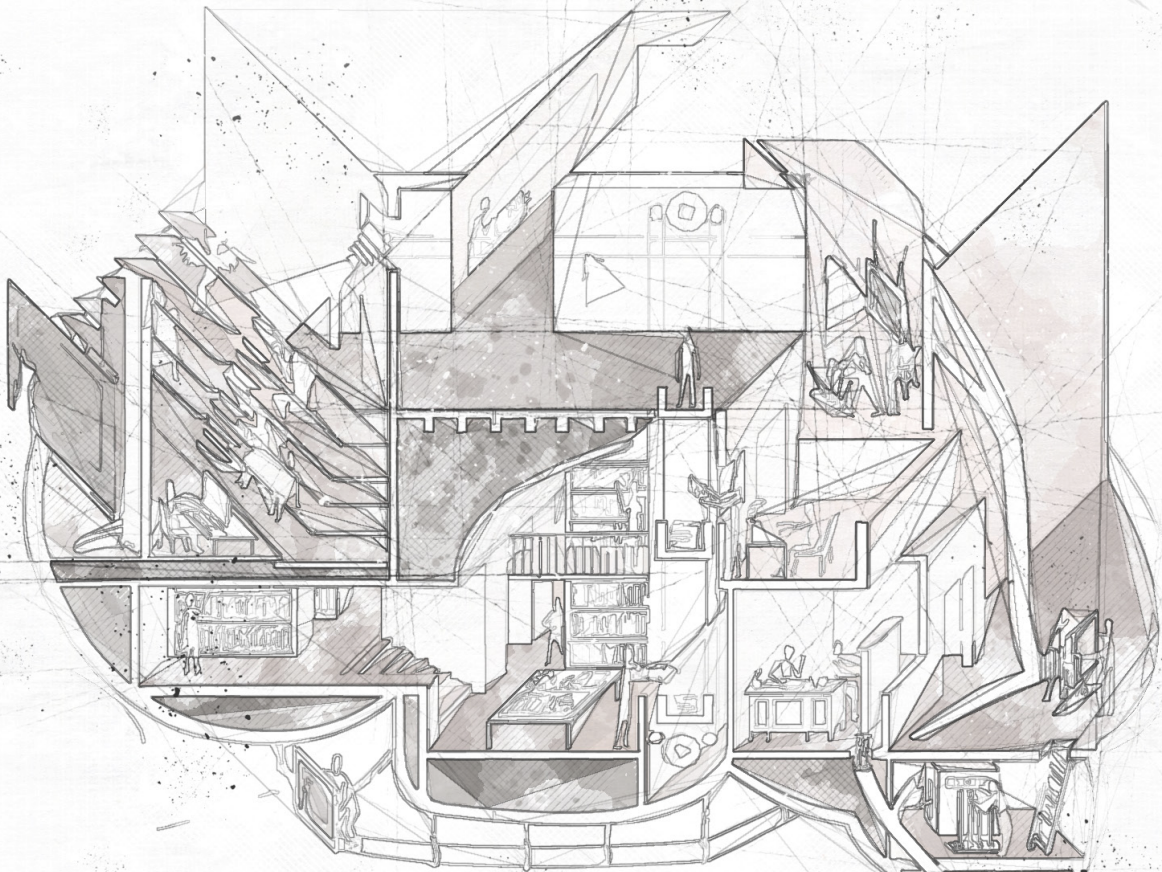


# NEURO CONSILIO

*Stimulating visual, haptic, olfactory and auditory senses to promote passive recovery in acute brain injury and post operative neurological patients*



**Petus Badenhorst Naude Brink**  
**13020553**

# Preface

## Declaration

I, Petrus Badenhorst Naude Brink hereby declare that the work contained in this proposal has not been previously submitted for a degree at any other higher education institution. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made. Referencing using the Harvard system is done to substantiate all source of information for the research proposal.

## Disclaimer

This dissertation covers medical topics related to neurological disorders and rehabilitation, I am not a health professional, and all the assumptions are based on secondary data from reputable medical sources. Despite this should you seek any medical advice or references please seek out a medical professional.

## Project Summary

### Author:

Petrus Badenhorst Naude Brink

### Study Leader:

Qaqamba Makula

### Course Coordinator:

Arthur Barker

### Research Field:

Health Facilities

### Programme:

Neurological Rehabilitation step down facility

### Client:

Cintocare Head and Neck Hospital

### Site:

215 Frikkie De Beer St  
Menlyn  
Pretoria  
0063

## Abstract

The following dissertation analyses how users experience space with their different senses. And how we as designers can utilise this to improve rehabilitative designs' responsiveness to cater to acute brain injury and post-operative neurological surgery patients.

The medical field has shown a rapid increase in neurological development that changes the way doctors have been treating patients thus far. With the rapid growth in development, the associated disciplines need to react to the change in knowledge to provide a facility that accommodates new treatment methods that will always provide the patient with the best care. When dealing with specialised fields, the architectural design process is limited by the designers' experience

and knowledge, and when it comes to the medical field, it is almost always limited. The regulations and medical planning guidelines cater to the minimum requirements and systematic applications and not set to adapt to patient needs. Thus a multidisciplinary collaborative effort is needed to address the patient's wellbeing properly.

For the architectural profession to design responsive environments that help promote the patients' passive recovery principles, we need to be able to identify the effect our spaces have on the brain.

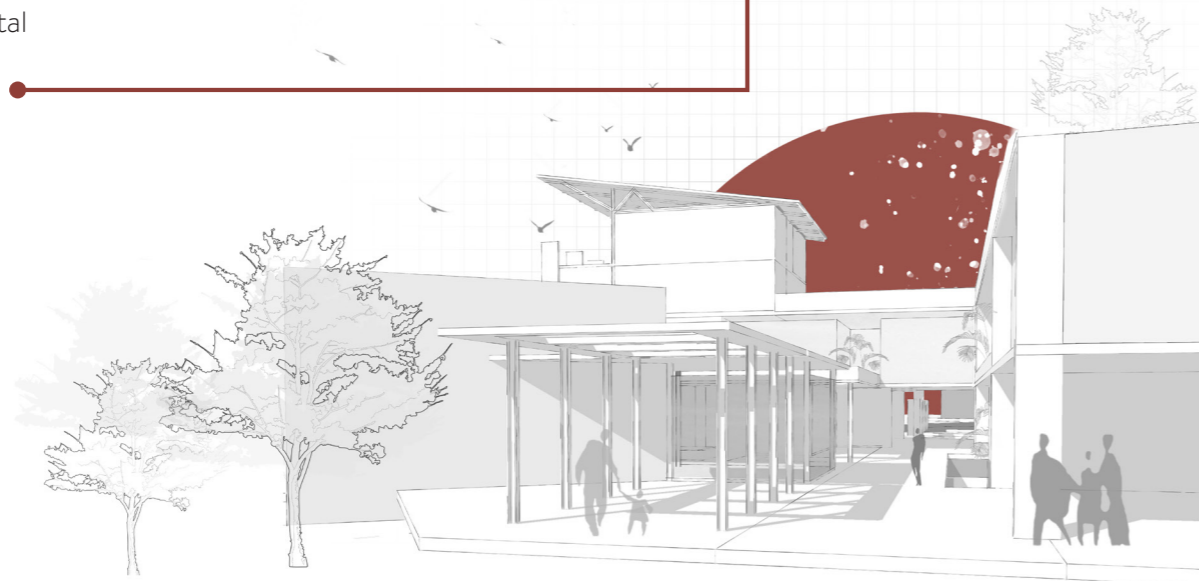
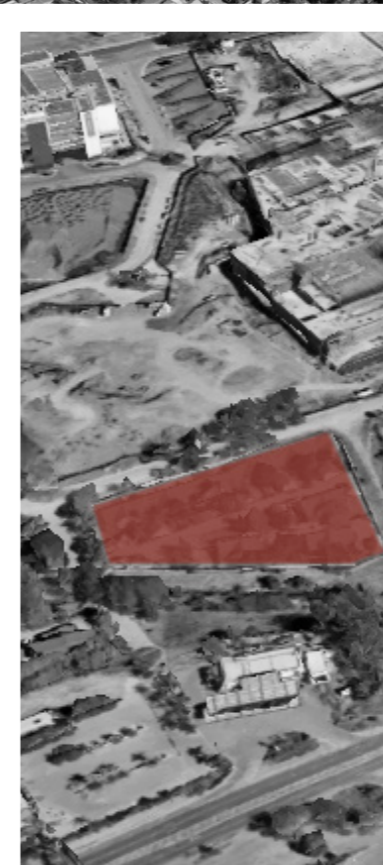
The research aims to broaden the philosophical approach to design to include rehabilitation principles to create more productive environments for patients.

By studying the effect of the spaces on the brain, we know from the brain's neuroplasticity that the constructive stimulation of the areas affected will increase its recovery rate. Once the principles have been identified, architectural drivers can be deduced from the data sets.

If correctly implemented, the responsive design principles can help produce better rehabilitative methods that don't have to rely solely on active rehabilitation applications. The end goal is to have this facility serve as a precedent for future projects with a multidisciplinary healthcare program that aims to incorporate responsible passive neurological treatments.

Keywords:

Neurology, rehabilitation, spatial exploration, Medical architecture, Neuro-architecture



# Acknowledgments

To my loving wife - Liezel Brink

For believing in me and staying by my side through all the hardships and late nights.

To my brother and business partner - Hannes Brink

Thank you for your companionship through long days and nights. Your design inputs and advice helped me keep my head up.

To my ever supportive parents - Andre & Susan Brink

For giving me the opportunity to study and pursue a career I have a passion for.

To my mentor and friend - Francine van Tonder

For your honesty, guidance, and helping me find my *raison d'être*.

***“Where attention goes, neural firing flows, and neural connection grows.”***

*Daniel J. Siegel*

# Table Of Content

## CHAPTER 00 Debut

<b>Preface</b>	
Declaration	
Disclaimer	
Project Summary	
Abstract	
<b>Acknowledgments</b>	

## CHAPTER 01 Introduction

<b>Prologue</b>	
About Myself	
Normative Position	
Medical Architecture Background	
<b>Project Introduction</b>	
Background	
South African Neurological Rehabilitation	
Global Rehabilitation Methods	
Translating treatment methods	
General Issue	
Urban Issue	
Architectural Issue	
Research Question	
Research Intentions	
Hypothesis	
Delimitations	
<b>General Issue</b>	
Societal Perspective	
<b>Urban Issue</b>	
Urban Disconnect	
<b>Architectural Issue</b>	
Systemic Dissaray	

## CHAPTER 02 Research

<b>Literature Review</b>	
The Eyes Of The Skin	
Hedonic Architecture	
Design As A Rehabilitive Tool	
Theoretical Outlook	
Spatial Data	
Neurological Data	
Rehabilitation and Treatment	
Sensory Based Treatment Principles	
Project Holter Monitor	
Holter Monitor Diagramme	
Holistic Research	
Data Organisation Diagramme	

## CHAPTER 03 Experiment

<b>II</b>	<b>Research Experiment</b>	<b>40</b>
II	Experiment Overview	40
II	Sensory Related Disorders	40
II	Experiment Process	41
III	Architectural Drivers	41
<b>IV</b>	<b>Visual Therapy</b>	<b>42</b>
	Related Neurological Condition	42
	Biological Trauma Location	42
	Reaction To Visual Stimulants	43
	Visual Interpretation:	43
	Biological Stimulatory Overlap	44
	Application Opportunities	44
	Conceptual Application	44
<b>16</b>	<b>Haptic Therapy</b>	<b>46</b>
16	Related Neurological Condition	46
16	Related Neurological Condition	46
17	Reaction To Haptic Stimulants	47
<b>18</b>	<b>Biological Response To Textures</b>	<b>47</b>
18	Biological Response To Textures	47
18	Biological Stimulatory Overlap	48
18	Application Opportunities	48
18	Conceptual Application	48
19	Haptic Passive Design Principles	49
19	<b>Olfactory Therapy</b>	<b>50</b>
19	Related Neurological Condition	50
20	Reaction To Olfactory Stimulants	51
20	Biological Response To Smell	51
20	Application Opportunities	52
20	Conceptual Application	52
<b>22</b>	<b>Sound Therapy</b>	<b>54</b>
22	Related Neurological Condition	54
<b>23</b>	<b>Neurological Reaction To Sound</b>	<b>55</b>
23	Neurological Reaction To Sound	55
<b>24</b>	<b>Neuro Reaction To Changing Frequency</b>	<b>55</b>
24	Neuro Reaction To Changing Frequency	55
	Biological Stimulatory Overlap	56
	Application Opportunities	56
	Conceptual Application	56
	<b>Experimental Summary</b>	<b>58</b>
	Findings	58
	Architectural Deductions	58
	Conclusion	59
<b>28</b>	<b>Literature Review</b>	<b>28</b>
28	The Eyes Of The Skin	28
30	Hedonic Architecture	30
32	Design As A Rehabilitive Tool	32
34	Theoretical Outlook	34
34	Spatial Data	34
34	Neurological Data	34
34	Rehabilitation and Treatment	34
35	Sensory Based Treatment Principles	35
36	Project Holter Monitor	36
36	Holter Monitor Diagramme	36
37	Holistic Research	37
37	Data Organisation Diagramme	37

CHAPTER **04** Project Analysis

**Project Location**

Global Coordination  
Site

**Programme**

Programme Development  
Users  
Demographic Breakdown

**Analysis and Influences**

Local Medical Precedent  
Medical Facilities  
International Medical Precedent  
Neurological Indications  
Lassnitzhohe Rehabilitation Goals  
Extensive Therapies  
Facilities

**Urban Development**

Urban Analysis  
Urban Plan  
Sun Angles  
Wind Directions & Rainfall  
Servitude & Plant Life  
Neighbouring Programmes

**Urban Vision**

**Site Analysis**

Site Description

CHAPTER **05** Conceptual Development

**Concept Development**

First Iteration  
Second Iteration  
Third Iteration

**Concept Resolution**

First Iteration

Second Iteration

Third Iteration

**Visual Interventions**

Patient Proprioceptive Oscillation  
Spatial Experience  
Visual Stimulation Goals

**Haptic Interventions**

Tactile Interaction  
Tactile Application  
Haptic Stimulation Goals

**Olfactory Interventions**

Adaptive Ventilation  
Odour Manipulation  
Olfactory Stimulation Goals

62

62  
64

65

65  
66  
67

68

68  
68

69  
69

69  
69

69  
69

70

70  
70

71  
71

71  
71

72

74  
74

**Auditory Interventions**

Appropriate Acoustics  
Responsive Acoustics  
Auditory Stimulation Goals

**Programmatic Application**

Neurological Research And Rehabilitation  
List Of Programmes  
Exploded Programme Isometric

88

88  
89  
89

90

90  
90  
91

CHAPTER **06** Design Development

**Site Plan**

Initial Site Concept  
Conceptual Development  
Conceptual Site Plan Process Work

**Lower Ground Floor Plan Development**

Initial Rehabilitation Concept  
Conceptual Development  
Conceptual Lower Ground Floor Plan Process Work

**Ground Floor Plan Development**

Initial Rehabilitation Concept  
Conceptual Development  
Conceptual Ground Floor Process Work

94

94  
96  
98

100

100  
102  
104

106

106  
108  
110

CHAPTER **07** Design Resolution

**Site Plan**

Medical Proximity Map  
Lower Ground Floor Plan

Strip Section 1

Research Application

Ground Floor Plan

Strip Section 2

Research Application

First Floor Plan

Strip Section 3

Research Application

Roof & Apartments

Apartments

Section 1

Section 2

Entrance Perspective

Sectional Perspective

114

115  
116

117

118

120

121

122

124

125

126

128

129

130

132

134

136

78

78  
79

80

81

81

81

81

82

82  
83

83

84

84  
85

85  
86

86  
87

87  
87

CHAPTER **08** Technical Resolution

Site Plan	140
conceptual Application	140
Site Plan	142
Lower Ground Floor Plan	144
Lower Ground Floor Plan	146
Section CC	148
Perimeter Detail C1	150
Material Palette	151
Ground Floor Plan	152
Ground Floor Plan	154
Section AA	156
Perimeter Detail A1	158
Material Palette	159
First Floor Plan	160
First Floor Plan	162
Apartment L01	163
Apartment L02	163
Section BB	164
Perimeter Detail B1	166
Material Palette	167
Detail 1	168
Isometric Concept	169
Detail 2	170
Isometric Concept	171
Detail 3	172
Isometric Concept	173
Detail 4	174
Isometric Concept	175

CHAPTER **09** Conclusion

Conclusion	178
Reflection	178
Conclusion	178
Bibliography	180

List Of Figures

Figure 1:	Map 1 (Author, 2020)
Figure 2:	Conceptual Brutalism (Jeck, 2017)
Figure 4:	Transparency Diagram, (Author, 2020)
Figure 3:	Displacement (Author, 2020)
Figure 5:	Offset Diagram, (Author, 2020)
Figure 6:	Contour Sketch, (Author, 2020)
Figure 7:	General Icons, (Amantaka, 2018)
Figure 8:	General Icons, (Amantaka, 2018)
Figure 9:	Principle Icons, (Amantaka, 2018)
Figure 10:	Eyes of the skin, (Britannica, 2019)
Figure 11:	Anxiety, (Krapht, 2017)
Figure 12:	EBD Diagrams, (Neumann, 2019)
Figure 13:	Absrtact Model, (Lavarignas, 2014)
Figure 14:	Research Concept, (Author, 2020)
Figure 15:	Holter Monitor, (Author, 2020)
Figure 16:	Research Organisation (Author, 2020)
Figure 17:	Neuro Afflictions, (Author, 2020)
Figure 18:	Heminiopia, (Author, 2020)
Figure 19:	Heminiopia Location, (Author, 2020)
Figure 20:	Heminiopia Stimulation, (Author, 2020)
Figure 21:	Heminiopia Overlap, (Author, 2020)
Figure 22:	Heminiopia Diagram, (Author, 2020)
Figure 23:	SPD, (Author, 2020)
Figure 24:	SPD Location, (Author, 2020)
Figure 25:	SPD Stimulation, (Author, 2020)
Figure 26:	SPD Overlap, (Author, 2020)
Figure 27:	SPD Diagram, (Author, 2020)
Figure 28:	Hyposmia, (Author, 2020)
Figure 29:	Hyposmia Location, (Author, 2020)
Figure 30:	Hyposmia Stimulation, (Author, 2020)
Figure 31:	Hyposmia Overlap, (Author, 2020)
Figure 32:	Hyposmia Diagram, (Author, 2020)
Figure 33:	APD, (Author, 2020)
Figure 34:	APD Location, (Author, 2020)
Figure 35:	APD Stimulation, (Author, 2020)
Figure 36:	APD Overlap, (Author, 2020)
Figure 37:	APD Diagram, (Author, 2020)
Figure 38:	Hand Drawing, (Author, 2020)
Figure 39:	Site Coordination, (Amantaka, 2016)
Figure 40:	Site Circles, (Author, 2020)
Figure 41:	Site Location 2, (Author, 2020)
Figure 42:	Programme Diagram, (Author, 2020)
Figure 43:	Site Users, (Author, 2020)
Figure 44:	Proximity Map, (Author, 2020)
Figure 45:	Rehab Location, (Amantaka, 2020)
Figure 46:	Urban Study, (Author, 2020)
Figure 47:	Solar Study, (Author, 2020)
Figure 48:	Wind Study, (Author, 2020)
Figure 49:	Green Study, (Author, 2020)
Figure 50:	Programme Study, (Author, 2020)
Figure 51:	Streetscape Existing, (Author, 2020)
Figure 52:	Streetscape Proposed, (Author, 2020)
Figure 53:	Urban Plan Proposed, (Author, 2020)
Figure 54:	Site Analysis, (Author, 2020)
Figure 56:	Maquette 1, (Author, 2020)

Figure 55: Progress Maquette 1, (Author, 2020)  
 Figure 58: Maquette 2, (Author, 2020)  
 Figure 57: Progress Maquette 2, (Author, 2020)  
 Figure 60: Maquette 3, (Author, 2020)  
 Figure 59: Progress Maquette 3, (Author, 2020)  
 Figure 61: Maquette 1, (Author, 2020)  
 Figure 62: Maquette 2, (Author, 2020)  
 Figure 63: Maquette 3, (Author, 2020)  
 Figure 64: Visual ISO 1, (Author, 2020)  
 Figure 65: ISO Brain 1, (Author, 2020)  
 Figure 66: Haptic ISO 1, (Author, 2020)  
 Figure 67: ISO Brain 2, (Author, 2020)  
 Figure 68: Olfactory ISO 1, (Author, 2020)  
 Figure 69: ISO Brain 3, (Author, 2020)  
 Figure 70: Auditory ISO 1, (Author, 2020)  
 Figure 71: ISO Brain 4, (Author, 2020)  
 Figure 72: Programme ISO 1, (Author, 2020)  
 Figure 73: Programme ISO 2, (Author, 2020)  
 Figure 74: Site Plan, (Author, 2020)  
 Figure 75: Site Plan Bumph, (Author, 2020)  
 Figure 76: Progress Work, (Author, 2020)  
 Figure 77: LGFP 1 (Author, 2020)  
 Figure 78: LGFP Bumph (Author, 2020)  
 Figure 79: Progress Work 2, (Author, 2020)  
 Figure 80: GFP 1, (Author, 2020)  
 Figure 81: GFP Bumph, (Author, 2020)  
 Figure 82: Progress Work 3, (Author, 2020)  
 Figure 83: Site P1, (Author, 2020)  
 Figure 84: LGFP P1, (Author, 2020)  
 Figure 85: GFP P1, (Author, 2020)  
 Figure 86: L01 P1, (Author, 2020)  
 Figure 87: Details P1, (Author, 2020)

## Abbreviations & Definitions

ABI	Acute Brain Injury
APD	Auditory Processing Disorder
SPD	Sensory Processing Disordere
EBD	Evidence-Based Design
EEG	Electroencephalography
SID	Sensory Integration Dysfunction
Proprioception	The Body's ability to perceive its own position in space.
Oscillation	Movement back and forth in a regular rhythm.
Hemianopia	Is partial blindness or a loss of sight in half of your visual field.
Hyposmia	A reduced ability to smell and to detect odors.
Olfactory	The sensory system used for smelling.
Logopedics	The study, and correction, of speech and language defects, and disorders in communication.

