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Mining Services

Experiences and learning around the decontamination and remediation of explosives facilities

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Agenda

- Remediation steps
- Experience at Mogwase
- Experience at Modderfontein
- Learnings

Need to remediate

The need to remediate is determined by:

- Reduction in manufacturing activity
- Change in manufactured products resulting in redundant processes
- Reduction in operating footprint
- Development of land previously used for manufacturing for alternative land uses

Remediation steps

- 1. Historic review
- 2. Identify contaminated areas

- 3. Clear vegetation and characterisation
- 4. Plant decontamination plan

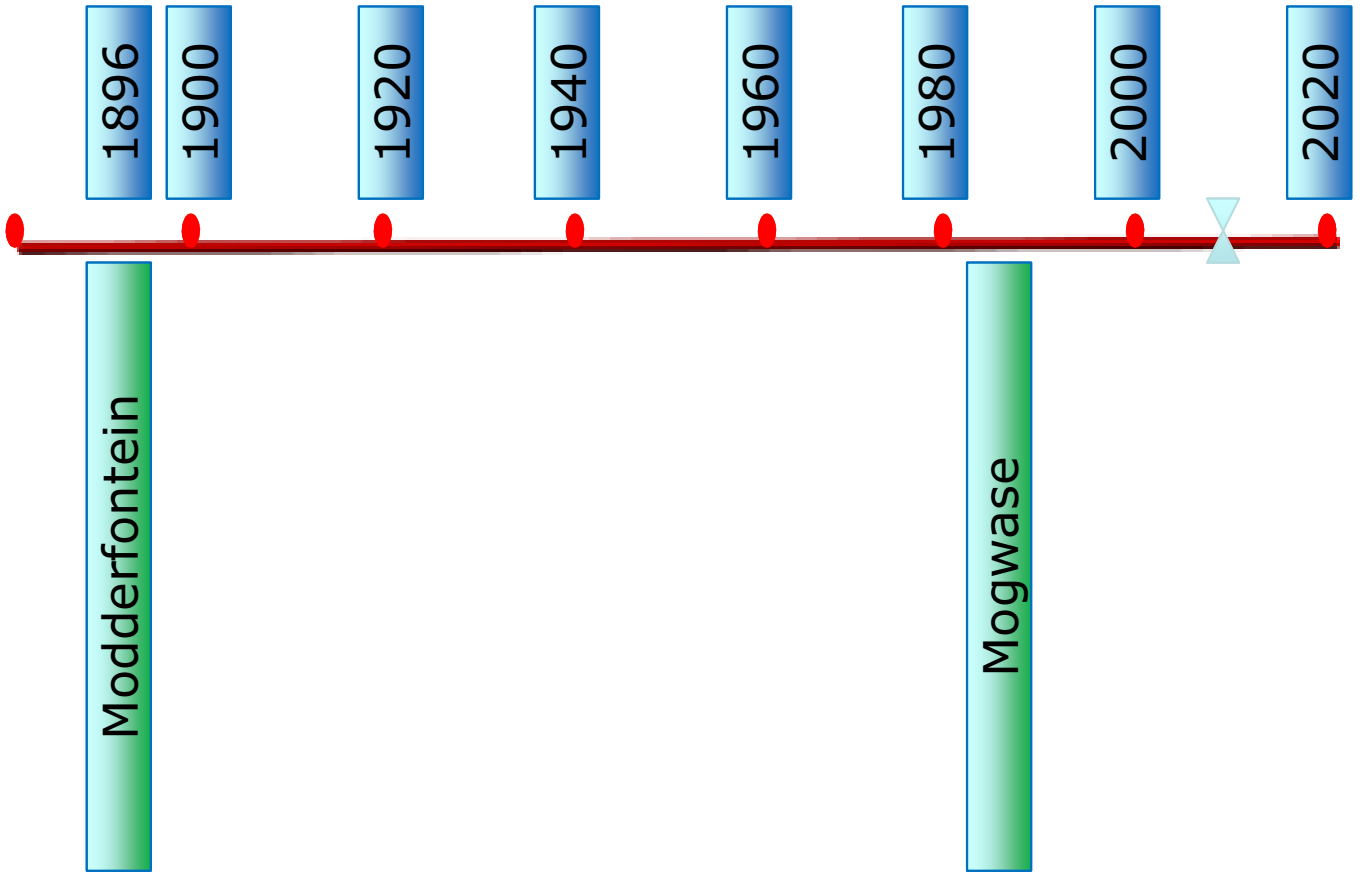
- 5. Explosives decontamination
- 6. Peer review

