IMPLEMENTING INNOVATION

Session 2

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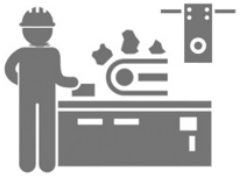
Business Cooperative Research Centres Program
CRC ORE
Optimising Resource Extraction

ROLE OF IMPLEMENTATION IN CRC ORE

Program 1 Define

Improving feed quality



Program 2 Separate

Enabling mass separation

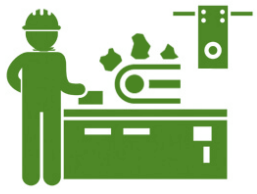
Program 3 Extract

Increasing extraction efficiency

Program 4 Control

Maximising system-value

OBJECTIVES & AIMS OF SITE IMPLEMENTATION PROJECTS



Pilot Scale Application and Assessment of resulting changes

Key metrics are improved productivity & capital intensity

Demonstrate Integrated System Value Solutions

Conducted through simulation, modelling and site deployment

Large Scale Site Implementation

Demonstrate the value and application of technology outputs

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GRADE ENGINEERING SITE PROJECTS IN LAST 12 MONTHS

1. *Blast Induced Material Movement (P5-001.B)*
2. *Detour Lake Grade Engineering Opportunity Assessment (P5-011)*
3. *Los Bronces Grade Engineering Study (P5-022)*
4. *Los Bronces Blast Modelling Study (P5-027)*
5. *Minera San Cristobal Grade Engineering Production Trial (P5-037)*
6. *Carmen de Andacollo Grade Engineering Concept Study (P5-040)*
7. *BHP Heterogeneity Partnership (P5-042)*
8. *Data Analytics for Integrated Sensor Trials at Escondida (P5-044)*
9. *Enhanced Blast Induced Material Movement (P5-045)*
10. *Physics Based Blast Movement Modelling (P5-048)*
11. *Heterogeneity Preservation Through Blasting and Digging (P5-050)*
12. *Mogalakwena Bulk Sensing Experimental Design (P5-052)*

ACTIVITIES CAN BE GROUPED INTO TWO KEY THEMES

Grade Engineering:

- Characterisation
- Blast Modelling
- Spatial Modelling
- Process Modelling
- Mine Planning
- Production Trials

Enhanced Grade Engineering:

- Sensor Fusion
- Spatial–Temporal Data Integration
- Heterogeneity Modelling
- Operationalisation of Grade Engineering

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MINERA SAN CRISTOBAL GRADE ENGINEERING PRODUCTION TRIAL

Production Trial Aim:

- To prove the upgradability of MSC ores via screening at production scale
- Campaign Grade Engineered and direct ROM through the concentrator to validate the grade improvement
- Understand operational aspects of implementing Grade Engineering

2 options to source material:

- ROM ex-pit
- Stockpile

MINERA SAN CRISTÓBAL S.A.

