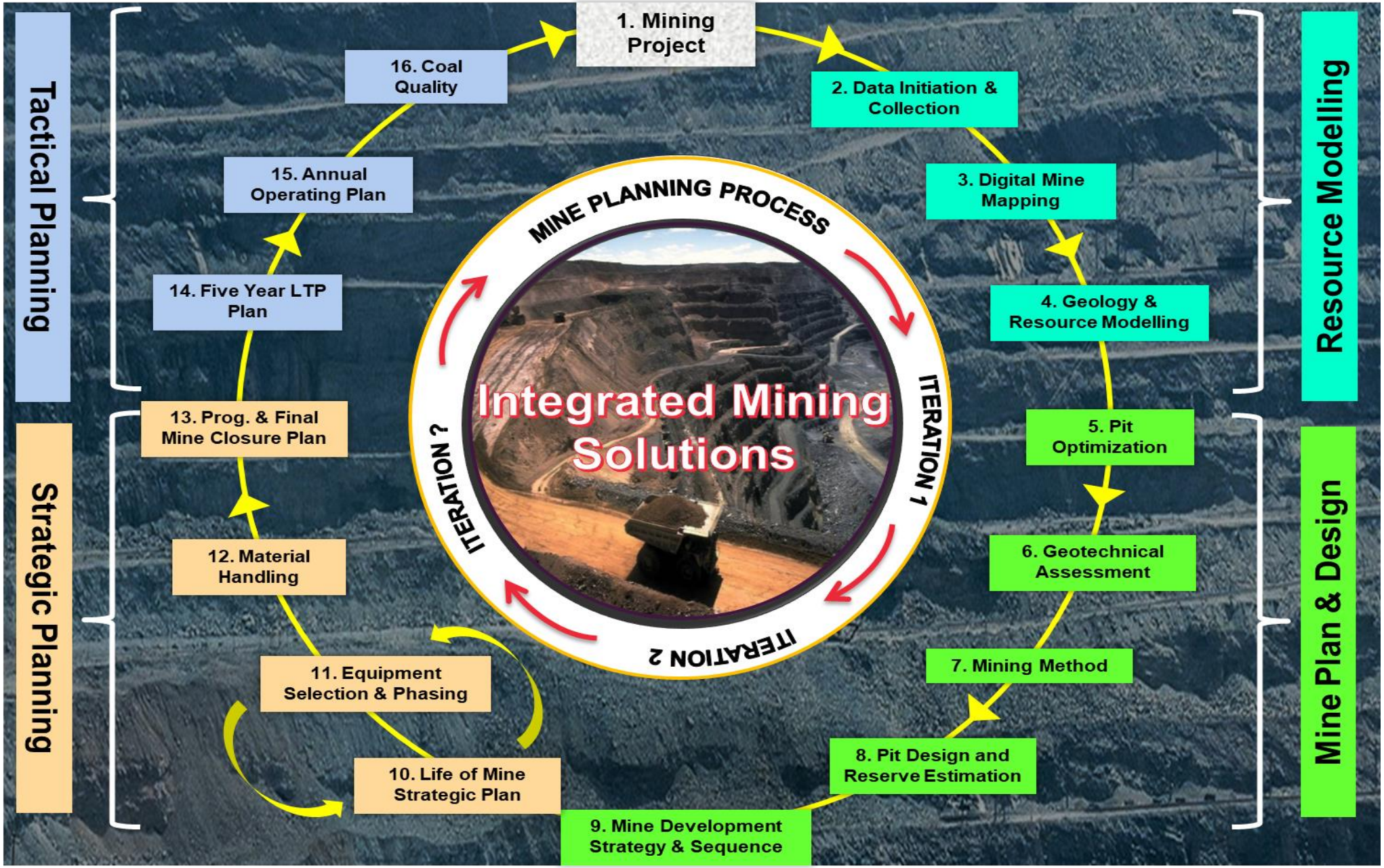
Digital Mine Mapping & Monitoring using drones

Webinar: Geospatial Technology supporting sustainable mandate towards digital infrastructure of mining

