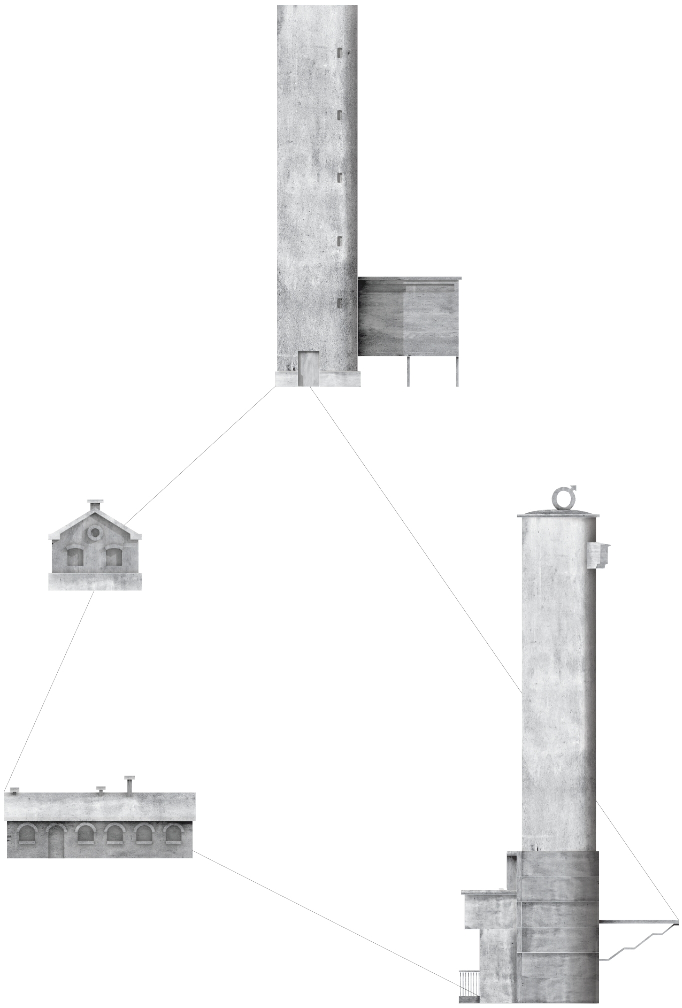


No longer mine

Repurposing the Tuolluvaara mine

Zuzanna Jakubowska | Master thesis 2025

Chalmers School of Architecture

Department of Architecture & Civil Engineering

Architectural Experimentation | Before and After Building

Examiner : Naima Callenberg

Supervisor : Daniel Norell

No longer mine

Repurposing the Tuolluvaara mine

Zuzanna Jakubowska
Master thesis 2025

Chalmers School of Architecture
Department of Architecture & Civil Engineering

Architecture and Urban Design
Architectural Experimentation | Before and After Building

Examiner : Naima Callenberg
Supervisor : Daniel Norell

Abstract

Abstract

Technological advances in the deindustrialization era have significantly impacted the mining industry, whose legacy of environmental degradation from excessive extraction still casts a shadow over many places around the world. One such place is Kiruna, the backbone of the thesis, where mining actions have led to the city's partial relocation of many remnants of great heritage value left behind – abandoned mines. One notable example is the Tuolluvaara mine, which hosts two rare mining towers that stand out due to their historical and visual significance. This thesis explores the future role of the Tuolluvaara mine in Kiruna, proposing a strategy for repurposing its premises.

This project follows the concept of continuity, based on the theory of Solà-Morales, to prevent architectural practices from becoming an aggressive act in the transformation of the postindustrial area. This approach applies both to the transformation of buildings and the land they occupy, paying attention to heritage and history. Grounded in theories of abandoned and decayed architecture as palimpsest, terrain vague and collective memory, the design becomes an interplay between the past and the present. A phased transformation is developed to ensure gradual public access and integration, using the concepts of conversions for site's premises alteration.

The design considers the significance of the heritage buildings, but also the insignificance and instability of the ground that they are standing on - a messy and haphazard result of the deposition of excavated masses from previous mining activities as well as of the piling up of the soil from the construction of Kiruna's new city centre. The project includes phytoremediation of the wasteland and separating it from public access until it regenerates while the buildings present on site are transformed into open-plan public spaces and adapted for a multifunctional implementation called a rotational programme. In a space defined by its users themselves, the architect's task is to establish a versatile framework capable of adapting to various scenarios as a response to the constantly changing challenges of the city's relocation. The study proposes solutions created on the layered example of Kiruna that could be applied to other cities facing similar challenges.

keywords: heritage, post-industrial landscape, adaptive reuse, transformation, mine

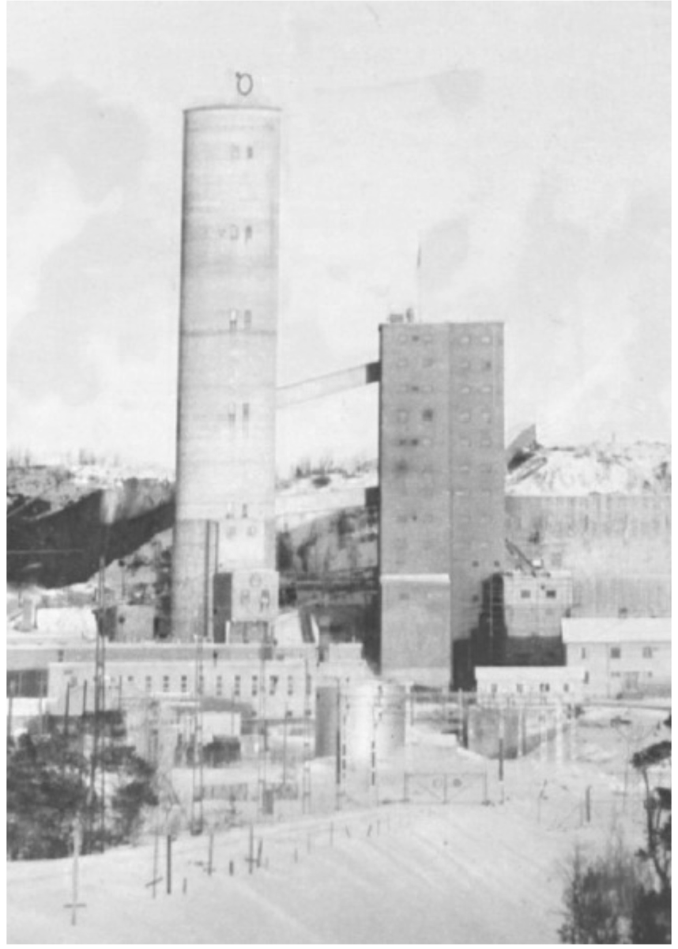


Fig. 1 *Tuolluvaara towers* (n.d).

| ZUZANNA JAKUBOWSKA is a graduate of PJAIT, Warsaw University of Technology and Chalmers University of Technology. Her professional background consists of working with architectural companies implementing modern technological solutions in the field of architecture. With a background in graphic design and animation, her work integrates the precision and innovation of adopted solutions and a combination of traditional and new technological inventions. Her work is focused on adaptable systems, energy efficiency and structural solutions. Her profound interest in computational design is reflected in her deep knowledge of numerous 3D software and techniques. In the case of the field of architecture, she combines minimalist design with complex solutions, combined with local context.

| **Contact**

Zuzanna Jakubowska
zjakubowska9@gmail.com

| **Academic**

MSc Architecture and Urban Design
Chalmers University of Technology
Göteborg, 2023 / 2025

Exchange semester
VIA University College
Aarhus, Denmark 2021

BSc Architecture
Warsaw University of Technology
Warsaw, 2018 / 2022

BA New Media Arts | Animation
Polish - Japanese Academy of Information Technology
Warsaw, 2026 / 2018

| **Professional**

Teaching Assistant
Chalmers University of Technology
Göteborg, 2024 / 2025

Junior Architect
FUEL Group
Warsaw, 2022 / 2023

Assistant Architect
Archigraf
Warsaw, 2021

| **Awards**

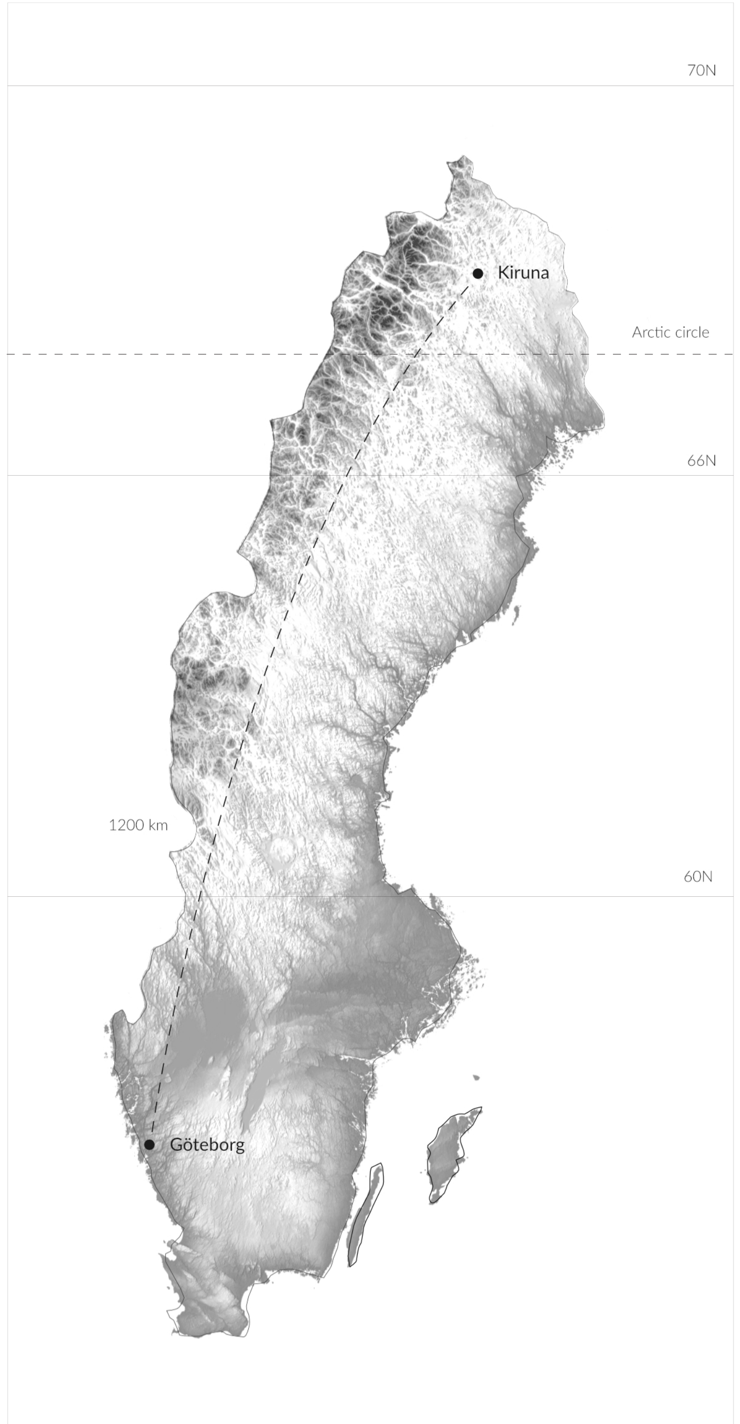
Troll's Tongue Observation Platform Competition
Honorable mentions
Buildner international 2025

Award of the Minister of Development and Technology for the best Bachelor's thesis
50th edition, 2022

Mitigation of anthropopressure and adaptation to climate change -Pro-environmental diploma competition
-III place

The most interesting Bachelor's Diplomas
Polish-Japanese Academy of Information Technology, 2019

Table of contents



1:15000000

Fig. 2 *Map of Sweden.*

Context

The city of Kiruna is located far north in Sweden, beyond the Arctic Circle and is about 1,200 kilometers away from the city of Göteborg - counting in a straight line. The map shows both cities in relation to the entire continent and to each other.

Fig. 3 *City transformation analysis based on the map of city relocation by LKAB.*

City transformation

Due to ground collapse caused by excessive mining, the endangered part of the city was relocated eastward (Rankin, 2023). The relocated town hall, along with the new city center, is now situated next to the Tuolluvaara mine-the site chosen for transformation in this project. Over the coming years, the city's transformation will continue, with more of its parts being moved eastward. This suggests that the future development of the city will follow this direction.

Urban mines

In the 1910 there were around 500 active mines extracting resource in Sweden. In 2022 there were only 12 left operating due to economic, technological and social reasons (Ore Production and Trends, n.d.).

The 19th-century technologies were too primitive to extract iron ore from greater depths, which caused closing or abandoning the mines extracting materials from shallow, open pits after depletion of resources. The other reason was a high cost of deeper resource extraction. Many years of mining activities have caused soil contamination, water pollution and landscape alteration (LKAB, 2024).

Today Kiruna struggles with high cost of soil and water depollution. (Kiruna Kommun, 2024)

1. Toulluvaara | inactive / active by law
2. Kiirunavaara | active | iron ore extraction
3. Haukivaara | inactive
4. Rektorn | inactive
5. Loussavaara | inactive
6. Viscaria | inactive

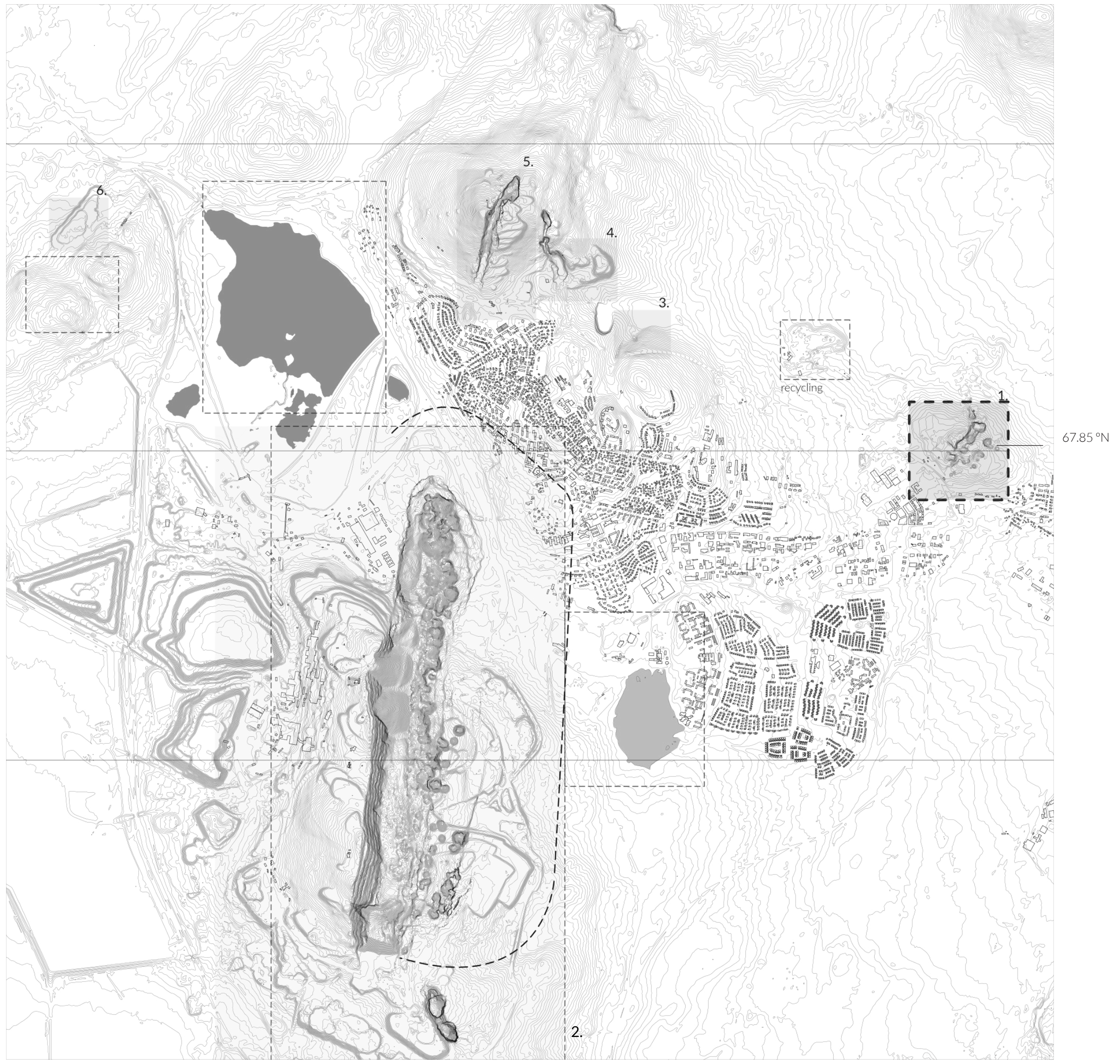


Fig. 4 *Map showcasing the location of the mines in Kiruna in 2024.*

1911

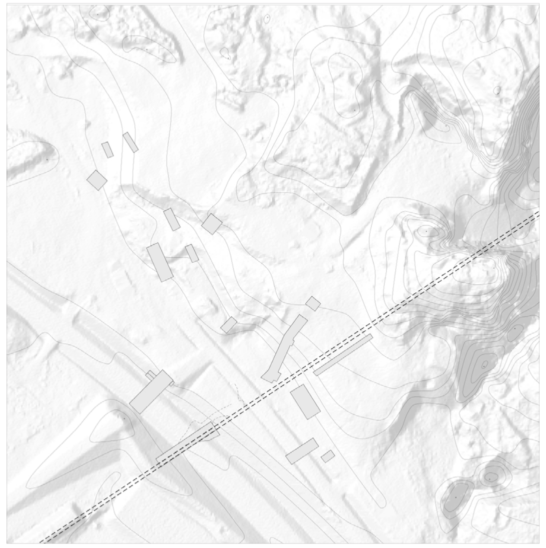


Fig. 5 *Area plan | 1911.*

1974 - 82

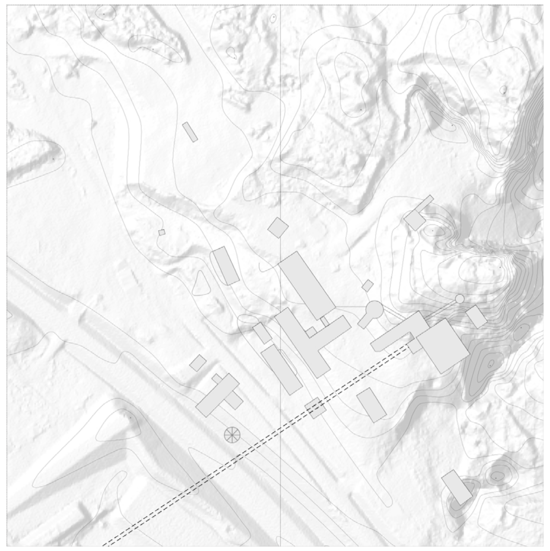


Fig. 6 *Area plan | 1974 - 82.*

2024

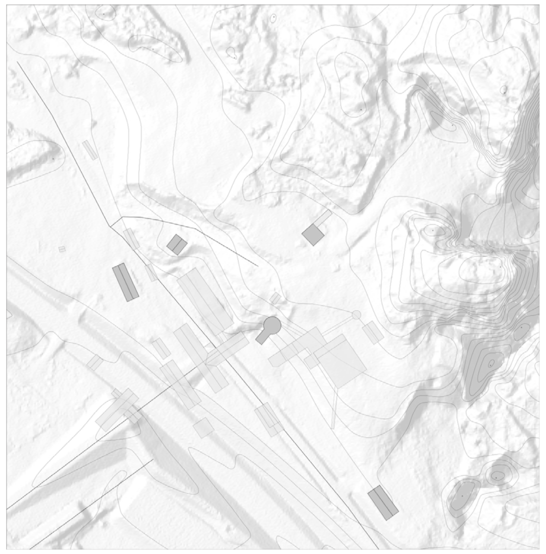


Fig. 7 Area plan | 2024.

Site changes

Changes - Tuolluvaara mining area since 1911

The Toulluvaara mine is located on Furuvägen street in the city of Kiruna, Norrbotten region. Within its area, there are remnants of iron ore extraction, which significantly impact the landscape with their size and the visible degree of resource extraction. There are two former mining towers present on the site–one of 74 meters tall and the other 52 meters tall.
From 1911 through the 1980s up until 2024, the mining area has undergone significant structural changes with many structures demolished.

Existing structures:

(1911)–repair shop, funicular railway, mine hoist, loading dock
(1974-82)–electricity workshop, compressing station, mechanical workshop, workers facility, mine hoists, processing plant, office, loading dock
(2024)–mine hoists along with two brick buildings–one of them being the former electricity workshop.

Research based on the technical documentation provided by LKAB.

Relevance

The relocation of Kiruna's city center due to excessive ground exploitation and collapse has positioned it 3 kilometers east, right next to the abandoned Tuolluvaara mine. This shift has caused a disagreement between Kiruna Kommun and LKAB company, regarding the fate of the Tuolluvaara towers. One tower belongs to Kiruna Kommun and the other to LKAB, adding another layer to the disagreement.

While some advocate for their destruction to make way for new housing developments, others argue for their preservation due to their heritage value and significance in the local consciousness. The towers, unique and among the last examples of mining hoists in Sweden, represent a postindustrial fabric and the destructive impact of mining. The mining tradition in Sweden dictates that where mining ends, the shaft of the hoist mining tower must be ceremonially blown up into the air. The mine, a source of prosperity through iron ore extraction, is paradoxically the cause of the city's downfall.

