DDES9012
ASSESSMENT 2

DUGOUT COOL REFUGE NETWORK

Visual Journal
Emergency Response - Design Solution

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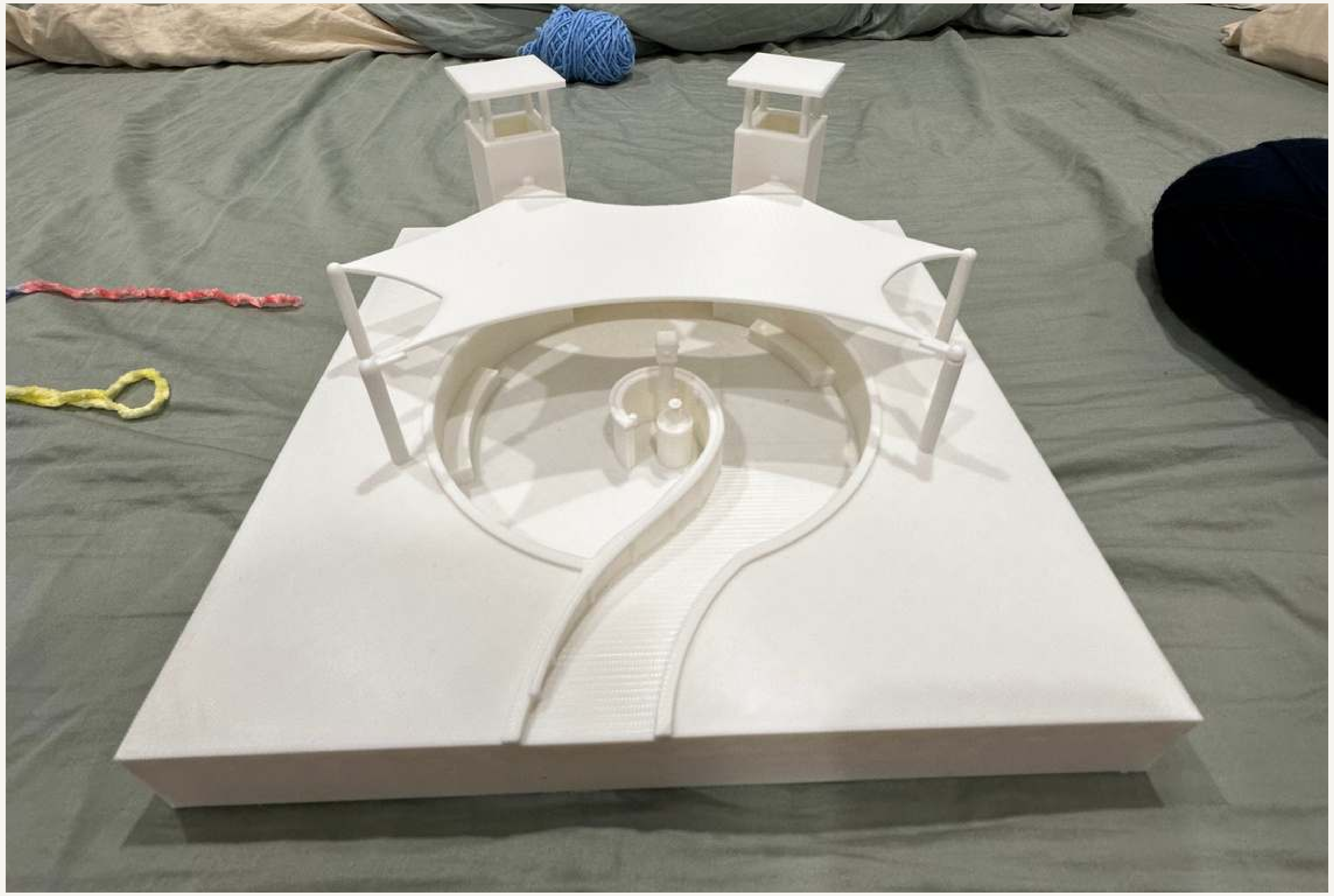
Contents and Evidence Tracker

A single PDF that makes every assessment requirement easy to find.



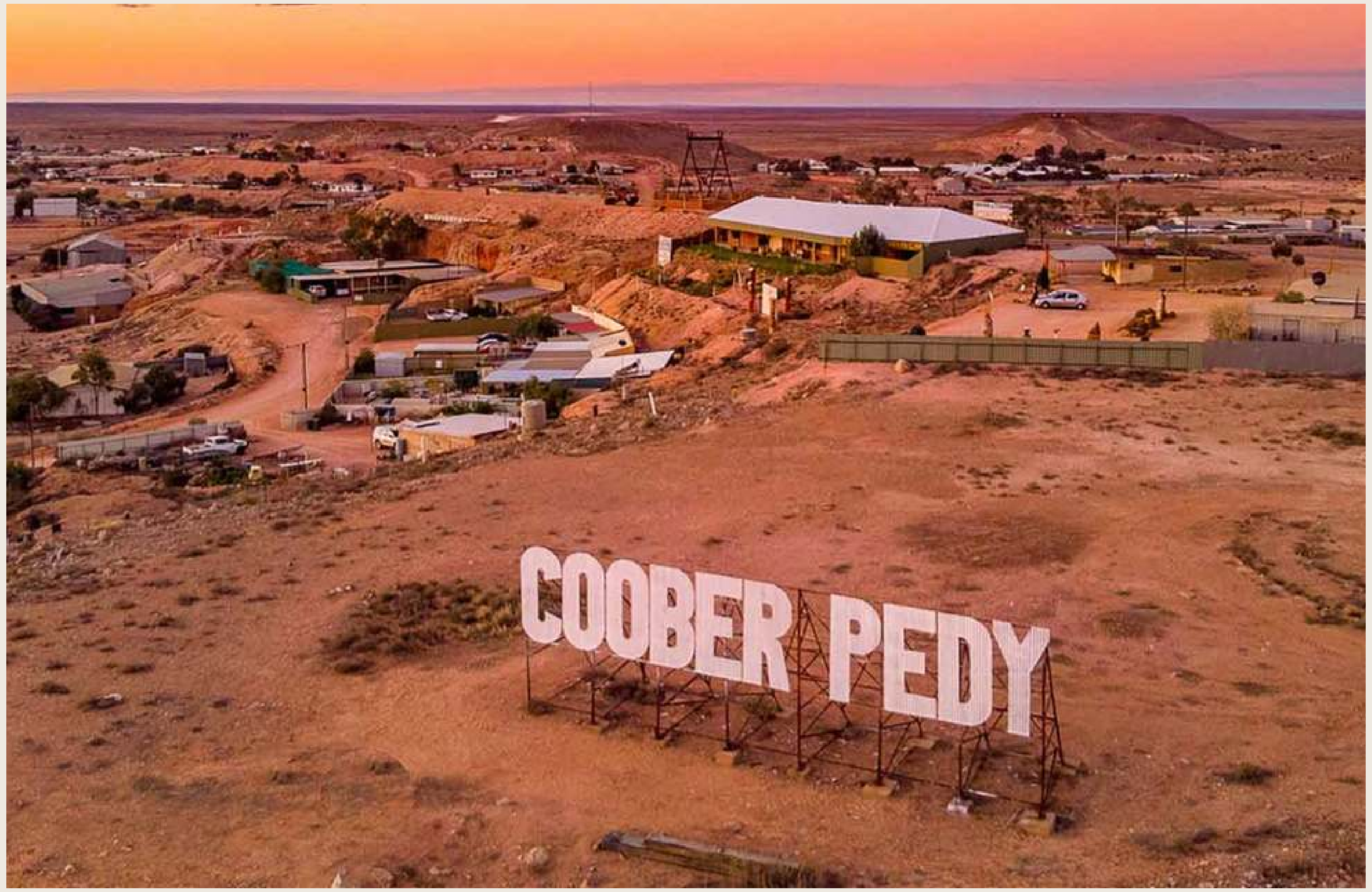
Extreme heat requires a shared public refuge

Heat in Coober Pedy is not only an environmental problem. It is also a problem of access, energy, water and community safety (Bureau of Meteorology, 2024; Australian Institute of Health and Welfare, 2024).

PROJECT AIM

Design a low-water, low-energy and accessible public heat refuge that uses Coober Pedy's dugout tradition, earth shelter and passive ventilation to protect vulnerable communities during extreme heat.

COOBER PEDY CONTEXT



Four findings shaped the design direction

Assessment 1 connected environmental risk with social, infrastructure and cultural conditions.

ENVIRONMENTAL

Extreme heat, water scarcity and climate change increase long-term risk.

COMMUNITY

Older adults, children, Indigenous communities and outdoor workers face higher heat risk (World Health Organization, 2023; Safe Work Australia, 2024).

INFRASTRUCTURE

Remote healthcare access, energy dependence and limited cooling reduce resilience.

CULTURAL

Local knowledge and connection to Country should inform culturally appropriate responses.

Source: Assessment 1 visual report, pp. 14-17.

The refuge must work for people at higher heat risk

01

Older adults

Rest, shade, drinking water and clear heat information.

02

Children + families

Safe waiting areas, supervision and simple wayfinding.

03

Outdoor workers

A nearby place for short recovery during dangerous heat.

04

People with mobility needs

Step-free entry, turning space and accessible seating.

Remote conditions change what a good cooling response looks like

A design for Coober Pedy must reduce dependence on systems that are expensive, water-intensive or difficult to maintain (Government of South Australia, 2024; Your Home, n.d.).

HEAT

Deep shade and ground contact reduce direct heat gain.

WATER

Water should be kept for drinking and emergency use, not continuous misting.

ENERGY

Passive cooling reduces dependence on air conditioning and peak power.

MAINTENANCE

Simple materials and clear construction support repair in a remote town.

Design implication: low-tech does not mean low ambition. It means the system matches the place.

Existing cooling works, but access is uneven

CURRENT RESPONSES

- Underground homes provide passive cooling (District Council of Coober Pedy, 2024).
- Air conditioning supports indoor comfort.
- Warning systems help people prepare.

GAPS

- Not everyone can access a dugout or reliable cooling.
- Energy costs rise during long heat events.
- Alerts do not create a physical place to recover.

Opportunity: turn private dugout logic into shared public cooling.

Secondary research connects the emergency to design decisions

DUGOUT LIVING

Earth shelter and thermal mass show how local building traditions reduce heat exposure (District Council of Coober Pedy, 2024; Your Home, n.d.).

HEAT AND HEALTH

Heat risk increases when people cannot reach safe cooling, water or healthcare support (World Health Organization, 2023; Australian Institute of Health and Welfare, 2024).

REMOTE RESOURCES

Water, energy, maintenance and transport conditions affect what can work over time (Government of South Australia, 2024; Australian Institute of Health and Welfare, 2024).

Three frameworks guided each design decision

01

Human-Centred Design

Start with the needs of older adults, children, outdoor workers and people with mobility needs (International Organization for Standardization, 2019).

Design result: step-free access, seating, water, information and help points.

02

Climate-Responsive Design

Use earth shelter, shade, airflow and thermal mass before mechanical cooling (Your Home, n.d.).

Design result: semi-underground form, deep canopy and dual ventilation towers.

03

Iterative Prototyping

Use sketches and models to test form, airflow, access and construction.

Design result: each test creates a visible change in the next version.

Research became six measurable design criteria

LOW WATER

No continuous misting; prioritise drinking and emergency water.

LOW ENERGY

Passive cooling before air conditioning.

ACCESSIBLE

Step-free route, wheelchair turning space and rest points.

CLIMATE FIT

Earth shelter, thermal mass and deep shade.

PUBLIC

Visible, shared and connected to everyday community places.

REPAIRABLE

Simple parts and materials suitable for remote maintenance.

Local knowledge changes the story from helplessness to resilience

PROBLEM STORY

Coober Pedy is too hot, resources are limited, and vulnerable residents have few safe cooling options.

EMPOWERING EXCEPTION

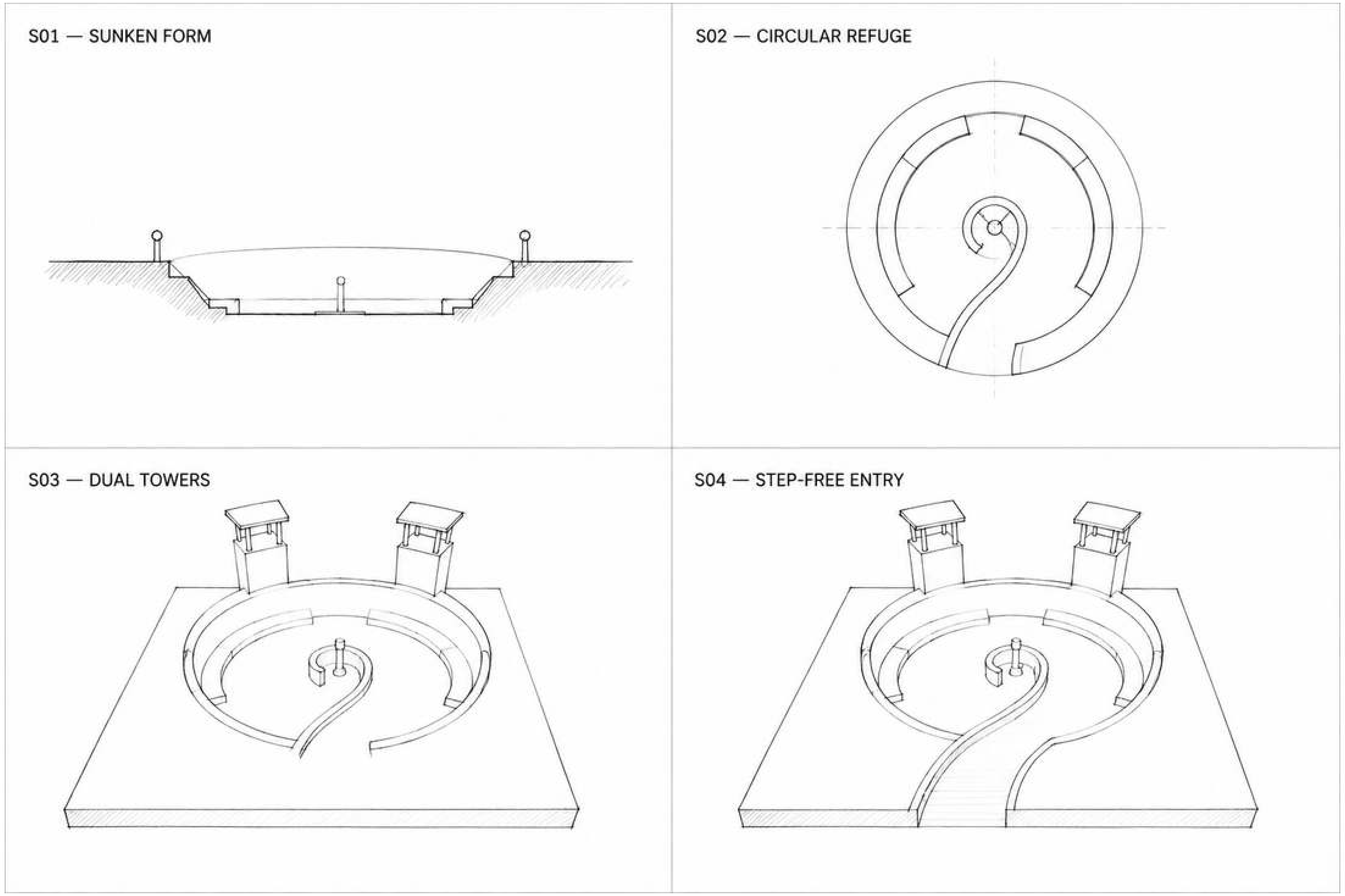
Residents already use underground dugout homes because earth stays cooler. The community has climate knowledge.

COUNTER STORY

The project makes this knowledge public, shared and accessible through a network of community refuges.

