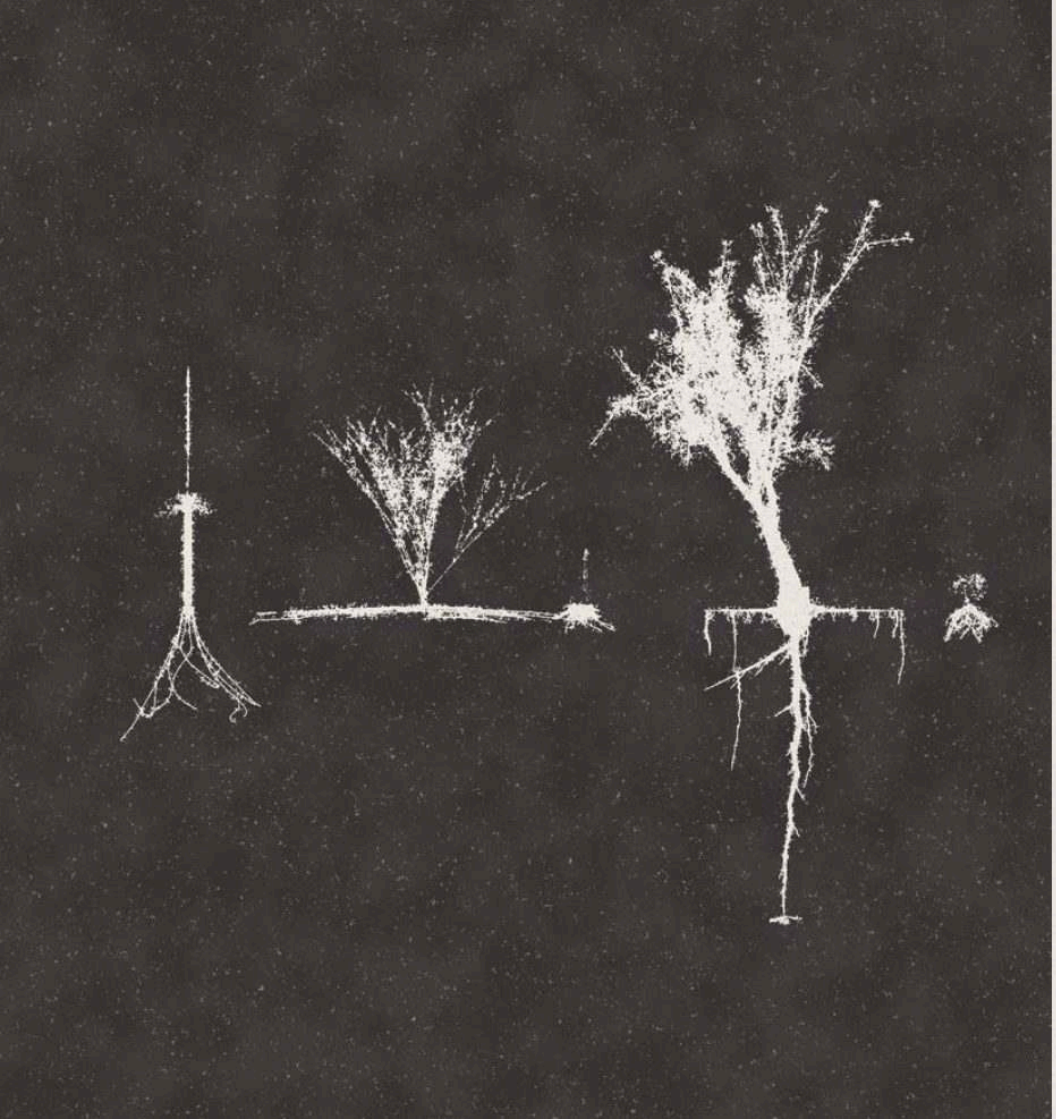


ARCHITECTURAL THESIS PROJECT
PROJECT PROPOSAL

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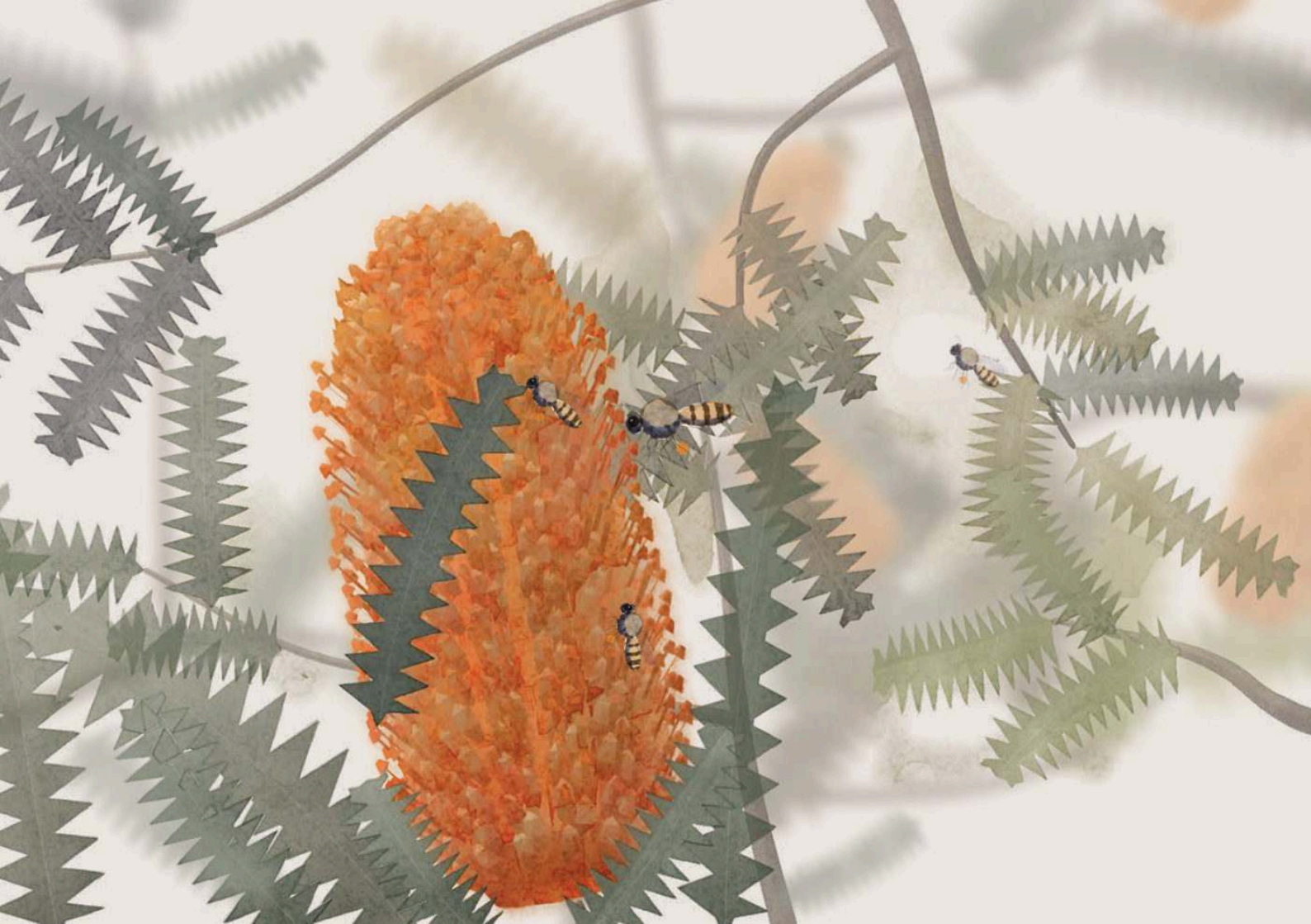
01

THESIS FRAMING

IN THIS SECTION

The question and abstract
Definitions
The problem and the claim
Literature review and position
Significance and method
The Design Companion
Framing the tool
Warwick Bushland
Semester one: the Death Manual





THE QUESTION

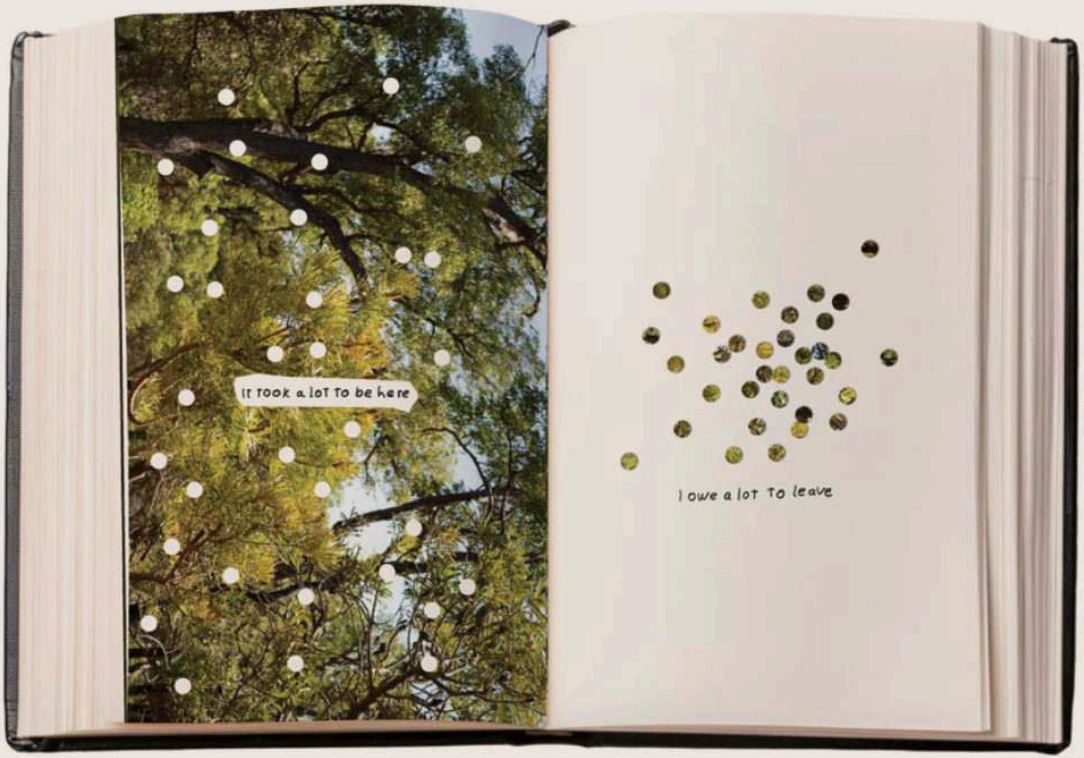
How can a community space be designed to earn its ecological footprint?

This project begins with a building's death, drafting its ecological restoration protocol before any design decision is made, to ask whether architecture can earn, rather than assume, its right to occupy a site.

A banksia flower spike with four bees. Watercolour by Author.

THE PROJECT

This project proceeds from the position that a building must earn its place ecologically before it can claim to serve a community socially. That earning is not a gesture made at the start of design; it is a commitment renegotiated across the entire life of the building, from the conditions that permit its construction to the protocols that govern its eventual return to the ground.



Collage by Author, after Unidentified artist, I've Got a Lot to Pine About, n.d., collage, digital image

ABSTRACT

How can a community space be designed to earn its ecological footprint? This project investigates that question not as a problem to be solved but as a condition to be sustained across the building's entire life and beyond. It proposes a design method that reverses the conventional architectural sequence. Rather than beginning with a programme and treating ecological impact as a compensatory afterthought, the project begins with a Death Manual: an ecological restoration protocol specifying the conditions a site must return to when the building's life is over. The Death Manual is the first drawing. Every subsequent decision is held against it.

This booklet is a working document, not a resolved one. What follows traces several parallel investigations: an ecological inventory, a reversed design sequence, a community mapping exercise, a speculative digital tool, each followed far enough to see where it leads, and none prematurely closed.

The gaps, the crossings-out, and the paths not taken are as much part of the research as the findings.

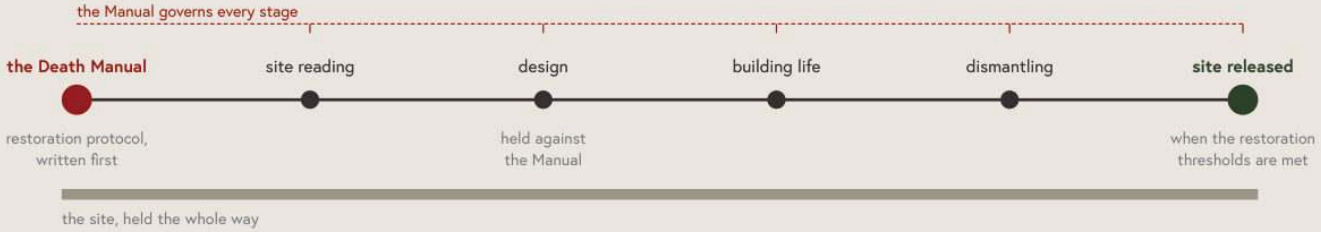
The method is tested at Warwick Bushland, a 65-hectare banksia woodland remnant on Perth's Swan Coastal Plain, selected through a randomised hat draw that deliberately surrendered the designer's authority over site selection. The question the project asks is not specific to this site. It asks whether any building, on any ecologically active ground, can demonstrate that its presence contributes more than it takes, and whether community can be supported by architecture without being prescribed by it (Till 2009, 48; Kimmerer 2013, 9; Mathews 2005, 40).

Drawing on Jeremy Till's argument that architecture too often assumes the right to act on a site without earning it (Till 2009, 48), Robin Wall Kimmerer's ethic of reciprocity, which frames ecological knowledge as an exchange rather than an extraction (Kimmerer 2013, 9), and Cedric Price's insistence that architecture should be designed for its own disappearance (Mathews 2005, 40), the project positions impermanence not as failure but as an ethical commitment. The building does not arrive with authority. It negotiates its footprint against what is already alive, already tended, and already meaningful, and **it begins by promising what it will give back**.

THE CONVENTIONAL SEQUENCE



THIS PROJECT, REVERSED



The usual sequence, and the reversed one: the Death Manual is drawn first. Figure by Author.

DEFINITIONS

1. Community is not just a fixed group of people bound by shared identity or geography; it is a condition that emerges and dissolves and re-emerges through sustained negotiation between people, place, and time. It cannot be assumed into existence by a building, nor delivered through good intentions alone. Jeremy Till argues that architecture cannot produce social outcomes by design; it can only create conditions in which they might become possible (Till 2009, 84).

2. Ecology is a web of relationships between living conditions, not a stable background state, but a dynamic set of interdependencies in constant negotiation with disturbance and time (Kimmerer 2013, 9). Morton argues there is no nature separate from us to preserve or connect to, only an entangled mesh of relationships we are already acting upon (Morton 2007, 14).

3. Nature is the totality of living and nonliving systems that exist independently of human intention, though never independently of human influence. It is not an external backdrop against which architecture performs, but the field of entangled relations within which any building is already embedded. Morton argues that the category of "Nature" as a pristine domain separate from human activity is itself a cultural construct that prevents genuine ecological engagement (Morton 2007, 14). Kimmerer offers an alternative: nature understood through reciprocity, where human and nonhuman life participate in mutual sustenance rather than extraction (Kimmerer 2013, 183).

4. Earning place is the ongoing demonstration that a building's presence contributes more than it takes, ecologically, socially, and culturally. Till observes that architecture too often assumes the right to occupy a site, arriving with authority it has not been granted (Till 2009, 48). To earn place is not a threshold crossed once at inception, but a condition that must be maintained, tested and negotiated across the full cycle of the building. It begins with a commitment to what the building will return to the ground when its life is over.

5. Adaptation is the capacity of a building to change its use, configuration, or meaning over time without requiring demolition or comprehensive redesign. It describes architecture's ability to absorb shifts in programme, population, climate, and culture across the full duration of its life.

In the context of this project, adaptation is not merely a technical strategy for flexible floor plans. It is an ethical commitment: a refusal to fix the building's programme at inception, and instead to allow whatever form of community arrives to reshape the space according to needs the designer cannot predict.

6. Negotiation is the ongoing, unresolved exchange between competing claims on a site (ecological, social, cultural, infrastructural) that cannot be settled by design but must be sustained across time. It is the condition in which multiple interests coexist without one overriding the others. The architect's role is not to resolve competing interests but to make them legible, holding space for disagreement as a productive condition of public life (Muf 2001, 12).



Banksia in flower, Warwick Bushland. Photograph by Author.

THE PROBLEM

Architecture assumes the right to occupy a site. A planning approval asks whether a building fits its zoning, its setbacks and its height limit. It does not ask what the ground was holding before the building arrived, or what it will hold after the building has gone.

The tools that do look at ecology measure what can be counted from above: canopy area, habitat area, the share of a site left green. They score a design once, at approval, and the score barely moves when a building goes in. What they do not see is the set of relationships a site holds: which animals feed on which plants, which roots run under the footprint, and how long each of those takes to come back.

Restoration, when it happens, comes at the end, as an obligation nobody drafted. By then the people who decided where the building stood have moved on, and the cost of that decision falls on the ground and on whoever looks after it next.

Warwick Bushland shows what this looks like over time. Seventy years of aerial photographs record the bushland being taken in pieces. What is left is a remnant of banksia woodland held together by volunteer labour.

This thesis asks a building to answer for its ground before it is drawn: to state what it will take, what that breaks, and how long the site will be owed once the building comes down.



Warwick Bushland, the walk track through banksia woodland and grass trees. Photograph by Author.



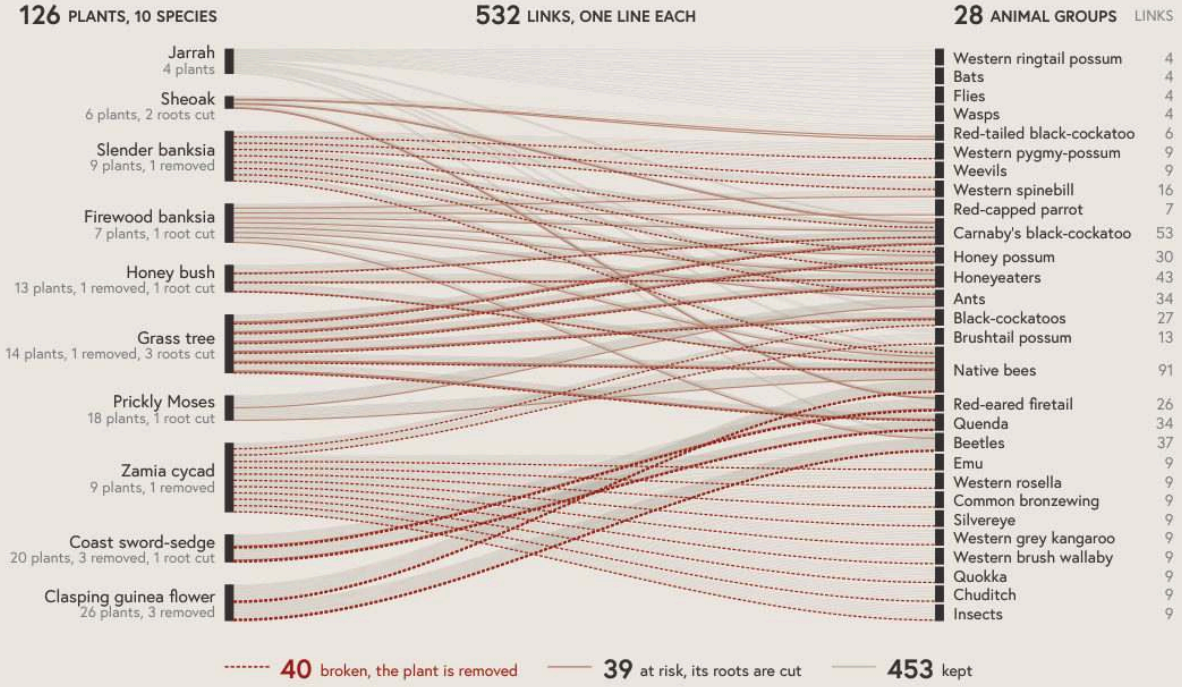
The cleared edge of Warwick Bushland, beside the road. Photograph by Author.

SEMESTER TWO

After the mid-semester review the question was what this does that a BIM model, or a published habitat index, does not.

THE CLAIM UNDER TEST

The published indices measure the habitat a design offers. This one measures the relationships it keeps or breaks.



The 532 links between the stand's plants and animals: 40 broken outright by the footprint, 39 at risk through cut roots, 453 kept. Figure by Author.

The question of whether architecture can earn its place, rather than simply assuming it, draws on several intersecting lines of inquiry.

This section reviews the theoretical positions and precedent projects that inform the thesis, organised around three argumentative threads: ecological obligation, designing from the ending, and adaptive negotiation.

Jeremy Till's Architecture Depends (2009) provides the foundational critique. Till argues that architecture habitually positions itself as an autonomous discipline, exercising control over contingency in pursuit of formal resolution. This autonomy is a fiction; buildings are always dependent on forces, social, economic, climatic or temporal, that exceed the architect's control (Till 2009, 48). When architecture ignores these dependencies, it arrives on site with an authority it has not earned. This project takes Till's critique and extends it ecologically; if a building depends on its site for its existence, **what does it owe that site in return?**

Robin Wall Kimmerer's Braiding Sweetgrass (2013) offers an answer grounded in Indigenous ecological knowledge. Kimmerer describes a relationship of reciprocity between humans and the living world, where taking is justified only by giving back (Kimmerer 2013, 183).

The concept of "earning" in this project borrows from that framing, that a building earns its ecological footprint not through a one-off offset but through ongoing, demonstrable contribution to the ecology it displaces. **Timothy Morton's Ecology Without Nature (2007)** complicates this further by arguing that the very concept of "nature" as a separate domain is a construct that prevents meaningful ecological engagement (Morton 2007, 14). If there is no pristine nature to protect, only an entangled mesh of relationships, then **the building's obligation is not preservation but participation**.

Stewart Brand's How Buildings Learn (1994) demonstrated that buildings change fundamentally over time, and that the best buildings separate fast-changing elements from slow ones, what Brand calls "shearing layers" (Brand 1994, 13). Brand's concern is with the building's life; this project extends his temporal awareness to the building's death, asking what conditions the building must create for the ecology that follows it. **Cedric Price's Fun Palace (1964)** offers a more radical precedent. Price designed the Fun Palace as a structure in perpetual process, one that is never finished, always adapting, and designed from the outset to be dismantled.

Price rejected the assumption that a building's value lies in its permanence, framing his creativity as sustained by a delight in the unknown (Mathews 2005, 81). The CTRL+Z studio's framing of architecture as duration rather than object draws directly on this lineage.

Ian Ritchie's Ghost Barn (2023) provides a contemporary precedent. The Ghost Barn reinstates a vanished agricultural building as a Corten mesh structure with no foundations, no columns, and no programme, just a form between architecture and absence (Ritchie 2024, 54). Ritchie invokes the Japanese concept of ma, essential emptiness, describing a space that gains substance from what it withholds rather than what it contains. This resonates with the current project's refusal to fix the building's function in advance.

Muf architecture/art's practice of working "with rather than for" communities informs the negotiation stance of this project. Rather than arriving with a predetermined programme, muf's method makes visible the competing claims on a site, holding space for unresolved tension as a productive condition (Muf 2001, 12). **Jack Kirne's concept of "strays"** adds a further dimension; those who exist outside dominant systems perceive the limitations of those systems precisely because they inhabit the margins (Kirne 2020, 1). Warwick Bushland is itself a kind of shadow place, a remnant ecology maintained by invisible volunteer labour, surrounded by a suburb that largely ignores its ecological significance.

The building owes the site more than it takes, that the obligation is ongoing rather than one-off, and that the architect arrives last, not first.



Reading notes. Drawing by Author.

POSITION

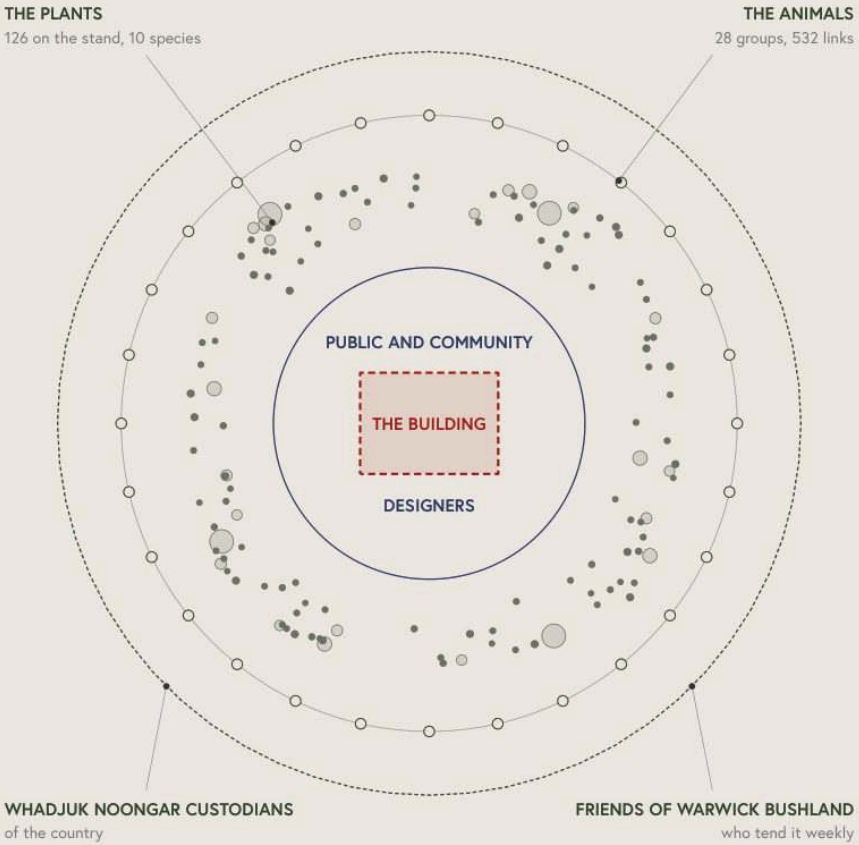
Jeremy Till argues that architecture depends on forces it does not control, and that its claim to autonomy is a fiction (Till 2009). This project extends that dependence to the ground: if a building depends on its site to exist, **it owes the site something in return**.

Kate Raworth draws an ecological ceiling an economy must not overshoot, and **Jason Hickel** argues for taking less (Raworth 2017; Hickel 2020). The Death Manual applies a ceiling to one building: a dig no deeper than 300 mm, a footprint that keeps the structural root zones, **a site held until what was taken flowers again**.

Aileen Moreton-Robinson shows how ownership in Australia rests on a possessive claim to land (Moreton-Robinson 2015), and **Val Plumwood** how the living world is treated as background to human purpose (Plumwood 1993). Both ask who decides. Here the architect does not decide alone: **the records of the plants and animals set terms the design has to meet**.

Timothy Morton and Anna Tsing describe a world without a separate nature, only entangled relationships (Morton 2007; Tsing 2015). The plugin draws those relationships, a plant to the animals that use it, so that **a footprint is read by what it breaks, not only by what it covers**.

Robin Wall Kimmerer describes taking as justified only by giving back (Kimmerer 2013). That is what earning means here. It is not decided by the architect or the developer but by the ground: **a building has earned its place when what it took has come back**.



Who the building is for, and who else has a say on the stand. Figure by Author.

SIGNIFICANCE

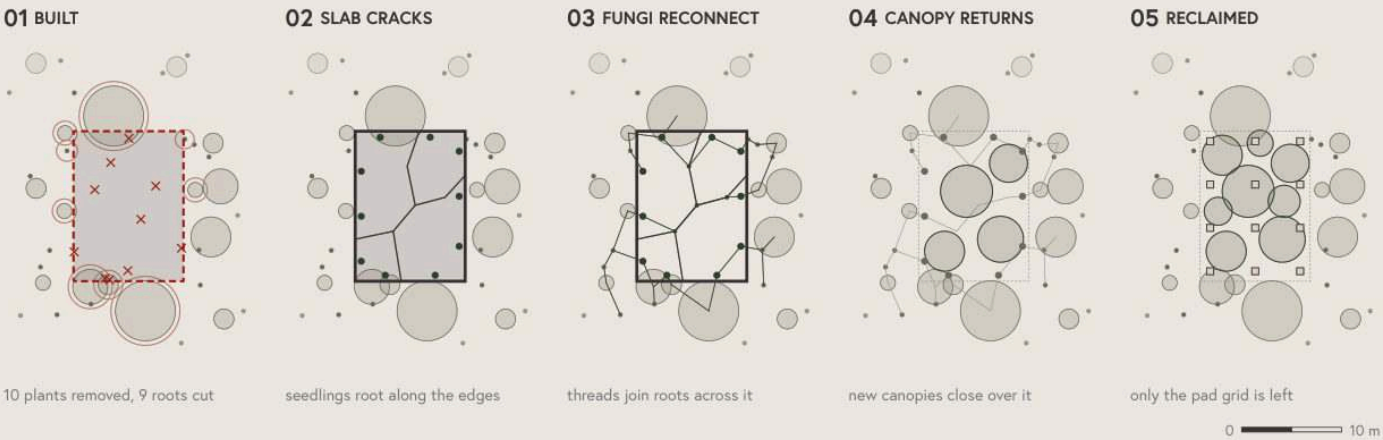
Architecture routinely assumes the right to occupy a site. Planning approvals, client briefs, and professional conventions all proceed from the premise that a building's presence is justified by its programme, its economic return, or its social utility. What is rarely asked, at any point in the design process, is **whether the building has earned the ecological ground it stands on**, and what obligation it carries to return that ground when its life is over.

This project identifies a specific gap in the discipline's engagement with impermanence. Stewart Brand demonstrated that buildings change over time, and that the best buildings separate fast-changing layers from slow ones (Brand 1994, 13). Cedric Price proposed structures explicitly designed for their own dismantling, framing his creativity as sustained by a delight in the unknown (Mathews 2005, 81). Neither extended this temporal awareness to the building's ecological afterlife, to the question of what the ground becomes once the building is gone. Brand is interested in adaptation during the building's life. Price is interested in dismantling.

This project occupies the gap between them: what the ground itself inherits, and what the building owes it, after both adaptation and dismantling are finished.

The significance lies in **reframing ecological obligation as a binding design constraint rather than a compliance afterthought**. The Lifecycle Visualisation Tool draws the ecological cost of a proposal before the proposal is built, removing the most reliable defence in the architect's repertoire, which is plausible ignorance. Once species count, canopy loss, soil disturbance, and reversibility are visible on the same screen as the footprint, the question stops being whether the ground can be afforded and starts being what has to be claimed to make losing it acceptable. The Death Manual goes further. It does not just make the cost legible. It binds the building to a restoration commitment drafted before the first line is drawn, and holds the building to that commitment for as long as it stands. A developer chasing a quick return cannot quietly absorb the ecological debt into a consultant's report and move on. **The debt is on the title.** The tool will not generate a design strategy that fails the ledger, and the Manual will not release the site until the restoration thresholds are met.

Right: from the built footprint to the final reclaim. Drawing by Author.



This is not a refusal of development. It is a refusal of the version of development that treats ecology as a line item to be negotiated downward. The tool and the Manual together propose that **if a building cannot be built without breaking the ground that holds it, then the building should not be built**. And if it can, then the terms of that building are not the architect's alone to set. The project also refuses to prescribe community. Community spaces are typically programmed in advance by designers who assume they know what a group of people needs.

The question is not how to create community through architecture, but **how to avoid overwriting the community that already exists**, in volunteer labour, in informal use, in the relationships people have already formed with place.

If architecture is to take ecological obligation seriously, **it must begin not with what it wants to build but with what it is willing to give back**. The Death Manual is that first gesture of willingness, drafted in advance and held to account.

METHOD

This project tests whether architecture can begin with the end. The method is not a sequence but a set of overlapping operations, each one designed to keep the ecological argument legible across a different register: site, drawing, diagram, tool, and image. The work proceeds through five operations.

The first is the surrender of authorship. The site was selected by a hat draw from ten banksia woodland remnants on the Swan Coastal Plain. The draw was not a gimmick. It was a methodological position: if the project argues that architecture must negotiate rather than impose, the site selection had to enact that logic from the outset. Warwick Bushland was the card drawn, and the project began with a site it had not chosen.

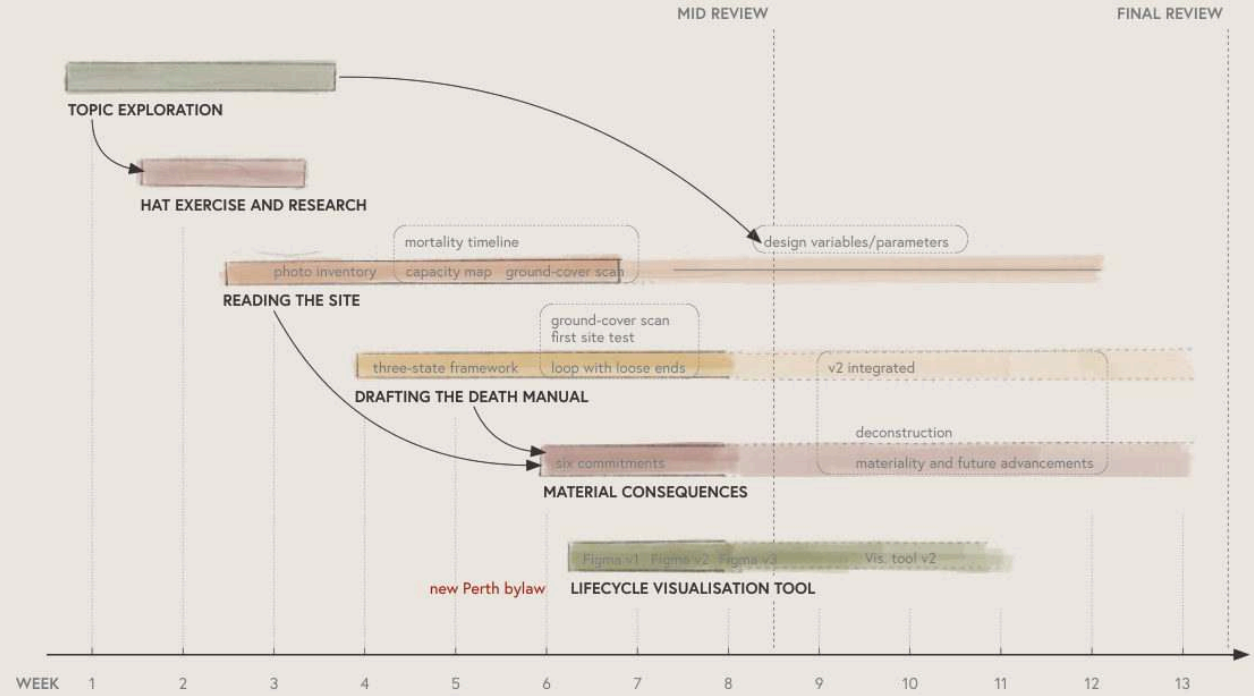
The second operation is reading the site. Warwick Bushland is documented through four parallel exercises: a photographic inventory of the banksia woodland community, a mortality timeline tracing seventy years of subtraction from aerial photographs, a ground-cover comparison scoring the bushland against twelve surrounding land conditions, and a capacity map reading the site as a forensic autopsy of what it still holds.

The site is read for what it has already given and what it has left to give, and the readings are held against the Death Manual's restoration thresholds before any architectural move is proposed.

The third operation is the drafting of the Death Manual itself. This is the project's central reversal. Rather than treating ecological obligation as something a building offsets at the end of its life, the Manual is drawn first, as a binding restoration protocol that the building must answer to from inception. The Manual specifies the species assemblages, soil conditions, and hydrological patterns the site must return to once the building is gone. Every subsequent design decision is constrained by it.

The fourth operation translates the Manual into material consequences. The Deconstruction Manual isolates six techniques (shallow footings, mechanical timber joints, sacrificial ground layers, lift-clear roof panels, disconnectable steel columns, and extractable foundation grids) that any building on this ground would have to engage with to leave the site recoverable. These are not a code. They are the minimum mechanical conditions the Death Manual requires.

The fifth operation is the development of the Lifecycle Visualisation Tool. The tool ingests site data through sensor inputs, processes it against ecological parameters drawn from the Manual, and returns a real-time envelope of permissible architectural moves. It does not generate designs. It makes the ecological cost of a decision visible before that decision is made. Following Dunne and Raby's speculative design framework, the tool opens debate rather than closing it with solutions (Dunne and Raby 2013, 6).



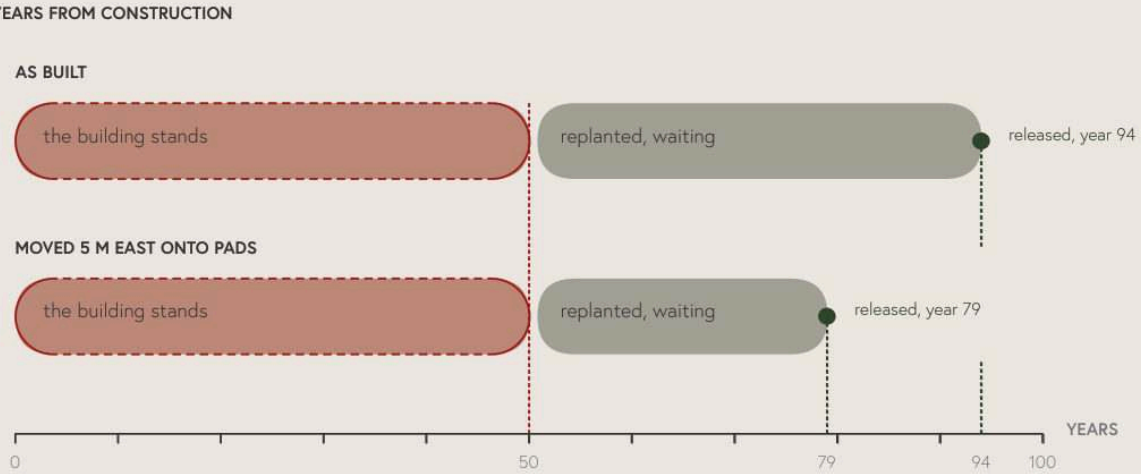
Across all five operations, the representational language remains deliberately unresolved. Glitch imagery, datamoshing, and the central voids of the collage method keep the architecture provisional, because the project's argument only holds if the building stays answerable to the ground.

The semester-one method week by week, from topic exploration to the final review. Drawing by Author.

THE METHOD

Architecture assumes the right to occupy a site. This thesis asks a building to earn its place, and to keep earning it for as long as it stands.

In semester one the Death Manual was written before the building. It caps excavation at 300 mm, sets floors for canopy and ground cover and a ceiling on weed load, and holds the site until the restoration is done. It is read in three states: the End, the Life and the Beginning. It set the terms a building has to meet, but it could not draw one.



How long the site is owed after fifty years, as built and on pads. Figure by Author.

THE DESIGN COMPANION

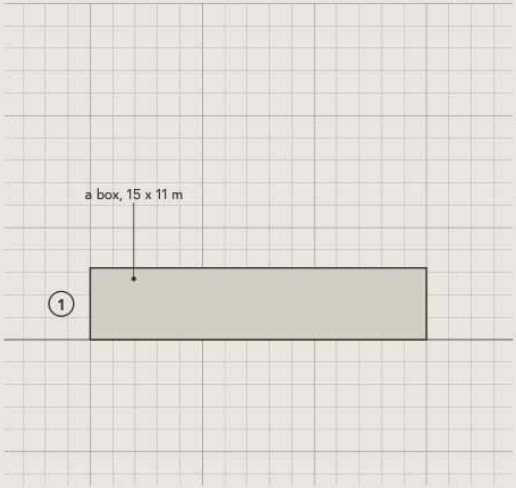
Semester two put the Manual in the drawing. The Design Companion is a Rhino plugin with each plant's record, its roots, growth, flowering and the animals it feeds, so a footprint is read by what it breaks.

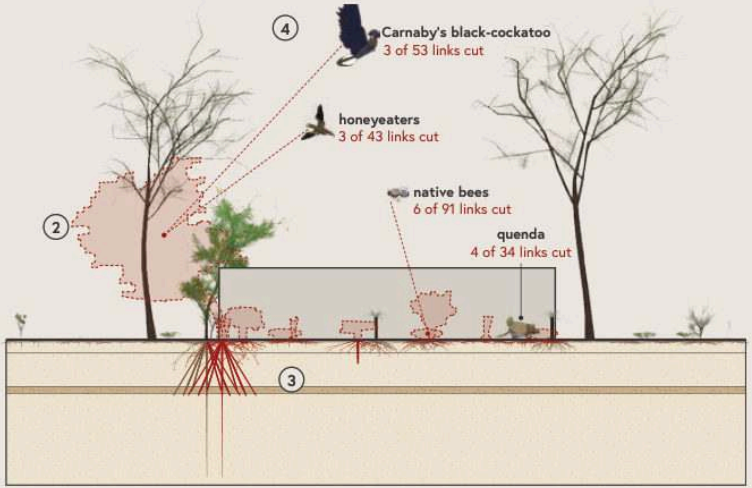


The recorded stand with a building's massing in place. Render from the plugin. Figure by Author.

Framing: the gap

When modelling in 3D, one typically starts with a blank file and begins the design process without any feedback from the surrounding environment. The proposal lets the designer see the consequences of their interventions in real time.





1 TODAY
a blank file
nothing answers
the box is placed on an empty grid
the file holds no site

2 PLANTS REMOVED
10 plants
inside the footprint
a slender banksia, 8 m tall
a grass tree, a zamia, a honey bush
3 guinea flowers, 3 sword-sedges

3 ROOTS CUT
9 plants
roots reach under the box
2 sheoaks, 15 m tall
a firewood banksia, 7 m tall
3 grass trees and 3 smaller plants

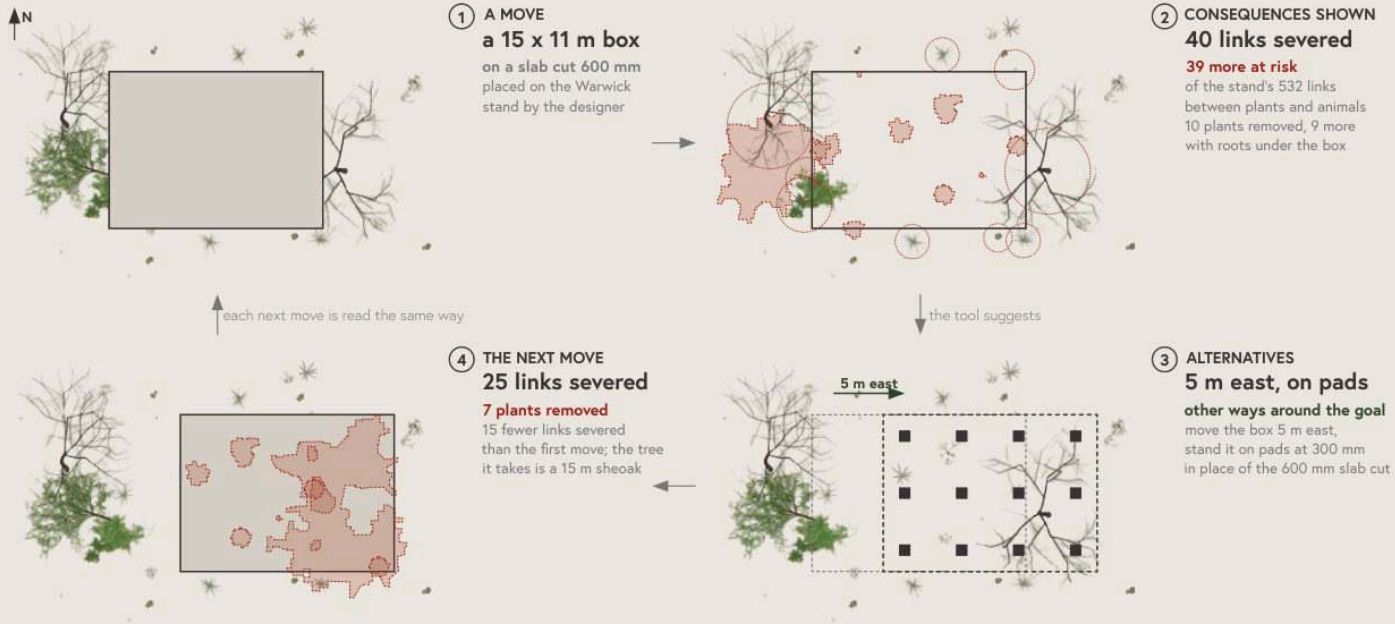
4 LINKS BROKEN
40 severed
39 more at risk
of 532 links between plants and animals on the stand

0 5 10 m

The Warwick stand looking north, with a 15 x 11 m box on it. Plants from the species builder; links from the plant and animal records. Figure by Author.

Framing: one design move

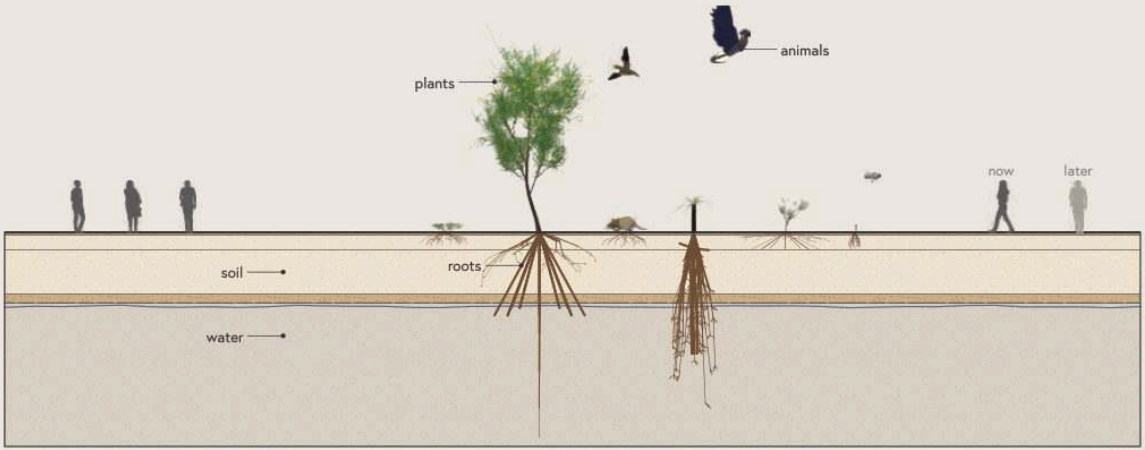
Negotiation is a fundamental part of the process. It makes the interconnections between different systems visible. The app doesn't just say no. It suggests changes and other ways around the user's goal, like material substitutions and form adjustments.



Plans of the Warwick stand: the first move, what it breaks, the tool's alternative and the next move. Figure by Author.

Framing: who the tool is for

The stakeholders of the Design Companion extend beyond its human users. People are stakeholders too, now and in the future, because they depend on these systems.



section at 1:250

DIRECT USERS

designers, planners

communities who read its record
test proposals and see their likely impacts before anything is built

WHAT IT REPRESENTS

living systems

stakeholders in the design
plants, animals, soil, roots, water with their own needs and conditions for survival

PEOPLE

now and later

they depend on these systems
people are stakeholders too, now and in the future

WHADJUK NOONGAR CUSTODIANS

Leeuwin is on Whadjuk Noongar Country.

Custodians are rights-holders, not clients.

The tool does not speak for them.

Plants, roots and soil from the plugin's species builder and the Warwick stratigraphy record; animals as watercolours. Figure by Author.

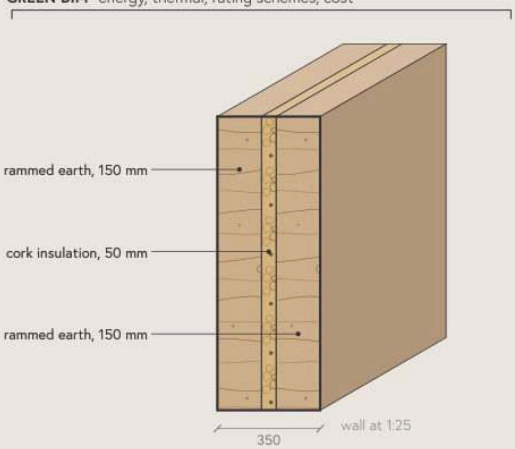
A WALL AND A PLANT, EACH WITH ITS DATA

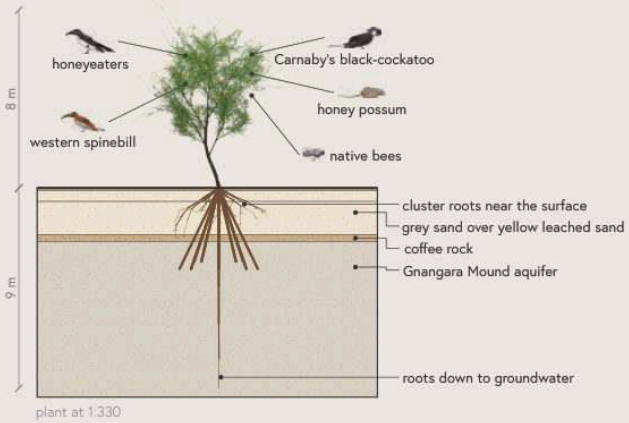
Framing: green BIM and eco-BIM

Existing green BIM brings environmental performance into early design and measures the building. Eco-BIM extends this to the plants, animals, soil and roots that the building affects.

ECO-BIM the building, and the plants, animals, soil and roots it affects

GREEN BIM energy, thermal, rating schemes, cost





THE WALL

insulated rammed earth

350 mm in three layers
R 1.55 m^2K/W, U 0.64 W/m^2K
606 kg/m^3, 54 kg $CO2e/m^3$ embodied
97% recyclable by weight

THE PLANT

slender banksia, Mangite

8 links to animals
8 m tall, roots to 9 m
flowers October to February
also western pygmy-possums, ants and weevils

Wall: the plugin's insulated rammed earth assembly and its computed figures. Plant: the slender banksia record, sourced values only. Green BIM fields: Chang and Hsieh 2020; Lu et al. 2017. Figure by Author.



Bottlebrush and bee. Watercolour from the plugin.

Warwick Bushland

The test site is Warwick Bushland, a 65-hectare banksia woodland remnant on Perth's Swan Coastal Plain. It was drawn from a hat, so I did not choose the ground the building has to answer to.

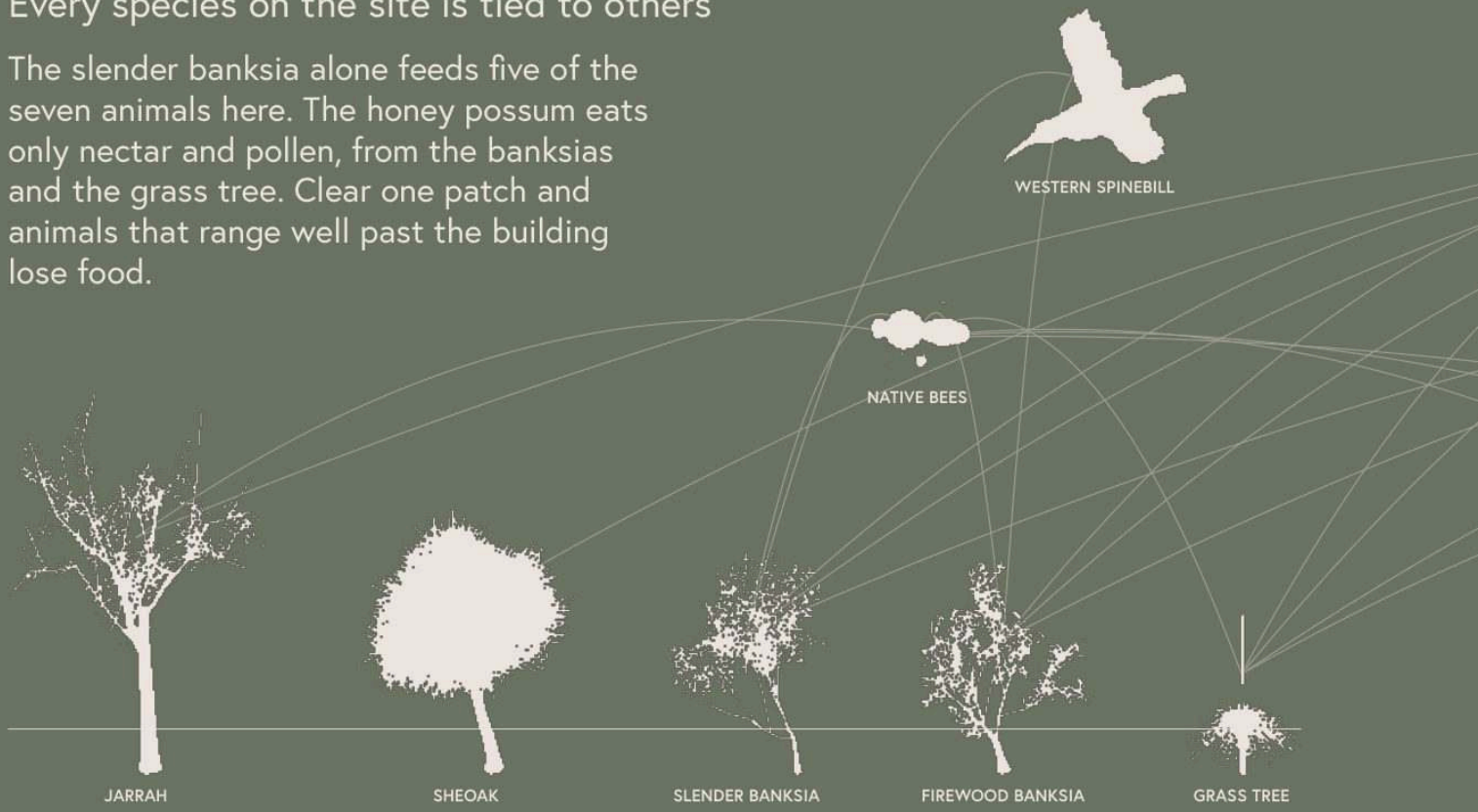


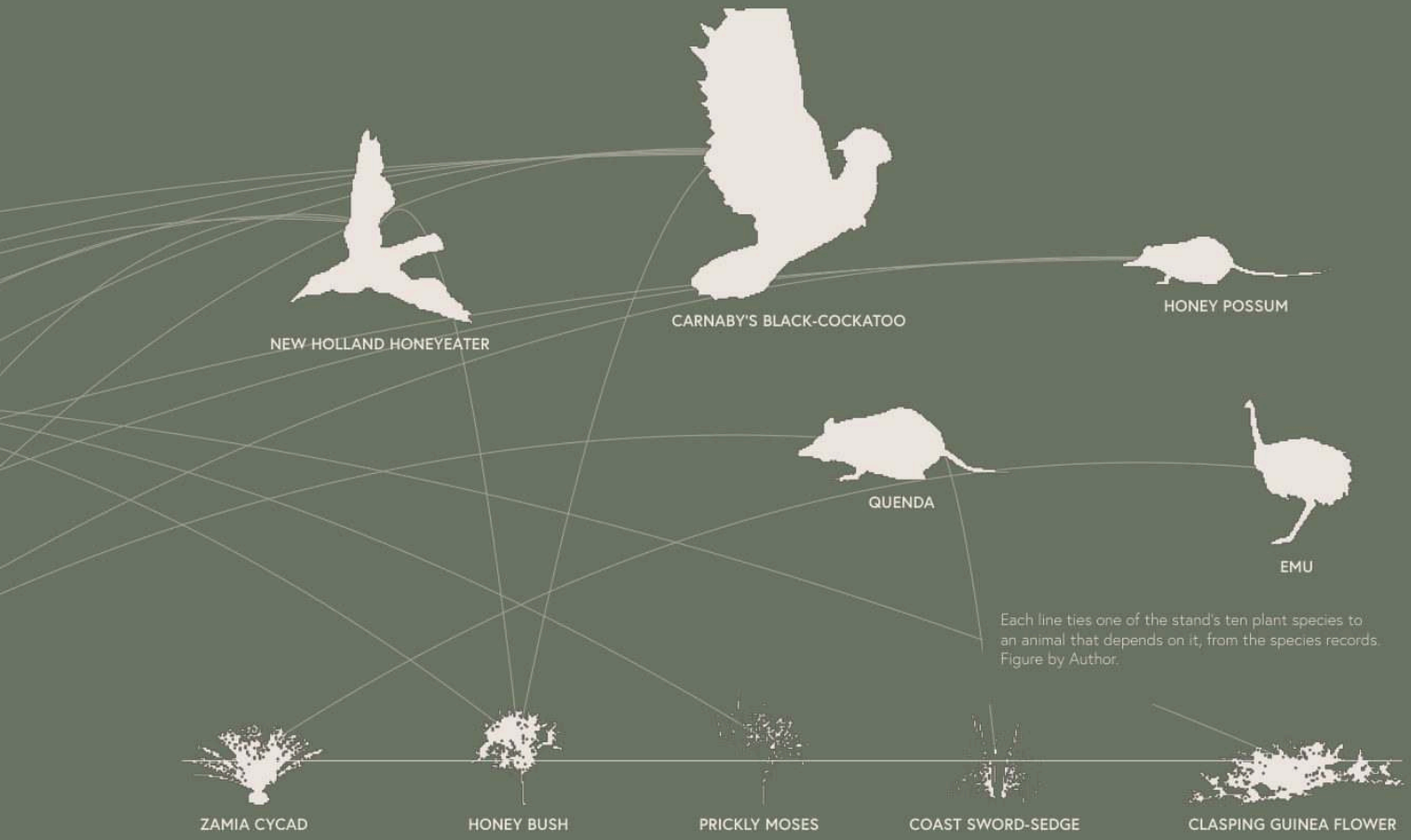
Western spinebill and New Holland honeyeater feeding at slender banksia. Watercolour from the plugin, birds and plants to scale.

PLANTS AND ANIMALS

Every species on the site is tied to others

The slender banksia alone feeds five of the seven animals here. The honey possum eats only nectar and pollen, from the banksias and the grass tree. Clear one patch and animals that range well past the building lose food.

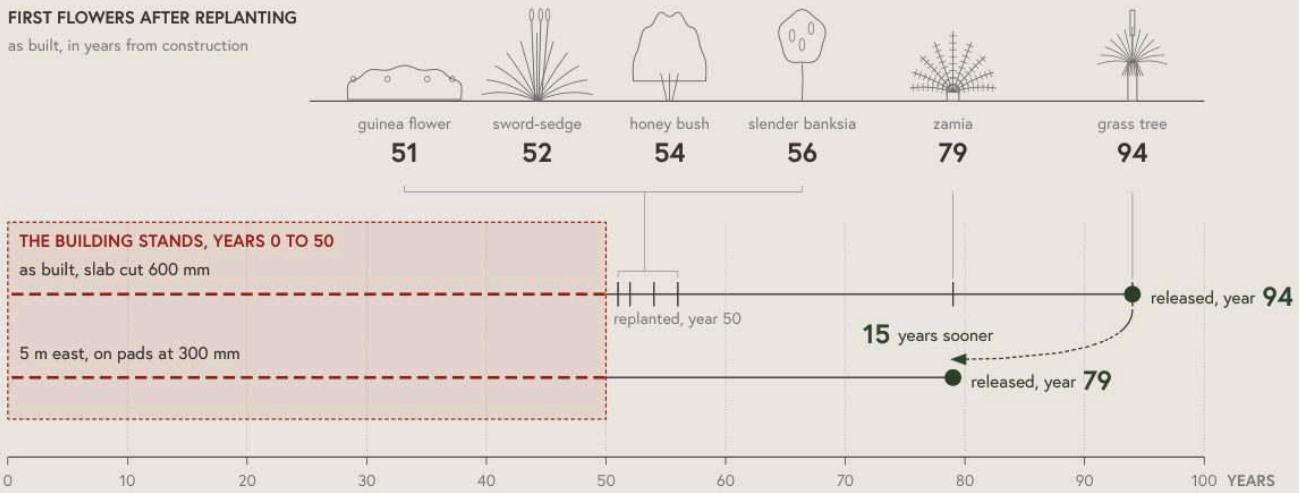




Each line ties one of the stand's ten plant species to an animal that depends on it, from the species records. Figure by Author.



The test ground at Warwick, 126 recorded plants of ten species grown forward 50 years. Figure by Author.



Years from construction. Red dashed: the 50 years the building stands. Ticks: each replanted food plant first flowers. Green: the site is released. Figure by Author.

WARWICK BUSHLAND, WARWICK.

Warwick Bushland is a **65-hectare remnant of banksia woodland on the Swan Coastal Plain,** held inside the Bassendean sand system that runs north from the Swan River through Perth's northern mid-suburbs.

The site is not pristine. It contains zones of intact Banksia attenuata and Banksia menziesii overstorey, areas of degraded edge condition where weed incursion and altered fire regimes have thinned the native understorey, and hard infrastructure such as public buildings, shared paths, and drainage easements.

This gradient of ecological condition is itself a design brief, the site already discloses which ground has been given and which ground is still being held.

Location: Warwick, City of Joondalup, WA

Bush Forever Site: 303

Area: ~65 hectares

Vegetation Complex: Banksia woodland

Soil Type: Bassendean Sands

Dominant Species: Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana

Groundwater: Gnangara Mound

Conservation Status: Threatened Ecological Community

Active Care: Friends of Warwick Bushland (volunteer bush care group)

Fire Regime: Fire-adapted; requires periodic low-intensity burning

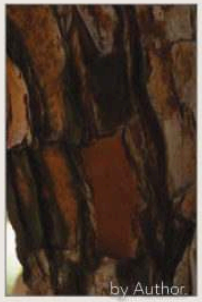


Figure from Google Earth

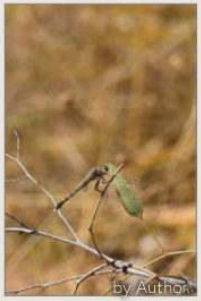
WARWICK BUSHLAND: ECOLOGICAL CONTEXT


by Author.


by Author.


by Author.


by Author.


by Author.


by Author.


by Author.


by Author.

Banksia woodland on the Swan Coastal Plain is not generic bushland. It is a **measurable ecological community with testable thresholds.** Reference sites in Banksia attenuata woodlands carry an average of 67 vascular plant species per 100m² quadrat, with the richest sites exceeding 80, against a background average of one weed species per quadrat (Gibson et al. 1994). Across the broader Swan Coastal Plain, more than 600 native plant taxa have been recorded from 233 sampled points, supported by roughly 15 native overstorey tree species (Department of the Environment 2016). The community is partially groundwater-dependent, drawing on the Gnangara Mound, which means every impervious square metre of new construction is a measurable subtraction from recharge.

Only about 40 per cent of the original woodland remains. In 2016 the community was listed as a nationally threatened ecological community under the EPBC Act (Department of the Environment 2016). These are not background facts. **They are the parameters any building on this ground must negotiate with**, and the figures the Death Manual is written against.

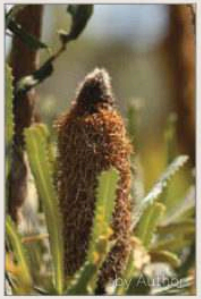
The Noongar six seasons mapped here have a true function, they organise fire, flowering, rain, and regrowth into **a temporal system that any building on this ground would have to align its operations with, or consciously and accountably refuse to.**


by Author.

ECOLOGICAL INVENTORY: LIVING HERITAGE

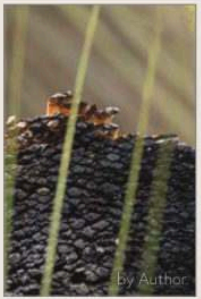


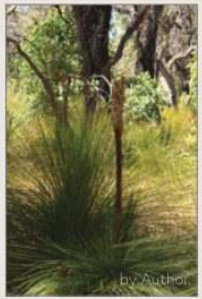




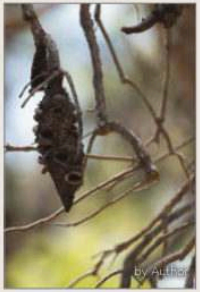


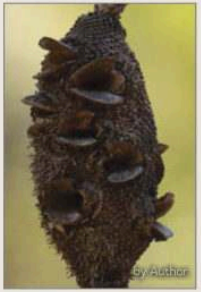
















The ecological inventory at Warwick Bushland is **not a static catalogue of species but a record of relationships under pressure.** The banksia woodland community; Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana, Xanthorrhoea preissii, Macrozamia riedlei have persisted on Bassendean sands above the Gnangara Mound for thousands of years under Whadjuk care. Its survival now depends on the ongoing labour of the Friends of Warwick Bushland, who weed, replant, and monitor the interface between woodland and suburb.

But inventory alone is insufficient. **What matters for this project is the relationship between what persists and what degrades;** where weed species like Ehrharta calycina (Veldt Grass) and Lupinus cosentinii (Blue Lupin)



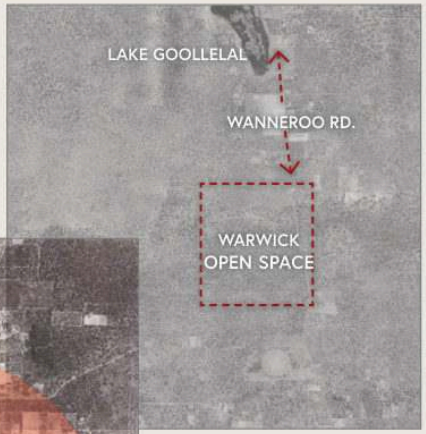
MORTALITY TIMELINE

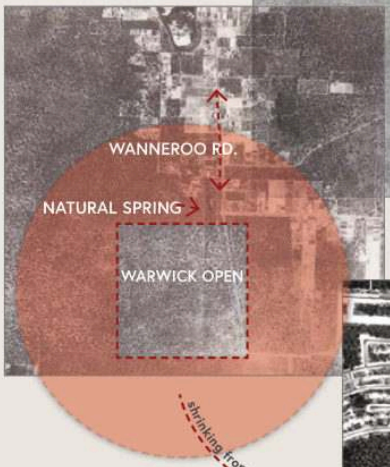
A TEMPORAL ANALYSIS OF WARWICK BUSHLAND

Seventy years of subtraction.

In 1953 the bushland extended unbroken across the frame.

By 2026 it has been carved from the outside by roads and housing and hollowed from the inside by sports infrastructure and drainage easements.







The timeline is not a lament. It is a forensic record of what was given away, decision by decision, and what remains. Every excision was permitted. Every one had a reason. None came with a commitment to return anything.

1953

1964

1970

1981

2002

2026

shrinking from the inside

A growing tumor







Did we take too much?

The question the Death Manual asks of any new proposal is not whether it can justify itself against what is already gone. That calculation is too easy; almost anything looks modest against seventy years of loss. The question is whether it can justify itself against what remains, and whether it can commit, in writing, to not being the thing that finally tips the balance.

Timeline compiled with images provided by Friends of Warwick and images obtained from Google Earth.



WARWICK BUSHLAND, 2002

The aerial the 2002 mortality map was drawn over. Google Earth, Maxar Technologies.



WARWICK BUSHLAND, 2017

The same frame, 2017.



WARWICK BUSHLAND, 2025

The same frame, 2025.

GROUND-COVER PERCENTAGE: CONTEXT AS ARGUMENT

The ground-cover comparison scores thirteen land parcels from bushland core to warehouse roof. It is not a ranking of bad actors. It is a **spatial argument about context**, showing what the site sits inside: a suburb where native ground cover drops from 99% in the woodland interior to 0% in the car park forty metres beyond the reserve boundary.



A new building on this site would not be inserting itself into intact bushland. It would be adding to a long sequence of insertions.

The question is whether to build on [illegible] conditions [illegible] ent to what comes after.



~99%	~95%	~80%	~50%	~40%	~35%	~ 30%	~25%	~20%	~10%	~5%	0%	0%
Bushland Core	**Bushland Edge**	**SHS Bushland Pocket**	**Jarrah Trail Clearing**	**Warwick Stadium / Leisure Centre**	**Warwick Open Space Oval**	**Warwick Bowling Club**	**Wanneroo Rd / Beach Rd**	**Warwick Grove Shopping Centre 1**	**Residential Warwick**	**Warwick Train Station**	**Warwick Grove Shopping Centre 2**	**Hamersley Public Golf Course**
-31.8430, 115.8055	-31.8448, 115.8045	-31.8460, 115.8068	-31.8438, 115.8048	-31.8462, 115.8042	-31.8455, 115.8028	-31.8452, 115.8035	-31.8488, 115.8092	-31.8395, 115.8085	-31.8410, 115.8078	-31.8432, 115.8120	-31.8395, 115.8085	-31.8520, 115.7785
Unbroken jarrah–banksia canopy. Interior of Bush Forever Site 202.	Canopy intact but verge weeds and trail compaction visible.	School buildings dropped into intact woodland. excision.	Mown kikuyu rectangle ringed by retained perimeter trees. Pervious centre, ecologically blank.	Building footprint and carpark softened by held tuarts and marri at the edges.	no canopy. Irrigated turf inside the reserve boundary.	Synthetic green, shadecloth, carpark. Inside Bush Forever Site 202.	Six-lane arterial roundabout. Mown verges and slip lanes; the reserve's hard edge.	Carpark and retail roof meeting a thin strip of retained trees along the boundary.	Tile roofs, driveways and lawn front yards. Occasional retained street tree, no understorey.	Park-and-ride decks, freeway median and sound walls. Linear	Warehouse roof. Total impervious cover.	Irrigated fairway, sand bunkers, scattered exotic trees. Pervious but ecologically inert.

Diagram images compiled from Google Earth footage.

Conventional architectural practice runs forward. **Brief, site, programme, form, construction, occupation, and eventually, as an afterthought, demolition. This project reverses that sequence.** It begins with the ground the building will eventually leave behind, uses that commitment to discipline the building's operational life, and only then returns to the ecological conditions that determine where and how the building can be placed.

The three panels below are not phases in time. They are three drawings that must be held simultaneously for any design decision to be made. The order in which they are read matters.

THE END



What does this site look like after the building is gone?

THE END is drafted first because what is owed is the only constraint heavy enough to discipline what is built. The Death Manual specifies what the site must look like after the building is gone: the species assemblages, soil conditions, and hydrological patterns the building's footprint must support upon decommissioning. This is the design brief written backwards from its conclusion.

THE LIFE



What does the building look like in operation adapted, used, negotiated with the community?

THE LIFE follows from that commitment. Within the building's operational period, the Death Manual governs material selection, ground coverage, and structural system. Nothing is embedded in the ground that cannot be removed without chemical contamination. Nothing is constructed above the water table that would impede its recharge. The building earns its place incrementally through the ecological services it provides while standing, and through the conditions it creates for what comes after (Brand 1994, 13).

THE BEGINNING



What are the conditions of the existing ecology?

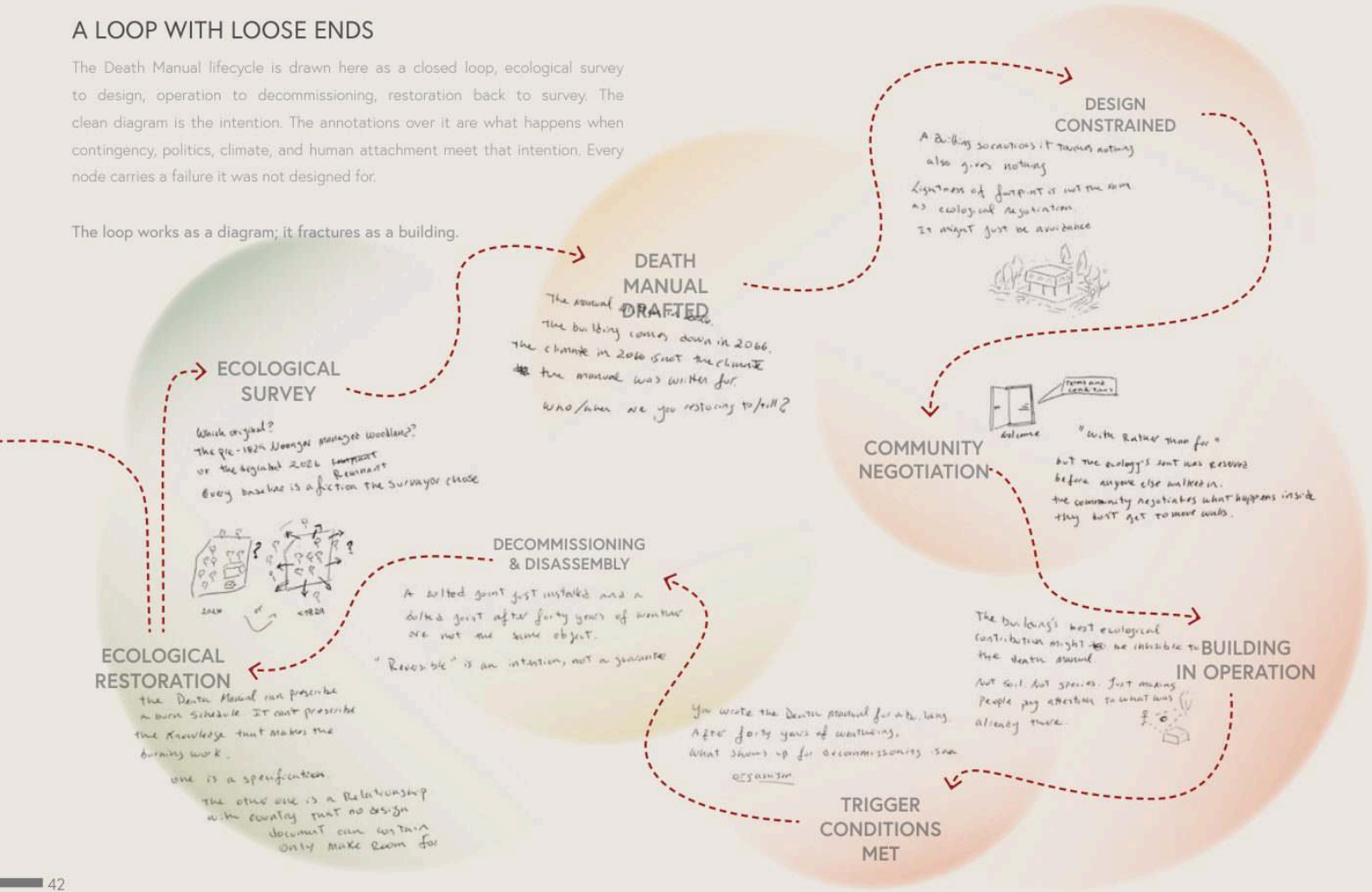
THE BEGINNING comes last. The existing ecological condition of the site, its vegetation, its fire history, its Noongar seasonal structure, and the weekly labour of the Friends of Warwick Bushland, is the starting point for form. The building does not arrive and impose itself. It negotiates its footprint against what is already alive, already tended, already meaningful. Following Till, architecture earns nothing by arriving with authority it has not been granted (Till 2009, 48). The beginning is the last word, because the ground gets to speak first.

Following Till, **architecture earns nothing by arriving with authority it has not been granted** (Till 2009, 48). **The beginning is the last word, because the ground gets to speak first.**

A LOOP WITH LOOSE ENDS

The Death Manual lifecycle is drawn here as a closed loop, ecological survey to design, operation to decommissioning, restoration back to survey. The clean diagram is the intention. The annotations over it are what happens when contingency, politics, climate, and human attachment meet that intention. Every node carries a failure it was not designed for.

The loop works as a diagram; it fractures as a building.



A LOOP WITH LOOSE ENDS PT2

Every node carries a failure it was not designed for. The manual is written in 2026 for a climate that will not be the climate of 2066. The restoration target references a baseline that is itself a fiction, because every baseline is chosen by someone with a reason for choosing it. The community negotiates what happens inside the building; they did not get to negotiate the ecology the manual commits to before anyone walked in. The decommissioning sequence assumes the bolted joint installed in year one is the same bolted joint found in year forty. It is not.

A building that acknowledges the gap between its drawn connections and their rusted future, between its restoration list and the cultural burning it cannot prescribe, between the community it imagines and the one that actually arrives, is not a weaker proposition. It is a more honest one.

PROPOSE NEW PERTH BUILDING REGULATIONS?

I keep circling the same thought. The logic of the project is that ecological obligation should be drafted before design, not after. That is not a position that belongs only to community. It could, in principle, be written as a planning instrument, a Perth-specific clause inserted into development control, requiring any proposal on ecologically active ground to submit a Death Manual alongside its DA. A binding restoration protocol with measurable thresholds, audited by whoever holds the land in trust.

