



SENSING WATER

HOW WATER CAN INCREASE THE USE OF OUR
SENSES WHEN EXPERIENCING ARCHITECTURE

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Department of Architecture and Civil Engineering
Examiner: Morten Lund
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Cover: *Illustration of water.*

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CHALMERS
UNIVERSITY OF TECHNOLOGY

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ABSTRACT

Imagine walking along a flowing mountain river. The sun is shining on the small waves of the flowing water, creating shining ripples on the ground. You arrive at a small waterfall and when the water crashes into the surface underneath tiny droplets are created surrounding your entire body. Although you can barely see them you can feel them dancing lightly on your skin, their weight contradicted by the loud crash of water beside you.

Water exists in so many shapes and forms. It can be fast and slow, reflecting and absorbing, floating, flowing and falling. Water covers 71% of the earth's surface yet it is rarely used in architecture.

The purpose of this thesis is to give meaning to water in architecture through the use of our senses.

The discussion on how our senses are used when perceiving architecture has been going on for quite a while but vision is still the outstanding sense when it comes to designing architecture. The other senses are normally forgotten and that is why water is important in this thesis. Can water in architecture trigger our senses to be more present when we experience architecture? In what ways and how can water trigger our senses?

The proposal started with the idea of mimicking a hiking trail that follows a mountain river in Switzerland. During a prep semester water was investigated on its own and four water elements were developed by mimicking water movements that could be found along this trail. The elements are Waterfall, Cascade, River and the Shadows and Reflections of water. The experiments investigated how these affected our senses in different ways.

The water elements have been brought into an architectural context by designing four pavilions. One for each element. The goal is to show that water affects the architecture around it and to investigate how it does this.

The proposal is a walk in Gothenburg that brings together the four water elements similar to the swiss hiking trail. They will display the movement of water, the sensory experience of water on its own as well as a sensory experience of architecture.

STUDENT BACKGROUND

I started my education 2013 in the Bachelor of Architecture and Engineering. After graduation my bachelor I continued to the Master of Architecture and Urban Design (MPARC) with first one semester abroad at École Supérieur d'Architecture in Lyon, France. When I came back I did one year at Chalmers before I took one semester off for an internship.

The internship I did during the spring of 2018 was at an engineering firm called Buro Happold Engineering in Bath, UK.

My last semester at Chalmers before the thesis I studied in the Matter, Space, Structure studio and did a prep course for my thesis semester.

STUDIES AND INTERNSHIP - TIMELINE

2013 - 2016	Architecture and Engineering
3 Years	Chalmers University of Technology
2016	Master of Architecture and Urban Design
1 Semester	École National Supérieure d'Architecture de Lyon
2016 - 2017	Master of Architecture and Urban Design
1 Year	Chalmers University of Technology
2018	Internship
7 Months	Buro Happold Engineering, Bath, England
2018	Masters of Architecture and Urban Design, Thesis
1 Semester	Chalmers Univesity of Technology

READING INSTRUCTIONS

This thesis booklet starts with going through the thesis question and background. After that the referenses are analysed and methods are taken from them to move along with investigations.

After that the context of the project of a walk, connecting four pavilions in Gothenburg, is described. Then further details on each of the pavilion is described with one chapter for each pavilion. The thesis is finished with a short conclusion aand discussion.

BACKGROUND AND THESIS QUESTION

Both water and the senses are rarely deliberately used in architecture as a design tool. Water is a subject well studied but it is still very rarely used.

“From timem immemorial, mankind has actually also investigated water from an artistic perspective. However, unlike the subject of air, the deliberate use of water as a medium has not been subjected to in-depth study. Water is usually depicted but much more rarely used.” (Herwig & Thallemer, 2008, p. 6)

How can water be seen as a useful architectural element rather than a problem to remove? The senses and why they are important to architecture is a well known discussion and many people are aware of the words of for example Juhani Pallasmaa where he writes in his book “The Eyes of the Skin”:

“The authenticity of architectural experience is grounded in the tectonic language of building the comprehensibility of the act of construction to the senses. We behold, touch, listen and measure the world with our entire bodily experience, and the experiential world becomes organised and articulated around the centre of the body.” (Pallasmaa, 2014, p. 69)

Even though many try to incorporate the senses in architecture the sense of vision is still in bias when it comes to design. To incorporate these two topics this thesis investigates how different movements of water affects our senses. Can the water become a trigger to our senses in architecture? In that case in what ways and how does it affect the senses? Can this increase the use of all of the senses, vision, touch, sound, scent and taste, in our experience of architecture?

ARCHITECTURE AND THE SENSES

Vision is the sense of first impressions. It is the sense that is dominant when it comes to architecture today and the question that seems to pop up the most when describing architecture is "What does it look like?".

I am not questioning or criticizing the sense of vision in this thesis but I wish to give the other senses an equal importance because, as stated, vision is an essential sense. It is often the first sense that sets an expression when experiencing architecture.

The sense of touch is mostly thought as a very physical sense and it is, but I believe there is a side to it that doesn't require the physical touch. I believe most people can, for example when looking at a certain material, get a feeling of what that material would feel like. If it is cold or warm, rough or smooth.

That could just be our memories bringing us a picture but I think it is important to notice that the sense of touch doesn't always have to come from a very conscious movement. Like reaching out and touching a wall for example.

"The hands are the sculptor's eyes; but they are also organs for thought, ..." (Pallasmaa, 2014, p. 60-62)

These memories are some of the things that makes the sense of touch as well as the other senses important. I think a lot of people can relate to the feeling when sometimes, even though we don't remember what something looks like, we can remember the smell or the touch of it.

"We need only eight molecules of substance to trigger an impulse of smell in a nerve ending, and we can detect more than 10,000 odours. The most persistent memory of any space is often its smell." (Pallasmaa, 2014, p. 58)

The sound is a sense that can make us experience a space very strongly without even seeing it. Depending on the material the sound will bounce of the surfaces differently and you can get an image of what the room is like without ever seeing it.

"Anyone who has become entranced by the sound of dripping water in the darkness of a ruin can attest to the extraordinary capacity of the ear to carve a volume into the void of darkness." (Pallasmaa, 2014, p. 54)

The last sense, taste, is not something we normally think of as important when experiencing architecture but the taste comes in as a combination of the other senses. When we see something, touch it and most of all smell it, it triggers our taste. It is the same as when we eat something and then we eat the same thing without smelling it and all of a sudden it tastes differently, something most of us have felt before. That is an example of when the senses are coming together to

ARCHITECTURE AND THE SENSES

influence our experience.

This makes me think the experience I had when visiting one of my references, the old water reservoir on Gråberget in Gothenburg. The room was pitch black. I couldn't see anything. But still when I made even the faintest of sounds it seemed as if I could hear the echo forever. I could feel the cold material of concrete and steel and I could smell the moisture in the room. All of these senses coming together gave me an image of what the room looked like even though I could barely see it.

All the senses together is what creates a sensory experience or an atmosphere as you might call it. I believe that the senses are what creates that feeling that Peter Zumthor talks about in his book "Atmospheres":

"I enter a building, see a room, and - in the fraction of a second - have this feeling about it." (Zumthor, 2015, p. 13)

The more we involve the senses in our experience of architecture the more we feel it. I believe that if we design more consciously for and with the senses we can change and enrich our experience of architecture. To create an architecture that more often holds a meaning so that we can get the sensation that Zumthor describes.

METHOD

During the prep semester before my thesis I investigated different water movements on their own to see how they affected our senses, sight, touch and sound. The water elements that I have brought with me into this thesis are waterfall, cascade, river and the shadow and reflections of water. The elements were all inspired by features from my main reference, the Flimser Wasserweg hiking trail in Switzerland which is a trail that follows a mountain river.

The investigations carried out during the prep semester has been very important for the continuation for the project and has been the base of how the different water elements affect our senses differently. The knowledge from these investigations are brought into the thesis but it is also built and reflected upon during new investigations.

The method I'm working with during the thesis is to investigate the water elements brought forward from the prep in an architectural context. I am doing this by bringing each of the element into pavilions whose goal and purpose is to enhance the sensual experience. The senses are evaluated and investigations will be performed to see how the architectural expression changes with the water element.

The most important investigation I am doing to evaluate the effect of the water in the pavilions is to compare the pavilions with versus without water. This is done through simple room models where the water feature is brought.

The method I am using to enhance the senses in the pavilions are methods taken from my references.

The material I have chosen to limit myself to is concrete because of its properties of withstanding water.

The pavilions are placed in a walk as a connection to Flimser Wasserweg. The hiking trail is the main reference for the program and therefore I am striving to create as many parallels between the two walks as possible but still staying in a city context for my thesis.

FLIMSER WASSERWEG

Reference, Program

The Flimser Wasserweg was a very sensory experience and that is why I wanted to turn the swiss hiking trail into a program for my walk in Gothenburg.

By trying to identify characteristics of the walk that affected the sensory experience and bringing those characteristics into the program I believe that I can enhance the sensory experience of the city walk.

Walking along the water

The trail follows the mountain river. Even when you don't see it you can hear it. By having this clear path to follow but still not having to think of where to go is a part that I think enhances the experience.

Not always seeing the water

Along the trail the water is not always visible. In between there are parts of the walk when you promenade on meadows and you can see the mountains and nature around.

I believe that this contrast, seeing versus not seeing the water, enhances the experience of both the scenes. Both the water and the landscape around it.

Bridges as stops and focus points

Creating the path is seven bridges by the Swiss engineer Jürg Conzett. The bridges are for me a way the see the water from a new angle and Conzett wanted them to be a way to get close to the water, not just go over the ravine but be placed into it (Dechau, 2013, p. 17).



Figure 1. Flimser Wasserweg, nature (Weisse Arena Gruppe, n.d.). Adapted with permission.



Figure 2. Flimser Wasserweg, water (Weisse Arena Gruppe, n.d.). Adapted with permission.



Figure 3. Flimser Wasserweg, bridges (Weisse Arena Gruppe, n.d.). Adapted with permission.

FLIMSER WASSERWEG

Waterfall

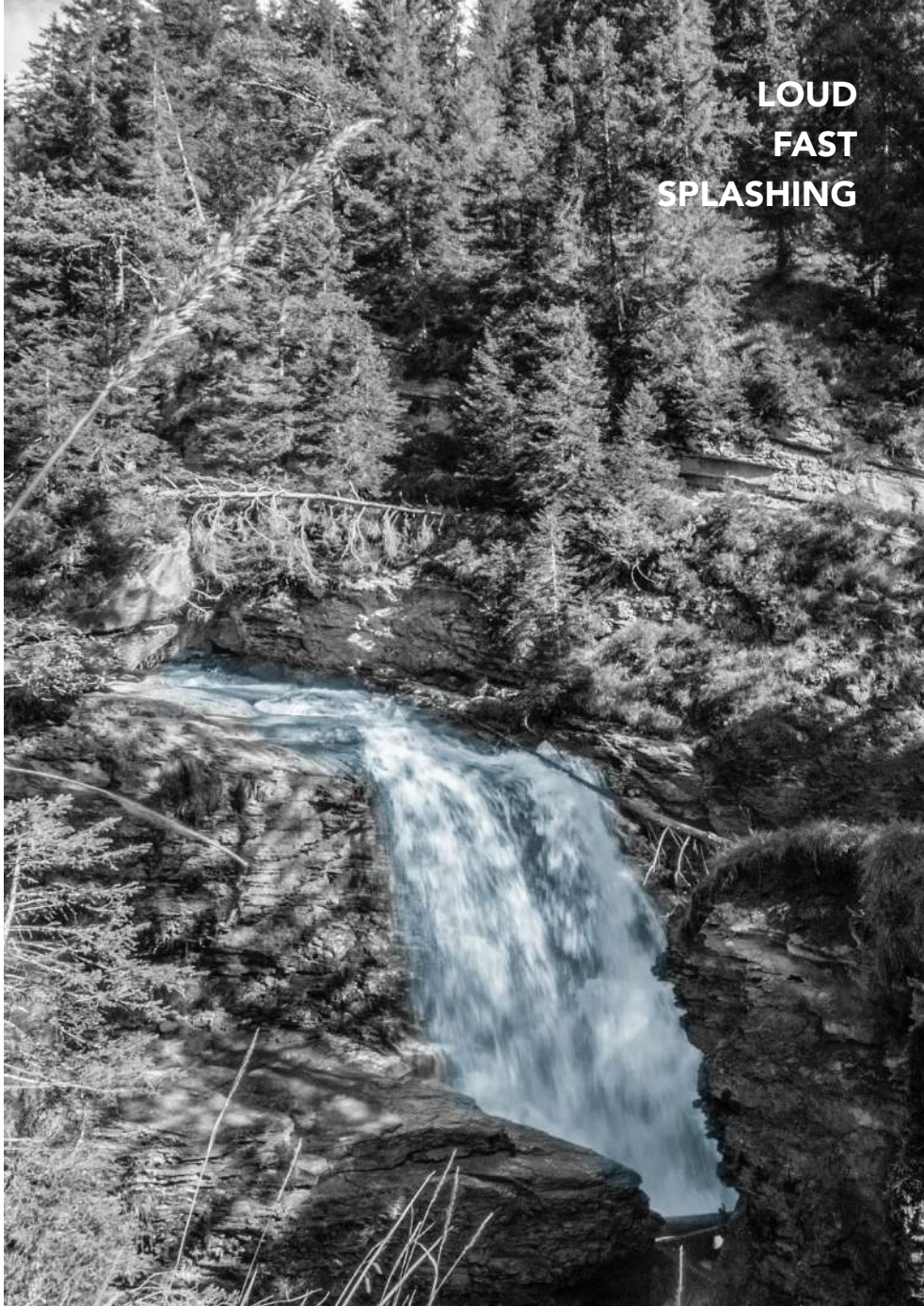


Figure 4. Waterfall, Flimser Wasserweg (Borgström, 2016). Adapted with permission.

FLIMSER WASSERWEG

Shadow

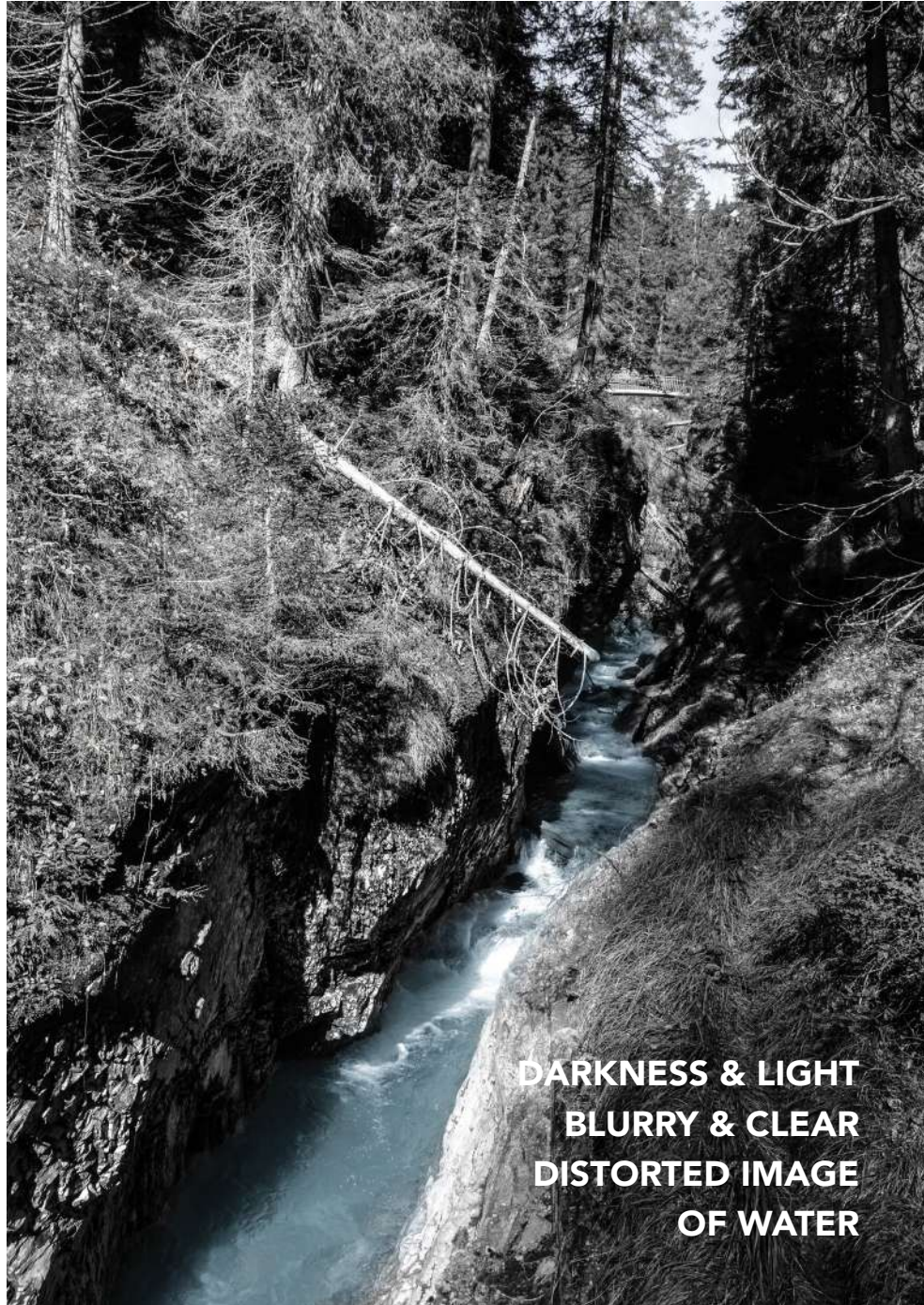


Figure 5. *Imagine the shadow of water on the cliff wall, Flimser Wasserweg (Björklund, 2016). Adapted with permission.*

