Evolution of Waste Rock Management and Cover System Design at BHPBilliton Iron Ore, Mt Whaleback Operations Western Australia

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bhpbilliton

MEND ML/ARD Workshop
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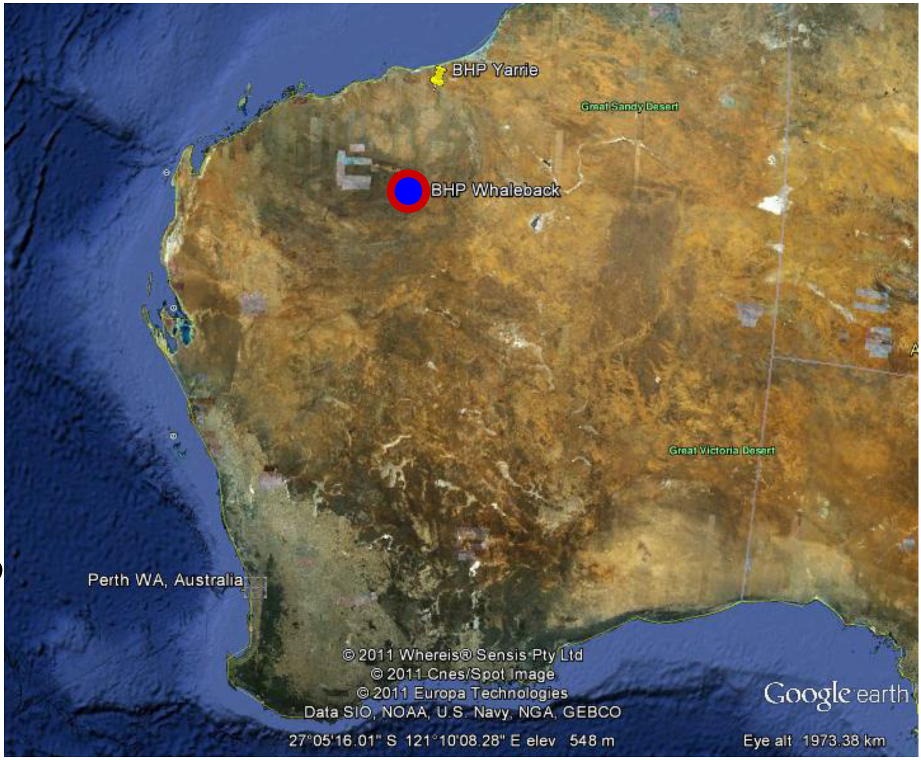
O'Kane Consultants
Integrated Geotechnical Engineering Services
Specialists in Unsaturated Zone Hydrology

Discussion Points

- General Background
- Evolution of Conceptual Models for Performance
  - Cover Systems
  - Waste Rock Management
- Key Points

Background

- *Site is approximately 1,200 km N-NE of Perth next to Newman, WA*
- *Pilbara Region of WA – Iron Ore Rich*
- *Deposit discovered in 1957*
- *2.5 billion year old Brockman (hematite) BIF deposits*
- *1967 – Mt Newman Mining with BHP project manager, commenced large-scale mining operations*
- *Mining commenced 1968*
- *Ore transported by rail to Port Hedland (420 km) for shipment to market*



BHP Billiton – Mt. Whaleback

- *Largest known continuous high grade iron ore deposit (hematite iron ore)*
- *Per annum:*
  - *~18 million wet tonnes of saleable product*
  - *~53 million tonnes of waste material*
- *15 to 25 years remain*
- *~3.3 billion tonnes of waste in OSAs*

- *Carbonaceous and pyritic shale units are significantly Net Acid Generating and certain units are susceptible to spontaneous combustion*
- *Nodular and disseminated pyrite:*
  - *~15% of waste volume*
- *Oxidized Overburden (BIF): barren*

Climate Background

- *Significant rainfall events over short periods*
- *High potential for evaporation*

- ***Average Annual:***
  - ***Rainfall: ≈ 310 mm***
  - ***PE: ≈ 3,000 mm***
- ***Distinct wet – dry seasons***
  - ***December to March: ~ 90%***
  - ***Cyclonic activity from coast***

"First" Evidence of ARD

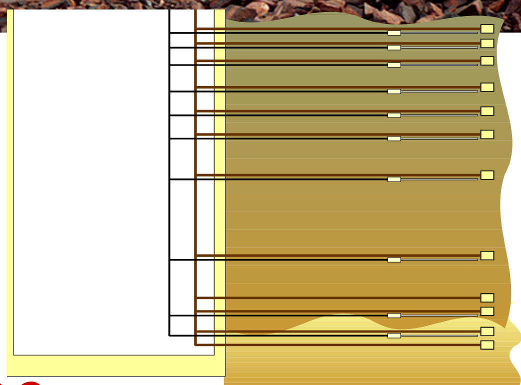
- *Cyclone Bobby 1995*
  - *~ 500 mm*
  - *Wettest on Record*
- *Uncontrolled release to Whaleback Creek*
  - *Low pH (~2)*
  - *Relatively low acidity*
- *Source of Toe Seepage?*

