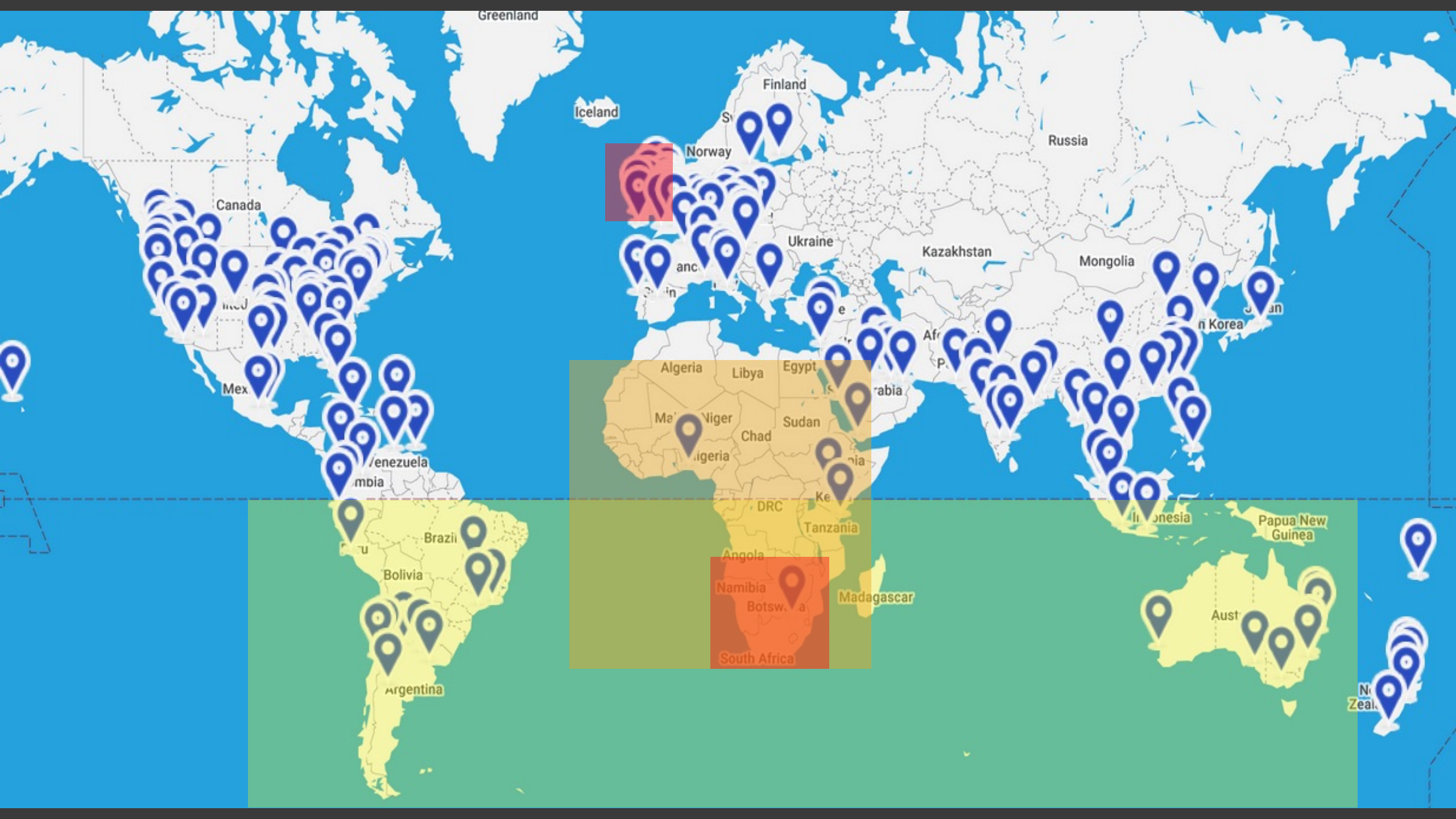
LLOYDWARWICK
INTERNATIONAL

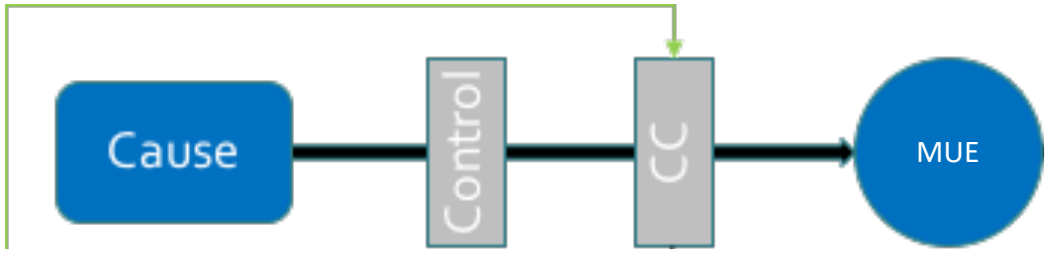
Major Mining Claims and Risk Control Failures

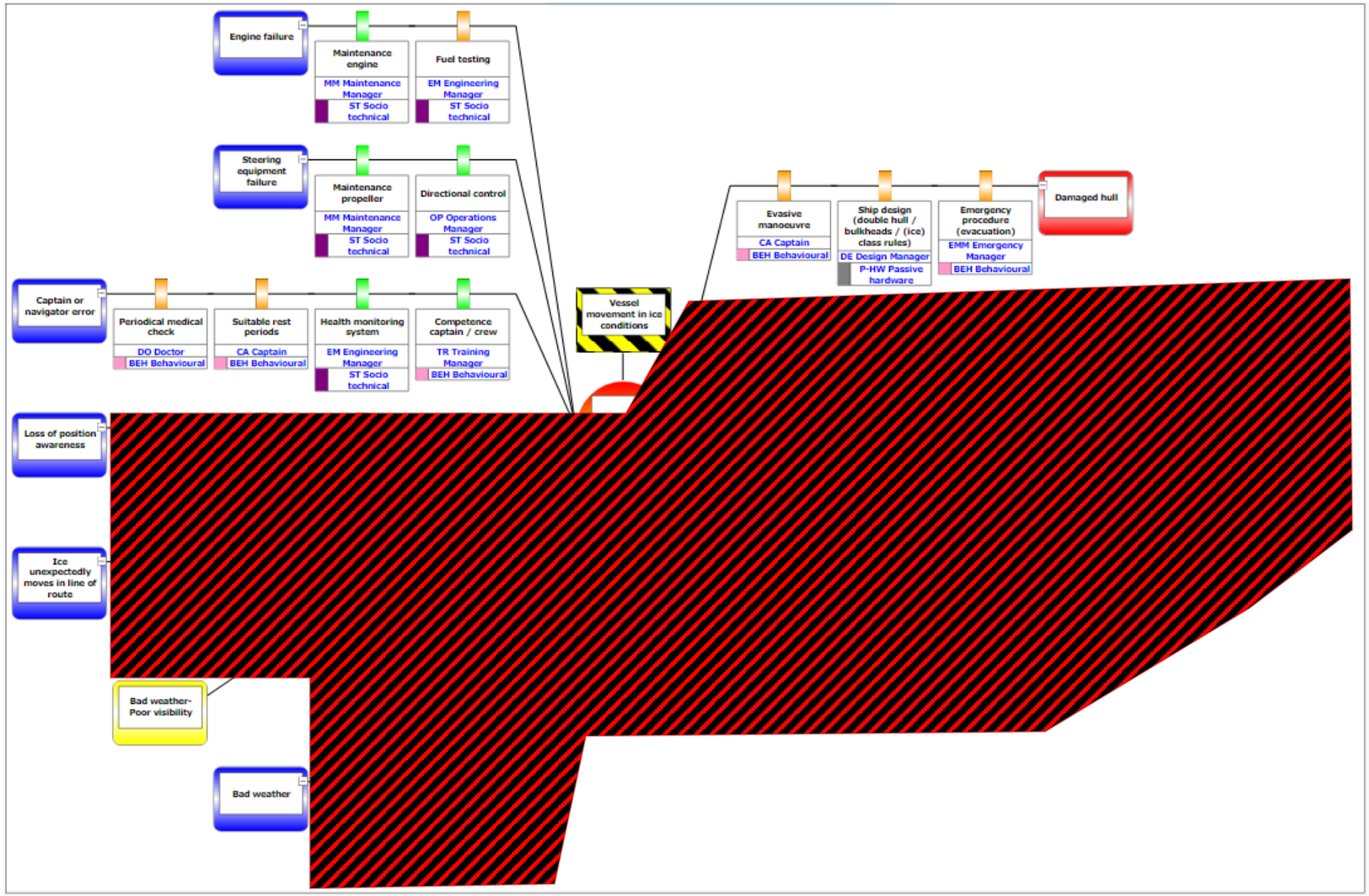
Le Roux van den Berg
Lloyd Warwick International


Greenland
Iceland
Finland
Norway
Russia
Canada
Ukraine
Kazakhstan
Mongolia
Korea
Algeria
Libya
Egypt
Sudan
Chad
Niger
Nigeria
DRC
Tanzania
Angola
Namibia
South Africa
Madagascar
Papua New Guinea
Venezuela
Brazil
Bolivia
Argentina

Control Theory

Risk Control Plans





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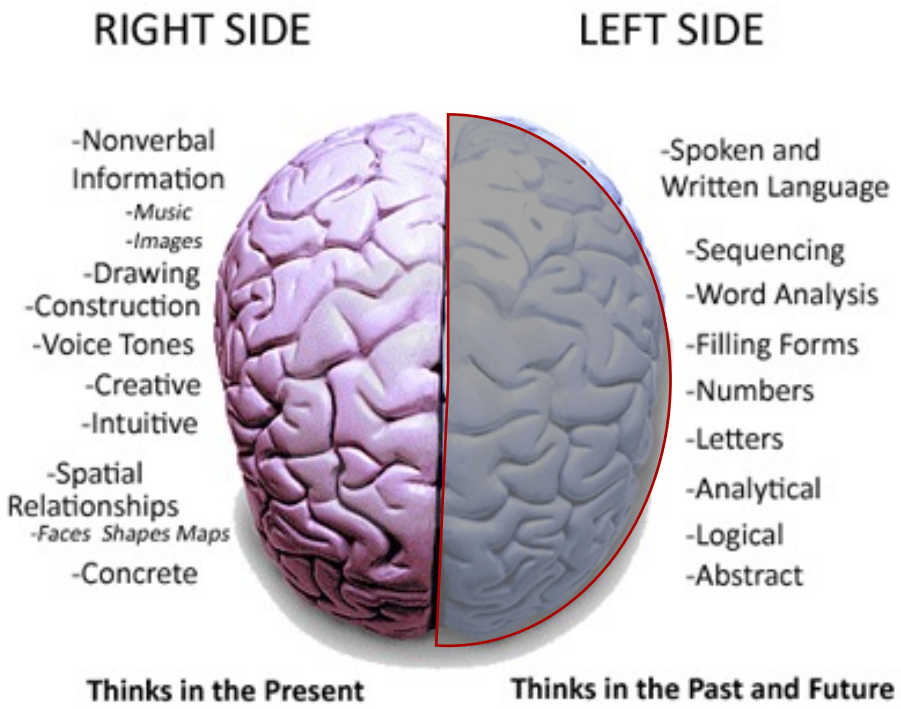
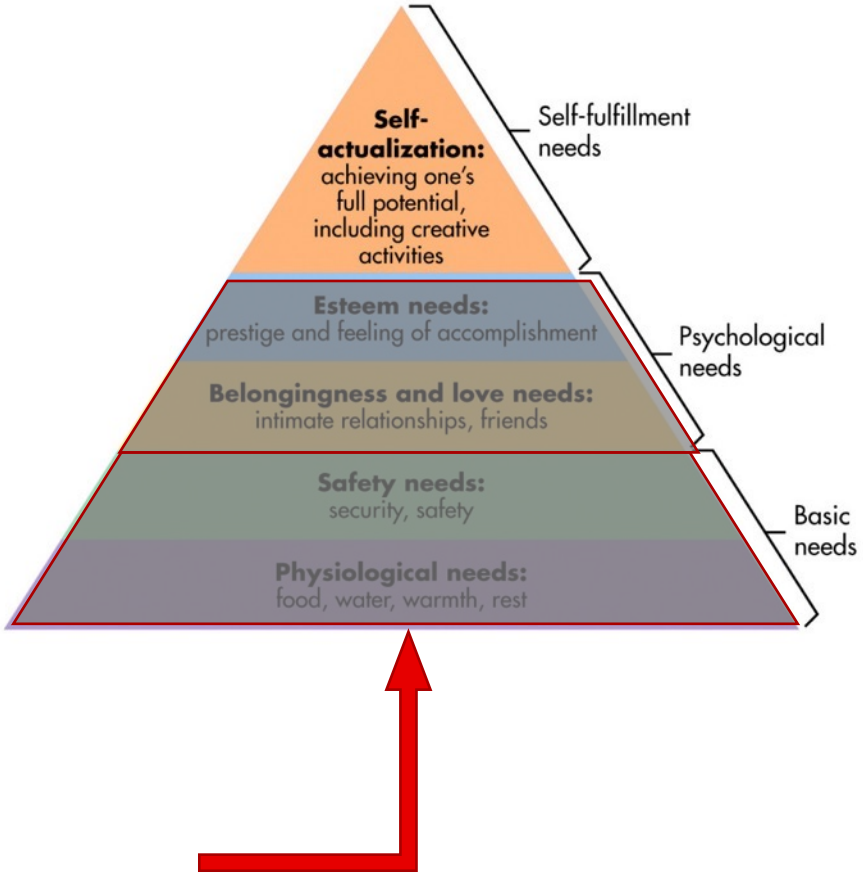
Behavioral Control Reliability





Key Mining Risks

- Political environment
- Legislation: stipulated shareholding / nationalisation
- Utility provider instability
- Long term industrial action
- Sympathy strikes & wild cat strikes
- Labour inefficiency / mechanical mining
- Exchange rates
- Commodity prices
- Community unrest

