Numerical groundwater flow modeling at the historic Rum Jungle Mine Site, Northern Territory (Australia)

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Department of Mines & Energy

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Site Background

- The Rum Jungle mine site is a historic uranium mine located near Darwin, NT, Australia (subtropical)
- ARD from waste rock, tailings, and open pits caused significant metal loading & fish kill in East Finnis River
- Initial rehabilitation (by government) was completed in mid-1980s but metal loads to river have remained elevated (Ferguson et al., 2011)
- NT Department of Resources has been tasked with developing a new rehabilitation plan (2010-2013)

Study Objectives

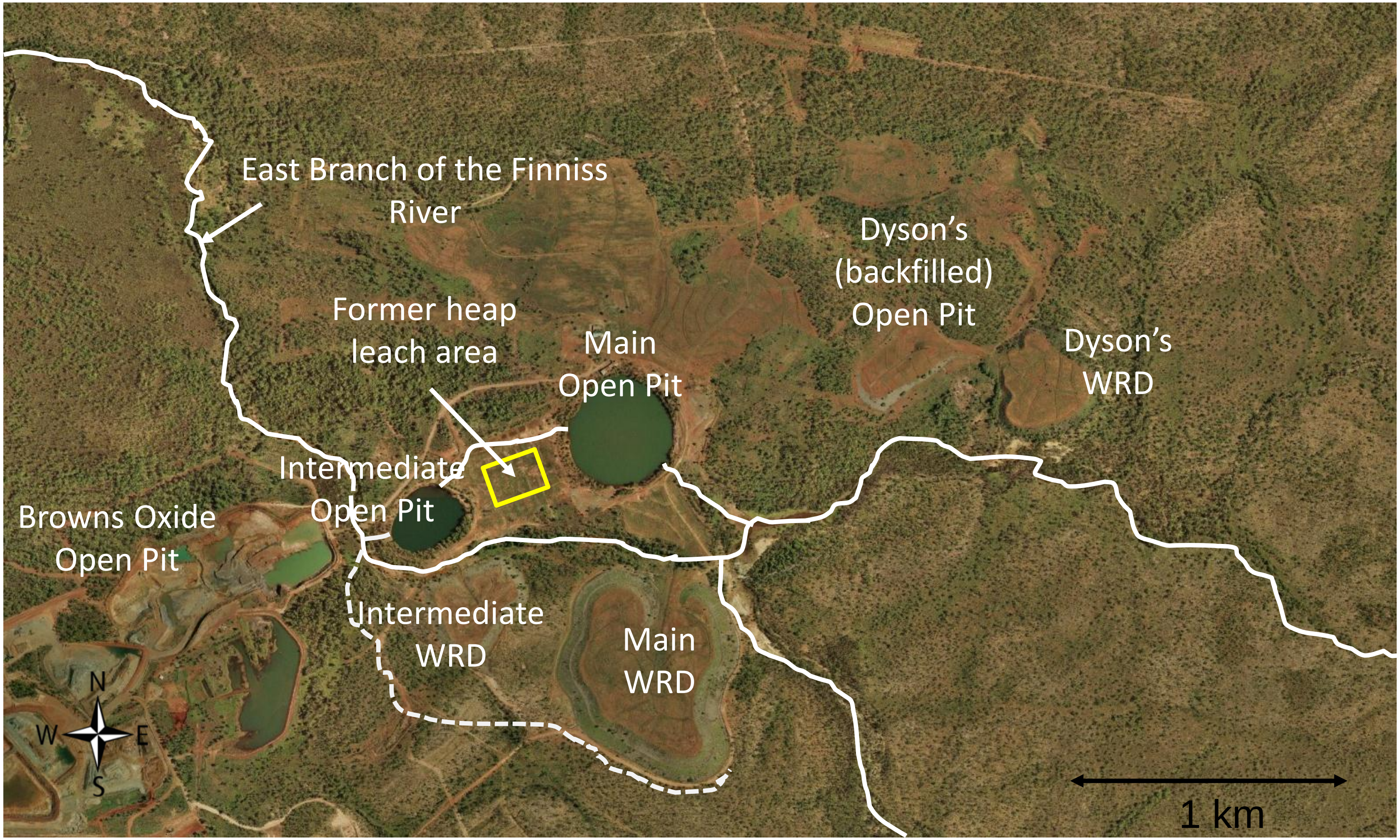
- RGC was retained by NT DoR to develop a 3D groundwater flow model for Rum Jungle mine site in order to:
  - Explain historic and current groundwater contamination on and offsite
  - Estimate seepage from different mine waste units (WRDs, backfilled open pits, Cu heap leach)
  - Estimate metal loading from different mine waste units to surface water (East Finnis River)
  - Evaluate different closure scenarios*

* Future work

Overview of Presentation

- Conceptual Model of GW Flow & Contaminant Transport
- Development & Calibration of Groundwater Flow Model
- Modeling Results
- Implications for Rehabilitation Planning
- Path Forward

