# EMBRACING INFRASTRUCTURE

## A RE-INTERPRETATION OF ARCHITECTURAL DESIGN AND ORNAMENTATION ON A WATER TOWER IN TRANÅS

JENNIFER GINDAHL/ / MASTER'S THESIS 2024
CHALMERS SCHOOL OF ARCHITECTURE / DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING EXAMINER:
DANIEL NORELL / SUPERVISOR: DANIEL NORELL


EMBRACING INFRASTRUCTURE
JENNIFER GINDAHL MASTER'S THESIS 2024
CHALMERS SCHOOL OF ARCHITECTURE DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING
ARCHITECTURE AND URBAN DESIGN MATTER SPACE STRUCTURE
EXAMINER: DANIEL NORELL SUPERVISOR: DANIEL NORELL

# AUTHOR

Jennifer Gindahl
jennifer.gindahl@outlook.com

MSc. Architecture and Urban Design 2022-2024
Chalmers School of Architecture
Matter Space Structure 3: Before and After Building
Housing Invention
Resistant Architecture: 1968 and beyond
Nordic architecture: Nordic Women
Matter Space Structure 1: Before Building

Internship OKIDOKI 2021-2022

BSc. Architecture 2018-2021
Chalmers School of Architecture

# ABSTRACT

This thesis examines how architecture can establish relations between water infrastructures, society, and water consumers. Based on this examination, including a typological study of the development of water towers, as well as current architectural thinking around infrastructure, the thesis culmimates in the design of a new water tower for the city of Tranås, located on the border between Småland and Östergötland, a municipality that currently has no water tower. Water infrastructure was one celebrated through decoration and ornamentation because access to water could not be taken for granted. With time this has disappeared as water provision is taken for granted, something not good for climate or symbol of city which the design aims to solve.

Infrastructure is a precondition for cities to exist and modern infrastructure creates a huge maze of structure underneath the ground. Water infrastructure is life obtaining as a vital source of water and the infrastructure system can be used as a both including, excluding and colonial tool to bring together or separate parts of a society, this is taken in consideration during early design phase. Water towers are important for the society's resilience against unpredictable happenings. Its purpose is to storage water that is enough to provide the city for a specific period. Water towers are low-tech buildings that only uses the laws of physics to function.

Taking cues from research presented in Infrastructural Love (Frichot et al., 2023), the thesis explores the significance a water tower can have from three perspectives, as a landmark, as a symbol, and as a salience for citizens and visitors of a city. How can architectural thinking be applied to water infrastructure objects and buildings? The research charts the emergence of water towers in the late 19th century until today, and investigates the hidden workings of the water infrastructure system as well as its objects and buildings.

The design examines and discusses how understanding of architecture in relation to water infrastructure above ground can expand the subject of architecture and to the society.

## KEY WORDS

Water infrastructure, hydraulic engineering, landmark, symbol, urban planning, salience, water towers typology

# TABLE OF CONTENT

# BACKGROUND/INTRODUCTION

## HISTORY OF WATER INFRASTRUCTURE (IN SWEDEN)

The emergence of cities revolves around water (literally). Water is the most important factor in cities bloodstream and the water has historically decide the place and space for defence, transports, trading and drinking. The start of Europe's water infrastructure is said to be the Roman aqueducts. Rome was a city that was built on seven hills, and with the help of the topography they were able to develop both water supply and sewage systems in their city. This was around 140 BC. The sources of the aqueduct Aqua Appia were channelled about 15 km before reaching Rome, and the Aqua Marcia was about 94 km long, channelled in both tunnels and in air. Within 500 years of the first aqueduct, ten more were to be built. For the sake of the principle of flow through, the grand fountains of Rome were part of the technical principle. Frontius, the aqueduct curator (curator aquarum) carried out detailed work and administration that has been found after him. He had understood that the aqueducts required slopes to make them work (between 1:250 and 1:1000), and that the water pressure was proportional to the area of the cross-section, but the velocity of the waters importance in relation to cross-section and flow, as well as a formula to determine the influence of pressure and friction, would first be figured out in the 19th century. Part of the late understanding of the formula could also be the fall of the Roman empire on the 400-500 AD, where the Romans aqueducts were destroyed. It then took until the 16th century before humans once again tried water infrastructure out in society again (Bjur, 1988).

It was common that citizens of a Swedish village were part of the ownership of a private water well, but on the 15th century public wells got more common (Bjur, 1988). At the end of the 18th century water was accessed and organized through joint solutions for the "common good" in the small societies. Citizens supplied themselves using tubes made of wood. But when the industrialization came, the health of people got better, and the citizens started to move in to the city to get a job. Thanks to the industrialization, the population grew bigger, and the need for bigger water capacity from their invented water infrastructure grew. Around the same time, the question of sanitary conditions in the city arisen and the fear of pandemics was big, which also required a more technical solution when it came to water infrastructure. So, in 1860, the system of water distribution as we think of it today was invented and was one of the earliest piped infrastructures in the Swedish cities. From this technical solution, other inventions were created and used in the field of water infrastructure, such as water works with distribution to individual households, steam engine driven pump houses, water towers and installation of water toilets. At this time, the city was well separated from the rural area, and there was no infrastructural service outside the city centre to speak of. But gradually the entire water infrastructure got expanded. Going from being concentrated in the city centres in the turn of the 19th/20th century, it had been expanded to the suburbs and more rural areas as well (Svedinger, 1989). As a consequence of the rise of industrial cities and citizens moving to the inner city to be a part of the city and its infrastructure, instead the nature, landscape and remote destination has become more exotic (Saari, 2015). The years between 1880 and 1920 were the time of scientific hydraulic engineering, when many both theoretical and practical advances were made. Much of that engineering and the modern art of hydraulic engineering of that time is to some extent still in use today (Bjur, 1988). When the infrastructure was introduced there was a sense of pride around the infrastructural buildings that cities wanted to show off. But during modernism, the infrastructure became so stripped down in its aesthetics that it started to be considered ugly. This resulted in the hiding of many infrastructural buildings and objects underground (Zawieja, 2022). When access to clean, running water and good sanitation began to became the norm, more water toilets and baths were subsequently installed, something that the Million home program pushed for. When water toilets and baths became the norm in Swedish households, water consumption increased rapidly, and water treatment plants and pipes had to be expanded (Svedinger, 1989).

In almost every Swedish city, it is the municipality's responsibility to govern the water infrastructure and all properties connected to it. Since 1983, water counts as food/viands and since then, the state's food service is the central supervising authority for the control and applicability of the water, something that the municipality is tasked with providing. This also means that it falls to the municipality to maintain the water infrastructure (Svedinger, 1989).

Helena Glantz, interviewed by Joanna Zawieja, claims that today, technical infrastructure and technical buildings are popping up like mushrooms. In the past they were hidden underground, but nowadays it's lack of space underground and they are forced to be place above ground (Zawieja, 2022). Today one could say we live in a "techno-city" where there is a blurred limit between the natural and the artificial.

*Figure 1 shows a group of soldiers gathered around a commonly owned water well (unknown, 1893), PDM*

The water as a resource is natural, but the engineering structures are artificial. We are dependent on both and the separation for a citizen in everyday life is not something common to think of (Saari, 2015).

## POSSIBILITY OF THE FUTURE

Saari points out the potential of being able to change attitudes towards sustainable water use and calls for designs that encourage cultural connections between infrastructure as a landscape and the public (Saari, 2015).

## WATER CONSUMPTION IN SWEDEN

Svedinger (1989) explains how, after the increasing water consumption in conjunction with the development of water infrastructure for sanitation during the Million program, the total water consumption per person has stopped increasing. Since 1995 the curve has instead started to decrease. This may be due to water-saving arrangements such as water-saving taps and more efficient technology that requires less water. With the reduction in water consumption, problems have arisen as the pipe networks have been dimensioned for greater water volumes than today's utilization corresponds to. This can cause stagnant water in the end pipes which leads to an unwanted growth of micro-organisms. Of all water use per year, approximately 2% is used for food and drink, while 15-30% accounts for leakage. Despite the large amount of leakage, this is not considered a problem as the capacity can still handle it and the cost of a reparation are seldom not equal or lower than the cost of the leakage. Although, Svedinger (1989) notes that many water treatment plants are old and in need of upgrading, rebuilding and modernization so that they can be controlled by computers (Svedinger, 1989). Looking at the statistic of water consumption together with the statistic of population in Sweden over time and calculate these together, one can conclude that the total water consumption has increased over time, and will probably continue to do so in the future (Statistiska Centralbyrån, 2022)(Statistiska Centralbyrån, 2024).



## INFRASTRUCTURAL LOVE

What would happen if we, instead of allowing the support to recede into the background as is done in most cases, in cities today, allow it to advance to the foreground, if we dedicate love and care to the support systems upon which our collective lives depend, Frichot et al (2023) ask. In that case, we need to shift the emphasis on moral objectivity and detachment to responsive and empathetic expressions of care towards the infrastructure. Infrastructural love requires radical engagement in the world. Infrastructure can benefit from the loving care of architecture in the aspect of a well working and sustained system that is more liable to life. This would achieve good relations between environments and technologies, natures and cultures, humans, non-humans and more-than-humans. When talking about loving care, Frichot et al (2023) highlight that it is about proximity, mixing longing and intimacy. Care on the other hand can be subdivided in the distinction between justice (in terms of fairness and equality requiring consistent application) and relations of care (which responds to need and must be cultivated). That includes reducing the distance between the architect and the infrastructural urban planning of today (Frichot, 2023).

Frichot et al (2023) claim that love and affect are often associated with feelings and emotions. Focus is on the way affect arouses the sensing body, which concerns both human, more-than-human, non-human and techno-social. Affect has the capacity of a body to affect, and to be affected in turn, moving it, before the body has consciously recognized that it has felt something or that something has changed (Frichot, 2023).

Frichot et al (2023) explains how the infrastructure systems, messiness could be seen as something perplexed and complicated, but it should not be seen as a threat. Instead, it should be seen as an opportunity that allows architecture to remain situated in the "real world". Infrastructure is composed of people, time, politics, ethics, and other messiness on which it also depends on. Historically, this "infrastructural, perplexed messiness" has shown itself when it comes to dealing with smell, for example, which has led to hands-on learning for the citizens. Today this messiness is less visible, and the "flush and forget"-technology does not encourage the same mindfulness, caring or responsibility as it once has, neither does it educate about the infrastructural systems. Today the systems really are infra – invisible, hidden below (Frichot, 2023).

Another aspect of the messiness is that the infrastructure contains out of non-movable bodies that never leave their designated space unless they are moved by living bodies, humans. One could say the city and society consists of living and non-living modern bodies that share this space. The obvious difference between the living and non-living bodies is that the non-living bodies are often iron, steel and stone and figurate as statuary and monuments, but these bodies also have needs that require care and are dependent on us to act in the world. Preservation and care are central to the urban infrastructuralization as the monuments of old infrastructural non-living bodies are "representatives of the progress of the present that will endure into the future" (Frichot, 2023).

## DEALING WITH UTOPIA & ARCHITECTURAL STORYTELLING OF A BUILDING

Utopia is a way to imagine the result of a city when planning it. Le Guin (2015) argues that the normal utopia's and dystopia's being written from a yang perspective, that means the masculine perspective, controlling perspective. Perhaps, she propose, we need to think more "yinly" to deal with utopia – "yintopia". This would mean that instead of relying on control as the yang does, the yin would then instead perform "acceptance of impermanence and imperfection, a patience with uncertainty and the makeshift, a friendship with water, darkness, and the earth", Le Guin writes. The two different "yintopia" and "yangtopia" would make two different stories, which allow for different sensitivities, problems, hopes and realities to work from (Le Guin 2015).

By being able to story tell architecture, a project or a built environment, the chance to create possibilities and potentialities, a thicken present is shaped. The stories can move from mouth to mouth (in form of words as well as marks and traces) of both humans and non-humans, designers, users, residents, birds, rivers, ornithologists, activists and many more. These live on the collective world-view, rather than the individual world-view (Frichot, 2023).

# PROBLEM DESCRIPTION

## GENERAL AIM & SPECIFIC PURPOSE

The general aim of the thesis is to understand the water infrastructure above ground of Tranås and to design a water tower connected to it. The purpose is also to understand the architecture of water infrastructure and its role in the city, how design can affect the city, and how a water tower can form a landmark.

## THESIS QUESTIONS

How can the architecture of water infrastructure reveal and design for otherwise hidden layers of engineering features to create a better understanding and appreciation among the public?

What significance does water infrastructure's architecture have to a society?

How has the water tower typology developed over time in Sweden, and how can this development be linked to infrastructures role in society?

## DELIMITATIONS

- The investigation in the thesis is made from a city/ society view.
- The economical aspect is just briefly examined in the theory, to understand the complexity of infrastructure in society. It is not taken in consideration in the design proposal.
- The thesis focus is on the existing buildings and city in Tranås, not what will come to be built and therefore risk to change the existing circumstances.
- The thesis is limited to examining water infrastructure above ground. Water infrastructure below ground is briefly examined in the theory part to create a comprehensive understanding.
- The report will focus on the public distribution and consumption, not the private distribution and consumption.

# THEORY

## VOCABULARY

### GROUND WATER

Groundwater is water extracted from soil or bedrock that has been completely water-filled, and with the help of the soil's and rock's purifying properties, the groundwater can maintain a relatively good quality right from the time it is collected. Sweden is a country with good access to groundwater and many municipalities take their drinking water from groundwater wells, but it is important to know that these sources can run out, if the withdrawal is greater than the supply of rainwater (Nationalencyklopedin, n.d.).

### SURFACE WATER

Surface water is extracted from the surface of lakes, streams, seas, and wetlands (Nationalencyklopedin, n.d.).

### RAW WATER

Raw water is water that has originally been surface water or groundwater and that, after undergoing some form of preparation or filtration in a water treatment plant, can be used as drinking water (Nationalencyclopedin, n.d.).

## DEFINITION OF CITY & SOCIETY

A city is a geographic area that is recognized of a certain legal status or a certain type of land use, according to the National Encyclopaedia of Sweden (Nationalencyklopedin, n.d.). A society is a term for a group of individuals united by a network of social relations with a certain duration and continuity over time. Society is territorially bounded, and its social concepts are regarded as something external, a background of possibilities and limitations for the activities of free individuals. Within this society, people's social perceptions can be seen as completely shaped by the social; her values, goals, world view and actions are products of socialization, internalization and control (Nationalencyklopedin, n.d.). Jonsson (2022) describes how we are always in this invisible medium of society, a medium that "fills the spaces between our bodies, creations and constructions". Jonsson (2022) means that the society is what drives our desires and navigates our emotions, impulses, shapes and civilizes us and argues that the idea that society is the sum of its individuals is backwards and "stupid" and explains that it is not the individuals who create society but the society that creates the individuals. He explains it by drawing the parallel to how even the most energetic entrepreneur in the capitalist and neoliberal contemporary society, as children need their guardians who change the diapers, nourish, gives care and guidelines. So, a person cannot live as an individual and realize herself without a relationship with others, the society. Society is fundamental (Jonsson, 2022).

## DEFINITION OF (WATER) INFRASTRUCTURE

According to the national encyclopaedia (n.d.) of Sweden, infrastructure is a system of facilities for production of energy, electricity, water- and sewage systems and telecommunications, but also included are roads and railways, airports and ports, power plants among fixed facilities such as airfields, oil pipelines and depots in a defence system (Nationalencyklopedin, n.d.). Hélène Frichot et al. (2023) describe infrastructure as "something both huge and hidden is conjured up, a dark and indistinct shadow (…). Conceptually, it is beneath structure, below architecture, under life as we know it, the infra signalling that it is lower in position, in value" (Frichot, 2023). Svedinger (1989) continues to explain that the concept of infrastructure has its origins in economists' discussion of buildings and facilities as an economic basis for growth. Water infrastructure, but also any other kind of infrastructure, contains of three main components: the system has a purpose (a market) to fulfil, it has a source where media is generated or destroyed (hence, the system has a process) and the system has a distribution network (Svedinger, 1989). For normal citizens, infrastructure is something that just should function. It's something we shouldn't see or notice as it is just a system of function, nothing fancy. Infrastructure is both a symbol of permanence, a channeller of flows and a marker of modernity (Frichot, 2023).

## (WATER) INFRASTRUCTURE AND ARCHITECTURE IN AN URBAN & SOCIETY VIEW

*"Infrastructure for transporting and treating water forms the social and technical foundation of urban settlement, yet its design has been compartmentalized into a field oblivious to the experiential qualities of a city. The story of water links*

*The illustration shows the complexity of the water infrastructure system under ground, that is all hidden, but all very much part of the over-ground-life. The illustration is also showing an axonometric view of Tranås water infrastructure in a scale of 1:24 000 and 1:2400*

*Left photo, figure 2: Water Tower of Skara, built 1898 (unknown, 1898).*

*Right photo, figure 3: Water Tower of Hallsberg, built 1954 (Borg, 1960)*

*Here one can see the different level of decoration and ornamentation of water towers built before and after the modernisation.*



*us to the past, and to the total ecosystem much bigger than our perception. It is the true connecting tissue of urbanity to natural processes, unraveling the artificial separation of nature, society and technology in the world of human experience" (Saari, 2015).*

Infrastructure is also a way for societies or the state to articulate their social political imagination, as infrastructure provides guides of how it wants us to live in the city. It shapes territories, nudges, governs citizens movements and shaping behaviour, as well as the economical and health standard the society should access or be provided with. It supports the basic utilities of water, sanitary and so on. Therefore, it can include, move and liberate just as much as it can exclude, contain and subjugate (Frichot, 2023). Jonsson (2022) explains how societies are often described as tending towards different categories. These categories are different ways of dividing people into groups in which people are brought together or separated, integrated or segregated. Geographical places are often divided into homogeneous and heterogeneous spaces, simple or complex spaces. Resources must be distributed between these spaces. With the help of infrastructure, the society decides how it wants to change the relations to these spaces. For example to thicken or thin out certain interpersonal relationships. With this phenomenon, the population learns the divisions of society, divisions that establish what some have a share in and what others lack, what is equal and what is unequal. This in turn causes societies to split and parallel societies to form (Jonsson, 2022). Historically, Frichot et al (2023) demonstrate how infrastructure has been used as a colonial instrument for the demarcation of territories and the transformation of the soil into profitable land. The non-living bodies of infrastructure are the base of modern urbanization and they transform the citizens into modern bodies. Infrastructure is the socio-technological and spatio-temporal glue that holds everything together in the city and is what can connect us to the earth (Frichot, 2023).

Talking about social political imagination, Jonsson (2022) articulate the meaning of imagination (Jonsson, 2022).

In today's neoliberal politics, Frichot et al (2023) point out how capitalism, fast-paced technological development contributes to a most likely irreversible climate change. We are in a post-human conjunction time, where we have to hope we can learn from the contemporary, as this time demands

a radical re-conceptualization of human and non-human relations, a rethinking that have to lead to other modes of practicing with environment-worlds. By using architecture and design it is possible to create a resistance from within the neoliberal, market-driven spatial products and create a large infrastructural system that organize the world. This is by designing active form, not passive or mute, as it has the capacity of expressing a disposition or capacity that unfolds over time to shape space and relationships. To do this, we need to transgress the disciplinary boundaries between architecture, urban planning, engineering and geography to confront the spatial products of global infrastructures and reclaim their potential (Frichot, 2023).

Water is a resource we as human beings, but also more-than-human and non-human others need to survive, and without it all of us would expire within a few days. To link back to the earlier paragraph on political justice and urban government on infrastructure, Frichot et al (2022) are concerned that we are heading towards a future with water scarcity, inequitable distribution and water wars. This is in addition to the non-infrastructural problems we associate water with today: drought, flood, and the failure to adequately distribute this life-sustaining resource. With this background, the mismanagement of water infrastructure can cause breakdown this medium for the equitable distribution of resources (Frichot, 2023).