The towers, once symbols of doom, now have the potential to be redefined as symbols of rebirth and renewal, serving the city's inhabitants and reclaiming the mine. Kiruna stands as a symbol and even as a showroom of the harm humans can cause. This project could serve as a model for other cities facing similar challenges, demonstrating that postindustrial sites can be redefined and reborn, taking responsibility for past actions. It gives the possibility of transformation and positive change showing that instead of destroying postindustrial places, they can be redefined and reborn, taking responsibility for our acts as creators.

The author of this thesis advocates for the preservation of the towers and their transformation for the mentioned reasons.

Dynamic and growth

Considering the buildings as a flexible spaces that can serve different purposes over time follow the idea of constant reinvention and mirroring the ongoing transformation of the city. During the relocation process, buildings can serve as furniture storage for city residents who have lost their homes. Once the process is complete, they serve other functions that meet the needs of current and future generations like community gardens, workshops, storage or exhibition spaces.

The concept of boundary

The approach uses a defined boundary to create a zone of transformation within a larger wasteland as a visual statement about the power of intentional growth. The wasteland visible outside and thriving green spaces inside the boundary create a contrast, showing the potential of intentional care as a value of investing in the environment and the community.

Phased transformation process

The phased approach allows for public access during transformation process through a walking bridge to create an opportunity for people to witness and engage with the transformation as it happens, making the process and integral part of the experience. The site would evolve this way in the public's consciousness and provide a sense of participation and ownership.

Mining heritage and cultural connection

The design is incorporating the mining heritage to the project by emphasizing the axis and tunnel - like spaces, both vertical and horizontal -provides the focus on cultural continuity together with providing a symbolic and physical pathway that leads people from the industrial past to the future. The site becomes a living testament to the city's industrial roots and its ongoing rebirth.

Visual landmark

The mining towers, with their height and historical significance, are natural landmarks. By focusing on the towers as a as central elements of the project a symbol of the new city emerging from the ashes of the old is created. This idea creates a narrative tied to the region's identity.

Collaboration with Kiruna Kommun

This project is created in collaboration with Kiruna Kommun, which oversaw design decisions and provided suggestions regarding needs and future changes. All design choices within the selected area are the author's own decisions in this thesis. Currently, construction work is underway to develop a hospital, school and other facilities near the Tuolluvaara mine, though not within its boundaries. If the towers are not to be demolished, the city intends to address the transformation of the mine site in the near future. However, since these plans remain distant at this stage, this work serves as a proposal for potential future changes.

Thesis questions

I. - What architectural strategies can be employed to connect memory and reinvention in repurposing the Tuolluvaara mine to ensure historical continuity and contemporary urban integration?

II. - How can an abandoned mining structure be repurposed to balance preservation with architectural intervention, considering heritage continuity together with contemporary relevance?

Deliminations

The project does not seek to establish an urban plan for the migrating city of Kiruna; instead, it views the area undergoing transformation as a combining element within the urban framework, providing continuity while elevating its character and emphasizing its importance in the ongoing migration process. The outcome does not consider detailed technical aspects due to the topic's complexity but rather proposes conceptual solutions for site and structure remodeling. The main focus of the project is not a comprehensive landscape transformation but rather treating it as a complement to the overall concept. The thesis does not provide a solution for the entire plot of the Tuolluvaara mining area, which includes exposed mining pits, but it proposes systemic solutions that can be applied to other cities facing similar challenges. The brick buildings on the site are not the main focus of this thesis, but due to their value and presence, they are included into the overall concept. No comprehensive solutions will be developed for these structures because the thesis prioritizes the two mining towers for more detailed evaluation. The phytoremediation process mentioned in the design is proposed as an overall method for site remediation, but the thesis doesn't include detailed technical solutions.

Purpose / Aim

The aim of the project is to transform the abandoned post - industrial Tuolluvaara mine along with its existing structures, repurposing it for use - this time by the city's residents.
Unlike other post-industrial transformation projects, this initiative follows the concept of phasing/continuity, as suggested by Solà - Morales. This approach applies both to the buildings and the area they occupy, ensuring respect for tradition and history while avoiding the assignment of a strictly defined function.

Flexible functions and urban adaptation

The absence of a fixed function - referred to as a rotational programme - allows the site to adapt to the city's evolving needs. During the current crisis, where residents are losing their homes due to major ground collapse and the city's eastward relocation, the mine's towers could serve as a temporary storage spaces for furniture and personal belongings.
Once the crisis stabilizes and personal items are moved into new apartments, the site's function will shift to serve the community's needs - for residential developments, this could mean vertical gardens, rental spaces, cafes, meeting areas or association-connected workshops.

Industrial heritage

Considering the visual dominance of the towers and the mine's historical significance, the project recognizes both its economic contributions and the negative perception of post-industrial sites - due to the damage they caused to the city. The goal is to reframe how the mine is perceived - preserving its symbolism but shifting its interpretation toward a positive perception.

A user - defined space

In the transformation of Tuolluvaara mine, it is not architect who defines its function but the users themselves. The architect's task is to establish a versatile framework capable of adapting to various scenarios.

Contrasting landscapes and Symbolic restoration

Another goal is to highlight the contrasts within the mine's surroundings. The current land - treated as wasteland - lacks historical value, unlike the structures on the site.
To emphasize this, an enclosed section of the mine's terrain by a pedestrian bridge, will serve as the project boundary. The contrast between lush greenery within the site and the wasteland beyond it creates a green stamp on the degraded landscape - visually showing the difference between neglect and renewal. This contrast becomes a symbol of what is possible - a damaged area revitalized by the same hands that once ruined it.

Integration into the city fabric

The project actively integrates the mine into urban fabric - no longer as an isolated, fenced-off site but as functional and dynamic urban component. Due to the city's eastward relocation and the proximity of the new city center, which can be reached by crossing the bridge over the expressway, Tuolluvaara mine is serving a new role in the city. The idea about integration is in this case a strong suggestion when it comes to future city development as the thesis does not propose any designed solution for the direct connection between the site with the city centre. The suggestion' s indicators are present on the site in the form of designated routes within the boundary - waiting and ready to be reconnected with the city.

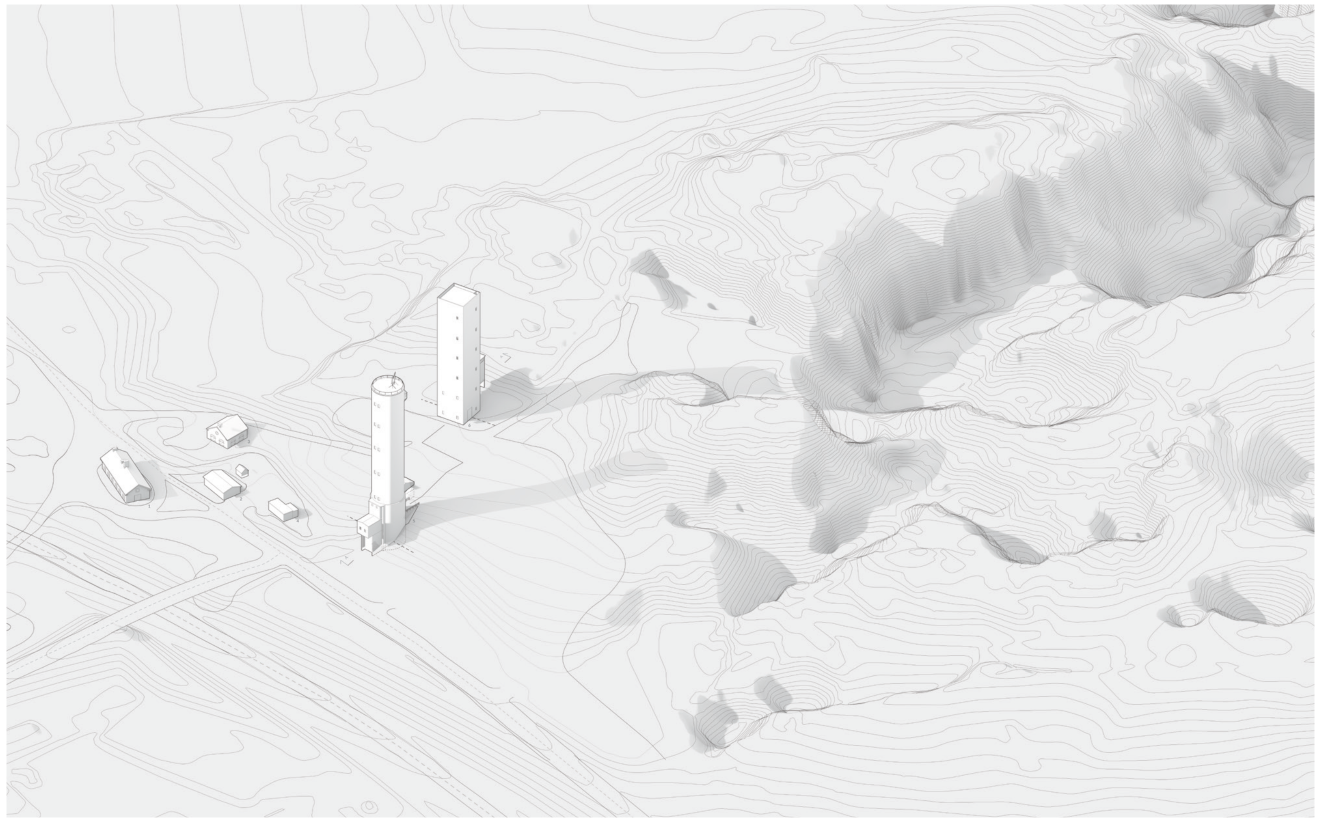


Fig. 8 *Tuolluvaara mine axonometric view.*

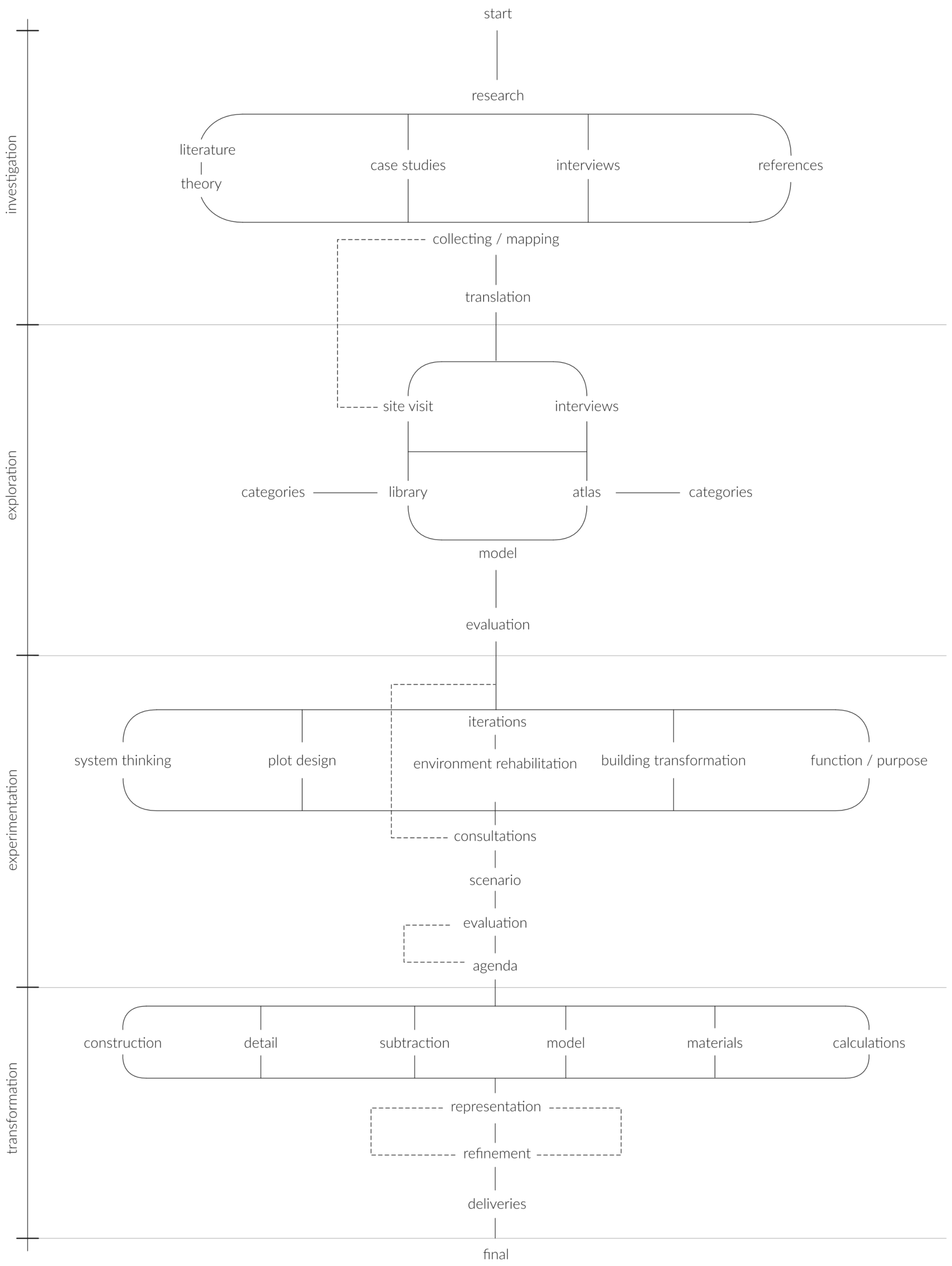


Fig. 9 *Phasing diagram.*

Method

Method

Data collection / analysis		Tools / results
Basic research | Qualitative	In the research, topics of postindustrial landscape and mining history and techniques of Sweden, Kiruna and Tuolluvaara region were studied in order to collect proper data. The research and analysis of Kiruna transformation and relocation was conducted together with site, landscape and building conditions and structures present on the project site.	Research based on articles, books, interviews (LKAB, Kiruna Kommun), websites, documentation and photographs. As a results diagrams and maps were made, showing important data, observations or conclusions using software such as QGIS, Affinity Designer, AutoCAD and Rhinoceros 3D
Design research | Qualitative	Four case study were chosen for research and solution application in the thesis project divided into two categories: landscape and building design.	Research based on articles, websites, documentation and photographs. As a result, a project implication paragraph was created, highlighting inspirations taken from each case study and they implementation in the thesis project.
Design - proposal creation, iteration and evaluation | Mixed method	Based on the previously gathered material a design proposal was created and evaluated. The phase of creating a preliminary design - experimentation phase - was interlaced with exploration phase, allowing for various iterations based on gathered information.	Design iterations were carried our using software such as Rhinoceros 3D with Grasshopper, Affinity Designer, AutoCAD. Final design presentation was made using software such as Rhinoceros 3D with Grasshopper, Affinity Designer, AutoCAD and 3ds Max, showing plans, sections, models, axonometries, maps, schemes, visualizations and elevations in order to showcase the compete project.

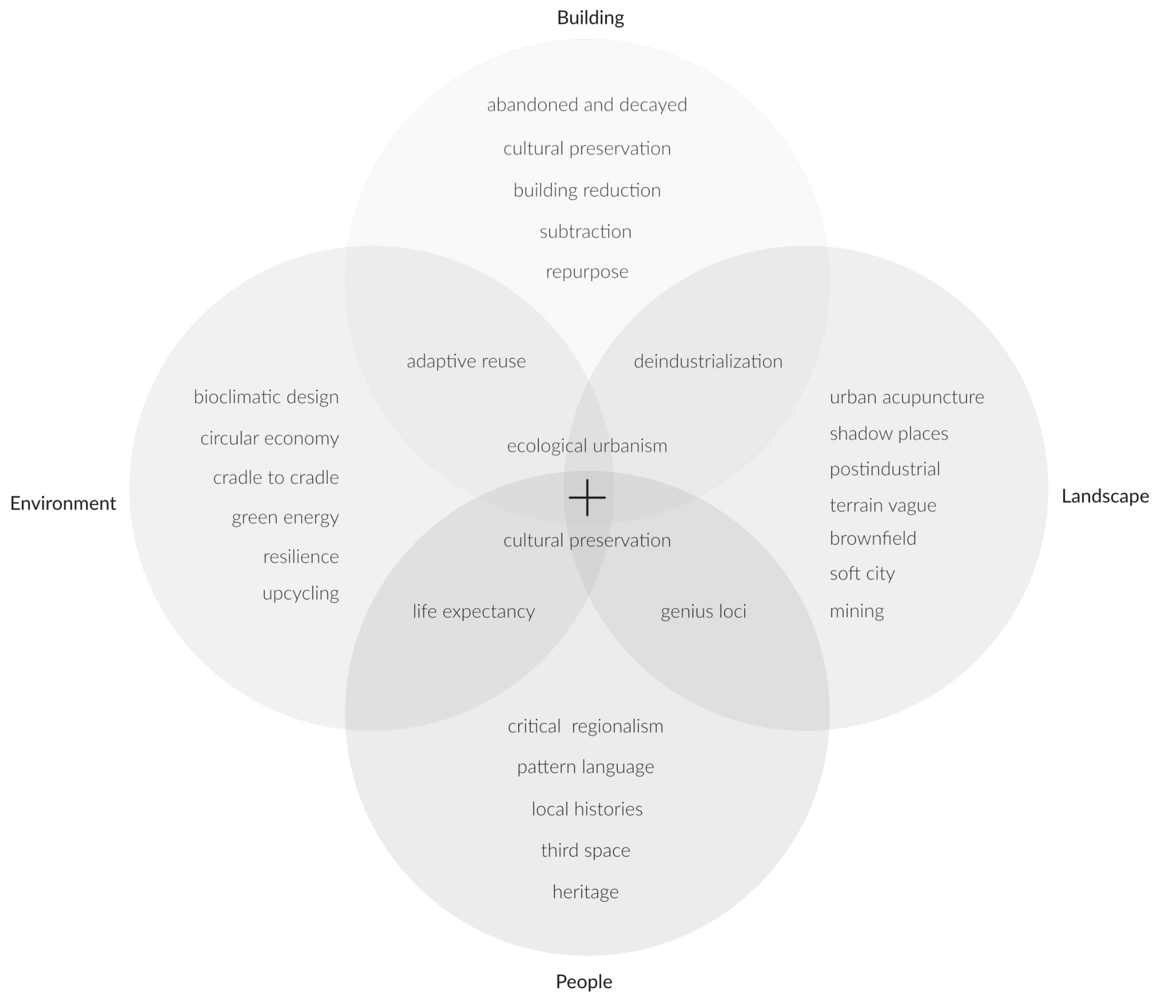


Fig. 10 *Positioning diagram.*

Division

There is a selection of four topics considered in the thesis, concerning different scales of the analyzed context: environment, landscape, buildings and people. The selection is made in order to systematize selected topics and understand their connections. This focus is strongly visible in the theory selection.

Fig. 11 *The view over Luossajärvi, Luossavaara, and Kiruna (Dahllof, T. (1927). CC PDM 1.0*

Historical development
Kiruna

In the 19th century technological advancements and developments in steel-making made mining on a larger scale possible. As an efficient transportation method the Malmbanan railway was created, shipping the ore between further distances. In 1890 Robert Schoug was the initiator of forming the Luossavaara-Kirunavaara Aktiebolag (LKAB) which main task was to continue expansion of the railway, giving the possibility to connect its section between Gallivare and Narvik in 1902 (Arnqvist & Sivenbring AB et al., 2014, pp. 24-25).

In order to attract the workforce a necessity to create settlements emerged. The finally chosen settlement scenario was to create one large community between the two mining mountains (Kiirunavaara and Luossavaara) as a better alternative to the previous one, in which workers would have to travel longer distances (Arnqvist & Sivenbring AB et al., 2014, p. 25).

The settlements were located along the railway and the community's name, went through different propositions like Luossavare, Luossavaara or Kirunavaara, before finally being shortened to Kiruna. In 1900 the terrain-adapted city plan for Kiruna was established and proposed by Per Olof Hallman and Gustaf Wickman–who became LKAB's company architect (Arnqvist & Sivenbring AB et al., 2014, p. 25).

When the Trafikaktiebolateg Grängesberg-Oxelösund (TGO) started taking over the shares, LKAB agreed with the Swedish state to share half of the ownership under condition of redeeming TGO. Another mining company started forming in 1900–Tuolluvaara Gruv Aktiebolag (TGA), which exploited iron ore in Tuolluvaara. In 1960s, the LKAB company switches to underground mining while the year 1969 is marked by the Great Miners Strike, leading to major reforms. In 1948 Kiruna becomes a city (Arnqvist & Sivenbring AB et al., 2014, pp. 28-31).

Due to high demand from India and China in 2000, raw material prices significantly increased, leading LKAB to increased ore extraction which caused major consequences in ground deformation due to excessive excavation. Large areas of the city were moved or demolished and the new urban transformation became real. New alternatives were chosen and the most suitable area based on many factors was the one near Tuolluvaara (Arnqvist & Sivenbring AB et al., 2014, pp. 33-34).

In 2011 the architectural competition was held concerning the creation of a new city centre and Kiruna urban transformation. In 2013 the winner was selected–White Arkitekter, who came up with a project called ''Kiruna 4 ever". For the ground deformation area the concept of „Mining City Park" was established, where green spaces after building's demolition could still be used (Arnqvist & Sivenbring AB et al., 2014, p. 34).

Historical background

Tuolluvaara | From mining to modern

Tuolluvaara is an area / district in the city of Kiruna with a rich history shaped by its mining heritage. Located in northern Sweden, Tuolluvaara's story begins in the late 19th century, with discovering iron ore deposits underneath its area (Arnqvist & Sivenbring AB et al., 2014, p. 28).

