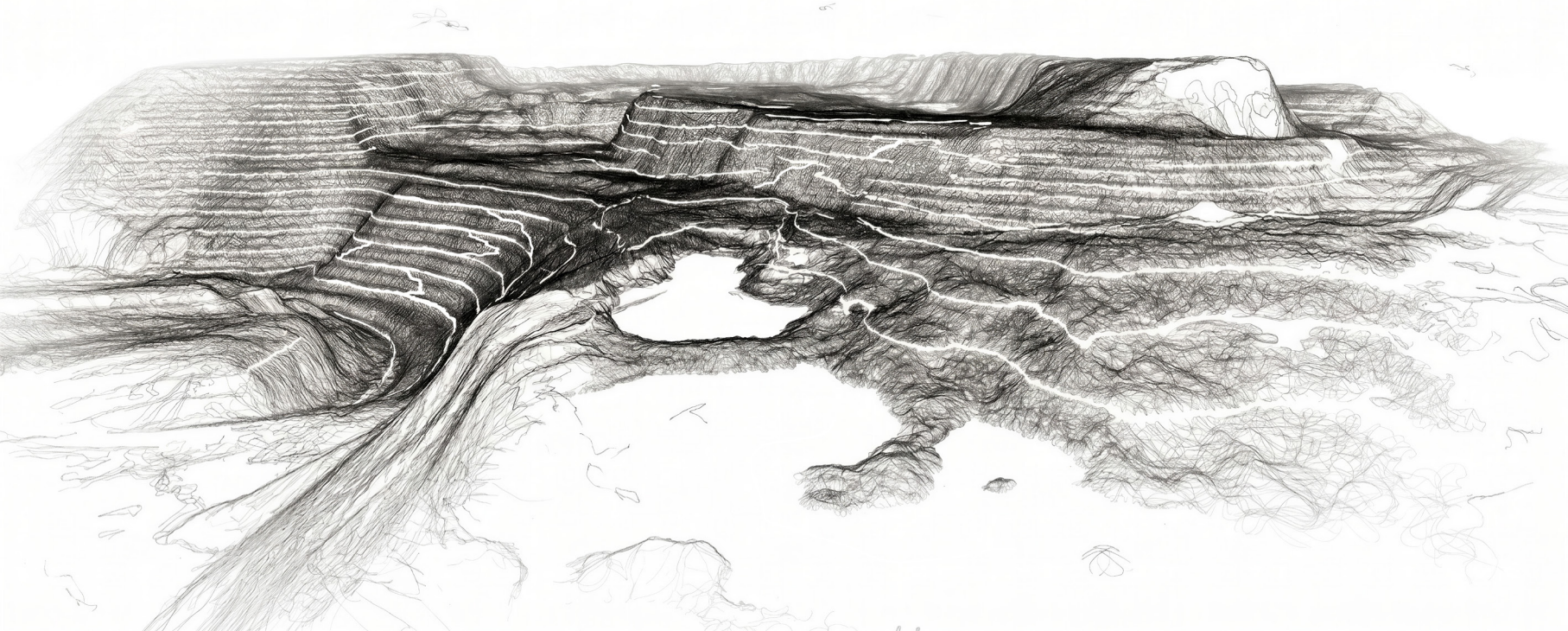


THE LIVING HEAP

Agnieszka Kania
Master Thesis Project
Cross Domain Studio
City of the Future



THE LIVING HEAP

ARCHITECTURAL AGENCY IN THE POST-EXTRACTION LANDSCAPE OF
THE UPPER SILESIAN COAL BASIN

Thermal Bath Complex & Landscape Strategy
on Makoszowy Heap

Delft University of Technology

Master Thesis
MSc Architecture
Cross Domain Studio - City of the Future

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All the visuals and photograph material has been
produced by the author if not stated otherwise.



Figure 1 | Erosion crack on the heap

ABSTRACT

The Upper Silesian Coal Basin in Poland is a fragmented post-industrial landscape dominated by anthropogenic coal mine heaps. Traditionally perceived as hazardous environmental liabilities and spatial barriers within the urban fabric, these monumental landforms are deeply embedded with regional cultural identity, industrial memory, and novel ecological systems. This research investigates the latent spatial, ecological, and cultural value of these post-mining structures, arguing against their conventional erasure or purely technical remediation.

Addressing the central question of how architecture can coexist with the evolving, unstable conditions of post-industrial terrains, this project uses the Makoszowy Heap as a primary case study. The methodology is grounded in Christophe Girot's theoretical framework of the "Four Traces" (Landing, Grounding, Finding, Founding) and combines regional-scale territorial mapping, on-site sensory fieldwork, and physical material experimentation.

The resulting design proposal shifts from concealing the heap's toxicity and instability to revealing its ongoing material and ecological transformations, such as acid mine drainage, erosion, and natural vegetation succession. The core architectural intervention is a Thermal Bath Complex situated in the stabilized, forested base of the heap. This complex operates on a circular material and energy strategy: it draws low-enthalpy geothermal energy from flooded underground mine shafts to heat the pools, and uses locally recovered mining waste - such as fly ash, crushed concrete, and limestone - as primary construction and water-filtration materials.

This project provides a transferable design framework for post-industrial regeneration across the Upper Silesian Coal Basin. By integrating architecture, landscape, and infrastructural remnants, the thesis demonstrates how former sites of extraction can be transformed into dynamic spaces of public engagement, ecological adaptation, and collective memory.

As I walk through the post-mining districts of Katowice, the influence of mining is visible everywhere. Cracked facades, uneven streets, and the constant industrial hum reveal the lasting presence of the underground landscape. In the distance, a dark heap gradually emerges behind the housing blocks, partly covered by trees and partly exposing bare soil.

As I approach, the smell of burnt coal, wet iron, and damp earth becomes stronger. Rust-coloured water flows through nearby streams, while remnants of industrial infrastructure ventilation shafts, concrete slabs, and old railway tracks appear among the vegetation. These traces guide my movement toward the heap and reveal its connection to the area's mining history.

The climb begins through a dense forest, but higher up the terrain becomes increasingly barren and unstable. Deep erosion cracks cut through the slope, coal fragments cover the ground, and signs of human presence remain visible in the form of tire tracks, abandoned objects, and worn paths.

When I reach the summit, the landscape suddenly opens. A vast crater unfolds before me, while the skyline of Katowice stretches across the horizon, punctuated by mine shafts and industrial structures. The dark soil, marked by black, orange, and red tones, creates a landscape that feels both natural and artificial. Standing at the edge of the crater I am surrounded by traces of industry and ongoing ecological change. Despite its scale, the site is unexpectedly quiet. The walls of the crater block the sounds of the city below until everything becomes completely still. No traffic. Only wind moving across loose stone.

Impression of the site

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Figure 2 | Peak of the heap

INTRODUCTION

Anthropogenic Landforms of Upper Silesian Coal Basin

For more than two centuries, the Upper Silesian Coal Basin (USCB), located in southern Poland has shaped the economic, spatial, and cultural landscape of Central Europe. Carboniferous coal deposits near the surface drove its transformation, enabling intensive extraction on an unprecedented scale. Former agricultural settlements rapidly evolved into one of the continent's most important industrial regions¹. At its peak, the basin contained more than fifty deep coal mines supported by extensive metallurgical, energy, and chemical industries. Coal became the region's economic foundation and the primary force structuring its cities, landscapes, and everyday life.

Unlike classical European cities that developed around historical cores, the Upper Silesian urban region emerged from the logic of extraction. Urbanization followed coal seams rather than pre-existing settlement hierarchies, resulting in a polycentric conurbation known today as the Górnośląsko-Zagłębiowska Metropolia (GZM), composed of closely adjacent yet administratively independent cities such as Katowice, Bytom, Zabrze, Gliwice, and Ruda Śląska.² Industrial facilities, workers' housing, transport infrastructure, and technical installations were positioned according to mining demands, producing a fragmented and discontinuous spatial structure. Industrial remnants now repeatedly interrupt dense urban areas, forming a patchwork landscape where everyday urban life coexists with large-scale anthropogenic landforms.

Over decades of intensive mining, enormous volumes of waste rock, slag, ash, and other materials were removed from underground and deposited on the surface. Simultaneously, underground extraction led to ground subsidence, altering hydrological systems and creating artificial depressions, ponds, and wetlands. Together with quarries, sandpits, and excavations, these processes produced a new, human-made topography that redefined the region's relationship to land.³ The result is a landscape of sharp contrasts: artificial hills rising above the urban skyline and sunken basins embedded between housing estates and industrial zones.

Among these anthropogenic forms, coal mine heaps are the most iconic and spatially dominant elements. The term itself reflects the region's industrial heritage, describing heaps of waste material generated during mining and processing. In the Silesian region alone, there are over three hundred heaps, collectively covering several thousand hectares.⁴ They vary in size, morphology, and degree of transformation, from small, partially vegetated mounds to massive, steep-sided structures that rival natural hills in scale. Today, the coal heaps of Upper Silesia are an intensively used everyday landscape. They serve as places for walking, recreation, and observation, yet they remain misunderstood.

Coal heaps have been perceived primarily as symbols of environmental degradation. Their composition includes materials prone to chemical reactions (carboniferous waste rock, residual coal, ash, pyrite, lead and cadmium) leading to soil and water contamination through processes such as leaching and acid mine drainage.⁵ Rainwater filtering through waste rock can mobilize heavy metals and salts, which are then transported into surrounding soils, groundwater, and anthropogenic water bodies formed by mining. Many heaps have also experienced spontaneous combustion, a phenomenon caused by the oxidation of coal residues and sulfide

minerals. Thermally active heaps emit gases, dust, and heat, degrading local air quality and microclimatic conditions. From this perspective, coal heaps function as persistent polluters and physical barriers within the urban fabric. They occupy land that was formerly agricultural or forested, disrupt natural water flows, and contribute to the perception of post-industrial areas as hazardous and undesirable. As a result, they have often been isolated, fenced off, or ignored within planning frameworks, reinforcing the fragmentation of the metropolitan landscape.



Figure 3 | Polluted River Kłodnica
Source: T. Staniek



Figure 4 | Burning heap
Source: SRK S.A./M.Tomalik

¹ Krzysztof Gasidło, "Problemy i ograniczenia przekształconych obszarów przemysłowych" [Issues and constraints of post-industrial transformation], Zeszyty Naukowe Politechniki Śląskiej: Architektura, no. 31 (1993):106.

² Alina Pancewicz, "Natural Environment in Post-Industrial Landscape Renewal," trans. Łukasz Borkiewicz, (Gliwice: Publishing House of the Silesian University of Technology, 2023): 26.

³ Gasidło, "Problemy i ograniczenia," 107.

⁴ Pancewicz, Natural Environment, 26.

⁵ Krzysztof M. Rostanski, "Silnie skażoneone tereny przemysłowe jako potencjalne miejsca rekreacji" [Heavily contaminated post-industrial areas as potential recreation sites], Rozwój Regionalny i Polityka Regionalna 64 (2023): 23.

Cultural Significance

Purely technical or environmental interpretation of spoil heaps overlooks their broader cultural and historical significance. As Lamparska-Wieland and Waga argue, these landforms function as “symbolic carriers of history” that contribute to the preservation of regional identity⁶.Over generations, spoil heaps have become deeply embedded within the cultural landscape of Upper Silesia, embodying the labour, knowledge, and social structures associated with mining communities. They serve as visible records of industrialisation, making the otherwise invisible underground processes of coal extraction legible on the surface. Beyond their industrial origins, many heaps have acquired additional ecological and spatial value. Through decades of spontaneous vegetation succession, they have developed into unique habitats supporting pioneer species and novel ecosystems distinct from the surrounding environment. Their elevated topography also provides visual landmarks and viewpoints that are rare within the dense urban fabric of the USCB⁷.

The cultural importance of spoil heaps is further reflected in their presence within regional art and photography. Rather than depicting them solely as industrial waste, artists have represented the heaps as defining elements of the Silesian landscape and collective memory. In the photographic series “Slask 1975–1992”, Michał Ciało portrays spoil heaps as monumental structures that dominate the surrounding landscape, emphasising both their physical scale and their symbolic power⁸.Later photographic works by Arkadiusz Gola highlight the contrast between post-industrial terrain and the natural environment. Human figures appear primarily as points of scale, conveying the vast dimensions of the anthropogenic landscape and the transformative impact of industrial activity. Earlier works such as Paweł Malczewski’s “Black Silesia 1934” similarly document the industrial character of the region, preserving landscapes that have since changed considerably.

These artistic representations demonstrate how spoil heaps can be understood as narrative landscapes - spaces where memory, experience, and imagination intersect. In this interpretation, a spoil heap is no longer merely a by-product of mining but a medium through which regional history and identity are continuously expressed and reinterpreted.

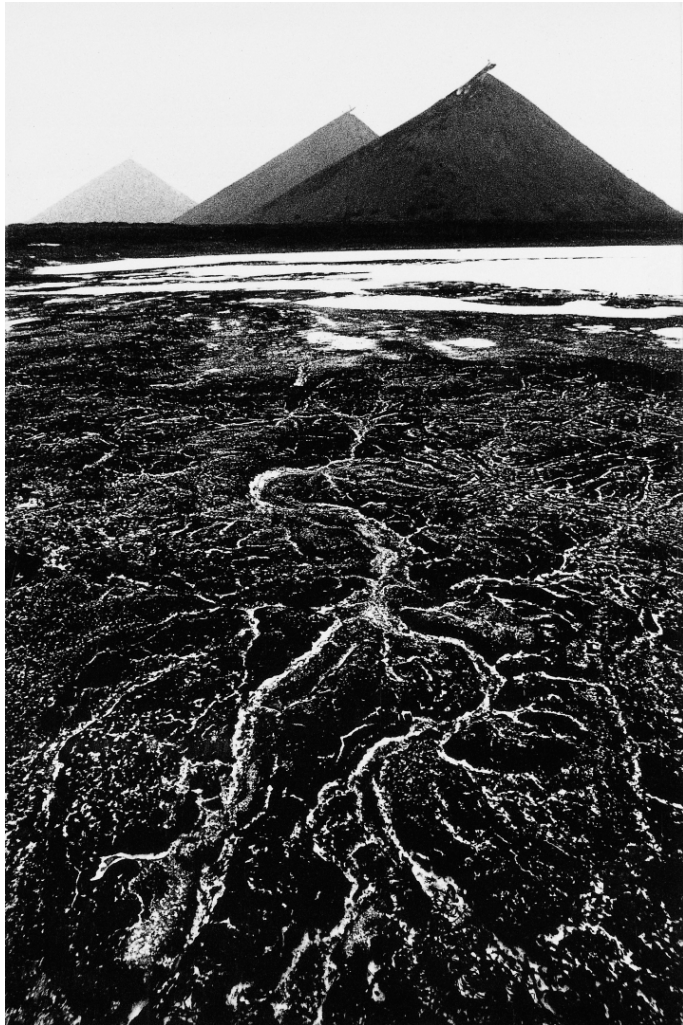


Figure 5 | Photography of the Post-extractive Silesian landscape
Source: Michał Ciało, 1992

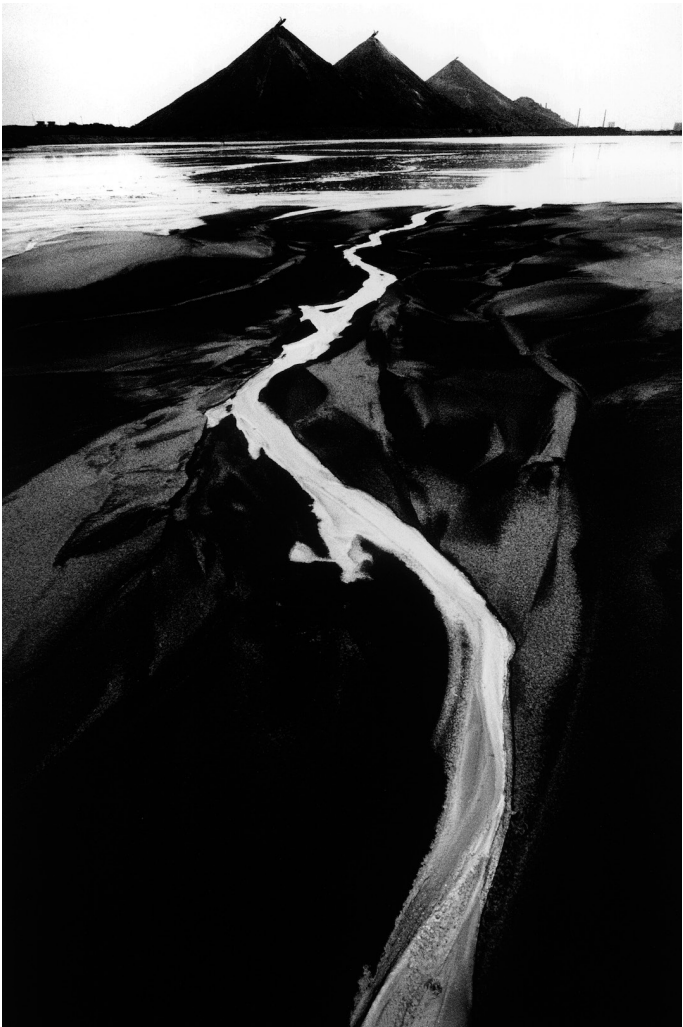


Figure 6 | Photography of the Post-extractive Silesian landscape
Source: Michał Ciało, 1992

⁶ Marzena Lamparska-Wieland and Jan Maciej Waga, “Znaczenie hald poeksploatacyjnych w krajobrazie Górnego Śląska” [The significance of post-mining dumps in the landscape of Upper Silesia], Archiwum

⁷ Pancewicz, Natural Environment, 26.

⁸ Elbieta Rybicka, “Landscape after Transformation,” Teksty Drugie, no. 1 (2024): 118–141.



Figure 7 | The Anthropocene vs the People
Source: Arkadiusz Gola, 2002

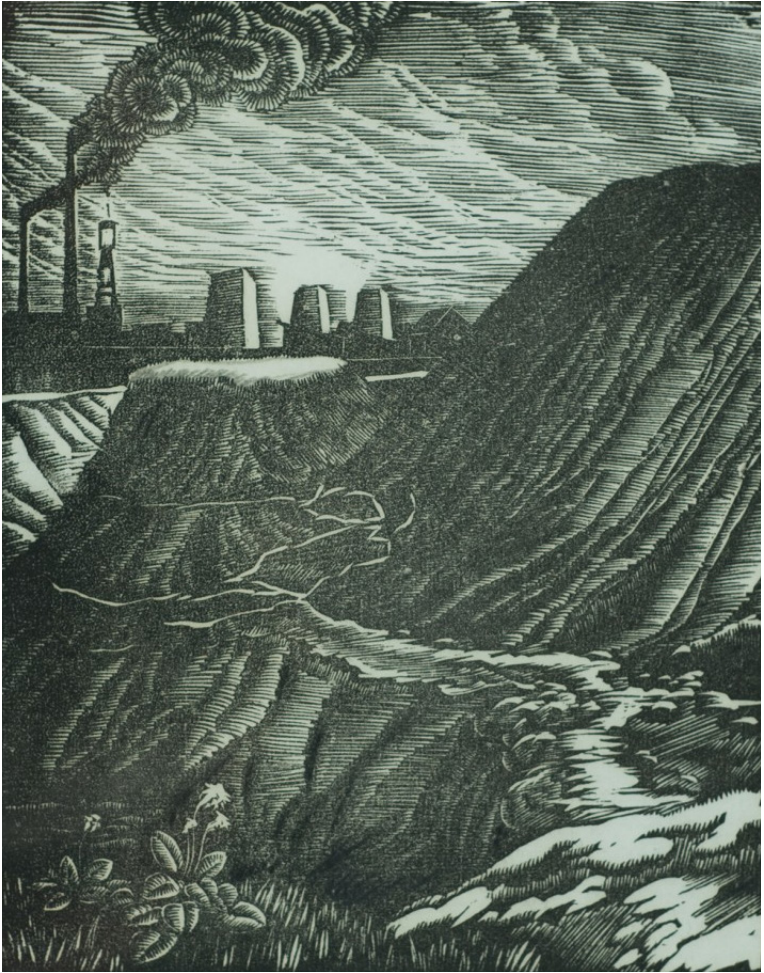


Figure 8 | Slag Heaps in Bogucice
Source: Woodcut by Pawel Steller, 1932



Figure 9 | Slag Heap in Szopienice
Source: Etching by Wladyslaw Zakrzewski, 1944

Contemporary Relevance

Despite their cultural significance, the number of spoil heaps in Upper Silesia has declined considerably over recent decades. Many have been removed or partially dismantled as their material was repurposed for infrastructure and road construction. This reduction reflects a broader tendency to perceive spoil heaps primarily as waste rather than as elements of industrial heritage worthy of preservation⁹. However, for many local residents, particularly those connected to the mining industry, the heaps remain powerful symbols of labour, collective memory, and regional identity.

The significance of spoil heaps is inseparable from the mining communities that created them. The closure of coal mines has affected both the physical landscape and the social fabric of Upper Silesia. Mining historically shaped entire communities, with workers often living, working, and socialising within closely connected neighbourhoods. As mines close, these social networks weaken, generating challenges related to employment, identity, and community cohesion. The decline of the mining sector has been substantial: while approximately 160,000 people were employed in Polish coal mining in 2018, projections suggest that this number could decrease to around 48,000 by 2030. The transformation of post-mining landscapes is therefore a social issue as well as an environmental and spatial one¹⁰.

In response to these challenges, the European Union established the Just Transition Fund (JTF) to support coal-dependent regions during the transition towards a more sustainable economy. In Upper Silesia, the program aims to create new job opportunities, support workforce retraining, and facilitate the transformation of former mining areas. The initiative acknowledges that the transition away from coal is an environmental, social, and economic challenge¹¹.

Experiences from Western Europe demonstrate alternative approaches to post-industrial landscapes. In former mining regions of Germany, Belgium, and France, spoil heaps have increasingly been preserved and reimagined as landmarks, ecological reserves, cultural destinations, and recreational spaces. Rather than being treated as waste, they are recognised as witnesses to industrial history and valuable components of regional identity. This shift reflects a broader understanding of anthropogenic landscapes as cultural assets capable of contributing to contemporary urban life¹².

In Upper Silesia, however, the integration of spoil heaps into the metropolitan landscape remains uneven and largely unresolved. The region is currently facing the challenge of redefining itself within the context of the post-coal transition. Only recently has attention shifted towards regeneration, ecological restoration, and the improvement of living conditions within the metropolitan area. Within this process, spoil heaps occupy a critical yet ambiguous position: they are simultaneously environmental liabilities and spatial resources, sources of pollution and carriers of memory.

⁹ Lamparska-Wieland and Waga, "Znaczenie hald poeksploatacyjnych," 103.

¹⁰ Lamparska-Wieland and Waga, "Znaczenie hald poeksploatacyjnych," 103.

¹¹ "EU Cohesion Funds Pave the Way for Social and Economic Transformation in Poland," European Social Fund Plus, European Commission, November 11, 2024, <https://european-social-fund-plus.ec.europa.eu/en/news/eu-cohesion-funds-pave-way-social-and-economic-transformation-poland>.

¹² Alan Berger, ed., *Designing the Reclaimed Landscape* (London: Taylor & Francis, 2008), 56.



Figure 10 | Miner working under the ground
Source: National Digital Archive in Poland

Motivation

My motivation for this thesis is rooted in a personal relationship with the Upper Silesian landscape, where I was born and raised. The anthropogenic coal heaps were never abstract industrial remnants but constant elements of my everyday environment. Their presence, distinctive forms, and monumental scale became embedded in my memory from an early age. This connection is further reinforced by my family history. My grandfather worked as a coal miner and later served as Mining Director of the Mortimer - Porobka coal mine in Sosnowiec during the 1970s. Although he passed away before I was born, photographs and family narratives about his life and work shaped my understanding of the region and its mining heritage. This personal connection has informed my interest in the future of post-mining landscapes and the question of how these sites can be transformed while preserving the cultural values embedded within them.



Figure 11 | My Grandfather in miners uniform
Source: Personal Photo Album

Introduction to the Site

While the project addresses the broader landscape of the Upper Silesian Coal Basin, the design investigation focuses on the Makoszowy Heap as a representative case study. The site was selected due to its scale, strategic location, and its potential to demonstrate how post-mining landforms can be integrated into contemporary urban and ecological systems. As one of the largest spoil heaps in the region, the Makoszowy Heap offers a unique opportunity to explore the relationship between industrial heritage, landscape regeneration, and public use.

The heap is an evolving anthropogenic landform that has been continuously shaped by mining activities since its establishment in 1906. Occupying approximately 170 hectares and extending over 2.5 kilometers, it forms a dominant landmark within the USCB . The site occupies a strategic position within the post-industrial landscape. Two primary spatial axes structure its surroundings. The first, referred to as the Industrial Axis, establishes a functional connection between the former Makoszowy Mine and the still-operational Sosnica Mine. The second, the Social Axis, improves permeability across the area by linking the northern urban fabric with the historic mining settlements and ventilation shaft complex located to the south. Together, these connections position the heap as both an infrastructural and social node within the wider metropolitan landscape.¹³

Unlike many spoil heaps in Upper Silesia that are affected by spontaneous combustion and internal burning processes, the Makoszowy Heap is considered structurally stable. This characteristic is particularly significant from a design perspective, as it allows for a broader range of interventions and longterm public use.

Today, the heap has already been informally appropriated by local residents as a recreational landscape. Its varied terrain attracts activities such as mountain biking, quad biking, hiking, and geocatching. These existing patterns of use reveal the heap's potential to function not only as an industrial relic but also as an active public landscape.

¹³ Polish Geological Institute, Detailed Geochemical Map of Upper Silesia in 1:25000] (Warsaw: Polish Geological Institute, 2026).

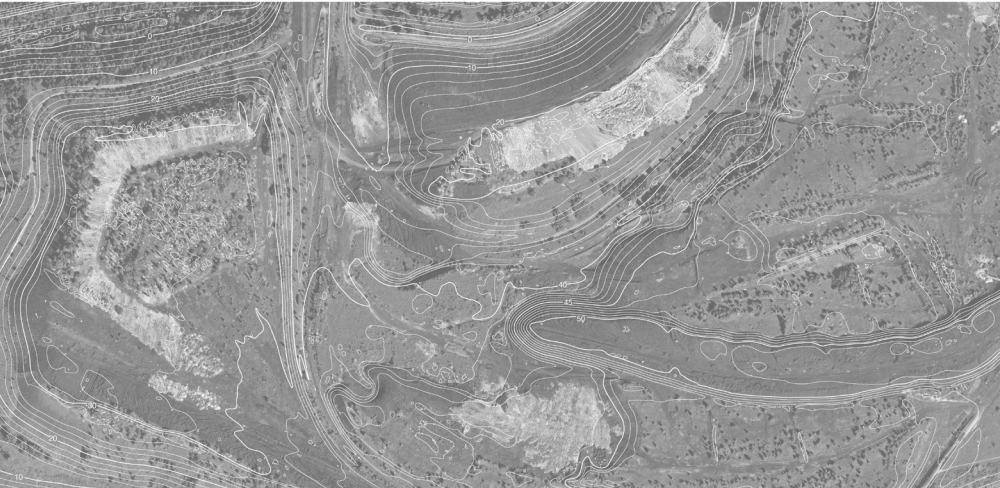


Figure 12 | Three scales of Makoszowy Heap

Problem Statement and Research Question

The central problem lies in the persistent failure to recognize and harness the latent ecological, spatial, and cultural value of coal heaps of Upper Silesian Coal Basin. As long as these post-industrial landforms are treated solely as hazardous remnants of extraction, they will continue to function as barriers that fragment the urban landscape and disconnect communities from their regional identity and industrial heritage.

