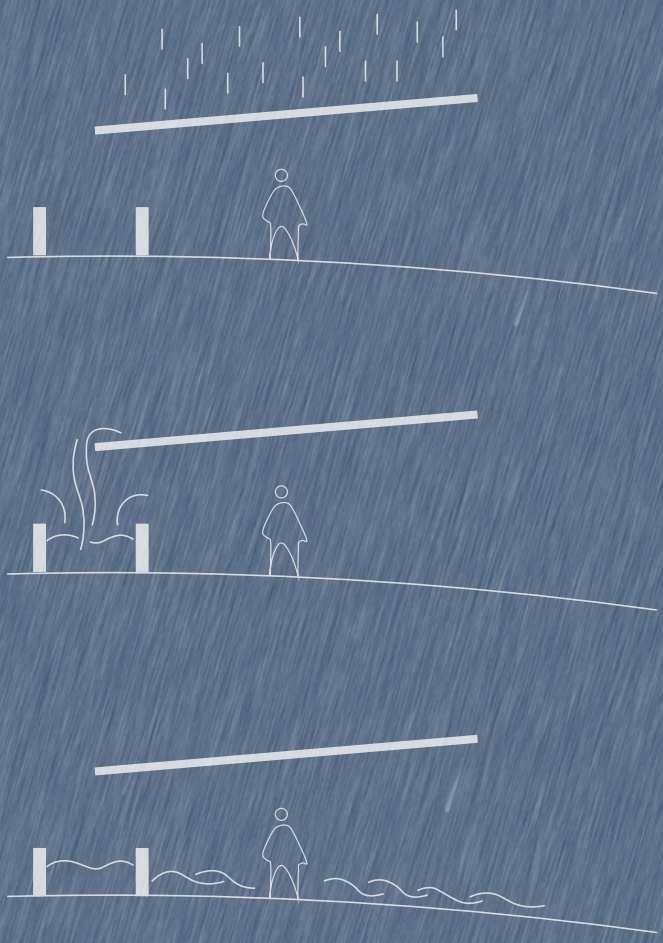
Rainwater Architecture

- Reimagining Kungstorget for Gothenburg's 400 year jubilee



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Year of graduation: 2023

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ACEX35

Master's thesis direction: Building & Tectonics

Year of graduation: 2023

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Figure 1. Atkins, Anna (Photographer). (2017, June 30th). [digital image]. Retrieved from https://unsplash.com/photos/rNBaaxyeWWM

Abstract

ABSTRACT

The purpose of this master thesis is to investigate, relating to the Gothenburg 400 year jubilee effort "Rain Gothenburg", what it means - in practice - to be the best city when it rains.

Western countries - Sweden included - today handle water in a wasteful, non-reflective manner as if it was an endless resource. Even though Gothenburg isn't facing a fresh water drought in the near future thanks to Göta Älv, the city - with the intent of being the best city when it rains - needs to become an exemplary model for how rain and cloudburst elegantly could be turned from a problem to a resource for the urban development.

Moreover, the population of denser urban areas are increasingly seeking refuge in rural environments for health and wellbeing. Has the city failed its inhabitants to provide the right preconditions for leading healthy, fullworthy lives?

Studies show that presence of green and especially blue spaces generate less subscriptions of antidepressants. Could, then, dense urban environments become healthier environments, if blue spaces are tightly interwoven with the everyday urban spaces?

This thesis therefore explores how rain in Gothenburg can be integrated in a central urban setting - utilized through new additions on Kungstorget - in order to generate awareness of the potential of rainwater as a resource, and to create intimate spaces and an increased proximity to blue spaces in central urban spaces, for enhanced experiences, healthier and more meaningful environments.

The project aims to re-establish the teeming life on Kungstorget, replacing parking lots with rainwater experiences and spaces for trade and interaction. The design is informed partly by historical, cultural and contemporary analyzes, and partly by how the architecture should interact with the rainwater chain.

This method could generate a teeming urban hub that demonstrates how Gothenburg is turning rain from an inconvenience to an asset, in the attempt of being the best city when it rains.

Keywords: Rain interventions, Phenomenology, Blue space, Atmosphere, Construction

STUDENT BACKGROUND

Prior experience

Chalmers School of Architecture
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Architecture consultant, Own firm
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Architect intern, We Group AB
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Sales, Kitchen designer, IKEA
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Assistant supervisor, NCC AB
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Studios

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22,5 hp	Matter Space Structure 2
4,5 hp	Design Tools
3 hp	History, Theory & Text
17 hp	Exchange studies, TU Wien
22,5 hp	Urban Space Design
7,5 hp	Master's Thesis Preparation
30 hp	Master's Thesis, Architecture

READING INSTRUCTIONS

The work is divided in three parts, where the first part function as an introduction for the design work. The introduction gives an understanding of the research question, the theoretical framework, references, aims with the thesis and the methods used in the work.

The second part explores the selected case study site - its history and current development plans.

The third part concludes the theory and references with principles regarding rain water interaction - which will be crucial for the development of the design. It also showcases the design proposal, which intends to relate to and answer the thesis's question and theoretical standpoints.

All figures are own produced if not otherwise stated.

METHOD

The thesis is developed first and foremost using research by design. This is done by designing models and sketches digitally and physically, of a building on Kungstorget which will interact with rainwater in different atmospheric ways. The models and sketches will be carefully analyzed, evaluated and iterated, relating to spatiality, atmosphere, construction, economy and relevance for the city.

The initial phase of the thesis is performed by researching about the site's history and contemporary development. This to gain understanding about the current needs and potential values that could impact the design. Theoretical studies about previous rainwater and architecture works are also performed, together with research about mental health in relation to water, and phenomenology in design.

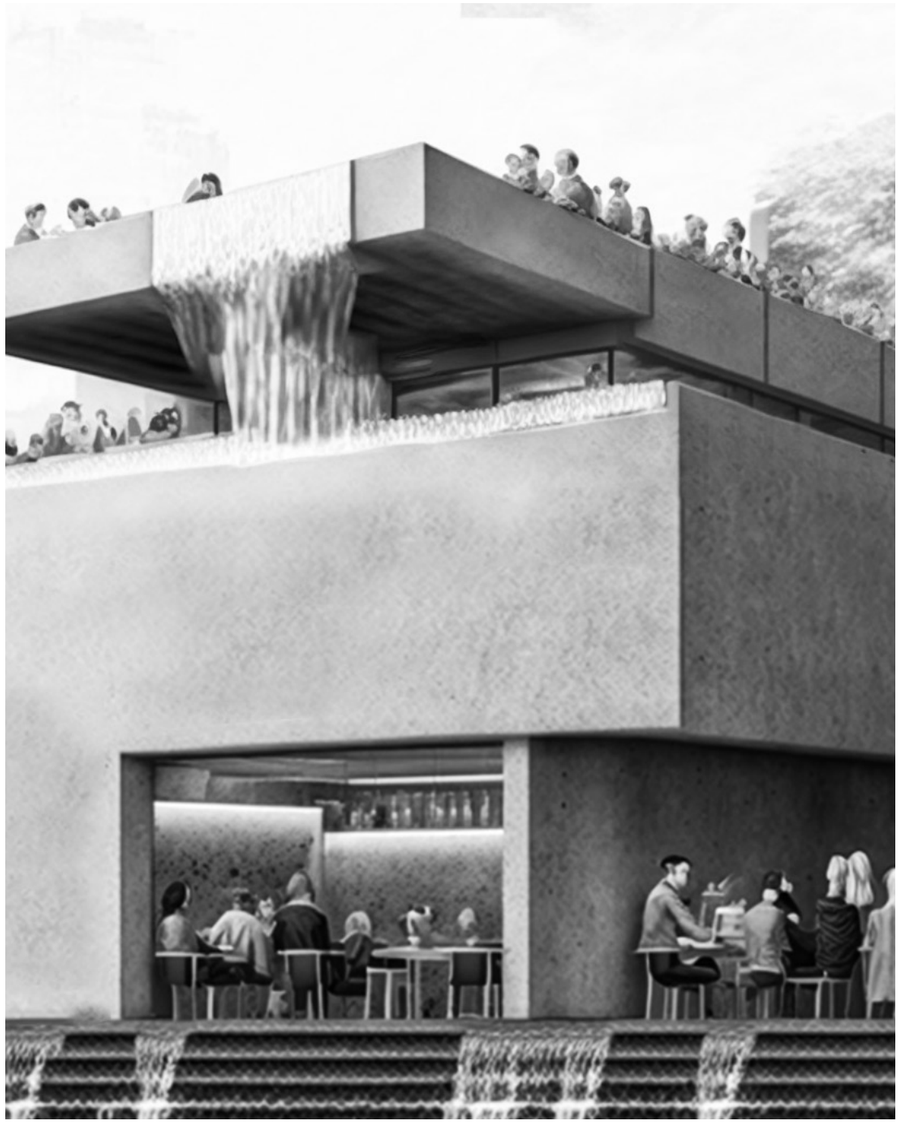


Figure 2. Image created by author in Midjourney

Research question

RESEARCH QUESTION

General question:
How can rainwater be utilized within a central urban addition and turned into a sensuous architectural element?

Specific case question:
How can Kungstorget be redeveloped in order to enhance trade, interactions and inner-city wellbeing and offer atmospheric places to seek refuge to when it rains - in relation to the Gothenburg 400 year jubilee effort "Rain Gothenburg"?

AIM

The aim of the thesis is to find ways to work with rainwater as a valuable resource rather than a nuisance, by designing a building and streetscape that captures and reuses rainwater and simultaneously generates wellbeing for the urban environment.

By taking a proactive approach to rainwater management, designers and planners can create more sustainable and resilient urban environments that support both human and ecological health.

The goal of this thesis is, then, not simply to manage rainwater but to intervene in the water cycle, creating more sustainable and resilient urban environments that benefit both people and the planet. This requires a shift in mindset from viewing rainwater as a problem to be solved to seeing it as a valuable resource that can be harnessed and utilized in creative and innovative ways.

DELIMITATIONS

The project aims at designing a building.
A building that in its construction, material choices and spatial qualities showcases one solution for how rainwater could be interwoven with the built environment.

The project will therefore not aim at proposing a general design solution for dealing with rainwater in urban settings, but rather ignite inspiration for the idea of bringing rainwater management into the design table in the first place.

The project neither aims at digging deep into solving technical rainwater capture and filtration solutions, but rather briefly study the field and then focus on the sensory and atmospheric aspects of rainwater management.

Background

Figure 3. Visionsbild Torslandaskolan [digital image]. (n.d.) Retrieved from https://goteborg2023.com/jubileumsprojekt/rain-gothenburg/#uppleva-regn

Figure 4. Ullnert, Marie (Photographer). Regnlekplatsen i Renströmsparken [digital image]. (n.d.) Retrieved from https://goteborg2023.com/jubileumsprojekt/rain-gothenburg/#uppleva-regn

Figure 5. Brunnslockspoesi [digital image]. (n.d.) Retrieved from https://stadsutveckling.goteborg.se/klimat-och-miljo/rain-gothenburg/upplevaregn/brunnslockspoesi/

Background // Problematization

GOTHENBURG'S 400 YEAR JUBILEE AND "RAIN GOTHENBURG"

Gothenburg is turning 400 years, and as a part of the jubilee, an effort to make Gothenburg the "best city to live in when it rains" has been announced.

The city wants to - in this effort - embrace the fact that it rains a lot in Gothenburg. It wants to look at the potential of rain to create a more beautiful, pleasant and climate adapted urban environment. (Rain Gothenburg, 2020)

The city has also realized that dealing with water only with regular storm water wells is not enough in order to handle future peaks of water flow. By this effort, Gothenburg also wants to find new ways of protection from the effects of too much rain.

Therefore, the "Rain Gothenburg" effort is intended for sparking ideas and solutions around both rain/flood resilience, but also solutions for artistic, creative and unique experiences from rain.

Until now, projects such as a rain playground, manhole cover poetry, rain dance, rain art workshops and a school for rain have been or are being in development. (Uppleva regn, 2020).

These projects are great for creating awareness regarding rain, but until now there have been a lack of actual, concrete projects showcasing how the buildings themselves - especially in dense urban areas - should actually deal with downbursts in a resilient and atmospheric way.

Therefore, with the jubilee around the corner, it seems relevant to focus the master thesis project on creating concrete solutions that speaks to the "Rain Gothenburg" initiative, providing the city with spaces that show what it means being best when it rains.

