Resource Recovery Learning Centre

DEVELOPMENT APPLICATION

REALM studios

contents

DA Report

Appendix

Project: Resource Recovery Learning Centre

Report Title: Development Application Report

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Prepared by: REALM studios

Acknowledgement of Country

We acknowledge that this project is located on the ancient lands of the Yuin peoples, Wadi Wadi and Wandandian groups.

As we develop conceptual design thinking on Country, we acknowledge with profound respect the traditional owners of this land and their continued deep connection to the land.

The Yuin people have cared for the Country for millennia. They are closely tied to the land through ceremony and spiritual connections. They have cared for the forests and waterways where the resource recovery centre now lies.

We pay our respects to elders past, present, and emerging. We also pay respects to the broader Shoalhaven Aboriginal community that continues to care for Country.

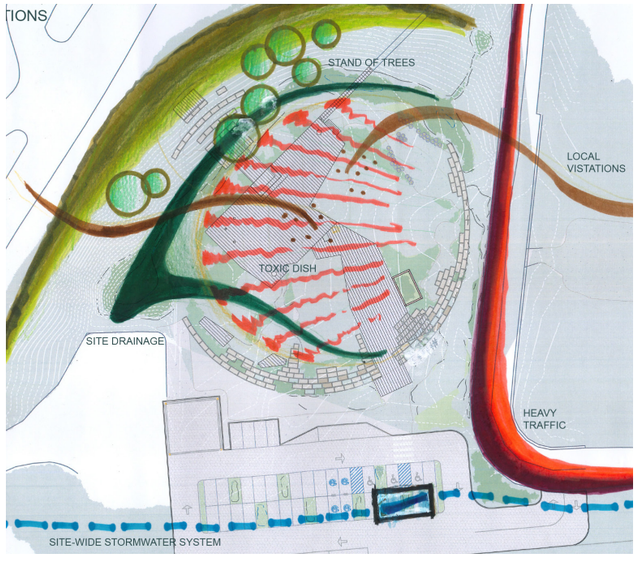
The impact of invasion and colonisation upon Aboriginal people resulted in the forcible removal of people from their ancestral lands. We stand for a future that respects and acknowledges Aboriginal perspectives, culture, language, truth-telling, and history. We advocate for continued efforts to fight for Aboriginal justice.

project location

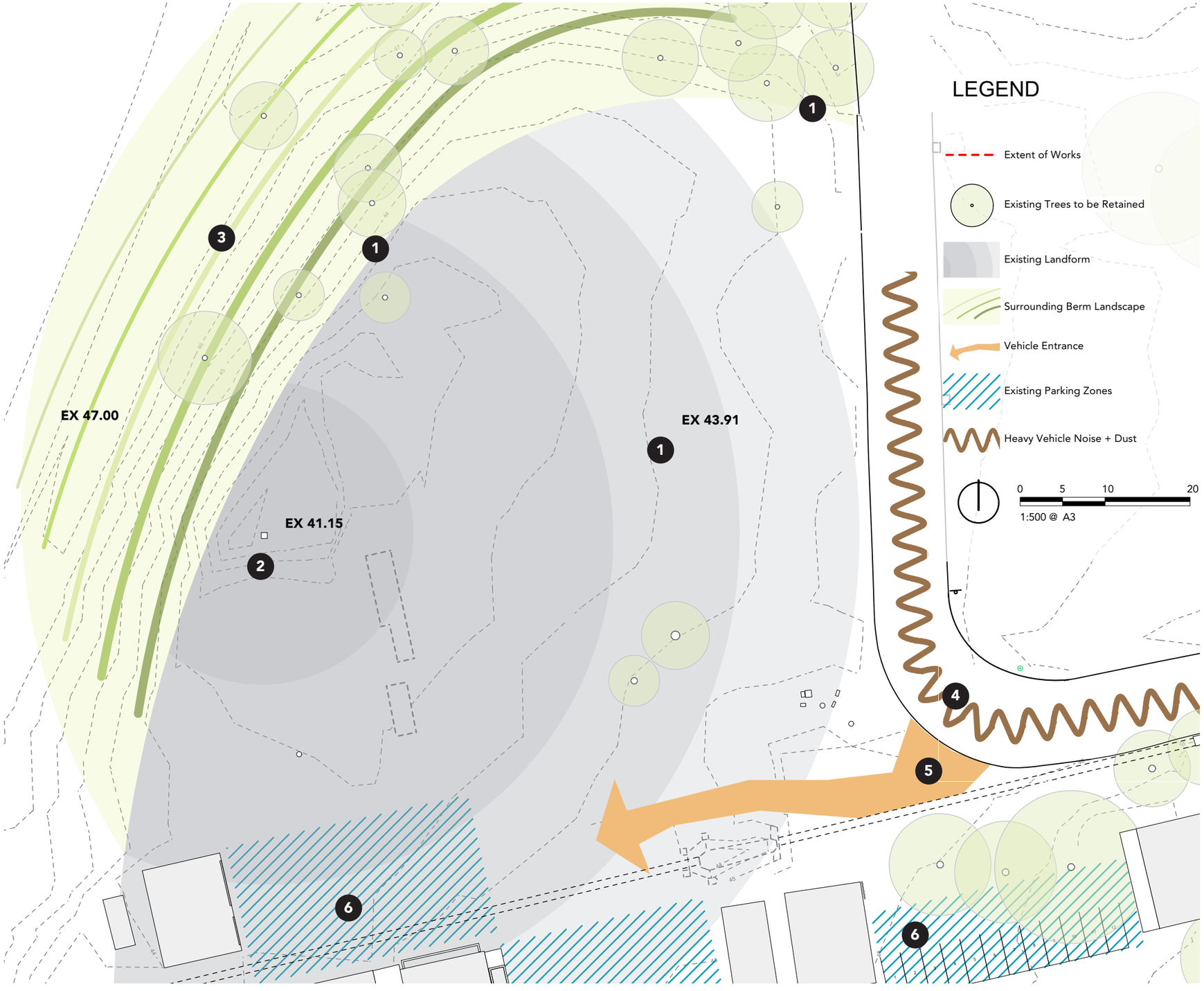
site analysis

Notes:

1. Stands of existing Eucalpt species
2. Dish landform with a soggy low point
3. Surrounding berm landform with parkland aesthetic
4. Heavy vehicle traffic and noise
5. Vehicle entrance
6. Existing parking and turning areas to be retained.



Early site analysis sketch

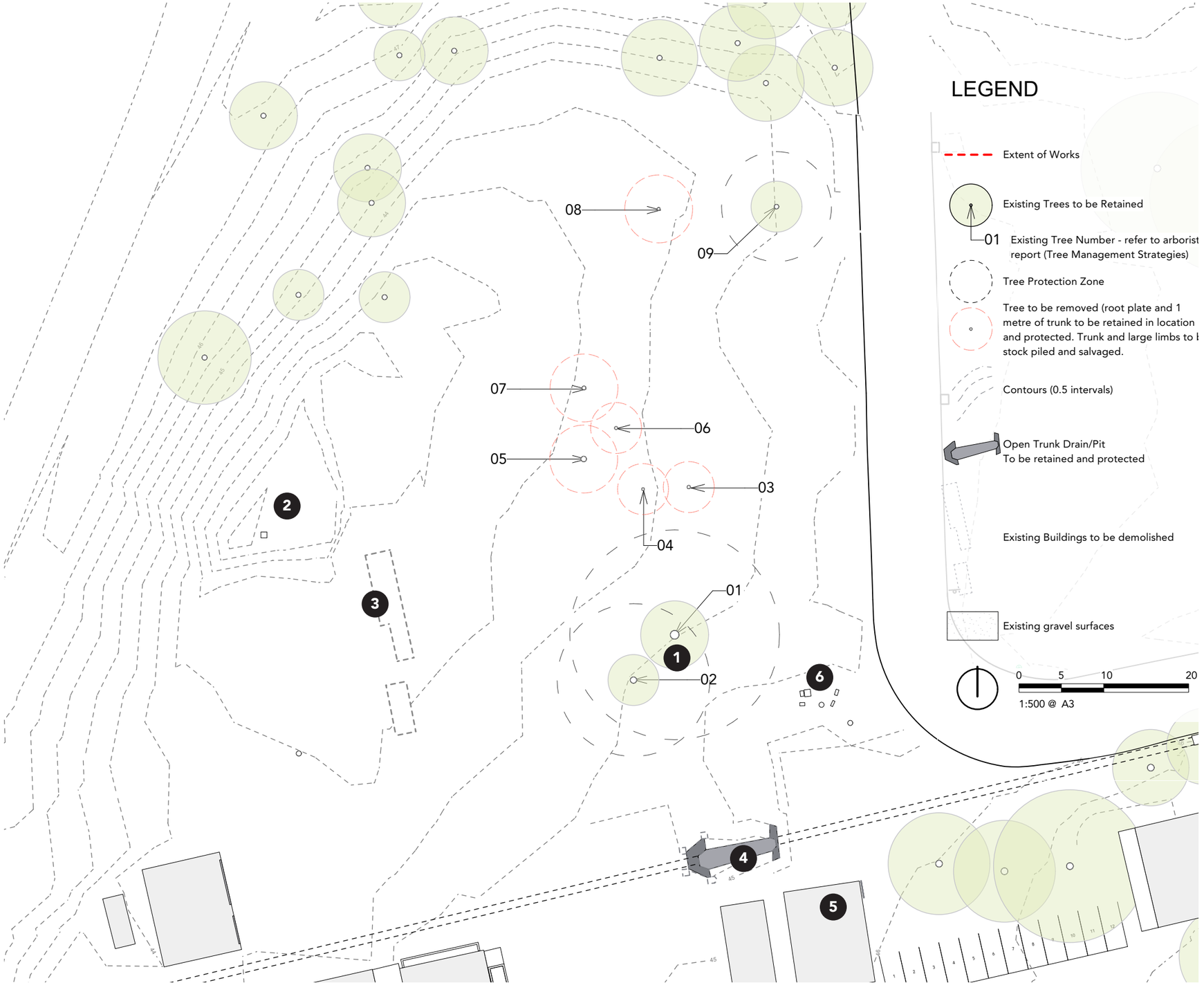


site conditions

Notes:

1. Significant tree specimens providing habitat for hollow dependant birdlife and marsupials.
2. Low point with soggy soil pockets.
3. Existing buildings to be demolished, refer to architect report
4. Existing 900 dia trunk drain with open pit segment
5. Existing demountable buildings to be retained
6. Existing services, powerpole and strays