How can architecture coexist with and respond to the evolving environmental conditions of the coal heap, embracing its instability, materiality, and ecological processes rather than attempting to erase or control them?

- Sub Q1. How can the specific material composition, ecological processes, and landscape qualities of the coal heap be revealed through architectural and landscape design?
- Sub Q2. How can architectural interventions encourage rituals of inhabitation, reflection, and collective experience that deepen public engagement with the coal heap's historical, ecological, and cultural significance?
- Sub Q3. How can the Makoszowy Heap serve as a case study for developing design strategies that could be adapted to other coal heaps in the Upper Silesian Coal Basin?



Figure 13 | Coal Heaps' slope slowly reclaimed by nature

Theoretical Framework

The conceptual foundation of this research emerged from an interest in post-industrial landscapes as carriers of memory, material history, and ecological transformation. A particular source of inspiration was the essay “The Right to Ruins” by landscape architect and researcher Adam Przywara, whose projects explore the relationship between material traces, and collective memory.¹ Especially influential was TopoScape’s Burza Park in Warsaw, where World War II rubble is preserved as a landscape resource and a carrier of memory. Its approach to revealing history through material traces informed the central premise of this research: that the coal heaps of Upper Silesia are not industrial waste alone; they are landscapes that embody stories of extraction, labour, and transformation.

Building upon this perspective, the research draws on several contemporary theories that challenge conventional perceptions of post-industrial territories as degraded or obsolete landscapes. The concept of Drosscape, introduced by Alan Berger, provides a framework for interpreting coal heaps as inevitable by-products of industrial and urban development.² Rather than viewing these landscapes as failures or residual spaces, Berger argues that they should be understood as valuable spatial resources that reveal the material consequences of economic and industrial processes. This perspective encourages a shift from remediation towards transformation and productive reuse.

The ecological dimension of this research is informed by Matthew Gandy’s writings on Natura Urbana, as well as concepts drawn from ruderal ecology and ecotones. Gandy argues that spontaneous urban vegetation should not be understood as a sign of neglect, but as an important component of contemporary urban ecosystems. Within spoil heaps, these processes have produced novel ecosystems characterised by unique microclimates, diverse species assemblages, and a high degree of resilience.³ Rather than isolated islands of industrial debris, the heaps can be understood as vertical ecotones - transitional boundaries between the subterranean geology of extraction and the biological processes of surface colonisation. This perspective highlights the edge effect, whereby the interaction between anthropogenic disturbance and natural succession generates distinctive environmental conditions that support diverse and often rare assemblages of species. As a result, spoil heaps challenge conventional distinctions between nature and industry, revealing post-industrial landscapes as dynamic environments continuously shaped by both ecological and anthropogenic processes.

To translate these ideas into a method of site analysis and design exploration, this research adopts Christophe Girot’s framework of the Four Traces as its primary analytical tool.⁴ Girot proposes four modes of engaging with landscape: Landing, Grounding, Finding, and Founding. Rather than approaching landscape as a fixed composition, the framework encourages a process of gradual discovery through direct observation, movement, and interpretation.

- Landing refers to the initial encounter with the landscape, often experienced from a distance. At this stage, attention is directed towards the overall form, scale, and visual presence of the coal heaps within the wider territory.

- Grounding involves an immersed engagement with the physical reality of the site. Through walking, observation, and sensory experience, the landscape is understood through its textures, slopes, materials, vegetation, and atmospheric conditions.
- Finding focuses on the discovery of specific traces and hidden narratives embedded within the landscape. These may include remnants of mining infrastructure, signs of ecological succession, patterns of erosion, informal pathways, or other indicators of ongoing transformation.
- Founding represents the synthesis of these observations into a design response. Rather than imposing a new order onto the landscape, the intervention emerges from the traces already present, establishing a new relationship between memory, ecology, and future use.⁵

As the primary methodological framework of this research, the Four Traces provide a means of revealing and interpreting the layered histories embedded within the Makoszowy Heap. The approach aligns with the broader objective of the project: to understand post-industrial landscapes not as sites awaiting erasure, but as dynamic territories where ecological processes, cultural memory, and future possibilities coexist

¹ Adam Przywara, “The Right to Ruins,” e-flux Architecture, May 2025, <https://www.e-flux.com/architecture/framing-renovation/672006/the-right-to-ruins>.

² Alan Berger, Drosscape: Wasting Land in Urban America (New York: Princeton Architectural Press, 2006).

³ Matthew Gandy, Natura Urbana: Ecological Constellations in Urban Space (Cambridge, MA: MIT Press, 2022).

⁴ Christophe Girot, “Four Trace Concepts in Landscape Architecture,” in Recovering Landscape: Essays in Contemporary Landscape Architecture, ed. James Corner (New York: Princeton Architectural Press, 1999), 2.

⁵ Girot, “Four Trace Concepts,” 2.

Methodology

The complexity of post-mining coal heaps in Upper Silesia requires a methodological approach that extends beyond a single scale or disciplinary perspective. The research methodology is grounded in Christophe Girot's theory of the Four Traces, which provides a framework for reading, experiencing, and interpreting landscape through observation, immersion, discovery, and design intervention.

The research began with a regional-scale investigation of the Upper Silesian Coal Basin, examining the spatial distribution of coal heaps and their relationship to the broader urban, ecological, and industrial systems of the region. Through extensive mapping and territorial analysis, the heaps were understood not as isolated landforms but as interconnected elements within a larger post-industrial landscape.

Building upon this regional perspective, the research subsequently focused on a single case study: the Makoszowy Heap. To structure the site analysis, the landscape was examined through four thematic lenses.

- Water - addressing contamination and acid mine drainage coverage,
- Soil - exploring soil conditions of the heap
- Air - investigating climatic conditions, soundscapes, and the formation of a memorial landscape.
- Energy - examining the geothermal potential of post-industrial mining infrastructure and opportunities for energy reuse.

These analytical layers were further complemented by on-site fieldwork, allowing for a direct engagement with the physical, ecological, and sensory qualities of the landscape.

The final stage of the research employed a research-through-design methodology. Prior to the design phase, a precedent study analysis was conducted, examining selected landscape and architectural projects that address post-industrial regeneration, adaptive reuse, ecological restoration, and the integration of cultural heritage within contemporary landscapes. The precedents were analysed to identify design strategies, spatial principles, and structural systems.

Drawing on insights from the precedent studies, the theoretical framework, site observations, and landscape analyses, design explorations were used as a tool for generating knowledge and testing alternative futures for the site. This process was supplemented by physical model making and experimentation with material production using resources extracted directly from the heap. Rather than producing a fixed solution, the design process served as a means of investigating how ecological restoration, industrial heritage, and new forms of public use could coexist within a post-mining landscape.

Interscalar Cartography

At the regional scale, the heaps were analysed as systemic nodes within the Upper Silesian Coal Basin. Rather than isolated landforms, they are embedded within networks of settlement, infrastructure, hydrology, vegetation, and cultural memory. Mapping revealed particularly strong connections to local water systems, reflecting the historical relationship between mining operations and nearby rivers and streams. The heaps also function as prominent visual landmarks, offering panoramic views across the metropolitan landscape (Figure 14).

Selected interfaces between the heaps and their surroundings were examined. Six different edging conditions were selected - lake, residential area, mine, highway, forest and river. The analysis revealed that the most significant interactions occur not on the summit but at the edges, where informal paths, ecological gradients, visual corridors, and everyday social encounters emerge. These edge conditions function as transitional zones through which the heap becomes integrated into daily life (Figure 15).

The study of natural reclamation processes further revealed the heaps as dynamic landscapes shaped by succession and change over time. This perspective aligns with the concept of Fourth Nature, which views post-industrial landscapes not as spaces requiring complete restoration, but as evolving environments where natural and anthropogenic processes coexist. Within this framework, spoil heaps are understood as landscapes to be observed, interpreted, and carefully adapted rather than erased or reconstructed (Figure 16).

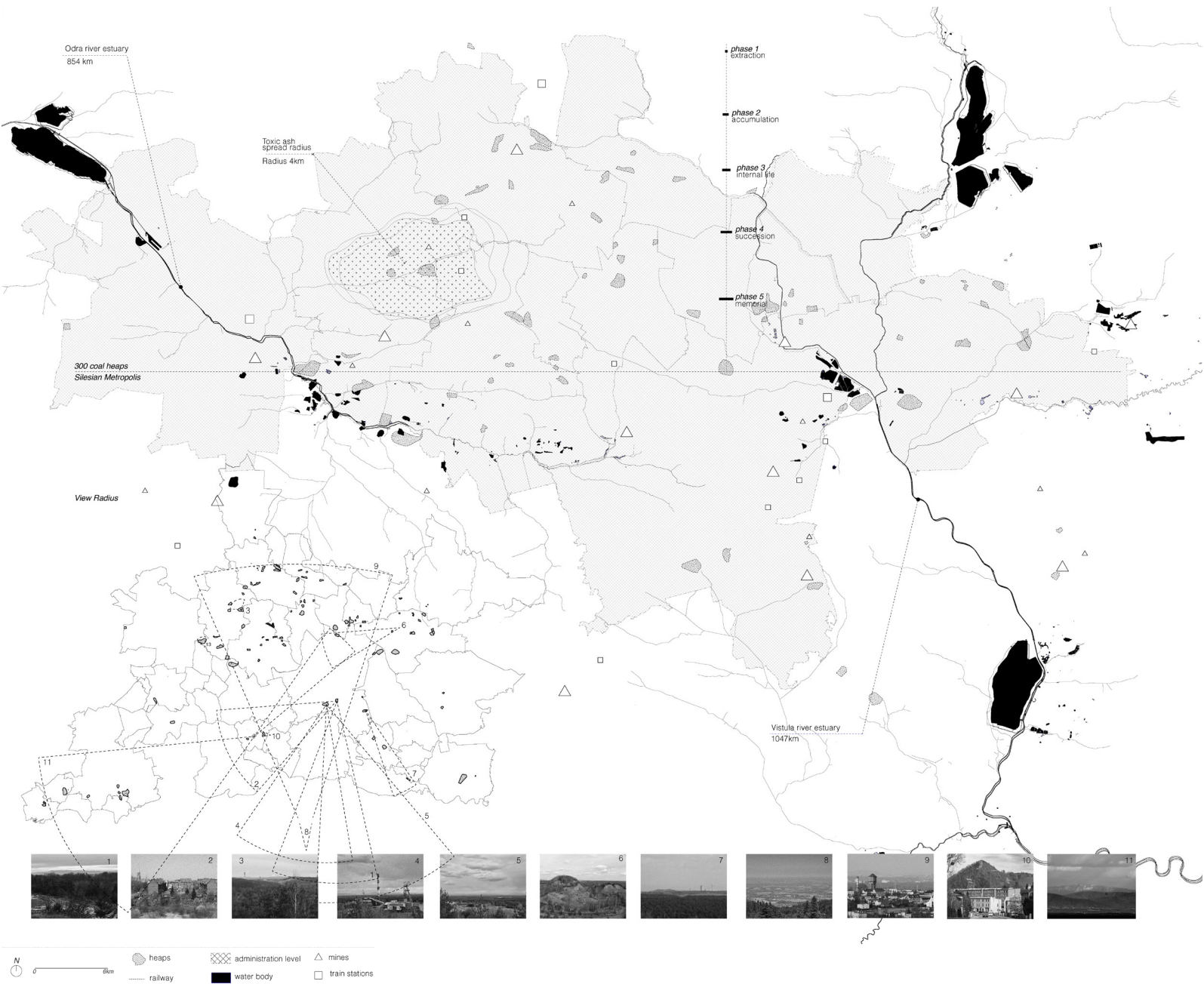


Figure 14 | Systemic mapping of the heaps in Upper Silesian Coal Basin and the synthetic diagram of the views from the Silesian heaps

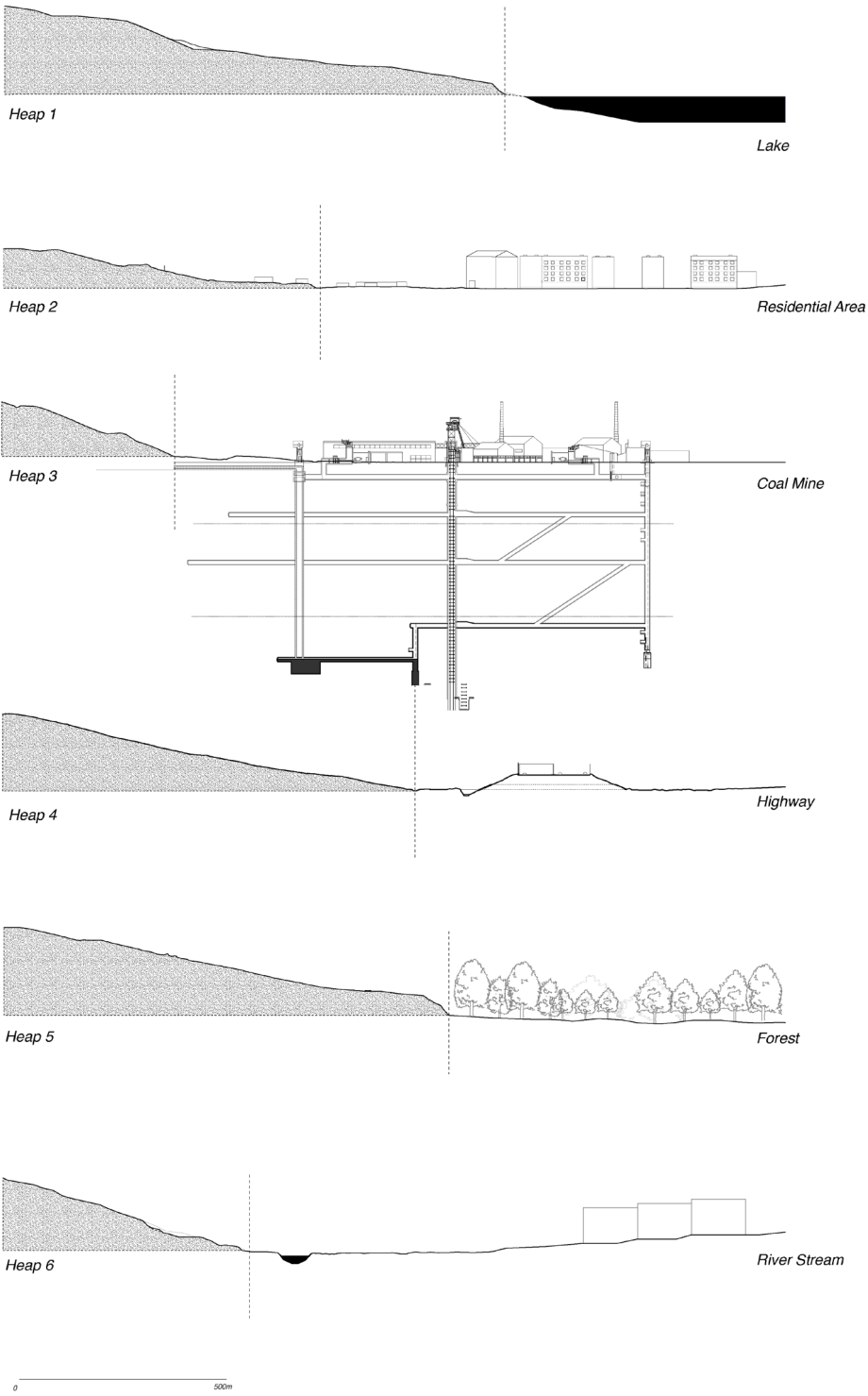


Figure 15 | Sectional drawings of the edge condition of six different heaps

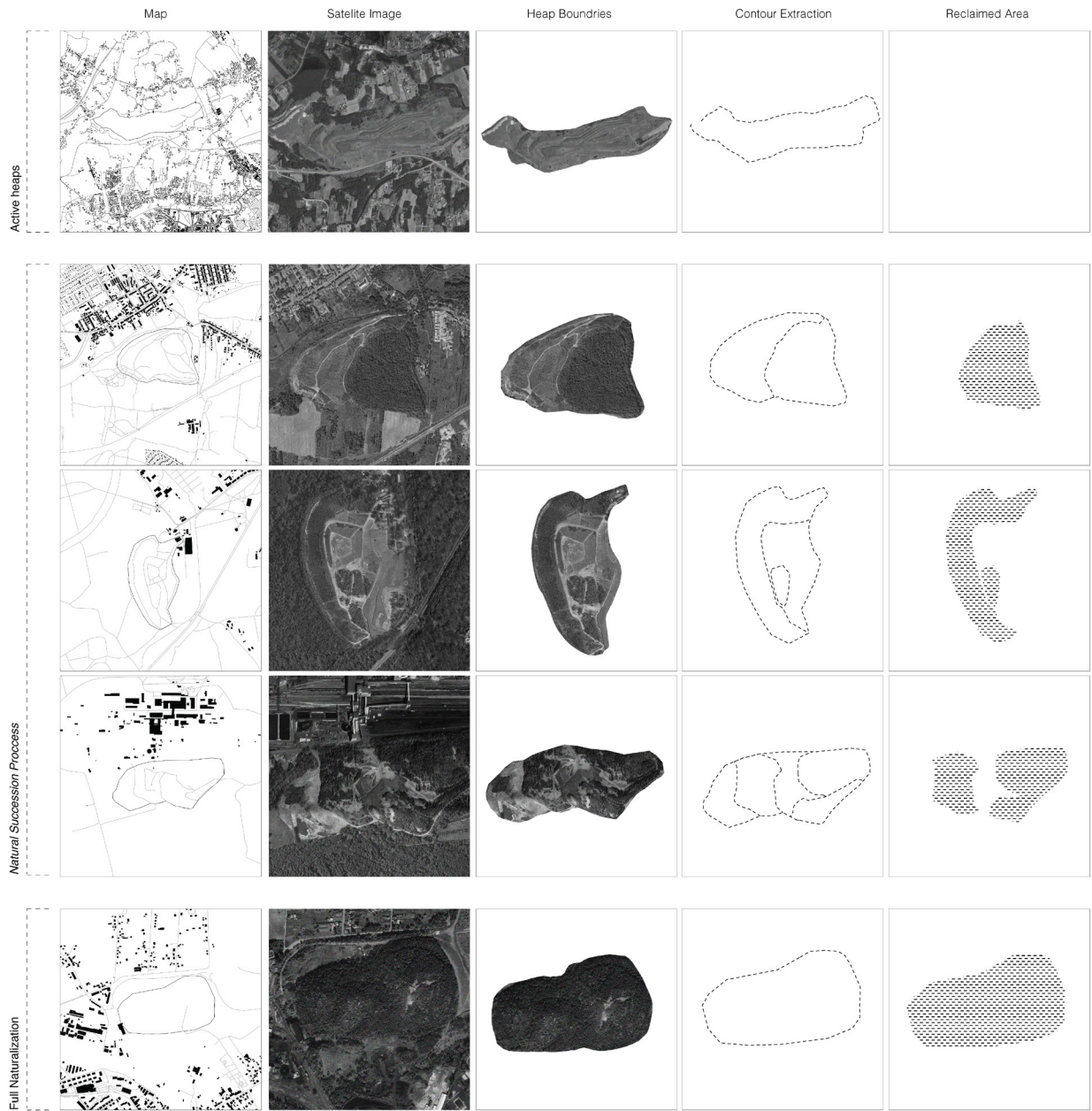


Figure 16 | Reclamation pattern matrix showing different types of heaps - fully reclaimed by nature, partially reclaimed by nature and active non-reclaimed heaps

Makoszowy Heap Analysis

The analysis of the Makoszowy Heap began with an examination of its position within the wider post-industrial landscape. Two primary axes structure the site and its surroundings. The first, the Industrial Axis, establishes a historical and functional connection between the decommissioned Makoszowy Mine and the still-operational Sosnica Mine. Intersecting this is the Social Axis, which links the historic mining settlement in the south with the ventilation shaft complex to the north improving accessibility and urban permeability across the site. (Figure 17).

To better understand the sensory qualities of the landscape, acoustic measurements were conducted at eight locations across the heap. The resulting “sound section” revealed a gradient between industrial and natural soundscapes, highlighting areas where the presence of infrastructure, vegetation, and topography influence the perception of the site. The loudest sound of the working mine reached almost 120sb, while the sound of the ventilation shaft reached 80db. In the centre of the heap the industrial sounds were almost undetectable. This analysis informed the positioning of the project and its relationship to both active and passive landscape experiences (Figure 17).

The physical structure of the heap was investigated through a series of topographical sections based on the data from Polish Geological Institute National Research Institute. These revealed significant differences in soil composition and stability across the site. The oldest and lowest areas of the heap, which have undergone extensive natural succession and forest development, were found to be the most stable and compacted. In contrast, the upper plateau retains fresher mining material and exposed coal deposits, creating a more dynamic and less consolidated terrain. As a result, the Makoszowy Heap can be understood as a self-reclaiming landscape, where vegetation, soil formation, and ecological succession continuously transform its structure over time (Figure 18).

Hydrology emerged as another critical layer of analysis. The heap is located between the Kłodnica River, a sedimentation pond, and a marshland system, making water movement a key environmental concern. Particular attention was given to the issue of acid mine drainage and the potential pathways of contaminated runoff. Mapping and tracing water flows across the heap helped identify how surface water interacts with surrounding ecosystems and informed the development of future landscape and remediation strategies (Figure 20).

Beyond these spatial and environmental systems, the site was analysed through the lens of ecological succession. The Makoszowy Heap represents a mosaic of ecotones and reclamation stages, ranging from exposed mineral substrates and active deposition areas to pioneer vegetation, shrubland communities, and mature forest systems. These zones collectively illustrate the gradual transformation of an industrial landform into a functioning ecosystem. Understanding this ecological chronology was essential for the design process, allowing interventions to respond to existing processes of regeneration rather than replacing them (Figure 19).

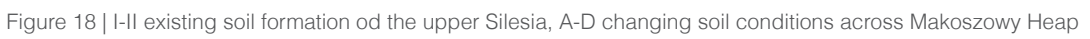
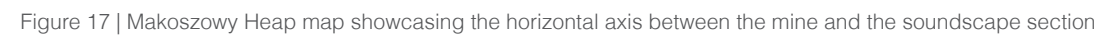




Figure 19 | Ecotones across the Makoszwy Heap showing that the heap is almost completely reclaimed by the forest while the peak of the heap still remains covered by fresh coal disposal



Figure 20 | Toxic run-off water mapping and Acide mine draining prone areas - bright white patterns reflects the water runoff from the heap which directly affects nearby water bodies like Kłodnica river, Marshlands and the Sedimentation lake

Energy and Material Potential

Beneath the site lies a significant but largely invisible resource: the flooded underground workings of the decommissioned Makoszowy Mine. Following mine closure, groundwater gradually fills the underground voids, creating a stable low-enthalpy geothermal reservoir. Due to the surrounding geology and geothermal gradient, mine water temperatures typically range between 30–40°C, providing a reliable source of thermal energy. Through heat exchangers and heat pump systems, this energy can be upgraded for applications such as space heating, domestic hot water production, and thermal bathing. Similar approaches are currently being explored in post-mining regions across Poland, including studies conducted at the former Szombierki Mine, demonstrating the potential of mine-water geothermal systems as renewable energy sources for post-industrial landscapes.¹

In addition to its energy potential, the site contains substantial material resources. Analysis of the heap revealed a heterogeneous composition of coal residues, limestone, and fly ash, each offering opportunities for reuse within a circular material strategy. Fly ash can be incorporated into alternative concrete production, while limestone possesses qualities that support water treatment by reducing acidity and facilitating iron sedimentation. Furthermore, the proximity of the decommissioned Makoszowy Mine presents opportunities for the recovery and reuse of existing construction materials, including crushed concrete and structural elements from former mining infrastructure (Figure 21).

Together, these findings demonstrate that the Makoszowy Heap contains both energy and material resources that can contribute to future landscape transformation

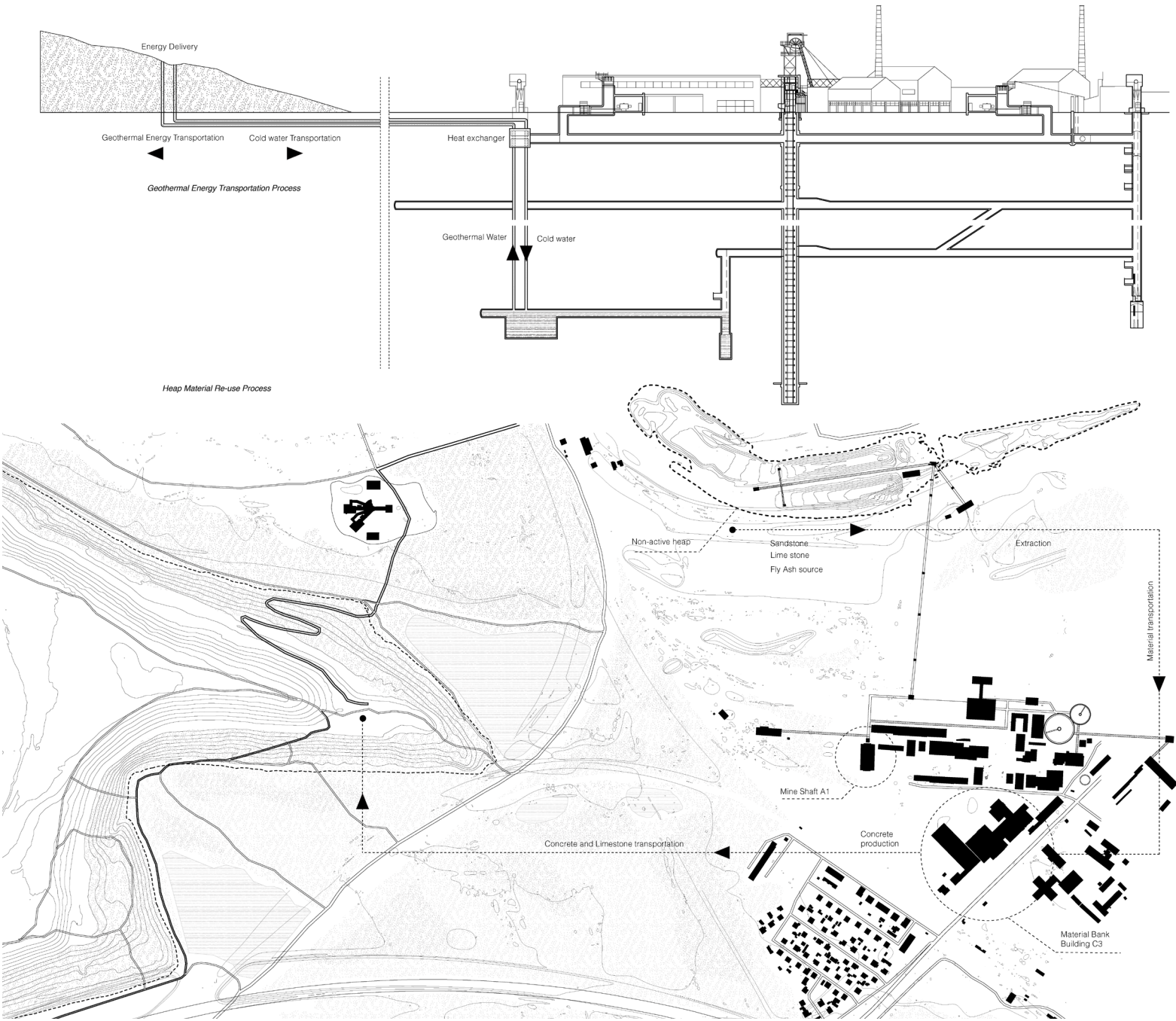


Figure 21 | Material and energy harvest map for the Makoszowy Heap

¹Ewa Janson et al., “Use of Geothermal Heat of Mine Waters in Upper Silesian Coal Basin, Southern Poland Possibilities and Impediments,” in Mine Water and Circular Economy , ed. Christian Wolkersdorfer et al. (Lappeenranta: International Mine Water Association, 2017).

