RESONANCE

by

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ABSTRACT

This project asks whether it is possible to represent sound through the medium of architecture and site design. Through the medium of exterior exhibition and performance spaces, the design explores ways within which the non-hearing population could have their senses activated through moments of haptic enhancement as well as vibrational tectonics. The site chosen for this study holds potential to extract and probe the latency of site conditions such as wind, water and seasonal change to place a higher focus on tactility of materiality and construction assemblies. The goal is for these sound experiences to reside within highly concentrated sensory encounters between the non hearing and hearing population.

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ACKNOWLEDGMENTS

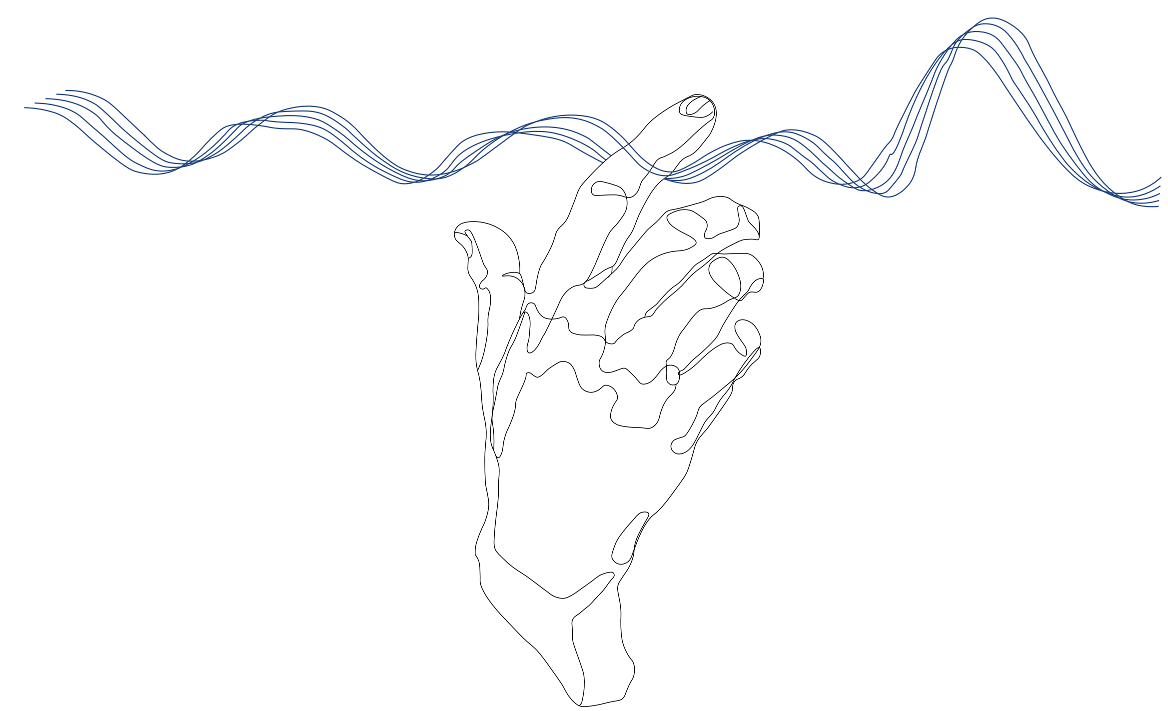
I would first like to thank my thesis chair Bill Pechet of the School of Architecture and Landscape Architecture at the University of British Columbia. Throughout the course of this thesis, Bill would constantly encourage me to dive deeper into the project as well as offer guidance whenever I needed direction. His willingness to make time to meet outside of scheduled hours was greatly appreciated as it allowed me to stay motivated and pushing the project further. I would also like to thank the other committee members Inge Roecker, Marko Simcic, and Brian Topp for their advice and critique throughout these past months. I appreciate the time they took out of their busy schedules to offer their own professional insight into this thesis.

Finally, I must thank my parents and sisters for their continuous support and encouragement through my years of education and through this thesis project. This accomplishment would not have been possible without them.

Thank You.

THESIS STATEMENT

This project seeks to question the notion of sound and how architecture can be designed to activate multi sensory environments to create a shared experience with the deaf population.



R E S O N A N C E

1. the quality in a sound of being deep, full, and reverberating.

2. the ability to evoke or suggest images, memories, and emotions.

CHAPTER 1

DEAF , SENSES , AND DESIGN

INTRODUCTION

As architects, studies that take us away from the normative way in which we experience our own lives can help extend the way that we think about materiality, about space, about programming, and about design. This project falls within a larger discourse about recognizing that we are not only designing for ourselves but for a range of human experience where a spectrum of encounter exists.

At times, architecture overlooks this spectrum of human experience. When thinking of the term disability, the common assumption is to assume that the impairment is physical. In reality, there are numerous disabilities such as hearing loss that is often invisible to the naked eye. Because architecture is such a visually driven medium, ones sense of hearing in the world of architecture is often gone unnoticed.

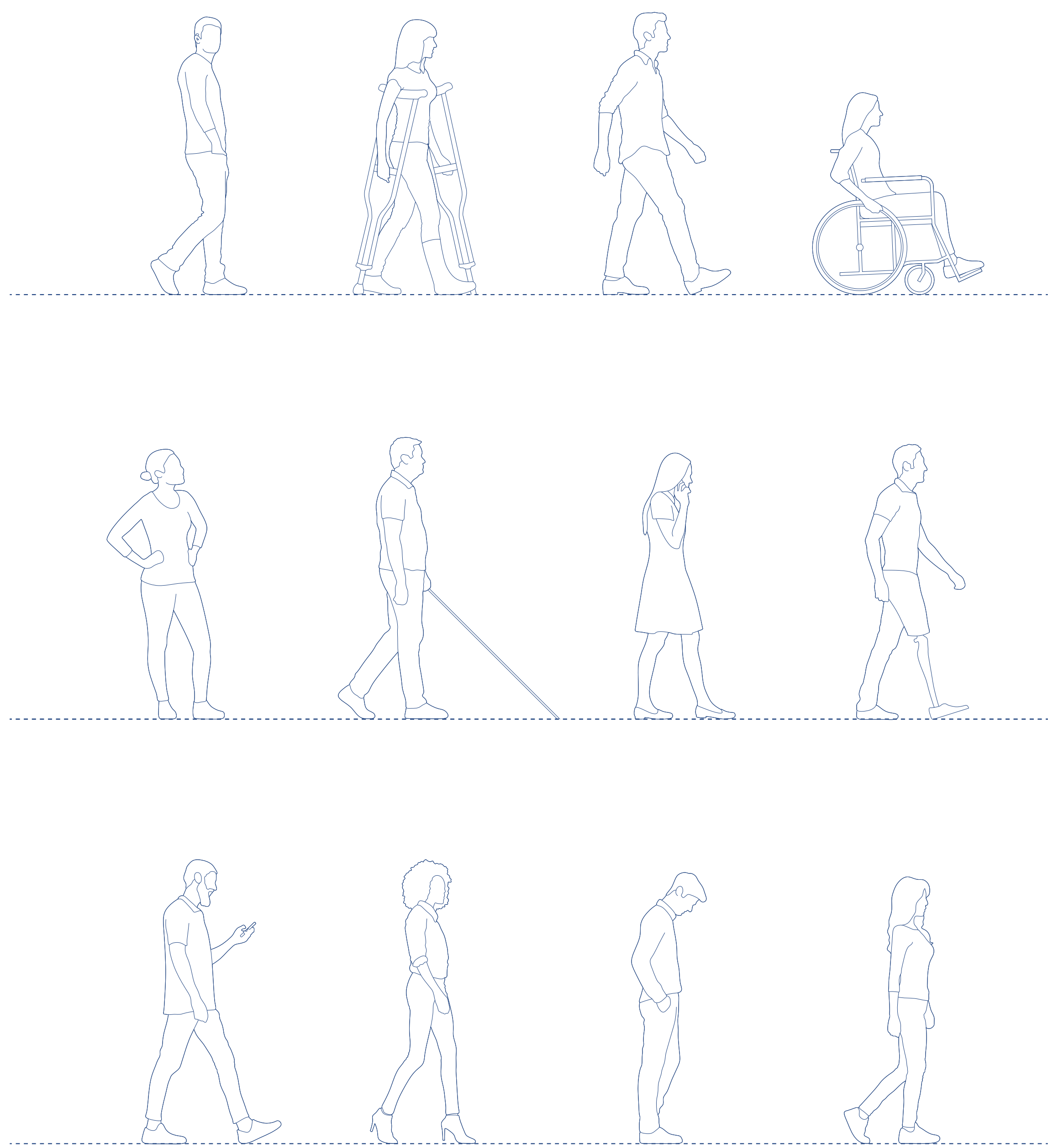


Fig. 01 - Visible vs Invisible Disabilities

HEARING LOSS

Hearing loss is broken down into two categories, conductive hearing loss and sensorineural hearing loss. Conductive hearing loss occurs within the outer and middle ear. This type of hearing loss occurs when something is not working within the ear canal, ear drum, middle ear bones, or middle ear space. Sensorineural hearing loss occurs when there is a connection issue with the brain, auditory nerves, or the cochlea.[1] Some people may experience temporary hearing loss within their life time. This is mostly always conductive hearing loss and is more common than permanent hearing loss. Permanent hearing loss is mostly always sensorineural.[2] The reasons for this type of impairment vary from: structural issues, drug related issues, physical trauma, infections, or genetics.

From these two types of hearing loss, there are five degrees of hearing in which deaf people are categorized under.[3] People who suffer from mild hearing loss may have a hard time hearing soft spoken people, but are able to hear loud or more intense sounds. They may have to ask people to repeat themselves in order to hear soft consonant sounds. Those with moderate hearing loss often use hearing aids to help them hear sounds and conversations. When hearing aids are removed, they may not always fully understand sounds. For moderately severe hearing loss, hearing aids are used but speech and sounds may still be difficult to interpret and understand. Without hearing aids, speech is inaudible. People with severe cases of hearing loss are unable to hear speech without the aid of their hearing aids or cochlear implants. Profound hearing loss is the most severe level of deafness. Without hearing aids, very loud sounds such as engines, airplanes, or fire alarms are not heard.

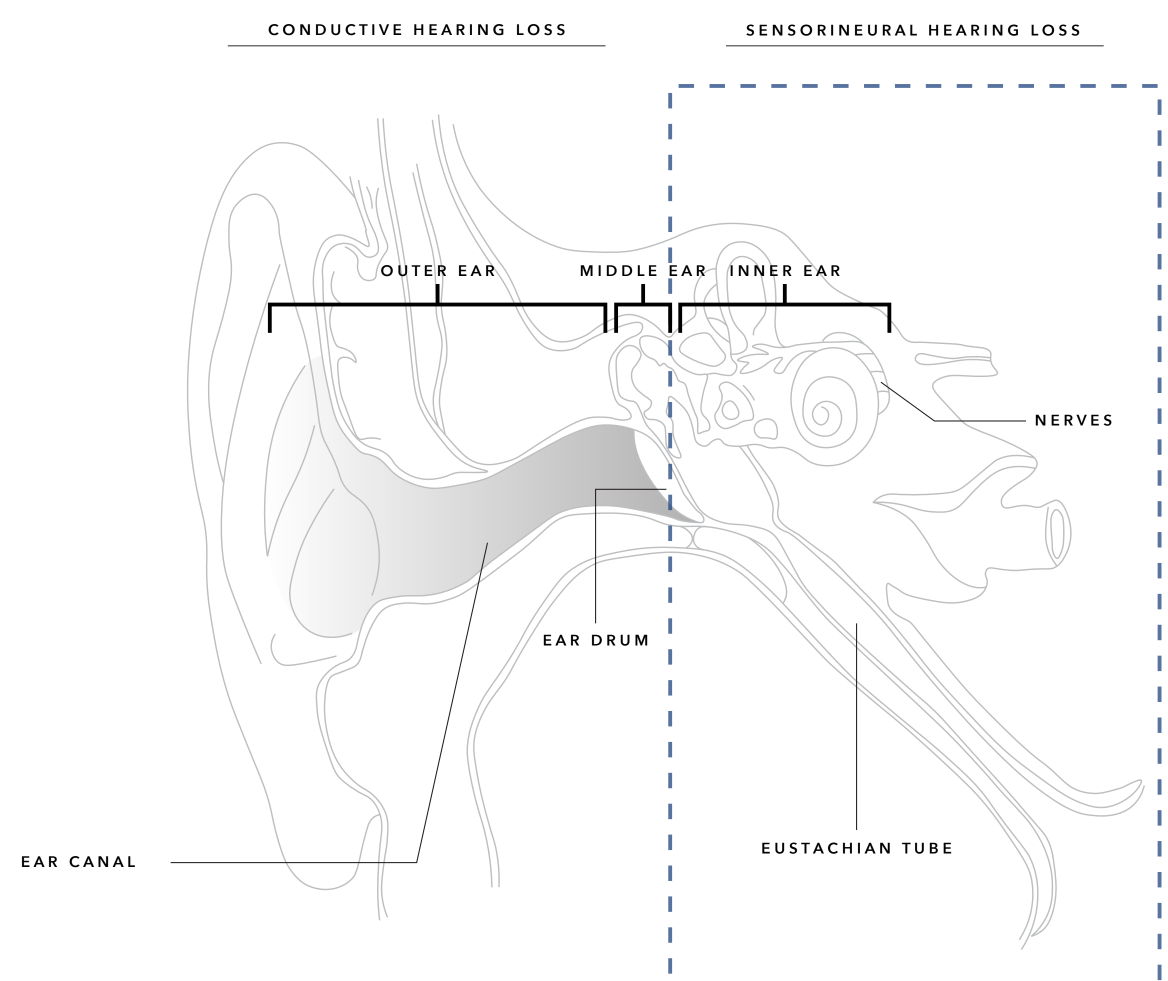


Fig. 02 - Diagram of the Ear

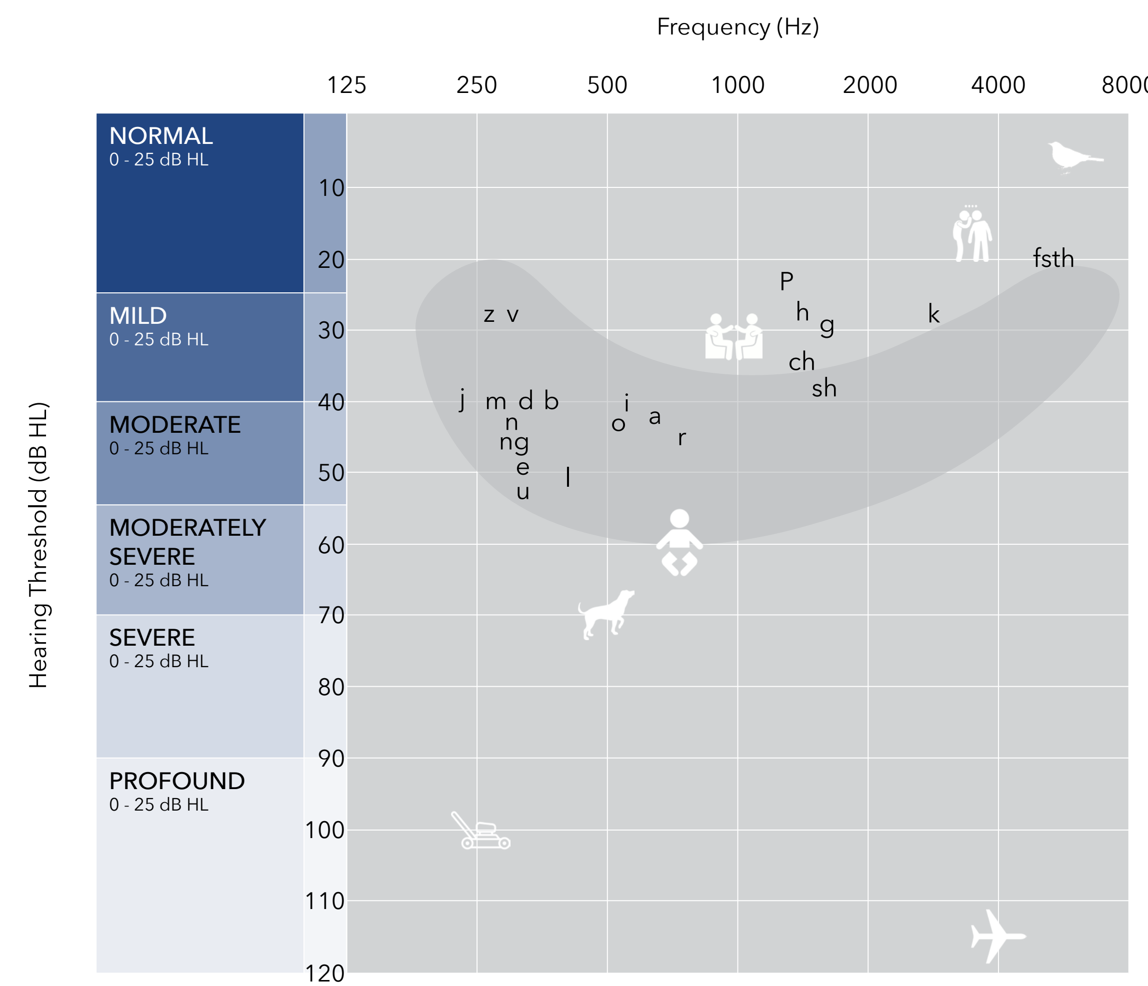


Fig. 03 - Hearing Levels

THE DEAF BRAIN

Hearing loss varies in severity from person to person. During the early stages of my research, I began to look at the the brain to better understand how those with hearing impairments could comprehend sound in alternative methods. For the fully abled population, the built environment is experienced through their five main senses: sight, sound, smell, touch and sometimes taste. For the deaf people, their sensorial experience of architecture is altered when compared to the abled population.

When one sense is unavailable, sensory responsibilities shift, and the processing of the remaining senses become enhanced to compensate for this missing information. This is referred to as compensatory plasticity.[4] The auditory sense tends to be responsible for understanding surrounding environments while simultaneously gathering information. For the deaf and hard of hearing population, they compensate with enhanced visual processing as well as a more refined sense of touch.

In the brain, there is the primary auditory cortex as well as the secondary auditory cortex. The neutrons located within the primary cortex respond mainly to sound, while the neutrons in the secondary cortex respond to other stimulants such as visual and vibrotactile touch.

In 1998, Finnish neuropsychologist Sari Levänen conducted studies on a deaf adult to better understand the secondary auditory cortex. In her findings she states, "When vibration is presented to the palms and fingers, activation of the secondary auditory cortex is greater and more widespread in deaf participants than in hearing participants."[5] Another separate study was conducted on the deaf brain in 2013 from the Kansei Fukushi Research Institute in Sendai Japan. In this study, Dr. Seji Ogawa examined that some of the visual processing advantages of deaf individuals may stem from frequent practice in the use of sign language.[6] Sign language requires users to pay close attention to detail of another signers hand and body movements as well as facial expressions. The findings in these scientific studies leads us to believe that music can be augmented into a visual and vibrotactile experience for the deaf population to enjoy. It suggests that visual sound experiences should take place within one's peripheral vision, leaving the central point of view open for performance observation.

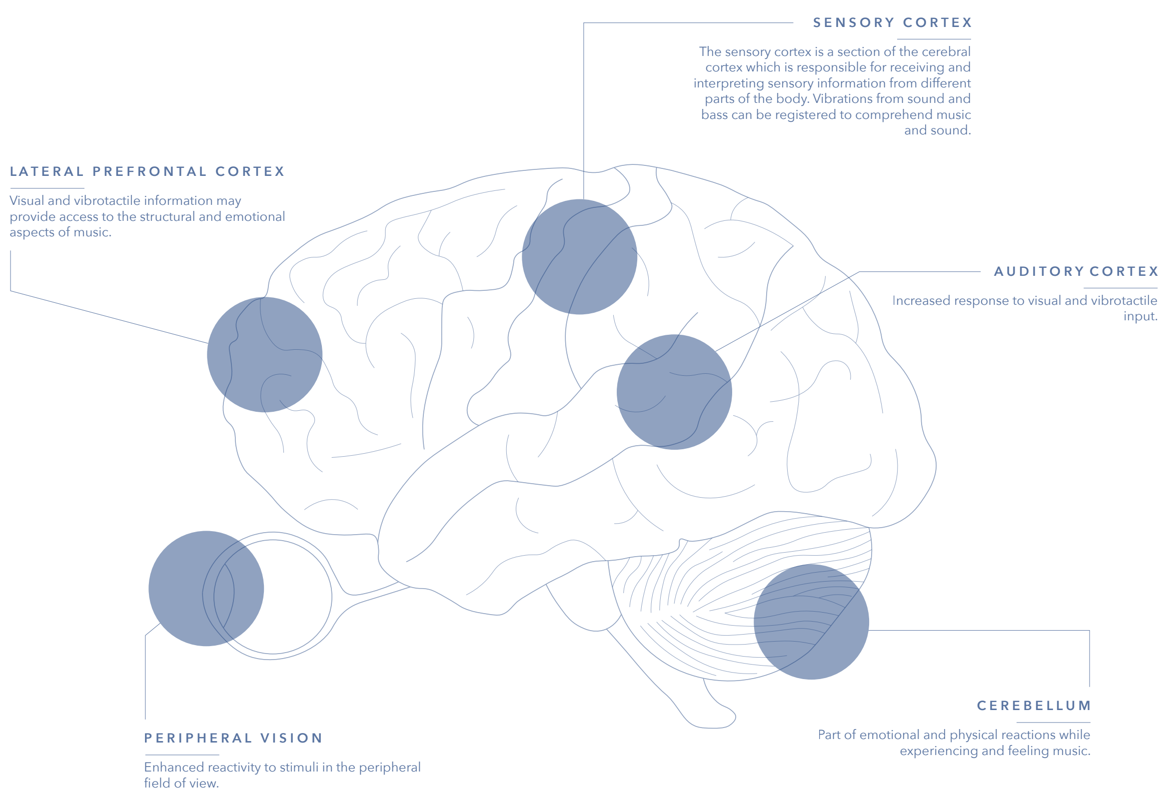


Fig. 04 - The Brain and Music

Within the brain, there are different locations that all in combination act on us and interpret how we are experiencing the environment. Some notable locations worth mentioning are the Sensory Cortex, which is responsible for interpreting sensory information from different parts of the body. The Cerebellum is responsible for regulating body movement and physical reactions. Peripheral Vision results in an enhanced reaction to stimuli in the peripheral field of view.

What I began to study is if there is a way that we can become cognizant of those brain functions in how we design? And can we potentially heighten those functions for those who have hearing loss in order for them to experience sound through alternative methods. These three key brain functions would play an important role during the design phase of the project.

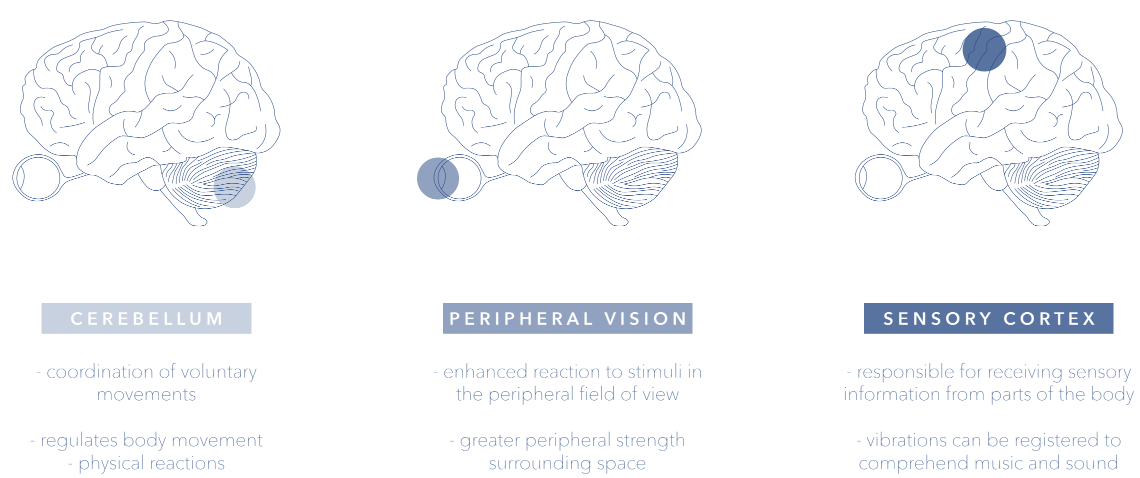


Fig. 05 - Brain Programs

MULTI SENSORY DESIGN

Throughout history, sight has been considered more essential than the remaining four senses. The Athenian philosopher Plato stated vision was "humanity's greatest gift." Leonardo Da Vinci stated, "The eye is the principal means by which humans appreciate the infinite works of nature."[7] Historical studies have shown that the five senses were individually studied and ranked through a hierarchical system. Sight was considered most essential while touch was ranked the lowest. However as time passed, designers began to expand their understanding of the remaining senses within the built environment.

Our world is a limitless bundle of sensory experiences. Often we interact with these experiences without even acknowledging how our senses are reacting to the spaces. It is not until we stop and study the interaction between each sense and the spaces we inhabit to fully understand the value and importance of our senses individually. Japanese graphic designer Kenya Hara states, "human beings are a bundle of very delicate receptor organs and at the same time, an image generating organ equipped with a vigorous memory-playback system. An image generated is a spectacle orchestrated through multiple sensory stimuli and revived memories. This is precisely where the designer works."[8]

Sight:

Peoples experience in space is based off of an instant reaction to what they are seeing. At its core, visual stimulation within the built environment helps us understand our surroundings. Our eyes are the threshold from environments to our own consciousness. Architect Juhani Pallasmaa stated, "As we look, the eyes touches, and before we even see an object, we have already touched it and judged its weight, temperature, and surface texture."[9]

The sense of sight in architecture goes beyond aesthetic qualities. Visual access to nature and natural daylight are considered essential to one's mental health.

