HELD

BY THE MOUNTAINS

Commoning through water, refuge
and repair in Sierra Norte de
Madrid

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CONTENTS

01 POSITIONING

the water machine	10-11
climatic cycles	12-13
alpine stressor dynamics	14-15
theoretical framework	16-17
methodological framework	18-19
questions	20-21

02 EXPLORATION

The Participants	24-25
Systemic Mapping	26-27
The Governance Territory	28-29
Ecotones	30-31
Aligning Territories	32-33
Sectional	34-35
Upland panels	36-37
Resevoir Panels	38-39
Matter Mapping	40-41
The Scope	42-43
Alpine Settlement	44-45
Critical Locations	46-47
Precedent Study	48-59

03 POTENTIALS

Potentials Hand Drawings	62-67
Field Study	68-77
Territorial Taxomony	78-79
Physical Model: Territorial	80-81
Perrejon Bajero	82-83
The Elements	84-85
A Thousand-year Life	86-87

04 THE DESIGN

First Arrival	90-91
Off-Grid Commons	92-93
Supply Drop	94-95
Water is the First Move	96-99
Holding Water	100-103
The Wet Room	104-107
Non-Extraction	108-111
Physical Model: Embedded Refuge	112-115
Sections	116-119
Operational Kitchen Plan -01	120-121
Detailed Axonometric Stern	122-123
Second Grotto Plan -02	124-125
Exploded Axonometric Roof Detail	126-127
Embedding Detail	128-129
Detailed Axonometric Bow	130-131
Renders	132-133
Mobile Clean Lab	134-137

05 DISCUSSION AND CONCLUSION 138-139

06 BIBLIOGRAPHY

Literature	140
Datasets	141
Sources	142-143
List of Figures	144-145

ABSTRACT

Held by the Mountains is an investigation of the responsibility architecture can take in fragile mountain territories. Starting with the premise that architecture can operate as a commoner of relationships between human, non-human life, and institutional actors in Alpine territories. The project is set within Sierra Norte de Madrid, recognizing that architecture does not simply solve complex environmental fragilities, but can take responsibility for performance within it. Performance in this project is evaluated in the context of a thousand-year horizon, mapping phases and potentials in a post-human future. This thesis investigates inhabitation as a mechanism for common knowledge and refuge as a commoner by re-imagining relationships between human and non-human participants to inform practices, morphologies, tectonics and construction logic. Positioning architecture as a reparative practice, a shared infrastructure through which environmental dependency becomes measured, experienced, and held over time.

Water as Commons; Material agency; Architecture as refuge; Mountainous territories; reparative infrastructure; Epistemic architecture; human–non-human relations

MOTIVATION

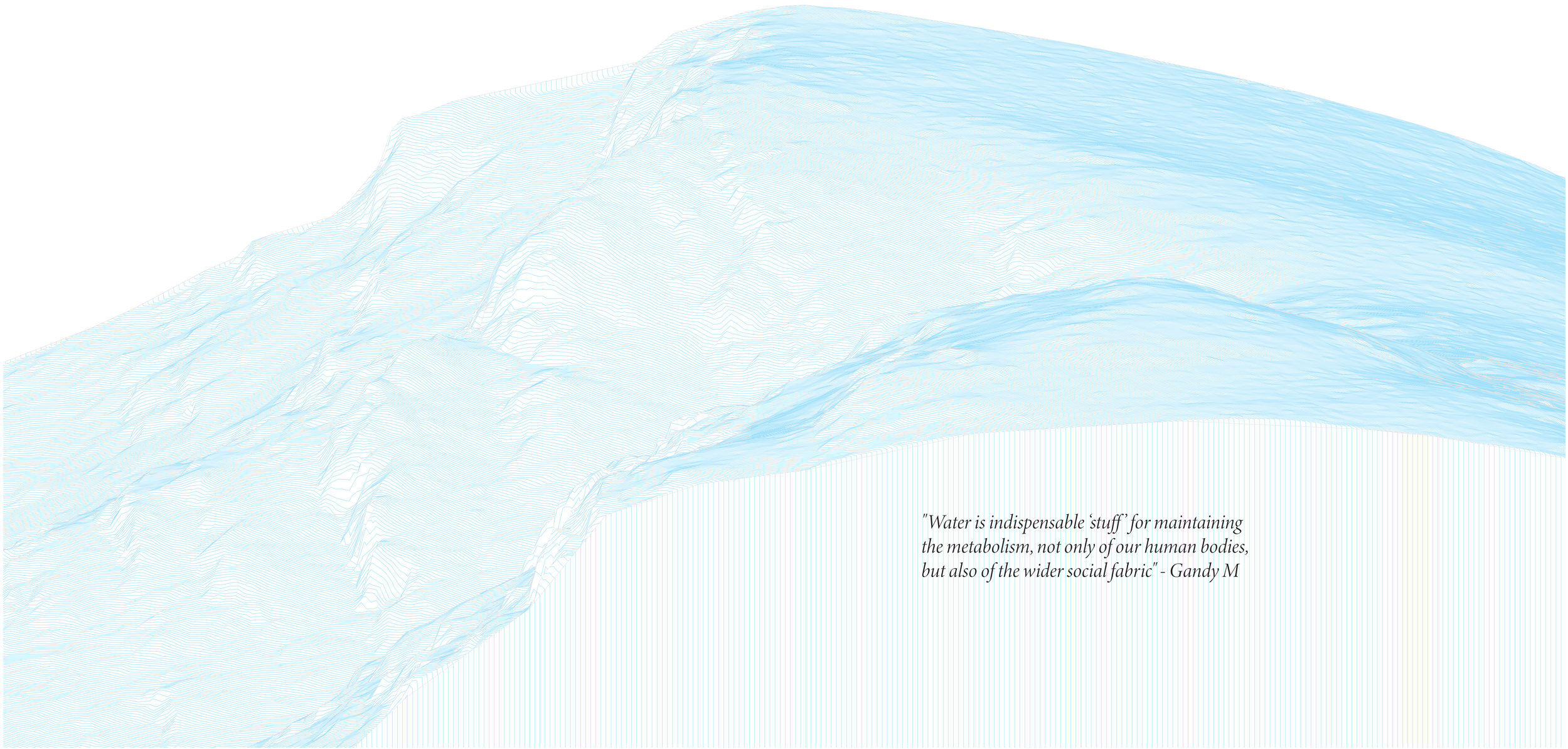
Professional

Professionally, this research is motivated by a desire to expand architecture's agency within infrastructural and environmental systems that are typically dominated by engineering or policy frameworks. Increasing levels of climatic stress expose the limits of human intervention in the natural world, particularly traditional infrastructure calibrated to historical averages that are increasingly likely to be exposed to seasonal extremes. This project seeks to reclaim architecture's capacity to work through section, construction logic, and material intelligence. Adopting the design mindset of doing more with less, with a focus on the hydrological systems that sustain our inhabitation needs, the ambition is to develop an architectural language that engages large-scale environmental systems while remaining legible, durable, culturally resonant and spatially compelling.

Personal

Raised in Michigan in the United States, I was surrounded by the largest freshwater lakes in the world, I experienced water as abundance, vast and seemingly inexhaustible. Later, being raised in part in the Netherlands introduced a radically different relationship: water as an engineered system, controlled by precise and highly visible infrastructures. A personal fascination developed from a life experience between these two contexts regarding how societies materialize their relationship with water. My interest stems from understanding the Anthropocene as a turning point in which infrastructures not only support human life but also actively shape climatic cycles and intensify instability. This brings into question the contrast between naturally buffered and highly engineered systems, where timing, scale and critically responsibility. Specifically, how water is an active participant in both the built environment and the broader natural world. This thesis comes from that tension, with the premise that architectural forms can neither romanticize nature nor over-optimize control, but instead engage water as a commons.

SECTION 01 POSITIONING



"Water is indispensable 'stuff' for maintaining the metabolism, not only of our human bodies, but also of the wider social fabric" - Gandy M

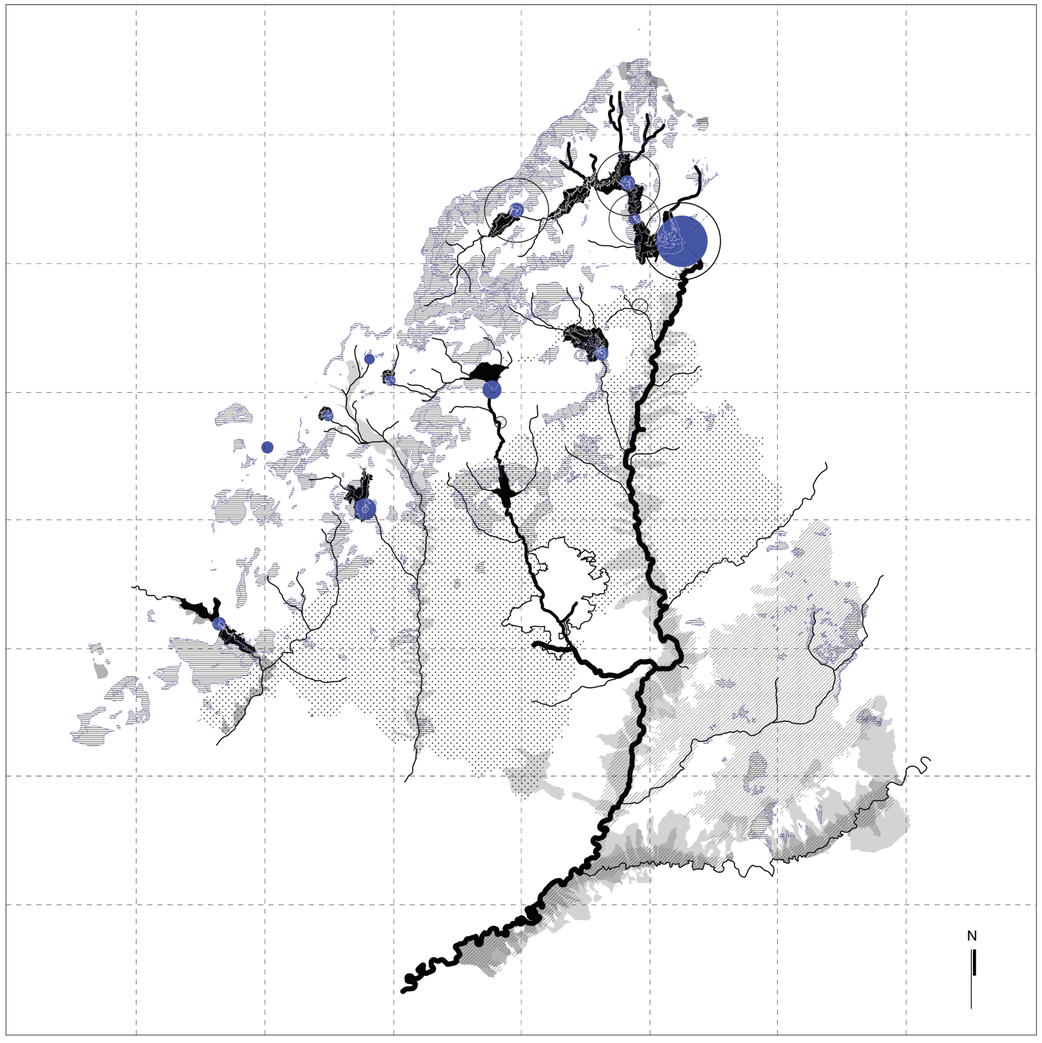
THE WATER MACHINE

Madrid is a hydrological artifact

Madrid can be seen as a dense metropolitan core, yet its survival depends on a water territory that extends from the city to the highest peak of the Iberian Central System. Reservoirs, dams, transfer canals, hydroelectric installations, aquifers, forests, and snow-dominated headwaters together constitute the water machine that predates the modern city and is simultaneously responsible for its existence. Mapping these distributed water infrastructure systems, both naturally occurring and artificially constructed. Madrid is rendered as a spatial artefact of flows, storage and delay rather than an isolated urban entity.

Natural regulation of water comes from snow accumulation in the mountains during the winter months. Warming temperatures in spring and summer release water gradually into rivers, reservoirs and forests, which further modulate this system by influencing evapotranspiration, infiltration, erosion, and sediment transport. Under climate change, however, these natural buffering mechanisms are weakening due to growing volatility. Measurable signals include declining snowpack, changing melt schedules, increased aridity, and more intense rainfall events. The rhythms on which Madrid's reservoirs and water supply networks rely are becoming disrupted. Jane Bennett's concept of vibrant matter informed this research and framing material systems, including water, stone and vegetation as active participants rather than passive objects.

Viewing Madrid's water system through this lens invites an architectural approach that engages with the natural world as an active system undergoing transition in which material interventions between climate, landscape, and city can be recalibrated.

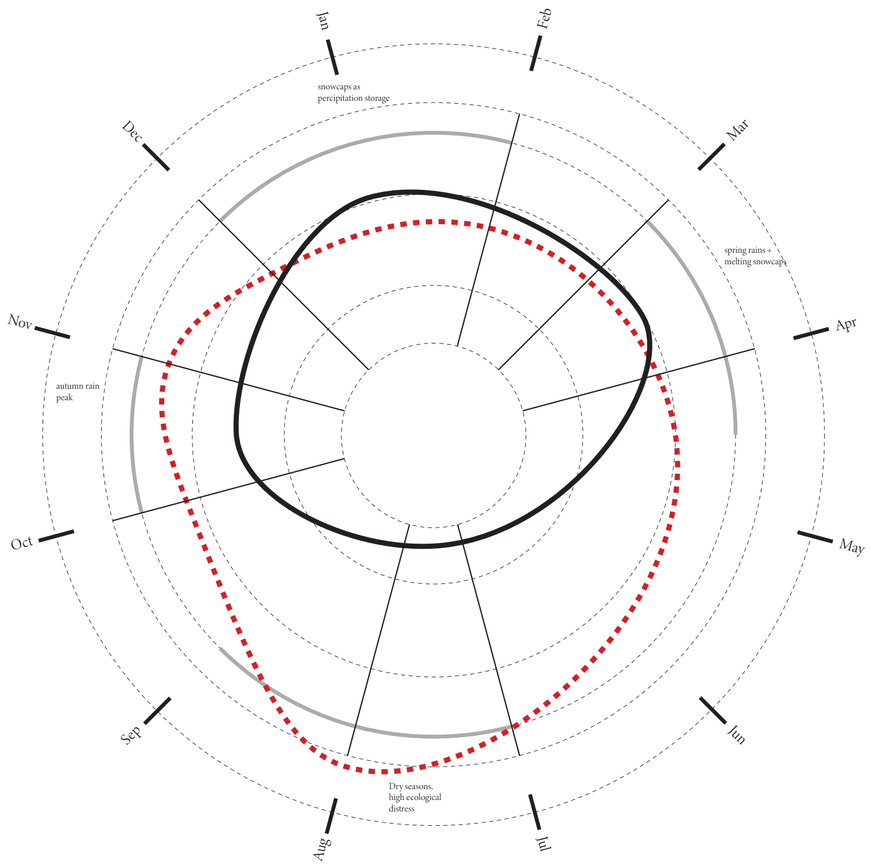


Madrid Comunidad
Scale 1:500000

- Pines, Oaks, Melojar forested areas
- Hydrolic energy Accumulation
- Resevoirs
- Cretaceous Carbonate Aquifer
- Tertiary Detrial Aquifer
- Hydrolic Energy Generation
- Basins
- Waterways
- 20 meter relief

CLIMATIC CYCLES

undulant scarcity and surplus



Distrubance and landscape stress

Hydrological system response

Madrid's seasonal cycles consist of four distinct conditions that operate along the axis of hydrological responsiveness and landscape stress. As opposed to operating as a smooth transition, mapping the cycle reveals a mismatch in response, creating downstream insecurity. melting snow, combined with rainfall in early spring, activates the water system and produces an outward distortion as water circulation, and the landscape distress contracts, as soils become saturated, disturbance is low, and warmer temperatures at this point lower ecological stress as vegetation is hydrated.

In summer, this relationship is reversed; the aridity of the climate produces prolonged droughts and evapotranspiration peaks, which, in turn, generate widespread ecological distress. In this condition, the diagram expresses a strong outward distortion of the landscape stress curve, in contrast with the drawdown of hydrological responsiveness; landscape disturbance is continuous, and scarcity becomes a lived experience. Returning rainfall in Autumn is when the hydrological processes become active. At the same time, in this case, water no longer acts as a stabiliser of the system but instead amplifies erosion and sediment transfer, along with operational strain.

In Madrid, winter can be understood as a grace period, during which natural repair processes reduce biological demand, lower temperatures, and allow restoration by slowing the system and allowing water accumulation in highland landscapes in preparation for the next cycle. This repair process is arguably the most vital for buffering the peaks of stressors in seasonal conditions that follow, and is highly affected by changes in temperature. Together, these patterns illustrate a systemic fragility in which stress arises not from absolute scarcity but from misalignment between the availability of water, the resilience of ecological systems, and the built environment's capacity to adapt to this volatility.

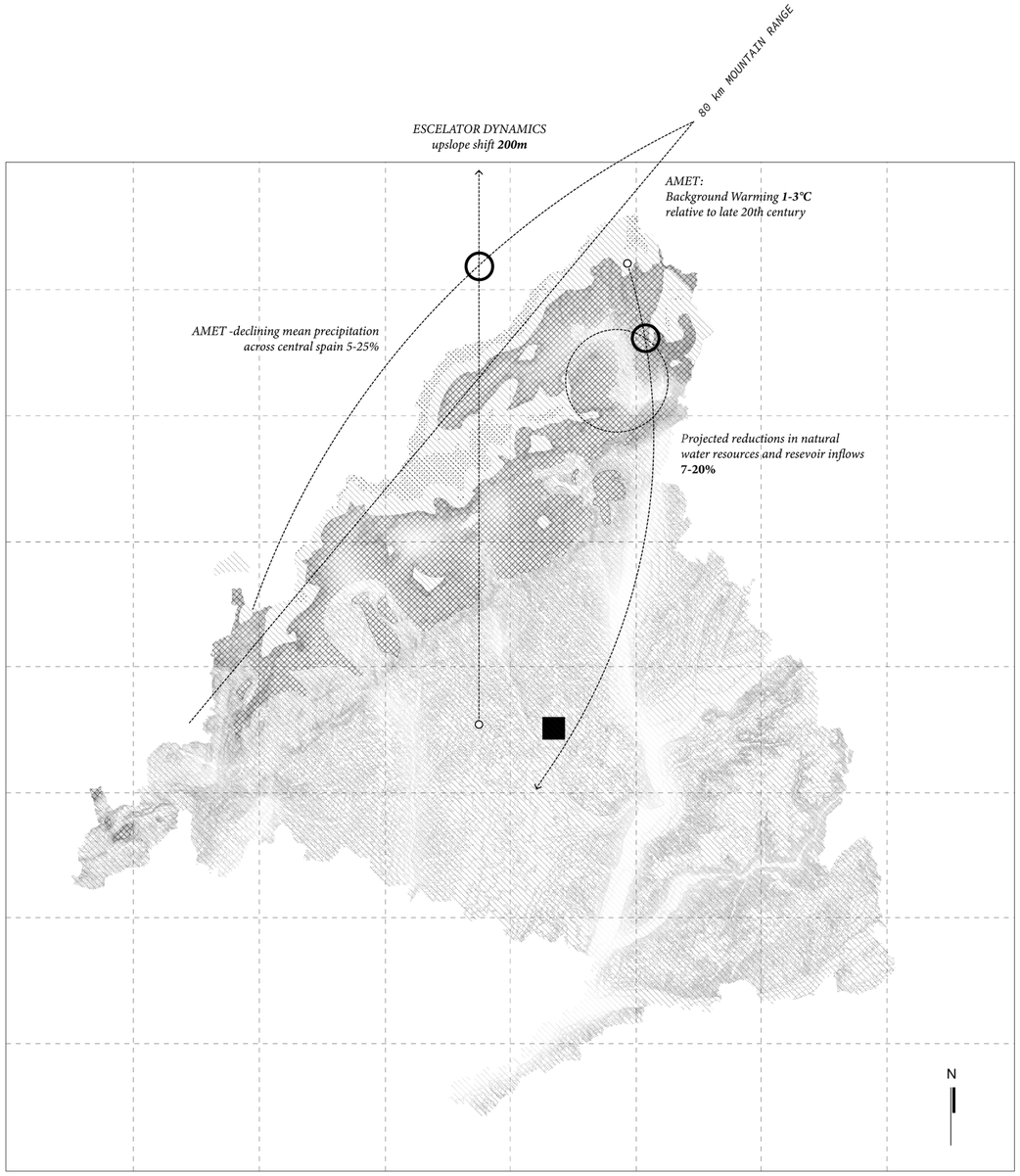
ALPINE STRESSOR DYNAMICS

humans the elements and the others

Mountain hydrology in the Sierra de Guadarrama is changing in ways that matter for Madrid's water system, particularly in relation to snow cover, runoff timing, vegetation structure, and alpine biodiversity. This change is not uniform year to year, and single extreme events such as a reservoir overflowing after decades cannot, on their own, be taken as proof of systemic failure. However, multiple observational studies and high-resolution models agree on the direction of change. Rising temperatures, even modest ones, reduce snow persistence most strongly at mid elevations, where snow cover is already close to its thermal limit.

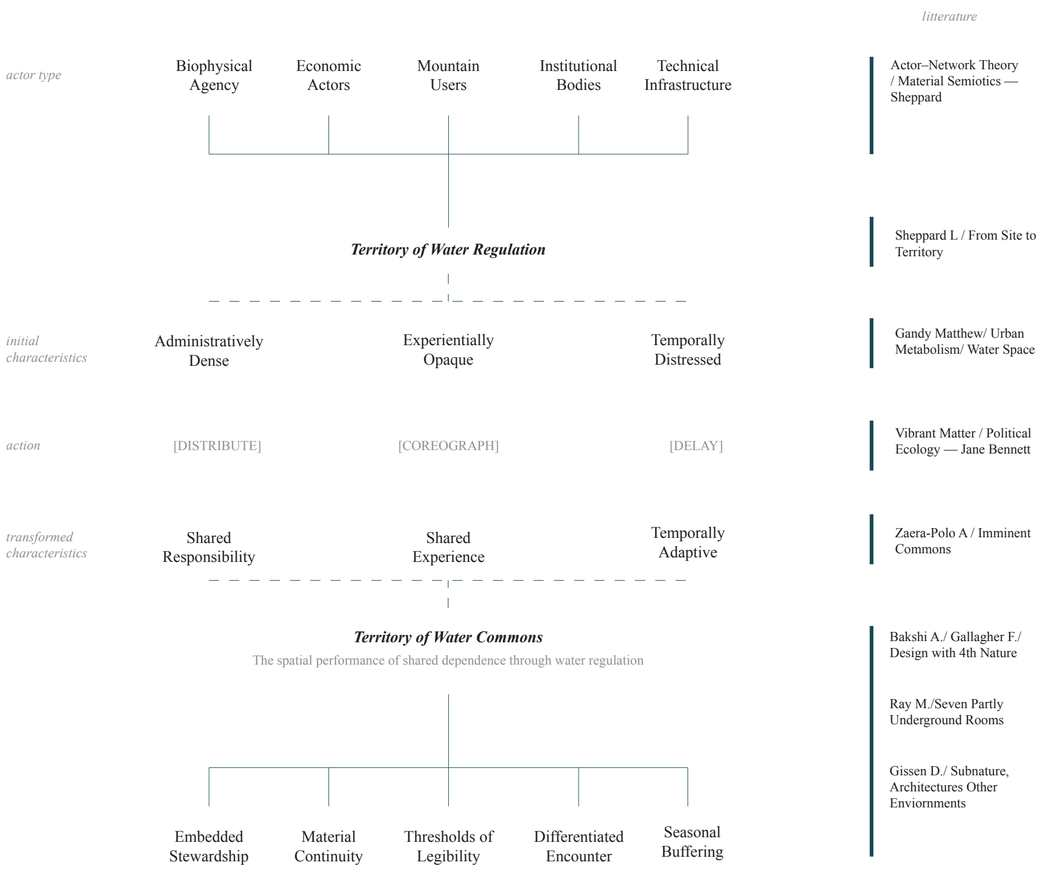
High mountain snow cover in the Peñalara Massif has shortened and become more variable. Observations between 2014 and 2020 show an average seasonal snow duration of approximately 80 days, with strong year-to-year variability (López Moreno et al., 2023). Modelling and regional analyses establish that this pattern is not isolated but a part of a broader decline in snow cover duration across Iberian Mountain ranges, particularly at mid elevations, where snow is most sensitive to temperature increases. Estimated reductions range "on average from -23% per °C at 1500 m to -13% per °C at 2500 m" (Alonso González et al., 2020; Cervera et al., 2023). The highest peak in the Iberian central system is Peñalara, significantly below the upper bound of the modeling analysis. Critically, as snowpacks thin and melt earlier, this buffering function weakens, leading to earlier runoff and longer dry periods later in the year. In addition, at higher elevations, repeated resurveys show upward shifts in plant species distributions and increasing dominance of warm-adapted generalist species (Jiménez Alfaro et al., 2014). While species variation at summits has sometimes increased, this reflects the loss of cold-adapted alpine specialists rather than ecological recovery. Similar upward shifts have been registered across multiple taxa, consistent with a regional escalator effect.

(Council of Europe, 2017). Cold-adapted alpine and subalpine communities face habitat contraction as suitable climatic conditions move upslope and diminish in area. Taken together, as it relates to mountain hydrology, the evidence points to a growing problem of timing rather than absolute scarcity. Water regulation and ecological buffering are becoming less reliable across seasons. Infrastructures designed around historical averages are increasingly out of sync with current conditions, not as a result of isolated outliers, but instead, because the baseline itself is shifting. This produces a condition of temporal fragility: reduced capacity to delay, store, and redistribute water, in addition to a reduction of continuous habitat for nonhuman species dependent on snow persistence and cool microclimates. However, we do not yet know the precise rate of future change, the interaction with extreme events, for example, prolonged drought or intense rainfall, or the limits of ecological reorganization. Current data identify trends and sensitivities but do not allow precise prediction of future system states. Despite extensive technical management, current responses remain largely centralized, effectively privatized, and optimized for historical conditions. This reveals a design gap at the intersection of research, infrastructure, and landscape. Facilitating the commoning of these processes through architecture can close the gap in this stressed and disconnected territory.



Madrid Comunidad
Scale 1:500000

snow risk high
Dam break flood risk
glacier potential zones
snow risk moderate
componding fragilities



litterature

Actor–Network Theory / Material Semiotics — Sheppard

Sheppard L / From Site to Territory

Gandy Matthew/ Urban Metabolism/ Water Space

Vibrant Matter / Political Ecology — Jane Bennett

Zaera-Polo A / Imminent Commons

Bakshi A./ Gallagher F./ Design with 4th Nature

Ray M./Seven Partly Underground Rooms

Gissen D./ Subnature, Architectures Other Enviornments

THEORETICAL FRAMEWORK

The Lens

Vibrant matter is the core theoretical point of departure for this research, informing how material, environmental forces, and architecture are understood as active rather than passive agents. Coupled with elemental interpretations of commoning, particularly those

concerned with imminent or practiced commons, this perspective frames the theoretical foundation of the project. Informed by these readings, here I introduce my own working conception of commoning. I understand commoning fundamentally as an act of sharing. Sharing is the root condition of the commons, and for architecture to meaningfully perform as a commons.

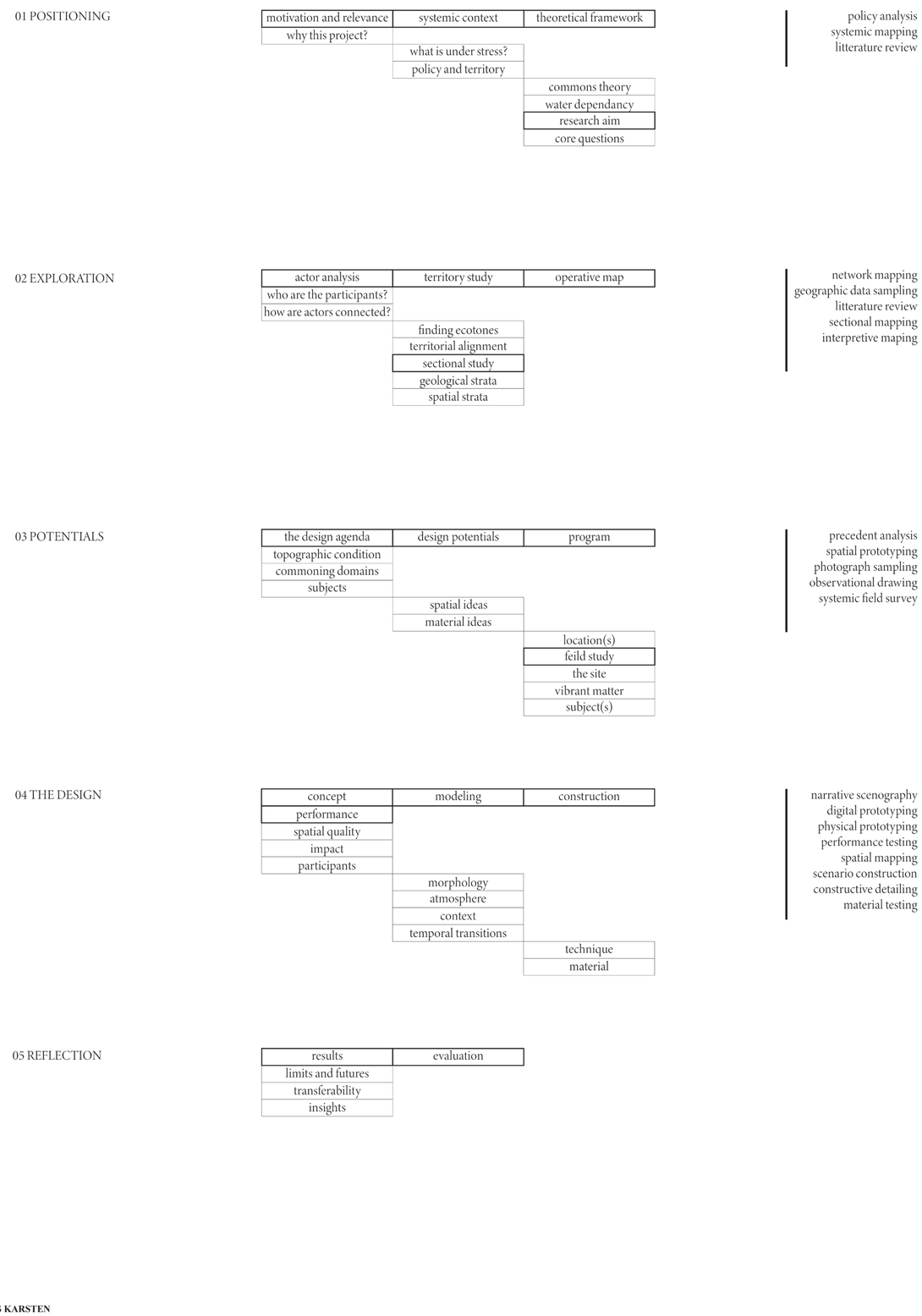
In this project, the performance rests on three pillars: sharing responsibility, sharing utility, and sharing experience. Together, these define commoning as a spatial and material condition produced through architectural performance. Within this framework, delay becomes the operative term. Delay describes an architectural approach in which the agency of matter, through mass, thickness, gravity, and time, actively shapes hydrological behavior. Through actions such as slowing, storing and staging water, architecture participates directly in processes of commoning. These actions generate specific commoning characteristics, which in turn inform the design agendas explored in the subsequent phases of the project.

METHODOLOGICAL FRAMEWORK

The project's development revolves around the field study. This is the epistemic driver, a moment when the research and ground truth are tested, and design potentials begin to emerge from experience of the territory, practices and cultures that can only be uncovered in person.

The framework is therefore organized into a pre- and post-visit phase. The pre-visit phase is grounded in interpretive mapping as a tool to engage the complexities of the problem field. Bringing together climate studies, geological studies, policy review, and commons theory, drawing on insights from mid-20th-century American cartographers, who often employ a trans-scalar mapping approach, to develop a systemic understanding of the territory.

The post-visit phase is a response to the interrogation of the relations and conflicts between the research and the ground experience emerging in a design phase from the ground up where potentials are examined, spatial ideas are proposed and evaluated via modeling, mapping and technical exploration in order to synthesize the findings into a coherent architectural proposal that evaluates the performance, systemic coherence and transferability on both the limits of the method and its capacity to generate actionable insight.



