AECI good chemistry

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# Remediation of Arsenic Impacted Soils with Ferrous Sulfate

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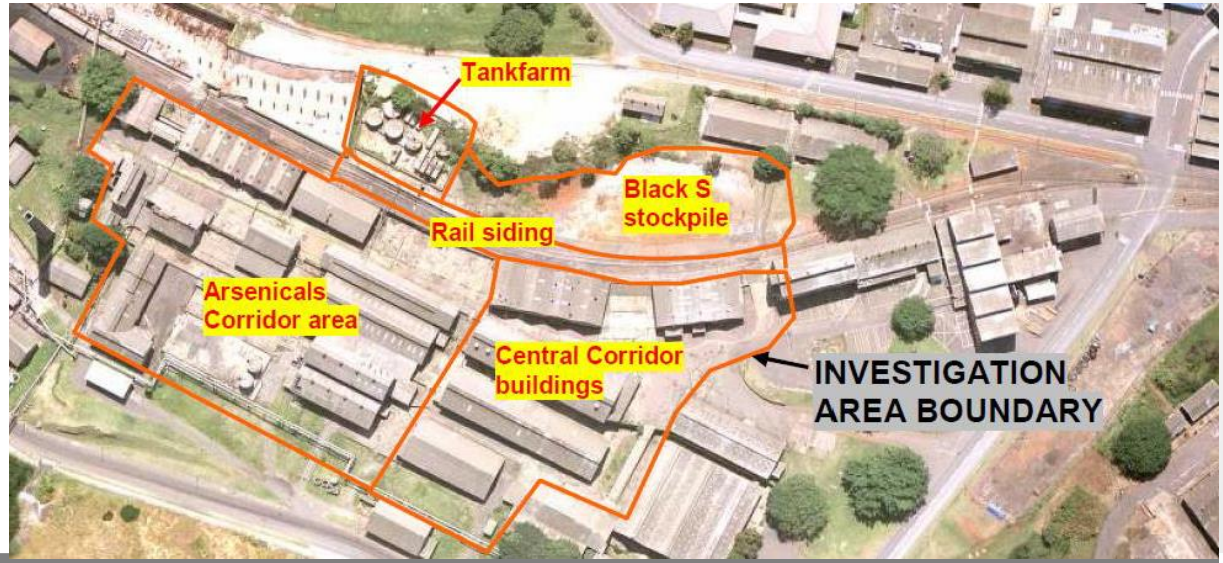
- Chemicals Insecticides and Dip Area (CID Area)
- 2.4ha – middle of an industrial complex ~250ha
- Operational from c.1927 to 1998
- Arsenic based (and other) pesticides manufactured and stored



# CID Plant

NOTES:

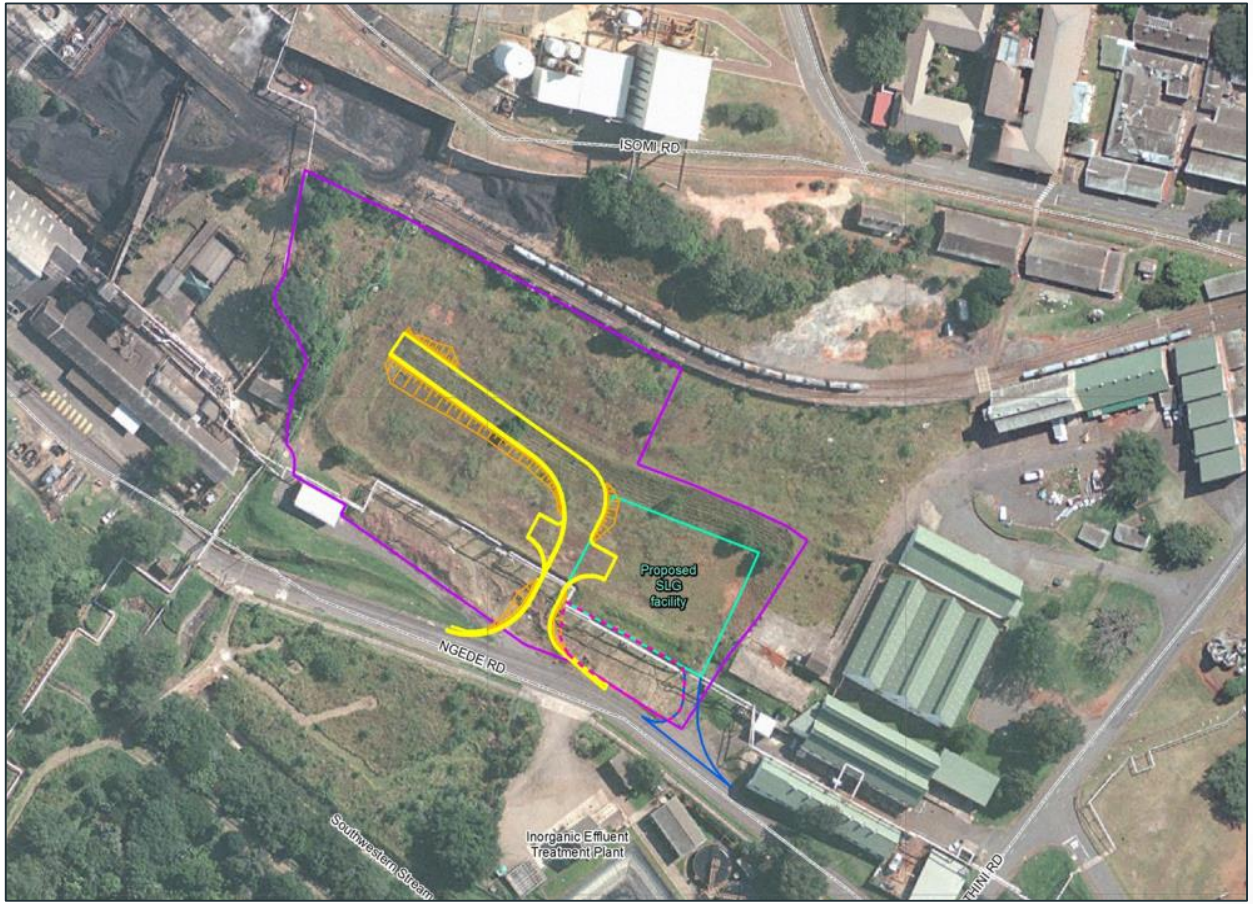
- Calcium arsenate one products
- As-trioxide imported in barrels
- However, As released in various forms

# Demolition Interventions 2006- 2008

- Buildings demolished
- As hot spots removed
- Soils treated with 5% ash and 5% Lime; BP
- Area profiled, compacted to reduce infiltration
- 2 Platforms created
- Released to Landlord

# Planned Development: 2015



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# Baseline / Site Assessment - 2015

- 20 m grid sampling over development footprint
  - Sampling at 3 depths;
  - Analyses over 150 determinands
- Significant residual impact : As
- Follow-up infill sampling around hotspots
- Separate ESA  - greater manufacturing area