The Origins of Tuolluvaara's Name

The name Tuolluvaara comes from the Sami word Duolluvárri, which translates to "Fire Mountain." The name likely originates from the way the mountain glows red at sunrise, with „dolla" meaning fire and varri meaning mountain (Persson, n.d). The name was preserved in historical records, for instance in the Wiklund K.B. 1910s study „The Lappish and Finnish Place Names of Kiruna and Torneräsk" (Wiklund, 1910).

The Discovery of Iron Ore and the Founding of Tuolluvaara Mining Company

The discovery of iron ore was made by the mining engineer Hjalmar Lundbohm together with August Malm in 1897-a few years after forming the LKAB company. The deposit was sold to consorcium of 8 Swedish companies involved in creation TGA. In 1900 the Tuolluvaara Mining Company (TGA) was formed, responsible for extracting iron ore from Tuolluvaara (Persson, C. & Luleå tekniska universitet, n.d., pp. 5-8).

Early Mining Operations and the Community's Growth

Lundbohm acted as an informal manager during the early years when the mining operations were run by LKAB personnel. In 1900 earth-moving work was carried out and for this reason an expensive Hällfors-type barracks with a hatch system were built due to the material shortage reasons (Persson, C. & Luleå tekniska universitet, n.d., p. 9).

In 1903, a simple transport road had been built between Tuolluvaara and Kiruna while by the following year, a cableway was constructed which connected the TGA mine to the railway, enabling more efficient ore transportation. By 1906, the first year-round miners had settled in the area with their families (Persson, C. & Luleå tekniska universitet, n.d. pp. 9-12).

Life in Early Tuolluvaara

Living conditions in early Tuolluvaara were very difficult for the miners. Interviews from 1952 revealed the realities faced by the workers in this time. Albert Johansson Lehto (1874–1961) described working and sleeping in the same clothes for months, until the garments rotted from sweat. Housing conditions were primitive, in the interview we can read about the four centimeter layer of dirt laying on the floor together with herring intestines (Persson, C. & Luleå tekniska universitet, n.d., pp. 21-22).

In 1912 Tuolluvaara was incorporated into Kiruna municipal society (Persson, n.d., p. 27).

Fig. 12 *Railway accident on the iron ore field, Kiruna (1914). CC PDM 1.0*

Fig. 13 *Inauguration of the railway section Kiruna - Tuolluvaara on September 12 (1958). CC PDM 1.0*

Fig. 14 *The cable car Tuolluvaara - Kiruna, in operation since 1905. 3,900 meters long (Vilson, S. 1941) CC PDM 1.0*

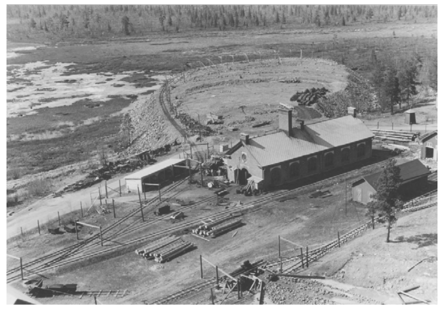


Fig. 15 *Tuolluvaara mines in Jukkasjärvi. View from the headframe (Vilson, S. 1941). Repair workshop. CC PDM 1.0*

Fig. 16 *Kiirunavaara ore mine (1903). CC PDM 1.0*

Posindustrial landscape

In Kiruna, a city in northern Sweden, one can witness an outstanding example of post industrial landscape, particularly in relation to iron ore extraction. According to article from 2020 the world's largest iron ore mine have been shaping this landscape by its activities for over a century. Due to heavy mining activities and the mine expansion, the ground collapse was caused in the western part of the city, leading to sudden shift in city's development (Wainwright, 2020).

The article also mentions that these actions forced the city to relocate its structures 3 km to the east, as land cracks formed, sinking parts of the city and making them uninhabitable. A huge effort was made to preserve buildings and infrastructure, with some dismantled and rebuilt, while others relocated in one piece.

These events transformed the city on a wast scale, never seen anywhere else, forcing it to struggle with their post-industrial future. They raise e questions about the city's dependence on resource extraction in light of significant alterations to the natural environment.

The new city design, conducted by White Arkitekter addresses these challenges with a focus on sustainability and heritage connectivity, rethinking the relationship between ecosystem and post-industrial urban fabric. Repurposing the heavily altered landscape in times of uncertainty presents a challenge in maintaining ecological balance and ensuring urban flexibility.

Due to the size of Kiruna's mining operations a large quantity of iron is shipped worldwide every day. Because of its importance in global economy and in the light of recent events the question rises concerning the future of resource extraction and the city's role in global economy.

Sectors such as textile, steel industries, shipbuilding and mining usually leave a physical impact on landscapes. They have been parts of decommissioning since 1970s (Marot, Harfst, 2021).

„Despite the fact that transformation processes took place under different framework conditions, the situation in the affected regions has been quite similar: declining economic roles, enhanced unemployment, shrinking tax bases, and outmigration-especially of skilled labour" (Marot, Harfst, 2021, p.168).

In many examples we can find ideas for land rehabilitation such as biomass plants testing, soil reclamation or water retention but usually the post industrial land is incompatible for revitalization for decades after the mining activities had ceased (Marot, Harfst, 2021).

„It follows, ceteris paribus, that landscape presents one of the most valuable, but at the same time also the most limiting burden of the transformation process in many small and medium-sized towns"(Marot, Harfst, 2021, p.169).

Mining and iron

In Europe, Sweden is the biggest producer of iron ore – the most important metal for modern industry. Iron ore has been traditionally sourced from regions of Kiruna-Malmberget in the north and Bergslagen in central Sweden (Jonsson et al., 2013).

„In the Middle Ages the Swedish iron industry belonged to the eastern branch of iron production, in which the 'bowl' furnace developed, not into the open hearths of the English bloomery type, but into 'shaft' furnaces" (Boëthius, 1958, p.148).

Boëthius states that the blask furnaces were owned by small iron makers called „bergsmän" and iron was produced on a small scale.

Early mining techniques included open pit mining, allowing for a big production and saving in labor without the need of requiring high-class workman. The underground mining-slicing was introduced later and gave a high percentage of ore extraction, together with lowering the costs of materials' usage (Camp & Francis, 1920, pp.52-55).

According to Camp & Francis (1920), the system of open pit mining is called milling :

„It consists of the following operations: first, the removal of the overburden from the ore body to be mined, this being done by steam shovel; second, the sinking of a hoisting shaft or incline to the bottom of the ore and the development of a system of underground tramming drifts tributary to the shaft and underneath the ore to be mined; third, the putting up of a number of raises (vertical openings) extending from the underground drifts through the ore; fourth, "milling " or shoveling the ore into the raises, through which it is drawn into tram cars operating in haulage drifts that lead to the shaft or incline, where it is hoisted to the surface"(pp.52-53).

The old methods of mining, described usually as charging the material with bare hands, have been replaced by mechanical ones where two types of hoist were used: the skip hoist and the bucket hoist (Camp & Francis, 1920, p.140).

Two towers of Tuolluvaara (M tower and C tower) despite their similarities, have been used for different activities. C tower's main task was to extract the underground resources, while M tower was responsible for transporting mining workers (LKAB, 2024).
In the structures many different levels of access could be found, integrated in one, strong frame within brutal aesthetics.

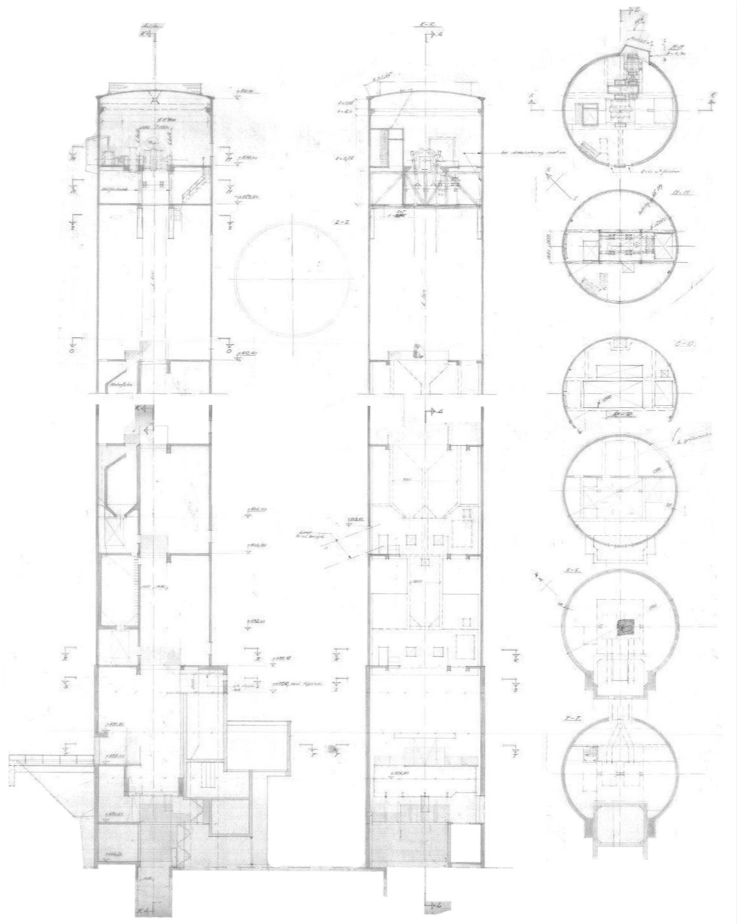


Fig. 17 *Mining tower elevations (LKAB, n.d.)*

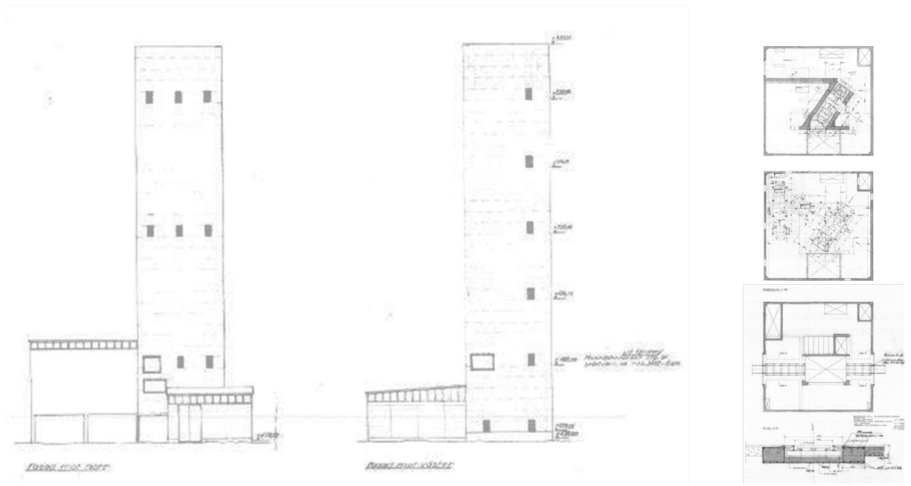


Fig. 18 *Mining towers plans and sections (LKAB, n.d.)*

Theory

Implications

The building

Abandoned and decayed-Matta-Clark is known for his concept of anarchitecture, which critiques conventional architecture by focusing on the social and political implications of urban space. Through his theories he reveals the overlooked and often hidden aspects of buildings and urban environments - those that have been abandoned or neglected. His approach challenges viewers to rethink their perceptions of architecture and the built environment, suggesting that decay can be an opportunity for creative engagement rather than a failure (Attlee, 2025).

The Matta-Clark idea of creating spatial shortcuts is used within the remodeling design of the tower's structure. The subtraction as a subject of event would be introduced for the towers in order to connect them with surrounding landscape and opening them for more light penetration and pointing the eye towards their inner structure.

The people

Collective memory - is shaped by the special representations, particual events or experience and social interactions to simplify a sense of spatial communication among people. Those representations are tied to objects, build environments or landscapes (Halbwachs & Coser, 1992).The term refers to the shared pool of memories and knowledge that is held by a group, community, or society. It encompasses the ways in which groups remember their past, shaping their identity, culture, and social cohesion. The philosopher Paul Ricœur argues that narrative plays a crucial role in shaping both individual and collective memory in terms of human plurality. He believes that people construct their identities through stories that integrate their experiences and memories. This narrative framework helps groups form a cohesive identity, allowing them to make sense of their shared history and culture (Clorinda, 2019).

The project integrates the theory in its design process, referring to the rich history of the abandoned mine and its past and future significance. It aims to change the perspective of the mine, transforming it from a symbol of human-caused destruction to a symbol of potential regeneration. This transformation highlights the possibilities for renewal in the minds of the residents, turning a site associated with landscape degradation into one of hope and revitalization.

Theory

Implications

The landscape | context

Terrain vague - the concept was first theorized by Ignasi de Sola- Morales and it is described as a wasteland, brownfield, void, dead zone, a contemporary or a vacant space that is mentally exterior but physically interior in the fabric of the city. Terrain vagues are spaces in the process of transformation or abandoned by the economic forces but open for possibilities or future reclamation. They are places where the city is no longer, where the memory of past dominates the present, strangers in our own city (Morales, 1995). The author states that the possibility of architecture acting on terrain vague, without becoming an aggressive act, is to ensure the continuity of flows and „the rhythms established by the passage of time and the loss of limits" (Morales, 1995, pp. 29 - 30).

Two heritage aspects can be found on the project site: the valuable building heritage and the mining ground that doesn't carry any heritage value. Based on the concept of terrain vague, the transformation introduces an element of continuity to its design through incorporating a phased approach of area remediation and rotational programme creation. The project solutions gives the opportunity of preserving the freedom of the place and the associated sense of „expectation" and „liberty" mentioned in terrain vague. The idea is also present in the transformation of the buildings themselves, where most of the historical fabric is preserved. The transformation of the abandoned mine serves as an element of continuity for the place, in contrast to demolishing its structure. The pedestrian bridge counters the idea of loosing of limits, reducing the site's freedom but highlighting the contrast between the surrounding wasteland and the regenerated green area. This open enclosure - as a stamp in the landscape - will protect the site from unwanted future development interference.

Architecture as palimpsest - in this theory a building or a landscape resembles a palimpsest described as multi-layered element where the past and present overlap. This element that can be erased and reused, carrying traces from the past. The process gradually leads to creation of heritage, which transforms the palimpsest into symbolic and social processes that can later be reconstructed through the traces they leave behind. By remodeling a building the new meaning and narratives are created called re - semanticization by Rudolph Machado (Van Cleempoel, 2020).

The project follows the theory of palimpsest on multiple levels, from the structure of buildings to the revitalization of the area. For the transformation the project is inspired by concepts of conversions, introduced by Philippe Robert (1976) and other scholars (Plevoets & Cleempoel, 2019). In this approach, the historical parts of the buildings are preserved both inside and outside, incorporating necessary infrastructure and openings for light penetration. The introduced elements are made out of rough construction materials, allowing the preservation of the historical layer while implementing new ones, continuing its history. To showcase the layers of time, the pedestrian bridge made out of reused wooden railway sleepers, serving as a site boundary, is enclosing a green stamp within the surrounding wasteland. Inside the boundary the main axis is elevated, made out of reused concrete railroad sleepers. Material chosen for the path structure (wood and concrete) emphasize temporariness and permanence. In the following phases of the project, the wooden path will loose its significance as a main one, giving it away to the main axis.

Shadow places-the theory of shadow places describes the hidden, often ignored spaces that bear the environmental or social costs of modern societies. Introduced as part of Val Plumwood work on environmental ethics and ecofeminism, the idea of shadow places reflects how certain regions, communities or ecosystems are heavily exploited to sustain the lifestyles of wealthier urban areas. These places remain largely invisible and forgotten (Fijn, 2016).

Based on the theory, the design introduces a rotational programme without a fixed function in order to create flexibility in the future use. The boundary for the project is created in form of pedestrian bridge which integrates the site's user into the transformation from the first phase. This boundary, connecting all the buildings on the site, involves users in the transformation from start to finish, creating a possibility of reshaping the relationship with the place as meaningful and responsible.

Reference

Implication

Fig. 19 Pedestrian bridge (Strong. J, 2018.)
© Jason Strong

Hälleskogsbrännan Visitor Center / pS Arkitektur | 2018

The project was created after the fire in 2014, allowing visitors to experience the consequences of the disaster by walking along a specially designed pedestrian bridge, located above the burn site. It provides an opportunity not only to witness the effects of the catastrophe but also to observe how nature recovers. (Pintos, 2019)

The project is inspired by the creation of a pedestrian pathway that allows visitors to experience the whole transformation-from start to finish. The Tuolluvaara mine transformation project, in comparison to the reference, offers a positive experience - observing the site's rebirth and renewal.

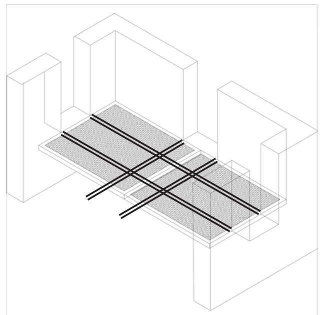


Fig. 20 Grating in the slab opening.

Mills Grain Silo Conversion / Prokš Prikryl Architekti | 2023

This transformation project embraces the idea of opening the building's ground level to public functions and integrating it with the public square, creating a unified open space. The concept of a communication core as a central connecting element throughout the building has been preserved and implemented in the design, emphasizing a sense of vertical movement. To ensure clear communication paths, some walkways have been designed using grating supported by beams, allowing transparency in the voids of open spaces. (Caballero, 2025)

The inspiration from the reference is the opening of the building's ground level and its connection with the surrounding landscape. Additionally, the idea of emphasizing vertical and creating a technical core has been drawn from this reference, as well as the use of transparent gratings to fill openings in the building's slabs, allowing better light penetration.

Reference

Implication

Fig. 21 View from the inside (Dujardin, 2016.)
© Filip Dujardin

PC CARITAS / Architecten De Vylder Vinck Taillieu | 2016

In this example, the concepts of continuity, transformation, and the building's character serve as the main topics of the renovation project. They highlight the nature of change - an inseparable aspect of every building's life-considering both past and future transformations. Rather than disregarding these transitions, the project embraces their continuation and considers future modifications as successors to previous ones, which carry forward their history. The building's spaces have been designed according to their specific functions and evolving needs to ensure appropriate care for each area (Cayupe, 2020).

In this case, the idea of continuity implemented in the reference project is used in the thesis. This value can be also found in the theory „Terrain Vague", by Ignasi de Solà-Morales, in which the author suggests how architecture can appropriately and non - aggressively influence such spaces. For this reason, in addition to new elements, the project will also preserve aspects of the old architecture when it comes to building elements, such as visible openings in the slabs and traces of the past in the form of damaged facade materials or remnants in the flooring left by the demolition of internal walls. Similarly to the reference, each space is „attended to" (Cayupe, 2020) in the way it requires.

Fig. 22 Pond with old structure. (Latz, n.d.)
© Michael Latz

Landschaftspark Duisburg Nord / Latz + Partner | 2002

This metamorphosis project revitalizes a polluted post - industrial site, where existing structures have been integrated to create a new landscape of green regeneration. The introduction of vegetation creates a striking contrast between the old architectural structures and the lush greenery. Existing waterways have been transformed into elements that support the renewal of ecological processes in the previously contaminated environment. They serve as symbols of nature - maintained under human supervision - forming a system that is both artificial and yet fully natural (Landezine, 2011).

The design solutions for the site's phytoremediation were drawn from the reference and implemented in the project, which includes a connected pond system with selected vegetation, responsible for purifying the land. Another source of inspiration is the contrast created by introducing lush greenery in between post - industrial mining structures. Considering the damage previously caused by human hands, the symbol of rebirth serves as an example of the responsibility we should take and the attempt to repair and reclaim the lost area.

Fig. 23 *Tuolluvaara - site plan .*

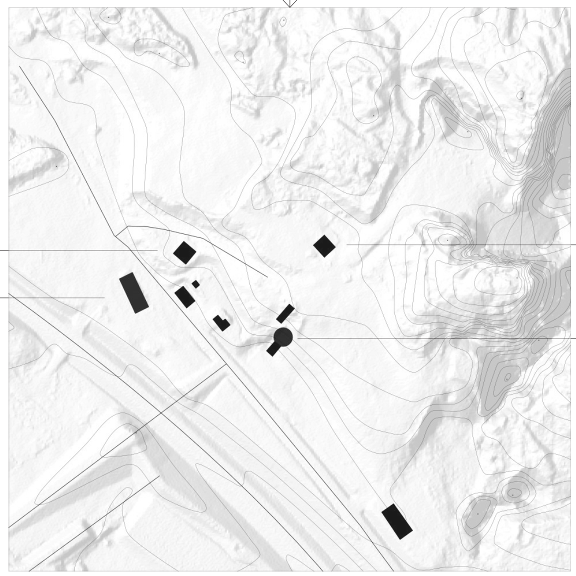


Fig. 24 *Site plan | zooming in.*

Site

The project site is located northeast of the new city center, separated by a highway. In 2024, the site contained two mining towers (M tower and C tower) and two brick buildings that were previously used as storage and a workshop. Additionally, temporary structures such as containers can be found on the site. Access to the site from the new city center is provided by a bridge over the highway and a dirt road that runs along the site in the direction of suburbs.