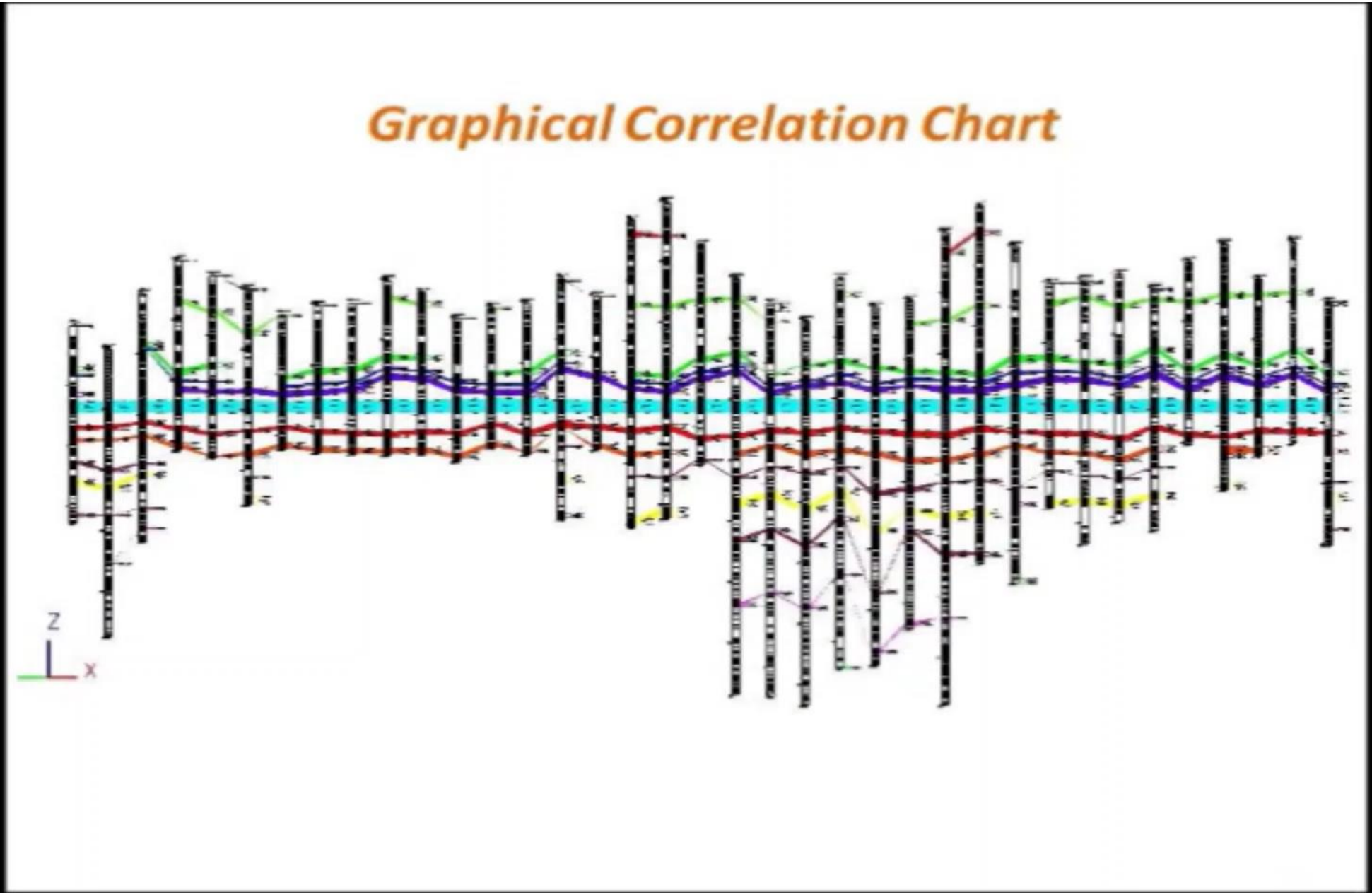
Chief – Natural Resources Division

19th October 2023

Mine Planning Process



Geology & Resource Modelling



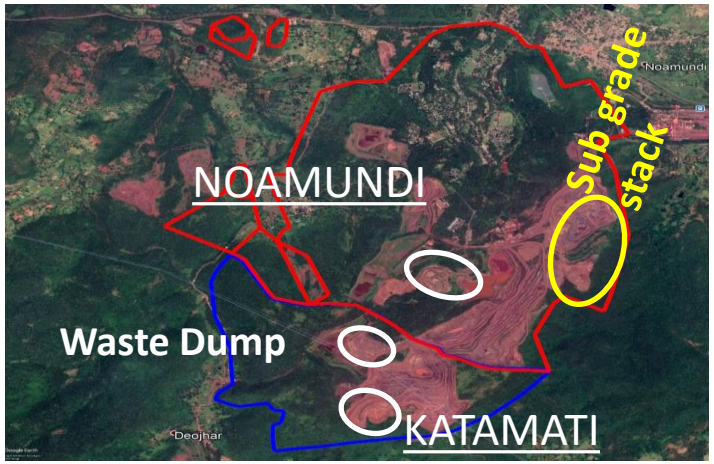
Technical Studies for Mine Planning

Topographical study

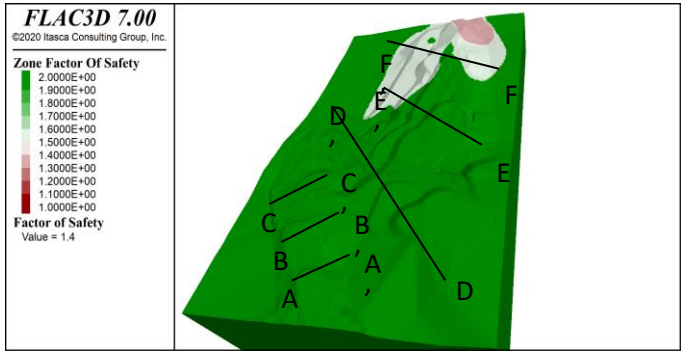
Geotechnical Study

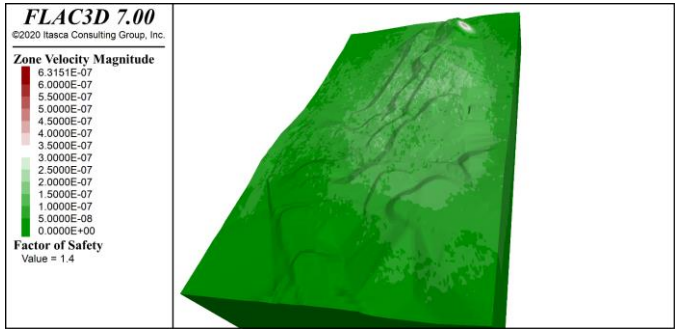
Hydrogeological Study

Surface Constraint Study

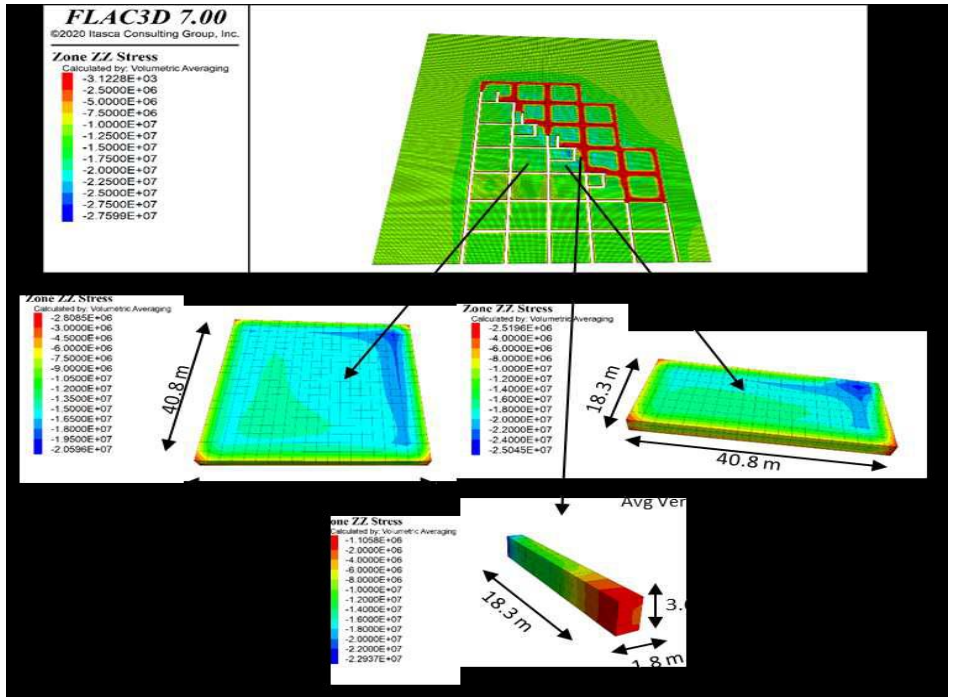


Noamundi Sub-grade Dump - Results





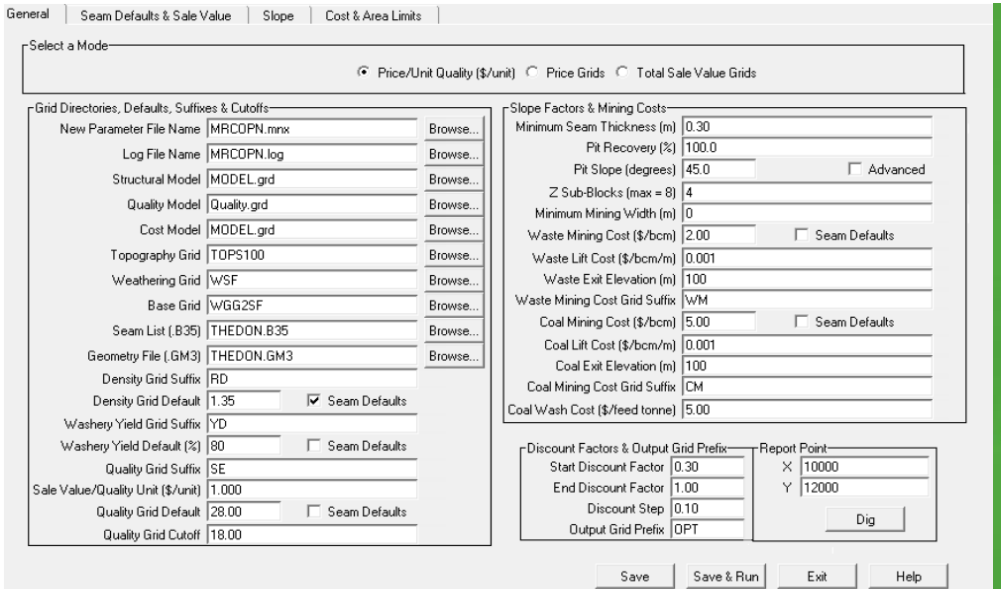
FoS 1.4



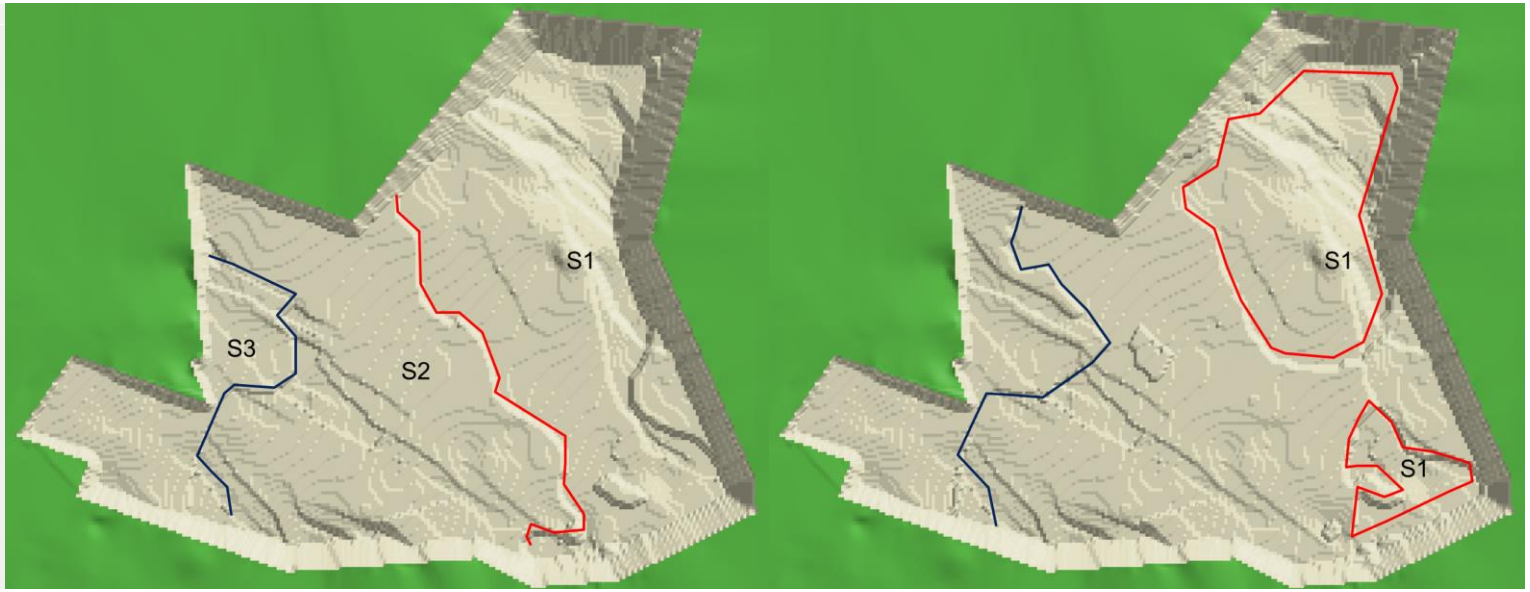
Underground roof and side stress mapping using numerical modeling

Parameter	Result
Density (g/cc)	2.209
Cohesion (Pa)	9830
Friction (°)	32
Dilation	2

Pit Optimization

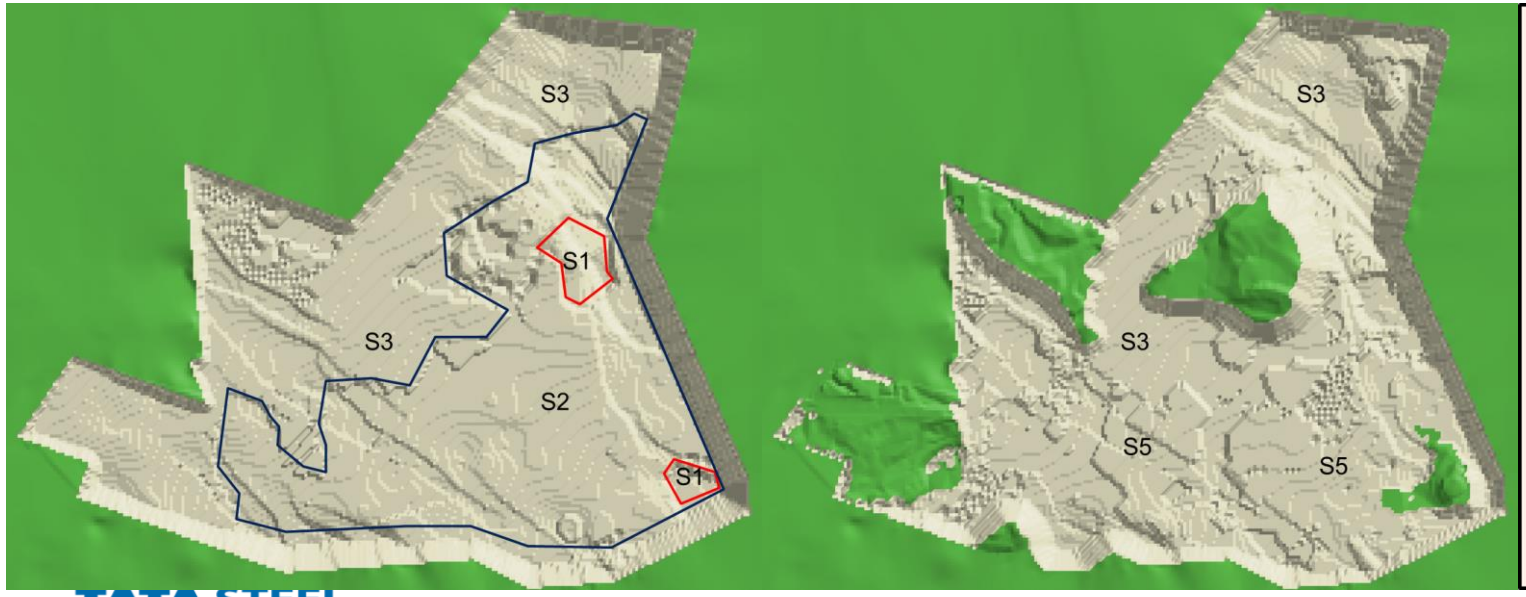


Input Parameters



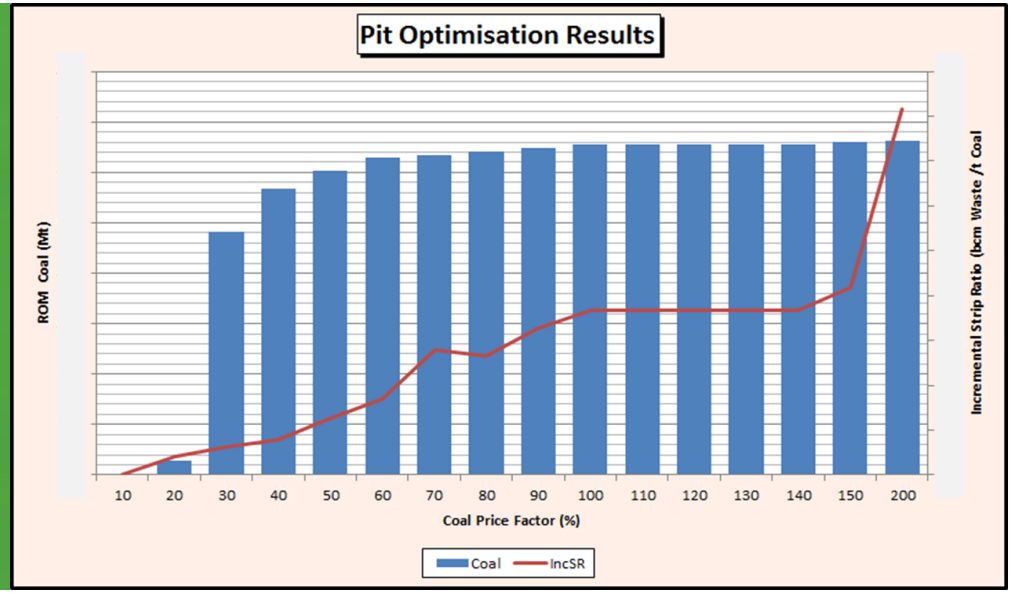
FF @ 150%

FF @ 100%



FF @ 70%

FF @ 30%



Break Even Strip Ratio at 100% FF is 18.3 (bcm/T)