I am not sure I want to make that the project. Proposing a new building regulation turns the thesis into a policy mockup, and the moment policy arrives, the speculative register collapses. Dunne and Raby are clear that speculative design works by opening debate, not by delivering finished instruments. A draft bylaw would close the debate too quickly.

I think perhaps a middle path is what would work for this project; to actually to treat the Death Manual as a proposition held up against current practice, not as a replacement for it. The Deconstruction Manual opposite is the first concrete output of that proposition; not a code, but a set of techniques that any future building on this ground would have to engage with if it

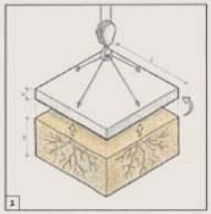
DECONSTRUCTION MANUAL

SIX COMMITMENTS

Before a spatial proposal can be made, **the Death Manual demands a structural commitment: the building must be able to leave.** Not in theory, not approximately, but completely, without leaving chemical, structural, or hydrological debt in the ground.

The six techniques are not individually radical. Shallow concrete footings, mechanical timber joints, sacrificial rammed earth layers, lift-clear roof panels, disconnectable steel columns, and extractable foundation grids are all available methods. What is radical is requiring them together, as non-negotiable conditions, before a design is drawn. Together they describe the **minimum mechanical conditions any proposal on this ground must satisfy.**

Reversibility is not a guarantee. It is an intention made structural. A bolted joint installed today and a bolted joint after forty years of weather, thermal movement, and biological colonisation are not the same object. The Deconstruction Manual acknowledges this. It is a specification for intent, not a promise of clean removal. What it refuses is the alternative: embedding permanence into the ground without acknowledging that permanence as a choice.



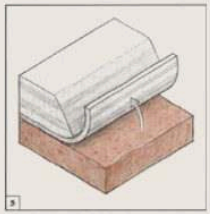
SHALLOW CONCRETE FOOTING

Minimise soil disturbance and protect Mycorrhizal health



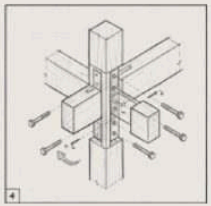
STEEL COLUMN DISCONNECTION

Enable column reuse via mechanical fastenings

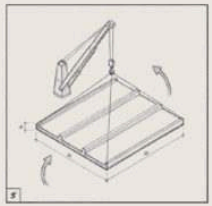


SACRIFICIAL RAMMED EARTH LAYER

Protect undisturbed substrate by using sacrificial ground layers

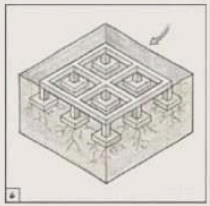


TIMBER BEAM JOINT ASSEMBLY



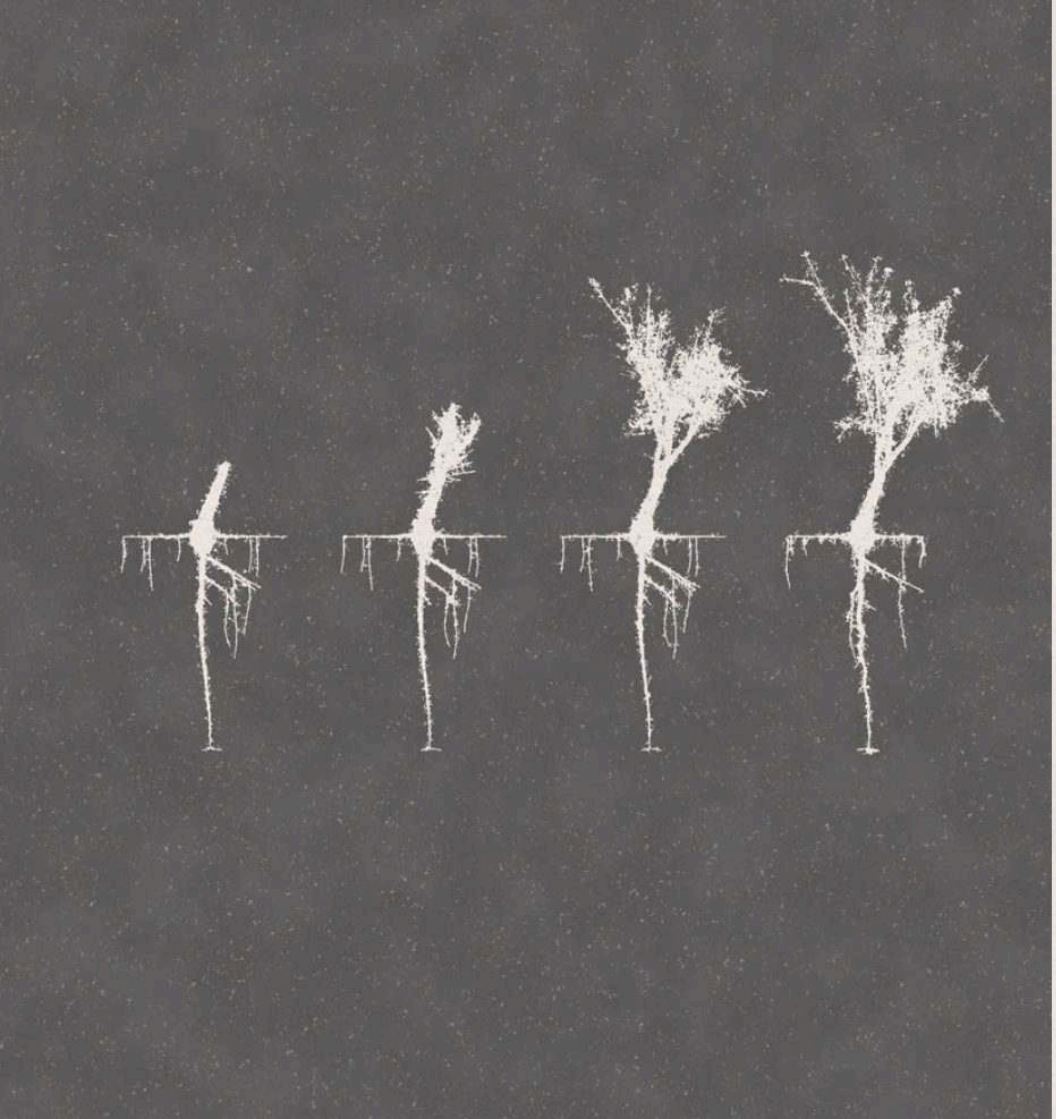
ROOF PANEL LIFT-CLEAR

Optimize roof material for off-site dismantling



FOUNDATION GRID EXTRACTION UNIT

Images generated with Gemini Nanobanana, an AI engine through precise command prompting



02

PROCESS

IN THIS SECTION

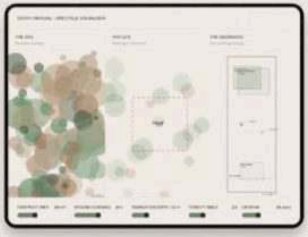
A website prototype
Rhino and Grasshopper
The Rhino plugin
The standalone app

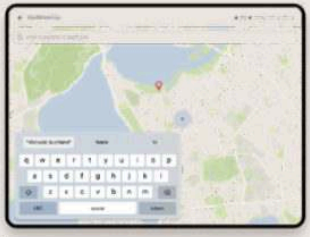


MARCH TO MAY 2026

Tool evolution: a website prototype

In semester one the Death Manual became an app that checked a design against its thresholds. It could show the numbers but could not draw the building, so nothing it made could be built from.







1

31 MARCH
The iPad mock-up for the mid review, one column for each state of the Death Manual.

9 APRIL
The site search, typing Warwick Bushland.

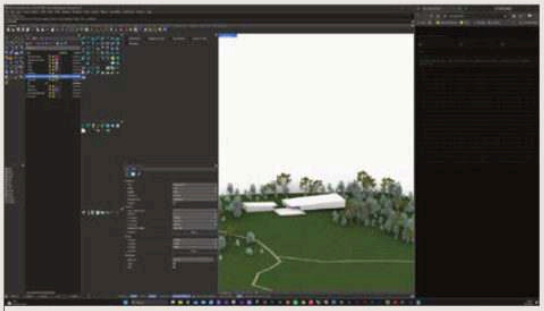
30 MAY
Version 3, a React web app with Mapbox. This design scored 65, on the go line.

Screenshots by Author. Dates from the semester-one process pages. The strip is spaced by event, with no time scale.

31 MAY TO 9 JUNE 2026

Tool evolution: Rhino and Grasshopper

Grasshopper sent the Rhino model to a ledger page on a local Flask server, and the ledger updated each time the model changed. It was a definition linked to a web page, and the plan was a Rhino plugin anyone could use.







2

31 MAY

1 JUNE
Rhino beside the ledger page from the local Flask server.

8 JUNE
A test building in the Warwick model. Grasshopper placed the trees from Atlas of Living Australia records.

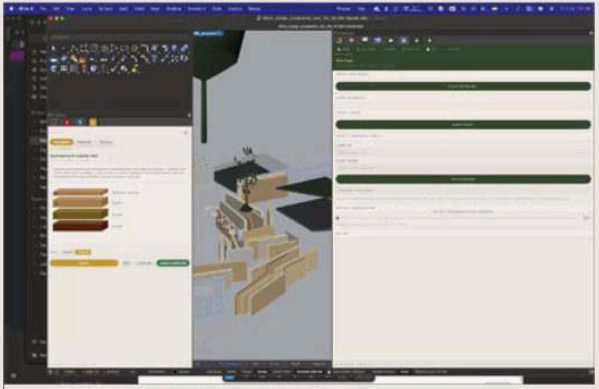
8 JUNE
The live ledger in a panel inside Rhino, connected to Grasshopper.

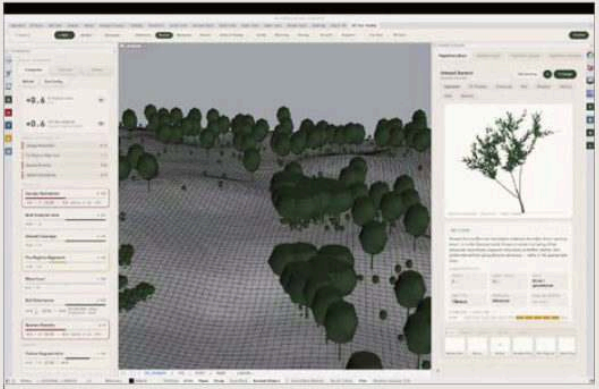
Screenshots and viewport captures by Author, from the Rhino Companion Test files, versions 1 to 5.

JUNE TO OCTOBER 2026

Tool evolution: the Rhino plugin

The plugin worked inside Rhino as a BIM tool, with the ledger and the species library docked beside the model. About 190 of its 680 Python files called Rhino directly, so a community meeting needed a Rhino licence.





3

12 JUNE

3 JULY
Walls drawn with the plugin, with the assembly library docked on the left.

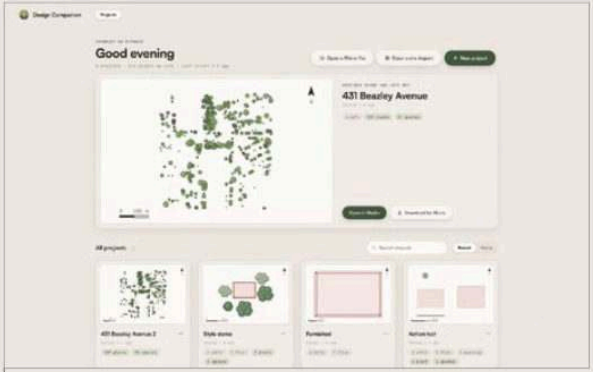
8 SEPTEMBER
The ledger on the left of the model and the vegetation library on the right.

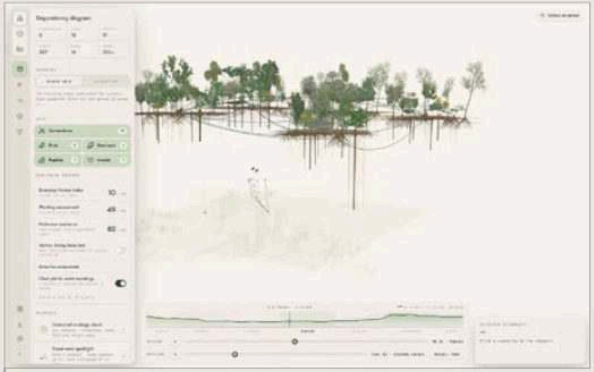
Screenshots by Author. First commit on 12 June, from the plugin's git history.

OCTOBER 2026

Tool evolution: the standalone app

By October the tool no longer needed Rhino to run. A project made in the app opens in Rhino, and the other way round, because both read and write one file format.





4

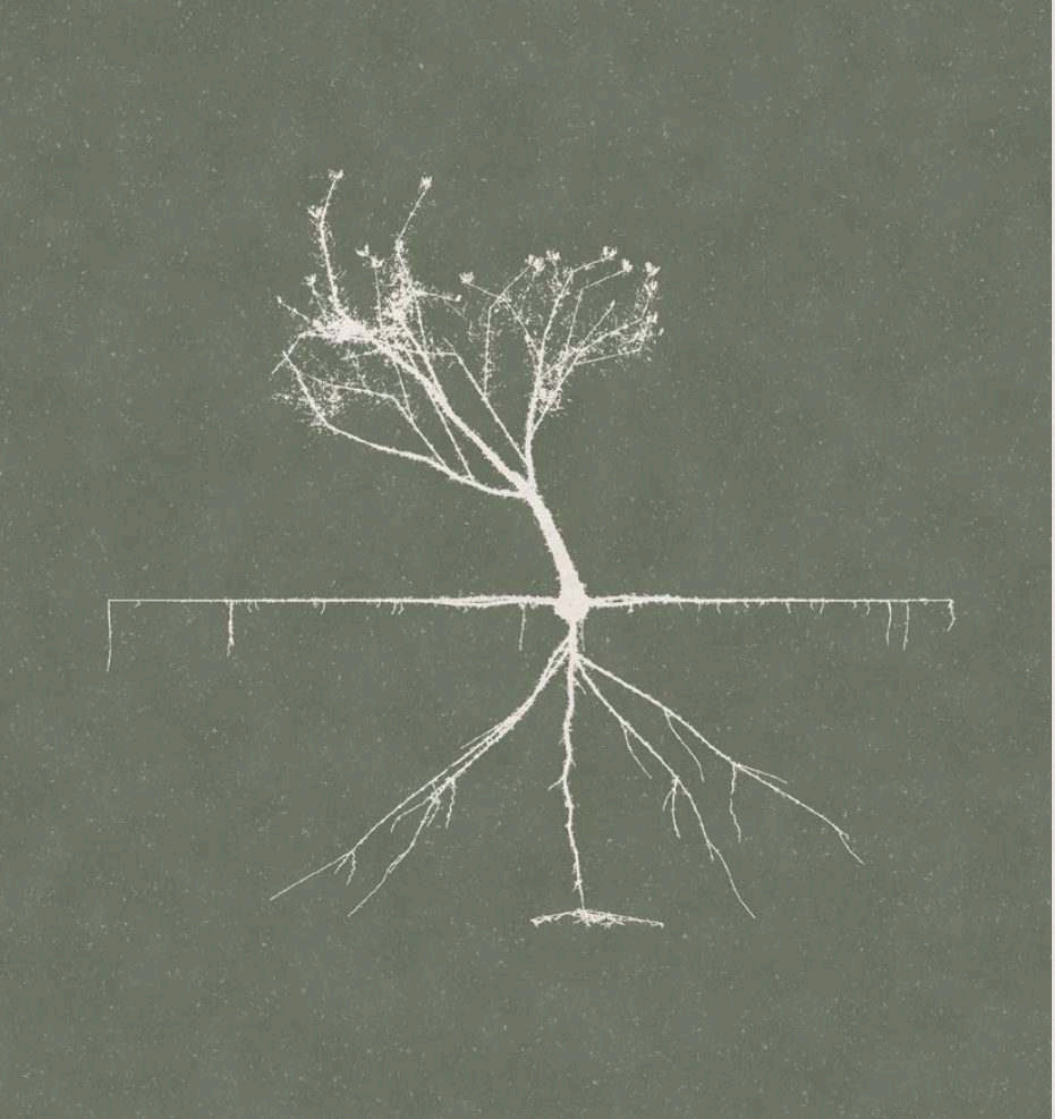
8 OCTOBER

10 OCTOBER
The app's home screen: the last project opened, with Open in Studio and Download for Rhino.

10 OCTOBER
The same project open in the app's Studio, in the diagram view.

1 NOVEMBER
Submission.

Screenshots of the app by Author, 10 October. The plan for the app is dated 8 October.



03

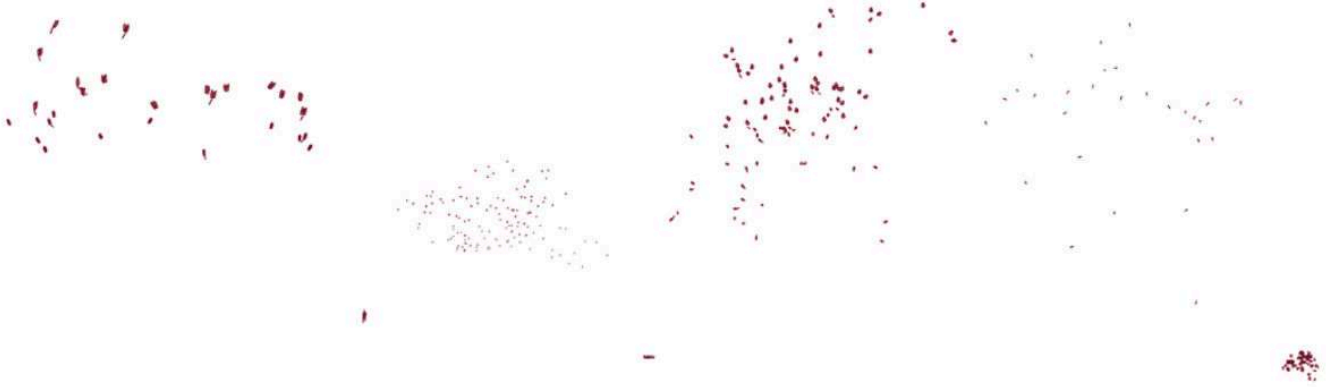
VEGETATION

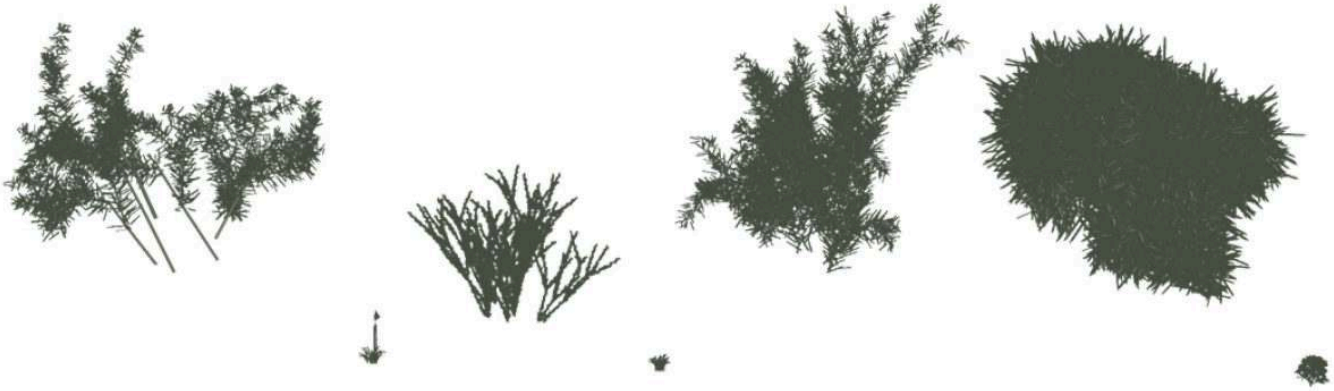
IN THIS SECTION

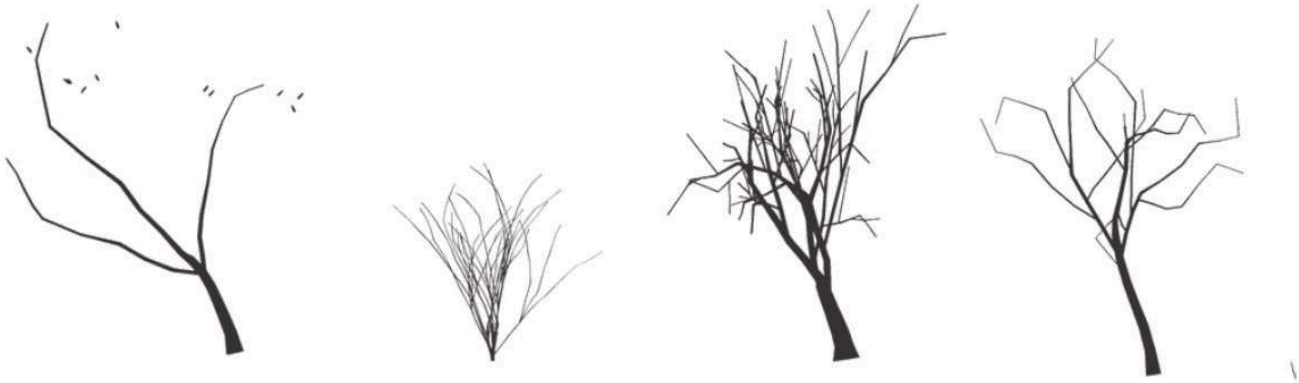
Species 3D models
Flowers, leaves, fruit and roots
Plans, elevations and seasons
Growth over time
Rendering and watercolour system

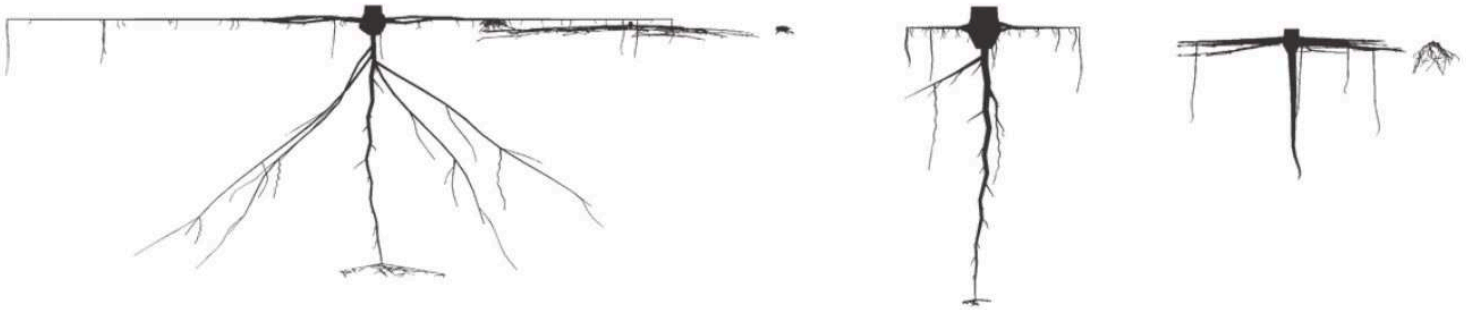


Vegetation: the plant, taken apart











Vegetation: why model the plants

WHY MODEL THEM

Most site plans draw Warwick Bushland as a green patch with a boundary. The plants inside it are what the animals live on. The banksias feed honeyeaters and black cockatoos through winter, the marri holds hollows, and the roots hold the sand together. A design that only sees the patch cannot see what its footprint breaks.

So each species is modelled from photographs and from one record of how it lives: its height at each age, how long it lives, when it flowers and fruits, how deep its roots go and which animals use it. Every drawing in this section comes from that record.

HOW THIS SECTION RUNS

A footprint breaks what the plants hold, so the plants have to be drawn as they are. The section goes from the species in the field to how long plants and buildings last on one plot, and how plants grow in groups. Then each plant is built up: branches, roots, flowers, fruit and the year. It ends with plan blocks, seasonal plan blocks and elevations.



Warwick Bushland, 3 March 2026. Photograph by Author.



Six of the Warwick plants as the plugin builds them, roots included. Figure by Author.









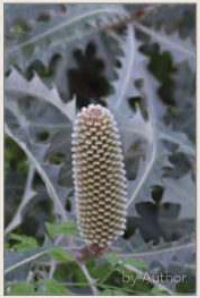




The ecological inventory at Warwick Bushland is **not a static catalogue of species but a record of relationships under pressure.** The banksia woodland community, Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana, Xanthorrhoea preissii, Macrozamia riedlei have persisted on Bassendean sands above the Gnangara Mound for thousands of years under Whadjuk care. Its survival now depends on the ongoing labour of the Friends of Warwick Bushland, who weed, replant, and monitor the interface between woodland and suburb.

But inventory alone is insufficient. **What matters for this project is the relationship between what persists and what degrades;** where weed species like Ehrharta calycina (Veldt Grass) and Lupinus cosentinii (Blue Lupin)












m = 0.12
bud
m = 0.26
flower
m = 0.40
flower
m = 0.54
spent
m = 0.68
green cone
m = 0.84
woody cone
m = 1.00
woody cone


m = 0.12
bud
m = 0.26
flower
m = 0.40
flower
m = 0.54
spent
m = 0.68
green cone
m = 0.84
woody cone
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m = 0.12
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woody cone


by Author.

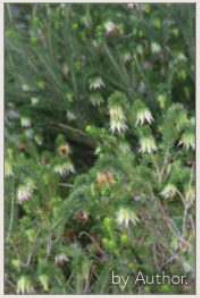
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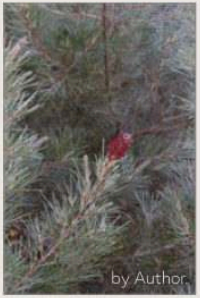
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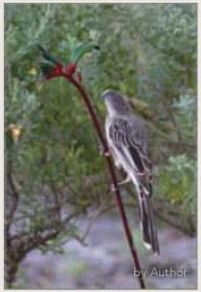
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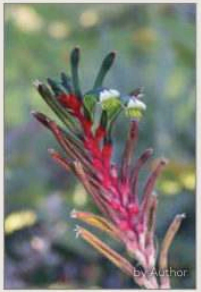

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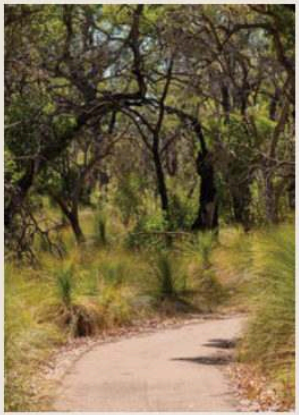
3 MARCH 2026

Vegetation: Warwick Bushland site visit



A sandy side track, a grass tree and fallen limbs at its edge. Photograph by Author.

TRACK, FIRE AND BARK



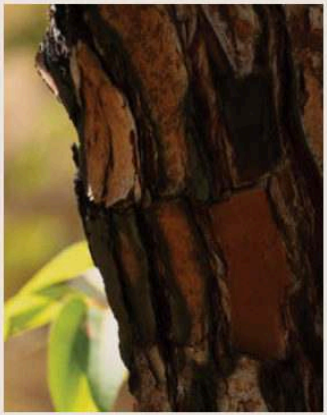
The walk track through banksia woodland, grass trees on both sides. Photograph by Author.



Burnt grass tree bases left on the ground. Photograph by Author.



Trunks blackened by fire, new growth around them. Photograph by Author.



Thick, deeply cracked bark, red where the outer layer has gone. Photograph by Author.

Full set: appendix, page 400

Vegetation: the species in the field

FIREWOOD BANKSIA, BANKSIA MENZIESII



IN FLOWER, KINGS PARK



THE PLUGIN'S FLOWER SPIKE



THE PLUGIN'S PLANT



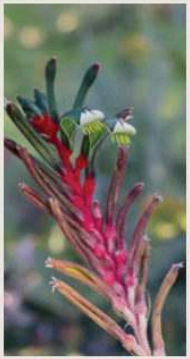
LABELLED, WARWICK TRACK

Photographs by Author.

RED-AND-GREEN KANGAROO PAW, ANIGOZANTHOS MANGLESII



IN FLOWER, KINGS PARK



THE WHOLE STEM



THE PLUGIN'S FLOWER



THE PLUGIN'S PLANT



WATERCOLOUR

Full set: appendix, page 292

Vegetation: the species record

Each species became a record to check a footprint against: height by age, root type and depth, flowering, the animals that use it and how it is drawn. The library grew from 19 species in June to 912 in September.

The first 3D gallery, on 3 July, drew about 160 species as cones, discs and green blobs. One plant could not be told from another.

ONE RECORD, IN PART

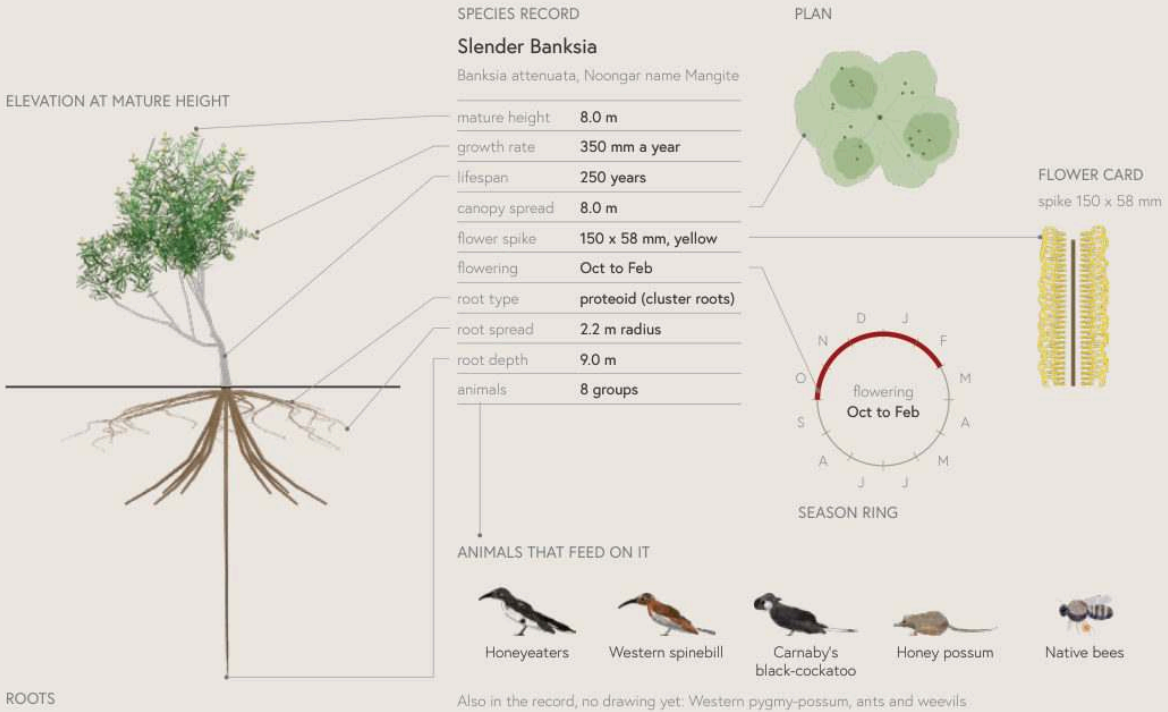
species_id	banksia-attenuata
common_name	Slender Banksia
scientific_name	Banksia attenuata R.Br.
root_type	proteoid
root_depth_mm	9000
height_by_age_class	seedling: 220, juvenile: 2400, mature: 8000, senescent: 7360
flowering_months	[1, 2, 10, 11, 12]
life_stage	growth_rate_mm_per_year: 350, lifespan_years: 250, hollow_bearing_age_years: 130, fire_response: "resprouter"

Slender Banksia, 8 of the 28 fields in its record. The 250-year life and 130-year hollow age were copied from the marri and are being corrected.

THE FIRST GALLERY, 3 JULY: PART OF A SHEET OF ABOUT 160 SPECIES



SLENDER BANKSIA | FIREWOOD BANKSIA | GRASS TREE | SHEOAK | JARRAH | ZAMIA CYCAD



Slender Banksia. Every drawing of the plant reads its values from this one record: height, spread, flowering, roots and the animals that feed on it. Figure by Author.

Full set: appendix, page 293

Vegetation: plant and building lifespans

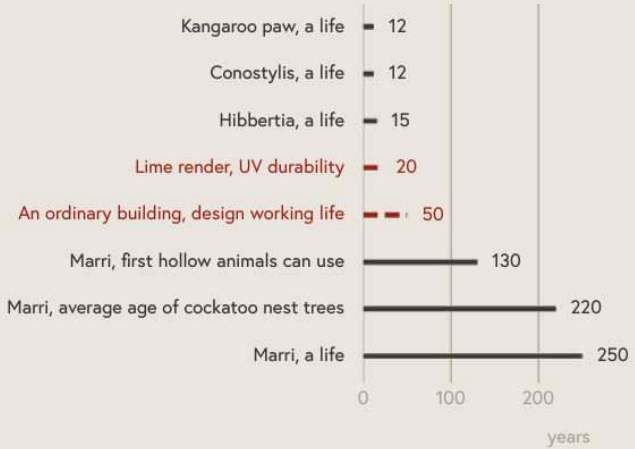
ONE PLOT AT FOUR AGES

To compare how long a building and its plants last, one plot is drawn four times in Rhino: a compressed earth block wall with a nest box, a marri, a slender banksia and three small shrubs. Only the age changes, at 1, 10, 50 and 150 years.

The wall stays the same in the model, but its records give it a life too. The lime render needs renewing every 20 years, and an ordinary building is designed for 50. The marri takes 130 years to hold a hollow an animal can use, and lives 250.

Apart from the shrubs, the building has the shortest life here. Before the marri holds a usable hollow, the render is renewed six times and a 50-year design life passes twice. A cut hollow tree is owed after the building goes.

LIVES ON THE SAME PLOT, IN YEARS



Plant lives and hollow ages from the species records; the 220 is the average age of marri nest trees in use (Johnstone, Kirby and Sarti 2013), not the age a hollow first forms. Render from the materials record. Design working life from AS/NZS 1170.0.

WHAT THE TOOL SHOWS

Each plant grows from its record: the marri goes from a seedling at 220 mm to a 25 m tree, and is drawn a little lower and wider once it passes 80 years and is counted as old.

WHAT IT DOES NOT SHOW YET

The 150-year marri is drawn with no hollow, though its record says it should have one. The ten-year marri has half its crown bare. The banksia record copies the marri's 250-year life and 130-year hollow age, which is wrong and being checked.



YEAR 1

At year 1 the marri, banksia and shrubs are seedlings a few centimetres to 220 mm tall.



YEAR 50

The shrubs live 12 to 15 years, so at 50 and 150 they are drawn as replanted. The tool does not yet replace them by itself.

Full set: appendix, pages 350 and 351

Vegetation: growth and seasons

JARRAH AT SEVEN AGES

Trees are usually drawn mature.

This jarrah is built at seven ages: 0.68 m at one year, 1.70 m at three, 3.30 m at six, 8.02 m as a sixteen year old juvenile, then 16.22 m, 25.71 m and 24.41 m at forty, one hundred and two hundred and fifty. The last tree is shorter than the one before it and has hollows.

I did not choose any of these ages. Jarrah's record gives a growth rate of 350 mm a year, a lifespan of 250 years and a hollow-bearing age of 130, and the life stage model reads all three. The same three values appear in the marri and banksia records, so they are being checked. The curve flattens near mature height and drops back in the last tenth of its life. Flowering first shows at forty years because it depends on size, and jarrah starts at 35 per cent of mature height. Change the record and the whole row redraws, so the time a felled tree takes to come back is read from its record.

Hollows take more than a century to form in eucalypts and cannot be replaced by planting or offsets (Gibbons and Lindenmayer 2002). Scenario 19 in the deck runs sixty years of restoration on a cleared site and still cannot breed a Carnaby's Black-Cockatoo.



Banksia in flower and in bud. Warwick Bushland. Photograph by Author.

Jarrah at five of its seven ages, from seedling to first flowering at 40 years. Figure by Author.

Full set: appendix, pages 338 and 339



Vegetation: grouping

VEGETATION GROUPS

Woodland plants depend on each other, so Vegetation Groups proposes whole communities, filtered by where the planting sits (bushland interior, edge and roads, or near water), under one of seven logics.

A structural guild fills the strata with one species per layer, from canopy to groundcover. Root niche partition picks plants whose roots work at different depths, so they do not compete for the same soil. Mycorrhizal network builds around a hub plant that handles the group's nutrient exchange; the code still uses a banksia as the hub, which is wrong, since banksias feed through cluster roots. Nurse and fixer adds a wattle or a sheoak to enrich the soil and shelter its neighbours. Year-round table staggers flowering so there is nectar across the year. Fauna habitat guild is built for one target animal at every layer, and pollinator chain keeps one pollination syndrome going across a continuous run of nectar sources.

THE SEVEN LOGICS

Each suggestion comes with its reasoning written out, and the group keeps its own canopy, carbon and water totals as plants are added or removed.

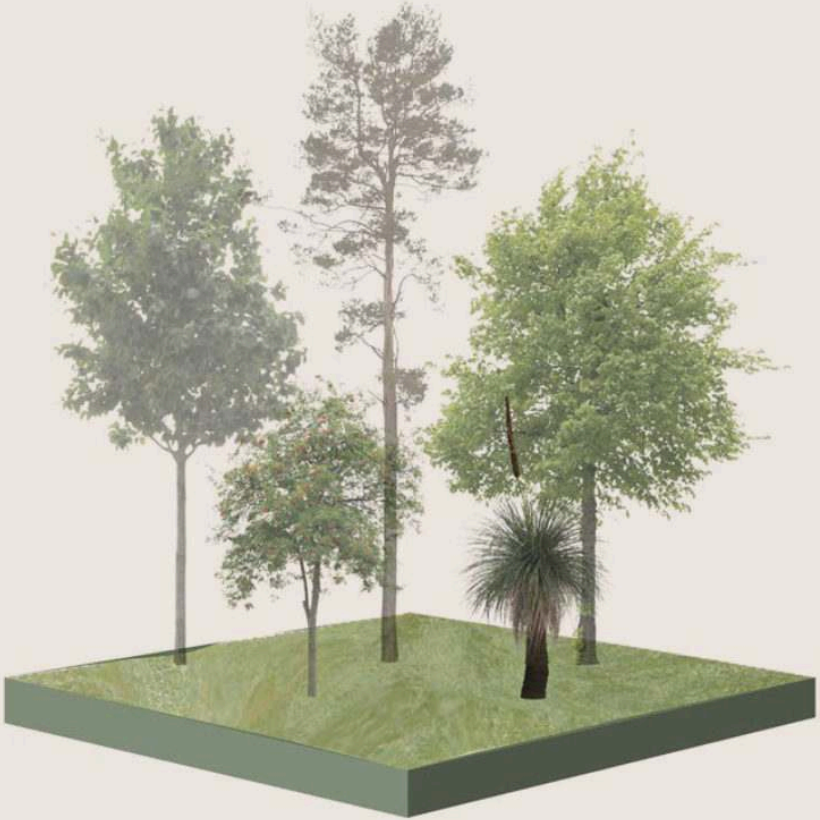
The root drawings in the second diagram are what the root niche logic reads. A jarrah drops sinkers towards the water table. An acorn banksia runs proteoid cluster roots through the top of the profile to mine phosphorus from sand that holds very little (Lamont 1982). A zamia holds a tuber, a jointed rush holds the surface with fibre, and the WA Christmas Tree sends out haustoria to take water from everything around it.



STRUCTURAL GUILD | ROOT NICHE PARTITION | MYCORRHIZAL NETWORK | NURSE AND FIXER | YEAR-ROUND TABLE | FAUNA HABITAT GUILD | POLLINATOR CHAIN

The seven grouping logics, as the Vegetation Groups panel draws them, at one scale. Figure by Author.

Full set: appendix, page 348



A placed group in 3D.



CLUSTERED, IN 3D



DENSE MAT, IN 3D

Two of the six arrangements in 3D on the site soil. Renders from the plugin. Figure by Author.

Vegetation: trunks, branches, leaves and flowers

Once the records were stable, each plant had to look like its species, so a designer can see what a footprint removes. The bole and limbs, the leaf outline and the flowers were rebuilt in turn, each beside the last.

AIM

A trunk and limb builder driven by the record, then leaves cut to each species' outline and flowers built from close-up photographs.

PROBLEM

Trunks came out as straight sticks, and every plant carried the same generic blade of a leaf.

OUTCOME

No flower is modelled without close-up photographs of that species.

CROWNS, THEN LEAVES | 14 SEPTEMBER

BEFORE



AFTER



EUCALYPTUS ACCEDENS

BEFORE



AFTER



EUCALYPTUS CAMALDULENSIS

BEFORE



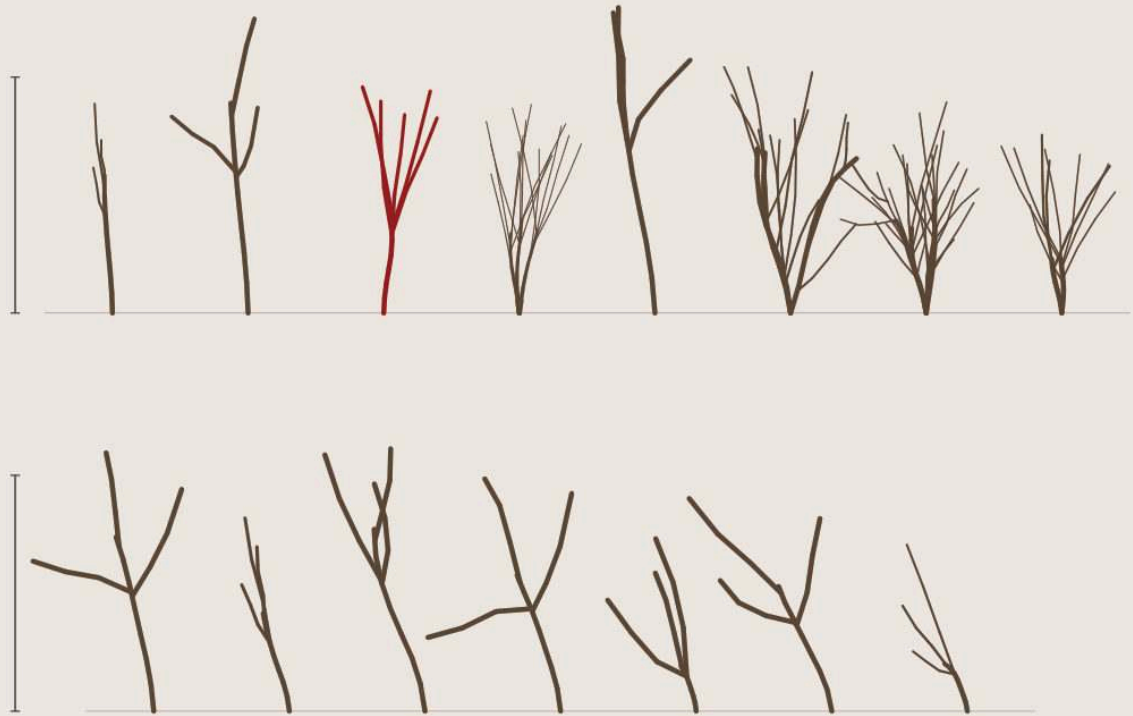
AFTER



EUCALYPTUS DECIPIENS

The first batch of crowns, before and after.

TREES AT 9.0 M, BOLE AND FIRST LIMBS



Bole and first limbs, drawn from the plugin's branch records: trees at 9.0 m, shrubs at 2.5 m, each group with its own scale bar. Figure by Author.

Full set: appendix, page 297

Vegetation: root systems

The roots were the weakest drawings in the tool, and the thesis depends on them most, because a building damages a site below the ground first. They went through four versions in ten weeks.

AIM

Root systems drawn from each species record: tap, sinker, proteoid cluster roots and fibrous mats.

PROBLEM

In July they were straight lines fanning out from one point, and a zamia's roots were drawn as a cluster of icosahedra.

OUTCOME

A root graph that branches and thins by order, then polish passes and levels of detail, so a whole stand can be drawn.



ORIGINAL

21 lateral branches, 18,946 faces



PASS 1, TOO ORDERLY

28 lateral branches, 22,800 faces



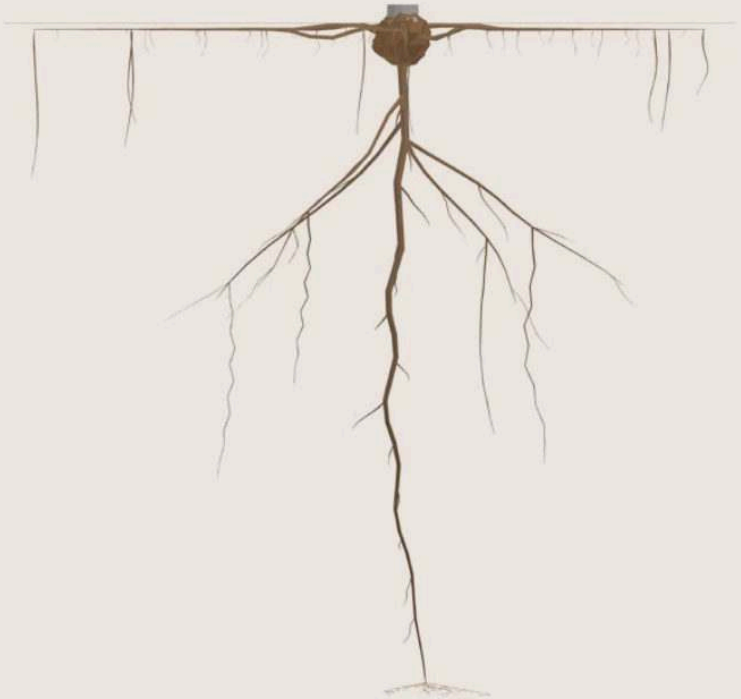
PASS 2, COMPLEX AND SMOOTH

60 lateral branches, 76,264 faces

16 September. Banksia repens in plan: the original, a first pass and a second pass that keeps the complexity and smooths the curves.

Full set: appendix, page 314

ELEVATION



WHERE THE POLISH ENDED, 23 SEPTEMBER

Proteoid roots of Slender Banksia, elevation on the left, plan on the right. They run through the top of the soil, where footings go.

PLAN, AT HALF THE SCALE



Vegetation: flower types

THE FLOWER TYPES

Each species with a drawing spec resolves to an inflorescence type, and each type is drawn its own way. The plate counts the species of each type.

The plate was redrawn on 19 October against the current library. 888 species with a flower now resolve to 41 inflorescence types. Cups lead with 90 species, then pompom heads with 70, airy panicles with 51 and funnel flowers with 48, and a long tail of types with one or two species. Twelve of the 41, covering 249 species, are still drawn with the same five-petal shape, so the plate also shows where the flower drawing is unfinished.

This flora runs on a small number of flower forms, most of them built for birds and insects that probe or brush, so a swap that looks minor on a plant list can remove a food source. Replacing a bottlebrush spike with a daisy head keeps the species count and the native tick, and it changes who can feed.

FLOWER, LEAF, FRUIT

Each species is reduced to three parts and set in a column, so the differences between close relatives are easy to read. Banksia attenuata, Banksia menziesii and Banksia ilicifolia share a genus and differ in all three.

The flower types on the right page are also drawn from the front, side and top. Building them this way caught errors I would not otherwise have found. A flower can be right from the front and collapse into a line from the side, and the side is the view a bird on a branch gets. Two of the organ builders were sizing geometry from the width in the spec and silently dropping the length, which put whole genera at the wrong proportion until the three views sat side by side.

41 TYPES ACROSS 888 SPECIES WITH A FLOWER, THE LIBRARY ON 19 OCTOBER 2026



cup

90 species



pompom head

70 species



airy panicle

51 species



funnel flower

48 species



catkin spike

45 species



simple umbel

42 species



petal flower

41 species



pea flower

38 species



bell

35 species



spikelet

33 species



smoke panicle

31 species



spider raceme

28 species

Full set: appendix, page 302

Vegetation: the library, a selection

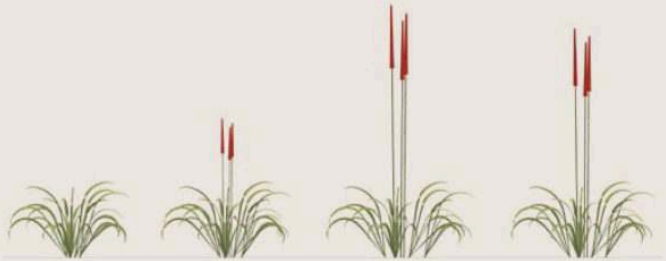
Each plant is drawn through its growth stages and seasons, and as flower, fruit, leaf and roots. The facts under each name come from its record: mature height, root depth, flowering and the animals that use it. A footprint is checked against these. This set is Anigozanthos manglesii, Banksia ilicifolia, Baumea articulata and Conostylis aculeata.

FINDING

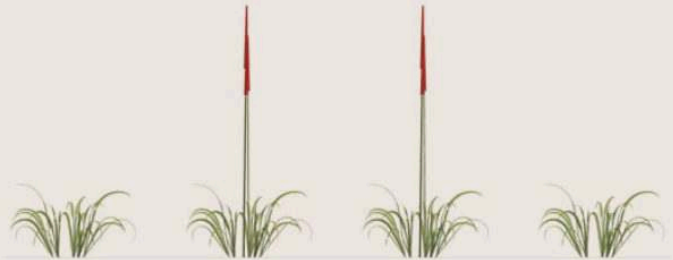
Conostylis aculeata, a 0.3 m herb in this set, turned out to be the template record the batch scripts copied. 241 species carried its carbon, water and leaf area, and 354 its 12-year life.

The 241 were recomputed on 25 September, with the record generator calibrated against 31 hand-researched WA natives.

1 RED-AND-GREEN KANGAROO PAW (NOLLAMARA)



GROWTH STAGES, SEEDLING TO OLD PLANT



THROUGH THE SEASONS

Full set: appendix, page 345

2 HOLLY-LEAVED BANKSIA

Banksia ilicifolia. Mature height 8 m. Roots to 8 m, proteoid. Flowers much of the year.



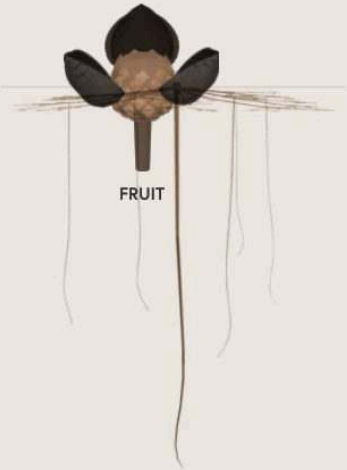
GROWTH STAGES, SEEDLING TO OLD PLANT



FLOWER, MUCH OF THE YEAR



LEAF LAID FLAT, TRUE PROPORTION



FRUIT

ROOTS, TO 8 M



THROUGH THE SEASONS

Vegetation: plants in plan

PLAN SYMBOLS

A footprint is decided in plan, so every species can be drawn from above. The plan symbol reads the same record as the elevation: crown spread, leaf texture and whether the plant is in flower.

On the right, four species run through the plan styles, from a bare outline to a filled and shaded crown.



BANKSIA ATTENUATA



BANKSIA MENZIESII



EUCALYPTUS MARGINATA



CORYMBIA CALOPHYLLA



XANTHORRHOEA PREISSII



MACROZAMIA RIEDLEI



ALLOCASUARINA FRASERIANA



HAKEA PROSTRATA



KINGIA AUSTRALIS



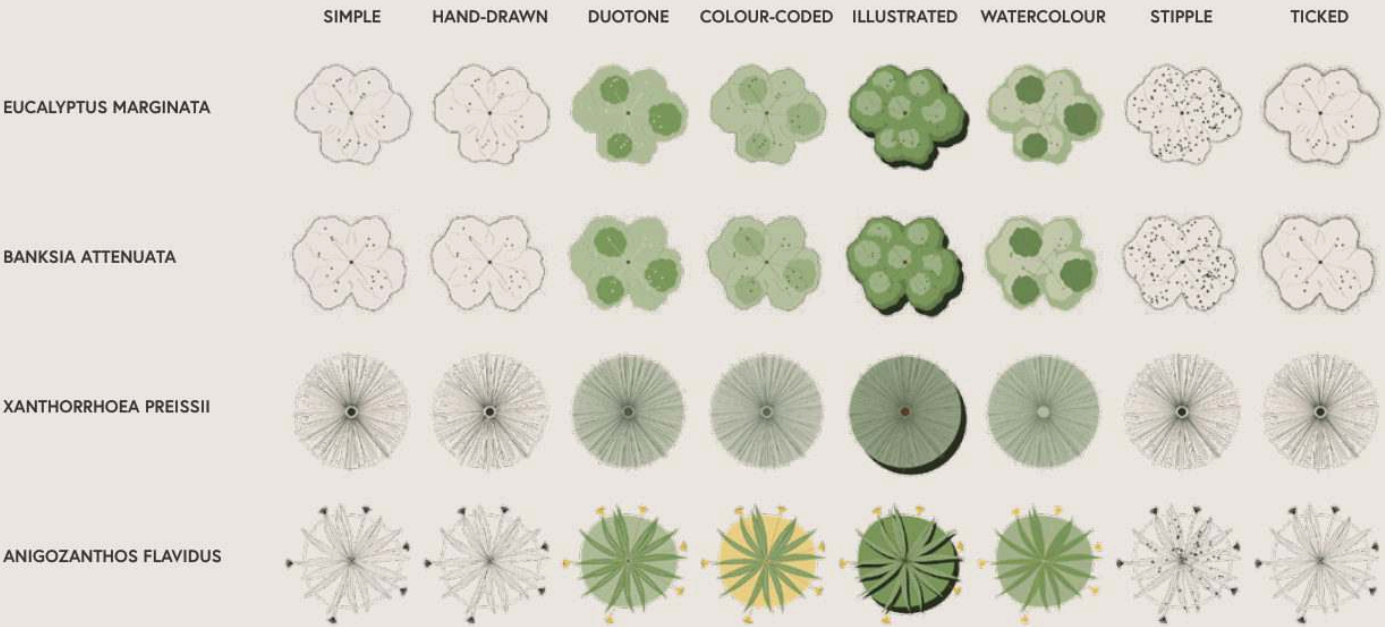
ANIGOZANTHOS MANGLESII



HIBBERTIA HYPERICOIDES



ACACIA PULCHELLA



Four species through the eight plan styles, from outline to full crown, each symbol fitted to its cell. Figure by Author.

Full set: appendix, page 328

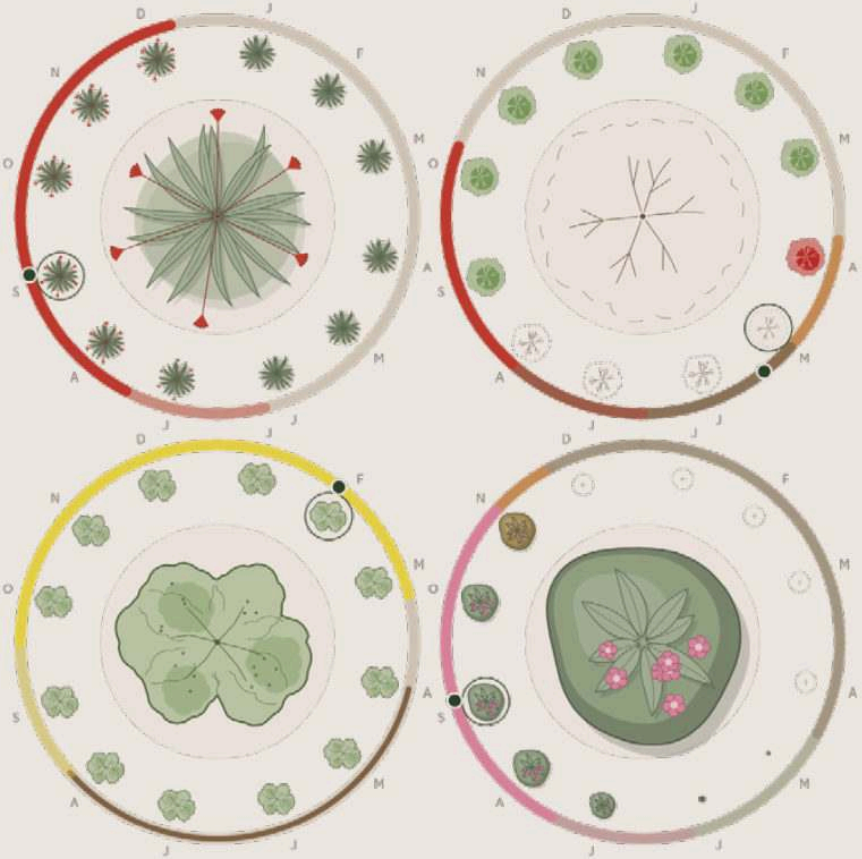
Vegetation: the year in plan

MONTH STRIPS

The same year can also run as a strip under a plant, month by month, with the six Noongar seasons underneath. Two versions were tried, one for a plant in flower and one at leaf-off.



The year as a strip, in flower.



SEASON RINGS

A ring around each symbol shows the months the plant flowers and fruits, so a plan shows food by month.

Four species with the year drawn round them.

Full set: appendix, page 336

Vegetation: four views

FOUR VIEWS

Each species is built as a 3D model and as an elevation with foliage and a measured height, 1.5 m for the wattle at the top of the sheet and 5.0 m for the two below it. Its flower and fruit are then drawn separately at a larger scale.

The flower and fruit get their own drawings because their shape decides which animals can feed. A pea flower, a bottlebrush spike and a cup are three different things to a bird with a curved bill. Fruit type affects which animals eat it, and when. A long pod, a hard follicle and a fleshy capsule are not interchangeable in a planting schedule, even when the plant list marks all three as native.

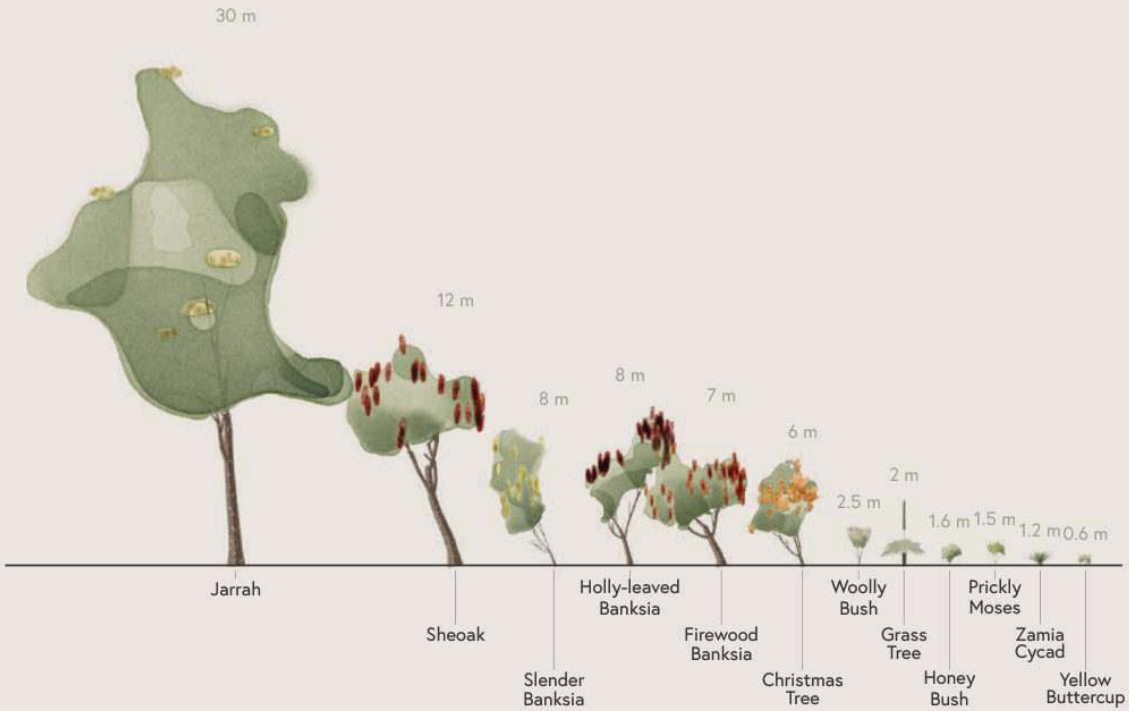
Drawing fruit at this size is also how a long-running error showed up. Forty-eight species were building a dry capsule where the plant makes a woody gumnut. Nobody notices that at canopy scale, but it changes what the plant is worth to a cockatoo.

The elevation has its scale bar and height on it, so it can sit beside a building section at the same scale.

SPECIES BY GROWTH FORM

Three rows at mature size on a shared ground line, grouped by growth form: trees, then shrubs, then grass trees, cycads, sedges and herbs.

The plate is used as a check. A species that is too tall for its neighbours, too dense, or the wrong green shows up here straight away, where it would pass unnoticed in its own frame. The worst bug in the library was caught on a sheet like this. A stray condition in the growth form code had 64 of 76 species drawing a phantom grass tussock on top of their real body, a saguaro included. Each one looked plausible until they were lined up together.



Twelve species at one scale, each at its recorded mature height on one ground line. Watercolour elevations from the plugin. Figure by Author.

Full set: appendix, page 322

Vegetation: watercolour rendering

METHOD

The first watercolour in the tool was a vector wash: flat tinted shapes with a soft edge. On 25 September it was set aside because it looked nothing like watercolour, and the painter was rewritten to work pixel by pixel.

From the references: a wash is one shape of pigment. Where two glazes overlap the edge stays hard. Highlights are paper left bare, and the shadow is a cool stain on the ground.

The plant painter does six things: a wet edge warped by noise, pigment pooling darker at the rim, soft blooms where the wash is still wet, two or three glazes laid over each other, granulation where the pigment is heavy, and a cold-press paper grain under everything.

PLANTS, 25 SEPTEMBER



CORYMBIA FICIFOLIA



ACER PALMATUM



JACARANDA MIMOSIFOLIA



QUERCUS PALUSTRIS



EUCALYPTUS MARGINATA

Full set: appendix, page 343



Week 17, April
Djeran
Leaves only.
No flowers recorded.

Week 37, September
Djilba
In flower.
Flowers recorded July to November.

Week 51, December
Birak
Flowering over.
Stems drying.

Week 7, February, the next year
Bunuru
Seed heads on dry stems.
Seed recorded January to March.

The red-and-green kangaroo paw at four weeks, each painted from its record: leaves only in April, flowers in September, going over in December and seed the next February. Figure by Author.

04

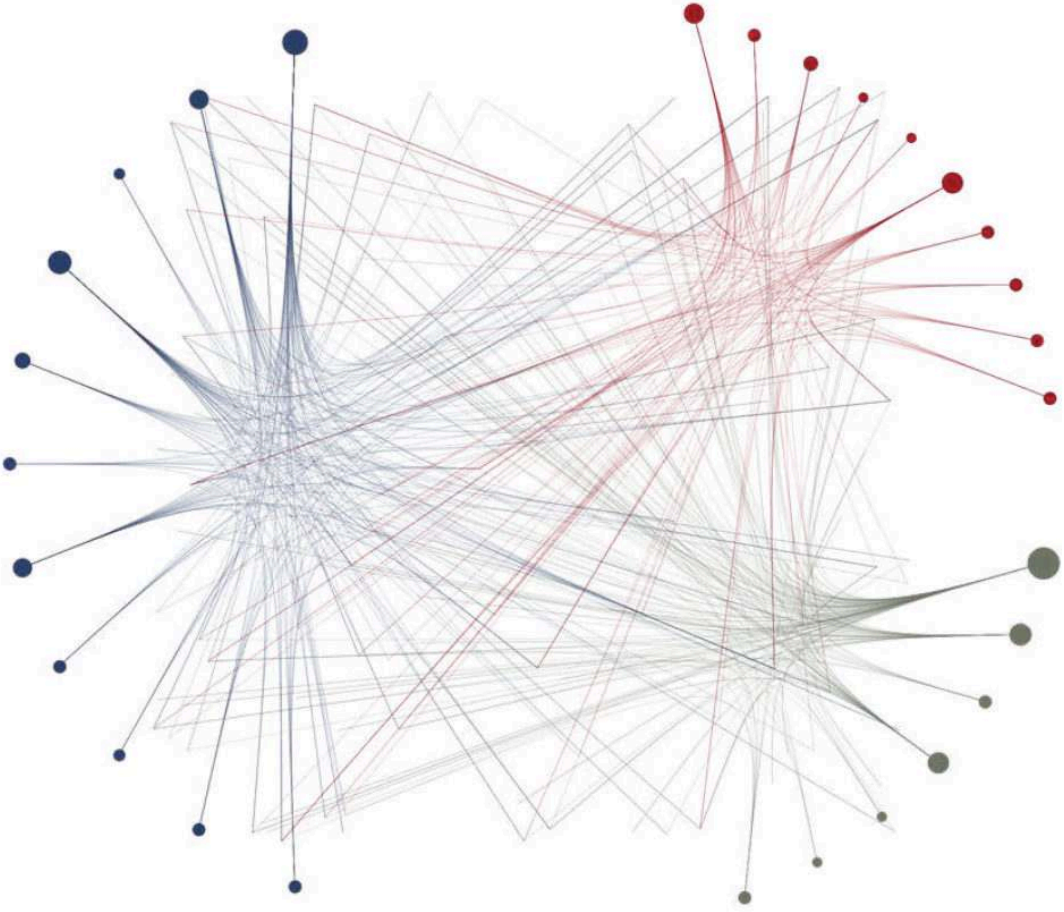
ANIMALS

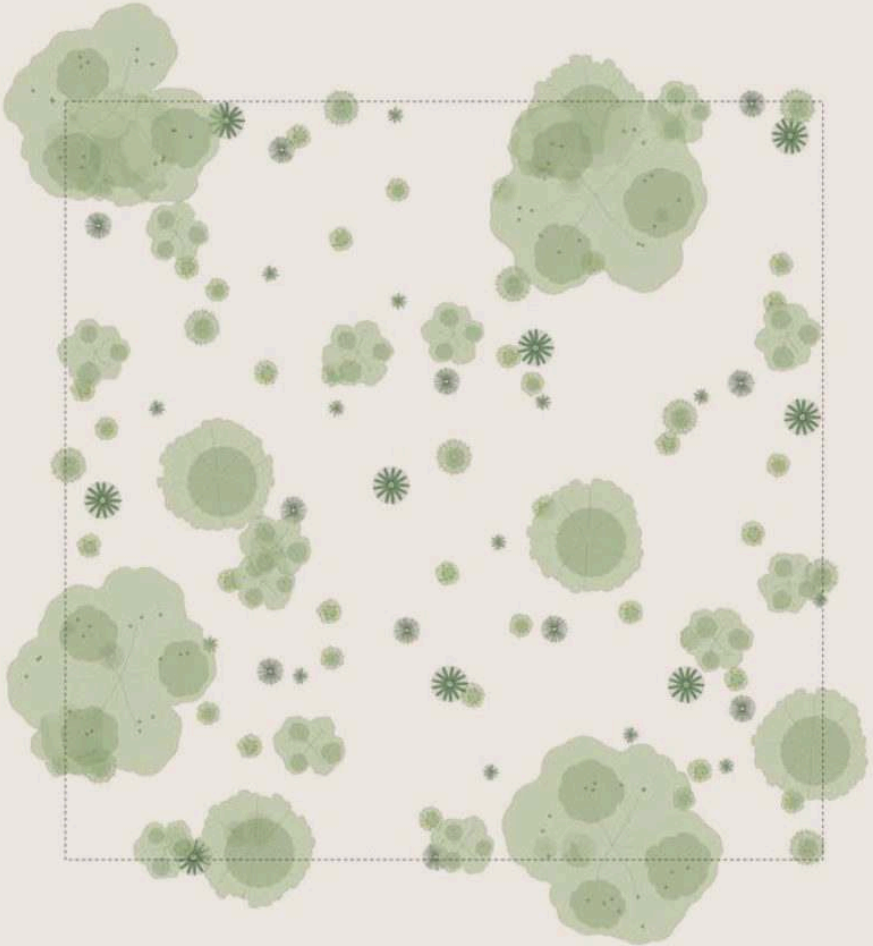
IN THIS SECTION

Plant and animal links
Fauna rigs and models
Nests and hollows
Feeding: flowers, seeds and prey
Introduced animals and urban pressure
Habitat fittings
What lives under the ground



Animals: the web over the ground



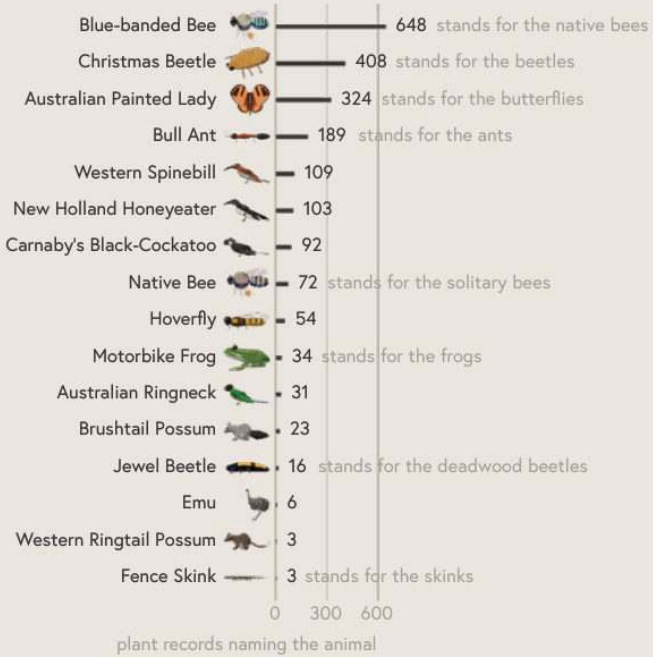


Animals: named in the plant records

Each of the 912 plant records names the animals that use it. Ranked by count, the list shows which animals a clearing touches most.

RANKED BY THE PLANT RECORDS THAT NAME THEM

The numbers count records. The blue-banded bee stands for all native bees, so it carries the 648 species that list the guild.



WHO IS NOT HERE

Where a record names a group, such as honeyeaters, parrots, small birds, waterbirds or reptiles, no body is drawn, since that would mean inventing a species. Six named animals have no model yet and are left off.

Groups are counted but not drawn. An animal without a reviewed model is left off the page.

Animals ranked by how many species records name them, painted from their rigs. Figure by Author.



CARNABY'S BLACK-COCKATOO



EMU



WESTERN RINGTAIL POSSUM



FENCE SKINK, TWICE THE PAGE SCALE

Full set: appendix, page 353

26 AUGUST TO 7 OCTOBER 2026

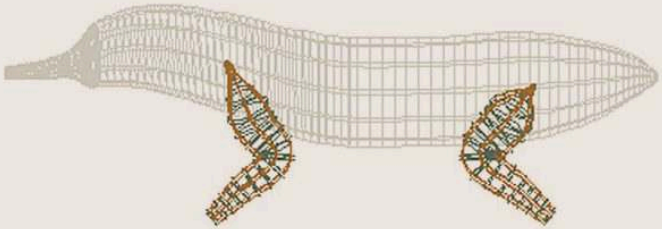
Animals: the fauna models

The animals came last. They began as painted shapes in the live view and became jointed rigs, each checked against photographs, with food and behaviour read from its record. With them a footprint can be read by which animals lose food.

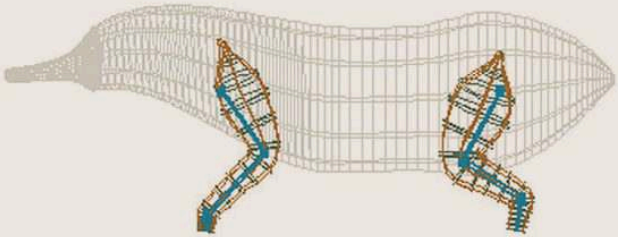
The first birds were flat painted shapes seen from above, and the first legs were tubes with no joints.

An animal without a reviewed model is left off the page. No similar species is drawn in its place.

THE NUMBAT'S LEGS, FROM THE SIDE



OLD TUBES



NEW JOINTED RIG

Watercolour painted from the rigs, so every animal with a reviewed model can be drawn.

OCTOBER: THE RIGS, PAINTED



LAUGHING KOOKABURRA



AUSTRALIAN MAGPIE



NUMBAT



QUENDA (BANDICOOT)

Full set: appendix, page 351

Animals: nests and tree hollows

HOLLOW AGES
The tool reads the age of a jarrah or marri from its trunk. Its records give 130 years to a usable hollow and 150 to one a black-cockatoo can use. The WA Museum puts it at 209. All are longer than a fifty-year building.

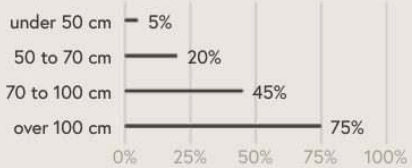
Of the 375 animal records, 39 nest in hollows: parrots, cockatoos, owls, kingfishers, possums, gliders, antechinus and bats. In the garden three share one marri trunk.

NESTS IN THE RECORDS
Every nest record says what it is made of and where it sits. The New Holland honeyeater builds a cup of bark and grass bound with spider web in a bush, so clearing the shrubs clears its nest. The frogmouth lays on a thin platform of sticks.

The nest box on page 103 is what a building can give back while a hollow takes over 130 years. A top entry, the DBCA guide notes, keeps out bees, galahs and corellas, which otherwise take a cockatoo's hollow.

Every hollow is drawn as the same round hole, though the records give a wide entrance for the cockatoo and a spout or knot for the ringneck. Nests in dense crowns, like the magpie's, are not drawn.

SHARE OF JARRAH AND MARRI WITH A USABLE HOLLOW, BY TRUNK DIAMETER



130 years: first hollows animals can use
150 years: large enough for a black-cockatoo
209 years: the WA Museum figure

Share of jarrah and marri with a usable hollow, by trunk diameter. The shares are marked indicative in the data; the three ages in red are sourced.



TAWNY FROGMOUTH: A PLATFORM OF STICKS



NEW HOLLAND HONEYEATER: A CUP



WESTERN SPINEBILL: A CUP

Full set: appendix, page 355

Animals: habitat fittings

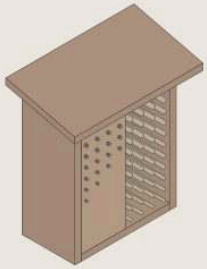
HABITAT FITTINGS AS BUILDING ELEMENTS

Of the library's 24 furniture and fitting families, ten give something back to animals or the garden that feeds them: a bee hotel, nest box, microbat box, bird bath, frog pond edge, beehive, compost bays, worm farm, raised bed and rainwater tank.

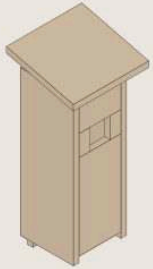
They are placed like any other element and scheduled with the building, so what it gives back is counted with the rest. Each family has 10 to 16 settings.

WHERE THE DIMENSIONS COME FROM

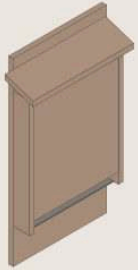
Each family records where its dimensions come from, because most catalogues do not cover them. The bee hotel follows Aussie Bee and Bush Blitz: holes of 3 to 10 mm, 100 to 150 mm deep and not drilled through. The bird bath follows a 2 to 3 cm margin for honeyeaters and finches.



BEE HOTEL
380 x 205 x 418 mm



NEST BOX
270 x 250 x 660 mm



MICROBAT BOX
430 x 120 x 770 mm

THE SCHEDULE AT DEFAULT SETTINGS

All ten drawn from the plugin's own families at their default settings, in the same axonometric and light; sizes, cost and carbon are the values each family reports to the schedule.

FITTING	SIZE, MM	COST, AUD	CARBON, KG CO2E
Bee hotel	380 x 205 x 418	72	5
Nest box	270 x 250 x 660	85	8
Microbat box	430 x 120 x 770	85	5
Bird bath	450 x 450 x 886	320	28
Beehive	412 x 643 x 1,043	530	43
Worm farm	534 x 702 x 805	250	18
Frog pond edge	2,000 x 3,550 x 1,450	1,150	40
Compost bays	3,400 x 1,200 x 895	500	51
Rainwater tank	2,471 x 2,473 x 2,680	1,800	288
Raised bed	1,840 x 940 x 665	444	57

Full set: appendix, page 364

DAY AND NIGHT, 11 AND 12 OCTOBER 2026

Animals: the feeding garden

METHOD

The garden is built from the plugin's plant bodies, with anchors where each one flowers, and the animals of the Living Field. Each animal goes to food its record lists, in flower that week and in reach. Predators hunt as their record says: a kookaburra drops from a perch, a kestrel hovers, a bobtail probes the ground. Week by week it shows which plants they depend on.