FLIMSER WASSERWEG

Cascade

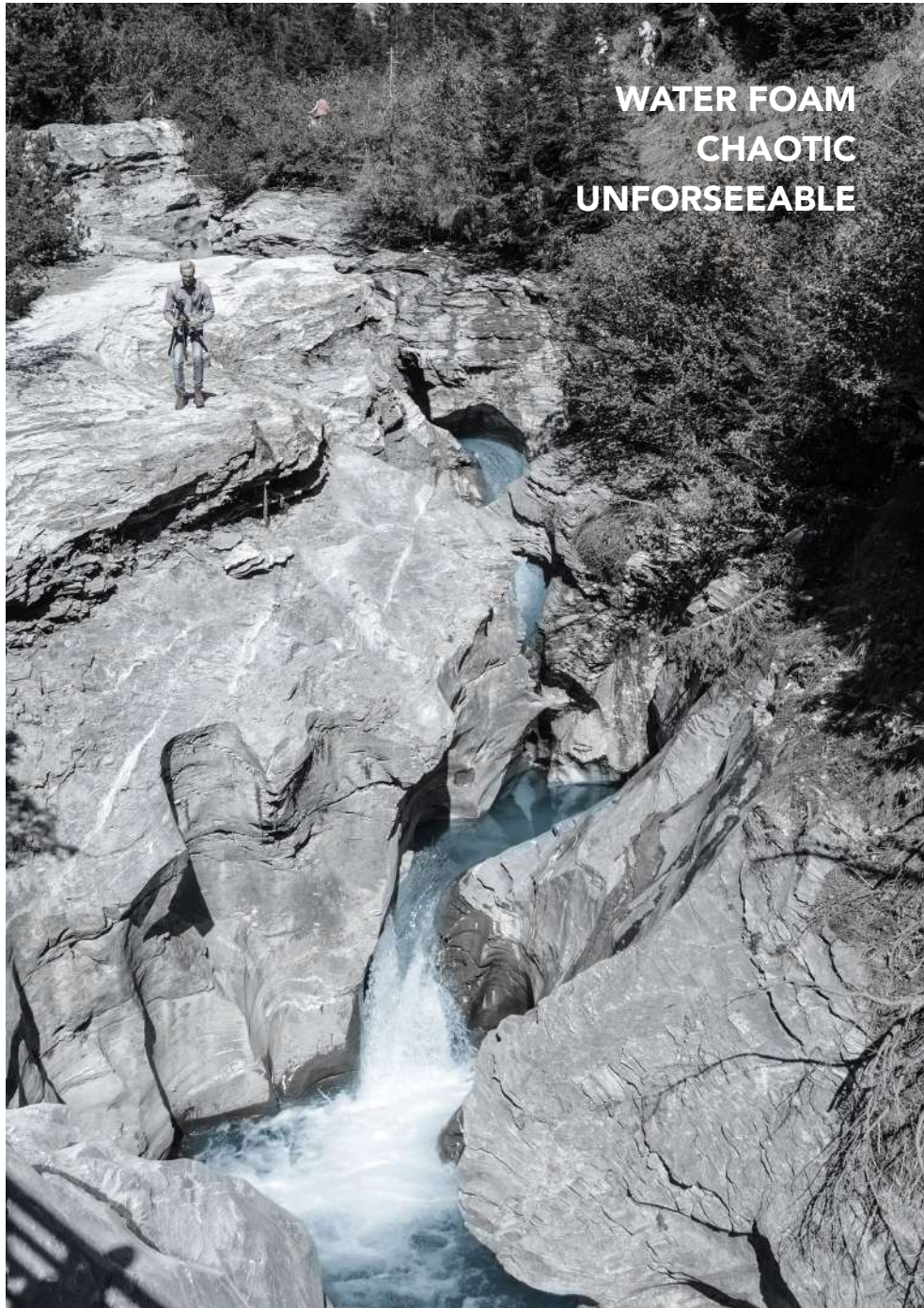


Figure 6. Cascade, Flimser Wasserweg (Björklund, 2016). Adapted with permission.

FLIMSER WASSERWEG

River



Figure 7. River, Flimser Wasserweg (Björklund, 2016). Adapted with permission.

THERME VALS 7132 SPA

Reference, Methods and Senses



Figure 8. Material, Therme Vals Spa (Global Image Creation – 7132 Hotel, Vals, n.d.). Adapted with permission.

The Therme Vals Spa by Peter Zumthor is also an experience I found affected my senses a lot. The project, as a spa, has also a strong relationship to water. In the different rooms of the spa Zumthor let's you see the water, feel it, smell, listen and taste the water and everything surrounding it.

In an interview Zumthor talks about the materials used in Vals that work together to create an architectural atmosphere as you might call it.

"... in Vals it's stone, water, light and shadow." (VernissageTV, 2016)

He speaks of the love affair of water and stone, and light and shadow. I

would like to interpret this as contrast. Stone and water are materials that go together naturally in nature. So does shadow and light, there can't be one without the other.

Another thing I think contributes to the experience in Vals is the clear structure of the plan and division of the different sensual experiences.

One of the rooms is very small in surface but very tall and this creates amazing accoustics, like an instrument. In another room a stream of water is poured from the ceiling and you can drink it.

In another the scent is enhanced and the scent of the water and minerals is combined with flower petals.

In one the bath is freezing and in the room straight across the water is very hot.

Each room has a different focus, and this also has to do with contrast. By focusing on one thing in one room and another thing in the next the difference between them will be much greater and this will enhance the experience.

THERME VALS 7132 SPA

Reference, Methods and Senses

“Users enjoy the water not only at various temperatures but in different spaces and conditions: in bright light, darkness, and twilight, or standing in shadow and looking into the brightness of a colorful, illuminated landscape. Sunlight trickles in through narrow slits or through the gaps we left open between the stone slabs of the ceiling. Daylight and landscape images flood the giant windows, giving shape and texture to the surfaces of stone and water in the changing light of the days and seasons.” (Zumthor & Durisch, 2014, p. 39)

The slits in the walls and ceiling that let the light simmer in could also be an interesting investigation. How can the light enhance the material and water.

Another feature is the stairs. How does the visitors approach the water? Here you enter the water on the first step but there is still a clear border between stone and water, floor and water.



Figure 9. Material, light and water, Therme Vals Spa (Global Image Creation – 7132 Hotel, Vals, n.d.). Adapted with permission.

KULTURTEMPLET, GRÅBERGETS VATTENRESERVOAR

Reference, Design and Senses



Figure 10. Kulturtemplet (Cyrino, n.d.).
Adapted with permission.

The experience I had in the so called Kulturtemplet on Gråberget made me think of some design elements that I found interesting.

One was the material here, which is concrete, and how that reverberated the sound and made it echo for a very long time.

Not only the material created this echo of sound but the size and shape as well. Something I can bring with me and investigate further.

The other was the vaults. They are a way to bring the load into the pillars but they also bring a softness to the otherwise clear straight surface. I started to think that I wanted to bring this vault out into the light more in my designs. Bring this hidden design of this Gothenburg temple to the surface.

DESIGN TOOLS AND INVESTIGATIONS BACKGROUND

Design for the senses

Through my references I have compiled some design tools and investigations to use in the pavilions. The idea is that these will become a uniform design language in the pavilions. This is so that they will become one walk and not four separate designs. What is important in the design tools is also that they are a way to enhance the senses. To see that more clearly I have made a list of the main elements that affect the different senses.

Vision - Light, form, material and senses
Sound - Form, material and senses
Touch - Material and senses
Taste - Senses
Scent - Material and senses

It is important to note that all the senses will affect each other in turn but the other things I will investigate.

Design tools

Contrasts - To enhance the sensory experience as Zumthor does it in Therme Vals
Vaults - Bringing the design of the water reservoir into the light
Material - The main material I have decided to work with is concrete. Concrete has the hardness as the concrete in Kulturtempel and the stone in Therme Vals. It has the ability to reflect the noise, increase the sense of sound and the ability to capture the water.

Investigations

- *What will the sensual experience be with versus without water?*
- *How do you create sensory contrasts? is this contrast between the senses or just between one sense and itself?*
- *How is the sound increased in the pavilions where this is desirable?*
- *Where should light be let in in the pavilions?*
- *How does the material affect touch, smell and taste?*

MODEL INVESTIGATIONS BACKGROUND

Models and background

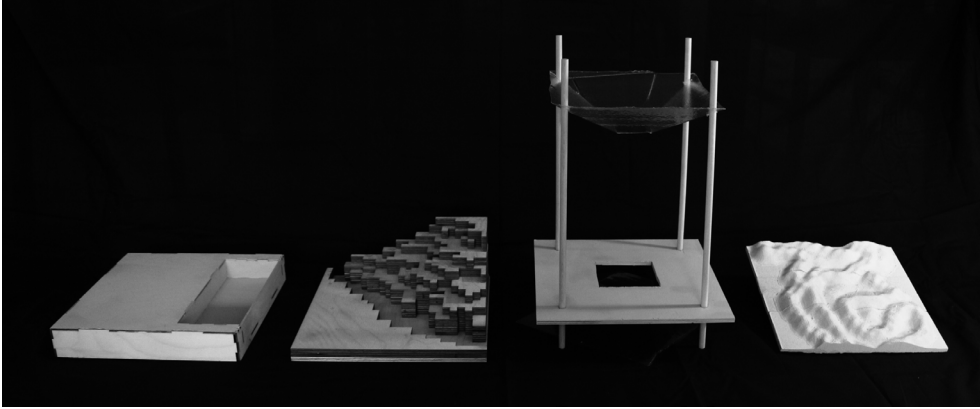


Figure 11. Water movement models. Author's own copyright.

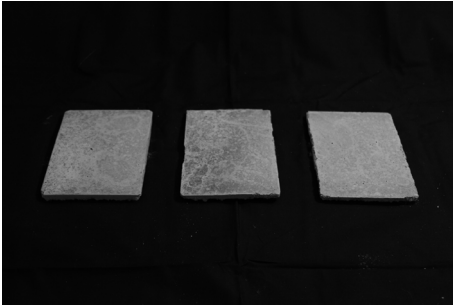


Figure 12. Material model. Author's own copyright.

The model investigations were made with models in foam, plastic and wood. There is also one material test where three small concrete slabs are used.

In the experiments for the four water elements I'm using my knowledge from last semester, but now also trying to place the elements into a room context. The models are approximately 30 × 30 cm so some consideration will need to be taken in the conclusions that there is no way to scale down water.

The room context in the models comes from that I'm placing foam walls around each model to "capture" the element. The experiments will be a comparison between the room without water and the room with water.

The second image shows the concrete plates used in the material investigations.

GOTHENBURG CONTEXT

A history of water

The program, of a walk, is placed in Gothenburg in a city context. I want the sensory experience to be easily accessible. One can go to one of the pavilions over lunch or go the whole walk when one have more time.

Gothenburg is a city known for its harbor and proximity to water. Through centuries Gothenburg has relied on its water sources for trade and business. 56% of Gothenburg's area is water (Statistiska Centralbyrån, 2018). I wanted to connect to this history and present times by placing my walk in Gothenburg connected to the natural water.



Figure 13. Gothenburg map with significant water's marked out (Google, Kartdata, 2018). Adapted with permission.

I wanted the locations of the pavilions to be connected to some of the different water elements that already existed in the city to connect to this history. These water elements are marked out on the map above surrounded by a marking of the area

I wanted to work within. It's the river, Vallgrav and Mölndalsån, The old watertowers in the city and the pond in Slottsskogen and Näckrosdammen.

GOTHENBURG CONTEXT

Locations

When deciding the locations I wanted to have a variety of locations, so that they marked out different types of water elements as well. Since the locations needed to combine a walk they could not be too far away from each other either. The chosen locations

are first by the river, underneath Älvsborgsbron. Then right next to the old water reservoir on Gråberget (Kulturtemplet). The next is close to the water tower in Slottsskogen and the last by the Vallgrav on the opposite side of Fiskekôrka.



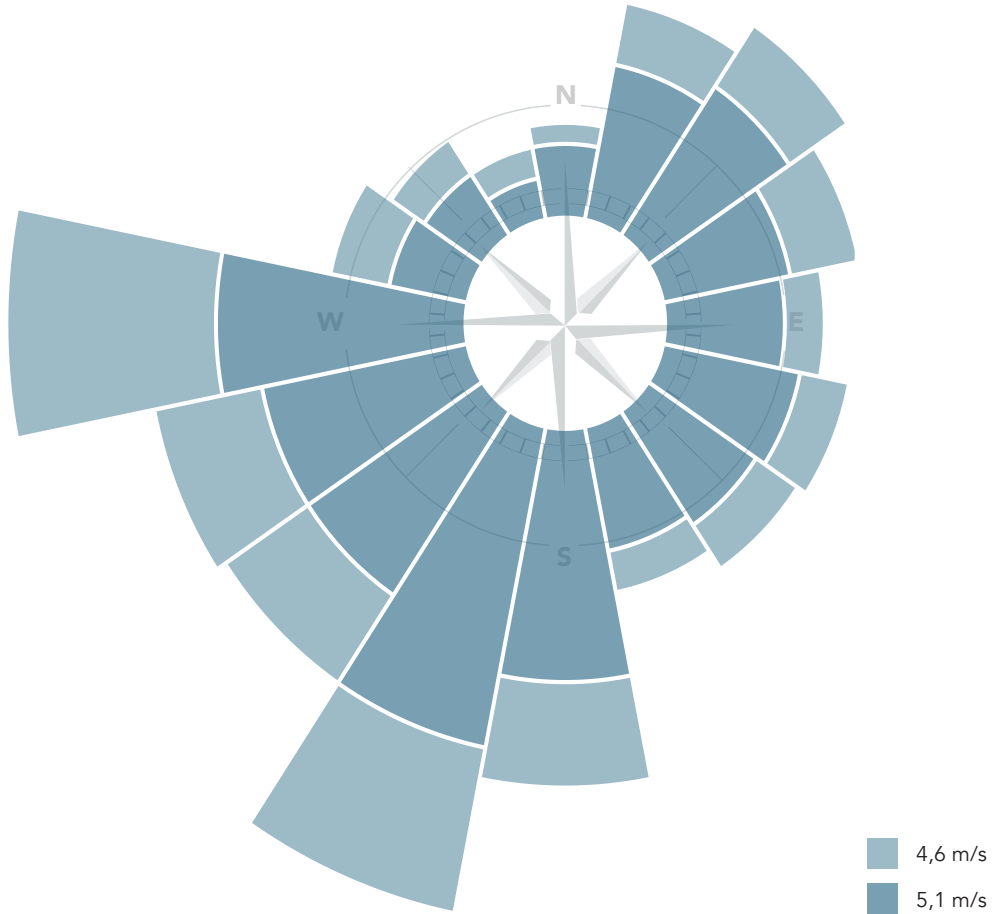
Figure 14. Gothenburg map with pavilion locations. (Google, Kartdata, 2018). Adapted with permission.

Topology was important for the locations as well. The Flimser Wasserweg is a natural mountain river and the water flows by gravity. I wanted a height difference in the walk to make a connection to the wasserweg and that height but also so that the water

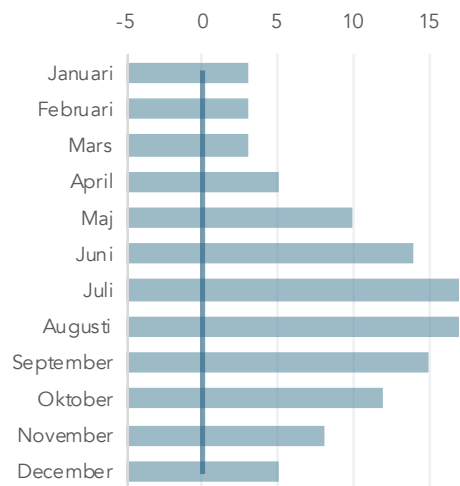
going along the walk might have a possibility to flow naturally by gravity.

GOTHENBURG CONTEXT

Climate



Gothenburg climate is windy but mild. Since my project is about flowing water I do not want it to freeze. The wind direction and strengt division over the year is shown in the rose chart above. The water temperature in Gotherburg is showed in the stable diagram to the right. The wind is mostly from the W - SW and in average in strengths between 4,6 - 5,1 m/s. The water temperature don't go below 0 so I believe if the water is kept in movement the risk of it freezing is very low.



SEQUENCE

The sequence of the pavilions is based on the city's water elements, the height and the natural order.

The sequence is first Waterfall, then Reflection, Cascade and River.



The waterfall is the forceful start of the walk. When the water falls it creates movement on the water underneath which, when light is reflected upon it, creates water like reflections and refractions.

The water continues to the cascade that falls down one after the other and ends up flowing down a river.

I wanted to place the waterfall as a forceful start but the reason for placing it under Älvsborgsbron was also first that I thought I might use the height of the bridge to drop the water from and create the waterfall. This is an idea I have let go because the fall becomes too high. I wanted to place either the river or the shadow of water in between the waterfall and the cascade since these two focus on similar senses and being two quite similar water movements.

The shadow of water made sense to place in close connection to the Kulturtemplet and to use that as a design reference. The reflections and refractions will be visible best in darkness where the contrast of light and dark will be the strongest. That's why the shadow of water became the second pavilion.

The next one is the cascade which is placed in the steepest slope after the water tower in Slottsskogen. By doing this the idea was that the pavilion could use the natural inclination of the ground to build upon when designing the cascade itself.

The last of the pavilions is the river as a calmer ending and as a connection to the slow flowing Vallgrav.

THE WALK

The walk in between the pavilions is based on the idea of following the water. I have mapped out all the waters and streams in the city, both old and new. Then I've tried to let the walk follow these streams as much as possible.

The section below shows the height difference of the walk in height above sea level. The height above sea level for the highest point on the walk (by the water tower in Slottsskogen) is approximately 83 m. It shows the locations of the pavilions on the two low points and two high points.

