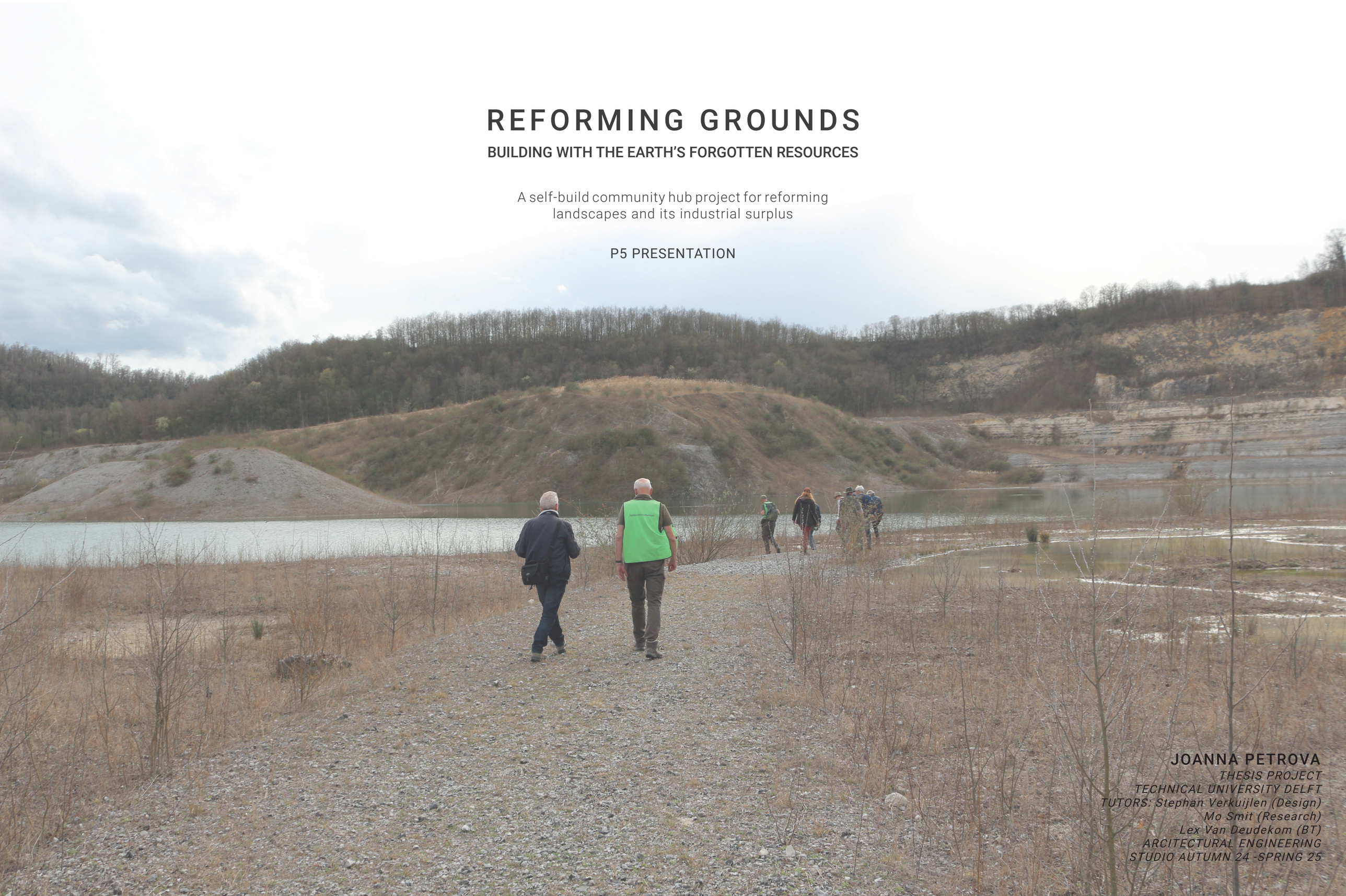
REFORMING GROUNDS

BUILDING WITH THE EARTH'S FORGOTTEN RESOURCES

A self-build community hub project for reforming
landscapes and its industrial surplus

P5 PRESENTATION



JOANNA PETROVA

THESIS PROJECT
TECHNICAL UNIVERSITY DELFT
TUTORS: Stephan Verkuijlen (Design)
Mo Smit (Research)
Lex Van Deudekom (BT)
ARCITECTURAL ENGINEERING
STUDIO AUTUMN 24 -SPRING 25

PROBLEM STATMENT

INTRODUCTION

PROCESS

ROUTING

PAVILIONS

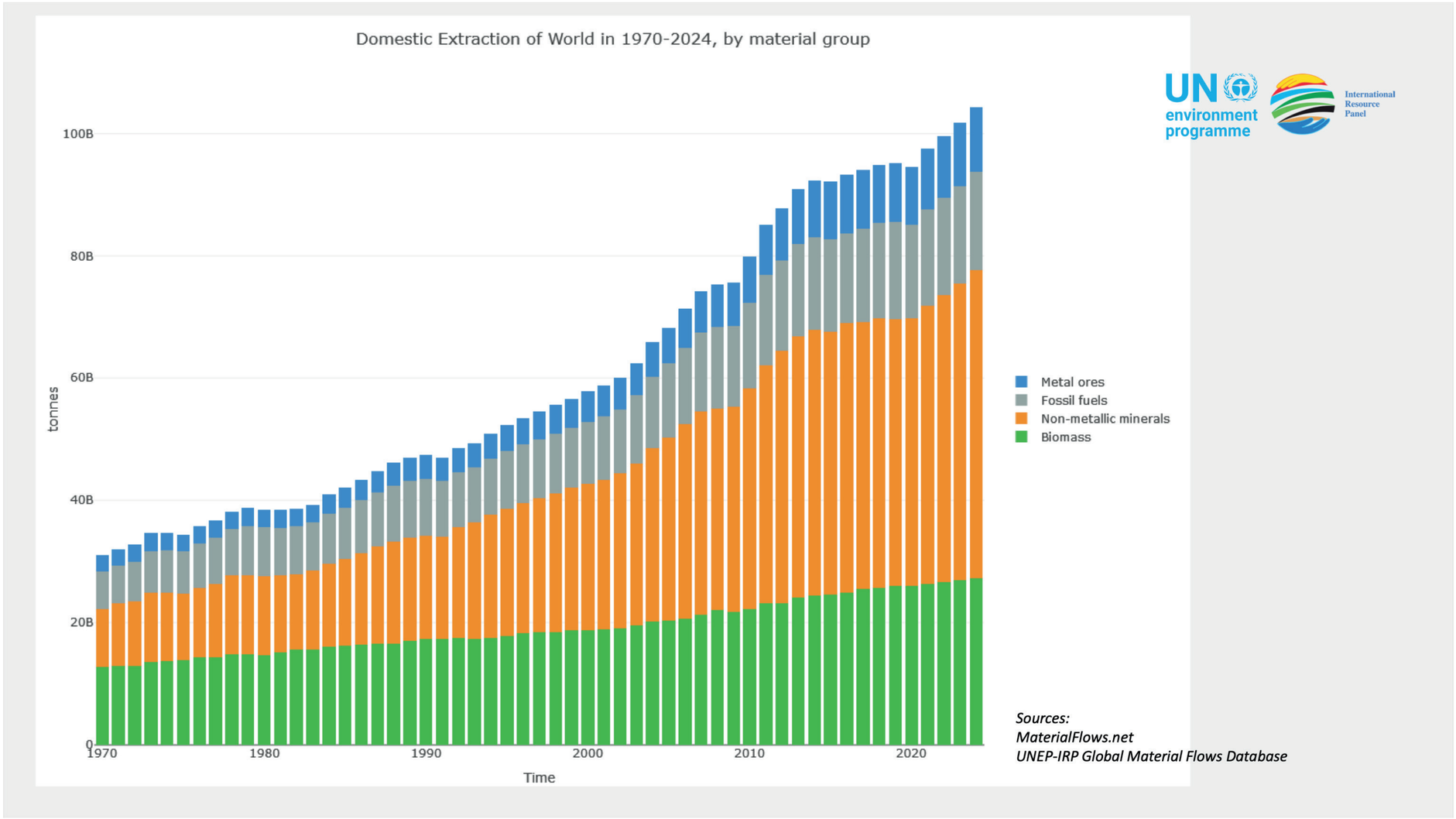
MATERIALS

BUILDINGS ARE RESPONSIBLE FOR **~40%** CO2 EMISSIONS

IRON, STEEL AND CEMENT **PRODUCTION** ACCOUNTS FOR
OVER 50% OF ALL INDUSTRIAL **(GHG)** EMISSIONS

GLOBAL EXTRACTION

JOANNA PETROVA **2025**



OVER **100 BILLION TONNES** OF MATERIALS EXTRACTED

REPORT FROM **EUROPEAN COMISSION**, 2023 STATES:

“In Europe, approximately 32 Mton of ornamental stones are extracted every year. Although extraction and processing methods have improved in the last decades, the circularity of the sector is still under development. In fact, approximately 50% of the extracted material becomes waste. Nowadays, enormous mountains of stone wastes are stored in facilities waiting to be disposed in landfills or recycled in applications such as embankments or refilling quarries. These wastes cause several environmental problems: GHG emissions from the transport of high volumes, respiratory problems on humans and animals by airborne particles, underground waters affected by the leachates or accidental spillages of sludge into rivers altering the ecosystem and biodiversity, etc.”

50% MATERIAL BECOME **MOUNTAINS** OF STONE **WASTE** SURPLUS

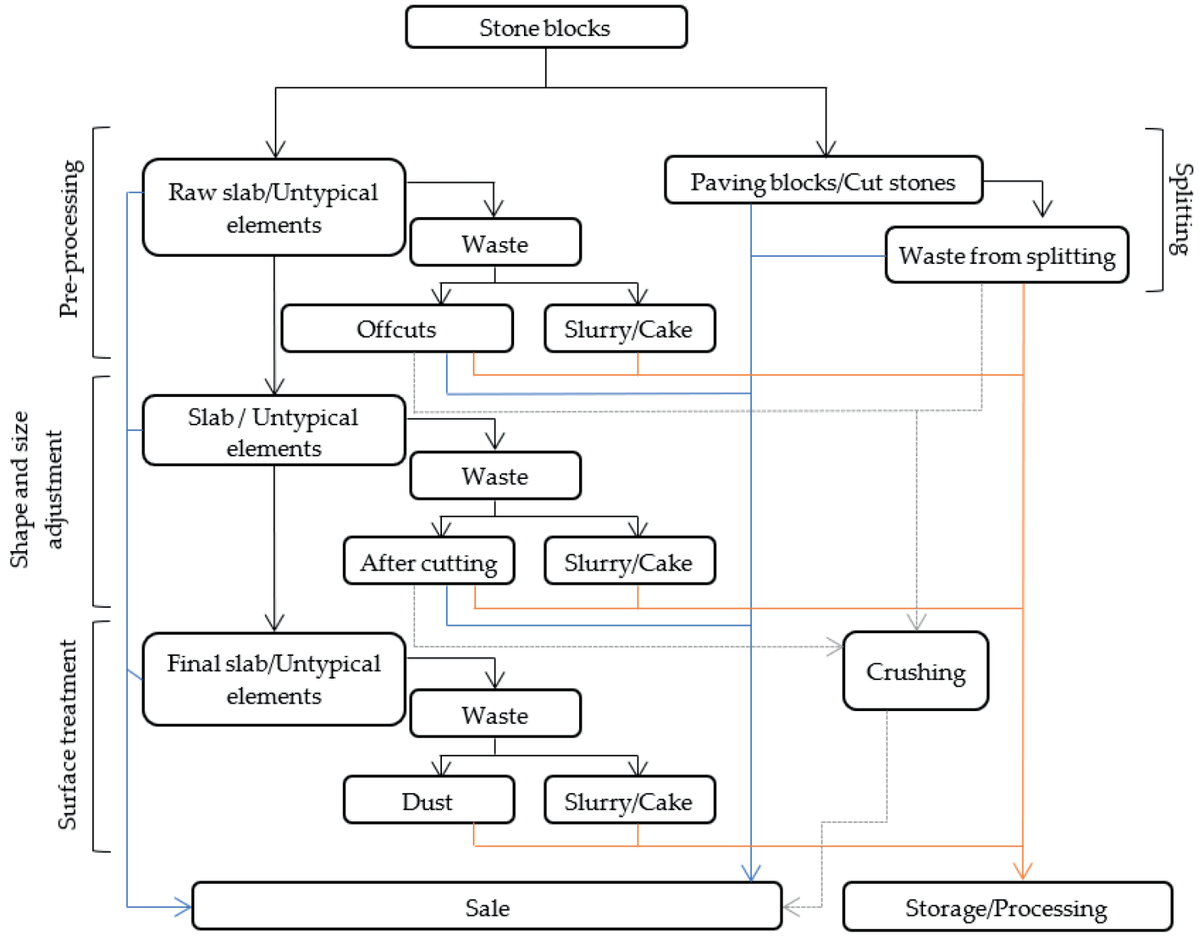
Table 2 Production of aggregate, quarry fines and quarry waste in the UK

Rock type	Annual production (million tonnes, 2005)		
	Saleable aggregate[1]	Quarry fines[e]	Quarry waste[4]
Sandstone	11.6	3.9	1.3
Limestone [2]	76.3	19.1	8.5
Igneous and metamorphic	46.0	11.5	5.1
Sand and gravel [3]	82.4	20.6	9.2
Total	216.3	55.1	24.1

1 Estimated aggregate production from Annual Minerals Raised Inquiry (Office of National Statistics, 2006)
2 Limestone including dolomite and chalk 3 Land- & marine-won sand and gravel
4. Estimated quarry waste modified from Defra mineral waste statistics (Defra, 2007)
e = estimated

8.5 MILLION TONNES LIMESTONE WASTE AND **9.2 MILLION TONNES** SAND AND GRAVEL

WASTE FROM PROCESSING



10-35% MATERIAL BECOME **WASTE** SURPLUS

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Circular.
FOR RESOURCE AND WASTE PROFESSIONALS

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Routeware The smartest way to manage waste and environmental services Learn M

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Walleys Quarry landfill site goes into liquidation

Legislation and Regulation, Environment and Energy

28th February 2025

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1 min

The controversial landfill site in Newcastle-under-Lyme, Staffordshire, has entered liquidation after being ordered to close last year.

Connect

in

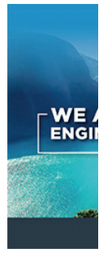
ENDS REPORT

Walleys Quarry tops EA league table of serious pollution incidents, data reveals

Pippa Neill 29 Feb 2024

The notorious Walleys Quarry landfill recorded 12 separate serious pollution incidents in 2022 and is only one of a small number of sites to receive the lowest 'F' compliance rating for two or more consecutive years, according to new Environment Agency (EA) data.

Aerial view of a landfill site. Source - GettyImages, Anton Petrus



Compl
Searcl

COMMON POST-USE AS LANDFILL

RECREATION, ECOLOGICAL REGENERATION AND HERITAGE

But what if...we combine ‘waste’, heritage, recreation and nature?

What if they could be productive again but in a regenerative way?

A MULTI-FACETED SOLUTION

EXPERIENCE **HERITAGE** OF HOW OUR MATERIALS OF WERE MADE AND **MAKING** FROM LEFTOVER
LOCAL INDUSTRY **SURPLUS** FOR A NEW LOCAL PRODUCTION BASED ON COMMUNTY ENGAGEMENT

CONTRIBUTE TO **ECOLOGICAL**, **ECONOMIC**, AND **SOCIAL** SITUATION

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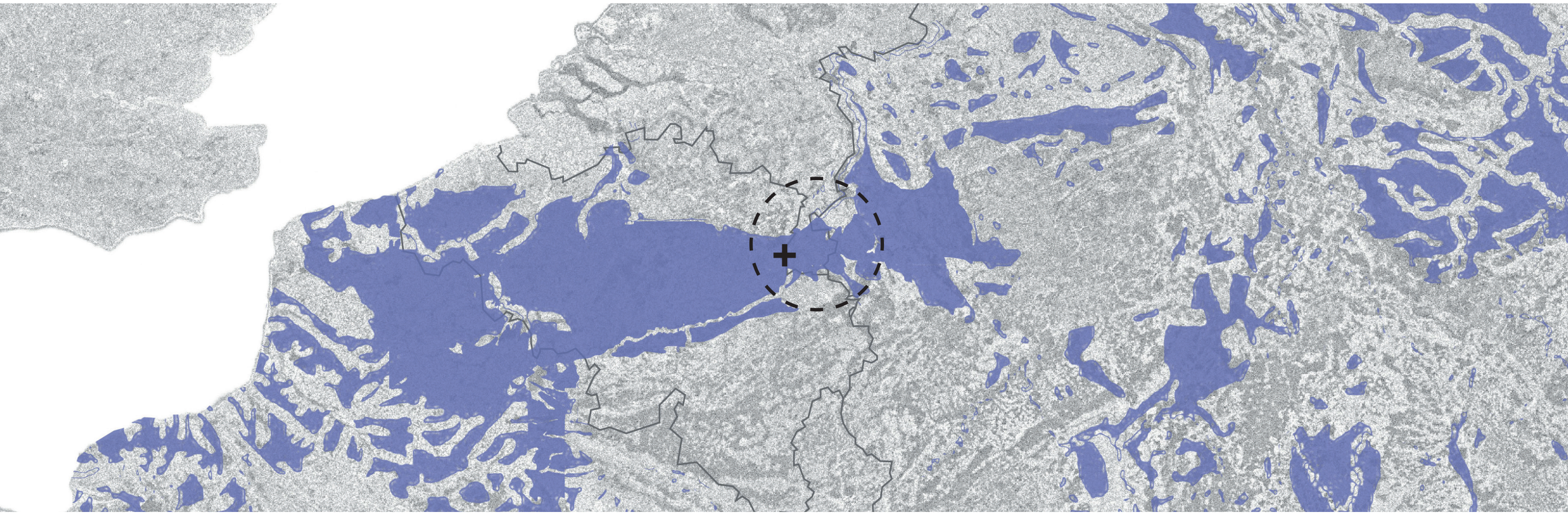

LIMESTONE FORMED **145-66 MILLION** YEARS AGO

CRETACEOUS OUTCROPS

JOANNA PETROVA **2025**

250 TUNNEL SYSTEMS FOR MARL (MAASTRICHT CHALK), **70% LOST** TO THE **ENCI** QUARRY (RED LINE)

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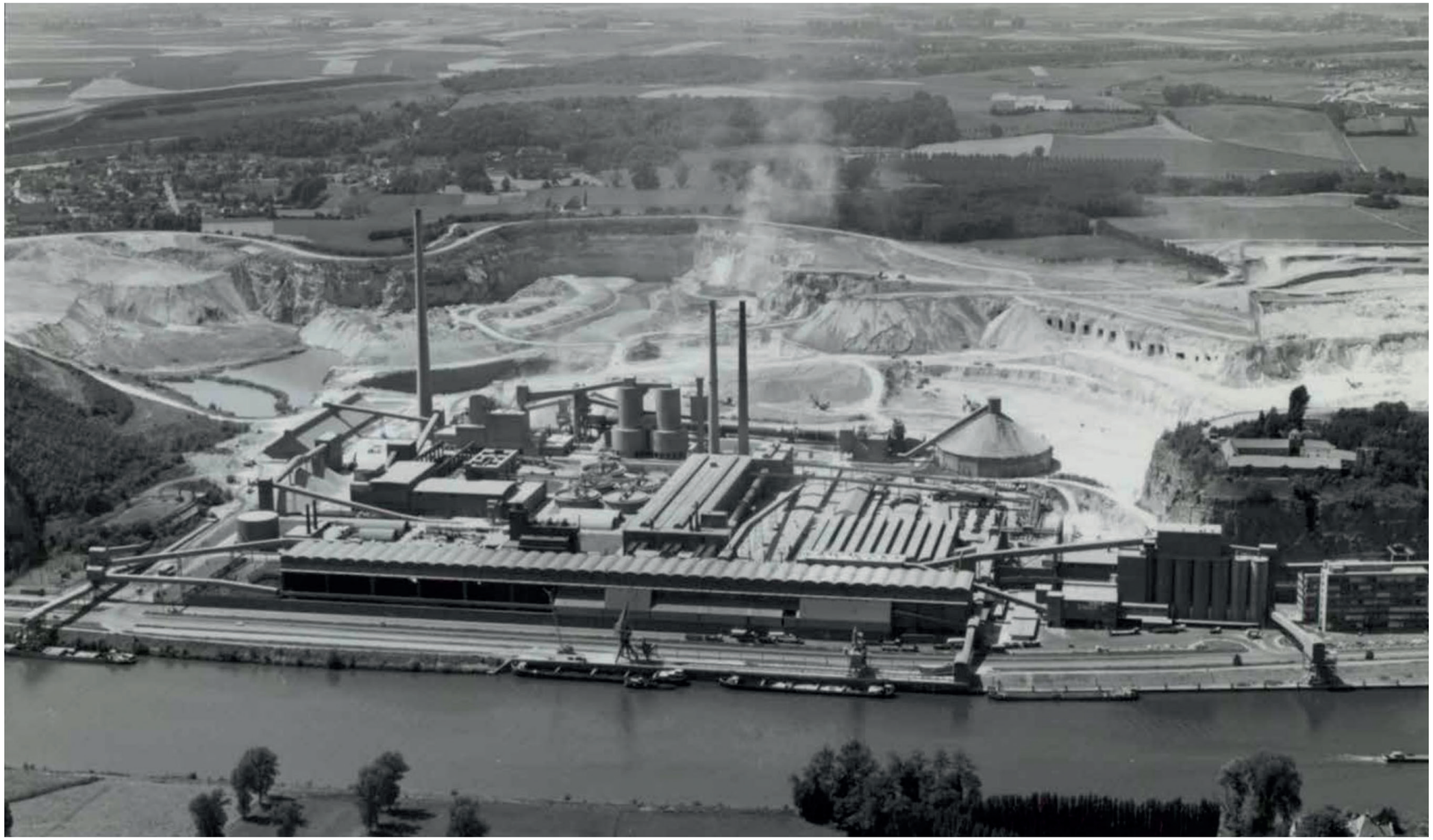
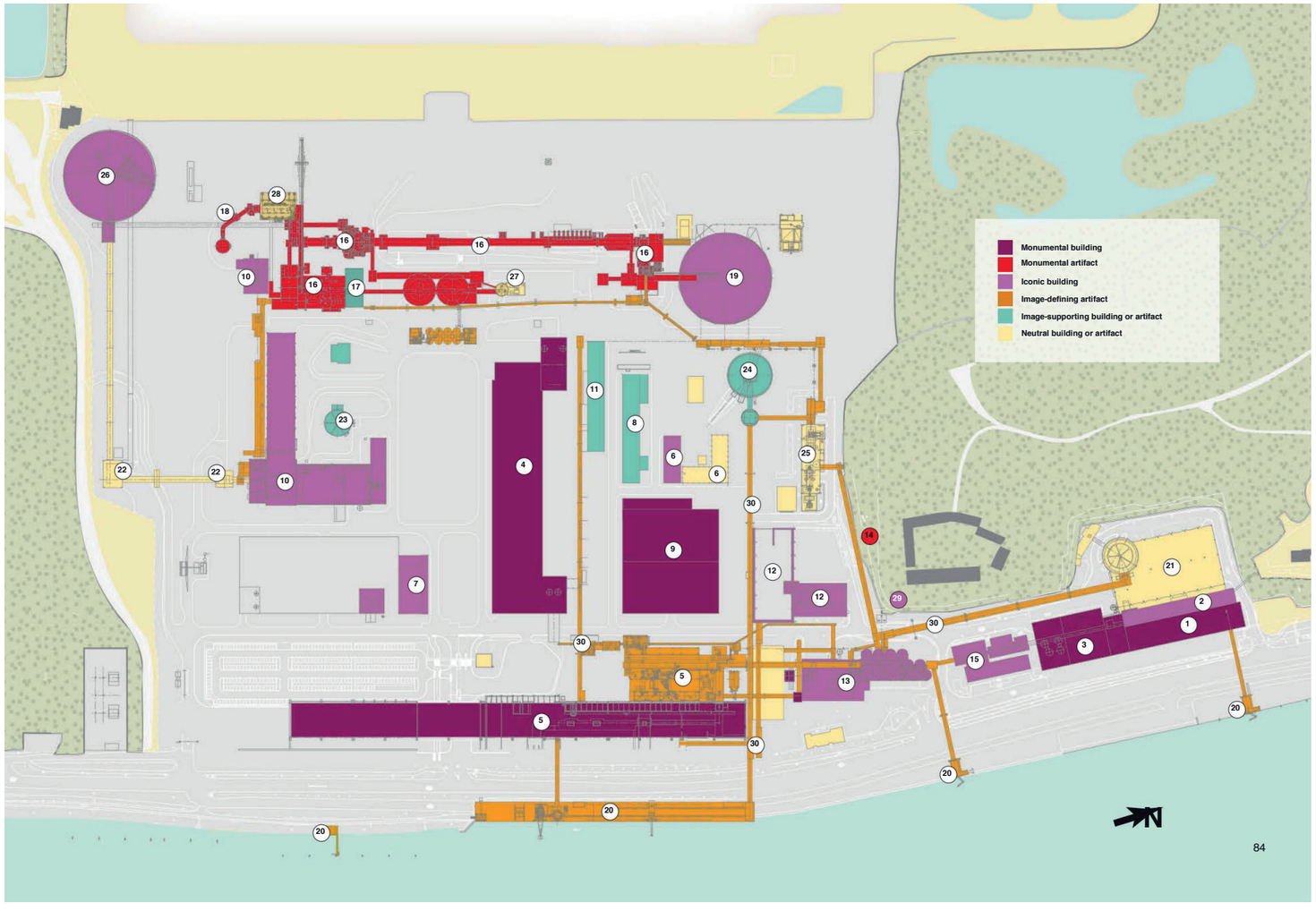


ESTABLISHED **1926**

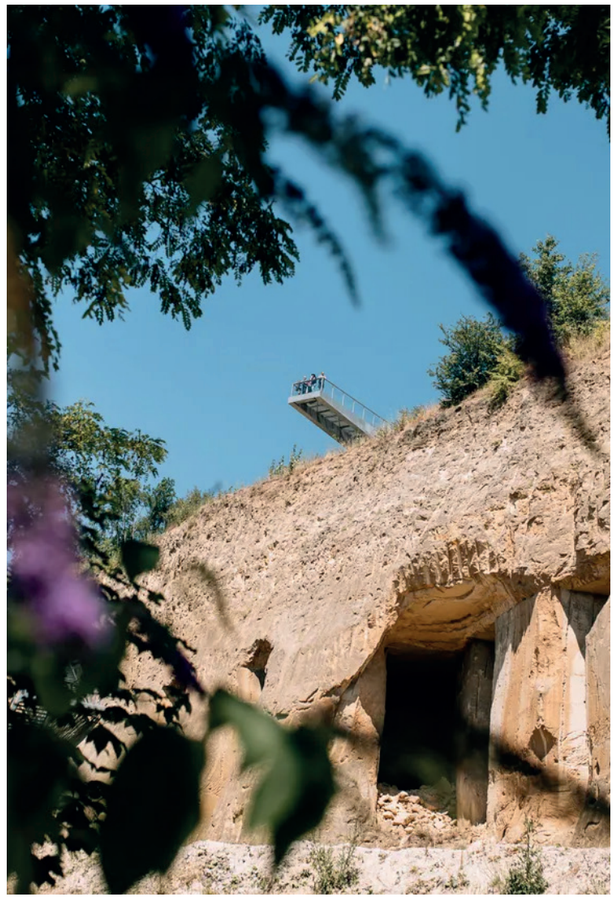
THE CONCERNED LIMBURG POPULATION

PEOPLE CALLING FOR THE **END** OF DESTRUCTIVE **EXTRACTIVISM,** ~1978

THE FACTORY TODAY



5 NATONAL MONUMENTS AND **18** MUNICIPAL MONUMENTS



NATURE RESERVE AND PERI-URBAN PARK

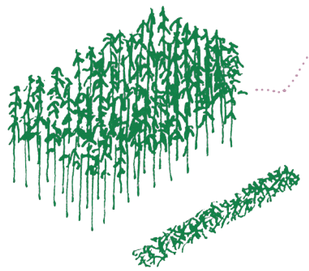
Rustgebied voor dieren
Geen toegang
Artikel 461 Wetboek van Strafrecht.
www.natuurmonumenten.nl
Natuurmonumenten

ENCI QUARRY
MAASTRICHT
CENTRUM

FROM MATERIAL **SCARCITY TO ABNDANCE**

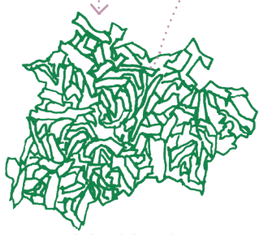
HARVESTING

Hurd is cut before turning to seed, then left to dry for about a month (retting), to seperate the fibres from the hurd.