Hollow specimen - tree 01

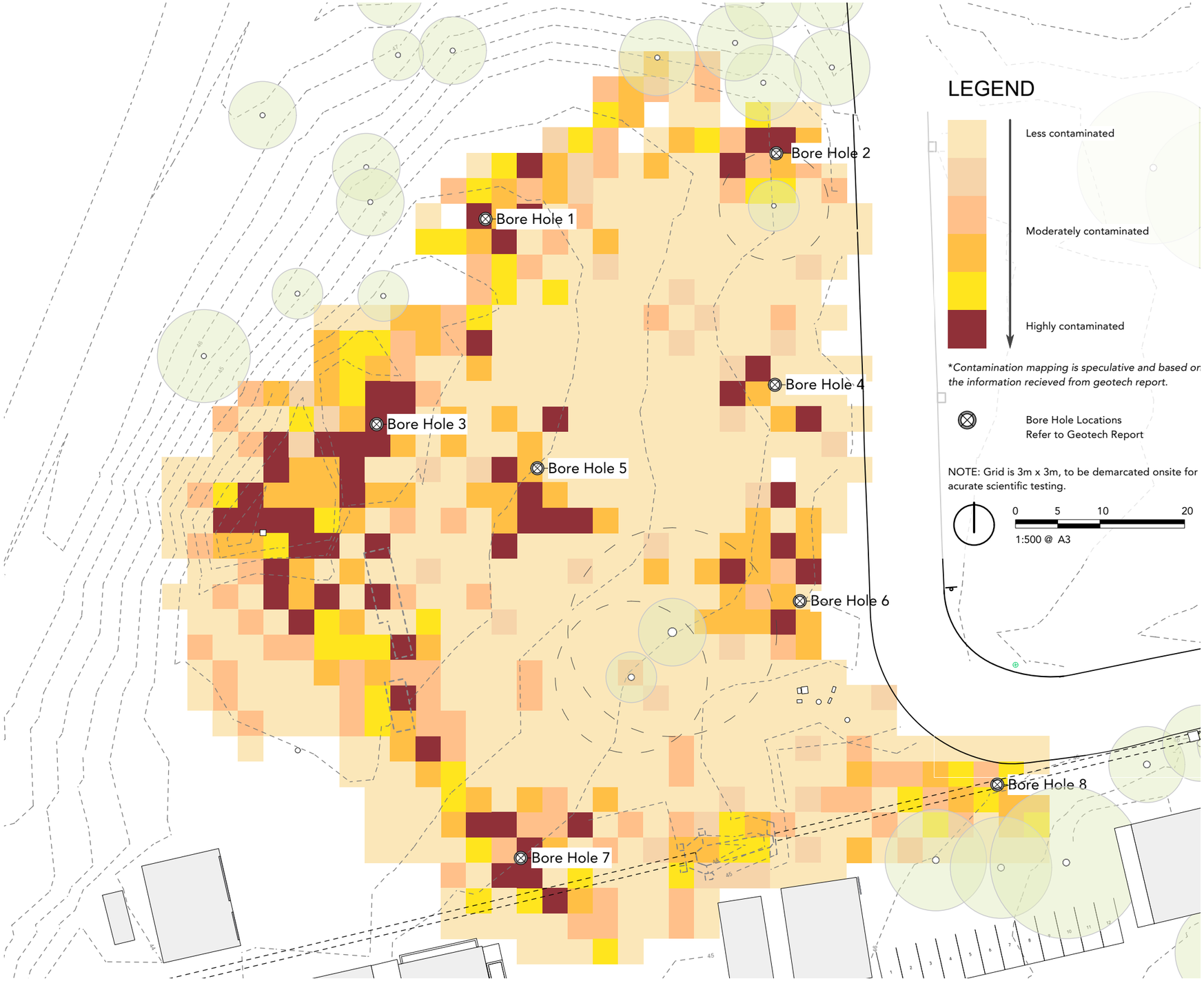


contamination condition

Geotech Findings

These findings has been informed from *Preliminary Stage 1 Site Investigation Report Appendix C: Laboratory Results Summary Tables by JK Environments 13 Mar 2023.*

- Asbestos has been detected within dumped Fibre Cement Fragment in Borehole location 5 & 6
- PFAS levels measured in Borehole location 2 & 6 were above the Human Health SAC (*Site Assessment Criteria*)
- Zinc concentrations found in Borehole 3 along with Copper concentrations found in Borehole 3 & 7 were above the Ecological SAC (*Site Assessment Criteria*)
- Total Recoverable Hydrocarbon levels found in Borehole 3 were above the SAC (*Site Assessment Criteria*)
- Borehole 3 contains the overall highest average of contaminants which measure above the SAC (*Site Assessment Criteria*).
- Processes such as erosion and stormwater mobilise contaminants in the soil, sending them to accumulate at the low point of the site and compact over time, resulting in Bore Hole 3's higher contamination reading.



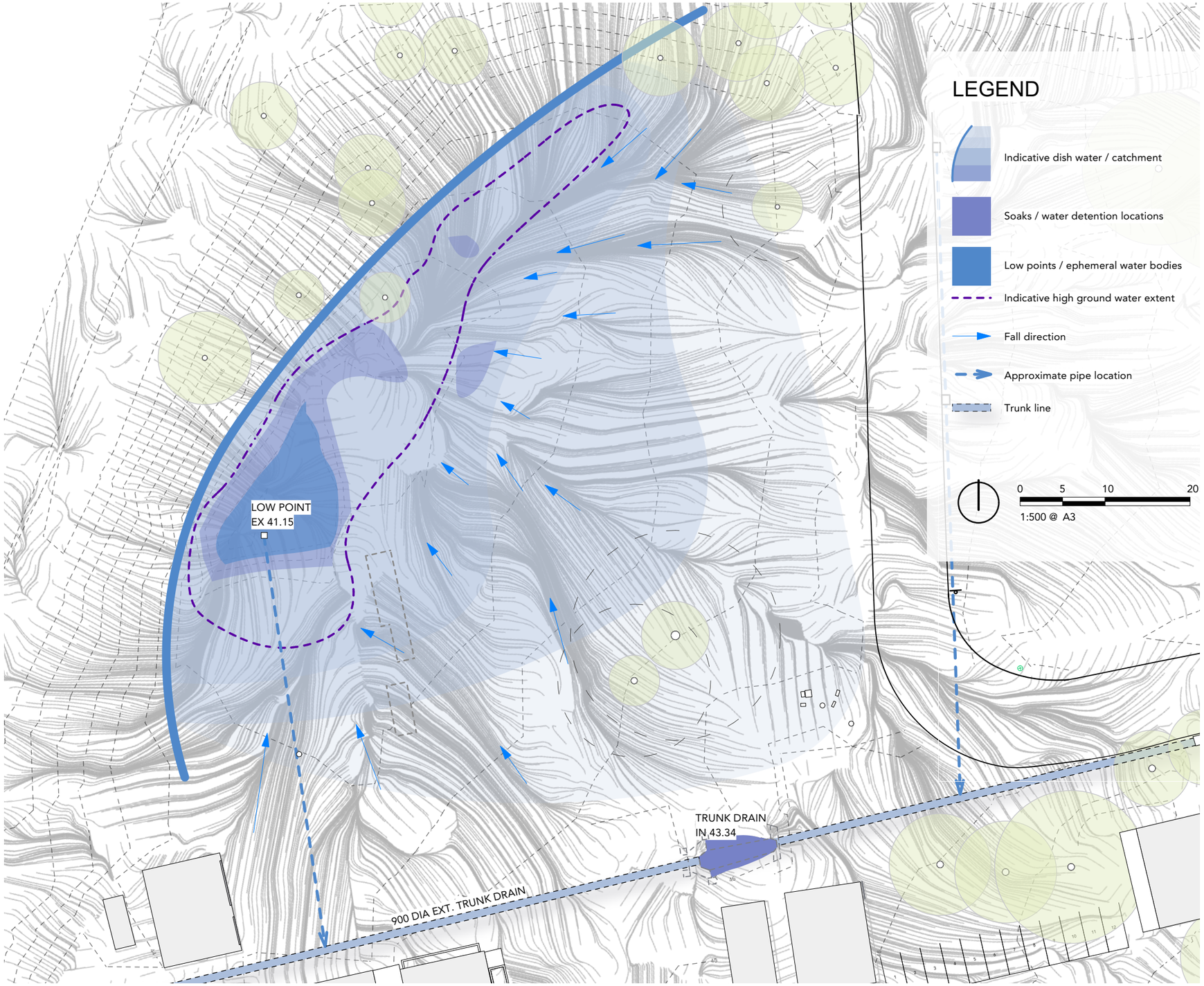
water condition

Ground Water Impacts

Ground water throughout the site poses a significant contamination risk. These findings has been informed from *Preliminary Stage 1 Site Investigation Report Appendix C: Laboratory Results Summary Tables by JK Environments 13 Mar 2023.*

- Initial groundwater measurement levels show the highest level was -2m (Borehole 3)
- Groundwater levels after completion of the overall site readings in Boreholes 1 & 3 were close to the surface level (-0.8m below the surface)
- Borehole 5 was the only hole which had dried out when it was re-measured
- A majority of the water flow on the site is channeled down towards the low point of the site