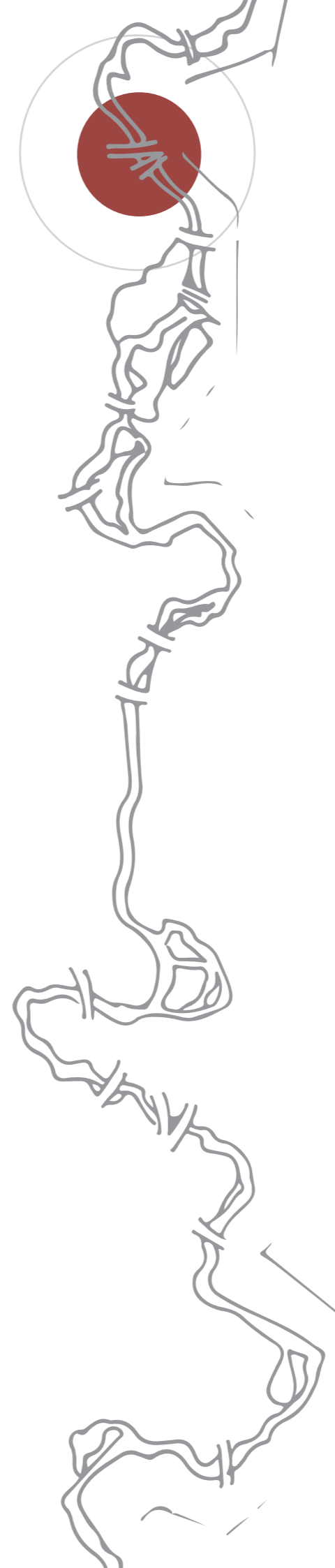


CHAPTER

# 01

## Introduction

---



# Prologue

## About Myself

Born and raised in Pretoria, I finished my Bachelors of Science in Architecture at the University of Pretoria. During my studies, I worked at a reputable model building company in Johannesburg and filled my spare time taking photos of my life. I had the opportunity to work for a few architectural firms and have taken what they had to offer and did my best to implement it to my architectural narrative. After finishing my undergraduate degree, I moved to Cape Town and worked at an international Architecture firm on projects worldwide.

Following my two years of work experience, I moved back to Pretoria to take the next step in my Architectural education. I finished my BArch Honours in 2019, where I could apply some of my new found skills and interests developed during my work experience and build a foundation for my Master dissertation.

## Normative Position

Confronting architectural narratives that clash with some of my own has been an ongoing trend in my career and has helped shape who I am today. One of which has been the paradoxical application of radical architecture. By the simple law of exposure, we cannot create revolutionary architecture due to the everyday exposure and subliminal precedents we encounter throughout our life and education.

Many radical architecture applications seem

unresponsive to some of the contextual drivers to adhere to their radical approach. Critical thinking: Defined as the process of actively conceptualising and or evaluating information gathered from observation, reflection and reasoning (Thinking, 2019). I strive to apply critical thinking and scientific methods to my architectural application and research. By providing myself with a framework that can help guide my design, I can ensure that my architectural interventions re responsive to some of the formalistic and regulatory restrictions applicable. By ensuring that my work has a proper foundation, I can spend more time applying the poetic and design applications that I as a designer want so subjectively superimpose.

Sustainability through technological exposure: When we start embracing the technology at our disposal the sustainable design solutions will follow shortly after. During my visit to a German parametric design conference, I witnessed biomimicry on a level I thought impossible. They tracked a mole in a controlled environment while it navigated around obstacles underground using the ground density and soil conditions and in real-time, the programme designed a railway tunnel through an existing mountain.

In awe of this, I was forced to ask myself if I am doing all that I can with the technology I seem to take for granted every day. Ever since I've been honing my skills when possible to ensure that my technological skills can improve my design applications. I believe we have a responsibility as architects to utilise the tools at our disposal to provide the best service and application methods to society and regain some of the respect we've lost over time.

Construction and material innovation: The Bauhaus use of materials has always fascinated me and I have a respect for applying materials in their raw form. It speaks to an honest application method, and the lack of processed materials pays homage to the natural elements that provide us with the sources of our designs.

When applied responsibly, problems and limitations fuel innovation and my design principles help me find application methods that I would not have learned otherwise.

## Medical Architecture Background

Working with SSH Design in Cape Town, I had the opportunity to work on the Kuwait Children Hospital. Once completed, the hospital will be the largest of its kind in the world. I worked with some of the industry-leading medical planners and international designers and on in house medical engineers. I was on the lead BIM team worked along with all the disciplines. I got to refine the knowledge I gained with my work experience in the implementation of my dissertation.



# Project Introduction

## Background

An alarming 2% of all routine autopsies done in South Africa reveal the presence of a brain tumor (Netcare, 2010). Despite Cape Town having the most advanced neurosurgical centre in Africa, the country is far behind the rest of the world in the field of neurology (UCT, 2018). Since 2010 there has been a steady increase in neurosurgical centres. The most recent hospital currently under construction in Pretoria called Menlyn Maine surgical centre specialises in head and neck trauma (Cintocare, 2019). However, despite the progress that has been shown in the neurological field, it has been happening in isolation focusing only on surgical centres and methods while neurological rehabilitation centres have been neglected.

## South African Neurological Rehabilitation

South Africa has organizations like Headway, a non-profit organization that offers support programs to adult survivors of Acquired Brain Injury, and some acute rehabilitation centres (Headway, 2018). They are not designed to accommodate the patients' needs, and all have multi program-based rehabilitation packages. The architectural field is responsible for providing design solutions for neurological and mental wellbeing, especially in a society that has not yet accepted the importance thereof and stigmatize it in everyday communities (Munsami, 2018).

## Global Rehabilitation Methods

The oldest and most successful neurological rehabilitation centre in the world is located in a small town closed to Graz in Austria. This hundred years old facility has continuously been adapting to changes in rehabilitation methods and successfully treated at Private Hospital Laßnitzhöhe (SANLAS Holding GmbH, 2021). They have a forward-thinking philosophy for rehabilitation, constantly looking for new treatment methods and are more than willing to incorporate the smallest changes in order to better treat the patients.

Post-operative patients, as well as patients suffering from ABI (Acute brain injury), rely on such facilities that serve as a step-down clinics and are often very expensive.

While the Private Hospital Laßnitzhöhe does cater to all aspects of the rehabilitation process and prioritising patient wellbeing, this is not the case with most neurological rehabilitation facilities.

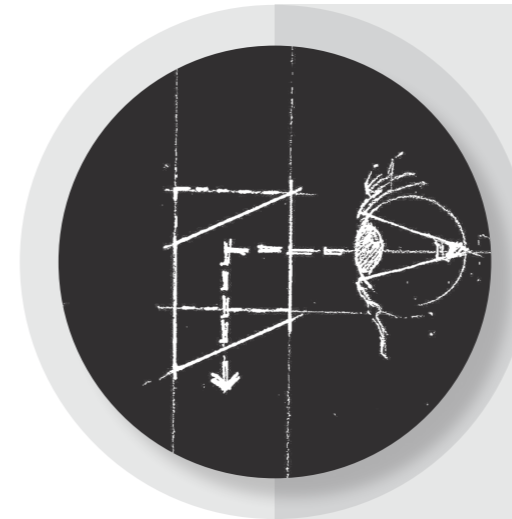
Most of the patient care for post-operative and ABI patients are done either in the hospital or at facilities that were neither designed nor operate in the best interest of the patient's recovery. They are governed by privatised medical aids and governmental funding to ensure that their facilities are as profitable as possible.

While researching the different treatment methods used in these facilities, I noticed the lack of adaptation towards new rehabilitation methods. Historically healthcare has been seen as a noble profession. Despite this, the monetary goals and patient turnover get in the way of prioritising patient wellbeing (SANLAS Holding GmbH, 2021).

## Translating treatment methods

The key to translating neurological rehabilitation methods into passive healing architectural spaces lies in identifying the non-invasive treatment methods to find the stimulatory factors that promote recovery. By doing so, I can use them as drivers in the design process consciously incorporating basic rehabilitation principles in the architecture (Kwan et al., 2017).

Some of the most widely used rehabilitation methods include Physical therapy, psychology, nutritional therapy, speech therapy, physiotherapy, displacement therapy, sensory intrusion therapy and Alleesthesia (Mukhina et al., 2017). Deconstructing these therapies and tying them to existing architectural spatial quality research and application will provide me with the data to design a responsible neurological research and rehabilitation centre.



## General Issue

The underlying stigmatisation of neurological conditions and disabilities creates a disconnect between the end-users and afflicted creating spaces that make for an unpleasant experience and eventual reduction in recovery rates because of the additional neurological distress.

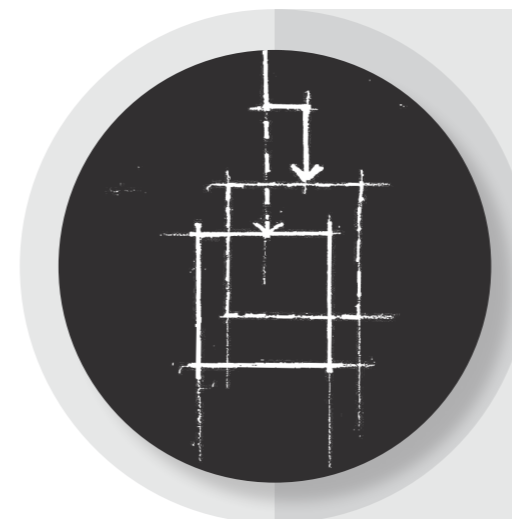
Figure 2: Displacement (Author, 2020)



## Urban Issue

Non-responsive design solutions to patient wellbeing needs stemming from a lack of interdisciplinary coordination and isolated design methods. The medical design and regulatory data supplied to Architects are superficial when dealing with patient well being and are focused around accommodating programmatic and technical applications.

Figure 3: Transparency Diagram, (Author, 2020)



## Architectural Issue

Translating the neurological rehabilitation methods into architectural drivers can help promote passive neurological rehabilitation while catering to a wider demographic. Creating safe and responsive environments that can help contribute to patient wellbeing rather than their distress.

Figure 4: Offset Diagram, (Author, 2020)

## Research Question

How can neurological rehabilitation methods be translated into Architectural design generators?

## Research Intentions

To establish a method of deconstructing neurological rehabilitation methods to identify the core stimulants, once identified, they can be tied to existing spatial research done on architecture. The applicable spatial interventions can be used to design healthier spaces that passively promote patient wellbeing.

The research has been structured to give designers the opportunity to explore various design methods while providing a framework to interpret future treatment and rehabilitation methods.

The research findings have been used to substantiate the design decisions going into my MArch dissertation to design a Neurological rehabilitation and research centre in Menlyn, Pretoria situated between Cintocare Head and Neck and Fearie Glen hospital.

By applying the research to a design project, the credibility of the findings can be judged from an architectural aspect to build credibility for the viability of appropriating the subtle passive design interventions. It can also set a precedent for responsible healthcare design than when successfully implemented can contribute to healthy building design sources substantiated by actual medical research.

## Hypothesis

Neurological Rehabilitation methods are restricted to programmatic application methods. Non-invasive Neurological rehabilitation methods and treatment methods can be deconstructed to provide sensory stimulation methods.

There is existing spacial research on Architectural effects on the user that can be tied to these various sensory experiences. These overlapping principles can theoretically be used to design passive rehabilitation spaces for Post-Operative neurological patients and patients suffering from ABI .

## Limitations

My education and work experience are limited to Architectural design and development. I will rely on secondary data to substantiate my neurological links to maintain credibility to the writing.

Because of the current restrictions due to the Corona pandemic, I cannot access any medical facilities for on-site precedent studies and am limited to readings.

My time and ethical clearance restrictions do not allow for first-hand spatial experience research on patients who suffer from neurological damage. The findings will have to be applied theoretically substantiated by the second-hand research done in similar cases.

## Delimitations

To achieve my research goal, the time allocated the spatial data regarding the effect of architecture on the user will be sourced from existing research. The findings will not be drastically affected by age or context and have been thoroughly researched.

The practical application of the architectural interventions will be left open-ended to provide data that can be interpreted without confirmation biased from the reader when designing future healthcare facilities.

## The Bigger Issue

Neurological knowledge is expanding exponentially with new information treatment methods and illnesses being discovered every day. When designing facilities that cater to the treatment or rehabilitation of neurological patients' architects have a responsibility to create environments that can accommodate and adapt to the different treatment methods.

Healthcare facilities are currently designed in large without having input as to the patients' needs rather than the programmatic and financial needs (Singha, 2020). To have a facility that can contribute to the patient's wellbeing, we have to change the narrative of healthcare design to have a multi-disciplinary holistic approach.

Fundamentally the problem lies with designers not being educated in the healthcare principles that promote healthy environments and don't spend time collaborating with healthcare professionals. When architects approach a design of a new healthcare facility, they can assume the data on spatial and healthcare principles needs to be updated to incorporate the latest information.

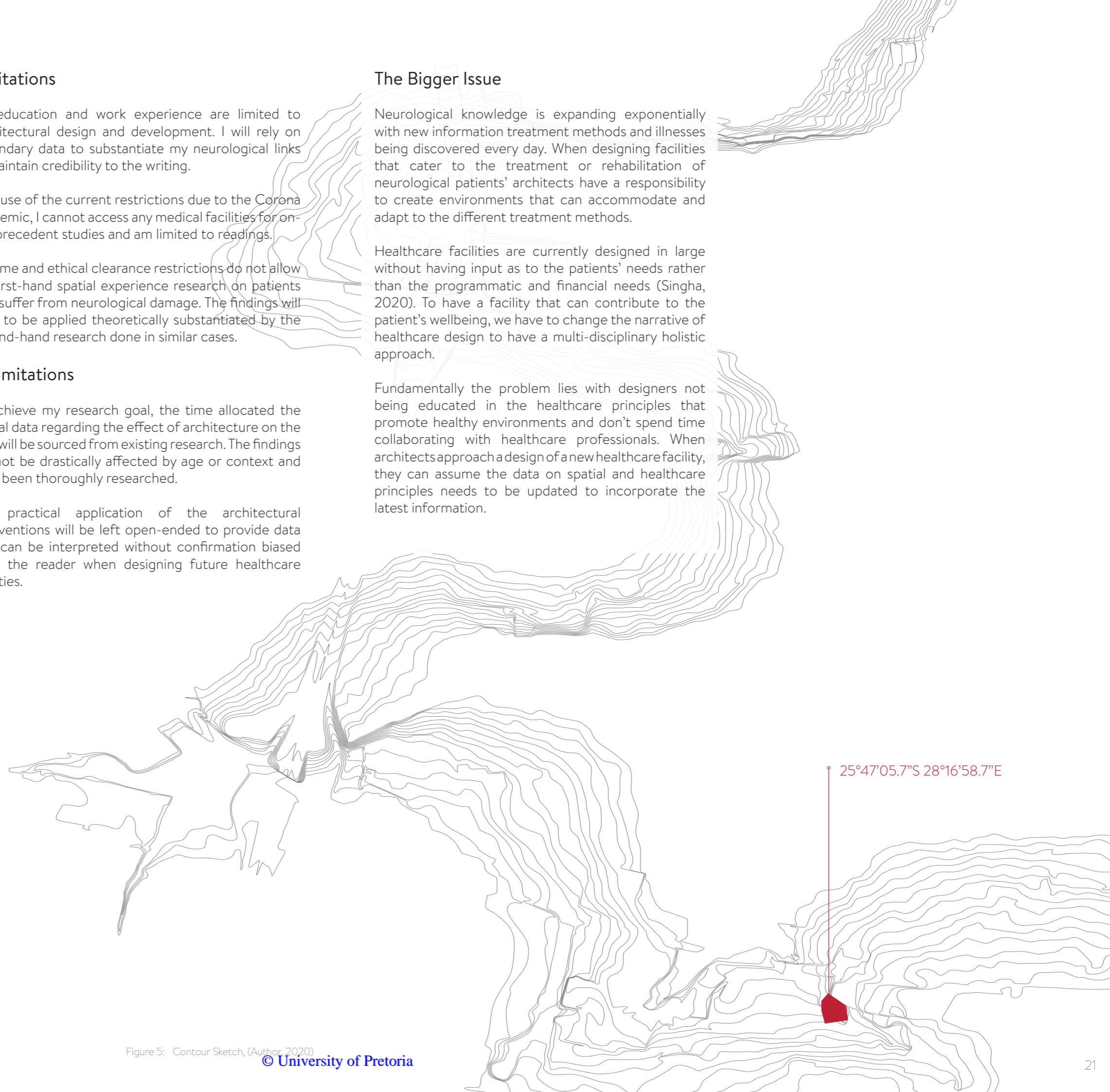


Figure 5: Contour Sketch, (Author 2020)  
© University of Pretoria

# General Issue

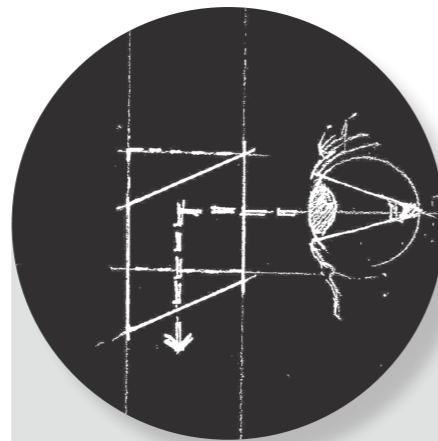
## Societal Perspective

The lack of empathy in society toward those with disabilities has crept into our fundamental approach to design. (Manchester, 2013). It has reached the point where accessible interventions have become a regulation rather than a design goal.

To empower those who have felt the underlying condescension of society due to their disabilities designers have to help empower these individuals and help them achieve independence.

The body is an extension of our minds, and our perception thereof can have physical impacts on our body (Brown, 1995). By bolstering the self-worth of those with disabilities, they can regain some of their independence and drive. The fundamental approach to design and inclusivity has been a talking point for a while now and the answer to the problem lies as deep as the problem itself.

The curb cut effect is an example of how inclusive design has positively impacted all people. The addition of cut curbs is no longer seen as merely an addition for wheelchairs and a method of quickly accessing the sidewalk (Alp and Altınçekiç, 2015). If you approach inclusive design with the mentality of making the intervention beneficial for all, it will become more prominent in designs and sought after by users. Thus benefiting all parties involved and contributing to designs that better cater to all demographics.



Empathy



Inclusive design



Perception



Empowerment

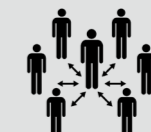
Figure 6: General Icons, (Amantaka, 2018)

# Urban Issue

## Urban Disconnect

When applying patient care to medical facilities, the lack of interdisciplinary coordination has led to hospitals becoming unhealthy spaces with negative connotations to extended stays. The inherent problem lies with the inability of any profession to be aware of another's extents (Almamalik, 2019). This is why we rely on interdisciplinary coordination to design and develop our healthcare facilities with medical planners to bridge the gap. However, despite this we still have a limited application to patient wellbeing with the focus of most facilities being on increasing surface efficiency and patient turnover. Very few medical facilities have successfully aligned their priorities to treat the end-user better.

It is challenging to overcome monetary motives when approaching a design, but if implemented correctly and designed responsibly, the quality of the space and user experience can be upheld while staying in budget. All it takes is a few projects to set a standard of patient care and responsive design to become precedents for future developments (Sharma et al., 2020). Patient wellbeing should be the main driver behind most decisions, and the problem of unhealthy hospitals will not be resolved until it becomes standard practice



Interdisciplinary



Medical planning



Development



Unhealthy spaces

Figure 7: General Icons, (Amantaka, 2018)

# Architectural Issue

## Systemic Dissaray

Noble intentions only result in successful designs if implemented correctly. When dealing with a field as specialised as medicine, it is essential to use an application method that provides clear architectural drivers (Sharma et al., 2020). The problem is the difference in data sets, where medical data is mostly quantitative architects rely on experiential data to inform our design drivers. The success of the multidisciplinary approach lies in our bodies themselves as the link.

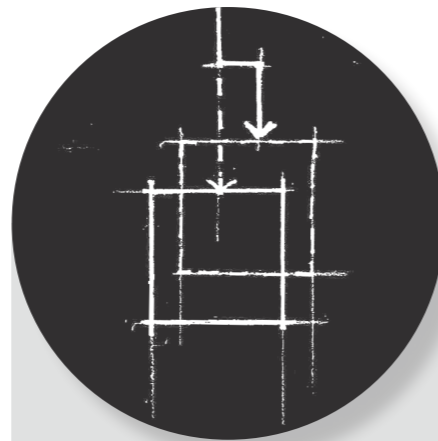
How we perceive space, smell, touch, and sound have a specific biological response, and by identifying how these senses are biologically interpreted, we can start to identify methods that can bridge these two fields. By doing so, our architectural drivers include spatial qualities that adapt to suit its rehabilitative medical counterpart.

This principle will be used to inform the proposed neurological rehabilitation and research centre.

## Universal Design

The term was coined by Architect Ronald Mace describing the concept of the built environment being designed to be accessible by everybody no matter their age status life status or general ability (Tariq, 2020). Selwyn Goldsmith pioneered the application of Universal Design by naming dropped curbs a standard feature for general building practice.