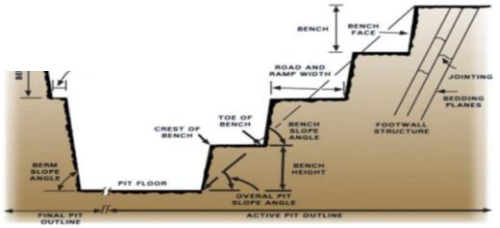
TATA STEEL
#WeAlsoMakeTomorrow

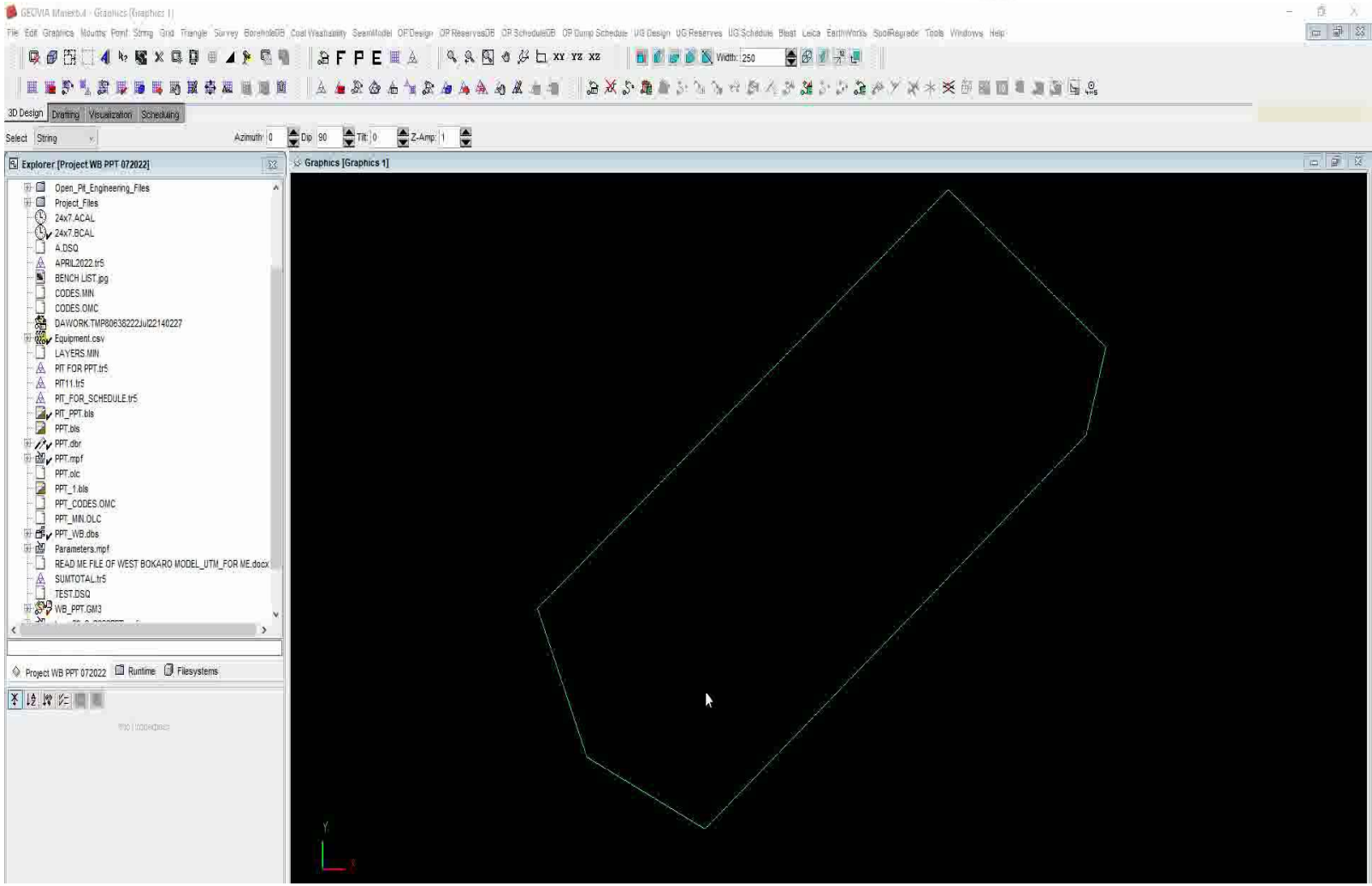
Mine Design

UPL Design Parameters	
Bench height	12 m
Individual Bench Slope	75°
Berm Width	10 m
Overall Pit Slope	45°
Haul Road Width	40 m
Haul Road Gradient	1 in 16

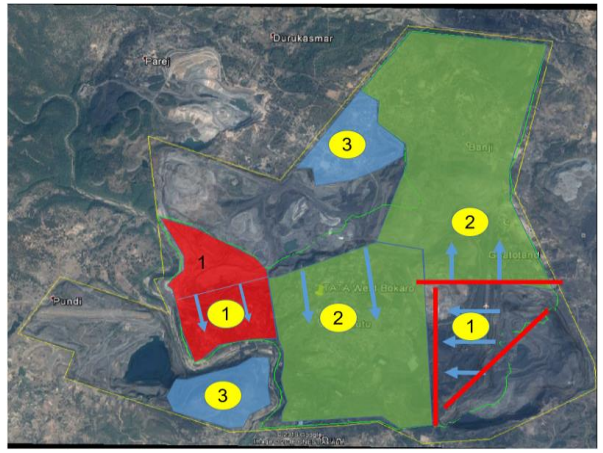
Dump Design Parameters	
Max Dump height	90m above OGL
Max height per lift	30 m
Individual Bench Slope	37°
Berm Width	30 m
Overall Dump Slope	22°
OB Swell Factor	1.25

Parameter for Conversion of In-situ to ROM Reserves		
Description	**Units**	**Factor Applied**
Global Loss	%	10
Roof Loss	m	0.07
Floor Loss	m	0.07
Roof Dilution	m	0.05
Floor dilution	m	0.05
Minimum Coal mining thickness	m	0.6

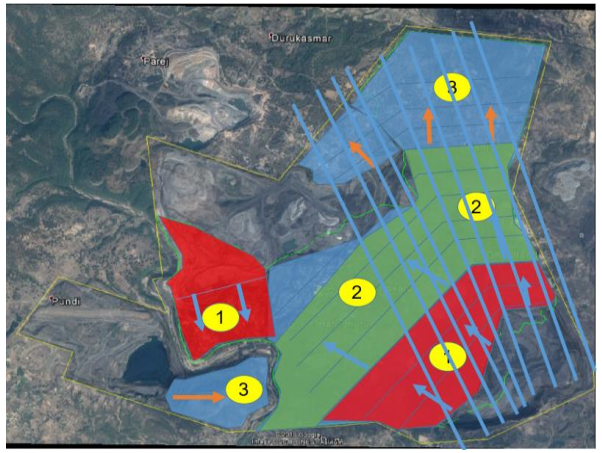




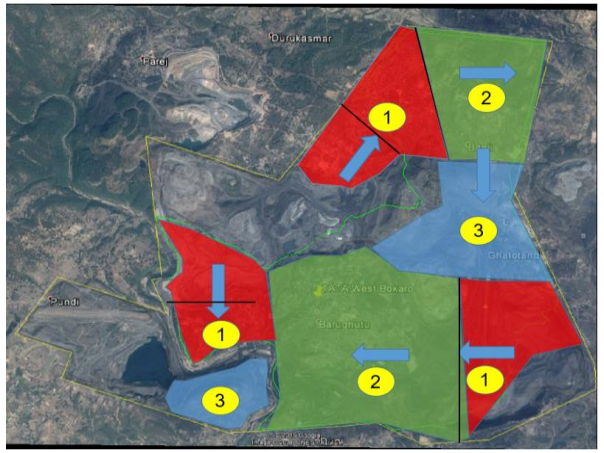
Long Term Development Strategy & Sequence



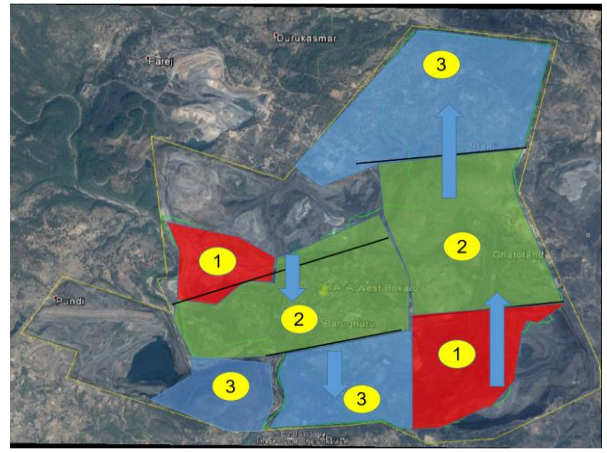
Sequence – I



Sequence – II



Sequence – III



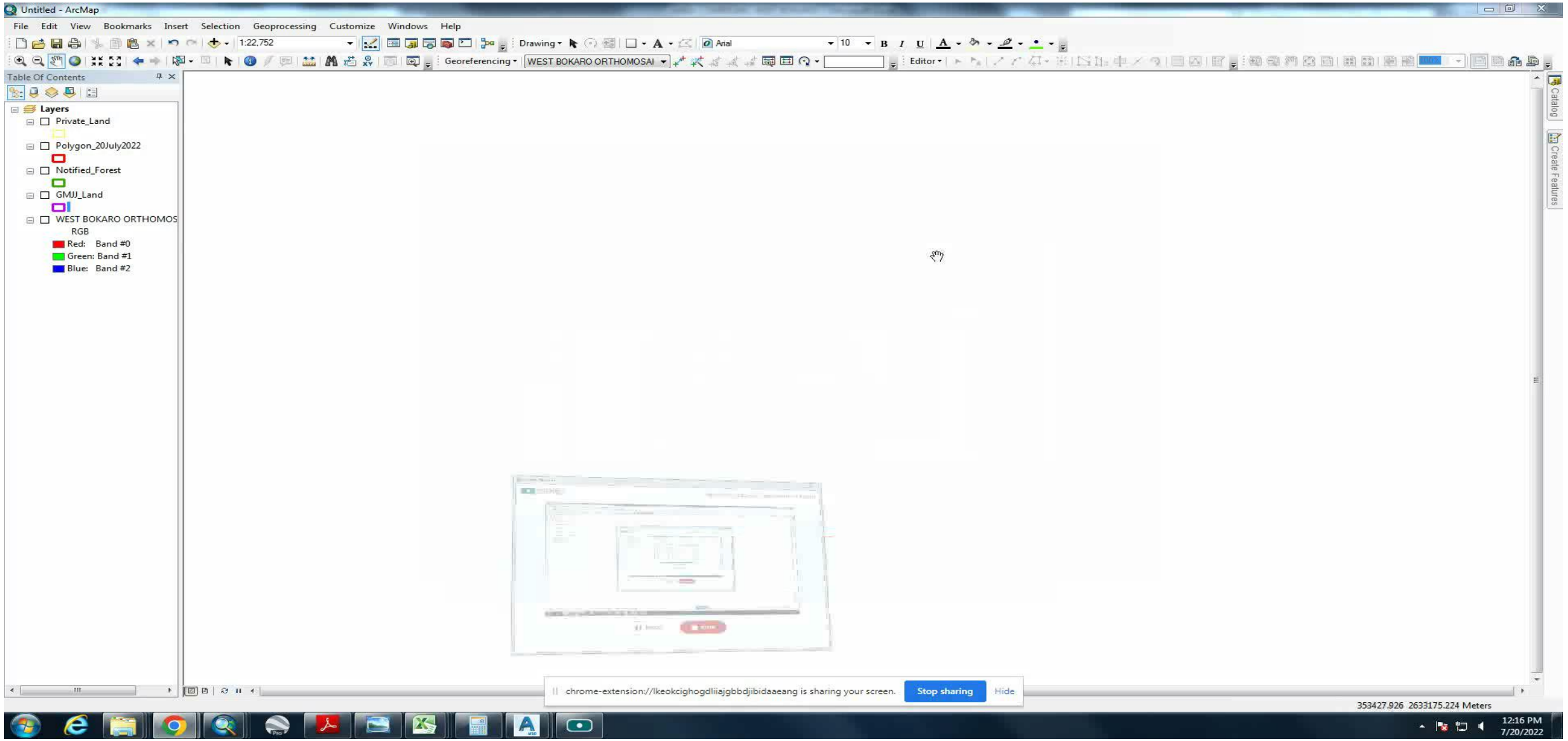
Sequence – IV

Seq II	Seq IV
Mine Life of 26 years	Mine Life of 29 years
Waste varies 60-70Mbcm/yr	Waste peaks at ~60 Mbcm/yr
ROM peaks at 20 MTPA for 16 yrs	ROM peaks at 18.5 MTPA for 14 yrs
Clean coal at 9.6 MTPA	Clean coal at ~ 9.0 (8.85) MTPA
No new rehandling of Expit waste	18 Mbcum of new rahndling of expit
Opex: Rs	Opex: Rs

Sequence	Rate	Dumping	Complexity	Wash/Banj	Score	Rank
1	3	4	3	4	14	5
2	4	3	5	3	15	2
3	4	3	4	2	13	7
4	5	4	4	5	18	1
5	3	4	4	4	15	2
6	3	5	4	3	15	2
7	3	4	4	3	14	5
8	5	2	2	3	12	8
9	3	3	3	3	12	8

Preparation of Long Term Plans

Georeferencing of ABP area over Cadastral Plan

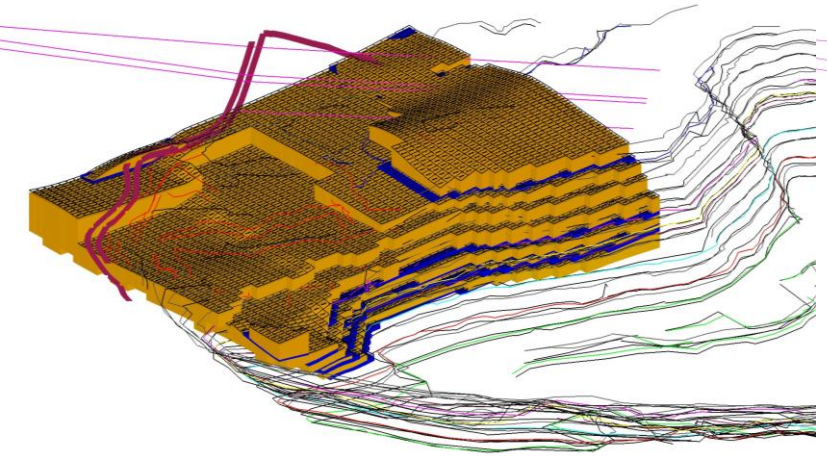


Short Term Planning

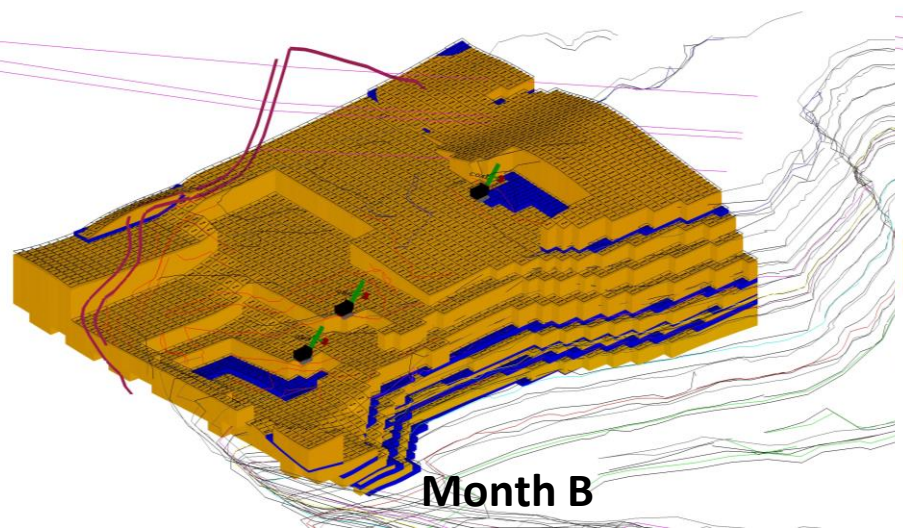
Short Term Planning (Quarterly/Monthly/Weekly Plan)