Sound:

Each space has its own unique sound qualities to it. The feeling between a room that echo's will result in a different feeling and experience than a room that is quiet and absorbs sound. The choice of material is crucial when designing spaces for specific programs. The interaction between sight and sound allows individuals to understand space, navigation, object and sound. One of the unique aspects about sound is that it can be invisible as well as unconsciously perceived. Sounds of a place can become so constant that our brain stops computing these sounds and they become lost in the sensorial activity of a place. It is not until we stop and truly pay attention and focus on the sounds around us.

Touch:

Billions of nerve cells are located within the human body. These cells inform us on temperature, texture and more. Tactile stimulation has the ability to positively or negatively influence one's experience with architecture or the built environment. Author Christopher N. Henry questions this theory in an article for Arch Daily. He states, "Does a heavy cold smooth door with a warm wooden handle have a different effect than a rough light warm door with a cold steel handle? We associate heaviness with weightiness and subsequently seriousness. Does a door's weight influence our perceptions of a space as we enter it? Could the tactile experience of the floors and walls influence people's perceptions of and attitudes towards others, or is there not enough tactile engagement to be significant?"[10]

Smell + Taste:

Like touch, smell has the ability to positively or negatively influence one's experience with architecture. Architect Ruth Newman describes smell as "Smell triggers some of the most powerful emotional responses and can cause some of our most visceral responses."[11] In architecture, smells surround us from the scent of hardwood flooring, to the natural smells of the buildings we inhabit. Smell is also like sound how it can become so constant that our brain does not register it as important information. In our homes or office spaces, smells may become so constant that there is no longer a reaction. Taste is the most ambiguous between all the senses when relating to architecture. Taste is often related with smells and can become a memory of a certain place or building.

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CHAPTER 2

CASE STUDIES

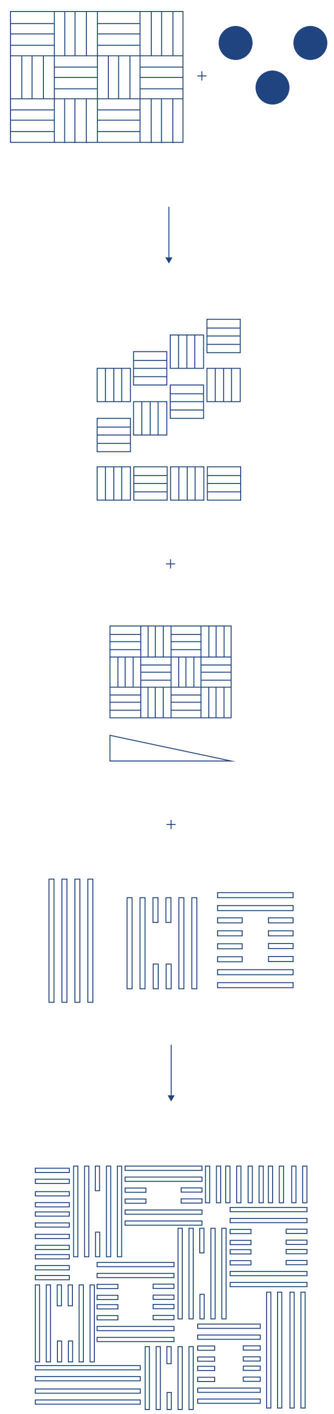
INTRODUCTION

For the purpose of this study, it is important to examine other projects around the world who experiment with multi sensorial spaces with a focus on sound design. Although these precedent examples differ in scale, site, and material, the common goal in each is to aid the user in experiencing sound in more ways than just our hearing. The deaf and hard of hearing populations would be able to use and interact with these spaces to understand sound in an unconventional way.

As previously stated, when one sense is limited or missing, other senses adapt and become more enhanced to process information. Through multi-sensory design projects such as these, remaining senses of the deaf population would become activated. These are projects that are inclusive and allow disabled populations to have equal opportunity to experience space and sound, like the abled.

SWISS SOUND BOX

At the 2000 Hanover Exhibition, Peter Zumthor designed the Swiss Sound Box Pavilion. The goal for the structure was to engage all senses of an occupant. The pavilions form derived from a basket weave plan. Stacked timber walls run parallel and perpendicular throughout the pavilion while the gaps between these walls vary depending on the type of program and performance space within the structure.[1] The narrow corridors are designated for circulation, while more open spaces are for performance and dining. The 8.68 meter tall timber walls consist of 118 individual beams of Swiss larch and pine held together by post-tensioning cables and linking planks. The stacking of these beams allowed for natural ventilation to pass through the walls of the structure as well as sound from performance programs. Other than metal sheathing fastened to the top of the structure, there is no protection from the natural weathering elements such as rain and wind. By having such an open and porous structure, elements such as sights, smells and sounds from the outside are able to penetrate the interior spaces. Wind will allow sounds from performers as well as the scent of weathered wood to pass through the perforated walls. Author Lance Hosey states, "The wooden structure provides an ideal location for the performances as it provides a sonic and tactile warmth for the visitor. The Swiss Sound Box plays with both thermal and acoustic temperatures. The structure is an enormous cabinet of larch and pine, warm to both the hand and the ear while it also breathes and sings with beautiful timber lungs."[2] The Swiss Sound Box Pavilion is a great example of multi sensorial design. It is a pace where once can rest and truly focus on their senses and how they are interacting with their surroundings.



Initial design: basket weave arrangement of each module

Spreading strategy to make place for service space

Spacial hierarchy: priority of performance spaces

Three modules of spaces: circulation, performance, dining

Assignment and adjustment of each module

Fig. 06 - Swiss Sound Box Program

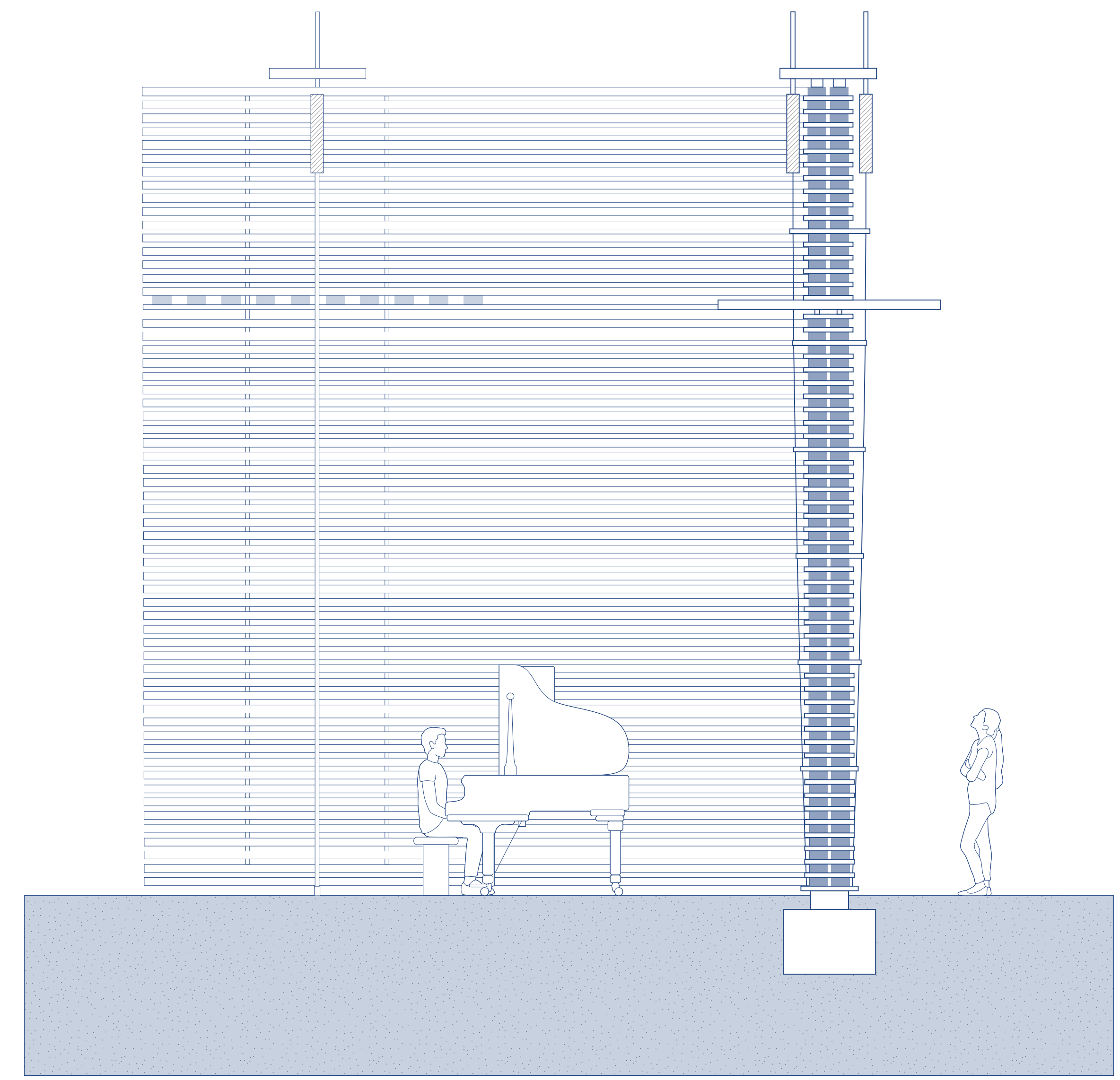


Fig. 07 - Swiss Sound Box Section

PLAYING THE BUILDING

This project titled "Playing the Building" was designed and created by artist and musician David Byrne as well as Färgfabriken Art Gallery in Sweden. According to David Byrne, "Playing the Building is a sound installation in which the infrastructure, the physical plant of the building, is converted into a giant musical instrument. Devices are attached to the building structure – to the metal beams and pillars, the heating pipes, the water pipes – and are used to make these things produce sound. The activations are of three types: wind, vibration, striking. The devices do not produce sound themselves, but they cause the building elements to vibrate, resonate and oscillate so that the building itself becomes a very large musical instrument."[3]

This sound installation begins to question how architecture can play a role in sound design and how itself can act a musical instrument. The project has had several different locations from Sweden, New York and London.[4] What is constant is the architectural structure in each of the pieces. "Playing the Building" is usually set within an empty warehouse or industrial setting where the structure of the architecture is exposed so it can be exploited by sound.

This idea of converting architecture into an instrument became a crucial point in my research and I began to think about how structures within the chosen site could be interacted with in a similar way.

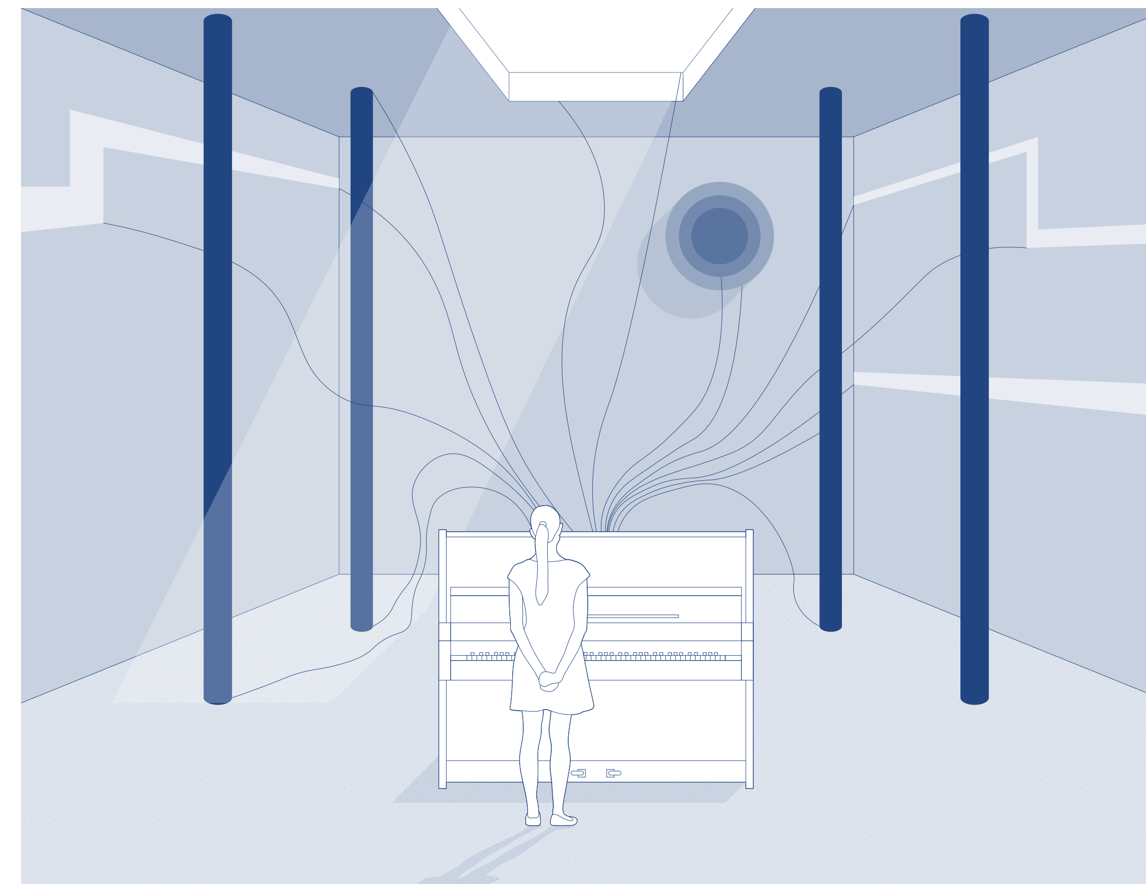


Fig. 08 - Playing the Building

ART OF FAILURE

This project is located within the Lakeland Region in Lusatia. Lakeland is the largest artificial lake in Europe and this tower acts as a beacon to the surrounding environment. This structure doubles as a piece of architecture as well as a sculpture as it emerges 30 meters high from the rocky terrain below. Constructed in 2010 as a part of an International Architecture Exhibition in Germany to pay respect to the regions industrial history as well as to look forward to the future.[5]

This observation tower uses corten steel as a material to stand out in contrast to the environment and be easily visible from a distance. The steel structure is comprised of three sides where two are closed and the front is open to reveal the numerous stairways.

The Art of Failure is an organization that specializes in sound design within architectural projects. A website titled "Resonant Architecture" spoke on the organization stating, "Since 2006, the collective Art of Failure has been creating a series of experiences that create a heightened perception of architecture by setting unusual buildings vibrating. The materials and structures activated by infra-bass vibrations reveal resonance frequencies and the physicality and acoustic qualities of the buildings chosen. A multimedia mechanism that involves sound, visuals and architecture, resonant architecture establishes a dialogue between architecture, the spatial components and geographical context."[6]

In a youtube video showing these low frequencies, you can hear how vibrations and resonance pass through the steel structure and echo across the landscape.[7] This was one of the earliest examples I saw where resonance was amplified through a building material like steel.

Fig. 09 - Art of Failure

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CHAPTER 3

SITE AND CONTEXT

INTRODUCTION

Currently, there are approximately 356 000 deaf and hard of hearing individuals in Canada, and 140 000 within Ontario alone.[1] According to Ontario's ministry of finance, the population in the central Ontario region is projected to increase by 31.5% (4.6 million), over the next 30 years, from an estimated 14.6 million to almost 19.2 million.[2] This 30 percent increase could potentially bring the deaf and hard of hearing population to 180 000 by the year 2050.

Within Ontario, there are limited resources that cater to deaf needs. The majority of these resources include, assisted residential living as well as community camps. One of the most notable resources in Ontario is the Bob Rumball Center for the Deaf. This organization specializes in: adult community programs, residential services, sign language support, as well as literacy and basic skills.[3] Due to limited locations, access to these spaces is restricted to a select number of people.

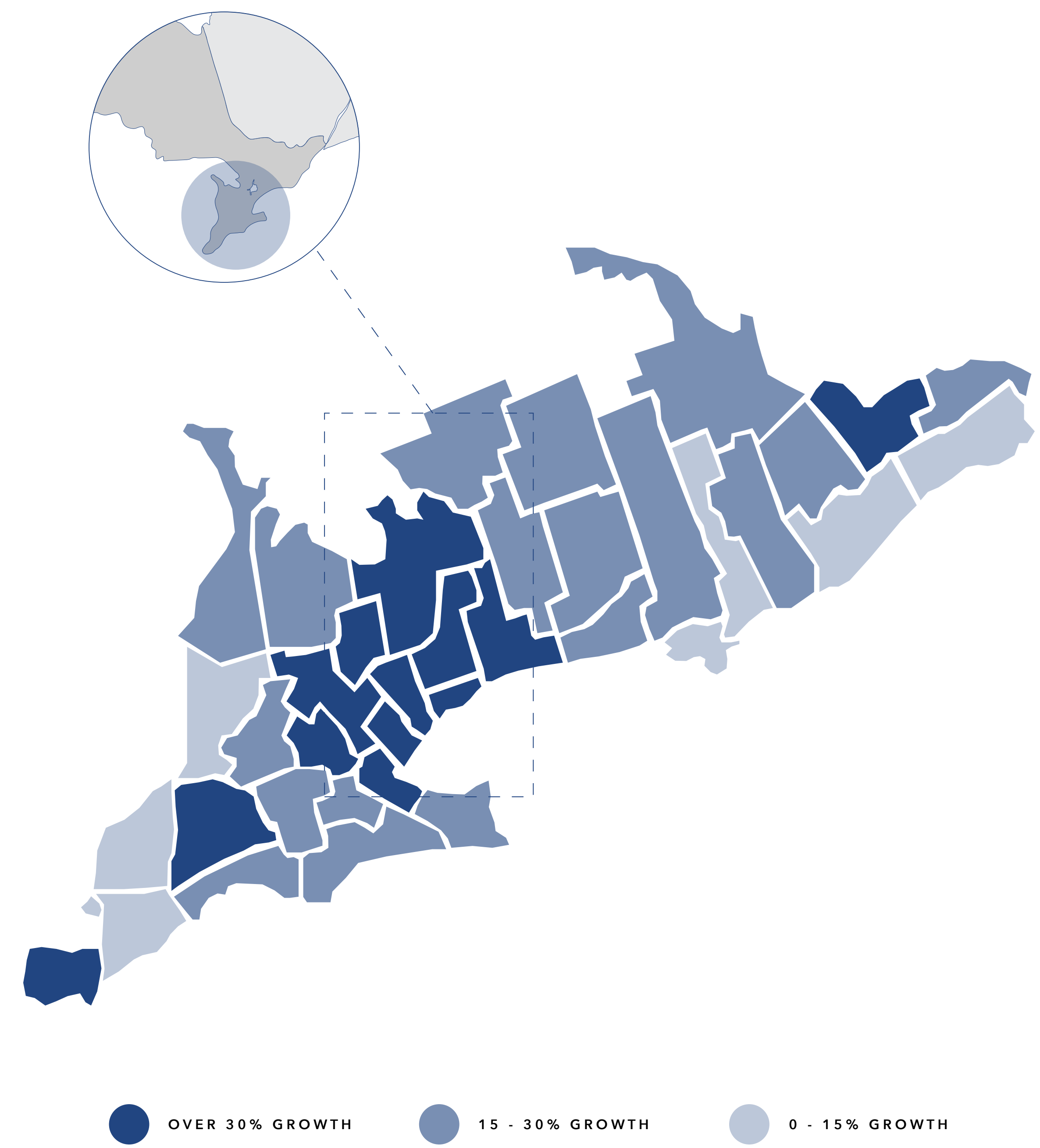

Fig. 10 - Population Projections

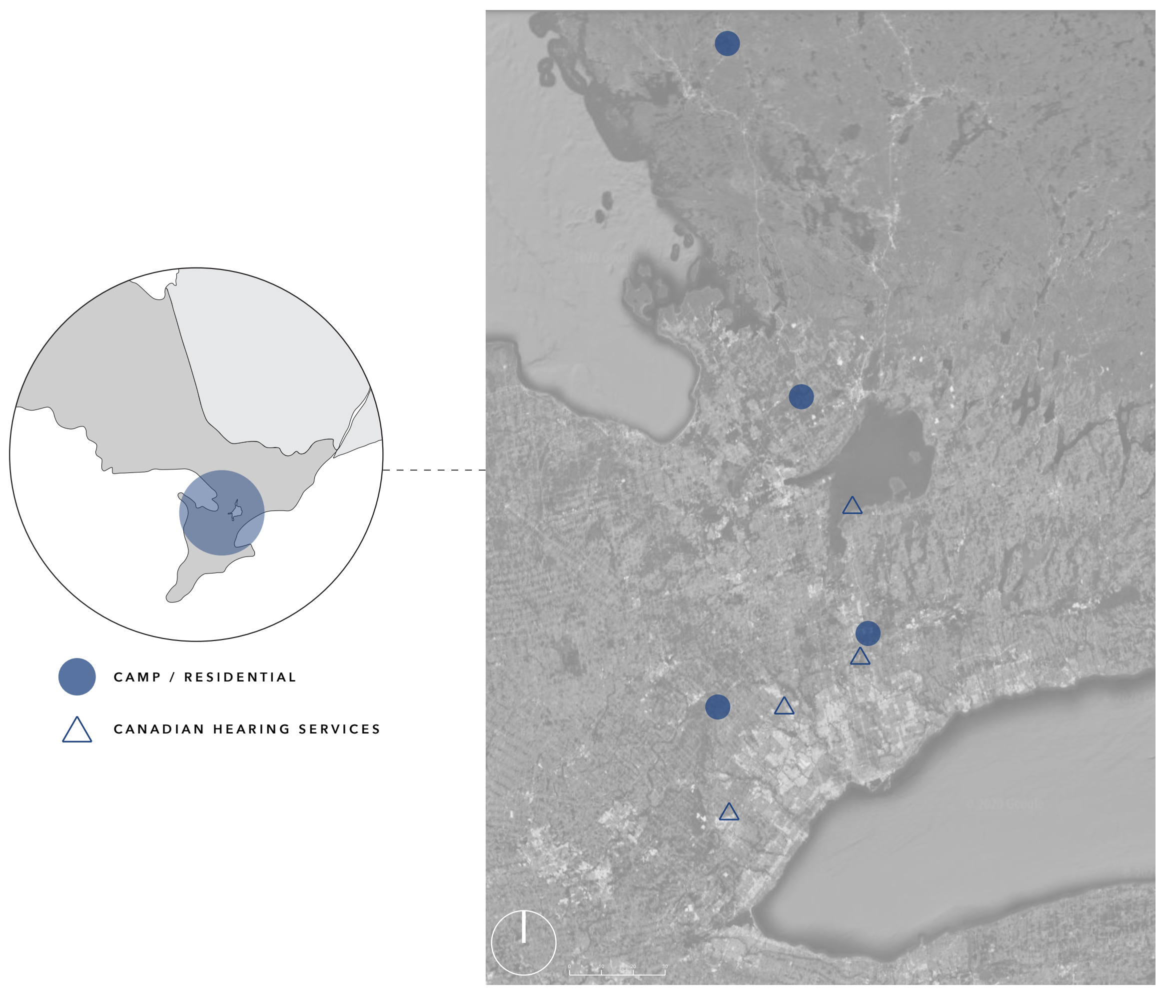

Fig. 11 - Current Resources

URBAN SPRAWL

With the city of Toronto being the most densely populated city in Ontario, the opportunity to grow comes with some issues.[4] The entire southern end of Toronto and its boroughs reside next to Lake Ontario, restricting southern expansion. Urban expansion and the continuously growing population of the greater Toronto area (GTA) has been forced to move North towards more rural environments. These Northern farming towns were once a contrasting setting to the downtown core, but over time, mass infrastructure and population rise has turned them into Toronto's endless and edgeless growing city. As time passes, the city intends to expand further North in order to utilize the available open land for future housing and commercial developments.

Other than population, another large factor for this urban sprawl is due to the rising living expenses in Toronto. Statistics show that living expenses in Toronto are 160% more expensive than town located an hour North of the city.[5]

Another aspect driving the population North is due to the recent Covid-19 pandemic. Working from home has become the new normal for many residents of the city. The larger expenses as well as smaller living spaces has been encouraging residents to look for more space. For some, there is no longer a need to be in the city. Mass transit stems from the downtown core and flows North through many other towns that would provide larger and cheaper living accommodations. A study conducted by Ryerson University examined this migration towards northern towns. In the report they state, "Toronto is the largest net loser of people to out-migration and they identified Simcoe County – along with Halton and Durham regions – as among the largest beneficiaries."[6]

Just over an hour north of downtown Toronto resides Simcoe County, who in a five year span from 2011-2016 saw a larger population growth rate (7.5%) than Ontario (4.6%) as well as Canada (5.0%).[7] A small lake side town called Innisfil resides within Simcoe County. It is here where I have chosen to situate my project.