MSC Estimates Grade Engineering value >$1b profit

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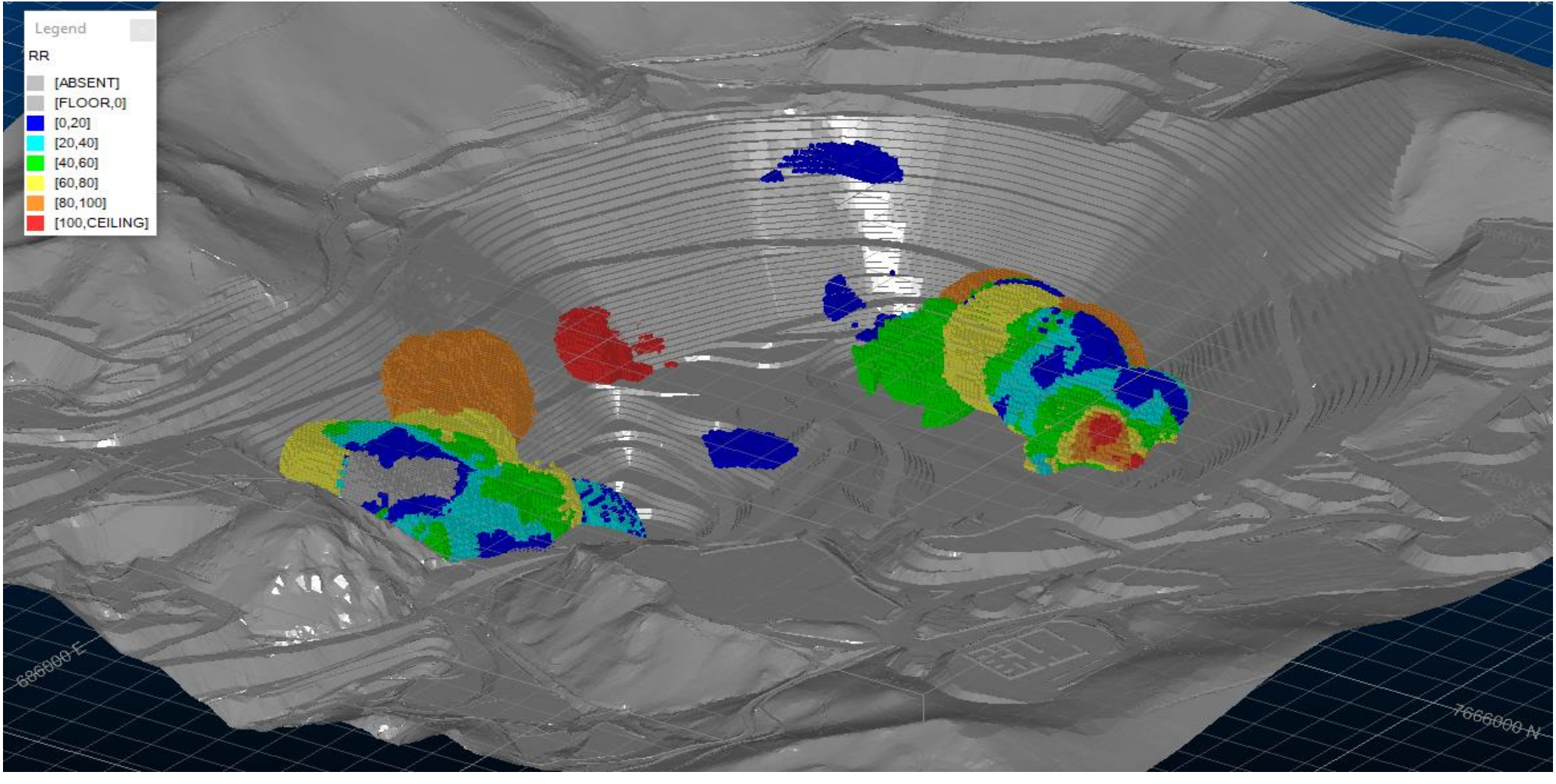
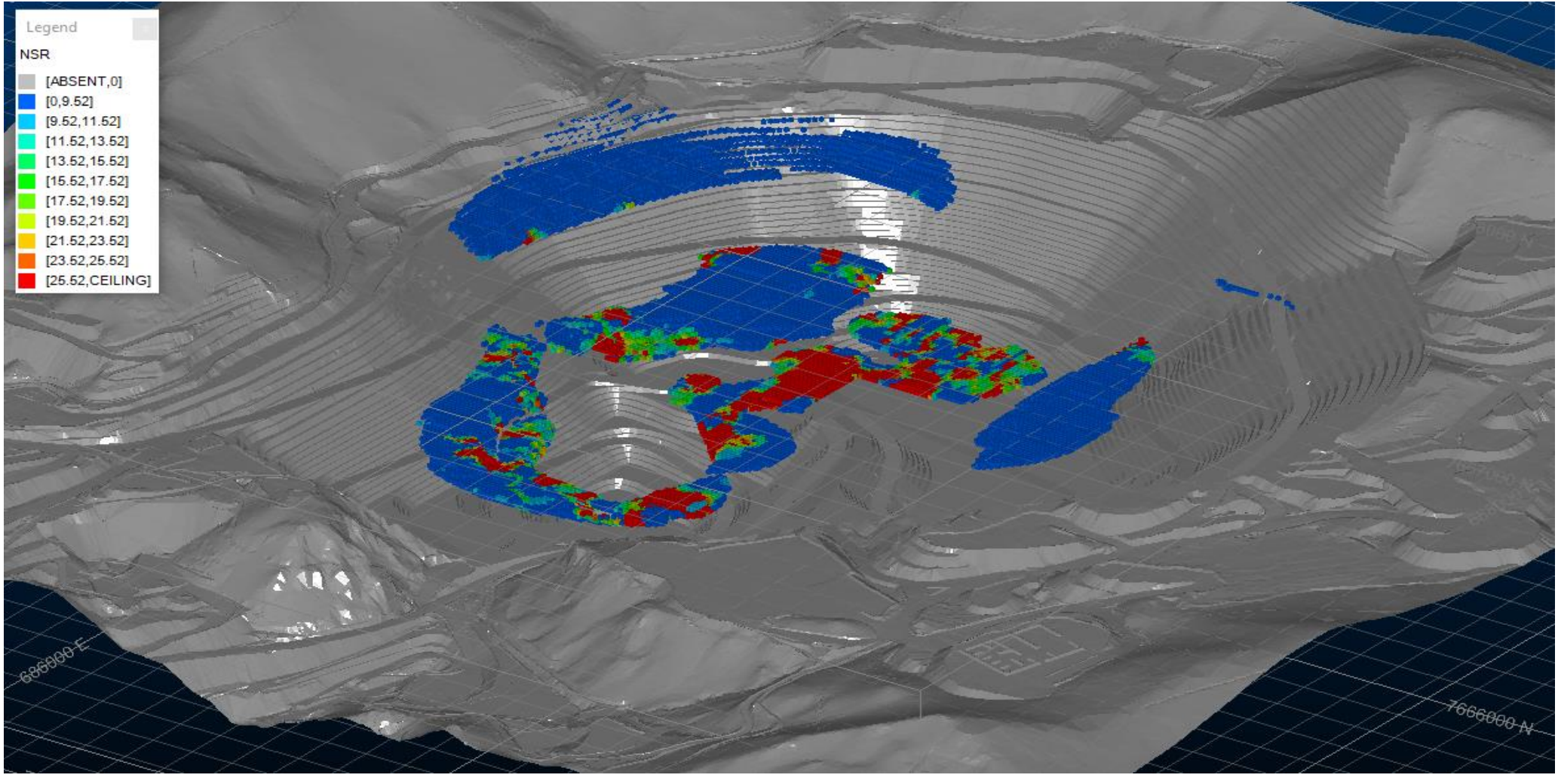
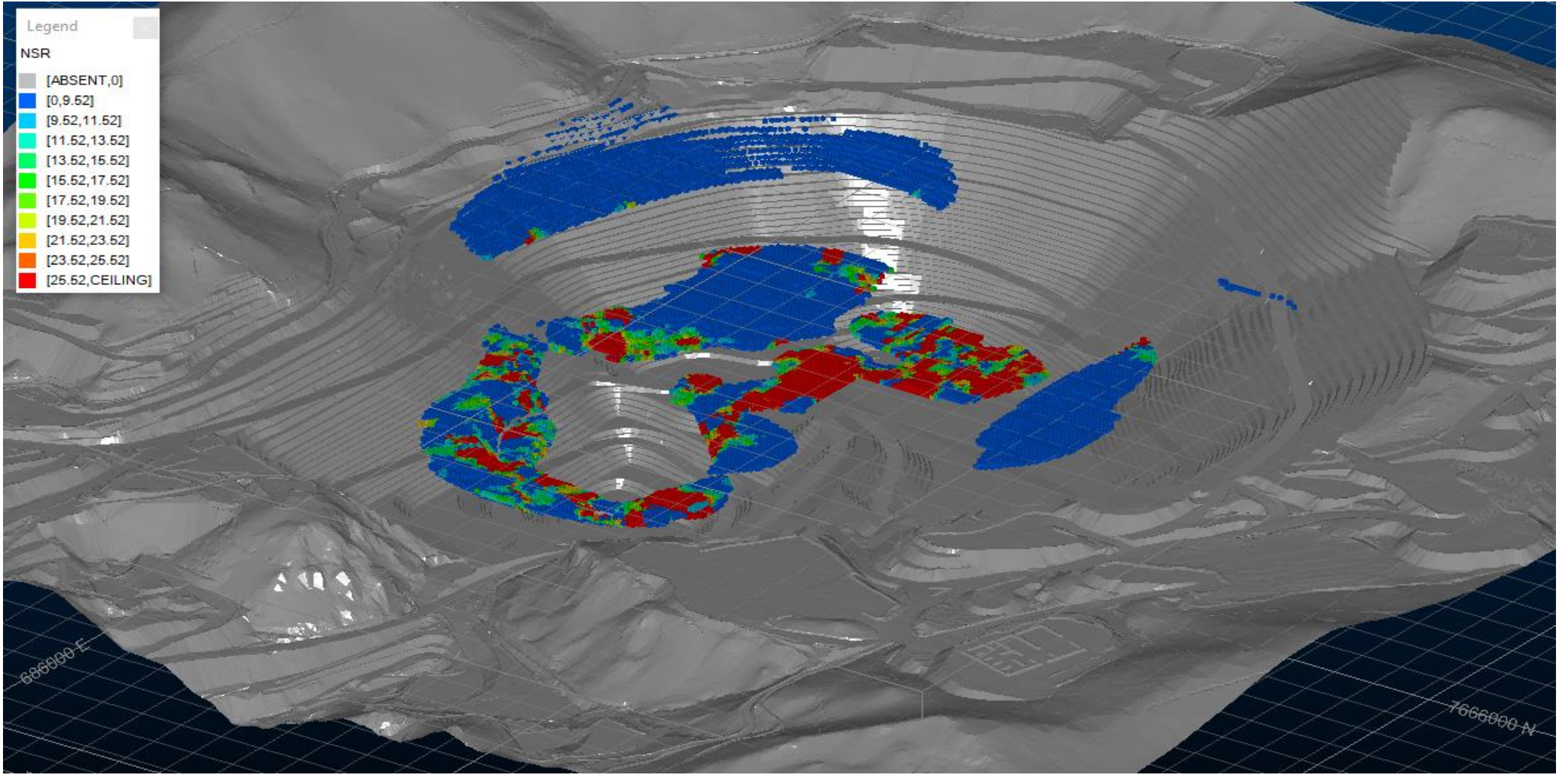
MAPPING OF UPGRADABILITY IN BLOCK MODEL