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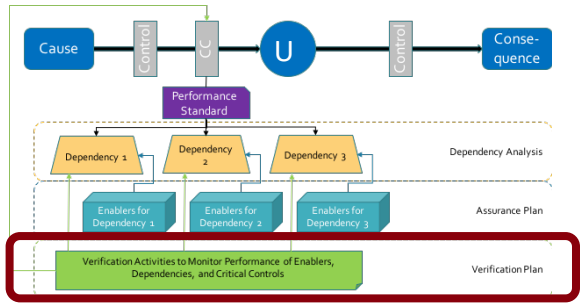
- Community unrest

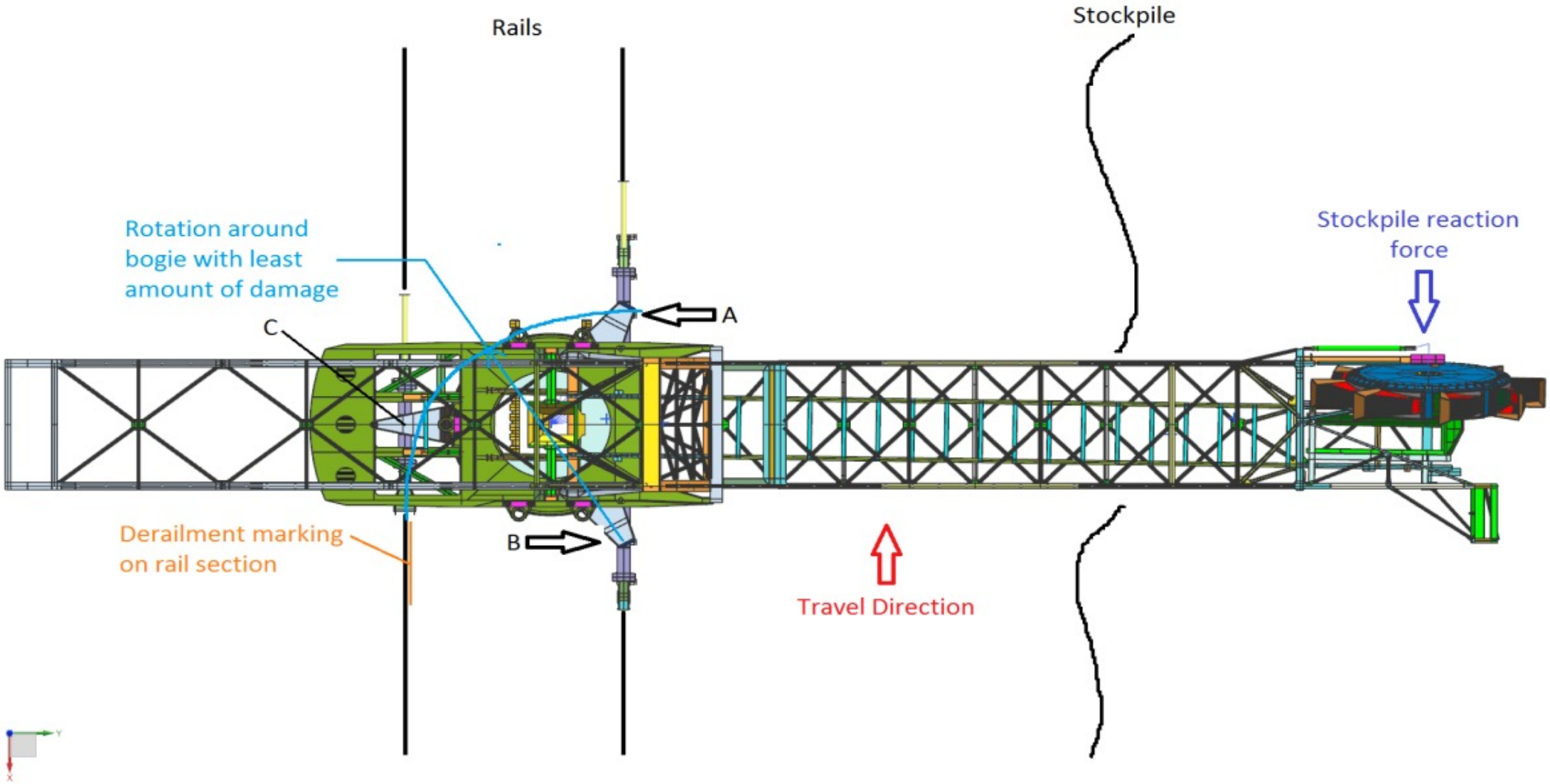
Resultant Claims

Pit Failure

- Control = Slope Angle @ Performance Standard
- Dependency = Mining Practice
- Verification = Radar Monitor and Human Response
- Control Quality = Human Behaviour