### THE STIGMA OF HAVING THE PUBLIC SO CLOSE TO THE PRIVATE

Saari (2015) clarifies how the efficiency of politics today "have overrun ecology, aesthetics and expression of meaning, and water has been stripped of its former symbolic values". Water has become "virtual water" as it has disappeared in pipes underground and hidden in walls and lost the naturalness for instead becoming pure infrastructure (Saari, 2015). Although in an urban landscape, infrastructure is often the only built or constructed in the view, but with the lack of aesthetic values and aesthetic strategies, it's often stigmatized with a negative connotation which in turn has led to the phenomenon "not in my backyard". It is describes how this is a result of the modernists stripped design, which has led them to be considered ugly, together with the post war utopia of the home, where there should be an invisible connection between the urban and public, and the home and private (Pohlar, 2010).

### THE SECRECY OF WATER INFRASTRUCTURE OF THE COUNTRY

Water infrastructure is a very secretive part of society, with the argument that "Water supply is an important activity for society, and certain water supply can therefore be important for overall defence and to protect the security of the kingdom". It is therefore very important that the public as well as potential enemies do not receive information that would allow them to cause harm or use the information for criminal activity or war, and thereby depriving us of our vital resource. The protection of the water infrastructure is therefore legislated by, "Offentlighets- och sekretesslagen (2009:400)", "OSL", "Säkerhetsskyddslagen (2018:585)" and "säkerhetsskyddsförordningen (2018:658)" (Svenskt Vatten, 2022).

## WATER TOWERS

"The water tower has a rare ability to bring the senses to life. Like monuments to the victory of civilization over darkness, they rise above city fabric and villa carpets and tell of a better society, rippling clean and full of life" (Bornstein, 2022).

### FUNCTIONING

Water distribution can take place in two different types of water towers: high reservoirs where the reservoir is located on pillars and thereby enable to distribute water out to the city with its own pressure and ground reservoirs which acts as a high reservoir but are placed on a hill instead of pillars. Since the topography in the Swedish landscape in many cases does not have such large differences in level, the higher reservoirs are often built as towers, water towers, i.e. a closed reservoir placed at a high height above ground level. This means that water towers often stand out in the silhouette of their landscape and cityscape and form a landmark in the city. Kungliga Väg- och Vattenbyggnadsstyrelsen (1967) propose that the larger dimensions and height over the city a water tower has, the more demands the municipality and citizens should have on the aesthetics and design of the tower and their landmark. Although the aesthetics of the water tower is important, the primary purpose of the water tower is to be a levelling magazine and a spare magazine which also demands a good structural design (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967).

The water tower's primary function is equalization of flow and reserve storage. Consumers' water use varies throughout the day. Waterworks are designed to be able to maintain an even pressure throughout the day, which is not adapted to consumer use. To solve this, water towers supply water when the use in the city is greater or smaller (Linder, Rain Chain, 2017). When the system function, with help of electricity, a pump is pumping water from a water treatment plant, aqueduct or ground water well up through the tower, to fill the big reservoir (Korolija, 2023). Since water towers do not need electricity, they are part of the system that is essential for the community if the power goes out, or if another crisis breaks out (which means that the pump in water works and pump houses that are powered by electricity stop working) that means that water cannot be distributed in other ways. For this system to work, water towers are driven solely by the laws of gravity and therefore have their reservoir located at a high altitude, placed on a hill and/or on tall pillars (Linder, Rain Chain, 2017). The tower must be higher than the buildings it serves, for the laws of gravity to work (Korolija, 2023).

## STRATEGIC PLACEMENT IN CITY

Water towers should preferably be on the opposite side of the water treatment plant in the city, so that approximately two thirds of the consumption is between the water treatment plant and the water tower (Persson, 2006). Andersson (1972) illustrate how this is hydraulically positive because the reservoir becomes a return reservoir where only the difference between the amount of water pumped from the waterworks and the amount of water directly consumed in the network is stored. This placement strategy explains why the more recently built towers often stand alone at the edge of a forest, while older water towers stand in the middle of the city, as the city has had time to "grow past them" since they were built (Andersson, 1972).

Architects Lyth and Wingårdh (2022) describe how Sweden's population is growing, which requires an expansion of the infrastructure (Lyth & Wingårdh, 2022). Rather than extending an existing water tower, it is hydraulic and pressure-wise easier to build a new water tower. The new water towers placement in the city will depend on the existing towers placement and the pressure they will create in the infrastructural system together (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967). From the point of view of the cityscape, it is important that the tower has such a shape and location that serves as a meaningful land and recognition sign from both land, sea and air. This is thus not only for those who live in the city but also for passers-by (Andersson, 1972). High towers often become a social symbol and a central benchmark that has overtaken church towers as a symbol. The location and design of the towers has therefore become an urgent task for architects and engineers (Andersson, 1972). Water towers are often massively out of human-scale (Pohlar, 2010).

In Sweden, lakes are used as a source of raw water, but the capacity that the lakes possess is often only used to a fraction. With a strengthened water infrastructure, it is possible to increase the capacity and secure the water supply (Bornstein, 2022).

## ARCHITECTS' CHALLENGE WITH WATER TOWERS AS AN ART OF BUILDING

Unlike, for example, residential architecture, a water tower has a relatively simple program. It is not filled with functional measures, standards, and rules, but "simply" requires that several thousand cubic meters of water is lifted many meters up in the air. The challenge in this particular architecture is to create as much a sculpture as architecture, engineering art, a landmark, a monument and a symbol of the city. The water tower must have a strong character and silhouette from both far and up close, for the interested population who make their way closer to the tower (Bornstein, 2022). But technical infrastructure buildings can be much more than just a part of a large network. They can also be part of the built environment and, like all other buildings in the community, contribute to the urban space. But water infrastructural buildings are objects of protection and must not include the population in a way so that the inside and the function can be understood (Zawieja, 2022).

## CHARACTERISTICS & GEOMETRY

Common to all water towers reservoirs are that they are rotationally symmetrical around a vertical axis. There are not many water towers that have a reservoir with edges as it is not good for the hydraulic pressure inside of the reservoir (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967). For pedagogy, one could divide a water tower into two parts: substructure and superstructure. In the substructure, the supporting structure is usually found, often in the form of a cylinder, column or a combination of these. There is also room here for shut-off devices and vertical communication in the form of stairs and possibly an elevator. In the bearing structure is the reservoir and stairs. In some cases, you can find a restaurant, cafe

*Figure AD: The building of Söndrums' Water Tower, year 1967 (unknown, n. d.)*

*Here one can see the substructure, superstructure and construction of a water tower. The shaft is built first and the construction is to form the mold that the reservoir is to be casted in.*

or viewing platform here, but this is not so common. In the superstructure is the shell, placed over the vital parts of the water tower. The shell rarely has a function for the water tower to be able to function. Belonging to a water tower are also various pipelines (infrastructure) and ventilation system, usually placed in a ventilation chamber under the bottom of the reservoir slab, on the water towers outside or underground. Water towers often have an appealing shape, beautiful construction, and a good material economy (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967)

## MATERIALS

Concrete has come to dominate as the construction material of water towers. Steel has also been used to some extent since the latter part of the 20th century, which could mean a renaissance for steel as a construction material in water towers, but that is probably not something that can be claimed to any great extent so far. There are also examples of towers made of bricks, plaster, lightweight concrete or perforated concrete, but these materials are less used today because of the risk of damage in the material. The façade material is preferably one that is maintenance free, therefore concrete is often the choice. To make the concrete more appealing, painting with silicon paint is often made, or a perforation in the concrete wall to create some kind of ornamentation. The reservoir itself is, in almost every case, built of concrete, and very seldom steel. (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967). The materials from which the water pipes are made are selected regarding corrosion, service life and water quality. The older lines were made of cast iron, these have over time begun to be supplemented by PVC lines, which by 1989 account for the largest part of all pipes (Svedinger, 1989).

## DEVELOPMENT OF APPEARANCE

Between 1890 and 1920, the dimensions of the superstructure were often made relatively narrow and small, and then the cylindrical shape of the substructure was made to have the same diameter as the superstructure, giving the impression of a tall cylinder. Around the turn of the century, this volume was often given the appearance of an old castle, which was reinforced by buildings located at its foot. In the latter half, the romanticism was lost and the cylinder took on a rawer expression, where more honest attempts were made to show the function of the water tower and distinguish the superstructure and substructure in appearance. With the development of industries, almost every major community got a water tower during this time (Andersson, 1972).

Between 1920 and 1950, low water reservoirs on high ground are believed to be more common. This is a conclusion drawn because of the few water towers built during this time (Andersson, 1972).

After the 1950s, however, the construction of water towers increased in the country. From this time, the water towers got much bigger than they have been before (Nationalencyklopedin, n.d.). The most common design during this time is a tall cylinder standing on several pillars in a wreath. In 1957, a revolution took place in water tower construction when Svampen in Örebro was built. Svampen was built in a tension-reinforced construction, which allows the concave shape around the vertical axis and also provides a favourable water pressure in the reservoir. After Svampen, the superstructures of the water towers that were built henceforth took on increasingly bold forms, and Andersson (2022) sees two directions that stemmed from this insight: that the superstructure and the substructure visually continue into each other - they look like mushrooms, or the superstructure and substructure are visually separated by a looks like a "saucer on a stick" where a giant bowl rests on slender pillars (Andersson, 1972).

## BUILDING METHODS

The first thing that is built on a water tower is usually reservoirs that are shaped and cast on the ground. This is then lifted successively with a jack, gradually after the substructure is completed. After this, a sliding mold casting takes place where the outer shell is created, alternatively, prefabricated concrete elements are lifted into place. Most common is the use of rational construction methods such as slip-form casting, pre-stressing, cranes and hydraulic lifting technology. In some cases, form-work has been used, but this is not as safe to use as there is a risk of deformations, and even very small deformations can cause cracks in the freshly poured concrete. After the concrete construction, a decorative exterior cladding can then be put in place, if wanted (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967).

For a water tower to be operable, it is required that the water maintains a temperature of between 0 degrees and +15 degrees Celsius. This is usually not a problem for water towers with larger reservoirs and sufficient water circulation, while water towers with smaller reservoir volumes require thermal insulation and possibly electric heating. Sandwich walls are a common construction type for water towers, where any

thermal insulation (if there is any) is placed on the inside of an external concrete construction, with eventual facade material attached to the outside. The material of the eventual insulation can be glass wool, mineral wool, cork or foam plastic (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967).

Modern water towers require advanced production techniques, which in turn require great care for construction and work planning (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967). A newer technique today is to use two reservoirs which enable the water to circulate more and therefor stay fresh and have a better quality (Lyth & Wingårdh 2022).

To be able to measure the needed size of a water tower, one need to know the number of citizens that the tower need to be able to provide with water. In cases where the consumption per person and day is unknown, one can assume the water consumption is 30 litres per person and day. The industries do also have to be dimensioned, but in cases where the numbers are unknown or uncertain, it can be estimated to estimated based on the plot area: 0.1 l/s and hectares. In addition to this, other water consummating activities have to be considered, such as the extinguishing water consumption with fire hydrants and special occupations such as hospitals have to be considered in the dimensioning of the water tower. After calculating the consumption per day in the society, it should be multiplied with three, for it to last three days (Persson, 2006).

### WATER TOWER AS A LANDMARK & SYMBOL

Water towers also have great significance for the city as a landmark and symbol of the importance of clean water. During the last century, the function of the water tower to transport water has been in focus, which has meant that the architecture and design have fallen into oblivion and the older, appreciated towers have been supplemented by simpler constructions which, even today, do not receive the same attention as the older towers in the city. Linder (2017) highlights how the respect for the clean water distribution is taken for granted these days and that there will be problems in the future with periodical drain (Linder, 2017). When the visibility of infrastructure is being removed, the experience of clean water is taken away from the urban realm, and left is the invisible maintenance network – the hidden city (Saari, 2015).

### WATER TOWER COMBINED WITH OTHER OPERATIONS

As mentioned in earlier paragraph, the secrecy of water infrastructure is high. This means that if other operations are combined with a water tower that is in function, the other operations may not tell anything about how the water tower functions (Svedinger, 1989). Although this, there exist other operations together with water towers. Svampen in Örebro has a restaurant and sky bar with performances (Örebro kommun, 2023). One of the water towers in Malmö, at Botildenborgsvägen, was built to be a viewpoint in the city to the citizens (Skånska vattentornssällskapet, n.d.). Kaknästornet in Stockholm works as a water tower, as well as a TV and radio mast, an observation terrace and a restaurant with a spectacular view of Stockholm (Royal Djurgården, n.d.). The water tower in Kalmar was built with a restaurant and view over Öland, Kalmarsund and the newly built bridge reaching to Öland, with the expectation that the tower would be a tourist attraction. After a few decades when the expectations wasn't reached, the operations other than the water tower facility was dismantled and the tower no longer became a place for the public (Wikipedia, 2023).

## OTHER WATER INFRASTRUCTURE OBJECTS & BUILDINGS

### WATER TREATMENT PLANT

A water treatment plant is a facility where groundwater or surface water is made to drinkable water. This should not be confused with a sewage treatment plant, which is a facility that cleans wastewater. In this facility, the water is prepared so that it maintains the quality specified by the requirements. This is usually done through filters, but chemical and biological processes can also take place in a water plant. It is also important to protect the water against possible corrosion in water pipes (NE vattenverk).

### PUMP STATIONS

Around 1850, people faced the choice of whether to continue supplying the city with water in the natural way, or whether to dare to introduce technical solutions. Pumping stations with steam engines became the answer to the courage of the time,

and the possibility of pumping out even more water became possible. This also made it possible to build higher heights and build on mountains, as the water with natural pressure (from water towers) cannot travel from high to high or low to high. The natural pressure requires large differences in height from high to low (Bjur, 1988).

### FIRE POSTS AND HYDRANTS

A fire post is a connection device that fire engines can connect a hose to if they need to fill up their car or put out a fire. The fire hydrant is mounted to the water infrastructural system underground. In Sweden, fire posts are usually placed in wells underground, but in other countries they are commonly designed as small pillar-like objects above ground (Nationalencyclopedin, n.d.). To prevent the problem of fire in cities around the turn of the century 1800-1900, the urban standard was to arrange fire hydrants every 100 meters (Bjur, 1988).

### WATER POSTS

A water post is a tap point for collecting drinking water, irrigation or fire fighting and it is collected from the water infrastructural system underground. The appearance of water posts differs, and they can be designed both as objects above ground or as wells (unknown, 2019).

### PUBLIC TOILETS

A shared and public place in form of lavatory pan (rooms) to carry out their needs on has exists since 70 B.C.. in Rome. In Sweden these has for a long time been in form of "dass" (Utbildningsradion, 2005).

The modern public toilets is a public space where you do something very private. Because of the scarcity of private feeing of these rooms, they are often considered to have bad hygiene and are therefore also treated bad and often get vandalised (Utbildningsradion, 2005).

### DRINKING WATER FOUNTAINS

A drinking water fountain is designed to spout water without using a drinking vessel. Therefore, they are designed as rays and can therefore be compared to a fountain. Water can either be designed to spray all the time like fountains do, or to be started with a button. There are examples of both more and less artistic designs of drinking fountains, where some are sculptural, and others are simply designed from steel and the focus is on its function (unknown, Wikipedia, 2021).

## LANDMARKS, MONUMENTS & SYMBOLISM

### DEFINITION AND RECOGNITION OF A LANDSCAPE

When moving through a piazza, one moves through enclosed forms, but the further out into the periphery of the city one go, the more it is like moving through a landscape of vast expansive texture – a mega-texture, not seldom a commercial landscape (Venturi, Scott Brown, & Izenour, 1977).

Landscape comes from the Dutch word landschap in the 16th century. It used to demarcate land, but with time it has become a word that describes a way to see space from distance. Landscape art got its name and to be developed until the 19th century. Landscape art is art of a visual panorama, which harmonize with the definition of landscape. Nowadays, the term landscape has come to include more than just the landscape of nature, and do now include urban and industrial spaces as well as representations of visual cultures (Saari, 2015). Although, Pohlar (2010) stresses that every landscape whether it is natural or urban, sensational or peaceful, leave an image in our memory. These images and memories will be mixed with symbolic meaning, emotion, and aspirations and all together create a richer understanding of the city. These experiences will then be part of the citizens individual actions, attitudes, motivations, feelings, and love towards the city. Therefore landscape plays an important role (Pohlar, 2010).

### DEFINITION AND RECOGNITION OF A LANDMARK

"A landmark is a salient geographic entity that marks a locality and can be used for orienting or navigating in the environment", says Peters et al (Peters, Wu, & Winter, 2010). In the article "Apollo's 2000 Theater Owners Want Landmark Designation To Maintain Its 'Glory'" Stell, who is restoring a building explains the importance of having a landmark recognition of the building in his area. He clarifies how it would make it an anchor and catalyst that draw people who could spend money in their business district (Savedra, 2023).

*1. American fire hydrant*
*2. Public toilet*
*3. Swedish fire hydrant*
*4. Pump station, built in modern time*
*5. Drinking water fountain*
*6. Drinking water fountain*
*7. Swedish fire hydrant brought up and used from underground*
*8. Pump station, built 1896*
*9. Water Treatment Plant*

1.


2.

3.

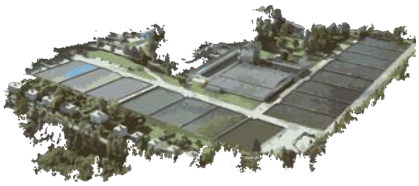
4.

5.

6.

7.

8.



9.

Landmarks attracts attention from human eye, and the feature's salience is mainly measured by the categories (Li, Zhang, Fang, Lu, & Shaw, 2014) (Peters, Wu, & Winter, 2010):

- Visual - attraction of a feature in a local environment, meaning size, colour, shape, visibility and singularity, or sharp contrast with its surroundings.

- Semantic - the significant meaning to the public, cultural and historical significance.

- Structural - the prominent spatial location in the structure of an environment, which can be affected by its position along a route.

But studies have shown different features or categories attract different amounts of attention from the eye. What is revealed in studies is that the feature's size is prominent, unorthodox shape (when feature is close to the centre of visual field, if the feature is far away the same effect was not observed), protruding shape compared to the surrounding shapes, eccentricity, as well as explicit marks (such as texts) led to shorter recognition time for the eye. Because of the attention the landmark takes, people tend to use landmarks in route descriptions and that in turn can shorten learning time for a new way and give better response in way-finding tasks. Although the findings of different feature's recognition time for landmarks, the author also concludes that cultural or historical characteristics have very much influence on the recognition of a landmark and tend to be presented on pictures, word cues and to get a role of target features environment (Li, Zhang, Fang, Lu, & Shaw, 2014). Many of these categories are independent from one another, but the authors explains that the measuring of colour of an attribute is the hardest to formalize, as it depends on lightning, viewing distance, surrounding colours and texture of the feature (Peters, Wu, & Winter, 2010). Another factor that has developed by time to be hard to adapt landmarks to is the complex setting of the new landscape of big spaces, high speeds, and complex programs (Venturi, Scott Brown, & Izenour, 1977).