Fig. 25 *Tuolluvaara mine - site division.*

sample point	depth	soil	remark	lab. analysis result
24TG03MG	0,5 - 1 m	silty and humus containing sand	brown	compliant with SEPA general quidelines
24TG07MG	0,5 - 1 m	silty sand	dark gray	cobalt > KM_2, copper > MRR_1
24TG08MG	0 - 1,5 m	silty sand, slightly gravelly sandy silty moran	brown, dark gray	cobalt > KM_2, , copper > KM_2
24TG09MG	0 - 0,5 m	silty sand	dark gray	cobalt > KM_2
24TG10MG	0 - 1,5 m	silty, rocky and gravelly sand, brick	dark gray, odd odour dark orange	copper, chromium, zinc >MRR_1 lead > MKM_3,

MRR_1 ≥ *Less than negligible risk (MRR) according to the Swedish Environmental Protection Agency's Handbook 2010:1,*
KM_2 ≥ *The Swedish Environmental Protection Agency's general guidelines for sensitive land use (KM), Report 5976 (2009, rev. 2022),*
MKM_3 ≥ *The Swedish Environmental Protection Agency's general guidelines for less sensitive land use (MKM), Report 5976 (2009, rev. 2022),*
FA_4 ≥ *Waste Sweden's recommended concentration limits for hazardous waste (FA), Waste Sweden Report 2019:01,*

Tyréns Sweden AB. (30.08.2024.) *Environmental engineering soil investigation, TGA Area Norrbotten Region, final report.* p.16 - 17

...Notes from the fieldwork are shown in Appendix 3. During the drilling, most of the filling was noted as crushed rock of the gravelly, blocky sand fraction. In some of the points, wood residues were noted and in point 24T10MG, odor and brick were noted in the material...

...At point 24T10MG, lead levels above the guideline value for MKM were found at two levels 0-0.5 and 1-1.5-m below the ground surface. Elevated levels of lead were also found at greater depths 1.5-2m and 2-2.5 meters below the ground surface at the same point, but below the guideline values. Elevated levels of zinc and a low level of PCB were also detected at the sample point...

Tyréns Sweden AB. (30.08.2024.) *Environmental engineering soil investigation, TGA Area Norrbotten Region, final report.* p.12

Otherwise, no contamination levels were found that exceeded the applicable guideline value for MKM. Levels of chromium or copper that exceeded the guideline value for KM were found in five of 14 analyzed soil samples. The levels are considered to be naturally occurring in the crushed rock material found in the area...

...In the area around point 24T10MG, lead levels above the guideline value for MKM were found. During the sampling, brick remains were also noted in the ground...

...Metal levels above the guideline value for KM have been found, but these are considered to be naturally occurring in the rock crushed material found in the area...

...Odor or demolition debris has been noted at four points in the geotechnical investigation...

Tyréns Sweden AB. (30.08.2024.) *Environmental engineering soil investigation, TGA Area Norrbotten Region, final report.* p.13

Fig. 26 *Soil analysis outcome. Based on the Environmental engineering soil investigation.*

Property

The division of the site into two parts is due to its ownership being split between Kiruna Kommun and LKAB. As a result, one of the towers (M tower) belongs to Kiruna Kommun , while the other (C tower) is owned by LKAB.

Ground analysis

At the request of Kiruna Kommun, soil samples were taken for laboratory analysis. The results showed the presence of wood, brick, gravel, silty, rocky and gravelly sand on the site. In the collected soil samples, elements such as cobalt, copper, chromium and zinc were found, in some areas exceeding the KM2 coefficient established by The Swedish Environmental Protection Agency's general guidelines for sensitive land use. This indicates the need for soil remediation before it can be designated for public use (Tyréns Sweden AB, 2024).

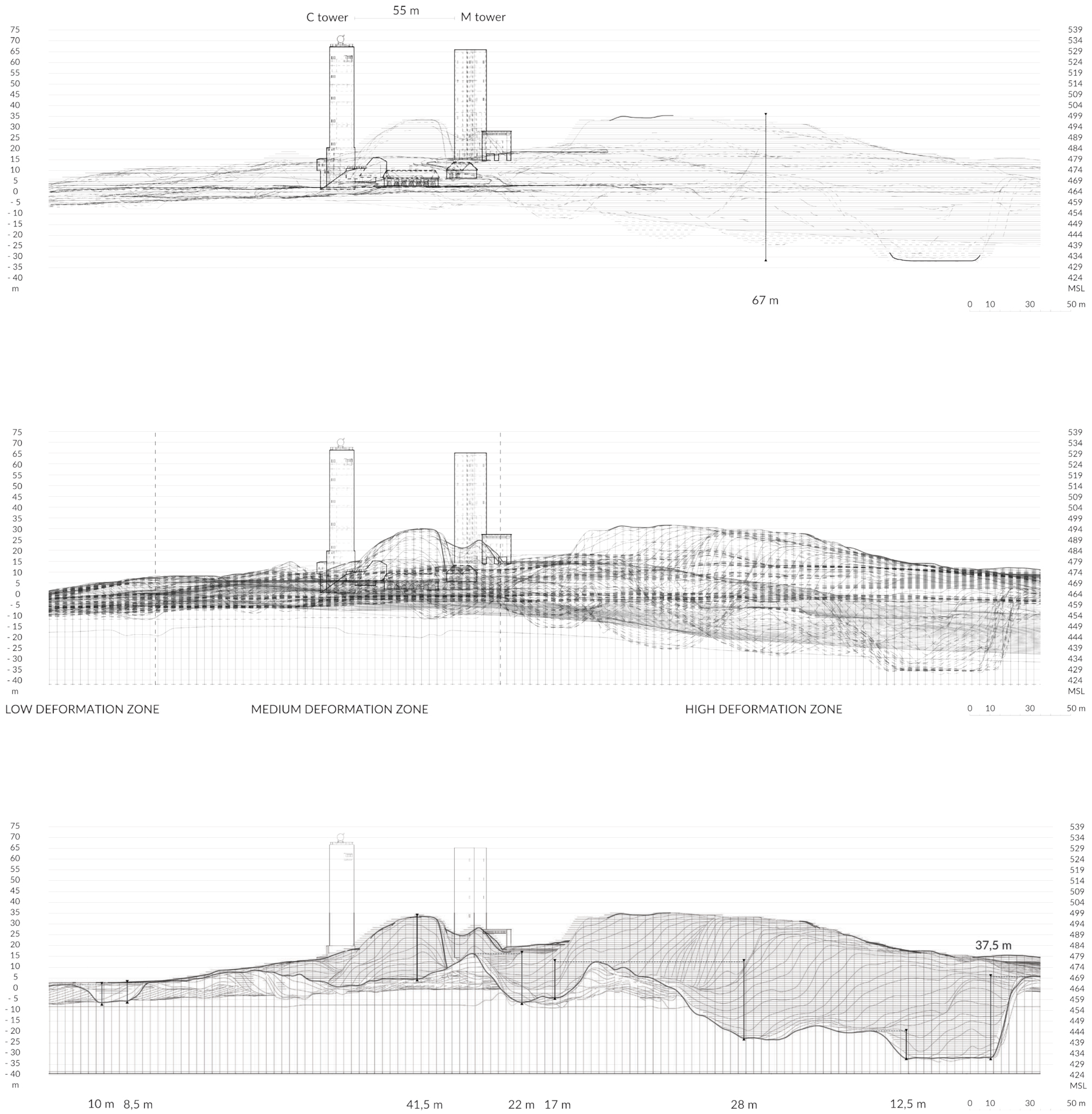


Fig. 27 *Tuolluvaara mine section.*

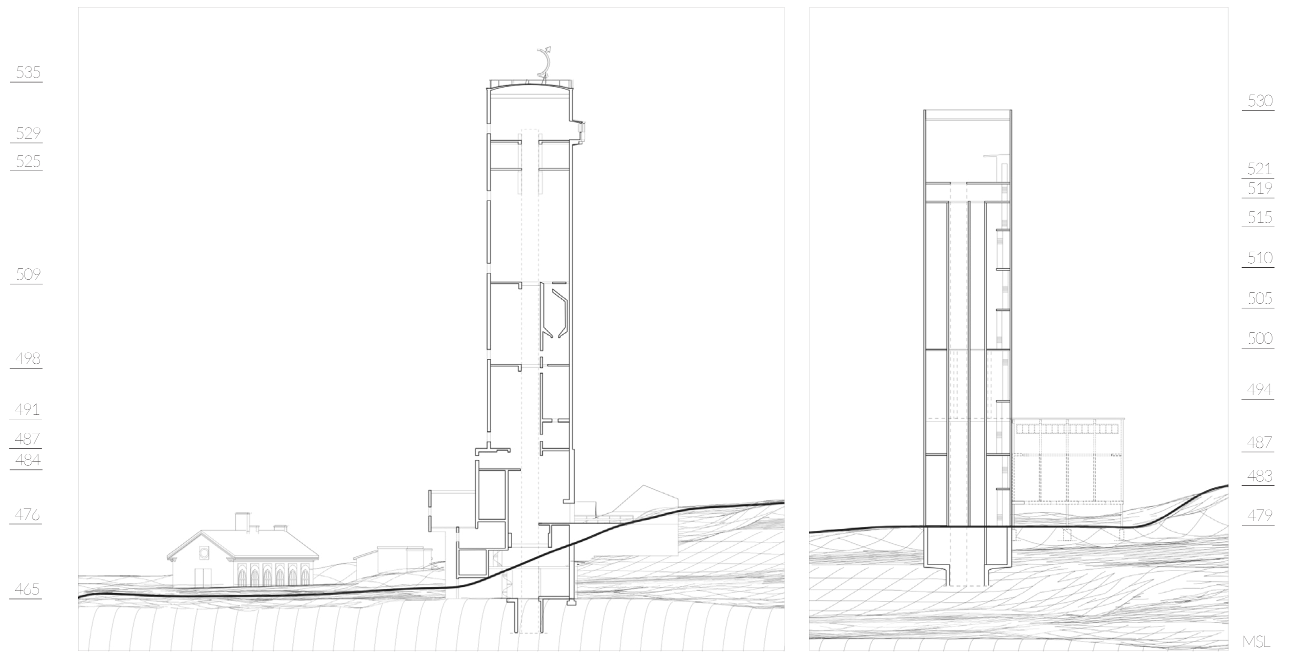


Fig. 28 *Tower's section.*

Section

A cross-section of the mine's terrain reveals numerous changes in elevation and slope. In the extraction area, the difference between the highest and lowest points reaches 67 meters. The towers reach a height of 72 and 65 meters, with a straight- line distance of 55 meters between them. The terrain is dominated by a mountain birch forest, along with pine and spruce. Elevation differences between building levels range from 5 to 15 meters.

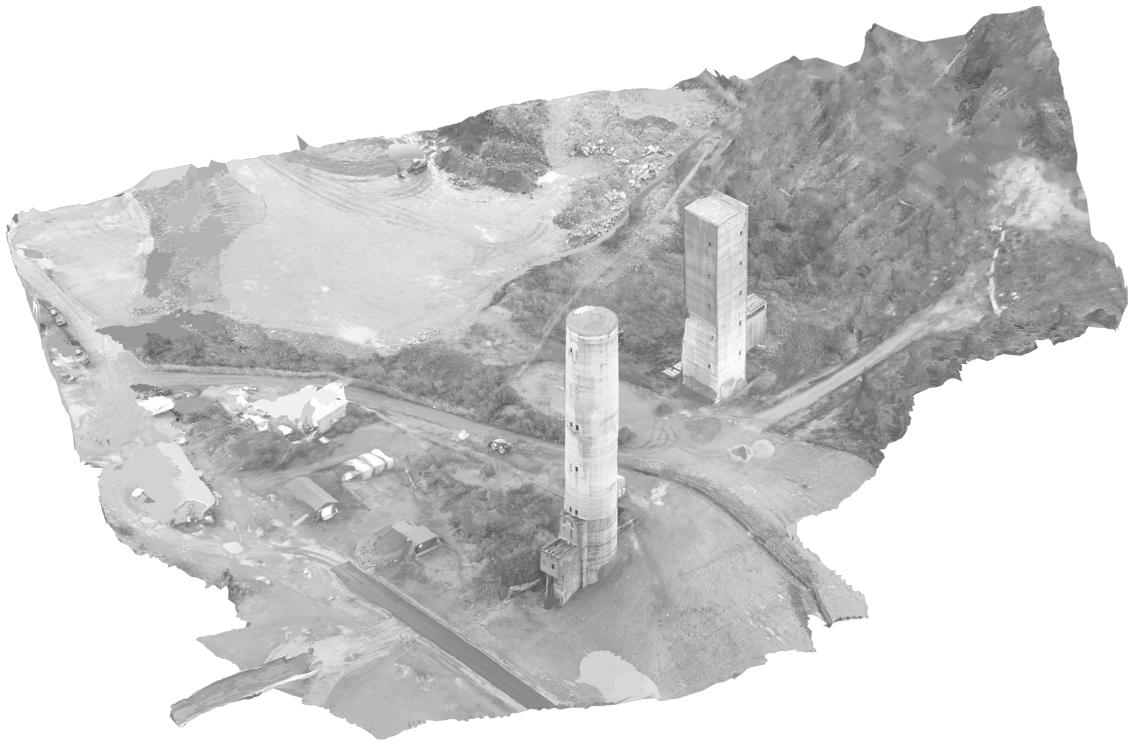


Fig. 29 *Tuolluvaara mine photogrammetry.*

Site's condition

The method used for analysis and familiarization with the elements of the site is photogrammetry based on the PDF Zephyr software, created on the basis of video footage recorded by a drone. The video footage was provided by LKAB. The analysis confirmed multiple land level differences on the site, as well as the visual condition of the buildings, type of materials from which they were elevated, the placement of fences, access roads and vegetation. The video recorded by a drone was made in 2024.

Fig. 30 *Two towers together (LKAB, 2024).*

Fig. 31 *C tower - back view (LKAB, 2024).*

Fig. 33 *M tower - front view (LKAB, 2024).*

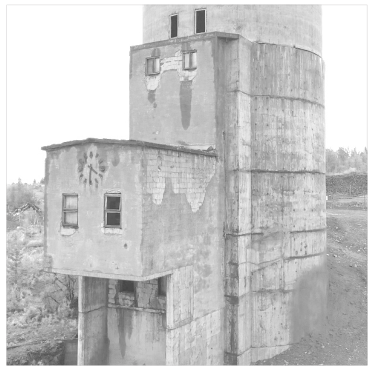


Fig. 32 *C tower - front view (LKAB, 2024).*

Fig. 34 *M tower - side view (LKAB, 2024).*

Tower's condition

The photographs and video provided by LKAB show actual condition of the structures in 2024. The passage of time and neglect of the towers are visible through water strains, corrosion and decay of the wooden elements. Many structural components are missing, including windowpanes, frames and ceiling boards while entrances and some windows have been sealed off.

The author of this project did not receive permission to enter the mine site nor the buildings, as access is prohibited. For this reason, the analysis is based on photographic material and documentation provided by Kiruna Kommun and LKAB.

Fig. 35 *Examples of damage present on the tower's facade (LKAB, 2024).*

Exterior

All visible changes in the photographs require a diverse approach in transformation. Water stains and damage signs should be repaired but they also serve as important traces of the past. The project aims to restore the damage to a level that ensures usability and future protection of the structures, while preserving their unique character rather than erasing it.

M tower C tower

Fig. 36 *Photographs of the tower's interiors (LKAB, n.d.).*

Interior

The interiors of the towers remain in their raw state, preserving structural elements such as steel staircases, trusses and machinery components. However, the interiors lack sufficient lightning.

A significant challenge arises from the varying floor heights and the infrastructure's incompatibility with public use regulations and legal standards. Regarding the interiors, the same approach as the external elements is applied - bringing them to a functional state while maintaining their unique historical character.

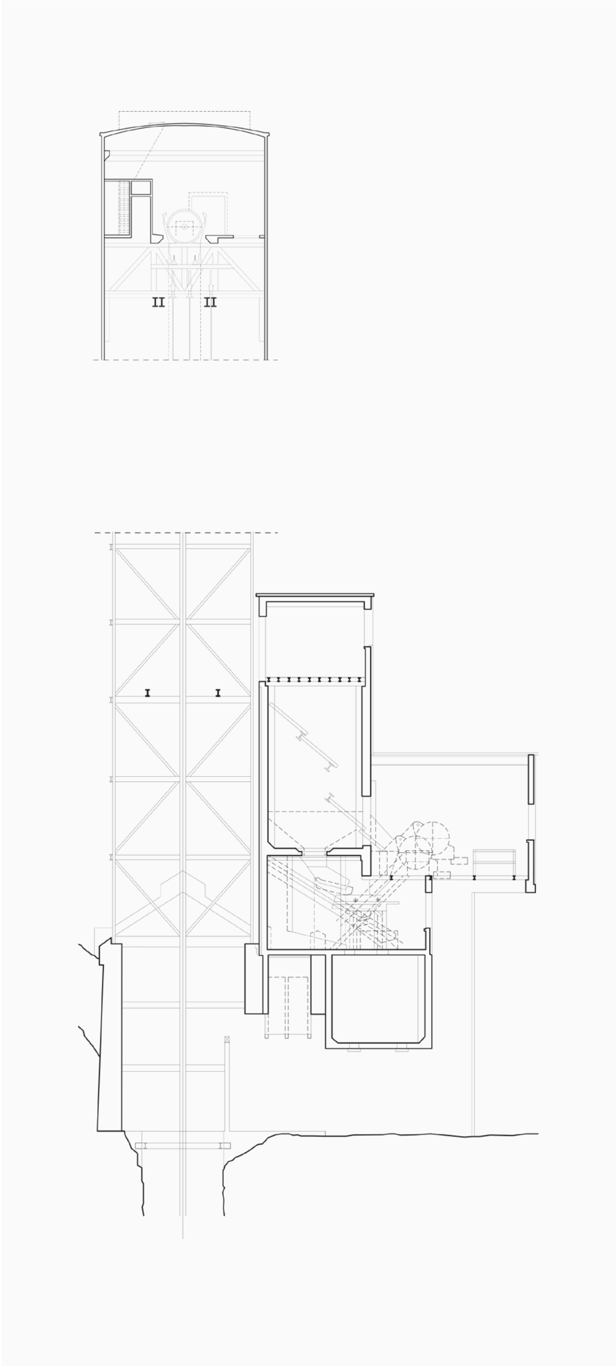


Fig. 37 *Machinery inside the C tower.*

Machinery

The hoist tower (headframe) was constructed as a supportive structure for machinery which consisted of cable sheaves and a resource bin (Niederhagemann, 2009, p. 1). This system was introduced to extract resources from the mining shaft and discharge them into the bin from where they could be further transported. The drawing depicts the machinery system inside the C tower.

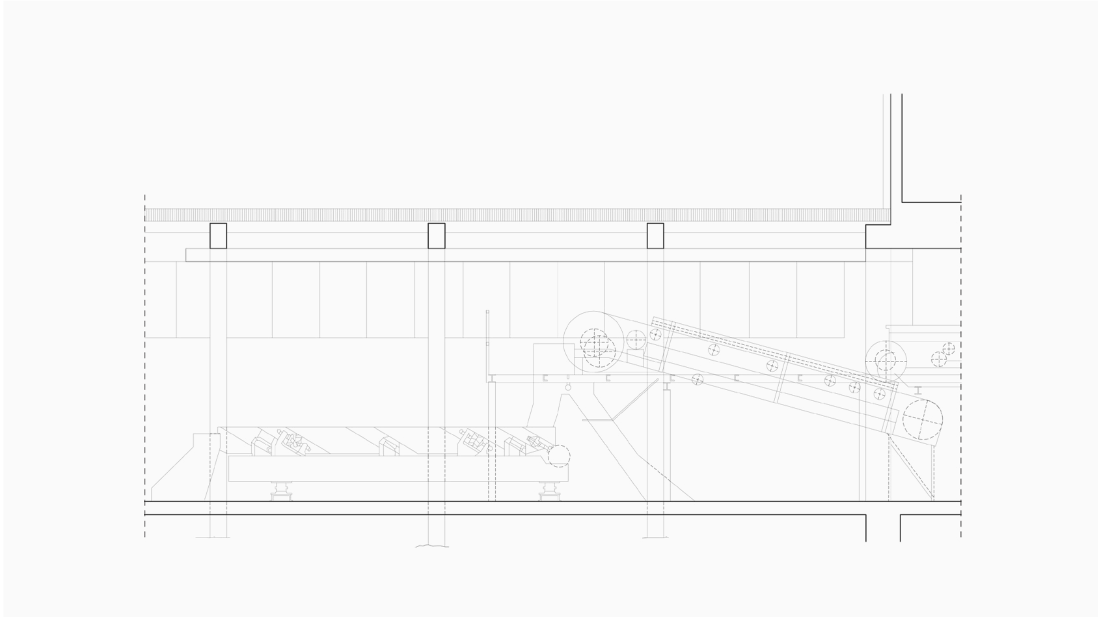


Fig. 38 *Machinery inside the M tower.*

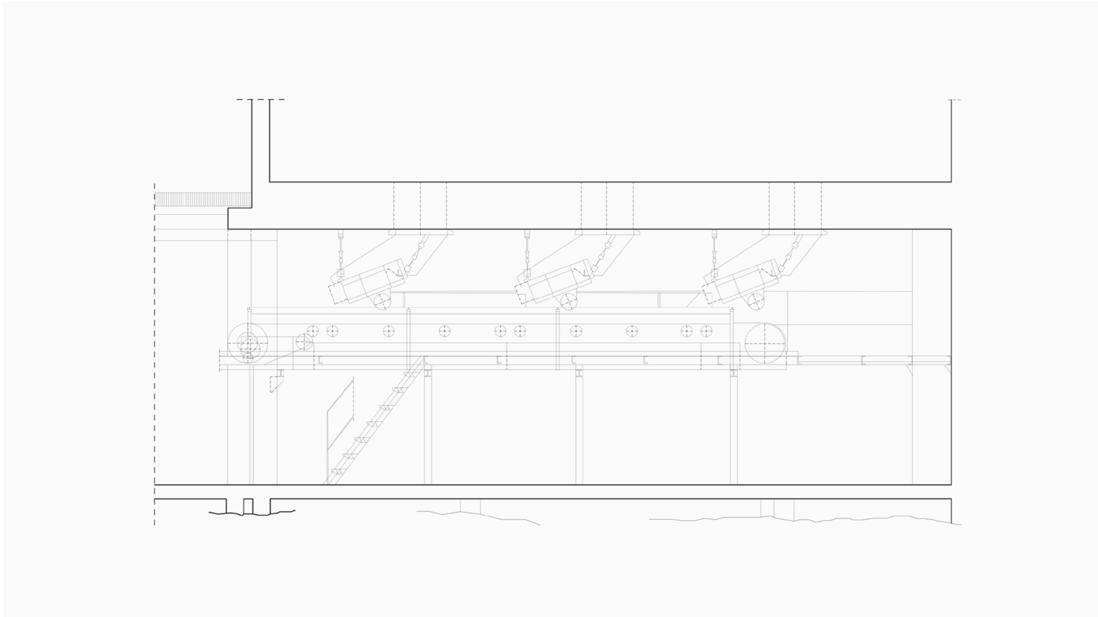


Fig. 39 *Machinery inside M tower - continuation.*

Unlike the C tower, the M tower was previously used for transporting people instead of resources (LKAB, 2025). It is unknown if all machinery elements are still present inside the towers.