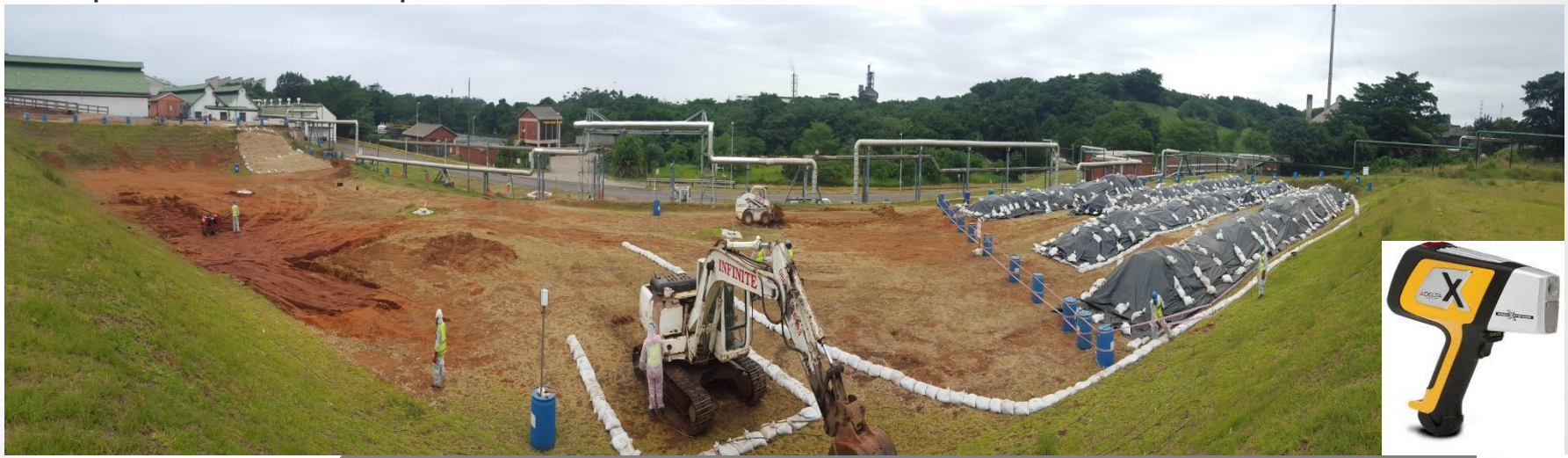
# Total As in Soil



# 2016 Phase I Remediation



- Hotspot removal based on portable XRF analyzer results
- Excavation and stockpiling of  arsenic impacted soils (625 $m^3$)
- Remediation of the remainder of the development footprint and the stockpiles would follow suit

# Conceptual Site Model



- The site is located approximately 1km inland
- It is underlain by about 30m of clayey Berea Red Sands - high iron content - assisted with natural attenuation
- Fractured tillite occur beneath the sands
- As releases over time exceeded natural attenuation capacity beneath – impacted groundwater (15mbgl)
- Groundwater impacts are localized beneath the site, rapidly decrease in concentration down gradient
- Main Risk drivers: surface water resource (stormwater channel); groundwater resource (potential use unlikely); direct exposure

- **RTVs'** protective **of surface and groundwater resources** as per the Framework for the Management of Contaminated Land, is calculated as follows:

$$RTV = DAF \times K_d \times C_w$$

- **Dilution Attenuation Factor (DAF)** and **Partition Coefficient (Kd)** - not applicable (20; 29L/kg)
- **Site specific values** had to be determined: **DAF and Kd**
- **Site specific remediation target values (SRTV):**
  - **Pre and Post developmen**t (**reduced infiltration 0,002m/y**)
- **Not useful** – too much arsenic

# Allowable Leachate Concentration

- Remediation strategy proposed : **stabilisation of the impacted soil** with **ferrous sulphate** (successful laboratory trial results)
- Remediation objective: dictated by the **As leachate concentration** and not the total As concentration
- RTV recalculated to represent **maximum allowable field leachate concentration**