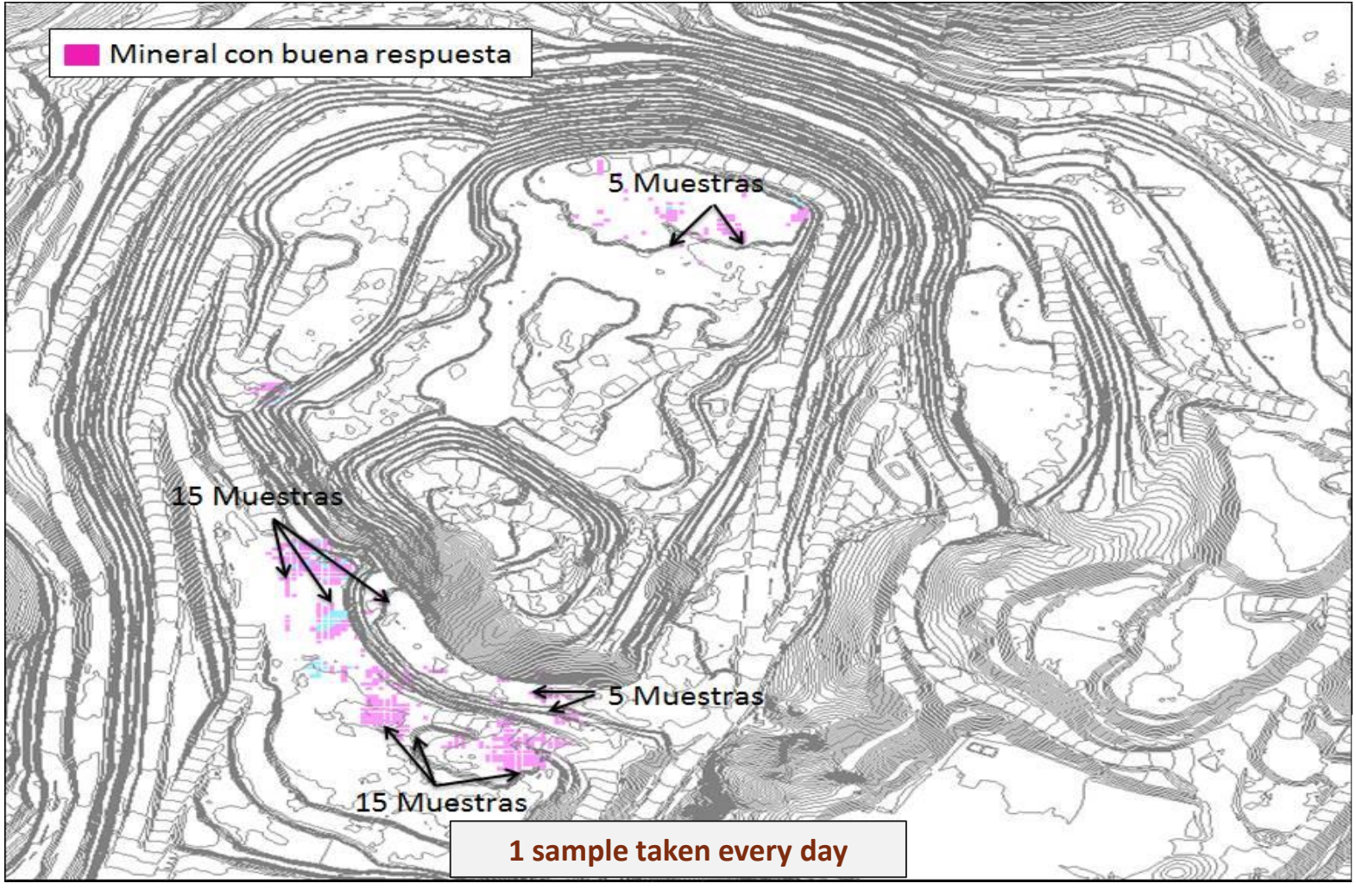
MINE PLAN 2018 JANUARY – AUGUST BY NSR BASE CASE



MINE PLAN 2018 JANUARY – AUGUST BY NSR WITH 20% MASS PULL



EX-PIT TEST WORK PROGRAM MARCH-APRIL: 40 X ~500KG SAMPLES



STOCKPILE MESO-SCALE SAMPLE TEST WORK PROGRAM

40x ~500kg per sample

25%	75mm, 3”	→	Assay Zn, Pb, Ag
25%	37.5mm, 1 ½ ”	→	Assay Zn, Pb, Ag
15%	19mm, ¾ ”	→	Assay Zn, Pb, Ag
20%	6.3mm, ¼ ”	→	Assay Zn, Pb, Ag
15%	Pan	→	Assay Zn, Pb, Ag

Obtain Particle Size Distribution Information

Obtain Metal Deportment Information

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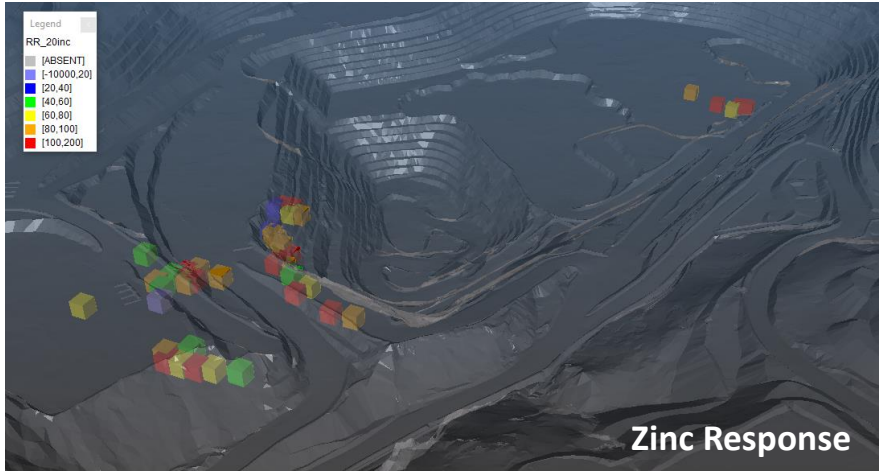
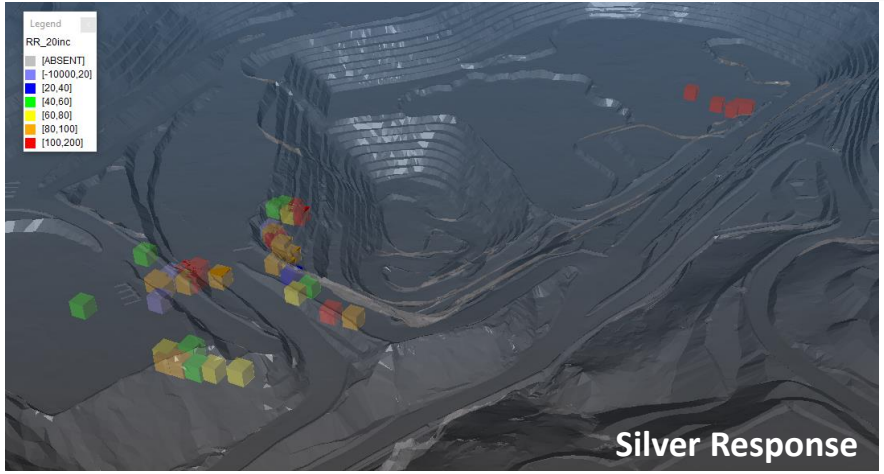
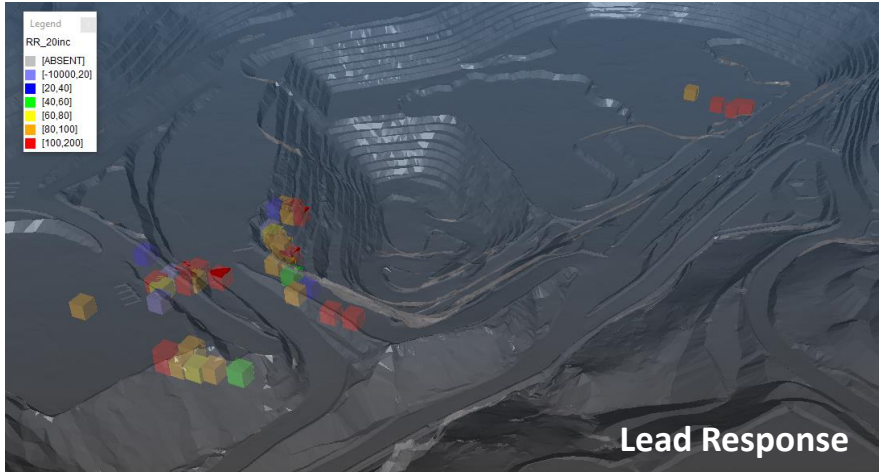
MESO SCALE SAMPLING IN ACTION