The garden was set to August and September. The animals on these pages are painted from the same rigs, each at the plant its records name.



AUSTRALIAN PAINTED LADY AT AN EVERLASTING

LIMITATIONS

Of the 912 plant records, 891 have their pollinators filled in at genus level, and many animal records are marked indicative. The paintings show what the records imply.

Insects are drawn many times life size so that they read at all, birds inside a crown are hard to see from any angle, and the quenda model stands too tall on straight legs. Bees feed deep in strap leaves where no camera reaches them.





RED FOX AND MOTORBIKE FROG, AT NIGHT

The fox is introduced and listed as a predator in 119 animal records.



NEW HOLLAND HONEYEATER AT KANGAROO PAW

Full set: appendix, page 356

Animals: the honey possum

HONEY POSSUM DIET

The honey possum weighs about nine grams and eats nothing but nectar and pollen. Its record in the tool says it needs around 7 ml of nectar and 1 g of pollen a day, mostly from banksias and Adenanthos, with eucalypts, Agonis, kangaroo paw and grass tree as well.

A footprint that clears banksias clears most of the possum's food. The scarlet banksia record lists it as a feeder, with nectar from June to September.

The rig was built from three iNaturalist observations and was the first animal taught to feed. It climbs, aims its snout at a flower and holds its tongue against it.

Its record also gives two to four young, breeding peaks in May to June and September to October, and a life of one to two years. Foxes, cats and owls take it. Sources: Wikipedia and Animal Diversity Web, marked indicative in the data, to be replaced with primary sources.



FEEDING, PHOTOGRAPH

Simon Colenutt, iNaturalist, CC BY, mirrored.



THE RIG AT REST, PAINTED

PHOTOGRAPH AGAINST MODEL

An audit on 12 October set the rig against three iNaturalist photographs and scored it 55 out of 100, provisional and not approved.

SHAPE

The photographed animal has a low, smooth back. The rig narrows at the neck and rises to a separate bump over the hips.

SNOUT

The real snout tapers finely out of the forehead. The rig reads as a flat tube.

FEEDING

The possum grips the flower close to its chest. The rig holds its paws away from any support.

COAT AND TAIL

The adult photographed has warm rufous flanks, and the rig is one muted brown. Its tail bends rigidly instead of hanging as a slender, flexible line.

LEAVES

The scarlet banksia has since been rebuilt with broad, toothed leaves round a squat flower head, as in the photograph.



THE SCARLET BANKSIA, REBUILT

Banksia coccinea from the builder, 3 m.

Full set: appendix, page 361

Animals: seed eaters

METHOD
The plant painter does not yet read cleanly on these trees. In flowering weeks it turns the marri's cream blossom into a black mass. So the plain Rhino models from the library pages are repainted as washes, and the birds are the rig paintings.

The banksia keeps its old cones, which the cockatoo's record names as a seed source, so a banksia kept is food kept. The birds are enlarged and placed by hand.

COCKATOO AND RINGNECK IN ONE MARRI
The marri record says it holds its seed in woody capsules all year, with nectar from January to April. That makes it food in every month, and in the garden both parrots went to it as soon as they were hungry.

The ringneck fed in the marri because its record says seeds. The marri record does not list it. The link was made by the feeding engine, not by the data, and the ringneck record is marked indicative.



CARNABY'S BLACK-COCKATOO ON A SLENDER BANKSIA
With last year's cones.



AUSTRALIAN RINGNECK IN A MARRI

Full set: appendix, page 359

Animals: predators in the feeding garden

HUNTING STYLES FROM THE RECORDS

The garden also runs at night. The red fox comes out at night, and its record gives it frogs, lizards, birds and small and medium mammals. It is introduced, and the record notes it as a major predator of bandicoots and possums in urban bushland.

Of the 375 animal records, 268 eat other animals, and each has a hunting style that sets how it moves when it is hungry. A kookaburra watches from a perch and drops. A kestrel hovers with its head still, then stoops. A bobtail and a quenda walk with the nose down and probe.

Prey records list their predators as well. The bobtail's gives the dugite, the carpet python, the red fox and the kookaburra.

LIMITATIONS

The quenda rig stands too tall on straight legs and its tail is too long. The kookaburra is native to the east and introduced in Western Australia, which its record notes but the garden does not show. The camera was moved until no plant stood in front of the animal.

ANIMAL RECORDS

Animal records	375
Eat other animals	268
List the fox as a predator	119
List the cat as a predator	176

HUNTING STYLE OF THE 268 THAT EAT ANIMALS

Ground probe	65
Sit and wait	26
Perch and pounce	22
Chase	21
Aerial hawk	19
Stalk and strike	19
Swim and forage	16
Dig	13
Hover and pounce	7
Soar and stoop	7
Web	5
Browse, graze, other	48



NANKEEN KESTREL, BEFORE THE STOOP



TAWNY FROGMOUTH DROPPING ON A FENCE SKINK



QUENDA CARRYING A GRASSHOPPER

Full set: appendix, page 360

Animals: introduced animals and urban pressures

PRESSURES IN THE RECORDS

The records also hold pressures that arrive with people: a person walking, a dog, a pet cat, window glass, outdoor light and feral honey bees. The engine adds them to a scene like an animal, so a design meets what its users bring.

A roaming pet cat is put at 186 kills a year, 110 of them native: 40 reptiles, 38 birds and 32 mammals.

CATS AND DOGS

Urban areas hold 39 to 70 pet cats per square kilometre. Fences, gates and paths set where cats and dogs can go.

GLASS

Using US median rates, a low-rise building kills about ten times as many birds a year as a house. Glass area and orientation affect bird strike (Loss et al. 2014).

LIGHT

Moths are drawn to a light from 10 to 30 m away, so a lit edge facing the bushland draws them out.

ONE ROAMING PET CAT, ANIMALS KILLED A YEAR



Source held in the records: Legge, Woinarski et al. 2020.

A DOG ALONG THE PATH

A small bird keeps about 8 m from a person and a medium bird 15 m, and further again when a dog is along.

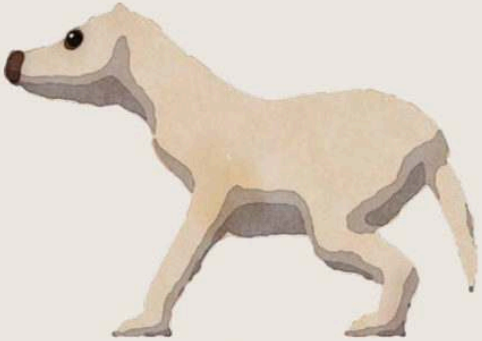
Most of these depend on the building and how it is managed.

WOODLAND WALKED WITH A DOG, PER CENT OF CONTROL

red dashed: brought by people



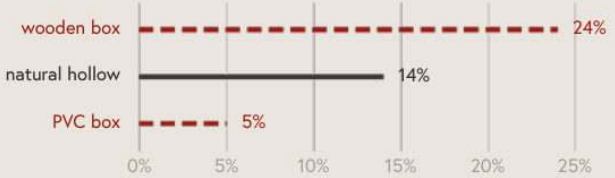
Source held in the records: Banks and Bryant 2007.



Dog. Walked woodland held 35% fewer bird species.

HOLLOWS TAKEN BY FERAL BEES, BY MATERIAL

red dashed: brought by people



Source held in the records: Berris et al. 2020.

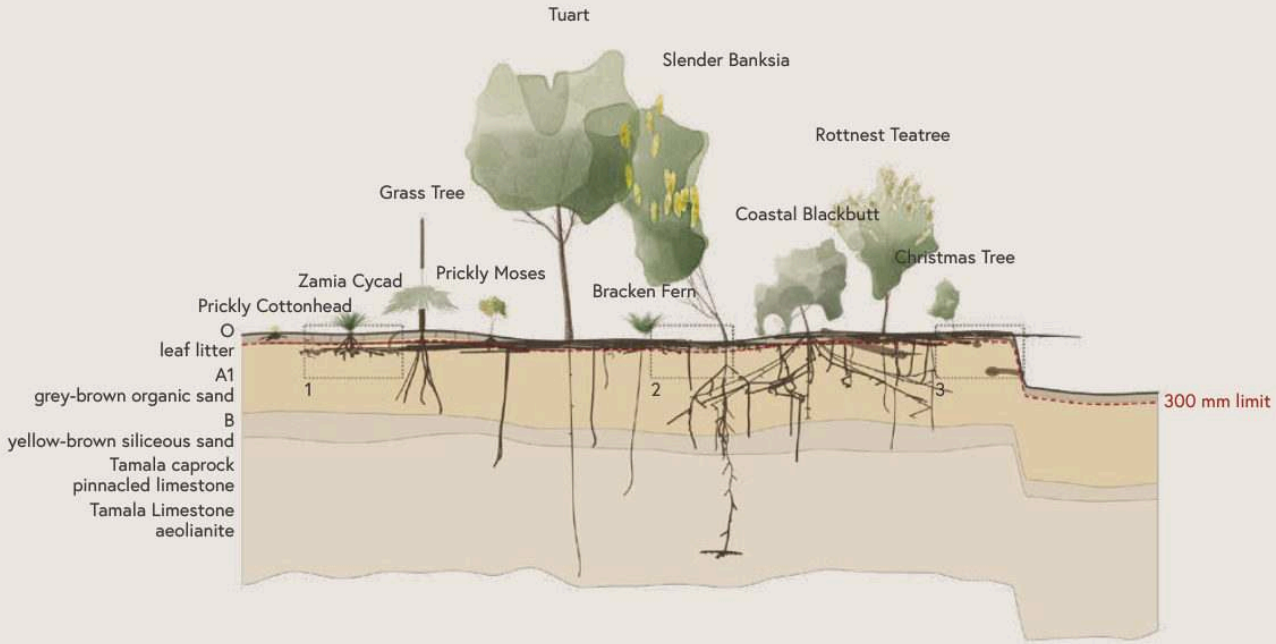
NEST BOXES

Feral bees took 24% of timber boxes against 5% of PVC ones, and a top entry deters bees, galahs and corellas.

Full set: appendix, page 362

LEEUWIN SOIL COLUMN, WHOLE AND ENLARGED

Ground: the live section



The live section of the Leeuwin soil column: plants, roots, burrows and the animals living in them. Windows 1 to 3, each 3 m of ground, are drawn larger in the appendix, pages 386 to 388. Figure by Author.

WHO LIVES IN THE TOP METRE		burrow to
3	Rakali (water rat)	1130 mm
1	Bull ant colony	680 mm
1	Moaning frog	450 mm
3	Blue-banded bee	330 mm
2	Bobtail skink	320 mm
2	Ground-nesting native bee	270 mm
3	Western banjo frog	250 mm
3	Earthworm	240 mm
3	King skink	190 mm
3	Rainbow bee-eater	130 mm
1	Christmas beetle	60 mm

Full set: appendix, page 386

Ground: the live section in 3D

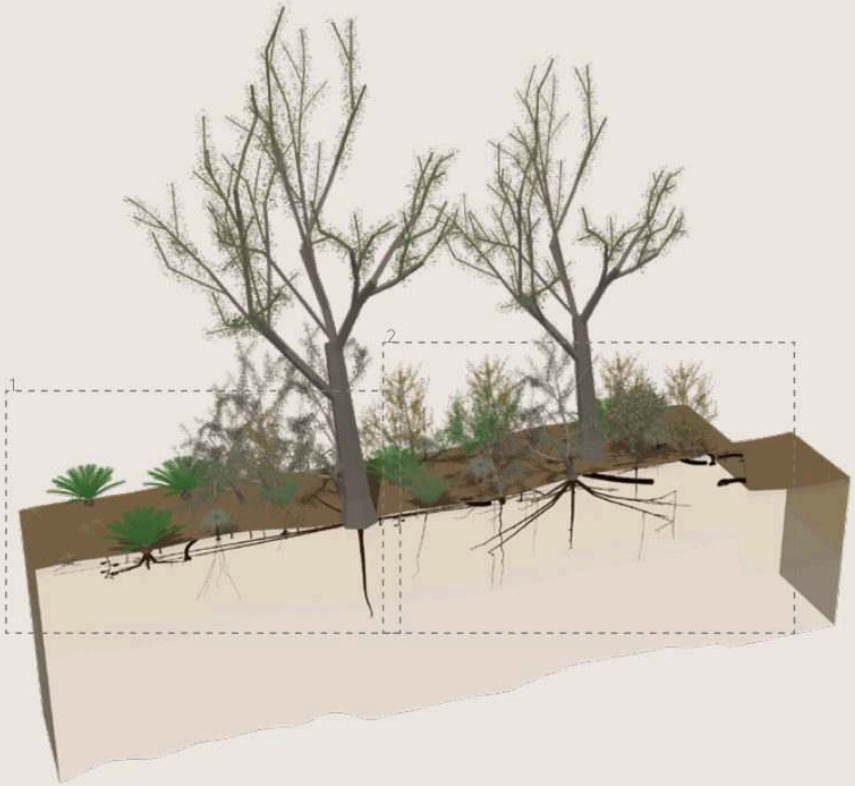
WHAT LIVES UNDER A PLAN

A plan shows where a building sits. The live section shows what lives under it. In the Leeuwin soil column the rakali burrow runs to 1.1 m, the bull ant colony to 680 mm and the moaning frog to 450 mm. The ground-nesting native bee, the banjo frog, the earthworm, the king skink, the rainbow bee-eater and the Christmas beetle all live within the top 300 mm, the depth a slab cut reaches first.

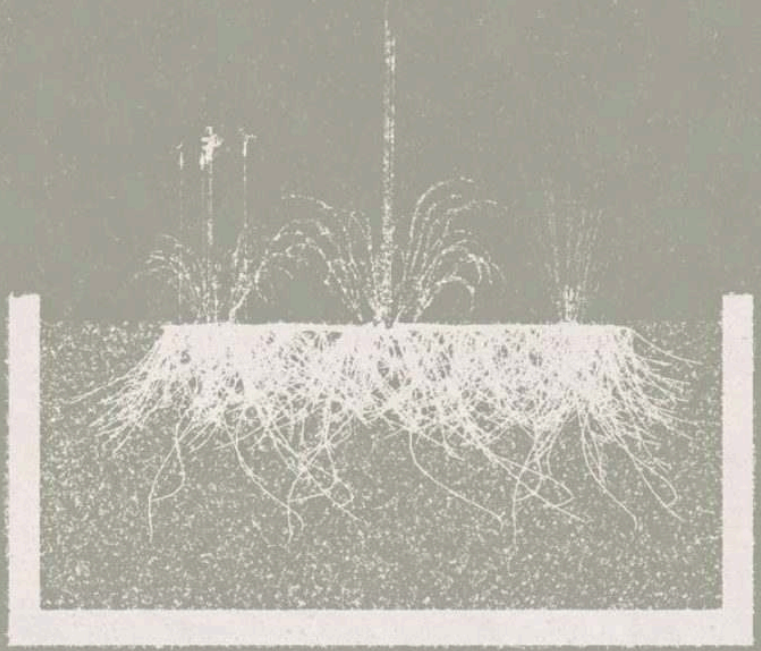


Details 1 and 2 of the x-ray section opposite, framed there: the roots and burrows behind the cut face. Render from the plugin. Figure by Author.

Full set: appendix, page 389



The same section with the soil in x-ray, showing the roots and burrows behind the cut face; dashed frames 1 and 2 are the details opposite. Render from the plugin. Figure by Author.

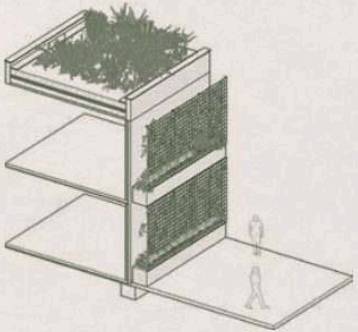


05

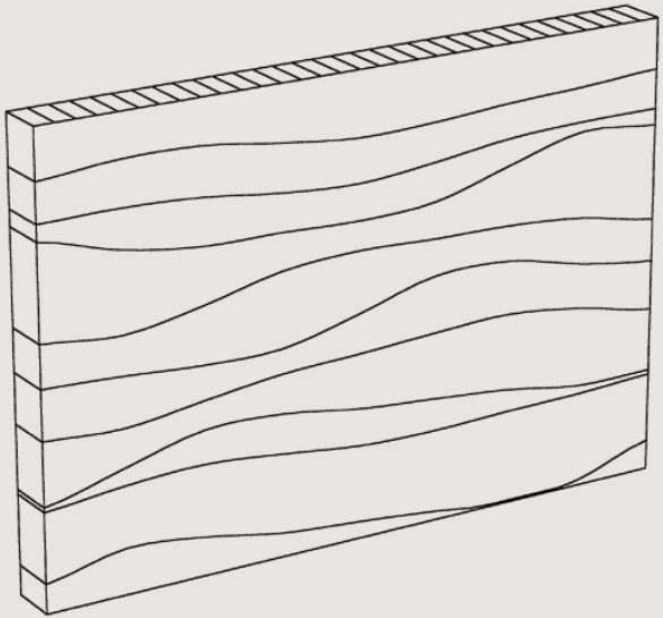
ASSEMBLIES

IN THIS SECTION

Reading the ground
Walls made of the site
Layered walls and how they meet
Brick, reused and patterned
One room, many walls
Curtain walls
Railings, roofs and green walls
All together
Site import

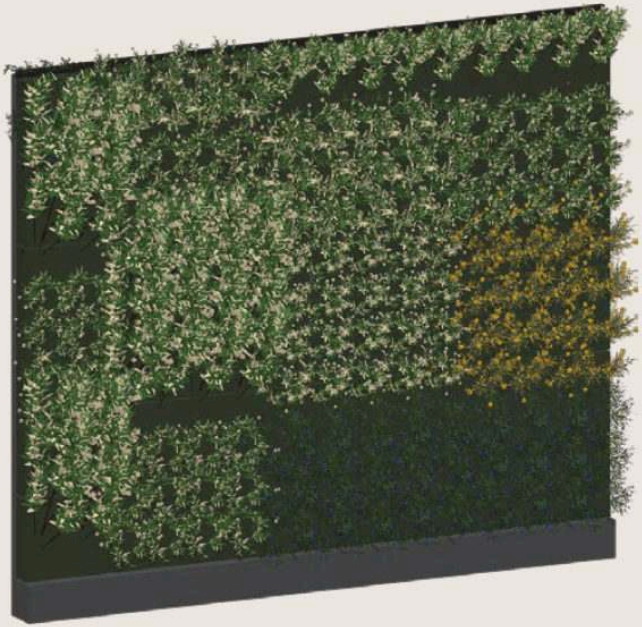


Assemblies: assembly types



STRATA WALLS

Rammed earth of the site's soil, in lifts that follow its horizons.



GREEN WALLS

A frame, tray or planter that carries library species on the face of a wall.

Full set: appendix, page 366



STREET FRONT

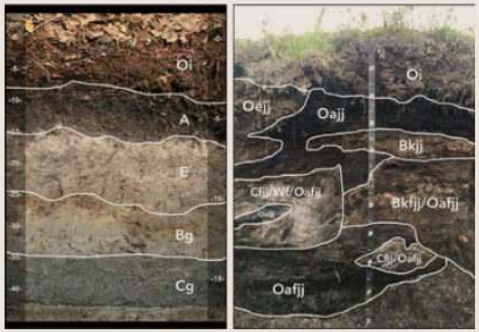
Cobogo screen boxes with planted caps over rammed earth, from the shared street model. Render in Rhino. Figure by Author.

Ground: reading the ground

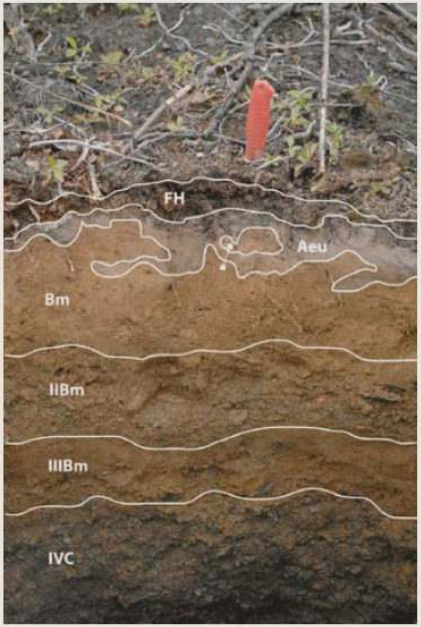
TEXTBOOK AND FIELD

The strata walls start from how the ground is layered. A textbook profile shows the horizons as flat bands, one above the other.

A pit dug in the field shows them as lenses and pockets that thicken, pinch out and are crossed by roots and stones. The walls take this second reading: the bands share one wave, but each lift changes thickness along the wall.

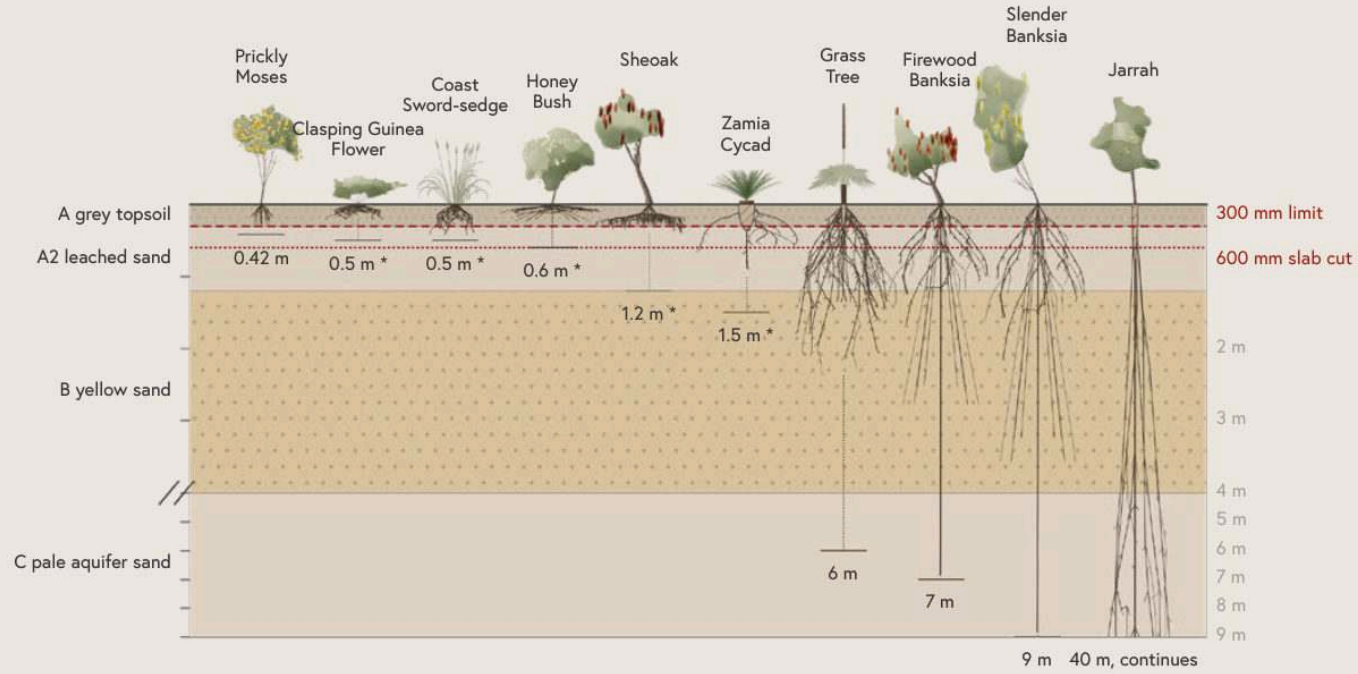


The textbook profile against the field. Reference collected 25 August 2026; source to be credited.



A field pit, its horizons traced as lenses and pockets. Reference collected 25 August 2026; source to be credited.

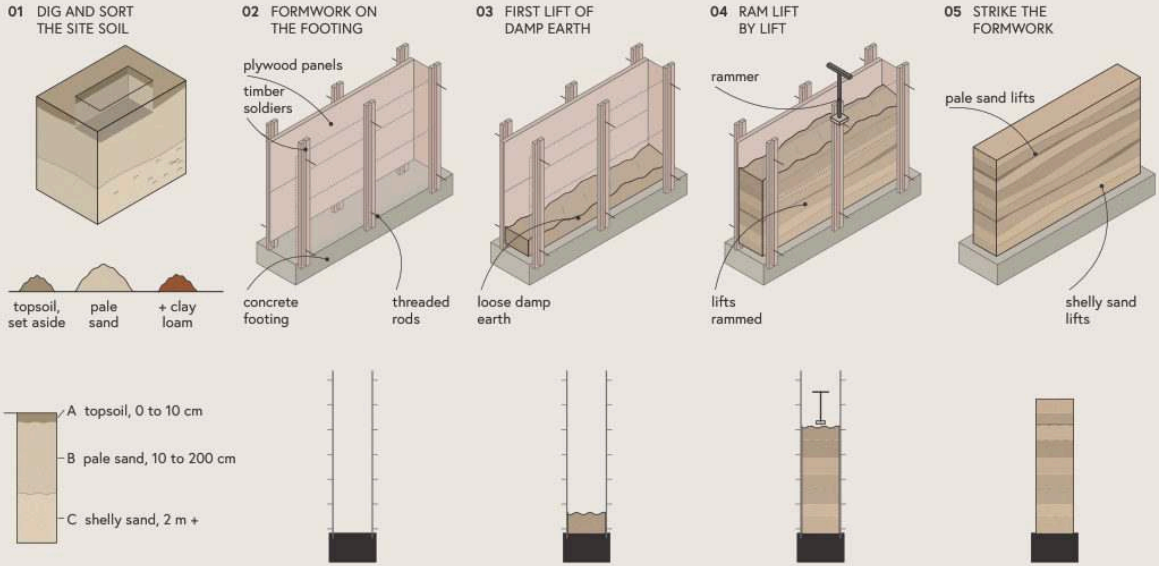
Full set: appendix, page 385



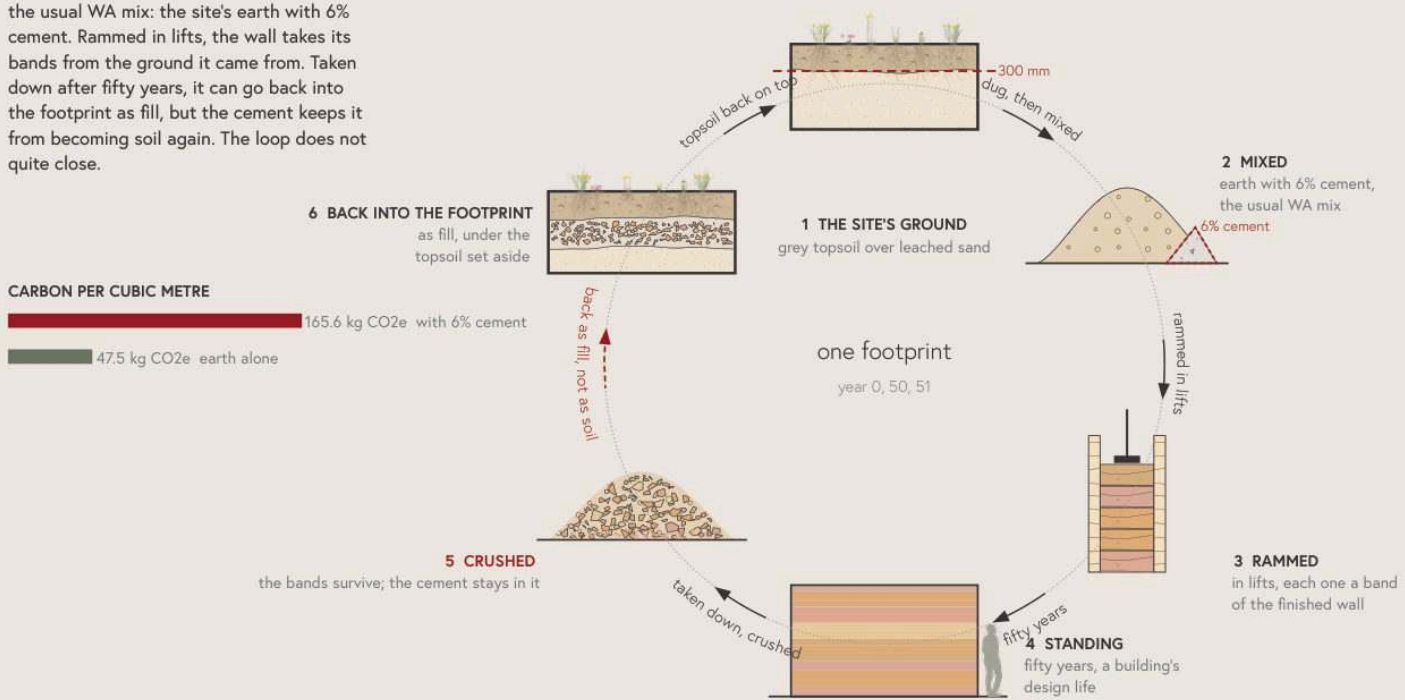
The ground at Warwick in section: the stand's ten species, each root system from its record, against the Death Manual's 300 mm limit (red dashed) and the 600 mm slab cut tested (dotted). Bars mark recorded root depth, dashed where the record goes deeper than the model (* estimated, others published). Wide spreads drawn narrower. Below 4 m drawn at 0.4 of the scale. Horizons: the generic Swan Coastal Plain sequence, not surveyed at Warwick. Plants not to scale. Figure by Author.

Assemblies: walls made of the site

FROM THE SITE SOIL TO THE WALL



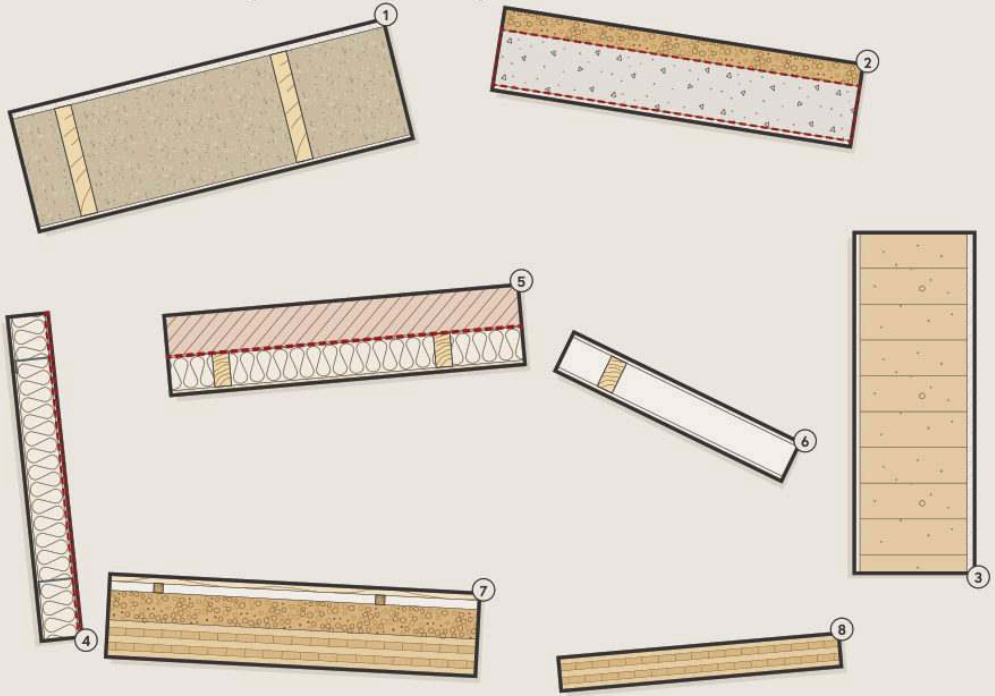
The rammed earth in the plugin's library is the usual WA mix: the site's earth with 6% cement. Rammed in lifts, the wall takes its bands from the ground it came from. Taken down after fifty years, it can go back into the footprint as fill, but the cement keeps it from becoming soil again. The loop does not quite close.



Bands from the plugin's classic strata wall; carbon and the 6% mix from its material records; ground, formwork and rubble in its section hatches.

Assemblies: layered and strata walls

Eight of the plugin's layered walls, each cut through at 1:20 and drawn in its own hatches, with the studs at their centres. Red dashes mark the layers whose material record gives them less than half back when the wall comes down.



1 HEMPCRETE WALL
332 mm, 3 layers

2 LOW-CARBON CONCRETE WALL
225 mm, 3 layers
Low-carbon concrete: landfill, 25% recyclable

3 COMPRESSED EARTH BLOCK WALL
325 mm, 3 layers

4 LIGHT STEEL FRAME EXTERIOR WALL
110 mm, 3 layers
Fibre cement: landfill, 20% recyclable

5 RECYCLED BRICK VENEER
215 mm, 4 layers
Building wrap: landfill, 0% recyclable

6 TIMBER STUD PARTITION
116 mm, 3 layers

7 CLT WALL
224 mm, 4 layers

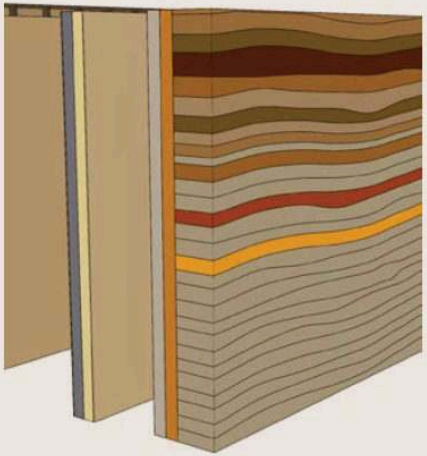
8 CLT INTERNAL WALL
90 mm, 1 layer

Layers, studs and centres from the plugin's assembly records; recyclability from its material records.

A wall in the plugin is a list of layers with materials and thicknesses. The rammed earth wall is made of the site's soil and takes its lifts from the site's own horizons, so the wall shows the ground it came from. The strata editor redraws the bands by hand, and the wall tiles end to end without a seam.

HOW THE BANDS ARE DRAWN

The editor shows the bands of one assembly. A boundary is drawn by clicking on it and dragging, and the wave and grain sliders set how much the lifts move. Whatever is drawn is kept in step across the whole stack.



THE END OF THE WALL

Each lift is its own solid, so it can be scheduled and taken back out.



THE STRATA EDITOR

Wave 20 per cent, grain 19, three bands.

Full set: appendix, page 369

Assemblies: how walls meet

A layered wall is several solids side by side, one for each material. Where two walls meet, every layer has to stop on the right line. On the morning of 11 October the test corners built in Rhino all failed: the cladding stopped short of each L corner and a partition ran into the wall it met. By the afternoon the cause was found and fixed.

AIM

Corners where every layer turns together, and walls that stop cleanly on the face of another wall.

PROBLEM

Each piece of a wall drawn as one line stored only the thickness of its outer layer, 9 mm instead of 202. The join pass then cut every corner in the wrong place.

OUTCOME

Each piece now stores the full depth, and corners mitred when drawn are left alone. Strata walls are still not joined.

FOUR MONTHS OF JOINS

12 JUN | FIRST JOINS

L and T joins found by touching solids, in the first geometry code.

9 JUL | MITRED LAYERS

Each layer of a polyline wall offset on its own, so corners mitre.

20 JUL | THE THICKER WALL WINS

At a corner the thicker wall runs through and the other trims back. T junctions added.

5 AUG | STRATA LEFT ALONE

Joins rebuilt strata walls flat over their bands, so strata walls were taken out of the join.

8 AUG | POLYLINES LEFT ALONE

Trimming a polyline wall broke its own mitre, so only straight walls are trimmed.

12 AUG | EXTEND, THEN CUT

Two straight walls are extended past the corner and cut on one mitre plane.

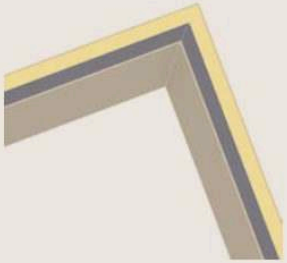
25 SEP | JOINS ON THE SHEETS

Plan drawings mark each wall end as L, T, a run or a free end with a cap.

11 OCT | THE FULL DEPTH

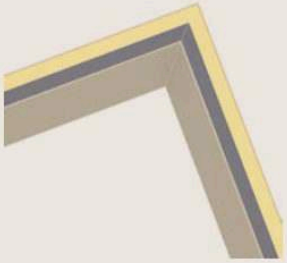
Each piece of a wall now carries the depth of the whole assembly, and its mitred ends are flagged.

Full set: appendix, page 370



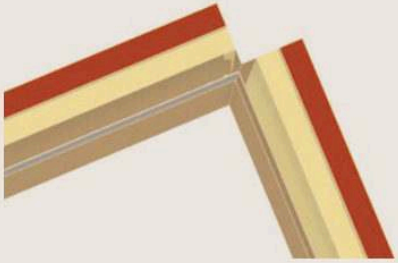
L, DRAWN AS ONE LINE

All four layers mitre on one line.



L, FROM TWO WALLS

Extended past the corner, then cut on the same mitre.



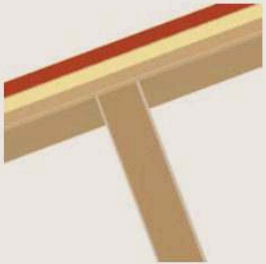
BEFORE: THE NOTCH

The same morning. The lining mitres, but the cladding and insulation stop short.



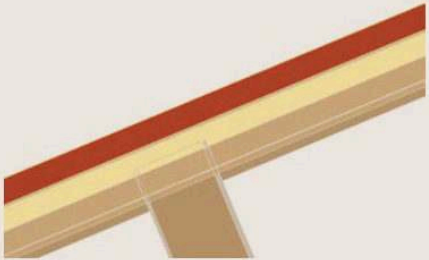
T JUNCTION

The 90 mm timber partition stops on the face of the lining.



T, 320 MM TIMBER FRAME

The earth block wall stops on the lining of a six-layer wall.



BEFORE: THE OVERLAP

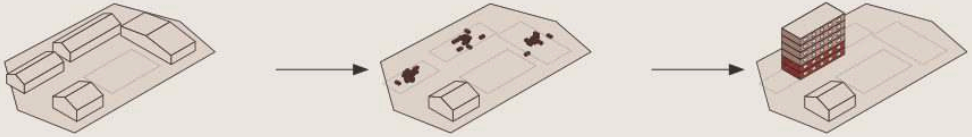
The stem was trimmed back by half the outer layer, not half the wall, so it ran into the header.

Assemblies: brick, reused

Brick from the barracks buildings on the site and from local demolition goes back into the new walls. The library reports each wall's brick by count, so a salvaged supply can be matched to a design.

PROCESS

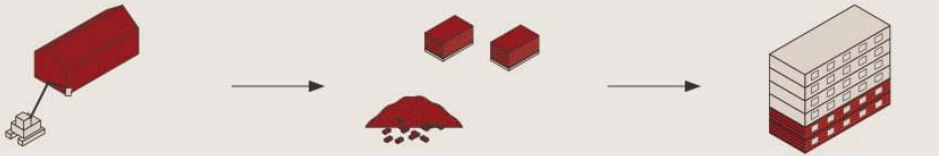
Leeuwin Barracks, East Fremantle



barracks buildings | bricks salvaged on site | new block, Drill Hall kept

SALVAGE

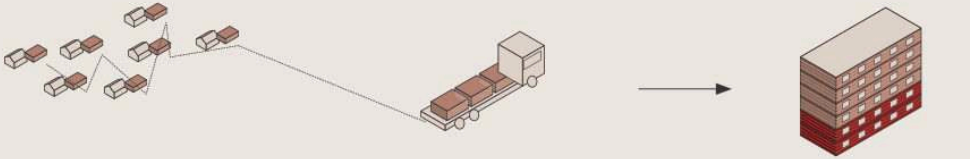
Barracks buildings taken down, bricks cleaned for reuse



barracks taken down | bricks cleaned, mortar off | lower walls in barracks brick

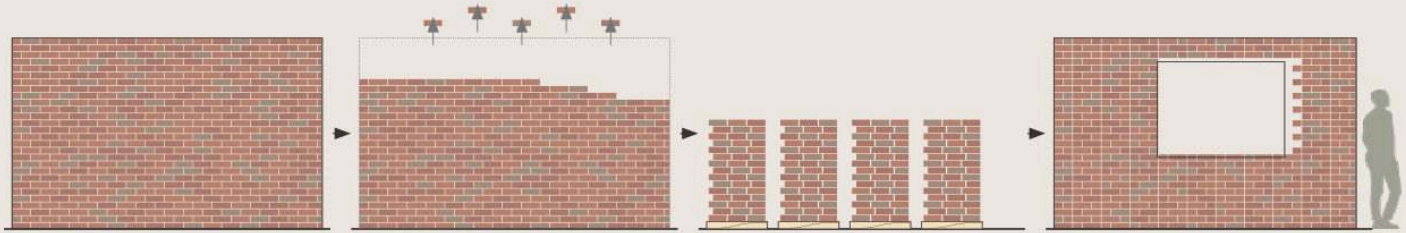
COLLECTION

Bricks from local demolition, brought in by truck



houses and sheds demolished nearby | bricks collected | upper walls in local brick

Fired clay brick is 60% recyclable in the plugin's record, "if the mortar joint allows clean separation".
Laid again, it is a recycled brick at 90%: "the firing carbon was spent on their first life".



1 THE WALL, YEAR 50
476 bricks in a 3.9 x 2.4 m face

2 TAKEN DOWN
from the top, a course at a time

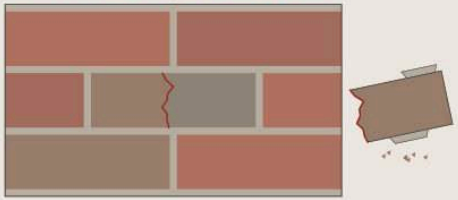
3 CLEANED AND STACKED
476, on four pallets

4 THE NEXT WALL
Flemish bond with a window,
3.8 m long: 469 of the 476

year 50, the building comes down — the next building

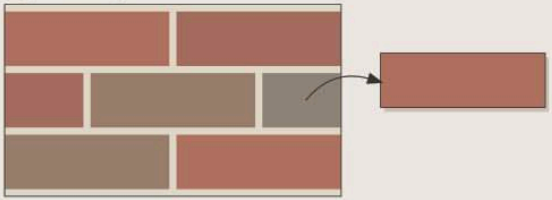
A JOINT HARDER THAN THE BRICK

Cement holds harder than the brick: the brick breaks first, with mortar still stuck to it, and leaves as rubble.



A JOINT SOFTER THAN THE BRICK

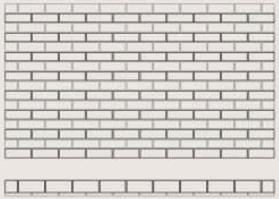
A soft joint gives first: the brick lifts out whole and clean, ready to be laid again.

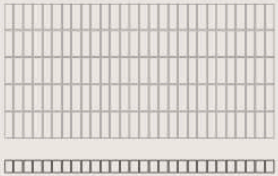


Walls laid by the plugin's brick coursing engine, 230 x 110 x 76 mm units with 10 mm joints, drawn at 1:90; joint details at 1:10.

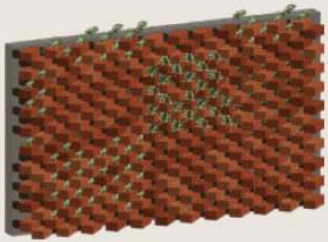
Assemblies: brick walls

Fifteen brick walls, laid by the tool brick by brick from bond and unit, with planter bricks, pockets or a coping planter in the courses. Each reports its brick count and carbon, so reused brick can be matched to a wall.





SOLID WALLS



DOGTOOTH PLANTING WALL

Dogtooth bond, 230 mm, 56 kg CO2e/m²



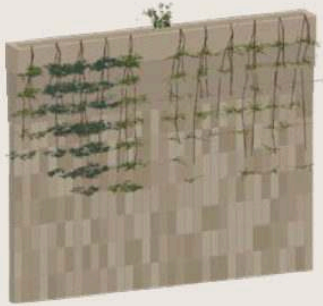
FLEMISH BOND GARDEN WALL

Flemish bond, 230 mm, 87 kg CO2e/m²



RACK BOND, PROUD COURSES

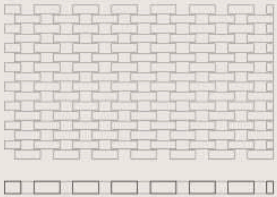
Rack bond, 230 mm, 236 kg CO2e/m²

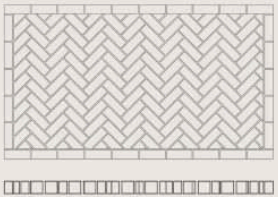


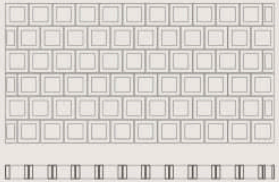
SOLDIER COURSES, PLANTER TOP

Soldier courses, 230 mm, 248 kg CO2e/m²

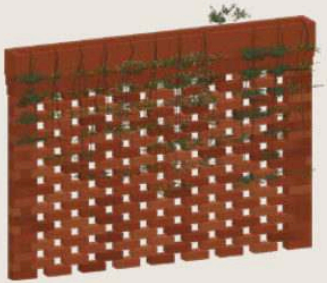
LINE ELEVATIONS ABOVE, RENDERS BELOW







SCREENS AND LATTICES



HIT-AND-MISS SCREEN

Hit-and-miss bond, 230 mm, 222 kg CO_2e/m^2



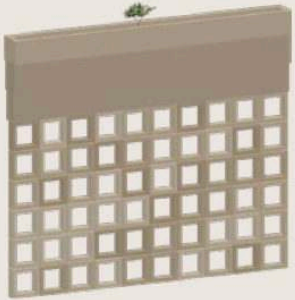
LONG-BRICK HERRINGBONE

Roman brick 490 x 90 x 40 mm, 232 kg CO_2e/m^2



TERRACOTTA COBOGO

Terracotta block, 230 mm, 287 kg CO_2e/m^2



BREEZE-BLOCK SCREEN

Breeze block, 230 mm, 220 kg CO_2e/m^2

Full set: appendix, page 375

Assemblies: one room, many walls

One interior, rendered again with each library wall in place of the rammed earth. The planters and the light stay the same, so only the wall changes.



RAMMED EARTH, FINE BANDS

Serpentine walls in courses, plaster ceiling, two built-in planters. Render in Rhino. Figure by Author.



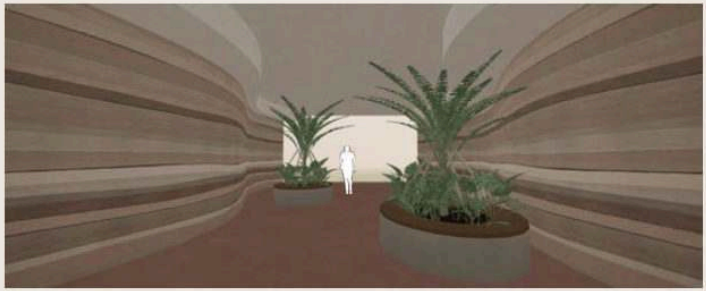
TWISTED BRICK



DOGTOOTH, PLANTED

Assemblies: rammed earth rooms

The same room with four rammed earth walls. A solid wall lets in little daylight, so the beds hold small shade plants.



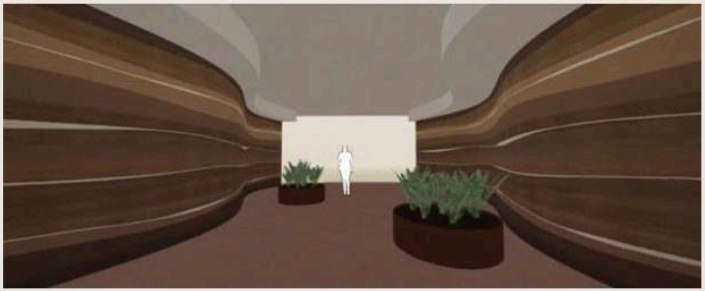
Fine bands. Seat edge planters, kentia palms over peace lily.



Classic bands. Limestone wall beds, fern grotto.



Ochre waves. Terracotta troughs, clivia and ferns.



Sienna strata. Corten edge planters, dry shade foliage.

Assemblies: perforated brick rooms

The same room with four perforated brick walls. They let daylight in, so the beds are larger and denser.



Breeze block. Precast concrete planters, kentia palms and fiddle-leaf fig.



Hit-and-miss brick. Rendered block beds, fig grove.



Terracotta cobogo. Terraced planters, lipstick and golden cane palms.



Brick lattice. Stainless planters, golden cane palm and umbrella tree.

Manuj Mohan 20020455

Assemblies: curtain walls

PERFORATED CURTAIN WALL

The perforations are real holes cut in the panel geometry. Hole size follows the luminance of an image: dark areas open up, light areas close down, and from a distance the holes read as the image.

The artwork here is the site's ground cover. Solid and open slatted bays sit between the perforated ones, and a bay can be left out where the building needs air instead of glass.

Every panel is a mechanically fixed sheet on a frame, which is the condition the Death Manual puts on anything above ground, so the screen comes off in pieces that can be reused.



The four perforated panels enlarged: hole size follows the artwork, dark areas open, light areas close.

Right: perforated curtain wall with an image-driven hole pattern, slatted bays and open bays. Figure by Author.

Full set: appendix, page 370



Assemblies: curtain wall studies



LINO PRINT, SQUARE HOLES

Only the carved lines are cut. Render in Rhino. Figure by Author.

ONE PANEL RUN, NINE STUDIES

The same five-panel run built by the plugin from five artworks. Each study changes the hole shape, the size range, the inversion or the panel form. The holes are real cuts through the panel mesh.

Artworks: banksia and cockatoo lino print, and pencil cockatoos (artists to be credited); gum blossom mural (artist to be credited); WA Nature colouring page, Room to Wonder 2022; magpie, Wendy Rix. Studies only: a built facade needs the artists' permission and cultural consultation.



LINO PRINT, HEXAGONS

Inverted: the carved lines open



MAGPIE, SQUARE HOLES

Black opens, white stays solid



MAGPIE, INVERTED

The white ground opens



GUM BLOSSOM MURAL, ROUND

Inverted: the white lines open



GUM BLOSSOM MURAL, SLOTS

Slot holes, sloped top



PENCIL COCKATOOS, HALFTONE

Round holes, size follows tone



PENCIL COCKATOOS, FOLDED

Folded 500 mm pleat

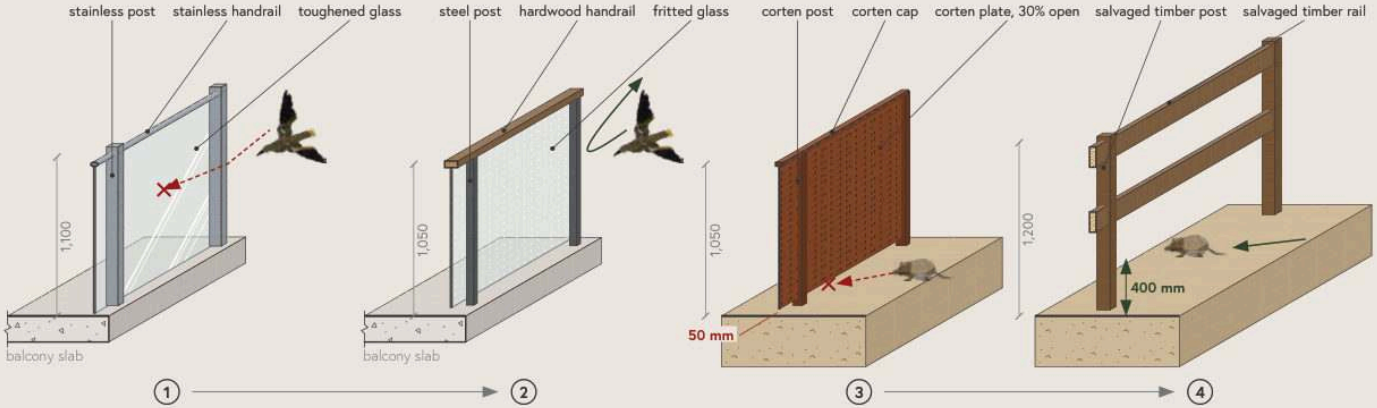


WA NATURE PAGE, ROUND

Ink lines thickened, then cut

Assemblies: railings

Two railings from the plugin's library, each with the animal it stops, and the library's own answer beside it, drawn as section perspectives at 1:50. Both hazards are graded strong in the plugin's wildlife record. On a balcony the building code caps openings at 125 mm, so the gap for animals belongs in fences at ground level.



1 GLASS BALUSTRADE
97% see-through
birds fly into it
1,100 mm, stainless posts and rail
71 kg CO2e/m
72% recyclable

2 BIRD-SAFE GLASS
marks 5 x 10 cm
birds turn away
1,050 mm, fritted glass, hardwood rail
69 kg CO2e/m
74% recyclable

3 PERFORATED CORTEN PANEL
50 mm gap
quenda stop here
1,050 mm, 4 mm plate, 30% open
42 kg CO2e/m
90% recyclable

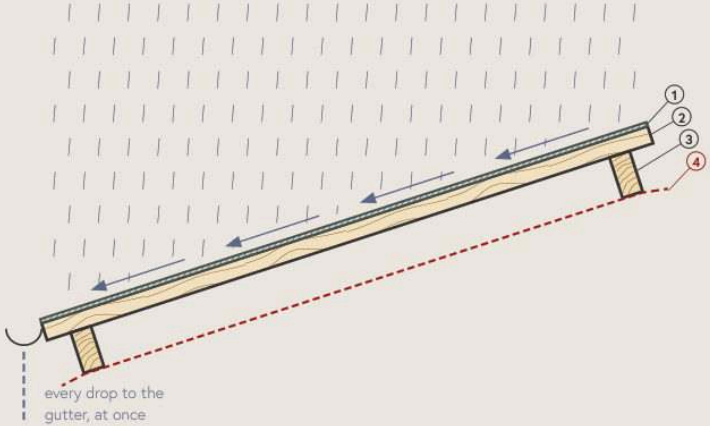
4 POST AND RAIL
400 mm gap
quenda pass under
1,200 mm, salvaged timber
-24 kg CO2e/m, held in the timber
Land for Wildlife WA: a clear 300 to 450 mm

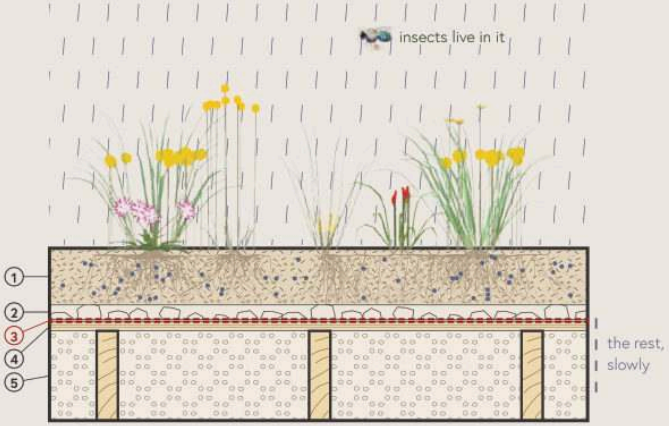


Railings cut through the plugin's railing families; carbon, recyclability and openness from its railing quantities; hazards from its wildlife record.

Assemblies: roofs

The same rain on two of the plugin's roofs, cut at 1:15. The iron sheds it all at once; the green roof keeps about half in its media. Each roof carries one layer that cannot be taken back: the sarking, the membrane.





PITCHED, CORRUGATED IRON

134 mm, shown at 18 degrees

rain kept: none

1 Corrugated steel roofing, 1 mm
2 Timber roof battens, 38 x 25 mm, running down the slope
3 Timber purlins, 90 x 45 mm at 1200 mm centres
4 Reflective sarking, 5 mm landfill, 0% recyclable

EXTENSIVE GREEN ROOF

361 mm, flat, on a timber deck; it cools the roof

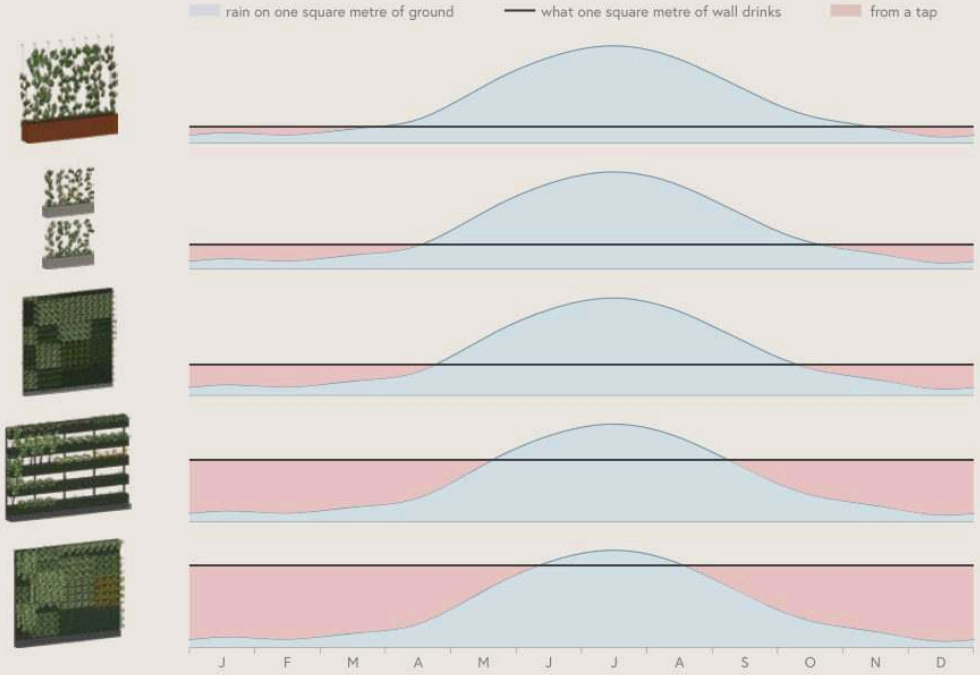
rain kept: about half

1 Lightweight growing media, 120 mm
2 Drainage and retention layer, 30 mm
3 EPDM membrane, 2 mm landfill, 20% recyclable
4 Plywood deck, 19 mm
5 Cellulose, 190 mm, between 190 x 45 rafters at 450

Layers, members, centres and recyclability from the plugin's roof and material records; plants and roots from its species builder; all at 1:15.

Assemblies: green walls

Five of the plugin's green walls through an average Perth year. Rain falls in winter and walls drink most in summer, so even the lightest needs a tap from December to March, and the heaviest need one for most of the year.



CABLE CLIMBERS
40 L from a tap
292 L a year, 0.8 L a day
climbers from a planter at the foot

PLANTER LEDGES
100 L from a tap
438 L a year, 1.2 L a day
a planter on every storey

FELT POCKETS
160 L from a tap
548 L a year, 1.5 L a day
no soil: a pump failure kills it in days

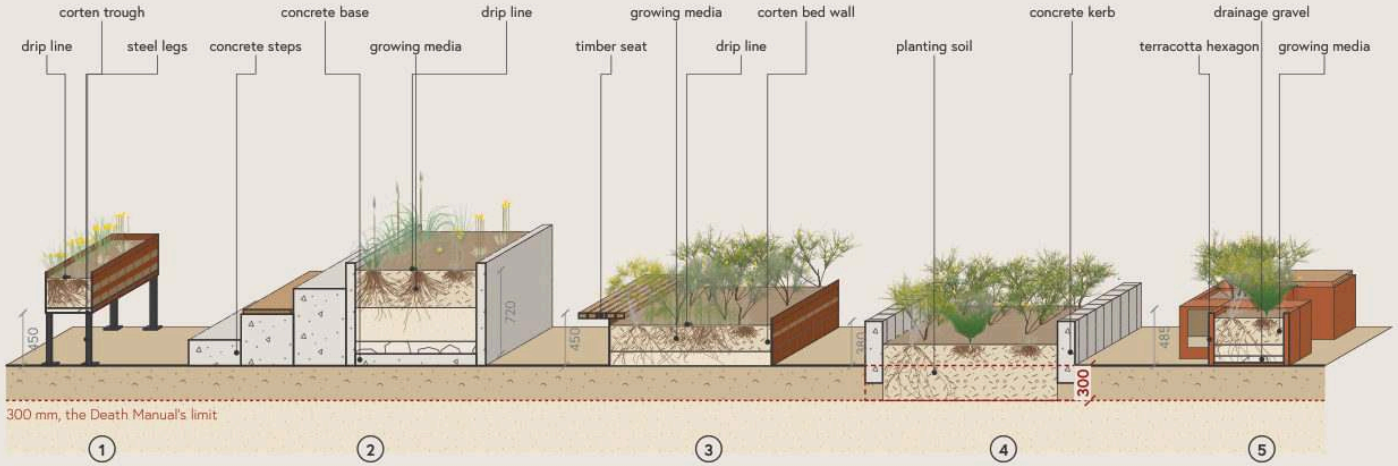
POTS ON RAILS
500 L from a tap
1,095 L a year, 3 L a day
the water figure is an estimate

CASSETTES
780 L from a tap
1,460 L a year, 4 L a day
4 L a day is its summer peak

Water and notes from the plugin's green wall records, each daily figure held all year; rain from the Bureau of Meteorology, Perth Metro 009225, mean of 1993 to 2026. A wall does not catch the rain that falls on the ground: the rain is there for scale.

Assemblies: planters and banks

Five of the plugin's planters that stand on the ground, cut through its own geometry. All five are watered for as long as they stand. Four sit on the ground and dig nothing. The meandering bed sets its kerbs and soil 300 mm down, the Death Manual's limit.



1 PLANTER ON LEGS
2.9 L a day
digs nothing
per metre of planter, from a tap
roots held 450 mm off the ground
57 kg CO2e/m

2 SEATING STEPS
3.5 L a day
digs nothing
per metre of planter, from a tap
the bed has a concrete base
183 kg CO2e/m

3 BENCH-EDGE PLANTER
4.2 L a day
digs nothing
per metre of planter, from a tap
a 450 mm seat on the bed edge
40 kg CO2e/m

4 MEANDERING KERB BED
3.6 L a day
digs 300 mm
per metre of planter, from a tap
kerbs and soil set 300 mm down
35 kg CO2e/m

5 HEXAGON PLANTER-SEATS
1.4 L a day
digs nothing
per metre of planter, from a tap
every third hexagon is a seat
125 kg CO2e/m

0 1 2 3 m

Sections cut through the parts the plugin builds; water, carbon and planting from its green wall and species records. Red dashed: ground dug out.

Full set: appendix, page 374

Assemblies: green walls in section



Rendered from the plugin's section of its storey planter system; markers placed by the plugin, build-ups from its assembly records.

1 GREEN ROOF
300 mm of soil over a concrete deck

2 ROOF BUILD-UP
632 mm in all, 6 layers

3 PARAPET
holds the soil at the edge

4 PLANTER LEDGE
a 600 mm planter on each storey

5 CLIMBER MESH
stainless, held 40 mm off the slab edge

6 FLOOR
CLT, 130 mm

7 WALL
recycled brick veneer, 215 mm

8 GROUND SLAB
low-carbon concrete, 150 mm

Two storeys at 3.1 m, the roof at 6.8 m. Every planter and the roof are watered from the building.

The seven species on the roof at 1:35, in the 300 mm of soil it gives them. Each roots deeper in its record: the red is the root the roof has no room for. Above each, the animals its record names. Those in red walk or hop and cannot reach a roof 6.8 m up, so the plant is there without its whole web.



Species from the plugin's section scene; plants, roots and root depths from its species builder and records; animals from the plant records, sorted by the fauna catalogue.

Assemblies: green walls drawn in Rhino

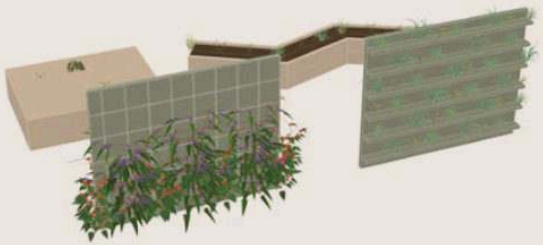
METHOD

Green walls and planters are drawn from the Tools panel like walls and slabs. Each one is built from a line or a closed outline, and the plants are real library species placed by the tool.

The library now holds 45 types: facade systems from cassettes and felt to cables, nets and storey ledges, planters on rails and along paths, banks, and brick walls laid in their bond with planter bricks set into the courses. For each type the tool decides how a plant sits: climbers at the foot of a mesh, trailers over a rim, groundcovers in a pocket.

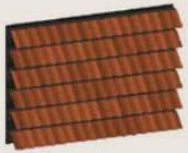
Full set: appendix, page 383

DRAWN TOGETHER IN ONE RHINO MODEL



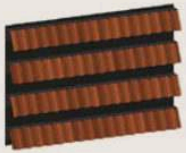
A raised bed, a mesh wall with climbers at its foot, a planter drawn along a bent line and a wall of planted ledges, each from its own outline in one model.

ONE TYPE, THREE SETTINGS: AS DRAWN, THEN TWO CHANGES



AS DRAWN

Clay tile shingle bands



TILE ANGLE 25, BAND PITCH 600

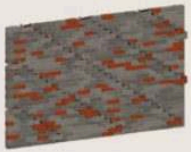


MAIN COLOUR DARK GREEN, MIX 0.04, WAVE 0



AS DRAWN

Brick wall with planter bricks



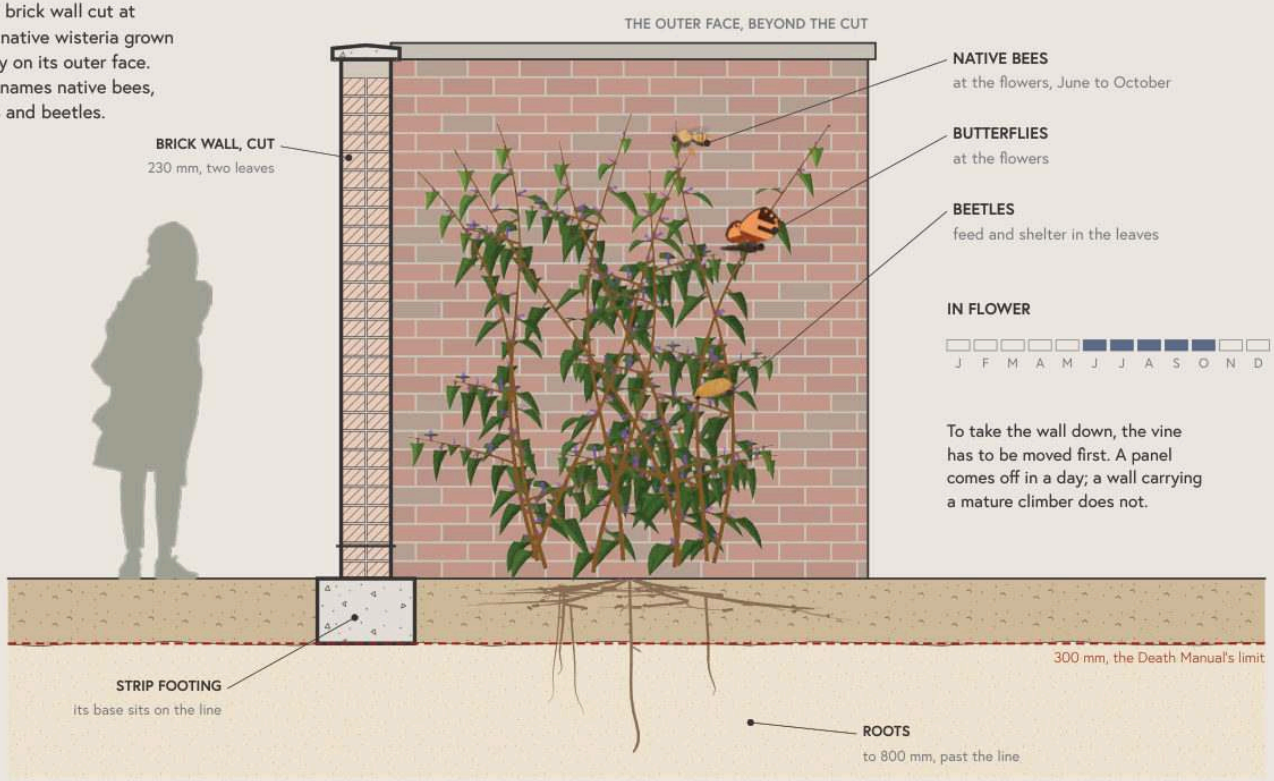
PATTERN DIAGONAL, EVERY 5



PALETTE CREAM, PATTERN GRID, PROJECTION 200

Assemblies: habitat walls

A 230 mm brick wall cut at 1:35, with native wisteria grown to maturity on its outer face. Its record names native bees, butterflies and beetles.



Wall, coping, footing and ground in the plugin's section hatches and brick coursing; the vine and its roots from its species and root models; animals from the rig watercolours.

Assemblies: all together

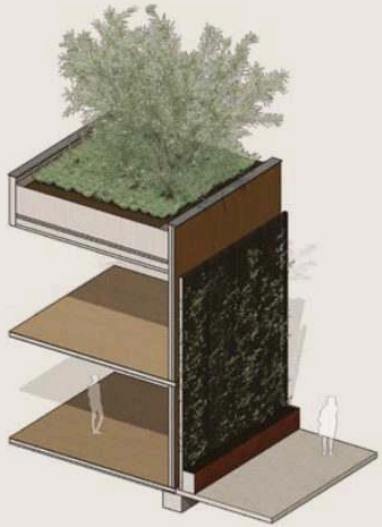
Each set puts a wall, a floor and a roof together for one plant community at Warwick. All four are drawn at one scale.



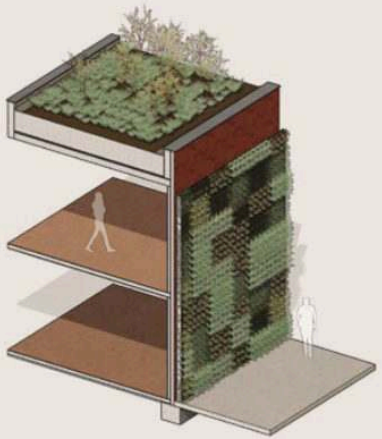
Coastal edge: cable climbers, extensive roof, limestone floors, rammed earth



Near water: felt pocket wall, garden roof, polished concrete, low-carbon concrete



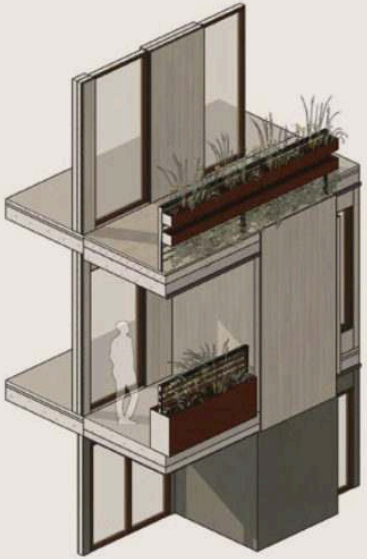
Banksia bushland: wire trellis, intensive roof, hardwood floors, timber-clad CLT



Sheoak edge: cassette wall, extensive roof, terracotta floors, reused brick

Assemblies: all together

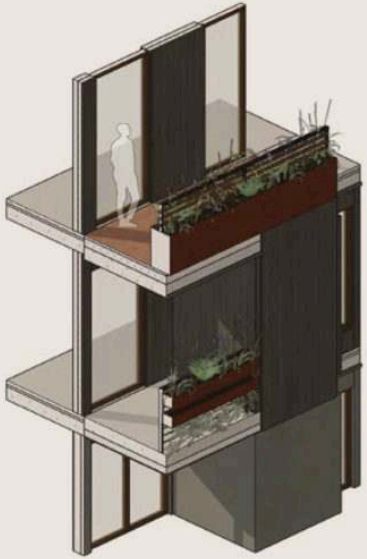
Four balconies with two guards each, so every guard type appears twice. The planting follows the community each one faces.



Hung cable over a slatted planter guard; dianella, lomandra, scaevola



Glass over a picket guard; kangaroo paw, conostylis, hibbertia



Slatted planter over a hung cable guard; juncus, dianella, patersonia



Picket over a glass guard; verticordia, conostylis, ptilotus

Assemblies: screens on two buildings



The tower in concrete, behind red steel mesh shutters.



The same tower in rammed earth, with timber slat shutters.



Stacked rooms in concrete, a red mesh screen and a cage above.



The same rooms in rammed earth, with timber slat screens.

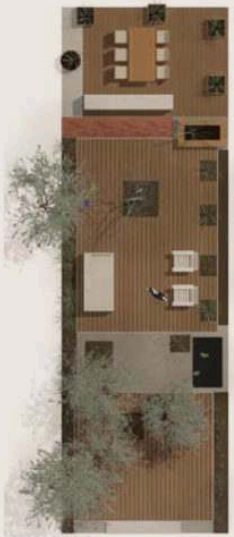
Assemblies: one garden, four plant communities



Coastal heath, with recycled brick.



Banksia woodland, with limestone.



Wetland edge, with a timber deck.



Jarrah and marri edge, with gravel.



Coastal heath, with recycled brick.



Banksia woodland, with limestone.



Wetland edge, with a timber deck.



Jarrah and marri edge, with gravel.

Site import: data sources

BUILT ON OTHER PEOPLE'S WORK

The site reading is built on open data and open code, most of it on GitHub or a government portal, and each source carries its licence into the site bundle. This is what the Design Companion uses, what each source gave, and where it stops.

TREES AND CANOPY

Landgate SLIP aerial

The current WA aerial at 0.2 m, laid under the model. Its free licence is for personal, non-commercial use, so trees are taken from it only when a designer switches that on for their own site.

Meta high resolution canopy height

facebookresearch/HighResCanopyHeight. A 1 m canopy height map from 2018 to 2020, version 2 published January 2026, CC BY 4.0. It gives crown heights, and misses about three quarters of young street trees.

DeepForest

weecology/DeepForest, MIT licence. A pretrained crown detector for aerial photographs, run when installed. Without it the import uses its own canopy peak finding.

Satellogic EarthView

1 m satellite imagery with a near-infrared band, CC BY 4.0. It took Welshpool from 47 crowns found by colour to 755. It does not cover Curtin.

Digital Earth Australia and Sentinel-2

Greenness, and the satellite record behind tree ages. Moving to Digital Earth Australia cut that download from 89 MB to 0.15 MB.

OpenStreetMap

Mapped trees, roads, paths and water through the Overpass servers, ODbL. Volunteers trace from imagery, so positions are real stems but coverage is patchy.

Council tree inventories

City of Perth (CC BY 4.0), Cockburn and others. Surveyed trees with species, the only source that names a tree rather than guessing it.

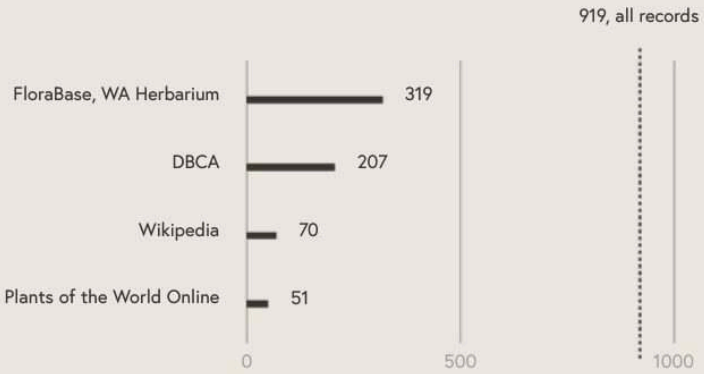
READ AND SET ASIDE

detectree, detectree2, geoai, AROSICS

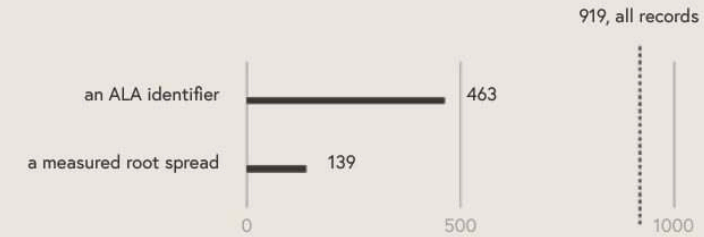
Reviewed for the canopy pipeline and not adopted. They are listed because dropping a source was a decision too.