PROCESSING

Baled, stored before hurd and fibre is seperated in decorticating machine.



MIXING

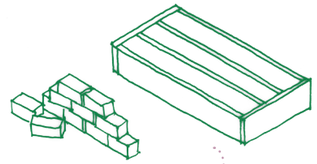
Hemp hurd is mixed with lime and water to create hemp-lime.

LIME PRODUCTION

Lime comes from heating limestone (CaCO3) into quicklime (CaO).

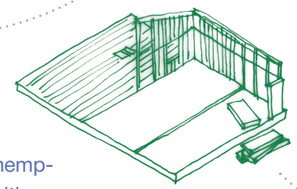
MANUFACTURING

Hemp-lime can be prefabricated into panels or blocks for controlled drying.



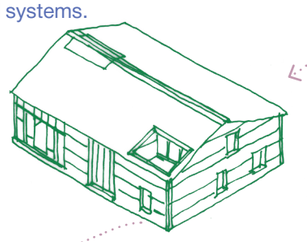
ASSEMBLY

Non-load bearing hemp-lime is combined with wood frames to create mass wall systems.



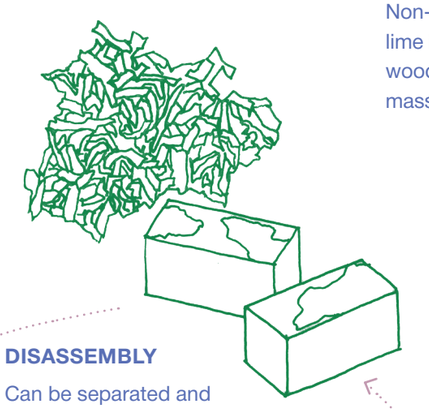
IN-USE

Naturally mould, rot, and insect resistant, vapour open and breathable with little maintenance required.



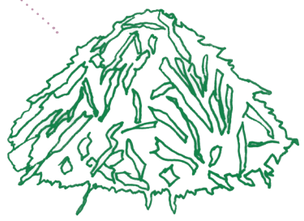
DISASSEMBLY

Can be separated and repurposed, downcycled, or composted.



MULCH

Hemp can be turned into biofuel or mulch for landscaping and soil enrichment.



PLANTING

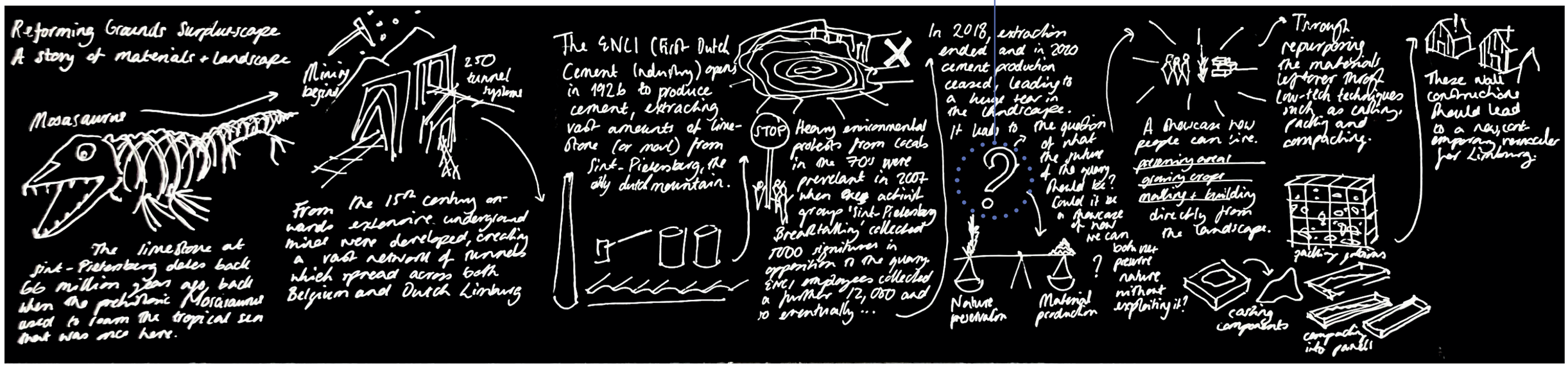
Industrial hemp is grown from seed, compact planting prevents weeds and promotes tall central stalks.

GROWING

Hemp reaches maturity in ~100 days. Deep root systems stabilise and regenerate soil.

1,167,714 TONNES LIME + **1,751,571 TONNES** OF HEMP SHIV = **194,635 SUB-URBAN HOUSES** (−1,710,507 TONNES CO_2)

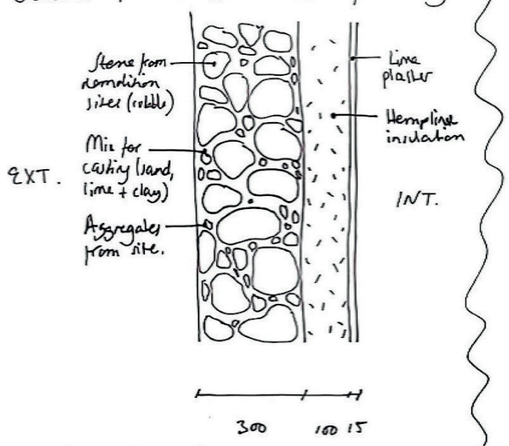
AN ALTERNATIVE STORY?



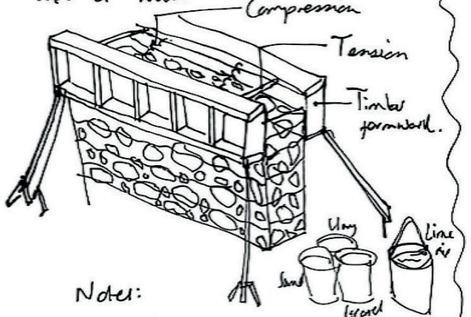
Grow, make + assemble housing co-operative

Permaculture farming	+	Processing facility	=	Regenerative production landscapes
Cultivated Building Materials	+	Re-puroused Industrial Surplus	=	Cooperative Housing

Section of cast stone wall for housing.

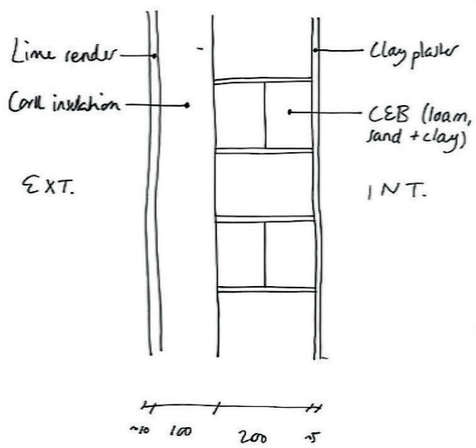


Axo of wall.

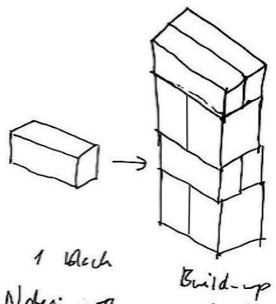


Notes:
- Could reverse order int ⇔ ext. if desired.

Section of Earth (brick) housing.

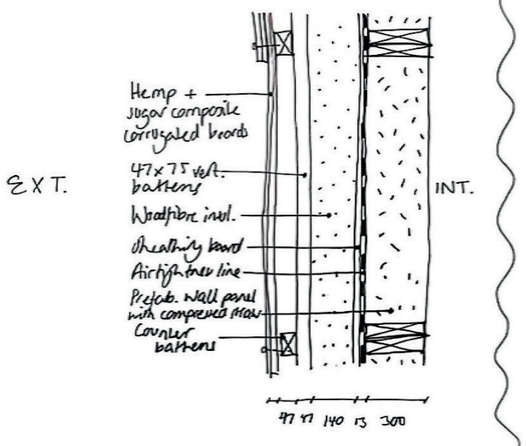


Axo of Compressed Earth Brick.

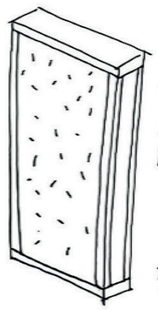


Notes: - The precedent for this is in Spain (47 social housing units by Peris+ Arquitectos) so might need to increase or add insulation to the build-up.

Section of Straw panel housing.



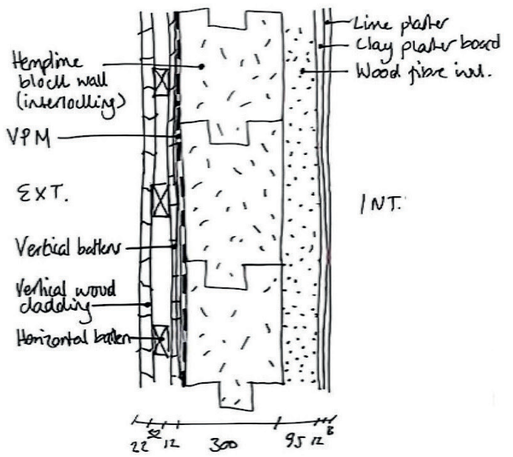
Axo of panel



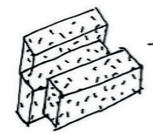
Timber cassette panel similar to Flat House by Material Cultures but instead with compressed straw like NZI Architects' social housing in France.

Notes:
- Could be combined with compressed (hand moulded) earth for better finish.
- NZI panel thickness 360mm ~~thick~~ no additional insulation. 300mm is a guess.

Section of Hempblock wall for housing.



Axo of block



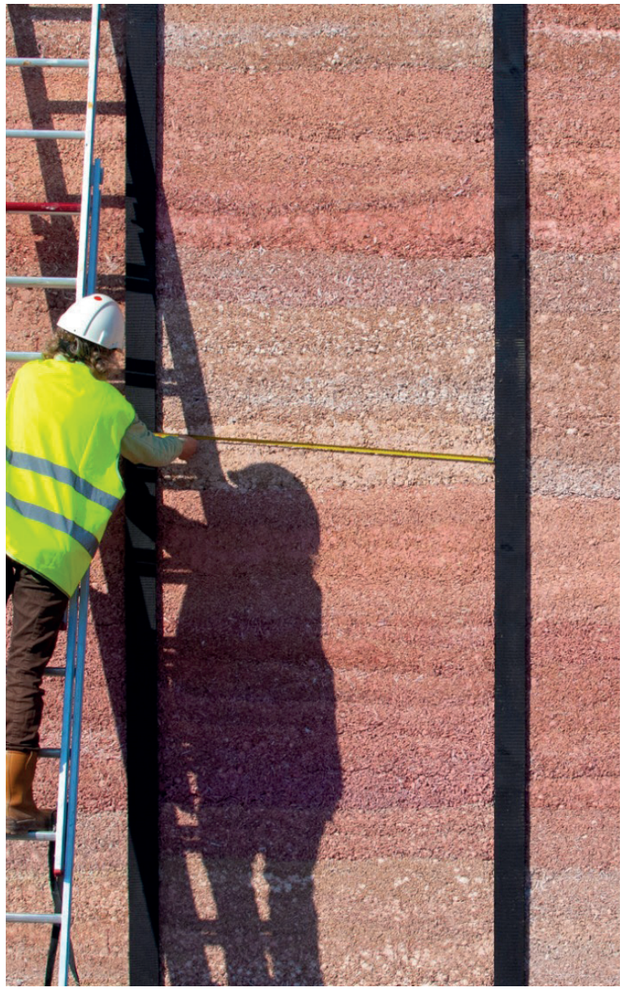
Similar to Isohemp (Belgian manufacturer) precast blocks but produced for on-site assembly. Used for Pierre Chavet Sport Hall in France.

Notes:
- is clay plasterboard necessary?
- could remove need for wood fibre insulation if you increase thickness of hempblocks / think.

PROMISING **GEO-BIO** COMBINATIONS

BLOCKS

PANELS



FORMWORK

VERSATILE CONSISTENCIES

LOAM + SAND + GRAVEL

CLAY + SAND + STRAW

LOAM + STRAW

PROCESS

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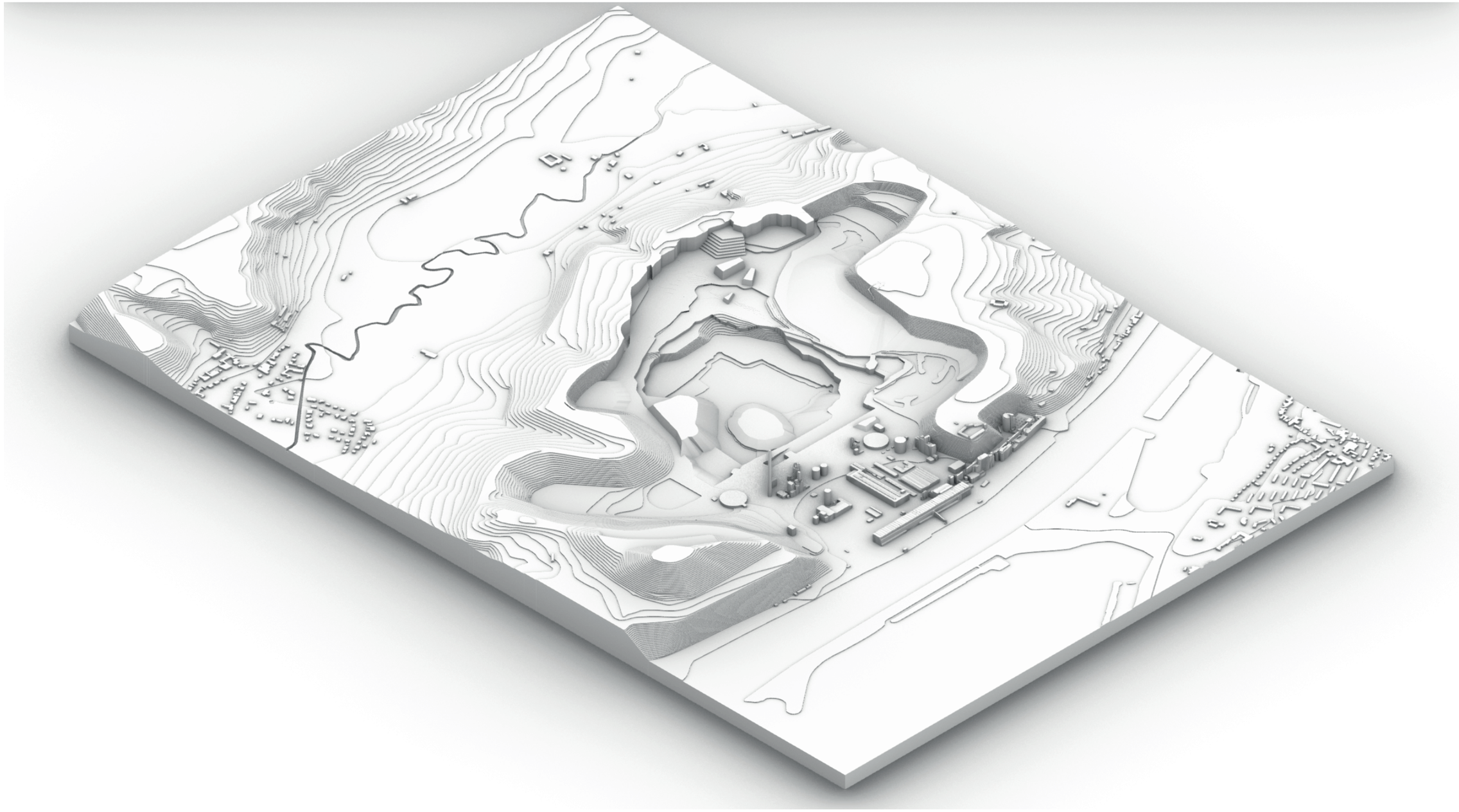
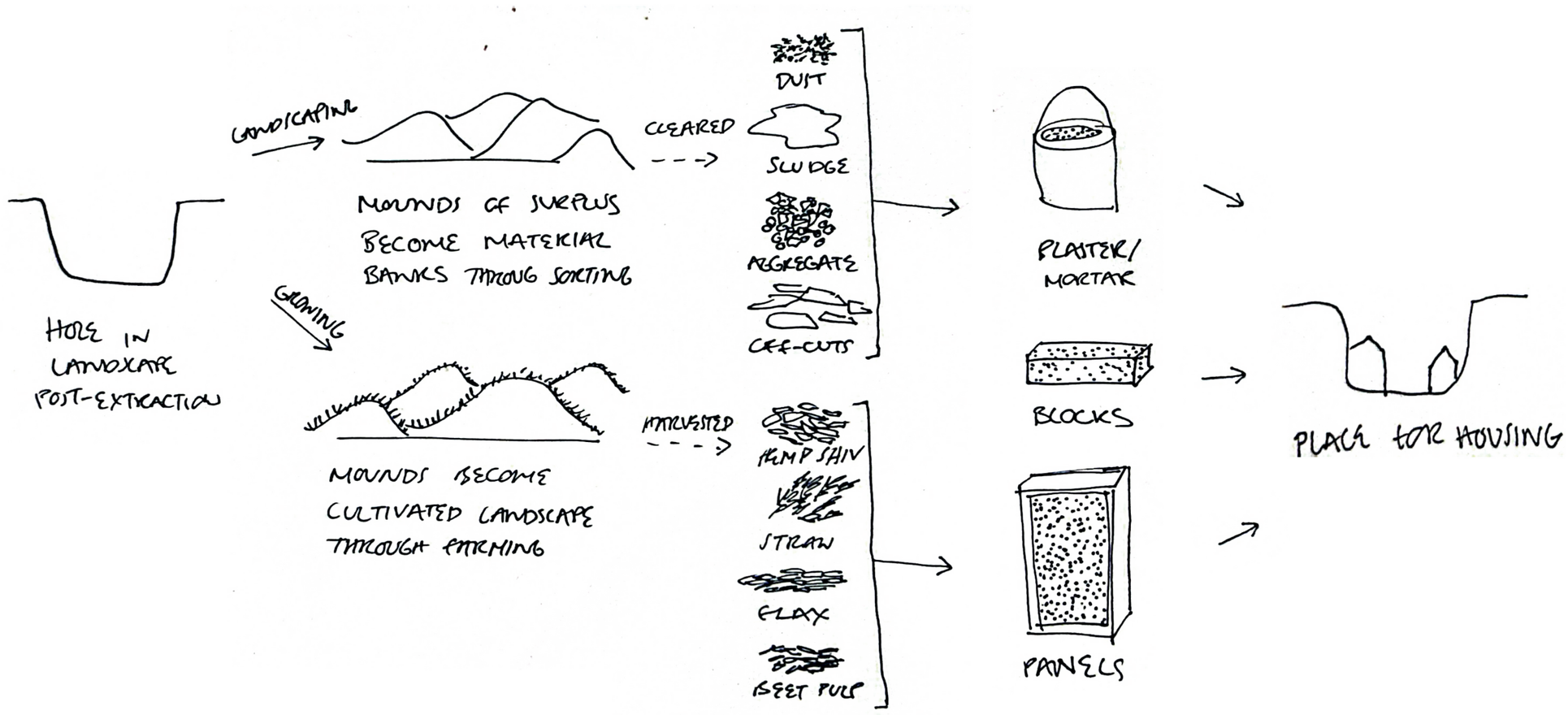
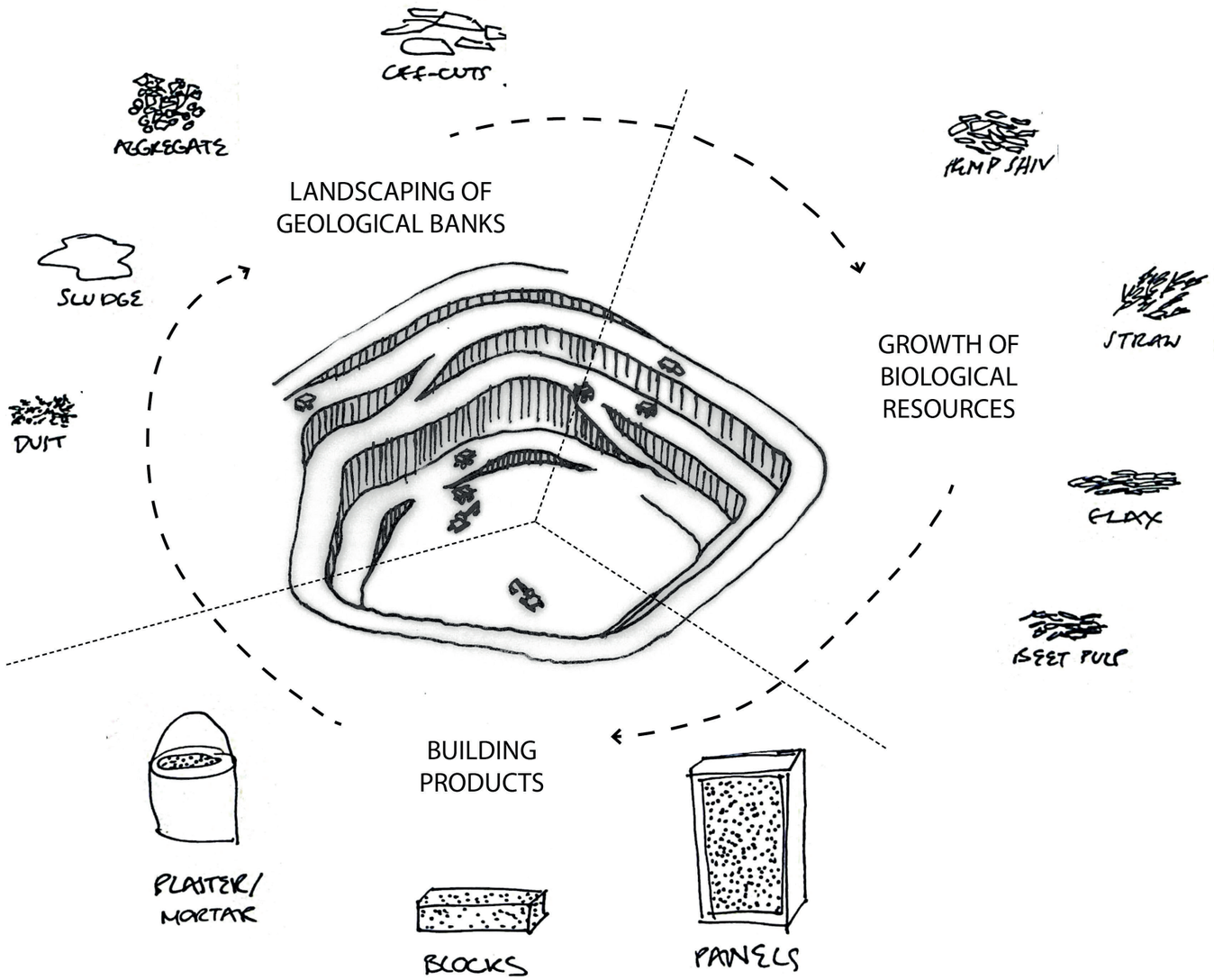



LANDSCAPING
CLEARED
DUST
SLUDGE
AGGREGATE
OFF-CUTS
MOUNDS OF SURPLUS
BECOME MATERIAL
BANKS THROUG SORTING
PLASTER/
MORTAR
HOLE IN
LANDSCAPE
POST-EXTRACTION
GROWING
HARVESTED
HEMP SHIV
STRAW
FLAX
BEET PULP
MOUNDS BECOME
CULTIVATED LANDSCAPE
THROUGH FARMING
BLOCKS
PANELS
PLACE FOR HOUSING



A NEW LOCAL SUPPLY CHAIN

USERS + ACTIVITIES

FARMERS

MAKERS

RESEARCHERS

RESIDENTS

STUDENTS

BUILDERS

ARTISTS/ARTISANS

ARCHITECTS

REFORMING GROUNDS

HEMPLIME WORKSHOP

08-22/06

at RG surplus-scape park, Sint Pietersberg, ENCI-groeve, Maastricht, Netherlands

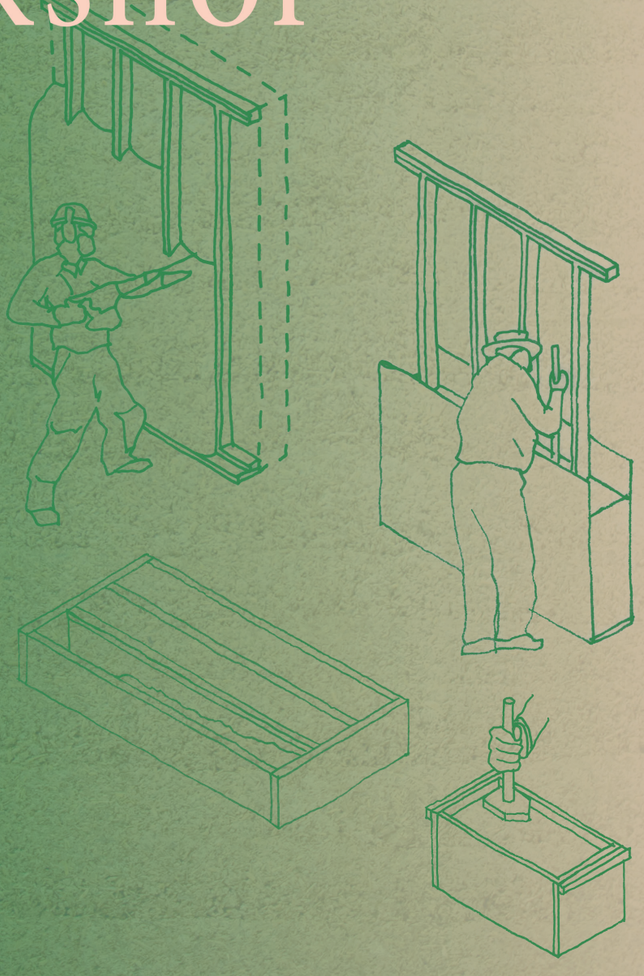
Hemplime walls for wood frame structures

