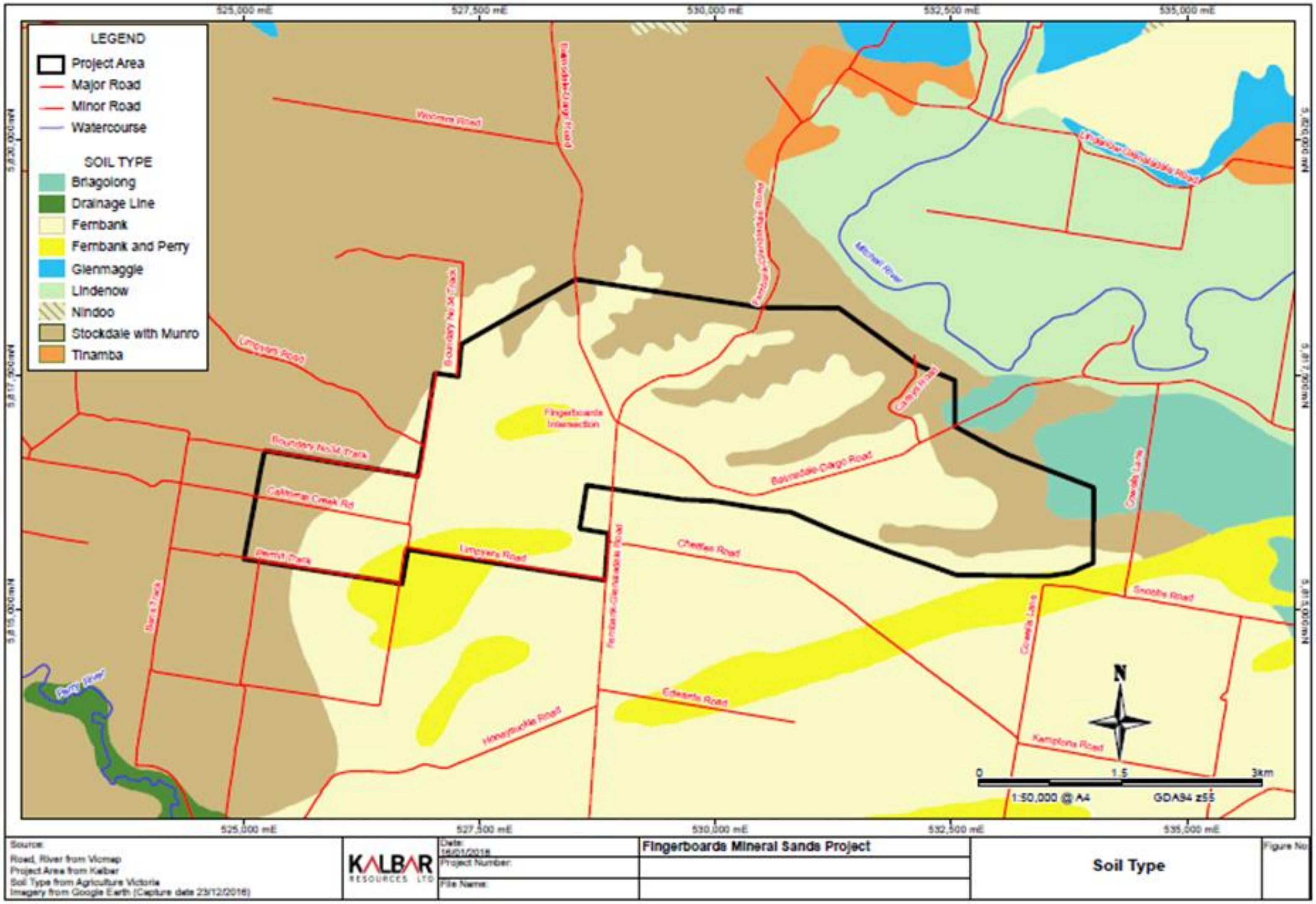
Soils and Rehabilitation: Fingerboards Mineral Sands Project

Rehabilitation planning

Rehabilitation plans integrate information on:

- Existing environment
- Rehabilitation goals
- Mining methods and impacts
- Materials available (soils, wastes)
- Rehabilitation methods and practices