QUESTIONS

The Aim

The aim of this project is to **interrogate relationships with mountainous territories** by positioning architecture as an interface for repair, monitoring, and shared hydrological knowledge.

Critical statement

Architecture must perform as a commoner of hydrological dependencies by staging vibrant matter within stressed territories of water regulation.

Epistemic

i. In what ways can architecture **entangle observation** and operation so that data is produced simultaneously through bodily experience, material behavior, and remote sensing?
ii. How can **architecture act as an instrument** of knowing that produces shared stewardship, in which spatial form, material behavior, and inhabitation generate knowledge as a common resource?

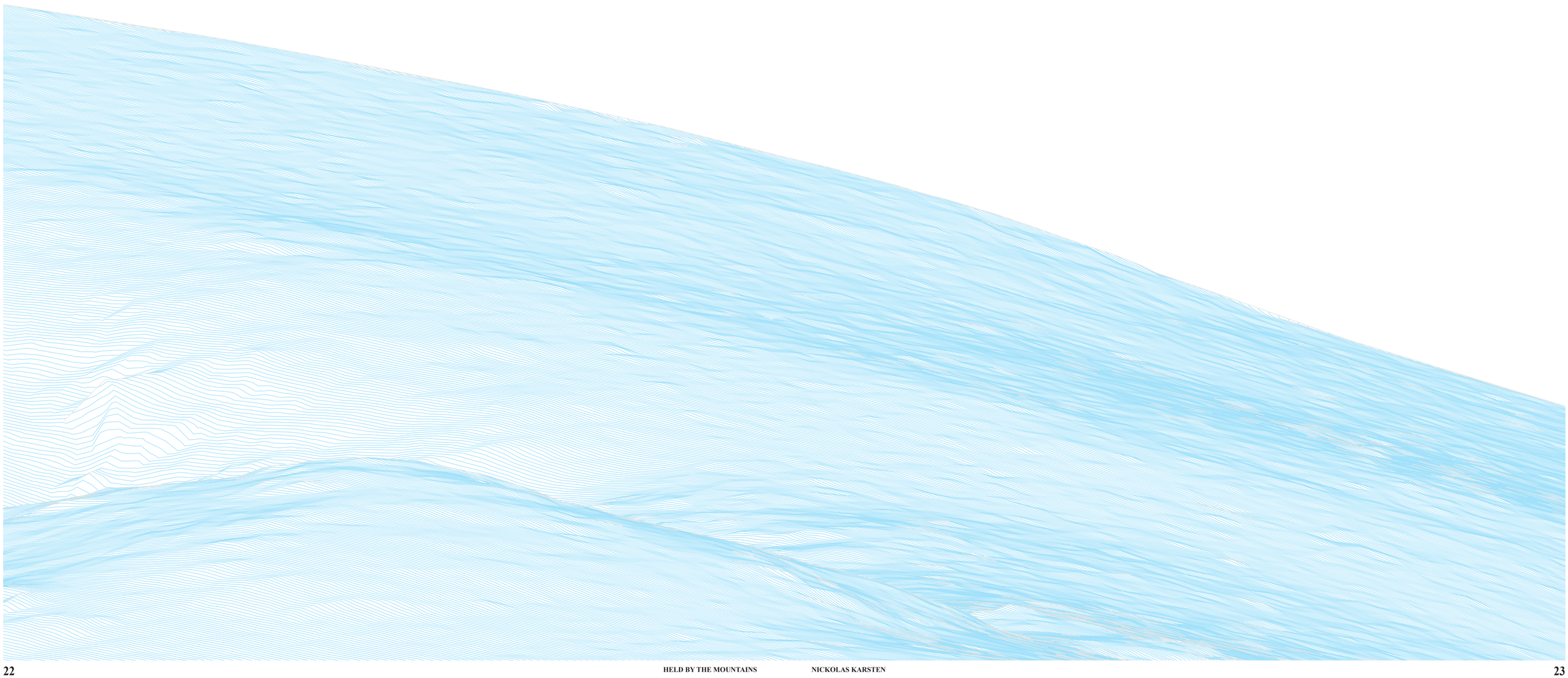
Commoning

iii. What role can architecture play in revealing **non-human co-inhabitants**, including groundwater, sediment, flora, and fauna, as active participants in territories of water regulation?
iv. How can architecture structure relationships between hikers, researchers, local communities, downstream users, and remote sensing systems through a **shared refuge**?
v. How can **construction in mountainous territories** be conceived as a practice of repair, in which material sourcing, logistics, and waste treatment actively participate in commoning?

Technical

vi. How can architecture act as a **reparative infrastructure** in mountainous territories, engaging hydrological gradients through form, section, and material continuity?
vii. How can **material systems** and **construction logics** be designed so that slow mountain hydrology can register spatially as trace, pattern, and record over time?

SECTION 02 EXPLORATION

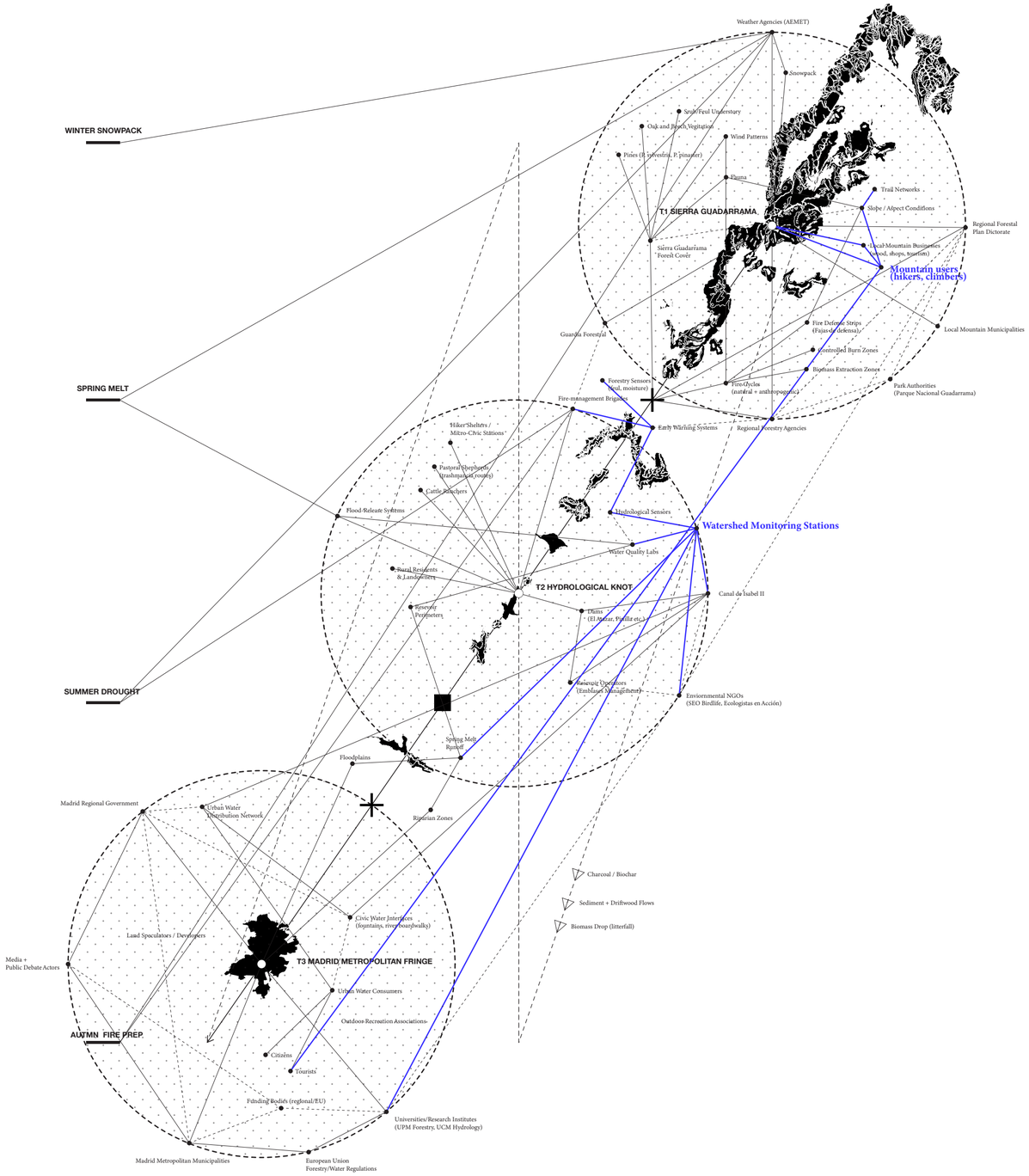


THE PARTICIPANTS

Excel exerpt, systemic research

Canal Isabel II	Bottom-left industrial logic		
Civic Water Interfaces (boardwalks, labs)	Civic/Public	Civic Infrastructure	T2>T3
Citizens; Research Groups	At reservoir edge cluster		
Madrid Regional Government	Governmental	Policy + Regulation	
Forest Plan; Canal Isabel II	Central governance square		
European Union Forestry/Water Regulations	Governmental	Policy Framework	
Forest Plan; Canal Isabel II	Peripheral governance reference		
Funding Bodies (regional/EU)	Governmental/Economic	Funding Entities	
Industry; Agencies	Soft nodes		
Media + Public Debate Actors	Human/Institutional	Public Discourse	T3
NGOs; Gov Agencies	Peripheral cluster in metro zone		
Land Speculators / Developers	Human/Economic	Urban Pressure	T3
Municipalities	Secondary nodes near metro fringe		
Spanish Ibex (Capra pyrenaica)	Non-human Fauna	Sierra Guadarrama / Reservoir	T2
Inhabits high-elevation rocky zones, influences vegetation patterns and trail ecologies			
European Roe Deer (Capreolus capreolus)	Non-human Fauna	Sierra Guadarrama / Reservoir	T2
Grazes forest understory, shaping regrowth and fire fuel structure			
Iberian Wolf (Canis lupus signatus)	Non-human Fauna	Sierra Guadarrama / Reservoir	T2
Top predator influencing grazing behaviors and livestock distribution			
Wild Boar (Sus scrofa)	Non-human Fauna	Sierra Guadarrama / Reservoir	T2
Modifies soil structure, aids seed dispersal, contributes to erosion patterns			
Black Vulture (Aegypius monachus)	Non-human Fauna	Sierra Guadarrama / Reservoir	T2
Indicator of ecological health; large protected habitat near Sierra			
Pinus sylvestris (Scots Pine)	Non-human Flora	Sierra Guadarrama / Reservoir	T2
Dominant managed conifer species; heavily influences biomass cycles and fire behavior			
Quercus pyrenaica (Melojo Oak)	Non-human Flora	Sierra Guadarrama / Reservoir	T2
Resilient deciduous species, crucial for biodiversity and post-fire regeneration			
Retama sphaerocarpa (Yellow Broom)	Non-human Flora	Sierra Guadarrama / Reservoir	T2
Fire-adapted shrub; colonizes clearing zones and influences fire spread			
Pastoral Shepherds (trashumancia routes)	Human	Sierra Guadarrama	T2
Livestock migration influencing fire-risk patterns and vegetation management			
Goatherds	Human	Sierra Guadarrama	T2
Shape shrub density; goats used strategically as fire-fuel reducers			
Olive Farmers	Human	Middle Foothills	T2
Depend on watershed regulation and slope stability; affected by erosion dynamics			
Small-Scale Orchard Growers	Human	Middle Foothills	T2
Use traditional irrigation linked to mountain runoff and seasonal flow variability			
Local Cheese Producers (Sheep & Goat)	Human	Sierra Guadarrama	T2
Economy dependent on grazing landscapes and climate-stabilized pastures			
Cattle Ranchers	Human	Foothill / Reservoir Edge	T2
Dependent on reservoir-adjacent grazing; impacted by drought and water-quality shifts			
Snowmelt Pulse (Spring)	Diagonal Flow (Transect)	Seasonal Hydrological Flow	MF
Controls reservoir fill rates, sediment release, and turbidity dynamics			
Autumn Biomass Drop (Litterfall)	Diagonal Flow (Transect)	Ecological Material Flow	MF
Seasonal leaf/needle accumulation influencing fire cycles and soil moisture			
Windthrow Timber (Storm events)	Diagonal Flow (Transect)	Material Flow	MF
Fallen trees feeding biomass cycles, salvage logging, and debris fields			
Low-Grade Biomass (Thinning Waste)	Diagonal Flow (Transect)		
Industrial Material Flow	MF	Used in flood-buffering devices, mulch, woodchips, and soil stabilization	
Charcoal / Biochar (from controlled burns)	Diagonal Flow (Transect)		
Material Flow	MF	Material that can be fed into soil restoration or water-filtration prototypes	
High-Turbidity Plumes (after rainfall peaks)	Diagonal Flow (Transect)		
Hydrological Flow	MF	Travel downslope >reservoir >spillways, influencing flood-management operations	
Pollen Clouds (Spring)	Diagonal Flow (Transect)	Ecological Flow	
MF	Seasonal biological flow marking phenology; lightly symbolic of ecosystem metabolism		
Cold-Air Drainage (Night katabatic flows)	Diagonal Flow (Transect)		
Atmospheric Flow	MF	Controls moisture dynamics and dryness of slopes; affects fire risk	
Remat Madrid (wood reuse program)	Central Square	Institutional	T3
Coordinates reuse of urban timber and integrates circular-economy streams with forest-derived material			
MITECO – Climate Adaptation Unit	Central Square	Governmental	T3
Shapes national adaptation strategy impacting forest-fire regimes and reservoir operations			
Hydrological Modeling Labs (UPM, CSIC)	Central Square	Institutional	T3
Produce predictive models that govern emergency discharges, drought protocols, and reservoir thresholds			
Forest Harvesting Cooperatives	Central Square	Human/Industrial	T3
Local cooperatives operating machinery, seasonal labor, and biomass removal under new extraction quotas			
Water-Quality Regulator (Confederación Hidrográfica del Tajo)	Central Square		
Governmental	T3	Sets ecological flows, spillway rules, and contamination thresholds across reservoirs	
Wood Industry Lobby Associations	Central Square	Industrial	T3
Madrid Metropolitan Green Infrastructure Agency	Central Square		
Governmental	T3	Links hydrological infrastructure with public space creation, river restoration, and landscape corridors	
Canal de Isabel II Crisis Response Unit	Central Square	Institutional	
T3	Manages floods, turbidity events, drought restrictions, and emergency distribution measures		
European Union Rural Development Fund (FEADER)	Central Square		
Governmental/Funding	T3	Finances forest stewardship programs, biomass logistics, and climate-resilient rural economies	
Regional Timber Certification Bodies (PEFC España, FSC Iberia)	Central Square		
Institutional	T3	Certify sustainable extraction, chain-of-custody, and forest-management compliance	
Hikers & Trail Users (PR/GR routes)	Human	Sierra Guadarrama	
T2	Generate seasonal pressure on landscapes; key public constituency for civic interpretation		
Tourists (winter + summer)	Human	Sierra Guadarrama	T2
Influence local economies; seasonal surges shape waste, water, and transport load			
Cyclists / Mountain Bikers	Human	Sierra Guadarrama	T2
Use fire roads and forestry tracks; influence trail management protocols			
Recreational Fishermen	Human	Reservoir Edges	T2
Dependent on water-quality levels and seasonal flow management			
Canoeists / Swimmers	Human	Reservoir Edges	T2
Public-facing			

Actor Name	Category	Sub-Type	Spatial Position	Connected To
Diagram Placement Notes				
Sierra Guadarrama Forest Cover	Non-human	Ecological System		
T1 – Mountain Zone	Forest Agencies; Fire Cycles; Snowpack; Wildlife			
large background layer near top-right				
Pine Stands (P. sylvestris, P. pinaster)	Non-human	Vegetation	T1 – Mountains	
Forestry Management; Timber Industry	Clustered as core biomass resource nodes			
Oak and Beech Stands	Non-human	Vegetation	T1 – Mountains	
Forest Ecology; Biodiversity Groups	Secondary vegetation nodes around pine cluster			
Shrub/Fuel Understory	Non-human	Vegetation/Fuel Load	T1	
Fire Regimes; Biomass Extraction	Shown as risk-intensity node			
Snowpack	Non-human	Climatic Hydrological Input	T1 – Mountain Peaks	
Spring Melt; Reservoir Inflows	Place high on y-axis (winter)			
Spring Melt Runoff	Non-human	Hydrological Process	T1>T2	
Snowpack; Reservoirs	Middle of y-axis (spring)			
Fire Cycles (natural + anthropogenic)	Non-human	Ecological Process	T1	
Understory; Drought; Gov Agencies				
Biodiversity (fauna)	Non-human	Wildlife System	T1	
Rural Communities; Park Authorities	Place as diffuse node cluster			
Wind Patterns	Non-human	Climate Driver	T1	
Slope, Fire Spread	Directional arrows			
Slope / Aspect Conditions	Non-human	Geomorphology	T1	
Fire Behavior; Water Movement	Subtle background layer			
Madrid Forestal Plan Directorate	Governmental	Regional Agency	T1	
Forestry Agencies; Timber Industry; Municipalities	Inside governance square near top-right			
Regional Forestry Agencies	Human/Institutional	Management Body	T1	
Forest Plan; Fire Brigades	Central in mountain regime cluster			
Guardia Forestal (Forest Rangers)	Human	Monitoring/Stewardship	T1	
Fire Brigades; NGOs	small nodes at edges of T1			
Fire-Management Brigades (BRIF)	Human/Institutional	Emergency Unit		
T1 -T2	Forest Plan; Local Municipalities	Connected to fire cycle nodes		
Local Mountain Municipalities (Rascafría, Lozoya, etc.)	Human	Communities		
T1	Forest Plan; Rural Communities; Reservoir Zones	Nodes along transect near mountain edges		
Rural Residents & Landowners	Human	Local Community	T1	
Timber Coops; Forestry Authorities	Clustered around municipalities			
Recreational User Groups (Hikers, Climbers)	Human	Civic Users	T1>T2	
Park Authorities; Micro-shelters	Small dispersed nodes across transect			
Environmental NGOs (SEO Birdlife, Ecologistas en Acción)	Human/Institutional			
Ecology Advocacy	T1>T2	Forest Plan; Reservoir Management	Placed inside governance square but slightly offset	
Timber Cooperatives (Cooperativas Madereras)	Industrial	Primary Wood Management	T1>T3	
Forestry Agencies; Timber Firms	Located between T1 and T2			
Timber Transport Companies	Industrial	Logistics	T1>T3	
Timber Cooperatives; Processing Plants	Place along transect line			
Private Forestry Owners	Human/Industrial	Land Managers	T1	
Cooperatives; Gov Agencies	Small nodes around mountain municipalities			
Madrid Regional Timber Industry Union	Industrial/Institutional	Industry Body		
T3	Timber Plants; Policy Actors	Inside governance square bottom-left		
Sawmills (regional)	Industrial	Primary Processing	T3	
Timber Supply; Industrial Rationality	Place inside industrial spine			
Engineered Timber Plants (CLT/Glulam)	Industrial	Manufacturing	T3	
Material Yards; Timber Flow Nodes	Medium major node			
Biomass Processing Plants	Industrial	Biofuel Facility	T3	
Biomass Waste; Fire-Regime Forestry	Adjacent to industrial spine			
Material Yards (wood, chips, offcuts)	Industrial	Storage/Sorting	T3	
Hydrological Devices; Processing Plants	Placed at bottom-left cluster			
Log Grading Stations	Industrial	Quality Control	T3	Forestry Agencies; Timber Plants
In industrial spine				
Kiln Drying Facilities	Industrial	Processing	T3	Timber Plants
In industrial spine				
Canal de Isabel II	Governmental/Institutional	Water Authority		
T2>T3	Reservoirs; Urban Distribution; Policy	Inside governance square, central		
Reservoir Operators (Embalses Management Teams)	Institutional			
Operational Authority	T2	Canal Isabel II; Flood Controls	Key node at center transect	
Dams (El Atazar, Pinilla, etc.)	Institutional/Non-human	Hydro Infrastructure	T2	
Reservoir Operators; Flood Cycles	Physical anchors along transect			
Watershed Monitoring Stations	Institutional	Technical Monitoring	T2	
Sensors; Water Quality Labs	Part of industrial rationality line			
Water Quality Labs	Human/Institutional	Scientific Monitoring	T2>T3	
Reservoir Ops; Research Institutes	Near S-line crossing T2			
Flood-Release Systems (spillways)	Infrastructure	Hydro-Regulation	T2	
Reservoir Operators; Flood Cycles	Moisture parabola			
Sediment + Driftwood Flows	Non-human	Material Process		
T1>T2>T3	Dams; Timber Yards	Material flow lines		
Hydrological Sensors	Institutional/Technical	Monitoring Tech	T1>T3	
Data Systems; Weather Agencies	Small nodes along S-line			
Forestry Sensors (fuel moisture)	Technical	Monitoring Tech	T1	
Fire Regimes; Rangers	At mountain edge of industrial spine			
Early Warning Systems	Technical	Control Infrastructure	T2>T3	Reservoir Ops; Fire Brigades
Connected by dotted lines				
Weather Agencies (AEMET)	Governmental	Climate/Weather Authority		
Fire Cycles; Snowpack	Inside governance square			
Scientific Research Institutes (UPM Forestry, UCM Hydrology)	Institutional/Academic	Knowledge Production	T1>T2>T3	Material Studies; Data Frameworks
Inside governance square center				
Universities + Research Groups	Human/Institutional	Academic Networks		
T1>T3	Governance; NGOs	Central soft nodes		
Local Mountain Businesses (wood shops, tourism)	Human	Economy	T1	
Local Residents	Peripheral small nodes			
Urban Water Consumers	Human	Citizens	T3	Canal Isabel II; Civic Interfaces
Bottom-left diffuse cluster				
Outdoor Recreation Associations	Human	Civic Groups	T1>T2	
Park Authorities; Trail Networks	Small nodes near shelters			
Hiker Shelters / Micro-Civic Stations	Institutional/Civic	Civic Interface		
T1>T2	Trails; Recreational Users	Along S-line		
Park Authorities (Parque Nacional Guadarrama)	Governmental	Protected Area Management	T1	
Forest Plan; NGOs	Inside governance square upper-right			
Madrid Metropolitan Municipalities	Governmental	Urban Governments	T3	
Canal Isabel II; Timber Industry	Along fringe			
Trail Networks (local + long-distance)	Infrastructure	Civic Landscape	T1>T2>T3	
Hiker Groups; Micro-shelters	As thin lines crossing S-line			
Fire Defense Strips (Fajas de defensa)	Institutional/Infrastructure			
Fire Management	T1	Forest Plan; Brigades	Adjacent to forest cluster	
Controlled Burn Zones	Institutional	Eco-management	T1>T2	



SYSTEMIC MAPPING

Actor-network transect map

Madrid's forest-water system is not a linear supply chain, but a dense web of interdependencies. A fragility stems from a misalignment in both responsibilities and temporalities.

In the upper Guadarrama landscape, non-human actors such as expanding pine and oak forests, accumulated undergrowth, drought-stressed vegetation and wildlife corridors interact with shepherds, hikers, rural residents and depopulating mountain municipalities.

Responsibilities are fragmented between numerous institutional actors such as the Regional Forestry Agency, Guadarrama National Park Authority, Guardia Forestal, municipal councils, and a growing number of environmental NGOs connected with one another and acting on critical zones along the mountain-metropolitan transect. Their mandates often overlap but rarely synchronize. Park authorities prioritize biodiversity protection, forestry agencies focus on biomass extraction and fire prevention, municipal authorities prioritize local economic survival, and research institutes model long-term risk without direct governance power.

These institutional tensions become most visible through the watershed: forest structure upstream directly modulates the hydrological behavior of the reservoirs that supply the region. Dense, even-aged pine stands and unmanaged undergrowth accelerate evapotranspiration in summer, reducing runoff during droughts, while winter snowpack melts and intense rain events produce volatile flows of sediment, and debris toward the basin infrastructure.

Canal de Isabel II, operating the reservoirs and conveyance network, manages water as a predictable asset, but its daily operational logic depends on ecological processes it does not control. conflicts emerge across scales, between conservation agencies and forestry contractors, between recreational users and fire-prevention practices, between rural depopulation and the labor needed to manage alpine forests, between climate-driven hydrological volatility and rigid infrastructural control systems, not to mention often under-acknowledged impacts to flora and fauna. Winter snowpack drives spring runoff that tests reservoir regulation mechanisms; spring melt carries sediment and driftwood from unmanaged forest floors; summer drought intensifies fire risk and deepens institutional disagreements about thinning and extraction; and autumn fire-prep seasons compress the labor and technical interventions required to stabilize the system.

THE GOVERNANCE TERRITORY

mountain policy and political landscape

Overflow and flash-flood events in the Sierra de Guadarrama are governed primarily by the Plan Estatal de Protección Civil ante el Riesgo de Inundaciones, approved by the Spanish Ministry of the Interior and integrated into the wider Plan Estatal General de Emergencias de Protección Civil (PLEGEM) since 2021.

Risk management of the Iberian Central system is central in this discourse. Flood risk and regimes and civil protection plans explicitly mention the requirement of central planning to mitigate hazards such as snowmelt, dam operations and post-fire runoff, thereby setting top-down control positioned as civil protection logic (Ministerio del Interior, 2021).

When such an event occurs, there are emergency phases that culminate in interior authorities publicly declaring "interés nacional", which centralizes decision-making and turns hydrological volatility into highly visible demonstrations of state capacity. The protection of lives and property is the emphasis when it comes to communications to the public from the administrative body. Crisis coordination involves Unidad Militar Emergencias (UME), Agencia Estatal de Meteorología (AEMET), and river-basin authorities, which trigger motorway closures, restricting access and emergency reservoir releases.

At the same time, Madrid forestal increases the tightening of the wildfire policy. It is a 160-million-euro program for 2026–2030 that commits to managing 6,000 hectares of natural environments and 100 kilometres of access tracks by creating "áreas de ruptura de combustible" and reinforcing firebreaks with heavy machinery. Additionally, preventive grazing has been incorporated into the annual wildfire plan, with more than 21,000 head of cattle, sheep, goats and horses deployed over roughly 3,300–4,000 hectares, especially in Guadarrama and Somosierra, with the logic being to reduce fuel loads along firebreaks and high-risk slopes (Comunidad de Madrid, 2025).

Fuel-break corridors, grazed strips and intensified timber-extraction areas affect local livelihoods, access regimes and landscape values through centrally planned interventions that prioritize metropolitan safety and forest productivity over the autonomy of mountain communities to make their own decisions. Canal de Isabel II sits at the centre of this situation as the regional public company that manages 13 reservoirs and extensive supply, drainage, and stormwater networks that tie mountain headwaters to Madrid's urban system (Canal de Isabel II, n.d.). Canal de Isabel has been a counterpoint of debates regarding privatization and statutory reforms. Civil platforms denounce the expanding commercial scope of the company (Europa Press, 2022). Today, Canal de Isabel II is positioned as a strategic climate-adaptation actor; a recent € 430 -million loan from the European Investment Bank is intended to modernize and expand the water infrastructure. It is also intended to cut losses and digitalize network management (European Investment Bank, 2025).

Conclusion

Uncertain futures of snow, fire, and runoff are managed through layered plans, emergency doctrines, and capital-intensive investments that stabilize metropolitan water supply. This centralized power relationship between CYII and the regional government exports much of the water volatility, uncertainty and disturbance onto mountain landscapes and communities.



Source: Bernaldo de Quirós, A. B., 1959. Junto al abrevadero. Archivo fotográfico "Ángel Benito".



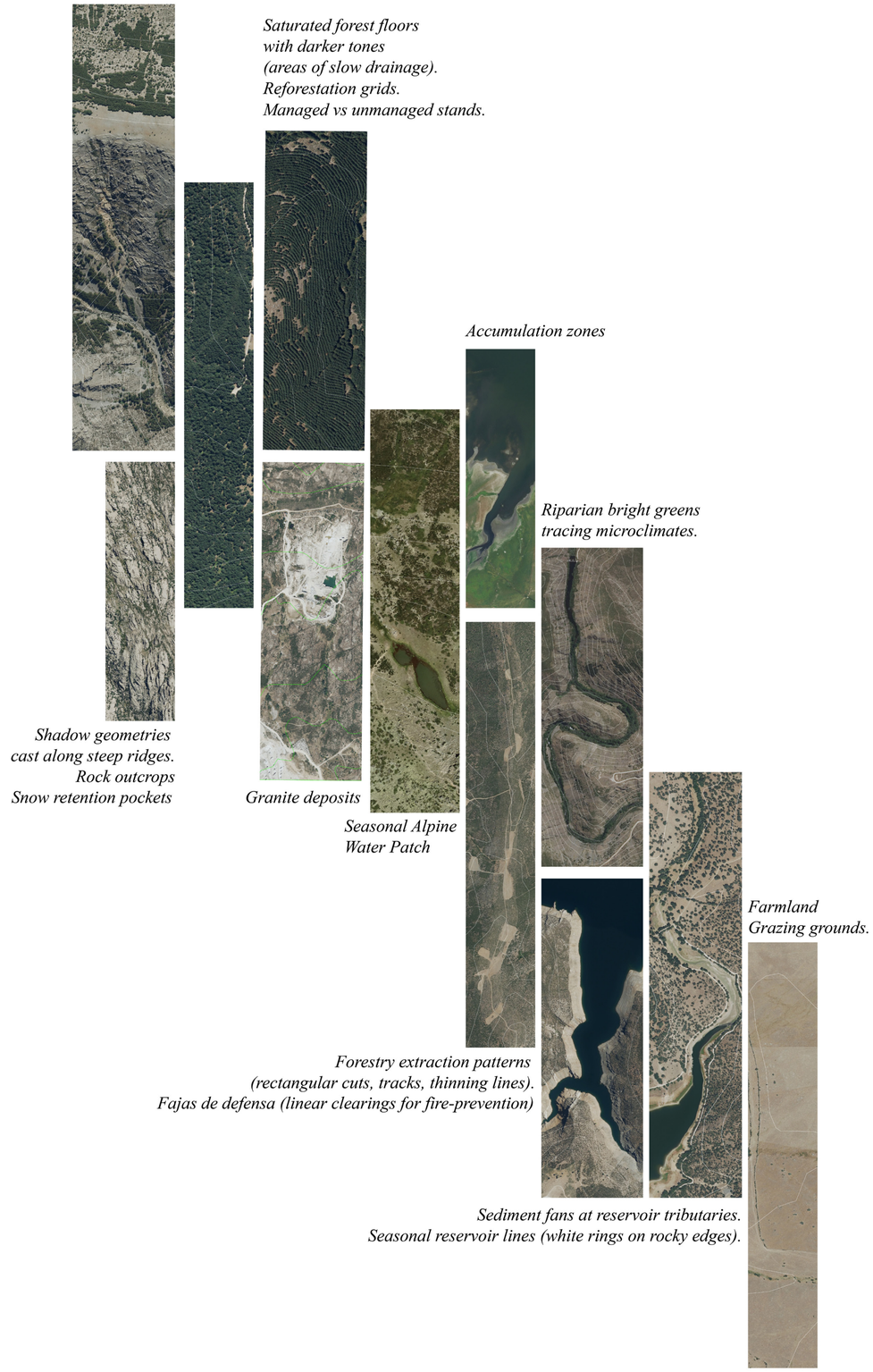
Source: google maps image; Retén de incendios forestales 2024

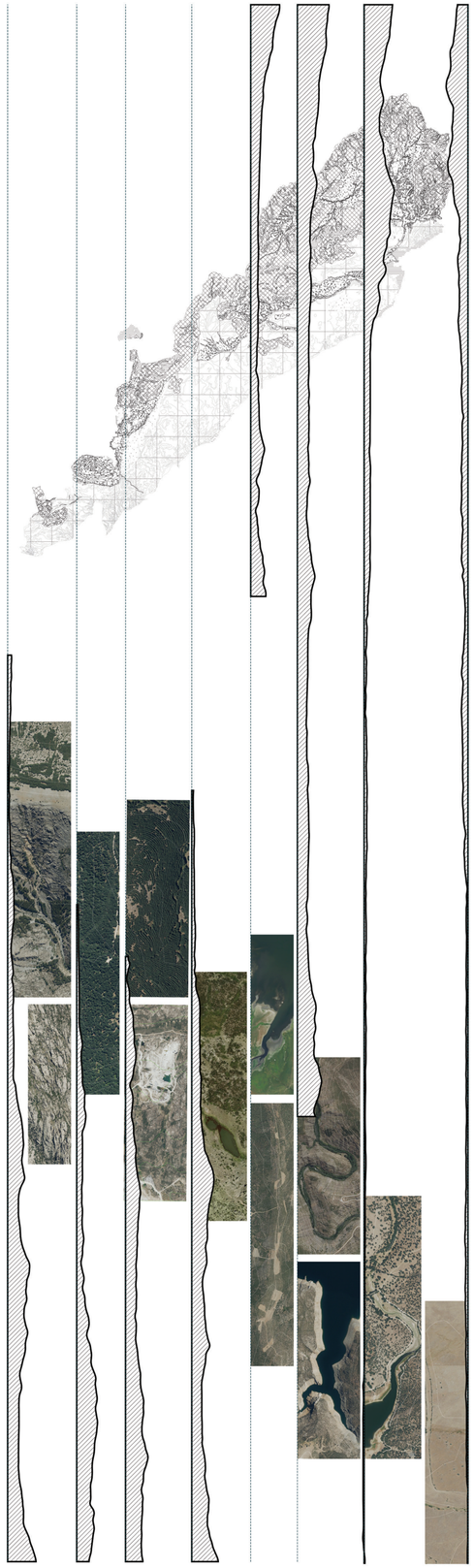
ECOTONES

folding landscapes

The folding of landscapes reveals hydrological dynamics that suggest specific modes of architectural alignment: Snow retention peaks, seasonal alpine water patches, and shaded rock outcrops together frame water as a time-based load. Here, accumulation and delayed release are already spatialized by topography and material mass. Potentials of architectural forms that operate through thickness, sectional depth, and gravity rather than enclosure emerge. These sites point toward seasonal buffering as fundamental to architectural performance. Saturated forest floors and river corridors introduce material continuity between soil, vegetation, and slow-moving water. The darkened traces reveal zones where hydrological delay already works in tandem with ecological productivity. When folded against potential areas of forest extraction and fire-prevention clearings, a tension becomes visible: fast, legible management logics disrupt slow hydrological processes. This misalignment suggests an architectural role in embedding responsibility within material systems, where construction logic and sourcing extend from excavation, stone deposits, and timber regimes already present on site.