Fig. 12 - Context Plan No.1

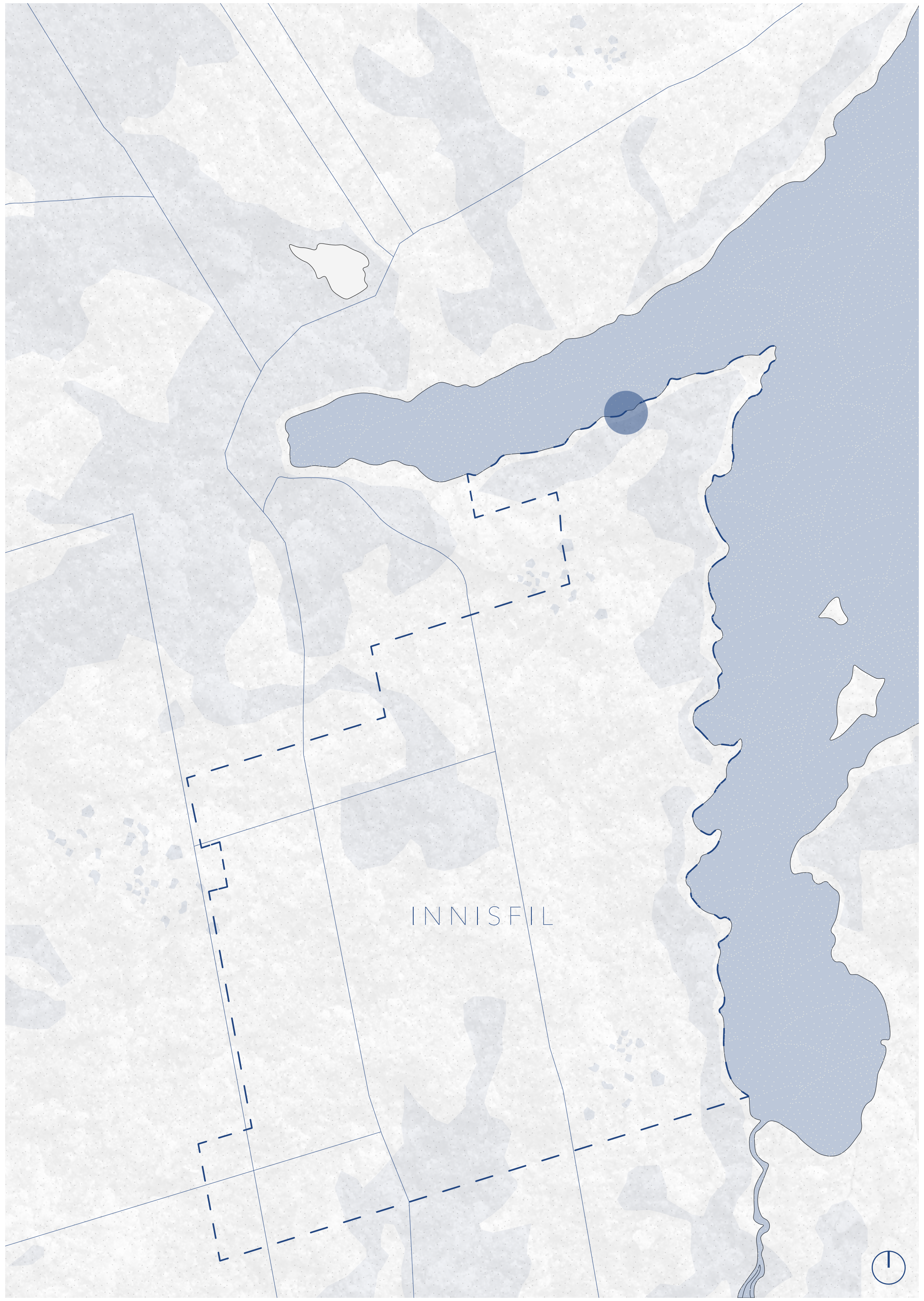

Fig. 13 - Context Plan No.2

SITE CONTEXT

The small town of Innisifl, Ontario is home to a population of 36 500.[8] The North and East coasts of the town are located adjacent to the large fresh water source, Lake Simcoe. Innisifl is a town that is experiencing increased growth from the GTA. Due to its abundance of open farmland and lakeside real estate, housing developments have become more popular as time passes. Developments such as Friday Harbour Resort in the North Eastern end of the town, added approximately 10 000 people to its seasonal population when it opened in 2018.[9]

Currently, the town has numerous mass transit systems. A major vehicular highway running North-South cuts through the middle of the town while a mass train and bus system flow through, connecting residents to neighbouring townships. The site I have selected for this project is located in the North end of the town. The location is situated within a rural setting adjacent to a residential neighbourhood. I have chosen this specific site because of its rural environments in contrast to neighbouring cities. The goal for this project would be to minimize unnecessary distractions in order to place focus on the buildings programs instead. By having a more isolated site, I will be able to achieve this. Along the North and West faces of the land is Lake Simcoe, while the East and Southern sides are natural forest terrain. The site used to be home to a campus extension from the local college but has since been vacated and pending demolition. The site is unique for its natural topographical slope. The site goes from a highpoint from the residential streets and neighbourhood, down to the water's edge. The existing clearing in the middle provides opportunity for structure and program for this project.

Fig. 14 - Context Plan No.3

AA

BB

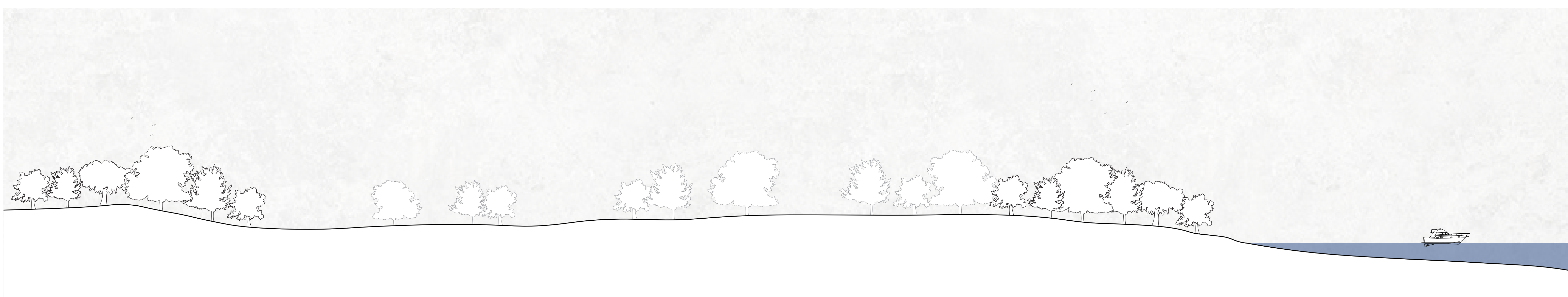

Fig. 15 - Site Sections No.1

Fig. 16 - Site Section No.2

Fig. 17 - Site Section No.3

Fig. 18 - Site Photos No.1

In Innisifl, the summers are comfortably warm and partly cloudy while the winters are freezing, dry, windy and mostly cloudy. The warm season lasts for 3.5 months from the end of May to mid-September. The average daily high during the summer months is 25 °C. The cold season lasts for 3.5 months from beginning of December, to mid-March. The average daily temperature during the winter is an average low of -12 °C and high of -4 °C.[10] With long winters comes snow and changing climate conditions. It is estimated that the most snow fall comes in mid-January when Innisfil receives an average of 12mm a day. Within the winter months, Lake Simcoe freezes over, and alters the landscape until the spring thaw. The sun path of the site significantly changes between summer and winter months.

During summer, a sunset is seen across the lake from the site where it sets in the North West region. During the shorter winter days, the sun sets behind the site, closer to South West and becomes hidden behind trees. The amount of wind on the site is greater due to its lakeside location. Wind tends to blow through the site as it comes off the North West region of the lake. This wind activity results in a larger wake on the West shore of the site.

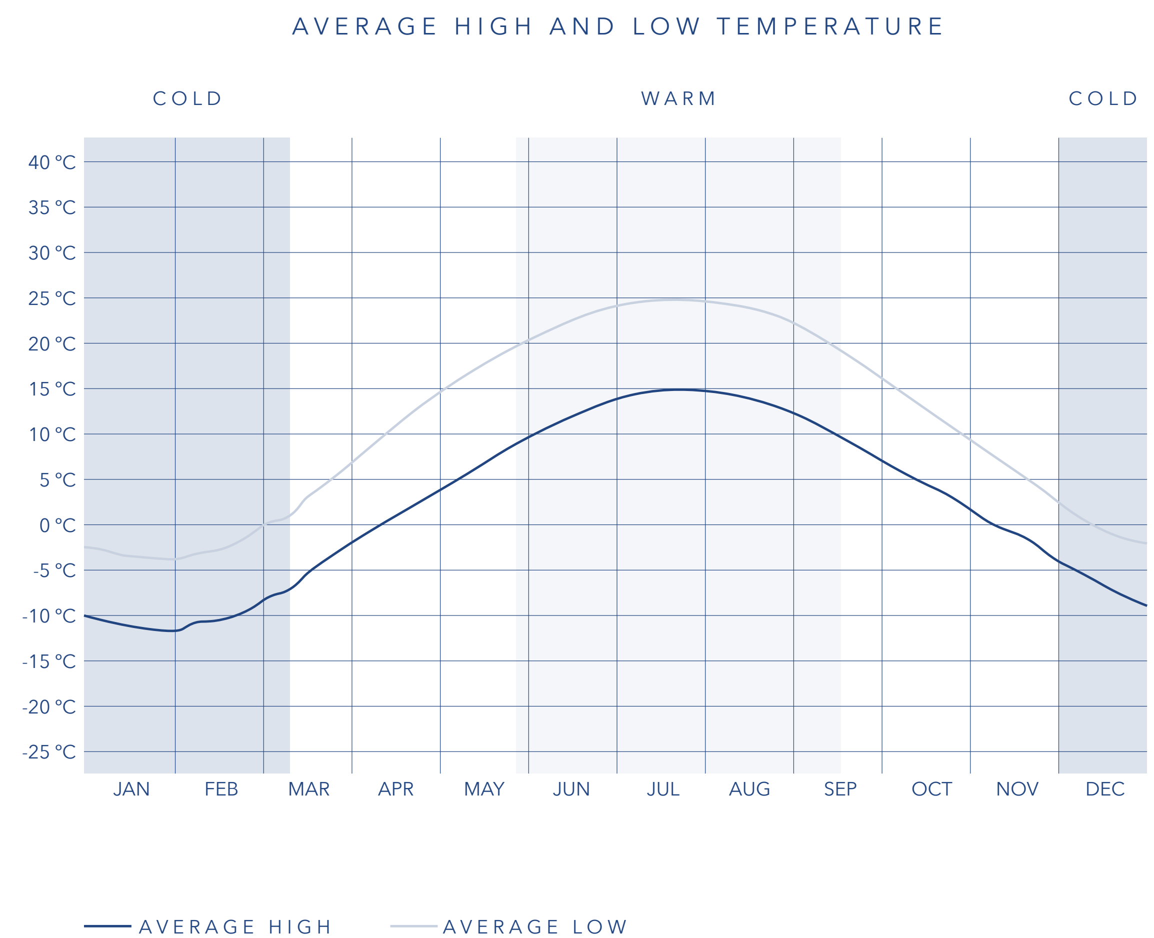

Fig. 19 - Average Temperature

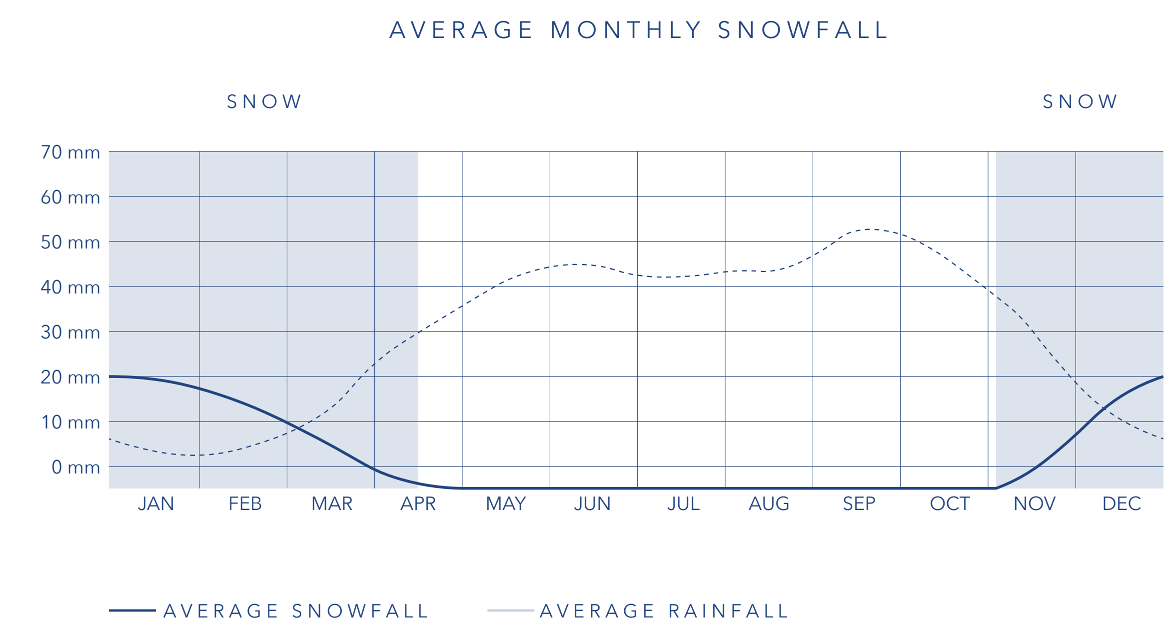

Fig. 20 - Average Snowfall

It was also important for me to begin to understand other important characteristics of the site such as topography, exiting vegetation, sound and light. When I was home during winter break, I was able to visit the site and document some of my findings. I created a series of maps that I could examine and overlay to find links and connections. I found that light and visibility was highest when traveling in between forest vegetation. There were clear paths with minimal tree canopies casting shadows above. The sound levels in these spaces were also higher because natural sounds were able to be dispersed without reflection. Sounds of wind through trees, the distant crash of rippling waves and the sound of animals such as birds would begin to echo in these spaces. When inside more densely populated areas surrounded by trees, sounds were dispersed and muffled. The existing vegetation created a buffer between water and land, affecting light and sound levels.

When these maps were layered, it showed me several sensory concentration points that would end up informing the locations of some of the future designs and structures.

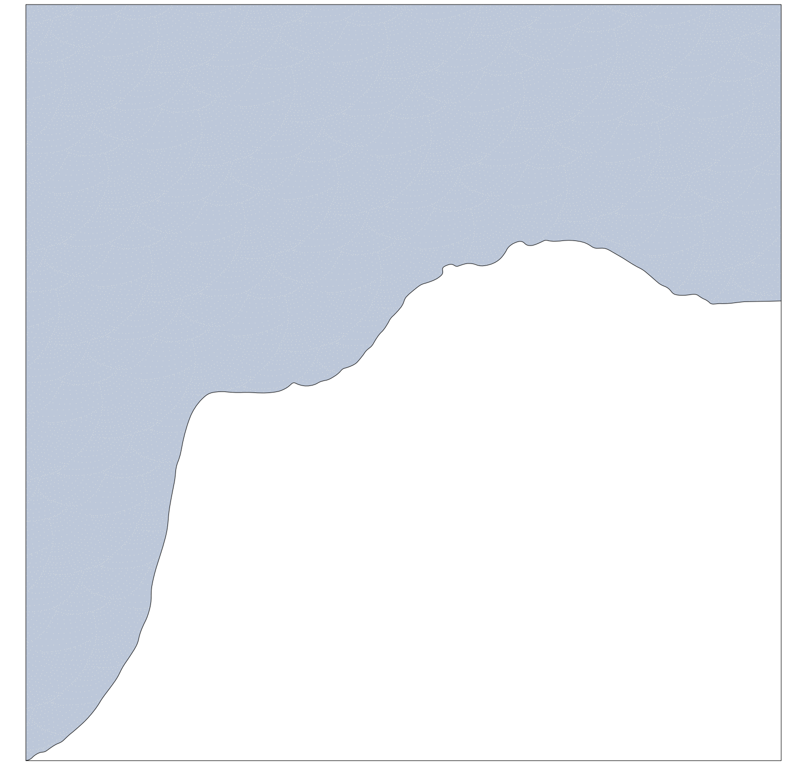

Fig. 21 - Water

Fig. 22 - Topography

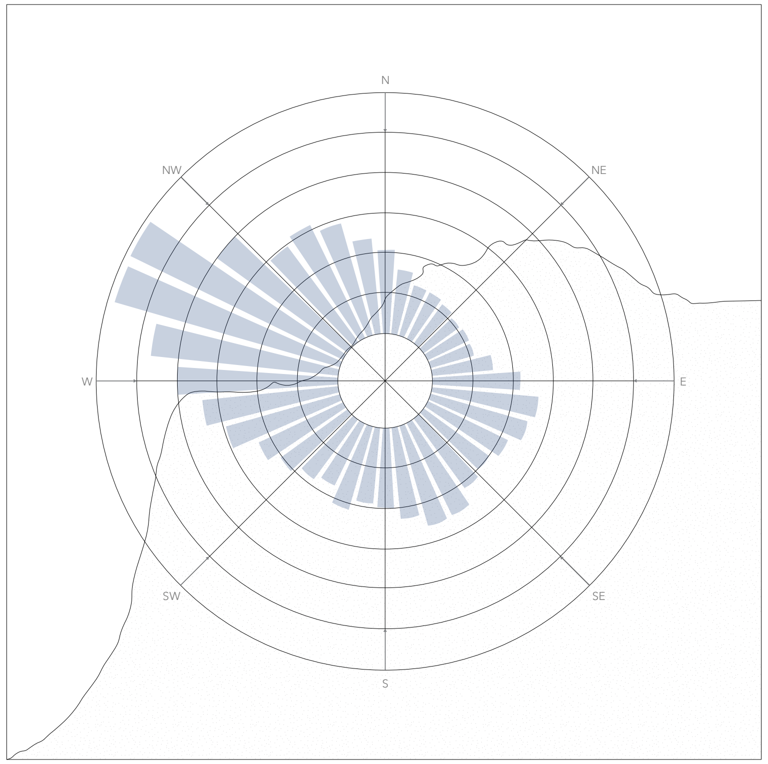

Fig. 23 - Windpath

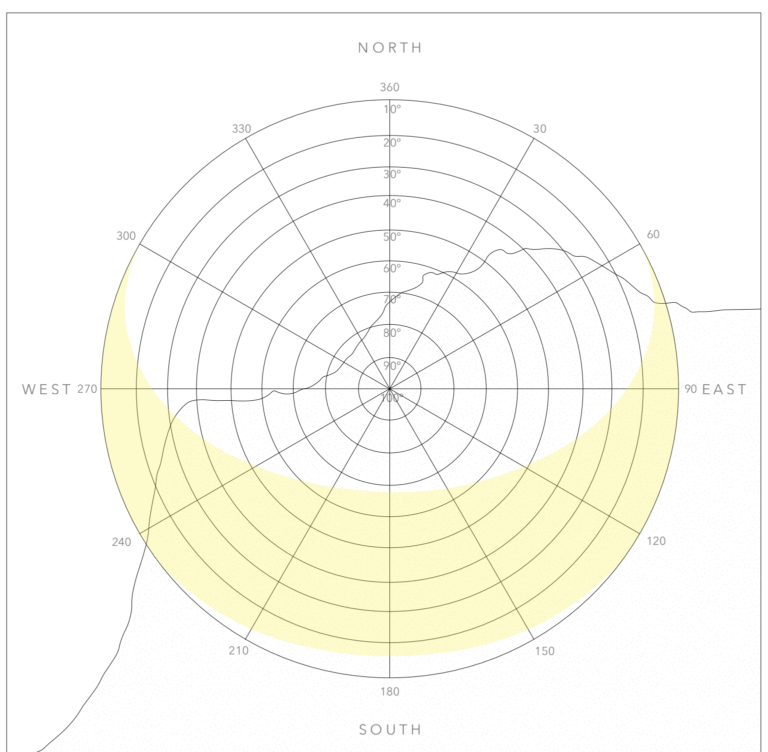

Fig. 24 - Sunpath

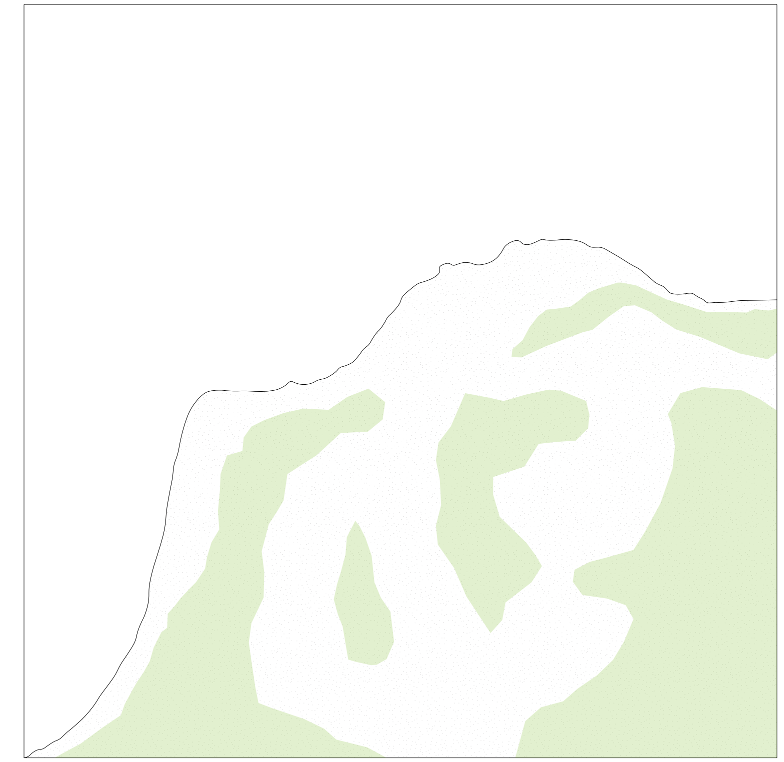

Fig. 25 - Vegetation

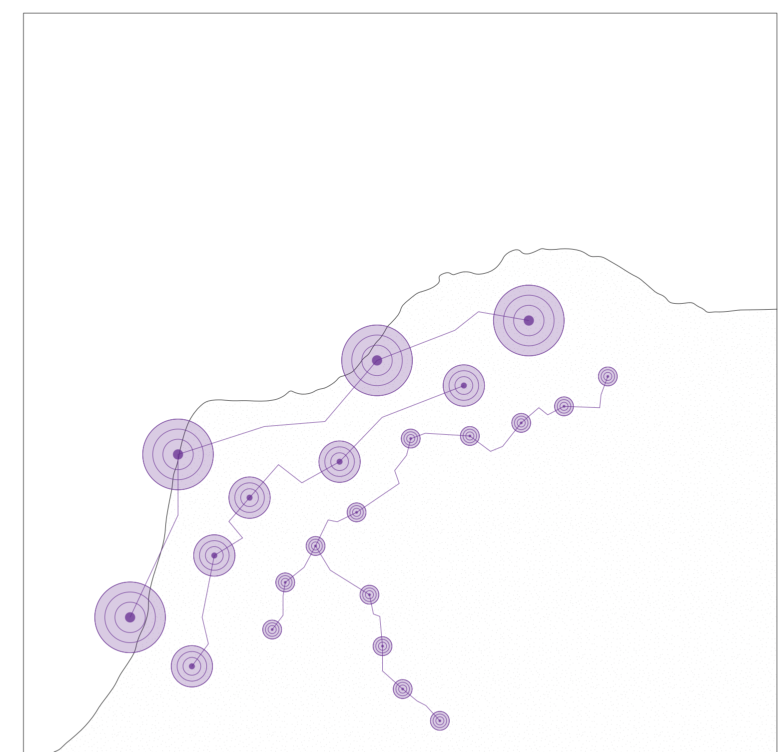

Fig. 26 - Sound Levels

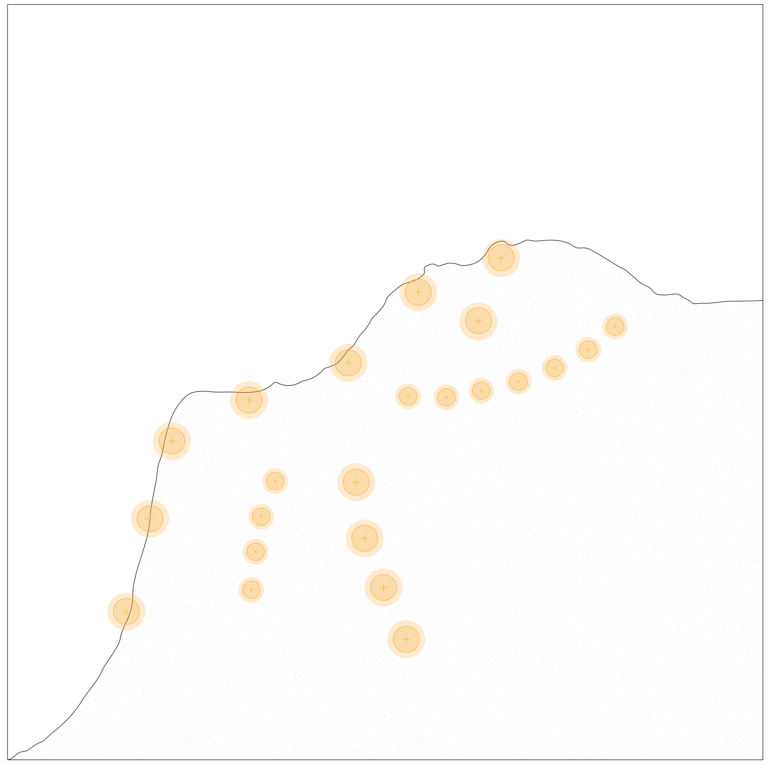

Fig. 27 - Light and Visibility

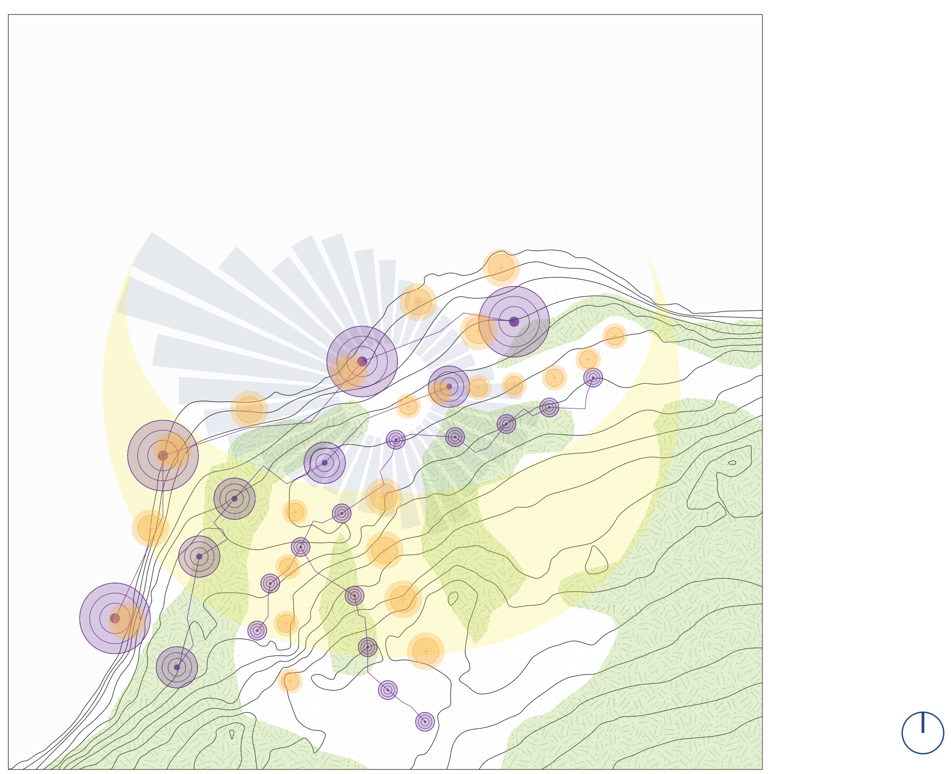

Fig. 28 - Site Conditions

SITE SENSES

One of the driving factors for me choosing this site was the opportunity for the public to interact with multiple senses such as smell, sight, sound and touch at the same time. This isolated location allows for the occupant to focus on their surroundings and pay closer attention to their senses. The occupants would smell the natural scent of pine and fir trees that populate the landscape as well as the earthy scent of evaporating lake water. Sounds of wind will rustle the canopy of trees, as well as touch the rippling water as it rushes ashore.

