THE UNDERWORLD:
SUB-URBAN SENSORIUM

by

Anastasia Diane Hiller

Bachelors of Arts in Architecture
University of Florida, 2012

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTERS OF ARCHITECTURE
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FEBRUARY 2016

Signature of Author _____
Department of Architecture
January 15, 2016

Certified by _____
Antón García-Abril, PhD
Professor of Architecture
Thesis Supervisor

Accepted by _____
Takehiko Nagakura
Associate Professor of Design and Computation
Chair of the Department Committee on Graduate Student

Thesis Advisor
Antón García-Abril, PhD
Professor of Architecture

Thesis Readers
Brandon Clifford, MArch
Belluschi Lecturer of Architecture

Caroline A. Jones, PhD
Professor of the History of Art

THE UNDERWORLD:
SUB-URBAN SENSORIUM

by
Anastasia Diane Hiller

Submitted to the Department of Architecture on January 15, 2016 in Partial Fulfillment of the Requirements for the Degree of Master of Architecture

Abstract

The underground has been typically viewed as a utilitarian space of expansion. Modernism has required an infrastructural underground, seen as a space of necessity. Historically, the underground has been a place of ceremony and ritual, an otherworldly escape from reality, inhabited by the literary, carceral or religious. The contemporary city calls for a reassertion of this ceremonial underground, extending beyond the infrastructural impulse. With populations rising, and land a finite commodity, the body and city call for a new space- unachievable at grade. The city with its many noises, sights and smells needs filtration. This thesis invites an exploration of the underground, and brings into question conventional disciplinary acts of representation.

Working within the underground requires a different set of architectural operations. The underground offers a freedom from existing architectural conventions. Carving becomes the tool of the architect, as the underground relies on excavation to create space. The underground becomes a zone of expression, whose qualities releases us from the banality of orthogonality, as it is a substance that must be carved. The underground enables the refusal of the rationalization of the city.

While mediating the path of the person the underground public space offers a sensorium to explore, not a labyrinth to merely follow. This proposal allows for different experiential conditions not found typically at grade, through manipulations of the perception of light, sound, materiality and depth. In working within the constraints of no light or air, and construction by subtraction, architectures of transition become how one moves through the project. Thinking underground is an exercise in total interiority, and provides an opportunity for reorienting the senses, through sequencing, light and scale. Entering the world of the subterranean subverts the visual dependency, as physical sensation underpins spatial cognition. This thesis positions the underworld as an unadulterated, highly stimulating and sensorial experience.

Thesis Supervisor: Antón García-Abril, PhD
Title: Professor of Architecture

Special Acknowledgments

First to my parents, thank you for your unconditional love, for always supporting me even when it worries you, and for dealing with me, your bull-in-the-china-shop.

To my classmates and friends at MIT, I have learned so much from you all and have appreciated every long moment spent together. Karen, Matt and Enas, I cherish our friendships.

Peter and Jess, from our lowly days in D1, which brought all-nighters and pure ridiculousness, to exploring Europe to now Boston living, you have been the best friends I could ask for. Team Pejena and antithesis always.

& to my Bobby, I could not have done this without you. Your love, patience, kindness, proofreading, and endless advice giving has kept me sane. My gratitude, appreciation and love can not be expressed enough. ILYROW.

TABLE OF CONTENTS

INTRODUCTION

"Alone, at last! Not a sound to be heard but the rumbling of some belated and decrepit cabs. For a few hours we shall have silence, if not repose. At last the tyranny of the human face has disappeared, and I myself shall be the only cause of my sufferings. At last, then, I am allowed to refresh myself in a bath of darkness!"

Baudelaire, At One O'Clock in the Morning

For Baudelaire, the chaos of the city was only dampened with the "silence and solitude of night."[1] Within the contemporary urban environment, we are inundated with media, noise and images at every hour. Imagined as a re-orienting refuge, this proposal looks to the often neglected underground as the context in which to operate, questioning architectural conventions while re-imagining how the body perceives space. In negotiating the overwhelming nature of the city, the underground becomes vital in restoring one's awareness of the body, as we are often inundated with sensations.

Seeing the underground as a "zone of expression", this proposal aims to transform the underground experience from a, "seemingly undesirable quality of darkness" to something, "filled with pleasure."[2] First as a study of the underground, understanding the environment's role in subterranean atmospheres is critical, with effects of moisture, light, air quality, ventilation, geology etc., as well as understanding its historical and cultural context. As the space of the underground relies heavily on atmosphere, this allows for a re-imagination of how the senses can be used in architecture, in a space that lacks light. Embedding a project underground is an exercise of total interiority. How do we use the ideas of spatial control (light, sequence, scale, etc.) as a method of creating psychological spaces and experiences, not defined by our architecture conventions proliferated at grade?

---

1 Charles Baudelaire, "At One O'Clock in the Morning" in Baudelaire in English, edited by Carol Clark and Robert Sykes, (New York, NY: Penguin Books, 1997), 241, line 1.

2 Rosalind Williams. Notes on the Underground (Cambridge, MA: MIT Press, 2008), 82.

CONNOTATIONS OF THE UNDERGROUND

Fig 1

The Underworld

In mythology, the underground, or underworld is associated with the afterlife. As the otherworld, beneath the surface of our world, it is the place of the souls of the departed. While in some cultures there is a negative connotation of the underworld, other cultures consider it more of a place of waiting between lives.

Fig 2

Caves

The cave, within architecture, has long been associated with primitive dwelling but was also considered as a metaphorical space of ignorance. For Laugier, the primitive hut was the antithesis to the unbearableness of a cave, primarily responding to its darkness and foul air. While light and ventilation are central to this debate, the dampness of caves offers cool and stable temperatures.

Fig 3

Transportation + Utilities

The underground has been typically viewed as a utilitarian space of expansion. From subway lines, power, storage, sewer and data, etc, modernism has required a certain sort of infrastructural underground. With the Industrial Revolution and the need for development, the underground became the foremost place for laying infrastructure, including the first subway, opened in London in 1863.

Fig 4

Storage

With vaults for the storage of valuables, crypts for the storage of the dead to infrastructure for the storage of waste and water, the underground has been looked to as a vessel for protection. Primarily useful for its ability to conceal, the underground also offers stable temperature conditions, making it primarily a space of storage.

Fig 5

Mining

As one of the first associations with the underground, mining was negatively seen as exploiting the earth for its resources. As a symbol for labor, mining was often considered punishment, with criminals and slaves as subterranean workers.

Fig 6

Water

Found deep within the earth, the planet's water within its interior is likely to be more than the amount of water in all of the oceans. At a more local level, aquifers exist beneath the surface of the earth, in which ground-water can be extracted from. When digging underground, water is more likely to surface, creating damp and humid conditions.

Fig 7

Ceremony

Many civilizations have looked to the underground as a burial place, for either the dead or for valuables. Ceremony and rituals become embedded in these practices. Caves and tunnels have been used for a variety of ceremonial reasons. The Incas looked to underground tunnels as passages marking a monk. The Lascaux Caves in France, seen above, reveal cave paintings, with examples of some paintings buried thousands of feet deep within the cave.

Fig 8

Carceral

As a symbol of cruelty or tyranny, dungeons have been used to hold prisoners. In the 14th century, dungeons were formally named, from the French meaning *'to keep'*. In many Medieval castles, prisoners would be housed in the dungeon, some of which were converted from storerooms, water-cisterns or even latrines. Their location underground was used due to its natural concealment.

Fig 9

Catacombs

Catacombs, derived from Latin for *'among the tombs'*, are any chamber used to create a burial place, and are often associated with religious practices. Both inscriptions and decorations often adorned catacombs as a cultural practice. There is a long standing association with other spatial uses within catacombs- including hiding war refugees, hideouts or cult meetings, due to its underground condition of concealment.

Fig 10

Counter Culture

Counter culture is the name given to social subcultures that differ from the mainstream. Often associated with dissatisfaction with current conditions, counter-culture is considered 'underground' as a movement that goes against the norm. While counter-culture can be political in nature, it can also refer to music or art.

Fig 11

Homelessness

As the underground offers concealment and protection from the elements, it is known as a place of refuge for the homeless. Prone to decay after abandonment, the underground is usually not regulated or monitored.
The abandoned subway lines in particular become places populated by the homeless in the city.

Fig 12

Rats + Trash

The ground accumulates the trash and dirt of the city, which eventually ends up in the underground spaces. Rats, as subterranean dwellers add to this condition. New York City's rat population has been estimated to be as large as its human population.

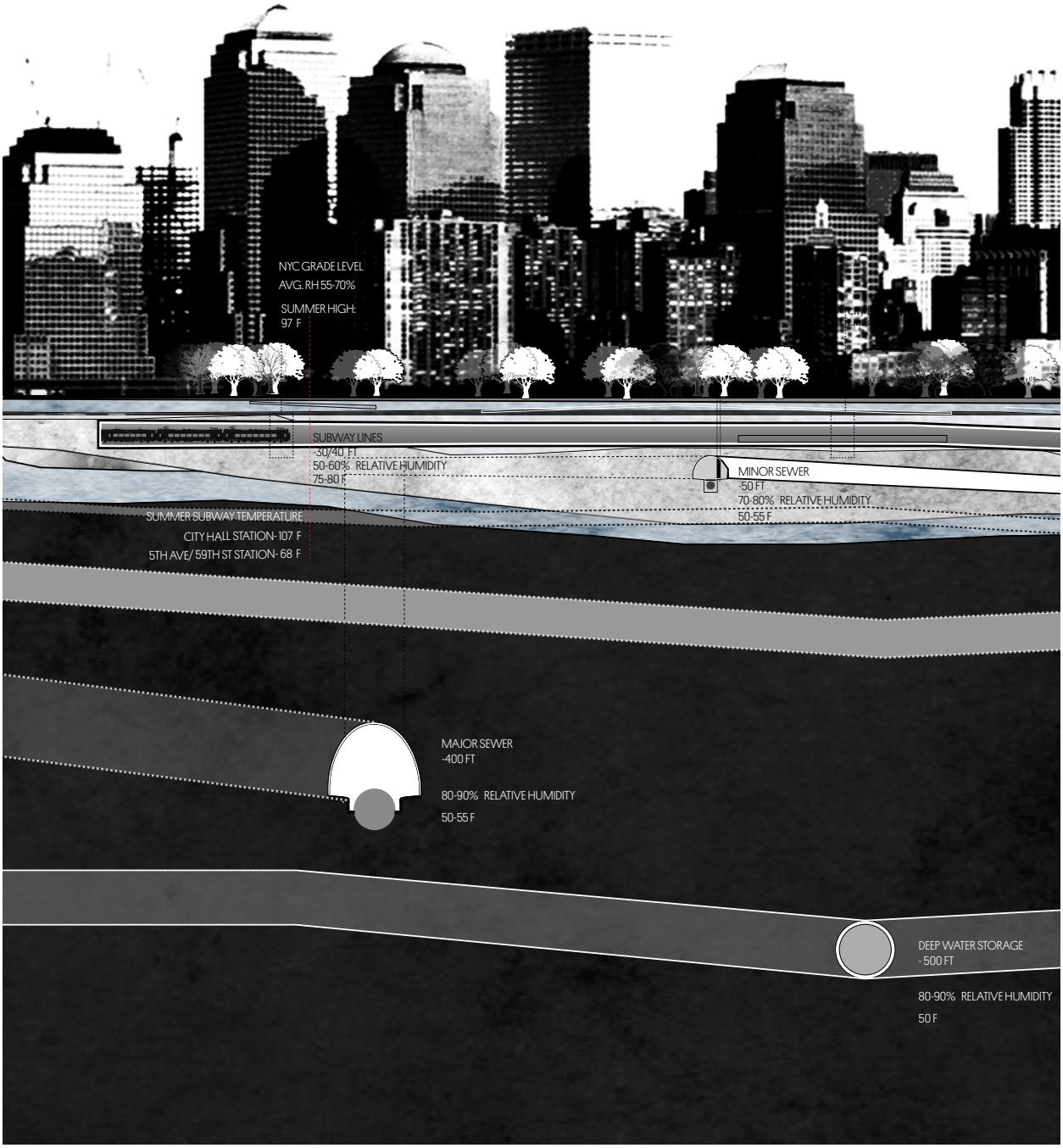
A New Underground

Breaking the stereotypes of underground culture, which negatively include the perverse or decay, this thesis attempts to redefine the underground to highlight its spatial and cultural utility, not achievable above ground. As a total environment, the underground can be seen as an architectural actor leveraging atmosphere to produce sensory control. The grittiness of the underground is something to celebrate, not something to sterilize.

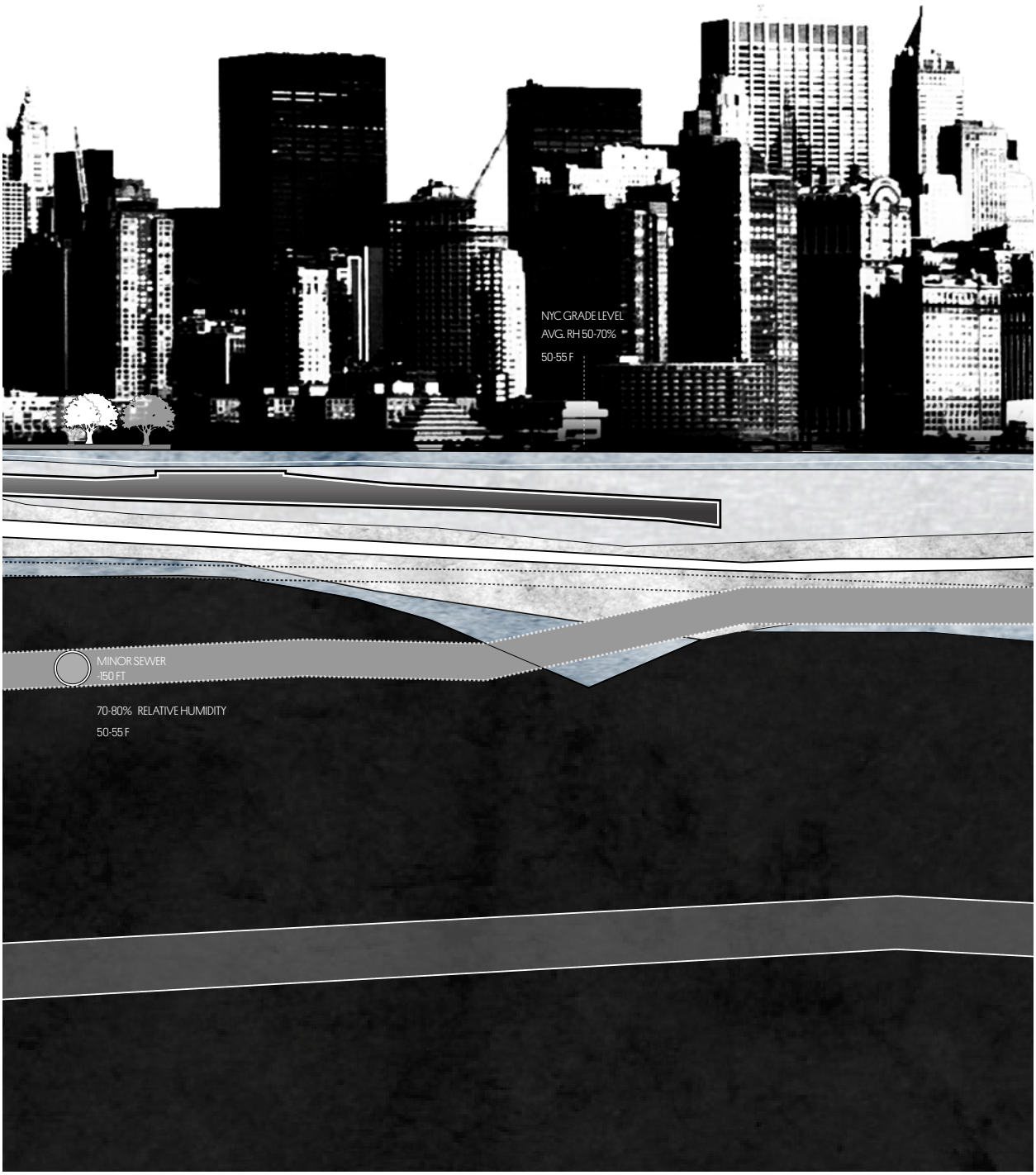
A SURVEY OF THE UNDERGROUND


MINING
Pogo Mine
Delta Junction, AK
VAULT
Shanghai Tunnels
Portland, OR
NUCLEAR BUNKER
Cheyenne Mountain Complex
Colorado Springs, CO
COMMERCIAL PLAZA
Subtropolis
Kansas City, MO
COMMERCIAL PLAZA
PATH
Toront, Canada
CEREMONY
Incan Tunnels
Cuzco, Peru
VAULT
Edinburgh Vaults
Edinburgh, United Kingdom
† CEREMONY
$ COMMERCIAL PLAZA
STORAGE
VAULT
REFUGE
CITY DEVELOPMENT
MINING
UTILITIES

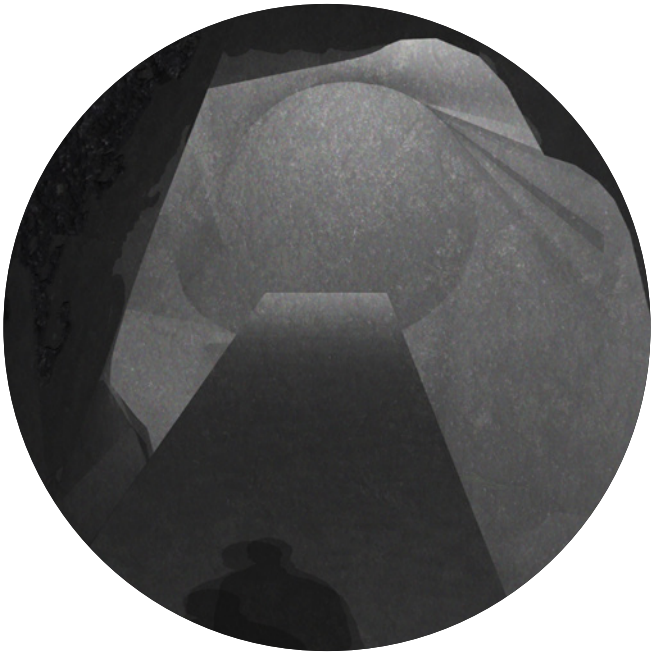
A survey of the underground highlights programmatic functions typically found below grade. While the context- both geographically and culturally range internationally, cutting across many cultures and places, there exists a sameness architecturally in color, form, texture and program.



In surveying the city, infrastructure underground extends as deep as the buildings above ground. A cut through a section of New York City, reveals the overlapping layers of both natural earth and artificial interventions. As buildings do extend below ground, often in storage or foundations, there exists an architectural opportunity of programming these spaces that are often overlooked.



Taking a slice through New York City, the subterranean is primarily occupied by urban infrastructure. From sewage drains, water pipes, power and communication lines, storage and transportation, these service extend below the surface of the earth over 500 feet.



A New Underground

This project aims to re-conceptualize culturally the ethos of the underground. Creating a new sensual experience within the city can only be achieved through the immersive environment of a subterranean intervention.

While previous underground projects attempt to re-imagine infrastructure, preconceived notions of program do not take in account the architecture of the underground. Seeing the underground as an architectural opportunity often ignored, this thesis begins by reframing architectural space of the underground.

Potentials

The underground influences the spatial conditions and atmospheres of the interventions, and allows for the release of the reliance on pure visual perception of a space. The underground can provide an as one can experience quietness, dampness, darkness, tenebrosity, and other spatial qualities, usually uncommon. This intervention aims to orient and disorient the individual as one relies on the non-visual to understand a sense of space. Relying on the total interiority of the underground, light, texture, view, and atmosphere control the experience of the project.

Fig 13

FILTERS
SIGHT

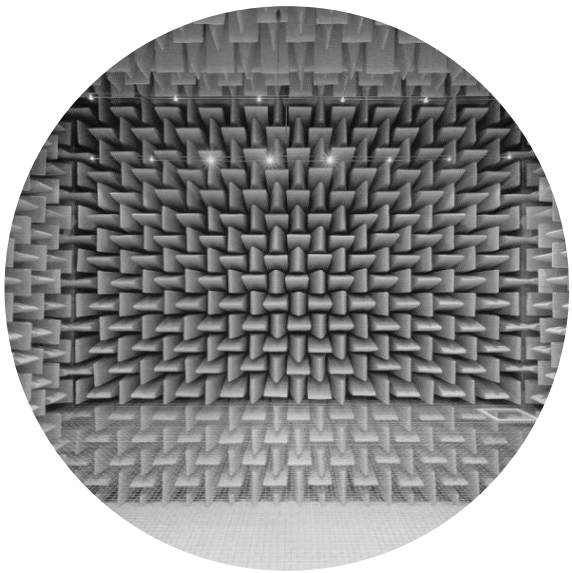


Fig 14

FILTERS
NOISE

Fig 15

FILTERS
LIGHT

Fig 16

FILTERS
ATMOSPHERE

METHOD

"Vision separates us from the world whereas the other senses unite us with it."

Juhani Pallasma, The Eyes of the Skin

The underground has been typically viewed as a utilitarian space of expansion. Modernism has required an infrastructural underground, seen as a space of necessity. Historically, the underground has been a place of ceremony and ritual, an otherworldly escape from reality, inhabited by the literary, carceral or religious. The contemporary city calls for a reassertion of the ceremonial underground, extending beyond the infrastructural impulse. This thesis views the underground as an unexplored, often neglected territory, in which immersive qualities allow for an unadulterated, highly stimulating and sensorial experience.

With populations rising, and land a finite commodity, the body and city call for a new space- unachievable at grade. The city with its many noises, sights and smells needs filtration. This thesis invites an exploration of the underground, that brings into question conventional disciplinary acts of representation.

What would it mean to reconsider the way we think about architecture based exclusively on the potentials of the underground?

If at grade, we design through form, and sunlight, what does it mean to create an architecture that prioritizes what is not typically at this foreground- when it is necessary to design through tactility, tenebrosity and acoustics?

What would it mean to respond to the manifesto of the underground?

MANIFESTO OF THE UNDERGROUND

THE MANIFESTO OF THE UNDERGROUND

We have a long history in engaging public space, but it does not go far enough.
The city is ruled by the grid.
The grid is ruled by the orthogonal.
We follow setbacks and FAR's.
We build with pieces; we cut and then assemble.
We draw two-dimensionally, and build what we draw.
We follow the laws of physics, we adhere to codes and rules, and it leaves us with a homogeneous fabric.

As construction methods have become tradition- that is what we must now question.
The building model of what is public and private in the city has changed, and architecture must respond to this.
Beneath the bustle of the city streets, the infinite landscape of the underground provides both an uncompromisable scale and potential for unconventional building necessary for the contemporary public space- one that restores one's awareness of the body.
Thinking underground is an exercise in total interiority, and provides an opportunity for reorienting the senses as one relies on a non-visual spatial itinerary- through sequencing, light and scale.

Entering the world of the subterranean subverts the visual dependency, as physical sensation underpins spatial cognition. This multi-sensorial way of thinking of the underground calls for a new type of representation and convention.

The underground offers a freedom from convention of tectonics:

- The underground offers a freedom from the orthogonal.
- The underground offers a freedom from linear directionality.
- The underground relies on excavation to create space, and carving becomes the tool of the architect.
- The underground calls for a subtractive set of operations, unlike our present space which relies on additive building techniques.

The underground offers a freedom from convention of structure and form:

- The underground offers a freedom from structural norms dictated by gravity.
- The underground offers a rejection of context, as volumes float in their spatial relationship to each other.
- The underground relies on naturally structural forms, like spheres, cylinders and arches, as the earth is carved.
- The underground calls for probing of space.

The underground offers a freedom from convention of visual perception:

- The underground offers a freedom from the horizon.
- The underground offers a freedom to explore, as spatial awareness is not dictated vis a vis perspective.
- The underground relies on ventilation and lighting, still for human habitation, but through its gradation/spectrum allows for a gradual, slower sense of bodily awareness.
- The underground calls for the end of the limitations of the visual alone- and demands to surpass interactions of the sensorial, to engage the disorienting, immersive and transitional spaces of the underground.

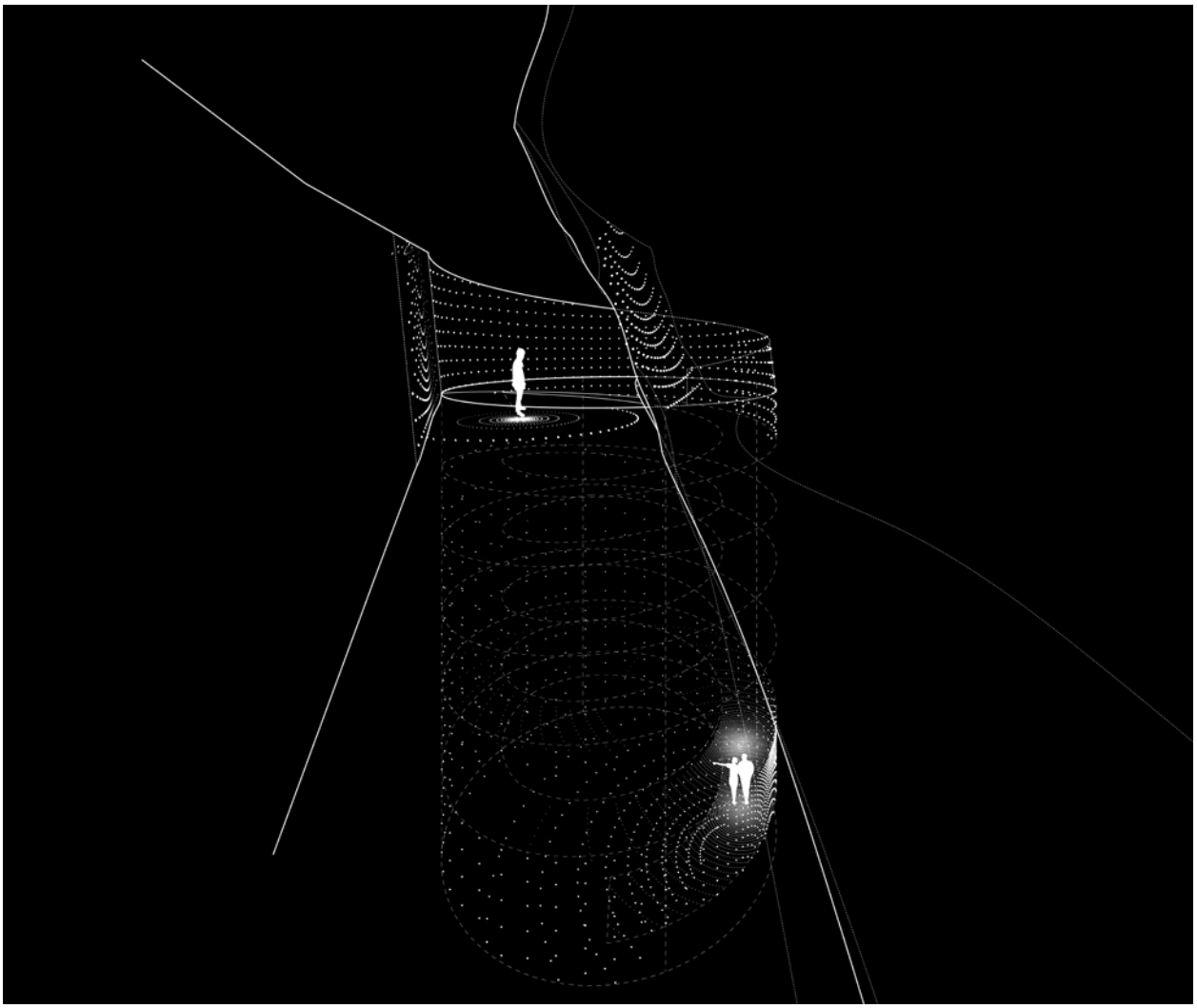
The underground innately has no horizon, no vertical, no perspective and no sky.
The underground enables the refusal of the rationalization of the city.
In conclusion, the underground is a zone of expression whose qualities release us from the banality of orthogonality, as it is a substance that must be carved.
The underground, categorized as obscure, its darkness, dampness and formlessness must be celebrated.

