite imagery of the study river catchments. The method for identifying very dense, moderately dense, and other density covers have been delineated by following the methods suggested by Forest Survey on India (FSI).

4.2 Grain size distribution

The analysis of grain size distribution of RBM was carried out with an objective to analyze the distribution of grains of various size in the sediment deposited in the river streams. The estimation of distribution of grain size in river bed material (RBM) in the selected river was carried out by pit digging (Table 2) and sampling the river stretch for analyzing grain size distribution. Pits with size of 2m × 1m × 1m (Figure 13) per segment were made at different intervals within cross sections throughout the stretch of the river. The sampling depth (1m) is further divided into two profiles *i.e.*0-50 cm (above 50 cm) and 50-100 cm (below 50 cm). The analysis of RBM was carried out to estimate different grain size distribution in sediment deposition. The profiles (0-50 cm and 50-100 cm) were selected to minimize the distribution errors for grain size and remove the biasness between upper and lower depth of RBM. The sampled RBM from each depth was weighed in iron bucket by using field balance. After that,the weighed material was filtered through various grades of sieves (<2mm, 2-5mm, 5-10mm, 10-20mm, 20-25mm and >50mm). Again, the screened material of each size of RBM was weighed and actual RBM fractions percentage was calculated.

Table 2 Number of cross sections and total number of pits

Sr. No.	Mining Site	No. of Cross Section	Total No. of Pits
1.	Kotawali	3	10

2.	Rawasan-I	5	17
3.	Rawasan-II	5	15

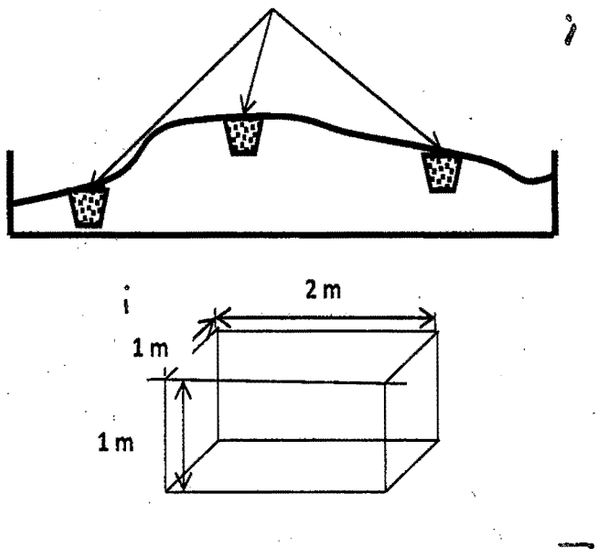


Figure 13. Sampling pits for study of grain size distribution

4.3 Deposition of RBM

In the present study, amount of deposition in the river during the rainy season has been calculated by surveying the river bed using Total Station. Total Station was used for both seasonal and perennial rivers. Also, already installed pillars (Figure 14) were utilized for analyzing the difference in deposition in the river bed material before and after rainy season. Topographical survey of the mining area was carried out along the Ganga River and its tributary i.e. Kotawali, Rawasan-I, Rawasan II in Haridwar District, Uttarakhand.

While carrying out the topographical field survey following are the major activities which were undertaken:

a) Identifying and establishing the benchmarks
b) Collection of Ground Control points
c) Plotting of the field Data – Contouring
d) Preparation of River cross sections

a) Identifying the benchmarks

The nearest GTS benchmark has been taken near the project site and is the starting point. The location and values of all the GTS benchmarks are given in GTS booklets and maps published by Survey of India, Dehra Dun. A baseline point "B" has been selected about 100 meters away from point "A" for azimuth purpose. The geographical positions of "A" is known and that of "B" is obtained accurately in WGS-1984 UTM co-ordinates using TS (Total Station) instrument with respect to "A". T.S has been set up over Point "A" and all initial settings such as levelling, etc. has been done according to the methodology. The U.T.M. (Universal Transverse Mercator) co-ordinates and elevations of both "A" and "B" have been entered in the T.S console. The T.S pointer was aimed towards a point, say "C"on top of a hill, which was meters away from "A", towards the survey area. By aiming the point "C" accurately and releasing the laser pulse, both geographical position as well as the elevation value have computed by the instrument and recorded into the memory. The elevation of Point "C" is now known with respect to the GTS benchmark point "A".

b) Collection of ground control points

All the required details of the survey area are collected with 5 m spot level considering the cross sections at every 50 m along the river longitudinal section covering total width of the river upto top of the bank left and right bank of the river. The required area has been surveyed by simple traversing in about 1200 hectare of the mining area. It was required to collect the required ground points once before the monsoon period and other after the monsoon period. Thus, obtaining the required quantity of the flood deposition to be mined/ excavated. Total survey area is mapped with total station and graduated ranging rod.

c) Plotting of the field data – contouring

All the survey data has been downloaded from the total station through set of software's in the excel format. The field data has been plotted in CIVIL 3D in the proper format and the surface has been generated. Thus, by proper processing of the field data contours of the desired/ required intervals have been generated.

d) Preparation of river cross sections

In the river cross sections are prepared at intervals of 50 m along the river. At each cross section, points have been made on both the side of the river at distance of 10m from the center of river bed. Negative (-) shows left side of bank and Positive (+) value is right side of river bank from the center of the river. At each point, elevation was taken before and after monsoon. These cross sections make the grid of 50m×10m for the whole stretch of mining area.

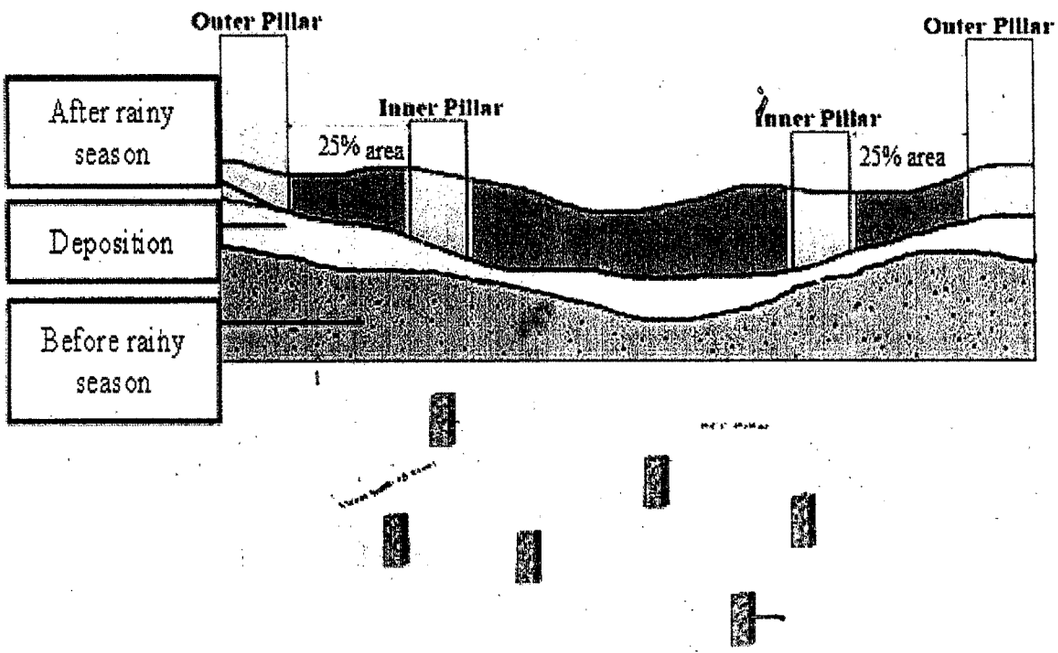


Figure 14: Schematic diagram showing deposition of river bed material and location of inner pillars at different cross sections of the river bed

Difference in elevation was calculated for each point in the grid of 50m×10m for the whole stretch of mining area. The difference in elevation depicts the deposition at each cross section of the river. For estimation of the average deposition at each cross section, the average of Deposition at each point was done for every cross section.

For quantity estimation of the RBM, the composite area (product of elevation and distance between two points across the river i.e. 10m) of each cross section was calculated and multiplied with distance between the two cross sections i.e. 50m. The total deposited RBM for the whole mining area was calculated by using formula

$$Q = \sum \frac{A1 + A2}{2} * D + \frac{A2 + A3}{2} * D + \cdots \frac{A(n-1) + A(n)}{2} * D$$

Where,
Q= Quantity of deposited river bed material
A_n = Composite area of n^{th} section
D = Distance between the cross sections

This provides the estimate of deposited RBM for one year in which the study has been carried out.

5. Findings

5.1 River Kotawali

a) Morphometric Analysis

The geomorphological patterns such as stream orders were delineated using ArcGIS tool. The river posses four levels of stream orders where the length of I order stream was 96.48 km followed by II, III and IV orders i.e. 69.40 km, 32.25 km and 20.19 km, respectively (Table 3). The total length of the stream of the Kotawali River was approximately 218.32km with mean bifurcation ratio of 2.33 and stream length ratio of was 0.72, 0.46 and 0.63 respectively for each order. The geometric parameters i.e. area, perimeter, length, form factor, elongation ratio and circulatory ratio, etc. were estimated and provided in Table 3. The stream frequency, drainage density, drainage intensity and length of overland flow were 0.84, 1.05, 0.80 and 22700.91, respectively (Table 4).

Table 3 Linear aspects of Kotawali River

	Stream Order, S_u	No of Streams N_u	Length of stream (km) L_u	Mean Stream Length (km) L_m	Stream Length Ratio R_l	Bifurcation ratio R_b	Mean Bifurcation ratio R_b
Kotawali	I	100	96.48	0.96	0.72	2.08	2.33
	II	48	69.40	1.45	0.46	2.53	
	III	19	32.25	1.70	0.63	2.38	
	IV	8	20.19	2.52			

Table 4 Morphological parameters of river Kotawali

Aspects	Parameters	**Kotawali**
Linear	No. of Stream	175
	Total Length	218.32
	Mean Bifurcation Ratio	0.69
Geometric	Area (km^2) A	207.96
	Perimeter (km) P	65.51
	Length (km) L_u	27.30
	Relative perimeter (P_r)	3.17
	Mean width (W_b)	7.62
	Length area relation km (L_{ar})	34.43

	Form factor ratio (R_f)	0.28
	Elongation ratio (R_e)	0.60
	Circularity ratio (R_c)	0.61
Relief	Basin Relief (H)	2045.00
	Relief Ratio (R_h)	0.07
	Relative Relief (R_{hp})	3.12
	Ruggedness Number (R_n)	2.15
Morphological	Stream frequency (Fs)	0.84
	Drainage density (Dd)	1.05
	Drainage Intensity (Di)	0.80
	Constant of Channel Maintainace (C)	0.95
	Length of overland flow (Lg)	22700.91

b) Grain size distribution:

Six different categories of the grain sizes were found on the sampled pit viz. <2mm, 2-5mm, 5-10mm, 10-20mm, 20-25mm, and >50mm (Figure 15). The grain size of 2-5 mm was calculated minimum (9%). <2 mm size grain dominated the sampled RBM with the share of 30% followed by was observed for (30%) followed by >50 mm size (20%), 20-25 mm size (15 %) and minimum for 2-5 mm size (9%) (Figure 15).

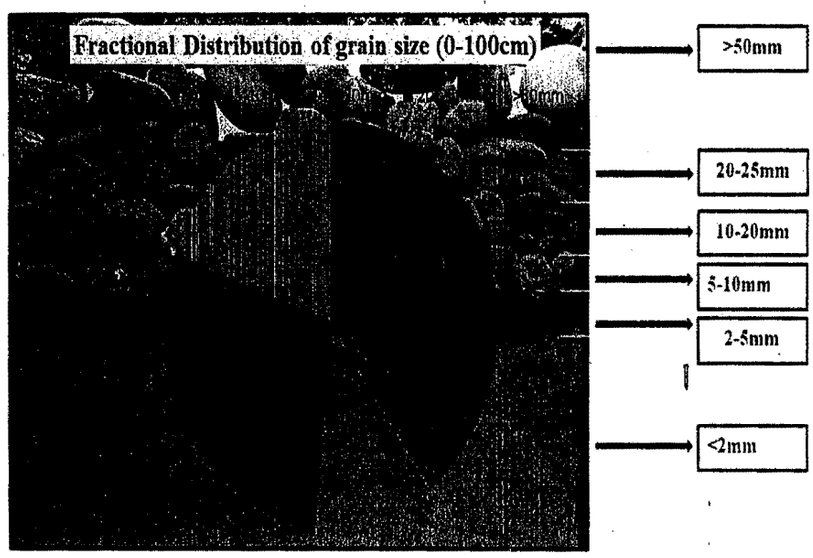


Figure 15: Distribution of grain size of RBM in river Kotawali

c) Deposition of Riverbed Material (RBM)

The length of the mining stretch in the river is 1.68km. The cross sections have been made at interval of 50m along the river and 10 m across the river. The elevation difference has been calculated at each cross section which represents the deposition of RBM in river. During the survey, the river was divided into 34 cross sections for measuring the depth of deposited river bed material before and after rainy season. Quantity of river bed material has been calculated at each cross section (Annexure I). The elevation difference has been recorded at various points along the river at difference of 50m and across the river at difference of 10m. Elevation difference was recorded at total 435 points along and across the river as given in Plan Map (Annexure II). Across the river, number of points for recording data varied according to the width of the river. The maximum and minimum number of points across the river for recording elevation difference is 17 and 10 respectively in the mining stretch of river Kotawali. The elevation varied pre and post monsoon at almost every cross section due to deposition of river bed material as shown in Figure 16.

Acreage survey:

To analyze the total river bed (study) area the length of river was equally divided into three sections i.e. Upper, Middle and Lower section (Table 5). The length of each section is approximately 550m for river Kotawali. The mining area in upper, middle and lower section is 7.20 ha, 7.70 ha, 6.85 ha respectively.

Table 5 Acreage survey of Kotawali River

River Section	Average width, m	Segment length, m	Net mining area, ha
Upper section	130.9	550	7.20
Middle section	140	550	7.70
Lower Section	114.2	600	6.85
		Total	21.75

Estimation of Riverbed Material (RBM):

In Kotawali, deposition of river bed material was analyzed before and after rainy season by carrying out topographical survey in each cross section. Deposition in the river has been calculated by averaging deposition found in different segments (Table 6). Negative values in deposition at few sites represent the scouring of material from the cross section hence, lower the elevation of the point from the initial value. In segment Ist, deposition varied from 0.04 m to 1.09 m with the average deposition in this section is 0.47 m. In segment IInd, the average deposition is 0.12 m and it varied cross section wise from -0.05 m to 0.39 m. Deposition of the RBM has decreased in the segment IIIrd which varied from -1.25 m to 0.44 m with the average deposition in this section is -0.55 m. In lower section, segment IIIrd deposition values are in negative which depicts runoff of the river. This can be because depositions have occurred on the sides of the river and deposition in the river has been washed off beyond the bank of the river.

Quantity of RBM:

The quantity of RBM has been estimated for each cross section and the volume varied from 0.00m^3 to 6016.83 m^3. The total amount of deposited RBM is 68310.60 m^3 for the river Kotawali. The cross sections with 0m^3 depositions indicate the wash off of the river bed material from that particular cross section.

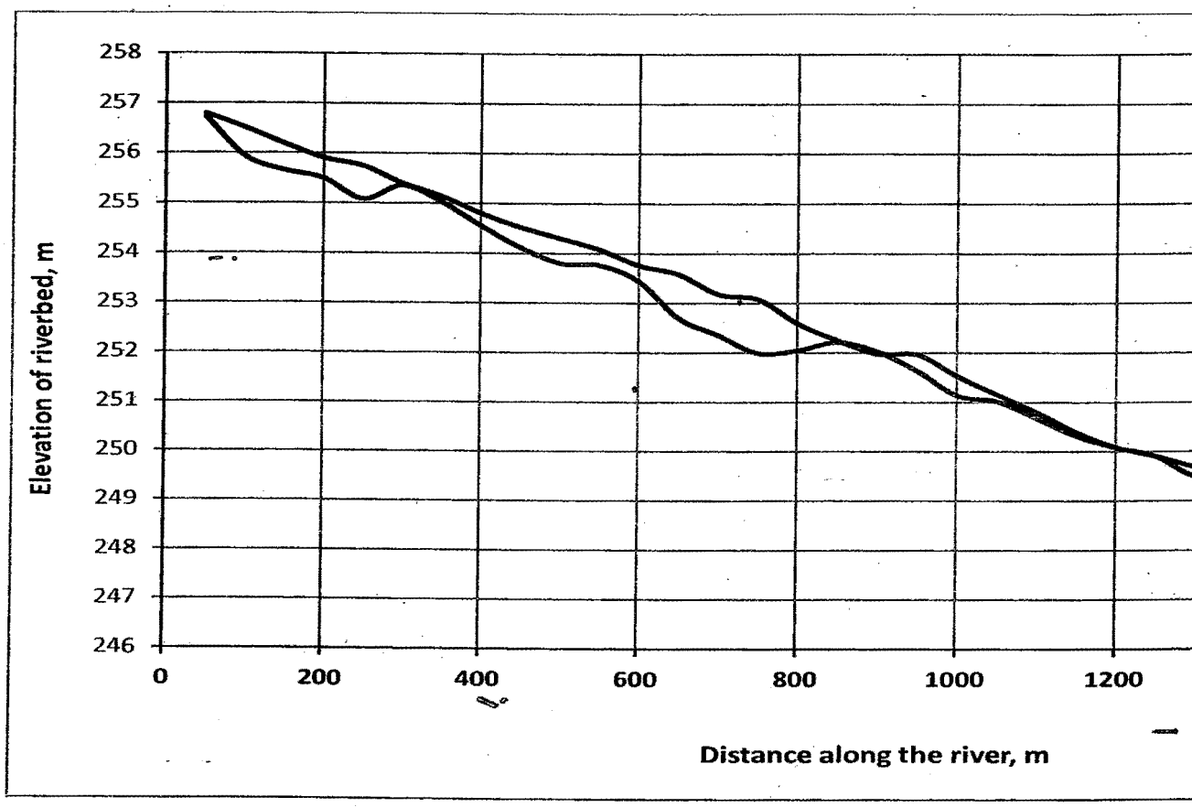


Figure 16: Elevation difference of riverbed at different cross-section along river (Kotawali)

Table 6: Deposition of RBM in different section of Kotawali River

S. No	Distances along river, m	RBM Deposition, m	River Segment	Remarks/comments
1	50	0.07		
2	100	0.58		
3	150	0.53		
4	200	0.41		
5	250	0.67		
6	300	0.04		
7	350	0.12		
8	400	0.25		
9	450	0.41	Ist	Average deposition is measurable and it may replenishable RBM
10	500	0.50		
11	550	0.31		
12	600	0.32		
13	650	0.88		
14	700	0.83		
15	750	1.09		
16	800	0.54		
Average Deposition		0.47		
17	850	0.04		
18	900	-0.05		
19	950	0.33		
20	1000	0.39		
21	1050	0.14		
22	1100	0.12	IInd	In this segment deposition was insignificant
23	1150	0.08		
24	1200	0.00		
25	1250	0.00		
26	1300	0.18		
Average Deposition		0.12		
27	1350	-0.18		
28	1400	-0.92		
29	1450	0.44		
30	1500	0.18		In this segment deposition was observed negative and shows that displace the RBM previously deposited
31	1550	-0.66	IIInd	
32	1600	-0.62		
33	1650	-1.40		
34	1700	-1.25		
Average Deposition		-0.55		