Reservoir edges and sediment fans at tributary inlets expose water as a spatial occupant whose presence changes over time scales. Architecture here could perform commoning through harnessing these material flows as a shared utility and protection. Alpine grazing grounds and the tension between unmanaged and managed forests bring differentiated encounter into question, the role of diverse species and where they accumulate in relation to the slow water processes, where alignment potentials exist between inhabiting processes and elemental processes.



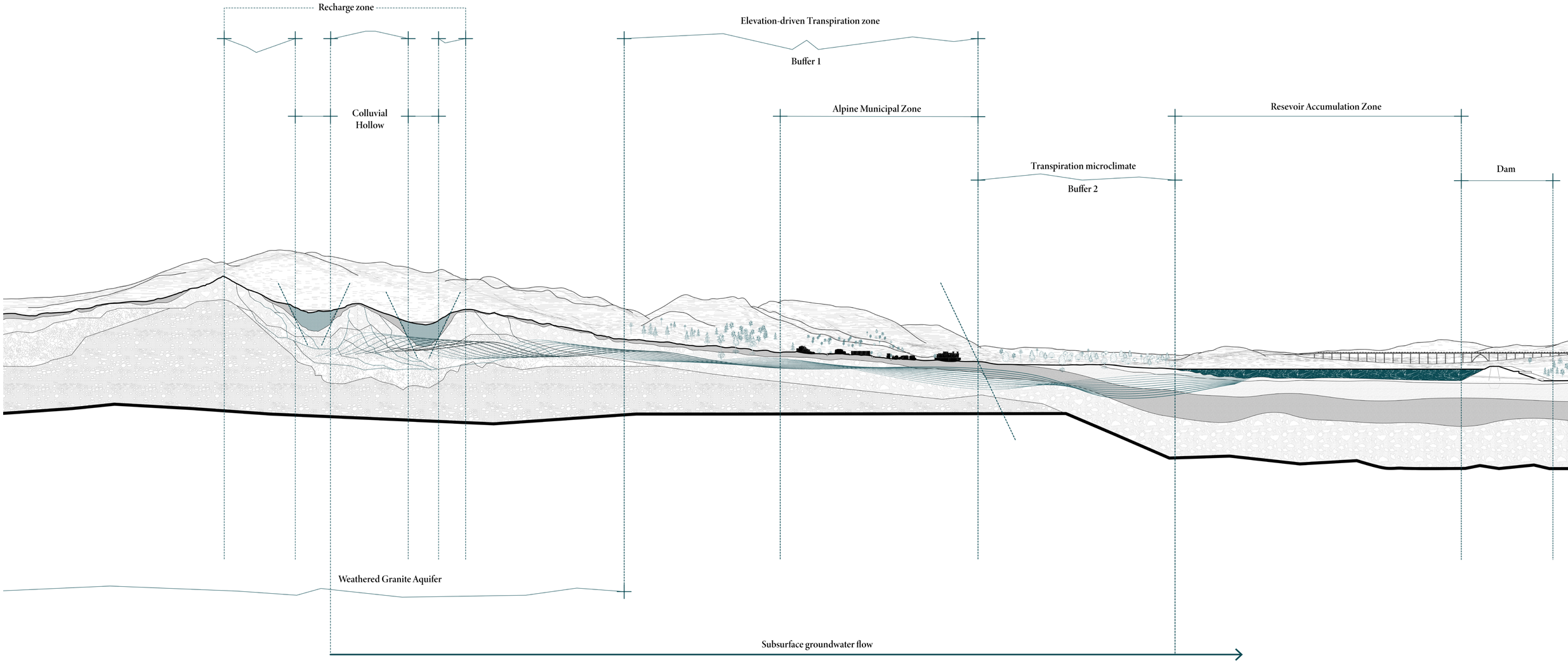


ALIGNING TERRITORIES

What the landscape desires

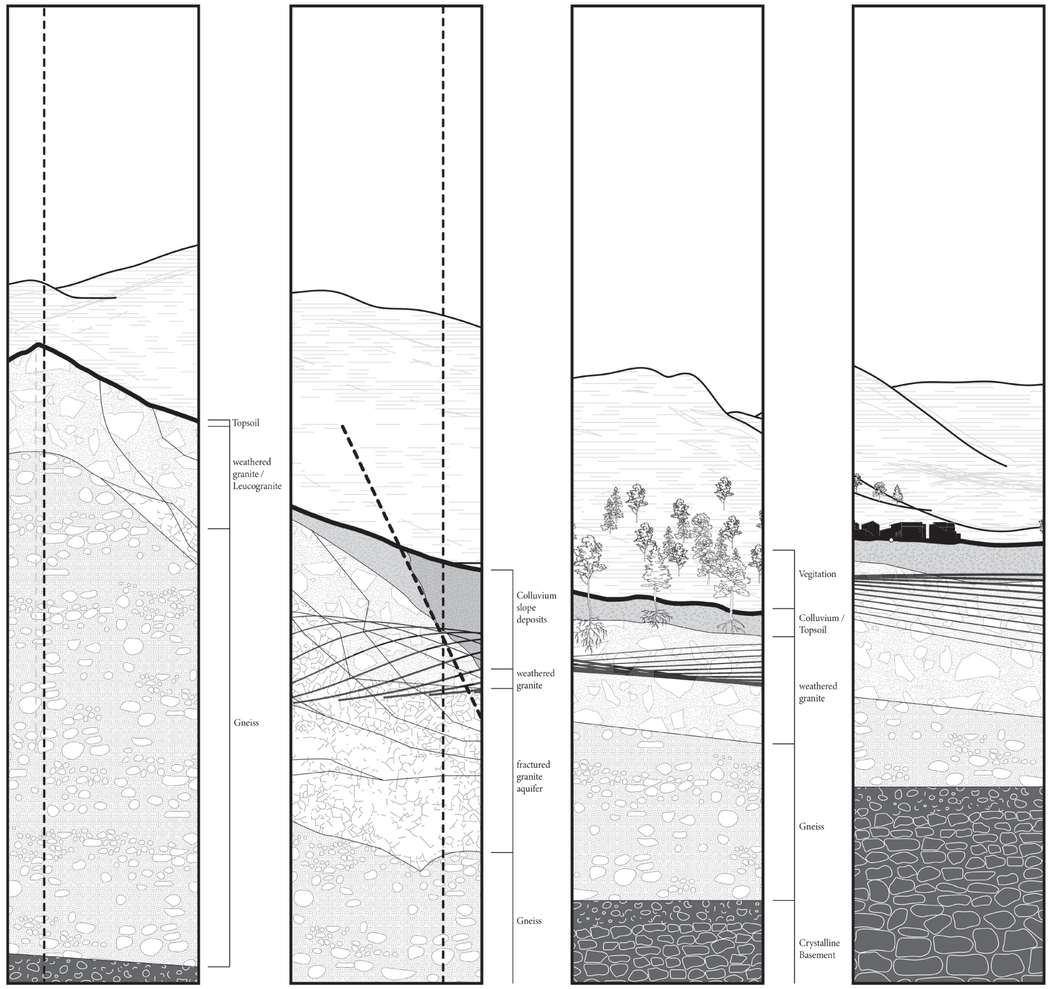
Aligning eight sectional cuts reveals a gradient of hydrological processes that intensify at specific territorial thresholds. Water behaves as a gravitational body that facilitates delay, accumulation and absorption. Appearing unevenly through the topography, forest structure, and sediment movement.

Rather than dispersing across the territory, responsibility concentrates at a limited number of critical sections. Across these critical sections, potentials for architectural forms emerge that extend geological logic rather than oppose it. A landmark, in this context, operates as a device of commoning, a place where hydrological behavior is made accessible, interpretable, and shared. Such forms could align recreational paths, research access, and infrastructural stewardship around slow water processes. This mapping brings into question surface legibility and subterranean activity. Pointing toward the necessity of a deeper sectional inquiry. While rock outcrops, sediment fans, and reservoir rings register seasonal change, the deeper processes of infiltration, storage, and delayed release remain concealed. This observation motivates the development of critical mega-sections as the next phase of research which render these processes in higher resolution. integrating underground hydrological flows, soil saturation, forest root systems, and sediment pathways with surface occupation and access.


Recharge zone
Colluvial Hollow
Elevation-driven Transpiration zone
Buffer 1
Alpine Municipal Zone
Transpiration microclimate
Buffer 2
Resevoir Accumulation Zone
Dam
Weathered Granite Aquifer
Subsurface groundwater flow

UPLAND PANELS

In the upland section, water is given shape by the granitic structure of Sierra Guadarrama. Precipitation enters the landscape through a thin, discontinuous soil cover and a mantle of fractures in the granite. Ground infiltration is rapid, yet storage is uneven. Water often accumulates within colluvial hollows between peaks, small pauses in the topography where loose slope material such as slate, gravel and granite stones thickens and delays downslope movement. From these pockets, infiltration feeds into a shallow fractured crystalline aquifers, formed within the weathered granite. These aquifers are typically both shallow and discontinuous, operating as a perched system, water is stored locally in fractures, gradually transferring it downslope through groundwater flow. Forested zones play an essential role in this process, intercepting rainfall, mediating evapotranspiration, and extending the time of water in the ground. Together, these elements construct a delicate and distributed system with conditions that slow and accelerate water.



Padriza Peak

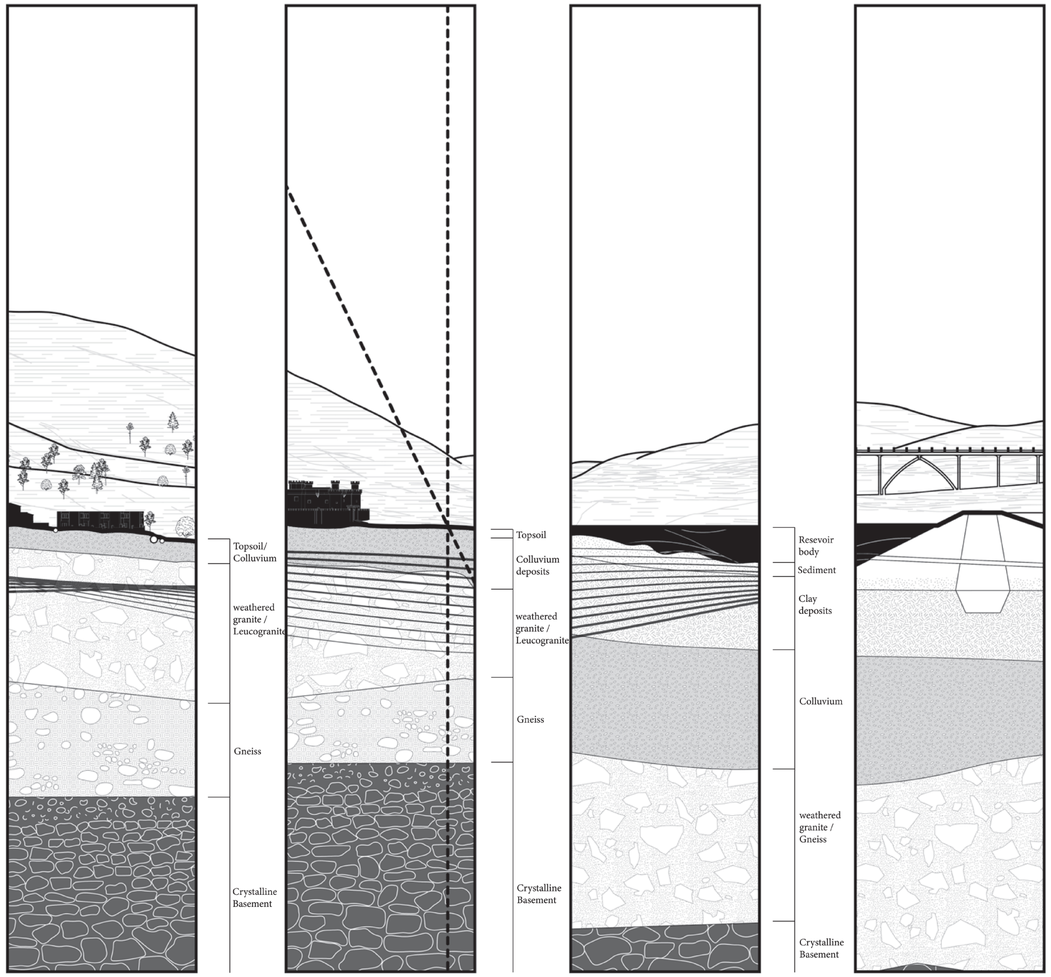
Colluvial slope

Transpiration Zone

Manzanares el Real

RESEVOIR PANELS

The reservoir section shows a transition from a natural apline water system to an artificial storage and regulation. The alpine town of Manzanares el Real sits on the slopes above the reservoir, situated around shallow groundwater networks that drain toward the valley. Between the town and the water body, a wooded transpiration zone acts as a natural buffer: deep-rooted vegetation moderates surface runoff, stabilizes soils, and sustains a local microclimate. At the reservoir, groundwater flow comes together as subsurface water enters thicker alluvial and lacustrine sediments along the margins of the Santillana Reservoir. Here, surface water and groundwater perform as a unified system, allowing exchange between the reservoir and adjacent saturated ground. The dam marks a water threshold, transforming slow, distributed mountain water into a managed system of storage and release.

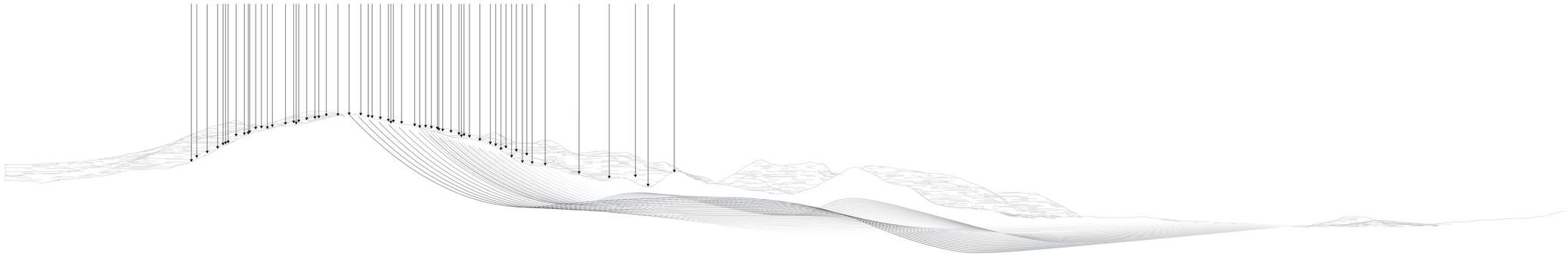


Manzanares el Real Apartments

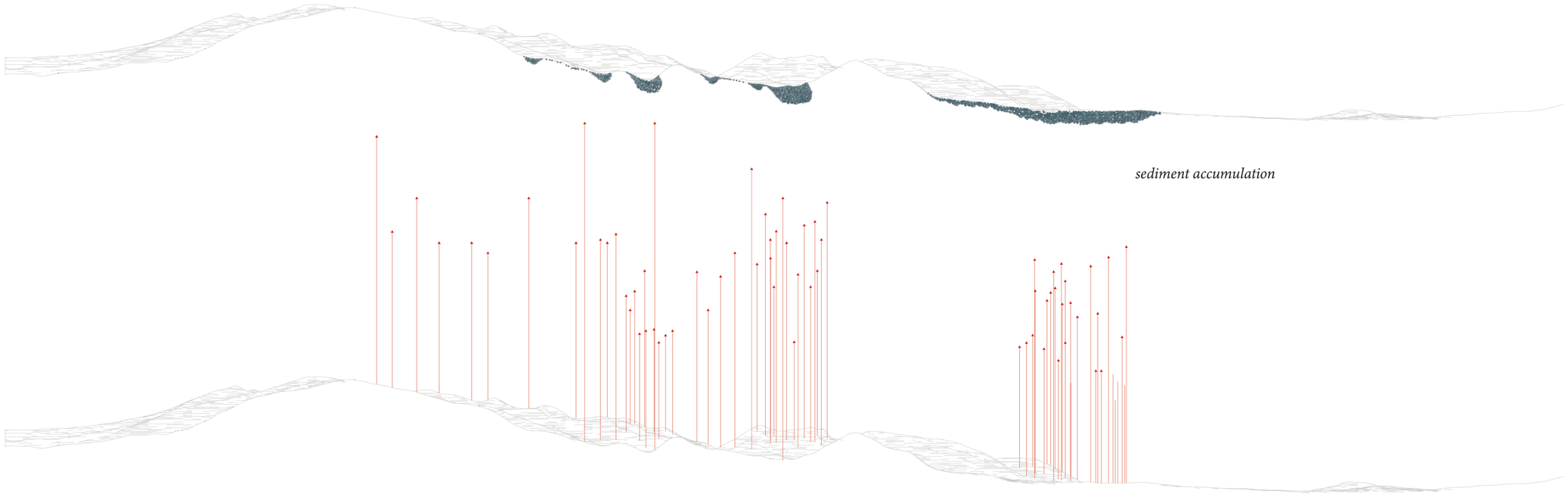
Castillo Manzanares el Real

Emblase de Manzares el Real O de Santallina

Presa de Santillana



percipitation and groundwater



sediment accumulation

flora transpiration

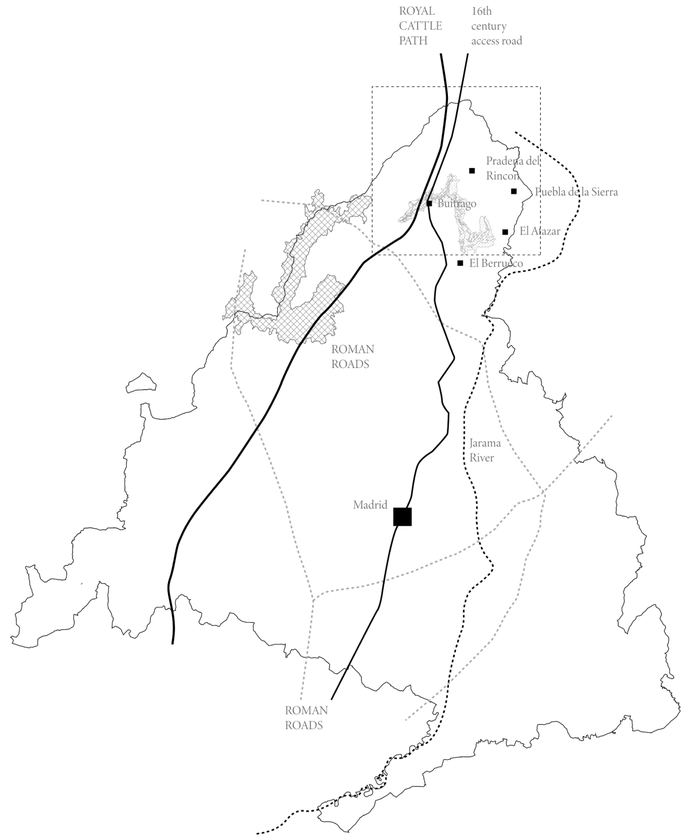
THE SCOPE

Held by the mountains is positioned as an inhabitable monitoring refuge. Set within the upland territory of Sierra Norte de Madrid, architecture operates within a saddle condition where two fields converge, where geological and hydrological conditions produce material agency and paths used by humans and others, presenting a critical moment for commoning between those seeking refuge, those with expertise and the territory.

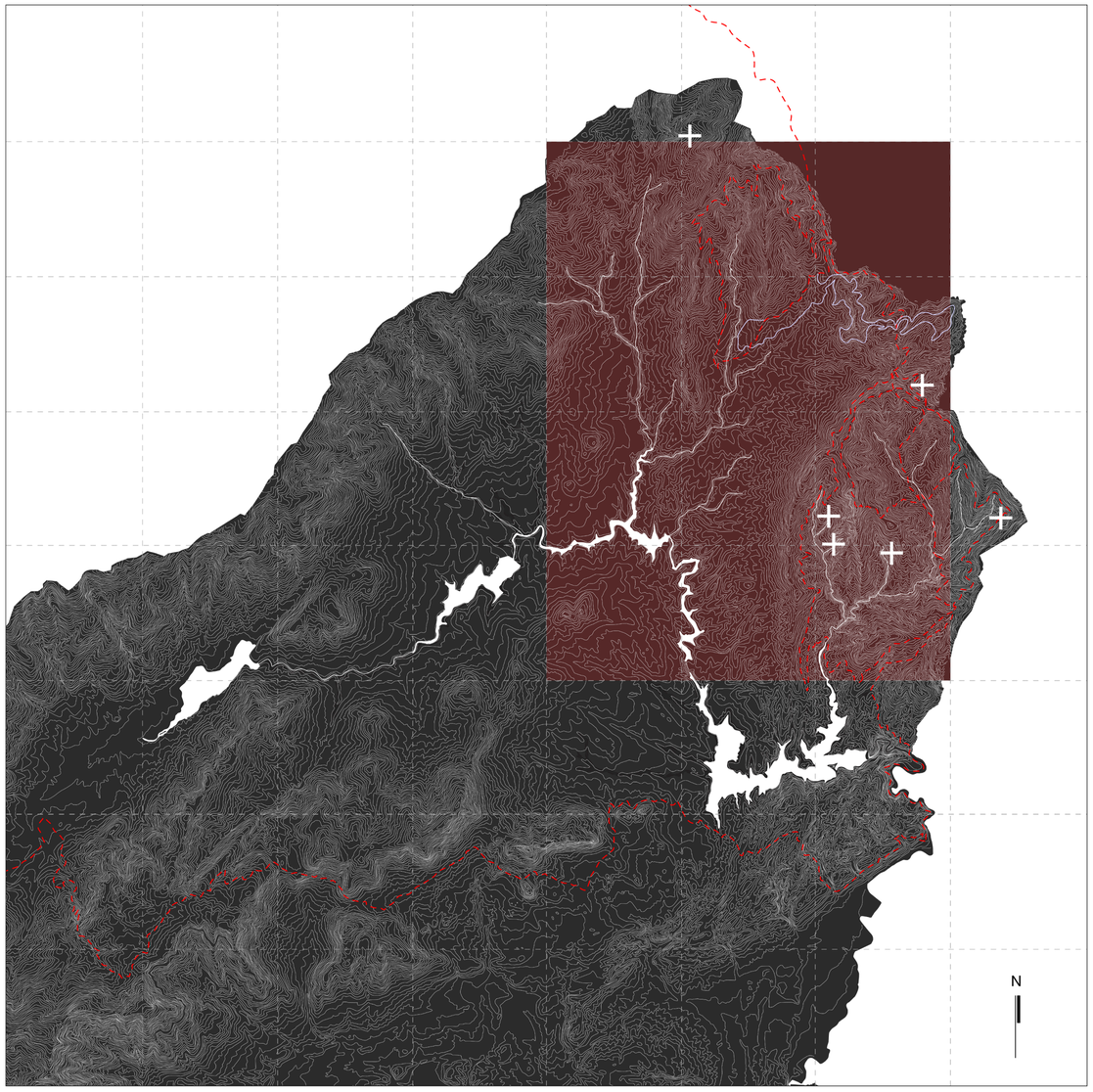
The architectural scope of the project is defined on four scales of observation held at equal relevance, which become legible across four distinct scales: the hiker at arm's length, the researcher at instrument range, the community at a territorial scale, and the satellite reading the mountain's surface. These scales together construct an ecology of observation that the architecture will mediate. Architecture becomes the interface between ways of knowing.

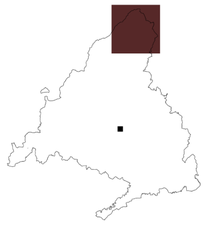
observation and operation are deliberately entangled. The architecture does not separate access from expertise. Territorial knowledge is not extracted from the landscape. It is produced through inhabitation. Routine and exposure close the distance between lived experience and scientific monitoring, making space for commoning across shared infrastructure. The structure must interact with the water table in order to monitor it, calibrate flows, record data, and stabilize localized ground conditions. As part of this scope, the project questions relationships to mountainous territories. Construction techniques, material sourcing, waste, and embedded knowledge of building in upland environments are treated as fundamental parts of the architectural inquiry. The project considers how construction in the mountains can respond to logistical limitations, material availability, and environmental exposure, allowing building processes themselves to participate in commoning.

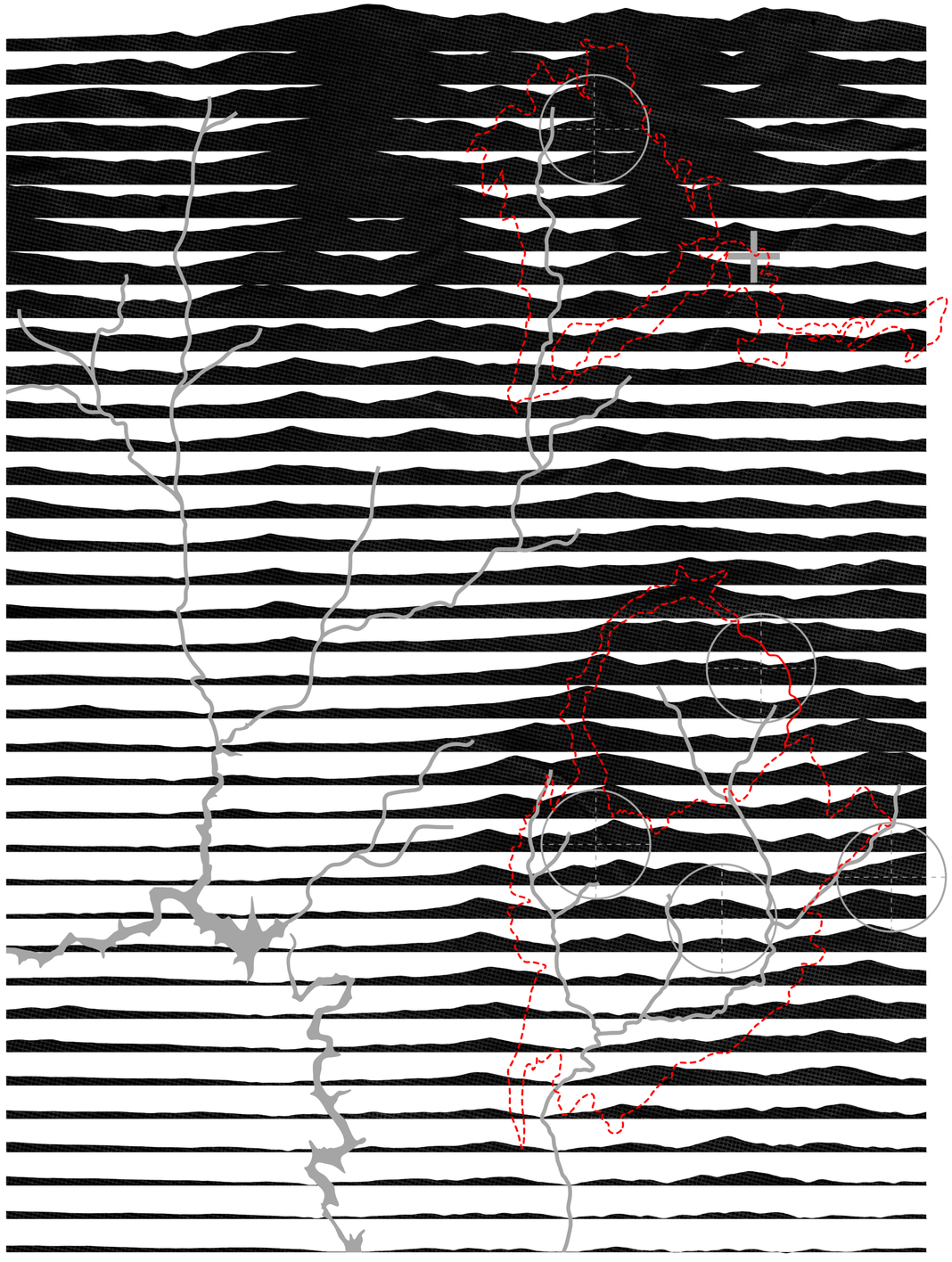
Held by the Mountains is a temporal reference point within the mountain, providing a fixed point against which the slow relationships between water and ground become both measurable and legible. It frames architecture not as a solution to environmental instability, but as a site of localized commoning, where responsibility, experience, and data converge, and where the fragile life of the upland is held in shared view.






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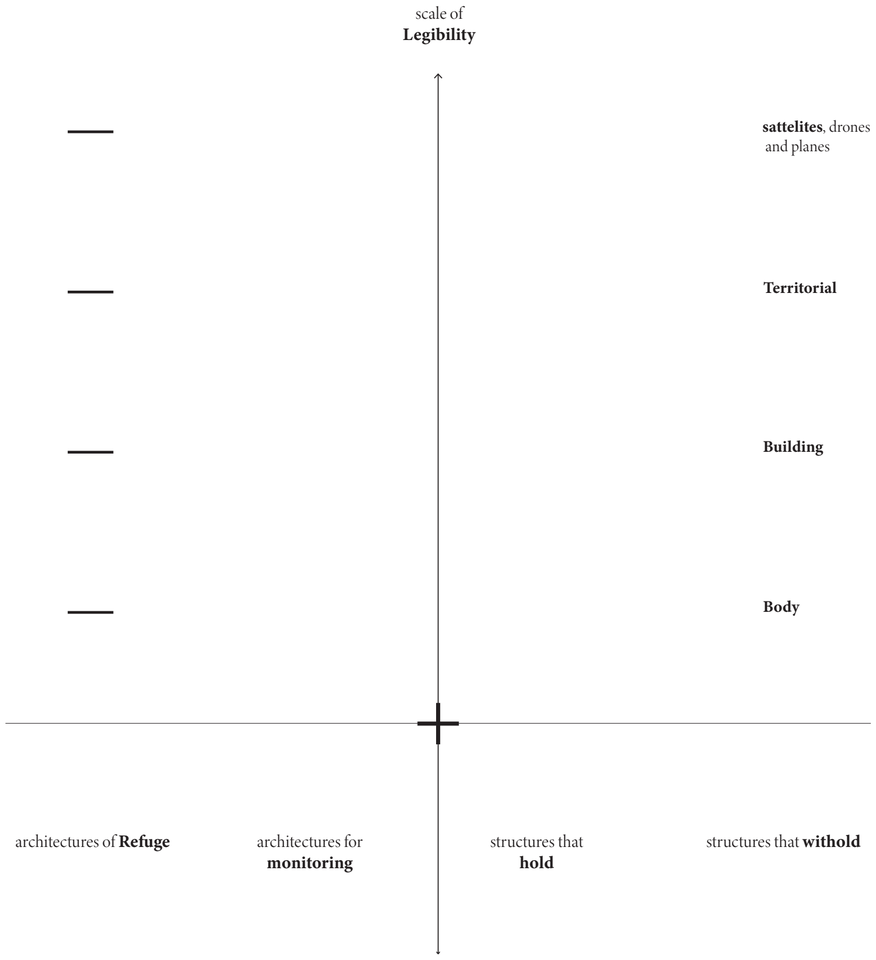




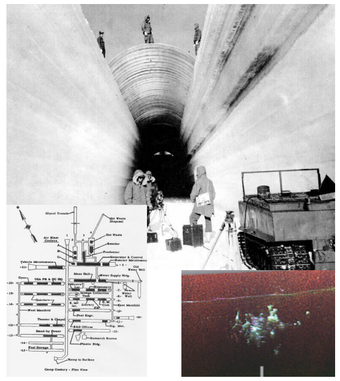
PRECEDENT STUDY

Matrix

The precedent study is organized in a matrix as an instrument for analyzing the relevance and potential of architectural ideas to inform the design process and to indicate the project's conceptual ambitions. Each precedent is organized according to how the architecture performs in alpine environments or how it deals with extreme climatic conditions. The horizontal axis comprises 4 operative categories: architectures of refuge, architectures for monitoring, structures that hold, and structures that withhold. These categories distinguish between resistance vs restraint, shelter and observation, and intervention vs mediation. Whereas the vertical axis traces the scale to which these precedents are legible, while one precedent is measurable, a satellite system, another may be legible at the scale of bodily experience; each scale describes a way in which knowledge can be generated by observation. The precedents include works that are not conventionally considered architecture; some are infrastructural, others instrumental, yet they align with the domain in which this project intends to operate and are viewed through an architectural lens to understand how the built environment can take responsibility for commoning.