The underground revolts traditional architectural convention.

THE PROPOSAL

While mediating the path of a person, the underground public space offers a sensorium to explore not a labyrinth to merely follow. Conceived as moments of transition, the proposal creates experiential conditions not typically found at grade, through manipulations of perception of light, sound, material and depth.

These spaces invite contemplation and imagination, provide a revelation of the hidden, and offer a space for slow and gradual discover of both the body and environment.

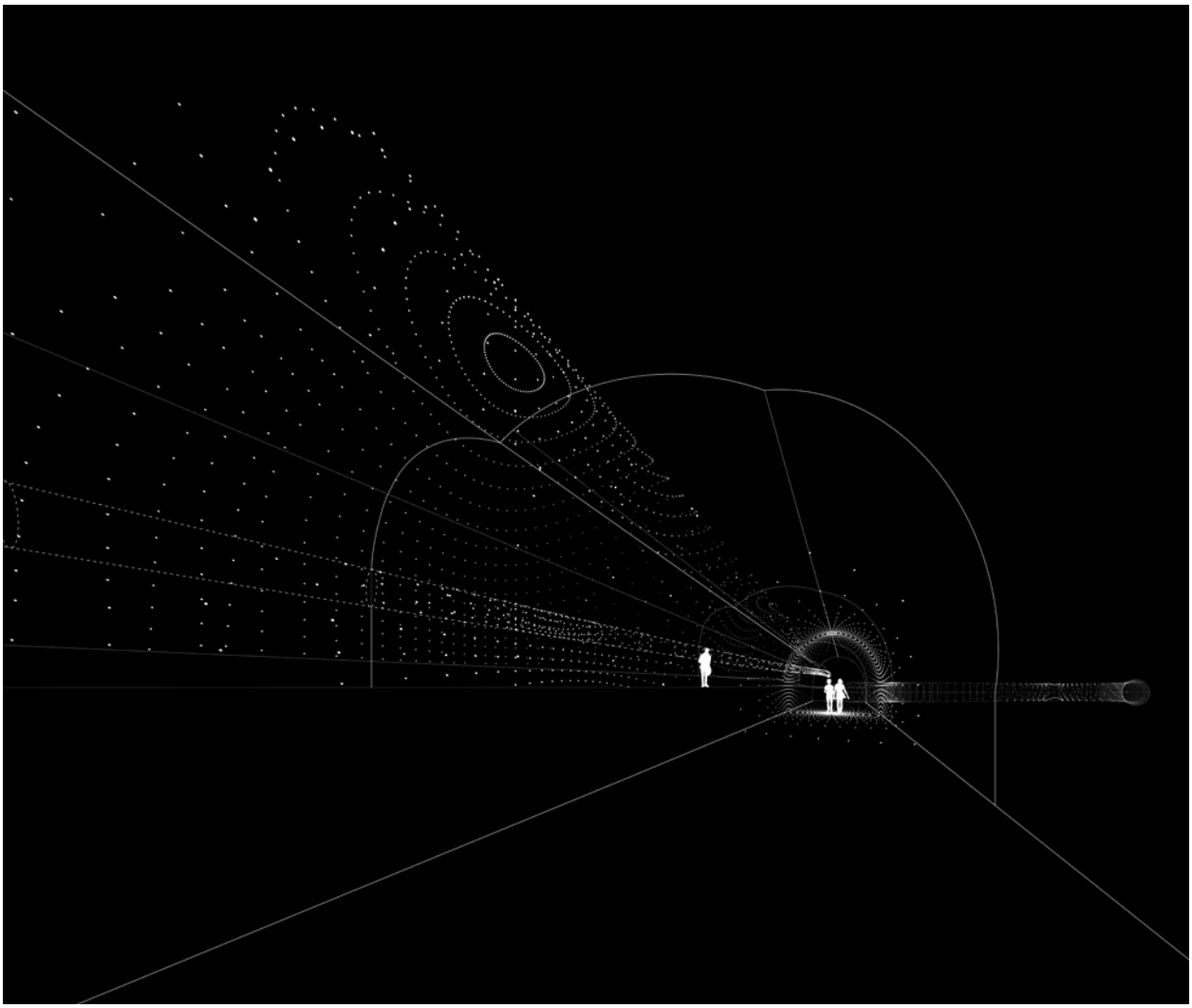


LIDAR representation showing the depth of the ramp, one would perceive from the light of the opening.

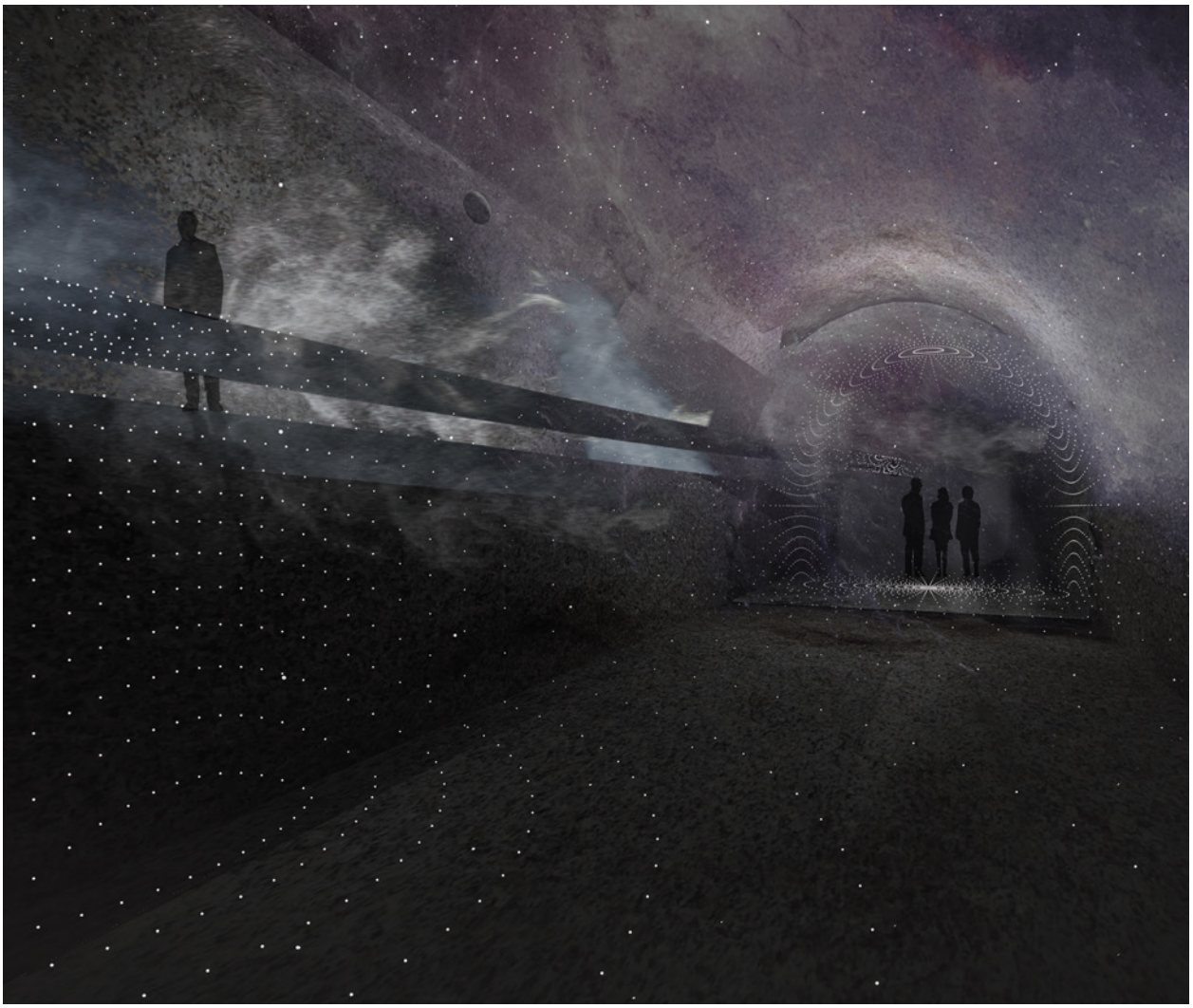
Portal render showing entrance to the underground, marked by tailings. The smooth constructed side on the left contrast with the granite deposit naturally occurring on the site, seen on the right.

The Portal

Entrance begins through the portal, marking the threshold between ground and sub-ground; a wall of earth emerges leading you down a continuous ramp. As a meeting of the constructed and the excavated, this marks the entry of the project.



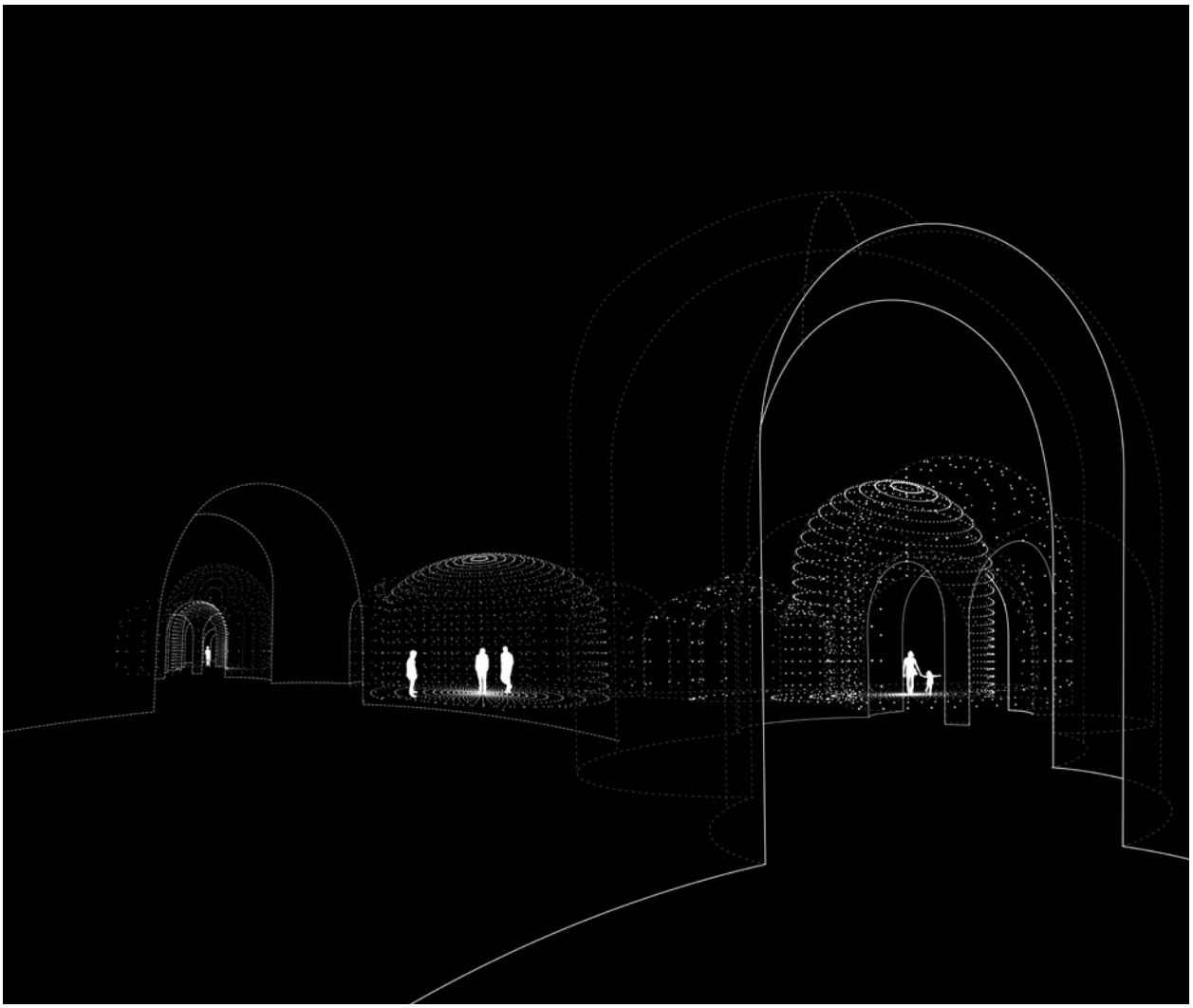
LIDAR representation of the length of the steam room. As a primarily tactile space, without the prevalence of light to guide one through the space, the body must rely on the *sense of touch* to understand the space. While the steam may disorient vision, the heat of the pipe can be used as a way-finding device.



One's relationship with the steam changes as one moves through the project as the ground undulates one's relationship with the height of the steam pipe. As hot air rises and the body moves vertically, this tactile change is felt.

Steam Chamber

The steam chamber exposes the hidden infrastructure and uses it to create a full body experience, by filling the room with steam created by the waste heat of the steam pipes and water of the bed rock.

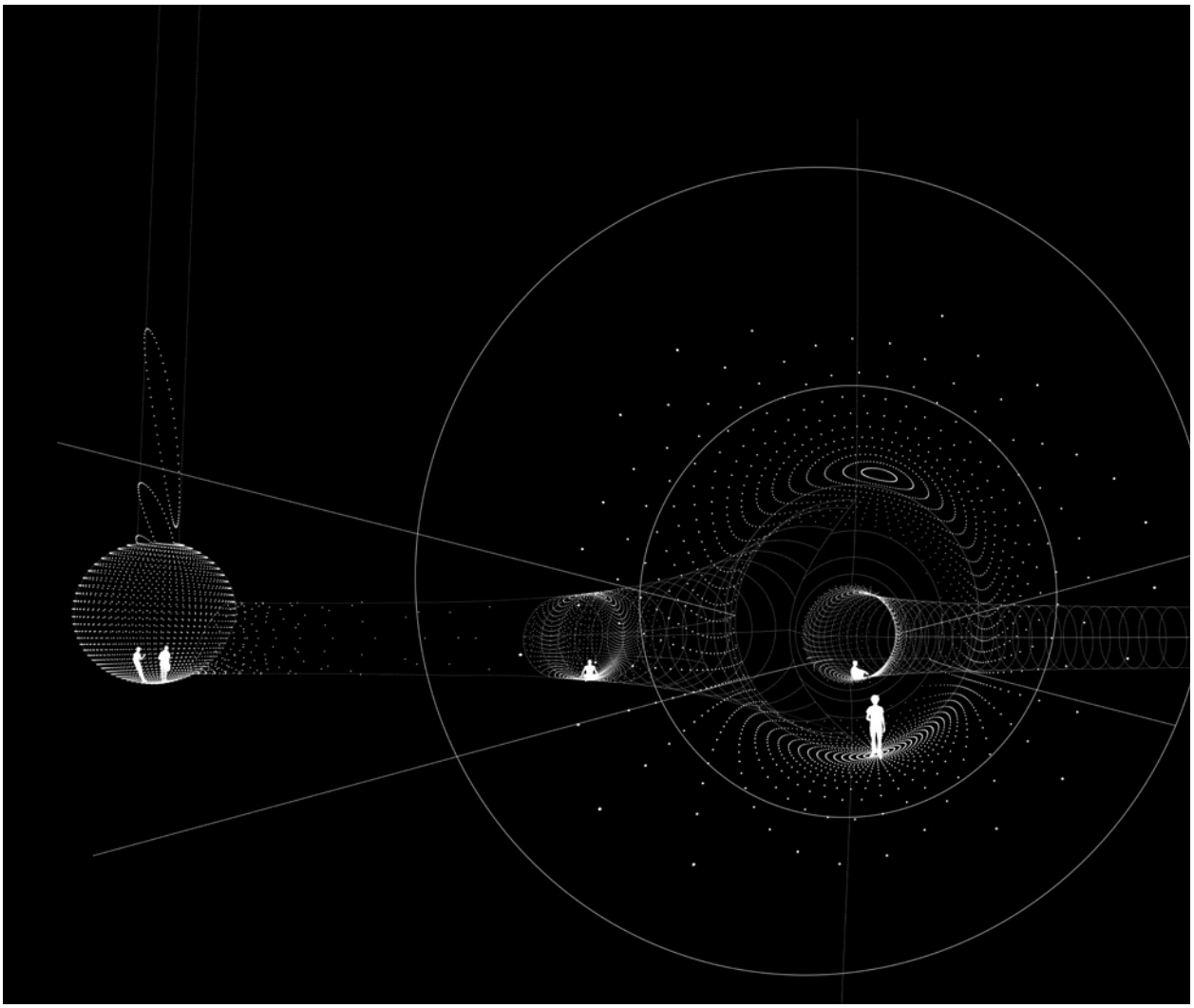


LIDAR representation of the depth of the sound chambers shows density and variation of the sound rooms. Without having the prevalence of light to guide one through the space, the body must rely on the *sense of sound* to understand the space. As the chambers differ in size, scale and texture, how the sound bounces through the space gives the individual a sense of orientation.

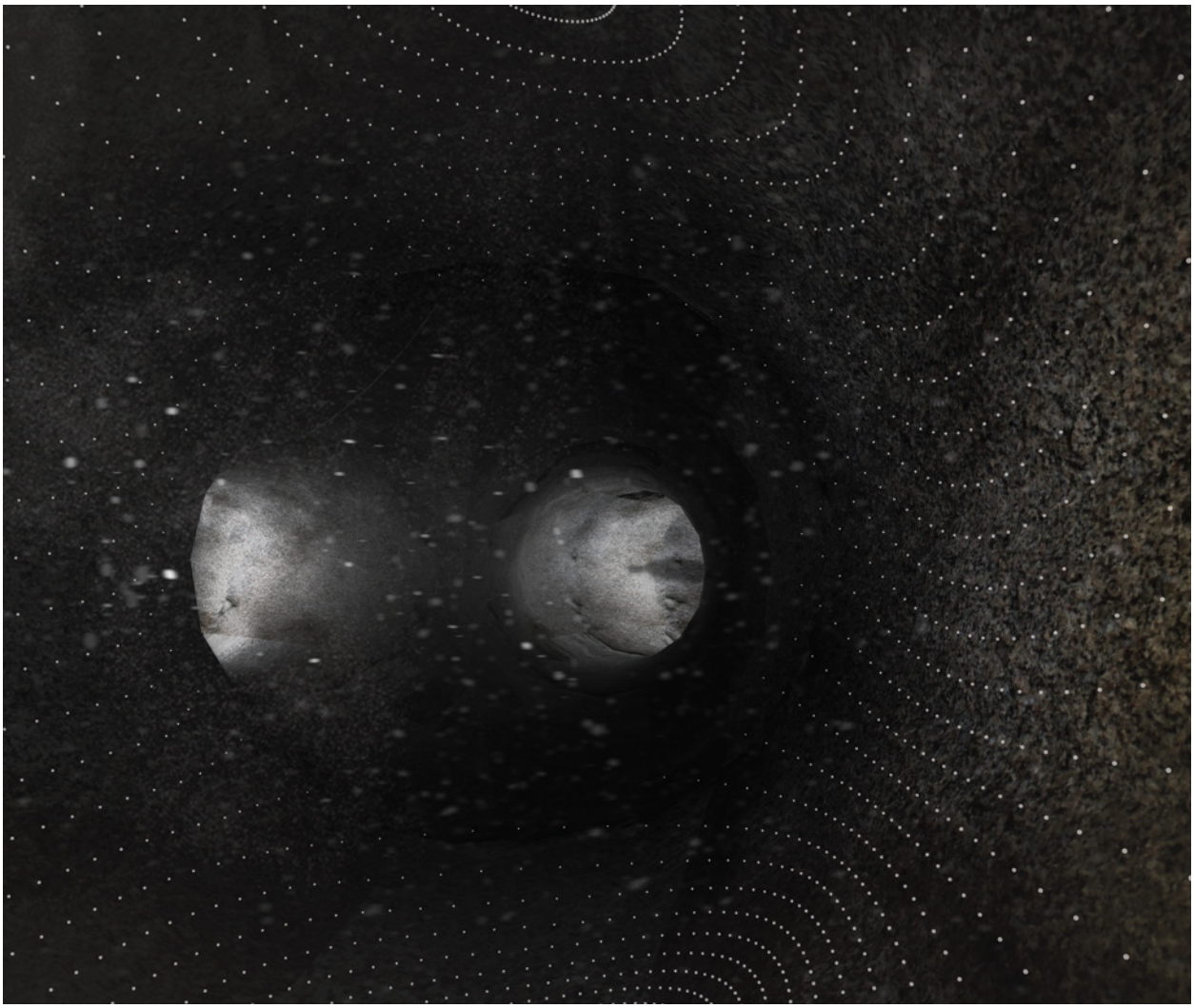
The echo chamber's coloration comes from the bioluminescent fungus typically found in caves or below ground. This colored light, an unusual form of natural light, influences one's visual perception of the space.

Echo Chamber

Playing on the ideas of gradient and the spectrum of light, the echo chambers are lit by bioluminescent fungus, as this low light allows for an understanding of the space to be driven from the sounds one emits- footsteps, voice or other.



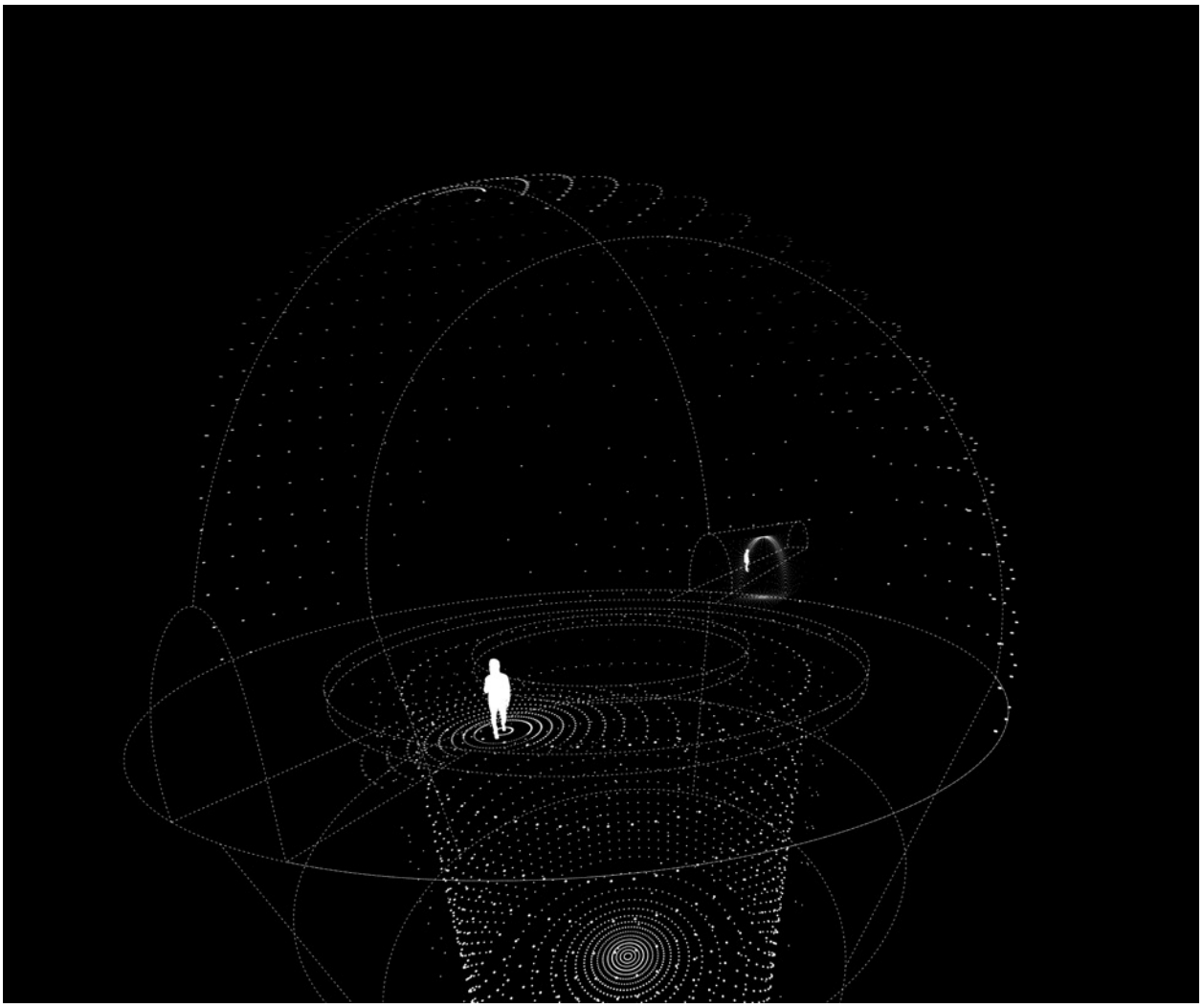
LIDAR representation of one of the tunnel paths. With such a limited point of view, typically dependent on sight alone, due to the tunnel's bends, the LIDAR offers a sense of itinerary one can not get at the local condition (seen in the render).