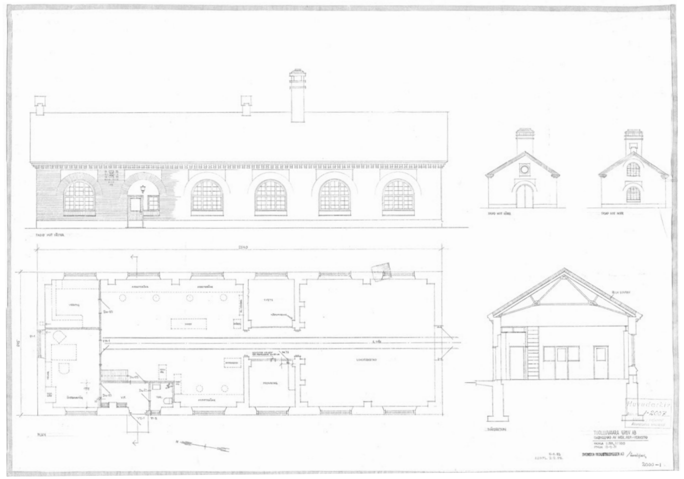


Fig. 40 *Bigger brick building plan, section and elevation (Huvudarkiv, 2007).*

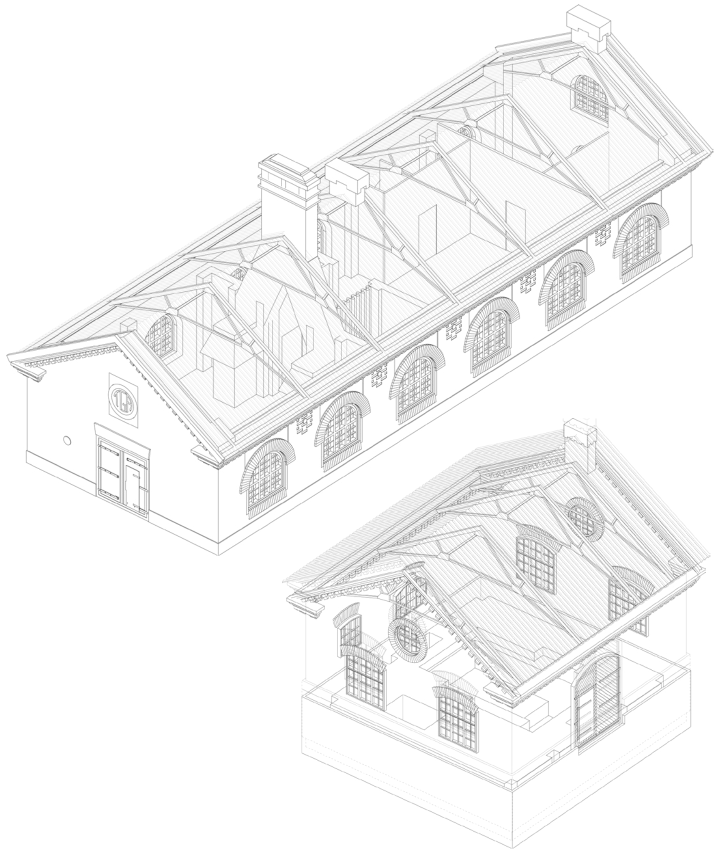


Fig. 41 *Brick building's axonometry.*

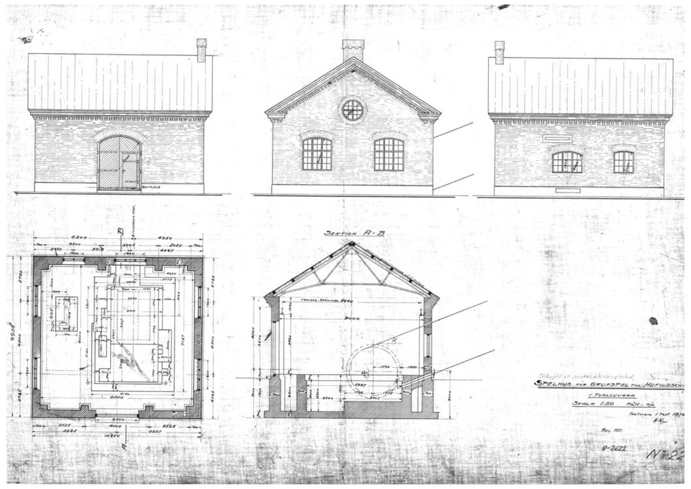


Fig. 42 *Second brick building plan, section and elevations (Huvudarkiv, n.d.)*

Fig. 43 *Site analysis.*

Brick buildings

Apart from the mining towers, the plot also contains two brick buildings. According to documentation from 1974 to 1982 (Demolition documentation of buildings in the TGA area / Kiruna / 2019.9), one of them (bigger one) was likely a railway electrical facility or a former mechanical workshop, while the other was identified as a storage building or an Old Game House.
These structures are among the oldest buildings on the site. While the thesis focuses more on the transformation of the mining towers, brick buildings have been included in the project due to their historical significance.
Both buildings remain well preserved to this day.

Site analysis

The plot is located northeast of the new city center. Its direct connection to the city center is a bridge over the highway. Another route leading to the plot is a dirt road running toward the suburbs. In the northeast part of the plot, there is a road leading to the extraction site, with a forest growing along it. The analysis highlights the directions of windows openings in the buildings, as well as two types of terrain and vegetation zones.

Design phases

The transformation of the site begins with the first phase, where vegetation and existing debris are removed to prepare for remediation activities. Ground leveling is conducted by moving soil within the site to create plateaus and fill uneven spaces. The soil movement is managed so that excavated soil from one part of the site is used to fill other areas, eliminating the need for hauling soil away. The roads are designated along with landscape pocket areas. The pedestrian bridge is elevated and necessary openings in the tower envelopes are made to integrate the bridge path and close the boundary loop, separating the project site from the surrounding wasteland. The bridge allows people to access the site without disturbing the transformation process, making them part of it from the beginning. The parts of the buildings interacting with the pedestrian bridge are secured to ensure safe passage. By the end of this phase, the pedestrian bridge is ready for use - made out of reused, wooden railway sleepers and compacted gravel from the site.

During this phase, a connected pond system, including five ponds, is created by excavating parts of the terrain to a depth of 300 mm. The wetlands are created by filling the ponds with water and planting selected vegetation for the remediation process. The phytoremediation stage begins. At the same time the main axis is elevated, created from reused, concrete railroad sleepers. Simultaneously, the building transformation starts, including the creation of technical infrastructure elements such as stairs and elevators inside the towers. Existing slab openings are patched with steel grid elements, selected walls are removed and facade openings are created to enhance light penetration. The load-bearing structure of the tower elements is reinforced, and the most damaged parts of the towers' facade are cleaned and plastered. Finishing touches are added to the landscape communication routes, and additional vegetation is planted. The pedestrian bridge remains intact during this phase.

During the third and final phase, finishing touches are added to the building interiors and connections to utilities such as water, electricity, and sewage are created. The pedestrian bridge stays intact, leaving a site boundary trace and allowing focus on other site routes and connections. The phytoremediation process continues for several decades until completion, ensuring that the landscape remains green and vibrant. The third phase never ends and because of its character provides continuity to the project's whole idea.

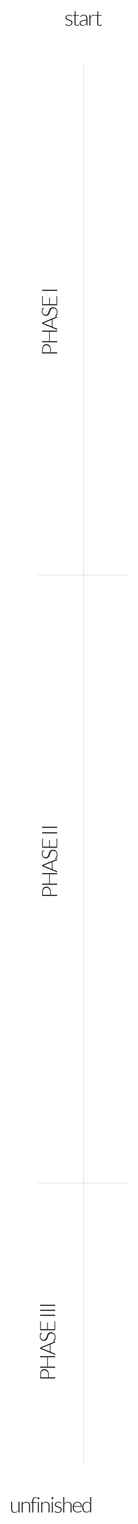


Fig. 44 *Phasing timeline.*

Design phases

Phytoremediation selected species
Characteristics | benefits

Carex pseudocyperus (Cyperus Sedge) :
Owns a robust root system and ability to tolerate heavy metals, reducing concentrations of heavy metals like cadmium, copper, lead and zinc.

Carex riparia (Greater Pond Sedge) :
Thrives in wet conditions and has a high biomass.

Phalaris arundinacea (Reed Canary Grass):
Adaptable to wetland conditions and cold climates, Excellent for removing chloride and heavy metals from soil and water.

Glyceria maxima (Reed Sweet Grass):
Prefers wet environments and has a high transpiration rate, Effective in chloride removal and improving water quality.

Phragmites australis (Common Reed):
A robust plant that can thrive in wetlands, Good for filtering pollutants and enhancing water quality.

Salix arctica (Arctic Willow):
Not for wetland conditions, Specifically adapted to Arctic conditions, useful for stabilizing soil and absorbing heavy metals.

Native plant species for the area

Deschampsia cespitosa (Tufted Hairgrass):
Highly adaptable to wet conditions, remove heavy metals.

Calamagrostis purpurea (Purple Reed Grass):
Adaptable to wetland conditions and grow in nutrient - poor conditions, removes heavy metals.

Filipendula ulmaria (Meadowsweet):
Thrives in wetlands, high biomass, remove heavy metals and improve soil quality.

Rubus idaeus (Raspberry):
Owns a robust root system and ability to grow in various soil types, stabilizes soil and absorbing contaminants.

Angelica archangelica (Garden Angelica) :
Grows well in wet conditions, high biomass, absorbes heavy metals and improves soil quality.

Downy Birch (Betula pubescens) :
Well-suited to cold climates and can tolerate poor soil conditions, Effective in stabilizing soil and absorbing heavy metals.

Norway Spruce (Picea abies):
Can withstand cold temperatures and is important in the local ecosystem, Effective in absorbing heavy metals and stabilizing soil.

Scots Pine (Pinus sylvestris):
More suitable than Picea abies (Maddah, Moraghebi, 2013), highly adaptable to the cold, nutrient-poor soils, effective in absorbing heavy metals and stabilizing contaminated soils, extensive root system preventing erosion, supports the growth of the ecosystem.

Research based on Swedish Plant Geography : dedicated to Eddy van der Maarel on his 65th birthday (Rydin et al., 1999).

Fig. 45 *Current state of the plot - plan drawing.*

Current state of the plot

In its current state, the plot is not suitable for sensitive land use. It is a wasteland with post-mining structures, which are of two brick buildings and two mining towers. The plot is fenced off from public and city use.

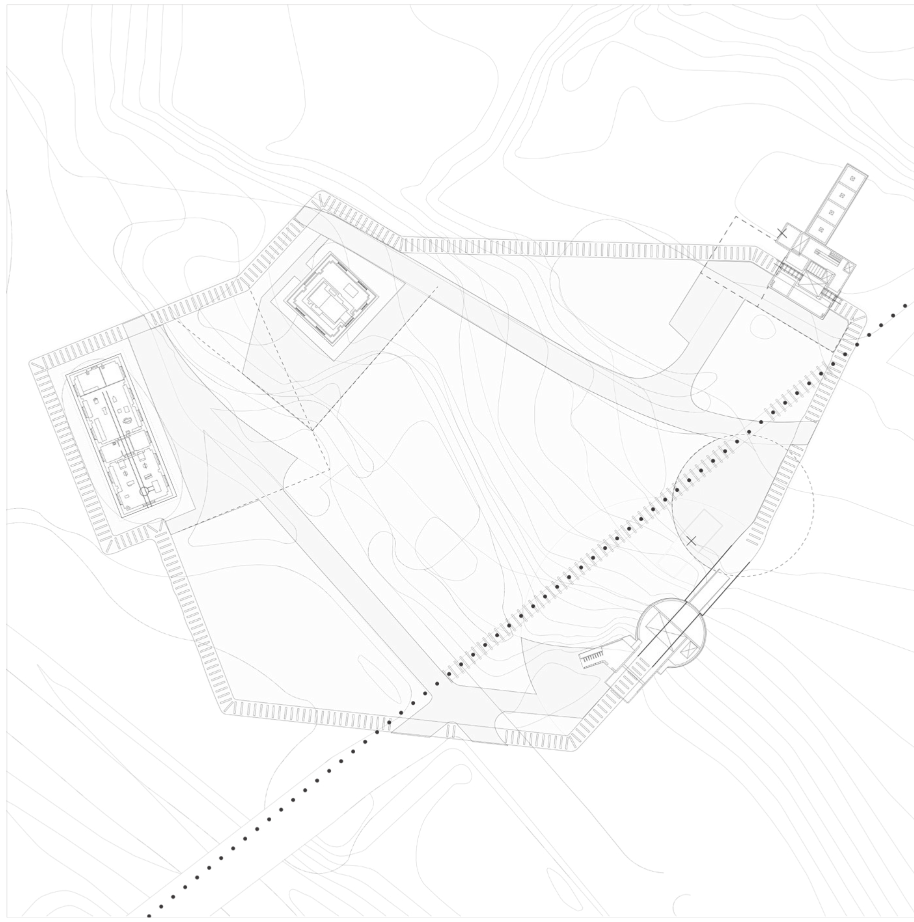


Fig. 46 *Phase I - plan drawing.*

Phase I

In the first phase, the boundary, marking the project area, is created in the form of an elevated pedestrian bridge. The bridge is made out of reused wooden railroad sleepers and elevated 10 cm above the ground level. In between the wooden elements, gravel is placed, crushed from rocks found on the site and pressed to form a flat surface. The main axis is designated and the common spaces between the buildings are made based on the offset of existing buildings' elevations. For the M tower, the common area on its left side is crated on the basis of the outline of previously existing structure in this place. The plan of the structure is visible in the M tower's documentation but it is not confirmed if this structure was demolished or never built. The ground floors of both towers are secured to enable the safe passage through them by pedestrian bridge and necessary opening in the tower's ground floor are made

Design phases

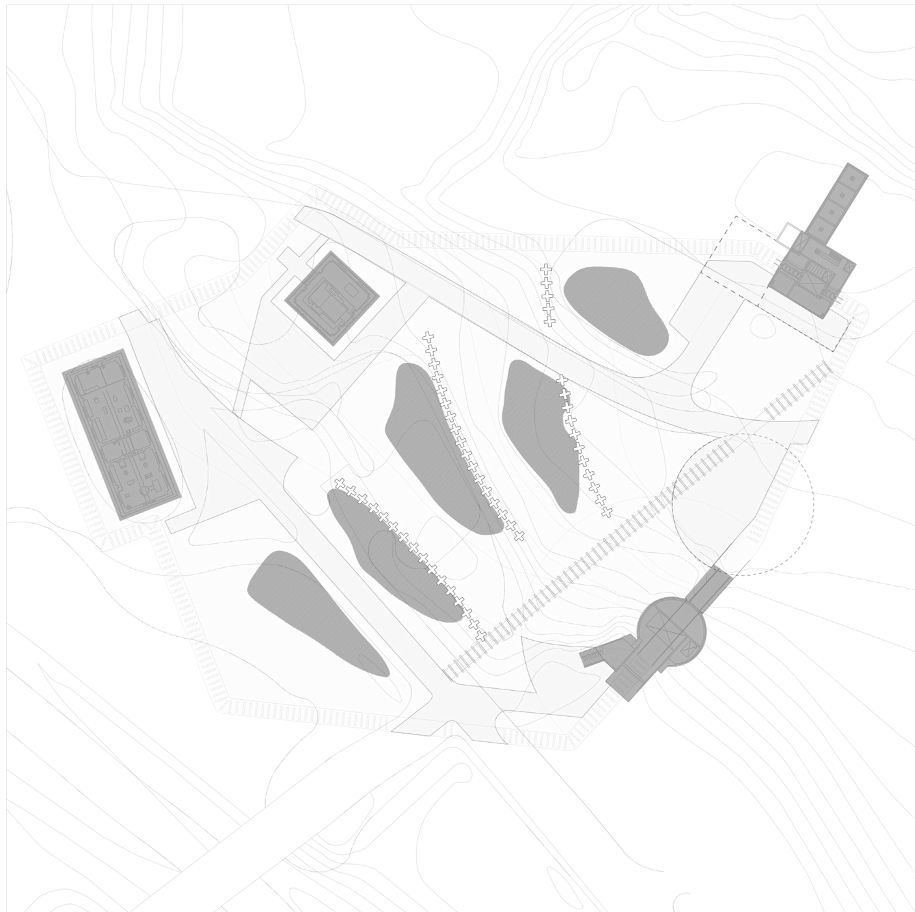


Fig. 47 *Phase II - plan drawing.*

Fig. 48 *Phase III - plan drawing.*

Phase II

The pond system is created with five wetlands and filled water, additionally the vegetation is planted. The main axis is elevated using reused concrete railroad sleepers. The buildings' transformation begins by incorporating stairs, elevators and technical infrastructure. Structural openings in slabs are patched with steel grids, selected walls are removed and new facade openings are made to improve light penetration. The tower's load bearing structure is reinforced, damaged facade sections cleaned and plastered and landscape routes completed. The pedestrian bridge remains unchanged.

Phase III

In the final phase, interiors are completed and utilities connected. The pedestrian bridge remains, marking the site boundary. Phytoremediation continues for decades, keeping the landscape green. Vehicle roads which are present on the site finish their tracks within the boundary, giving possibility for their future connection with the bridge to city center and other roads existing nearby. This ongoing phase allows for future adjustments and potential housing or service development. The drawing of the final phase visualize a possible location of the future development around which are not the part of the thesis' project. This implication shows the area usage of the project for future development as a complementary area.

PROPOSED CHANGES

EXISTING PLAN

Fig. 49 *Phase III - plan drawing.*

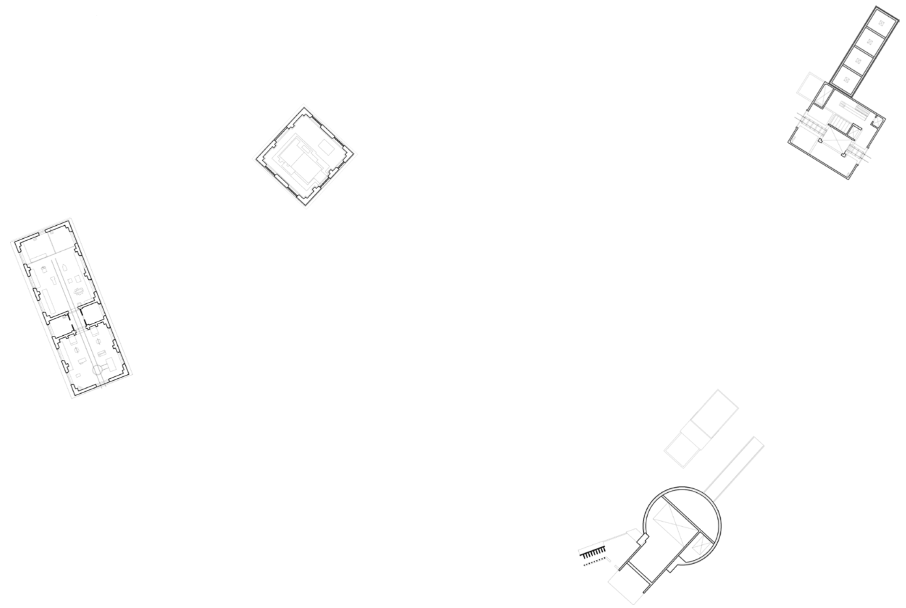


Fig. 50 *Collection of buildings' plans - before changes.*

All proposed changes are visible on the plan drawing marked with thicker line weight. The changes include:

-pedestrian bridge marking the boundary of the project
-walking path following the main axis showcasing the property of site's division
-wetland ponds with cross retaining walls
-changes in the course of vehicle roads
-technical spaces near the buildings
-introduction of new elements inside the building's interiors

There are many changes proposed to the building's interiors in order to reinvent them for public use without losing the sense of their heritage significance. The elements introduced are chosen in order to ensure needed public infrastructure but in a way that is not disturbing to the present tectonics.