Full set: appendix, page 401

SPECIES RECORDS CITING EACH SOURCE



WHAT THE RECORDS CARRY



Species records citing each source, and what the records carry, from the species file as it stood on 13 October 2026, while root records were being replaced with measured spreads. A record can cite several sources or none, so the bars do not add up to 919.

Site import: trees

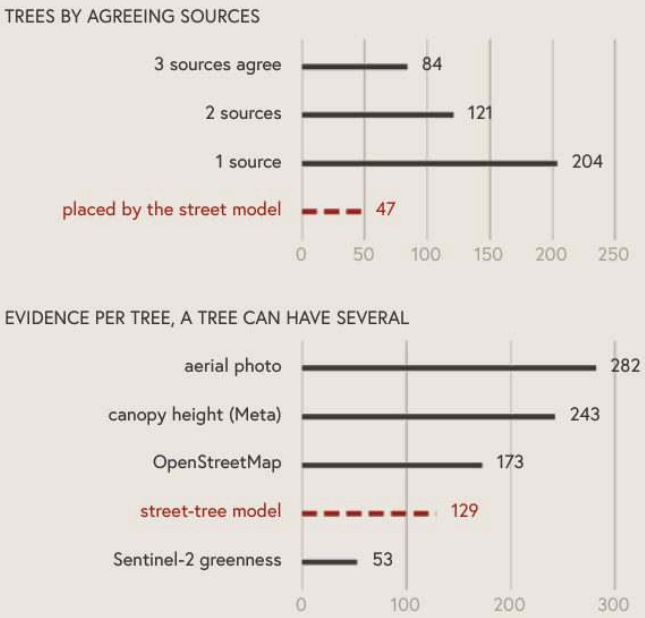
NO SOURCE IS ENOUGH ON ITS OWN

A site import starts with the trees already standing, and no single source can be trusted to find them. The aerial photograph sees crowns but not species. The Meta canopy height map dates from 2018 to 2020. OpenStreetMap holds the trees volunteers chose to map, and Sentinel-2 greenness is 10 m coarse. The import reads all of them and keeps their agreement as the measure of confidence.

The early test on page 282 compared the sources by eye. This version counts them.

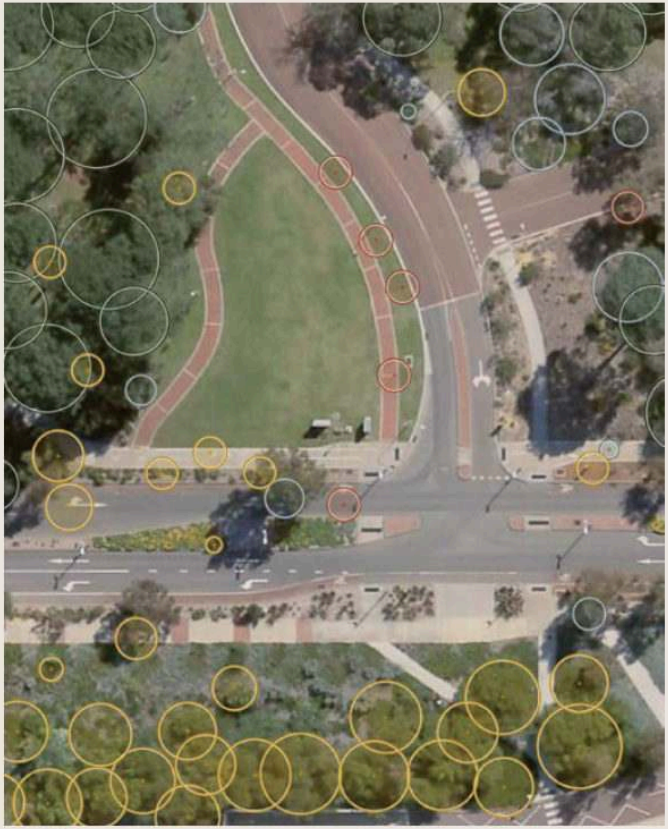
COUNTED, NOT GUESSED

At Curtin it placed 456 trees: 84 confirmed by three sources, 121 by two, 204 by one, and 47 placed by the street-tree model where the satellite shows living cover but no source marks a trunk. The confidence travels with each tree into the model, so a designer can see which existing trees are certain before deciding what to keep.



Top, trees by the number of agreeing sources. Bottom, how many trees each source supports: aerial photo 282, canopy height 243, OpenStreetMap 173, street model 129, Sentinel-2 greenness 53.

Full set: appendix, page 403



Detail of the same site, where crowns run together over the path.

Checking the trees

CHECKED AGAINST THE GROUND

To know how good the import is, it has to be checked against the ground. 24 squares of 40 m at three sites were labelled by hand, tree by tree. A model trained on 46 numbers per candidate lifts the score from 64.9 to 71.6, and it is only ever scored on squares it never trained on.

The import as it is now scores an F1 of 64.9: 52 per cent of the trees it places are real.

The trained model scores an F1 of 71.6: 75 per cent of its trees are real.

The target F1 of 95 was not met.

NOT EVERY CIRCLE IS A TREE

Sources can agree and still be wrong. At Fremantle the import placed 987 trees. 291 came from the photo alone, and most of them are lawn and roof edges. 304 were found by the photo and the canopy height together, and most of those are real. 187 came from the street-tree model, and many of those stand in the road.

A SECOND OPINION

A free vision model, run locally, looked at all 1,337 Fremantle candidates and agreed with the hand labels 85 per cent of the time. It makes labelling faster. It is never treated as the truth.

FREMANTLE, 24 HAND-CHECKED SQUARES



Fremantle, every imported tree by where it came from. Yellow: the photo only, mostly lawn and roof edges. Cyan: photo and canopy height, mostly real. Red: the street-tree model, often in the road.



The same 1,337 candidates as a free vision model, run locally, sees them. Green: tree. Orange: shrub. Red: not a plant.

Full set: appendix, page 404

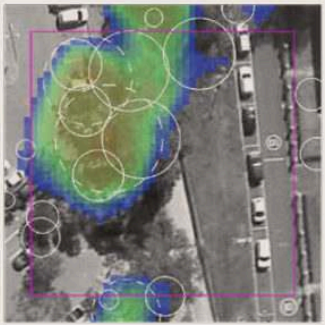
HOW A TREE IS CHECKED: ONE 40 M SQUARE OF FREMANTLE

Every number on the score comes from squares like this one.



1 WHAT THE MODEL SEES: THE PHOTO

Every candidate tree any source proposed. White: kept by the import now. Blue dashed: a canopy-height top the import dropped.



2 WHAT THE MODEL SEES: CANOPY HEIGHT

Meta's 1 m canopy height model (blue low, green 10 m, red 20 m). Per candidate the model also reads greenness, texture, its shadow, which sources found it and how close its neighbours are: 46 numbers.



3 THE HARD TRUTH

A person looked at the photo and the height map and said, for every candidate in the square: tree (green), shrub under 3 m (orange), not a plant (red), the same tree twice (grey), unsure (purple, not scored). Trees with no circle at all are added (cyan +).



4 HOW THEY ARE COMPARED

The model's answer for this square, from a model that never trained on it. Green: kept, and a real tree. Red cross: kept, but not a tree. Cyan dashed: a real tree it dropped or no source found.

THIS SQUARE

The import now: 5 real trees kept, 1 false tree, 2 real trees missed. 83% of what it keeps is real; it finds 71% of the real trees.

The trained model: 3 real trees kept, 1 false tree, 4 real trees missed. 75% of what it keeps is real; it finds 43% of the real trees.

Precision = kept trees that are real. Recall = real trees that were kept. F1 combines both (out of 100). The site score adds up every checked square the same way; a model is never scored on a square it trained on.

The method in one 40 m square: what the model sees, the hand-checked truth, and how the two are compared.

Note, unresolved. The test set is small, about 4 points of chance either way. The vision model is weak on bare winter trees and on bushland: at Cockburn it finds 38 per cent of real trees.

Green spaces

LAWN, BEDS, SAND AND COURTS

The ground between the trees matters as much as the trees. Lawn, planted beds, sand and courts behave differently for water, heat and the animals that cross them.

NAMING THE ERRORS

The first version classified the aerial by colour and scored 90.6 per cent against 160 hand-labelled points. Most of its errors had causes that could be named: the ground under a crown or its shadow was guessed from the crown, leafy texture was read as lawn, and crowns over paving were counted as green.

The rules now take the ground under a crown from what surrounds it, separate texture from lawn, drop crowns over paving, smooth the outlines, draw mapped pitches as mapped and recognise the silver-grey of WA groundcovers. That reached 92.5 per cent, and the current version, with canopy height added, scores 91.9. A trained random forest was tried and scored 83.8, so it is not used.

Full set: appendix, page 404

AROUND A BUILDING

Lawn green, planted beds orange.



AERIAL PHOTO



BEFORE, FIRST VERSION



AFTER, CURRENT VERSION

AT THE SPORTS COURTS

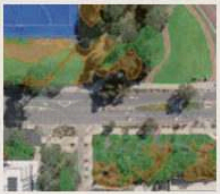
Courts blue.



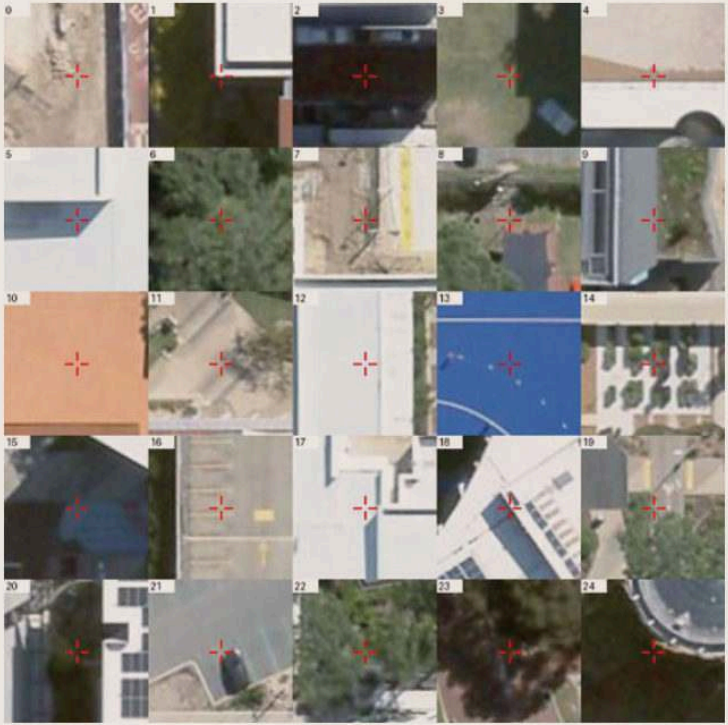
AERIAL PHOTO



BEFORE, FIRST VERSION



AFTER, CURRENT VERSION



GROUND TRUTH

One of 48 labelling sheets, 1,200 points over four sites, used to score the classifier against what is on the ground.

Roads

CENTRELINES INTO SURFACES

Roads come from OpenStreetMap as centrelines with tags, with no surfaces. Built as drawn, two side roads a few metres apart made two overlapping junctions, footpaths ran through car parks, and divided roads left stray median ends and slivers. Each case is now cleaned before anything is built.

LEVELS AND THE GROUND

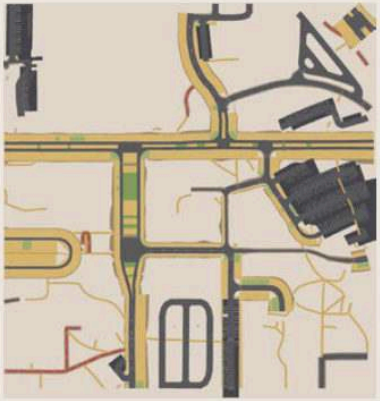
The 5 m LiDAR is bare earth, so bridges and cuttings are not in it and have to be inferred. Where roads cross on different levels they no longer join or cut each other: a deck rises to clear the road below at 5.3 m, at no more than 8 per cent. Rail is laid in its trench at Perth's 1067 mm gauge, and tunnels are skipped.

SCORES

Each site is scored out of 100 for gaps, stacked surfaces, spikes and fit to the ground. Beazley scores 85, a smaller window 270 m to its north 91, and Kings Park 86. Joondalup scores 49 because its rail cutting walls count as spikes. The Narrows interchange scores 43: freeway interchanges are not solved yet.

Full set: appendix, page 405

BEAZLEY, AS BUILT



The Beazley road network as built: lanes, kerbs, verges, footpaths, cycle paths in red, car parks with bays, and markings.



Detail at twice the scale: the main road's two junctions with their crossings, medians and verges.

BEFORE

AFTER





Two side roads a few metres apart now build one junction.





Footpaths stop at the car park edge.





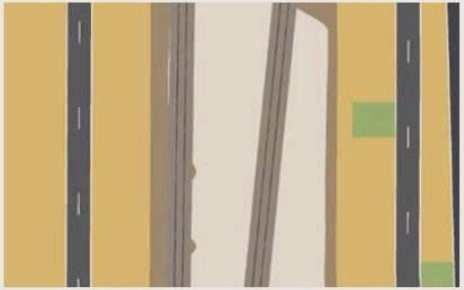
A Y junction with no stray median end or wedge sliver.

FREEWAY OVER ROAD: SEPARATE LEVELS



Kwinana Freeway over Mounts Bay Road, on separate levels.

YANCHEP LINE, OPEN TRENCH



Yanchep Line in its open trench at Joondalup.

Traffic, water and time

WATER FOR ANIMALS

Water comes from OpenStreetMap during import, and from WA wetland mapping (DBCA-019) with DWER streams and drains in the background. Perth basins and sumplands hold water from June to November, so seasonal water is kept apart from permanent water. Animals in the Studio drink at the edge only in the months the water is there.

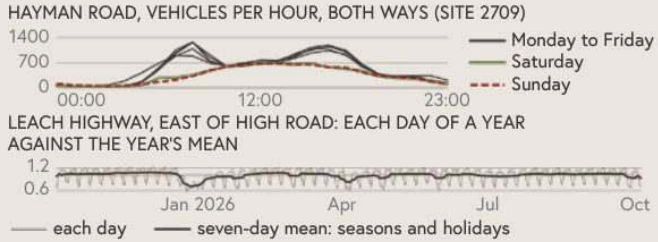


Herdsman Lake. Blue: permanent water. Yellow: seasonal. White dots: drinking points every 15 m along the edge.

TRAFFIC IN TIME

Animals in the model meet cars, so traffic needs a shape in time. Main Roads WA measures Hayman Road hour by hour for each weekday: two weekday peaks and a flat weekend. The Leach Highway counter gives every day of a year, with weekends, school and public holidays and the Christmas dip. Cars in the Studio follow these by hour, weekday and date.

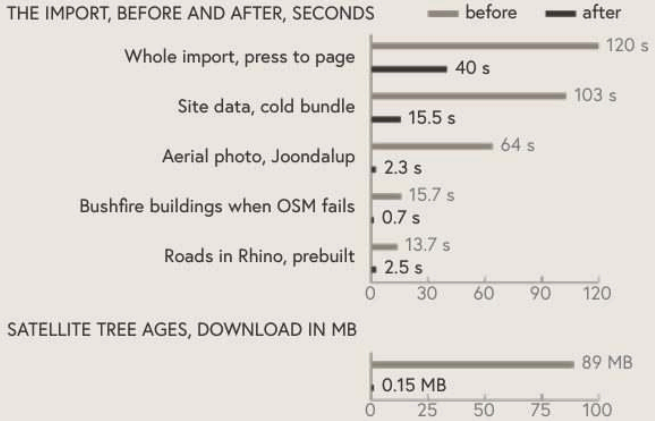
No open source gives volumes for every street. Google, TomTom and HERE are paid and give speeds, not counts. Other streets take their road type's daily estimate spread over the measured local shape, an estimate that is marked as one.



Top, Hayman Road measured hour by hour (Main Roads WA TrafficMap, site 2709). Bottom, every day of a year at the Leach Highway permanent counter.

WHAT HAD TO BE OVERCOME

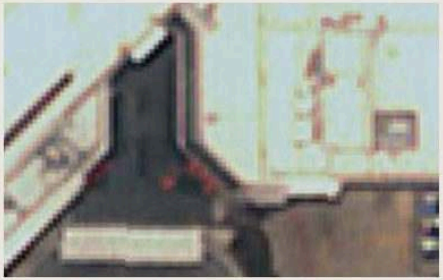
Most of the work was in what the sources would not do. OpenStreetMap servers fail or rate-limit, so map data is raced across mirrors and retried in the background. Government servers can take 15 to 20 s. The LiDAR has no bridges, car parks and junctions need cleaning before they build, and colour alone cannot tell a mulch bed from sand.



The whole import from 120 s to about 40 s. Satellite tree ages from an 89 MB download to 0.15 MB, using Digital Earth Australia instead of full Sentinel-2 tiles.

Sources: GA 5 m LiDAR, Landgate SLIP aerial, OpenStreetMap, Meta 1 m canopy height, Digital Earth Australia and Sentinel-2, Main Roads WA TrafficMap, DBCA and DWER (SLIP), ALA and GBIF, DPLH heritage, DFES bushfire.

AERIAL PHOTO, JOONDALUP



Open imagery: Satellogic 2022, 1 m, 64 s to find.



Landgate: current, 0.2 m, 2.3 s.

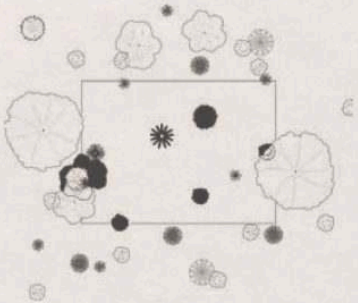
Joondalup. Open 1 m imagery took 64 s to find. Landgate's current 0.2 m aerial takes 2.3 s, so WA sites use it when trees from the photo are switched on.

06

THE TEST

IN THIS SECTION

Three states of one site
Roots against the footprint
The stand across fifty years
Moving the footprint
What the indices miss



Three states of one site

WARWICK BUSHLAND

A building that is taken out does not give the site back on the same day. To test this, the same patch of Warwick Bushland, 126 recorded plants, is drawn before the building, while it stands and after it has gone. The red is what the first and third plans do not share.

WHAT IS LEFT

Ten of the 126 plants stood inside the footprint, and one of them straddled its west edge. Each comes back as a seedling, so the red marks where a shrub or tree had been. The rectangle is the ground the slab leaves compacted.

TEST

Whether taking the building out in four steps gives the ground back, and how much of the stand is still missing on the day it goes.

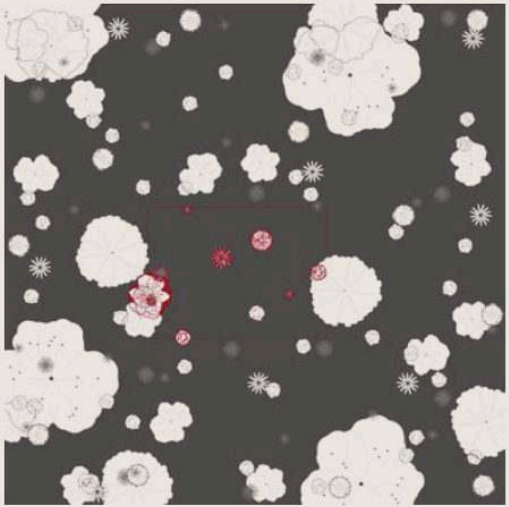
FINDING

On the day the building is removed the footprint is still bare ground. Taking it out does not repay the site.

CHANGE

Each of the four steps needed a connection that could be undone, which became the six details in the next entry.

THE SCAR, IN PLAN



The returned plan, with every part that differs from the first plan in red. Figure by Author.

Full set: appendix, page 405

THE THREE STATES



01 BEFORE

The stand as recorded.



02 OCCUPIED

The footprint in place, ten plants gone.



03 RETURNED

The footprint taken out, seedlings where the ten stood.

TAKING IT BACK OUT, IN FOUR STEPS



0 STANDING

The building as drawn.



1 ROOF PANELS

The roof comes off.



2 WALLS AND FRAME

Lifted out.

The bay, taken apart

THE BAY, EXPLODED

A building can only give its ground back if it comes apart. The bay, its smallest repeating piece, is exploded in the order the decommission follows: roof panels, walls and frame, deck, footings, then bare ground. The six details on the right make each step possible.

1 ROOF PANELS

Lift clear first, as whole panels.

2 WALLS AND FRAME

Unbolted and lifted out in pieces.

3 THE DECK

Boards come up off the bearers.

TEST

Whether each connection can be undone in the order the decommission needs, and whether all six fit inside one repeating bay.

FINDING

All six sit inside the bay. The sacrificial earth is the only layer meant to stay behind, because it is site soil and can go back into the profile.

CHANGE

The sacrificial earth became a working element of its own, the stratigraphical wall built from the site's horizons (page 122).

THE BAY, WHOLE



Assembled, with the three plants placed from the species records.

Full set: appendix, page 406

THE SIX DETAILS



SHALLOW FOOTING

Minimises soil disturbance.



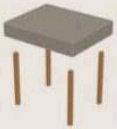
STEEL COLUMN

Reusable by disconnection.



TIMBER JOINT

Fasteners can be reclaimed.



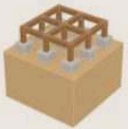
ROOF PANEL LIFT

Panels lift clear.



SACRIFICIAL EARTH

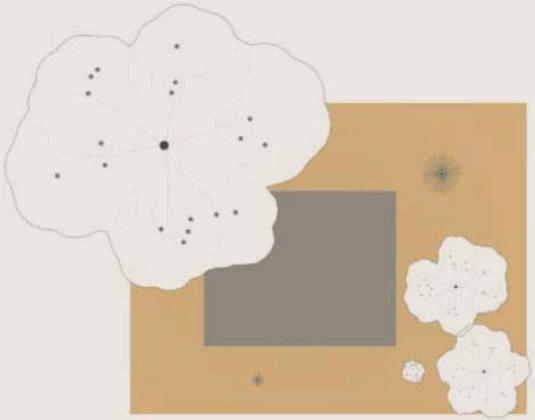
Protects the ground beneath.



FOUNDATION GRID

Extracted in full at the end.

THE BAY, IN PLAN



Pen style, the canopies drawn as plan symbols.

HOW IT WAS MADE

The bay is drawn in Rhino from the plugin's assembly library: a rammed earth back wall, a timber frame side wall, an elevated boardwalk deck on six pads, timber posts and a timber frame flat roof. A slender banksia, a sheoak and a grass tree are placed from the species records.

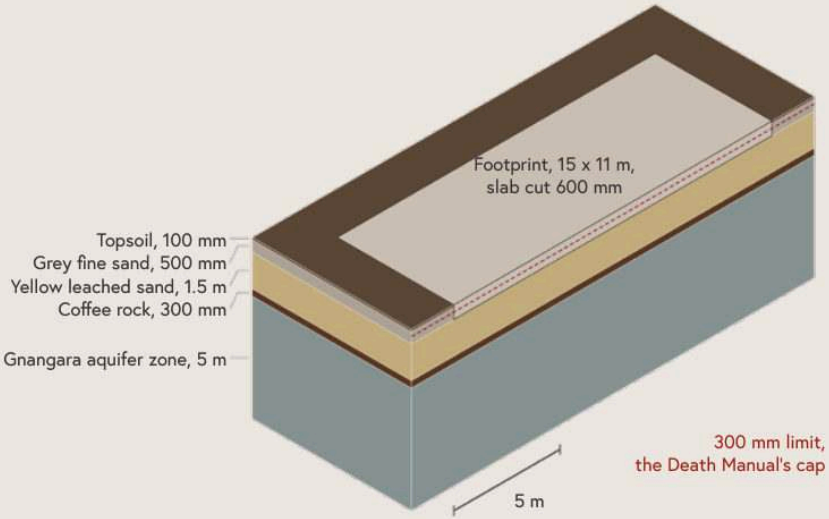
The ground under the footprint

THE GROUND UNDER THE FOOTPRINT

A footprint takes soil as well as plants. The left page draws the ground under it, one block per layer at its recorded thickness. The right page takes one recorded community through the clearing and lays the last plan over the first to show what did not come back.

THE CUT

The 15 x 11 m footprint set 600 mm into the Warwick profile, twice the Death Manual's 300 mm cap, with coffee rock and the aquifer below. Figure by Author.



Isometric, true scale on all three axes. Sectioned on the footprint's long centre line.

TEST

What the footprint sits on, and what it takes out of one recorded community, drawn from the side and from above.

FINDING

In plan the cleared footprint is still legible after the building has gone. I could not tie the four ground profiles to a measured soil column on the site, so they are shown as types.

CHANGE

The loss above ground led me to the roots, in the next entry.

FOUR PROFILES AT ONE SCALE, TOPS ALIGNED



PROFILE 1, WARWICK

Swan Coastal Plain, 7.4 m.



PROFILE 2, GENERIC WA

Coastal plain, 1.5 m.



PROFILE 3, A TEST ASSEMBLY

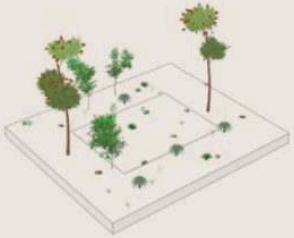
Made in the editor, 0.95 m.



PROFILE 4, STAT WALL 2

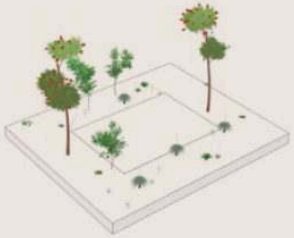
The same three layers, redrawn.

WHAT DID NOT COME BACK



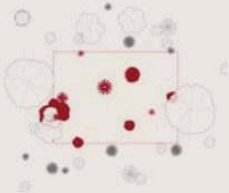
01 STAND

The community around the footprint, as recorded, with the footprint outlined.



03 AFTER

The footprint cleared, the ten gone and the ground compacted.



THE SCAR

The after plan, with every part that differs from the stand in red.

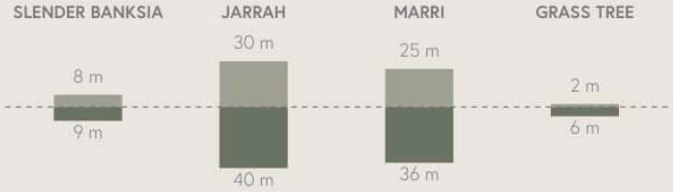
Full set: appendix, page 406

The roots

PAST THE LINE OF THE BUILDING

A plant outside the footprint can still lose its roots to it. The left page draws the community's roots in 3D. The right page lays the footprint and the excavation over them in plan, to compare what the cut takes with what was there.

ABOVE THE GROUND AND BELOW IT, IN METRES



Mature height above the line, recorded root depth below it, on one scale. All four are recorded as rooting deeper than they grow tall.

TEST

How far the roots reach past the line of the building, and whether the recorded depths behind the drawings hold up.

FINDING

Over 130 records sat on a default root depth of 500 mm, so their roots came out the same size whatever the plant. Six prostrate banksias carried the 5.2 m depth then recorded for Banksia attenuata (now 9 m).

CHANGE

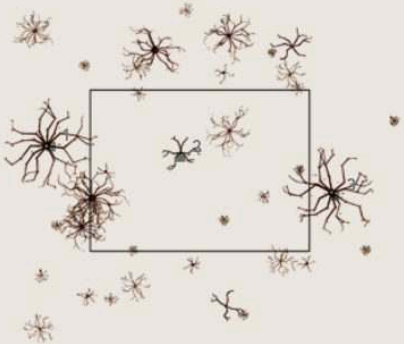
The data audit on 25 September put the six banksias back on the proteoid default. The 500 mm defaults are still to be replaced.

THE ROOTS, IN 3D



The same community, drawn from below. Figure by Author.

THE ROOTS, IN PLAN



The footprint outline over the root spread of the recorded community.

1 WEST EDGE

The largest system crosses the footprint line.

2 INSIDE

A small plant stands under the footprint and goes with the cut.

3 EAST EDGE

The second large system reaches in from the east.

WHAT THE CUT TAKES

18 per cent of the root spread drawn in plan lies inside the footprint, measured from the drawing.

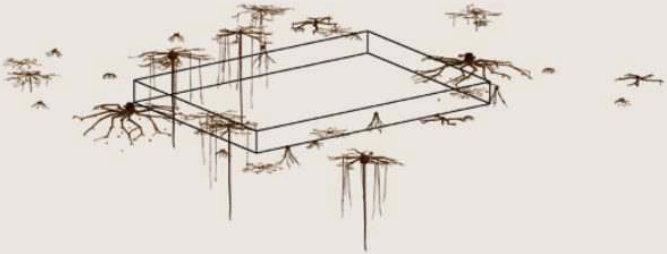
The footprint covers a quarter of the frame and less than a fifth of the roots, because the two largest systems stand outside it. Those plants stay, and the dig still cuts their roots at the west and east edges. A plant count misses this.

THE EXCAVATION



The footprint cut into the ground.

THE EXCAVATION, WITH THE ROOTS IT MEETS



One tree through time

ONE TREE AT NINE AGES

A site is owed as long as its plants take to grow. One jarrah is drawn at nine ages and as a growth row, where the hollow gap is every tree too young for a hollow. The rates are the library's, slower than a project programme.

TEST

One jarrah at nine ages, to see how long its record says it takes to become the tree the animals need.

FINDING

The record puts hollows at 130 years and the lifespan at 450, so the drawing stops well short of a full life. The audit also found 143 records that could never reach their own mature height within their own recorded life.

CHANGE

The 143 were recomputed on 25 September, and the quality gate now flags any life stage that cannot reach its own height.

THE BAR UNDER EACH AGE

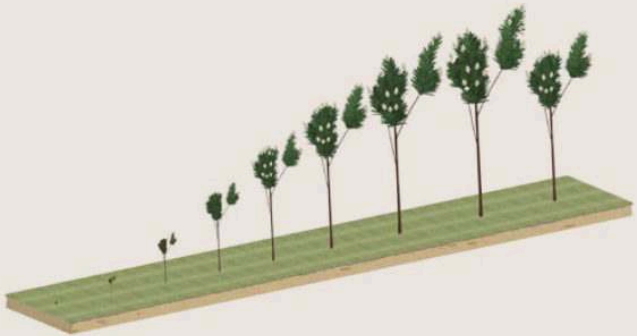
NO HOLLOWS: 1 TO 80 YEARS

HOLLOWS POSSIBLE FROM 130 YEARS



Eucalyptus marginata at nine ages, seedling to 250 years, all at one scale. Figure by Author.

AND ON ONE GROWTH ROW



One jarrah at successive ages: the hollow gap is every tree short of 130 years.

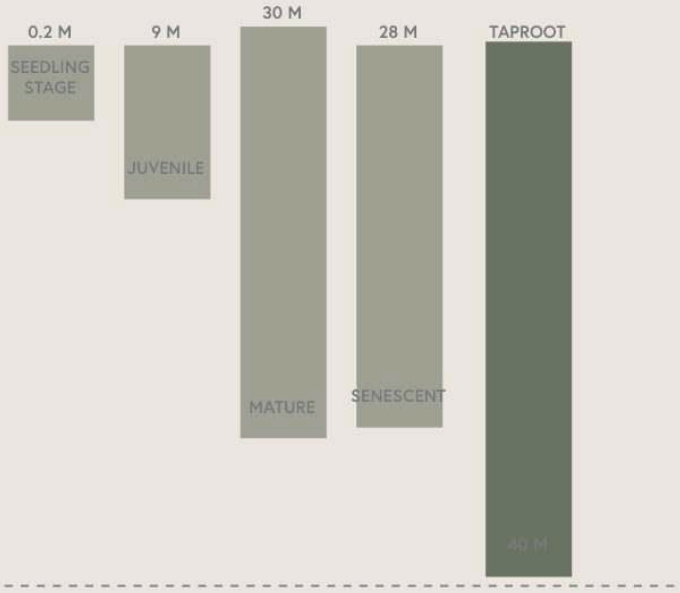
WHY IT DOES NOT CLOSE

Before a jarrah can carry a hollow: 130 years. Recorded lifespan: 450 years.

Planting cannot speed this up. Hollows form only as the trees age, however long the project runs.

THE RECORD, DRAWN TO ONE SCALE

The height the species record gives each life stage above the line, its taproot below. The drawings of the nine ages follow the record's growth rate instead.



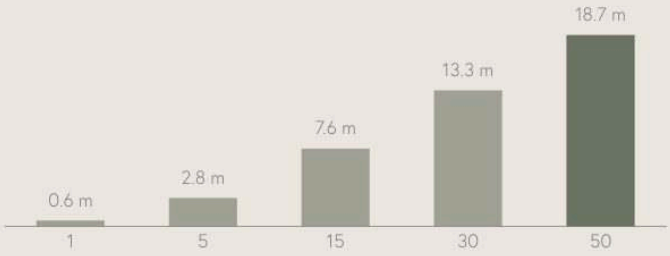
Full set: appendix, page 407

The stand across fifty years

ONE VIEWPOINT, ONE SCALE

Fifty years is the life the test gives the building. The stand the jarrah belongs to is drawn at five points across it, from one viewpoint and at one scale, and year 50 is drawn largest on the right page. Each of the 126 plants grows by its species' recorded mature height, growth rate and lifespan.

TALLEST JARRAH, IN METRES



Hollows need a tree of 130 years or more, so every tree here is still too young to carry a hollow for the animals on the next pages.

YEARS 1 TO 30



1 YEAR

126 plants of 10 species. The tallest, a jarrah, is 0.6 m.



5 YEARS

26 plants are over 2 m. The tallest jarrah is 2.8 m.



15 YEARS

126 plants of 10 species. The tallest, a jarrah, is 7.6 m.



30 YEARS

All 26 trees are over 5 m. The tallest jarrah is 13.3 m.

YEAR 50, DRAWN ON ITS OWN



50 YEARS

The tallest jarrah is 18.7 m. The middle plant of the 126 is 1.2 m. Figure by Author.

TEST

The 126 plants of the stand grown forward fifty years, each species at its recorded growth rate, to see the site at the end of a long project.

FINDING

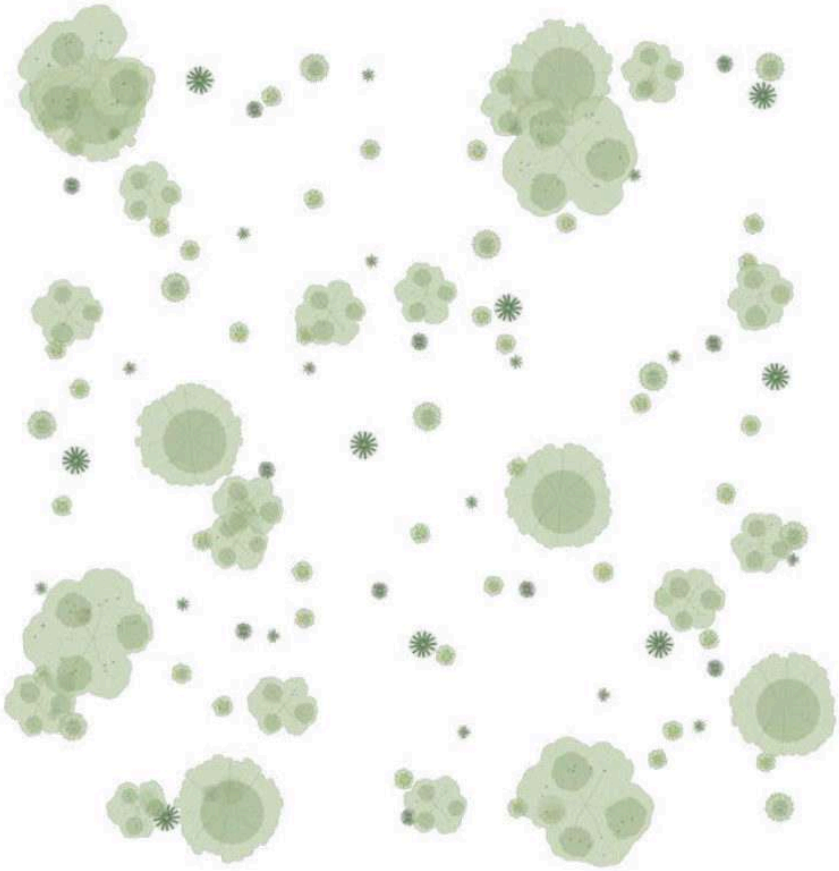
At year 50 the tallest jarrah is 18.7 m, still short of its recorded 30 m, and the middle plant of the stand is 1.2 m. No tree is near hollow age.

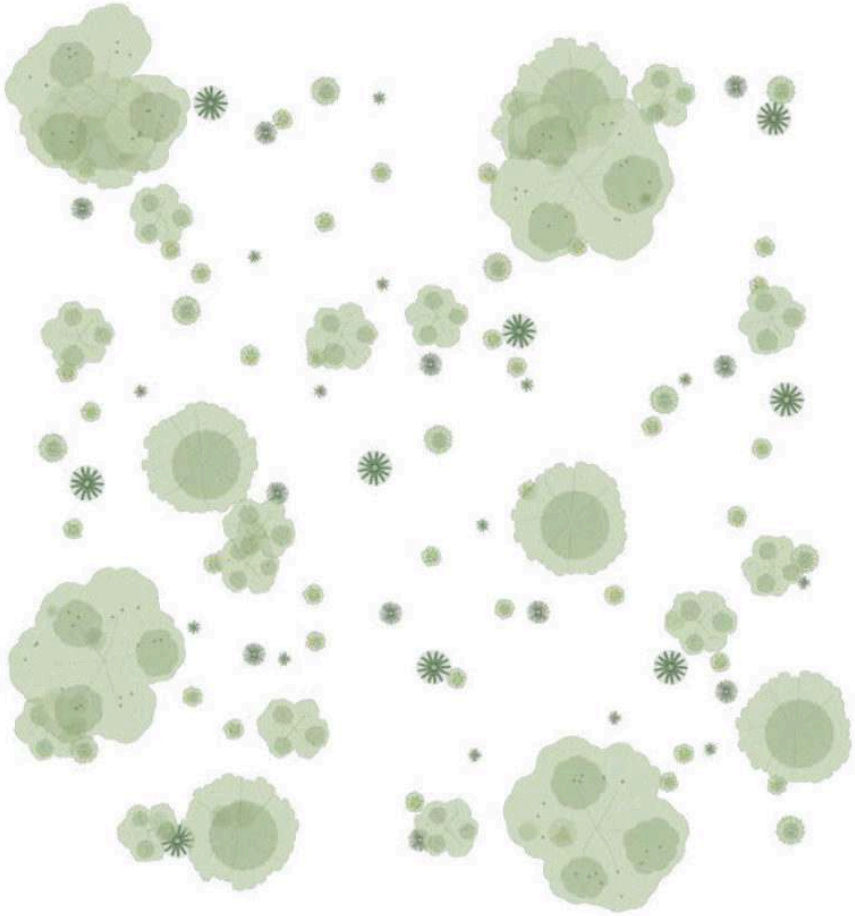
CHANGE

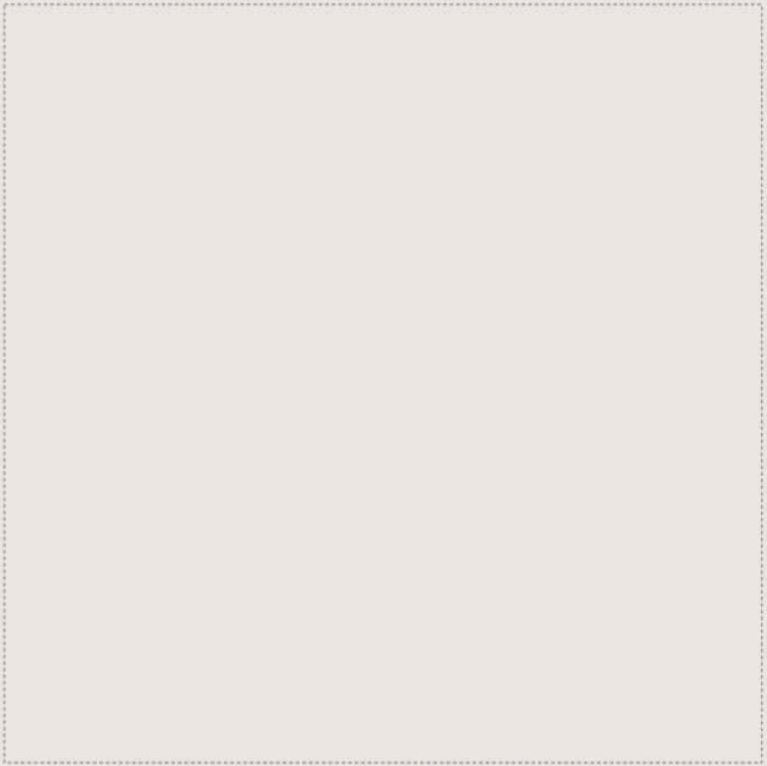
The Live View had been growing plants from its own table, which had drifted from the records on 12 rows. Since 25 September it reads the records.

Growth: the canopy over time









One plant and what depends on it

RANKED BY WHAT LEAVES WITH THE PLANT

Clearing a plant takes the animals that feed or shelter on it. Each row draws a plant with the animals its record names, then the same ground without it, then the plan. Rows are ranked by how many animals leave with the plant. Only animals with a reviewed model are drawn, larger than life and ghosted where the plant has gone. The severed dependency counts every group the records name.

EUCALYPTUS MARGINATA

5 modelled animals leave with the jarrah.



WITH ITS ANIMALS | WITHOUT THE PLANT | FROM ABOVE

Eucalyptus marginata. Mature height 30 m, roots to 40 m (sinker lateral). Used by the Western Ringtail Possum, Brushtail Possum, Blue-banded Bee, Christmas Beetle and Carnaby's Black-Cockatoo.

CORYMBIA CALOPHYLLA

5 modelled animals leave with the marri.



WITH ITS ANIMALS

Corymbia calophylla. Mature height 25 m, roots to 36 m (sinker lateral). Used by the Western Spinebill, New Holland Honeyeater, Carnaby's Black-Cockatoo, Western Ringtail Possum and Blue-banded Bee.

BANKSIA ATTENUATA

4 modelled animals leave with the slender banksia. Drawn at a larger scale than the two eucalypts.



WITH ITS ANIMALS



WITHOUT THE PLANT



FROM ABOVE

Banksia attenuata. Mature height 8 m, roots to 9 m (proteoid). Used by the Western Spinebill, Carnaby's Black-Cockatoo, Blue-banded Bee and Bull Ant.

XANTHORRHOEA PREISSII

2 modelled animals leave with the grass tree. Drawn at a larger scale than the two eucalypts.



WITH ITS ANIMALS



WITHOUT THE PLANT



FROM ABOVE

Xanthorrhoea preissii. Mature height 2 m, roots to 6 m (fine fibrous). Used by the Carnaby's Black-Cockatoo and Blue-banded Bee.

TEST

Four plants drawn with their animals, without the plant and from above, to see whether the dependants read at all.

FINDING

In the first renders the animals were too small to see, and the with and without frames looked almost the same. The audit also showed that banksias are not mycorrhizal. They feed through cluster roots.

CHANGE

The animals are now drawn at a size that reads and ghosted on the bare plot. The fungal network in the model runs through the eucalypts instead of the banksias.

Full set: appendix, page 407

Roots against the footprint

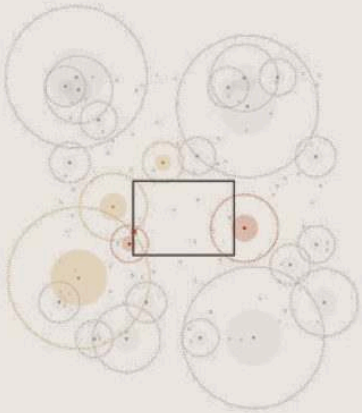
ROOT ZONES

Every tree carries a root zone from its species record: the spread of its roots, scaled to its age and never smaller than its canopy. The inner 40 per cent is the structural root zone, which a footing must not cut. The plugin checks each plant of 3 m or more against nearby walls and marks the clash while the wall can still move.

Laid over the recorded stand at 50 years, the footprint takes 1 of its 26 trees outright and reaches 5 more that stay standing. It cuts the structural root zone of a firewood banksia and a sheoak, and enters the outer root zone of a slender banksia, a sheoak and a jarrah.

26 trees of 3 m or more. 2 structural zones cut. 3 root zones reached.

THE STAND IN PLAN



The stand in plan with the footprint. Red: structural root zone cut. Amber: root zone reached. Grey: clear. Dashed rings are the full root zones, filled discs the structural zones.

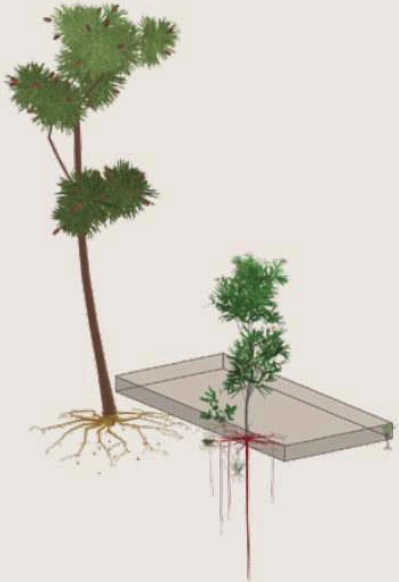
READING THE PLAN

- structural root zone cut
- plant removed by it
- the footprint
- tree of 3 m or more, clear
- root zone reached
- plant under 3 m

Dashed ring: the full root zone.
Shaded disc: the structural root zone, the inner 40 per cent.

Full set: appendix, page 408

THE WEST EDGE, DUG 600 MM



The west edge of the footprint dug 600 mm, twice the Death Manual's 300 mm cap. Roots the cut reaches inside their structural zone are drawn red, roots it only enters are amber.

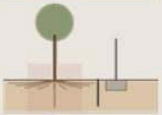
WHAT THE CLASH ASKS FOR

A serious clash means roots cut and a footing that can be lifted as the tree grows. A caution can still be answered in the construction, and the plan says which answer applies before anything is dug.

There are three. A root barrier on the building side turns the roots down before they reach the footing. A pier footing is placed between the main roots instead of a strip across them. A beam lifted over the zone bridges it, so the roots pass beneath the building and the piers stand outside the structural zone.



A pad footing inside the structural root zone cuts the roots it sits on.



A root barrier turns the roots before they reach the footing.



Piers outside the structural zone, with a beam lifted over the roots.

One tree in layers

A JARRAH AT FIFTY YEARS

A tree is more than the part a building is checked against. One jarrah is drawn in layers: crown edge, limbs, leaf clumps, roots, and the two root zones the plugin measures against a building. The last drawing puts them together with a building edge 2.5 m from the trunk.



5 m

Fig. 1 Crown edge



5 m

Fig. 2 Branches



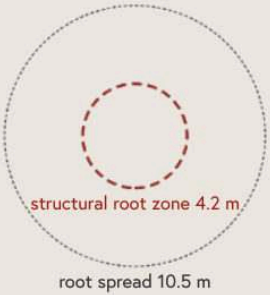
5 m

Fig. 3 Leaf clumps



5 m

Fig. 4 Roots, a taproot and its laterals



5 m

Fig. 5 Root spread and structural root zone

WHAT A BUILDING SEES

A building check reads a tree as two circles, a root spread of 10.5 m and a structural root zone of 4.2 m, which a footing must stay outside. Drawn apart, the layers show what those circles leave out.

Root spread 10.5 m and structural root zone 4.2 m from the species record; crown from its plan symbol. Figs. 1 to 5 at one scale, Fig. 6 larger. Figure by Author.

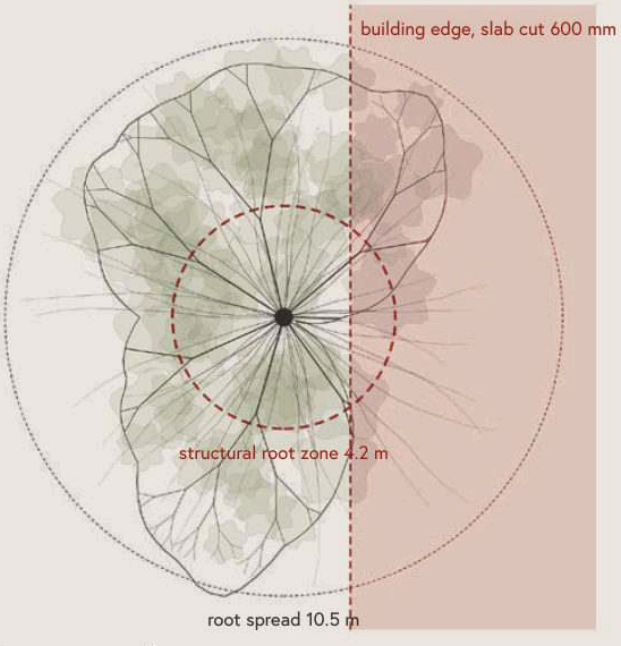


Fig. 6 Together, with a building edge 2.5 m from the trunk

The 300 mm line

DIGGING PAST THE LINE

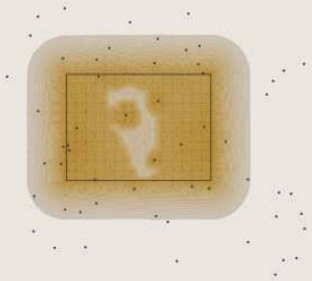
The 300 mm cap in the Death Manual is a conservative threshold set by this project. Below it, mycorrhizal networks, seed banks and soil horizons do not come back within a construction timeline.

The disturbance gradient in the plugin scores every 500 mm cell of the site: how far the nearest dig goes past that line, how close it is, and whether the cell sits inside a root zone. A dig shallower than the line still scores, at a low base value, because any construction disturbs the ground.

The same footprint is scored twice. Cut as a slab 600 mm into the profile it peaks at 0.64 and puts 45 m² above half intensity, most of it where root zones run under the edge. Set on twelve pad footings dug to 300 mm it peaks at 0.14 and nothing reaches half. The building is the same size. What changes is how it meets the ground.

Full set: appendix, page 408

A SLAB CUT 600 MM



A slab cut 600 mm. Grey is light disturbance, amber rising to red where the dig crosses the line inside a root zone.

IN SECTION, DEPTH DRAWN FOUR AND A HALF TIMES



Peak, slab at 600 mm: 0.64

Over half, slab: 45 m²

TWELVE PAD FOOTINGS AT 300 MM



Twelve pad footings at 300 mm, on the same footprint and the same scale.

IN SECTION, DEPTH DRAWN FOUR AND A HALF TIMES



Peak, pads at 300 mm: 0.14

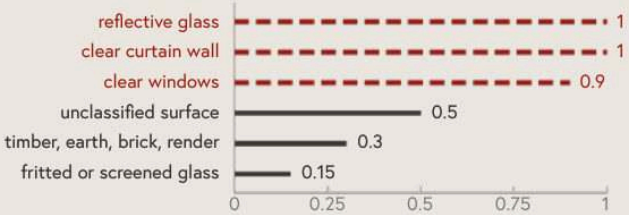
Over half, pads: 0 m²

GLASS AND BIRDS

Birds do not see clear glass. The plugin gives every surface a strike risk from its material: reflective glass and clear curtain walls at the top, clear windows just under, unclassified surfaces at half, opaque timber, earth, brick and render at 0.3, and glass marked at 5 by 10 cm or closer, the 2 by 4 rule, at 0.15 (Klem 1990; Sheppard and Phillips 2015).

The tiers are relative and indicative, and an assembly can carry its own value. No strike rates were measured. They put a price on a facade before it is drawn. A clear curtain wall facing the bush is the riskiest surface in the library. The cheapest correction keeps the glass and patterns it.

RELATIVE STRIKE RISK BY SURFACE

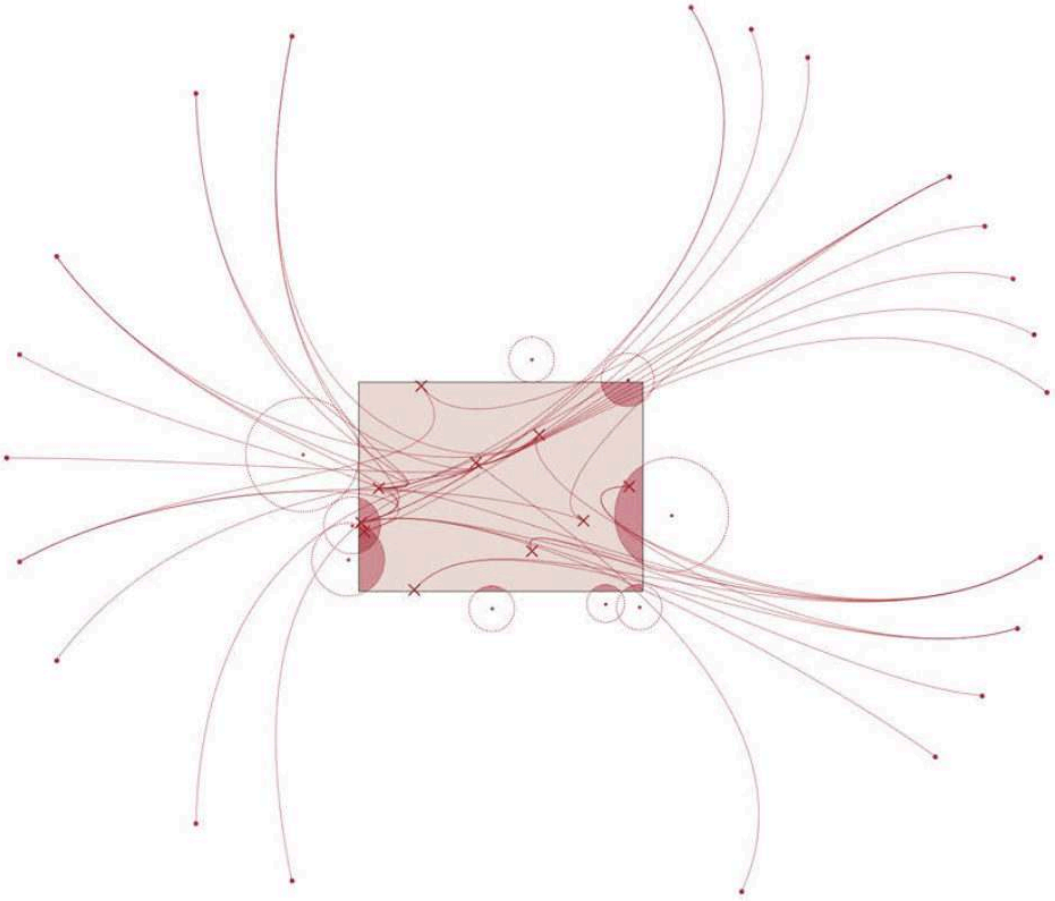


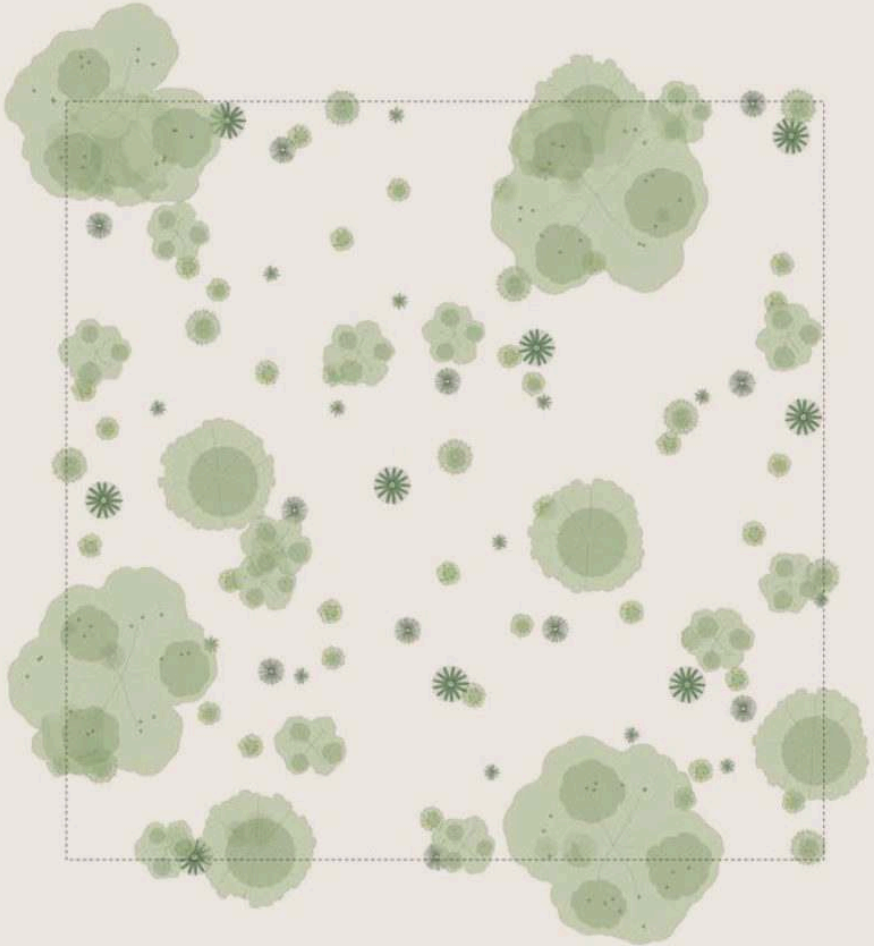
Red dashed: glass at a risk of 0.9 or more.

Strike risk by surface, from the plugin's collision tiers.

13 of the 42 assemblies in the library are glass with a strike risk of 0.9 or more.

The test: lift the building off





Dependencies broken

LINKS BROKEN

40 of 532 links broken outright, seven and a half per cent of the network.

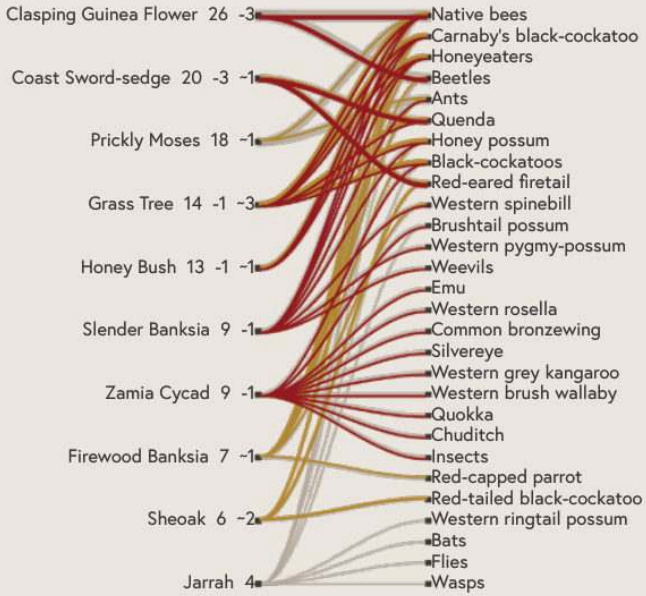
ONE STAND, AS A NETWORK

At mid-semester review the class asked to see a severed dependency. Every species here is tied to others: each of the 126 plants carries the animals its record names. The footprint removes ten plants and cuts the roots of nine more.

A PERCENTAGE HIDES THE CLOCK

Seven and a half per cent is the kind of figure an index would call minor. It is not the same loss for every animal. Beetles and native bees lose clasping guinea flower, which a seedling replaces in a year. The emu loses a zamia, whose seed it carries, and a replanted zamia does not flower for 29 years. Honeyeaters, native bees, the honey possum, the quenda and black-cockatoos lose a grass tree, which first flowers at 44.

Full set: appendix, page 409



The stand as a network. Plants on the left with their count in the stand, minus those removed and − those with cut roots; animal groups on the right. Red: links broken by the footprint. Amber: links at risk through cut roots. Line weight is the number of plants. Figure by Author.

532 LINKS, TEN PLANTS, 28 ANIMAL GROUPS

The stand holds 532 links between ten plant species and 28 animal groups. The building breaks 40 outright, in red, and puts 39 at risk through cut roots, in amber. An area index records none.

EACH ANIMAL, BY ITS SLOWEST LOSS

ANIMAL	FOOD PLANTS	REMOVED	ROOTS CUT	WAITS
Native bees	91	6	6	44 years
Carnaby's black-cockatoo	53	3	7	44 years
Honeyeaters	43	3	5	44 years
Quenda	34	4	4	44 years
Honey possum	30	2	4	44 years
Black-cockatoos	27	2	3	44 years
Brushtail possum	13	1	0	29 years
Emu	9	1	0	29 years
Western rosella	9	1	0	29 years
Common bronzewing	9	1	0	29 years

After the building

THE SITE IS NOT FINISHED WHEN THE BUILDING IS

The building is given a 50-year working life, the design life of an ordinary building (Standards Australia 2002). When it is decommissioned, its footprint is replanted with the species it removed. The plugin gives each the year it first flowers, from its recorded growth rate and reproductive height. That is how long the animals wait.

The last of them, a grass tree, flowers in year 94, 44 years after the building has gone. The Death Manual holds the site until then. Restoration ends when the last animal that lost a food source has it back.

Note, unresolved. First flowering stands in for food. Seed and fruit come later, so every wait here is the shortest it could be. The ages for zamia and grass tree, the two slowest, rest on recorded growth rates that are worth checking against field data.



How long each animal waits for the food plants the footprint took. One block is five years; the animals keep feeding on the rest of the stand. Figure by Author.

Full set: appendix, page 410

WHAT THE BUILDING OWES WHEN IT LEAVES

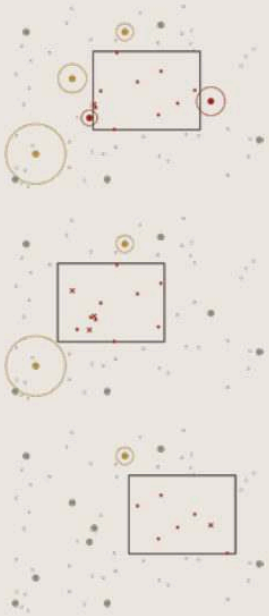
Replant 3 clasping guinea flower	flowers in year 51
Replant 3 coast sword-sedge	flowers in year 52
Replant 1 honey bush	flowers in year 54
Replant 1 slender banksia	flowers in year 56
Replant 1 zamia cycad	flowers in year 79
Replant 1 grass tree	flowers in year 94
Watch 9 plants with cut roots	grass trees, sheoaks and five more
Restore 165 m² of soil profile	the 15 by 11 m footprint
Cockatoo nest trees taken	none, no jarrah or marri
Footing priced	a slab cut 600 mm, as tested

The site is released in year 94, when the last lost food source flowers again.

AN INVOICE, NOT A SCORE

This is the Death Manual's invoice, drawn up before the building. Every line comes from the model: the plants the footprint removes, the roots it cuts, the depth it digs and the species records behind each one.

WHERE IT COULD HAVE STOOD



AS BUILT

Plants taken 10. Trees taken 1. Structural zones cut 2. Root zones reached 3.

5 M WEST

Plants taken 12. Trees taken 3. Structural zones cut 0. Root zones reached 2.

5 M EAST

Plants taken 7. Trees taken 1. Structural zones cut 0. Root zones reached 1.

Crosses are plants removed, large crosses trees of 3 m or more; red rings structural root zones cut, amber root zones reached.

As built and 5 m east are drawn larger on pages 206 and 207.

Moving the footprint

TWO POSITIONS, TWO FOUNDATIONS

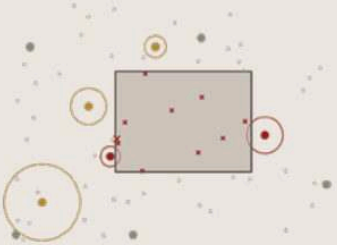
With the building moved 5 m east and set on pads, the site is released in year 79 instead of year 94.

TWO LEVERS

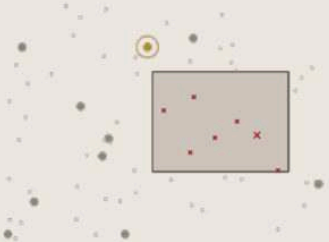
Where the footprint sits and how it meets the ground are still open while the design is drawn, and both change the debt. The same building is scored four times, at two positions and on two foundations: a slab cut 600 mm, twice the Death Manual's cap, and twelve pads at 300 mm.

Note, unresolved. The site is held until the slowest lost food plant first flowers, a lower bound. Disturbance uses the plugin's working defaults, which are still to be calibrated.

SLAB CUT 600 MM



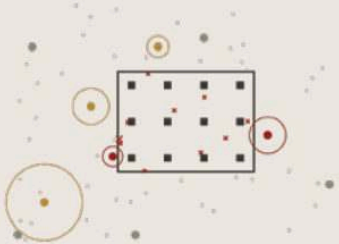
AS BUILT



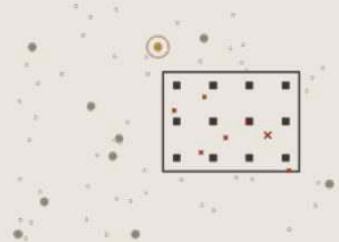
5 M EAST

Full set: appendix, page 411

PADS AT 300 MM



AS BUILT



5 M EAST

Top: as built. Bottom: 5 m east. Left: a slab cut 600 mm. Right: twelve pads at 300 mm. Crosses are plants removed, large crosses trees of 3 m or more; red rings structural root zones cut, amber root zones reached.

THE FOUR OPTIONS, AS THE PLANS ARE LAID OUT

	slab cut 600 mm	pads at 300 mm
as built	released, year 94 10 plants taken 40 links broken 2 structural zones cut 3 root zones reached disturbance peak 0.64 45 m² over half	released, year 94 10 plants taken 40 links broken 2 structural zones cut 3 root zones reached disturbance peak 0.14 0 m² over half
5 m east	released, year 79 7 plants taken 25 links broken 0 structural zones cut 1 root zone reached disturbance peak 0.64 46 m² over half	released, year 79 7 plants taken 25 links broken 0 structural zones cut 1 root zone reached disturbance peak 0.14 0 m² over half

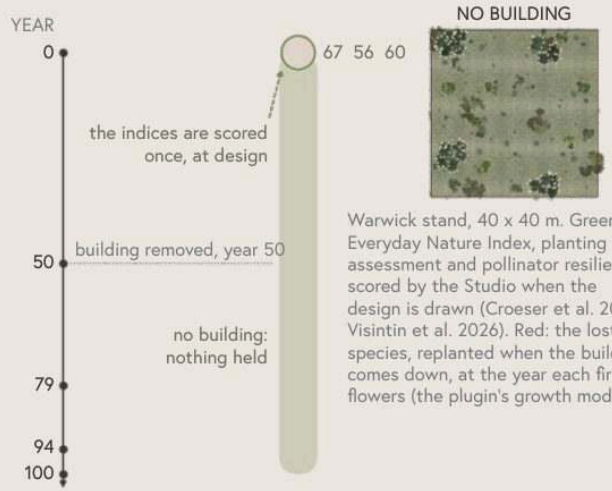
position: what is taken

foundation: how much ground is disturbed

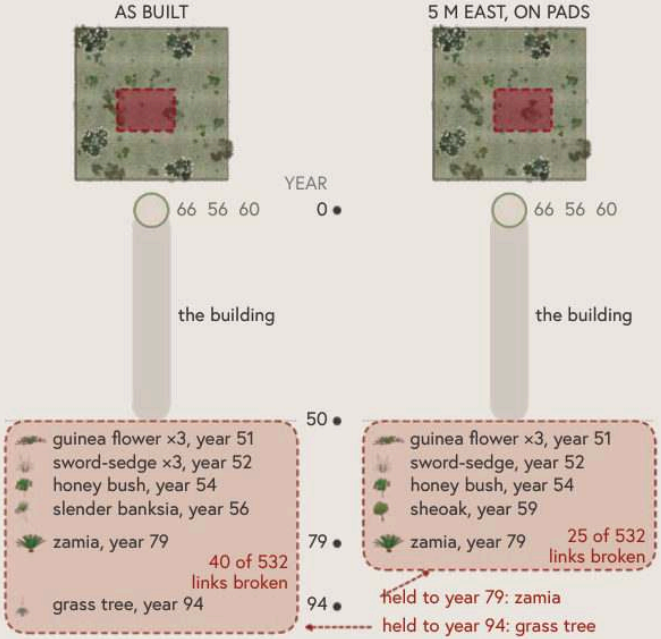
What the indices miss

SCORED ONCE, AT DESIGN

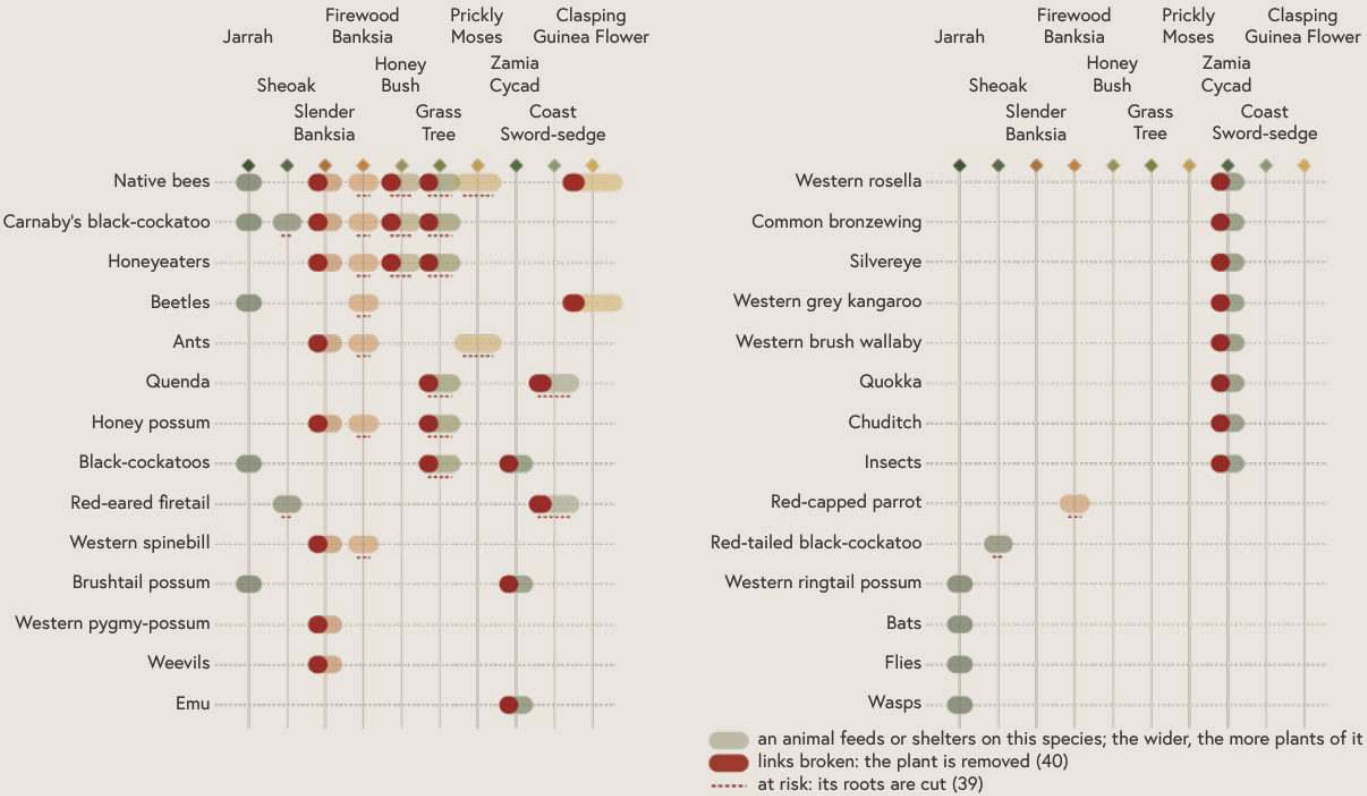
The published indices score the stand almost the same with and without the building: 67 before, 66 after. They count habitat area and planting, and a 15 by 11 m footprint barely changes either. The network on the right shows what they miss: 40 of 532 links broken, and a site held until year 94.



Warwick stand, 40 x 40 m. Green: Everyday Nature Index, planting assessment and pollinator resilience, scored by the Studio when the design is drawn (Croeser et al. 2026; Visintin et al. 2026). Red: the lost species, replanted when the building comes down, at the year each first flowers (the plugin's growth model).



The same stand with no building, as built, and 5 m east on pads. Figure by Author.



Who depends on which plant in the recorded stand, and what one footprint breaks: 532 links, 40 broken, 39 at risk. Figure by Author.