Low point of the site



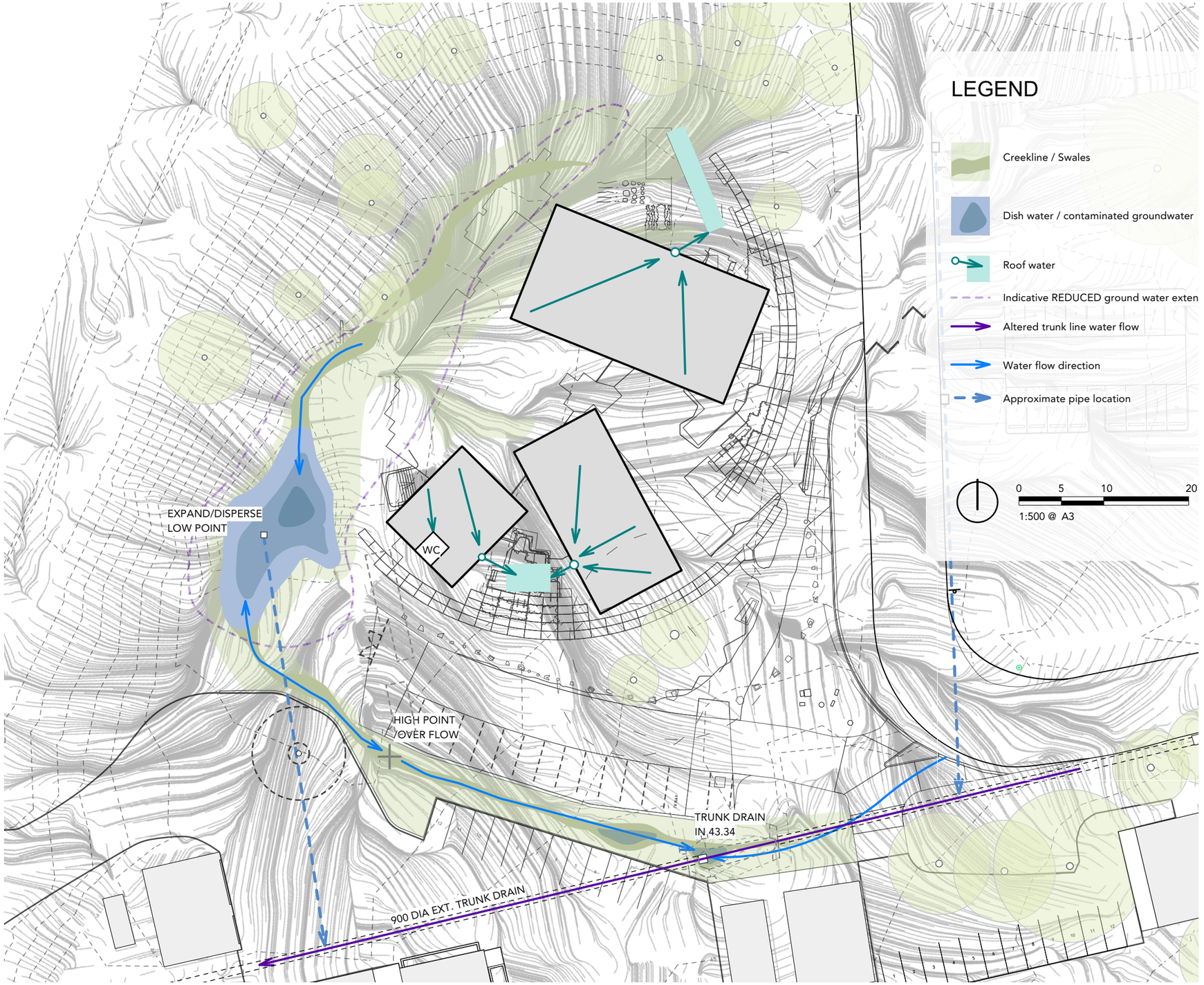
landscape approach

water approach

Water Types

- Water from all roofs is directed into water catchment areas which feed into the new creekline running through the western portion of the site
- The low point of the site has an expanded capacity; all water flow from the site is directed to this point
- The carpark features a new integrated swale which collects water from the car spots and diverts it to the expanded low point
- The existing open trunk drain pit is integrated as part of the swale system

Water treatment incorporated into car park (Silo Park, Auckland)

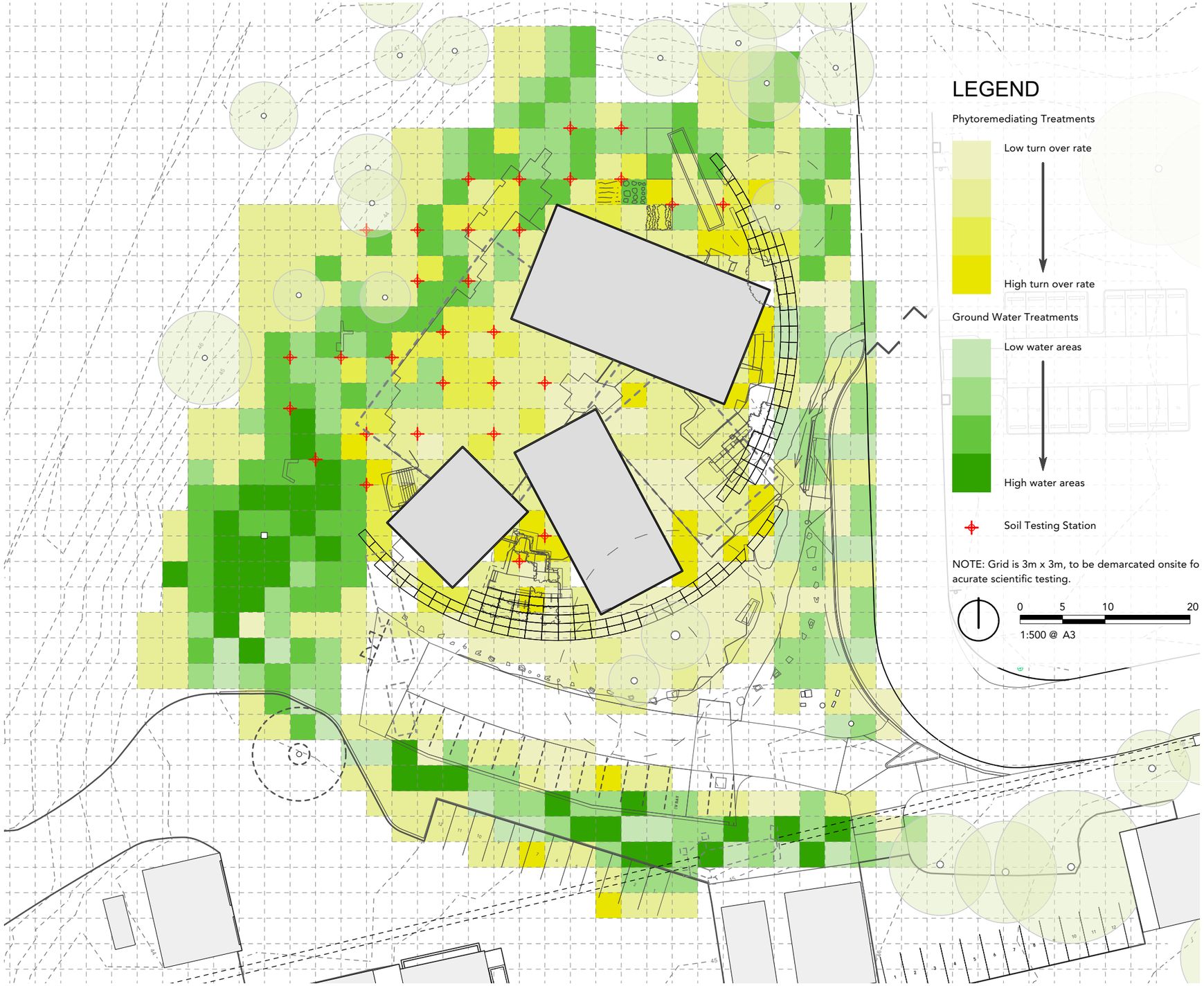


phytoremediation approach

Method

- Site is cleared of any non-required vegetation and the soil is ripped in preparation for seed sowing
- Land is divided into 3m x 3m grid with general soil testing holes located every 6m
- Planting in the 3m grids will consist of monoculture plantings and polyculture plantings
- Planting is cycled frequently to ensure that any toxins or chemicals that are remediated do not leach back into the soil
- Plants are incinerated once removed
- Hyperaccumulator Planting is based on Monthly (*highly reproductive species*), Annual, and Biennial cycles
- Areas of planting which are planted with seeds are covered with hydro-mulch to ensure adequete moisture retention

Phytoremdiation methodology at White Bay Power Station, Sydney.



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movement approach

Human Movement

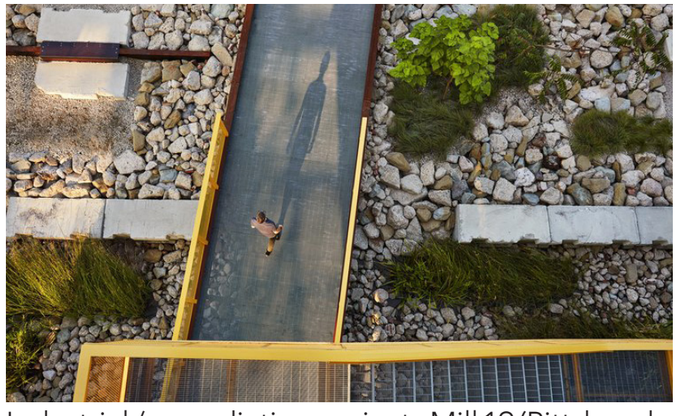
- Human movement is restricted or allowed on the ground plane once testing has been conducted. Safety will need to be considered for ground plane movement. A clean zone free of contaminants is predicted in the north of the site where testing showed low contaminants concentrations.
- Internal courtyard spaces are designed as raised plinths of gabion, gravel and paving. This breaks up the decked landscape and offers seating and gardening experiences.

Traffic Movement

- TBC

Fauna Movement

- Openings and porosity have been designed in the gabion walling to allow for ground dwelling animals to move across the site freely.



Industrial / remediation project - Mill 19 (Pittsburgh, USA)

materiality approach

Permeable Ground Surfaces

We have used raised and permeable surfaces across the site as part of the water management and phytoremediation strategies.

1. Deck: raised mesh deck with phytoremediation planting underneath creates outdoor pavilion “rooms” and connects the indoor pavilions.
2. Crushed aggregate pathways: pathways positioned above the existing ground level provide accessible connections across the site.
3. Gabion stepping stones: as an extension of the gabion wall, deck-level gabion blocks provide secondary break-out spaces and connections down into the landscape.
4. Permeable paving: permeable carparking and road surface blurs the boundary between the landscape and road.

Raised Furniture Items

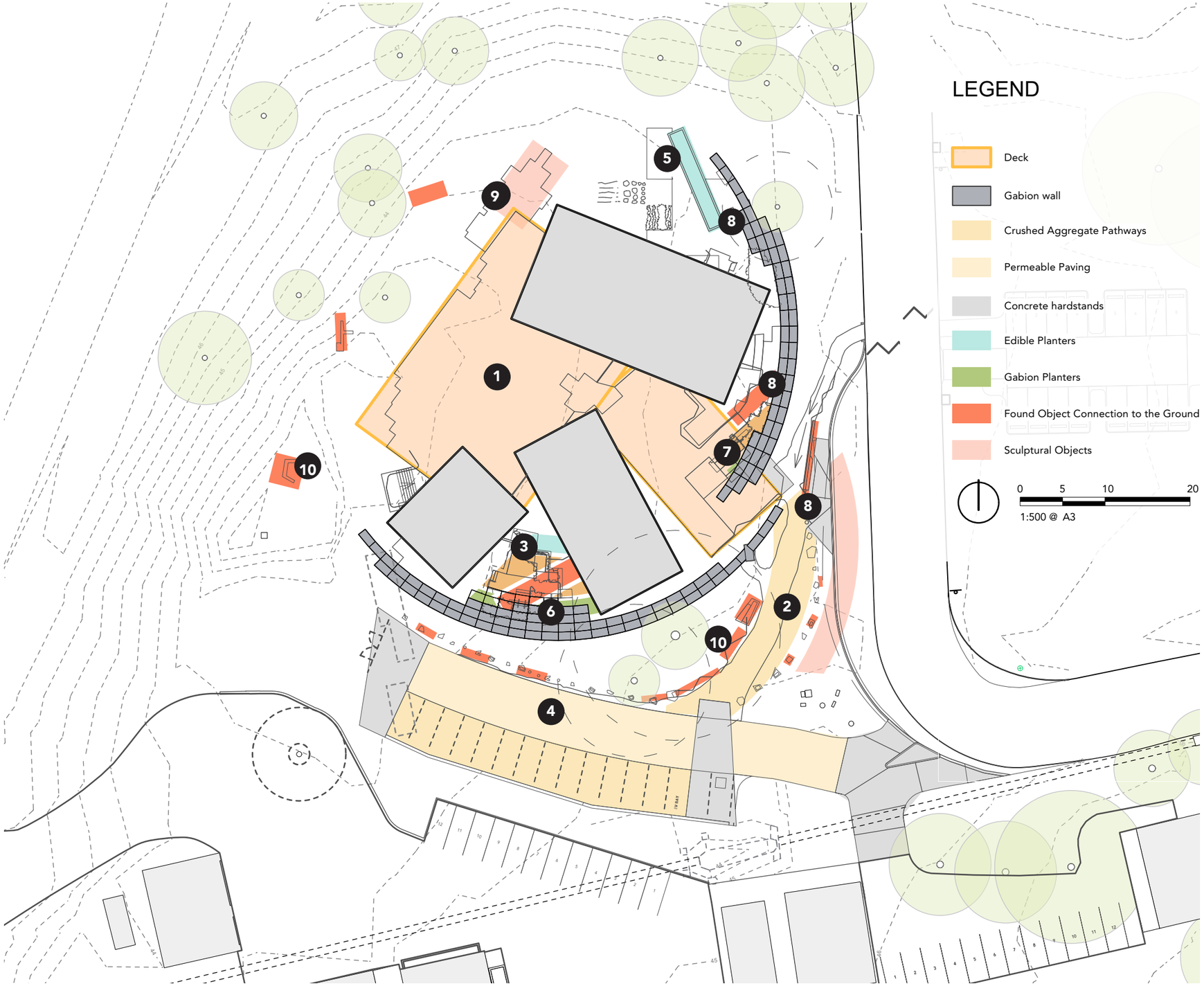
We have used raised planters and furniture to create non-contaminated spaces for habitation.