Site Survey and Landscape Observation

The Makoszowy Heap was visited on several occasions as part of the research process. While mapping and analytical studies provided an understanding of the site’s spatial and environmental systems, the site visits offered a direct encounter with the landscape and its atmospheric qualities. The fieldwork focused on tracing and documenting the character of the heap through photography, sketching, and on-site observation.

Particular attention was given to the material and sensory qualities of the landscape. Photographs and sketches recorded variations in colour, texture, topography, vegetation, and geological composition, revealing the layered nature of the anthropogenic terrain. Equally important was the documentation of traces left by both industrial activity and everyday human use, including remnants of mining infrastructure, informal pathways, tire tracks, erosion patterns, and spontaneous vegetation.

The visits took place during the winter season, when the absence of dense vegetation exposed the underlying structure of the heap and made its industrial origins more legible. The muted colour palette of dark coal residues, exposed soils, and dormant vegetation emphasized the site’s raw materiality, while changing weather conditions highlighted its atmospheric character.

One of the most striking observations was a large erosion cracks cutting through different parts of the heap. The scale of this feature revealed the ongoing geomorphological processes shaping the landform and demonstrated that the heap remains a dynamic landscape subject to continuous transformation through weathering, water movement, and settlement (Figure 21,22).



Figure 22 | Erosion crack measuring approximately 5 m in width and 50 m in length



Figure 23 | Small erosion crack measuring approximately 2m in width and 10m in length



Figure 24 | Old railway structure on the Makoszowy Heap



Figure 25 | Concrete blocks for heavy machinery



Figure 26 | Stream affected by acid mine drainage and iron precipitation adjacent to the Makoszowy Heap



Figure 27 | Lunar-like landscape on the summit of the Makoszowy Heap



Figure 28 | Transition between active coal deposits and naturally reclaimed terrain



Figure 29 | Abandoned earthmoving equipment on the upper plateau of the heap

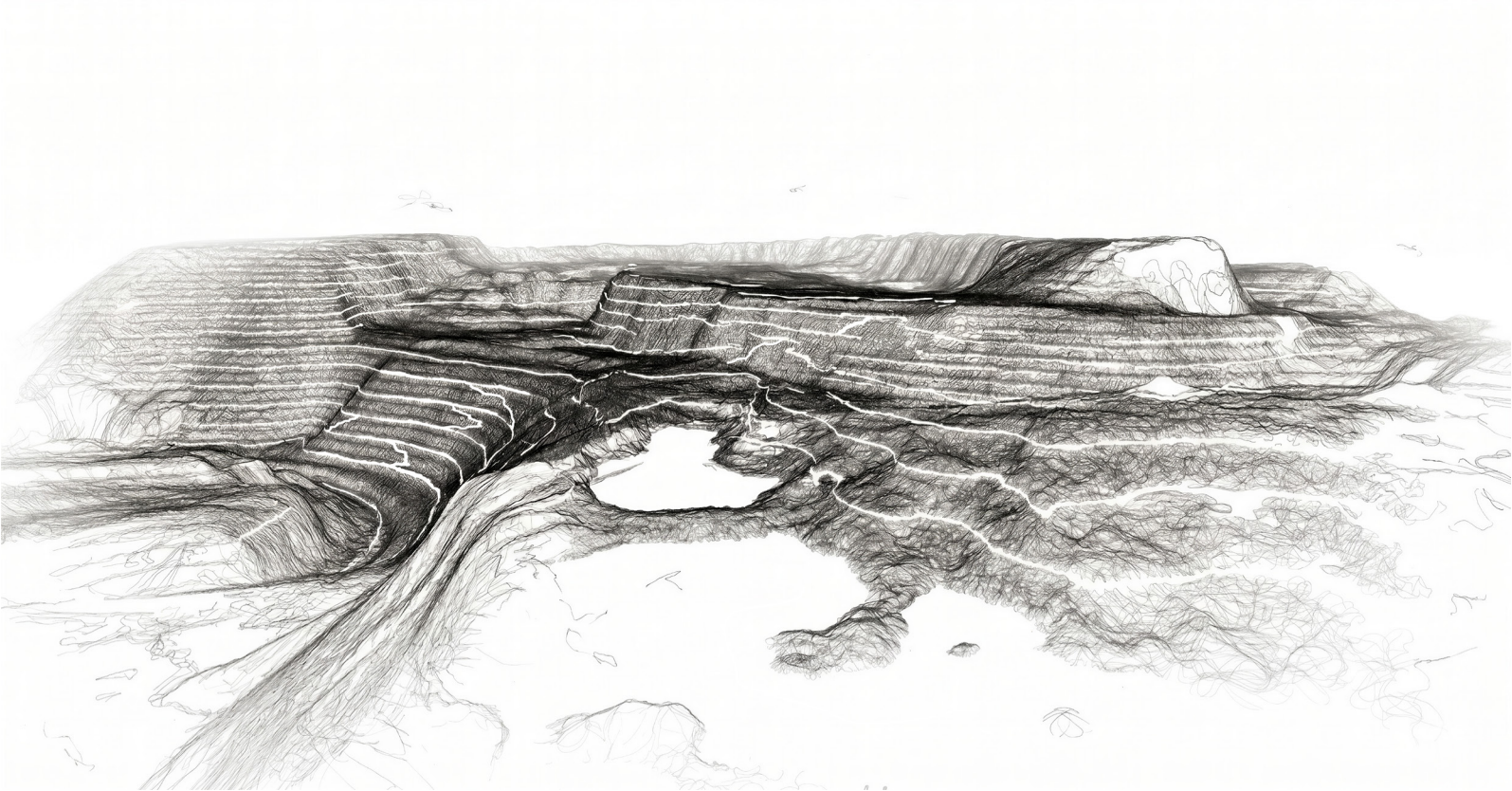


Figure 30 | Makoszowy Heap impression drawing

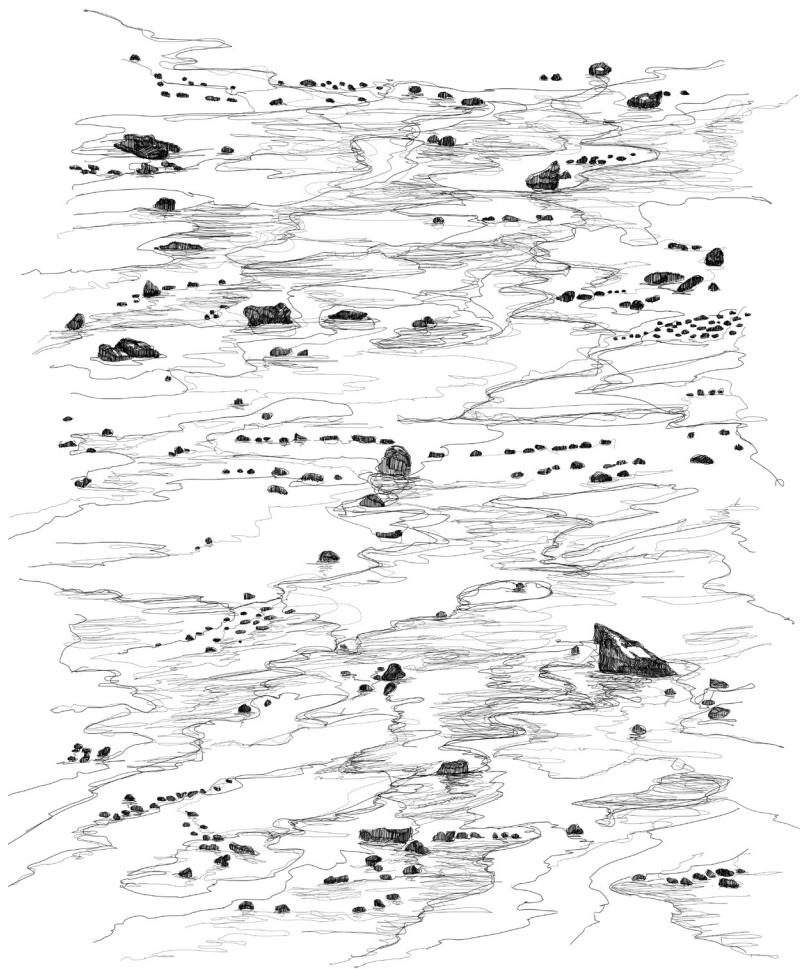


Figure 31 | Coal fragments in the water



Figure 32 | Soil cracks patterns

Design Exploration

Precedent study analysis formed a crucial step in the design development process. The methodology began with the creation of a comprehensive precedent matrix, categorizing and evaluating a broad range of examples drawn from landscape, land art, and architecture. From this analysis, the key designs that most heavily influence the project were selected. Ultimately, this selection of case studies was identified to directly inform the project's program, materiality, structural logic, and atmospheric approach.

The research began with historical precedents in water management and spatialized water systems. The Minoan drainage networks at Knossos, for instance, demonstrate early techniques of controlled flow, sedimentation, and filtration. These ancient systems reinforced the understanding that water on the Makoszowy site is not a neutral element, but rather a carrier of industrial contamination and geological memory. Consequently, water is treated as a design medium, shaped through slowing, filtering, and spatial sequencing. Key principles extracted from these precedents such as controlling flow velocity to enhance sedimentation, utilizing layered materials for progressive filtration, and introducing oxygenation were adapted to improve overall water quality and ecological performance.² Additionally, the spatial sequencing of traditional Roman baths was analyzed to understand how to logically organize these thermal environments according to precise temperature gradients.

A central reference for atmospheric and programmatic exploration was Therme Vals by Peter Zumthor. The project was analysed in terms of its sequencing of thermal spaces and its constructed transitions between light and darkness. The linear progression of bathing chambers informed the interpretation of thermal rituals within the Makoszowy project. This analysis directly led to the development of a linear spatial sequencing of the thermal baths, used as a design tool to better understand and structure temperature gradients, spatial transitions, and atmospheric variation.³

Landscape and earthwork strategies were informed by the work of Robert Morris, particularly his approach to earthworks and perceptual framing of landscape⁴. His use of constructed mounds as spatial and visual devices provided insight into how topography can structure perception and guide visitor experience.

Material and architectural integration was further explored through the example of the Sinclair Mosque. The project demonstrates how heavy monolithic stone construction can be embedded within sloped terrain, creating a sense of continuity between building and landscape.⁵ Its integration of roof surfaces with the ground plane, along with its emphasis on thermal mass and insulation, informed the approach to embedding architectural elements within the evolving topography of the heap.

Together, these case studies establish a set of transferable principles relating to atmospheric sequencing, water as a spatial and ecological medium, topographical manipulation, and material integration. These principles directly informed the development of the Makoszowy Heap design strategy.

² Andreas N. Angelakis and Joan B. Rose, eds., Evolution of Sanitation and Wastewater Technologies through the Centuries (London: IWA Publishing, 2014).

³ "The Therme Vals / Peter Zumthor," ArchDaily, February 11, 2009, <https://www.archdaily.com/13358/the-therme-vals>.

⁴ Iris Amizlev, "Land Art: Layers of Memory - The Use of Prehistoric References in Land Art" (PhD diss., Université du Québec à Montréal, 2001).

⁵ "Sancaklar Mosque / Emre Arolat Architects," ArchDaily, June 17, 2014, <https://www.archdaily.com/516205/sancaklar-mosque-emre-arolat-architects>.

	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	
Landart	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	
Landscape	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY
	Ground Relation	Composition	Program	Material Expression	Material Effect	Atmospheres	Technology	
Architcture	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	 The Mound / Robert Morris 1965, New York, NY The Mound / Robert Morris 1965, New York, NY	

Figure 33 | Precedent Design Matrix consisting of 40 case studies



Figure 34 | From the top:
Minoan Water Filtration system: Slow water system following the turns of the stairs with the intermediate sediementation tanks and the turning points where gets oxidizes to lower the toxin level.
Sequencing of the Roman Baths and the temperature change - Apodyterium, Tepidarium, Caldarium and Frigidarium.

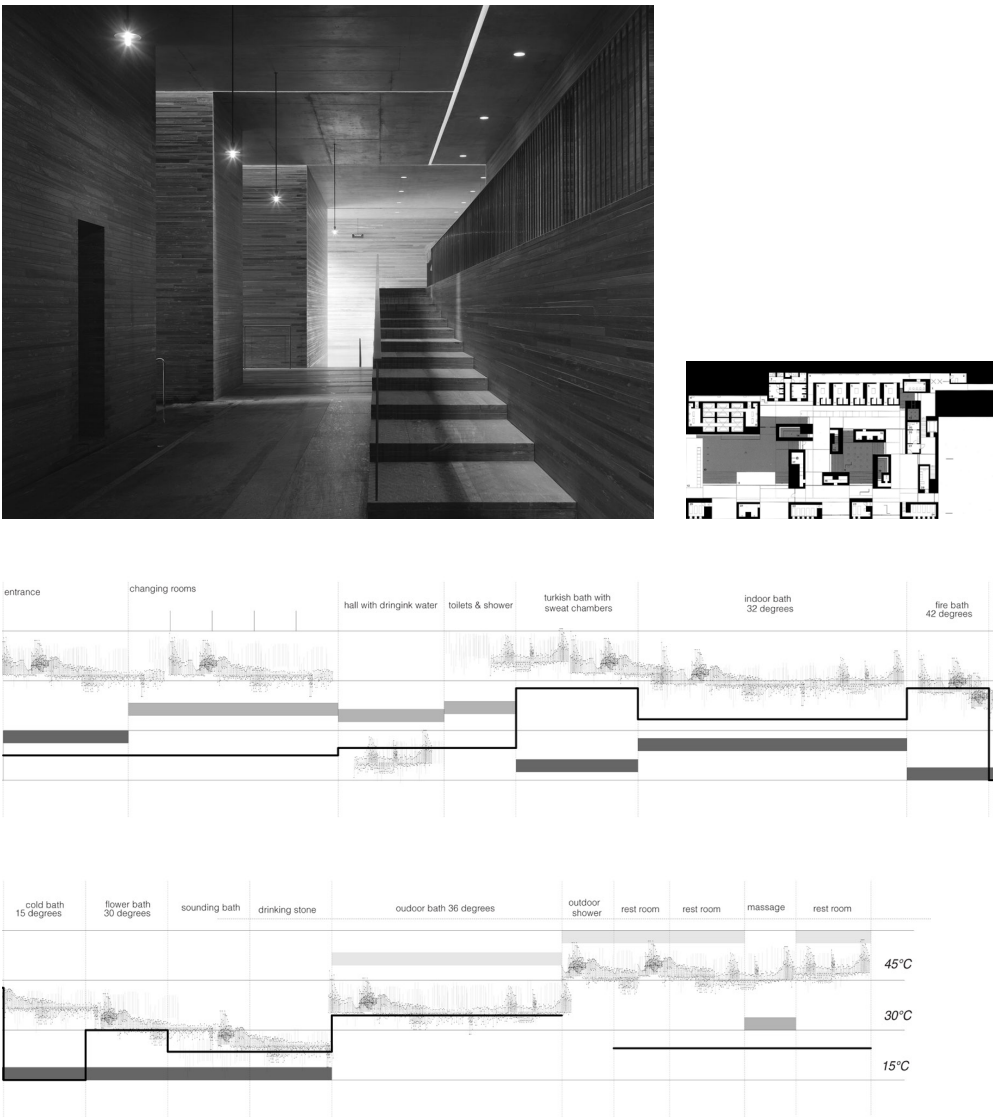


Figure 35 | From the top:
The contrast between artificial light, stone material and water creates a mysterious atmosphere.
Functional Floor plan of the baths with one indoor and one outdoor pool.
Atmospheric diagram - linear distribution of the spaces in the Zumthor's Baths and 3 atmospheric qualities - light, sound and temperature.

"I was pleased with the site because people could get to it, and insofar as I do something like that, that is physical I want it to be experienced for what it is. It is important to me that it is there and available"
Robert Morris

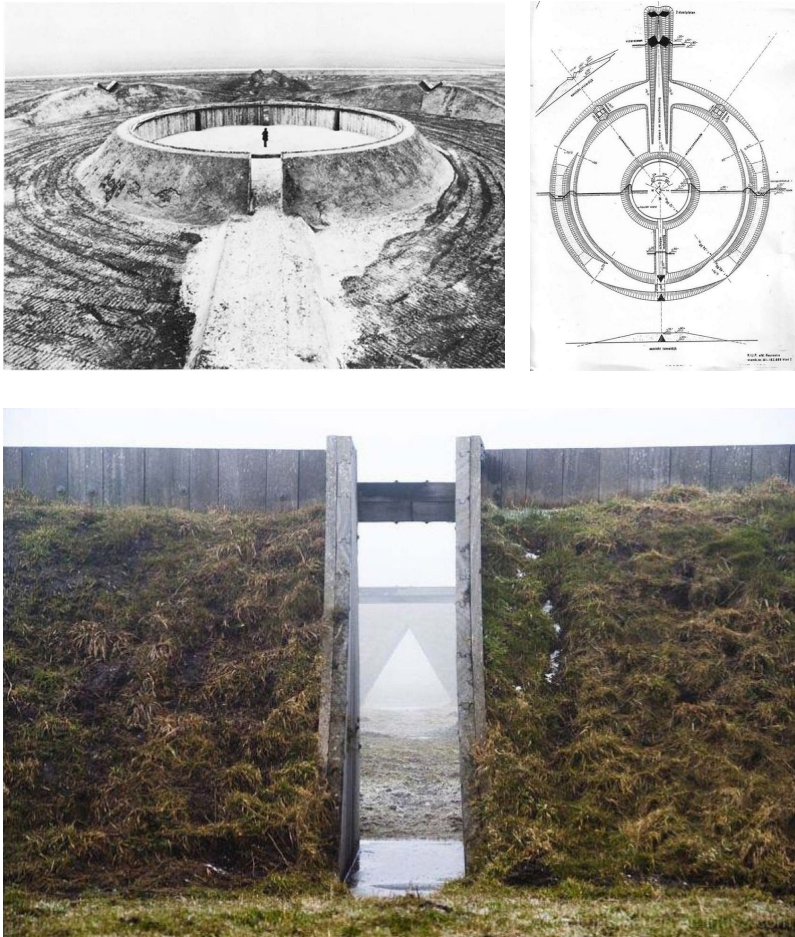


Figure 36 | From the top:
Robert Morris's quote that served as the inspiration for the intervention design on the Mkaowszowy Heap.
Earthwork precedent imagery, and conceptual sketch of the proposed interventions showing the mound cut with the concrete tunnels which direct the visitors to the centre of the mound.
Contrast between the natural greenery and artificial concrete walls.



Figure 37 | From the top:
Stone Material and texture sketch.
Combination of gray slate stone with the reinforced concrete roof as the representation of the raw and humble connection with the Earth.
Roof acting as the continuation of the landscape, covered by the sloping terrain, extra thermal insulation layer.

Material Research

Material research explored how resources already present within the heap and the surrounding post-industrial landscape could be reused as potential construction materials. Given that water contamination and acid mine drainage are among the site's most pressing environmental challenges, the investigation focused on materials with filtration, remediation, and landscape stabilisation potential.

The research translated these principles into a series of speculative filtration walls and landscape structures, combining materials found within the heap with reclaimed materials from decommissioned mining infrastructure. Different material compositions were explored for their environmental, structural, and spatial qualities:

- Gabion walls - constructed from steel mesh cages filled with reclaimed materials. Their porous structure allows water to flow through while slowing runoff, reducing erosion, and creating opportunities for sediment capture. Within the project, gabions also function as retaining structures, seating elements, and landslide protection.⁶
- Limestone - investigated for their ability to neutralise acidic water and facilitate the precipitation of dissolved iron. Due to its alkaline properties, limestone has been widely used in passive treatment systems for acid mine drainage.⁷
- Crushed concrete infill - sourced from decommissioned mining structures and reused within gabions and retaining systems. The material provides structural stability while reducing construction waste and supporting a circular material economy.
- Biomoss and vegetated systems - considered as living filtration layers capable of supporting phytoremediation and biological water treatment processes.⁸

In parallel, the research investigated the potential of fly ash as a low-carbon alternative to conventional cement. Fly ash, a by-product of coal combustion, can partially replace Portland cement within concrete mixes. When mixed with water and aggregates, the fine particles react with calcium hydroxide produced during cement hydration, forming additional cementitious compounds that improve durability while reducing the embodied carbon of the material. Within the project, fly ash recovered from mining waste streams is explored as a locally sourced binder that transforms an industrial by-product into a valuable construction resource.⁹

To further investigate the material character of the heap, a series of physical material experiments were conducted using samples collected during site visits. Crushed limestone and coal fragments were processed and combined with cement-based and fly ash concrete mixes to produce prototype wall samples. The objective was not only to test material performance but also to explore how the colour palette, texture, and geological identity of the heap could be translated into architectural elements. These experiments informed the material language of the project, allowing the architecture to emerge directly from the physical characteristics of the site.

⁶ Y. Wang, J. V. Smith, and M. Nazem, "Optimisation of a Slope-Stabilisation System Combining Gabion-Faced Geogrid-Reinforced Retaining Wall with Embedded Piles," KSCE Journal of Civil Engineering 25, no. 12 (2021): 4535–4551, <https://doi.org/10.1007/s12205-021-1300-6> [cite: 1.1.3].

⁸ Rafael Alvarez Gutiérrez et al., "Preliminary Research on Moss-Based Biocomposites as an Alternative Substrate in Moss Walls," Sustainability 15 (2023): 16500, <https://doi.org/10.3390/su152316500> [cite: 1.1.3].

⁷ C. A. Cravotta III, "Oxic Limestone Drains for Treatment of Dilute, Acidic Mine Drainage," in Proceedings Nineteenth Annual West Virginia Surface Mine Drainage Task Force Symposium (Morgantown, WV: West Virginia Surface Mine Drainage Task Force, 1998), <https://www.usgs.gov/publications/oxic-limestone-drains-treatment-dilute-acidic-mine-drainage>.

⁹ M. Thomas, Optimizing the Use of Fly Ash in Concrete (Portland Cement Association, 2007)



Figure 38 | Material exploration through model making
Three types of walls were constructed using materials extracted during the site visit. From the front, these include: limestone with iron staining, a gabion wall infilled with a mixture of rock and coal, and lastly, a concrete wall made from crushed concrete debris.



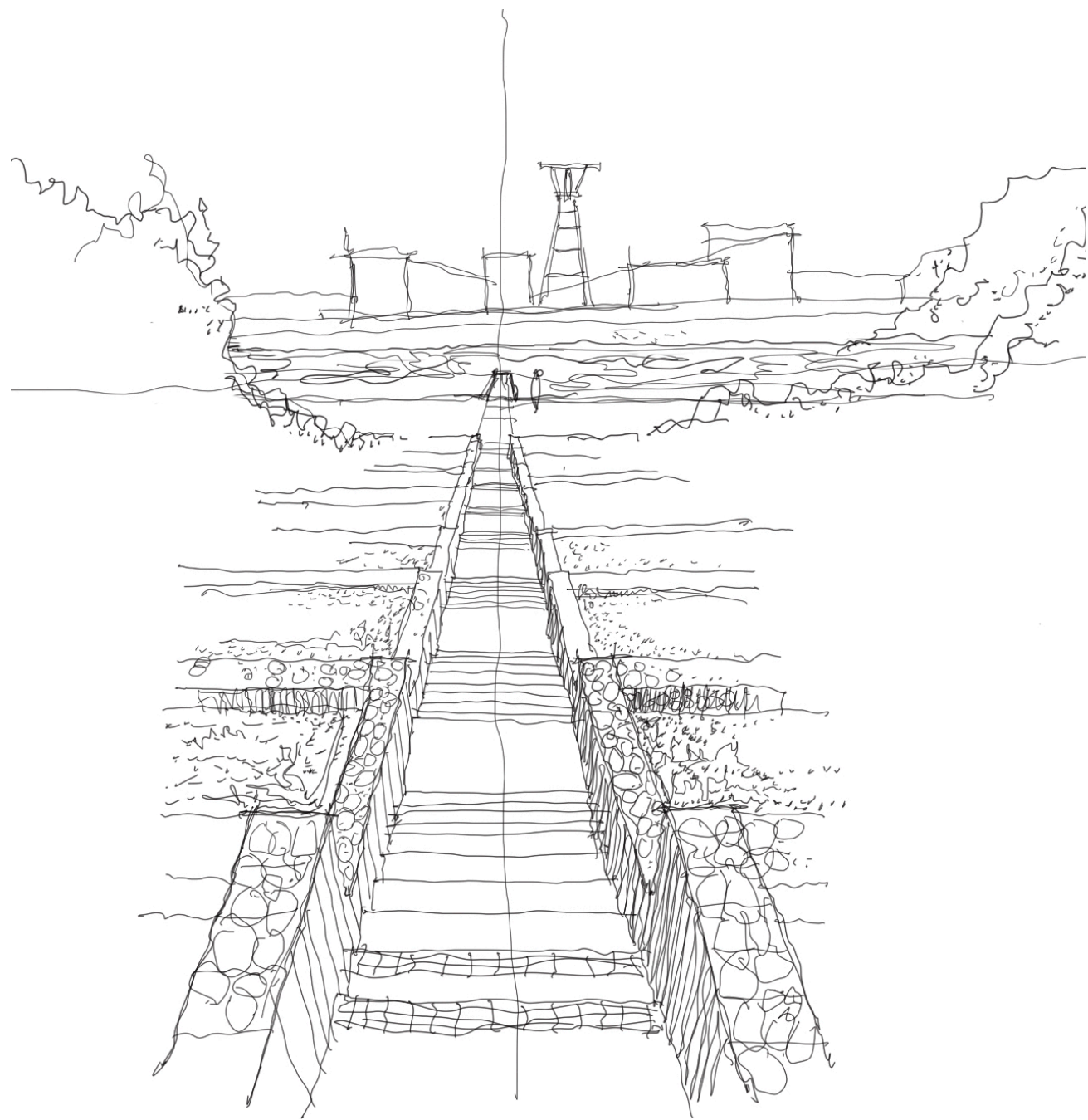


Figure 39 | Concept Sketch of stone path with gabion walls

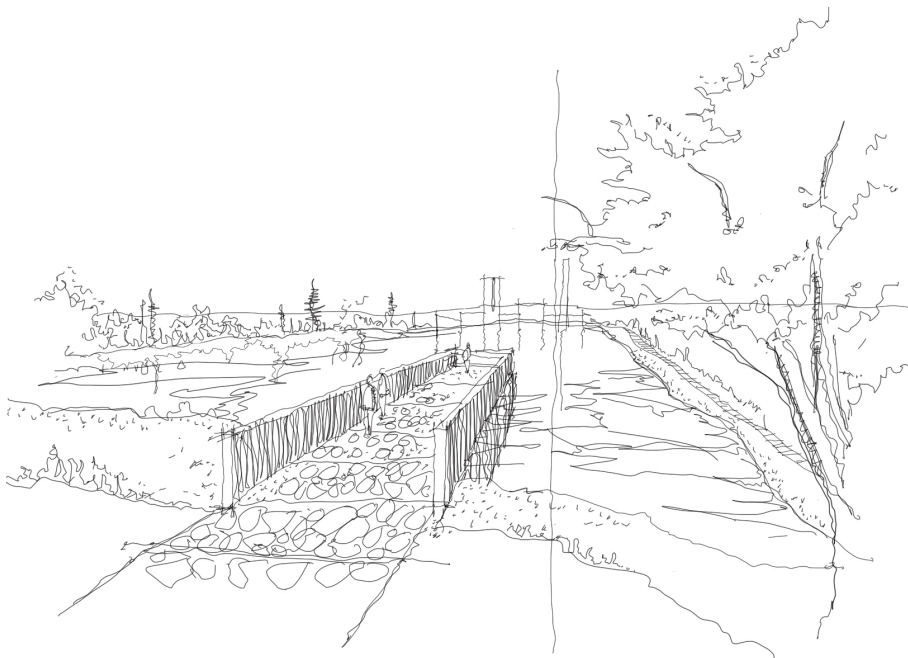


Figure 40 | Concept Sketch of Lake Platform with the view towards decommissioned Makoszowy mine

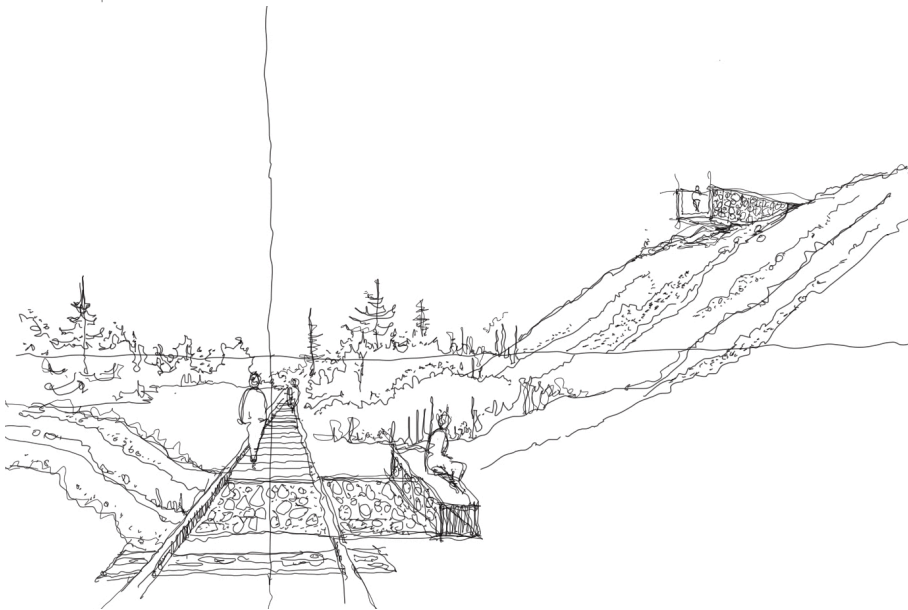


Figure 41 | Concept Sketch of Railway Path and the erosion look-out on the right.