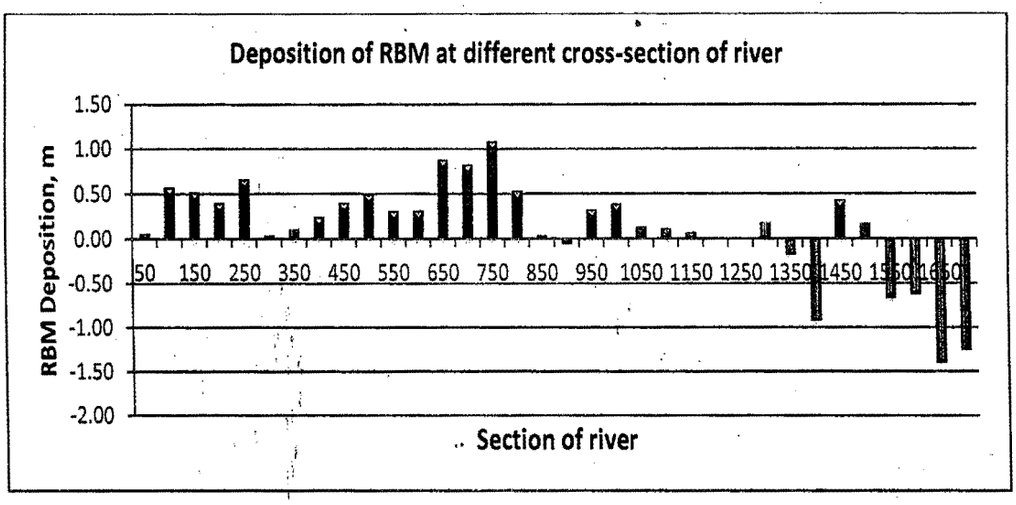


Figure 17: Deposition of RBM in Kotawali River at different cross sections

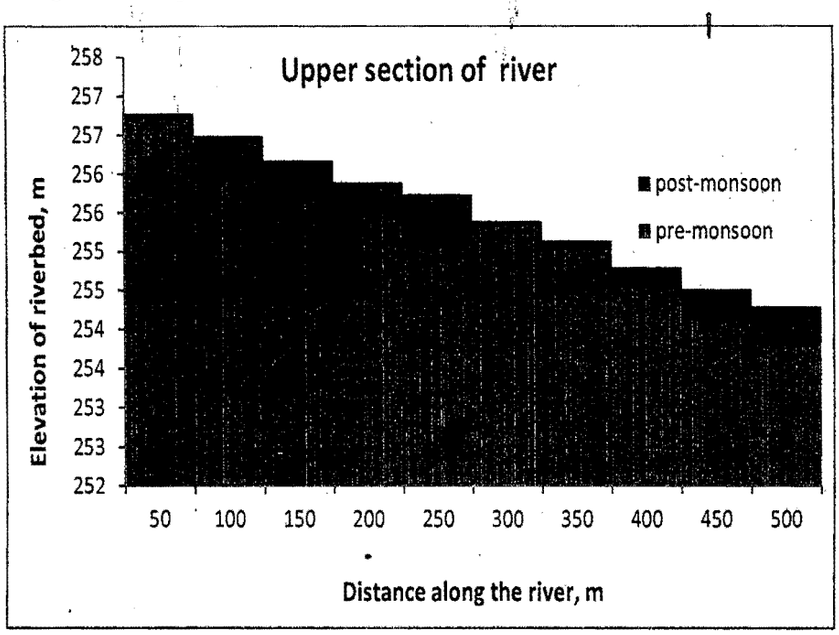


Figure 18 Deposition of RBM in upper section of river Kotawali

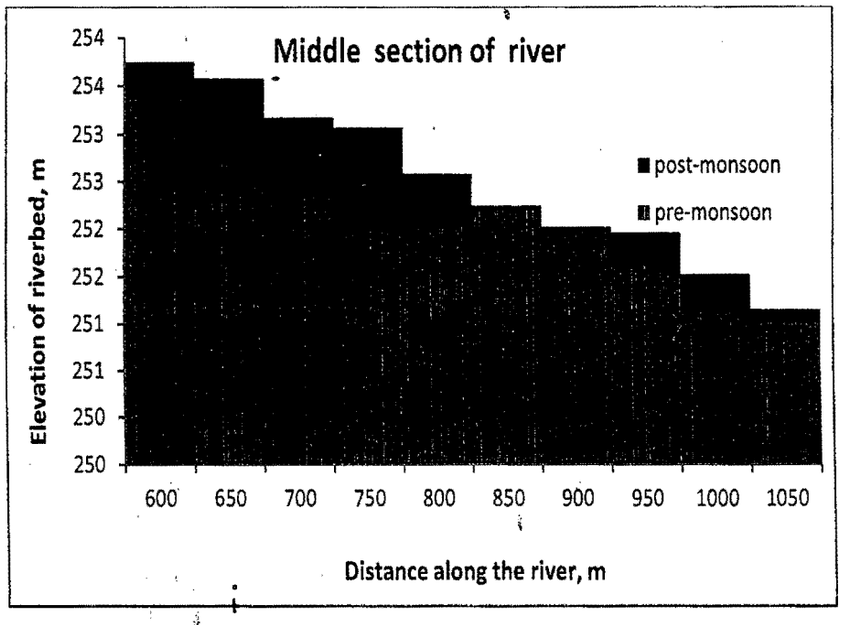


Figure 19: Deposition of RBM in middle section of river kotawali

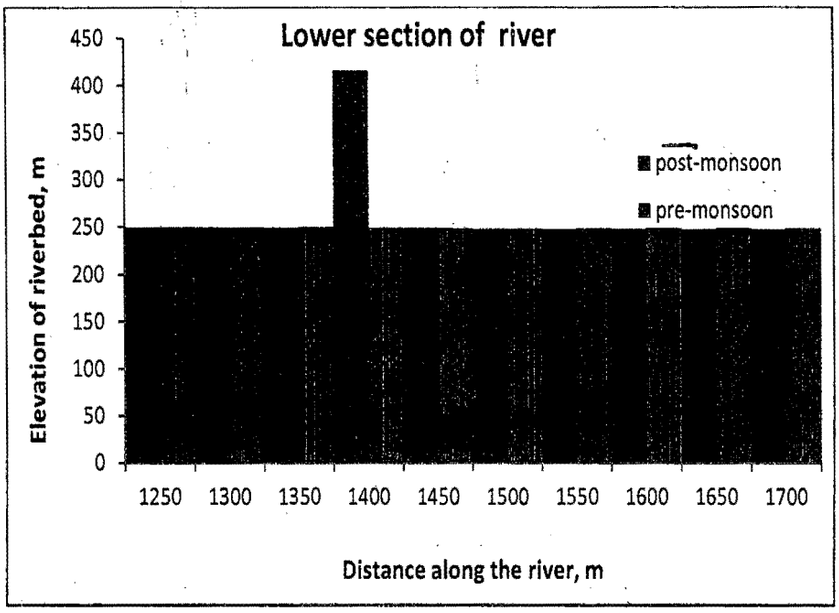


Figure 20: Deposition of RBM in lower section of river Kotawali

5.2 River Rawasan I

a) Morphometric Analysis

The geomorphological patterns such as stream orders were delineated using ArcGIS tool. The river posses four levels of stream orders where the length of I order stream was 6.48 km followed by II, III and IV orders i.e. 6.38 km1.44 km and 6.48 km, respectively (Table 7). The total length of the stream of the Rawasan-I River was approximately 20.78 km with mean bifurcation ratio of 1.72 and stream length ratio of was 0.98, 0.23 and 4.50 respectively for each order. The geometric parameters i.e. area, perimeter, length, form factor, elongation ratio and circulatory ratio, etc. were estimated of the river watershed provided in in Table 8. The stream frequency, drainage density, drainage intensity and length of overland flow were 0.83, 1.02, 0.82 and 212.35, respectively (Table 8).

Table 7: Linear aspects of Rawasan-I River

	Stream Order, Su	No of Streams Nu	Length of stream (km) Lu	Mean Stream Length (km) Lm	Stream Length Ratio R_l	Bifurcation ratio Rb	Mean Bifurcation ratio Rb
Rawasan I	I	7	6.48	0.93	0.98	1.17	1.72
	II	6	6.38	1.06	0.23	3.00	
	III	2	1.44	0.72	4.50	1.00	
	IV	2	6.48	3.24			

Table 8: Morphological parameters of river Rawasan-I

Aspects	Parameters	**Rawasan I**
Linear	Stream Order	17
	Total Length	20.78
	Mean Bifurcation Ratio	1.72
Geometric	Area (km^2) A	20.44
	Perimeter (km) P	24.86
	Length (km) L_u	10.18
	Relative perimeter (P_r)	0.82
	Mean width (W_b)	2.01

	Length area relation km (L_{ar})	8.56
	Form factor ratio (R_f)	0.20
	Elongation ratio (R_e)	0.50
	Circularity ratio (R_c)	0.42
Relief	Basin Relief (H)	111.00
	Relief Ratio (R_h)	0.01
	Relative Relief (R_{hp})	0.45
	Ruggedness Number (R_n)	0.11
Morphological	Stream frequency (Fs)	0.83
	Drainage density (Dd)	1.02
	Drainage Intensity (Di)	0.82
	Constant of Channel Maintenance (C)	0.98
	Length of overland flow (Lg)	212.35

b) **Grain size distribution:**

Six different categories of the grain sizes were found on the sampled pit viz. <2mm, 2-5mm, 5-10mm, 10-20mm, 20-25mm, and >50mm (Figure 21). The grain size of 10-20 mm was calculated minimum (5%). Overall average grain size distribution, the maximum percentage of grain (Figure 21) was observed for <2 mm size (33%) followed by >50 mm size (31%), 20-25 mm size (16 %) and for 5-10 mm size (8%).

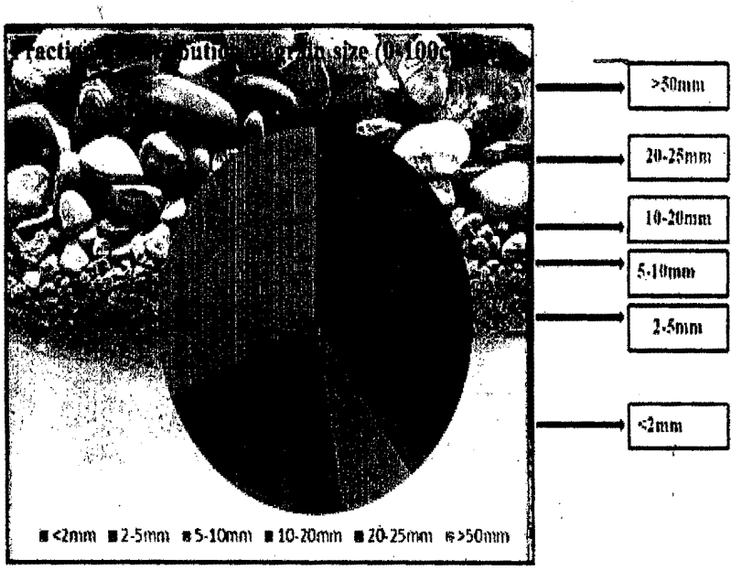


Figure 21: Distribution of grain size of RBM in river Rawasan-I

c) **Deposition of Riverbed Material (RBM)**

The length of the mining stretch in the river is 4.15km. The cross sections have been made at interval of 50m along the river and 10 m across the river. The elevation difference has been calculated at each cross section which represents the deposition of RBM in river. In survey, the river was divided into 83 cross sections for measuring the depth of deposited material before and after rainy season. Quantity of river bed material has been calculated at each cross section (Annexure I). The elevation difference has been recorded at various points along the river at difference of 50m and across the river at difference of 10 m. Elevation difference was recorded at total 1538 points along and across the river as given in Plan Map (Annexure II). Across the river, number of points for recording data varied according to the width of the river. The maximum and minimum number of points across the river for recording elevation difference is 33 and 8 respectively in the mining stretch of river Rawasan-I. The elevation varied pre and post monsoon at almost every cross section due to deposition of river bed material as shown in Figure 22.

Acreage survey:

To analyze the total river bed (study) area the length of river was equally divided into three sections i.e. Upper, Middle and Lower section. The length of each section is 1400 m for river Rawasan I. The mining area in upper, middle and lower section is 23.45 ha, 23.35 ha and 30.20 ha respectively (Table 9).

Table 9: Acreage survey of Rawasan-I River

River Section	Average width, m	Segment length, m	Net mining area, ha
Upper section	173.70	1350	23.45
Middle section	166.79	1400	23.35
Lower Section	215.71	1400	30.20
		Total	**77.00**

Estimation of Riverbed Material (RBM):

In Rawasan-I, deposition of river bed material was analyzed before and after rainy season by carrying out topographical survey in each cross section. Deposition in the river is calculated by averaging deposition found in cross sections in upstream, middle and downstream sections (Table 10). Negative values in deposition at few sites represent the wash off of material from the cross section hence, lower the elevation of the point from the initial value. In Segment I, deposition varied from 1.12m to 1.79 m and the average deposition in this section is 1.49 m. For segment IInd, the average deposition is 0.51m and it varied cross section wise from 0.15m to 0.86 m. In Segment IIIrd, deposition varied from 1.0m to 2.52m and the average deposition in this section is 1.36 m. In segment IVth, deposition varied from 0.47m to 0.89m and the average deposition in this section is 0.66 m. In Segment Vth ,VIth & VIIth, deposition varied from -0.20 m to 0.85 m, 0.76 m to 2.58 m, 1.0 m to 1.93 m and the average deposition in each section is 0.64, 1.47 m and 1.35 respectively (Table 10).

Quantity of RBM:

The quantity of RBM has been estimated for each cross section and the volume varied from 2551 m^3 to 22231.30 m^3. The total amount of deposited RBM is 699420.55 m^3 for the river Rawasan-I.

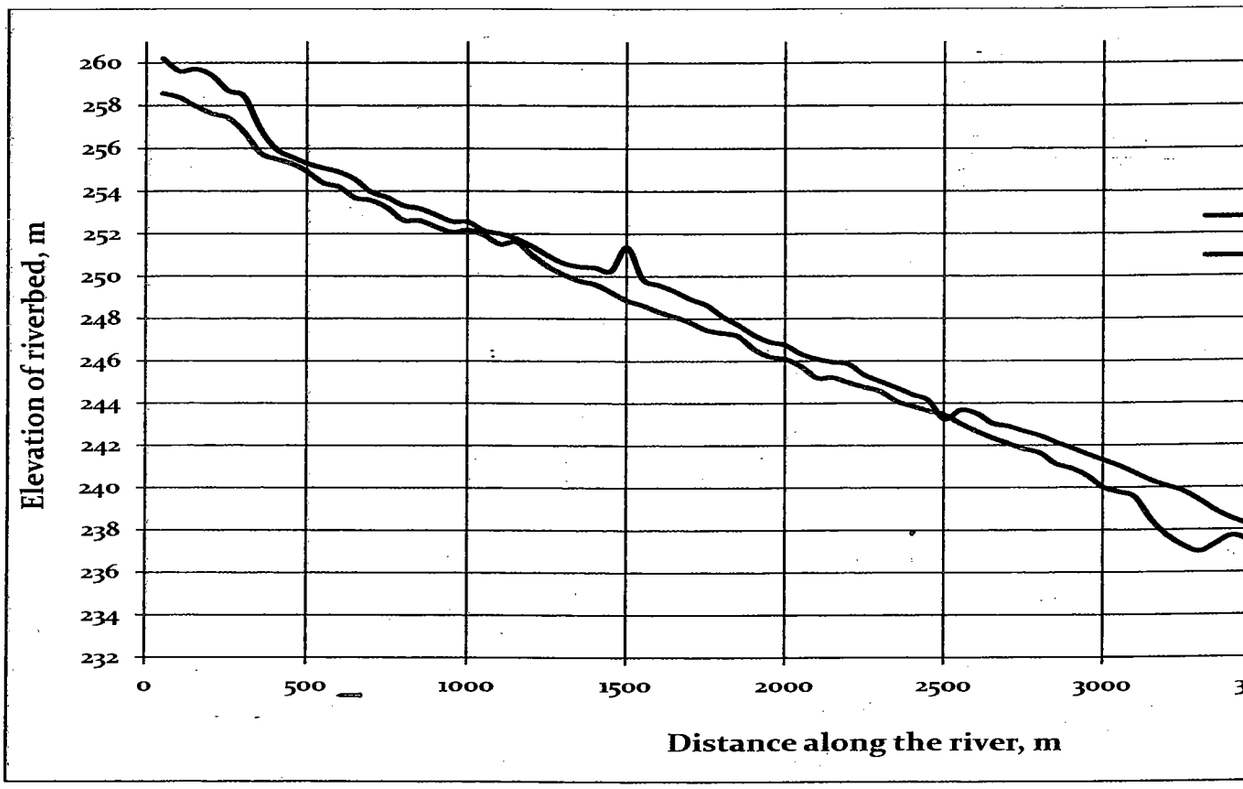


Figure 22: Elevation difference of riverbed at different cross-section along riv

Table 10: Deposition of RBM in different section of Rawasan I River

S. No.	Distances along the river, m	RBM DEPOSITION, m	River Segment	Remarks
1	50	1.63		
2	100	1.23		
3	150	1.74		
4	200	1.79	I[st]	Average deposition is measurable and significant and it may replenishable RBM
5	250	1.27		
6	300	1.66		
7	350	1.12		
Average Deposition		1.49		
8	400	0.46		
9	450	0.31		
10	500	0.38		
11	550	0.69		
12	600	0.69		
13	650	0.86		
14	700	0.39		
15	750	0.48		
16	800	0.68		
17	850	0.56		Average deposition is measurable and significant and it may replenishable RBM
18	900	0.56	II[nd]	
19	950	0.50		
20	1000	0.38		
21	1050	0.21		
22	1100	0.49		
23	1150	0.15		
24	1200	0.42		
25	1250	0.51		
26	1300	0.53		
27	1350	0.67		
28	1400	0.79		
Average Deposition		0.51		
29	1450	1.00		
30	1500	2.52		
31	1550	1.24		Average deposition is higher in this segment and it may replenishable RBM
32	1600	1.26	III[rd]	
33	1650	1.20		
34	1700	1.10		
35	1750	1.19		

Average Deposition		1.36		
36	1800	0.80	IVth	Average deposition is measurable and it may replenishable RBM
37	1850	0.53		
38	1900	0.67		
39	1950	0.71		
40	2000	0.66		
41	2050	0.60		
42	2100	0.89		
43	2150	0.73		
44	2200	0.88		
45	2250	0.58		
46	2300	0.47		
47	2350	0.65		
48	2400	0.55		
49	2450	0.49		
Average Deposition		0.66		
50	2500	-0.20	Vth	Average deposition is negative in few sections due to washing away of sediments and it may replenishable RBM
51	2550	0.64		
52	2600	0.85		
53	2650	0.70		
54	2700	0.83		
55	2750	0.85		
56	2800	0.82		
Average Deposition		0.64		
57	2850	1.03	VIth	Average deposition is higher in this segment and it may replenishable RBM
58	2900	0.97		
59	2950	1.03		
60	3000	1.31		
61	3050	1.26		
62	3100	1.15		
63	3150	1.86		
64	3200	2.35		
65	3250	2.58		
66	3300	2.43		
67	3350	1.58		
68	3400	0.83		
69	3450	0.76		
Average Deposition		1.47		
70	3500	1.00	VIIth	Average deposition is higher in this segment
71	3550	1.17		

72	3600	1.10		and it may replenishable RBM
73	3650	1.09		
74	3700	1.16		
75	3750	1.21		
76	3800	1.26		
77	3850	1.39		
78	3900	1.51		
79	3950	1.45		
80	4000	1.43		
81	4050	1.64		
82	4100	1.93		
83	4150	1.51		
Average Deposition		**1.35**		