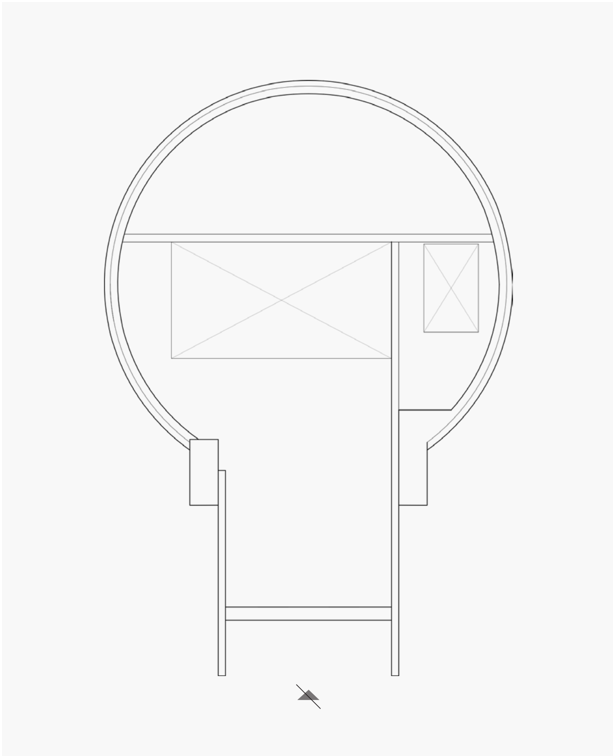
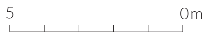


Fig. 51 *C tower plan, ground level before changes.*



Interventions

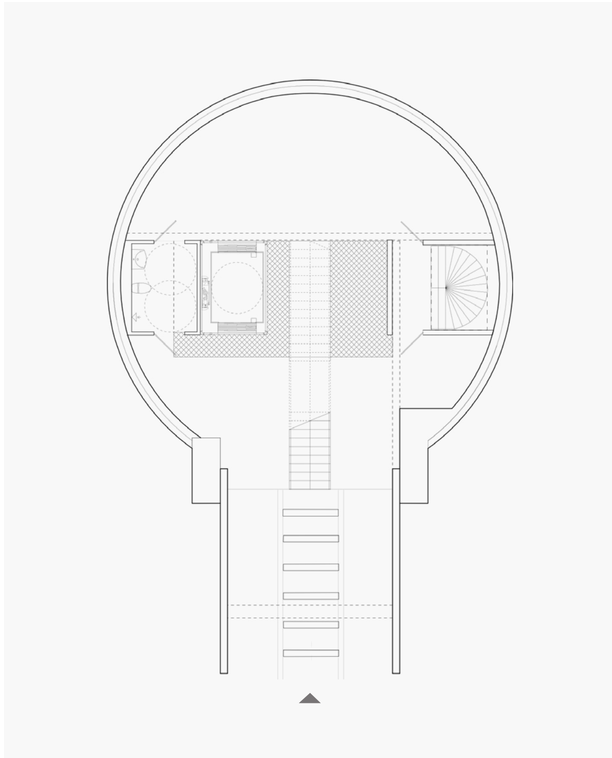
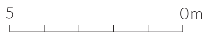


Fig. 52 *C tower plan, ground level after changes.*



C tower | internal changes

The first change that is proposed inside the tower is construction of the path, seamlessly connecting its interior with the landscape. The path consists of pedestrian bridge which attaches to the designed staircase, creating straight, axial connection. A few elevation's sealed entrances are opened to provide connection. Another addition to the plan is introduction of restrooms and vertical transportation including stairs and elevators. Some parts of the tower are thermally isolated and visible perforations in the slab covered with platform gratings. The windows are enlarged in order to provide better light penetration and additional structural elements are provided to improve load - bearing capacity. Many partition walls are removed to free up the plan.

The placement of the restrooms, elevators and staircases is dictated by the layout of the tower. Elevators and staircases fit into existing slab perforations in order to prevent from creating additional ones. All these elements are placed in a horizontal layout, creating an interior plan that can be easily separated into parts for a multi-functional space division, accessible from both sides of this technical stripe. The free space that the placement of the elements creates in the middle of the plan provides better light penetration from window openings, but also from upper floors thanks to the platform grating's translucent structure. All changes are made in a way that leaves the trace of the building's past, visible in remnants of the partition walls on the floor or visible slab perforations.

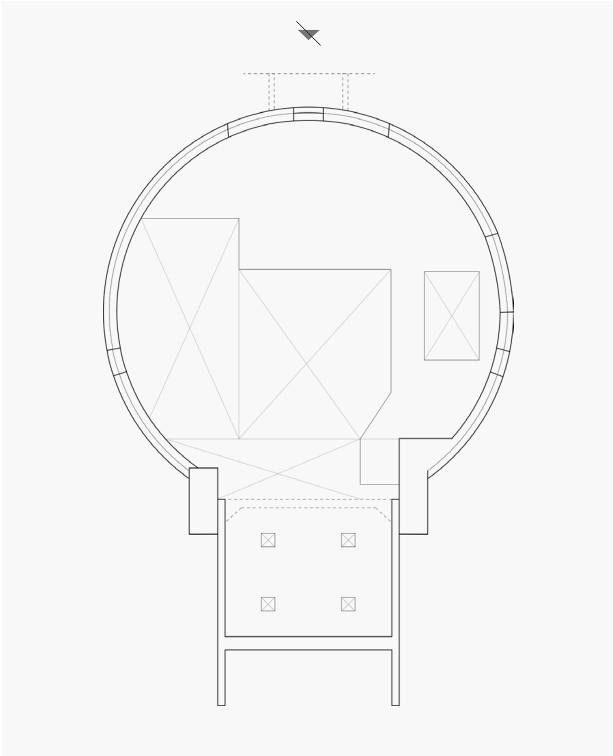


Fig. 53 *C tower plan, level +476 before changes.*

5 0m

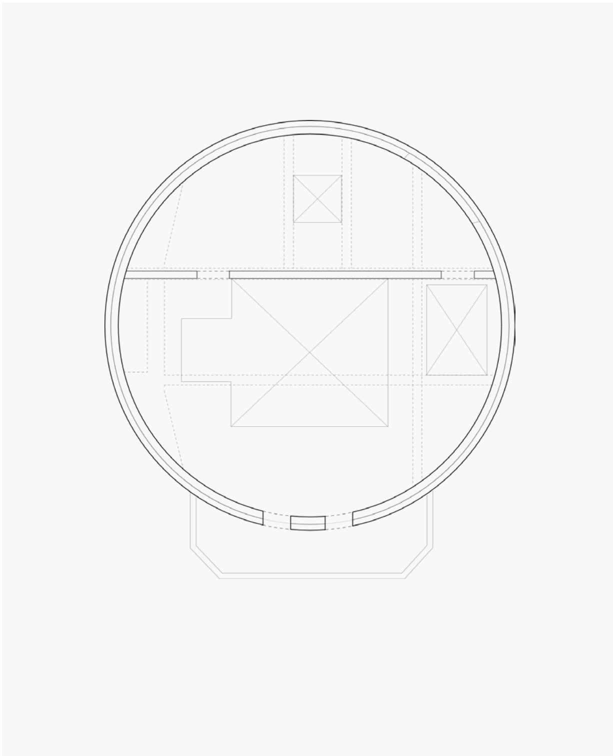


Fig. 54 *C tower plan, level +487 before changes.*

5 0m

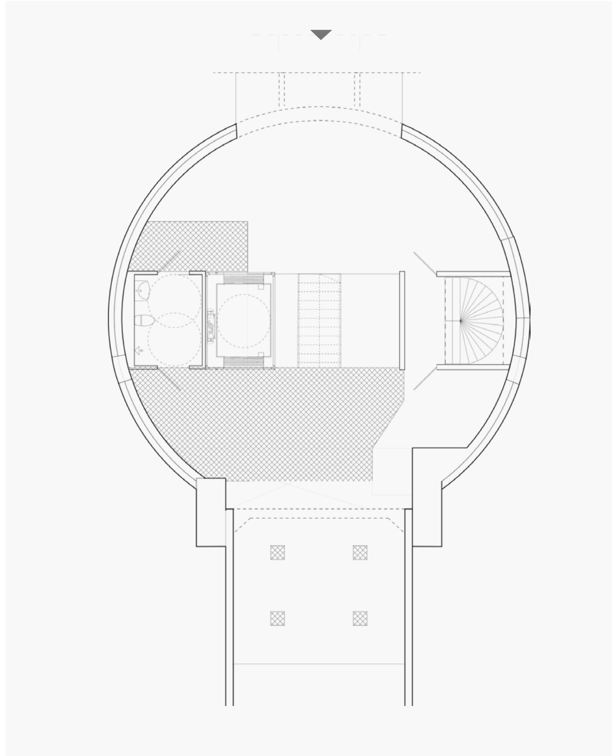


Fig. 55 *C tower plan, level +476 after changes.*

5 0m

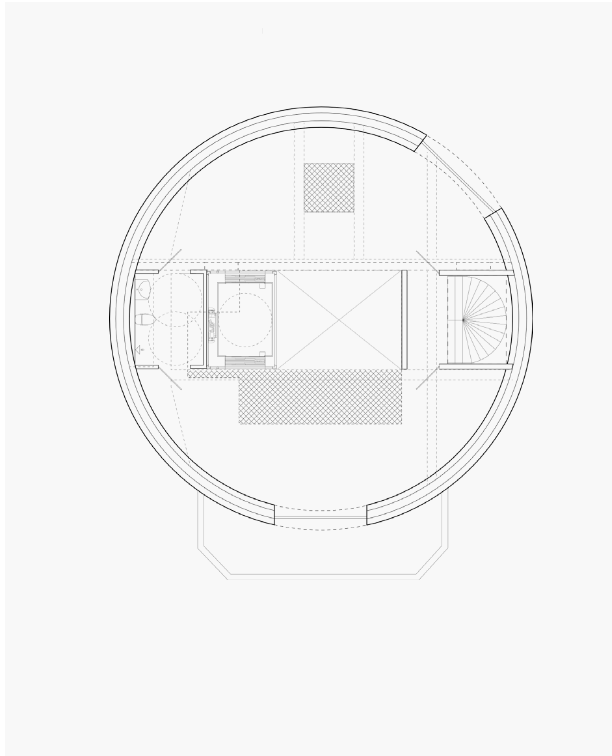


Fig. 56 *C tower plan, level +487 after changes.*

5 0m

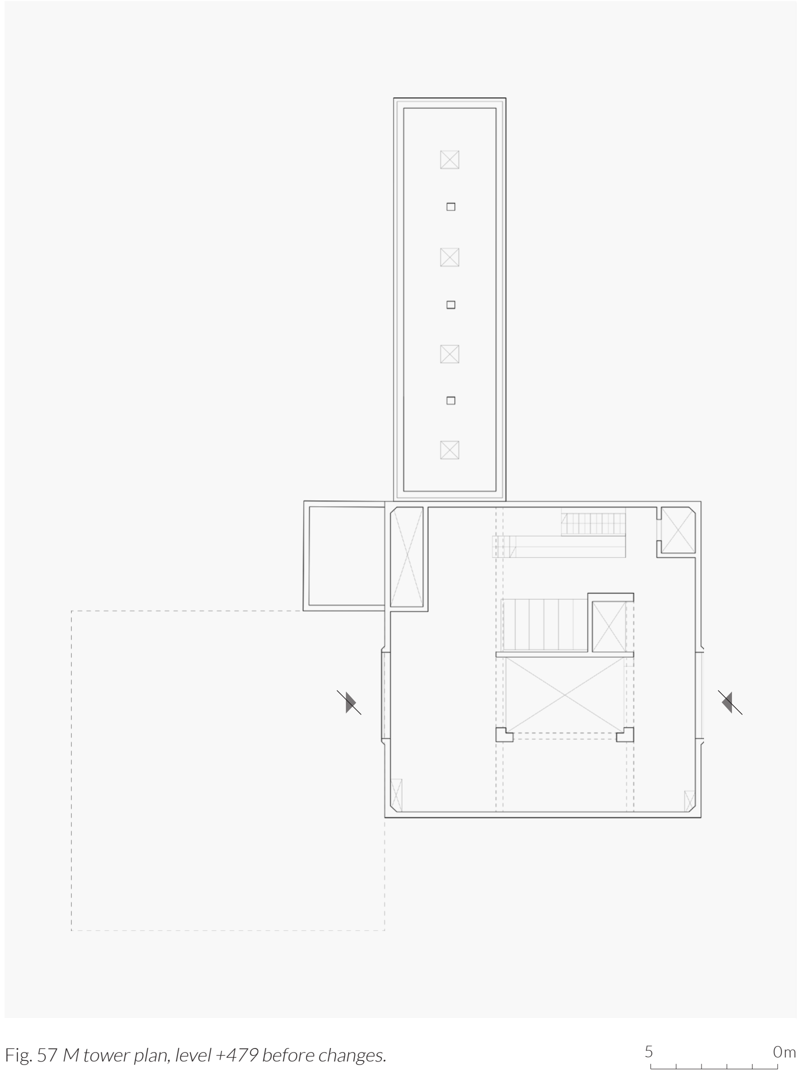


Fig. 57 *M tower plan, level +479 before changes.*

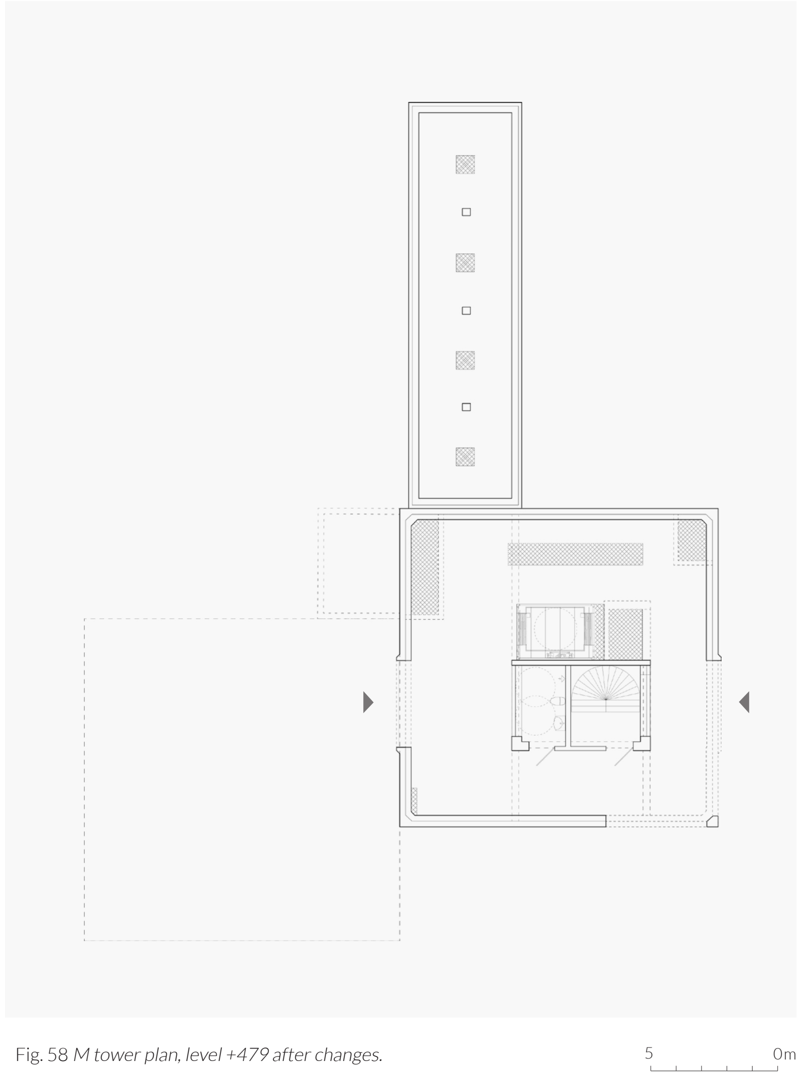


Fig. 58 *M tower plan, level +479 after changes.*

M tower | internal changes.

In the M tower, similar changes are made following the example of the C tower. Because the M tower layout is different when it comes to shape and structural elements' placement, a slightly different approach is used. Instead of a horizontal technical zone, a central core is created implementing all needed elements-restrooms, elevator and staircase. This decision was dictated mainly by the slab perforation placement and overall plan layout, together with fulfilling standard and technical requirements.