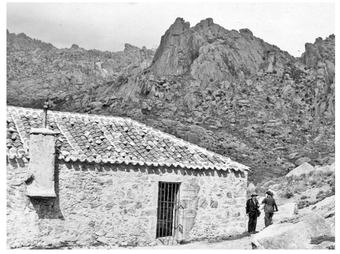
Camp Century (Greenland Ice Sheet, 1959–1967): Subglacial tunnel settlement / research outpost (U.S. Army). Habitable infrastructure whose buried geometry is now detectable via remote sensing; an extreme refuge embedded in a cryospheric medium



Refuge des Cosmiques (Mont Blanc massif, France; rebuilt/constructed c. 1990) High-alpine refuge on a rock promontory, accessed from Aiguille du Midi. Refuge as territorial node on a mountaineering network; legible as a fixed point within a dangerous route system. Space for 140+ mountaineers



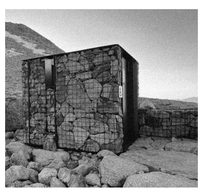
Refugio Giner de los Ríos (La Pedriza, Sierra de Guadarrama, Madrid Spain; early 20th c.) Mountain refuge building on a classic route landscape. Architectural refuge as civic/intellectual mountain infrastructure in the Spanish context. Evidence of mountain refuge heritage in Madrid



Field huts (Davis Station region / Vestfold Hills, Australian Antarctic Territory; "Marine Plain" and related huts) Small-scale field refuges for scientists; survival + operational base. Refuge as bodily necessity within research logistics; long-duration habitation under exposure.



Longs Peak Privies (Rocky Mountain National Park, USA; NPS + Colorado Building Workshop) Backcountry sanitation refuge/utility at altitude. Bodily systems (waste, shelter from exposure) designed as minimal-impact backcountry infrastructure.

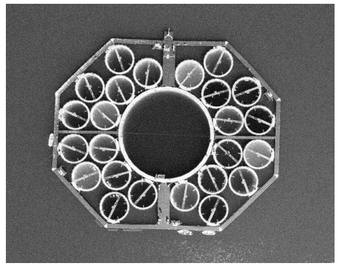


ARCHITECTURES OF REFUGE

Architectures of refuge are places where exposure is negotiated in environments that are otherwise difficult or unsafe to inhabit and where there is potential for commoning on the level of new relationships between disconnected participants. In contexts such as ice tunnels beneath the Greenland ice sheet or alpine routes on Mont Blanc, which are exposed to the elements, it becomes clear that refuge is not about comfort, but about enabling shared endurance. These precedents show that refuge often depends less on formal enclosure than on clear material decisions. Antarctic field huts rely on lightweight, adaptable construction that can withstand extreme conditions while remaining movable and repairable. The Cosmiques Hut combines facade lightness with anchoring, while Camp Century constructs refuge through excavation rather than addition. These examples frame refuge as a careful balance between protection, exposure, and collective responsibility rather than architectural assertion.

ARCHITECTURES FOR MONITORING

Architectures of monitoring are often tied closely to architectures of refuge. Both tend to emerge at points where environmental forces are strongest and where proximity to the phenomenon being observed is essential. The Schneefernerhaus research station on the Zugspitze and the Cosmiques Hut occupy similar positions within extreme alpine terrain, yet one shelters scientific instruments while the other shelters bodies. There is a tension between access and exposure in order to remain close to valuable data. Each case demands a specific spatial and material response shaped by what is being measured. Projects such as LakeLab Stechlin make the practice of monitoring the territory visible, exposing experimental infrastructure to the landscape and to remote sensing systems. These examples suggest that monitoring produces its own architectural expression, one stemming from necessity and long-term presence.



LakeLab, Lake Stechlin (Stechlinsee), NE Germany (IGB / Leibniz Institute) Large experimental / monitoring infrastructure on a lake. Monitoring as an apparatus at landscape scale, generating datasets that can be paired with remote sensing.



Environmental Research Station Schneefernerhaus (Zugspitze, Germany; established 1999; 2650 m) High-altitude research station with long-term measurement programs. Monitoring as territorial commitment; a stable node for atmospheric / environmental observation.





EMET high-mountain observation network (Spain; refuges/ski areas as manual stations) Distributed meteorological observation practice and infrastructure. Monitoring as networked civic service.

Atalaya de Torrepedrera / Atalaya de El Berrueco (Sierra Norte, Madrid; medieval watchtower) Historical territorial monitoring/communication node. A pre-instrumental monitoring architecture; topographic siting as surveillance logic.





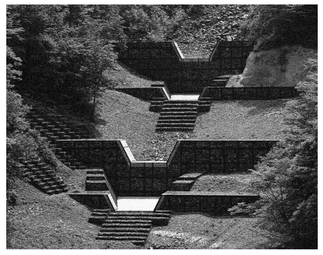
Vega de Liordes weather station (Picos de Europa region; León, Spain) Remote station + expedition/maintenance culture (often enthusiast/scientific crossover). Monitoring as bodily effort and exposure; maintenance as field practice.

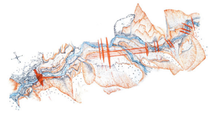
Tarfala Research Station (Sweden) “weathering station” / boundary blurring study (Springs / RCC) Research-station lived infrastructure, weathering as agent. Monitoring entangled with habitation; material/weather co-produce the record.

Greenhouses of Almería ("Sea of Greenhouses," Campo de Dalías / El Ejido, Spain) Territorial greenhouse field; high-albedo surface legible from satellites. Not a mountain structure, but a definitive precedent for orbital readability through surface material logic (albedo/reflectance).



Sabo gabion/check-dam systems (Japan; category reference via Sabo Technical Center) plan lineage credited to Masao Akagi; Sediment/debris flow control infrastructure. Territorial holding of sediment pulses; repeatable typology across catchments.

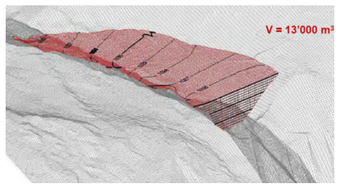




Steel-pipe / slit "open sabo dam" typology (Japan; permeable steel-pipe check dams) "Permeable" holding structure that traps boulders/sediment while passing water. A building-scale structural language for selective capture.



Flexible debris-flow barrier + retention system (Illgraben context; ring-net barrier literature)
Flexible barrier(s) for debris flow mitigation (ring-net systems). Holding as event-based capture with known failure/overflow performance logic.



Structural avalanche protection: snow nets / snow bridges (Swiss context; SLF/WSL) Retaining structures that prevent slab release in start zones. Holding as pre-failure restraint on steep slopes; bodily legibility in the mountain.



Blockhaus 13 bunker (Colmenar del Arroyo, Community of Madrid; built late 1938–early 1939) Defensive shelter/fortification. Bodily refuge + holding position.



structures that hold

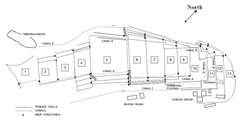
STRUCTURES THAT HOLD

Structures that hold uncover designs that intervene at moments of potential failure. Sabo dams, avalanche fences, and military bunkers operate through resistance. These structures are often highly utilitarian, with a role that extends beyond protection alone. Sabo dams do not simply block sediment; they capture, sort, and gradually release material, allowing damaged landscapes to stabilize and repair over time. Across these precedents, holding emerges as a form of care grounded in robustness and endurance, as in the Blockhaus 13 bunker, where architecture assumes responsibility by standing in the path of force and accepting long-term material conditions.

STRUCTURES THAT WITHHOLD

Structures that withhold operate by slowing, distributing, and conditioning environmental forces rather than confronting them directly. In the Peruvian Andes, systems such as the Amunas and the terraced waterworks at Tipón demonstrate how withholding becomes a territorial practice. Water is guided, delayed, and infiltrated through carefully constructed channels, basins, and stepped surfaces. These systems rely on tectonics, Stone is assembled to remain permeable, allowing water to pass, settle, and return gradually to the ground. Across these precedents, withholding emerges as an architectural strategy rooted in construction logic, where stability is achieved through restraint and repetition





Tipón Archaeological Park (Cusco region, Peru; Inca hydraulic terraces & fountains, 15th c.) Terraced hydraulic system with controlled distribution, infiltration, and display. "Withholding" through stepped hydraulic delay and distributed control across terraces; strong aerial-pattern logic.







Amunas (Peruvian Andes; infiltration canal systems associated with Huamantanga and related regions) Ancestral infiltration / recharge infrastructure to delay water and extend dry-season flow. Withholding through infiltration and seasonal time-shift, rather than forceful holding.



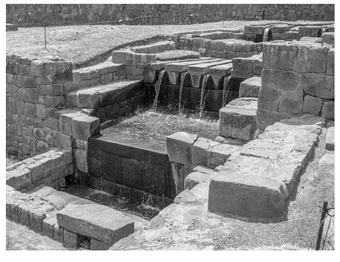
Allmannajuvet Zinc Mine Museum (Sauda, Norway; Peter Zumthor; completed 2016) Inhabitable route-based heritage/refuge elements on a steep industrial landscape. Withholding through pacing, and controlled exposure at a landscape promenade scale.





Dominus Winery (Yountville, Napa Valley, USA; Herzog & de Meuron; completed 1997/1998) Winery with gabion "stone wickerwork" envelope. Withholding through porous envelope, thermal buffering, and controlled permeability.

Rammed Earth House (Rauch House) (Schlins, Austria; Boltshauser + Martin Rauch; completed 2008/2009) Rammed-earth dwelling / demonstration of earth construction. Withholding through thermal/hygroscopic mass + construction discipline (material as climate governor).



Tipón (again, used here specifically for bodily proximity to ritualized fountains/flow control) Fountain/terrace hydraulics experienced at arm's length. Withholding becomes felt (temperature, sound, wet stone, stepped drop structures)

structures that withold

ARCHITECTURA NEGRA

The Critical Precedent study

The stone and slate buildings of the Sierra Norte de Madrid, commonly referred to as Arquitectura Negra, form a precise and instructive precedent for architecture in mountainous territories. Constructed almost entirely from locally extracted slate and stone, they embody a material economy in which availability, weight, and weathering capacity directly inform architectural form.

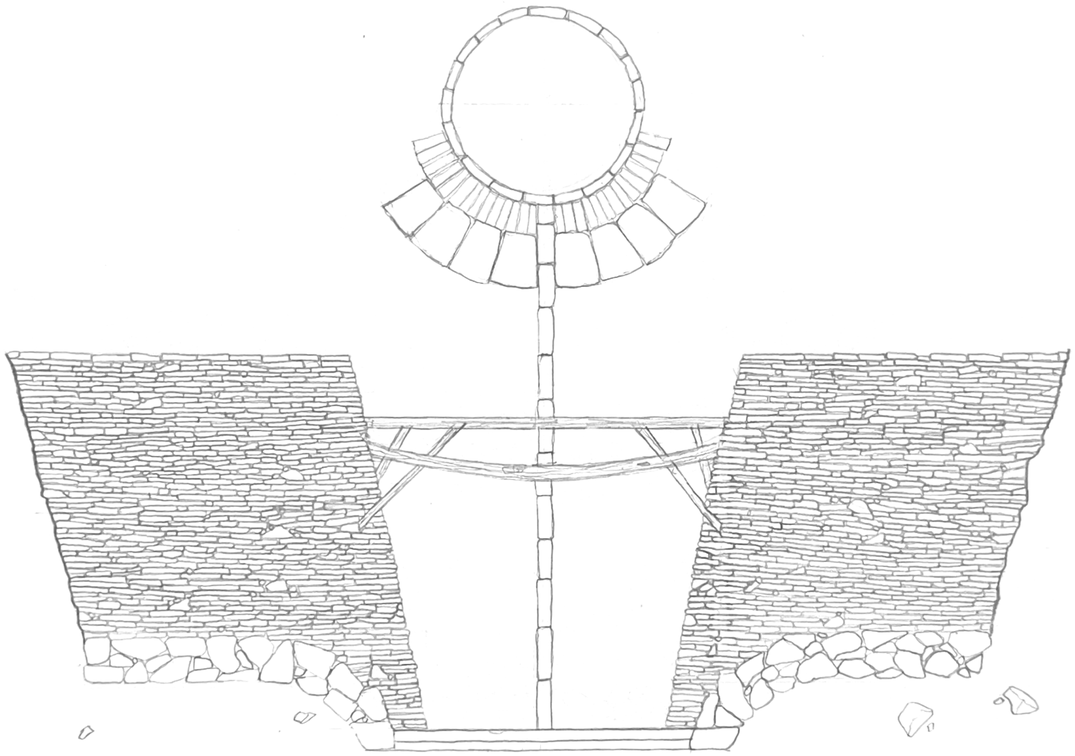
Tectonics are explicit. Construction technique and architectural expression are inseparable. Load-bearing stone walls are assembled with minimal processing, privileging mass, gravity, and compression. Slate is split, layered, and overlapped, operating simultaneously as structure, enclosure, and water-management device. The hand drawing produced for this study operates as a tectonic reading rather than a descriptive survey.

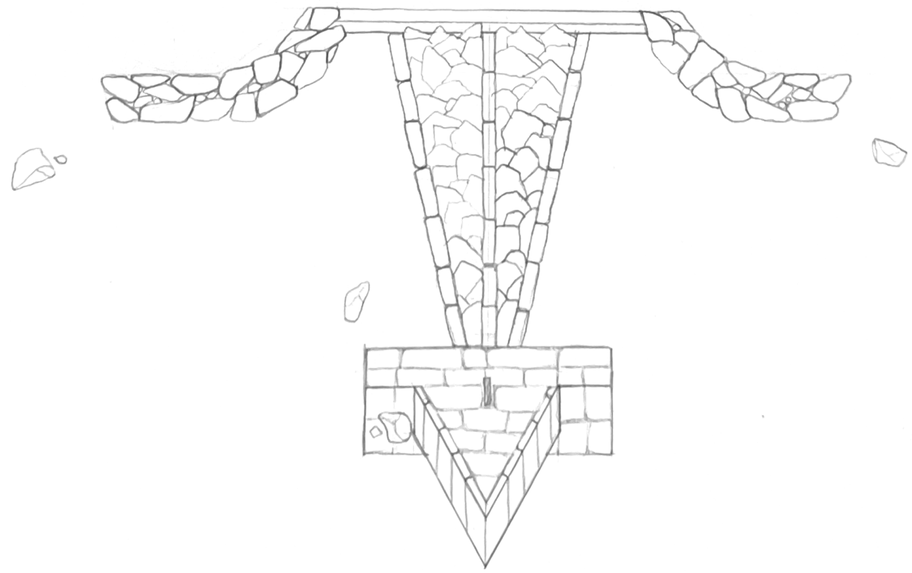


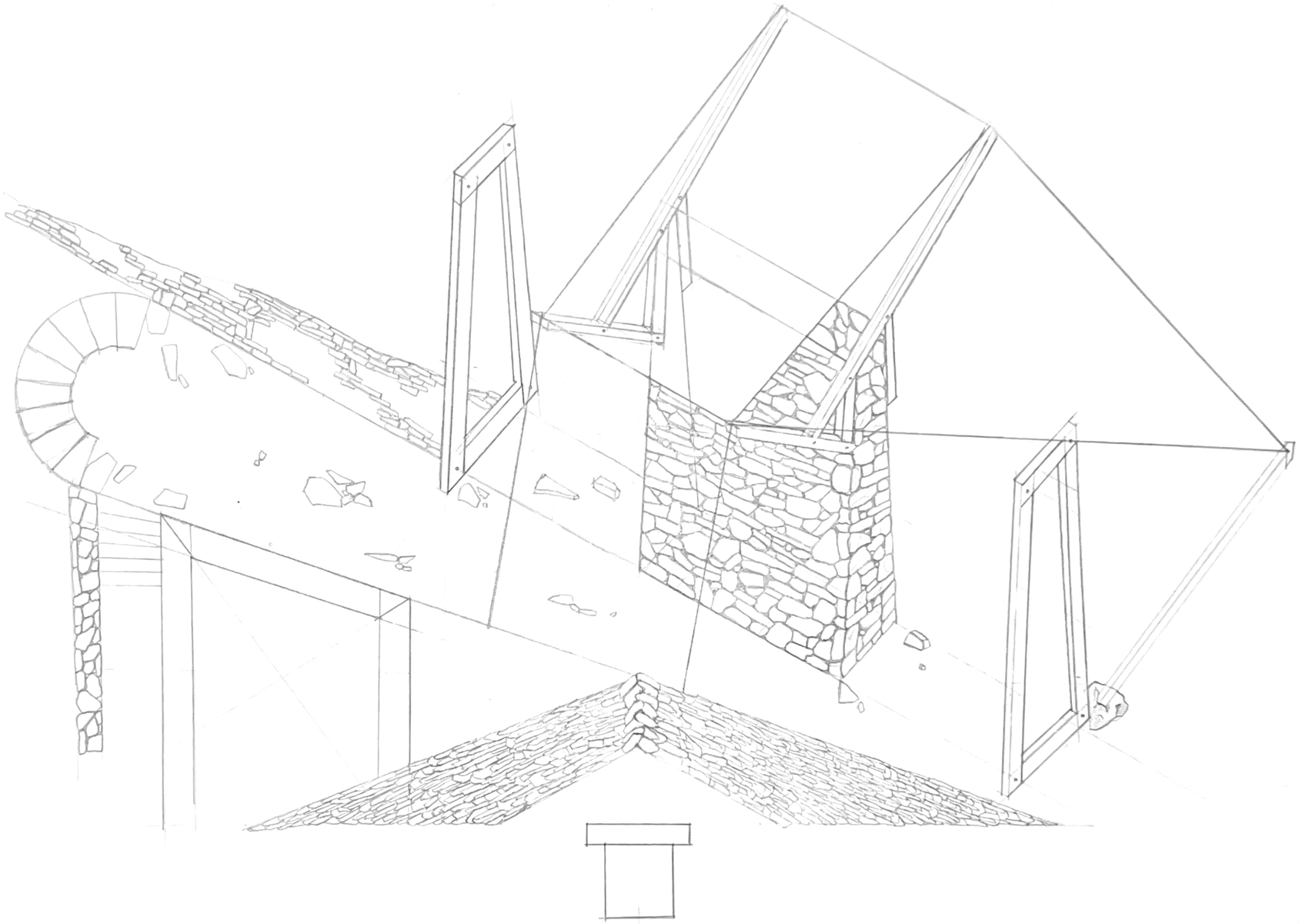
Rodríguez Lorenzo, V. (2023, August 4). **Los pueblos negros de Guadalajara**. La misma cantinela. Los pueblos de la arquitectura negra near Madrid and Guadalajara, featuring slate and stone construction characteristic of traditional rural architecture in the Sierra Norte de Guadalajara

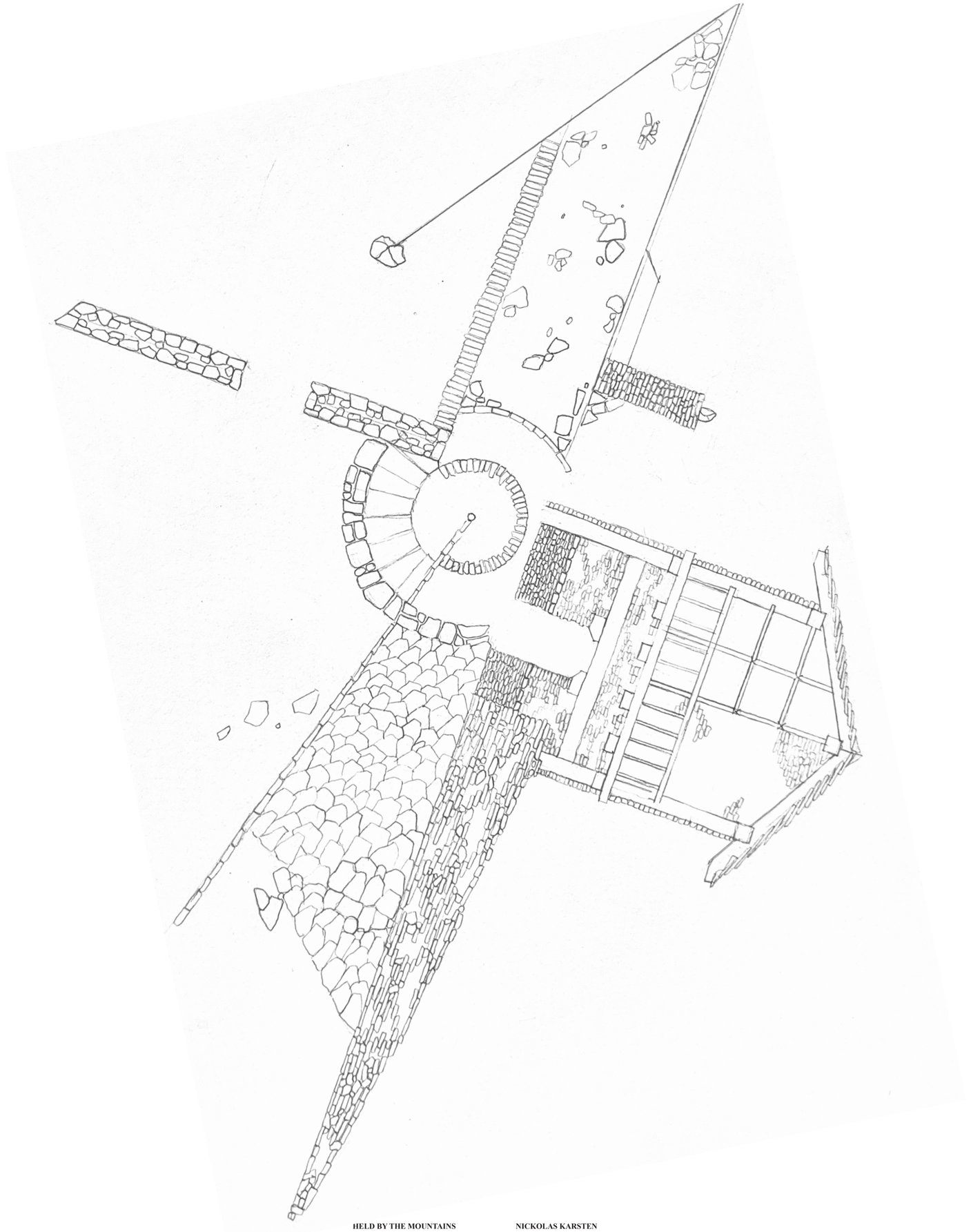


SECTION 03 POTENTIALS



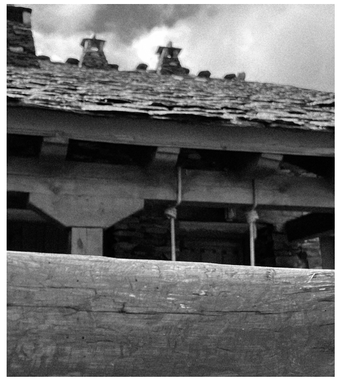


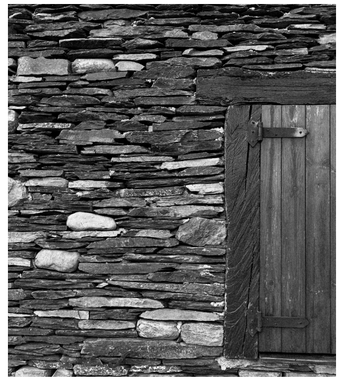


















Feild Note 1: *Construction here is not a choice of expression but a consequence of proximity. Granite, slate, and stone are not selected, they are available. What is built emerges directly from the ground it occupies, often beginning with what is already there. Embedded in outcrops, anchoring walls and defining thresholds. The building does not sit on the landscape; it is assembled from it.*
Material logic follows climate. Thick stone walls temper heat and cold, while the weight of slate roofs resists wind and sheds water without complication. Timber appears only where necessary, spanning, framing, or closing, but never dominating. These structures persist because they are aligned with the conditions that formed them. They weather, darken, and shift, but remain intact, not as monuments, but as continuations of the terrain. Their longevity is not engineered through precision, but through acceptance of exposure, repair, and gradual transformation. In this sense, they are less buildings than stable states of the landscape itself.















Feild Note 2: *Layered time is legible through ruins. Remnants of old fincas, segmented grazing land, and other habitations sit everywhere, overgrown, degraded, and reintegrating with the landscape. They become unintended habitation for non humans. If buildings are abandoned but made of material from the landscape, nature adapts their use and the building never truly fails; it only changes occupant and function.*

What follows is not simply decay, but a shift across time. Structures built from granite, slate, stone, and timber persist beyond human use for hundreds of years, gradually transforming as organic elements return to the ground and mineral elements endure. What remains is a climate sheltered terrain that continues to support life. To build here is to anticipate this transition, where architecture is not erased but absorbed, leaving behind a framework for future human or non human inhabitation.



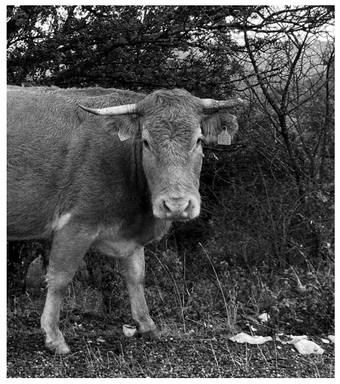












Feild Note 3: *Production is one with the landscape in this territory. Cattle, sheep, bee cultivation, logging practices slate supply. Nature is relentless; what endures are the hard parts of the landscape itself. Dry-stone walls don't pretend to be sealed. Their openings, gaps, cracks, and imperfections expect external forces such as water flows, hail bullets, wind gusts, snow loads, sun rays. Matter passes through as a constant condition. That inevitability is not a failure; it is the premise.*













Feild Note 4: *Human agency here has to exist through the landscape, not imposed upon it; this is the only way. Like a diversion dam, interventions can shift direction and provide utility. Habitations must orient around concentrations of material agency to be effective and productive. What is taken will be repaired. This is inevitable.*











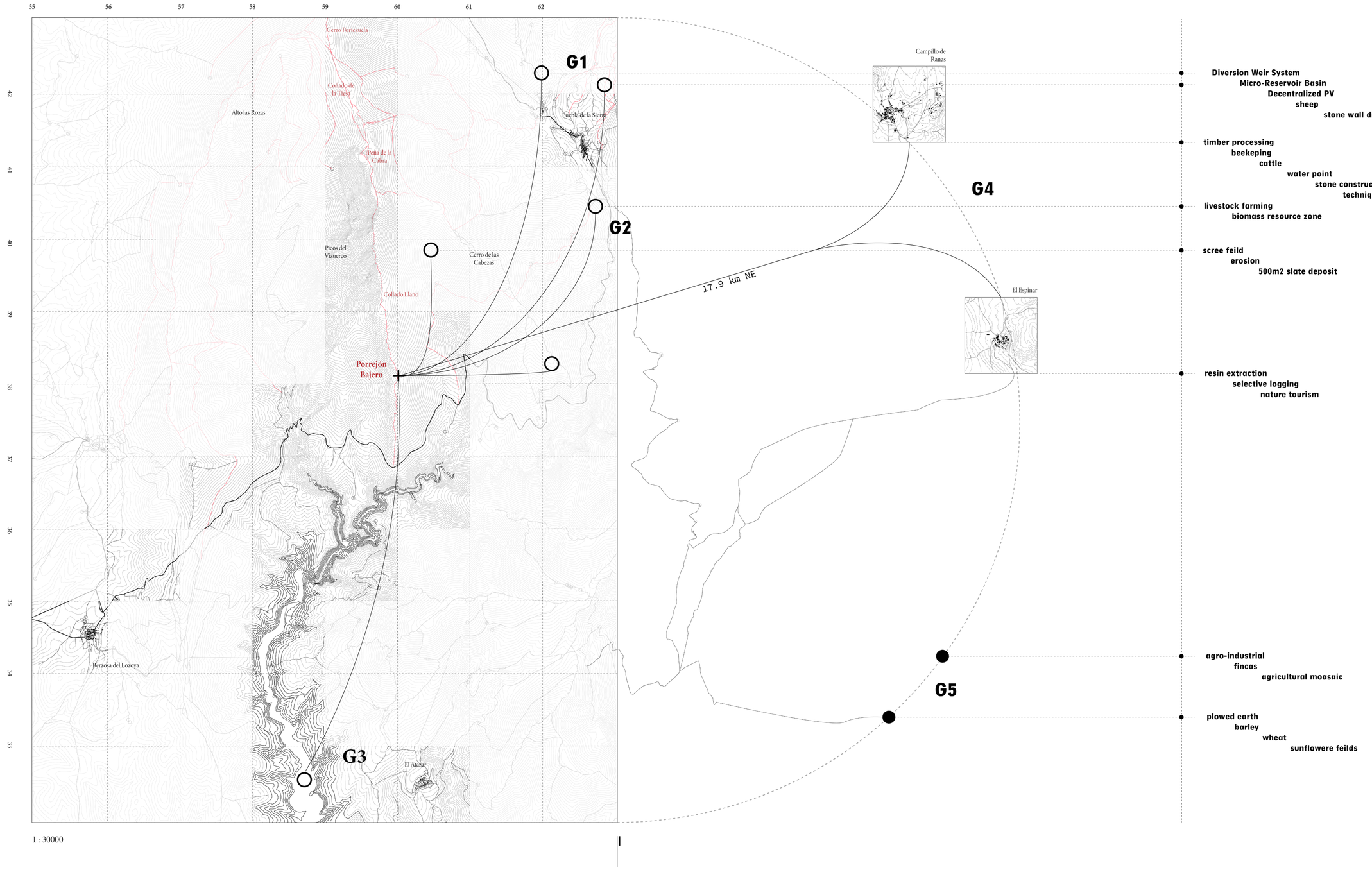






Feild Note 5: *This territory is in constant change, and architecture must position itself through distinct states of use across the seasonal cycles to be successful here. It must hold up under intense summer sun and dryness, come alive in winter, and perform in the rainy months as well. Not only perform, but also be used to tend the territory during these conditions: to provide utility, monitor, and to maintain.*