Scheduling Scenario Outputs & Face Positions:

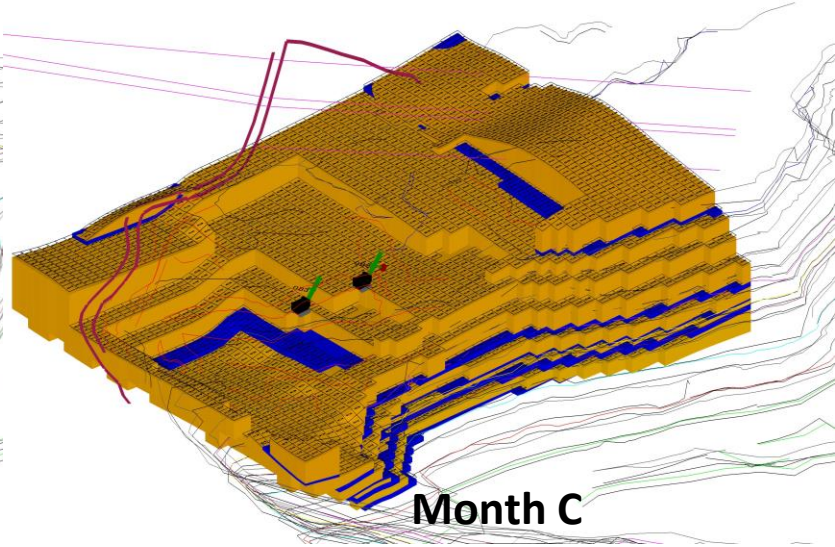
Schedule Number	Pit Number	Layer Name	Waste Volume	Coal Tonnes	Stripping Ratio
2	333	S11OB	22347.6	0	
2	333	S11C	0	7053.2	
2	333	S10OB	1102239.6	0	
2	333	S10C	0	165037.4	
2	333	S9OB	201392.4	0	
2	333	S9C	0	58133.9	
2	333	S8OB	53976	0	
2	333	S8C	0	93599	
Grand Total			**1379955.6**	**323823.5**	**4.26**



Month A

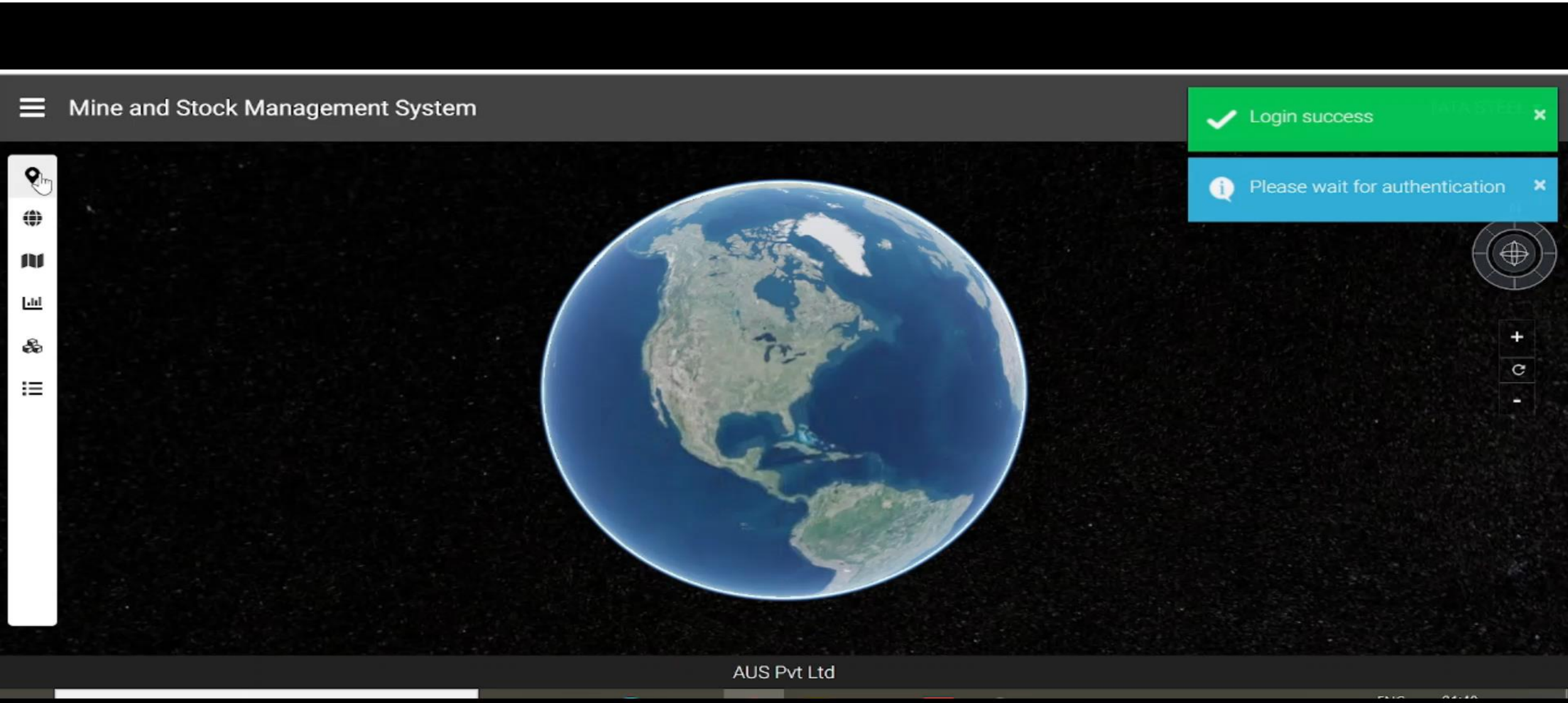


Month B

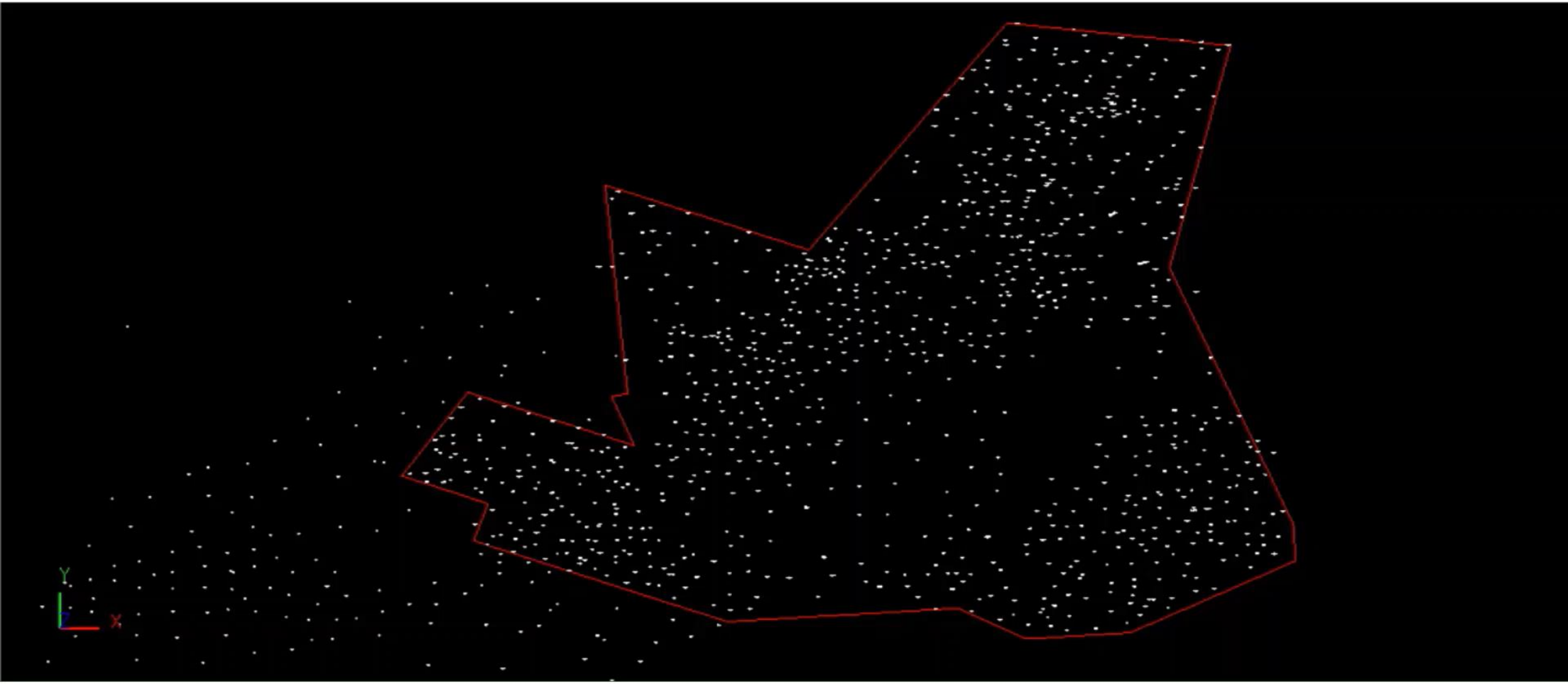


Month C

Remote Monitoring through Cloud Platform



Remote Monitoring through Integration of Minex & Drone applications

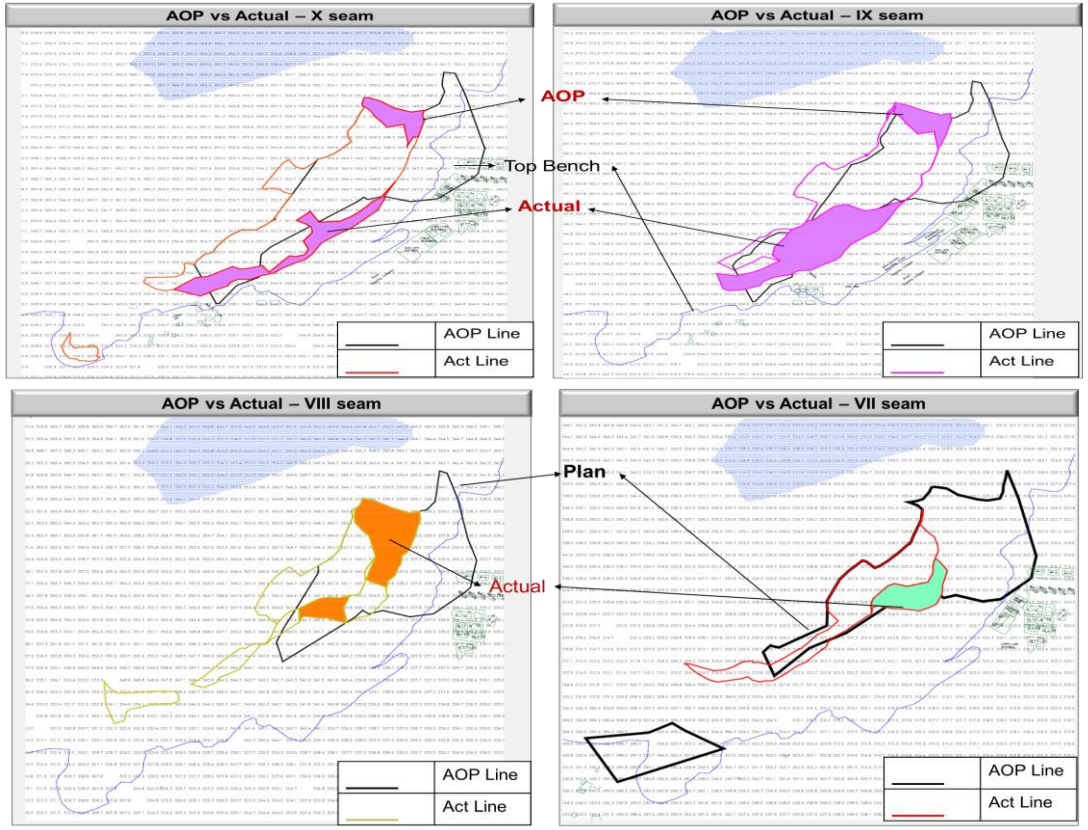


Spatial Compliance (Plan Vs Actual)