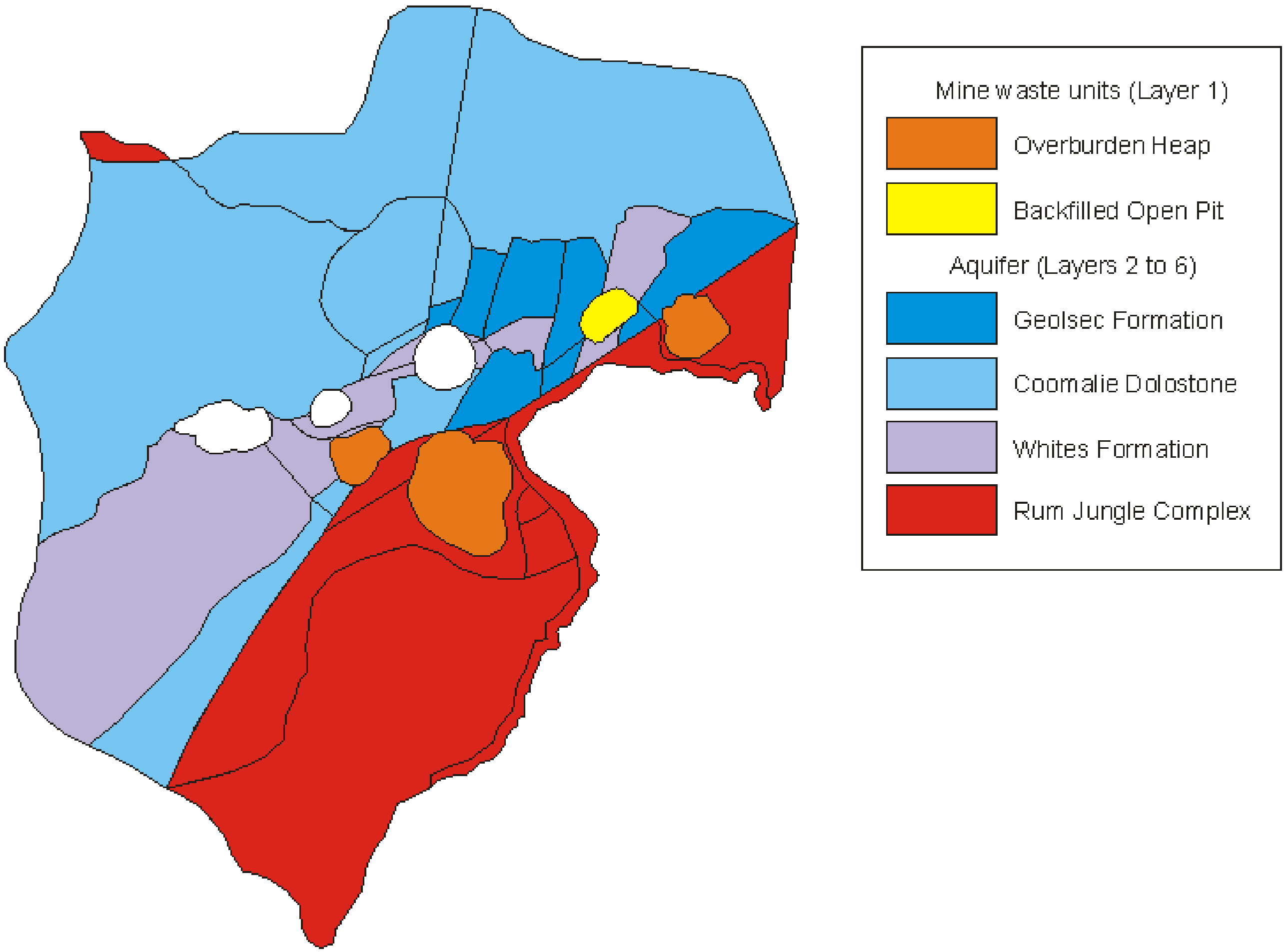
Site Layout



East Branch of the Finniss River
Former heap leach area
Main Open Pit
Dyson's (backfilled) Open Pit
Dyson's WRD
Intermediate Open Pit
Browns Oxide Open Pit
Intermediate WRD
Main WRD
N
W
E
S
1 km

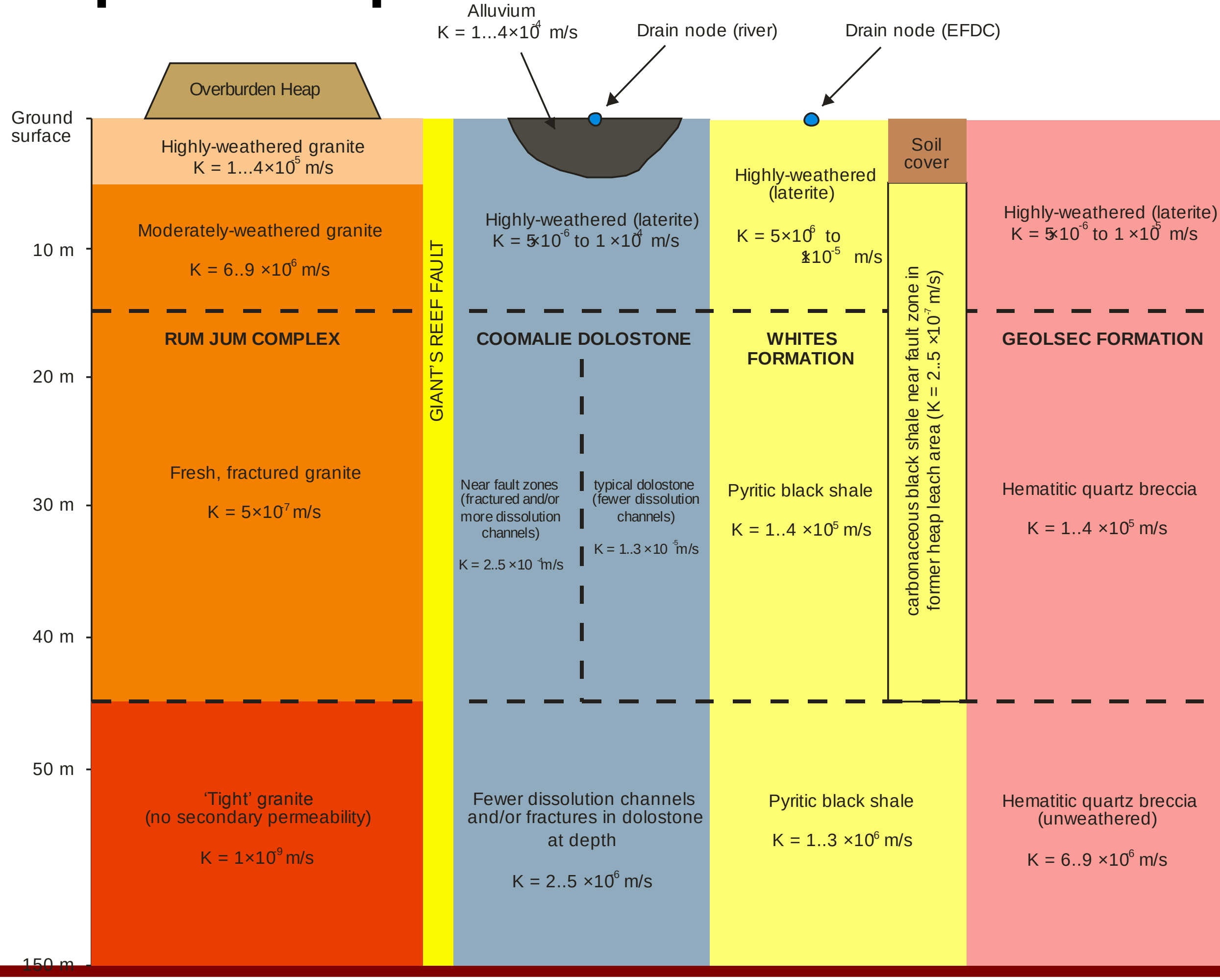
Conceptual Model

Hydrostratigraphic Units



Conceptual Model

Aquifer Properties



"Highly-weathered rock and alluvium"