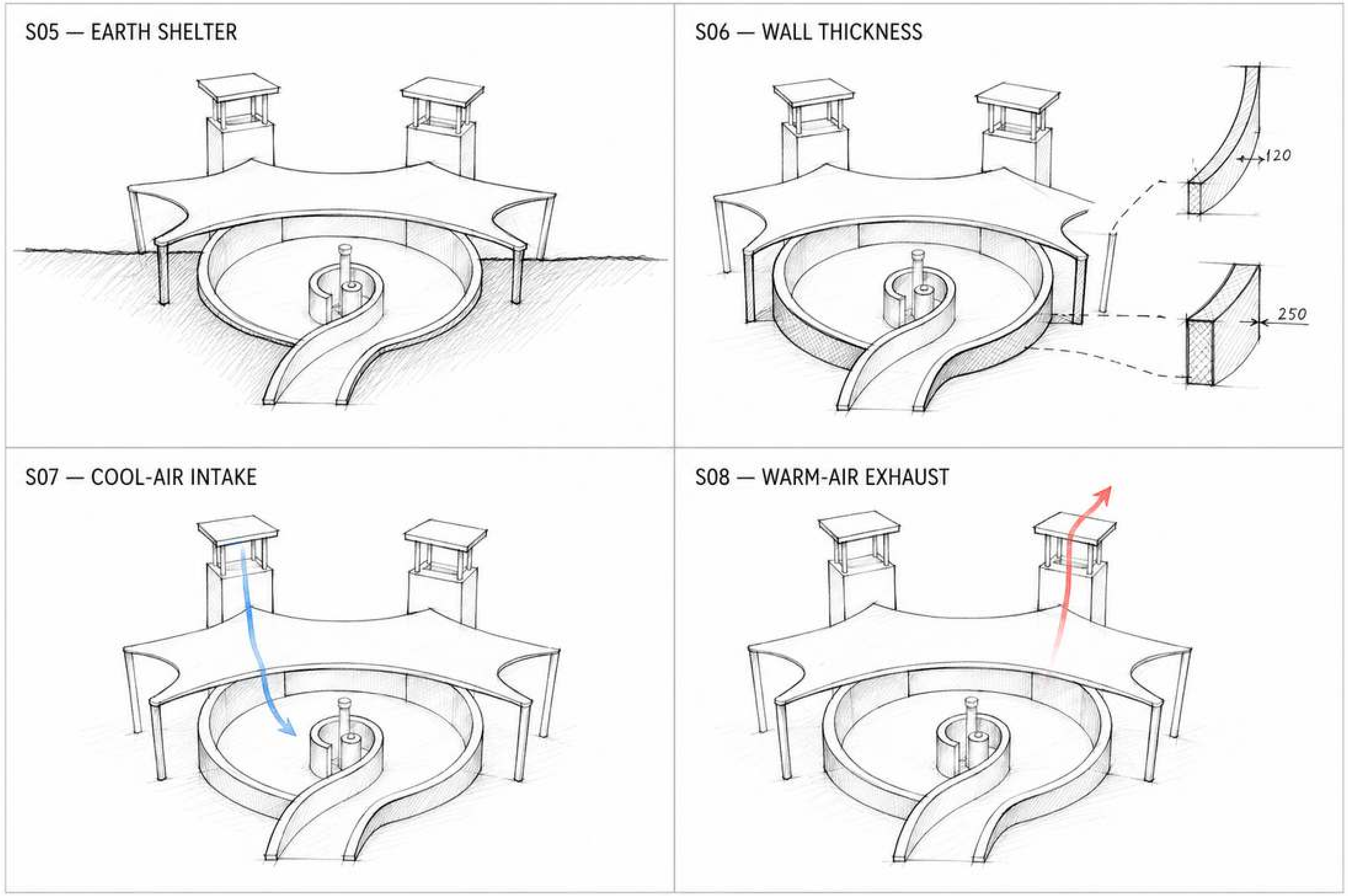
Sketches S01-S04 | Early shelter forms

Thirty-two numbered project sketches record what was tested, learned and changed.



Sketches S05-S08 | Moving below ground

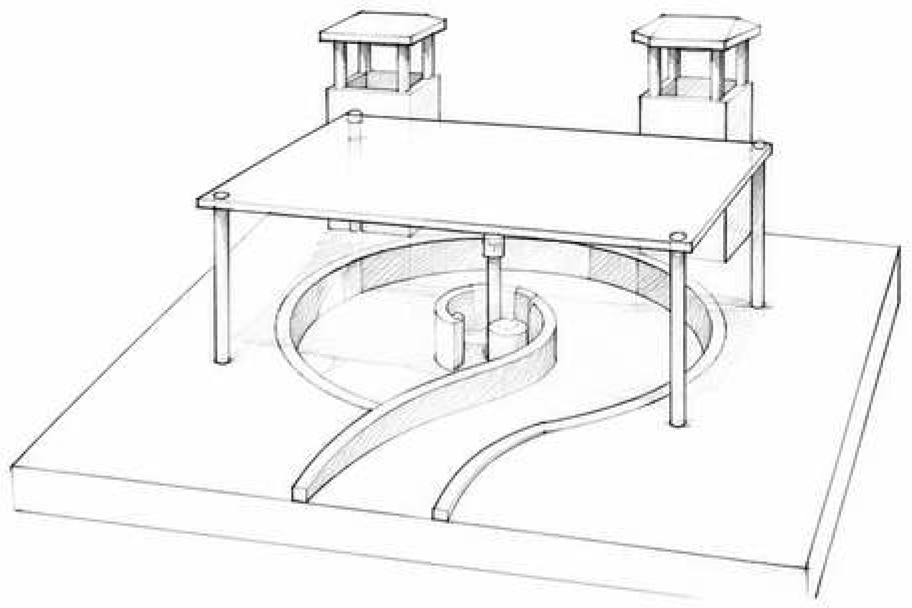
Thirty-two numbered project sketches record what was tested, learned and changed.



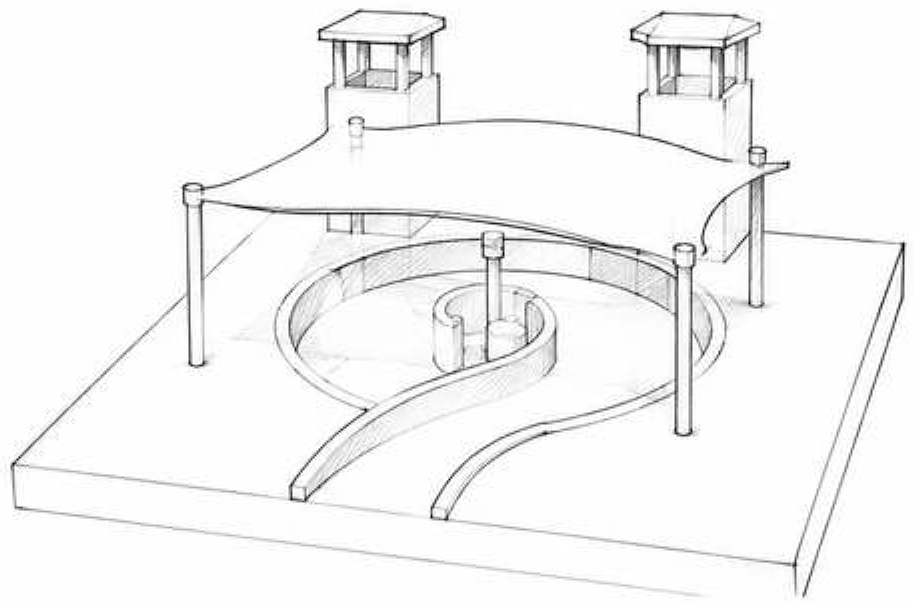
Sketches S09-S12 | Canopy and shade

Thirty-two numbered project sketches record what was tested, learned and changed.

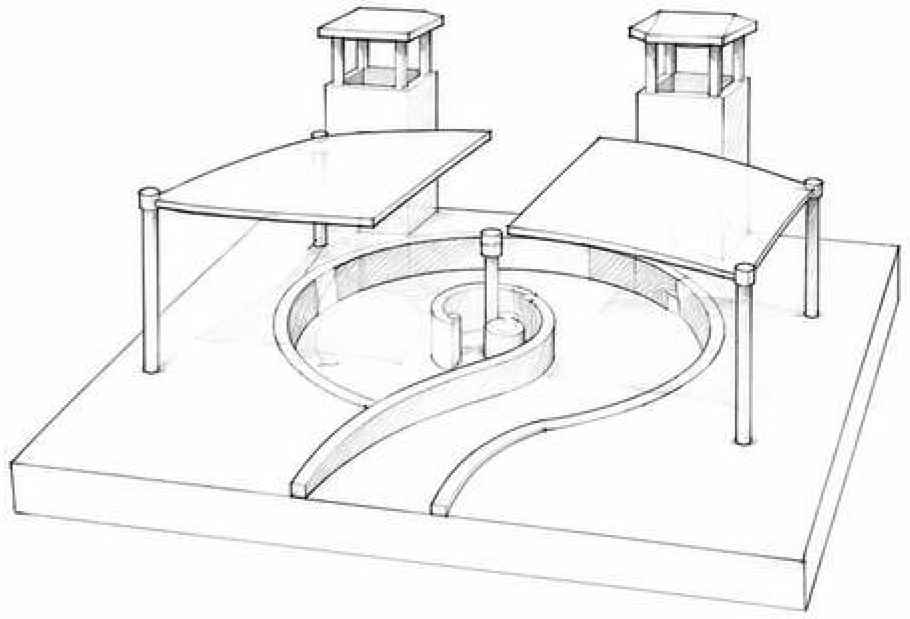
S09 — FLAT CANOPY



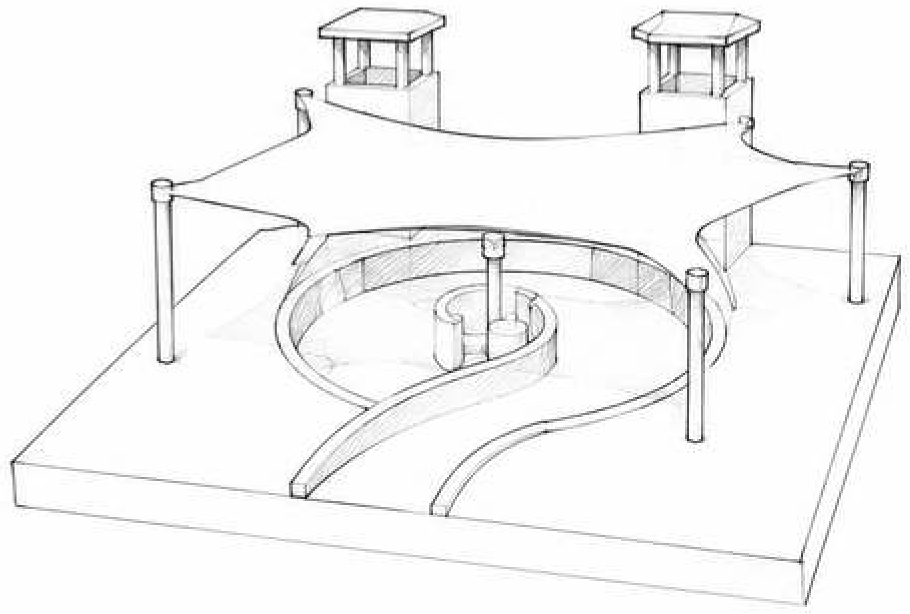
S10 — CURVED CANOPY



S11 — SPLIT CANOPY



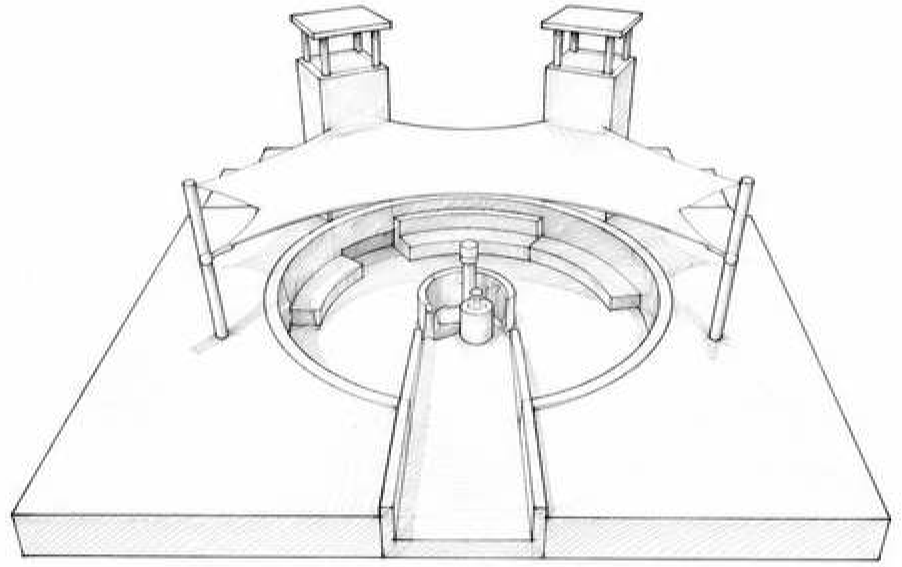
S12 — INTEGRATED CANOPY



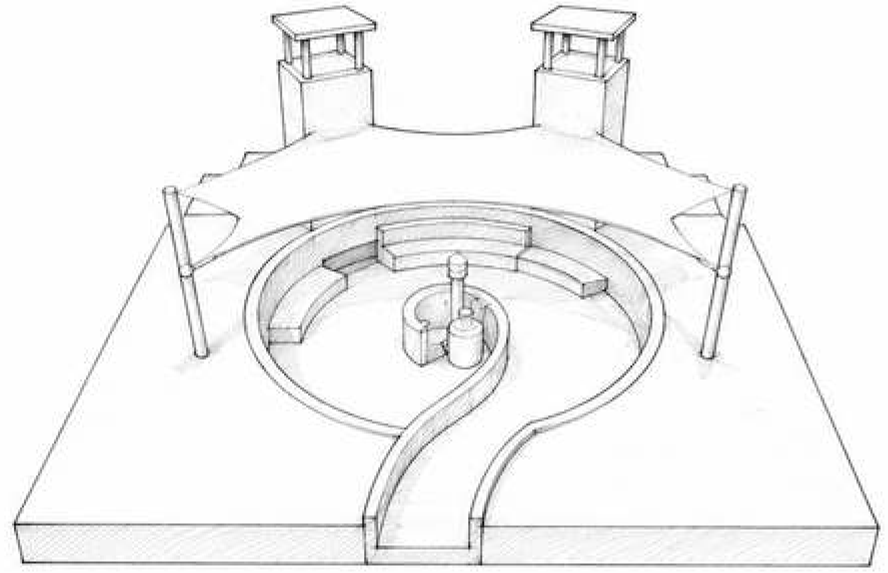
Sketches S13-S16 | Ramp development

Thirty-two numbered project sketches record what was tested, learned and changed.