5. Edible Planters: raised planters are separated from the toxic ground to enable edible planting.
6. Gabion Planters: raised planters are separated from the toxic ground and interspersed through the gabion wall with terraced trees and feature planting to bring vegetation up to the level of the deck.
7. Seating: cantilevered timber benches are integrated with the gabion blocks as part of the secondary break-out spaces.

Experimentation: Design with Waste

We have identified locations across the site with the opportunity to incorporate unique found objects from the Shoalhaven Waste Depot that are uncovered during the detailed design and construction process.

8. Informal seating: scattered found objects in key locations for seating including along walkways and at the deck edge.
9. Connection to the ground: found objects placed as an informal connection between the raised deck and ground level.
10. Sculptural Objects: found objects incorporated as sculptural elements and planters in the landscape.



landscape plan

Notes

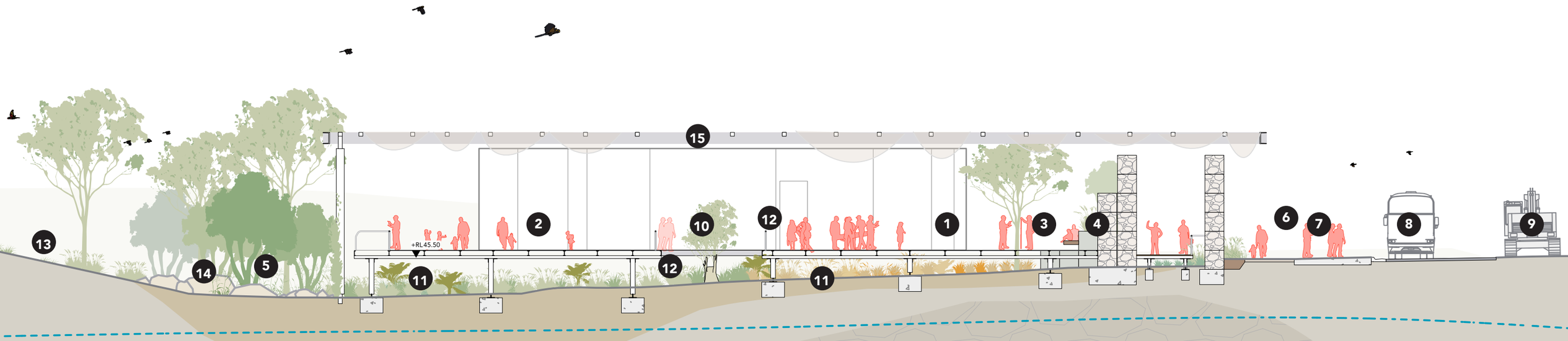
1. Multi-purpose room pavilion
2. Front of house pavilion
3. Office pavilion
4. Entry deck
5. Outdoor learning deck
6. Entry courtyard with seating
7. Staff courtyard with seating and above ground wicking garden beds
8. Creekline that enhances the natural water line
9. Water treatment at topographical low point
10. Ramped entry path lined with found objects
11. Bus drop-off zone
12. Swale
13. Significant existing tree specimens with protected regenerative zones
14. Embankment planting and regeneration
15. Sculpture garden with above ground wicking garden beds
16. Gabion wall

landscape sections

Notes

1. Steel mesh entry deck integrated with recycled timber cladding
2. Outdoor learning deck with removeable panels for below deck landscape maintenance
3. Entry courtyard with seating
4. Gabion wall with raised planting
5. Creekline that enhances the natural water line with hydological planting
6. Entry path with recycled sculptures
7. Bus drop off landing zone
8. Bus drop off bay
9. Flatrock Road
10. Regenerating existing tree cut down for safety reasons
11. Phytoremediation planting below the deck
12. Recycled pipe handrail
13. Embankment planting and regeneration
14. Opportunity for future bridging connection from the deck across to the embankment
15. Canopy structure refer to architects drawings

Key Plan



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landscape sections

Materiality

Swale as linear blue/green treatment system

Erosion/compaction control unit for a feathered edge between the hardscape and softscape

Existing scribbly gums to be retained

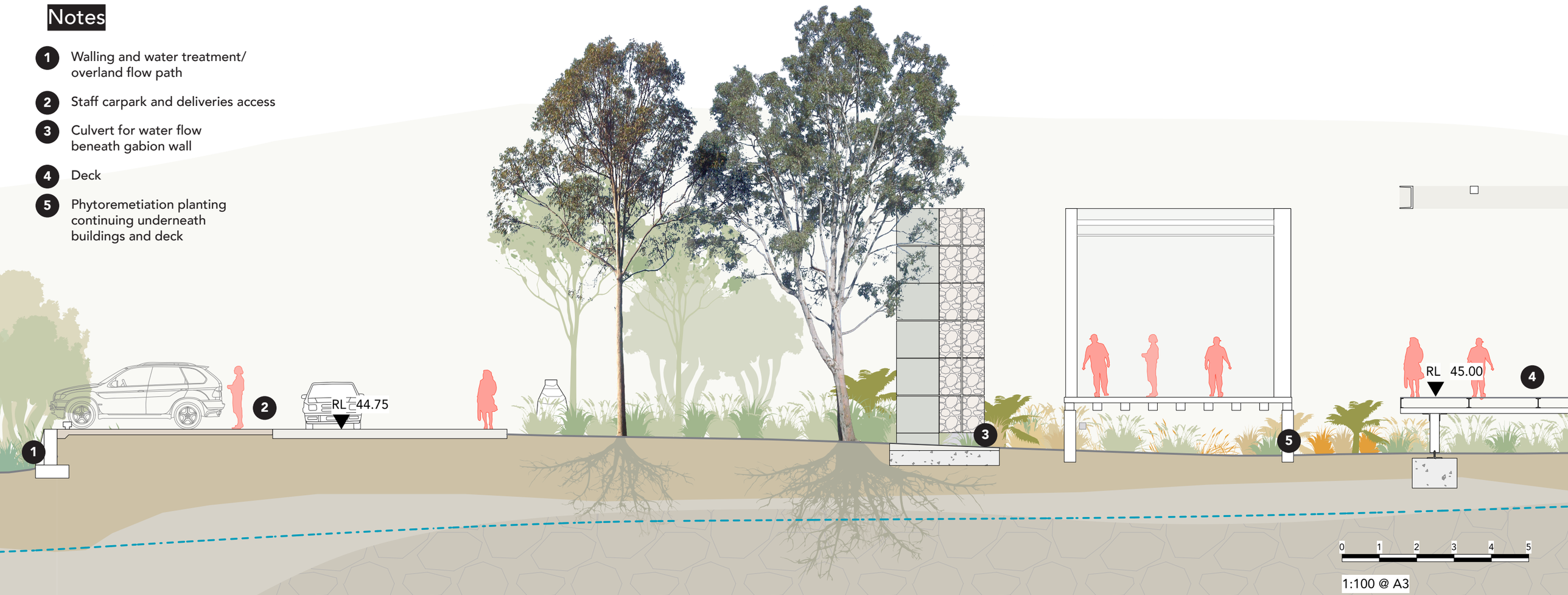
Native planting abutting gabion walls

Suspended deck over remediating landscapes

Key Plan

Notes

1. Walling and water treatment/ overland flow path
2. Staff carpark and deliveries access
3. Culvert for water flow beneath gabion wall
4. Deck
5. Phytoremetiation planting continuing underneath buildings and deck



landscape sections

Materiality

Permeable car parking spaces with integrated planting

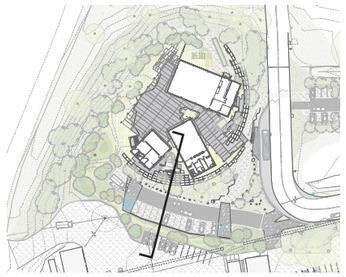
Key found objects integrated into the gabion wall

Compacted gravel terraced ground planes

Found objects integrated into the ground surface as sculptural paving

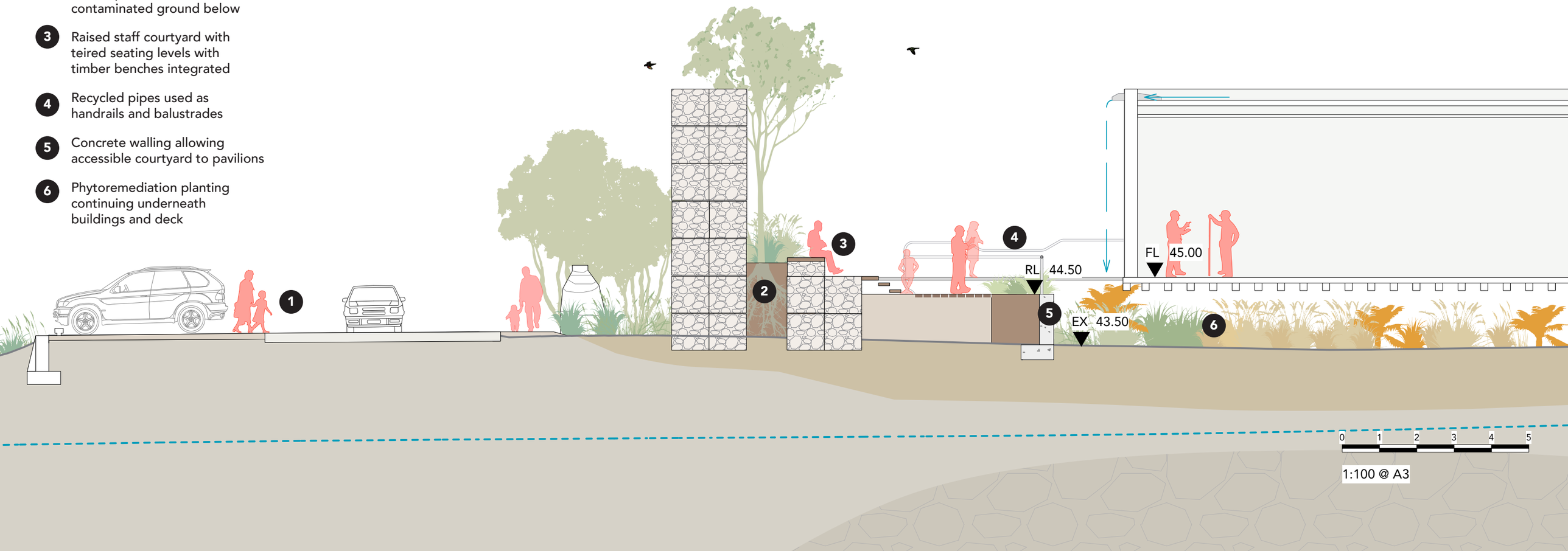
Gabion cages cladded with timber for pleasant seating nooks

Key Plan



Notes

1. Carpark and deliveries access
2. Raised planting within gabion wall, separated from the contaminated ground below
3. Raised staff courtyard with teired seating levels with timber benches integrated
4. Recycled pipes used as handrails and balustrades
5. Concrete walling allowing accessible courtyard to pavilions
6. Phytoremediation planting continuing underneath buildings and deck



landscape detail

re-use strategy

We have developed a strategy of re-use across the site in consultation with Second Edition, with the aim of incorporating as many re-used materials as possible, and providing a platform for ongoing material experimentation and testing.