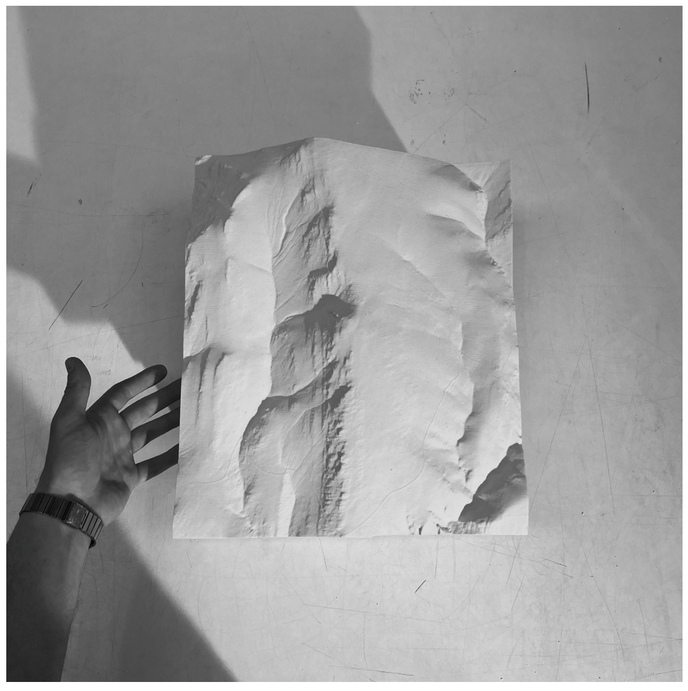
A TERRITORAL TAXOMONY

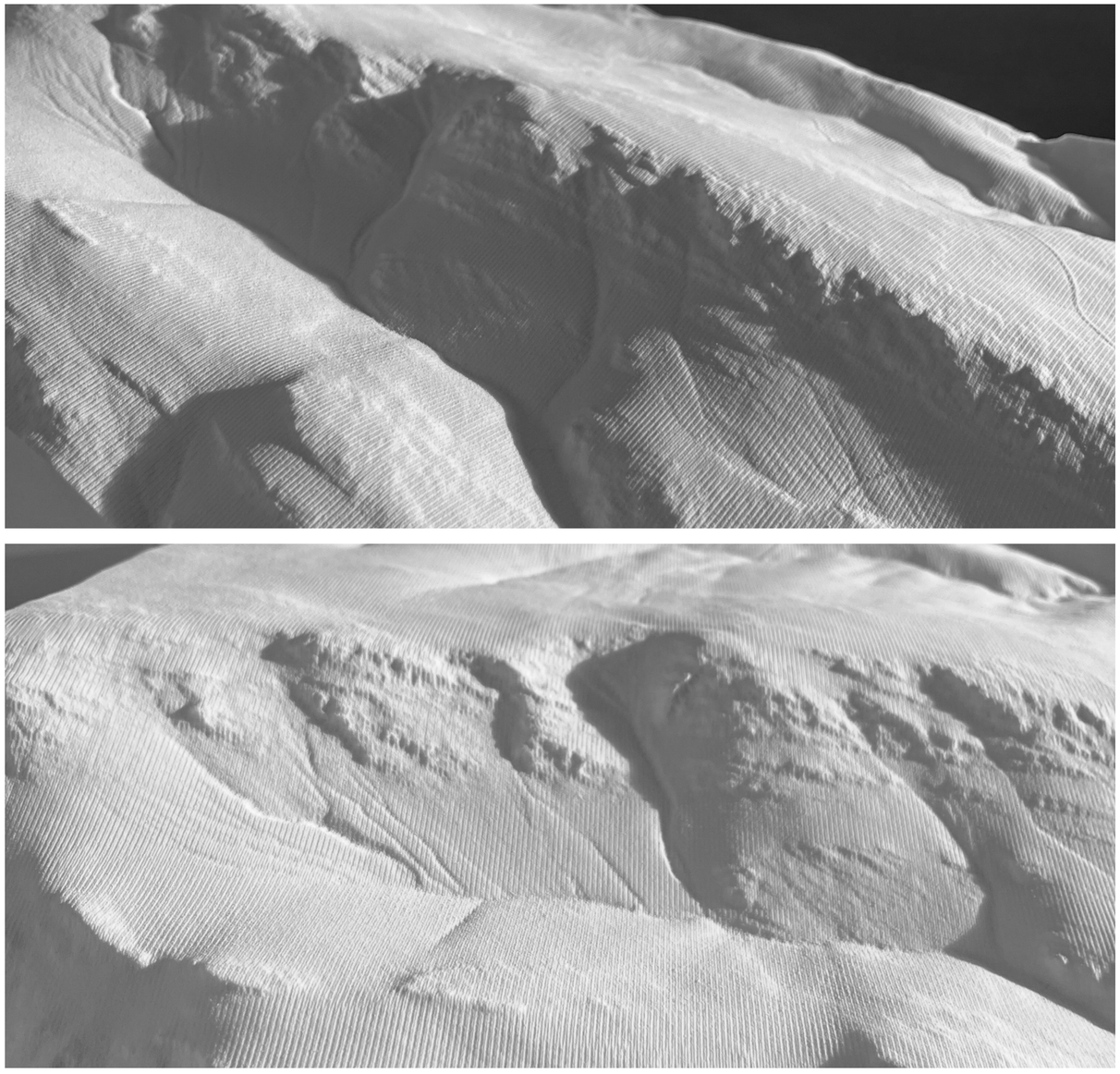


1 : 30000



TU Delft workshop CNC Machine -physical fabrication



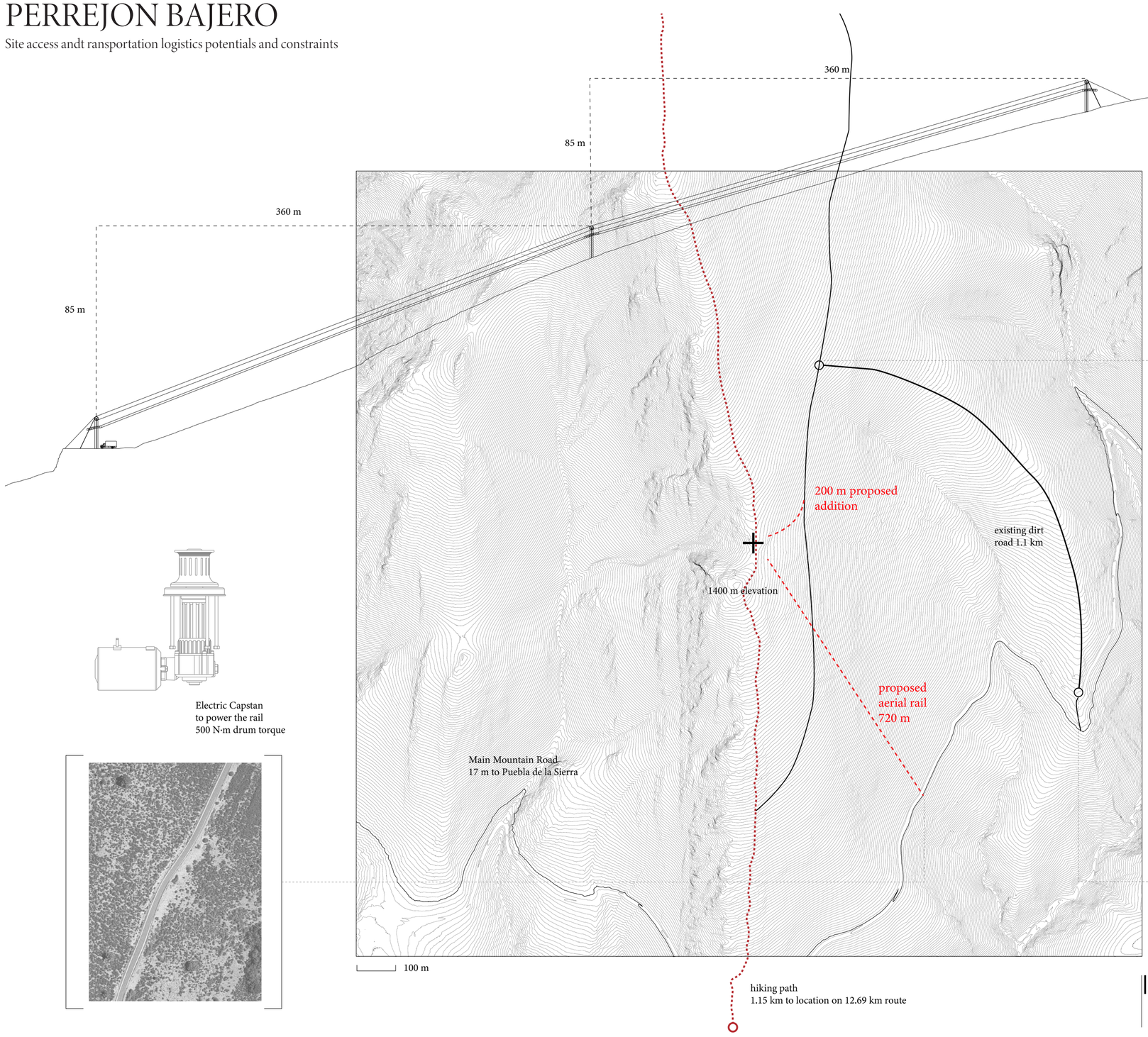


1:6000 NECURON model of Sierra Norte de Madrid ridge containing Perrejon Bajero

Model Dimensions: 325 x 367 x 96 mm
Real Dimensions 1950 x 2200 x 598 m

PERREJON BAJERO

Site access andt ransportation logistics potentials and constraints





local pack mule - humane
working load 15-20% body
weight ~ 65 kg



Electric Capstan
to power the rail
500 N·m drum torque



rider and light load only - 120 kg
25% grade comfortable incline



total travel time from CDB
1h 34 m, maximum load 200-300 kg 15–20%
grade incline



THE ELEMENTS

Conditions and constraints of the climate

The ridge, gully topological site condition is volatile climatically, and the elements, therefore, must determine design decisions related to situating the architecture. Winds shift throughout the day and across seasons. Wind prevails from the west, with gusts from the north. Localized upslope currents are produced by the gully, with depressions that generate temporary pockets of calm. These overlapping conditions produce turbulence, acceleration and sudden changes in temperature. The elemental mapping reads these movements against the terrain and generates the understanding that each position along the ridge carries a distinct microclimate. The project responds to this highly differentiated condition by selecting, as opposed to resisting. The refuge is constructed on the leeward side of the ridge, where the terrain provides a depression pocket.

The turbine is displaced from the main structure at a moment when the wind conditions are both relatively consistent and strong.

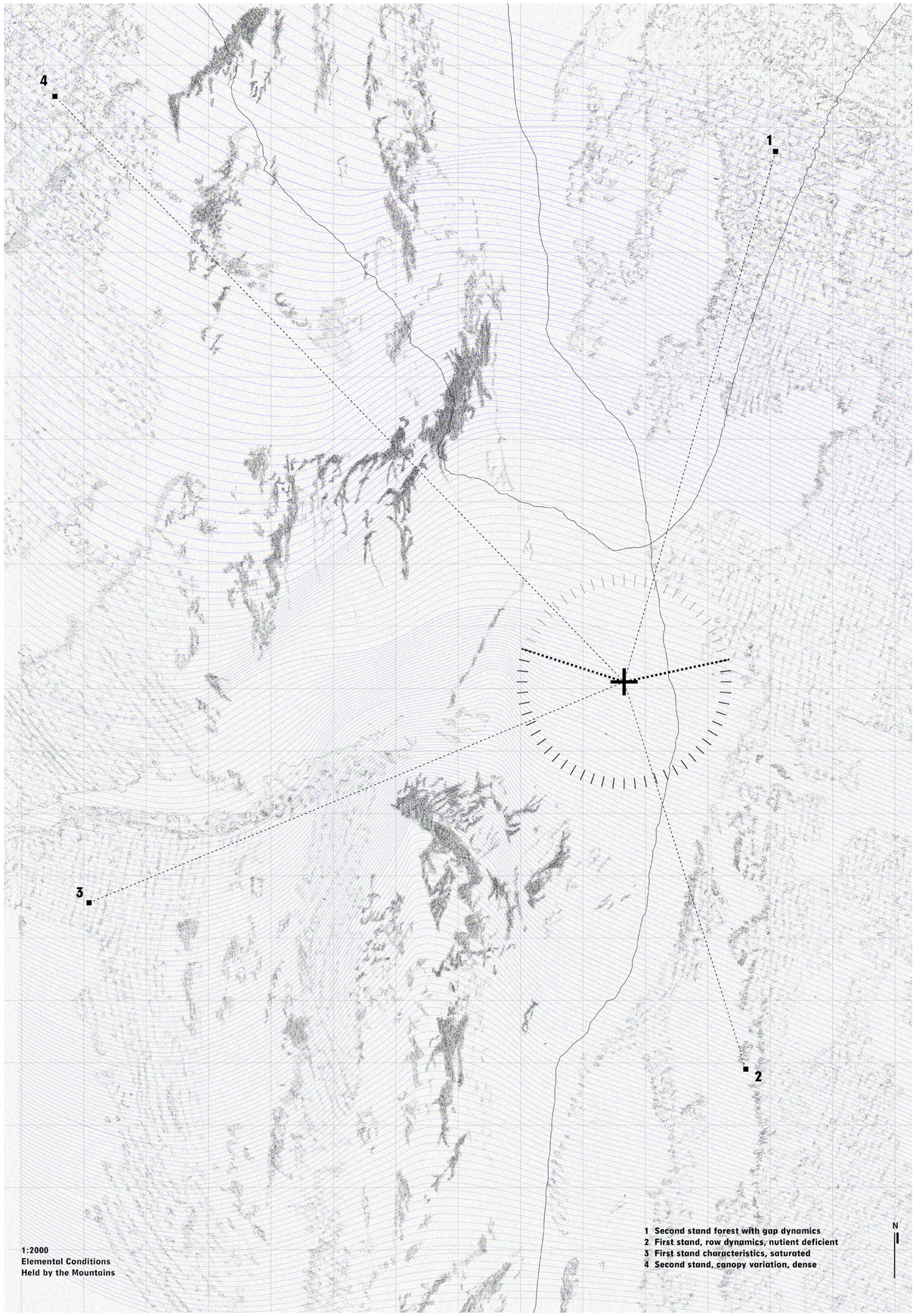
Seasonal variation is extreme; however, it is clear that winter conditions dominate with sustained periods of cold for 3/4 seasons. Heating becomes the primary demand for the refuge, whereas during the summer months a passive cooling strategy is employed, making use of thermal mass to purge accumulated heat at night, ventilation and air movement, to lower temperatures. This strategy allows the building envelope to perform across both extremes, prioritizing heat retention while allowing controlled ventilation, without relying on mechanical input.

Air conditions

Category	Condition	Direction	Quality	Implication
Regional Synoptic 1	Prevailing annual	W-NW	Moderate; strong in storm periods	Dominant exposure is W-NW sector
Regional Synoptic 2	Winter episodes	N-NW	Cold, gusty	Protect N-facing surfaces; avoid direct entry.
Day Microclimate	Anabatic Upslope	(W) upslope from gully	Moderate daytime breeze	Use for summer ventilation
Night Microclimate	Katabalic downslope	Toward gully (W)	Cold, narrow, abrupt	Sheild W side
Terrain effect 1	Gully edge turbulence	W sector	High turbulence near slope break	Direct wind with aerodynamic forms
Terrain effect 2	Consistent flow	NW	Accelerated flow	Preffered turbine siting
Building Strategy 1	Wind protection	Sheild W-NW	aerodynamic form	Create buffered pressure zone near exits.
Building Strategy 2	Entry Placement	Leeward (E)	Calm pocket	Main enterence
Energy Strategy	Wind turbine	Setback from gully NW	Mast 12-18 m guyed	Seperate energy outpost from building

Seasonal transition context

Season	Avg Daytime High	Avg Night Low	Typical Diurnal Swing	Extremes	Constraints
Winter (Dec-Feb)	5-9 °C	-5 to -1 °C	10-15 °C	Down to -12 °C occasionally	Strong heating strategy, wind protection and snow load management
Spring (Mar-May)	12-20 °C	0-7 °C	12-18 °C	Frost possible into April	Facade Depth, Thermal mass, Heating/ventilation
Summer (Jun-Aug)	24-30 °C	10-15 °C	15-20 °C	32-35 °C with heat waves	Night purge ventilation, thermal mass
Autumn	10-22 °C	0-8 °C	12-18 °C	Frost by late Oct	Re-engage heating and moisture control.



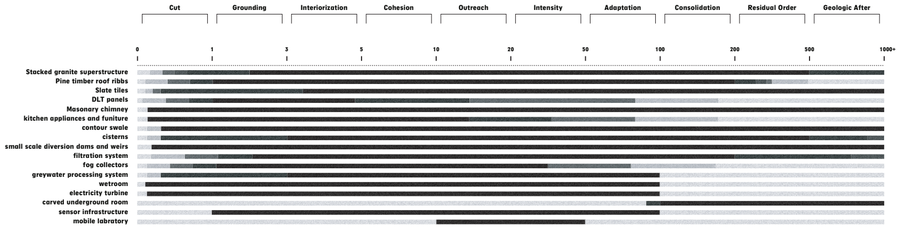
A THOUSAND-YEAR LIFE

Designing beyond human occupation

The post-human lens is the approach of "critically rethinking the ways of being in the world that are currently emerging". To "address complex dimensions underpinning the historical milieu." As Braidotti argues, "for humanity to re-invent itself affirmatively, through creativity and empowering ethical relations" (Gómez-Luque & Jafari, 2017).

In this framework, I consider treating this refuge not as a finished product with a fixed program, but instead as an unfolding and refolding of components and materials used in an effort to establish a temporal relationship between materials, systems, infrastructures, and ecological agency that becomes guiding for the design decisions that follow. The ambition is to consider a thousand-year life, one that passes through chapters of inhabitation where the project expands, settles and contracts to a new level of occupation now dominated by the non-human. As a result, the design process shifts away from human use as the measure of architectural value, but instead considers how vibrant matter, environmental forces and non-human participants can continue to find refuge through the architecture.





Sunken courtyard extraction and provisional sheltering; initial fire pit established within granite fragments as a gathering and working point for further construction. Fractured granite stones are stacked to provide immediate protection from the climate. A contour swale is cut on the northern slope and lined with slate; first rudimentary surface cistern established. Prefabricated compost toilet and wetroom set up is brought to site and assembled.

Granite superstructure completed; segmented timber beams and DLT floors constructed. Slate envelope stabilised. The Base camp becomes operational. Hearths maintain thermal comfort in extreme conditions. The space begins to function as refuge. Filtration system is added to the cisterns

Active occupation. Groups of researchers have meetings, cook, eat and sleep on site, kitchen, room and furnishings become fitted and routines are established. Data from the territory is transmitted to sattelites, while longer term research continues governments and policy makers and provides downstram utility. the cistern system is expanded into three subsurface chambers and the filtration is now optimized

local grain farmers. cattle herders, bee cultivators, forest fire crews, logging companies, NGOs, land owners, can make appointment for consulting on pressing issues related to nutrients, drought, biodiversity disease etc.
the ritual space brings together hikers, locals government officials and researchers for the purposes of repairing the territorial fragilities.

the observation deck is constructed and, with funding from the work a prefabricated and engineered lightweight labratory is brought in by helicopter as a mobile lab To further research on site and with more reach to further expeditions to fragile territories.

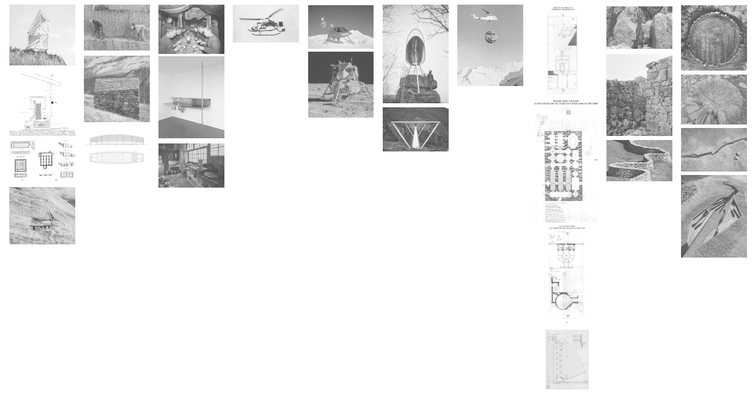
The observation deck is maintained and partially replaced as needed. The laboratory operates at peak capacity, with periodic upgrades to instrumentation and enclosure systems. Timber elements in the main structure undergo first cycles of replacement. Water infrastructure remains stable, with filtration and storage systems periodically renewed.

Use becomes more intermittent and specialised. Technical systems begin to simplify or are selectively maintained. The laboratory is taken away by helicopter. The ritual space persists as the most stable architectural condition. Water systems continue to operate with reduced technological dependency.

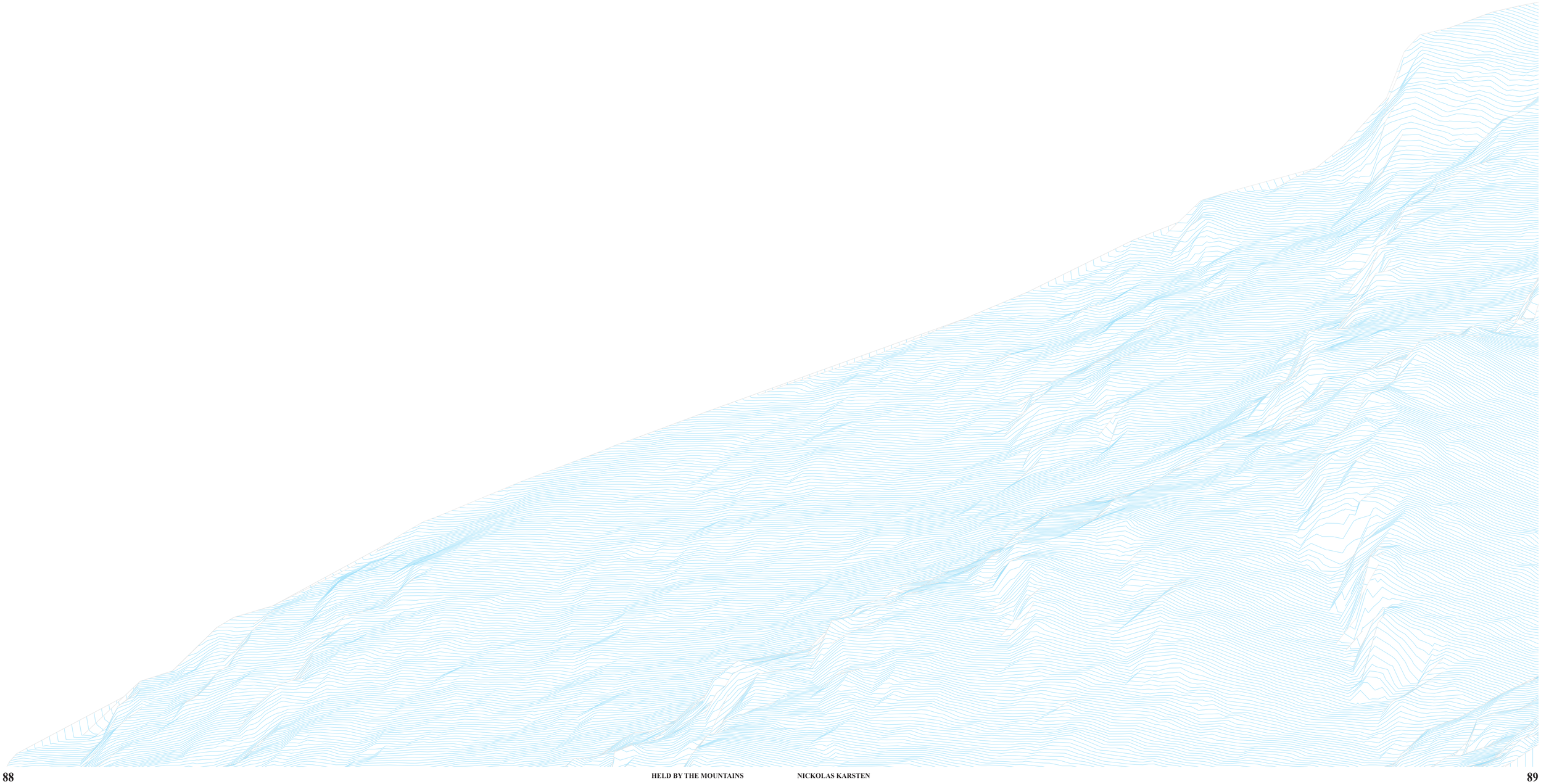
The underground becomes more secured, contracting to a controlled, thermally stable environment. The underground space stores data, soil cores, fungal cultures, and plant tissues. It functions as both archive and reserve, linked to the cistern system as a cold, stable emergency supply.

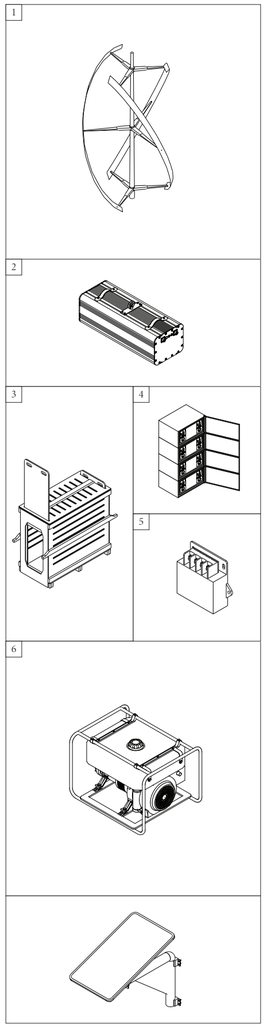
Maintenance becomes discontinuous. Lightweight and high-tech elements, lab, wetroom, bridge deck, are progressively removed, replaced, or abandoned. Their anchorage points and infrastructural traces remain embedded in the site. The underground chamber persists as a stable void, though access may be limited. Granite structures, cistern basins, and water channels continue to shape microclimatic conditions. The site transitions from active occupation to selective reuse and ecological integration. the site is refuge for the iberian ibex, spanish imperial eagle and the occasional hiker to stop, rest and hydrate

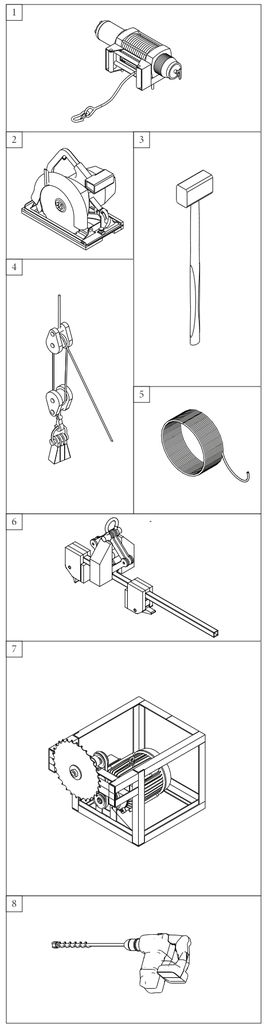
The project is no longer maintained as architecture. Excavated and constructed mineral elements, courtyard, chamber, cisterns, swales, and granite walls remain legible within the landscape. Water flows continue to follow established paths, leaving mineral and biological traces. The underground persists as a partially accessible archive. The site operates as a hydrological and geological memory, with residual spatial order readable through terrain, and ecological patterns. overgrown with shrubs, trees through the long term saturation.

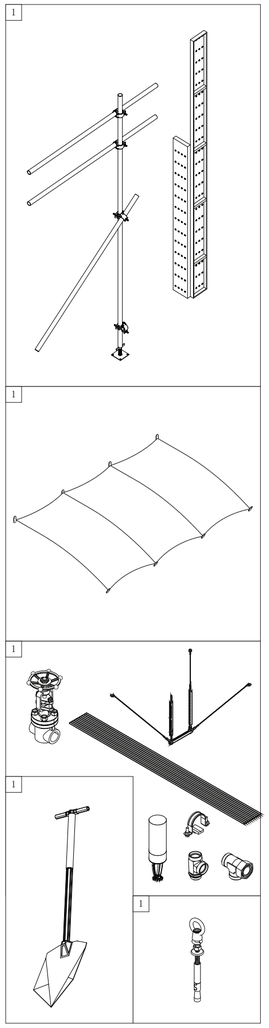


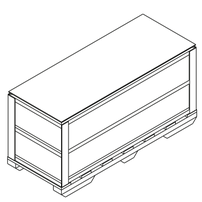
SECTION 04 THE DESIGN



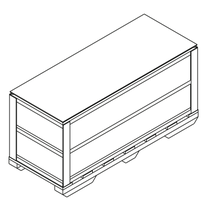




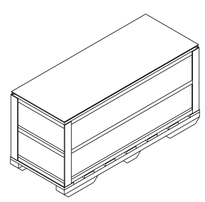




Energy Crate 658 kg
2200 x 1100 x 950 mm



Construction crate 328 kg
2200 x 1100 x 950 mm



Shelter crate 327 kg
2200 x 1100 x 950 mm



Energy crate			
vertical axis turbine head	1	180 kg	3500 mm (7 kW)
lithium battery modules	4	61 kg	550 × 350 × 200 mm
field server	1	85 kg	800 × 600 × 1200 mm
charging station	1	24 kg	600 × 400 × 700 mm
inverter + dc control cabinet	1	18 kg	500 × 300 × 600 mm
backup generator	1	42 kg	650 × 500 × 550 mm
disel feul canister	10 L	8,5 kg	350 × 180 × 470 mm
satellite communication node	1	8 kg	80 × 380 × 70 mm
Construction crate			
electric winch	3	50 kg	1.2-1.5 ton electric drum
circle saw (stone cutting)	1	14 kg	700 × 350 × 450 mm
diamond blades	15	18 kg	Ø350 mm blades
sledge hammer	1	7 kg	800mm length
pulley system	5	18 kg	2 ton capacity
steel cable reel	1	24 kg	500 × 500 × 120 mm
rail-mounted stone cutting carriage	1	36 kg	800 × 400 × 300 mm
stone lifting clamp	2	12kg	1.5 ton capacity
rotary hammer drill	1	9 kg	550 × 120 × 280 mm
Shelter crate			
scaffolding			
large stainess steel pipes	5	14 kg	4000 mm
small stainless steel pipes	5	5 kg	2000 mm
connection elements	10	1,2 kg	pipe clamps
footings	6	6 kg	adjustable base shoes
stainless steel panels	10	22 kg	500 mm
tensile membrane	5	26 kg	800 × 450 × 450 mm packed
rock anchor kit	1	8 kg	M16 / M20 expansion anchors
excavation shovel	1	2,5 kg	1000 mm
pipe kit	1	20 kg	

First Arrival

The inhabitation process are initiated by a crew of five who climb the mountain together to reach the site identified in the initial survey. This operation requires specific planning and coordination, with an added level of tolerance for the unpredictability of rapidly changing conditions in the mountains. What is brought is negotiated and precise. This drawing records that constraint. Each element is selected against the carrying capacity of a single utility helicopter, in addition to what can be carried on each member's personal hiking capacity. What cannot be flown must be transported by land through an established network of dirt roads, initially by a capable off-road vehicle or traditionally by pack mule. Weight, volume and sequence of assembly determine what the project will become.

Tools for cutting and splitting granite, extraction components, anchoring systems, lightweight structural elements, temporary shelter components, energy systems and measurement equipment are categorized into designated crates. Each item is chosen for its importance to inhabitation and monitoring, and its versatility to serve multiple roles at once and be metabolized in the construction phases that follow.

The crew's expertise guides this operation, relying heavily on local guides who lead based on their lived experience of this territory. None of these crew members is a builder in the traditional sense, because construction in this territory requires a unique skill set that is, in essence, cross-domain. The goal is to establish the conditions for building, to make the first cut.

As a result of careful organization and planning, securing initial shelter, ensuring water security, and setting up the technical and mechanical equipment is quick, allowing experts to start their work and share insights into material conditions such as ground stability, water flow rates, beneficial fractures in the granite outcrops, and calm climatic zones. What is missing must be gathered and manufactured by the territory itself.