Universal design is a visual combination of the barrier-free concept and accessibility movement and primarily inspired by assistive technology (Tariq, 2020). By considering these concepts, you have an architectural application that is not always visually distinguishable but prides itself on its architectural application and accessibility.



Equitable



Flexibility



Simple & Intuitive



Perception Information

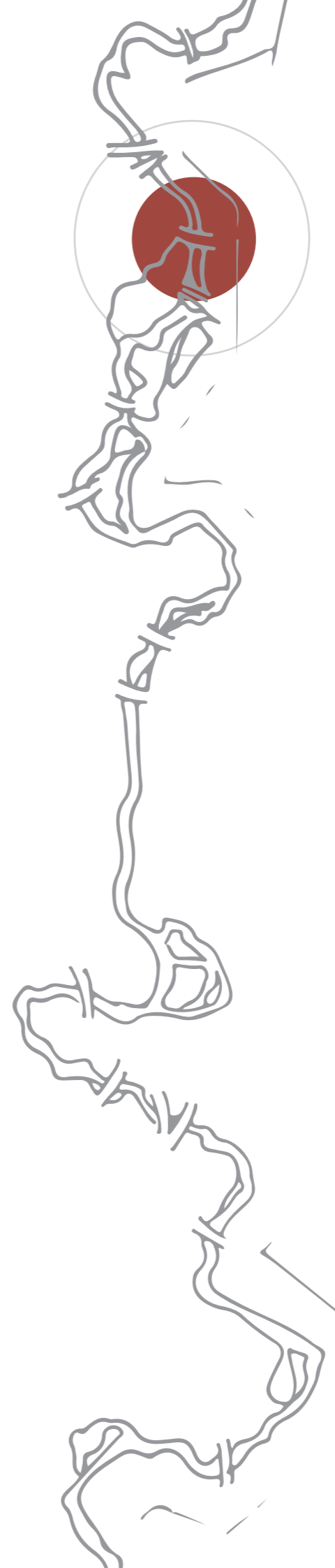
Figure 8: Principle Icons, (Amantaka, 2018)



CHAPTER

# 02 Research

---



# Literature Review

## The Eyes Of The Skin

- Juhani Pallasmaa (1996)

Pallasmaa's novel focusses mainly on the argument that Architecture is based less on sight and more on the other senses. He argues that the interpretation and effect that the other senses have on the body contributes significantly more than we give credit for. He wants architects to better understand spaces we design by relying on senses other than sight (Pallasmaa, 1996).

The premise revolves around our skin being the oldest and most sensitive of our organs. At the time of him writing his book, this was believed to be correct. However, medicine has since proved that our sense of smell is by far the most acute (Pallasmaa, 1996). Despite this, I don't believe it discredits his argument as the sense of touch still outweighs our sight's sensitivity and longevity.

Despite the fact that our vision isn't our most acute sense, architecture still relies primarily on visual drivers. Pallasmaa writes about the pre-conscious perceptual realm, which relies on our peripheral vision contextualising our environment. He believes this perceptual realm has a significantly larger impact than our focussed vision.



Figure 9: Eyes of the skin, (Britannica, 2019)

*"I confront the city with my body; my legs measure the length of the arcade and the width of the square; my gaze unconsciously projects my body onto the facade of the cathedral, where it roams over the mouldings and contours, sensing the size of recesses and projections; my body weight meets the mass of the cathedral door, and my hand grasps the door pull as I enter the dark void behind. I experience myself in the city, and the city exists through my embodied experience. The city and my body supplement and define each other. I dwell in the city and the city dwells in me."*

*-Juhani Pallasmaa (1996)-*

## Hedonic Architecture

- Rossitza Iovtcheva (2014)

In Rossitza Iovtcheva's thesis, she explores the Hedonic Architectural principles based on the coexistence of Hyper and Hypo stimulating experiences (Iovtcheva, 2014). This type of research will be critical to this study's success as it provided a method of quantifying the brain's response to spatial quality. A quantitative clinical data analysis on the brain's dopamine levels is used as a baseline for her research.

The research is done by distancing herself from the study to attempt some objectivity. Her positivist philosophy leads to some very clinical results based on the single truth she found from her clinical research of the human brain (Iovtcheva, 2014).

Her Realist ontology fits with conventional brain studies but did limit the outcomes of the study. The addition of qualitative research and outcomes would have improved the research potential.

The case studies done were all using practical temporary interventions/installations meant to shock or overstimulate the user in such a way as to release dopamine to the brain.

The direct application method can be useful, but the neurological reactions are erratic and tend to have polarised effects varying from user to user.

The application of the hypo stimulants is limited in their practical application. Despite this, I believe there is merit in the research to substantiate more subtle application methods with more predictable outcomes, especially when dealing with rehabilitation programmes.



Figure 10: Anxiety, (Krapht, 2017)

Rossitza used the principle of EBD (Evidence-Based Design) design to fuel her architectural interventions. She focussed on the following three conceptual drivers.



Social support



Integration of Nature



Control

Figure 11: EBD Diagrams, (Neumann, 2019)

## Design As A Rehabilitative Tool

- Dianne Smith (2015)

Writings on Neurology and the brain are well funded and have many research resources allocated towards it. Despite this, it is still the organ we know the least about (Lewis, 2018). As a well-respected researcher in her Interior design field, this paper laid the foundations for multidisciplinary research to follow (Smith, 2015). Smith used a dualistic epistemology using both edic and emic based sources in her research. This method compliments her holistic paradigm, which I think is applicable when approaching a topic with polarised research opinions regarding neurological research conventionally founded in a realist paradigm.

Her holistic approach aims to look at the content of her research and not the whole to better grasp research conclusions. The relativist ontological application worked well due to the nature of her data which was less quantifiable (Smith, 2015).

Smith's data collection was done by applying broad search terms that were applicable to the research. Once the data was collected, she used a qualitative data analysis by filtering the data based on keywords derived from her initial research. The author delves into key interior elements and how they affect patients with ABI.

Here the author delves into key interior elements and how they affect patients with ABI. However, the rehabilitation scope is too broad to accommodate a feasible centre. Even though it does well to identify which interior elements could stimulate ABI patients, she did not apply these principles architecturally, but she only did so in isolated theoretical scenarios. By using a similar approach to generate potential architectural drivers, I can more clearly provide responsive architectural drivers.

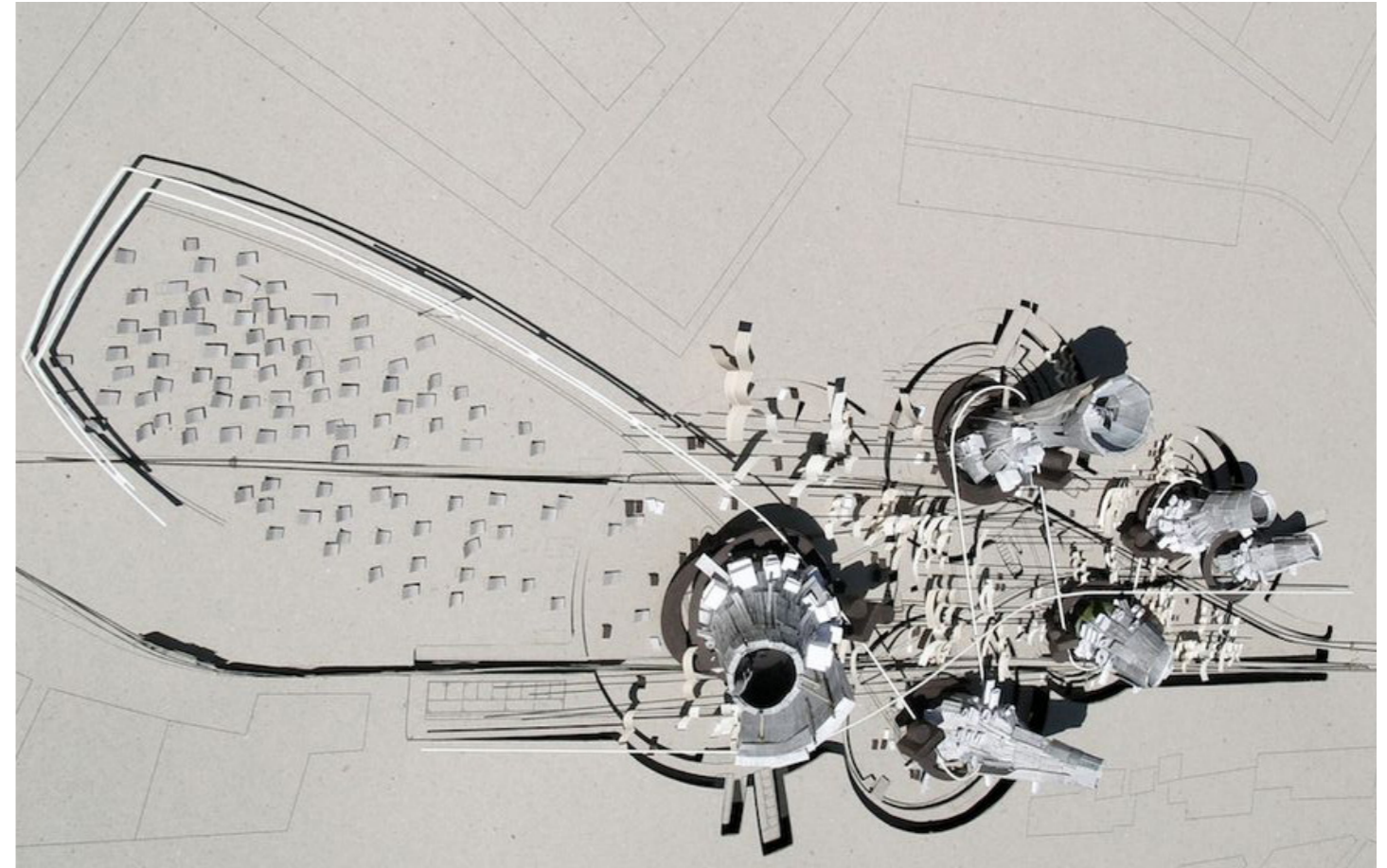


Figure 12: Absrtact Model, (Lavarignas, 2014)

Smith and Mcdonald speaks about the need for responsive design for impairment centers:

*“The benefit of impairment-centered approaches is that they offer insight into the challenges ABI survivors face, and highlight ways in which the physical environment can help an individual to overcome these challenges.”*

-Dianne Smith (2015)-

## Theoretical Outlook

The research was done using an interpretivist theoretical paradigm with a dualistic approach to the data analysis, interpreting it with qualitative and quantitative methodologies. This is to produce conclusions that can have architectural principles based on medical (quantitative) and spatial (qualitative) data.

The quantitative data served as a method of identifying the core principles regarding passive neurological rehabilitation and how they affect the patient's rehabilitation. By compiling this data, I was able to identify the principles of stimulation that can potentially be translated into architectural interventions. The research was done by identifying the successfully implemented rehabilitation methods based on application rates and patient recovery statistics. Keywords such as neurological rehabilitation, haptic stimulation therapy, non-invasive rehabilitation methods and physical neurological rehabilitation were used to gather the article's data.

## Spatial Data

My architectural spatial data will be analysed through the lens of Juhani Pallasmaa who before his time, promoted the importance of senses other than sight to create user centered spaces. He views haptic sense as the primary sense for experiencing a space. He strongly believes that life-enhancing architecture has to simultaneously address all the senses and fuse our image of self with our experience of the world.

## Neurological Data

Because of my limited time and lack of medical education, the majority of my neurological data will be secondary data. My research would not have been possible if not for research on Neuro Plasticity, as it forms the base of all future passive rehabilitation principles. Polish Neuro-Scientist Jerzy Konorski coined the term Neuro Plasticity in 1948.

The studies on it consisted of documenting the change in animals brain function and structure based on their environment. There were promising results, and it was not until 1998 that the first conclusive evidence of human neuroplasticity was found. This changed the whole way research was done on the brain as before this, it was believed that once we reach adolescence our brain capacity stagnates, and no new neurons or brain growth can occur.

This discovery opens the way for our context and environment to influence our neurological systems directly. The potential new applications are endless. This thesis aims to use this knowledge to propose different passive rehabilitation methods to improve the rehabilitation process.

## Rehabilitation and Treatment

The principle of Allesthesia will drive the rehabilitation and treatment methods. It is defined as a psychophysiological phenomenon that describes the dependent relationship between an organism's internal state and the perceived pleasure or displeasure of stimuli. This will bridge the architectural and neurological application methods by finding relevant stimulants that promote similar responses on the human body.

Dr Paul Farmer, a healthcare specialist, working hand in hand with architects to design facilities that cater to patient needs has been programmatically making these connections to allow designers to achieve responsible designs.

The projects he has worked on was used as a precedent for a multidisciplinary design application. The research done by the USA government on sensory deprivation provides a framework for the effects of the senses on the human body.

This was done to create a benchmark for the two extremes of sensory exposure to quantify the extent of an intervention to adequately effect the user of a space. Neuroscientists have recently proved neuroplasticity in 2018, where previously it was believed that any brain matter damaged lost was lost for good (Wenger and Kühn, 2018).

Without this, the research and application of any passive neurological rehabilitation would be irrelevant. Neuroplasticity, also known as brain plasticity, or neural plasticity, is the brain's ability to undergo biological changes, ranging from the cellular level to large-scale changes involving cortical remapping. Such changes often happen as a result of psychological experiences

## Sensory Based Treatment Principles

As architects, we are limited as to our biological effect on the users of our space. By identifying the neurological disorders most prevalent in Postoperative and ABI patients and which senses their disorder relates to I can map the overlapping stimulants.

Due to our brains plasticity and recovery potential by stimulating the affected areas, we can help it create new neural pathways or fix broken ones (Wenger and Kühn, 2018).

The Neurological disorders deconstructed in the journal are hemianopia, sensory processing disorder, auditory processing disorder and olfactory disorders due to degenerative neurological diseases.

The experiment looks at the biological origin of the disorder and the affected areas of the brain. Once allocated the associated sense and its biological effect on the brain is mapped, looking at various stimulatory variables to map the desired stimulatory reaction. By reflecting on the two data sets, the overlap in neurological response can be identified to help inform designers of architectural drivers that can be used to design spaces with passive rehabilitation principles.

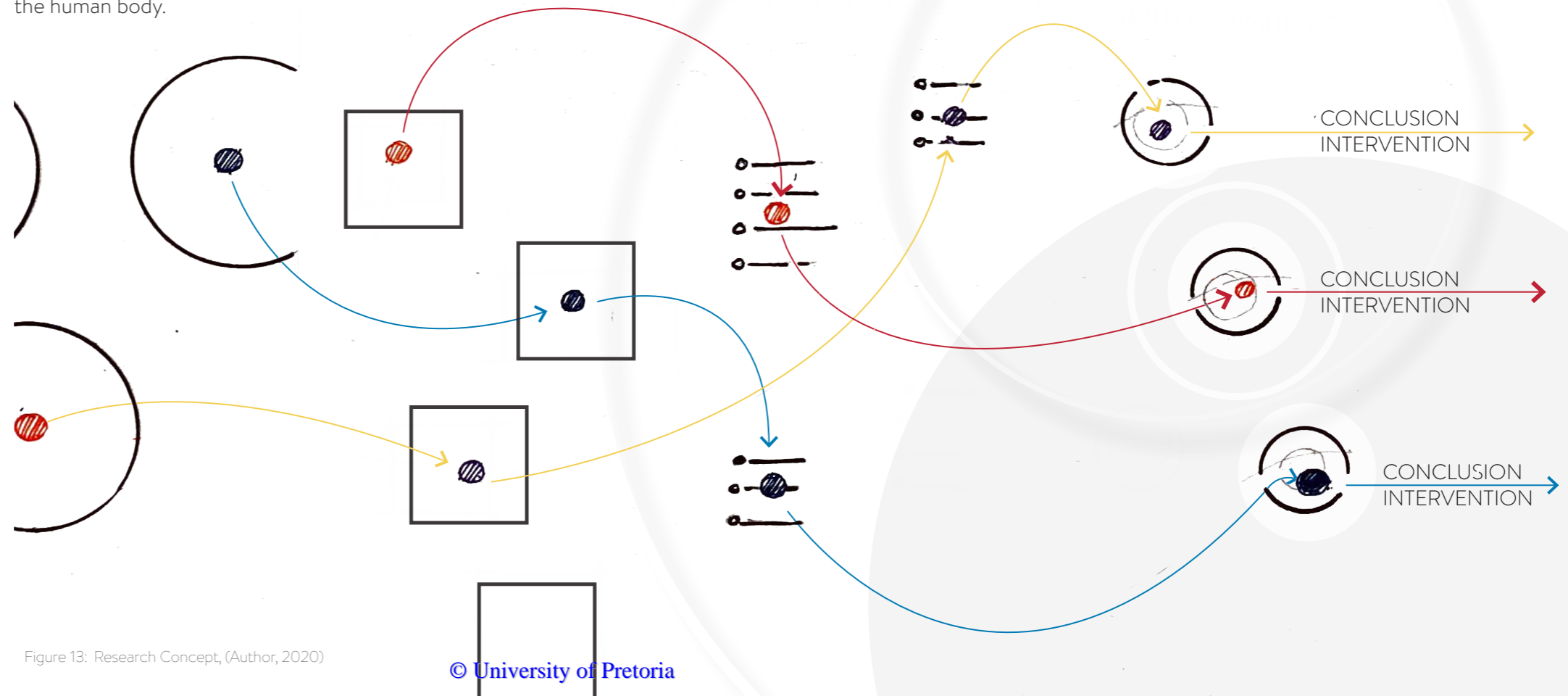


Figure 13: Research Concept, (Author, 2020)

## Project Holter Monitor

The serves as my research touchstone, a constant reminder and method of measuring the collaborative success of architecture and medicine to create successful rehabilitation facilities. While researching medical and architectural applications related to neurological rehabilitation, I constantly evaluate and organise the methods that have existing interdisciplinary collaboration as precedents.

The isolated applications are highlighted as points to be improved to help guide my application and further the field to promote a more holistic approach to healing. The closer to the x-axis the graph, the better the collaborative attempts. Ideally, at the end of the project, I can bring the two fields together by identifying the outliers in the respected fields and addressing them to the best of my capabilities.

## Holter Monitor Diagramme

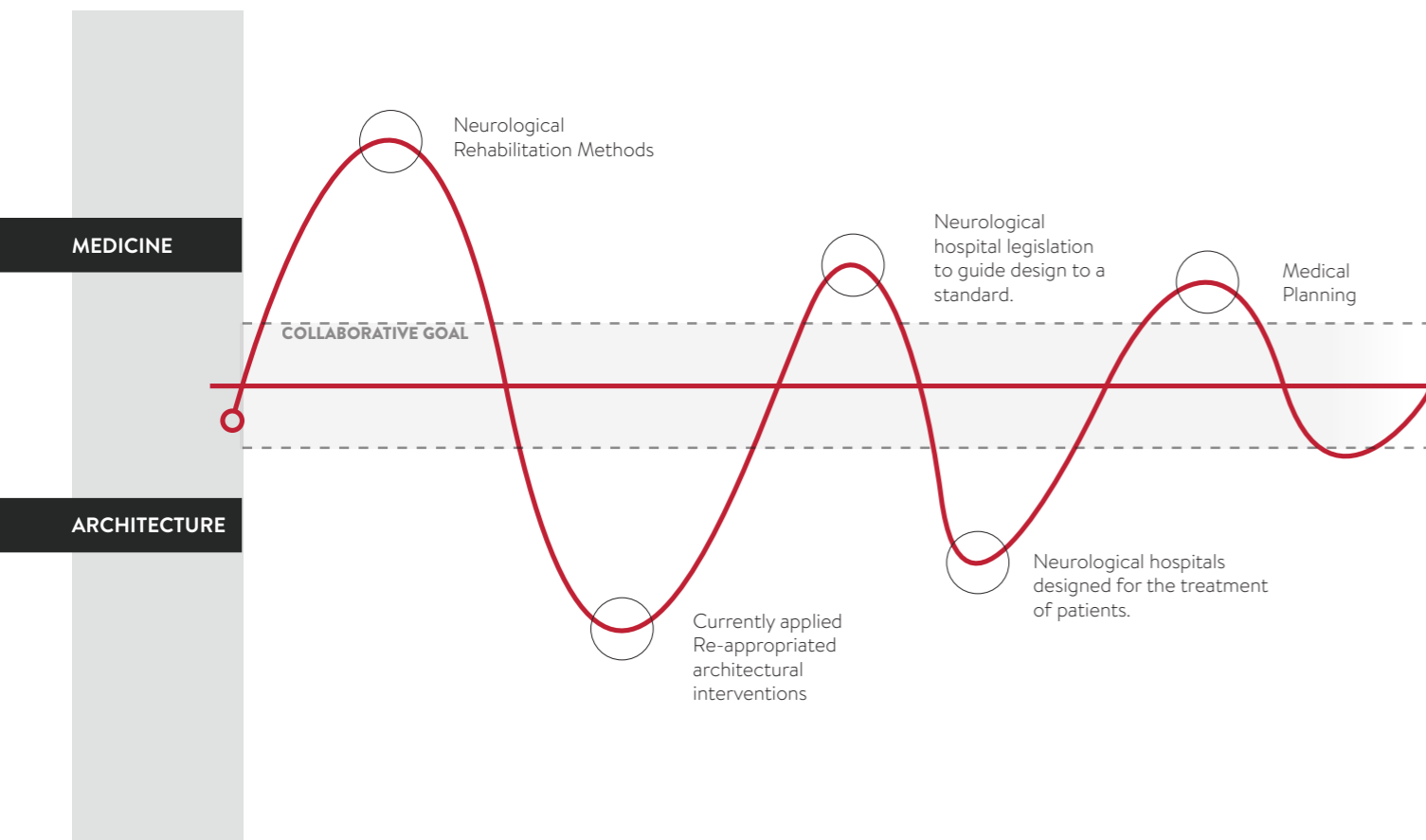


Figure 14: Holter Monitor, (Author, 2020)

## Holistic Research

In parallel with my holistic design principles for the rehabilitation centre, I implemented a research system that covers the different aspects of the projects to ensure I have considered all the variables. The various sources were categorised as either: Medical, spatial or contextual data.