METAL DEPORTMENT RESULTS FOR 40 EX-PIT SAMPLES







High metal deportment signatures obtained that confirming initial characterisation results and spatial modelling work.

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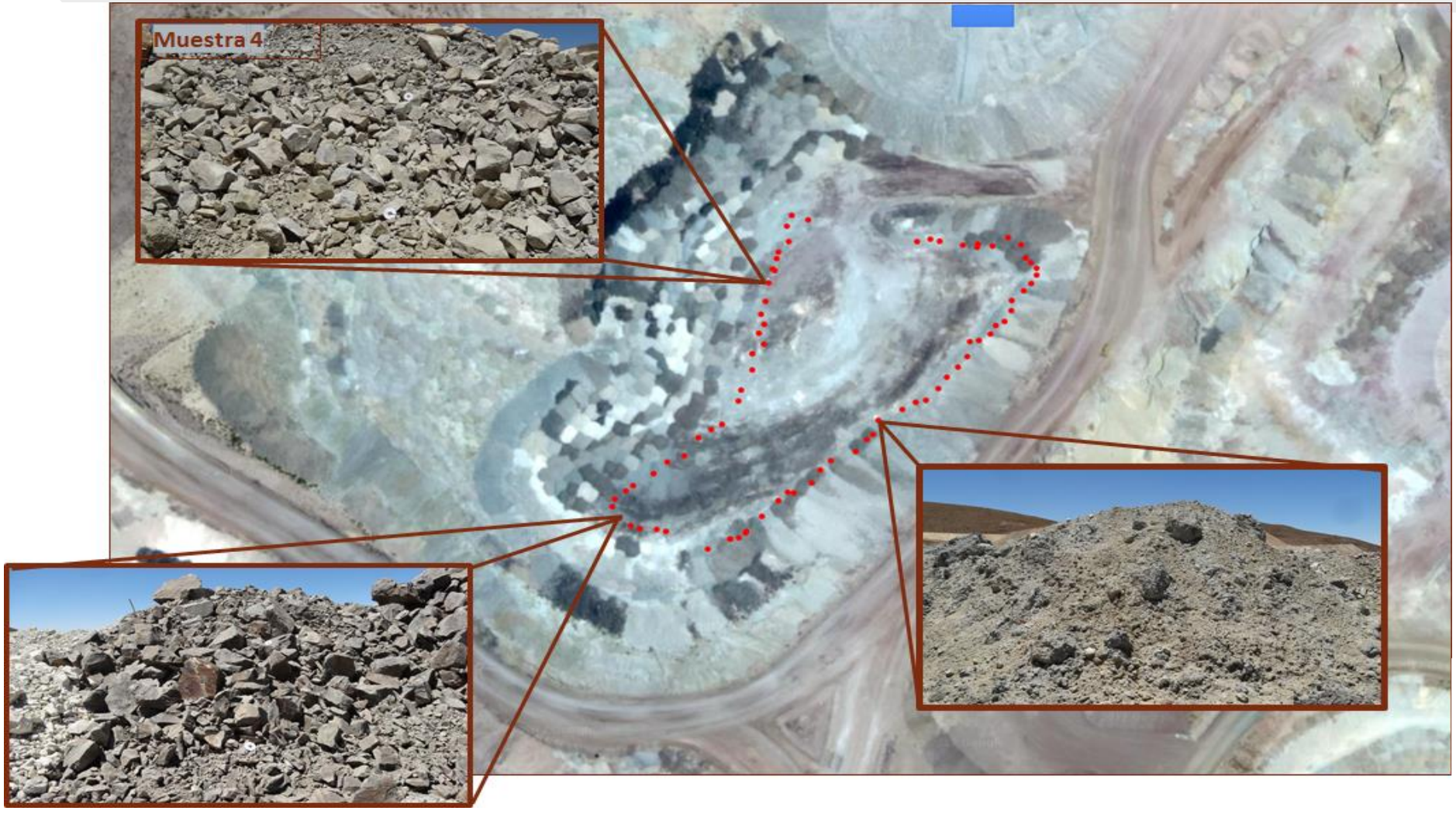
BURRO CANCHA STOCKPILE SIZE DISTRIBUTION ANALYSIS



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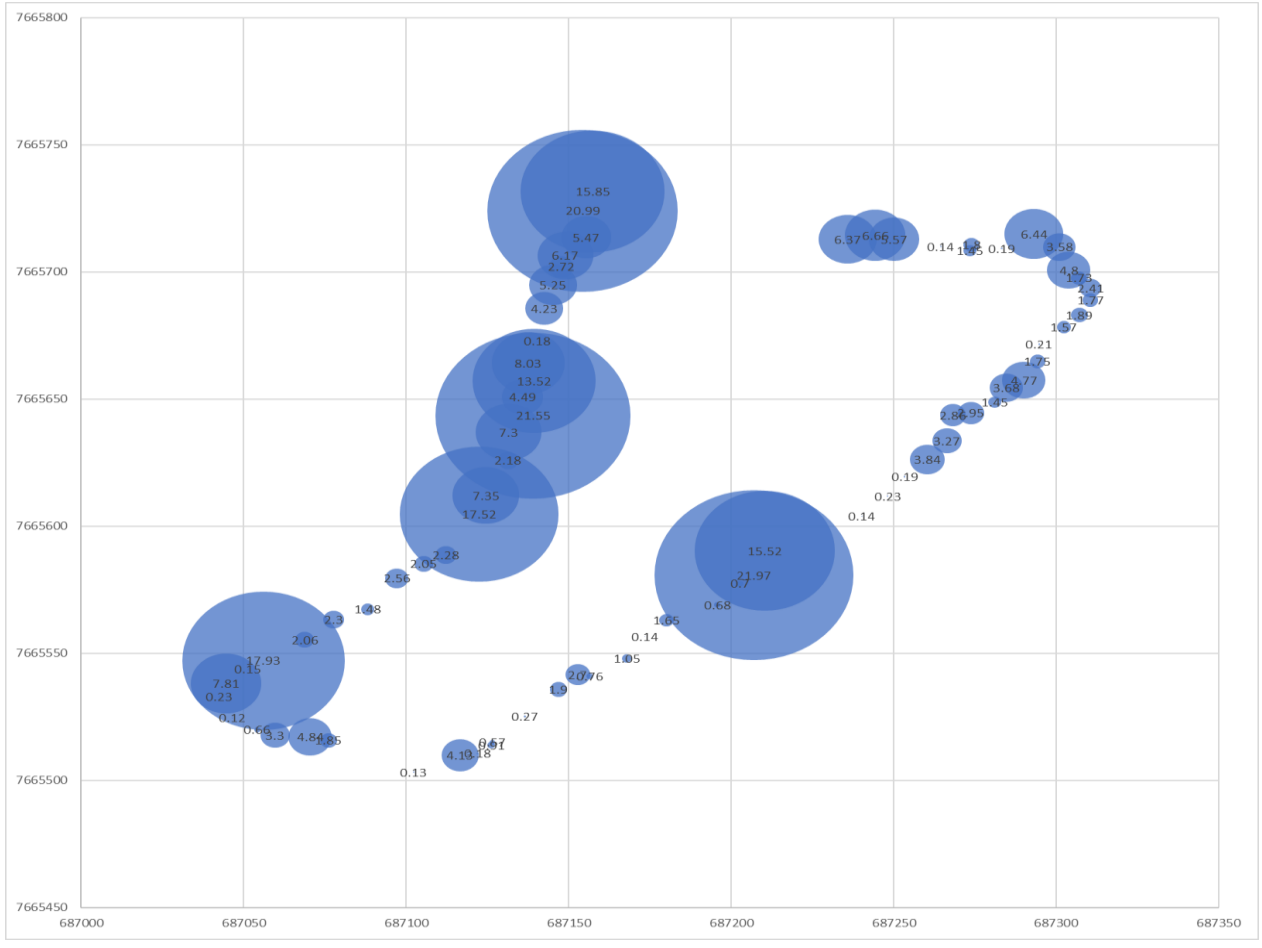