- 7. Chemical decontamination
- 6. Peer review

- 5. Contouring
- 6. Land release report

Experiences

Remediation experiences at two of AEL's sites will be discussed:



Experiences: Test Range, Mogwase

Experiences: Test Range, Mogwase

Test Range, Mogwase

1. Historic review

- The site was used for 15 years
- For : testing (emulsion detonability, quality control)
  destruction (blasting explosives, accessories)
- Facility had been closed for 3 years when it was decided to remediate
- Due to short time since closure site personnel still remembered what activities had taken place and where

Test Range, Mogwase

2. Identify contaminated areas

- Contaminated site size: 300m x 300m (90 000m^2) including 21 test pits

- Explosive contamination that was visible and buried:
  - Detonators (detonated and partially detonated)
  - Associated components (explosive contaminated debris, connectors, safety fuse and electric detonator wire)

- Because the site had not been used for 3 years:
  - it was covered in grass
  - some of the 21 pits were filled with water

Test Range, Mogwase

Test Range, Mogwase

3. Remediation plan - developed

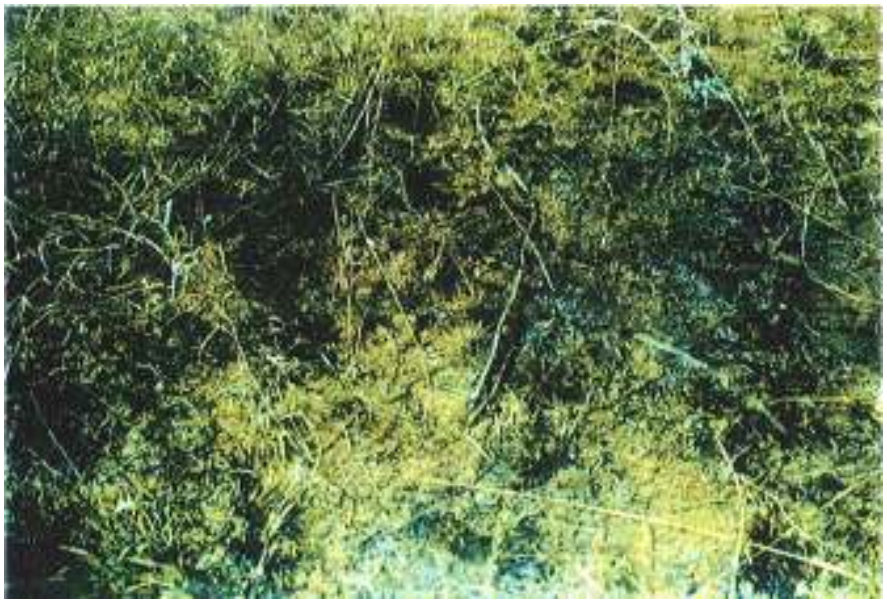
- Developed and approved by the CIE
- The plan:
  - Identification of a contractor with knowledge of explosives to do the remediation – Mechem selected
  - Development of a remediation methodology following a hazard study
  - Training of personnel involved in the remediation
  - Implementation of the methodology (taking into consideration problem areas such as vegetation, soil type, weather)
  - Regular review of the methodology
  - Regular audits (4 levels) by persons required to close out the remediation work
  - Photographic record and recording of data as progress is made
  - Report writing
  - Record of decision on success of decontamination

Test Range, Mogwase
Remediation plan - Audits

- 4 levels of audit conducted:
  - Standby auditing – the standby was allocated by the factory and was present daily to ensure that the correct methodology was followed
  - Project Manager – to audit the methodology on a periodic basis and take steps to correct any problems identified by the standby
  - Consultants – visit the site on a weekly basis to monitor the effectiveness of the methodology and to provide advice on any changes that need to be made
  - External auditor – to audit the appropriateness of the method and verify that the agreed method was adhered to

Test Range, Mogwase
Remediation plan - implemented

- Step 1
  - Grass burned



Test Range, Mogwase
Remediation plan - implemented

- Step 2
  - Detonators in trees : cut and burned

Test Range, Mogwase

Remediation plan - implemented

- Step 3
  - The remediation site was divided into blocks (50m x 50m) using dropper poles and tape
  - Total of 36 blocks – each block was numbered
  - These were further sub-divided into lanes 5m wide using rope

Test Range, Mogwase

Remediation plan - implemented

- Step 4
  - Teams, three people each, were used in the lanes to look for detonators and associated components.

