# Shoal Bay Waste Management Facility

## Integration of Leachate Treatment and Landfill Rehabilitation



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# Current Site View



# Current Site View



# 2005 Site Plan

# Landfill development: 2010



**2010**

# Landfill development: 2010 – 2013



## 2012

# Landfill development: 2010 – 2013



**2013**

# Seepage made the need for change clear



**2014**

# Determine A Way Forward

- Had to run multiple elements in parallel to manage the situation
- A long-term pathway was needed.
- Short term solution required as well.

# Feasibility, trials and interim storage

## Permanent solution

2015: EOI and feasibility

2017: Pilot development

2018: Pilot findings reported

## Create interim storage

Two new covered leachate storage ponds

Storage works progressed while treatment trials continued

**Storage and treatment development progressed in parallel**

# Why the solution had to be self-contained




## Works could not accept leachate

- Capacity constraints
- PFAS concerns
- Leachate quality

**A fully self-contained treatment and irrigation system was required**

# Storage works: 2014 – 2015



## 2014 — September

# Storage works: 2014 – 2015



## 2015 — May

# Storage works: 2014 – 2015



**2015 — September**

# What the pilot changed



- MBBR selected as the preferred biological process.
- Low biodegradable carbon required external carbon dosing.
- Recirculation arrangement refined using trial results.

# PFAS became a central part of the trial

**99.5%**

**PFAS removal target through foam fractionation**

Purely as a guide, the range of estimated disposal costs is summarised below.

Targeted outcome

| | Foamate fraction (%) | Foamate volume pa (kL) | Drying efficiency (%) | Final Waste (T) | Disposal Cost per kg ($) | Annual disposal cost ($) |
|---|---|---|---|---|---|---|
| **Scenario 1** | 5 | 2,550 | 0 | 2555 | 4.95 | $ 12,647,250 |
| **Scenario 2** | 2 | 1,020 | 50 | 511 | 4.95 | $ 2,529,450 |
| **Scenario 3** | 0.5 | 260 | 75 | 63.9 | 1.28 | $ 81,760 |
| **Scenario 4** | 0.26 | 140 | 75 | 33.5 | 1.28 | $ 42,880 |

# Recirculation reached its practical limit

**Collect leachate** → **Pump back to the top** → **Retain within the waste**

The landfill behaved like a sponge, until its capacity was reached. In 2019, estimated up to 200 ML was estimated to be stored.