A landmark can have high impact on an environment and the Eiffel Tower, for example, is described *"as a deeply meaningful object within the landscape of Paris. The tower is omnipresent in the mind and inseparable from any contemplation of the city. The important element is the ability to visit the tower and ascend to its viewing platform. The object as a landmark within the city and at the same time provides a panorama of the city. The panorama is far more meaningful than the ability to view. The understanding of the city in this way engages memory and familiarity. This act of engaging the city in this way solidifies the experience within the mind of the dweller". "The Eiffel Tower is an excellent historical example of the artistic expression of industry and technology. Second, it is the formal expression of innovative strategies and marks a fundamental turning point in architectural imagery as a result of advanced industrial and technological changes. Third, the image of the Eiffel Tower has proven to be a lasting international cultural icon that creates a recognizable image of place even for those who have never physically visited the city. And finally, the tower's lack of public function provides some interesting insight on the relationship between public use, image, and value."* (Pohlar, 2010).

## DEFINITION OF AND RECOGNITION OF A SYMBOLISM

Within symbolism, the goal is not to reproduce reality photographically, but to capture the soul of things in art, often with connections that are religious, personal or literary. The aim is for the dark, the mysterious and the incomprehensible instead of the logical (Nationalencyklopedin, n.d.). There has been a documentation of a declaim of symbolism in art and architecture during 20th century, supported by Modern architects. Symbolism was seen by them as the declaration of content communicated through implication to previously known forms. It was not a way the modernists aimed, but instead of symbolism they wanted to communicate through the inherent, physiognomic properties of the form (Venturi, Scott Brown, & Izenour, 1977).

The drawing architect relies on the literature and idioms of his own day, and the architect can choose to imitate if it sits well with him, or by parody, if it doesn't. Symbolism of a building is read through "associations and past experience; It provides layers of meaning, beyond the 'abstract expressionist' messages derived from the inherent physiognomic characteristics of the forms - their size, texture, colour, and so forth. These meanings come from our knowledge of technology, from the work and writings of the Modern form givers, from the vocabulary of industrial architecture, and from other sources" (Venturi, Scott Brown, & Izenour, 1977)

## THE RECIPROCITY OF ART AND SOCIETY

The notion of 'staging surfaces' discusses all the different

scales a horizontal plane includes all the way from sidewalk to the entire infrastructural matrix. Urban relationships play a much more significant role than spatial forms when it comes to the staging. What Saari (2015) concludes is the collective imagination as the engine of design and planning and landscape urbanism as a speculative thickening of the world of possibilities, an important part of urban environment (Saari, 2015). Art and design know how to make society visible and a meaningful place, therefore art and design have always had a central place in all human societies. One can see this when studying different places throughout the ages, and note how significant places are decorated more than others, this to manifest what holds the citizens together. Art requires social context and a society requires aesthetic representations. It is through art that society represents itself (Jonsson, 2022).

## ARCHITECTURAL WORK ON INFRASTRUCTURE

Infrastructure is the technical solution to a sector-wide and interdisciplinary problem, which has required and continues to require integration of skills from different fields of knowledge - architects, hydraulics, designers, production technicians and concrete and steel experts (Svedinger, 1989). The most well-known water towers in the country are all examples of good cooperation between these professions (Kungl Väg- och Vattenbyggnadsstyrelsen, 1967). The architectural aspect gets especially clear when the pragmatic work of the engineer is insufficient, and the imaginative construction of supportive spaces and relations from the architects is needed. Altogether, all infrastructure of a city constitutes a collection of built objects, and an admixture of architectural and infrastructural prowess. What is most common to think about as architectural infrastructure is Roman aqueduct which is truly an art of architecture and engineering in one. Another good example of architectural infrastructure is the Indigenous Australian Eel Trap is an artful infrastructural object. But other, more everyday-examples of architectural infrastructure are waiting rooms and warehouses, call centres and parking lots, toll booths, public toilets, garbage dumps, slaughterhouses and electrical stations (Frichot, 2023).

Historically, infrastructure has been excluded and repressed when planning urban environments. This is seen in for example architectural drawings, and how infrastructural buildings and objects are placed in the city - out of sight and separated from the landscapes of our everyday lives (Frichot, 2023).

*The drawing is showing part of the infrastructure in Vasastaden, Gothenburg, and the schematic symbols that lack design information in this 2D drawing.*

*Lightning post*

*Well*

*Underground facility*

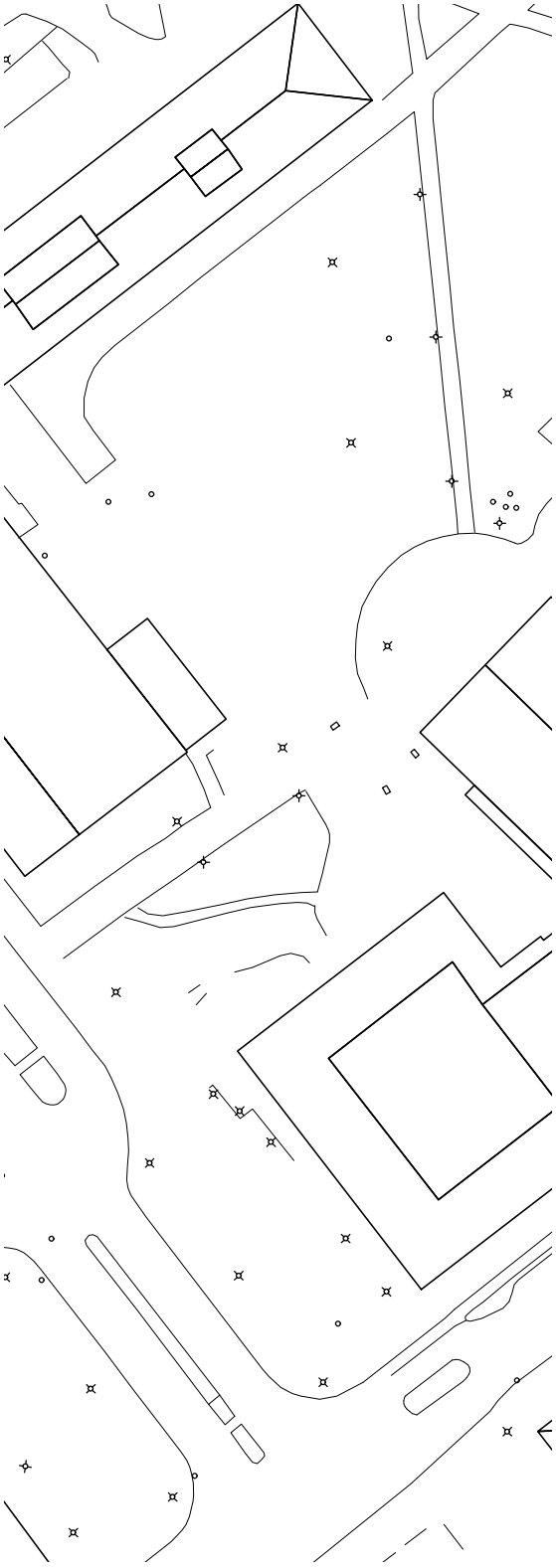
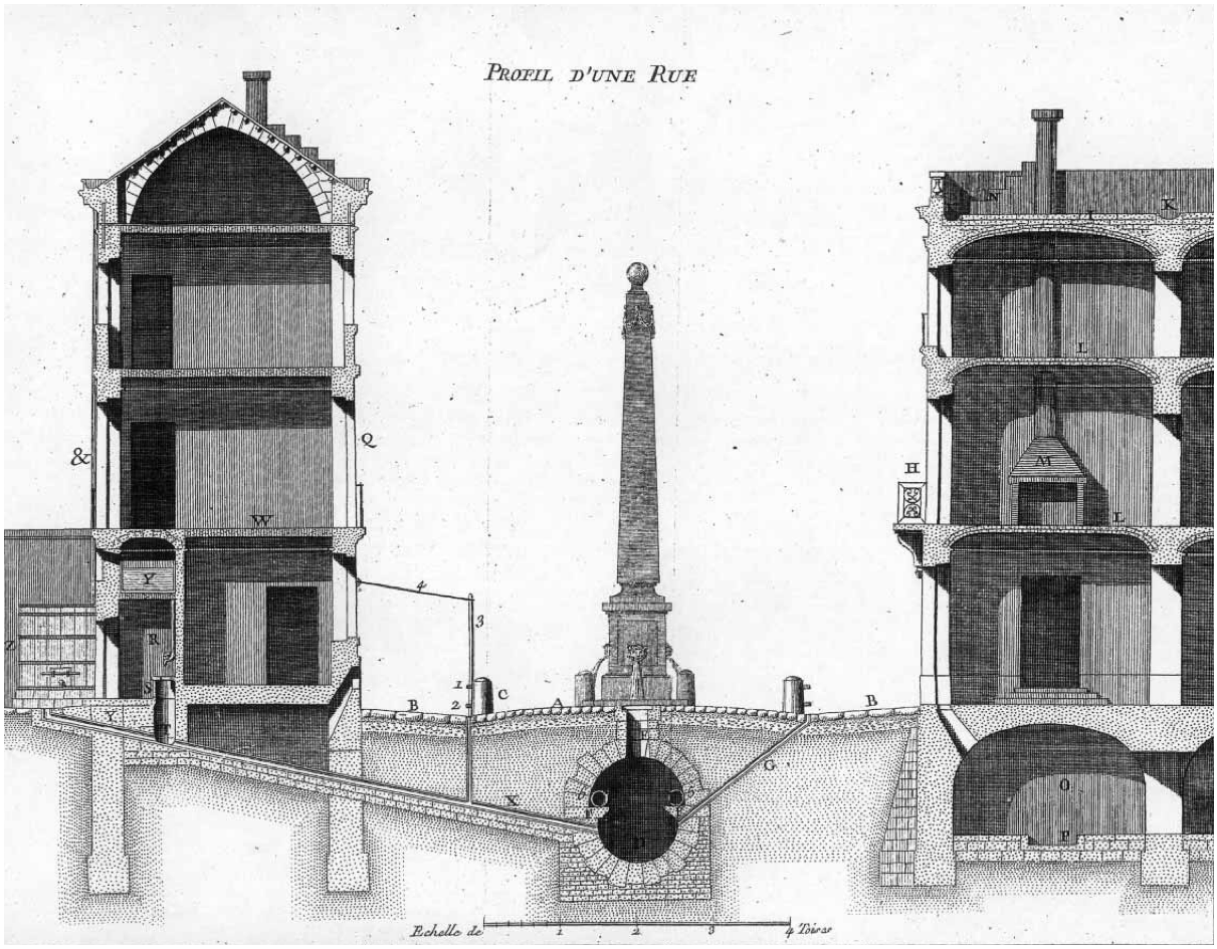


*Figure 4: Pierre Patte: Section of a Street. From Mémoires sur les objets les plus importants de l'architecture, 1769 (Wikipedia, 2021).*

*The section is considered to be the first made on infrastructure in a city, as part of a spatial realm. The representation is especially interesting as Patte is placing the infrastructure and street in relationship to building interiors, and therefore also established the view of the city as a collection of representational forms (Saari, 2015).*




Caldenby (2022) explains that planning processes and landscapes are fragmented within architecture, in a negative sense, and goes on to explain how today we see the global economy being fragmented (Caldenby, 2022). Frichot et al (2022) posit that the work of architects is what maintains the relations between peoples, places, and things, when at its best, but is in this case also, a very political tool. Therefore the architectural work in urban environments cannot get lost (Frichot, 2023).

## WATER INFRASTRUCTURE ON DRAWINGS

Water infrastructure is often a collection of small objects in the city and are not easy to show in a plan in scale 1:1000, which city maps often are. So, a question that arises is how to show all objects fluxes and flows, or seasonal variation, or change with time on a map or drawing (Venturi, Scott Brown, & Izenour, 1977).

## UNDERSTAND THE PAST

Infrastructural systems are part of the environmental humanities, which is a field that needs the understanding of ecological and social challenges facing all life on earth. To understand, the architect must deal with and understand former approaches to the humanities to best address contemporary climate emergencies beyond human exceptionalism. This involves looking at the distributed interventions and complex connections that we have, to study the relational architectural ecologies to be able to develop them. The world is constant and radically changing around

us, and by studying the past theories and methodologies, it's easier to cope with the contemporary challenges. This involves studying natural and constructed environments around us, the environments in which we depend (Frichot, 2023). Izenour et al. (1977) emphasizes that by learning from the existing landscape, the architects get a good base for being and working revolutionary, the architects need to question how we look at things. But today, architects are out of the habit of looking non-judgemental at the urban environment around us, and the modern architecture is more progressive, trying to be too utopian, not adjusted enough to the existing conditions or enhancing the urban environment it is in (Venturi, Scott Brown, & Izenour, 1977).

## MAKE INFRASTRUCTURE VISIBLE

To make infrastructure more visible, which can encourage mindfulness, caring or responsibility, it is also a pedagogical opportunity which in turn reacquaints us with wider communities of life. At the same time it informs us about the ecological consequences of our activities (Van der Ryn & Cowan, 1996). What we focus on and bring to attention as architects will also be the subject of our communication and our design, which involves big responsibility (Saari, 2015).

## INVOLVE COMMUNITY

Another method the authors propose is to involve the public of the city and can contribute to sociocultural imagination which can offer a cultural terrain for collective dreaming, aspiration, collaboration, and negotiation. This can be explored in an educational context where focus can be to reclaim radical imaginaries for the future, based on architectural histories and learnings from the public common (Frichot, 2023). Izenour et al. (1977) describes how involving the community is a "socially desirable activity to the extent that it teaches us architects to be more understanding and less authoritarian in the plans we make". It is part of civic and cultural enhancement (Venturi, Scott Brown, & Izenour, 1977). By working with infrastructure as an architect, it is also possible to expand the client's understanding, knowledge and ambition for architecture. But for this to be possible, an understanding of the infrastructure system is also required from the architect. Regarding infrastructure, the technical function is as important as the aesthetic function in the city (Zawieja, 2022).

## TODAY'S ECONOMICAL URBAN CLIMATE.

Space today is sacred, and Izenour et al. (1977) claims it has been that way since Modern architecture took place. This means painting, sculpture and literature should not take up any space or be "spatial characteristics" in architecture. These are separate subjects and should not be confused. Architectures form should be defined by the service of program and structure. If these were to be mixed, this would also mean mixing of styles and media, which in turn could evoke associations and romantic allusions or programmatic symbolism, like older architecture than the Modern does. At that time, it was considered that the artistic part of architecture enriched the meaning and contained messages beyond their ornamental contribution to architectural space. In Modern architecture, space is sacred, but as a paradox styles and signs are considered anti-spatial, disconnected from architectural buildings, and communication is ranked over space and dominates it. But the signs of Modern architecture only contains the most necessary messages and communication. This philosophy says that architecture defines very little, and a disconnected sign can say more. Therefore the architecture is built cheaper. Another paradoxal thing about Modern architecture is how program is the main thing that should form the architecture, no extras, to make it cheaper, but at the same time other objects like swimming pools are allowed to take place even though they are more symbolic than useful (Venturi, Scott Brown, & Izenour, 1977).

# CONTEXT OF THE PROJECT

## TRANÅS

Tranås is a town consisting of 18 800 people and an area of 403 km² land, which is on the border between Småland and Östergötland and belongs to Jönköping County. Tranås has arisen north-west to the lake Sommen, whose river Svartån flows out of Sommen and meanders through Tranås in a south-westerly direction. Tranås city centre is concentrated just north of Svartån, and Svartån acts to some extent as a barrier to the other side of the city where there is a lot of industry, especially in north-eastern Tranås (NE, n.d.).

Lake Sommen is easily accessible from the city of Tranås. It is a lake that has many lobes, an irregular shape, and a large number of islands and islets. Lake Sommen is a nutrient-poor lake, which means it has clear water. This makes it a good surface water source. Its water surface is 132 km2 and is 145 meters above sea level, and its deepest point is 53 meters below the surface. Sommen's catchment area is 1651 km2 and consists mostly of forest land with a smaller proportion of bog and crop-land. On the water's inflow path to the Sommen, it is purified through the sand and soil it flows through.

In 1874, Tranås became part of the Eastern main line, which runs through the centre of the city. The city grew up around this, and on the east side of the railway a grid of streets was laid out. Tranå's main street that runs through what is today the centre of Tranås, which was designed as a wide tree-lined boulevard. When Tranås was provided with a railway, the population went from 990 inhabitants in 1881 to 5,000 in 1919. From the beginning, Tranås was an industrially oriented town with a focus on fur goods and skins as well as furniture, carpentry, sporting goods. Nowadays, Tranås is a city with a differentiated business life, with a strong furniture industry (NE, n.d.).

In 1899, Tranås' water spa was built, which is now run as a Swedish National Insurance Agency hospital and conference centre. Along the tree-lined boulevard is the city square, where the city hotel with its library is located. Along the Somme lies the city hall, erected in 1953 (NE, n.d.).

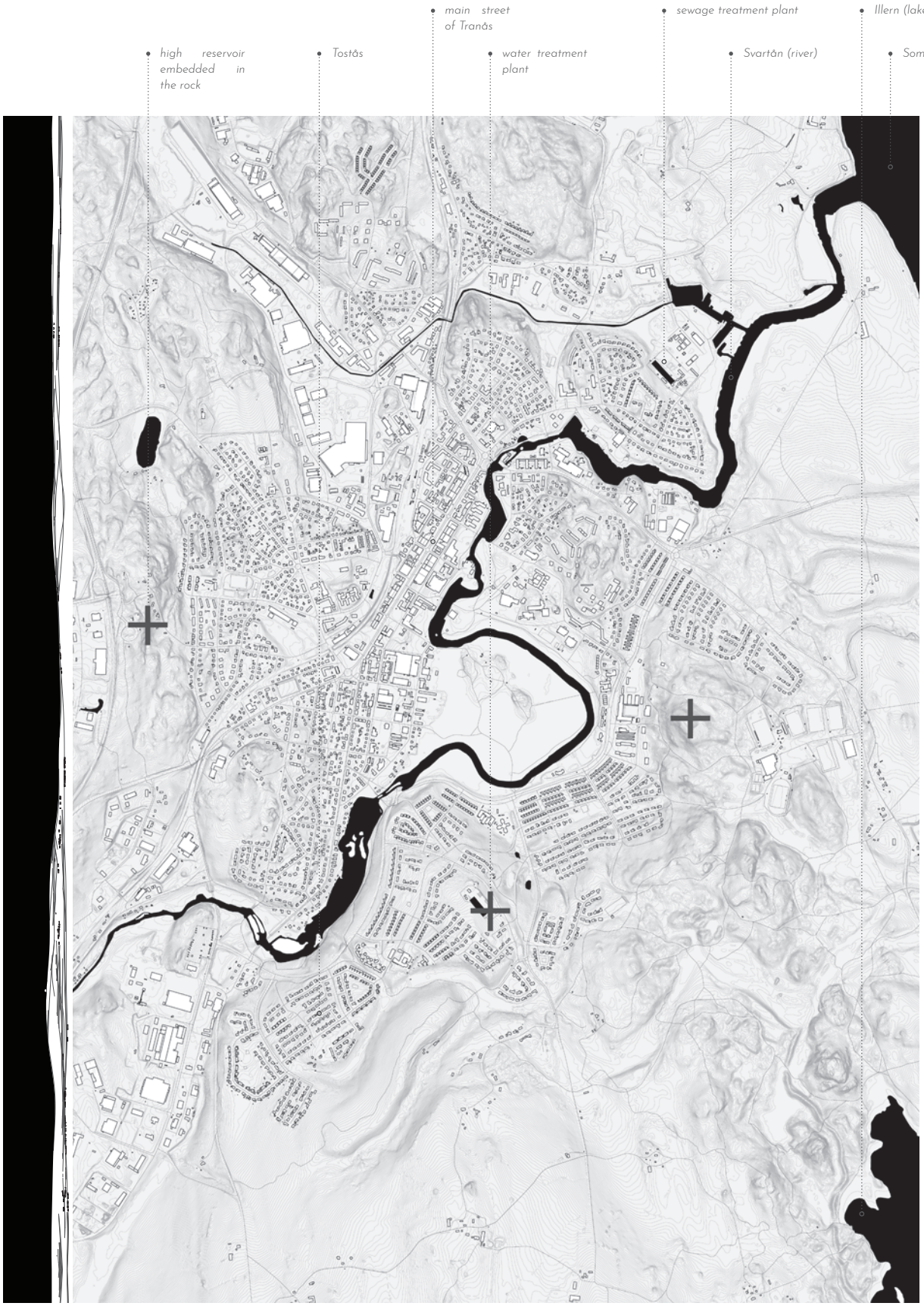
Tranås has a hilly and varied landscape with height differences of more than 100 metres. Currently, Tranås does not have a water tower, but instead has a reservoir embedded in the mountain at Höganloft, in the north-western part of the city. This place is located high, which allows for self-fall from this point out to the rest of the city. The exception, however, is Tostås, a residential area located in the southern part of

