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Where have all the career Drill and Blast Engineers gone?

The power of choice to make a compromise.

Decision making

Empowerment

Accountability

Specialisation

Career
D&E Engineer

Specialisation? It is not a bad idea so why is it not condoned?

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The Drill and Blast Engineer's Tool Box

What's in it?

- ❖Mine planning
- ❖Mine scheduling
- ❖Mine Geology
- ❖Geotechnical to maintain safe pit walls
- ❖Geochemistry for hot/reactive ground
- ❖Detonics to understand correct product selection
- ❖Initiation systems to decide whether to use EBS, NONEL or detonating cord
- ❖Environmental design implications to meet the mine's EA requirements

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A Day in the Life of a D&B Engineer at Dawson Mine

- **Knowledge & Experience**
- **Experience outside the "norm"**
- **Suppliers are a source**
- **Drive Change**
- **Retention**

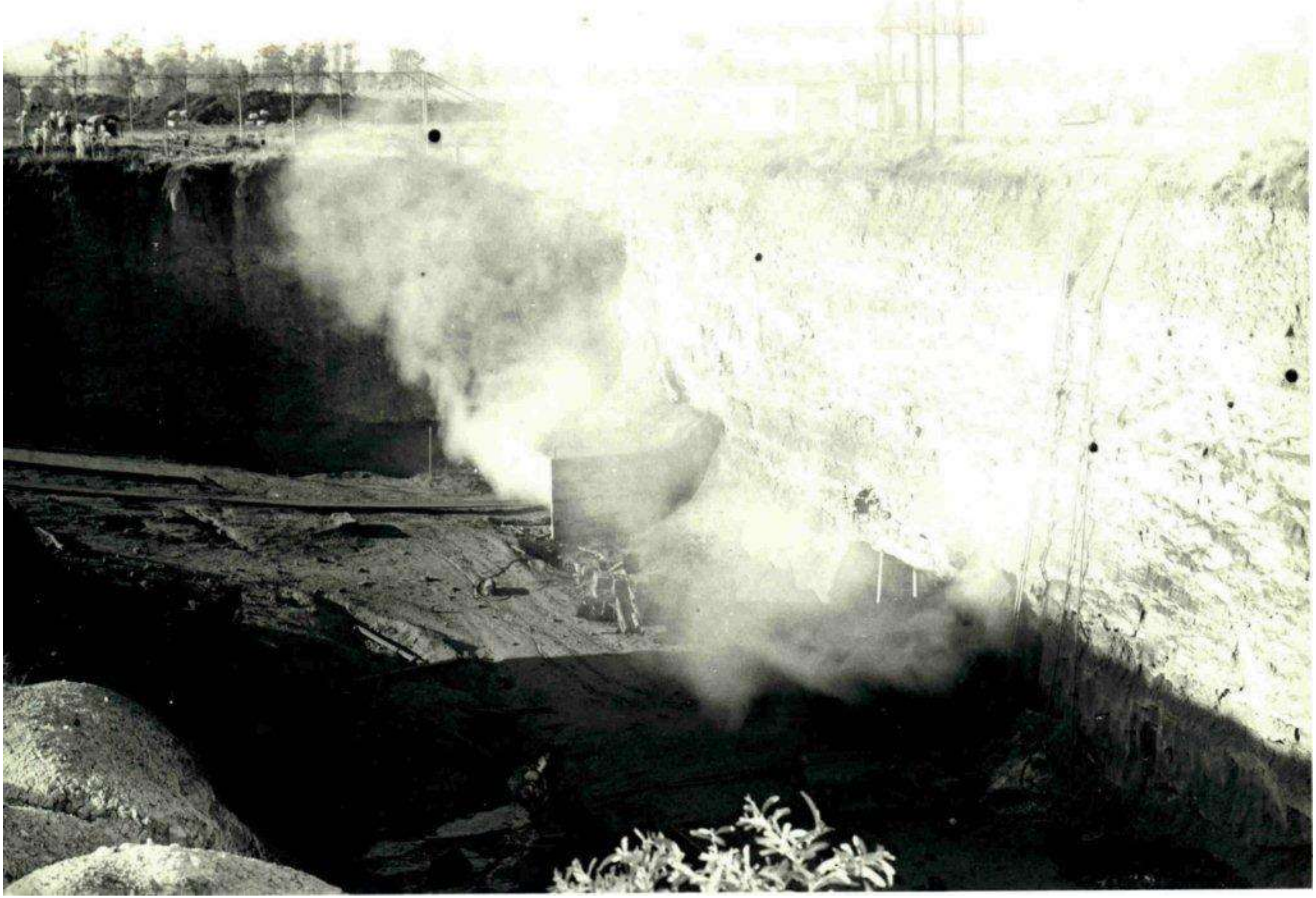
CHALLENGE # 1

HOT HOLES AND REACTIVE GROUND

D&B ENGINEER TOOL BOX

- Geology
- Geochemistry
- Detonics
- Initiation system limitations

20 September 1975 Kianga No. 1
13 lives Lost



16 July 1986 Moura No. 4
12 lives lost

7 August 1994 Moura No. 2
11 lives lost

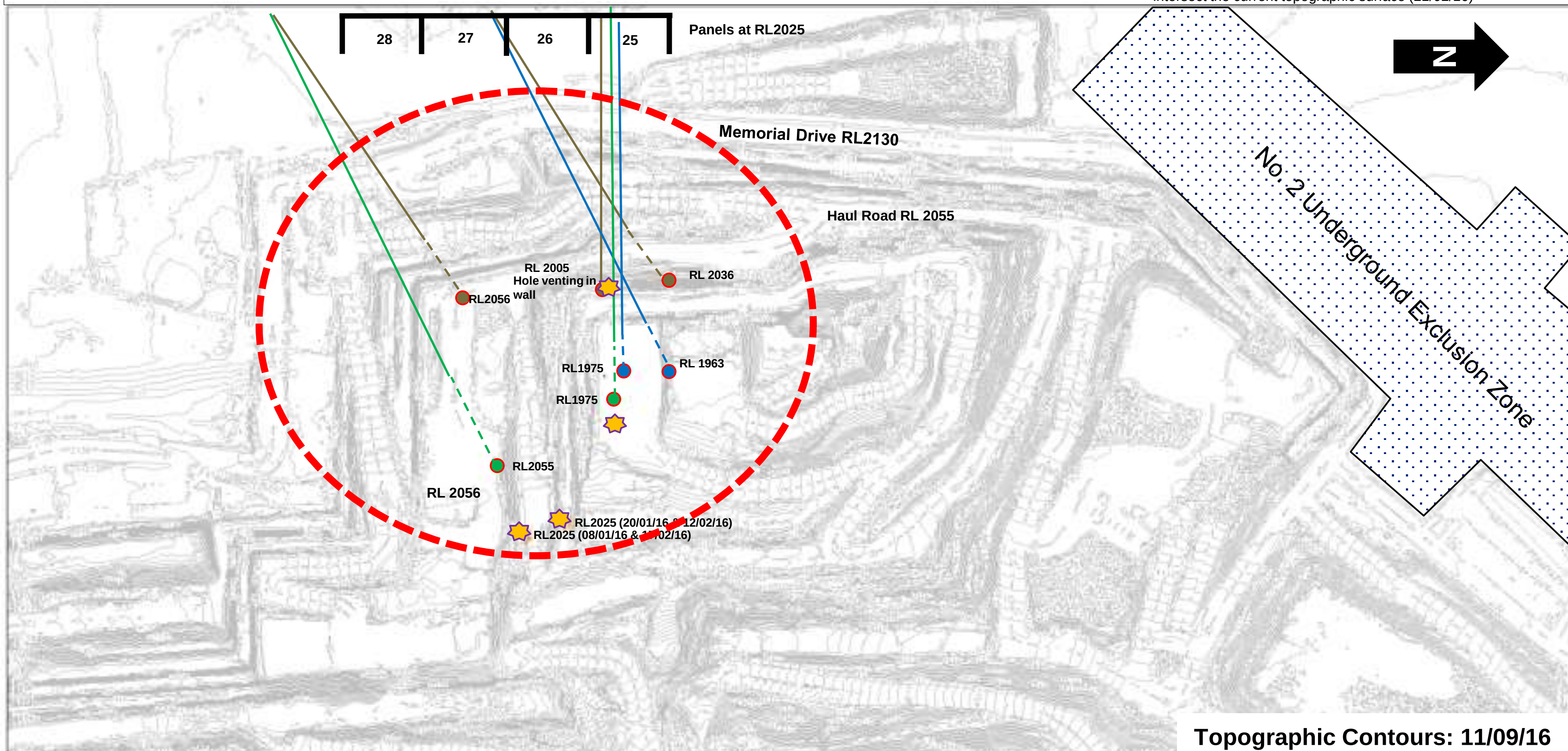
TERRACE HOT GROUND

TERRACE GAS MAP

Legend

- Past gas venting areas with survey pick-up
- A seam lateral gas hole
- C seam lateral gas hole
- D seam lateral gas hole
- Build section of gas hole; prior to entering target seam
- Gas hole in target seam

Note: Gas holes are plotted and annotated an RL where they intersect the current topographic surface (21/02/16)

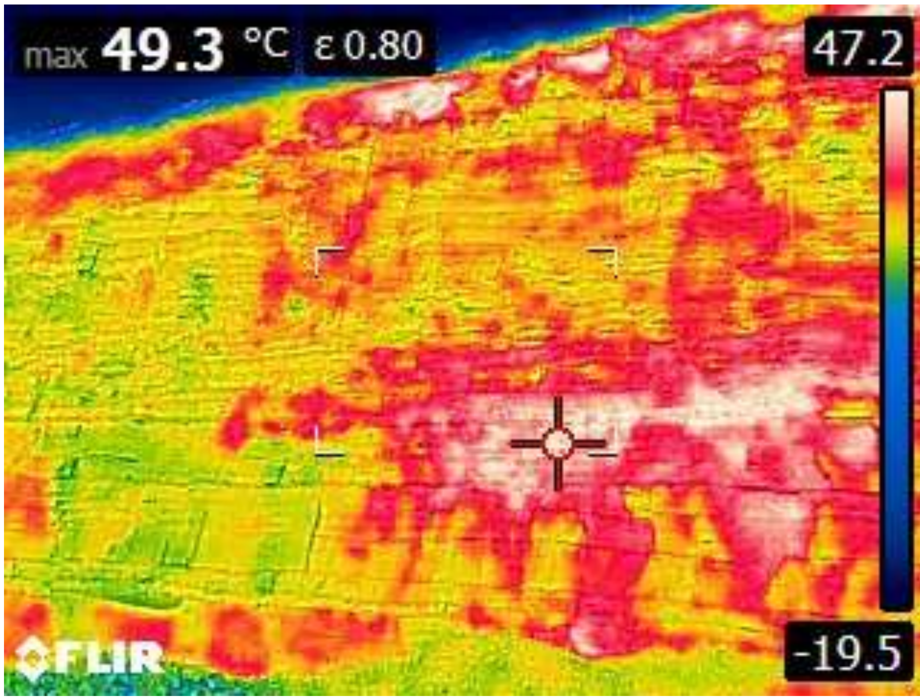


If you are working in these areas and require more information please do not hesitate to contact the Geology Team on 4990 9422 or 4990 9421