Mixing formula for hemp and lime spray/formwork/ moulds, assembly, finishes and maintenance advice

50 euros for 2 consecutive days (lunch included)

Sign up on www.eventbrite.nl/working-with-natural-materials

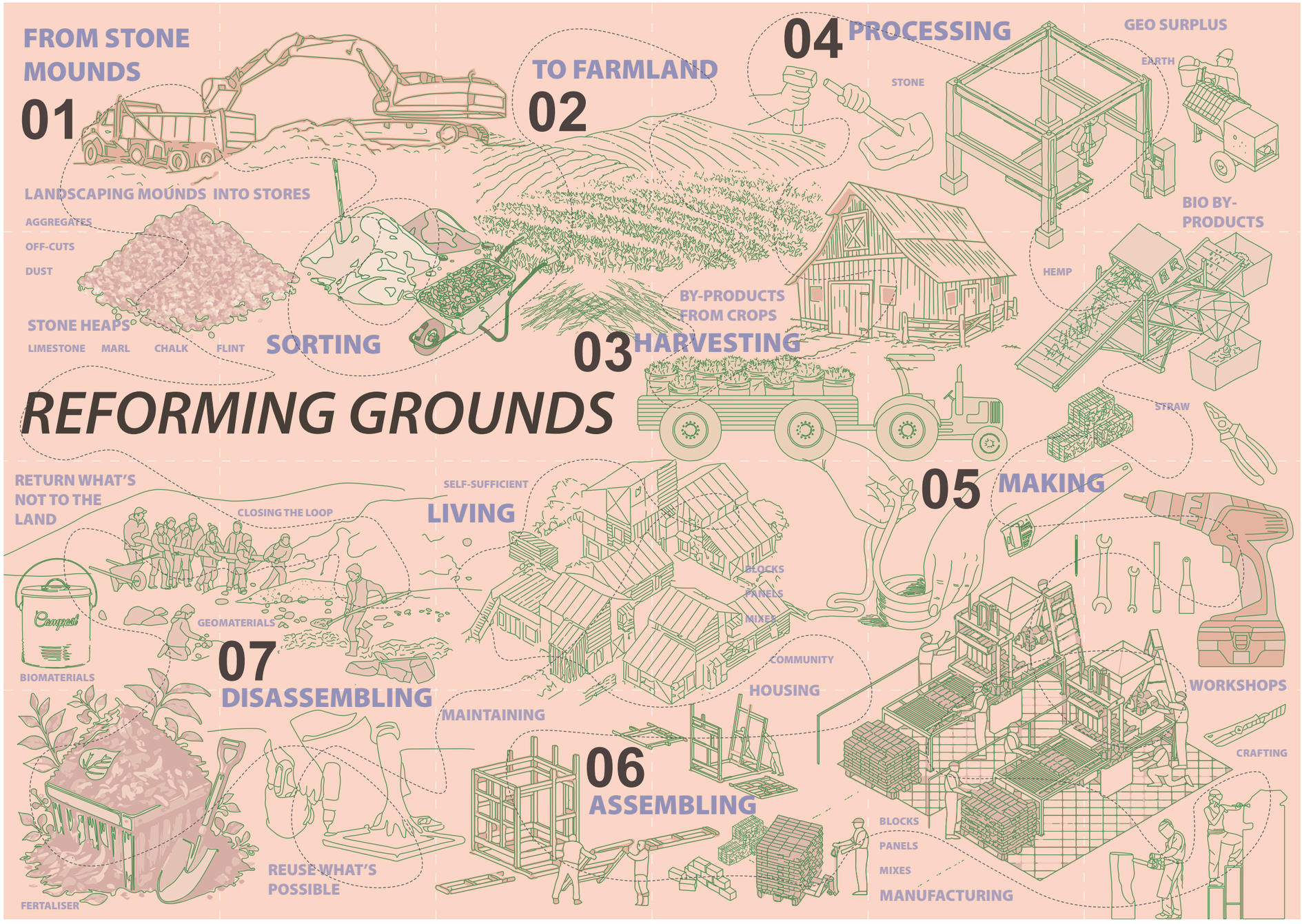
Maximum of 12 participants per day. Safety shoes are obligated. Other safety equipment provided on site. From 9:00 until 17:00



RG cooperative

Learn more about the initiative at www.rgcooperative.nl/surplus-scape park

JOANNA PETROVA **2025**



REFORMING GROUNDS

A self-build community hub for reforming landscapes and its industrial surplus.

I

Towards a regenerative surplus materialscape

Repurposing,
farming,
making,
building,
and living together
from the ecoregion

collect
cultivate
make
assemble
co-housing
collective

program

Building with the earth's forgotten resources

At the masterplan scale, the design vision is to regenerate the ex-cement ENCI limestone quarry in Maastricht into a productive surplus-scape landscape park from limestone surplus material banks into mosaic permaculture farmlands. This will enable research, making and the processing of collected and cultivated materials, i.e. the crop by-products and the existing geological deposits to be manufactured into building components, using hemp, straw, earth and stone. The overarching ambition is to set the precedent in the radical reforming of ex-quarries as a place to facilitate emergent civic typologies towards self-sufficiency.

A 'Grow, Make, and Assemble' Co-operative is proposed to live, work and care for the place; a co-housing cooperation with knowledge/skills/interests in cultivating, making and/or researching into new construction techniques using the available bio-geo resources. To support this program — and aid in the strengthening of crafts skills, materials science R&D and community building — artisan studios, workshops, materials labs and a community centre are proposed. This demonstrator project aims to encourage regenerative design around land stewardship, finance, governance and building design. In effect, to show the civic infrastructure needed for neighbourhood or community transitions towards circular economies. Through a participatory approach and collective design, the aim is to re-establish people's connection to the land and foster cultures of care and repair towards materials and the regional architectures which they can produce.

program

Collect

01 MAKE + TEST CENTRE

The proposed circular neighbourhood is situated in the open-pit where the limestone was once extracted. The initial phase is in building the central hub for the making and testing of materials which is a public building to be funded by the Gemeente Maastricht encompassing a research centre and makerspace including prototype testing for building components (primarily blocks, panels and casting/plaster mixes). This is located at the key transition zone along the quarry that connects to all the nodes, it will also facilitate tours which focus on the history of the material production, the ongoing research material explorations with the surplus and the future material outlook towards becoming a circular material production hub that integrates a wide range of natural materials.

The land will be gradually reformed into various stockpiles around the site that support each zone of the masterplan as it transitions towards a surplus-scape park. Each pavilion in the landscape will benefit from their own stone material banks or stockpiles in their becomings and then in the support of the other upcoming pavilions.

sorting and collecting stone stockpiles

02 BARNS + MICROFACTORY

All of the built and non-built elements are not fixed, but adapt over time as the landscape transitions from the large-scale sorting and collection of materials towards the collection of a moasic of geo and bio materials. As the stone surplus gets used for the making of the pavilions, the resource focus will gradually shift towards bio materials whereby certain zones or mounds which have grown into farmland become abundant in hemp and straw by-products from crops. The barns and microfactory will enable the storage, shelter for cattle and sheep and the material processing of the by-products.

mounds to farmscape to bio products, wheat and hemp

Cultivate

03

04 MICROFACTORY ADDITIONS

earth, stone, hemp and straw material mosaic

The production facilities expand as the farm grows, they gradually become specialised pavilion microfactories, each one a specialised space for the material processing that it is used for. My research focused on the industrial by-products that can be found already in the Netherlands and wider regional farms, such as hemp shiv and straw from wheat farms, so I suggest facilities for stone from the quarry, earth from excavation sites, and straw/hemp from farming.

The manufacture be small to mid-scale, with mechanised and manual methods of processing of the four materials. These will sometimes be combined together to form bio- geo-hybrids, to optimise the properties of the different materials. For the stone processing facility, a bridge saw, diamond cutter, CNC mill and chiseling stonemans tools will be available. For the earth, a mixer and space to make wooden formworks. For hemplime, a decorticator (seperating the hurd from the fibre) and mixer. The straw requires almost no processing unless the pieces need to be grated down to smaller or finer pieces, so the place will mostly house the baler and worktables. All of these include storage for the materials.

Make

craftspeople led-workshop learning

05 ARTIST + ARTISAN STUDIOS

The makerspace in the make + test centre, as well as the production facilities (material processing microfactories) function as open workshop spaces which are accessible for all but focus on creatives such as artists and artisans. These workshop areas also function as learning-spaces where both researchers and makers lead workshops to teach the public how to make natural building components from the materials from the site. These material products will eventually be used for the assembly of the artist studios to house creatices wth rentals ranging from per night to more permenant in-house residencies.

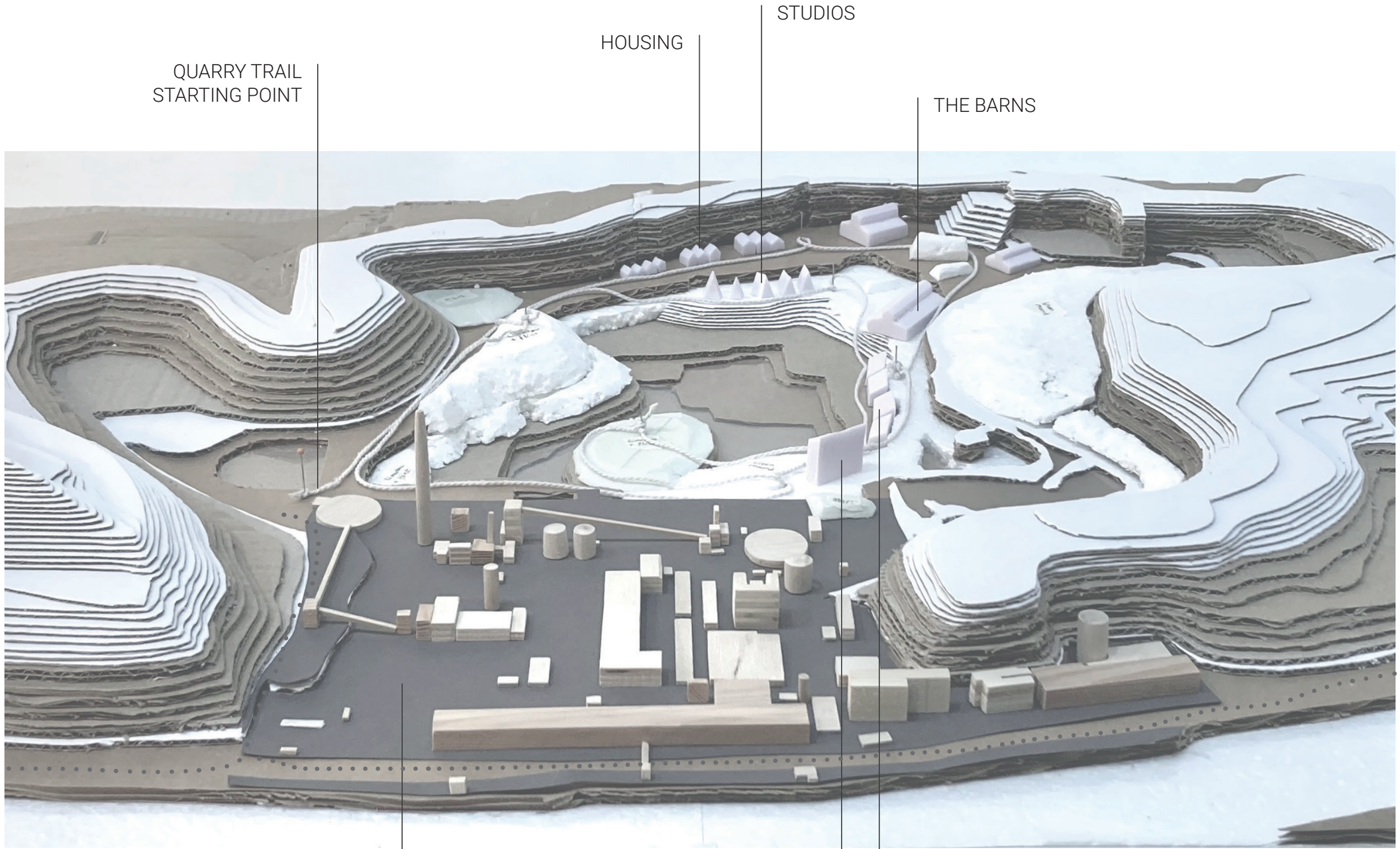
06 CO-OPERATIVE HOUSING

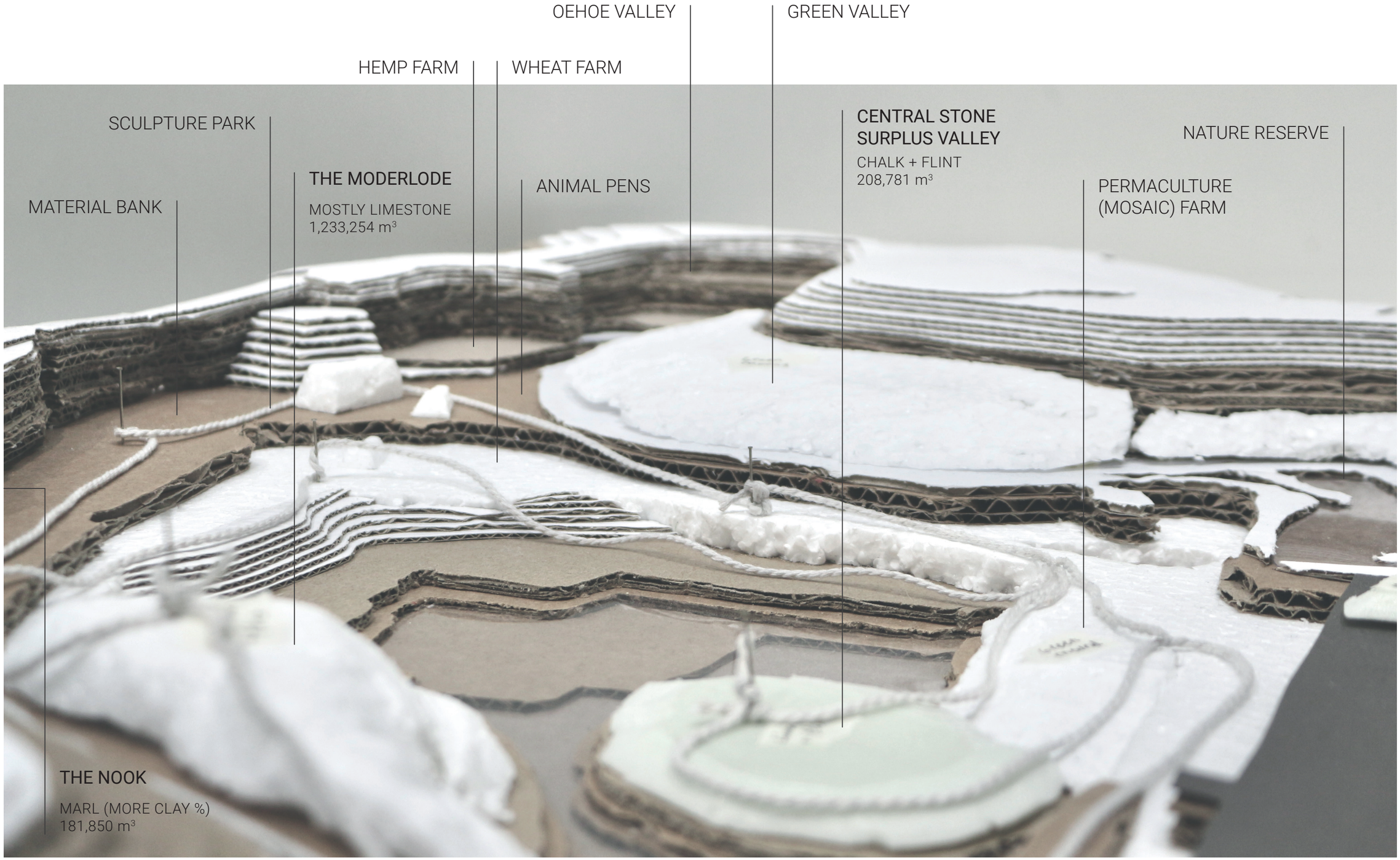
assembly workshops to diverse living spaces

The warmer spring-autumn months will facilate assembly-based workshops for the construction of the cooperative housing, from one bed to three bed, two-storey constructions. The houses will both enable the cooperative to station themselces closer to the place they care and maintain and be ablle serve as a showacse for the material products from the site, primarily insulative infill emements for a wood frame construction, but also some structural stone and earth walls.

07

Assemble


QUARRY TRAIL
STARTING POINT
HOUSING
STUDIOS
THE BARNS
EXISTING FACTORY HERITAGE SITE
MAKE + TEST CENTRE
MICROFACTORIES



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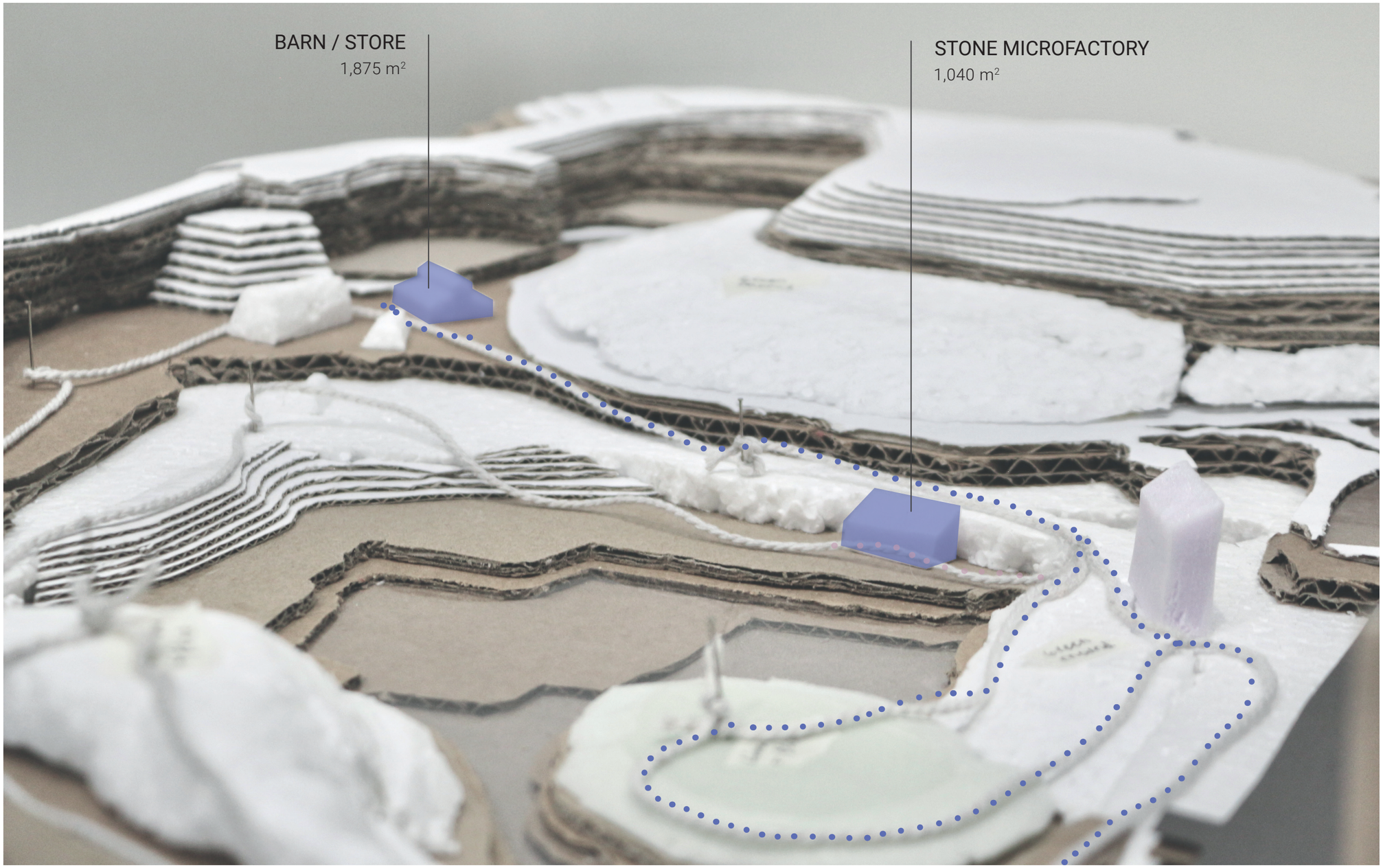
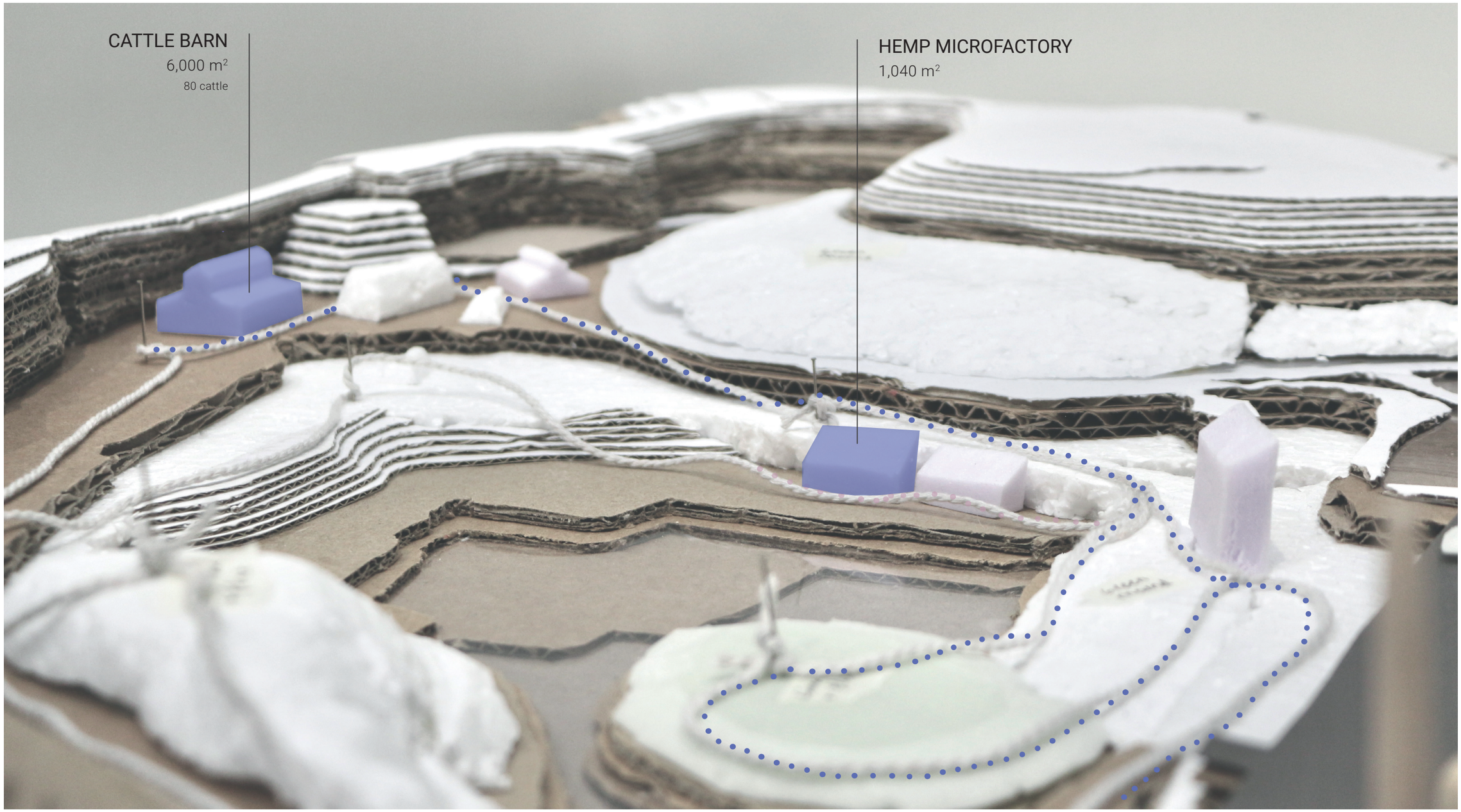
CENTRAL HUB
1,344 m²