Once sorted, they were separated by the type of source: Theoretical, practical secondary, precedent or regulatory data. This helped me efficiently allocate my research hours to cover all the possible sources to best implement my research.

## Data Organisation Diagramme

	THEORY		PRACTICAL		SECONDARY	PRECEDENTS	REGULATION
#1 MEDICAL DATA	CINTOCARE. 2019.	Health E NEWS. 2020.	ABBOTT, G. 2020.	HEADWAY. 2018.	WHO. 2006.		
#2 SPATIAL DATA	ANDERSON, C. 2017.	ANDERSON, C. 2017.	DIANNE SMITH, P. D. A. J. M., BPSYCH(HONS.) 2015.	ARCHDAILY. 2019.	NORD, C. 2017.		
#3 RESEARCH DATA	UCT. 2018.	TANYA LEWIS, S. W. 2018.	IOVTCHEVA, R. 2014.	ARCHDAILY. 2020.	MUNSAMI, A. 2018.		

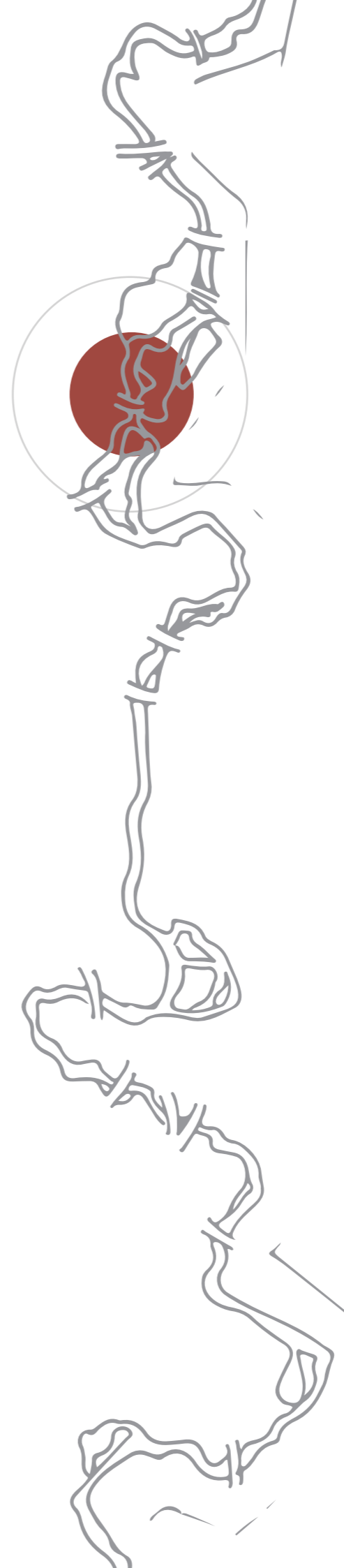
Figure 15: Research Organisation (Author, 2020)



CHAPTER

# 03 Research And Experiment

---



# Research Experiment

## Experiment Overview

Using the readings and existing neurological rehabilitation methods, I've devised an experiment to provide architectural solutions for neurological rehabilitation problems. The experiments are currently limited to the senses that architects have the most control over. By stimulating the visual, olfactory, auditory and haptic senses, we can analyse the neurological responses to see if they overlap with the biological trauma locations associated with the most common sensory-related neurological conditions.

Any intervention inspired by the experimental conclusions will have a colour allocation to indicate the designs stimulatory intentions throughout the project.

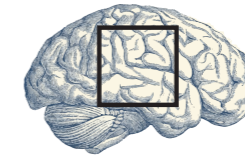
## Sensory Related Disorders

- Hemianopia:**  
Neurological condition related to visual analysis
- Sensory processing disorder:**  
Neurological condition related haptic experience
- Hyposmia:**  
Neurological condition related olfactory recognition
- Auditory processing disorder:**  
Neurological condition related auditory experience

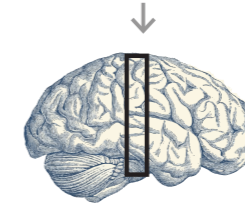


## Experiment Process

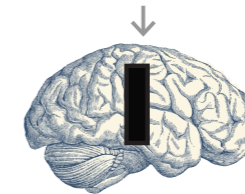
**Step 1:**  
Research neurological disorder identified by literature study and allocate the biological origin of the disorder



**Step 2:**  
Map sensory stimulant related to the aforementioned neurological condition



**Step 3:**  
Identify overlap between biological location of the condition and the sensory stimulated areas.



## Architectural Drivers

Once the biological stimulatory overlap has been determined, the feasibility and effectiveness of the passive rehabilitation methods can be determined in order to respond effectively and appropriately.

The stimulatory research and application in a rehabilitative context will be the informant when it is being re appropriated into an architectural intervention. This can produce conceptual architectural principles that can be better practically implemented.

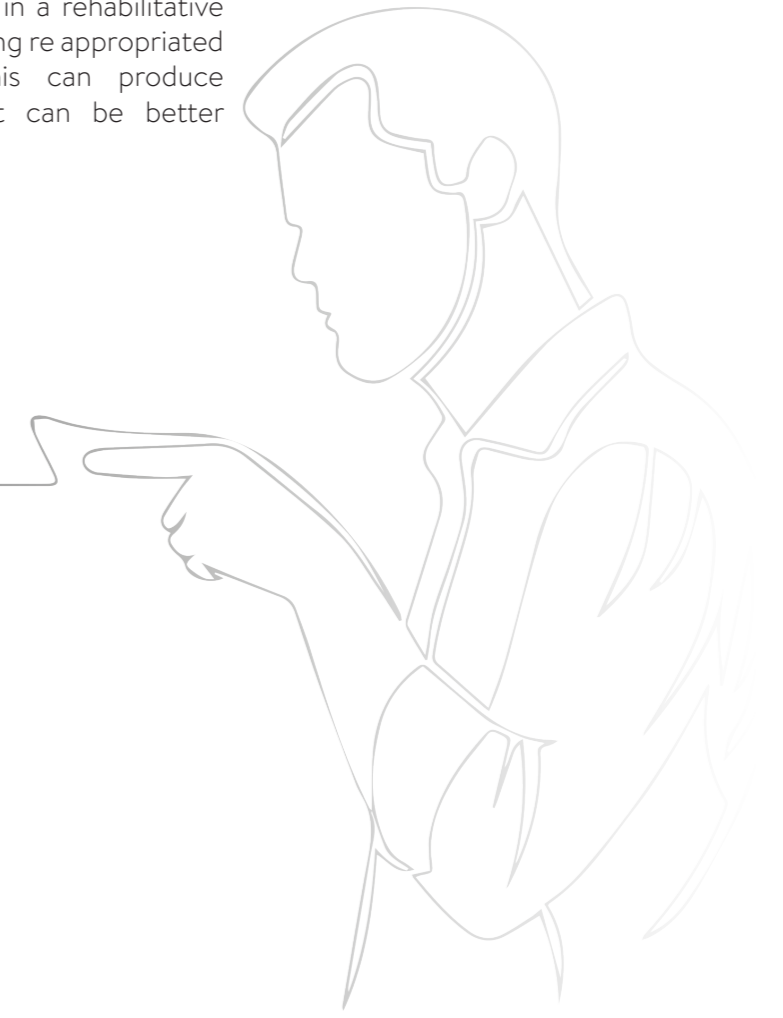


Figure 16: Neuro Afflictions, (Author, 2020)

# Visual Therapy

## Related Neurological Condition

Hemianopia refers to vision impairment resulting from brain damage and is a common side effect of acute brain injury and in some cases, is found in postoperative neurological patients (Szalados et al., 2020). The severity differs from case to case depending on the trauma and location on the brain.

Symptoms include distorted sight, double vision, difficulty understanding what you see, vision that appears dimmed and, visual hallucinations. The everyday impact of Hemianopia can be crippling, and the treatment merely mitigates the side effects (Szalados et al., 2020).

## Biological Trauma Location

The symptoms stem from the trauma on the brain in certain areas, as illustrated below.

■ Visual Trauma allocation



Figure 17: Heminiopia, (Author, 2020)

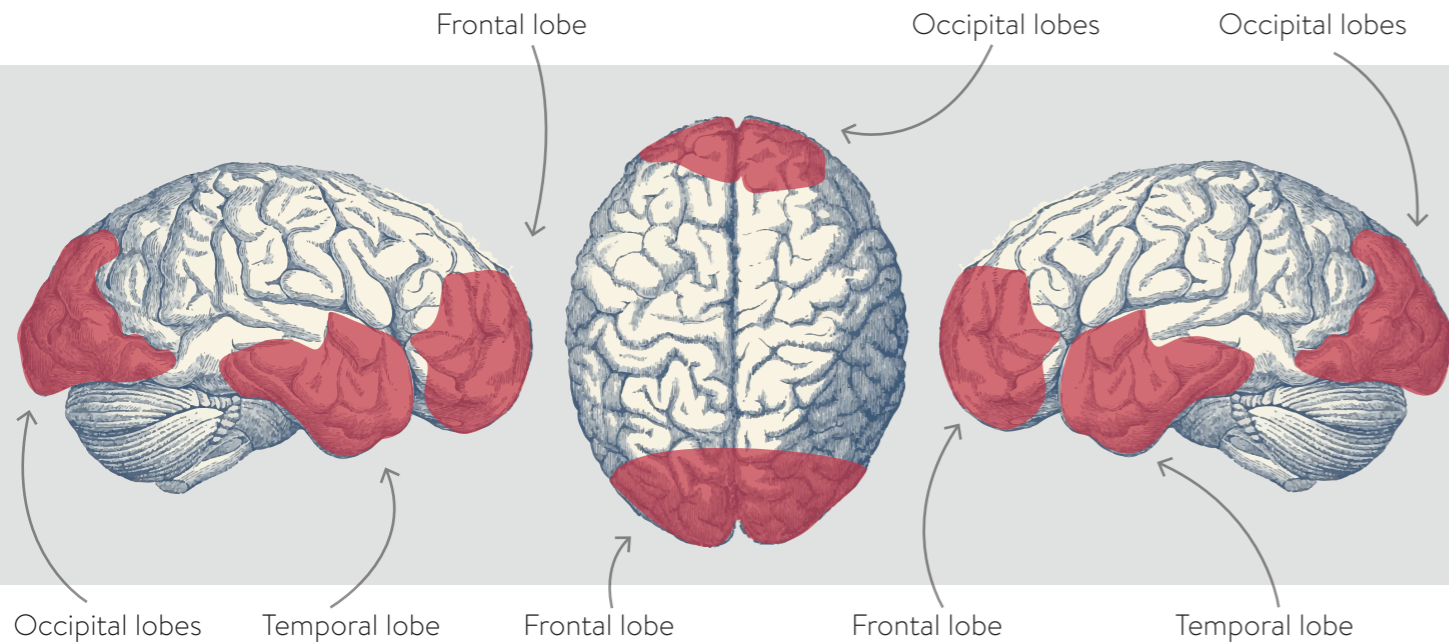


Figure 18: Heminiopia Location, (Author, 2020)

## Reaction To Visual Stimulants

Based on the brain areas that are affected by Hemianopia I have been able to identify the following spatial drivers that stimulate similar regions of the brain that have been damaged to cause the vision impairment (Sahraie et al., 2019). Because of the nature of the illness, the architectural drivers are mainly visual. Using Micheal Peers study on the human experience of scale, I have been able to identify the following principles (Peer, 2019).

## Visual Interpretation:

Based on the observed object's scale and intimacy, the users' perception stimulates different brain regions.

- Room Scale
- Building Scale
- Urban Scale

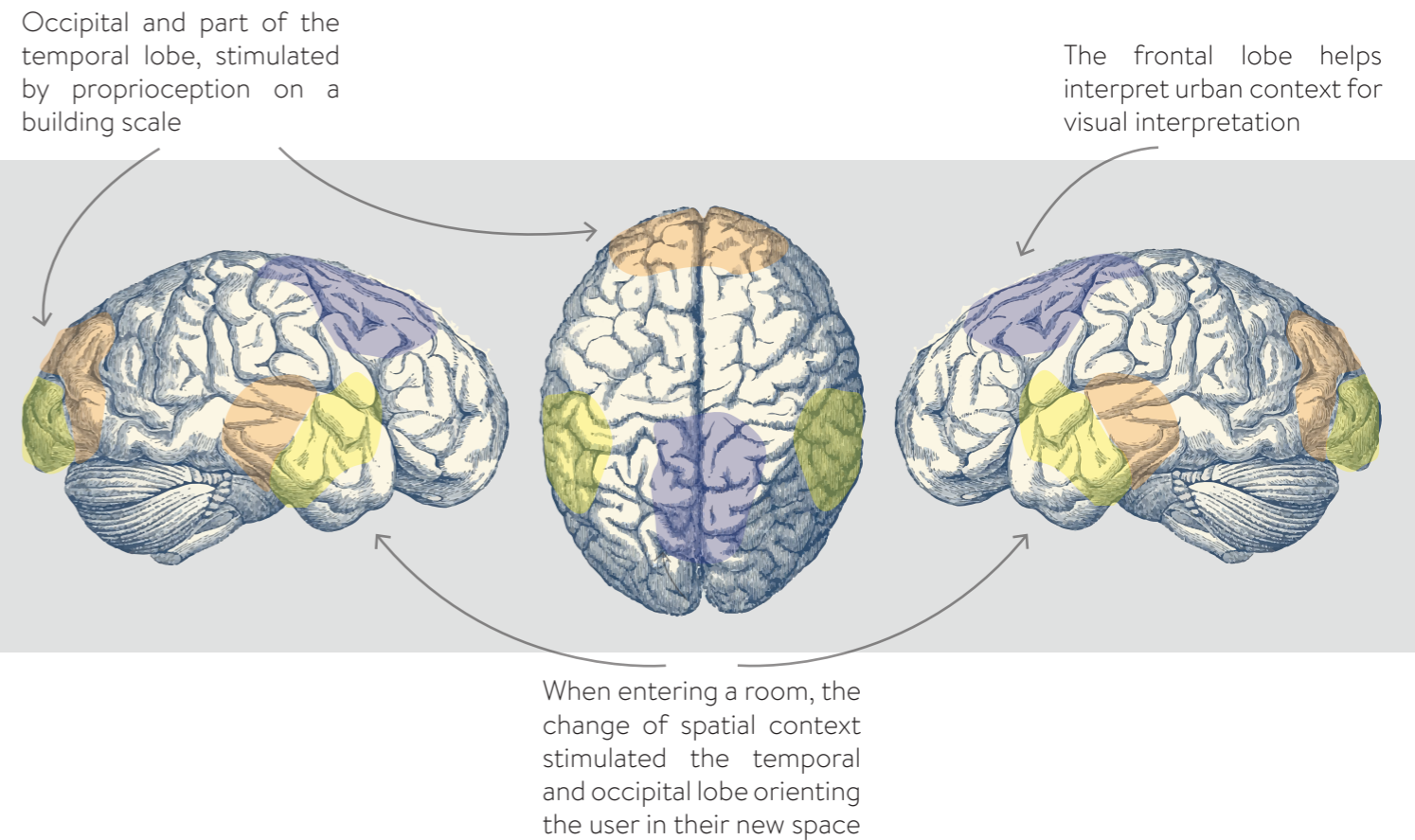
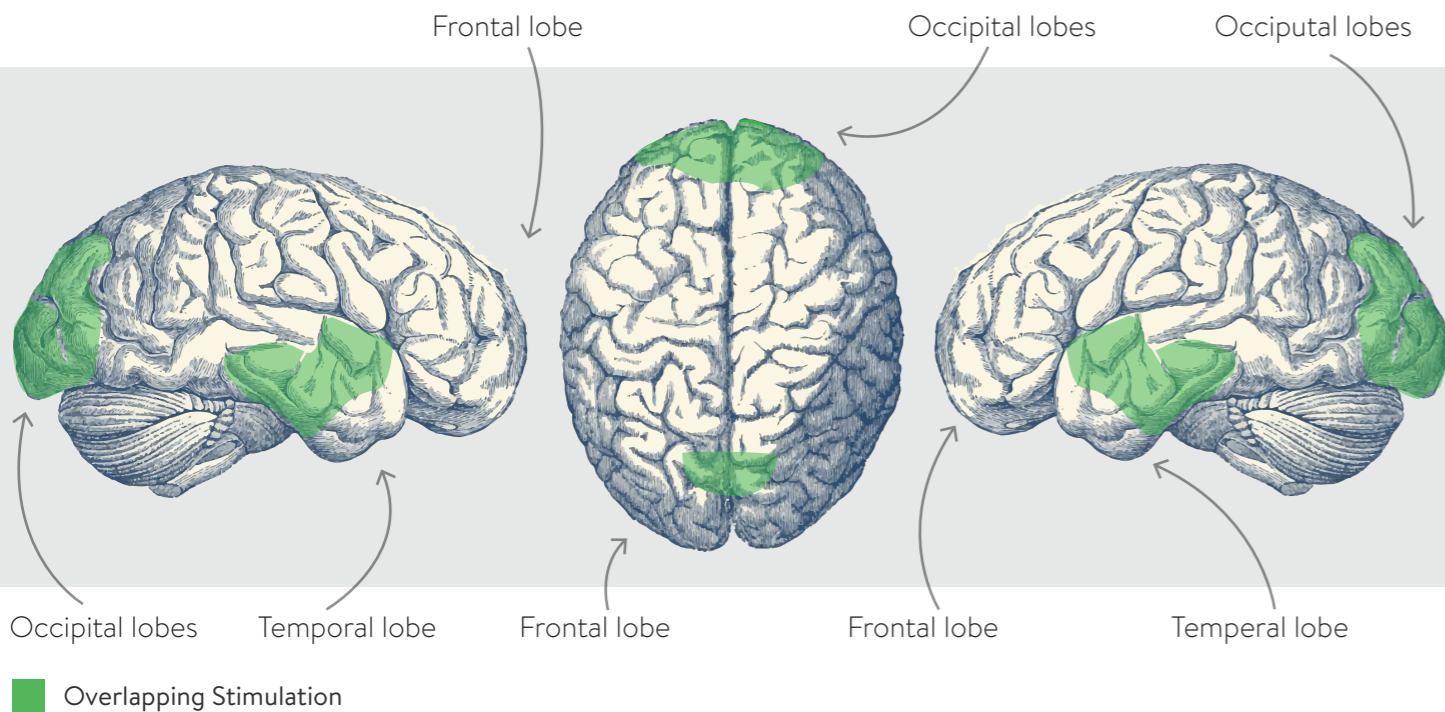


Figure 19: Heminiopia Stimulation, (Author, 2020)

## Biological Stimulatory Overlap

Based on the physical trauma location and the visual stimulation findings, I can deduce it is possible to visually stimulate a user to neurologically target the effected areas related to Hemeniopia (Szalados et al., 2020). Based on the fundamentals of neuroplasticity, we can assume that the stimulation of these areas can strengthen neural pathways and improve a patients response to active neurological treatments.

The biological overlap is significant enough that the oscillating visual scale's introduction could have a significant impact on the patient's recovery. Once implemented, the results need to be properly documented to track potential contributions. If correctly implemented the interpretation of the space through scale and thresholds can stimulate the areas indicated below that correlate with the physical trauma locations of Hemeniopia.



## Application Opportunities

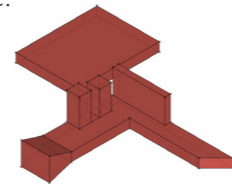
When designing passive rehabilitation interventions that can contribute to hemianopia treatment, it is essential to address the different aspects of the building on multiple scales. Thoroughly immerse the user in the space they are inhabiting to force their brain to process their surroundings.

By implementing thresholds that create a different sense of space as they progress through the facility, they will cognitively adapt to their surroundings and reinterpret them consciously or as Pallasmaa indicated in his research subconsciously through their peripheral vision.

## Conceptual Application

- Intermediate thresholds,
- Permeable barriers,
- Oscillating proprioceptive experiences, and
- Plan and sectional shifts in scale.

Refer to page 80 for conceptual Visual Rehabilitation application

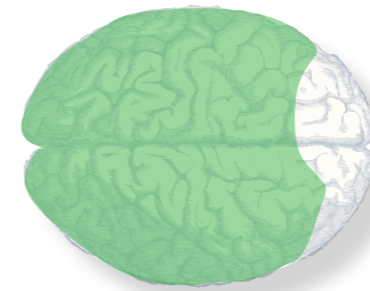


## Visual Stimulation Diagram Summary

The neurological disorder with the most promise of passive rehabilitation is hemianopia where the overlapping neurological responses overlap significantly. Also the potential application methods are the easiest to implement architecturally without disturbing any medical or architectural regulations.

## Visual Stimulation Potential Diagram

Estimated 80% stimulatory overlap based on research data and potential architectural stimulants.



- A lot of potential passive systems,
- Easy implementation, and
- A lot of stimulatory overlap.

## Visual Passive Design Principles

The passive visual stimulants' success relies on creating a progressive narrative for the patient while transitioning between spaces. The oscillating spatial experiences have to be applied on plan and section to have a holistic application. By exposing users to different visual scales of the building at separate intervals, some subtle and some abrupt, the building will have a positive rehabilitation concept.