METHANE IGNITION

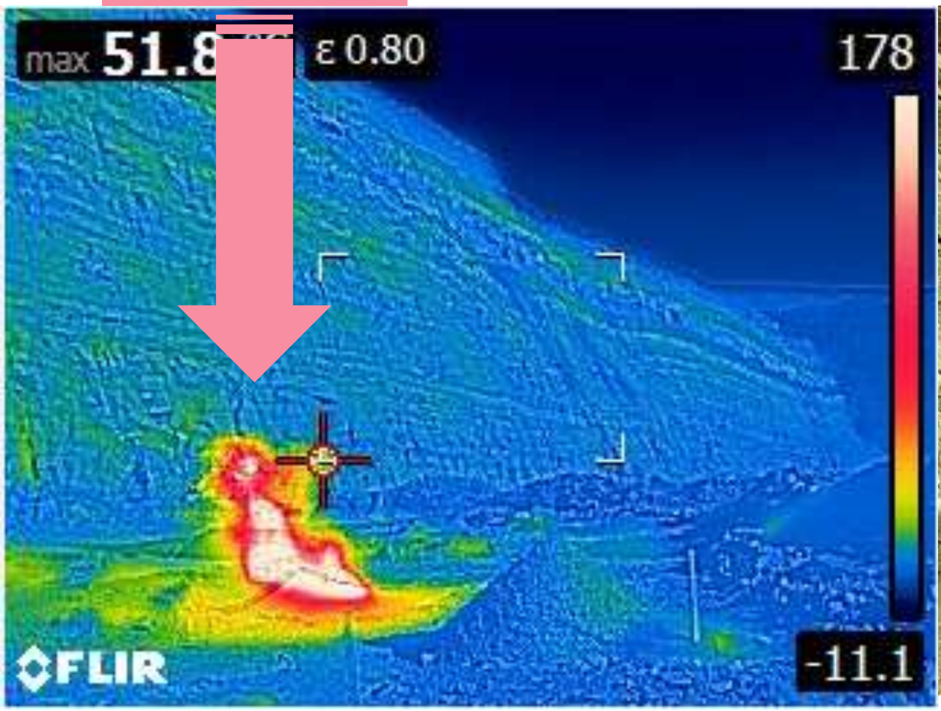
METHANE IGNITION

HOT GROUND



HOT GROUND

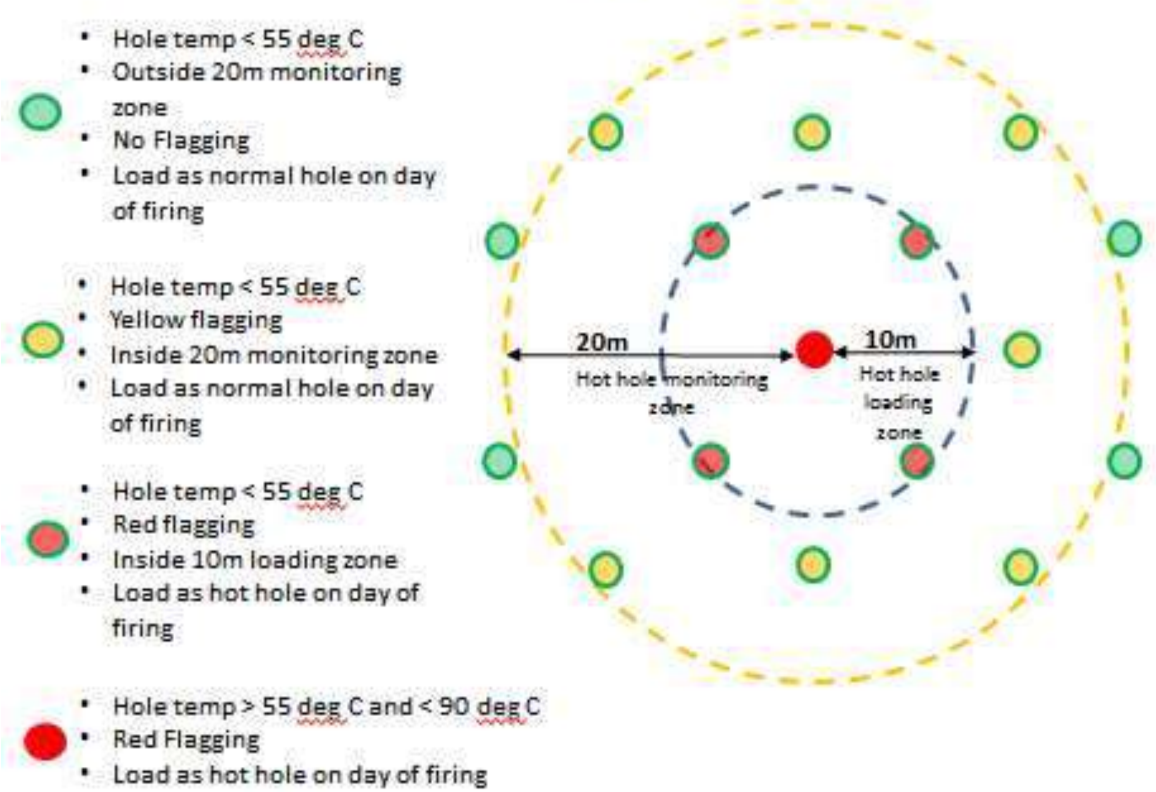
+300^{0}C
Hole



+300^{0}C
Hole

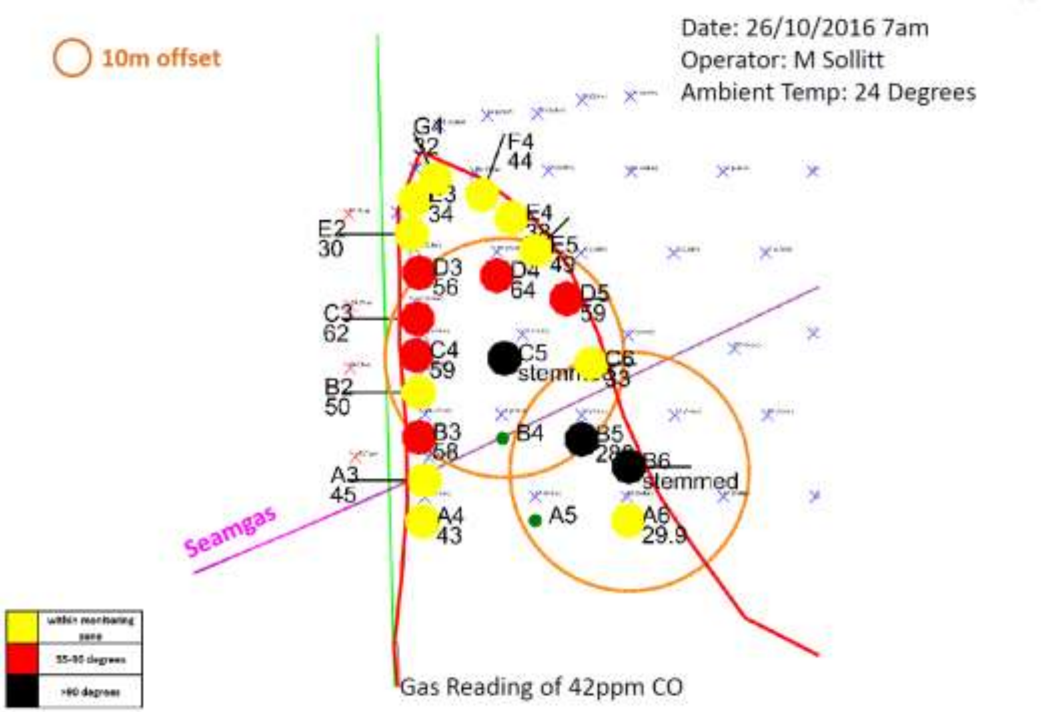
HOT GROUND

HOT SHOT - Loading Holes Greater then 55 deg C and less than 90 deg C



HOT GROUND

TCE_P26_C1945_WEST HOT SHOT HOLE TEMPS



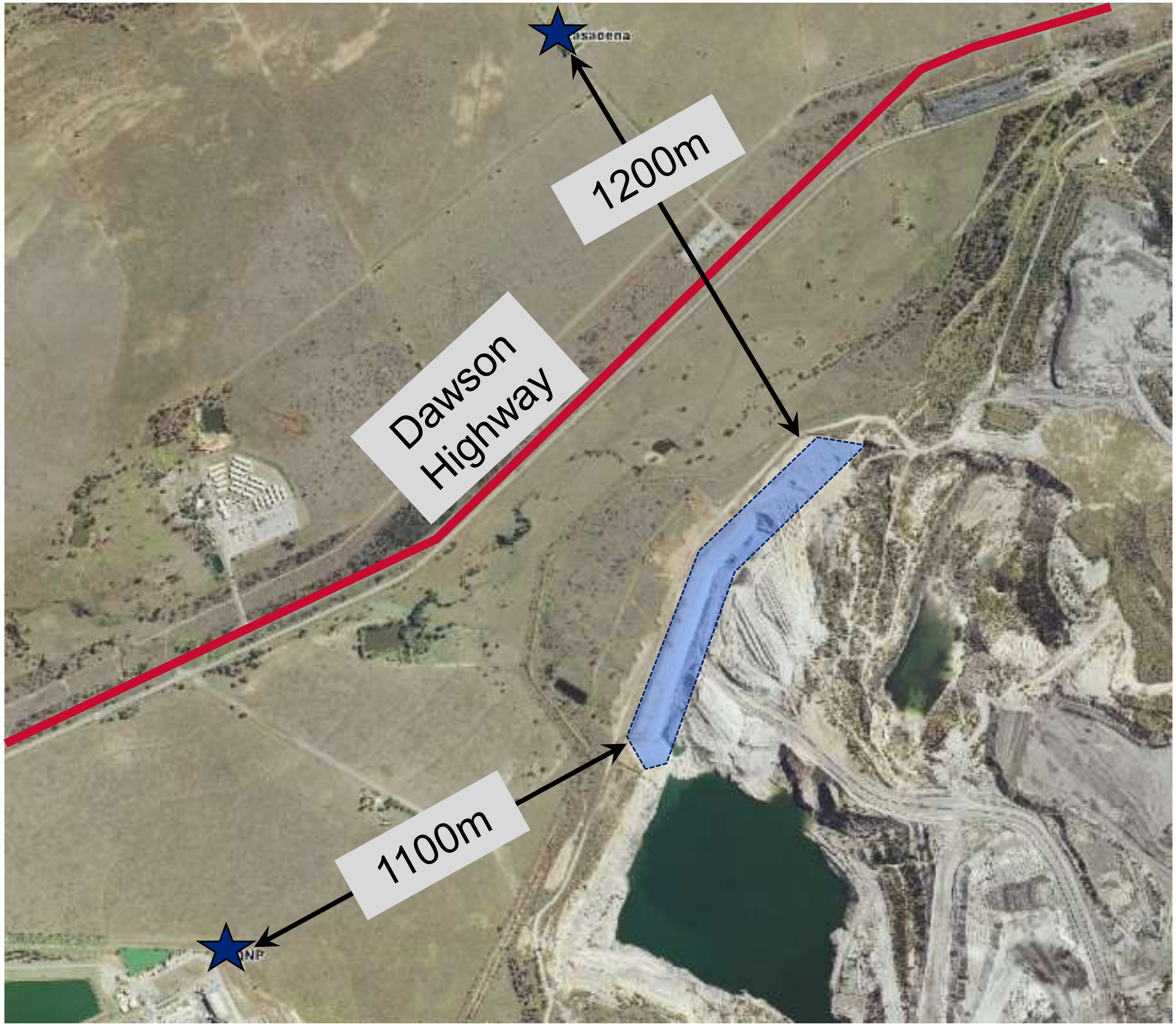
HOT GROUND & MISFIRES

CHALLENGE # 2

BLAST VIBRATION

D&B ENGINEER TOOL BOX

- **Geology**
- **Detonics**
- **Initiation system limitations**
- **Fundamentals of Vibration and Overpressure**


1200m
Dawson Highway
1100m


Base Of Weathering resulted in stemming at 15m below collar
28. 12. 2015 00:07

THE PROBLEM

- **Hole depth ranged from 40 to 60m = 2000 to 3000kg bulk explosive**
- **Original assumption that using conservative approach from AS2187.2 would meet EA requirements**

First Shot PPV (mm/s)	k = 1140		k = 1000		k = 800		k = 600	
	QNP	Pasadena	QNP	Pasadena	QNP	Pasadena	QNP	Pasadena
V	3.8	13.2	3.3	11.6	2.7	9.3	2.0	6.9
AI down the echelon	3.1	5.8	2.7	5.1	2.2	4.1	1.6	3.1
Flat	7.0	14.2	6.1	12.5	4.9	10.0	3.7	7.5
Stand Up	3.1	5.6	2.7	4.9	2.2	4.0	1.6	3.0

Second Shot PPV (mm/s)	k = 1140		k = 1000		k = 800		k = 600	
	QNP	Pasadena	QNP	Pasadena	QNP	Pasadena	QNP	Pasadena
V	5.8	13.6	5.1	11.9	4.1	9.5	3.1	7.2
AI down the echelon	5.5	6.1	4.8	5.4	3.9	4.3	2.9	3.2
Flat	12	14.14	10.5	12.4	8.4	9.9	6.3	7.4
Stand Up	5.5	6.05	4.8	5.3	3.9	4.2	2.9	3.2

THE PROBLEM REVISITED

However….

- **1000kg test holes indicated a vibration control constraint**

- **So a significant amount of engineering design went into the load and initiation design of the first blast.**