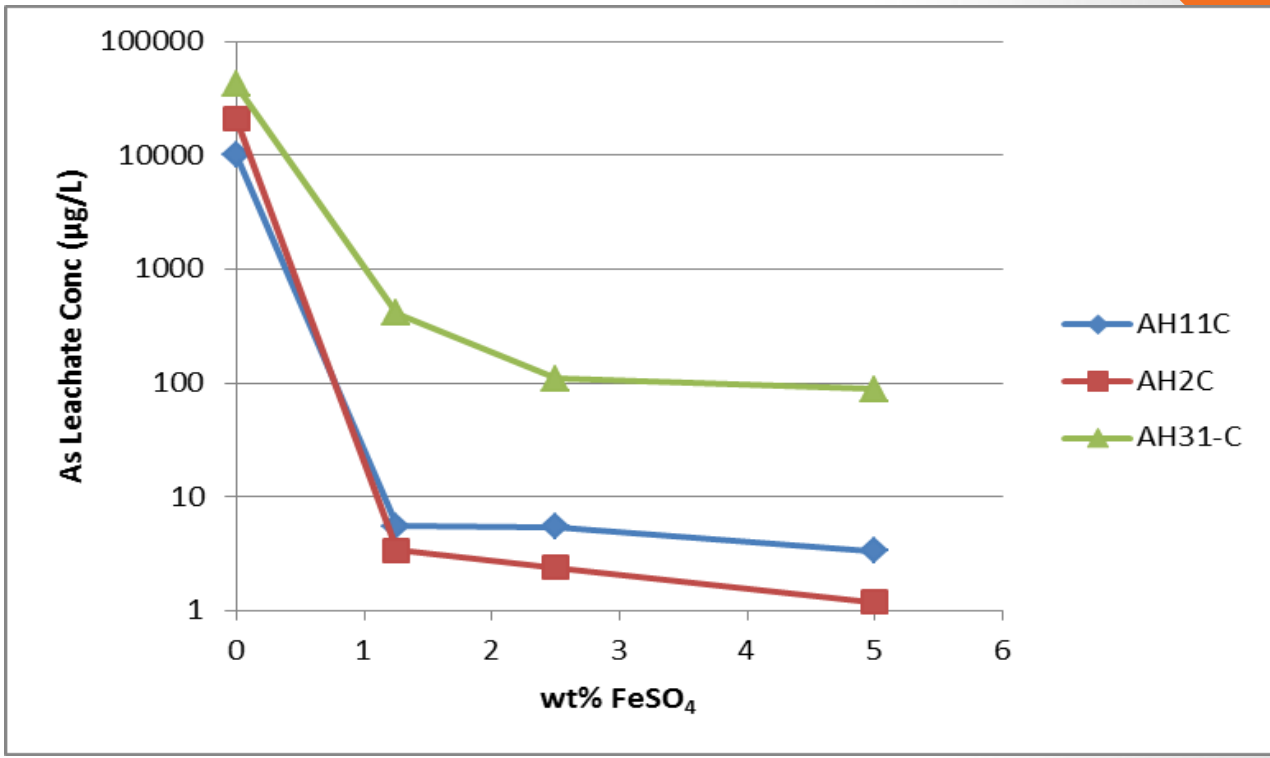
$$C_{leachate} = DAF \times Cw$$

Development of site specific impact to groundwater soil remediation standards using the synthetic precipitation leachate procedure, Vers 3.0 November 2013. New Jersey Dept. Environmental Protection

- Differences wrt Synthetic Precipitation Leachate Procedure (SPLP) and field leachate generation a conservative approach - leachate criterion (Cl) **reduced by half (50%)**
  - SPLP = 0.5 x $C_{leachate}$
- **Pre-development** and **post development scenarios**

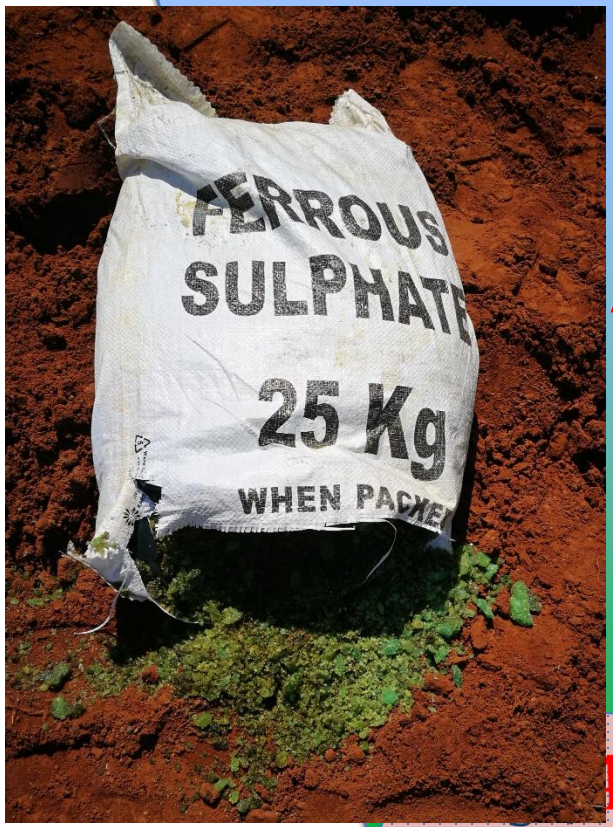
# Stabilisation Trails: Field

- 5 x 5 m x 1.5 m deep field trial
- Treated @ 2.5 wt.% ferrous sulfate
- Resampled after 1, 2 and 5 weeks
- 90 and 99% reduction in leachate As