Rolling Plan & Projections for Annual Target

Description		April		May		June		July		August		September		October		November		December		January		February		March		Year	
		Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Rev	Plan	Rev	Plan	Rev	Plan	Rev	Plan	Rev	Plan	Rev	Plan	Rev
Over Burden	QAB	11.25	11.20	12.64	12.52	12.71	12.83	10.51	14.56	9.38	10.94	9.64	10.36	9.96	10.80	9.96	10.80	9.96	10.80	9.96	11.00	10.03	11.50	10.03	11.96	126.04	139.27
	QSE	3.69	3.66	3.30	4.04	6.37	6.76	8.10	8.36	10.72	10.05	10.80	10.65	10.80	10.84	10.80	10.85	10.80	11.00	10.80	11.00	10.76	11.00	11.70	11.00	108.64	109.21
	Total (OB)	16.34	14.87	15.94	16.16	19.08	19.59	18.61	22.92	20.10	20.99	20.44	21.01	20.76	21.64	20.76	21.65	20.76	21.80	20.76	22.00	20.79	22.50	21.73	22.96	236.08	248.09
Raw Coal	Total QAB	2.30	2.31	2.30	2.57	3.04	3.07	2.90	2.92	2.80	2.76	2.80	2.91	2.80	2.90	2.40	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.45	31.34	31.89
	Total QSEB	0.80	0.82	0.70	0.68	0.90	0.89	1.60	1.58	1.30	1.03	1.54	1.52	3.11	3.28	3.36	3.35	3.36	3.40	3.28	3.30	3.00	3.15	3.30	3.30	26.25	26.30
	Total RC	3.10	3.12	3.00	3.25	3.94	3.96	4.50	4.50	4.10	3.79	4.34	4.43	5.91	6.18	5.76	5.85	5.86	5.90	5.78	5.80	5.50	5.65	5.80	5.80	57.59	58.23

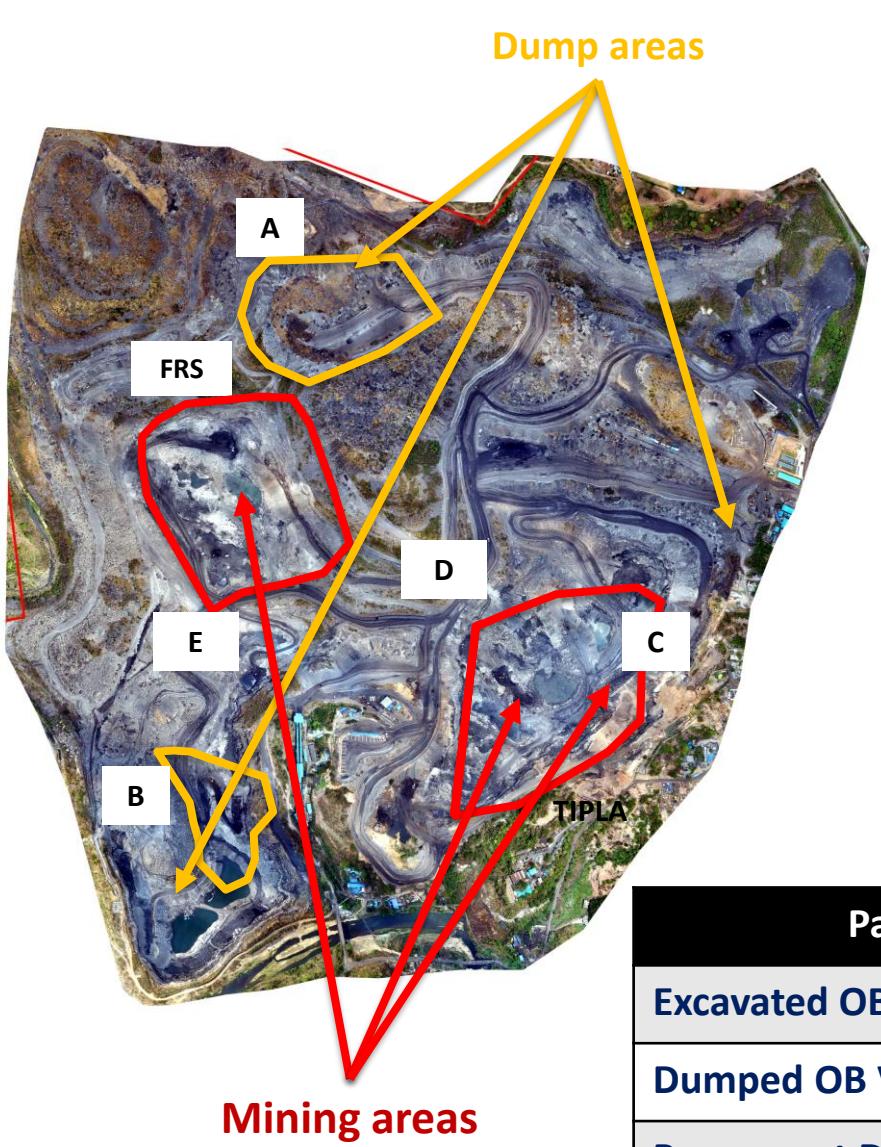
KPI	KPI's	UoM	Sep					YTD		
			ABP	Rolling Plan	Actual	Compliance		ABP	Actual	Comp
						With ABP	With Rev Plan			With ABP
P	Clean Coal	LT	2.14	2.09	2.17	101%	104%	12.48	12.37	99%
	Raw Coal	LT	4.34	4.4	4.23	97%	96%	25.39	25.59	101%
	Solid OB	L CuM	18.64	18.5	18.78	101%	102%	91.75	87.71	96%
	Loose OB	L CuM	1.81	2	2.22	123%	111%	18.77	19.64	105%
	Total OB	L CuM	20.44	17	21.00	103%	124%	110.51	107.35	97%
	Middling Coal	LT	0.94	0.95	0.96	102%	101%	6.32	6.65	105%
	RC Exposure	LT	2	2	2.23	112%	112%	2.00	2.23	112%
	CC Stock	KT	15	15	29.74	198%	198%	15.00	29.74	198%
Q	CC Disp Ash	%	18.50%	18.50%	18.60%	101%	101%	18.50%	18.60%	100.54%
	CC Disp Moist	%	10%	10%	9.59%	96%	96%	10%	9.59%	95.90%
C	Clean Coal	CPT	3884	4027	4612	119%	119%	3700	4629	125%
D	CC Disp	LT	2.14	1.78	2.01	94%	113%	12.48	12.23	98%
	Midd Disp	LT	0.94	0.6	0.64	68%	106%	6.32	6.72	106%
	Tailing Sale	LT	0.5	0.5	0.52	104%	104%	3.38	3.18	94%
	Reject Sale	LT	0.45	0.45	0.42	94%	94%	3.13	3.93	126%

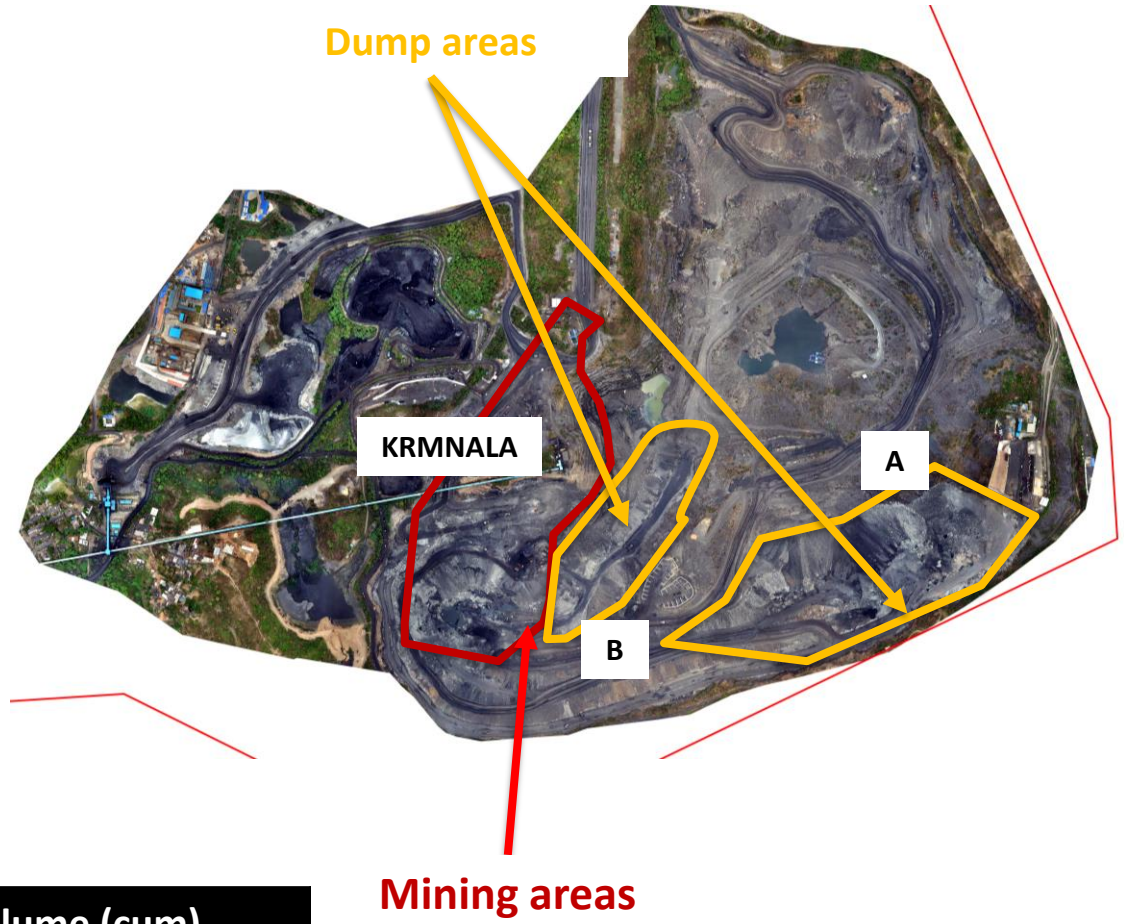


Performance Monitoring on PQCD

Area Compliance

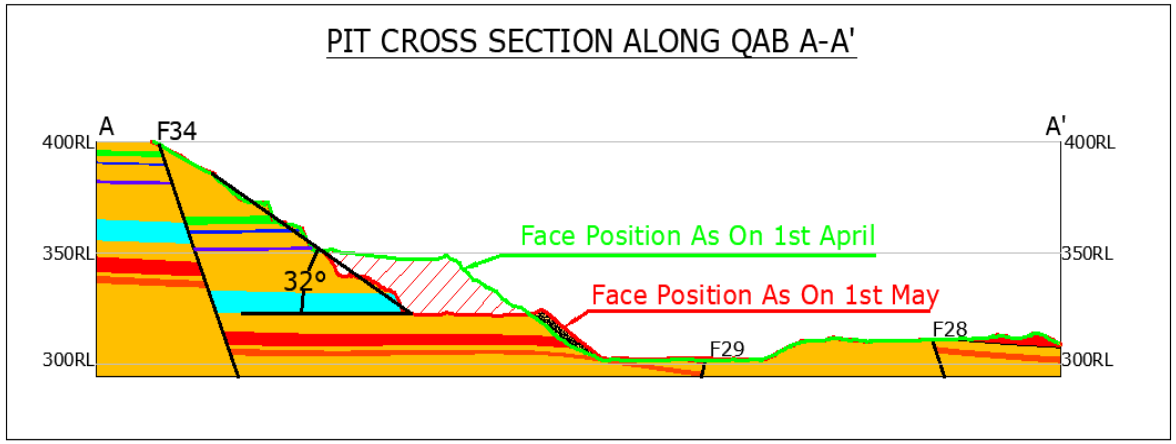
Dump Compliance (Plan Vs Actual)