Highly-weathered rock (laterite) from 0 to 15 m in undisturbed areas

Alluvium to 5 m near the East Finniss River and its tributaries

"Variable-weathered bedrock of the Mount Partridge Group"

15 to 45 m in undisturbed areas

5 to 45 m near the fault zone in the former heap leach area

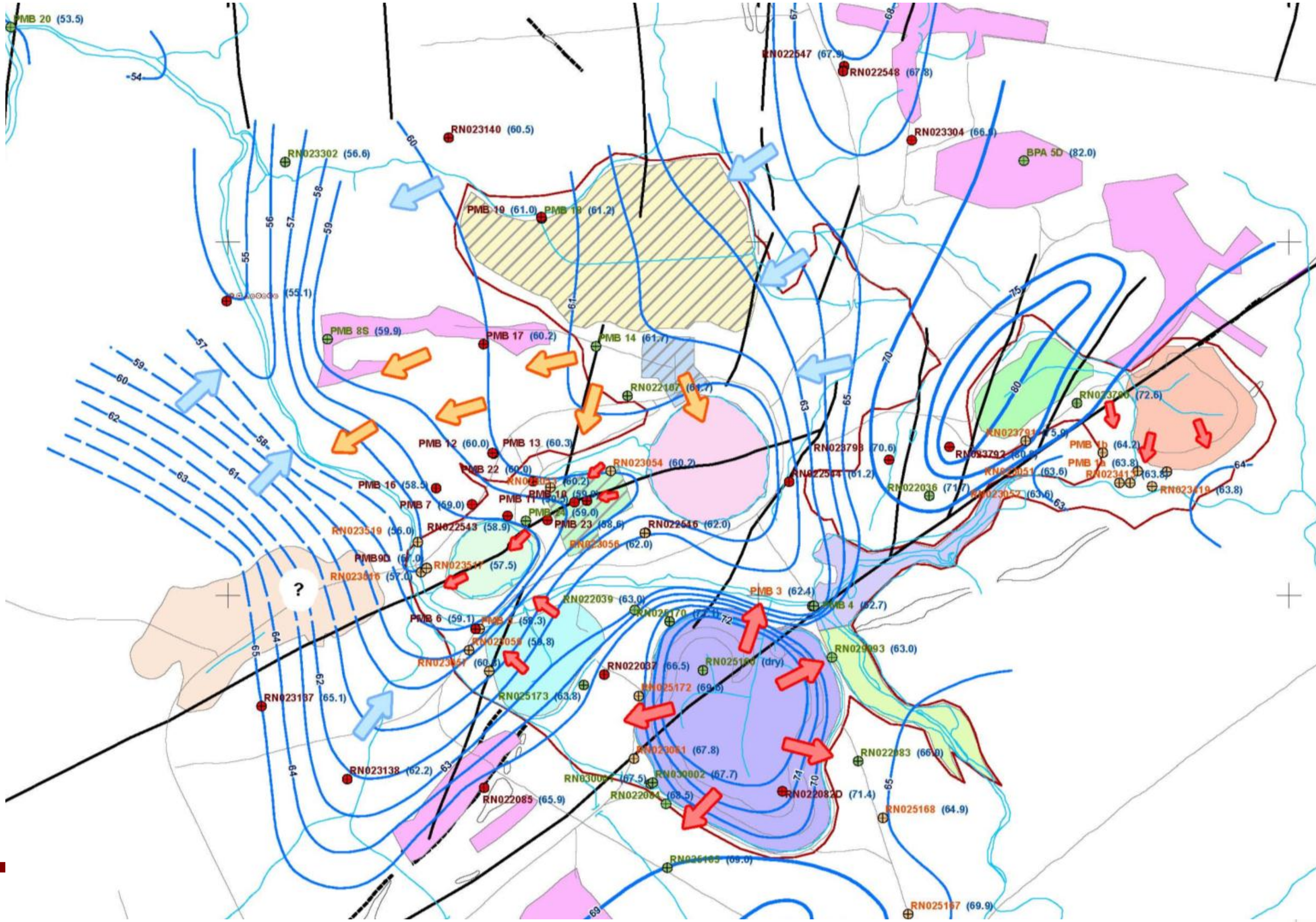
"Competent bedrock of the Mount Partridge Group"

45 to 150 m (bottom of model domain)

Lower secondary permeability at depth due to fewer fractures and/or dissolution channels