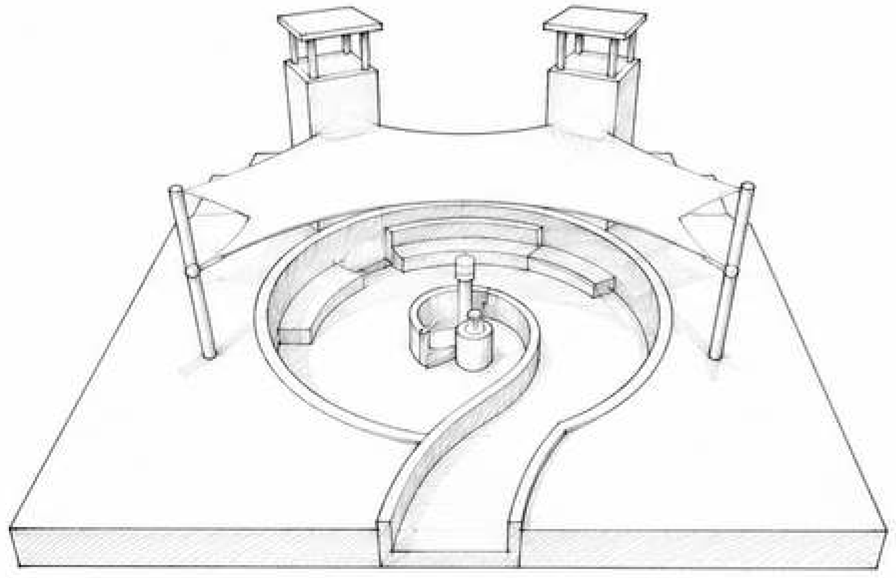
S13 — STRAIGHT RAMP



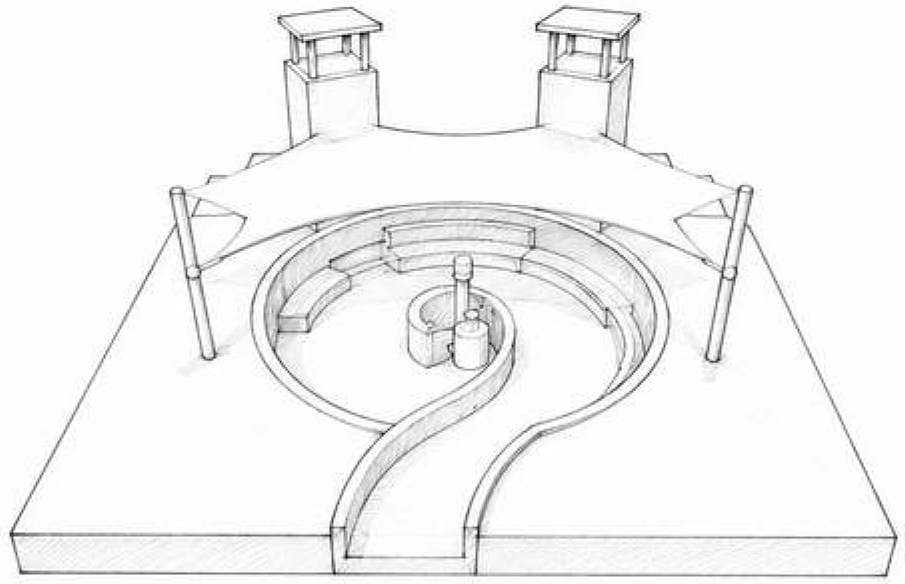
S14 — OFFSET RAMP



S15 — CURVED RAMP

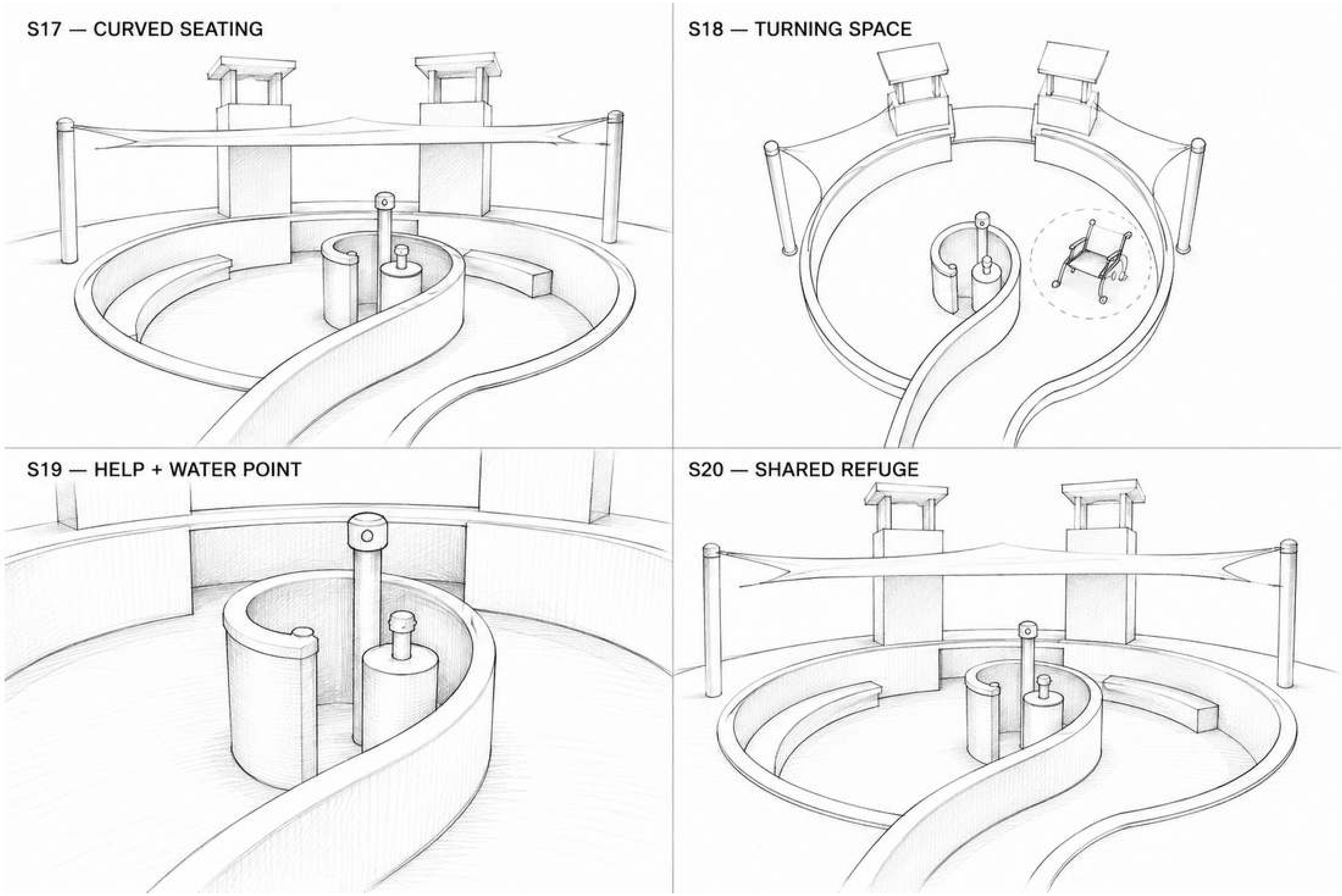


S16 — FINAL S-RAMP



Sketches S17-S20 | Refuge interior

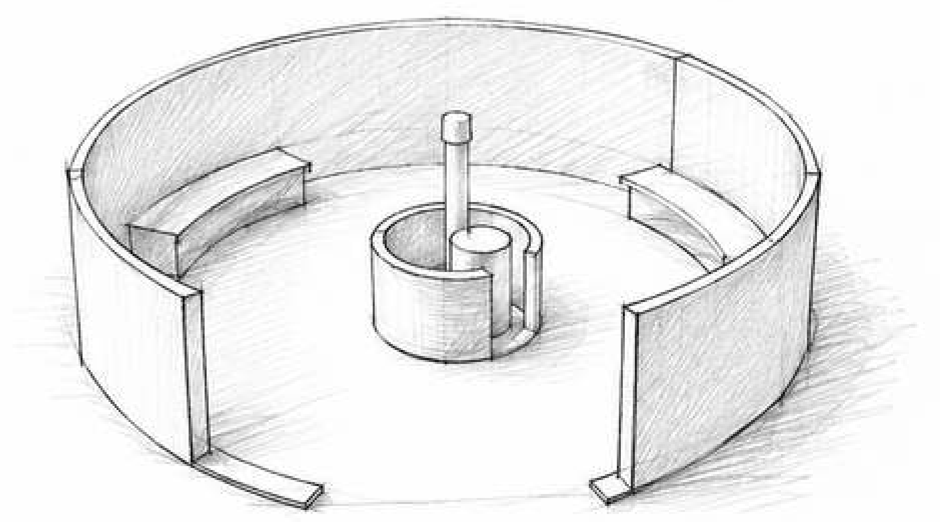
Thirty-two numbered project sketches record what was tested, learned and changed.



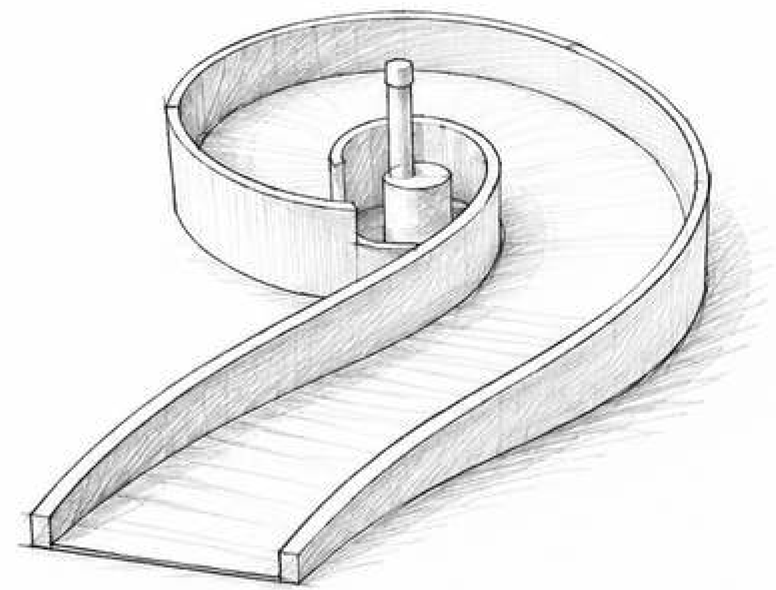
Sketches S21-S24 | Paper-model testing

Thirty-two numbered project sketches record what was tested, learned and changed.