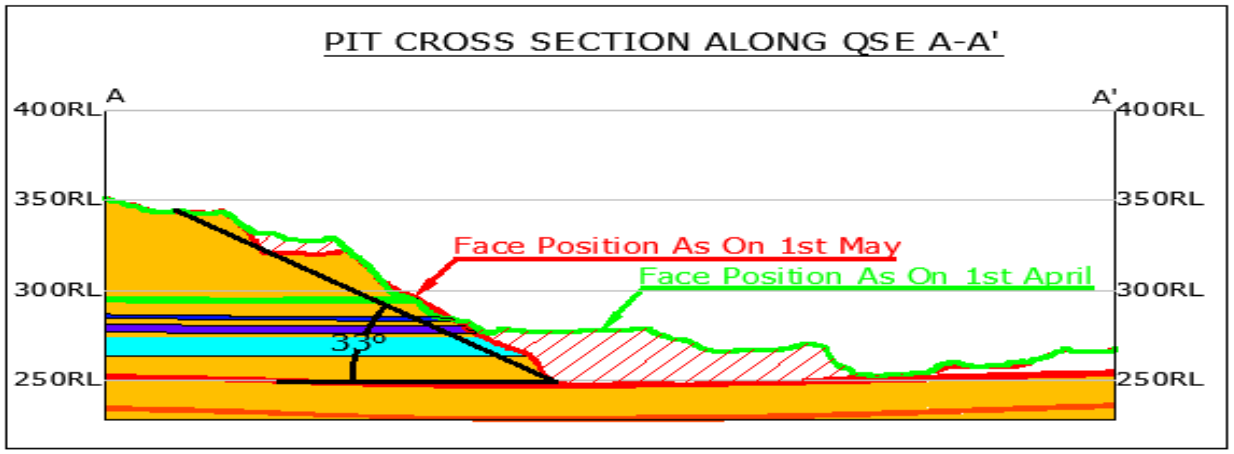


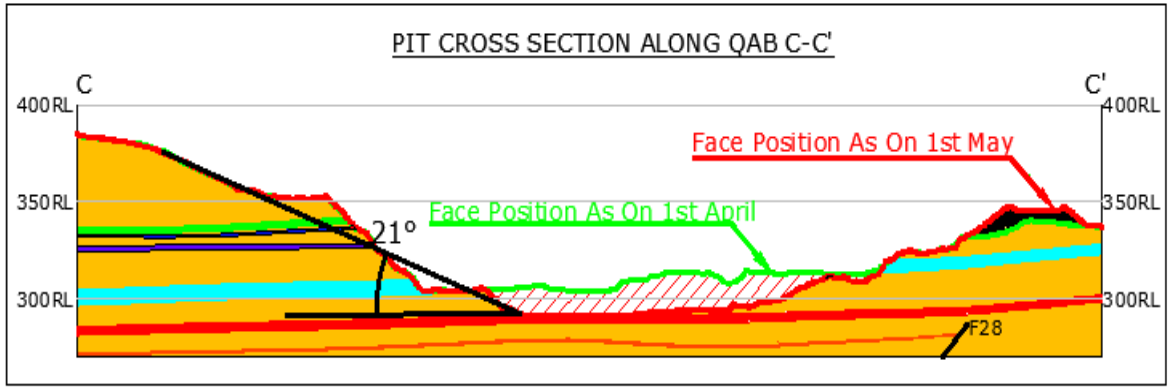


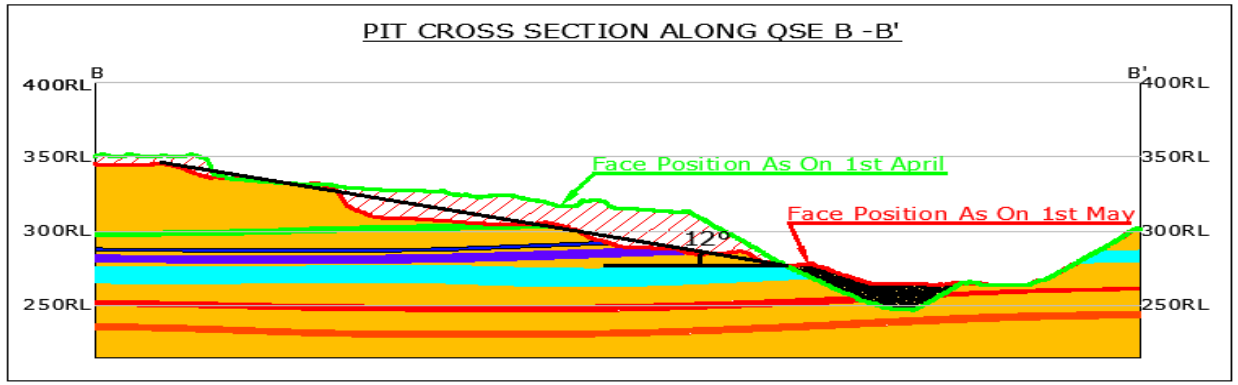
Particulars (QSE)	Volume (cum)
Excavated OB Volume (BCM)	8,63,765
Dumped OB Volume (LCM)* [A+B]	9,91,817
Permanent Dump [A+B]	9,16,716 (92.5%)
Temporary Dump [Ramps/Roads]	75,099 (7.5%)

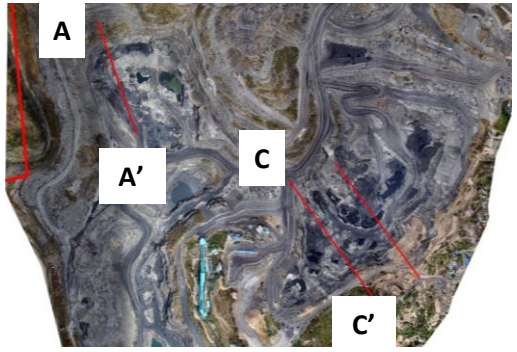
Depth Compliance (Plan Vs Actual)