Conceptual Model

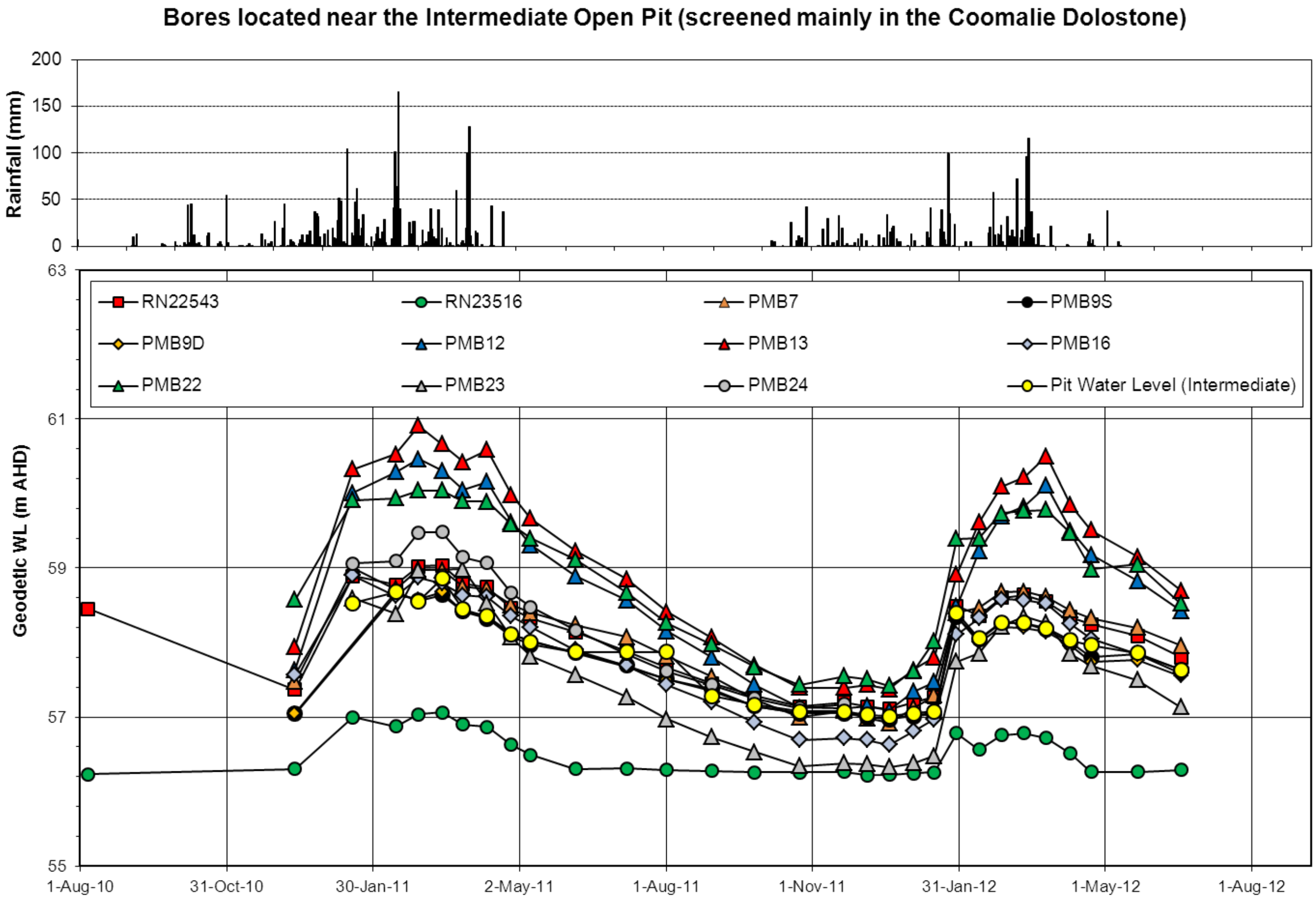
GW Flow & Contaminant Transport



1 km

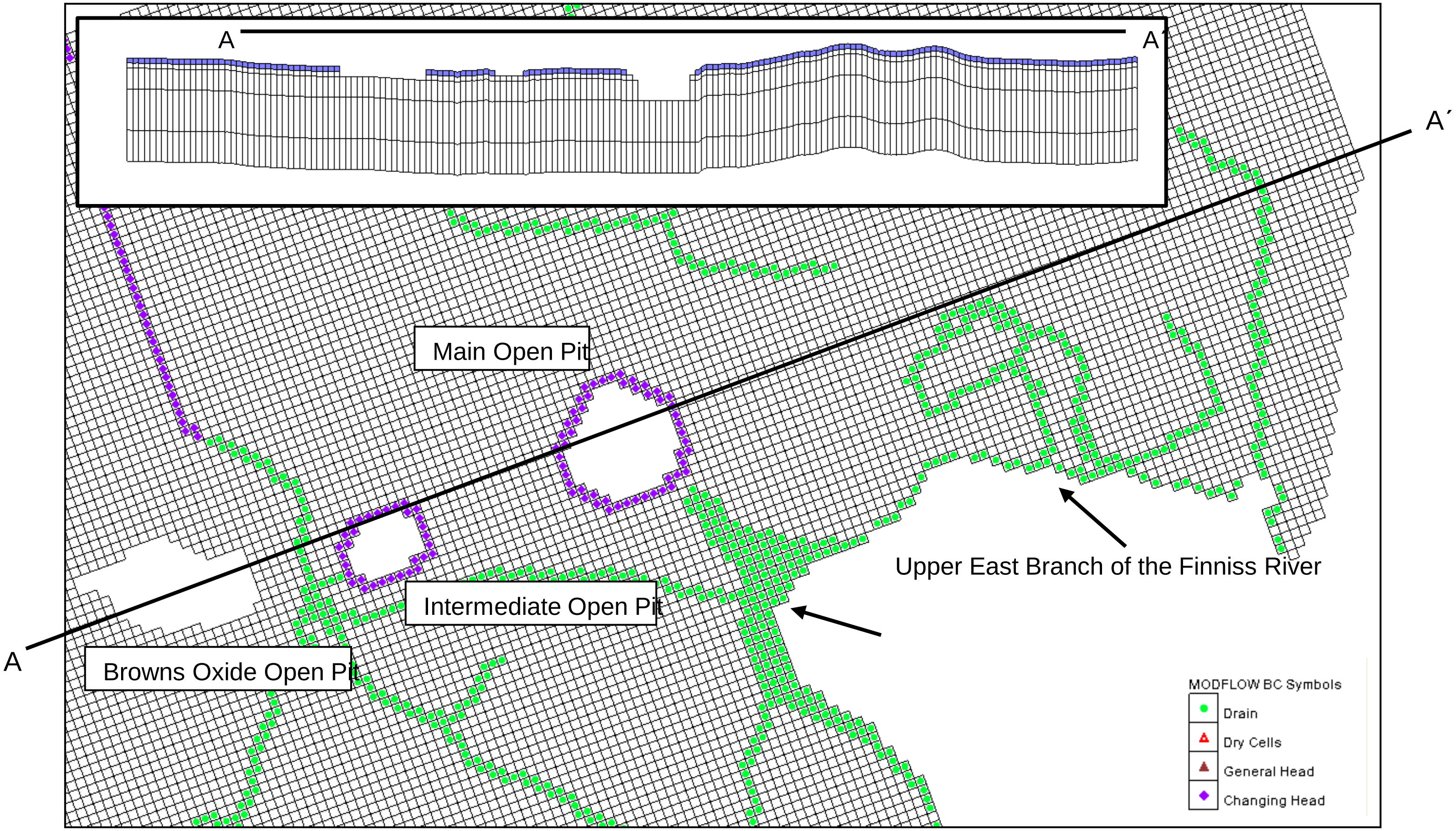
Conceptual Model

Seasonal groundwater levels