Bubble size represents 20% passing size.

Results showed coarser material from the images on the western side of the stockpile, but this does not mean that the same will apply for the body of the material.

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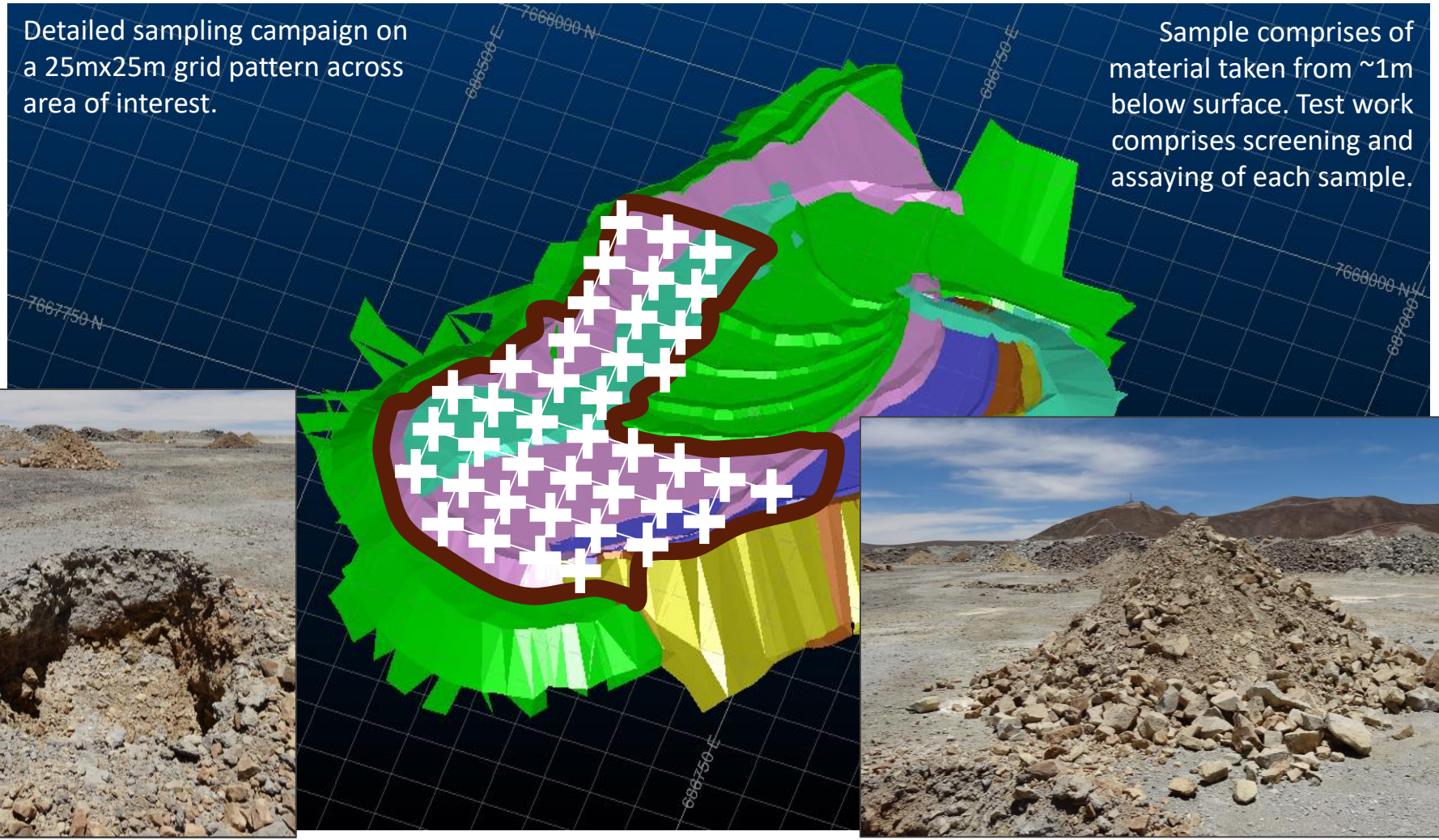
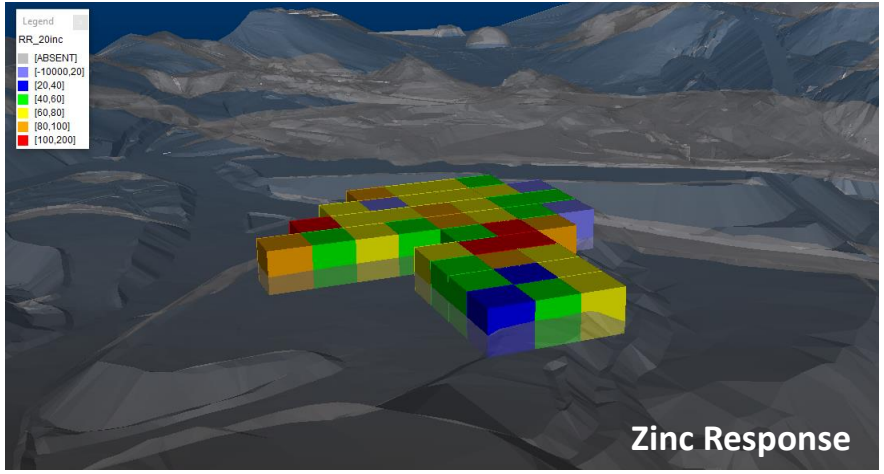
SAMPLING TO UNDERSTAND METAL DEPORTMENT RESPONSE

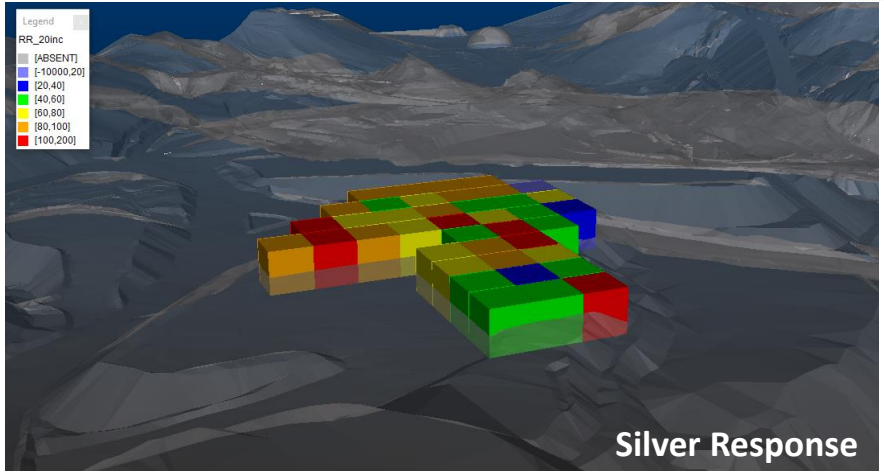
Detailed sampling campaign on a 25mx25m grid pattern across area of interest.