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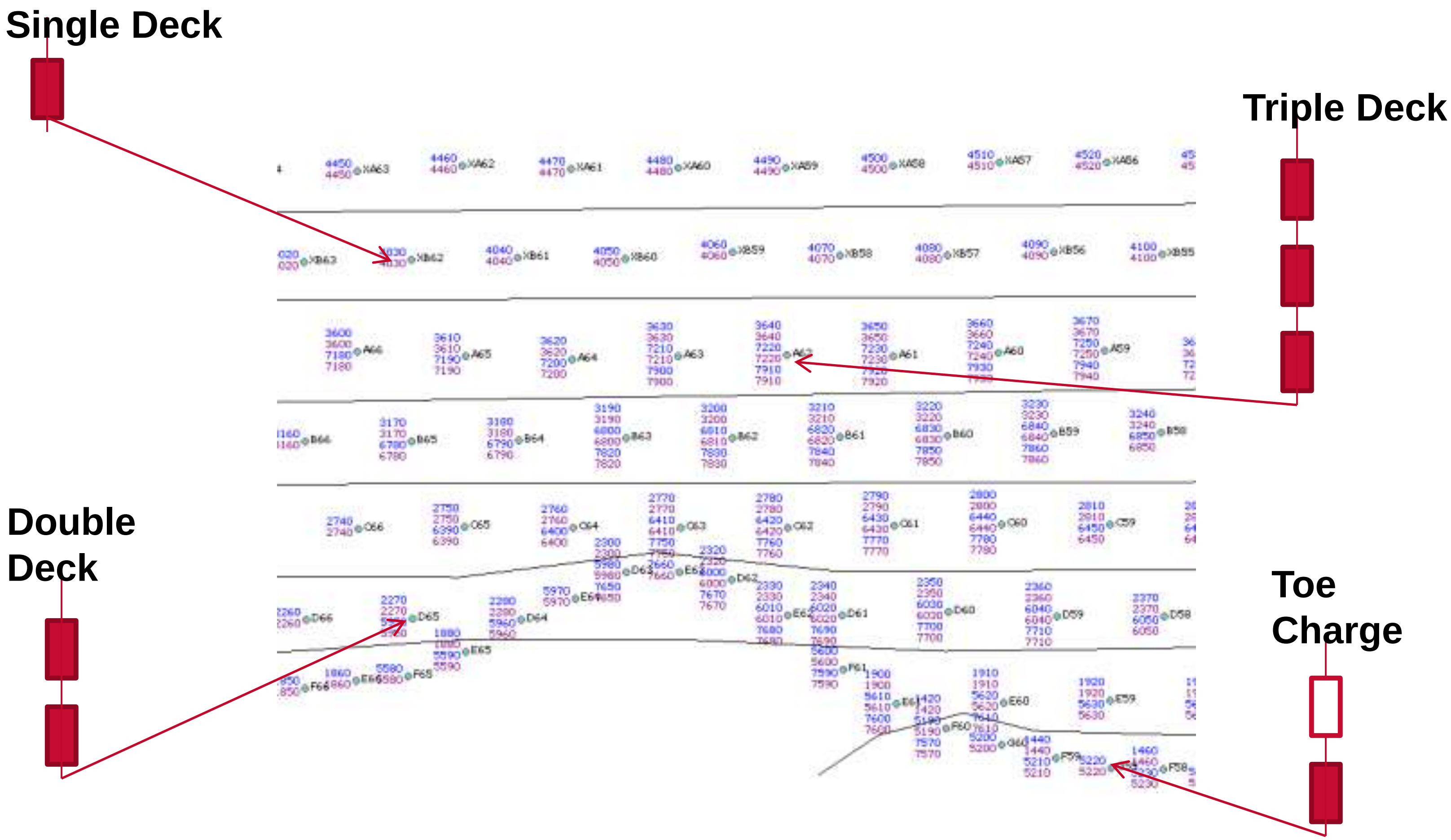
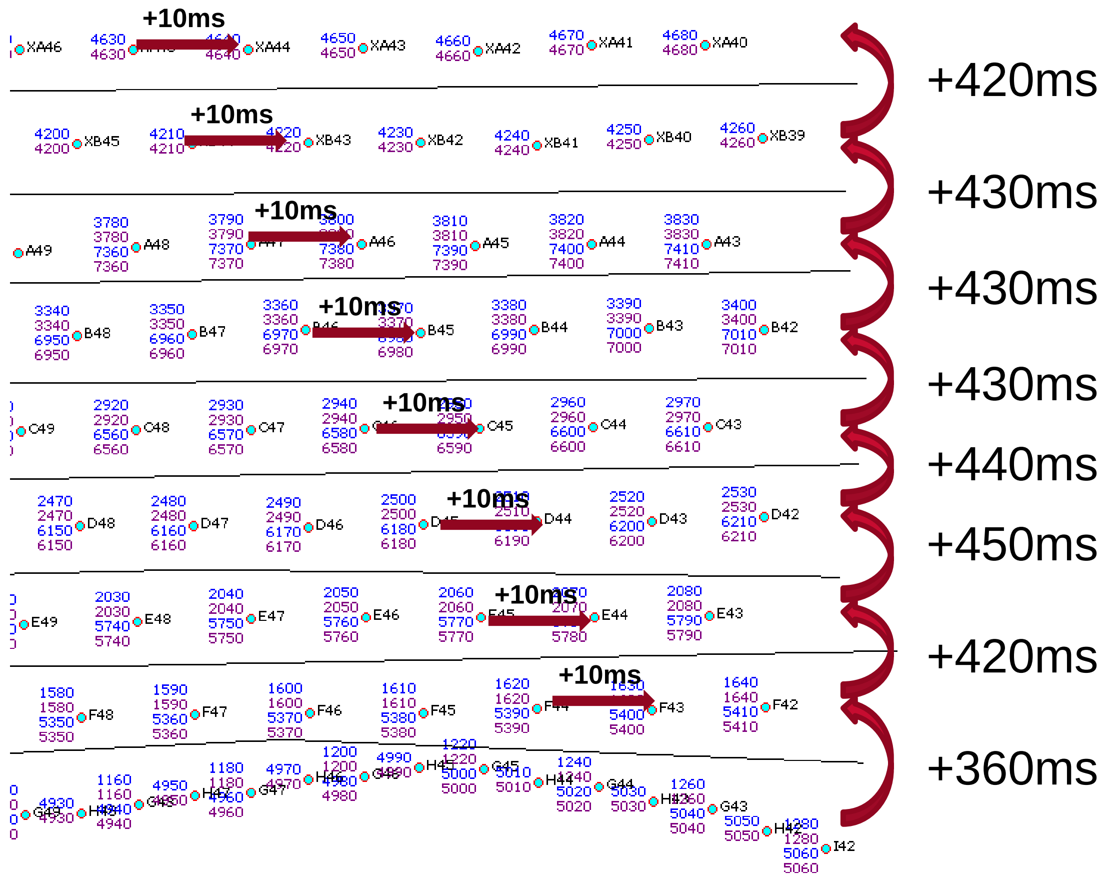
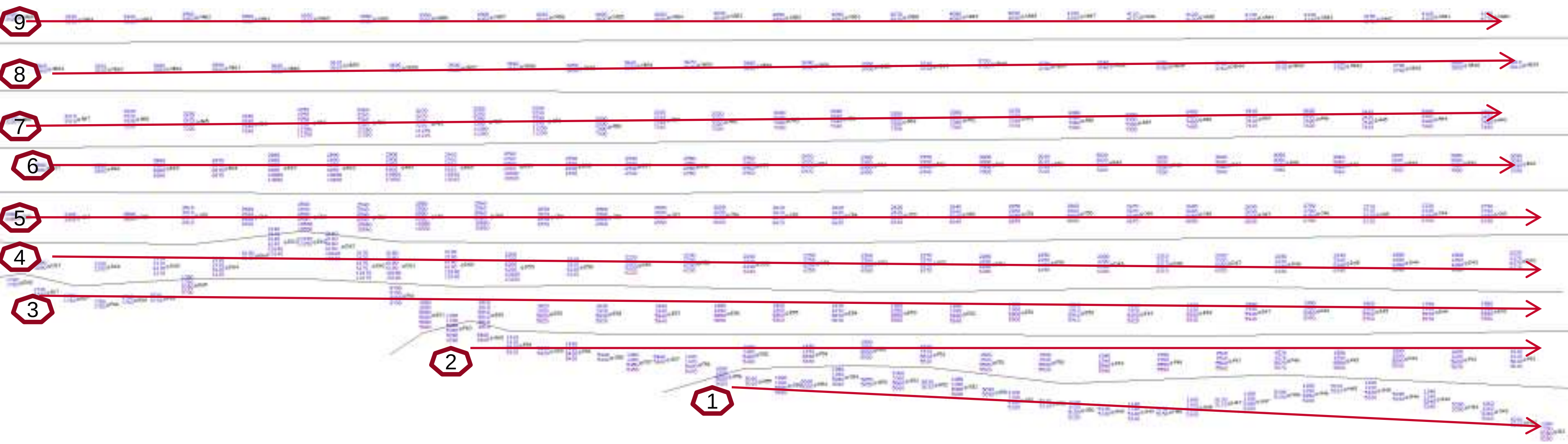


Timing Design



Timing Design



- *10ms b/w holes*
- *300-400ms b/w rows*
- *3000-4000ms b/w decks*

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FIRST BLAST

Results

Low Level vibration exceedance at QNP
Low Level overpressure exceedance at Pasadena

So….

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Invitation for a

ROBUST discussion

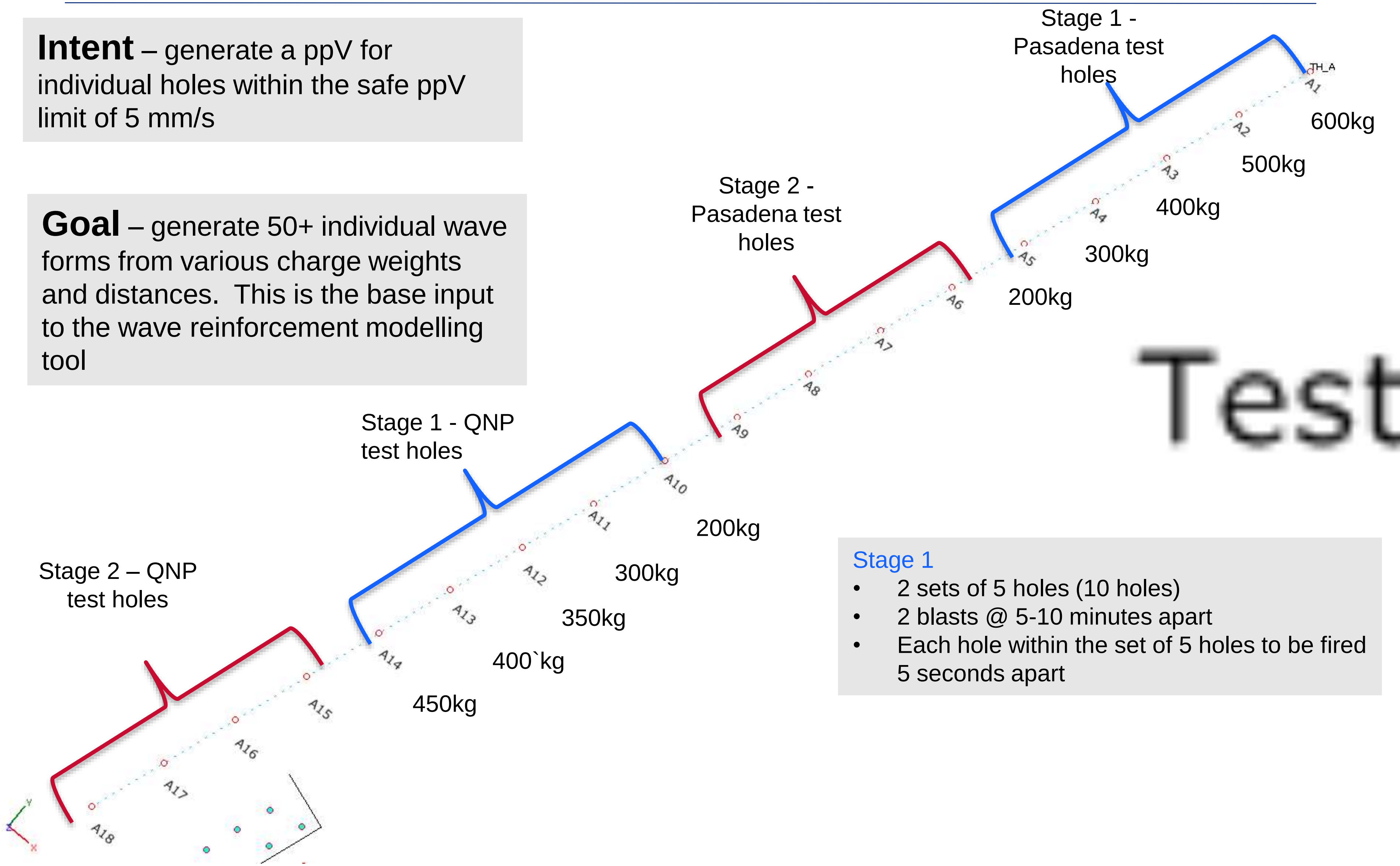
with GM/SSE

Go out there and engineer a solution

Jan 2016 - Predicative ppV from wave reinforcement model

Intent – generate a ppV for individual holes within the safe ppV limit of 5 mm/s

Goal – generate 50+ individual wave forms from various charge weights and distances. This is the base input to the wave reinforcement modelling tool



Stage 1
- 2 sets of 5 holes (10 holes)
- 2 blasts @ 5-10 minutes apart
- Each hole within the set of 5 holes to be fired 5 seconds apart

Test Layout – Based on Scaled Distance Site Law

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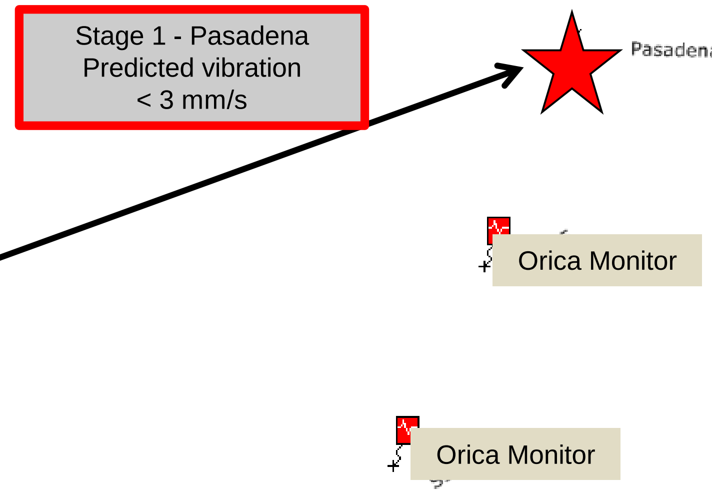
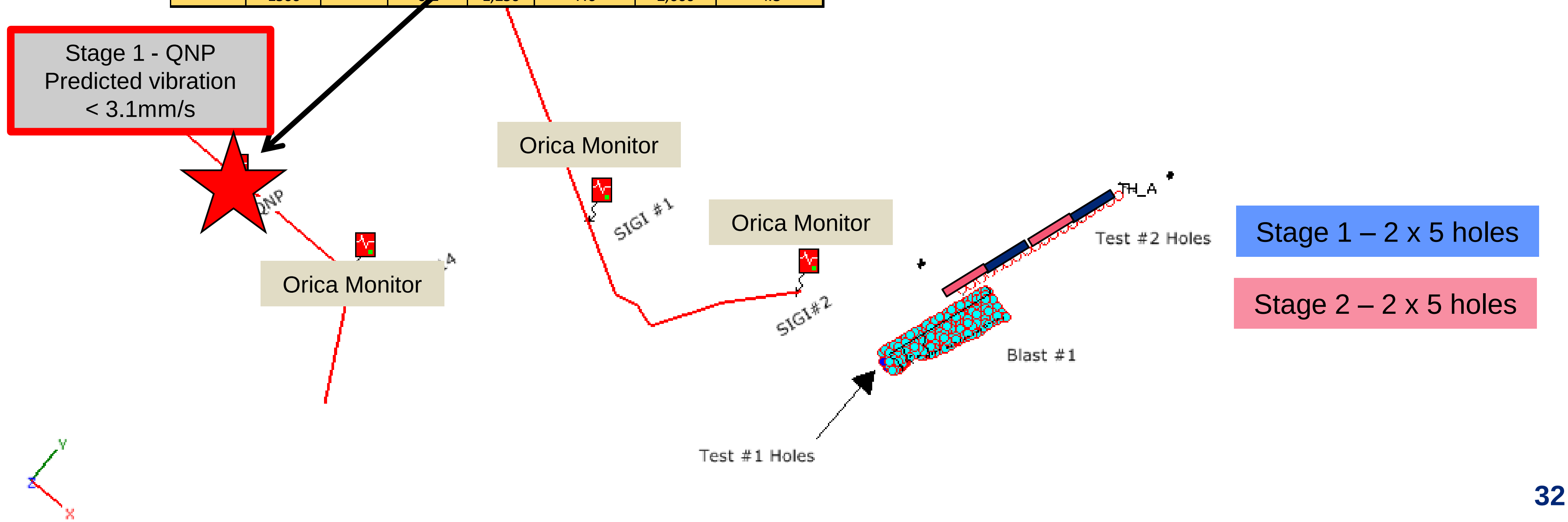
Hole ID	Charge (kg)	Stage	Shot Sequence	Dist to QNP	Predicted SD vibration @ QNP	Dist to Pasadena	Predicted SD vibration @ Pasadena
					500		500
TH_A1	500	Stage 1	2.1	1,657	2.8	***1,546***	3.0
TH_A2	450	Stage 1	2.2	1,641	2.6	1,563	2.8
TH_A3	400	Stage 1	2.3	1,625	2.5	1,580	2.6
TH_A4	300	Stage 1	2.4	1,609	2.1	1,597	2.1
TH_A5	200	Stage 1	2.5	1,593	1.7	***1,613***	1.7
TH_A6	TBC	Stage 2	4.1	1,577		1,630	
TH_A7	TBC	Stage 2	4.2	1,561		1,647	
TH_A8	TBC	Stage 2	4.3	1,545		1,664	
TH_A9	TBC	Stage 2	4.4	1,529		***1,680***	
TH_A10	200	Stage 1	1.5	***1,513***	1.8	1,697	1.6
TH_A11	300	Stage 1	1.4	1,496	2.3	1,714	2.0
TH_A12	350	Stage 1	1.3	1,480	2.6	1,731	2.1
TH_A13	400	Stage 1	1.2	1,464	2.8	1,748	2.3
TH_A14	450	Stage 1	1.1	***1,448***	3.1	1,765	2.4
TH_A15	TBC	Stage 2	3.4	1,432		1,782	
TH_A16	TBC	Stage 2	3.3	1,416		1,799	
TH_A17	TBC	Stage 2	3.2	1,400		1,816	
TH_A18	TBC	Stage 2	3.1	***1,384***		1,833	
Test#1a	1000		0.0	1,250	5.9	2,000	3.4
	1500		0.1	1,250	7.6	2,000	4.3