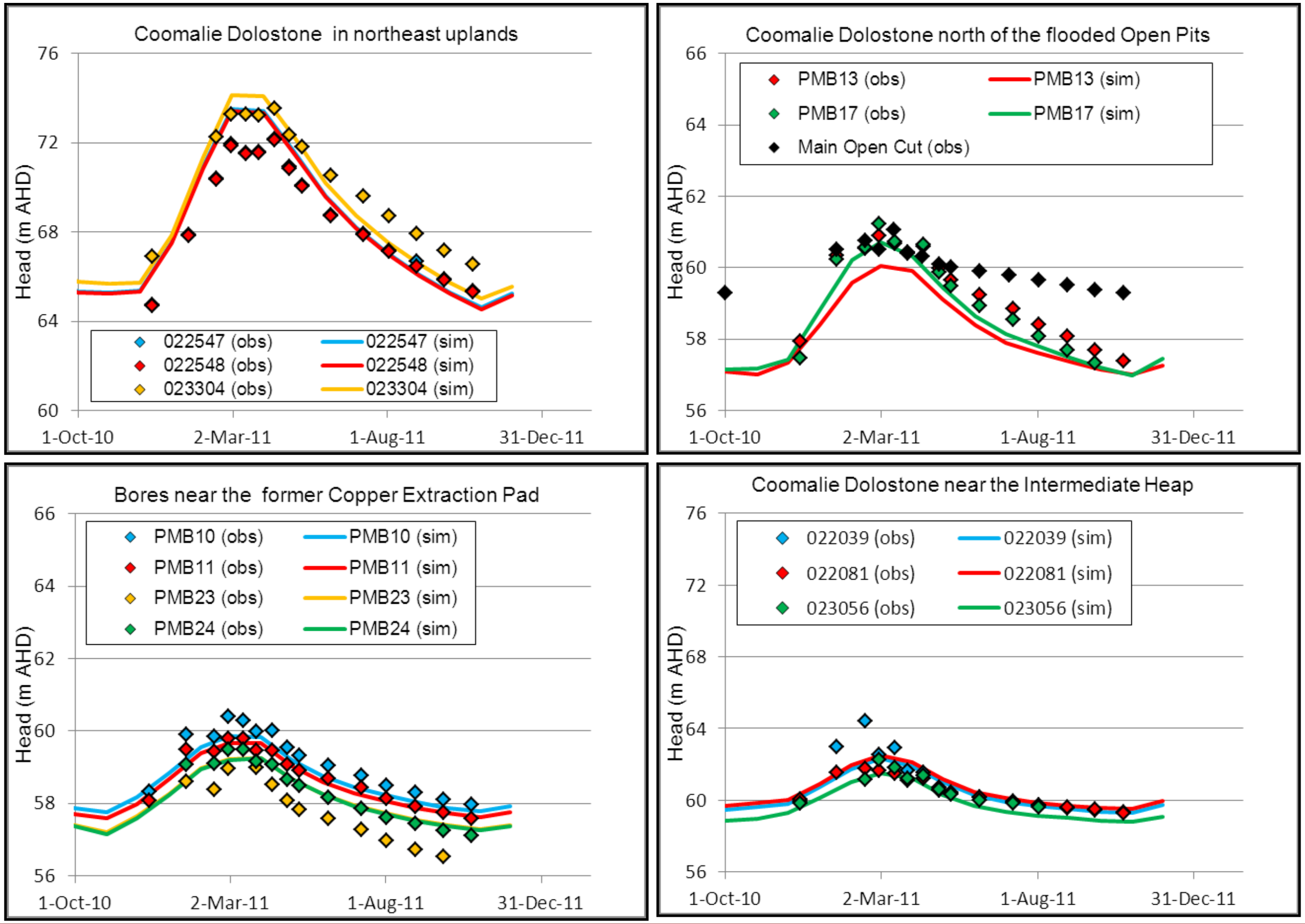
3D Groundwater Flow Model

Model Setup



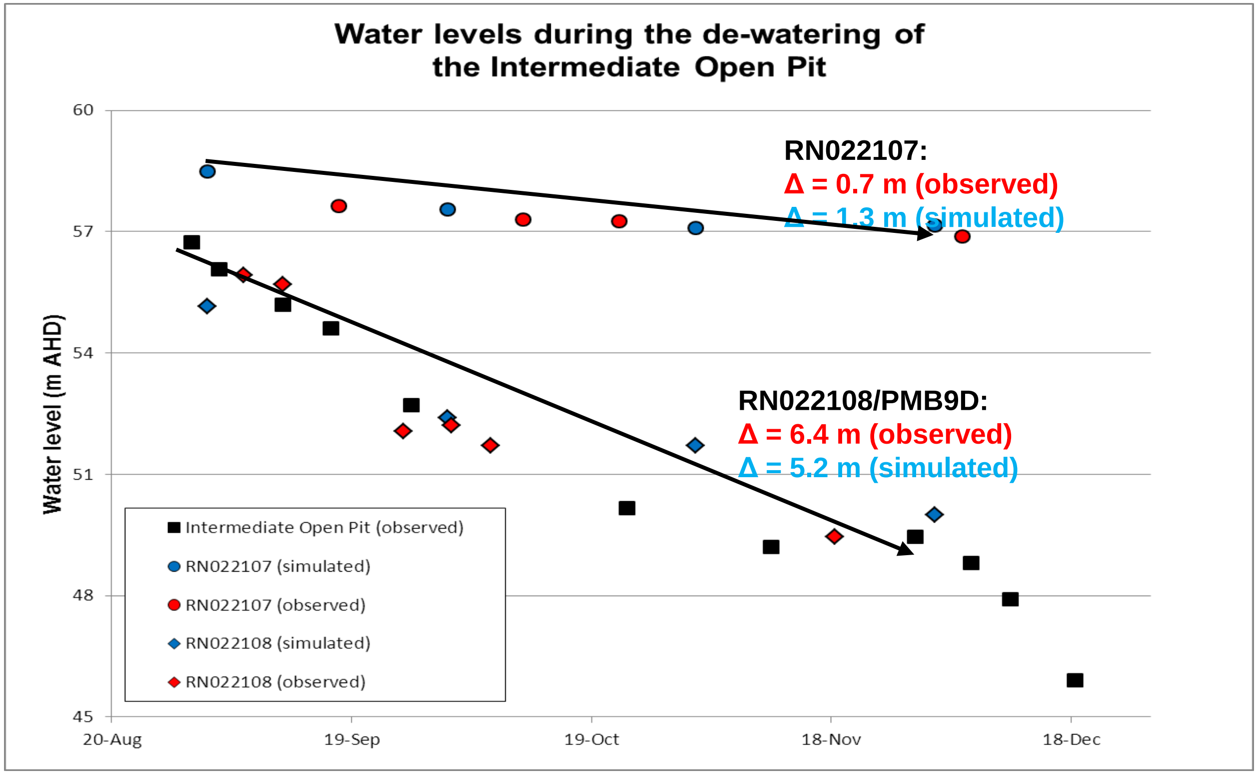
3D Groundwater Flow Model

Model Calibration



3D Groundwater Flow Model