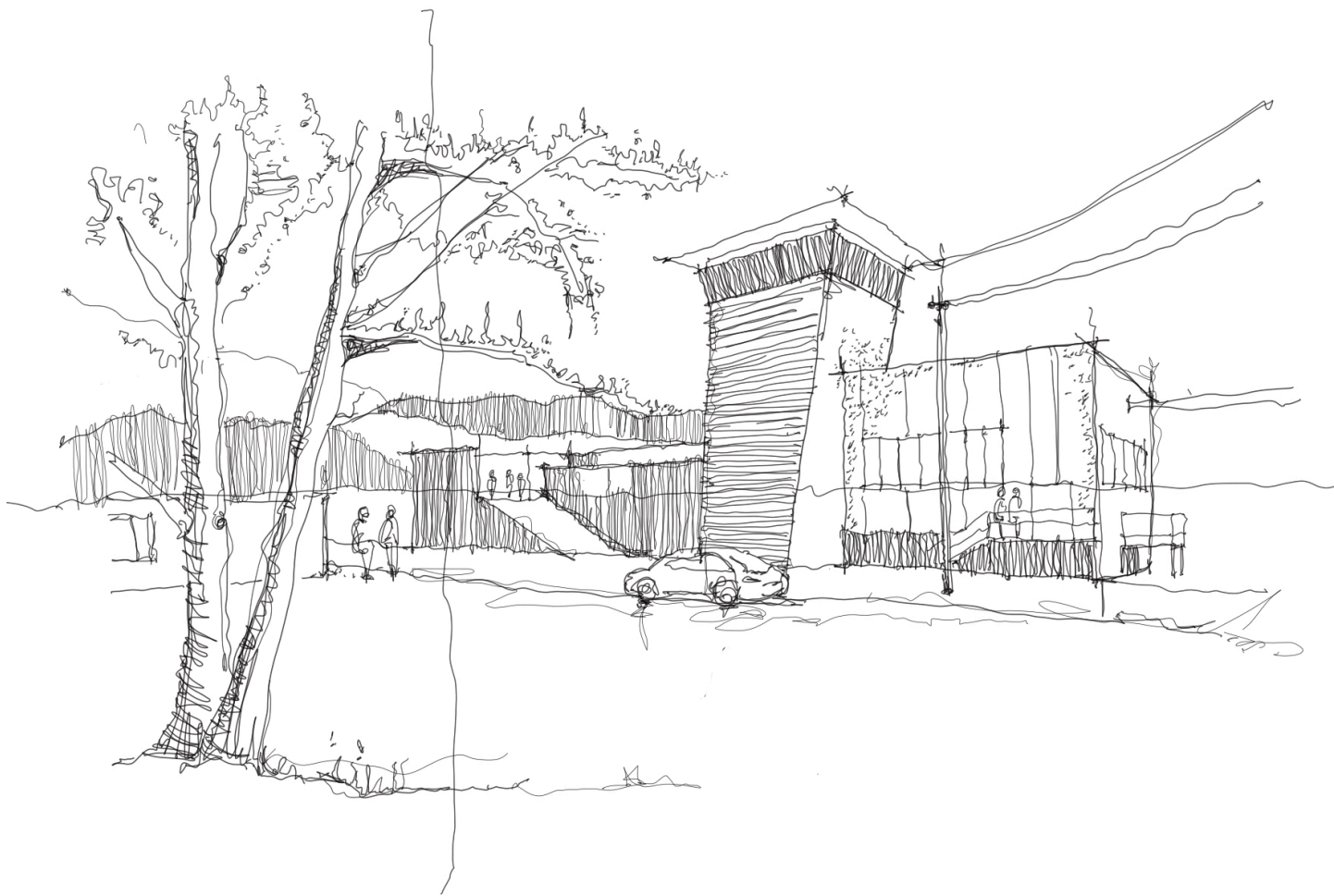


Figure 42 | Old ventilation shaft as the car park and first contact with the heap, from where visitors walk to the Thermal Baths Complex

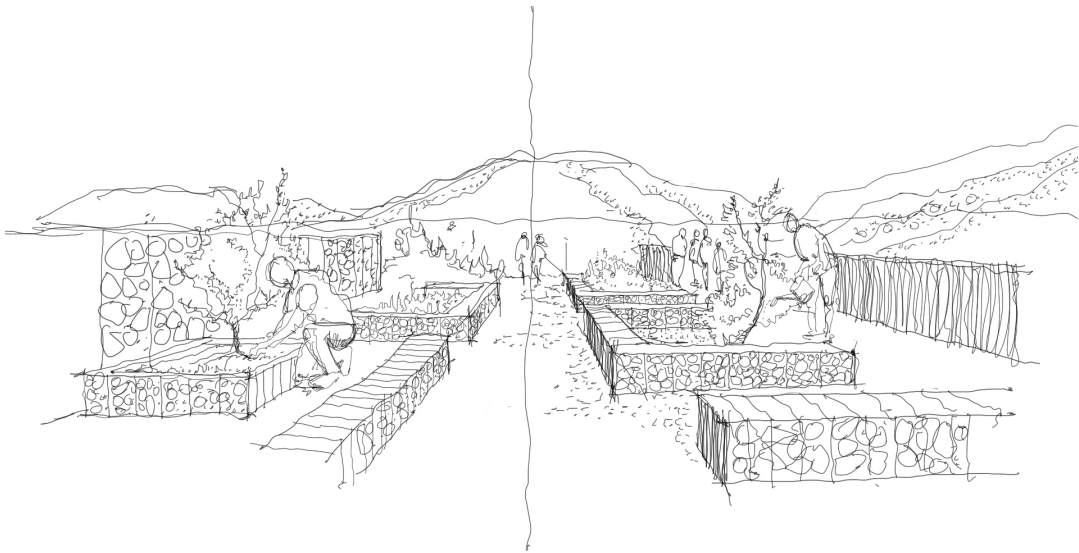


Figure 43 | Concept Sketch of communal gardens located at the upper plateau of the heap

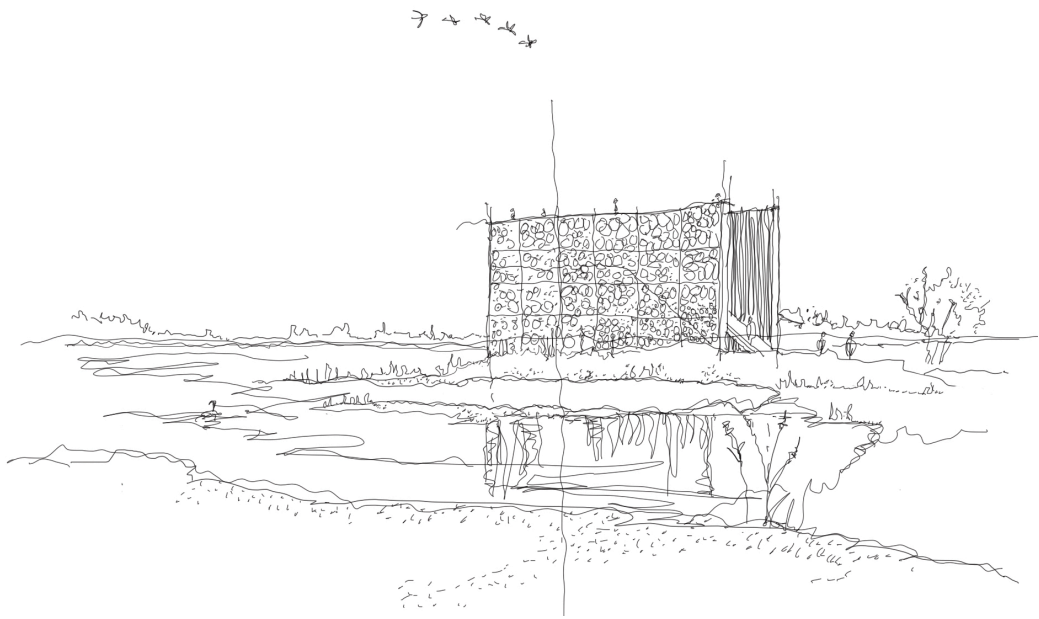


Figure 44 | Concept Sketch of marshland platform made form gabion walls acting as the bird observatory

Research Conclusion

The research demonstrates that the coal heaps of the Upper Silesian Coal Basin should not be understood as residual landscapes awaiting remediation, but as dynamic environments shaped by ongoing ecological, material, and social processes. Analysis of the regional network of heaps, the detailed study of the Makoszowy Heap, site observations, material investigations, and precedent studies revealed the coexistence of contamination and regeneration, instability and resilience, industrial heritage and emerging ecological value.

Particular attention was given to the role of water as both an environmental challenge and a landscape-forming agent. Acid mine drainage, iron sedimentation, erosion, and natural filtration processes were identified as visible expressions of the site's continuous transformation. Rather than concealing these processes, these processes can instead become legible elements of the landscape, allowing visitors to engage directly with the environmental consequences and ongoing recovery of the post-mining terrain.

The heap's existing resources hold further potential. Flooded mine shafts offer opportunities for geothermal energy production, while limestone, fly ash, and reclaimed mining materials provide a basis for circular material strategies. Together, these findings point towards an approach that works with the site's existing conditions rather than replacing them. The design proposal therefore seeks to integrate architecture, landscape, infrastructure, and ecological processes into a single spatial framework. The project explores how architectural interventions can coexist with the evolving conditions of the heap, revealing rather than concealing its traces of extraction, succession, and transformation. In doing so, the design aims to demonstrate how post-industrial landscapes can become spaces of public engagement, ecological adaptation, and collective memory.

This phase of the research also concludes three of Christophe Girot's Four Traces of landscape reading: Landing, Grounding, and Finding. Through large-scale mapping, site observation, material experimentation, and the documentation of ecological and industrial processes, a detailed understanding of the heap's physical, cultural, and environmental conditions was established. These investigations provide the foundation for the fourth trace, Founding, which forms the next stage of the project. The design phase therefore translates the knowledge gathered through research into architectural and landscape interventions that emerge directly from the site's existing conditions, material realities, and evolving processes.

RESULTS

Conceptual Framework & Design Position

The design exploration for the Makoszowy Heap begins with a shift in perspective: moving away from designing isolated architectural objects or attempting to “solve” the perceived problems of the landscape, and instead designing with the landscape itself. The project treats the coal heap not as a vacant site awaiting redevelopment, but as an evolving system shaped by ecological succession, industrial history, and ongoing material transformation. While developed for the Makoszowy Heap, the proposal seeks to establish a broader approach applicable to post-industrial coal heaps throughout the Upper Silesian Coal Basin.

At the core of the project is the understanding of architecture as a flexible and adaptive system rather than a collection of autonomous objects. Boundaries between architecture and landscape become intentionally blurred: a wall is no longer simply a barrier but may function simultaneously as a filter, retaining structure, habitat, greenhouse, or place of rest. Likewise, the notion of a memorial is reinterpreted not as a singular monument, but as an atmospheric condition embedded within the landscape and experienced through movement, sound, materiality, and spatial perception.

Rather than concealing the heap’s unstable conditions, toxicity, and ongoing ecological processes, the design seeks to reveal them. Processes such as acid mine drainage, erosion, iron sedimentation, and natural succession are understood as visible expressions of landscape transformation rather than problems to be hidden. By exposing these processes, the project challenges the long-standing perception of coal heaps as inaccessible and undesirable territories, transforming them into places of learning, recreation, and collective memory. In doing so, it combines local cultural practices - including walking, gardening, leisure, and exploration with opportunities for reflection on the region’s industrial heritage.

The design represents the final stage of Christophe Girot’s concept of the Four Traces: Founding. Building upon the processes of Landing, Grounding, and Finding, the project translates the accumulated site readings and discoveries into a coherent design response. The resulting masterplan is structured around five key landscape systems: movement, soil, water, views and nature.

- Movement becomes the primary tool for engaging with the landscape. A network of paths is developed according to the varying ground conditions of the heap. On the unstable upper plateau, elevated corten steel walkways allow visitors to safely traverse areas where toxicity and erosion remain active. Existing railway infrastructure discovered on the site is reused as part of the circulation network, while reclaimed limestone paths are introduced within the more stable forested areas.
- Land and soil stabilisation respond directly to the unstable conditions of the heap’s upper slopes and edges. Gabion structures filled with crushed concrete recovered from decommissioned mines are used to stabilise vulnerable areas while also functioning as seating elements and landscape infrastructure. Large erosion cracks, some reaching several meters in width, are preserved and transformed into viewing points. These interventions act

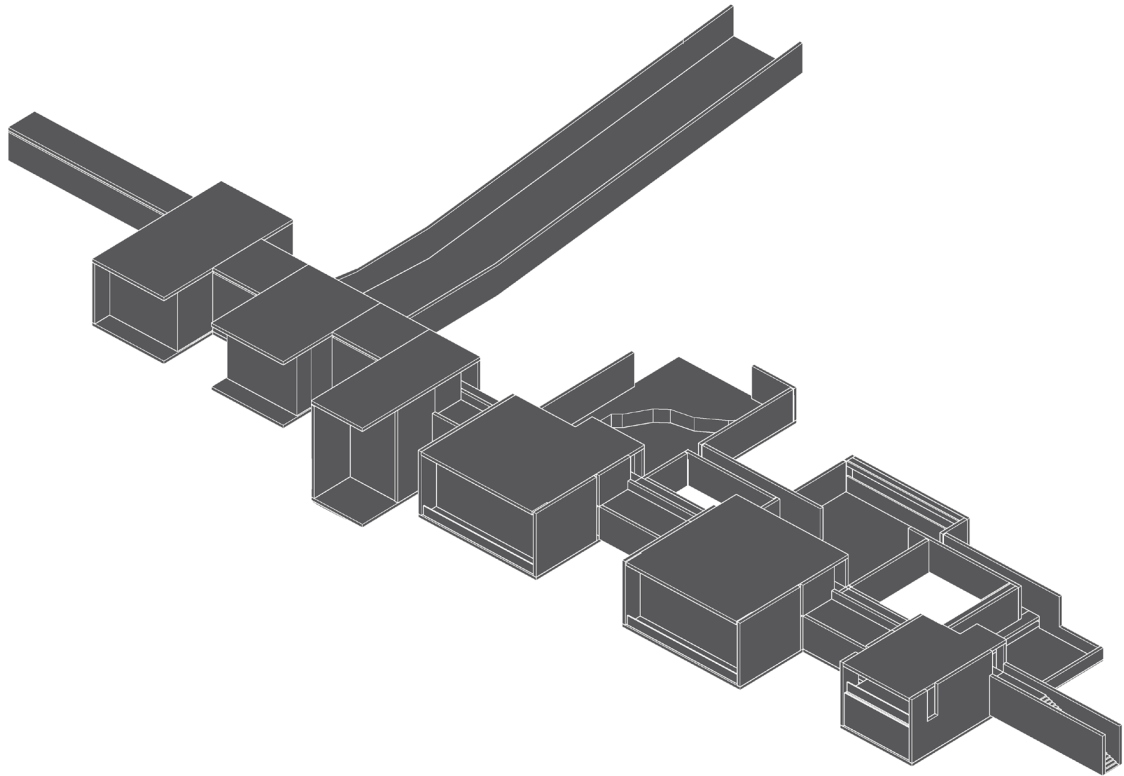
as land-art elements, allowing visitors to safely observe the dynamic geomorphological processes shaping the heap.

- Water is approached as a visible and active landscape process. Rather than controlling or redirecting water flows, the design allows natural runoff patterns and erosion processes to remain legible. The movement of water across the heap continues to shape the landscape, while material choices ensure resilience to contaminated runoff. The thermal bath complex represents a contrasting interpretation of water: transforming a substance often associated with pollution and acid mine drainage into a source of leisure, wellbeing, and renewal.
- Views form the final layer of the masterplan. The elevated position of the heap provides extensive panoramas across the industrial landscape of Upper Silesia, including views towards active and former mining sites. A series of viewing platforms positioned along the river, lake, and key points of the circulation network frame these relationships, encouraging visitors to reconnect with the broader territorial context of the heap.
- Nature is approached not as a landscape to be fully reclaimed or controlled, but as an ongoing ecological process. Rather than replacing the existing succession with conventional planting schemes, the project creates spaces where pioneer species and ruderal vegetation can continue to develop and be actively observed. Dedicated testing and cultivation areas allow experimentation with species adapted to the harsh conditions of the heap, contributing to ecological restoration while preserving the site’s unique character. These spaces also create opportunities for social interaction and knowledge exchange between former miners, local residents, researchers, and younger generations. In this way, ecological succession becomes both an environmental and social process, building new relationships between people and the post-industrial landscape.

Together, these interventions establish a masterplan that responds directly to the existing conditions of the Makoszowy Heap while proposing a transferable framework for the future transformation of post-industrial coal heaps. Rather than erasing industrial traces, the project embraces them as the foundation for new ecological, social, and spatial relationships.

THERMAL BATH COMPLEX

Base of the heap
20m



Program: 6000sqm

- Wet Area
- 2x outdoor swimming pools (25 °C)
 - Outdoor brine water garden
 - Indoor swimming pool (28 °C)
 - 2x cold plunge pools (15 °C)
 - Sound water chamber (28 °C)
 - 2x Finnish saunas (60–70°C)
 - Sweat stone room (60–70°C)
 - Stone massage room
 - Sound relaxation room
 - Kids water play room
 - Changing rooms
 - Shower area

- Dry area
- Entrance water courtyard
 - Exhibition Foyer
 - Complex management office
 - Restaurant

Function
Leisure
Contemplation
Relax
Social

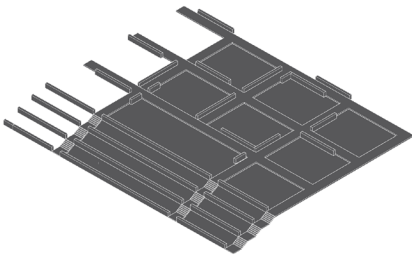
Atmosphere
Monumentality
Ground connection
Dark vs Light interior

Materiality
Lime stone
Reinforced Concrete

Soil Type
Compacted old parts of the heap, natural reclamation and soil stabilization by developed forest

COMMUNAL GARDENS

Upper plateau of the heap
60m



- Types: 1000sqm**
1000sqm
- Plateau gardens for pioneer plant testing and gabions as the production walls
 - Sloped gardens for water run-off filtration and control

Function
Recreation
Social
Plant monitoring
Water flow direction

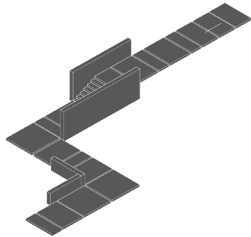
Atmosphere
Openness

Materiality
Lime stone
Gabion walls

Soil Type
Non-reclaimed grounds

WALKING PATHWAYS

Whole area
0-68m



- Types: 3 Path Types**
- Lime stone paths with gabion walls
 - Corten steel path
 - Reused rail tracks

Function
Exploration
Recreation
Water flow direction
Soil stabilisation

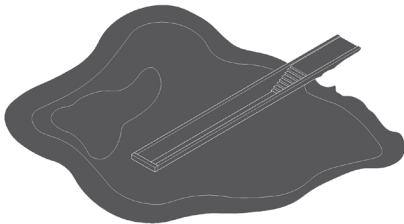
Atmosphere
Surprise
Mystery

Materiality
Existing rails
Lime stone
Corten steel
Gabion walls

Soil Type
All types

WATER PLATFORMS

Base of the heap
0m



- Types: 3 Water Platforms**
- Sedimentation lake platform
 - Klodnica river platform
 - Marshland bird observatory platform

Function
Exploration
Water monitoring
View

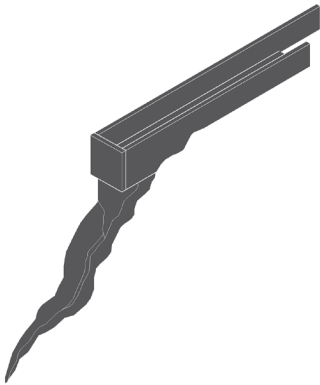
Atmosphere
Ending

Materiality
Reinforced fly-ash concrete
Gabion walls

Soil Type
Water body

EROSION VIEWPOINTS

Top of the heap
68m



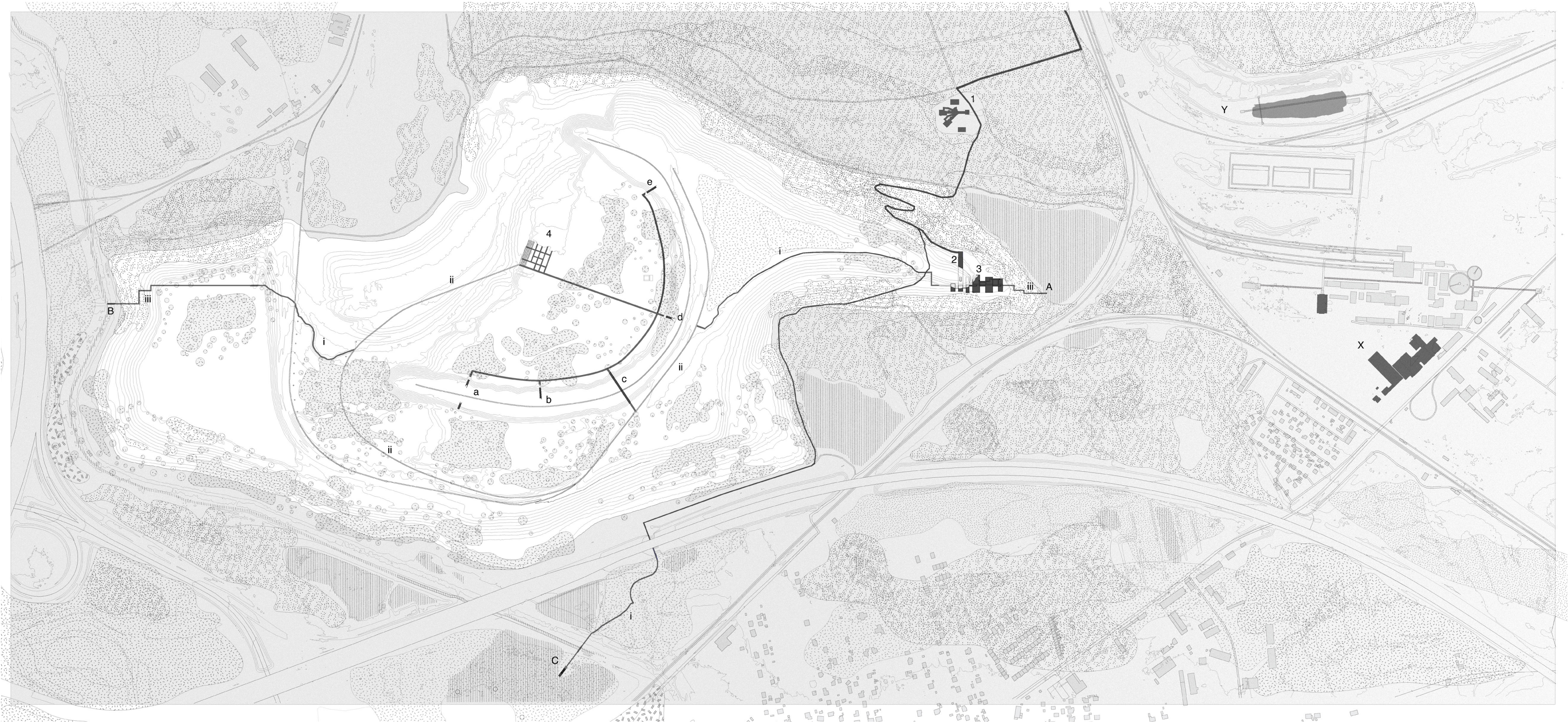
- Types: 5 Erosion Points**
- Four lookouts embayed in the erosion crack
 - One tunnel