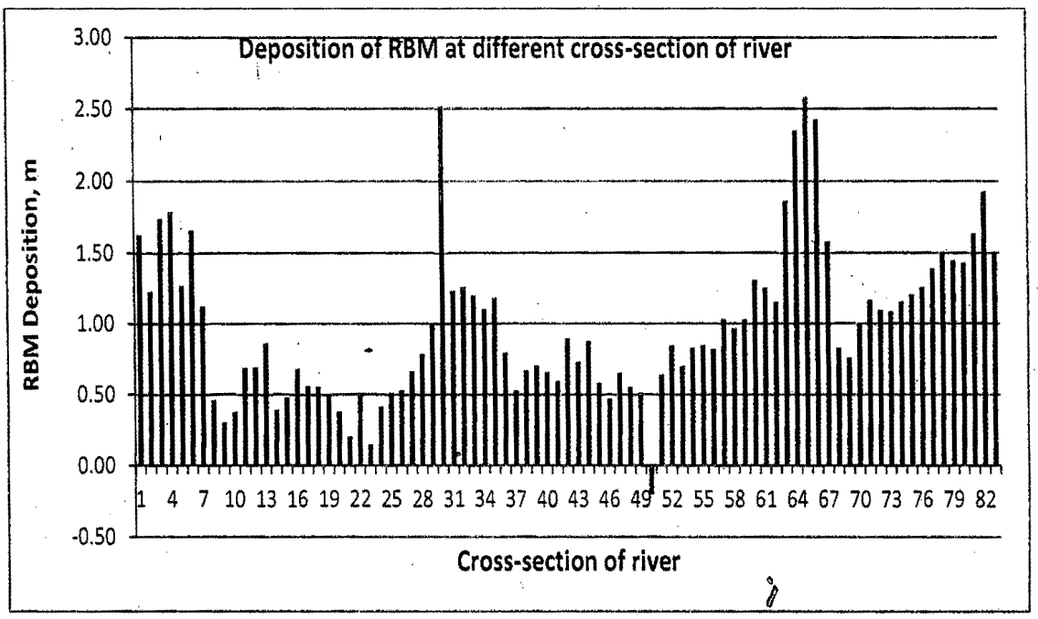


Figure 7: Deposition of RBM in Rawasan-I River at different cross sections

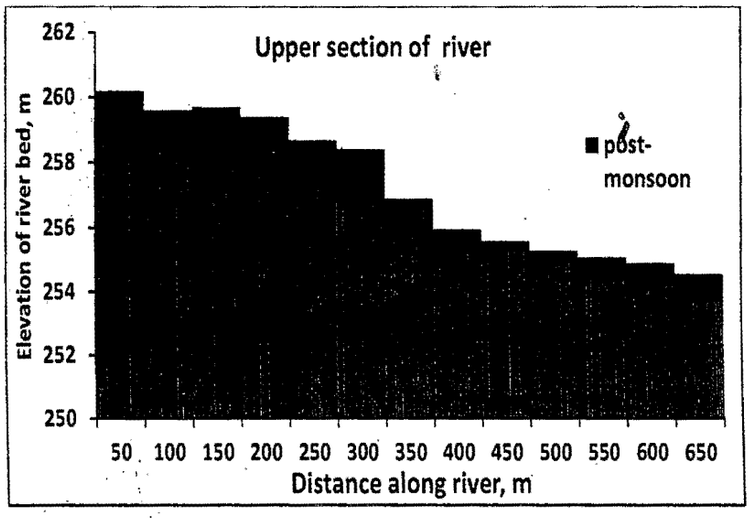


Figure 8: Deposition of RBM in upper section of river Rawasan-I

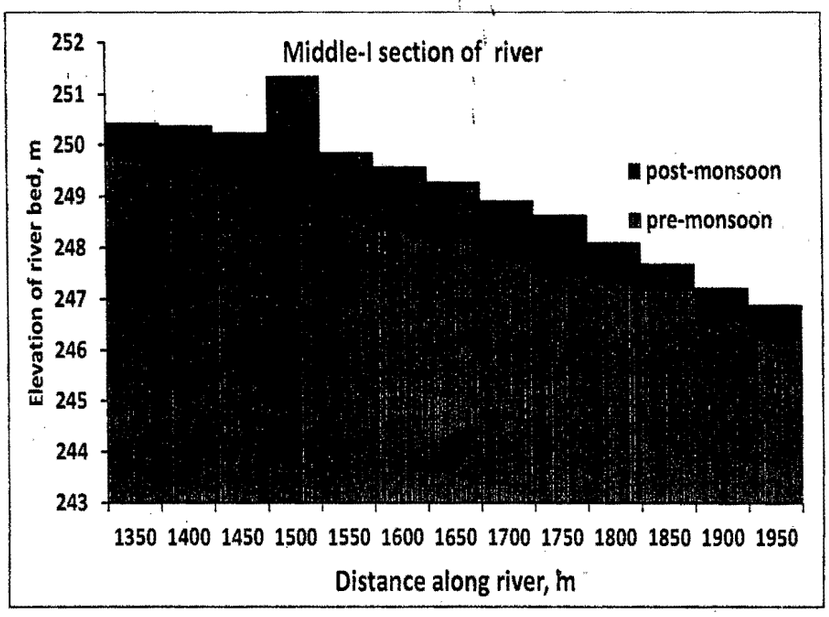


Figure 9: Deposition of RBM in middle-I section of river Rawasan-I

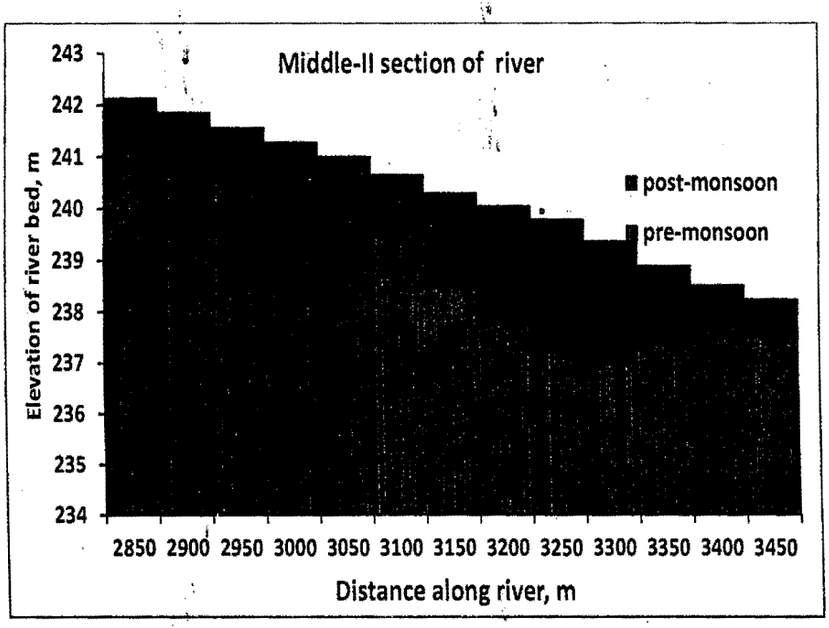


Figure 10: Deposition of RBM in middle-II section of river Rawasan-I

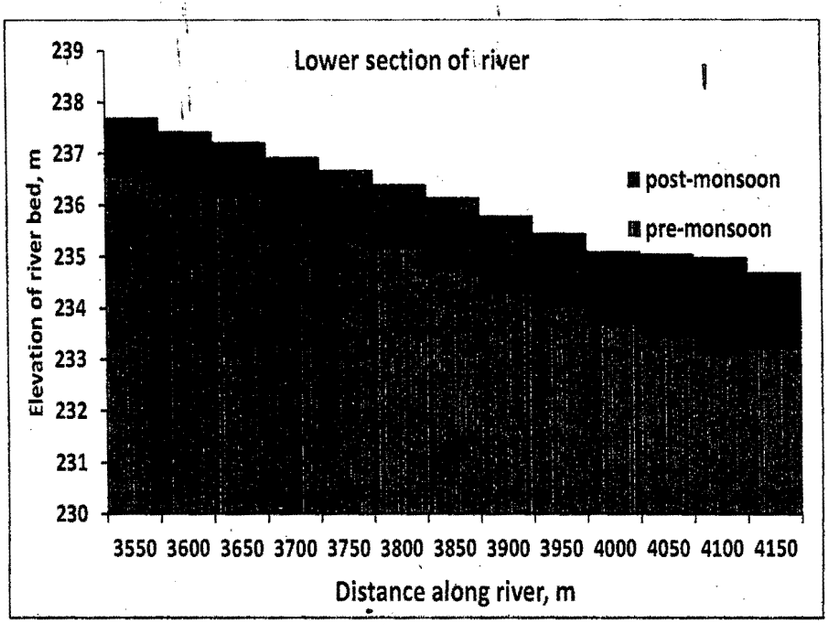


Figure 11: Deposition of RBM in lower section of river Rawasan-I

5.3 River Rawasan-II

a) Morphometric Analysis

The geomorphological patterns such as stream orders were delineated using ArcGIS tool. The river posses four levels of stream orders where the length of I order stream was 151.39km followed by II, III and IV orders i.e. 77.67km, 24.08km and 33.01km, respectively (Table 11). The total length of the stream of the Rawasan II River was approximately 286.15km with mean bifurcation ratio of 3.65 and stream length ratio of was 0.31, 1.37 and 8.67 respectively for each order. The geometric parameters i.e. area, perimeter, length, form factor, elongation ratio and circulatory ratio, etc. were estimated of the river watershed provided in in Table 12. The stream frequency, drainage density, drainage intensity and length of overland flow were 2.32, 1.49, 1.56 and 27547.19, respectively (Table 12).

Table 11: Linear aspects of Rawasan II River

	Stream Order, Su	No of Streams Nu	Length of stream (km) Lu	Mean Stream Length (km) Lm	Stream Length Ratio Rl	Bifurcation ratio Rb	Mean Bifurcation ratio Rb
Rawasan II	I	299	151.39	0.26	0.31	2.53	3.65
	II	118	77.67	0.20	1.37	5.13	
	III	23	24.08	1.44	8.67	3.29	
	IV	7	33.01	40.88			

Table 12: Morphological parameters of river Rawasan-II

Aspects	Parameters	**Rawasan-II**
Linear	Stream Order	447
	Total Length	286.15
	Mean Bifurcation Ratio	3.65
Geometric	Area (km^2) A	192.53
	Perimeter (km) P	82.91
	Length (km) L_u	28.10
	Relative perimeter (P_r)	2.32
	Mean width (W_b)	6.85
	Length area relation km (L_{ar})	32.87
	Form factor ratio (R_f)	0.24
	Elongation ratio (R_e)	0.56
	Circularity ratio (R_c)	0.35
Relief	Basin Relief (H)	1438.00

	Relief Ratio (R_h)	0.05
	Relative Relief (R_{hp})	1.73
	Ruggedness Number (R_n)	2.14
Morphological	Stream frequency (Fs)	2.32
	Drainage density (Dd)	1.49
	Drainage Intensity (Di)	1.56
	Constant of Channel Maintainace (C)	0.67
	Length of overland flow (Lg)	27547.19

b) Grain size distribution:

Six different categories of the grain sizes were found on the sampled pit viz. <2mm, 2-5mm, 5-10mm, 10-20mm, 20-25mm, and >50mm (Figure 28). The grain size of 5-10 mm was calculated minimum (5%). Overall average grain size distribution, the maximum percentage of grain (Figure 28) was observed for <2 mm size (38%) followed by >50 mm size (24%), 20-25 mm size (15 %) and minimum for 2-5 mm size (12%).

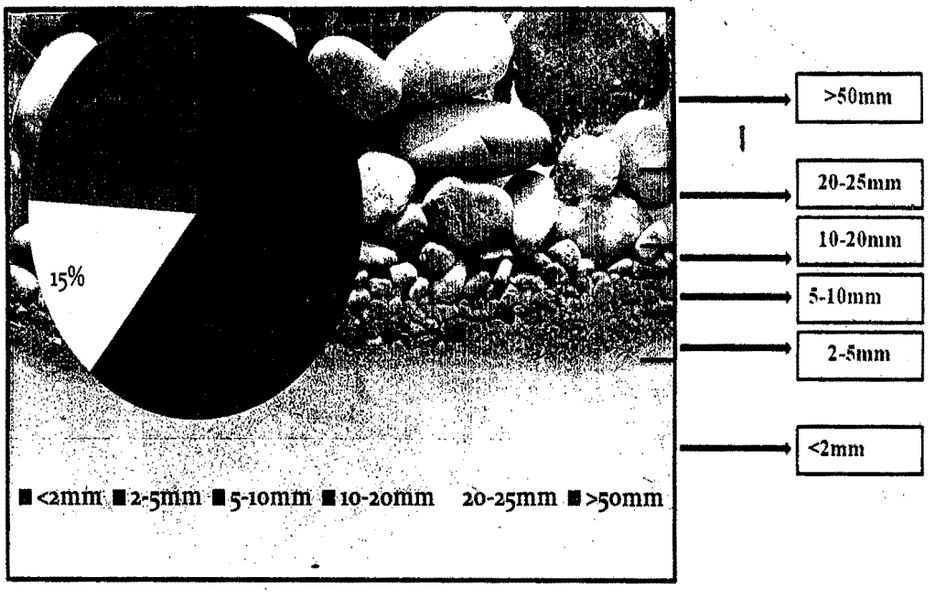


Figure 28: Distribution of grain size of RBM in river Rawasan-II

c) Deposition of Riverbed Material (RBM):

The length of the mining stretch in the river is 3.35km. The cross sections have been made at interval of 50m along the river and 10 m across the river. The elevation difference has been calculated at each cross section which represents the deposition of RBM in river. In survey, the river was divided into 68 cross sections for measuring the depth of deposited material before and after rainy season. Quantity of river bed material has been calculated at each cross section (Annexure I). The elevation difference has been recorded at various points along the river at difference of 50m and across the river at difference of 10 m. Elevation difference was recorded at total 1012 points along and across the river as given in Plan Map (Annexure II). Across the river, number of points for recording data varied according to the width of the river. The maximum and minimum number of points across the river for recording elevation difference is 21 and 7 respectively in the mining stretch of river Rawasan-II. The elevation varied pre and post mohsoon at almost every cross section due to deposition of river bed material as shown in Figure 29.

Acreage survey:

To analyze the total river bed (study) area the length of river was equally divided into three sections i.e. Upper, Middle and Lower section. The length of each section is approximately 1050m for river Rawasan-II. The mining area in upper, middle and lower section is 14.17 ha, 18.06 ha, 19.14 ha respectively (Table 13).

Table 13: Acreage survey of Rawasan-II River

River Section	Average width, m	Segment length, m	Net mining area, ha
Upper section	135	1050	14.17
Middle section	172	1050	18.06
Lower Section	174	1100	19.14
		Total	**51.37**

Estimation of Riverbed Material (RBM):

In Rawasan-II, deposition of river bed material was analyzed before and after rainy season by carrying out topographical survey in each cross section. Deposition in the river is calculated by averaging deposition found in cross sections in upstream, middle and downstream sections (Table 14). Negative values in deposition at few sites represent the wash off of material from the cross section hence, lower the elevation of the point from the initial value. In segment Ist, deposition varied from 0.45 m to 1.05m and the average deposition in this section is 0.71m. In segment II&III section, the average deposition is 0.41m and 0.77m respectively and it varied cross section wise from 0.25m to 0.61m and 0.38m to 1.14m. Deposition of the RBM has increased in the lower section, segment IVth which varied from 0.31m to 1.53m and the average deposition in this section is 1.04m (Figure 29).

Quantity of RBM:

The quantity of RBM has been estimated for each cross section and the volume varied from 1241.85 m^3 to 21110.20 m^3. The total amount of deposited RBM is 344573.50 m^3 for the river Rawasan-II.

504

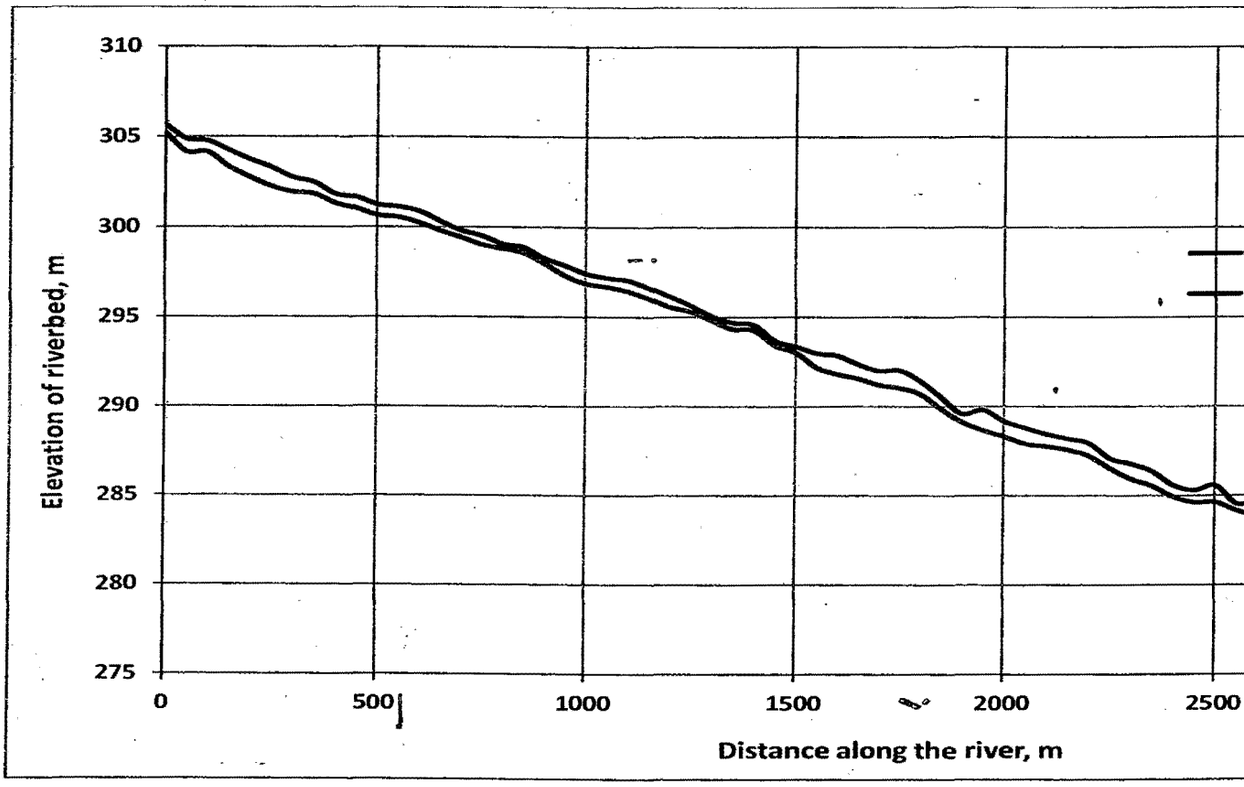


Figure 29: Elevation difference of riverbed at different cross-section along river (Rawasan-II)

505

Table 14: Deposition of RBM in different section of Rawasan-II River

S. No.	Distances along the river, m	RBM Deposition, m	River Segment	Remarks
1	0	0.45		
2	50	0.71		
3	100	0.62		
4	150	0.91		
5	200	0.98		
6	250	1.05		
7	300	0.81		Average deposition is low but significant in this segment and it may replenishable RBM
8	350	0.64	I[st]	
9	400	0.78		
10	450	0.62		
11	500	0.59		
12	550	0.57		
13	600	0.64		
14	650	0.52		
Average Deposition		0.71		
15	700	0.37		
16	750	0.49		
17	800	0.25		
18	850	0.31		
19	900	0.27		
20	950	0.56		
21	1000	0.55		
22	1050	0.49		Average deposition is significant in this segment and it may replenishable RBM
23	1100	0.61	II[nd]	
24	1150	0.60		
25	1200	0.61		
26	1250	0.33		
27	1300	0.25		
28	1350	0.36		
29	1400	0.29		
30	1450	0.25		
31	1500	0.35		
Average Deposition		0.41		
32	1550	0.80		
33	1600	1.04	III[rd]	Average deposition is significant in this segment and it may replenishable RBM
34	1650	0.79		
35	1700	0.79		

506

36	1750	0.99		
37	1800	0.73		
38	1850	0.65		
39	1900	0.45		
40	1950	1.14		
41	2000	0.85		
42	2050	0.89		
43	2100	0.69		
44	2150	0.63		
45	2200	0.72		
46	2250	0.56		
47	2300	0.85		
48	2350	0.82		
49	2400	0.67		
50	2450	0.68		
51	2500	0.95		
52	2550	0.38		
Average Deposition		0.77		
53	2600	0.95		
54	2650	1.29		
55	2700	0.79		
56	2750	0.84		
57	2800	0.89		
58	2850	0.86		
59	2900	0.54		
60	2950	0.98		
61	3000	1.05	IV[th]	Average deposition is significant in this segment and it may replenishable RBM
62	3050	3.98		
63	3100	1.53		
64	3150	0.95		
65	3200	0.65		
66	3250	0.54		
67	3300	0.47		
68	3350	0.31		
Average Deposition		1.04		