Retain

- Existing trees: retain existing trees T01-T04, T06-T09. Trees must be adequately protected during works.

Re-Use

- Rocks and boulders: opportunity to re-locate boulders from surrounding areas as landscape features and informal seating. Maintain a raw/natural finish with all sharp edges removed.

Re-Purpose

- Existing tree: T05 is required to be removed as part of the proposed works. Split and re-use T05 as informal seating and artificial habitat hollows. The tree is to be felled as an entire tree segment and reworked by a local carpenter.
- Personal and scrap items: objects to be used in the gabion wall, gabion stepping stones, and gabion planter modules. Collected objects dimensioned from 0.1x0.1m up to 1.0x1.8m. These objects should be sourced from the Shoalhaven Waste Depot and from personal items within the local community. There is opportunity for community involvement to embed personal items into the gabions.
- Vessel-shaped found objects: found objects from the Shoalhaven Waste Depot to be used as raised planters. Collect objects dimensioned from 0.6m up to 3.0m. These objects could include a concrete stormwater pipe, concrete culvert, and cast-iron bathtub. Modify the objects in consultation with the landscape architect to ensure usability as a planter. Ensure all sharp edges are removed.
- Unique found objects: found objects collected from the Shoalhaven Waste Depot curated as sculptures in the landscape. Collected objects dimensioned from 1.0m up to 5.0m. These objects could include agricultural machinery and vehicles. Maintain a raw finish, ensuring all sharp edges are removed.

Re-Process

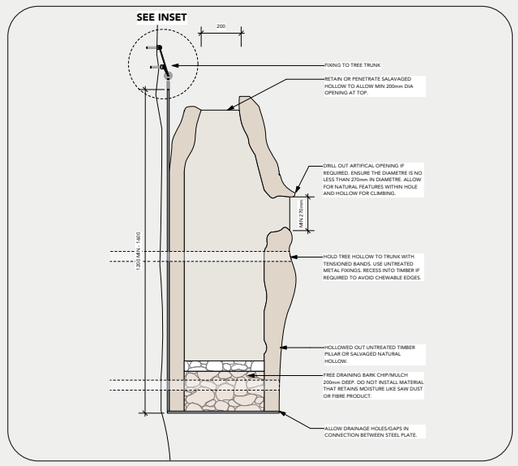
- Crushed gabion fill: recycled concrete, bricks, and tiles sourced from the Shoalhaven Waste Depot crushed into pieces dimensioned from 0.1m to 0.2m and used as fill for the gabion wall, gabion stepping stones, and gabion planter modules.
- Recycled aggregate concrete: recycled concrete, bricks, tiles, and glss sourced from the Shoalhaven Waste Depot crushed into pieces dimensioned from 0.01m to 0.05m and used as aggregate for concrete surfaces.
- Crushed glass mulch: recycled glass sourced from the Shoalhaven Waste Depot re-processed into pieces dimensioned from a fine grain to 0.01m as a glass mulch and sand, ensuring no sharp edges.

Existing Tree

Existing site trees.

Timber as a landscape crossing. Carden Hall Elementary School (Terremoto)

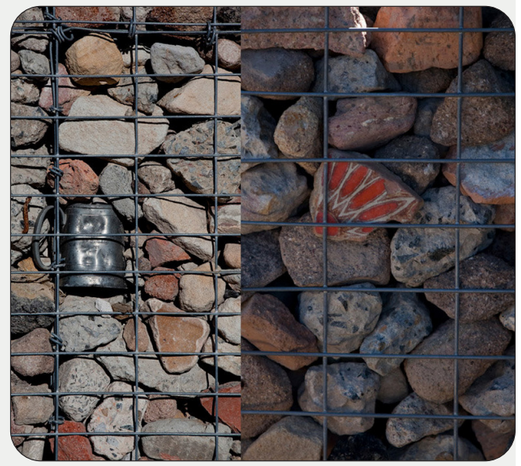
Timber salavaged in large profiles for display



Timber as an artificial raised hollow.

Gabion Wall

Objects curated as gabion infill. Raised planting contained within the gabion walls.



Objects scattered through gabion infill. Ballast Point Park (McGregor Coxall)

Raised Planters

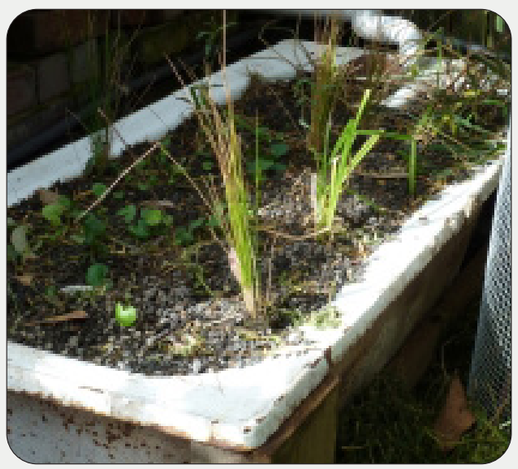
Sculptural Objects

Concrete stormwater pipes and culvets as raised planters.

Recycled metal pipes such as fire sprinkler systems used as handrails and balustrades.

Scrap metal objects distributed through the planting across the landscape. Seventh Avenue Garden LA

Place-specific objects curated through the landscape as framing devices. Cocoroc (REALMstudios)



Cast iron bath as a raised planter.

Re-crafted scrap metal as a raised planter. Cafe Ohlone (Terrenoto)

Scrap objects to frame planting beds. Seventh Avenue Garden LA (Horvitz and Terremoto)

Scrap objects used as sculptural pots. Dicker Data (Sturt Noble Associates)

material palettes

Minimise and Simplify

The material palette for the landscape is elegant in its simplicity. Material quantity is minimised by reducing surfaces and furniture to only what is necessary. The elements included are designed to serve multiple purposes as art, amenity and education. Materials are used in a way that maximises their inherent properties, their detailing and joints are simplified and exposed. The surfaces of materials also have a robust raw finish where possible to further minimise material use.

Design with Waste

The material palette identifies opportunities to incorporate re-processed aggregate, fill, and mulch as well as unique found objects from the Shoalhaven Waste Depot. Following the principle "form follows availability", many of these materials will be sourced during the detailed design and construction process. The external habitable garden spaces will be furnished with elements of repurposed industrial archaeology recovered from the Depot.

Resource Efficient Design

Where possible, materials are used from the site or surrounding local areas, have a low embodied energy, and are selected for their robustness, textural quality and reference to place. Key elements including the deck, gabion structures and paved surfaces are comprised of material units of standard dimensions to minimise offcuts and enable disassembly for ongoing maintenance.

Flexibility for Future Adaptation

Adaptation is key behind the material choice. The landscape is not a static entity, but instead an evolving space that provides a platform for material innovation and experimentation. The proposed materials are re-purposed and re-processed where possible and are interchangeable across a fixed structural grid enabling onging transformation.

Design for Disassembly

The simple material palette which minimises material variation and the number of connections, while avoiding secondary finishes, hazardous materials, composite materials, and chemical connections that are difficult to reverse means that dissassembly will be streamlined.

Surfaces

Crushed recycled aggregate path. Aggregate to include recycled concrete, tiles, and glass or similar.

Webforge steel walkway and deck. Work with standard sheet sizes to minimise offcuts including through the use of straight edged forms.

Mosaic of random recycled unit pavers (recycled pavers, tiles, concrete slabs and aggregates).

Crushed and tumbled recycled aggregates 20mm - 300mm DIA to creekline and garden beds.

Erosion/compaction control unit (precast/plastic) infilled with recycled aggregate and soil.

Cast insitu concrete with seeded/inlay recycled content located at thresholds.

Furniture

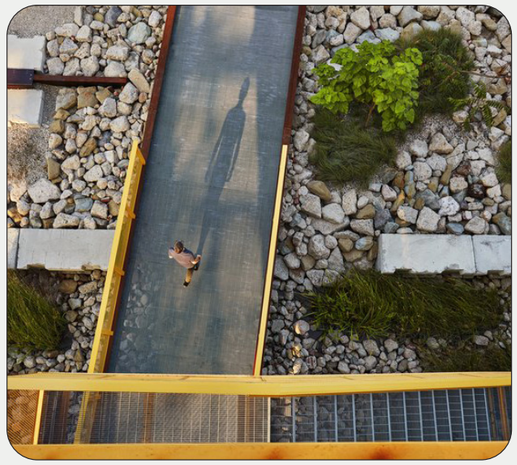
Gabion cages with compliant timber backrests.

Recycled timber lengths as informal outdoor benches.

Surplus concrete insitu forms used as seating plinths. Finishes could include adhoc boarding and varying concrete types layered.

Gabion walling fitted with supporting steel structures to provide seating finishes/materials.

Spaces



Suspended decking over remediating landscapes.

Pourous and integrated landscaped carparks.

Internal courtyard spaces.

Demarcated soil testing zones.

detail design

Planting in Stepped Gabion

1. Terraced gabion blocks contain pockets of raised soil 2-3m deep separated from the contaminated ground and used for native planting including canopy trees
2. Planting within the gabion blocks
3. Gabion block
4. Recycled fire sprinkler pipes used as handrails and balustrades. Including active sprinklers for irrigation.