One of the goals for this project would be to bring aspects of this exterior sensory activity into the interior spaces. This could be tested through seasonal components in summer versus winter. This could be accomplished through testing various materials and their percussive qualities during this seasonal shift.

A study conducted in 2015 examined the experience of multi sensory environments among people with visual impairments. Author Gavin R. Jenkins states, "the relationship that a person has with an environment can be enhanced when there are a variety sensory stimulations that go beyond visual aesthetics like smelling a flower and/or touching an object. When an environment relies solely on a single sense it decreases the ability of the space to engage and welcome a diverse range of individuals because their needs are not met. For example, an individual with low to no vision would not be able to navigate a park that had no signs and limited textured pathways unlike a sighted person would have. A multi- functional space should provide a balanced sensory experience that does not overwhelm or deter a person from using the space. For example, an individual with low to no vision would not be able to navigate a park that had no signs and limited textured pathways unlike a sighted person would have. A multi- functional space should provide a balanced sensory experience that does not overwhelm or deter a person from using the space."[11]

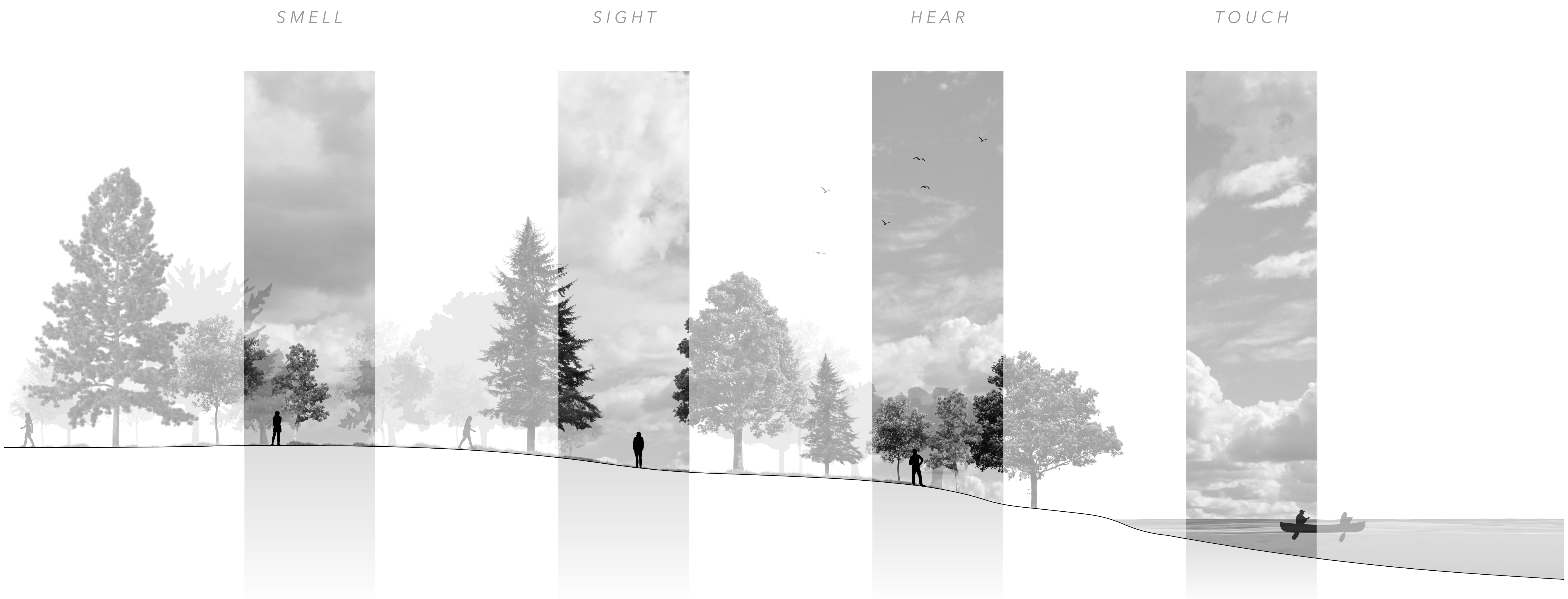

Fig. 29 - Site Senses

During my January site visit, I took a collection of images and video recordings to log my surroundings. These recordings were crucial for me to account for what the experience was like on the site. The winter conditions displayed the severity of the winter climate compared to the warm summers. I tried to record different situations are the site that would display different sound and light levels. There are some up close video clips that show how the ice water rushes ashore over the beach pebbles. In contrast, there are some videos that are from a panoramic perspective that show a large amount of the surrounding landscape. From these videos, one is able to hear and see trees rustling as wind whips through the site.

It was important for me to showcase these videos to my committee and reviewers for them to gain a better understanding of the site. When compiling the videos into a collection, I began to edit and manipulate the sound on some of the clips. By purposely muting some moments or enhancing reverb, one may begin to understand how someone with hearing impairments would experience the site through their eyes rather than their ears. The video became more about seeing sound and these natural occurrences rather than hearing them.

The link to the site visit video is:https://www.youtube.com/watch?v=vWys0aQSRAs

Fig. 30 - Site Photo No.2

Fig. 31 - Site Photo No.3

ENDNOTES

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CHAPTER 4

THE CONCEPT

INTRODUCTION

When I was home over winter break, I conducted some of my own investigations. My Aunt is a profoundly deaf individual. Without the use of her hearing aids, sounds are non existent. She has always been a big fan of music, and it had me curious as to how she would be able to comprehend music and sound when she did not have the use of her hearing aids. Knowing that sound can be registered through different parts of the brain such as the sensory cortex and peripheral vision, I did my own experiments using a guitar as well as a stereo bass.

I had my aunt take her hearing aids out and place her hands on the stereo bass and the body of the guitar. While sitting on the floor, I began to produce sound by strumming guitar chords as well as play songs with a prominent bass on the stereo. When sound was produced, she explained how although she did not hear anything, she could feel vibrational energy emitted from the guitar and the bass through her hands and fingers, as well as through her body as she sat on the floor. Rather than hearing sounds, she had an understanding of tempo and timing through the music that was played through these devices. This had be curious about how materials can help aid the transfer of this energy into bodies so that sound can be felt.

Fig. 32 - Investigation with Aunt

INVESTIGATION

With this understanding that sound can be translated to a visual as well as a vibrotactile experience, I decided to conduct more tests with myself. These images are stills from a video that is a collection of investigations intended for me to explore the tactility reaction of different materialities as well as the visual response I would receive from these movements. Working from home and being social distanced from a workshop, I tried to get creative around my apartment and make use and activate common objects that were available to me.

Some of these explorations involved me using mesh like items such as a blanket and a plastic garbage bag. I would drape these over an open window, then record and examine its movements as wind energy activated the material. This exploration was my way of turning the energy and sound of wind, into something that can be seen and become visual.

Other tests I began to conduct were to study different materialities and their sound qualities. One test titled “the bar” explored how glass and the different geometries would create different pitches when tapped with a piece of metal. Another video titled “the kitchen” explore the same idea but with various pots and pans and other cooking devices. With this one, there was a sense of exploration as it became a fun exercise to see the types of beats and melodies you could create just through the use of touch.

What I found interesting about each of these tests is how the geometries when aligned together form their own version of a sound wave. These investigations and tests became a pivotal moment in my research and will re surface later on in my designs.

Fig. 33 - Investigaton at Home No.1

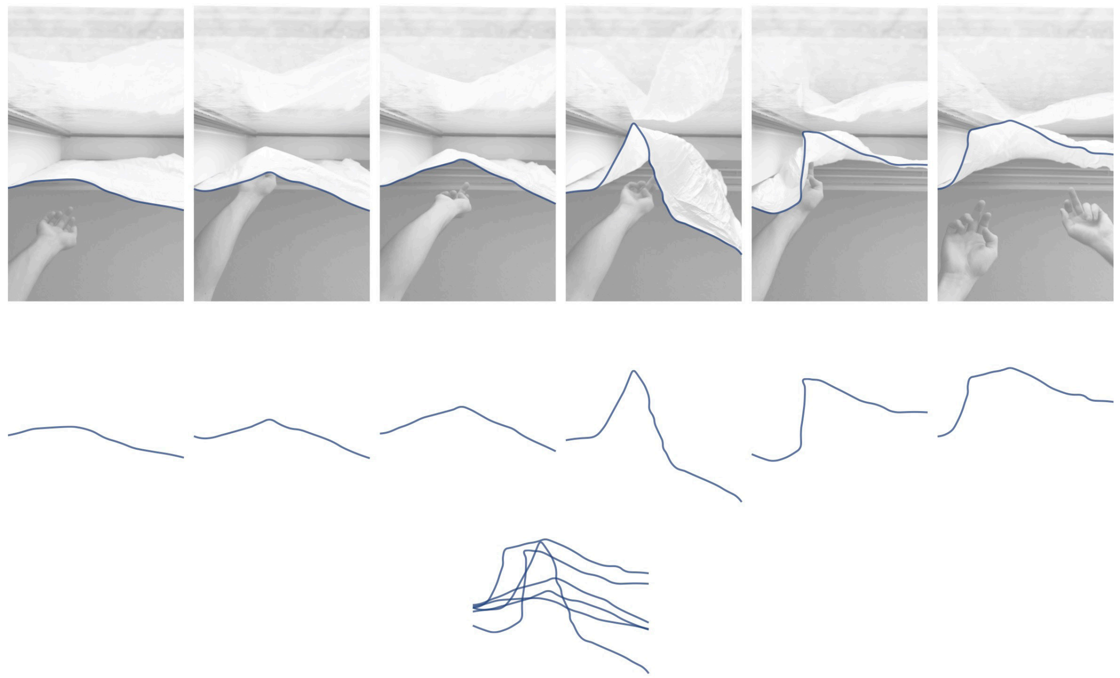


Fig. 34 - Investigation at Home No.2

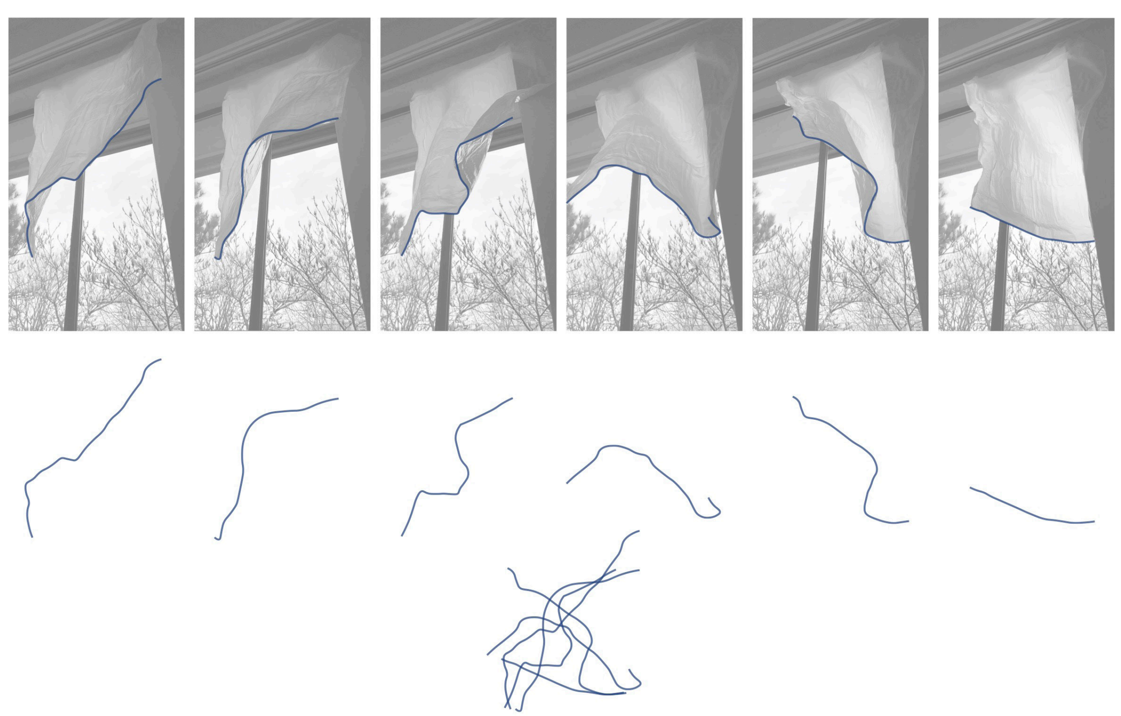


Fig. 35 - Investigation at Home No.3

MATERIAL + SOUND

I knew from these experiments that materiality would play an important role in the design. This diagram is showing a variety of materials comparing their sound absorption levels as well as their thermal conductivity. I chose to compare these two topics because the chosen materials in these spaces will be exposed to a variety of temperature changes, from +30 in the summer to -30 in the winter. From this study I was able to see that a material such as steel was highly thermal conductive, yet had low sound absorption due to its common flat form. Timber on the other hand had a higher sound absorption rate but low thermal conductivity.[1]

It also should be noted that not all materials act the same way. Concrete and steel are usually manufactured in a flat form. When sounds interact with these faces, they will bounce off due to their low sound absorption. In contrast, steel and concrete have the ability to be altered into organic forms. A perforated steel facade or a multi angled concrete surface would end up diffusing and breaking up sound, avoiding reverb and echo.

It was important for me to better understand material form and its sound properties. Next is a series of diagrams showing how geometries contribute to sound dispersion within a space. Spaces with highly reflective and flat walls tend to create more echo and reverberation, where as a space with more angles or curvature contributes to a more controlled dispersed sound.[2]

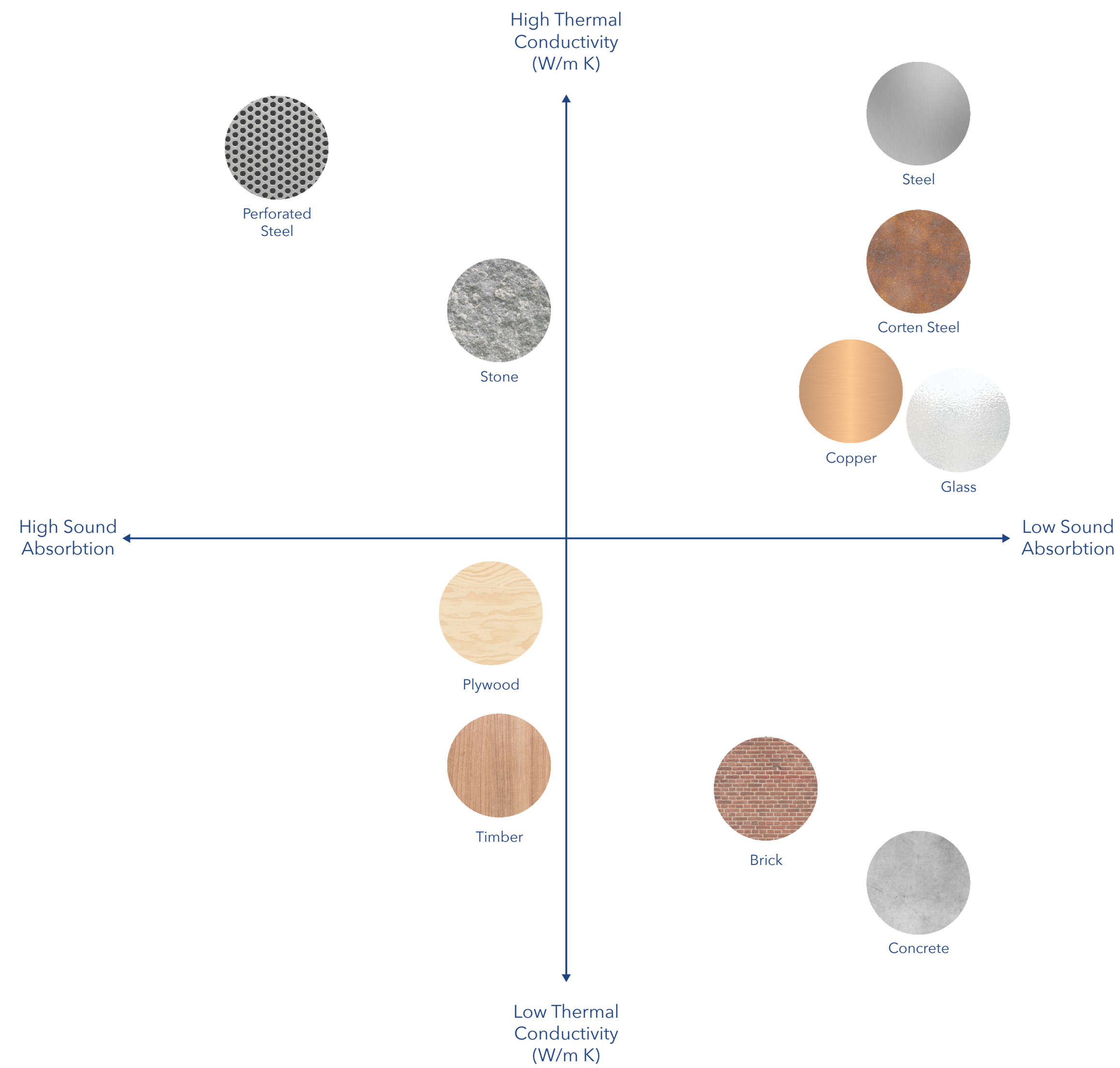
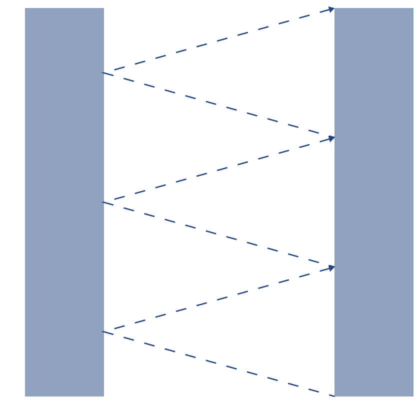
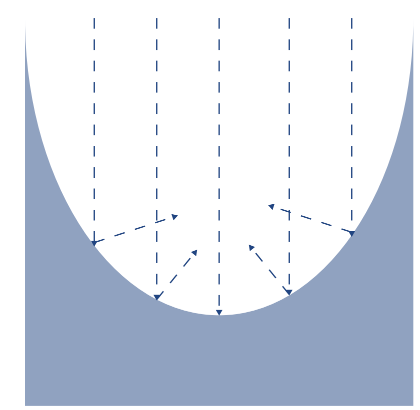


Fig. 36 - Material Properties

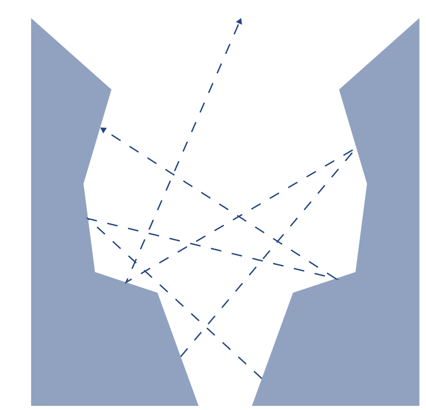


Highly reflective flat parallel walls produce an un-even dispersion as well as a "flutter echo"

Angled side walls spread the sound and contribute to even dispersion



Curved surfaces produce reflections towards a sound concentration



Walls can be broken into angled segments. These anti-focusing surfaces are used for dispersion

Fig. 37 - Sound and Material

For the deaf population, I found that it was best to design spaces that maximize reverberation and resonance. The idea of an inhabitable steel plenum became the starting point for the design. By having a space bound by flat reflective steel walls, users who occupy and interact with this form would end up being able to amplify their own movements and in turn, feel them through the structure that they are inhabiting.

These steel plenums evolved into a kit of parts for me to investigate. It allowed me to study properties of the form such as thickness, length as well as how sound and vibrational activity would be dispersed within them. This kit of parts will emerge again when forms are introduced onto the site.

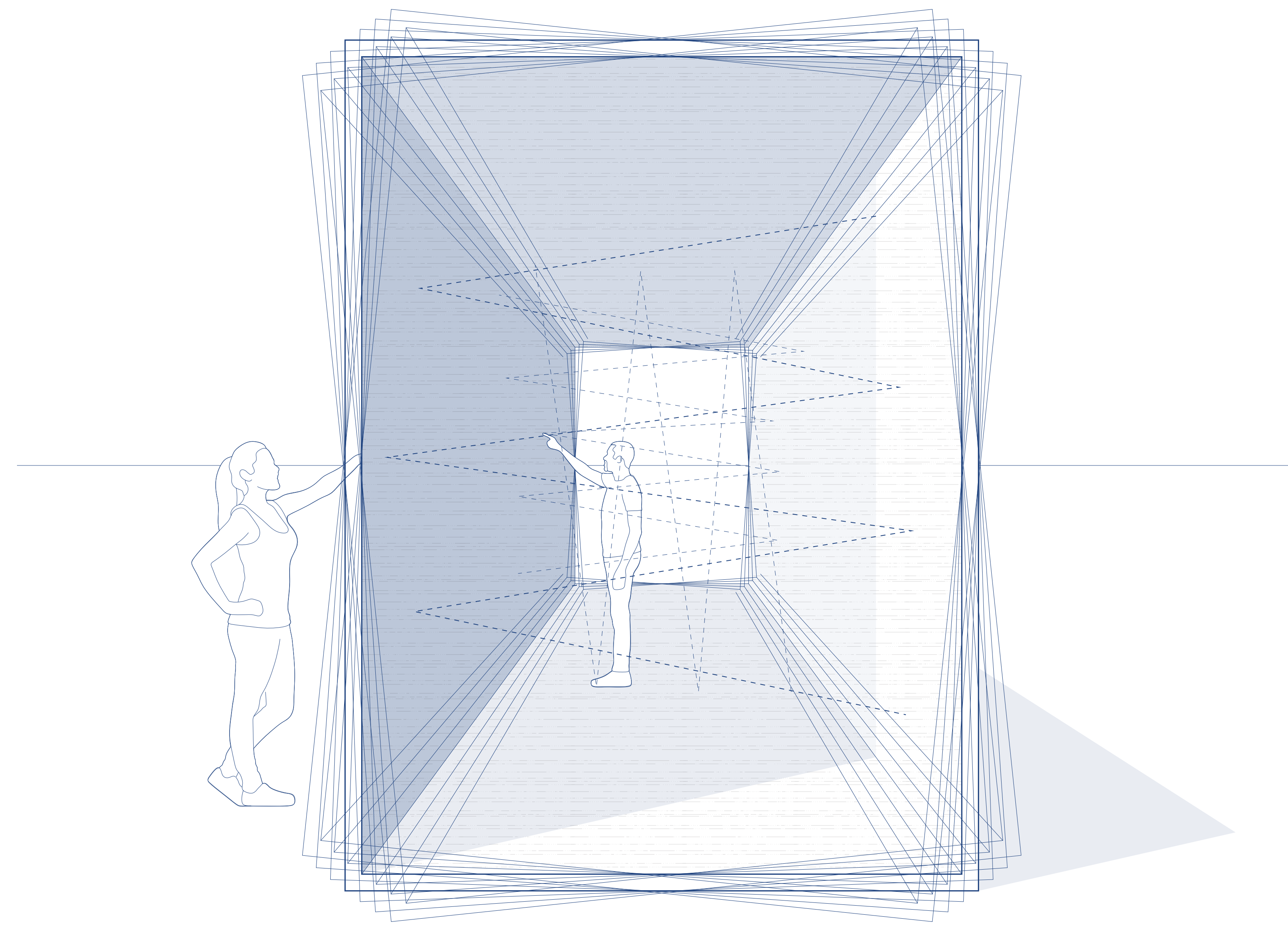


Fig. 38 - Resonance Amplified

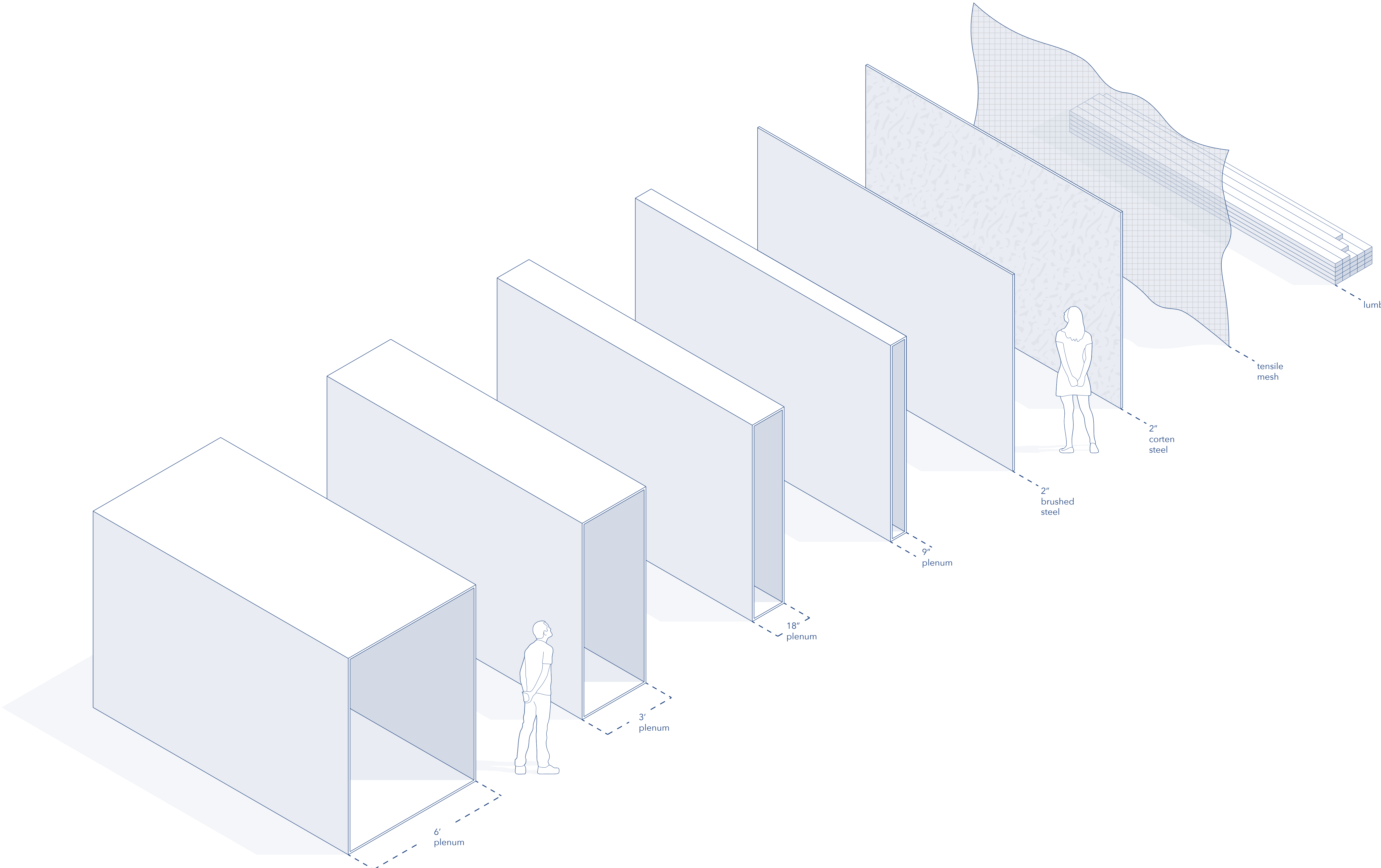


Fig. 39 - Kit of Parts

SITE PLANNING

The designs around the site went through a few iterations over the course of the semester. Initially, I was proposing to have a full network of structures connected by an elevated pathway that would carve itself through the forest.