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Test Results

- All EA requirements met

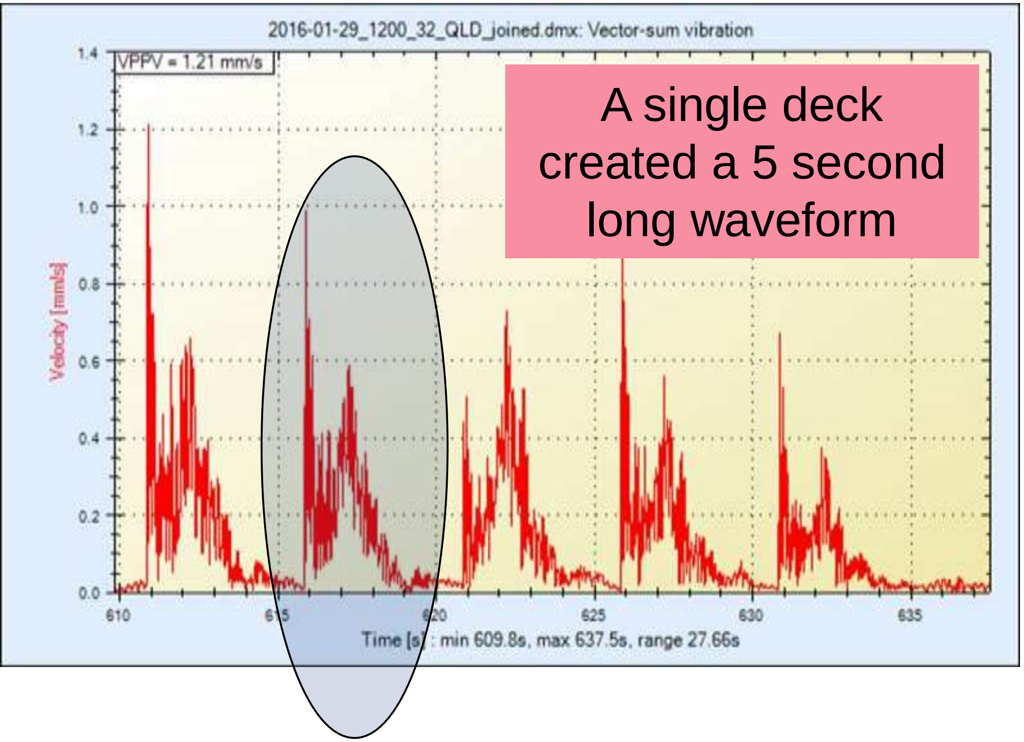
But….

- When Kim Henley (ORICA) rings me up and says to the effect

"Very interesting res
I wasn't expectin

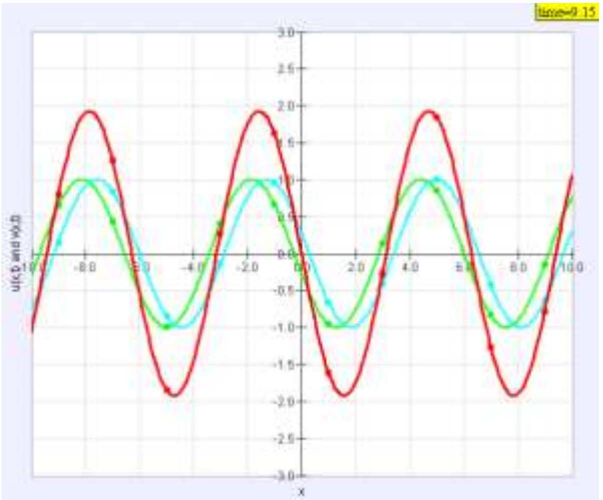
My confidence turned to a worried frown.

Jan 29 – Test Blast Hole Results



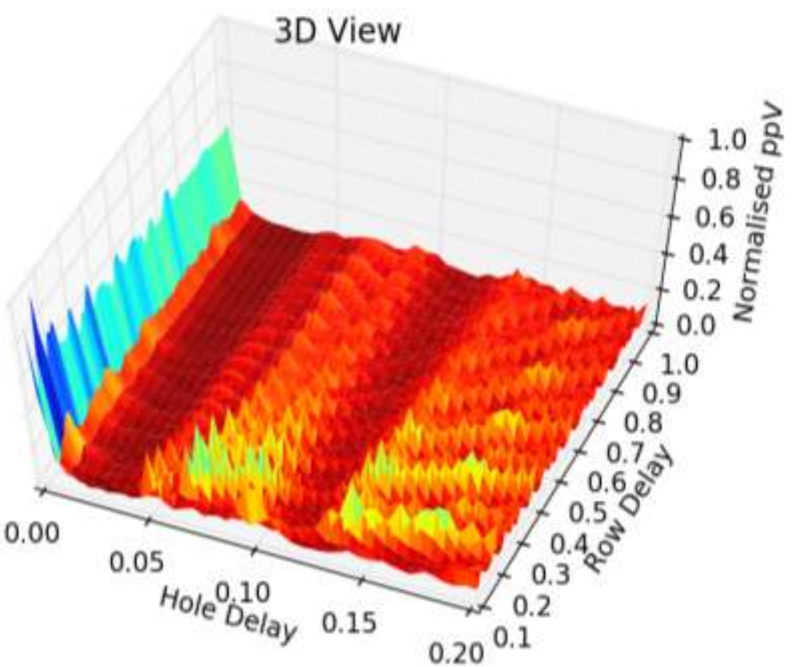
A single deck created a 5 second long waveform

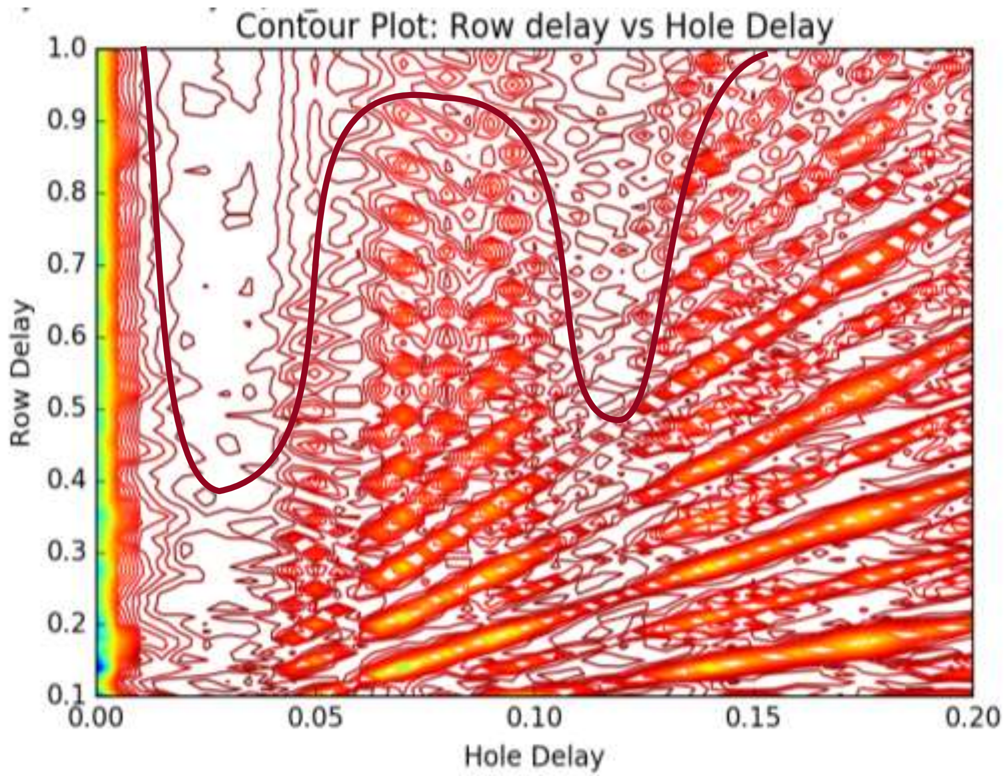
The object is to model Wave Super Positioning



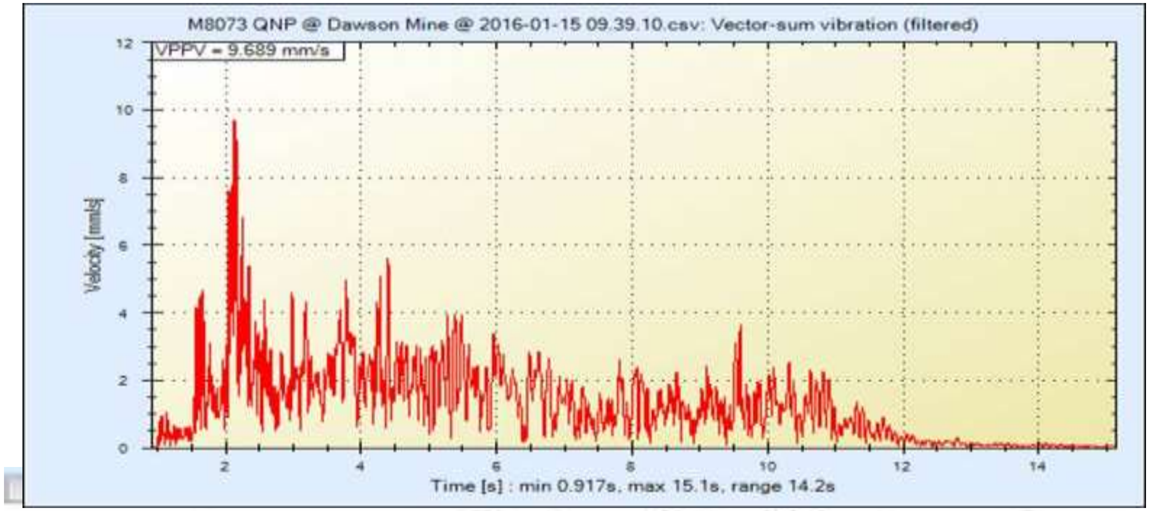
Seed waveform

Multiple Seed waveforms modelled in blast simulation

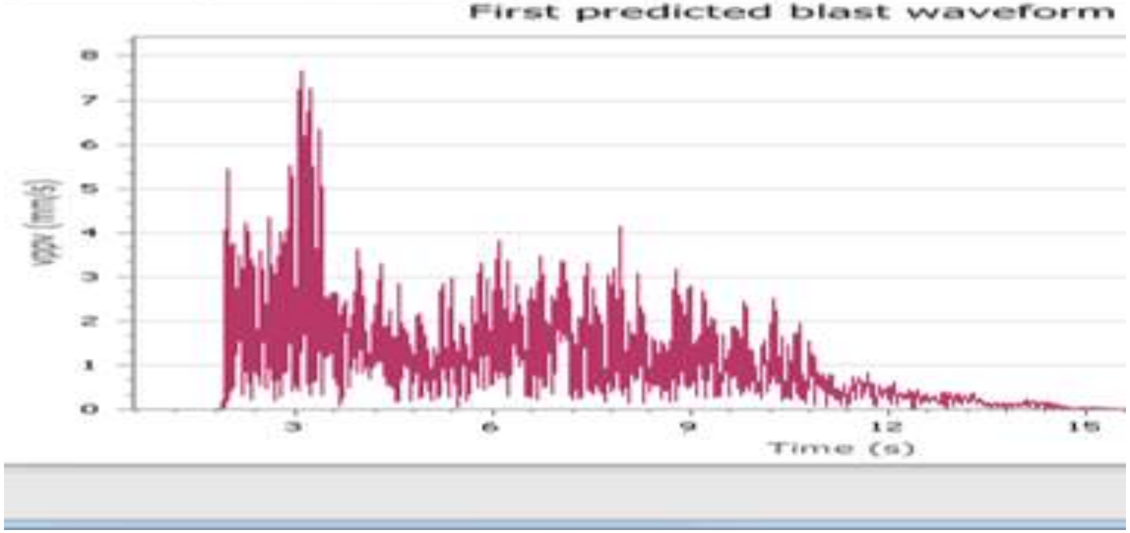

3D View
Normalised ppV
1.0
0.8
0.6
0.4
0.2
0.0
Row Delay
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Hole Delay
0.00
0.05
0.10
0.15
0.20