Figure 6. Choy, Suhyeon (Photographer). (2017, November 2). Rain [digital image]. Retrieved from https://unsplash.com/photos/HCDugQDdtfc

Background // Theory

THEORY - HEATH, WELLBEING & BLUE SPACES

Data suggests that being near blue spaces - for example lakes, rivers, and oceans - can have significant effects on health and well-being. Possibly even better effects to well-being than being near green spaces - such as forests and parks.

For example, a study discovered that the presence of blue spaces in the everyday environment can "positively impact mental health". (McDougall, Hanley, Quilliam, Bartie, Robertson, Griffiths, & Oliver, 2021). The study looked at the correlation between blue space availability and antidepressant prescription data for over 2 million adults in Scotland. It showed that high neighborhood freshwater coverage, residing close to the coast, or residing close to a freshwater lake was associated with lower antidepressant medication prevalence. The findings even suggested that being close to blue spaces may have a greater impact on the amount of antidepressant prescriptions than green spaces.

Another study found that individuals who lived near the coast had higher levels of physical activity and better self-reported health, compared to those who lived inland. (White, Alcock, Wheeler, Depledge, 2010).

Additionally, a review found that exposure to blue spaces can have positive effects on respiratory and cardiovascular health. (Gascon, Triguero-Mas, Martínez, Dadvand, Forms, Plasència, & Nieuwenhuijsen, 2015).

Figure 7. Ng, Nicholas (Photographer). (2021, May 3). Tranquility [digital image]. Retrieved from https://unsplash.com/photos/SvU-kkCV_88

Background // Theory

THEORY - SENSES & PHENOMENOLOGY

The general field of architecture to approach when aiming for designing atmospheric and sensous spaces with the help of rain would reasonably be phenomenology. This field is a philosophical approach that emphasizes the sensory and emotional experience of space, rather than the purely functional or technical aspects of building design. (Rethinking the Future, 2023).

In order to achieve an atmospheric space, architects can use a range of sensory stimuli to create a particular mood or ambiance. For example, the use of different textures, lighting, sounds and scents can all contribute to the creation of a sensory-rich environment that stimulates the senses and creates a particular emotional response in the user. (Rethinking the Future, 2023).

One prominent architect who has embraced the phenomenological approach is Juhani Pallasmaa. In his book "The Eyes of the Skin: Architecture and the Senses", Pallasmaa argues that the senses are the primary means through which we experience and understand the world around us, and that architecture should be designed to engage with these senses in a holistic way. (Pallasmaa, 2005). Pallasmaa (2005) advocates for the use of materials that have a sensory quality, such as natural wood, stone, and clay, and for the integration of different sensory elements into the design of buildings. He argues that this approach can help to create spaces that are more meaningful, memorable, and emotionally resonant for the users.

Another influential figure in the field of phenomenological architecture is Peter Zumthor. Zumthor's approach to architecture is focused on creating atmospheric spaces that are rooted in the sensory experience of the environment. In his book "Atmospheres", Zumthor describes how the emotional qualities of a space can be influenced by factors such as lighting, acoustics, and the use of materials. (Zumthor, 2006).

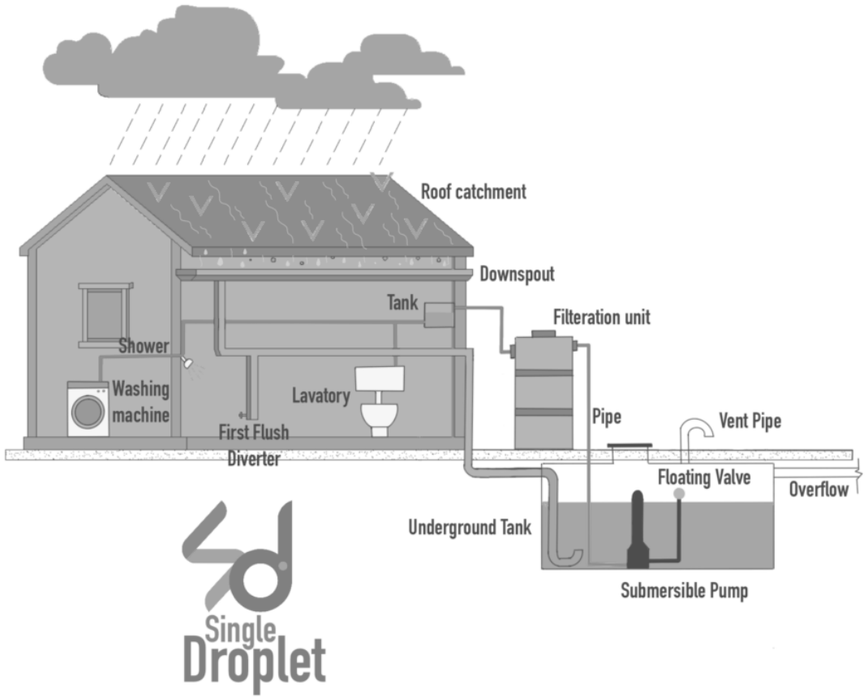


Figure 8. Diagram figure Rainwater Collection System. Adapted from Top 5 Important Components Of Rainwater Harvesting by Single Droplet, Retrieved March 2023 from https://singledroplet.com/components-of-rainwater-harvesting/

THEORY - RAINWATER CAPTURE

Rainwater capture in architecture refers to the practice of designing buildings and landscapes to capture and reuse rainwater as a sustainable water management strategy. This can help to reduce water consumption, alleviate pressure on municipal water supplies, and mitigate the impact of stormwater runoff on the environment.

One example of successful rainwater management in architecture is the California Academy of Sciences in San Francisco. The building features a green roof with a rainwater capture system that collects and filters rainwater for reuse in the building's toilets and irrigation system. The building also includes a wetland ecosystem that filters stormwater runoff from the surrounding area. (Living roof, 2023).

Another example is the Bullitt Center in Seattle, which was designed to be the greenest commercial building in the world when it was completed in 2013. The building features a 56,000-gallon cistern that collects rainwater for reuse in the building's toilets and irrigation system. The building also includes a rooftop garden that helps to absorb rainwater and mitigate the urban heat island effect. (Rainwater Harvesting, 2013).

The Edith Green-Wendell Wyatt Federal Building in Portland, Oregon, is another example of successful rainwater management in architecture. Within the building, a green roof with a rainwater capture system is featured, which collects and filters rainwater for reuse in the building's toilets and irrigation system. It also includes a rain garden that helps to absorb stormwater runoff from the surrounding area. (Edith Green-Wendell Wyatt Modernization Project, 2022).

With these projects in mind, one could argue that rainwater capture in architecture is an important strategy for sustainable water management. By designing buildings and landscapes to capture and reuse rainwater, architects can help to reduce water consumption, alleviate pressure on municipal water supplies, and mitigate the impact of stormwater runoff on the environment.

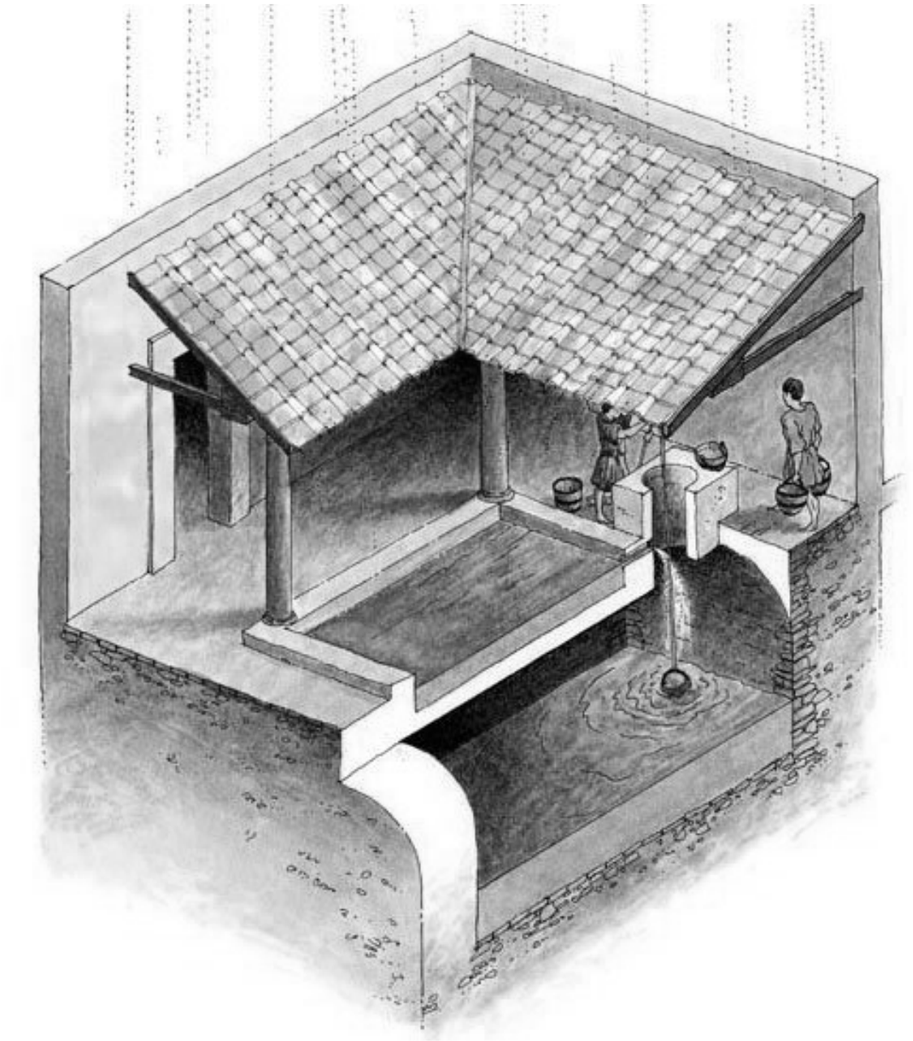


Figure 9. Roman Impluvium. Adapted from The Roman Domus as a Caribbean Urban Housing Solution by Andrew Malone, Retrieved October 2022 from http://andrewmalone.blogspot.com/2016/08/the-roman-domus-as-caribbean-urban.html

Background // References

REFERENCE - ROMAN IMPLUVIUM

Roman impluviums were a type of architectural feature found in ancient Roman homes. They were essentially rectangular or square openings in the roof of the atrium or central courtyard of a Roman house, designed to collect rainwater and channel it into a pool or cistern located below. (Laurence, 2011).

Laurence (2011) explains that the impluvium served a practical purpose in Roman homes, as it helped to collect and conserve water, which was a valuable resource in ancient Rome. It also provided a way to cool the house during hot weather, as the water in the impluvium would help to create a cooling effect as air passed over it.

Figure 10. Berndtson, Hampus (Photographer). (n.d.). [digital image]. Retrieved from https://www.dezeen.com/2021/05/20/lundgaard-tranberg-architects-danish-pavillion-venice-architecture-biennale/

Figure 11. Berndtson, Hampus (Photographer). (n.d.). [digital image]. Retrieved from https://www.dezeen.com/2021/05/20/lundgaard-tranberg-architects-danish-pavillion-venice-architecture-biennale/

Background // References

REFERENCE - DANISH PAVILION, VENICE BIENNALE

The Danish Pavilion at the Venice Architecture Biennale is an innovative architectural project that explores the role of water in design. Lundgaard & Tranberg Architects created a circular pavilion that showcases the natural flow of rainwater through the building, offering visitors a unique experience that challenges traditional notions of water management in architecture (Parkes, 2021).

According to Dezeen (Parkes, 2021), the pavilion incorporates a rainwater collection and distribution system that allows for the collection and distribution of rainwater throughout the building. The collected rainwater is stored in a basin beneath the building, and is distributed for various purposes, including plant irrigation, tea brewing, and as a contemplative experience.

The Pavilion represents an innovative and sustainable approach to water management in architecture. The circular design, rainwater collection system, and promotion of sustainable water usage in design all contribute to a unique and thought-provoking experience for visitors. This project offers valuable insights into the possibilities of water in architecture, and the role of sustainable design in promoting ecological responsibility.

Figure 12. Lovelace, Paul (Photographer). (n.d.). [digital image]. Retrieved from https://www.sydneyballart.com/timeline

Figure 13. Cavalari, Kauã (Illustrator). (March 2020). [digital image]. Retrieved from https://www.behance.net/gallery/93244621/Glenn-Murcutt-Ball-Eastaway-House-Modelagem-e-Renders?tracking_source=search_projects_recommended%7CGlenn+Murcutt

Background // References

REFERENCE - BALL-EASTAWAY HOUSE

The Ball-Eastaway House is a residential project designed by Australian architect Glenn Murcutt in 1981. Located in Glenorie, New South Wales. (Murcutt, 1996).