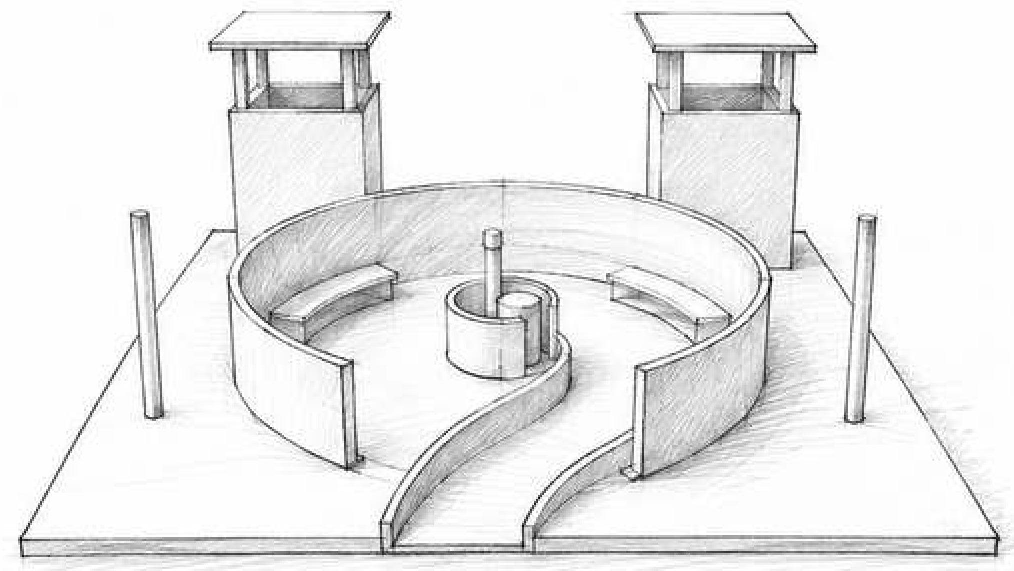
S21 — CURVED WALL TEST



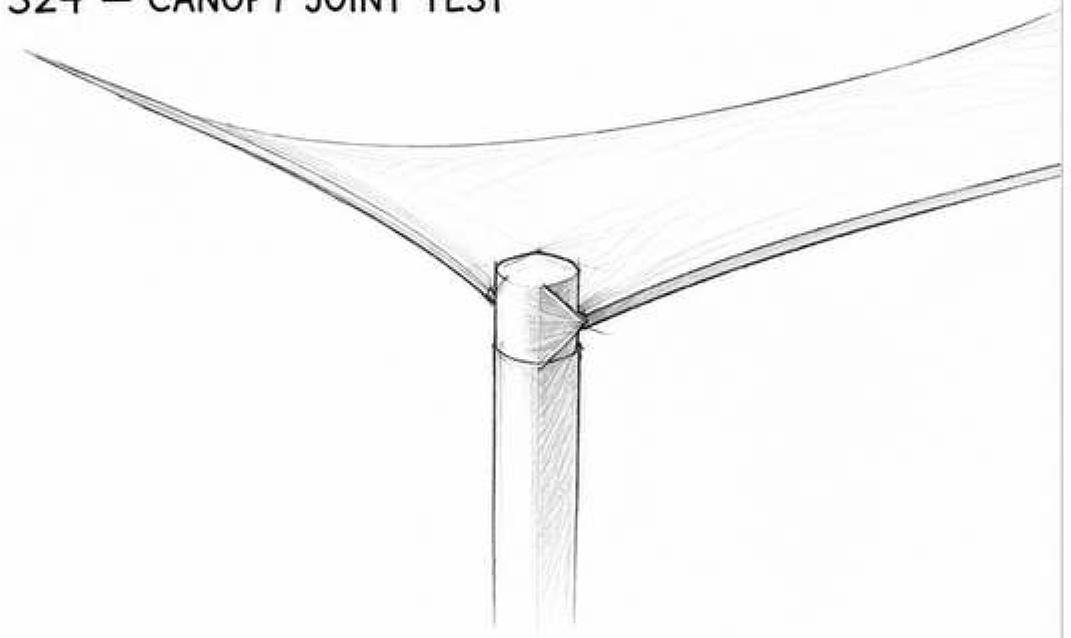
S22 — RAMP CURVE TEST



S23 — TOWER SPACING TEST

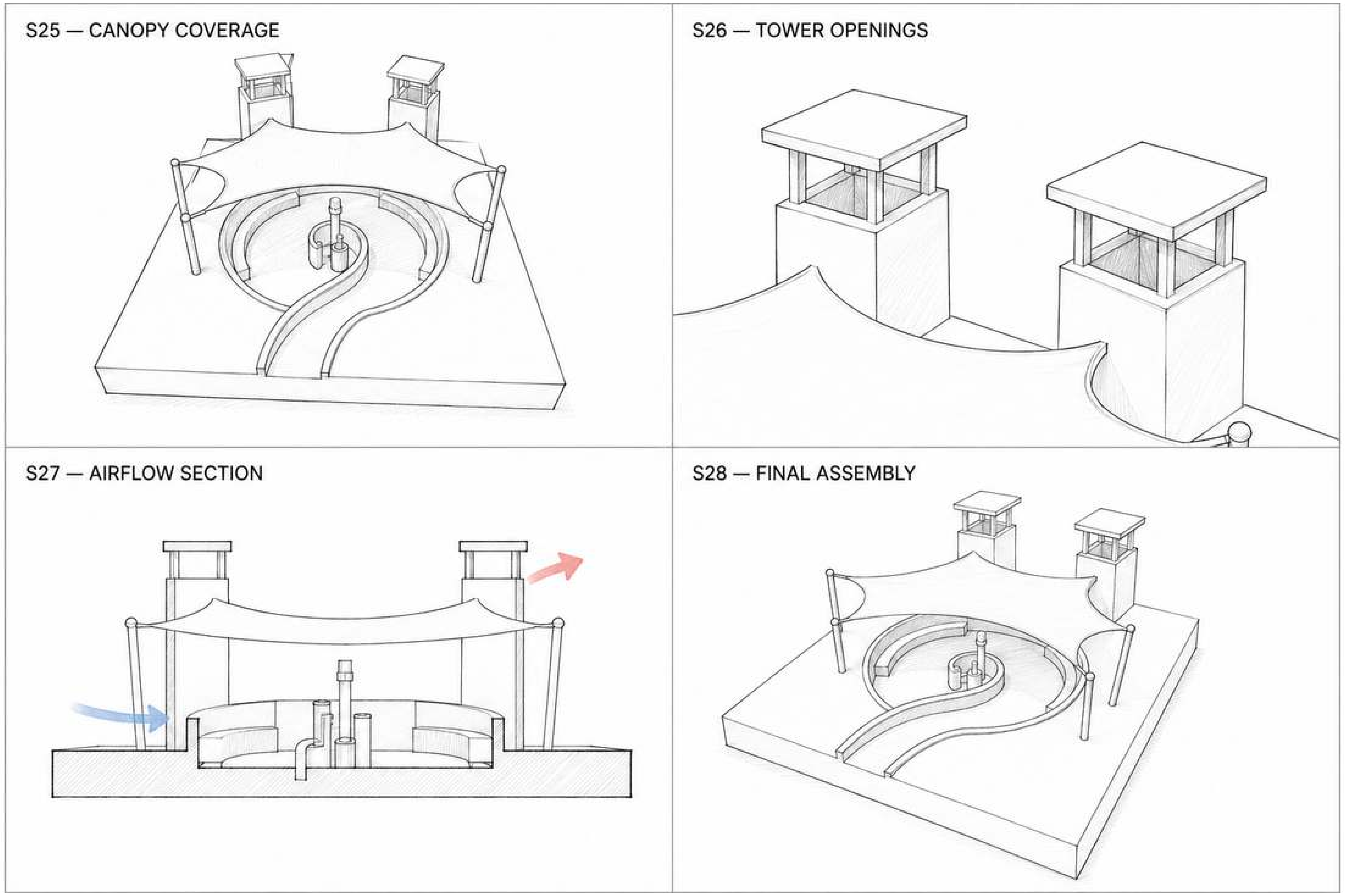


S24 — CANOPY JOINT TEST



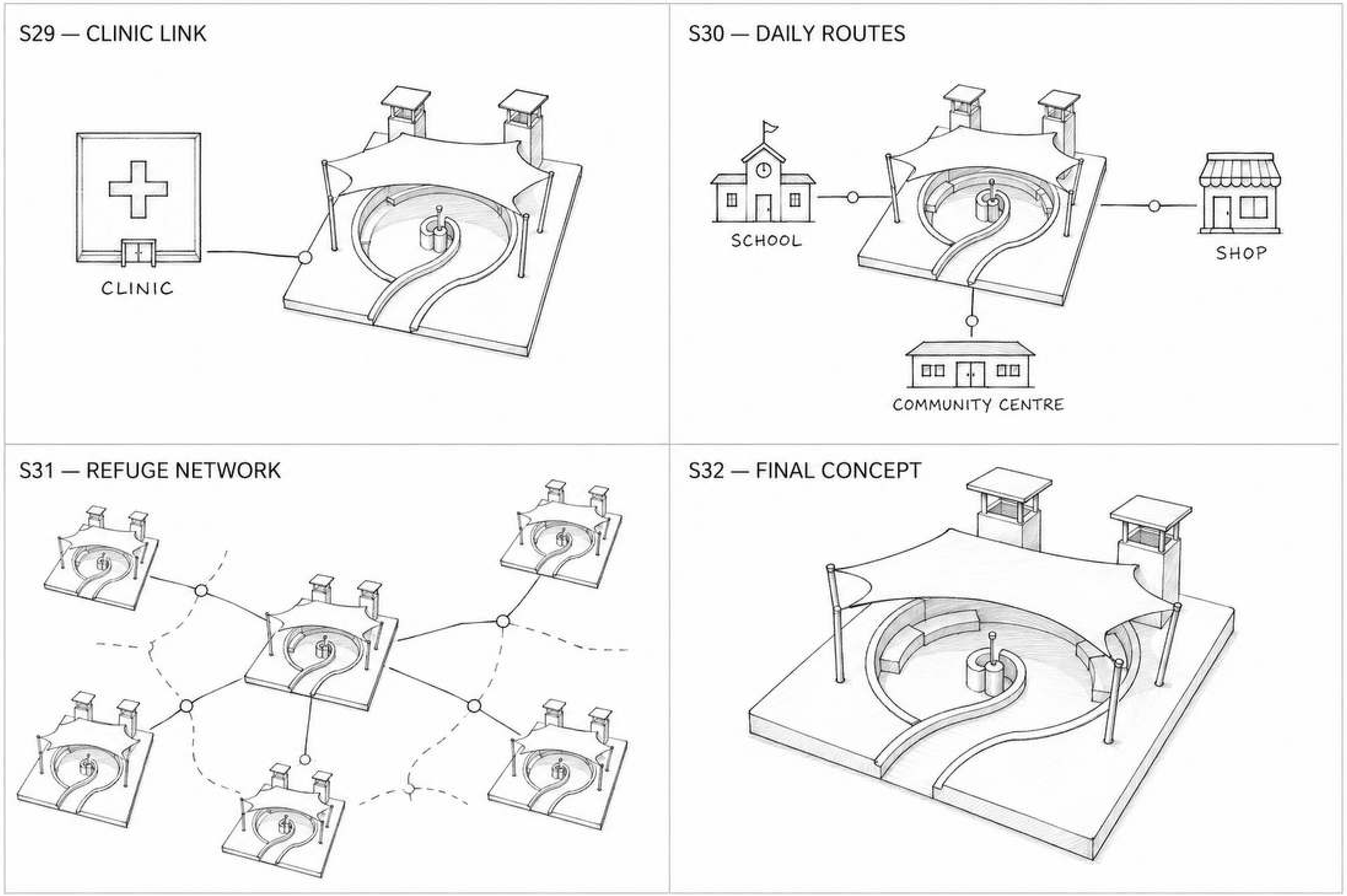
Sketches S25-S28 | Final refinement

Thirty-two numbered project sketches record what was tested, learned and changed.



Sketches S29-S32 | Network and integration

Thirty-two numbered project sketches record what was tested, learned and changed.



Each iteration added one necessary layer

01 Shade > **02** Earth > **03** Airflow > **04** Network

01 — Shade

A simple shelter reduced direct sun but did not solve ground heat or unequal access.

02 — Earth

The refuge moved below ground to use Coober Pedy's dugout logic and thermal mass.

03 — Airflow

Two towers created a clear intake-to-exhaust path without mechanical cooling.

04 — Network

The object became a community system linked to everyday destinations.

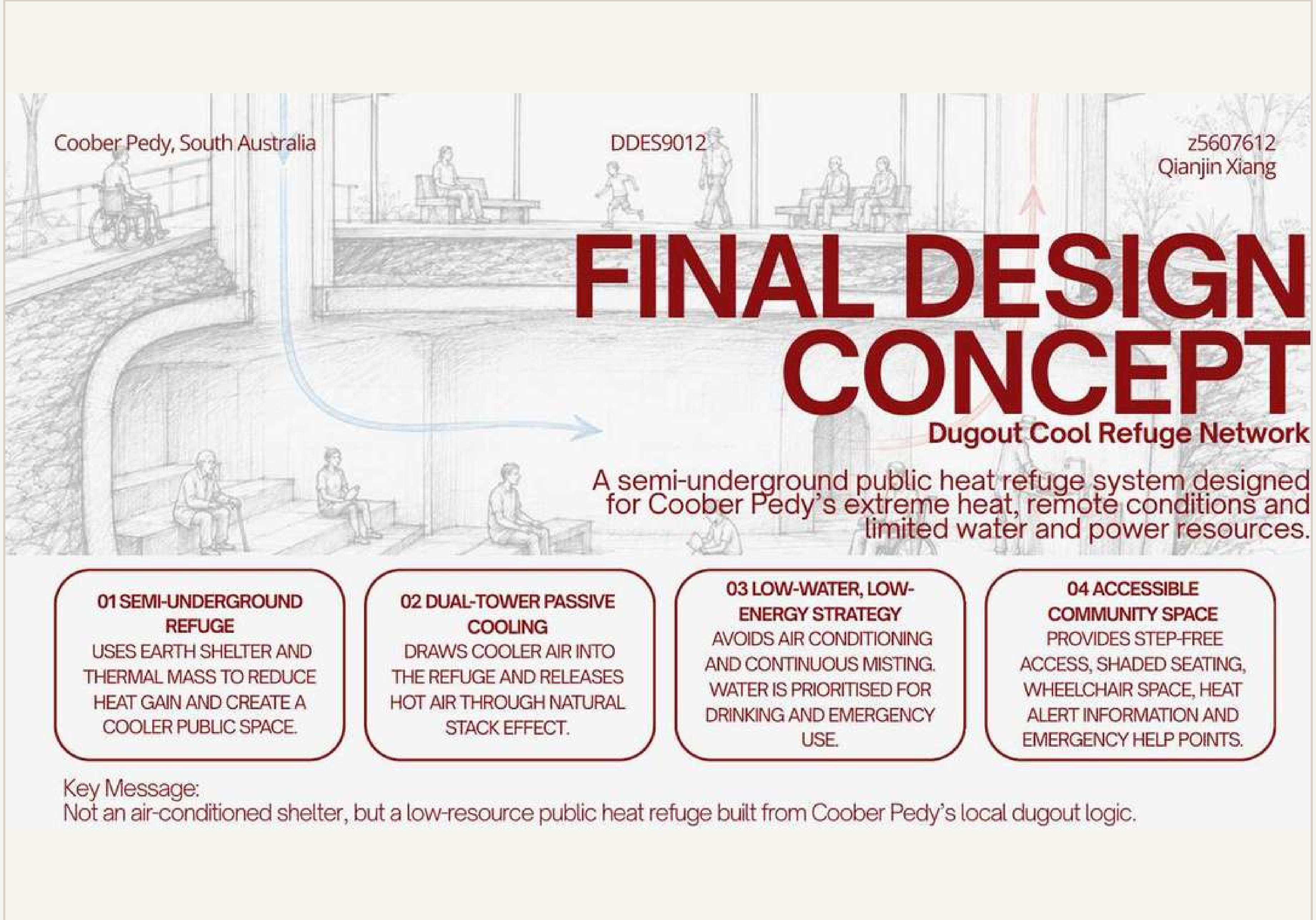
Resolved direction: a semi-underground public refuge using shade, earth and passive airflow.

The semi-underground concept best fits the design criteria

CRITERIA	SHADED SHELTER	COOLING POD	DUGOUT REFUGE
Low water	High	Medium	**High**
Low energy	Medium	Low	**High**
Accessible	High	Medium	**High**
Climate fit	Medium	Low	**High**
Public use	Medium	Low	**High**
Remote repair	High	Low	**High**

Decision: develop the Dugout Refuge because it combines local climate logic, public access and low-resource operation.

The selected concept combines four linked systems



01 SEMI-UNDERGROUND

Earth shelter and thermal mass reduce heat gain.

02 DUAL TOWERS

Cooler air enters while warm air rises and leaves by stack effect.

03 LOW RESOURCE

No continuous misting and less dependence on air conditioning.

04 ACCESSIBLE PUBLIC SPACE

Ramp access, shaded seating, water, information and help.

Material tests translated the idea into a buildable model

MODEL MATERIALS

- Layered cardboard for thick earth walls
- White card or fabric for the shade canopy
- Paper or card towers for airflow testing
- Clear model figures for scale and access
- Wire or strip material for ramp handrails

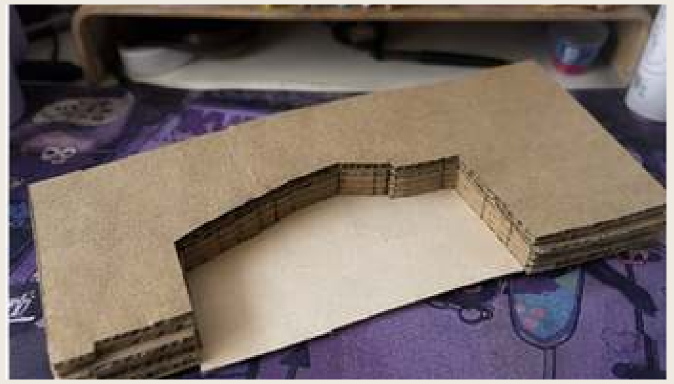
TESTING QUESTION

Primary design research question: Can a low-tech scale model clearly communicate earth shelter, shade, airflow and step-free access?

Process photographs P01-P04 | Base, walls and first canopy

Original paper-model photographs show the design developing step by step.

P01



Initial earth-wall footprint.

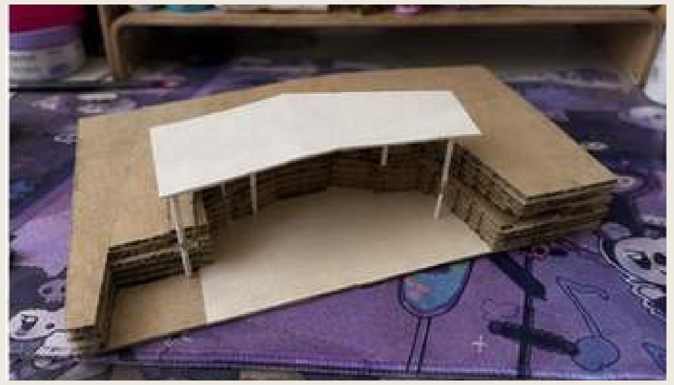
P02

Increased wall thickness.

P03

First canopy size test.

P04

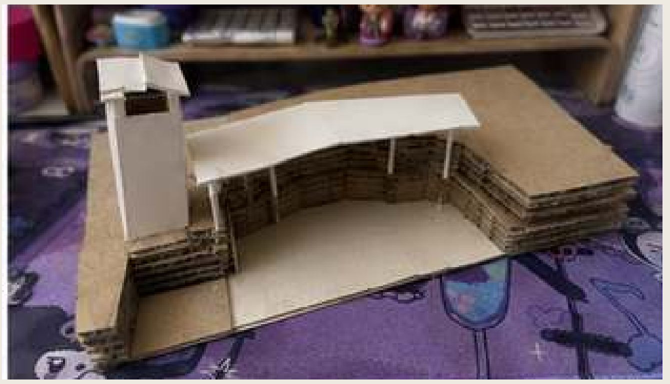


Canopy support test.

Process photographs P05-P08 | Tower and airflow testing

The two towers were added separately before the airflow paths were tested.

P05

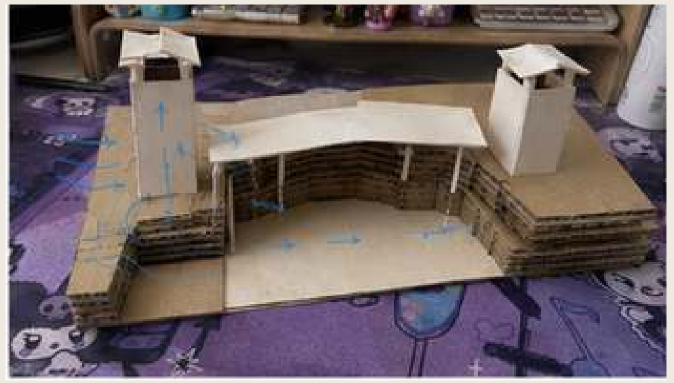


Intake tower position.

P06

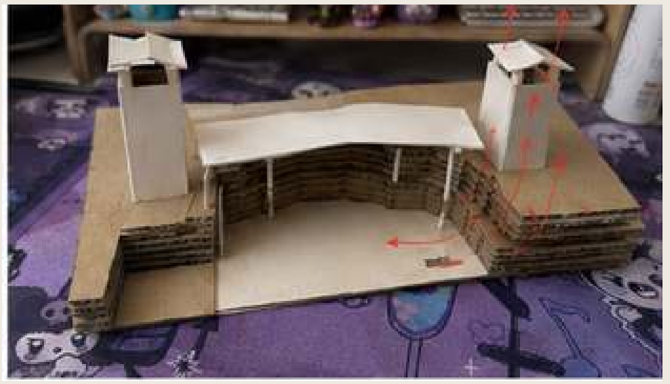
Exhaust tower position.

P07



Cool-air path test.

P08



Hot-air exhaust test.

Process photographs P09-P12 | Access, seating and scale

Ramp, seating and scale figures tested access and use of the refuge.

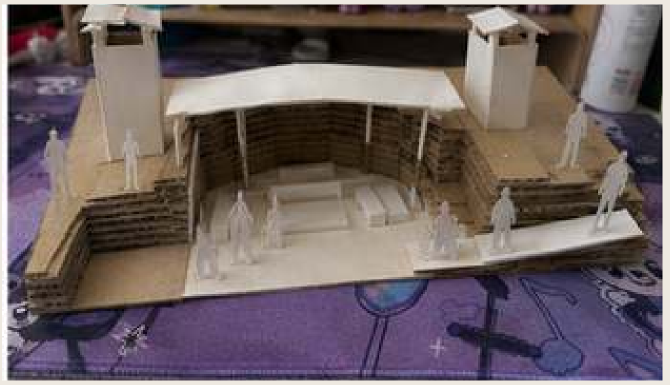
P09

Ramp placement test.

P10

Seating layout test.

P11



Human scale and access test.

P12

Completed paper model.

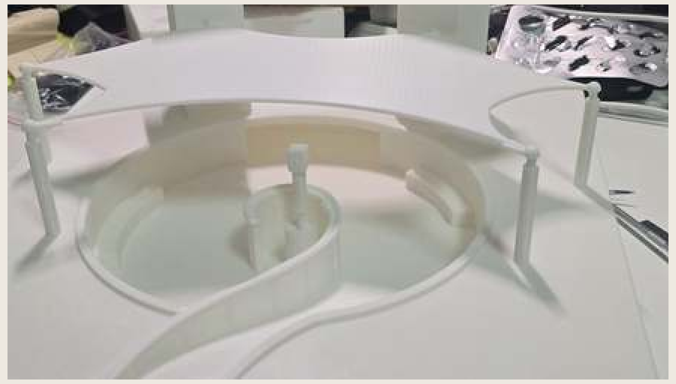
Process photographs P13-P16 | From paper model to 3D print

The final paper model was translated into printed canopy, tower and wall details.

P13

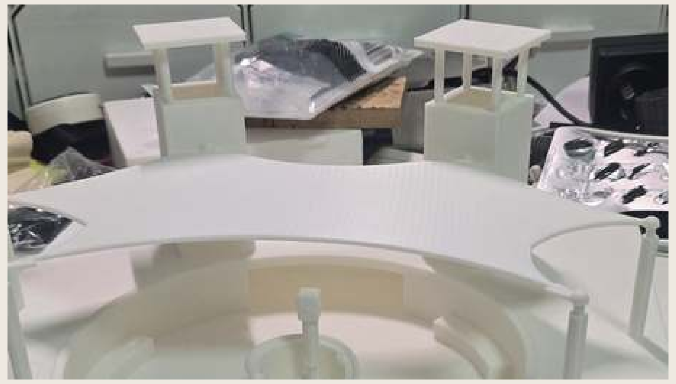
Final paper-model photograph.