- Trails confirmed: ferrous sulfate effective in significantly reducing arsenic leachability

# Stabilisation Trails: Field




**Objective**

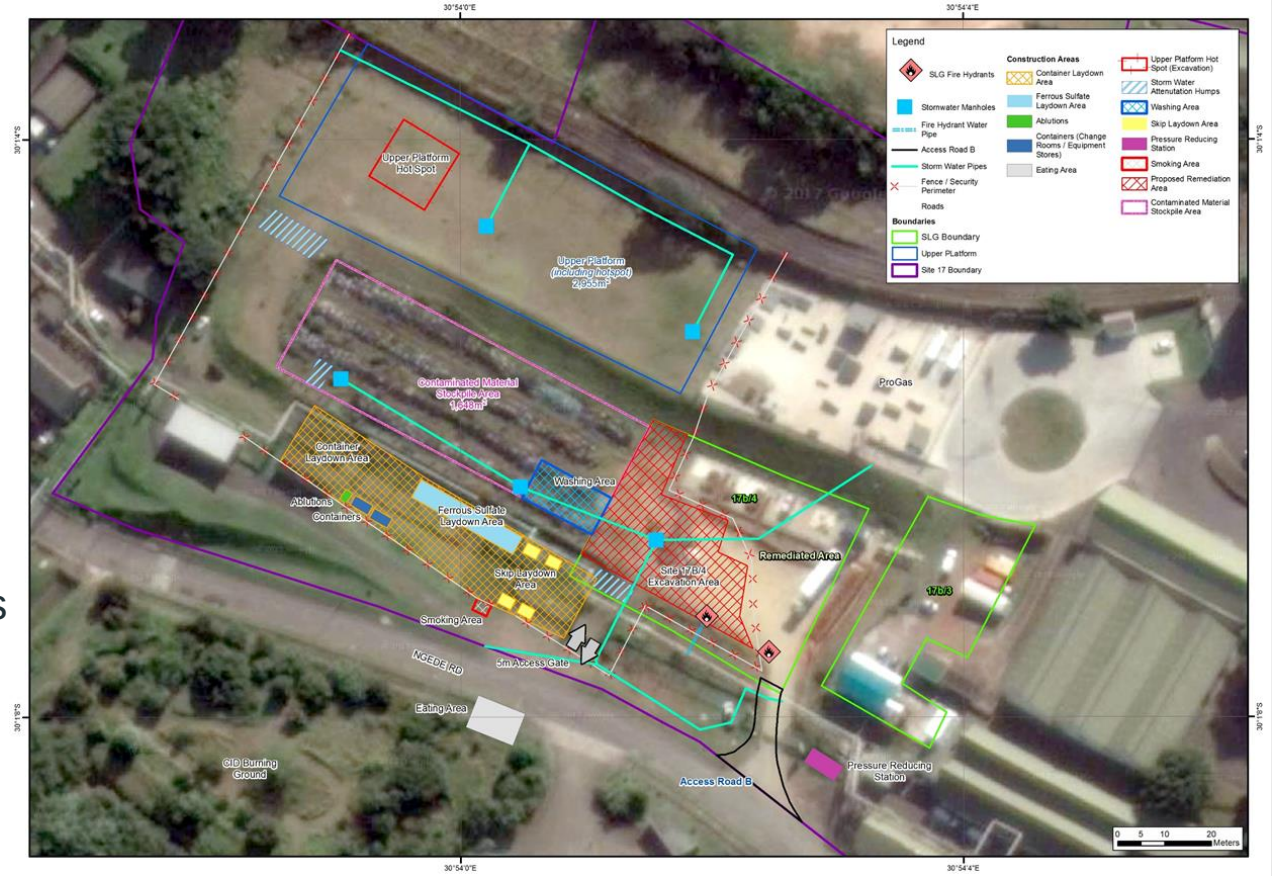
- Reduce arsenic leachability from soils
- Prevent soil migration and direct exposure
- Maximum Permissible Leachable As Concentration:
    - Uncapped Areas : < 2.25 mg/L
    - Capped Areas : < 22.5 mg/L

**Achieved through:**

- Chemical treatment, capping and stormwater control

# Site Establishment

- Lay down areas, offices, stores, ablutions, skips, plant
- Fencing
- Air & PM Monitoring
- Storm Water Controls
- Communication with surrounding land users



# Ferrous Sulfate Delivery


# 2017 Phase II Remediation






#DurbanFloodsRelief

THE MERCURY appeals to readers to donate non-perishable food and blankets for distribution to flood victims. Drop off your donations at the Independent Media building, 18 Osborne Street, Greyville, Durban.