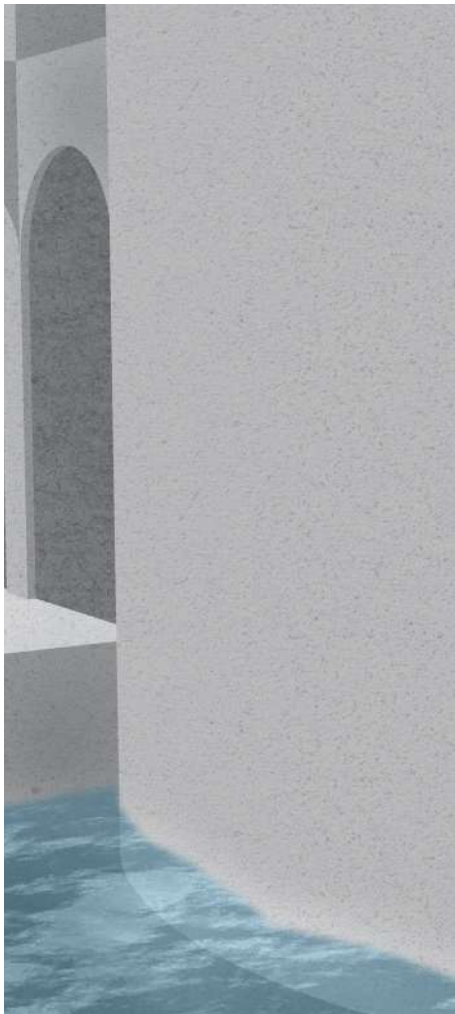
The walk is approximately 5,6 km long.



ABSENT AND PRESENT WATER

The water will not always run in the walk and the pavilions. The investigations made during this thesis were made to compare and see the influence of water in a context compared to the same context without water. The idea is that the visitors will be able to experience these different sensory experiences as well.

Another reason for not always having the water on is of an environmental aspect. It will take energy, and water of course, to have the water flowing so the shorter amount of time the better. This will be done so that the water will only be on when there are visitors in the pavilions (read more on the next page).



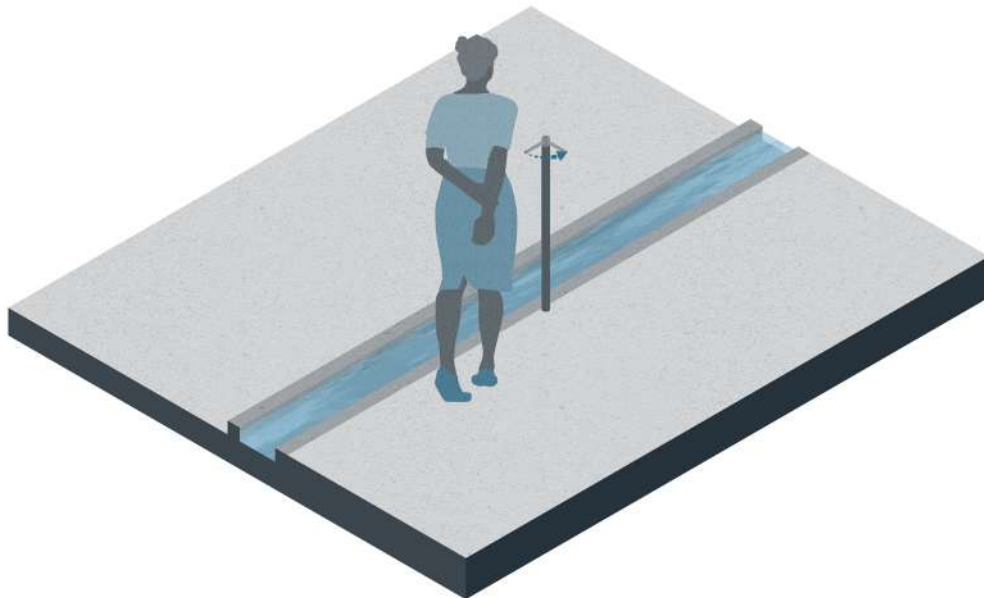
TO FOLLOW THE WALK

In order for everyone to follow the walk there will be a small gutter in the ground with flowing water when the water is turned on. This will also bring a further correlation to the Flimser Wasserweg and enhance the trail of water even more both physically and in idea.

A reference for the water gutter is the so called Hobson's Conduit in Cambridge.



Figure 15. Hobson's Conduit, Cambridge, UK (Hadley, n.d.). Adapted with permission.



The water will be controlled by the visitors themselves. A bit before the pavilion there will be a tap where you can turn on the water. This will turn the water on for 20 min which will be enough to get to the pavilion and experience the water. But this also gives the opportunity for the visitor

to be in the pavilion when the water stops. The reason why the visitor gets to control the water is so that the water will not run when no one is there which would be a waste of water. It also gives the visitor the control to decide whether they wish to experience the pavilion with or without water.

WATER FLOW

The water comes from the two water pump stations that are in the context for the pavilions and on the two heights of the walk. The water tower in Slottsskogen is still in use and right next to the old water reservoir on Gråberget a new pump station and reservoir is built and is in use.

The water will be taken from these two stations when the water is turned on and through the gutter the water will run to the pavilions on the lower heights.

For the waterfall though, the water will be pumped up directly from the river.

In the illustration below you can see the water origins in circles and the direction of the water flow from the two high points.



THE PAVILIONS AND RAIN

The water cycle will not be affected or changed by rain. Rainwater and floodings are both big questions in today's climate discussions. I could see these pavilions, in the future, to be a solution to some of these problems by showing that the water can be used and has a purpose but I have decided to not bring this discussion further into my thesis.

The reason is because it would take so much rainwater to make for example the waterfall pavilion work that it would require a big area and container to collect and store the rainwater.

Also because during the rain the water will be around us. The pavilions would be less desirable to go to and the contrast between the rain and the water in most of the pavilions will make the experience less powerful than compared to when it's dry outside.

SIMILARITIES TO FLIMSER WASSERWEG

Comparison to Flimser Wasserweg and the Gothenburg walk

Flimser Wasserweg

Following water

- Following a mountain river.

Different movements of water

- Because of the terrain holding the water it moves differently in different places.

Stops by special water features

- Bridges that brings focus to that part of the water.

Pauses from the water

- The walk goes between being beside the water and walking on meadows where the water can't be seen.

Gothenburg Waterway

Following water

- Following the old waterstreams of the city.

Different movements of water

- The pavilions build upon the idea of different movements of water.

Stops by special water features

- Pavilions that brings focus to the water features.

Pauses from the water

- The walk goes between the water in the pavilions and the city walk. Also between the water being on and there not being any water.

SITE PLAN WITH WALK





LEGEND

-  Existing water
-  Historical water
-  Buildings
-  Roads
-  The walk
-  Pavilion location

MATERIAL STUDY

How are the senses affected by wet concrete

This investigation's purpose was to see how the senses of sight, scent and touch are affected differently depending on whether the material, concrete, is dry, moist or wet.



Figure 16. Concrete pieces, Dry. Author's own copyright.

TOUCH

The concrete pieces had been outside so they were already quite cold on the time of the experiment.

The difference between the dry and the moist concrete was not a lot.

The difference between these and the wet concrete on the other hand was quite a lot. You got the touch both of the concrete but also water and it stayed a lot longer on your skin after the touch because the water was still on your hand. The temperature difference was very intense as well. The wet concrete was a lot colder.

I also noted down how long it takes for the concrete to dry and it took approximately one hour. But I imagine this is a longer time when it is a bigger structure with a lot more water in the air than for just one small piece of concrete.

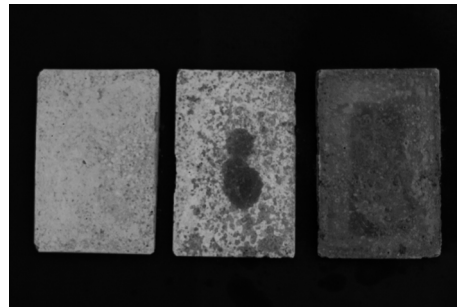


Figure 17. Concrete pieces, Dry, Moist and Wet. Author's own copyright.

SCENT

The scent of the concrete is only sensed when I am really close to the concrete (almost touching it). The scent of the dry vs. moist is not very different but once again I feel like the wet concrete has a stronger smell of both water and concrete. I believe this is because the water releases the concrete particles and brings out that smell more.

Even though I had to be really close to the concrete to smell anything I believe that this is not the case when it's a bigger structure that surrounds oneself. The senses will be much more intensely affected.

VISION

Visibly the moist and the wet concrete appear very differently.

The moist is in texture not very different from the dry concrete but the dark spots over the concrete makes it more interesting when getting close. The contrast in colour is stronger.

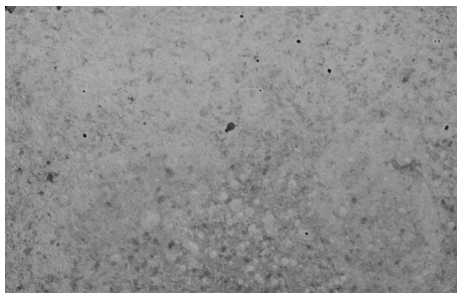


Figure 18. Concrete, Dry. Author's own copyright.

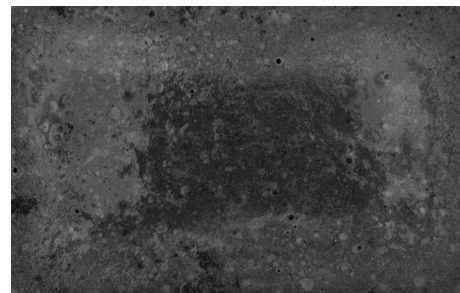


Figure 19. Concrete, Wet. Author's own copyright.

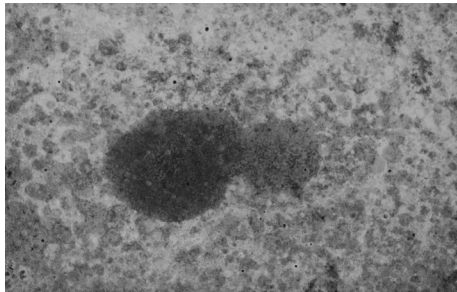


Figure 20. Concrete, Moist. Author's own copyright.

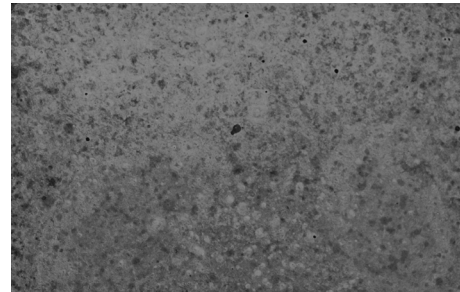


Figure 21. Concrete, Moist. Author's own copyright.

I remade the experiment on the moist concrete because the first time it got a big wet patch in the center and I wanted to see what the concrete looked like when having a more uniform spray of water on it.

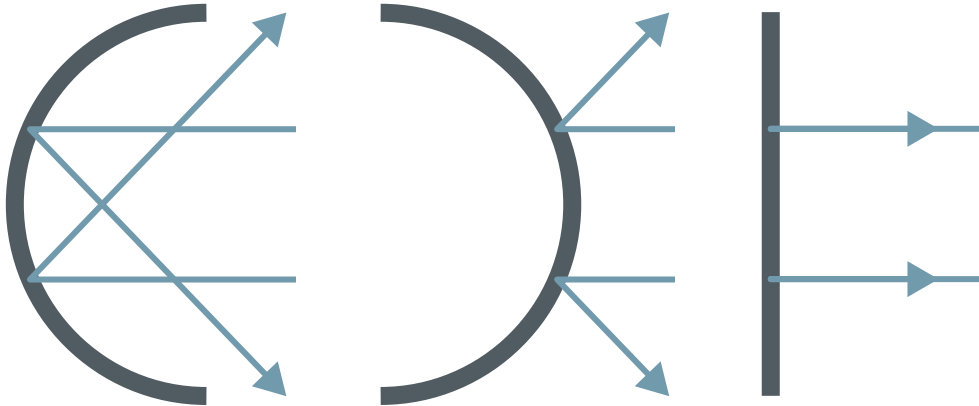
The second attempt made the concrete more similar to the dry one. I imagine the first attempt being the transition between wet and the second moist. When there is more water in the air and maybe bigger drops but still not fully wet.

INCREASE THE SOUND

Investigation in how the sound can be increased where it's desirable

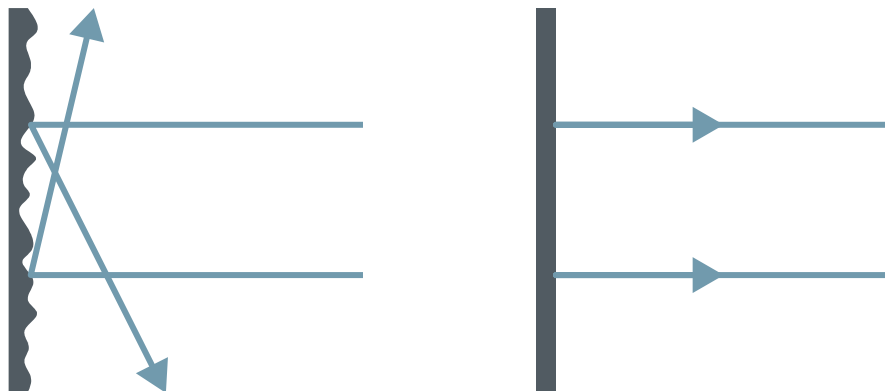
When sound is reflected on a surface it is desirable to diffuse the sound. This means to spread the sound so it is more even and not just a hollow echo.

To do this it is good if the surface is uneven because then the sound will spread in many directions.



If the sound has the purpose of being concentrated in a specific area the shape of the surrounding surfaces needs to direct the sound there. That has to do with the angle and that the surface creates a focus point.

A convex surface will spread the sound, a concave will focus the sound and a straight surface will just reflect the sound straight back if the sound comes in perpendicular to the surface.



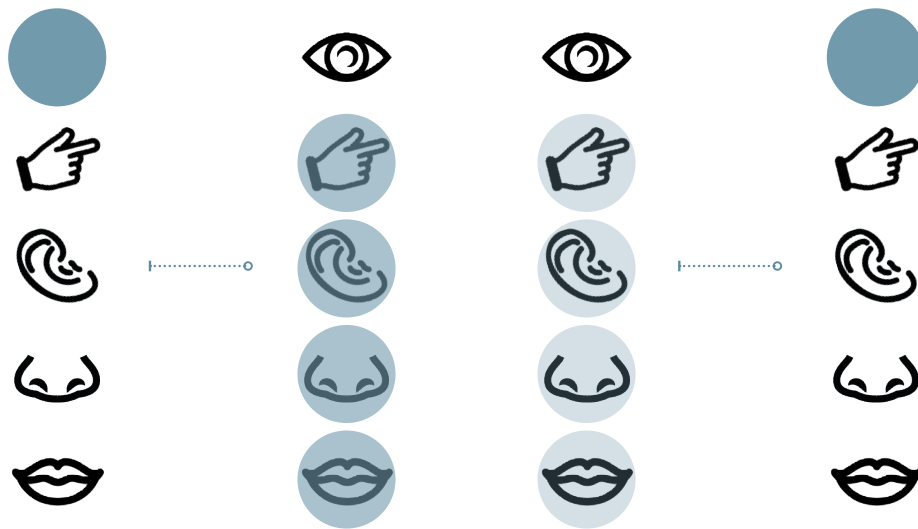
SENSORY CONTRAST

Sensory contrast can mean many things. It can be the contrast of one sense or of many.

When one sense is removed it can be done either to enhance that sense later and to make that particular sense more evident. Or it can be done to

enhance the other senses still present. By removing one sense it can be easier to acknowledge the others.

The same thing can be done with several senses at one time to either enhance the removed senses later or to enhance the senses still present.



Many people have felt the sensation when you're in a dark room and all of a sudden you hear things you didn't hear when the light was on. When we try to smell things many people automatically close their eyes. By cutting of one sense it is easier to focus on the others. By limiting the

expressions entering our mind we can process the ones that are left more easily.

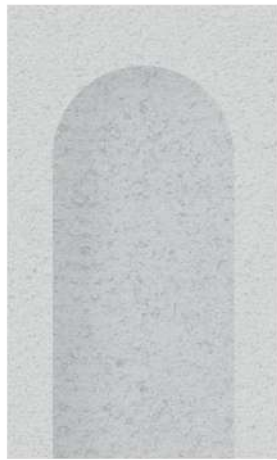
I am working with both type of contrasts to enhance certain senses in different parts in the pavilions.

PAVILION DESIGN

Common design

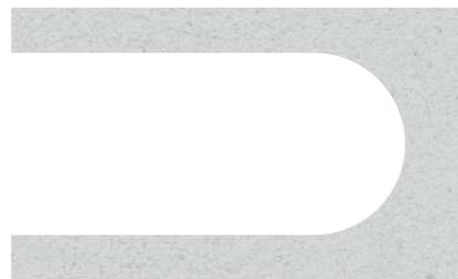
When designing the walk through the pavilions there are a couple of design elements that are the same for all of them. The reason for this is to make the four pavilions uniform to create one walk.

The other design features are the ones already mentioned before that are important in order to design the sensory experience.



The pavilions are built up of a grid structure with columns 1.2 m inbetween. The distance is set as a comfortable distance to walk inbetween.

The columns are 300 × 300 mm thick.



In some parts the vault is a double span (The distance of two openings and one column). This is dependent on the form and function of the pavilion and based on the need for open space versus more columns.

Where walls are created inbetween the columns the wall is 200 mm thick and centered in the columns. This keeps the vaulted structure visible between all the columns.

PAVILION DESIGN

The material



Figure 22. Smooth concrete (Woodship & Magnolia, n.d.). Reprinted with permission.



Figure 23. Rough concrete (Created by Kues1 - Freepik.com, n.d.). Reprinted with permission.

As the material can withstand the force of the water quite well I chose to work with concrete. The surface is something I have decided to work with as a way to diffuse the sound.

The columns and beams are made of smooth concrete but the parts where the vault is filled up, to create a wall, a rougher, more uneven, concrete is used.

This is done consistently throughout all the pavilions to not create an uncomfortable echo. This, even though, not all of the pavilions will have a particularly loud noise.