After more iterations I went back and decided to pick out unique sensory specific locations that could have the potential to house structure. These three highlights would offer different opportunities for people to engage and travel through the site. There is one that straddles the waters edge, one located within an existing forest clearing, and another that engages with topography.

Within these three larger spaces, there was an opportunity to have a smaller supporting cast of structures. The network that links these are now defined by ones own journey and sense of exploration through the forest and the existing trees.

What emerged in the end was a series of seven pavilions specifically placed around the site. There are three larger structures that have the ability and opportunity to house performance and gathering. In between the network of the main three, there is a smaller supporting cast of structures that offer a more subtle interaction for those who occupy them. Each of the seven structures are derived from the singular steel plenum, but then transformed and placed in unique positions are the site. Each structure has the ability to have programable sound spaces, but they are also designed for incidental encounter when there are no performances going on. They can act as places of shelter and beacons within the forest if someone was just out for a walk.

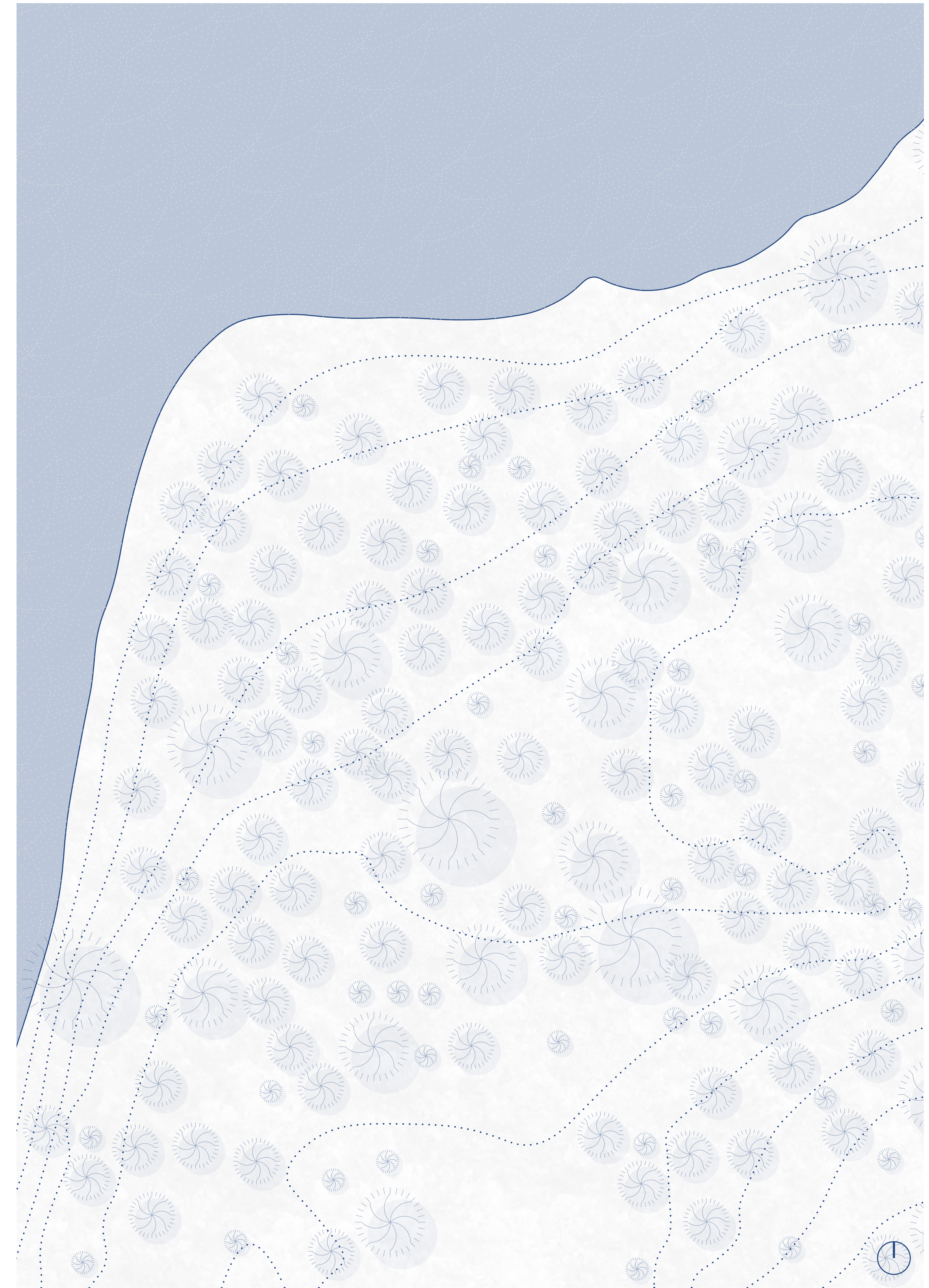


Fig. 40 - Tree Plan

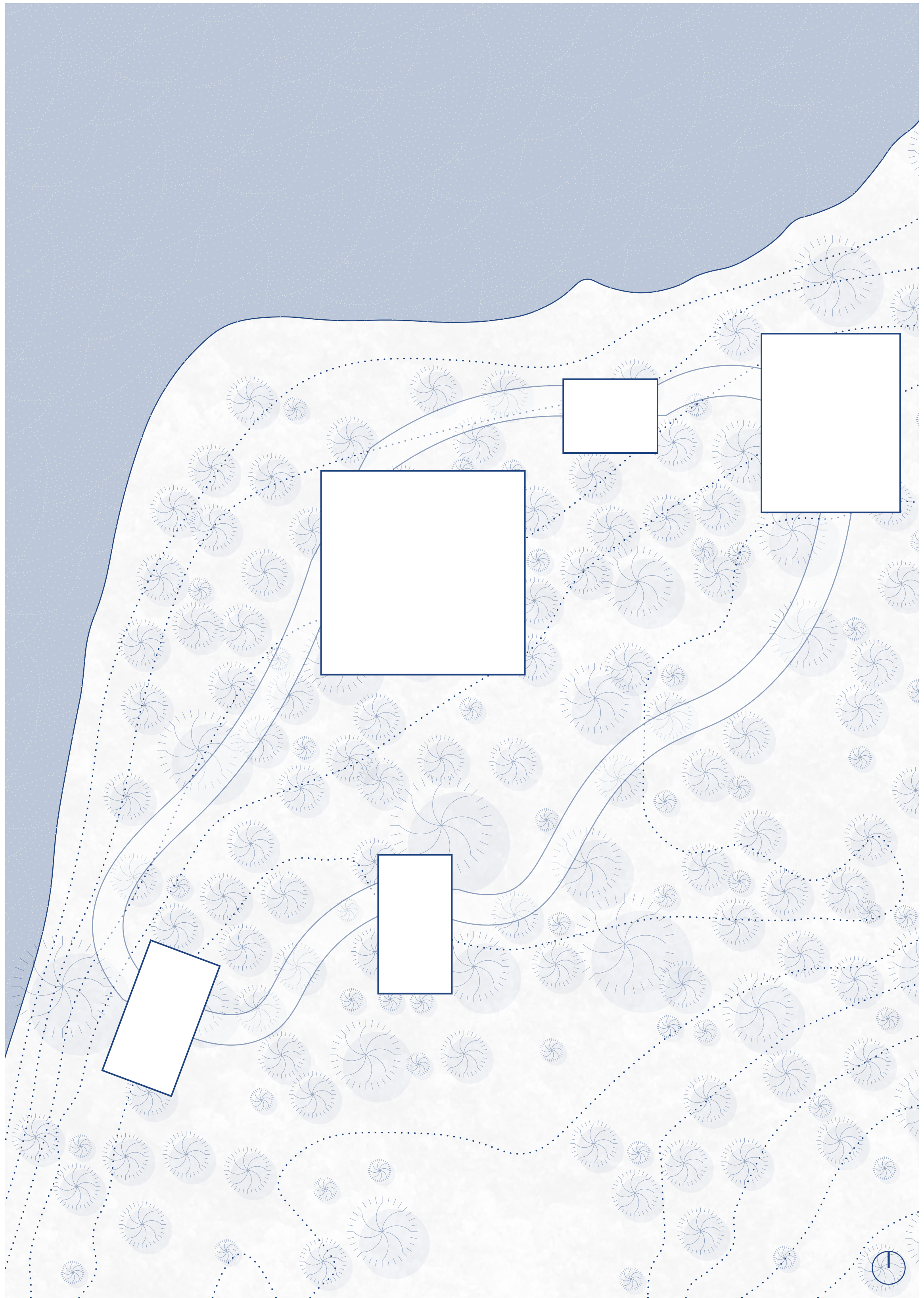


Fig. 41 - Iteration No.1

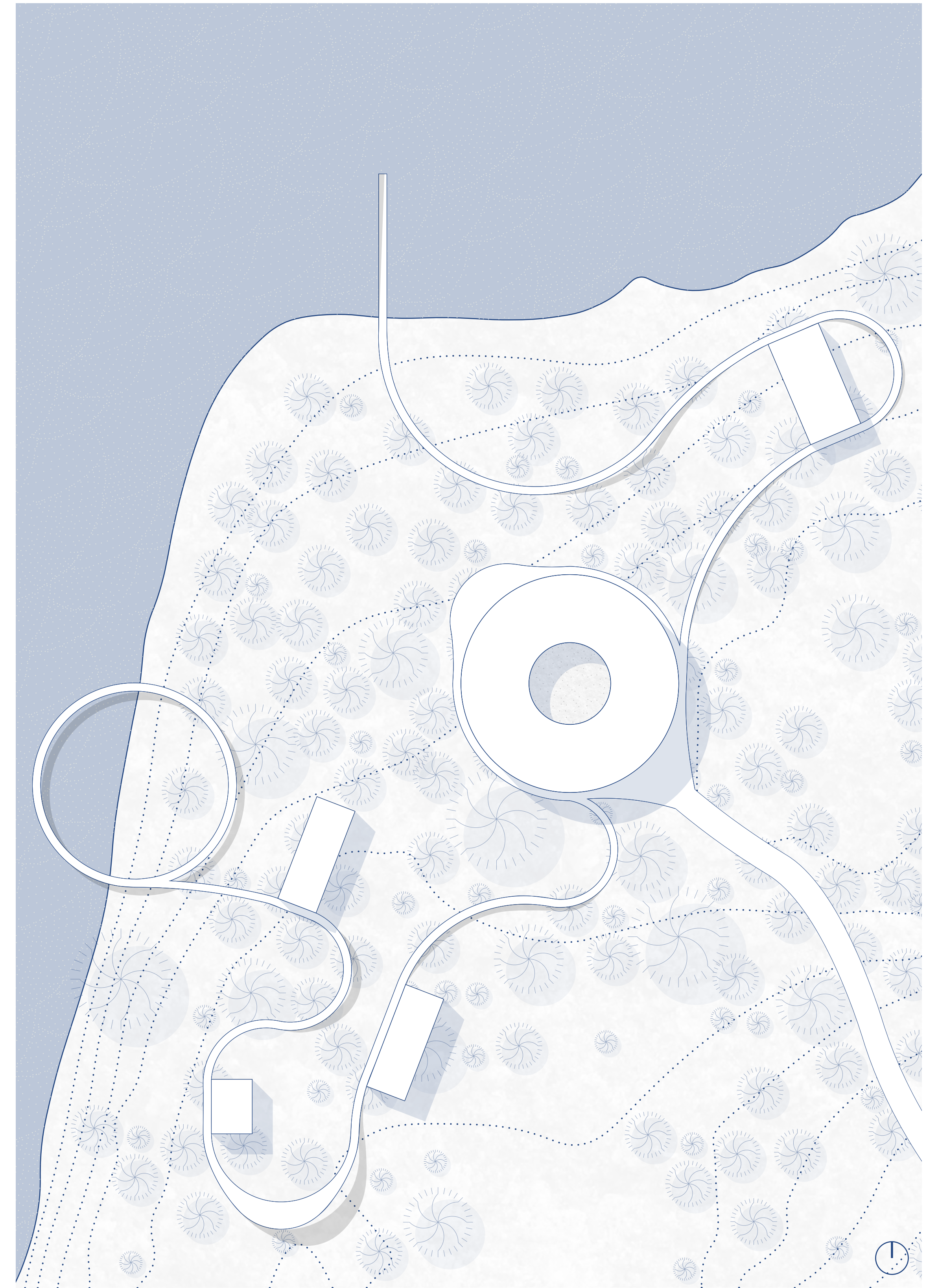


Fig. 42 - Iteration No.2

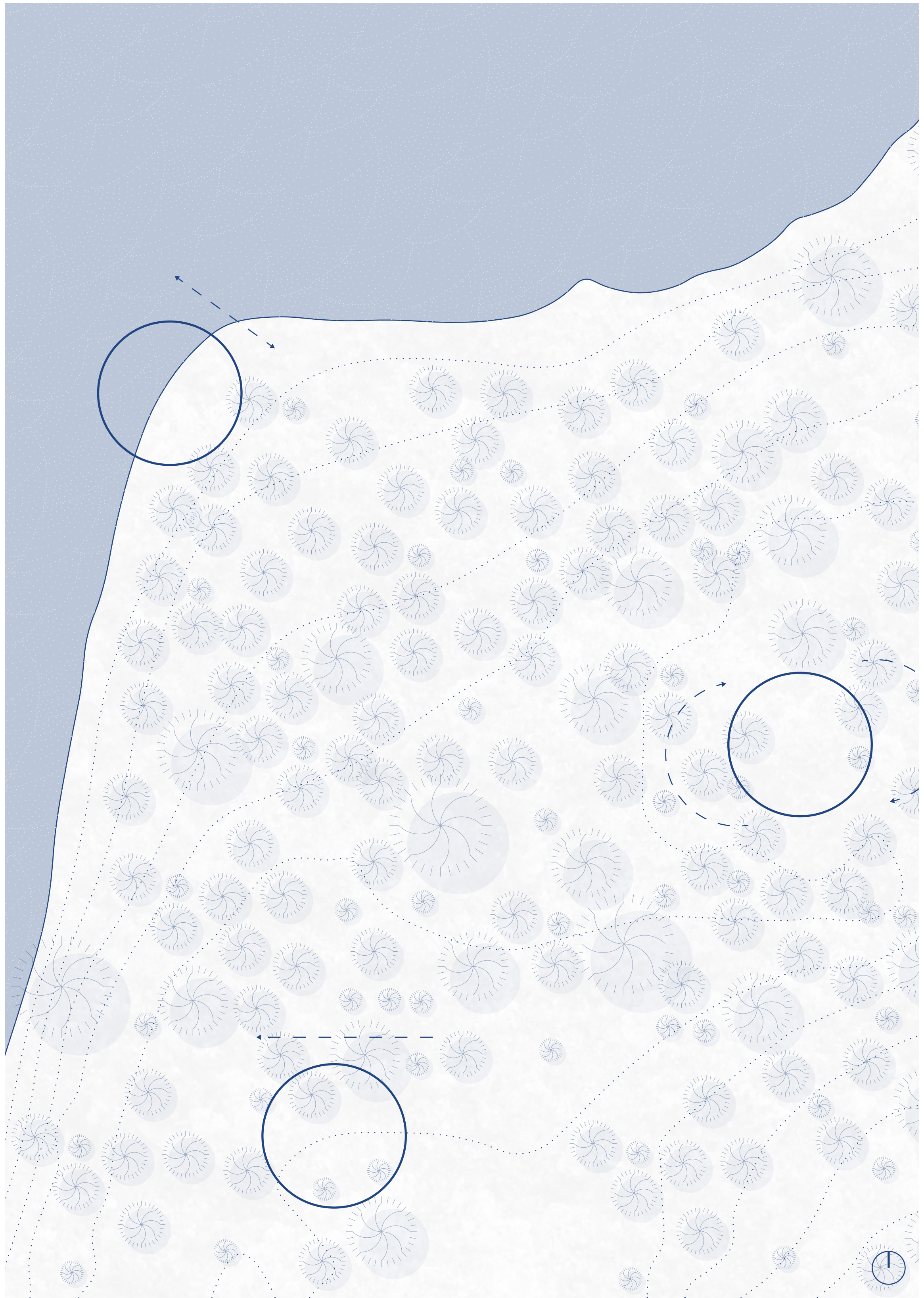


Fig. 43 - Iteration No.3

Fig. 44 - Supporting Cast Network

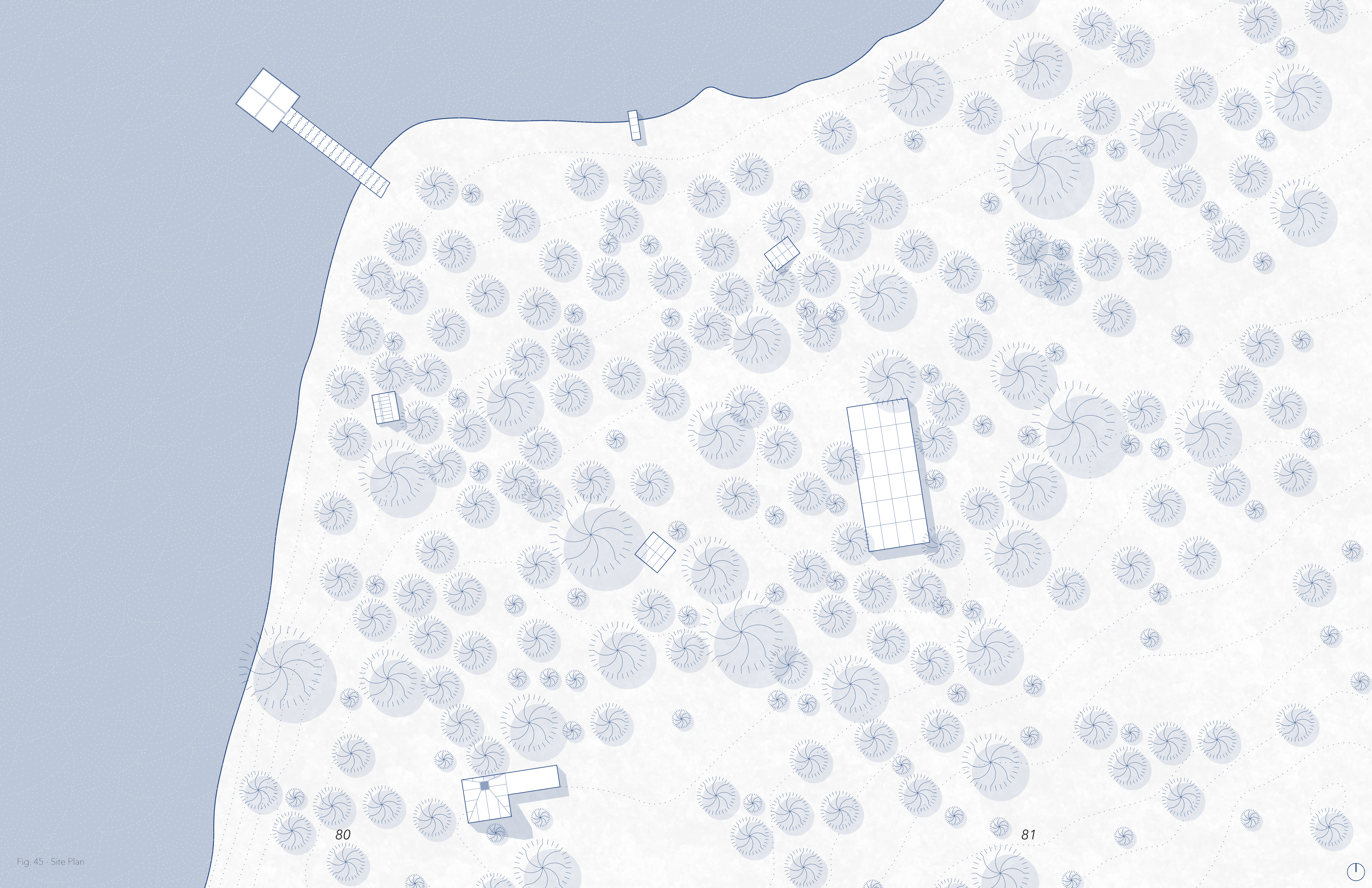


Fig. 45 - Site Plan

LAND PAVILION

The first pavilion is located inland surrounded by existing forest. The idea of this pavilion derives from the initial brain studies of how users can begin to understand sound through more ways than just their ears. This pavilion does this by placing a focus on touch and the vibrational interaction between steel structure and human bodies.

Coming back to the kit of parts mentioned earlier, this pavilion explores ways in which we can take the simple steel plenum, and expand and transform it into inhabitable space. This pavilion is comprised of varying widths of steel channels that allow for unique interactions of movement as well as sound dispersion and resonance.