Cantilevered Bench

1. Recycled timber bench cantilevered off gabion wall
2. Recycled timber bench surface on top of gabion block
3. Planting within the gabion blocks

Entry Courtyard

1. Recycled timber bench cantilevered off gabion wall
2. High-rotation phytoremediation planting adjacent to the edge
3. Planting within the gabion blocks

Below Deck Planting

1. Removable permeable deck panels enable ongoing maintenance of the phytoremediation groundcover planting
2. Low-rotation phytoremediation below deck planting
3. High-rotation phytoremediation planting adjacent to the deck edge
4. Metal stake
5. Rope delineating 3x3m grid for ongoing observation and analysis

Gabion Stepping Stones

1. Gabion block stepping stones positioned to enable maintenance access into the landscape
2. Found objects placed as sculptures amongst the paving
3. Planting at natural ground level with high-rotation phytoremedation planting palette at gabion block edge

landscape evolution

remediation staging

Staging overarching framework

Phytoremediation is implemented in three main stages: ***Inception, Transition and Native Ecologies***

The stages respond to the various changes in the remediation of the site, from hyperaccumulator uptake and overall contamination levels. The stages are designed to systemmatically phase the RRLC through the process of decontamination.

Stage 1: Inception

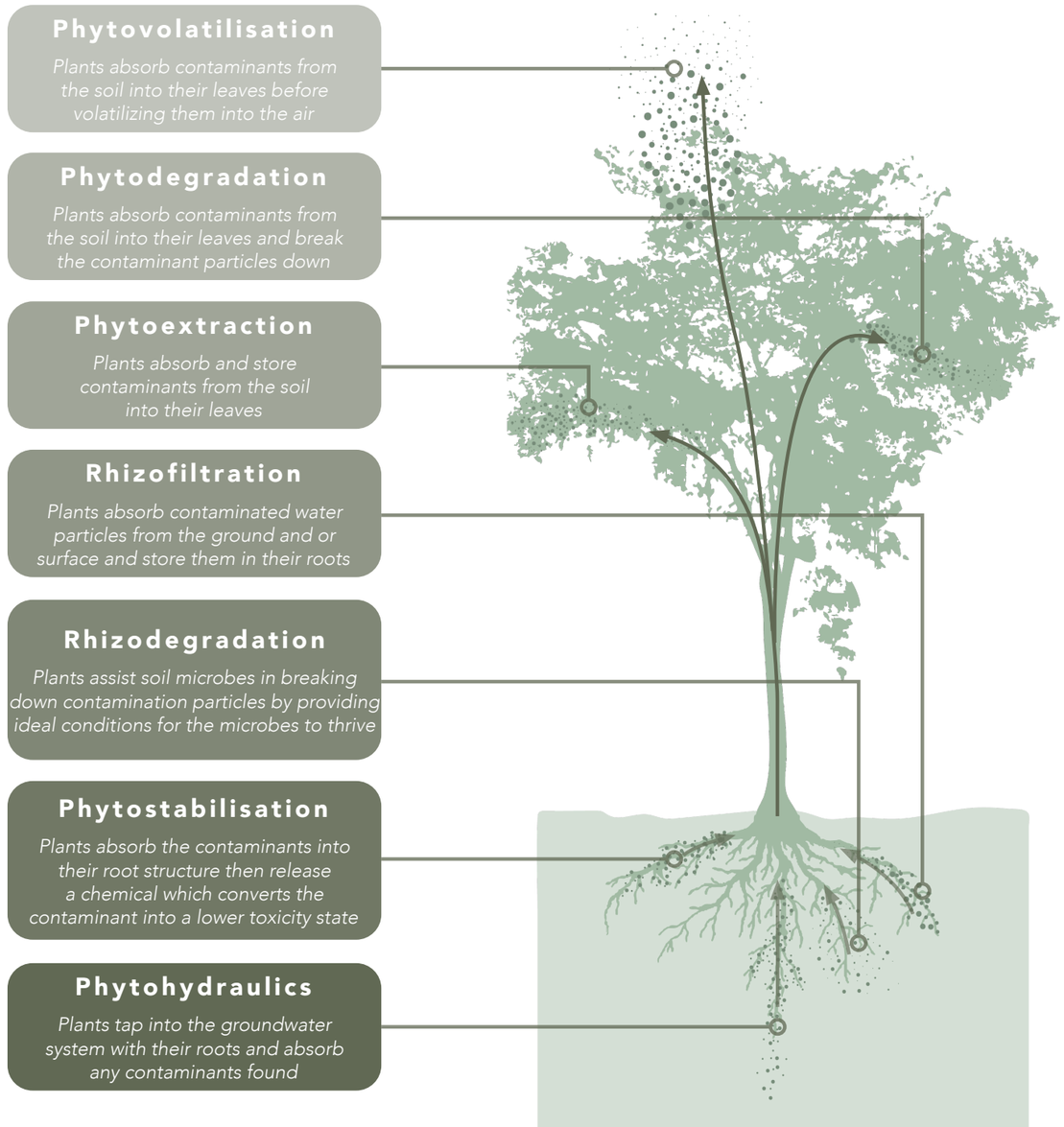
- Initial cleanup of the site; all unnecessary vegetation is removed
- Soil is ripped and prepared for seeds to be sown
- Soil testing areas are designated and grid layout is applied at 1:1 scale on site
- Initial soil samples are collected and planting is implemented in contaminated areas

Stage 2: Transition

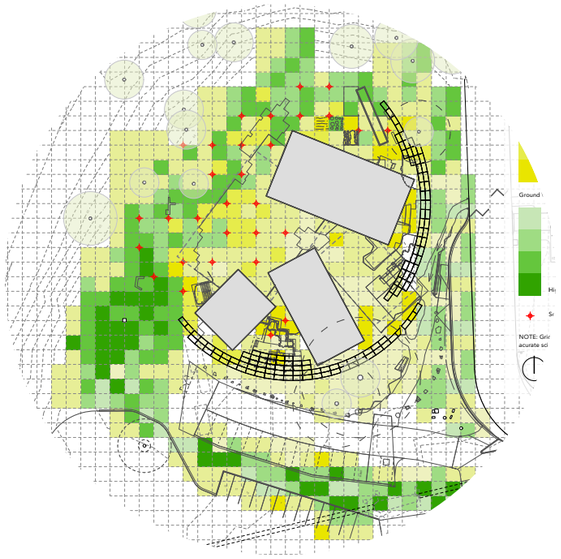
- Soil testing program continues throughout the planted areas
- Areas of planting may decrease depending on the contaminant levels in the testing sites
- Planting palette transitions into Native revegetation in areas of nil to low contamination values

Stage 3: Native Ecologies

- Overall Planting palette shifts into native revegetation with plant selection being shaped by plants from Plant Community Type (PCT) ***3654 Shoalhaven lowland bloodwood shrub forest***



STAGE 1 - INCEPTION



Stage 1: Inception

- Initial cleanup of the site; all unnecessary vegetation is removed
- Soil is ripped and prepared for seeds to be sown
- Soil testing areas are designated and grid layout is applied at 1:1 scale on site
- Initial soil samples are collected and planting is implemented in contaminated areas
- Soil and ground is prepared before Architecture is constructed to ensure easy transition into phytoremediation planting strategy

Future Architecture

Ground preparation for phytoremediation to take place before construction

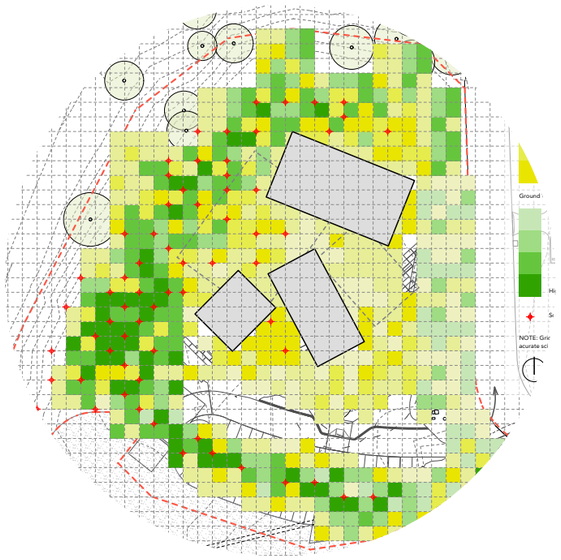
Rubble piles

Recycled material from the tip to create new waterway banks and various sculptural forms

Hydromulch

Utilised to protect and promote new sapling and seed growth

STAGE 2 - TRANSITION



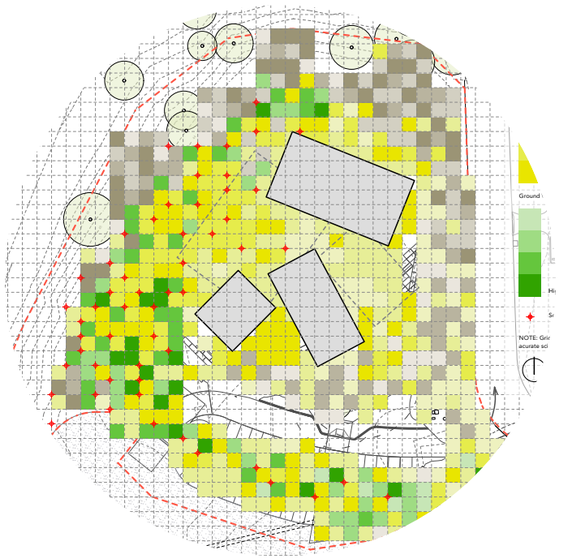
Stage 2: Transition

- Soil testing program continues throughout the planted areas
- Areas of planting may decrease depending on the contaminant levels in the testing sites
- Planting palette transitions into Native revegetation in areas of nil to low contamination values
- Main planting consists of Sunflower (Helianthus annuus) and various grass / sedges