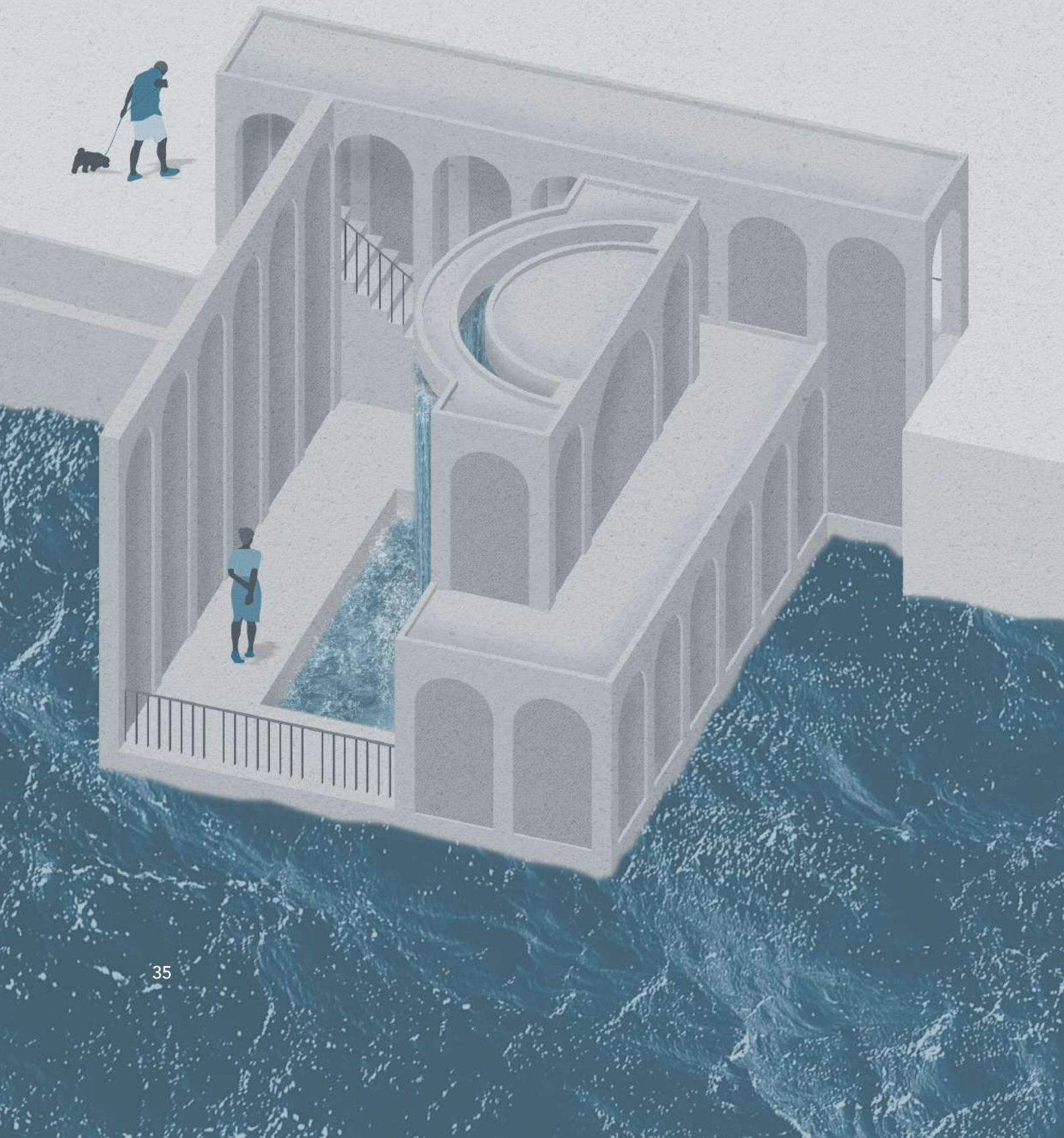
The consistency is also another choice made to accentuate the vaulted structure more and to have a uniform design tool in all the pavilions.

The rougher concrete is used on the ceiling of the pavilions as well to create more diffusing surfaces to counteract the parallel walls.

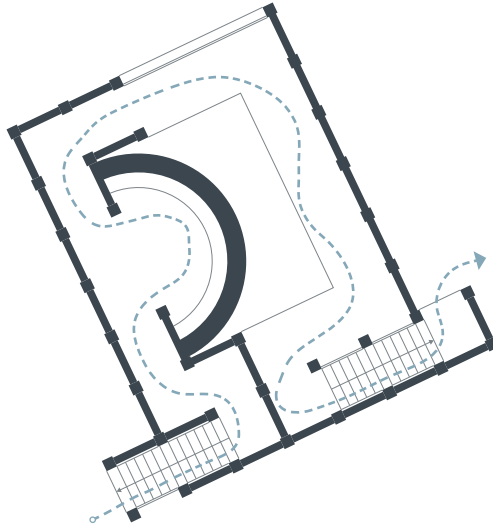
Something to note is how concrete will be affected over time by the water. Generally concrete is very strong in withstanding damages due to weather. With moisture vegetation normally comes in the picture. Some vegetation will probably start growing on the concrete if it's not taken care of but for the cascade and waterfall it is more likely that the vegetation does not withstand the high pressure of the flowing water.

THE WATERFALL

Exterior axonometry



WALKTHROUGH STORY



When entering the waterfall you are faced with the first instance of darkness, where the visual sense is removed as much as possible.

In the walk down you can sense how you walk closer and closer to the water. The noise is loud, very loud, yet there is no water to be seen. You can also sense the moisture in the air, smell and almost taste the concrete from the narrow corridor around you. The noise becomes louder and louder and in the opening in the middle of the corridor you can see a ray of light and as you move closer you start to see more and more of the water crashing down in front of you.

Here the room is still dark but the light slit in the ceiling leads the light down through the water in a very poetic way. You are very close to the water in the small room so you can feel the drops of the water flying around you and, because of the rays of light flowing

in, even the tiniest drops seems to be floating around in the air. You continue the walk back into the second half of the corridor where your vision gets to rest a bit more again with the help of the darkness and the other senses get more apparent in your experience.

When stepping out in the next opening you find yourself outside. It's not just you and the water any more. You can hear a faint sound of cars from the bridge above but the sound of the water around the corner is still overpowering. Now you get to observe the water from a bit of a distance and you realize even more how the water splashes and flies around when it crashes into the water surface underneath. It is truly a force of nature that engages all of your senses.

PREP INVESTIGATIONS RESULT

The sensation of the waterfall



Figure 24. Waterfall model. Author's own copyright.

The waterfall is the element that affect our hearing the most. It is not difficult to imagine that water falling from a height will give a lot of sound. It also affects our touch a lot since the impact towards the surface makes the water spread into drops. For really tall waterfalls it almost looks as if fog is surrounding the pool underneath.

From the prep semester I've decided to move on with the waterfall with water underneath the fall (instead of a hard surface).

With more water underneath the sound was a little bit more dappened but not a lot and there was more water splashing when there was water underneath.

For the waterfall I believe that a taller waterfall is desireable because the shorter ones will be a part of the cascade element.



THESIS INVESTIGATIONS RESULT

With or without water

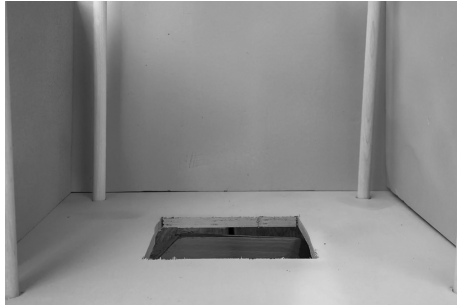


Figure 25. Waterfall model, no water. Author's own copyright.

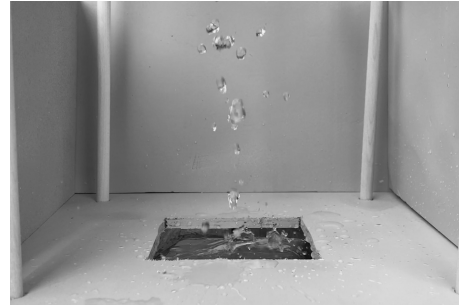
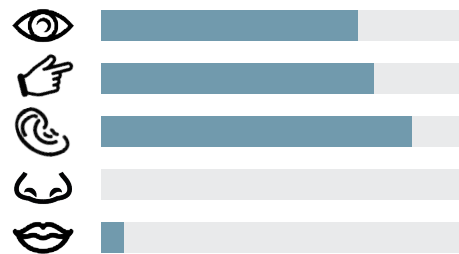
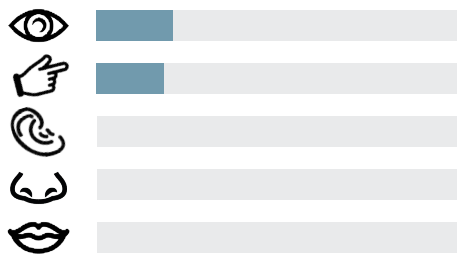


Figure 26. Waterfall model, water. Author's own copyright.



For the waterfall movement in this investigation it was difficult to get the right movement of the water due to the properties of water. It was still possible to evaluate some of the effects of the water through the models.

These results are also based on the knowledge I gathered from the investigations during the prep semester.

The water in the model added dynamic movement which engages the visual sense more.

The touch and taste of the room increased due to the splash of the water and the possibility to indirectly feel it on your body.

The sound is the sense that increases the most. Without the water the room is quiet but the water adds a lot of sound and makes you experience the room in a different way.

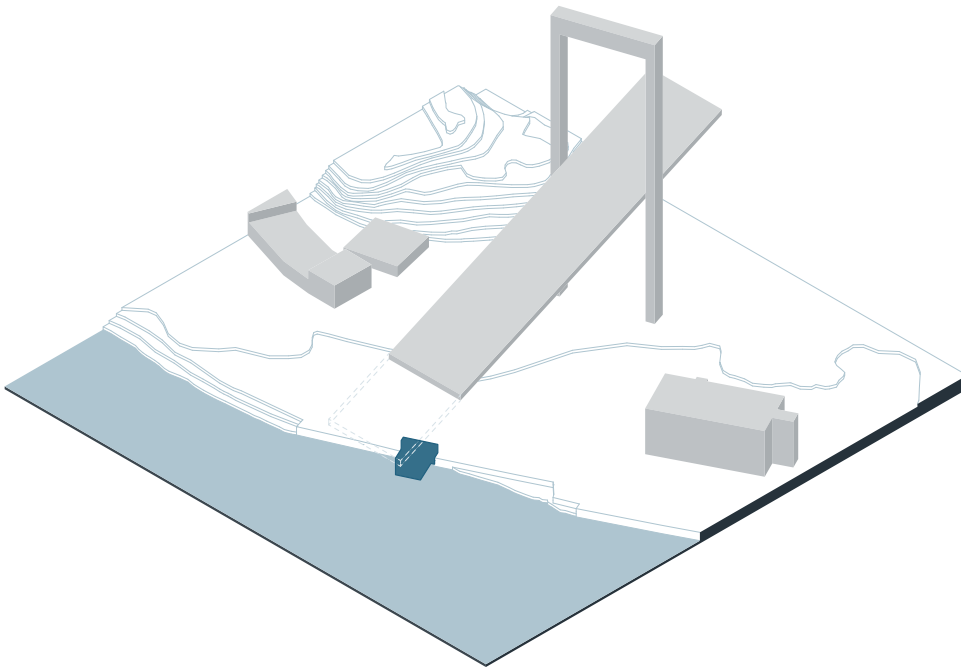
CONTEXT



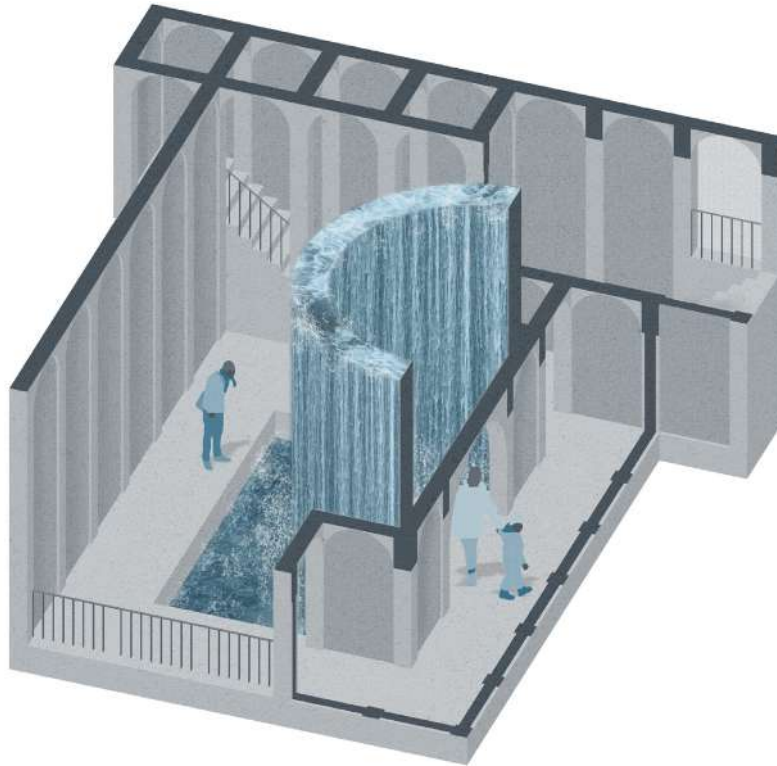
Figure 27. Pavilion location, Waterfall. (Google, Kartdata, 2018). Adapted with permission.

The waterfall pavilion is placed close to Älvsborgsbron in the west of Gothenburg. It is connected to the river and harbour entrance. This is a way to connect to both historical context and geographical context.

The structure brings you almost into the river and let's you not just observe the flowing water of the waterfall but also the natural stream of the river.



INTERIOR AXONOMETRY & DESIGN WALKTROUGH

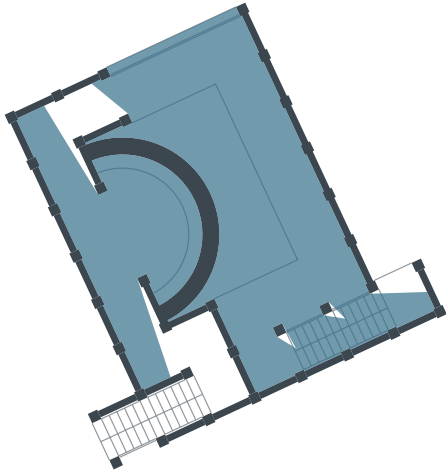


The entrance has one opening where the stair starts, but yet another opening to the side. This is to mark the entrance for the people coming from that side as well as to let in the needed light so that people won't trip in the stair. The corridor leading to the smaller room with the concave waterfall is made as low as possible to create a tight and dark space. The idea is also to "turn off" the sense of vision to increase the other senses and especially the sense of sound that is very outstanding in this pavilion. The smaller waterfall room is a room where the water surrounds you and you are forced to get close to the water and feel the drops on your skin. The light slit is created to bring the light down

through the falling water and the motion and vision of the falling water is the focus. When walking out on the other side of the waterfall wall you are a bit further away from the waterfall and you get to observe the movement from a distance. The pool underneath is bigger so the splash of the water crashing down will be more visible than in the smaller darker room. The tall wall opposite to the open waterfall is created to hide the waterfall from the visitors coming from that side. This is also why the exit is hidden towards the river so that people will take the right path. Since the waterfall is hidden the only sense present on approaching is the sense of sound which will be very loud.

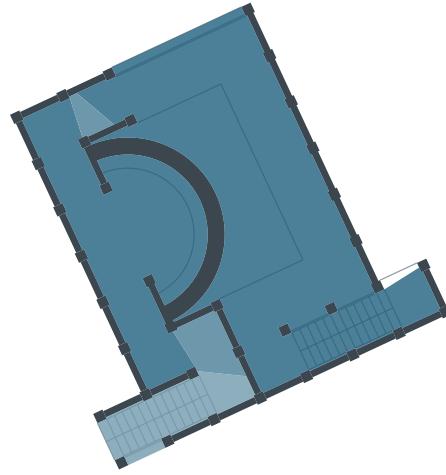
THE SENSES

VISION



The visual diagram shows from where in the pavilion the water is visible. The water won't be visible in the entrance where the sound is the sense focused on. The water will also be cut off from the vision for a bit in the transition between the darker waterfall area and the open. The contrast this gives is thought to increase the visual experience of the open waterfall.

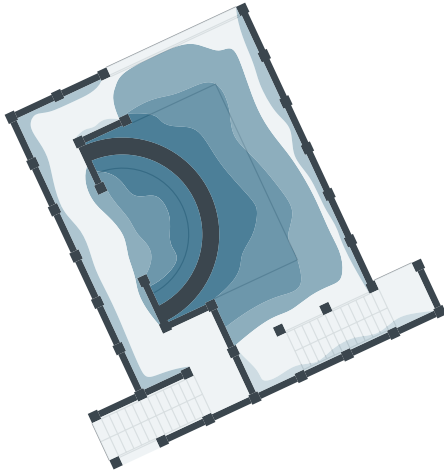
SOUND



The waterfall is the pavilion where the sense of sound is the strongest. The noise will be strong throughout the whole structure and even on the outside. The sound will diffuse and be reflected on the surfaces and won't be dampened throughout the building. The noise of the water will cancel out the sound from the traffic around.

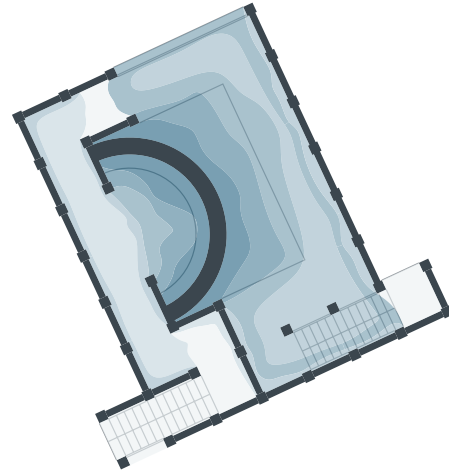
THE SENSES

TOUCH

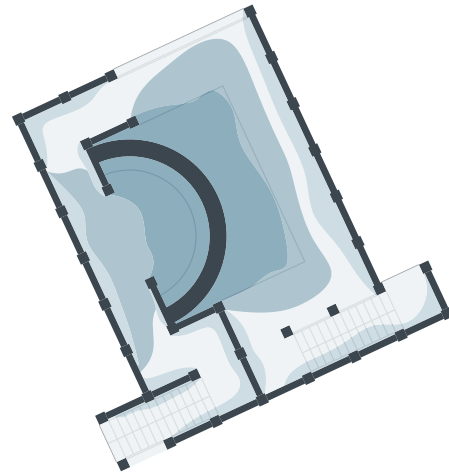


The splash of the water makes the sense of touch very strong in this pavilion as well. It is stronger the closer to the water you get. It also covers a bigger area in the open waterfall area because the watersurface underneath the waterfall is bigger here. The walls around the waterfalls will also be affected by the moisture and increase the sense of touch.