07

LEEUWIN

IN THIS SECTION

Moodboard
Mass studies and plan options
Chosen scheme and project data
Where we may not build
Sun
Massing
Section to the river
Facade and three levels of care



Moodboard

PINTEREST BOARD, LEEUWIN HOUSING

To come: Pinterest reference 1

To come: Pinterest reference 2

To come: Pinterest reference 3

To come: Pinterest reference 4

To come: Pinterest reference 5

To come: Pinterest reference 6

MATERIAL AND DETAIL SNIPPETS

To come: perforated screen, halftone image

To come: material snippet

To come: detail snippet

To come: material snippet

To come: detail snippet

PALETTE

Colour 1, to choose

Colour 2, to choose

Colour 3, to choose

Colour 4, to choose

Colour 5, to choose

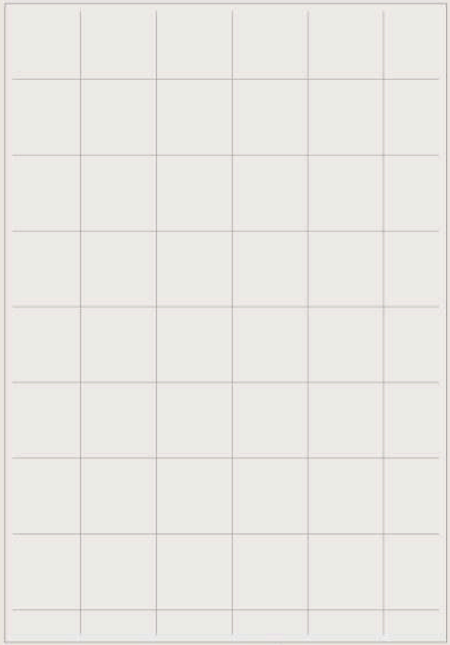
Colour 6, to choose

Colour 7, to choose

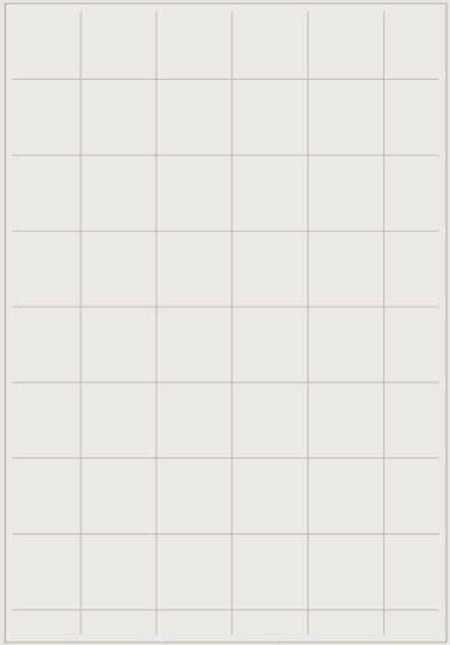
Colour 8, to choose

Mass studies

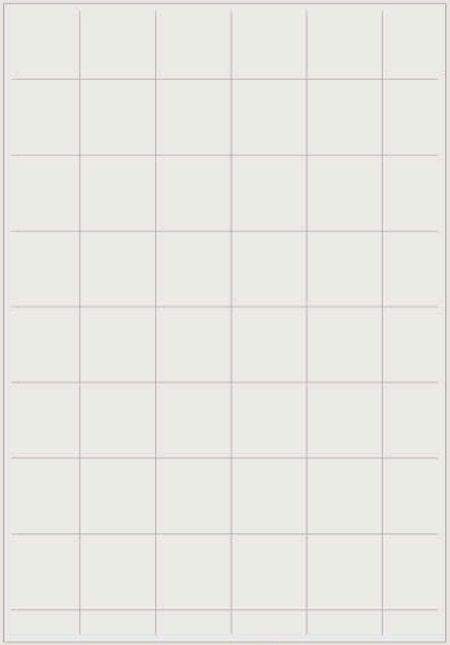
MASSING SKETCHES



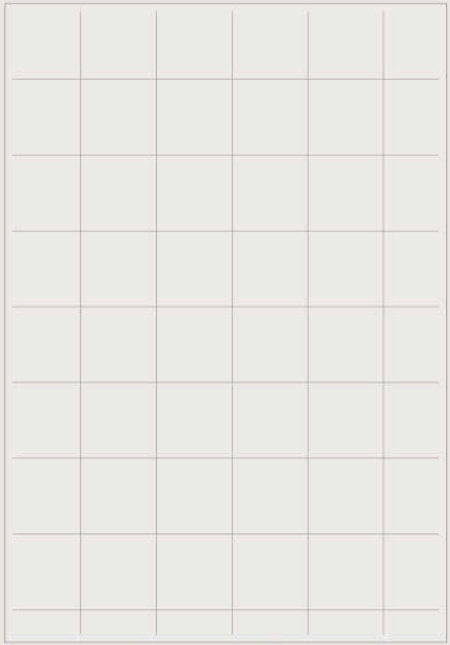
Mass study 1 scale



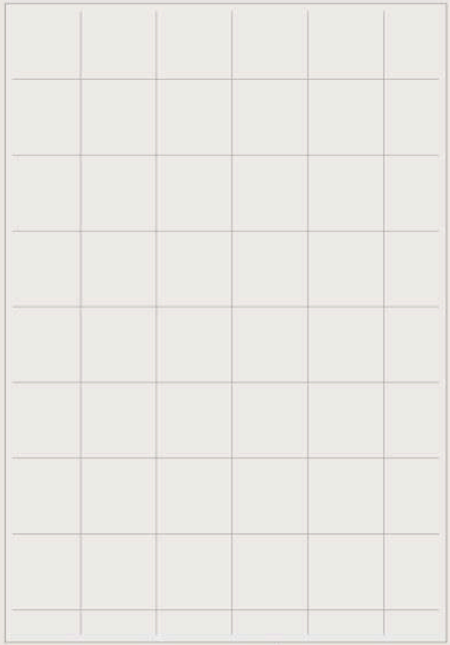
Mass study 2 scale



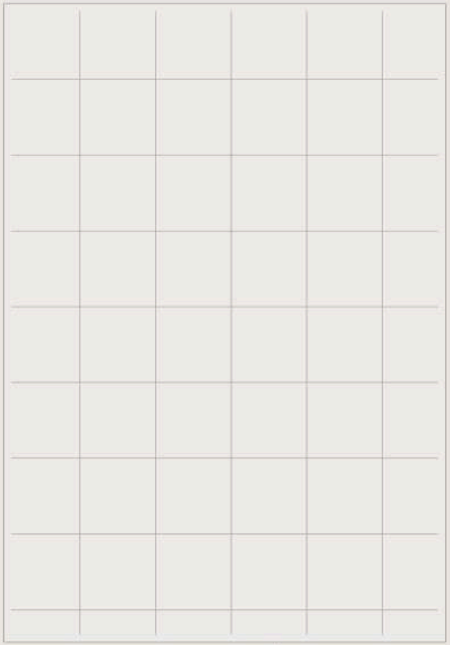
Mass study 3 scale



Mass study 4 scale



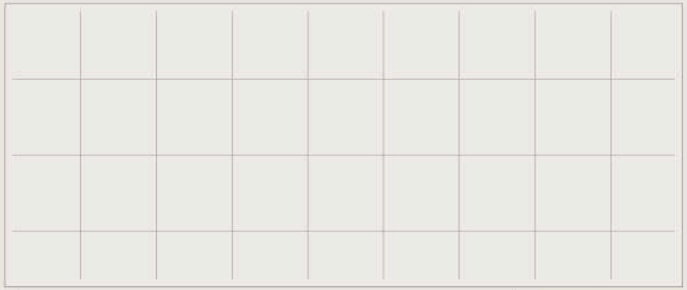
Mass study 5 scale



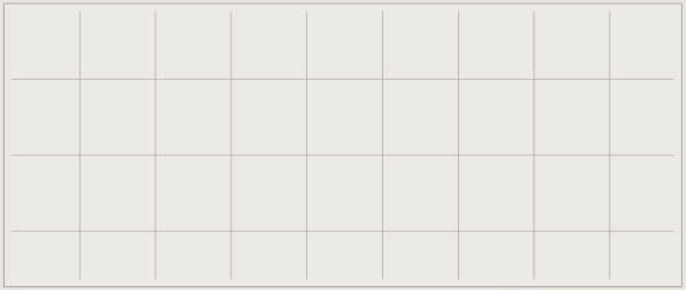
Mass study 6 scale

Plan options

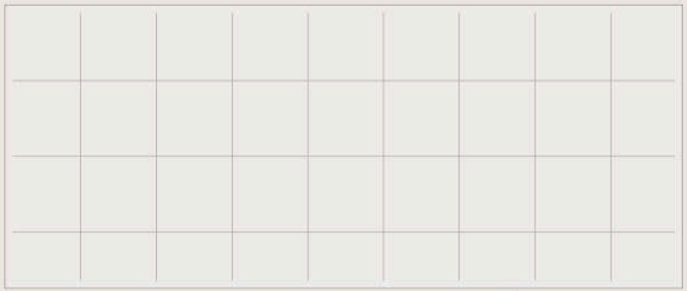
PLAN SKETCHES



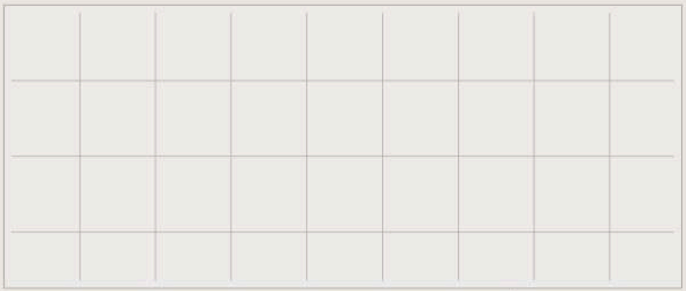
Plan option 1 scale



Plan option 2 scale

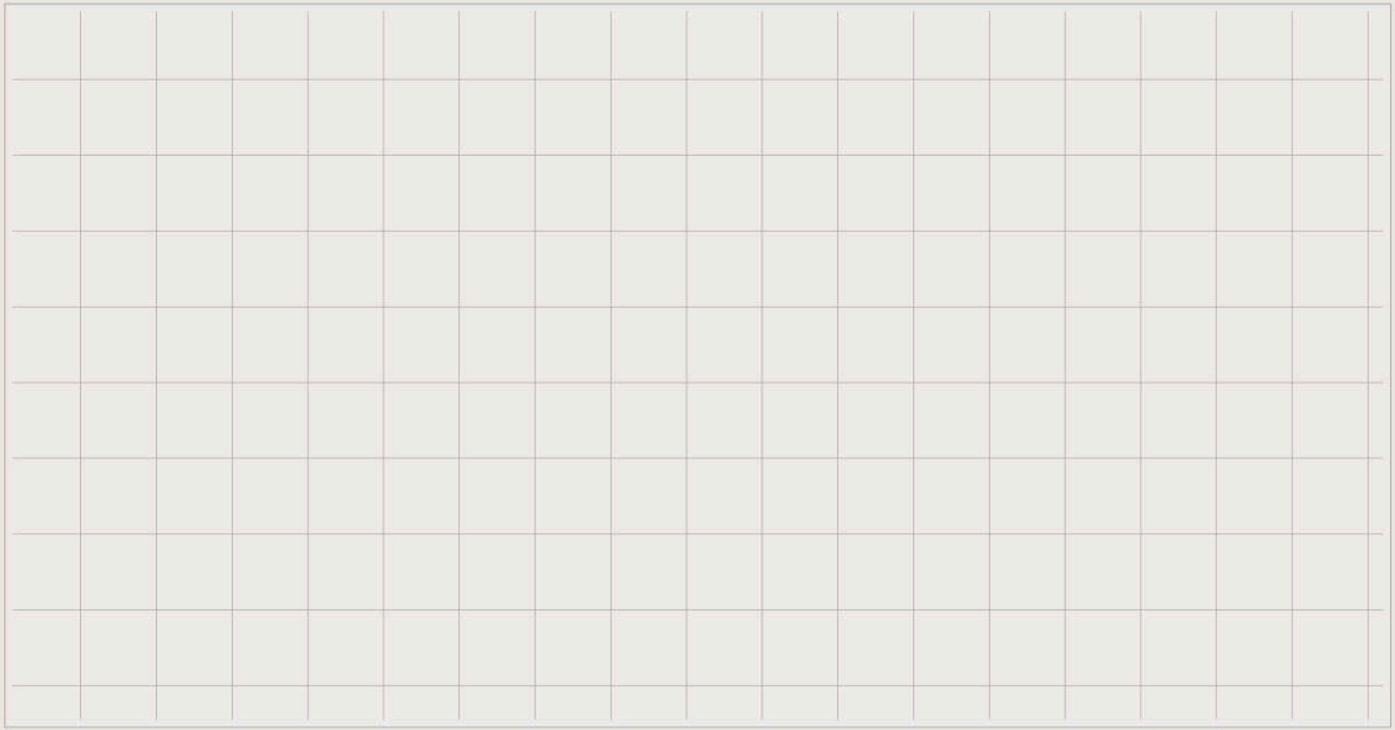


Plan option 3 scale



Plan option 4 scale

Chosen scheme



Chosen scheme, plan

scale

Project data

Leeuwin Barracks is a 14.3 ha Defence site on the Derbarl Yerrigan in East Fremantle, announced for sale in February 2026. The Town's Vision Plan expects about 1,440 to 1,500 apartments there. This project takes one block of that plan and designs it three times on the same lot, at three levels of care: A neglect, B some care, C full care. The dwellings and the facade stay the same, so only the decisions about the ground and the ecology change.



Candidate lots on existing barracks buildings and car parks, in red; Lot L1, the riverside lot this project builds on, is labelled. Site boundary in black.

SITE	Leeuwin Barracks, Riverside Road, East Fremantle, on the Derbarl Yerrigan (Swan River)
SITE AREA	14.3 ha, Defence land; sale announced 4 February 2026
PROPOSAL	one apartment block of the Town's Leeuwin Vision Plan (about 1,440 to 1,500 apartments in all)
HEIGHT	six storeys or less (2019 cap)
POSITION	on an existing barracks building or car park, clear of the foreshore control area and the Drill Hall
CLIENT	the community and the public; designers and their communities
REGULATORY FRAMEWORK	R-Codes Volume 2; Swan River Development Control Area (DBCA)
HERITAGE	the Drill Hall (listed); the parade ground kept as open space
TEST	the same block at three levels of care: A neglect, B some care, C full care
TO FOLLOW	footprint and dwelling count, from the site import

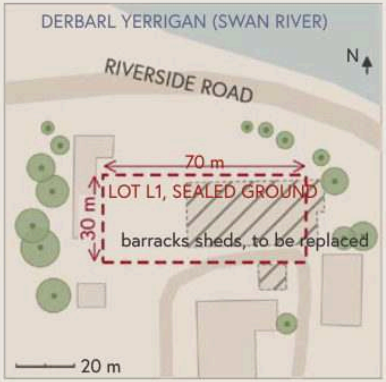
Where we may not build

KEY

- no build: tree root zones, slope over 1 in 4, river setback 30 m (provisional) 0.8 ha
- build with care: tree protection zones, slope 1 in 6 to 1 in 4 1.8 ha
- already built: existing barracks buildings 2.1 ha
- site, Leeuwin Barracks 14.7 ha; open ground left 9.9 ha



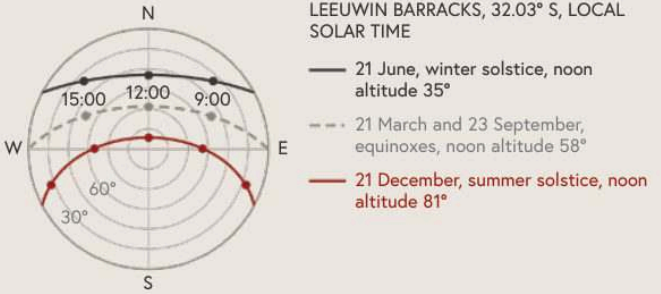
The lot sits on existing barracks sheds and sealed ground, clear of the foreshore control area, the Drill Hall and the parade ground. Building here takes no bushland. Care on this site means what the block does below ground and how much soil it leaves able to hold roots.



Lot L1 today, in plan from the site import: the barracks sheds the block replaces, hatched, and the 15 imported trees at their measured crown spread (river red gum and peppermint 4 each, stout paperbark 2, river sheoak, brush box, broad-leaved paperbark, tuart and Canary Island palm 1 each). Figure by Author.

Sun

At 32 degrees south the winter sun stands 35 degrees above the northern horizon at noon, and the summer sun 81 degrees. The river lies to the north of the lot, so a block that steps down towards it keeps winter sun on its lower terraces and on the deep soil in front of it.



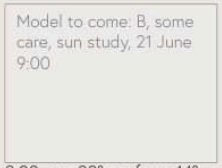
Above, the sun's path across the year at Leeuwin Barracks, from its latitude. On the next three pages, one scheme to a page, in plan with north up: the finished block on lot L1 on 21 June and 21 December at 9:00, 12:00 and 15:00, local solar time. Ground and roof shadows of the block, its neighbours and the trees are cast from the computed sun. Under each plan, the share of the lot's open ground in shade. Figure by Author.

A, NEGLECT

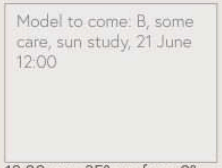
21 JUNE, WINTER SOLSTICE	21 DECEMBER, SUMMER SOLSTICE
Model to come: A, neglect, sun study, 21 June 9:00	Model to come: A, neglect, sun study, 21 December 9:00
9:00, sun 20° up, from 44°	9:00, sun 50° up, from 89°
Model to come: A, neglect, sun study, 21 June 12:00	Model to come: A, neglect, sun study, 21 December 12:00
12:00, sun 35° up, from 0°	12:00, sun 81° up, from 0°
Model to come: A, neglect, sun study, 21 June 15:00	Model to come: A, neglect, sun study, 21 December 15:00
15:00, sun 20° up, from 316°	15:00, sun 50° up, from 271°

B, SOME CARE

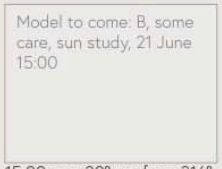
21 JUNE, WINTER SOLSTICE



9:00, sun 20° up, from 44°

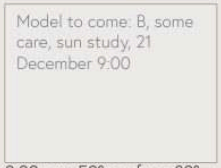


12:00, sun 35° up, from 0°

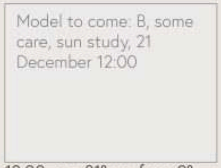


15:00, sun 20° up, from 316°

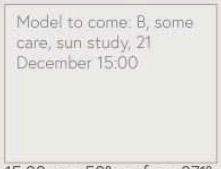
21 DECEMBER, SUMMER SOLSTICE



9:00, sun 50° up, from 89°



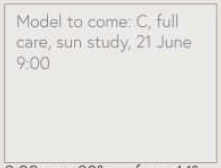
12:00, sun 81° up, from 0°



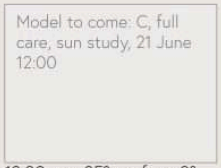
15:00, sun 50° up, from 271°

C, FULL CARE

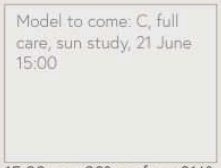
21 JUNE, WINTER SOLSTICE



9:00, sun 20° up, from 44°

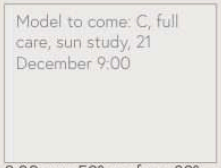


12:00, sun 35° up, from 0°

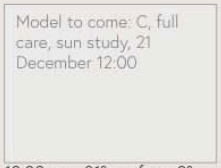


15:00, sun 20° up, from 316°

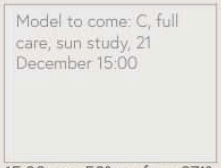
21 DECEMBER, SUMMER SOLSTICE



9:00, sun 50° up, from 89°



12:00, sun 81° up, from 0°



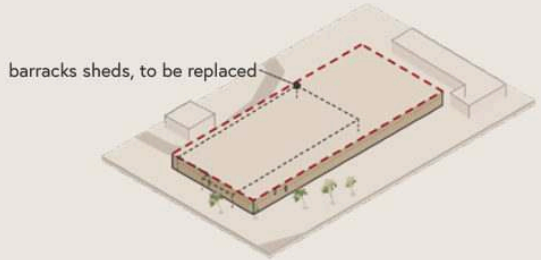
15:00, sun 50° up, from 271°

Massing

A clears the lot and digs a basement car park under all of it. B keeps the same block over the same basement and adds planter balconies and trees on the basement roof. C has no basement: the block stands on pads, steps down to the river in six, four and two storeys, and plants every lower roof.

THE LOT TODAY

Lot L1, 70 x 30 m: two barracks sheds on sealed ground, Riverside Road and the river to the north. The same lot, the same floor area, three levels of care.



Full set: appendix, page 411

A, NEGLECT

Model to come: A, neglect, massing, step 1

STEP 1

Cleared and dug: a car park under the whole lot

Model to come: A, neglect, massing, step 2

STEP 2

The block set on it: 50 x 14 m, six storeys

Model to come: A, neglect, massing, step 3

STEP 3

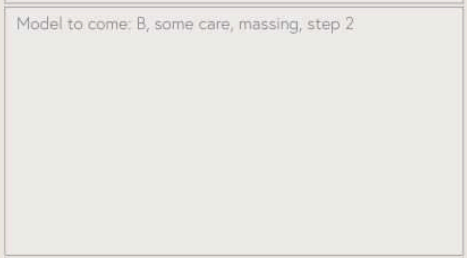
Paved to the boundary: one box on sealed ground

B, SOME CARE



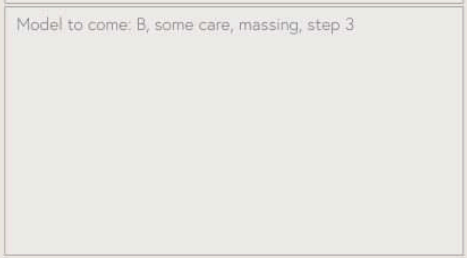
STEP 1

The same block over the same basement



STEP 2

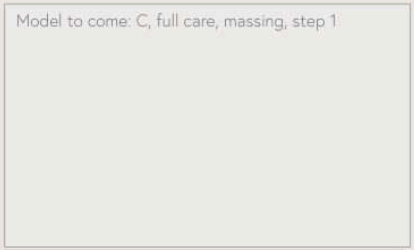
Planter balconies on the north face



STEP 3

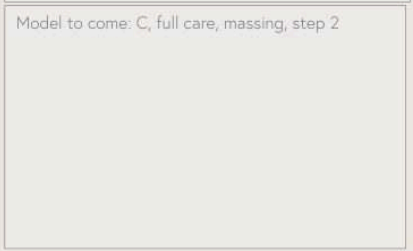
Native trees in the setbacks, on the basement roof

C, FULL CARE



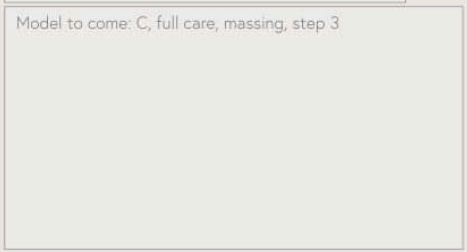
STEP 1

No basement: the block on pads, the soil left whole



STEP 2

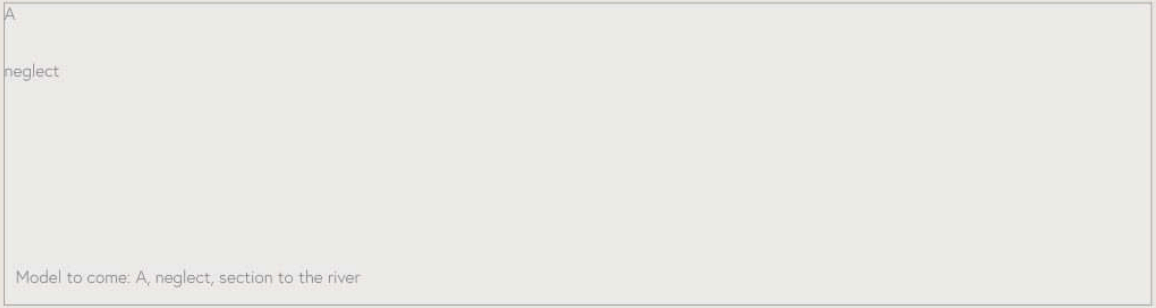
Stepped to the river: 6, 4 and 2 storeys

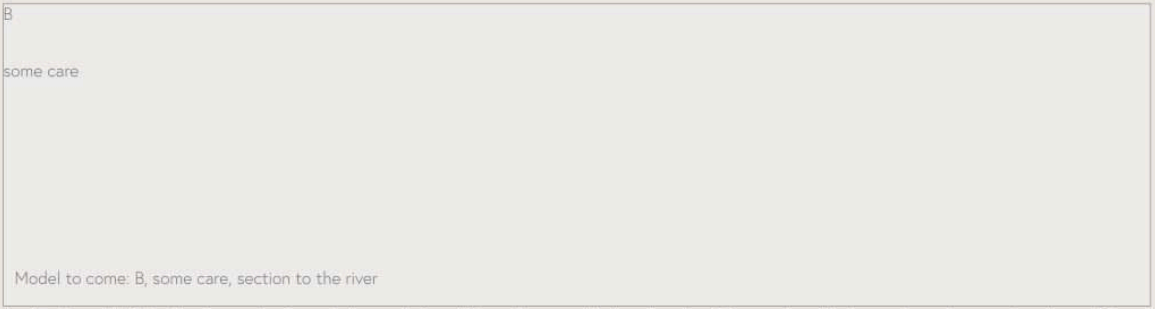


STEP 3

Every lower roof a planted terrace, deep-soil trees to the north

Section to the river





Section from lot L1 to the river on the imported ground: A and B on a basement below river level, C on pads, with the roots each one cuts or keeps. Figure by Author.

In A and B the basement is 3.6 m deep under the whole lot, so nothing planted above it can root into the ground. A tree on B's basement roof has 600 mm of soil and stops at the slab. In C the ground runs under the pads and the trees in front of the block root into deep soil. The basement takes more than the footprint does.

THE GROUND UNDER LOT L1, IN PLAN: HATCHED THE CAR PARK, DASHED THE BLOCK ABOVE ITS PADS

Model to come: A, neglect, ground plan

A neglect. A car park 62 x 26 m, 3.6 m deep, under the lot; the ground left whole is the 488 sq m rim round it, sealed.

Model to come: B, some care, ground plan

B some care. The same car park, trees in 600 mm of soil on its roof; the 488 sq m rim left whole.

Model to come: C, full care, ground plan

C full care. No basement: the block stands on pads and all 2,100 sq m of the lot stays whole ground.

C

full care

Model to come: C, full care, section to the river

Manuj Mishra 20829455

Shared facade



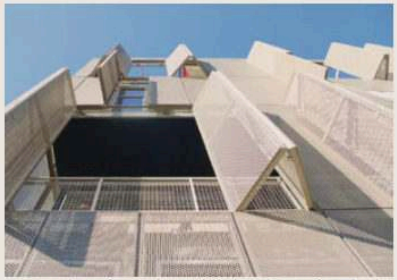
Green perforated mesh in front of the balconies, planting showing through the openings



Folding perforated shutters: the screen opens and closes per apartment



Brick lattice with climbers growing through it



Sawtooth perforated panels, Cherokee Lofts: shade and privacy from one folded sheet



Brick lattice with a framed opening to a tree behind



Warm brick and terracotta inside, the same palette as the screen

A, NEGLECT

THE BLOCK THAT TAKES ITS GROUND



The ordinary walk-up block: a box set on its lot, no response to what was there



Shored excavation for a car park: the ground is removed before anything is built



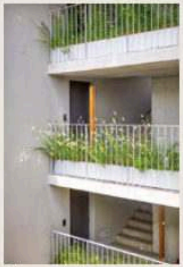
Basement dig across the whole lot: the soil, roots and seed bank go with it

B, SOME CARE

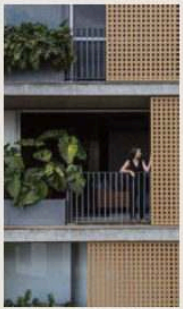
TODAY'S GOOD PRACTICE: PLANTERS ON THE BLOCK



Perforated screen carrying planter boxes on each floor



Planter balconies along the whole facade, watered by residents



Brick screen and large-leaf planting on every balcony

C, full care



Terraces stepping down, each roof a planted garden



Stepped section in diagram: green on every step



Stepped house with deep planter edges on every level



Casa Terrazas section: soil depth and trees on the terraces



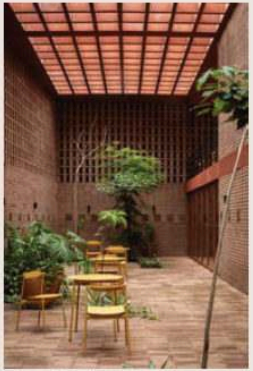
Raised planted roof walk around existing trees



A garden on the roof, trees in deep soil beside the house



Deck built around a trunk, the tree left standing



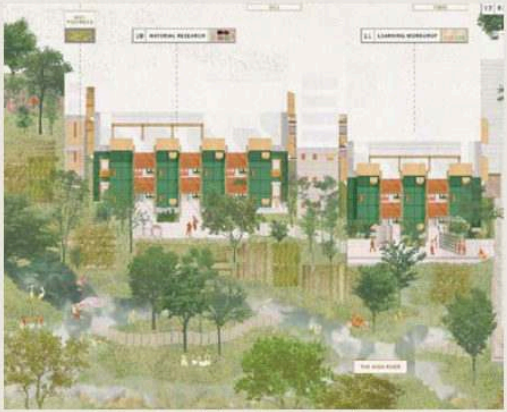
Shared brick courtyard under a timber pergola



Lifted on columns: the ground keeps running under the building



6a Tree House: the plan wraps an existing tree



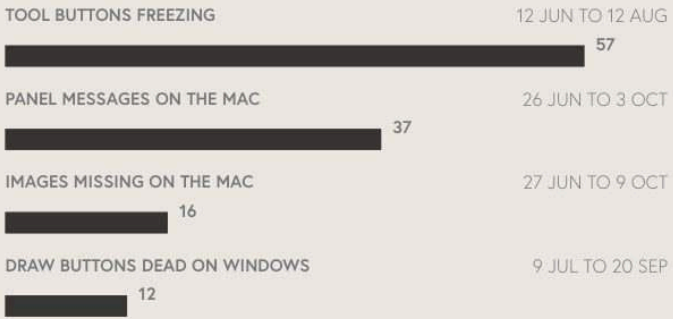
Drawing style: section with the planting named and drawn

What took longest to fix

MAC AND WINDOWS

Most of the time on the plugin did not go into features. It went into making the same code behave on a Mac and on Windows, inside a program that was never designed to host web pages and Python side by side. These are the problems that cost the most, ranked by how often the code had to be changed to fix them.

RANKED BY THE NUMBER OF CHANGES IT TOOK



Full set: appendix, page 412

TOOL BUTTONS FREEZING

Buttons froze when they retyped a command or asked for a point from inside a message. Fixed with one runner that waits until Rhino is idle.

PANEL MESSAGES ON THE MAC

Clicks in the panels were lost before they reached Python. On a Mac the only way out of the page is its title text, which holds about 1 KB and merges messages sent close together. Fixed with a queue that sends one message at a time and splits large ones.

AIM

A plugin that works the same on a Mac and on Windows, from the same code.

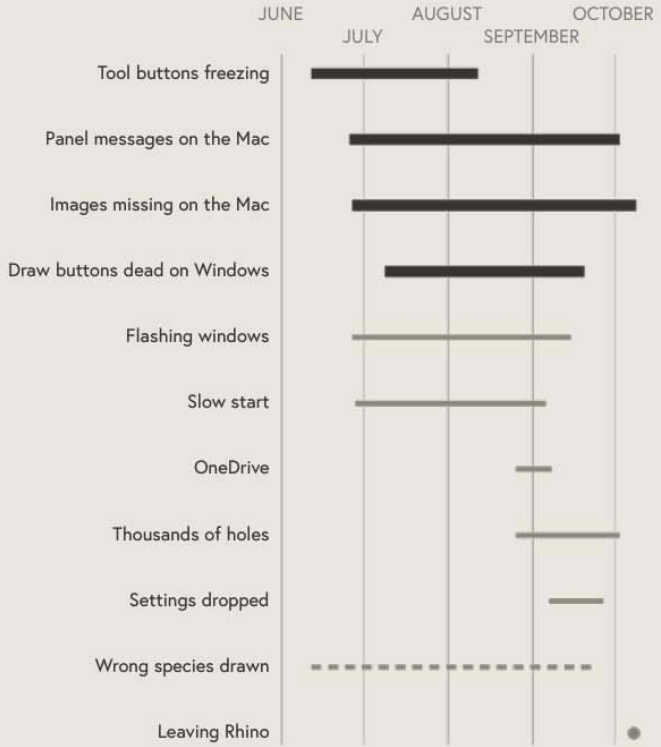
PROBLEM

Each platform failed in its own way, often silently, with no error to read.

OUTCOME

Rules written down after each fix, so the same mistake is not made twice.

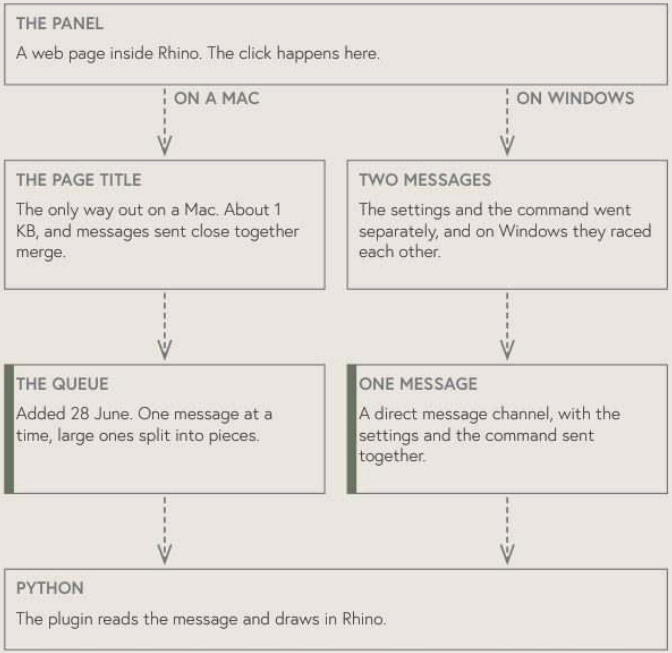
WHEN EACH WAS OPEN, JUNE TO OCTOBER



ELEVEN PROBLEMS ON ONE CALENDAR

The four that took the most changes in black. The start of "Wrong species drawn" was not recorded.

HOW A CLICK IN A PANEL REACHES PYTHON, ON A MAC AND ON WINDOWS



The two paths are two of the ranked problems: panel messages on the Mac, 37 changes, and draw buttons dead on Windows, 12 changes. The marked boxes are the fixes.

Limits

NOT YET TRUSTED ON ITS OWN

The tool cannot yet be trusted to read a site on its own. Checked against squares labelled by hand, the tree import scores an F1 of 64.9, against a target of 95. Many species records are marked indicative, and the disturbance figures are working defaults that have not been calibrated against monitoring data.

It was never tested with a community, or with the volunteers who look after Warwick. Whether the drawings make sense to them is the question the next stage has to answer.

The plugin was written with AI coding tools, and every figure in these pages was checked against its source. Next I would test it with a community group and replace the indicative records with measured ones.

ONE HAND-CHECKED 40 M SQUARE OF FREMANTLE

Every number on the score comes from squares like this one.



HOW THEY ARE COMPARED

The model's answer for this square, from a model that never trained on it. Green: kept, and a real tree. Red cross: kept, but not a tree. Cyan dashed: a real tree it dropped or no source found.

THIS SQUARE

The import now: 5 real trees kept, 1 false tree, 2 real trees missed. 83% of what it keeps is real; it finds 71% of the real trees.

The trained model: 3 real trees kept, 1 false tree, 4 real trees missed. 75% of what it keeps is real; it finds 43% of the real trees.

Precision = kept trees that are real. Recall = real trees that were kept. F1 combines both (out of 100). The site score adds up every checked square the same way; a model is never scored on a square it trained on.

The model's answer for one hand-checked square, the kind the F1 score adds up. How each square is checked: see page 161. Figure by Author.

Full set: appendix, page 413

WHAT IT STILL GETS WRONG, GATHERED FROM THE PAGES

Checking the trees, page 160

The test set is small, about 4 points of chance either way. The vision model is weak on bare winter trees and on bushland: at Cockburn it finds 38 per cent of real trees.

Green spaces, page 162

The target was 99 per cent and it is not met. At 1 m a mulch bed with small shrubs looks like sand, and colour alone cannot separate them.

Animal gouache, appendix page 345

Faults in the rig carry into the painting. The Christmas beetle reads as a smooth lump and the cockatoo crest is a stub, because both are missing on the model, not in the paint.

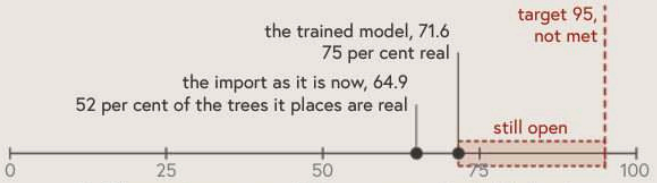
Nests and tree hollows, page 102

Every hollow is drawn as the same round hole, though the records give a wide entrance for the cockatoo and a spout or knot for the ringneck. Nests inside dense crowns, like the magpie's, are not drawn.

The feeding garden, page 104

Insects are drawn many times life size so that they read at all, and the quenda model stands too tall on straight legs.

WHAT IS SCORED, AND HOW FAR IT FALLS SHORT



WHAT IS NOT SCORED YET

Species records with gaps	no score
marked indicative in the plugin, not measured	
Disturbance	no score
uncalibrated defaults, not checked against monitoring data	
Use by people and a community	no score
never tested	

The one measure the tool is scored on, against its target, and what has no score yet. Figure by Author.

Mona McGraw 2082455

Answering the question

THE QUESTION

How can a community space be designed to earn its ecological footprint?

THE ANSWER

A community space earns its ecological footprint when what it took has come back. Before it is built it states what it will take, what that breaks and how long the ground is owed, then holds to it.

On Warwick the footprint takes ten plants and cuts the roots of nine more. Every species there is tied to others, and it breaks 40 of the 532 links between them. The site is held until year 94, when the last plant taken flowers again. With the building on pads 5 m east, it is released in year 79.

The answer is a footprint placed while it can move, and a restoration that outlasts the building. The architect draws the end first. The ground decides when the place has been earned.

WARWICK BUSHLAND



A spent banksia flower spike, Warwick Bushland. Photograph by Author.

Full set: appendix, page 413



YEAR 0
BEFORE

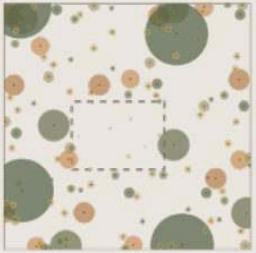
126 plants of ten species. 532 links between plants and animals.



YEAR 1
THE BUILDING GOES IN

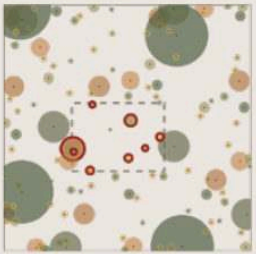
10 plants removed, 9 with roots cut. 40 links broken.

the building stands for fifty years



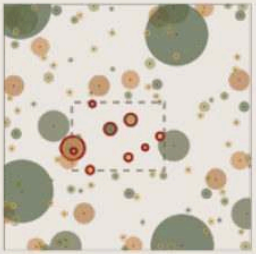
YEAR 50
TAKEN OUT, REPLANTED

The removed species go back in as seedlings.



YEAR 56
THE SLENDER BANKSIAS FLOWER

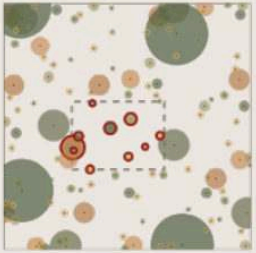
Western spinebill, western pygmy-possum, ants and weevils can return.



YEAR 79
THE ZAMIAS CONE

Emu, western rosella, common bronzewing, silvereye, western grey kangaroo, western brush wallaby, quokka, brushtail possum, chuditch and insects can return.

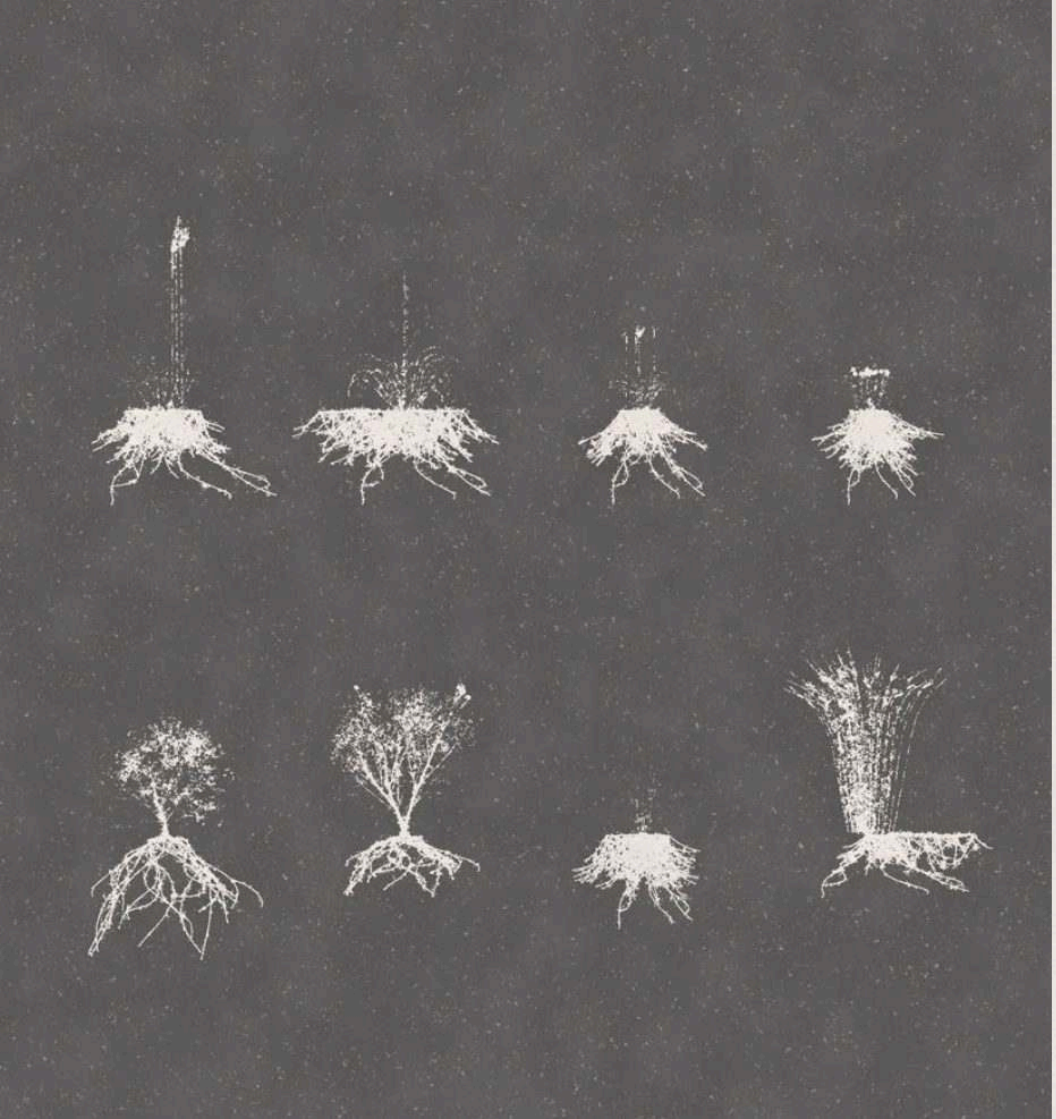
the site waits for its food sources



YEAR 94
THE GRASS TREES FLOWER

Honeyeaters, Carnaby's black-cockatoo, honey possum, native bees, black-cockatoos and quenda can return. The site is released.

The Warwick stand through one building's life and the years the site is owed after it. Figure by Author.



08

APPENDIX

IN THIS SECTION

Theoretical ground and sources
Conceptual proposal
Planting studies
Process, February to November
Full sets



Software implementations:

Models were manually modelled in Rhino 3D.

Plugins implemented: VisualARQ and RhinoLands

Models were then rendered in Autodesk Twinmotion and edited in Adobe Photoshop.

Interfaces designed in Figma and Framer, designs were then translated by Claude into functioning code based models.

Non author produced images were created completely by Copilot and/or Gemini Nanobanana through text prompting as well as through image layering processes.

Some texts written with the assistance of AI, implementing local LLMs (Qwen 2.5 and Qwen 3.8 27B) Claude, Codex and Perplexity's chat based responses.

"YOU'D BE LUCKY IF YOU GET A TENT"







While assembling a set of cards as a gift for my classmate Ren; whose thesis addresses crisis shelter, I was struck by a parallel I had not anticipated.

Ren's project confronts situations where people have no authority over their own conditions: you are dealt the cards and you go from there. The cards themselves hold this tension visually; idyllic landscapes sit beside scenes of fire and displacement, beauty alongside catastrophe, as though the same hand could deal either, and you would not know which until you turned it over.

The phrase Ren said, "you'd be lucky if you get a tent" caught my attention; it captures a reality in which architecture is not a choice but a circumstance, and the designer's control is an illusion.

This resonated with my own project more than I initially expected. The hat exercise that selected Warwick Bushland was a deliberate act of being dealt a card; surrendering the designer's preference for a site and accepting whatever arrived.

But the parallel runs deeper than method. If this project argues that a building must earn its ecological footprint, it also

The question of whether architecture can earn its place, rather than simply assuming it, draws on several intersecting lines of inquiry. This section reviews the theoretical positions and precedent projects that inform the thesis, organised around three argumentative threads, ecological obligation, designing from the ending, and adaptive negotiation.

Jeremy Till's Architecture Depends (2009) provides the foundational critique. **Till argues that architecture habitually positions itself as an autonomous discipline, exercising control over contingency in pursuit of formal resolution.** This autonomy is a fiction; buildings are always dependent on forces, social, economic, climatic or temporal, that exceed the architect's control (Till 2009, 48). When architecture ignores these dependencies, it arrives on site with an authority it has not earned. **This project takes Till's critique and extends it ecologically; if a building depends on its site for its existence, what does it owe that site in return?**

Robin Wall Kimmerer's Braiding Sweetgrass (2013) offers an answer grounded in Indigenous ecological knowledge. Kimmerer describes a relationship of reciprocity between humans and the living world, where taking is justified only by giving back (Kimmerer 2013, 183). **The concept of "earning" in this project borrows from that framing, that a building earns its ecological footprint not through a one-off offset but through ongoing, demonstrable contribution to the ecology it displaces.** Timothy Morton's Ecology Without Nature (2007) complicates this further by arguing that the very concept of "nature" as a separate domain is a construct that prevents meaningful ecological engagement (Morton 2007, 14). **If there is no pristine nature to protect, only an entangled mesh of relationships, then the building's obligation is not preservation but participation.**

Stewart Brand's How Buildings Learn (1994) demonstrated that buildings change fundamentally over time, and that the best buildings separate fast-changing elements from slow ones, what Brand calls "shearing layers" (Brand 1994, 13). Brand's concern is with the building's life; this project extends his temporal awareness to **the building's death, asking what conditions the building must create for the ecology that follows it.** Cedric Price's Fun Palace (1964) offers a more radical precedent. Price designed the Fun Palace as a structure in perpetual process, one that is never finished, always adapting, and designed from the outset to be dismantled. Price rejected the assumption that a building's value lies in its permanence, framing his creativity as sustained by a delight in the unknown (Mathews 2005, 81). The CTRL+Z studio's framing of architecture as duration rather than object draws directly on this lineage.

Ian Ritchie's Ghost Barn (2023) provides a contemporary precedent. The Ghost Barn reinstates a vanished agricultural building as a Corten mesh structure with no foundations, no columns, and no programme, just a form between architecture and absence (Ritchie 2024, 54). Ritchie invokes the Japanese concept of ma, essential emptiness, describing a space that gains substance from what it withholds rather than what it contains. This resonates with the current project's **refusal to fix the building's function in advance.**

Muf architecture/art's practice of working "with rather than for" communities informs the negotiation stance of this project. Rather than arriving with a predetermined programme, muf's method makes visible the competing claims on a site, holding space for unresolved tension as a productive condition (Muf 2001, 12). Jack Kirne's concept of "strays" adds a further dimension; those who exist outside dominant systems perceive



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FIGURE LIST

Figure 1. https://www.theverge.com/2024/6/18/24181166/sphero-bolt-plus-toy-programming-stem-robot

Figure 2. https://www.nist.gov/news-events/news/2020/11/using-lasers-save-lives

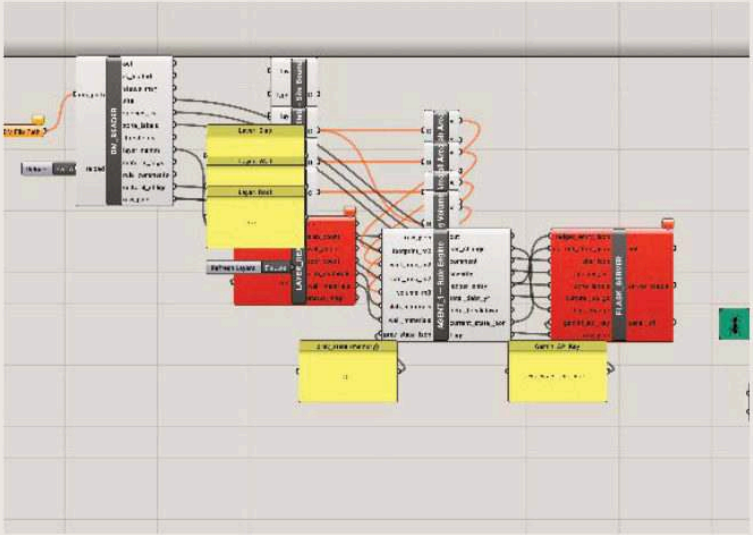
Figure 3. https://longwoodgardens.org/gardens/conservatory-district/green-wall

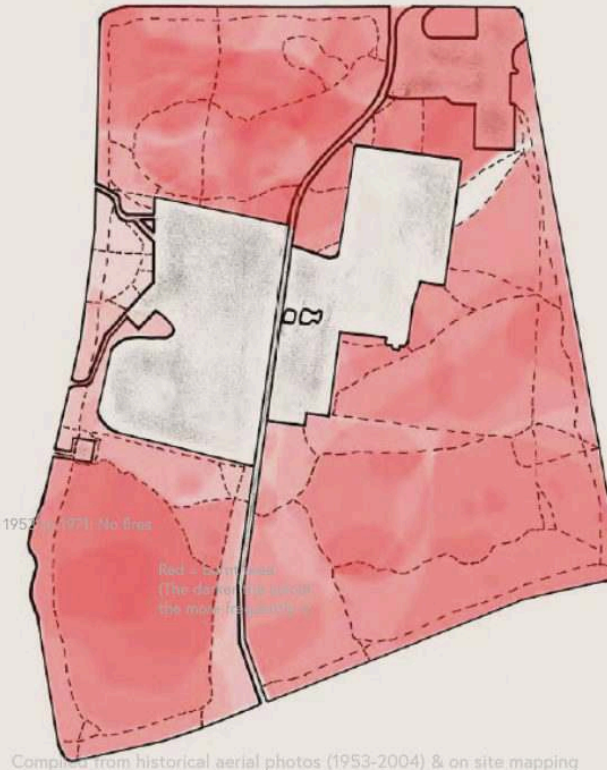
Figure 4. https://www.asla.org/universalgardens.aspx
Figure 5. https://www.apple.com/augmented-reality/
Figure 6. https://medium.com/design-bootcamp/liquid-glass-or-ux-mirage-what-wwdc25s-boldest-design-gets-right-and-worryingly-wrong-f7befa173b1f
Figure 7. https://www.google.com/url?sa=i&url=https%3A%2F%2Fpngtree.com%2Fso%2Fgreen-water-effect&psig=AOvVaw3lxMhFCMTNuiHycs9FzvB6&ust=1759914382877000&source=images&cd=vfe&opi=89978449&ved=0CBgQjhxqFwoTCJghJDekZADFQAAAAAdAAAAABAL
Figure 8. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.nbcnews.com%2Ftechnolog%2Fnew-robotic-ball-way-spheros-creator-ready-roll-next-big-6c10921794 Figure 9.&psig=AOvVaw0e46lK_9qeWEZWRwspHdjY&ust=1759914559809000&source=images&cd=vfe&opi=89978449&ved=0CBgQjhxqFwoTCLjwh-TekZADFQAAAAAdAAAAABAE
Figure 10. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.slashfilm.com%2F780660%2Fhow-the-jurassic-world-team-pulled-off-that-gyrosphere-scene%2F&psig=AOvVaw2nR23bpBeuYuOCuApe4-sg&ust=1759915143540000&source=images&cd=vfe&opi=89978449&ved=0CBgQjhxqFwoTCLD8ovngkZADFQAAAAAdAAAAABAi

Figure 11. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.dreamstime.com%2Ffigure-glowing-hands-reaches-out-to-two-rotating-spheres-made-interconnected-lines-dots-representing-figure-image326993800&psig=AOvVaw1k1nDik-kgoPSWNv3SJDUu&ust=1759915303341000&source=images&cd=vfe&opi=89978449&ved=0CBgQjhxqFwoTCKDT-cfhkZADFQAAAAAdAAAAABAE

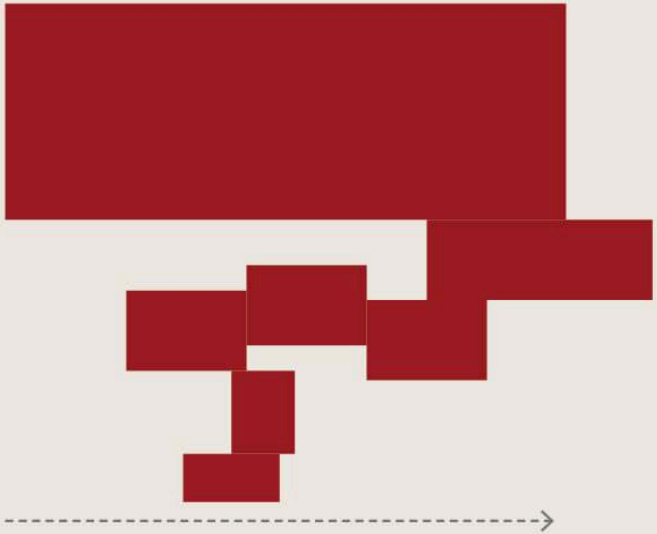
Figure 12. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.vecteezy.com%2Ffree-videos%2Fradar-scan&psig=AOvVaw3XUfIVKUpIDpFt99dIsjbU&ust=1759915513195000&source=images&cd=vfe&opi=89978449&ved=0CBgQjhxqFwoTCJiwkK_ikZADFQAAAAAdAAAAABAi

Figure 13. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.pinterest.





Compiled from historical aerial photos (1953-2004) & on site mapping (1999-2005)



Start with a single line, then build off of that, no undoing, no ctrl X

Six ways of planting

SIX ARRANGEMENTS, ONE PAGE

Scattered, clustered, linear, edge planting, dense mat and hedge or line, each drawn from the side and from above. None of them is ecologically neutral, so they are compared on one page.

The arrangement affects what grows between the plants as much as the choice of species does. A dense mat shades out weeds and the seedlings of everything else. A scatter leaves open ground, and open ground on Bassendean sand is where veldt grass gets in.

TEST

The six planting arrangements in 3D, built from the same layout engine the panel uses, to see what each one leaves between the plants.

FINDING

The dense mat only reached 2,216 plants at a spacing of 212 mm. At the stated 420 mm the engine gives 577.

CHANGE

A plant count is now checked against its own spacing before it is quoted.

IN PLAN



01 SCATTERED **02 CLUSTERED** **03 LINEAR**

Figure by Author.

Full set: appendix, page 413

THE SIX, FROM THE SIDE



01 SCATTERED

Even spacing with natural gaps.



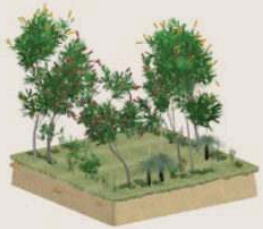
02 CLUSTERED

A few drifts, shared across species.



03 LINEAR

Rows along the long axis.



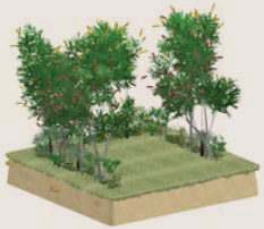
04 EDGE PLANTING

A band held against the boundary.



05 DENSE MAT

Close-packed on a hexagonal grid.



06 HEDGE OR LINE

Follows a curve the designer draws.

Host plants with and without their animals

RANKED BY THE ANIMALS THAT USE THEM

Each host plant stands on the same ground twice: once with the animals its record names, and once without it, where the same animals are ghosted because they have nothing left to use. The hosts are ranked by how many animals use them, and the animals are drawn larger than life so they can be read.

THE HOST USED BY THE MOST ANIMALS



WITH THE PLANT **WITHOUT IT**

Melaleuca preissiana. Mature height 9 m, roots to 0.7 m (lateral plate). Used by the Western Spinebill, New Holland Honeyeater, Blue-banded Bee, Australian Painted Lady, Christmas Beetle and Motorbike Frog.

ELEVEN HOSTS

6 animals use the moonah.

35 animal uses across the eleven hosts.

13 different animals.

READING THE PAIRS

The Moonah names the most and the Jointed Twig-rush names 1. Without the plant, the plot is bare and its animals are drawn as ghosts.

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Stock, William D., Hugh Finn, Jackson Parker, and Ken Dods. 2013. "Pine as Fast Food: Foraging Ecology of an Endangered Cockatoo in a Forestry Landscape." PLoS ONE 8 (4): e61145. https://doi.org/10.1371/journal.pone.0061145.

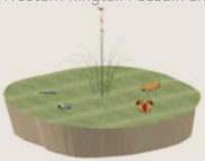
THE OTHER TEN, IN RANK ORDER: THE NEXT FOUR





WA PEPPERMINT, 5 ANIMALS

Agonis flexuosa. Used by the Blue-banded Bee, Australian Painted Lady, Christmas Beetle, Western Ringtail Possum and Carnaby's Black-Cockatoo.





COAST MAT-RUSH, 4 ANIMALS

Lomandra maritima. Used by the Blue-banded Bee, Australian Painted Lady, Christmas Beetle and Fence Skink.

TEST

Eleven host plants drawn with their animals and without them, on the same ground and at one scale.

FINDING

The eleven name 35 animal uses and 13 animals. The audit then found that Maritime Pine was missing from the library, although Carnaby's Black-Cockatoo feeds on it heavily on the Swan Coastal Plain (Stock et al. 2013).





WANDOO, 5 ANIMALS

Eucalyptus wandoo. Used by the Western Spinebill, New Holland Honeyeater, Carnaby's Black-Cockatoo, Australian Ringneck and Brushtail Possum.





PRICKLY COTTONHEAD, 3 ANIMALS

Conostylis aculeata. Used by the Blue-banded Bee, Christmas Beetle and Bull Ant.

CHANGE

Maritime Pine was added on 25 September carrying Carnaby's, so the cockatoo's food list now includes it.

Full set: appendix, page 414

Thirty plants at maturity

THIRTY PLANTS, KEYED

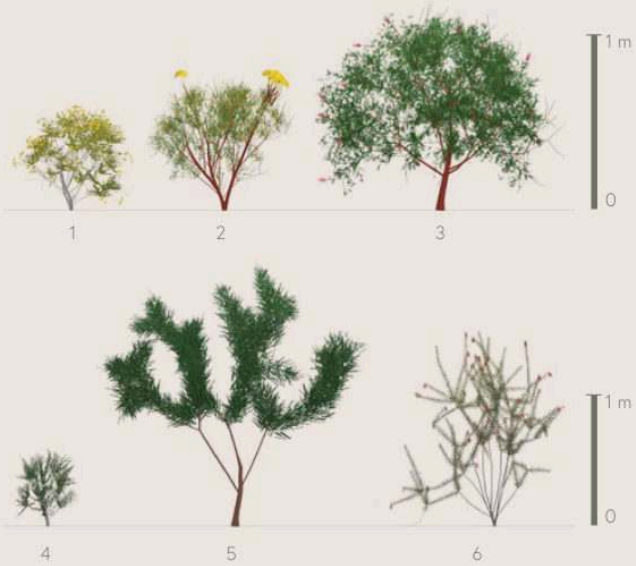
Thirty plants from the library, each drawn from the mature height recorded for it. The shortest is the Prickly Cottonhead at 0.3 m and the tallest is the Tuart at 30 m. The seven trees share one scale. Each row of shrubs or understorey is drawn as large as its page allows and carries its own scale bar, so heights compare within a row and against the bar, not across rows.

SEVEN TREES



1 Holly-leaved Banksia, 8 m
2 Swamp Paperbark, 8 m
3 Christmas Tree, 6 m
4 Sheoak, 12 m
5 Flooded Gum, 15 m
6 Native Willow, 5 m
7 Tuart, 30 m

SHRUBS, 1 TO 6



1 Yellow Buttercup, 0.6 m
2 Morrison's Featherflower, 0.8 m
3 Hummingbird Grevillea, 1.2 m
4 Pinkcups, 0.6 m
5 Common Astartea, 2 m
6 Silky-leaved Blood Flower, 1.5 m

TEST

Thirty plants from the library drawn at maturity, numbered and keyed, as a check on the set.

FINDING

The rows are drawn at three different scales. Measured against their records the trees sit within 5 per cent and the shrubs and understorey within 3 per cent; the grass tree's flower spike stands 73 per cent above its recorded height.

CHANGE

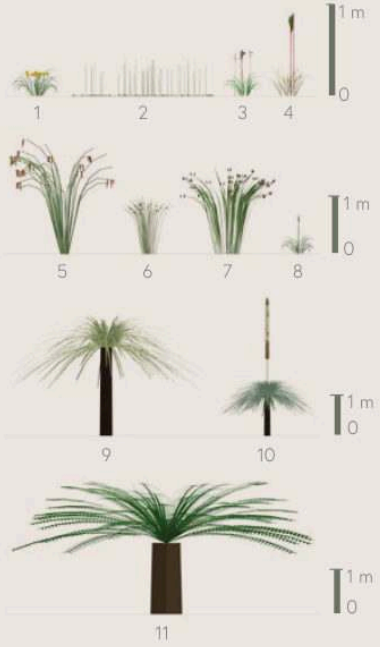
The title no longer claims one scale, each row carries its own scale bar, and every row was rendered again at the recorded heights.

KEY, UNDERSTOREY

1 Prickly Cottonhead, 0.3 m
2 Common Dampiera, 0.4 m
3 Purple Flag, 0.5 m
4 Red-and-green Kangaroo Paw, 0.9 m
5 Jointed Twig-rush, 2 m
6 Sea Rush, 1 m
7 Pithy Sword-sedge, 1.5 m
8 Blueberry Lily, 0.7 m

9 Kingia, 3 m
10 Grass Tree, 2 m
11 Fraser's Cycad, 3 m

ELEVEN OF THE UNDERSTOREY



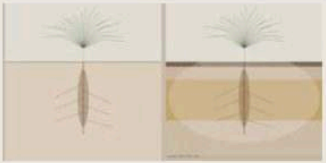
Shrubs 7 to 12: appendix. Figure by Author.

Beds, roots and range

STUDIES

These studies fed the pages before. They test how symbols sit together in a bed, whether a root drawing changes when the soil behind it is switched on, and where the species in the library come from.

In the soil test the roots stay the same and only the ground behind them changes, so a section can show the site's own horizons without redrawing the plant.

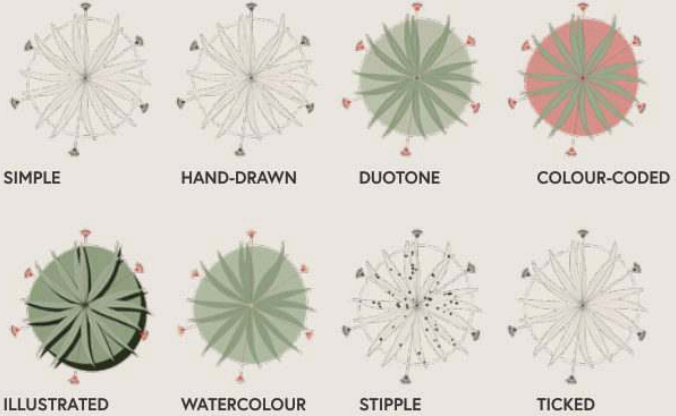


Roots without the soil, and with it. 29 June.



A planted row. 13 August.

ANIGOZANTHOS MANGLESII, EIGHT PLAN STYLES



WHERE THE SPECIES COME FROM

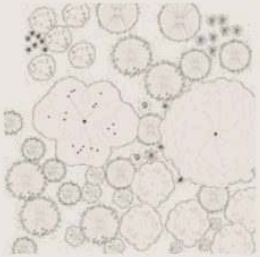


Where the library's species come from, cropped to the latitudes that carry plants. 10 September.

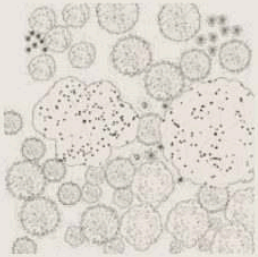
Full set: appendix, page 416

ONE BED, SIX PLAN STYLES

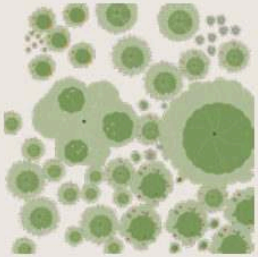
The same planting bed in six plan styles, from bare outlines to full crowns: trees over shrubs over grasses, drawn with the plugin's plan symbols.



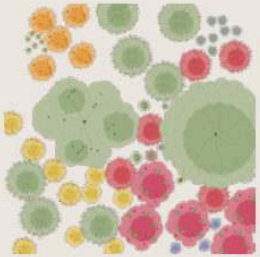
SIMPLE



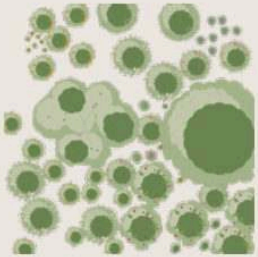
STIPPLE



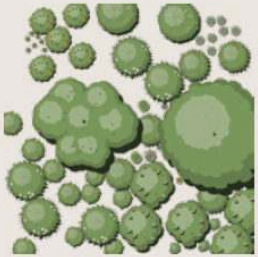
DUOTONE



COLOUR-CODED



WATERCOLOUR



ILLUSTRATED

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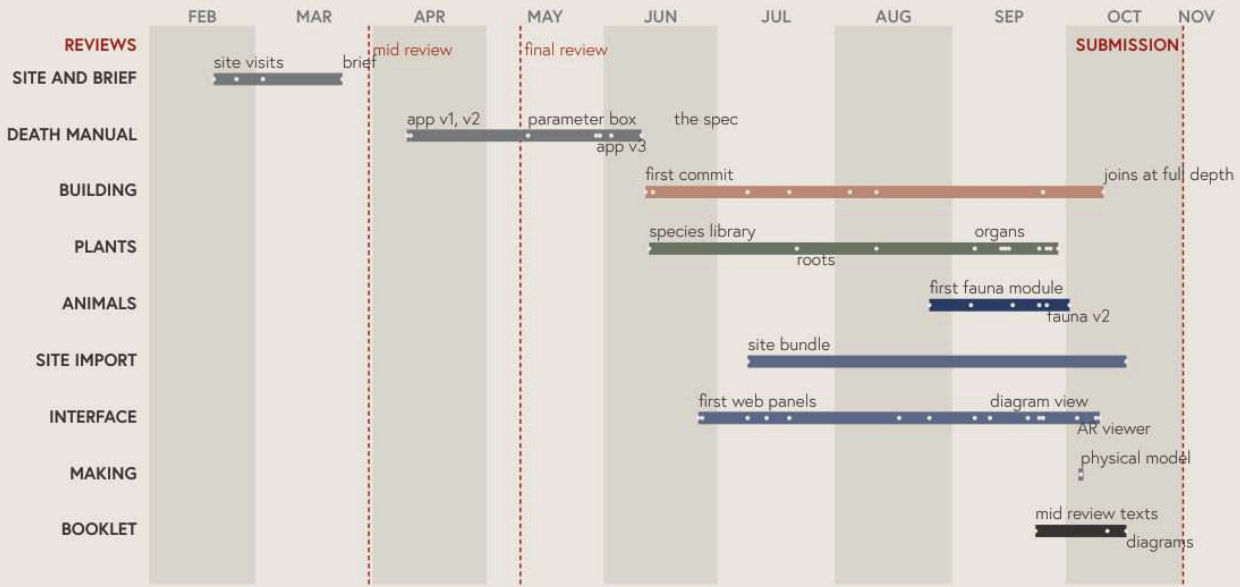
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Manuj Mishra 23823455

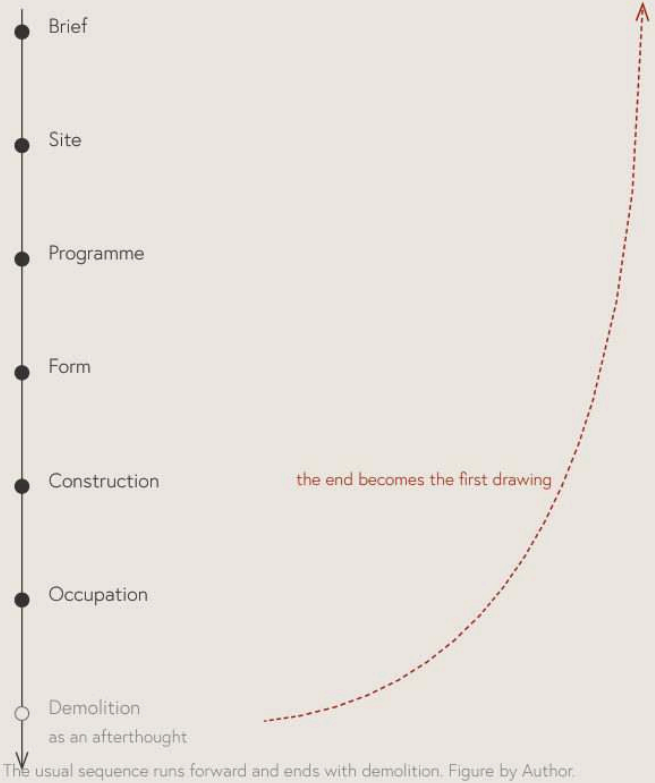
FEBRUARY TO NOVEMBER 2026

Process: the year



How long each part of the work ran, from its dated process pages; reviews in red. Figure by Author.

CONVENTIONAL PRACTICE RUNS FORWARD



The usual sequence runs forward and ends with demolition. Figure by Author.

THE DEATH MANUAL REVERSES THAT SEQUENCE



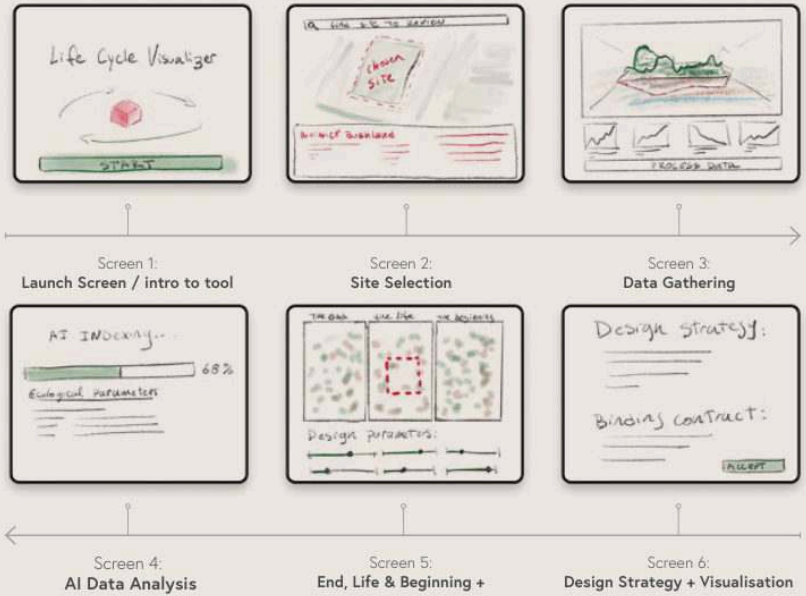
The Death Manual's three states, read from the end. They are three drawings held at once, and the order they are read in matters. Figure by Author.

LIFECYCLE VISUALISER: PROTOTYPING

The tool allows a designer to gather site-specific ecological data; species assemblages, soil profiles, groundwater depth, fire history, alongside architectural parameters such as footprint area, ground coverage ratio, foundation type, and material toxicity. **It then generates three comparative views: the site before intervention, the site during the building's life, and the site after the building's removal.** Each view is measured against the Death Manual's restoration targets.

The tool does not predict the future. It makes the ecological cost of design decisions visible in advance, so that the Death Manual's constraints become legible as spatial consequences rather than abstract policies.

Before any architectural input is accepted, the site must be surveyed, scanned, and read against the restoration protocol drafted for it. **The tool refuses to generate a design strategy until the site has spoken first.**



Screen 1:
Launch Screen / intro to tool

Screen 2:
Site Selection

Screen 3:
Data Gathering

Screen 4:
AI Data Analysis

Screen 5:
End, Life & Beginning +

Screen 6:
Design Strategy + Visualisation

INITIAL ECOLOGICAL PARAMETERS

What follows is a specification of what the tool measures, what data it ingests, and how those readings are translated into binding constraints any future proposal must answer to.

The thresholds shown here are illustrative. The tool re-derives them from the reference ecology of whichever site it is deployed on

SPECIES RICHNESS TARGET; Minimum native species count per 100m² required at post-decommissioning restoration, benchmarked against the nearest intact reference site. At Warwick, this is 67 species per 100m² (Gibson et al. 1994).

WEED LOAD CEILING; Maximum permitted introduced species per 100 m² quadrat, set against the intact reference condition for the site.

CANOPY COVER PRESERVATION; Minimum percentage of existing canopy retained within a defined buffer of the building footprint, sized to maintain overstorey continuity for the dominant species.

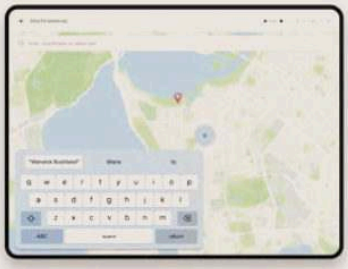
HYDROLOGICAL RETENTION; Minimum percentage of pervious surface within the development envelope, calibrated to sustain local recharge or runoff conditions appropriate to the site's hydrological context.

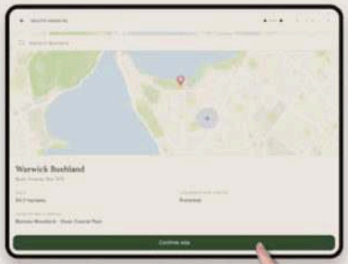
SOIL DISTURBANCE DEPTH; Maximum permitted excavation depth, set to protect the soil horizons, microbial networks, and root systems characteristic of the site's substrate. At Warwick, this threshold is set at 300 mm, a conservative design threshold



THE END: *Lifecycle Visualiser App*

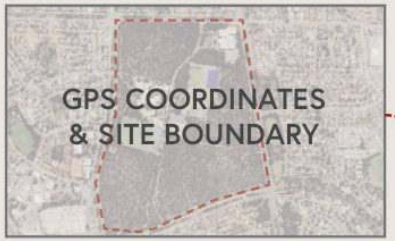


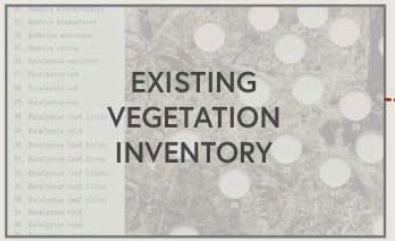


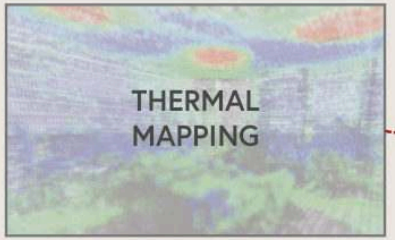


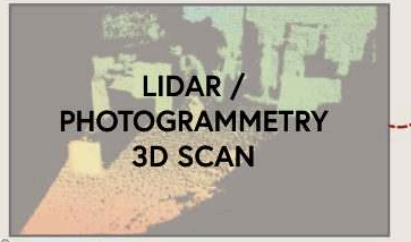












SOIL PROFILE SAMPLE

GROUNDWATER DEPTH READING

FIRE HISTORY OVERLAY

HYDROLOGICAL CONTEXT

ML

AI

GOOGLE ALPHA NETWORK

LIFECYCLE VISUALISER V1: DATA PROCESSING

The tool's intelligence is not in the interface. It is in what happens between the s
scan and the interactive panel the designer eventually sees. The diagram bel
traces that process, site data is drawn on seven layers of ground-truth data, gather
from a combination of remote sensing, and existing ecological inventories, as well
additional environmental support from Google's new GoogleAlpha project. Then t
is then passed through a Machine Learning unit that compiles the data and agains
fixed set of ecological parameters drawn from the Death Manual, then weighed by t
Artificial Intelligence against the site's measured capacity, and returned as a dynar
interface whose allowances shift in real time as the designer adjusts the proposal. T
designer does not decide alone. The ground is a silent second author at every step

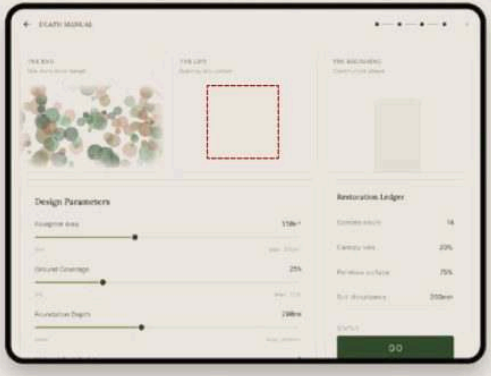
OUTPUT

1. **Three-panel dynamic interface** (End / Life / Beginning)
2. **Live parametric sliders** with allowances that tighten or loosen based on ecological capacity
3. **Restoration ledger;** a running tally of what the building takes and what it owes back
4. **Final Status;** Go / flag / refuse indicator against Death Manual thresholds

ECOLOGICAL PARAMETERS

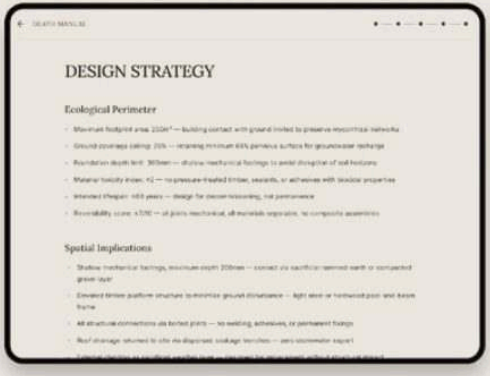
1. Species richness target
2. Weed load ceiling
3. Canopy cover preservation
4. Groundwater recharge
5. Soil disturbance depth

MACHINE LEARNING (ML) is a subset of artificial intelligence (AI) focused on building systems that learn patterns



The designer adjusts five architectural parameters.

Each slider is tethered to the restoration ledger on the right; move the footprint up and the species count drops in real time.