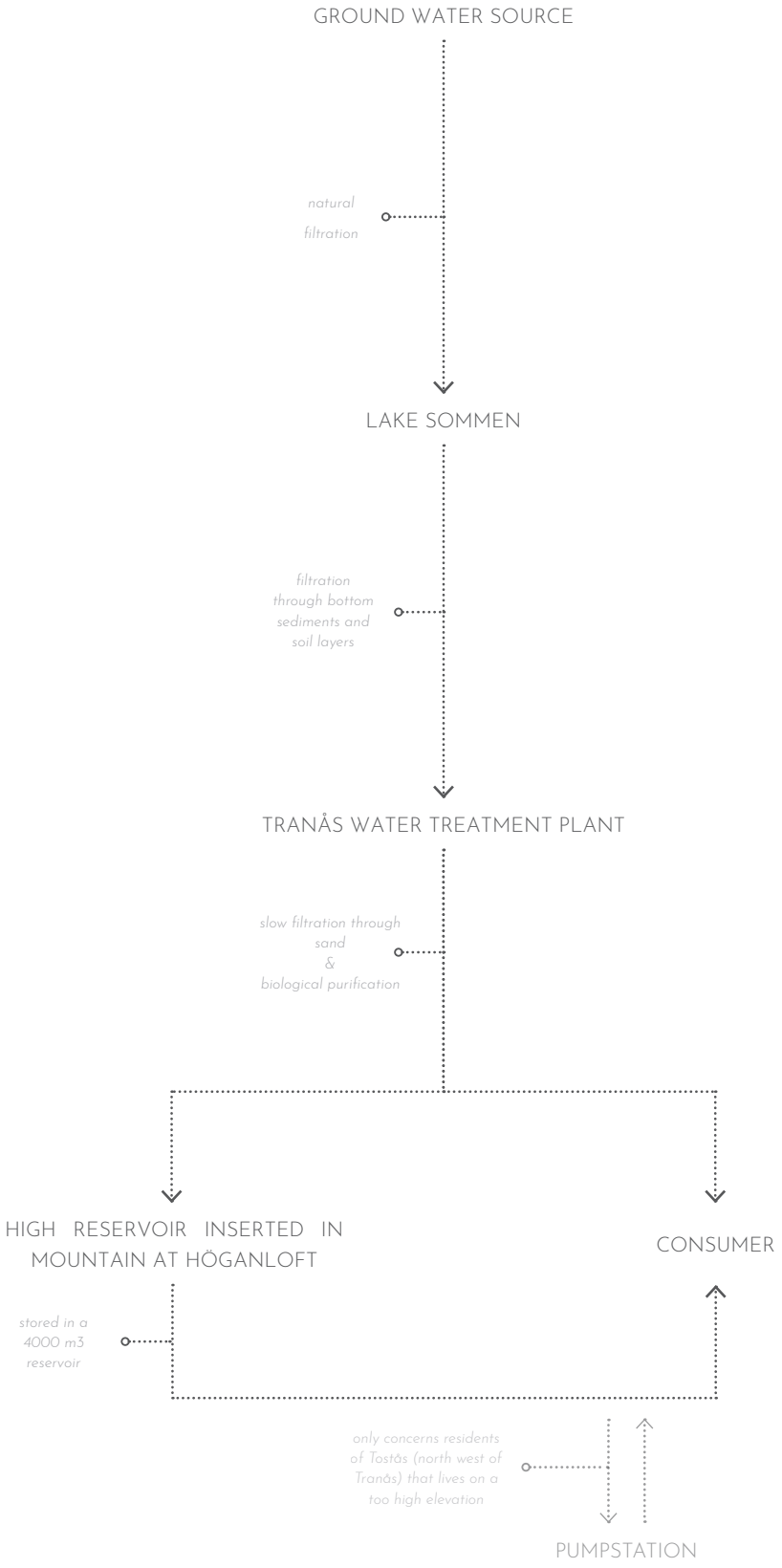
*Top picture: The entering to the existing reservoir of Höganloft in Reanås*

*Lower illustration: Tranås is marked on the map of Swedisn*

Tranås. This area is high above the height of the reservoir in the landscape, which requires booster pumps to give the costumers access to water, which means that this area is not covered by the resilience and protection that a high reservoir should provide (Jan Samsson, personal communication 2024-02-08).

According to Perssons (2006) way of dimensioning the volume needed on a reservoir, Tranås would need a reservoir of 3700 m3, with its 18 800 citizens. This would enable Tranås to grow and supply even its residents on a higher elevation with water in emergencies, as well as helping surrounding municipalities (Persson, 2006).


high reservoir embedded in the rock
Tostås
main street of Tranås
water treatment plant
sewage treatment plant
Svartån (river)
Illern (lake)
Sommen (lake)
N
(km)
1
0,5
0
Scale 1:28 000


GROUND WATER SOURCE
natural filtration
LAKE SOMMEN
filtration through bottom sediments and soil layers
TRANÅS WATER TREATMENT PLANT
slow filtration through sand & biological purification
HIGH RESERVOIR INSERTED IN MOUNTAIN AT HÖGANLOFT
CONSUMER
stored in a 4000 m3 reservoir
only concerns residents of Tostås (north west of Tranås) that lives on a too high elevation
PUMPSTATION

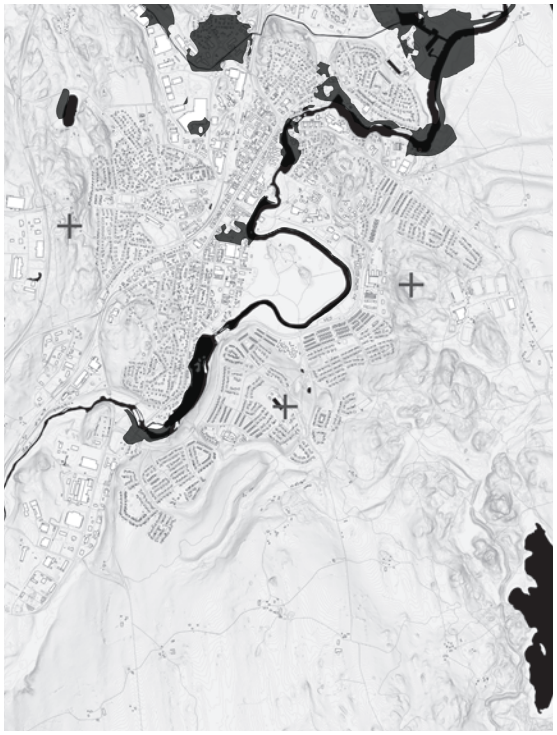
*The marked area on the maps are the surfaces below the specified elevation The various drawings show:*

*145 meters above sea level - the lowest surface in Tranås, at the level of the Sommen and Svartån*

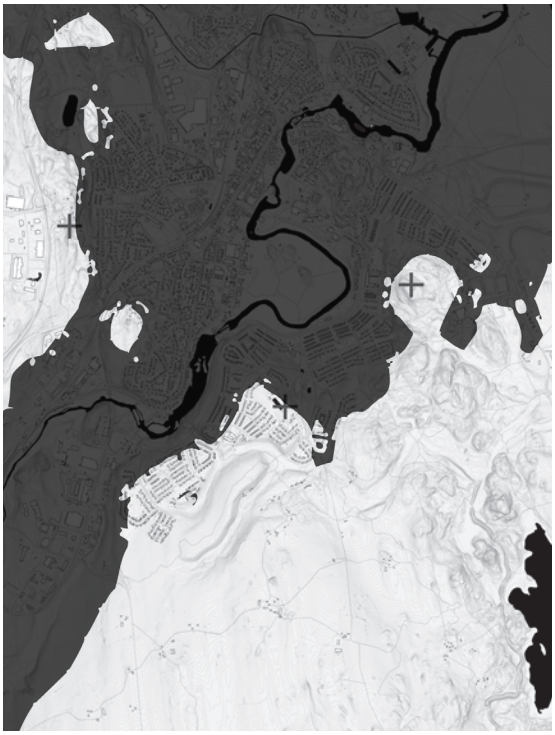
*185 meters above sea level - the height at which Tostås is located*

*195 meters above sea level - the height at which a water tower can be placed if it is 40 meters high*

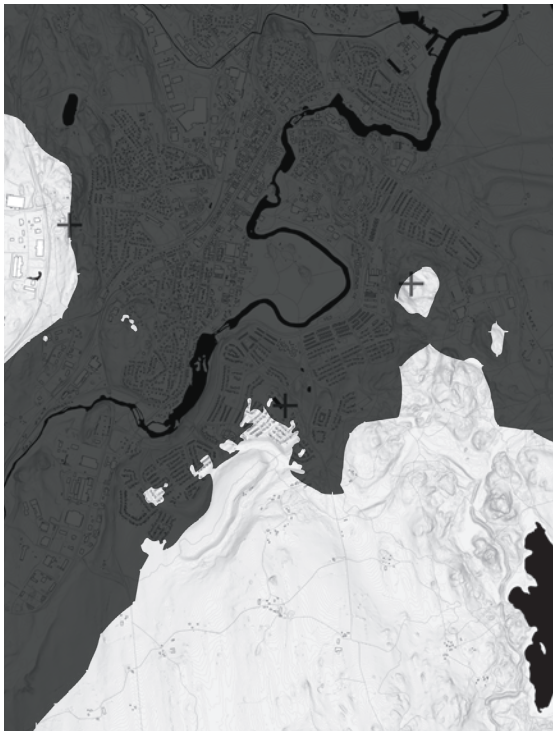
*235 meters above sea level - the height at which the reservoir needs to be located, if the reservoir is not to stand on a structure*



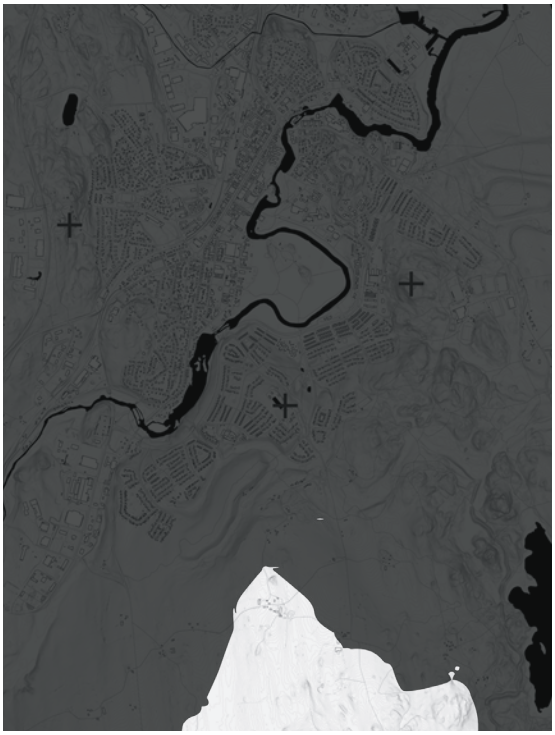
*145 meter above sea level*



*185 meter above sea level*



*195 meter above sea level*



*235 meter above sea level*

# METHOD & TOOLS

The project's method investigate the significance of the water infrastructure's architecture for the city, with an extra focus on the water tower. As a background, the importance of the architecture of the water infrastructure is examined in general, in the form of creator of society, a tool for colonization, a tool for democracy and a fundamental prerequisite for the health of society. A closer examination is made of the water tower's architectural qualities, and what they mean in terms of landmark and symbol. This exploration takes place through the theoretical background of the subject, and then leads me on to a design exploration where a water tower is created that responds to the theory.

As Bernd and Hilla Becher has done, existing water towers are documented to note typologies and differences. To take their method further, not yet built water towers that have been part of the Värmdö competition are documented in the same way. After that, the same method is applied in form of imaginative water towers that are to be part of the analysis of what water towers look like, symbolize and allude to (Becher & Becher, 1988) (Sveriges Arkitekter, 2024).



After that, with the exploration just made as a background, design proposals are made to explore different opportunities. Qualities water towers should have, found in the theory are taken in consideration when choosing design version. Further decoration and relief design is made by drawing workshops.

*Oxelösund*
*1899*

*Helsingborg (demolished)*
*1906*

*Kungsör*
*1910*

*Hässleholm*
*1910*

*Gnesta*
*1910*

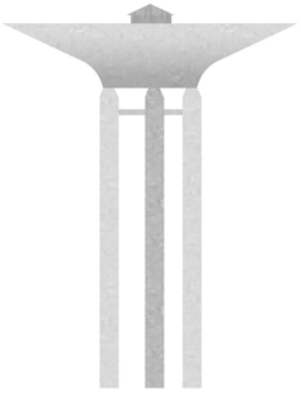
*Linköping*
*1910*



*Trelleborg*
*1912*

*Malmö*
*1916*

*Sandviken*
*1930*

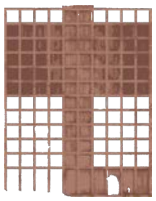


*Landskrona*
*1970*

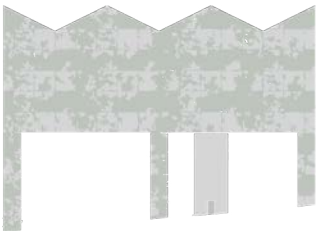
*Helsingborg*
*1960*

*Botkyrka*
*1957*

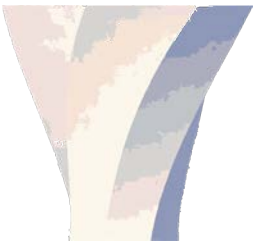
Elevations of existing water towers with their place and building year



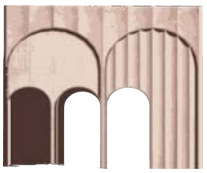
*Mirage*



*Hemmesta kronan*



*Virvel*

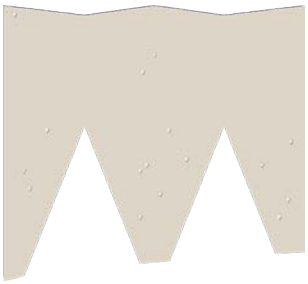


*Hemmesta bågar*

*Samothrake*

*Porta pelagus*

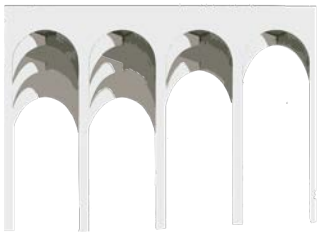




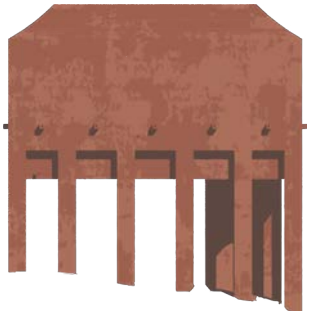
*dubbelVV*

*Droppen där vattnet bor*

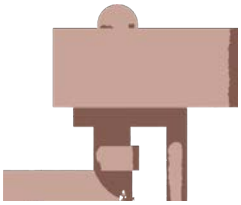
*Hällen*



*Gläntan*



*Spqh*



*Stapeln*

Elevations of water towers from the competition in Värmdö 2024, marked with their competition name

0 20 40 (m)

Skala 1:1300

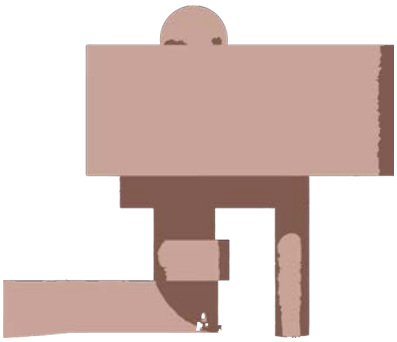
# ANALYSIS OF THREE WATER TOWERS FROM DIFFERENT TIMES

## EARLY WATER TOWERS
HÄSSLEHOLM - 1910

Clear division of a stone masonry base, a brick shaft and a green copper crown, a design typology of water towers that dominates this time period. The tower is house-like with symmetry and holes in the facade that forms windows. The facade has relief's, perforations, ornaments and shifting in colour that detail the facade. The volume is vertical and is in most cases more or less designed as a tall cylinder.

## MEDIUM-OLD WATER TOWERS
LANDSKRONA - 1970

The three-parted typology of a base, shaft and crown is still present, but in different form. The base is long, often in form of pillars or legs. The shaft is shorter and more sculptural. The crown is small and similar looking to the rest of the parts of the water tower, especially when it comes to materials. The materials do not differ between the different parts of the tower, and is now in almost every case in concrete. The silhouette is sculptural and symmetric around an vertical tangent. The volume is vertical, but not shaped as a cylinder.



## NEWER WATER TOWERS
STAPELN - 2024

The three-parted typology has gone lost, more or less. What is kept is the base, often in form of pillars or legs. The hole volume is sculptural and playful with little details in form of relief's, perforations, ornaments or shifting in colour that detail the facade. The water tower is not symmetrical around a vertical tangent, and not too symmetrical in its elevations either. The material is still concrete, but now often coloured. The volume doesn't have to be vertical and a square-like or horizontal volume is more and more common.

# WATER TOWERS AS A TYPOLOGY

Water towers are and have always been a shell covering the function of the tower. Inside, there's a high reservoir, standing on pillars, having stairs leading up to it. The shell has had different aesthetics and purposes over time, which is shown on the three towers on the left hand side.

The earliest water towers are tall and three-parted with high detailing. During the mid-20s' the volumes of the tower reservoirs come to get larger. The three-parted volume is still present, but the proportions are different. Going to modern water towers, the volumes are still large, but the three-parted typology have more or less gone lost, and the typology has gone to be more sculptural than before. But going from being tall, high towers in the earliest water towers, the volumes are nowadays more often horizontal in their form, and not as neat. The detailing is still present, but not on the same level as it once have been. Material-wise the water towers have gone from having a wide range of differentiation, including colours and technicalities. In the mid 20s', the material was always grey concrete. Nowadays the material is most often concrete, but the colours can differentiate.