**Recirculation deferred the problem; it did not provide an enduring outlet**

# Leachate Breakouts Still Occurring







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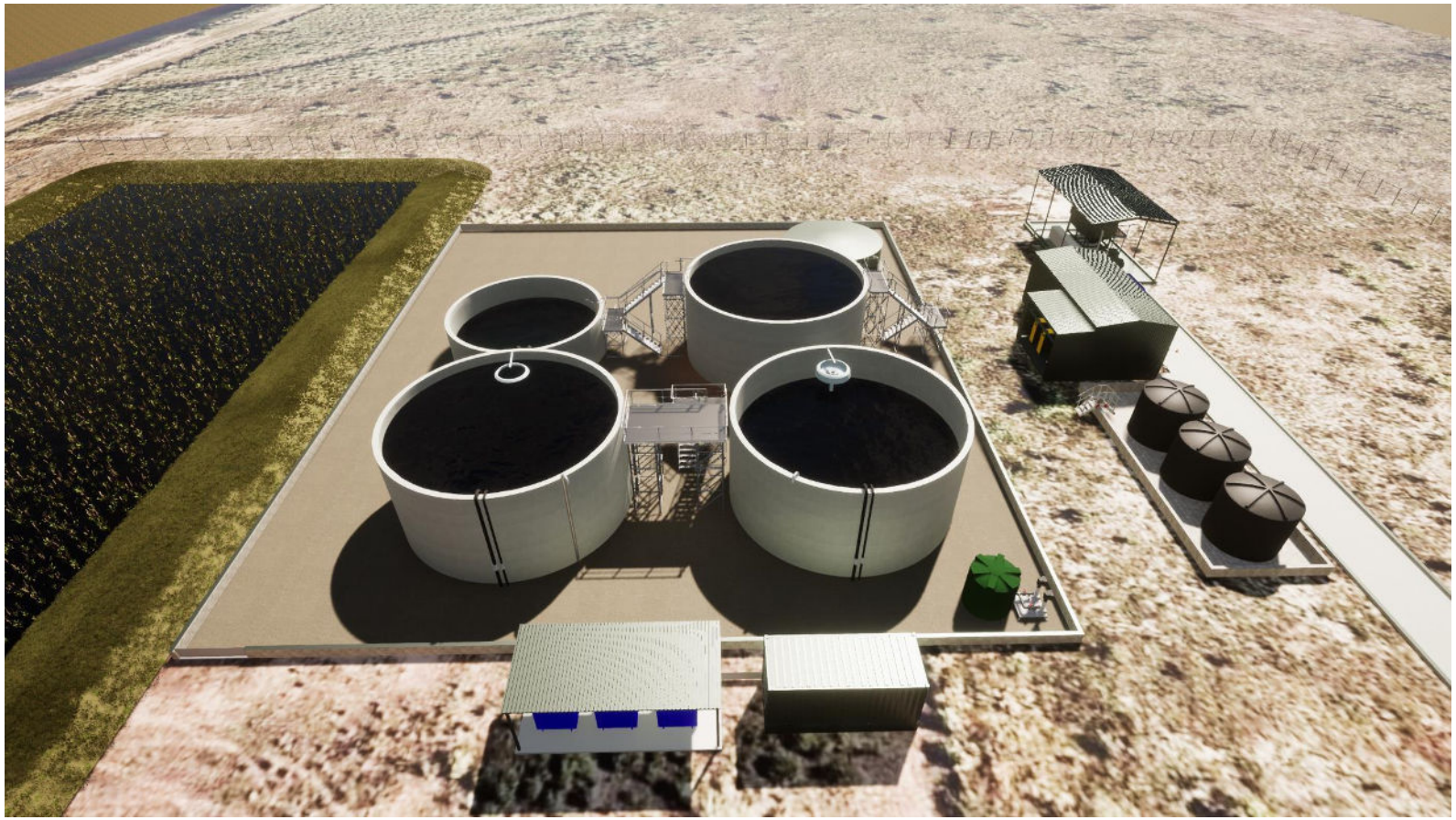


# Innovation and the commercial agreement

- Water and Carbon Group delivered strong technical work through the trial.
- The development process generated valuable intellectual property.
- An agreement enabled Council to benefit from future use of that IP.

**Innovation and Council's commercial interests progressed together**

# The proposed treatment plant



# Council approval and delivery strategy

- 2018: Council supported full-scale concept development.
- May 2019: memorandum recommended the detailed design commitment.
- Delivery strategy separated design/construction from operation and maintenance.
- Approvals, funding and commissioning performance remained key conditions.

# The treatment specification

**Front-end PFAS treatment** → **MBBR treatment** → **Wetland polishing**

- Specified treatment capacity: 50 ML per annum.
- Treated water intended for controlled irrigation over vetiver grass.
- Residual colour and elevated salinity remained design considerations.

# The original cost was difficult to hold

| Historical offer | Capital estimate |
|---|---|
| Original | A$13.13 million |
| August 2019 | A$16.65 million |
| October 2019 | A$15.88 million |