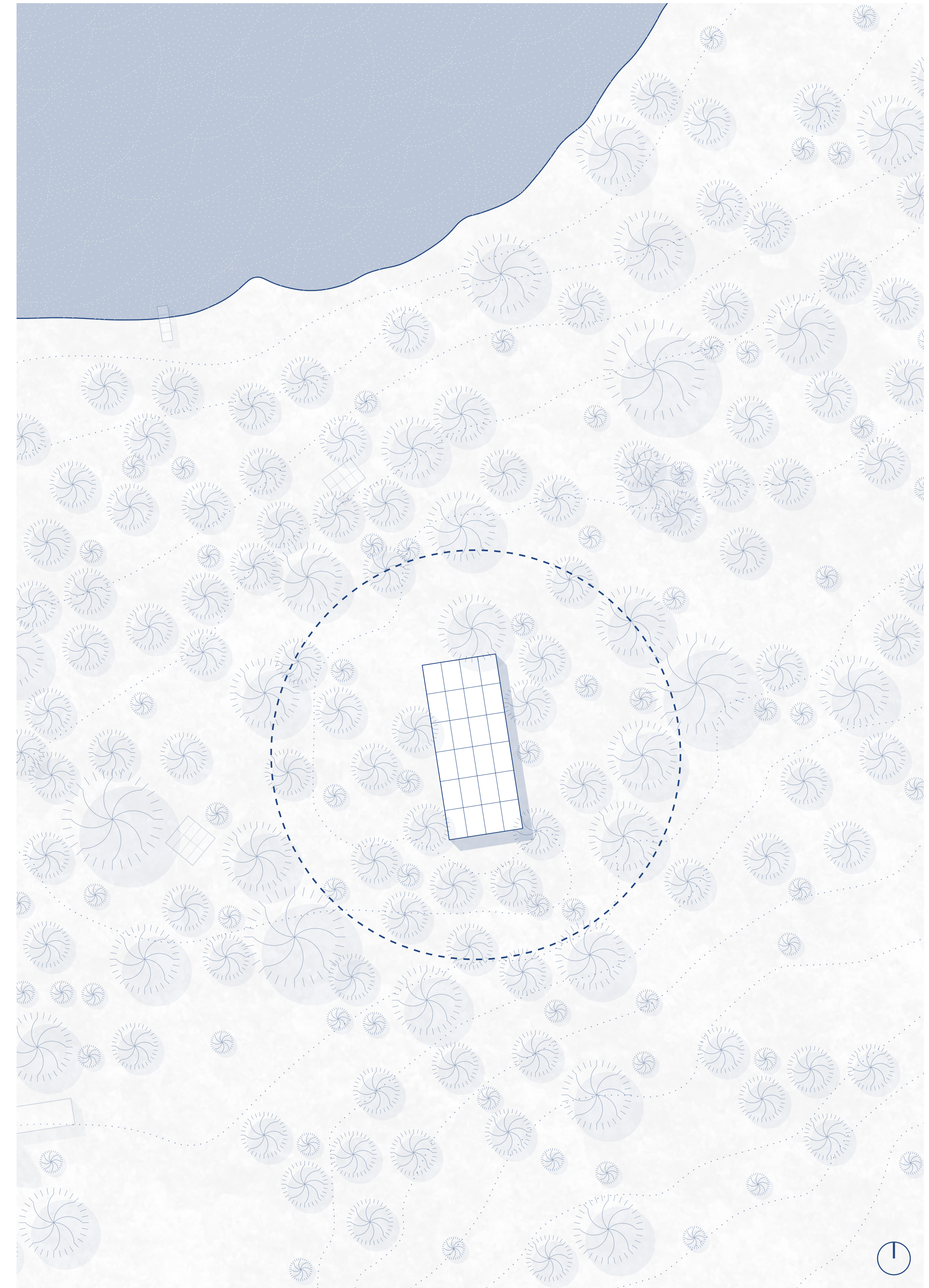


Fig. 46 - Site Plan (Land)

Fig. 47 - Land Pavilion Exterior

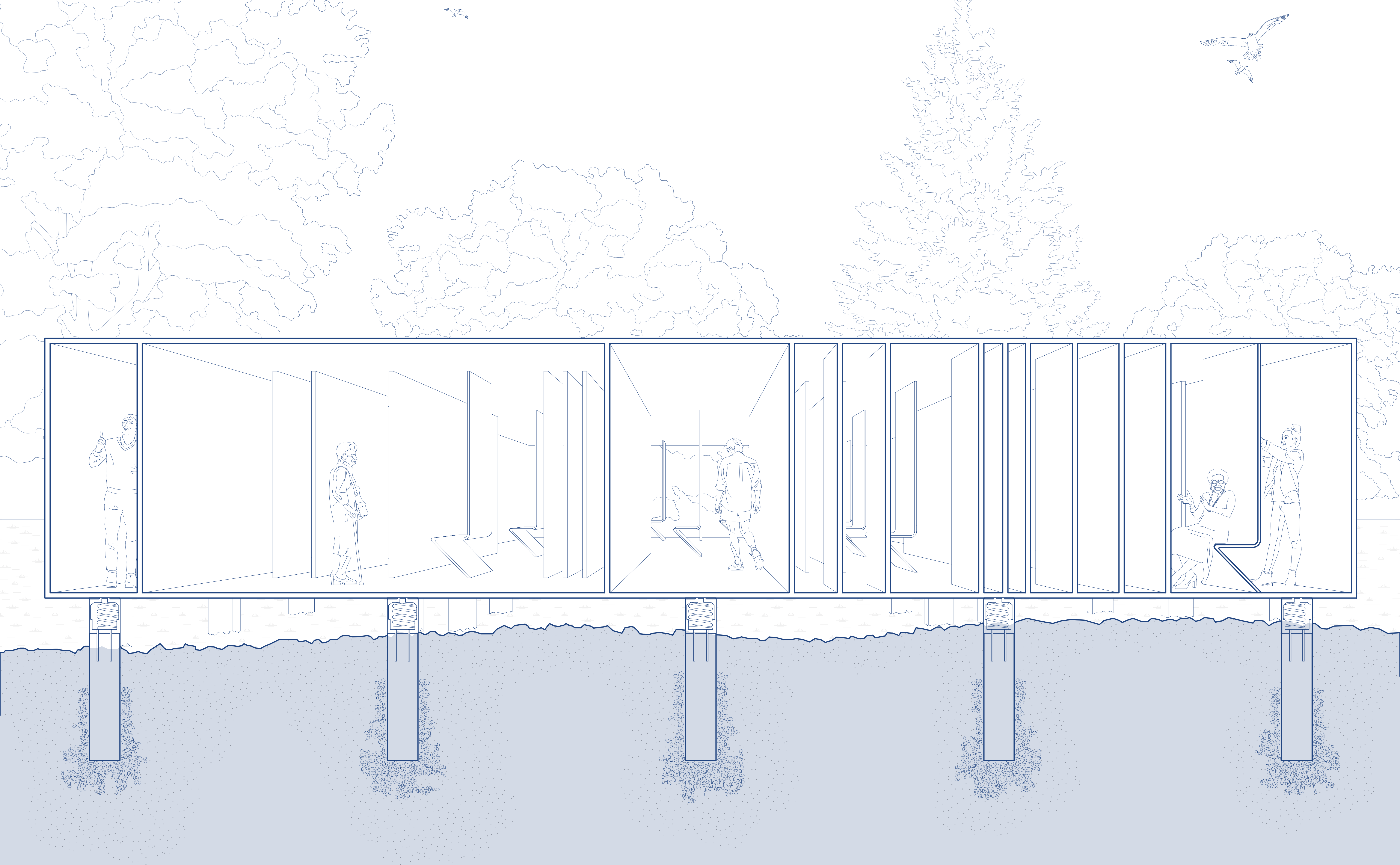


Fig. 48 - Land Pavilion Section Perspective

Within the structure, there are moments of compression and release as the steel paths open up into various sized performance spaces. Within these plenums, there are also opportunities to sit and rest on rotating steel panels.

These panels have the ability to open and close to allow different types of performance to take place, as well as offer a unique interaction between user and structure. These various sized interior spaces allow for different types of performance from a larger concert to smaller more intimate settings.

The rotating panels as well as the steel walls can facilitate performance, but they can actually become part of the performance as well. There could be percussionists playing the steel structure, where they are hitting the panels and allowing the vibrations resonate through the structure. The open interior spaces allow for people to sit or lay on the floor to begin to have a new perspective on what sound is and how it can be touched.

This section shows the structural foundation system implemented into this pavilion. They are called jack up spring floating floor systems and it is the same foundational system that is used for gyms, bowling alleys and other spring type surfaces.[3] It is a structural system that intentionally amplifies movement and vibrations. I am imagining that the steel frames are supported by this type of foundational system to allow for users to feel their own movements though vibration within the structure as well as the movement and vibrations of others such as performers.

Fig. 49 - Land Pavilion Floor Plans No.1

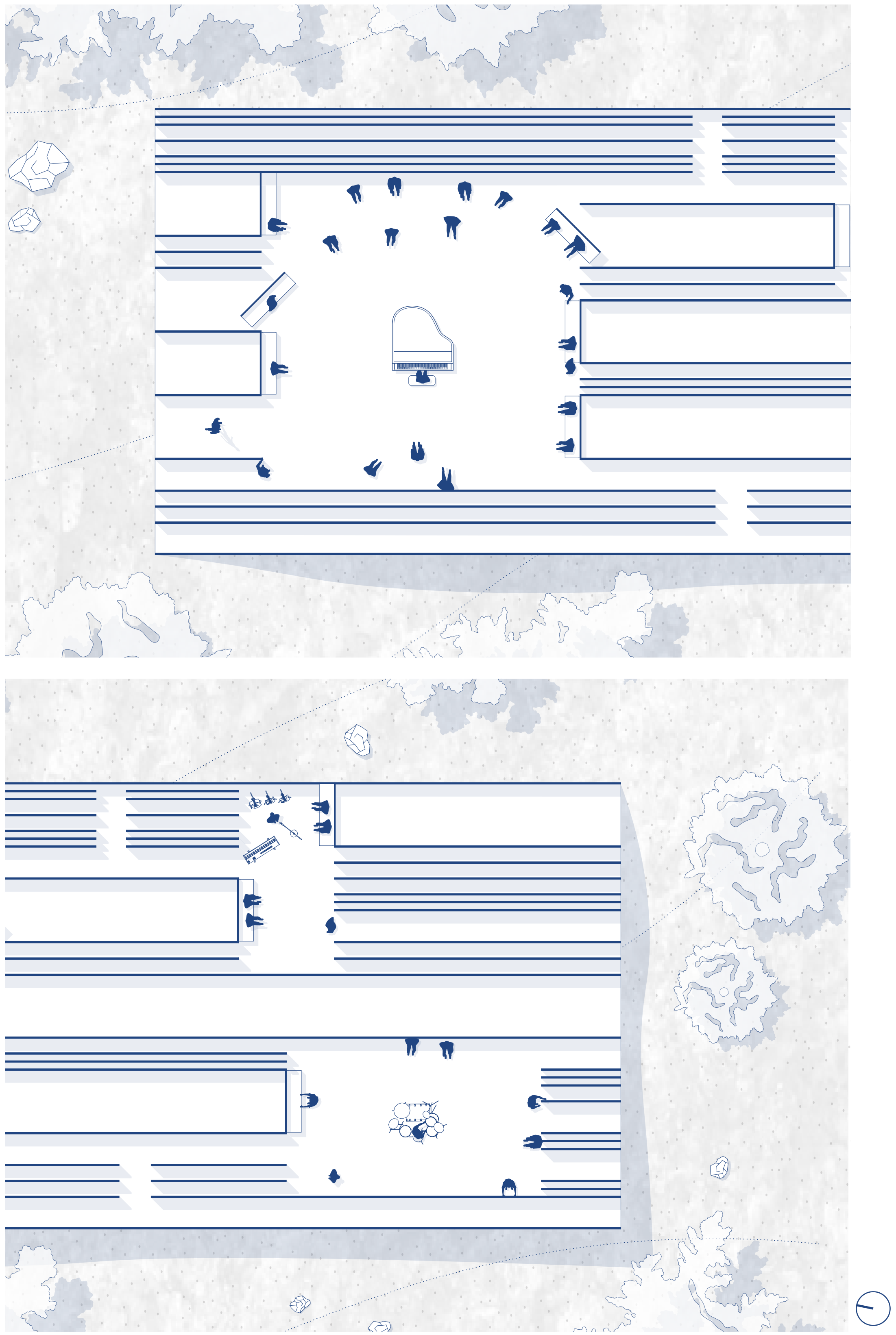


Fig. 50 - Land Pavilion Floor Plans No.2

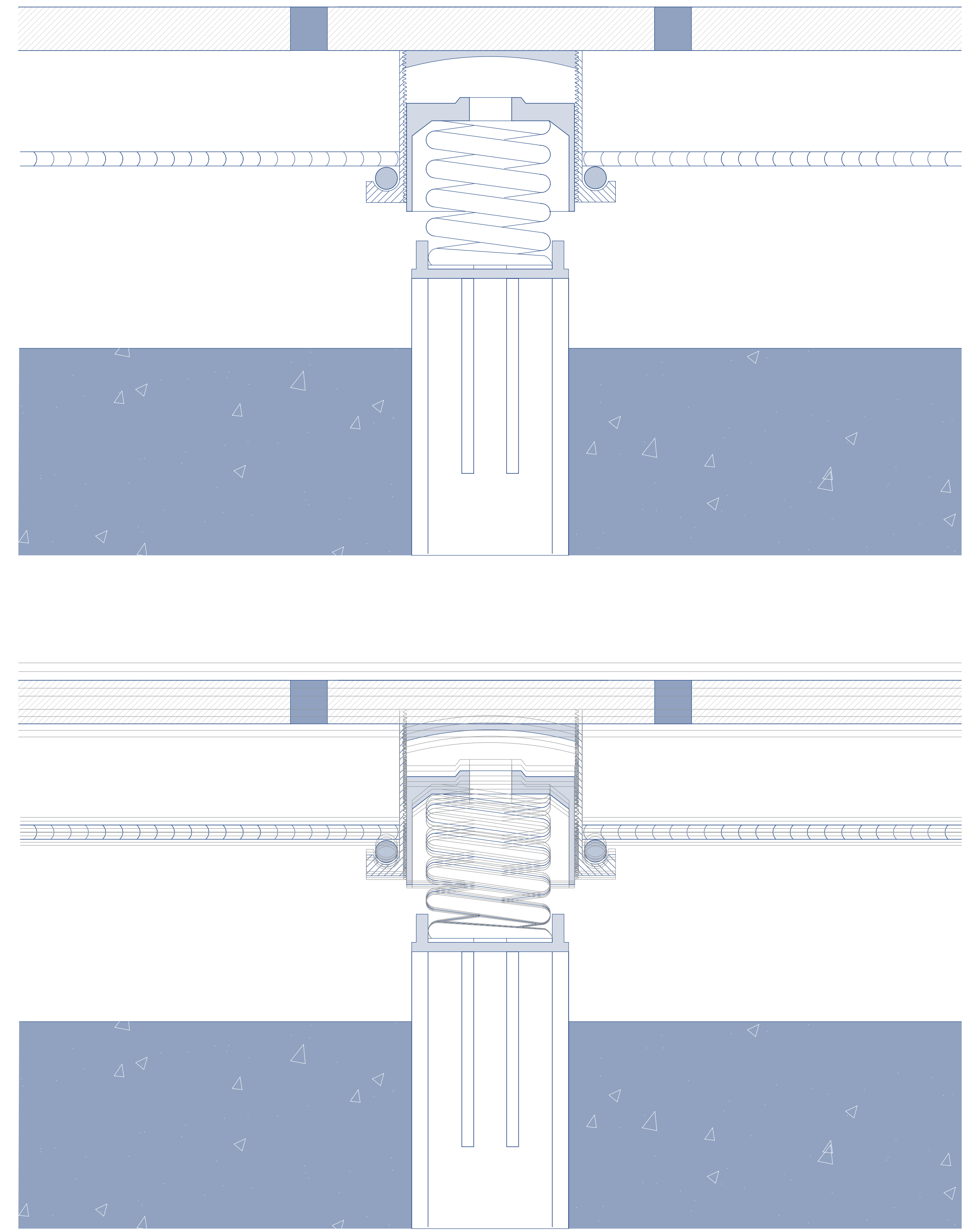


Fig. 51 - Foundation Detail

Fig. 52 - Land Pavilion Interior

WATER PAVILION

The second of the 3 main pavilions is located on the coast connecting people from land to water. The inspiration for this structure related back the brain studies of how sound can be translated into something visual. This pavilion also took inspiration from the test in my apartment when I studied how existing conditions such as wind could be translated into something visual through a material like mesh.

In this pavilion, we see the steel plenums acts as a floating walkway that brings people over the water into a mesh covered steel enclosure. This floating walkway system works by having the steel plenums connected by hinges that will move and rotate depending on water levels and wave energy. This energy is able to be converted into vibrations and transferred into the bodies that walk, sit or lay over them.

The opening at the end of the dock is a larger space where there could be opportunity for gathering or performance. This opening space encourages people to sit and get close with the structure to feel the wave energy being transmitted.

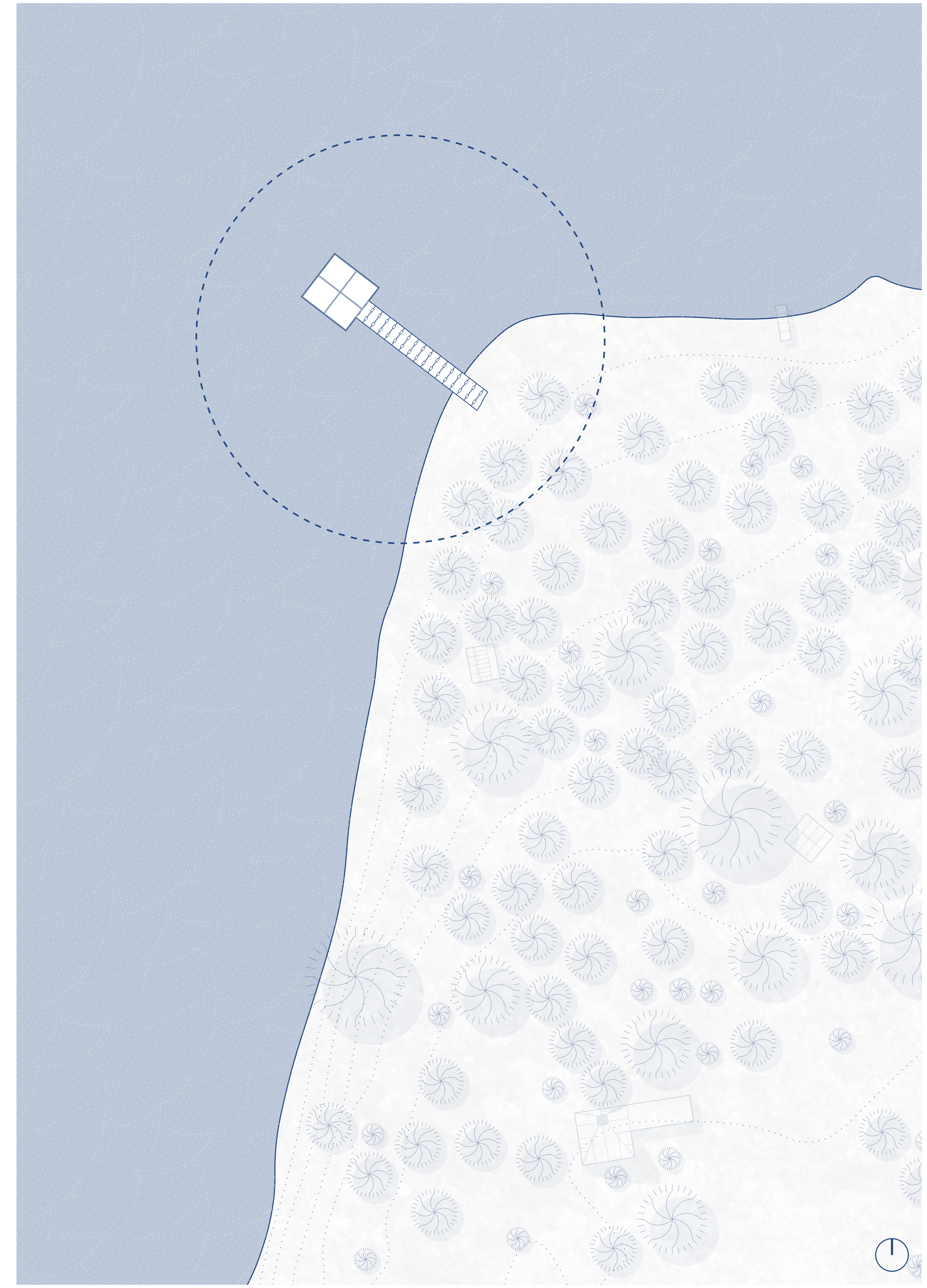


Fig. 53 - Site Plan (Water)

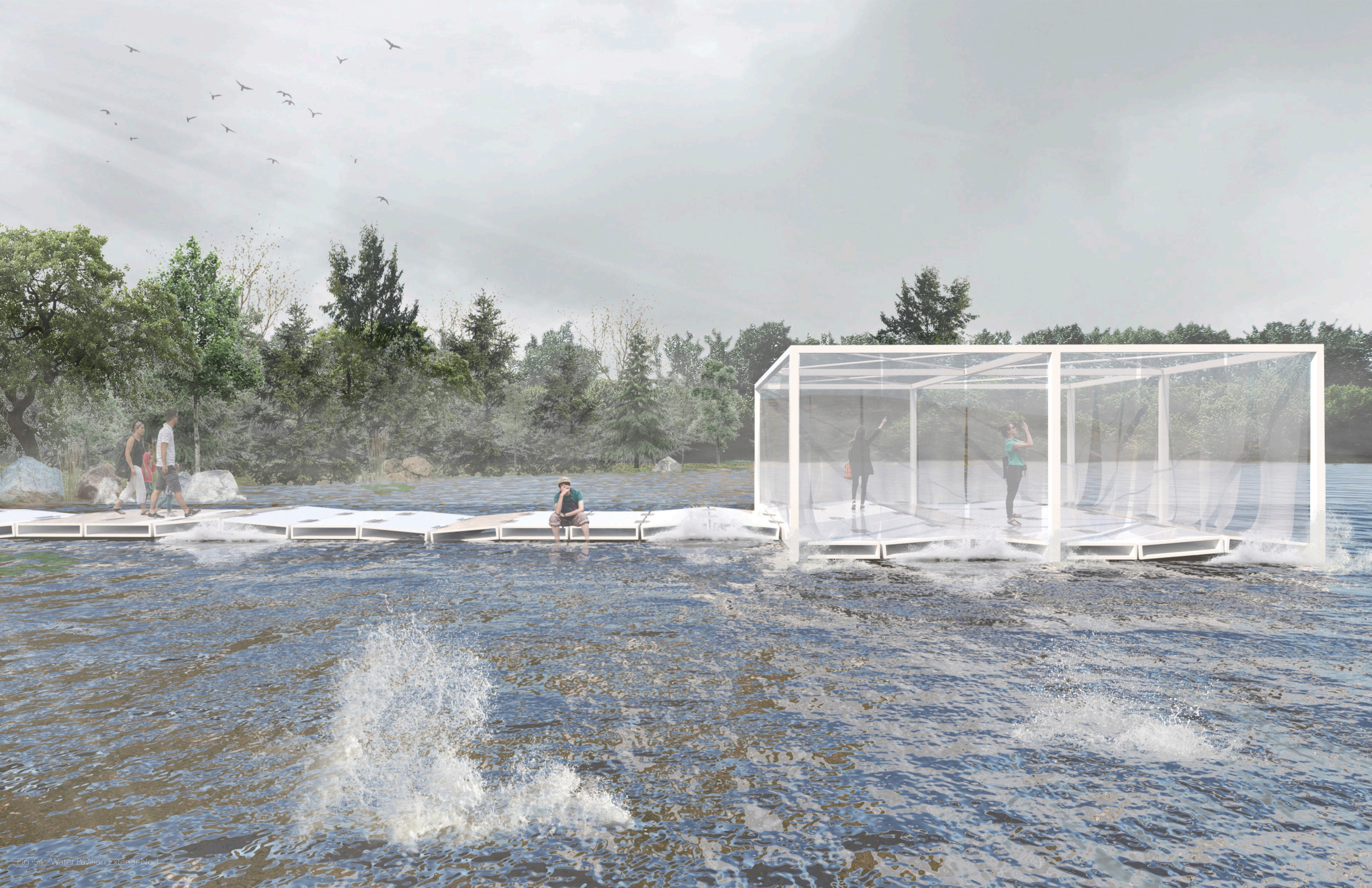


Fig. 54 - Water Pavilion Exterior No.1

As perviously mentioned, the end of this dock is surrounded by mesh that semi encloses the space. There are two key components of this dock. There is a structural frame that is fixed, while the steel plenum dock is free to move and float within the frame. The mesh is fixed to the top of the structural frame and then stretched to the top of the dock.

The idea for this is to visually see the sound of wave and wind energy. As the floating dock moves, it begins to stretch and compress the mesh, converting the sound of wave energy and the movement of wind into something that can become visual. This mesh would also act as a transforming threshold between interior and exterior conditions.

By being over the waters edge, and not protected from the forest trees, this pavilion is exposed to changing weather conditions in the winter. I feel as thought this space can still be activated and engaged with during the frozen winter months as the locals walk across the frozen lake. This space could act as an entry way and beacon to the site for visitors coming from the Simcoe side.