*The design laboration is investigating what a water tower looks like and how it possibly can look. The delimitations for the laboration are that every tower has to be 30 meters high, without materials and have to be placed in the same spot in nature similar to Tranås.*

*What can be discussed from the laboration is how much of infrastructure the different towers looks like, how inviting they are, how transparent they are and how heavy they are.*









*Diagram of existing water towers and designs of water towers from the Värmdö competition.*

*The water towers are placed in a diagram showing whether they are horizontal or vertical, house-like or infrastructural like. The existing water towers are more vertical and house-like, while the competition-designs are more horizontal and infrastructure-like.*

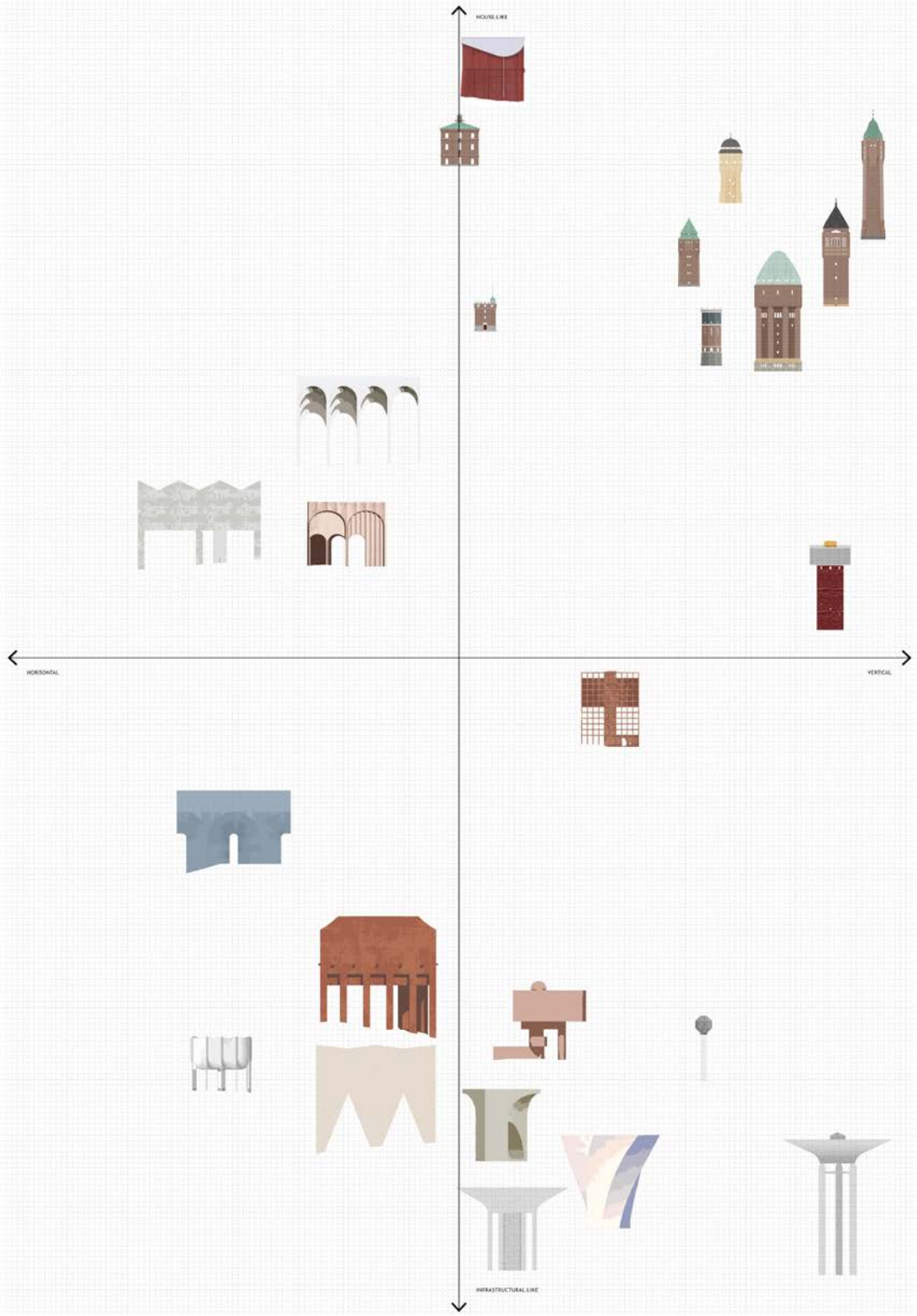


*Diagram of water towers from the first design elaboration made in the master thesis.*

*The water towers are placed on the right side of the diagram, meaning they are vertical. The designs are more infrastructural-like than house-like.*

# A WATER TOWER SHOULD

**Symbolize relationship**
... with infrastructure, with care, with society, with humans, non-humans and more than humans

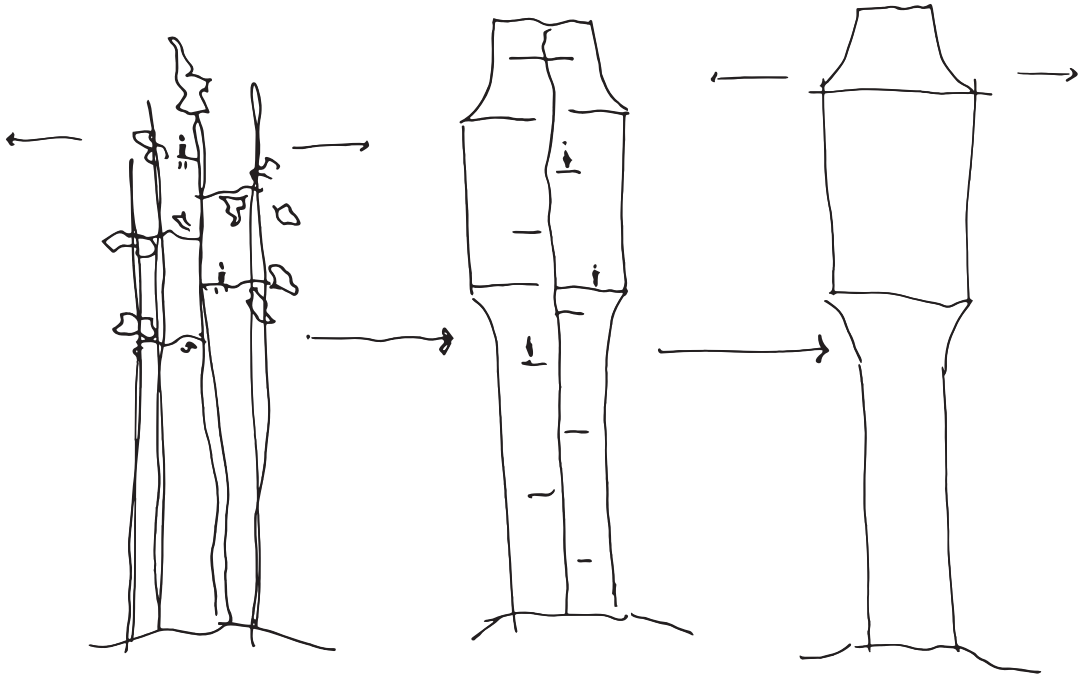
**Act including**
... to increase the awareness of the waters value as a vital source

**Have a tall silhouette**
... with good salience for citizens and tourists to relate Tranås to

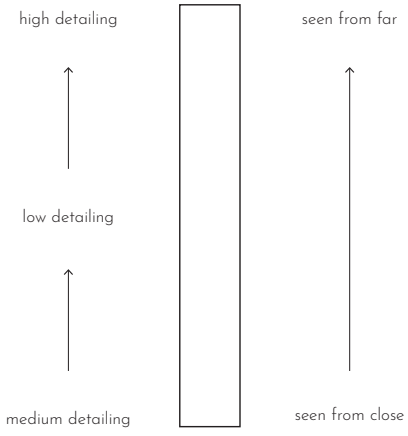
**Teach the perplexed infrastructure**
... by showing its function so that understanding is created. That could in turn lead to a "yintopia" understanding of water infrastructure

**Be open for the society to visit**
... in an non-colonisational and democratic way, welcome the whole society no matter class, location, gender or age to visit and take part of the experience and the learnings from infrastructure

**Be built of sustainable material**
... standing many, many years. Both for environmental reasons, but also to stand as a monument when obsolete






high detailing
low detailing
medium detailing
seen from far
seen from close

# RESULT

The result of the thesis is a water tower situated on Junkaremålen in Tranås and has a capacity of 400 m³ water. The reservoir complements the existing reservoir on Höganloft and is able to provide all citizens, including integration of the citizens living in Tostås.

## ARCHITECT WORKING WITH WATER INFRASTRUCTURE

As an architect working with the engineering art I deliberately chose to work with the concept of the pine trees and their appearance. Another choice has been to make the infrastructure a designed object, working with infrastructural love to create more affection between humans of the site, non-humans that visit and the more than human structure. By deliberately design, decorate and relief the water tower, the reciprocity between art and society contribute to make the water tower a more significant object. The concept together with the carefully designed piece will create a bond to the site and the citizens, which can contribute to make the water tower a stronger symbol and landmark of Tranås.

## FUNCTIONING

The water tower consists of a substructure and a superstructure. The substructure consists of the high reservoir and a truss which it is held by. The superstructure consists of a outer shell strengthened by a truss on the inside. Outside of the superstructure is a metal net that also is part of the superstructure, and is a transparent shell enabling a view from the tower (see the axonometry for a construction explanation). The reservoir is rotated around its vertical axis for hydraulic reason. The sub- and superstructure are almost rotated around its vertical axis, this is for clarity, understanding and educational reasons, as well as for the material economy.

The water tower is free of electricity in its own function, but need the pump of the water treatment plant to receive water to its spare magazine.

As this water tower is open, there is no need for electrical ventilation. It is enough with the natural ventilation.

## INFRASTRUCTURAL LOVE

The water tower allows the infrastructure to advance in the foreground, instead of under ground. This is made through having both pipes, construction and reservoir visible, and everyone visiting can see the construction ageing, faulting, being repaired and working. All part of the water towers life, in line with the "yintopia"-way of seeing infrastructure. The visitor has to adapt to the water towers structure, walk under and over the truss and its beams to be able to visit every corner of the construction.

The water towers open design enables to connect humans to earth and its more-than-human powers, where water is one of them.

### STORYTELLING

Creating an open infrastructural object, both in terms of design of construction and in terms of including the public, the storytelling mouth to mouth and by traces on site can thicken the present of the water tower and its role in Tranås.

As a resistance to the fast-paced society and technology, the water tower is designed to re-conceptualize and to be experienced on the way up, regardless of taking stairs or elevator. Therefore both of them are open, and the construction and function is to be experienced on the way up to the top. The form is active, expressing both disposition and capacity.

## APPEARANCE

The location is chosen partly for hydraulically advantageous reasons, but also to improve the possibilities for the tower to become a social symbol for Tranås. The tower is placed in sight lines from intersecting streets to Tranås' main street.

The design of the water tower has deliberately been made to create shadows, silhouettes and an appealing appearance both from distance and close up. Therefore, the design has construction, shadow-elements and silhouette-elements layered over each other, all contributing to an interesting shape and design with a broad set of qualities.

### LANDMARK

With the concept that the water tower follows, the tower blends into its place, but also gets a protruding shape compared to its surroundings by the tower bending to the crowns of the pines and extending its own crown over the pines, so as not to disturb the place.

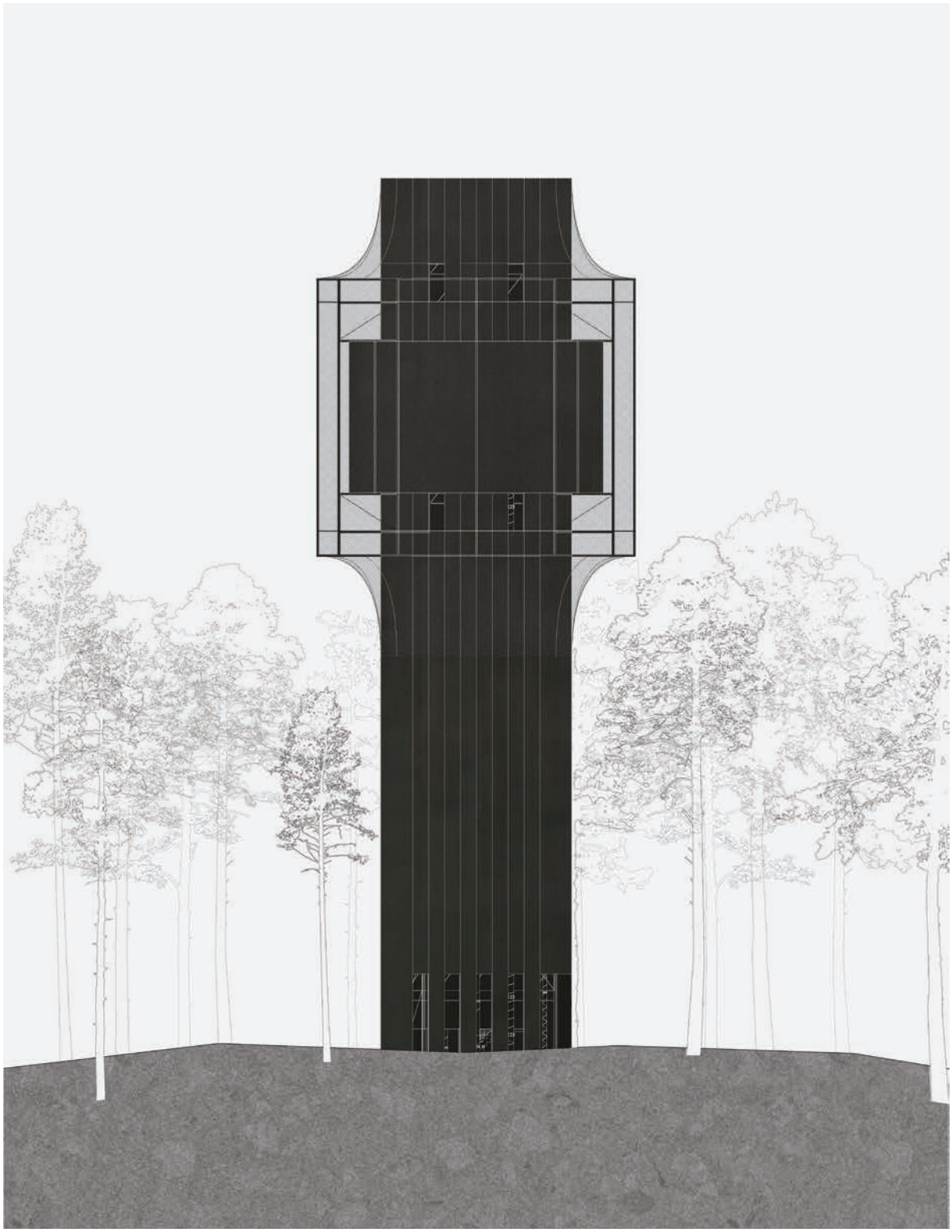
Based on the landmark design strategies: visual, semantic and structural, the tower has been designed to have good conditions to become a landmark for Tranås.

The capacity to see the water tower has been worked on by creating a silhouette that rises above the treetops on the site and is visible in the landscape. Its black colour is visible both in nature and in its contrast against the sky. The shape and silhouette is based on the shape of the pines, but stands out in the surroundings thanks to its colour and its silhouette against the sky.

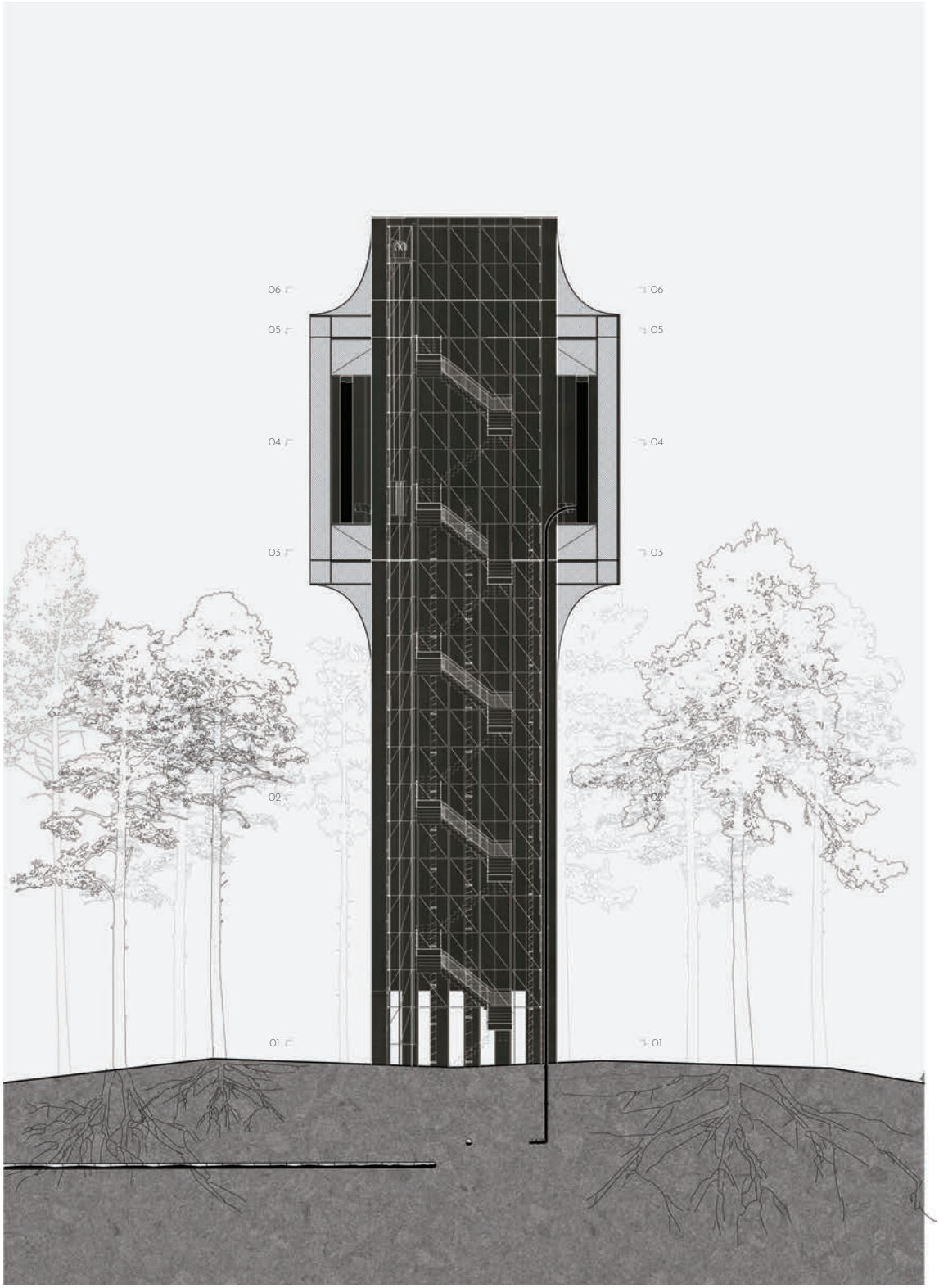
The semantic has been worked on by creating a designed, embossed and shadow-creating object that will contribute to making the place a more significant place for Tranås.

The structural has been worked on by showing off the construction and infrastructure and creating curiosity. This is clearly visible up close to the water tower. To create a similar structural curiosity to the water tower from afar, the semi-transparent metal mesh has been placed on top, which both sounds and creates curiosity about what is happening inside. Another structural choice is the location of the tower in the city. The tower is located on a hill and its location is within sight lines from several intersecting streets to Tranås' main street.