# The original irrigation footprint had a monitoring cost

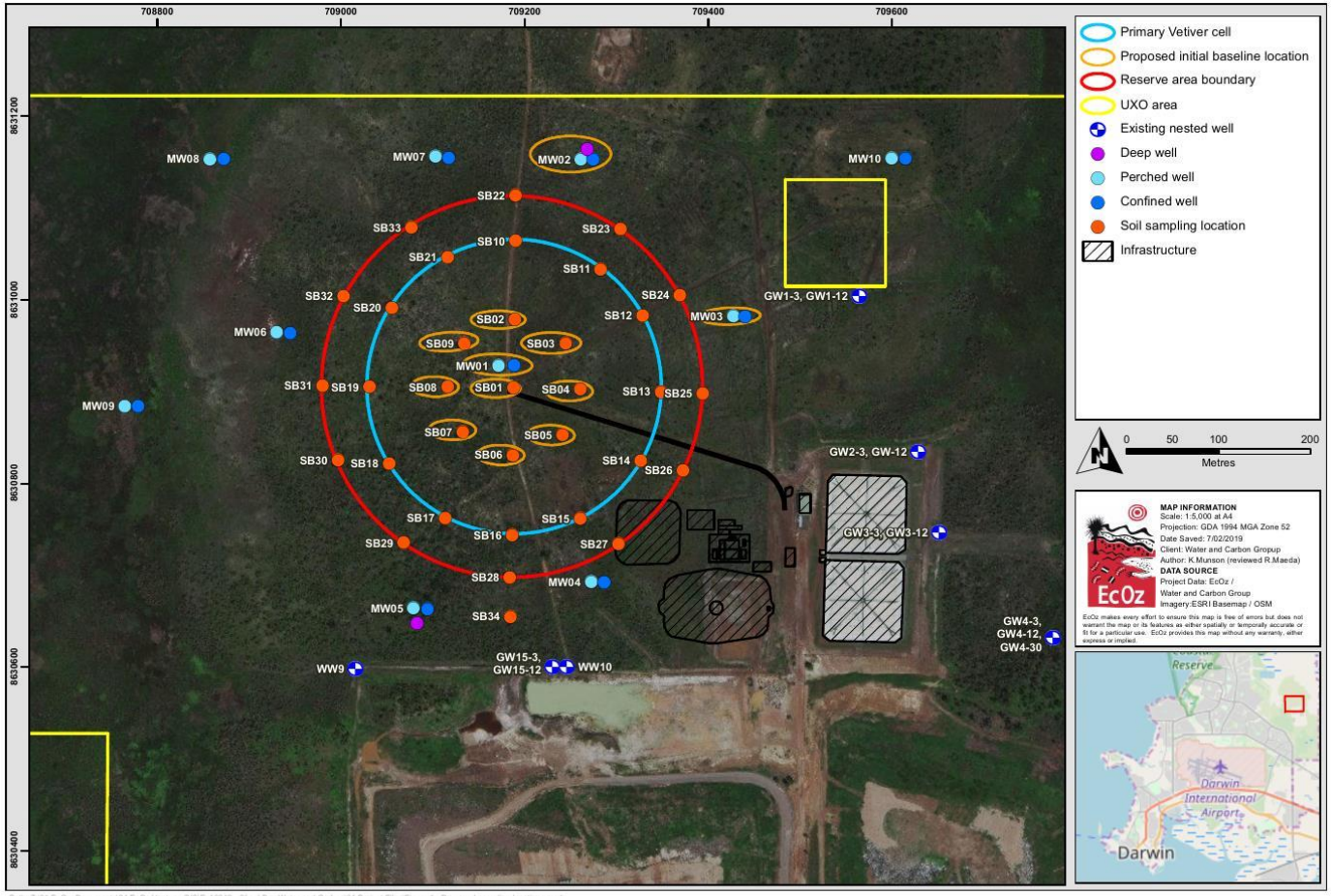



**Figure 1. Proposed sampling locations**

# The irrigation area changed the economics

## Initial approach

Establish an estimated 8 ha dedicated vetiver area for treated leachate irrigation.

## Integrated approach

Incorporate the vetiver growing area into the rehabilitation cap across Stages 3 and 4.