Cover Systems – Conceptual Models Over Time

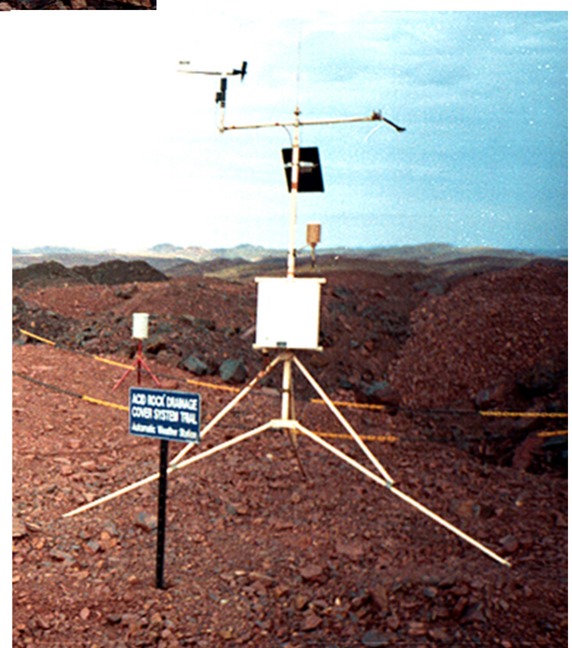
- **Late 2000s** - S&R Cover System.... Slopes and Flat Upper Surface
  - *Clear understanding for the need to rely on cover systems for long-term management of seepage from OSAs*
  - *Establishment of sustainable vegetation*
  - *Much more extensive understanding for natives species rooting and transpiration characteristics required*
  - *Much higher level of confidence with required cover thickness*
  - *Linking net percolation rates to impacts to the receiving environment*

W22 Test Plots and Monitoring (1997)

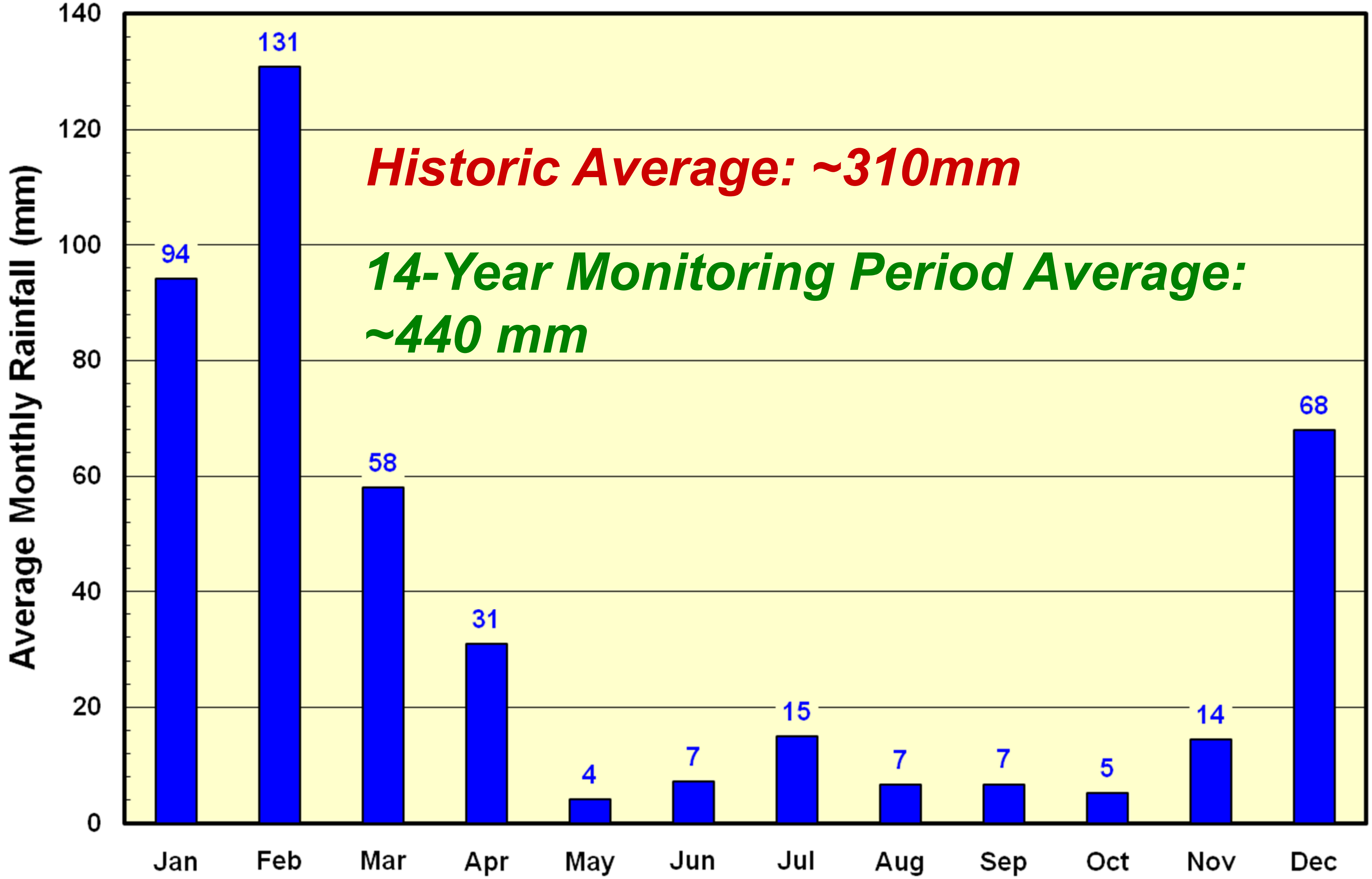
- Test Plot No.1 (2m) and No.2 (4m)
  - *ROM Inert Material – 1 ha*
  - *Relatively Horizontal Block Dump Surface*
- Test Plot No.3 (2m)
  - *ROM Inert Material – 0.75 ha*
  - *Sloping Surface*