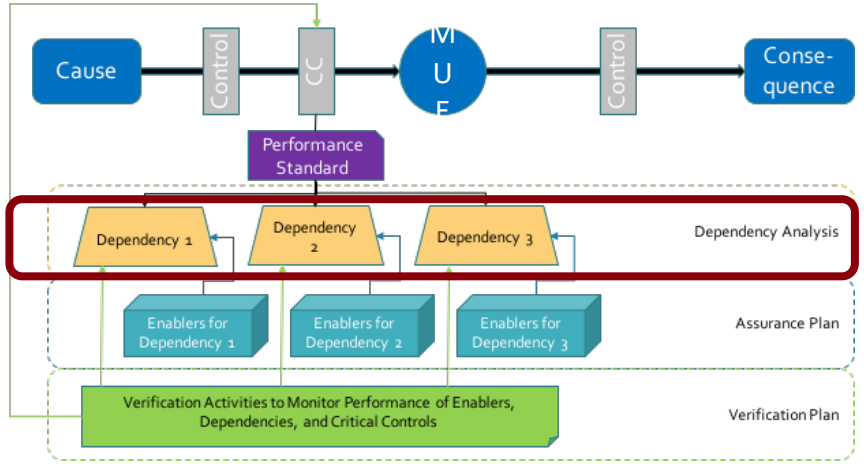
Equipment Collapse

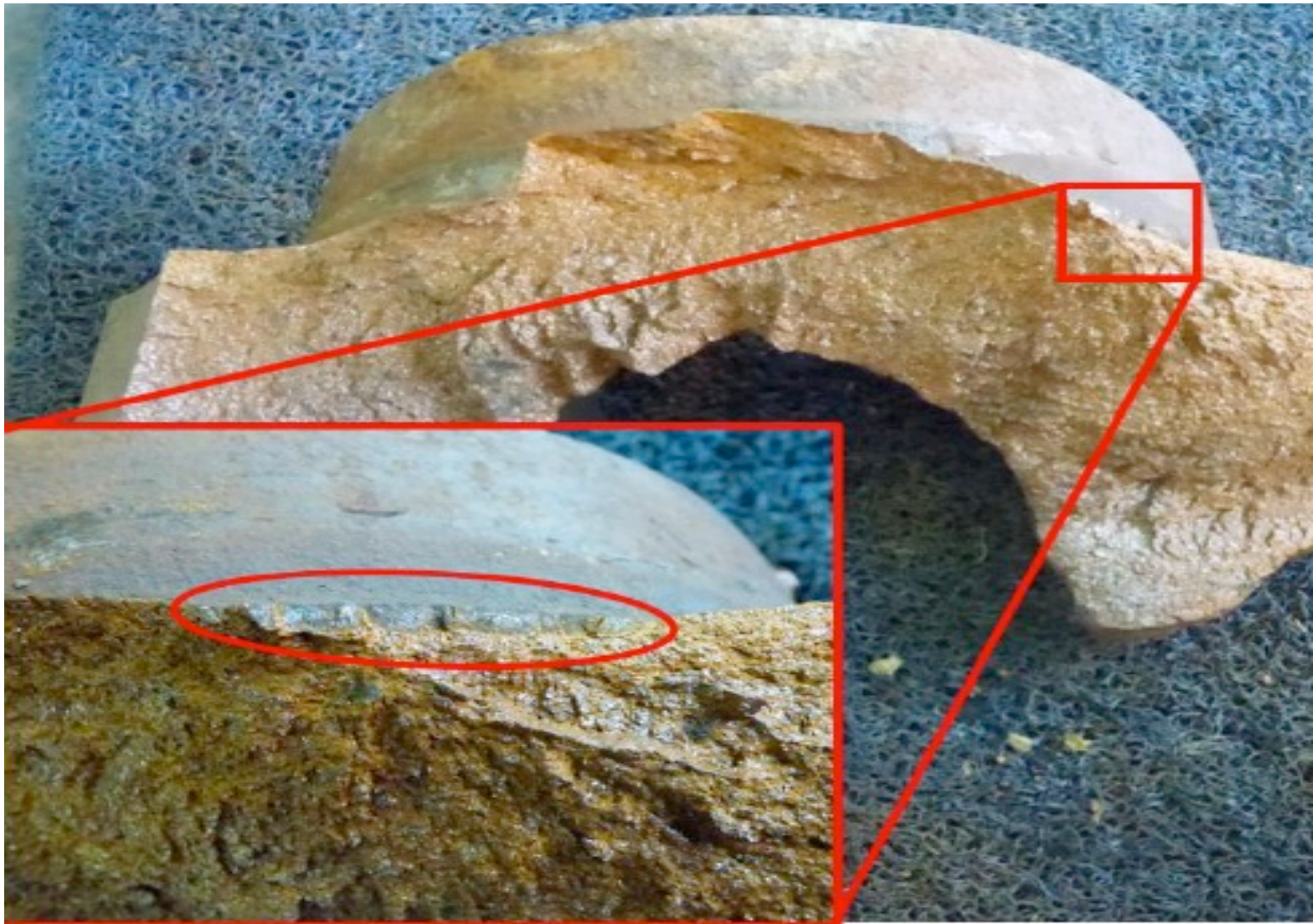


Equipment Collapse

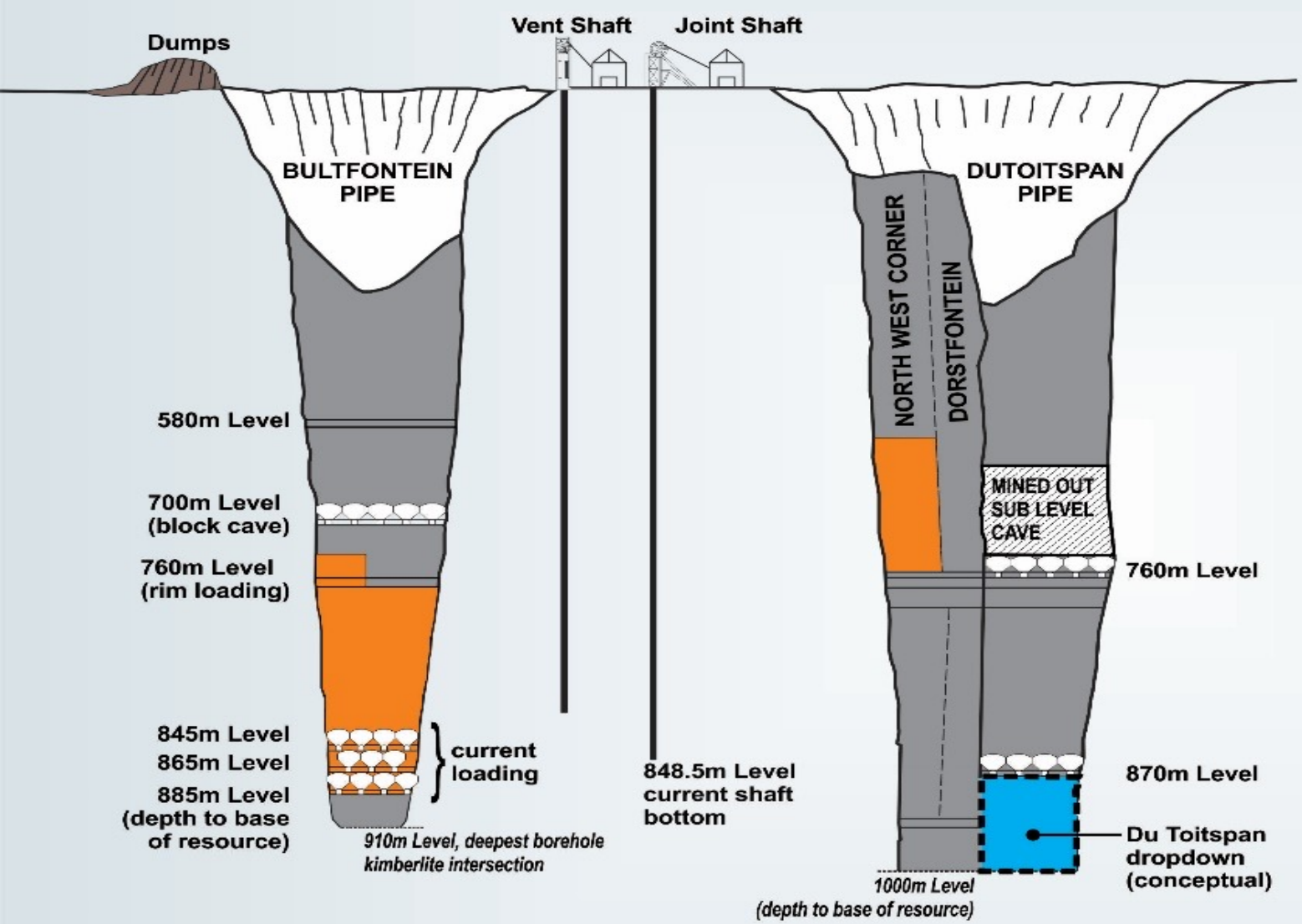
Equipment Collapse

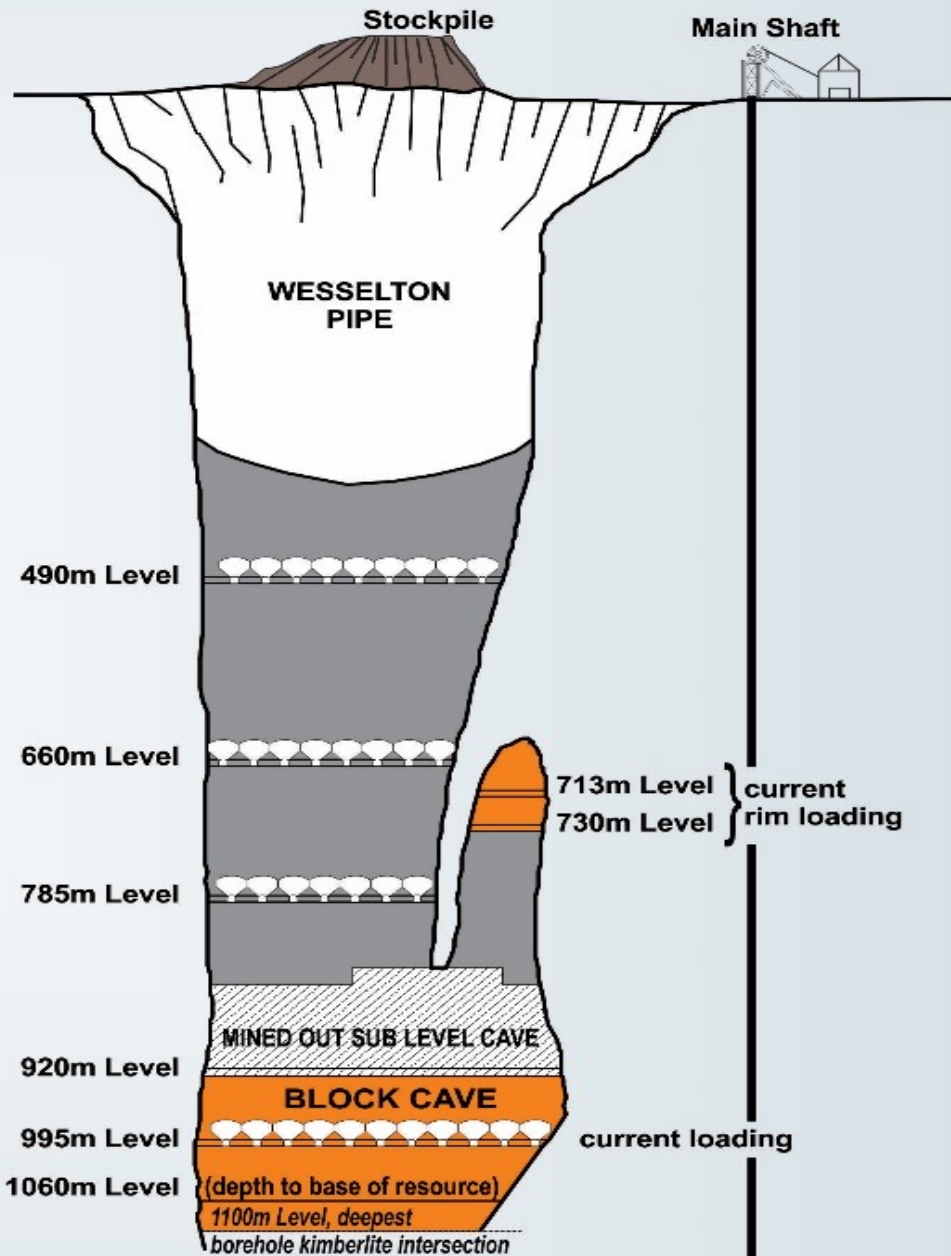
- Control = Reclaimer height when staking
- Dependency = SOP, Equipment Integrity
- Verification = None
- Control Quality = Human Behaviour; Engineering



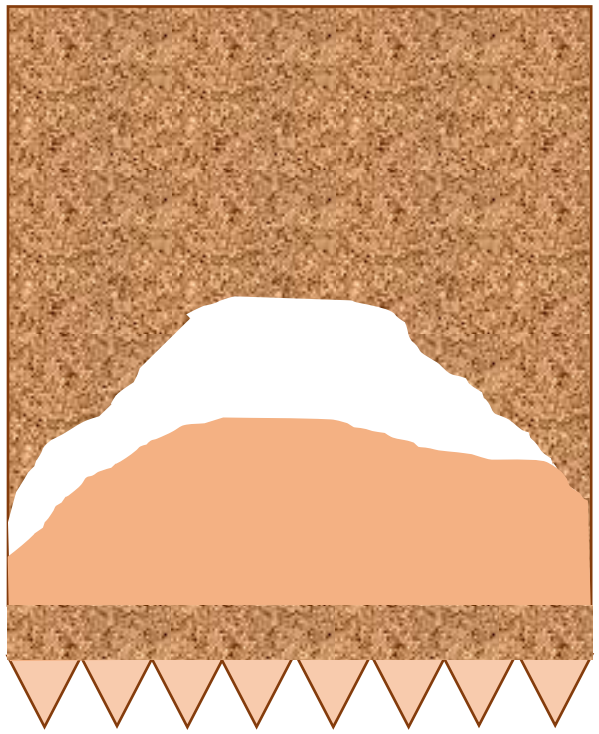


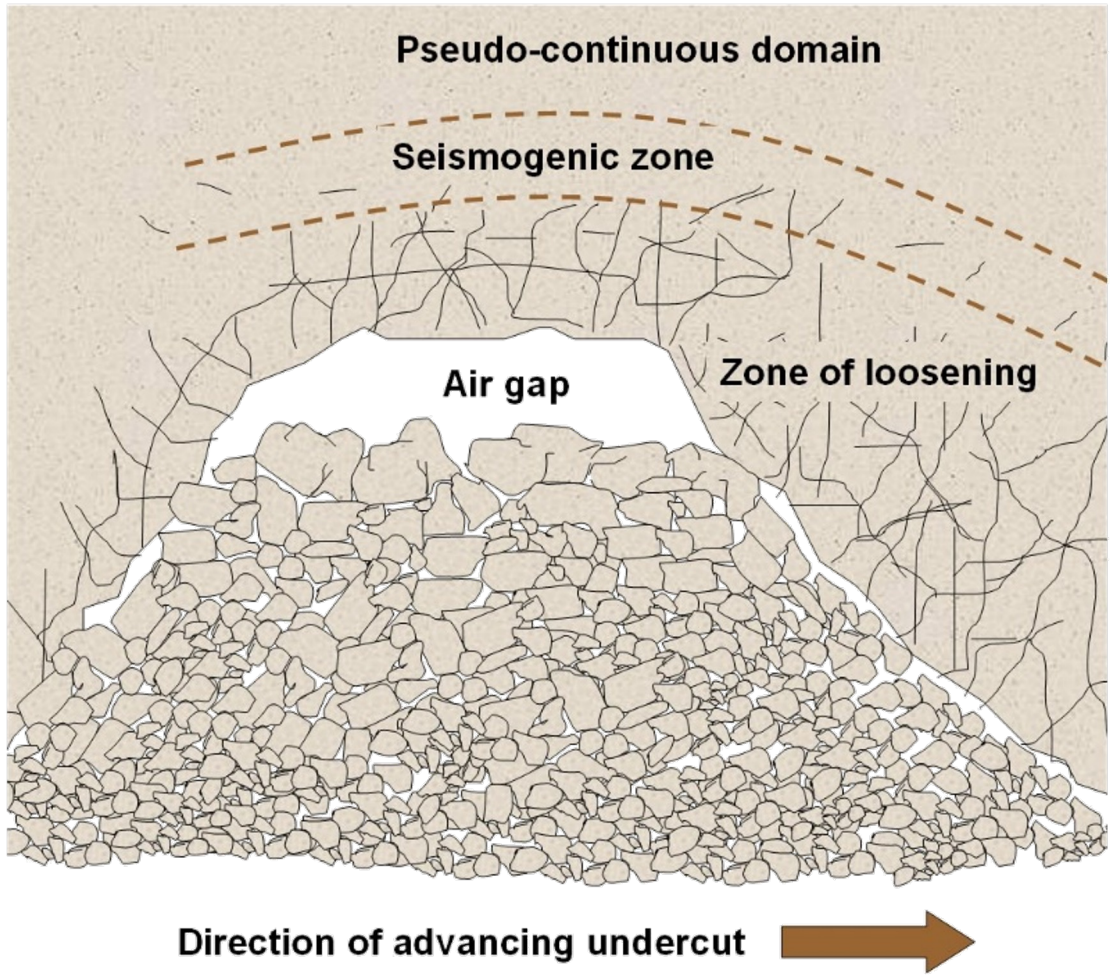
Mud Rush


Dumps
Vent Shaft
Joint Shaft
BULTFONTEIN PIPE
DUTOITSPAN PIPE
NORTH WEST CORNER
DORSTFONTEIN
580m Level
700m Level (block cave)
760m Level (rim loading)
MINED OUT SUB LEVEL CAVE
760m Level
845m Level
865m Level
885m Level (depth to base of resource)
current loading
910m Level, deepest borehole kimberlite intersection
848.5m Level current shaft bottom
870m Level
Du Toitspan dropdown (conceptual)
1000m Level (depth to base of resource)

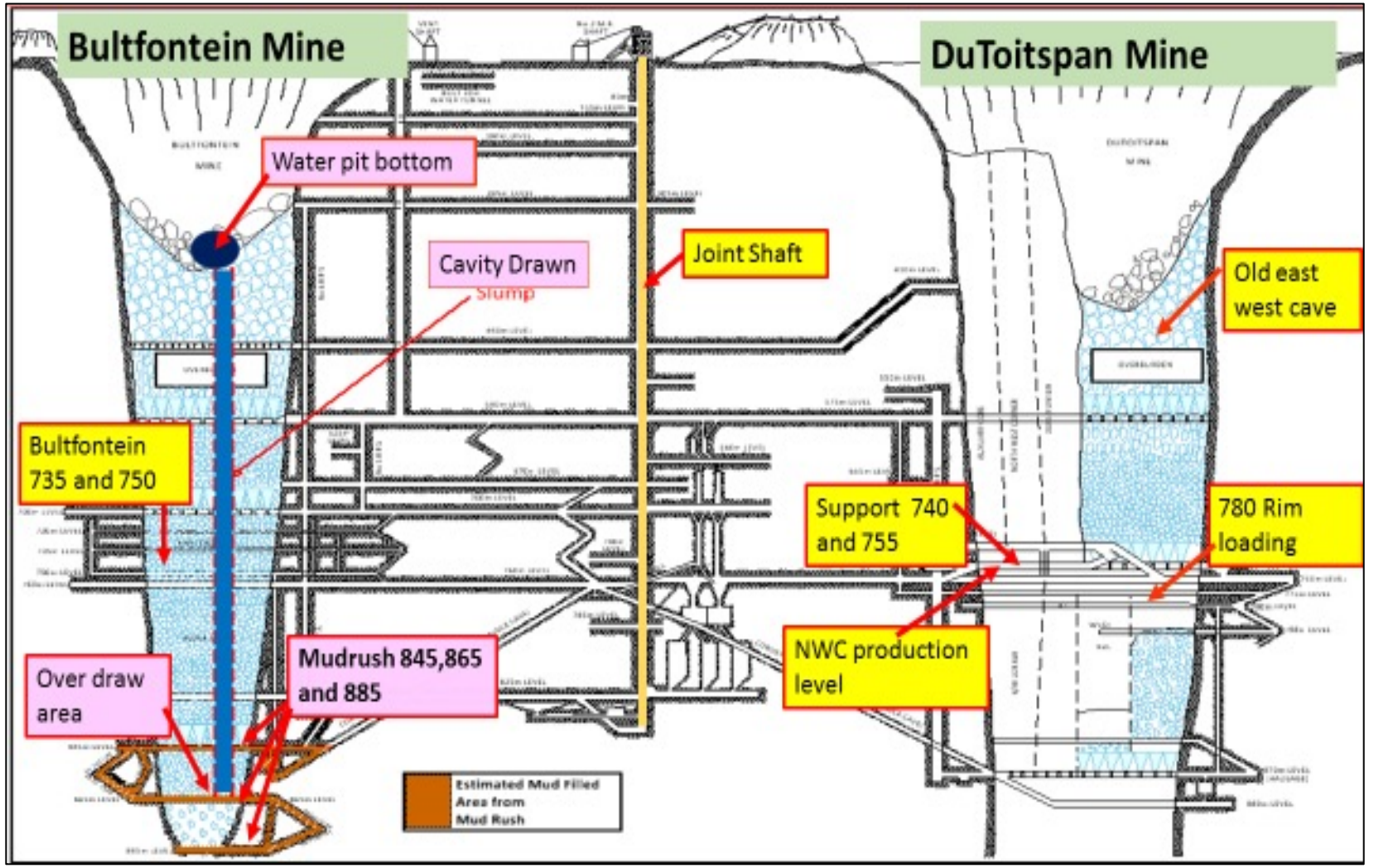

Stockpile
Main Shaft
WESSELTON PIPE
490m Level
660m Level
713m Level
730m Level
current rim loading
785m Level
MINED OUT SUB LEVEL CAVE
920m Level
BLOCK CAVE
995m Level
current loading
1060m Level
(depth to base of resource)
1100m Level, deepest borehole kimberlite intersection

Mud Rush




Pseudo-continuous domain
Seismogenic zone
Air gap
Zone of loosening
Direction of advancing undercut