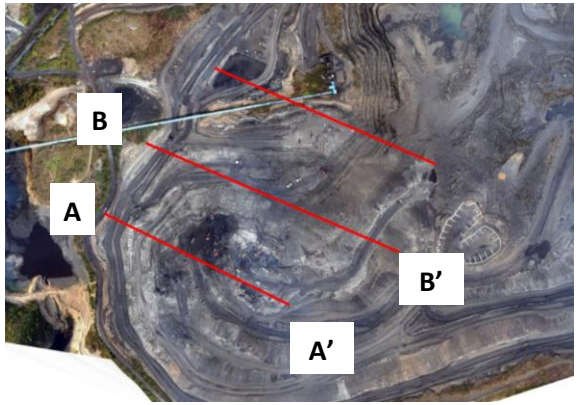




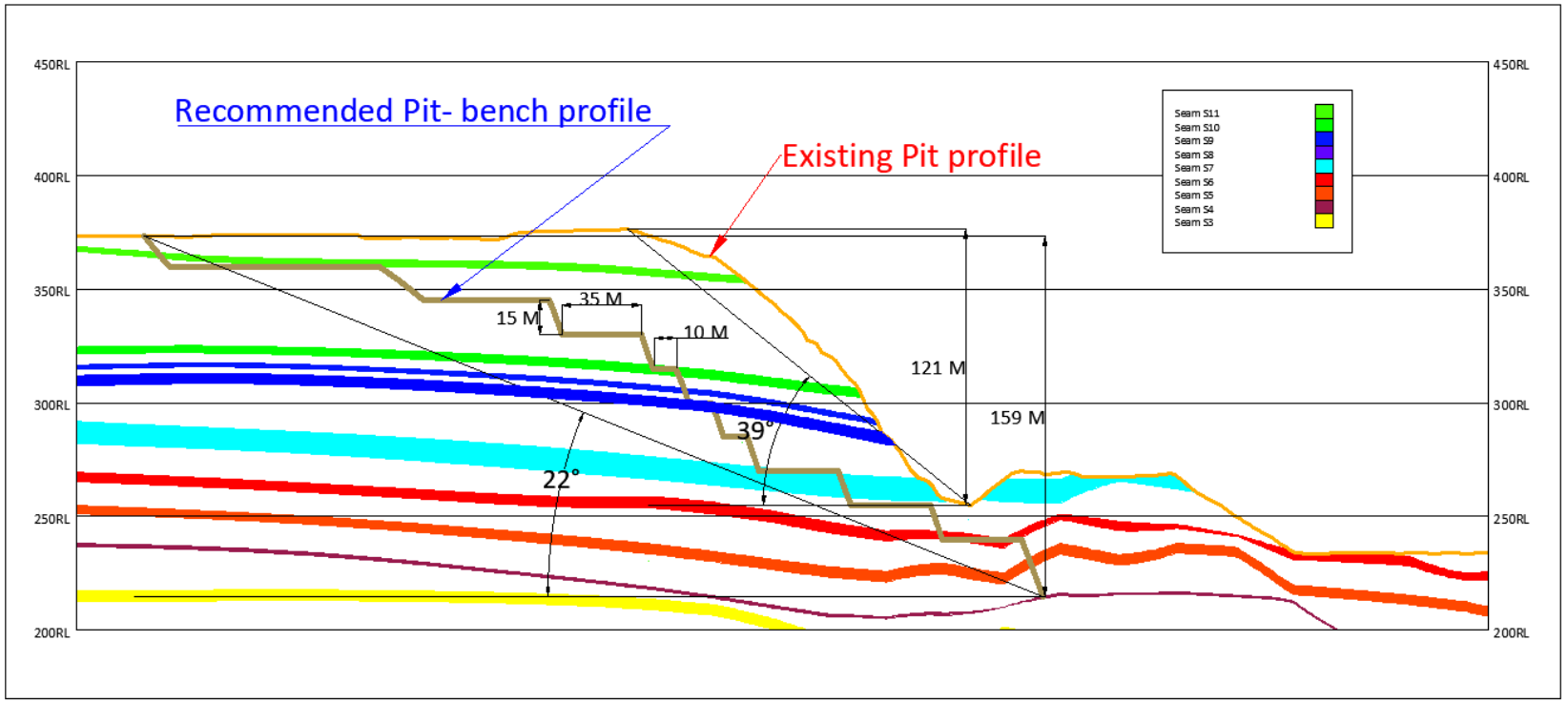


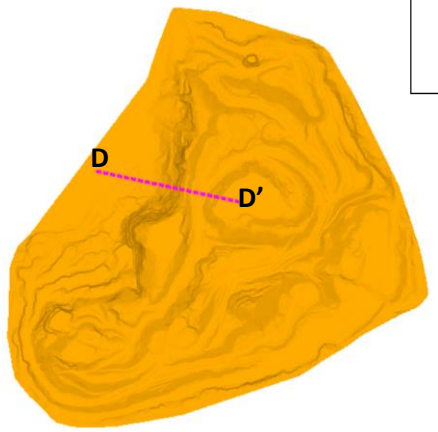




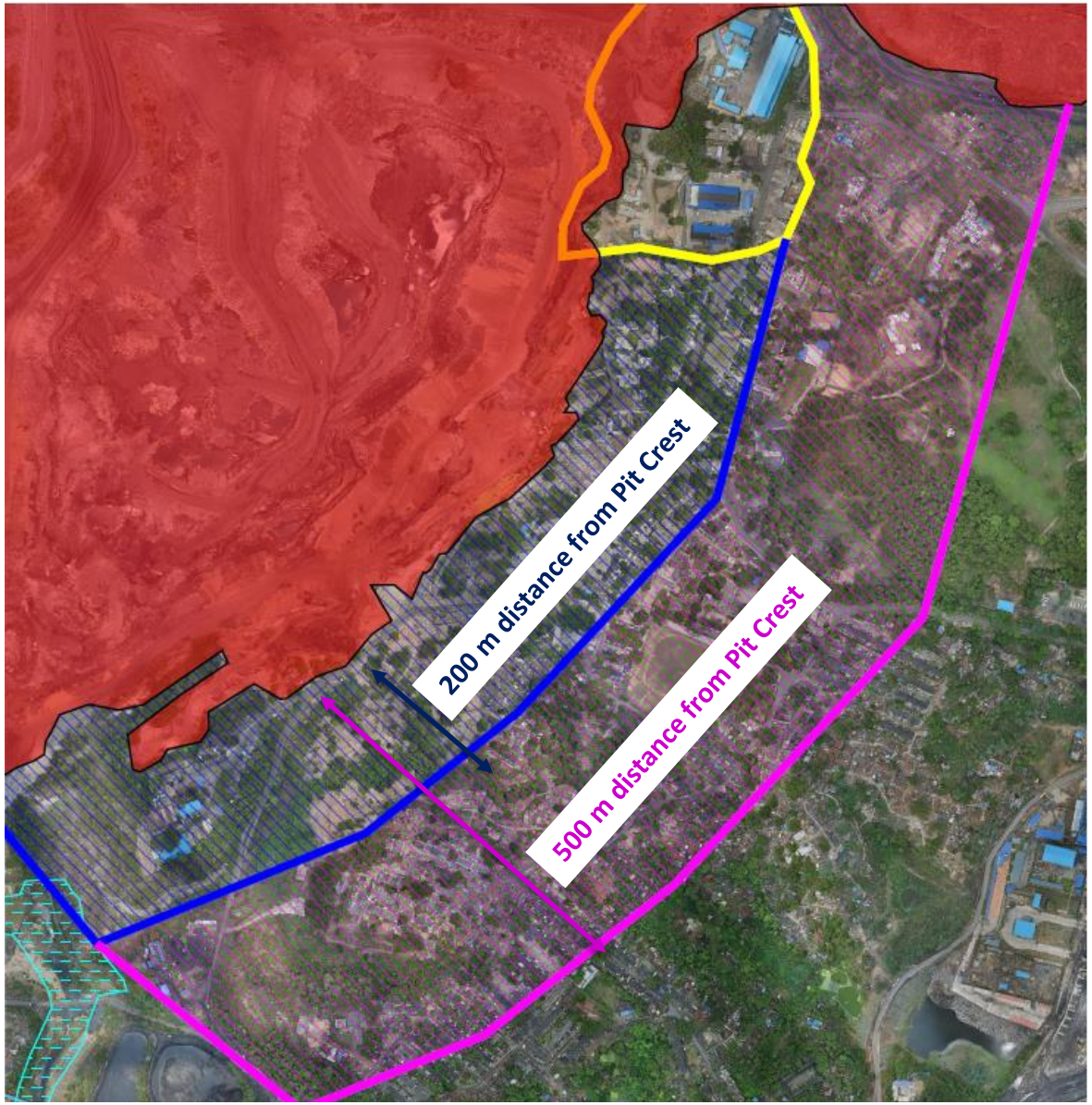


Recommended pit profile





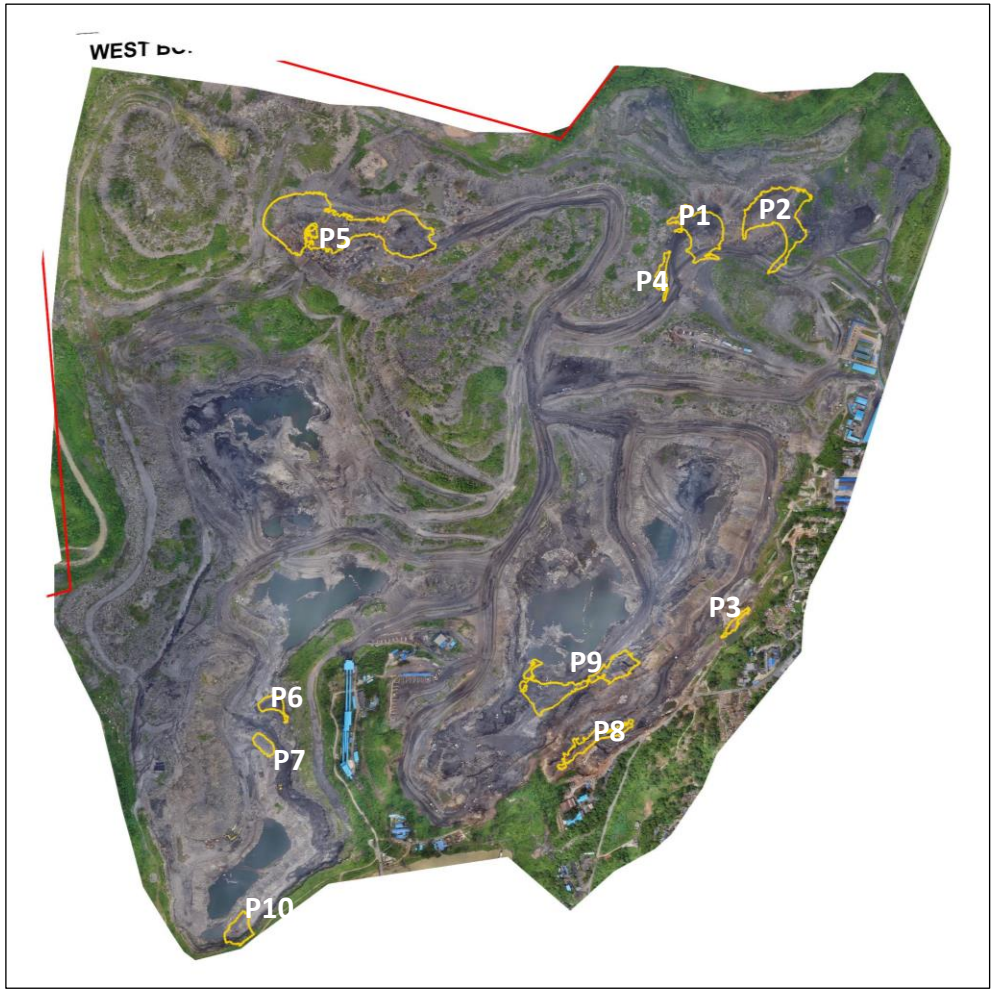
Surface Infra with in 200 & 500 m from working pit



With in X m	Existing Infra
0 – 200 m	Officer's Colony
	Butcher Mohalla
	Hospital
	Mosque & Gurudwara
	Amar Nagar
	SBI
200 – 500 m	Officer's Colony
	Club & JRD Park
	Contractor Shed
	D A V School
	Fire Brigade
	NOPR colony

Excavation Volume in Sep'23 – NRD

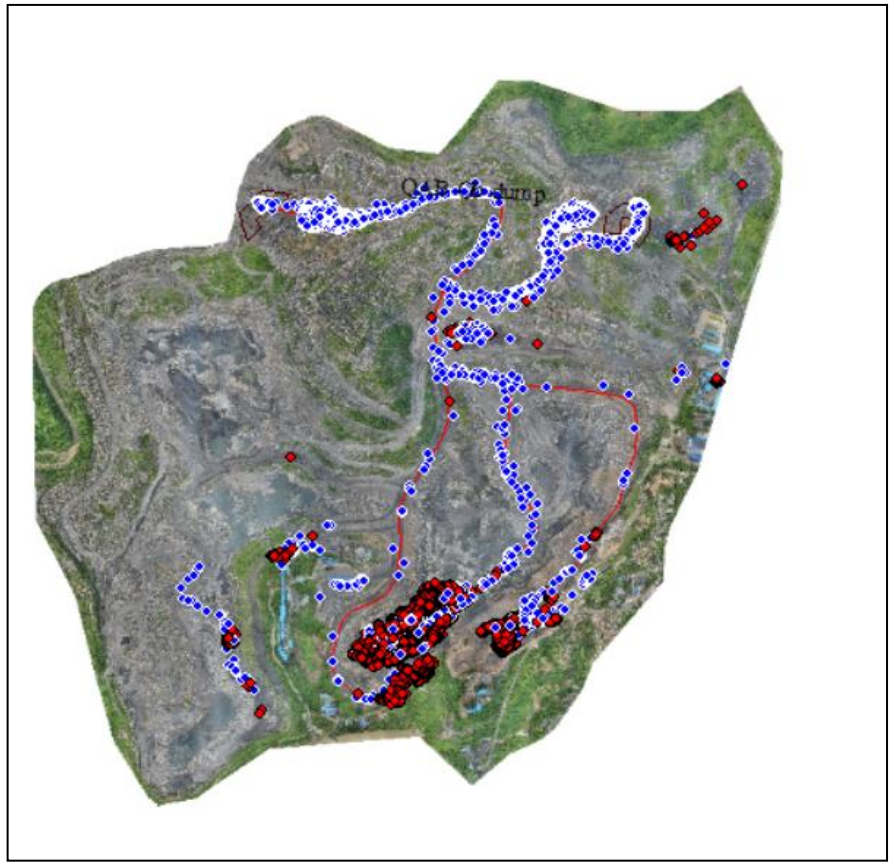
** Swell Factor – 20%M*



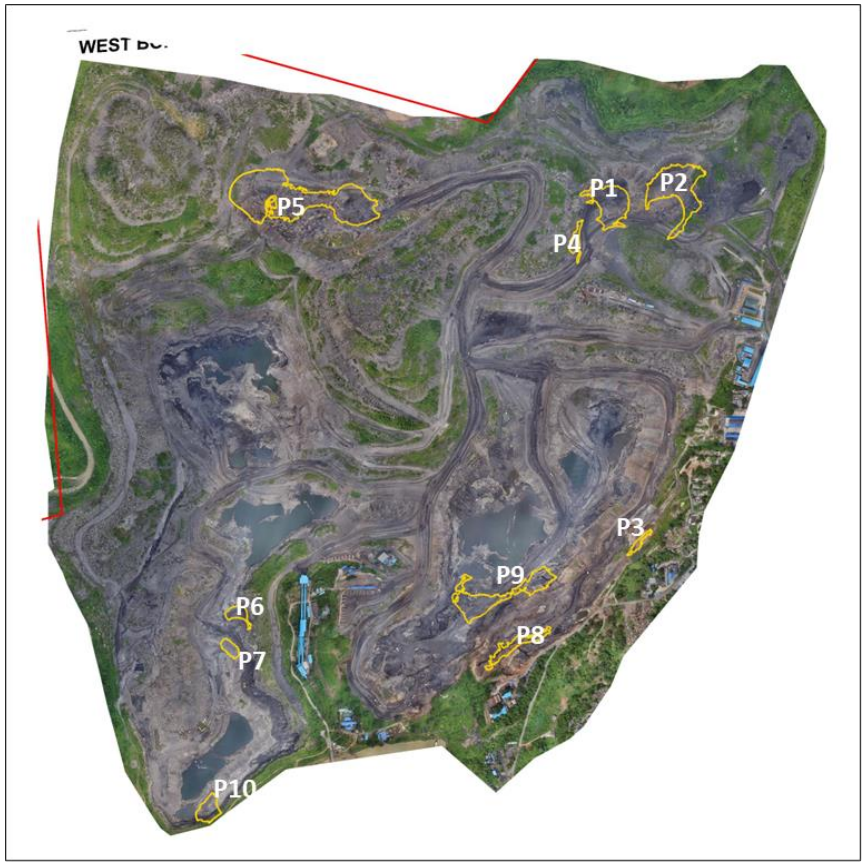
Particulars	Volume (cum)
Excavated OB Volume (BCM)	5,59,885
Excavated OB Volume (LCM)	6,71,862
Dumped Volume - P1 (LCM)	92,099
Dumped Volume - P2 (LCM)	2,00,382
Dumped Volume - P3 (LCM)	1,419
Dumped Volume - P4 (LCM)	2,333
Dumped Volume - P5 (LCM)	2,68,157
Dumped Volume - P6 (LCM)	10,846
Dumped Volume - P7 (LCM)	7,651
Dumped Volume - P8 (LCM)	8,750
Dumped Volume - P9 (LCM)	31,641
Dumped Volume - P10 (LCM)	21,030
Total Dumped Volume (LCM)	6,44,308

A difference of about 1.28 lakh cum in OB is observed between the excavated vs dumped volume

Data Comparison Analysis of FMS vs Drone Survey



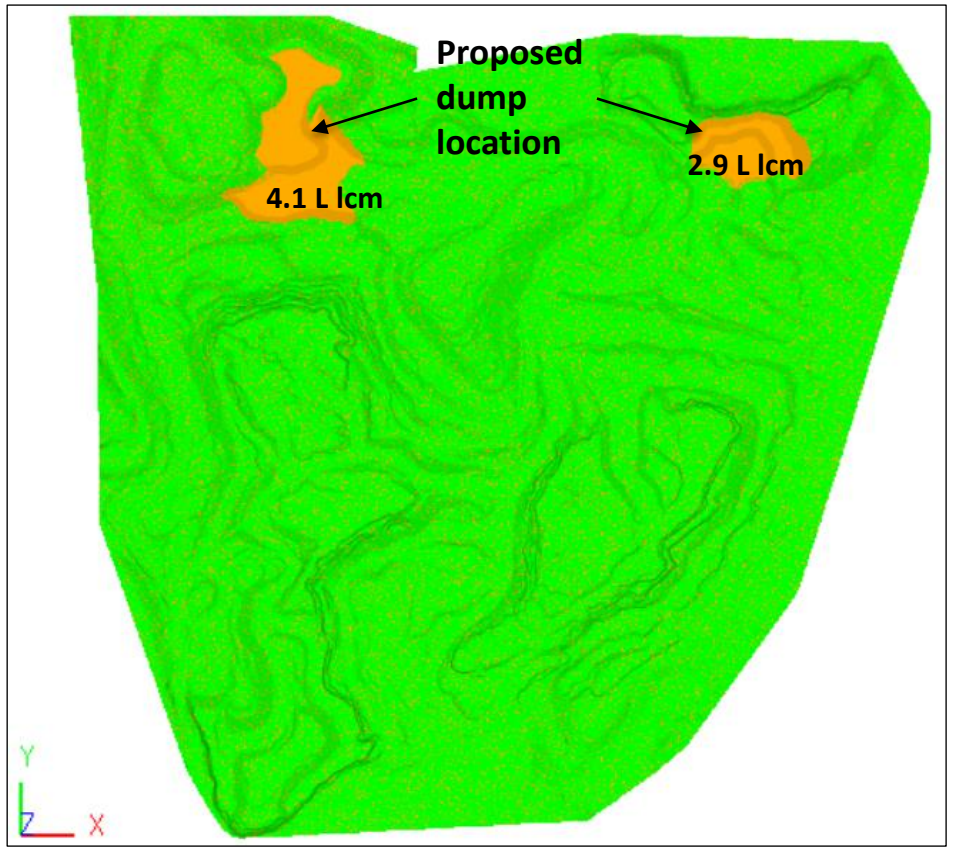
FMS data captured from 13th – 30th September. Blue dots represent location of material dumped during the period