SCENT

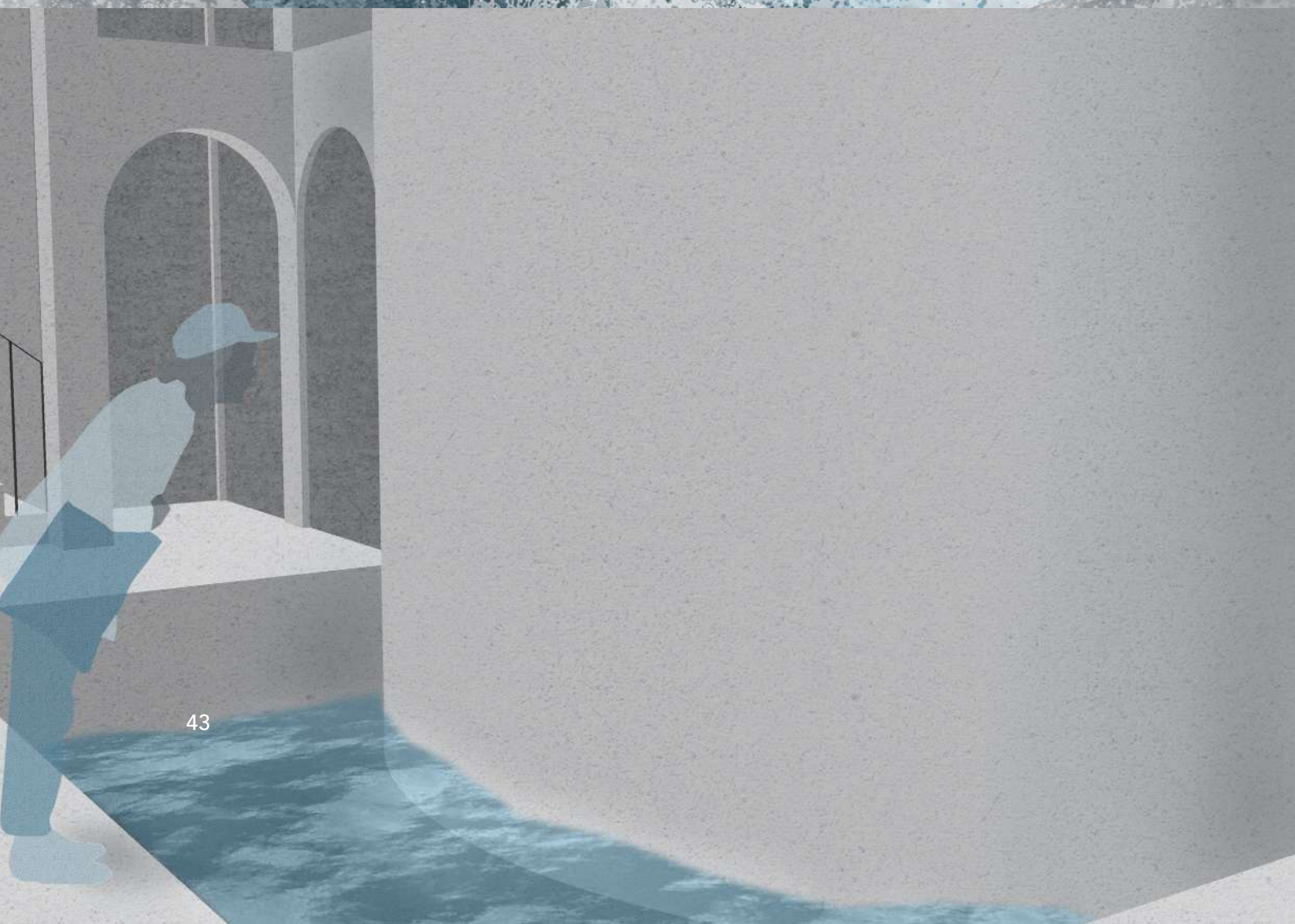


TASTE



Due to that there are a lot of moisture in the air the taste and smell will be increased around the waterfalls and closer to the surfaces as well.

PERSPECTIVE 1
Water and no water



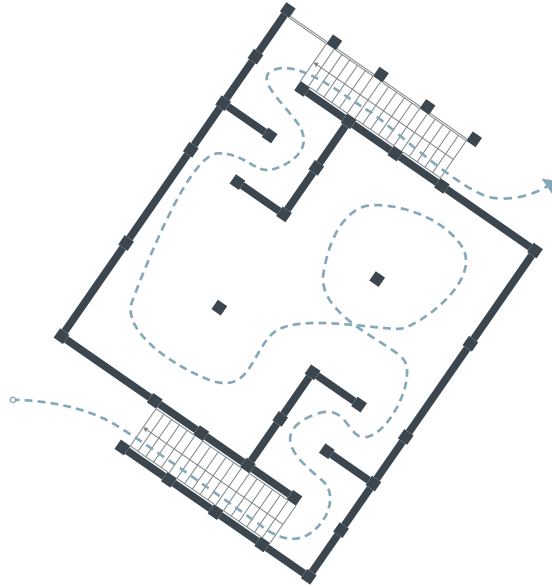
PERSPECTIVE 2
Water and no water



THE SHADOW
Exterior axonometry



WALKTHROUGH STORY



In the second pavilion you approach the structure that just looks like five pools of water. When you are right next to the pools you get two different experiences.

When walking up on the roof of the structure to get closer to the pools you see more and more of what hides underneath. These are not just regular pools of water, underneath they show another image of the water. You can feel the wind and see how it changes the surface of the waterpools and affect the shadow movement underneath. The other way leads you once again down a stair. Here it is not the stair

that is dark but you can see the dark opening in the pavilion like a dark cave opening. After you have gone through the opening you are led through a slithering corridor. You cannot hear the water or sense it in any way but when you turn around the last corner of the corridor you are amazed by the dancing rays of light around you. It is as if you are surrounded by the water but there is nothing to be sensed, no smell, taste, touch or sound of water. The other senses are engaged a bit by the light that move around and invites you to follow it and touch the concrete that captures it.

PREP INVESTIGATIONS RESULT

The sensation of the shadow

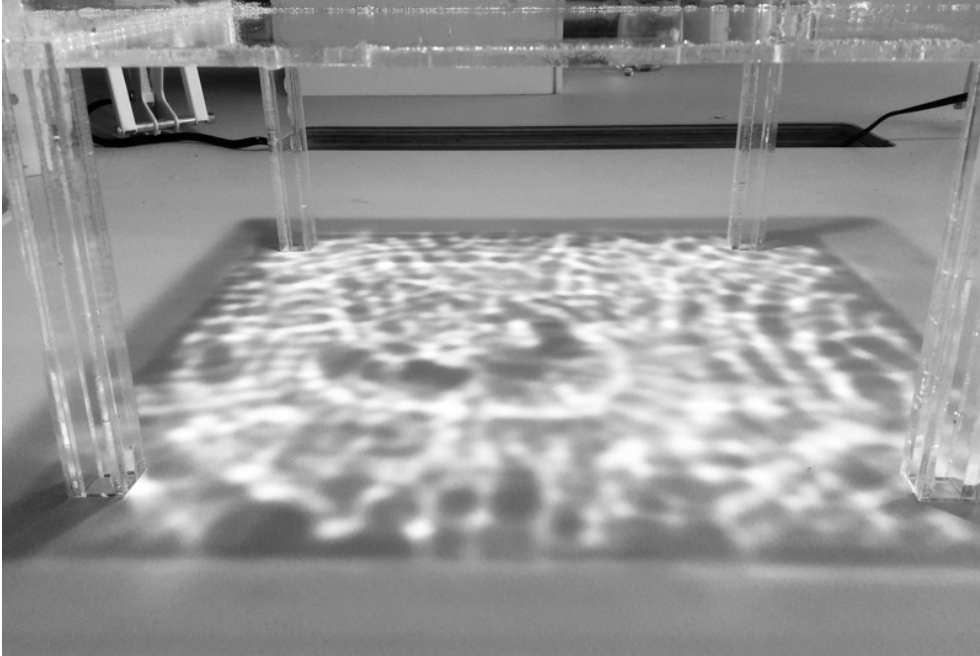
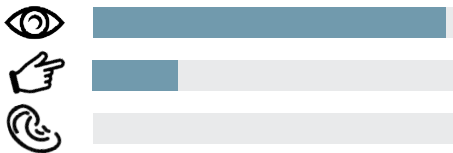


Figure 28. Shadow model. Author's own copyright.



What I realized from my investigations on the shadows and reflections of water was that this element affects our eyes most of all. It doesn't give any noise and there is no water to touch. But it does affect the sense of touch anyways since the movement of light on a surface will make you want to touch that surface more. It gives you a feeling of wanting to follow the movements of the shadows with your eyes and hands.

Out of the different investigations for this element I realized that the parameters that gave the picture above were most desirable. The amount of water in the box was quite little which made the movements of the water very dynamic and the shadow and reflections were very clear.

THESIS INVESTIGATIONS RESULT

With or without water

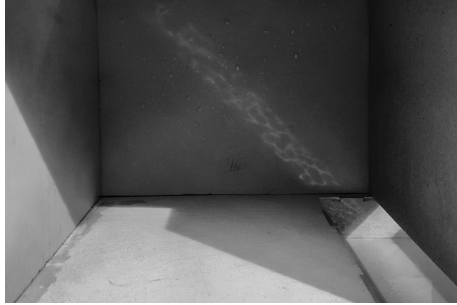


Figure 29. Shadow model, no water. Author's own copyright.

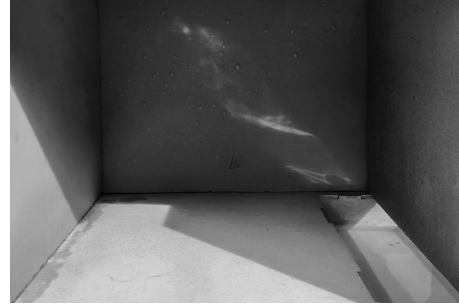
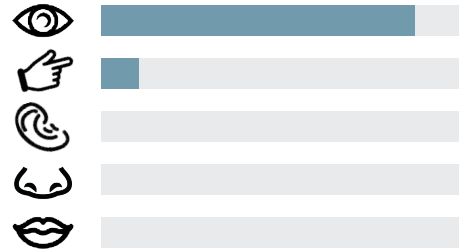
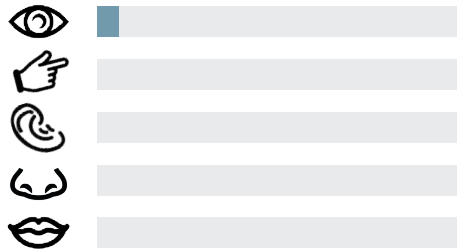


Figure 30. Shadow model, water. Author's own copyright.



As mentioned the shadow of the water increases the visual experience the most. It also increases the sense of touch a bit.

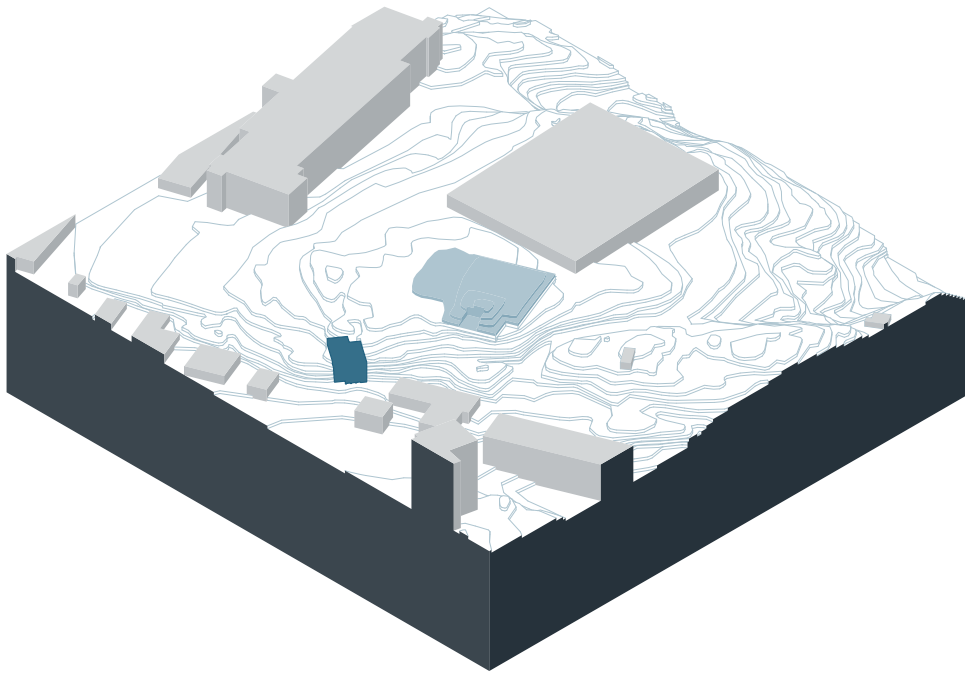
CONTEXT



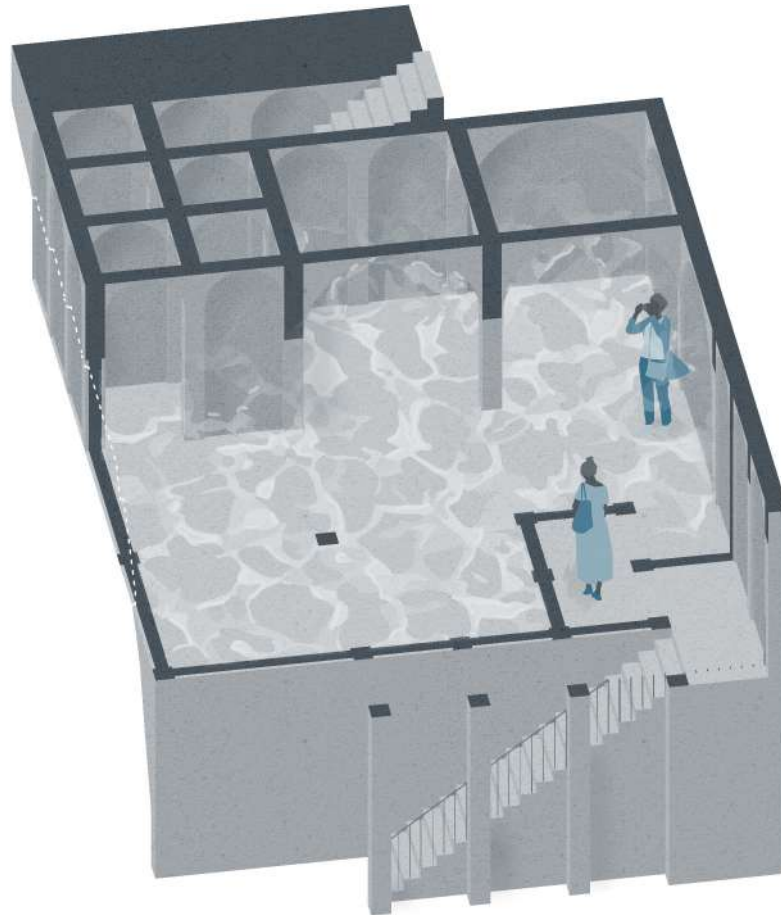
Figure 31. Pavilion location, Shadow. (Google, Kartdata, 2018). Adapted with permission.

The second pavilion on the walk is the shadow pavilion that lies in strong connection to Kulturtemplet, the old water reservoir which is one of my references.

To link to the context and the pavilion's purpose the pavilion is placed into the ground almost hidden when coming from above. In the same way that the old reservoir is hidden except for the entrance.



INTERIOR AXONOMETRY & DESIGN WALKTHROUGH

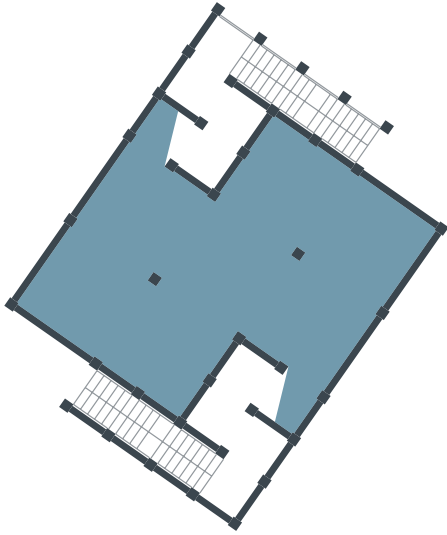


When arriving towards the shadow pavilion there is a path above that leads you onto the small roof of the structure. This gives a chance to observe the water and see the movement by the wind. The entrance goes down the stair that leads you into the ground. After walking down the stair the entrance begins with a dark corridor once more. The purpose of this is not to enhance the other senses but to dull the sense of vision because that is the sense of focus in this pavilion. When stepping out into the bigger room

the reflections and refractions of the water will bounce on every surface of the room. The distinctness of the light images will depend on the wind that creates the movements in the water but also on the sun's position and the clarity of the sun. Even a cloudy day will create the refractions they will only be more blurry and diffuse. The exit from the structure is a dark slithering corridor again. This is a mirror of the entrance so that people might be able to walk in from the other side of the pavilion as well.