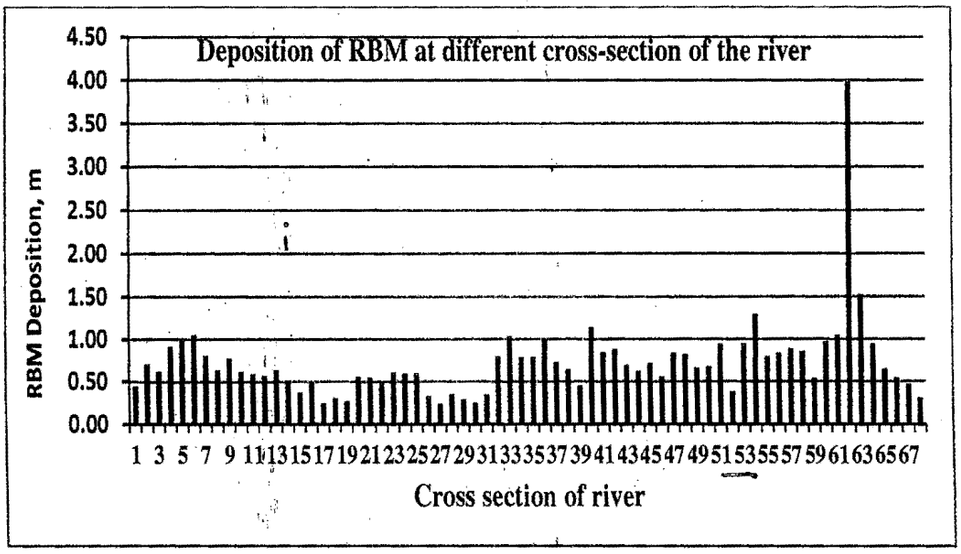


Figure 12: Deposition of RBM in Rawasan II River at different cross sections

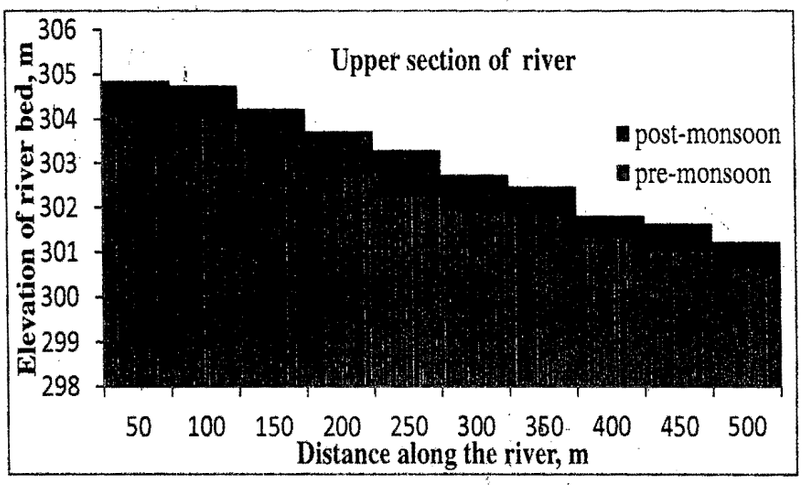


Figure 13: Deposition of RBM in upper section of river Rawasan-II

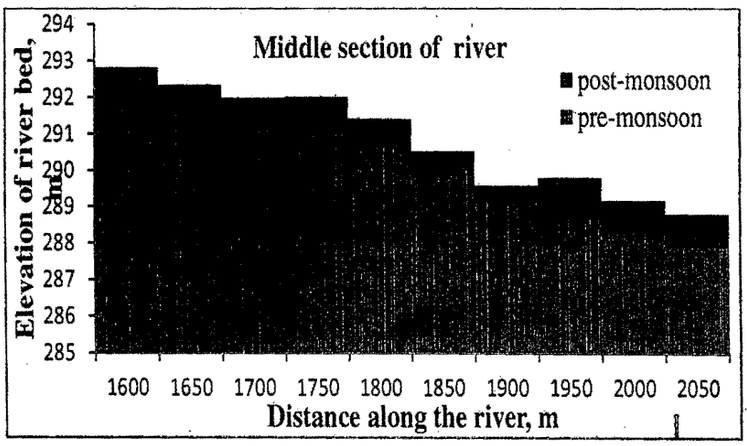


Figure 14: Deposition of RBM in middle section of river Rawasan-II

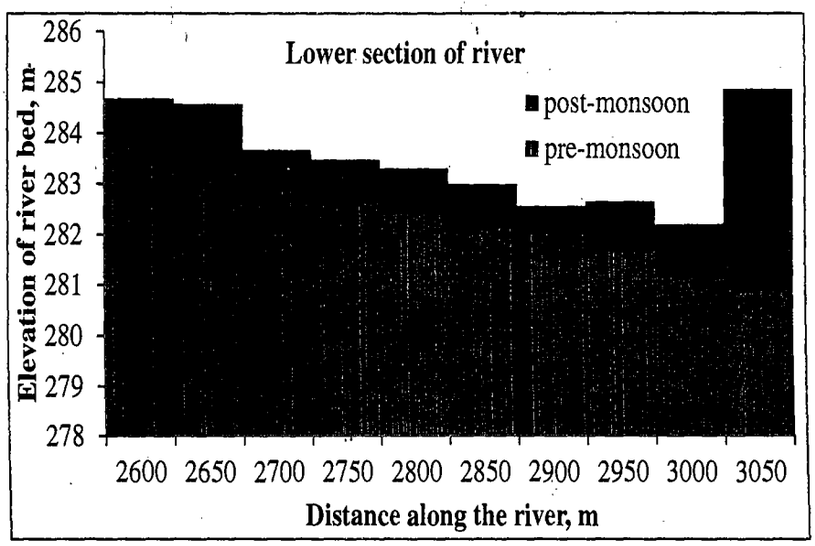


Figure 15: Deposition of RBM in Lower section of river Rawasan II

6. Summary

The study was conducted during May and September, 2018 to investigate the deposition of river bed material in different rivers (i.e. ***Kotawali, Rawasan-I and Rawasan-II***) of Haridwar, district, Uttarakhand. The objective of the study was to understand morphology, grain size distribution and deposition of the river bed material. Cross-sections were made at distance of 50 m in all the three rivers. Kotawali, Rawasan-I and Rawasan-II were divided into 34, 83 and 68 cross-sections, respectively. Moreover, river Kotawali (1.70 km), Rawasan-I (4.15 km) and Rawasan-II (3.35km) were divided into various segments by clustering cross sections. River Kotawali was divided into three segments whereas Rawasan-I & Rawasan-II in seven and four segments, respectively. Observation points were made at each cross section on both the side from the center of river at distance of 10m. Elevation difference of river bed was recorded pre-monsoon and post-monsoon in river Kotawali, Rawasan-I and Rawasan-II at total 435, 1538 and 1012 points to estimate RBM deposition along and across the river respectively. For ease of data representation, all three rivers were divided into three sections i.e. upper section, middle section and lower section. The observations were taken from all the points on the cross sections and river wise findings are narrated below:

Kotawali

The catchment of Kotawali River is 207.96 km^2 and the river bed (study) is 0.74 km^2. The river possesses up to fourth order streams. For the purpose of study, the river course was delineated in to three segments on the basis of deposition. The average deposition in I^{st}, II^{nd} and III^{rd} segment was 0.47 m, 0.12 m and -0.55 m respectively (Table 6). Significant deposition was observed in the upper segment where as in II^{nd} segment it was insignificant. In the III^{rd} segment, value of deposition was negative which shows that the RBM previously deposited has been displaced because of scouring during monsoon (Figure 16, 17). After monsoon an increase in particles of grain size <2mm and >50mm was observed as the sediments from the upstream has got washed out to the downstream sites. Quantity of estimated RBM deposited in Kotawali River during the rainy season 2018 was 68310.60 m^3 (Annexure I, Table A).

- In upper section, high deposition was observed in cross sections at 100 m to 250 m and 500 m longitudinal distance (Table 6 & Figure 18).

- No significant deposition was observed at 300 m (Figure 18) in the upper section of the river.
- In the middle section of river, high deposition (up to 1.09 m) was observed at 600-800 m while no deposition was observed at 900 m (Figure 19).
- In the lower section from 1250 m to 1700 m, there was no significant deposition rather the RBM has been displaced from these cross sections due to flow of the river (Figure 20). Only exception was at 1400 m, where significant deposition was recorded.
- In cross section 750, exceptionally high deposition (1.09 m) was observed at the right bank of the river (Table 6).
- The quantity of deposited RBM was almost negligible at cross section of 850 m, 900 m, 1350 m, 1400 m and from 1550 m to 1700 m (Annexure I, Table A).

Rawasan-I

The catchment of Rawasan-I River is spread over 20.44 km^2 area and the river bed (study) area is 0.99 km^2. The river possesses up to fourth order streams. For the purpose of study, the river course was delineated in to seven segments on the basis of deposition. The average deposition in I^{st} to VII^{th} segments was 1.49 m, 0.51 m, 1.36 m, 0.66 m, 0.64 m,1.47 m and 1.35 m respectively (Table 10). As evident significant deposition was observed in all the segments of river Rawasan-I and average deposition increased in downstream (Figure 22, 23). Before monsoon, < 2mm grain size dominated the RBM followed by boulders which is of >50mm size. After monsoon, the percentage of fine size particles (<2mm) increased while the percentage of boulders has decreased. This could be because of the long basin length of the river which was approximately 15.07 km providing sufficient time for settlement of smaller particles. The mining area lies downstream approximately 4.5 km. The quantity of estimated RBM deposited during the rainy season 2018 was 699420.55 m^3 (Annexure I, Table B).

- In upper section, high deposition (1.63 m to 1.66 m) was observed at cross sections on 50 m to 300 m longitudinal distance (Table 10 & Figure 24).
- In the middle section of river, very high deposition (2.52 m) was observed at 1500 m while high deposition (up to 2.52 m) was observed at 1450 m to 1800 m (Figure 25).
- In the lower section from 3550 m to 4150 m, there was significant deposition of RBM (Figure 26).

- Significant deposition was observed in Rawasan-I and cross-section at 3250 and 3300, high deposition has been observed (2.58 m, 2.43 m) (Table 10).
- In cross section at 3300, high deposition (2.43 m) was observed at the center of the river (Table 10).
- The quantity of deposited RBM was very high at cross section 3200 i.e. 22231.30 m^3 and lowest deposition was at cross section 2450 i.e. 1790.20 m^3 (Annexure I, Table B).

Rawasan-II

The catchment of Rawasan-II is 193.53 km^2 wherein the river bed (study) area comprises 1.00 km^2. The river possesses up to fourth order streams. For the purpose of study, the river course was delineated in to four segments on the basis of deposition. The average deposition in I^{st}, to IV^{th} segment was 0.71 m, 0.41 m, 0.77 m, and 1.04 m respectively (Table 14). Significant deposition was observed in all the segments of river Rawasan-II and average deposition increased towards the downstream (Figure 29, 30). Before monsoon, particles with grain size < 2mm dominated the RBM followed by boulders which is of >50mm size. After monsoon, percentage of fine size particles <2mm and boulders (>50) mm was increased as the sediments from the upstream has got washed out to the downstream. The quantity of estimated RBM deposited during the rainy season 2018 was 344573.50 m^3 (Annexure I, Table C).

- In upper section, significant deposition was observed in cross sections at 50 m to 300 m distance along the river (Figure 31).
- In the middle section of river, significant deposition was observed at 1600 m to 2050 m (Figure 32).
- In the lower section from 2600 m to 3050 m, there was significant deposition of RBM and very high deposition (1.05 m to 3.98 m) at the end of the river at 3000 m to 3050 m (Figure 33).
- High deposition was observed in cross-section at 3100 towards the left side of the bank, which is 1.53 m (Table 14).
- High deposition was observed in cross-section at 3050 towards the right side of the bank, which is 3.98 m (Table 14).

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Minutes of visit to the mining area of Ganga River and its tributaries at Haridwar on 4th November, 2018

With reference to NGT order dated 15th October, 2018 to submit an annual/interim report by 19th October 2018, in continuation to which Forest Research Institute (FRI), Dehradun initiated field survey for data collection in seven streams of river Ganga and its tributaries. A team of officials from FRI and Uttarakhand Forest Development Corporation (UFDC) visited the mining area on 4th November 2018 and took a note of the situation prevailing.

Presently, the survey and data collection of three rivers out of seven could only be carried out due to the fact that the mining area to be surveyed in Ganga River and its tributaries are flooded with large volumes of water. Water has been diverted in the streams due to construction work being carried out by the irrigation department. The water has not receded completely and it is not possible for the team to continue with the survey and data collection.

Photographs from the sites have been attached along with the minutes at the back side of it.

Name and designation of the team of officials that visited the mining site, with their signatures are as follows:

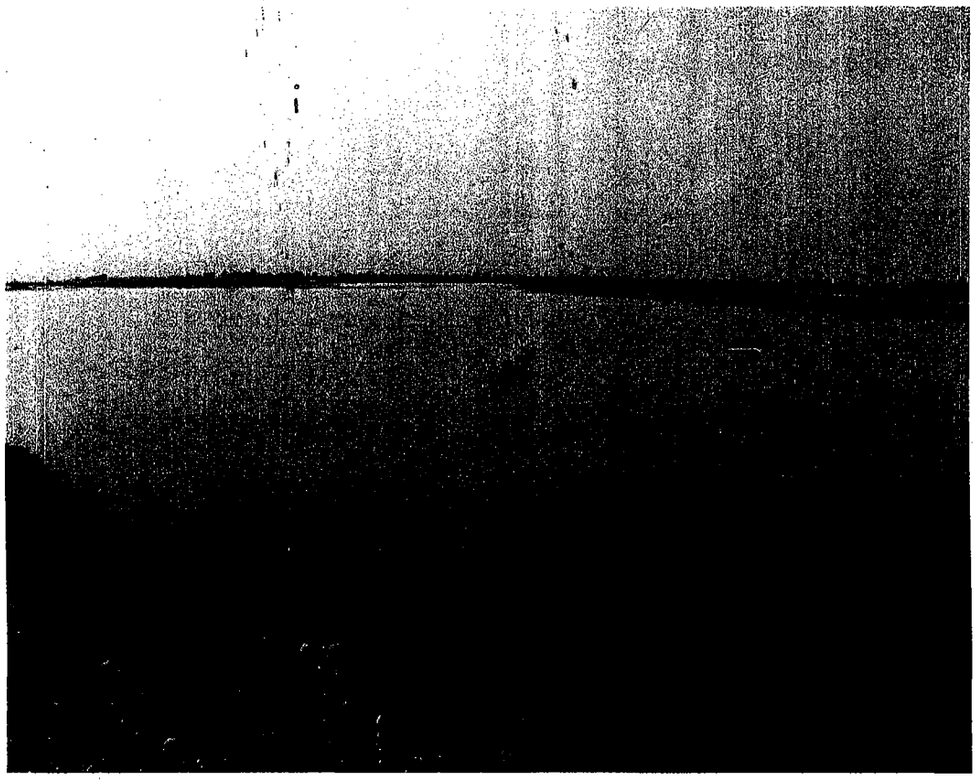
S.N.	Name and Designation	Signature
1.	Dr. Parmanand Kumar, FRI, Dehradun	
2.	Vijay Pal Singh Deputy logging officer Uttarakhand Forest Development	
3.		
4.	Het Ram Deputy Logging officer	
5.		
6.		
7.		
8.		

9.	गोपाल सिंह रावत हवलदार	
10.	एस० के० काम्बोज S.T.O F.R.I D.Dun	
11.		
12.		

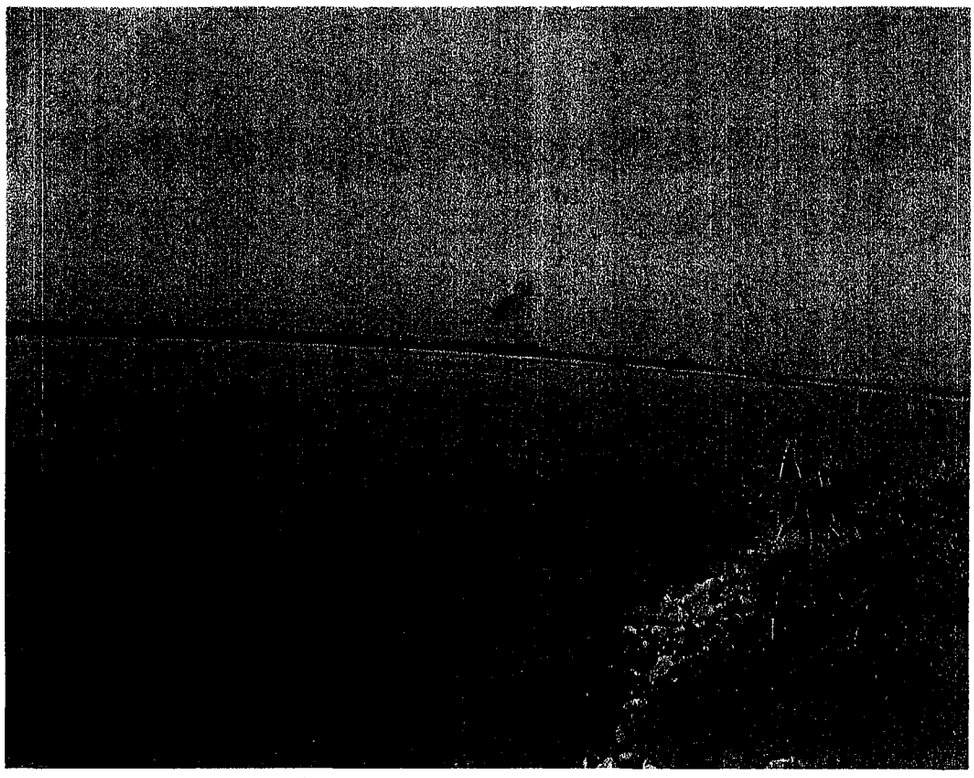
Present Situation of Mining Area in Ganga River

Mining area at Bhogpour

Mining area at Bishanpur



Mining area at Chidiyapur



Mining area at Shyampur

Annexure-1

Quantity estimation of deposited riverbed material (RBM) after rainy session

Table A: Estimated quantity (m^3) of riverbed material (RBM) in Kotawali River

S. No.	Distances along the river, m	Distances b/w cross-section, m	Composite area of cross-section, m^2	Volume of RBM, m^3
1	50	50	15.05	752.40
2	100	50	72.34	3870.60
3	150	50	82.49	3488.40
4	200	50	57.05	3171.95
5	250	50	69.83	2334.03
6	300	50	23.53	1386.50
7	350	50	31.93	2043.75
8	400	50	49.82	2893.28
9	450	50	65.91	3683.48
10	500	50	81.43	3216.73
11	550	50	47.24	2397.03
12	600	50	48.64	4158.75
13	650	50	117.71	5754.75
14	700	50	112.48	6016.83
15	750	50	128.19	4551.05
16	800	50	53.85	1492.78
17	850	50	5.86	0.00
18	900	50	0.00	0.00
19	950	50	40.89	2757.83
20	1000	50	69.42	2784.45
21	1050	50	41.96	2333.78
22	1100	50	51.40	2429.75
23	1150	50	45.80	1996.48
24	1200	50	34.06	1124.85
25	1250	50	10.93	1019.65
26	1300	50	29.86	0.00
27	1350	50	0.00	0.00
28	1400	50	0.00	1342.90
29	1450	50	53.72	1997.23
30	1500	50	26.17	654.33
31	1550	50	0.00	0.00
32	1600	50	0.00	0.00
33	1650	50	0.00	0.00
34	1700	50	0.00	0.00
Total quantity of RBM (m^3)				68310.60