Canna Lily
Canna indica
Hydrological Plant

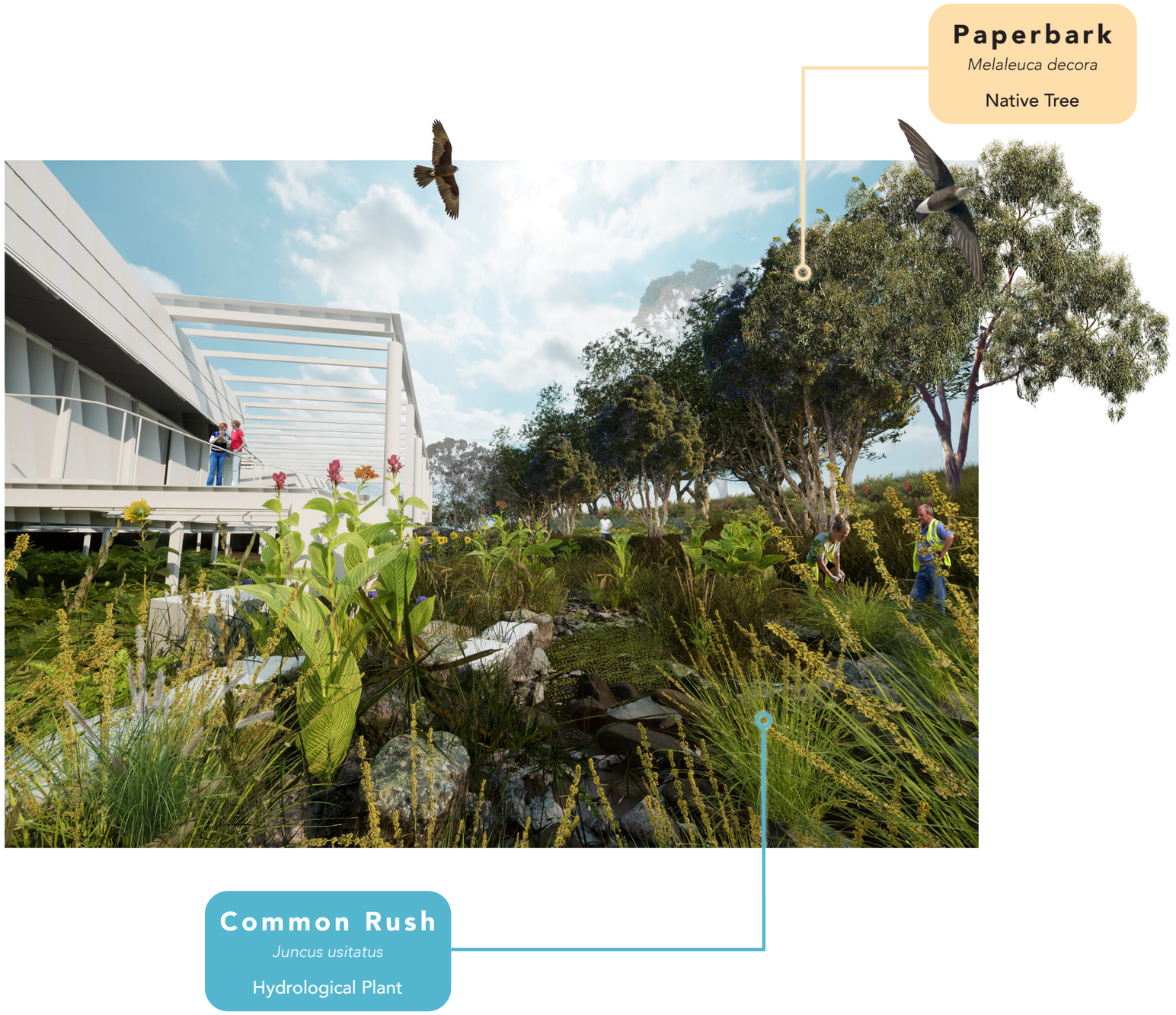
Sunflower
Helianthus annuus
Phytoremediation Plant

STAGE 3 - NATIVE ECOLOGIES



Stage 3: Native Ecologies

- Overall Planting palette shifts into native revegetation with plant selection being shaped by plants from Plant Community Type (PCT) 3654 Shoalhaven lowland bloodwood shrub forest
- Plantings include Nowra Heath Myrtle (Triplarina nowraensis) and Paperbark Tree (Melaleuca quinquenervia)
- Remnant planting from previous phytoremediation plants will be retained including Canna Lily (Canna indica) and Sunflower (Helianthus annuus)
- Greater attention in vegetating phenomenological creek which runs to the low point



planting staging

Planting Selection

Plants utilised within Stages 1 & 2 are predominately hyperaccumulator plants.

The site currently has high concentrations of heavy metals including Lead, Zinc, Copper and Chromium, along with PFAS, Hydrocarbons and Asbestos which have all been revealed within the indicated boreholes in the provided Geotech report (Preliminary Stage 1 Site Investigation Report by JK Environments 13 Mar 2023) . There is potential that there are additional contaminants surrounding these boreholes which have not been documented.

Planting is cycled and rotated based on the performance and response to the contaminants in the soil. Areas of higher contamination levels will require higher plant turn over rates to ensure that contaminants are not leaching back into the soil and recontaminating the ground plane. Plants are also chosen for their lifecycles, with Annual plants preferred for their fast growing capacity and short life expectancy.

Planting is divided into three main mix palettes: Phytoremediation planting, Hydrological planting and Native Revegetation Planting. Trees will also feature in each of all the three palettes. The Phytoremediation planting palette is designed to be weaved throughout the site including through the gabion wall and is primarily geared towards soil decontamination. Hydrological planting is geared towards groundwater and water remediation, specifically designated for the swale areas and the new implemented creekline. Plants in this mix are primarily grass types which can withstand high moisture. Trees with the capacity to tap into the groundwater table with their roots are also included within this mix.

Phytoremediation Plants

Plants within this palette are known as Hyperaccumulators. These plants have the ability to remove contaminants out of the soil through various means. This palette will primarily be used in Stage 1 of the project, which focuses on remediating the damaged and contaminated soils. Plants in this palette include Sunflower (Helianthus annuus) and Mustard (Brassica juncea).

Hydrological Planting

Plants within this palette are also comprised of hyperaccumulators, however, they primarily remediate toxins and contaminants found within water sources. These plants will also be used in Stage 1 but planting of these species may continue into Stage 2 and 3. Hydrological planting will occur around the new implemented creek bank as well as the low point. Plants in this palette include Canna Lily (Canna indica), Reed Canary Grass (Phalaris arundinacea) and Papyrus (Cyperus papyrus).

Native Planting

This strategy considers the surrounding vegetation community of Shoalhaven lowland bloodwood shrub forest. This is through a transition to native species in the wetland, shaded and embankment zones. A combination of endemic species from PCT 3654 Shoalhaven lowland bloodwood shrub forest and other NSW natives will be selected to ensure a healthy ecology establishes, whilst also not potientially locking the site up for future operations.

Phytoremediation Planting (High Turn Over)

- Sunflower *Helianthus annuus*
- Alyssum *Alyssum wulfenianum*
- Blue Lupin *Lupinus angustifolius*
- Copper Flower *Haumaniastrum robertii*
- Indian Mallow *Abutilon avicennae*
- Sweet Pea *Lathyrus odoratus*
- Kangaroo Grass *Themada triandra*
- Switchgrass *Panicum virgatum*
- Vetivar *Chrysopogon zizanioides*
- White Mustard *Sinapsis alba*
- Mustard *Brassica juncea*
- Tussock Grass *Poa labillardierei*
- Tall Sedge *Carex appressa*
- Red Fescue *Festuca rubra*
- Red Clover *Trifolium pratense*
- Pig Face *Carpobrotus glaucescens*
- Corn *Zea mays*
- Kale *Brassica oleracea*
- Silverbeet *Beta vulgaris cicla*
- Common Poppy *Papaver rhoeas*

Hydrological Planting

- Canna Lily *Canna indica*
- Duckweed *Lemna minor*
- Papyrus *Cyperus papyrus*
- Southern Cat-tail *Typha domigensis*
- Giant Duckweed *Spirodela polyrhiza*
- Reed Canary Grass *Phalaris arundinacea*
- White Mustard *Sinapsis alba*
- Common Rush *Juncus usitatus*
- Cypress Sedge *Euphorbia cyparissias*

Trees

- Broad Leaved Hickory* *Acacia falciformis*
- Sunshine Wattle* *Acacia terminalis*
- Old Man Banksia* *Banksia serrata*
- Black Sheoak* *Allocasuarina littoralis*

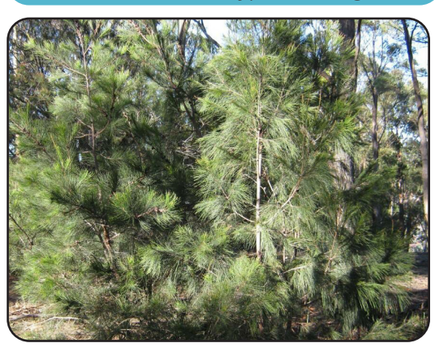
Mustard *Brassica juncea*

Sunflower *Helianthus annuus*

Kangaroo Grass *(Themada triandra)*

Southern Cat-tail *Typha domigenus*

Canna Lily *(Canna indica)*



Black Sheoak* *Allocasuarina littoralis*

* Plants found in Shoalhaven lowland bloodwood shrub forest. Note: Planting to be a mix of native plants from NSW and local endemic species.

Phytoremediation Planting

- Sunflower *Helianthus annuus*
- Alyssum *Alyssum wulfenianum*
- Blue Lupin *Lupinus angustifolius*
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- Switchgrass *Panicum virgatum*
- Vetivar *Chrysopogon zizanioides*
- White Mustard *Sinapsis alba*
- Mustard *Brassica juncea*
- Tussock Grass *Poa labillardierei*
- Indian Grass *Sorghastrum nutans*
- Common Bentgrass *Agrostis capillaris L.*
- Ray Grass *Lolium perenne*
- Pig Face *Carpobrotus glaucescens*
- Onion *Allium cepa*
- Common Poppy *Papaver rhoeas*

Hydrological Planting

- Canna Lily *Canna indica*
- Common Reed *Phragmites australis*
- Reed Canary Grass *Phalaris arundinacea*
- Common Rush *Juncus usitatus*

Natives

- Mat Rush* Lomandra confertifolia
- Tussock Grass Poa spp.
- Purple Coral Pea Hardenbergia violacea
- Ivy-leaved violet Viola hederacea
- Slender Rice Flower* Pimelea linifolia

Trees

- Red Bloodwood* Corymbia gummifera
- Rough Barked Apple* Angophora floribunda

Onion *(Allium cepa)*

Purslane *(Portulaca oleracea)*

Common Poppy *Papaver rhoeas*

Common Rush *Juncus usitatus*

Common Reed *Phragmites australis*

Red Bloodwood* *Corymbian gummifera*

* Plants found in Shoalhaven lowland bloodwood shrub forest. Note: Planting to be a mix of native plants from NSW and local endemic species.

STAGE 3 - NATIVE ECOLOGIES

Native - Mid Storey / Shrubs

- **Native Fuchsia*** Correa reflexa
- **Pink Heath*** Epacris impressa
- **Hairpin Banksia*** Banksia spinulosa
- **Holly Lomatia*** Lomatia ilicifolia
- **Bottle Brush** Callistemon linearifolius
- **White Correa** Correa alba
- **Gymie Lily** Doryanthes excelsa
- **Dwarf Sheoak** Allocasuarina nana
- **Christmas Bush** Ceratopetalum gummiferum
- **Flaky Barked Tea Tree*** Leptospermum trinervium

Native - Ground Cover / Grasses / Ferns

- **Trailing Guinea Flower*** Hibbertia empetrifolia
- **Flax Lily** Dianella longifolia
- **Rasp Fern** Doodia aspera
- **Rough Tree Fern** Cyathea australis
- **Mat Rush** Lomandra multiflora
- **Kangaroo Grass** Themeda triandra
- **Swamp Lily** Crinum pedunculata
- **Swamp Fern** Blechnum sp.
- **Tall Sedge** Carex appressa.