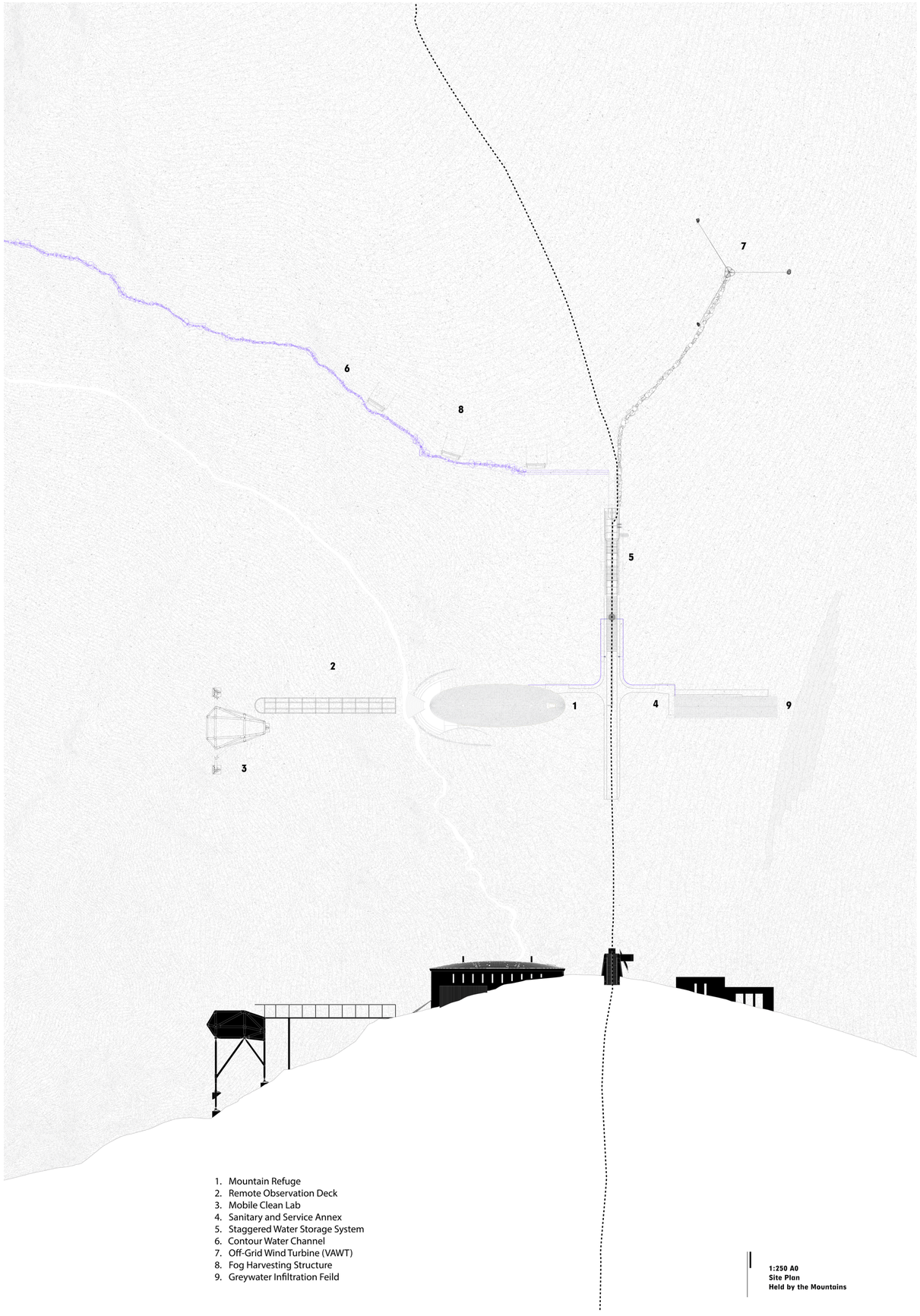
Potential Crew

Geological technician
Interprets ground qualities, identifies fracture patterns in the granite, and evaluates aquifer potential.

Masonry expert (dry stone specialist)
Directs extraction and construction using on-site material. Overseeing splitting, dressing, and placement of stone.

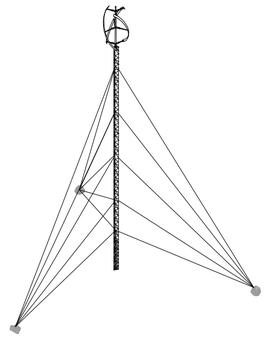
Field researcher (generalist / technician)
Coordinates data collection, documentation, and communication systems. Manages equipment, maintains operational continuity of the outpost.

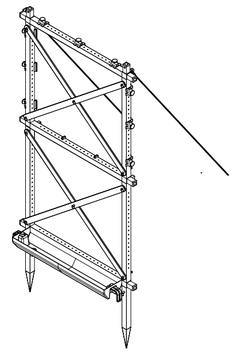
2 Local guides (territorial knowledge)
Provides knowledge of terrain, climate, and access routes. Advises on seasonal conditions, safe movement, and material availability. Supports logistics, transport, and decision-making based on experience in the region.



1. Mountain Refuge
2. Remote Observation Deck
3. Mobile Clean Lab
4. Sanitary and Service Annex
5. Staggered Water Storage System
6. Contour Water Channel
7. Off-Grid Wind Turbine (VAWT)
8. Fog Harvesting Structure
9. Greywater Infiltration Feild

1:250 A0
Site Plan
Held by the Mountains





OFF-GRID COMMONS

A system of resource negotiation

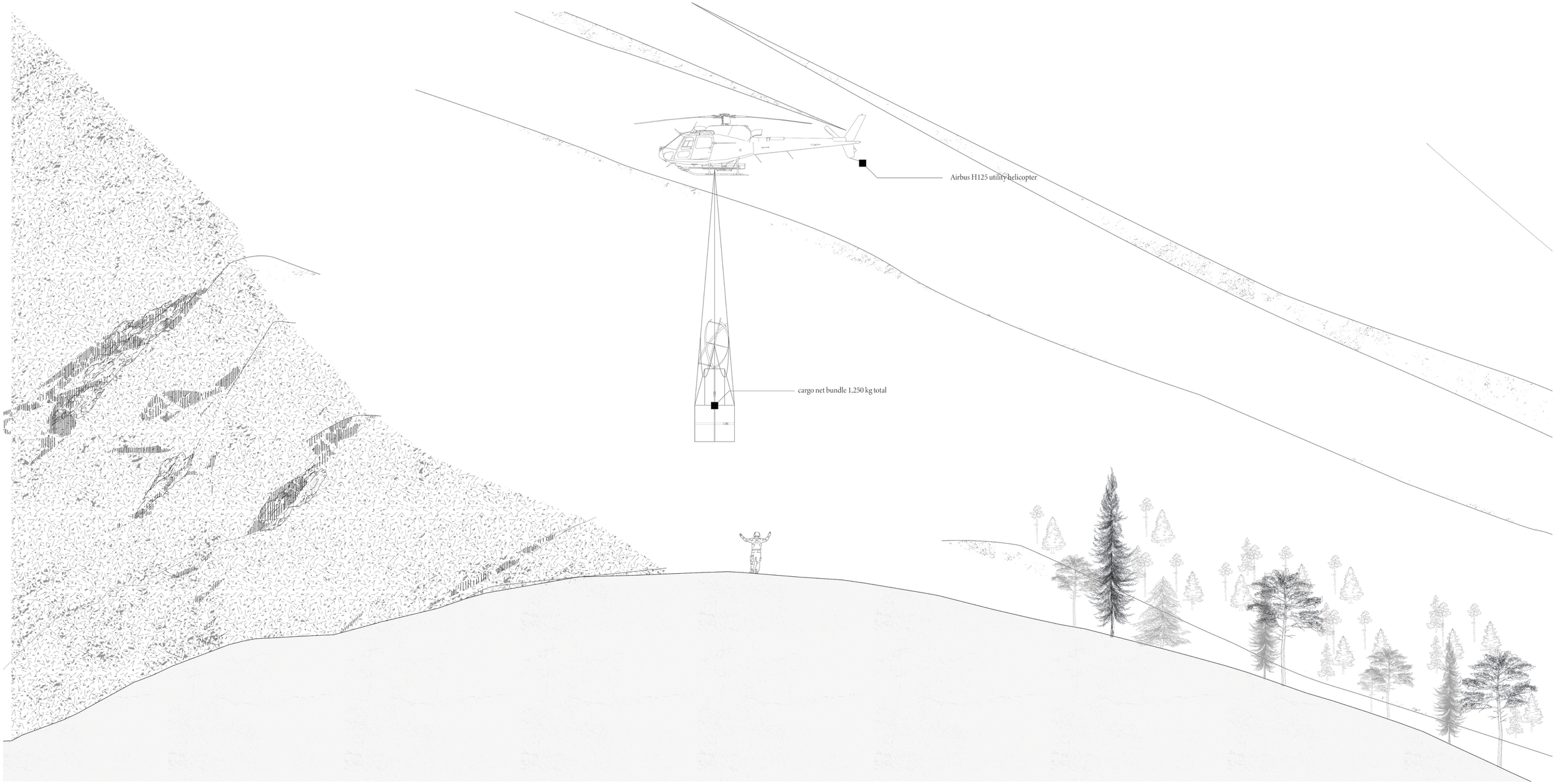
The situation plan is conceived as a territorial system that operates independently from city infrastructure out of necessity. Negotiation stems from the acknowledgment that water, electricity, material, human labour and waste are both valuable, finite and at times, scarce.

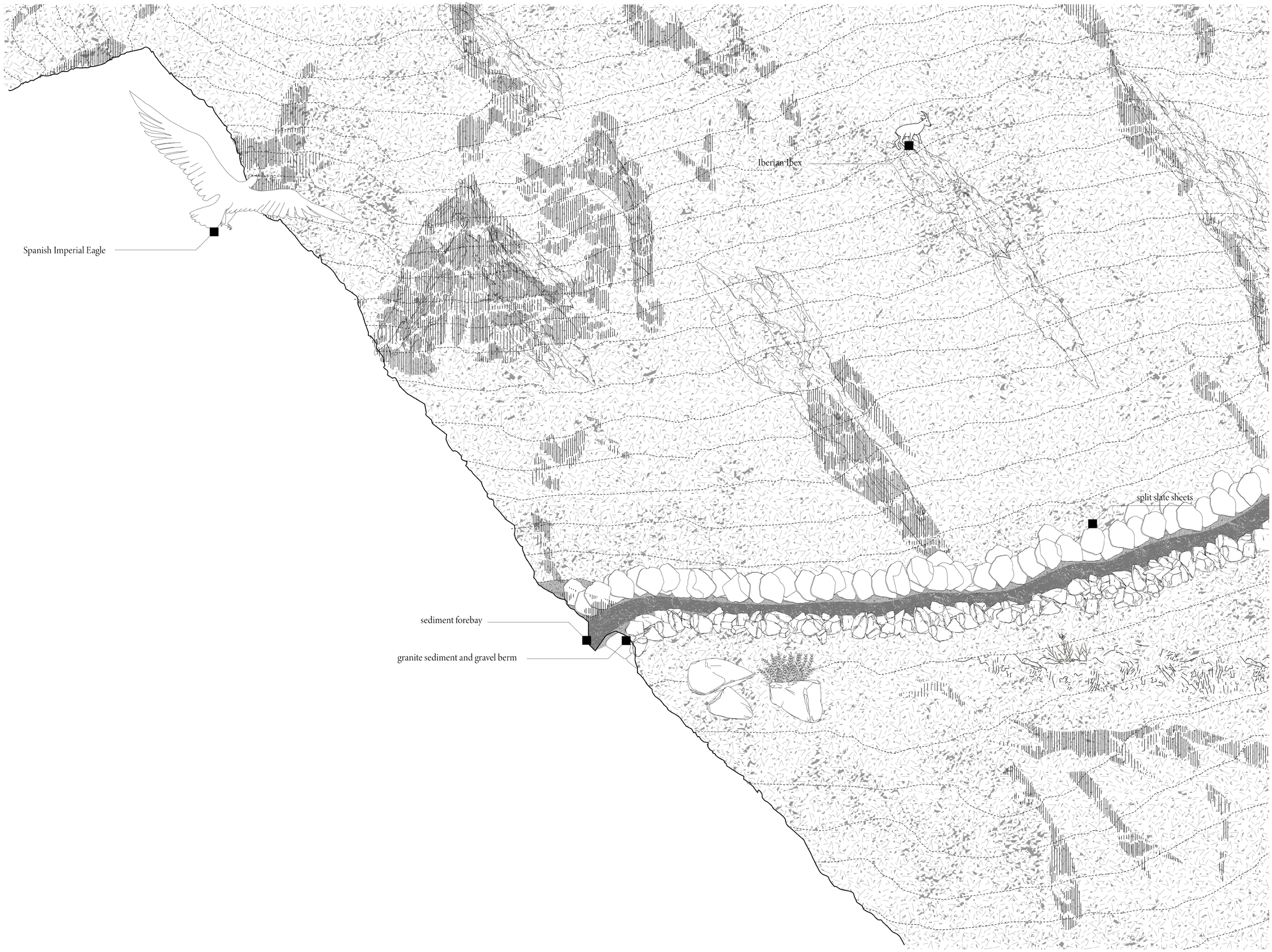
Each component of this system is integrated based on its efficiency within the territory's elemental conditions, its ability to provide refuge, and its capacity to be metabolized in practice and by the territory over time.

A 350m contour swale retains 100-180 m2 of water during rainy periods, having the potential to bring the cisterns to full capacity. Seasonal conditions dictate that in summer months, there are likely prolonged periods of drought when the water stores need to be monitored and negotiated. Fog collectors are a component of this system for that exact reason: they collect water that requires little filtration and remains productive during periods of minimal rainfall. A total of 4 fog collectors with an active mesh area of 24 m2 produce between 25 and 120 L/day during productive periods.

Research practices drive the refuge's energy demand. These practices are prioritized over creature comforts. A 3kW vertical axis wind turbine (VAWT) supplies this demand with an estimated 12-15 kWh/day. This supports essential electrical demands, such as a small refrigerator, an electric stove, and a server. The outlets on the operational kitchen table are prioritized secondly, and water heaters and artificial lighting last.

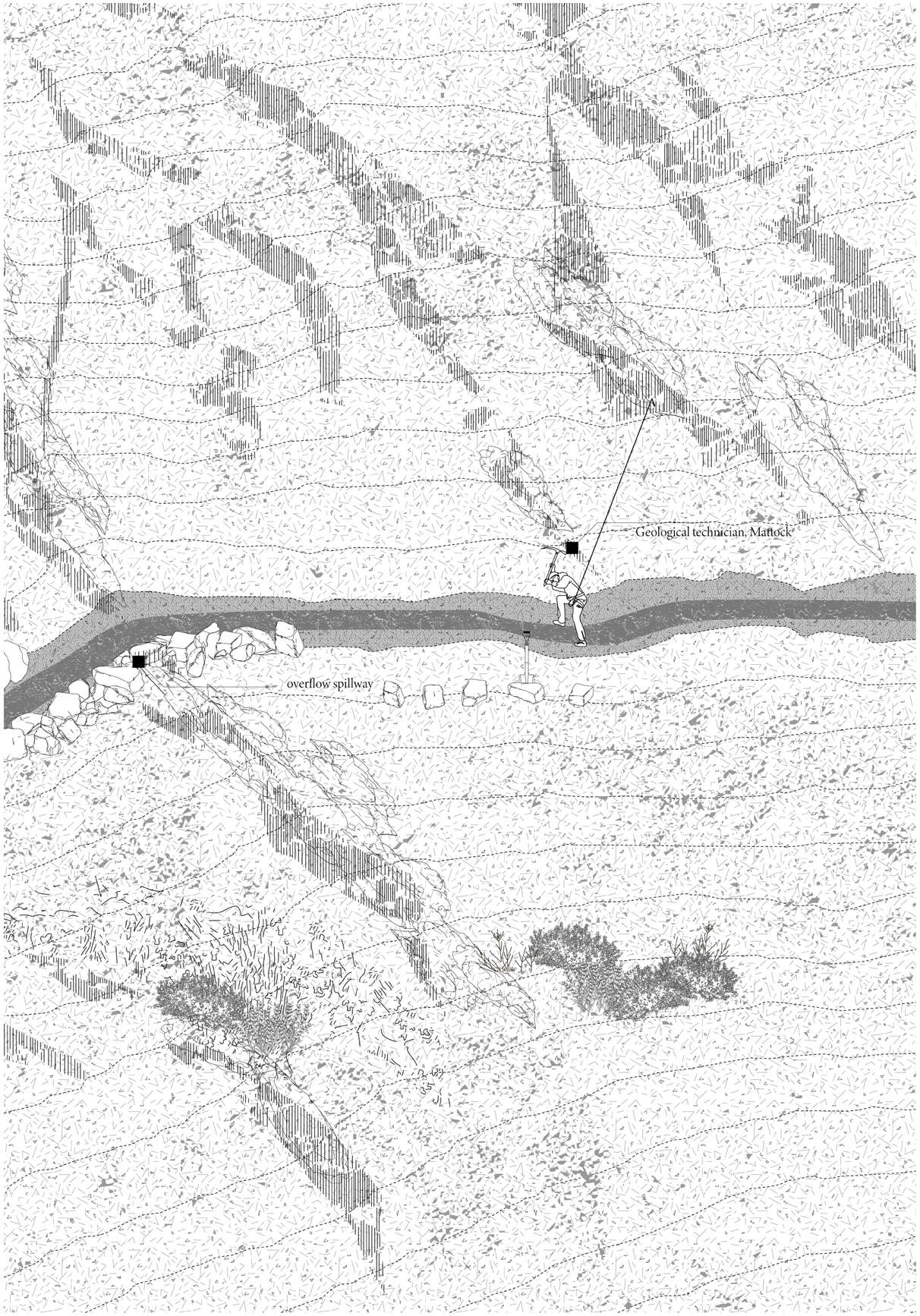
Alongside these technical systems, the refuge depends on an economy of waste and seasonal practices. Timber is collected through active forest management, where thinning is practiced. This is stored and kept dry during the winter months, when heating demand rises. Chimney ash is used in the operational kitchen as a filtering agent and reintroduced to nutrient-deficient forest soils. Grey water is filtered to remove oils and used to hydrate vegetation. Human waste is composted and metabolized by the landscape. This approach reframes waste as a reparative catalyst and defines the long-term maintenance strategy as necessary practices rather than charity.


Airbus H125 utility helicopter
cargo net bundle 1,250 kg total



Water Point
Contour Swale

Northern Edge
1:100
Phase 1

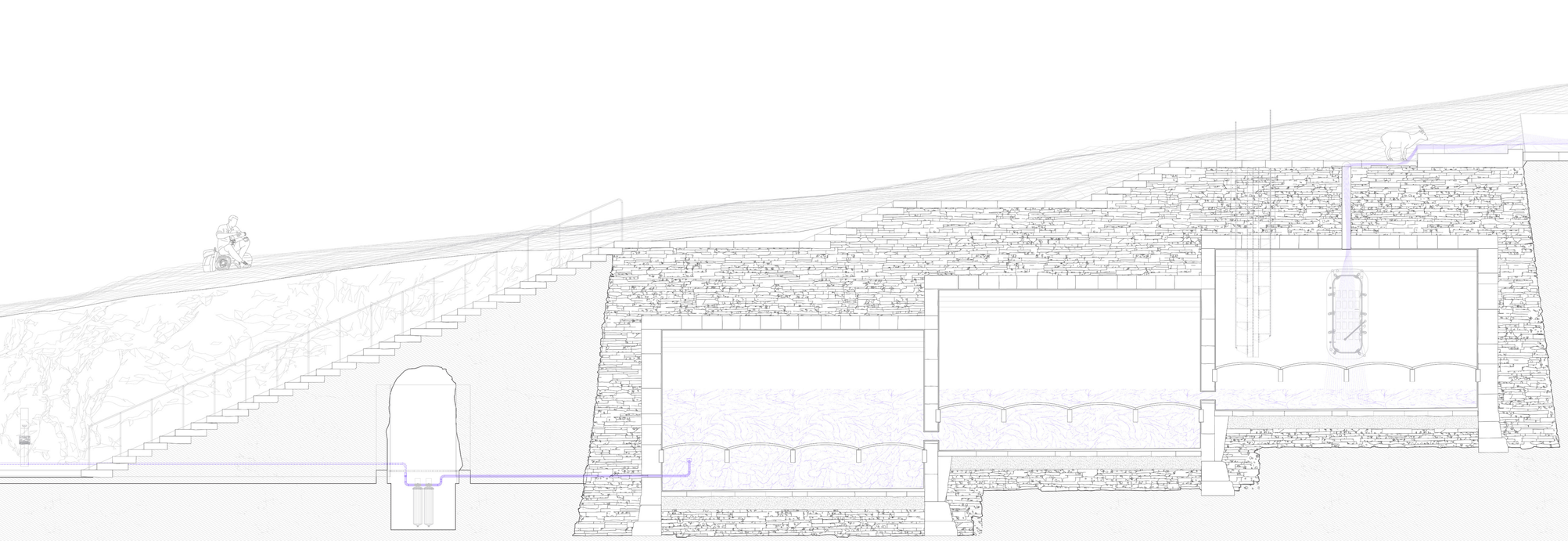




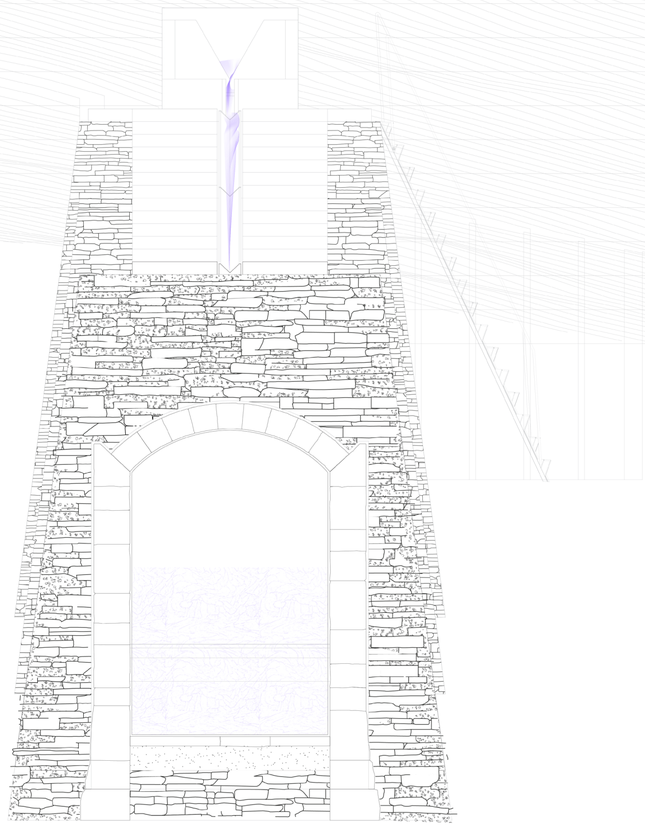
Film Photograph of the Northern Slope Site Boundary taken at 1400 meters

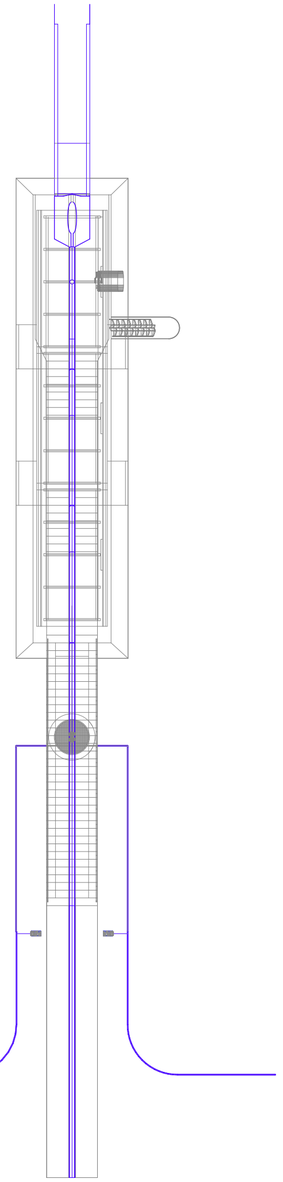
Water is the first move

Water security starts with a shallow line cut into the slope. This intervention can be placed where water has an accelerated runoff rate, in this case by delaying the water through accumulation in an incision in the landscape, which concentrates rainfall events and snowmelt runoff and directs it to water cisterns where it is held. A series of loosely packed stone and coarse aggregate dams are constructed along the contour at intervals. This functions as a localized check dam that reduces flow velocity during heavy rainfall events and blocks sediment debris, initiating the filtering process. Additionally, localized diversion dams can be activated to divert water during prolonged, intense rainfall when the system depth from an overflow condition section is between 400 and 600 millimeters and has an average retention capacity of between 100 and 180 cubic meters per filling event. This retention capacity can be adjusted drastically by a slate panel lining that can be actively adjusted to the desired infiltration rate. In more volatile years, when conditions are more stable, a balance can be found between water capture and infiltration. In both cases, this becomes a reparative infrastructure through delay, stabilization of fragile slope soils, and increasing moisture retention. Simultaneously, establishing water infrastructure for the refuge has the benefit of reducing stress on the downstream reservoir system, EL Atazar. Ultimately, establishing a more resilient ground condition for the systems in the phases that follow. Gravity material and its integration into the site's water gradient are the starting points for the design.



1:50 900, 594
Cistern Section
Held by the Mountains





HOLDING WATER

A cistern system, from runoff to commons

The gravity-powered cistern system is embedded in the slope along the existing hiking route. Along this path, this infrastructure enters into a relation between the mountain and living participants in the Sierra Norte mountain landscape. Water arrives through rainfall, runoff, and fog capture, carrying water and thermal energy through seasonal variation. The staggered design creates a connected filtration system composed of porous terracotta tiles that allow water to pass but stop debris and sediments.

A Weir at the start of the system allows flow rates to be accurately measured for territorial monitoring, enabling variations to be recorded and compared, producing knowledge at two levels: the passive observer and the active researcher. This water flows to its first destination, a shallow basin carved from a slab of granite obtained during extraction, a feature that provides water security for the non-human, a drinking point. The water then flows into the first chamber of the cistern system, where all large debris is filtered, accessible for maintenance via a lightweight ladder and watertight aluminum door, components you might find on a marine vessel.

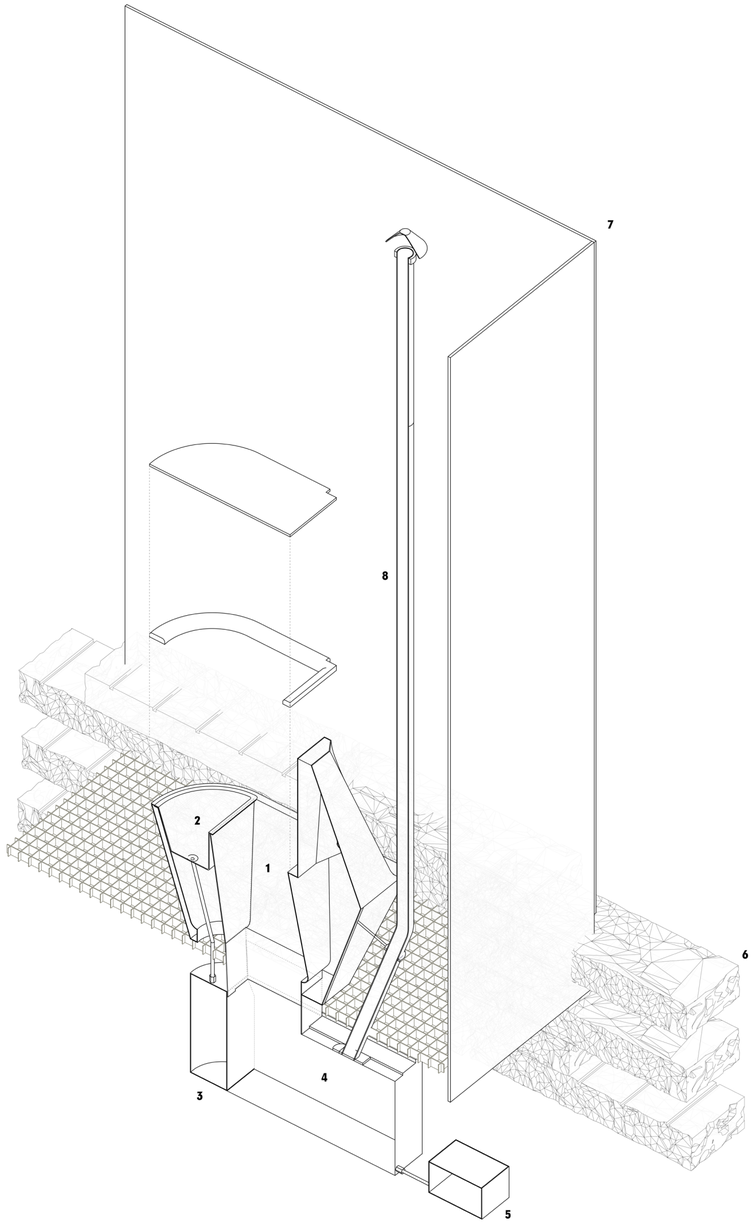
The tectonics of this architecture make use of degrees of precision, where the chamber construction is more precisely cut and carved granite components, in contrast to the variably stacked slate and granite off-cuts from the extraction process that could not find place in the construction of the main refuge wall structure, held together by dry-stacking expertise and organic material and gravels available on-site.

Water is extracted from the lowest cistern, pre-treated mountain water that needs just a final filtering in the sequence to be suitable for drinking, making its way to the water-point for human consumption, where water bottles are filled by active crew members and visitors alike, then finally, splitting off towards the refuge to the east and to the showers in the west. The water becomes legible through weir flows and an overflow channel along the hiking path.

In this sense, the system becomes a water commons, not for immediate consumption, but for drought, future occupation and non-human ritual.