Murcutt (1996) describes that the building consists of two separate pavilions connected by a covered walkway, and features a number of sustainable design elements, including passive solar heating and cooling, rainwater collection, and a composting toilet.

One of the most striking features of the house is its innovative use of rainwater collection and storage (Pallasmaa, 1996). The roof of the house is designed to collect rainwater, which is then stored in underground tanks and used for all domestic purposes, including drinking water.

Another feature of the Ball-Eastaway House that relates to rainwater is the way the roof is designed to channel water away from the house during heavy rains. The roof is gently sloped to encourage rainwater to flow into gutters, which then lead the water to storage tanks. This not only ensures that rainwater is collected and used effectively but also protects the house from potential damage caused by heavy rainfall. (Pallasmaa, 1996)

The project is chosen as a reference due to its conscious design regarding rainwater capture - to create a proper architectural element out of the rainwater management systems.

Site

Site

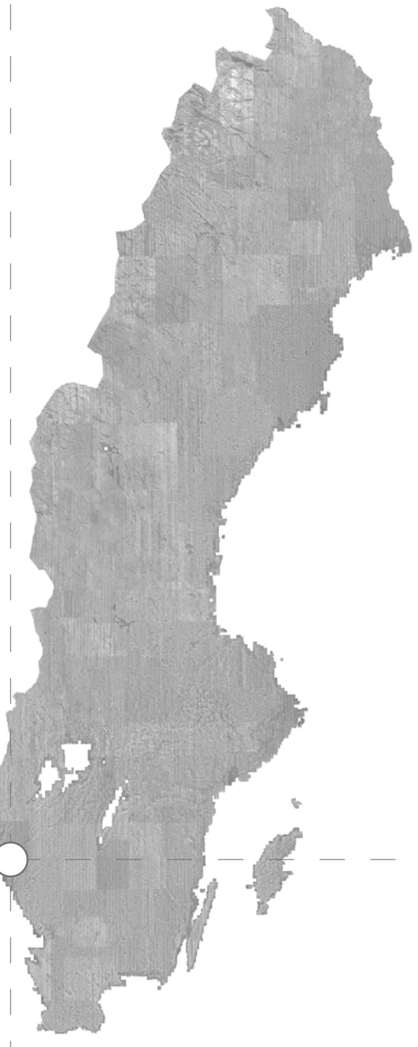


Figure 14. [Aerial photo of Sweden]. Lantmäteriet. https://minkarta.lantmateriet.se/

LOCATION - KUNGSTORGET, GOTHENBURG

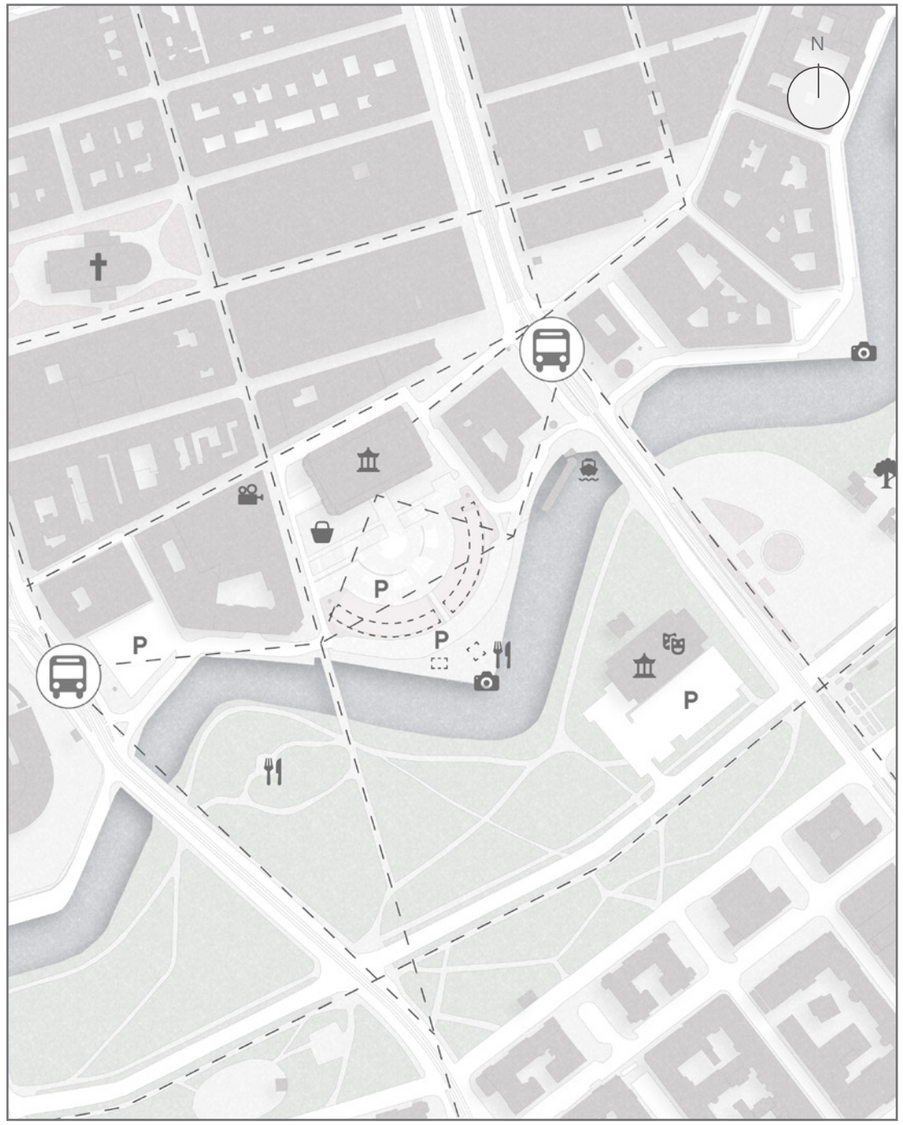
The specific case site for the thesis investigation centers around Kungstorget in Gothenburg. It lies just within the Moat which is encircling the inner city.

The site has been picked as a case study spot for investigating rainwater interventions in an urban setting partly due to its central location in Gothenburg, but also partly because it is a today underdeveloped site with huge potential of improvement. It is also a site which the city of Gothenburg is already planning to redevelop within the near future - although unclear exactly how yet.

Therefore it is the perfect spot for Gothenburg to showcase how the city handles rainwater, for the 400 year jubilee.

Figure 15. [Aerial photo of central Gothenburg]. Lantmäteriet. https://minkarta.lantmateriet.se/

Site



Site analysis, 1:4000

THE SITE TODAY

Legend

- View point
- Land mark
- Market
- Cinema
- Theatre
- Parking
- Bus stop
- Park
- Torn down structures
- Main pedestrian flows
- Church
- Picnic site

Images photographed by the author

Site

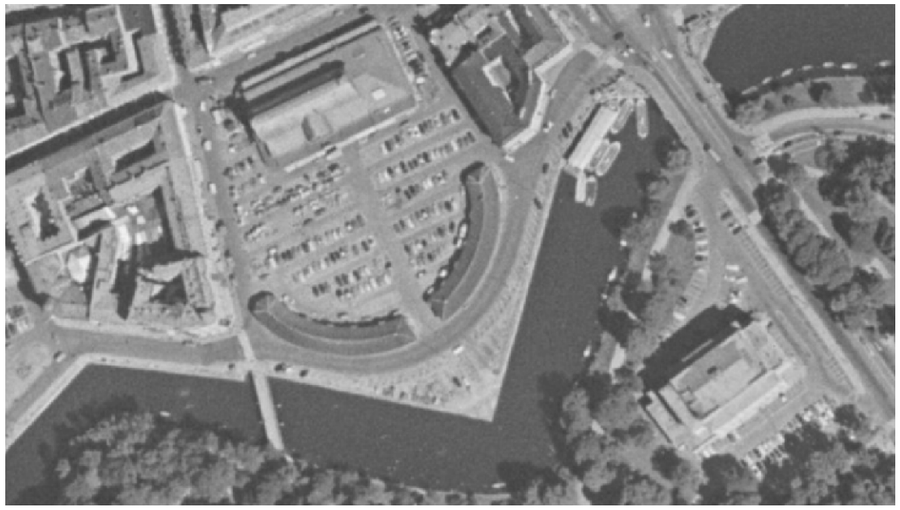


Figure 16. [Aerial photo of Kungstorget 1960]. Lantmäteriet. https://minkarta.lantmateriet.se/

Figure 17. [Postcard of Kungstorget]. Vårt Göteborg. https://vartgoteborg.se/gamla-goteborg/basarerna-pa-kungstorget/

SITE HISTORY

In the early 1800's, when the old fortifications around central Gothenburg were torn down, the area around current Kungstorget was uncovered. The new empty space was at first used as an area for trade with timber. (Vårt Göteborg, 2010)

In the mid 1800's, the area became the new square for retail trade in central Gothenburg, after it was relocated from Gustav Adolfs Torg. During this time, Vårt Göteborg (2010) describes that two Bazaar buildings were raised, to help serve the needs of the relocated wholesalers.

The Bazaar was split across the middle, creating two wings that properly framed the square. The building was built up mainly in wood and partly in brick and housed 76 shops turned both in towards the square and out towards the canal.

Vårt Göteborg (2010) continues to describe that in the early 1900's the Bazaar was gradually turned into merely a building for storage, as most of the businesses moved into the newly built Saluhallen.

Kungstorget and the Bazaar went through smaller refurbishment due to Gothenburg's 300 year jubilee. The building was however further left in decay, and multiple attempts of tearing it down were made during the mid 1900's.

It was eventually torn down in 1966, but not without critique. It was written that the building had a function for the cityscape, and that proposals for a new building on the site with the same footprint should be made. (Vårt Göteborg, 2010).

During the late 1900's until today, many proposals and attempts of reimagining Kungstorget have been made. However, it now consists mainly of parking lots.

Today, Kungstorget still remains an important public space in Gothenburg, with cafes, restaurants, and shops surrounding the square. It continues to be a popular gathering place for locals and tourists alike.

Site

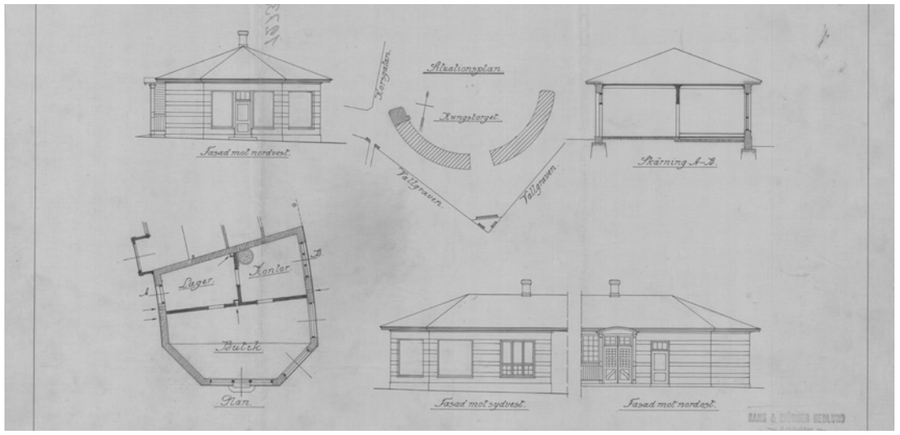


Figure 18. Hedlund, H & B (1914, June 9). [Ritning till förändring av Bazaren å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

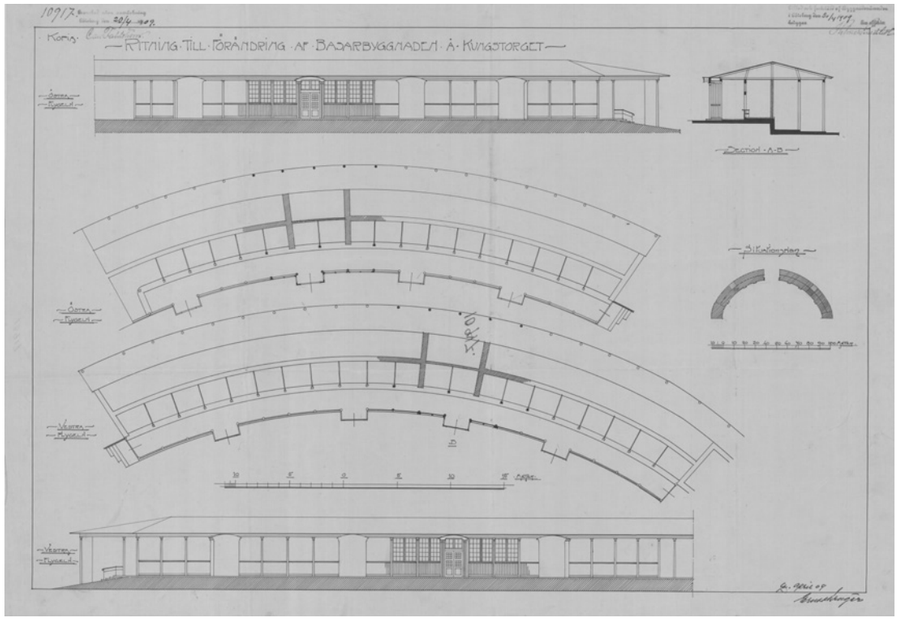


Figure 19. (1909, April 20). [Ritning till förändring av Bazarbyggnaden å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

ARCHIVE DRAWINGS OF THE OLD BAZAAR

Drawings extracted from the regional archive showcase the scale and measurements of the old Bazaar. By studying the drawings, one could see that it had a central core where shops and storage was held, and surrounding arcades on both sides.