**The cap became part of the leachate solution**

# Two construction projects, one operating system

## Treatment plant

Process performance

Treated-water quality

Storage and pumping

## Cap and irrigation

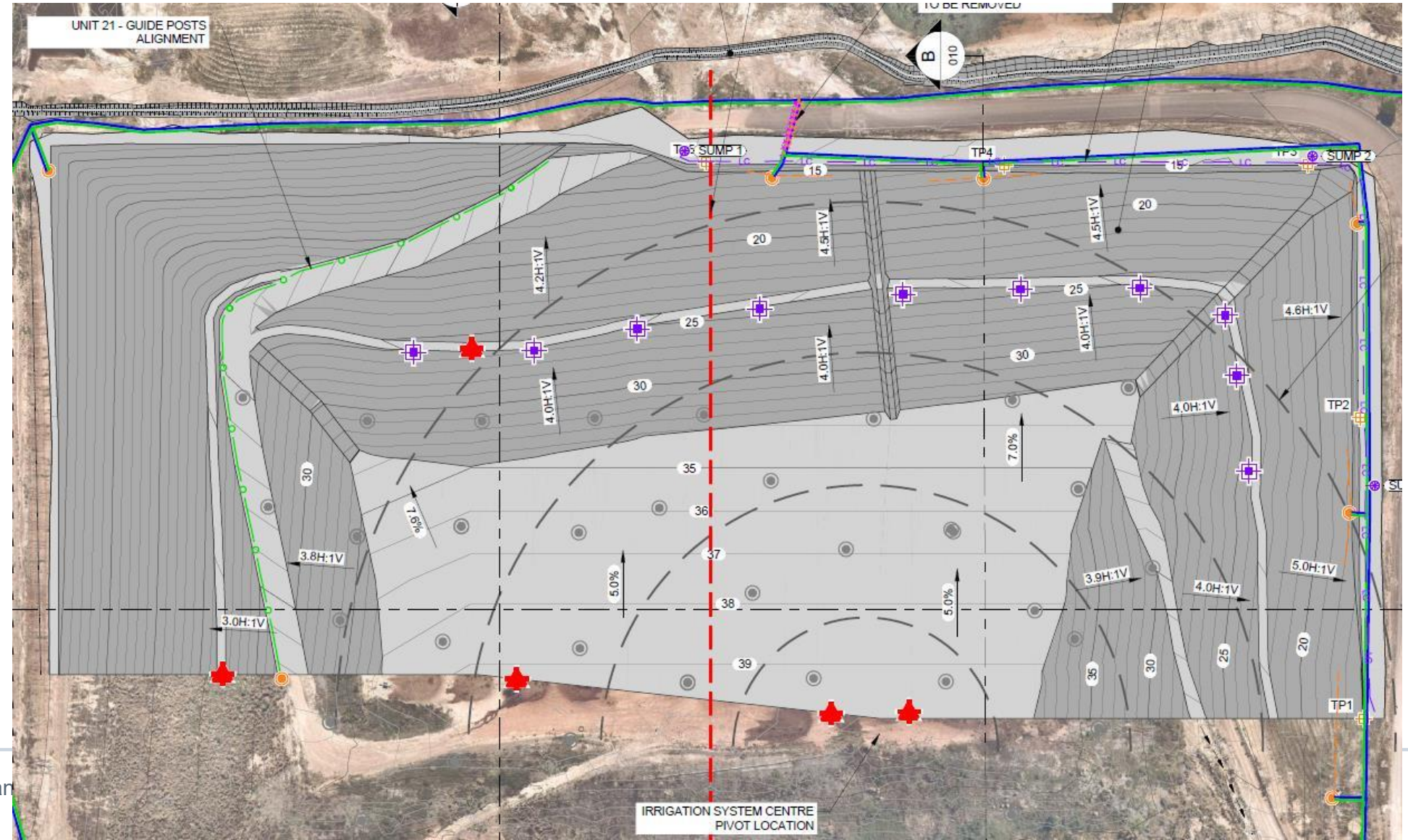
Cap design and construction

Vetiver establishment

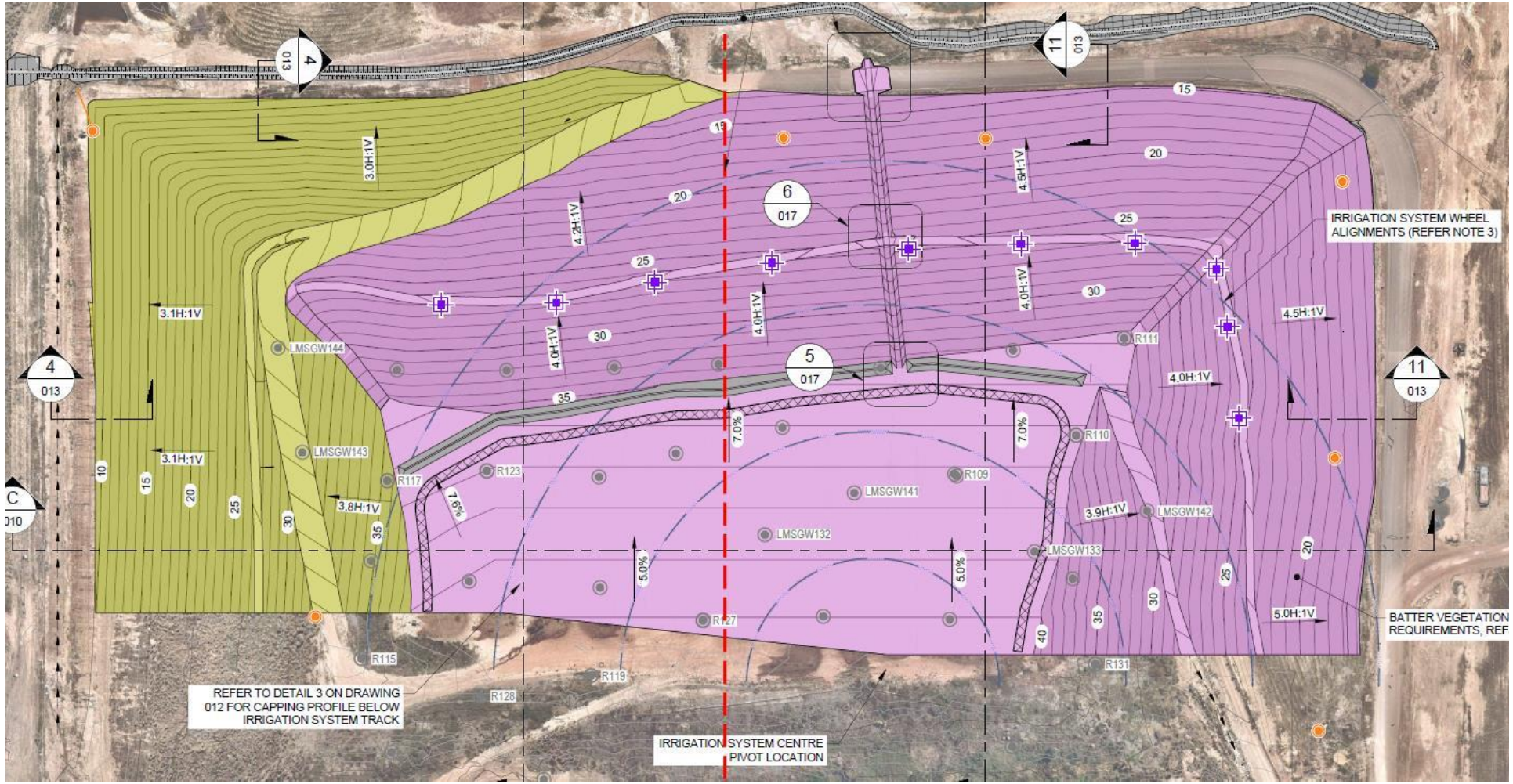
Irrigation coverage

**Interfaces: levels • pipework • access • controls • commissioning**

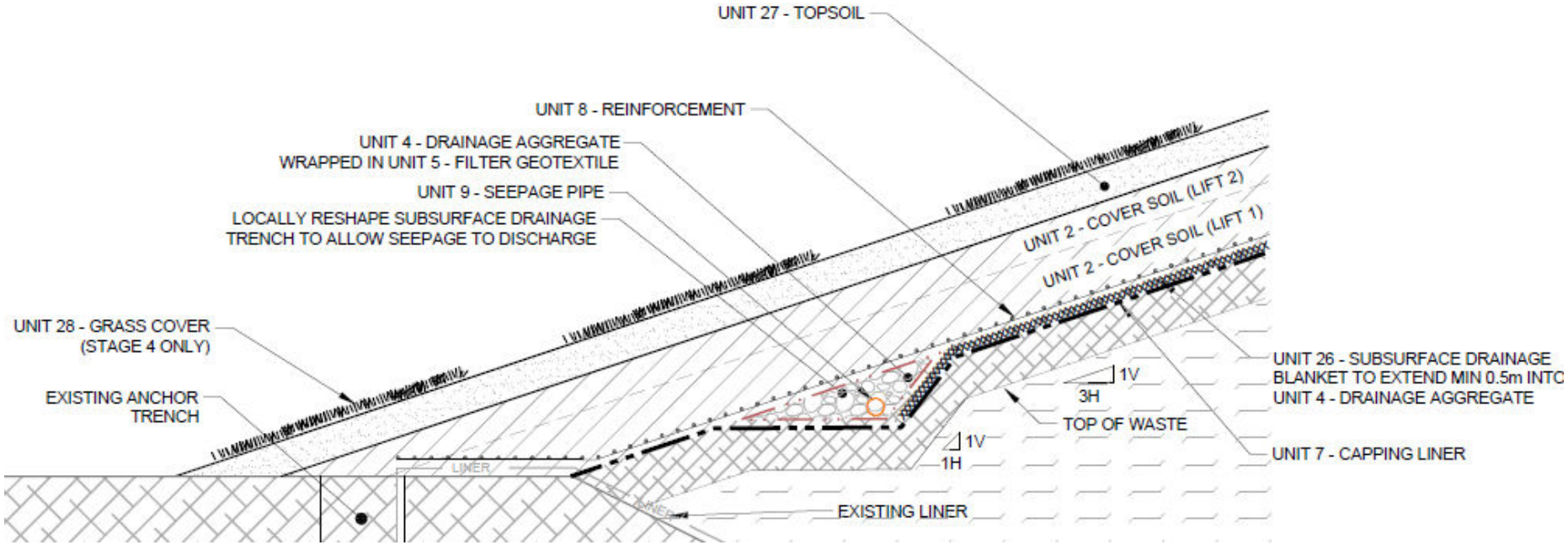
# Capping of Stages 3 and 4



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# Irrigation changed the soil specification

- Friable upper soil and high infiltration capacity supported irrigation.
- Top 500 mm: specified organic matter content of 2 – 5%.
- Three 250 mm soil lifts balanced vegetation needs and veneer stability.
- Salt management had to be considered above the coated GCL barrier.

# Vetiver roots changed the drainage approach

## Root interaction

Deep vetiver roots could obstruct a continuous drainage layer above the barrier.

## Design response

Local drains at the crest, mid-slope benches and toe, with accessible flushing points.

**Local drains managed seepage; they did not prevent full-depth saturation**

# Saturation and vegetation establishment

- Before vetiver established, saturated cover soils could move on the slopes.