THE SENSES

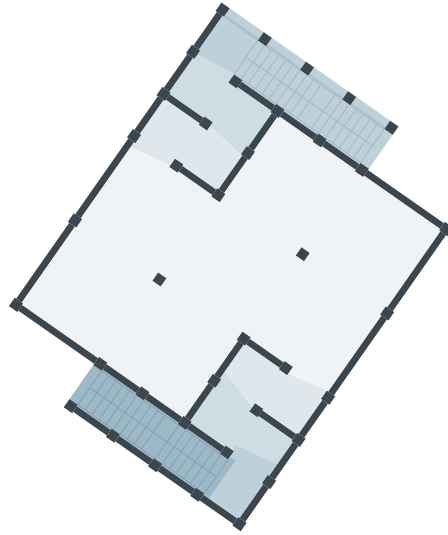
VISION



The shadow of the water is visual in only in the main room.

The sense of vision is stronger than the other senses because the shadow is silent and the water can't be felt.

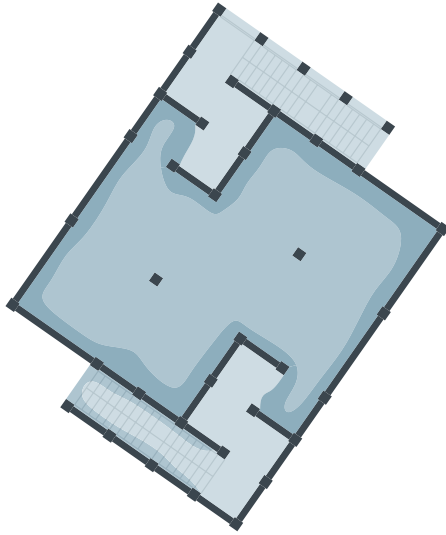
SOUND



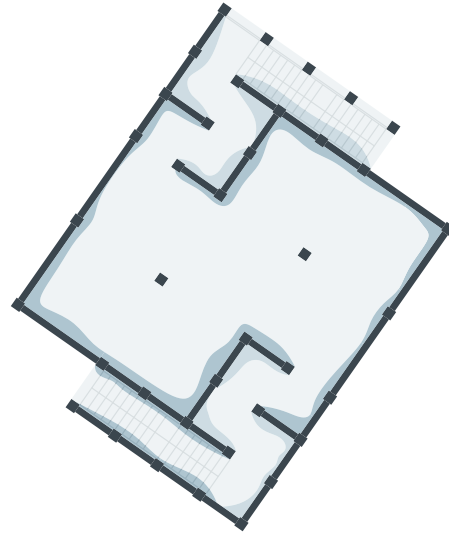
The sound of the moving water in the pools can be heard from the outside but will not be heard as you move into the structure.

THE SENSES

TOUCH

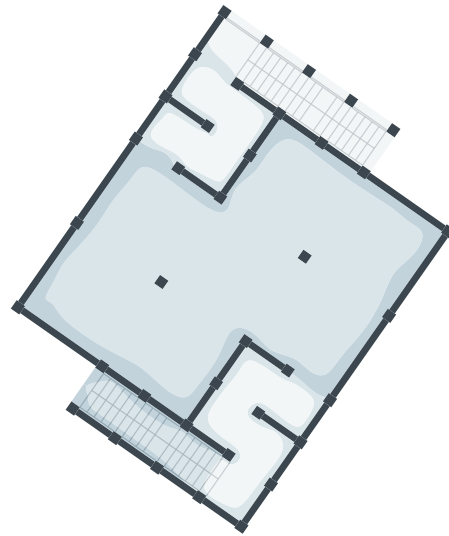


SCENT



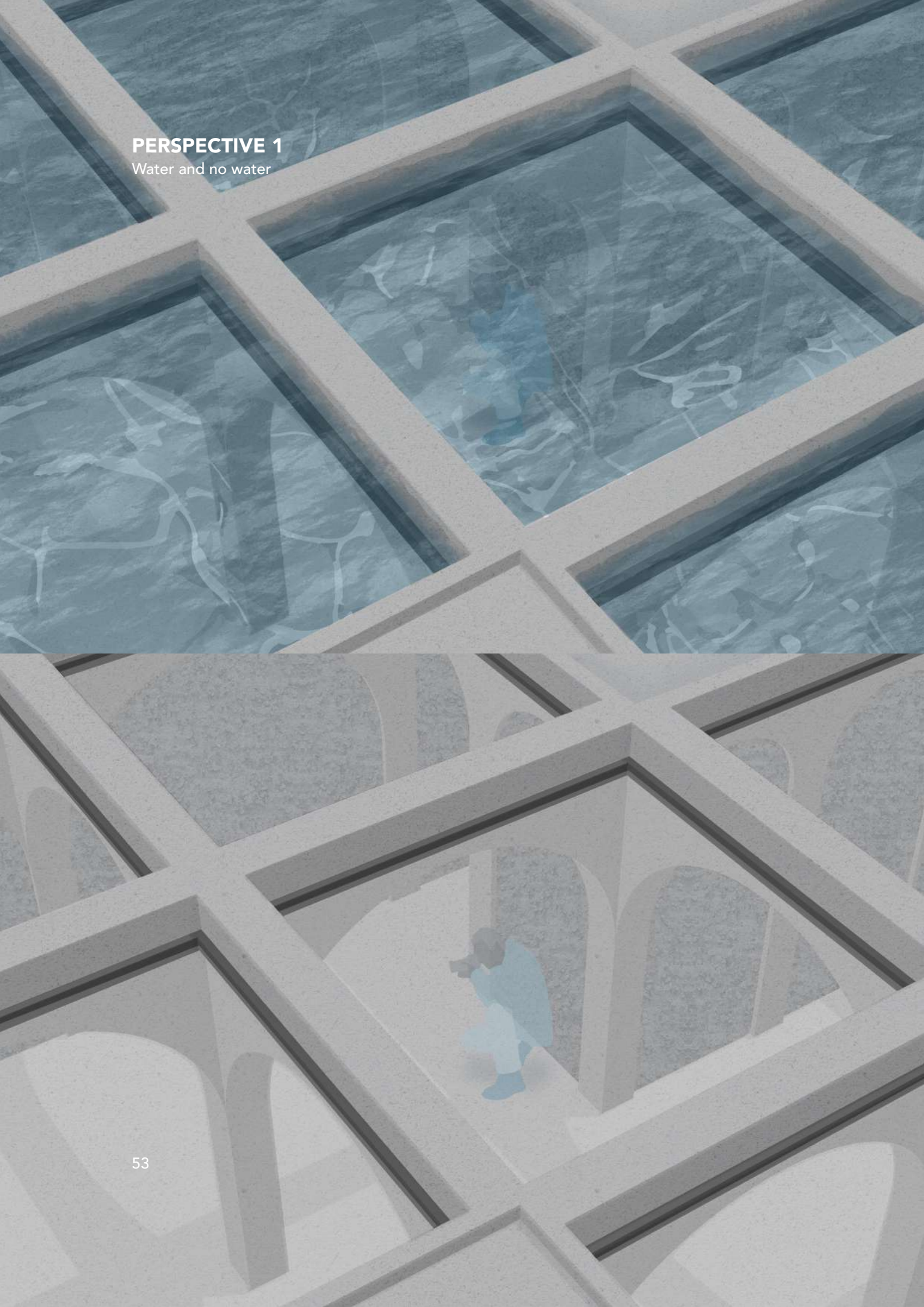
The touch is the second strongest sense. Even though the shadow itself isn't wet it brings a new focus to the material and a dynamicity to the material that makes you want to touch it and experience the sense of touch more.

TASTE



The sense of scent and taste will also be a bit affected due to the other senses creating the sensation of water.

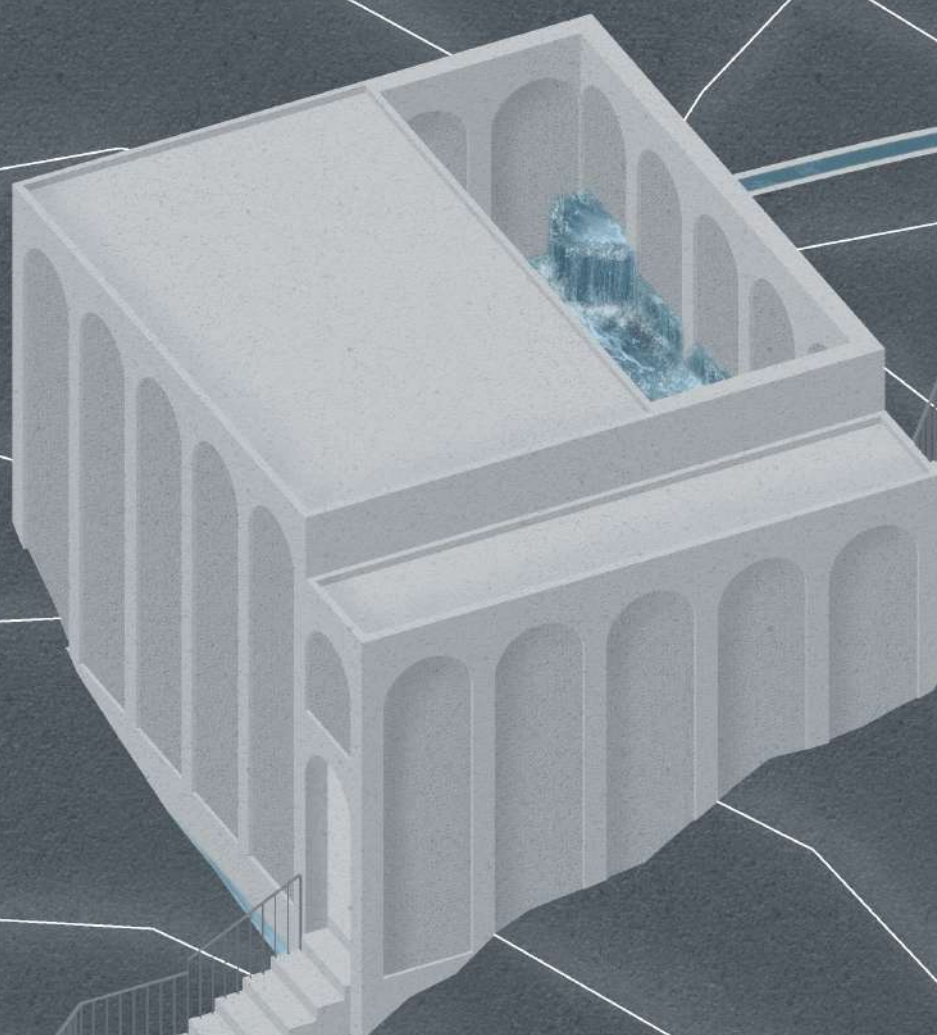
PERSPECTIVE 1
Water and no water



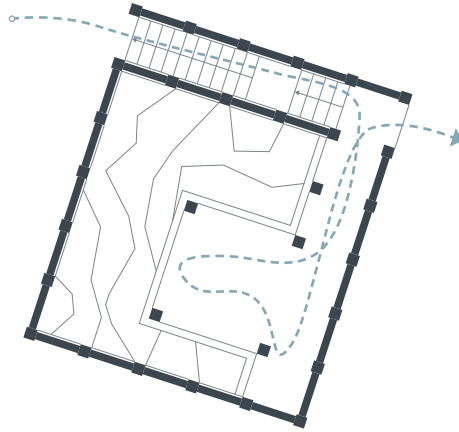
PERSPECTIVE 2
Water and no water



THE CASCADE
Exterior axonometry



WALKTHROUGH STORY



In the middle of the long stair leading you down the slope you meet the quite closed off structure from the outside. The entrance is a long corridor and meets you like a tunnel where you can see the light in the end. You follow the stair down and you can hear the quite monotone rumbling, crashing sound of water. The sound gets louder and louder and as you are almost by the exit you turn around the corner and you are surrounded by the falling cascade around you. As you move further in the room the water goes from splashing around your feet to splashing around your face. You get

to view higher falls and lower falls. The light is focused on the water from a big opening in the ceiling. The only thing you can see is the sky as the walls around you are closed except for the small openings where the water is flowing into the structure. The water around you splashes in every direction and the drops are easily felt in the air and on your skin. The taste on your tongue and smell is also quite evident and as you stand in the center of the water you feel as if you are surrounded by all the sensations the water has to give.

PREP INVESTIGATIONS RESULT

The sensation of the cascade

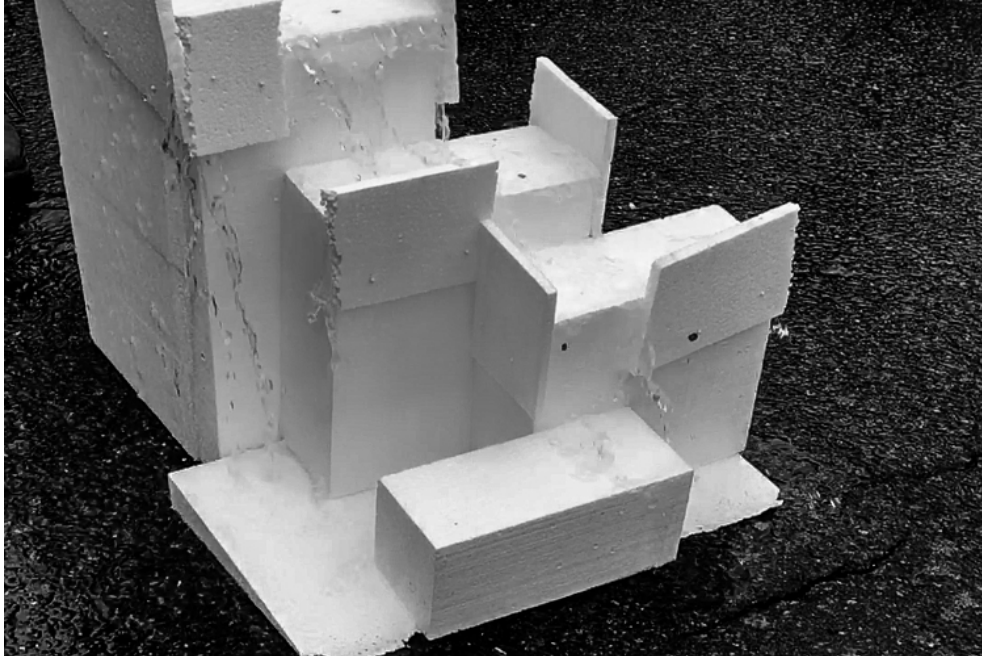


Figure 32. Cascade model. Author's own copyright.



To differ them as much as possible I have decided to move forward with a cascade that have a lot of different levels in different heights and a more irregular shape to make the water run in many different directions.

The cascade has pretty similar effects on the senses as the waterfall. What differs the cascade from the waterfall is the height of the falls, the number of falls and the direction of the falls. Which can be described easily by if the pieces in the picture above would have been put straight in front of each other or irregularly.

THESIS INVESTIGATIONS RESULT

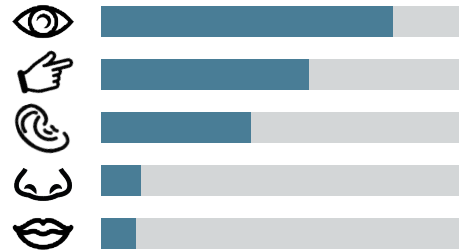
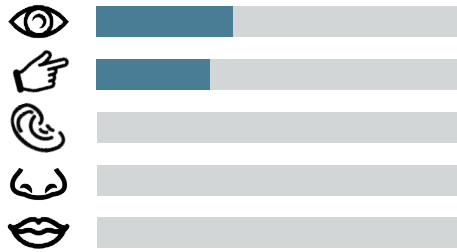
With or without water



Figure 33. Cascade model, no water. Author's own copyright.



Figure 34. Cascade model, water. Author's own copyright.



The cascade is similar to the waterfall. It adds experience to all of the senses. Most of all the visual, sound and touch experience. The visual sense is increased a bit more for the cascade than the waterfall due to the movement in different directions and the build up of several small waterfalls.