To solve the height difference on site, the old Bazaar building was designed in a way that let the storage room of the higher situated shop turned towards the square overlap the storage room of the lower shop turned towards the canal - in a zig-zag pattern seen in the section below.

Another noticeable discovery made from studying the drawings is that on the outer corners of both of the wings, there were solid brick constructions, deviating a little bit from the regular Bazaar design.

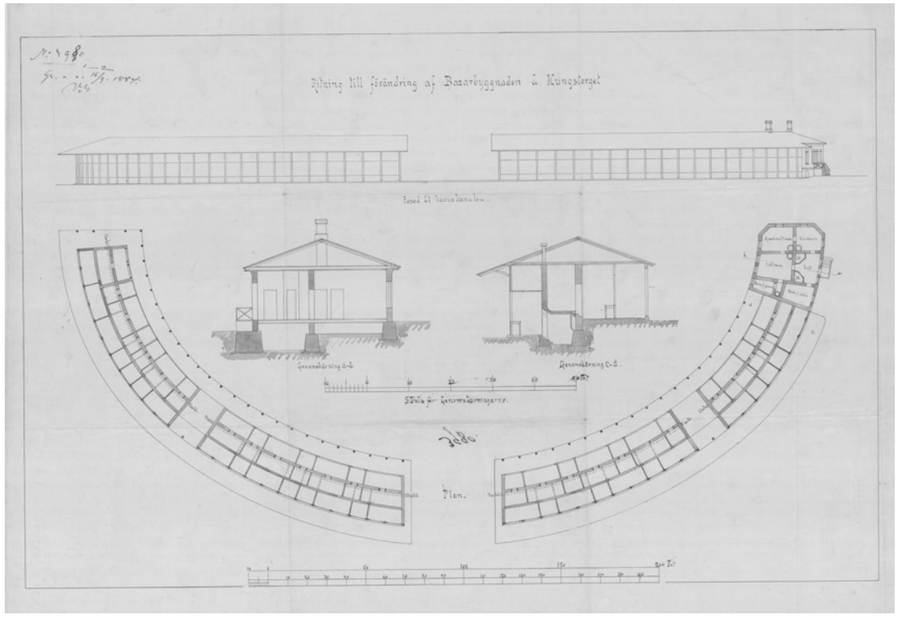


Figure 20. (1884, September 16). [Ritning till förändring af Bazarbyggnaden å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

Site

Figure 21. Plan sketch. From Utredning av Higabs Byggrätter by Higab, Gestalt Arkitektur, 2018

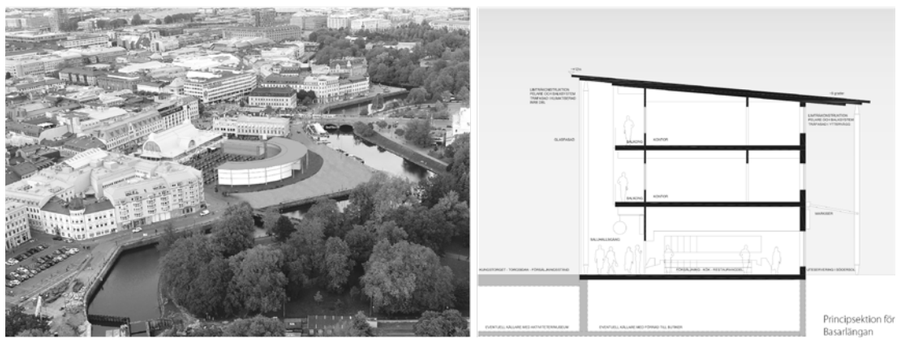


Figure 22.Aerial montage view and section. From Utredning av Higabs Byggrätter by Higab, Gestalt Arkitektur, 2018

SITE INVESTIGATIONS BY THE MUNICIPALITY

There are ongoing studies regarding what the city of Gothenburg should do on Kungstorget, and a development plan has been established between the main actors on site - Higab, Park- och naturförvaltningen, Wallenstam and Trafikkontoret.

This plan is describing in what direction the main actors want to go regarding Kungstorget, and states that "The character of the square is meant to combine tradition with innovative thinking". (*Utvecklingsplan av Kungstorget,* 2019)

The document (2019) also states that "Due to the lack of a collected vision and development plan, the board group is experiencing that the development has been put on hold. A collected grip, a clear goal is prioritized. What has been done until now has only scratched the surface. The work on the area has been missing a holistic perspective."

The need for the redevelopment of Kungstorget is, according to the document (2019) "To create a meeting ground at the forefront with focus on food and drinks, the obvious choice in central Gothenburg that attracts active and conscious people with an interest for food, food experiences and city life."

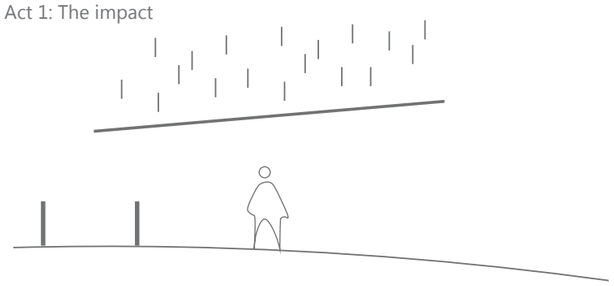
Based on this, Higab has started working on a proposal for redevelopment of Kungstorget. This proposal suggests to create an extension of Saluhallen, located approximately where the old Bazaar once stood.

The suggested program for this building is similar businesses as the ones within Saluhallen, with traditional retail trade towards the square, and restaurant service towards the canal. (*Utredning av Higabs Byggrätter*, 2018).

The proposal (2018) also suggests strengthening the connection to the bastion by placing kiosk pavilions and sun benches there.

Proposal

Act 1: The impact



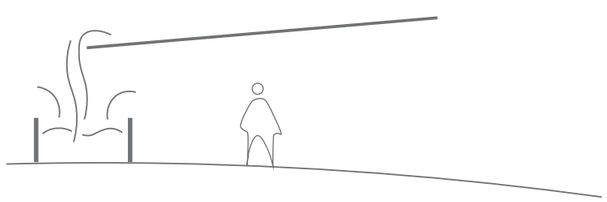
Rain function

- Shelter
- Collector
- Distributor
- Sound enhancer

Sensory enhancement

- Sound of pattering
- Protection (comfort)

Act 2: The fall



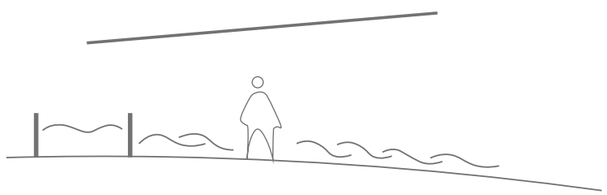
Rain function

- Art piece
- Vertical distributor
- Cooling

Sensory enhancement

- Sound of spashing
- Visual stimuli

Act 3: The runoff



Rain function

- Drainage
- Flood mitigation
- Ground art piece
- Interactability

Sensory enhancement

- Sound of rippling
- Visual stimuli
- Haptic possibility

DESIGN REFLECTIONS - RAIN INTERACTION PRINCIPLES

To reach atmospheric enhancement using rainwater as the means - one must first think about how architecture could interact with the rainfall.

If no architecture is present, the rain will just fall unstopped to the ground and flow away in arbitrary directions.

When architecture is introduced, it can then tap into the water chain and redirect it to create a tailored space - generating a more pleasant experience when it rains.

The first architectural element that the rain reaches is the roof structure. This part of the building has the potential of limiting certain parts from being exposed to rain. This is a fundamental aspect for creating pleasant rain experiences, since protection from the cold and wet rain provides comfort - which is key for being receptive to other pleasant sensory experiences.

The roof also has the ability to collect the rain through a large surface area, and distribute it to desirable points of exposure. A large surface area means a lot of potential water collection, which could lead to a more impactful scene where the water pours down - creating a larger soundscape and more powerful visuals. The interaction between the pattering raindrops and the roof could also be an effect worth enhancing - creating a soundscape under it that reminds of calm, rainy days under the porch.

The second act in the tapped-in rainwater chain is happening when the collected water is poured from the roof to the ground.
In conventional water management, this aspect is hidden away in a pipe. If, however, handled properly, the fall has the potential of becoming a dynamic spectacle - an art piece that works just as much as a symbol of rain as it does as an atmospheric element generating both a splashing soundscape, and visual stimuli.

The third act in the water chain is the runoff phase - where the water travels from the impact point of the fall, down to the canal. Instead of merely leading the water down into a hidden manhole cover, the rippling water could be used as an atmospheric resource - that could be seen, followed, heard and allow for interaction. It could then become a dynamic imprint on the ground - providing the space with a sense of direction and order.

Proposal

Site plan 1:4000

SITE INTERVENTION

Presently, Kungstorget is predominantly characterized by the presence of cars and parking lots. However, despite the parked cars and road noise, it remains a popular spot for people to enjoy their lunch in the sun. This highlights the immense potential for the site to be transformed into a welcoming and revitalized space for visitors to relax and unwind.

To truly honor one of central Gothenburg's most appealing areas, Kungstorget would greatly benefit from thoughtful design and development. Moreover, it would benefit from incorporating areas that offer scenic views even during rainy days.

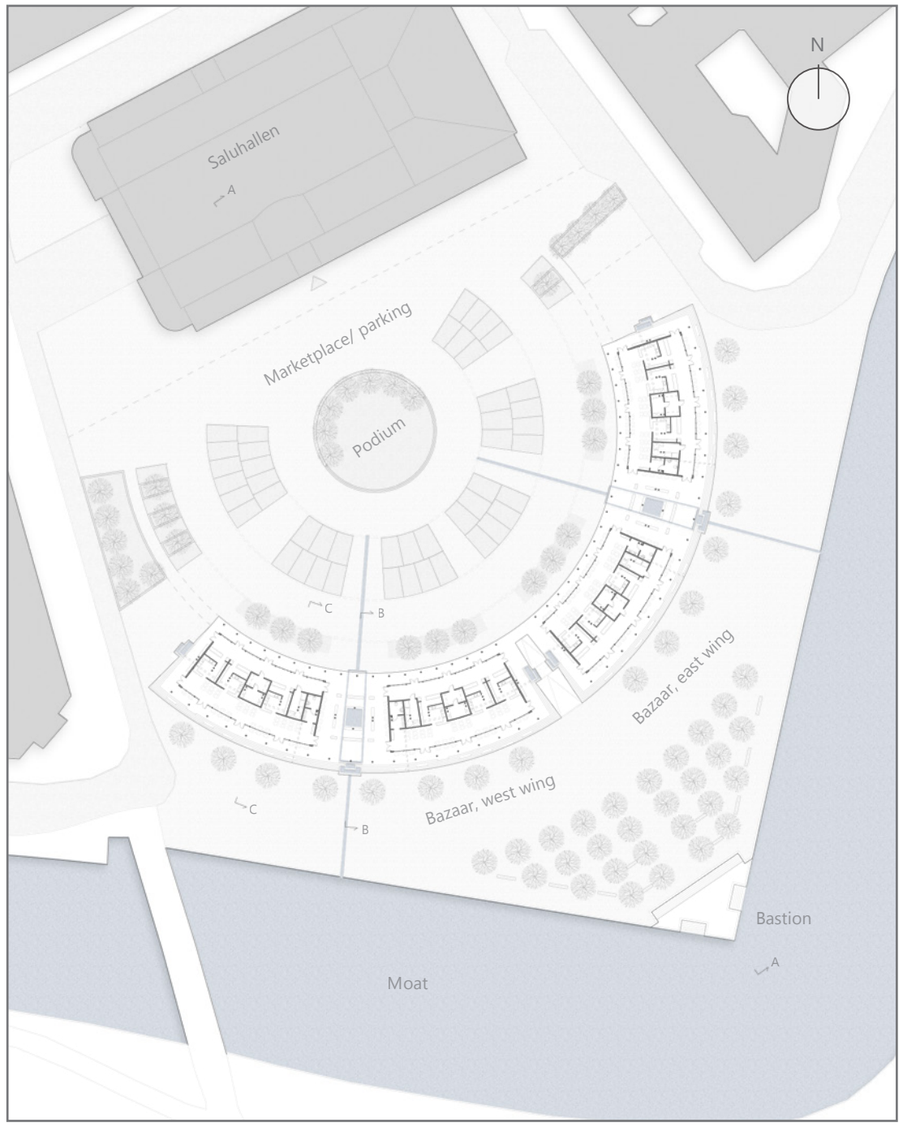
By reintroducing the Bazaar to the square, Kungstorget would receive comprehensive attention, harmonizing materiality, history, scale, and sightlines. The Bazaar's design encompasses 12 food market shops, influenced by the ongoing pre-study conducted by Higab. These shops would offer raw food products, similar to Saluhallen, within an indoor arcade. Additionally, each shop would feature a restaurant section facing the opposite direction, accompanied by interconnected outdoor seating areas arranged as a food court, both indoors and outdoors. The concept also allows customers to purchase food from the market shops and enjoy it anywhere along the stairs, either under the sheltered roof or in the sun-exposed areas, or even bring the food to the stairs near the tip of the bastion.