Table B: Estimated quantity (m^3) of riverbed material (RBM) in Rawasan-I River

S. No.	Distances along the river, m	Distances b/w cross-section, m	Composite area of cross-section, m^2	Volume of RBM, m^3
1	50	50	186.89	9344.65
2	100	50	161.62	11114.60
3	150	50	282.97	14316.63
4	200	50	289.70	11910.03
5	250	50	186.70	10342.60
6	300	50	227.00	9416.23
7	350	50	149.65	5526.48
8	400	50	71.41	3488.98
9	450	50	68.15	3380.28
10	500	50	67.06	4464.98
11	550	50	111.54	5588.83
12	600	50	112.02	5927.50
13	650	50	125.08	4884.05
14	700	50	70.28	4110.63
15	750	50	94.15	5204.65
16	800	50	114.04	5669.43
17	850	50	112.74	5827.80
18	900	50	120.37	5459.08
19	950	50	97.99	4545.73
20	1000	50	83.84	3235.23
21	1050	50	45.57	3764.53
22	1100	50	105.01	3817.60
23	1150	50	47.69	3145.75
24	1200	50	78.14	4135.65
25	1250	50	87.29	4345.55
26	1300	50	86.53	4895.93
27	1350	50	109.30	5734.25
28	1400	50	120.07	6549.45
29	1450	50	141.91	7224.15
30	1500	50	147.06	7647.48
31	1550	50	158.84	8028.10
32	1600	50	162.28	7709.25
33	1650	50	146.09	7099.85
34	1700	50	137.90	7109.38
35	1750	50	146.47	6452.28
36	1800	50	111.62	4753.20
37	1850	50	78.51	4324.43
38	1900	50	94.47	4864.18
39	1950	50	100.10	4679.20
40	2000	50	87.07	4099.55
41	2050	50	76.91	5073.28

42	2100	50	126.02	5950.00
43	2150	50	111.98	6079.25
44	2200	50	131.19	5842.28
45	2250	50	102.50	4420.65
46	2300	50	74.32	4198.90
47	2350	50	93.63	4313.70
48	2400	50	78.92	3723.50
49	2450	50	70.02	1790.20
50	2500	50	1.58	3076.03
51	2550	50	121.46	7444.78
52	2600	50	176.33	8052.35
53	2650	50	145.76	7873.53
54	2700	50	169.18	8002.63
55	2750	50	150.92	7256.65
56	2800	50	139.34	8551.60
57	2850	50	202.72	10541.63
58	2900	50	218.94	11235.10
59	2950	50	230.46	10265.88
60	3000	50	180.17	10572.13
61	3050	50	242.71	11521.38
62	3100	50	218.14	14123.33
63	3150	50	346.79	19409.40
64	3200	50	429.59	22231.30
65	3250	50	459.67	21270.13
66	3300	50	391.14	15418.73
67	3350	50	225.61	8335.45
68	3400	50	107.81	5469.58
69	3450	50	110.97	7293.65
70	3500	50	180.77	11009.38
71	3550	50	259.60	14317.08
72	3600	50	313.08	16079.53
73	3650	50	330.10	16769.50
74	3700	50	340.68	16647.63
75	3750	50	325.23	16693.78
76	3800	50	342.53	17175.55
77	3850	50	344.50	17807.88
78	3900	50	367.82	16805.85
79	3950	50	304.42	14237.45
80	4000	50	265.08	13278.35
81	4050	50	266.05	13335.83
82	4100	50	267.38	9236.15
83	4150	50	102.07	2551.63
Total quantity of RBM (m^3)				**699420.55**

Table C: Estimated quantity (m^3) of riverbed material (RBM) in Rawasan-II River

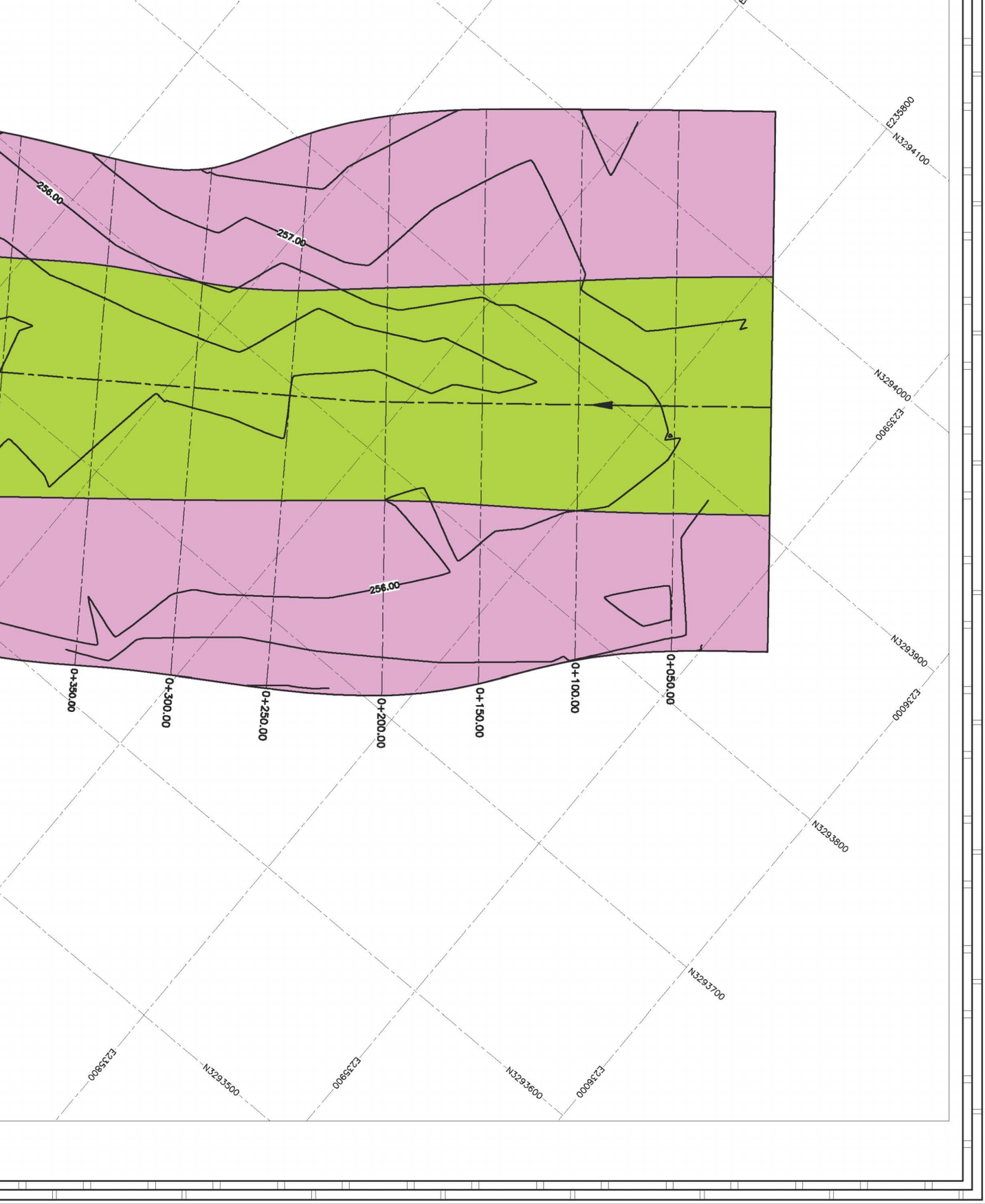
S. No.	Distances along the river, m	Distances b/w cross-section, m	Composite area of cross-section, m^2	Volume of RBM, m^3
1	0	50	24.84	1241.85
2	50	50	38.16	2402.45
3	100	50	57.93	3311.05
4	150	50	74.51	4257.80
5	200	50	95.80	5279.50
6	250	50	110.38	5522.28
7	300	50	105.52	4551.33
8	350	50	76.54	4177.20
9	400	50	90.55	3949.70
10	450	50	67.44	3373.98
11	500	50	67.52	3669.68
12	550	50	79.27	4254.48
13	600	50	90.91	4193.83
14	650	50	76.84	3589.83
15	700	50	66.75	3286.13
16	750	50	64.69	2317.18
17	800	50	28.00	1555.48
18	850	50	34.22	1597.48
19	900	50	29.68	2285.10
20	950	50	61.73	3080.55
21	1000	50	61.49	2943.30
22	1050	50	56.24	3292.08
23	1100	50	75.44	3853.10
24	1150	50	78.68	4028.63
25	1200	50	82.47	3324.98
26	1250	50	50.53	2043.20
27	1300	50	31.19	2093.53
28	1350	50	52.55	2511.13
29	1400	50	47.90	2482.78
30	1450	50	51.41	2945.03
31	1500	50	66.39	5500.20
32	1550	50	153.62	8218.55
33	1600	50	175.12	7702.03
34	1650	50	132.96	6065.88
35	1700	50	109.68	5529.55
36	1750	50	111.51	5210.00
37	1800	50	96.89	4826.40
38	1850	50	96.16	4062.30
39	1900	50	66.33	5440.28
40	1950	50	151.28	6817.98
41	2000	50	121.44	6415.63

42	2050	50	135.19	5862.83
43	2100	50	99.33	5014.93
44	2150	50	101.27	5272.63
45	2200	50	109.63	5251.90
46	2250	50	100.44	6650.85
47	2300	50	165.59	7818.88
48	2350	50	147.16	6852.75
49	2400	50	126.95	5856.15
50	2450	50	107.30	6114.13
51	2500	50	137.27	4612.98
52	2550	50	47.25	4320.85
53	2600	50	125.58	6163.68
54	2650	50	120.97	6151.60
55	2700	50	125.10	5632.48
56	2750	50	100.20	5275.65
57	2800	50	110.83	5379.63
58	2850	50	104.36	4382.00
59	2900	50	70.92	5281.88
60	2950	50	140.36	8133.38
61	3000	50	184.98	19668.80
62	3050	50	601.77	21110.20
63	3100	50	242.64	9874.35
64	3150	50	152.34	6270.55
65	3200	50	98.48	4725.15
66	3250	50	90.52	4585.60
67	3300	50	92.90	3714.48
68	3350	50	55.68	1391.93
Total quantity of RBM (m^3)				**344573.50**

ANNEXURE – II

PLAN MAP AND SECTION MAP OF RIVER

(Kotawali, Rawasan-I and Rāwasan-II)


256.00
257.00
256.00
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0+300.00
0+250.00
0+200.00
0+150.00
0+100.00
0+050.00
E235800
E235900
E236000
N3294100
N3294000
N3293900
N3293800
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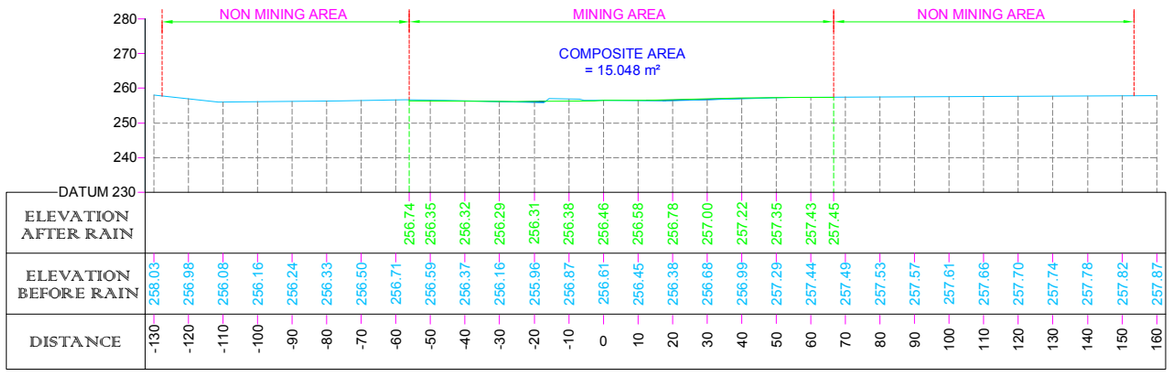

DISTANCE	-130	-120	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
ELEVATION BEFORE RAIN	258.03	256.98	256.08	256.16	256.24	256.33	256.50	256.71	256.59	256.37	256.16	255.96	256.87	256.61	256.45	256.38	256.68	256.99	257.29	257.44	257.49	257.53	257.57	257.61	257.66	257.70	257.74	257.78	257.82	257.87
ELEVATION AFTER RAIN									256.74	256.35	256.32	256.29	256.31	256.38	256.46	256.58	256.78	257.00	257.22	257.35	257.43	257.45								

CHAINAGE (0+250)

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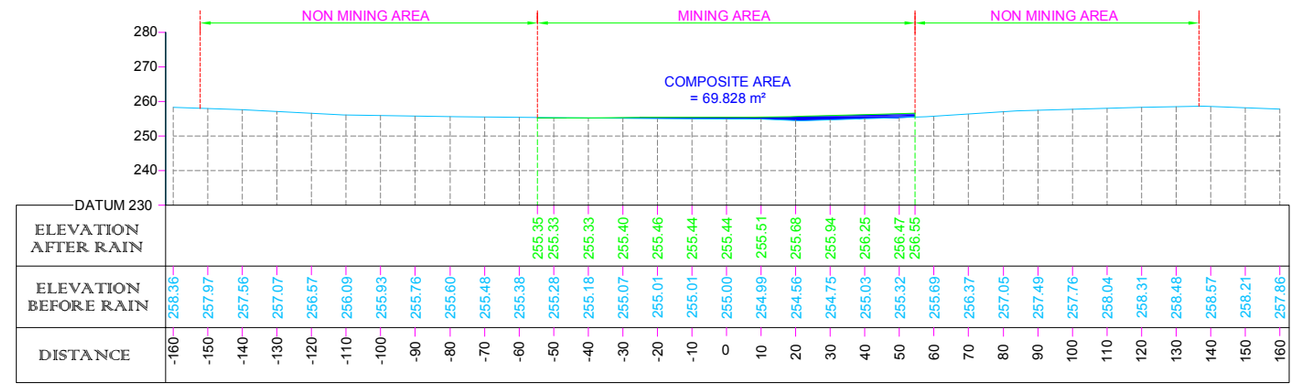

DISTANCE	-160	-150	-140	-130	-120	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
ELEVATION BEFORE RAIN	258.36	257.97	257.56	257.07	256.57	256.09	255.93	255.76	255.60	255.48	255.38	255.28	255.18	255.07	255.01	255.01	255.00	254.99	254.56	254.75	255.03	255.32	255.69	256.37	257.05	257.49	257.76	258.04	258.31	258.48	258.57	258.21	257.86
ELEVATION AFTER RAIN												255.35	255.33	255.33	255.40	255.46	255.44	255.44	255.51	255.68	255.94	256.25	256.47	256.55										

CHAINAGE (0+450)

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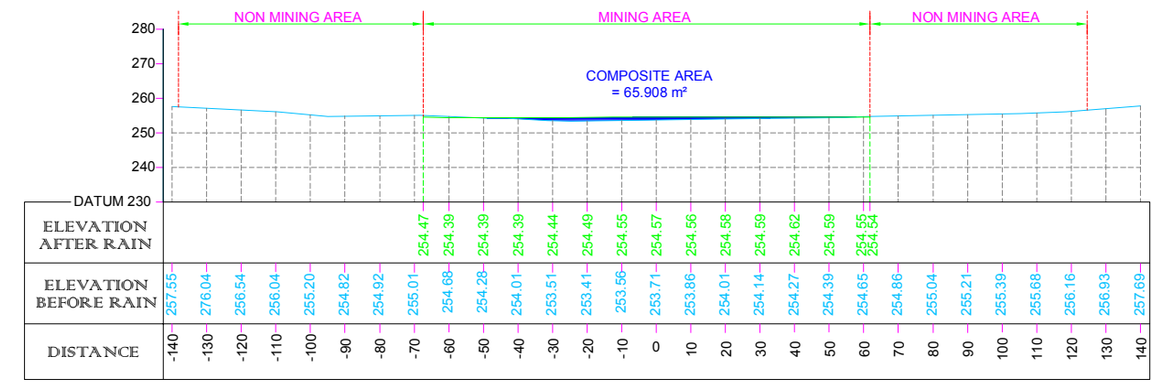
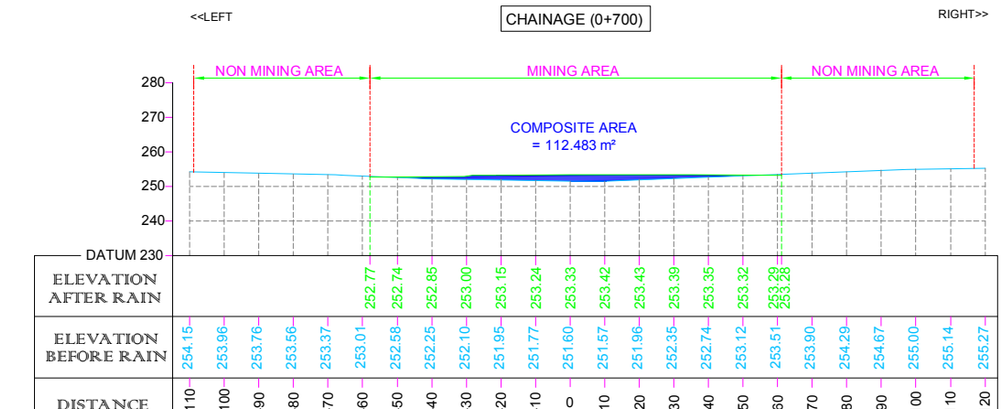


DISTANCE	-140	-130	-120	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140
ELEVATION BEFORE RAIN	257.55	276.04	256.54	256.04	255.20	254.82	254.92	255.01	254.68	254.28	254.01	253.51	253.41	253.56	253.71	253.86	254.01	254.14	254.27	254.39	254.65	254.86	255.04	255.21	255.39	255.68	256.16	256.93	257.69
ELEVATION AFTER RAIN																													

CHAINAGE (0+700)

<<LEFT RIGHT>>



DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120
ELEVATION BEFORE RAIN	254.15	253.96	253.76	253.56	253.37	253.01	252.58	252.25	252.10	251.95	251.77	251.60	251.57	251.96	252.35	252.74	253.12	253.51	253.90	254.29	254.67	255.00	255.14	255.27
ELEVATION AFTER RAIN																								

CHAINAGE (0+950)