Function
Exploration
Soil monitoring
View

Atmosphere
Surprise
Mystery

Materiality
Post-tensioned
lime stone

Soil Type
Unstable
Erosion Cracks



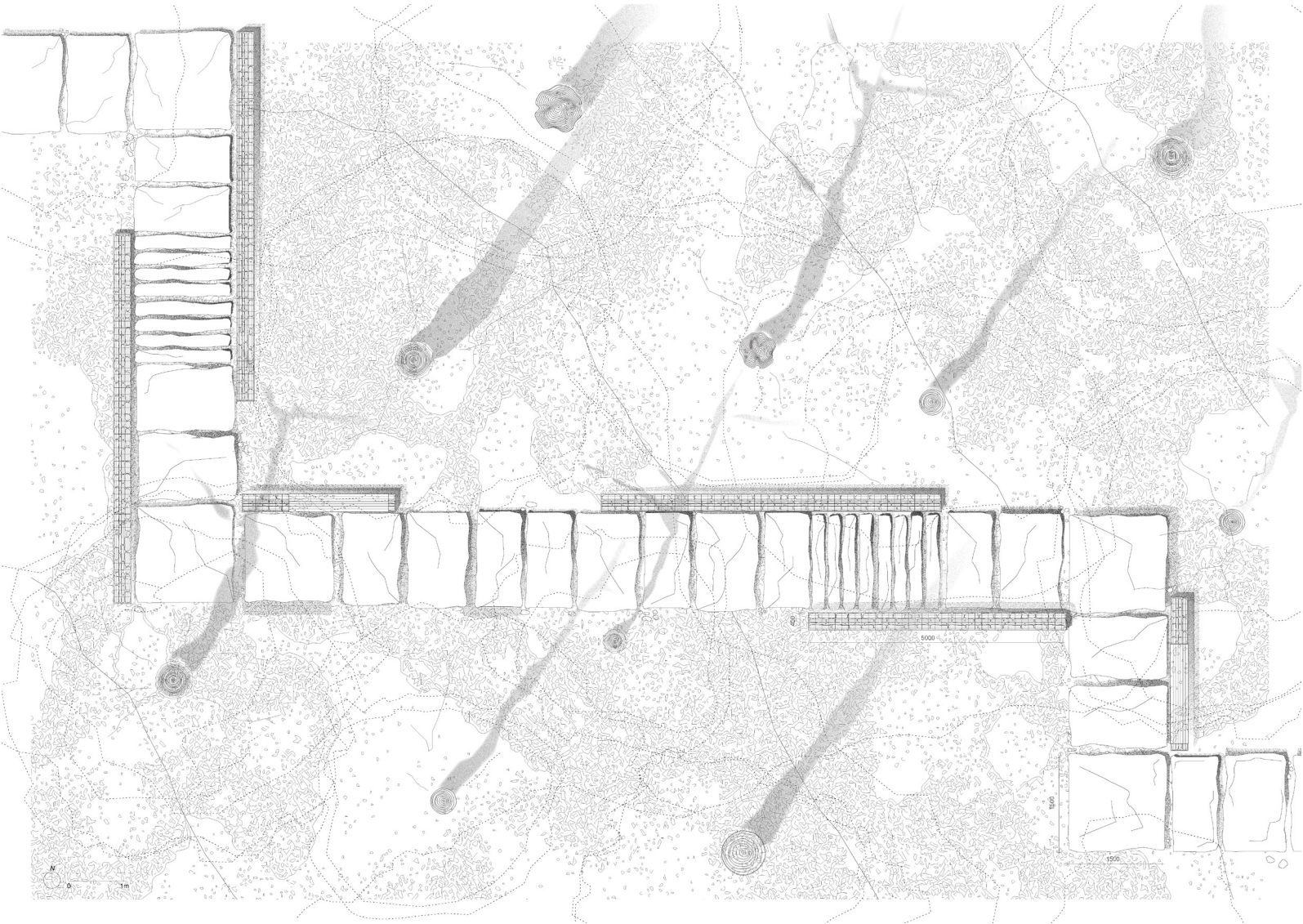
Plan 1:25000

1. Car Park by the Old Ventilation Shaft
2. Drop-off Point
3. Thermal Bath Complex
4. Communal Pioneer Plant Testing Gardens

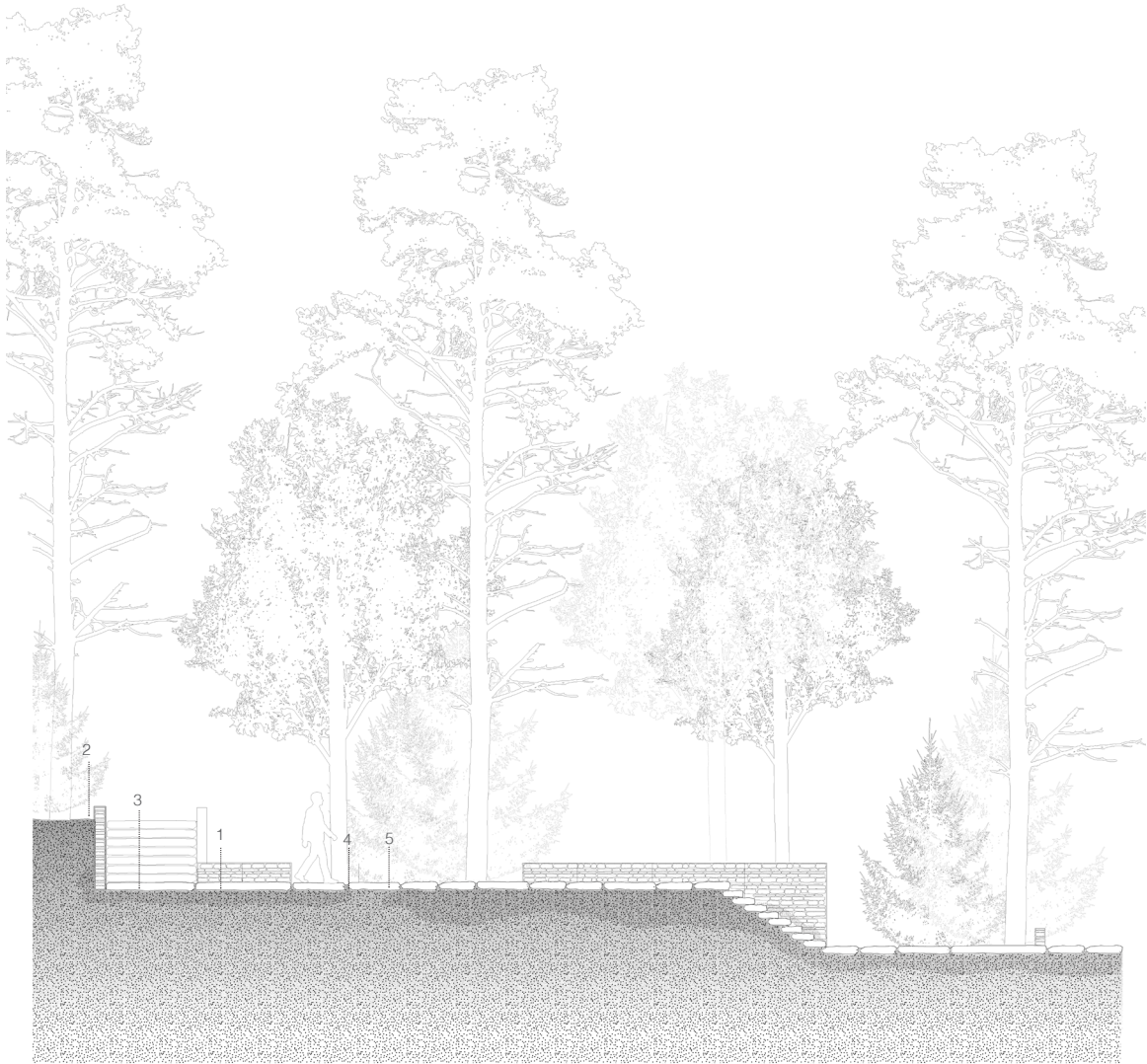
X. Material bank & Geothermal Energy Source
Y. Fly ash, Concrete and Limestone Source

A. Sedimentation Lake Platform
B. River Platform
C. Marshland and Bird Observatory Platform

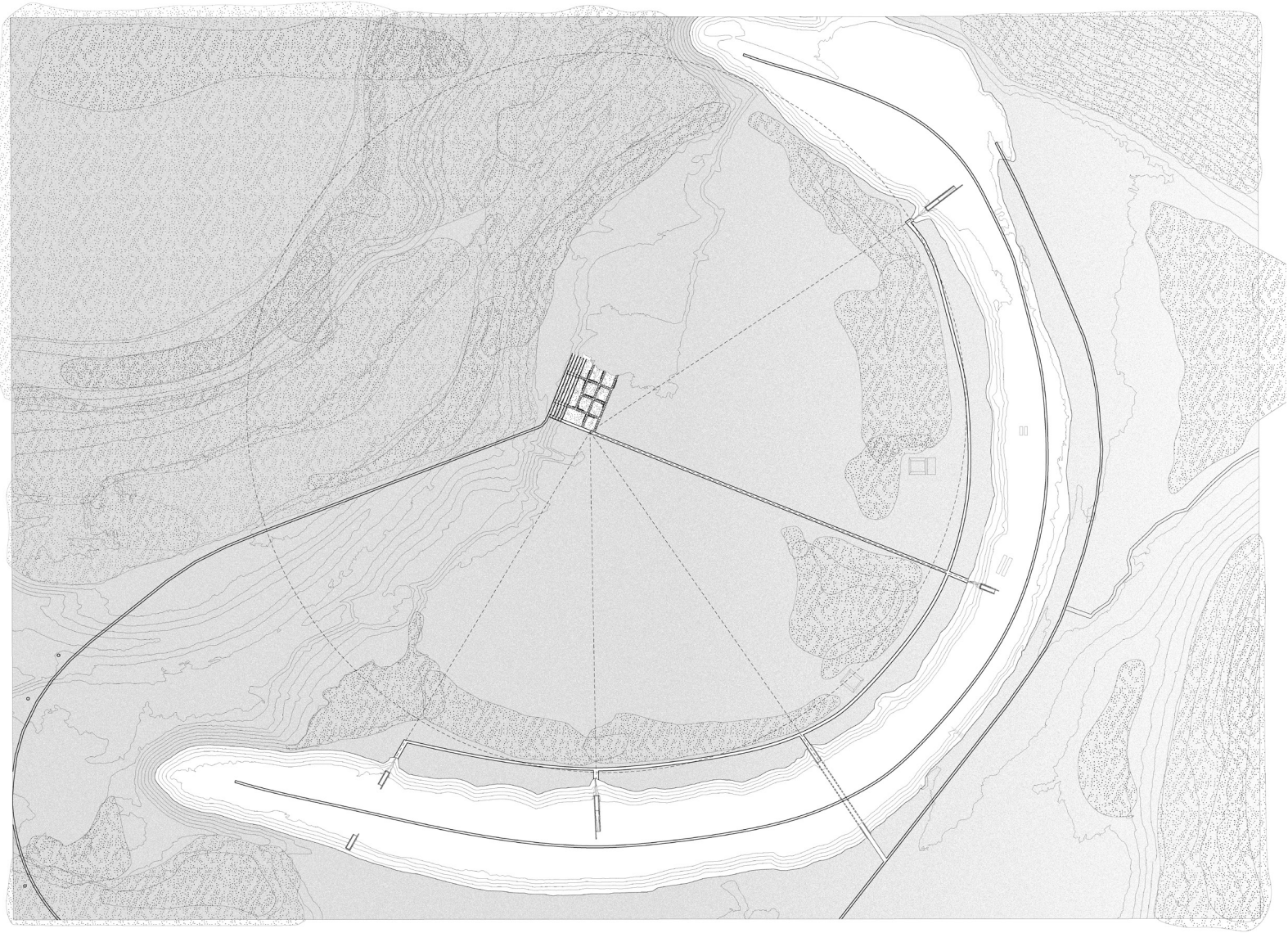
a. Erosion look-out
b. Sloped erosion look-out
c. Tunnel through the heap
d. Erosion look-out
e. Sloped erosion look-out
i. Corten Steel Paths
ii. Railway Paths
iii. Limestone Paths



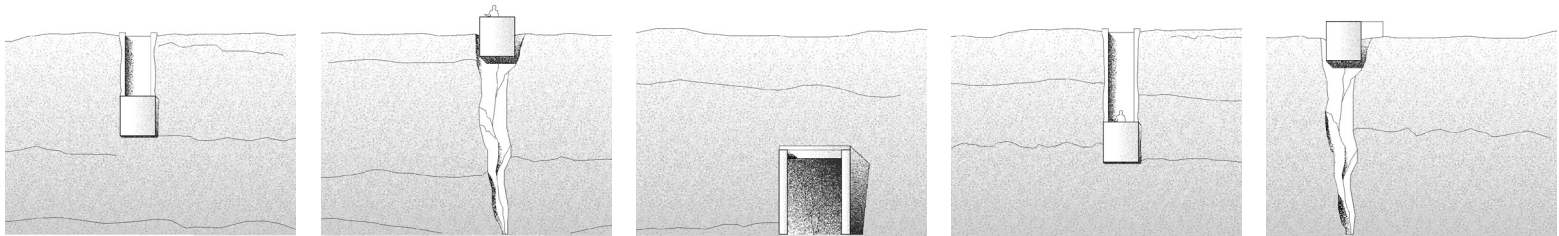
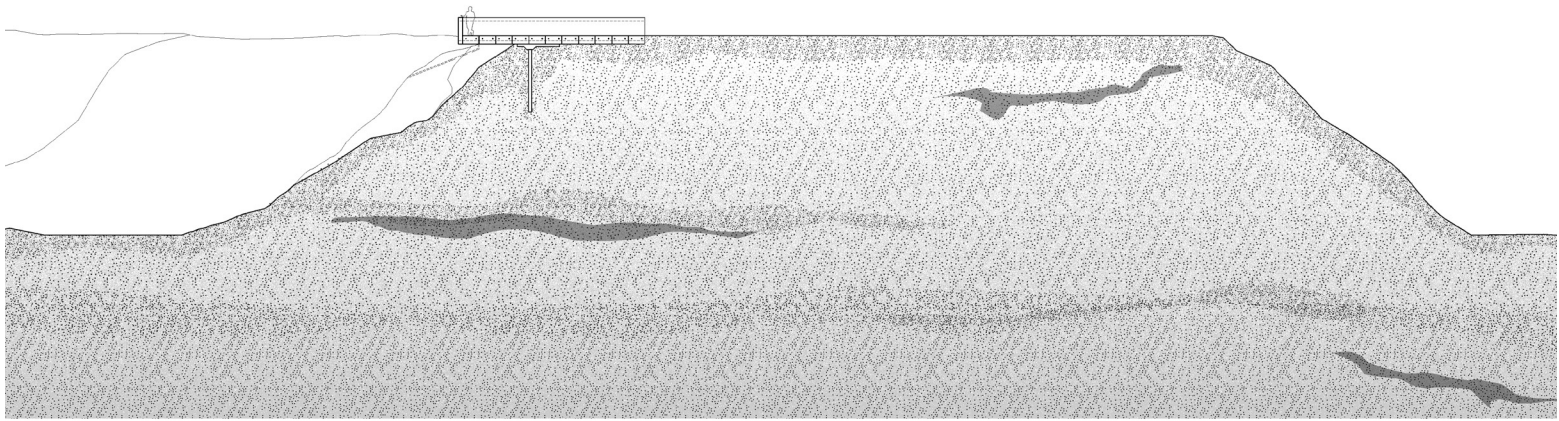
Plan 1:50



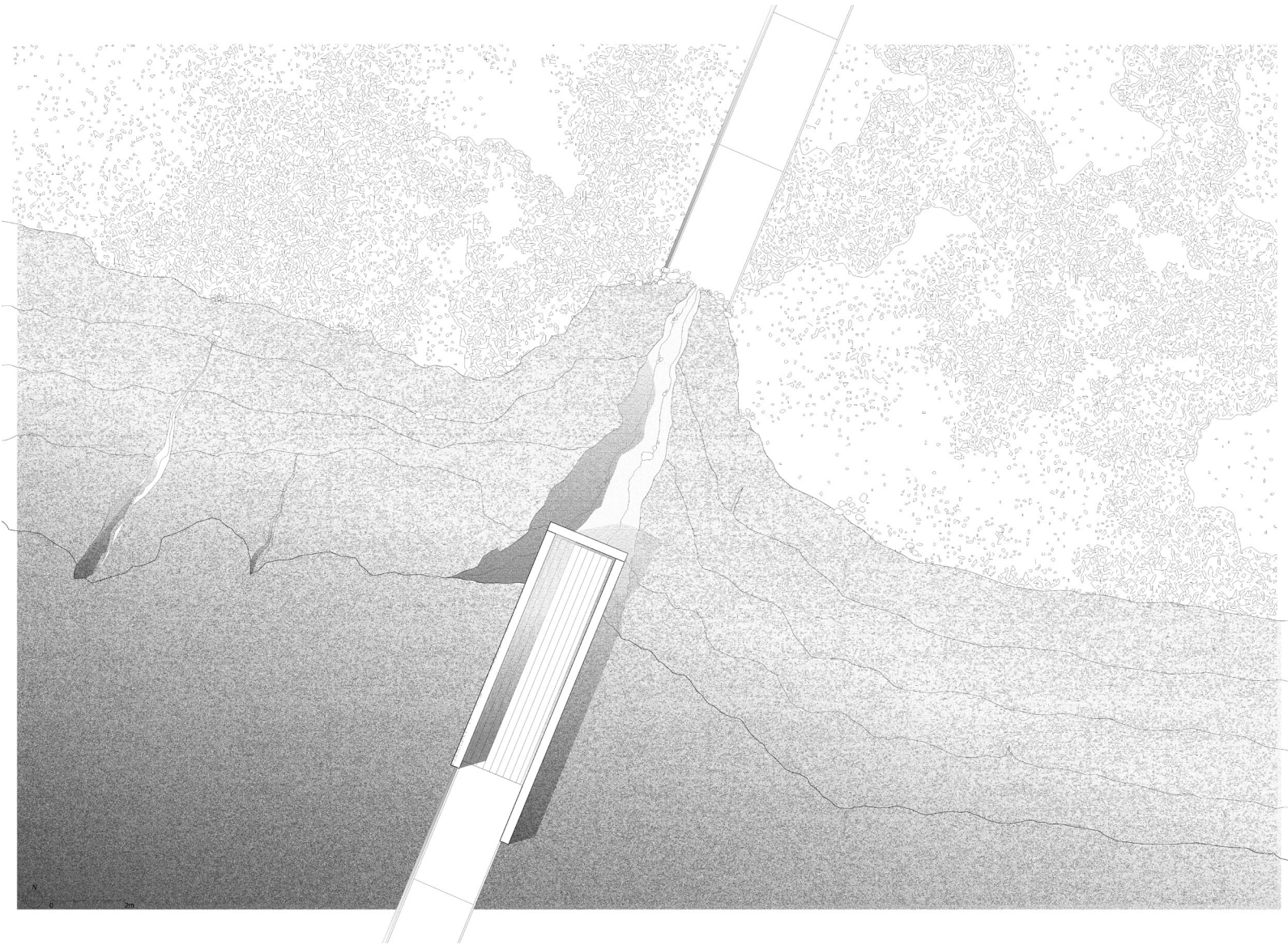
Section 1:50
1. Gabion wall seat
2. Gabion retaining wall
3. Limestone block 1500x1500mm,
4. Limestone block 1500x1000mm,
5. Limestone block 1500x500mm



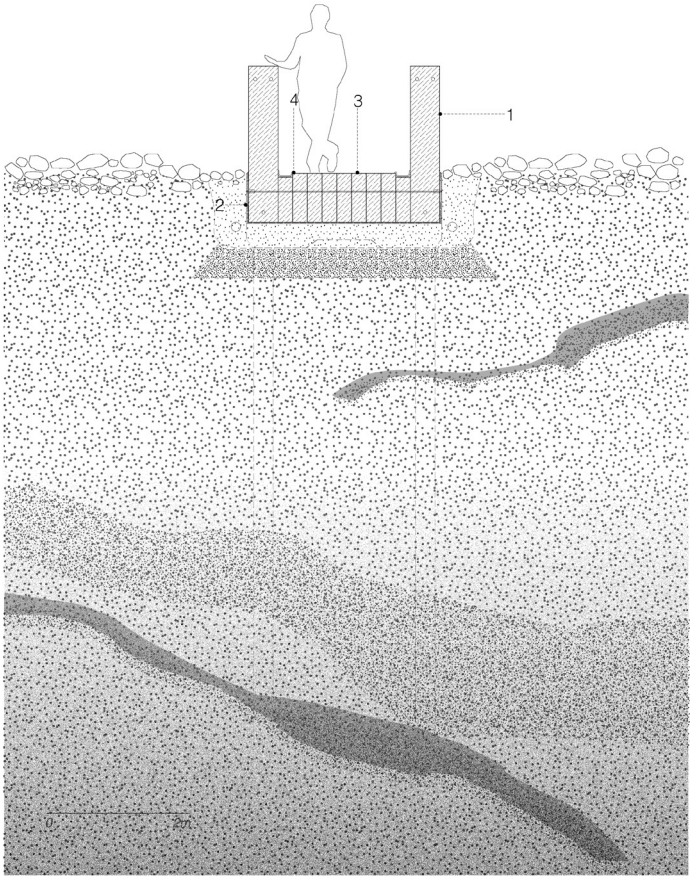
Plan 1:500



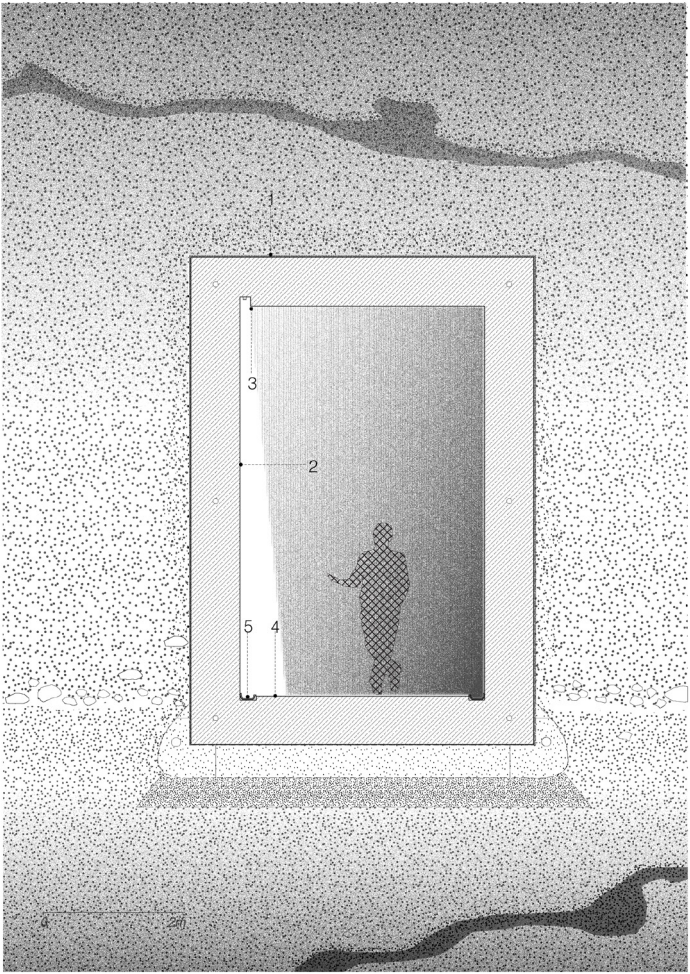
Section and Elevation 1:200
Erosion Lookout Interventions



Plan 1:50



Section 1:50
Erosion look-out
1. 300mm prefabricated post-tensioned limestone beam
2. Dimple drainage membrane over EPDM waterproofing
3. 150mm post-tensioned limestone beams (9 units)
4. Linear channel drain



Section 1:50
Tunnel through the heap:
1. Dimple drainage membrane over EPDM waterproofing
2. 500mm reinforced concrete wall
3. Light fixture
4. 500mm reinforced concrete slab
5. Linear channel drain

Thermal Bath Complex

The main intervention is a thermal bath complex located at the base of the Makoszowy Heap, within the oldest and most stable part of the landform. This area has undergone extensive natural reclamation and is now covered by dense forest, where decades of ecological succession have gradually transformed the former industrial terrain. The stable ground conditions make this location suitable for construction, while the surrounding woodland provides an unusual setting for a thermal bathing experience. The visitor journey begins near the historic ventilation shaft, where the existing parking area is located. From this point, visitors may either walk through the landscape of the heap or arrive directly at the bath complex. The approach is conceived as part of the experience, allowing visitors to engage with the site’s material, ecological, and historical character before entering the building.

The design draws inspiration from the sensory and atmospheric qualities of Peter Zumthor’s Therme Vals. Particular emphasis is placed on atmosphere, materiality, and the gradual transition between landscape and architecture. The ventilation shaft acts as a symbolic threshold between the industrial past and the contemporary experience of the site, marking the transition from the open landscape into the humid and enclosed environment of the baths.

The approximately 6,000 m² complex is designed to accommodate around 150 users simultaneously. Its spatial organisation reinterprets the sequence of the classical Roman bath, moving through changing temperatures and atmospheric conditions in a continuous progression. This ritualised movement through space references the historical routines of miners descending into the underground workings, transforming an act once associated with labour into one of relaxation and reflection.

The bathing experience is divided into two contrasting environments shaped by the site’s topography. Outdoor pools are positioned within openings in the forest and engage directly with the landscape of the heap, offering views of the surrounding terrain. In contrast, the interior bathing spaces are embedded within the landform itself, creating darker and more intimate environments that emphasise sensory immersion, thermal qualities, and a connection to the site’s geological history.

To support year-round use and encourage broader public engagement, the thermal program is complemented by a public café and exhibition spaces. These functions provide opportunities to communicate the history of mining in the region while creating spaces for social interaction. The swimming pools are heated using geothermal energy extracted from the flooded shafts of the former Makoszowy Mine, directly linking the bathing experience to the site’s post-industrial infrastructure. This renewable energy source enables the complex to operate throughout the year, while during winter the outdoor pools maintain a stable water temperature, creating an unusual thermal experience within the surrounding landscape.