Soils: DNRE mapping in 2005

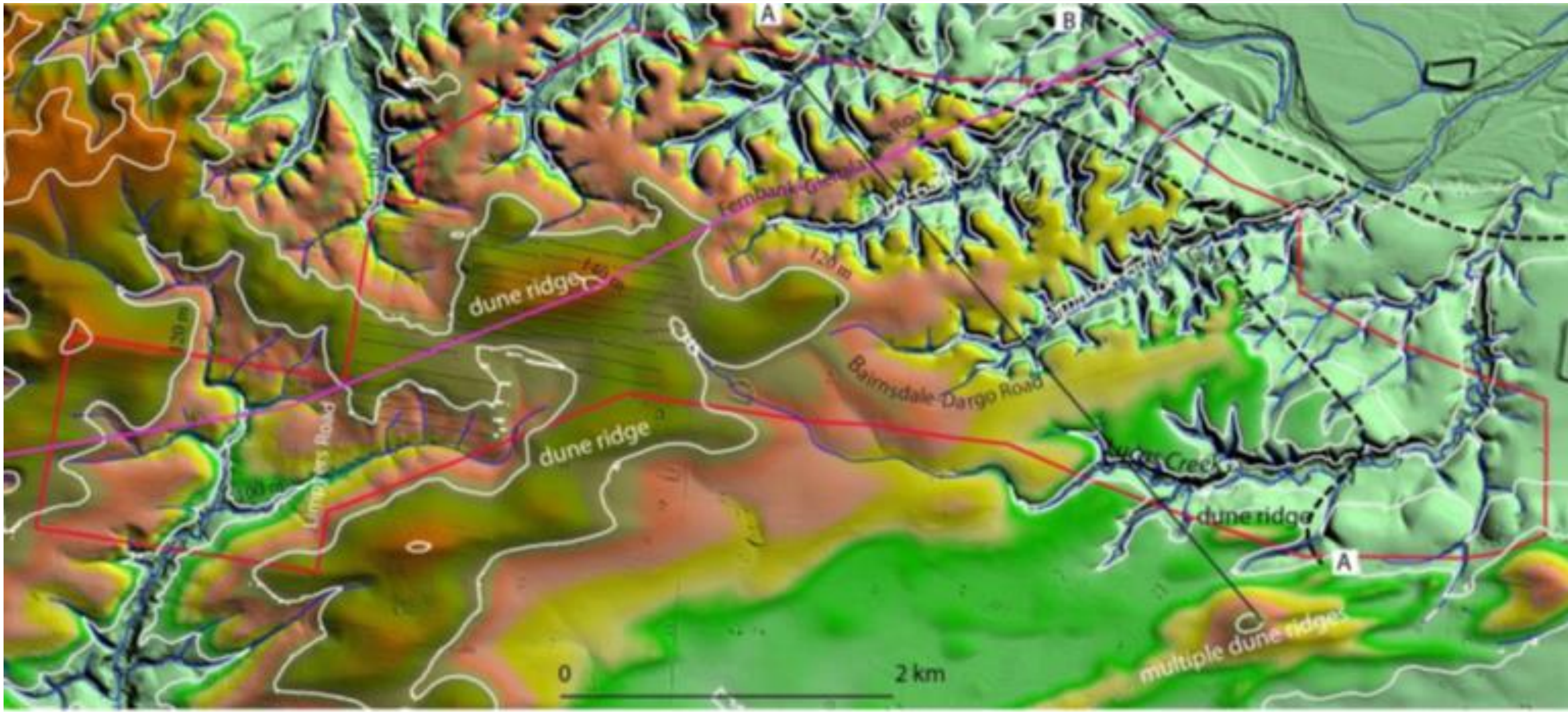


Soil types identified

Fernbank	Sodosol
Perry	Podosol
Stockdale	Sodosol
Munro	Podosol*

- Sodosol: Surface soils of strongly to moderately acidic clay loams to sands and invariably have a bleached subsurface soil. Sodic medium to heavy clays at a variable depth, generally before 50 cm. (Commonly described as duplex.)
- Podosol: Dark grey strongly acidic loamy sands or sands overlying paler coloured strongly acidic sands. Strongly acidic yellowish brown sand generally occurs before 1m.

Geomorphology influence - dunes



Podosol occurrence (deeper sand surface layers) reported to be associated aeolian dune deposits.

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Soil type and rehabilitation: Sodosol

Sodosol management notes (DNRE) (Fingerboards):

Whole profile

Plant available water is very low (estimated at 47 mm).

The dense and coarsely structured subsoil is likely to restrict root depth. The A2 horizon will be seasonally saturated.

Roots in the subsoil will be confined to cracks in the soil and not penetrate deeply.

Surface (A) horizon

The surface (A1) horizon has low nutrient holding capacity

Soil type and rehabilitation: Podosol (Perry – DNRE)

Whole profile

Plant available water capacity (PAWC) would be very low but can be increased by additional organic matter.

Surface (A) horizons

Able to utilise light rains falling on dry soil, but plants will soon suffer moisture stress unless further rainfall occurs. Organic matter is important in these sandy soils to enhance both water and nutrient holding capacity.

The surface soil has extremely low inherent fertility and is extremely deficient in potassium. Also likely to be naturally deficient in nitrogen, phosphorus, and sulfur.