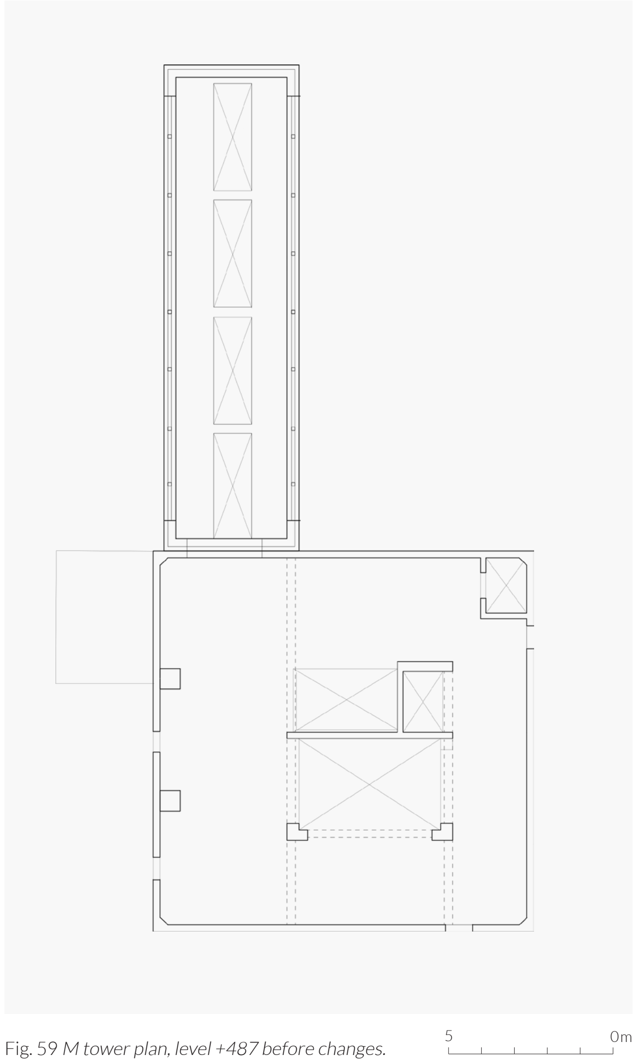


Fig. 59 *M tower plan, level +487 before changes.*

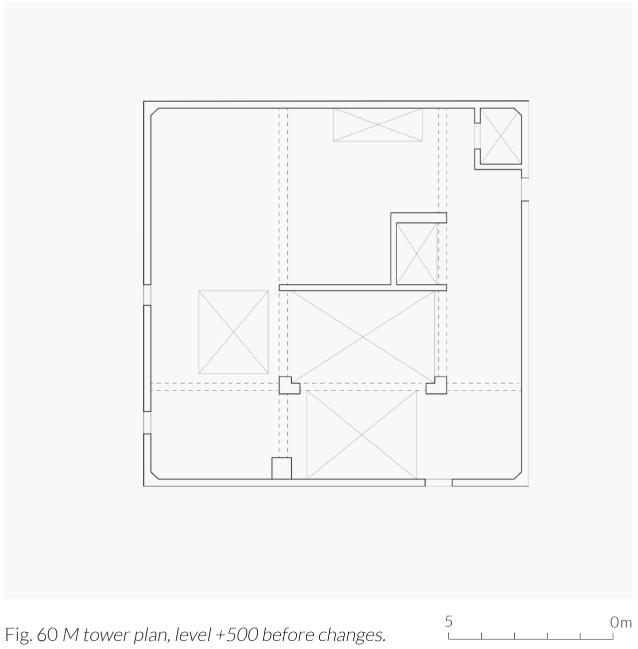


Fig. 60 *M tower plan, level +500 before changes.*

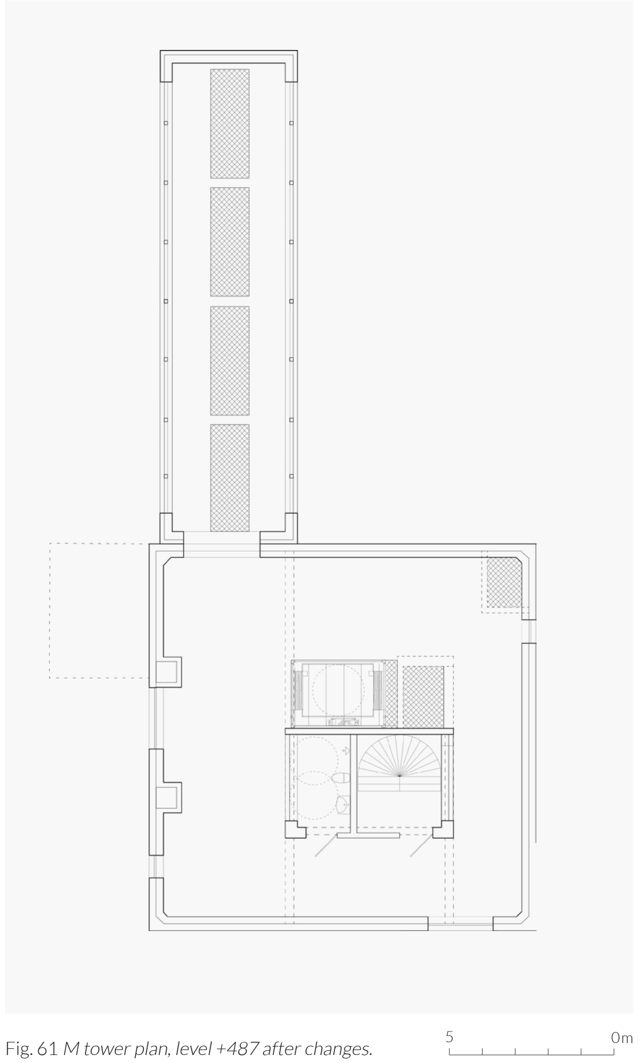


Fig. 61 *M tower plan, level +487 after changes.*

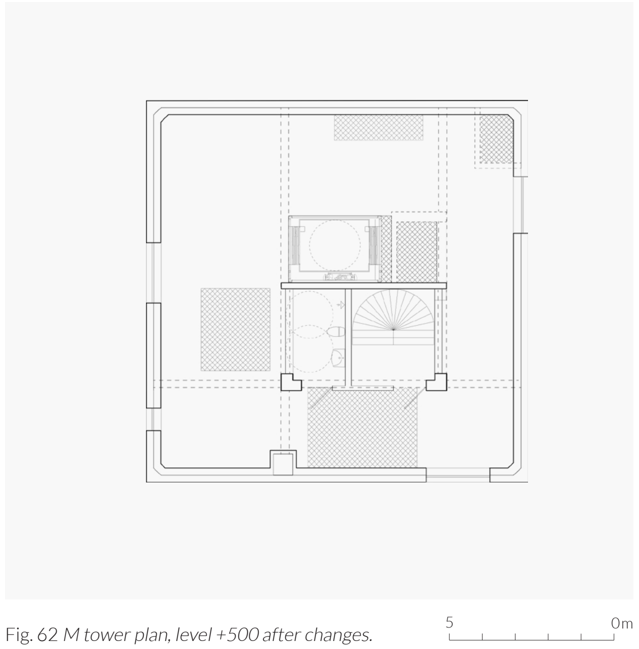


Fig. 62 *M tower plan, level +500 after changes.*

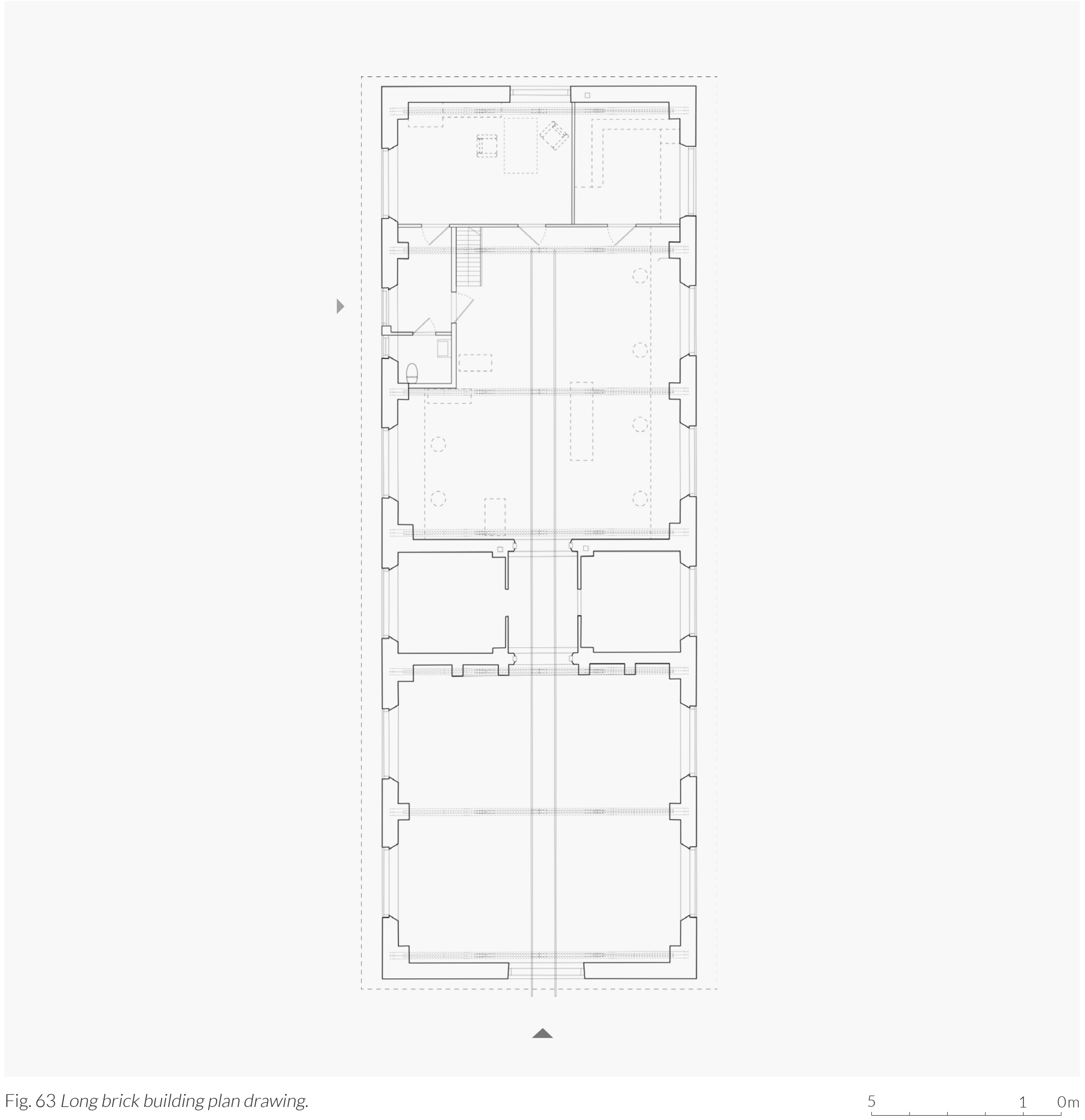


Fig. 63 *Long brick building plan drawing.*

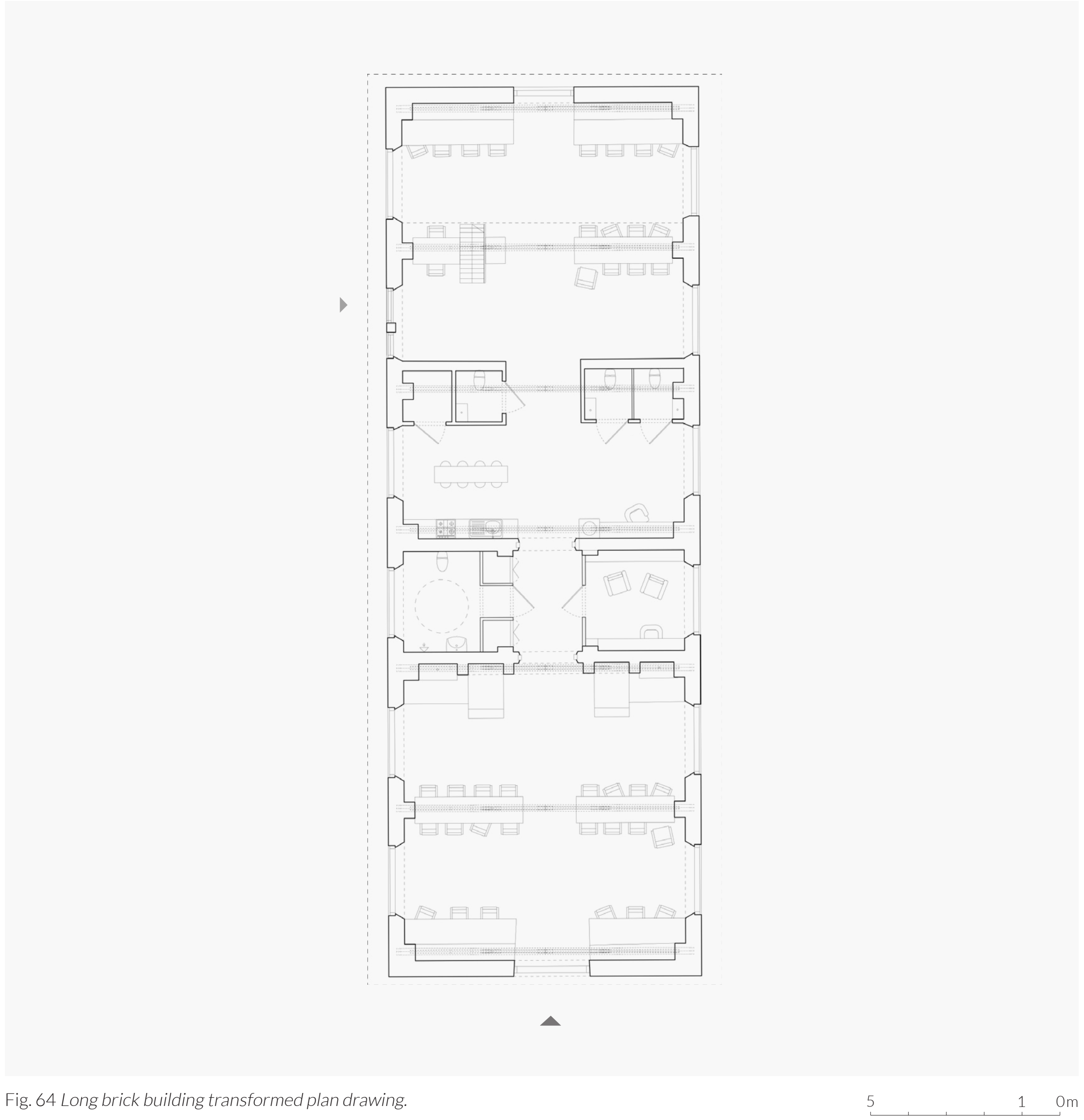


Fig. 64 *Long brick building transformed plan drawing.*

Brick building I - old workshop

Interventions inside the brick building include separation of the building's interior into three parts. On the two sides of the building, workshop spaces are created together with an introduction of old furnaces in the middle. Additionally, the administration room is implemented in the center together with four bathrooms and a small kitchenette.

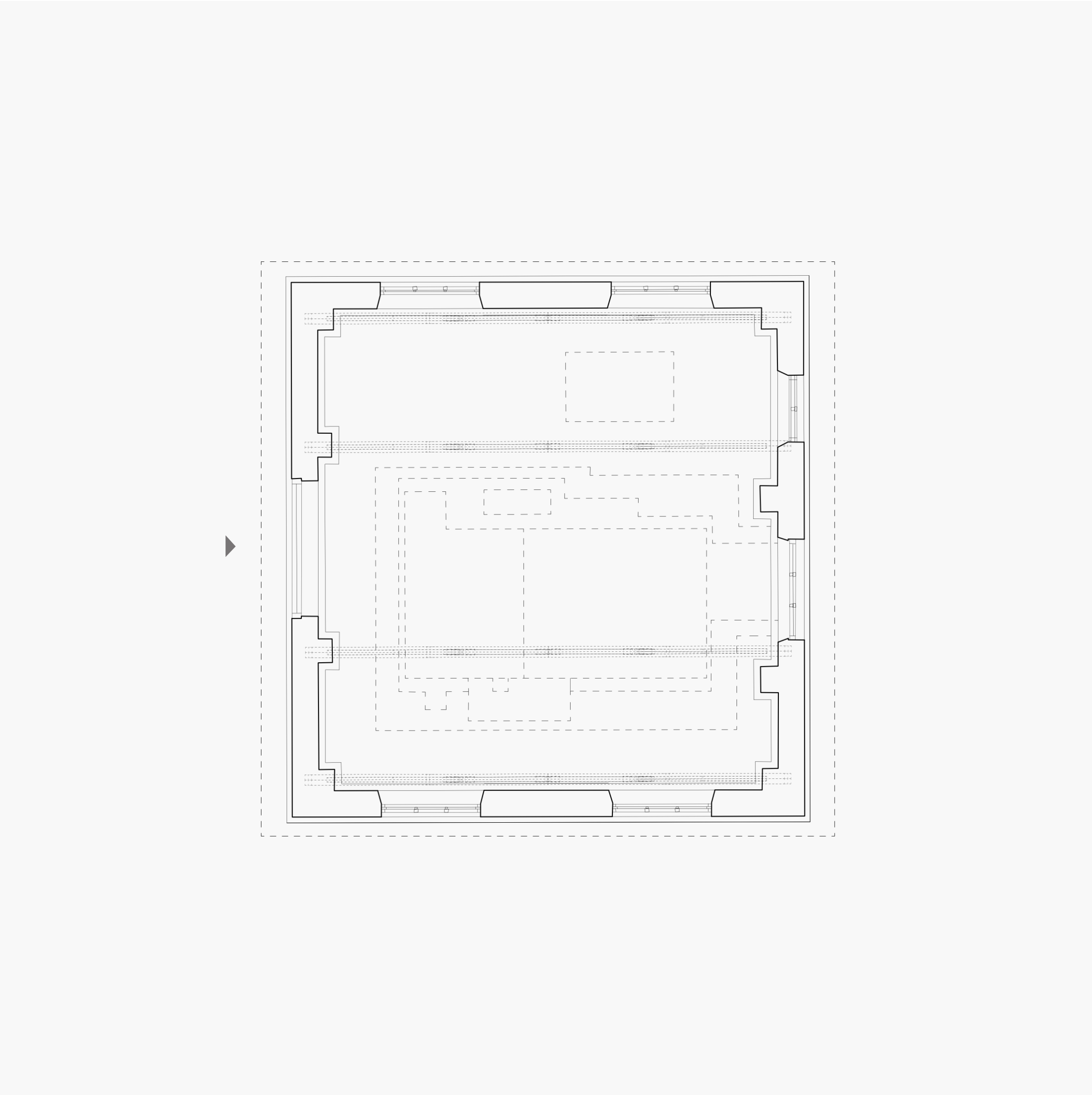


Fig. 65 *Square brick building plan drawing.*

5 1 0m

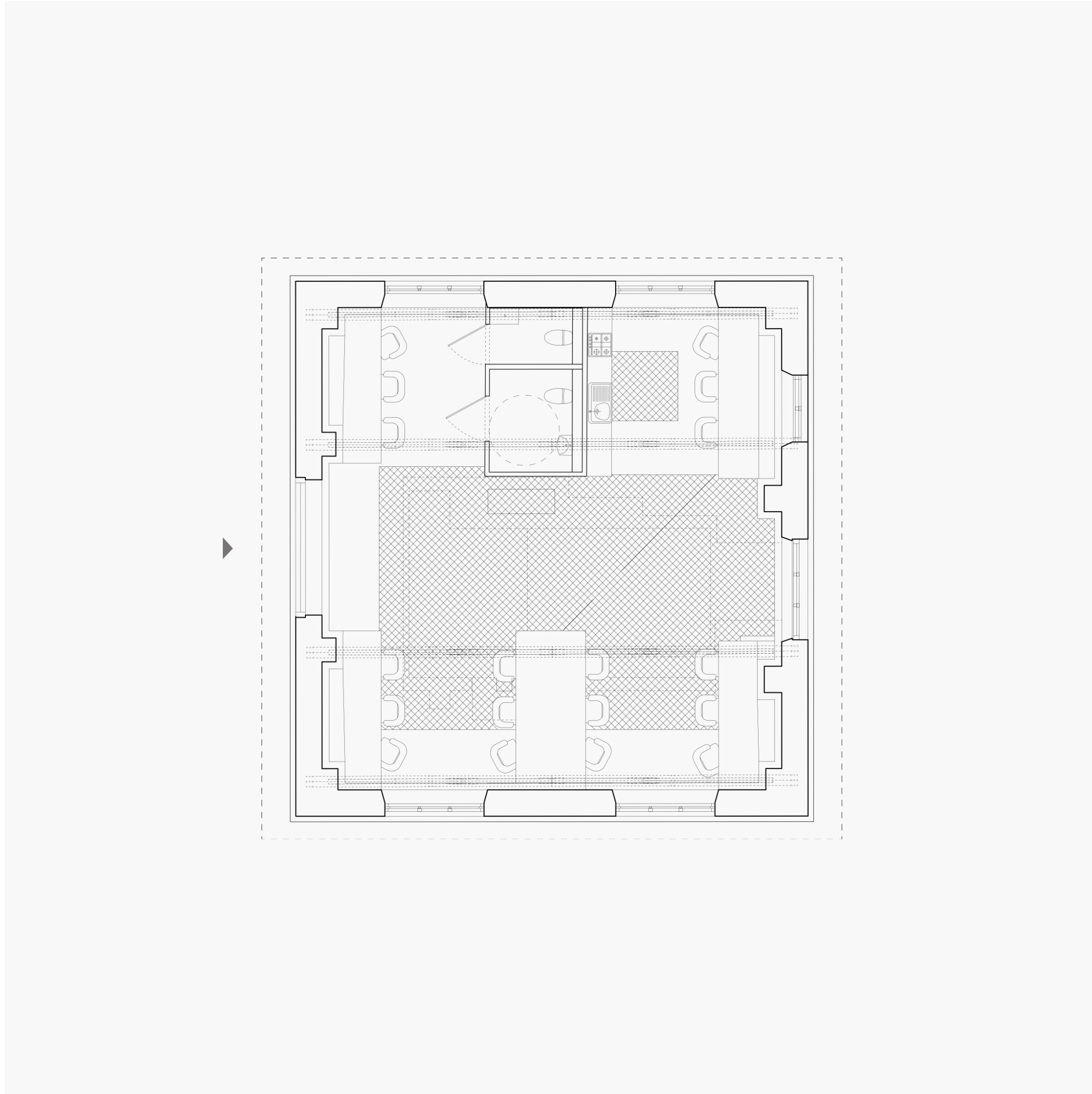


Fig. 66 *Square brick building transformed plan drawing.*

5 1 0m

Brick building II - old storage

In the case of the second brick building, a technical core including bathrooms and a small kitchenette is introduced on the side of the building in order to achieve an open plan. In the place of the open pit in the floor, a steel grating structure is installed in order to preserve visible traces of the past while ensuring free movement around the building.