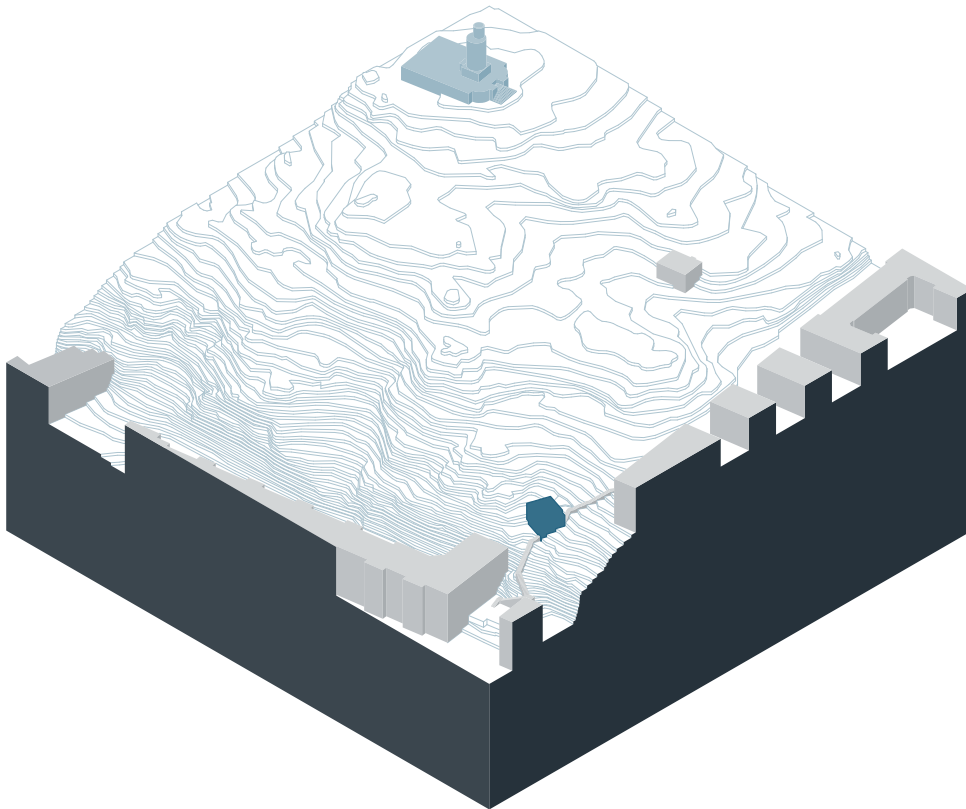
CONTEXT



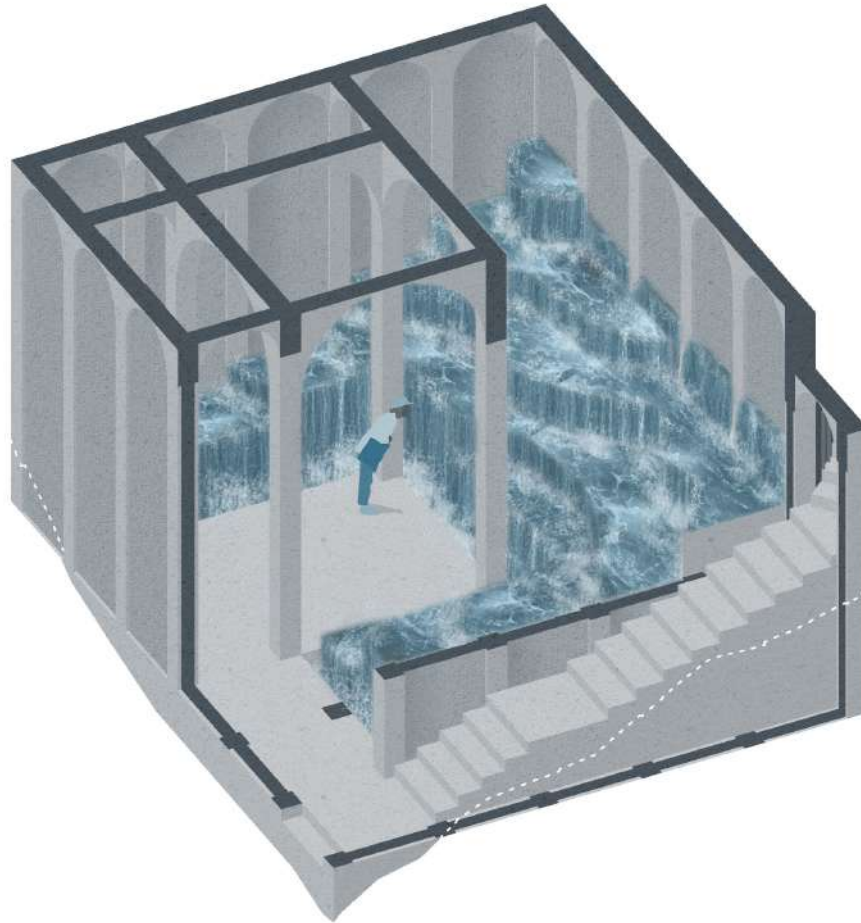
Figure 35. Pavilion location, Cascade. (Google, Kartdata, 2018). Adapted with permission.

The cascade pavilion is placed near the old water tower in Slottskogen. The pavilion is placed in the staircase that leads towards the Linné area down from the water tower.

It is placed in the stair to make use of the existing walk that is already there and a place that is natural for people to use.



INTERIOR AXONOMETRY & DESIGN WALKTHROUGH

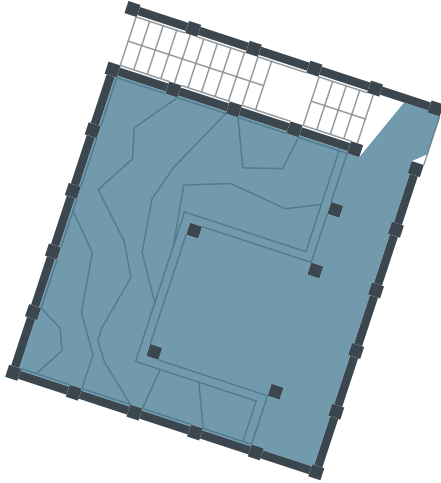


The entrance and exit connects the corridor to follow the stair that is already in the context today. Since it is a straight corridor with two openings straight through it will not be completely dark. You get into the cascade room from the landing in the end of the corridor. You enter quite a tall room. The height is given due to the stair inclination and the need for height for the water to fall. As mentioned the cascade is a bit more visual than the waterfall because of

the very dynamic movement in several instances. To enhance this a platform is built up that takes you into the cascade and lets it surround you. You get to experience the cascade both from above when entering and seeing the lower platforms and in eye height when you move further in. The roof is open above the cascade. The reason for using a ceiling window is also to let the water be the focus and to let the room be closed except for the view of the sky above.

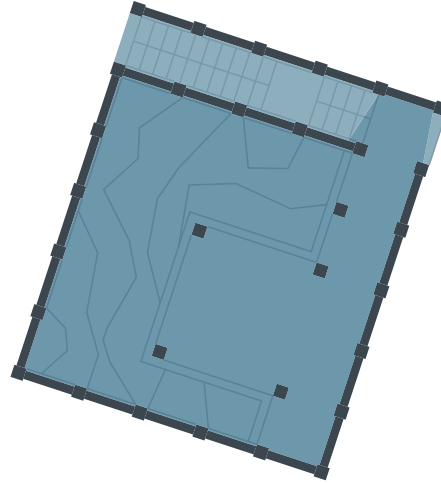
THE SENSES

VISION



The water will not be visible in the stair down towards the room but first when you get around the corner.

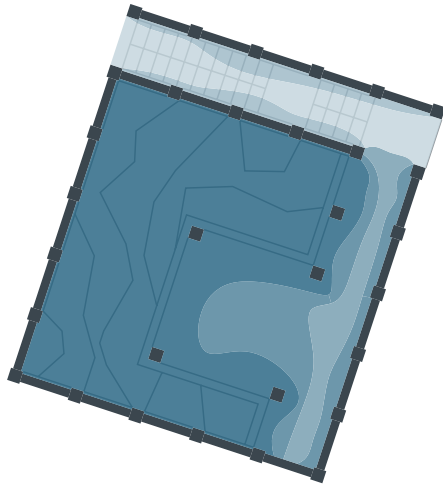
SOUND



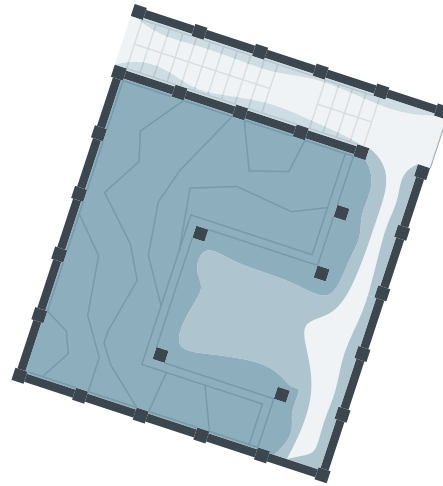
The sound will not be as loud as in the waterfall pavilion but will be quite similarly strong throughout the whole structure.

THE SENSES

TOUCH

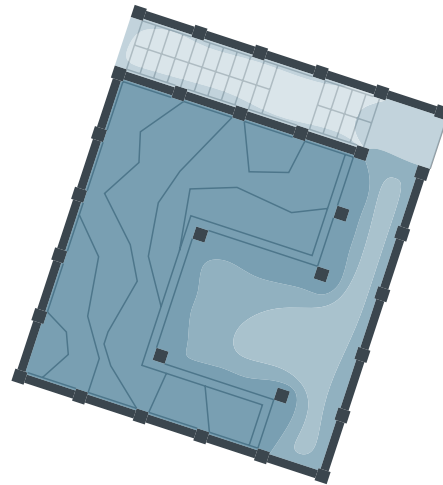


SCENT



The splash of the water makes the sense of touch very strong in this pavilion as well. Since the water falls on more places around you than in the waterfall the sense of touch will be a bit increased.

TASTE



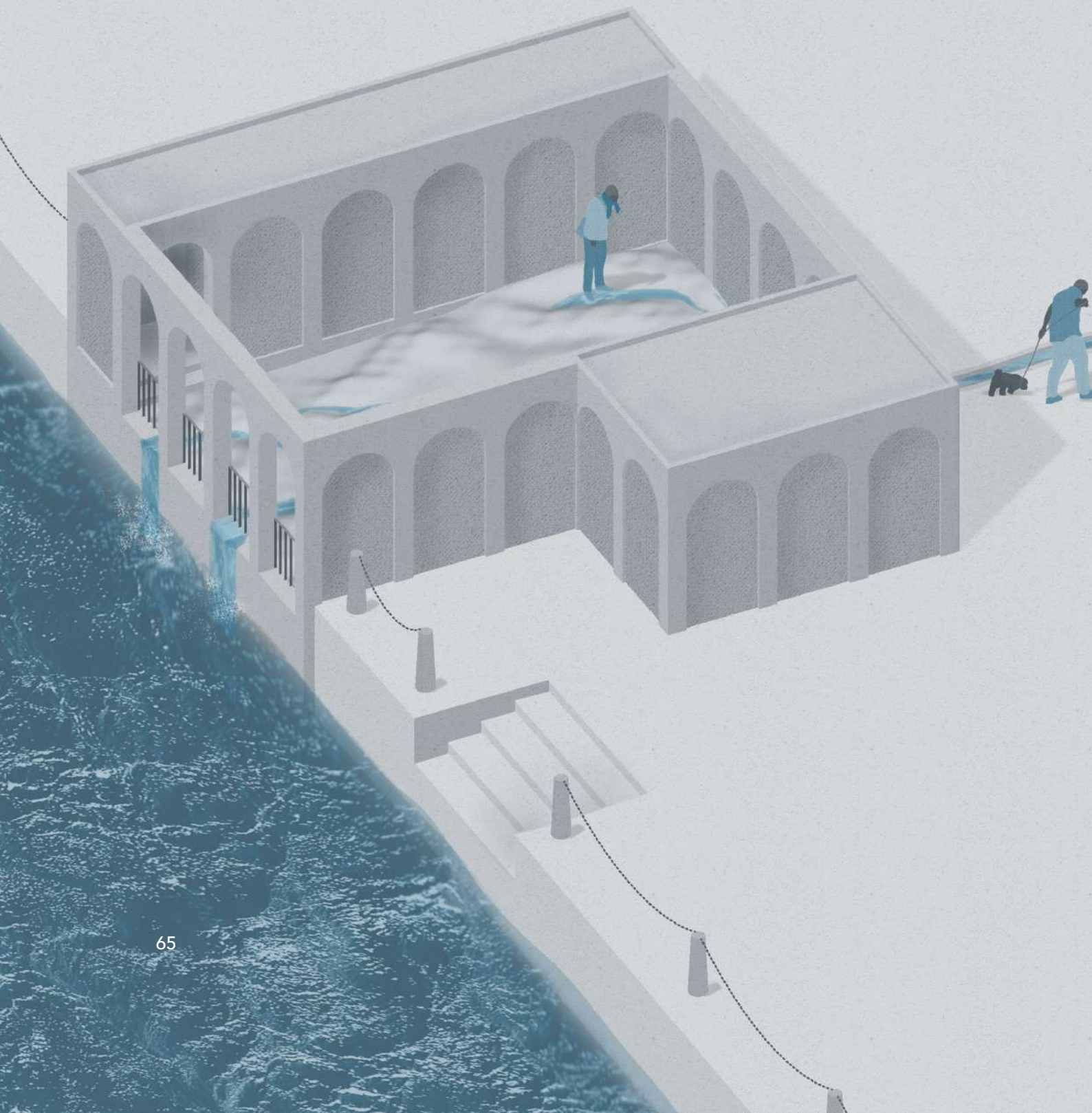
Due to that there are a lot of moisture in the air the taste and smell will be increased around the waterfalls and closer to the surfaces the same as for the waterfall. But the sensations will be a bit increased because of the closed room.

PERSPECTIVE
Water and no water

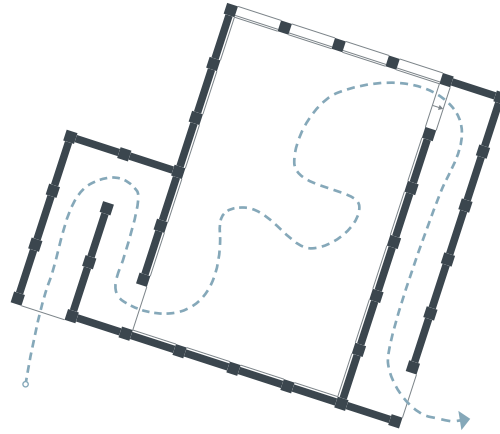


THE RIVER

Exterior axonometry



WALKTHROUGH STORY



When entering the last pavilion you are once again met by a slithering dark corridor that dulls the sense of vision and enhances the other senses. When you step out from the corridor you find yourself outside again, but in a sort of man made landscape. You can see the water calmly flowing down the landscape. It is difficult to anticipate where in the landscape the water will flow. You have to walk around and across and you decide to bend down and feel the flowing water on your hand. Even though it is a calm stream it is quite heavy in your hand and it has a force in it that you couldn't foresee.

The rippling sound of the water is very faint but you can still hear it within this waterscape in the city. You follow the water to where it flows over the edge into the river again and the circuit is closed. The water runs out into the river and continues it's journey. When you step through the last corridor your sense of vision is dulled and you can hear the distinct sound of water once more before you step out into the instead murmuring city of Gothenburg.

PREP INVESTIGATIONS RESULT

The sensation of the river

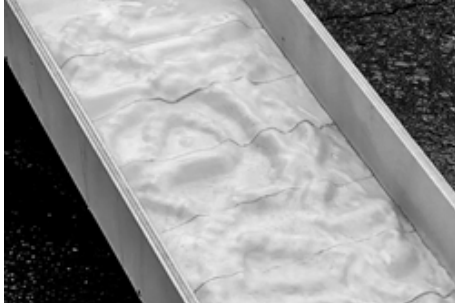
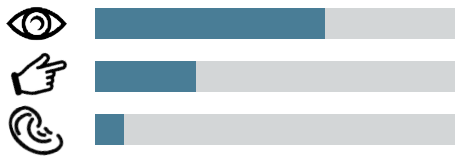


Figure 36. River model. Author's own copyright.



From my prep investigations the movement of the river I've brought with me is a slow calm river.

When there is little water in the model and the surface underneath is smooth the water runs down slowly and calmly. It doesn't affect the senses directly as much but what I have realized is that this also intrigues our senses. When we only get a hint of the sound of pouring water we try to listen more intensely. When the water runs more slowly and we can actually see where it goes we try to look more.

The other reason why I chose to move forward with the calm river is because the more forceful it is the more it resemble the cascade in the sensual experience.

THESIS INVESTIGATIONS RESULT

With or without water

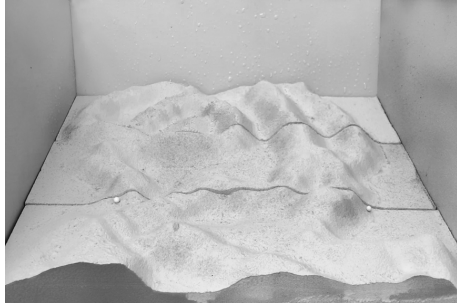
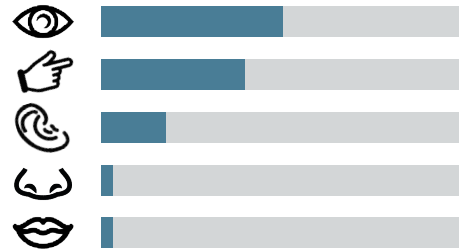
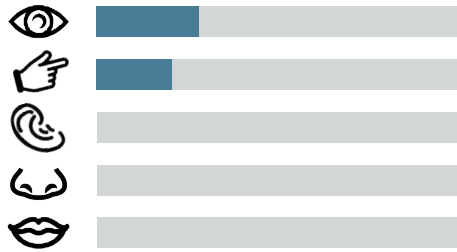


Figure 37. River model, no water. Author's own copyright.



Figure 38. River model, water. Author's own copyright.



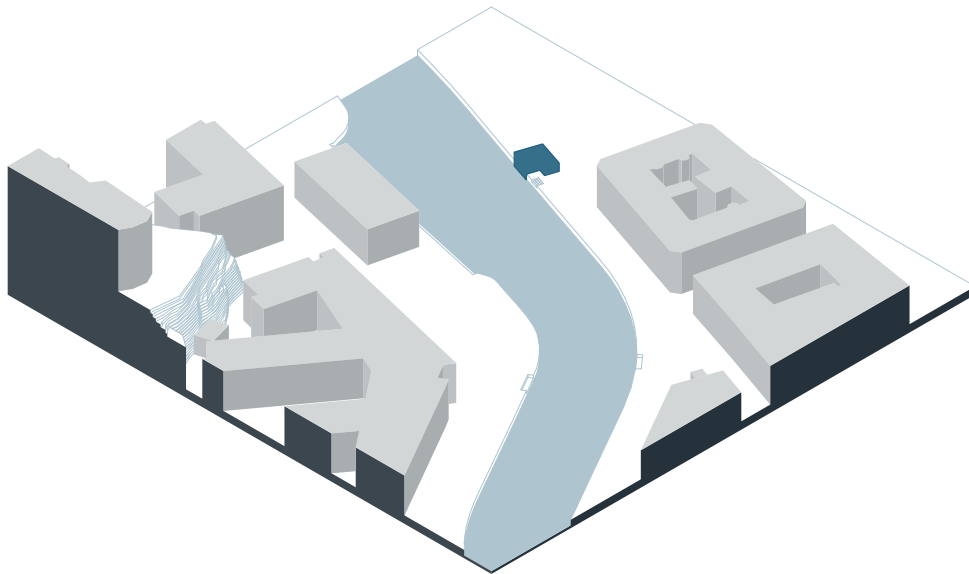
The visual sense is what is increased the most in the river model. There is no water splashing around in the air so the taste and smell is not that affected. The touch is also affected through direct movement. The water is easy to feel and touch.