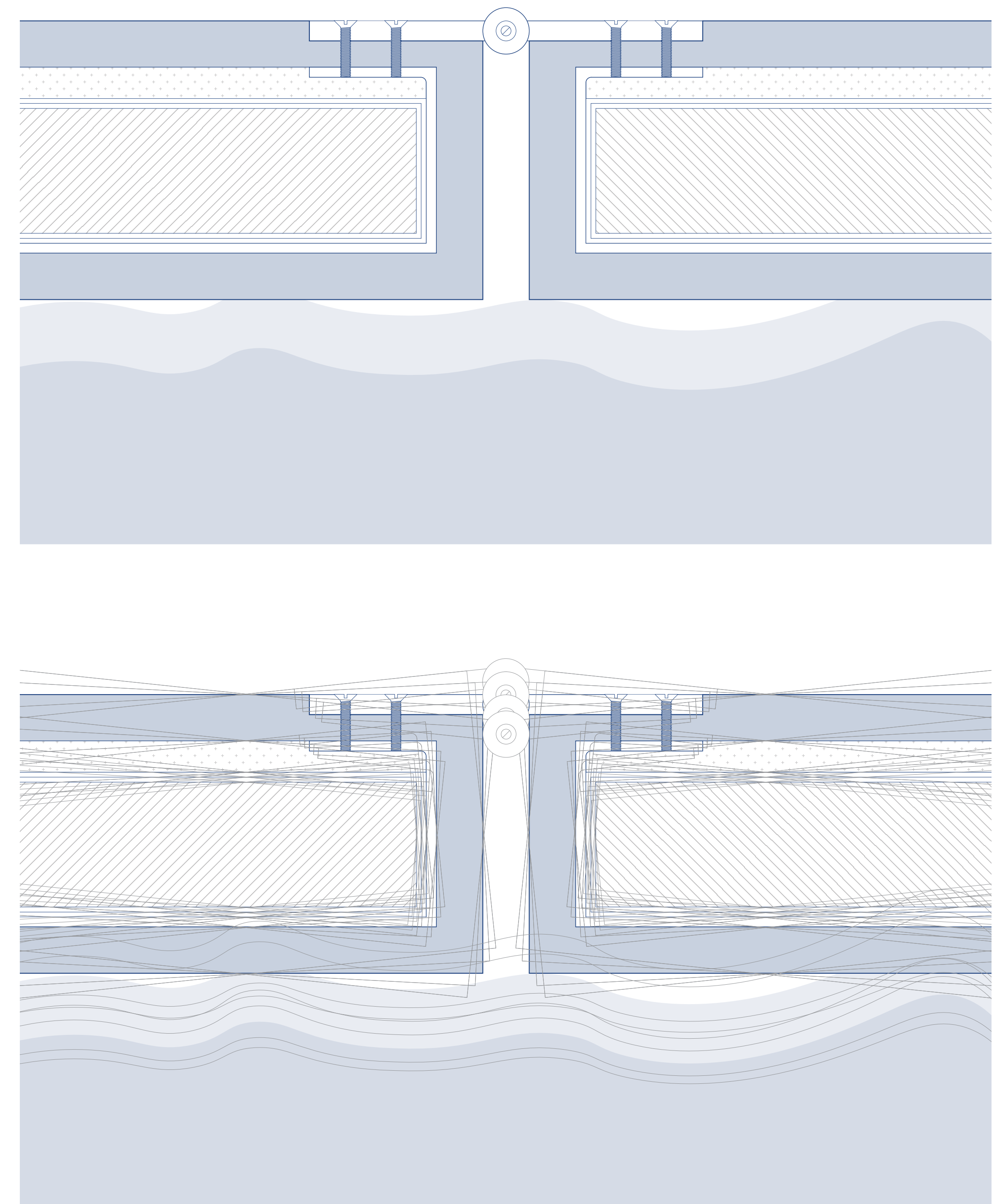


Fig. 55 - Dock Detail No.1

Fig. 56 - Water Pavilion Interior

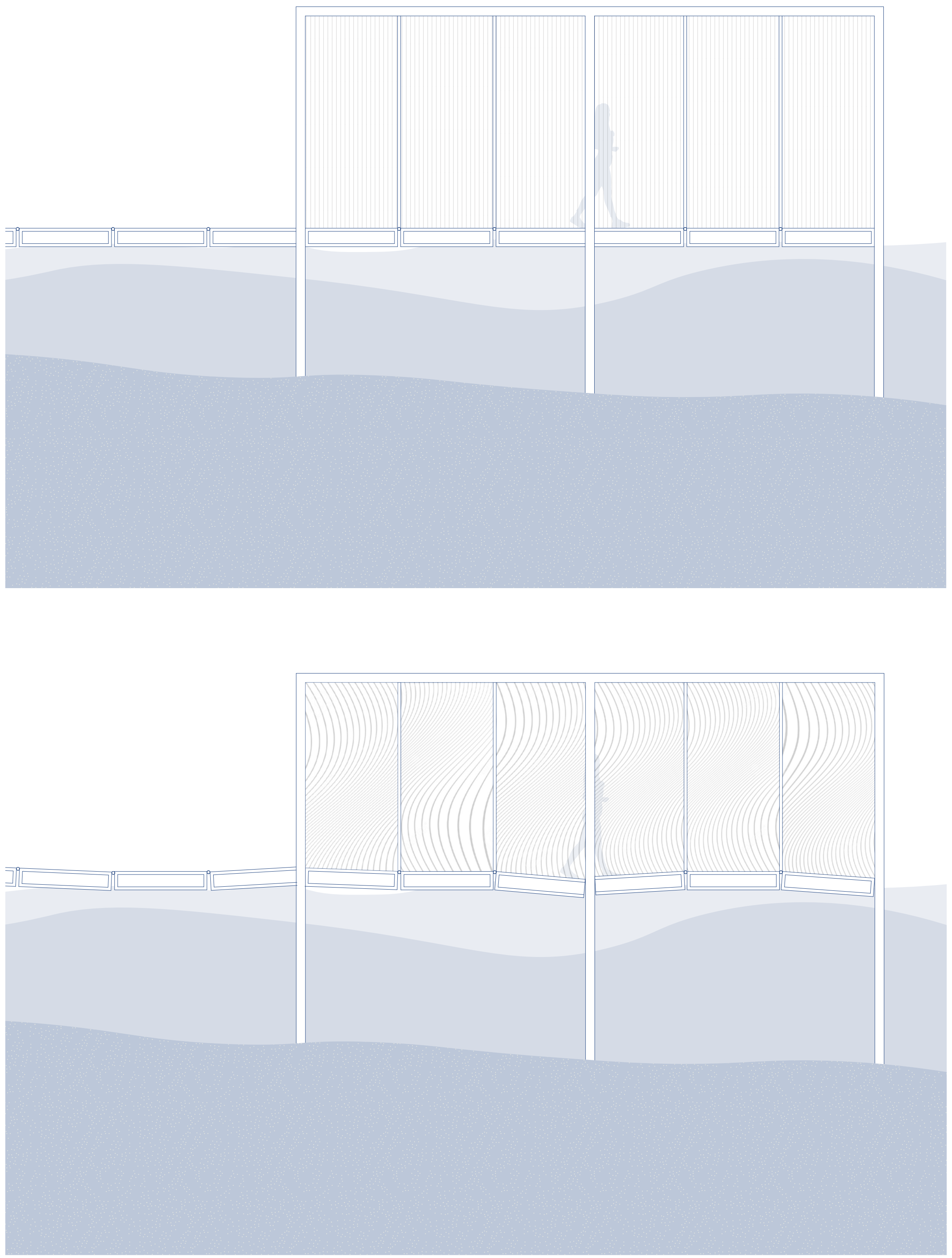


Fig. 57 - Dock Detail No.2

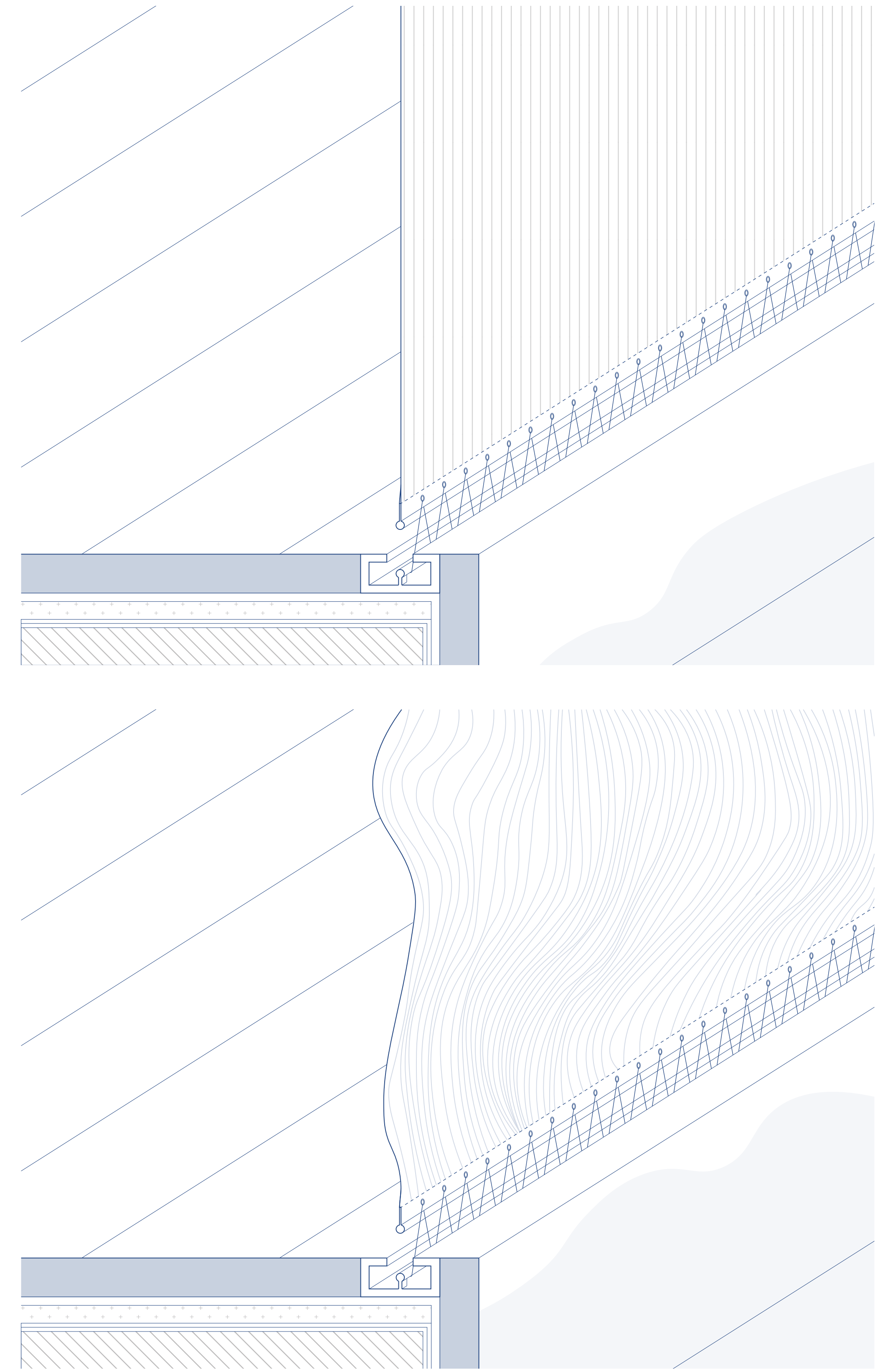


Fig. 58 - Dock Detail No.3

Fig. 59 - Water Pavilion Exterior No.2

SILENCE PAVILION

This third larger pavilion represents more of a contrast to the previous two. This space places a focus on silence and enclosure. Studies have shown that silence itself is actually still a sound. Not only does the materiality of this pavilion differ from the others, it also houses interior program and enclosure that is sealed off from exterior conditions. By being removed from any urban setting, this project required space for storage and service, as well as communal washrooms for the people of the park.

From the kit of parts, I added timber and other insulation materials that would absorb sound energy rather than disperse it, in contrast to the previous two structures. Inside this pavilion, there is a central focal point of a fire that releases its heat energy up a chimney.

This space was more about creating a sense of empathy for those who do not have hearing impairments. This anechoic like chamber would contrast all other pavilion on site and bring forward a focus on ones own sound, hearing and senses. The fire becomes a central focus in the space for people to sit, and have a moment of silence and reflection.

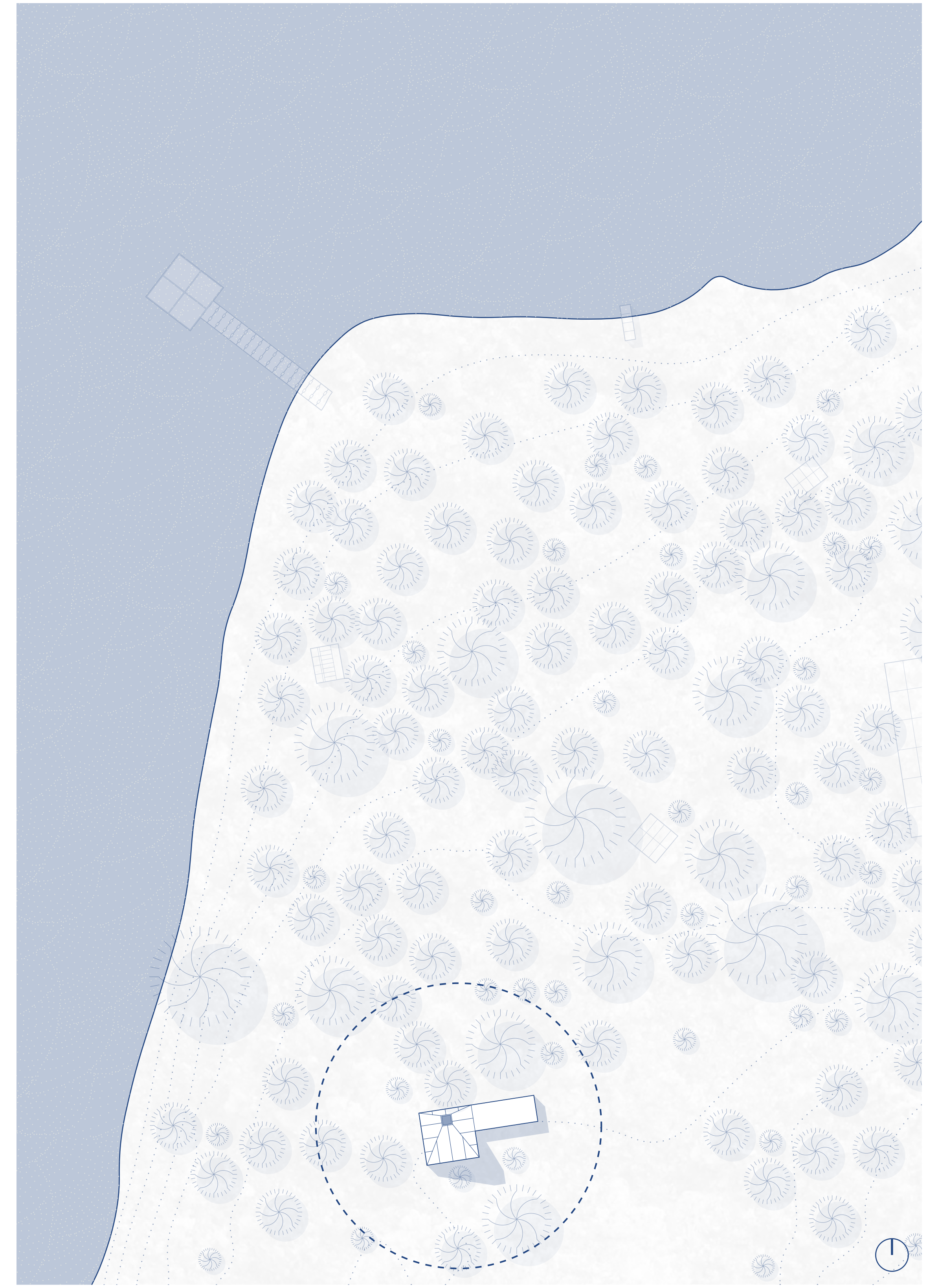


Fig. 60 - Site Plan (Silence)


Fig. 61 - Silence Pavilion Exterior

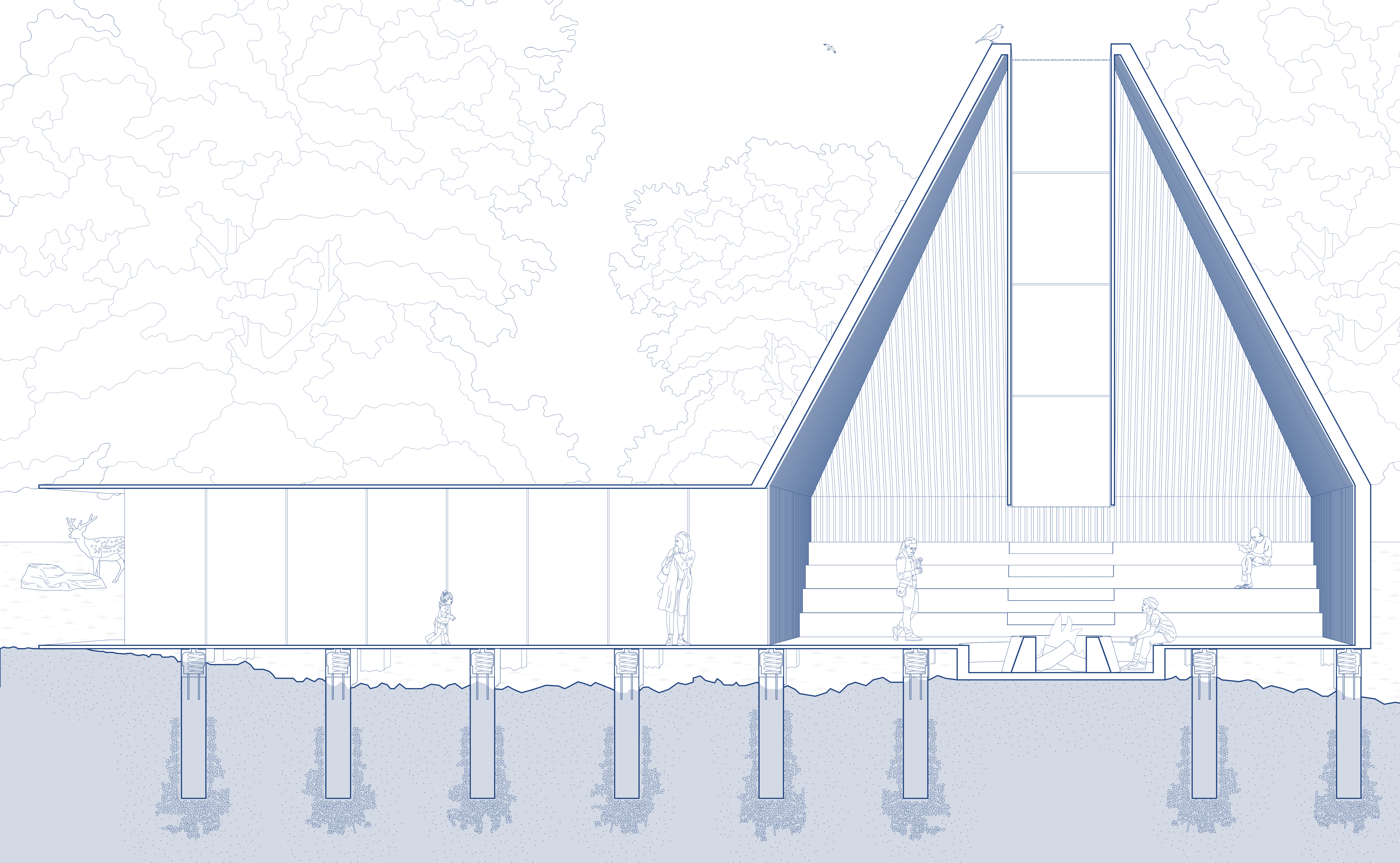


Fig. 62 - Silence Pavilion Section Perspective

Fig. 63 - Silence Pavilion Interior

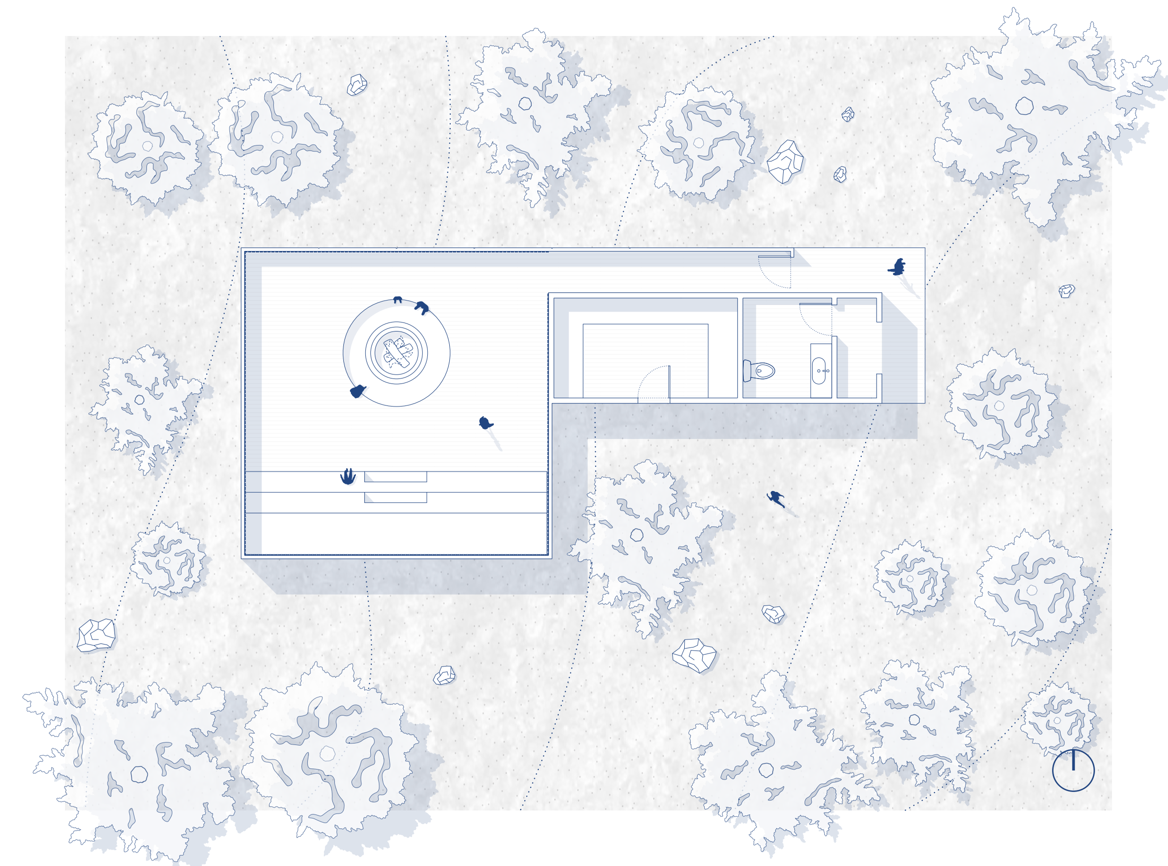


Fig. 64 - Silence Pavilion Floor Plan

IN - BETWEEN SPACES

As previously mentioned, along with the three main pavilion structures, there is a smaller set of supporting cast pavilions that scatter through the site. These spaces take inspiration from the kits of parts and the use of the steel structure and plenums.

I explored these spaces through the medium of a video animation. The walkthrough animation is from the perspective of one moving through the forest interacting with these smaller pavilions. The sounds you hear are abstractions of subtle tactile interactions between person and environment. For someone with hearing loss, these sounds could be attributed to a tactile experience through vibration and resonance. The link for that video is: https://www.youtube.com/watch?v=AUQPzfuK7ng

Fig. 65 - Site Plan (In - Between)

STAGE

This first in-between space shows a steel plenum extruded from the earth allowing for the possibility of pop up performance, as well as gathering. The public is encouraged to sit and interact with the steel form as it amplifies and disperses vibration. The plenums are also large enough that some people may want to inhabit them and lay down inside these spaces. It would end up creating an unconventional sound experience for those feeling the vibrational activity that is above them.

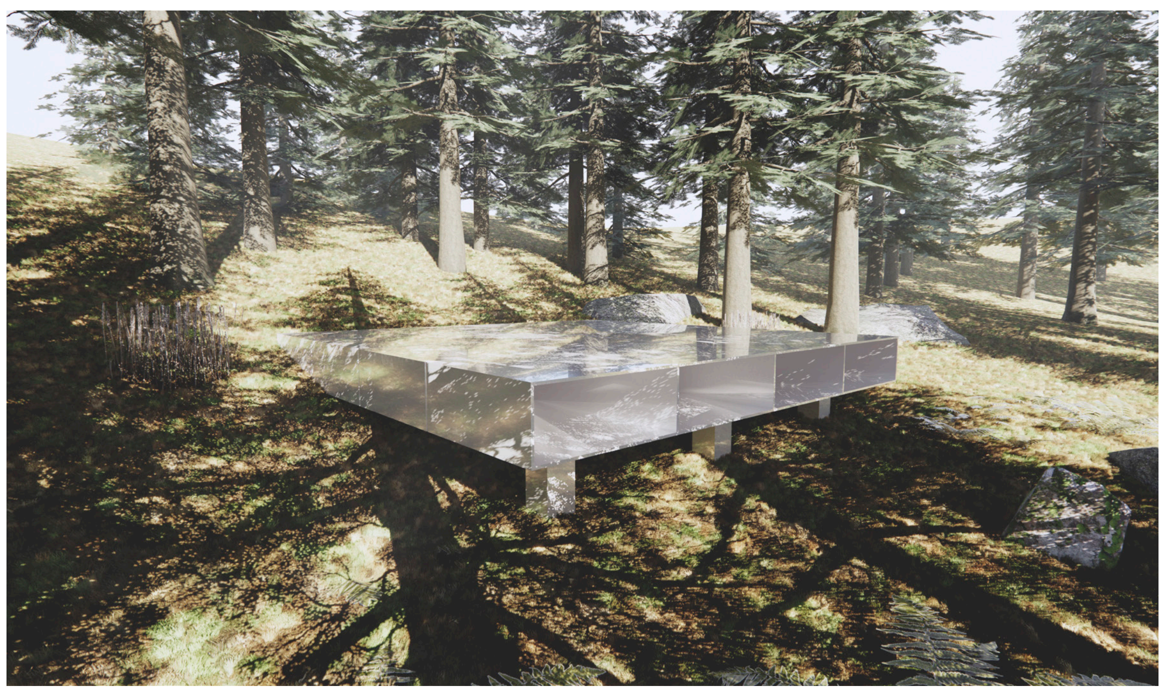


Fig. 66 - Stage Render

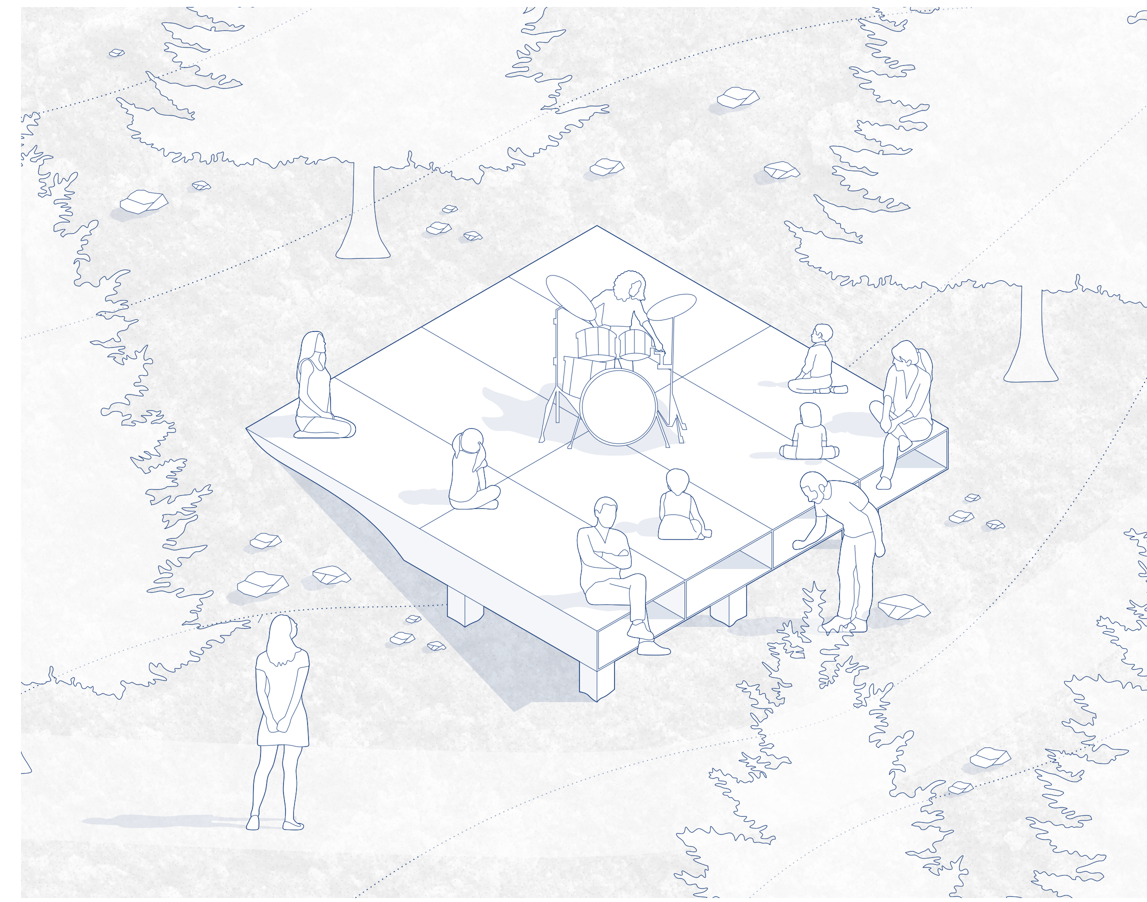


Fig. 67 - Stage Axo

REST

This seating space is more about a moment of rest and observation. Its steel form would have the ability to amplify noises and external movement such as the sound of falling pinecones and rain but also melting snow, and ice during the winter months. These exposed steel structures will end up standing out and contrast the colour palete of the surrounding forest. It will become a visual network for those who are out for a walk in the park and want to experience each of these spaces.