Test Range, Mogwase

Remediation plan - implemented

- The teams walked up and down and left and right in the lanes.
- This meant that the ground was inspected four times.
- Detonators and associated components found were placed in buckets half filled with oil which were emptied into larger drums.
- The area was then checked with a metal detector.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548

Test Range, Mogwase
Remediation plan - implemented

- Step 5
  - A mechanical rake was used to break up the top 50mm of the soil surface.

  - The soil was first raked in one direction then again at 90 degrees to the first direction.
  - People walked behind the rake collecting detonators and associated components.

Test Range, Mogwase
Remediation plan - implemented

– The mechanical raking also resulted in the collection of the burned grass which was hand raked into piles for further burning

Test Range, Mogwase

Remediation plan - implemented

- Step 6
  - The area was checked with metal detector.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265

Test Range, Mogwase
Remediation plan - implemented

- Step 7
  - The soil was ripped 250mm deep using a mechanical ripper and the area cross ripped at 90 degrees.
  - People walked behind the ripper collecting detonators and associated components that were exposed

Test Range, Mogwase

Remediation plan - implemented

- Step 8
  - The area was checked with metal detector to pick up any detonators under the ground.
  - The entire area was again raked with the mechanical rake.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154

Test Range, Mogwase
Remediation plan - implemented

- Step 9
  - The 21 explosive pits were then decontaminated:
    - The grass in each pit was burned.
    - Each pit was visually inspected and live detonators and associated components removed.
    - The soil in each pit was loosened by firing a series of explosive charges connected with detonating cord
    - Rubber rakes and prodders were used to further loosen soil in and around the walls of the pits to a depth of 500mm
    - A metal detector was used to check that no detonators were left in the pits
    - As fly soil from the destructions in the pit may have covered some detonators, the ridges of the pit were graded down to 250mm lower than the original surface level. The soil was raked out to a thin layer and visually inspected for detonators and associated components.

Test Range, Mogwase

Remediation plan - implemented

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154
- Inspection 4: 83

Test Range, Mogwase
Remediation plan - implemented

- Step 10
  - Due to the effectiveness of the grading, the entire 300m by 300m area was also graded and raked.
  - The area was again inspected.

Test Range, Mogwase
Remediation plan - implemented

- Step 11
  - To determine the effectiveness of the decontamination, trenches 1m deep, 1m wide and 2m long were dug in selected areas in order to determine the depth of excavation necessary to remediate the site.
  - Inspection of the trenches found no live detonators and associated components deeper than the 250mm.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154
- Inspection 4: 83
- Inspection 5: 0

Test Range, Mogwase
Remediation plan - implemented

- Step 12
  - Final audit
    - The Site Manager at the factory randomly selected 25 sites where the soil was sifted. No live detonators or associated components were found during this process
    - The AEL Consultant selected two 50 meter lanes for regrading. In one lane one block was graded in the second lane eight blocks were graded. The heaped lines of soil were then raked out to a thin layer and the grass raked into heaps by the auditing teams. The grass was then burned. Four detonators were initiated during this process.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154
- Inspection 4: 83
- Inspection 5: 0
- Audit (Manager): 0
- Audit (Consultant): 4

Test Range, Mogwase
Remediation plan - implemented

- Step 13
  - Following the discovery of the 4 detonators the entire site was again raked with the mechanical and hand rakes and grass collected in the raking process burned.
  - The hand raking revealed four detonators.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154
- Inspection 4: 83
- Inspection 5: 0
- Audit (Manager): 0
- Audit (Consultant): 4
- Inspection 6: 4

Test Range, Mogwase

Remediation plan - implemented

- Step 14
  - With the discovery of the four detonators it was decided to review the remediation methodology

Test Range, Mogwase

Remediation plan - implemented

- A mechanical sieve was introduced to physically sieve the soil.
- The sieve consisted of a hopper, 6mm sieve and 3 conveyor belts
- The sieve was commissioned by sieving soil into which 20 empty detonator casings were mixed
- Material < 6mm was collected from the conveyor belt by tipper truck for reuse on the ground.

  Material > 6mm was collected onto the second conveyor belt which dropped the material onto the third slow moving conveyor belt from which operators picked the detonators and placed them into buckets containing oil.
- This process took 4 months.