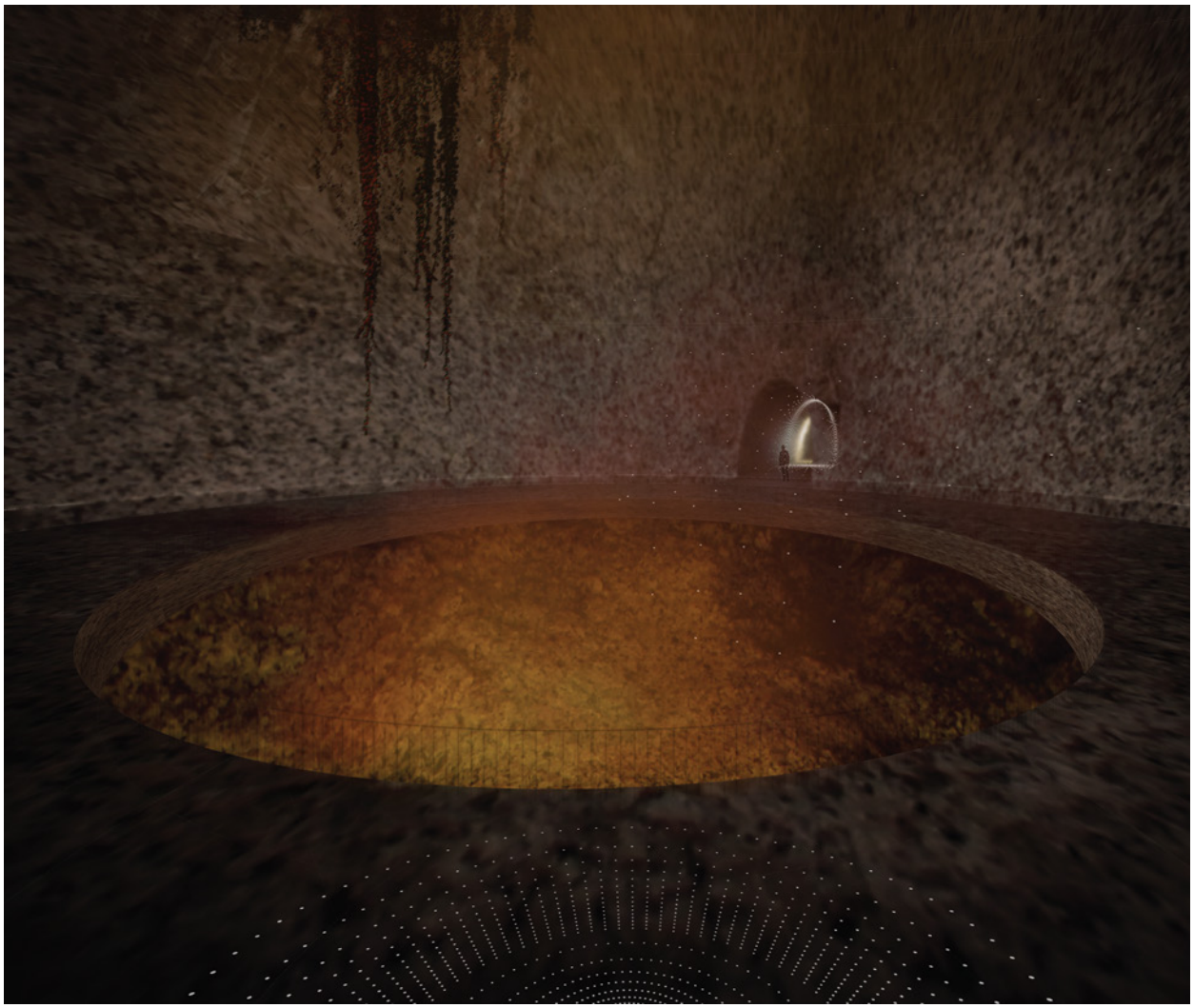
As the individual moves through the space with a single light source, relying on a short range of vision forces a cautious itinerary, as the geometry of the tunnel continually challenges questions of perception of what is typically considered horizontal and vertical. With the removal of the conventionally defined horizon underground, one must rely on their eye-line for visual orientation, and more importantly their other senses for spatial cognition.

Tunnel

One aspect of the underground path is the perception one can get at the local scale. Navigating with candlelight directs the person's path. The way multiple individual lights and shadows bend around tight tunnels allow for a disorienting of what is vertical or horizontal.



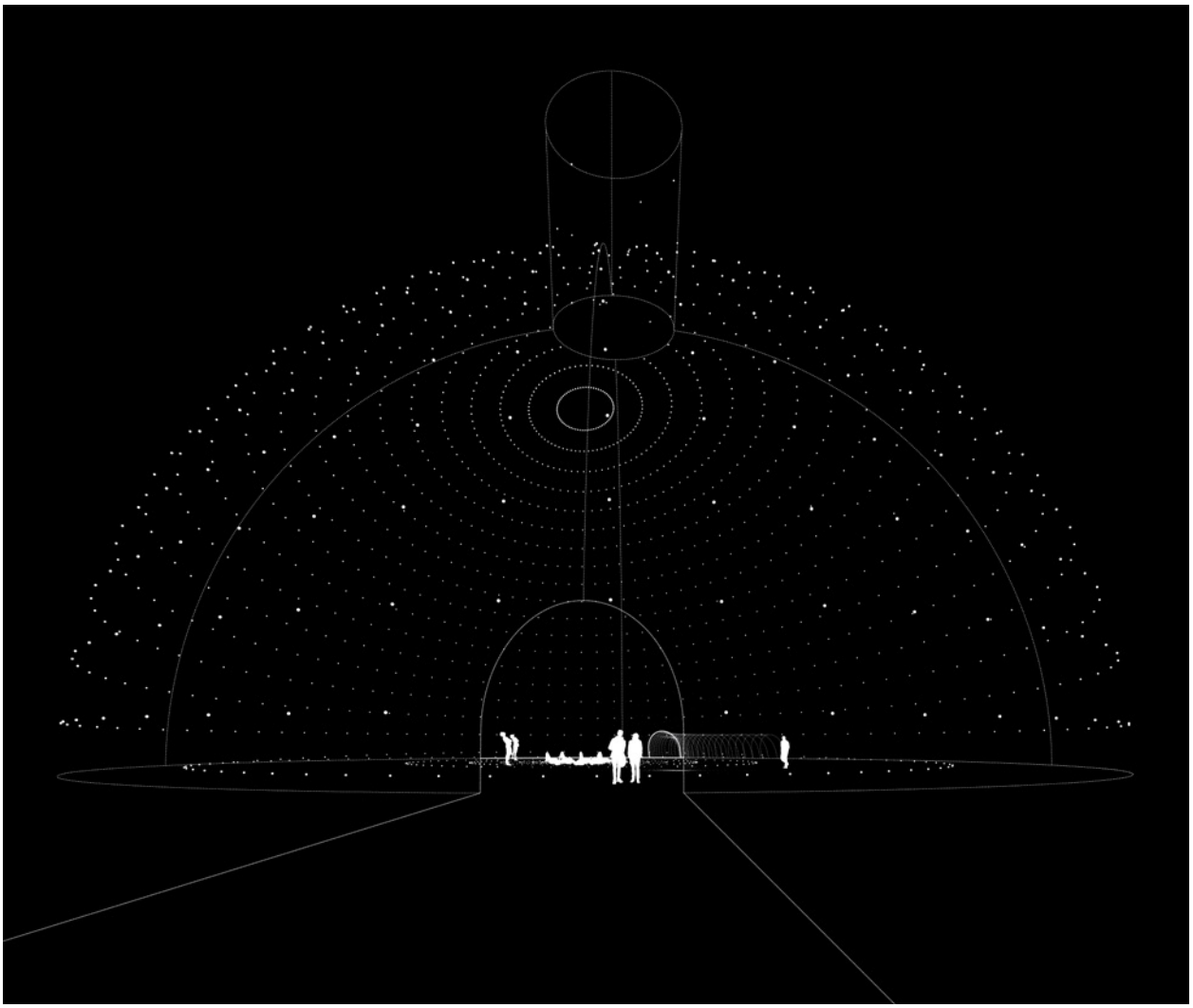
In this chamber, as one would not have to rely on sight alone, one can use their *sense of smell, touch and sound* to navigate the space. The depth of the hole becomes what is interrogated, while the tall domed volume allows for the smoke to rise above the individual's sight line. The depth can then be experienced due to the other senses of the body it probes. In this chamber, the spatial experience becomes about feeling what one can not explicitly see directly, even though it is lit to be seen.



The heat of the fire, the light's reflection against the granite and the smell of the fire all define a central point to the room. As a point of attraction in the underworld, as it would be visible from a distance, the glowing of the fire would challenge the expectations of an individual when they actually would experience the space in a multi-sensorial way.

The Hole

As one moves further within the underworld, and deeper within the underground, one sees this chamber from a great distance. Lit from a fire at the bottom of the hole, this chamber exaggerates the depths of the ground.



The LIDAR drawing represents the full domed volume of the oculus chamber. Having a central light source brings the individual back to a visual perception, as they move through the room.

As the culmination of the proposal, this deepest chamber reinforces the effects of the gradation of light, contrasted through the other types of natural light found within the other chambers. As the most expected form of light for the underground, a skylight, the depths of this chamber make the perception of the light more noticeable, and the individual more sensitive to their perceptions.

The Dome

Lastly, the dome provides the greatest sense of scalelessness, as an oculus lit from above. Due to its depth and the individual's tenebrosity, or the gradual sensitivity to small amounts of light, faint light would provide a sense of the volume.

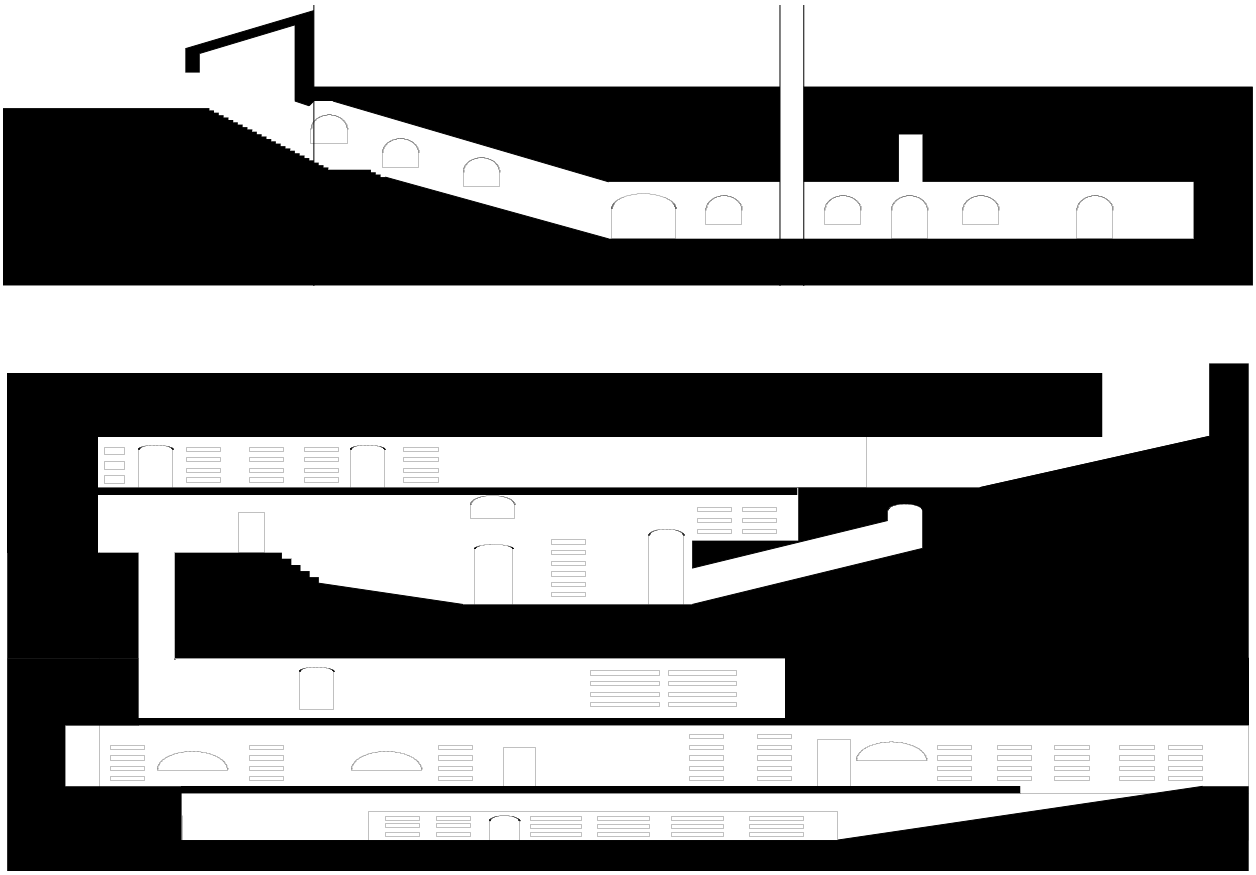
By limiting one's primary dependency on the visual, the underground offers a new way of experiencing space.

REPRESENTATION OF THE UNDERGROUND

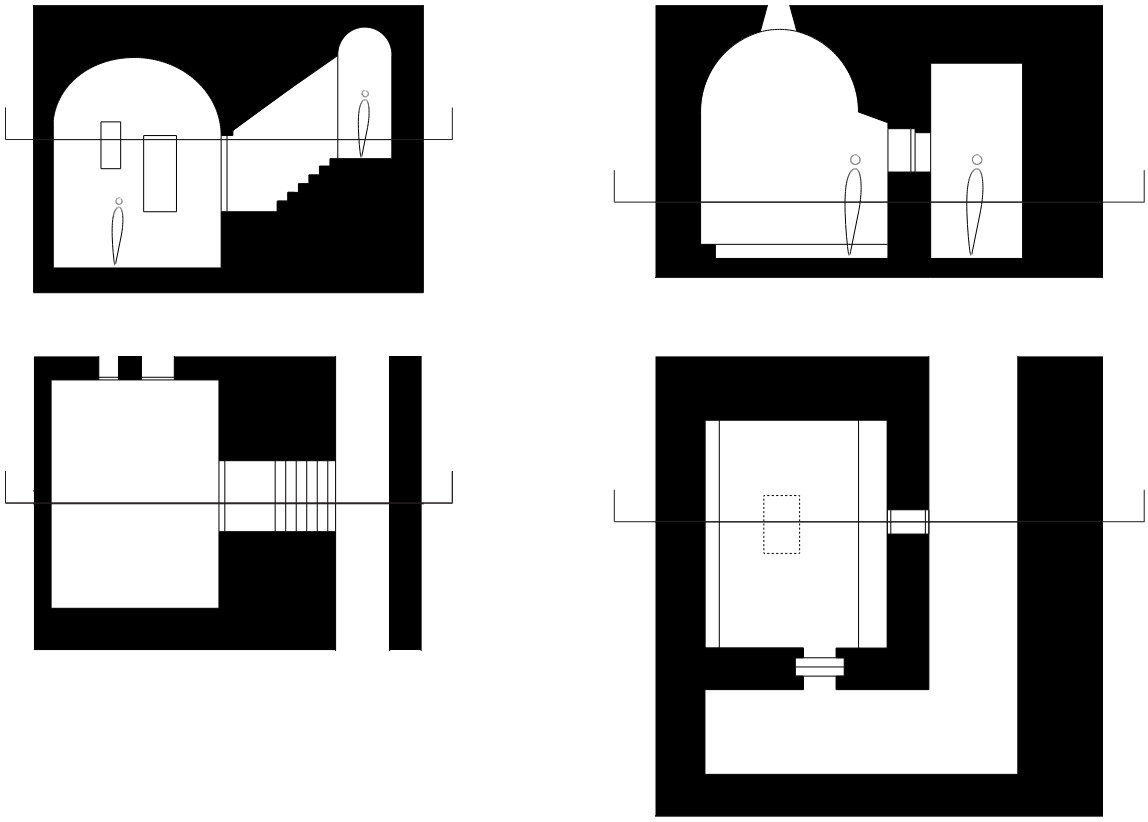
The underground revolts traditional architectural convention.

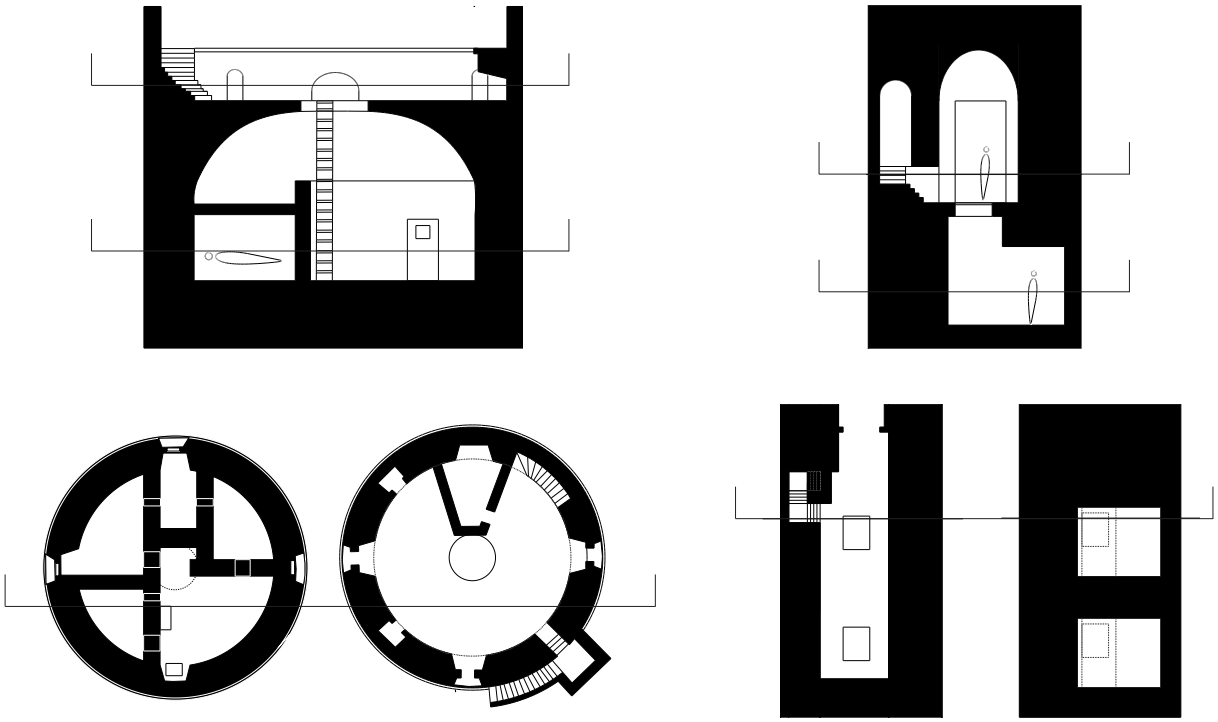
FORMAL TYPOLOGIES

A survey of typical underground spaces, primarily prison cells, monk cells and crypts, were looked at to understand relationships between chamber and circulation. Spatial adjacencies were particularly critical to this understanding, as bodily awareness stems from the perception of how one can be seen within a space.



Section cuts of different catacombs and crypts revealed the importance of a threshold, or portal of entry, questioning architectural ideas of concealing and revealing.

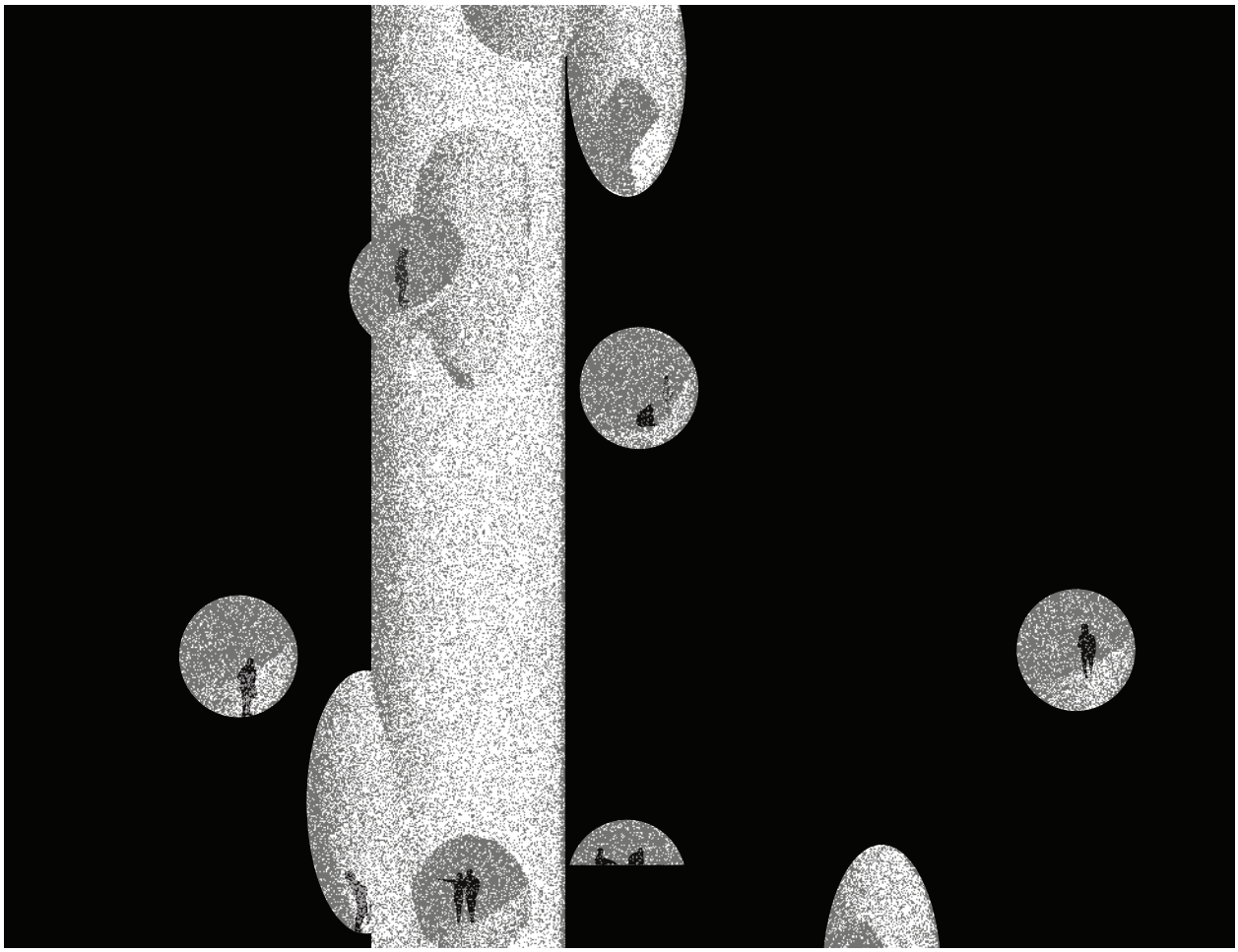




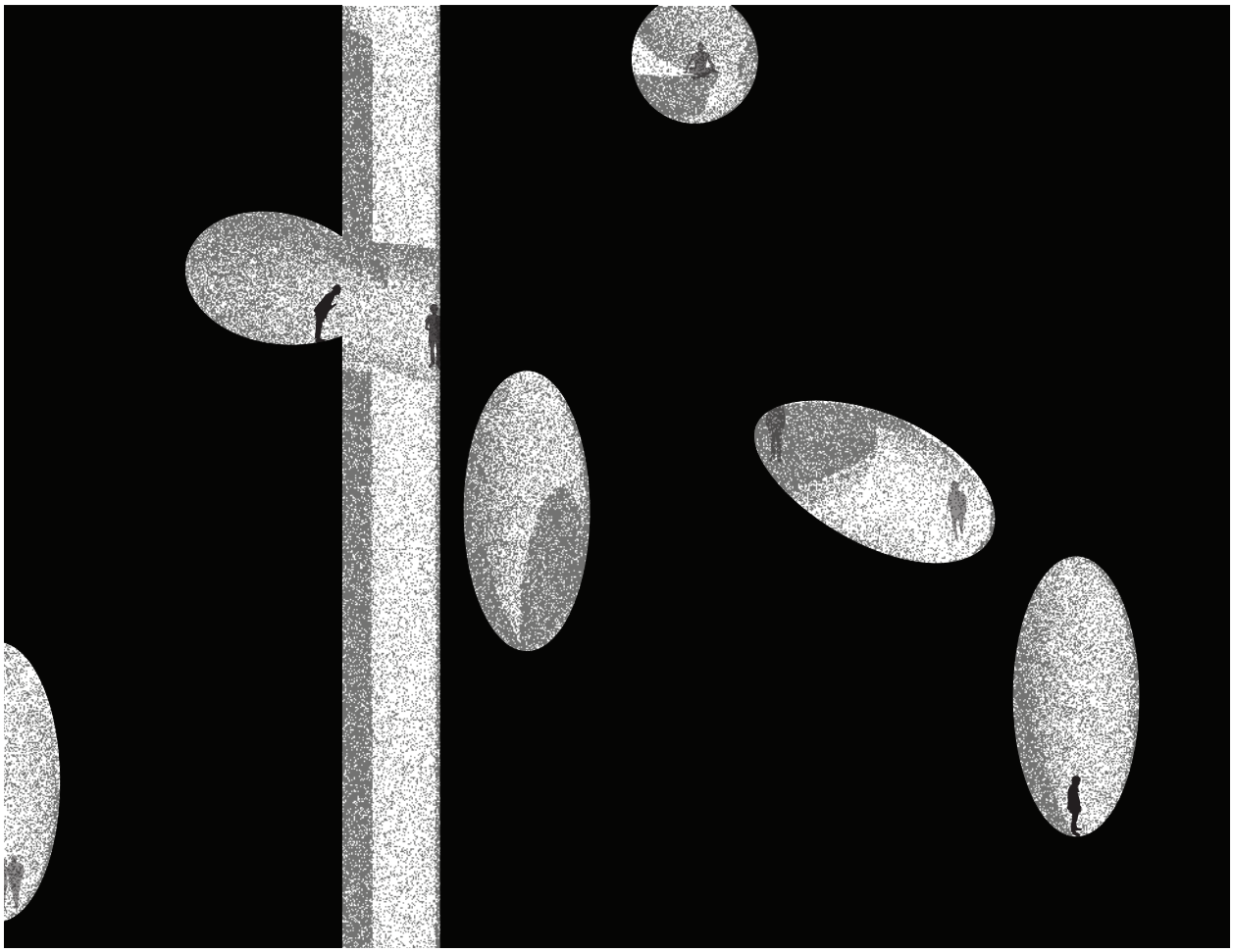
Sections and plan studies of different underground chambers revealed spatial ideas of surveillance and perception, both visual and other. These four prison chambers, with different architectural relationships between the prison cell and the adjacent volume, all had an adjacent space so that one could see the prisoner. This project looks to the point of view of the prisoner, often unable to see outside of the cell, they must rely on other senses for spatial cognition.