*The illustration shows the new water tower in its surroundings.*



*Elevation towards XXXX*

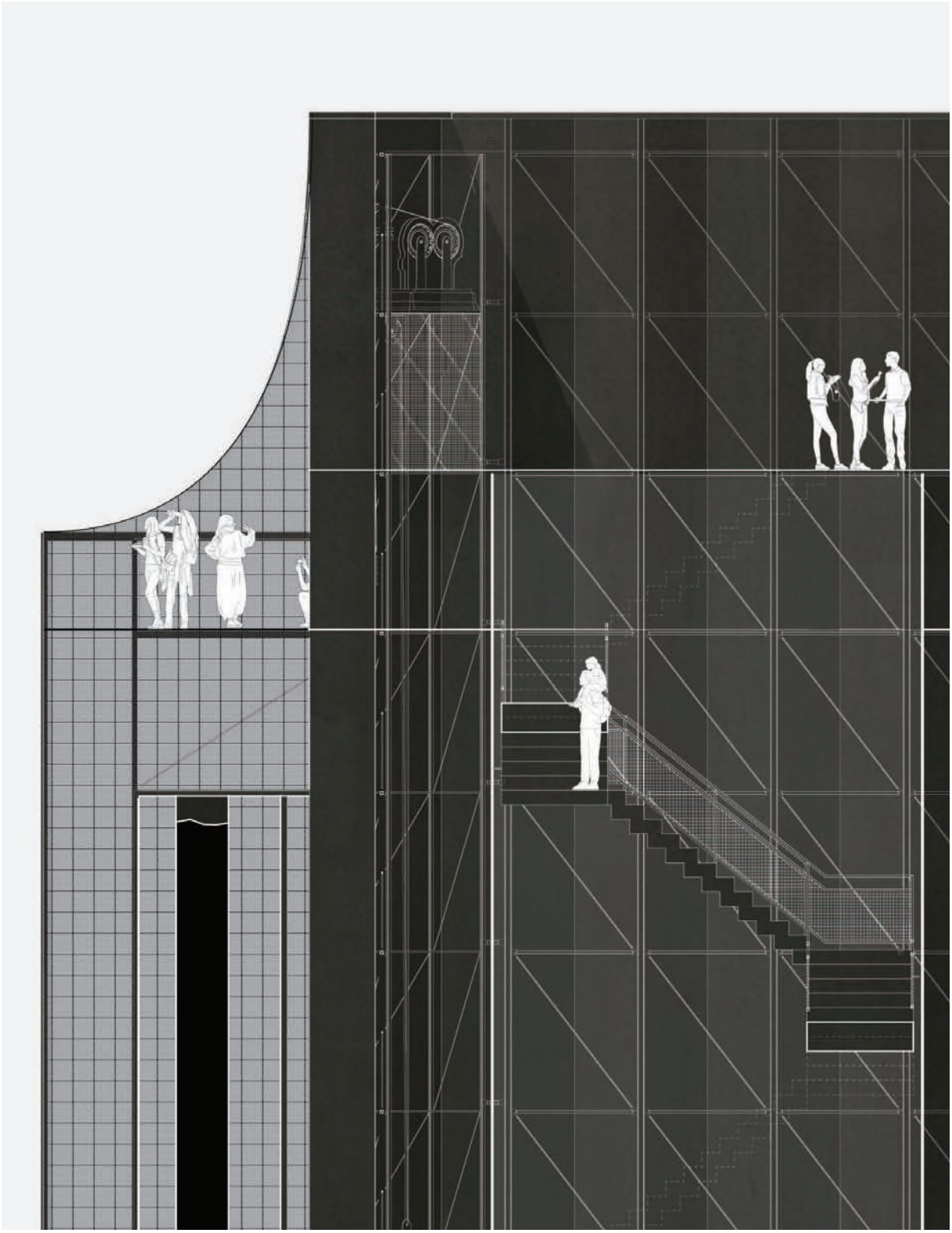



*Section XX-XX*

0 5 10 20 m

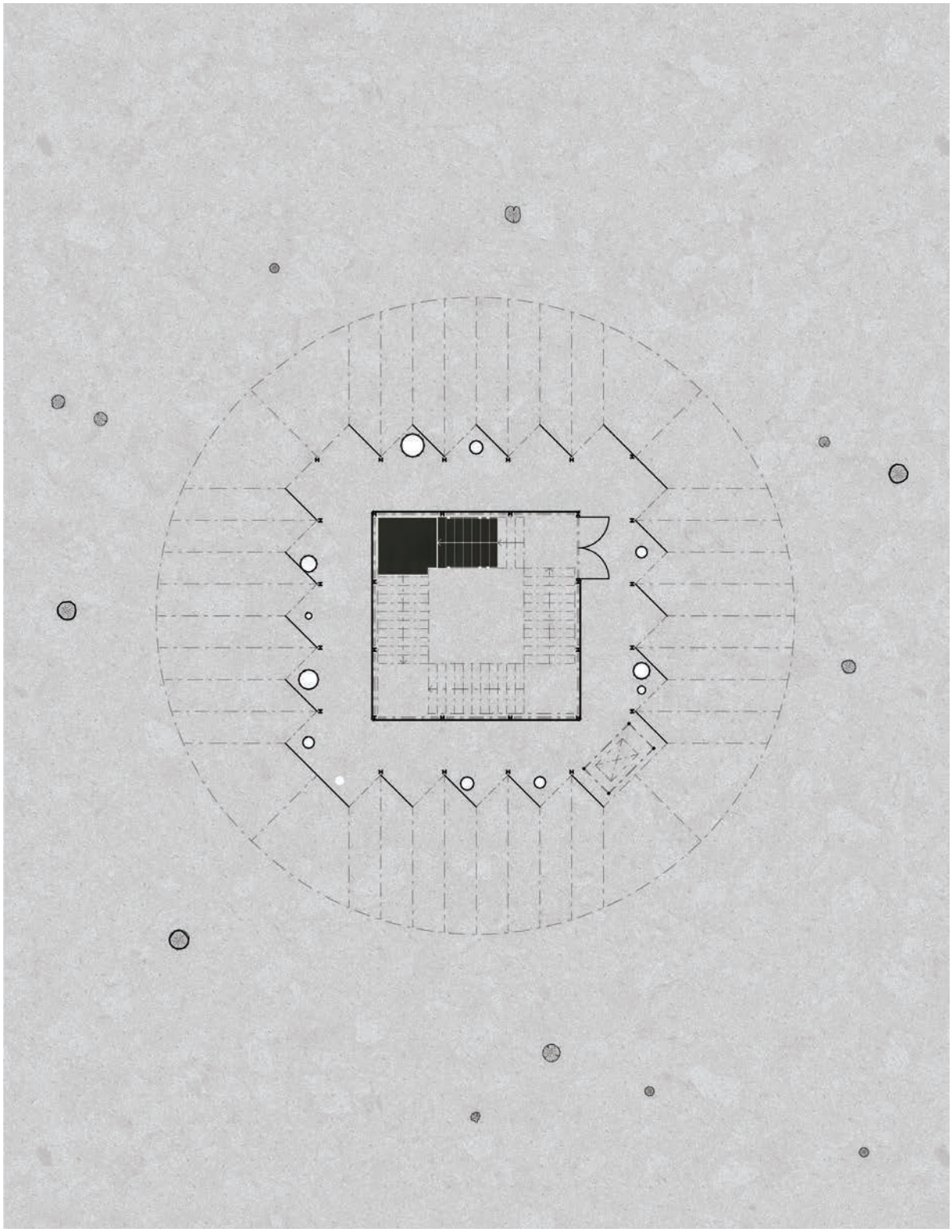
Skala 1:500

*The section shows the construction and the life of the building*



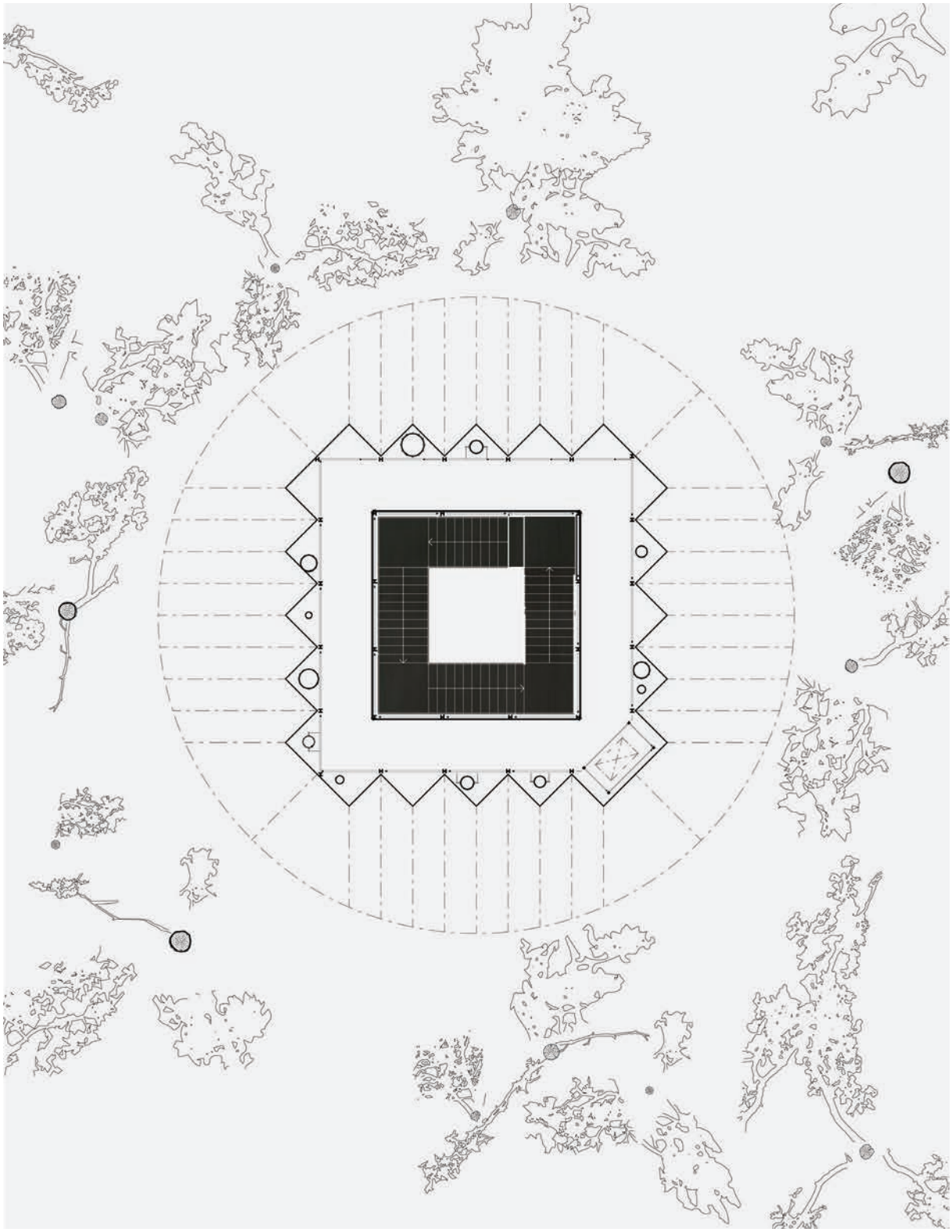
0 1 2 4 m

Skala 1:100



*Plan 01*

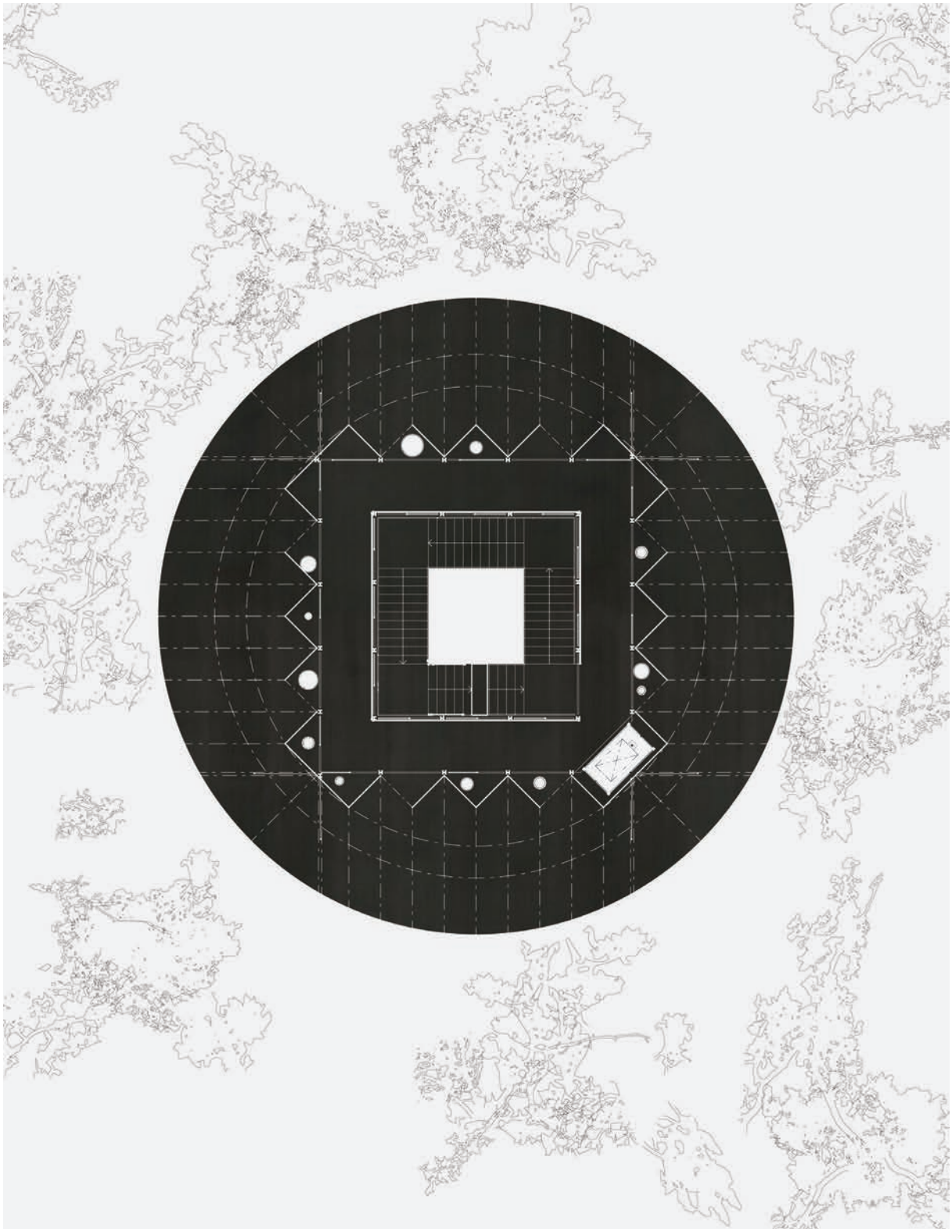
*The plans shows the interior of the water tower and its function.*