Contour Plot: Row delay vs Hole Delay
Row Delay
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Hole Delay
0.00
0.05
0.10
0.15
0.20

Feb 16 – Building Vibration Prediction Model



1 - Actual Vibration Wave From 1st blast



2 – Predicted Vibration Wave from 1st blast

7 Blasts - Feb 16 to Aug16

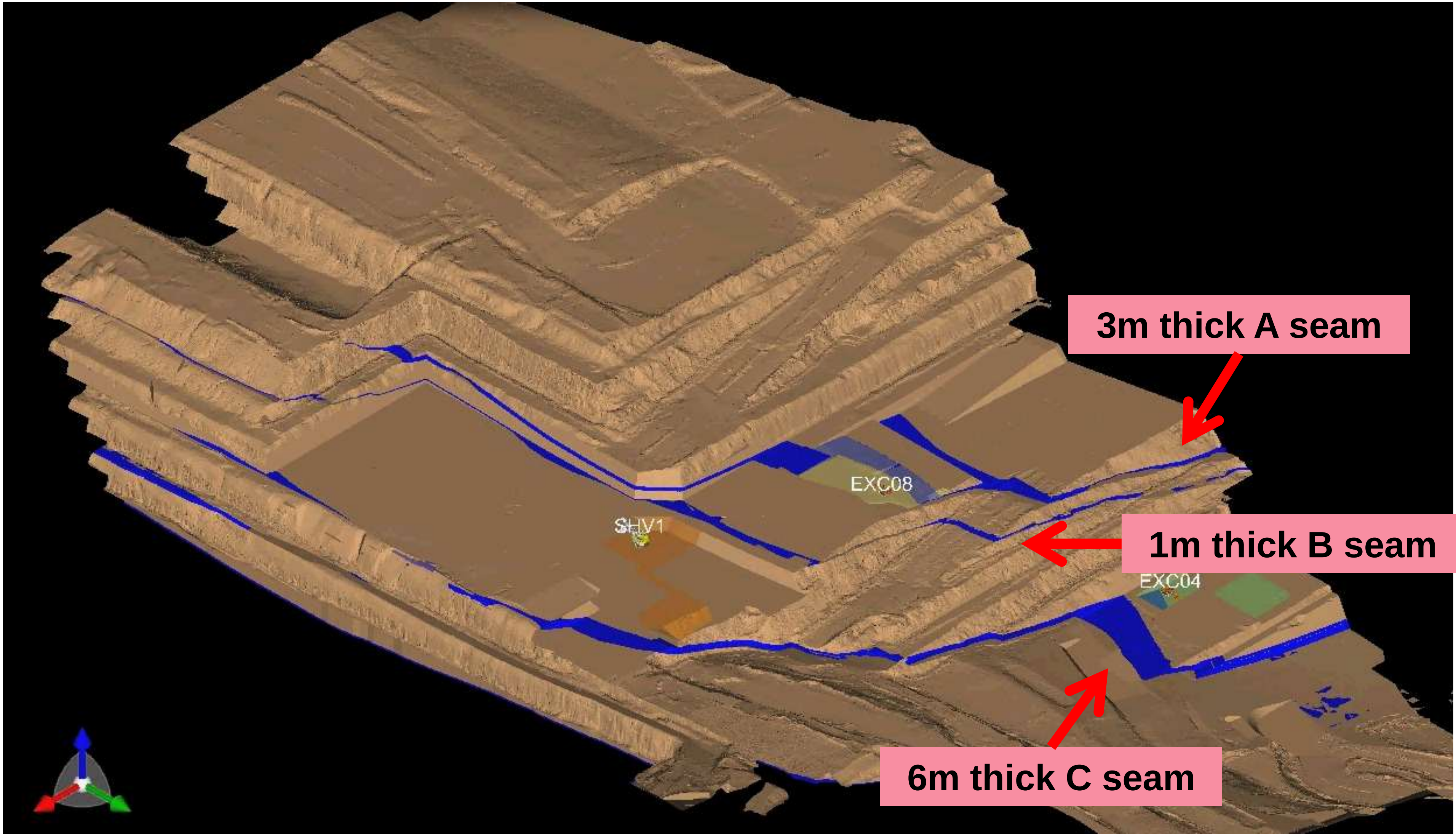
CHALLENGE #3

THROUGH SEAM BLASTING

D&B ENGINEER TOOL BOX

- Mine planning
- Mine scheduling
- Geotechnical to maintain safe pit walls
- Mine Geology
- Detonics
- Initiation system limitations
- Vibration and Overpressure fundamentals

THROUGH SEAM BLASTING



Through Seam Blasting Methodology

OPTION 1

Blast the bottom first then the top.
This maximises confinement of the charge below the target seam hence minimise movement

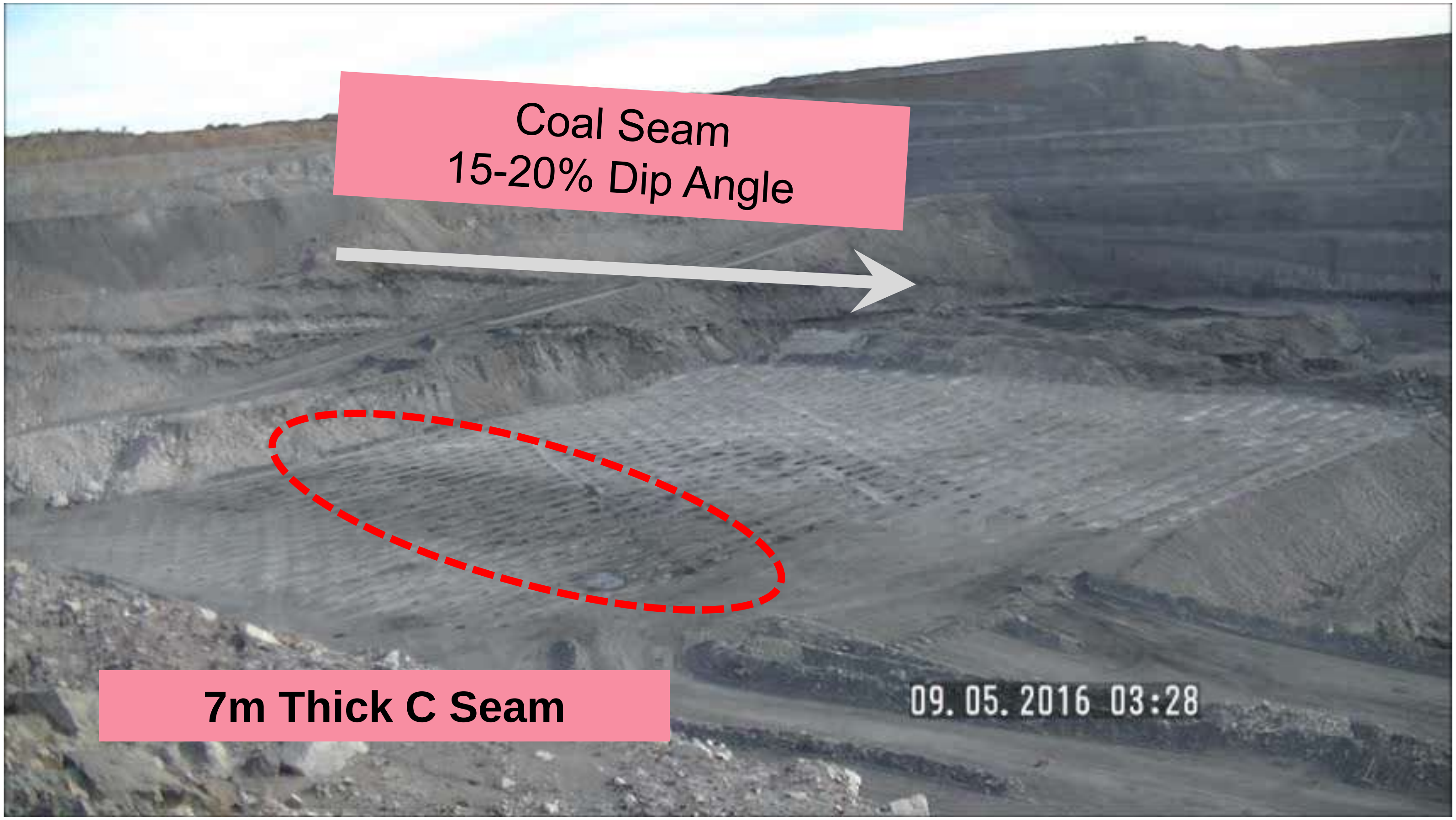
OPTION 2

Blast the top first then the bottom.
A significant timing delay MUST be applied to the bottom deck to allow the material above the target seam to settle and provide confinement

D&B CONSIDERATIONS

- Correct geometry of decks within the same horizon
- Separation distances to mitigate risk of shrink wrapping of EBC
- Complexity of loading from a production perspective
- Stemming lengths when the coal day lights out on the bench
- Explosive deck stand-off distances from roof and floor of target seam
- Complexity of timing Design
- Direction of Firing