Test Range, Mogwase

Remediation plan - implemented

- An audit confirmed that there were no more detonators

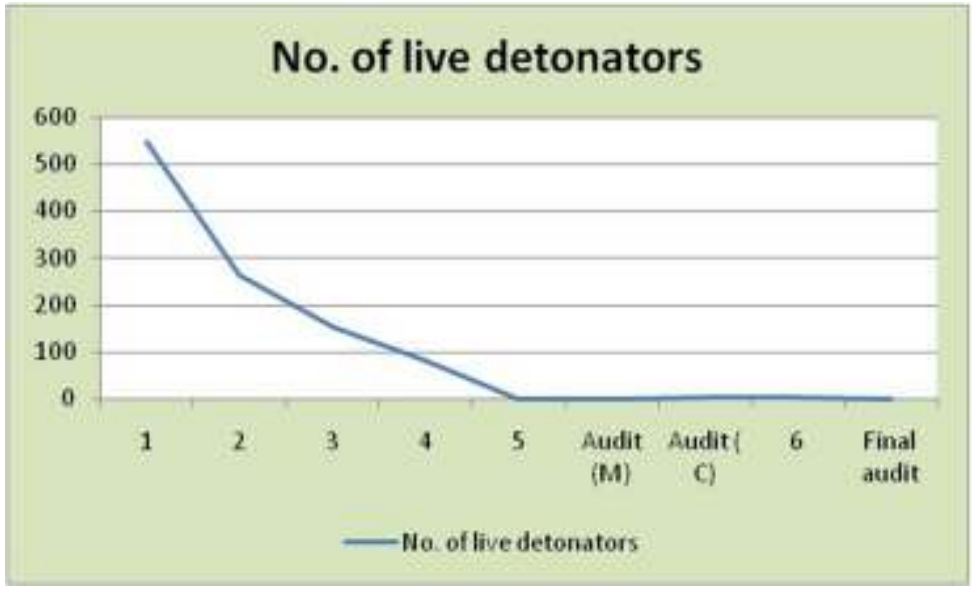
- In the final audit 30 front end loader buckets of soil were randomly selected and sieved.
  - No detonators or any debris related to explosives was found in the fine material
  - The coarse material was sieved 4 times and only small pieces of exploded detonators were found.

- The area was finally declared decontaminated.

Test Range, Mogwase

Inspection yield of live detonators

- Inspection 1: 548
- Inspection 2: 265
- Inspection 3: 154
- Inspection 4: 83
- Inspection 5: 0
- Audit (Manager): 0
- Audit (Consultant): 4
- Inspection 6: 4
- Final audit: 0



Test Range, Mogwase

The remediated site 12 years later

Experiences: Modderfontein , South Africa

NG decontamination : communications

- Nitroglycerine production stopped in 1994
- Production buildings were decontaminated of explosives
- In 2005 explosive contaminated drains needed to be decontaminated while people with the knowledge were still available
- Decontamination of drains by blasting

HOWEVER…..

Experiences: Modderfontein , South Africa

NG decontamination : communications

- Neighbours :
  - tenants, own employees and public

- Required a public participation/communication programme

Experiences: Modderfontein , South Africa

NG decontamination : Public participation

Inside complex

- Leaflets issued to tenants
- Email sent to tenants and employees
- Siren prior to blast

Outside Complex

- Articles in local newspapers
- Telephone hotline for complaints

Blast and vibration monitoring equipment measured each blast

Experiences: Modderfontein , South Africa

Black powder dump: Cost reduction

- Black powder plant closed in 1993
- Decision to remediate Black powder dump in 2008
- Heterogeneous dump
- Dump was about 10 000 m^2 in area and was of variable depth up to about 3 m.

Experiences: Modderfontein , South Africa

Black powder dump: Cost reduction

- Easy option :remove the entire contents to a hazardous landfill site.
- Easy option cost estimate: R15,4 million (2008).
- Cost reduction option:
  - segregate the different materials
  - conduct atomic adsorption analyses on the material to determine whether the material
    - had to be disposed to a hazardous landfill site
    - could be treated and delisted to a lower class landfill site (lower disposal costs)
    - could remain in situ
    - could be recycled e.g.metal.
- The final cost for the waste separation option, which included disposal and backfilling, was R9.5 million (2008).

Experiences : Learnings

- *Firing of detonators should be done in a meshed area to minimise the dispersion of fired detonators*
- *Explosive debris must be collected daily to prevent the burying of fired detonators and waste by subsequent firing and by rainstorms*
- *Weekly "chicken" parade to be held to check the area for detonators and associated components*
- *Remediate the site as soon as activities have ceased to prevent problems with growth of grass, trees and rain, loss of people with knowledge of the plant*
- *Where people can be impacted by the remediation activities establish a communication system to keep everyone informed – measure impacts expected to result in complaints or damage claims*
- *Explore material segregation options to reduce remediation costs*


Thank you
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