P14



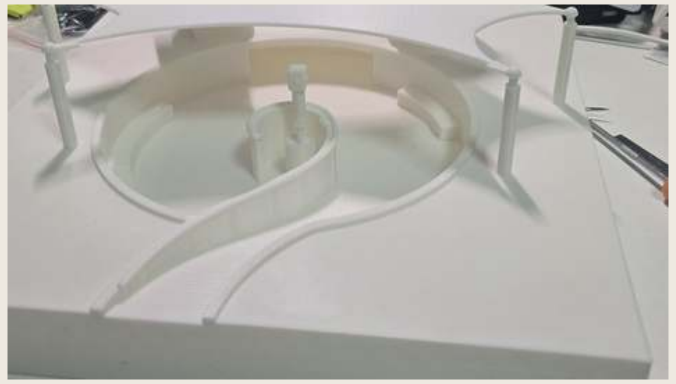
3D-printed canopy curvature.

P15



Dual-tower height check.

P16



Wall and canopy-support detail.

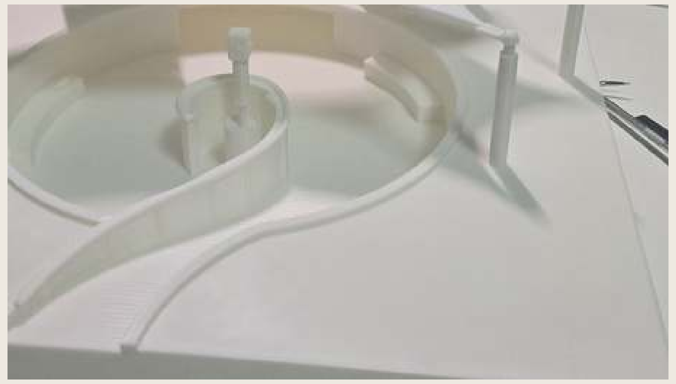
Process photographs P17-P20 | 3D-print details and assembly

Detail crops document the curved ramp, refuge interior and completed assembly.

P17

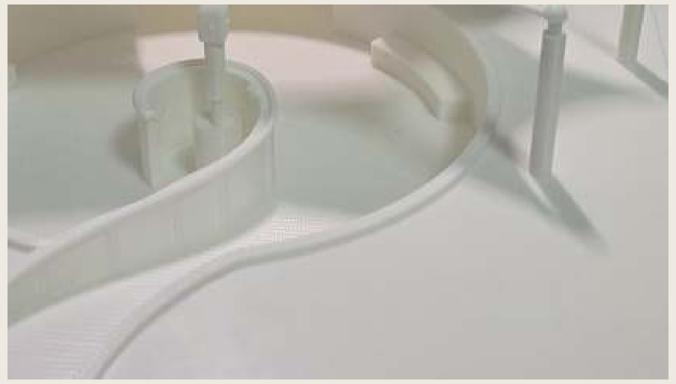
Curved ramp connection.

P18



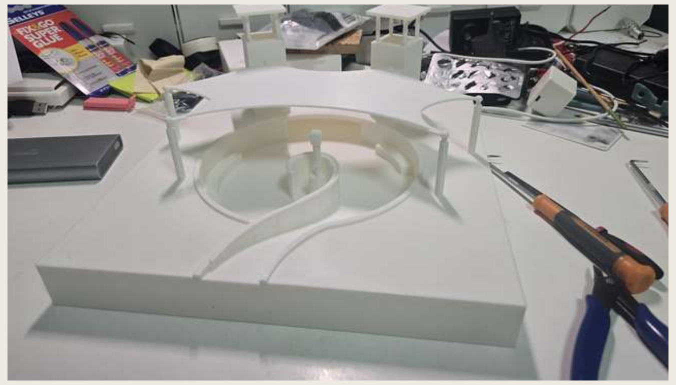
Circular refuge and seating.

P19



Central support-point detail.

P20



Final printed-model assembly.

Earth shelter testing

EARTH WALL TEST

WHAT I TESTED

Layered cardboard simulated thick earth walls and the semi-underground condition.

WHAT I LEARNED

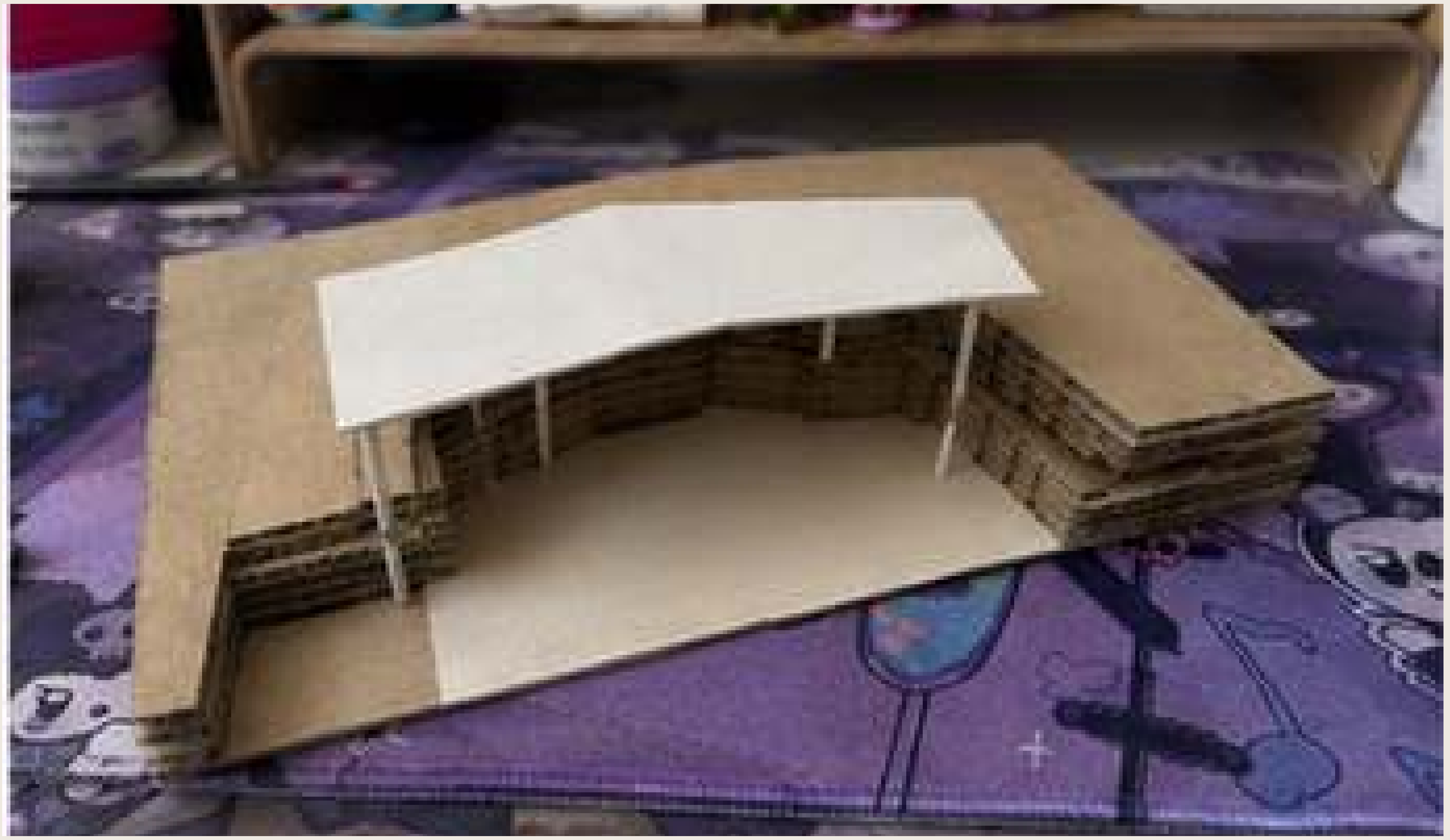
The thicker wall made the dugout idea clearer and gave the seating edge more structure.

WHAT CHANGED

Increase visible wall depth and keep the inner refuge below ground level.

Shade canopy testing

CANOPY TEST



WHAT I TESTED

Different widths and overhangs tested how much of the waiting area stayed shaded.

WHAT I LEARNED

A wider, simple white canopy protected more seating while keeping the refuge open.

WHAT CHANGED

Extend the canopy over occupied areas and keep supports clear of circulation.

Dual-tower airflow testing

AIRFLOW TEST

WHAT I TESTED

Two towers tested a clear cool-air intake and hot-air exhaust path.

WHAT I LEARNED

Tower position must connect to the low refuge space and remain easy to read in section.

WHAT CHANGED

Keep one intake tower and one taller exhaust tower with visible airflow arrows.

Accessibility testing

RAMP + CIRCULATION TEST

WHAT I TESTED

Ramp width, slope direction, turning area and seating clearances were checked with figures.

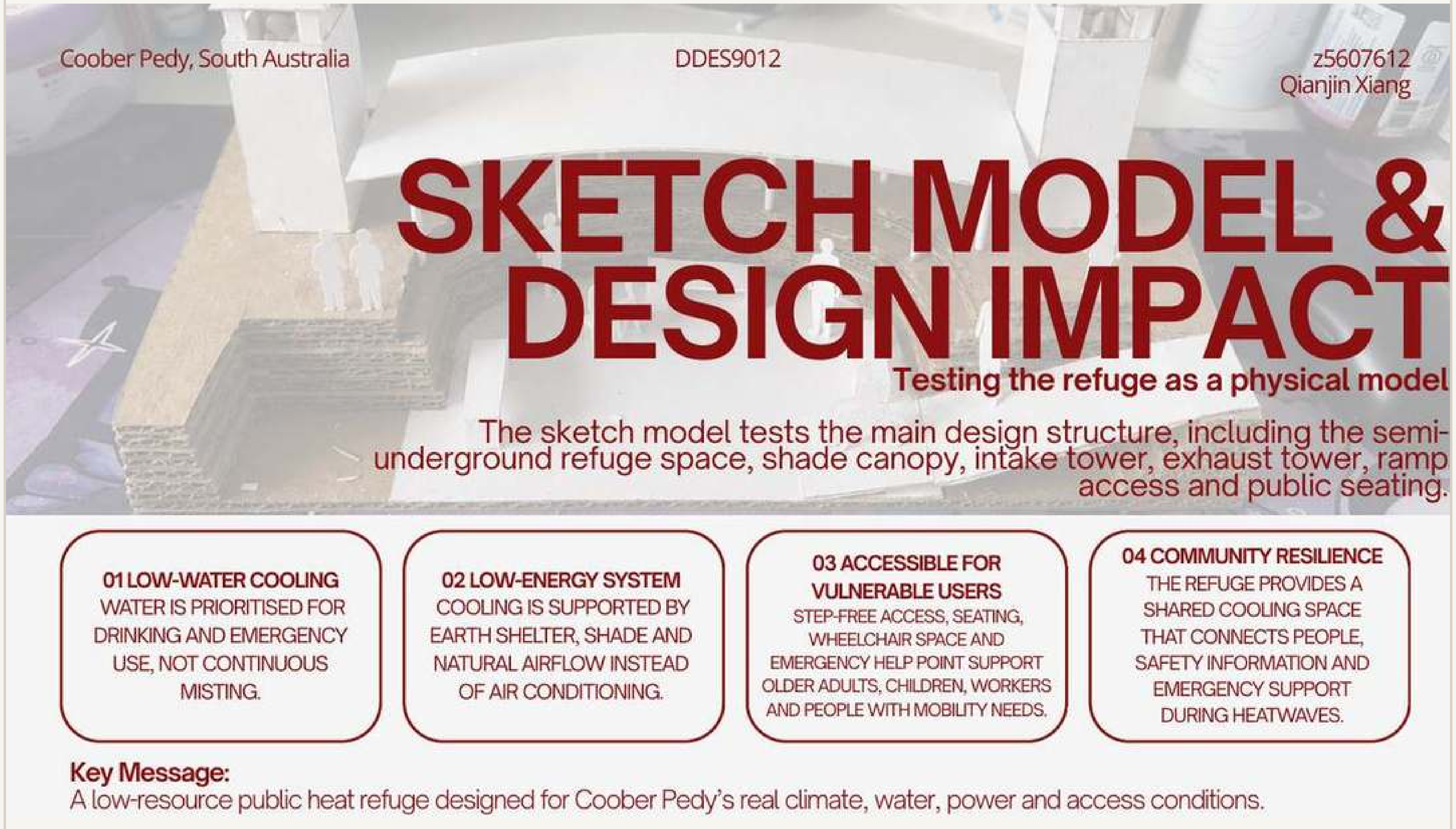
WHAT I LEARNED

The entrance must be part of the main route, not a separate back access.

WHAT CHANGED

Use a clear step-free entry, rest points and wheelchair space beside shared seating.

The sketch model confirmed the main system and exposed the next tests



CONFIRMED

The semi-underground form, canopy, two towers, ramp and seating can be read as one system.

IMPROVED

The paper model exposed uneven walls, a detached canopy, an abrupt ramp, and unclear tower openings and airflow paths. The final model resolves these with smooth layers and a continuous curved ramp.

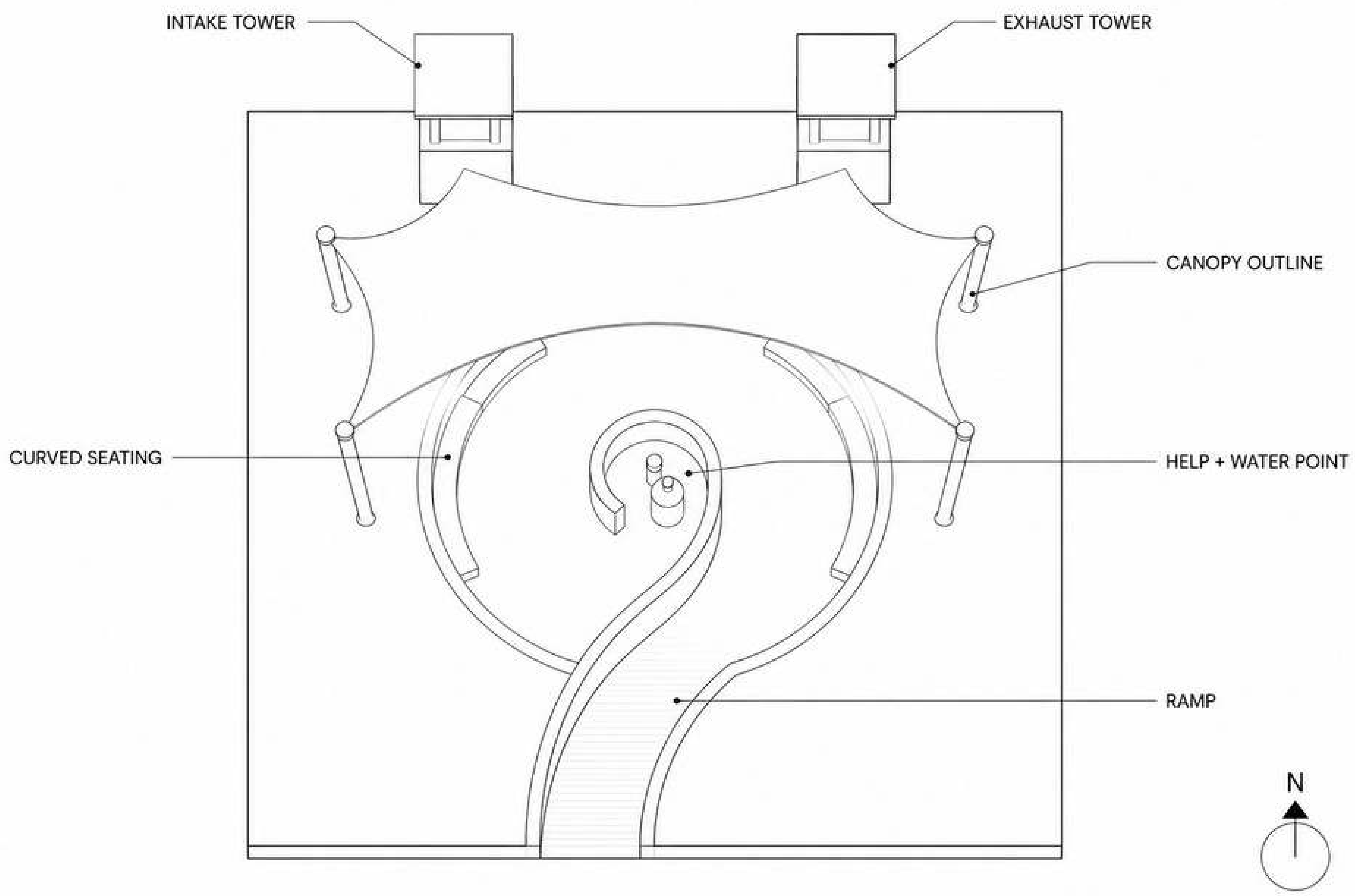
STILL TO TEST

Measure airflow and temperature difference, confirm ramp dimensions, and seek local feedback.