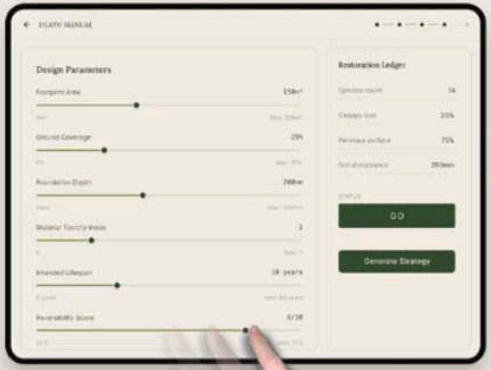


The output is not a design. It is an envelope of constraints. The building must fit

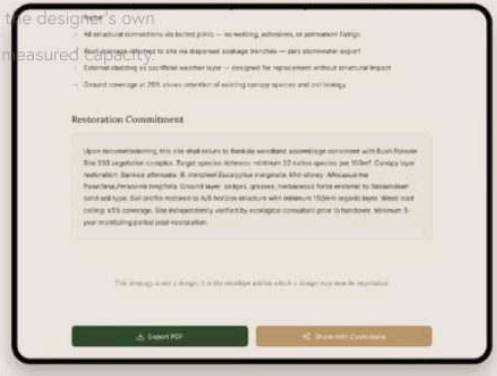
The tool's only visible output: three states held simultaneously, sliders that move together, a

The final output is a binding written commitment that sets target species, soil remediation protocol, canopy restoration density, monitoring period.

This is the Death Manual itself, generated from the designer's own inputs and the site's measured capacity.



Additional sliders like, Material Toxicity Index and Reversibility Score, force the designer to account for what the building leaves in the ground when it goes. A low reversibility score triggers a warning;



WHO IS THE TOOL FOR?

IF THE ECOLOGICAL COST OF A BUILDING IS VISIBLE BEFORE IT IS BUILT, WHAT EXCUSE REMAINS FOR BUILDING IT ANYWAY?

The goal of the Lifecycle Visualisation Tool is to produce something the discipline has not historically been required to look at; a measurable account of what a proposed building takes from its site and what it owes back. The data exists. The harder question is what is done with it.

If left on the designer's screen, the data becomes another tab in the consultant report. Read once, filed, ignored. The site loses what it was always going to lose, but now with better documentation. Knowing the cost is not the same as refusing to pay it.

Made public, and held by the bush carers, the neighbours, the council, the Whadjuk custodians; the same data changes what can be argued for. It does not need to compel anything by force. It only needs to remove the most common excuse for inaction, which is that nobody knew.

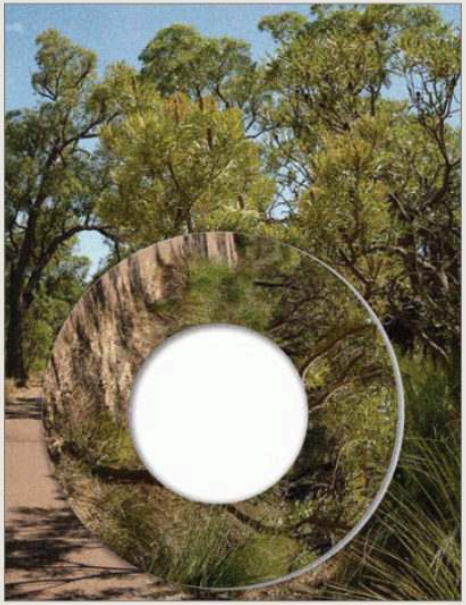
Once the cost of a square metre of banksia woodland is legible, the burden of justification shifts. The question stops being whether the ground can be afforded and starts being what has to be claimed to make losing it acceptable. Most of those claims do not survive being said out loud.

This tool is a work in progress.
Version 1: https://bottom-stone-59794565.figma.site
Version 2: https://zero-width-43153286.figma.site
Version 3: (not fully working) https://www.figma.com/proto/6MWvJoJtlcYvv9oyDcGJGP/thesis-app-v1?node-id=1-784&viewport=1896%2C805%2C0.35&t=DDm8Mf6ZCmbB4h5f-1&scaling=contain&content-scaling=responsive&starting-point-node-id=1%3A784&page-id=0%3A1



Notes

- What happens with this data?
- Who holds the Manual after the building is built?
- Do we need to "make"/oblige the users to do what's best for the site?
  or just let them make some "quick money" out of their immediate necessity and ruin the site and its cycle?
- What if the developer ignores it; is it advisory, or binding?
- Can the tool refuse to generate a plan that fails the ledger?
- Is the volunteer bush carer the auditor?
- Who pays for the audit?
- Do we trust the people who benefit from the answer to ask the question?



This collage shows that a small, deliberate absence or change can completely reorient the way an ecology is seen, understood, and valued. What was background becomes foreground. What was taken for granted becomes the subject.

A small subtraction reorganises an entire visual field. Drawing on Theaster Gates's practice of using voids and removals as generative acts, not losses but reframings that force the viewer to reconstruct meaning around what is missing (Ritchie 2024, 53). Here, the void does not destroy the image; it redirects attention to its edges.

Figure by Author, based on/remixed: Unidentified artist, I've Got a

LIFECYCLE VISUALISER WEB APP V4
SITE AND CONTEXT ANALYSIS.

The conventional site and context analysis documents existing conditions through static drawings, aerial photographs, and written description. This project substitutes the Lifecycle Visualiser, a web-based tool drawing on Atlas of Living Australia species occurrence data and published conservation inventories for Bush Forever Site 303.

Rather than describing the site, the Visualiser gathers the site's ecological data and renders it as a set of active parameters, each calibrated against published conservation thresholds. The condition this analysis defines is not context. It is obligation. To read the site is to incur a debt. The analysis and the design brief are produced simultaneously by the same instrument (Kimmerer 2013, 382).

Every AI call in the application receives site name and site area as context so the model knows it is responding to a specific, named place. This prevents the model from producing generic ecological language that could apply to any remnant anywhere. The ecological parameters returned are not a template. They are this site's conditions, derived from its own data.







```
Site data fields written into every LLM call:

site_name           → string, geocoded from user search
site_coordinates    → [lat, lng], from map click / geocoder result
site_polygon        → GeoJSON polygon, drawn by user on map
site_area_ha        → float, calculated from polygon geometry
map_style           → "outdoors-v12" (default) or "satellite-v9"
```

Manu Molina 20821456

FEBRUARY TO MAY 2026

Semester one: the Death Manual as an app

In Semester 1 the Death Manual became an iPad app. It had three columns, the End, the Life and the Beginning, with sliders for footprint, coverage, depth, toxicity and lifespan. It went through three working versions between April and May before it moved into Rhino.

AIM

An app a community could use to see what a building takes from Warwick Bushland before it is designed.

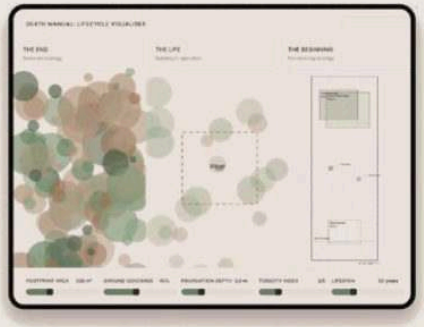
PROBLEM

The app could show the numbers but could not draw the building. Nothing it made could be built from.

OUTCOME

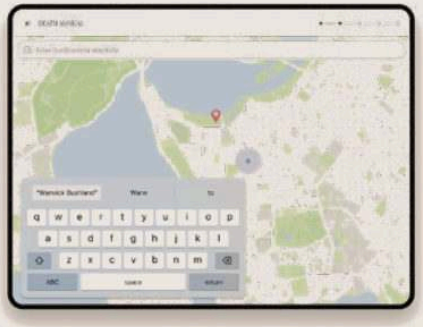
A plugin inside the drawing software, so the numbers sit on the model that gets built.

THE IPAD MOCKUP, 31 MARCH, AND THE SITE SEARCH, 9 APRIL



31 MARCH

The iPad mock-up of the Lifecycle Visualiser, one column for each state of the Death Manual. Figure by Author.



9 APRIL

The site search, typing Warwick Bushland.

WHAT HAPPENED IN SEMESTER 1

18 FEB TO 3 MAR | THE SITE

The site chosen by drawing from a hat, then 325 site photographs at Warwick.

24 FEB | FIRE CARDS

A deck of bushfire playing cards, the first exercise.

24 MAR | THE BRIEF

The CTRL+Z studio brief and the reading and making plan.

31 MAR | MID REVIEW

The A1 presentation and the iPad mockup.

10 TO 11 APR | APP V1 AND V2

Built in Figma Make and published as two figma.site versions. Mortality maps of the site for 2002, 2017 and 2025.

10 MAY | FINAL REVIEW

The A2 project proposal, then the A3 panels on 13 May.

30 MAY | APP V3

A React web app with Mapbox, checking a design against the Death Manual thresholds.

31 MAY | THE FIRST RHINO LINK

Grasshopper Python nodes talking to a Flask server, with the Warwick site data.

THE RESTORATION LEDGER OF VERSION 3, ALL SIX PASSED

Footprint area	150 m²
Ground coverage	25%
Fire regime	7/10
Canopy restoration	65%
Weed load	3 sp/100 m²
Soil disturbance	200 mm

ECOLOGICAL SCORE



30 MAY
Version 3 scored this design 65, on the go line; 42 is the flag line. Cropped from the app screen.

COOL DATA... NOW WHAT?

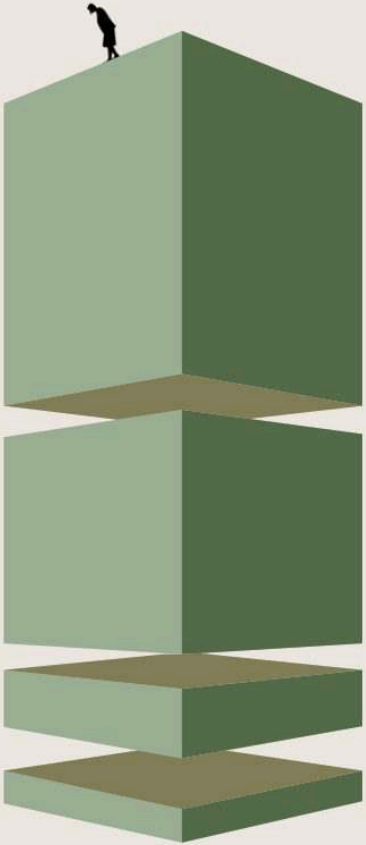
Yes, collecting ecological data produces great information.

But while that information can be very helpful, it can also be easily discarded or dismissed right after the site analysis, going into the design stage.

So why not find a way to carry this data into the design stage? A way to make sure these guidelines are being followed throughout the entirety of the building's cycle, from the very beginning.

What happens when all of that data enters the design workflow: does it advise the designer, or does it bind them?

These questions lead to the idea of creating a full experience from start to end, not just for the designer but for every user of the building throughout its lifetime.





The End Lifecycle Visualiser

Starting with the Lifecycle Visualiser, which compiles all of the chosen site's data, applicable parameters, and guidelines, the user then has the ability to export this data as a file to be imported into a Design Companion

Design Companion

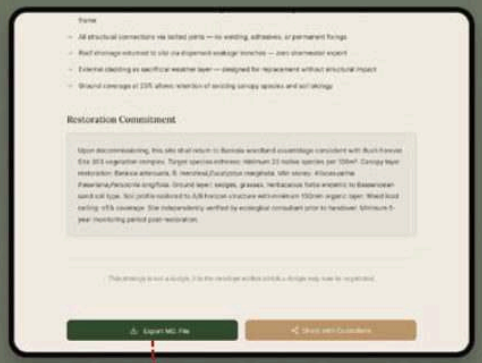
For now this companion is a Grasshopper definition within Rhino that connects to a web interface. Eventually the intention is to make a Rhino plugin available for anyone to implement in their own design stage. This interface helps the designer merge pure data with visual data when it most matters: the design process.

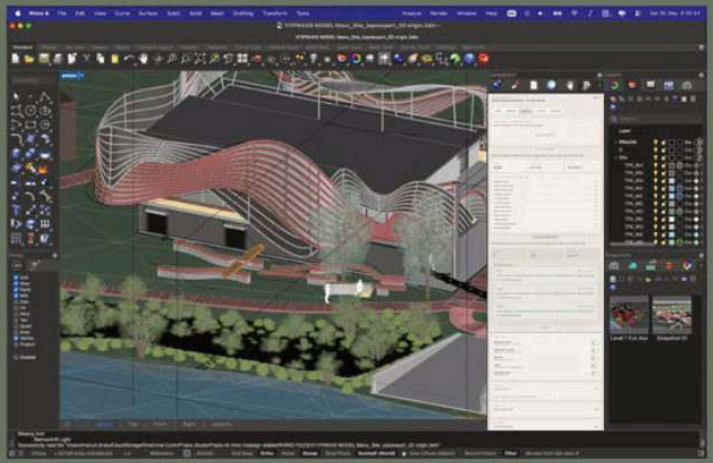
The Life

This integration is a live showcase of the constant negotiation the building has with its site. It does not stop after the building has been built. Users can visualise the debts the construction still holds against the site. It auto-updates the lifecycle of the building and its life expectancy; since 100% prediction is impossible, but this tool would help to close the gaps between the initiation of the building and its

The Beginning This is the set of tools tailored for the building's decommissioning: the end of the cycle that brings the site back to its beginning.

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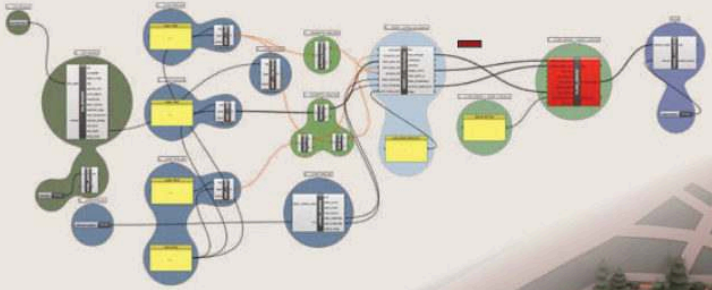




DESIGN COMPANION

FROM INFORMATION TO OBLIGATION

The Grasshopper (GH) canvas and the Rhino model together are where that sequence becomes operative. Data about the site does not sit as reference material. It is computed into the ledger in real time, and when a threshold is crossed, the decision is recorded and stays there.





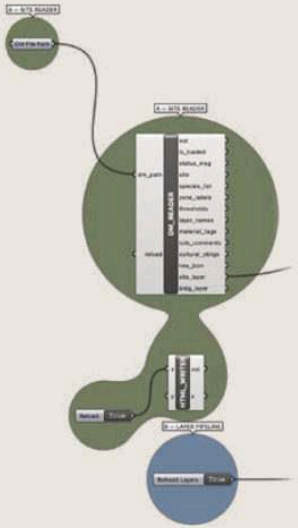
DESIGN COMPANION

RHINO IN BROWSER PANEL

The Design Companion is the architectural design tool built into the ecological framework. It runs (for now) as a browser panel inside Rhino, served from a local Flask instance (eventually it will run natively in Rhino), with a live connection to the Grasshopper canvas. Every time the model recomputes, the companion updates.

The relationship between the two is not advisory. Grasshopper reads the geometry, that the user inputs through a layers system, which allows Grasshopper to understand what's what in the viewport, boundaries, topography, geometries and assemblies.

Once the site is established, the GH definition calls the Atlas of Living Australia API using the site centroid as a query origin, runs intersection tests between the building footprint and the mapped ecology, and computes the ledger values.





PARAMETERS & AUTOMATION

RHINO BROWSER PANEL

The companion operates with a two-agent architecture. Both agents share the same site and Death Manual context but serve different moments in the workflow (Till 2009, 140, Dunne and Raby 2013, 35).

Agent 1 LEDGER (LLM)
Is the ecological auditor. It fires automatically every time the Grasshopper canvas recomputes. It reads the current ledger values, checks them against the Death Manual's thresholds, and returns a plain-language audit: footprint size, species in displacement zone, restoration debt in growing seasons, binding flag status. It does not offer suggestions. It reports consequences.

```
footprint_m2_current          → float, computed from Rhino Slab
layer area
ground_coverage_pct           → float, slab / site area ratio
canopy_area_m2               → float, computed from Vegetation layer
foundation_depth_mm              → float, from structural layer
attribute
weed_zone_intersect_pct     → float, footprint overlap with mapped
weed zones
soil_disturbance_area_m2     → float, excavation extent from Rhino
geometry

restoration_debt_score       → float, 0–100, computed in GH Python
  formula: negative params reduce score, positive params increase
it,
          with canopy and fire multipliers applied

ledger_log[]                 → array of timestamped decision objects
  each entry: { timestamp, parameter_changed, old_value, new_value,
                score_delta, binding_flag }
  binding_flag = true if change crosses a floor threshold
```

Any decision that moves a parameter across a floor threshold is flagged as binding. It stays in the ledger permanently. It cannot be undone without explicit acknowledgement. This is the anti-offsetting logic of the project: once you have crossed the line, the crossing is on the record (Kimmerer 2013, 9).

Agent 2 SPECIES
The live inquiry agent, running on Gemini Flash for more open-ended responses. It can be asked about site ecology, design decisions, or restoration obligations. It knows the site by name. It knows the Death Manual's thresholds. It does not answer in generalities.

External API data
API: Atlas of Living Australia (ALA) occurrence records
Endpoint: https://biocache-ws.ala.org.au/ws/occurrences/search

Parameters sent to ALA:

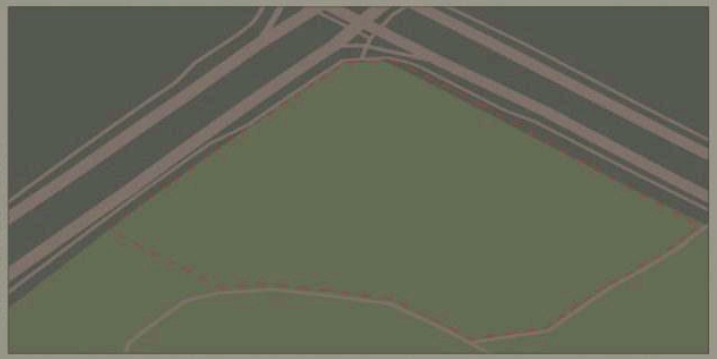
```
lat                    → site centroid latitude (from Rhino site
boundary layer)
lng                  → site centroid longitude
radius_km             → computed from site area (sqrt(area/π) as
approximation)
group_by             → "species"
```

EXISTING VEGETATION

AUTOMATIC PLACING AND VISUALISATION

Species occurrence data pulled from the Atlas of Living Australia gives the companion a list of what is present on site. That list becomes the source for a **procedural tree library inside Grasshopper**, **each species gets its own geometry, parameterised to a range of crown spreads and growth stages.** The library is not a collection of generic tree shapes. It is rebuilt from the occurrence data for each project run, it is this site's true vegetation, not a placeholder for vegetation in general.

Placement is automatic. A Grasshopper component reads the canopy density estimates from the survey data, distributes tree instances across the site boundary layer, and populates the Rhino viewport without any hand-placement. **What appears in the 3D view is a computed output of the ecological record.**

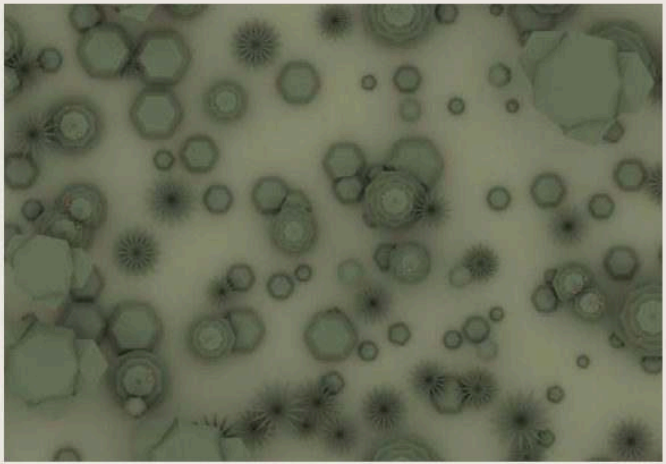




AUTOMATIC VEGETATION PLAN



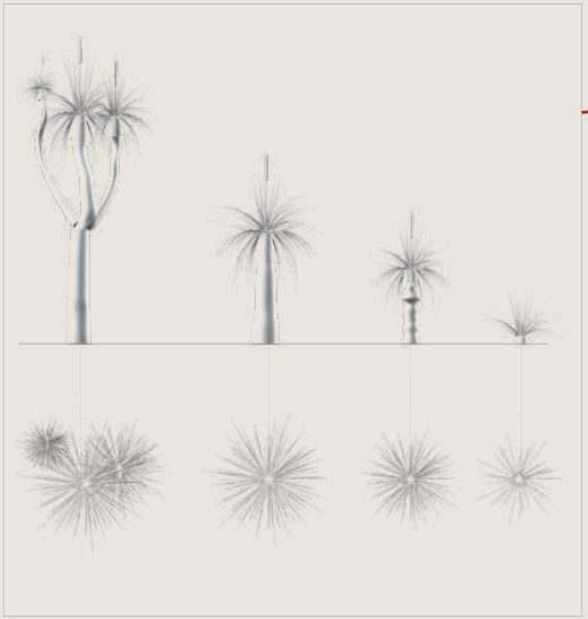
PROCEDURAL GROWING VEGETATION



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The procedural vegetation library began with hand-modelled geometry. The Grasshopper definition reads these geometries from a referenced library, matches them to species occurrence records from the Atlas of Living Australia, and places instances procedurally across the site boundary layer using a distribution weighted by canopy density estimates.

This example of Xanthorrhoea component is parameterised by caudex height, crown radius, and leaf count, with each variable driven by a normalised growth stage input (0–1). The script below generates the base geometry for a single Xanthorrhoea preissii instance. This is replicated for all species in the live library when they need to computed into the viewport, grasshopper created a visual representation of each species from a base code that auto-generates itself according to preset set internal parameters



```
import rhinoscriptsyntax as rs
import random
import math

def generate_xanthorrhoea(ori-
gin, growth_stage, seed=None):
    """
    Generates a Xanthorrhoea
preissii geometry.
    growth_stage: 0.0 (juve-
nile) to 1.0 (mature)
    origin: Rhino Point3d
    """
    if seed:
        random.seed(seed)

    # Trunk parameters
    trunk_height = 0.1 +
(growth_stage * 2.8)   # 0.1m
juvenile to 2.9m mature
    trunk_radius  = 0.05 +
(growth_stage * 0.15)

    # Crown parameters
    leaf_count    = int(80 +
(growth_stage * 120))   # 80
juvenile to 200 mature
    leaf_length   = 0.4 +
(growth_stage * 1.2)
    crown_spread  = 0.3 +
(growth_stage * 1.1)

    geometries = []

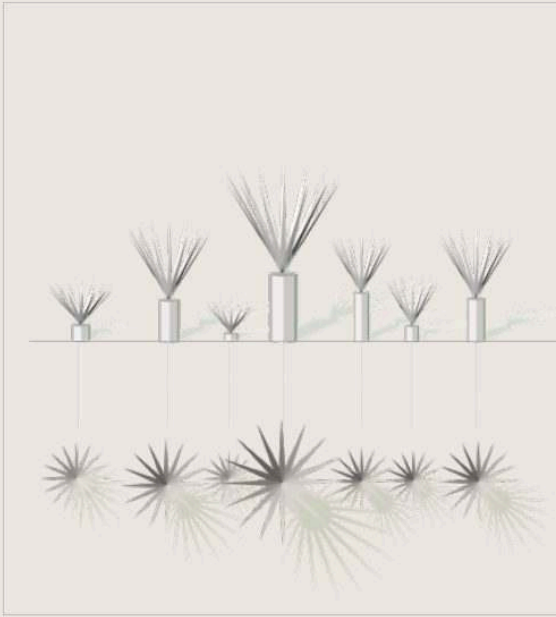
    # Trunk
    trunk_base = origin
    trunk_top  = rs.PointAdd(-
origin, [0, 0, trunk_height])
    trunk = rs.AddCylinder(
        rs.PlaneFromNor-
mal(trunk_base, [0, 0, 1]),
        trunk_height,
        trunk_radius
    )
    geometries.append(trunk)

    # Leaves
    for i in range(leaf_
count):
        angle  = (2 * math.pi
* i) / leaf_count
        angle += random.uni-
form(-0.05, 0.05)
        droop  = random.uni-
form(0.3, 0.5)

        leaf_start = trunk_top
        leaf_mid   =
rs.PointAdd(trunk_top, [
            math.cos(angle) *
crown_spread * 0.6,
            math.sin(angle) *
crown_spread * 0.6,
            leaf_length * 0.3
        ])
        leaf_end   =
rs.PointAdd(trunk_top, [
            math.cos(angle) *
crown_spread,
            math.sin(angle) *
crown_spread,
            -(leaf_length *
droop)
        ])

        leaf_curve = rs.Ad-
dCurve([leaf_start, leaf_mid,
leaf_end], 3)
        geometries.append(-
leaf_curve)

    return geometries
```



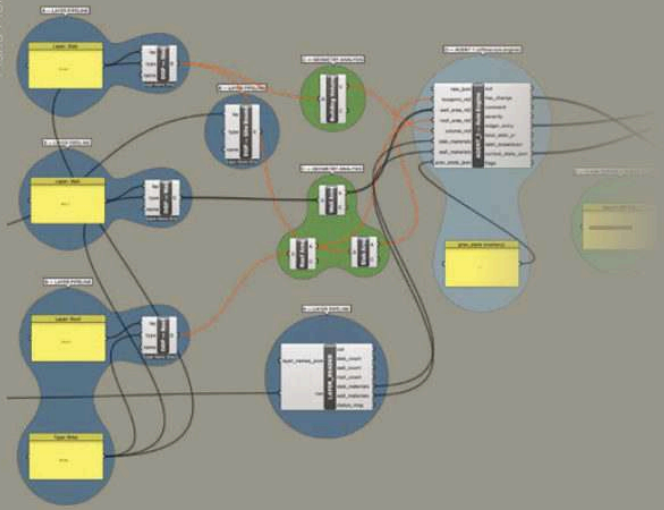
ARCHITECTURE DESIGN

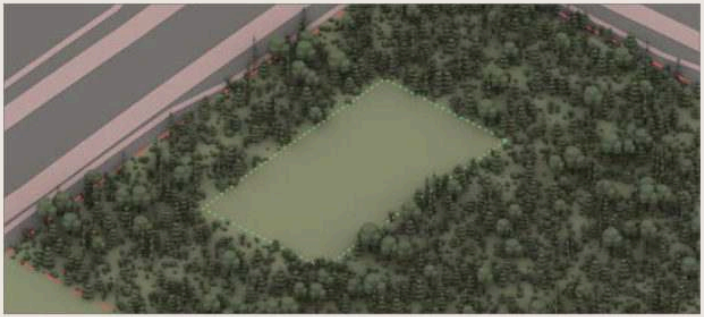
READING OF GEOMETRY AND ASSEMBLIES

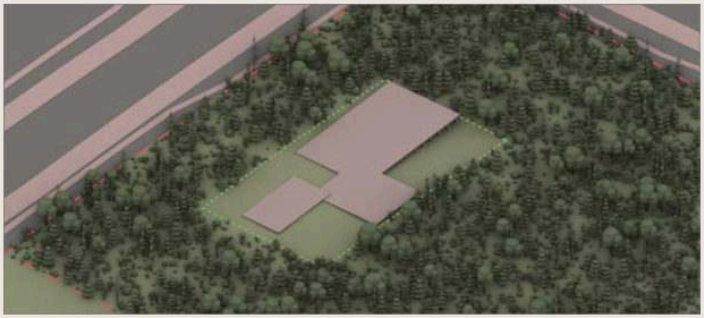
The companion draws on several simultaneous data layers that do not all originate from the same source. Site boundary geometry comes from a named Rhino layer. Building element geometries, slab, walls, roof, planting zones, come from separate named layers parsed by the Grasshopper canvas. Ecological occurrence data is pulled live from the Atlas of Living Australia API. Weed zone polygons are read from a GIS-sourced layer mapped into the Rhino coordinate system.

Each layer feeds a different part of the computation. None of them communicate directly. Grasshopper is the interpreter. It reads the geometries, calls the external API, runs the intersection tests, and computes the ledger values. **A single move of the building footprint in Rhino can simultaneously update the footprint area, the at-risk species count, and the weed zone intersection percentage.**











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AN EXPANDED LEDGER:

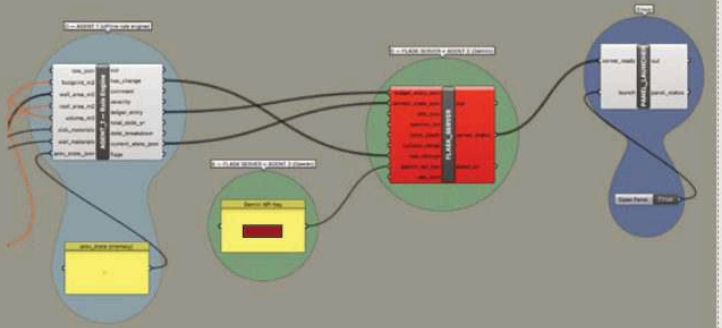
THE FULL PARAMETER SET

The six parameters of the physical tray system were a starting point. As the Design Companion developed, it became clear that the initial set measured ecological impact but did not measure the building's temporal relationship to that impact, its material legacy, or the governance conditions that would determine whether the Death Manual was ever honoured. The parameter set expanded across four categories.

ECOLOGICAL PARAMETERS

Groundwater Recharge and Footprint Area are the most directly coupled; every additional square metre of impervious surface is a measurable subtraction from the Gnangara Mound's recharge capacity. But Canopy Cover is implicated too, because trees transpire, draw water upward, and regulate the moisture balance across the sand profile. Reduce the canopy and the hydrological conditions that understorey species depend on begin to shift, which means Weed Load increases as native species lose competitive advantage, which in turn reduces Soil Carbon Return as the organic layer thins. Fire Regime Alignment sits across all of them: banksia woodland without appropriate fire becomes senescent, canopy density drops, understorey species fail to regenerate, and the mycorrhizal networks that connect root systems across the site are progressively isolated.

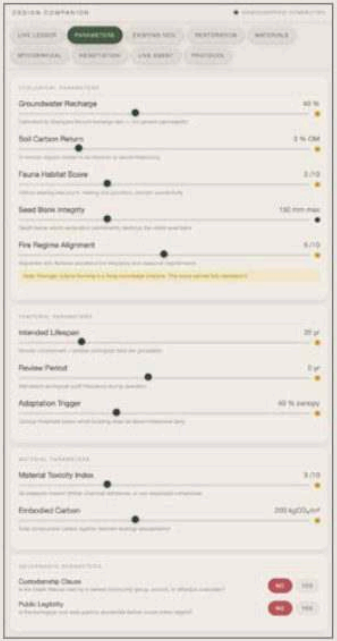
What this means in practice is that a designer who optimises for one parameter while ignoring the others does not achieve a partial improvement. They disrupt the system. A shallow footprint that leaves canopy intact but prevents fire regime alignment does not earn ecological credit; it delays the cost. The ledger is designed to make this interdependence visible. A parameter falling below its floor threshold does not simply reduce the score. It raises a binding flag; that the consequence of this decision is on



TEMPORAL PARAMETERS place the building in time. Intended Lifespan governs the scale of ecolog debt per generation; a shorter commitment means a smaller debt accruing to any one building cy Review Period mandates a 5-year ecological audit frequency during operation. Adaptation Trig sets the canopy threshold below which the building must be decommissioned early, regardless of original lifespan commitment.

MATERIAL PARAMETERS quantify what the building deposits in the ground. Material Toxicity In flags pressure-treated timber, chemical adhesives, and non-separable composites as binding violati Embodied Carbon, currently at 200 $kgCO_2/m^2$, is weighed against the restored ecology's sequestra potential; the building must not emit more carbon in construction than the restored woodland sequester across the monitoring period.

GOVERNANCE PARAMETERS are binary. Custodianship Clause asks whether the Death Manu held by a named community group, council, or Whadjuk custodian. Public Legibility asks whether ecological cost data is publicly accessible before construction begins. Both are currently set to No.



Visit this link for a demo of the UI (not connected to Grasshopper nor API, demo data from Warwick used. https://manu-thesis.framer.website/live-demo

MATERIAL CONSEQUENCES:
WHAT THE BUILDING LEAVES BEHIND

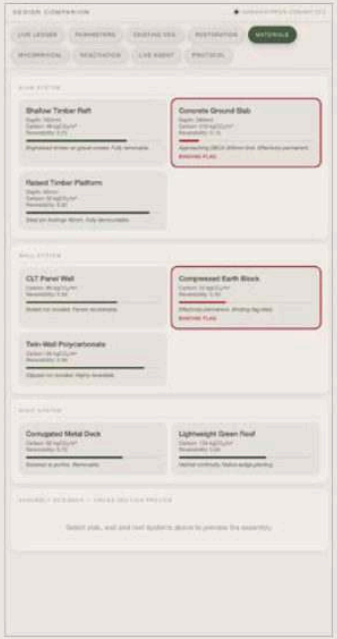
What the building leaves in the ground is not only a question of material toxicity. It is a question of what the ground was doing before the building arrived, and what it will need to do again after the building is gone.

The material system of the Death Manual is calibrated to this. Shallow footings are specified not because they are structurally minimal but because the most biologically active zone of the Bassendean sand profile sits in the upper 300mm.

Mechanical connections are required not for ease of disassembly alone but because adhesives and chemical anchors introduce compounds that persist in the sand column long after the structure above them is removed.

The material toxicity index flags these compounds as binding violations precisely because they are not recoverable by the same ecological processes that can restore canopy, seed bank, and weed load over time.

What lies beneath the footprint is an extense root architecture of the banksia woodland, proteoid clusters, sinker roots, nitrogen-fixing nodules, lateral surface mats ; structures the underground ecology that no planting plan can rebuild within a human construction timeline. The 300mm threshold exists to protect that architecture. The material choices exist to ensure that when the building leaves, it leaves that architecture with a chance.





THE MYCORRHIZAL NETWORK

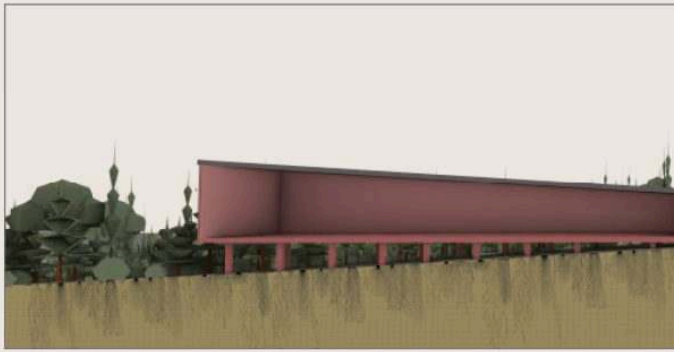
WHAT FOOTPRINTS INTERRUPT

The Mycorrhizal tab visualises the one thing that cannot be seen from above.

Beneath the site, the banksia woodland is threaded by fungal networks connecting root systems across the reserve. These networks facilitate nutrient transfer, water sharing, and stress response communication between plants. **When a foundation is placed, it does not just remove the soil beneath the building. It severs the network threads passing through that zone, isolating sections of the woodland from each other.**

The network map updates in real time as the footprint is repositioned in Rhino. At the current configuration, a disturbance depth of 185mm across 259m² interrupts the network across that area while leaving 65 hectares of intact woodland unaffected. The figure 185mm is within the 300mm threshold but is not cause for complacency, mycorrhizal networks in Bassendean sand are densest in the upper 150-200mm of the profile, meaning this depth already reaches the most biologically active zone.

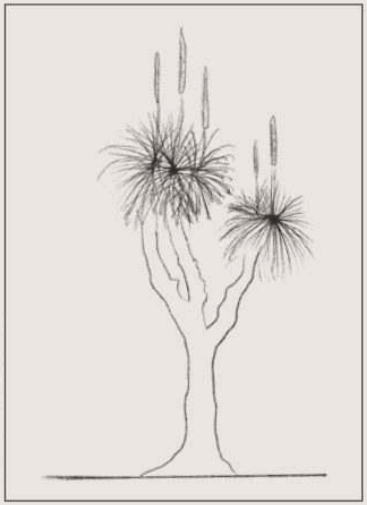


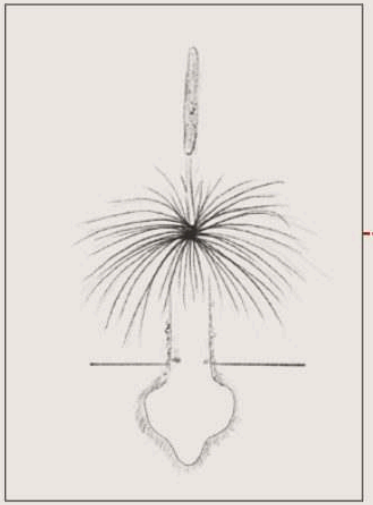




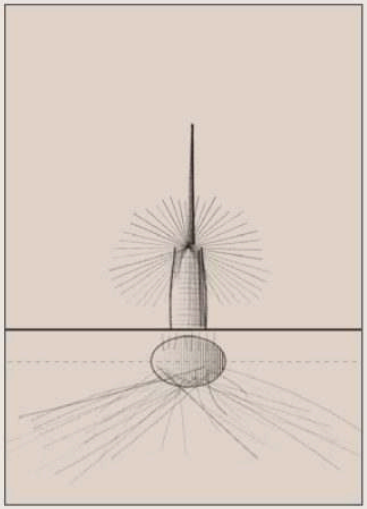
VEGETATION AND THEIR ROOTS VISUALISATION

FROM REAL SKETCH, TO GENERATED SKETCH, TO 3D MODEL









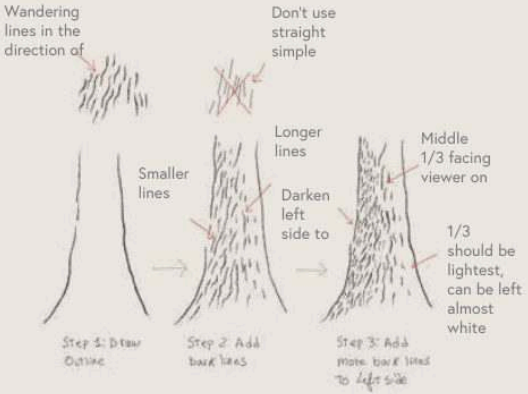
The vegetation library is not yet complete. What exists at this stage is a pipeline, not a finished database.

The goal is to build a gallery of section drawings for the key species of the Swan Coastal Plain, accurate enough to be technically useful, and drawn in a consistent hand that keeps the database identifiably personal. The drawings show both the above-ground form and the root system below: the section view is the one that matters most for this project, because the root is what the building's footprint actually threatens.

In this instance the output is not 3D geometry but a 2D vector section. Python code integrated in GH generates these procedural plant drawings, producing section views from species parameters rather than from pre-drawn assets. The results are rough for now, it is not yet a polished illustration tool, but they are consistent and scalable across species

.

Eventually these 2D sections will sit alongside the 3D Rhino geometries already



VEGETATION GROUPING

AUTOMATIC SUGGESTED GROUPING

Once species are identified from the occurrence data, **the companion cross-references their root system characteristics and mycorrhizal associations. The grouping algorithm compares species parameters and clusters plants that can coexist underground without displacing each other's fungal networks or competing for the same soil resource zones** (Kimmerer 2013, 20).

The output is not a planting plan in the conventional sense. It is a **set of compatible clusters**, each assigned a spatial footprint derived from the combined crown spreads of its members. The companion writes these clusters back as suggested geometry. The designer can accept or override them; overrides are logged.

Notes, for future integration

The grouping algorithm as currently built clusters species by mycorrhizal compatibility and soil resource zone, using the site's own occurrence data as its input. The output is ecologically grounded. It is also ecologically constrained, which is exactly what the Death Manual requires.

But the algorithm raises a question I have not resolved.

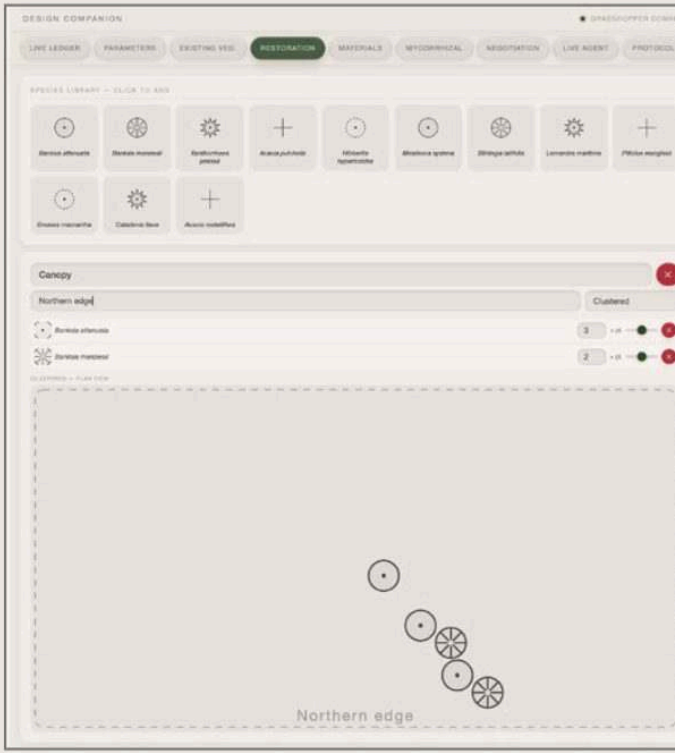
What if the grouping logic were extended? a food-provider cluster, a culturally significant species group, a therapeutic edge planting? it would become something more than a restoration tool.

Introducing groupings by function rather than by ecological compatibility risks selecting species that are native but not endemic to this particular site. A food-provider grouping might draw in species from elsewhere on the Swan Coastal Plain that do not occur in this reference ecology. This would technically satisfy the nativity requirement while undermining the Death Manual's site-specificity. The restoration parameter would accept it? The ecological argument?

I do not want to resolve this here. I think the ability to define custom groupings is worth building, and I think the Death Manual's parameter floors should retain authority over any grouping the designer constructs. A therapeutic cluster that crosses the weed load ceiling, or introduces a species absent from the reference ecology without explicit custodian agreement, should trigger the same binding flag as any other threshold breach.

The feature would not override the obligation. It would test it. That is a productive tension, not a design problem to be solved.)





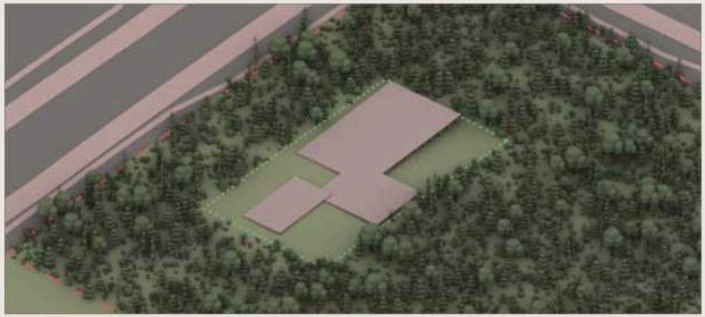
The arrangement comes from the species data, not from a design preference applie afterward. Irregular groupings, variable densities, no compositional hierarchy.

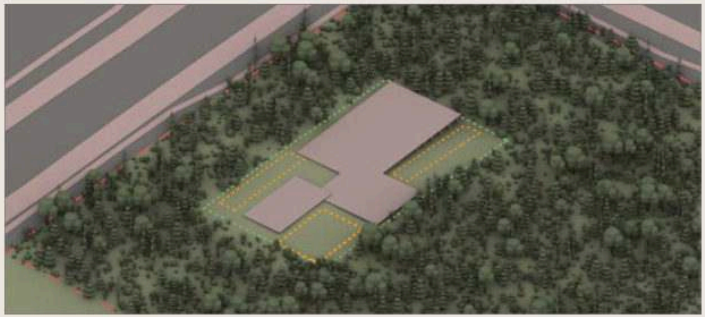


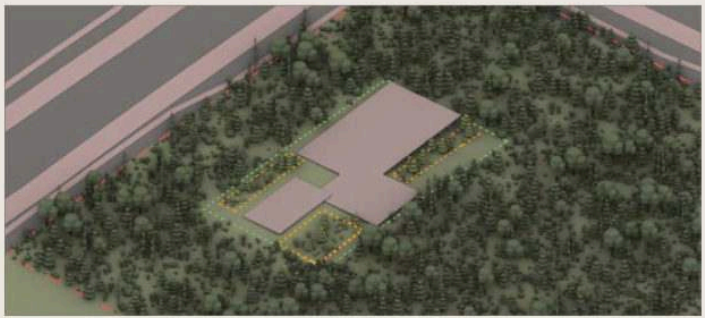
VEGETATION GROUPING

AUTOMATIC GROUPING PLACEMENT

The designer's input is a closed curve drawn in the Rhino viewport. It defines a planting zone, an area the designer has determined should receive new vegetation. Everything that follows is computed.







ELEVATION FROM SPECIES RECORDS

Every plant in it was generated by the Design Companion from a species record, at the height and crown spread the record gives for a mature plant, and placed at its distance from the viewer.

I work this way because I can chase an error in a generated drawing. If a banksia looks too heavy, I can trace it to a number in a file and decide whether the number is right. Several of the corrections in this section started like that. A plant looked wrong, I traced it back to its record, and the fix then carried into every drawing made from that record.

Distance is shown with opacity, not line weight, so the plants further back fade without being drawn differently. The trees at the front are the ones named in the site inventory. Behind them is woodland of the same community, which the survey gives as a density, with no individual trees.

The birds are in the elevation because the pla underneath them are a food supply and nest sit Without the birds the drawing would only be stocktake.



Existing vegetation elevation, generated in the Design Companion from species records. Figure by Author.



SPECIES RECORDS AND THEIR DRAWINGS

The top half of the spread is the data. Each species has one file, holding height and canopy spread by age class, root type, root depth and spread radius, mycorrhizal affinity, flowering and fruiting months, conservation status, the fauna recorded feeding or nesting on it, and a Noongar name where one has been given. The bottom half is what the engine draws from each file, with nothing added by hand.

The library held 737 records when this spread was drawn, 517 of them with fauna associations. It now holds 919. Every drawing in this document can be traced back to the file it came from.

This also shows where the method is weak. A record filled in by genus fallback is drawn as confidently as a sourced one, and it is still a guess. There are 134 records on a default root depth of 500 mm and 118 on a default spread radius of 1400 mm, so their roots come out the same size whatever the plant above ground is doing. Another 479 have root type recorded as fibrous. Some of that is true of the plants and some is a default that was filled in when nothing better was known. The record does not say which.

I am keeping those numbers visible as data quality work so they do not get averaged away.

Species records and the drawings generated from them. Figure by Author.

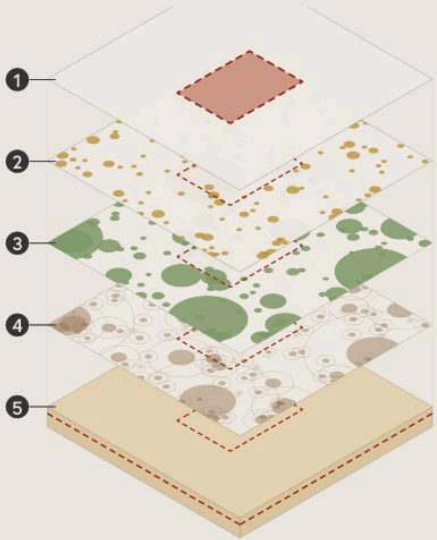
THE DESIGN COMPANION

What the plugin reads

The Design Companion is a plugin for Rhino, the modelling software architects already use, and a standalone app that opens the same project without it. It is for designers and the communities they work with, before anything is drawn.

It reads a site in layers: the ground and its horizons, the roots and the zones a footing must not cut, the plants and how they grow, and the animals that depend on them. The building comes last, as one more layer read against the others.

The order matters. A footprint drawn first decides what the site loses. A footprint drawn last has to answer to what the site already holds.



THE BUILDING

15 x 11 m footprint, as drawn by the designer; red dashed: the same footprint read on each layer below.

ANIMALS

532 links between plants and 28 animal groups; the bigger the disc, the more links break if that plant goes.

PLANTS

126 plants of 10 species, canopies grown to 50 years by the growth model.

ROOTS

Root zone of each plant from its record; filled: the structural zone a footing must not cut.

GROUND

Spearwood sand; red dashed: the 300 mm excavation line of the Death Manual.

The Warwick stand at 50 years, read layer by layer. Figure by Author.

The tool: the companion in Rhino

THE COMPANION IN RHINO

The companion now runs as a Rhino 8 plugin on Mac and Windows, docked beside the model, so the cost sits next to the drawing. In Semester One it was a page on a local server.

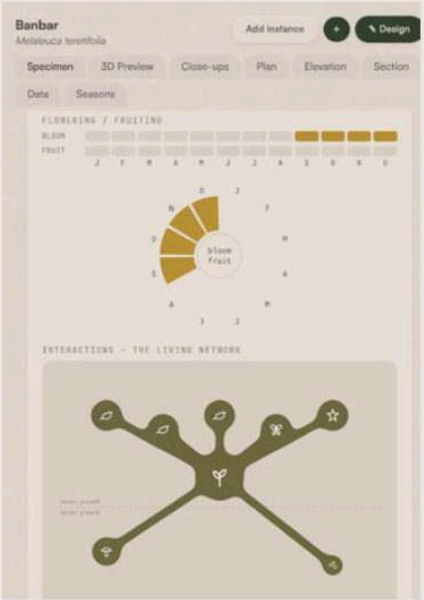
Each parameter scores between minus five and plus five. The weighted set gives a base ecological score, and a Climate Urgency Multiplier then produces a second, climate-weighted score beside it. I kept them as two ledgers so a good score cannot hide a bad one.

The clearest test is the vision plan. Entered as the eleven values the 1,500 dwelling community vision plan implies, it scores minus 4.36 on the base ledger and minus 4.81 climate weighted. Every card is critical and the verdict is REFUSE. Run on the measured site bundle with nothing built, the same engine returns GO at plus 1.23. If the ledger failed the unbuilt bush as well, its refusal of the vision plan would mean nothing.

THE VEGETATION LIBRARY PANEL

The panel runs inside Rhino on four tabs: Vegetation Library, Species Dossier, Vegetation Groups and Vegetation Schedule. Each species opens into eight views: Specimen, 3D Preview, Close-ups, Plan, Elevation, Section, Data and Seasons.

Under that is the Interactions diagram. Each arm is a species that depends on this plant or that this plant depends on. The disc at the end is sized by the strength of the tie, and the line is dashed where the exchange happens below ground. These are the ties a footprint can cut.



The Specimen tab for Banbar, with its flowering calendar and the honeyeaters, native bees, butterflies, root fungi and wind it is tied to.

Full set: appendix, page 390

12 TO 30 JUNE 2026

Assemblies: walls, slabs and roofs

The plugin began as a BIM tool inside Rhino. In the break after Semester 1 the first sessions built walls, slabs, roofs, openings and railings, drawn by hand or from a curve, with a section cut engine and a docked panel to run them. A 19 species library came in on the same days, but the building was the first thing the tool could make.

AIM
Walls, slabs and a roof that join and cut in section, so a drawing set could come out of the model.

PROBLEM
It was a building tool with plants added. It did not yet measure what the walls would take out of the ground.

OUTCOME
The panels moved to a web view on 26 June, and after that most of the work went into the species library.

101 commits in June. July and August had four each.

12 JUN | FIRST COMMIT
Walls, slabs, roofs, openings, a section cut engine and a 19 species library, built in 21 sessions on one day.

14 JUN | WALL, SLABS AND ROOF WORKING
Joined and cut in section.

26 JUN | FIRST WEB VIEW PANELS
The docked panels move from Eto to HTML.

27 JUN | LEVELS, SECTIONS, STAIRS
A levels panel and walls that know their level, a sections panel, then stairs, columns and beams, on one day.

27 JUN | RAILINGS
Railing families of several members, drawn along a line with a preview of the profile.

28 JUN | SHEETS AND HATCHES
Hatch and fill patterns on sheets, and the scaffold of a desktop app.



THE TOOLS PANEL, 6 JULY
Wall, slab, roof, openings and railing, each drawn or taken from a curve.

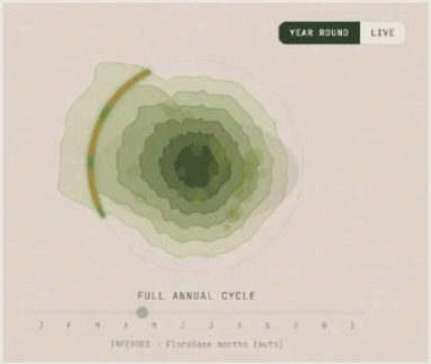
Full set: appendix, page 368

The tool: section, seasons, plan

SECTION AND SEASONS

Section draws the plant in its ground. With accurate soil on, the horizons come from the plugin's Bassendean sand profile, and the roots are built at their recorded depth and spread. Here they are fibrous to 0.7 m and spread 4.0 m under a 3.3 m canopy on a 5.0 m plant, so a footing can cut roots outside the canopy line.

Seasons has two modes. Year round stacks the annual cycle into one glyph so species can be compared. Live steps through the months, dormancy included, to show when each plant is in flower.



Seasons, year round: the whole annual cycle stacked into one glyph.

PLANTS WITH AND WITHOUT THEIR ANIMALS



Full set: appendix, page 391

The tool: scenarios

TWENTY SCENARIOS

One design gives one outcome, so the tool tests it against twenty scenarios. Each changes the same model by a fixed rule, and they are grouped under the Death Manual's three states.

Dunne and Raby describe futures as "not a destination or something to be strived for but a medium to aid imaginative thought" (Dunne and Raby 2013, 3), and the scenarios are written in that spirit. None of them is a prediction.

None of them is baked into the model either. A scenario is drawn over the geometry by a display conduit and disappears when you step off it.

OPTIONS AGAINST ALL TWENTY SCENARIOS

A proposal can always be made to look reasonable by choosing which future to show it in. Design options are saved as Rhino snapshots, each a real arrangement of massing, and every option is run against all twenty futures. The appraisal reports the worst cell in that matrix, because the worst case is the fair test.

Refuse is the scenario where the tool says no. Nothing degrades in it. The massing greys out and is not generated, and the existing vegetation stays at full health. The refusal is recorded against the site, since the limit is in the ground. Some ground cannot carry development at any scale that meets its obligations, and a tool that can say so takes a degrowth position (Hickel 2020).

PLANT DETECTION

Existing trees are read from imagery, so the stand a building takes from is counted before design starts. The overlays compare where each source puts them: Curtin from open data only, then from the site photograph.

Welshpool tests the open alternative. Satellogic EarthView is 1 m satellite imagery under CC BY with a near-infrared band, and with it detection went from 47 crowns found by colour to 755. Curtin sits in a 2 km gap between its two Perth strips.



Welshpool, crowns detected from 1 m Satellogic EarthView imagery using its near-infrared band.

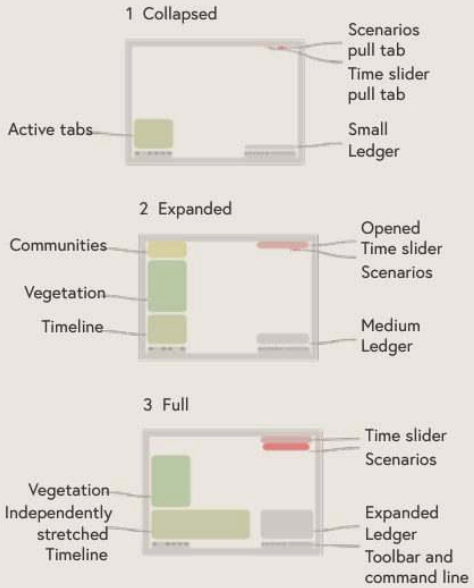
Full set: appendix, page 393

The tool: the ledger without the plugin

THE SAME LEDGER, WITHOUT THE PLUGIN

The companion is built for somebody who models, but the ledger is meant for other people too. Public Legibility is already a governance parameter in the protocol. It asks whether the ecological cost is readable before construction starts, and the protocol will not generate a printable manual while it is set to no. This interface is my attempt to make the answer yes.

In all three the model stays the biggest thing on the screen. A community meeting is an argument about a place, and an interface that covers the place with its own instruments makes the place harder to discuss (Muf 2001, 12).



Collapsed, expanded, full. Active tabs, communities, vegetation, timeline, ledger, scenarios, time slider.

ANIMALS IN THE LIVING FIELD

The Living Field is the viewer where the site is played forward. Planted vegetation grows across fifty years, the model can be burnt or cleared, and building surfaces weather as the year slider moves. The animals live on the plants they are recorded on, and they leave when those plants go.

Ninety-six animals are built as rigs: twenty birds, seventeen mammals, twelve reptiles, five ground birds, four frogs and thirty-eight invertebrates. The birds on this page are the ones flying in the viewer. Each is tied to its host species through the interaction data the Specimen tab draws, so nothing in the sequence is scripted to a year.

Two rules limit what the viewer claims to know. A tag that names a group instead of a species, such as honeyeaters or small mammals, is counted and given no body, because drawing one would mean choosing a species the record does not choose. And a species whose model is authored but not yet reviewed stays a placeholder instead of borrowing its nearest relative. A Western Pygmy-possum weighs about ten grams. Drawn as a Ringtail, which weighs a kilogram, it would put a convincing wrong animal on the site.

Full set: appendix, page 395

The tool: interfaces

THE DRAWING STYLES
The interface went through a docked panel, a web view panel set and the DC Studio page, and the drawings went through as many styles. A paper texture and a watercolour wash were tried in July, ink and stipple in September, and six vegetation styles were set side by side on 25 September.

PROBLEM
Each new panel added another place to look. The first renders looked either like CAD linework or like a game engine.

OUTCOME
The diagram view, and the watercolour style the plates now use.

THE TOOLS PANEL, FOUR VERSIONS
By 26 August it held curtain walls with a facade designer, ceilings, furniture, services and annotation. By 9 October massing, a brick designer and planters, green walls and vegetation groups sat beside the walls, so planting was drawn from the same panel as the building.



25 SEPTEMBER

Six styles: botanical line, flat leaves, depth clumps, depth with leaf texture, painterly and watercolour blocks.

Full set: appendix, page 397

The tool: a standalone app

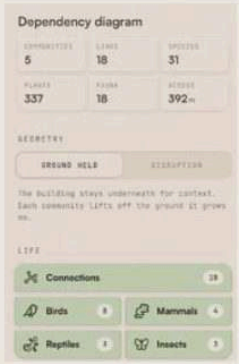
AUGUST TO OCTOBER
In August the tool gained twenty scenarios in three groups, the End, the Life and the Beginning. In September the diagram view drew the plant groups as floating communities over the site. By October the tool no longer needed Rhino to run, and the same project opens in Rhino, as a desktop app and on the web.

PROBLEM
About 190 of the 680 Python files still called Rhino directly, so a community meeting needed a Rhino licence.

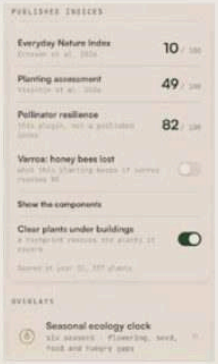
OUTCOME
One core, three hosts and one file format that each of them reads and writes.

WHERE IT STANDS
On 8 October the local server opened a real Perth bundle with terrain and 225 buildings, and walls and massing could be drawn without Rhino. Backward compatible means a project made in the app still opens in Rhino, and the other way round.

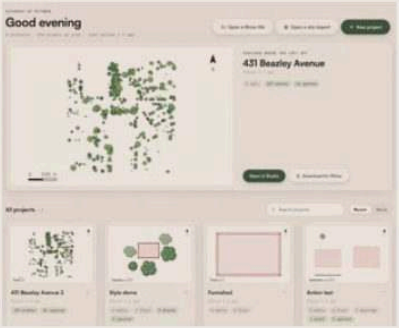
THE DEPENDENCY DIAGRAM, READ



COUNTS AND LIFE
Five communities, 337 plants and 18 fauna across 392 m.



PUBLISHED INDICES
Two published scores and one of the tool's own, labelled as such, read at year 12.



THE APP, 10 OCTOBER
The home screen: the last project opened, with Open in Studio and Download for Rhino, and every project below it.

Full set: appendix, page 398



2051



2076



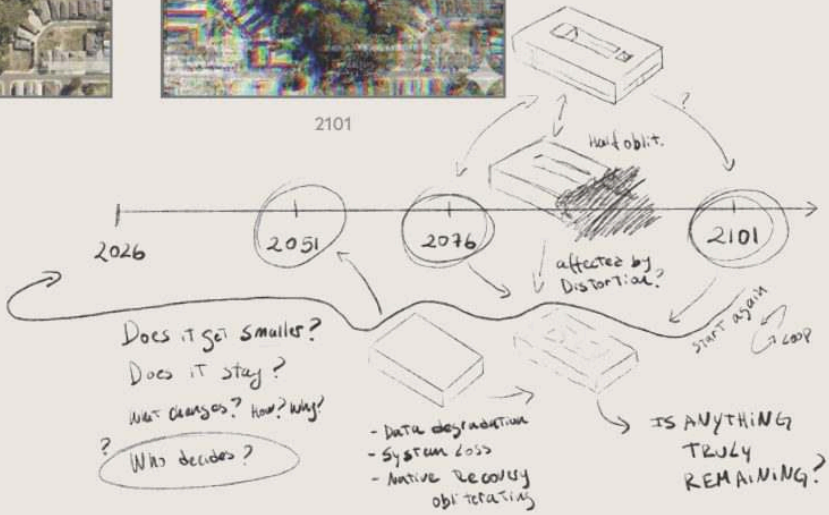
2101

The manual is written in 2026 for a clim
a community, and a site that will all l
changed by 2076.

**The question is not whether it will sur
intact. It will not, not in full. The questio
whether it is worth writing anyway.**

The glitch images are honest about thi
document that degrades is still a docum
A commitment that requires renegotiatio
still a commitment. The alternative, desig
without any written obligation to
ground, is not more realistic. It is just m
comfortable.

**The project must design for uncerta
rather than pretend it away.** That me
building the mechanism for renegotia
into the manual itself: review periods, na

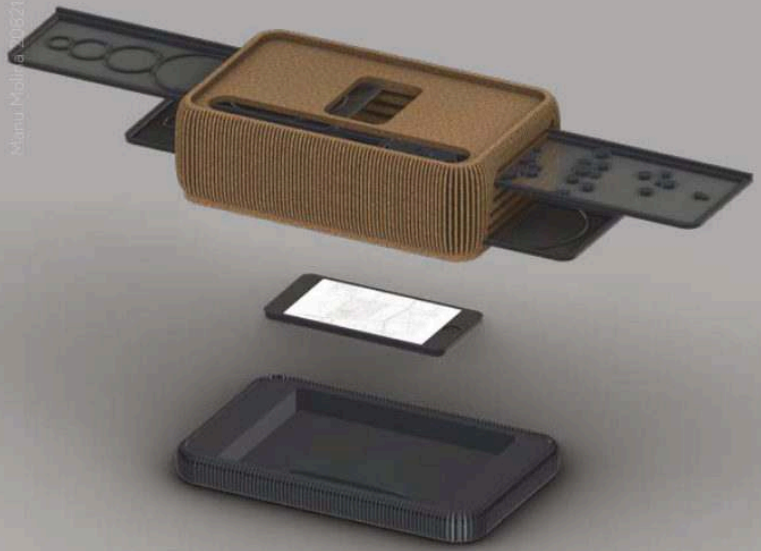


Images generated with Gemini Nanobanana, an AI engine through precise

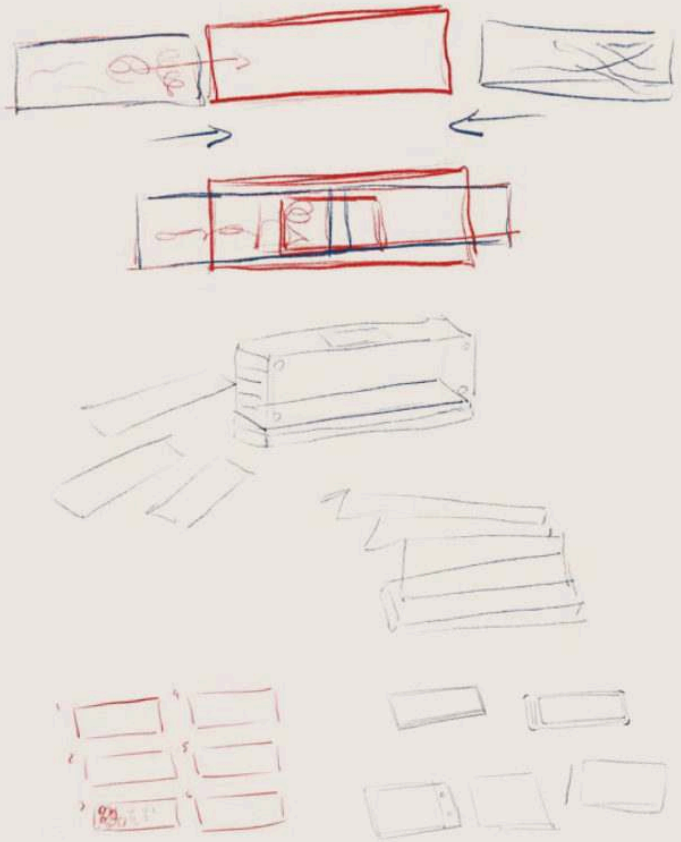
THE NEGOTIATION BOX
CONCEPT CREATION

The negotiation box is the project's substitute for the conventional site plan. Where a site plan documents spatial conditions, boundaries, levels, existing structures; the negotiation box documents ecological obligations.

It performs the same analytical function: mapping what exists and what matters. But it does so through the language of debt rather than description. The site is not a blank canvas to be understood and then designed upon. It is a set of living relationships that the building must negotiate with before it draws a single line.



The box did not arrive fully formed. It developed through a sequence of material experiments and attempts to figure out how an abstract scoring system could become something physical; something that could be held, read, and negotiated with in a single gesture.



Each iteration asked the same question: how do you make an obligation visible before it becomes a building?

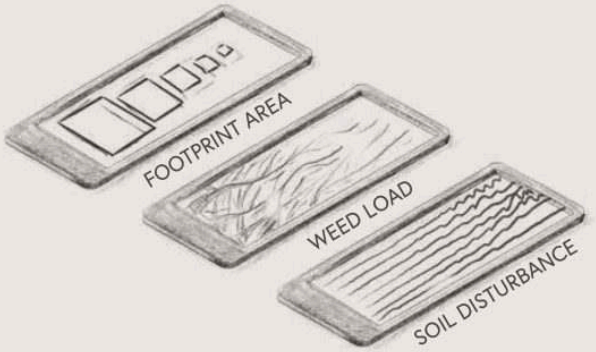
THE NEGOTIATION
PARAMETERS... WHY THESE AND NOT OTHERS?

To make the negotiation between a building and its site visible before any spatial decision is made, the project required a set of measurable terms. Six ecological parameters were established as the foundation of that negotiation. Each one corresponds to a form of ecological impact that construction on Bassendean sands inflicts, and that existing planning frameworks do not require a designer to account for before breaking ground. These parameters are the operating logic of the negotiation box. They do not describe the site. They describe what the building owes it.

The six parameters of the physical tray system were not chosen arbitrarily. Each one corresponds to a form of ecological damage that a building on Bassendean sands inflicts, and that existing planning frameworks do not require a designer to quantify before construction begins.

Footprint Area is the most legible parameter: the direct surface area where the building makes contact with ground it removes from ecological function. Ground Coverage extends this to all impervious and semi-impervious surfaces, including paths, drainage channels, and car parking. Together they determine how much of the site's recharge contribution to the Gnangara Mound is subtracted per square metre.

Fire Regime Alignment is included because banksia woodland does not persist without fire. The dominant species depend on periodic low-intensity burning for seed release and understorey regeneration. A building that prevents or disrupts the fire regime around its footprint imposes an ecological cost that no vegetation planting can offset.

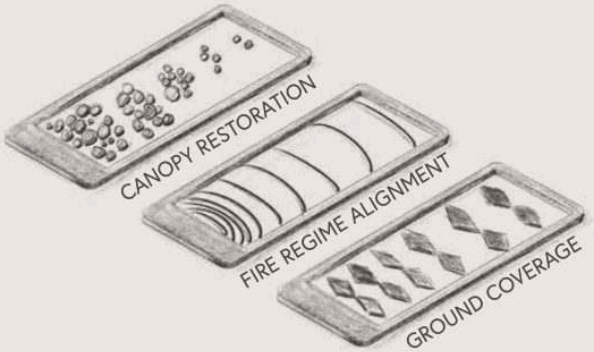


The parameter cannot be fully scored, however. Noongar cultural burning is a living knowle practice, not a management schedule, and a score cannot represent what it actually is. Thi acknowledged within the tool itself, and it is not resolved.

Canopy Restoration and Weed Load address the two sides of the same ledger: the native spe the building displaces and the introduced species that colonise the disturbed edge. Reference s in intact Banksia attenuata woodland carry 67 vascular plant species per 100m² (Gibson et al. 19 the Canopy Restoration parameter holds that figure as the restoration target.

Soil Disturbance is set at 300 mm, a conservative design threshold rather than a published li The Commonwealth conservation advice for the Banksia woodlands asks that soil disturbance kept to a minimum to protect the soil seed bank (Department of the Environment 2016). Below t depth, mycorrhizal networks, seed banks, and soil horizon structure are permanently disrupted. the hardest floor in the system.

These six were chosen because they can be measured, because they correspond to real conditi on this site, and because they exclude what cannot honestly be quantified. The things that car be scored — the cultural significance of specific trees, the relationship between the Friend Warwick Bushland and the ground they tend, the accumulated knowledge of decades of volun work — are not parameters. They are the context within which the parameters are held.



PHYSICAL MODEL

3D PRINTED TRAYS WITH SUSPENDED MESH

The six trays are independently 3D printed, at layer four, the slicer's G-code is modified to introduce a pause. At that moment in the print, a fine mesh is laid over what been printed and secured to the build plate. When printing resumes, the following layers close over it, trapping the mesh permanently within the body of the tray.

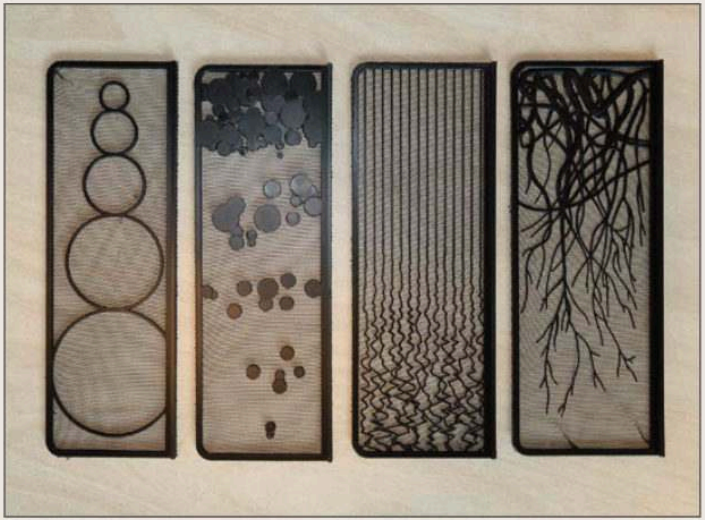
Each data the mesh represents the ecological score range, the parameter thresholds are physically suspended inside the object.











SYSTEM AND METHODOLOGY PLANNING

The diagram traces draft of the full project workflow from site selection through data collection, parametric design, and community negotiation, to decommissioning and ecological restoration. It is shown as a loop because that is what the project proposes; a cycle that ends where it begins, in the ground.



NEGOTIATION

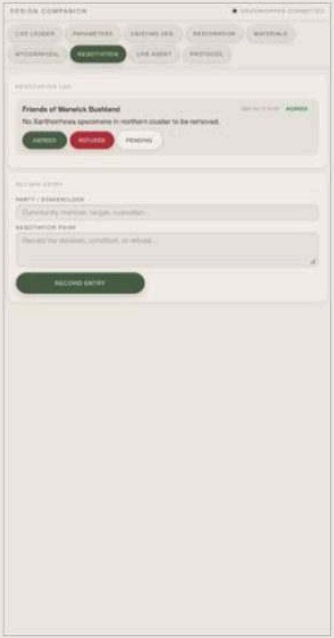
THE BUILDING'S OTHER SIDE

Design negotiation in most architectural practice is a conversation between the architect and the client. This project adds three more parties: the site's ecology, formalised through the ledger; the community, formalised through the negotiation log; and the Whadjuk custodians, who must be named before the Protocol tab will generate a printable document.

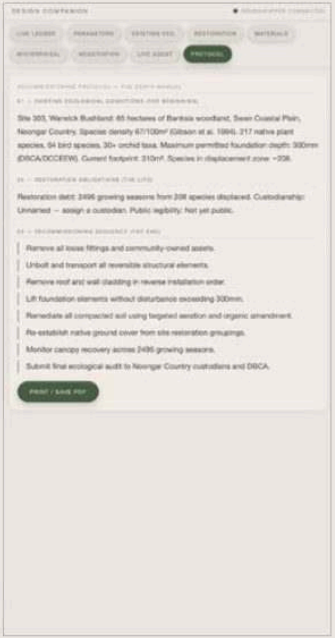
The Negotiation tab records decisions in real time. A logged entry from the Friends of Warwick Bushland reads: no Xanthorrhoea specimens in the northern cluster to be removed. Status: Agreed. This is not an advisory preference. It is a condition, recorded against the designer's name, attached to a specific area of the site. If the footprint moves into that zone, the negotiation log will show that the condition was known and overridden. The binding flag system ensures that this cannot happen quietly.

The Live Agent answers questions about the site, the ecology, and the restoration obligations using the site's own data as context. It knows this site is 65 hectares of banksia woodland on Bassendean sands in Noongar Country. It knows the current footprint displaces 208 species and carries a restoration debt of 2,496 growing seasons. When asked what the building owes, it responds from those figures.

The Protocol tab produces the final document: existing conditions, restoration obligations, decommissioning sequence. It ends with a submission instruction: submit final ecological audit to Noongar Country custodians and DBCA. The document cannot be printed until a custodian is named. The architecture cannot begin until the ending is committed to.







Manuel Alvarez Castellanos

GRASS TREE, XANTHORRHOEA PREISSII



In flower at Warwick Bushland. Photograph by Author.



The plugin's plant.

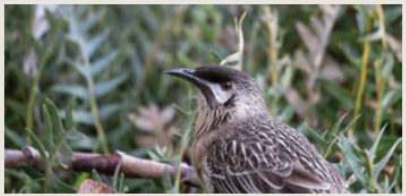


A grass tree trunk, blackened by fire, Warwick Bushland. Photograph by Author.

A WATTLEBIRD



At Kings Park. Photograph by Author.



The same bird, its head turned. Photograph by Author.

The species record

HOW THE PLANTS WERE DRAWN IN JULY



ELEVATION **PLAN** **SECTION**



Habit, flower and fruit from the same record. Figure by Author.

THE FIRST SPECIES PROOF, 4 JULY

Slender Banksia in elevation, plan, section and 3D. The roots are eight straight strokes.