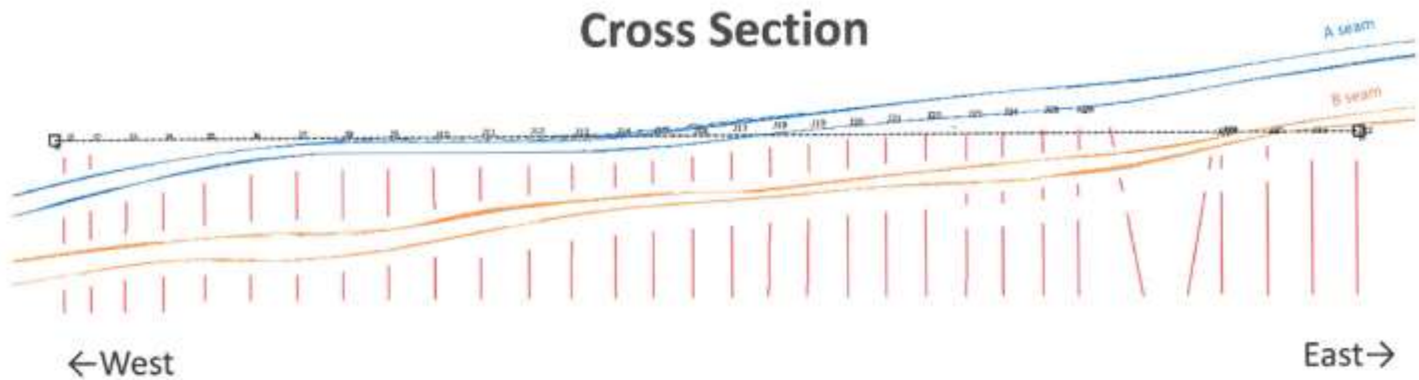
OPTION 1 – Bottom then Top

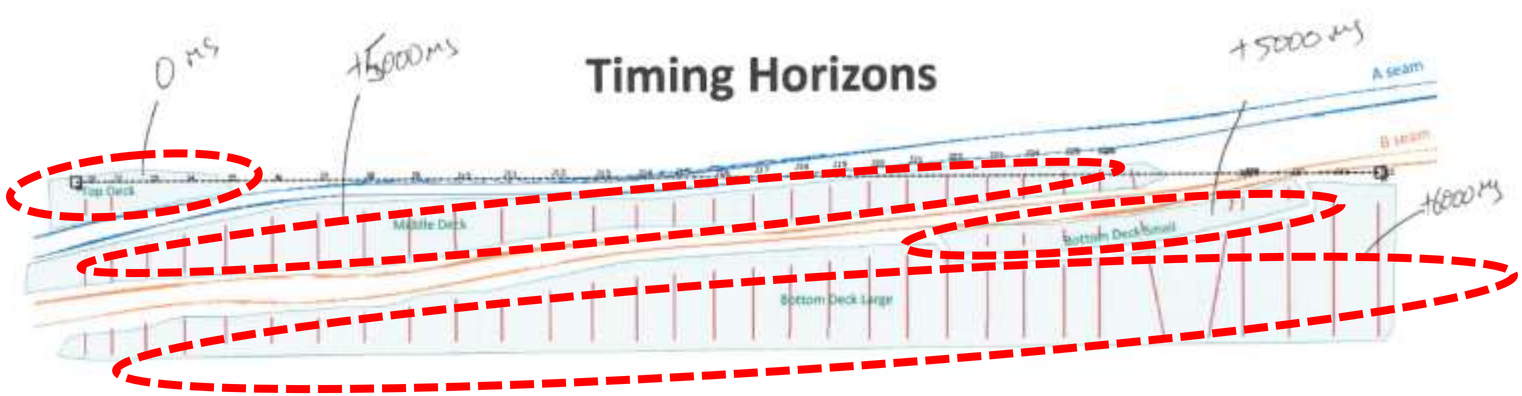


OPTION 2 – Top then Bottom

BEAR TRAP #1

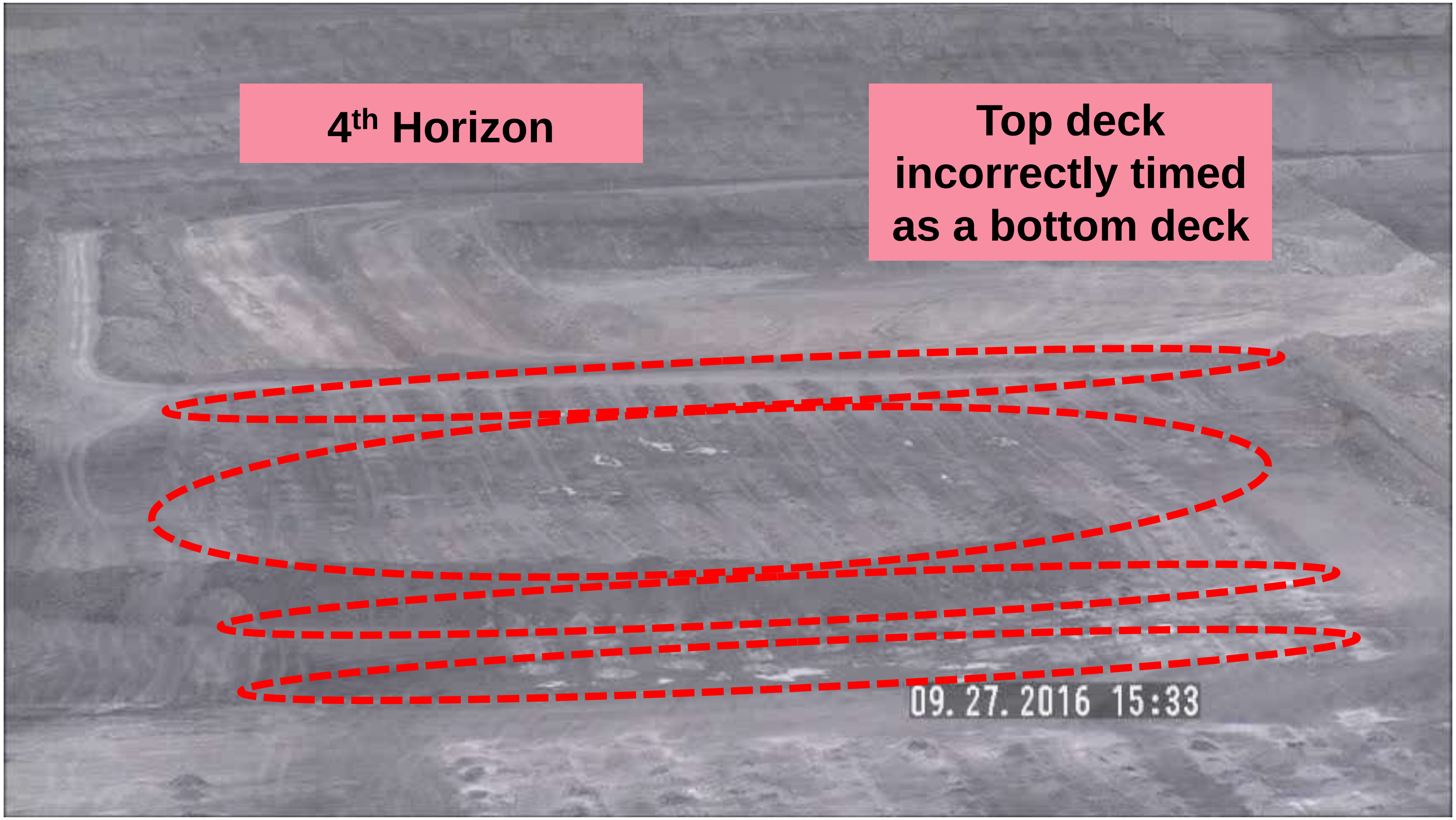
Complex Timing Designs – 1 deck out of 1000





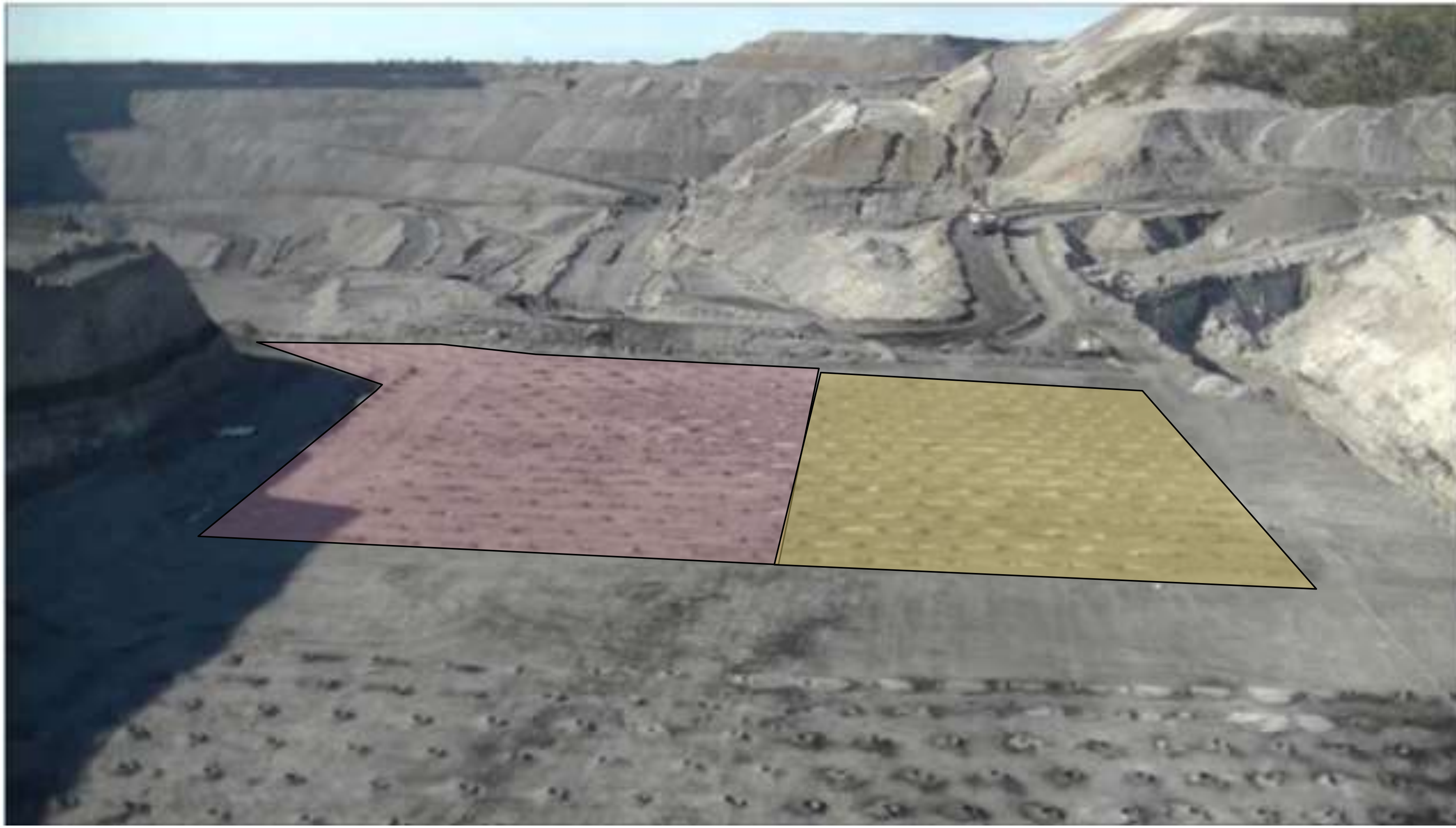
BEAR TRAP #1

Complex Timing Designs – 1 deck out of 1000



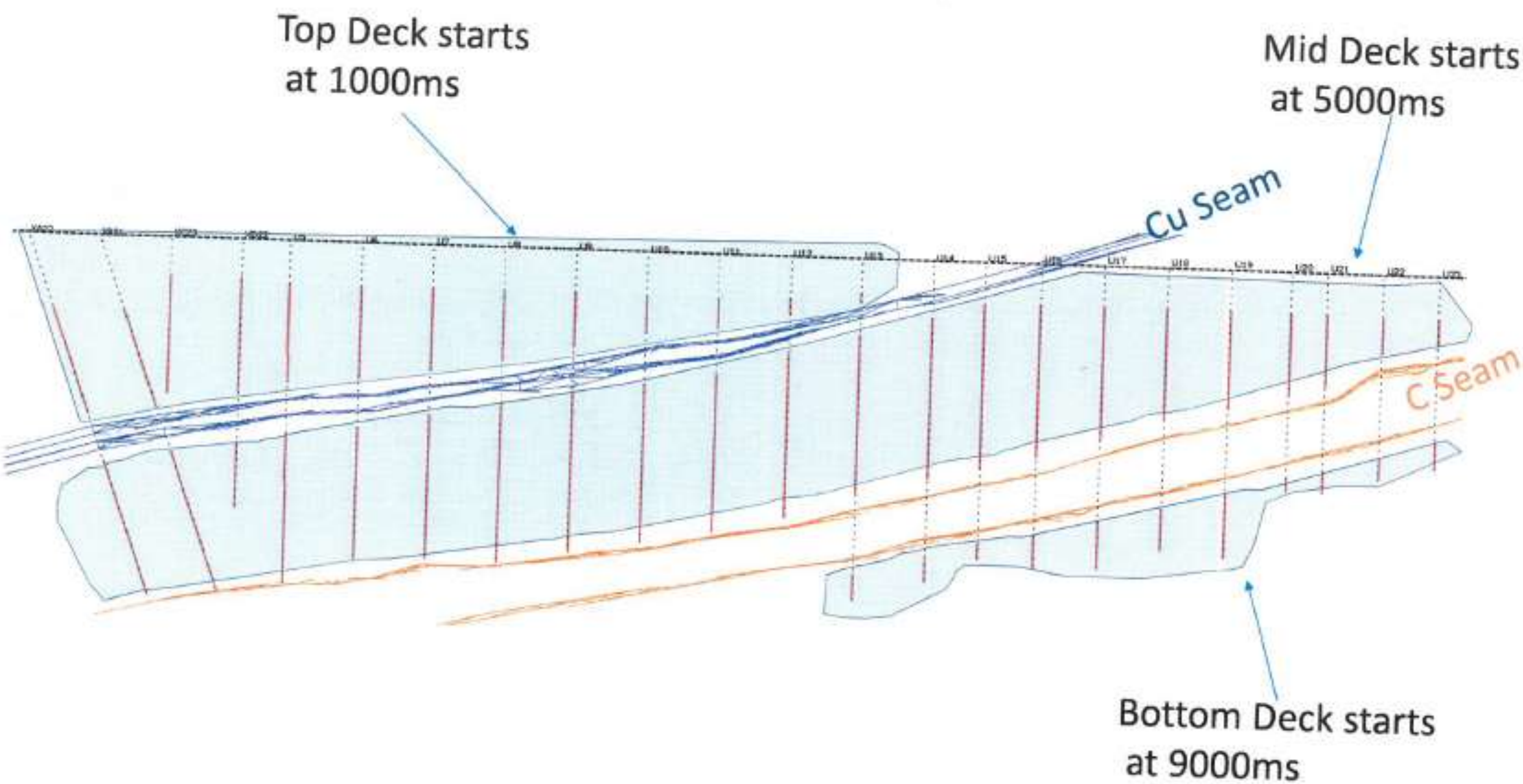
BEAR TRAP #2

DIRECTION OF FIRING – UP DIP or DOWN DIP



BEAR TRAP #2

BEAR TRAPS



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BEAR TRAP #2

DIRECTION OF FIRING – UP DIP or DOWN DIP

CHALLENGE # 4

Bench Preparation for Steeply Dipping Seam

D&B ENGINEER TOOL BOX
Mine Planning
Mine Scheduling
Geology
Detonics
Initiation system limitations

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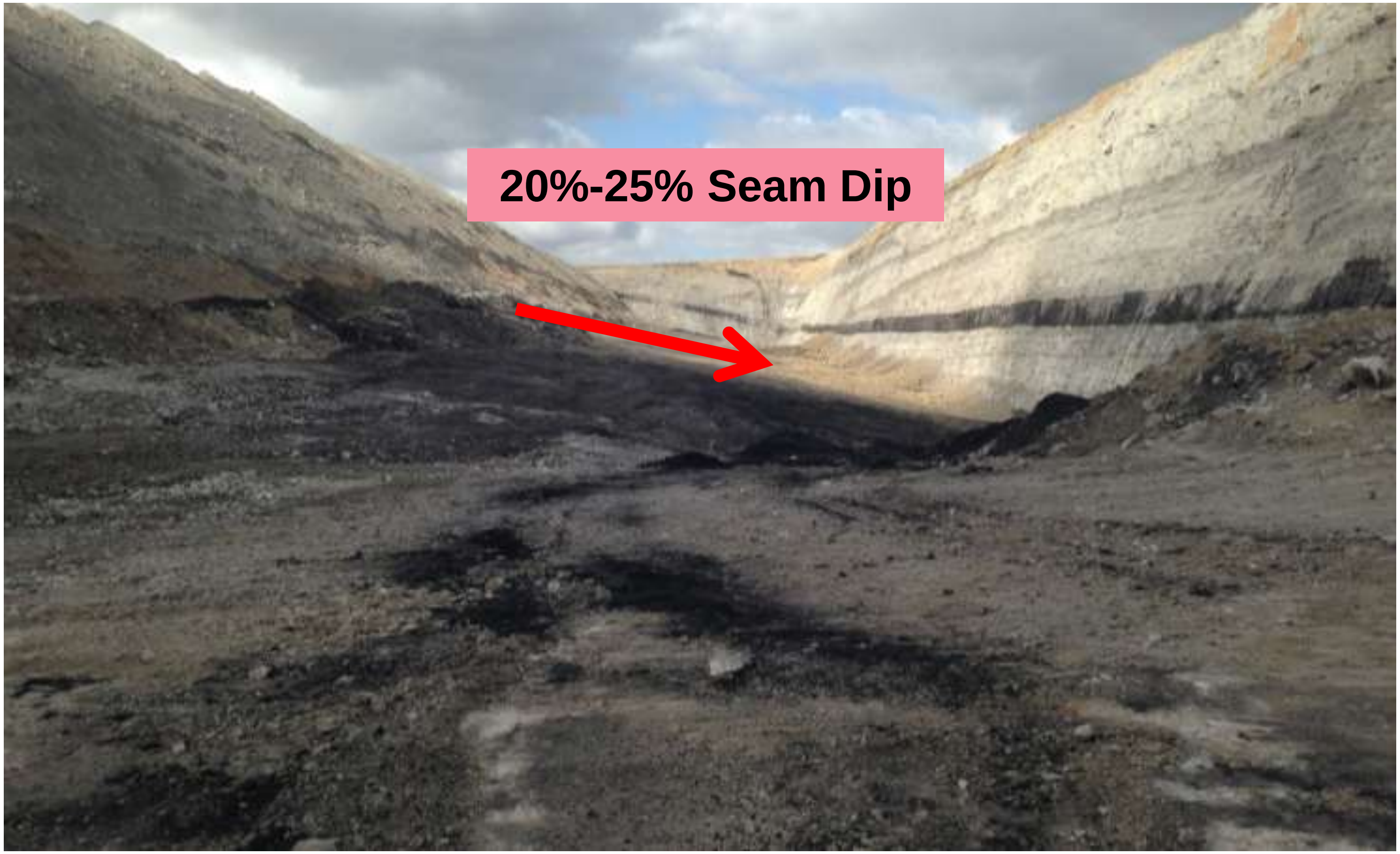
HOW DO YOU DRILL THIS WITH A D90K?