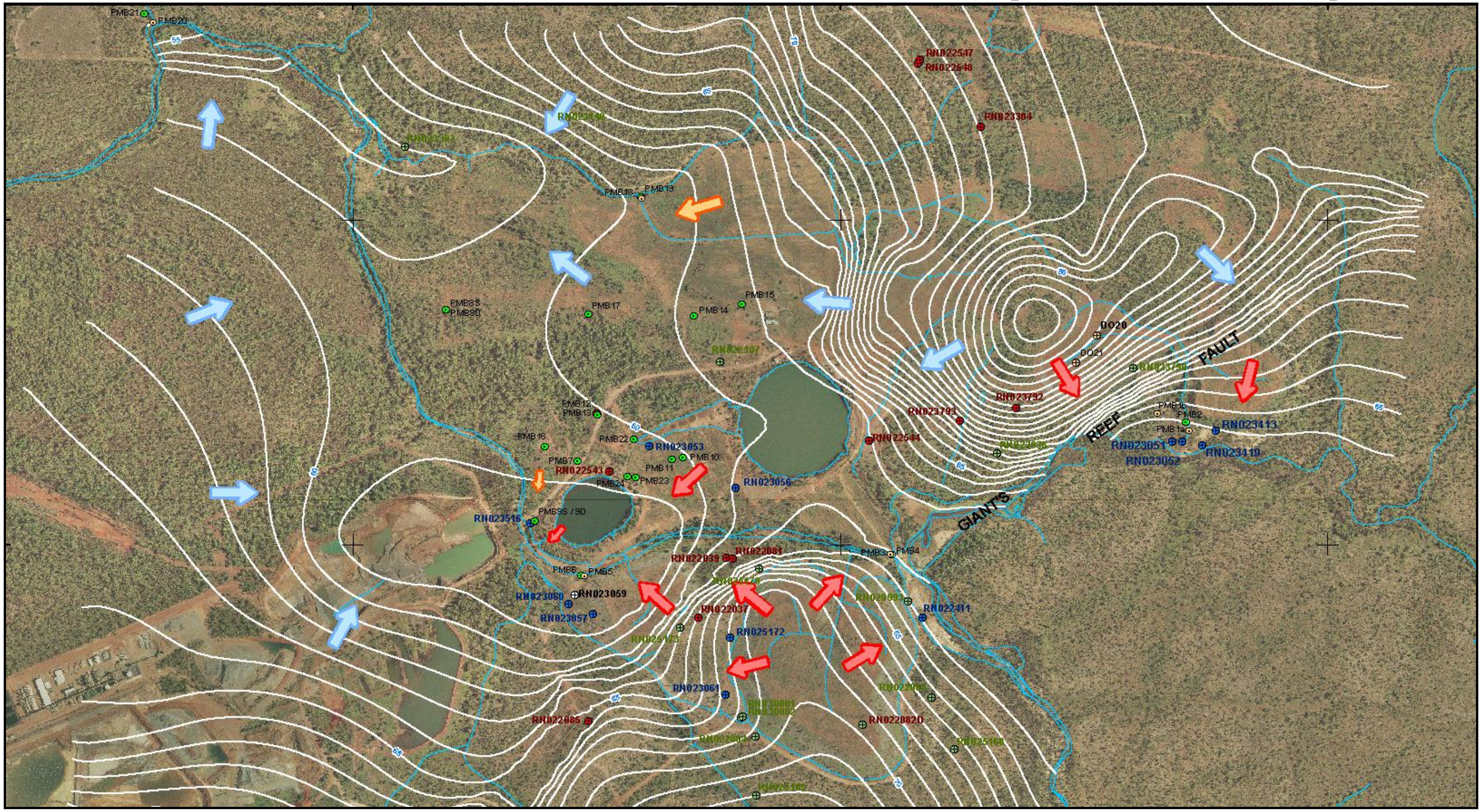
Model Verification



Simulating a de-watering trial conducted in 2008

Modeling Results

Simulated Groundwater Flow Field (Wet Season)