FORMAL ADJACENCIES

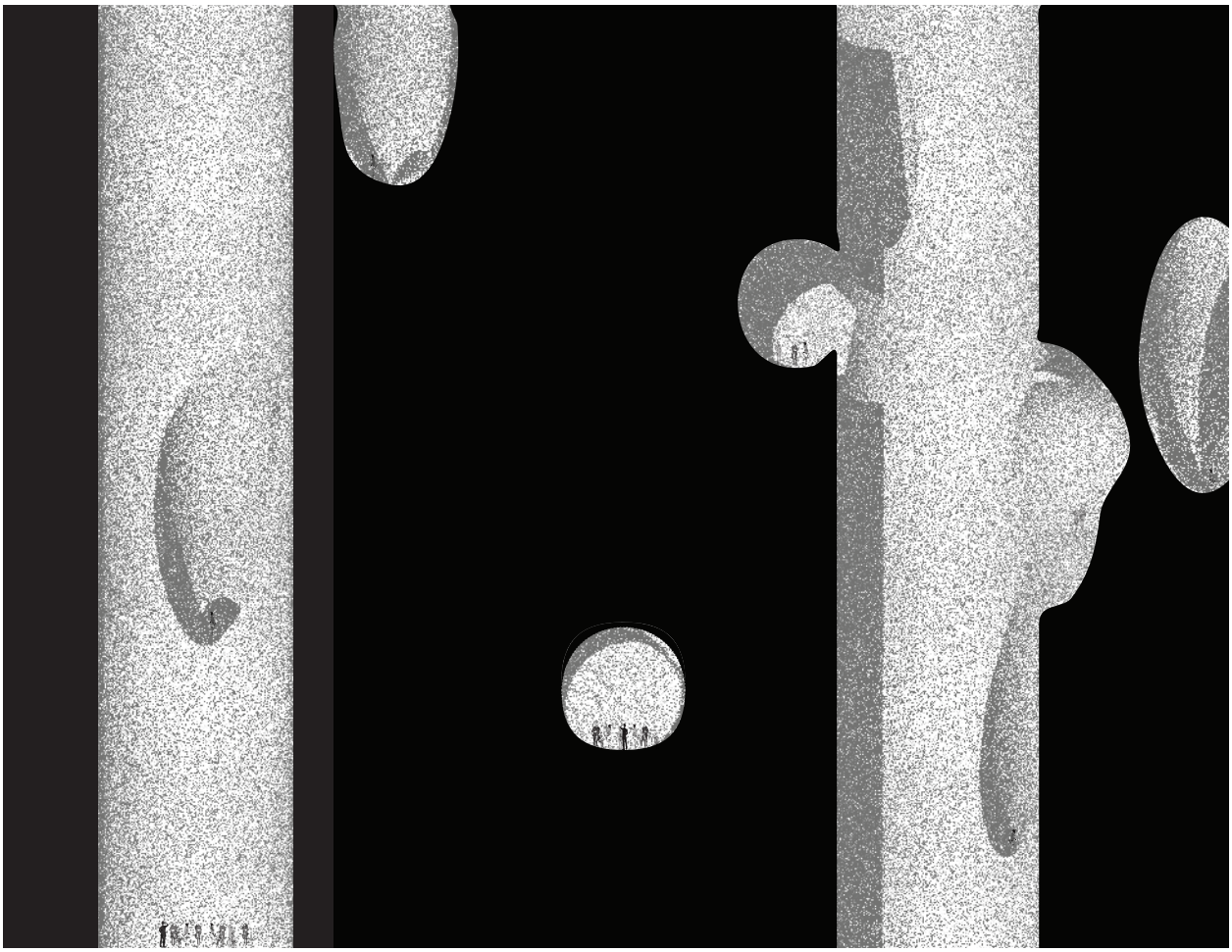
Drawing from the studies of the underground chambers and their spatial adjacencies, how underground architecture uses the adjacent space can be interrogated. In the underground, adjacent space no longer has to be on the same "floor plane", as volumes can be carved in any direction. How can an underground spaces appear to float in relation to each other? The underground offers spaces not bound by gravity, not reliant on orthogonal structure, and carved, not assembled. This allows for the potential of a freeing of space between two volumes.



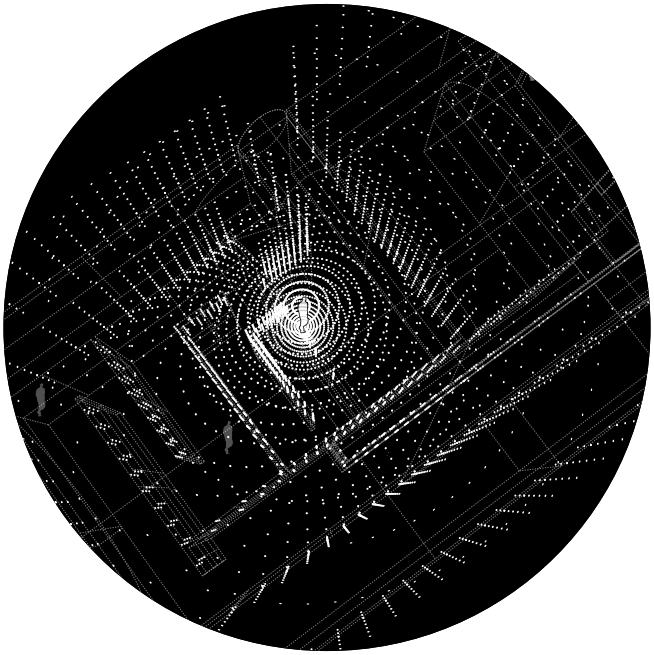
As tunnels run through the project, their intersections allows for moments of engagement, regardless of their planar relationship.



Cross section through a ventilation shaft.



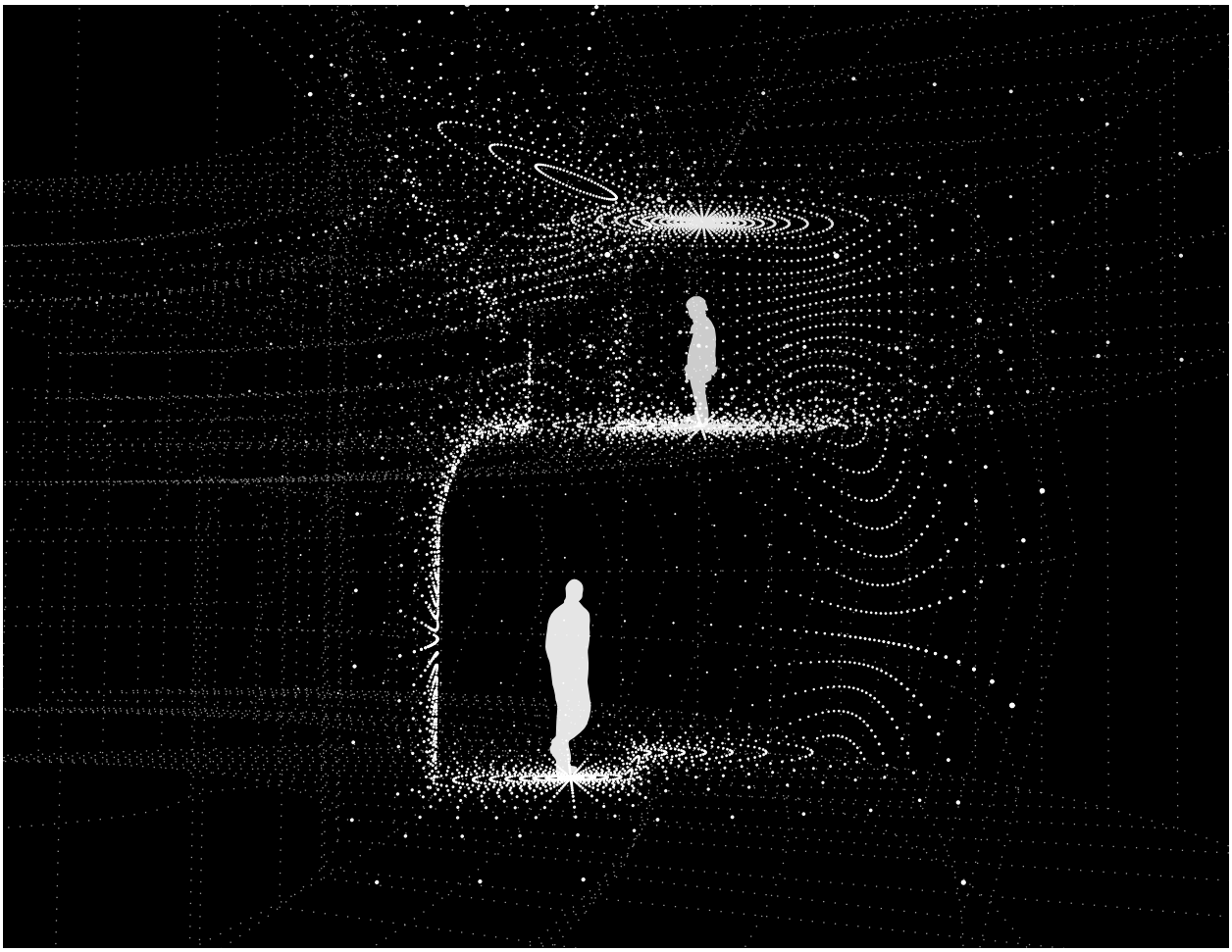
Cross section through a ventilation shaft and a luminous shaft.



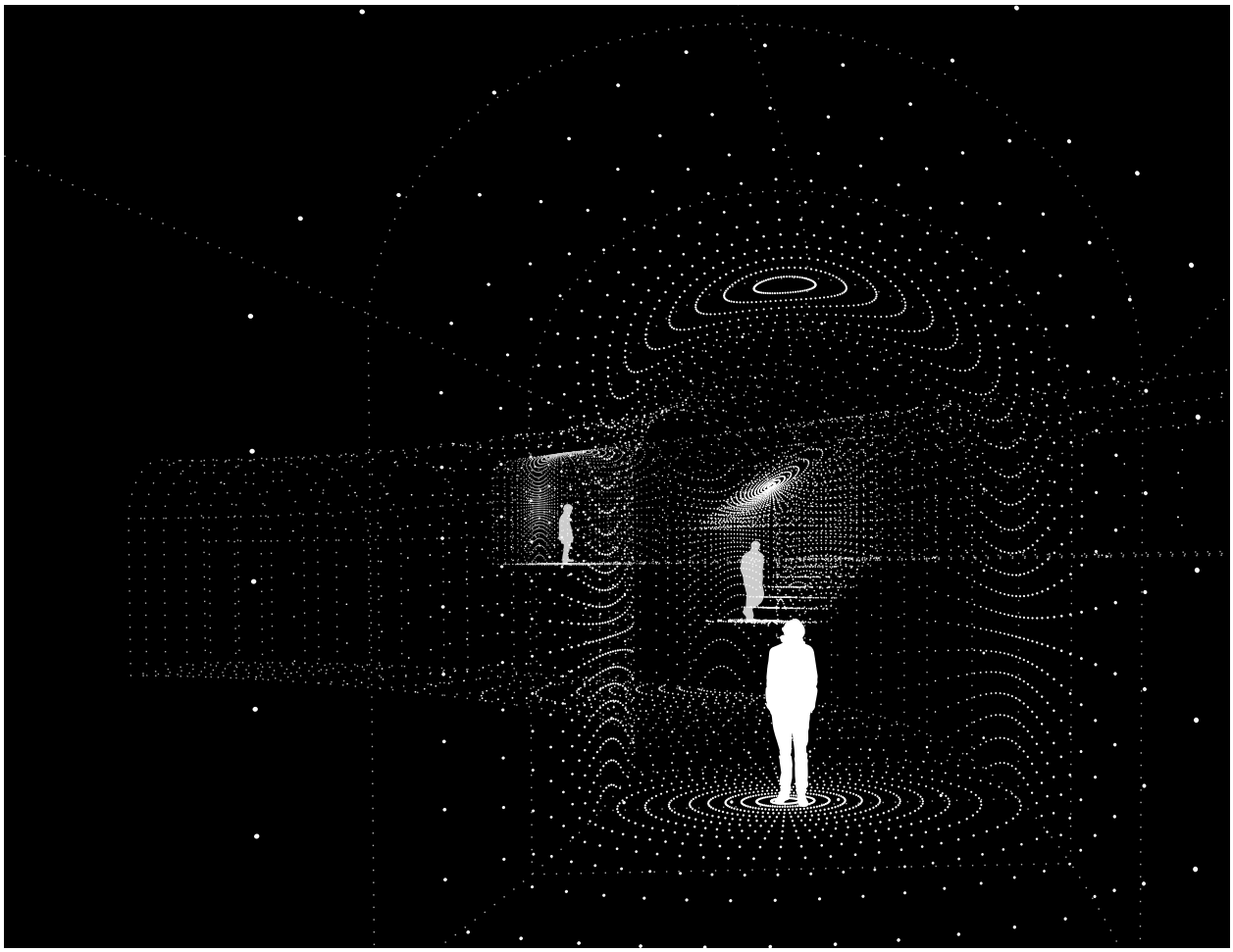
As much of this thesis attempted to define the underground, it also addressed the representation of the underground. One method of testing this representation was through critiquing the 2D convention of drawing. The process of LIDAR, or Light Detection And Ranging, measures distance through the use of lasers. 3D scans of the space then produce a point cloud of the perceivable space around a given perimeter based on depth of field, the body's rotation and an individual's height. LIDAR allows for an exploration of space not defined by one or two single planes, found in a conventional plan or section. Additionally, LIDAR allows for a mapping of space that more accurately describes space perceived by the body's other senses, as one could hear or feel spatial relationships that one may not see, that can be articulated in the 3D drawings.

FORMAL REPRESENTATIONS

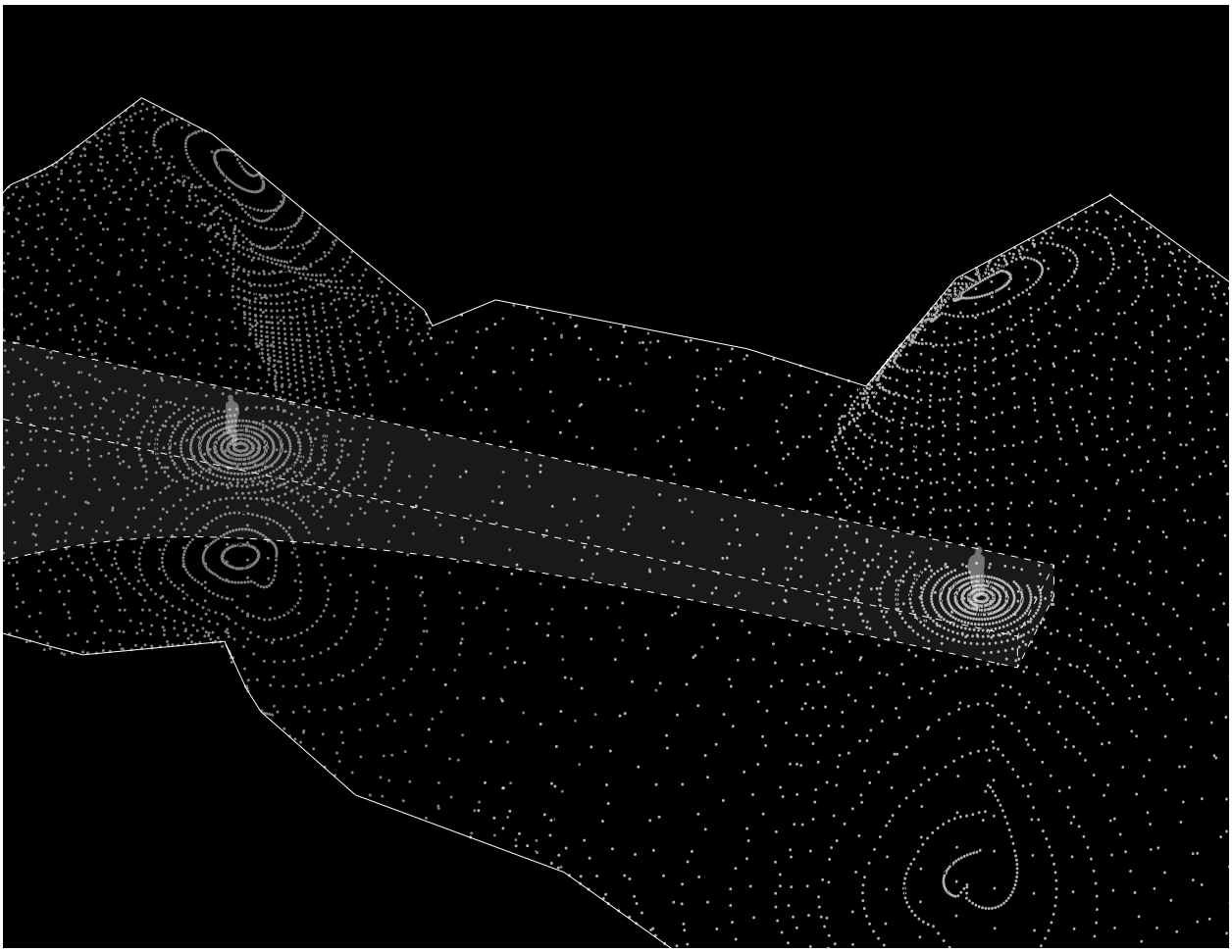
Thinking about the underground calls for a non-conventional method of representation. Here, LIDAR drawings show the spaces of the volumes in terms of points. Representative of how sound waves travel through the space, these drawings allow for a three-dimensional view of a space. This type of drawing speaks to the dynamism that the itinerary evokes, and the multi-sensorial capabilities of the underground.



LIDAR drawing of two vertically connected spaces, a condition that in the traditional sectional drawing would be limited in showing depth.



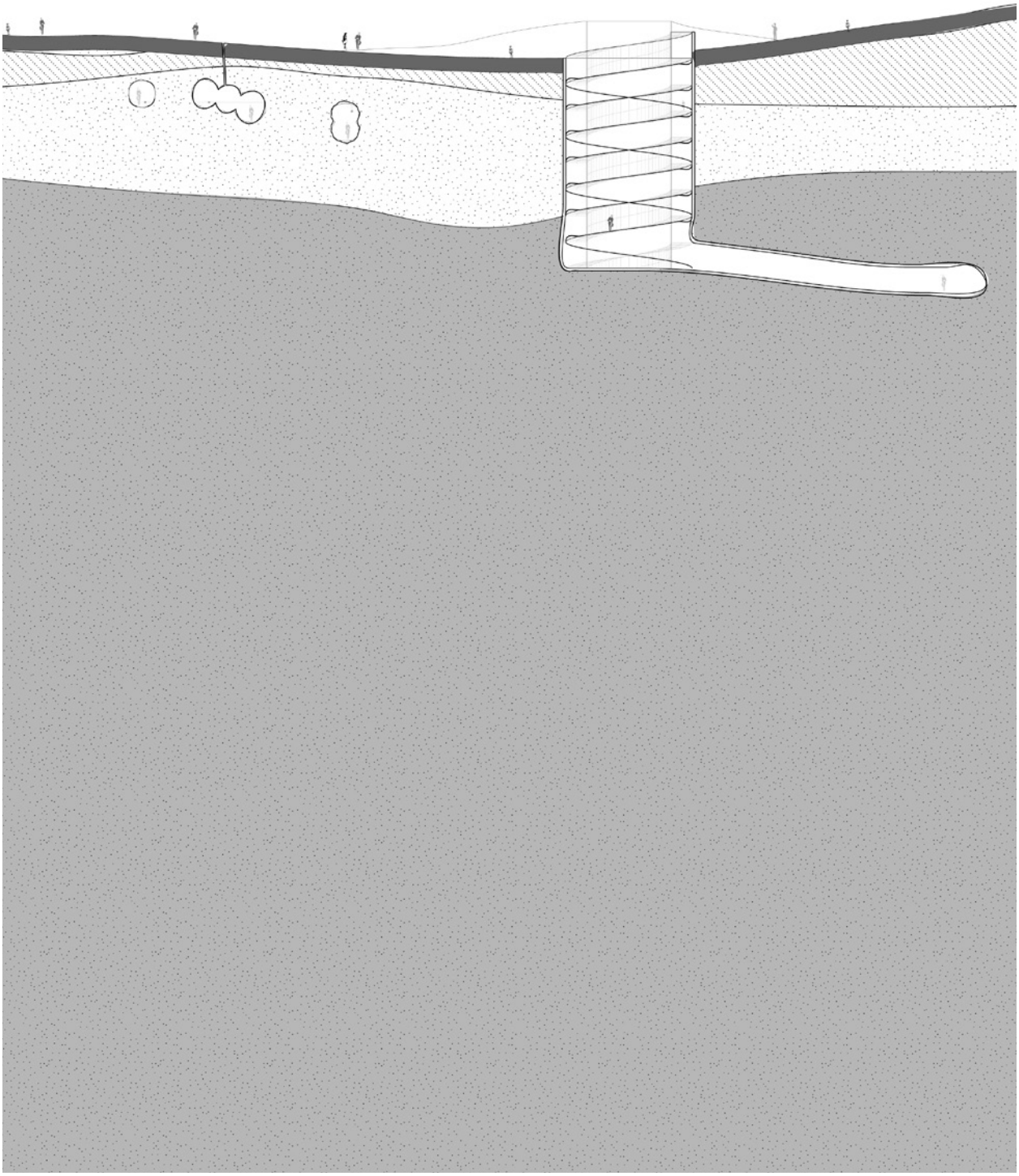
These spaces looked at the relationship between different levels of occupation. Adjacencies here are vertically driven, and call for an analysis of how other senses are perceived within these types of spaces, where light and sound are not merely parallel to the chambers.



The LIDAR drawings were also used to show a mapping of people through the project. Their overlapping fields highlighted areas perceived by multiple individuals at the same time, creating a density of points.

PORTAL + STEAM ROOM

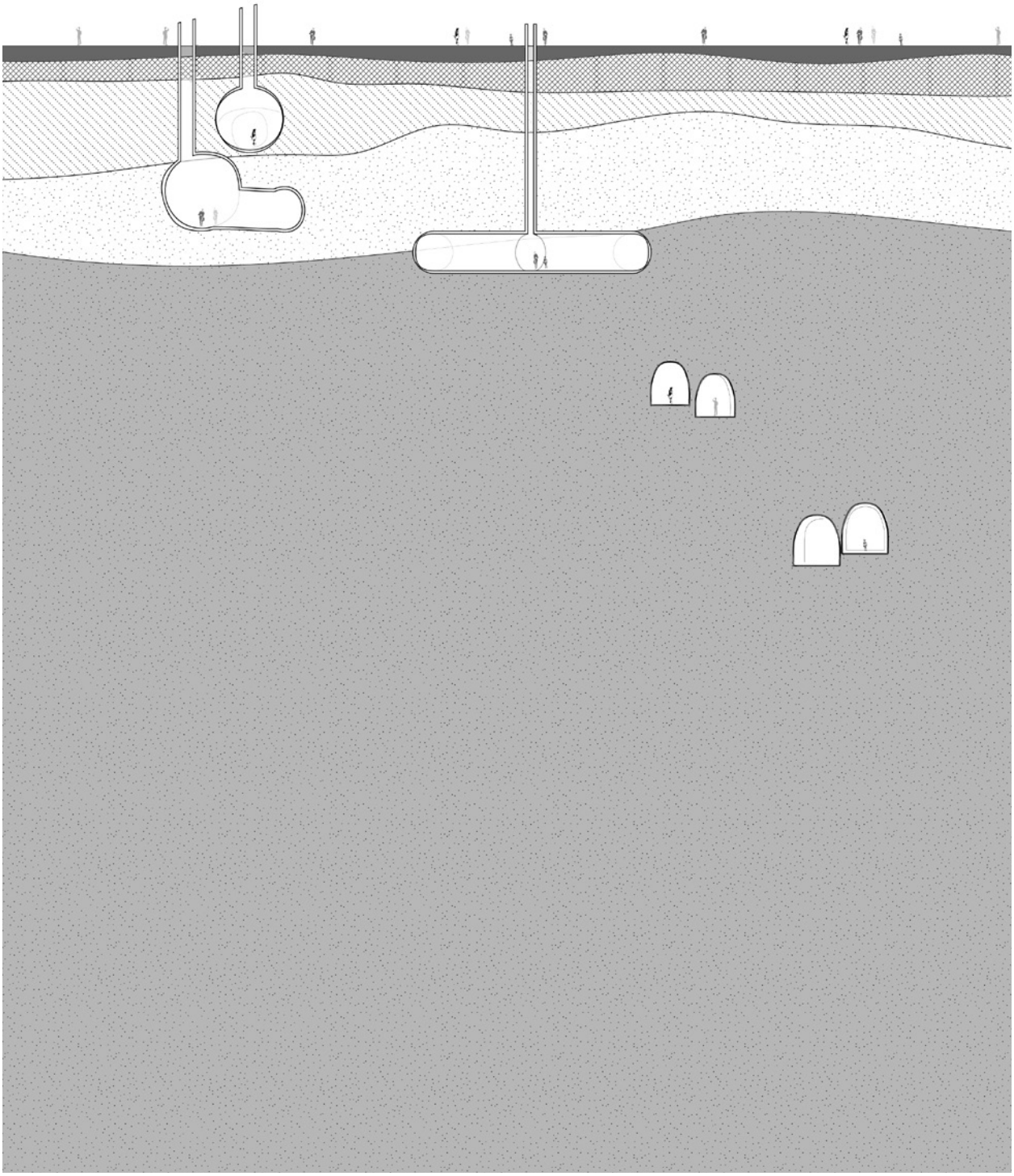
The portal from grade to underground is marked by a ramp that joins earth and sky. Natural light, from above, acts as a beacon for this entrance and provides light for the chambers. Closest to the surface, the small chambers use the steam from the steam pipes in the city to provide another sensory experience.