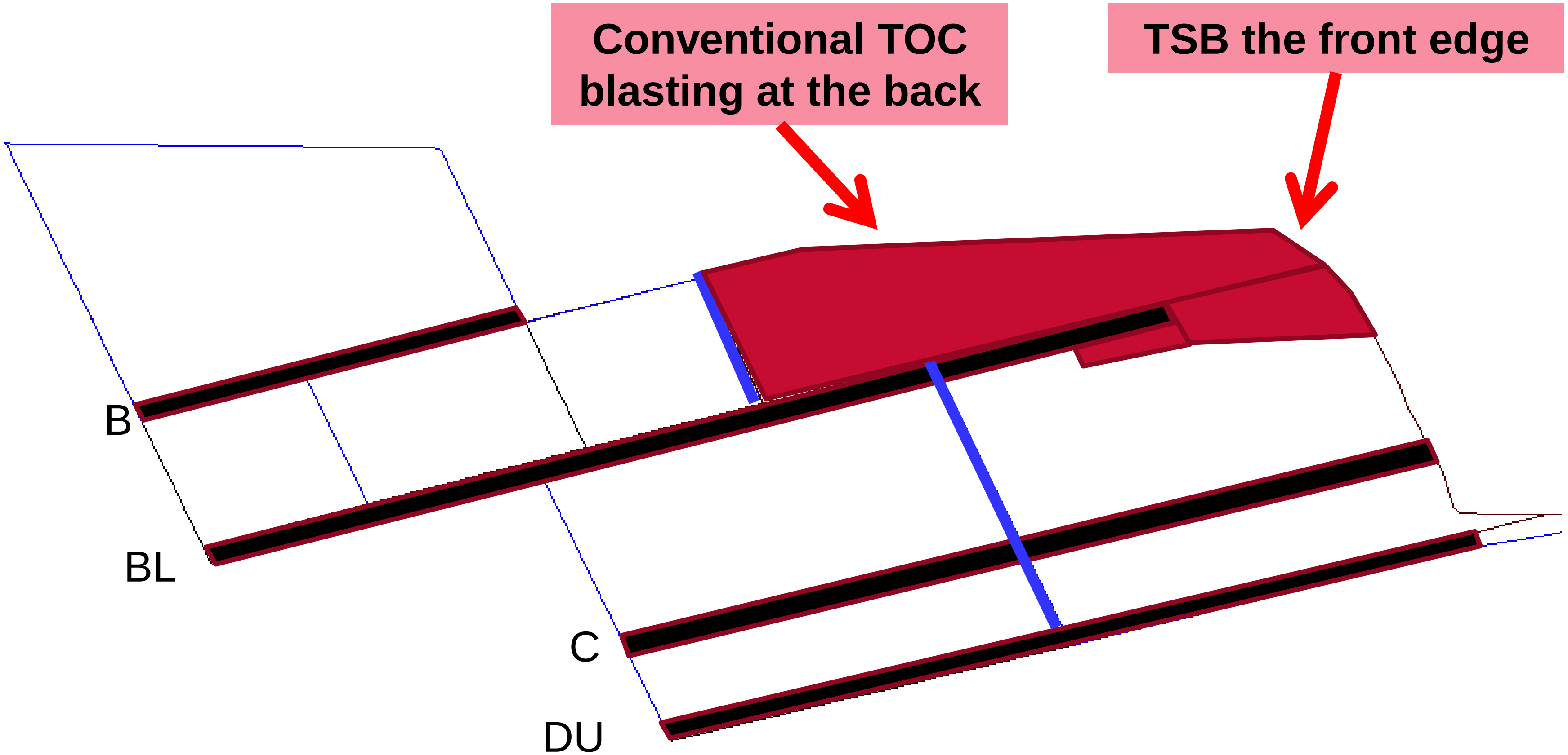


D&B CONSIDERATIONS

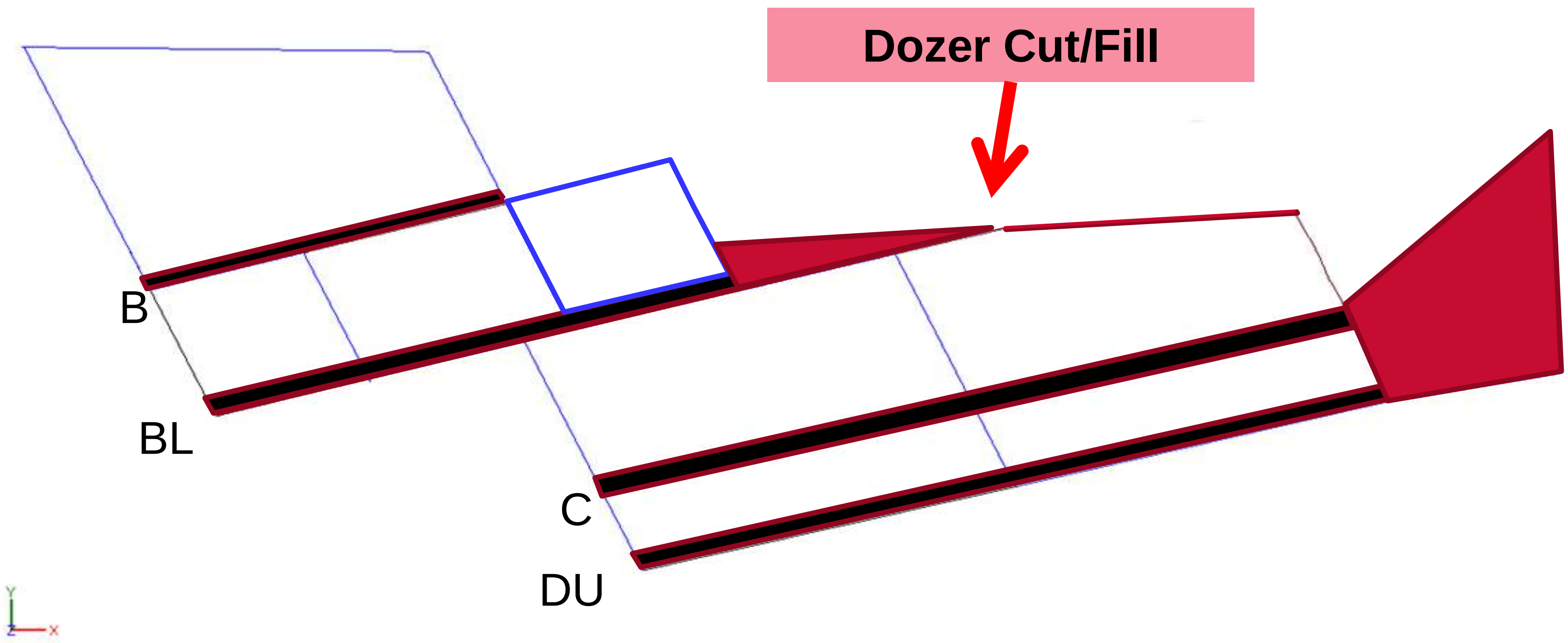
Blasting Grades / Ducting Damage

THE EXPENSIVE WAY IS TO FILL THE BENCH BACK IN

THE D&B SOLUTION



THE D&B SOLUTION



THE D&B SOLUTION

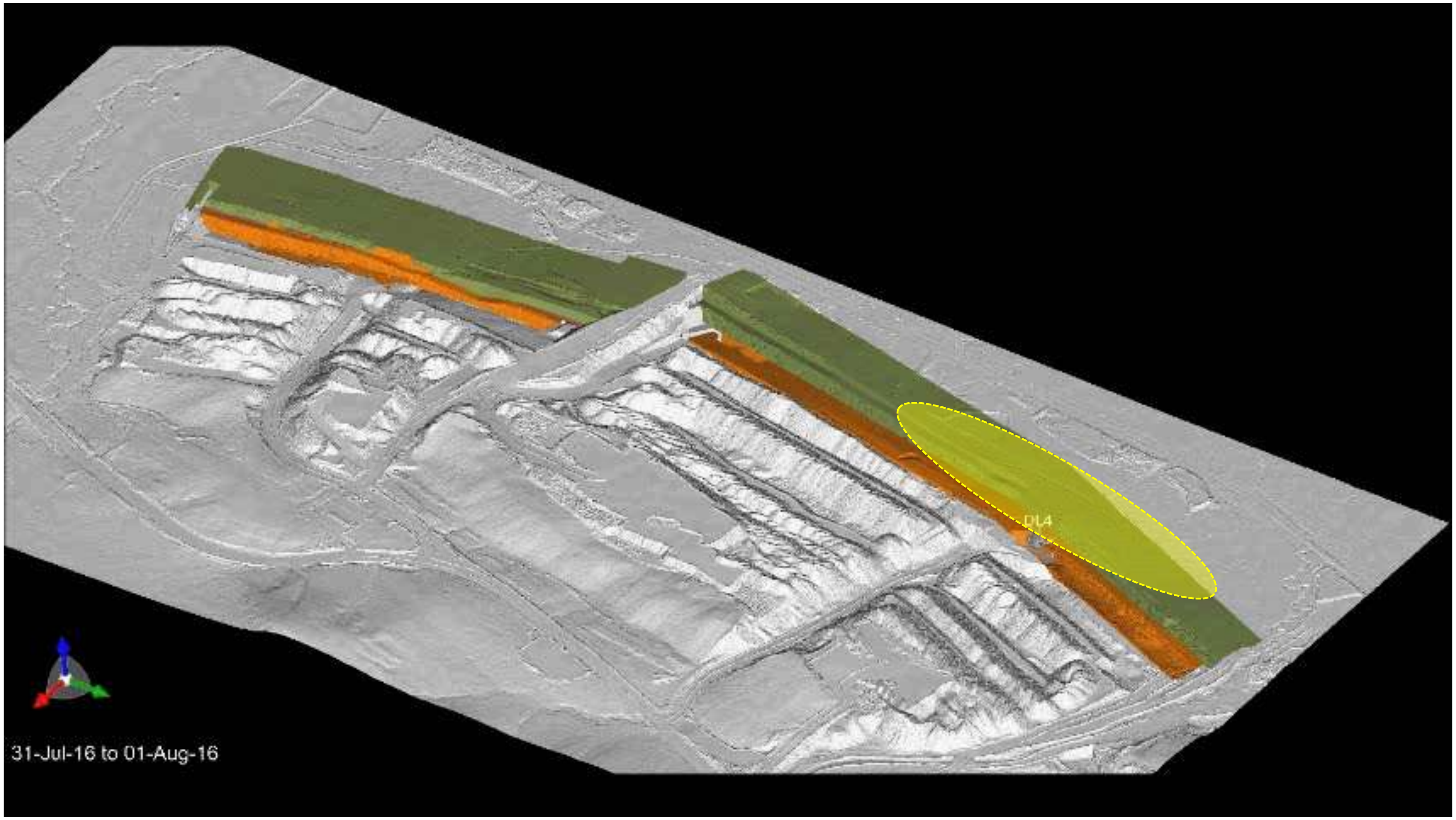
CHALLENGE # 5

MINE SCHEDULING CONSTRAINTS

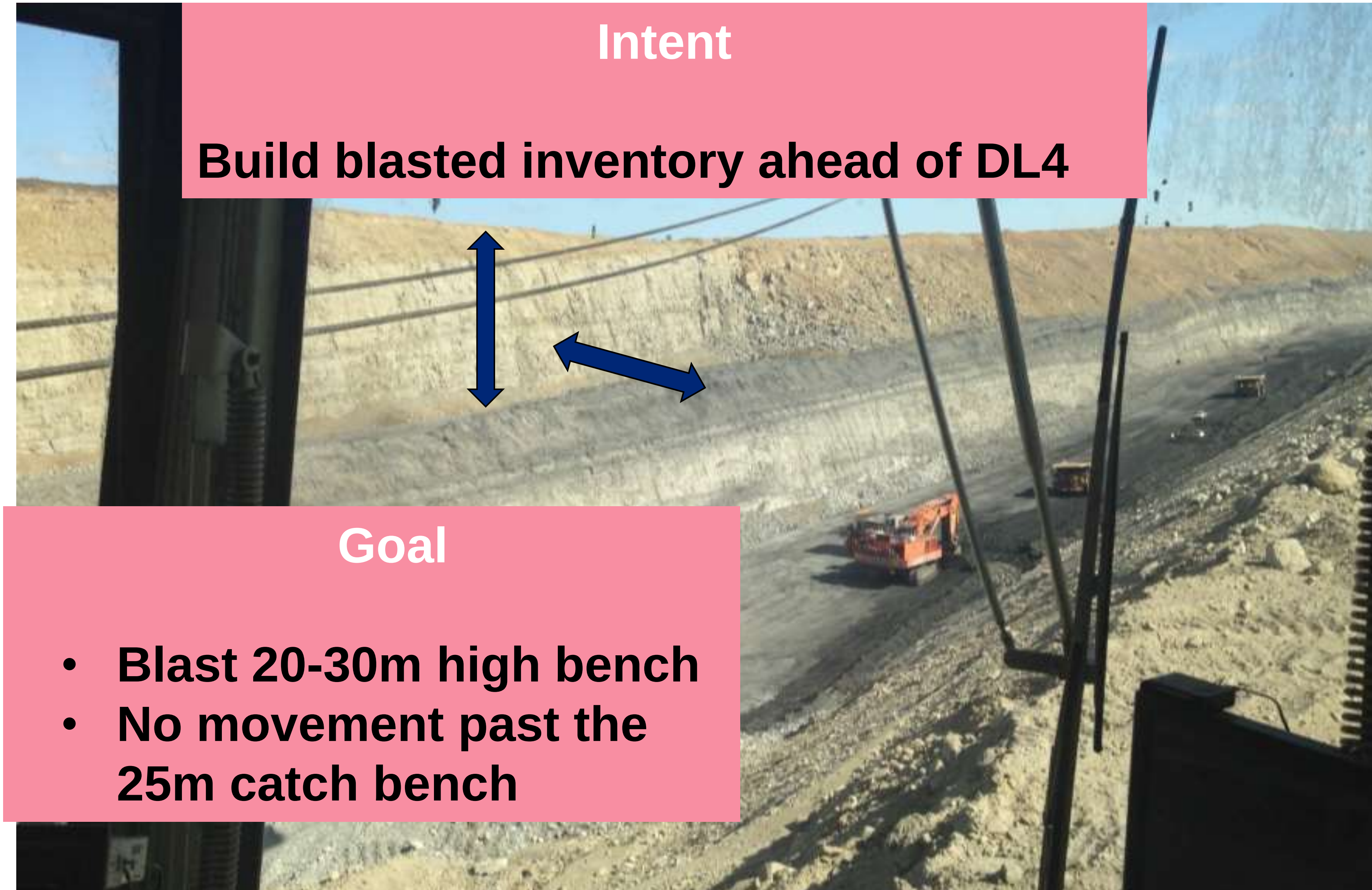
D&B ENGINEER TOOL BOX
Mine Planning
Mine Scheduling
Geology
Initiation system limitations
Detonics

MINE SCHEDULING CONSTRAINTS

Deswik Short Term Dragline Schedule



MINE SCHEDULING CONSTRAINTS



Intent

Build blasted inventory ahead of DL4

Goal

- **Blast 20-30m high bench**
- **No movement past the 25m catch bench**

D&B CONSIDERATIONS

- Face burden / burden movement
- Depth to BOW
- Effective pf per row
- Delay timing between rows
- Overpressure constraints

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Final Profile

CHALLENGE # 6

THROUGH SEAM BLASTING IN DL STRIPS