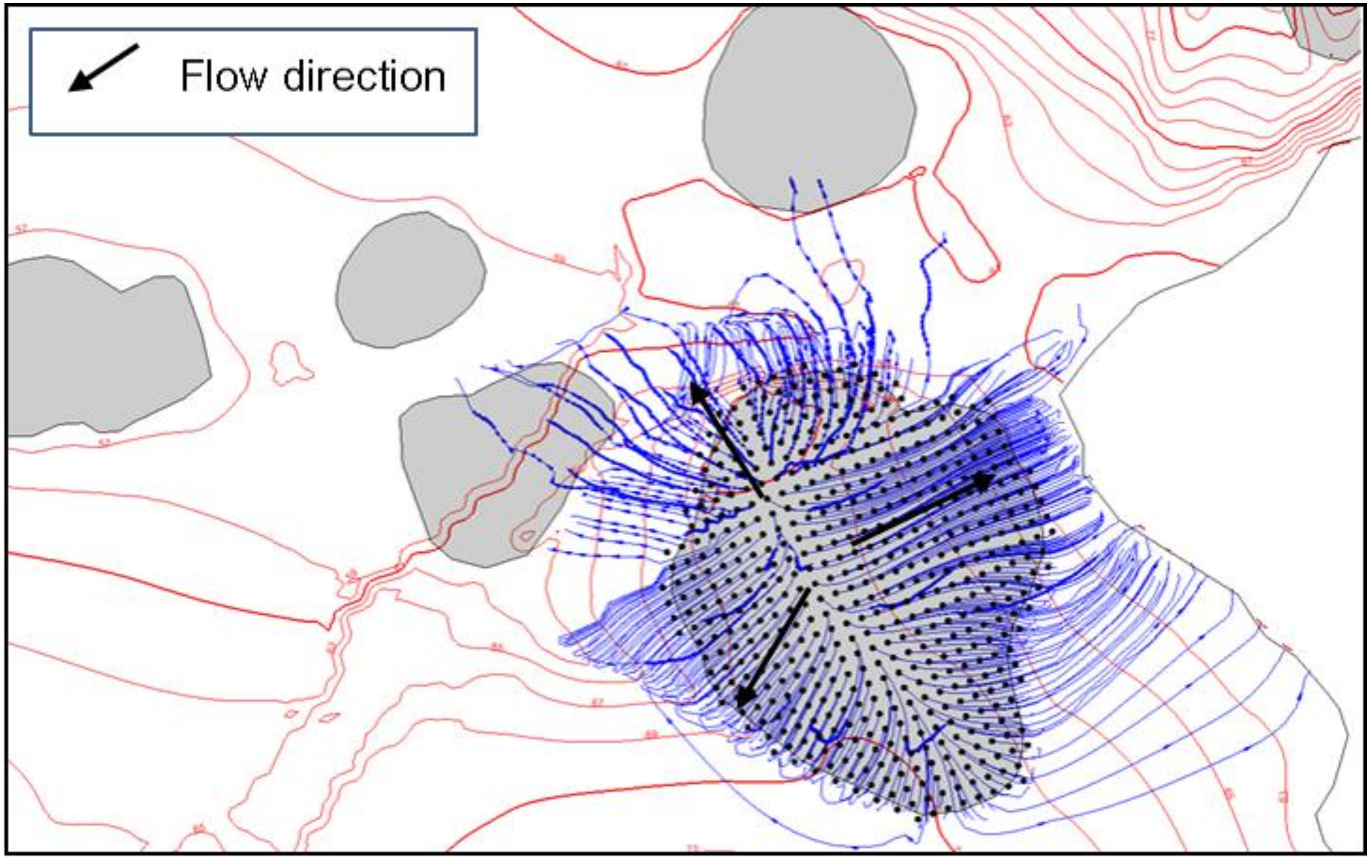
Modeling Results

Annual Water Balance

- The Main and Intermediate Open Pits represent a net source of water to the groundwater system (4 and 7 L/s, respectively)
- The Browns Oxide Open Pit represents a major sink for groundwater (22 L/s) due to active de-watering
- Seepage from mine waste units are estimated at:
  - Main WRD: 6 L/s
  - Intermediate WRD: 0.6 L/s
  - Dyson’s WRD: 2.0 L/s
  - Dyson’s backfilled WRD: 0.6 L/s

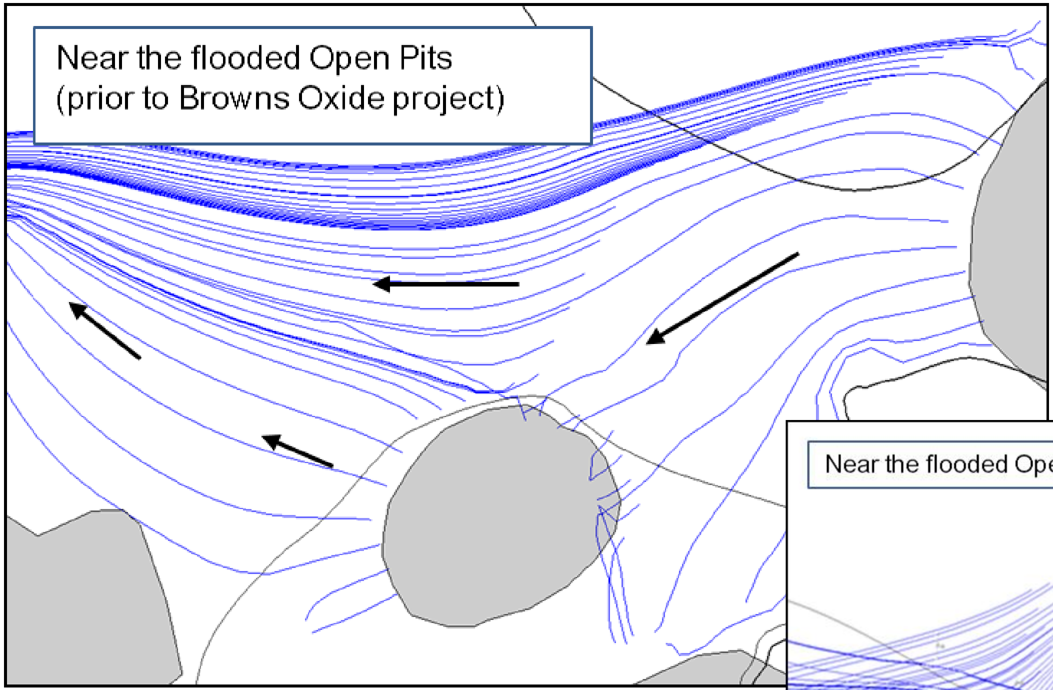
Implications for Rehabilitation

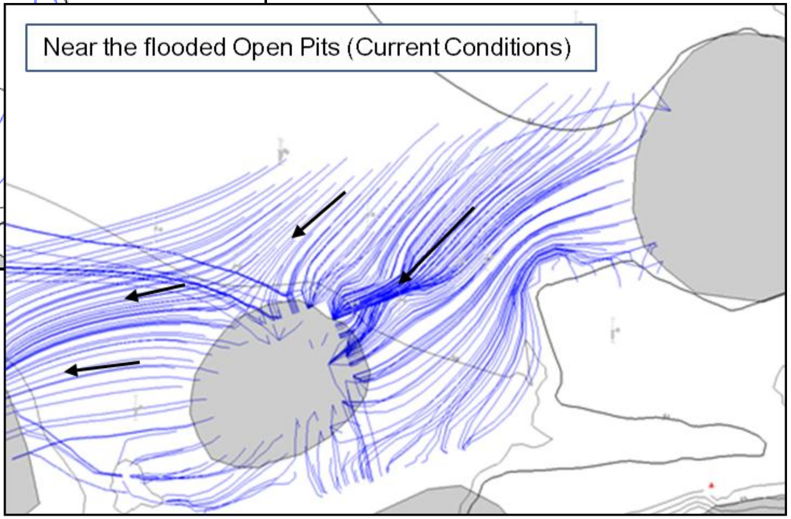
Flow Path Analysis (for Contaminant Loading)