REPRESENTATION: ***Architectural Conventions***

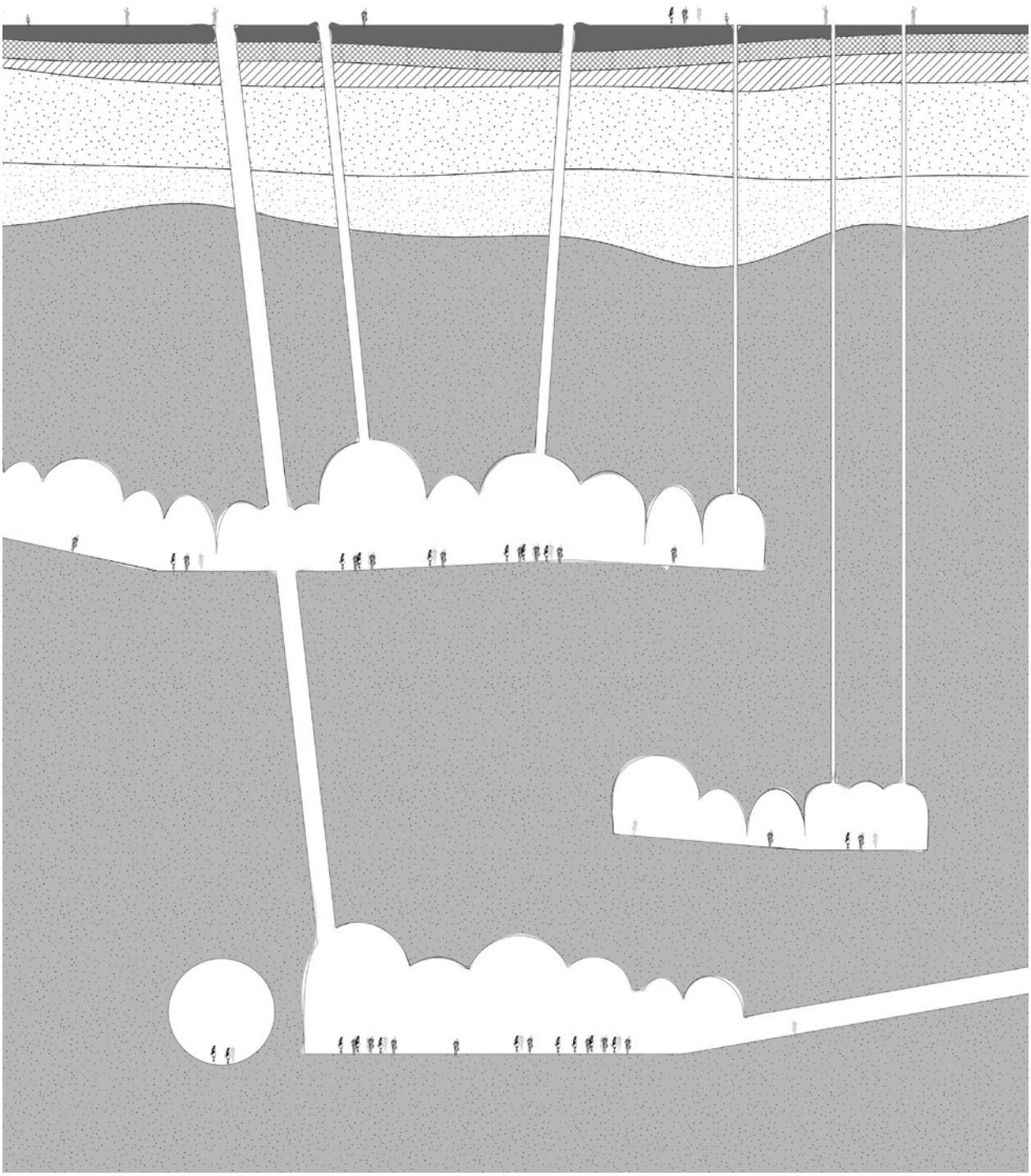
LIGHT WELLS

These chambers vary in height within the earth's layers to create different spectrum of lights as it is directed from above. The light's limits of distance allow for the individual's awareness of tenebrosity.



ECHO CHAMBERS

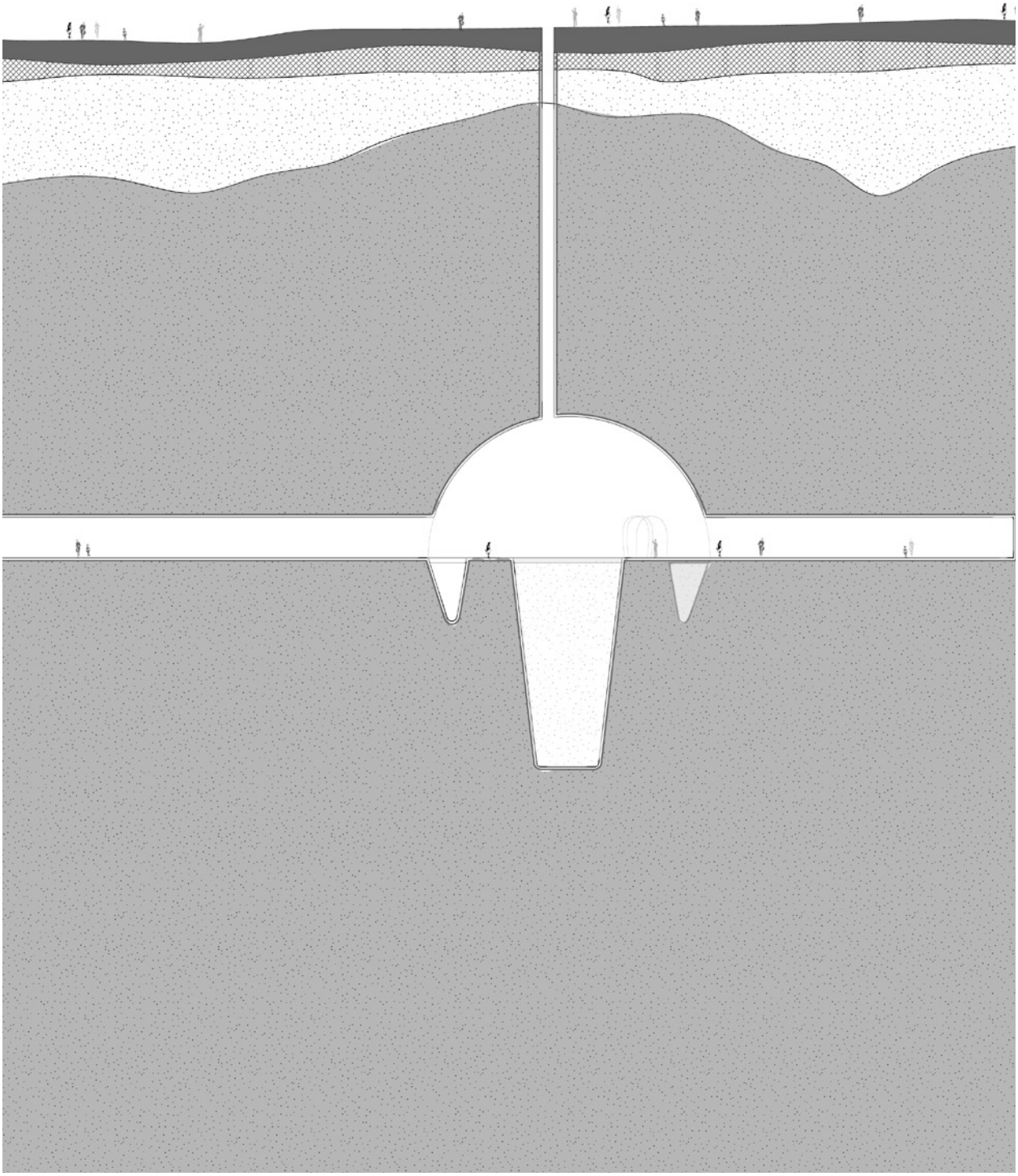
These chambers are designed to produce a variety of sounds, that would guide an individual through the different spaces. Deeper into the earth, with the natural light of bioluminescent fungus, the body does not rely on light for spatial awareness, but is oriented through the space due to the sound waves of the individual rooms.



REPRESENTATION: ***Architectural Conventions***

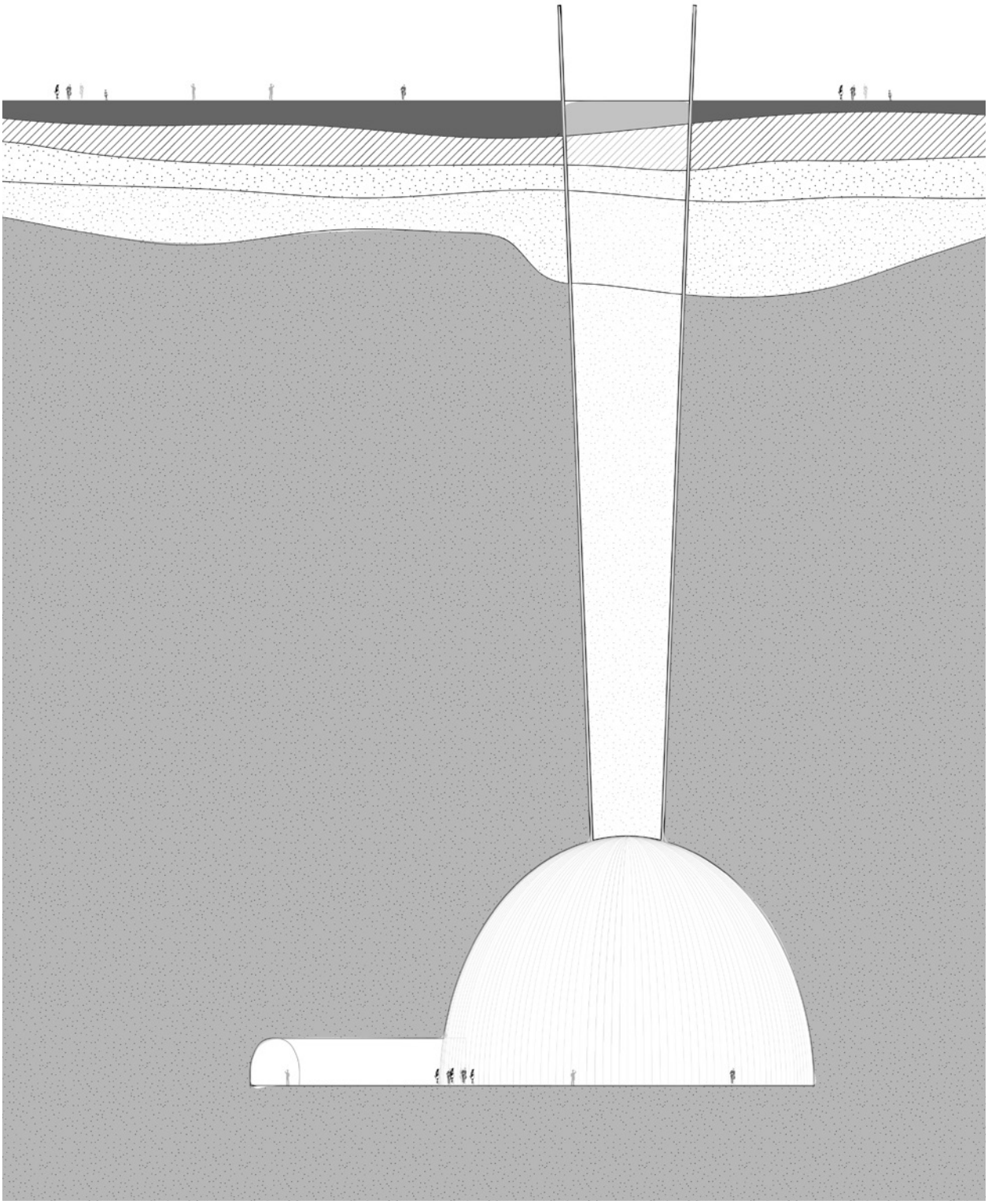
BIG HOLE

Within the granite layer of the earth, this hole is dug to express the extreme massiveness of the earth. Lit from the natural light of fire, one moves through the space along the itinerary.

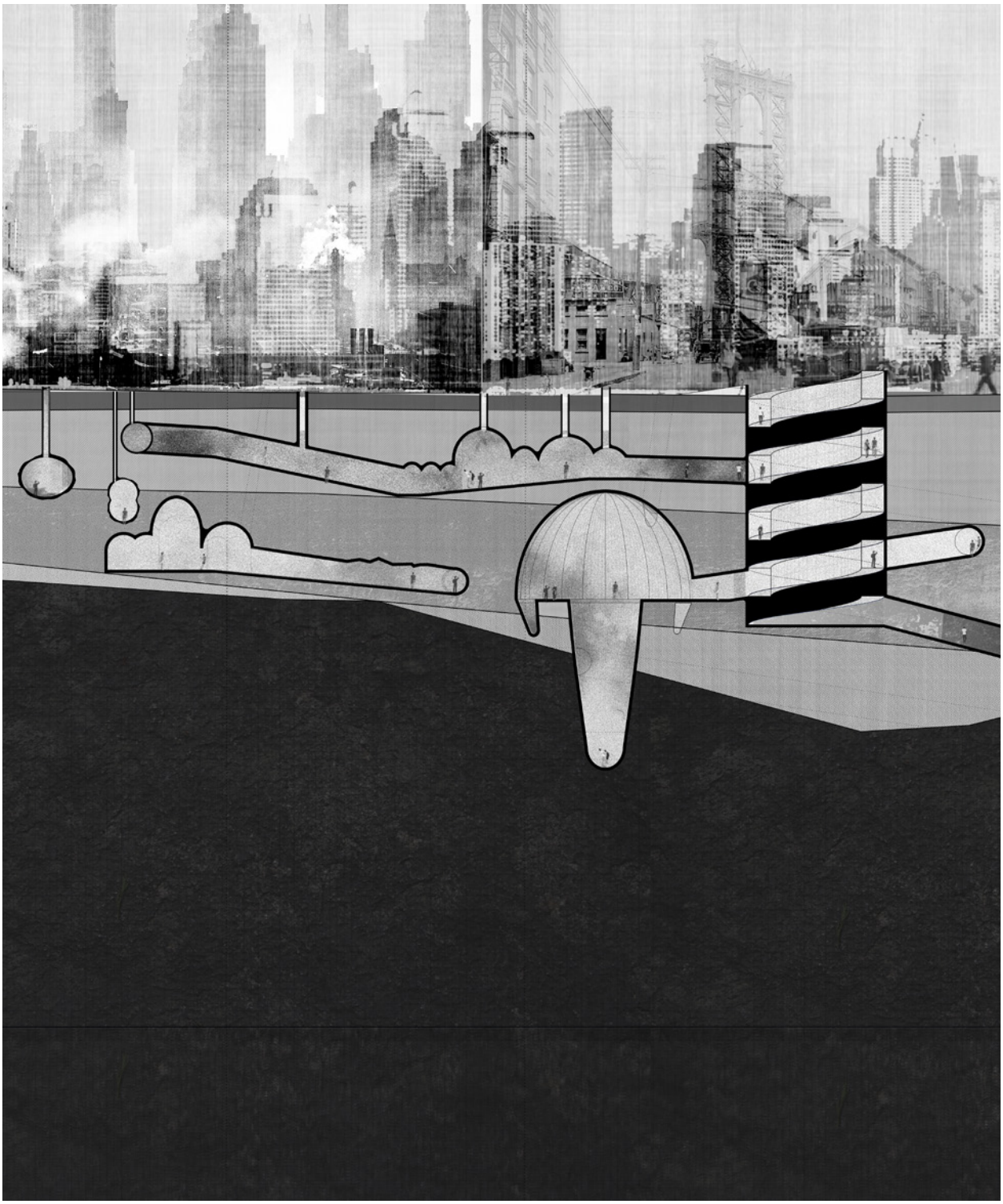


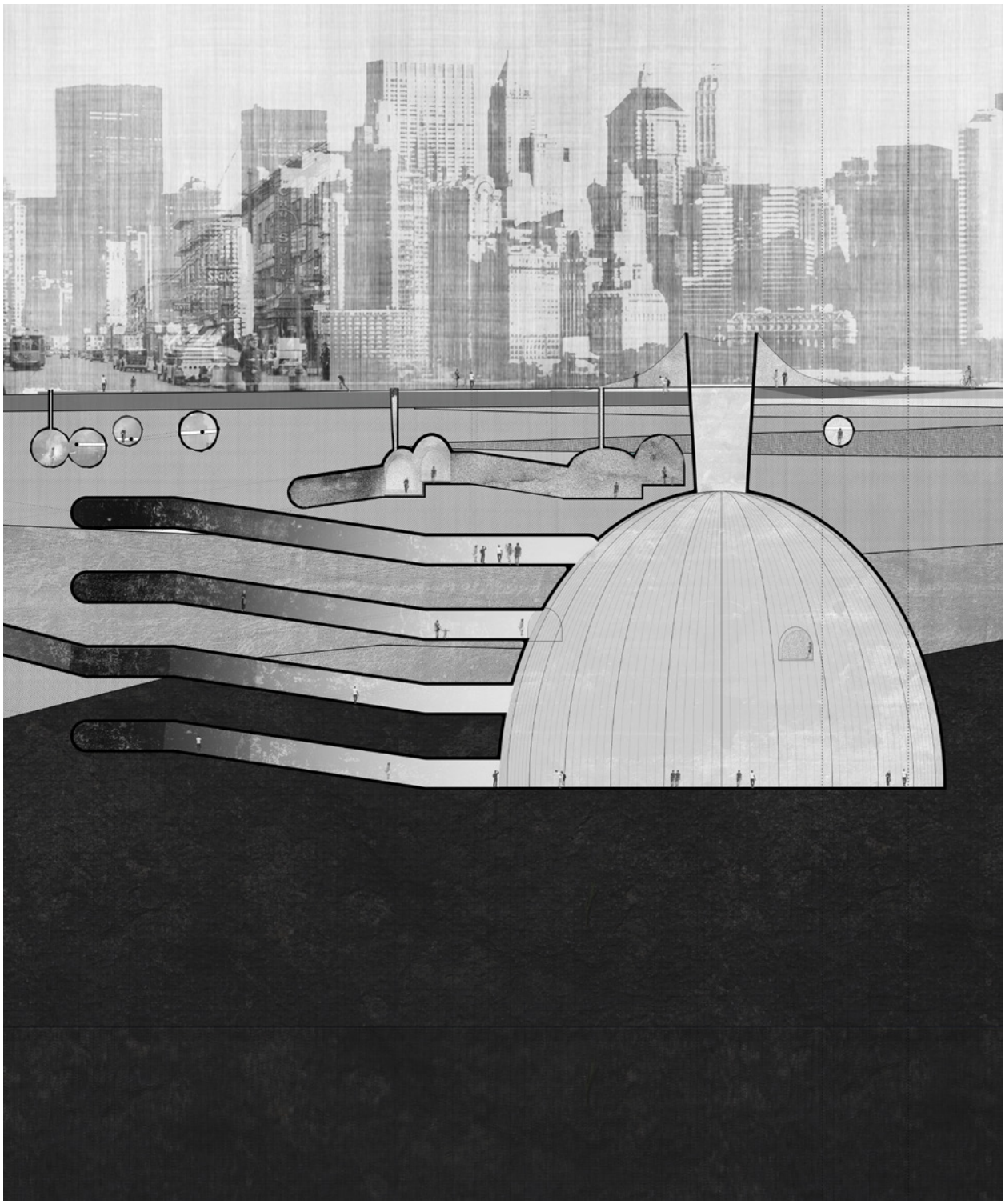
THE DOME

To show the shear scalelessness of the underground, the largest and deepest chamber is buried within the earth, but lit from above. This skylight acts as the attractor of the space. To feel the extreme depth in this chamber, one can feel the discomfort of being underground.



REPRESENTATION: ***Architectural Conventions***





Sited within the context of Manhattan, this underground proposal responds to both the infrastructure located in the city as well as the geological layers of earth and rock. Highlighting the spectrum of senses, this project is about a slow gradation of light, sound and form to allow a new spatial awareness for an individual.

The underground revolts traditional architectural convention.

Fig 17 Final Thesis Presentation, 17 December 2015

The thesis, as it looked at the underground as a way to question conventional architecture practices, also re-imagined the presentation method. Removing the drawing from the wall, around a cyclorama, allowed for the drawing to be walked around and experienced, not as prescribed path or itinerary but as individual moments more representative of how one would walk through the underground proposal.

Fig 18 Final Thesis Presentation, 17 December 2015

The 16 ft. long drawing was hung around a 5.25 ft. diameter circle frame, making it occupiable on the interior. The LIDAR drawings were inverted, and printed and then pin-poked by hand to create a tangible light effect, as light showed through the points, representative of the 3D point clouds.

Fig 19 Final Thesis Presentation, 17 December 2015

Each chamber of the underground proposal also had a render to represent the space alluded to by the LIDAR drawings. Sitting below the panorama drawing, these renders provided a sense of the atmosphere of the rooms, all unique due to their range of natural light.

Fig 20 Final Thesis Presentation, 17 December 2015

The drawing's frame was built to be 6ft tall, in order to have the drawing align with the average eye line. By confronting the drawing at such a proximity, the observer or juror feels both engaged in the space, as well as be able to see the light that shines through it.

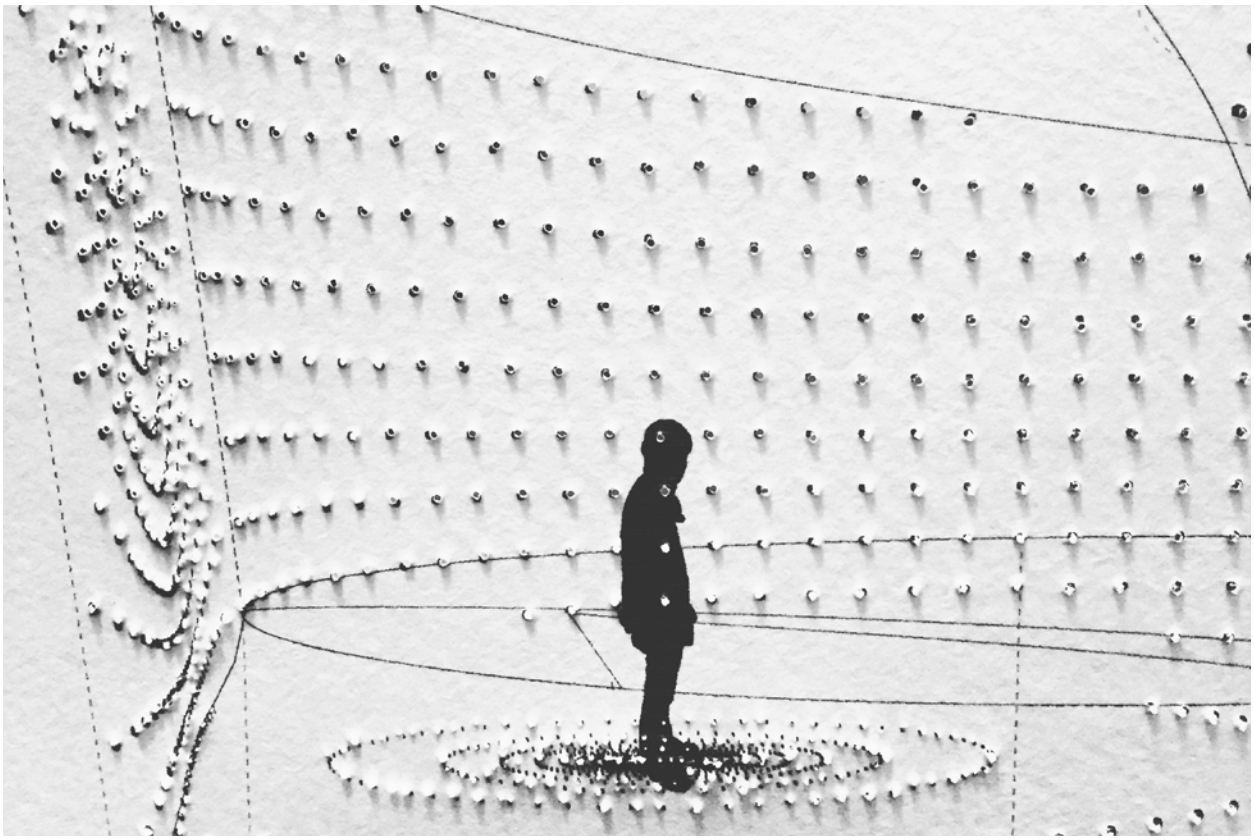


Fig 21 Final Thesis Presentation, 17 December 2015

A detail look at the pin-poked holes representing a 5 degree axis of rotation for the LIDAR drawings. This one shows the entrance of the ramp, into the portal.

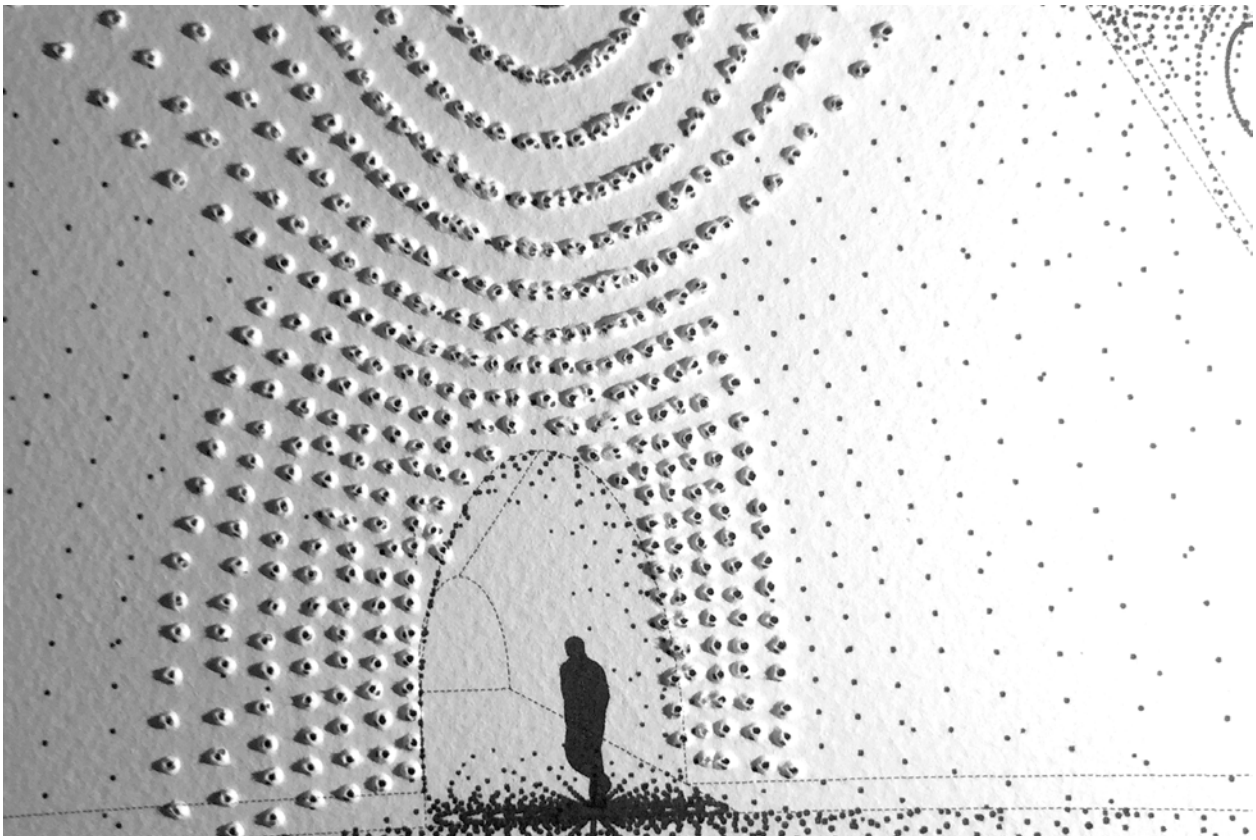


Fig 22 Final Thesis Presentation, 17 December 2015

A detail look at the pin-poked holes representing a 5 degree axis of rotation for the LIDAR drawings. This one shows the back wall to one of the domed spaces.