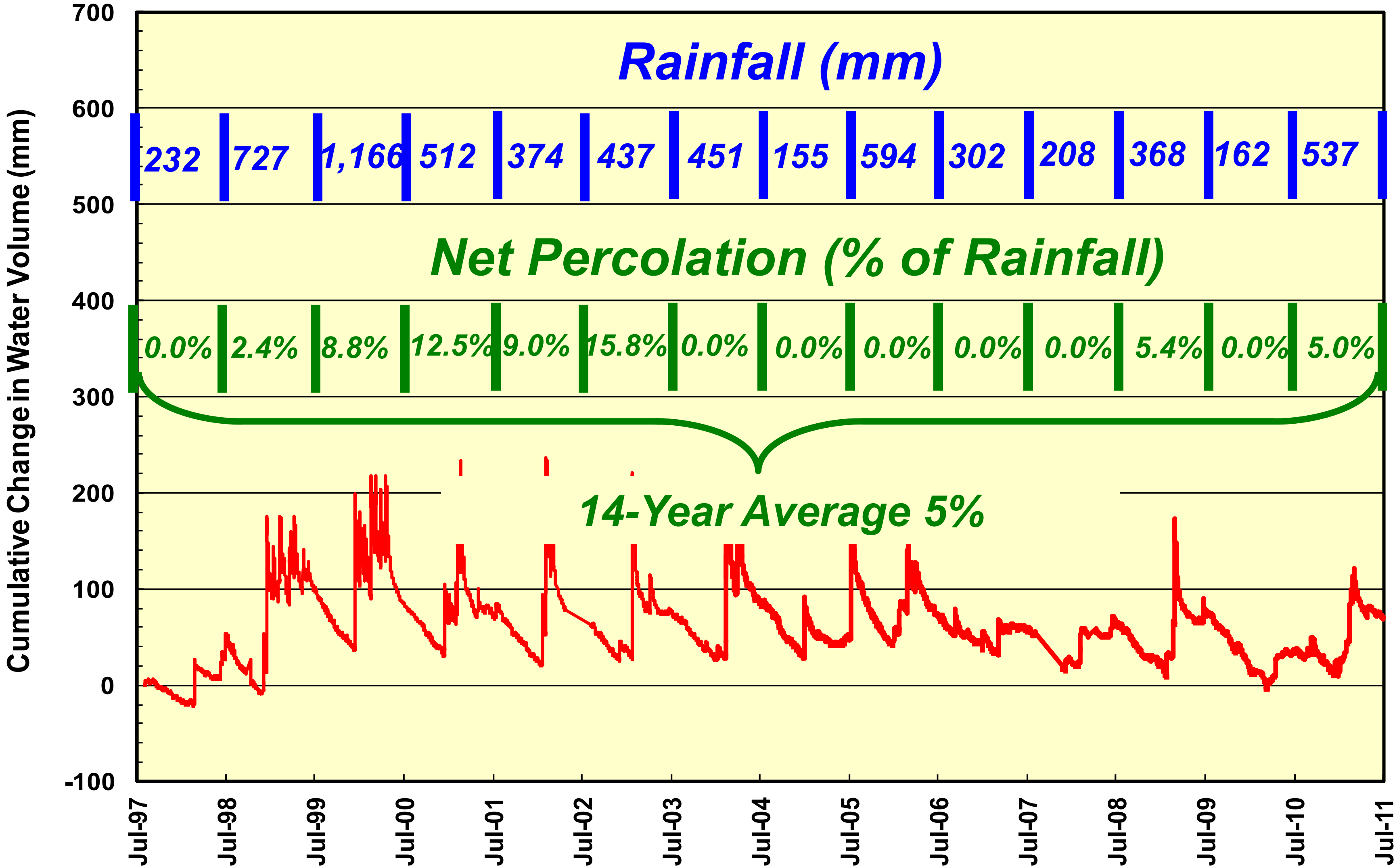
1996:
Predicted Net Percolation
1m cover: < 0.1%