Do not claim measured cooling performance until it has been tested.

The final plan aligns access, seating, canopy and ventilation towers

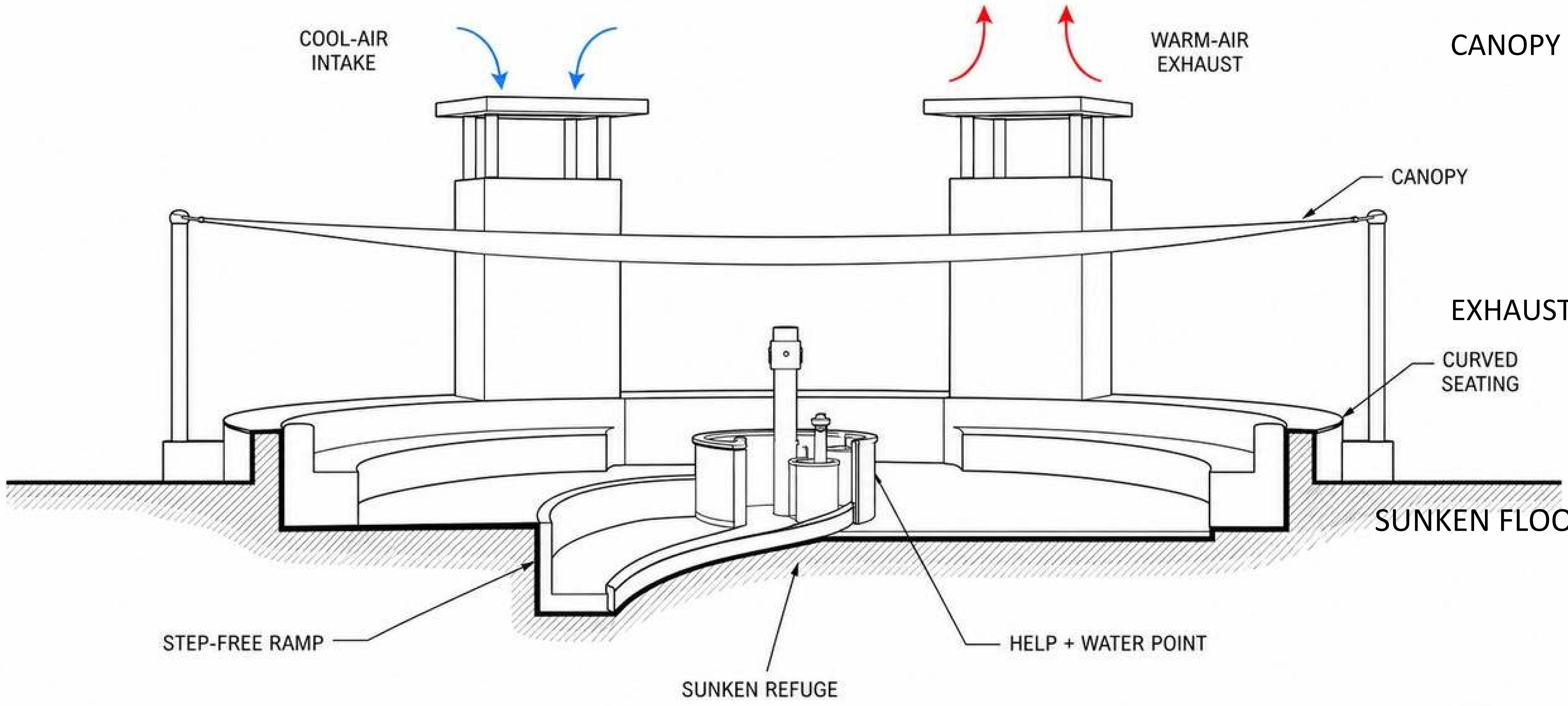
PD01 — PLAN | 1:50 | mm



INDICATIVE DIMENSIONS (mm)
Refuge Ø9000 · Canopy Ø11000
Ramp 1200 clear / 1:20 max
Turning zone Ø1500

The section explains earth shelter, shade and passive airflow

PD02 — SECTION | 1:50 | mm



CANOPY CLEAR 2400

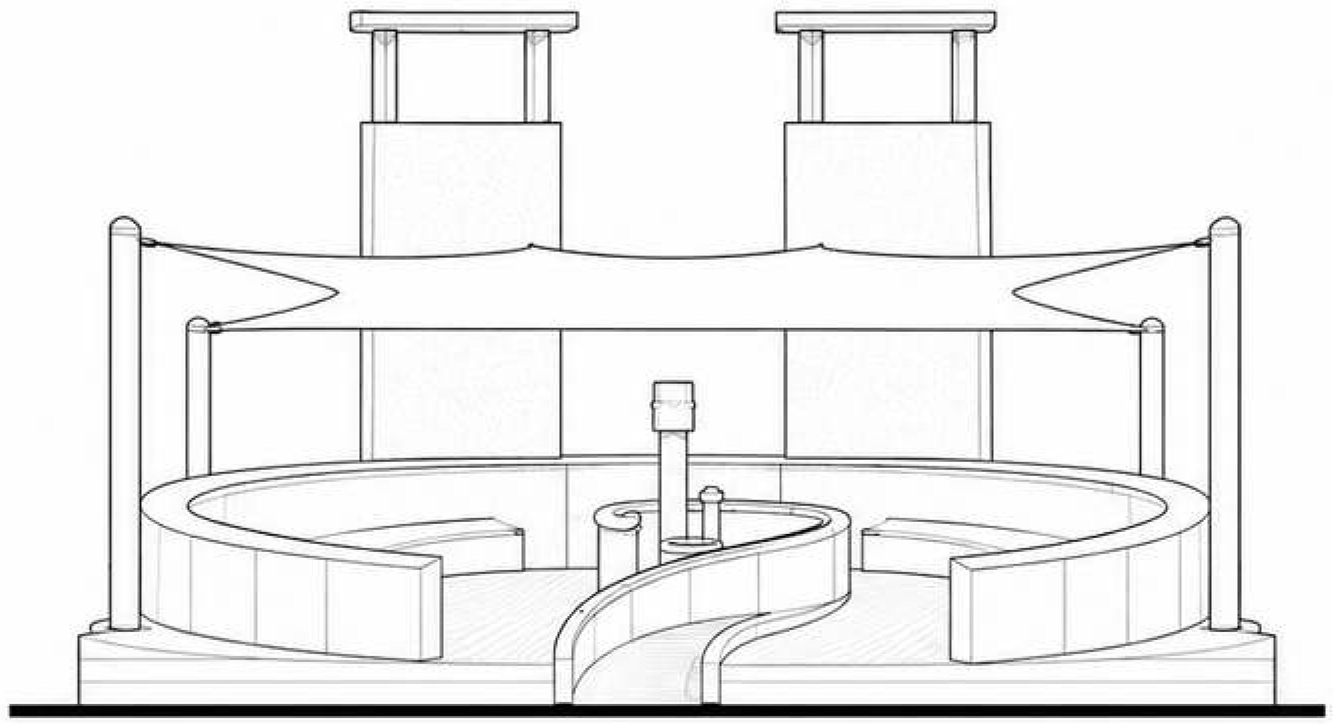
INTAKE 3600

EXHAUST 4200

SUNKEN FLOOR −600

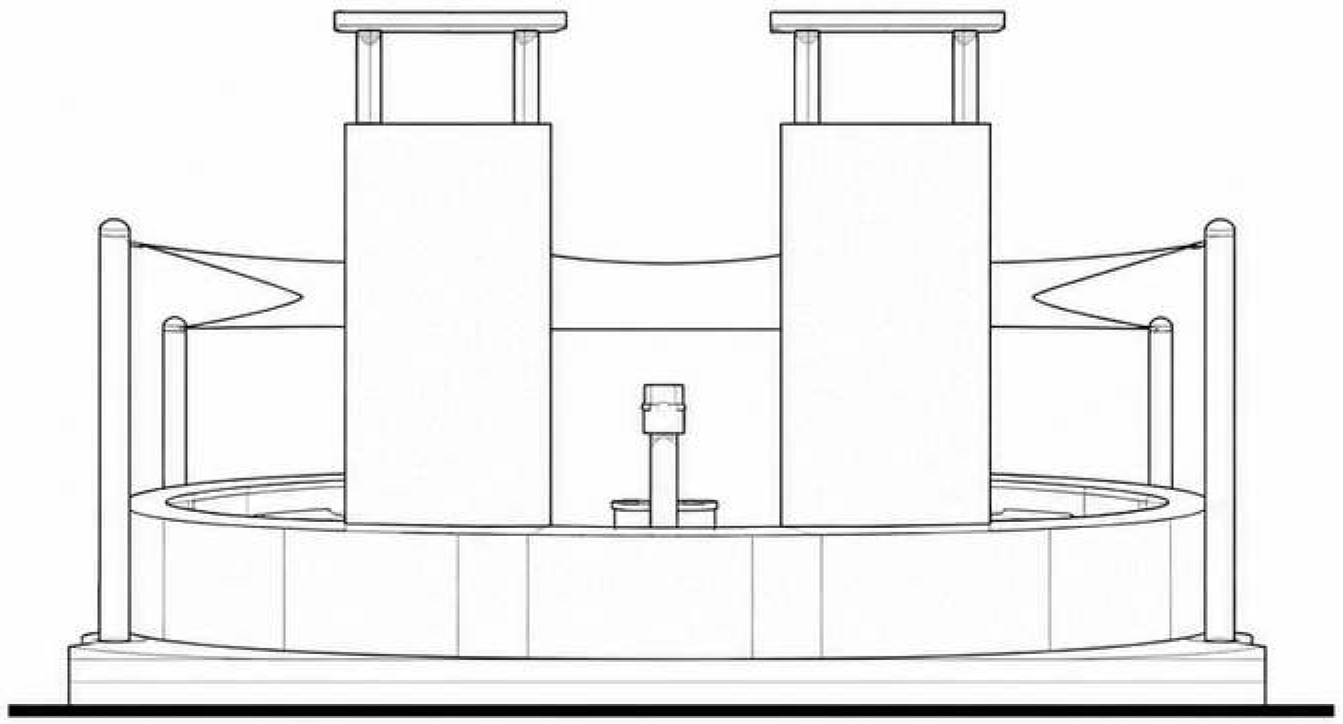
Front and rear elevations confirm canopy and tower proportions

PD03 — FRONT + REAR ELEVATIONS | NTS



FRONT ELEVATION

NTS

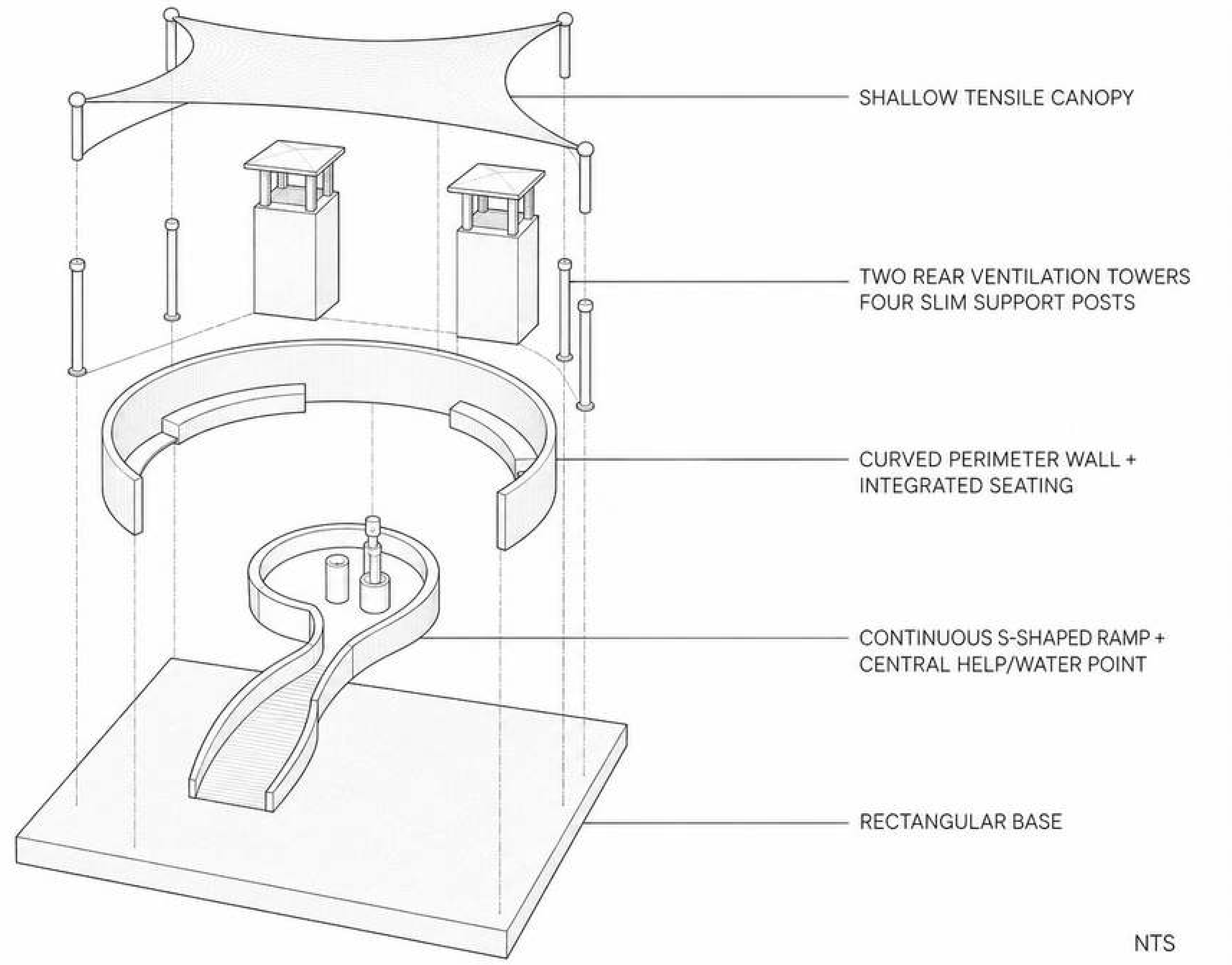


REAR ELEVATION

NTS

The exploded axon clarifies assembly and maintenance

PD04 — EXPLODED AXONOMETRIC | NTS



The physical model confirms key assembly details

MODEL VERIFICATION | Ramp, support point and printed wall connection

The final proposal is a public refuge, not a private building

F01 - FINAL PHYSICAL MODEL

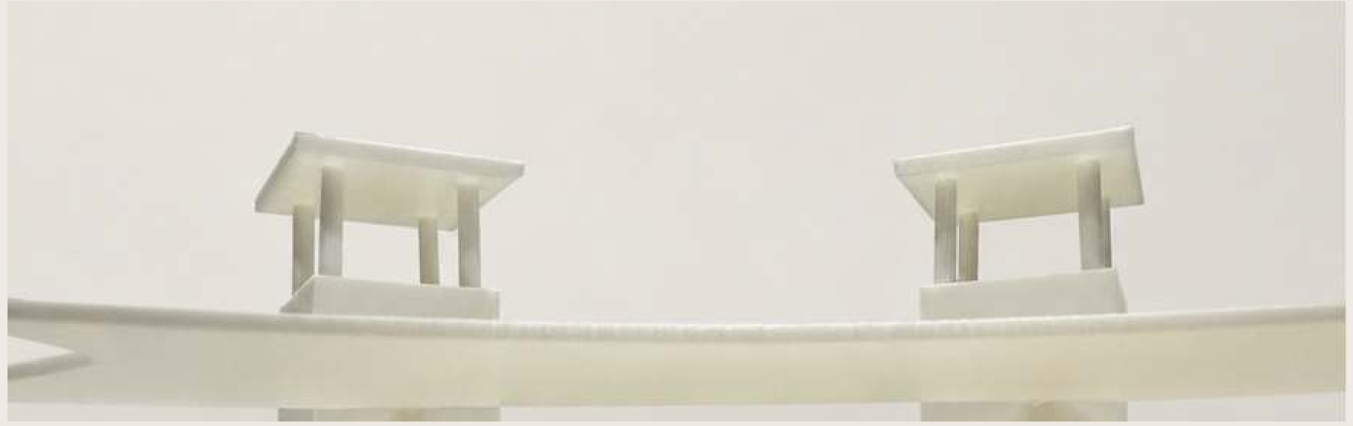
DUGOUT COOL REFUGE NETWORK

A semi-underground public heat refuge for Coober Pedy. Earth, deep shade and passive airflow reduce heat exposure, while a step-free ramp connects cooling, water and emergency information.