The 3 acts of the rain interaction principles are added to the Bazaar's design. It therefore features a rainwater capture system on the roof - which is providing a lot of rainwater capture area and a lot of protected area from rain. The captured water is then guided into cascading basins and streams, creating an atmospheric experience that elicits a calming and soothing effect as it gracefully flows and ripples throughout the square.

The Bazaar aims to establish a connection between tradition and innovative thinking, aligning with the development plan devised by the stakeholders involved in Kungstorget. Its objective is to revive lost quality features from the past and merge them with contemporary ideas and principles concerning rainwater management.

The square itself is reorganized around the circular motion facilitated by the Bazaar. This entails introducing new ground cover, rearranging trees, incorporating an exposed drainage system, and creating a central podium for hosting events. The arrangement of stones in the paving is deliberately designed to indicate specific areas for market stalls during market days, while the same slots in the pavement can be used for parking on regular days.

Proposal



Site plan 1:1000

PROPOSED PROGRAM

BAZAAR, MARKET AND FOOD COURT

Total footprint	2 x 760 m2

Exterior rain protected spaces:

Impluvium (2 pcs)	135 m2
Arcade (2 pcs)	100 m2
Gables (4 pcs)	25 m2

Interior units (4 pcs):

Bazaar shop unit (3 pcs) -	18 m2
Warm dish preparation	7 m2
Food market sales	6 m2
Storage space	5 m2
Food court -	80 m2
Indoor seating for food consumption	
Heated arcade -	35 m2
Indoor space for food market	
Public WC -	10 m2
Accessible WC	
Anteroom with sink	
Utility room -	10 m2
Garbage containers	
Water filtration unit for grey water	
Cold storage -	8 m2
Freezer room -	7,5 m2
Undergound water tank -	11 m3

QUANTIFICATIONS

Removed trees	23
Added trees	70
Removed parking lots	155
Added exterior marketplace/parking lots	68
Added rain protected area	1920 m2
Peak rainfall month	Aug
Peak rainfall amount/day	124 mm
Rain capture area roof	1920 m2
Peak rain capture roof	238 m3/day
Peak gutter total rain flow	0,3 l/s
Peak individual gutter flow	0,04 l/s
Rain capture area square	5000 m2
Peak rain capture square	620 m3/day
Peak main stream total rain flow	0,7 l/s
Peak individual main stream flow	0,35 l/s

Proposal

Illustration of square scenario around podium

Proposal

Illustration of scenario around the tip of the Bastion

Illustration of arcade & gable

THE NEW BAZAAR

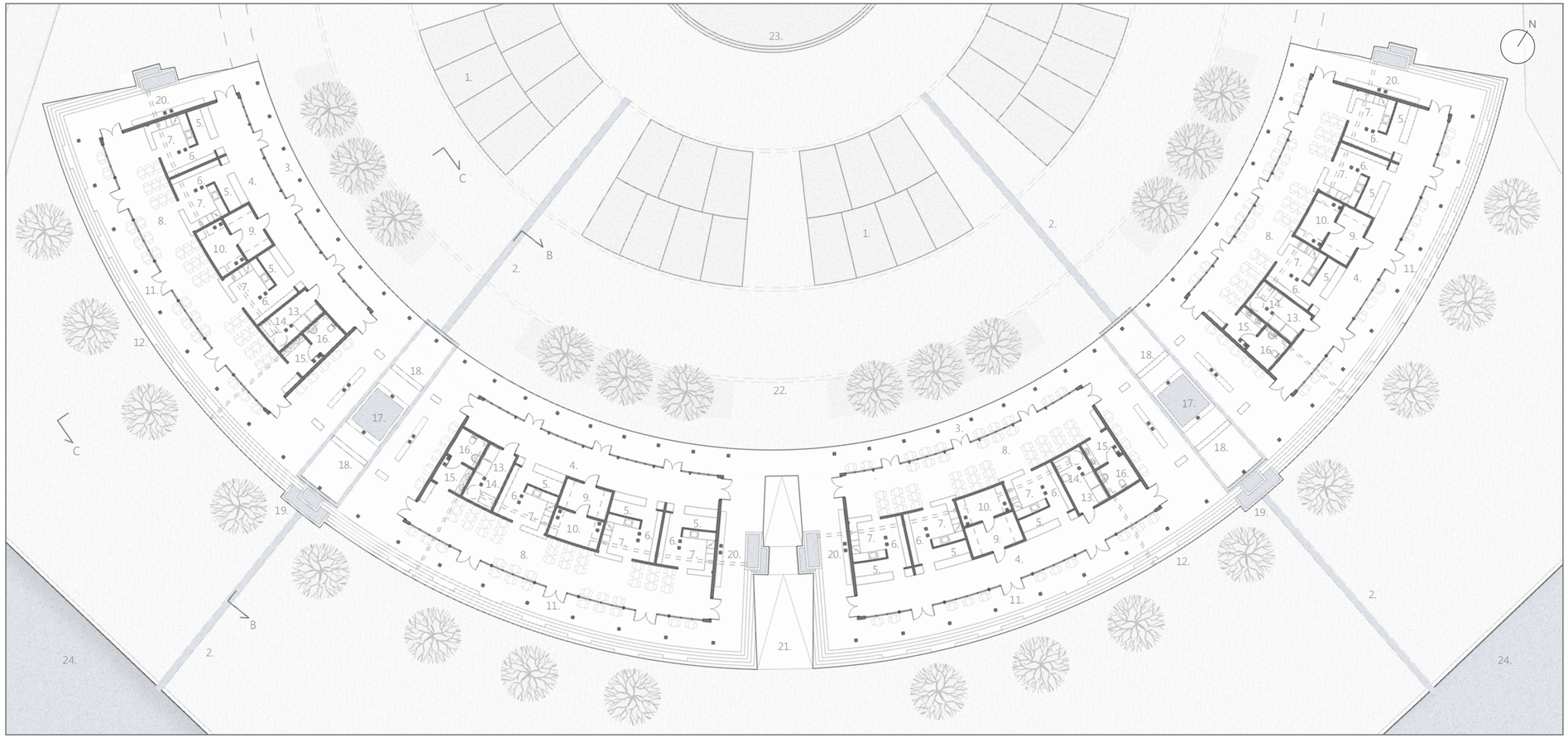
The focal point of the case study proposal for Kungstorget, concerning Rain Gothenburg, revolves around the Bazaar building. Situated on the approximate site of the old Bazaar, it spans 15 meters in width and has a diameter of 100 meters.

The Bazaar structure comprises two distinct construction principles: the canopy and the inner wooden core. The canopy serves as an exoskeleton that primarily interacts with rainwater, while the inner core accommodates the building program and shields visitors from other weather elements. These architectural components are structurally independent from each other. The canopy is a permanent fixture of the building, while the inner core employs lightweight construction, designed for adaptability and flexibility according to current requirements.

The purpose of the Bazaar is to establish a link between tradition and innovative thinking, aligning with the development plan for Kungstorget devised by the stakeholders on-site. It aims to revive lost quality features from the past and merge them with the aforementioned design strategies that emphasize interaction with rainwater.

PLAN & PROGRAM

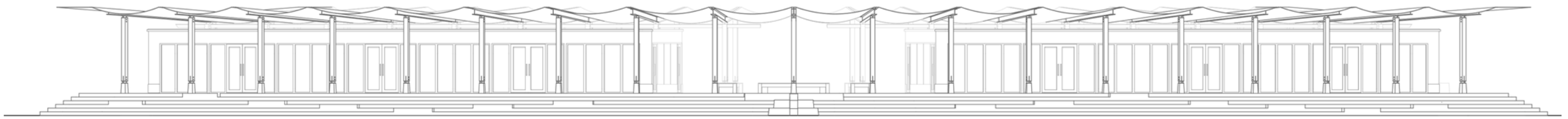
1. Marketplace allocations/Parking lot
2. Main exposed gutter
3. Pedestrian path towards square
4. Heated arcade for food market
5. Cashier space for food market
6. Storage
7. Warm dish preparation space + cashier space for food court
8. Food court
9. Cold storage with hatch to underground water tank
10. Freezer room
11. Rain protected arcade
12. Integrated seating in stairs
13. Garbage space
14. Rainwater filtration unit for flushing/sink
15. Anteroom with sinks
16. Accessible WC
17. Impluvium
18. Rain protected seating
19. Cascading basins
20. Rain protected seating along gable
21. Main path towards the Bastion
22. Secondary exposed gutter
23. Central podium for events
24. Moat