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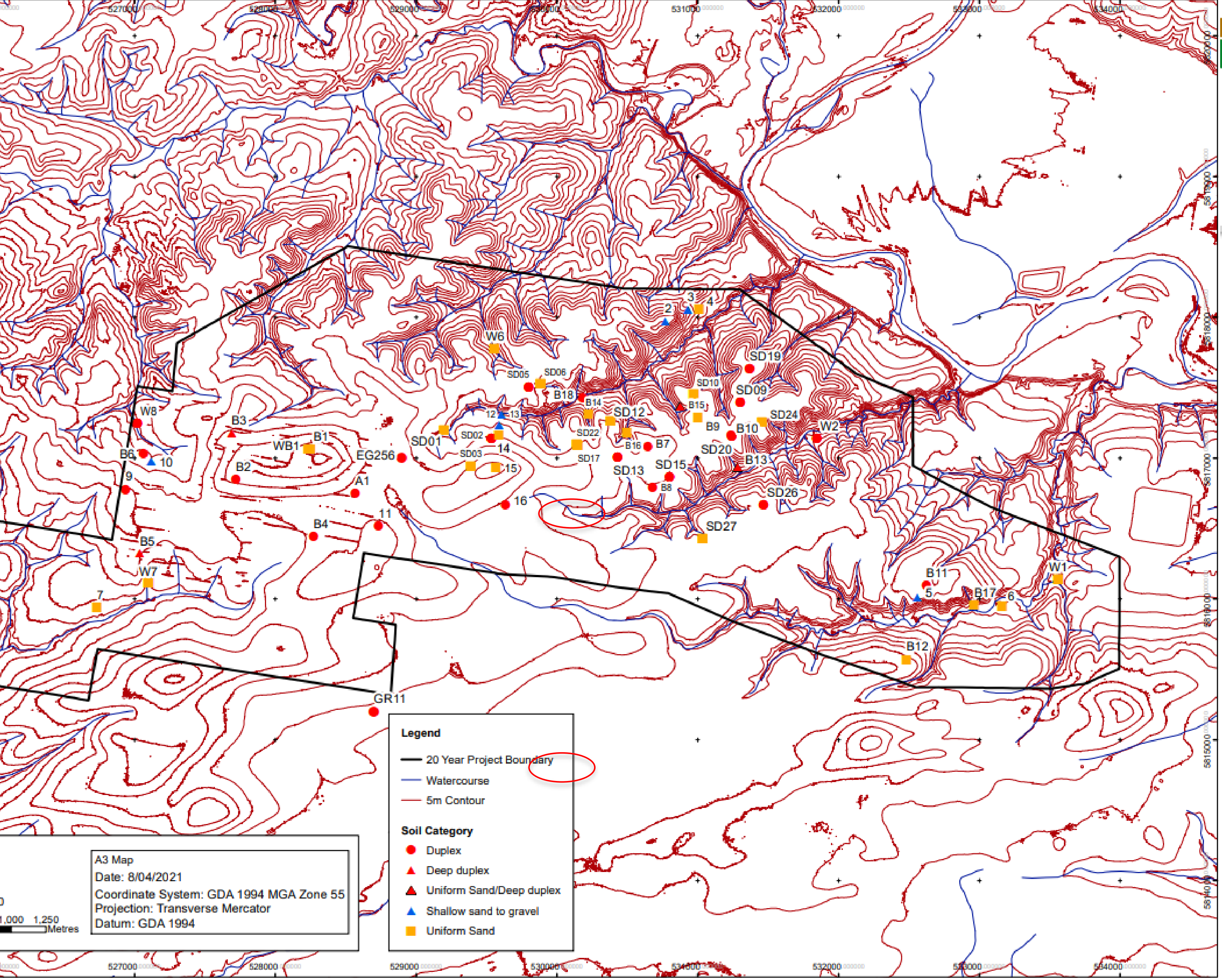
Initial assessment

- Drill cores sampled and analysed (20)
- Described profiles (Long & Assoc.) (16)

Subsequent assessment (18)

- Profile descriptions
- Infiltration measurements
- Chemical and physical analysis


Legend
20 Year Project Boundary
Watercourse
5m Contour
Soil Category
Duplex
Deep duplex
Uniform Sand/Deep duplex
Shallow sand to gravel
Uniform Sand
A3 Map
Date: 8/04/2021
Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994
1,000 1,250
Metres
527000
528000
529000
530000
531000
532000
533000
534000
W6
SD05
SD06
SD19
SD10
SD09
B18
B14
SD12
B15
SD24
W2
W8
B3
WB1
B1
EG256
SD01
SD02
SD03
SD22
SD17
B16
B7
B9
B10
SD20
B13
SD13
SD15
B8
SD26
SD27
B6
B2
A1
B4
B5
W7
B11
B17
W1
B12
GR11

Soils identified

- Broadly consistent with DNRE mapping (sodosol/podosol)
- Generally an acid, sandy topsoil layer of varying depth overlying gravel or clay
- Sandy surface layer has (across the site):
  - Consistent particle size, acid pH, low salinity
  - Variable chemical fertility, but commonly low
- Clay (B horizon) layers are typically sodic and dispersive

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Soil suitability for rehabilitation - conclusions