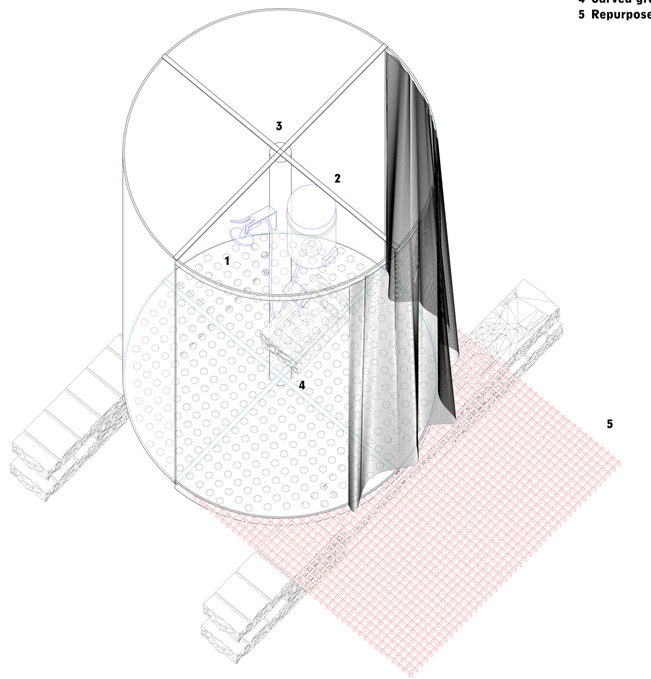
1:25 A1
Cistern Short Section
Held by the Mountains

1 Folded aluminum toilet chassis
2 Removable urie seperator
3 Unscrewable fluid waste chamber
4 Removable solid waste chamber
5 Lechate drain
6 Granite base support
7 Lightweight stainless steel wall pannels
8 Gaseous flue shaft with electric fan



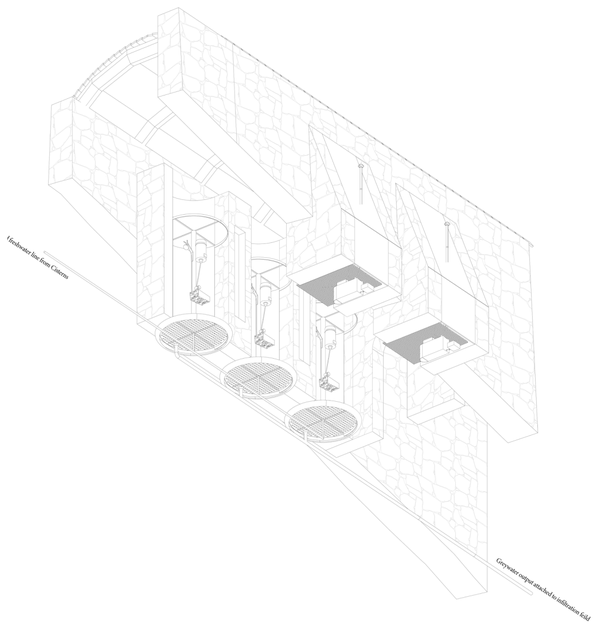
Scale 1:5, A0
Latrine
Held by the Mountains

1 Removable stainless steel shower head
2 Localized low energy electric water heater
3 Single water shaft for combined wet system
4 Carved granite water basin
5 Repurposed steainless steel construction scaffolding



Scale 1:5, A0
Alpine shower
Held by the Mountains

The Wet Room



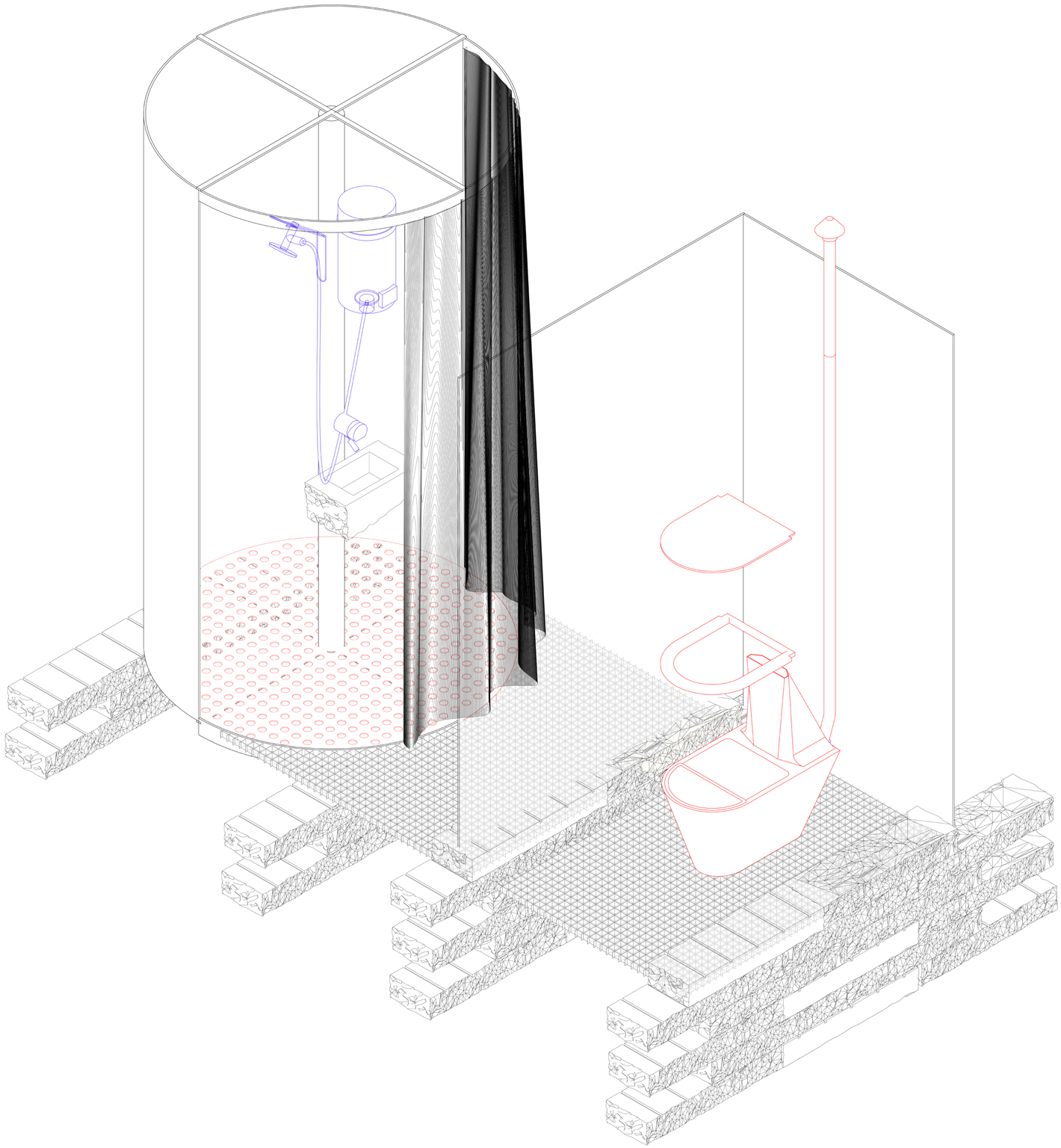
The sanitation system for an off-grid refuge is a primal human necessity, after water, this is a central pillar to what refuge means. The system consists of a compost toilet, wash basin and shower in a compact assembly, combining functions such as the shower and wash basin allow water supply through a single shaft, reducing plumbing complexity and consolidating water use. Details such as an energy efficient electric heater and removable shower head mean that water use can be negotiated and minimized. The catchment is attached to a simple grey water system directed to a controlled infiltration area downslope. If natural soaps are used exclusively, it needs minimal filtration.

The compost toilet on the other hand is entirely a dry system, this is achieved by separating solid and fluid waste at the source. This strategy keeps odor to a minimum and allows for an efficient compost reaction. The practice of using the restroom becomes a ritual where a handful wood-chips are thrown into the solid waste chamber after each use, which maintains aerobic conditions. The use of local ground worms and a vertical ventilation pipe that is both naturally and mechanically ventilated makes this a robust system that can endure over the long-term.

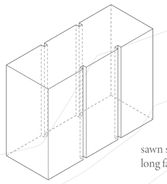
The compost process produces a nutrient-rich output. This is where the waste can become a reparative practice, by introducing this output into the surrounding forest soil, waste is treated as a resource that supports regeneration of first stand forests which are notoriously nutrient deficient, through monitoring and mapping these nutrient deficient locations during forestry surveys, the concept of refuge extends to regeneration of the natural environment.

Material choice and assembly were essential to this design, constructed from folded stainless steel and aluminum components. The system is lightweight, corrosion resistant, and designed for disassembly. Parts can be transported in modules, carried by hand or pack animal, and assembled on site without specialized equipment.

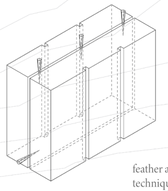
This system is self-contained, independent of sewer infrastructure, hygienic, and adaptable over time to accommodate more modules. Later phases of the project need roughly 3 showers and 2 toilets to accommodate teams of 8-10 people. These features of the design support a long-term cycle of use, maintenance and eventual removal from the site.



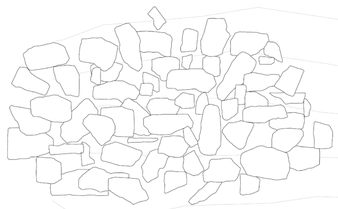
Scale 1:8, A0
Wet Room
Held by the Mountains



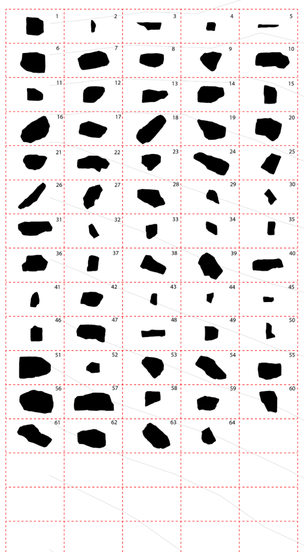
sawn sides to seperate
long faces,

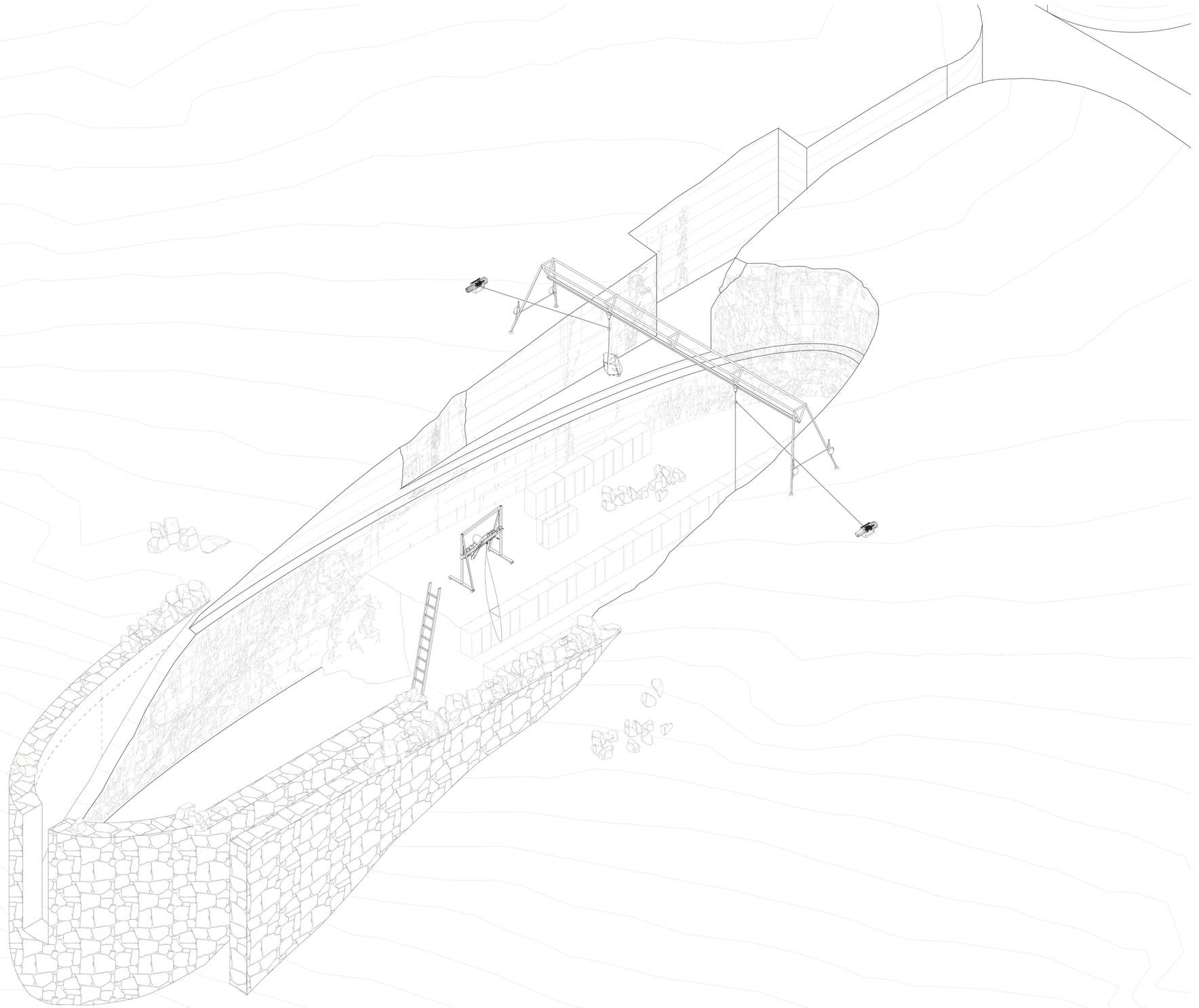


feather and plug splitting
technique rough geometric
texture





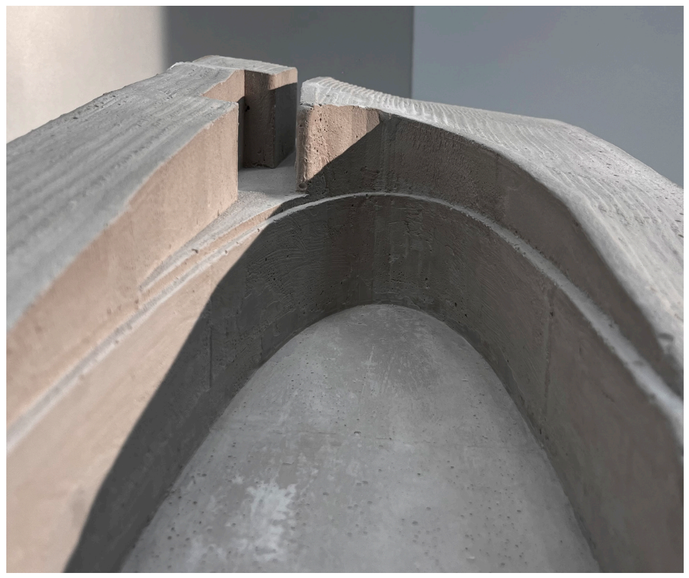




1:50 A0
Non-Extractive Approach
Held by the Mountains



Cast Gypsum Non-extraction model
Scale 1:50
910, 265 mm



NON-EXTRACTION

A non-extractive approach to architecture is the acknowledgment that architecture carries with it a material consequence: every wall, roof, pipe and foundation implies an extraction and transport from somewhere else. “Shouldn’t the pit, however, also fall within our definition of architecture, and by rights be entitled to the full consideration as part of the architectural process itself (Space Caviar, 2021).

By treating the extracted volume space-making itself, it allows the architecture to become durable, more thermally stable and less dependent on imported systems that come with an energy cost. The extracted granite is then metabolized by the refuge as monolithic walls, floors and stairways.

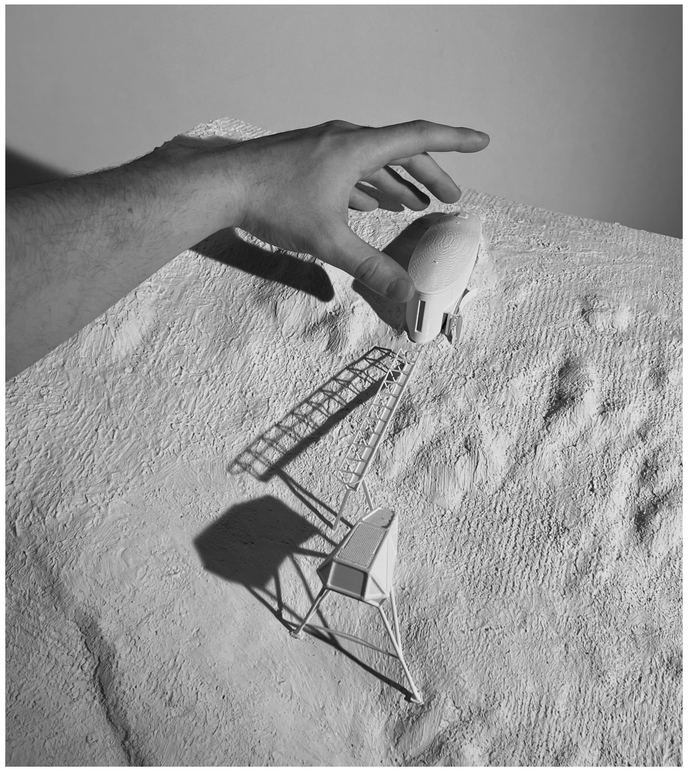
The practice of extraction and the true expense of the construction are therefore localized and legible. The principle of degrees of precision is adopted, employing a combination of contemporary and traditional techniques, where cutting, splitting, shaping, and the residual off-cuts all become part of the process, to be used only where needed. The equipment on site consists of lightweight construction, wire saws, plug-and-feather splitting tools, and electric hoist systems. These methods inherently produce a variety of more and less precise granite stones and further define the tectonics of the design, accounting for a high tolerance for fracturing due to site conditions.

I argue the landscape desires hydrological delay; this function is the primary fragility of the ongoing transition as climate volatility climbs. Ultimately, this space will hold water and provide refuge over the thousand-year life of the project. In this sense, the project considers embedding as both a spatial and an ethical decision: an approach to inhabitation that is part of the water gradient and material intelligence, rather than separate.



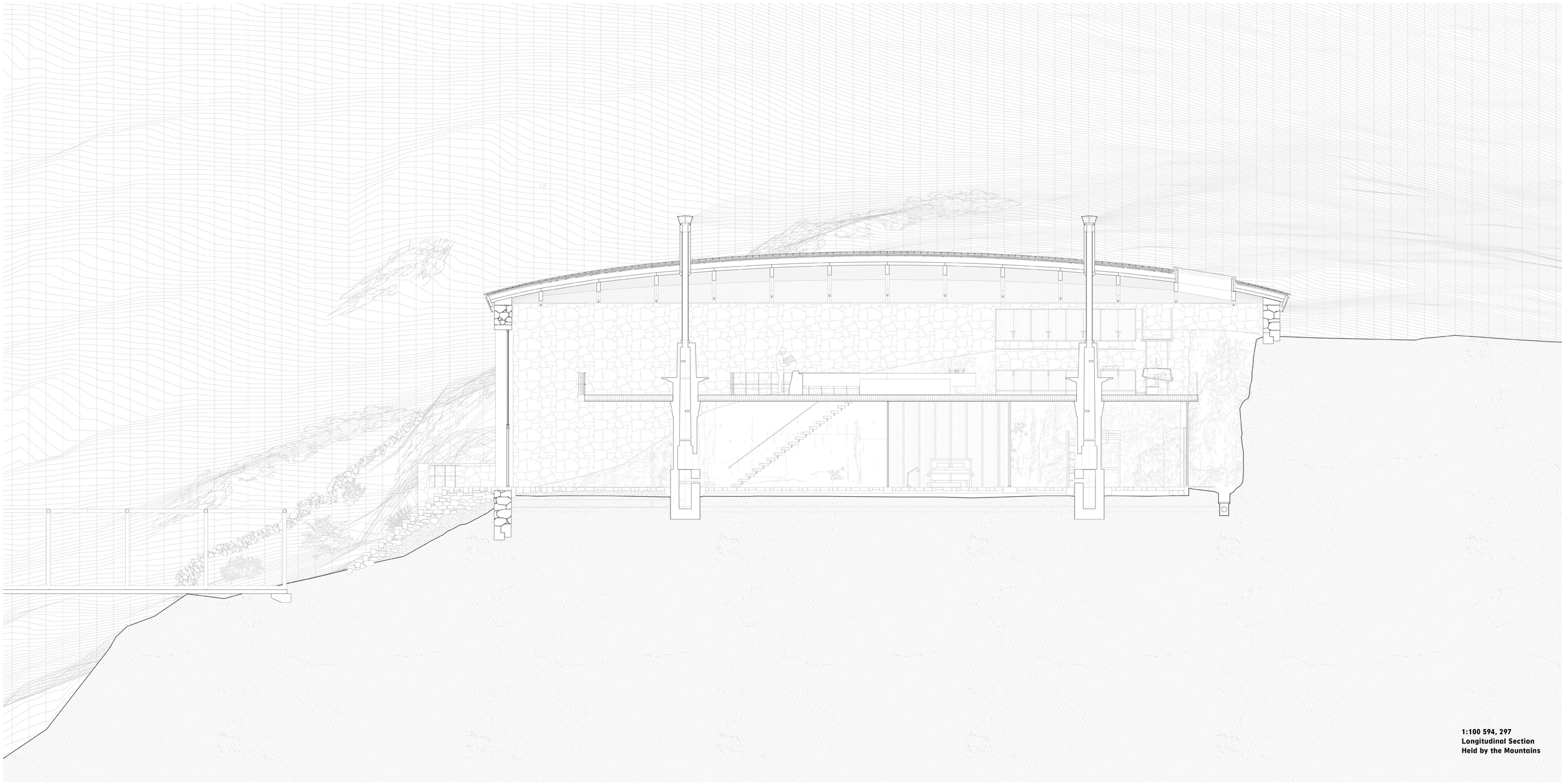
Embedded Refuge Model
Scale 1:250
600, 600, 290 mm
High-resolution 3D terrain prepared with Lidar Dataset,
CNC cut XPS
Gypsum-based Filler Finish



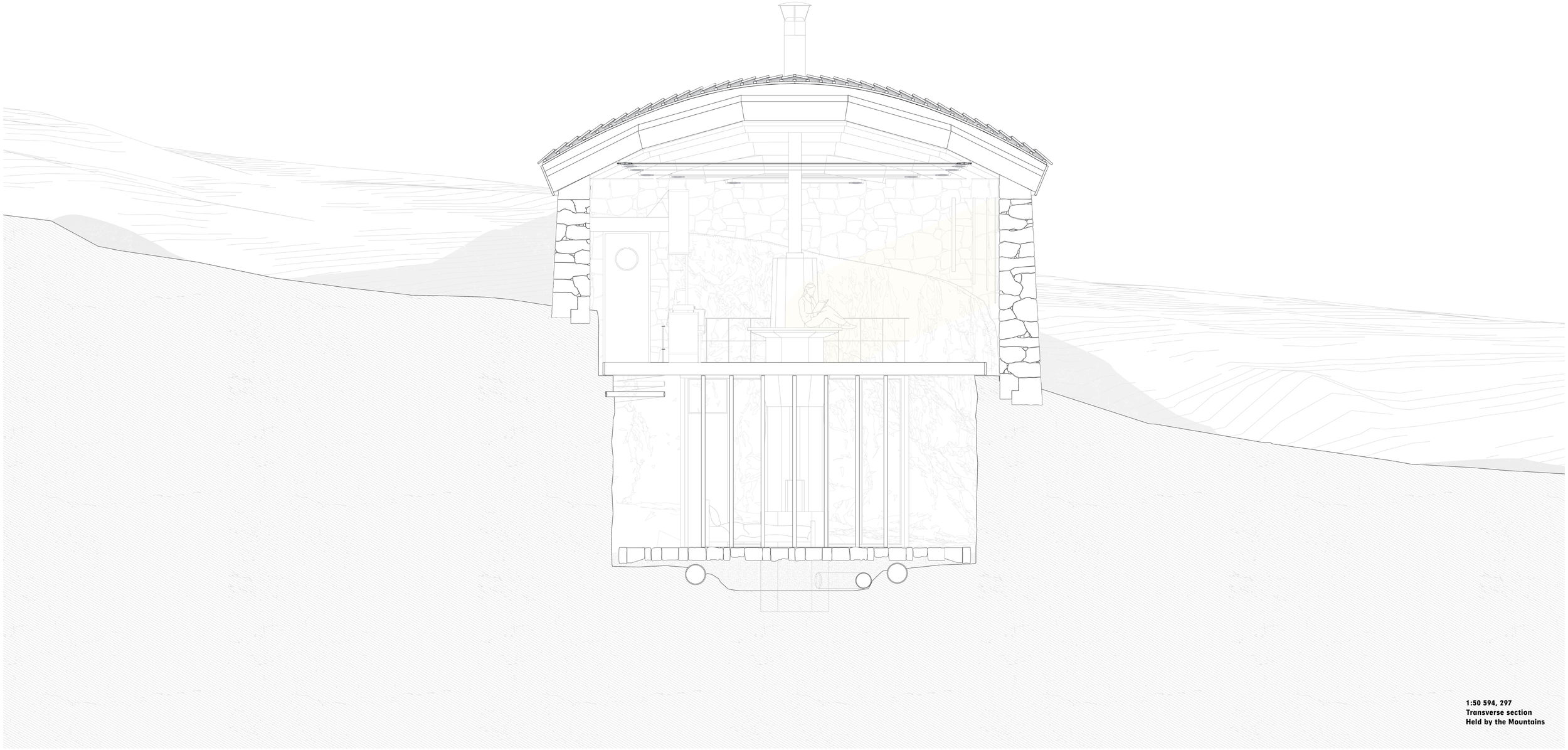




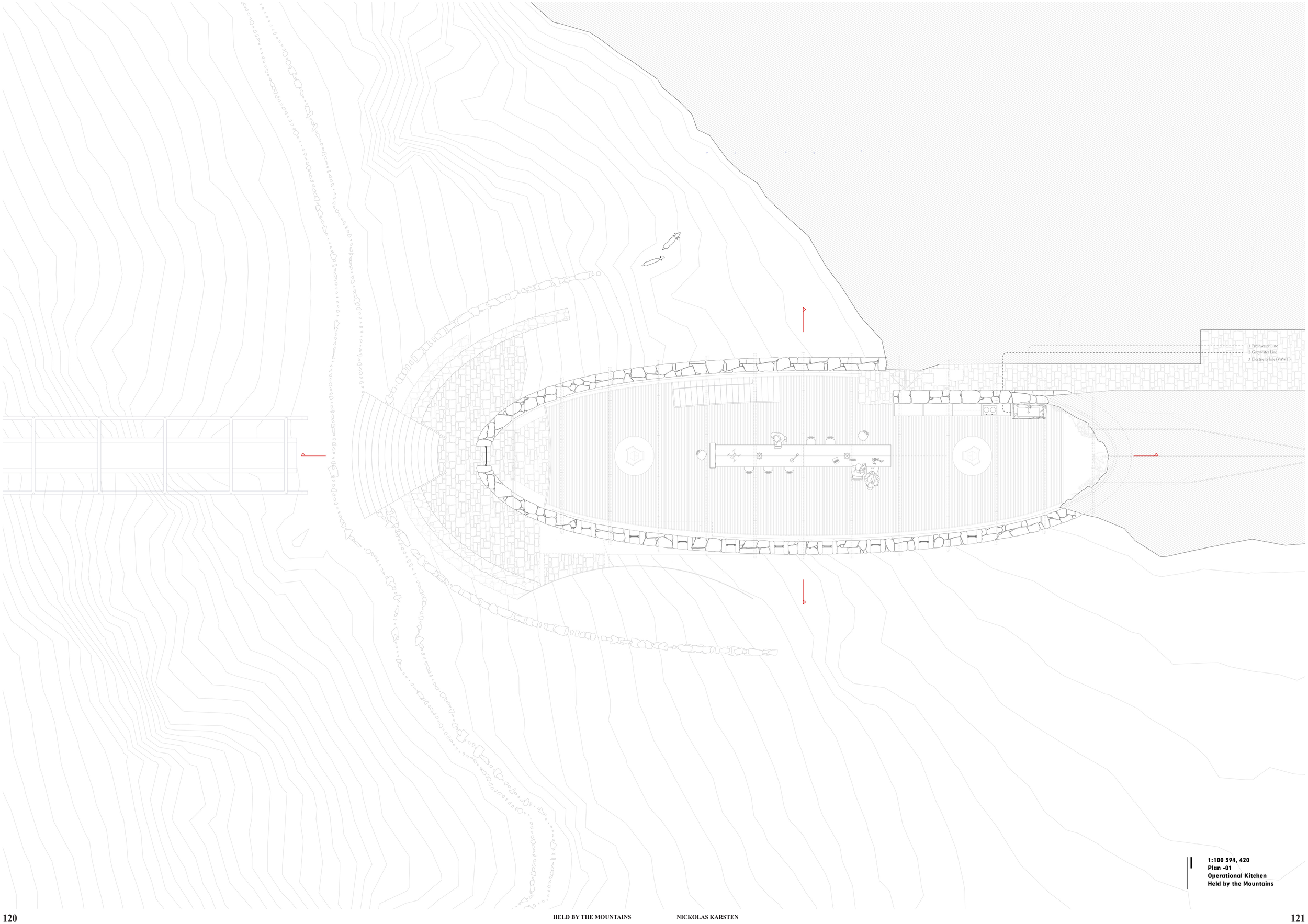




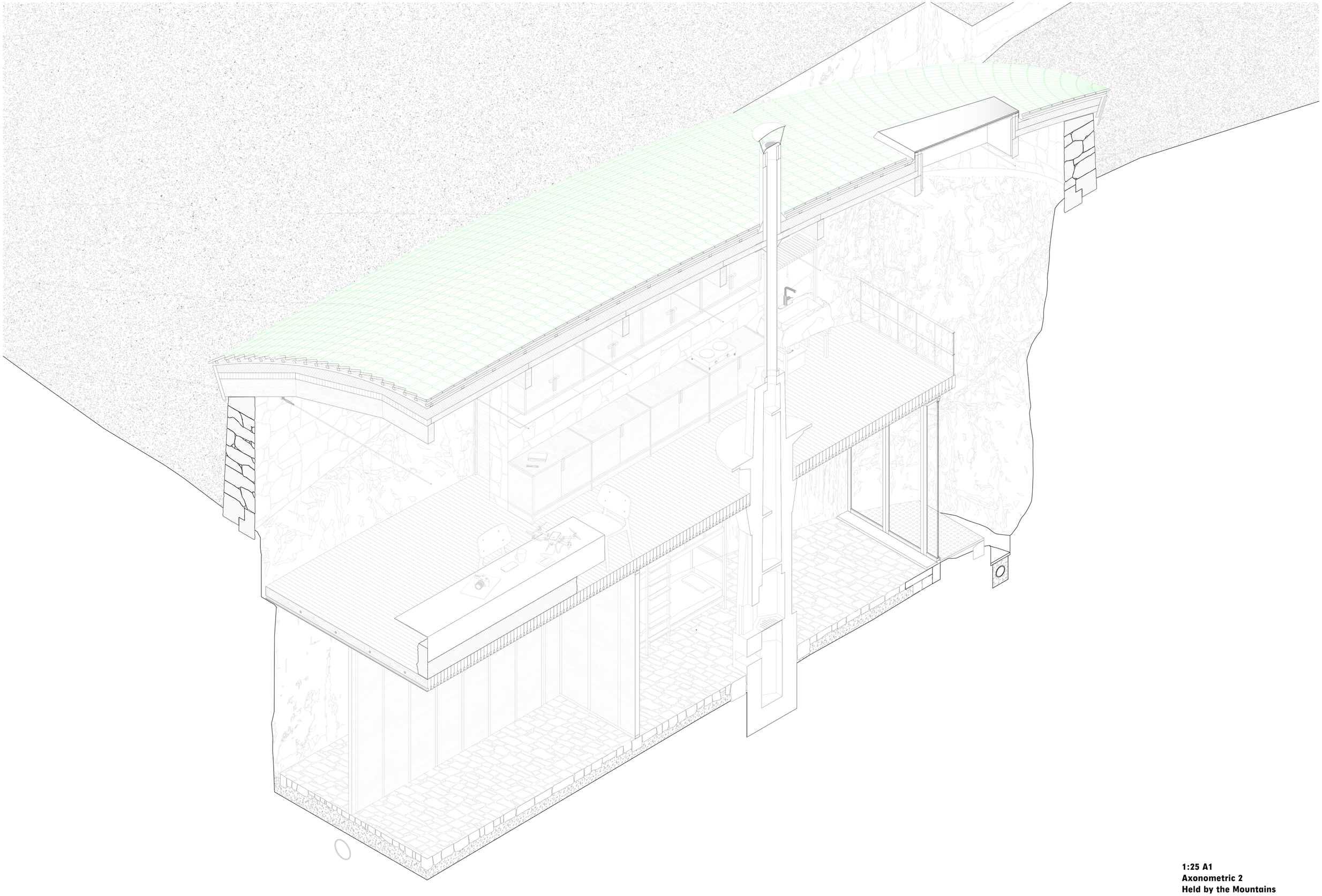
1:100 594, 297
Longitudinal Section
Held by the Mountains



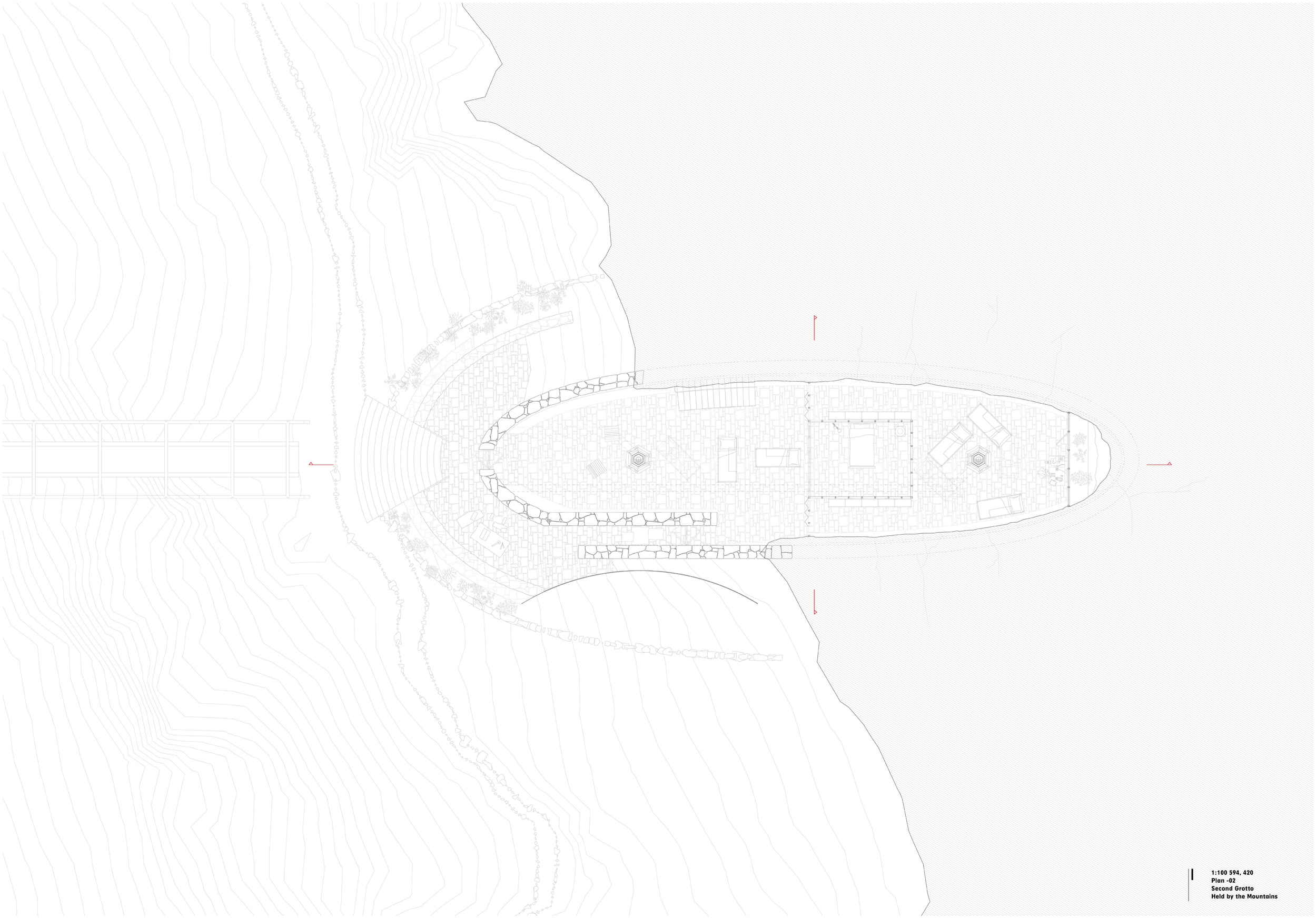
1:50 594, 297
Transverse section
Held by the Mountains