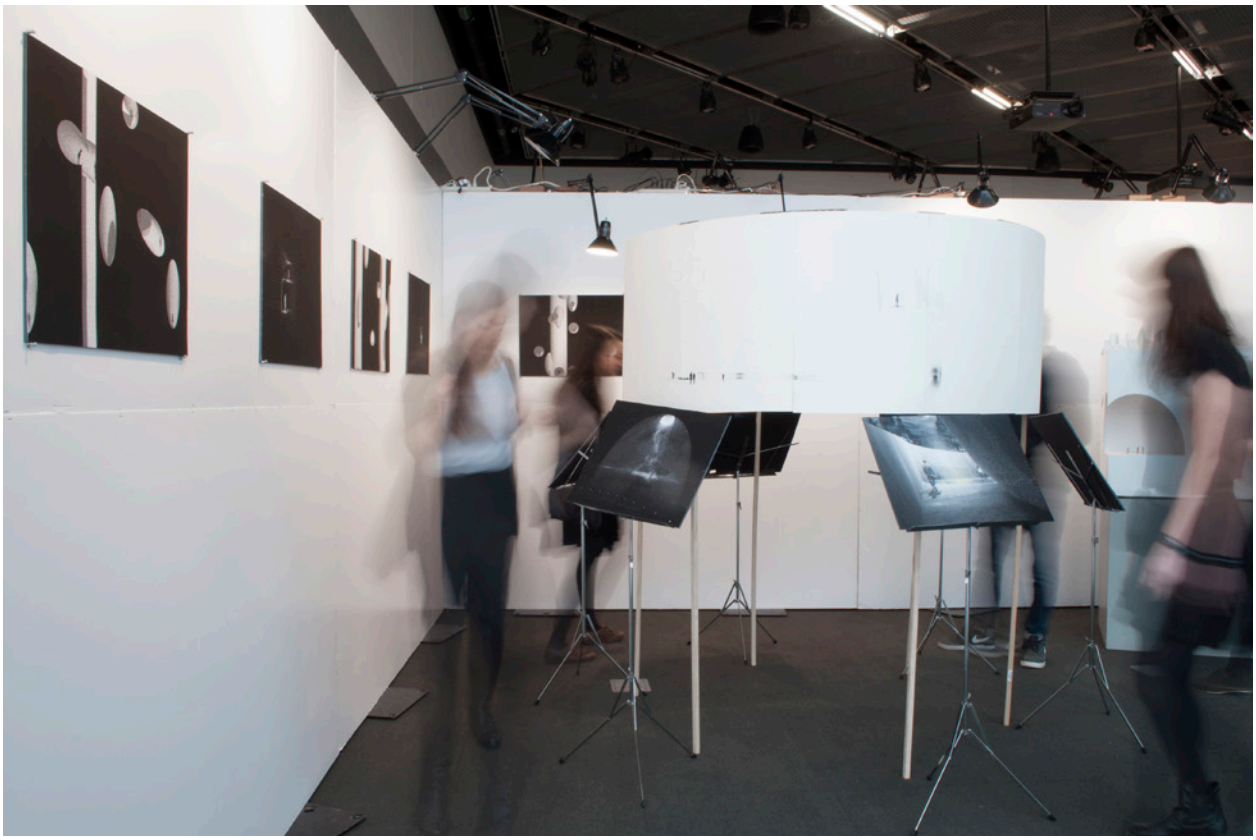


Fig 23 Final Thesis Presentation, 17 December 2015

Jurors walk around the panorama to get a sense of itinerary or procession through the project. Having the juror's actually negotiate the space of the review called into question the space of representation.

Fig 24 Final Thesis Presentation, 17 December 2015

Jurors occupy the cyclorama to see the lighting effects of the pin-poked LIDAR representations. The interior of the cyclorama also allows for a cacophonous experience, as it echoes the sound when one is in the space. This thesis attempted to continually re-imagine how other senses could be addressed in a representation of an architectural space.

Fig 25 Final Model, 17 December 2015

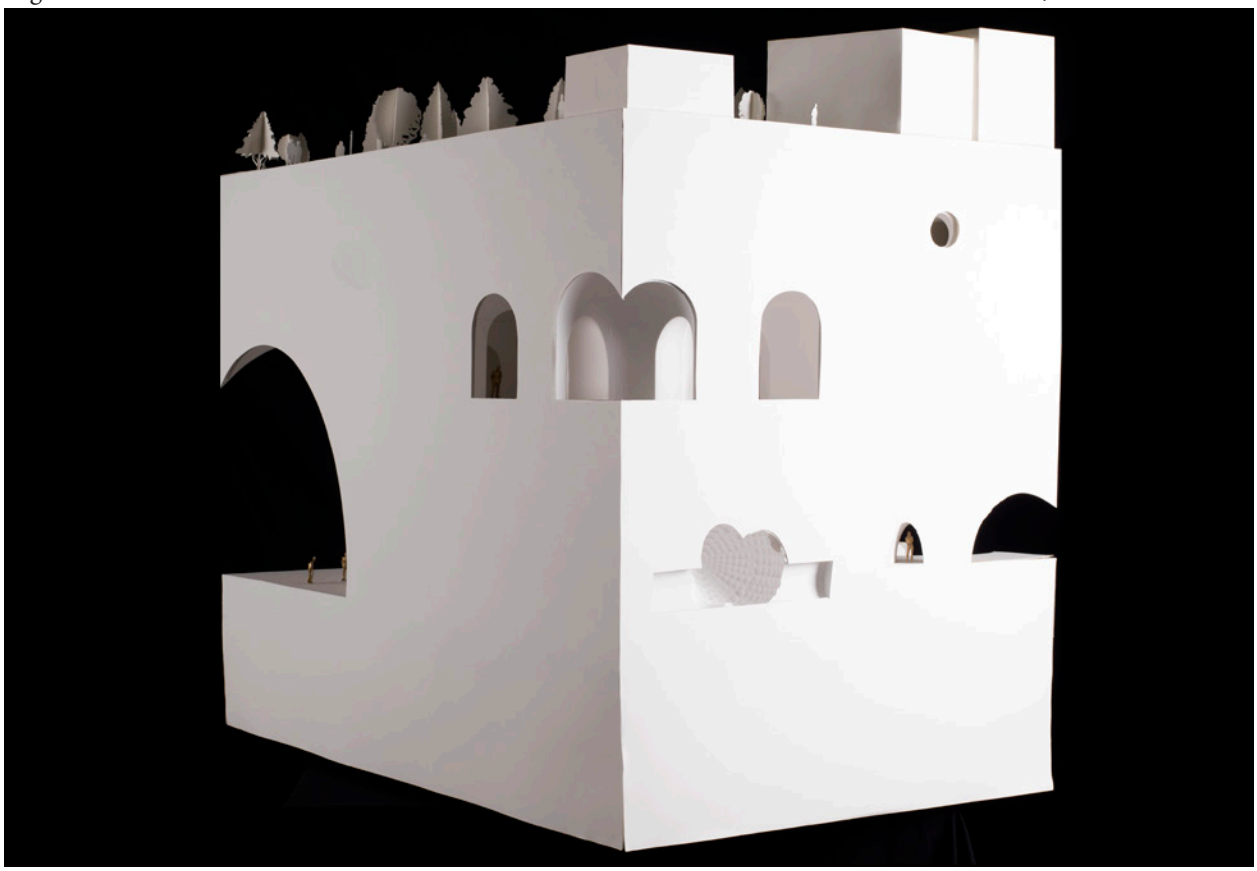


Fig 26 Final Model, 17 December 2015

Fig 27 Final Model, 17 December 2015

Fig 28 Final Model, 17 December 2015

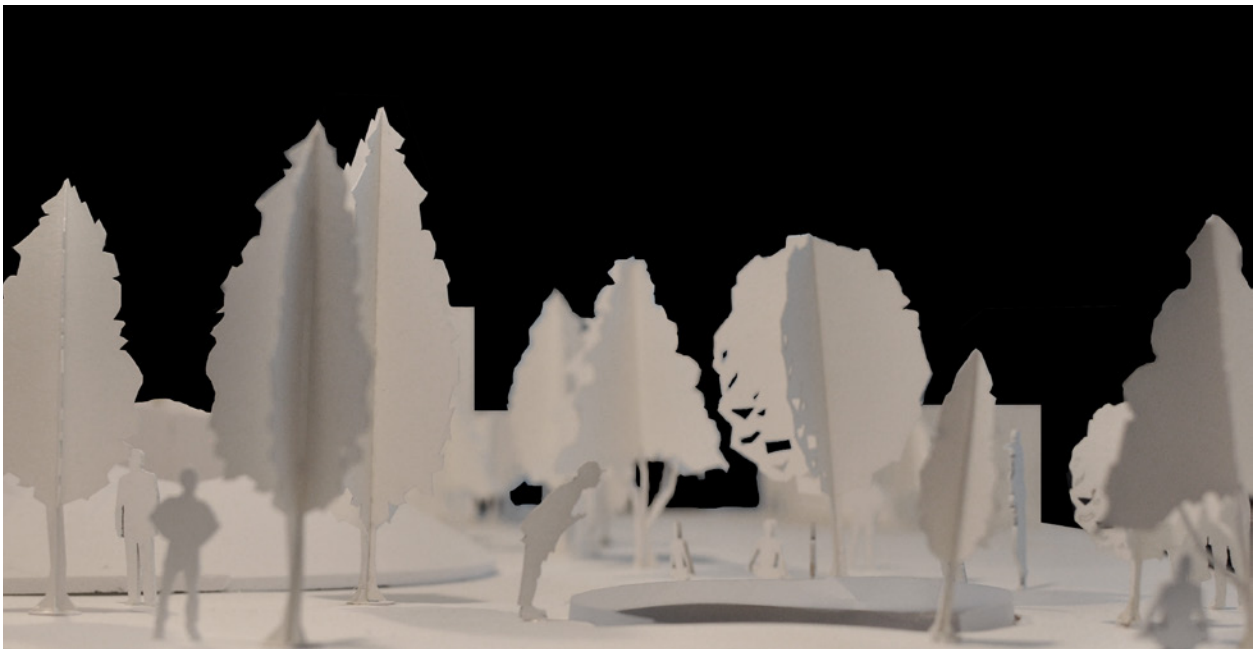


Fig 29 Final Model, 17 December 2015

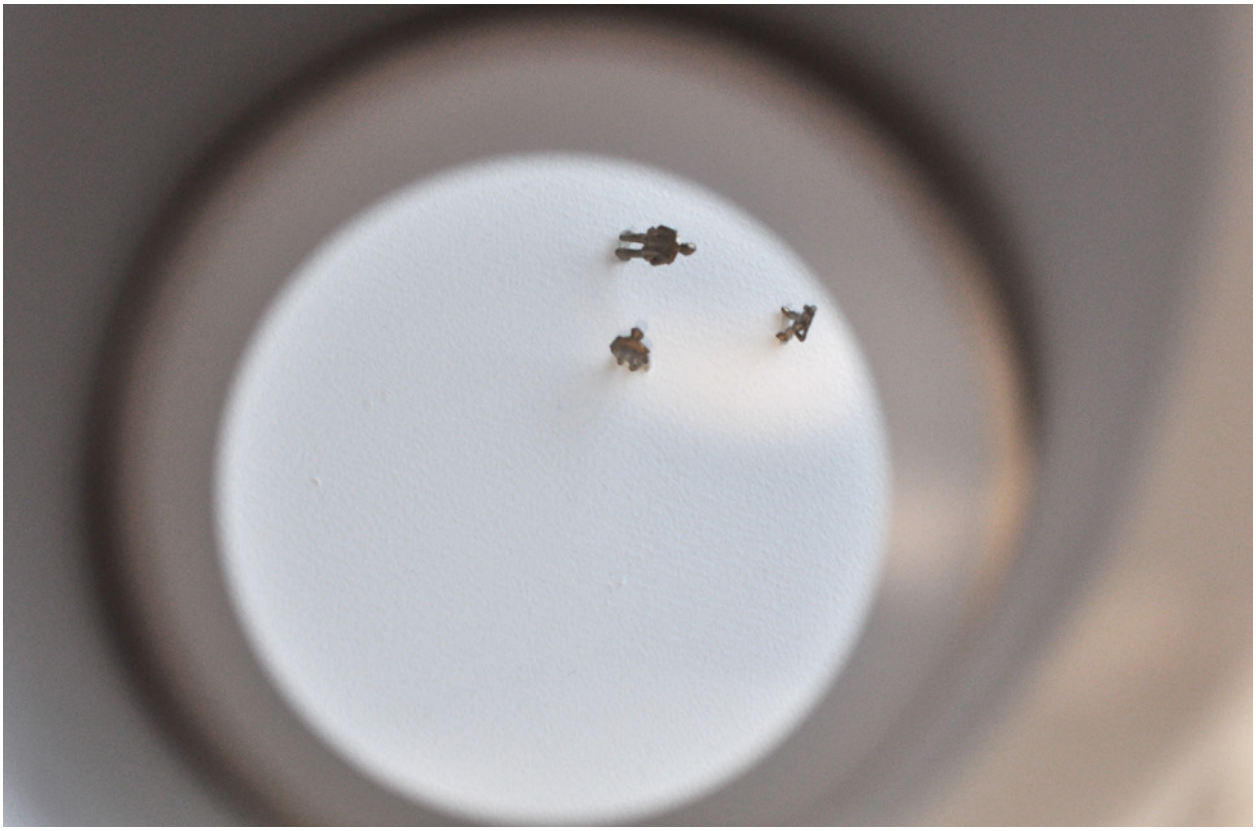


Fig 30 Final Model, 17 December 2015

Fig 31

Steam Room

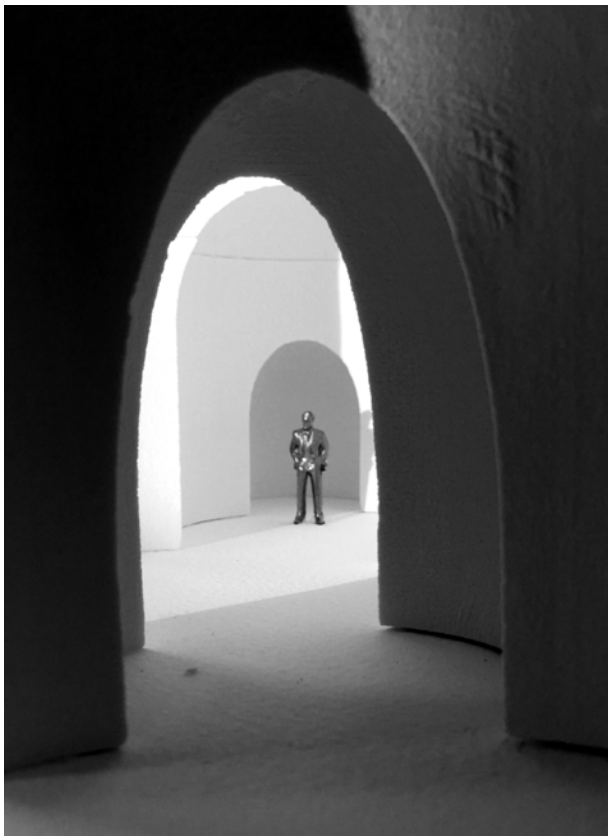


Fig 32

Echo Chamber

Fig 33

Steam Room

Fig 34

The Hole

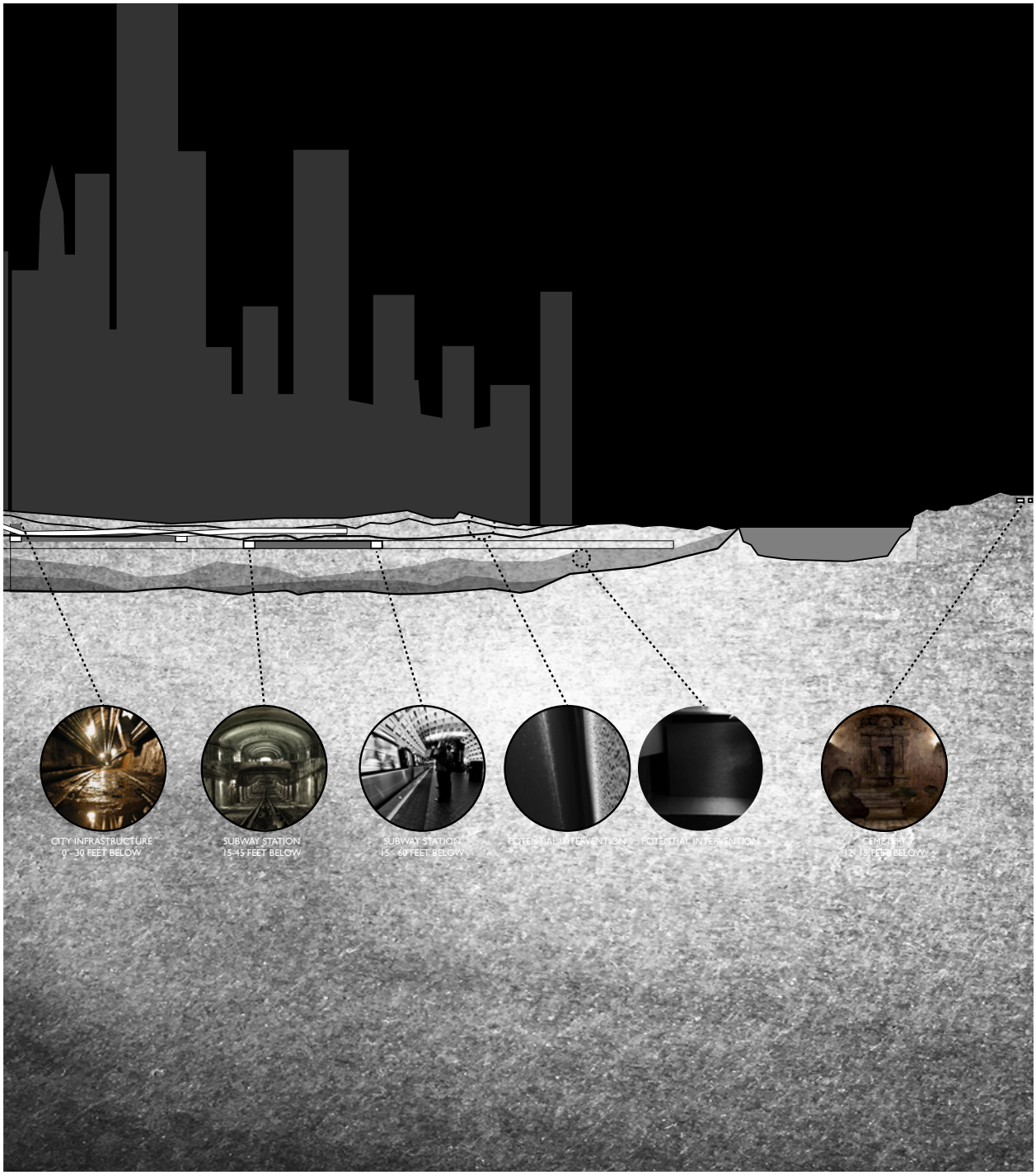
The contemporary city calls for a reassertion of the ceremonial underground, extending beyond the infrastructural impulse. This thesis views the underground as an unexplored, often neglected territory, in which immersive qualities allow for an unadulterated, highly stimulating and sensorial experience.

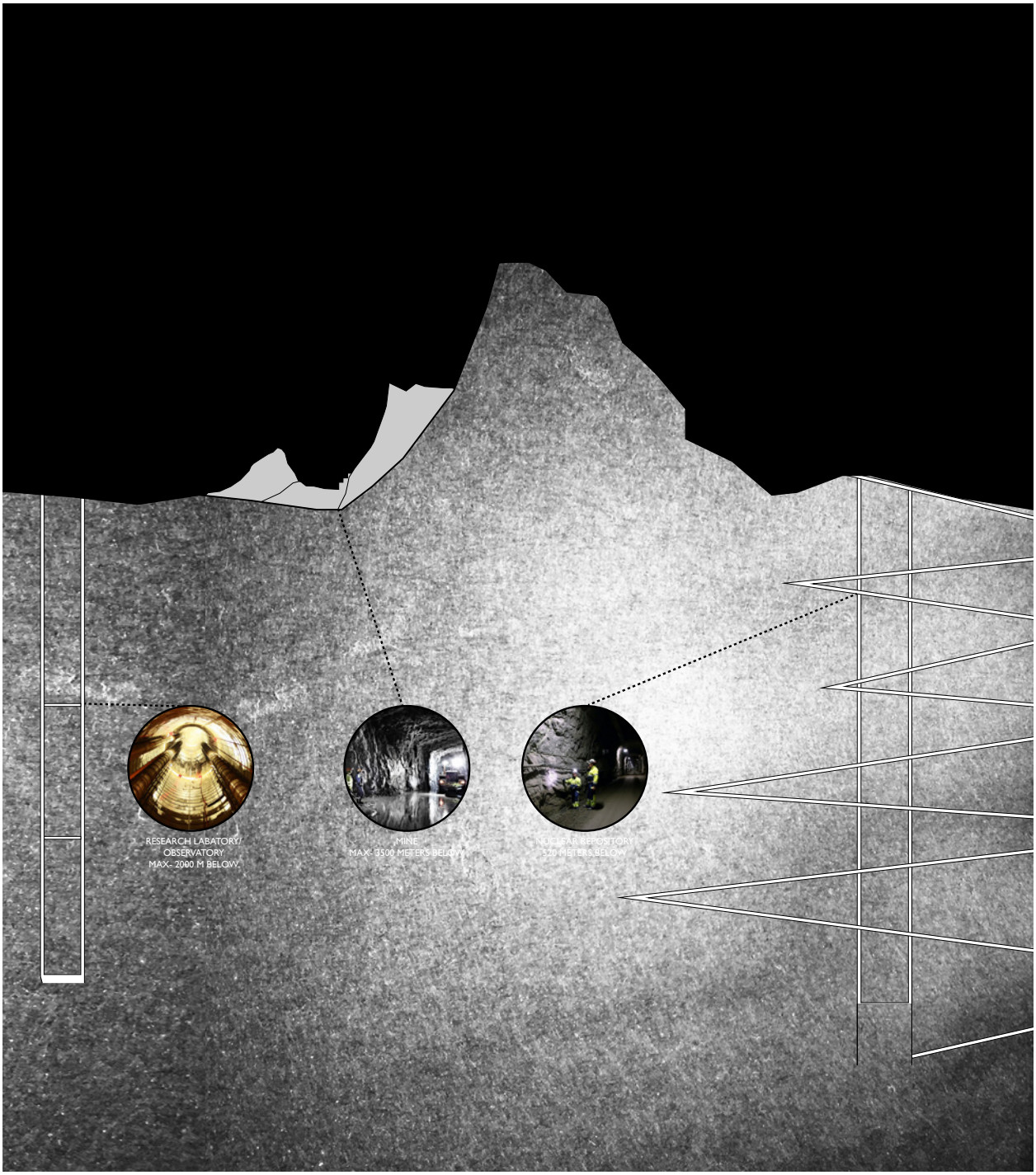
The underground revolts traditional architectural convention.

APPENDIX

"The traveler descends to a realm of dampness, darkness and formlessness... neither ugly or beautiful, but something else entirely: obscure but pleasingly obscure, terrible but delightfully so."

Rosalind Williams, Notes on the Underground


CITY INFRASTRUCTURE
0 - 30 FEET BELOW
SUBWAY STATION
15-45 FEET BELOW
SUBWAY STATION
15 - 60 FEET BELOW
POTENTIAL INTERVENTION
POTENTIAL INTERVENTION
CEMETERY
15-15 FEET BELOW



A panorama of the world's subterranean uses.

Pictured from left to right: city sewer, city subway tunnel, city subway station, proposed space, proposed space, cemetery, laboratory, mine shaft and nuclear waste depository.