BARN / STORE
1,875 m²
STONE MICROFACTORY
1,040 m²



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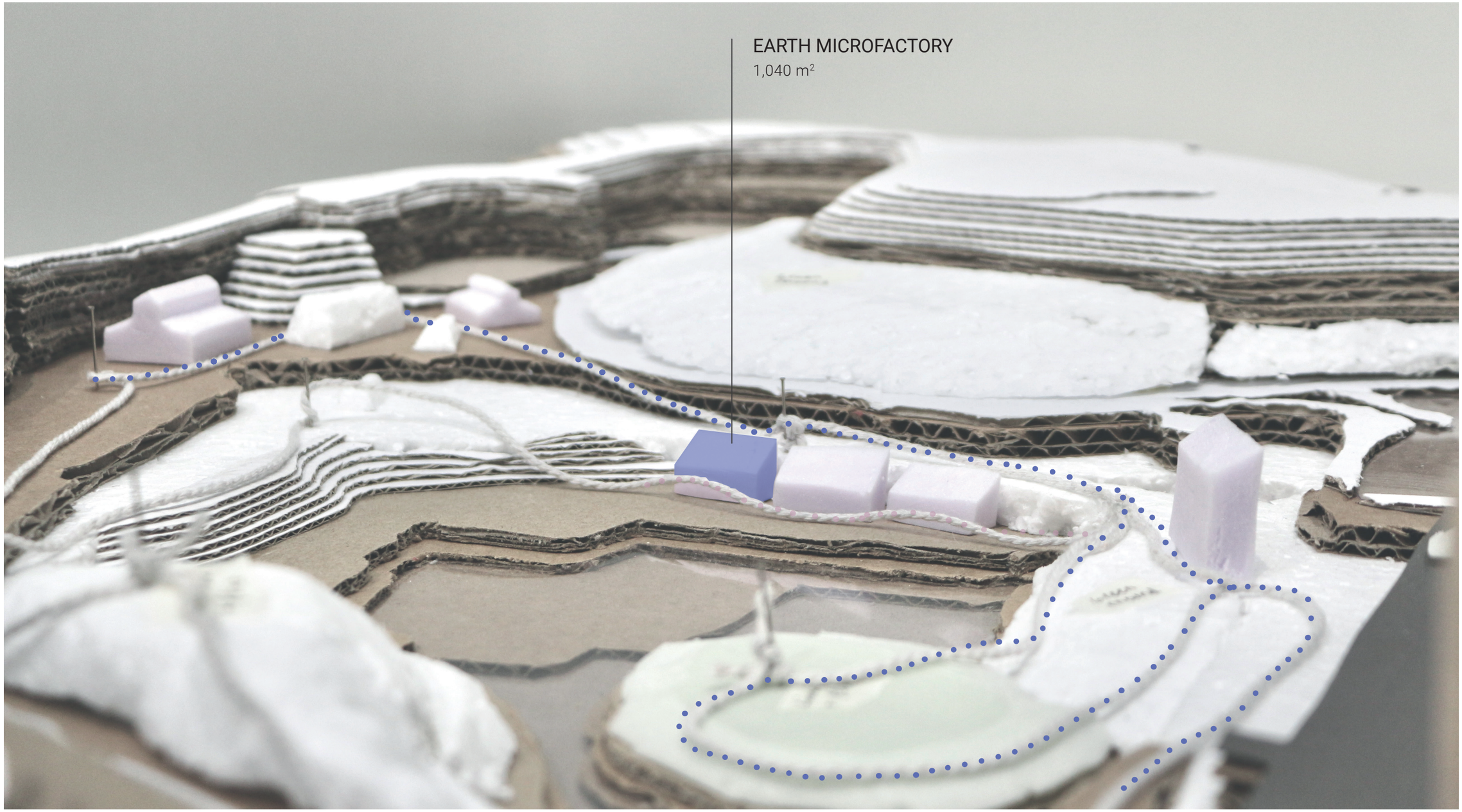
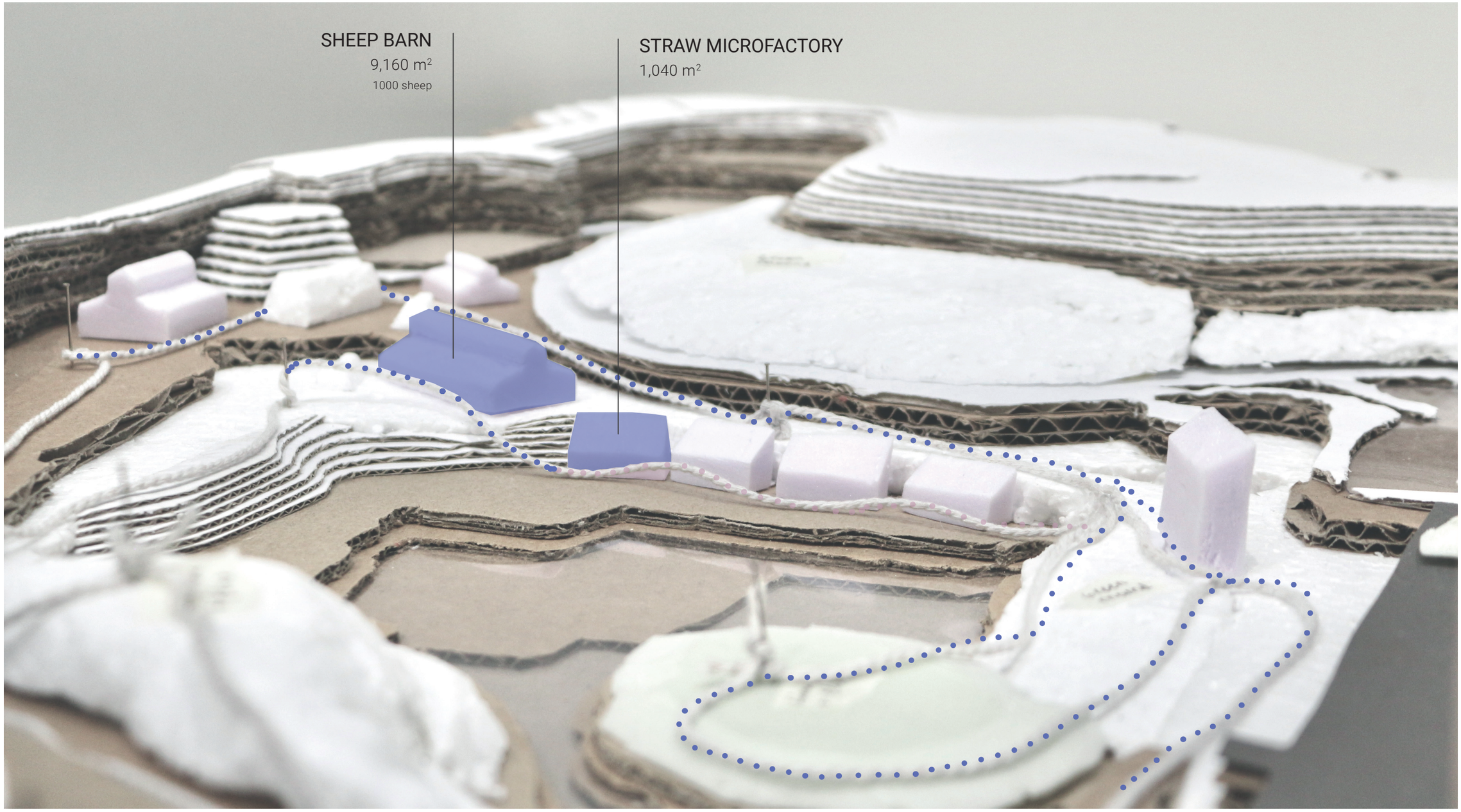
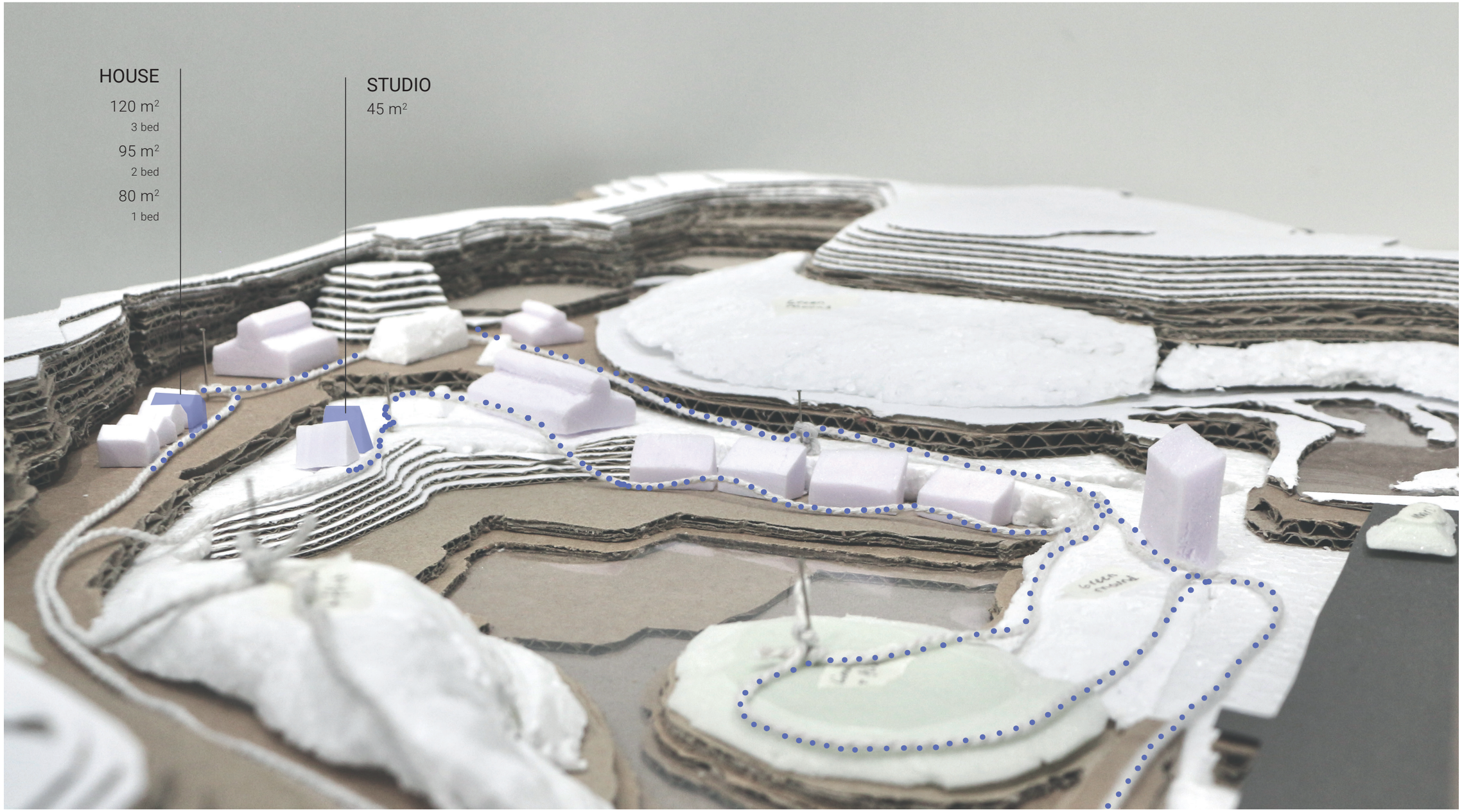
ARCHITECTURAL ENGINEERING

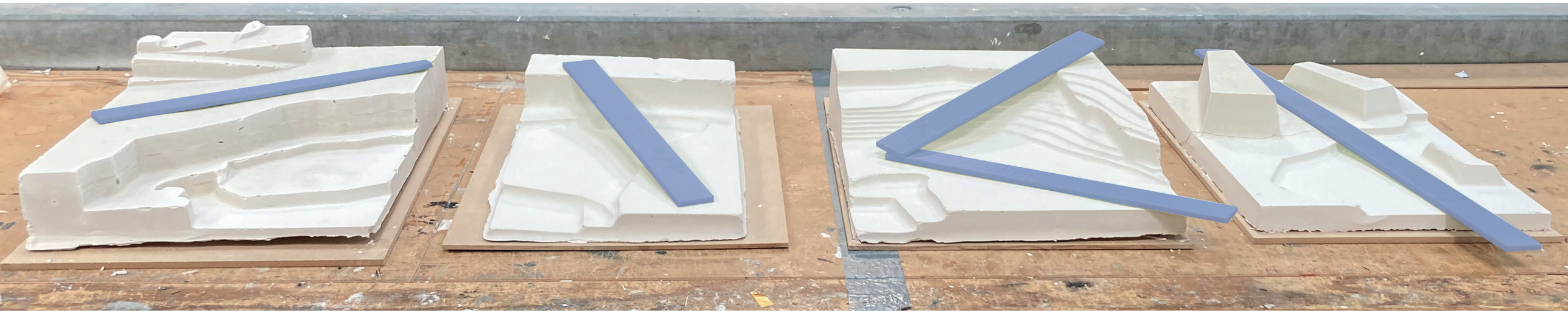

EARTH MICROFACTORY
1,040 m²


SHEEP BARN
9,160 m²
1000 sheep
STRAW MICROFACTORY
1,040 m²


HOUSE
120 m²
3 bed
95 m²
2 bed
80 m²
1 bed
STUDIO
45 m²

ROUTING

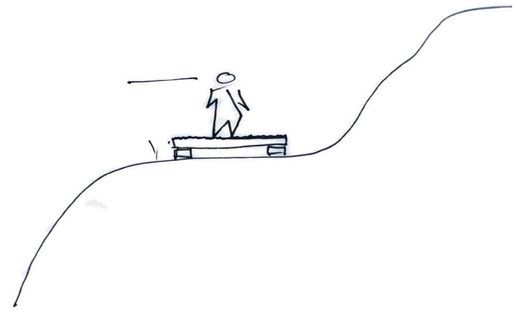
OVEN 8 - A NETWORK OF MATERIAL FLOWS

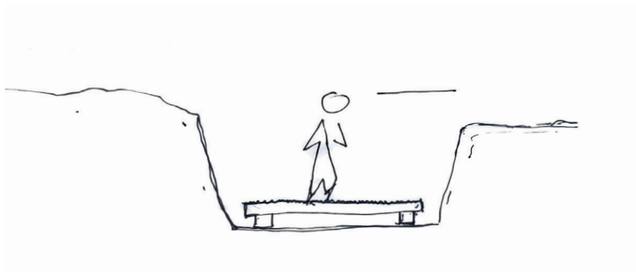


THE LOOKOUT TOWER

CONNECTING TRAIL

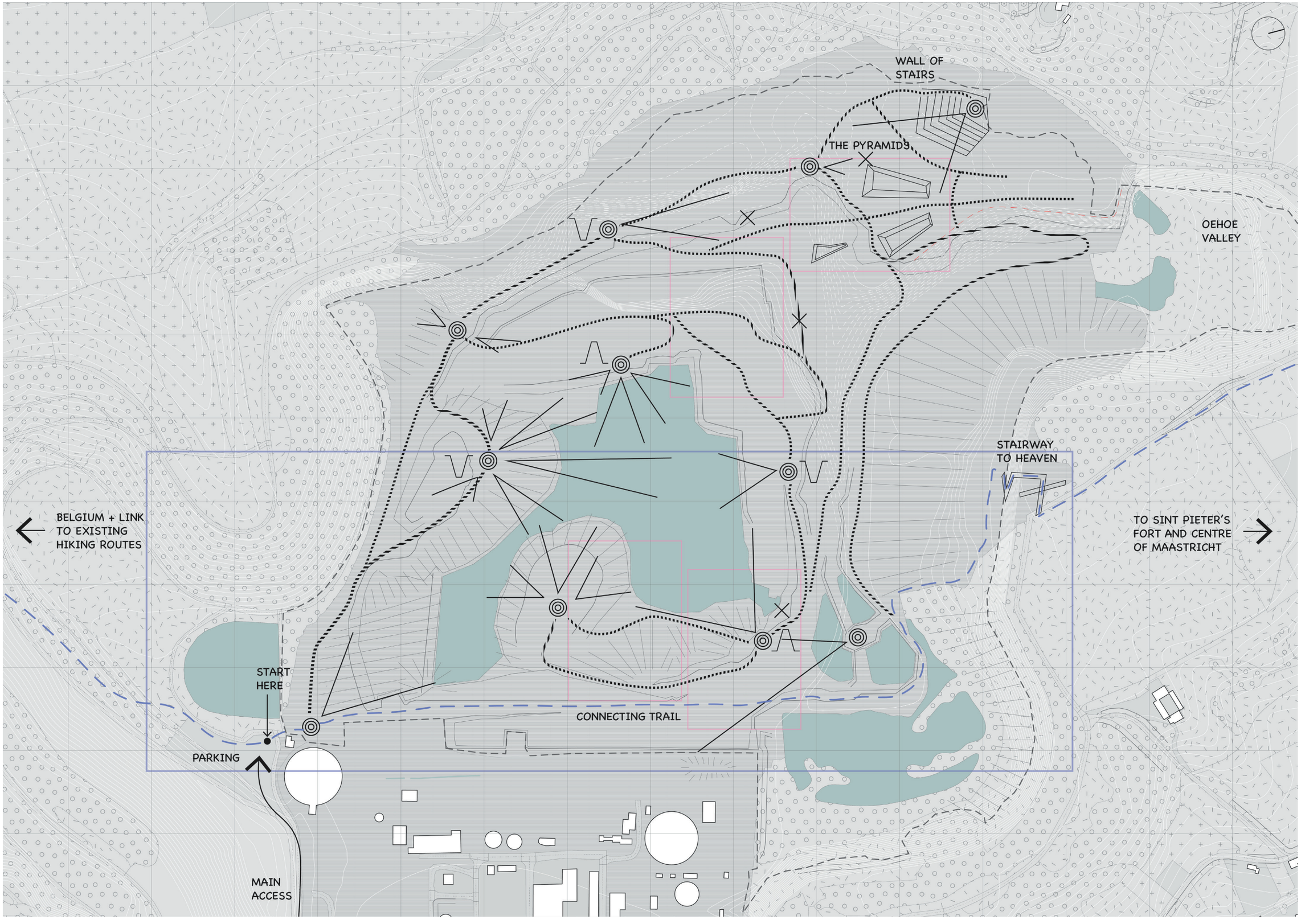
MOSES BRIDGE





MATERIAL BANKS FOR STORAGE

PARTING THE LAND TO FORM THE WALKWAY



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PAVILIONS

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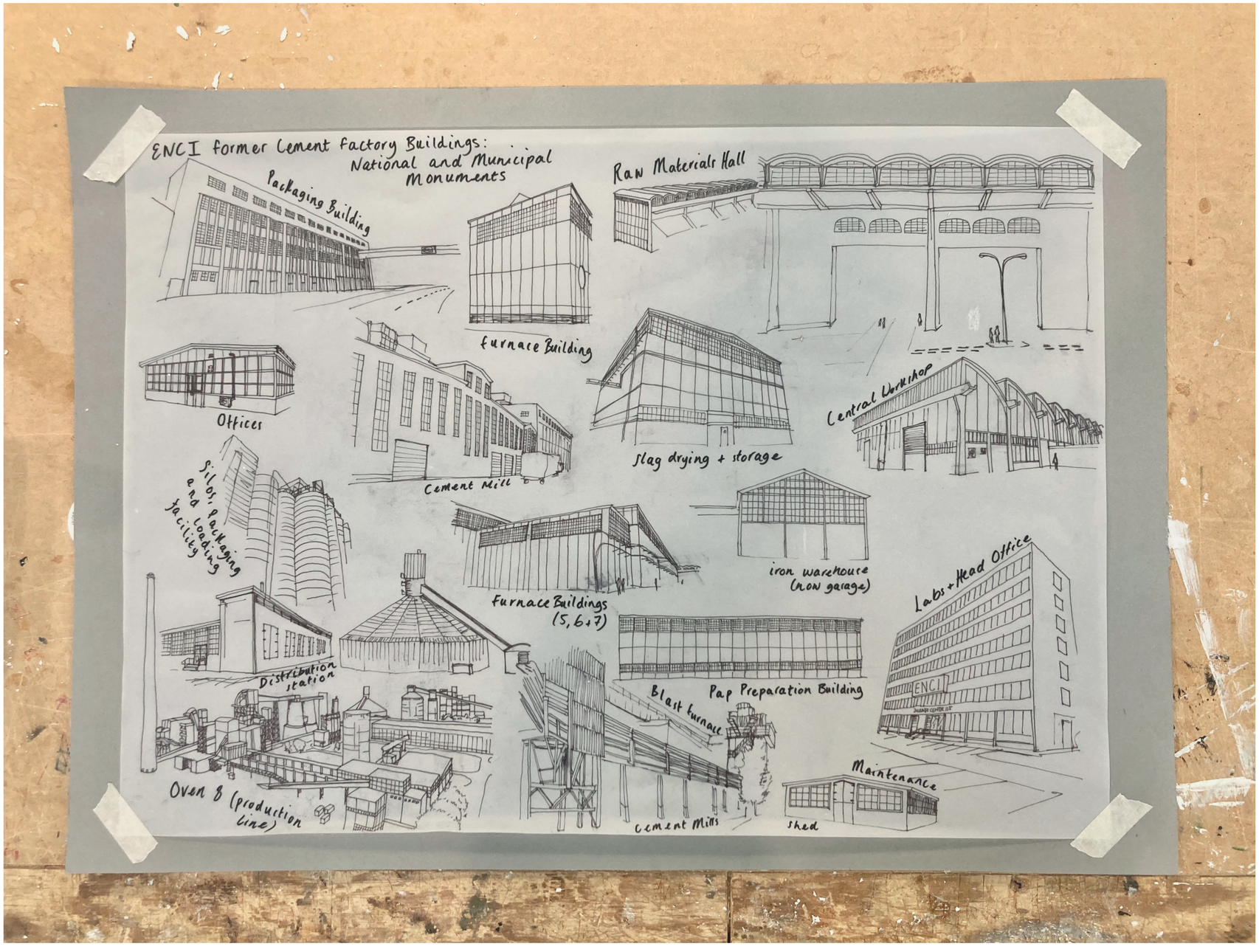
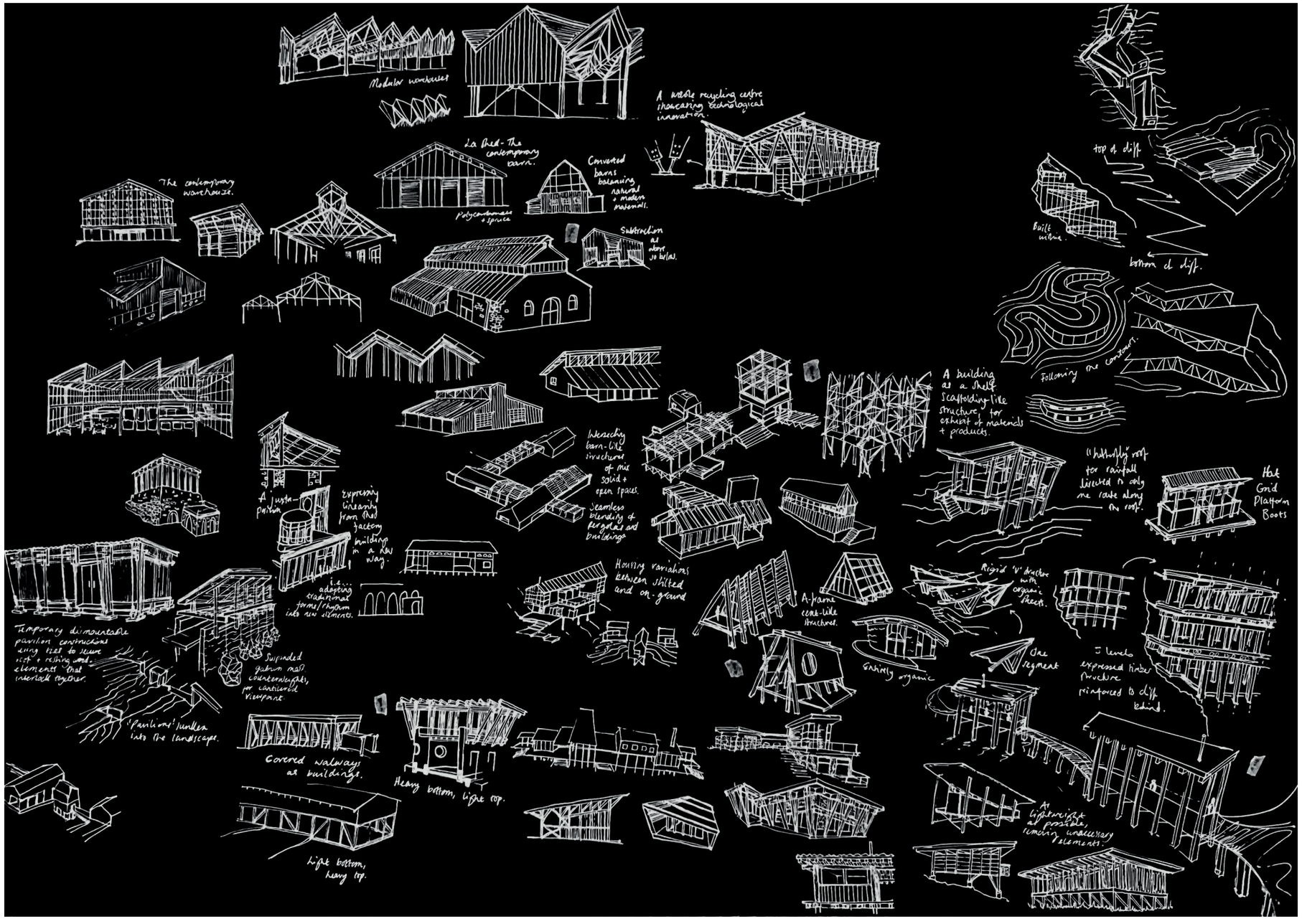
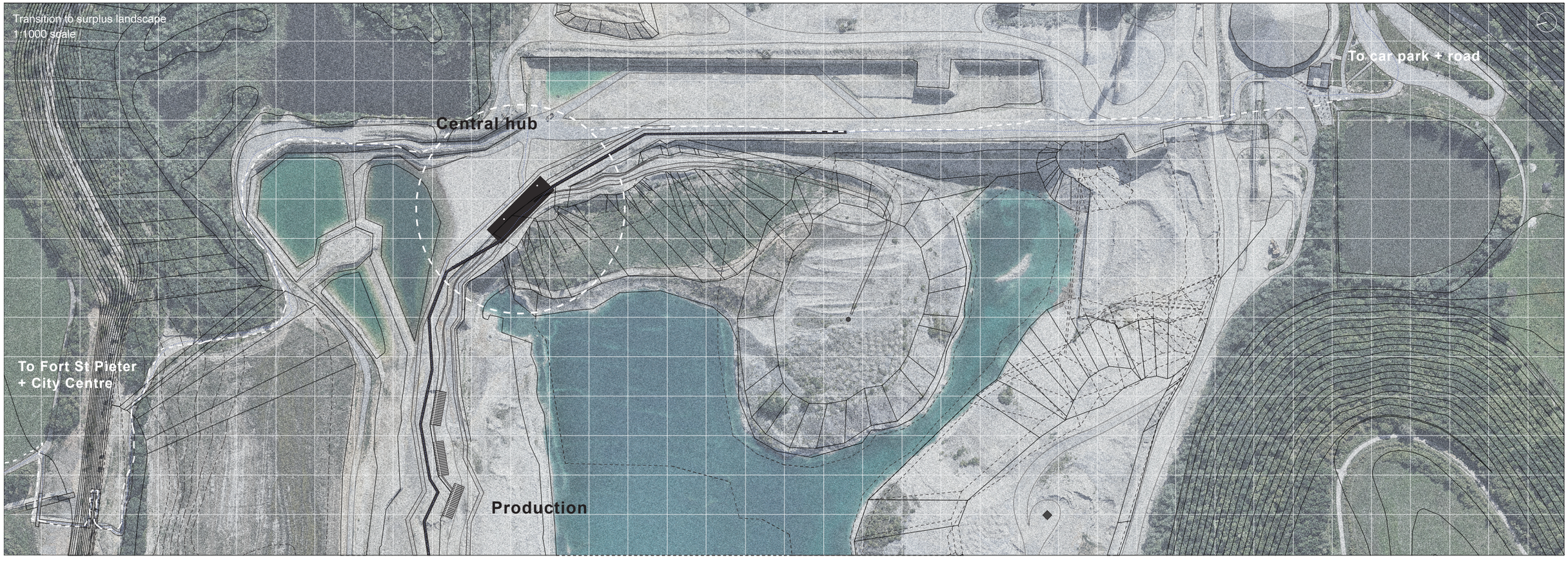



Modular warehouses
A waste recycling centre showcasing technological innovation.
The contemporary warehouse.
a.k.a third - The contemporary barn.
polycarbonate + spruce
Converted barns balancing natural + modern materials.
Subtraction as above so below.
top of cliff
built within
bottom of cliff.
Following the contours.
A building as a shelf scaffolding-like structure for exhibit of materials + products.
Interacting barn-like structures of mix solid + open spaces.
Seamless blending of Pergolas and buildings
A juxta-position
expressing linearity from that factory building in a new way.
i.e... adopting rectangular forms/rhythm into new elements.
Housing variations between shifted and on-ground
"butterfly" roof for rainfall directed to only one route along the roof.
Heat Grid Platform Boots
Rigid "V" structure with organic sheets.
A-frame cask-like structures.
Entirely organic
One segment
3 levels expressed timber structure reinforced to cliff behind.
Temporary dismountable pavilion constructions using steel to secure rest + resting wood elements that interlock together.
Suspended gabion wall counterweights, for cantilevered viewpoint.
"Pavilions" sunken into the landscape.
Covered walkways as buildings.
Heavy bottom, light top.
light bottom, heavy top.
As lightweight as possible, removing unnecessary elements.