Trees

- **Honey Myrtle** Melaleuca decora
- **Blue Leaved Stringybark*** Eucalyptus agglomerata
- **Smoothed Barked Apple** Angophora costata

Bottle Brush *Callistemon linearifolius*

Tea Tree* *Leptospermum trinervium*

Trailing Guinea Flower* *Hibbertia sp.*

Swamp Lily *Crinum pedunculata*

Stringybark* *Eucalyptus agglomerata*

Smoothed Bark Apple *Angophora sp.*

* Plants found in Shoalhaven lowland bloodwood shrub forest. Note: Planting to be a mix of native plants from NSW and local endemic species.

additional research

phytoremediation approach

What is Phytoremediation?

Phytoremediation is a branch of phytotechnologies which involves the utilisation of specific plants known as hyperaccumulators to remove toxins, heavy metals and contaminants out of the ground without the requirement to transport soil off site for treatment.

Hyperaccumulator plants are sown or planted into the ground in specific areas and begin to remove toxins out of the soil. Hyperaccumulator plants vary in their toxin uptake effectiveness and what contaminants they are able to remediate. The phytoremediation process relies on the cycling of plants, to ensure that plants are not over-accumulating and leaching toxins back into the soil. Once they have accumulated toxins to their maximum potential, they are removed and sent for incineration to ensure that the contaminants are not leaked back into the environment.

There are seven main types of hyperaccumulators which each remove toxins from the soil in varying ways. These include: ***Phytovolatilisation, Phytodegradation, Phytoextraction, Rhizofiltration, Rhizodegradation, Phytostabilisation and Phytohydraulics***.

Phytovolatilisation

Plants absorb contaminants from the soil into their leaves before volatilizing them into the air

Phytodegradation

Plants absorb contaminants from the soil into their leaves and break the contaminant particles down

Phytoextraction

Plants absorb and stores contaminants from the soil into their leaves

Rhizofiltration

Plants absorb contaminated water particles from the ground and or surface and store it in their roots

Rhizodegradation

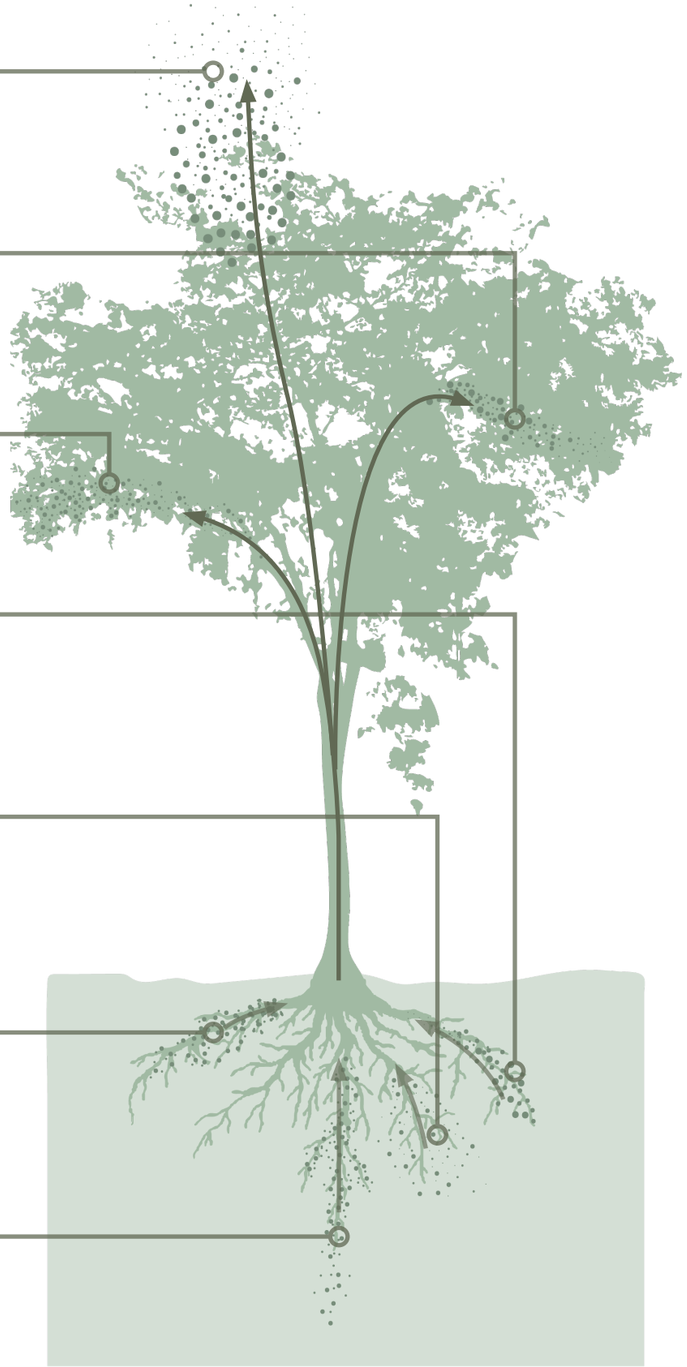
Plants assist soil microbes in breaking down contamination particles by providing ideal conditions for the microbes to thrive

Phytostabilisation

Plants absorb the contaminants into their root structure then release a chemical which converts the contaminant into a lower toxicity state

Phytohydraulics

Plants tap into the groundwater system with their roots and absorb any contaminants found



Case Study 1

Delprat Gardens

Newcastle Industrial Heritage Association / University of Newcastle

Project Location:
Mayfield, Newcastle NSW

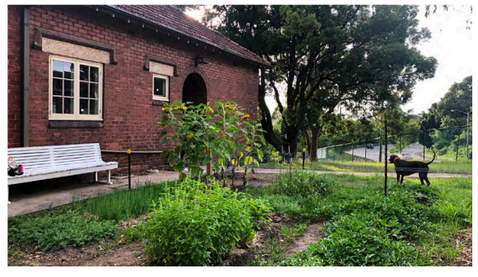
Project Size:
10,440m²

The Delprat Gardens located in Newcastle is a research project site with the focus of utilising phytoremediative technologies to remediate a contaminated former BHP site. The project uses a wide variety of hyperaccumulator plants each with different functions and outputs to remove toxins out of the soil. The site is divided into several thematic planting areas, such as a Flowering meadow, Kitchen garden, Cottage garden and an Orchard grove garden.

The site was cleared of existing vegetation and soil ripping occured to help with soil compaction. An irrigation system was installed to ensure survival of the plants.

Plants were hand sown into the ground by workers and covered with a general groundcover mulch.

The hyperaccumulators that have been planted on the site have been successfully proven to remove various heavy metals and contaminants including copper and lead out of the soil.



Case Study 2

Power Plants Phytoremediation

University of Technology Sydney / University of Newcastle

Project Location:
Rozelle, Sydney NSW

Project Size:
580m²

The Power Plants Phytoremediation was a pilot project conducted at the former White Bay Power Station in located west of Sydney. The focus of the project was to test the feasibility of phytoremediation as a regenerative framework for contaminated sites. A small portion of the site was divided into several planting plots which were planted with various hyperaccumulator plants to understand how each responded to the contamination.

The site was cleared of existing vegetation and soil ripping occured to help with soil compaction. An irrigation system was installed to ensure survival of the plants.

Planting took the form of sprinkling seeds into the various plots, with hydro-mulch providing a protective covering. Planting was subsequently investigated and tested after 1 month, 2 months and 6 months.

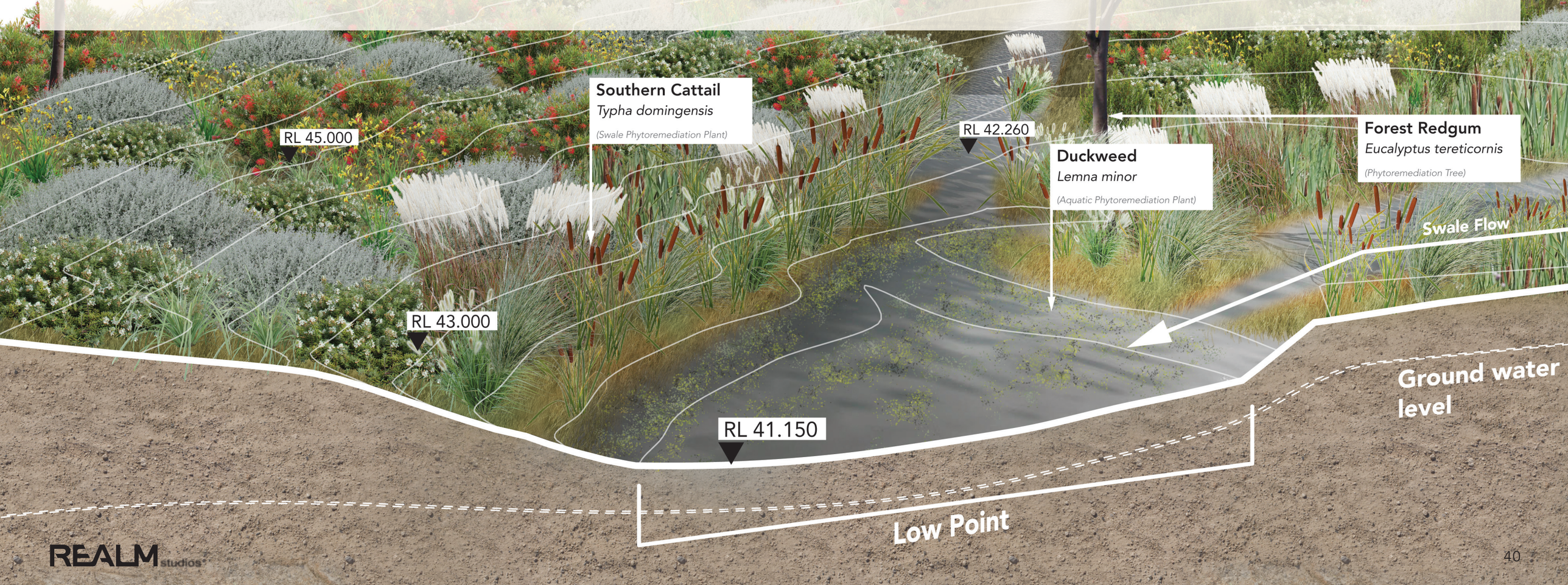
The hyperaccumulators utilised on the site were proven to be effective in remove the various heavy metals such as Arsenic and Vanadium.

Ground Water Strategy

Groundwater holes 1 & 3 have both been measured to have risen to -0.8m from the ground plain, which will result in potential contamination of the low point currently in the western portion of the site.

This area will form part of the broader water story and remediation of water throughout the site. Plants along these corridors will consist of aquatic hyperaccumulators which will be planted along the edge of the low point or within the waterbody itself.

	Initial groundwater level	Ground level on completion	Borehole research extents	Existing Level of Borehole
Borehole 1	-3m	**-0.8m**	5.3m	43.2m
Borehole 2	-6m	-3.9m	7.3m	44.4m
Borehole 3	-2m	**-0.8m**	4.5m	42.9m
Borehole 4	-6m	-2m	7.5m	44.5m
Borehole 5	-	Dry	6m	43.3m
Borehole 6	-7m	-2.2m	7.5m	43.3m
Borehole 7	-3m	-3.4m	6m	44.5m
Borehole 8	-2.8m	-2.8m	6m	45.9m



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