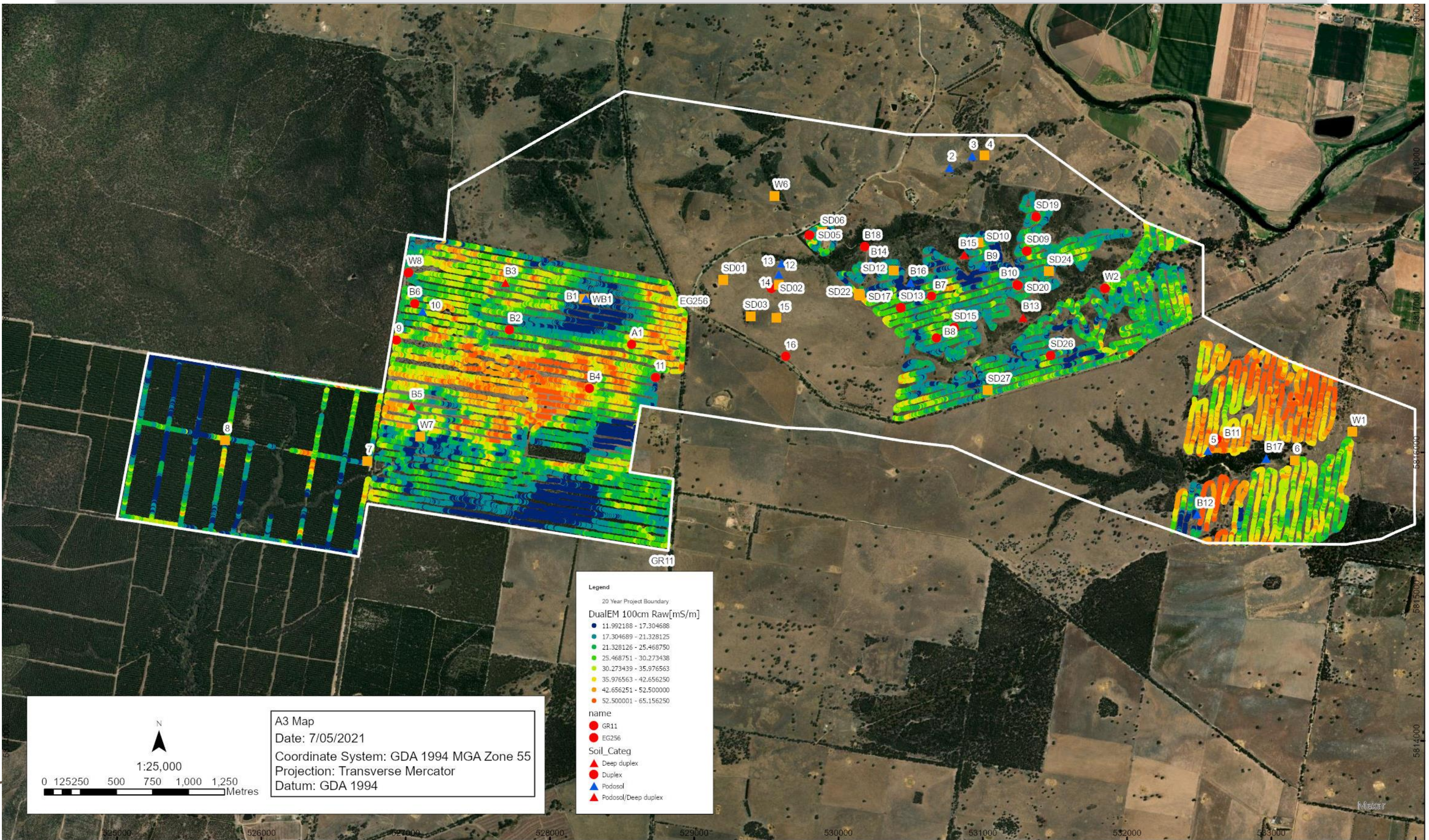
- Clay subsoils highly unsuitable as:
  - Dispersive, hard setting, impermeable
  - Increased risk of tunnel erosion
  - In practice, gypsum amendment of these materials has been virtually impossible to implement and would create environmental risks
- Sandy subsoils could be used but would give sub-optimal results as:
  - Chemical fertility and water holding capacity are very low
- Surface soil is suitable for rehabilitation with amendment
- Potential to form more productive soils if a more suitable subsoil could be constructed.