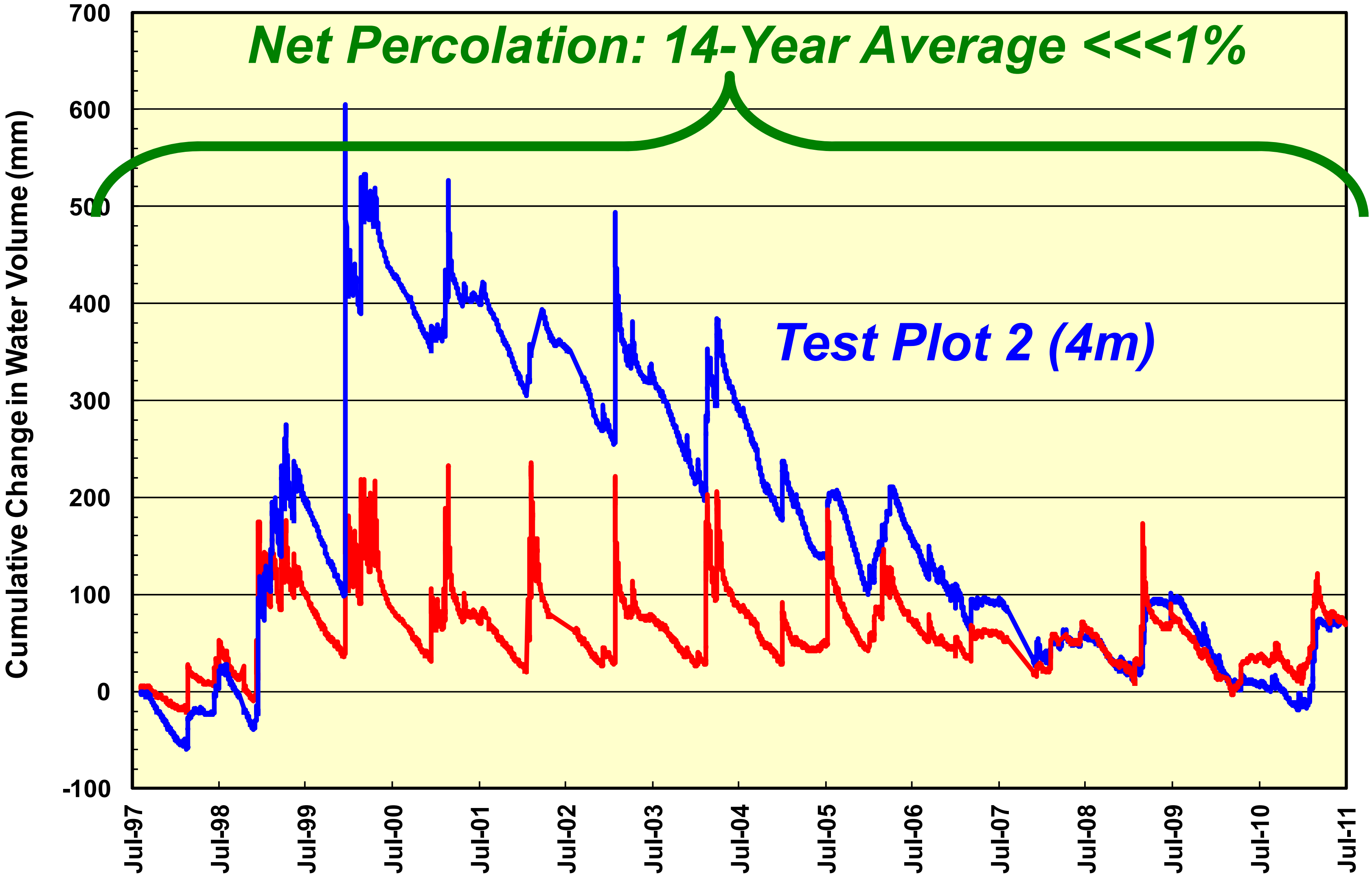
Rainfall: 14 year Monitoring Period



Measured Volume of Water – Test Plot 1 (2 m)



Measured Volume of Water – Test Plot 2 (4 m)



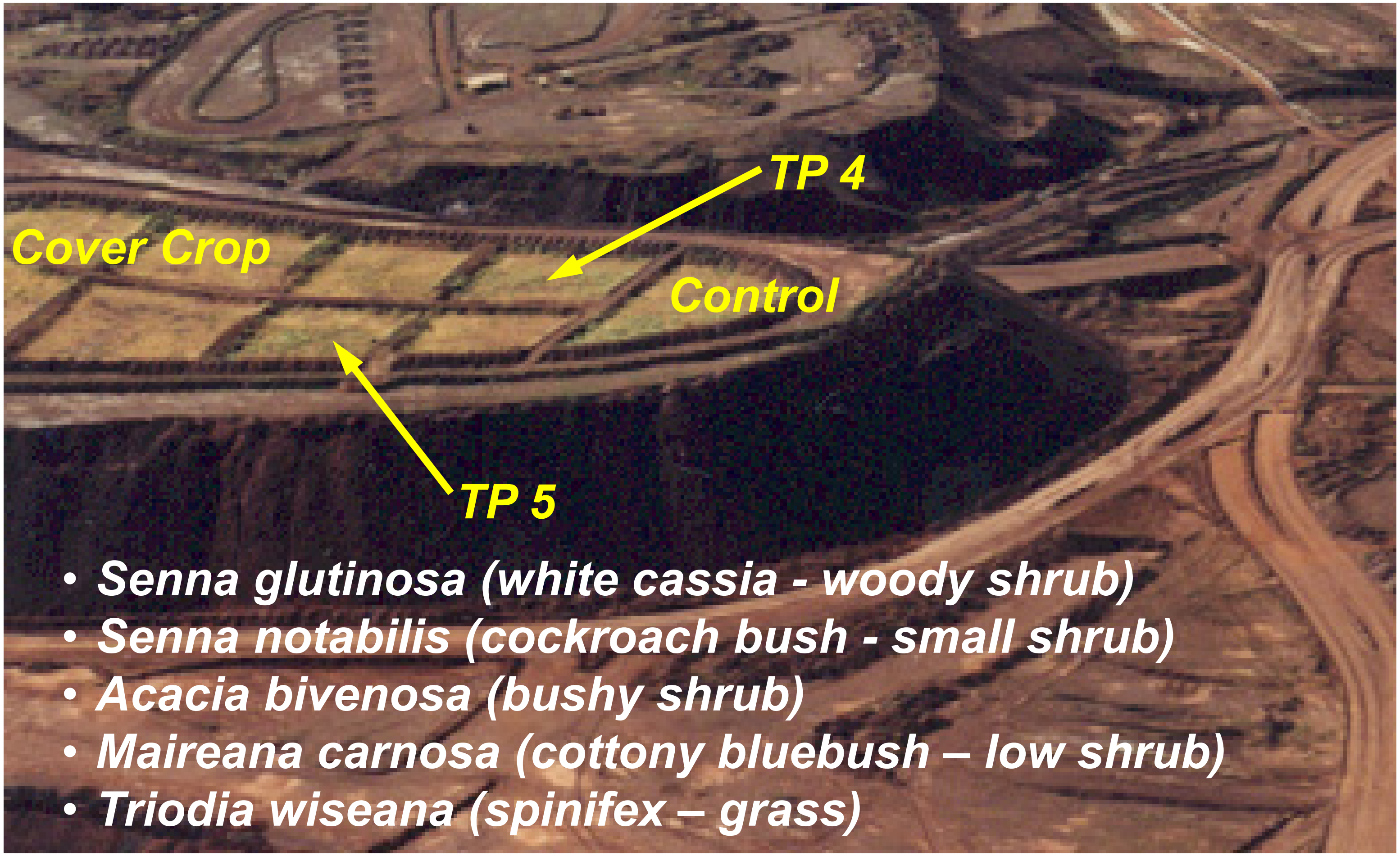
Transpiration Rates?