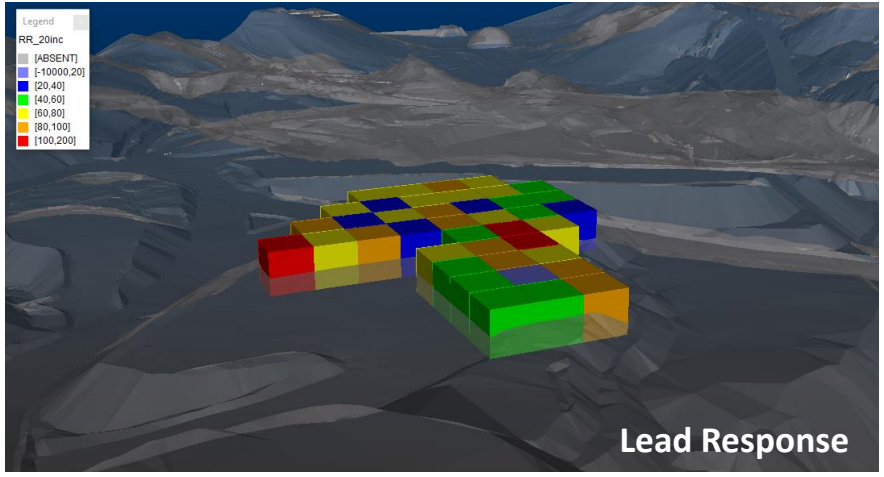
Sample comprises of material taken from ~1m below surface. Test work comprises screening and assaying of each sample.



METAL DEPORTMENT RESULTS FOR 40 STOCKPILE SAMPLES







High metal deportment signatures obtained that confirming initial characterisation results.

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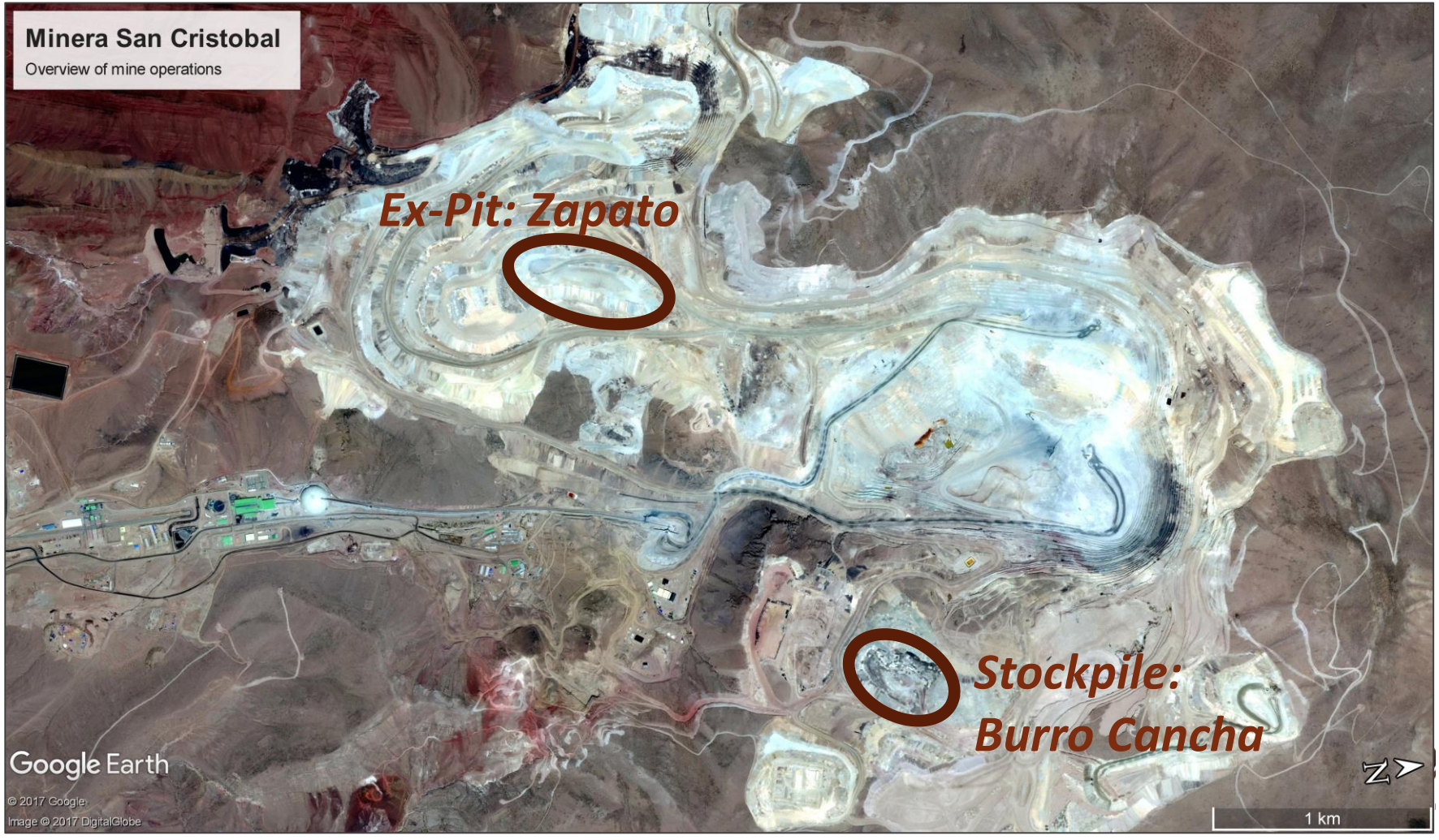
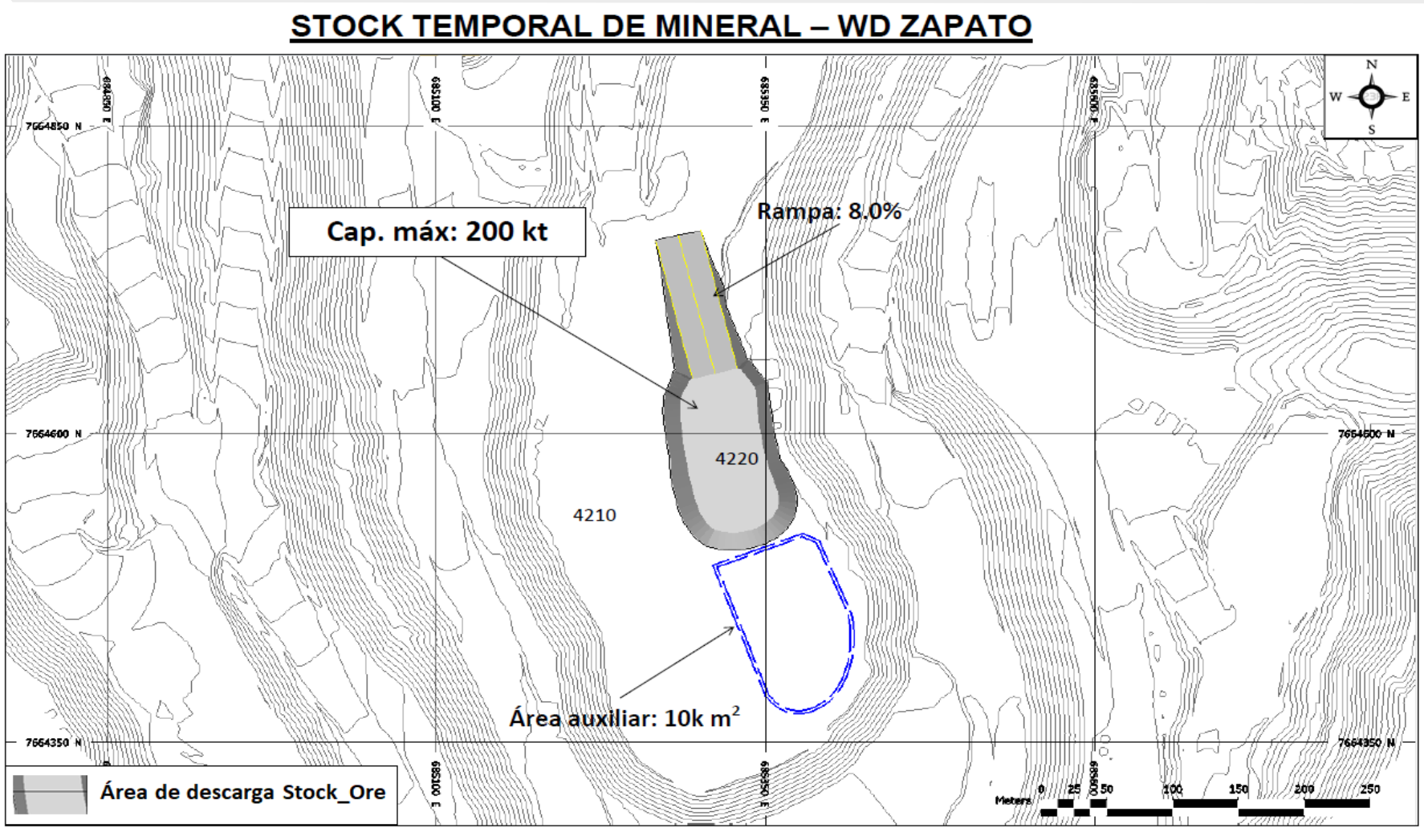
LOCATION OF SCREENING PLANT FOR SITE TRIALS