Infiltration capacity of site soils

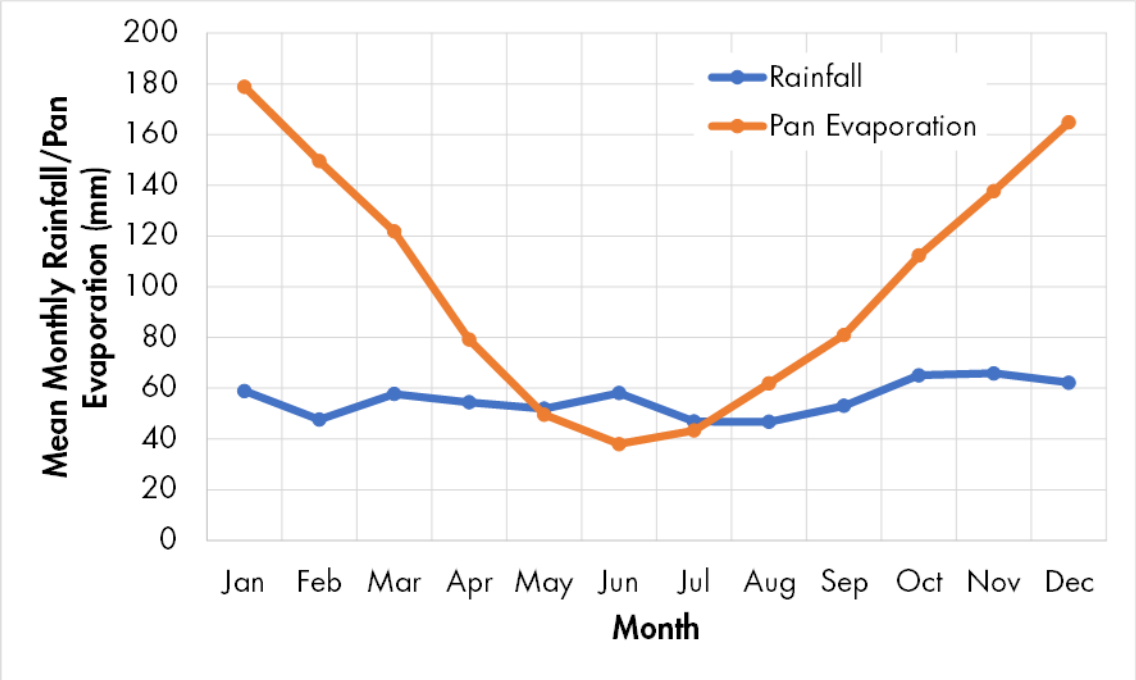
- Shallow sodosol (B horizon at ≤ 50 cm)
  - Surface: 69 mm/h
  - B horizon: **0.5 mm/h**
- Podosol
  - Surface: 233 mm/h
  - B horizon: 100.5 mm/h

Data clearly demonstrate throttle to infiltration created by the sodosol B horizon.

Electromagnetic induction and topsoil depth



Subsoil and climate – making the most of potential



- Potential for waterlogging in May – July (infiltration capacity)
- Increasing water stress in spring – summer (water holding capacity)