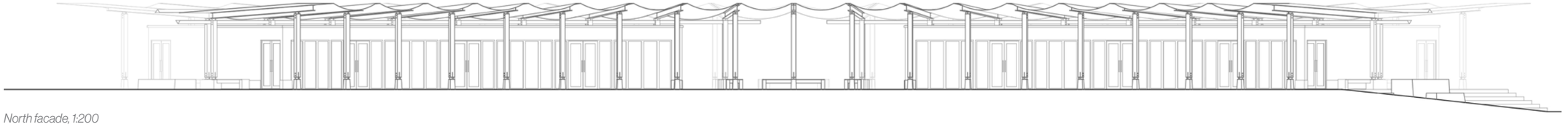
Plan 1:250

Proposal

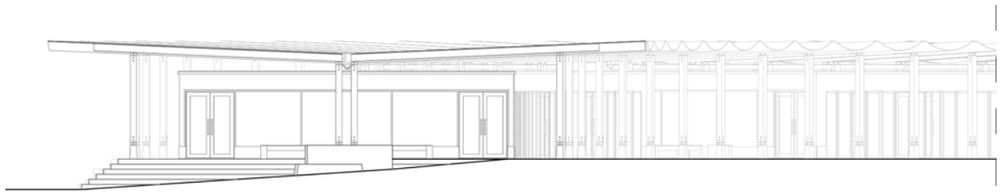
FACADES, WEST WING



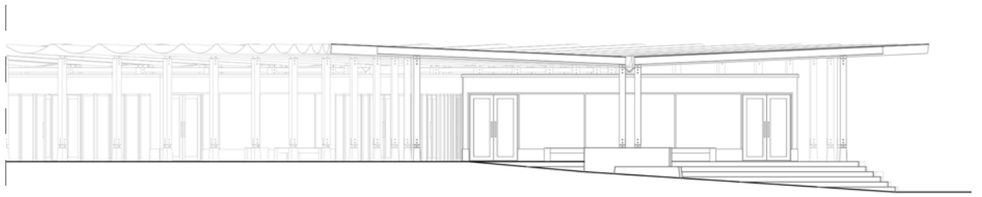
South facade, 1:200



North facade, 1:200



East facade, 1:200

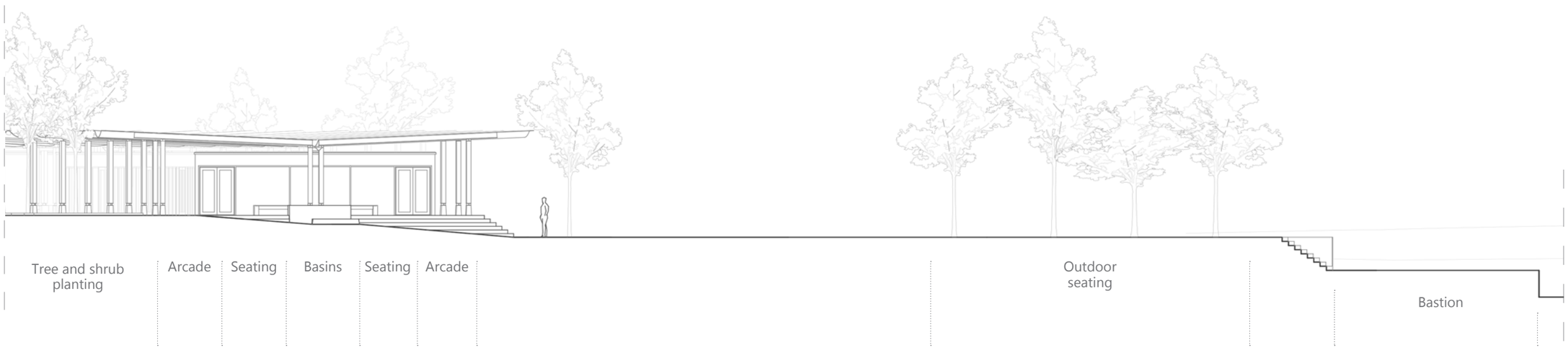


West facade, 1:200

Proposal

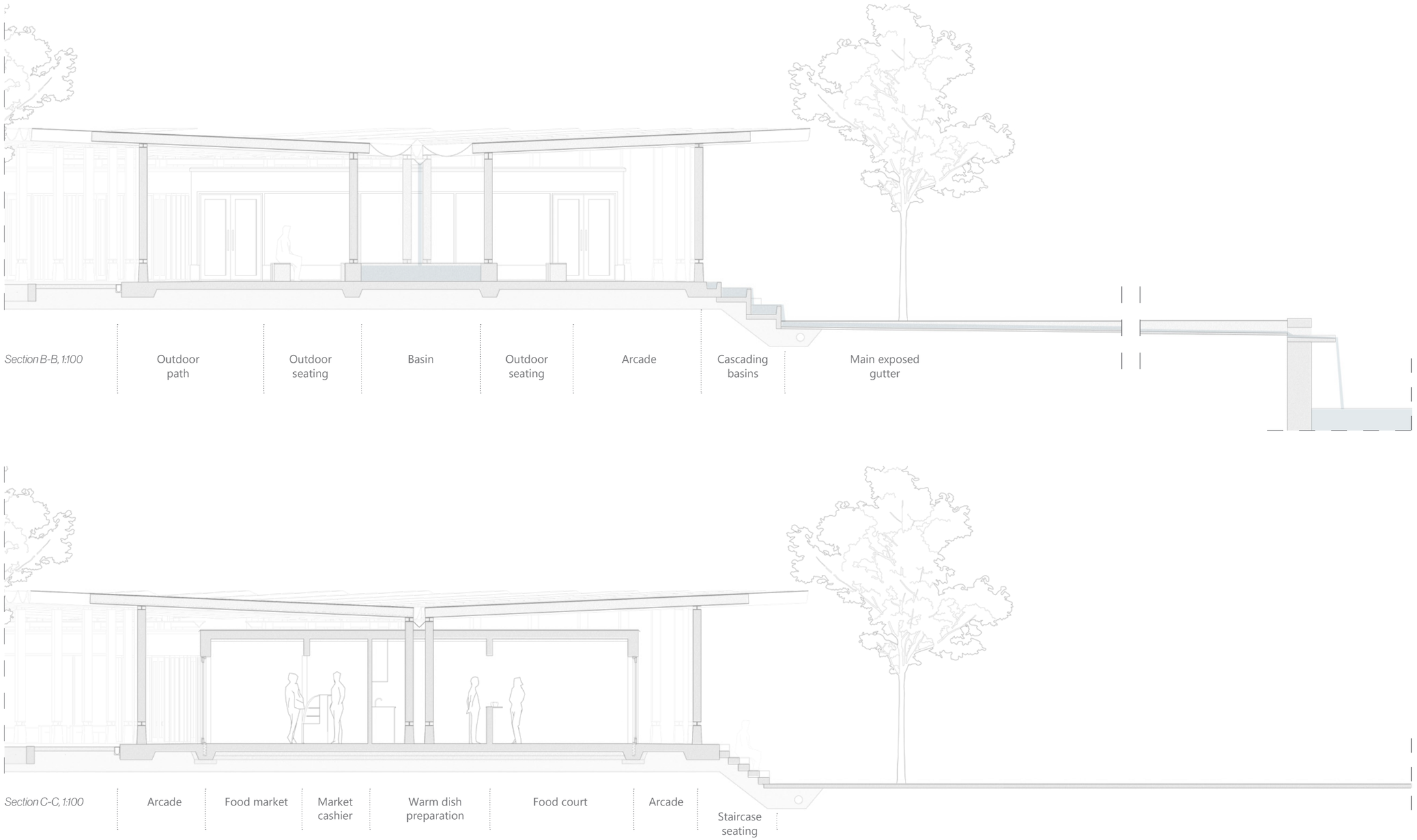
SECTIONS

Section A-A, 1:200



Section A-A, 1:200, Continuation

Proposal


Section B-B, 1:100
Outdoor path
Outdoor seating
Basin
Outdoor seating
Arcade
Cascading basins
Main exposed gutter
Section C-C, 1:100
Arcade
Food market
Market cashier
Warm dish preparation
Food court
Arcade
Staircase seating

CONSTRUCTION MEETS RAIN

Rainwater capture is the key aspect informing the design of the bazaar. The building's roof and gutter system are specifically designed to gather rainwater and steer its path to create unique atmospheric experiences.

The roof of the building is angled and shaped in a specific way to allow for maximum rainwater capture. The gutter system is strategically placed to direct the water flow towards the Impluviums and basins where it can be captured and used for various purposes, such as irrigation and flushing.

In addition to its functional benefits, the rainwater capture system also provides unique atmospheric experiences for visitors. As the rainwater flows down the gutter system, and cascading down into the basins - it becomes an art piece and almost an architectural element in itself - a column of water which exists only in the present.

The choice of galvanized steel and zinc-coated sheet metal as materials for the building's canopy is also informed by its endurance regarding rain. Steel and sheet metal are highly resistant to rust and corrosion, making them ideal choices for structures exposed to rainwater. The canopy is specifically designed to protect the building's structure from rain while also allowing for maximum sunlight exposure, creating a bright and welcoming environment.

The rainwater capture system is an integral part of the bazaar building's design. Its functional benefits, combined with its ability to create unique atmospheric experiences, make it a key element of the building's overall aesthetic.

Illustration of staircase seating and the Impluvium room

Proposal

THE ARCADE

The arcade plays a vital role in the design, offering visitors an unhindered pathway while ensuring protection from rain. It stands as a prominent feature, allowing people to engage with their environment while remaining sheltered from adverse weather conditions.

The unobstructed path of the arcade holds significant importance for the overall functionality and design of the bazaar. It enables visitors to move freely between shops without being exposed to rain or other weather elements. This seamless flow ensures a delightful shopping experience, where individuals can explore and engage with various vendors without the hindrance of weather conditions.

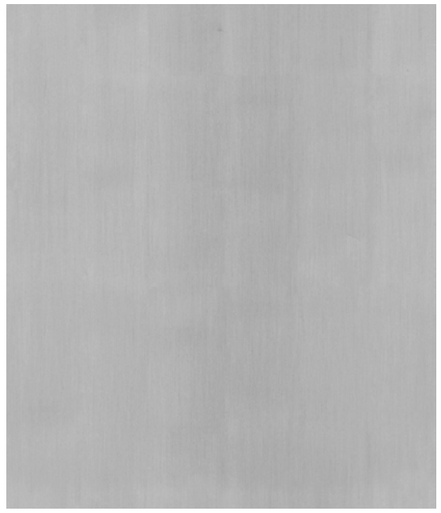
Furthermore, the arcade provides seating areas, inviting visitors to sit and relish the surrounding view. It allows them to observe and be captivated by the rain while still providing protection. This harmonious blend of shelter and connection with nature creates a soothing atmosphere for individuals within the arcade.

The presence of the arcade contributes to the potential for unobstructed atmospheric environments in the urban setting, even during rainfall. By being in close proximity to the new additions on Kungstorget, visitors can experience a seamless integration of indoor and outdoor spaces, embracing the ambiance and unique qualities of the surroundings, regardless of the weather conditions.

Illustration of the inner arcade

Proposal

Galvanized steel



Zinc coated sheet metal

Concrete

Larch

MATERIALITY

The materials chosen to work with are robust, tactile and logical materials which are used where they make the most sense.

Galvanized steel is used as the main material for the canopy - allowing for material efficiency, providing a lightweight appearance and being able to withstand the elements.

Bent zinc coated plate sheets are used as material for the roof. The material is good at withstanding the elements and provides a thin, lightweight appearance.

Concrete is used as a base for the structures. It is a strong, robust material that gives the appearance of ground, and withstands the test of time. It is also a material which can allow water to run on it without damaging it.

Larch is used as cladding and as construction material for the inner core. It is a popular wood species used for construction and cladding around the world, and it is particularly suitable for use in areas with damp and rainy climates like Gothenburg.

One of the main advantages of larch is its natural durability. Larch is resistant to rot and insects, making it a good choice for outdoor use as it requires less maintenance than other wood species. This can be particularly important in areas with high humidity or a lot of precipitation, as moisture can cause problems with rot and mold on other types of wood.

Larch is also a stable wood species that does not shrink or swell as much as other wood species. This makes it less prone to cracking or deformation over time, which is important for the building's structural integrity and appearance.

In addition to its functional properties, larch also has an aesthetically appealing reddish color that ages beautifully to a silvery gray tone. This makes larch ideal for use as cladding material, as it can give buildings a natural and warm feel.