CONTEXT

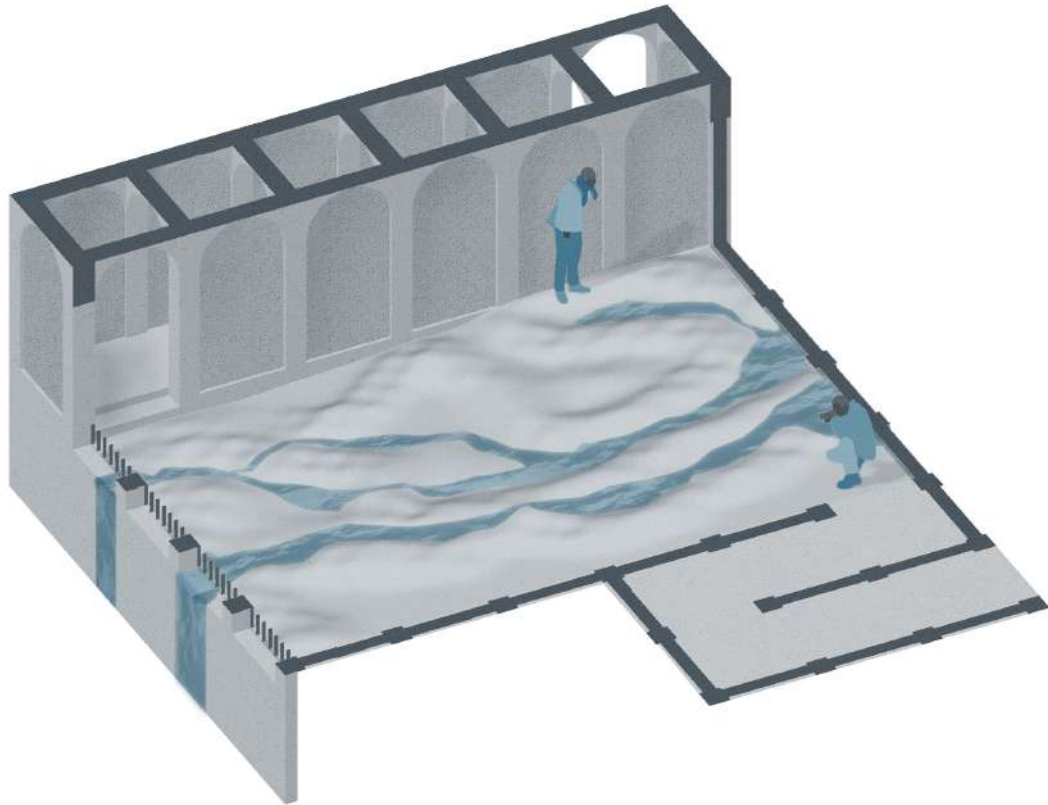


The river pavilion is placed a bit into the Vallgrav in the very center of Gothenburg. The water of the river flows down and ends up in the river to close the circuit of the water.

Figure 39. Pavilion location, River. (Google, Kartdata, 2018). Adapted with permission.



INTERIOR AXONOMETRY & DESIGN WALKTHROUGH

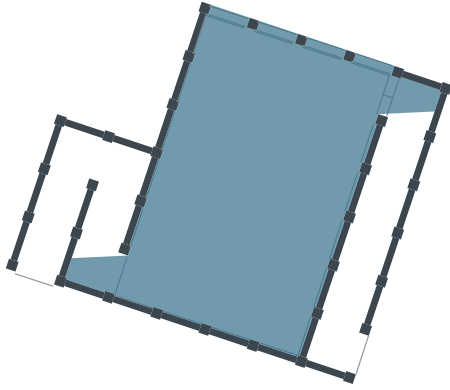


The river pavilion starts as the other pavilions with a dark corridor to dull the sense of vision. As you enter the landscape the water will flow more or less and depending on that it takes different routes in the landscape. When crossing you are therefore forced to follow the water with your gaze, get close and step over it in some parts and it is a constant surprise where it will flow. The end of the water is running out of the edge and into the river again. The room of the river is very open. Three of the walls are closed and the one to the river is

left with open vault so it is possible to follow the end of the water as you walk through it. The room is left without a ceiling to let the light shine on the water more easily and this is needed in the whole room since the water runs unpredictably around. The exit of the pavilion is also led through a darker corridor both to enhance the sound when exiting but also to create a similar experience for the people that come from the other side and uses this opening as an entrance.

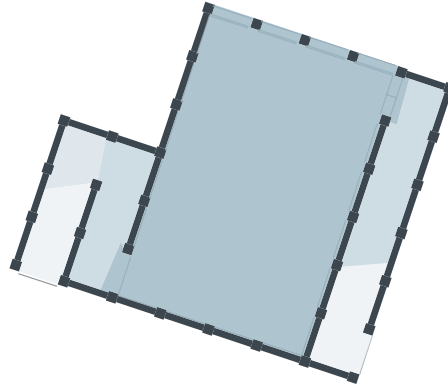
THE SENSES

VISION



The water will be visible in the river room. It will also be seen from across the Vallgrav but it will not be a clear vision due to the subtleness of the water movement in this case.

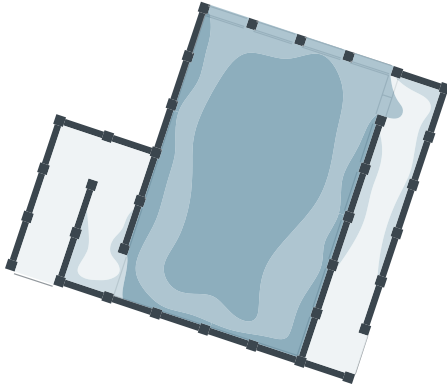
SOUND



The sound will not be particularly strong and it will be mixed in with the sound of the city. The faint sound will, even though not strong, make you want to listen for it more strongly and make you want to exclude the sound of the city.

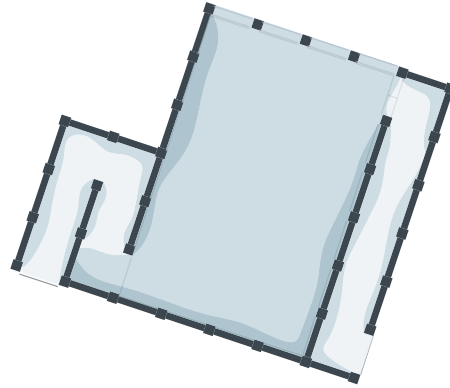
THE SENSES

TOUCH

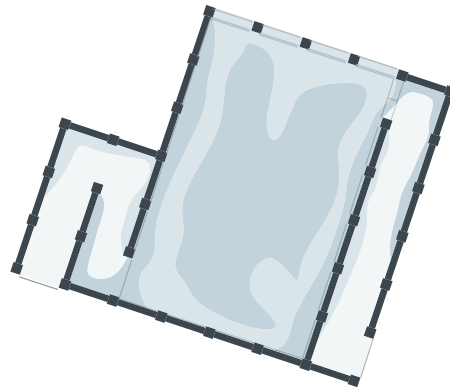


The touch in this case is quite direct. The pavilion will not be very moist from the water movement. But where the water slithers it is easily accessible to touch and feel by your own desire.

SCENT



TASTE

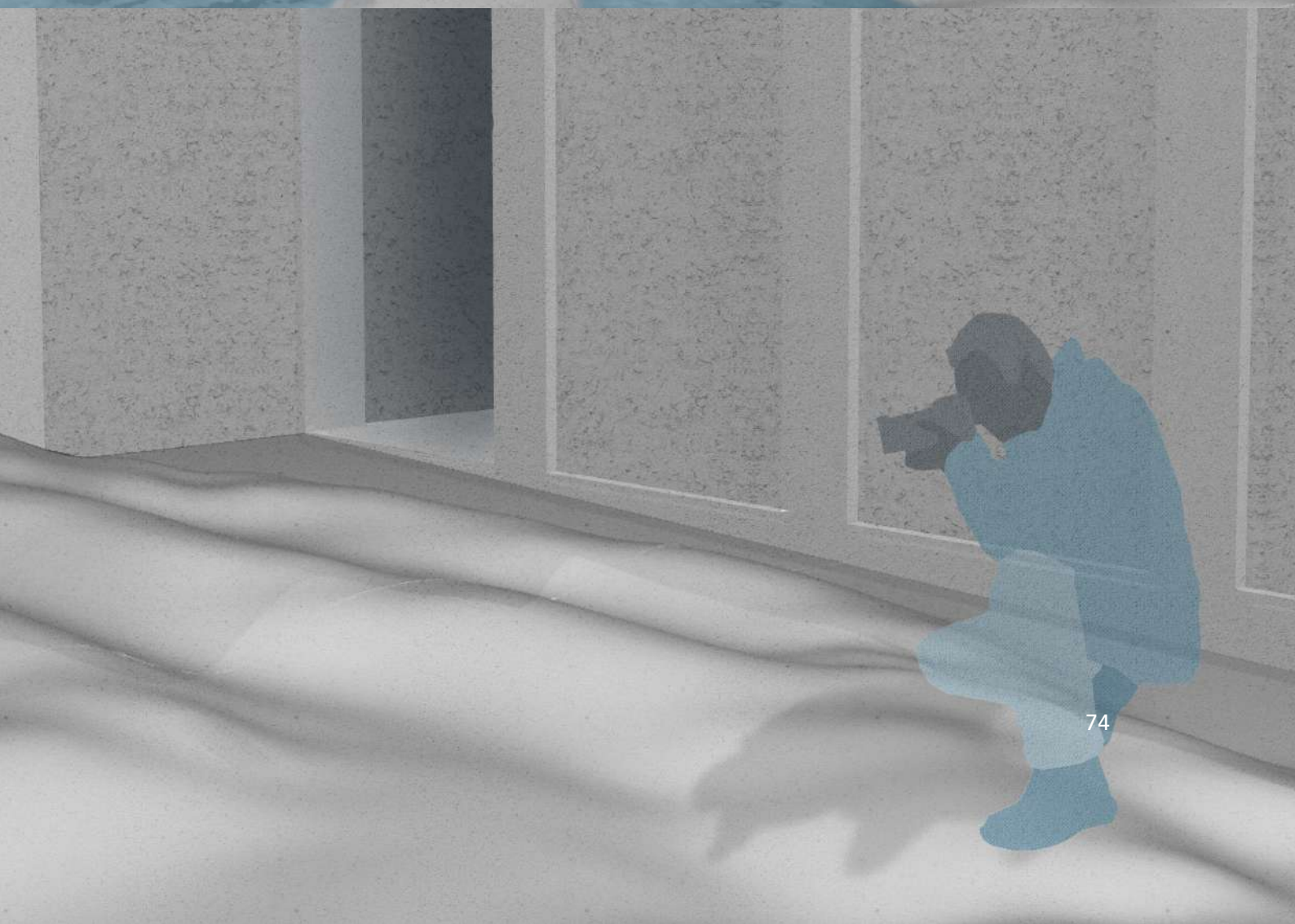


As for the shadow pavilion the scent and taste are not very strong in this pavilion but are felt because of the interaction with the other senses.

PERSPECTIVE 1
Dark entrance situation

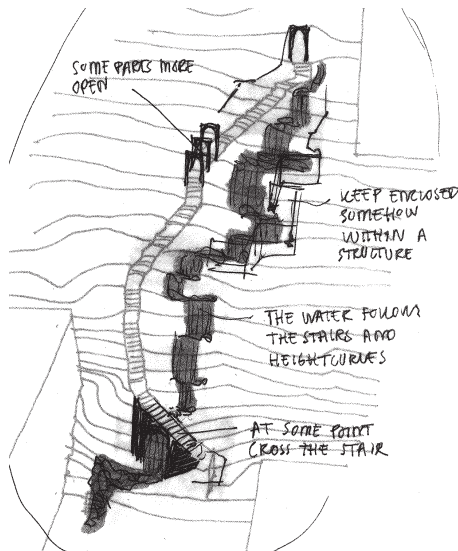
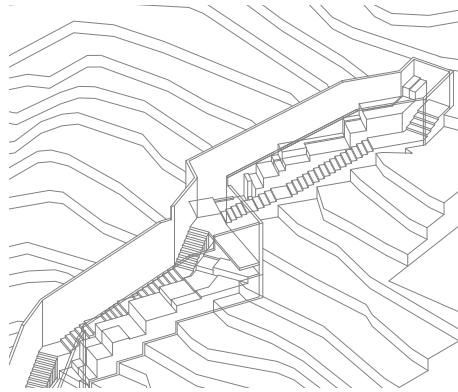
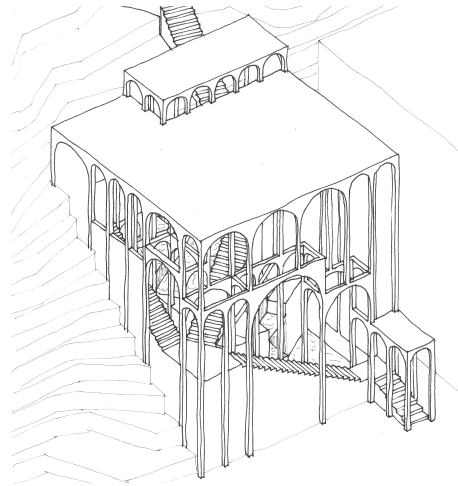
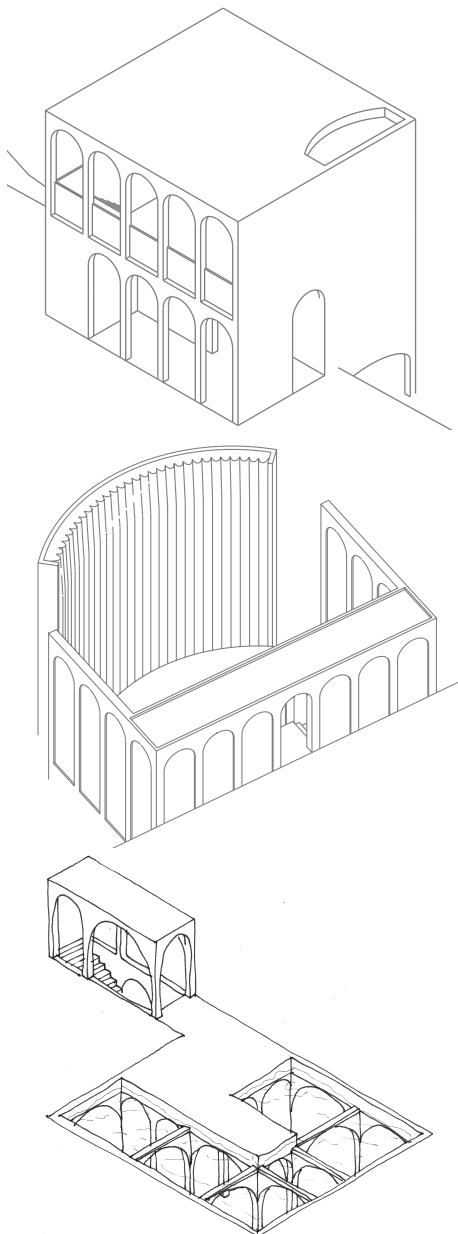


PERSPECTIVE 2
Water and no water



SKETCHES

I have worked by drawing sketches by hand but also by building the structures in a 3D modeling program and modifying and alternated the two methods of sketching the pavilions.



MODEL PICTURES

Models used during the presentation

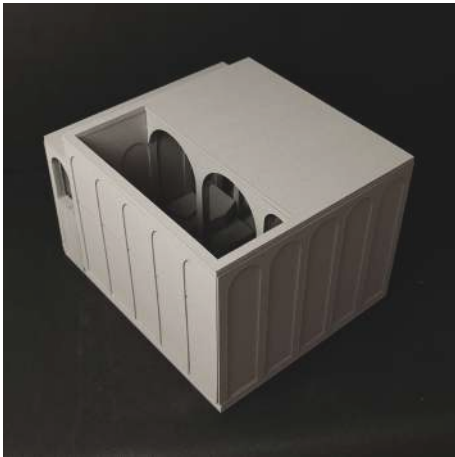


Figure 40 - 45. Models. Author's own copyright.

CONCLUSION & DISCUSSION

To conclude I would like to bring you back to the beginning of my thesis again and state my thesis questions once more.

Can the water become a trigger to our senses in architecture? In that case in what ways and how does it affect the senses? Can this increase the use of all of the senses, vision, touch, sound, scent and taste, in our experience of architecture?

By instinct and by conclusion from my first investigations on how water affects our senses I could quickly determine that the water does affect our senses and that different movements affect them differently. The water triggers the senses through its properties, the sound, the touch, the smell, etc. of water. I believe it affects us so because water is such a familiar subject for most people. I have been able to bring in a lot of my own experiences in this thesis because of the belief that people with approximately the same geographical conditions will have the same kind of relationship with water and understand it in a similar way. My conclusion based on the model investigations is also that the senses, triggered by the water, changes our experience of the architecture around us. This might sometime be by taking some focus from the architecture itself and bringing it to the water, but one can also see that in the case of bringing water into a structure the water becomes part of the architecture as well. It doesn't just have to be seen as a separate installation. The dynamic movement of the water affects our senses and is reflected into our view of the architecture surrounding it.

From the project one can also conclude that the sense of vision still takes a big part in the experience but that the other senses have gotten a bigger focus than they normally would. This is also due to the fact that I have designed with the focus to enhance all the senses which is important to note. It is not only the water that enhances the senses, but the architecture and water complement each other. By surrounding the water by architecture that can bring forth the sense one wish to enhance, and by merely not just focusing on vision during the design process, the other senses get to take an even bigger part in the experience of the architecture as well.

What I hope to bring into the discussion of the senses in architecture is not so much that the senses are important, but I hope to have brought in new possibilities of designing for the senses with water. I have brought in new methods of designing for the senses. Because of the fast-rising temperatures and melting ices there are a lot more running water around us and by finding purposes for water in architecture we can actually use that water instead of finding ways of shutting it out of the buildings. I hope that I have given the water a purpose to be shown inside a building instead of hiding it and removing it to the outside something I this thesis can inspire other architects to do in the future.

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