Low-resource cooling built from local dugout logic.

One model brings cooling, access and emergency support together

F02 - TOWERS + CANOPY

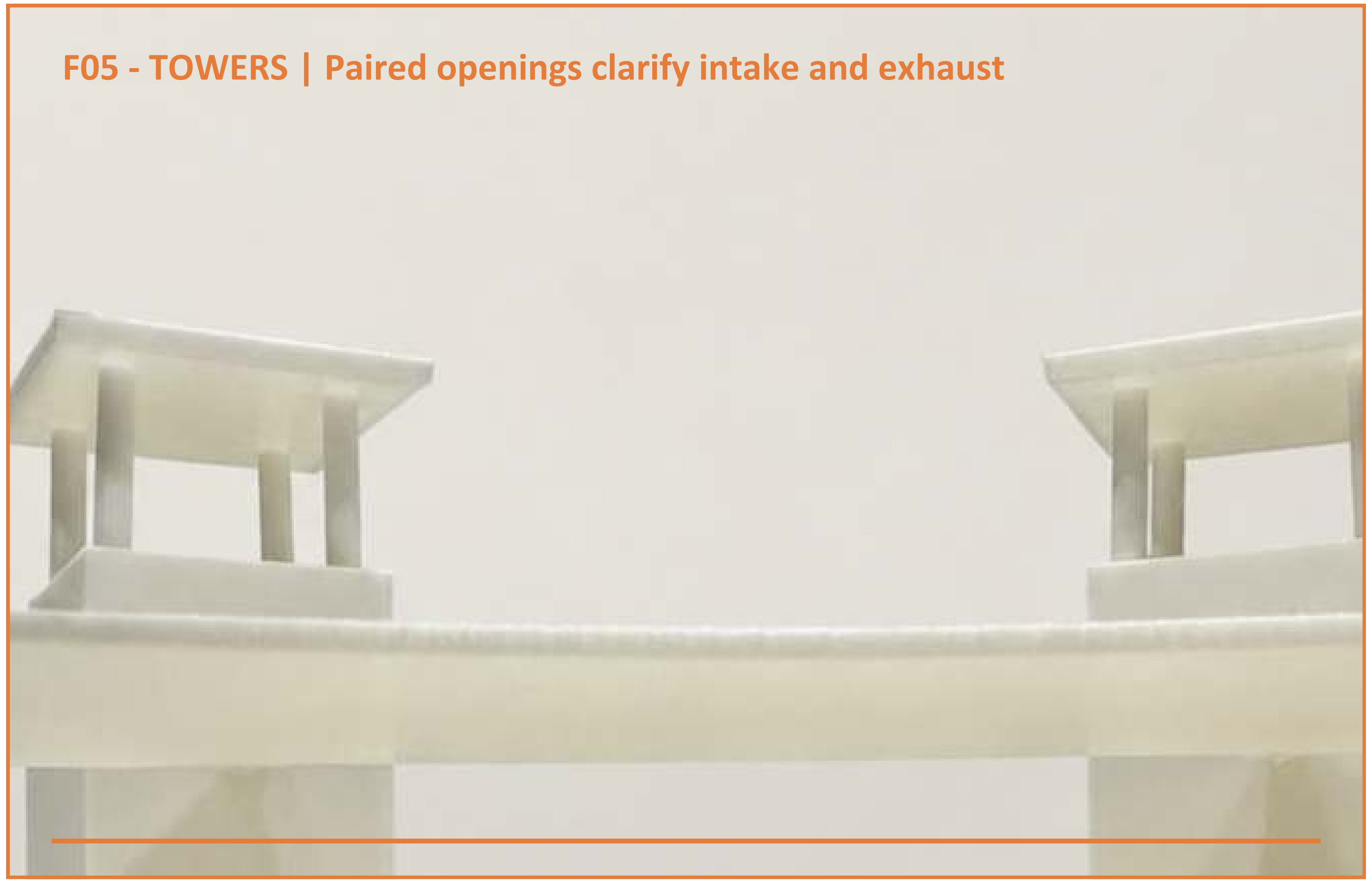


F03 - RAMP + REFUGE DETAIL

The refuge supports arrival, recovery and safe onward travel

F04 - INTERIOR | Shaded seating and central support point

F05 - TOWERS | Paired openings clarify intake and exhaust



01 ARRIVE

02 COOL DOWN

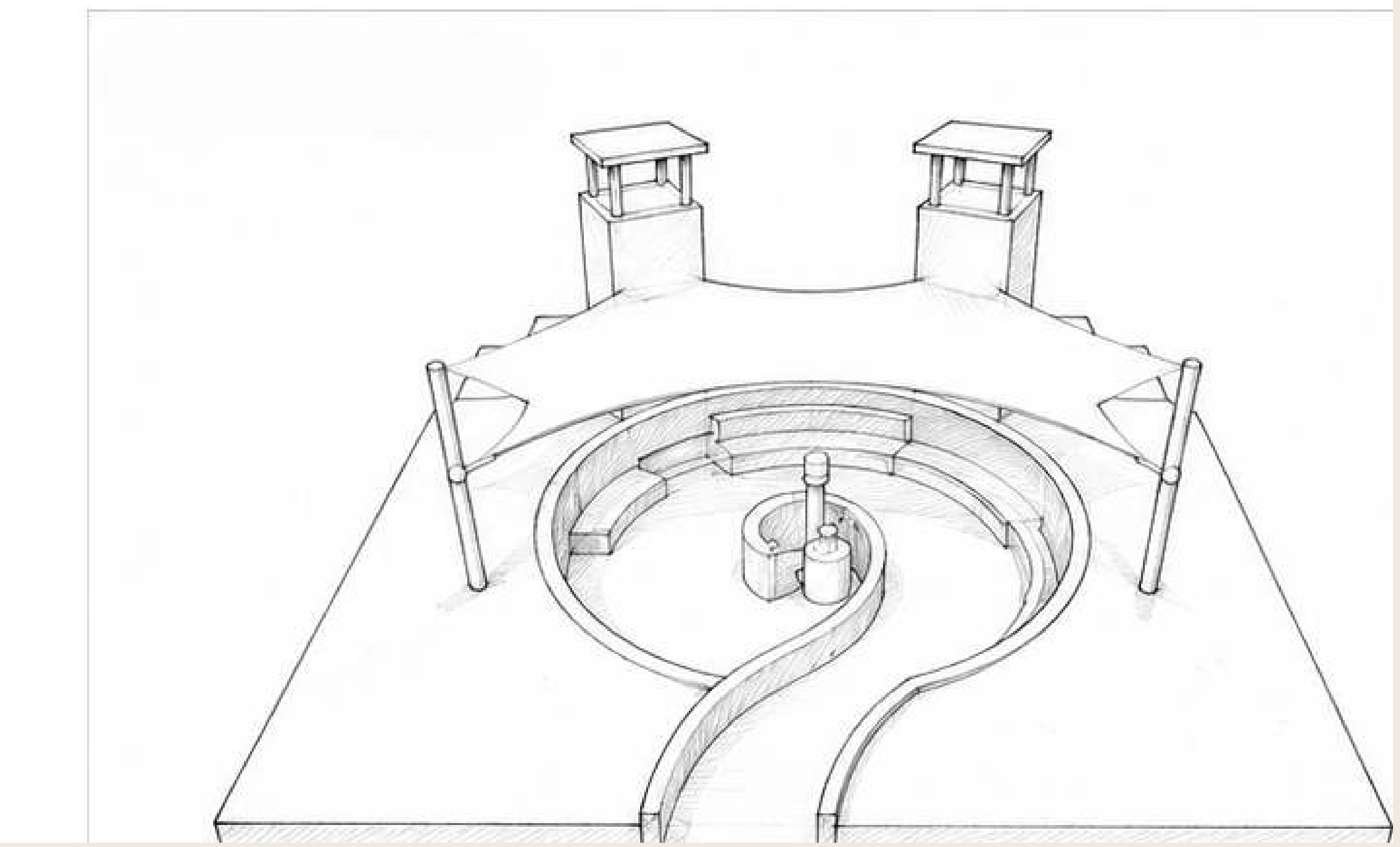
03 GET INFORMATION

04 CONTINUE SAFELY

Accessibility is part of the main route, not an added feature

F06 - ACCESSIBLE PLAN | Step-free entry and clear turning space

F07 - RAMP DETAIL | 1:20 maximum slope and 1500 mm turning zone



Design checks: step-free entry | clear circulation | rest points | wheelchair space | visible information | shared seating

The physical model confirms the final geometry

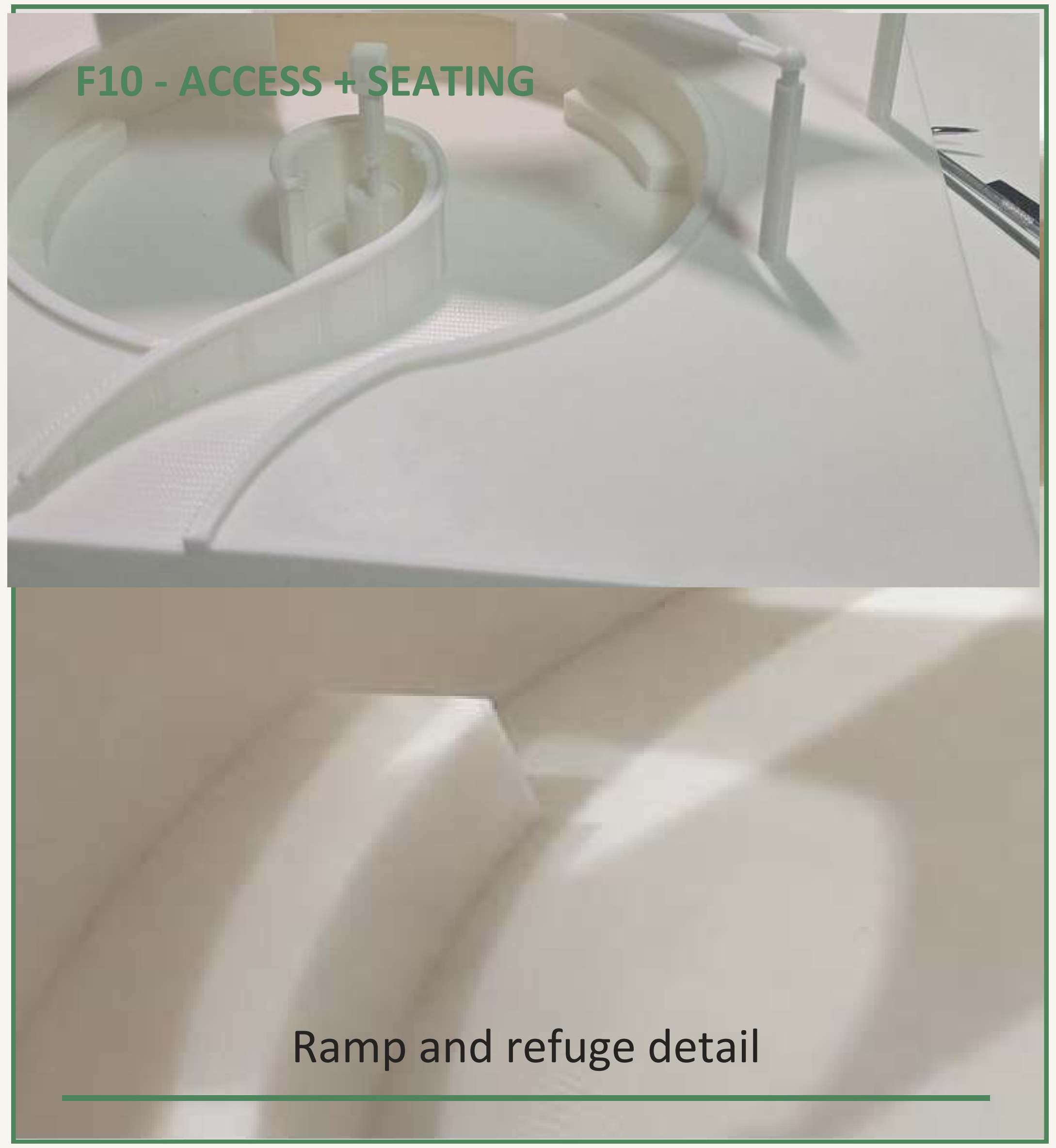
F08 - COMPLETE MODEL

Current 3D-printed model

F09 - TOWER + CANOPY

Tower and canopy detail

F10 - ACCESS + SEATING



Ramp and refuge detail

The final geometry resolves the paper-model limits: a continuous curved ramp improves access; the integrated canopy extends shade; smooth walls clarify structure; and distinct ventilation towers communicate airflow.

The design responds well, but performance and community fit still need testing

RESEARCH INTEGRATION

The proposal directly addresses heat, unequal access, water scarcity, energy dependence and vulnerable users.

CONCEPTUAL DEVELOPMENT

The design visibly develops from a shaded shelter to an earth-sheltered refuge and community network.

CREATIVE RESPONSE

It adapts local dugout logic into shared emergency infrastructure rather than a generic cooling centre.

NEXT EVIDENCE

- Measure internal and external temperature.
- Test airflow speed and tower position.
- Confirm accessible ramp dimensions.
- Seek feedback from local residents and Traditional Owners.
- Review material durability and maintenance.

The design is promising, but it should not claim proven cooling performance before these tests are complete.

DDES9012 · ASSESSMENT 2

DUGOUT COOL REFUGE NETWORK

A low-resource public heat refuge for Coober Pedy

EARTH · SHADE · AIRFLOW · ACCESS

Qianjin Xiang | z5607612

In Coober Pedy, heat becomes an access problem

01 **EXTREME HEAT**

Long heatwaves create immediate health risk.

02 **LIMITED RESOURCES**

Mechanical cooling is difficult to sustain.

03 **UNEQUAL ACCESS**

Not everyone has a dugout or reliable cooling.

04 **HIGHER RISK**

Vulnerable users are affected first.

The response must fit the town’s real resource conditions.

Local knowledge guided three design methods

PRIVATE DUGOUT KNOWLEDGE → SHARED PUBLIC COOLING

Earth protects the occupied space from outside heat.

01 HUMAN-CENTRED DESIGN

Start with people, access and support needs.

02 CLIMATE-RESPONSIVE DESIGN

Use earth, shade and local airflow.

03 ITERATIVE PROTOTYPING

Test the form, find problems and improve it.

These methods convert local knowledge into a public design decision.

Testing changed the shelter step by step

SHADE

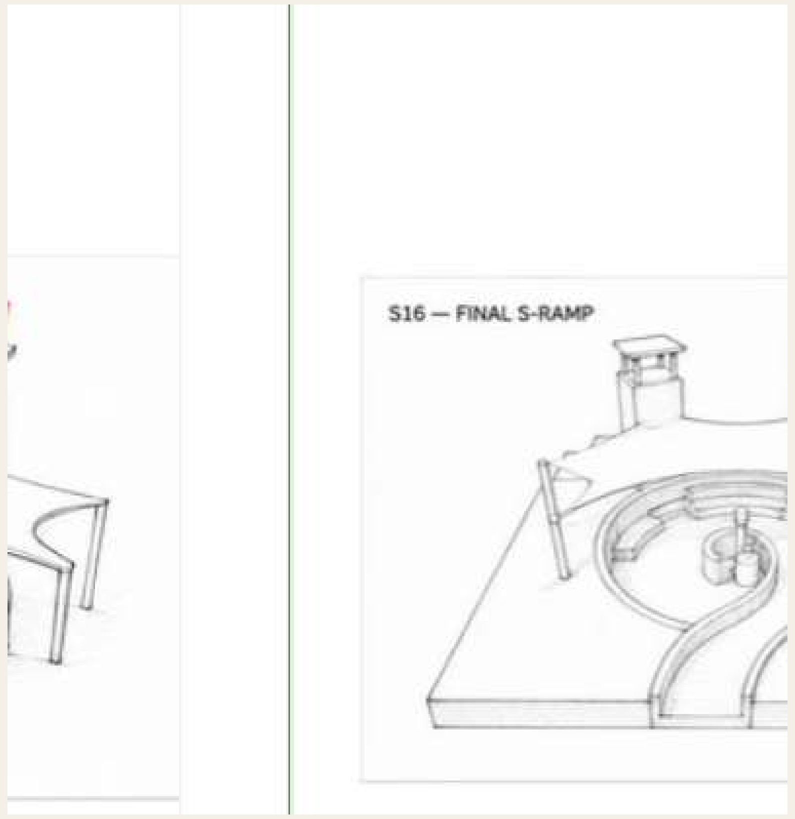
The first shelter gave shade but did not use enough earth.