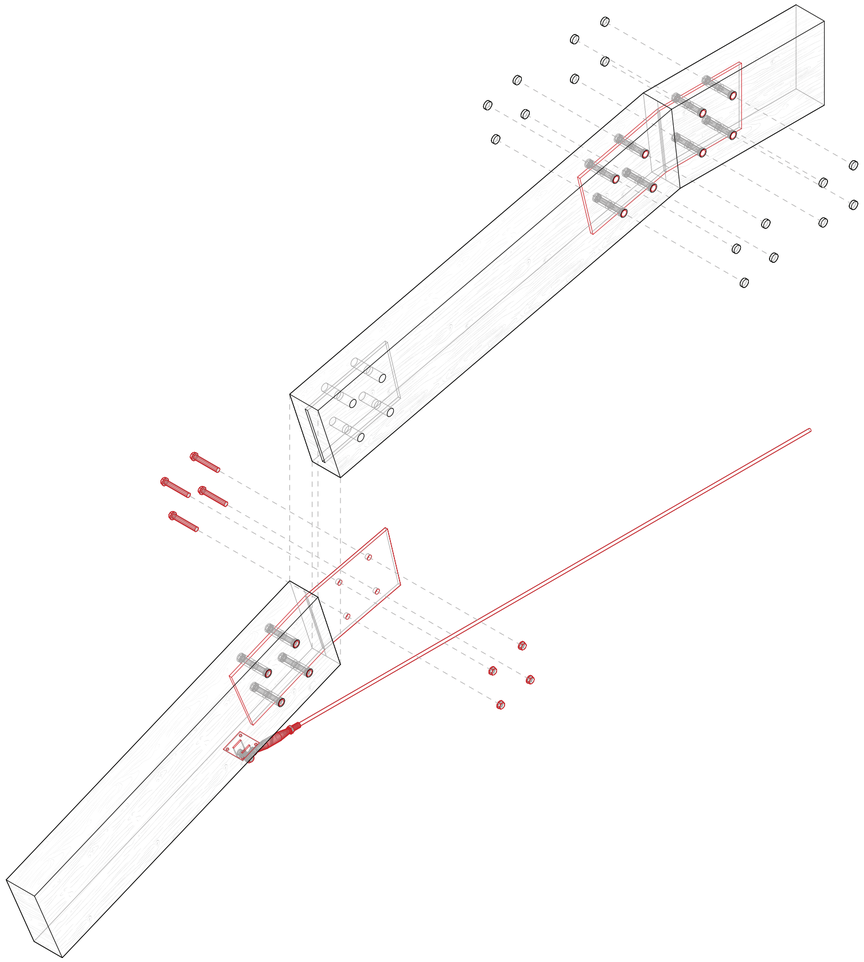
1:100 594, 420
Plan -01
Operational Kitchen
Held by the Mountains



1:25 A1
Axonometric 2
Held by the Mountains

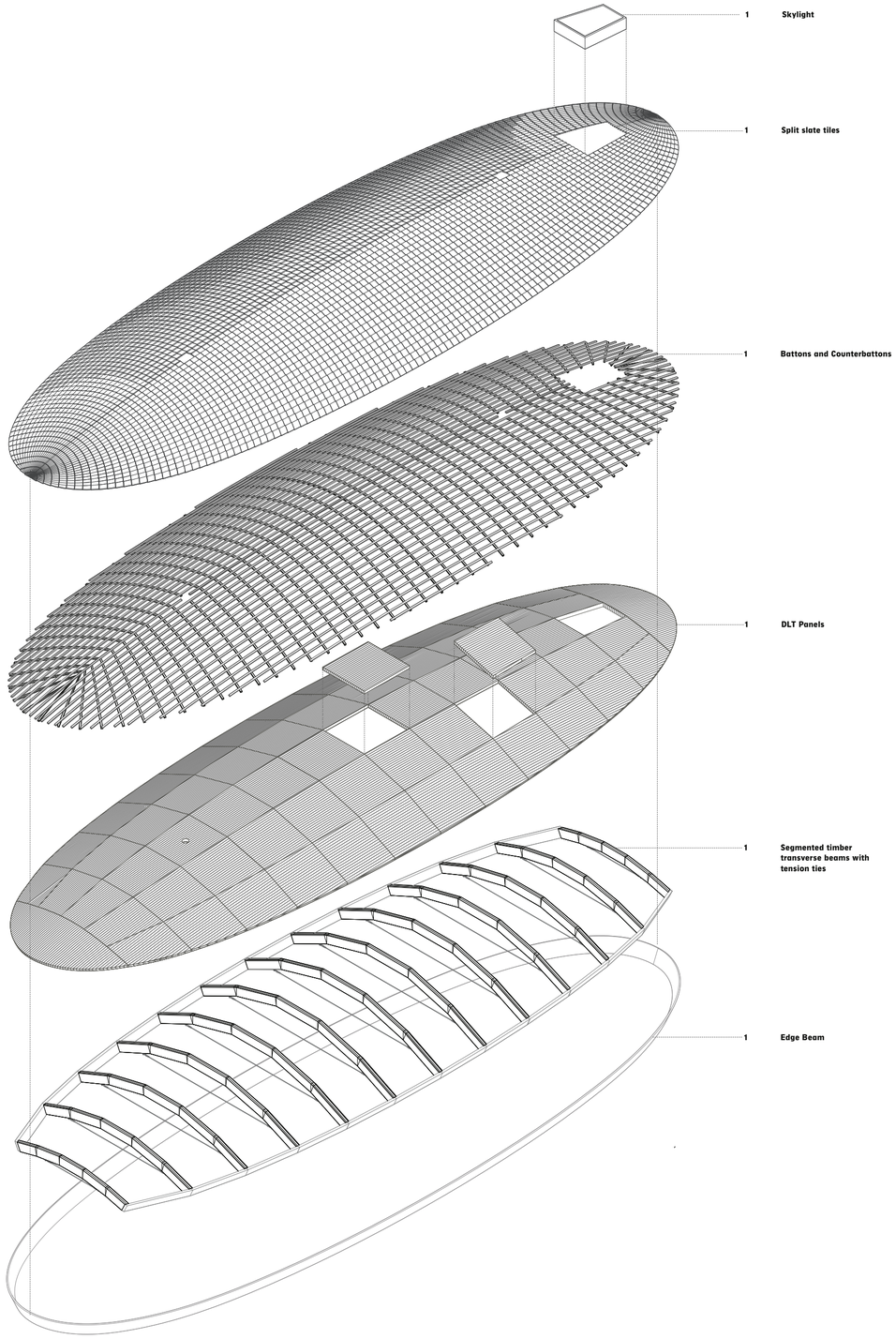


1:100 594, 420
Plan -02
Second Grotto
Held by the Mountains



The roof construction is designed as a vessel-like ellipse to adopt an acceptance mindset, given exposure to wind and water throughout the seasons can be extreme and volatile. The curved surface sheds water efficiently and is aerodynamic, reducing wind loads.

The superstructure is composed of segmented timber roof beams and a DLT panelling system between the bays, which allows each piece to remain light for transport and construction logistics while approximating the desired curvature of the roof. Hidden stainless steel plates with hidden bolted connections between plates conceal the connection, and tension ties connect the beam across its span, which nearly eliminates horizontal thrust on the variable granite walls. In this way, the loads are transformed into compressive forces. The battens are oriented with respect to the path of the water to make shedding efficient and to allow for a robust thousand-year split-slate roof construction, taking precedent from Architectura Negra and other mountain typologies that have outlasted human occupation. The edge condition is made robust with an edge beam and a sacrificial timber weathering layer. In total, this strategy is heavy, robust and repairable.

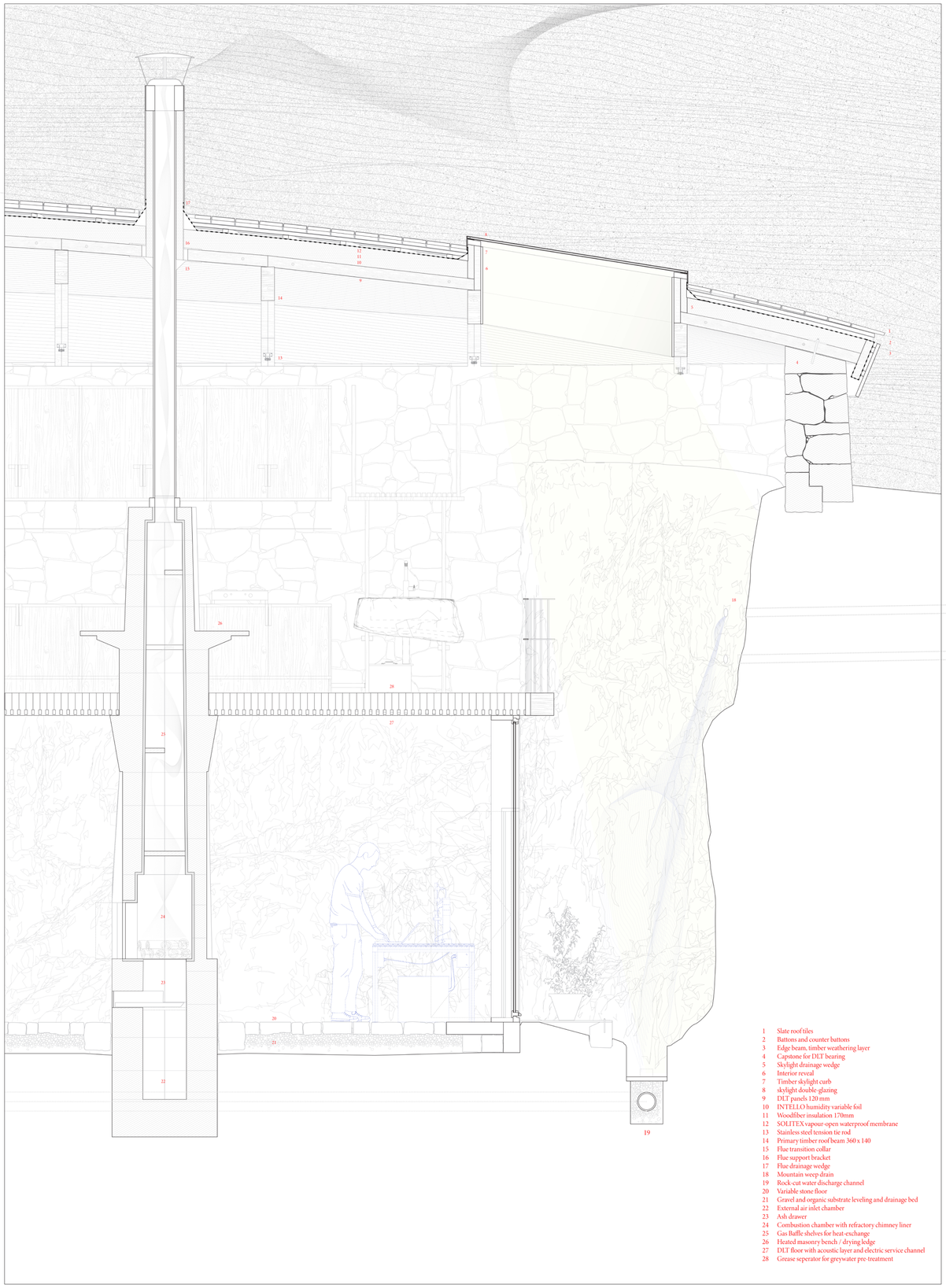


1:50 A0
Exploded Axonometric
Vessel-like roof structure
Held by the Mountains

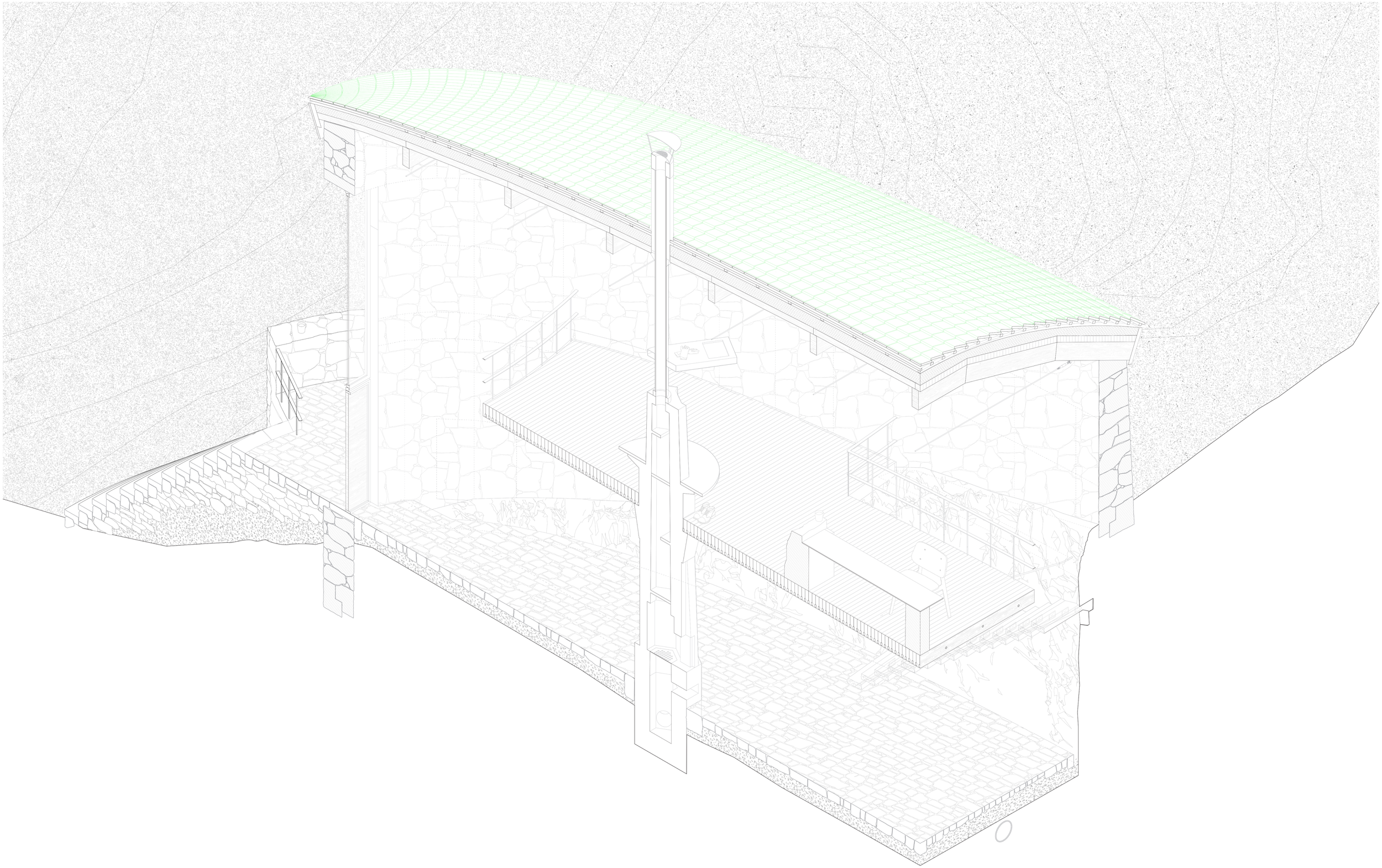
The embedding detail illustrates how architectural performance can make natural mountain processes legible and create a relationship between inhabitation and vibrant matter. Doing more with less in this context means that spatial atmosphere and tectonic logic are generated by the extracted volume by embedding the refuge in the terrain. The skylight illuminates the underground and the seasonal processes of the mountain-water gradient, and the main drain carries water through the building and outside to a planting strategy to the west.

The variable granite wall has a 3% tapering as it rises, taking insight from ancient stone construction strategies for lasting and robust tectonics. DLT flooring is seated on the extracted rock ledge with an EPDM pad, reducing additional structural requirements and acts as another feature of the embedding strategy.

Unlike the wall logic, the roof tectonics are layered to manage moisture, maintenance and ventilation. An INTELLO humidity variable membrane is used as it is seasonally adaptable, allowing vapor transfer in the summer months and limiting vapor transfer in winter. This is a resilience strategy through seasonal drying cycles in the summer. A breathable waterproof membrane protects the roof from moisture damage. The underground floor is designed with a variable stone floor as it is a durable, low-maintenance surface that is intended to endure for centuries.



1:12.5 A0
Detailed Section A-D
Mountain Habitation
Held by the Mountains



1:25 A1
Axonometric
Held by the Mountains



14:23, February 2032 — Snowstorm
Exterior view from the mountain approach



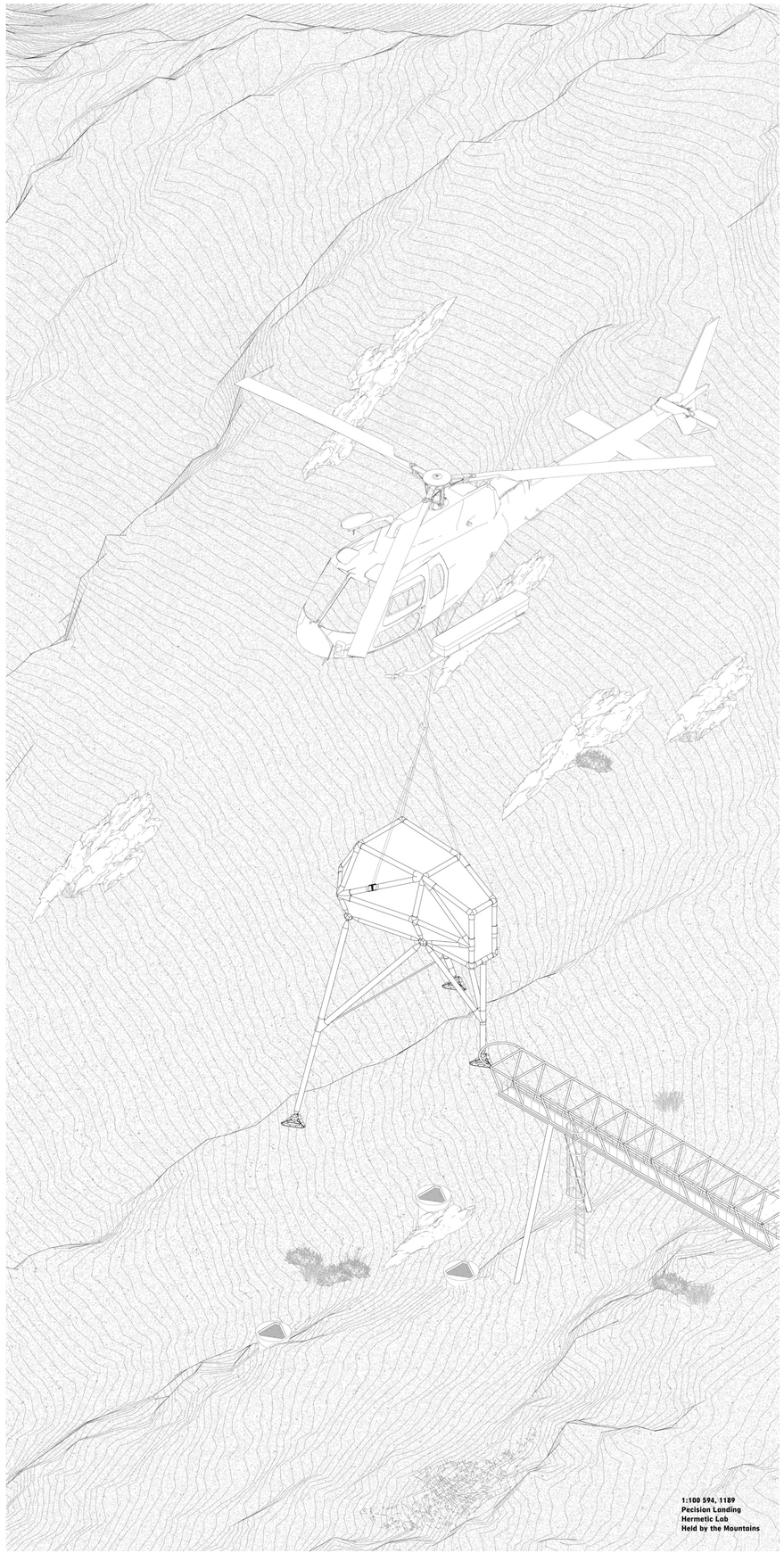
21:07, February 2032 — Refuge
Interior view during the same storm

The mobile clean lab is an architectural component of the monitoring and refuge system that is flown in by utility helicopter during the outreach phase of the project's thousand-year life and is designed to be removed again during the adaptation phase, without leaving permanent alteration of the ground conditions. Its purpose is to conduct research that the open refuge cannot support; a controlled environment containing a hermetic chamber with overpressure allows for study of biological processes that are under-researched and less legible to the naked eye. This includes the study of fungi, disease, root systems, and material samples that require isolation and security. This is a mobile lab, meaning the design implies it can be moved relatively easily and quickly for outreach studies in other remote alpine territories in Spain that are undergoing transition and locations showing signs of stress that are less easily understood without the proper facilities.

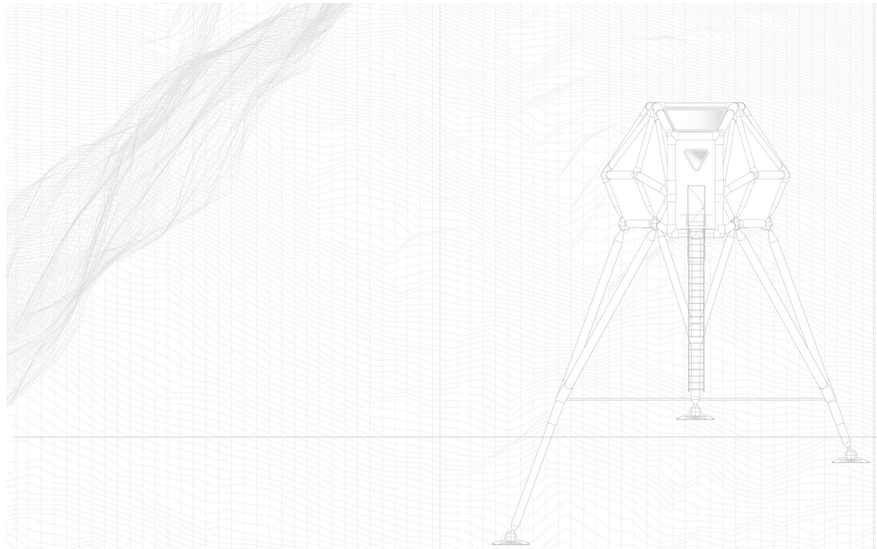
Drawing from Richard Horden's work on mobile refuges and laboratories. This architecture is defined by lightness, proposing a relation between architecture and landscape that hovers above it, allowing natural processes to continue undisturbed beneath. It does not transform the steep outcrops where the Iberian ibex takes refuge and feeds on mountain shrubs.

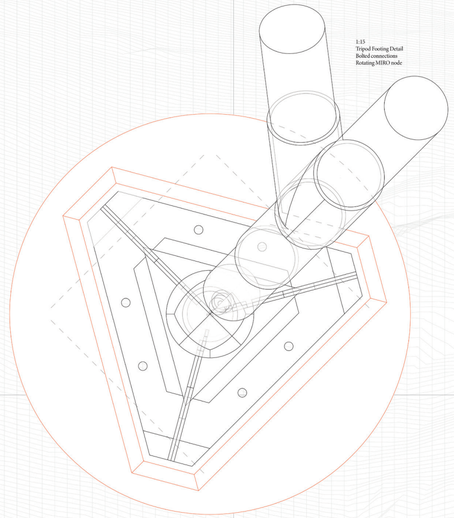
Tectonically, the lab mirrors the same method as the refuge; adopting a tolerance framework through height-adjustable legs, feet that can articulate to the topography and MIRO connections to tolerate variable loads such as wind, rain and snow. The tripod design of the legs is inherently stable, extending this truss structure through the body and contributing to a unified load-transfer strategy, reading as one coherent truss. The aluminum facade system and continuous aerogel insulation layer forms a resistant skin designed to perform in high-exposure conditions.

The solar array on the roof provides clean energy for lab research and doubles as a backup energy source for the refuge as an emergency provision.

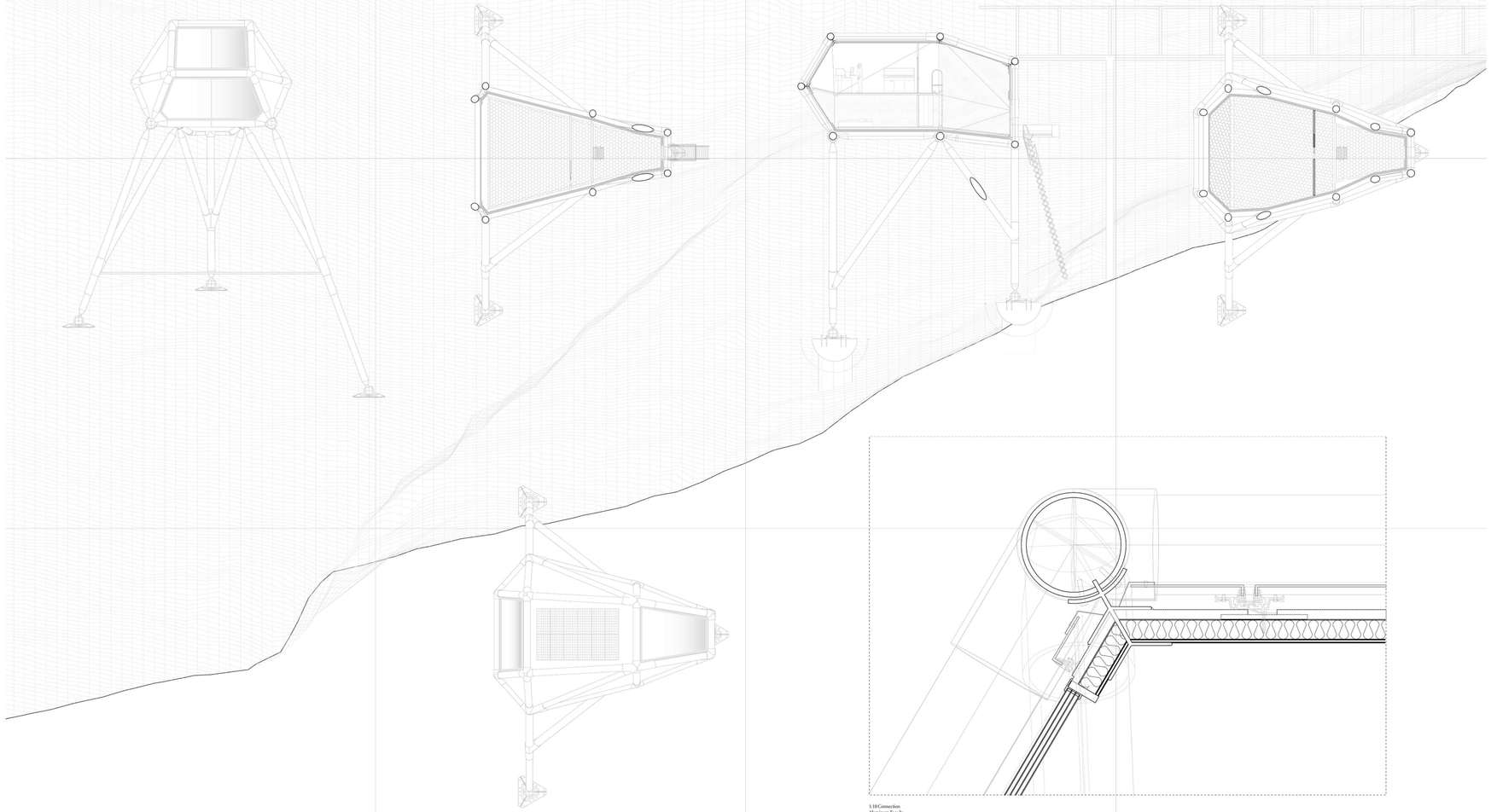


1:100 594, 1189
Pecision Landing
Hermetic Lab
Held by the Mountains





1:15
Tripod Footing Detail
Bolted connections
Rotating MIRO node



1:10 Connection
Aluminum Facade
Aerogel insulation
Tripple gazed windows

1:150 594,594
Mobile Clean Lab
Held by the Mountains

DISCUSSION AND CONCLUSION

Transferability, Limits, Futures and Insight

Eight resulting thesis positions and principles

1. Architecture in this context must be understood as a part of the natural systems that have existed for thousands of years and will still operate for thousands of years into an unknown future.
2. A post-human lens to the design process allows for consideration of vibrant matter and the non-human participants that are critical to the resilience of fragile territories.
3. In extreme climates, an acceptance and tolerance framework for detailing, construction and programing is where material intelligence has the potential to achieve a level of permanence.
4. Adopting the mindset of doing more with less in Alpine territories with logistics constraints and grappling longterm fragility, in the context of the Anthropocene, is where the practice of architecture can take responsibility for producing utility with a net-positive impact on the natural world.
5. The practice of commoning is achieved not through program alone, but by entangling socially disconnected practices such as operation, observation, recreation and maintenance as a shared ritual.
6. Asking the question; what can my architecture contribute to the territory? Instead of the reverse, allows for a design approach that, in its essence, is reparative.
7. Inhabitation became a form of knowledge generation. productive knowledge is generated on several scales from scientific measurement to bodily experience and the commoning of knowledge happens when these scales are interdependent.
8. An off-grid system can be an effective mechanism for non-extraction and repair only when it is socially maintained and that maintenance is a shared responsibility.

The origin of this project was the interrogation of relationships between humans and mountainous territories, thinking about repair, and how that relates to hydrological processes and human practices; the importance of monitoring to gain insights on repair; and the policies and mandates that give structure to management and maintenance that dictate the dual responsibility between institutions and those that inhabit alpine settlements. Highlighting the stressors on these communities and infrastructures, both natural and artificial, that impact Madrid's long-term resilience.

Making the argument that the commoning of these dependencies can be achieved through inhabitation and that refuge can be the catalyst for sharing responsibility, utility and experience.

The design process revealed that the responsibility of architecture in this context is to consider the complexities of the territorial system, and operate as a system in the territory by actively embedding itself within a long-duration time horizon. To design for a thousand-year life is to accept that resilience does not depend on technical optimization, but on material intelligence and the capacity to perform in extreme climatic variations where weathering, overflow, wind and exposure are a precondition for success. Net-positive utility of inhabitation as a strategy for repair can be achieved by design. Developing a system so that it is the path of least resistance is reparative, and relies on a re-thinking of post-modern conventions related to infrastructure and comfort. This project takes an off-grid approach to inhabitation, not to be independent of the city, but as a strategy for making dependencies legible, producing knowledge through experience and examining how self-sufficiency can be interdependent and understood through the lens of both human and non-human participants.

The project must acknowledge the limitations of the design. The material conditions related to the degree of granite fracturing, size and usability of stone during the excavation and construction process and the precise behavior of the ground during construction remain informed predictions based on systematic assumptions. These material behaviors are only knowable through realization, yet the architectural value of the project rests in developing the approach to architecture in this context rather than on the precise ground behavior.

Understanding the limits of what architecture can take responsibility for is equally important. This Project makes the argument that architecture's role is not to singularly solve climatic, political or institutional pressures that act on a territory; rather, architecture takes responsibility for how it performs. Delay, hold, absorb, filter, saturate, dry, reveal, support are examples of architectural performance that have the effect of repair and the form-giving of otherwise disconnected relationships. The transferability of the project can be described in these terms, as a method for designing within fragile and extreme territories, asking how architecture can contribute to the systems that sustain it.

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