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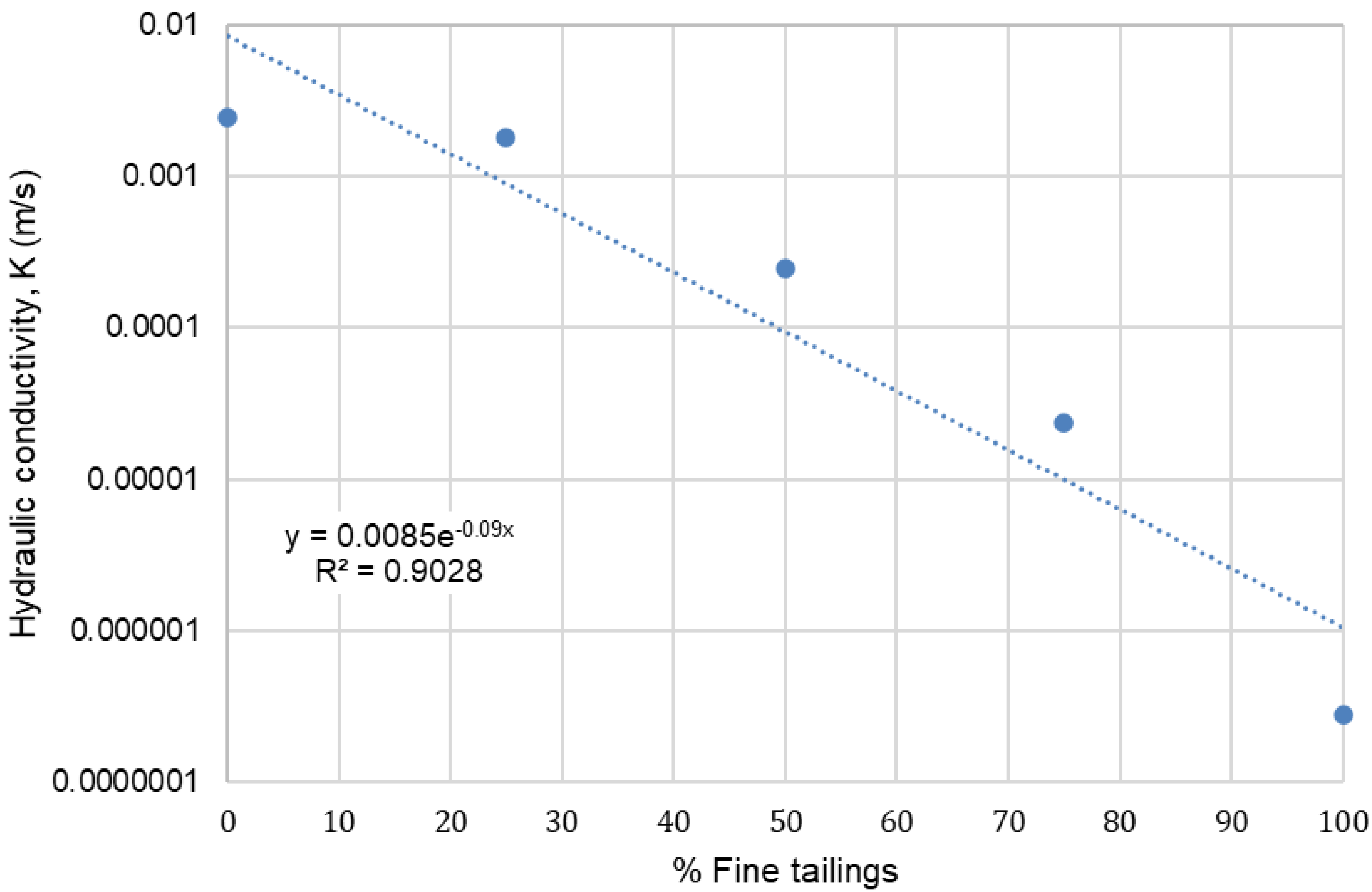
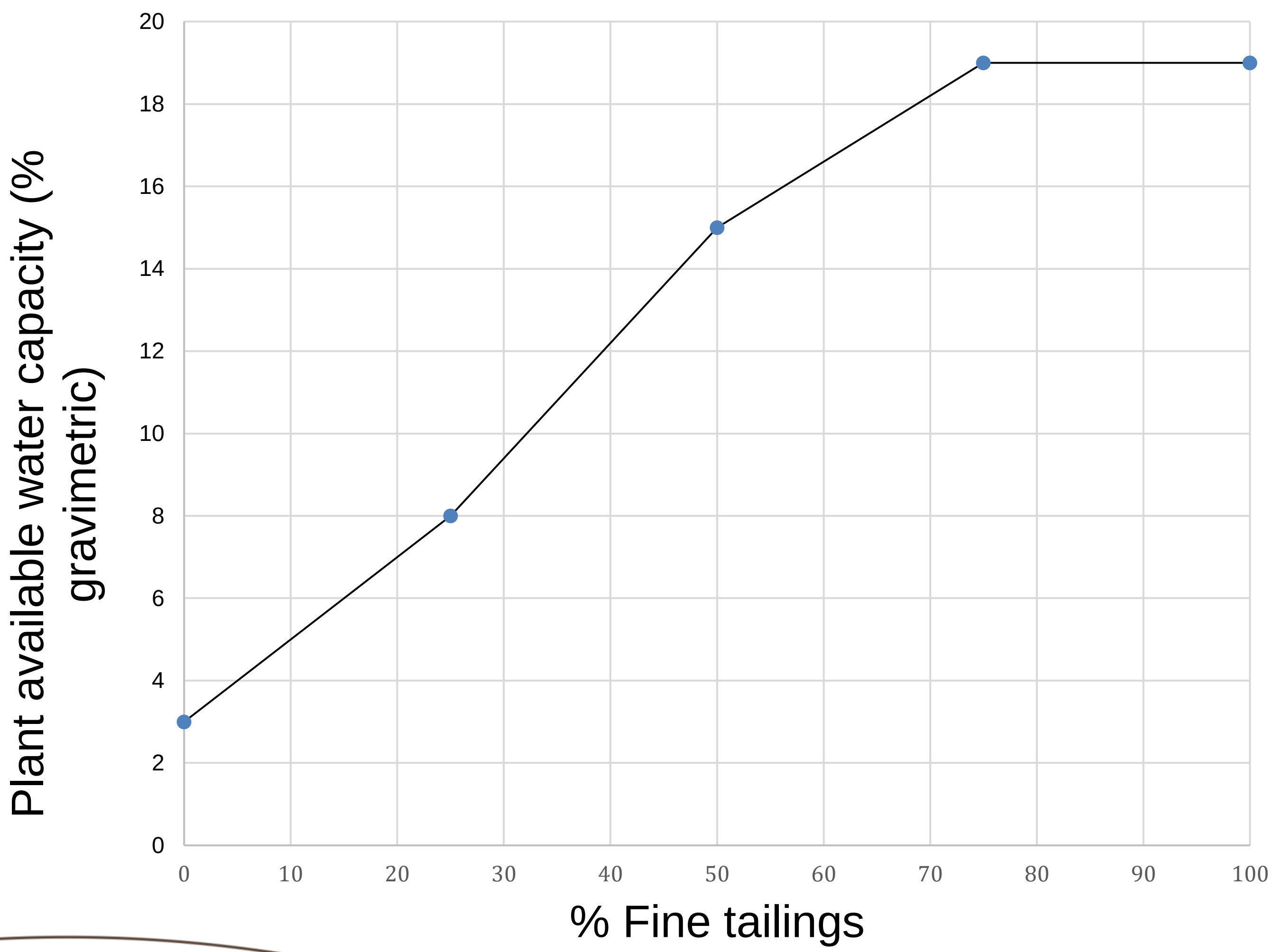
Testing tailings mixtures – permeability of fine/sand mix