Vegetated
Field Trials

Rooting
and
Transpiration
Characteristics of
Native Species?

Bare Surface Field Trials and Control Sites

W29 Landform and Vegetation Trials (2000)



- *Senna glutinosa (white cassia - woody shrub)*
- *Senna notabilis (cockroach bush - small shrub)*
- *Acacia bivenosa (bushy shrub)*
- *Maireana carnosa (cottony bluebush – low shrub)*
- *Triodia wiseana (spinifex – grass)*

The "Vision"....a Reality

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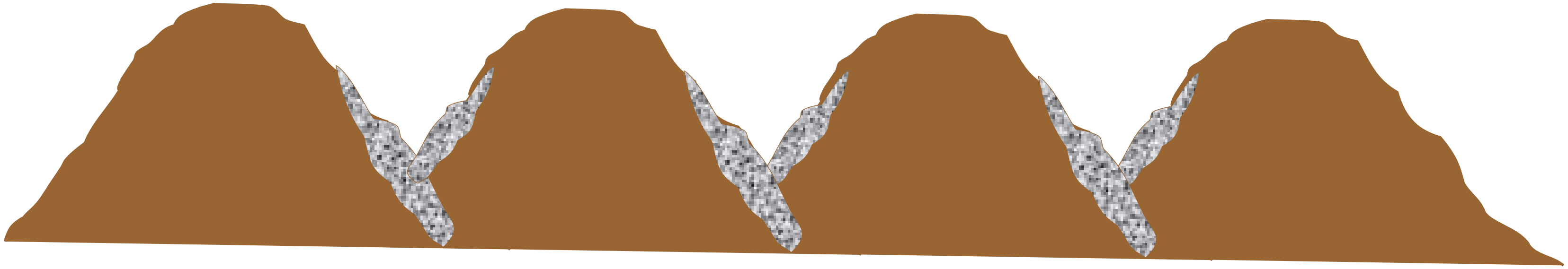
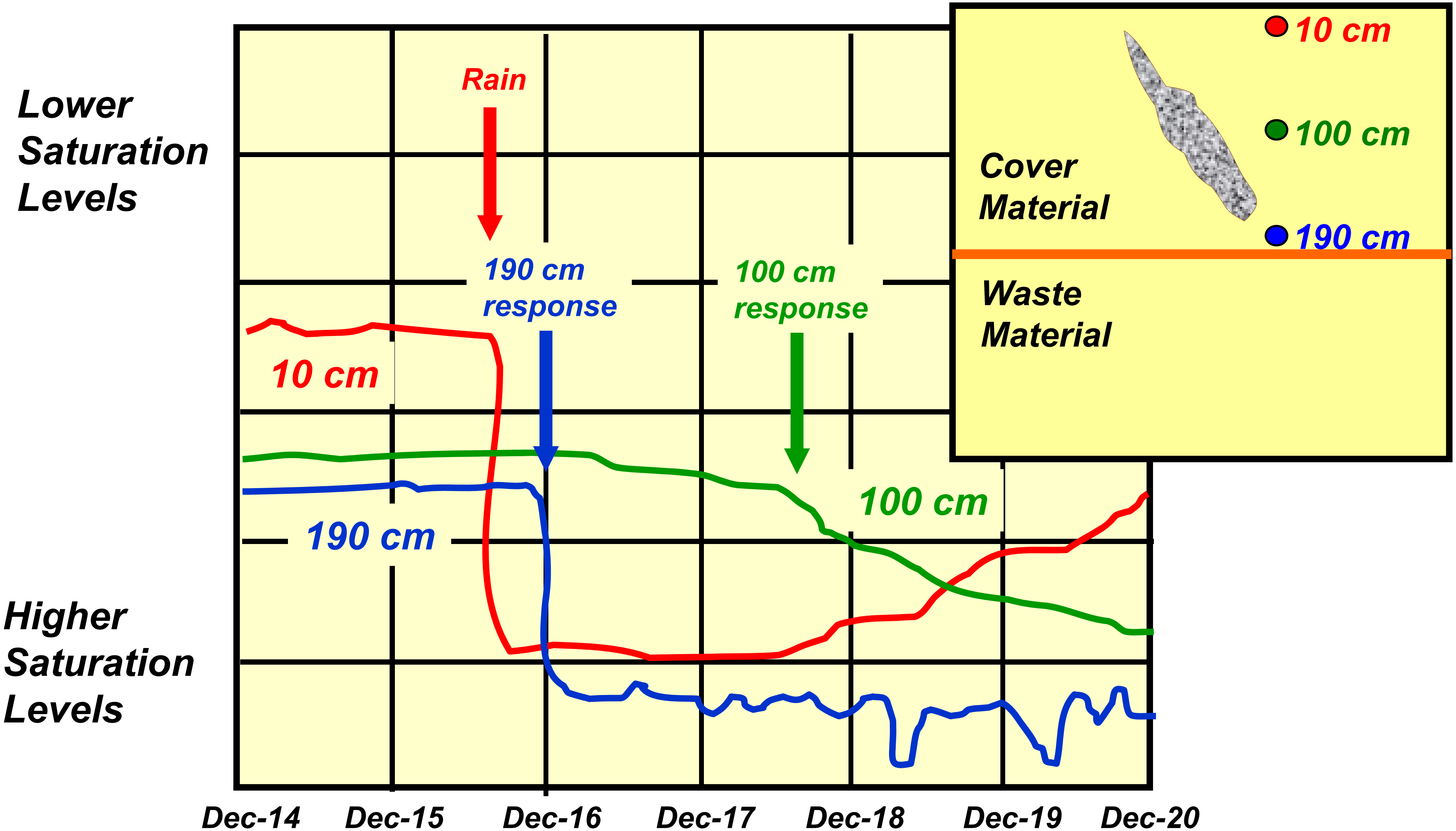
Construction and QA/QC