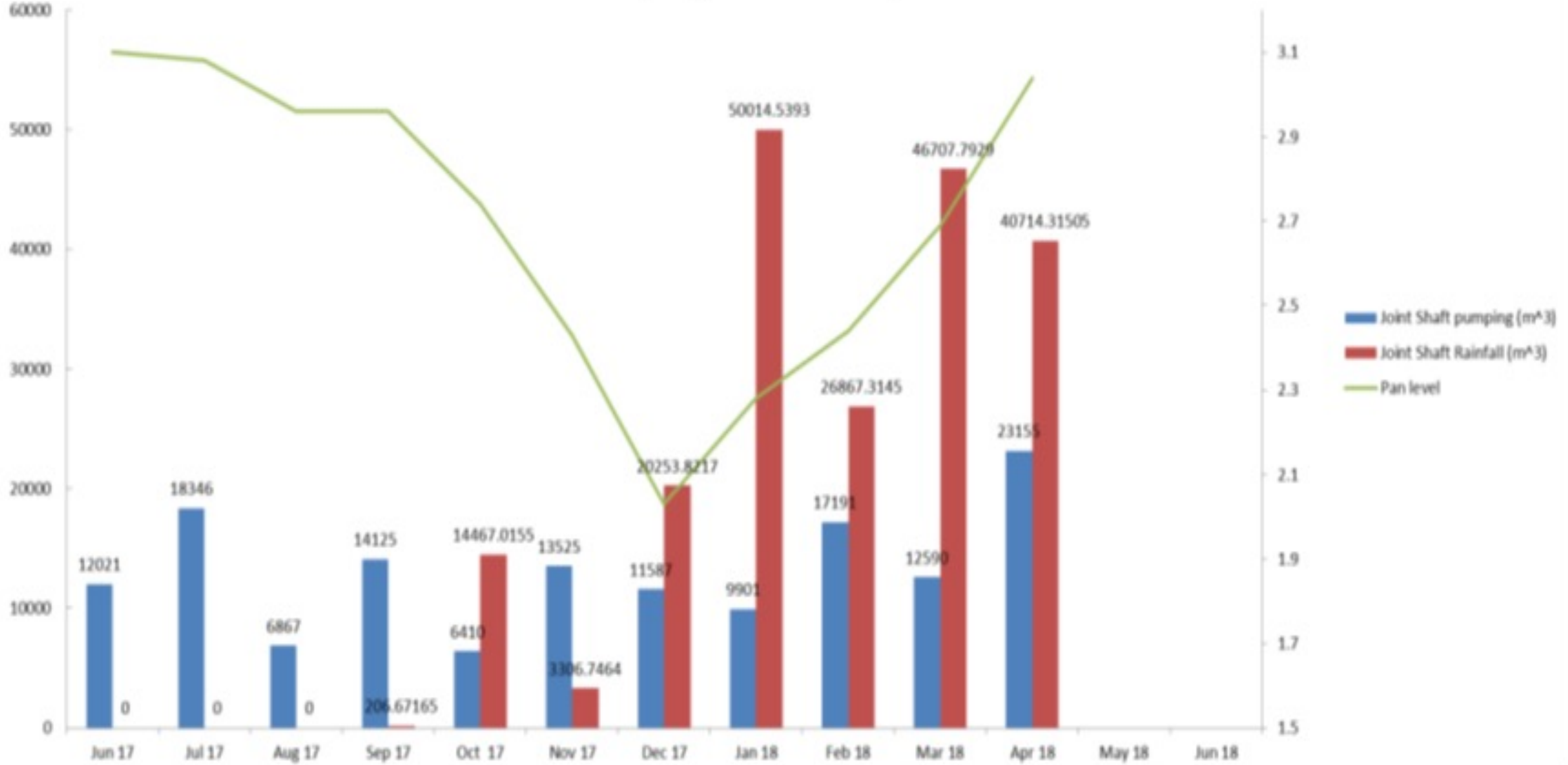
Mud Rush



Mud Rush Requirements:

1. Fines
   (mud forming material)
2. Water
   (sufficient to wet fines)
3. Trigger
   (disturbance to initiate movement)
4. Discharge Point
   (to allow material to enter workings)

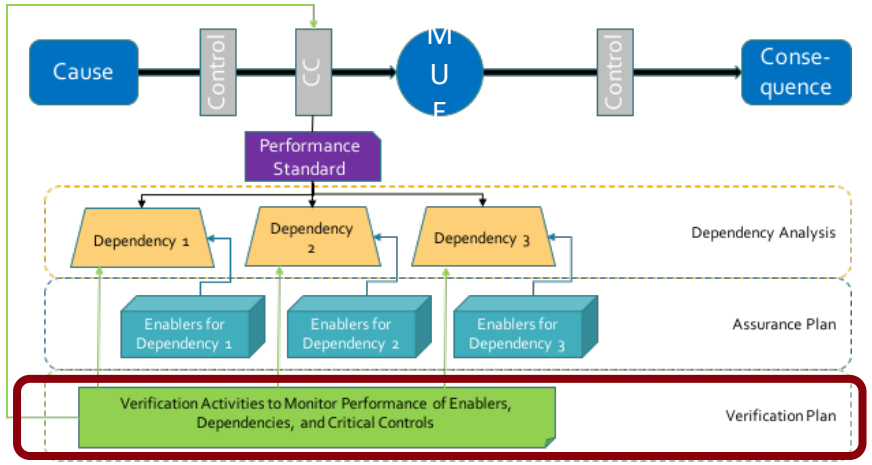
Joint Shaft Pumping, Rainfall and pan level 2017 - 2018



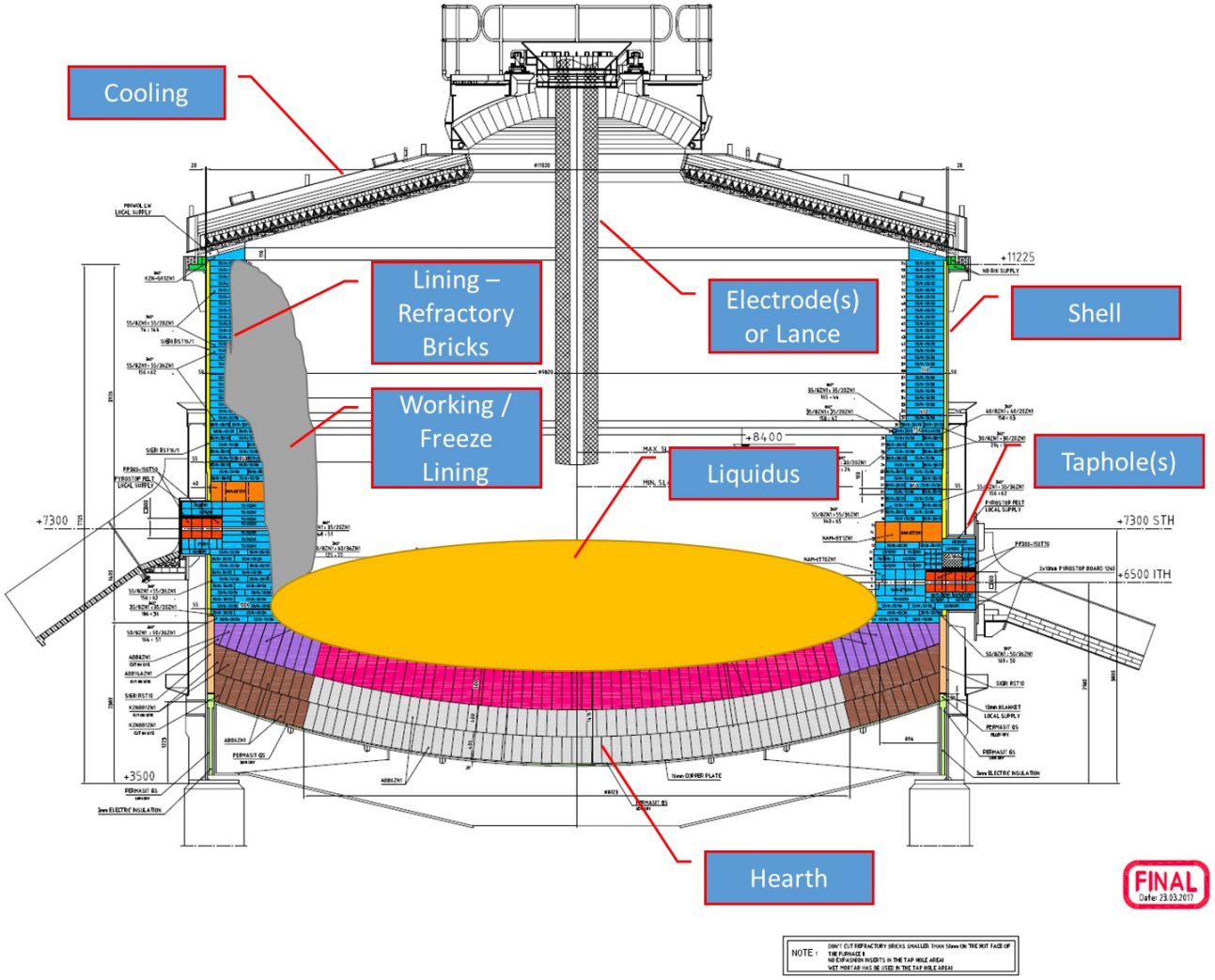

Tunnel 105 - 732
15.09.2006 04:08:43

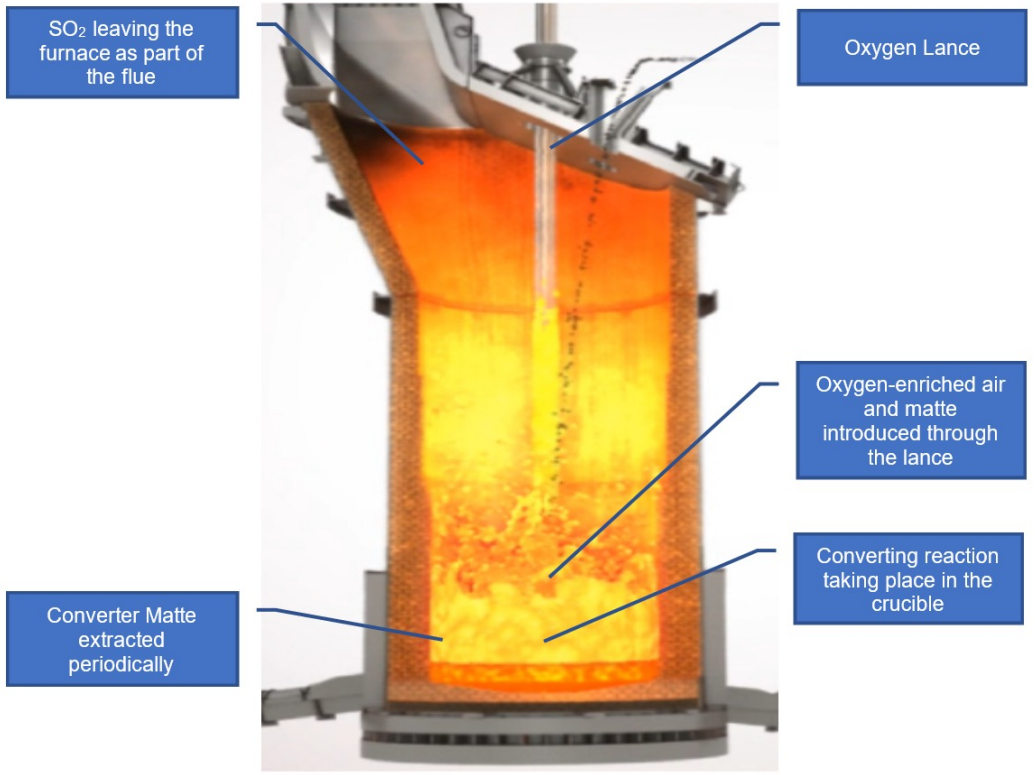
Mud Rush

- Control = Water level
- Dependency = Pumping
- Verification = Water Balance
- Control Quality = Human Behaviour