CONCEPTUAL PLANNING OF EX-PIT STOCKPILE



SAMPLING STATISTICS CALCULATOR FOR QA/QC ANALYSIS

SAN CRISTOBAL MINE

SAMPLE MASS CALCULATOR v.2

	User-defined
	Calculated
	Set/Customizable/Modified

Indicative sample masses required as a function of metal deportment to main mineral carriers

GENERIC METAL IN SULFIDE		
gangue density (g/cm3) =	2.5	g/cm3
mineral density (g/cm3) =	4.5	g/cm3
metal grade (%) =	0.1	%
metal content of mineral (%) =	80	%
sulfide liberation size (um P95) =	200	um
comminution P95 (mm) =	150	mm
Desired sampling RSD (%) =	**10**	**%**
mineral grade (%) =	0.125	%
g =	0.25	
f =	0.5	
alpha =	1.8	
Minmum sample mass =	53.781	kg

Zn IN SPHALERITE		
gangue density (g/cm3) =	2.5	g/cm3
mineral density (g/cm3) =	4.2	g/cm3
metal grade (%) =	0.1	%
metal content of mineral (%) =	67	%
sulfide liberation size (um P95) =	207	um
comminution P95 (mm) =	150	mm
Desired sampling RSD (%) =	**10**	**%**
mineral grade (%) =	0.149254	%
g =	0.25	
f =	0.5	
alpha =	1.8	
Minmum sample mass =	43.671	kg

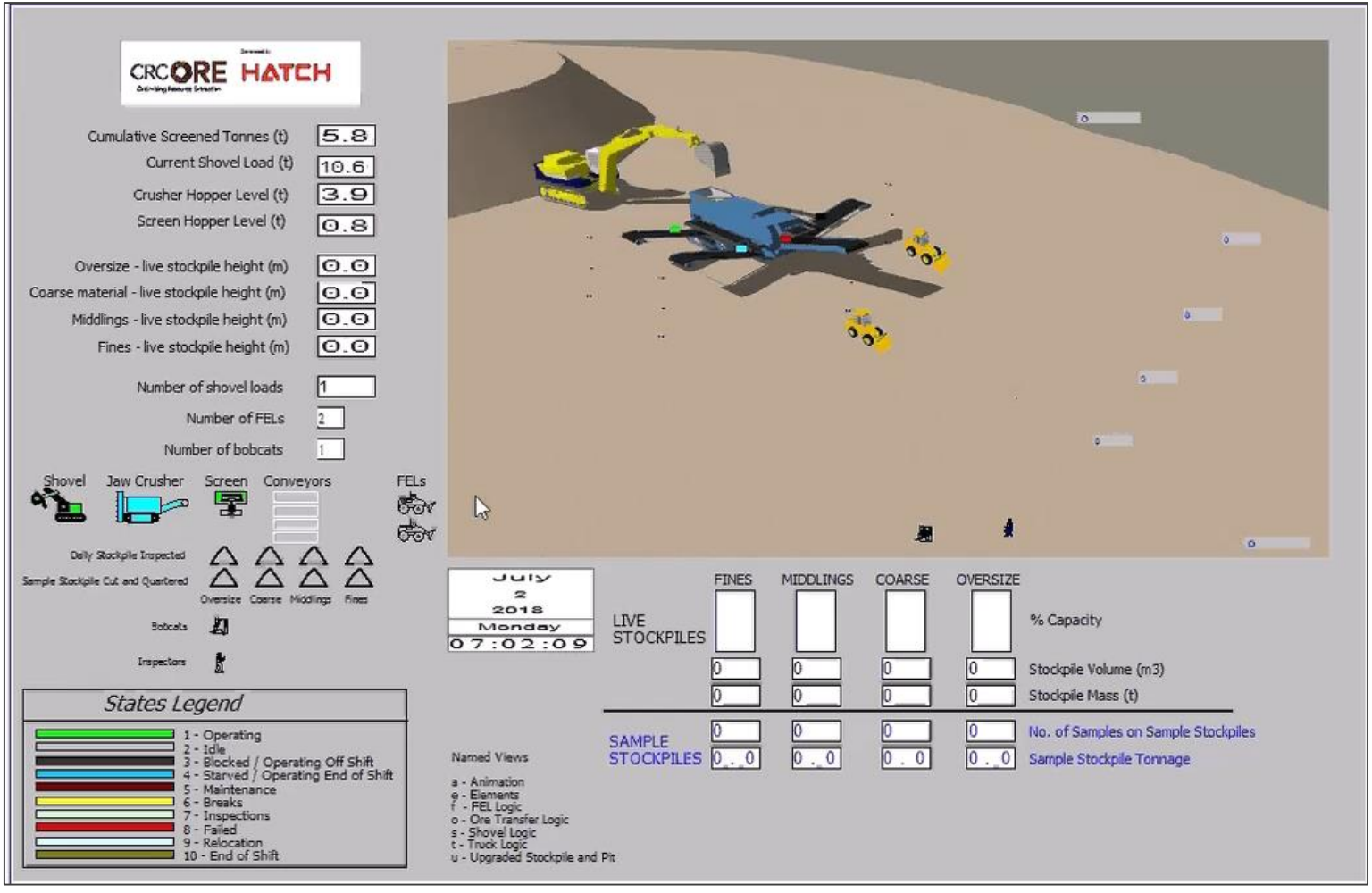
Pb IN GALENA		
gangue density (g/cm3) =	2.5	g/cm3
mineral density (g/cm3) =	7.6	g/cm3
metal grade (%) =	0.1	%
metal content of mineral (%) =	87	%
sulfide liberation size (um P95) =	175	um
comminution P95 (mm) =	150	mm
Desired sampling RSD (%) =	**10**	**%**
mineral grade (%) =	0.114943	%
g =	0.25	
f =	0.5	
alpha =	1.8	
Minmum sample mass =	84.143	kg