Figure 20: Hemeniopia Overlap, (Author, 2020)

Figure 21: Hemeniopia Diagram, (Author, 2020)

# Haptic Therapy

## Related Neurological Condition

Sensory Processing Disorder (SPD) is a condition in which the brain has trouble receiving and responding to information that comes in through the senses (Blanche and Gunter, 2019). Formerly referred to as Sensory Integration Dysfunction, it is not currently recognized as a distinct medical diagnosis (Goldberg et al., 2006).

Some people with sensory processing disorder are oversensitive to things in their environment. Familiar sounds may be painful or overwhelming. The light touch of a shirt may chafe the skin. These symptoms can lead to anxiety in many patients due to sensory overload.

## Related Neurological Condition

SPD is caused by a white matter deficiency prevalent in a study done by the UCSF (Leigh, 2017). The deficiency is prevalent in the occipital lobe with structurally impaired white matter in the parietal lobe. The affected areas can be seen as illustrated below.

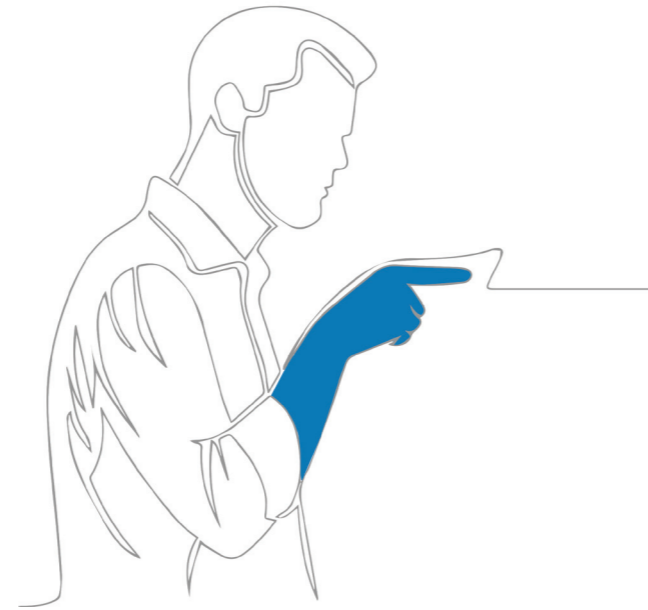


Figure 22: SPD, (Author, 2020)

■ Haptic Trauma Location

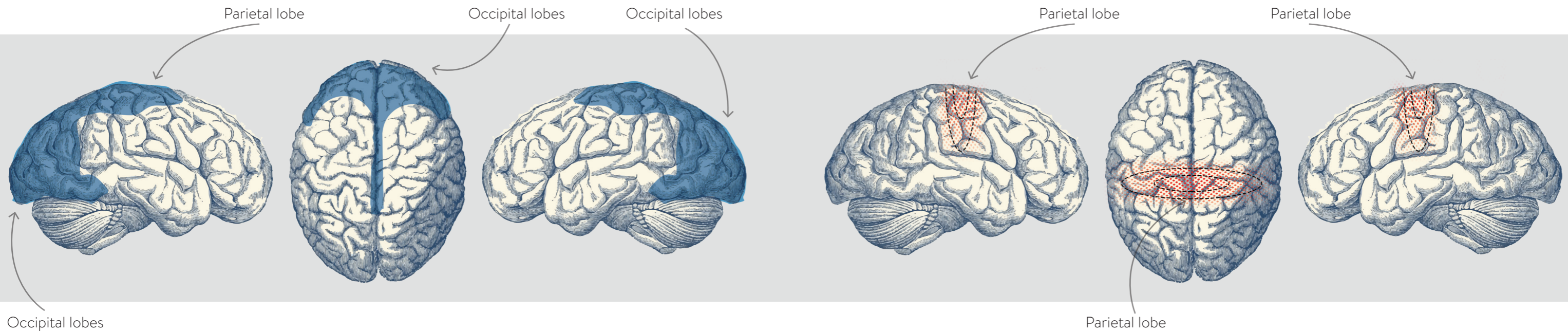


Figure 23: SPD Location, (Author, 2020)

## Reaction To Haptic Stimulants

Our tactile experience of a surface we encounter has varying effects on our brain as well as our perception of a space. Justin D. Lieber and his team have done extensive research on the brain's stimulatory reaction to different surfaces (Lieber and Bensmaia, 2019). By oscillating the textures we experience through architecture, we can stimulate different areas of the brain to use our natural plasticity to stimulate the affected areas.

## Biological Response To Textures

The brain's reaction to texture is based on its quality. The more fine the material, the less the intensity but, the broader its exposure. The coarser the material, the more intense the reaction however, it's limited to a smaller area of the parietal lobe (Lieber and Bensmaia, 2019). The effect can be seen illustrated below. The red hatch indicates the extent of the exposure while the black dashed line represents the different tactile response zones.

Figure 24: SPD Stimulation, (Author, 2020)

## Biological Stimulatory Overlap

If designed correctly, the tactile differences in the user experience will continuously have the patient exposed to textures that stimulate your somatosensory cortex's extent to create a structured white matter needed for recovery (Lieber and Bensmaia, 2019).

Theoretically, the neurological reaction to the tactile stimulation should provide the brain with the tools to repair the white matter damage as the stimulation of a damaged part of the brain can mitigate brain atrophy.

If designed correctly, the tactile differences in the user experience will continuously have the patient exposed to textures that stimulate your somatosensory cortex's extent to create a structured white matter needed for recovery. The area that has any stimulatory overlap has been illustrated below.

## Application Opportunities

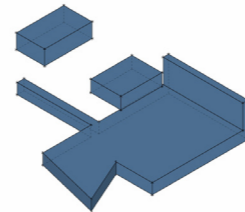
The design will have to passively stimulate the haptic senses that cover the widest area of the somatosensory cortex whose job is to interpret different textures. The design will have to create a user interface for your architecture with people interacting with your design to allow for exposure to tactile oscillation.

This can be achieved by identifying the elements users typically interact with and alternating them in ways that allow your brain to process the material change subconsciously.

## Conceptual Application

- Interactive design interventions,
- Oscillating textures to exposed surfaces, and
- Contrasting textures to single surfaces.

Refer to page 82 for conceptual Haptic rehabilitation application

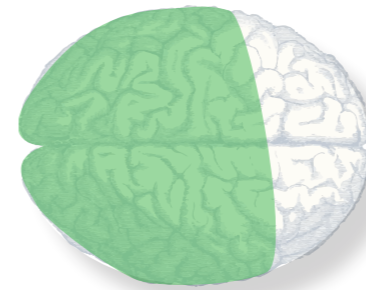


## Haptic Stimulation Diagram Summary

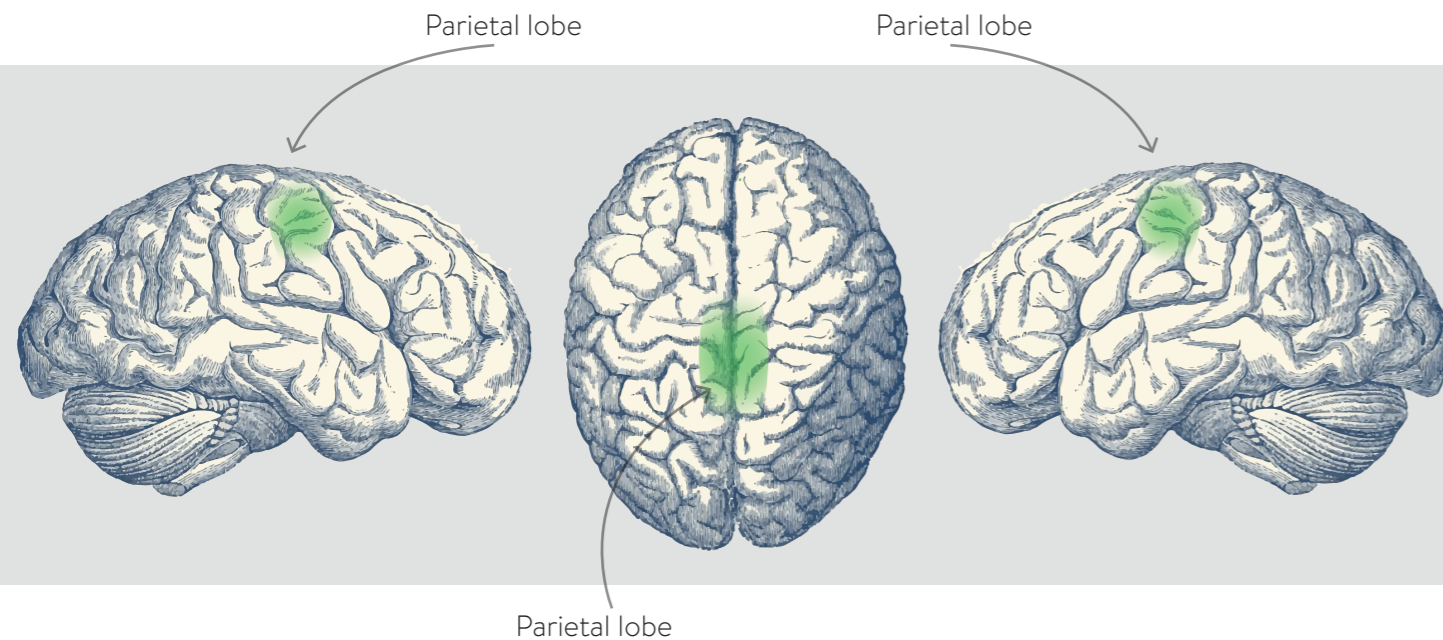
Sensory processing disorder is the other disorder that allows for easy architectural application. However, the application needs to be meticulous not to hinder everyday interaction but rather simultaneously improve the space's quality while allowing normal functions to occur.

## Haptic Stimulation Potential Diagram

Estimated 60% stimulatory overlap based on research data and potential architectural stimulants.



- Clear architectural driver potential
- Multiple application methods
- Stimulatory overlap dependant on application method



■ Overlapping Stimulation

## Haptic Passive Design Principles

The tactile oscillation will be applied mostly to public and rehabilitative spaces. The medical facility has strict material restrictions for sanitary reasons. The success of the passive haptic rehabilitation lies in promoting human interaction with the building and its surfaces. Understandably current pandemic guidelines restrict surface contact. However, the interventions will be well ventilated and made of surfaces with little to no bacterial cohesion.

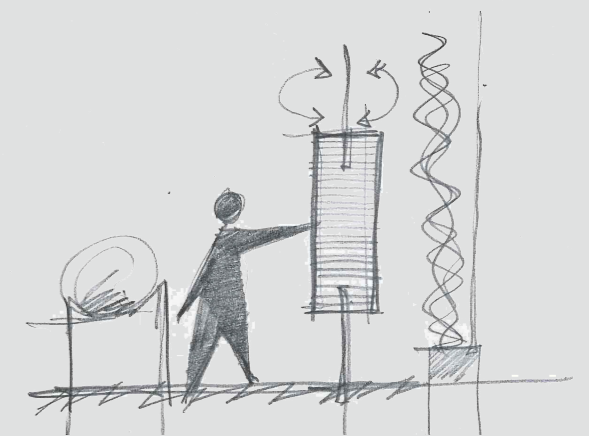


Figure 25: SPD Overlap, (Author, 2020)

Figure 26: SPD Diagram, (Author, 2020)

# Olfactory Therapy

## Related Neurological Condition

There are many olfactory disorders, most of which affect the older population. This is generally contributed to degenerative neurological diseases. Physicians at large often overlook olfactory tests and can be vital to a patient's diagnosis, and the symptoms thereof can reduce their quality of life (El Haj and Larøi, 2020).

Hyposmia is a reduced ability to detect odours. In rare cases, someone may be born without a sense of smell, and a condition called congenital anosmia (Marrero-González et al., 2020). Parosmia is a change in the standard perception of odours, such as when the odour of something familiar is distorted.

Despite being an auditory disorder, the origin usually stems from a neurological source. Hyposmia is specifically located on the areas of the brain illustrated below.

■ Olfactory Trauma Location



Figure 27: Hyposmia, (Author, 2020)

## Reaction To Olfactory Stimulants

Our sense of smell is 10000 times more sensitive than our sense of taste. Because of how our brain interprets different odours, it is also the sense that has an enormous impact on our neural network. Odours can trigger memories or emotions we aren't actively aware of to stimulate larger brain areas than most of our other senses (Crunelle, 2019). How we process a odour is only part of the biological reaction the beauty lies in how our brain interprets the different odours making connections to past experiences or similar odours.

## Biological Response To Smell

Our brain processes odor through the Basal Ganglia. After that, the neurological response depends on the brain's interpretation thereof. If it evokes a memory, the hippocampus and frontal lobe are very active and associates it with a new odour and the occipital lobe processes the new data (Blair, 2021).

The implications of the brains method of processing odour mean the reaction to different olfactory stimulants isn't limited only to the areas that process it. It creates a chain reaction interacting with various regions of the brain, as illustrated below.

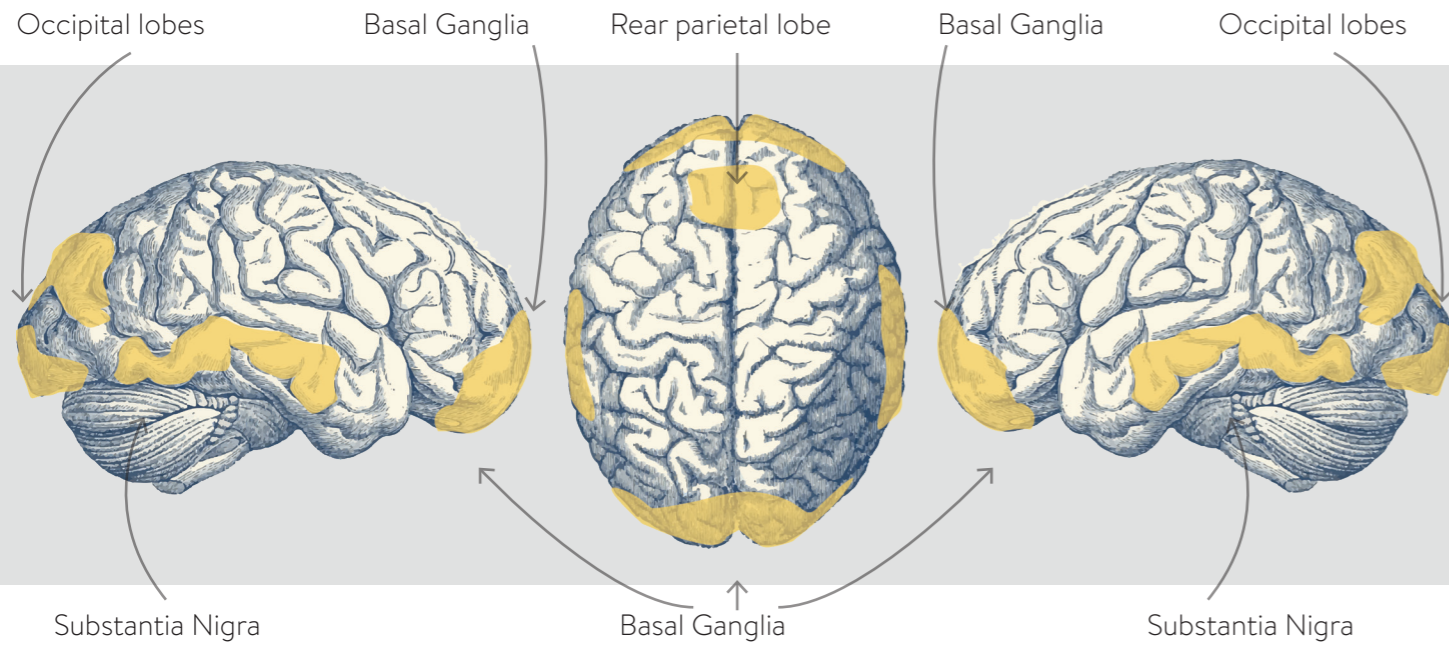


Figure 28: Hyposmia Location, (Author, 2020)

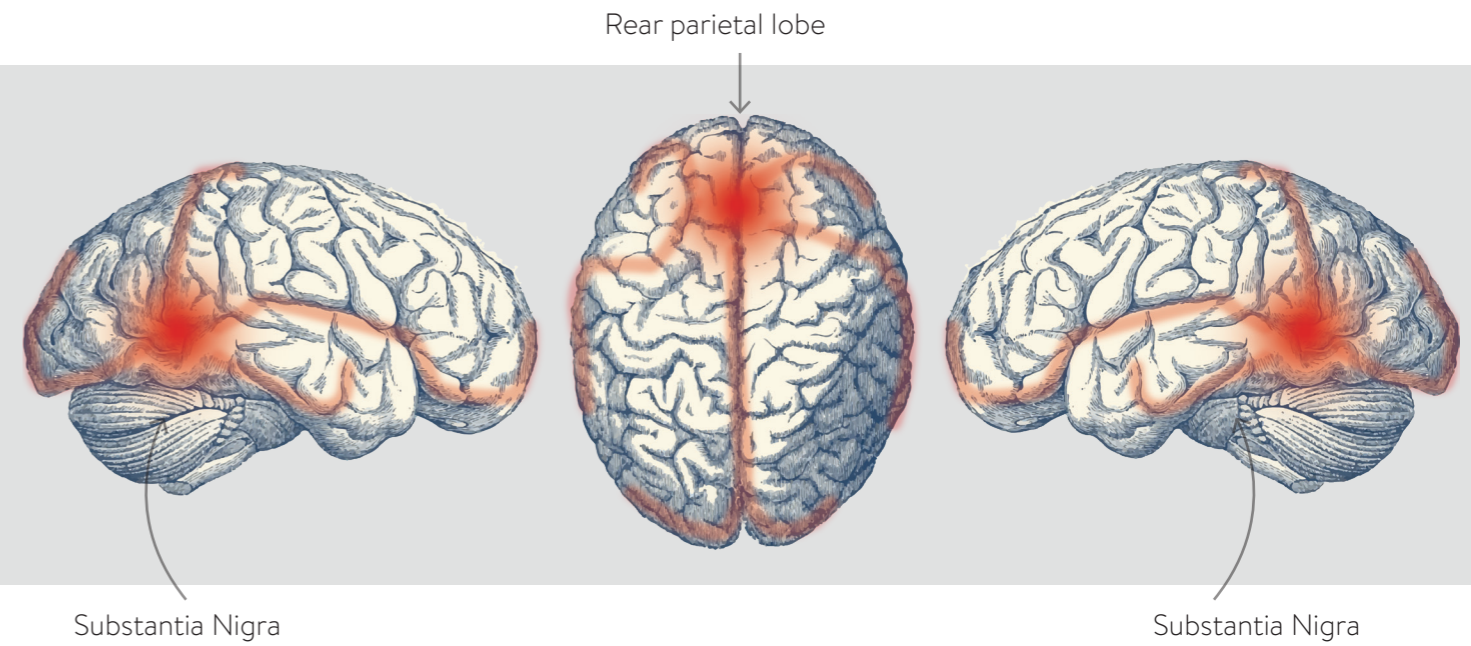


Figure 29: Hyposmia Stimulation, (Author, 2020)

## Biological Stimulatory Overlap

If the space allows for various odours through ventilation and natural interventions, the biological reactions will stimulate the affected areas as illustrated below.

To consider research on the spread of Covid 19 all mechanical ventilation was avoided in the design. Whereas natural ventilation deep lobbies and access controlled areas were applied in the design.

## Application Opportunities

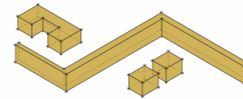
Of the four senses that the study has deconstructed smell is the hardest to design for as there are many different variables. However, using proper ventilation and less air conditioning, you will have more natural odours that vary from visit to visit, thus increasing the chances of triggering an emotional response in the patients. This is also better to restrict the spread of air born pathogens such as Covid.

There are artificial methods of introducing odour into a design however, a natural approach to including biophilic interventions with various odours can help create spaces that evoke different neurological responses (Blair, 2021). Stimulating the multiple areas associated with Alzheimer's and Parkinson's patients (El Haj and Larøi, 2020).

## Conceptual Application

- Natural ventilation,
- Various olfactory stimulants, and
- Adaptive odour generators.

Refer to page 84 for conceptual Olfactory rehabilitation application

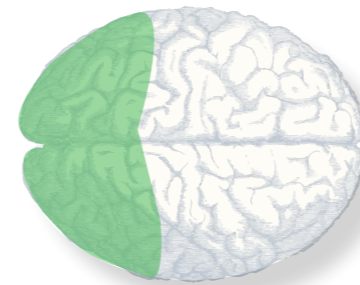


## Olfactory Stimulation Diagram Summary

The Olfactory stimulation has a lot of variables associated with its application. The ventilation and clinical circumstances will differ based on the program, and while these can be dealt with, it might reduce the efficiency of the architectural intervention.

## Olfactory Stimulation Potential Diagram

Estimated 40% stimulatory overlap based on research data and potential architectural stimulants.



- Biologically, very efficient method of stimulation,
- Not very efficiently stimulated architecturally, and
- Potential Clash with regulatory restrictions.