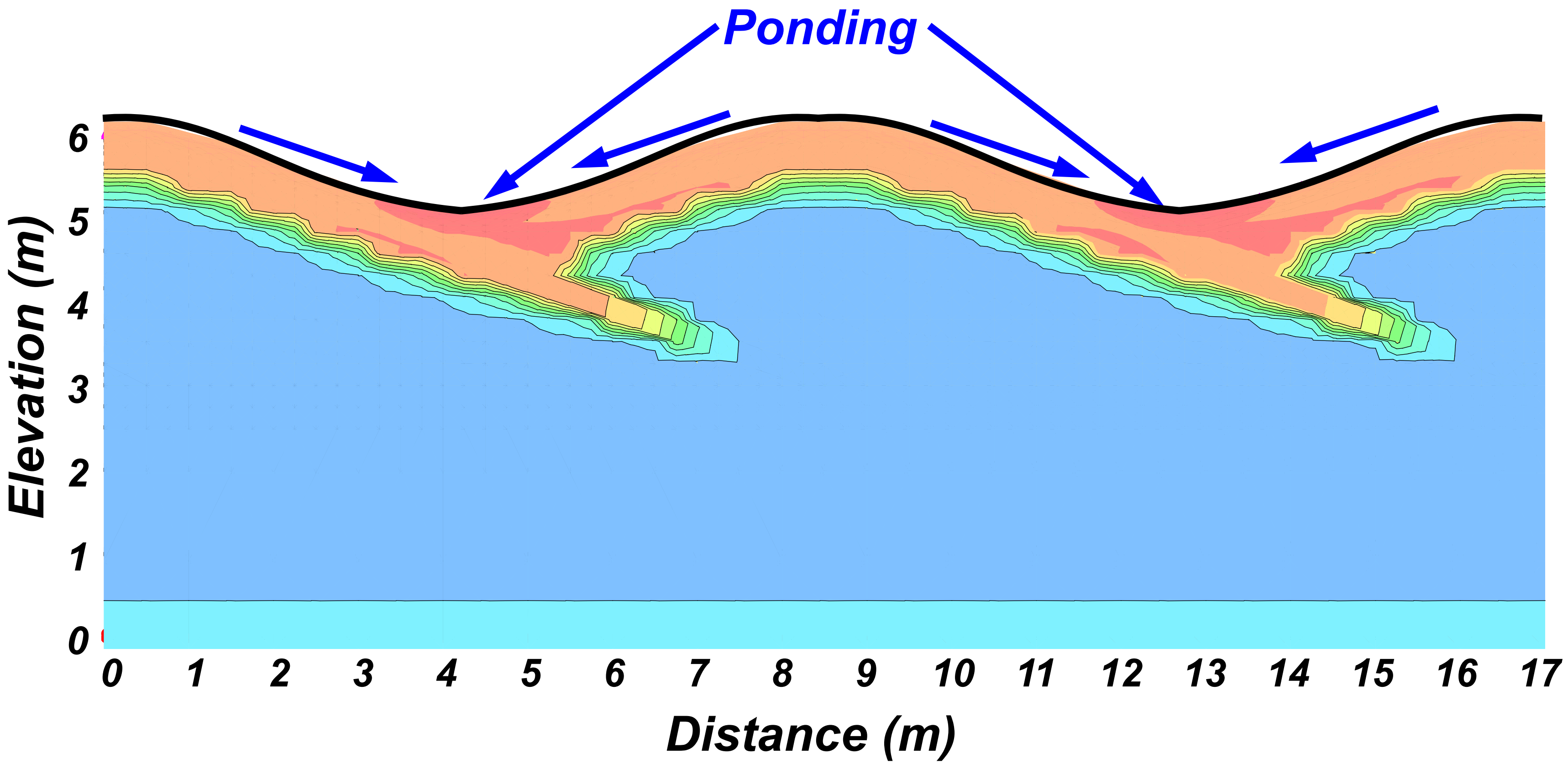


Near Surface Preferential Flow due to Segregation During Placement

Evidence of “Macro-Pore” Flow



2D Performance (bare surface)