Ag IN PYRITE		
gangue density (g/cm3) =	2.5	g/cm3
pyrite density (g/cm3) =	5.1	g/cm3
Ag grade (ppm) =	100	ppm
Ag content of pyrite (%) =	0.23	%
pyrite liberation size (um P95) =	201	um
comminution P95 (mm) =	150	mm
Desired sampling RSD (%) =	**10**	**%**
pyrite grade (%) =	4.35	%
g =	0.25	
f =	0.5	
alpha =	1.8	
Minmum sample mass =	1.654	kg

Ag ASSUMPTIONS:

- pure pyrite Ag content: 2 300 ppm
- all Ag in liquid solution in pyrite

UNDERSTANDING EQUIPMENT LOGISTICS AND DAILY WORK PLANS



LOKOTRACK ON ROUTE TO MINERA SAN CRISTOBAL

Don’t Underestimate the effort involved in getting equipment to site
(e.g. permitting etc..)

EX-PIT GRADE ENGINEERING STOCKPILE

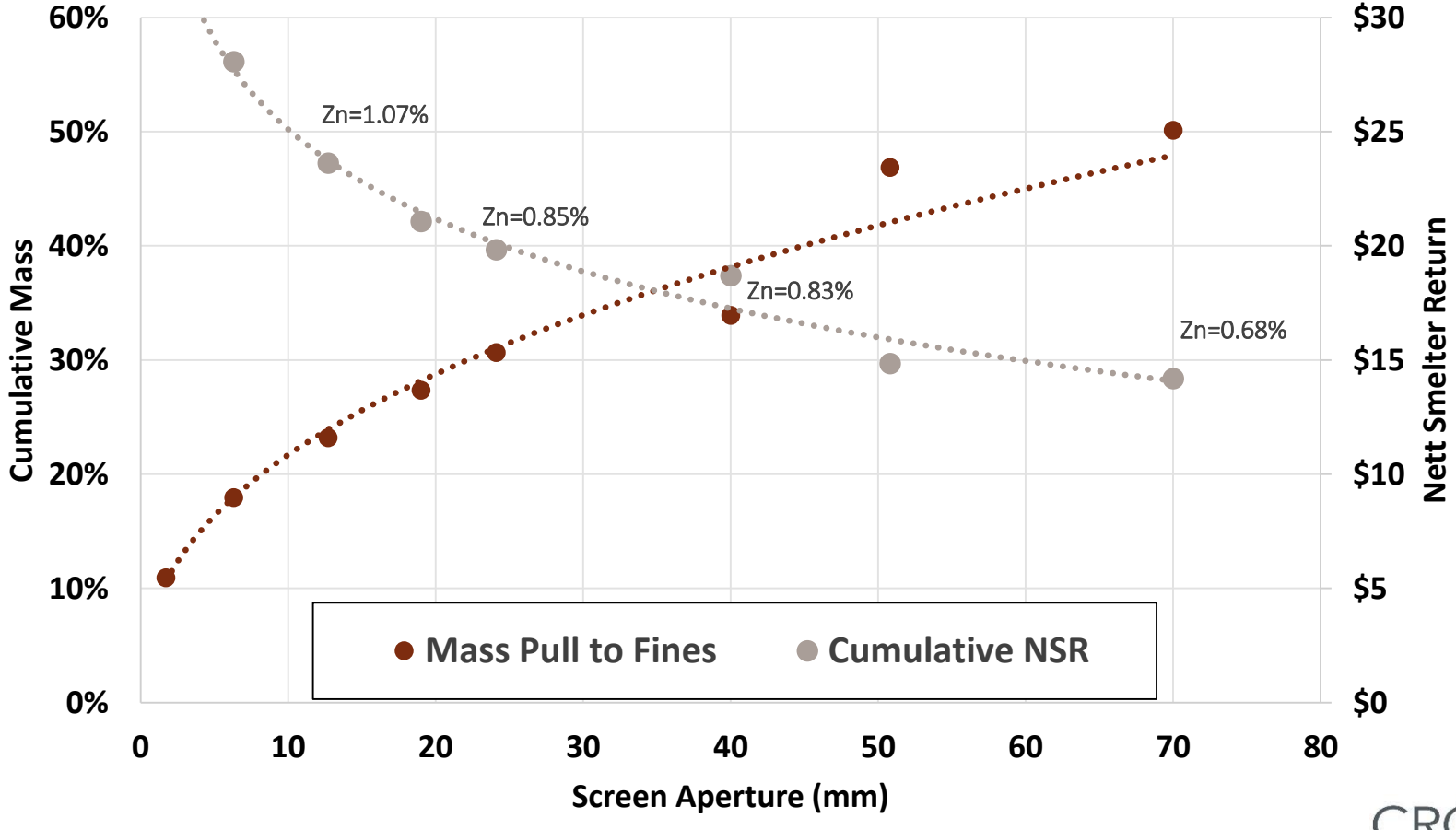
SETUP OF EQUIPMENT ON SITE

TRIAL IN ACTION!!

SETUP EXPERIMENTS KEY TO DEFINING OPERATIONAL WORKFLOW

Trial Date	# of Trials	Operation Time (h/mm)	Sample taken	Lab Results	Topography	Stockpile	Equipment	Sampling
29/10/2018	1	3:00	Fine	Received	Received	CRC ORE	Scav 349, 992	sampled once from the cone
30/10/2018	1	3:00	Fine	Received	N/A	CRC ORE	IT28, 992	sampled once from the cone
3/11/2018	3	4:00	Fine, middle	Received	Received	CRC ORE	962	sampled once from the cone
4/11/2018	1	5:00	Fine, Middle	NRY	No Result Yet	CRC ORE	LT, 980, 992	sampled every hour
6/11/2018	1	3:00	Fine, Middle, Coarse	Fine/middle only	No Result Yet	CRC ORE	LT, 980, IT28	sampled every hour
7/11/2018	3	1:30	Fine, Middle, Coarse	Fine/middle only	Received	Pit (low Grade), Burro Cancha	LT, 962,IT28	Three samples for each trial
8/11/2018	1	2:45	Fine, Middle, Coarse	Fine/middle only	Received	CRC ORE	LT, 992, 962, IT28	Sampled every half an hour

PRELIMINARY RESULTS ARE HIGHLY PROMISING



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SITE TEAM SUPPORTING THE PRODUCTION TRIALS

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