PRECEDENTS

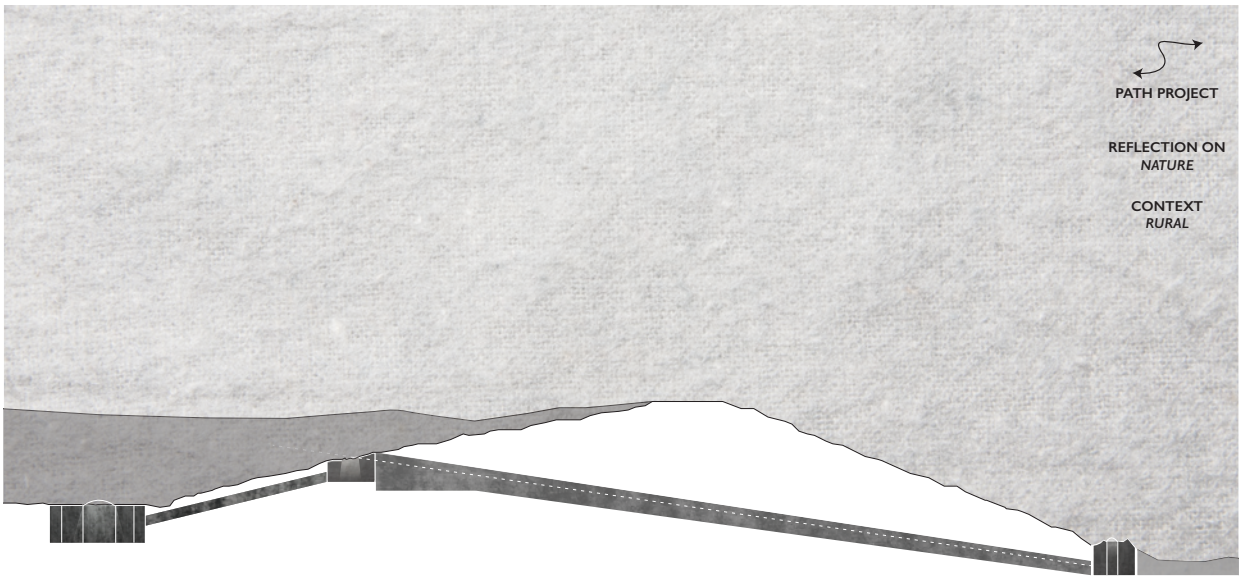
RODEN CRATER PROJECT: *James Turrell*

Fig 35

Roden Crater Project

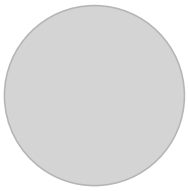
ARCHITECT: James Turrell
LOCATION: Near Flagstaff, Arizona
ELEVATION: +5400 ft
DEPTH OF PROJECT: 600 ft
NUMBER OF UNDERGROUND SPACES: 5 rooms
NUMBER OF TUNNELS: 5
SUBTERRANEAN AREA: N/A
PROGRAM: Observatory/ visitor's center

The Roden Crater Project, situated within its expansive desert landscape, uses its monumentality to express feelings of the sublime. Operating with many of the senses in mind, Turrell aims to create an all encompassing experience. Relying on the architectural manipulations of the interior, this project deploys scale to manipulate the senses.



SENSORY TESTING

- light, darkness, color, form perception, celestial sightings, landscape
- planetary radio emissions
- wall surfaces, floor surfaces, geology
- anthropocentric, depth perception
- areas for supine observation



SUBTERRANEAN AREA

SENSES ENGAGED

MEMORIAL TO THE MURDERED JEWS: *Peter Eisenmann*

Fig 36

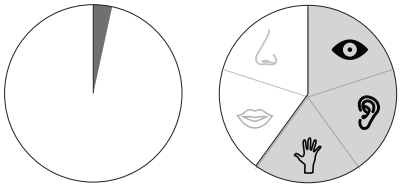
Memorial to the Murdered Jews

ARCHITECT: Peter Eisenmann
LOCATION: Berlin, Germany
DEPTH OF PROJECT: 15 ft
NUMBER OF UNDERGROUND SPACES: 11 rooms
NUMBER OF TUNNELS: N/A
SUBTERRANEAN AREA: 800 sq meters
PROGRAM: Memorial site, visitor's center

The Memorial to the Murdered Jews heightens one's sensual experience with the space with the change between exterior and interior. The monument at grade level provides a overwhelming experience with echoing sounds and changes in topography and one's horizon line. Sensory deprivation is then felt when descending into the subterranean volume. This spatial disorientation allows the underground to assume the quality of the sublime.

SENSORY TESTING

- light, darkness, absence, materials, topography
- auditory zones: urban noises, echoing, silence
- material surfaces, statue heights
- spatial disorientation, all encompassing experience



SUBTERRANEAN AREA SENSES ENGAGED

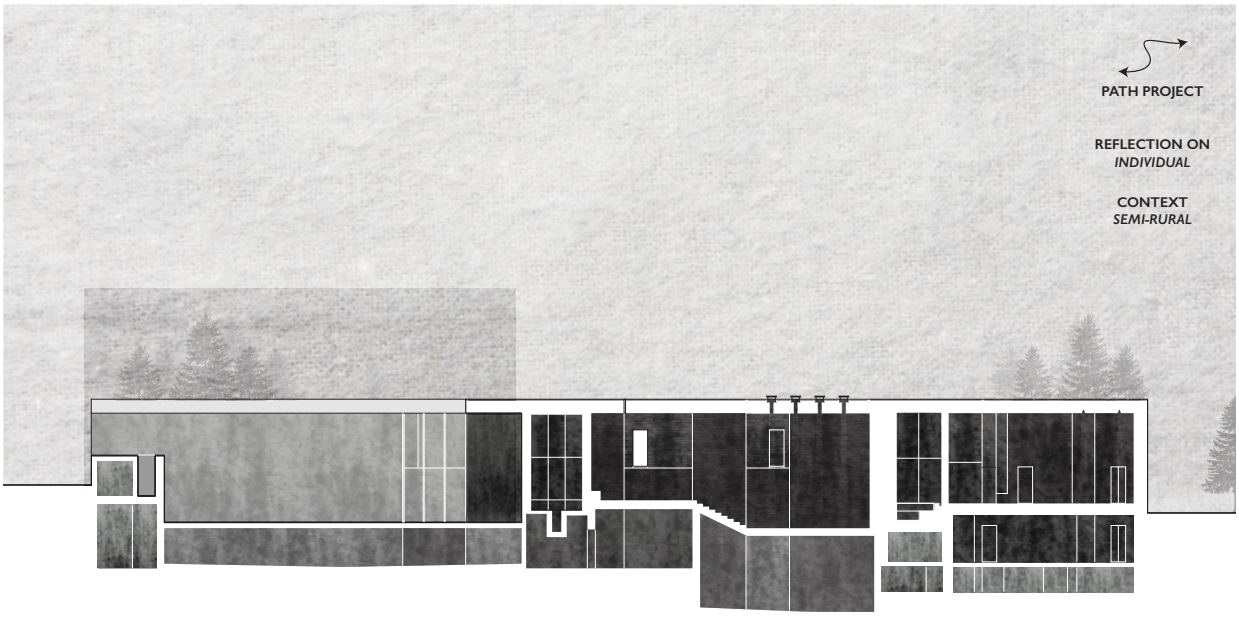
THERMAL VALS: *Peter Zumthor*

Fig 37

Thermal Vals

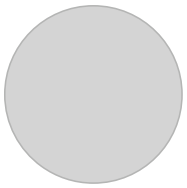
ARCHITECT: Peter Zumthor
LOCATION: Vals, Switzerland
DEPTH OF PROJECT: 48 ft
NUMBER OF UNDERGROUND SPACES: 70 rooms
NUMBER OF TUNNELS: N/A
SUBTERRANEAN AREA: 40,000 sq ft
PROGRAM: Bath, spa

Therme Vals uses light, darkness, form and materiality specifically to address the body and its senses in space. Situated within the Alps and covered with a green roof, the baths use interiority to express different spatial conditions. Zumthor designs with sound, temperature, moisture and light to create spaces that alter one's orientation and perception.



SENSORY TESTING

- light, darkness, reflection, materials, landscape
- echoing bath chamber
- floral bath chamber, mineral water
- mineral water
- temperatures, material, water, surfaces
- ergonomics, spatial disorientation, all encompassing experience
- supine seating



SUBTERRANEAN AREA

SENSES ENGAGED

DUPONT CIRCLE: *Various*

Fig 38

Dupont Circle

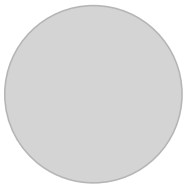
ARCHITECT: Multiple
LOCATION: Washington D.C.
DEPTH OF PROJECT: 25 ft
NUMBER OF TUNNELS: 2
LENGTH OF TUNNELS: 4000 ft total
SUBTERRANEAN AREA: 75,000 sq ft
PROGRAM: Mixed use

This proposal takes an abandoned trolley station and re-imagines it as a new public space. A five year plan for the space involves creating an art gallery, restaurants and shops, as well as provide a space for community performances and both public and private events. This is the second project proposal for this location, as a food court was opened and closed in the mid-1990's.

SENSORY TESTING

light, darkness, vastness

urban noises, echoing



SUBTERRANEAN AREA

SENSES ENGAGED

SIMILARITIES

In researching the previous precedents, the projects, though different in program and location, had similarities that dealt with its situation within a specific context, including providing a space for a path, itinerary or journey, as well as allowed for some kind of reflection. Additionally all related architectural moments to the body, and created a retreat for the individual.

Fig 39

BODY

Fig 40

RETREAT

Fig 41

PATH PROJECT

Fig 42

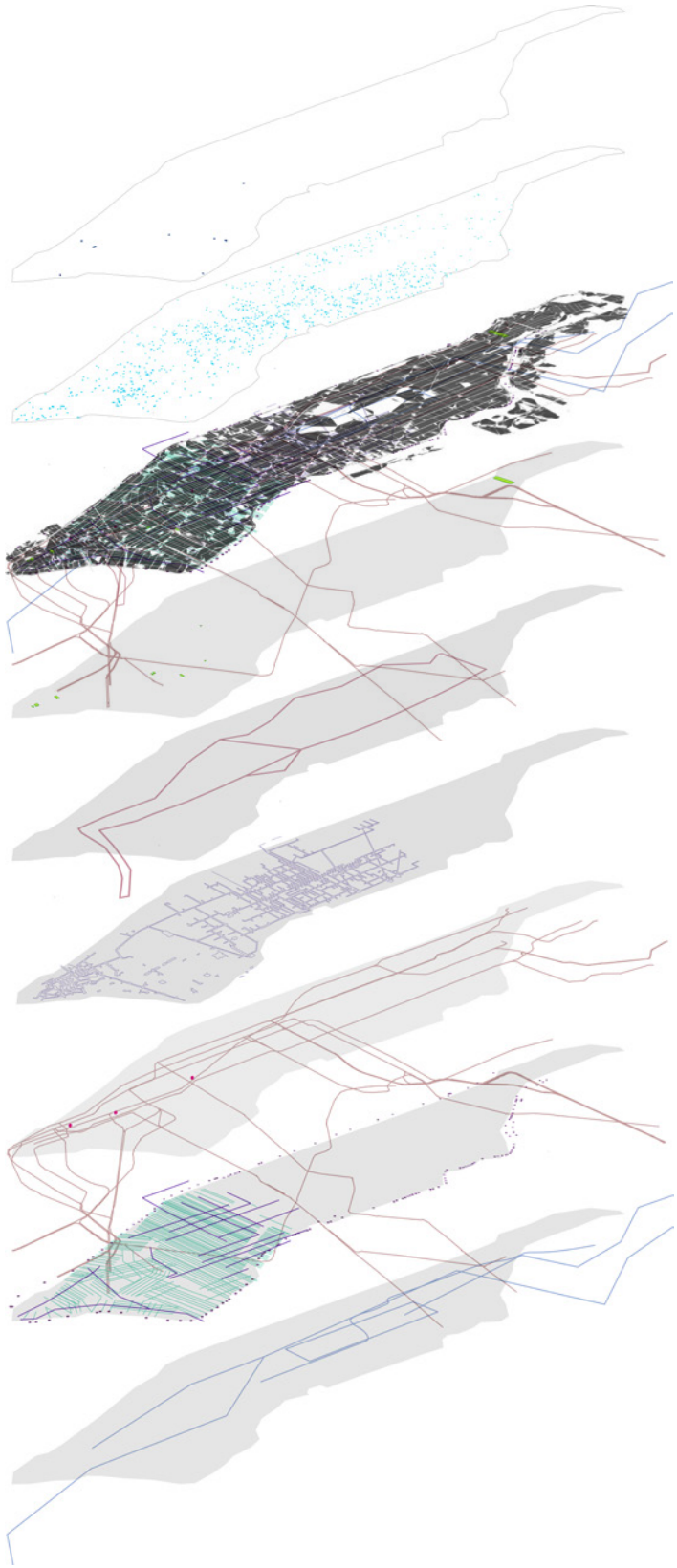
REFLECTION

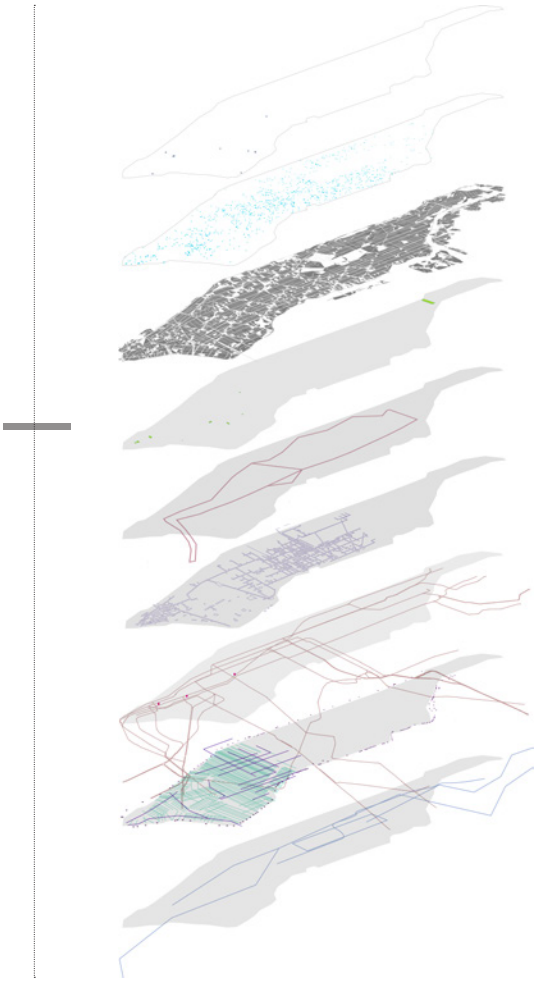
URBAN UNDERGROUND
CASE STUDY: New York City

New York City, NY

NUMBER OF RESIDENTS: 8.5 million
NUMBER OF TOURISTS: 54 million annually
MILES OF ROADS: 20,000 miles
MILES OF SEWER PIPES: 6,000 miles
NUMBER OF SUBWAY LINES: 34
NUMBER OF SUBWAY STOPS: 147

The layers of the city sink deep underground. The first thirty feet below grade house infrastructure, including electricity, water lines, cable, steam, and gas. Below 30 feet most subway lines run, but can range to as deep as 180 feet below. Most of the large sewage is collected 200 feet below, specifically under water lines.

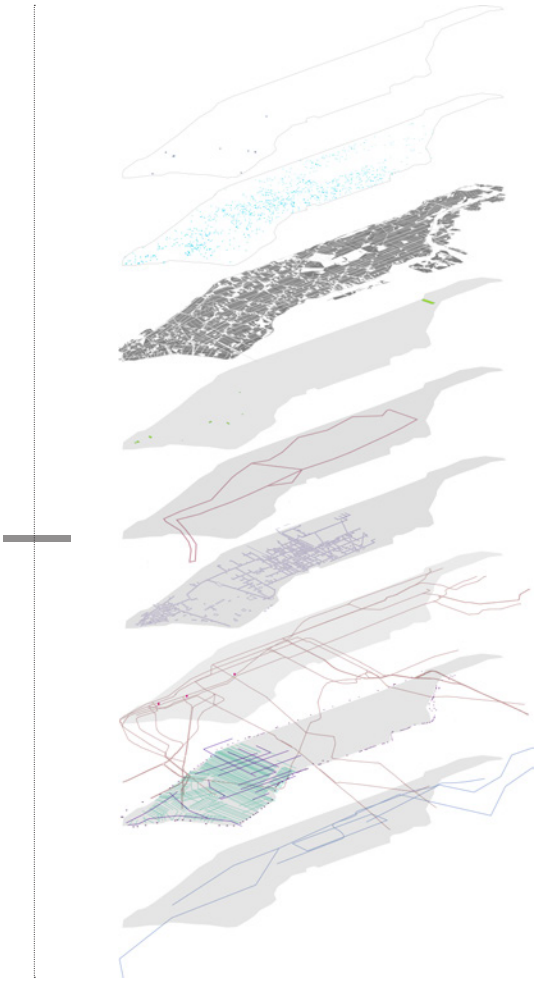




Cemeteries

NUMBER OF CEMETERIES: 7
DEPTH: 8-15 ft

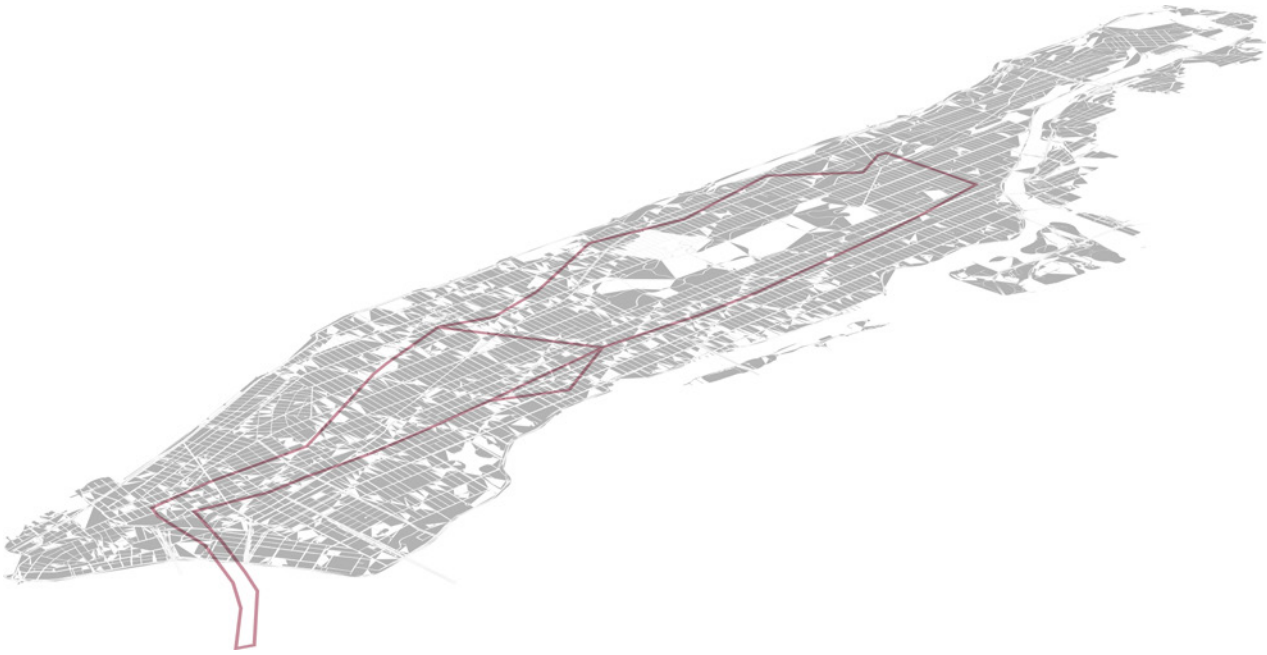
Prior to building Central Park in 1857, cemeteries were used by the public as areas of refuge and quiet. The seven cemeteries in Manhattan are were started between the1600-1800's, as cemetery construction was prohibited during the 1800's with population increases.

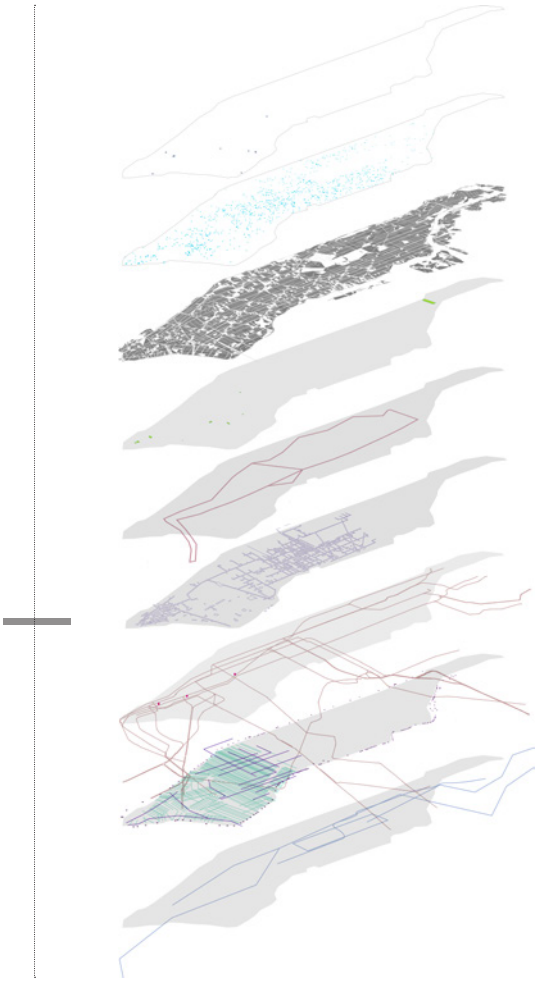


Pneumatic Tubes

MILES OF TUBES: 27
PIPE DEPTH: 4-6 feet

In 1897, the pneumatic tube was installed to distribute mail through the city. While it was stopped in 1953, it covered 27 miles of tubing.

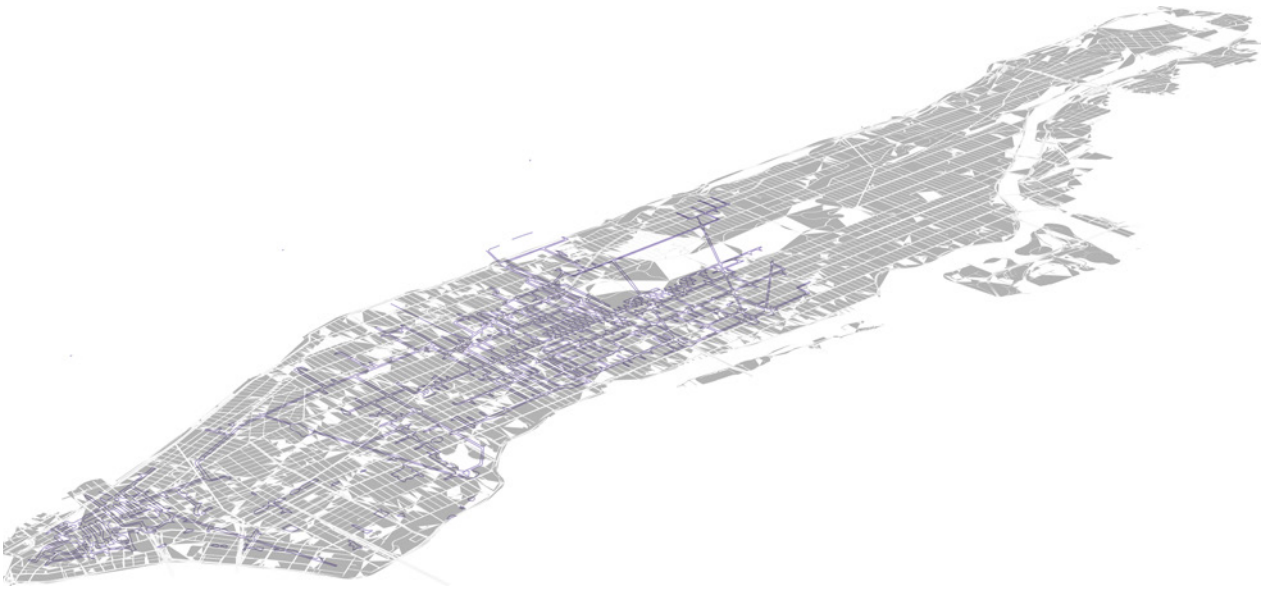


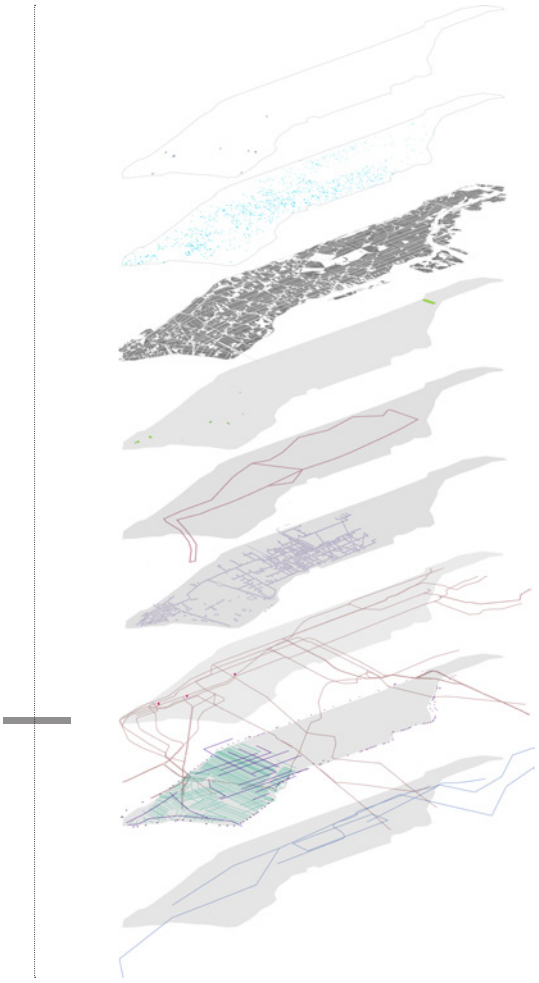


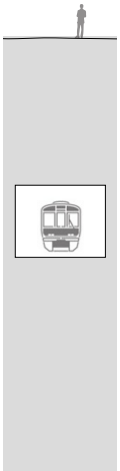
Steam

MILES OF STEAM LINES: 105
PIPE DEPTH: 10-30 feet

Bringing steam to 2000 buildings, used for both heating and cooling, the 105 miles of New York City's steam lines is the largest steam system in the world.