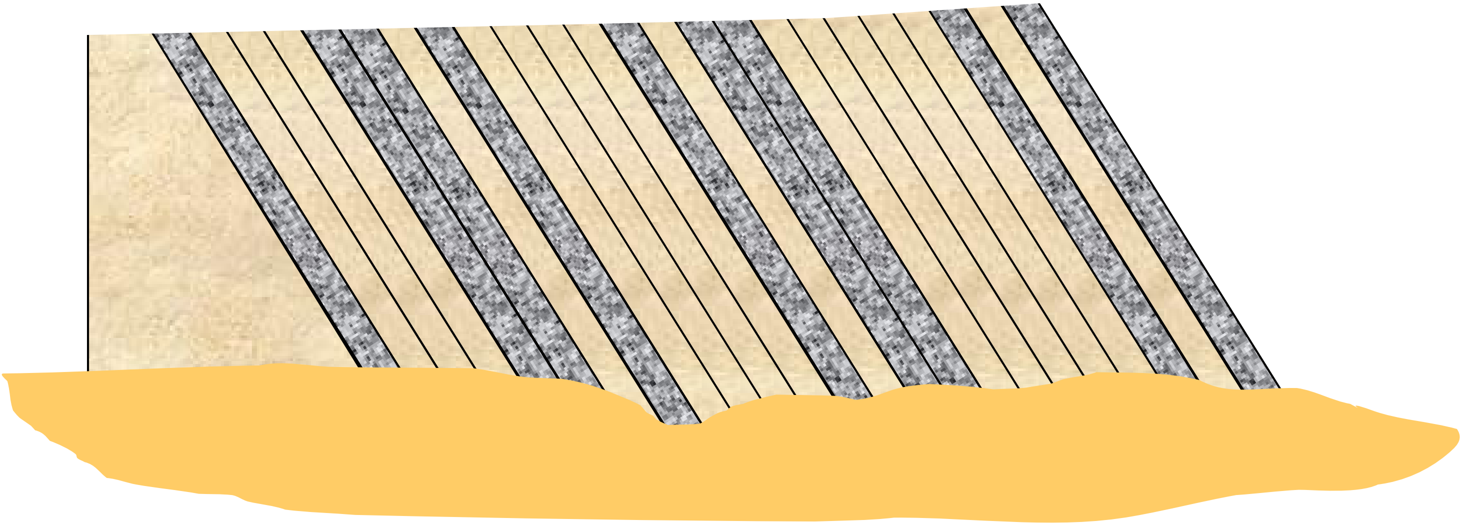


Waste Material Management – Conceptual Models Over Time

- Late 1990s - Short- and Medium-Term Strategies
  - ARD Management Catchment Scale = Evaporation Ponds
  - Introduction of Modular Mining Truck dispatch that incorporates waste material tracking
  - Encapsulation and raising of NAG waste above ground surface

- 2000s - Medium - and Long-Term Strategies
  - W40 Soak Area
  - Strategic placement of waste and covers approx. 5m thick
  - Reduction of long-term liabilities: cost and environmental

OSA Construction pre-1995



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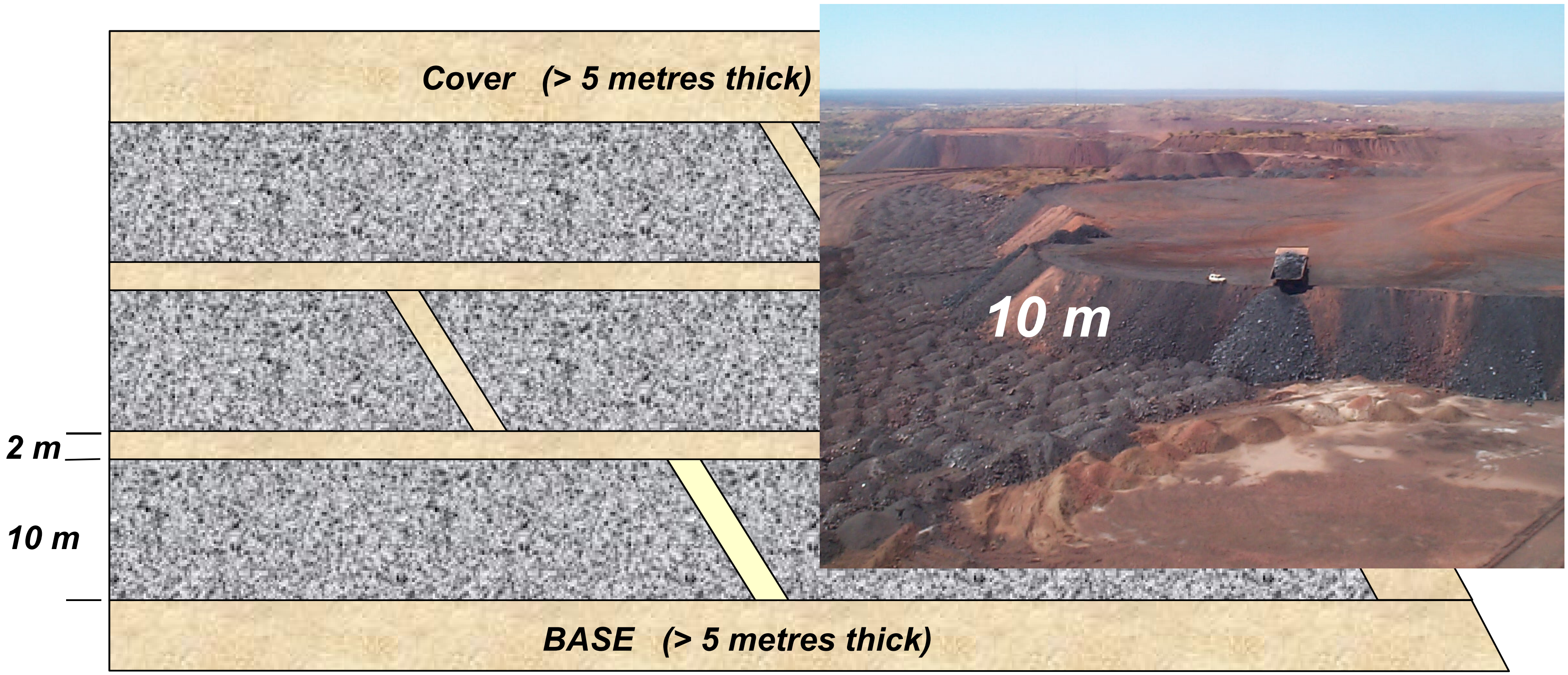
OSA Construction – 2000s