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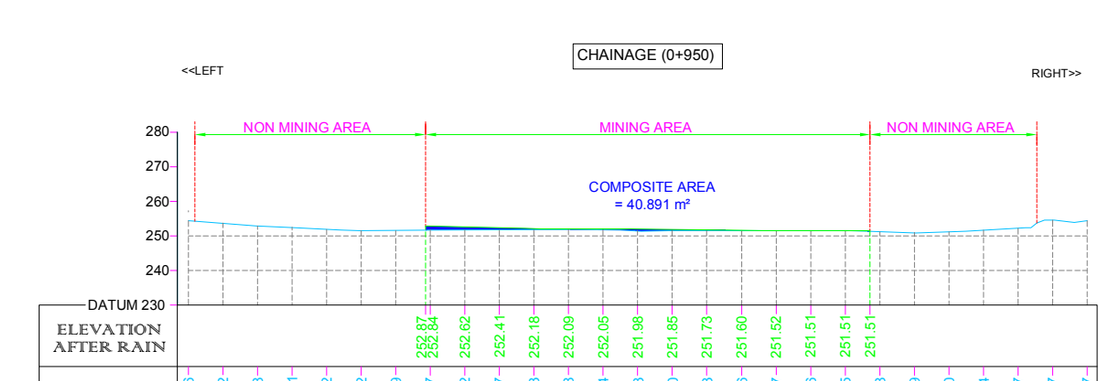
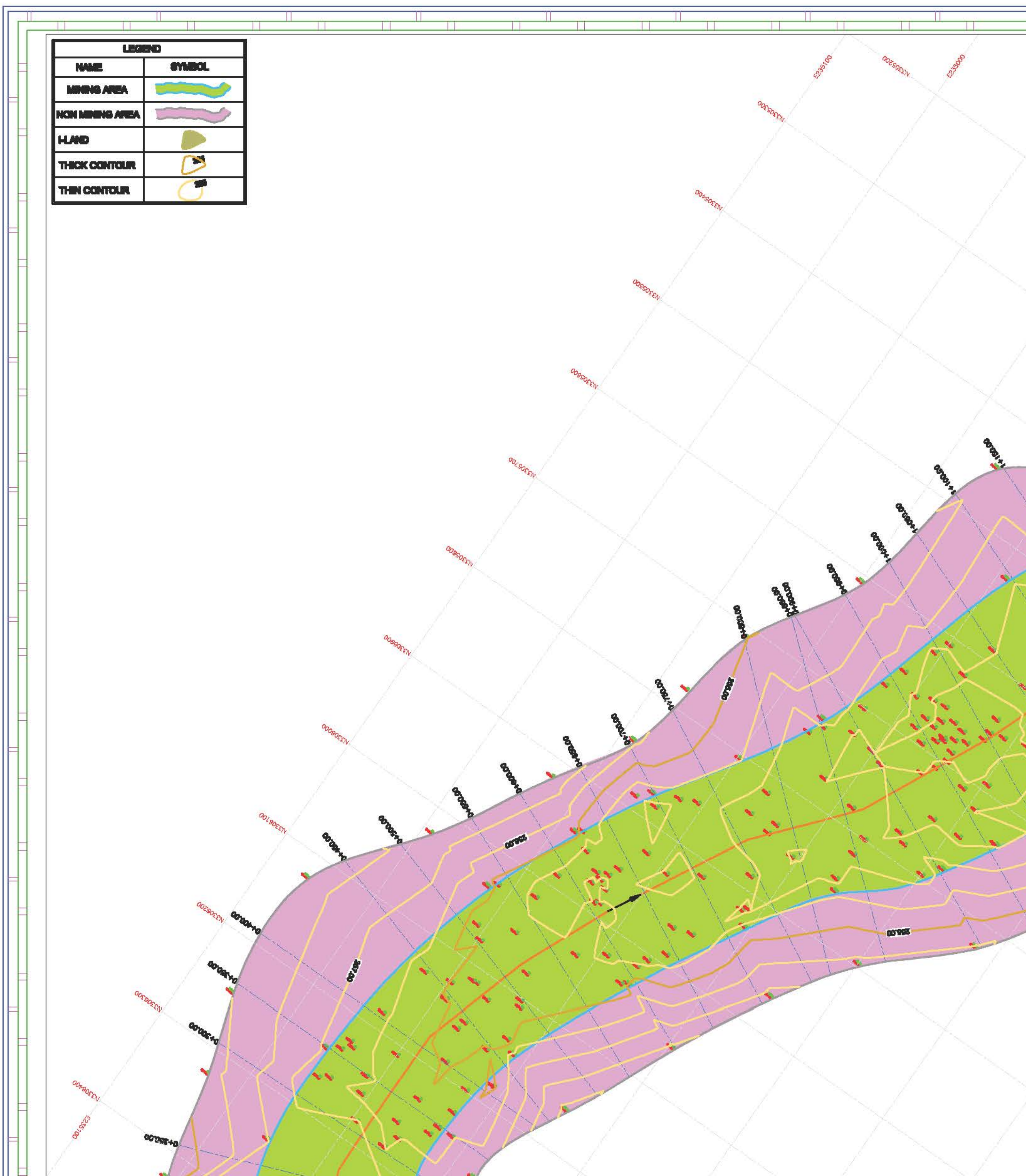
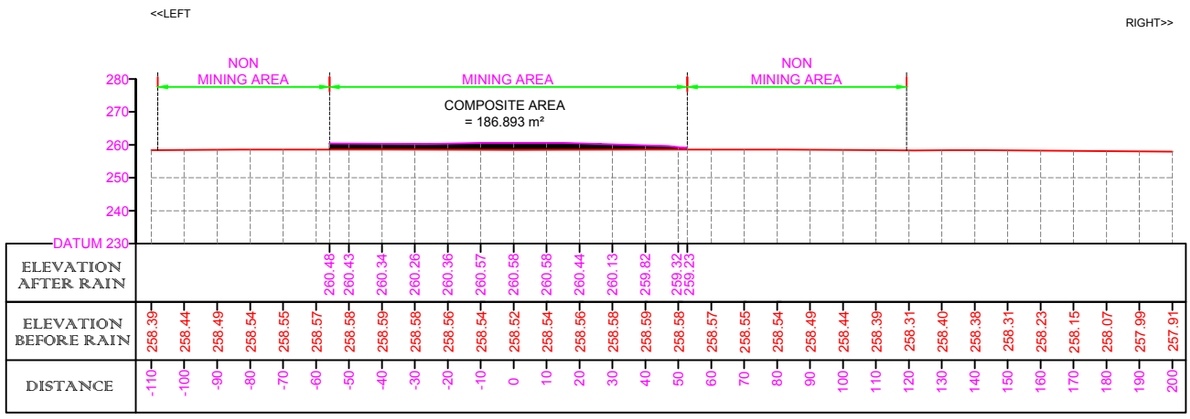


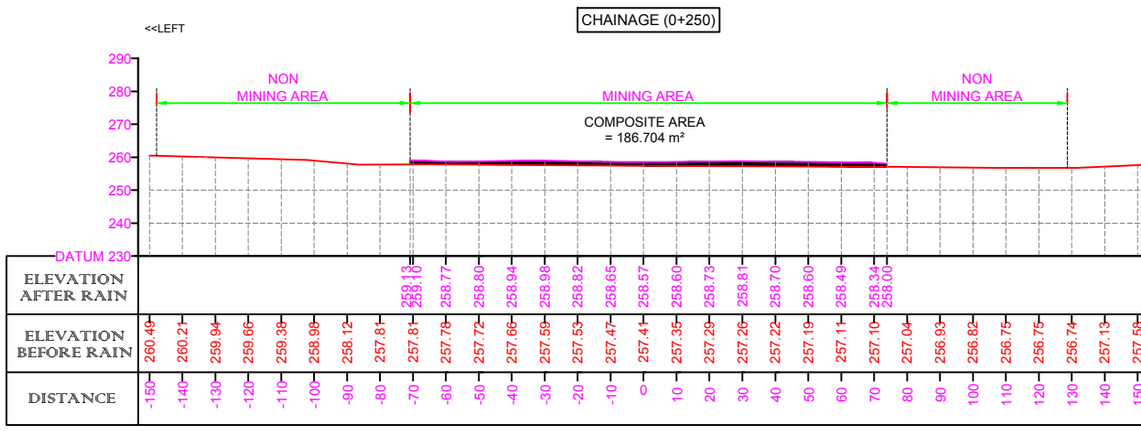
DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120
ELEVATION BEFORE RAIN	254.46	253.72	252.98	252.51	251.92	251.52	251.59	251.67	251.72	251.77	251.83	251.88	251.84	251.53	251.50	251.53	251.56	251.57	251.56	251.55	251.28	250.99	251.30	251.74	252.27	254.67	254.47		
ELEVATION AFTER RAIN																													


LEGEND
NAME
SYMBOL
MINING AREA
NON MINING AREA
I-LAND
THICK CONTOUR
THIN CONTOUR

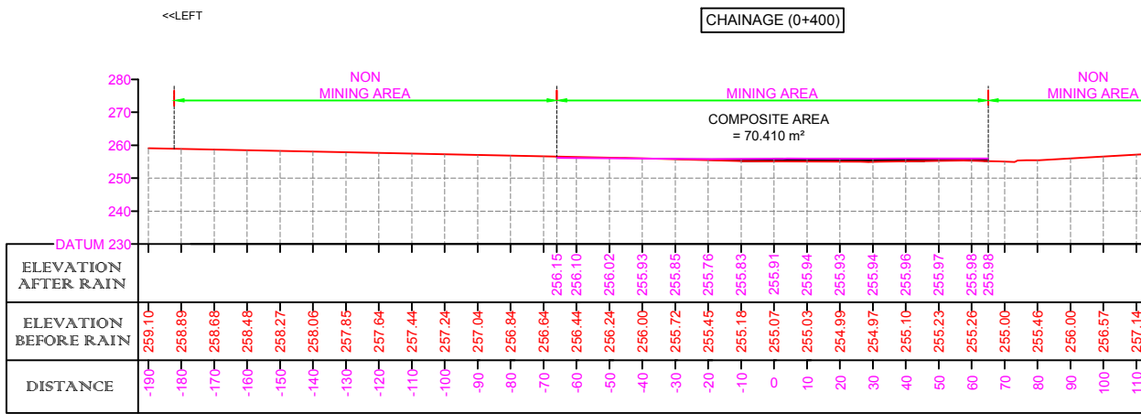
CHAINAGE (0+050)



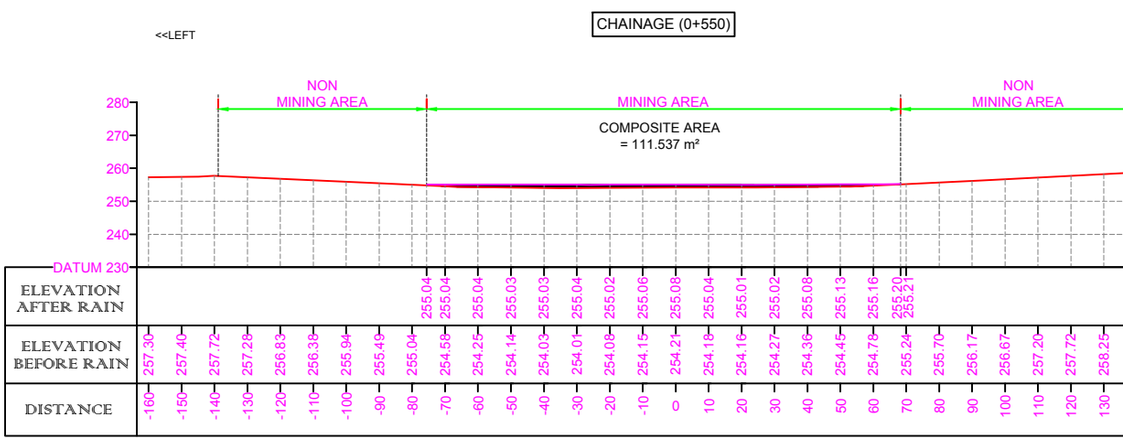
CHAINAGE (0+250)



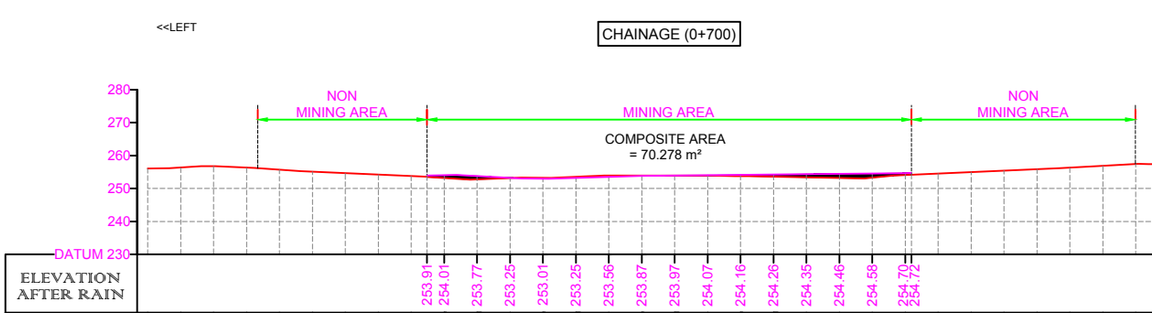
CHAINAGE (0+400)



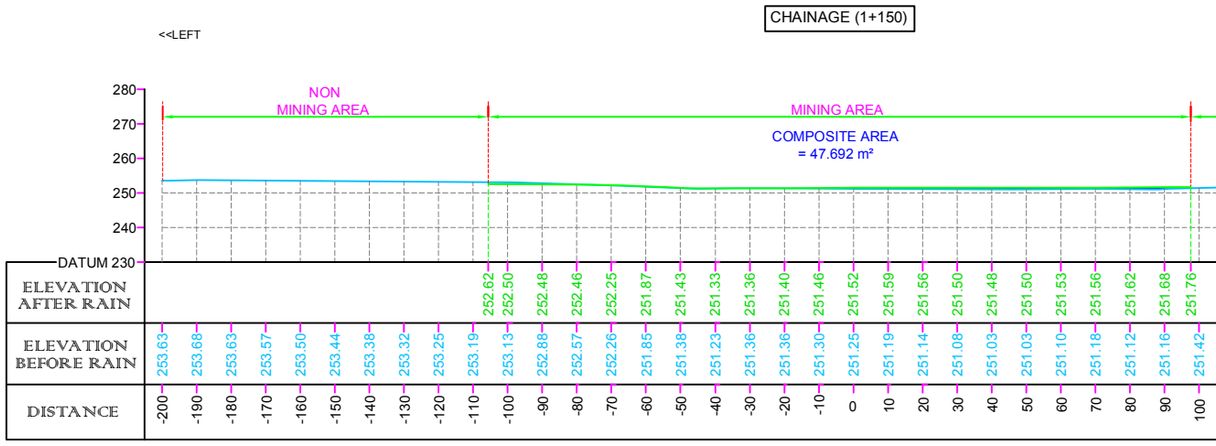
CHAINAGE (0+550)



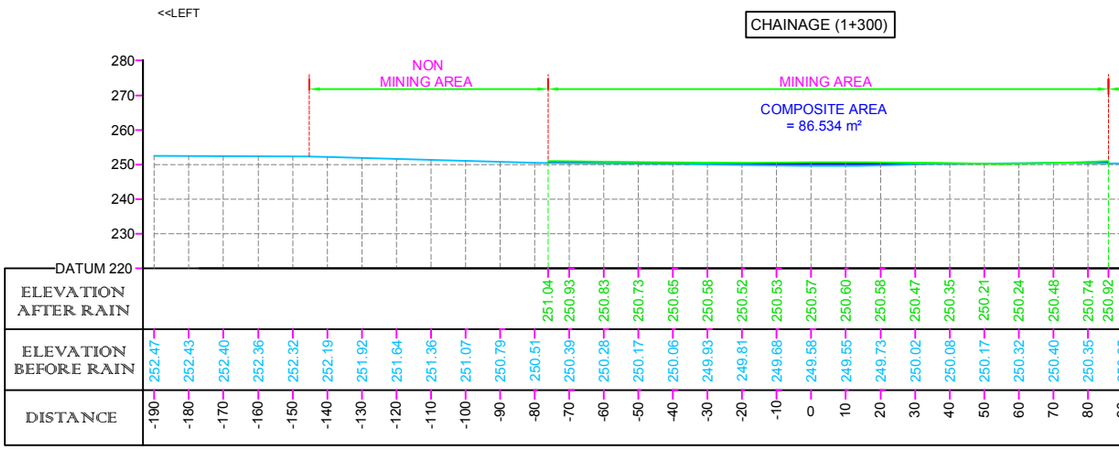
CHAINAGE (0+700)



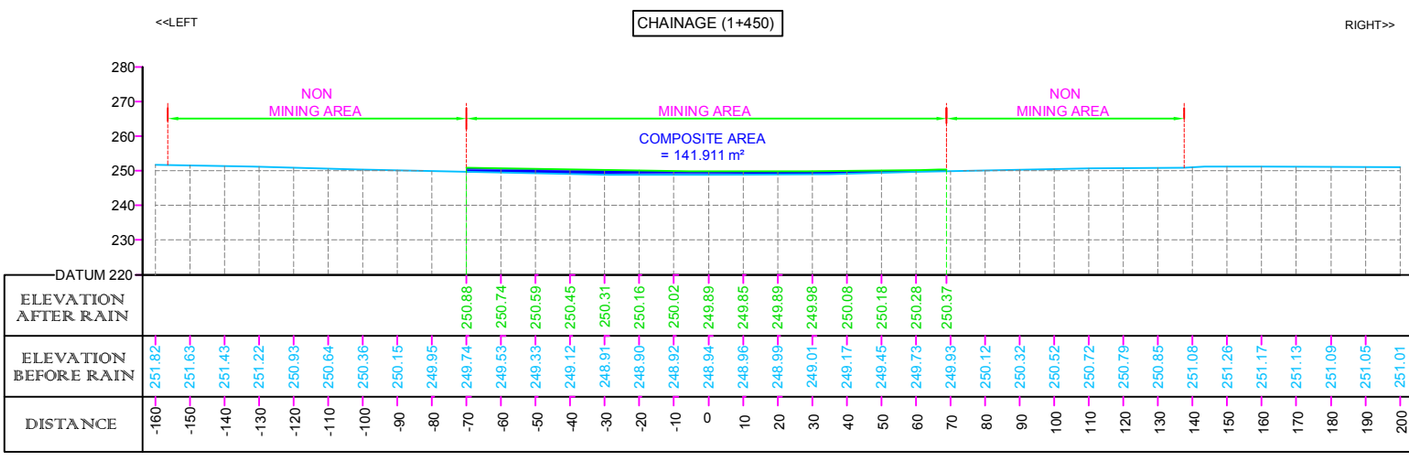
CHAINAGE (1+150)



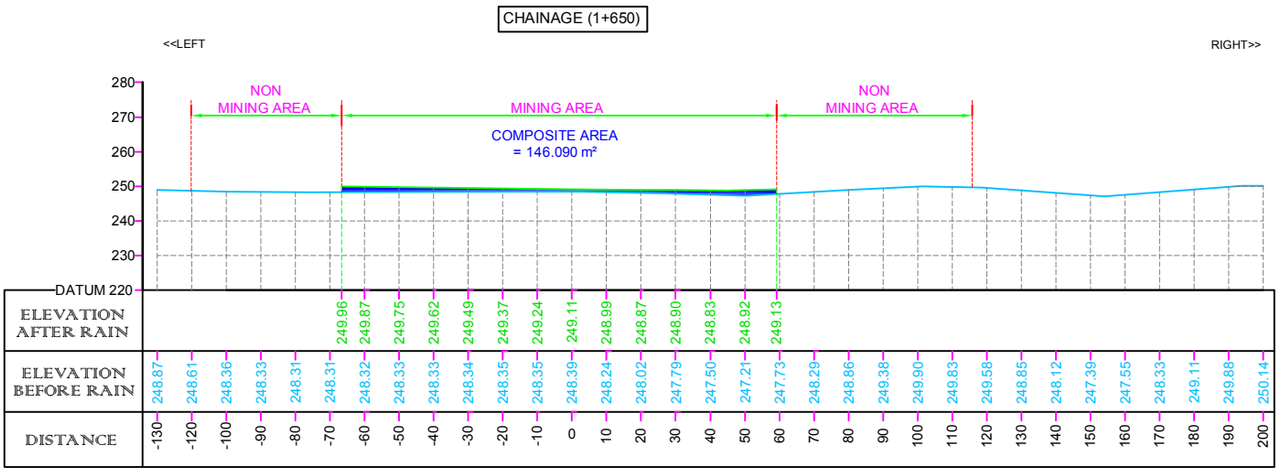
CHAINAGE (1+300)



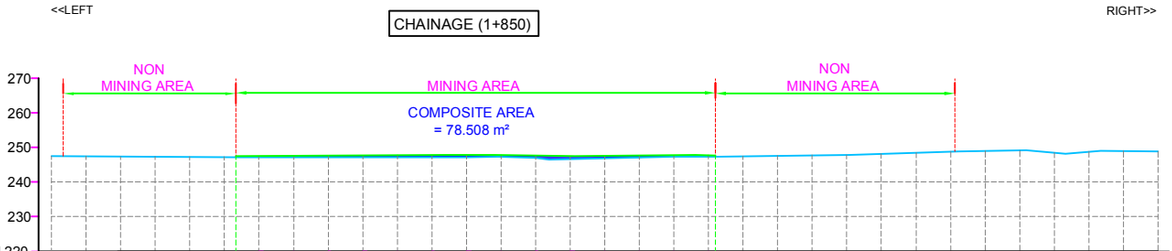
CHAINAGE (1+450)



CHAINAGE (1+650)



CHAINAGE (1+850)



CHAINAGE (2+450)