Axonometry

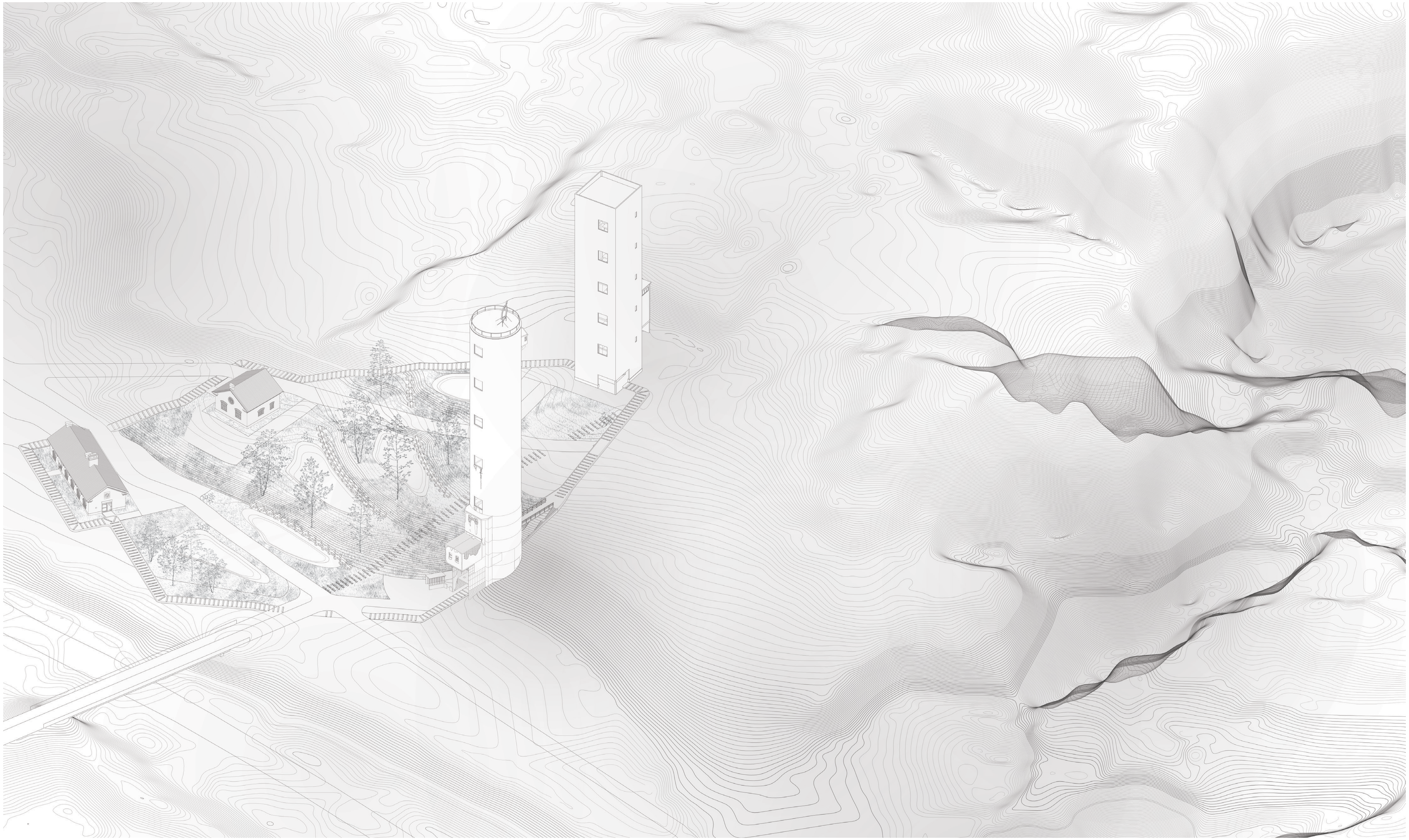


Fig. 67 *Axonometry drawing.*

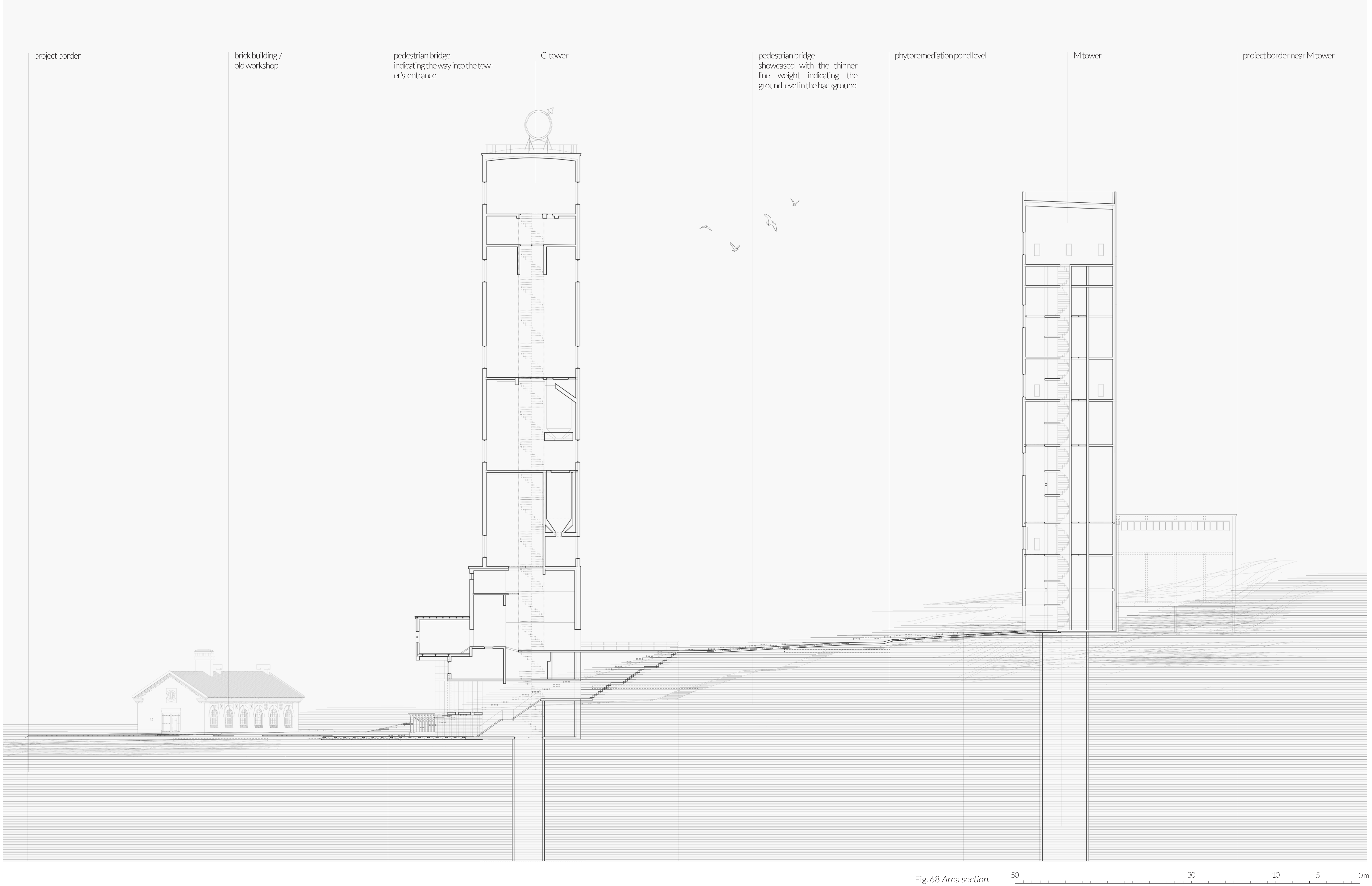


Fig. 68 *Area section.*

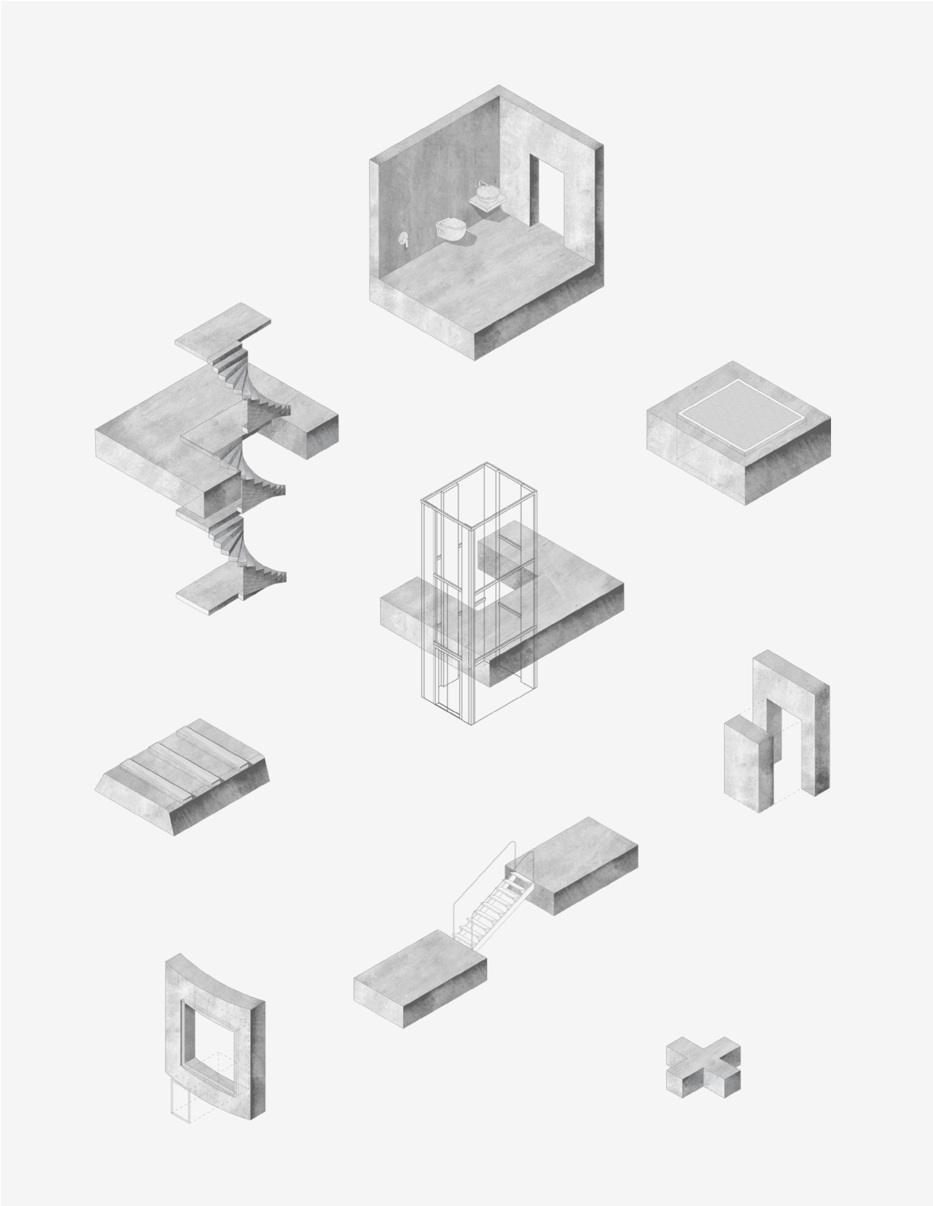


Fig. 69 *Element convention drawing.*

Fig. 70 *First person view while entering the project area.*

Fig. 71 *C tower interior.*

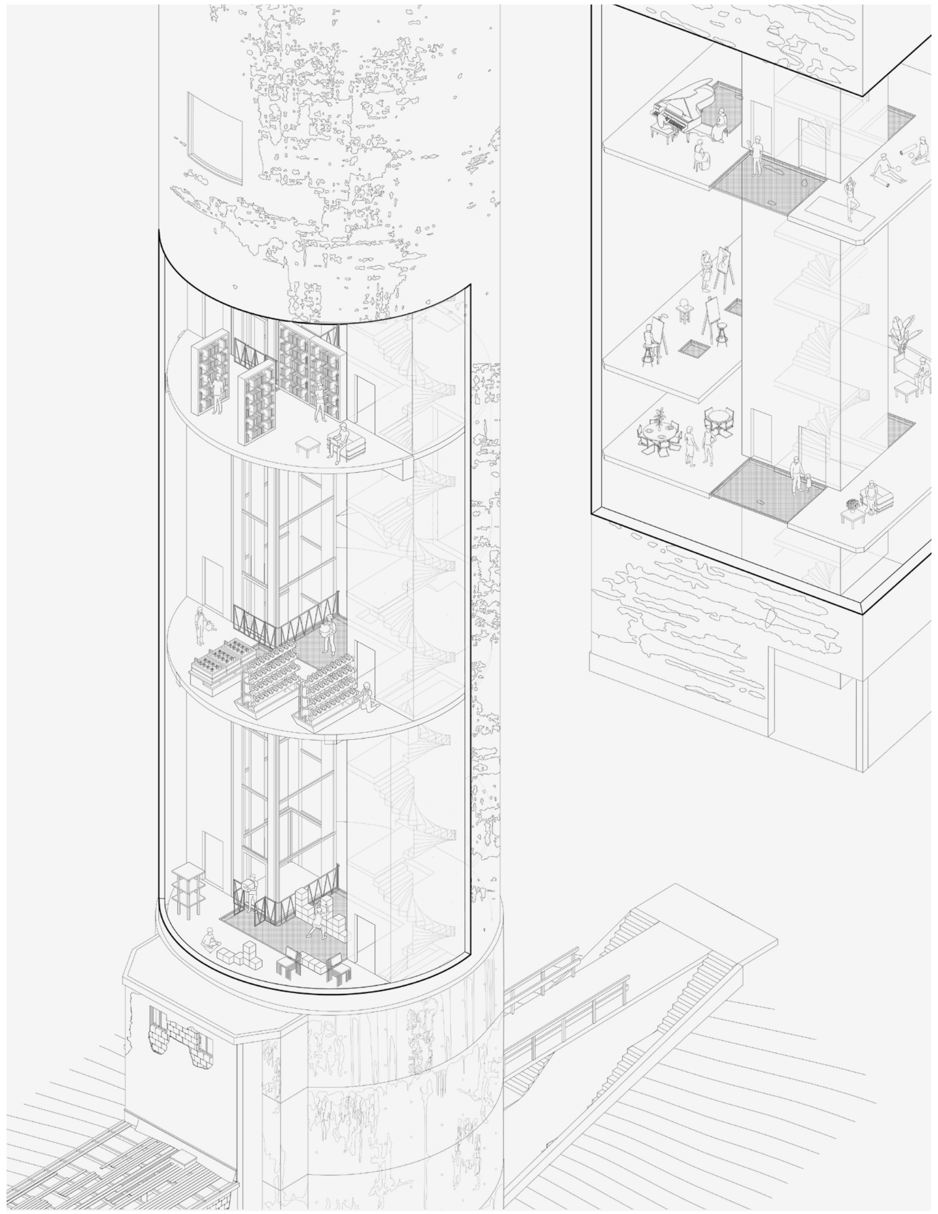


Fig. 72 *Axonometry - activities layering time.*

Discussion

The main idea leading to the transformation of the abandoned Tuolluvaara mine is to continue its history but also to open its borders and make it available to the city's residents in challenging times of the city's relocation and dynamic changes happening during this period. The Tuolluvaara mine, one of those areas where mining activities connected with the collapse of the city take place, is given back to the city as compensation for the damage caused. The project uses a phased approach, assuming gradual transformation of the area in which residents can participate from the first phase due to providing them with early access to the transforming site. There is a distinction between the topic of the mine structures that carry significant historical value and the wasteland, which does not carry this value at all. Therefore, the thesis applies two different design approaches to them, understanding their differences. As a result a kind of reserve / oasis or a landscape green stamp is created among the poisoned land of the surrounding wasteland.

The project reflects reference projects by introducing elements of continuity / movement, such as a pedestrian bridge, opening the ground floor of the towers and connecting them with the surrounding landscape and introducing a technical core in both towers. This approach emphasizes verticality and horizontality, which refers to the history of the place associated with the resource route. In the main topic of continuity, there is also a reference to Solà-Morales' terrain vague theory, which exemplifies this approach in order to prevent an architectural act becoming aggressive towards the terrain characterized by the sense of freedom. This approach is directly connected in this project with the creation of spatial shortcuts introduced in the theory of Matta–Clark, in relation to opening the towers and creating their connection with the surrounding landscape. Additionally, aspects of the old structures' elements are preserved in the form of visible slab openings, filled with translucent steel grating, traces of the past in damaged façade materials or visible trails of destroyed partition walls on the floor, emphasizing continuity and historical significance. Another aspect is the introduction of a rotational programme, allowing for multifunctional structures' use, which maintains the sense of freedom. These interventions refer to the theory of architecture as palimpsest as well, accenting the layers of time.

The distinction between the postindustrial structures carrying a significant heritage value and insignificant soil present on the site, together with creating the contrast between them, is included in the idea of the terrain phytoremediation. The contrast is created and visible in its final phase between degraded wasteland and lush vegetation contained within the area of the project. The distinction is made possible by the introduction of a pedestrian bridge which, on the one hand, creates an element of continuity as allowing the users to enter the area from the first phase of transformation but also creates a transgressable border. Usually, the transformation process happens in isolated conditions where access is strictly forbidden. Here, a symbol of renewal is created and it showcases that the border of an abandoned inaccessible mine exists only in people's subconscious. Reshaping the relationship with a place and regaining the once lost area with these interventions is based on the theory of collective memory and shadow places, which inspired the idea.

The method used to create this thesis in the form of intertwined research and design phases allows for implementing changes and evaluating them in the light of new information. The use of various softwares and techniques such as 3D modeling, creating photogrammetry, mapping or document analysis allow for an in-depth study of the subject not only of the plot but also of its structures in a remote, inaccessible place. The complexity of the project allows for more in-depth study in the future concerning additional aspects such as analysis of the underground mining shafts and tunnels or a thorough verification of the internal condition of both mining towers and structures located on the site that are not covered by any technical documentation. Additionally, further research would include more comprehensive study of the load-bearing conditions of both towers and their thermal conductivity. Unlike reference projects, this thesis carries the transformation of both the postindustrial landscape and its structures, an aspect that is rare when looking for reference projects concerning the transformation of post industrial areas. This thesis stands in opposition to the assumption that the building needs a defined function from the beginning, based on the analysis of changes occurring in the present and also in the past, in which buildings changed their functions depending on the circumstances they were found in. Selected theories are a basis for the design interventions. Therefore the thesis agrees with their postulates and proposes solutions consistent with their philosophy and assumptions.

Kiruna, in the context of the thesis, is the most extreme and unique example of postmining damages caused by human hands and its layered example shows that in the era of today's crises, the needs of architectural users can change rapidly. In the case of Tuolluvaara transformation, this intervention provides a sense of agency for people in times of crisis. The choice of transforming a postindustrial mining site in this case is conditioned by these premises, which provided a strong foundation for the creation of the project. The structures present as concrete structures do not arouse the desire for transformation due to the negative attitude towards their materiality, in contrast to the transformations of beautiful historic brick or wooden buildings. The thesis finds value in other aspects, such as historical context in relation to the city, its inhabitants and the mining history and draws attention to the needs of local communities, but also makes it clear that heritage is not always beautiful – but undeniably present. This thesis creates solutions that could be applied within cities facing similar challenges.

LITERATURE

Arnqvist & Sivenbring AB, MAF Arkitektkontor AB, Arkitekten Inger Olsson AB, Westerlinds arkitektkontor AB, Bebyggelse i Norr (2014). *Kulturmiljöanalys kiruna etapp 2.* https://kiruna.se/download/18.5a56c80e173056cc42e657e7/1594033219271/dive2_liten_141005.pdf

Boëthius, B. (1958). *Swedish iron and steel, 1600–1955. Scandinavian Economic History Review*, 6(2), 144–175. https://doi.org/10.1080/03585522.1958.10411402

Camp, J. M., & Francis, C. B. (1920). *The making, shaping and treating of steel (2nd edition).* The Carnegie Steel Company. http://ci.nii.ac.jp/ncid/BA02641859

Clorinda, V. M. C. (2019). *Paul Ricœur on collective memory: the cohesion of social life.* Voluntas Revista Internacional De Filosofia, 10(3), 87. https://doi.org/10.5902/2179378639936

de Solà-Morales, I. (1995). *Terrain Vague. In C. Davidson (Ed.).* Anyplace (pp. 118–123). Cambridge, MA: MIT Press. ©1995 Massachusetts Institute of Technology. https://esquerdadireitaesquerda.wordpress.com/wp-content/uploads/2014/04/terrain-vague-sola-morales-21.pdf

Fijn, N. (2016). *A shadow place: Plumwood Mountain.* Landscapes, 7(1), 12. https://researchprofiles.anu.edu.au/en/publications/a-shadow-place-plumwood-mountain

Halbwachs, M., & Coser, L. A. (1992). *On collective memory*. https://doi.org/10.7208/chicago/9780226774497.001.0001

Jonsson, E., Troll, V. R., Högdahl, K., Harris, C., Weis, F., Nilsson, K. P., & Skelton, A. (2013). *Magmatic origin of giant 'Kiruna-type' apatite-iron-oxide ores in Central Sweden.* Scientific Reports, 3(1). https://doi.org/10.1038/srep01644

Marot, N., Harfst, J. (2020). *Post-mining landscapes and their endogenous development potential for small- and medium-sized towns. Examples from Central Europe.* The Extractive Industries and Society, 8(1), 168-175. https://doi.org/10.1016/j.exis.2020.07.002

Niederhagemann, S. (2009). *Reactivation of headframes. WIT Transactions on the Built Environment*, 1, 513–519. https://doi.org/10.2495/str090451

Persson, C. & Luleå tekniska universitet. (n.d.). *Tuolluvaara i ljuset av Kiruna* [Slide show].

Plevoets, B., & Van Cleempoel, K. (2019). *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline* (1st ed.). Routledge. https://doi.org/10.4324/9781315161440

Rydin, H., Snoeijs, P., & Diekmann, M. (1999). *Swedish Plant Geography : dedicated to Eddy van der Maarel on his 65th birthday.* Acta Phytogeographica Suecica, 84. http://www.diva-portal.org/smash/record.jsf?pid=diva2:565333

Tyréns Sweden AB. (2024). Miljöteknisk markundersökning TGA-området.

Van Cleempoel, K. (2020). *Fidelity and Freedom in the Theory of Adaptive Reuse: Thinking with T.S. Eliot and Walter Benjamin.* Writingplace, (4), 30–47. https://doi.org/10.7480/writingplace.4.5276

Wiklund, K. B. (1910). *De lapska och finska ortnamnen vid Kiruna och Torneträsk / förtecknade och förklarade af K. B. Wiklund.* https://digital.ub.umu.se/node/717217/metadata

WEB PAGES

Attlee, J. (2007). *'Towards Anarchitecture: Gordon Matta-Clark and Le Corbusier', in Tate Papers no.7.* https://www.tate.org.uk/research/tate-papers/07/towards-anarchitecture-gordon-matta-clark-and-le-corbusier, accessed 9 April 2025.

Caballero, P. (2025, March 21). *Automatic Mills Grain Silo Conversion / Prokš Prikryl architects.* ArchDaily. https://www.archdaily.com/1017279/automatic-mills-grain-silo-conversion-proks-prikryl-architects?ad_source=search&ad_medium=projects_tab

Cayupe, A. (2020, September 7). *PC CARITAS / architecten de vylder vinck taillieu.* ArchDaily. https://www.archdaily.com/871034/pc-caritas-architecten-de-vylder-vinck-taillieu?ad_source=search&ad_medium=projects_tab

Landezine. (n.d.-c). *Landschaftspark Duisburg Nord by Latz + Partner.* https://landezine.com/post-industrial-landscape-architecture

Pintos, P. (2024, July 25). *Hälleskogsbrännan Visitor Center / PS Arkitektur.* ArchDaily. https://www.archdaily.com/929087/halleskogsbrannan-visitor-center-ps-arkitektur?ad_source=search&ad_medium=projects_tab

Rankin, J. (2023, February 5). *Why a Swedish town is on the move – one building at a time.* The Guardian. https://www.theguardian.com/world/2023/feb/05/why-a-swedish-town-is-on-the-move-one-building-at-a-time-kirkuna-arctic-circle

The geological survey of Sweden. (2023, November 30). *Ore production and trends.* https://www.sgu.se/en/mineral-resources/mineral-statistics/ore-production-and-trends/

Wainwright, O. (2020, September 24). *Kiruna: the town being moved 3km east so it doesn't fall into a mine.* The Guardian. https://www.theguardian.com/artanddesign/architecture-design-blog/2014/oct/22/kiruna-sweden-town-moved-east-iron-ore-mine

INTERVIEWS

Interviews conducted by the author herself with Kiruna Kommun' city architects and LKAB representative Joel Ahlquist are marked in the thesis as (Kiruna Kommun, 2024) and (LKAB,2024).

References

LIST OF FIGURES

AI Appendix

In this work AI has been used to translate literature from Swedish language to English and in order to understand its content. Additionally it was used as a grammar check for author's own written words (https://www.grammarcheck.net/editor/ and https://copilot.microsoft.com/chats/D3p5abWU9aVij1NtiYeEM) using prompts like „ translate to English" or „check grammar".

The output has been used as a basis of understanding literature text before being referred to by an author in her own words.