THE MERCURY
GET A HEAD START
WEDNESDAY, OCTOBER 11, 2017
WITH BUSINESSREPORT



Dbn 13/21
Pmb 7/19
SEE PAGE 27

# STORM HAVOC IN KZN

- At least 8 dead, 9 missing
- Vehicles submerged
- Southern KZN hit hard

Bernadette Wolhuter

VIOLENT storms – and the strong wind, rain and hail they brought with them – left a trail of devastation in Durban and parts of the province yesterday.

At least eight people were killed and nine people are believed to be missing.

The southern regions were among the worst affected.

Robert McKenzie from KZN EMS said a 12-year-old boy died after he was swept away in a stream in Izingolweni, inland from Port Shepstone, and confirmed he was aware of at least four deaths.

Police Search and Rescue units were at Prince Mshiyeni Memorial Hospital in uMlazi where two people were killed when a wall collapsed.

Police were also in Old Main Road in Isipingo where one person died after the vehicle he was in became flooded.

In the Durban CBD, the SAPS attended the scene where a toilet wall collapsed, leaving one person dead.

Several private ambulance services raced to Rotterdam Road, in the Bayhead area, where a former police officer was crushed to death when a container fell on his car.

Rescue Care's Garrith Jamieson

The N2 highway near the old Durban airport was flooded yesterday morning and flooded vehicles were stuck for hours.

A container ship blocks the entrance to the harbour. Gale force winds blew the ship sideways as it was leaving

Will not drive, says expert

# 2017 Phase II Remediation



# 2017 Phase II Remediation





# 2017 Phase II Remediation





# Confirmatory Sampling Plan

## Stockpiles

| Remediation Target Levels (SRK Report 498676/3, January 2017) | | |
|---|---|---|
| **Criteria** | **Leachable Arsenic (µg/L)** | |
| Remediation Target Level for Unpaved Areas | 2 250 | - |
| Remediation Target Levels for Paved Areas | 22 500 | - |
| **Results of Analyses** | | |
| **Sample Number** | **Sample Date** | **Leachable Arsenic (µg/L)** | **pH** |
| CS1+CS2 | 03/11/2017 | <2.5 | 5.57 |
| CS3+CS4 | 03/11/2017 | 2.6 | 7.24 |
| CS5+CS6 | 03/11/2017 | <2.5 | 6.92 |
| CS7+CS8 | 03/11/2017 | <2.5 | 4.99 |
| CS9+CS14 | 03/11/2017 | <2.5 | 4.70 |
| CS10+CS11+CS12+CS13 | 03/11/2017 | <2.5 | 7.34 |
| CS15+CS16 | 03/11/2017 | <2.5 | 3.88 |
| CS17+CS18 | 03/11/2017 | <2.5 | 7.46 |
| CS19+CS24 | 03/11/2017 | <2.5 | 4.76 |
| CS20+CS21+CS22+CS23 | 03/11/2017 | <2.5 | 4.89 |
| CS25+CS26+CS27 | 03/11/2017 | <2.5 | 4.80 |
| CS28+CS29 | 03/11/2017 | <2.5 | 4.39 |
| CS30+CS31+CS32 | 03/11/2017 | <2.5 | 4.40 |
| CS33+CS34 | 03/11/2017 | <2.5 | 3.54 |
| CS35+CS36 | 06/11/2017 | 8.5 | 7.01 |