Slender Banksia



Firewood Banksia



Grass Tree



Sheoak



Jarrah



Christmas Tree

Zamia Cycad

Holly-leaved Banksia

Woolly Bush

Prickly Moses











Honey Bush

Yellow Buttercup

Morrison's Featherflower

Rose Coneflower

Parrot Bush











Hummingbird Grevillea

Prickly Cottonhead

Common Dampiera

Pinkcups

Flooded Gum

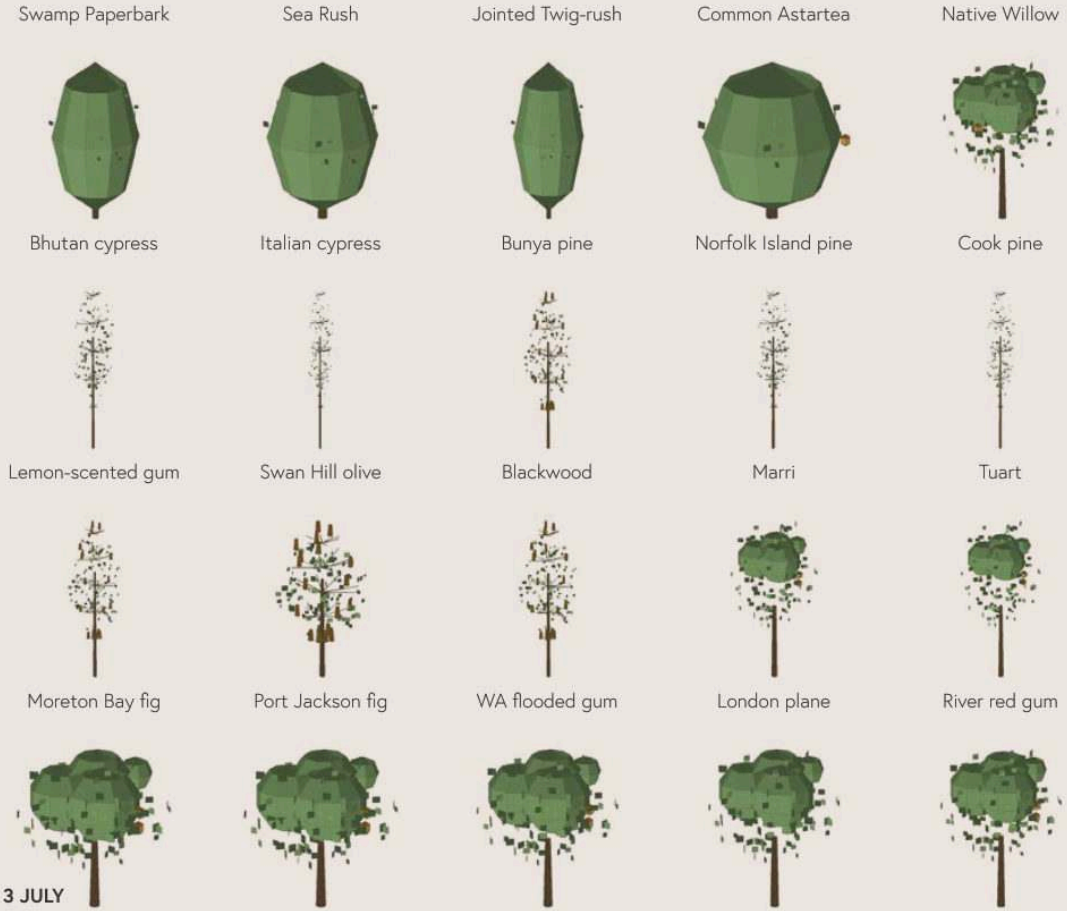












THE FIRST GALLERY, 3 JULY

Part of a sheet of about 160 species.



Palms from the species sheet of 10 September, each drawn from its record and labelled with its mature height.

Trunks, branches, leaves and flowers

TRUNKS, 9 M, CENTRELINES OF THE BOLE AND FIRST LIMBS

SEED 3

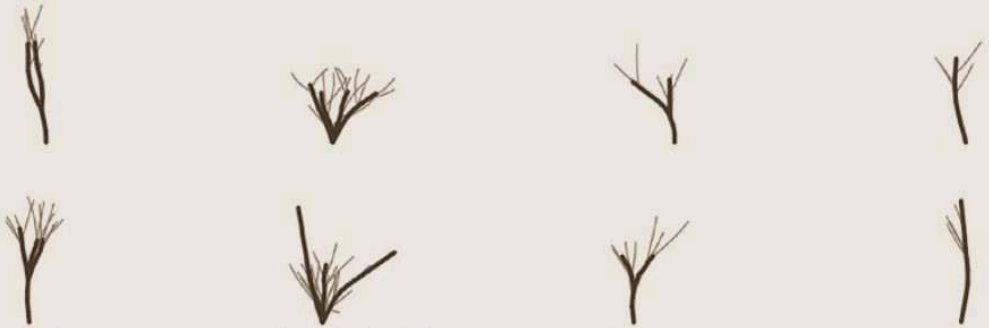
SEED 11



Eucalyptus diversicolor | Eucalyptus marginata | Corymbia calophylla | Eucalyptus gomphocephala

SEED 3

SEED 11



Acacia saligna | Melaleuca rhaphiophylla | Banksia menziesii | Agonis flexuosa

The bole and first limbs only, straightest to most sinuous. Figure by Author.

BEFORE AFTER BEFORE AFTER BEFORE AFTER



Eucalyptus loxophleba Eucalyptus marginata Eucalyptus patens

BEFORE AFTER, BLOOM CARDS

ACACIA CYCLOPS
72,232 and 72,264 faces



EUCALYPTUS MACROCARPA
18,500 and 18,860 faces



CHORIZEMA ILICIFOLIUM
41,138 and 41,474 faces





The first batch of crowns, before and after.

BEFORE, ONE QUAD A LEAF

AFTER, THE REAL LEAF OUTLINE

BANKSIA SPECIOSA
13,800 to 120,244 faces





BANKSIA GRANDIS
12,090 to 64,185 faces





BANKSIA NIVEA
5,980 to 60,060 faces





©Daniel McGinnis 2008/2015

BANKSIA COCCINEA
8,674 to 75,370 faces



Each pair is one species, before on the left and after on the right.

VERTICORDIA GRANDIS
64,458 and 65,242 faces



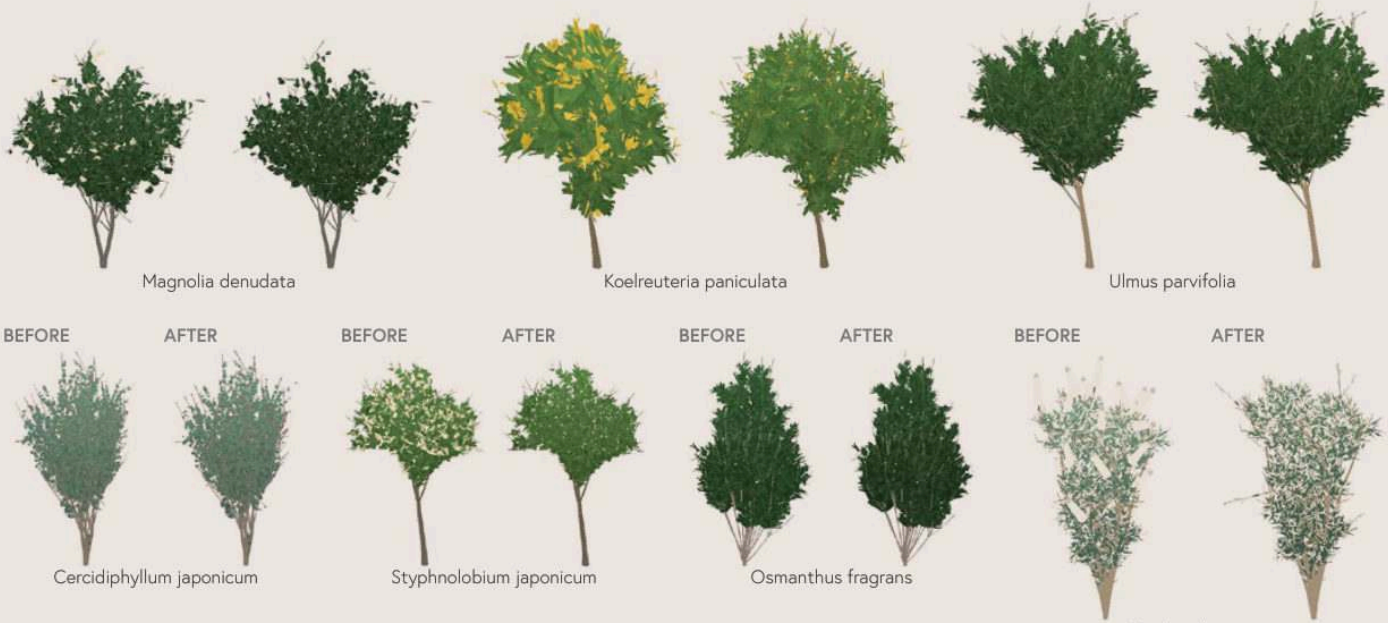
Each plant whole and its bloom close up, before and after, rebuilt from close-up photographs of the species.

TEN TREES AND SHRUBS, BEFORE AND AFTER THE POLISH

BEFORE AFTER BEFORE AFTER BEFORE AFTER



Acer palmatum Camellia japonica Lagerstroemia indica



27 SEPTEMBER, BEFORE

Ten trees and shrubs before the leaf and flower polish.

27 SEPTEMBER, AFTER

The same ten, with leaf outlines and bloom sizes from the records.

Flower types



palm panicle
28 species



star cluster
27 species



single flower
26 species



myrtle bottlebrush
24 species



bottlebrush spike
23 species



spadix
23 species



daisy head
21 species



dense spike
21 species



bracteate head
18 species



axillary cluster
17 species



tubular head
15 species



raceme spike
14 species



tepal spike
13 species



dome head
9 species



head raceme
9 species



kangaroo paw
9 species



umbel
8 species



feather head
7 species

front axo top

Coast Saltbush, spikelet



front axo top

Milkmaids, umbel



Lemon-scented Darwinia, bracteate head



Swamp Peppermint, cup



Coast Daisybush, daisy head



Short-stem Flax-lily, spider raceme

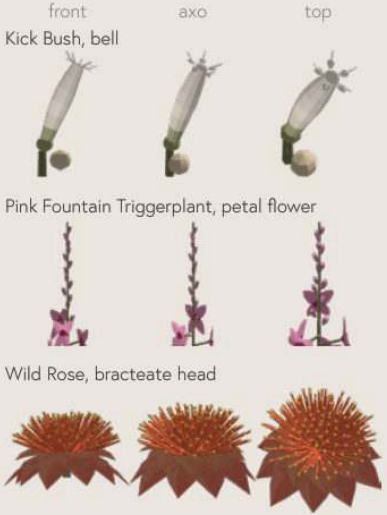


Chittick, cup



Basket Flower, cup





Thirteen flowers of the library, each drawn from the front, at an angle (axo) and from above, and named with its species and its current flower type; Coast Saltbush, Swamp Peppermint and Pink Fountain Triggerplant framed on their flowering tips. Renders from the plugin's organ builder. Figure by Author.



iris flower
5 species

woolly spike
3 species

triad panicle
2 species

one sided bottlebrush
2 species

cone head
2 species

fringe lily
2 species



palm spike
2 species

panicle
2 species

open face
2 species

ground cup
1 species

spadix panicle
1 species

	FLOWER	LEAF	FRUIT
Slender Banksia Banksia attenuata			
Firewood Banksia Banksia menziesii			
Acorn Banksia Banksia prionotes			
Harsh Hakea Hakea prostrata			
Hummingbird Grevillea Grevillea thelemanniana			
Jarrah Eucalyptus marginata			

	FLOWER	LEAF	FRUIT
Marri Corymbia calophylla			
Lesser Bottlebrush Callistemon phoeniceus			
One-sided Bottlebrush Calothamnus quadrifidus			
Swamp Paperbark Melaleuca rhaphiophylla			
WA Peppermint Agonis flexuosa			
Common Astartea Astartea scoparia			

	FLOWER	LEAF	FRUIT
Prickly Moses Acacia pulchella			
Orange Wattle Acacia saligna			
Hairy Yellow Pea Gompholobium tomentosum			
Yellow Buttercup Hibbertia hypericoides			
Brown Boronia Boronia megastigma			
Tar Bush Eremophila glabra			

Vegetation: flowers from three sides

For a close-up, the plugin seats each species' flowers on a leafy shoot grown from one of its own twig tips. The vegetation work rendered that shoot from three sides and checked it against photographs of each species for colour, size, shape and count.

The checks fill 34 sheets of five species. Shown are the 38 whose shoot fits whole in all three frames, so that no plant is cut. The photographs are not reproduced here, because their sources were not recorded. Each shoot is framed to fill its cell, so the rows are not at one scale.

READING THE ROWS

Each row is one species' flower shoot from the plugin, turned a third of a turn between frames: from 0°, from 120° and from 240°. The common name sits above the scientific name.

FROM 0°	FROM 120°	FROM 240°
		

PANJANG
Acacia lasiocarpa

FROM 0°	FROM 120°	FROM 240°
		

SWAN RIVER PEA
Gastrolobium celsianum

Full set: appendix, page 311

FROM 0° FROM 120° FROM 240°



STALKED GUINEA FLOWER
Hibbertia racemosa



ROBIN REDBREAST BUSH
Melaleuca lateritia



LARGE-FLOWERED THOMASIA
Thomasia grandiflora

FROM 0° FROM 120° FROM 240°



CHITTICK
Lambertia inermis



COCKIES TONGUES
Templetonia retusa



SCARLET FEATHERFLOWER
Verticordia grandis



Flower, leaf and fruit for twenty-four species, drawn from each organ record; specimens not to scale. Figure by Author.

Flowers from three sides

FROM 0° FROM 120° FROM 240°

DRUMMOND'S WATTLE Acacia drummondii



FROM 0° FROM 120° FROM 240°

CLAY WATTLE Acacia glaucoptera



FROM 0° FROM 120° FROM 240°

PANJANG Acacia lasiocarpa



MANNA WATTLE Acacia microbotrya



BASKET FLOWER Adenanthos obovatus



FOXTAILS Andersonia caerulea



KICK BUSH Astroloma pallidum



BROWN BORONIA Boronia megastigma



SWAMP SHEOAK Casuarina obesa



PRICKLY BITTER-PEA Daviesia decurrens



MARNO Daviesia divaricata



TAR BUSH Eremophila glabra



FROM 0° FROM 120° FROM 240°

POWDERBARK WANDOO Eucalyptus accedens



FROM 0° FROM 120° FROM 240°

SILVER PRINCESS Eucalyptus caesia



FROM 0° FROM 120° FROM 240°

WANDOO Eucalyptus wandoo



EGG AND BACON PEA Eutaxia obovata



BROOM BALLART Exocarpos sparteus



SWAN RIVER PEA Gastrolobium celsianum



HAIRY YELLOW PEA Gompholobium tomentosum

FUCHSIA GREVILLEA Grevillea bipinnatifida

WOOLLY GREVILLEA Grevillea vestita







FROM 0° FROM 120° FROM 240°

GREY GUICHENOTIA Guichenotia ledifolia

FROM 0° FROM 120° FROM 240°

EMU TREE Hakea francisiana

FROM 0° FROM 120° FROM 240°

STALKED GUINEA FLOWER Hibbertia racemosa







HOLLY-LEAVED HOVEA Hovea chorizemifolia



COMMON HOVEA Hovea trisperma



WHITE MYRTLE Hypocalymma angustifolium



CHITTICK Lambertia inermis



FROM 0° FROM 120° FROM 240°

ROBIN REDBREAST BUSH Melaleuca lateritia



FROM 0° FROM 120° FROM 240°

COAST DAISYBUSH Olearia axillaris



FROM 0° FROM 120° FROM 240°

PIXIE MOPS Petrophile linearis



WEEPING PITTOSPORUM
Pittosporum angustifolium



BERRY SALTBUSH Rhagodia baccata



WA SANDALWOOD Santalum spicatum



COCKIES TONGUES Templetonia retusa



LARGE-FLOWERED THOMASIA
Thomasia grandiflora



SCARLET FEATHERFLOWER Verticordia grandis



WOODY PEAR Xylomelum occidentale



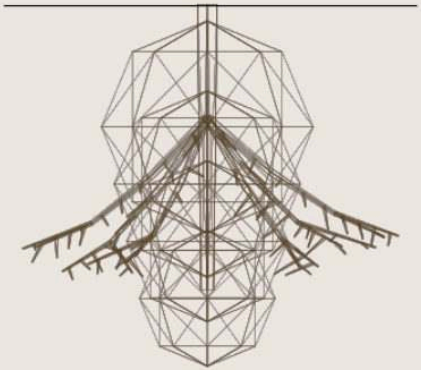
READING THE ROWS

Each row is one species' flower shoot from the plugin, turned a third of a turn between frames: from 0°, from 120° and from 240°. The common name sits above the scientific name.

Flower shoots of the 19 species from Grevillea to Xylomelum, continued from the previous page. Each shoot is framed to fill its cell, so the rows are not at one scale.

Root systems

JULY: SIX ROOT TYPES



Zamia, tuberous. Depth 1500, spread 1500 mm



Sea rush, fibrous. Depth 400, spread 600 mm



Sheoak, lateral plate. Depth 1200, spread 3000 mm



Twig-rush, fallback. Depth 500, spread 1200 mm

Christmas tree, haustorial. Depth 300, spread 4000 mm



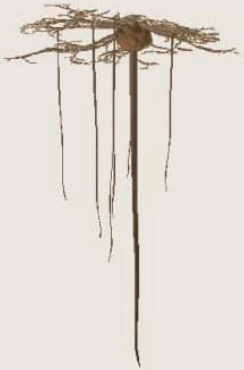
Paperbark, sinker. Depth 1200, spread 4000 mm

01 22 JULY

Six root types as straight-line wireframes. Figure by Author.

NEAR

BANKSIA ATTENUATA



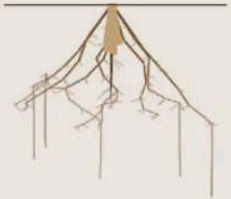
41,530 faces

SEPTEMBER: THE FIRST ROOT GRAPH, THEN THE POLISH

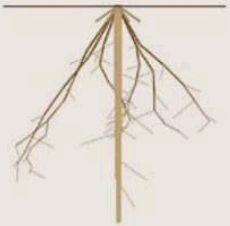


Jarrah, sinker and heart

Acorn banksia, proteoid



Balga, lignotuber



Zamia, tuberous



Jointed rush, fibrous



WA Christmas tree, haustorial

The first root graph. Line weight follows root radius: jarrah, acorn banksia, balga, zamia, jointed rush and the WA Christmas tree.

FAR, BEFORE THE CUT



14,212 faces

FAR, AFTER THE CUT



5,920 faces



9,044 faces



5,784 faces

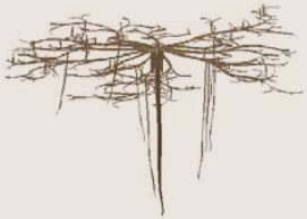
EUCALYPTUS MARGINATA



35,192 faces

NEAR

MELALEUCA PREISSIANA



38,066 faces

FAR, BEFORE THE CUT



9,382 faces

FAR, AFTER THE CUT



5,578 faces



8,342 faces



2,600 faces



18,464 faces

05 27 SEPTEMBER

Levels of detail for one system.

Calibration

FIVE SPECIES, FOLIAGE ON

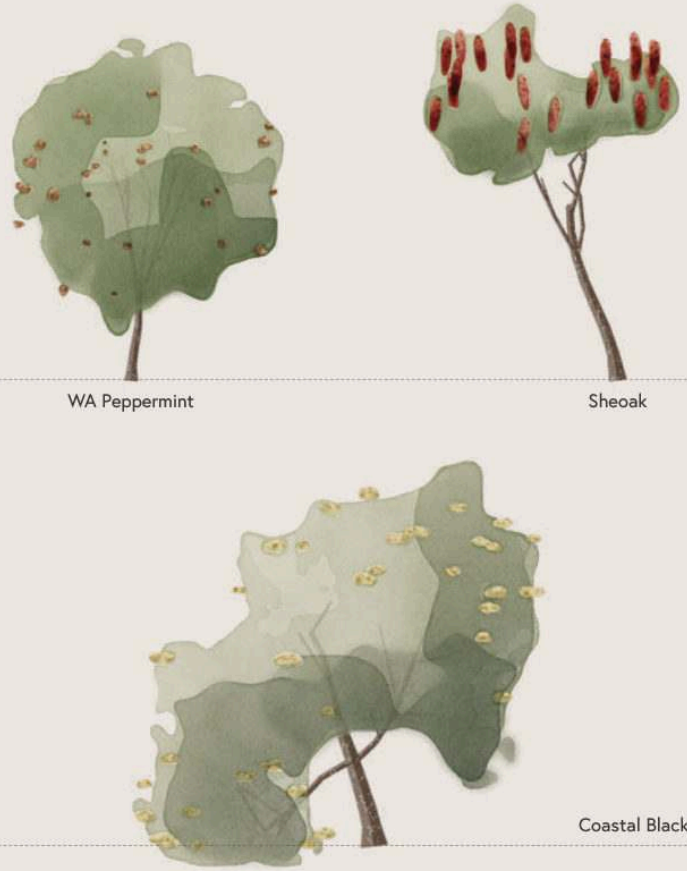


SHRUBS AT 2.5 M, BOLE AND FIRST LIMBS



Each group ranked from the straightest main stem, top left, to the one that wanders furthest from its base.
Red: Agonis flexuosa, the species the curvature was calibrated against.

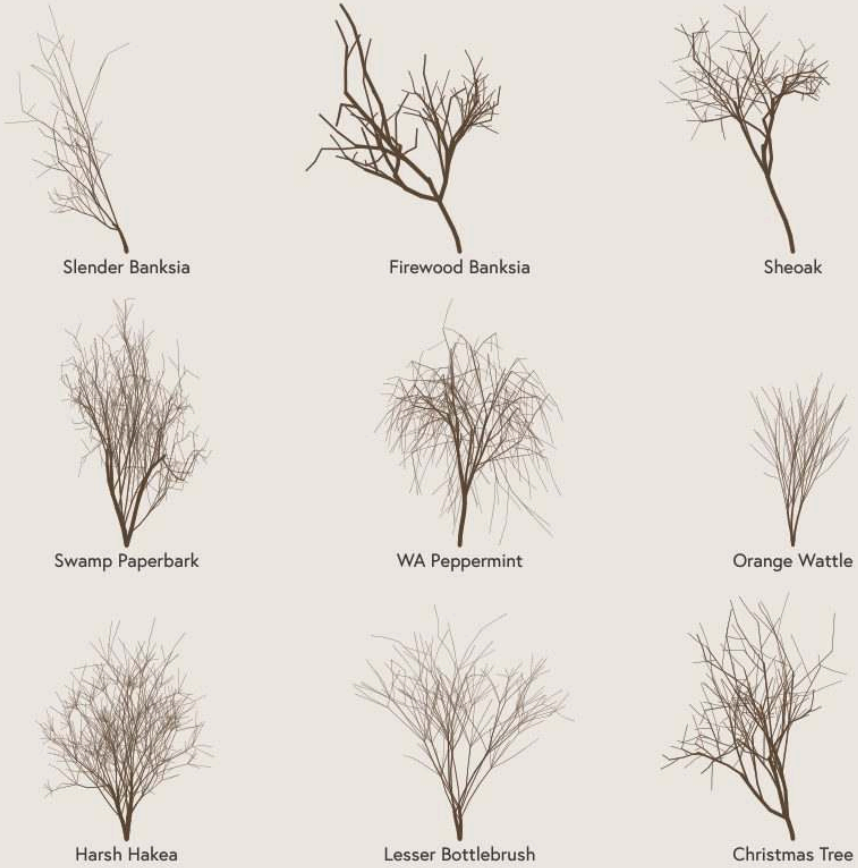
Bole and first limbs, drawn from the plugin's branch records: trees at 9.0 m, shrubs at 2.5 m, each group with its own scale bar. Figure by Author.



Five species with the foliage on, each grown to a 9.0 m setting and drawn at one scale on its row's ground line; the crowns finish between 7.7 and 9.6 m. Watercolour elevations from the plugin. Figure by Author.

FIFTEEN TREES, EVERY BRANCH AT 9.0 M





Every branch of fifteen Swan Coastal Plain trees, each drawn at 9.0 m, at a smaller scale than the bole drawings: see the 5 m bar. Figure by Author.

Four views



Species by growth form at mature height, each filling its cell of one height: first the trees. Renders from the plugin. Figure by Author.

Jarrah Eucalyptus marginata	Slender Banksia Banksia attenuata	Grass Tree Xanthorrhoea preissii	Red-and-green Kangaroo Paw Anigozanthos manglesii
3D MODEL			
			
ELEVATION			
			
PLAN			
			

FLOWER



FRUIT



Four species, each drawn from one record as a 3D model, a watercolour elevation, a plan symbol, and its flower and fruit. Figure by Author.

Silky-leaved Blood Flower
Calothamnus sanguineus



Albany Bottlebrush
Callistemon glaucus



Scarlet Kunzea
Kunzea baxteri



Robin Redbreast Bush
Melaleuca lateritia



Chenille Honeymyrtle
Melaleuca huegelii



Banbar
Melaleuca teretifolia



Scarlet Featherflower
Verticordia grandis



Plumed Featherflower
Verticordia plumosa



Cockies Tongues
Templetonia retusa



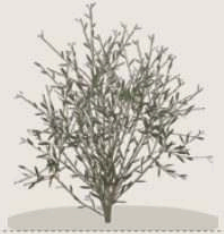
Marno
Daviesia divaricata



Common Brown Pea
Bossiaea eriocarpa



Common Hovea
Hovea trisperma





Shrubs, then grass trees, cycads, sedges and herbs, each at its mature size in a cell of one height. Renders from the plugin. Figure by Author.



Twelve species from the library, each filling its cell of one height. Renders from the plugin. Figure by Author.

Plants in plan





Mseq McGinn 2009/455


Eucalyptus erythrocorys
Eucalyptus forrestiana
Eucalyptus gomphocephala
Eucalyptus loxophleba
Eucalyptus macrocarpa
Eucalyptus marginata
Eucalyptus patens
Eucalyptus preissiana
Eucalyptus rudis
Eucalyptus salmonophloia
Eucalyptus tetraptera
Eucalyptus todtiana
Eucalyptus torquata
Eucalyptus wandoo
Eutaxia obovata
Exocarpos sparteus
Ficinia nodosa
Frankenia pauciflora
Gahnia trifida
Gastrolobium capitatum
Gastrolobium celsianum
Gompholobium knightianum
Gompholobium tomentosum
Grevillea bipinnatifida
Grevillea crithmifolia
Grevillea eriostachya
Grevillea excelsior
Grevillea hookeriana
Grevillea leucopteris
Grevillea obtusifolia
Grevillea olivacea
Grevillea pinaster
Grevillea thelemanniana
Grevillea vestita
Grevillea wilsonii
Guichenotia ledifolia
Hakea bucculenta
Hakea corymbosa
Hakea cucullata
Hakea francisiana
Hakea laurina
Hakea lissocarpha
Hakea multilineata
Hakea orthorrhyncha
Hakea petiolaris
Hakea prostrata
Hakea trifurcata
Hakea varia
Hakea victoria
Hardenbergia comptoniana
Hemiandra pungens
Hibbertia amplexicaulis
Hibbertia cuneiformis
Hibbertia hypericoides
Hibbertia racemosa
Hibbertia stellaris
Hovea chorizemifolia
Hovea trisperma
Hypocalymma angustifolium
Hypocalymma robustum


Isopogon dubius


Isopogon formosus


Jacksonia sternbergiana


Juncus kraussii


Juncus pallidus


Juncus pauciflorus


Juncus subsecundus


Kennedia beckxiana


Kennedia coccinea


Kennedia nigricans


Kennedia prostrata


Kingia argentea


Kingia australis


Kunzea baxteri


Kunzea ericifolia


Kunzea glabrescens


Lambertia inermis


Lasiopetalum floribundum


Lechenaultia biloba


Lechenaultia formosa


Lechenaultia macrantha


Lepidosperma gladiatum


Lepidosperma longitudinale


Leucopogon parviflorus


Lomandra caespitosa


Lomandra hermaphrodita


Lomandra maritima


Macrozamia dyeri


Macrozamia fraseri


Macrozamia riedlei


Melaleuca cuticularis


Melaleuca fulgens


Melaleuca huegelii


Melaleuca incana


Melaleuca lanceolata


Melaleuca lateritia


Melaleuca nesophila


Melaleuca preissiana


Melaleuca radula


Melaleuca rhaphiophylla

Melaleuca teretifolia

Melaleuca viminea

Melaleuca viridiflora

Microlaena stipoides

Neurachne alopecuroidea

Nuytsia floribunda

Olearia axillaris

Patersonia occidentalis

Patersonia umbrosa

Pericalymma ellipticum

Petrophile linearis

Philotheca spicata

Pimelea ferruginea

Pimelea rosea

Pittosporum angustifolium

Podolepis gracilis

Pteridium esculentum

Ptilotus exaltatus

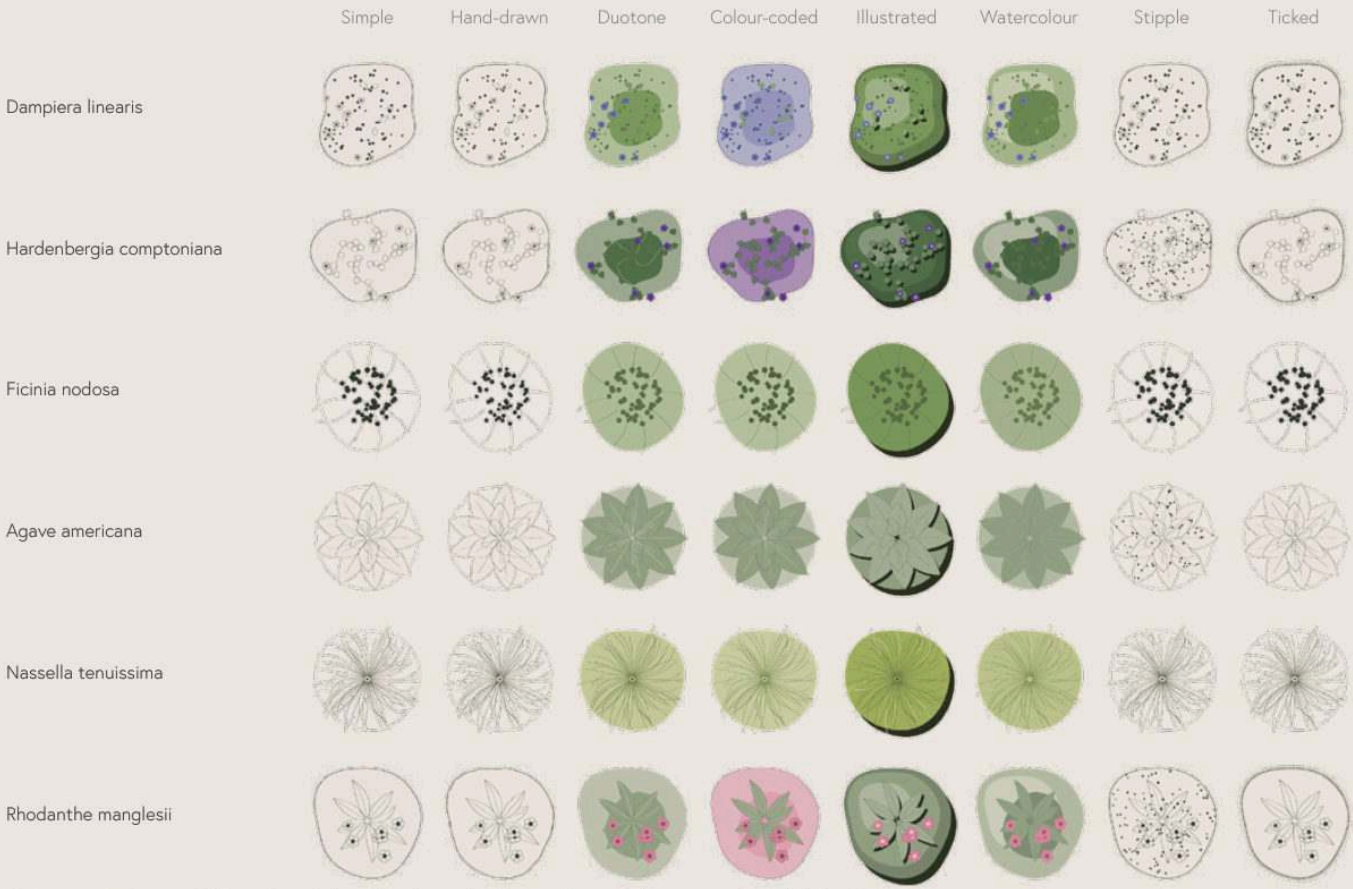
Ptilotus manglesii

Ptilotus polystachyus

©Meng McShane 2003/2456



The 288 species the Atlas of Living Australia records as native to Western Australia, drawn in the Illustrated plan style, A to Z over both pages. Figure by Author.



Twelve species by growth form through the eight plan styles, from outline to full crown, each symbol fitted to its cell so a low mat and a small daisy read as well as a tree. Figure by Author.

Simple Hand-drawn Duotone Colour-coded Illustrated Watercolour Stipple Ticked

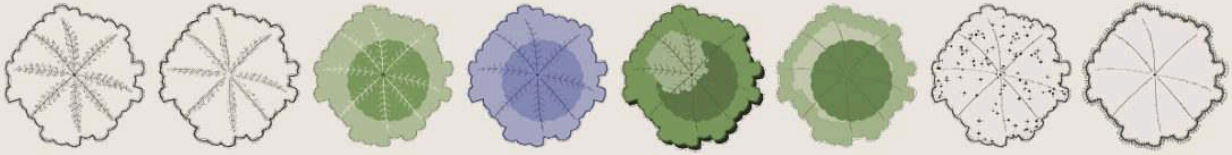
Eucalyptus marginata, clumped tree



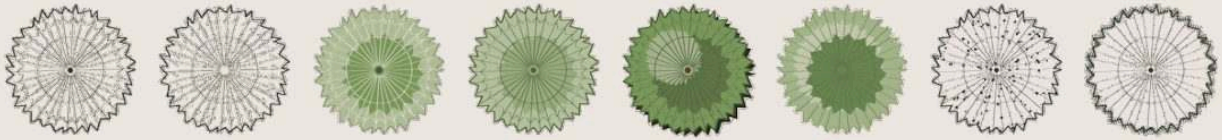
Salix babylonica, weeping tree



Jacaranda mimosifolia, fine-leaved tree



Pinus pinea, conifer

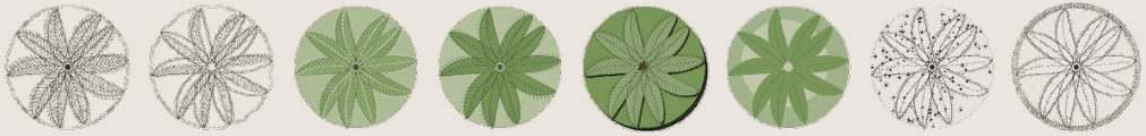


Simple Hand-drawn Duotone Colour-coded Illustrated Watercolour Stipple Ticked

Archontophoenix cunninghamiana, palm



Livistona australis, palm



Macrozamia riedlei, cycad

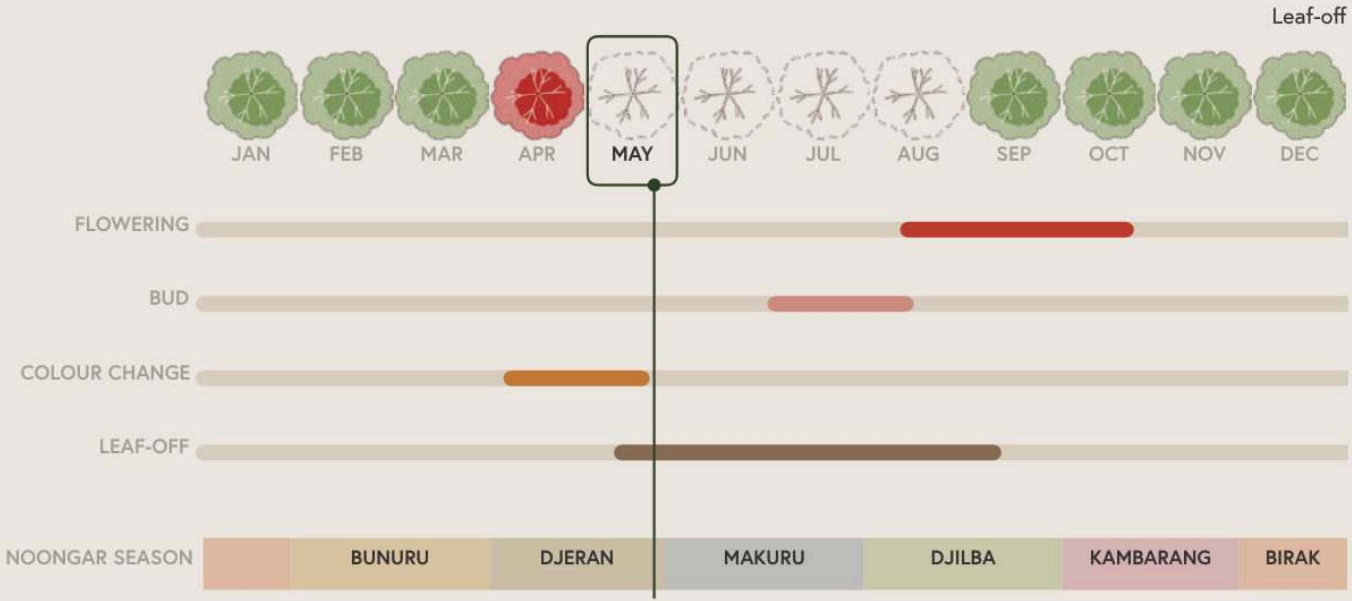


Dicksonia sellowiana, tree fern

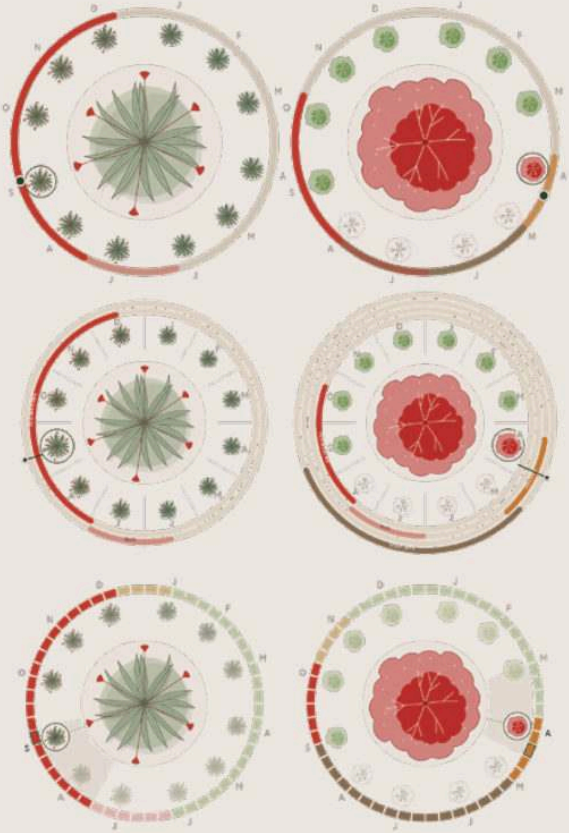


Trees, palms, a cycad and a tree fern through the eight plan styles, one crown family to a row. Figure by Author.

The year in plan



The same strip at leaf-off.



Three ring designs for two species.



Ring and dot markers, two layouts.

Growth and seasons

THE FIRST FOUR AGES, DRAWN 3 TIMES LARGER



1 yr, seedling
0.68 m

3 yr, seedling
1.70 m

6 yr, seedling
3.30 m

16 yr, juvenile
8.02 m



One species at seven age classes, with flowering and hollow formation. Figure by Author.

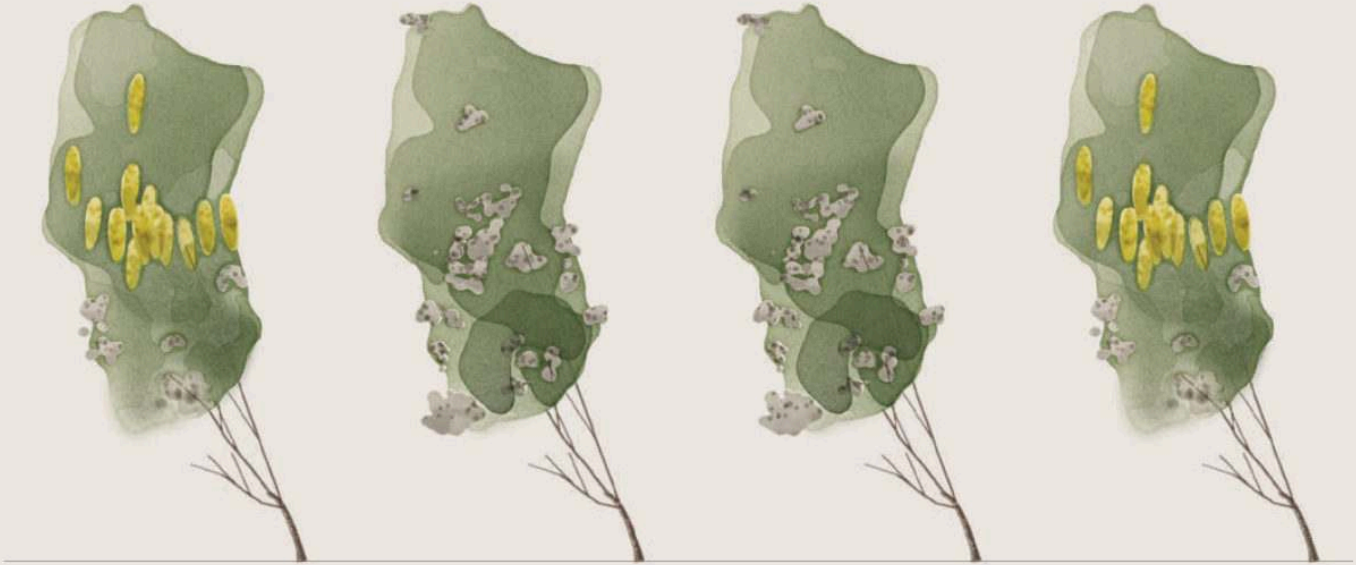
AGE AND SEASON STUDIES

In the top row the season is held and the age changes: seedling at 1.0 m, juvenile at 3.6 m, mature at 8.0 m. Underneath, the age is held and the season moves through summer, autumn, winter and spring, and the four drawings look close to each other. Banksia woodland does not have a northern autumn. So the four seasons look similar.

The bottom row is one inflorescence taken through maturity, from bud at m = 0.12, through two flowering states and a spent head, to green cone at 0.68 and woody cone at 1.00. Cone state tells a black-cockatoo whether the tree is worth working, and in many banksias the seed stays locked in the follicles until fire opens them (George 1984), so seed release also depends on fire.

A site visited once gets recorded in one of these states. Running the plant through its year also shows whether the site has food in February.





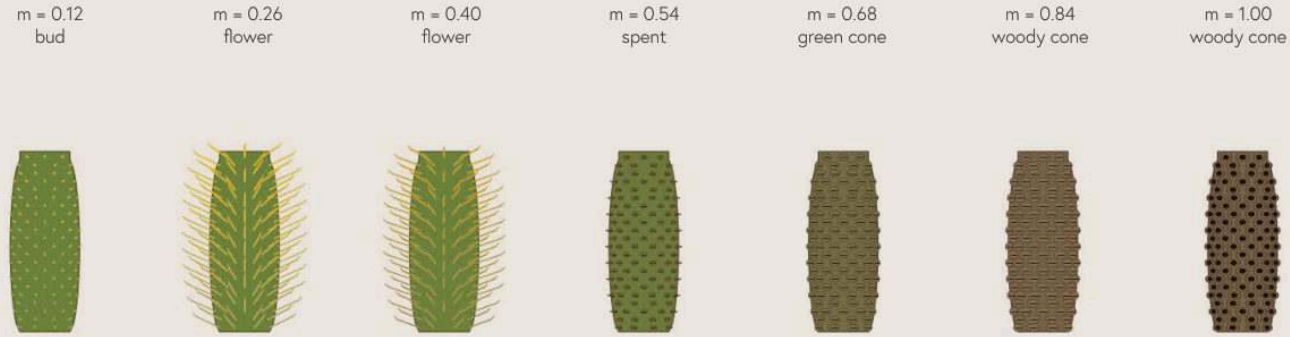
Banksia attenuata painted by the plugin at three ages on one ground line, then at 8.0 m through four seasons.
Figure by Author.





Banksia in flower and in bud. Warwick Bushland. Photograph by Author.

An old cone, the seed held. Warwick Bushland. Photograph by Author.



One Banksia attenuata inflorescence from bud to woody cone, drawn by the plugin. Figure by Author.

Watercolour rendering

PLANTS, 25 SEPTEMBER

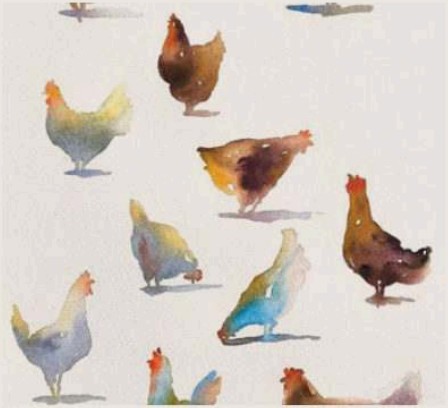


Corymbia ficifolia | Acer palmatum | Jacaranda mimosifolia | Quercus palustris | Eucalyptus marginata



Corymbia | Acacia | Kangaroo paw | Jacaranda

Top, the painterly dab style. Middle, the watercolour wash on the same five trees. Bottom, flowers laid as separate glazes.







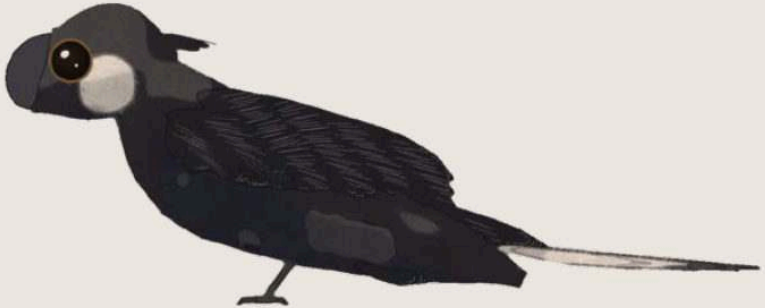


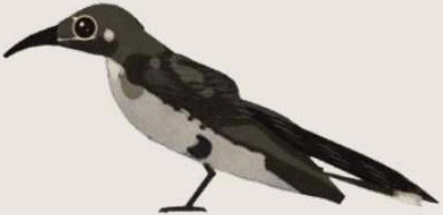




The reference board. Hens by Evgenia Dvornikova, tomatoes by Victoria Fitton. The other artists are still to be credited.

ANIMALS, 10 OCTOBER: GOUACHE FROM THE SAME RIG















Limitations: faults in the rig carry into the painting. The Christmas beetle reads as a smooth lump and the cockatoo crest is a stub, because both are missing on the model, not in the paint.

The library, a selection

VEGETATION

1 RED-AND-GREEN KANGAROO PAW (NOLLAMARA)

Anigozanthos manglesii.
Mature height 0.9 m. Roots to 0.5 m, rhizomatous.



Western Spinebill

New Holland Honeyeater



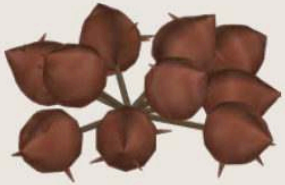
Growth stages, from a seedling to an old plant.



Through the seasons: winter, spring, summer and autumn.



Flower, Aug to Nov



Fruit



Leaf, laid flat, base on the left



Roots, to 0.2 m.



Growth stages, from a seedling to an old plant.



Through the seasons: winter, spring, summer and autumn.



Flower



Fruit



Leaf, laid flat, base on the left



Roots, to 0.5 m. Figure by Author.

3 JOINTED TWIG-RUSH

Baumea articulata.
Mature height 2 m. Roots to 0.5 m, rhizomatous.



Motorbike Frog



Growth stages, from a seedling to an old plant.



Through the seasons: winter, spring, summer and autumn.



Flower



Fruit



Leaf, laid flat, base on the left Roots, to 0.5 m.

4 PRICKLY COTTONHEAD

Conostylis aculeata.
Mature height 0.3 m. Roots to 0.2 m, fine fibrous.
Flowers Aug to Nov.



Blue-banded Bee

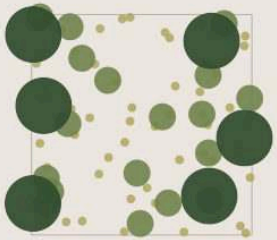


Christmas Beetle



Bull Ant

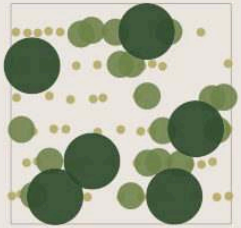
Grouping



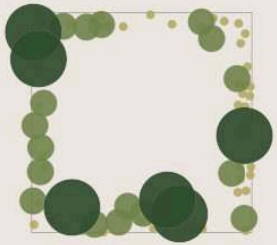
Scattered, 76 plants



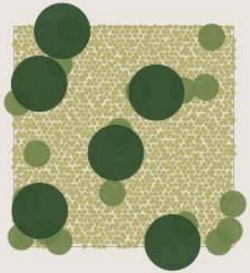
Clustered, 76



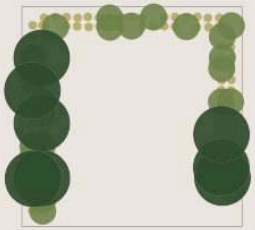
Linear, 76



Edge planting, 76

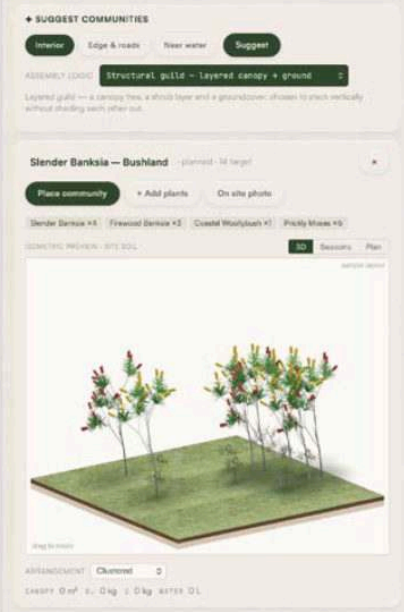


Dense mat, 2,216



Hedge or line, 102

The six arrangements in plan, each a run of the plugin's layout engine with one species mix on a 72 m² plot: trees dark green, shrubs mid green, ground layer pale. Figure by Author.



Vegetation Groups, with a suggested community placed in isometric.

SIX ARRANGEMENTS

The panel preview and the placement command in Rhino share one layout engine, so the card and the model cannot drift apart. The six arrangements are Scattered, Clustered, Linear, Edge planting, Dense mat, and Hedge or line.

Scattered uses blue noise sampling, which gives even spacing with natural gaps instead of the clumps and bald patches pure randomness produces. Clustered builds a few drifts and shares their centres across every species in the group, so a mixed community reads as one stand. Linear runs rows along the long axis, offset like brickwork where there is more than one. Edge planting holds a band against the boundary. Dense mat close-packs on a hexagonal grid; the frame shown was drawn at 212 mm spacing. Hedge or line is the only one that follows an open curve the designer draws instead of filling an area.

None of these is ecologically neutral. A dense mat shades out weeds and also shades out the seedlings of everything else. A scatter leaves open ground, and on Bassendean sand open ground is where veldt grass, Ehrharta calycina, gets in.



Structural guild



Mycorrhizal network



Root niche partition



Nurse and fixer



Fauna habitat guild



Year-round table



Pollinator chain

The seven grouping logics, as the Vegetation Groups panel draws them, at one scale. Figure by Author.

Plant and building lifespans

YEAR 1, THE SEEDLINGS DRAWN 3 TIMES LARGER





The fauna models



Australian Magpie



Australian Raven



Carnaby's Black-Cockatoo



Wedge-tailed Eagle

7 SEPTEMBER

Eighteen birds as painted flight shapes, seen from above. Figure by Author.

NEW JOINTED RIG

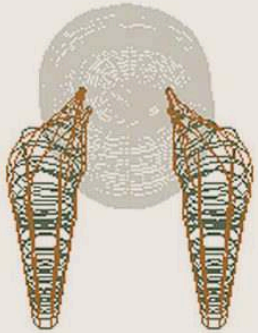




Silver Gull



Tawny Frogmouth



SEPTEMBER: FROM PAINTED SHAPES TO BODIES



Splendid Fairy-wren



Western Spinebill



New Holland Honeyeater



Willie Wagtail



Robin



Rainbow Bee-eater



Welcome Swallow



Australian Ringneck



Nankeen Kestrel



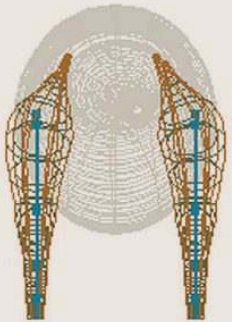
Sacred Kingfisher



Laughing Kookaburra



Galah



NEW JOINTED RIG

OLD TUBES

24 SEPTEMBER

A numbat's legs, the old tubes against the new jointed rig.



MOTORBIKE FROG



TEDDY BEAR BEE



WESTERN HONEY BEE

Named in the plant records

INSECTS

Painted from the rigs, in rank order within each group. Each painting follows the animal's body length, compressed so the smallest still read, and each page has its own scale: the insects are drawn far larger than the birds. Lengths from the fauna size records.



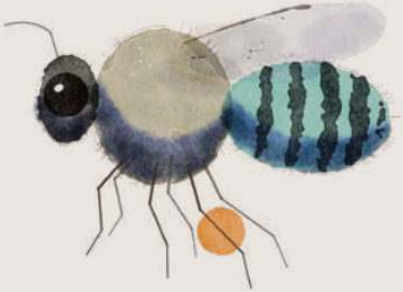
Christmas Beetle



Australian Painted Lady



Native Bee



Blue-banded Bee



Bull Ant



Hoverfly

BIRDS



Western Spinebill



Brushtail Possum



Motorbike Frog

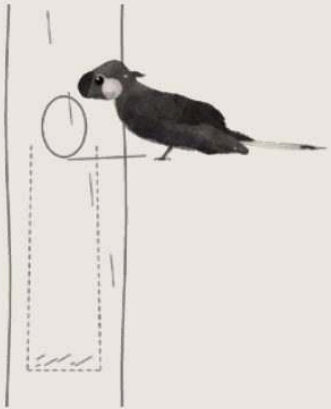


New Holland Honeyeater



Australian Ringneck

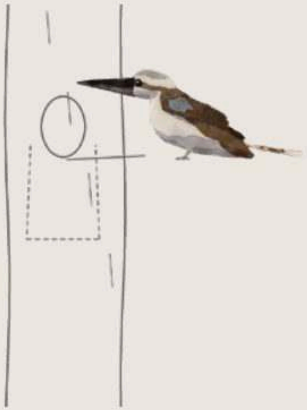
Nests and tree hollows



Carnaby's black-cockatoo: a deep hollow, wood chips at the base.



Australian ringneck at its hollow.



Laughing kookaburra: a bare chamber.



Nankeen kestrel: a scrape on the hollow floor.

Hollows and nests in ink, drawn from the nest records; the birds are watercolours painted from the rigs.

The feeding garden

ANIMALS



A western spinebill hovering at a flowering branch of slender banksia. Watercolour from the rig; the banksia painted from close-up photographs of the species, at true relative size.



Laughing kookaburra, which hunts by dropping from a perch.

Flower visitors

ANIMALS



A New Holland honeyeater among the flower spikes of a slender banksia. Each visit is painted from the rig in the pose the garden captured, bird and flower at true relative size; the banksia is painted from close-up photographs of the species.

Flower visitors, painted



Western spinebill hovering at the top flower of a whole kangaroo paw, bird and plant at true relative size.



Western spinebill at a kangaroo paw.



New Holland honeyeater landing at a slender banksia in flower. The banksia is painted from close-up photographs of the species, bird and flower at true relative size.

Seed eaters

Days in the hollow 70



Detail of the same painting: the cockatoo on the lowest branch.

Carnaby's record lists seeds, flowers and nectar, breeding from July to January, with one chick usually raised from two eggs after about 70 days in the hollow. Its seed diet from banksia, hakea and marri is noted as well known but not stated in the cited sources.

Months the marri holds seed	12
Chick usually raised	1

Seed eaters, painted

ANIMALS

THE PARTS: TWO PAINTED BIRDS, BY LENGTH TO THE POWER 0.33



Carnaby's black-cockatoo.

Predators in the feeding garden

ANIMALS



Night, at the frog pond: a red fox and a cub with a motorbike frog in its mouth. Every animal is painted from its rig in the pose the garden captured, at true relative size.



Laughing kookaburra dropping from its perch.

The honey possum



A honey possum at a scarlet banksia, Banksia coccinea. Photograph: source to be credited.

PAINTED FROM THE RIG, AND THE FIRST FEEDING TEST

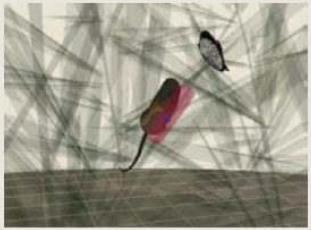


Watercolour, from three-quarters.



Gouache, from the same rig.

4 October: the snout aimed at a flower marker.



THE RIG NOW, AGAINST TWO PHOTOGRAPHS



Side. Photograph: Thomas Mesaglio, iNaturalist, CC BY, mirrored.



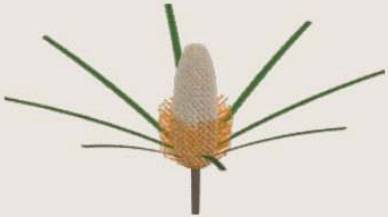
Scarlet banksia



Bull banksia



Firewood banksia



Acorn banksia



Lesser bottlebrush

The flower of each species from the builder, smooth-shaded, each drawn to fill its cell: scarlet, bull, firewood and acorn banksias, and a lesser bottlebrush.

Introduced animals and urban pressures

ANIMALS



Pet cat. 186 kills a year when it roams. The cat, dog, fox and rabbit share one scale, set by body length to the power 0.33 so the rabbit still reads.



European rabbit. Four to five litters a year.

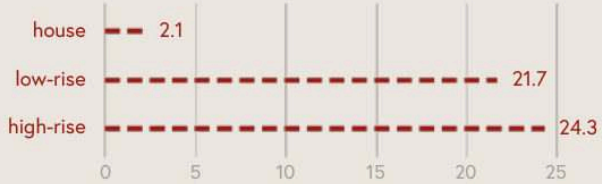
INTRODUCED ANIMALS, PAINTED FROM THEIR 3D MODELS



Red fox. Listed as a predator in 119 records.

BIRDS KILLED BY GLASS, PER BUILDING A YEAR (US MEDIANS)

red dashed: brought by people



Source held in the records: Loss et al. 2014 (US medians, no Australian rate found).

FERAL HONEY BEES



A European honey bee, the feral bee of the records, at Kings Park. Photograph by Author.

Habitat fittings



An earth-block wall carrying a bee hotel, with a nest box on a post, a bird bath and a frog pond edge, planted with kangaroo paw, grevillea, hibbertia, a grass tree and a banksia.

ON THE GROUND, DRAWN AT 1:20

0 500 mm

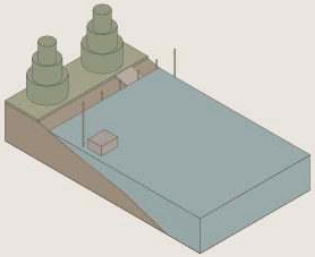


450 by 450 by 886 mm high. A shallow 2 to 3 cm margin for small honeyeaters, on an 80 cm pedestal.

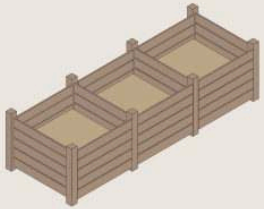
412 by 643 by 1,043 mm high. Langstroth boxes, eight or ten frames, on a stand.

534 by 702 by 805 mm high. A four-tray stack with a collector tray and tap.

FOR FROGS, DRAWN AT 1:40 0 1,000 mm



FOR THE SOIL, DRAWN AT 1:40 0 1,000 mm



COMPOST BAYS

3,400 by 1,200 by 895 mm high. Three bays of 1,000 mm with removable front boards.

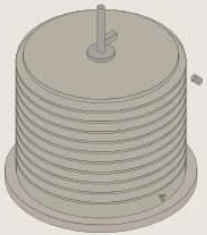
2,000 by 3,550 by 1,450 mm high. A shallow sloping side, then 600 mm deep at the deepest, with logs and rocks.

FOR WATER, DRAWN AT 1:40

0 1,000 mm

FOR FOOD, DRAWN AT 1:40

0 1,000 mm

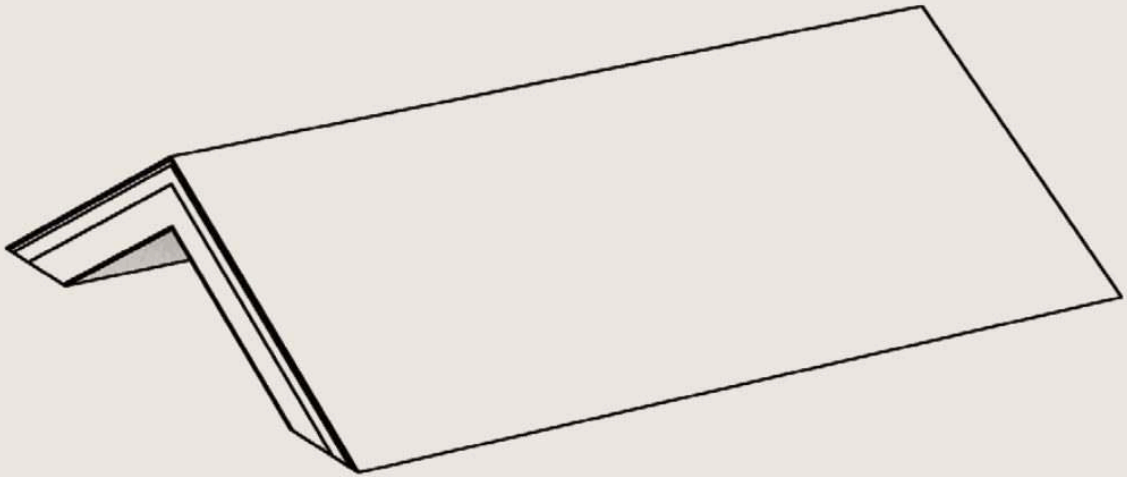




2,471 by 2,473 by 2,680 mm high. Round tanks from 1,800 to 13,600 litres, with corrugation rings; drawn at 5,200 litres.

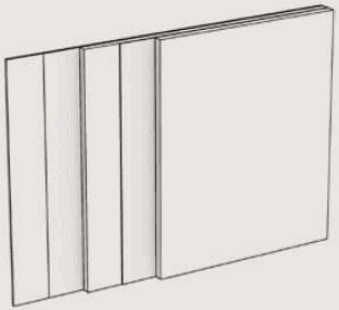
1,840 by 940 by 665 mm high. 1.24 square metres of growing area.

Assembly types



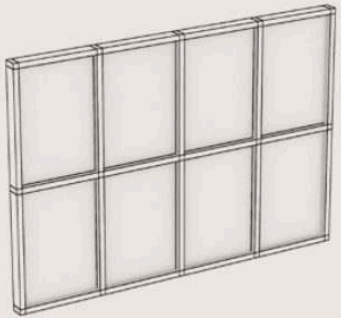
Pitched, flat and green roofs, each from its assembly's layers.

Terracotta Tiles, 15 mm	Interlocking clay tiles
Tile battens, 25 mm	50 x 25 tile battens at 330
Rafters, 90 mm	90 x 45 rafters at 600
Sarking, 1 mm	Reflective sarking
Cellulose Insulation, 200 mm	R5 in the ceiling
Clay Board Ceiling, 13 mm	Clay board



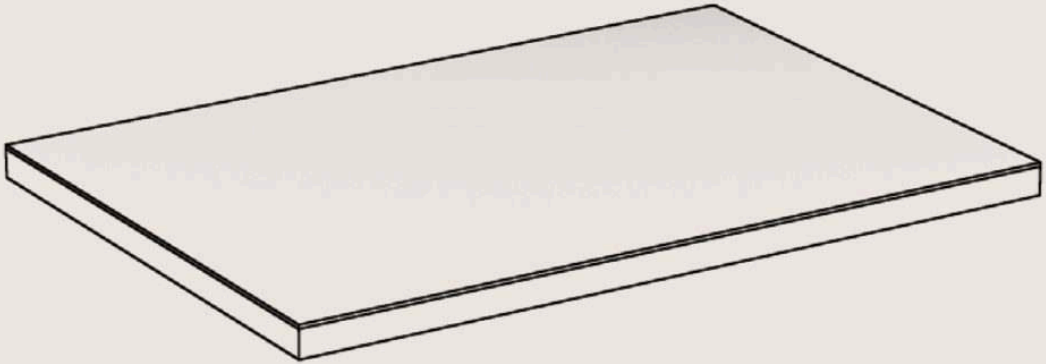
LAYERED WALLS

One solid for each material, so a wall reports what it is made of and how much of each.



CURTAIN WALLS

Mullions and transoms set out from the type's grid, carrying glass or panels.



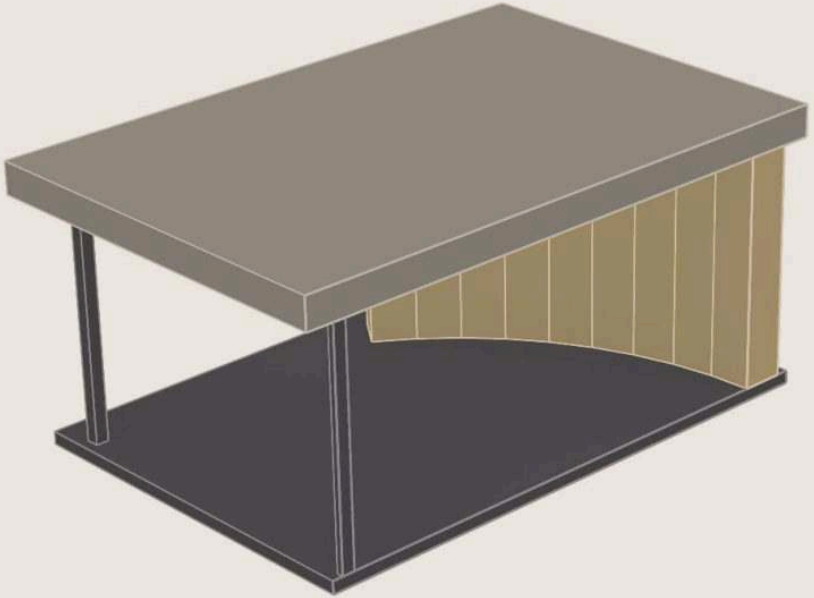
A floor built in layers over a drawn outline.

Hardwood Boards, 19 mm	Tongue and groove jarrah
Joists with sheep wool, 140 mm	R3 between joists; 140 x 45 joists at 450

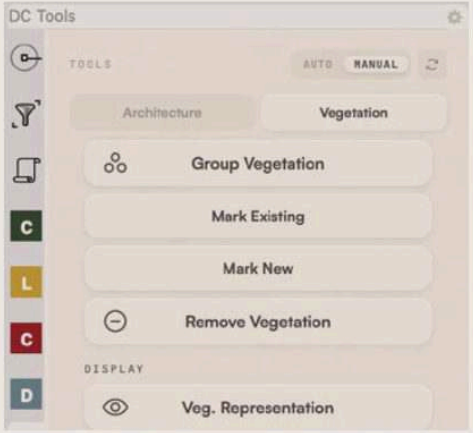
THE FIRST MODEL, AS IT IS DRAWN NOW



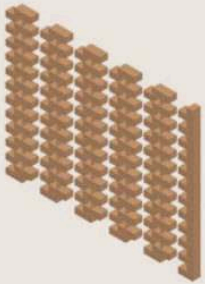
A bay drawn with its own walls, slab, posts and roof. Figure by Author.



A wall drawn from an arc with the same tool, on its slab, with posts and a flat roof.



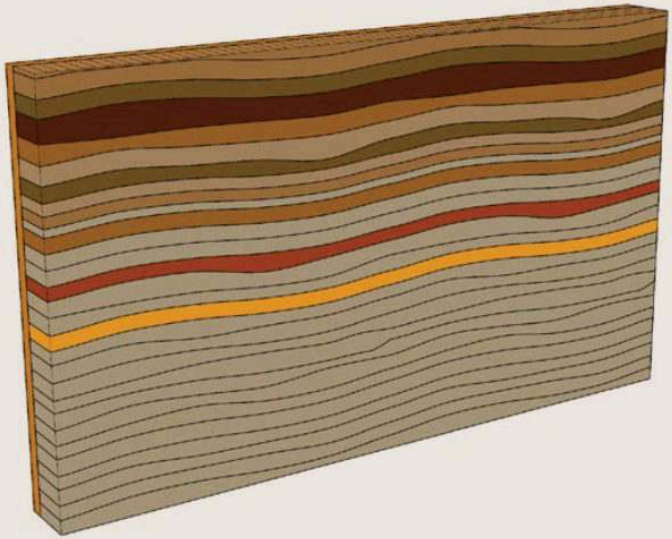
Docked in Rhino, with Vegetation open: group, mark and remove, and how the plants are shown.



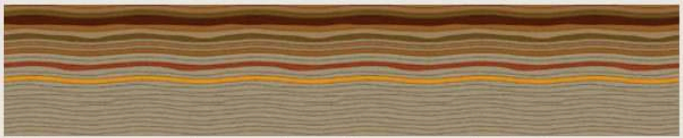
Laid as a screen with open joints.

Walls made of the site

A STRATA WALL, AS DRAWN IN RHINO

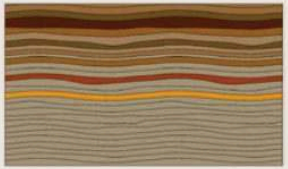


31 bands from the site soils, Pen display. Figure by Author.



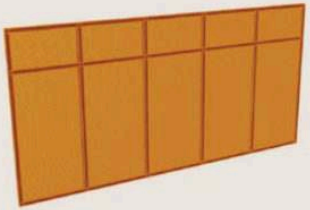
The bands meet at each join, so a long wall has no seam. Sketched first on page 122.

THE SAME WALL, THREE TIMES, END TO END



The strata wall flat on: the bands pinch and swell but never cross.

CURTAIN WALL ASSEMBLIES, ONE RENDER SCALE



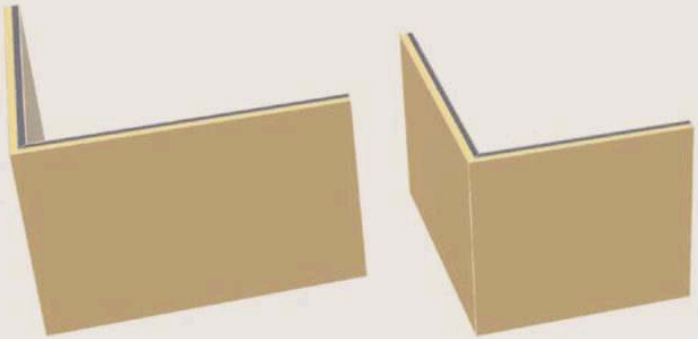
The panel holes come from an image.



A second panel set.

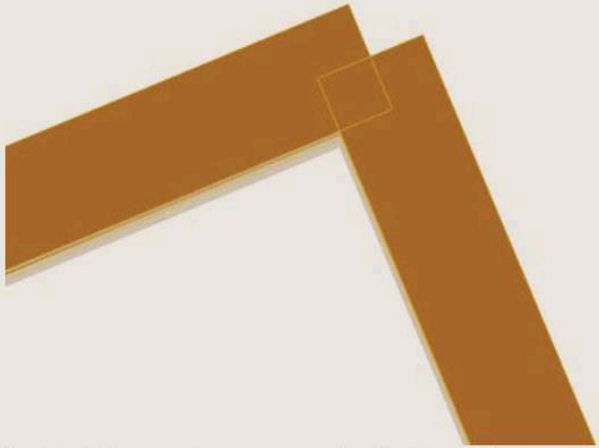
How walls meet

AFTER THE FIX, BUILT IN RHINO ON 11 OCTOBER



Steel frame wall, 202 mm in four layers, 2.7 m high.

The same wall, drawn as two walls and joined.



Not joined. The two ends stay square and overlap. Next, cutting the bands on a mitre.

Stratigraphical walls



Horizontal



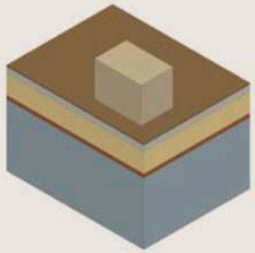
Wavy



Lens

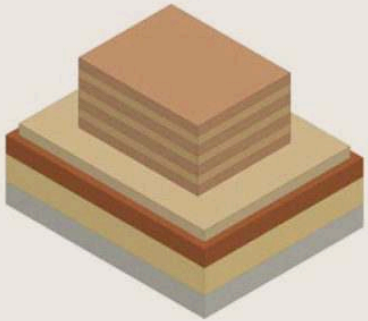


Fine

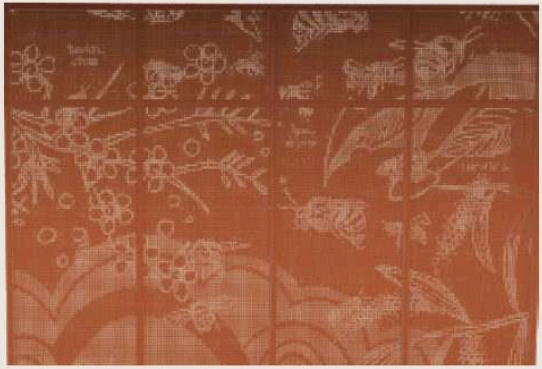


The wall set into the ground, horizons continuing below.

The four lift patterns the engine lays down, from the site's own horizons.



The wall in compacted lifts, over the site horizons.



The four perforated panels enlarged: hole size follows the artwork, dark areas open, light areas close.



Perforated curtain wall with image-driven hole pattern, slatted bays and open bays. Figure by Author.

Layered and strata walls

LAYERED WALLS, EACH LAYER STOPPED SHORT SO THE BUILD-UP SHOWS

Each type built in Rhino by the plugin from its library record, 3.9 m long and 2.7 m high, Pen display. All walls on these pages at one scale. Figure by Author.



230 mm, 5 layers



RAMMED EARTH WITH INSULATED STUD LINING

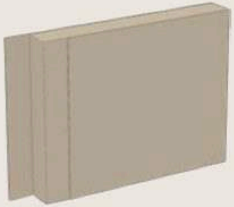
403 mm, 3 layers

A 300 mm rammed earth wall, earth outside, with a 90 mm insulated stud lining and plasterboard inside for services and insulation.

TIMBER FRAME EXTERIOR WALL, HEMP INSULATION

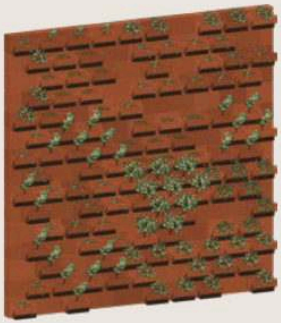


340 mm, 3 layers



505 mm, 3 layers

STRAW BALE WALL, LIME AND CLAY RENDER



230 mm deep, 3 m high

2 L/m² a day, 110 kg/m² wet, 37 kg CO2e/m²

1.17 L/m² a day, 15 kg/m² wet, 29 kg CO2e/m²



180 mm deep, 3 m high



400 mm deep, 1.8 m high



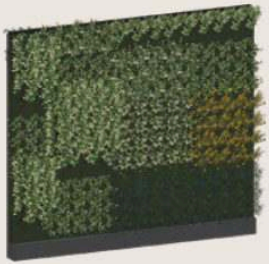
1000 mm deep, 3 m high

PRE-GROWN HEDGE SCREEN IN A TROUGH

EXPANDED-METAL SHELVES (PARTY WALL)

1.56 L/m² a day, 16 kg/m² wet, 23 kg CO2e/m²

1.4 L/m² a day, 225 kg/m² wet, 76 kg CO2e/m²



140 mm deep, 2.4 m high



270 mm deep, 3 m high

BRICK LATTICE WITH TRAILING PLANTER

4 L/m² a day, 40 kg/m² wet, 49 kg CO2e/m²

0.65 L/m² a day, 140 kg/m² wet, 144 kg CO2e/m²



180 mm deep, 3 m high

Under each type: its depth and height as drawn, then water a day, wet weight on the wall and embodied carbon per square metre, from the tool's report on the run shown. Each type drawn 3.0 m long from one camera at one scale and planted by the tool with library species suited to it. Figure by Author.

STAINLESS ROPE NET, WEBNET TYPE

1.17 L/m² a day, 10 kg/m² wet, 31 kg CO2e/m²



430 mm deep, 2.7 m high

Under each type: its depth and height as drawn, then water a day, wet weight on the wall and embodied carbon per square metre, from the tool's report on the run shown. Each type drawn 3.0 m long from one camera at one scale and planted by the tool with library species suited to it. Figure by Author.