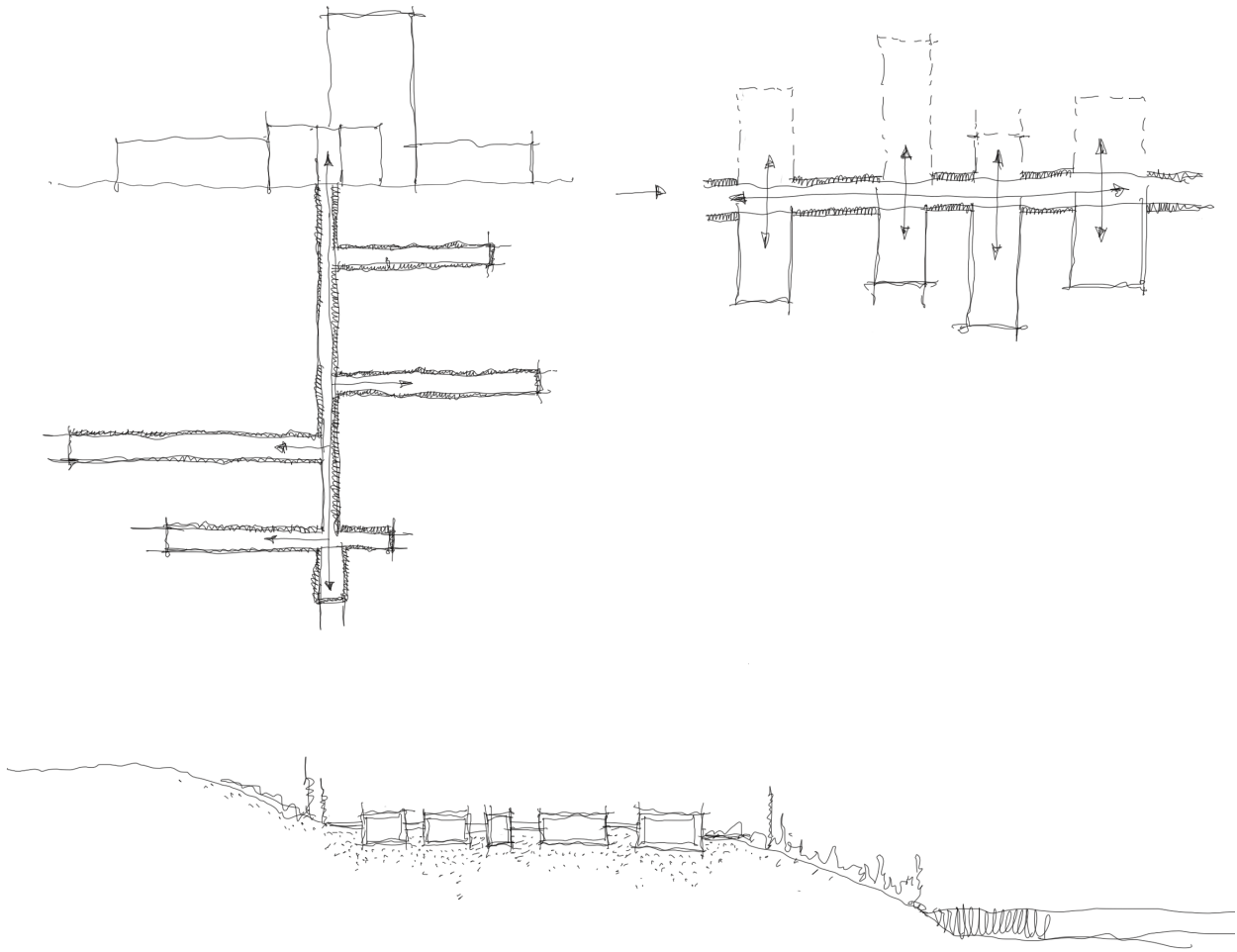
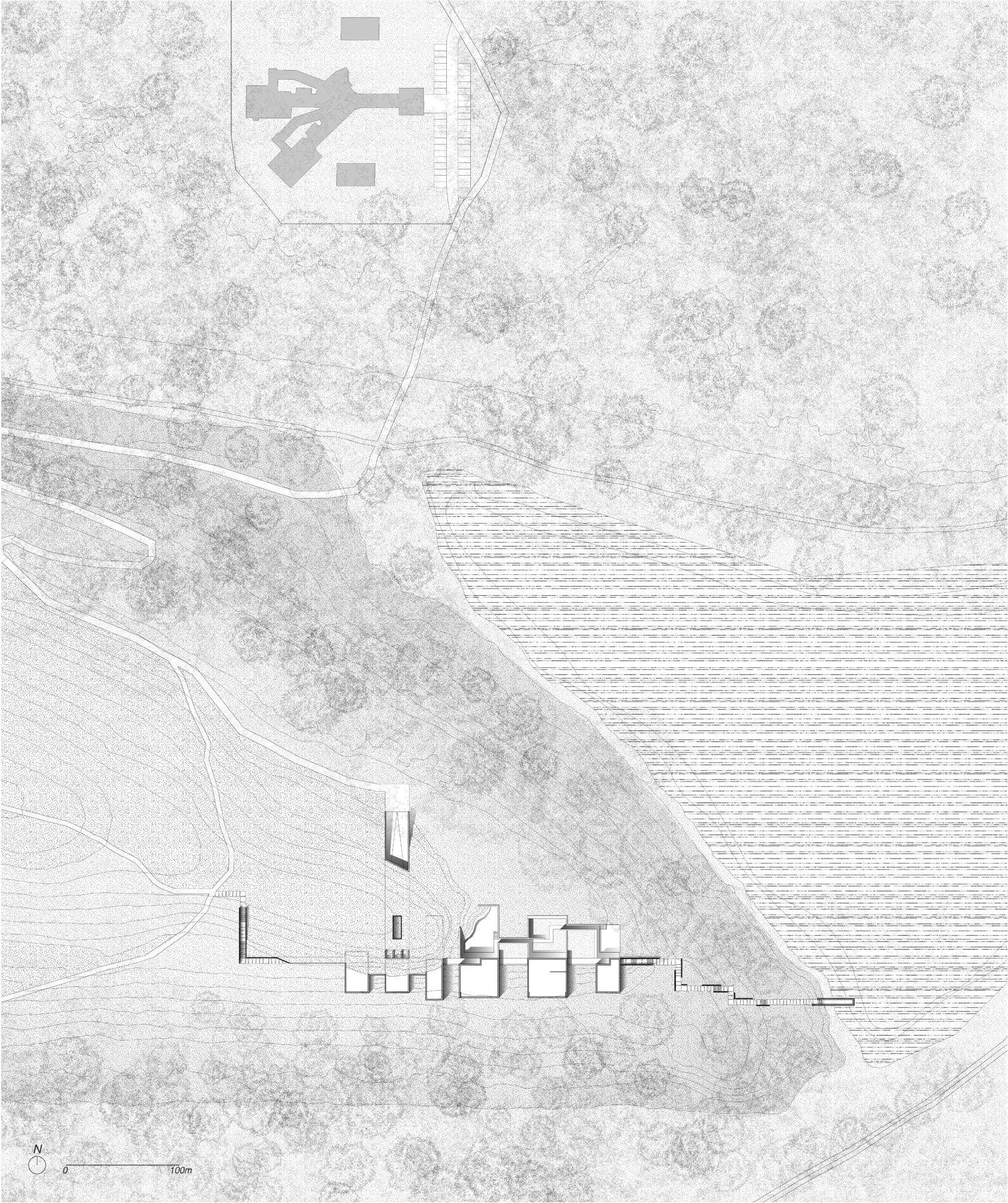
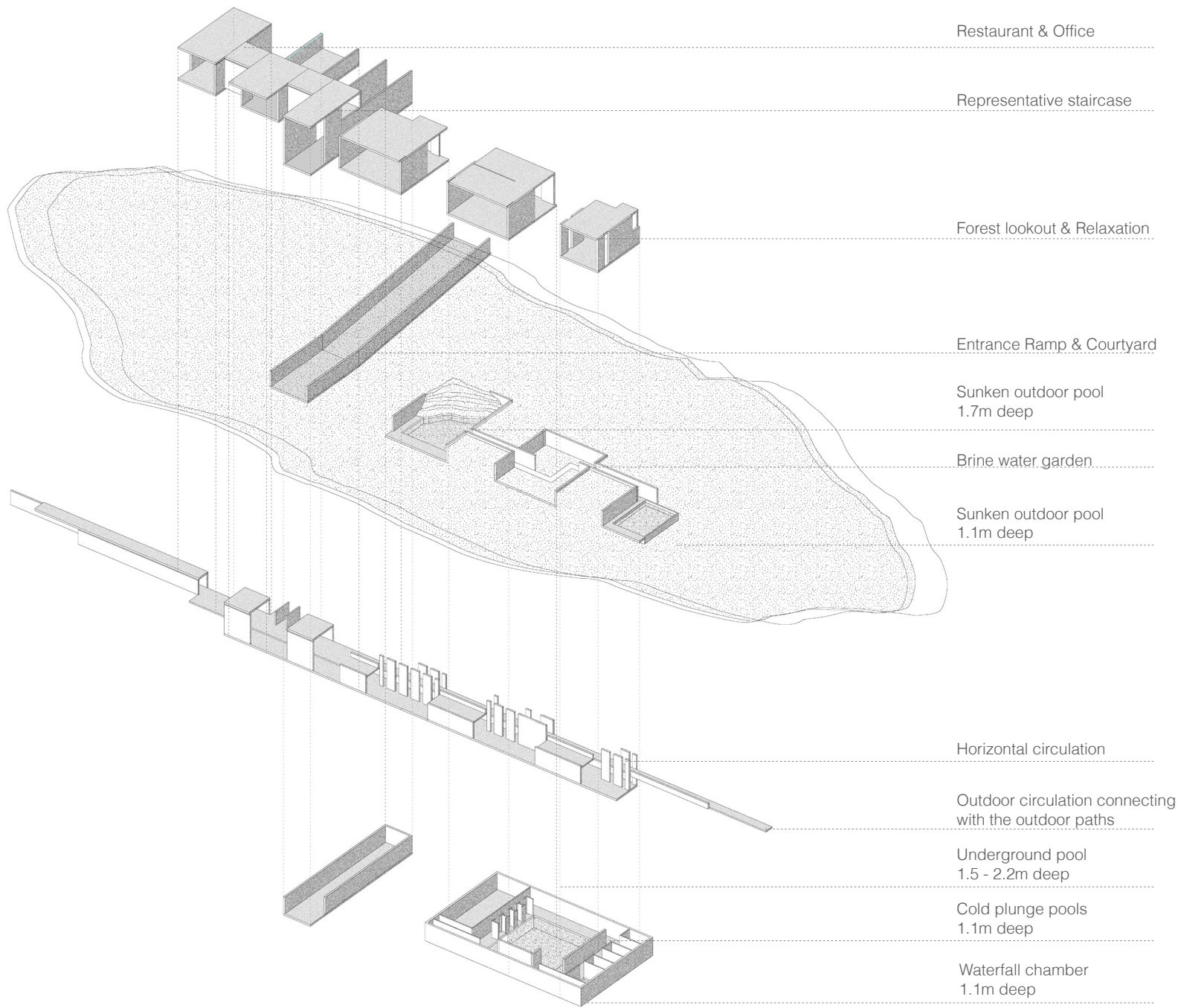
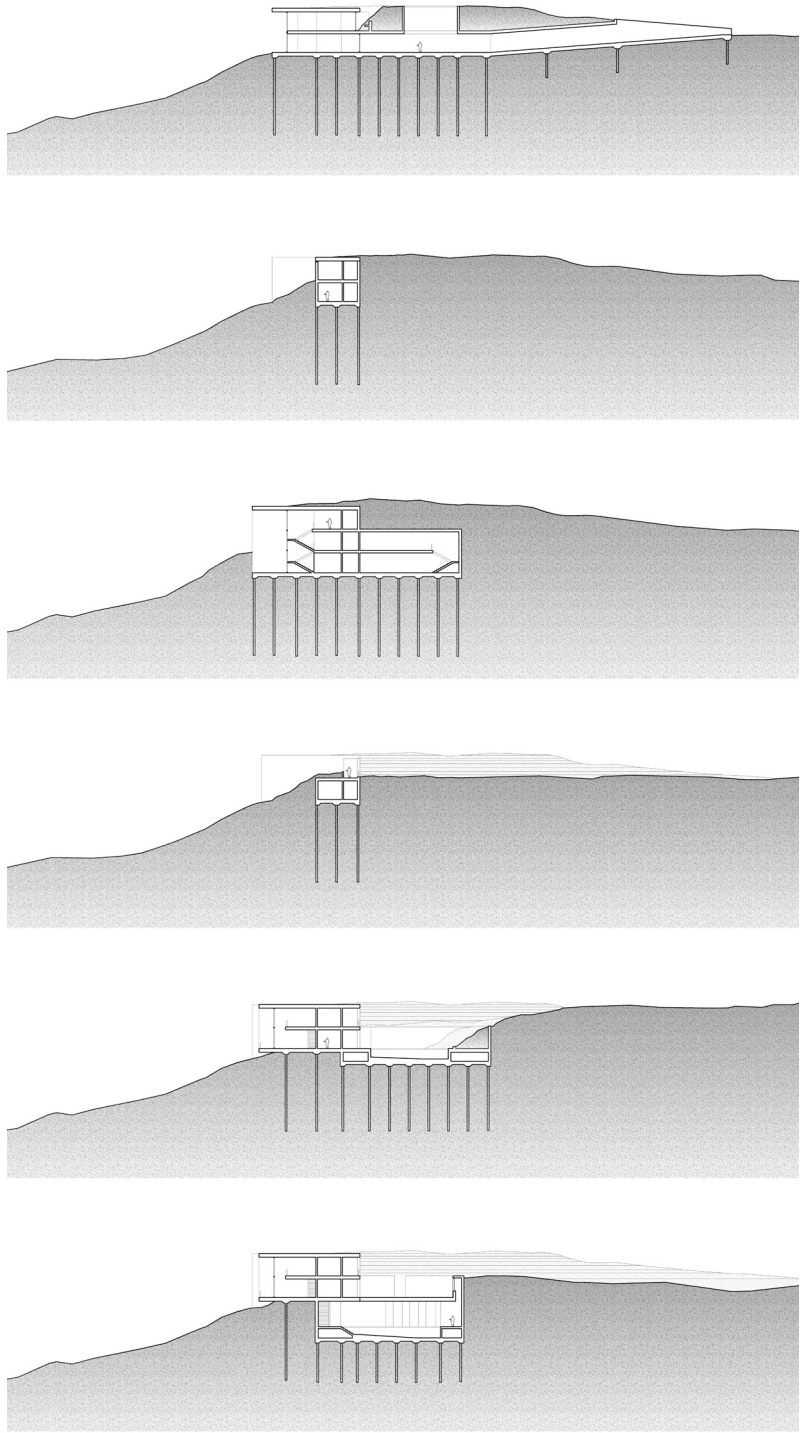


Figure 45 | Thermal Bath Complex Massing Concept inspired by the movement in the mine shafts

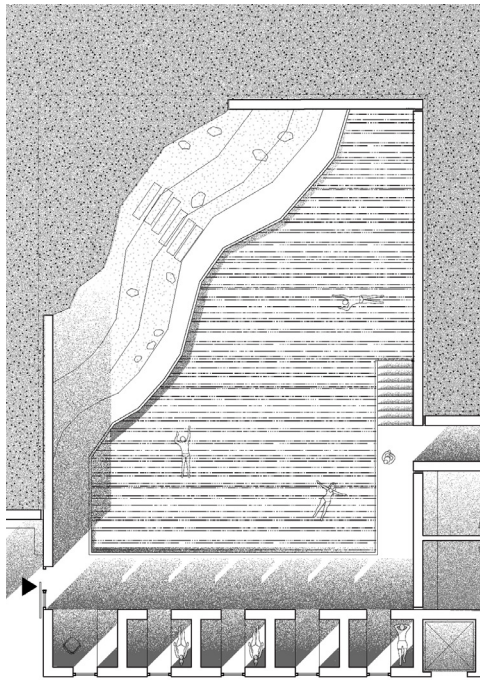


Context & Massing

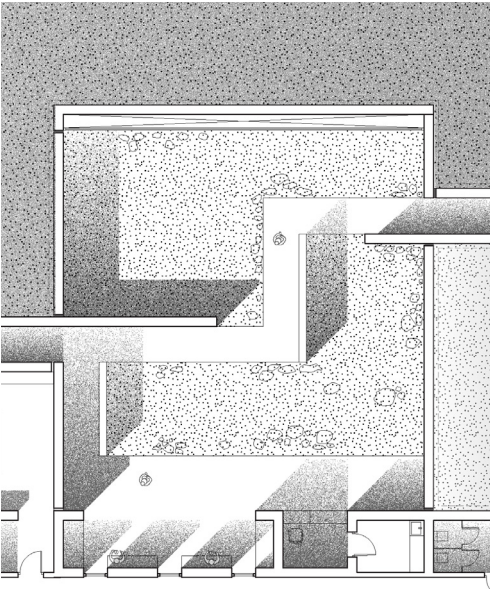




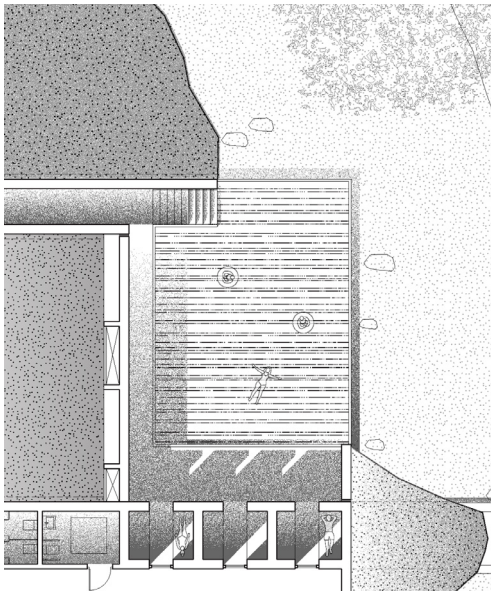
Sections 1:200
1. Entrance section
2. Horizon circulation section
3. Representative staircase section
4. Horizontal circulation and the outdoor passage section
5. Swimming pool section
6. Sunken courtyard section



Pool1
Rather than acting as a rigid boundary between the architecture and the landscape, the natural slope of the heap descends directly into this sunken pool. The terrain forms an angled, textured wall that is ideal for seating and sunbathing. This seamless transition dissolves the edge between the built environment and the post-industrial landform, allowing users to physically feel and engage with the topography of the heap while swimming.



Courtyard
Drawing upon the Silesian tradition of brine graduation towers, the Brine Garden utilizes a saline water wall filtered through spruce branches to purify the air and facilitate respiratory inhalation. Within this therapeutic space, the ground plane is intentionally left raw and covered with excavated geological fragments from the heap. This allows visitors to physically interact with the site's rugged material qualities while engaging in the ritual of inhaling the mineral-rich air.



Pool2
As the most intimate of the outdoor basins, this pool is scaled to accommodate both adults and children. Taking advantage of the shifting topography, the water surface is set flush with the adjacent ground level of the heap. This zero-edge condition enables users to experience the surrounding terrain at eye level, while offering views toward the neighboring forest and the broader post-industrial landscape.