Upper Platform Hotspot &

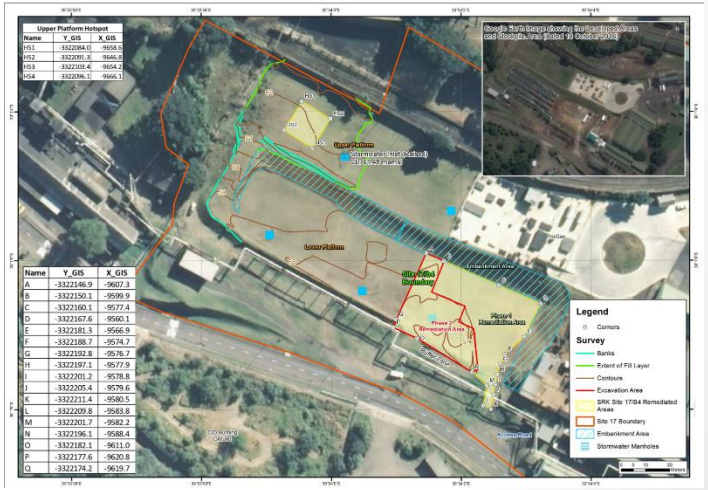
Development Footprint

| Rmediation Target Levels (SRK Report 498676/3, January 2017) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Criteria | | | | Leachable Arsenic (µg/L) | | | |
| Remediation Target Level for Unpaved Areas | | | | 2 250 | | | |
| Remediation Target Levels for Paved Areas | | | | 22 500 | | | |
| **Results of Analyses - Upper Platform Hotspot** | | | | | | | |
| **Confirmatory Sample Number** | **Subsample Localities** | **Sample Depth (m)** | **Sample Date** | **Leachable Arsenic (µg/L)** | | | **pH** |
| CH | CHA | 0.0 to 0.5 | 1-Nov-17 | <2.5 | | | 5.09 |
| | CHB | 0.5 to 1.0 | 1-Nov-17 | <2.5 | | | 4.62 |
| | CHC | 1.0 to 1.5 | 1-Nov-17 | <2.5 | | | 5.42 |
| **Results of Analyses - Excavation Site 17b4** | | | | | | | |
| **Confirmatory Sample Number** | **Subsample Localities** | **Sample Depth (m)** | **Sample Date** | **Treatment Round 1** | | **Treatment Round 2** | |
| | | | | **Leachable Arsenic (µg/L)** | **pH** | **Leachable Arsenic (µg/L)** | **pH** |
| CE1 | CE1A to CE1H | 0.0 to 0.5 | 13-Nov-17 | 12 | 6.49 | - | - |
| | | 0.5 to 1.0 | | 14.2 | 4.89 | - | - |
| CE2 | CE2A to CE2H | 0.0 to 0.5 | 13-Nov-17 | 2 409 | 7.49 | 74.4 | 6.91 |
| | | 0.5 to 1.0 | | 8 726 | 7.63 | 216.7 | 7.28 |
| CE3 | CE3A to CE3H | 0.0 to 0.5 | 13-Nov-17 | 23.2 | 6.49 | | - |
| | | 0.5 to 1.0 | | 98.1 | 7 | - | - |
| CE4 | CE4A to CE4H | 0.0 to 0.5 | 13-Nov-17 | <2.5 | 5.97 | - | - |
| | | 0.5 to 1.0 | | 16.5 | 7.04 | - | - |
| CE5 (Stockpile of material that did not fit back into the excavation | CE5A to CE5I | NA | 13-Nov-17 | 11 | 6.33 | - | - |

Note
**Red highlighting** – indicates reported leachable arsenic concentrations that exceeded the remediation target level for unpaved areas

# Dec 2017 Phase II Remediation Close Out





# Project Achievements

- The **entire upper platform** has been released for **re-development**
- The tenant on the **lower** platform **completed** their development **and started operating** within **months**
- The **site** is once again **generating revenue**
- **Risks** to **human health & environment** have been **successfully mitigated**

- **Project:**
  - **Time frames** were **met** even with **development pressures**
  - Project **completed** well **within budget**
  - **No soil** was **sent to landfill**

- **Watch this space:**
  - **Phase 3 Remediation**: Remainder of the **Lower Platform**

- **Treatment with ferrous sulfate** : **simple and effective** way to remediate arsenic impacted sites and
- **Does not require** any inaccessible technologies or equipment

- **However:**
  - Arsenic remains **bound to the soil** in the form of **insoluble precipitates**
  - **Future site use**, and **long term management** of sites to be remediated in the manner should be considered **before** this treatment approach is adopted

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