Implications for Rehabilitation

Influence of Brown's Oxide Pit





Implications for Rehabilitation

Contaminant Loading (by mine waste unit)

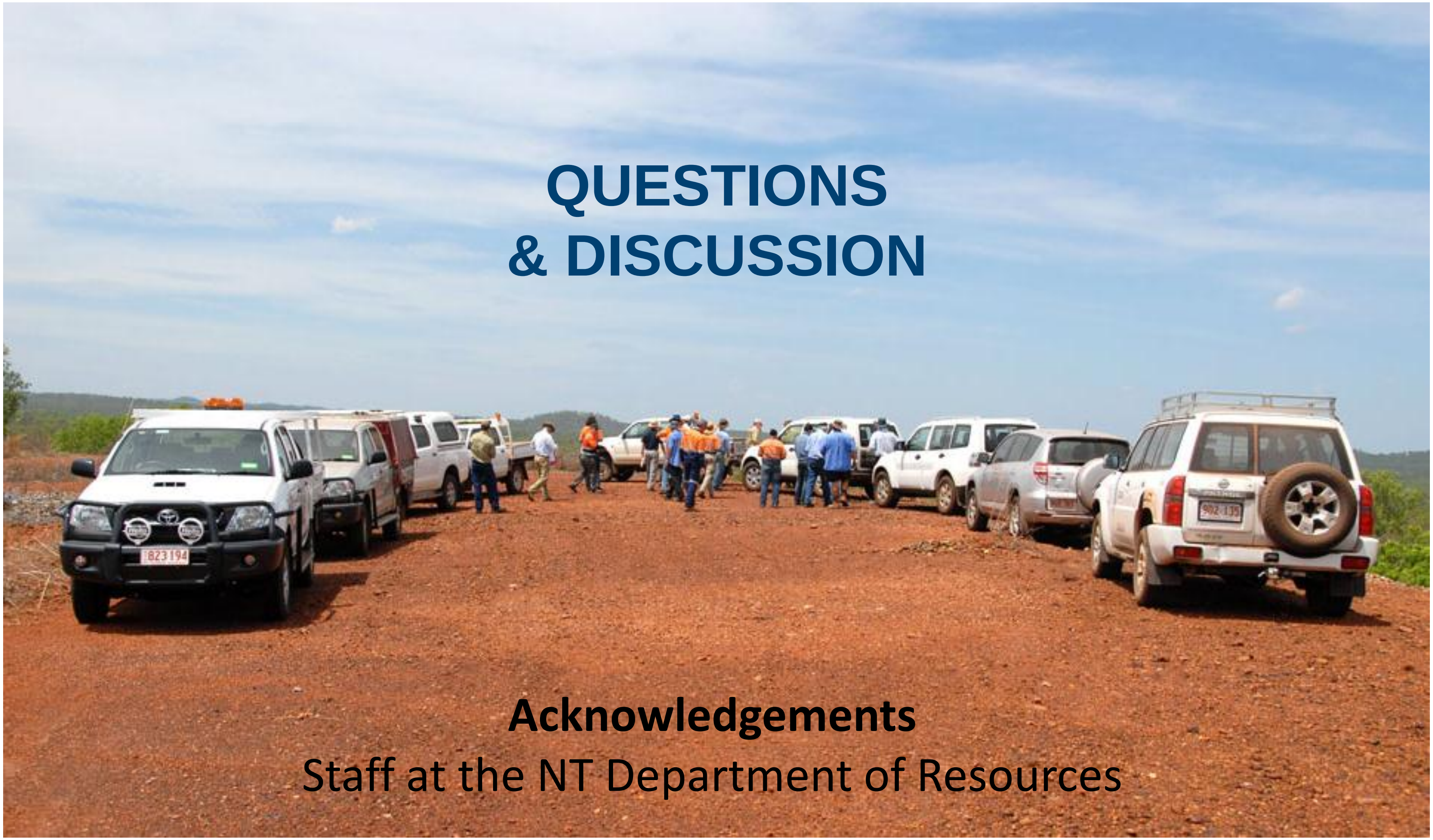
			Annual contaminant loads, in tons				
Feature	**Flow, ML**		**SO_4**	**Cu**	**Mn**	**Ni**	**Zn**
Main WRD	200		1144	0.7	2.2	0.8	1.3
Intermediate WRD	23		593	1.1	2.7	2.1	5.0
Dyson's WRD	64		385	0.0	1.0	0.2	0.0
Dyson's (backfilled) Open Pit	24		152	1.8	3.2	1.2	0.1
Total:	311		2275	3.6	9.1	4.2	6.5

Key observations:

- 50% of the annual SO_4 load to the river is attributed to seepage from the Main WRD
- Intermediate WRD & Dyson's (backfilled) Open Pit are significant sources of metals
- Metal loads from Dyson's WRD are low (because it was only mined for uranium)

Path Forward

- Update model calibration using 2011/2012 monitoring data (water level and seepage flows)
- Use calibrated flow model for rehabilitation planning:
  - Predict groundwater flow and contaminant loading for alternative closure scenarios (e.g. waste relocation to flooded pits, high quality covers in-place)
  - Use flow model to design seepage interception systems (if required)
  - Use flow & contaminant load model to set performance targets for design of rehabilitation measures (e.g. acceptable rates of infiltration through waste rock cover)



QUESTIONS
& DISCUSSION

Acknowledgements

Staff at the NT Department of Resources