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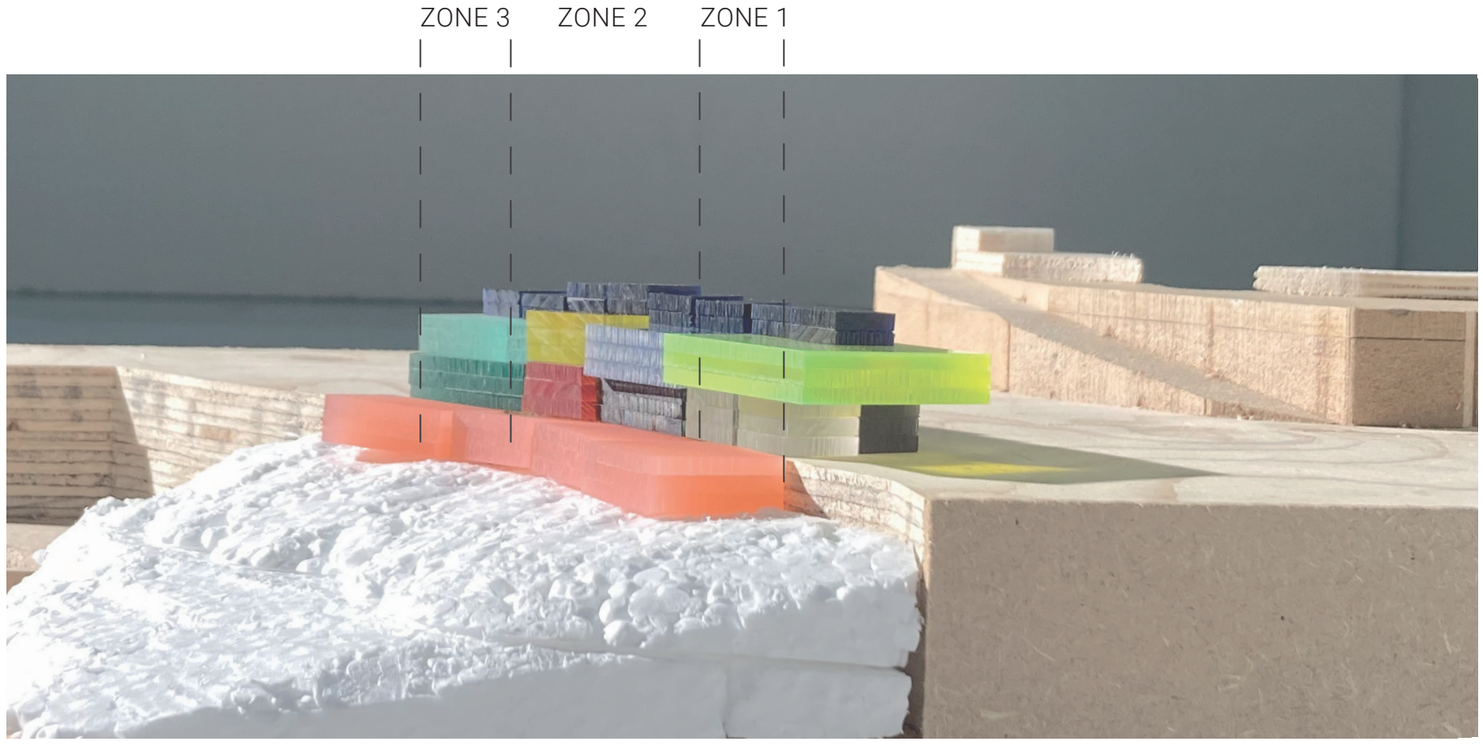
ARCHITECTURAL ENGINEERING

MAKE + TEST CENTRE ZONING



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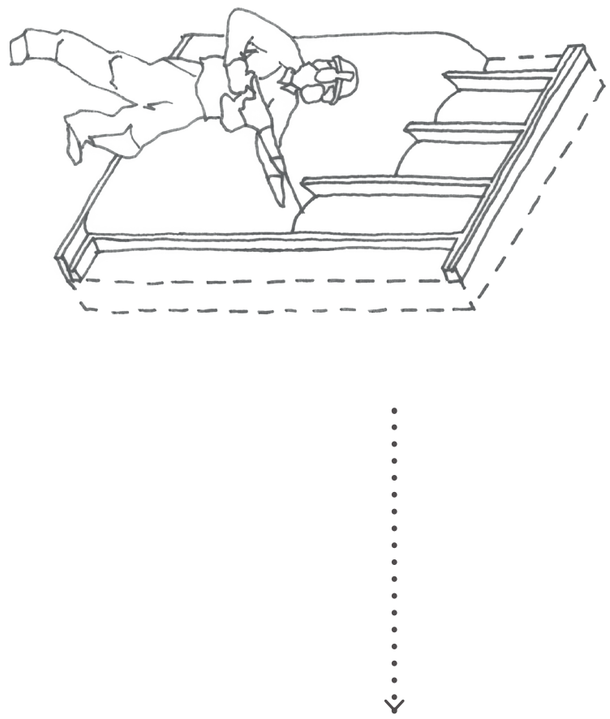
MATERIALS

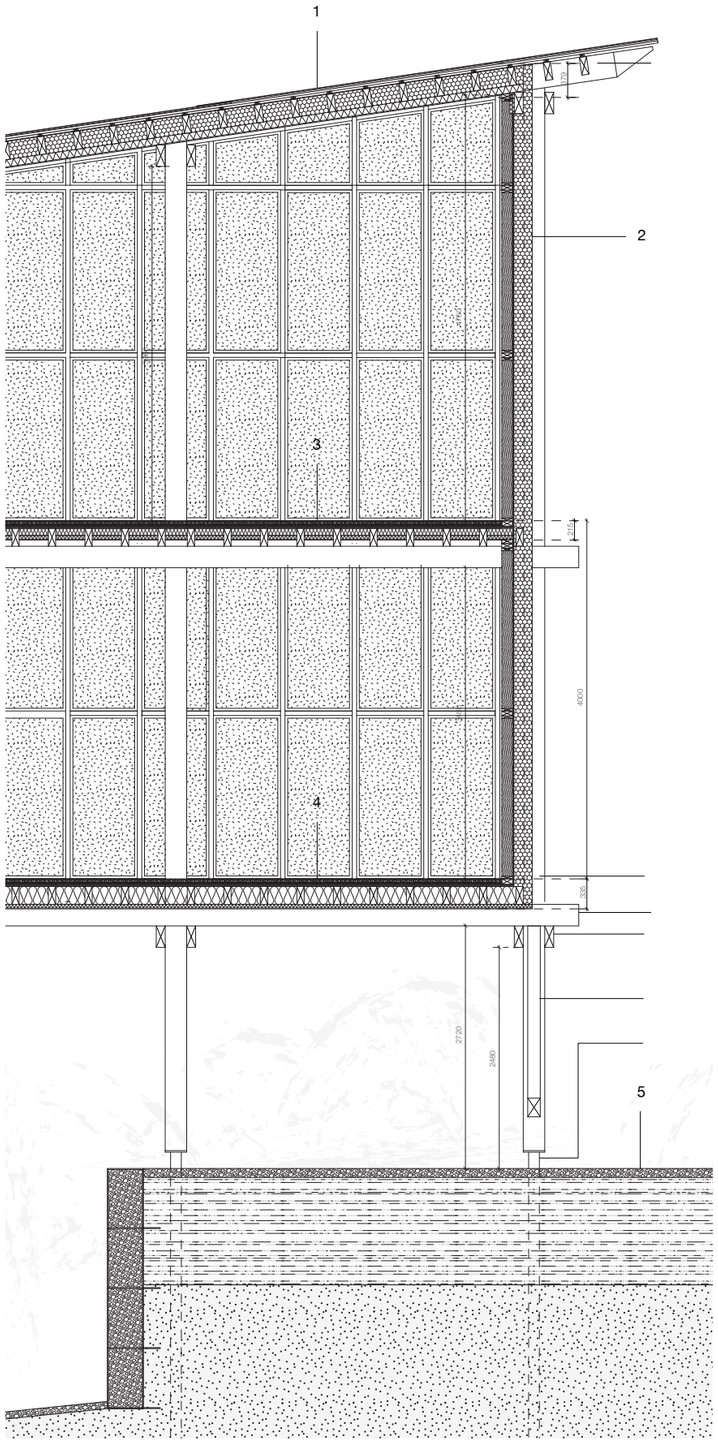
FRAMING THE FEATURE

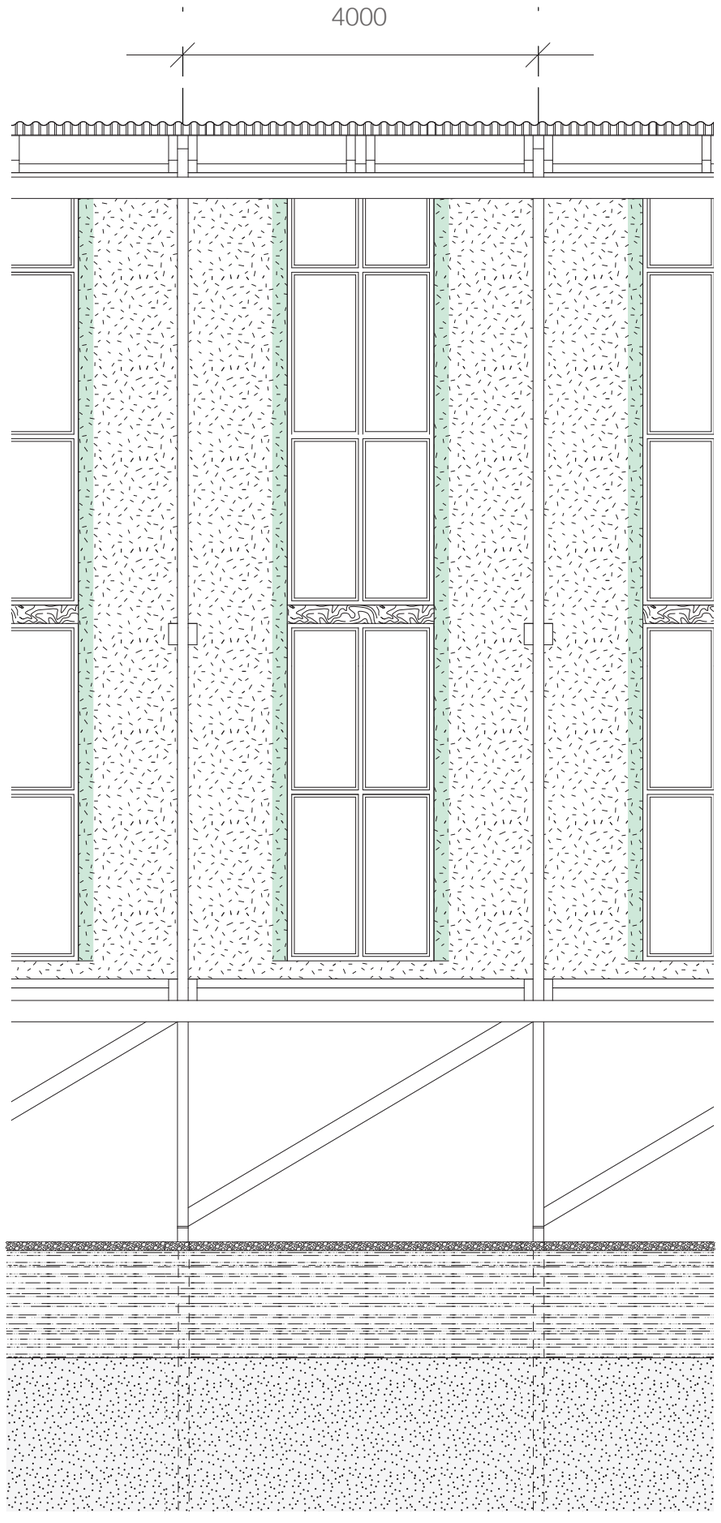
INTERNAL WALLS - EARTH

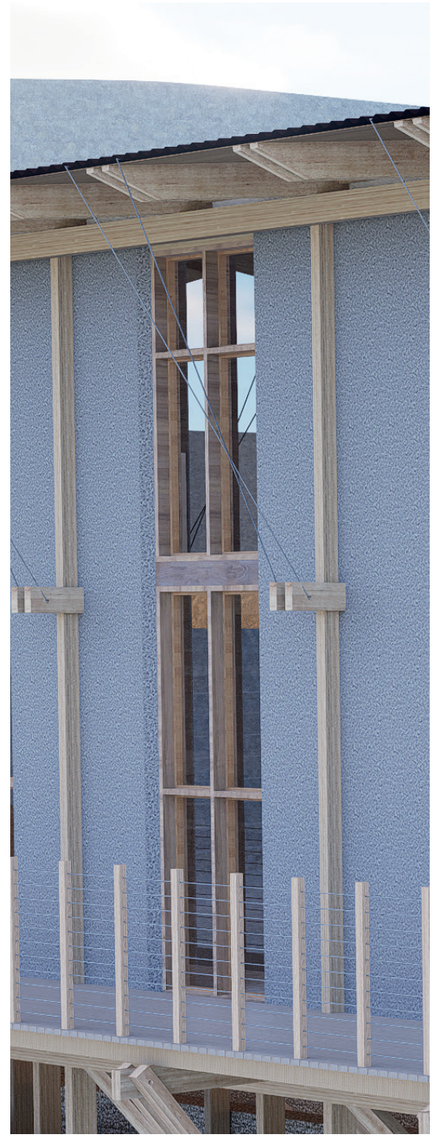
EXTERNAL WALLS - HEMPLIME



BAY DETAIL







2 Wall

220 mm low-density spray applied hemplime onto
120 mm timber framing with split reed mats
Airtightness line and sheathing
120 x 50 mm timber cross-framing with
prefabricated hemplime panels
R-value ≈ 6.9 m²K/W
U-value ~0.145 W/m²K

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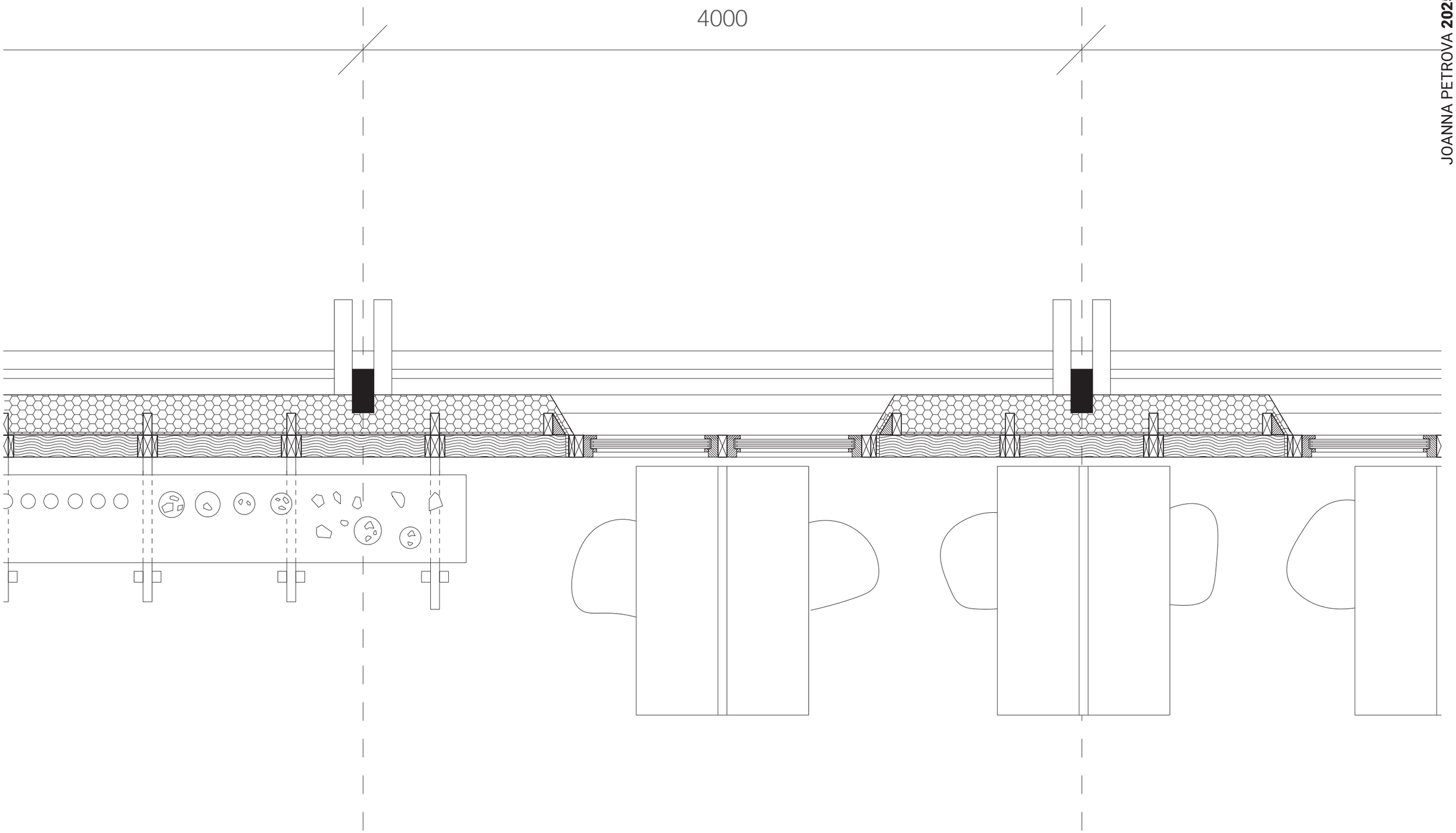
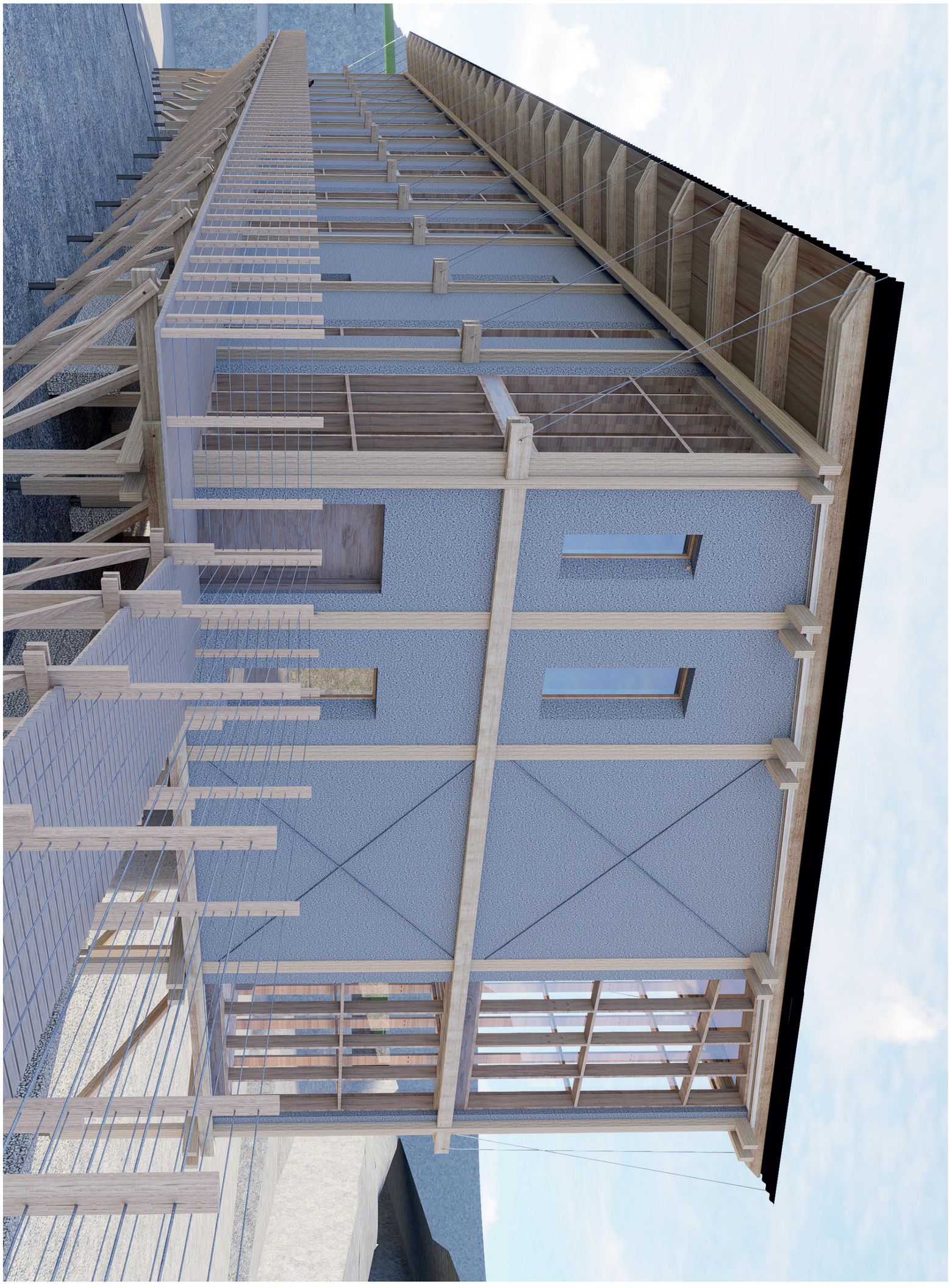
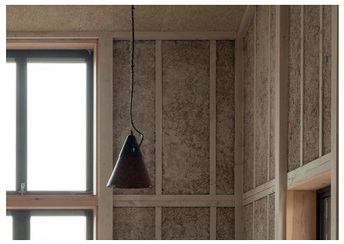
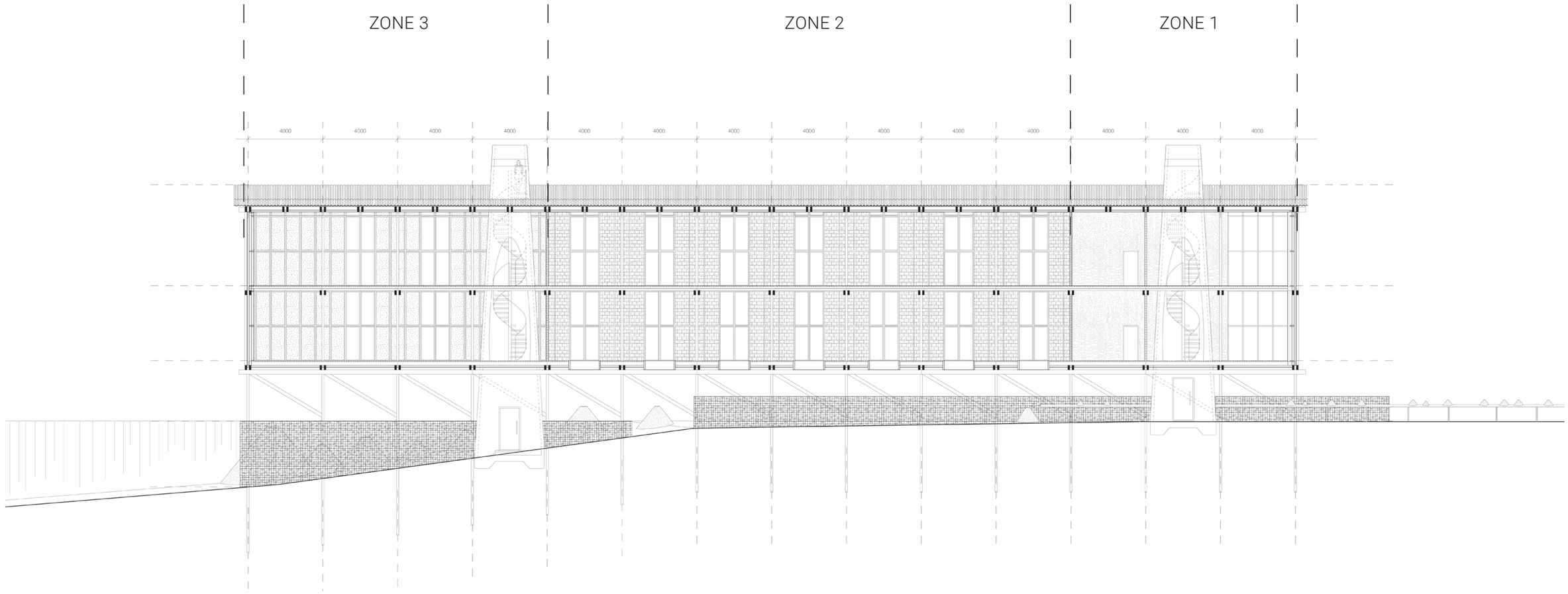
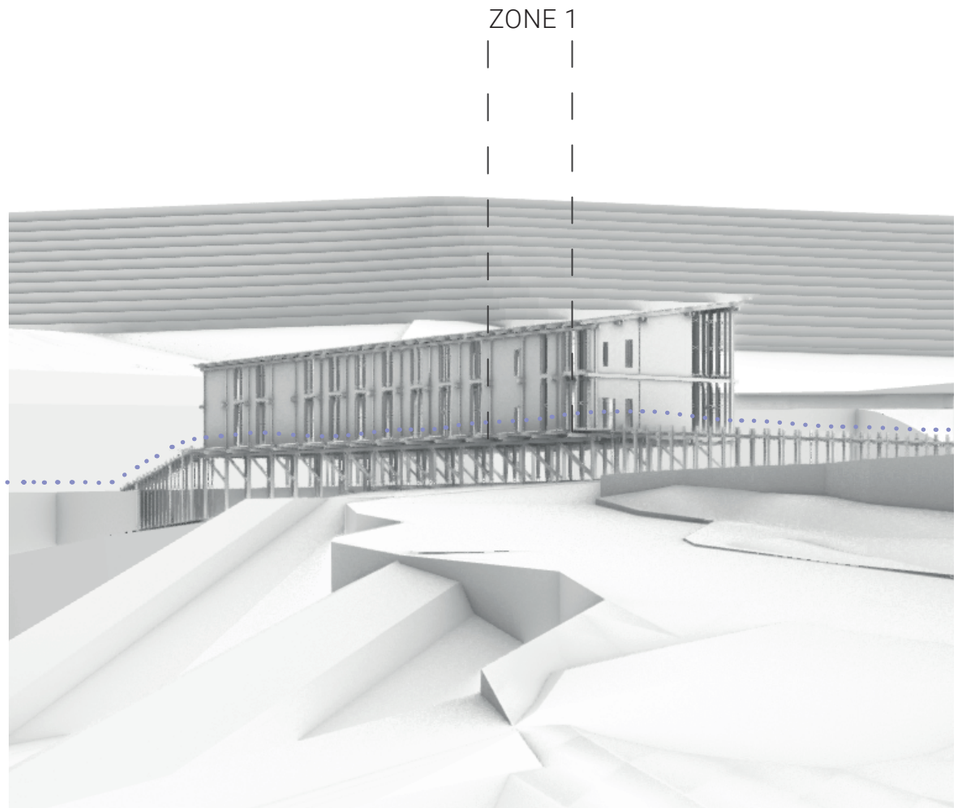