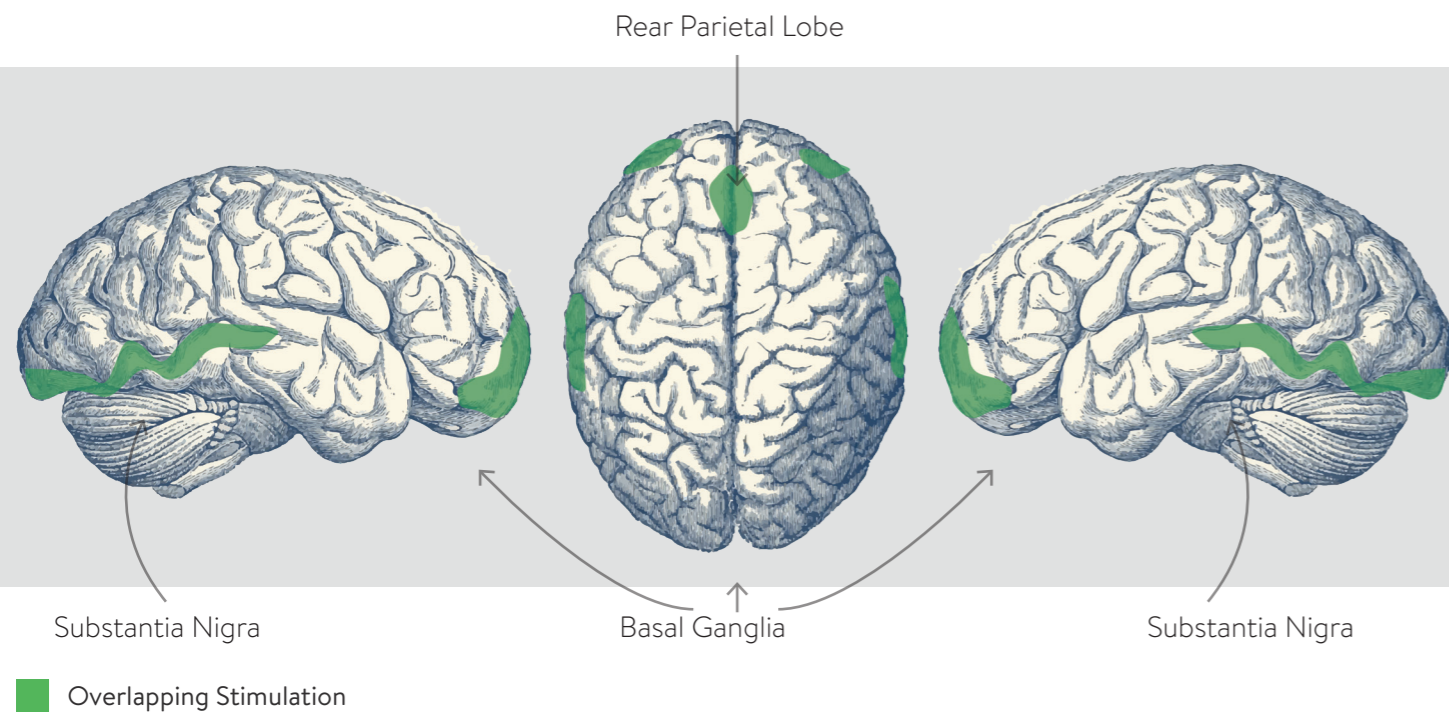


Figure 30: Hyposmia Overlap, (Author, 2020)

## Olfactory passive Design Principles

The olfactory drivers are clear in their efficiency but not as evident in their architectural application. The seasonal changes and amount of variables make it hard to control. However as the designer, we can allow the exposure of varying scents to reach the users of the space. By using natural ventilation systems as opposed to centralised air conditioning, the olfactory exposure already increases significantly.

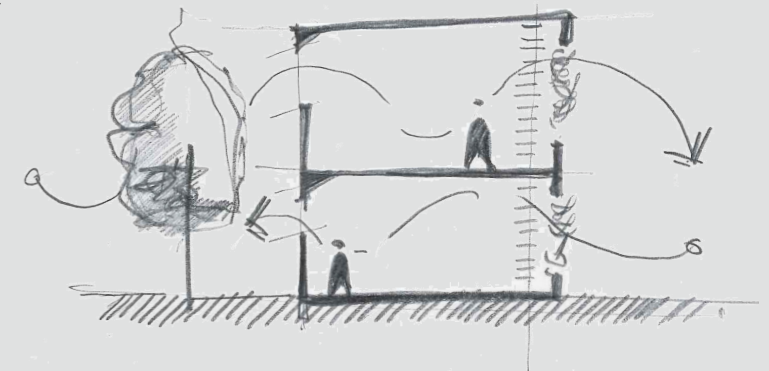


Figure 31: Hyposmia Diagram, (Author, 2020)

# Sound Therapy

## Related Neurological Condition

People with Auditory Processing Disorder (APD) have difficulty hearing small sound differences in words, leading to confusion and stress when they constantly misinterpret instructions or conversations. This is a common symptom of acute brain injury and is also known to be caused by certain viral infections (Read et al., 2002).

There is no known cure, but occupational therapy and hearing aids have reduced the symptoms significantly. Despite being an auditory disorder, the origin usually stems from a neurological source. The intensity can vary from case to case but always has everyday life implications (Iwano and Murase, 2013).

■ Auditory Trauma Location

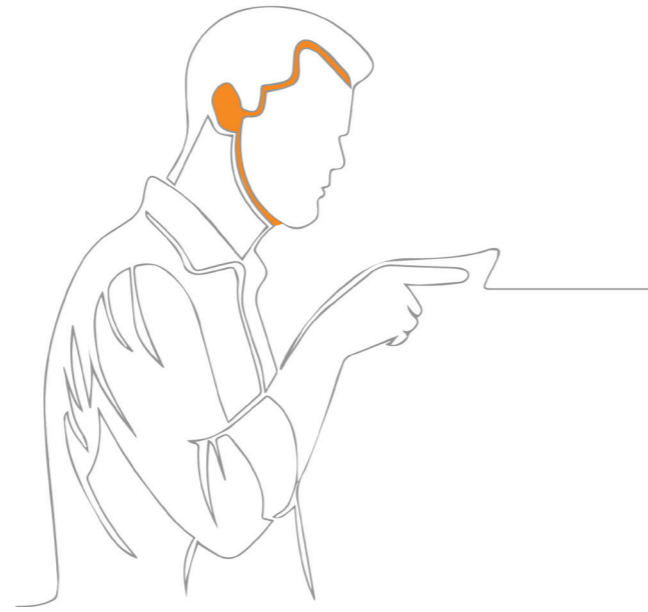


Figure 32: APD, (Author, 2020)

## Neurological Reaction To Sound

The brain runs on electricity, and neurons fire at different rates and patterns depending on what they're doing. Specific brainwave frequencies, typically measured from the scalp using Electroencephalography (EEG), are associated with various cognitive and emotional states. (Formisano et al., 2003) Brainwaves start to match an external stimulus's frequency, like a binaural beat, and brain areas that might ordinarily fire at different rhythms become synchronized. The goal is that by getting your brain to fire at the desired rate, you'll begin to embody the corresponding mental state.

## Neuro Reaction To Changing Frequency

■ Delta & Theta Waves

Theta waves 4 Hz to 8 Hz signify deep relaxation

■ Alpha Waves

Alpha waves 8 Hz to 12 Hz related to a passively attentive state

■ Beta waves

Beta waves 12 Hz to 30 Hz and are tied to feelings of Attention

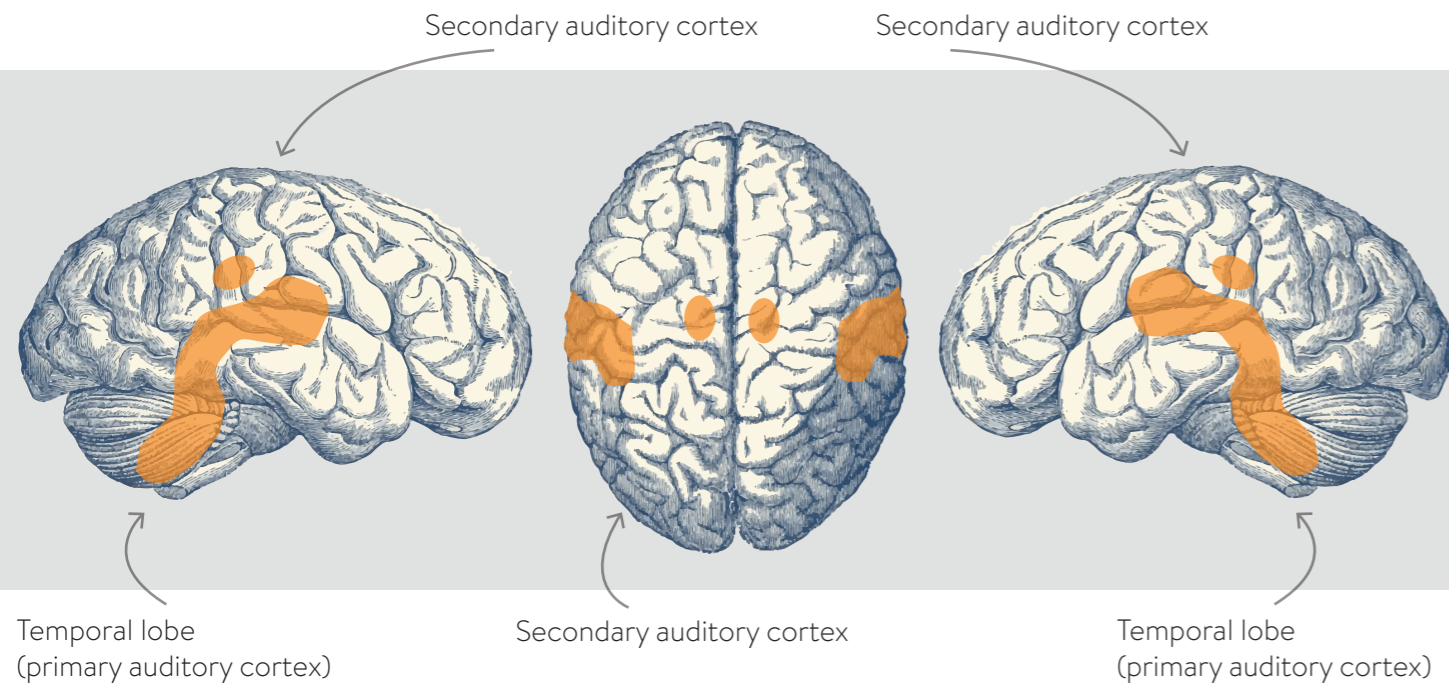


Figure 33: APD Location, (Author, 2020)

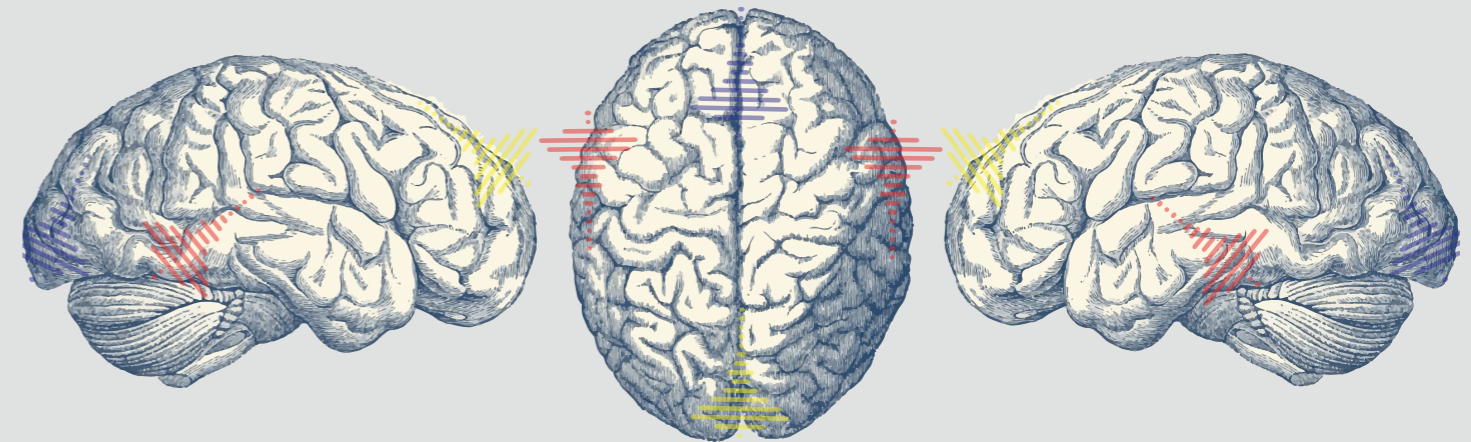


Figure 34: APD Stimulation, (Author, 2020)

## Biological Stimulatory Overlap

If the acoustics allow for the sound waves that best compliment a medical professional's patient, it can contribute to a healthier space and a more productive one, allowing for better patient care and recovery (Iwano and Murase, 2013).

The effects of auditory stimulation reach further than just patients. It can also improve the staff's productivity and the quality of the spatial experience for the public.

If the space allows for various odours through ventilation and natural interventions, the biological reactions will stimulate the affected areas as indicated on the right.

## Application Opportunities

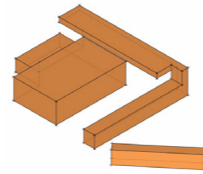
As designers, we have limited control over auditory stimulants as there are unpredictable variables that contribute to the sound in a space. However, ensuring that the spaces we design allow for the sounds that best suit the patient and program, we can have a design that helps improve ABI patients auditory processing disorder symptoms allowing them to recover.

Spaces of healing and rest should have sound insulation that allows delta and theta waves to be maintained for patient comfort. Therapy spaces should have alpha waves to enable patients to be comfortable while being attentive to the applied therapies. The surgical and for formalistic programmes would do well with beta waves that keep the medical professionals attentive while treating patients.

## Conceptual Application

- Interior design with proper acoustic design,
- Material use that relates to the identified auditory frequency that best suits the space, and
- Technological interventions in rehabilitation spaces that control the acoustic experience of the space

Refer to page 84 for conceptual Auditory rehabilitation application

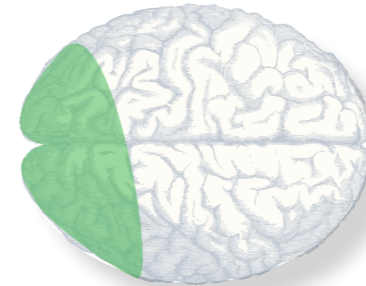


## Auditory Stimulation Diagram Summary

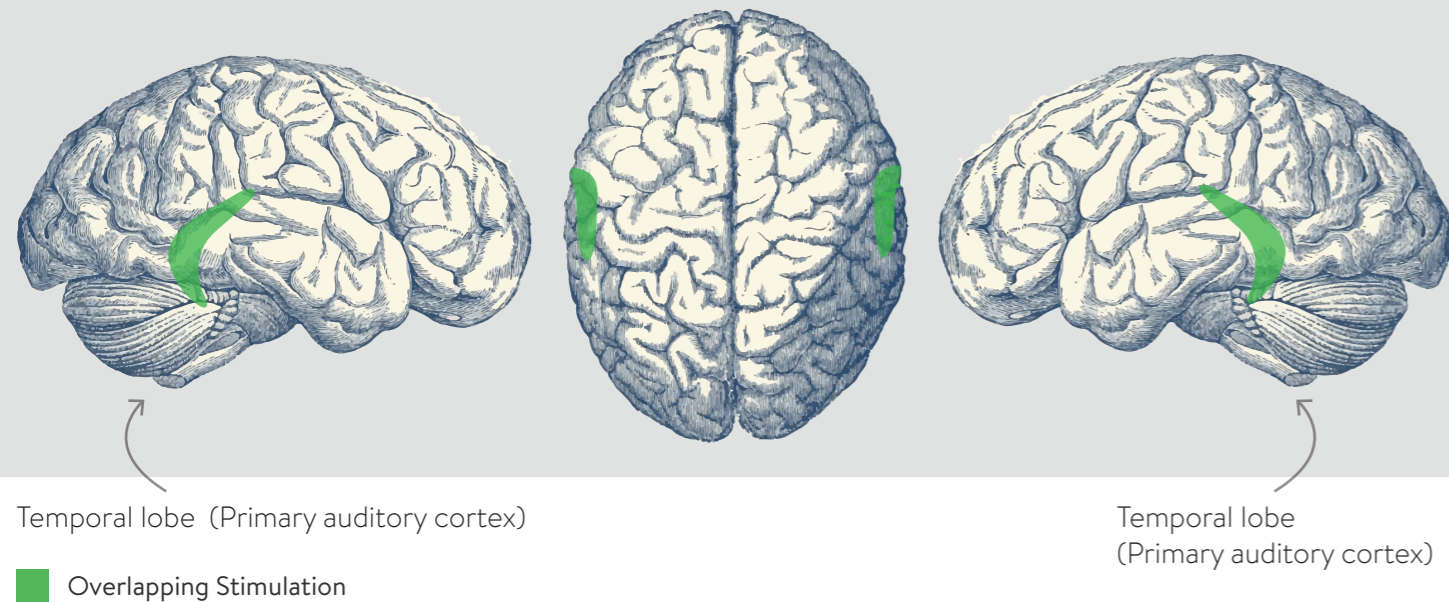
Auditory stimulation has similar issues where the variables are tied to the contextual noise levels, and the number of people inhabiting the space. Thus, the acoustics need to be flexible in its application to accommodate the different variables so that the user experience is not monotonous throughout its progression.

## Auditory Stimulation Potential Diagram

Estimated 30% stimulatory overlap based on research data and potential architectural stimulants.



- Small stimulation overlap,
- Only efficiently implementable internally, and
- A high amount of external variables



## Auditory Passive Design Principles

The acoustics and auditory design needs to be applied responsibly to each programme. Contrary to the other stimulants, the noise should be constant and controlled with a frequency reactive to the patients need in each space. The issue is that there are various contributing factors to the ambient and contextual noise that is hard to control with passive design applications.

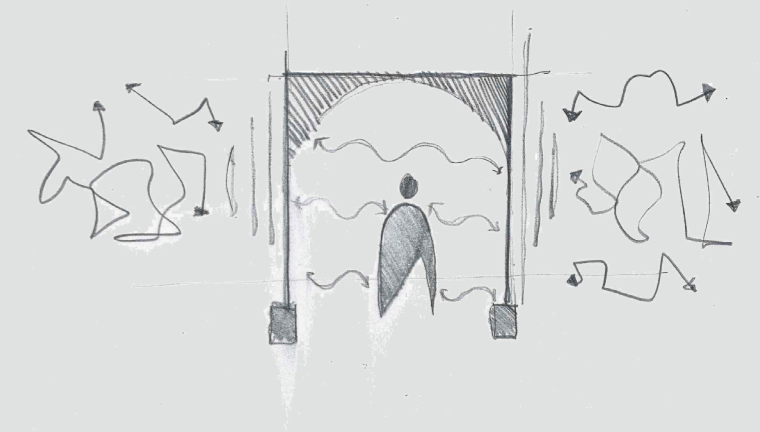


Figure 35: APD Overlap, (Author, 2020)

Figure 36: APD Diagram, (Author, 2020)

# Experimental Summary

## Findings

The identified neurological disorders all have an impact on the sensory perception of the patients. Throughout the experiment, there are varying levels of overlapping stimulatory drivers. Based on the principles of neuroplasticity, the result could increase susceptibility to practical neurological rehabilitation methods.

## Architectural Deductions

The various stimulation methods have all produced different architectural drivers. The principles have been identified as follows. The eventual application thereof will have to be coordinated with the applicable programme and function of the space it will be applied to.

## Conclusion

As recently discovered, the brain's neuroplasticity allows the neurological recovery and adaptation to its circumstances previously thought impossible (Wenger and Kühn, 2018). The discovery of this phenomenon makes the application of passive neurological rehabilitation methods all the more viable.

By substantiating the architectural drivers and rehabilitation methods with a theoretical application, you can improve funding and real-life application chances. Based on my isolated experiment, it is theoretically possible to improve the patient's rehabilitation process by incorporating responsive interventions. These applications' success will have to be documented once implemented in practice by documenting the recovery times and patient responses to treatment.

The experiment only covers four major disorders. There is an endless list of neurological conditions, and due to my project's limitations, I won't be able to analyse the majority of them. Despite this, I think the experiment helps to set in motion the potential collaboration opportunities for future projects.