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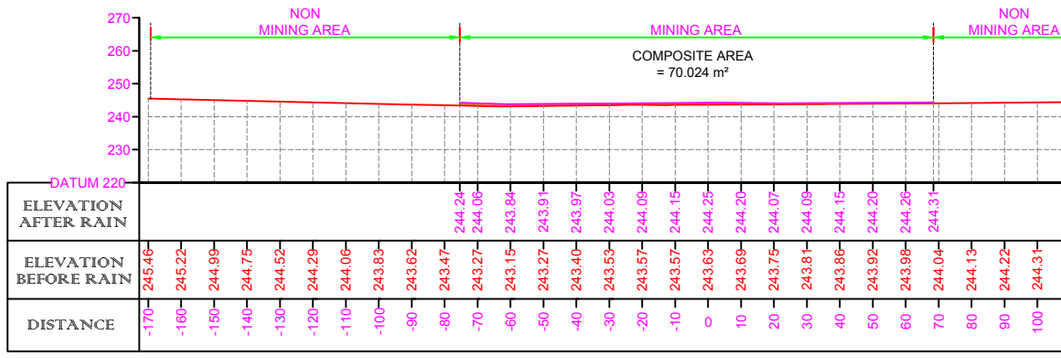
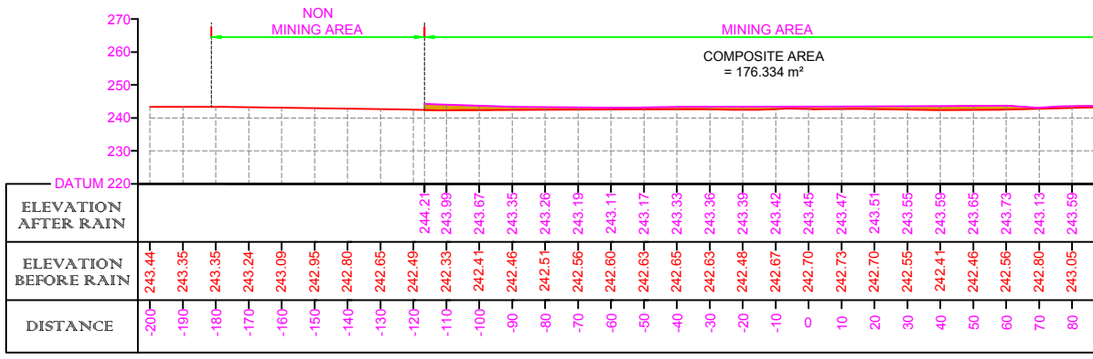


DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-170	245.46	
-160	245.22	
-150	244.99	
-140	244.75	
-130	244.52	
-120	244.29	
-110	244.06	
-100	243.83	
-90	243.62	
-80	243.47	244.24
-70	243.27	244.06
-60	243.15	243.84
-50	243.27	243.91
-40	243.40	243.97
-30	243.53	244.03
-20	243.57	244.09
-10	243.57	244.15
0	243.63	244.25
10	243.69	244.20
20	243.75	244.07
30	243.81	244.09
40	243.86	244.15
50	243.92	244.20
60	243.98	244.26
70	244.04	244.31
80	244.13	
90	244.22	
100	244.31	

CHAINAGE (2+600)

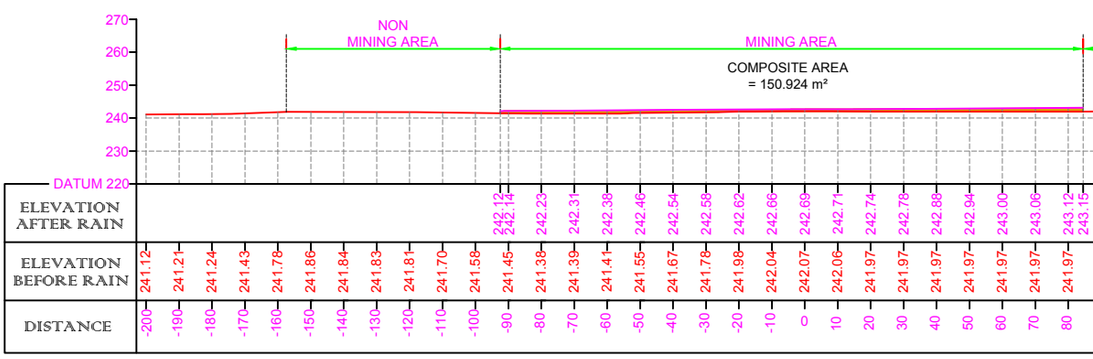
<<LEFT



DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-200	243.44	
-190	243.35	
-180	243.35	
-170	243.24	
-160	243.09	
-150	242.95	
-140	242.80	
-130	242.65	
-120	242.49	
-110	242.33	244.21
-100	242.41	243.99
-90	242.46	243.67
-80	242.51	243.35
-70	242.56	243.26
-60	242.60	243.19
-50	242.63	243.11
-40	242.65	243.17
-30	242.63	243.33
-20	242.48	243.36
-10	242.67	243.38
0	242.70	243.42
10	242.73	243.45
20	242.70	243.47
30	242.55	243.51
40	242.41	243.55
50	242.46	243.59
60	242.56	243.65
70	242.80	243.73
80	243.05	243.13
		243.59

CHAINAGE (2+750)

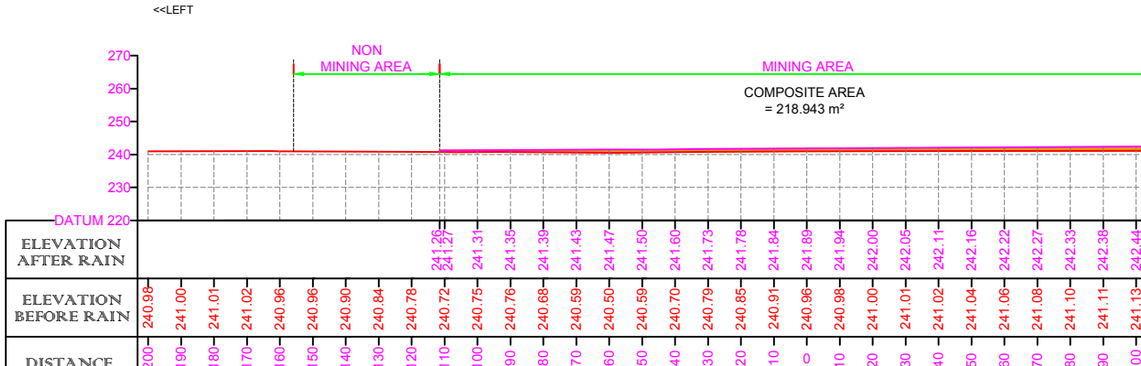
<<LEFT



DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-200	241.12	
-190	241.21	
-180	241.24	
-170	241.43	
-160	241.78	
-150	241.86	
-140	241.84	
-130	241.83	
-120	241.81	
-110	241.70	
-100	241.58	
-90	241.45	242.12
-80	241.38	242.14
-70	241.39	242.23
-60	241.41	242.31
-50	241.55	242.38
-40	241.67	242.46
-30	241.78	242.54
-20	241.98	242.58
-10	242.04	242.62
0	242.07	242.66
10	242.06	242.69
20	241.97	242.71
30	241.97	242.74
40	241.97	242.78
50	241.97	242.88
60	241.97	242.94
70	241.97	243.00
80	241.97	243.06
		243.12
		243.15

CHAINAGE (2+900)

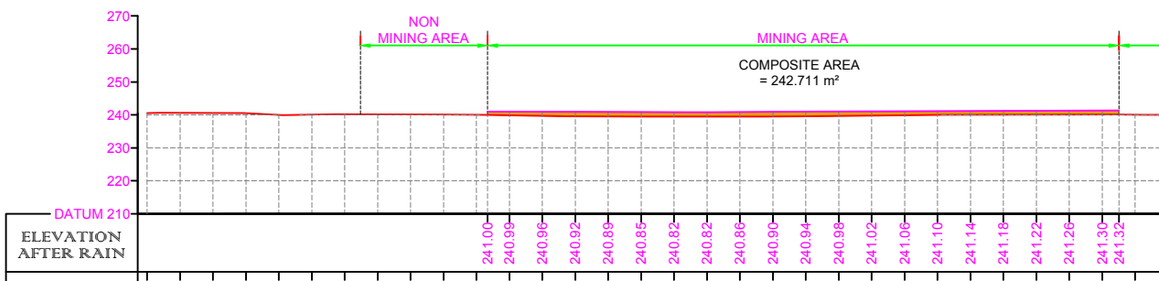
<<LEFT



DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-200	240.98	
-190	241.00	
-180	241.01	
-170	241.02	
-160	240.96	
-150	240.96	
-140	240.90	
-130	240.84	
-120	240.78	
-110	240.72	241.25
-100	240.75	241.27
-90	240.76	241.31
-80	240.68	241.35
-70	240.59	241.39
-60	240.50	241.43
-50	240.59	241.47
-40	240.70	241.50
-30	240.79	241.60
-20	240.85	241.73
-10	240.91	241.78
0	240.96	241.84
10	240.98	241.89
20	241.00	241.94
30	241.01	242.00
40	241.02	242.05
50	241.04	242.11
60	241.06	242.16
70	241.08	242.22
80	241.10	242.27
90	241.11	242.33
100	241.13	242.38
		242.44

CHAINAGE (3+050)

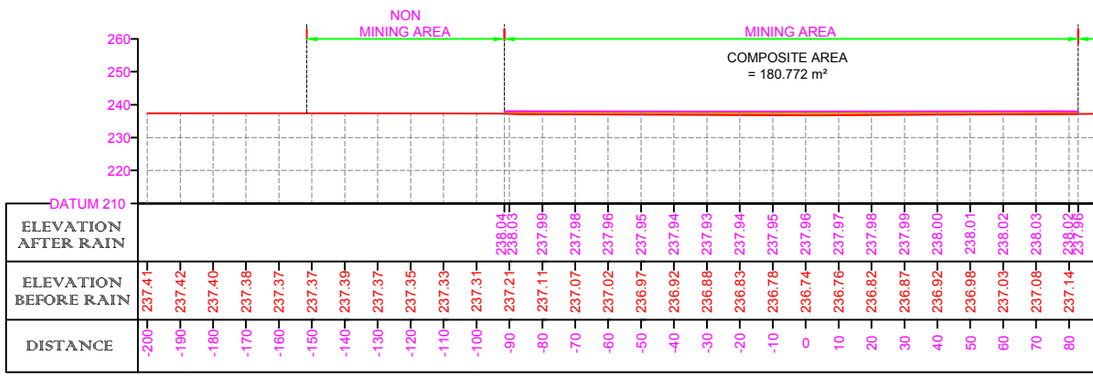
<<LEFT



ELEVATION AFTER RAIN
241.00
240.99
240.96
240.92
240.89
240.85
240.82
240.82
240.86
240.90
240.94
240.98
241.02
241.06
241.10
241.14
241.18
241.22
241.26
241.30
241.32

<<LEFT

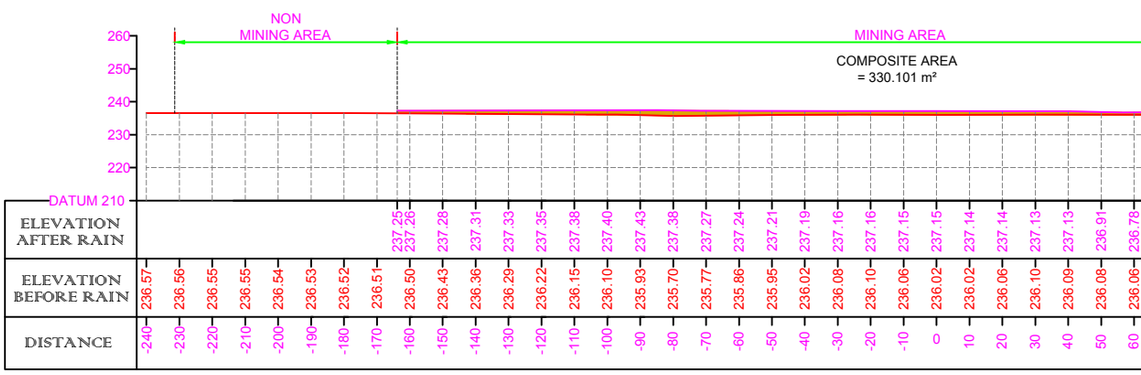
CHAINAGE (3+500)



DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-200	237.41	
-190	237.42	
-180	237.40	
-170	237.38	
-160	237.37	
-150	237.37	
-140	237.39	
-130	237.37	
-120	237.35	
-110	237.33	
-100	237.31	
-90	237.21	238.04
-80	237.11	238.03
-70	237.07	237.99
-60	237.02	237.98
-50	236.97	237.96
-40	236.92	237.95
-30	236.88	237.94
-20	236.83	237.93
-10	236.78	237.94
0	236.74	237.95
10	236.76	237.96
20	236.82	237.97
30	236.87	237.98
40	236.92	237.99
50	236.98	238.00
60	237.03	238.01
70	237.08	238.02
80	237.14	238.03
		237.96

<<LEFT

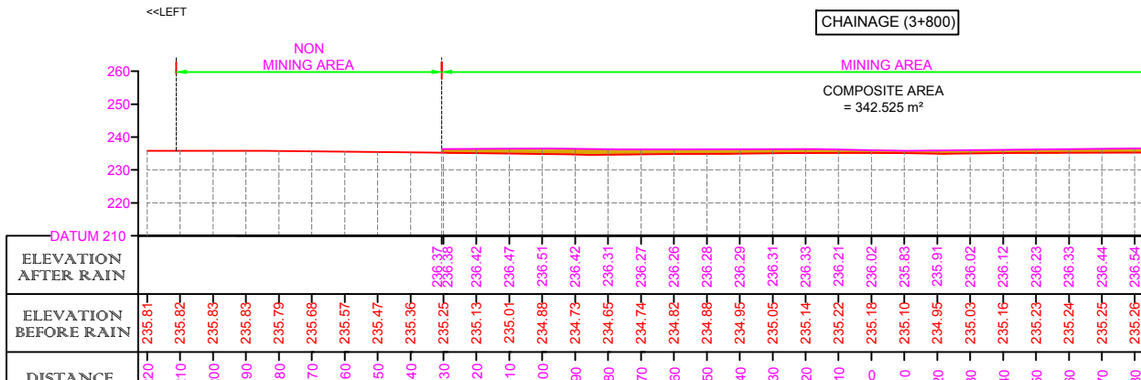
CHAINAGE (3+650)



DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-240	236.57	
-230	236.56	
-220	236.55	
-210	236.55	
-200	236.54	
-190	236.53	
-180	236.52	
-170	236.51	
-160	236.50	237.25
-150	236.43	237.26
-140	236.36	237.28
-130	236.29	237.31
-120	236.22	237.33
-110	236.15	237.35
-100	236.10	237.38
-90	235.93	237.40
-80	235.70	237.43
-70	235.77	237.38
-60	235.86	237.27
-50	235.95	237.24
-40	236.02	237.21
-30	236.08	237.19
-20	236.10	237.16
-10	236.06	237.16
0	236.02	237.15
10	236.02	237.15
20	236.06	237.14
30	236.10	237.14
40	236.09	237.13
50	236.08	237.13
60	236.06	236.91
		236.78

<<LEFT

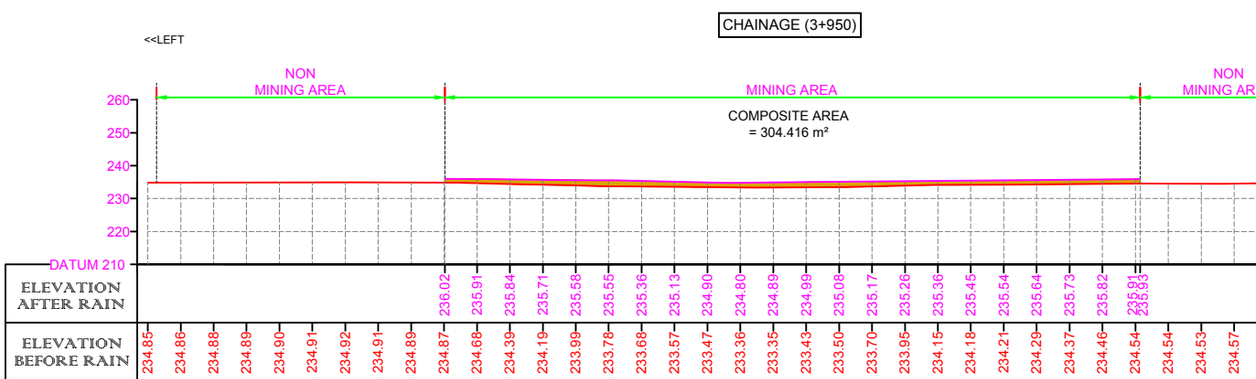
CHAINAGE (3+800)



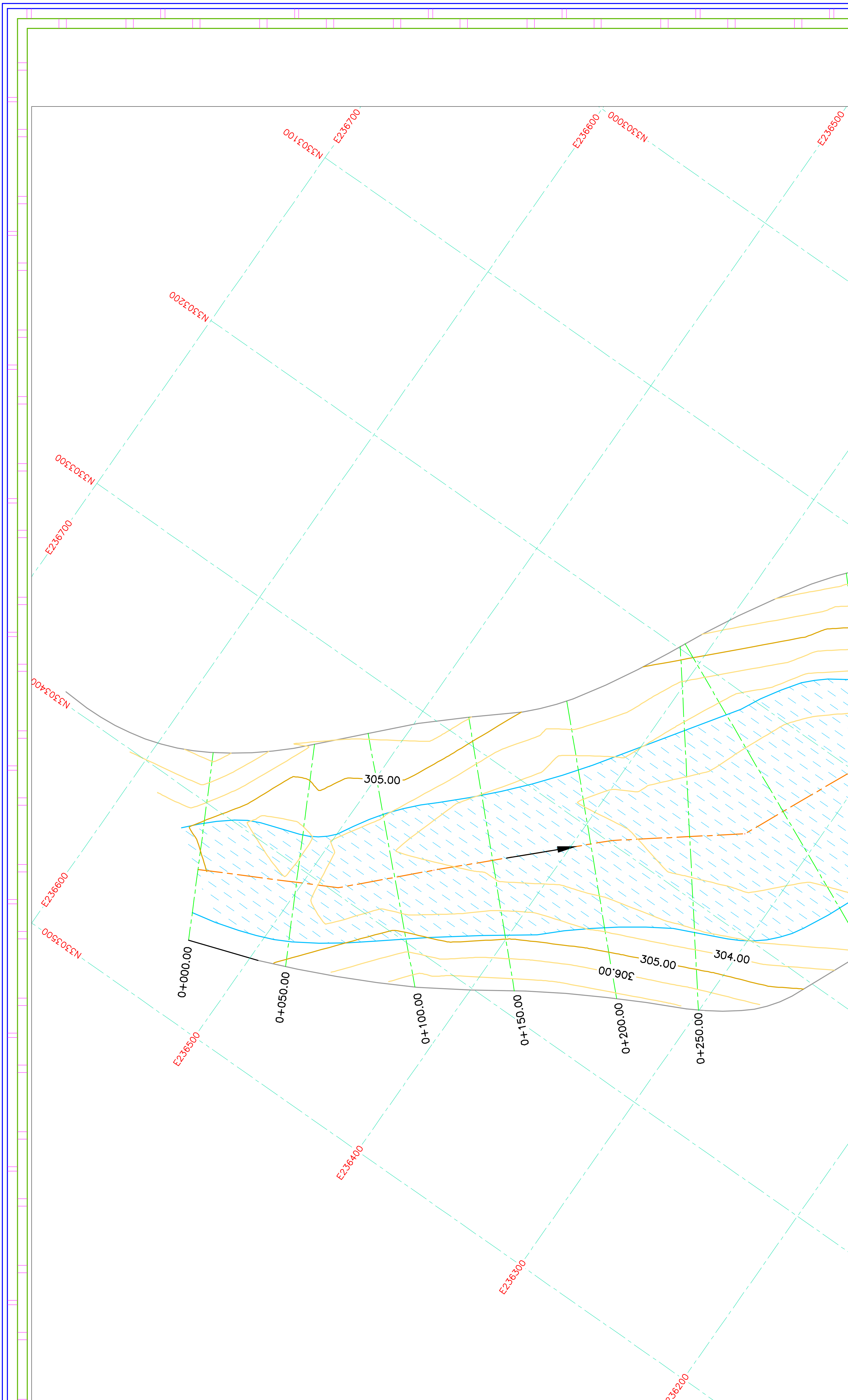
DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-220	235.81	
-210	235.82	
-200	235.83	
-190	235.83	
-180	235.79	
-170	235.68	
-160	235.57	
-150	235.47	
-140	235.36	
-130	235.25	236.38
-120	235.13	236.42
-110	235.01	236.47
-100	234.88	236.51
-90	234.73	236.42
-80	234.65	236.31
-70	234.74	236.27
-60	234.82	236.26
-50	234.88	236.28
-40	234.95	236.29
-30	235.05	236.31
-20	235.14	236.33
-10	235.22	236.21
0	235.18	236.02
10	235.10	235.83
20	234.95	235.91
30	235.03	236.02
40	235.16	236.12
50	235.23	236.23
60	235.24	236.33
70	235.25	236.44
80	235.26	236.54