D&B ENGINEER TOOL BOX
Mine Planning
Mine Scheduling
Geology
Initiation system limitations
Detonics

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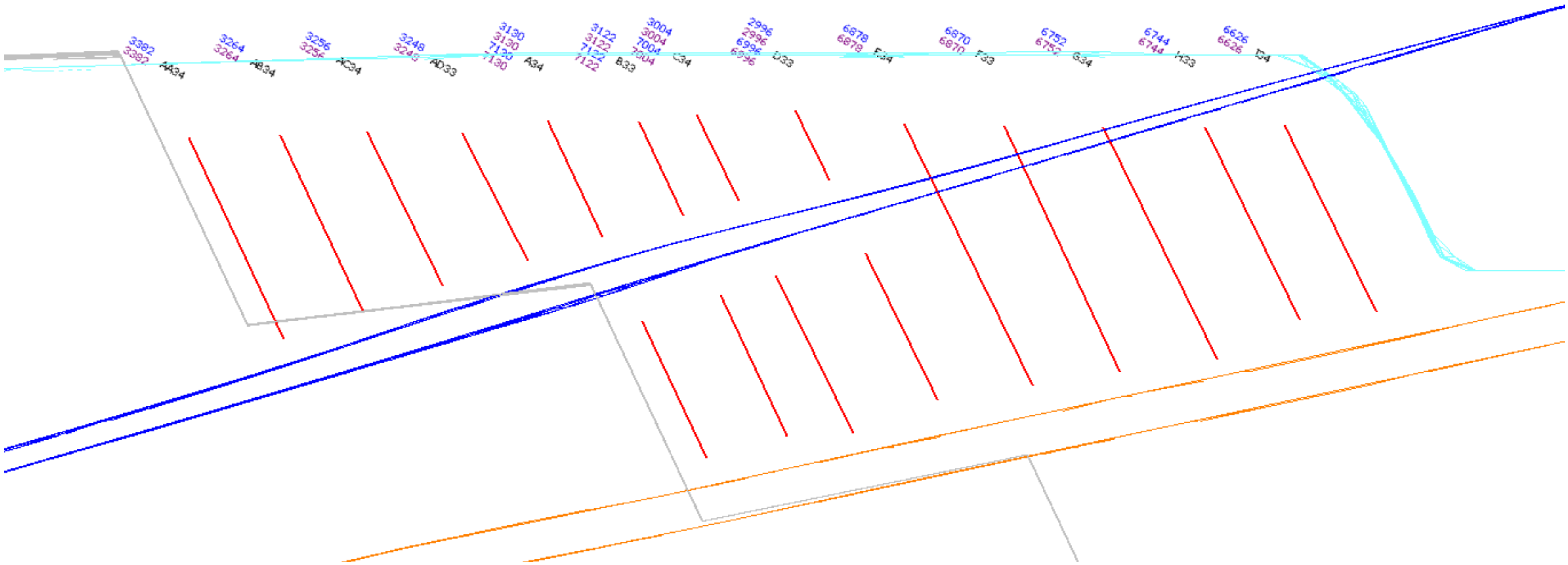

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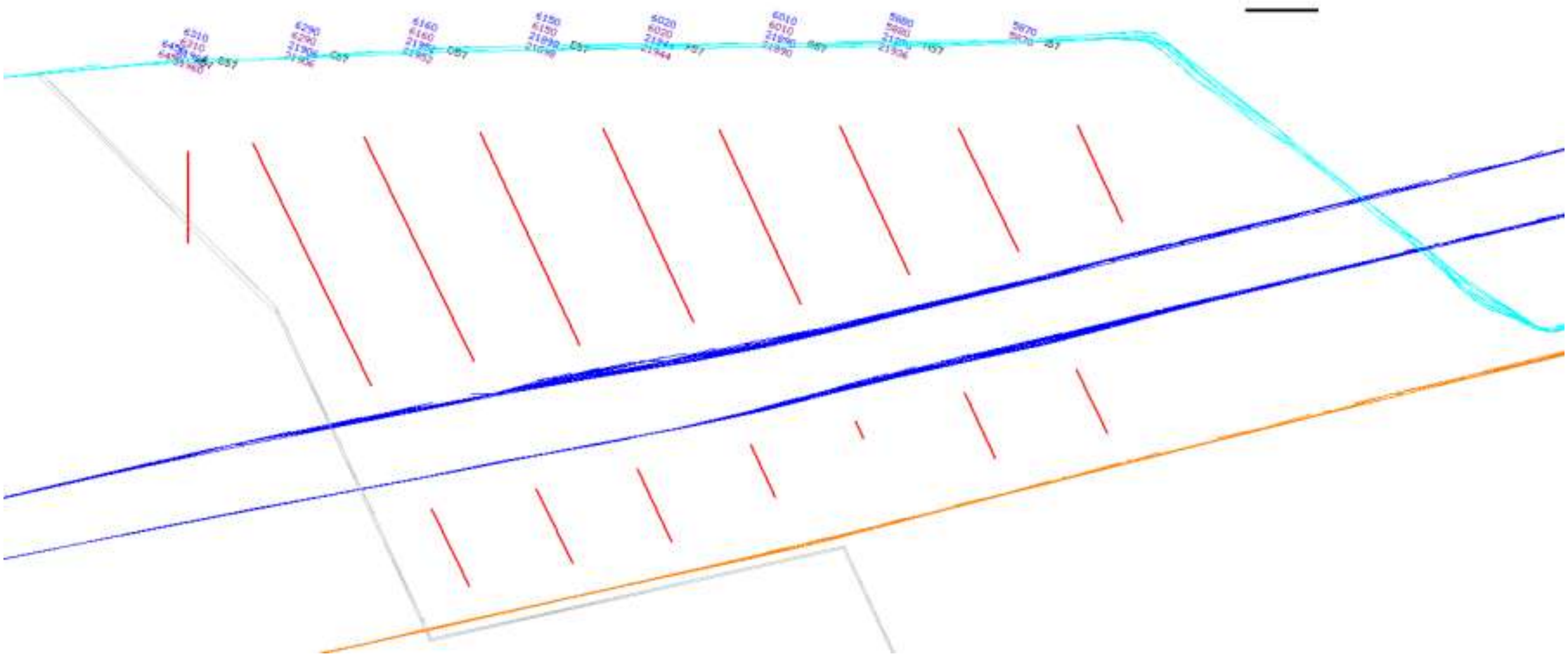
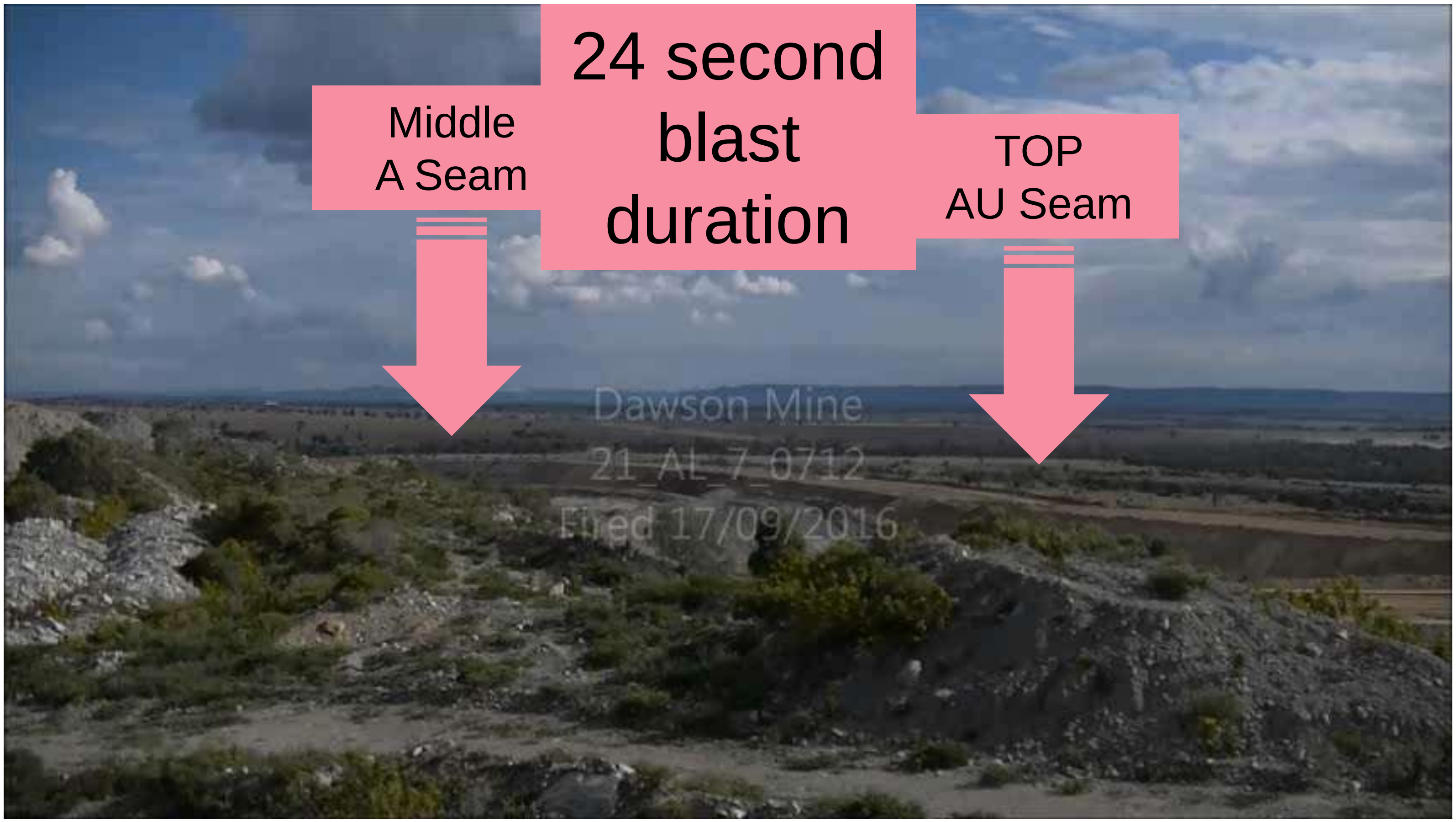


AngloAmerican



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Have you had enough challenges??

Lessons learned from a day at Dawson Mine?

- Extremely complex D&B process.
- Driving mining costs down by 30% in 3 years
- Required a very tight mining schedule
- Pushed requirements of D&B technical designs well past the bounds of “NORMAL”
- Increased pressures of safe and timely delivery of D&B production processes

The Current D&B Team at Dawson Mine

What is the level of compromise between a generalist and a specialist?

CHALLENGE # 7

My challenge to the industry

How do we stem the knowledge leakage from D&B Engineering?