Proposal

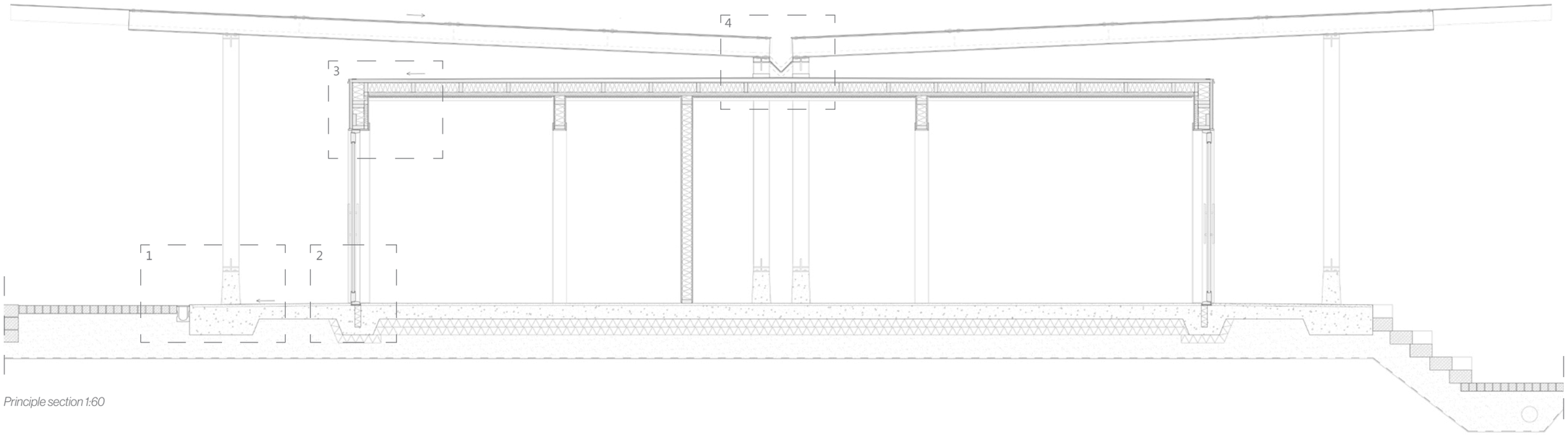
Illustration of food court

Proposal

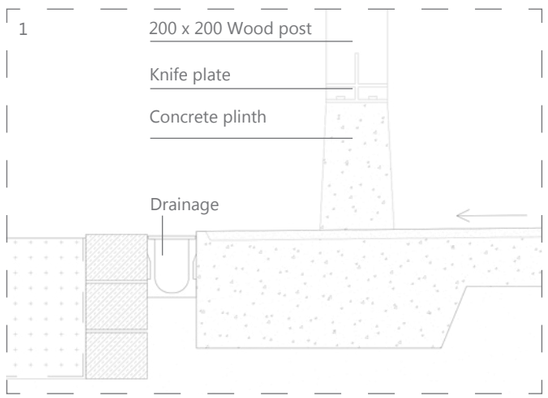
Illustration of food market

Proposal

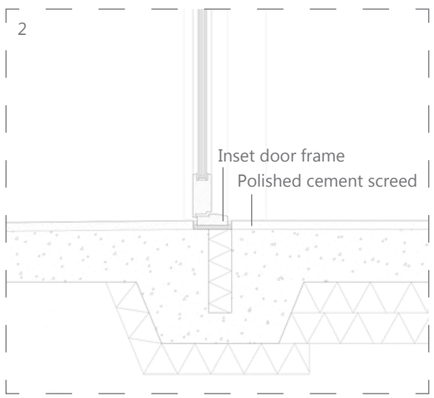
DETAILS & CONSTRUCTION



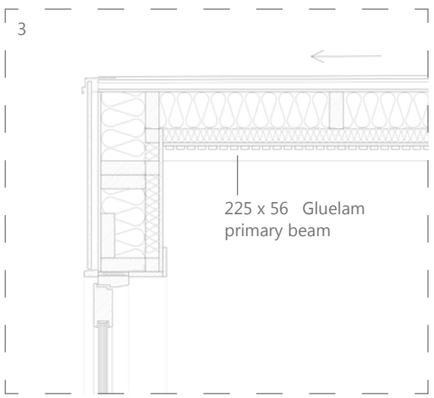
Principle section 1:60



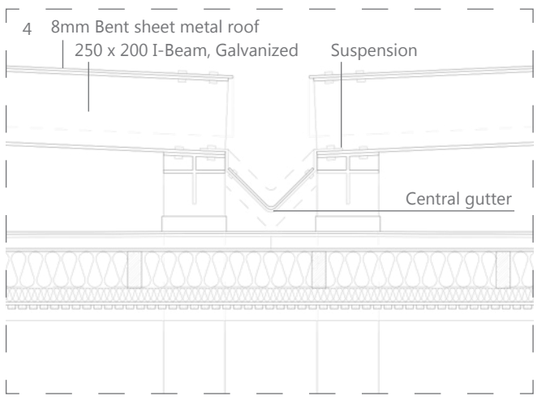
Detail, Post/Plinth, 1:20



Detail, Floor, 1:20



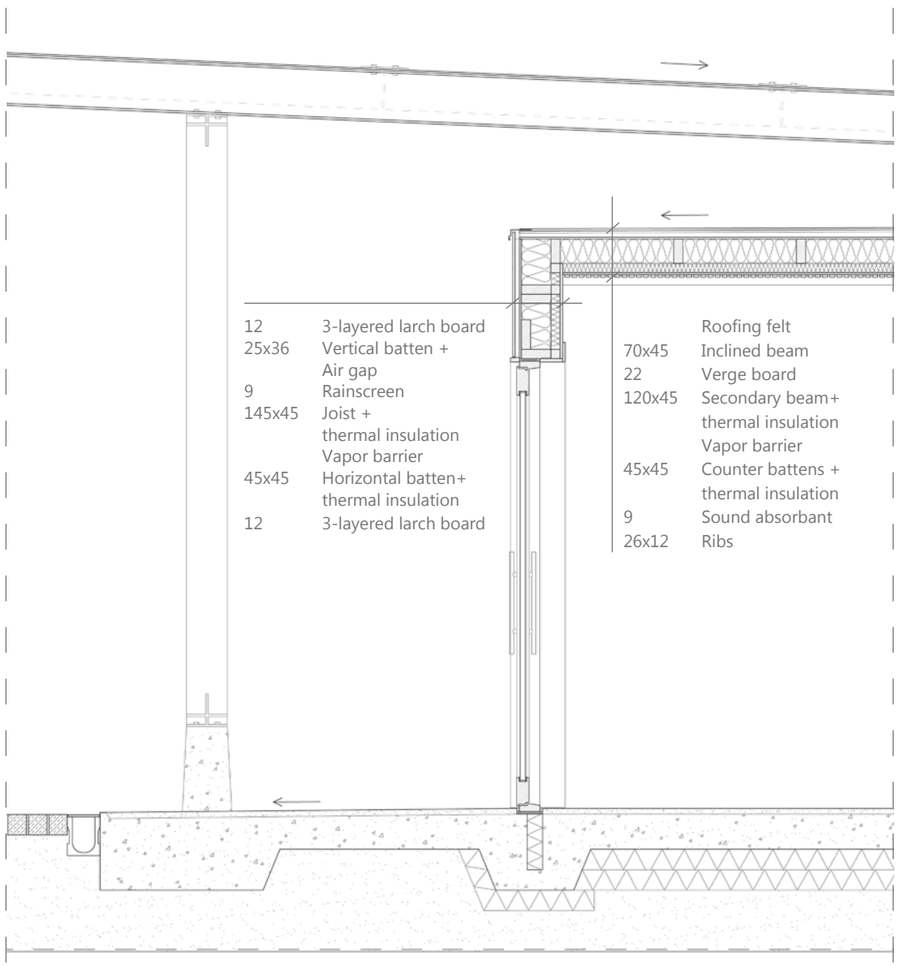
Detail, Wall/roof, 1:20



Detail, Central gutter, 1:20

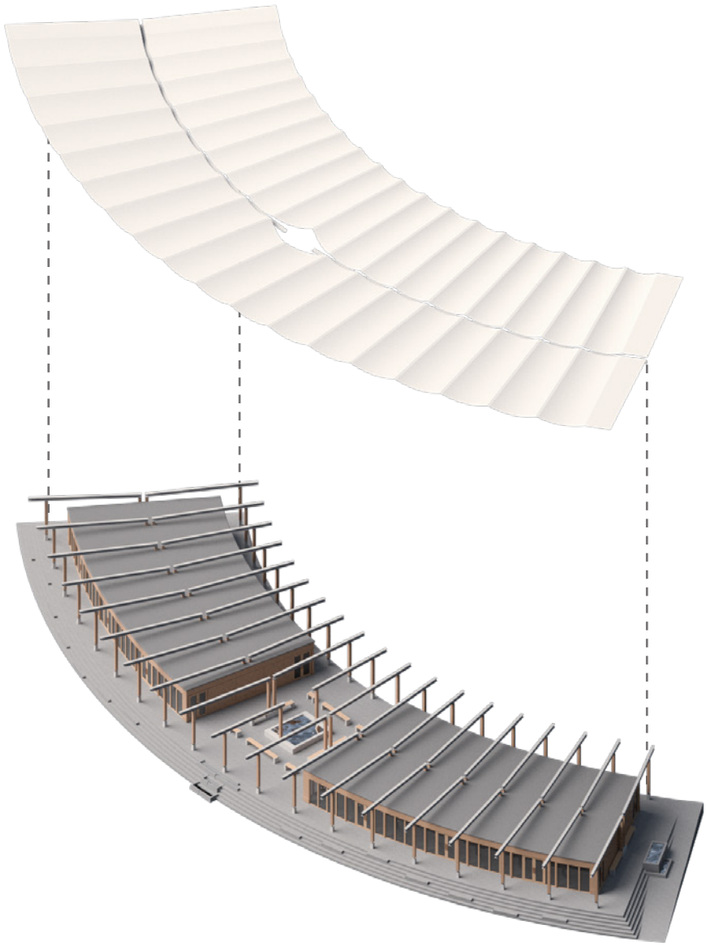
Proposal

Facade elevation, 1:30

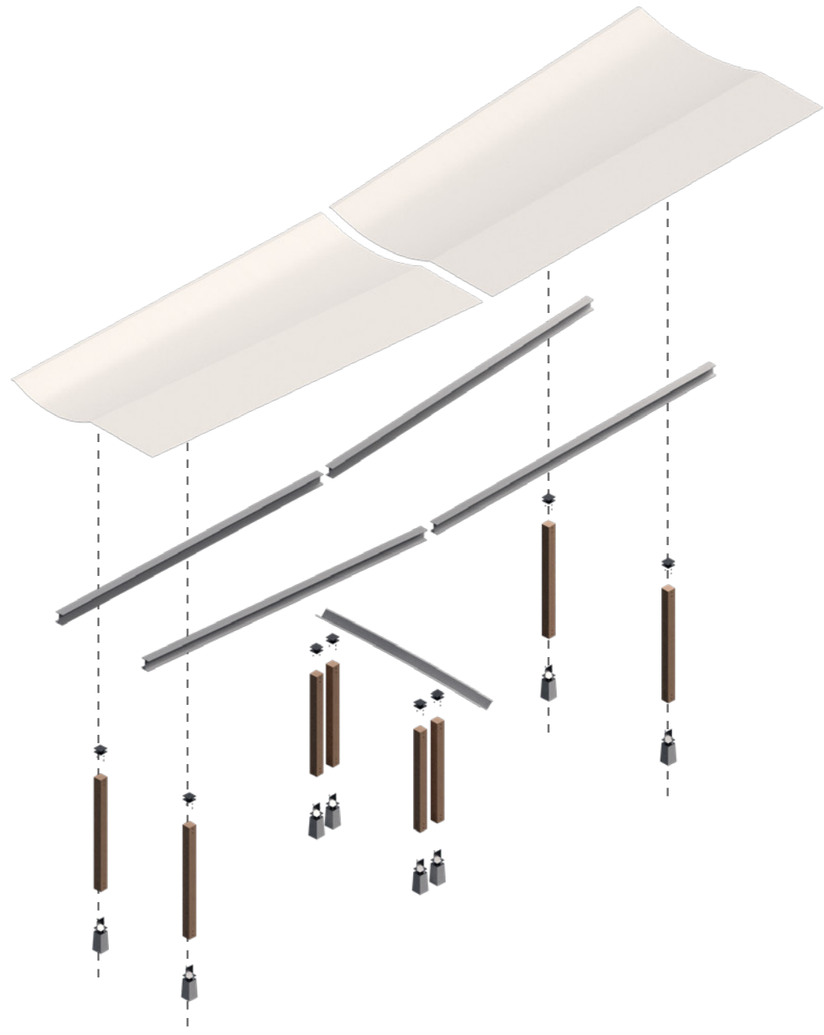


Facade section, 1:30

Proposal

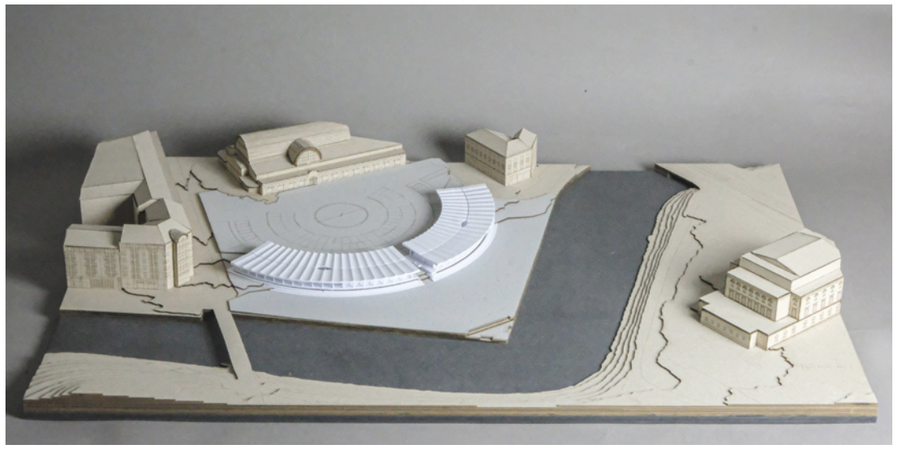


Construction model



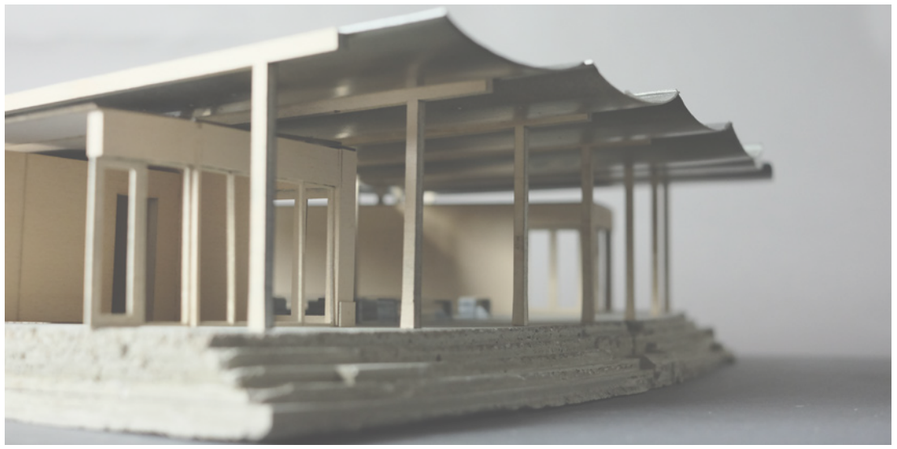
Assembly principle

PHYSICAL MODELS



Situation model Kungstorget, 1:300

Building model, Impluvium, 1:50



Building model, Impluvium, 1:50

Building model, Impluvium, 1:50

Proposal

DISCUSSION

Rain Gothenburg

How does a city become good when it rains? What does it even mean to be good when it rains? Rain is mostly cold, wet and uncomfortable - which all are factors working against quality of life.