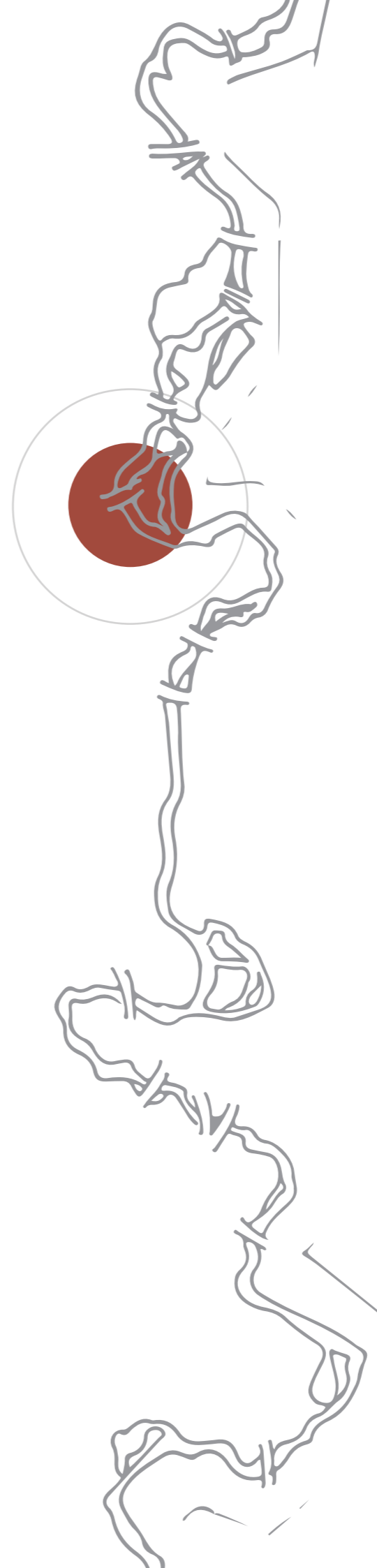
Figure 37: Hand Drawing, (Author, 2020)



CHAPTER

# 04 Project Analysis

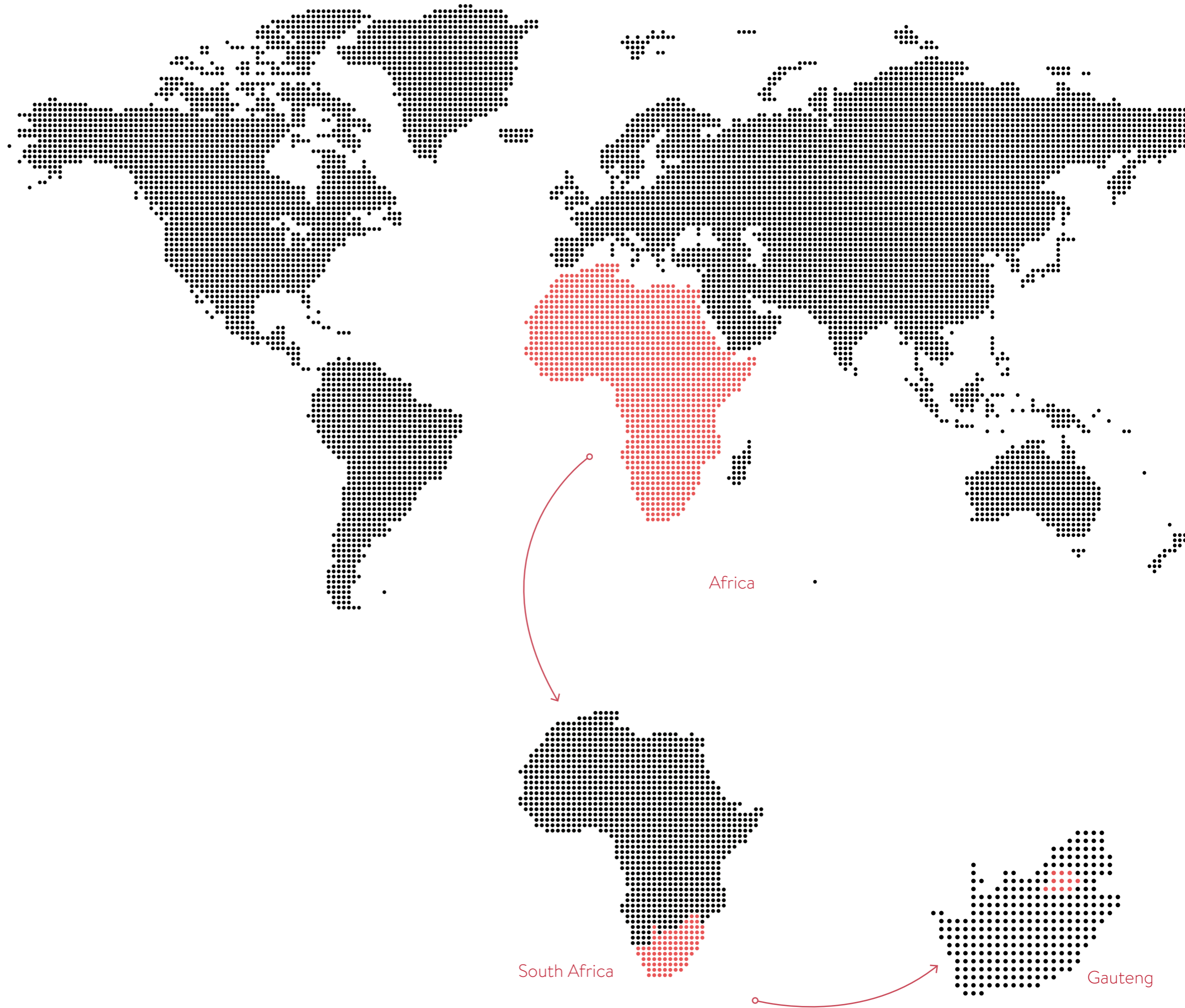
---



# Project Location

## Global Coordination

The research and experiment findings will be applied to a site situated in Menlyn, Pretoria. With a rich history and culture, the project will be used to treat people from all ethnical and cultural diversities. The grassland biome provides the site with many natural elements for collaboration. Pretoria is continuously developing and has some of the best neurological, spinal and ortho hospitals in South Africa and the African continent.



## Site

The property has been recently demolished and set to be rezoned in 2023 from a low-density residential area to a commercial clinical designated site area. It is very close to the Cintocare head and neck surgical centre being built at Menlyn Maine and just down the road from Faerie Glen Hospital, which provides a lot of opportunity for programmatic collaboration. There is a lot of collaborative potential with the housing units to cater to patients, friends, or families that could require accommodation close to the rehabilitation facility.

There are inherent sensitive conditions to react to programmatically and functionally when addressing any form of rehabilitation. These will have to be accommodated while addressing the identified existing needs.

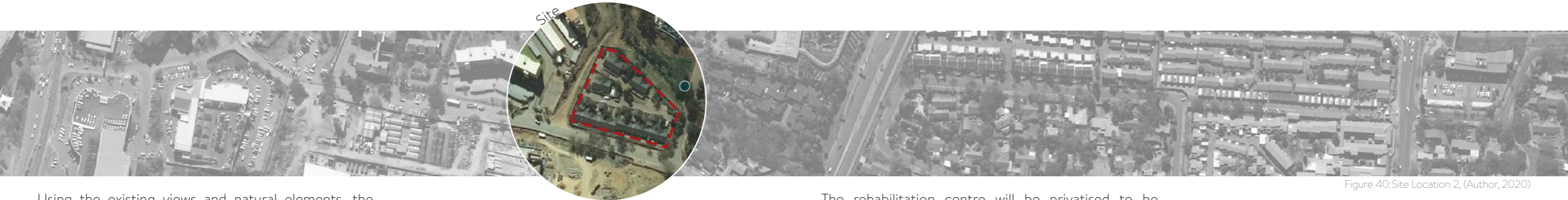


Figure 40: Site Location 2, (Author, 2020)

Using the existing views and natural elements, the rehabilitation centre will serve as a catalyst to improve the public health in and around the site. The average surrounding building height is around four storeys, and most of them have a clear line of sight onto the servitude running diagonally north of the site. Maintaining these views are critical for the integrity of the project.

The surrounding buildings have a wide range of programs ranging from high-density housing units, garages, offices, hospitals, and a large shopping centre on the southern side. By its very nature, the site wants to lean towards a public-serving programme that wants to utilise the natural elements to the north. This can be achieved in tandem with the rehabilitative programme I'm proposing.

Currently, the park north of the site is mainly used as an informal pedestrian thoroughfare with scattered gathering spaces in the shade. There seems to be a lack of cohesion between the different programmes on the site as they neither interact nor complement each other. My project will attempt to address this disconnect on a macro and micro scale using the existing conditions to drive the proposed ones.

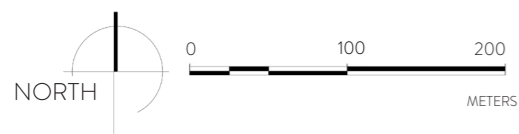


Figure 39: Site Circles, (Author, 2020)

## Programme

### Programme Development

The project will serve as a step-down facility for Cintocare head and neck hospital and Faerie Glen hospital. The project will have a holistic approach to healing that caters for active and passive rehabilitation methods with the patient's well-being as its primary objective. The project will include public programs as well with a pharmacy, restaurant & parklet.

The rehabilitation centre will be privatised to be included in the private hospital chain that Cintocare created. However to give back to the community and the neurological development field the rehabilitation centre will consist of a research facility that in partnership with the surrounding universities document and evaluate the implemented systems to better them for facilities to come.

The practical programmes include medical consultation operating theatres with supporting systems, piazza dining, a day visiting rehabilitation facilities, and a specialised on-site stay in a rehabilitation facility.

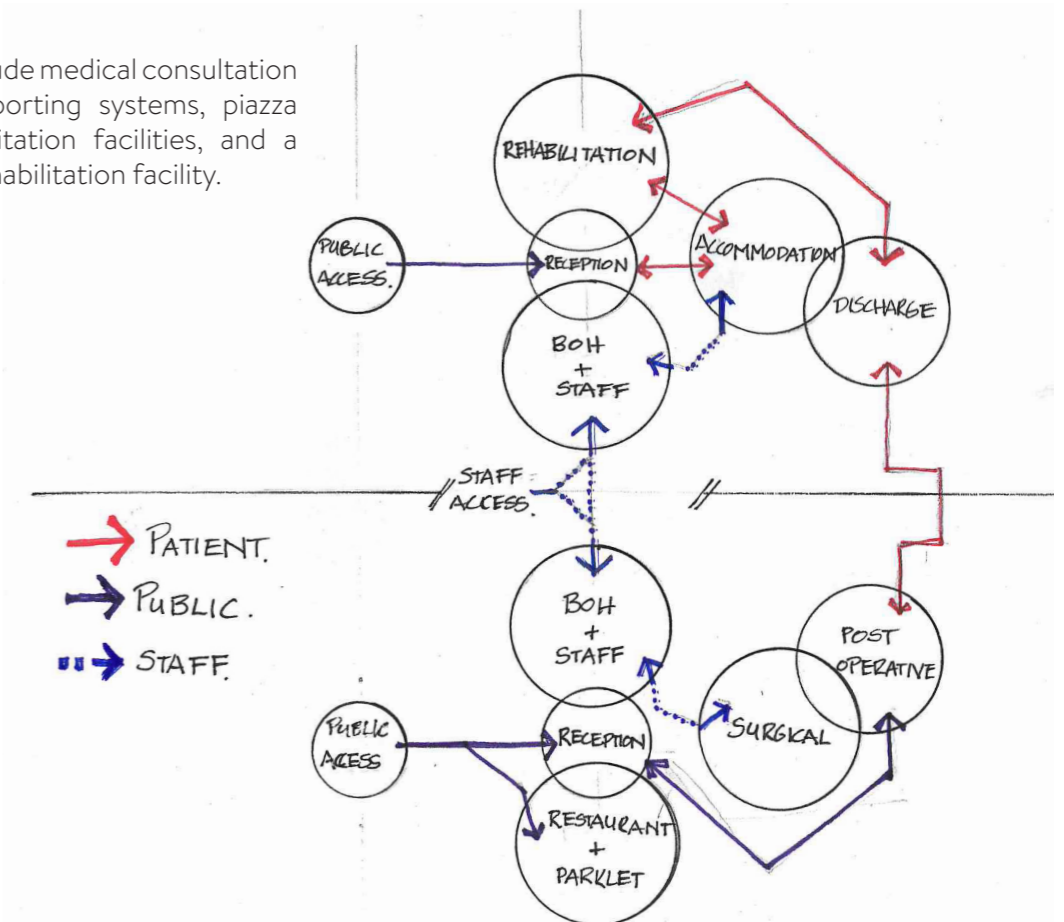


Figure 41: Programme Diagram, (Author, 2020)

## Users

The projects' main goal is to help facilitate the rehabilitation process for patients of the centre and the public. The passive rehabilitation systems implemented are meant to facilitate the different needs of the various patient types.

The users fall under the following categories:

### Patients:

- Neurological,
- Physical therapy,
- Psychological, and
- Trauma.

### Public

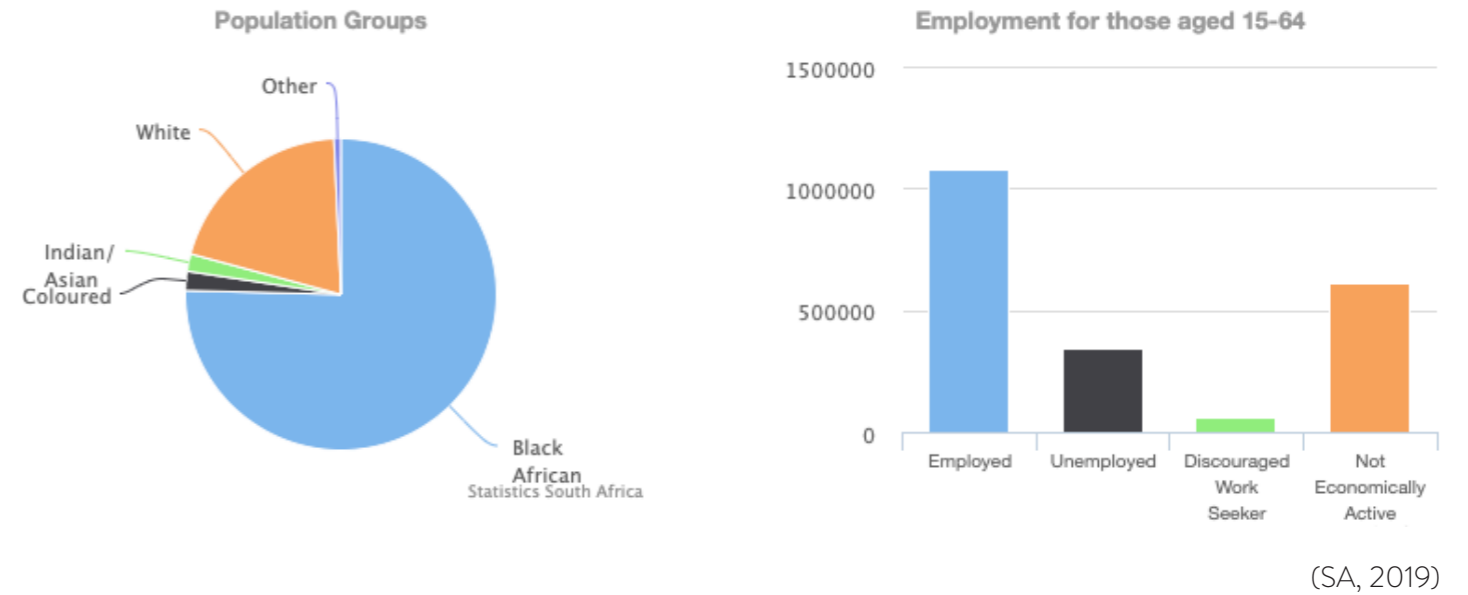
- Restaurant users,
- Park-goers, and
- Patient visitors.

The majority of the passive rehabilitation principles will be aimed at improving the inpatient experience. There are various programmatic and functional systems in place to treat the different types of patients that the facility is aimed at. If the project can facilitate these patients and host the various necessary treatment methods, then the passive can work in tandem to try and heal the patients as best it can.

The public's needs revolve mostly around the improvement of the public spaces surrounding the park and providing medical care to the community. The street corner's activation via the parklet and piazza will help address some of the more macro urban issues affecting Frikkie de Beer street.

Frikkie de Beer street is still developing compared to the surrounding area with demolished and unused spaces and a low-density typology compared to the other side of the road.

## Demographic Breakdown



**Sarah**  
168mm  
63kg  
Park Goer

**Daniel**  
179mm  
78kg  
Waitor

**Linda**  
158mm  
55kg  
Nurse

**Rajesh**  
175mm  
76kg  
Doctor

**Min**  
155mm  
55kg  
Patient

Figure 42: Site Users, (Author, 2020)

# Analysis and Influences

## Local Medical Precedent

Cintocare was a big inspiration for the development and progress of the dissertation. The construction of a world-class head and neck facility creates many opportunities for future medical growth and complementary programmes such as the one I am proposing.

Cintocare will be the first green hospital in Africa and one of five globally. They help boost the state of the art technology we use in South Africa (Cintocare, 2019). This is the hospital that's going to change the state of healthcare in South Africa. Their amount of design implemented to ensure the ultimate patient treatment is staggering. Technologically the hospital can't be compared to any other hospital in the country (Cintocare, 2019). They can run completely independent of the municipal services and even have their own oxygen plant not having to rely on transported oxygen reducing the carbon impact by mitigating the number of services that need to be transported to the hospital.

## Medical Facilities

The choice of site was largely influenced by its proximity to medical facilities and suppliers. With Cintocare to the east and Faerie Glen to the west, the site can access both main roads leading to these hospitals. Allowing easy access to the facility in case of an emergency and reduces travel time for any patients coming from these facilities.

There are buildings in the area that serve as medical infrastructure as illustrated below, ranging from pathology labs, pharmacies and medical suppliers. The rehabilitation facility will not attempt to replace these existing programmes but rather accommodate their services by collaborating with them.

## International Medical Precedent

Private Hospital Lassnitzhohe is a hundred-year-old facility which has been continuously adapting to rehabilitation methods. The private hospital is located close to the Styrian provincial capital of Graz. Their clinic is one of the most modern private hospitals in Austria with 229 beds distributed in single and double rooms, a total area of about 11,000 m<sup>2</sup>, spacious therapy areas and a large modern indoor pool. The health resort located in the green area provides a beautiful view. The attractive symbiosis of old and new creates an extraordinary atmosphere that positively supports a speedy recovery (SANLAS, 2020).

### Neurological Indications

- Strokes,
- Parkinson's disease,
- Multiple sclerosis,
- Diseases of the peripheral nervous system, and
- Nerve root damage, etc.

### Lassnitzhohe Rehabilitation Goals

*"We attach great importance to a holistic approach, which takes into account the individual living and working conditions. The rehabilitative measures derived from them make it easier to reintegrate into work, social and family life after rehabilitation"* (SANLAS, 2020).

### Location

Miglitzpromenade 18, 8301 Laßnitzhöhe, Graz Austria

## Extensive Therapies

**Physical Therapy** - They have highly trained and experienced team consisting of medical masseurs and massage therapists, as well as medical-technical professionals.

**Psychology** - They offer therapeutic aids for coping with illnesses, reintegration into family and work life, as well as counseling of patients and their relatives.

**Nutritional Therapy** - The right and conscious diet is a fundamental pillar of a healthy lifestyle. In the context of nutritional therapy, we advise patients with metabolic issues to pursue nutritional therapy.

**Speech Therapy** - Commonly used in neuro-rehabilitation is very diverse and range from logopedic clarification and speech therapy to counseling of relatives and patients.

**Physio Therapy** - For the avoidance of dysfunctions of the musculature system and the preservation and restoration of the natural movement sequences.

### Facilities

- Spacious therapy area,
- Modern indoor swimming pool,
- Winter Garden,
- Hairdresser and pedicurist,
- Cafeteria with adjacent terrace,
- Kiosk, lounge,
- Relaxation area with a tea corner, and
- Library.

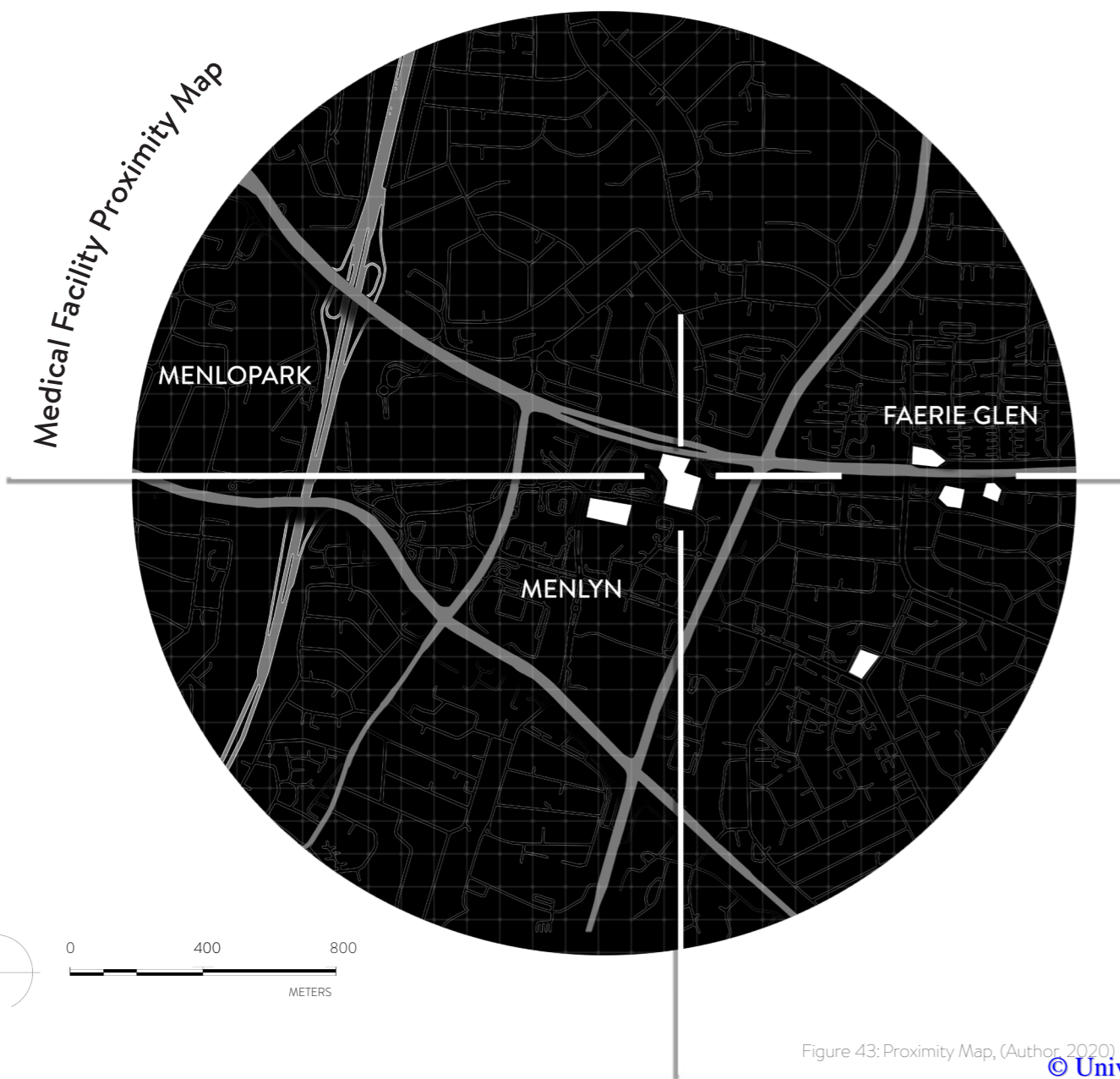


Figure 43: Proximity Map, (Author, 2020)