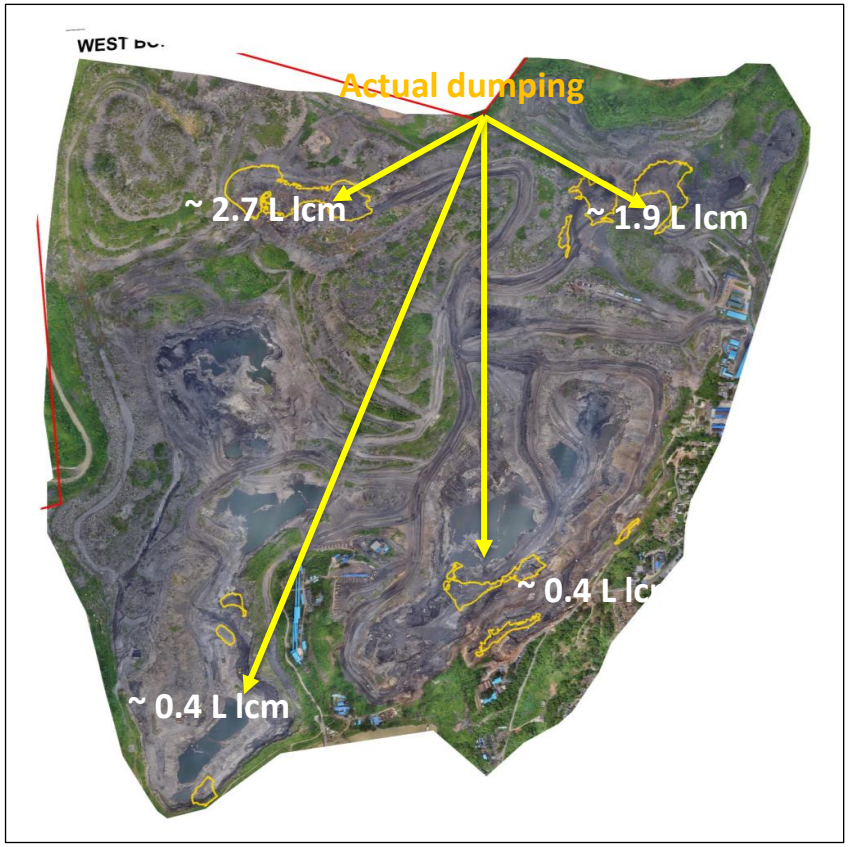


Drone data analysis from 1st – 30th September. Polygons represent dumping area during the period

Dumping done in haul roads are often not captured through drone survey due to small change in Z value. There is lot dumping happening in undesignated places.

QAB Dumping: Planned Vs Actual for September'23

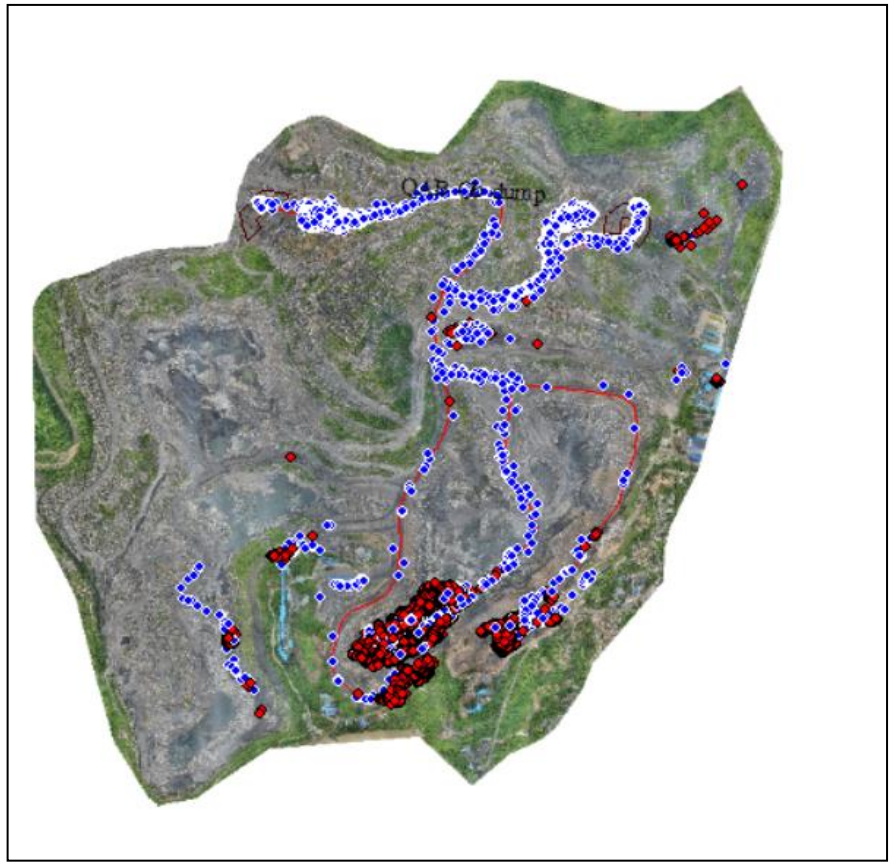




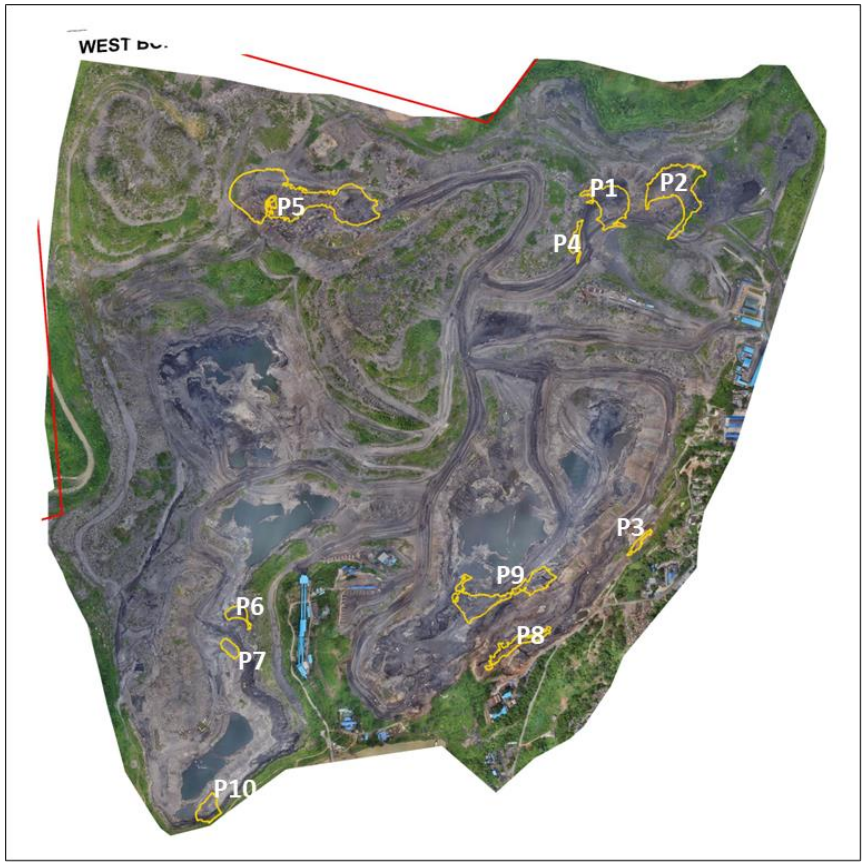
Waste Vol. generated	7.0 L lcm

Waste Vol. dumped	5.4 L lcm

Data Comparison Analysis of FMS vs Drone Survey



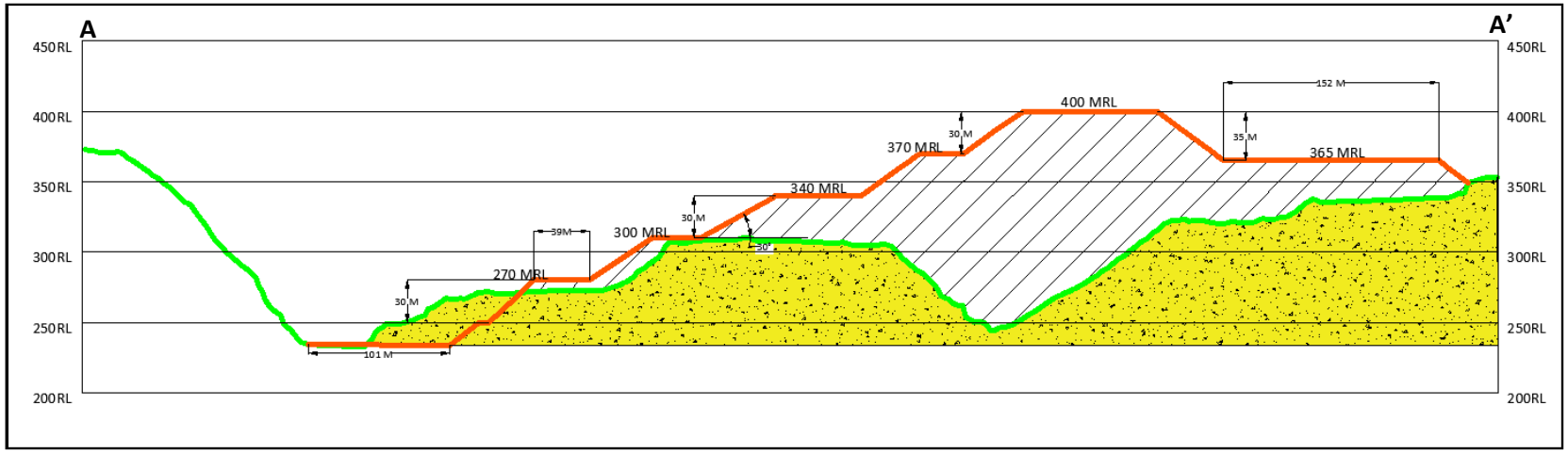
FMS data captured from 13th – 30th September. Blue dots represent location of material dumped during the period

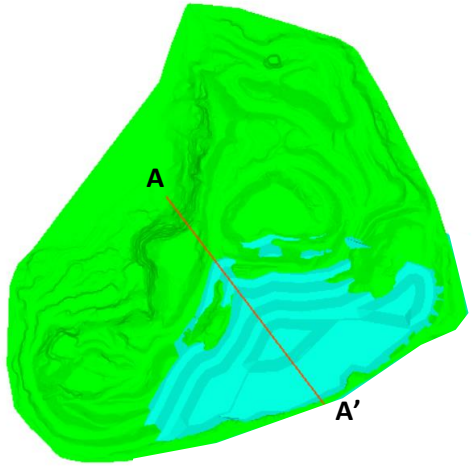


Drone data analysis from 1st – 30th September. Polygons represent dumping area during the period

Dumping done in haul roads are often not captured through drone survey due to small change in Z value. There is lot dumping happening in undesignated places.

Dump Sections





Advantages of drone based mine mapping and monitoring

1. Very easy to monitor compliance and mine profile
2. Can easily monitor plan vs actual
3. Transparency in volume measurements with proof that cannot be manipulated
4. Resource model get updated every month with actual ground profile
5. Stock reconciliation becomes easy with verifiable records
6. Planning mine sump location and capacity
7. Remote inspection of mine from anywhere
8. Shift supervisor and HEMM operators get a better view of the mine
9. Improving mine productivity with better haul road and dump planning
10. Mine owners can use the technology for evaluating the performance of the MDO
11. MDOs can use it for improving mine safety, compliance and productivity

Mine Reclamation

TATA STEEL

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