<<LEFT

CHAINAGE (3+950)

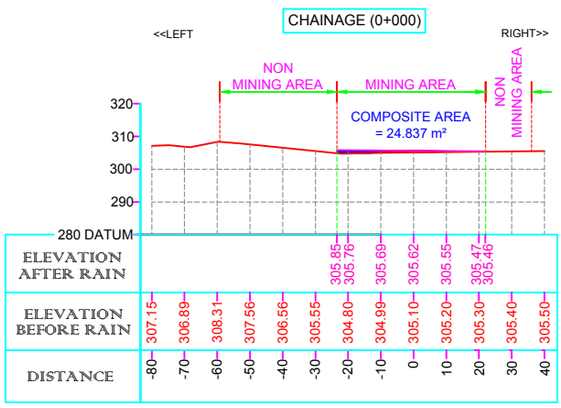


DISTANCE	ELEVATION BEFORE RAIN	ELEVATION AFTER RAIN
-200	234.85	
-190	234.86	
-180	234.88	
-170	234.89	
-160	234.90	
-150	234.91	
-140	234.92	
-130	234.91	
-120	234.89	
-110	234.87	236.02
-100	234.68	235.91
-90	234.39	235.84
-80	234.19	235.71
-70	233.99	235.58
-60	233.78	235.55
-50	233.68	235.36
-40	233.57	235.13
-30	233.47	234.90
-20	233.36	234.80
-10	233.35	234.89
0	233.43	234.99
10	233.50	235.08
20	233.70	235.17
30	233.95	235.26
40	234.15	235.36
50	234.18	235.45
60	234.21	235.54
70	234.29	235.64
80	234.37	235.73
90	234.46	235.82
100	234.54	235.91
110	234.54	235.93
120	234.53	
130	234.57	



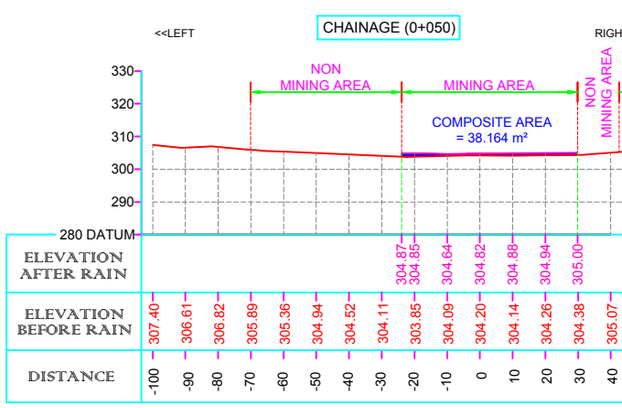
E236700
N3303100
E236600
N3303000
E236500
N3303200
N3303300
E236700
N3303400
E236600
N3303500
305.00
305.00
304.00
306.00
0+000.00
0+050.00
0+100.00
0+150.00
0+200.00
0+250.00
E236500
E236400
E236300

CHAINAGE (0+000)



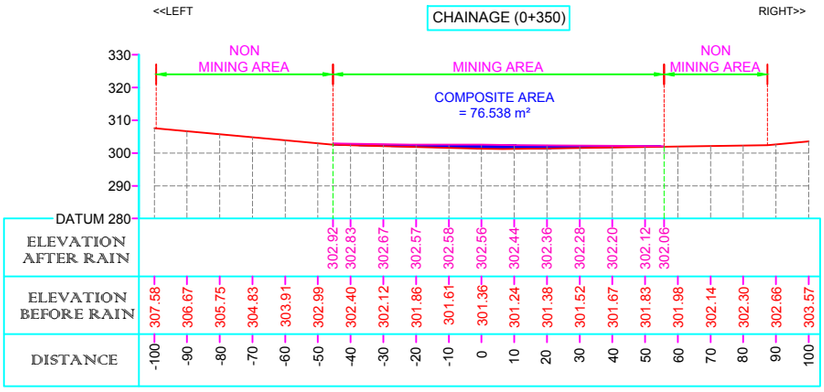
DISTANCE	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40
ELEVATION BEFORE RAIN	307.15	306.89	308.31	307.56	306.56	305.55	304.80	304.99	305.10	305.20	305.30	305.40	305.50
ELEVATION AFTER RAIN							305.85	305.76	305.69	305.62	305.55	305.47	305.46

CHAINAGE (0+050)

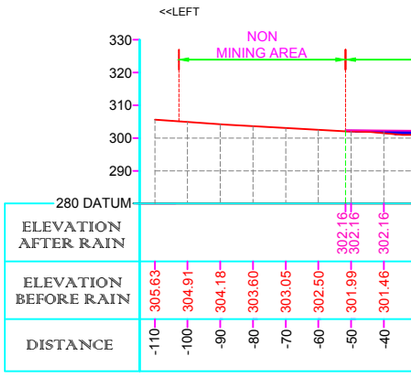


DISTANCE	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40
ELEVATION BEFORE RAIN	307.40	306.61	306.82	305.89	305.36	304.94	304.52	304.11	303.85	304.09	304.20	304.14	304.26	304.38	305.07
ELEVATION AFTER RAIN									304.87	304.85	304.64	304.82	304.88	304.94	305.00

CHAINAGE (0+350)

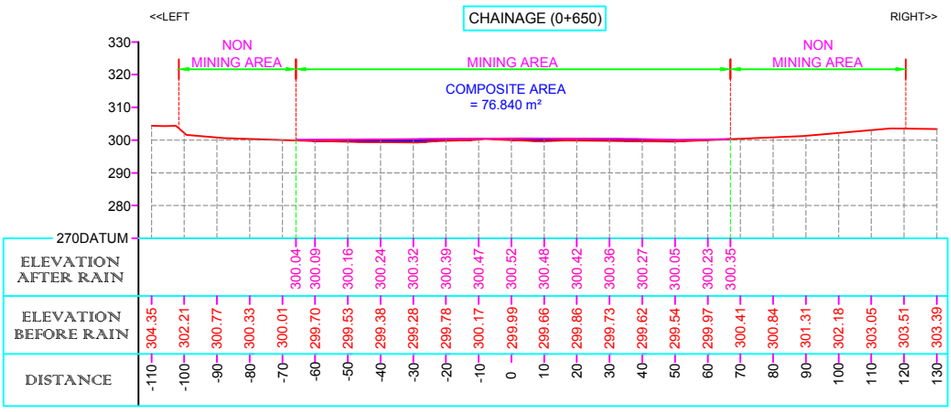


DISTANCE	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
ELEVATION BEFORE RAIN	307.58	306.67	305.75	304.83	303.91	302.99	302.40	302.12	301.86	301.61	301.36	301.24	301.38	301.52	301.67	301.83	301.98	302.14	302.30	302.66	303.57
ELEVATION AFTER RAIN							302.92	302.83	302.67	302.57	302.58	302.56	302.44	302.36	302.28	302.20	302.12	302.06			

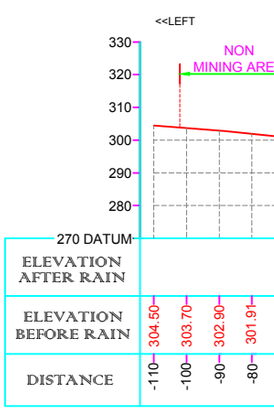


DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40
ELEVATION BEFORE RAIN	305.63	304.91	304.18	303.60	303.05	302.50	301.99	301.46
ELEVATION AFTER RAIN							302.16	302.16

CHAINAGE (0+650)

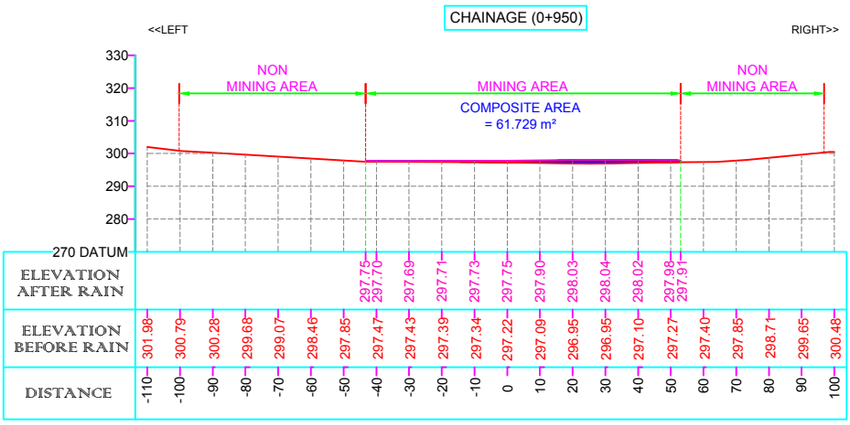


DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130
ELEVATION BEFORE RAIN	304.35	302.21	300.77	300.33	300.01	299.70	299.53	299.38	299.28	299.78	300.17	299.99	299.66	299.86	299.73	299.62	299.54	299.97	300.41	300.84	301.31	302.18	303.05	303.51	303.39
ELEVATION AFTER RAIN												300.04	300.09	300.16	300.24	300.32	300.39	300.47	300.52	300.48	300.42	300.36	300.27	300.05	300.23	300.35

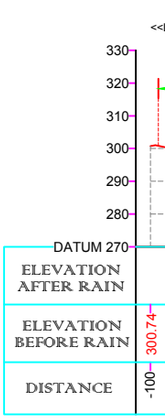


DISTANCE	-110	-100	-90	-80
ELEVATION BEFORE RAIN	304.50	303.70	302.90	301.91
ELEVATION AFTER RAIN				

CHAINAGE (0+950)

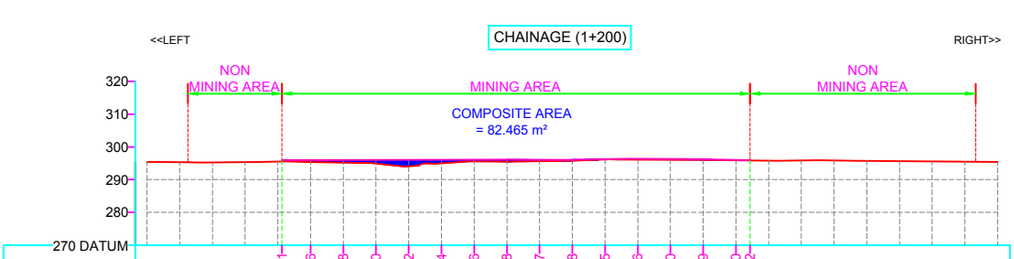


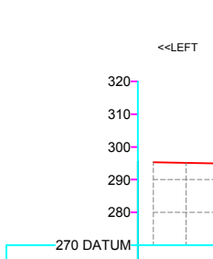
DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
ELEVATION BEFORE RAIN	301.98	300.79	300.28	299.68	299.07	298.46	297.85	297.47	297.43	297.39	297.34	297.22	297.09	296.95	296.95	297.10	297.27	297.40	297.85	298.71	299.65	300.48
ELEVATION AFTER RAIN												297.75	297.70	297.69	297.71	297.73	297.75	297.90	298.03	298.04	298.02	297.98	297.91			



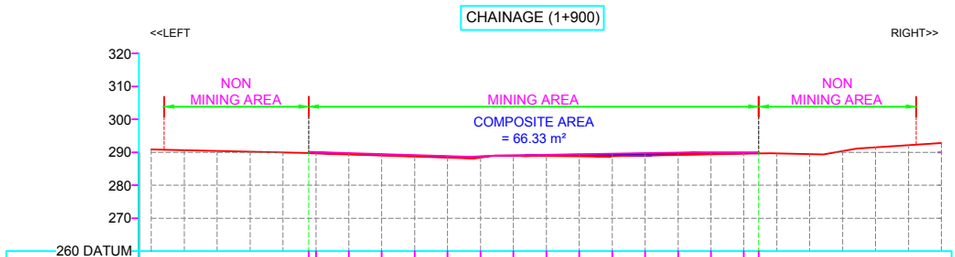
DISTANCE	-100
ELEVATION BEFORE RAIN	300.74
ELEVATION AFTER RAIN	

CHAINAGE (1+200)



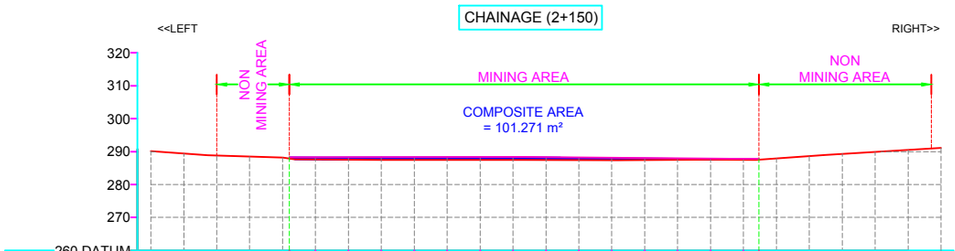


CHAINAGE (1+900)



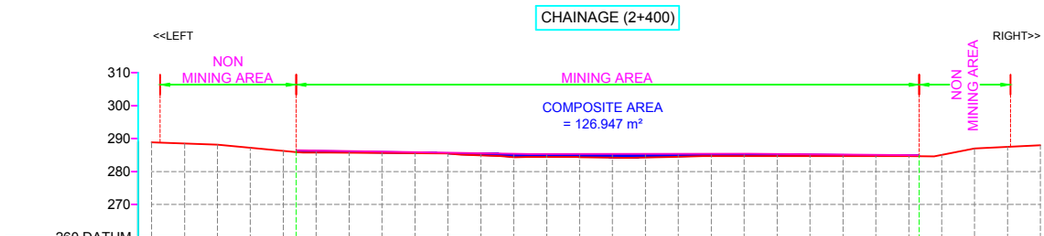
DISTANCE	-110	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120
ELEVATION BEFORE RAIN	290.89	290.67	290.44	290.21	289.99	289.70	289.37	289.04	288.71	288.38	288.40	288.96	289.08	289.25	288.93	288.81	288.77	288.99	289.15	289.39	289.62	289.64	289.45	290.41	291.54	292.20	292.86
ELEVATION AFTER RAIN						290.15 290.07	289.72	289.43	289.14	288.85	288.80	289.08	289.25	289.42	289.58	289.75	289.92	289.99	289.99 289.98								

CHAINAGE (2+150)



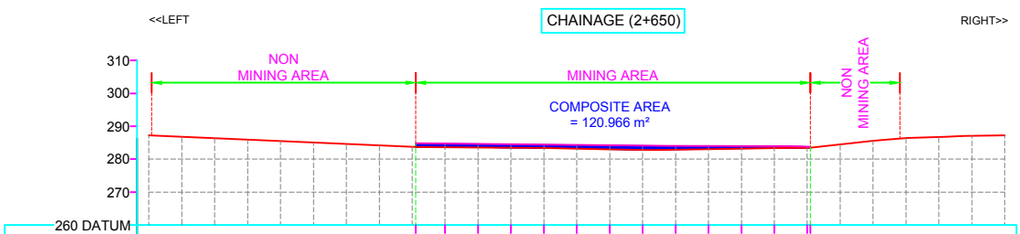
DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	120
ELEVATION BEFORE RAIN	290.09	289.41	288.82	288.48	288.14	287.58	287.52	287.48	287.48	287.48	287.48	287.49	287.47	287.44	287.42	287.46	287.51	287.57	287.50	287.92	288.64	289.30	289.89	290.49	291.09
ELEVATION AFTER RAIN					288.29	288.30	288.31	288.32	288.34	288.35	288.36	288.38	288.33	388.24	288.15	288.06	287.97	287.89	287.83 287.83						

CHAINAGE (2+400)



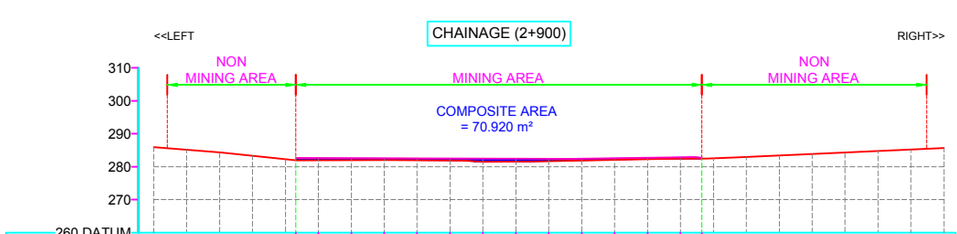
DISTANCE	-110	-110	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140
ELEVATION BEFORE RAIN	288.90	288.52	288.14	287.21	286.28	285.77	285.72	285.63	285.54	285.43	284.92	284.31	284.42	284.37	284.23	284.28	284.49	284.66	284.68	284.69	284.70	284.71	284.72	284.72	285.08	286.97	287.50	288.02
ELEVATION AFTER RAIN					286.51	286.41	286.24	286.06	285.89	285.72	285.55	285.38	285.31	285.33	285.35	285.37	285.39	285.41	285.43	285.36	285.27	285.18	285.10	285.01 284.98				

CHAINAGE (2+650)



DISTANCE	-140	-130	-120	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120
ELEVATION BEFORE RAIN	287.26	286.82	286.38	285.94	285.50	285.06	284.62	284.18	283.73	283.60	283.54	283.47	283.40	283.20	283.01	282.81	282.89	283.06	283.20	283.34	283.42	284.47	285.55	286.39	286.70	287.13	287.23
ELEVATION AFTER RAIN									284.84	284.74	284.64	284.53	284.42	284.32	284.21	284.10	284.01	283.99	283.97	286.96	283.77 283.74						

CHAINAGE (2+900)



DISTANCE	-110	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	120
ELEVATION BEFORE RAIN	285.91	285.12	284.33	283.32	282.30	281.99	282.02	282.04	281.96	281.87	281.46	281.57	281.71	281.91	282.10	282.29	282.41	282.55	282.97	283.42	283.87	284.32	284.77	285.22	285.67
ELEVATION AFTER RAIN																									

533

BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI

APPEAL NO.23 OF 2016

IN THE MATTER OF:

DR. VIJAY VERMA .....APPELLANT

VERSUS

UTTARAKHAND FOREST DEVELOPMENT CORPORATION & ORS. .....RESPONDENTS

PROOF OF SERVICE

S. No.	APPELLANT & RESPONDENTS DETAILS/PARTICULARS	MODE OF SERVICE
1.	Dr. Vijay Verma S/o Late J.P. Verma, H.No.86, Bilkeshwar Colony, Haridwar, Uttarakhand-249401	Kalyan 19/11/2018
2.	Uttarakhand Forest Development Corporation Through its Managing Director, Aranya Vikas Bhawan, Dehradun, Uttarakhand – 248001	Rahul Verma 19/11/18
3.	Environment Impact Assessment Authority Through its Secretary Ministry of Environment Forest & Climate Change, Government of India, Indira Paryavaran Bhawan, Jorbagh, New Delhi-110003	19/11/18
4.	Mines & Geology Department Through its Director, Bhopalpani, Raipur-Thano-Airport Motor Marg, P.O.: Dhanyari, Dehradun-248008	Rahul Verma 19/11/18
5.	Uttarakhand Environment & Pollution Control Board Through its Member Secretary, 29/20, Nemi Road, Dehradun, Uttarakhand-248001	19/11/2018
6.	Central Pollution Control Board Through its Member Secretary, Parivesh Bhawan, East Arjun Nagar, Delhi-110032	19/11/18

Sanjay

SANJAY KATYAL
ADVOCATE
A-53, Ashok Vihar, Phase-III,
Delhi-110052

NEW DELHI
DATED:- 19.11.2018