Furnace Losses





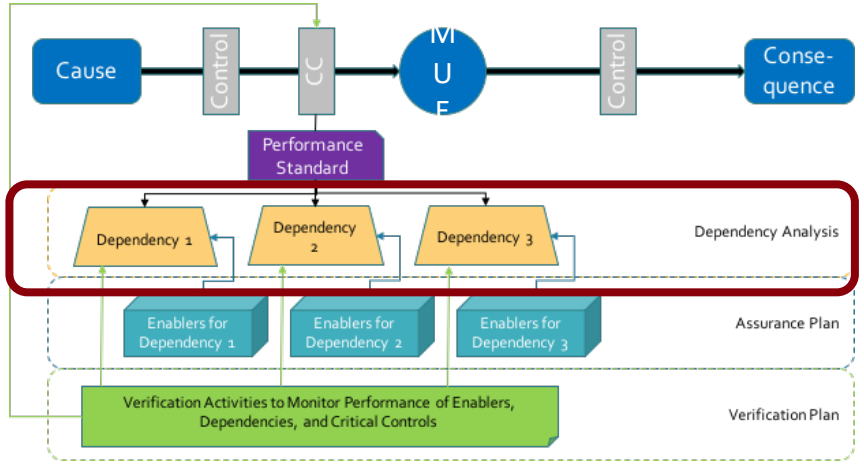

10
9
8
7
6
5
4
3

New panel
Old panel

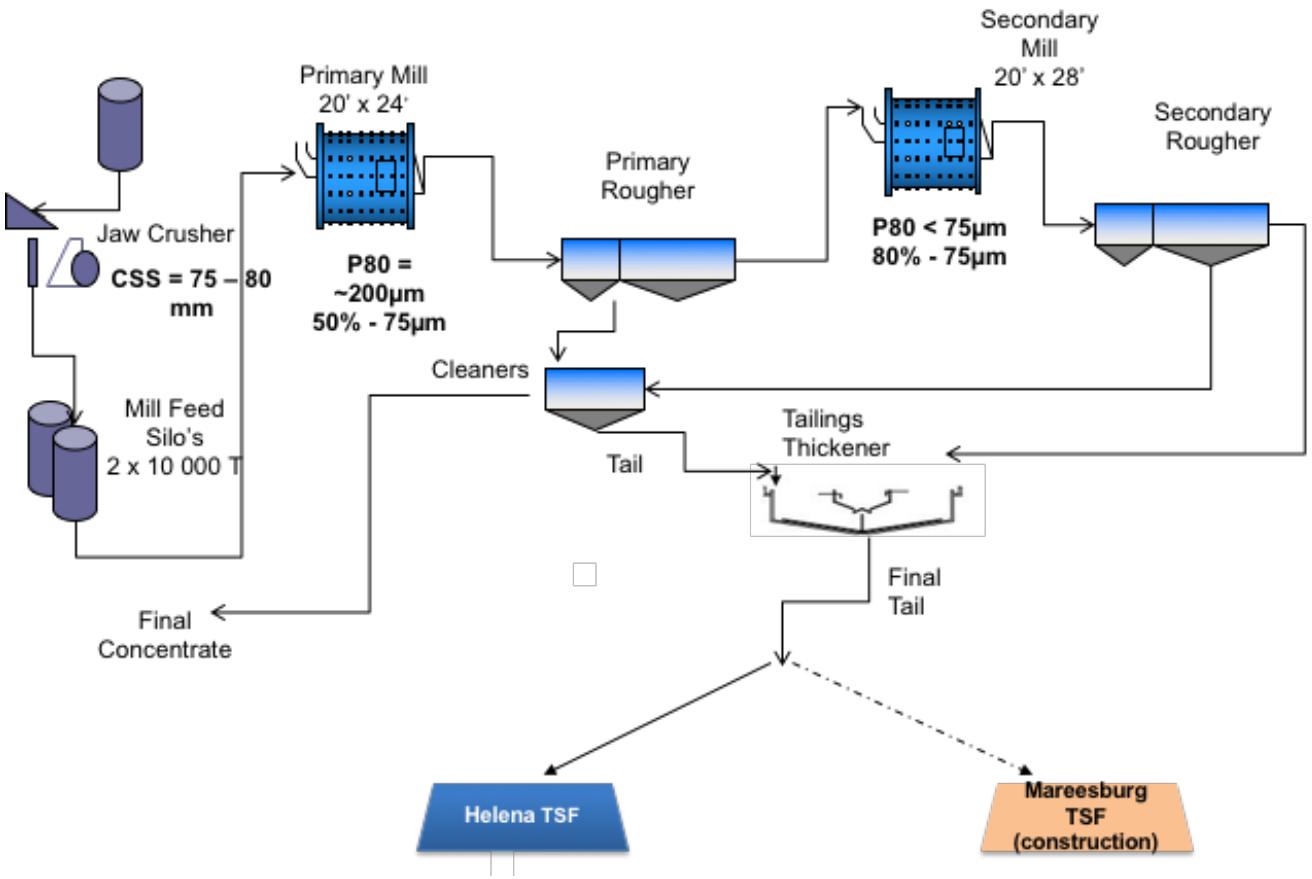
Original panel
New panel

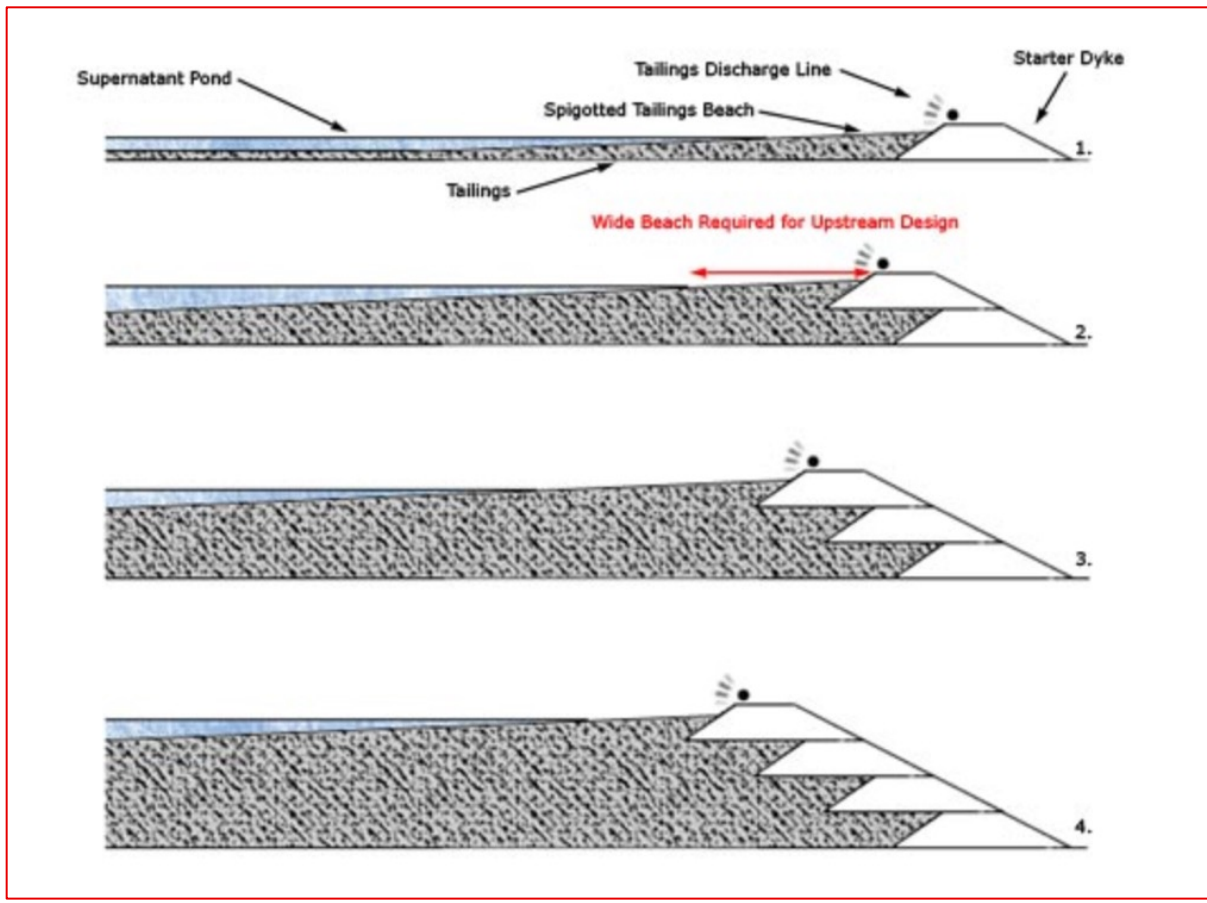
Furnace Losses

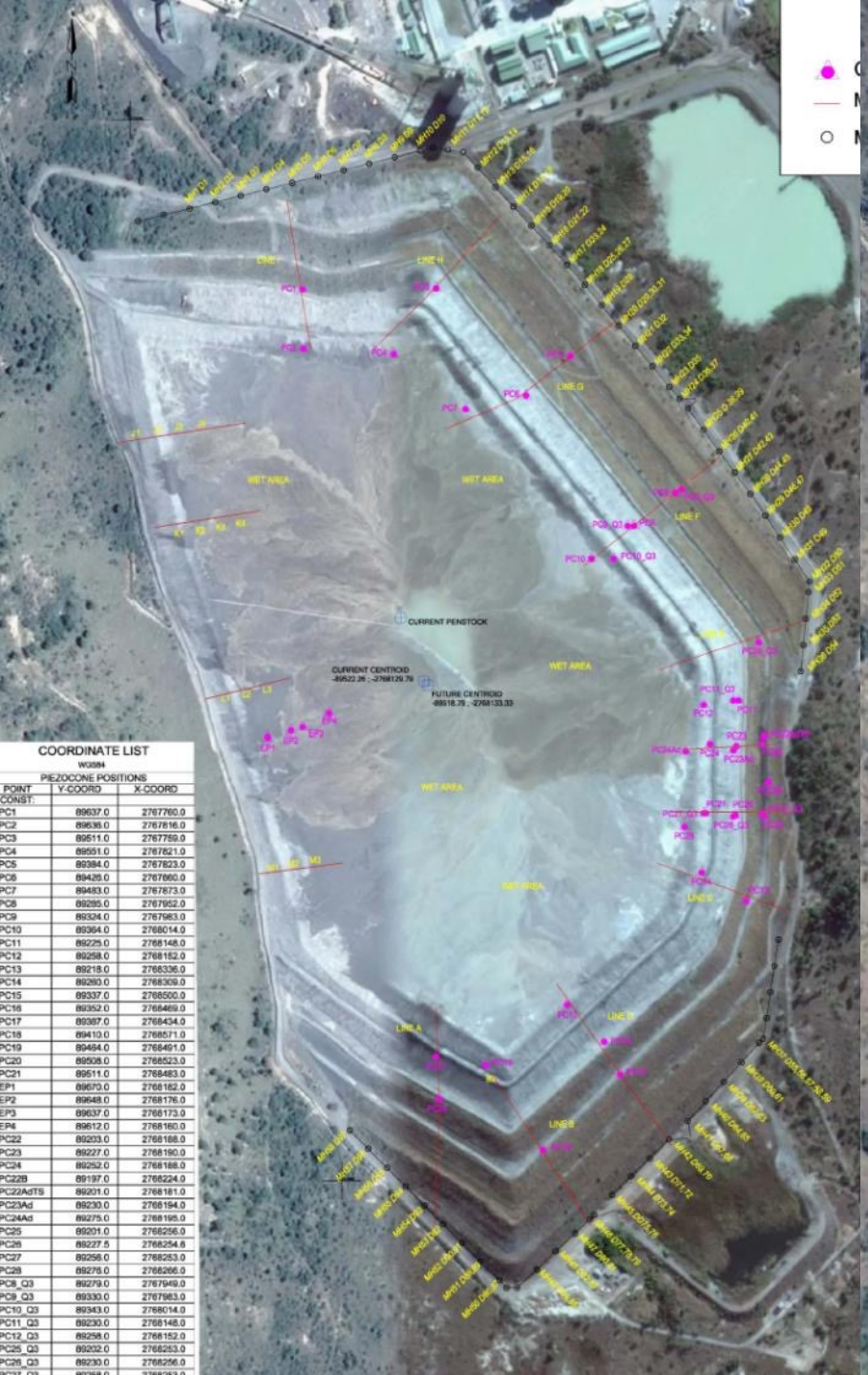
- Control = Residual Heat
- Dependency = Cooling/ Isolation Installation
- Verification = Temperature Probes
- Control Quality = Human Behaviour



TSF


Primary Mill
20' x 24'
Secondary
Mill
20' x 28'
Secondary
Rougher
Primary
Rougher
Jaw Crusher
CSS = 75 – 80
mm
P80 =
~200µm
50% - 75µm
P80 < 75µm
80% - 75µm
Cleaners
Mill Feed
Silo's
2 x 10 000 T
Tailings
Thickener
Tail
Final
Tail
Final
Concentrate
Helena TSF
Mareesburg
TSF
(construction)


Supernatant Pond
Tailings Discharge Line
Starter Dyke
Spigotted Tailings Beach
Tailings
Wide Beach Required for Upstream Design
1.
2.
3.
4.