Being good when it rains could refer to a lot of topics - Both an environmental discussion about freshwater resourcefulness, or about flood and cloudburst mitigation and resilience, about protection from rain, or about using rain as a tool for creating a more atmospheric environment.

This master's thesis has been focusing on the two latter fields. Exploring how the new built environment in central Gothenburg could relate to the aspiration from the municipality in the sensory and atmospheric areas of study could then bring forward ideas and further discussions on how a public building could be designed in order to enhance the urban wellbeing in the city.

As the theory suggests, interweaving blue spaces into everyday life could potentially generate a healthier environment for the city's inhabitants.

One could argue that central Gothenburg is full of blue spaces - meaning the moat, canals and the river - and that the city doesn't really need these kinds of interventions. Those situations are great, and the city should definitely further invest in accessibleizing them.

This thesis, however, instead addresses how the built environment could bring blue spaces further into people's everyday paths and into situations where there are currently lacking atmospheric properties. It concerns successively weaving a web of blue spaces into the city, eventually democratizing these situations by providing an abundance of them far away from the canals and river. If the city wants to become the best city when it rains, why not use the rain/building interaction as a means to create a healthier, bluer city?

Discoveries

In this master's thesis the wider field of rainwater interventions and wellbeing becomes boiled down into a specific case study - which allows for detailed and precise explorations, and brings forward one answer to the question of "How can rainwater be utilized within a central urban addition and turned into a sensuous architectural element?".

Thus, there could be a multitude of other answers and solutions for how to incorporate rainwater as a sensory resource. However, the precise explorations conclude some general aspects.

First of all - in order to generate an environment that provides comfort and quality, one must be provided with an abundance of options for protecting oneself from the rain. If not protected from the rain, all other design efforts for creating delightful rain situations will be in vain, since the experiencer will be distracted by being soaking wet and cold. Therefore, new public buildings should incorporate generous arcades and protected exterior promenades that allow pedestrians to experience the rain without being directly impacted by it.

Secondly - in most cases today, rainwater is considered an annoyance that should be steered away, hidden and removed from the buildings as quickly as possible. Merely a problem to be solved. However, running water has exceptional sensory properties. Instead, the occurrence of rain should be seen as an opportunity. There you have a free source of atmospheric enhancement to tap in to.

The building should therefore expose the gutter system as much as possible - letting the passers-by take part of the spectacle. To visualize the water runoff path throughout the building and surroundings and possibly provide parts that are interactable - could be a means to interweave the urban fabric with blue spaces effectively.

Reflections

Working with the topic of rainwater intervention in an architecture context has, however, occasionally been a struggle. Architecture is a complex and holistic practice that requires a plethora of different inputs and considerations from different fields to make a wholesome space. Only focusing on one topic when designing architecture risks leading to something that feels out of place and arbitrary.

Therefore, this thesis has been dealing with a lot more than just rainwater details. It has been about making a public place that answers to the demands of many different fields. In that sense, some of the initial goals of the master's thesis - generating precise rainwater interaction details etc and focusing only on the rainwater aspect - have during the process become less prioritized. However, this will certainly be the case whenever it comes to designing architecture in practice. There will always be compromises for the greater good of the project outcome.

Another struggle dealing with the topic of water in architecture is the risk of taking it one step too far - generating a theme park-esque situation. Throughout the process, the task of balancing between elegance and gaudiness has been ever present. If designing water occurrences and spectacles everywhere and in every situation, with sculptures, fountains

CONT. DISCUSSION

and streams, that would have led to a project feeling more like a water world than a central public square. However, scraping away too much of these occurrences would water down the essence of the thesis itself.

Conclusions

The main objective of the project was to design a building that captures and uses rainwater as a resource. A resource for creating an atmospheric spectacle throughout the rainwater runoff chain to enhance the presence of blue spaces in the overall urban environment.

The design of the building includes a tailored roof, arcades, exposed gutters, rain columns, and cascading basins that work together to capture rainwater and use it for visual and auditory purposes, and for internal usage such as flushing toilets and for irrigation.

The secondary objective was to provide the city with a detailed proposal for how to incorporate the ideas of a good city when it rains into Kungstorget for the 400 year jubilee.

Hopefully, the ideas presented in this work can ignite further discussion around the potential of Kungstorget - which today could be seen as one of the sites within central Gothenburg having the most unused potential.

By taking a holistic approach that considers the specific challenges and opportunities presented by the local context, it is possible to develop effective and sustainable interventions that contribute to the overall quality of life for the local community.

Overall, the master's thesis demonstrates the potential of rainwater interventions through the built environment to create more sustainable and livable urban environments.

One could say that a good city when it rains views their building stock as "engines" for wellbeing, using rain as their "fuel".

BIBLIOGRAPHY

BOOKS

Laurence, R. (2011). *Roman Pompeii: Space and Society.* Routledge

Murcutt, G. (1995). *Ball-Eastaway House*. Architecture Australia, 84(6), 51-60.

Pallasmaa, J. (1996). *Glenn Murcutt: Buildings and Projects 1962-1995.* Thames and Hudson.

Pallasmaa, J. (2005). *The eyes of the skin: architecture and the senses.* John Wiley & Sons.

Pomroy, P. (2011). *Glenn Murcutt: thinking drawing / working drawing*. Thames and Hudson.

Zumthor, P. (2006). *Atmospheres: Architectural environments; surrounding objects.* Birkhäuser, cop.

OFFICIAL DOCUMENTS

Higab, Park- och naturförvaltningen, Wallenstam, & Trafikkontoret. (2019). *Utvecklingsplan för Kungstorget.*

Higab, Gestalt Arkitektur. (2018). *Utredning av Higabs Byggrätter.*

ARTICLES

Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). *Nature experience reduces rumination and subgenual prefrontal cortex activation.* Proceedings of the National Academy of Sciences, 112(28), 8567-8572.

Gascon, M., Triguero-Mas, M., Martínez, D., Dadvand, P., Forns, J., Plasència, A., & Nieuwenhuijsen, M. J. (2015). *Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review.* International Journal of Environmental Research and Public Health, 12(4), 4354-4379.

Oliver D.M. (2021). *Neighbourhood blue space and mental health: A nationwide ecological study of antidepressant medication prescribed to older adults.* Elsevier B.V.

White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2010). *Would you be happier living in a greener urban area?* A fixed-effects analysis of panel data. Psychological Science, 21(6), 920-928.

Bibliography

WEBPAGES

Bullitt Center. (2013). *Rainwater Harvesting.* Retrieved from https://www.bullittcenter.org/water/

California Academy of Sciences. (2023). *Living Roof.* Retrieved from https://www.calacademy.org/exhibits/living-roof

General Services Administration. (n.d.). *Edith Green-Wendell Wyatt Federal Building.* Retrieved from https://www.gsa.gov/about-us/regions/welcome-to-the-northwest-arctic-region-10/buildings-and-facilities/oregon/edith-greenwendell-wyatt-modernization-project

Göteborg2023. (2022) *Uppleva regn.* https://goteborg2023.com/jubileumsprojekt/rain-gothenburg/#uppleva-regn

Göteborgs stad. (2022). *Rain Gothenburg.* https://stadsutveckling.goteborg.se/klimat-och-miljo/rain-gothenburg/

Göteborgs stad. (2022). *Vatten i Göteborg, Skyfall* [Dataset]. https://www.vattenigoteborg.se/Downpour/ScenarioResult

Parkes, J. (2021, May 20). *Rainwater flows in and out of Danish Pavilion at Venice Architecture Biennale. Dezeen*. https://www.dezeen.com/2021/05/20/lundgaard-tranberg-architects-danish-pavillion-venice-architecture-biennale/

Schires, M. (2021, July 19). *How (and Why) to Let Weather Into Your Buildings: 6 Projects that Bring Nature Inside. ArchDaily*. https://www.archdaily.com/878034/wind-sun-and-rain-how-and-why-to-let-weather-into-your-buildings

Västra Götalandsregionen. (n.d.). *Basarerna på Kungstorget.* Retrieved January 22, 2023, from https://vartgoteborg.se/gamla-goteborg/basarerna-pa-kungstorget/

FIGURES

Figure 1. Atkins, Anna (Photographer). (2017, June 30th). [digital image]. Retrieved from https://unsplash.com/photos/rNBaaxyeWWM

Figure 3. Visionsbild Torslandaskolan [digital image]. (n.d.) Retrieved from https://goteborg2023.com/jubileumsprojekt/rain-gothenburg/#uppleva-regn

Figure 4. Ullnert, Marie (Photographer). Regnlekplatsen i Renströmsparken [digital image]. (n.d.) Retrieved from https://goteborg2023.com/jubileumsprojekt/rain-gothenburg/#uppleva-regn

Figure 5. Brunnslockspoesi [digital image]. (n.d.) Retrieved from https://stadsutveckling.goteborg.se/klimat-och-miljo/rain-gothenburg/upplevaregn/brunnslockspoesi/

Figure 6. Choy, Suhyeon (Photographer). (2017, November 2). Rain [digital image]. Retrieved from https://unsplash.com/photos/HCDugQDdtfc

Figure 7. Ng, Nicholas (Photographer). (2021, May 3). Tranquility [digital image]. Retrieved from https://unsplash.com/photos/SvU-kkCV_88

Figure 8. Diagram figure Rainwater Collection System. Adapted from Top 5 Important Components Of Rainwater Harvesting by Single Droplet, Retrieved March 2023 from https://singledroplet.com/components-of-rainwater-harvesting/

Figure 9. Roman Impluvium. Adapted from The Roman Domus as a Caribbean Urban Housing Solution by Andrew Malone, Retrieved October 2022 from http://andrewmalone.blogspot.com/2016/08/the-roman-domus-as-caribbean-urban.html

Figure 10. Berndtson, Hampus (Photographer). (n.d.). [digital image]. Retrieved from https://www.dezeen.com/2021/05/20/lundgaard-tranberg-architects-danish-pavillion-venice-architecture-biennale/

Figure 11. Berndtson, Hampus (Photographer). (n.d.). [digital image]. Retrieved from https://www.dezeen.com/2021/05/20/lundgaard-tranberg-architects-danish-pavillion-venice-architecture-biennale/

Figure 12. Lovelace, Paul (Photographer). (n.d.). [digital image]. Retrieved from https://www.sydneyballart.com/timeline

Figure 13. Cavalari, Kauã (Illustrator). (March 2020). [digital image]. Retrieved from https://www.behance.net/gallery/93244621/Glenn-Murcutt-Ball-Eastaway-House-Modelagem-e-Renders?tracking_source=search_projects_recommended%7CGlenn+Murcutt

Figure 14. [Aerial photo of Sweden]. Lantmäteriet. https://minkarta.lantmateriet.se/

Figure 15. [Aerial photo of central Gothenburg]. Lantmäteriet. https://minkarta.lantmateriet.se/

Figure 16. [Aerial photo of Kungstorget 1960]. Lantmäteriet. https://minkarta.lantmateriet.se/

Figure 17. [Postcard of Kungstorget]. Vårt Göteborg. https://vartgoteborg.se/gamla-goteborg/basarerna-pa-kungstorget/

Figure 18. Hedlund, H & B (1914, June 9). [Ritning till förändring av Bazaren å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

Figure 19. (1909, April 20). [Ritning till förändring av Bazarbyggnaden å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

Figure 20. (1884, September 16). [Ritning till förändring af Bazarbyggnaden å Kungstorget]. Regionsarkivet, Gothenburg, Sweden.

Figure 21. Plan sketch. From Utredning av Higabs Byggrätter by Higab, Gestalt Arkitektur, 2018

Figure 22.Aerial montage view. From Utredning av Higabs Byggrätter by Higab, Gestalt Arkitektur, 2018