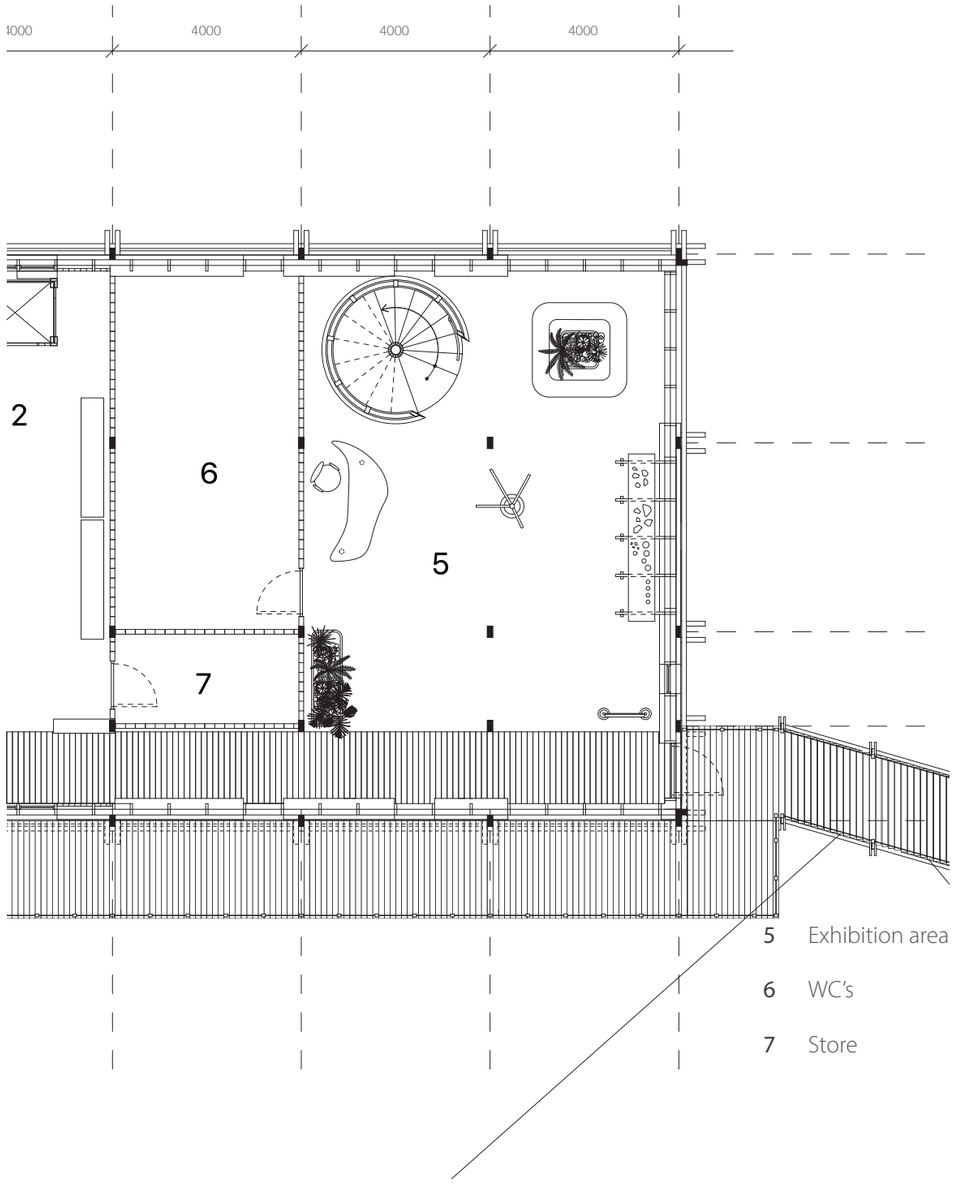






EXTERNAL WALL - INNER FRAME

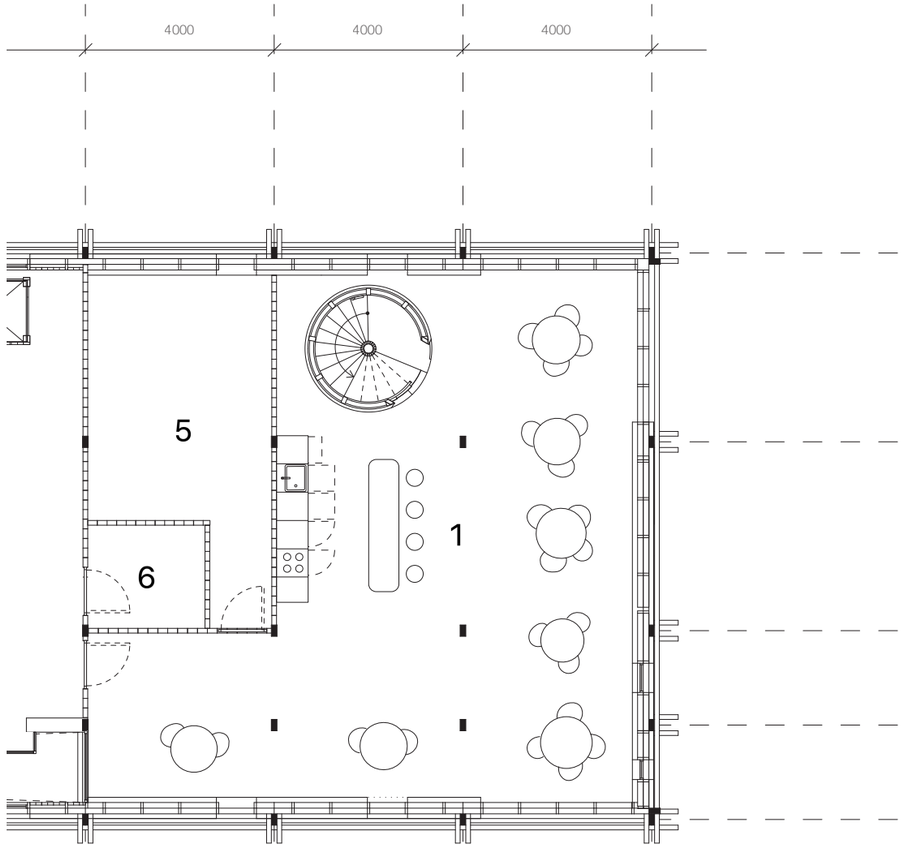

ZONE 1



5 Exhibition area

6 WC's

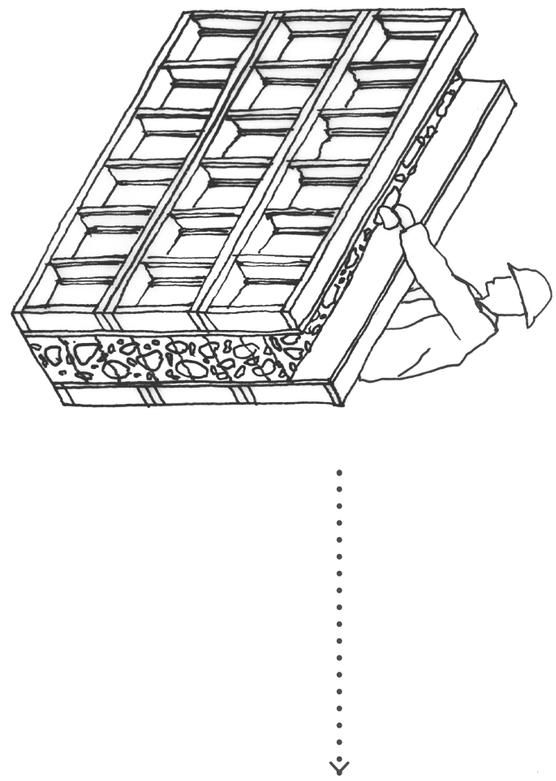
7 Store

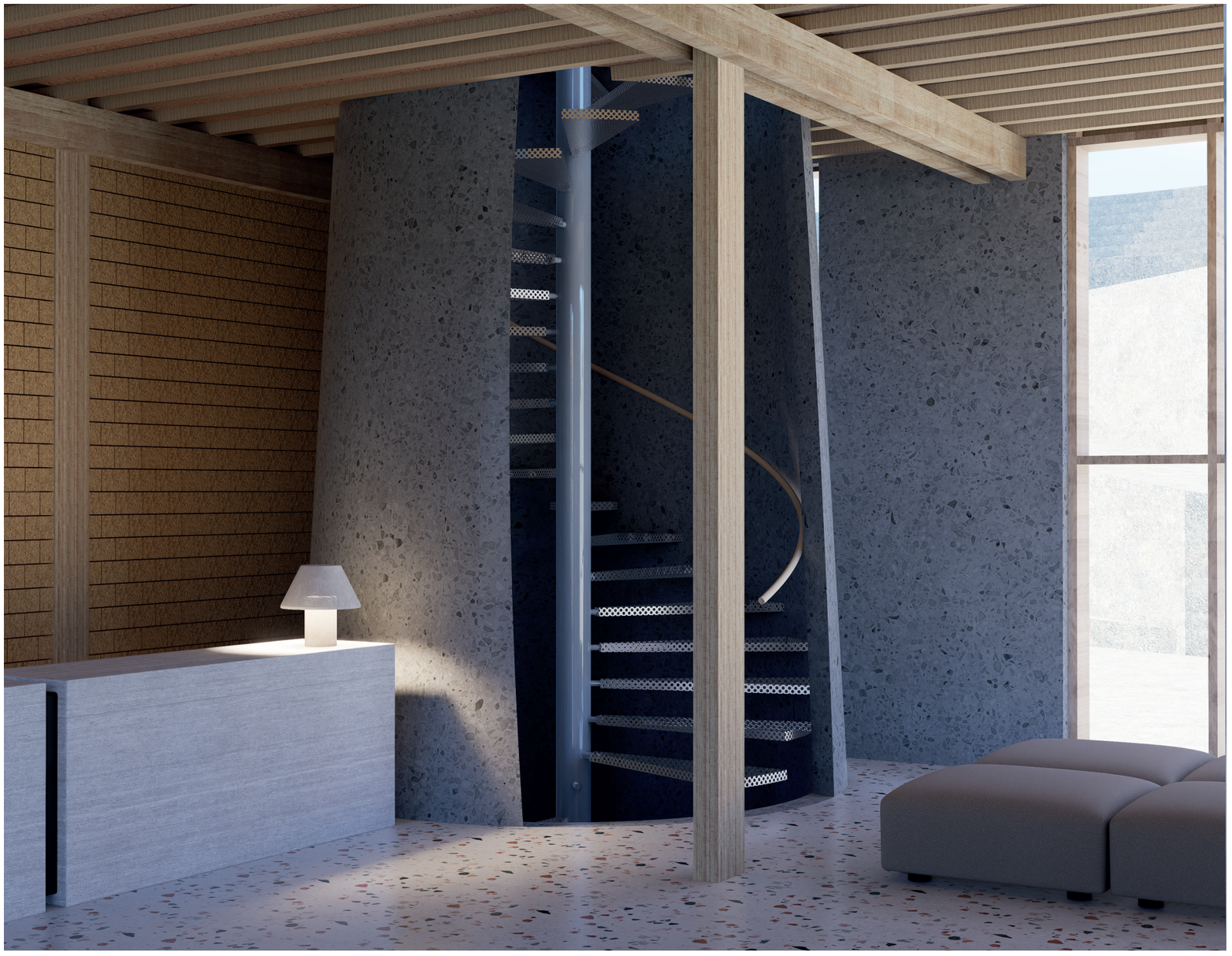


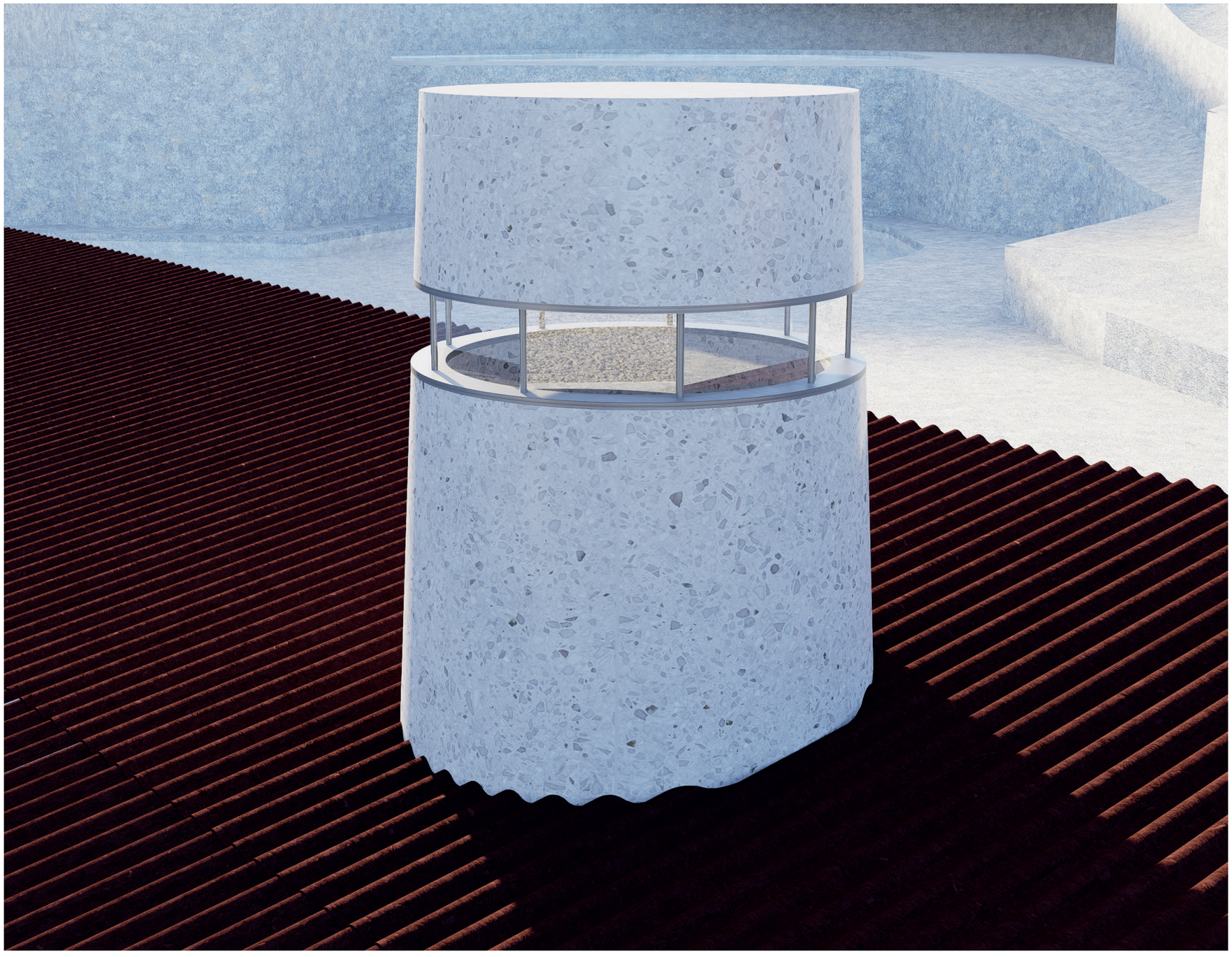
1 Community kitchen

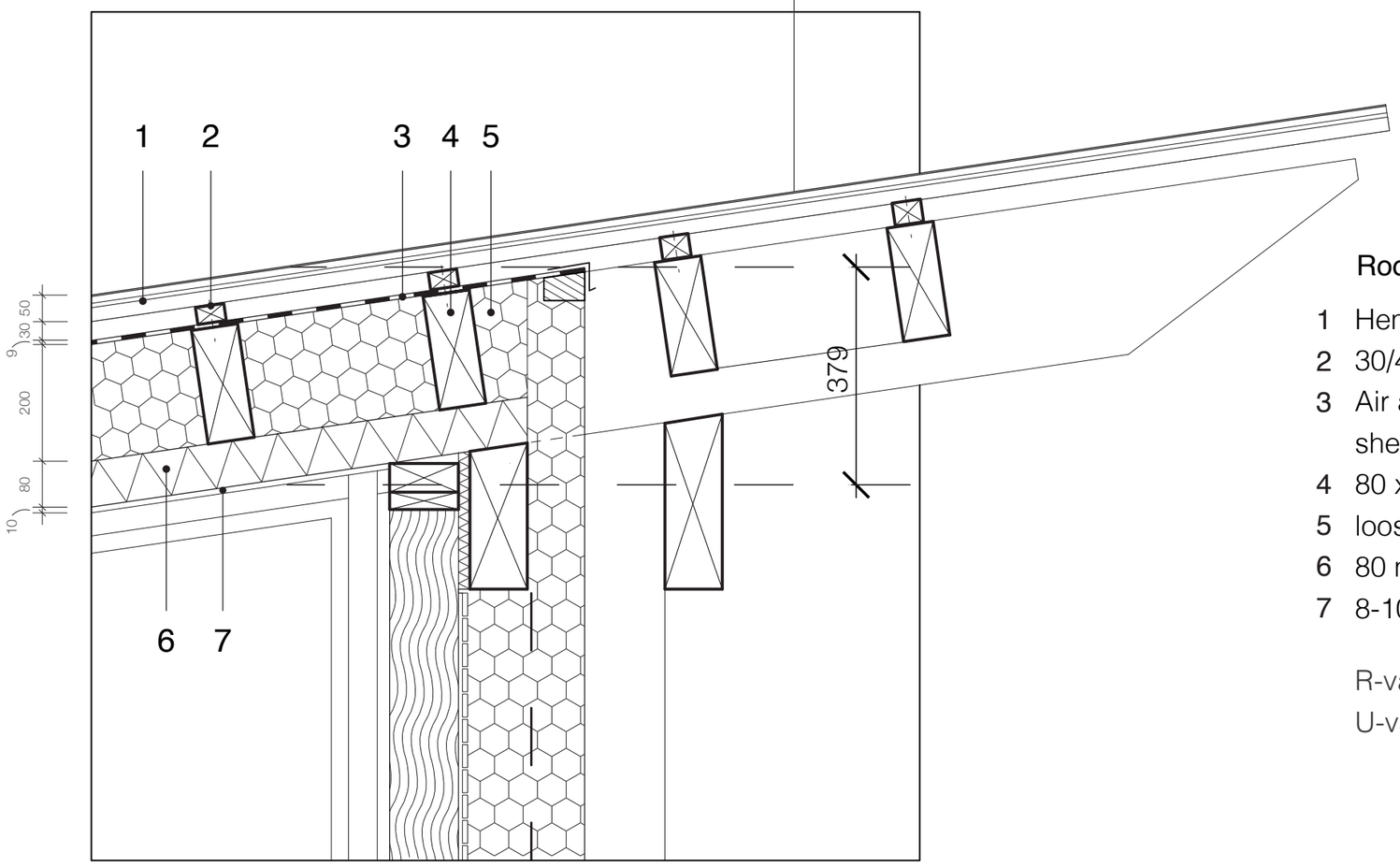
5 WC's

6 Store





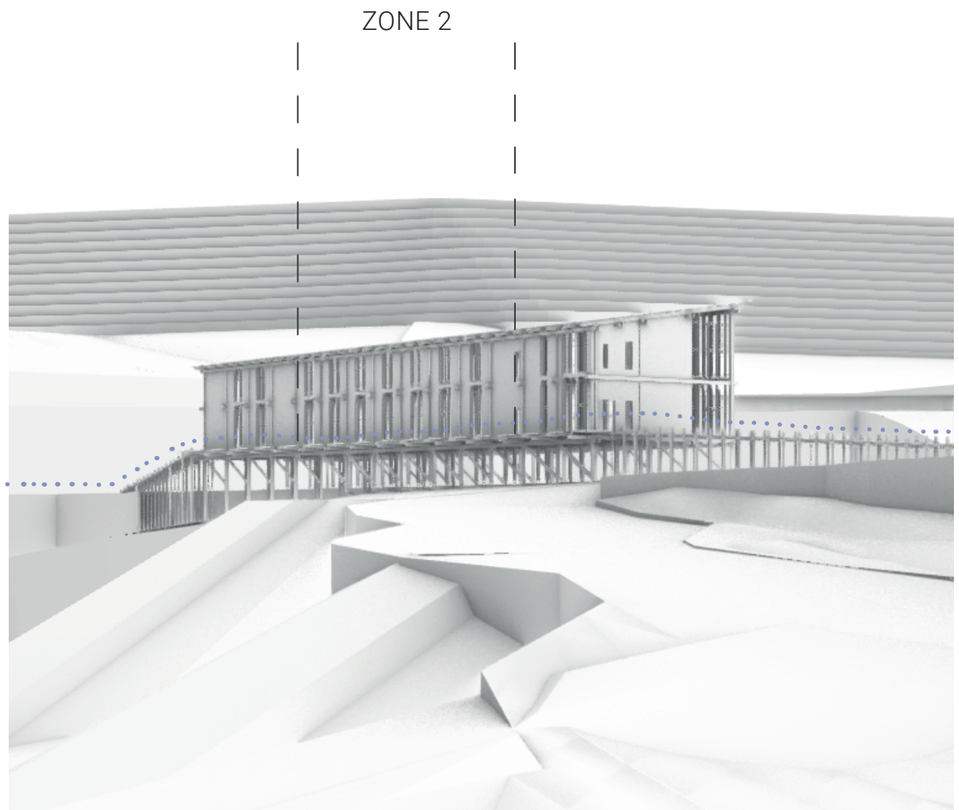


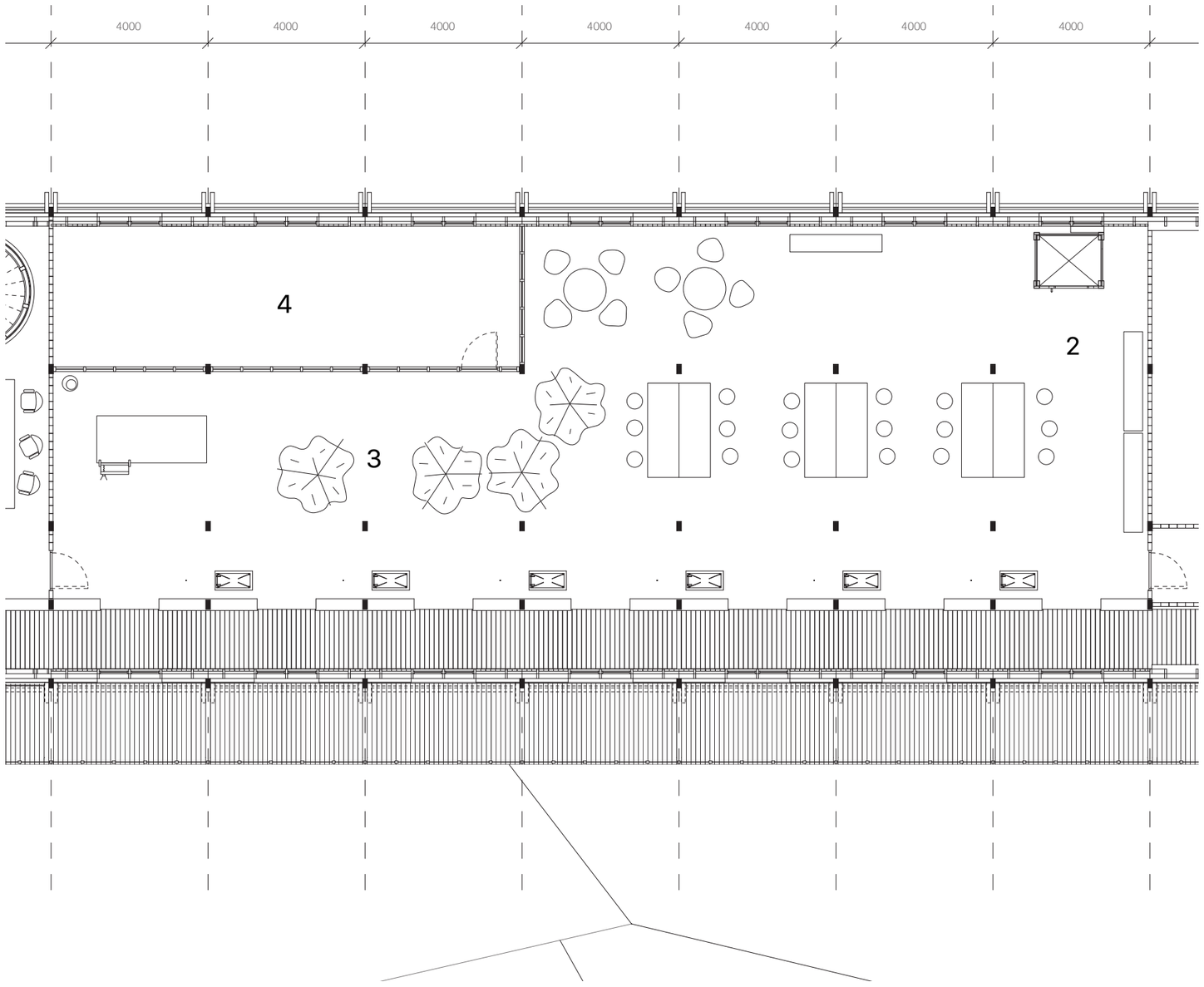


Roof

1 Hemp and sugar composite corrugated sheets
2 30/40 x 50 mm battens and counter-battens
3 Air and weather barrier membrane and timber sheathing
4 80 x 200 mm roof joists with blown cellulose or
5 loose hemp insulation in-between
6 80 mm woodfibre insulation boards
7 8-10 mm clay plaster finish