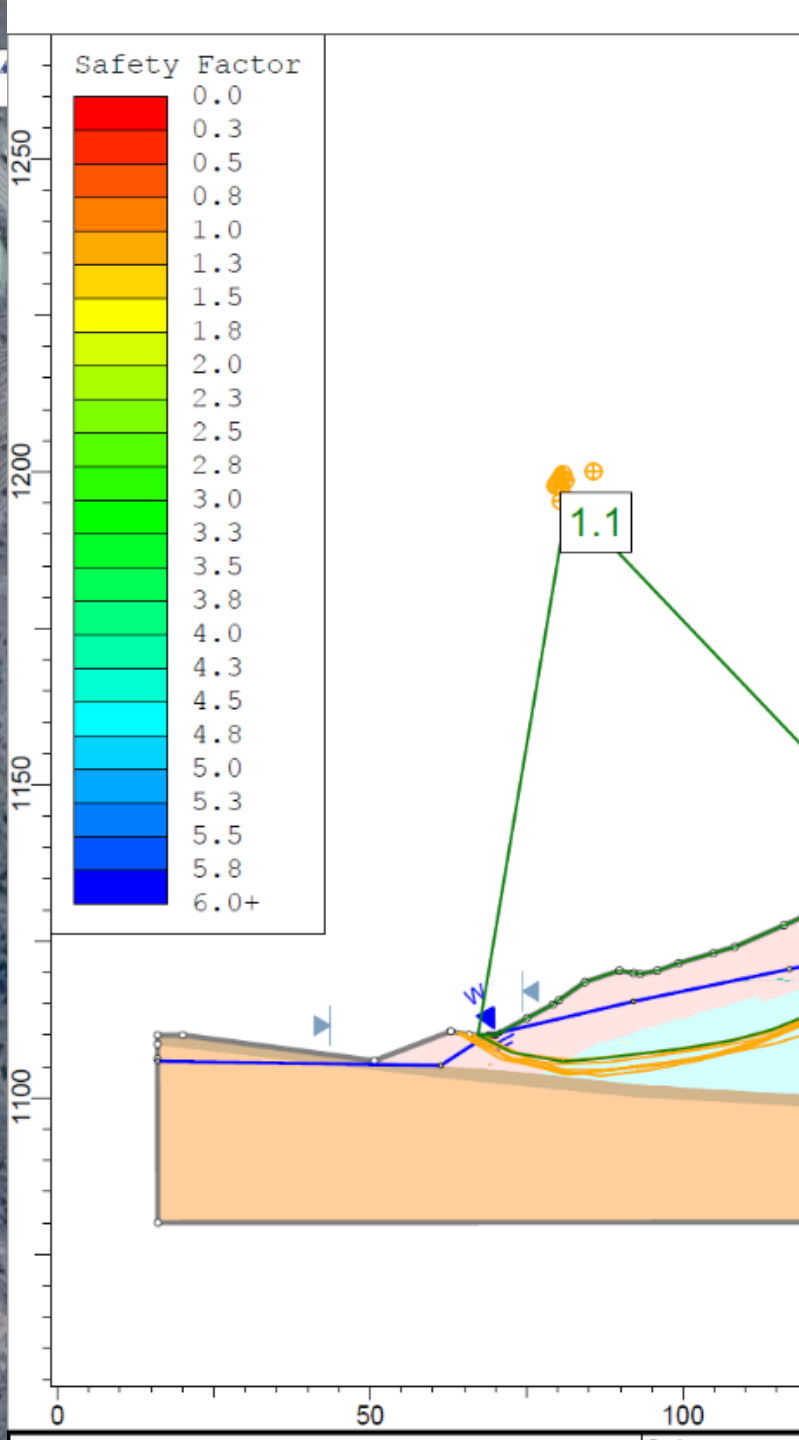


COORDINATE LIST

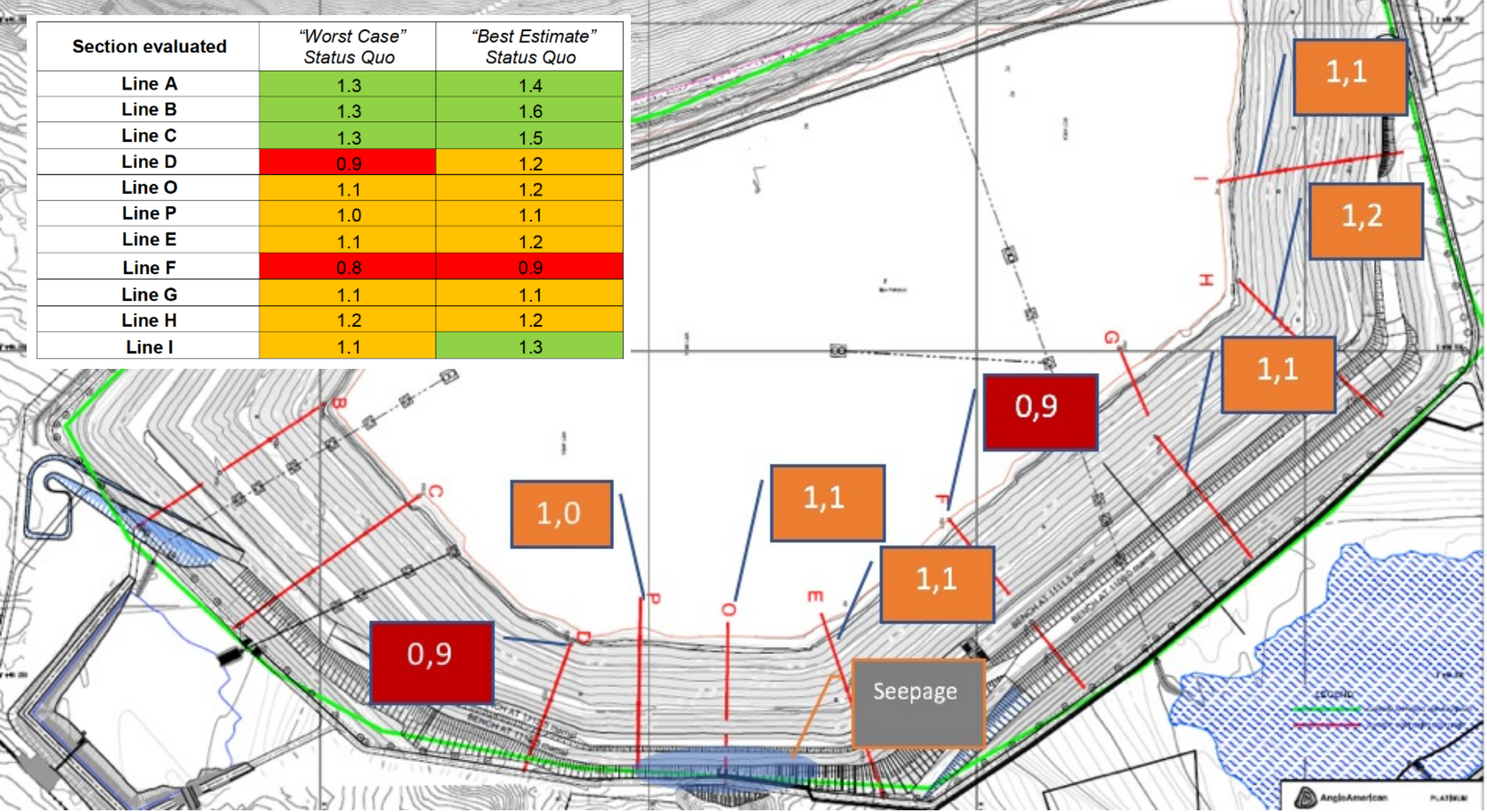
W3594

PIEZOCONE POSITIONS

POINT	Y-COORD	X-COORD
CONST:		
PC1	89637.0	2767760.0
PC2	89636.0	2767816.0
PC3	89511.0	2767759.0
PC4	89551.0	2767821.0
PC5	89384.0	2767823.0
PC6	89426.0	2767660.0
PC7	89483.0	2767873.0
PC8	89295.0	2767952.0
PC9	89324.0	2767983.0
PC10	89364.0	2768014.0
PC11	89225.0	2768148.0
PC12	89258.0	2768182.0
PC13	89218.0	2768336.0
PC14	89280.0	2768309.0
PC15	89337.0	2768500.0
PC16	89352.0	2768469.0
PC17	89387.0	2768434.0
PC18	89410.0	2768571.0
PC19	89464.0	2768491.0
PC20	89508.0	2768523.0
PC21	89511.0	2768483.0
EP1	89670.0	2768162.0
EP2	89648.0	2768176.0
EP3	89637.0	2768173.0
EP4	89612.0	2768160.0
PC22	89203.0	2768188.0
PC23	89227.0	2768190.0
PC24	89252.0	2768188.0
PC22B	89197.0	2768224.0
PC22AdTS	89201.0	2768181.0
PC23Ad	89230.0	2768194.0
PC24Ad	89275.0	2768195.0
PC25	89201.0	2768256.0
PC26	89227.5	2768254.6
PC27	89258.0	2768253.0
PC28	89275.0	2768266.0
PC8_Q3	89279.0	2767949.0
PC9_Q3	89330.0	2767983.0
PC10_Q3	89343.0	2768014.0
PC11_Q3	89230.0	2768148.0
PC12_Q3	89258.0	2768152.0
PC25_Q3	89202.0	2768253.0
PC26_Q3	89230.0	2768256.0



Section evaluated	*"Worst Case" Status Quo*	*"Best Estimate" Status Quo*
Line A	1.3	1.4
Line B	1.3	1.6
Line C	1.3	1.5
Line D	0.9	1.2
Line O	1.1	1.2
Line P	1.0	1.1
Line E	1.1	1.2
Line F	0.8	0.9
Line G	1.1	1.1
Line H	1.2	1.2
Line I	1.1	1.3

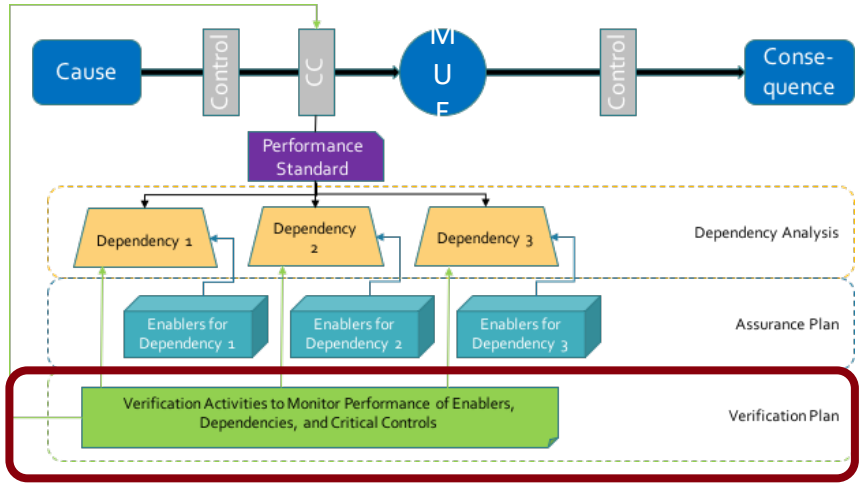


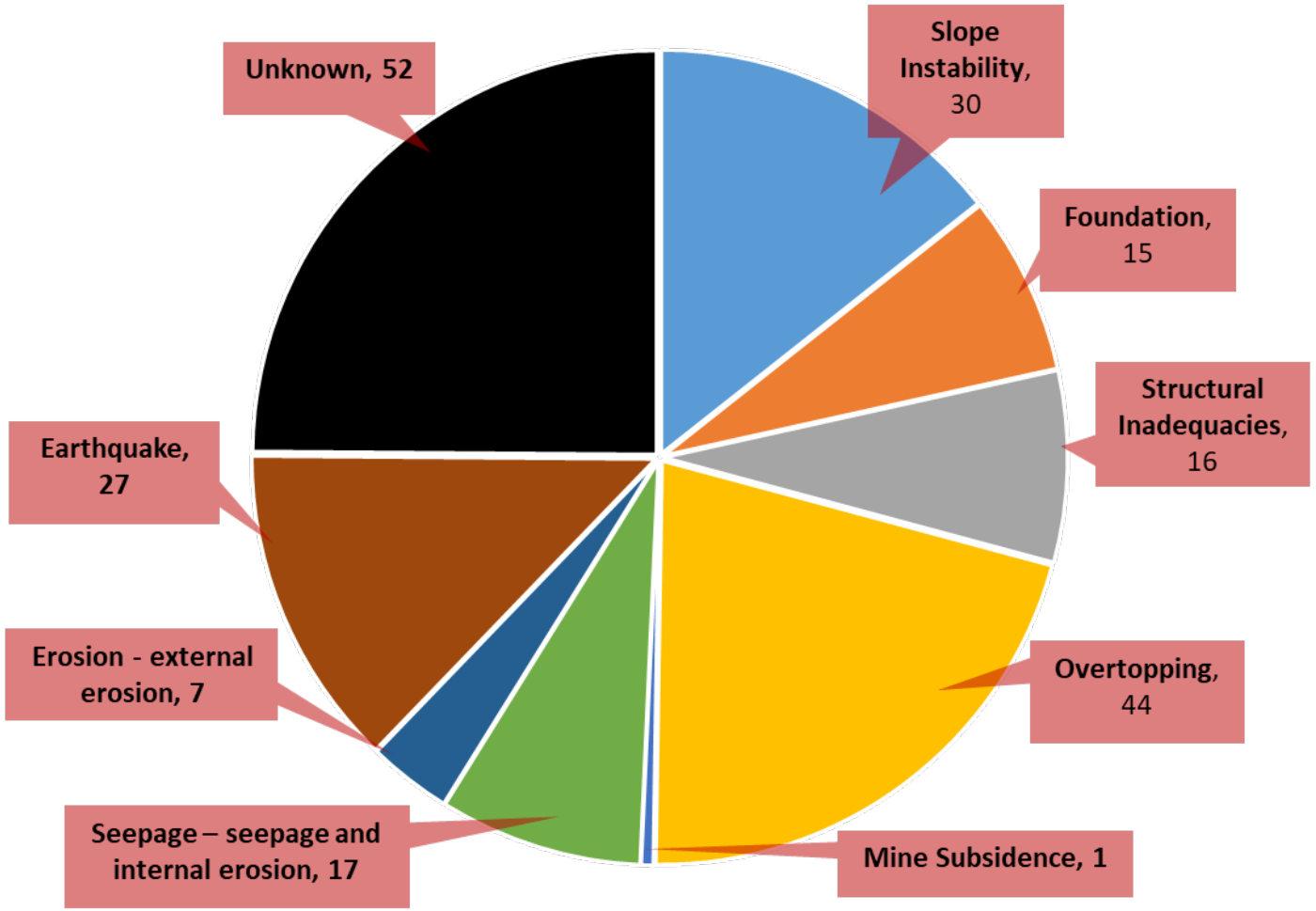

BBC NEWS


TV Globo
25/01/2019 12:28:24

TSF

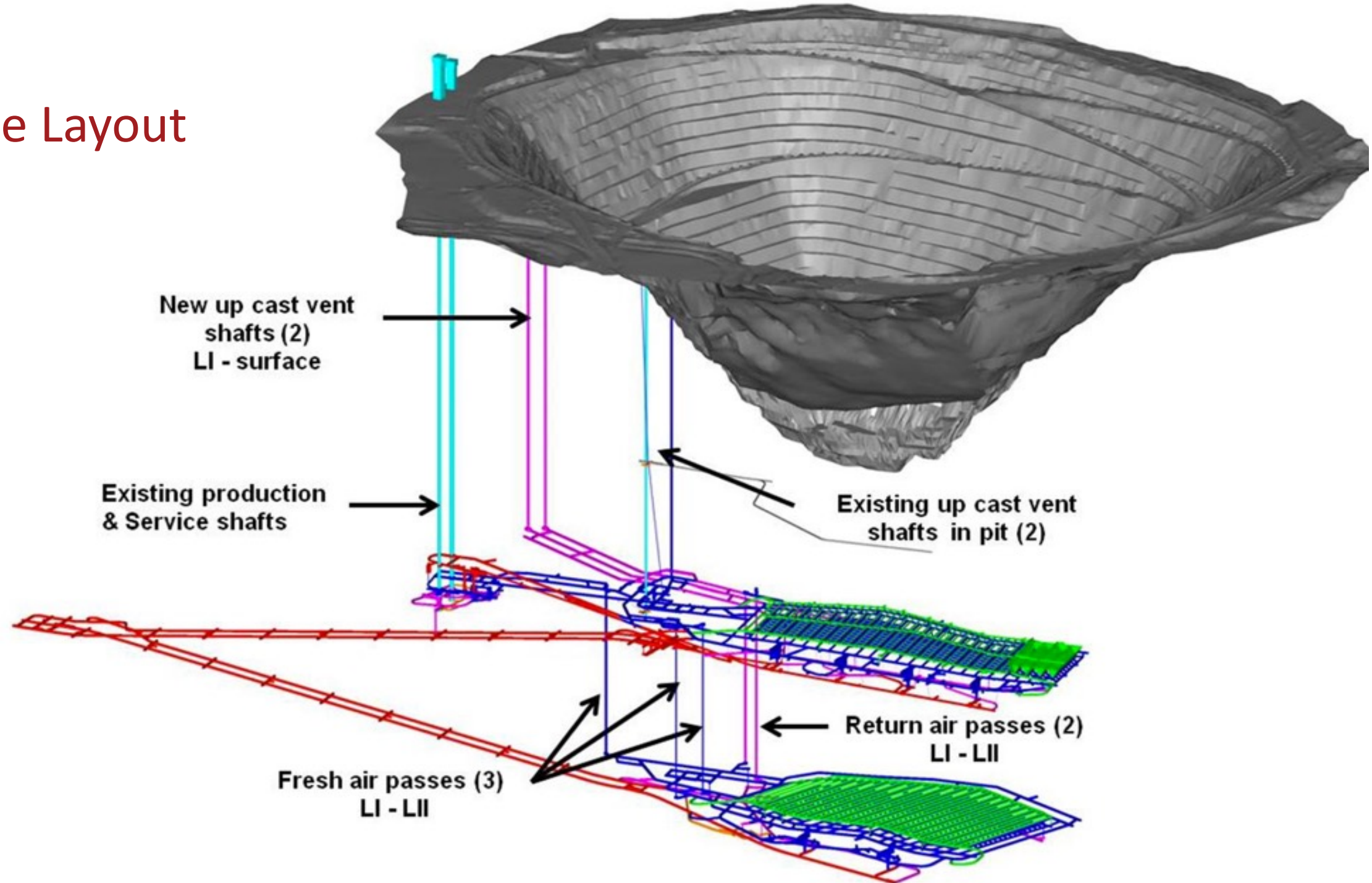
- Control = Static Liquefaction
- Dependency = Water, Fines
- Verification = Phreatic Surface
- Control Quality = Human Behaviour