SIDES (> 5 metres thick)

Inert overburden (A Class)

NAG overburden (B and C Class)

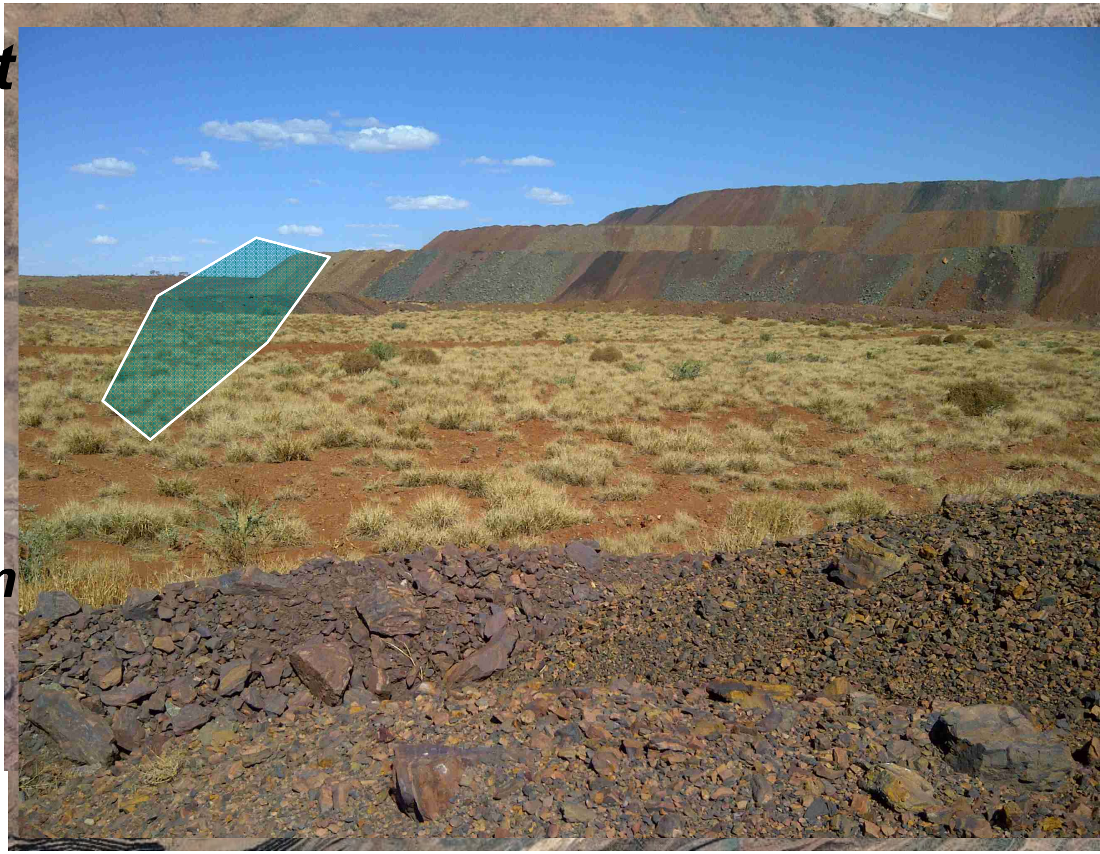


2010 – W40 Soak Areas

- *Combining learnings from OSA Management and Cover System Concepts Evolution*
  - *Extension of existing OSAs with Inert Waste*
  - *Wider berms separating paddocks*
  - *Sloped in case of surface berm failure*
  - *Larger, more irregular paddocks*
  - *Seeded with mix of native grass and shrubs*

Function

- *Capture and contain runoff from OSA Landform*
- *Prevent flow-through of seepage from surround catchment*
- *Aim is to decrease seepage from W19 to ARD dam*



Strategic Waste and Cover Placement

- *Integrated* OSA construction (*mine* planning) and *closure* planning
- 5m cover for all OSAs
- Implementation/planning for now = incremental cost i.e. *Reduced cost long term*
- Life of mine 15 - 25yrs

Key Points

- *Cover System Conceptual Models* **adapted to increased understanding of system function and requirements**
- ***Cover System Field Trial Program On-going***
  - ***High Intensity Rainfall Events have Strong Influence on Net Percolation Rates***
- ***Evolution of waste management philosophy on site***
  - ***Pre-1995: limited to simplest and cheapest placement of waste material at time of extraction***
  - ***Post-1995: increasing consideration for strategic planning that incorporates closure planning during operations***
  - ***Decreases long-term liabilities both financial and environmental***
- ***Future studies; large scale OSA trials to assess infiltration of meteoric waters into the Dump profile***

In Closing

Rain

Sun

Fire

Cover System Longevity