R-value ≈ 7.4 m^2K/W
U-value ≈ 0.135 W/m^2K

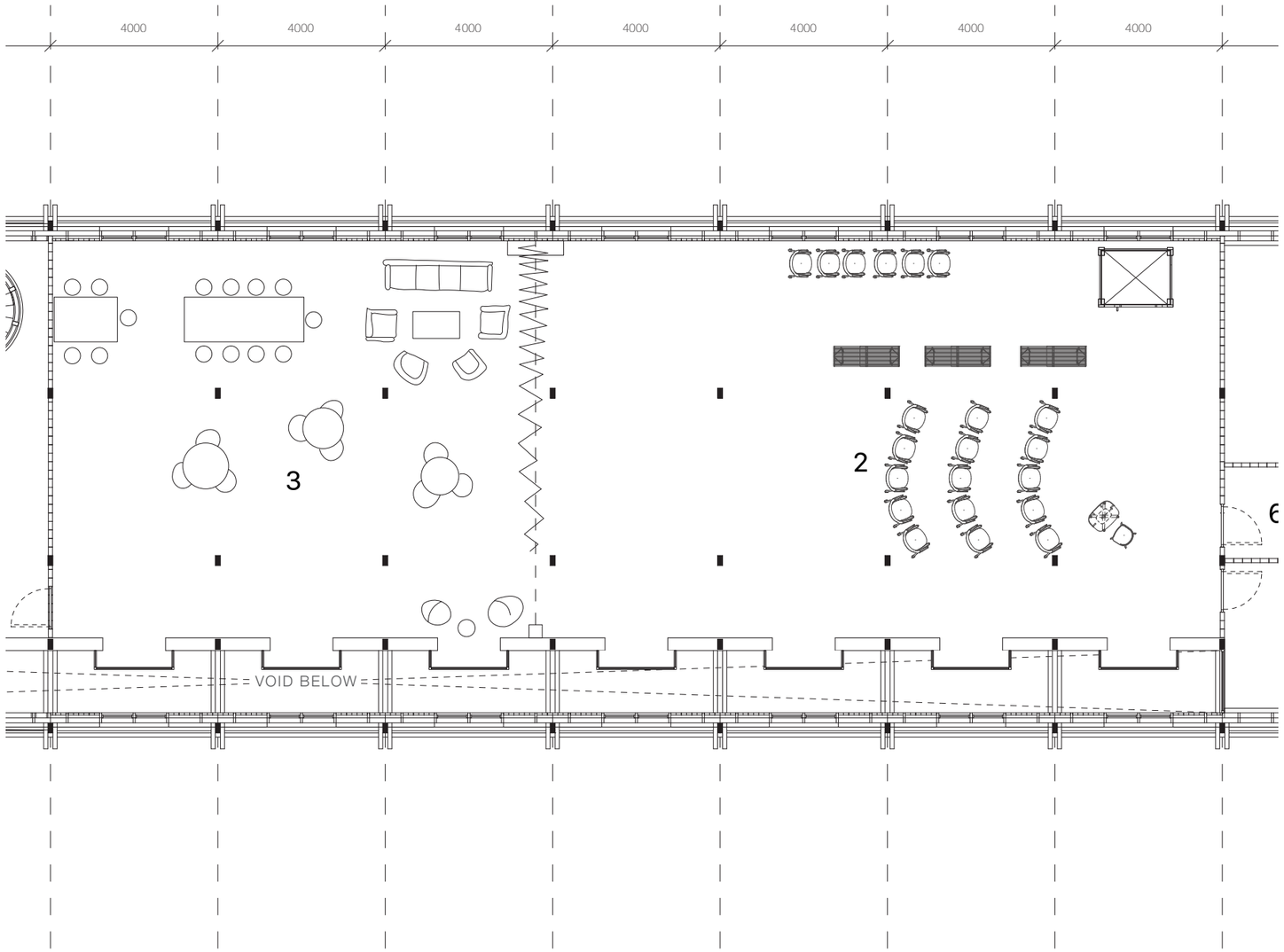

ZONE 2



2 Makerspace

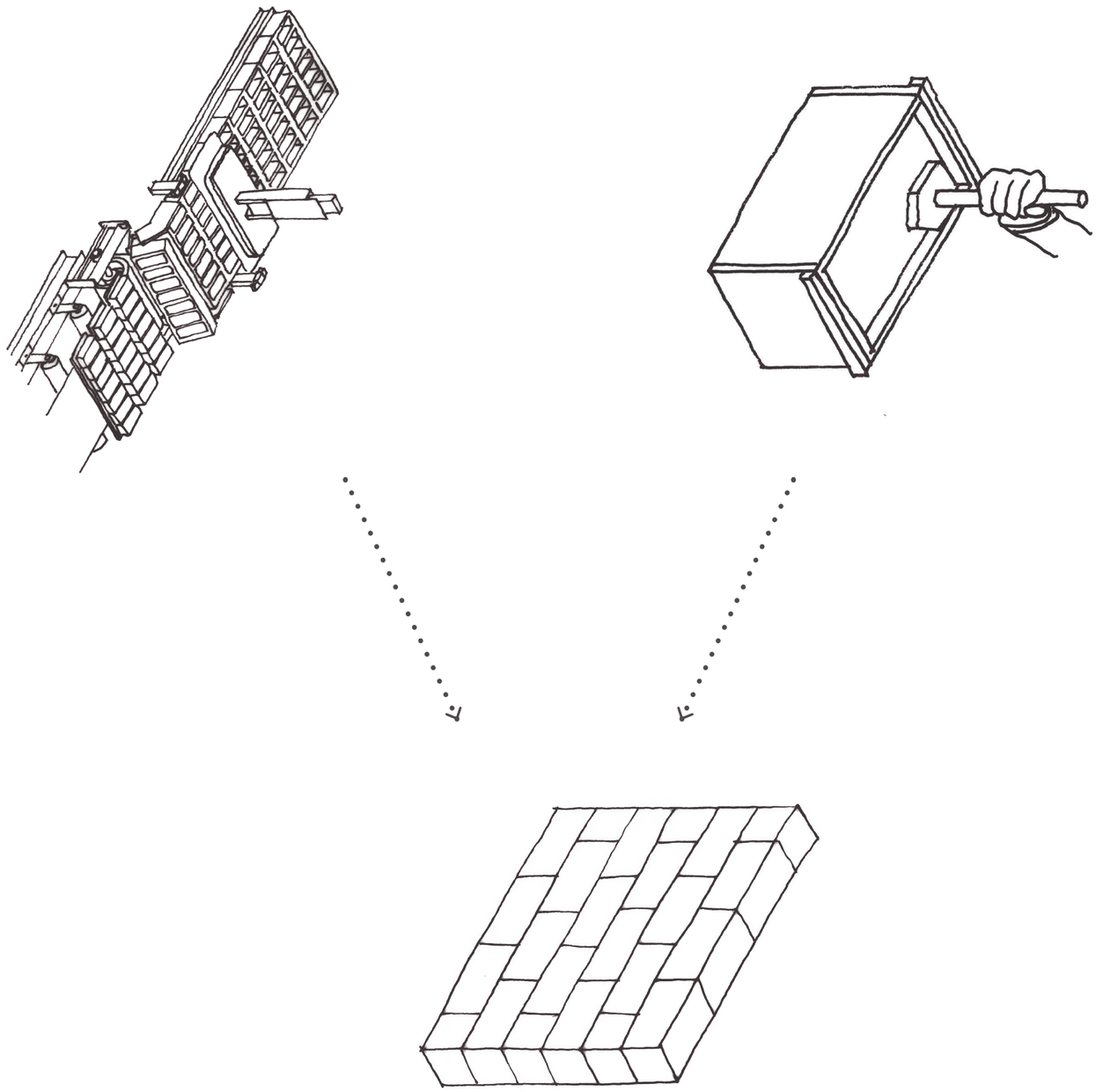
3 1:1 prototyping

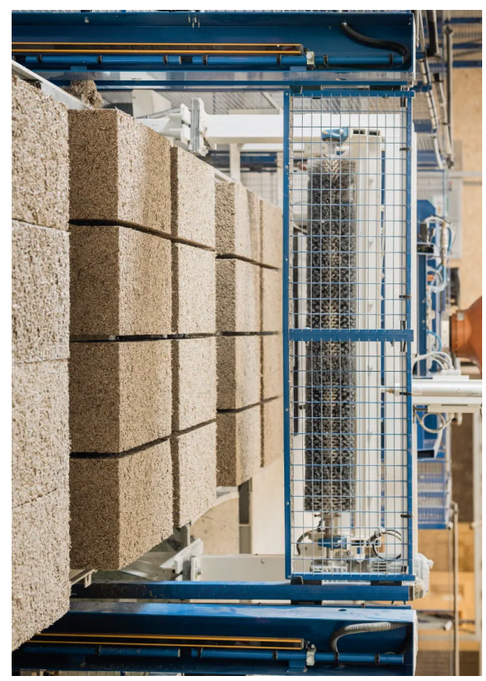
4 Wood workshop



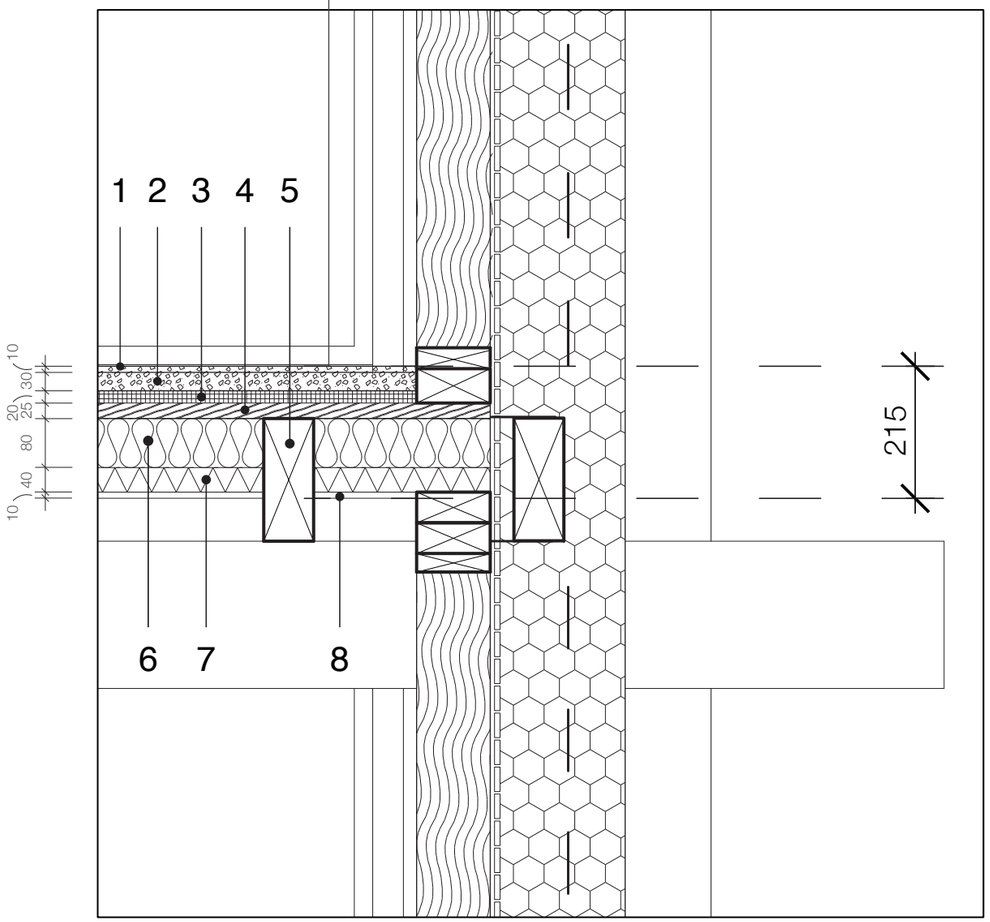
2 Meeting Hall

3 Living Room





FLOOR FINISH DETAIL



Mid-Floor

1 Cast lime + terazzo (finish) 10-15mm
2 30mm lime-sand screed
3 20 mm recycled natural rubber and cork granulate sound absorbtion mat
4 25 mm oak floor planks
5 80 x 200 mm exposed floor joists with 80 mm
6 hemp fibre batt insulation in-between
7 40 mm wood fibre panels
8 8-10 mm clay plaster finish to soffit

LnT,w ≈ 50-53 dB (impact sound insulation)
DnT,A ≈ 55-58 dB (airborne sound insulation)

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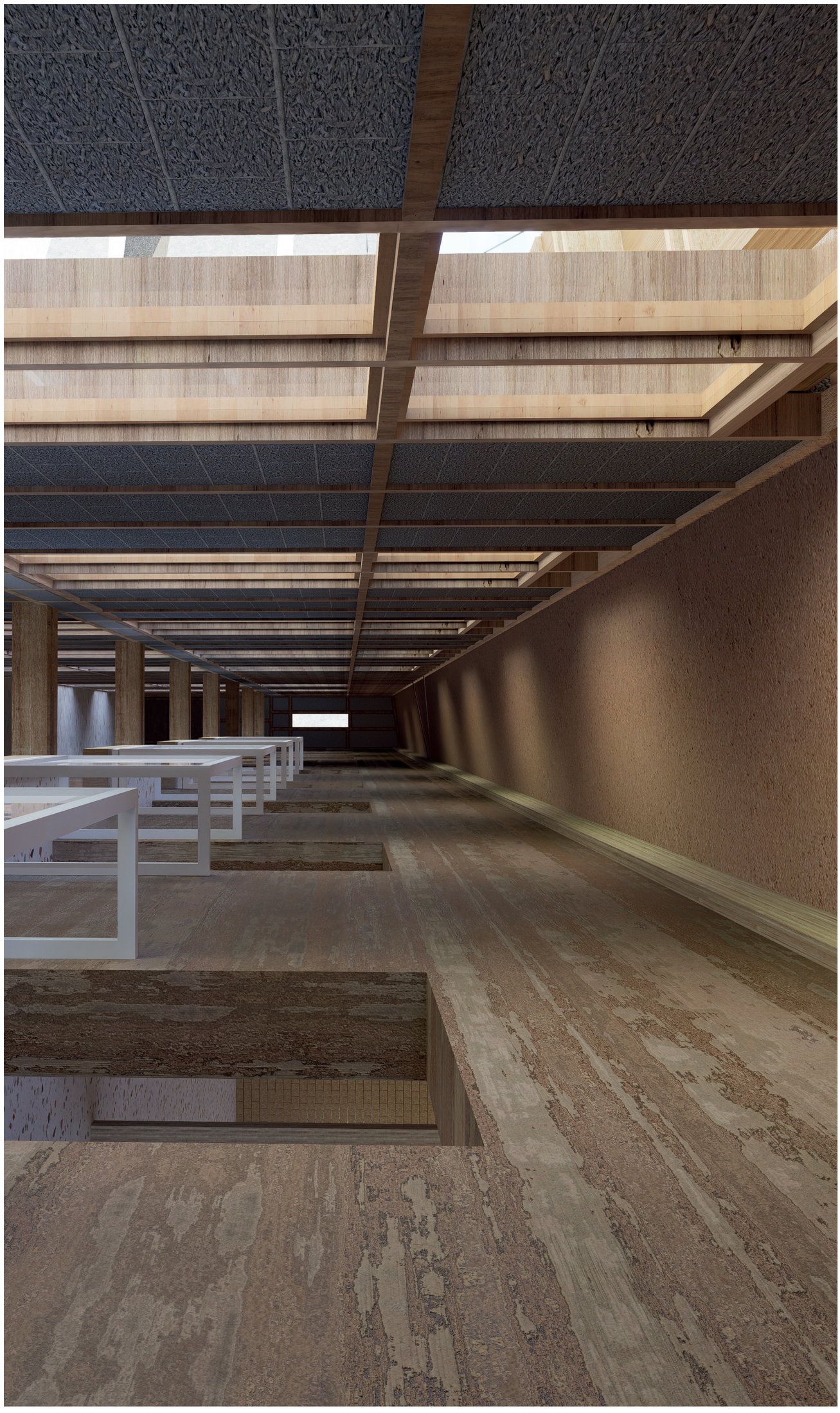
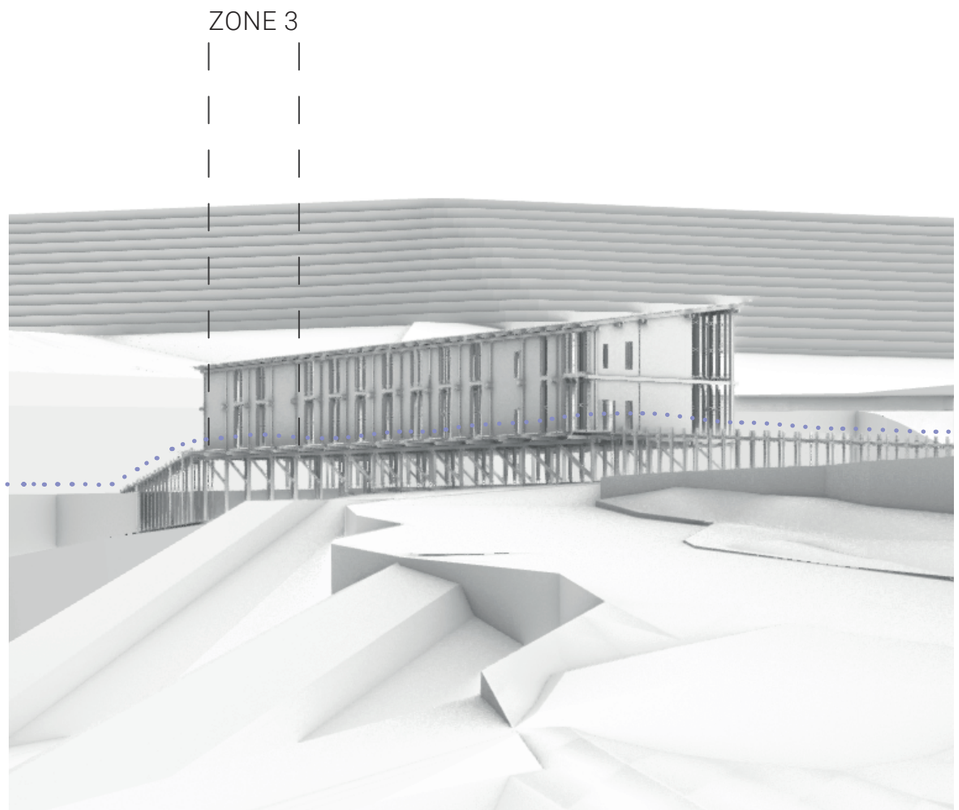
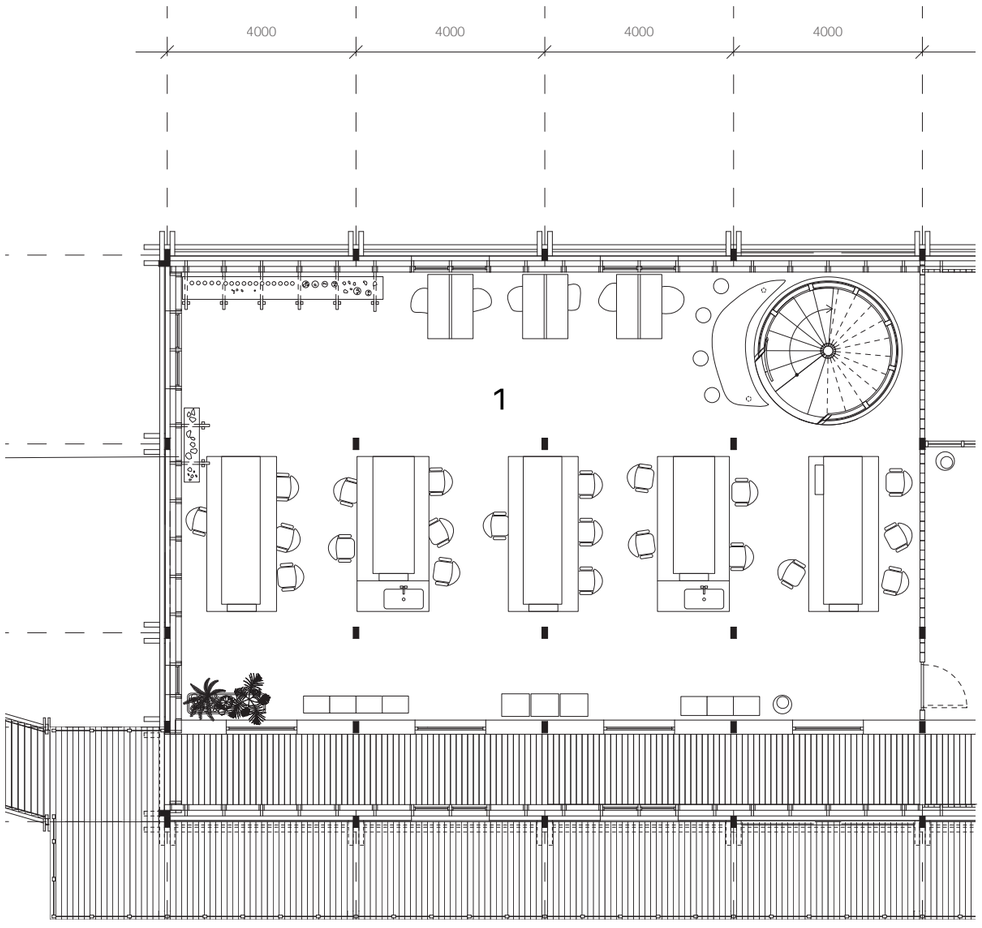
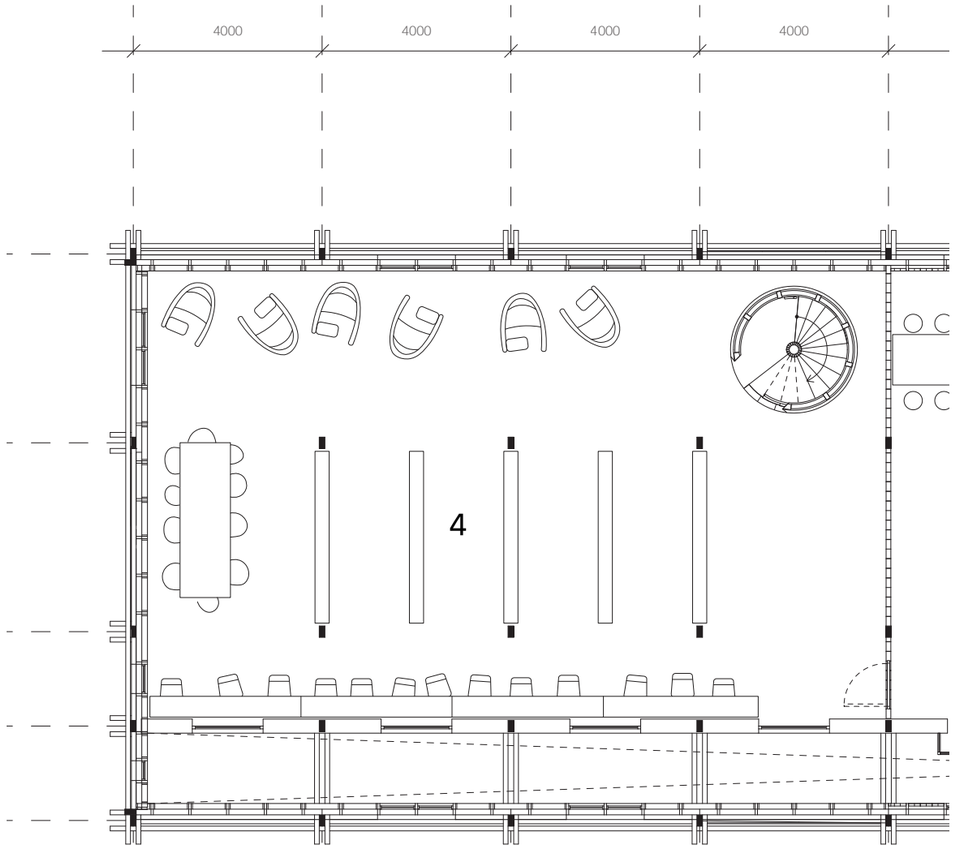