Testing subsoil mixtures – water holding capacity



Benefits from “improved” subsoil

- Reduced waterlogging in winter
- Largely eliminate lateral seepage and tunnel erosion risk
- Increased water storage in profile, giving extended pasture growth into spring and after large storms
- Increased rooting depth, giving more carbon and nutrient accumulation/retention at depth
- Greater resilience and drought hardiness of all vegetation
- Increased biomass production

Landform, function, and rehabilitation

- Identify key landform zones (domains)
- Assess risks and goals for each zone
- Link final land use and vegetation to zones
- Identify rehabilitation actions to address risks and goals

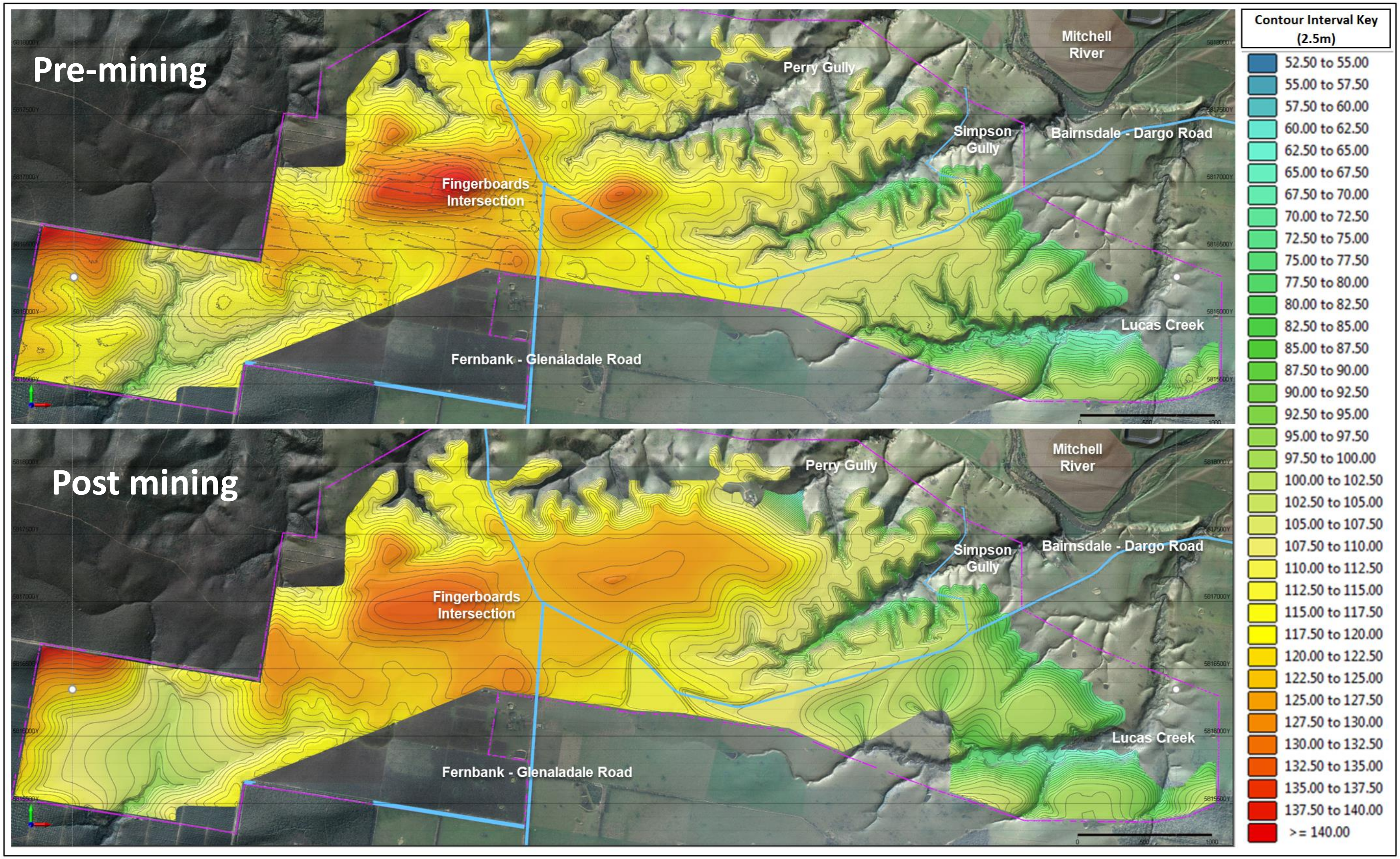
End result is that landform, soils, vegetation, and land use are integrated to achieve goals for that zone