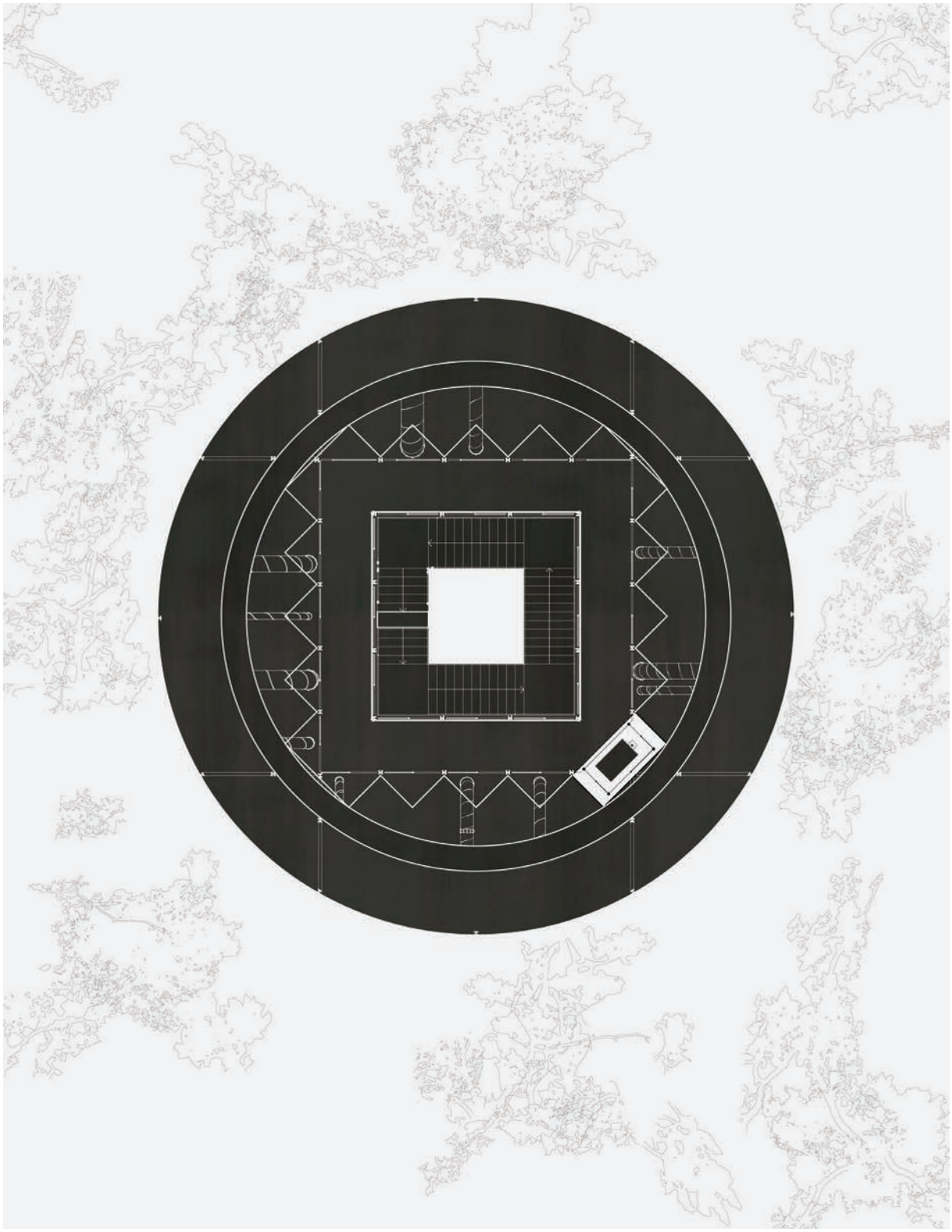
*Plan 02*

0 2 4 8 m

Skala 1:200



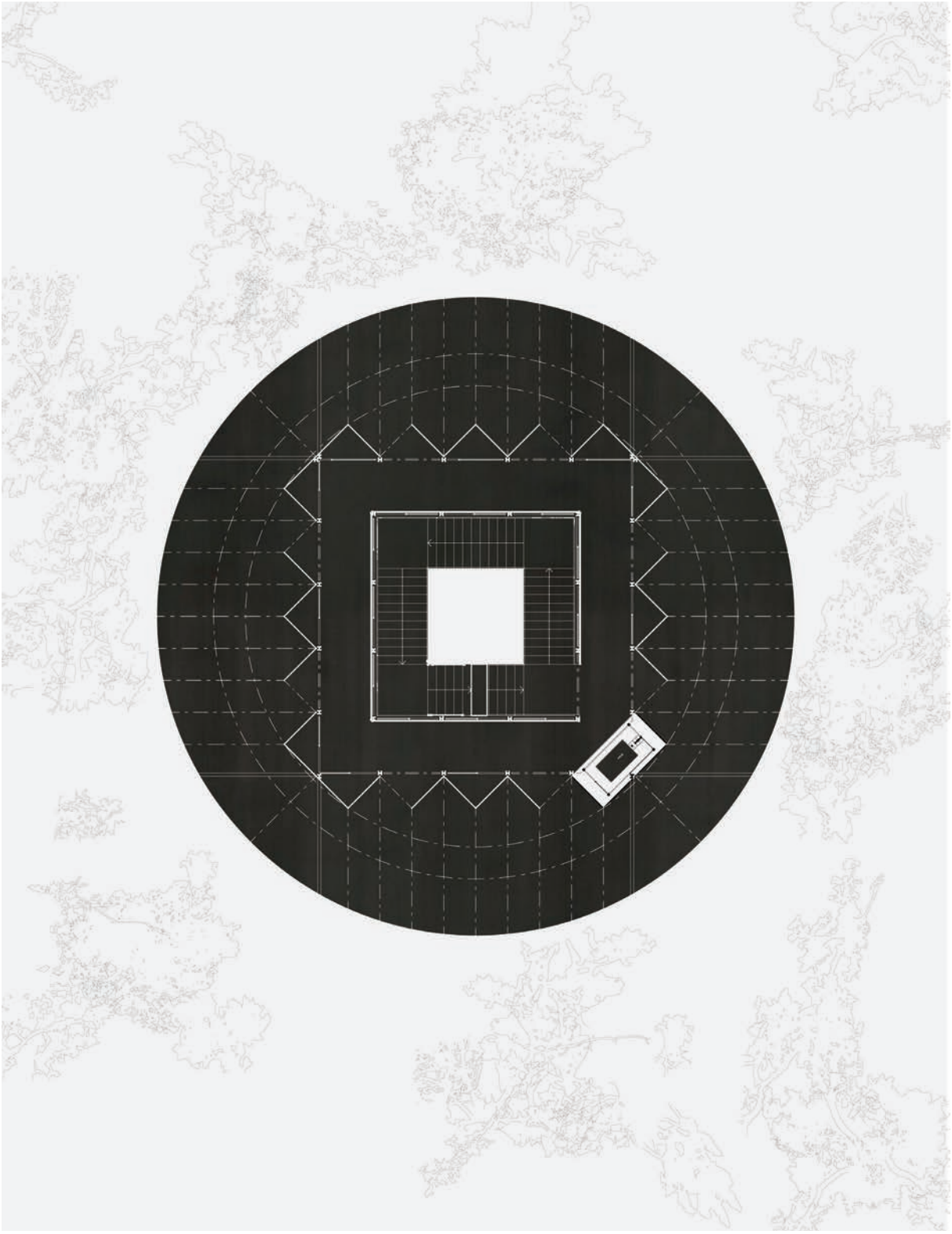
Plan 04



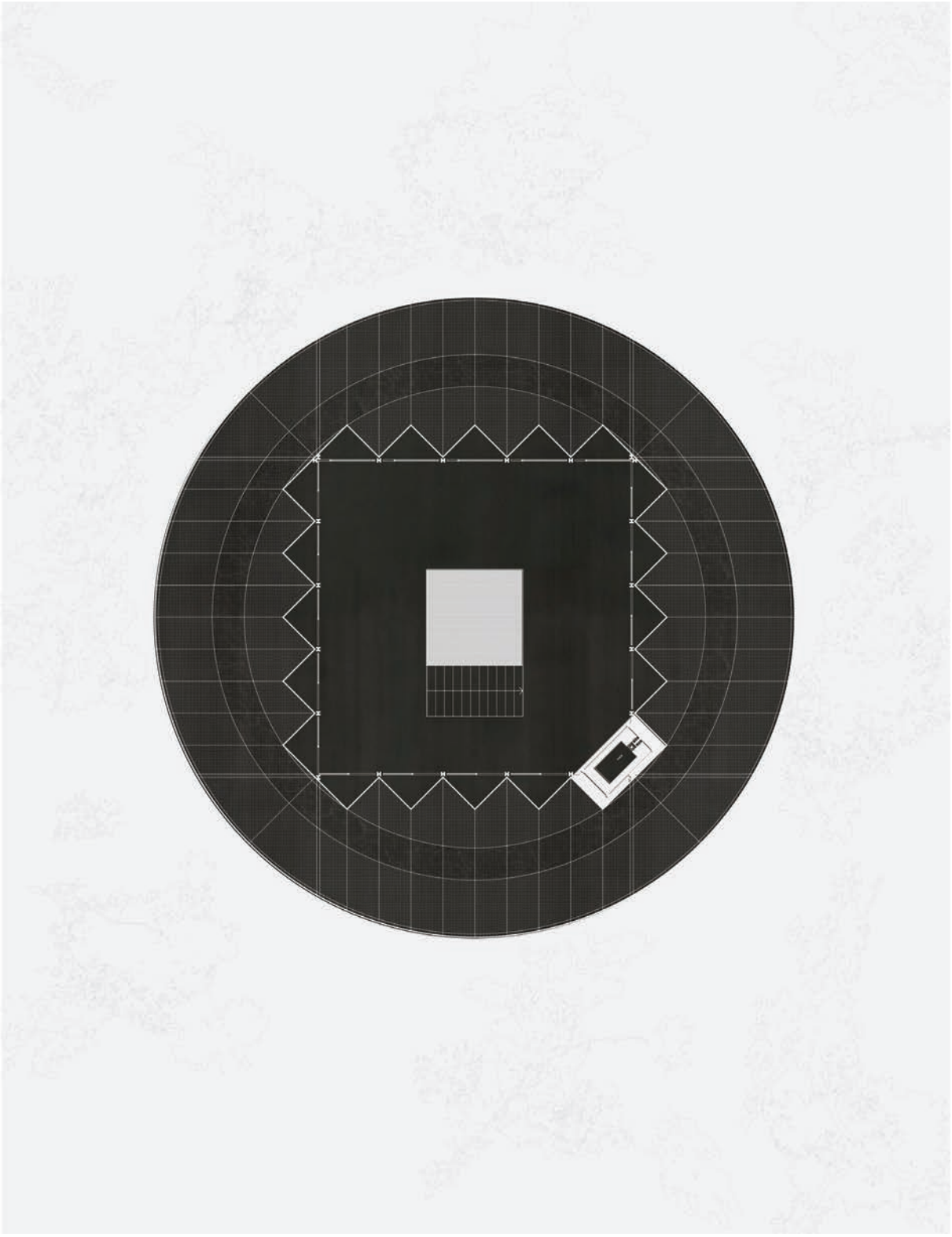
*Plan 04*

0 2 4 8 m

Skala 1:200



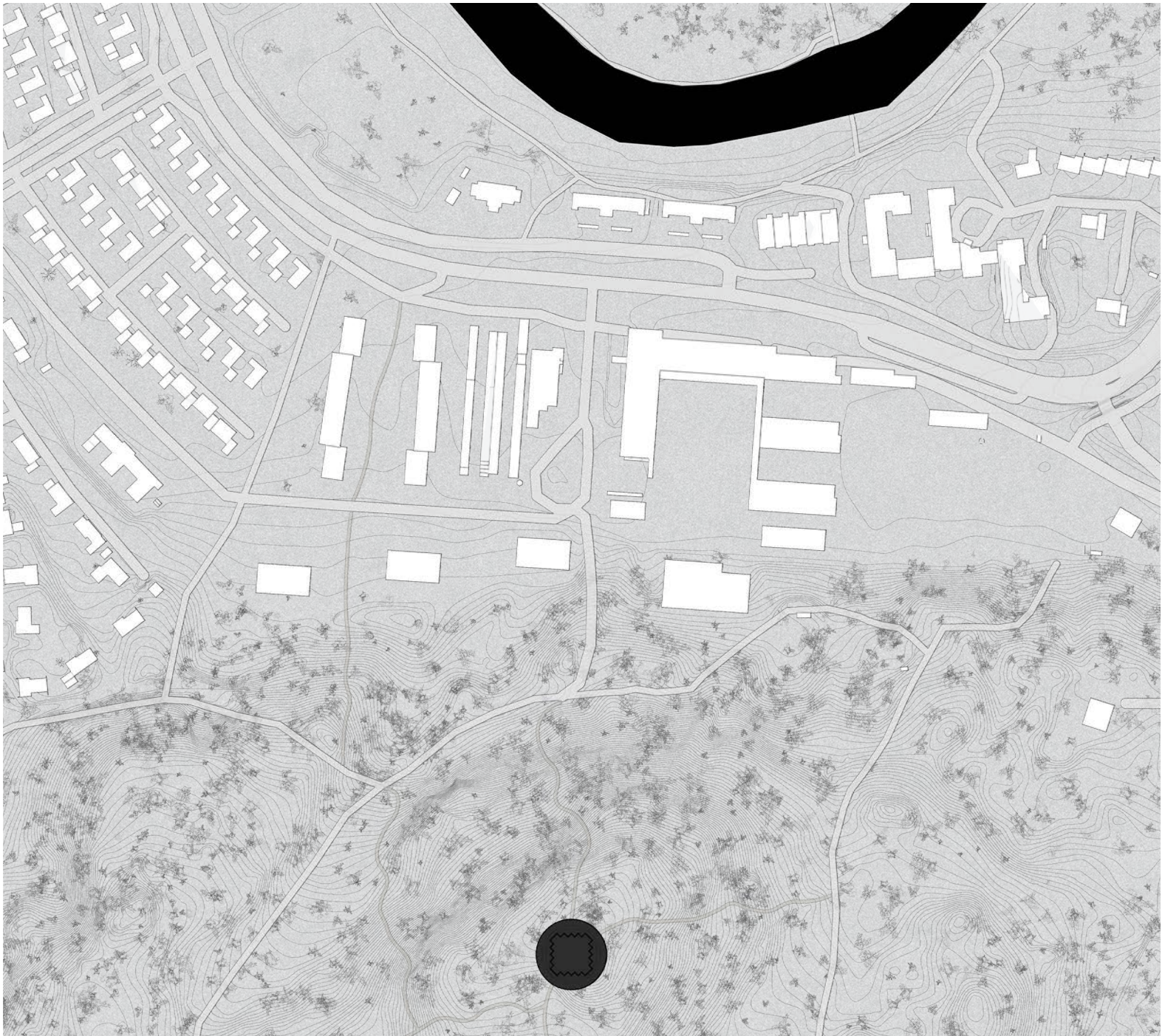
*Plan 05*



*Plan 06*

0 2 4 8 m

Skala 1:200

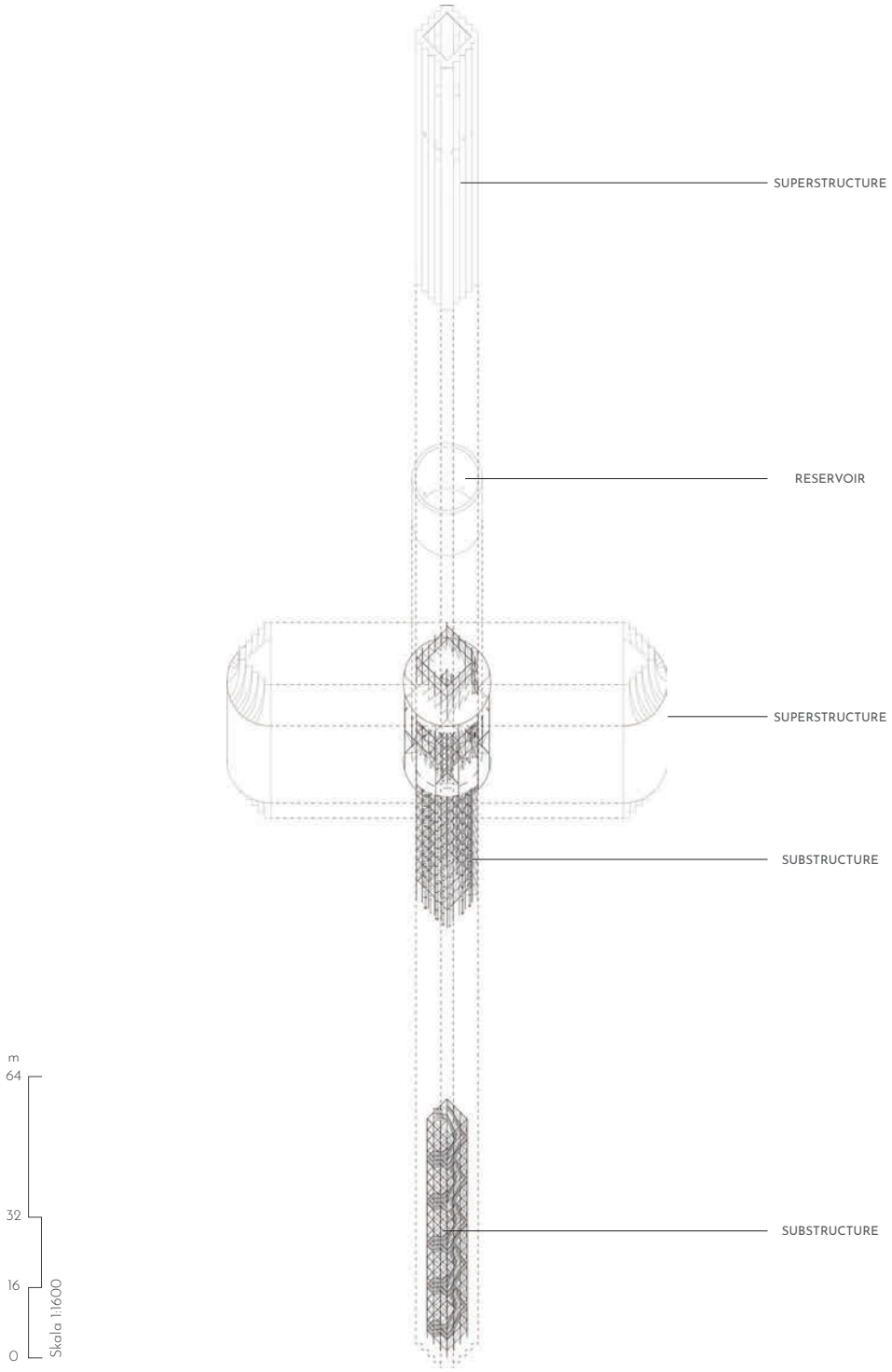


*The situation plan shows the water tower in its surrounding area.*

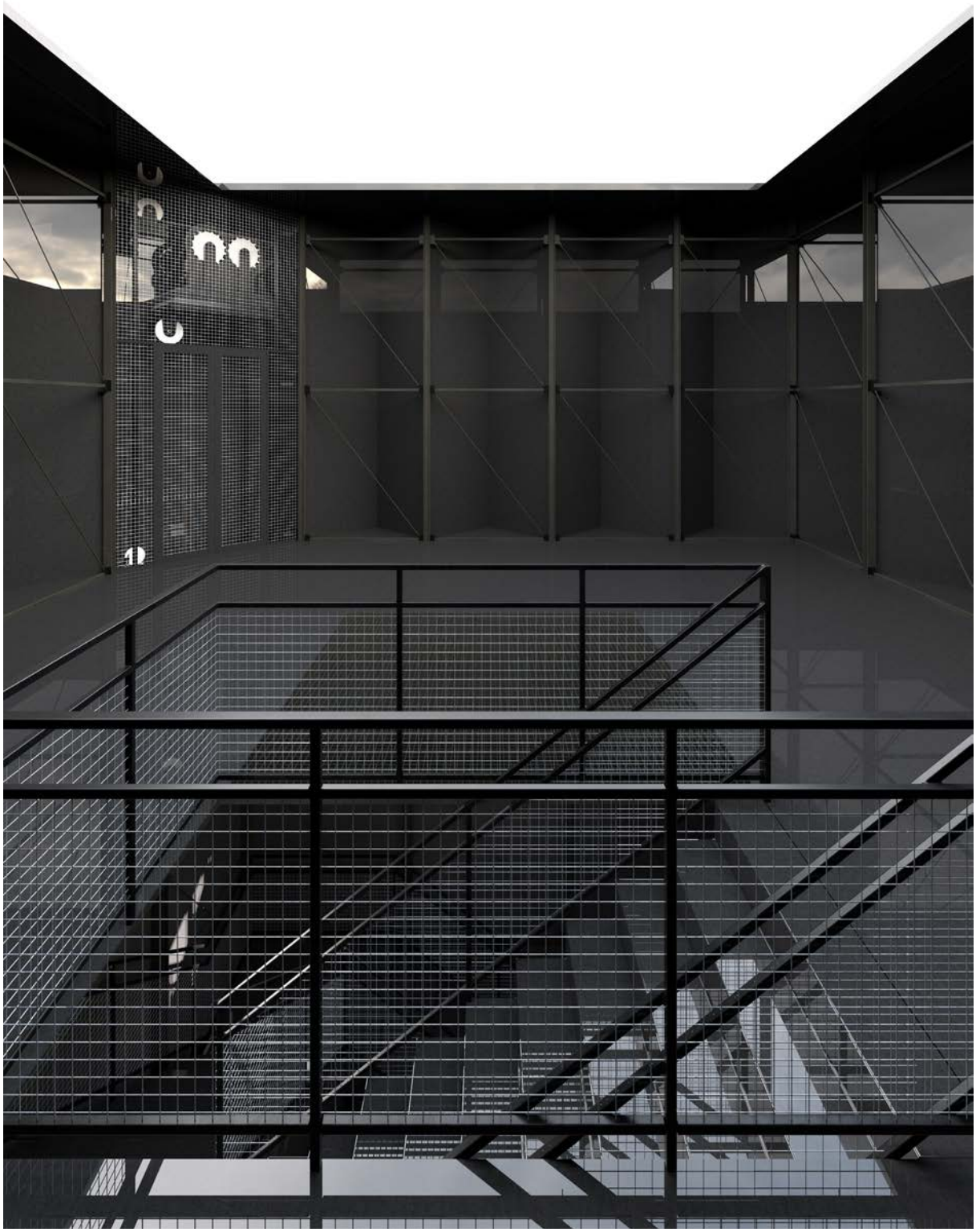
0 15 30 60 m

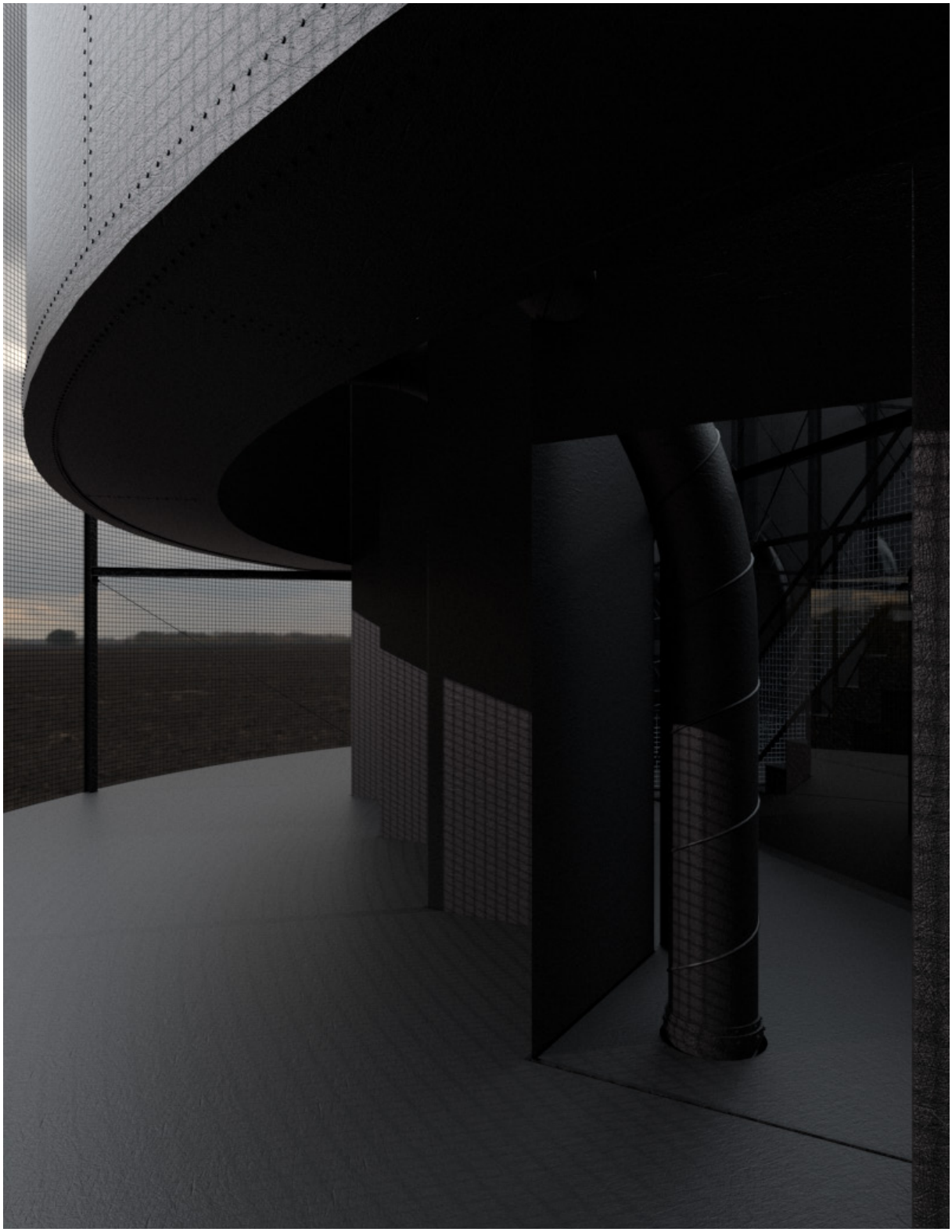
Skala 1:1500

*The axonometric shows the construction and the function of the water tower.*



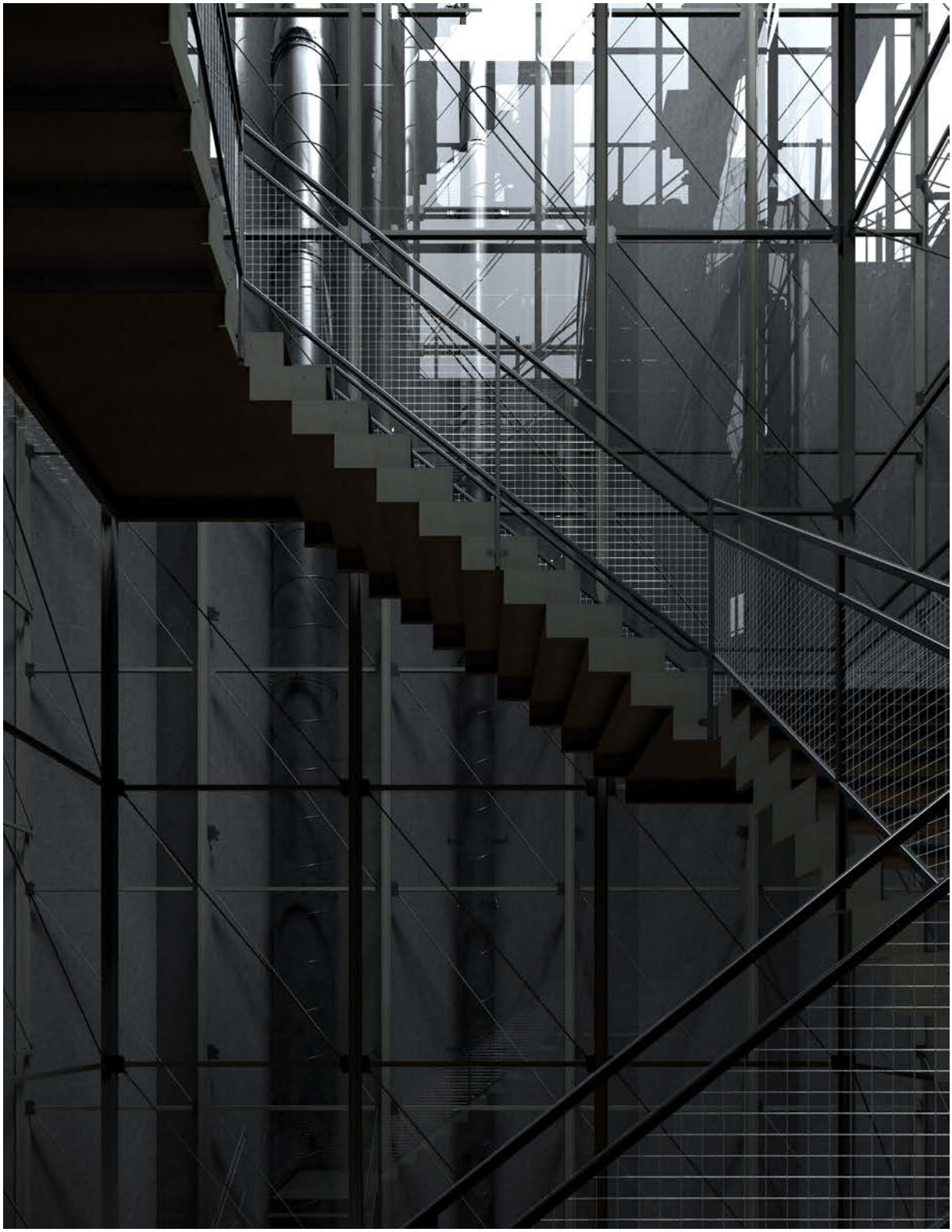
*The illustration shows the interior of the water tower*

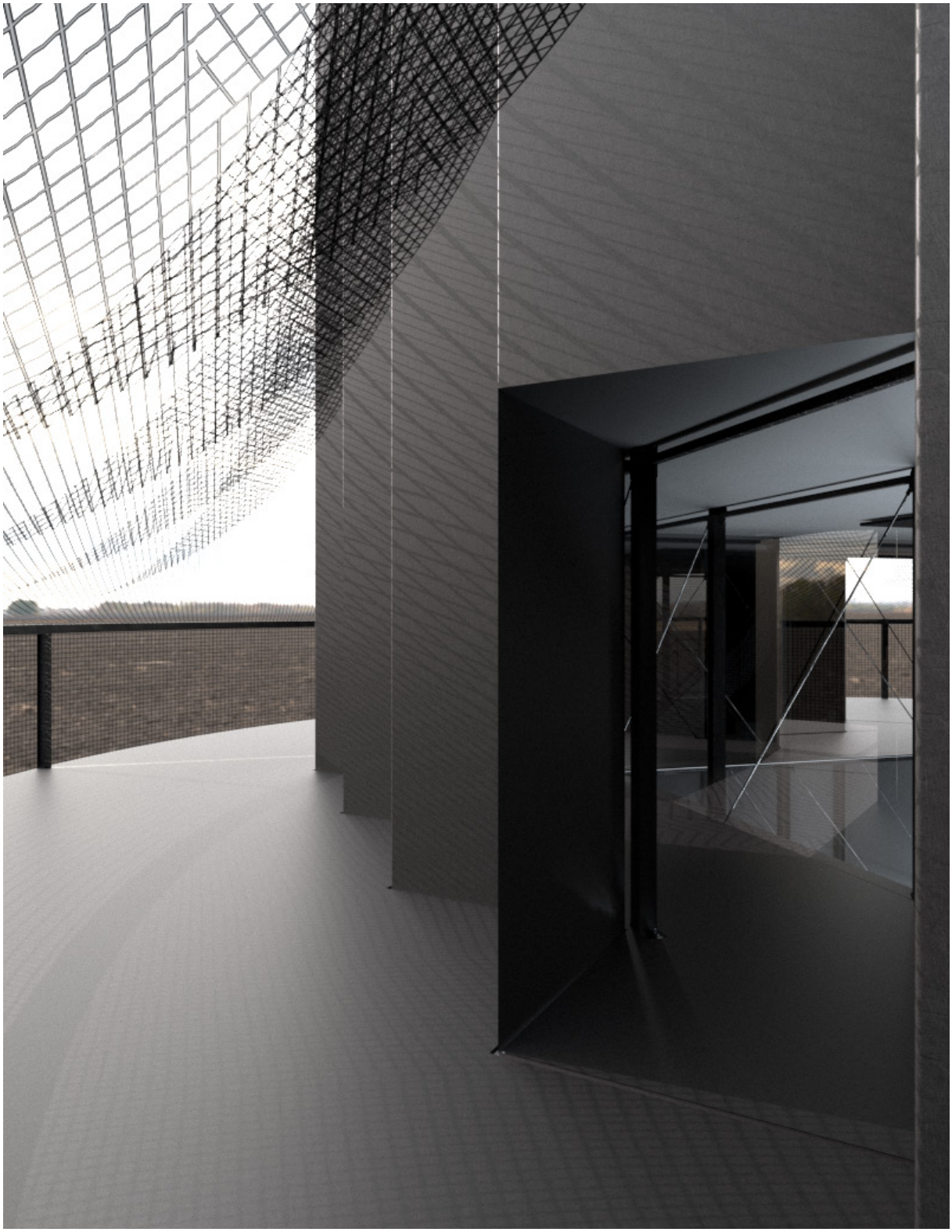




*Left side: The room under the reservoir*

*Right side: The staircase*





*Left side: The room over the reservoir*

*Right side: The water tower in its surrounfing forest*

# DISCUSSION

## UNDERSTANDING ARCHITECTURE IN RELATION TO THE ENGINEERING FEATURE OF WATER INFRASTRUCTURE

One interesting aspect that Granath (2022) is mentioning is that water towers are described as sculptural monuments and something that is standing out and noticed in nature, meanwhile other water infrastructural installations such as water treatment plants and pump stations are described as engineering art and installations "formed to fit in nature".

One thought that arose in me when reading about ornamentation, love and symbolic values of buildings (Izenour et al. 1977) was if it could be so that we have decorated buildings that we are grateful to (schools and museums with knowledge, water towers with vital water, churches that have contact with God, etc.). And in contrast to the earlier studied water towers that was built around the 19th century that had a high level of ornamentation, love and symbolic values, resources today are taken for granted, so today we do not show as much appreciation and gratitude in the form of ornamentation, love and symbolic values on these kind of buildings, water infrastructural buildings and installations included.

Another theory as to why water infrastructure and its degree of embellishment and symbolic values looks the way it does is that it may be a political, neoliberal, choice, where money goes before aesthetics (Frichot et al. 2023) (Izenour et al. 1977). This in turn creates a vicious circle where this political choice leads to worse aesthetic values, which in turn leads to it water infrastructure not being part of the utopian picture or perception(Le Guin 2015), which in turn leads to the "not in my backyard phenomenon", which in turn leads to the aesthetics becoming even more depressed, which in turn leads to water infrastructure being something not worth putting money on, and so it goes on.

Reading about the secrecy of water infrastructure (Svenskt Vatten, 2022), another thought about the development of the aesthetics of water towers was if the reason that water towers are not designed with too much ornamentation, love and symbolic values is because water towers are a classified business and that government therefore don't want to make them nice, to not create attention. But then, one could ask themselves why competitions of water towers often are announced.

Saari (2015) argues how important it is to increase the gratitude towards our vital water in the future to fight the scarcity and over use of water. This together with the thoughts that arose in me reading for this thesis made me do the water tower as a designed and reliefed infrastructural object, making it a proud piece and landmark of Tranås. This is also done with the hope that the love and care for the design of water towers can be taken back, together with the gratitude for the provision of water in our societies.

## SIGNIFICANCE OF WATER INFRASTRUCTURE'S ARCHITECTURE TO SOCIETY

From what Jonsson (2022) describes about the society, that it forms us and "claims our souls", and how we also are dependent on it and its functions, one can conclude that the invisible medium in the society that Jonsson (2022) is talking about is the infrastructure. One can replace the word society that he uses to the word "infrastructure", and conclude that infrastructure creates the individual, and the individual can not be without infrastructure who "changes its diapers". The society require a secure relationship with infrastructure, "preferably so secure that she can take it for granted and not have to think about it". And the fact that we preferably should have the relationship so secure that we can take it for granted draws parallels to how Frichot (et al 2023) talks about how dependent we are of infrastructure, and how we notice this relationship once it stops working.

Kungl Väg- och Vattenbyggnadsstyrelsen (1967) describes how high towers had always had a mark of social symbol, symbol of community and a monument. Jonsson (2022) discusses how society is something common that all in that society are dependent on. As a conclusion of these arguments one can say that people of a society feel that they are and that they represent their water tower, their symbol of their common society.

Discussing how society and infrastructure is something expressed as a common owning one could discuss how we today are very individualized. With this, one can question whether it is a reason why you don't see much of the water

infrastructure today, that the common is gone in society and thus also the common infrastructure. This is an argument that Pohlar (2010) and the phrase "not in my backyard" support, that no one wants to share things, but only experience that it is private and privately owned.

With this as a background, concluding that the infrastructure is the society - a hole common, I have through my design argued that the water tower is a place the common should access and take part of. For fighting the "not in my backyard"-syndrome I have, as mentioned earlier, designed the object as the reverse of a stripped of design as water towers today normally have, and instead decorated it with relief and ornamentation to make it a stronger symbol and a proud piece of Tranås.