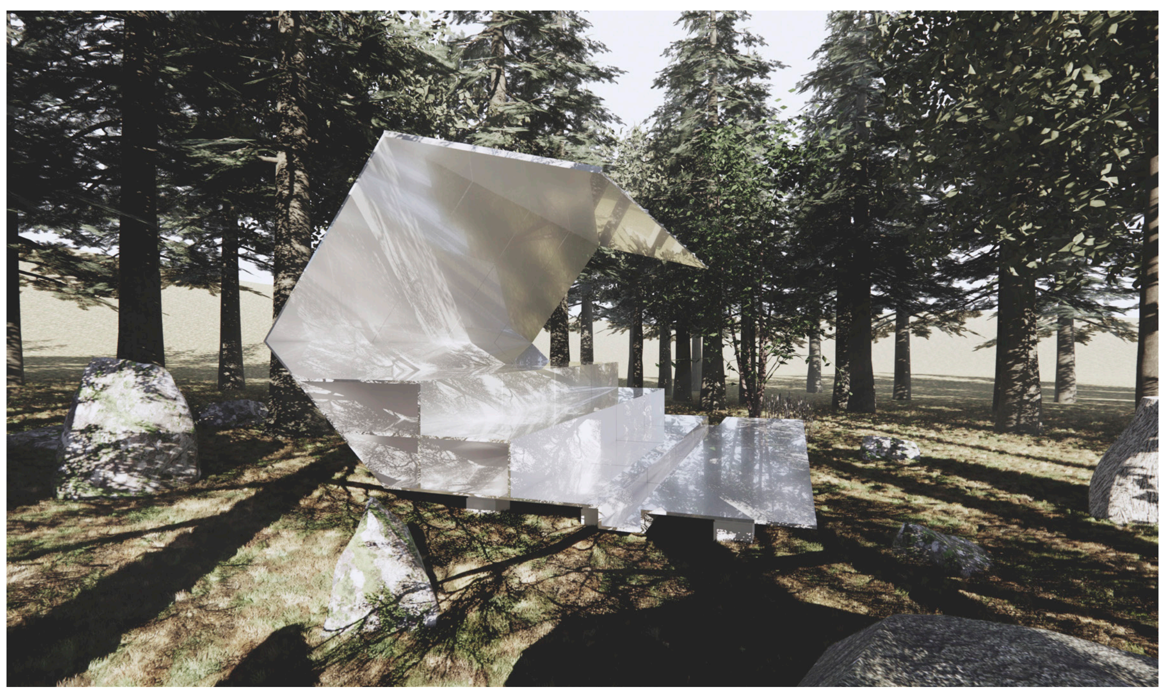


Fig. 68 - Rest Render

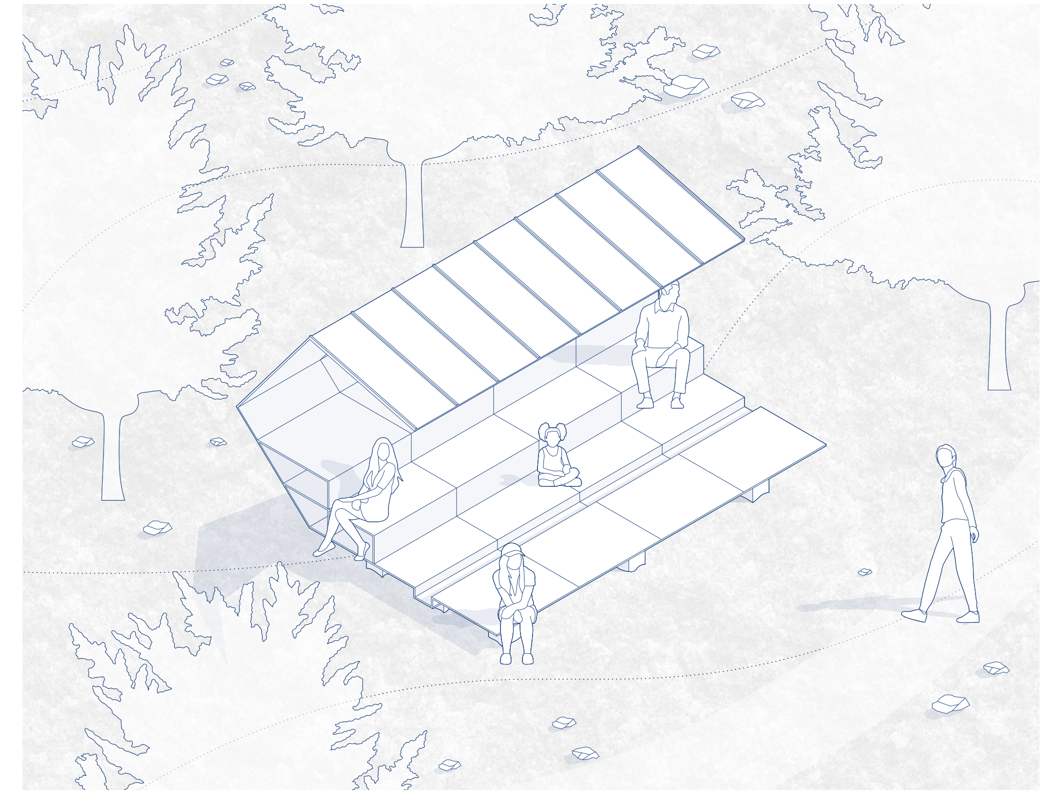


Fig. 69 - Rest Axo No.1

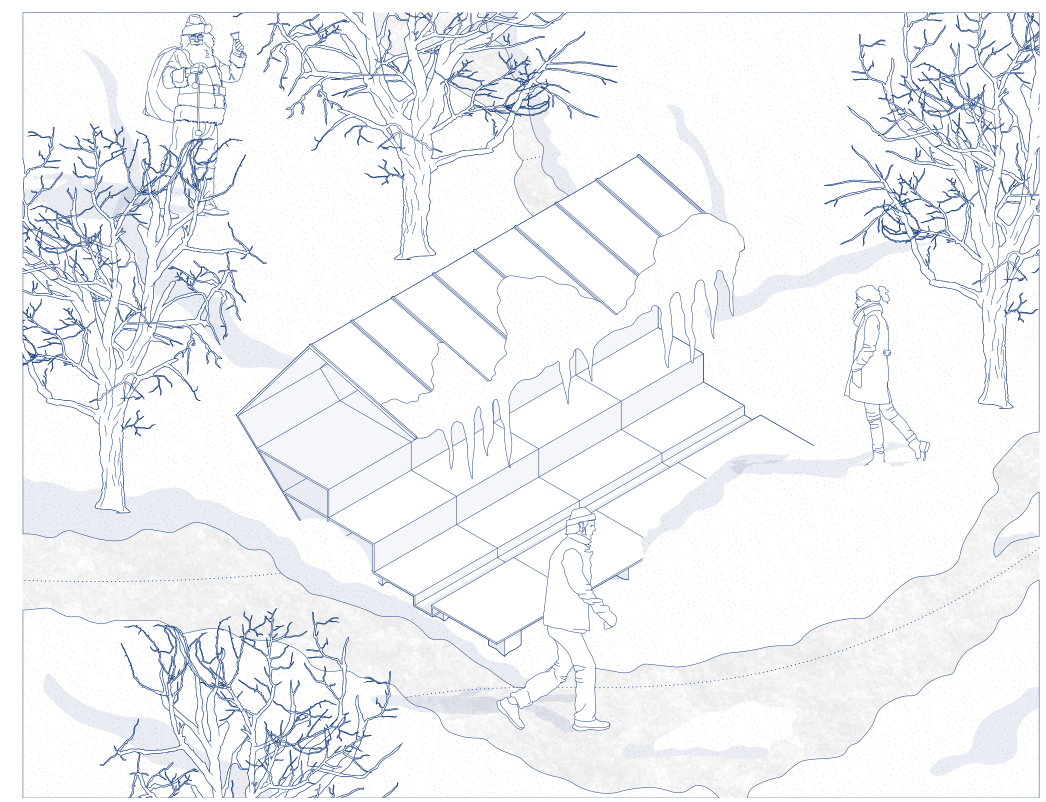


Fig. 70 - Rest Axo No.2

INSERT

This next space maximizes the steel form as it expands and extrudes to become a larger more inhabitable space as it embeds itself into the existing slope of the site. This space has the ability to be activated for performance on top or inside as well as act as enclosure. There would be a unique interaction between the users inside the plenum and those who are on top.

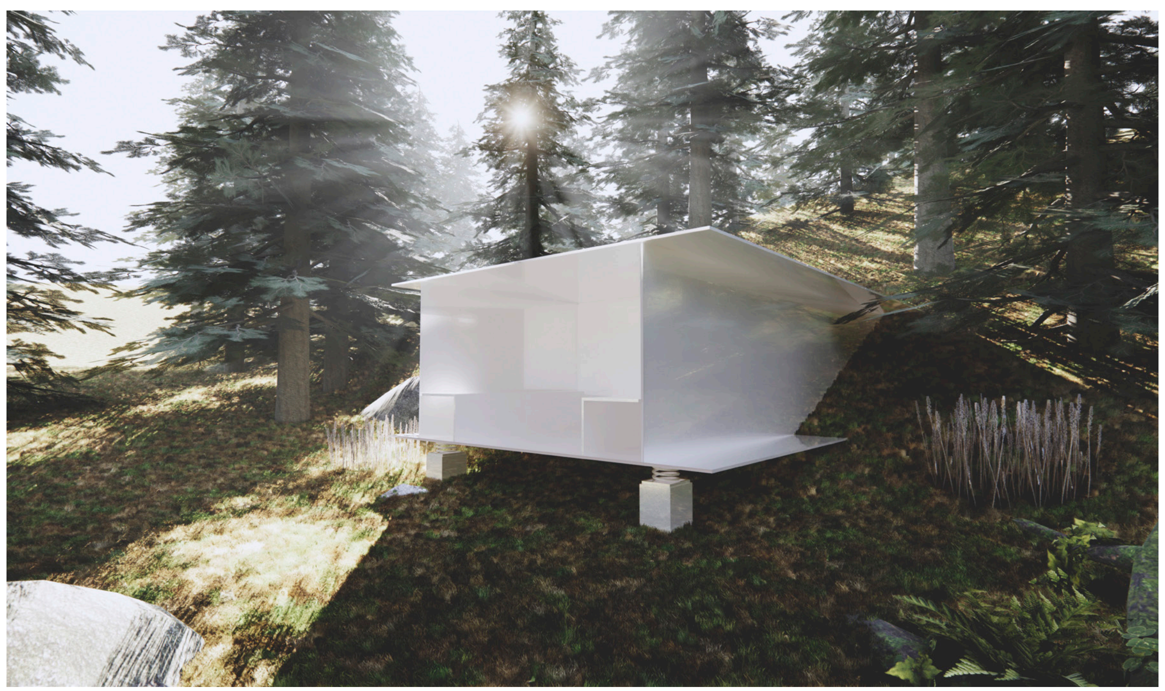


Fig. 71 - Insert Render

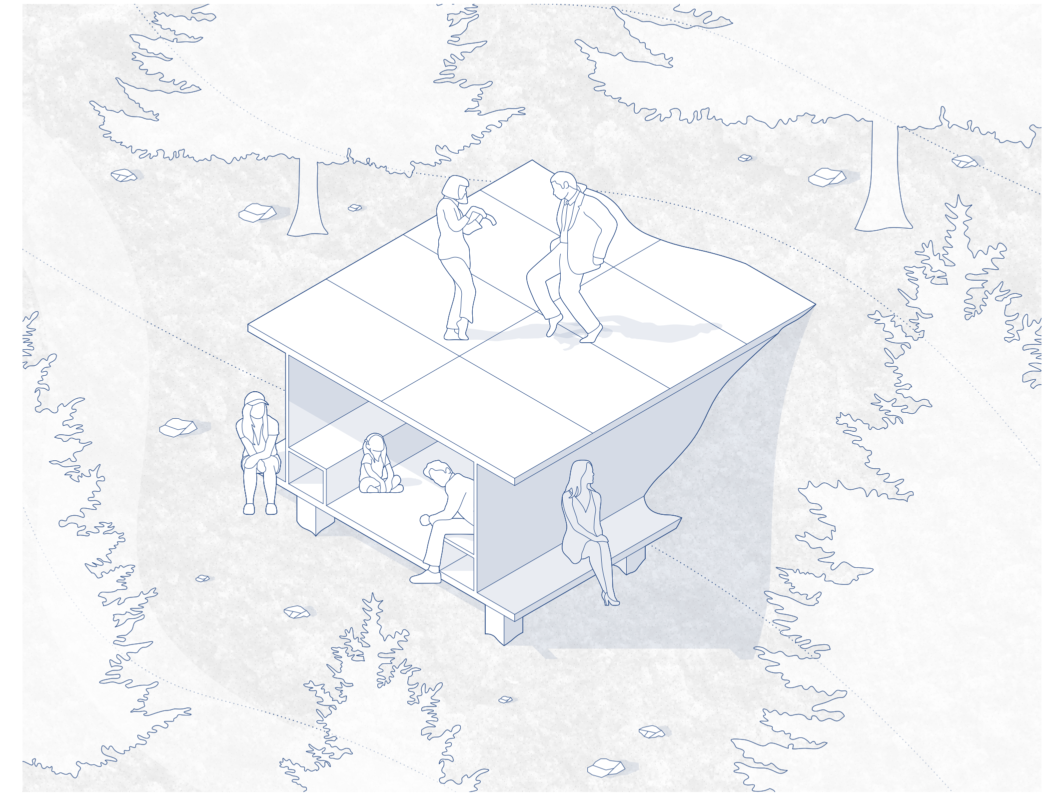


Fig. 72 - Insert Axo No.1

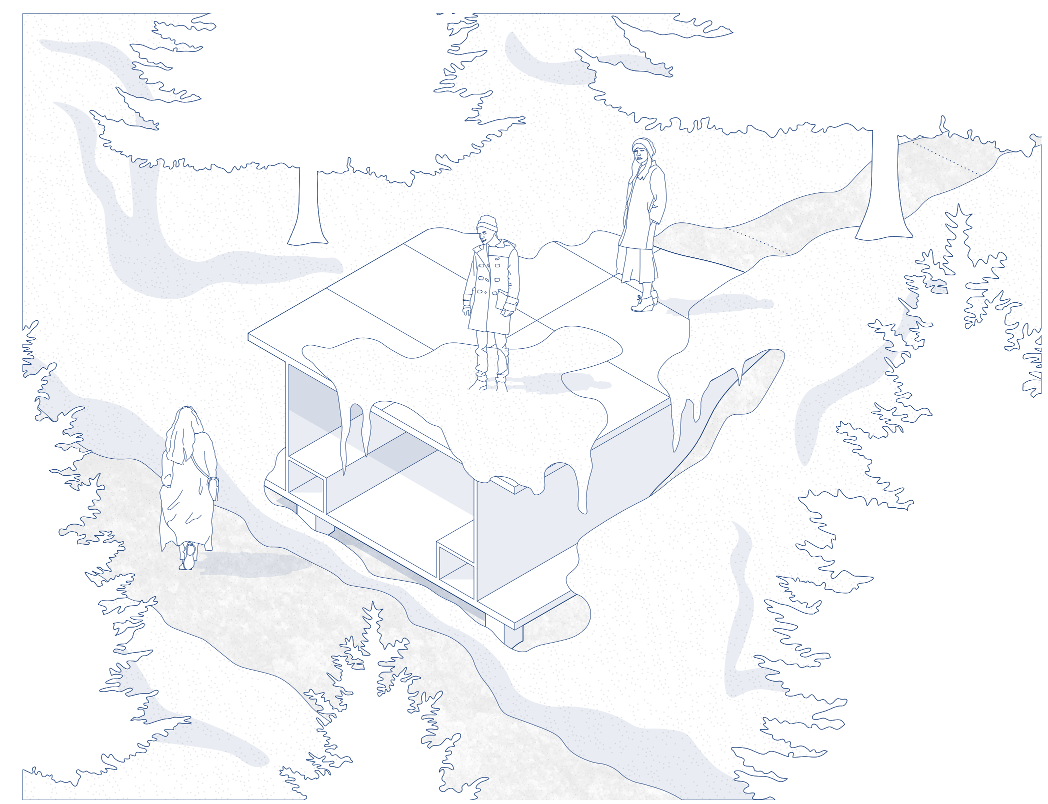


Fig. 73 - Insert Axo No.2

DIVE

This last in between space is more of a private moment where people can enter a steel frame that plunges into the lake. Wave and water energy would be transferred into a tactile experience through the steel and the interior conditions of this space would change depending on moving water level.

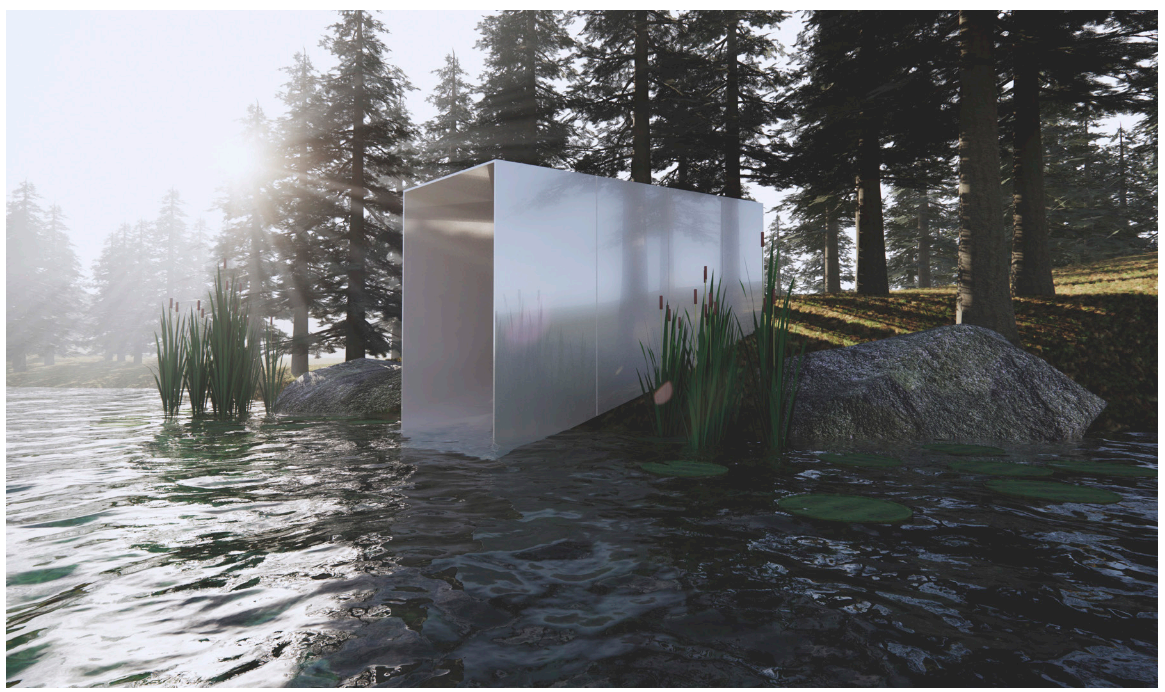


Fig. 74 - Dive Render

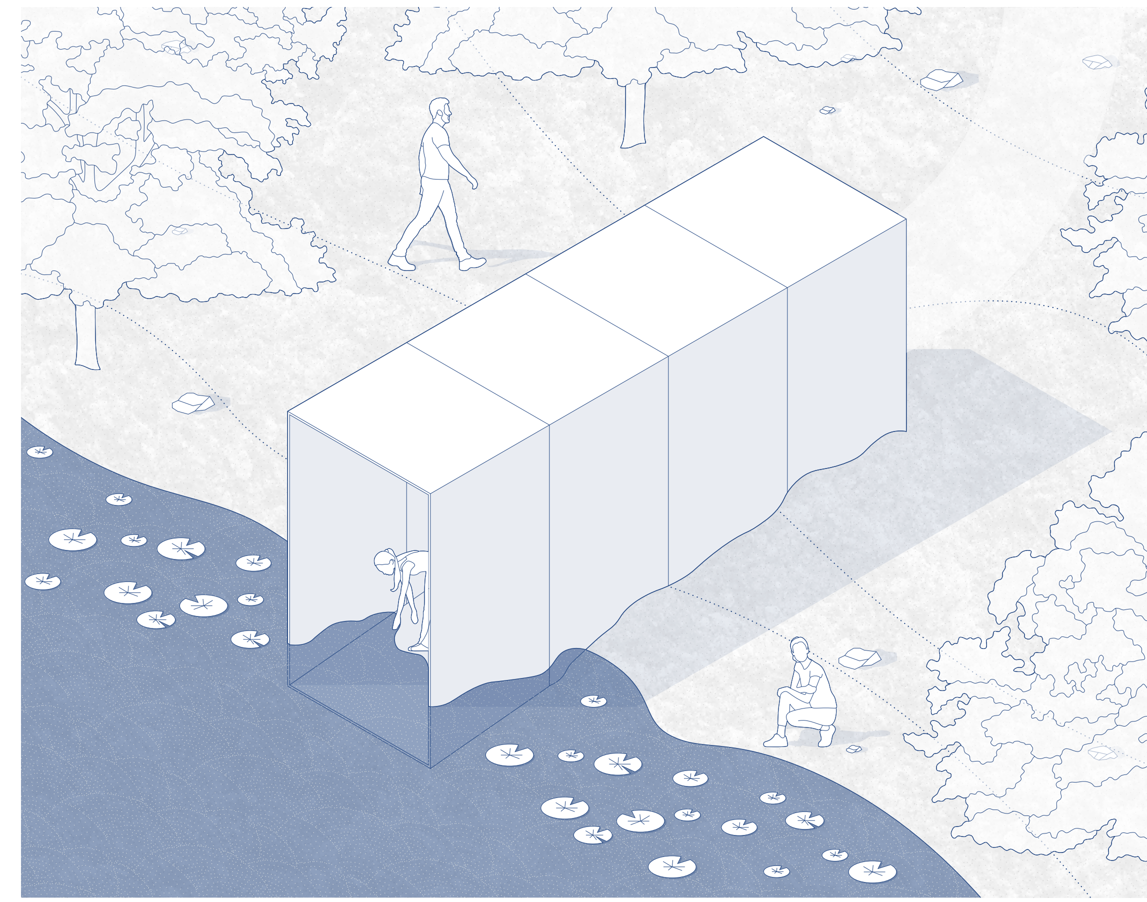


Fig. 75 - Dive Axo

CONCLUSION

In conclusion this study has been about how we can use materials to encourage and maximize sound dispersion and vibrational resonance in structures to experience sound in non conventional ways.

These three main pavilions each offer a different experience of sound. One places a focus on feeling sound and the vibrational energy that can be transferred through material. One focuses on visualizing sound and converting existing site conditions such as water and wind energy into something that can be seen. The last places a focus on a sense of silence and stillness in contrast to the other structures around the site. It is through these structures I believe there can be shared experiences of sound for both people along the spectrum of non hearing, and the hearing.

Fig. 76 - Three Pavilions

ENDNOTES

1. “Sound absorption and insulation fuctional composites,” Research Institute of Wood Industry, October 14, 2016, accessed January 24, 2021, https://doi.org/10.1016/B978-0-08-100411-1.00013-3

2. Eduardo Souza, “Keys To Improve Architectural Acoustics: Sound Absorption and Diffusion,” ArchDaily, April 12, 2019, accessed January 26, 2021, https://www.archdaily.com/912806/understanding-sound-absorption-and-diffusion-in-architectural-projects

3. “Mason Jack-Up Floor Slab Systems,” Mason Industries,Inc, accessed March 26, 2021, https://mason-ind.com/jack-up-floating-floors/

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