Landform zones

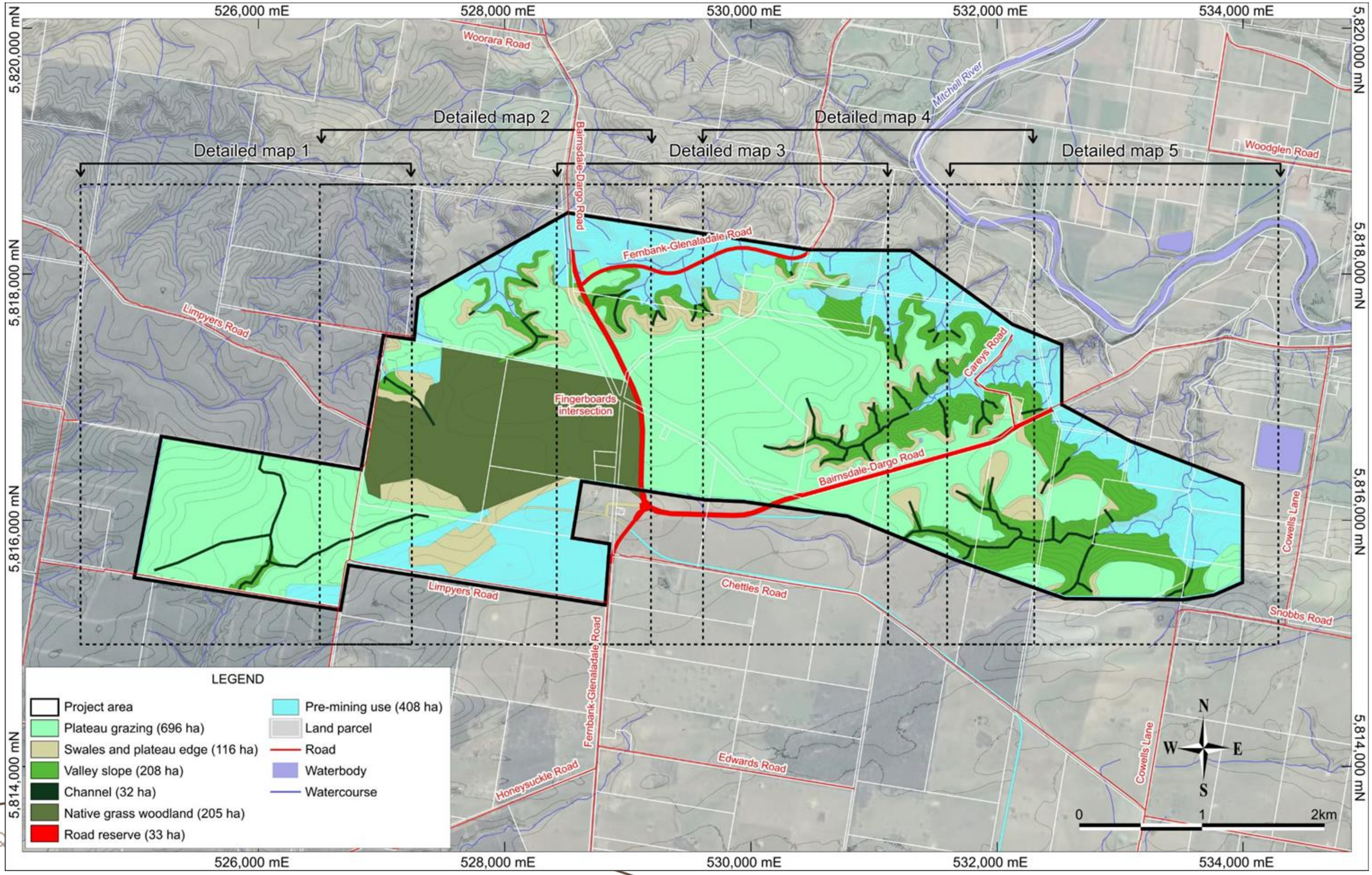
For each zone …

- Risks?
- Priorities?
- How do they interrelate?

Landform reconstruction



Rehabilitation zones



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Erosion control planning

Surface erosion, aim to:

- Increase, or at the very least, maintain, surface cover
- Reduce runoff
- Reduce, or not exceed, current gradients
- Reduce flow concentration

Sub-surface (tunnel) erosion, aim to:

- Avoid any areas of prolonged ponding
- Minimise/eliminate lateral seepage & ensure any subsoil layers exposed to seepage are not dispersive
- Minimise deep drainage and potential for seepage flows intercepting valley slopes.

Revegetation works

- Seeding for grasses, legumes, forbs
- High seeding rates to give rapid surface cover and to swamp current weed populations
- Likely combination of seeding and tube stock planting for trees and shrubs
- Potential for use of hydroseeding or hydromulching if erosion (wind or water) is a problem (e.g., for specific areas) or needed for initial establishment

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Overview

- Changes to landform are not large
- Changes in soil properties are aimed at increasing physical and chemical fertility
- Revegetation domains are planned to improve overall landscape function and stability
- Materials excavated do not present major challenges such as AMD, clay dispersion, or salinity.
- Major aim of rehabilitation planning is to ensure that landforms, soils, and final land use are integrated to achieve functional landscapes that meet rehabilitation goals.