- Geosynthetic reinforcement did not resolve every internal soil failure mode.
- Rainfall, irrigation and vegetation establishment had to be coordinated.
- The assumed benefit of mature roots required careful operational judgement.

# Site progression: 2022



**2022 — March**

# Centre pivot routes shaped the drainage design

- Wheel routes influenced the northern chute location and bench grades.
- Crossable bunds and batters were coordinated with the irrigation designer.
- Wheel routes: 1 m wide × 0.2 m deep riprap on filter geotextile.
- The steeper western batter was outside the mobile irrigation extent.

# Centre pivot routes shaped the drainage design



# Phased Approach Tieing into LTP Completion



# Operations Seasonal water balance

**Leachate generation** → **Available storage** → **Treatment capacity** → **Irrigation demand**

- Match treatment output to the water that can be applied appropriately.
- Allow storage to buffer periods of reduced irrigation demand.
- Review seasonal storage trends alongside annual treatment volumes.

# Environmental controls in the pilot design

- Baseline, quarterly and annual soil and groundwater monitoring were proposed.
- Irrigation governed by soil moisture and appropriate dry-weather conditions.
- Runoff controls and infrastructure monitoring formed part of the irrigation concept.
- Salinity, nutrient loading and cap performance remain key operating interfaces.

# Three years of operating experience

- Vetiver grass growing well
- Stored leachate volumes have reduced significantly.
- Reliance on off-site disposal has been eliminated.
- Ongoing operational risks have reduced – no breakouts.
- The system continues to be refined after this time frame

# Key Learnings/Changes

The polishing wetland is now bypassed

Costs are a bit higher than originally modelled but in the same ball-park

Current throughput remains below design

Have to balance irrigation so don’t overload soils with salts

First rains treat as a first flush to capture salts

# Lessons for regional landfill operators

- Consider treatment, storage, irrigation and rehabilitation together.
- Use trials to resolve uncertainty before committing to full-scale delivery.
- Address intellectual property and commercial value early.
- Plan construction interfaces and keep refining after commissioning.

# Leachate management belongs in the closure strategy

## Treatment + irrigation + rehabilitation

An integrated solution has reduced stored leachate and operating costs while supporting landfill rehabilitation.

## Questions and discussion