1.35 L/m² a day, 70 kg/m² wet, 32 kg CO2e/m²



1660 mm deep, 0.5 m high

BENCH-EDGE PLANTER ALONG A PATH

9.33 L/m² a day, stands on the ground, 131 kg CO2e/m²

2 L/m² a day, stands on the ground, 40 kg CO2e/m²



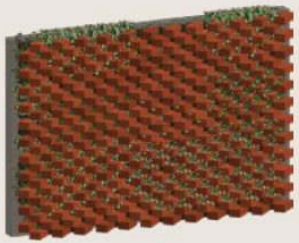
750 mm deep, 1.2 m high



1800 mm deep, 0.6 m high

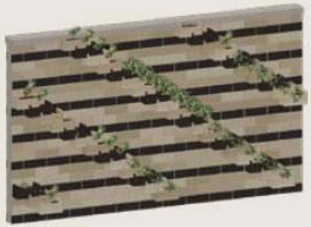
6 L/m² a day, stands on the ground, 11 kg CO2e/m²

2 L/m² a day, stands on the ground, 84 kg CO2e/m²



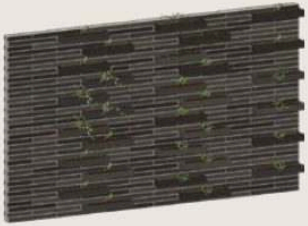
240 mm deep, 2 m high

Brick walls



Stretcher bond, standard brick 230 x 110 x 76 mm, 230 mm deep

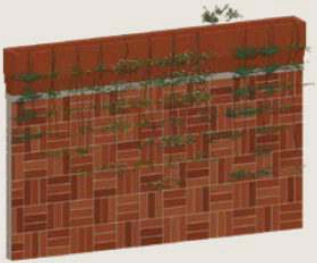
1 L/m² a day, stands on the ground, 87 kg CO2e/m²



LONG-FORMAT BRICK WITH PLANTER GRID

Stretcher bond, roman (long, thin) 490 x 90 x 40 mm, 230 mm deep

1 L/m² a day, stands on the ground, 34 kg CO2e/m²



Basketweave, standard brick 230 x 110 x 76 mm, 230 mm deep

1.09 L/m² a day, stands on the ground, 236 kg CO2e/m²



HERRINGBONE PANEL WITH PLANTER TOP

Herringbone, standard brick 230 x 110 x 76 mm, 110 mm deep

1.09 L/m² a day, stands on the ground, 236 kg CO2e/m²





FLEMISH BOND WITH DIAPER PATTERN

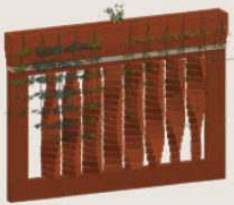
ENGLISH BOND, RECYCLED BRICK, PLANTING STRIPES

Flemish bond, standard brick 230 x 110 x 76 mm, 230 mm deep

English bond, recycled brick 230 x 110 x 76 mm, 230 mm deep

1 L/m² a day, stands on the ground, 87 kg CO2e/m²

1 L/m² a day, stands on the ground, 4 kg CO2e/m²

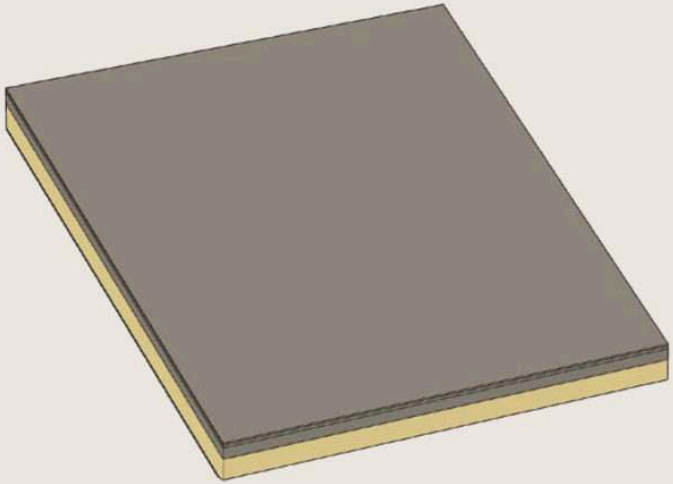


Twisted bond, standard brick 230 x 110 x 76 mm, 230 mm deep

1.09 L/m² a day, stands on the ground, 236 kg CO2e/m²

Under each wall: its bond, its brick as length by depth by height, and its depth, then water a day and embodied carbon per square metre from the tool's report. Each wall drawn 3.0 m long and 1.8 m high from one camera at one scale, painted by the author.

ROOF FORMS, ONE ASSEMBLY OVER ONE 3.9 BY 3.0 M PLAN, 30 DEGREES



One pitch over the whole depth, so at 30 degrees it rises twice as high as the gable.

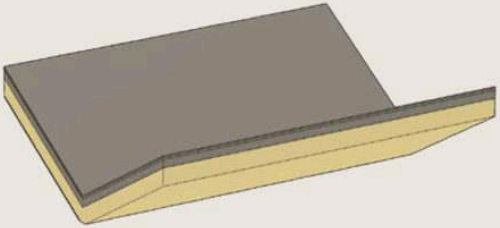


Two pitches meeting at a ridge.

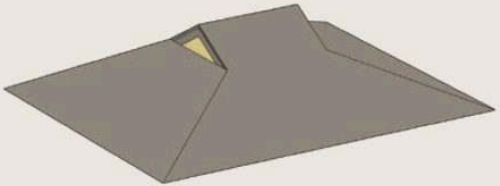


Four pitches, the ends sloped as well.

GABLE



Two pitches falling to a valley.

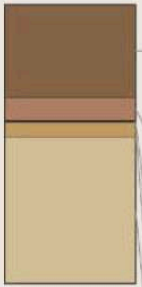


A hip with a small gable at the ridge.

Each form built in Rhino by the plugin from the same roof assembly, Pen display, all at one scale. Figure by Author.

GREEN ROOFS, BUILD-UPS AT 1:10

EXTENSIVE GREEN ROOF, TIMBER DECK, 361 MM



Lightweight Growing Media, 120 mm
Scoria-based extensive media

Drainage and Retention Layer, 30 mm
Drainage cell filled with scoria

EPDM Membrane, 2 mm
Root-resistant EPDM

Plywood Deck, 19 mm
F14 plywood on falls

Rafters with cellulose, 190 mm
Blown cellulose R4; 190 x 45 rafters at 450

INTENSIVE GREEN ROOF, CONCRETE DECK, 632 MM



Growing Media, 250 mm
Lightweight media

Topsoil, 50 mm
Loam top for planting

Drainage Layer, 50 mm
Scoria drainage

EPDM Membrane, 2 mm
Root-resistant EPDM

Low-carbon Concrete Deck, 200 mm
Post-tensioned slab

Cork Insulation, 80 mm
Cork soffit insulation

GARDEN ROOF, GARDNET SLOPED (OVER 3:12), 416 MM



Vegetation (sedum mat or tile), 20 mm
Pre-grown mat on steep pitches

LiteTop media in GardNet cells, 100 mm
Fills 100 mm cells

GardNet HDPE cells and tendons (solid equivalent), 3 mm
75-300 mm cells, 4.76 mm braided steel tendons

Hydrodrain drainage, 10 mm
Drainage composite

Styrofoam XPS insulation, 75 mm
Inverted roof insulation

Hydroflex RB root barrier, 1 mm
Root barrier and protection

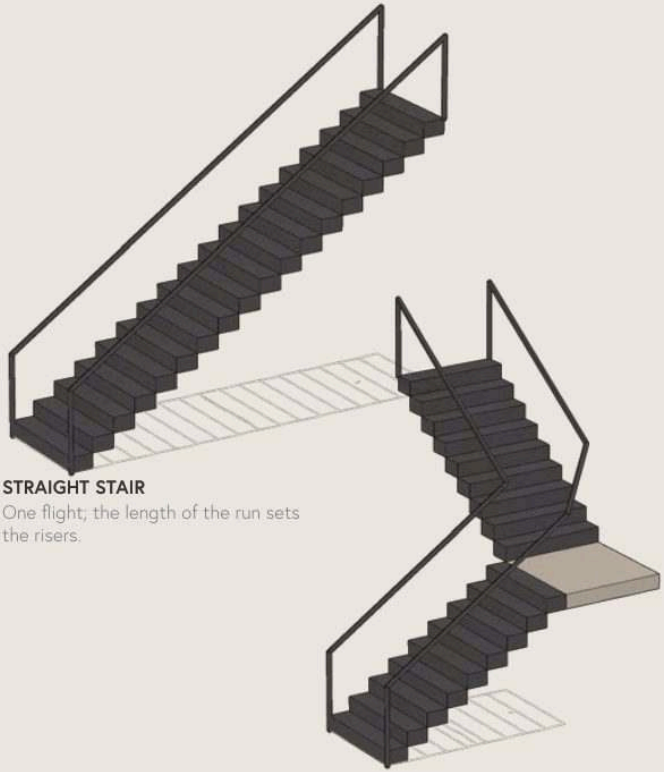
MM6125-FR rubberised asphalt, 6 mm
Hot fluid applied, reinforced

Surface conditioner, 1 mm
Primer

Concrete deck, 200 mm
Approved structural substrate

The three green roofs at the same 1:10, planting up; each layer, thickness and specification from its record. Figure by Author.

STAIRS, ONE STOREY OF 3.0 M



STRAIGHT STAIR
One flight; the length of the run sets the risers.

L STAIR
Two flights turning a corner at a landing.

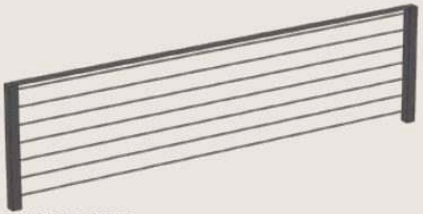
RAILINGS AND SCREENS, 3.9 M RUNS



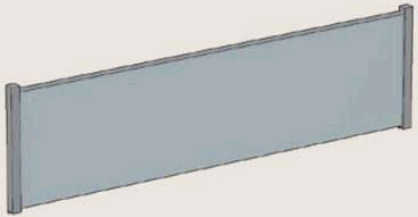
HARDWOOD BATTEN BALUSTRADE



RAILINGS AND SCREENS, CONTINUED



CABLE RAILING



Habitat walls

ASSEMBLIES

6 SEP 2026

TEST

Climbers on one wall at years 1, 2, 3, 5 and mature.

FINDING

A 72 degree fan threw a 3 m ivy across 10.5 m of wall, against a 2 m spread.

CHANGE

The fan now runs on a sideways budget taken from the species spread.

FACES AT EACH GROWTH STAGE, EACH CLIMBER TO ITS OWN SCALE



Hedera helix, English ivy: self-clinging, fanning across the masonry.

Epipremnum aureum: rooted at the head of the wall and trailing down its face.

Hardenbergia comptoniana, native wisteria: set along the base and climbing. Figure by Author.

Year 1, growth 0.12, shown 1.3x
2,404 faces



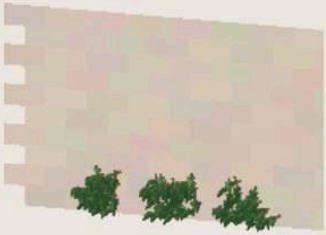
Year 1, growth 0.12, shown 2.8x
816 faces



Year 1, growth 0.12, shown 2.7x
1,230 faces



Year 2, growth 0.30
21,996 faces



Year 2, growth 0.30
2,890 faces



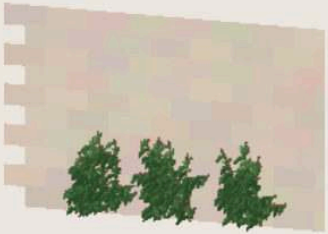
Year 2, growth 0.30
9,166 faces



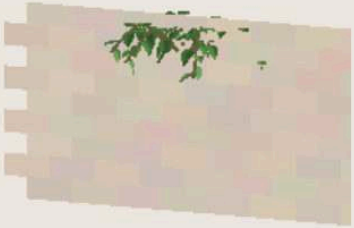
Year 3, growth 0.52
51,586 faces

Year 3, growth 0.52
6,916 faces

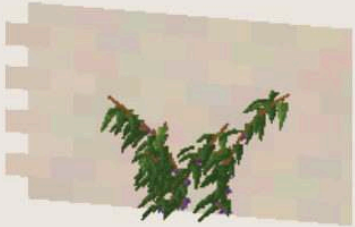
Year 3, growth 0.52
14,904 faces



Year 5, growth 0.78
84,620 faces



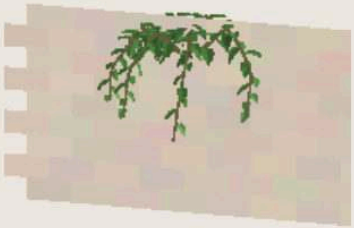
Year 5, growth 0.78
12,882 faces



Year 5, growth 0.78
32,998 faces



Mature, growth 1.00
202,230 faces



Mature, growth 1.00
16,740 faces



Mature, growth 1.00
38,736 faces

HABITAT WALLS, CONTINUED: A CLIMBER GROWN OFF THE WALL



A CREEPER ON THE GROUND



Green walls and planters

Because the plants are library species, a green wall reports the same flowering and fauna records as the ground planting.



Kennedia prostrata, scarlet runner, at the same five growth values, one scale.

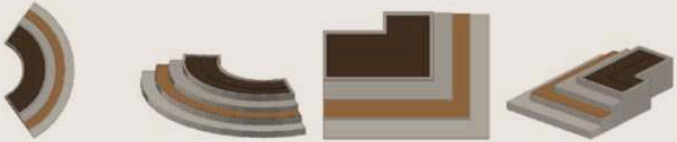


CLOSER, IN THE SAME MODEL



Planted ledges: grasses and groundcovers set along each ledge by the tool.

SEATING STEPS WITH PLANTING



BRICK WALL WITH PLANTER BRICKS



STACKED PLANTER BLOCKS



AS DRAWN

KERB AMPLITUDE 0, KERB HEIGHT 450

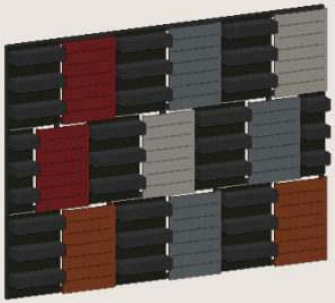
KERB AMPLITUDE 320, KERB LENGTH 2500, BROWN

BENCH-EDGE PLANTER ALONG A PATH





AS DRAWN



TURN MAX 0, NO POOL

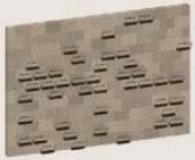


TURN MAX 40, CELL WIDTH 450

TERRACOTTA POCKET BLOCKS



AS DRAWN



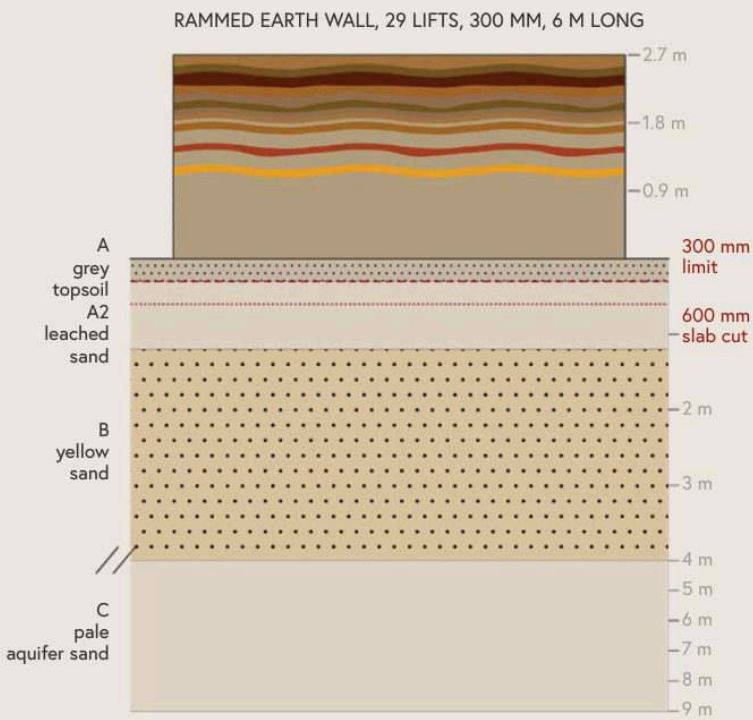
PLANTED SHARE 0.3, CREAM



CELL WIDTH 450, POCKET DEPTH 180, LIP HEIGHT 180

Each type redrawn with its settings changed in the panel; lengths in millimetres, angles in degrees. Figure by Author.

Reading the ground



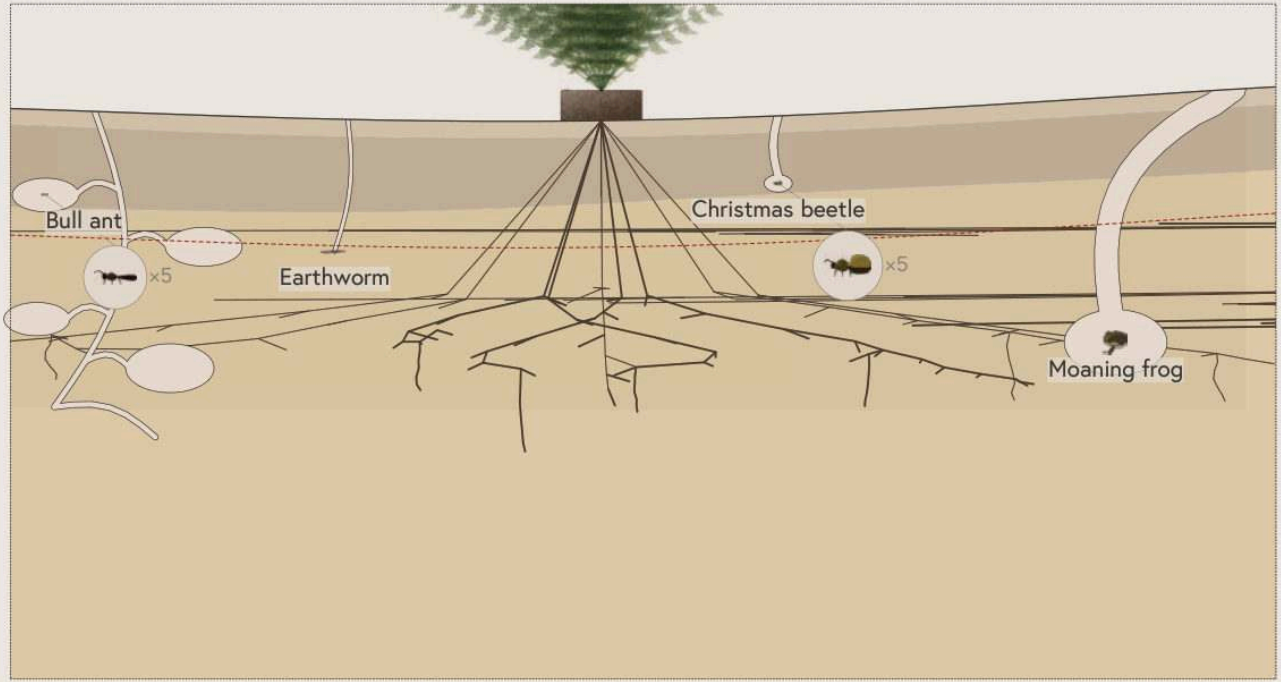
A strata wall drawn by the plugin, 6 m long and 2.7 m high, over the ground at Warwick, at the scale and on the ground line of the root sections that follow. Horizons indicative, not surveyed at Warwick. Figure by Author.



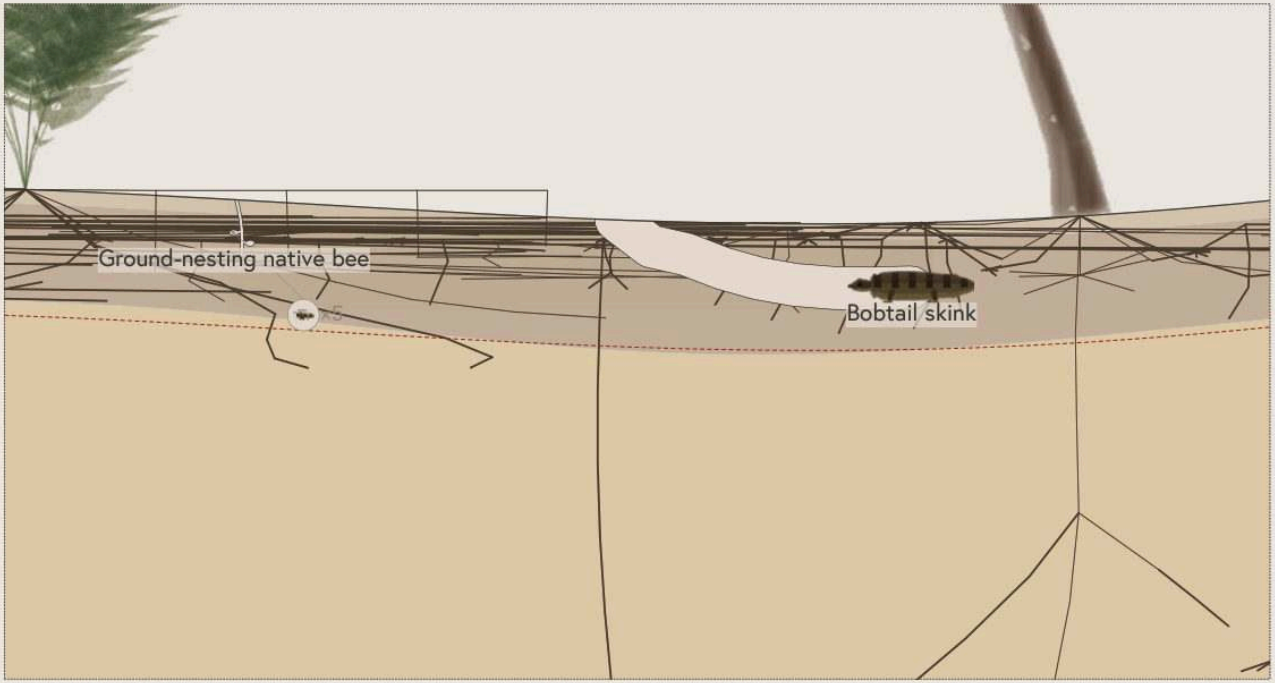
Soil profiles drawn as bands. Reference collected 25 August 2026; source to be credited.

The live section

1

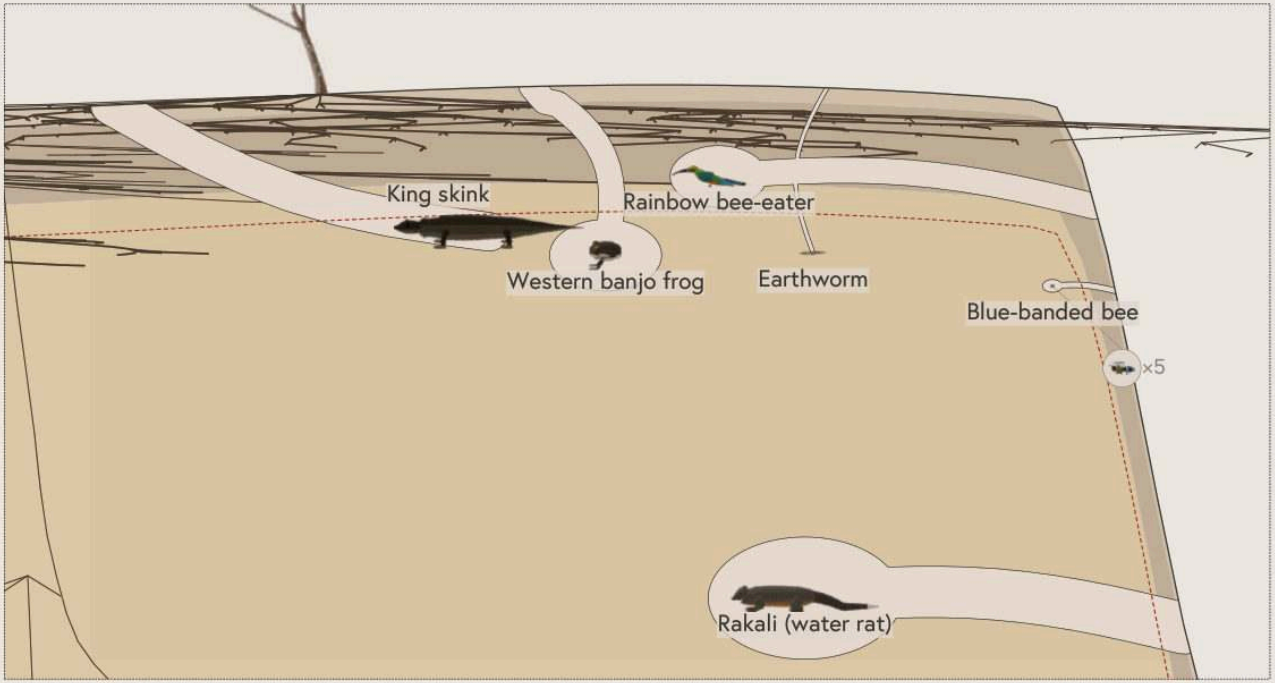


2

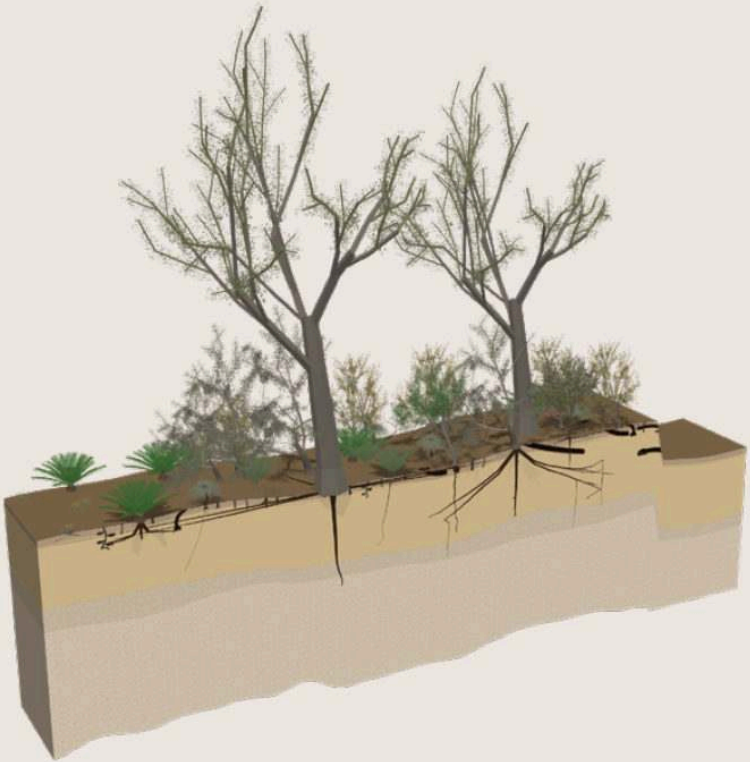


Windows 1 to 3, enlarged. Animals from the plugin's own rigs, at true size; insects also shown five times larger in circles. Burrow depths from the soil section's fauna records. Figure by Author.

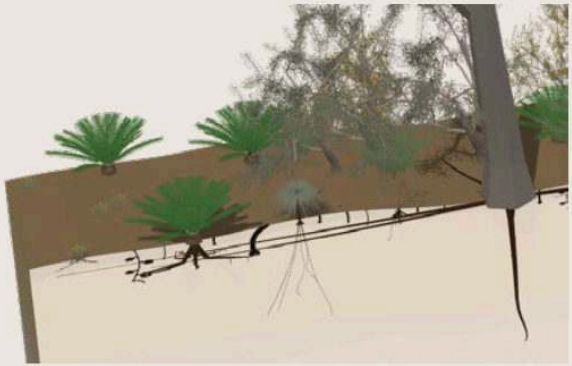
3


King skink
Rainbow bee-eater
Western banjo frog
Earthworm
Blue-banded bee
×5
Rakali (water rat)

The live section in 3D

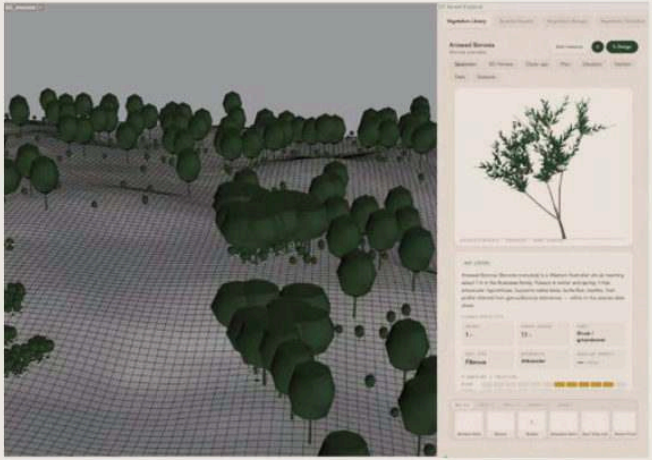


1

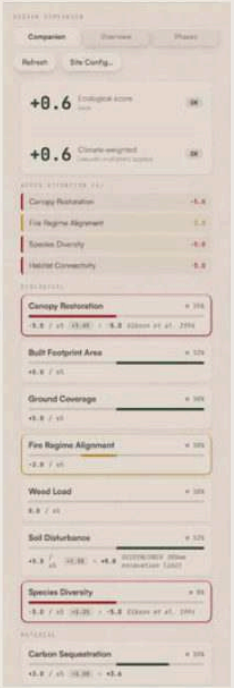


The live section in 3D, as the Design Companion shows it: 28 m of cut, the soil column under the planting. Render from the plugin. Figure by Author.

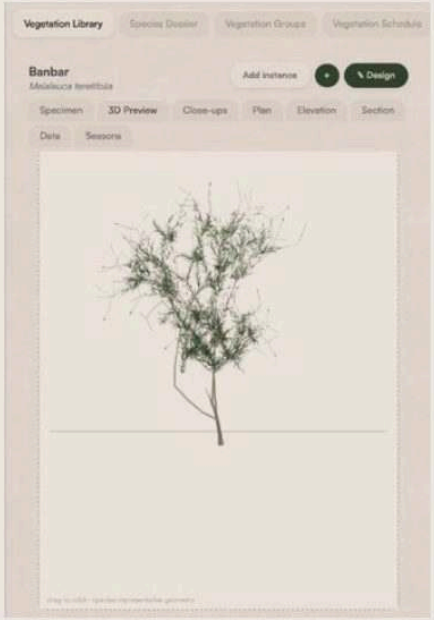
The companion in Rhino



The Design Companion in Rhino 8: the model explorer at right, one species open; the ledger, docked at left, is cropped here and shown enlarged beside. Figure by Author.

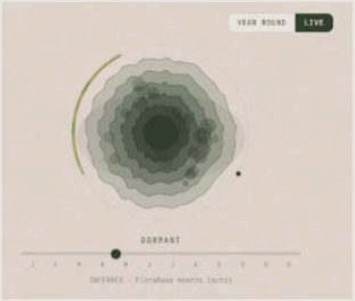


The ledger from the Rhino screenshot, enlarged: the two scores, the four cards that need attention and the weighted parameters with their sources.

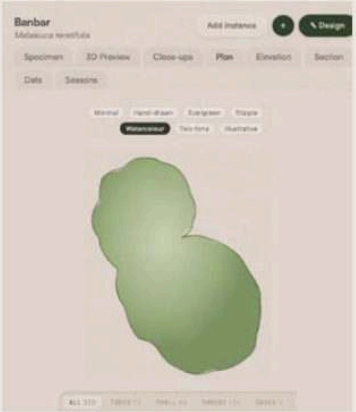


The Vegetation Library with Banbar open in 3D Preview: the eight views of one record as tabs, and the model drawn from it.

Section, seasons, plan



Seasons, live: one month at a time, here dormant.



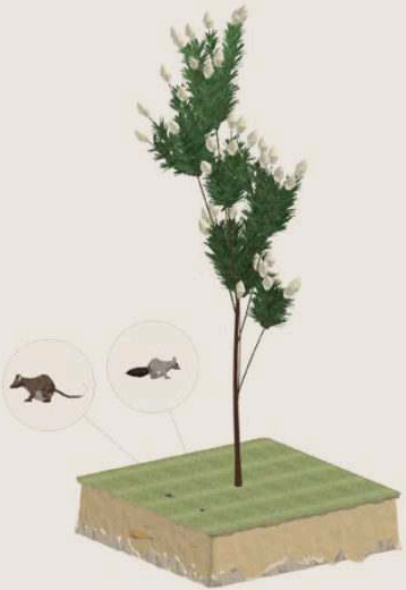
Plan, in one of its seven styles: the style chips, the generated plan symbol and the species rail's filters, with the empty field between them cut out.

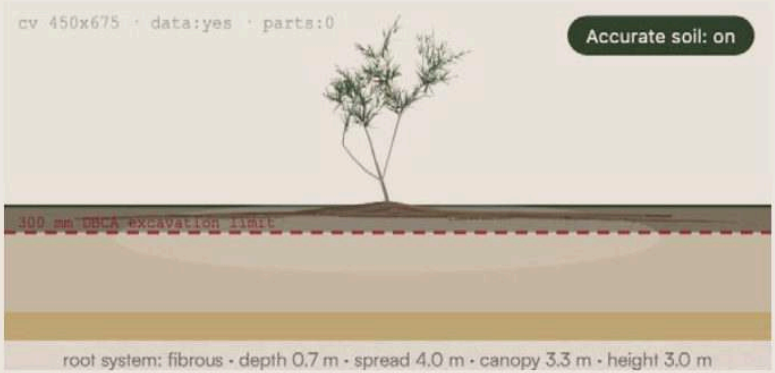
Top left: Banksia attenuata with the animals its record names: Carnaby's Black-Cockatoo, Western Spinebill and New Holland Honeyeater.

Top right: the same plot without the plant. The animals are ghosted.

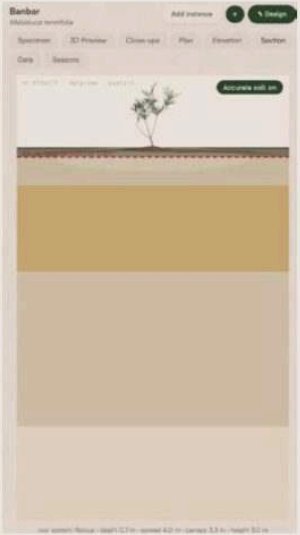
Right: Eucalyptus marginata with its animals: a Western Ringtail and a Brushtail Possum on the ground, too small at true size to read, so each is shown again six times larger in a circle.

Animals in these three plots are the plugin's rig watercolours, set in place of the 3D rigs of the render. All three plots at one scale.





Section, with the site soil switched on: the plant, its fibrous roots and the 300 mm excavation limit, enlarged from the view below right.



The whole Section view: the four horizons of the Bassendean sand under the plant.



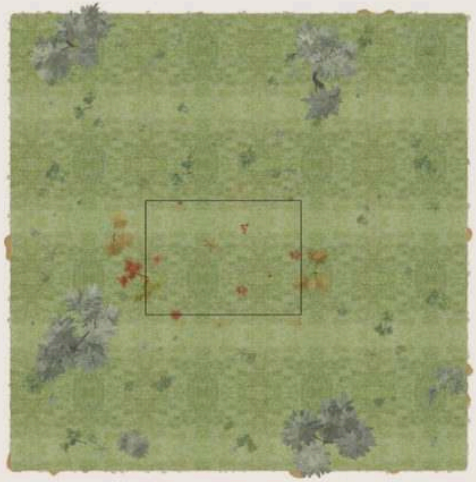
A second scenario run, three views: the stand before, the footprint outlined with the trees it reaches coloured, and the massing in place. Renders from the plugin. Figure by Author.



Before.



With the footprint.



The losses, in plan.



After.

One scenario over the recorded stand: before, with the footprint, the losses in plan, and after.





Curtin, open data only. Yellow: crowns from the Meta 1 m canopy height map. Blue: trees mapped in OpenStreetMap. Pink: modelled trees where the satellite shows living tree cover.

Curtin, the same ground, crowns detected from the site photograph.

The ledger without the plugin



Western Grey Kangaroo, 2 m long

Red Fox, 1.05 m long

Brushtail Possum, 0.72 m long

Western Ringtail Possum, 0.7 m long



Echidna, 0.4 m long

Honey Possum, 0.165 m long

Seven mammal rigs as the plugin paints them, each drawn at its total length to the power 0.33 so a kangaroo and a honey possum still read together; lengths from the plugin's life-size records. Figure by Author.





Splendid Fairy-wren



Western Spinebill



New Holland Honeyeater



Rainbow Bee-eater



Welcome Swallow



Australian Ringneck



Laughing Kookaburra



Galah



Australian Magpie



Tawny Frogmouth



Carnaby's Black-Cockatoo



Wedge-tailed Eagle

The first birds in the Living Field, drawn as flat top-down shapes and replaced by full rigs (page 100): Splendid Fairy-wren, Western Spinebill, New Holland Honeyeater, Rainbow Bee-eater, Welcome Swallow, Australian Ringneck, Laughing Kookaburra, Galah, Australian Magpie, Tawny Frogmouth, Carnaby's Black-Cockatoo and Wedge-tailed Eagle. Figure by Author.

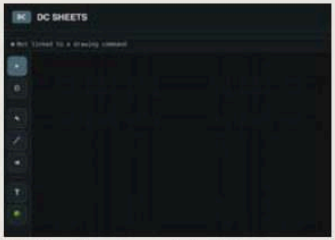


Quenda (Bandicoot), 0.45 m long



Two plots from the Living Field on the site soil, a grass tree and a tree; the two birds in its crown are too small to read at this size. Renders from the plugin. Figure by Author.

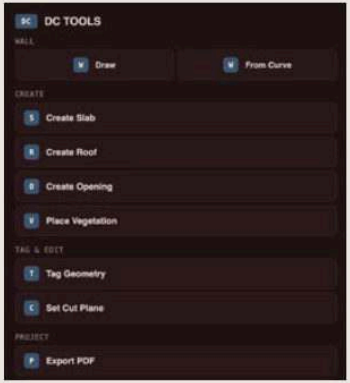
THE INTERFACE, VERSION BY VERSION

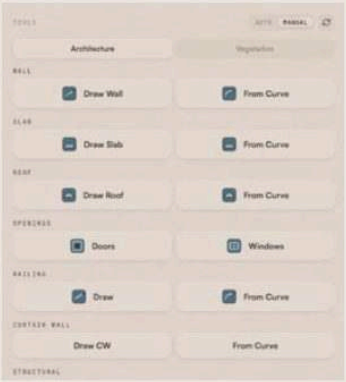




The first Sheets panel, dark: its title, status line and a short tool rail.

Sheets on paper, with the Illustrate and Arch switch and the drawing tools down the side.





27 JUNE



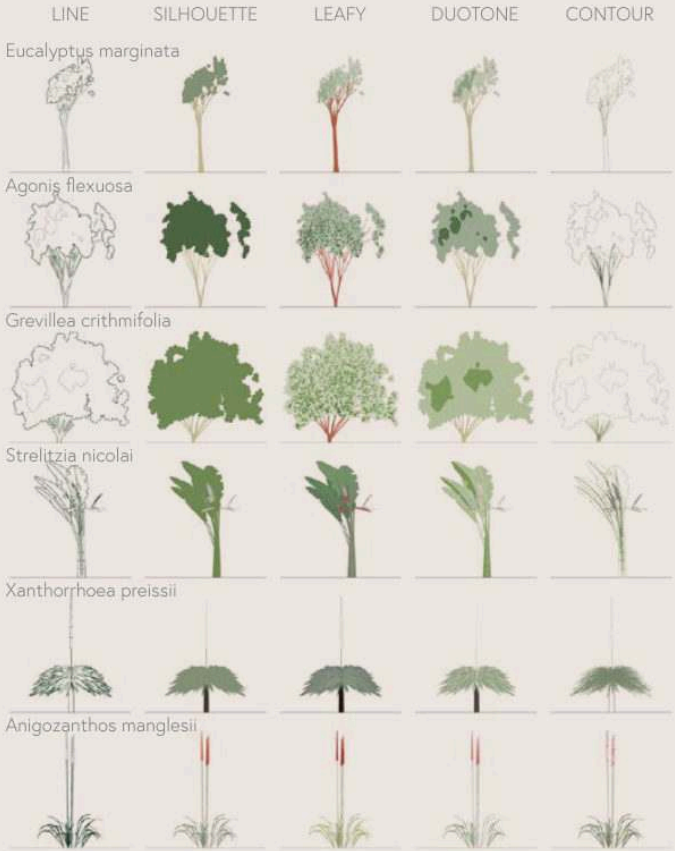
A Site Studio basemap of the context. Figure by Author.

9 JULY

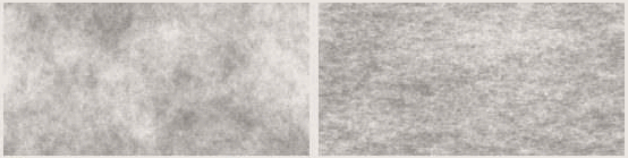


21 SEPTEMBER

The Lifecycle Visualiser, opening screen.



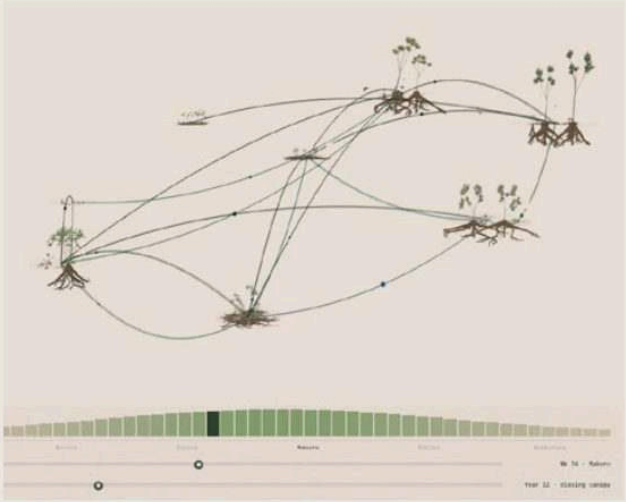
The elevation styles sheet: five styles, one species to a row.



Watercolour rag and paper fibre, the first textures.

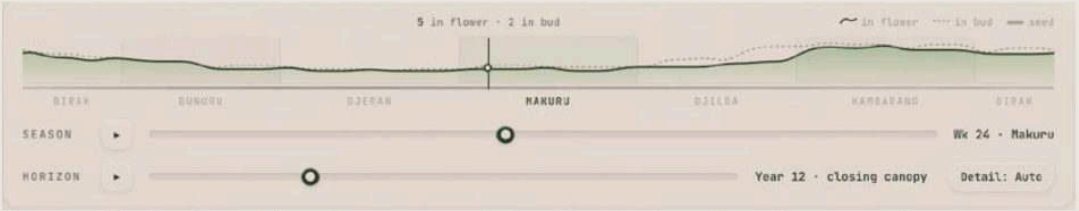
A standalone app

THE TOOL



The first diagram view: the plant groups float as a habitat network above the season and horizon bars.

The scenario engine was written on 5 August. The twenty scenarios, as drawn on 1 October, are on pages 418 and 419. Figure by Author.



Flowering, bud and seed through the six Noongar seasons; the horizon runs the planting forward, here to year 12.

ONE CORE, THREE HOSTS

HOSTS

RHINO

The plugin, as before. Reads and writes the project inside a .3dm.

DESKTOP APP

A local server and the Studio page, with no Rhino installed.

WEB

The same page, hosted.

ONE CORE

DC CORE, IN PLAIN PYTHON

The ledger, the species records, the vegetation and fauna builders and the scenarios, with no Rhino import.

ONE FILE

.3DM

Rhino's own file

out

back, with every Design Companion string and object

.DCP PROJECT FILE

A zip of JSON and meshes, read and written by every host.



431 Beazley Avenue in the desktop app: 337 plants, their roots and the links between them over the ghosted buildings.

Manaj Mishra 2082/4456



One morning walk along the tracks of Warwick Bushland, 3 March 2026, photographed between about 10.20 and 11.10.



Warwick Bushland from above, 2025. Google Earth, image © 2025 Airbus.

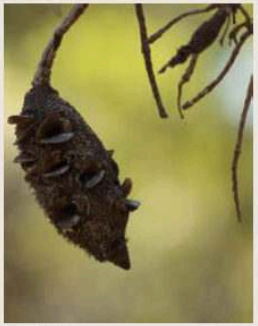
A fallen trunk among grass trees beside the track. Photograph by Author.

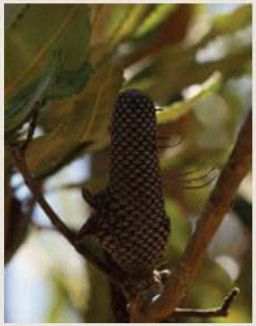
FIRE



A grass tree trunk burnt hollow, its leaf bases charred in rings. Photograph by Author.

BANKSIA CONES





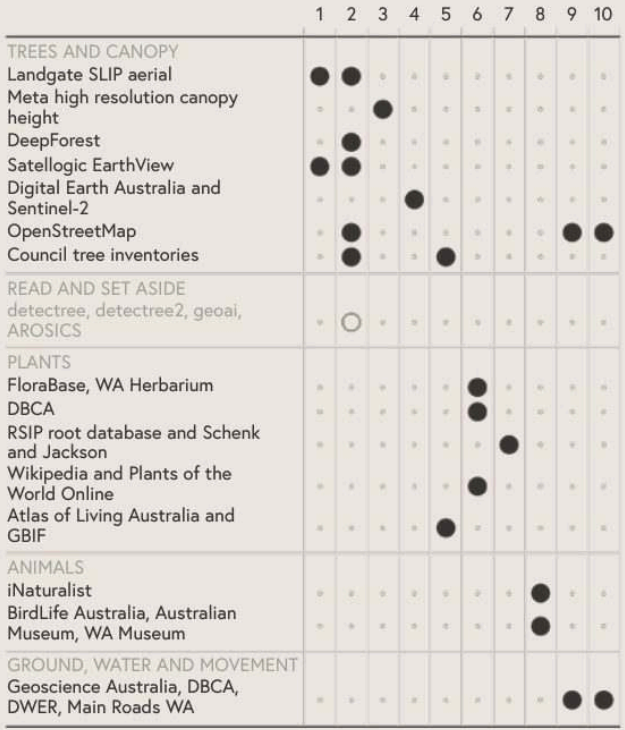
An old banksia cone, its follicles split open. Photograph by Author.

A banksia cone still on its branch. Photograph by Author.

Data sources

PLANTS	
FloraBase, WA Herbarium	The source behind 319 of the 919 species records.
DBCA	207 records, including the Banksia woodland community listing.
RSIP root database and Schenk and Jackson	Harvard Forest HF426 (Tumber-Dávila et al. 2022) with Schenk and Jackson (2002): rooting depth and lateral spread for 139 species records, replacing default root sizes.
Wikipedia and Plants of the World Online	70 and 51 records, marked indicative in the data.
Atlas of Living Australia and GBIF	463 species carry an ALA identifier. Occurrence records give the species recorded near a site.
BirdLife Australia, Australian Museum, WA Museum	Nest, breeding and hollow records behind the animal ecology file.
GROUND, WATER AND MOVEMENT	
Geoscience Australia, DBCA, DWER, Main Roads WA	5 m LiDAR of bare earth, wetland and stream mapping, and measured traffic.
ANIMALS	
iNaturalist	CC BY photographs used to review every animal model against the living species, and 664 call recordings referenced.

Meng Mulan 20820455



1 Aerial imagery
2 Tree positions
3 Crown heights
4 Tree ages
5 Species named
6 Plant records
7 Root spread
8 Animals
9 Terrain and water
10 Roads and traffic

What the site model takes from each source, as the list states it. Hollow: reviewed and not adopted.

Trees



Detail of the site plan beside, at twice its scale. The planted bed by the road is found by one source only (yellow); the street trees carry two or three.



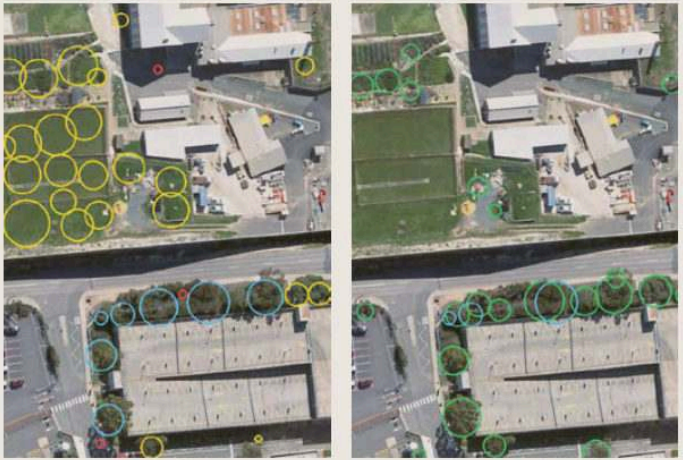
Every imported tree on the aerial. Green: photo, OpenStreetMap and canopy height agree. Blue: two agree. Yellow: one source only. Red: placed by the street-tree model.

Checking the trees

SITE IMPORT

BEFORE: THE IMPORT

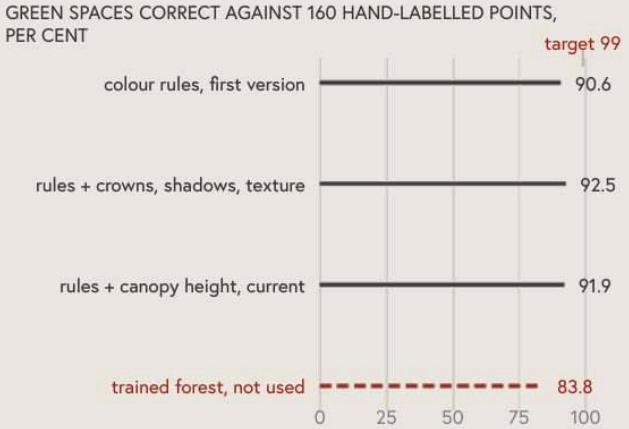
AFTER: PERTH-TUNED DEEPFOREST



A Fremantle detail. Left, the import: yellow circles from the photo alone fall on lawn. Right, DeepForest retrained on the Perth hand labels keeps the street trees and leaves the lawn.

Green spaces

SITE IMPORT



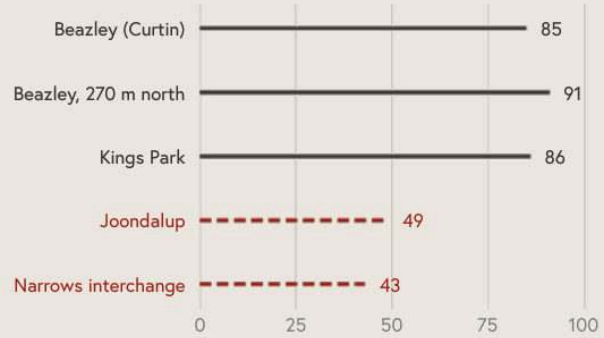
Accuracy against 160 hand-labelled points at Beazley.

Note, unresolved. The target was 99 per cent and it is not met. At 1 m a mulch bed with small shrubs looks like sand, and colour alone cannot separate them.

Roads

SITE IMPORT

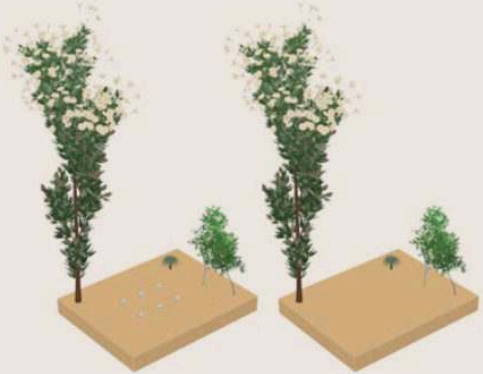
ROAD GEOMETRY QA, OUT OF 100:
GAPS, STACKED SURFACES, SPIKES, GROUND FIT



Red dashed: rail cutting walls counted as spikes (Joondalup); freeway interchanges not yet solved.

Three states of one site

THE TEST



3 THE DECK

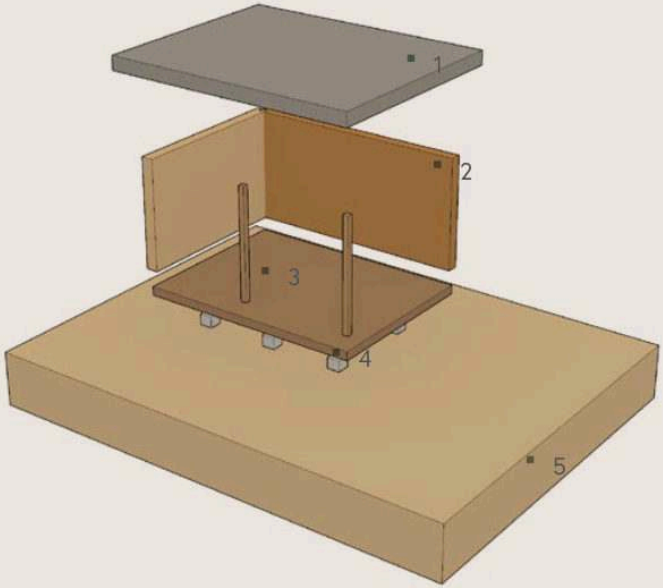
Boards come up off the pads.

4 THE PADS

Pulled, and only the ground is left.

The bay, taken apart

THE BAY, EXPLODED IN THE ORDER IT COMES DOWN



THE BAY, EXPLODED

Drawn in Rhino with the plugin, Pen display. Figure by Author.

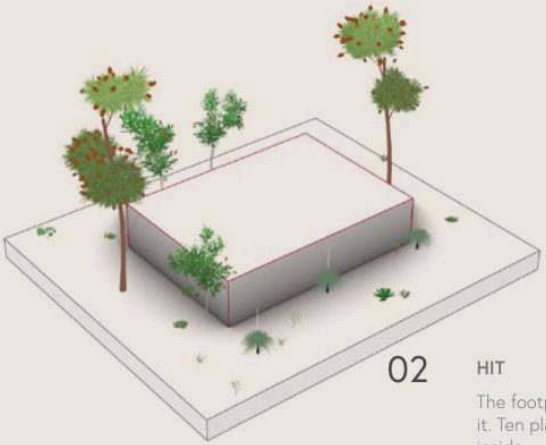
4

Shallow, so pulling them barely opens the soil.

5

The only part meant to stay.

The ground under the footprint



02

HIT

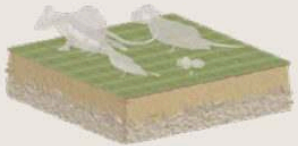
The footprint set over it. Ten plants stood inside.

One tree through time



One plant and what depends on it





WITHOUT THE PLANT



Western Spinebill



New Holland Honeyeater



Carnaby's Black-Cockatoo



Western Ringtail Possum



Blue-banded Bee

Roots against the footprint

FINDINGS

THE TREES THE FOOTPRINT REACHES AND LEAVES STANDING

Species	Roots	Root zone	Structural	To the wall	
Firewood Banksia	proteoid	2.8 m	1.1 m	0.6 m	Cut
Sheoak	fine-fibrous	5.0 m	2.0 m	1.5 m	Cut
Slender Banksia	proteoid	3.0 m	1.2 m	2.7 m	Reached
Sheoak	fine-fibrous	5.0 m	2.0 m	3.0 m	Reached
Jarrah	tap	10.5 m	4.2 m	8.8 m	Reached

Root types: AusTraits 7.0.0 (Falster et al. 2021). Rooting depths in banksia woodland: Dodd and Heddle 1989. Note, unresolved. No species-level source gives a lateral root spread for these five trees, so the root zones are modelled from tree size and are not measured.

The 300 mm line

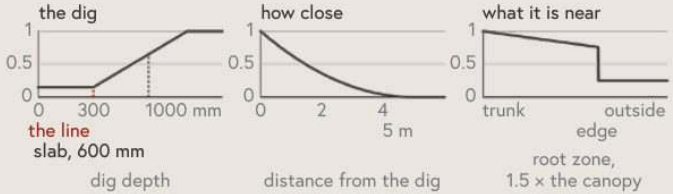
FINDINGS

Note, unresolved. The 300 mm line, the 5 m falloff and the root zone taken as one and a half times the canopy are the plugin's working defaults. They are still to be calibrated against monitoring data before the figures are quoted as more than a comparison.

THE DISTURBANCE SCALE ON THE PLANS



HOW ONE CELL IS SCORED: DIG, DISTANCE AND ROOT ZONE MULTIPLIED



The three factors multiplied for each 500 mm cell, with the plugin's working defaults; the strongest nearby dig counts.

Dependencies broken

EACH ANIMAL, BY ITS SLOWEST LOSS, CONTINUED

Animal	Food plants	Removed	Roots cut	Waits
Western pygmy-possum	9	1	–	6 years
Weevils	9	1	–	6 years
Red-eared firetail	26	3	3	2 years
Beetles	37	3	1	1 year
Red-capped parrot	7	–	1	nothing lost
Red-tailed black-cockatoo	6	–	2	nothing lost
Western ringtail possum	4	–	–	nothing lost
Bats	4	–	–	nothing lost
Flies	4	–	–	nothing lost
Wasps	4	–	–	nothing lost

Waits are the years a replanted seedling of the slowest lost food plant takes to first flower, from the plugin's growth model. Roots cut counts every plant left standing, of any height, whose recorded root spread crosses the footprint edge. The check in Roots against the footprint takes only trees of 3 m or more, against root zones scaled to age, so it also reaches a slender banksia and the jarrah.

THE ANIMALS THAT WAIT 44 YEARS, FOR THE GRASS TREE



Carnaby's black-cockatoo



Honeyeaters, a New Holland honeyeater



Quenda

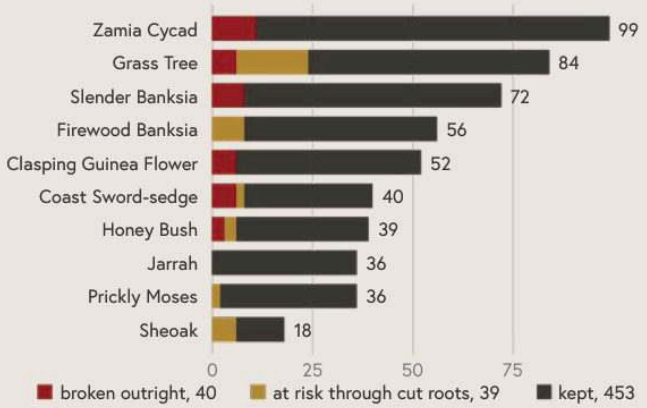


Honey possum



Native bees

Six animals wait 44 years. Carnaby's black-cockatoo stands for both cockatoo rows of the table, the species and the black-cockatoo group.



Links per plant species in the stand: red broken by removal, amber at risk through cut roots, grey kept.

Silvereye	9	1	–	29 years
Western grey kangaroo	9	1	–	29 years
Western brush wallaby	9	1	–	29 years
Quokka	9	1	–	29 years
Chuditch	9	1	–	29 years
Insects	9	1	–	29 years
Ants	34	1	2	6 years
Western spinebill	16	1	1	6 years

After the building

The same invoice can be written for where the building could have stood. Moved 5 m west, the footprint takes three trees instead of one. Moved 5 m east, it takes seven plants instead of ten and cuts no structural root zone at all. The tool does not choose the position. It puts the cost of each one on the table while the footprint can still move.



A grass tree spike at Warwick Bushland, the last of the lost plants to flower again. Photograph by Author.

Moving the footprint

The two choices do different work. Position decides what is taken: 5 m east the footprint removes 7 plants instead of 10, breaks 25 links instead of 40, cuts no structural root zone instead of 2, and the site is released in year 79 rather than 94, because it no longer takes the grass tree. Foundation decides how much ground is disturbed: pads at 300 mm bring the peak from 0.64 to 0.14 and the ground above half intensity from 45 m² as built and 46 m² 5 m east to 0, at either position. The model clears the whole footprint for either foundation, so pads change the dig, not the plants taken.

NOT A SCORE, A CHOICE

Neither choice is enough alone. Together they keep the dig inside the cap and shorten the debt by 15 years. The tool does not make the decision. It makes it visible while the footprint can still move.

READING THE PLANS

- footprint, slab cut 600 mm
- pad footing, dug 300 mm
- plant removed
- tree of 3 m or more, removed
- structural root zone cut
- root zone reached
- tree of 3 m or more, clear
- smaller plant, clear

Massing

The lot and three steps of massing for A neglect, B some care and C full care on lot L1, the same floor area each time, among the imported trees and barracks footprints. Trees: the site import's own trees (species and measured height), drawn as the Design Companion species elevations. Figure by Author.

THE THREE SCHEMES IN FIGURES

	FOOTPRINT	STOREYS	FLOOR AREA	BASEMENT	OPEN LOT GROUND
A neglect	50 x 14 m	6	4,200 m²	62 x 26 m, 3.6 m deep	1,400 m², sealed
B some care	50 x 14 m	6	4,200 m²	62 x 26 m, 3.6 m deep	1,400 m², over the basement
C full care	50 x 20 m	6, 4, 2	4,200 m²	none, on pads	1,100 m², deep soil

What took longest to fix

57 CHANGES | 12 JUN TO 12 AUG

37 CHANGES | 26 JUN TO 3 OCT

IMAGES MISSING ON THE MAC

16 CHANGES | 27 JUN TO 9 OCT

Thumbnails in the viewport never appeared on a Mac. McNeel confirmed that its image drawing only works on the older OpenGL engine, not Metal. Fixed by drawing with shapes, or laying the image on the ground as a texture.

SETTINGS DROPPED | 7 TO 27 SEP

New settings vanished in transit. Every one is now listed in the bridge.

SLOW START | 28 JUN TO 6 SEP

Every panel loaded its data at once. Now each loads on first use.

THOUSANDS OF HOLES | 26 AUG TO 3 OCT

Cutting perforations as solids hung Rhino. The panels are now meshes.

DRAW BUTTONS DEAD ON WINDOWS

12 CHANGES | 9 JUL TO 20 SEP

Every wall, slab and stair tool did nothing on Windows. The code assumed an old browser engine, and two messages sent back to back raced each other. Fixed with a direct message channel and the settings and command sent as one message.

WRONG SPECIES DRAWN | UNTIL 23 SEP

Plants were looked up by the wrong form of their name and drawn as a generic plant.

LEAVING RHINO | 8 OCT

About 190 of 680 Python files still called Rhino directly, the start of the standalone work.

AND THE SMALLER ONES

ONEDRIVE | 26 AUG TO 8 SEP

Edits reverted silently and conflict copies, two of them empty, were committed. A check now fails on them.

FLASHING WINDOWS | 27 JUN TO 15 SEP

Every action made the screen jump. Fixed by making Rhino the owner of each floating window.

Limits

REFLECTION

SEED EATERS, PAINTED, PAGE 108

The birds are scaled up to read at page size.

PREDATORS IN THE FEEDING GARDEN, PAGE 109

The quenda rig stands too tall on straight legs and its tail is too long. The kookaburra is native to the east and introduced in Western Australia, which its record notes but the garden does not show. The camera was moved until no plant stood in front of the animal.

THE 300 MM LINE, PAGE 196

The 300 mm line, the 5 m falloff and the root zone taken as one and a half times the canopy are the plugin's working defaults. They are still to be calibrated against monitoring data before the figures are quoted as more than a comparison.

AFTER THE BUILDING, PAGE 204

First flowering stands in for food. Seed and fruit come later, so every wait here is the shortest it could be. The ages for zamia and grass tree, the two slowest, rest on recorded growth rates that are worth checking against field data.

MOVING THE FOOTPRINT, PAGE 206

The site is held until the slowest lost food plant first flowers, a lower bound. Disturbance uses the plugin's working defaults, which are still to be calibrated.

Answering the question

CONCLUSION



The walk track through banksia woodland and grass trees, Warwick Bushland. Photograph by Author.

Six ways of planting

WORKING STUDIES



04 EDGE PLANTING 05 DENSE MAT 06 HEDGE OR LINE

Host plants with and without their animals





MORRISON'S FEATHERFLOWER

Verticordia nitens. Used by the Blue-banded Bee, Christmas Beetle and Australian Painted Lady.



PRICKLY MOSES

Acacia pulchella. Used by the Blue-banded Bee and Bull Ant.



FRASER'S CYCAD

Macrozamia fraseri. Used by the Emu and Brushtail Possum.





CHRISTMAS TREE

Nuytsia floribunda. Used by the Blue-banded Bee and Australian Painted Lady.

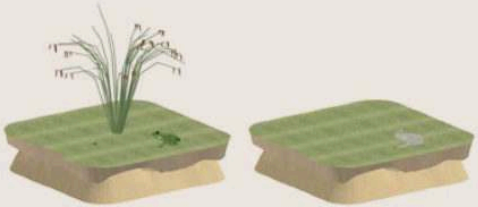




QUANDONG

Santalum acuminatum. Used by the Emu and Brushtail Possum.





JOINTED TWIG-RUSH

Baumea articulata. Used by the Motorbike Frog.

THE 13 ANIMALS ACROSS THE ELEVEN HOSTS



















Australian Ringneck



Brushtail Possum

Western Ringtail Possum



Carnaby's Black-Cockatoo



Fence Skink



Emu



Bull Ant

The library, set 2 of 4

WORKING STUDIES



Through the seasons: winter, spring, summer and autumn.



Flower, Aug to Dec



Fruit



Leaf



Roots, to 0.2 m.

The library, set 3 of 4

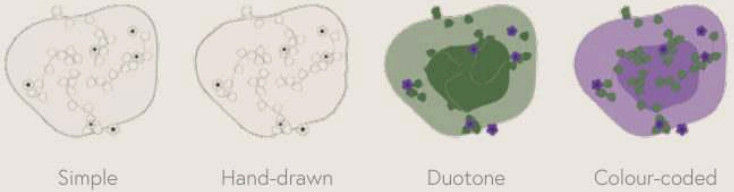
WORKING STUDIES



Roots, to 0.5 m. Figure by Author.

Beds, roots and range

HARDENBERGIA COMPTONIANA



Two species through the eight plan styles, drawn from the plugin's plan symbols.

Mang McGraw 2002/04/05

Scenarios 1 to 20

THE END AND THE LIFE

The twenty scenarios run in three groups, the End, the Life and the Beginning, in the order of the Death Manual. The End takes the building away in six steps: the plan arrives, the clearing happens, the loss is followed past the boundary, an outside authority draws a line, the line becomes permanent, and the tool refuses. The Life then puts the site under pressure.

THE LIFE AND THE BEGINNING

The heatwave, the drawdown and the king tide put the site under the most stress. Scenarios 16 to 18 then run forward: a retreat, the extraction ending, the planting coming back. In A Bird Returns the site looks recovered but the bird cannot breed, because hollows take longer to form than the restoration has run. The Custodian Gate ends the deck with the custodian field empty.



01 THE FOOTPRINT LANDS



02 THE CHAINSAW ARRIVES



03 PULL ONE THREAD



04 THE RED LINE



05 NEVER BUILD AGAIN



06 REFUSE



07 THE UNDERGROUND



08 THE VALUE GAP



09 THE DROUGHT LEDGER



10 THE SILENT SEASON

Figure by Author.

TEST

The first twelve scenarios drawn as 3D exhibits of the same site, each from the file it runs on.

The last eight scenarios, from the pressure peaking to the end of the deck, with each plan read against its side view.

FINDING

Nine of the twenty still run on placeholder massing, eight blocks standing in for the twenty-five of the vision plan. The value gap cannot be drawn outside Rhino because it needs the ledger.

In A Bird Returns the site looks recovered after sixty years, but the bird cannot breed, because hollows take longer than that to form. Rewilding reuses the stand's planting positions, which was my assumption.

CHANGE

Scenarios are drawn over the model and never baked, so the ledger cannot count a felled site as though it had been cleared.

The Custodian Gate stays the last exhibit. When the custodian field is empty, the tool generates nothing.



11 THE DIEBACK FRONT



12 THE LONG NIGHT



13 THE HEATWAVE



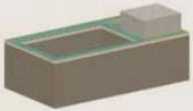
14 THE DRAWDOWN



15 THE KING TIDE



16 MANAGED RETREAT



17 EXTRACTION ENDS



18 REWILDING



19 A BIRD RETURNS



20 CUSTODIAN GATE

METHOD

This project tests whether architecture can begin with the end. The method is not a linear sequence but a set of overlapping operations, each one designed to keep the ecological argument legible across a different register: site, drawing, artefact, tool, and image.

The first operation is the surrender of authorship. The site was selected by a hat draw from ten banksia woodland remnants on the Swan Coastal Plain. If the project argues that architecture must negotiate rather than impose, the site selection had to enact that logic from the outset. Warwick Bushland was drawn, and the project began with a site it had not chosen.

The second operation is reading the site as forensic evidence. Warwick Bushland is documented through a photographic inventory of the woodland community, a mortality timeline tracing seventy years of aerial subtraction, a ground-cover comparison scoring the bushland against twelve surrounding land conditions, and an ecological context analysis holding the site's figures against Gibson et al.'s 1994 reference data and the EPBC listing conditions. The readings are held against the Death Manual's restoration thresholds before any architectural move is proposed.

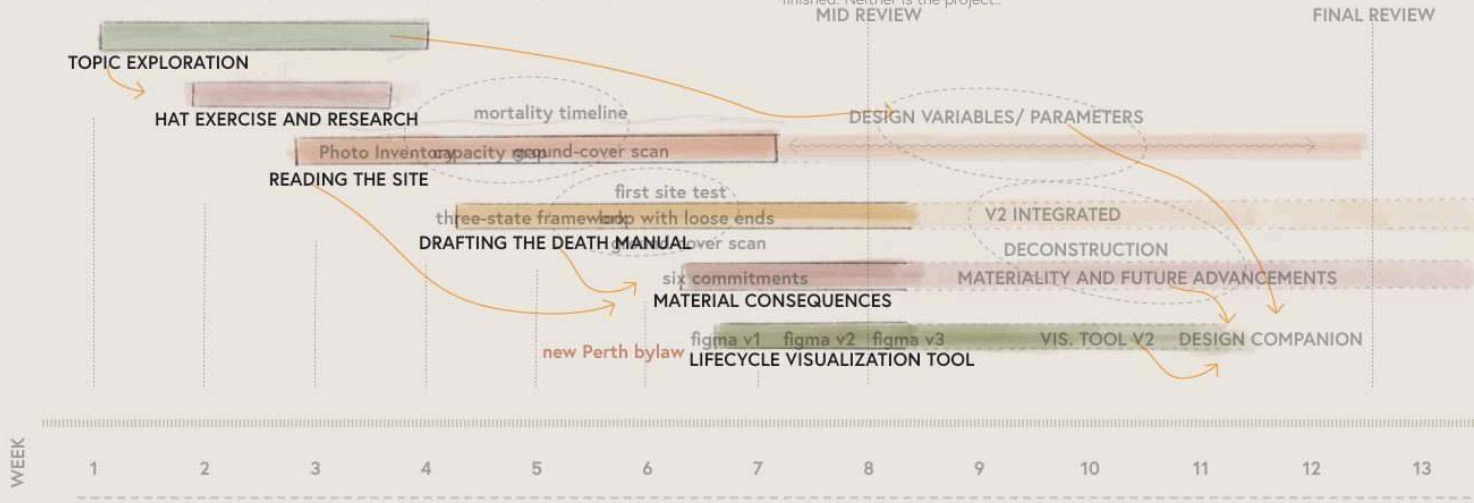
The third operation is drafting the Death Manual. Rather than treating ecological obligation as something a building offsets at the end of its life, the Manual is drawn first, as a binding restoration protocol the building must answer to from inception. The Manual specifies the species assemblages, soil conditions, and hydrological patterns the site must return to once the building is gone. Every subsequent design decision is constrained by it.

The fourth operation translates the Manual into material consequences. The Deconstruction Manual isolates six techniques, shallow footings, mechanical timber joints, sacrificial ground layers, lift-clear roof steel columns, and extractable foundation grids, that any building on this ground would have to eng with to leave the site recoverable. These are the minimum mechanical conditions the Death Ma requires.

The fifth operation is the negotiation box; a physical artefact that translates the Death Manual's ecological parameters into something that can be held, arranged, and scored by hand before a des is drawn. Each of the six 3D-printed trays carries a parameter and a scored position along a range f −5 to +5. The total is tallied against a scale embedded in the cork body of the box. The artefact d not compute. It negotiates. A phone embedded in the body shows the site. The trays show what proposal is asking of it. The score shows whether the building has earned the right to ask.

The sixth operation is the Lifecycle Visualisation Tool and Design Companion. Together, these to ingest site data, process it against the Death Manual's ecological parameters, and return a real-t envelope of permissible architectural moves. The Lifecycle Visualiser gathers site-specific ecolog data and generates the Death Manual's binding constraints before any architectural input is accep The Design Companion carries those constraints into the design environment itself, running a browser panel inside Rhino with a live connection to the Grasshopper canvas. Every time the mo recomputes, the companion updates, species displacement count, mycorrhizal network interrupt restoration debt, binding flag status. The tools do not generate designs. They make the ecolog cost of a decision visible before that decision is made. Following Dunne and Raby's speculative des framework, the tools open debate rather than close it with solutions (Dunne and Raby 2013, 6).

Both the artefact and the digital tools remain works in progress. The negotiation they enact is finished. Neither is the project..



SIGNIFICANCE

Architecture routinely assumes the right to occupy a site. Planning approvals, client briefs, and professional conventions proceed from the premise that a building's presence is justified by its programme, its economic return, or its social utility. What is rarely asked is whether the building has earned the ecological ground it stands on, and what obligation it carries to return that ground when its life is over.

This project occupies a gap that existing literature has not closed. Stewart Brand demonstrated that buildings change over time, and that the best buildings separate fast-changing layers from slow ones (Brand 1994, 13). Cedric Price proposed structures explicitly designed for their own dismantling (Mathews 2005, 81). Neither extended this temporal awareness to the building's ecological afterlife; to the question of what the ground becomes once the building is gone. Brand is interested in adaptation during the building's life. Price is interested in dismantling. This project occupies the gap between them: what the ground itself inherits, and what the building owes it, after both adaptation and dismantling are finished.

The significance lies in reframing ecological obligation as a binding design constraint rather than a compensatory afterthought. The Lifecycle Visualisation Tool makes the ecological cost of a proposal visible before the proposal is built, removing the most reliable defence in the architect's repertoire, which is plausible ignorance. Once species count, canopy loss, soil disturbance, fauna corridor disruption, and reversibility are legible on the same screen as the footprint, the question stops being whether the ground can be afforded and starts being what has to be claimed to make losing it acceptable.

The Design Companion extends this further. It is not only an information-generating tool. It is a design environment in which the ecological record of a site is present at every decision point; where moving a footprint updates a species displacement count, where crossing a threshold raises a permanent flag, where the restoration debt is a figure the designer cannot close. This reframes the project from an analytical instrument into something that could change the way architecture is practised: not by producing better-informed consultant reports that sit beside the drawing, but by making the ecological argument inseparable from the drawing itself. The Design Companion asks whether the building earns its place not once, at planning, but continuously, across the full duration of design (Kimmerer 2013, 382). In doing so, it proposes a model for architectural practice in which the ground has a seat in the design process, not as context, but as constraint.

The Death Manual goes further still. It does not just make the cost legible. It binds the building to a restoration commitment drafted before the first line is drawn, and holds that commitment for as long as the building stands. A developer seeking a quick return cannot absorb the ecological debt into a consultant report and move on. The debt is on the record. The tool will not generate a design strategy that fails the ledger, and the Manual will not release the site until the restoration thresholds are met.

Tested on Warwick, that commitment has a date. The footprint in LOG 08 removes ten plants and cuts the roots of nine more, which breaks 40 of the 532 links between the stand's plants and the animals their records name. Under eight per cent reads as minor. Read by what each animal waits for, it is not: the slowest food plant the building takes, a grass tree, first flowers 44 years after the building has gone, so the Manual holds the site until year 94. Moved five metres east, the same building would take seven plants and cut no structural root zone. That is the difference the tool makes. The cost of each position is on the table while the footprint can still move.