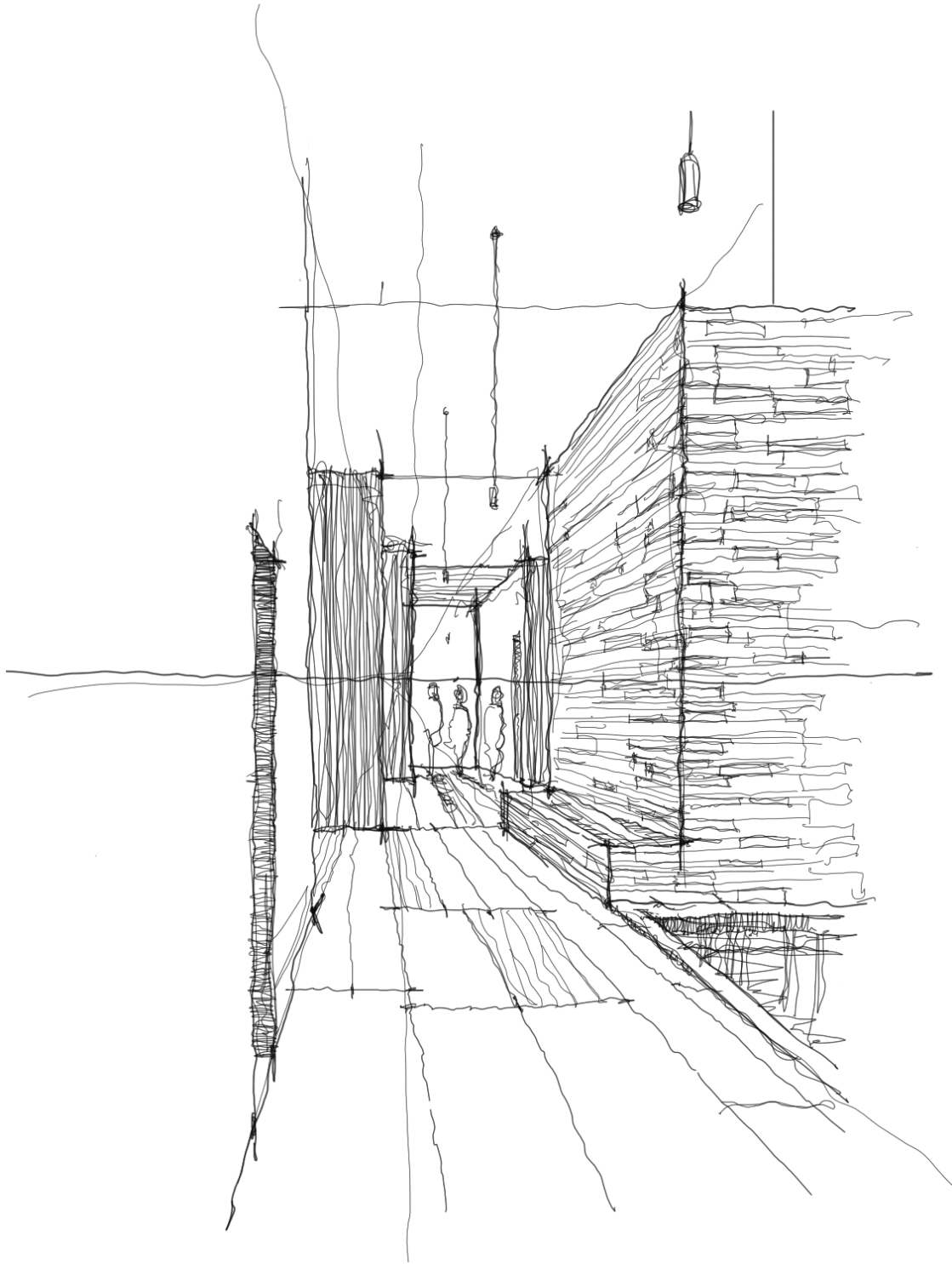


Figure 46 | Concept Sketch of the horizontal corridor with the stone tiles

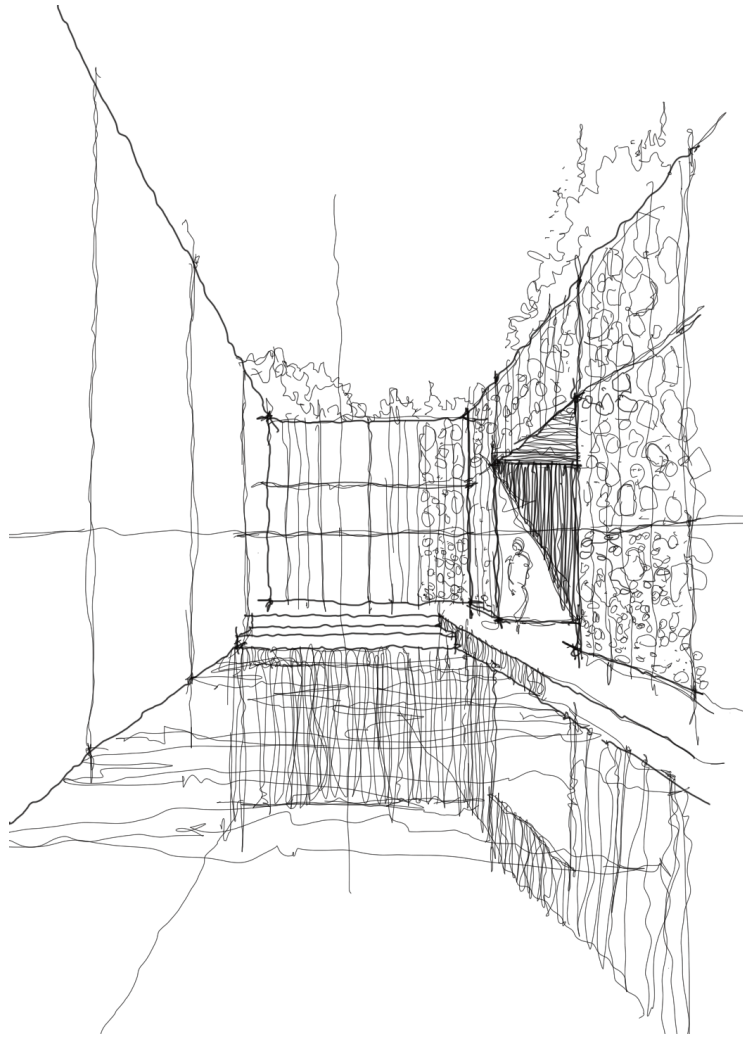


Figure 47 | Concept Sketch of exterior pool with the stone wall

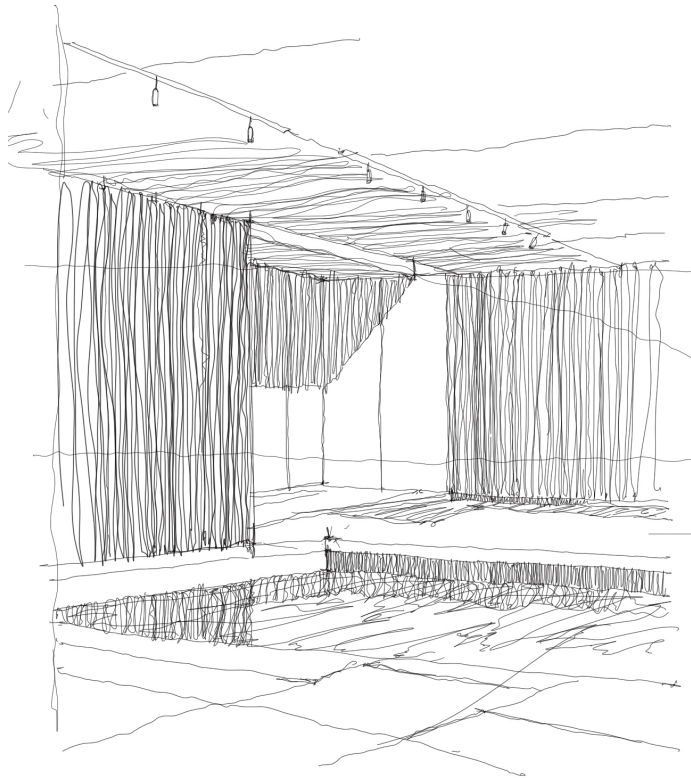
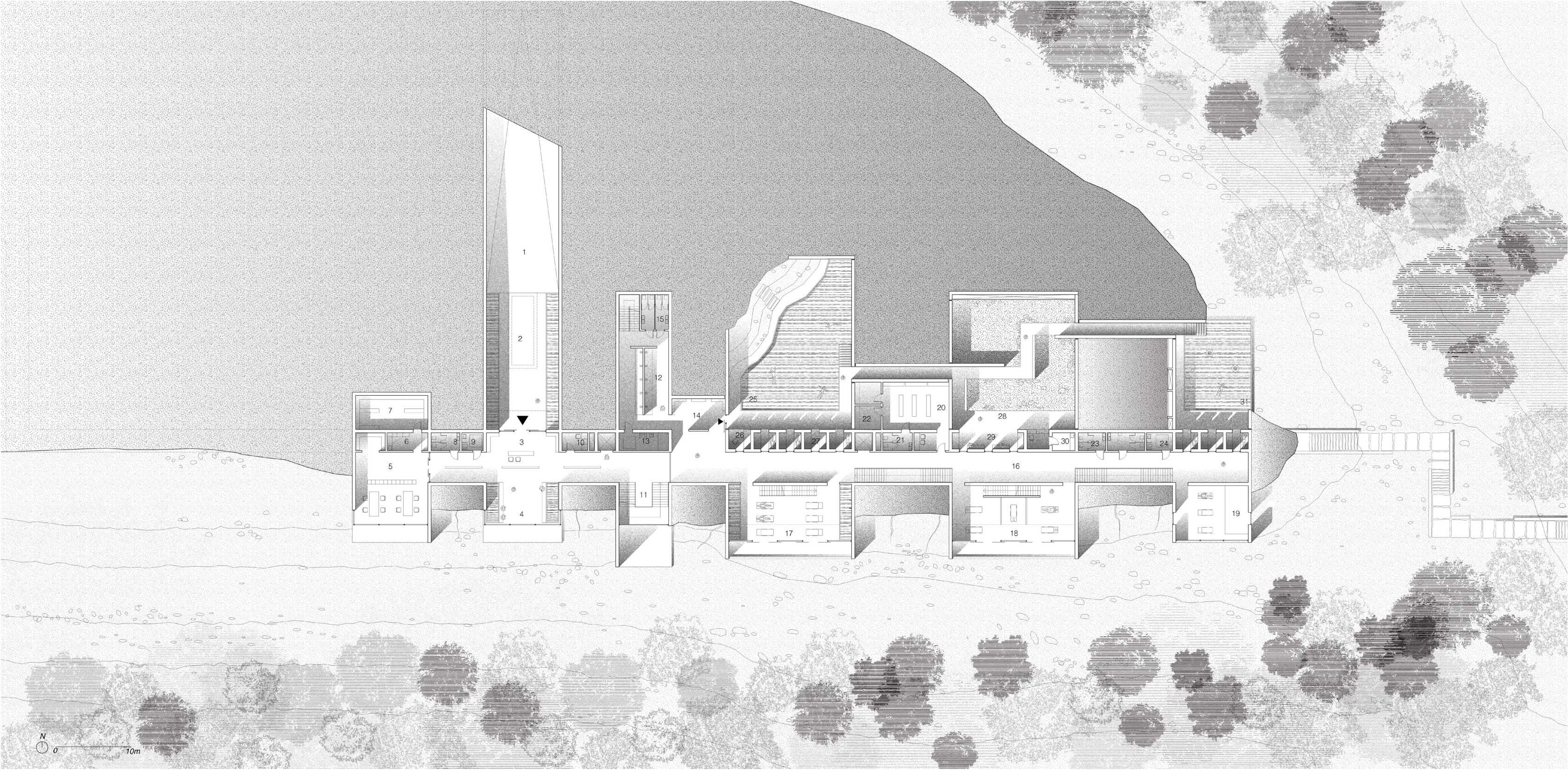
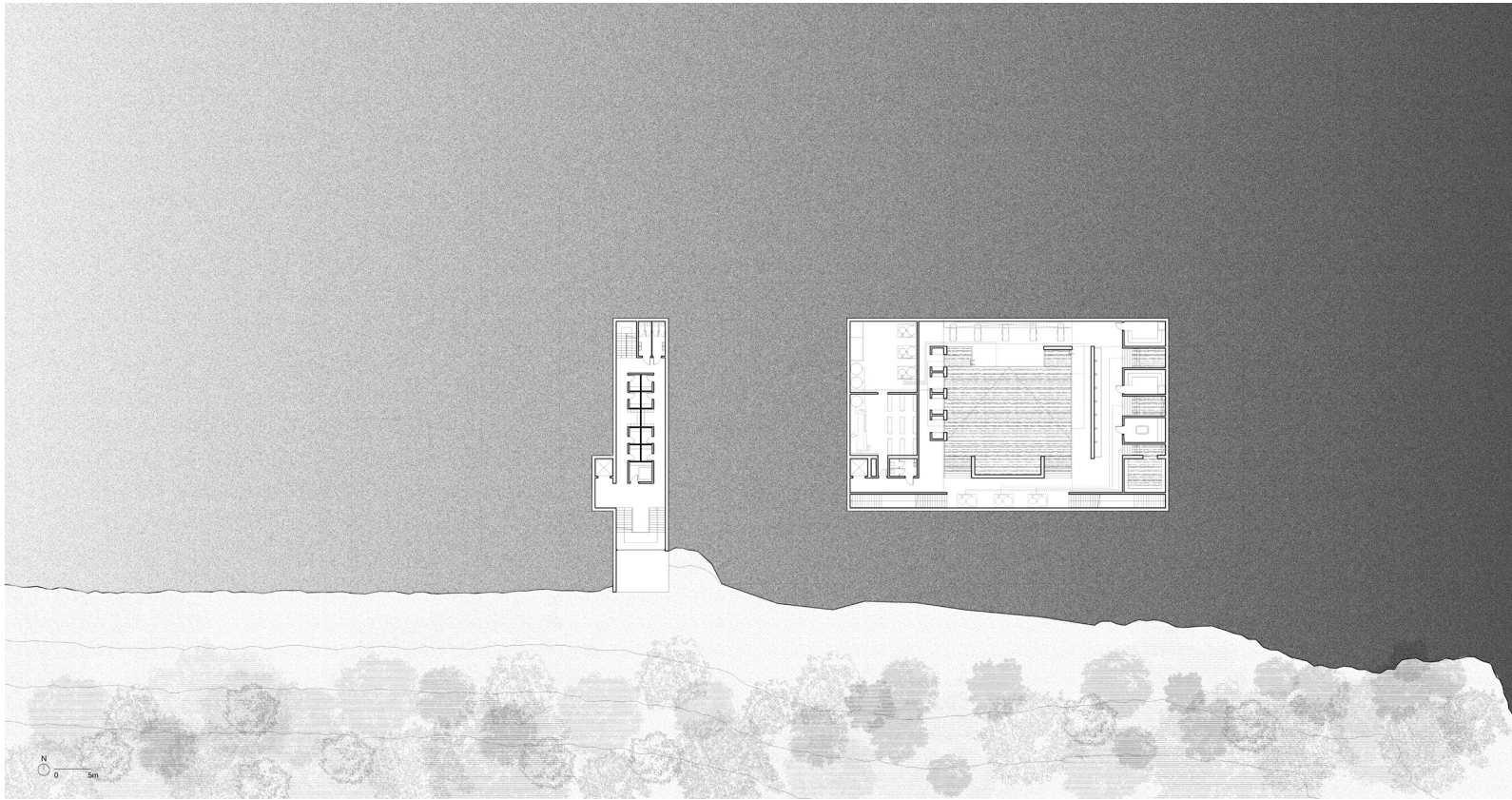


Figure 48 | Concept Sketch of the underground pool with the horizontal skylight



Plan 1:200

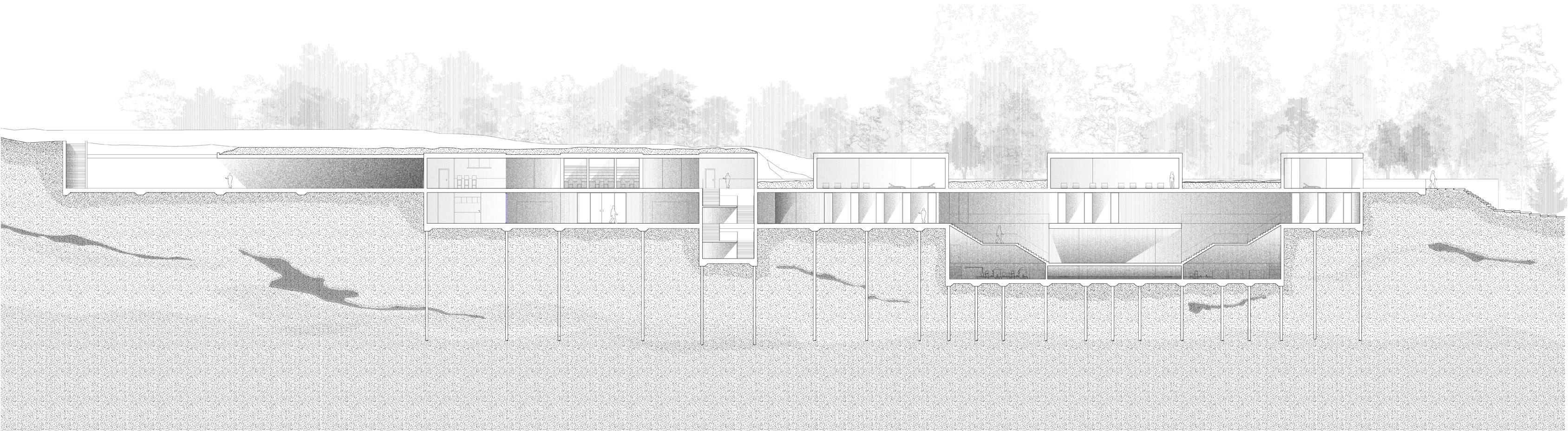
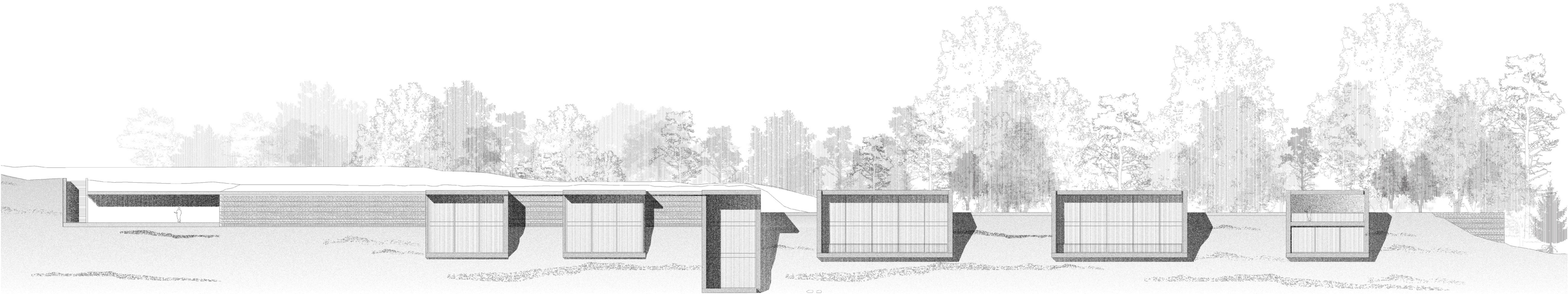
- | | | | | | | | | |
|--------------------|-------------------|------------------------------|--------------------------|---------------------------|-------------------------|--------------------------|--|------------------------------|
| 1. Sloped Entrance | 5. Complex Office | 9. Disabled WC | 13. Disabled Shower | 17. Sound Relaxation Room | 21. Staff WC | 25. Large Pool 1.7m deep | 28. Water Brine Courtyard with Heps Soil | 30. Outdoor cafe and kitchen |
| 2. Water Courtyard | 6. Office Kitchen | 10. Security Control | 14. Waiting/ Drying Room | 18. Massage Room | 22. Staff Changing Room | 26. Lifeguard Station | 29. Seating Alcove | 31. Small Pool 1.1m deep |
| 3. Reception | 7. Back of House | 11. Representative Staircase | 15. WC | 19. Kids Room | 23. WC | 27. Relaxation Alcove | | |
| 4. Foyer | 8. WC | 12. Showers | 16. Internal Corridor | 20. Staff Room | 24. Disabled WC | | | |



Plans 1:200
Basement Plan
Ground Floor



Plans 1:200
First Floor
Roof



Scale 1:200
South Elevation
Long Section

Materiality and Specifics of Thermal Bath Complex

The material strategy of the Thermal Bath Complex reinforces the project’s broader narrative of transformation, reuse, and regeneration. Rather than relying on imported resources, the design treats the decommissioned Makoszowy Mine and the spoil heap itself as a material bank, drawing upon the site’s existing resources to create a circular construction process

Materials recovered from former mining infrastructure, including crushed concrete and demolition waste, are repurposed within landscape interventions, retaining structures, and site infrastructure. The spoil heap itself is also understood as a resource. Fly ash extracted from the heap is incorporated into low-carbon concrete production, while limestone, one of the dominant geological components of the heap, is used throughout the project due to its durability and its ability to reduce water acidity and facilitate iron sedimentation. In addition, material excavated during the construction of the thermal bath complex is retained and reused on site for landform shaping, embankments, and landscape modeling, minimizing waste and reducing the need for imported materials.

These strategies establish a closed material cycle in which both the former mine and the heap become sources of construction material rather than waste streams. This process also creates opportunities for a new form of post-industrial production. Existing mine buildings can be repurposed for the storage, processing, and distribution of reclaimed materials, while former miners can apply their geological and technical expertise to material recovery and production. In this way, extraction is transformed into regeneration, supporting both landscape restoration and local employment.

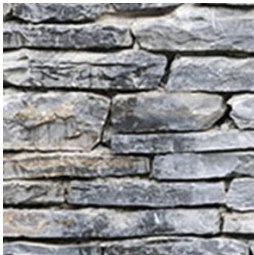
The architectural expression of the complex draws directly from the material character of the heap. Dark gray tones, layered textures, and patterns of erosion and soil cracking inform the spatial atmosphere of the baths. Natural light is introduced through narrow openings and shadow gaps between concrete elements, creating a changing play of light that recalls the fissures and fractures found within the landscape. Stone tiles of varying sizes and textures further reference the heterogeneous surface conditions of the heap.

To soften the monumental character of the concrete architecture, textured and pressure-washed concrete finishes line the interior. These surfaces provide a richer tactile experience while improving the acoustic performance of the underground bathing spaces by reducing sound reflection and echo. The result is an environment that balances the raw materiality of the industrial landscape with the sensory qualities expected of a thermal bath

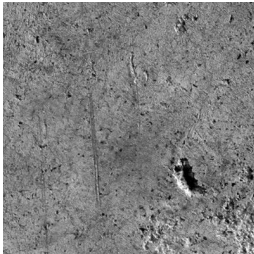
The structural system is based on long-span BubbleDeck floor slabs, allowing spans of up to 20m without intermediate columns and creating the open spaces required for the swimming pools and bathing halls. The outdoor pools are framed by heavy retaining walls constructed from limestone, embedding the geological identity of the site directly into the architecture while supporting the environmental processes that shape the surrounding landscape.

Exterior Walls

Limestone



Reinforced Concrete



Interior Walls

Exposed Concrete



Pressure-washed Concrete



Pressure-washed Concrete



Interior Walls

Stone Tiles Outdoor



Stone Tiles Indoor

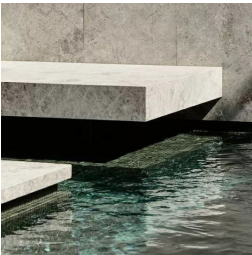


Dark Timber Kids Room

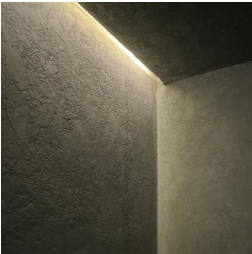


Shadow Gap Details

Pool Surface



Artificial Lighting



Rain Water Drainage



Interior Water Fountain



Interior Details

Stainless Steel Barriers



Stone Basin

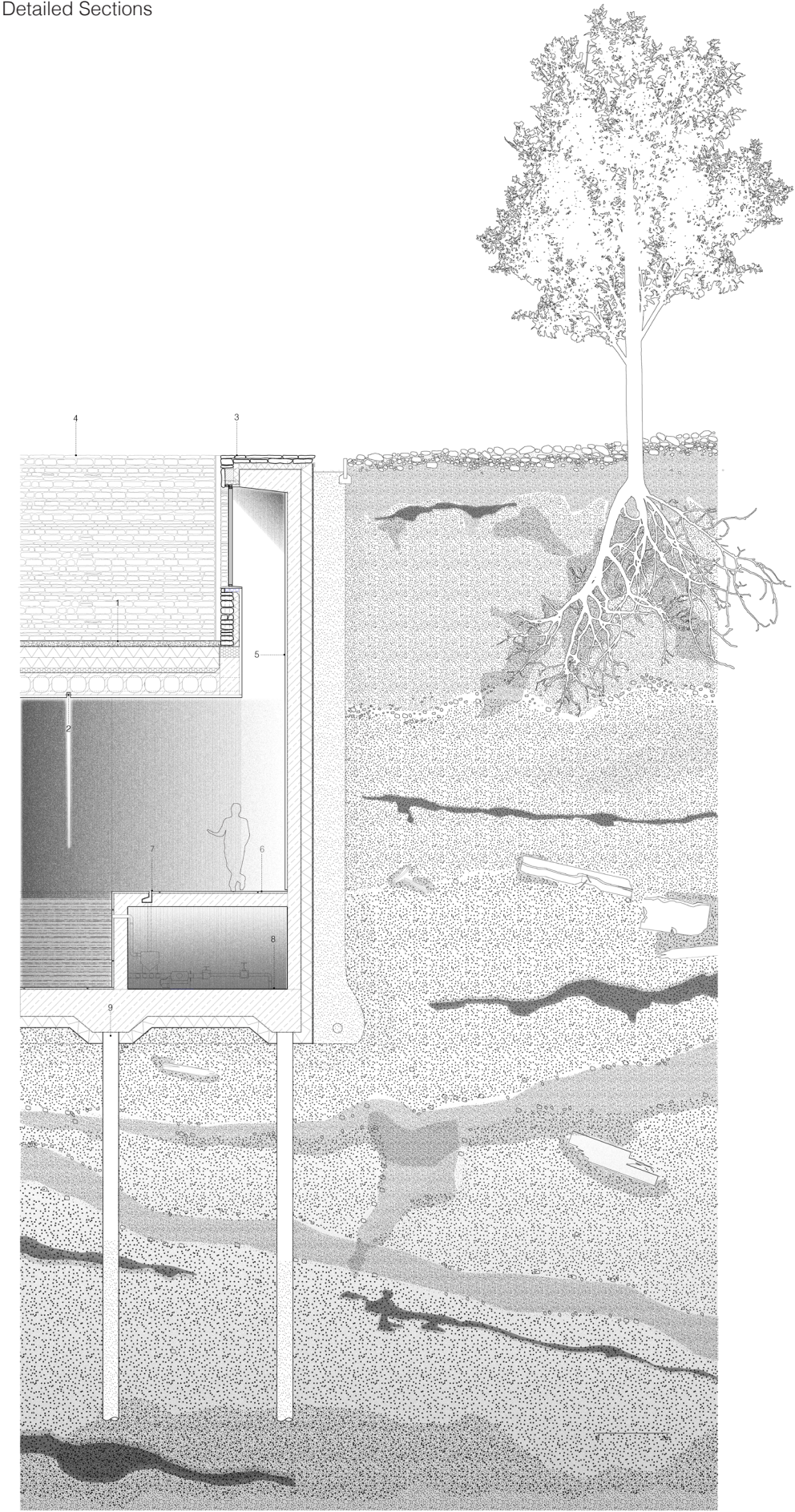


Stainless Steel Tabletop

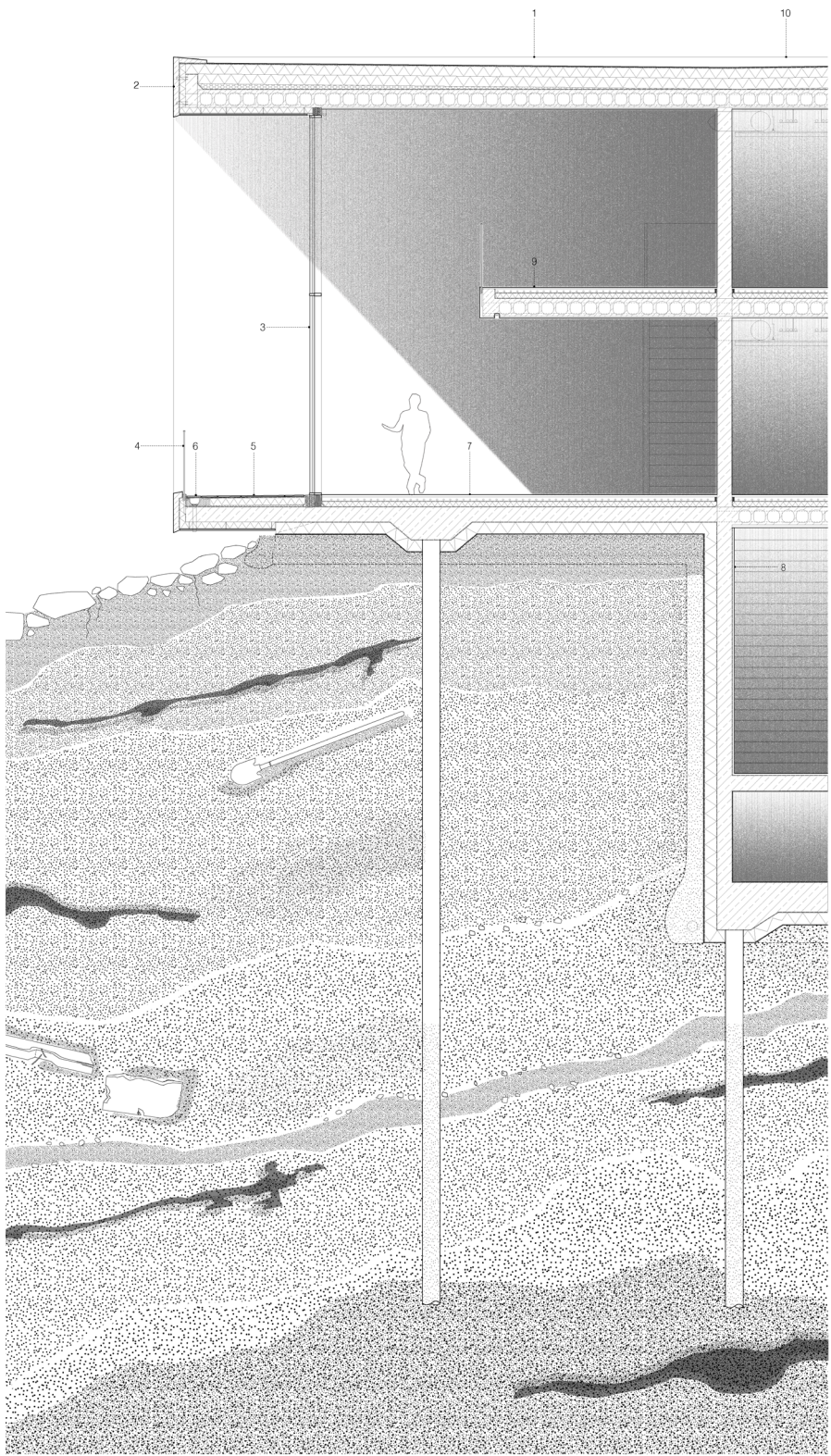


Exterior Water Fountain





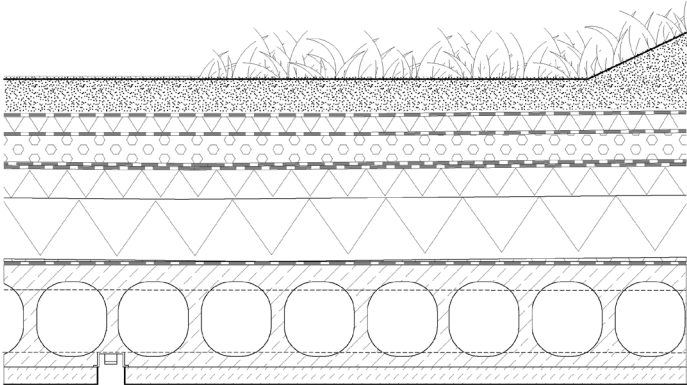
- Section 1:20
1. Layer of heap's soil
Waterproofing EPDM membrane
Separation layer
2x 200mm Foamglas thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab
50mm Fly ash concrete panel
2. 100mm Recessed shadow gap / light fixture housing
3. 160mm Limestone layer
100mm Foamglas thermal insulation
Waterproofing membrane
200mm Fly ash reinforced concrete slab
Waterproofing membrane
4. 500mm Limestone retaining wall on mortar with mechanical fasteners
5. 50mm Pre-cast fly ash concrete panel textured surface
Mineral membrane
200 Fly ash reinforced concrete retaining wall
Waterproofing EPDM membrane
200mm Foamglas thermal insulation
Dimpled foil layer
Vertical drainage layer
Filter geotextile
6. 30mm stone tiles
Waterproofing membrane
200 Fly ash reinforced concrete slab
Waterproofing EPDM membrane
7. Pool drain
8. Waterproofing membrane
200 Fly ash reinforced concrete slab
Waterproofing EPDM membrane
200mm Foamglas thermal insulation
Waterproofing membrane
Stabilized substrate
Native Soil
9. Ø300mm Reinforced concrete foundation



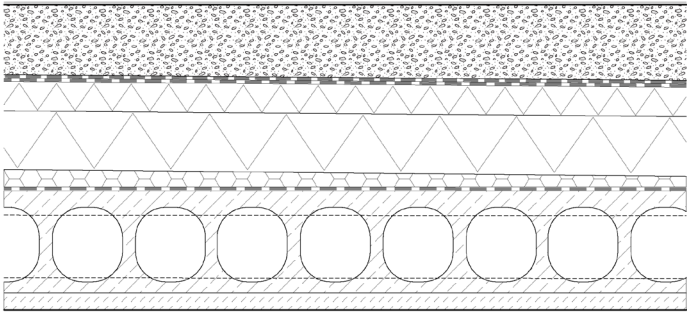
- Section 1:20
1. Waterproofing EPDM membrane
Separation layer
2x 200 Foamglas thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab
50mm Fly ash concrete panel
2. Pre-cast fly-ash concrete elevation panel
3. Triple-glazed unit with overheating/solar control coating
Aluminum window frame
Internal fabric roller blind within concealed ceiling pocket
4. Structural glass balustrade with steel handrail
5. 30mm stone tiles layed on rubber spacers
Waterproofing EPDM membrane
Separation layer
200mm Foamglas thermal insulation
Downward edge XPS
Vapor barrier foil
200mm Fly ash reinforced concrete slab
100mm EPS thermal insulation
Cement cover panel mechanically attached
6. Hidden slot drain under stone floor panels
7. 30mm stone tile finish
50mm cement screed with floor heating
Silver foil
100mm Foamglas thermal insulation
200mm Fly ash reinforced concrete slab
Waterproofing EPDM membrane
200mm Foamglas thermal insulation
Waterproofing EPDM membrane
Stabilized substrate
Native Soil
8. 5. 50mm Pre-cast fly ash concrete panel textured surface
Mineral membrane
200 Fly ash reinforced concrete retaining wall
Waterproofing EPDM membrane
200mm Foamglass thermal insulation
Dimpled foil layer
Vertical drainage layer
Filter geotextile
9. 30mm stone tile finish
50mm cement screed with floor heating
Silver foil
100mm Foamglas thermal insulation
500mm BubbleDeck slab
50mm Fly ash concrete panel
10. Waterproofing EPDM membrane
Separation layer
2x 200 Foamglas thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab
Air void for services