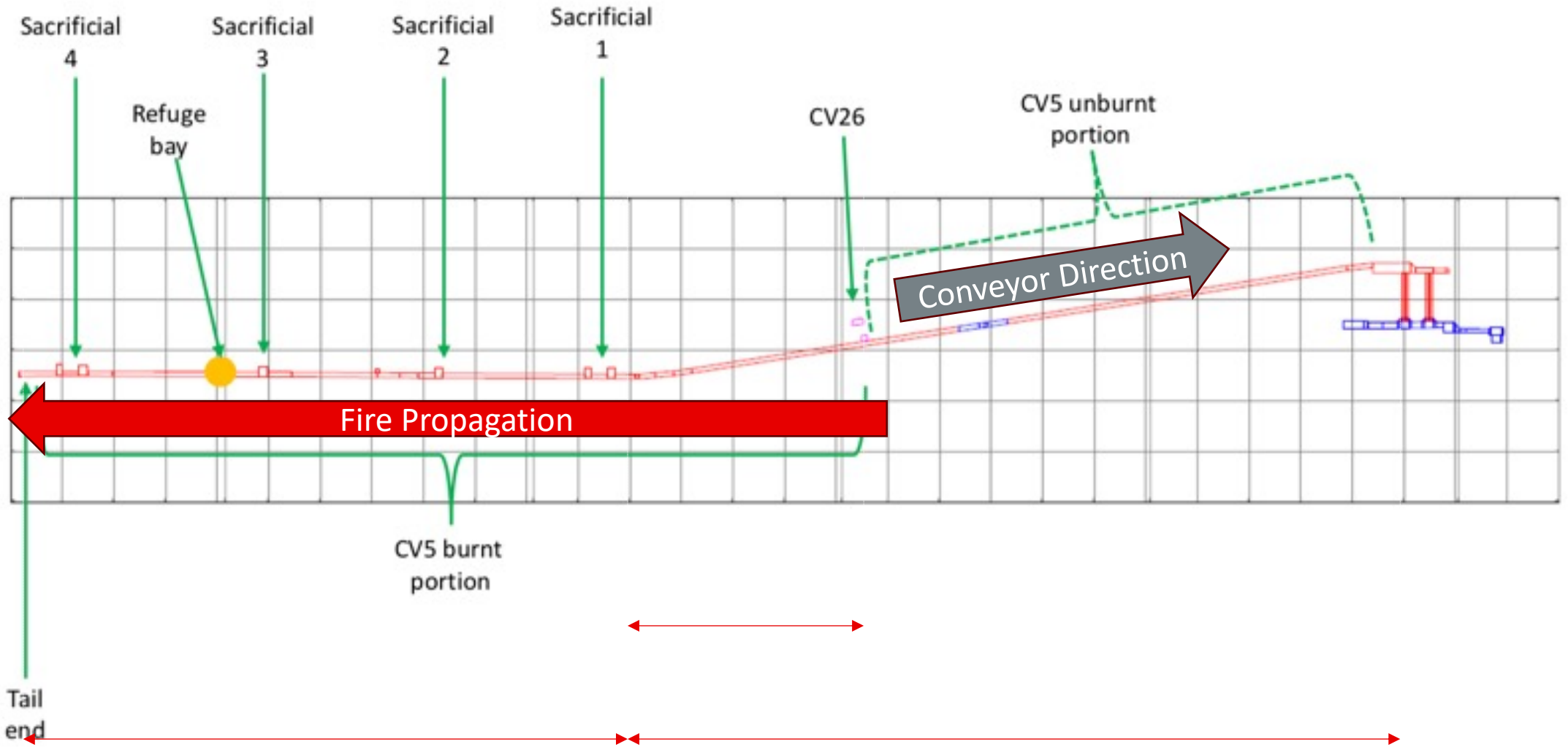


Case Study: Underground Conveyors

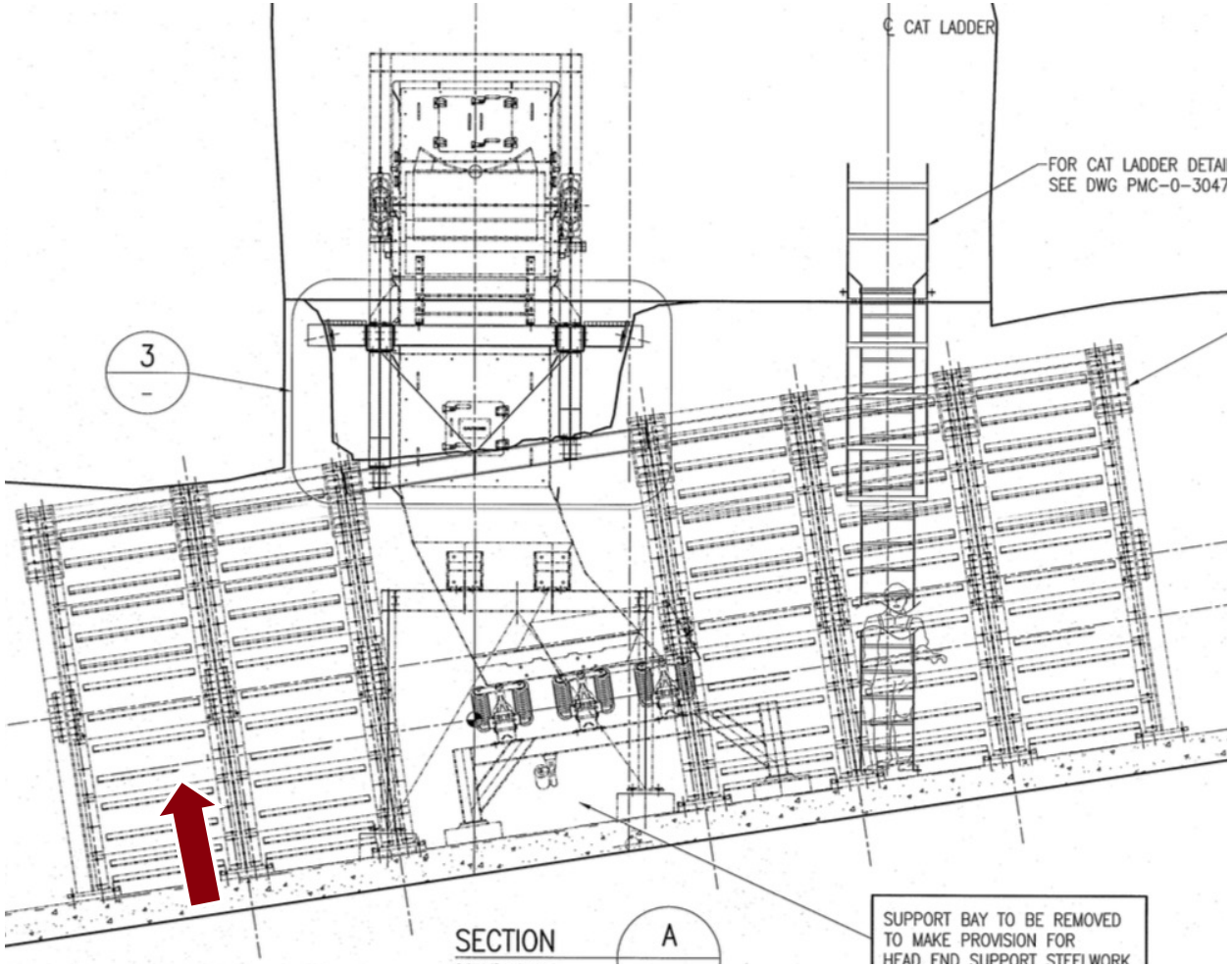
Mine Layout

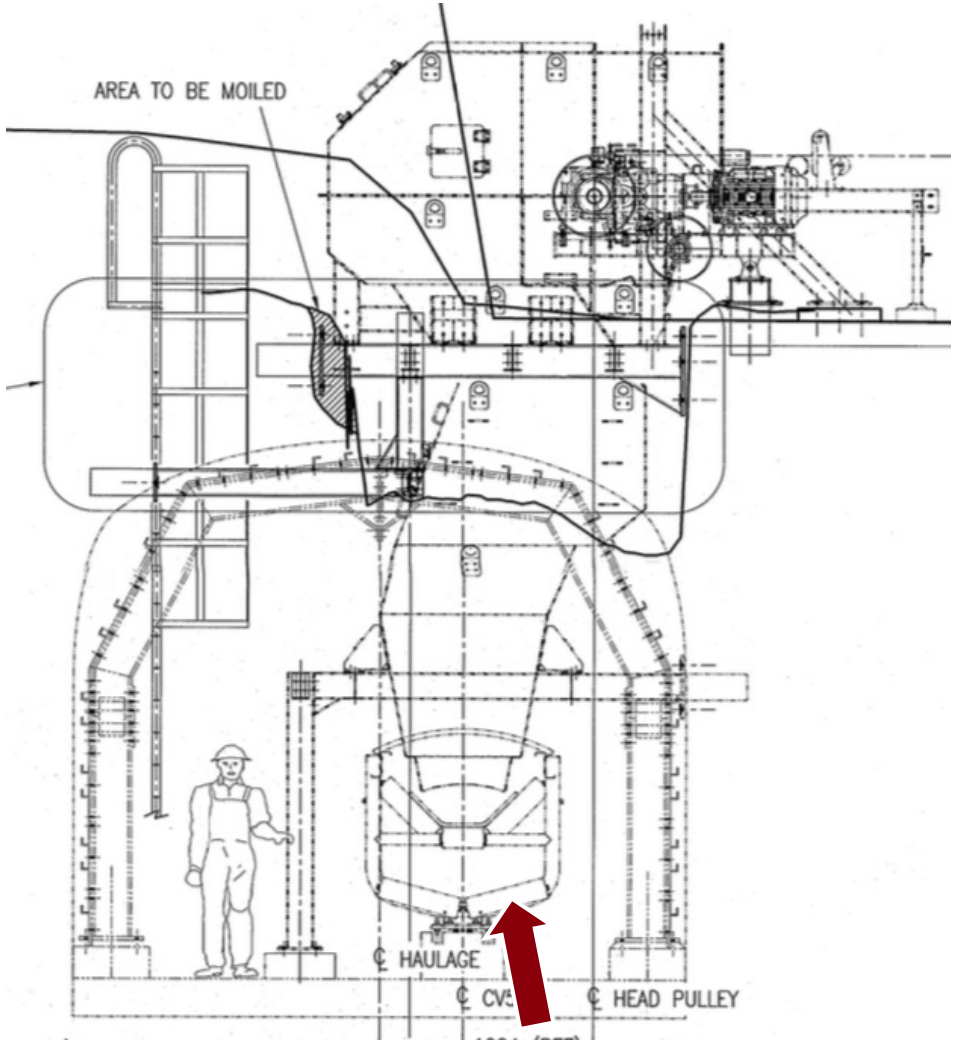

New up cast vent shafts (2) LI - surface
Existing production & Service shafts
Existing up cast vent shafts in pit (2)
Return air passes (2) LI - LII
Fresh air passes (3) LI - LII