### ASPECTS OF THE FUTURE

The water takes and has always taken a complex, secret detour from the waterworks to the final consumer. This finding combined with the fact that in the future there will be problems with periodic drought (Frichot et al, 2023) means that building more water towers to increase reservoir capacity (which distributes extra during drought) and shorten the long and complex path to the end consumer could be a solution to raise awareness and prevent periodic droughts. This would also mean that infrastructure is shown more which also could raise awareness of the water shortage and savings in society.

## INTERPRETED ARCHITECTURAL DESIGN IN WATER INFRASTRUCTURE AND THE EFFECTS IT CAN GET

Looking back at what Frichot et al. (2023) wrote, it is important to use design and architecture to create active form in the in our contemporary neoliberalistic world to make a change, especially as infrastructure historically has been depressed from architectural drawings and thought.

### INFRASTRUCTURAL LOVE

By allowing the construction and function to be visible, take place and to advance in the foreground, the humans, non-humans and more-than-humans can interact with each other in the tower, and hopefully an responsive and emphasis expression of care can create relations between them. Hopefully, this will in turn lead to bigger appreciation of the water towers vital role in society and contribute to more responsible water use. To show the construction and the infrastructure of the water tower is a decision made to create a "yintopia" attitude towards water tower, which all is part of the caring and loving attitude towards infrastructure.

### APPEARANCE

The goal has been to not let economics or politics status of today overrun the expression of meaning that water towers have. This is done by using tools as layering of construction, shadow-elements and silhouette-elements over each other, as well as doing a more complex and inviting shape than infrastructural objects normally allows to have.

The appearance is done with the landmark salience measurements in focus (Li, Zhang, Fang, Lu, & Shaw, 2014) (Peters, Wu, & Winter, 2010), but as Jonsson (2022) mentions, it is hard to see what importance an art object have for society straight away. Instead the culture and the storytelling around it has to have its time and path before the signification can be concluded. Therefore, I can argue I have done my best to make the water tower of Tranås a good landmark with the landmark salience measurements as a method and background, but if the result was successful one can only say when a certain amount of time has passed.

# REFERENCES/BIBLIOGRAPHY

## WRITTEN SOURCES

Frichot, H., Carbonell, A., Frykholm, A., & Karam, S. (Red.) (2023). *Infrastructural Love - Caring for Our Architectural Support Systems*. BIRKHÄUSER.

Izenour, S., Scott Brown, D., & Venturi, R. (1977). *Learning From Las Vegas*. MIT Press.

Svedinger, B. (1989). Stadens tekniska infrastruktur - en kunskapsöversikt. Statens råd för byggnadsforskning.

Jonsson, S. (2022). *Den otyglade skönheten - Fem saker konsten vet om demokratin*. Norstedts.

Kungl Väg- och Vattenbyggnadsstyrelsen (Nr VA 19). (1967). *Vattentorn i Sverige*.

Bjur, H. (1988). *Vattenbyggnadskonst i Göteborg under 200 år*. Göteborgs VA-verk.

Andersson, B. B. (1972). Vattentorn. Chalmers Tekniska Högskola.

Linder, E. (2017). Rain Chain. Chalmers Tekniska Högskola.

Granath, K. (2022). Vägen till rening. Arkitektur, 3, start 21–27.

Bornstein, P. (2022). Vattnets vardagliga högtidlighet. Arkitektur, 3, 33–40.

Lyth, J. & Wingårdh, G. (2022). Arkitekten beskriver Helsingborgs vattentorn. Arkitektur, 3, 41–41.

Zawieja, J. (2022). "Vi jobbar. med kantareller" Arkitektur, 3, 42–50.

Becher, B. & Becher, Hilla. (1988). *Water Towers*. The MIT Press.

Persson, K. M. (2006). *Att dimensionera vattentorn - To design water towers*. Tidsskriften vatten, 4, 341-354.

Örebro kommun. (2023). *Vattentornet Svampen*.

Saari, H. (2015). *The Urban Infrastructural Landscape in Transition*.

## DIGITAL SOURCES

Nationalencyklopedin. (n.d.). *Infrastruktur*. Nationalencyklopedin. https://www.ne.se/uppslagsverk/encyklopedi/lång/infrastruktur

Le Guin, U. K. (2015 april). Utopiyin, Utopiyang. Ursula K. Le Guins. https://www.ursulakleguin.com/blog/97-utopiyin-utopiyang

Van der Ryn, S. & Cowan, S. (1996) Ecological Design Tenth Anniversary Edition. Island Press. https://dev.ecoguineafoundation.com/uploads/5/4/1/5/5415260/ecological_design_10th_edition.pdf

Almqvist, H. & Lundgren, A. (2016). Vattnets väg - Göteborgs Stad. Göteborgs Stad. https://www.youtube.com/watch?v=4hJFQhdawZ8

Sveriges Arkitekter. (2024-01-22). *Tävling om vattentorn är avgjord Sveriges Arkitekter*. https://www.arkitekt.se/tavling/tavling-om-vattentorn-pa-varmdo/

Nationalencyklopedin. (n.d.). *Tranås*. Nationalencyklopedin. https://www.ne.se/uppslagsverk/encyklopedi/lång/tranås

Skånska vattentornssällskapet. (n.d.). *Vattentorn: Skåne*. Skånska vattentornssällskapet. http://eber.se/vattentorn-skane/

Royal Djurgården. (n.d.) *Kaknästornet - Ett av Stockholms mest kända landmärken*. https://royaldjurgarden.se/attractions/kaknastornet/

Wikipedia. (2023). *Vattentornet i Kalmar*. https://sv.wikipedia.org/wiki/Vattentornet_i_Kalmar

Statistiska Centralbyrån [SCB]. (2022). *Små förändringar i vattenanvändningen*. https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/vattenanvandning/vattenuttag-och-vattenanvandning-i-sverige/pong/statistiknyhet/vattenuttag-och-vattenanvandning-i-sverige-2020/

Statistiska Centralbyrån [SCB]. (2024). *Folkmängd efter region, kön och år*. https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__BE__BE0101__BE0101A/BefolkningNy/table/tableViewLayout1/



## FIGURES & PICTURES

Figure 1: Digitala Museum, "En grupp soldater samlade kring en vattenbrunn. Bakom syns byggnader som tillhör Hälsinge regementes kaserngård i Mohed", Downloaded: 02 May, 2024. [Photography]. https://digitaltmuseum.se/021016970989/en-grupp-soldater-samlade-kring-en-vattenbrunn-bakom-syns-byggnader-som

Figure 2: Digitala Museum, "Skara. Vattentornet vid Eskilsgatan.", Downloaded: 02 May, 2024. [Photography]. https://digitaltmuseum.se/021017205856/skara-vattentornet-vid-eskilsgatan

Figure 3: Digitala Museum, "Vattentornet.", Downloaded: 02 May, 2024. [Photography]. https://digitaltmuseum.se/021016228588/vattentornet

Figure 4 Wikipedia (2021). *Project for an ideal street, by Pierre Patte, 1769*. Wikipedia. https://en.wikipedia.org/wiki/File:Project_for_an_ideal_street,_by_Pierre_Patte,_1769.png#filehistory

All pictures, illustrations and diagrams not noted with source are taken/made by me.