EARTH

The occupied space then moved partly below ground.

AIRFLOW

Two towers created a clear intake and exhaust path.



ACCESS

The final curved ramp made the route continuous and step-free.

The final form is the record of these decisions — not a single aesthetic leap.

Four linked parts work as one refuge

01 **SEMI-UNDERGROUND REFUGE**

Earth buffers the occupied space.

02 **DUAL VENTILATION TOWERS**

The airflow path is visible.

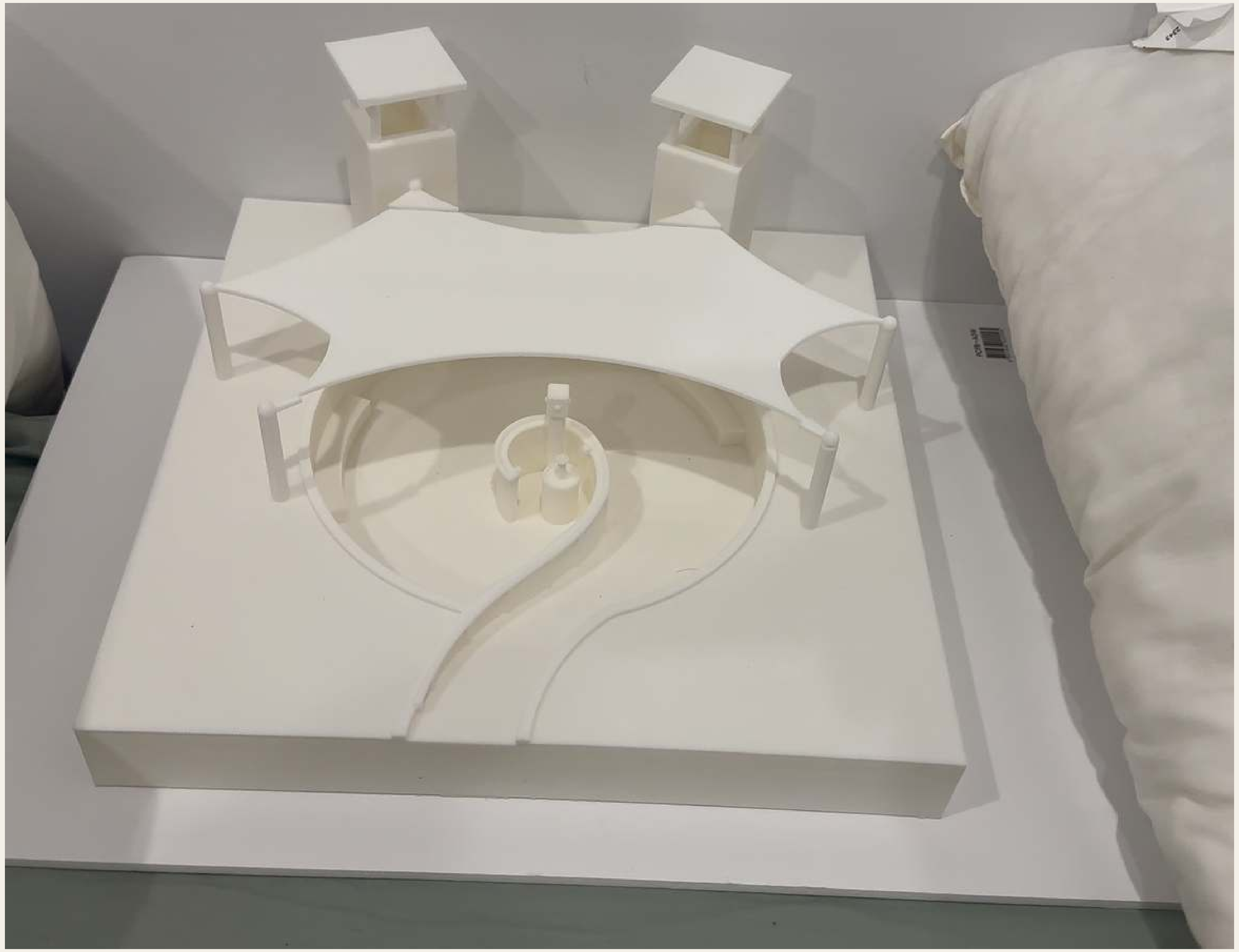
03 **DEEP WHITE CANOPY**

Shade protects seating and circulation.

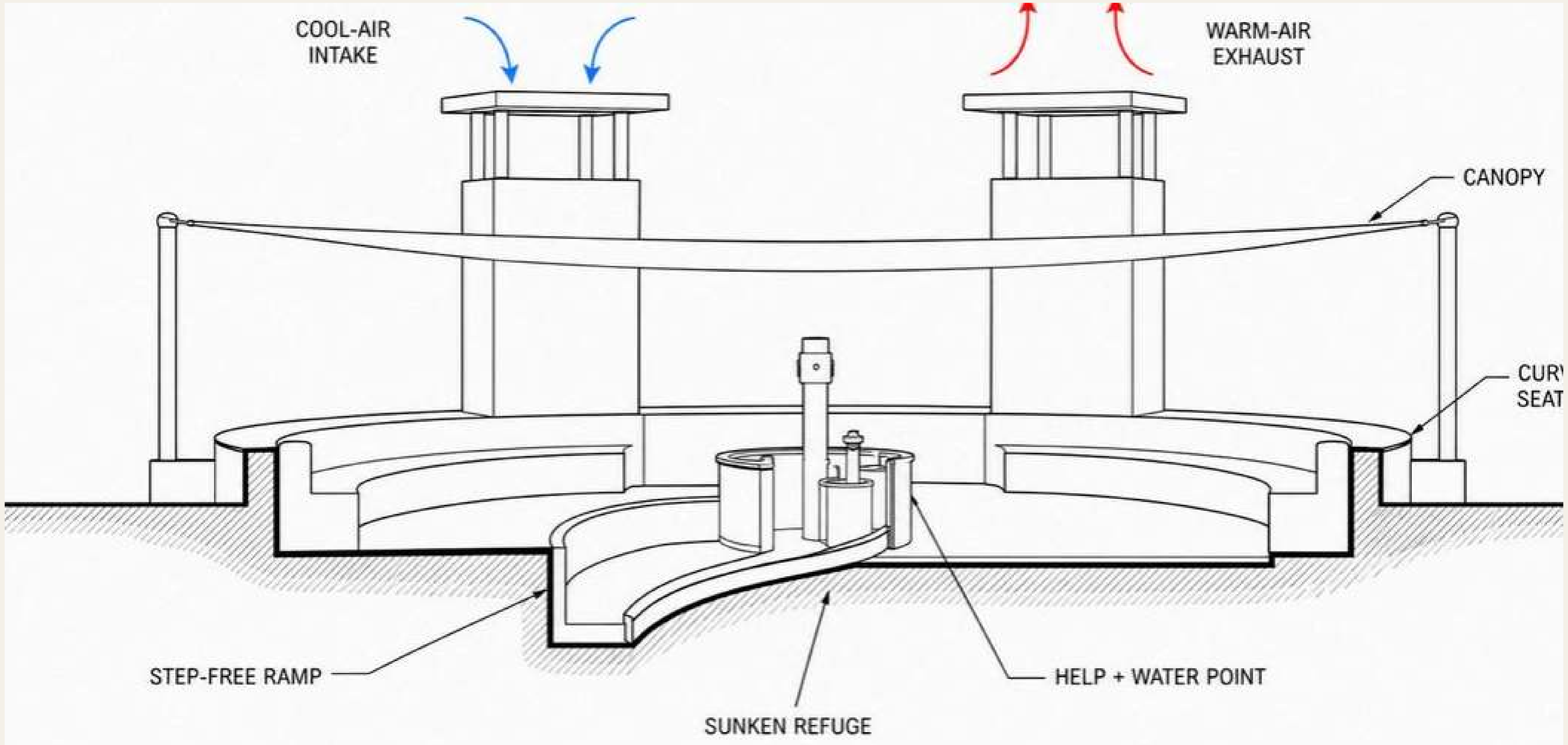
04 **STEP-FREE SUPPORT SPACE**

Access, water and help are integrated.

LOW WATER · LOW ENERGY · SHARED ACCESS



Earth, shade and airflow form one cooling strategy



COOL AIR IN

Air is drawn down through the intake tower.

EARTH + SHADE

Thermal mass and canopy reduce heat gain.

HOT AIR OUT

Warm air rises through the exhaust tower.

PROPOSED PERFORMANCE

Technical cooling performance still requires measurement.

Access is part of the architecture — not an add-on

STEP-FREE ENTRY

A clear curved ramp connects directly from the public route.

REST + RECOVERY

Shaded seating supports different bodies and ages.

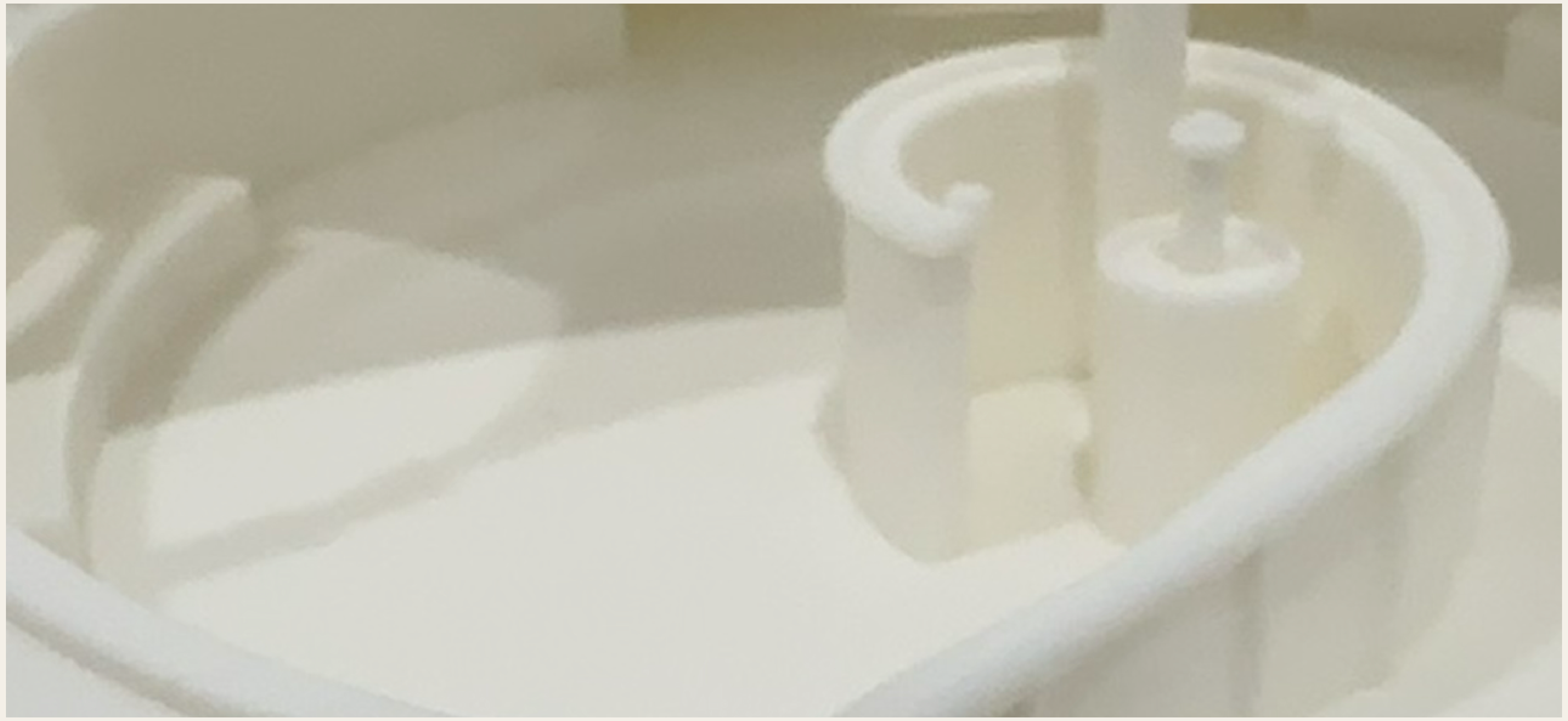
WATER + INFORMATION

Shared services sit visibly at the centre.

COMMUNITY NETWORK

Clinic, school, shop and community centre become refuge points.

The physical model resolved visible design problems



EARLY PAPER MODEL

— UNEVEN WALLS	Smoother continuous wall geometry
— SHARP RAMP TURNS	One continuous curved route

FINAL PHYSICAL MODEL

— SEPARATE CANOPY	Canopy connected to the whole composition
— UNCLEAR TOWER OPENINGS	Two towers read as intake and exhaust

The design is resolved — its performance still needs testing

01 AIRFLOW TESTING

Test the intake and exhaust path.

02 TEMPERATURE

Measure conditions inside and outside.

03 FULL-SCALE ACCESS

Check ramp dimensions at 1:1 scale.

04 LOCAL FEEDBACK

Consult local people and Traditional Owners.

Feedback and measurement can make the proposal safer, more useful and technically credible.

LOCAL KNOWLEDGE BECOMES SHARED SAFETY

Earth, shade, airflow and public access work together as one low-resource refuge for Coober Pedy.

LOW WATER | LOW ENERGY | ACCESSIBLE | PLACE-BASED

Reflection and evaluation | Part 1 of 2

A 500+ word reflection evaluates the context, design response, access, success and limitations.

CONTEXT + PROBLEM

This design project developed from the finding that heatwaves in Coober Pedy are not only caused by extreme temperature, but are intensified by access, infrastructure, water, energy and community vulnerability. In Assessment 1, the research showed that older adults, children, Indigenous communities, outdoor workers and people with mobility needs can face higher risk during prolonged heat. It also showed that existing responses, such as underground homes, air conditioning and warning systems, are useful but uneven. Not every resident has access to a dugout home, air conditioning can create high energy demand and cost, and water-based cooling is difficult to justify as a main strategy in a remote desert town.

DESIGN RESPONSE

The Dugout Cool Refuge Network responds to this emergency scenario by translating Coober Pedy's local dugout logic into a shared public heat-refuge system. Instead of proposing a heavily mechanical cooling centre, the design uses earth shelter, deep shade and dual-tower passive ventilation to create a lower-resource cooling space. This approach is important because it connects the design to the climate and construction culture of the place. The semi-underground form and thermal mass reduce heat gain, while the intake and exhaust towers create a simple airflow strategy that can be understood through the model.

Reflection and evaluation | Part 2 of 2

ACCESS + RESOURCE USE

The project also aims to improve social access. Step-free ramp entry, shaded seating, wheelchair space, heat alert information and emergency help points are included so that the refuge can support vulnerable users rather than only able-bodied adults. The network idea connects refuge points to community destinations such as the clinic, school, shops and community centre, making the design more useful during real heatwave events. Another important decision was to avoid treating water as an unlimited cooling resource. In a desert town, drinking water and emergency use should be prioritised, so the design avoids continuous misting and instead relies on shade, ground contact and ventilation. This helped me make the project more realistic for a remote place where maintenance, cost and resource availability matter as much as appearance.

SUCCESS + LIMITATIONS

Through sketching and model testing, the proposal changed from a simple shaded shelter into a more resolved semi-underground public space. The material tests helped me understand how wall thickness, roof overhang, tower placement and circulation affect the design. The most successful part of the project is the way the final concept combines local environmental knowledge, low-resource operation and accessible public use. However, there are limitations. The passive cooling system would need further technical testing to measure temperature difference and airflow performance. The cultural and community aspects would also require consultation with local residents and Traditional Owners before real implementation. Overall, the design successfully responds to the heatwave scenario by offering an inclusive and climate-responsive refuge, while also showing that emergency design in remote communities must address people, place and resources together. If developed further, the next stage would involve measuring internal temperature, testing airflow with a more accurate model under different seasonal wind conditions and discussing the network locations with people who understand Coober Pedy's daily heat patterns, travel routes and community needs.

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