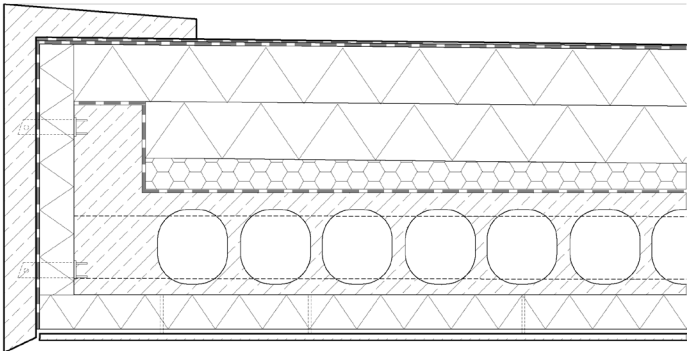
Elevation 1:20



- Roof 1:5
Type 1: Subterranean roof structure with intensive landscape buildup
- Coal heap's natural vegetation
Vegetation layer
Filtration membrane
Retention and drainage layer
Separation and protective layer
Waterproofing membrane
100mm PIR thermal insulation
200mm PIR thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab

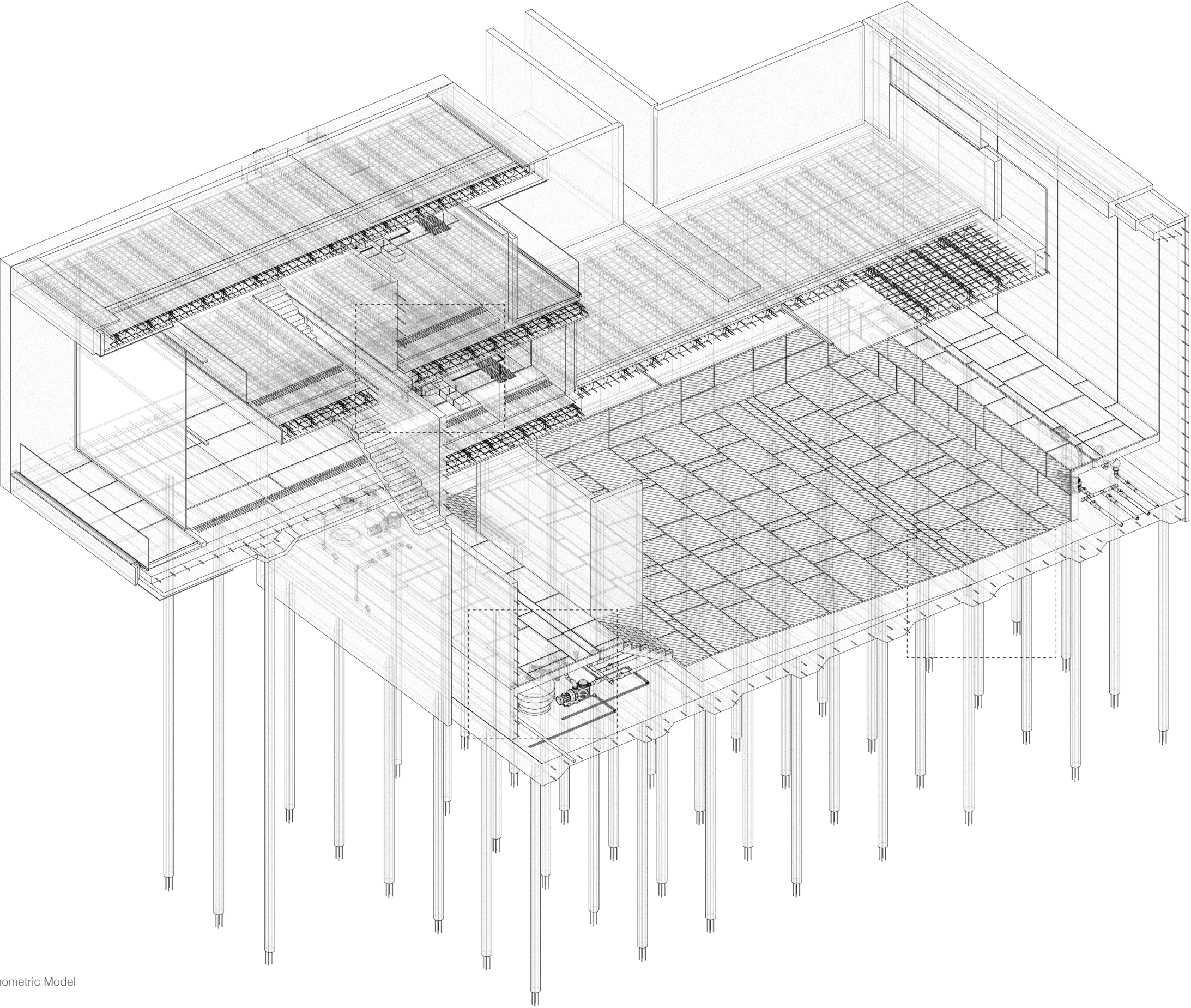


- Roof 1:5
Type 2: Cantilevered canopy with gravel ballast
- Protective layer with gravel
Waterproofing membrane
100mm PIR thermal insulation
200mm PIR thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab



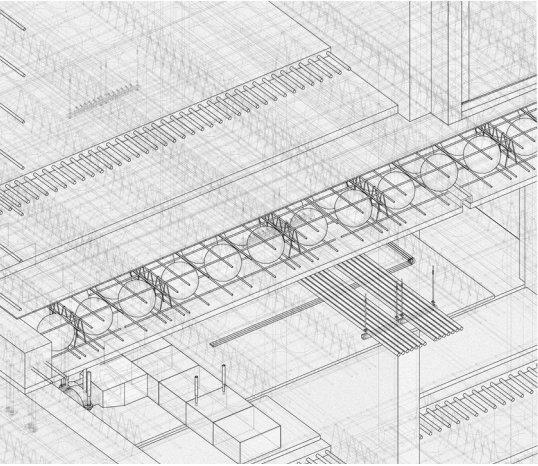
- 1:5 Roof
Type 3: Flat roof
- Waterproofing EPDM membrane
Separation layer
2x 200 Glassfoam thermal insulation
Downward edge XPS
Vapor barrier foil
500mm BubbleDeck slab
50mm Fly ash concrete panel

0 400mm

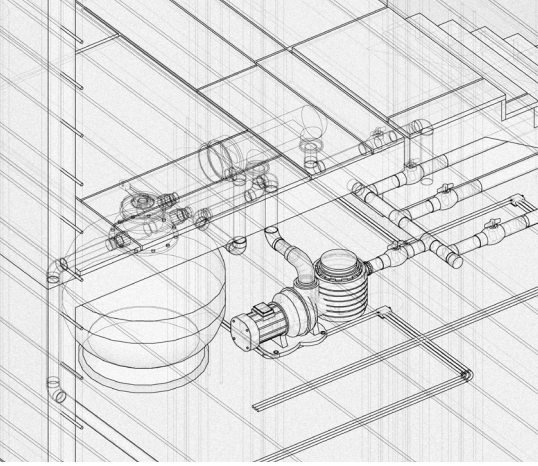


Structural Axonometric Model

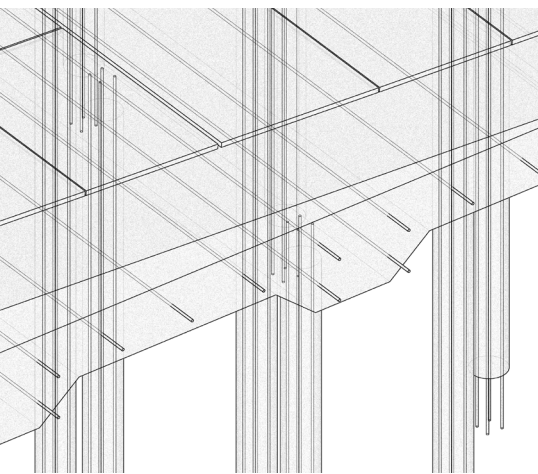
Floor Systems:
BubbleDeck Slab with Suspended Ceiling

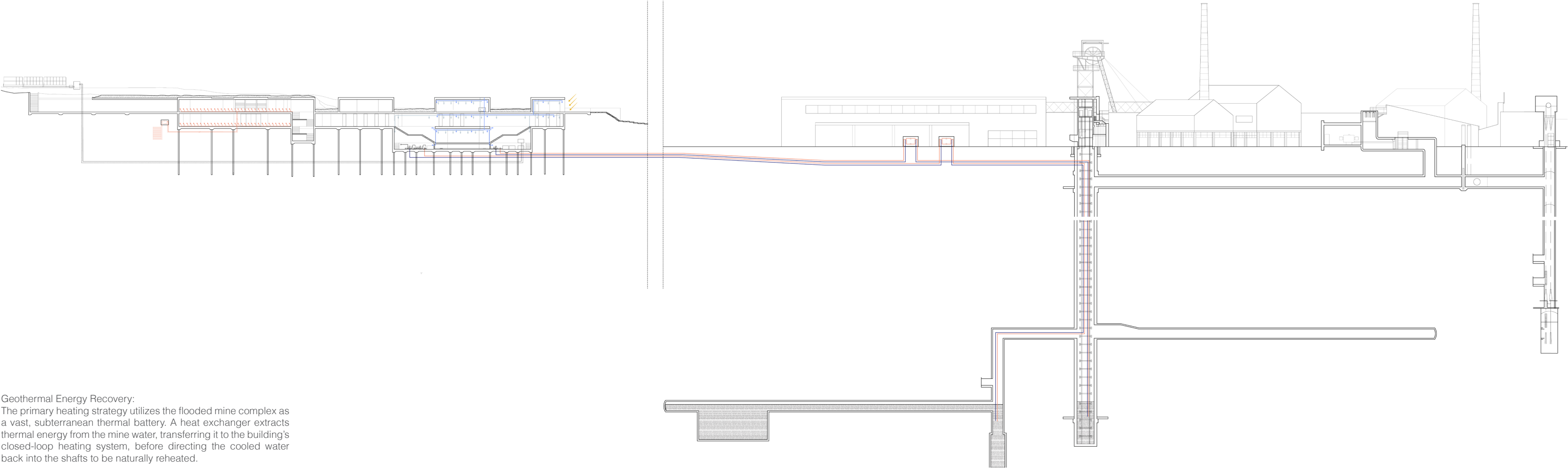


Pool Systems:
Geothermal Heating & Pumping



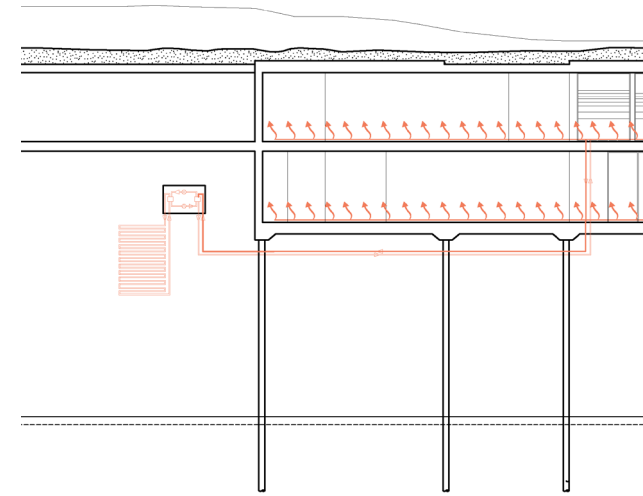
Foundation System:
Deep Piles and RC Slab for Unstable Ground





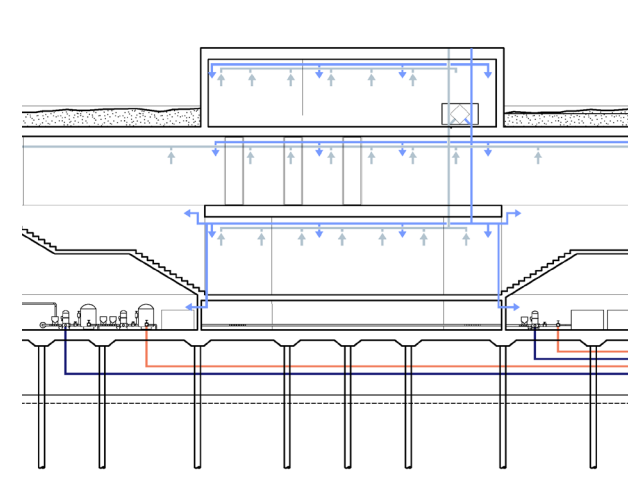
Geothermal Energy Recovery:
The primary heating strategy utilizes the flooded mine complex as a vast, subterranean thermal battery. A heat exchanger extracts thermal energy from the mine water, transferring it to the building's closed-loop heating system, before directing the cooled water back into the shafts to be naturally reheated.

Radiant Heating



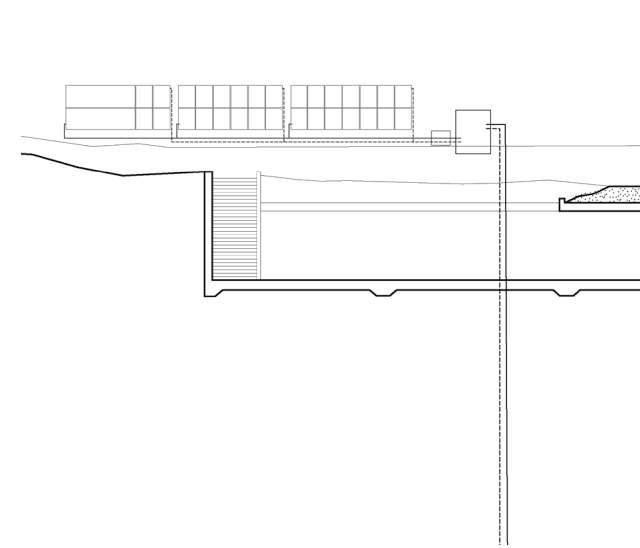
The thermal energy harvested from the geothermal source supplies hot water directly to a radiant floor heating system. This provides highly efficient, even heating across the large interior volumes.

MVHR



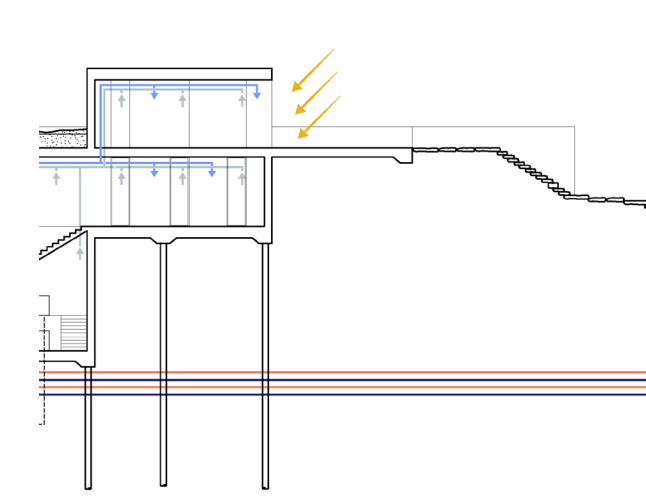
To manage the high humidity generated by the swimming pools and prevent energy loss, MVHR system is implemented. This system exhausts stale, humid air while capturing its sensible heat to warm the incoming fresh air.

Photovoltaics



PV array located south facing slopes of the heap to offset the electrical loads required to run the geothermal heat pumps and the MVHR fans,

Passive strategies



Thermal Mass Integration Cantilevering roof for shading Adjustable interior blinds and heat-reflecting glazing on the south-facing facade.



Figure 50 | Underground hot water pool



Figure 51 | Concrete and stone finishes

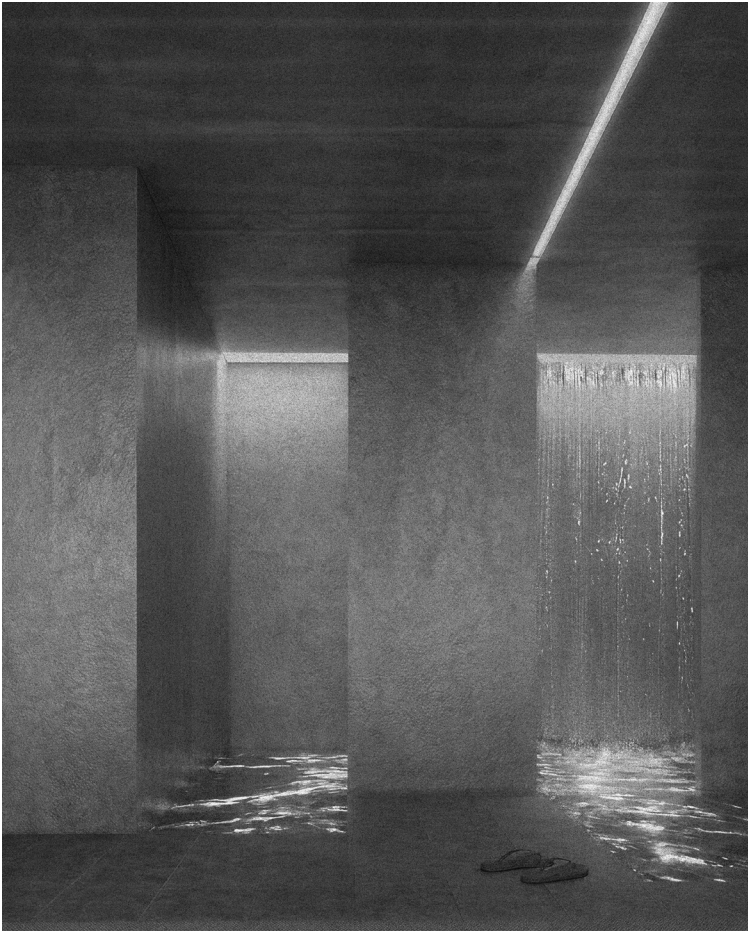


Figure 52 | Underground cold plunge pool and waterfall pool



Figure 53 | Outdoor pool with sloping heaps soil



Figure 54 | Relaxation rooms



Figure 55 | Horizontal corridor with light and dark play



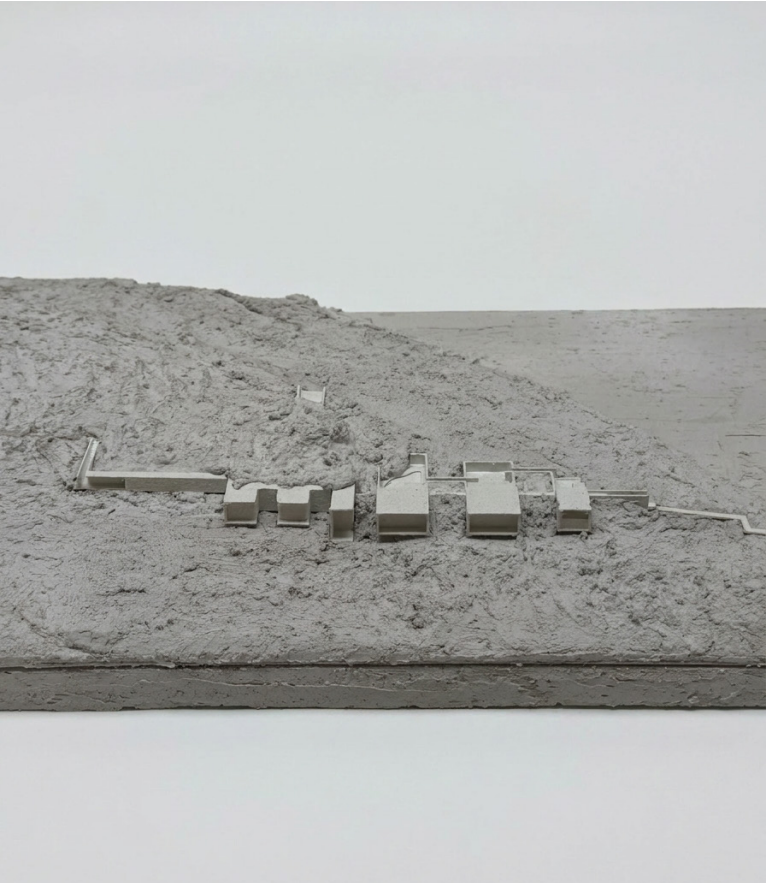




Figure 56 | Standing above the erosion crack on the Makoszowy Heap

EPILOGUE

Conclusion

The persistent failure to recognize and harness the latent ecological, spatial, and cultural value of the Upper Silesian Coal Basin’s anthropogenic landforms served as the catalyst for this research. For too long, post-industrial coal heaps have been treated solely as hazardous remnants of extraction and spatial barriers that fragment the urban landscape, disconnecting communities from their regional identity and industrial heritage. This thesis addressed the central research question: How can architecture coexist with and respond to the evolving environmental conditions of the coal heap, embracing its instability, materiality, and ecological processes rather than attempting to erase or control them?

The proposed masterplan and architectural interventions answer this question by conceptualizing architecture not as an isolated, static object, but as a mediator of ongoing landscape processes. Through the application of Christophe Giroit’s “Four Traces” the design methodology shifted from attempting to “solve” or conceal the heap’s conditions to actively designing with them.

The specific material composition and ecological processes of the site are revealed rather than hidden. The design embraces the landscape’s true qualities by embedding the Thermal Bath Complex into the stabilized, forested topography. Processes like acid mine drainage are rendered legible, allowing visitors to observe the site’s ongoing environmental recovery. Furthermore, the intervention’s physical expression responds directly to the terrain: the walking paths change their materiality according to the shifting soil conditions. On the unreclaimed portions of the heap, communal gardens are strategically located to test ecological reclamation through active social engagement and cultivation. By utilizing repurposed fly ash, crushed limestone, and tactile details reflecting natural erosion cracks, the project roots itself in the physical reality of the post-industrial landscape

Architectural interventions encourage public engagement by transforming former sites of extraction into spaces of recreation, reflection, and collective memory. While the Thermal Bath Complex reinterprets the historical routine of miners descending into the earth, public engagement is primarily driven by the extensive network of walking paths that invite visitors to physically explore the varied terrain of the heap. Along these routes, preserved erosion points function not merely as beautiful visual spectacles, but as spaces of reflection where one can witness and understand the ongoing geomorphological processes, revealing that the heap is, in fact, a living, evolving landscape. Strategically placed lookout water platforms extend the spatial experience beyond the site itself, connecting the heap with its broader post-industrial surroundings and preventing it from being perceived as an isolated object. By providing these accessible spaces for both younger and older communities, the design fosters social interaction and ensures the region’s industrial heritage remains relevant and integrated into daily life.

The Makoszowy Heap serves as a case study for developing transferable design strategies. The methodology utilized here prioritizing observation, circular material economies, and the harnessing of geothermal energy from flooded mine shafts - establishes a framework adaptable to other anthropogenic landforms in the Upper

Silesian Coal Basin. While time constraints limited a comprehensive exploration of applying this specific masterplan to other local sites initially considered during the research phase, such as the Kostuchna and Murcki heaps, the conceptual framework remains highly adaptable. Future applications could shape this design logic to respond to entirely different post-industrial typologies, including heaps currently at high risk of spontaneous combustion.

Implications and Recommendations for Future Practice and Research

This graduation project holds implications for the architectural profession, particularly regarding how designers approach the rapidly expanding field of post-industrial regeneration. This thesis challenges the conventional paradigm of “remediation” which often relies on the total erasure of industrial traces or the imposition of artificial ecological control. Instead, it advocates for a strategy of transformation and coexistence, demonstrating that architecture can embrace instability and ongoing natural succession.

Beyond the immediate context of post-industrial regions, this project proposes a shift in architectural thinking that is needed in our current era of instability. As we face an uncertain future, the question of what kind of ground or soil we will be building on becomes paramount. Whether architects are confronted with post-war rubble, shifting water landscapes, or eventually even the extraterrestrial terrain of the moon, we can no longer rely on the assumption of a stable, predictable site. The profession must develop the capacity to design together with unstable landscapes, treating unpredictability and continuous terrain transformation as foundational design parameters rather than obstacles to be engineered away.

The project highlights the necessity of blurring the traditional boundaries between architecture and landscape. When dealing with complex post-industrial terrains, architecture can no longer be understood solely as the design of autonomous buildings. It must function as an interconnected system of environmental infrastructures, productive landscapes, and memorial routes.

For the future research. A more detailed, quantitative assessment of the proposed material cycles, specifically the long-term structural viability and carbon performance of locally sourced fly ash concrete, is necessary to transition these concepts into widespread practice. Additionally, the ecological processes explored in this thesis operate over decades, future research could investigate how architectural structures can mechanically and programmatically adapt to changing levels of ecological succession and soil stabilization over a 50-to-100-year timeline.

Reflection

This thesis originated from a deeply personal relationship with the landscapes of Upper Silesia. Having grown up in the region, coal heaps were never perceived as extraordinary anomalies; they formed the everyday horizon, monumental yet rarely questioned. Their presence was so deeply embedded within the local fabric that they often became invisible to daily perception. Coupled with my family's direct history in the local mining industry, this research carried an unavoidable personal dimension. The project began with a simple question: Why are these immense anthropogenic landforms still largely perceived as problematic waste rather than valuable spatial and cultural resources? Whenever I told people that I wanted to base my design on the heaps, they would often question it, asking, “Why heaps? Nothing has ever been designed there.” That sentiment embedded itself deep in my mind, and I became determined to challenge it by fully exploring the architectural possibilities of these terrains. Throughout the intensive research and design process, I realized that coal heaps are exceptionally complex simultaneously serving as archives of industrial history, evolving ecological systems, and vital social landscapes.

In all honesty, I found myself lost at the beginning of this process, overwhelmed by the sheer scope and monumental size of the heaps. Confronting a landform spanning nearly 170 hectares with deeply complex ecological networks was incredibly daunting. Translating that massive scale into a tangible architectural intervention was a profound challenge, and while I persistently tried to overcome it, the sheer vastness of the site remained one of the most demanding hurdles of my entire graduation project.

One of the lessons of this graduation project was the necessary shift in my own design mindset. At the onset, I approached the site through a highly conventional architectural lens, searching for a singular formal gesture capable of “solving” the conditions of the heap. I discovered that the true value of the site lies precisely in its instability, toxicity, and continuous transformation. The realization that ecological succession, water filtration, material weathering, and social appropriation operate simultaneously fundamentally changed my trajectory. The framework provided by Christophe Girot’s “Four Traces” was instrumental in this shift, guiding me past superficial observation into deep site interpretation, heavily supported by acoustic mapping, topographical analysis, and hands-on material experimentation.

This project transformed my understanding of what industrial heritage can be. Rather than preserving mining traces as static, untouched monuments, I learned that memory is best preserved when it is actively inhabited. By designing a system of mediation rather than a fixed object, I have concluded that true post-industrial regeneration does not erase the scars of extraction, but rather invites the public to step directly into the ongoing narrative of the landscape’s recovery.

I would like to express my sincere gratitude to my graduation tutors, Alper Semih Alkan and Chiara Pradel, for their guidance, critical feedback, and continuous support throughout this research and design process. I truly appreciate that their critiques were sometimes tough, as those exact moments consistently sparked deep reflection and pushed me to my limits as a designer. Their insights challenged me to look beyond immediate solutions and engage with the broader cultural, ecological, and theoretical dimensions of the project. Their ability to suggest new directions of inquiry and provide alternative perspectives significantly enriched this thesis. Through our discussions, I developed a deeper understanding of landscape, heritage, and architecture as profoundly interconnected fields.

I am also grateful for their patience and encouragement during the more challenging moments of the graduation process. Whenever I became lost in the complexity of the research or the immense scale of the post-industrial terrain, my tutors helped me regain focus and move forward. Their mentorship has been invaluable, shaping not only this project but also my development as an architect and researcher.

Lastly, I want to express my gratitude to my family and my supportive boyfriend Dimitris. Thank you for your belief in me, your patience during the endless hours I spent working, and for keeping me grounded throughout this entire journey.

Agnieszka Kania
11th June 2026
Delft

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