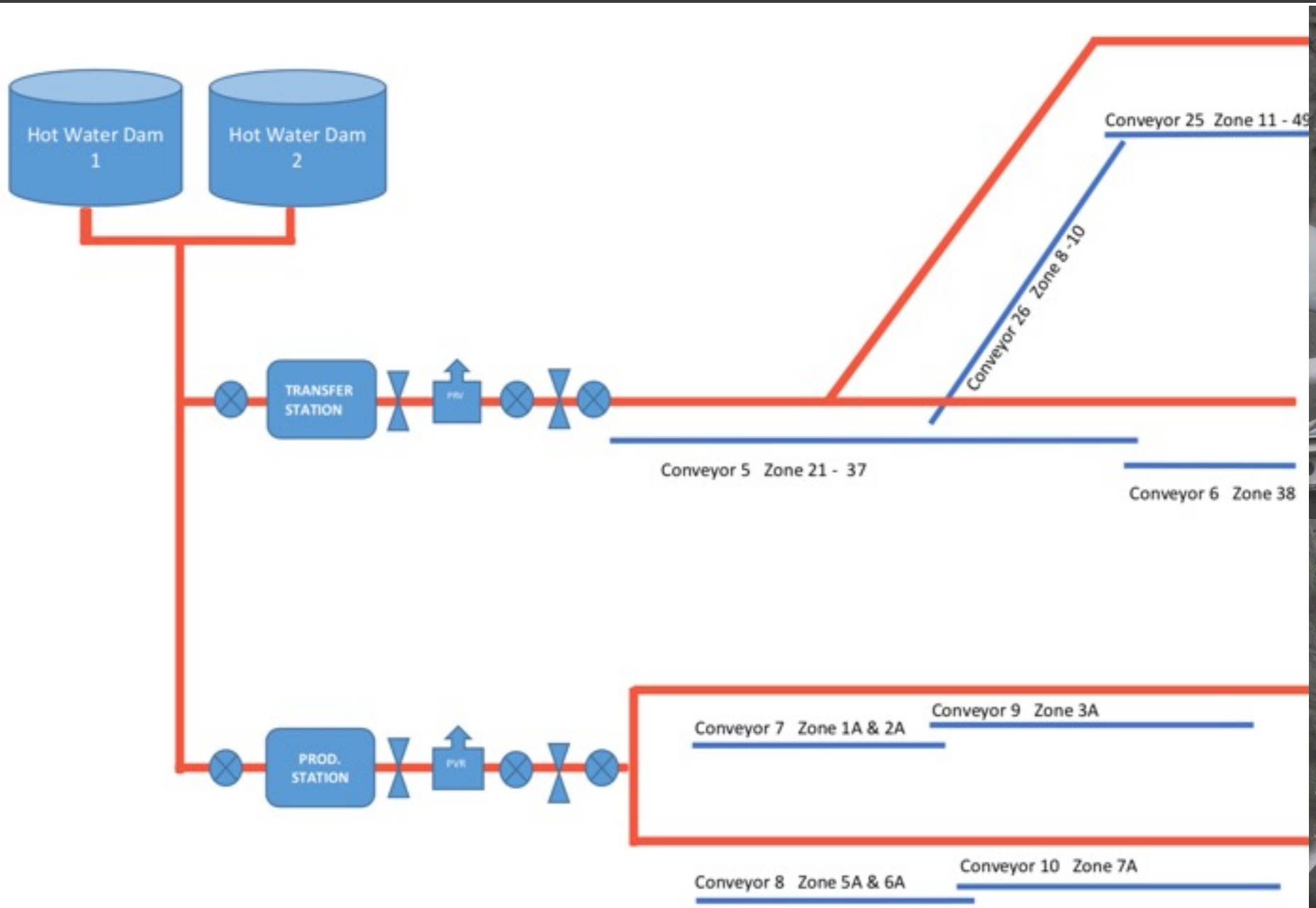
Fire Propagation

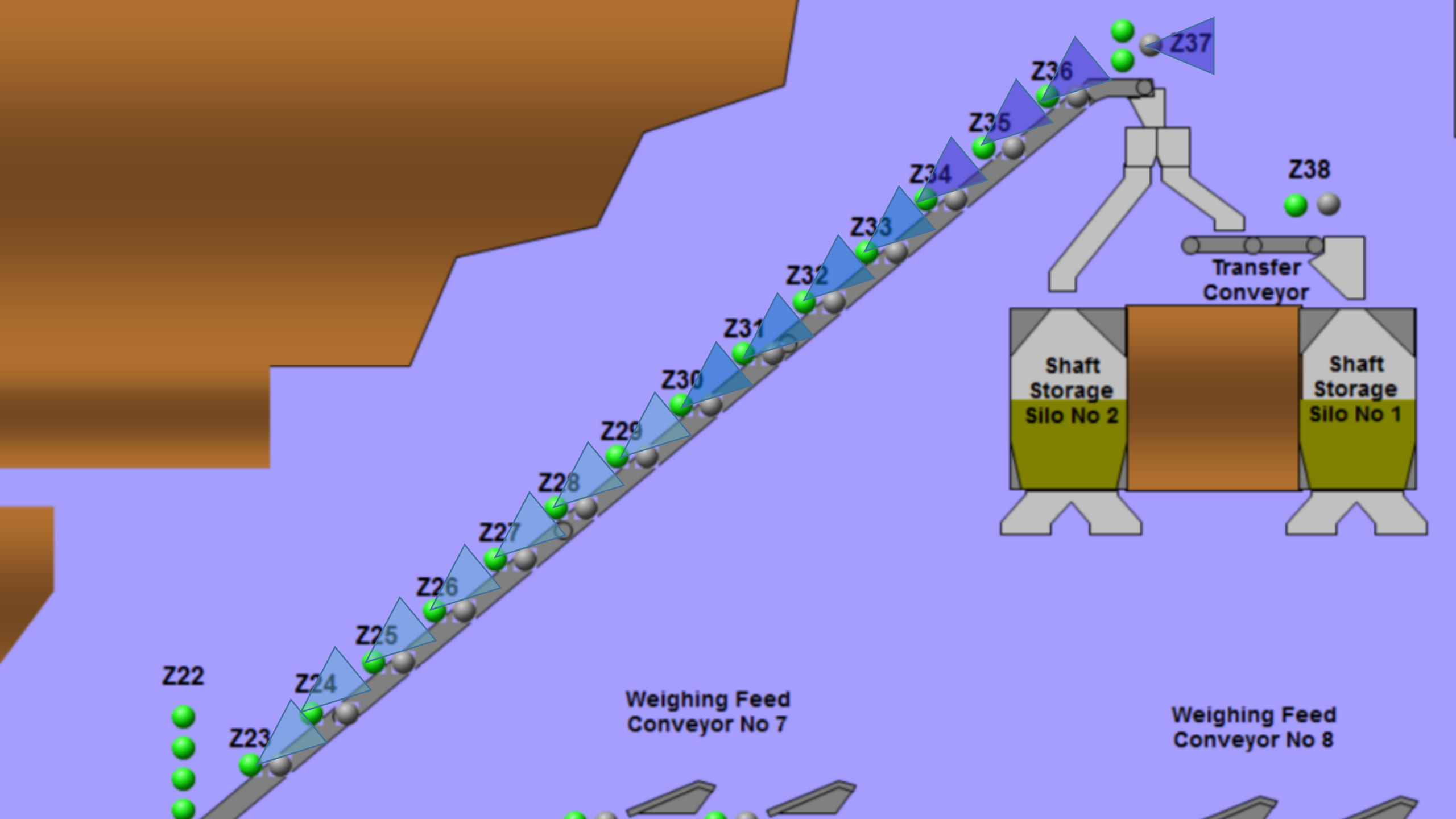


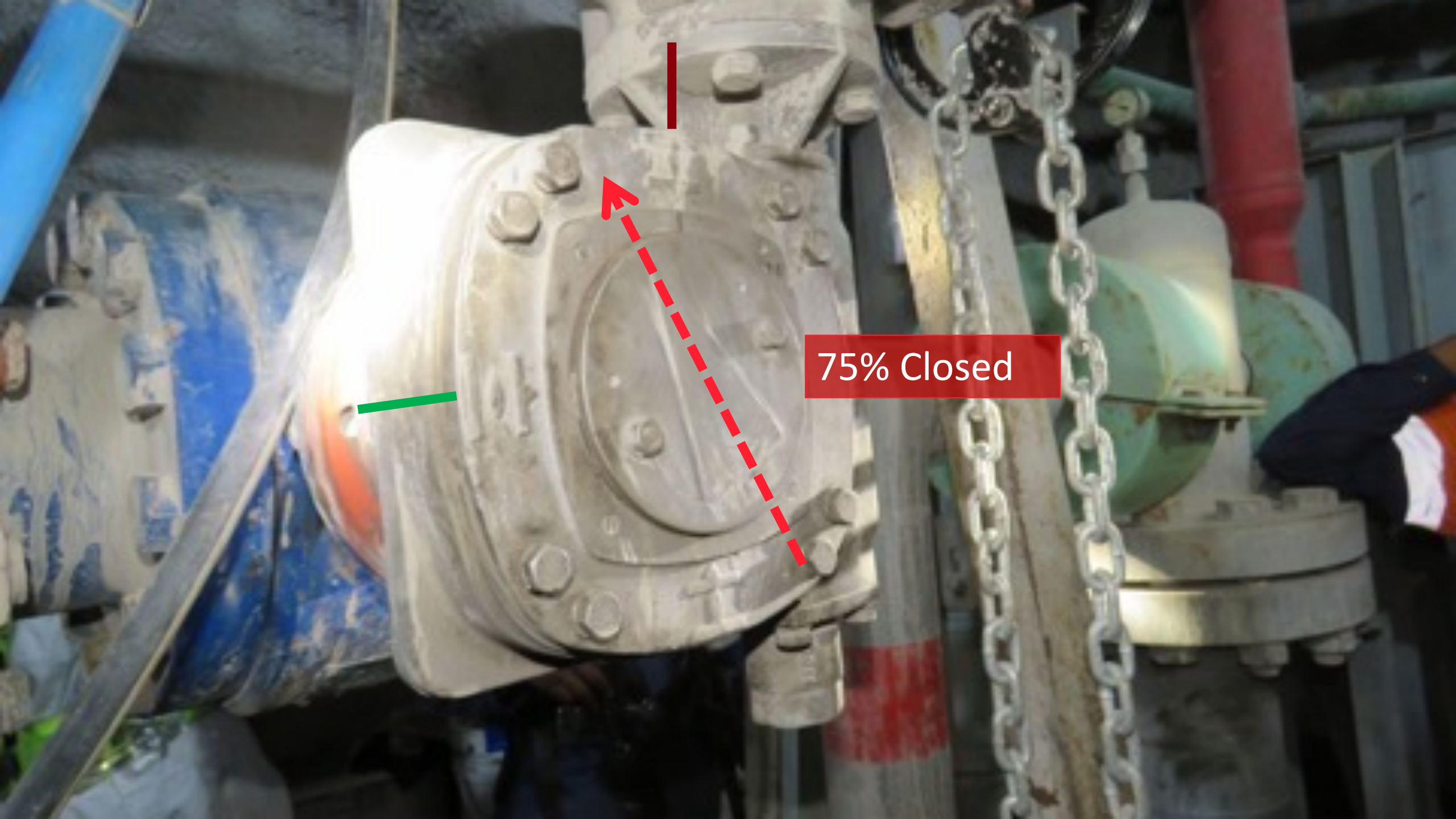
Idler Location






Hot Water Dam 1
Hot Water Dam 2
TRANSFER STATION
PROD. STATION
Conveyor 25 Zone 11 - 49
Conveyor 26 Zone 8 -10
Conveyor 5 Zone 21 - 37
Conveyor 6 Zone 38
Conveyor 7 Zone 1A & 2A
Conveyor 9 Zone 3A
Conveyor 8 Zone 5A & 6A
Conveyor 10 Zone 7A


Z37
Z36
Z35
Z34
Z33
Z32
Z31
Z30
Z29
Z28
Z27
Z26
Z25
Z24
Z23
Z22
Z38
Transfer
Conveyor
Shaft
Storage
Silo No 2
Shaft
Storage
Silo No 1
Weighing Feed
Conveyor No 7
Weighing Feed
Conveyor No 8

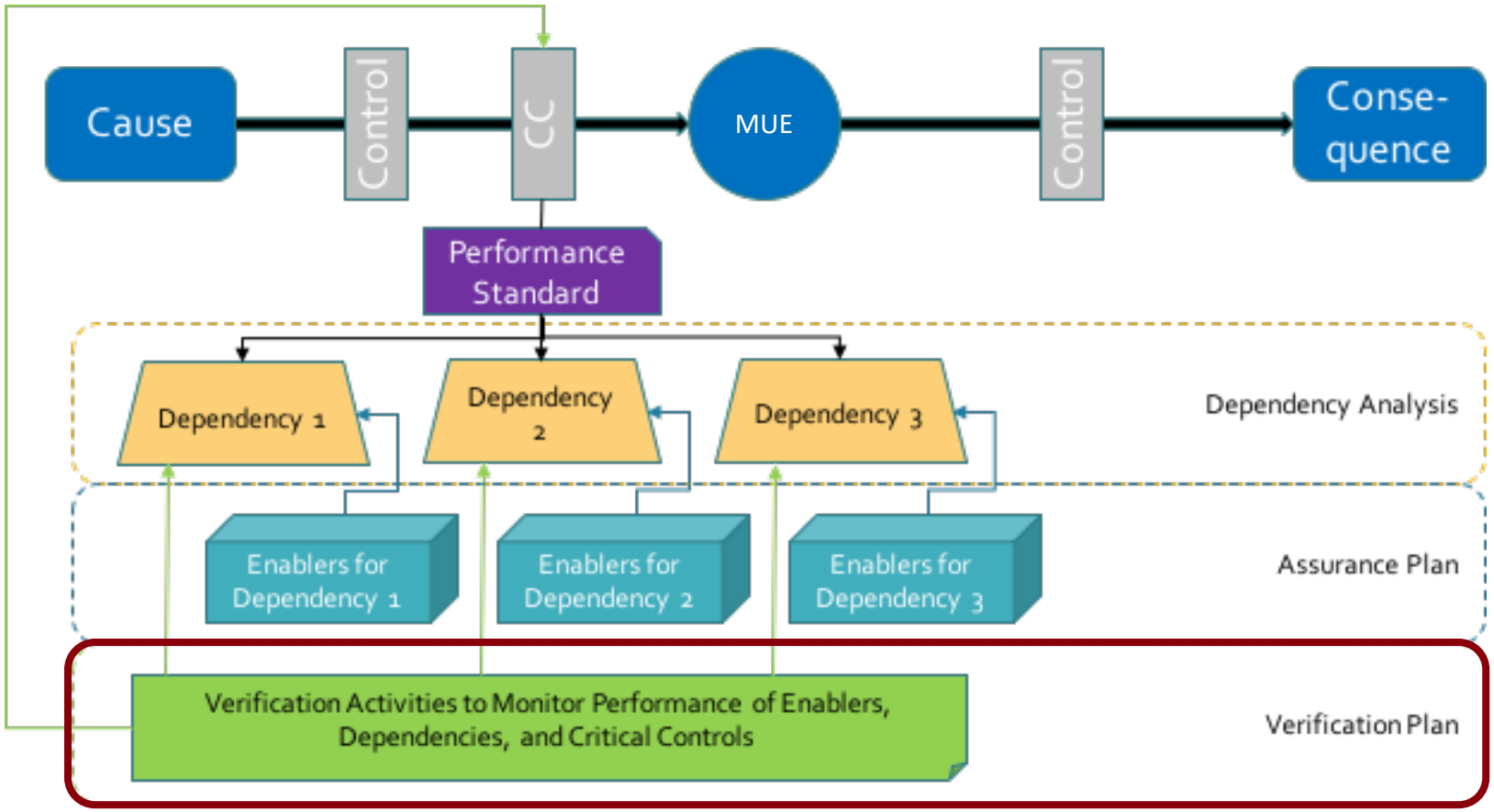

75% Closed

Conveyor Fire

- Adequate Conveyor Design
- Incorrect Bottom Roller Support Bracket Fabrication
- Control System Override Function
- Adequate Fire Detection and Suppression Design
- Adequate Water Supply
- Adequate Water Supply
- Automatic Control Valves not Installed to DCS
- Operating Pressures Verified
- Control Valve Manually Manipulated and Only 25% Opened

Compliance Items Recorded, but
None of The Issues Identified in Risk Survey or Monitoring Activities

Conveyor Fire



- Control = Fire Suppression
- Dependency = Water pressure, Water flow, Accurate detection
- Verification = Pressure Gauge, Flow Valve Position, Detection Testing
- Control Quality = Human Behaviour

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