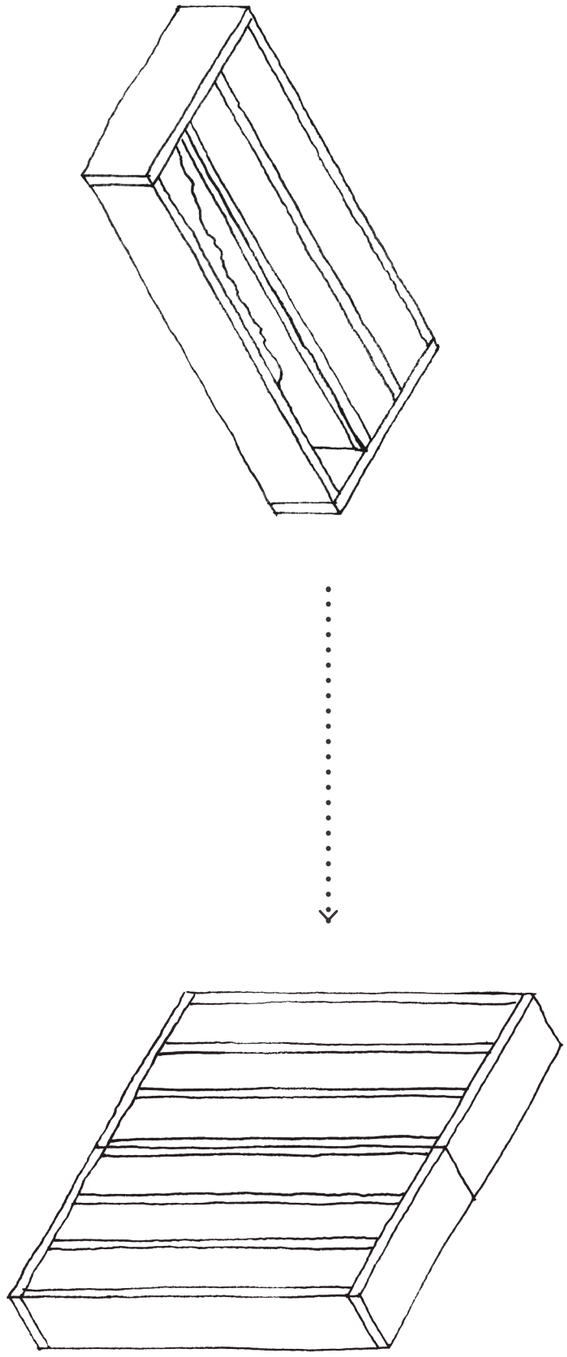

ZONE 3

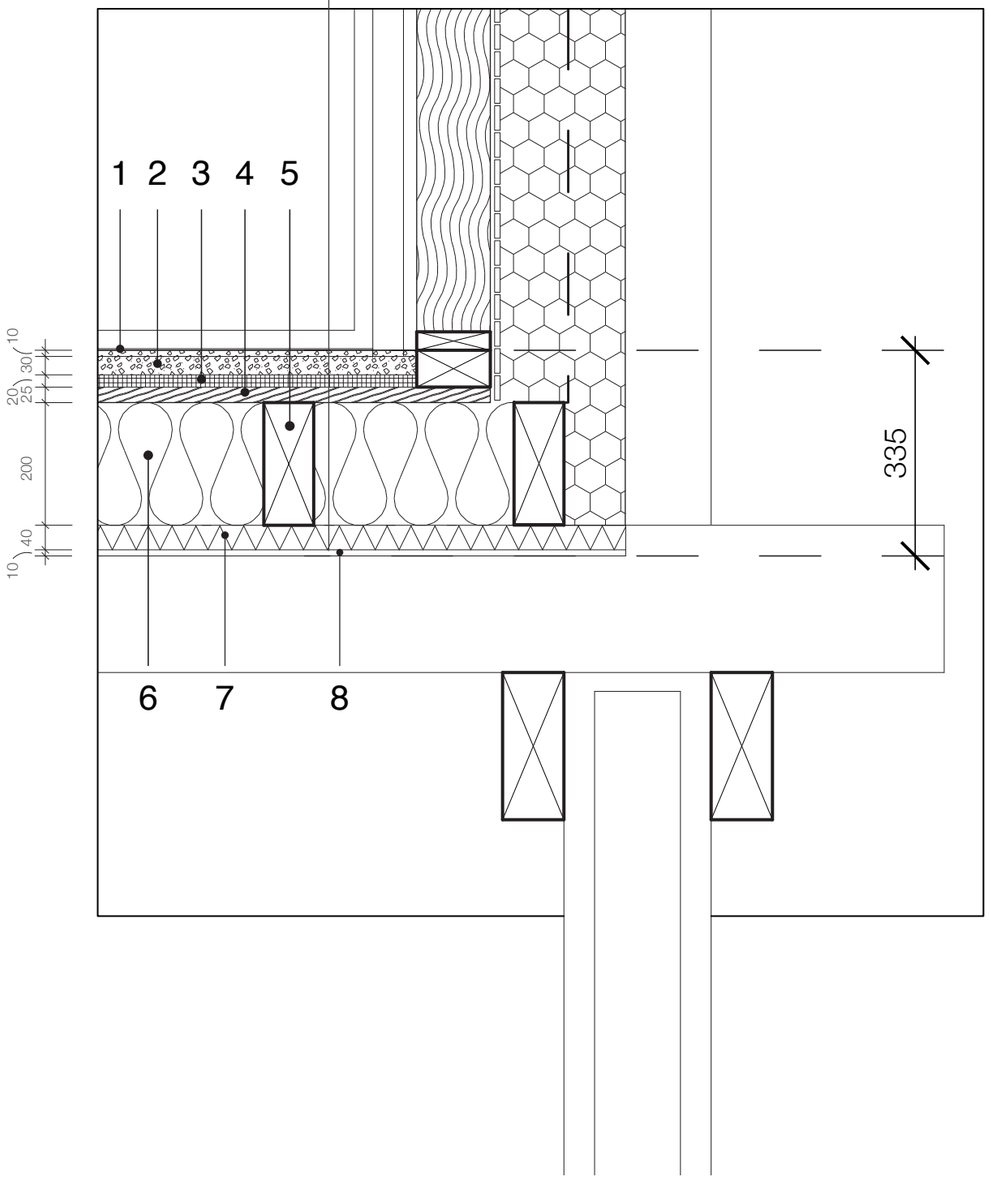


1 Research labs



4 Library





Bottom Floor

1 Cast lime + terazzo (finish) 10-15mm
2 30mm lime-sand screed
3 20 mm recycled natural rubber and cork granulate sound absorbtion mat
4 25 mm oak floor planks
5 80 x 200 mm exposed floor joists with 200 mm
6 hemp fibre batt insulation in-between
7 40 mm wood fibre panels
8 8-10 mm clay plaster finish to soffit

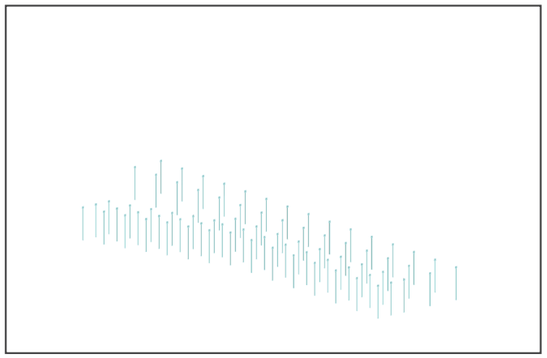
R-value ≈ 6.67 m^2K/W
U-value ~0.15 W/m^2K

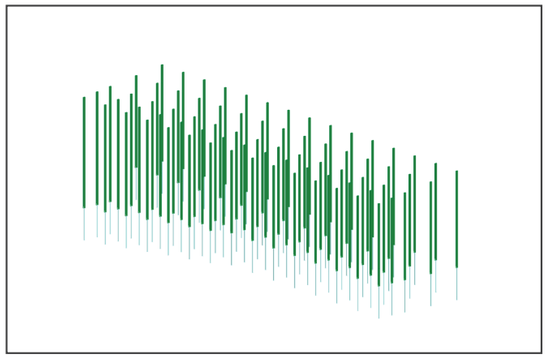
THANK YOU FOR LISTENING!

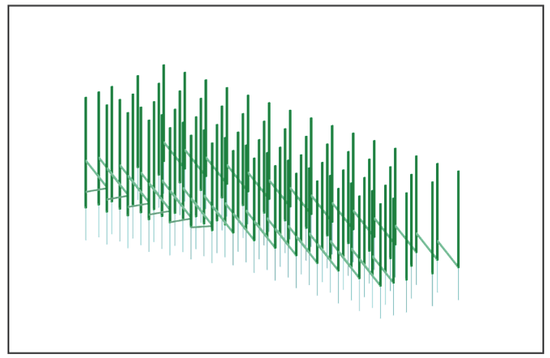
STEEL HELICAL (SCREW) PILE FOUNDATIONS
FROM ROTOPILE

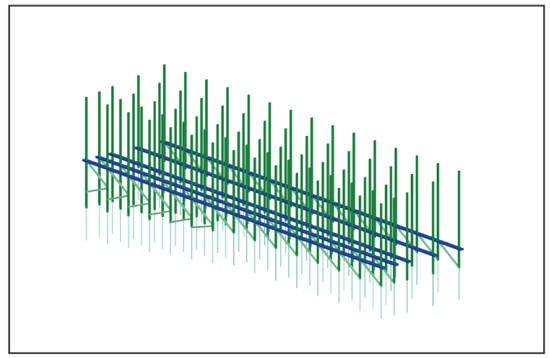
METAL BRACKET CONNECTION TO POSTS

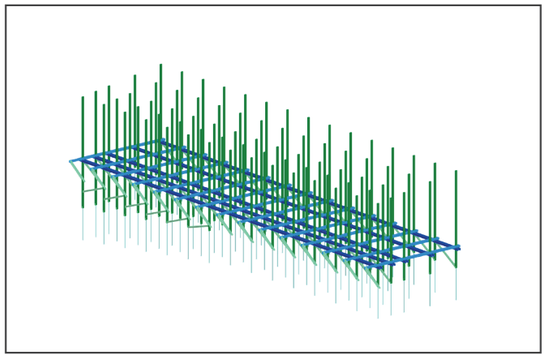
JOANNA PETROVA **2025**

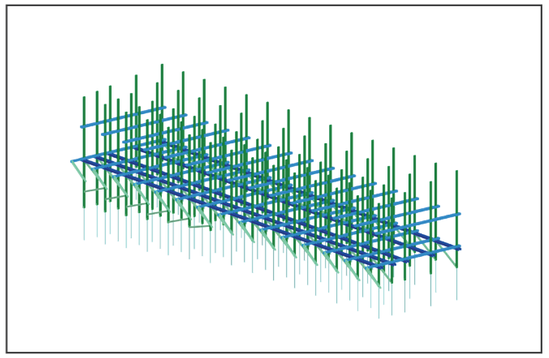


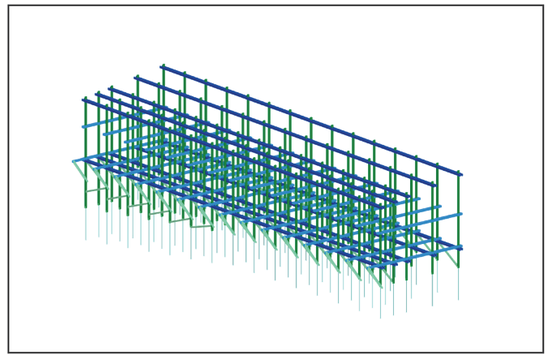


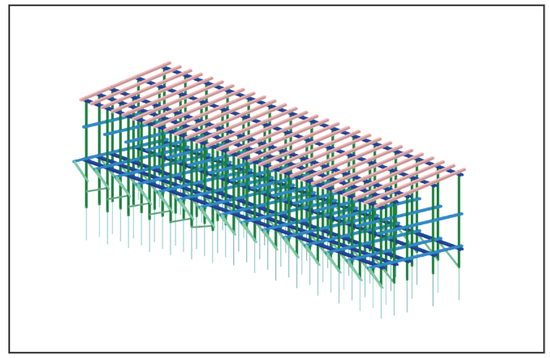


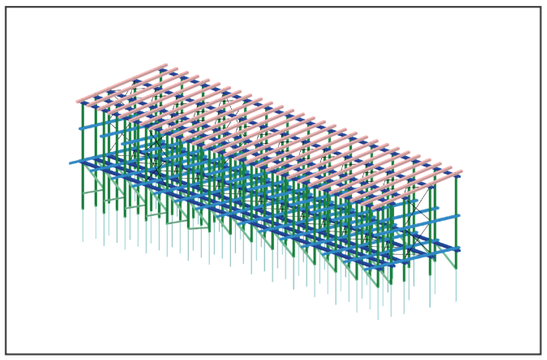


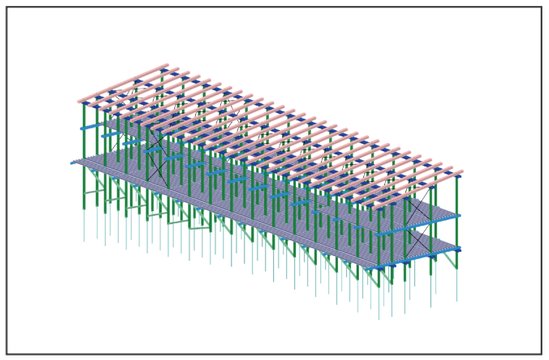


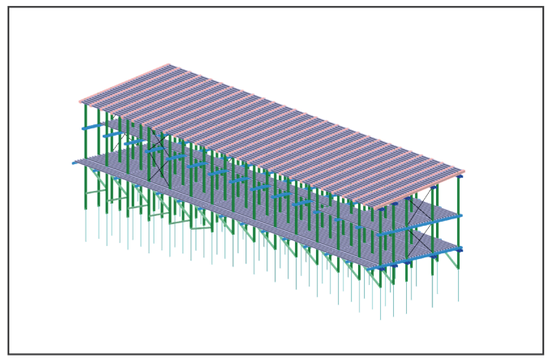


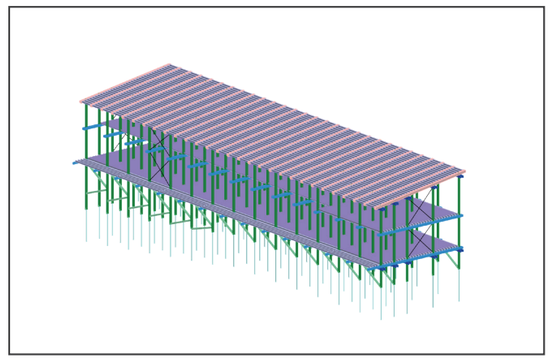




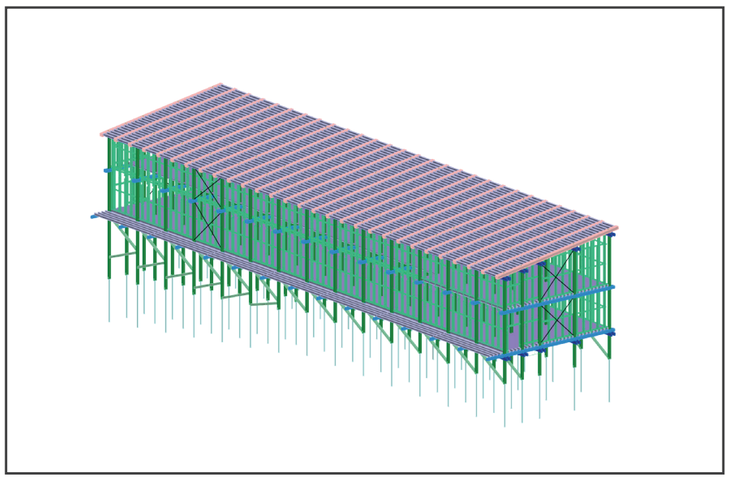


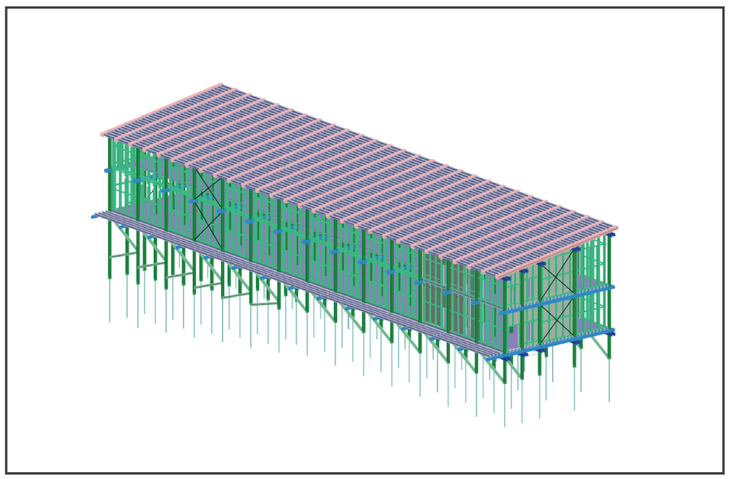


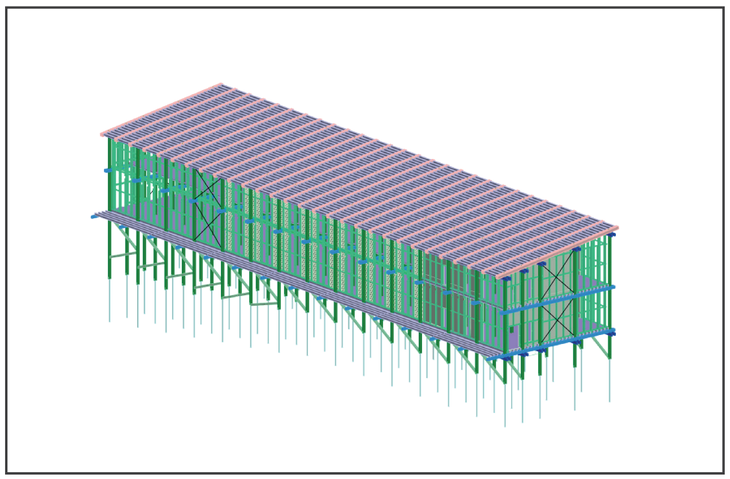


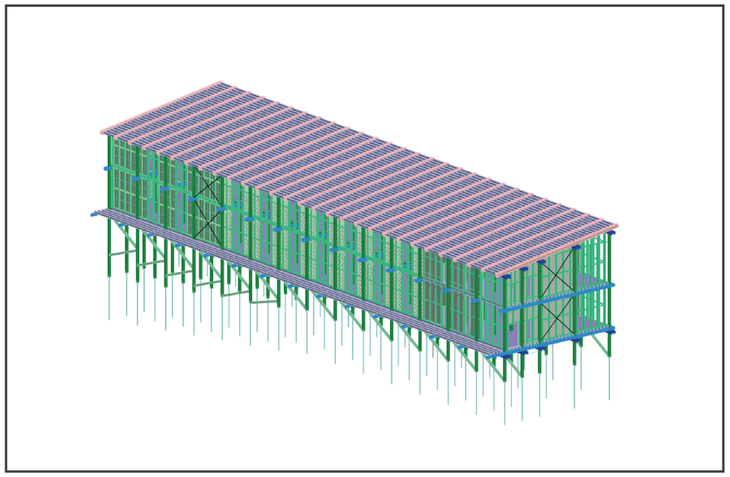


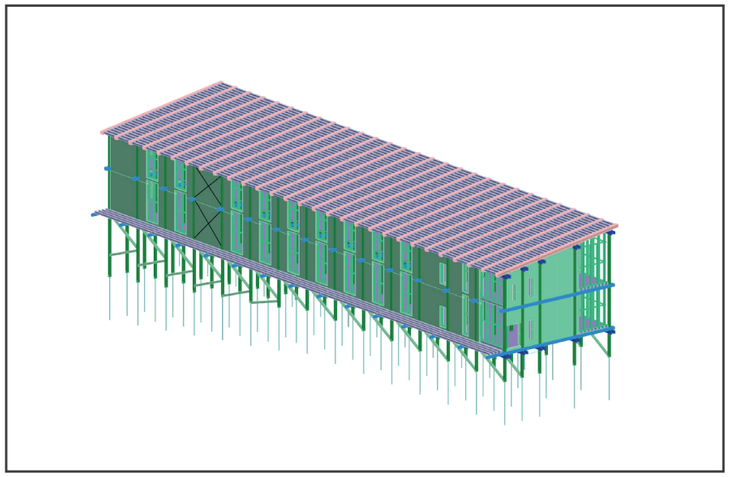
JOANNA PETROVA **2025**

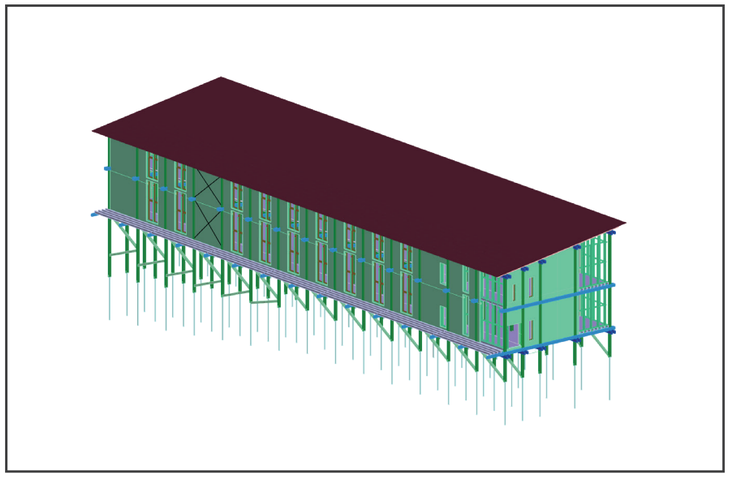


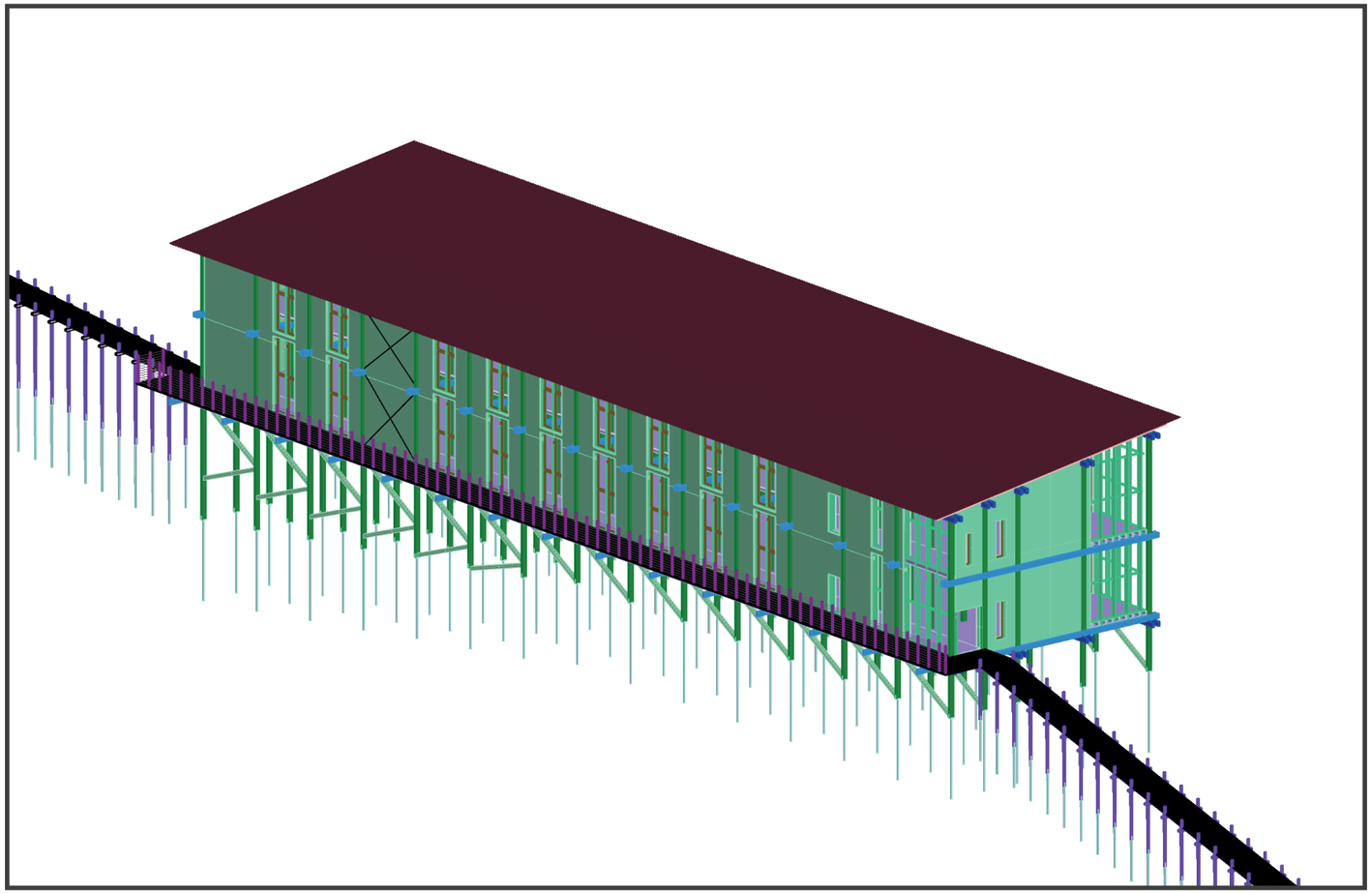






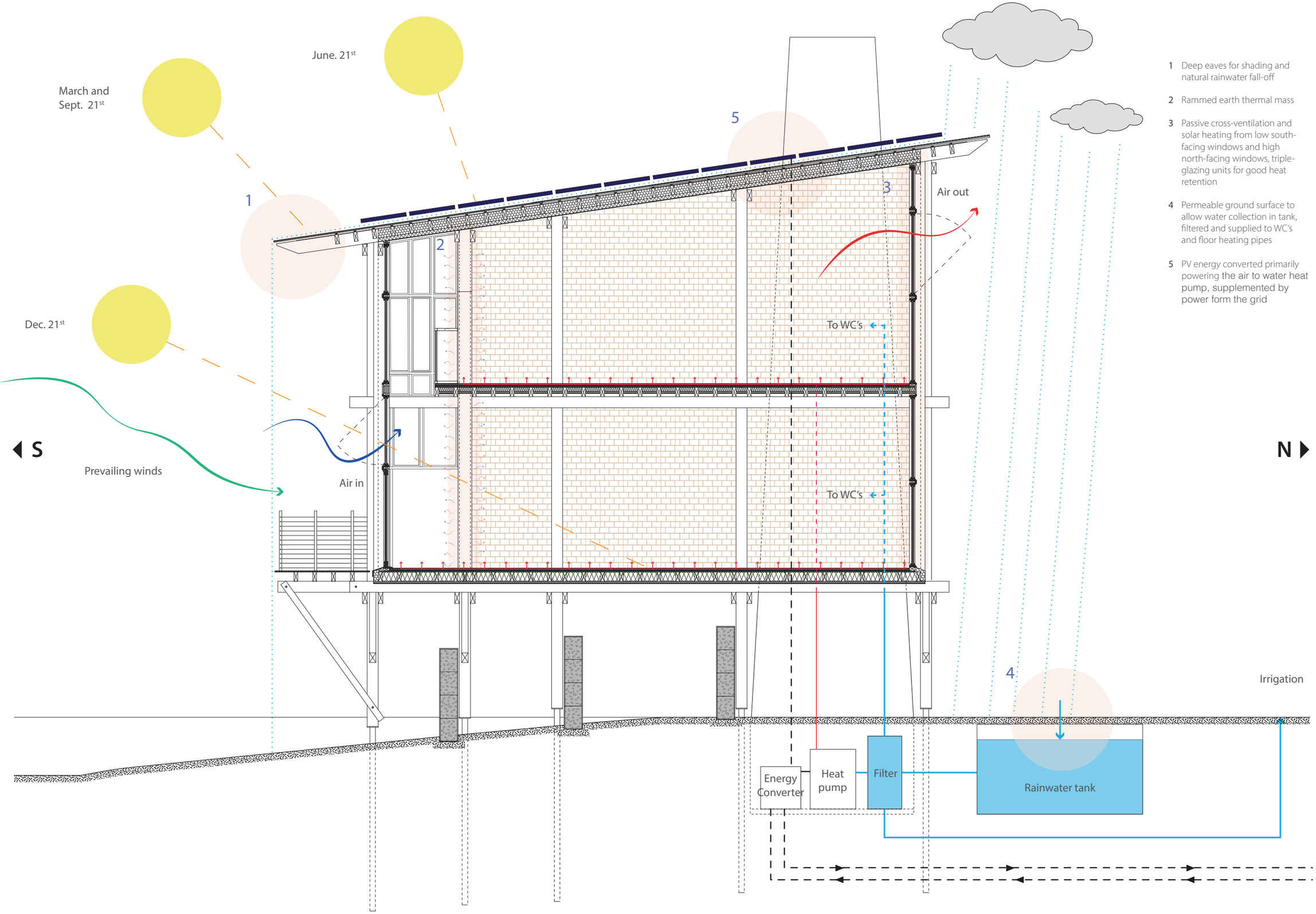






CLIMATE STRATEGY

JOANNA PETROVA **2025**



1 Deep eaves for shading and natural rainwater fall-off

2 Rammed earth thermal mass

3 Passive cross-ventilation and solar heating from low south-facing windows and high north-facing windows, triple-glazing units for good heat retention

4 Permeable ground surface to allow water collection in tank, filtered and supplied to WC's and floor heating pipes

5 PV energy converted primarily powering the air to water heat pump, supplemented by power form the grid