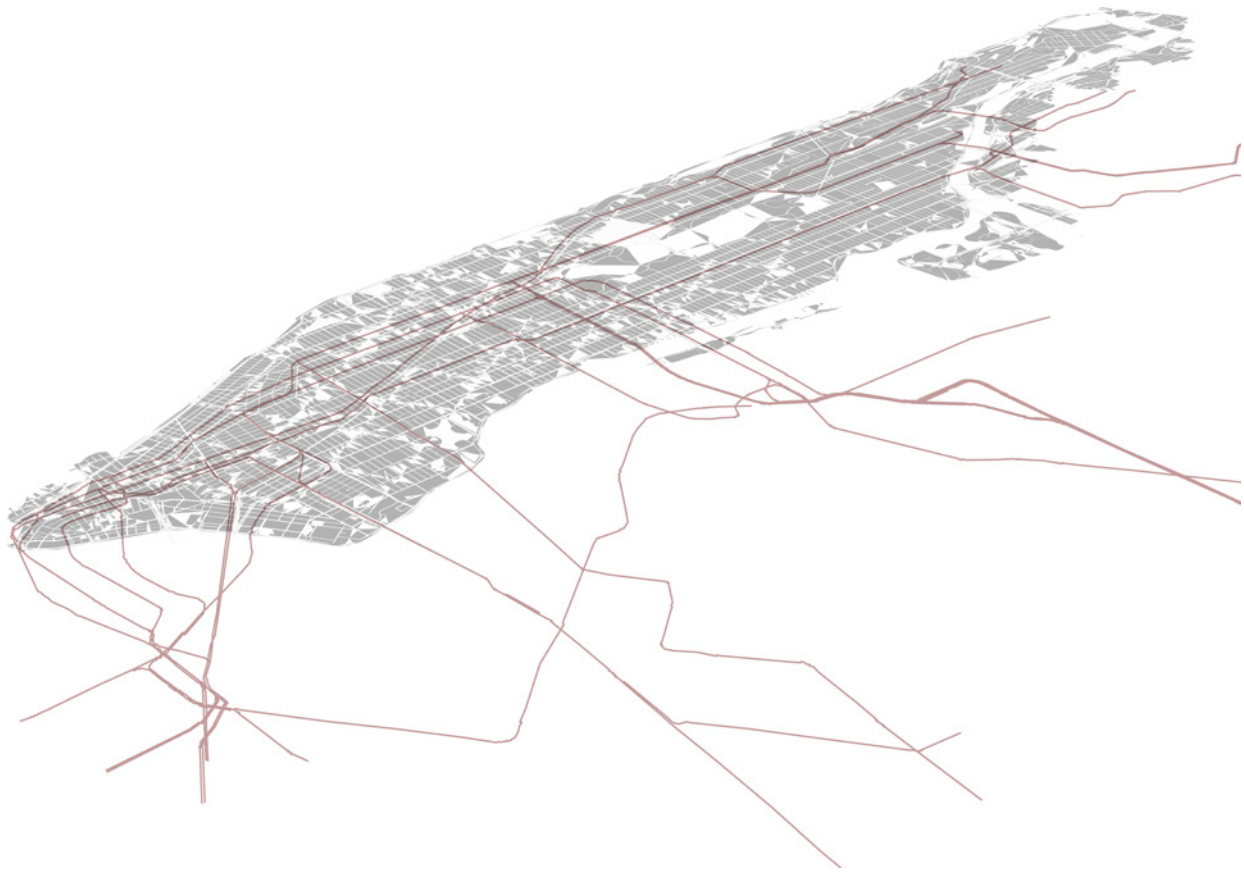




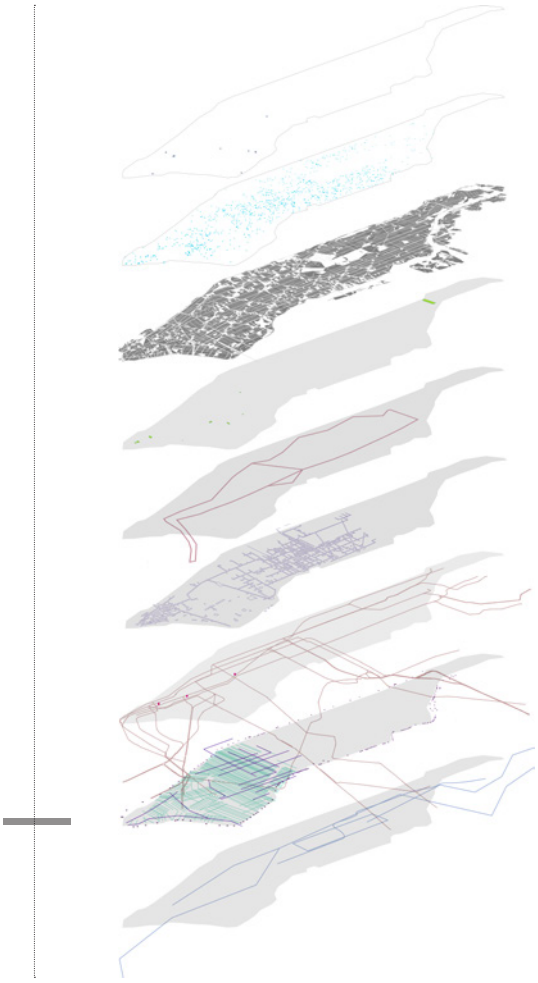
The Subway

MILES OF LINES: 840
LINE DEPTH: 30’ to 180’
NUMBER OF UNDERGROUND STATIONS: 227

New York City’s subway includes 660 miles of track in passenger service, but 840 miles of track in total. There are 24 subway lines in total. It is the busiest subway system in the United States, but only the seventh busiest in the world.



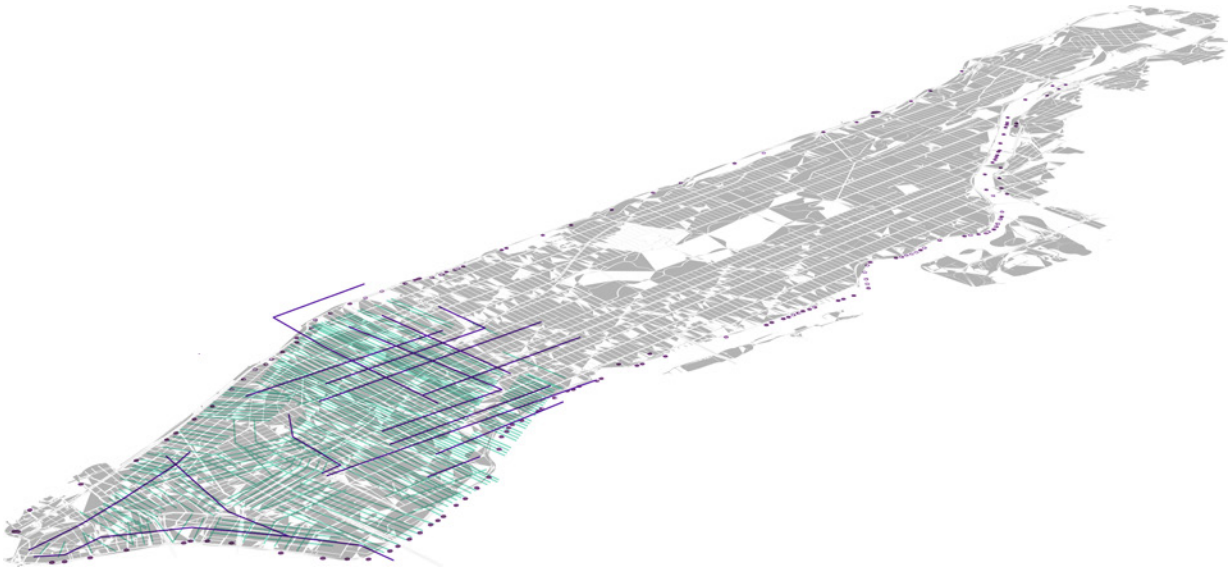
APPENDIX II: *CASE STUDY: NYC UNDERGROUND*

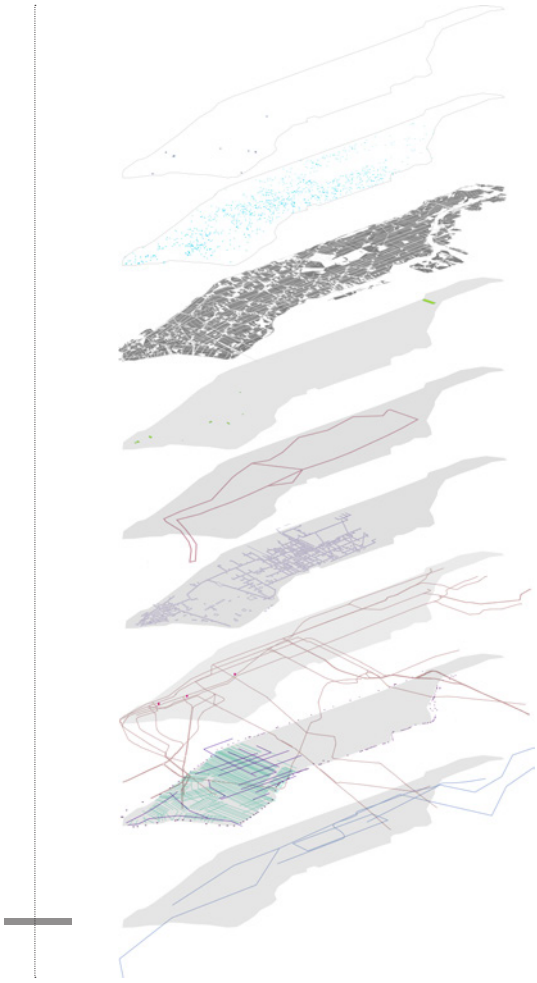


The Sewers

MILES OF SEWER LINES: 6000
PIPE DEPTH: 10 feet +

Highlighted are major sewer lines, local sewer lines and Combined Sewer Outflows (CSO). 6000 miles of sewer pipes range from 6" to 89" in diameter, usually 12". Typically buried more than 10' underground to avoid clean water pipes, in case of a burst.

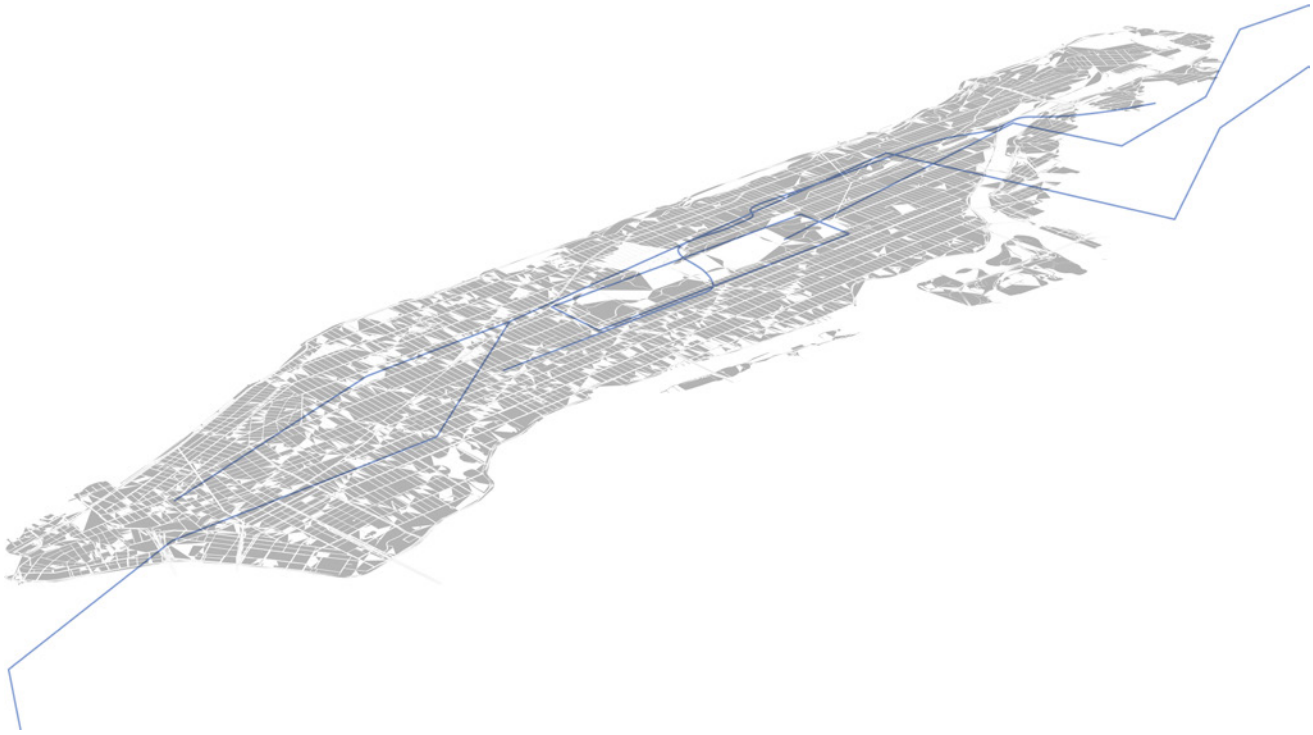




Water

PIPE DEPTH: 500 ft
PIPE WIDTH: 12 feet
NUMBER OF TUNNELS: 2

Both the Croton and Catskill Watershed, located in the southeastern NY , provide water supply to NYC, as far as 100 miles away. It is the largest unfiltered water supply system in the United States, delivering 1.2 billion gallons every day, through tunnels built and maintained since 1917.



EXTENDED ESSAY

With increasing urban populations and new technologies, the contemporary city, even more has become a place for everything. With more 'non-stop, never-sleep' energy, the city produces and enables overwhelming sensations, over-saturation and hyperactive. It is estimated that the average urbanite sees up to five thousand advertisements a day—from ads on the street, in the subway, to even in doctor's offices.[1] While these sights and sounds surround the urban environment, in boasting everything, the city lacks its own antithesis. Within the city, where does one see nothing?

Although urbanism has always been integral to architecture, it has been made necessary through our ever-expanding modern world. The urban environment is growing, urban populations are rising, and we continue to build. Instead of consolidating construction, our cities continue to expand, which leads to urban sprawl, perpetuating this bigness. One, often neglected area of our urban environment, is the subterranean. This research aims to investigate the cultural and social significance the subterranean has once provided and how it could again influence our urban architectures with the intent to develop the subterranean beyond an infrastructure.

As a site of extreme urbanism, New York City is characterized by the density and intensity of a modern city. With a population of 8.5 million people, and tourism that boasts up to 54 million visitors annually, New York City is the densest city in America. As a city, New York, is unique as, "it relies on communal delivery of services to an extent few cities do- eg., on a unified system of water delivery, on in-city generation of power, on the world's largest central steam system."[2] The infrastructure associated with New York City, reaches deep below the city's surface. With a history of digging deep for specific functions or programs, New York City's underground environment can move beyond a tactic of infrastructure into an architectural opportunity. The chaos of urbanity intrinsic to the city of New York, necessitates a place of solace.

This project aims to be an urban psychological respite centered around a theory of sensation. Today, inundated with media, information and images, design has become reliant on visuals alone, but "architecture has the potential to put essences back into existence."[3] In The Eyes of the Skin, Juhani Pallasma warned that designing with only sight in mind severely limits architecture. He emphasizes the importance of synesthesia within design as, "vision separates us from the world whereas the other senses unite us with it."[4] This thesis aims to question and re-situate sensation within the architecture of the urban environment. With an interest in understanding the psychological effects and opportunities of subterranean architecture in particular, this project aims to create a psychological experience using the underground as the architectural actor.

As the counter-city operates to provide a refuge within the urban environment, the park historically has operated similarly within the city. Central Park was initially opened in 1857, after the need for undisturbed open space was realized. New Yorkers were desperate for quiet, open spaces, that cemeteries became areas of refuge. While Central Park is pertinent in reducing the clamor of New York City, as a refuge, the park has limitations. The park can muffle out some of the noises or visual disturbances of the city, yet it operates within the same plane, so inevitably it is still rooted within its urban context. Visually, one can still see the high-rises around the park, or hear the noises of the zoo. As this thesis proposal desires a more extreme filter for the city's sensations, turning to the underground becomes critical.

The underground is not generally associated with inhabitable space. Lack of light, and the dangers of poor ventilation make the subterranean environment categorically dangerous. Historically the underground developed through the need for mining and infrastructure. Similarly, the cave, within architecture, has long been associated with primitive dwelling but was also considered as a, "metaphorical space of ignorance."[5] For Laugier, the primitive hut was the antithesis to the unbearableness of a cave, primarily responding to its "darkness and foul air."[6] While light and ventilation were central to this debate, the dampness of caves offered, "cool and stable temperatures."[7] The cave offers architectural opportunities through the atmospheres associated with the subterranean.

Dealing with the constraints of the underground necessitates working within the environment in different ways. Considerations of ventilation, light, heat, humidity and water levels become even more significant than when building above ground. While building below ground offers some practicalities (thermal massing, controlled environments and encourages sustainable practices), particularly for Northern cities, culturally and atmospherically the underground environment can and must do more.

Thinking underground is an exercise in total interiority, dependent on a set of measures of deliberate but delicate control, not typically employed in building above ground. Historically, the underground offers an escape from the normal. In literature, entering the bowels of the earth was related to mystery and adventure. Rosalind Williams in her survey on Notes on the Underground identifies the literary or historical accounts that relate a sense of mysticism and fear with this subterranean journey, "because the traveler descends to a realm of dampness, darkness and formlessness."[8] She describes an "aesthetic significance" associated with the underworld- the sublime, "neither ugly or beautiful, but something else entirely: obscure but pleasingly obscure, terrible but delightfully so." [9] The tension between the contrasting emotional experiences of the sublime can be concretized through architecture. Building

underground provides an opportunity for reorienting the senses as one relies on its interiority, through sequencing, light and scale to create a sense of this sublime.

Transcending purely the cognitive processes of sensation, architecture is about creating experience and engaging the human memory as "critical functions of the building."[10] While operating through spaces, material, light, shadow and form, architecture creates a, "sense of order into the measureless and meaningless natural space."[11] As Pallasma charges architecture to be "life enhancing", he insists that it, "address all the senses simultaneously, and help to fuse our image of self with the experience of the world." [12] It is therefore paramount for architecture to return to addressing fundamentally human perception—and focus on creating an experience for the body in space. Being rooted in the urban environment and against the alienating aspects of the city, creating sensations for the body encourages self-awareness often lost in the density of the city. As a key to reinvigorating the human psyche, sensation within architecture can produce a new kind of spatial experience. The power of this project is rooted in its totality and in its ability to build a theory of sensation. The deployment of a subterranean architecture enables this exploration of the sublime. Rather than simply considering it as the space of infrastructure, this research proposes a way to rethink the capacity of the underground as both the solution to an urban problem and as a new space for design.

Notes

1. http://www.nytimes.com/2007/01/15/business/media/15everywhere.html?_r=0
2. Kate Ascher, The Works: Anatomy of a City (New York: Penguin University Press, 2005) introduction.
3. Steven Holl, Intertwining (New York: Princeton Architectural Press,1996) 11.
4. Juhani Pallasma, The Eyes of the Skin: Architecture and the Senses (West Sussex, UK: John Wiley & Sons Ltd., 2012) 28.
5. David Gissen, Subnature: Architecture's Other Environments (Princeton: Princeton Architectural Press, 2009) 31.
6. Gissen, 30.
7. Gissen, 31.
8. Rosalind Williams. Notes on the Underground (Cambridge, MA: MIT Press, 2008) 82.
9. Williams, 83.
10. Joy Monice Malnar and Frank Vodvarka, Sensory Design, (Minneapolis: University of Minnesota Press, 2004), 287.
11. Pallasma, 12.
12. Pallasma, 12.

BIBLIOGRAPHY

Adcock, Craig. E.. James Turrell: The Roden Crater Project: an Exhibition Organized by the University of Arizona Museum of Art, Tucson. Tucson: University of Arizona, 1986.

Adcock, Craig. James Turrell: The Art of Light and Space. Berkeley : University of California Press, 1990.

Ascher, Kate. The Works: Anatomy of a City. New York: Penguin University Press, 2005.

Baudrillard, Jean. Simulacra and Simulation. Trans. Sheila Faria Glaser. Ann Arbor : University of Michigan Press, 1994.

Bloomer, Kent C.. Body, Memory, and Architecture. New Haven : Yale University Press, 1977.

Cohen, Paul E. Manhattan in Maps, 1527-1995. New York : Rizzoli International Publications, 1997.

Debord, Guy. Society of the Spectacle. New York : Zone Books, 1994.

Gissen, David. Manhattan Atmospheres : Architecture, the Interior Environment, and Urban Crisis. Minneapolis : University of Minnesota Press, 2014.

Gissen, David. Subnature: Architecture's Other Environments. New York: Princeton Architectural Press, 2009.

Hauser, Sigrid. Peter Zumthor Therme Vals. Zurich : Scheidegger & Spiess, 2007.

Heller, Vivian. The City Beneath Us : Building the New York Subways. New York : W.W. Norton, 2004.

Holl, Steven. Intertwining : Selected Projects 1989-1995. New York: Princeton Architectural Press, 1996.

Howes, David. "Architecture of the Senses", in Senses and the City : An Interdisciplinary Approach to Urban Sensescapes. Ed. Mădălina Diaconu. Wien : Lit, 2011.

Jones, Caroline. Sensorium : Embodied Experience, Technology, and Contemporary Art. Ed. Caroline A. Jones. Cambridge, Ma : MIT Press, 2006.

Malnar, Joy Monice and Vodvarka, Frank. Sensory Design. Minneapolis: University of Minnesota Press, 2004.

Marble, Scott. Architecture and body. Ed. Scott Marble ... et al. New York : Rizzoli, 1988.

Pallasma, Juhani. The Eyes of the Skin: Architecture and the Senses. West Sussex, UK: John Wiley & Sons Ltd., 2012.

Rasmussen, Steen Eiler. Experiencing Architecture. Trans. Eve Wendt. Cambridge, MA: MIT Press, 1962.

Ray, Mary-Ann. Pamphlet Architecture 20: Seven Partly Underground Rooms and Buildings for Water, Ice, and Midgets. New York : Princeton Architectural Press, 2011.

Solis, Julia. New York Underground : The Anatomy of a City. New York : Routledge, 2005.

Tanizaki, Junichiro. In Praise of Shadows. New Haven, Conn. : Leete's Island Books, 1977.

Von Meijenfeldt, Ernst. Below Ground Level : Creating New Spaces for Contemporary Architecture. Ed. Ernst von Meijenfeldt and Marit Geluk. Trans, Roz Vatter-Buck. Basel, Boston : Birkhäuser-Publishers for Architecture, 2003.

Williams, Rosalind H. Notes on the Underground: An Essay on Technology, Society, and the Imagination. Cambridge, MA: MIT Press, 2008.

IMAGE CREDITS

Connotations of the Underground

Fig 1: Crossing the Styx, illustration by Gustave Doré, 1861

Fig 2: Underground Cave, http://yobarte.deviantart.com/art/underground-cave-140351491

Fig 3: Shanghai Tunnels, Portland, Oregon, Photograph by Corey Templeton, 2013

Fig 4: Mill Creek Sewer, Photograph by Brendan Clinch, 2013. http://hiddencityphila.org/2013/01/theres-a-world-going-on-underground/

Fig 5: Underground Miners, http://www.undergroundminers.com/imhuber24.jpg

Fig 6: Karez Underground Water system, 2013. https://thevelvetrocket.files.wordpress.com/2013/11/karez-underground-water-system.jpg

Fig 7: Lascaux Cave, Photograph by N. Aujoulat, 2003. http://www.bradshawfoundation.com/lascaux/gallery/lascaux6b.jpg.

Fig 8: Dungeon at Wewelsburg Castle, http://www.scrapbookpages.com/WewelsburgCastle/Photos2008/Dungeon6730.jpg

Fig 9: Paris Catacombs, http://bestactivityweekends.com/wp-content/uploads/2013/02/paris-catacombs.jpg

Fig 10: Easter Sunday Love-In, Malibu Canyon, California, Photograph by Lisa Law, 1968

Fig 11: Still frame from "Dark Days", USA 2000, Dir. Marc Singer, 94min

Fig 12: https://trainpigs.files.wordpress.com/2011/09/emily-ann-epstein-rat-photo-for-amny.jpg

Potentials of the Underground

Fig 13: Toronto's Subway Tunnels; http://www.infiltration.org/subway.htm

Fig 14: Echo Chamber, http://www.canhifi.com/Resources/TechnicalInfoType/ImageFile/akustik_tunedcity_»_feldmann,_joachim__scientific_echo_chamber_and_anechoic__m.jpg

Fig 15: Jameos Del Agua Cave, Photograph by Andrew Tickner, 2012. http://mw2.google.com/mw-panoramio/photos/medium/78862570.jpg

Fig 16: Fog, http://www.shakespeareances.com/shakespeareancesimages/DonmarJuliusCaesarAtStAnns_PavelAntonov.jpg

Representation

Fig 17: Dec. 17, 2015; Final Review, Photograph by Robert White

Fig 18: Dec. 17, 2015; Final Review, Photograph by James Addison

Fig 19: Dec. 17, 2015; Final Review, Photograph by James Addison

Fig 20: Dec. 17, 2015; Final Review, Photograph by James Addison

Fig 21: LIDAR hand drawing, on watercolor

Fig 22: LIDAR hand drawing, on watercolor

Fig 23: Dec. 17, 2015; Final Review, Photograph by James Addison

Fig 24: Dec. 17, 2015; Final Review, Photograph by James Addison

Fig 25: Final Model, Photograph by Andy Ryan

Fig 26: Final Model, Photograph by Andy Ryan

Fig 27: Final Model, Photograph by Andy Ryan

Fig 28: Final Model, Photograph by Andy Ryan

Fig 29: Final Model, Photograph by Bob White

Fig 30: Final Model, Photograph by Bob White

Fig 31: Final Model, Photograph by Ana Hiller

Fig 32: Final Model, Photograph by Ana Hiller

Fig 33: Final Model, Photograph by Ana Hiller

Fig 34: Final Model, Photograph by Ana Hiller

Appendix: Supplementary Research

Fig 35: Roden Crater Project, Photography by Agostino De Rosa; http://www.iuav.it/Ateneo1/docenti/architettu/docenti-st/De-Rosa-Ag/Ricerche-i/Geoemtrie-/Roden-crat/immagini-Roden-Crater.doc_cvt_file/image006.jpg

Fig 36: Memorial to the Murdered Jews, Photography by Juan de Dios Santander Vela, 2013. http://www.photographyblogger.net/wp-content/uploads/2013/07/Berlin-Holocaust-Memorial-1.jpg

Fig 37: Thermal Vals; http://homeli.co.uk/wp-content/uploads/2014/05/Seating-area-overlooking-Swiss-mountainside-in-Therme-Vals-Spa.jpg

Fig 38: Disused Streetcar Tunnel Under Dupont Circle, Photography by Eric Purcell, 2013. http://www.urbanghostsmedia.com/home/twamoran/urbanghostsmedia.com/wp-content/uploads/2013/03/dupont-trolley-station-abandoned.jpg

Fig 39: Body, http://t14.deviantart.net/AECyJJaEktB4TI40-NxY0PPeYPk=/fit-in/300x900/filters:no_upscale():origin()/pre06/6d7b/th/pre/i/2011/298/b/9/still_life_by_geiss-d4dxy7g.jpg

Fig 40: Castle Walls, https://farm3.staticflickr.com/2831/9510734201_da14a82b9b_b.jpg

Fig 41: Path, https://pp.vk.me/c10977/v10977369/1b69/GXBX0_KYckY.jpg

Fig 42: Water reflection, http://data.whicdn.com/images/29903362/original.jpg