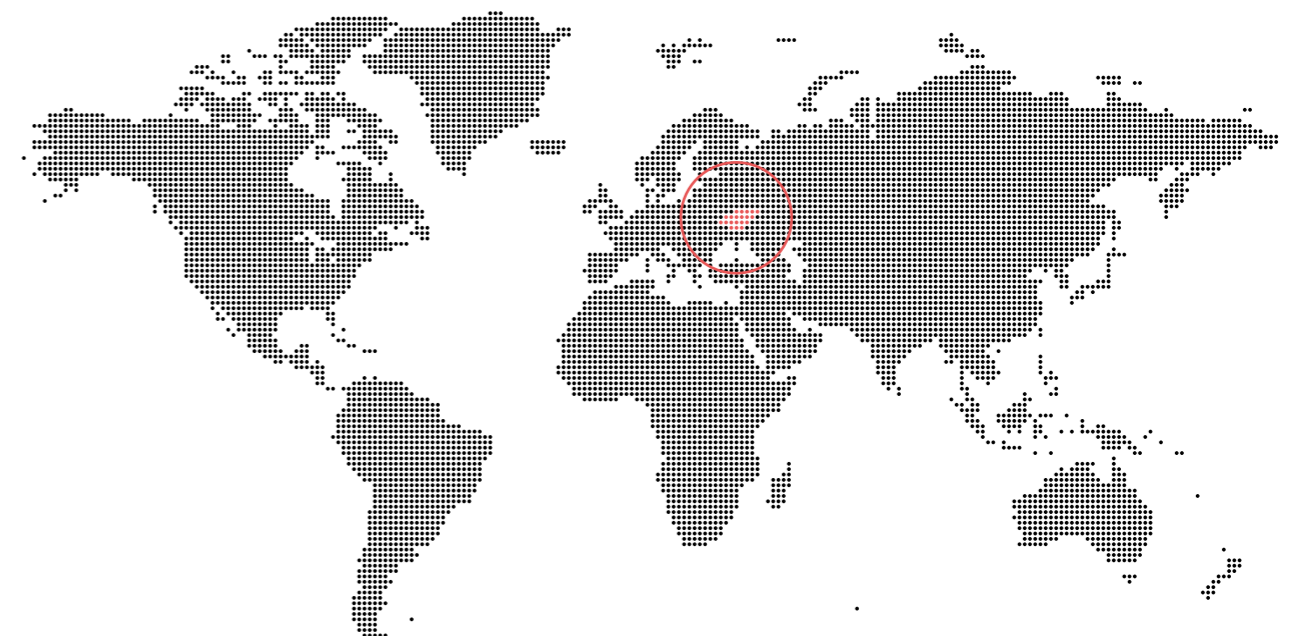


Figure 44: Rehab Location, (Amantaka, 2020)

# Urban Development

## Urban Analysis

Because of the project's delimitations, the urban proposal will be limited to the bordering site conditions. It will extend into the city as a conceptual proposal to improve the quality of the urban context. The design proposals were based on drivers derived from the following urban analysis spanning 5 km radius around the site.

The Menlyn area is mainly focussed around retail and office space. A lot of money has been spent to develop the area with the addition of new malls, a casino, and many apartment buildings. Scattered throughout these large programmes are small residential units and undeveloped land.

I am concerned about urban growth trajectory as it does not necessarily react to the inhabitant's needs. Most of the people working in the area use public transport from far, and the transport services in the area are limited and paired with the intensity of the traffic during peak hours it makes commuting very unpleasant.

## Urban Plan

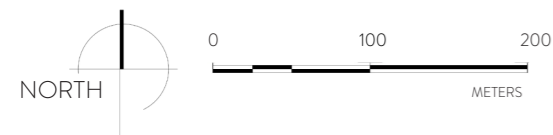


Figure 45: Urban Study, (Author, 2020)

## Sun Angles

The month with the highest average low temperature in January at 18°C and the coldest months with the lowest average low temperature are June & July at 5°.

The site has a natural north-facing orientation looking out onto the park. This can help inform the building orientation to reduce mechanical cooling, thus reducing the buildings' overall carbon footprint.

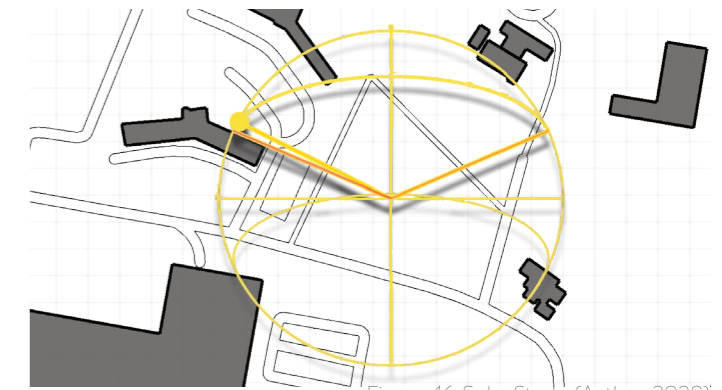


Figure 46: Solar Study, (Author, 2020)

## Wind Directions & Rainfall

The month with the highest rainfall is January with an average of 154mm. The month with the lowest precipitation in July with just 3mm.

The windiest parts of the year are from the end of July to the end of November. With average wind speeds of more than 11 km/h. The windiest day of the year is September 25, with an average hourly wind speed of 15 Km/h.

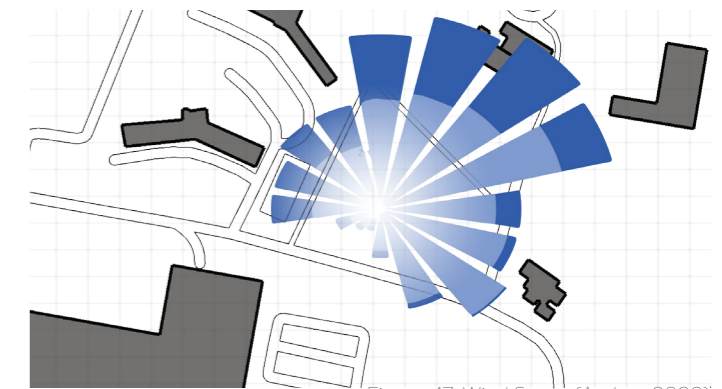


Figure 47: Wind Study, (Author, 2020)

## Servitude & Plant Life

The servitude running diagonally across the map has fed the natural elements on its borders, creating a green strip. Large trees and grass are growing along its path, creating natural shade and can inspire some collaborative programmes for the project, ideally helping to preserve the natural elements from future deconstructive projects.

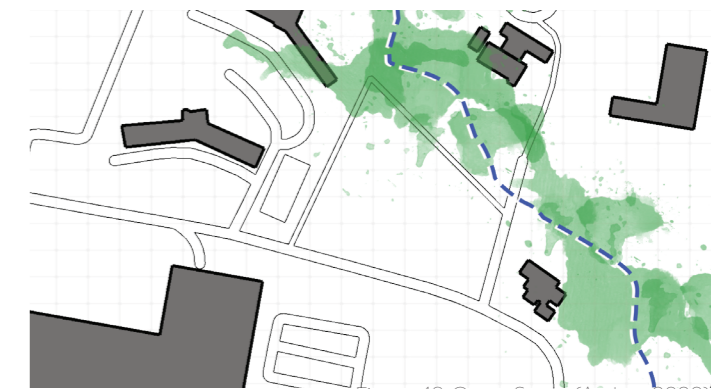


Figure 48: Green Study, (Author, 2020)

## Neighbouring Programmes

The sites neighbouring programmes range from low density, commercial and retail. The majority of the city block is dedicated to retail space and contrasts with the small residential units to the east. The retail and larger accommodation units are quite tall buildings and can look down onto the site. Thus the views from above should be considered.

- Retail
- Residential/ Mixed use
- Office and commercial

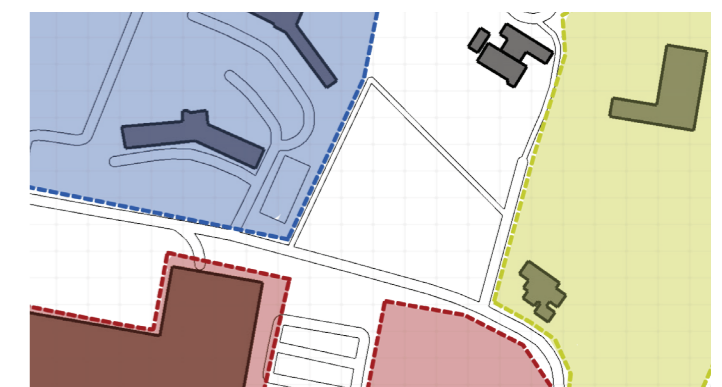


Figure 49: Programme Study, (Author, 2020)

# Urban Vision





## Connection

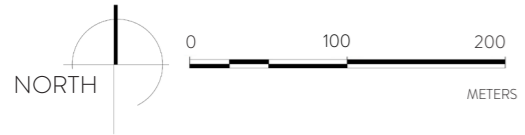
Based on the urban analysis, a few issues can be addressed on an urban scale. Using the urban context to inform any proposals is essential to ensure the design responds to the users' needs and has an overall positive impact on the long run not only for the community but also for anybody who visits it.

### Urban Issues:

- Safety,
- Transport,
- Accessibility, and
- Unfriendly public interface.

## Urban Map Legend

- High traffic routes 
- Public programmes 
- Public transport stops 
- Pedestrianised road 



## Conceptual Proposal

On a larger scale, the issues will be addressed by creating public transport stops for both taxi and bus services as indicated. The traffic and intersections gave a good indication of where to allocate these stops.

The public safety issues can be mitigated by implementing public-serving programmes that have late night functions to provide passive surveillance for the public and businesses. These can also serve as an accomodating function for the public transport stops.

The park just north of the site will be kept intact to promote more green spaces in the community by having the building merge with the landscape, and designing pedestrian walkways for safer travel that does not disturb the natural elements. Frikkie de Beer road, as indicated below in blue, will be the illustrated example used as a reference for the urban applications on a larger scale.

## Current Street Interface

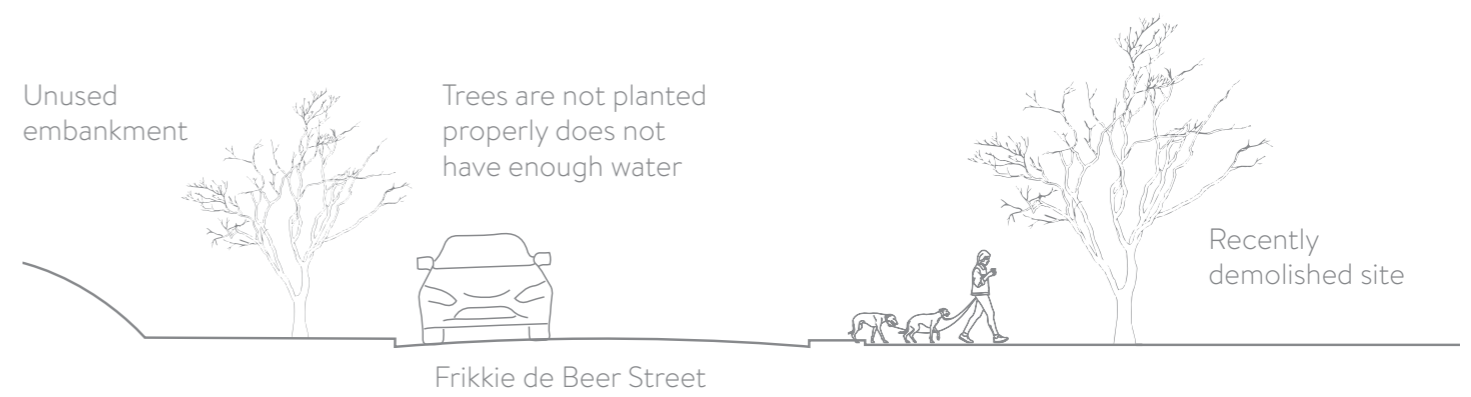


Figure 50: Streetscape Existing, (Author, 2020)

## Proposed Street Interface



Figure 51: Streetscape Proposed, (Author, 2020)

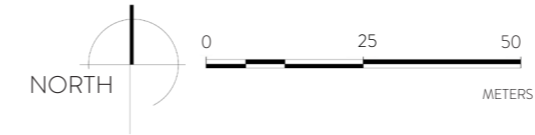
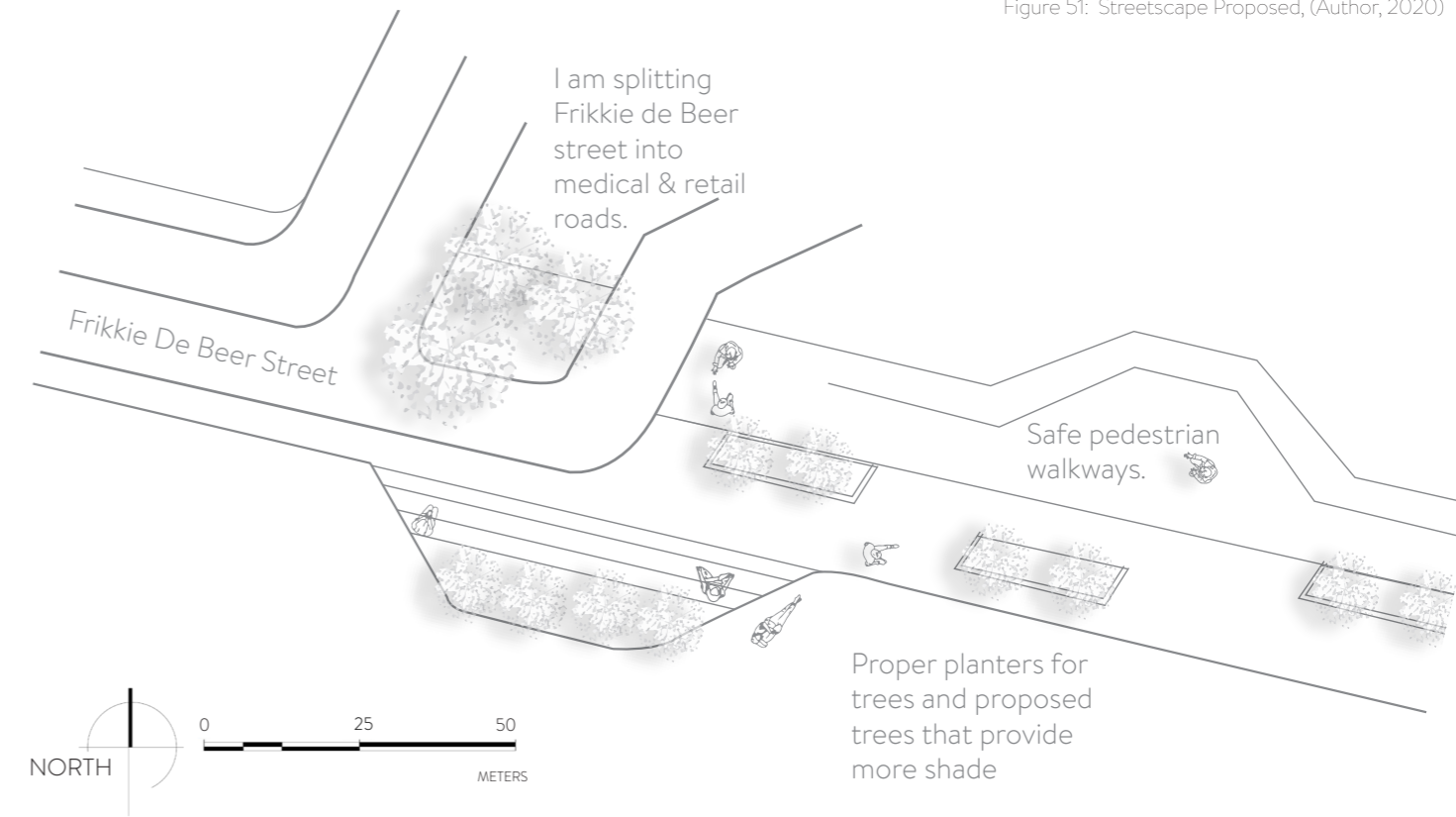


Figure 52: Urban Plan Proposed, (Author, 2020)

# Site Analysis

## Site Description





The site has a significant slope running northwards. The previous residential unit's demolition has since been cut and filled; however, I think the project can benefit from a gradual reintroduction of the natural slope. The site's lowest point is at the servitude that runs with water throughout most of the year. The water ensures that the natural elements on its banks are well fed.

As indicated on the site plan, various gathering spaces have been appropriated by the site's various users. These are usually dictated by some natural shade elements or pickup spots for public transport. These areas serve as a form of passive surveillance that can improve the site's overall security.

There is an opportunity to complement these areas with a public-serving programme that either improves the gathering space's quality or provides programmatic collaboration. The desire lines indicated in red are observed pedestrian routes through and around the site. These are very informal and give a good indication of how pedestrians access and move around the site. Using this data, the public serving programmes and thoroughfares can be designed responsively to the context.

Unfortunately, the site's existing trees were mostly removed during the demolition of the residential units that previously inhabited the site. I would potentially like to reintroduce similar trees and natural elements that provide shade and natural continuity with the existing trees in the area.

## Legend

-  Pedestrian routes
-  Gathering spaces
-  Existing trees
-  Views

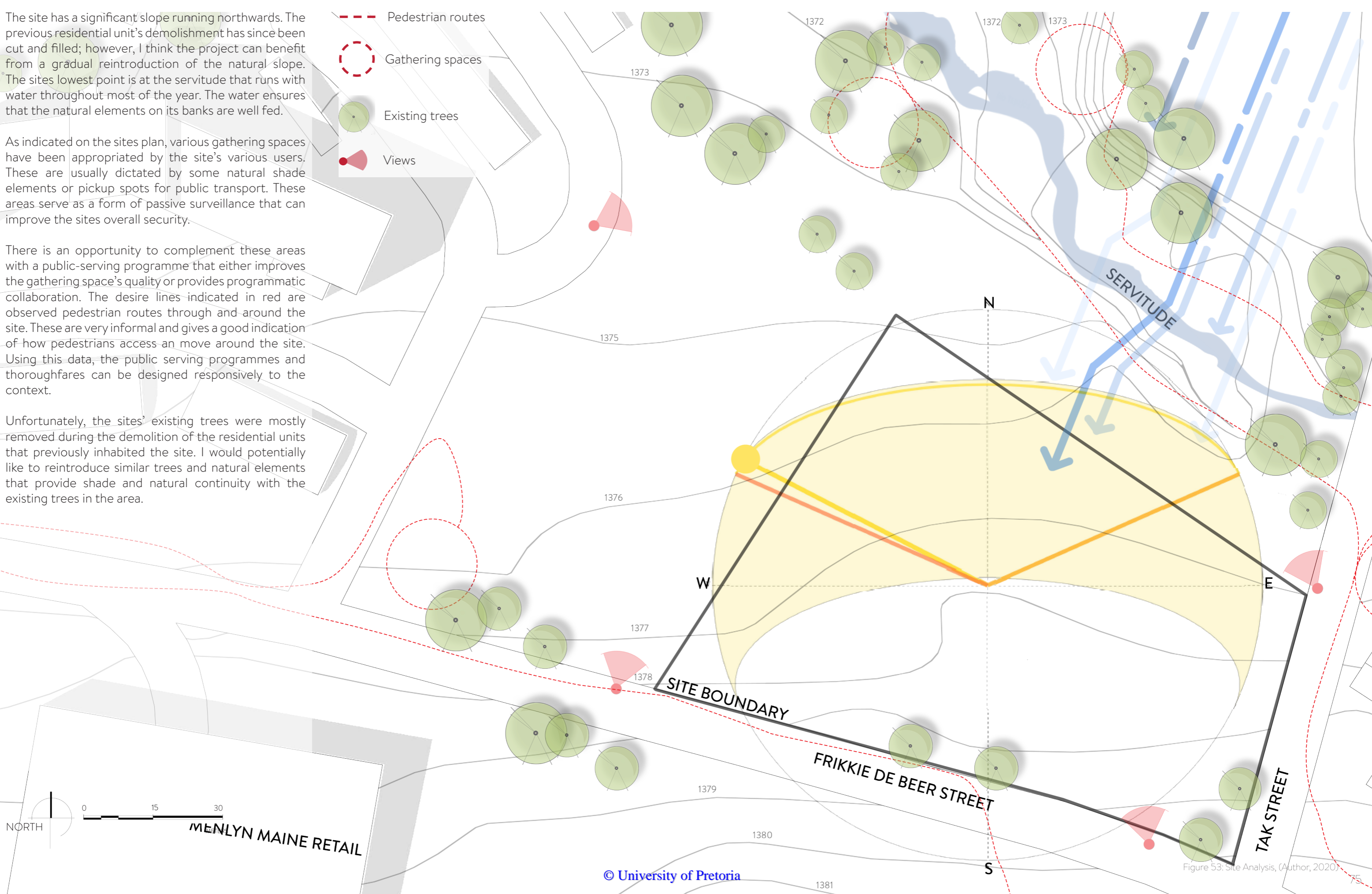


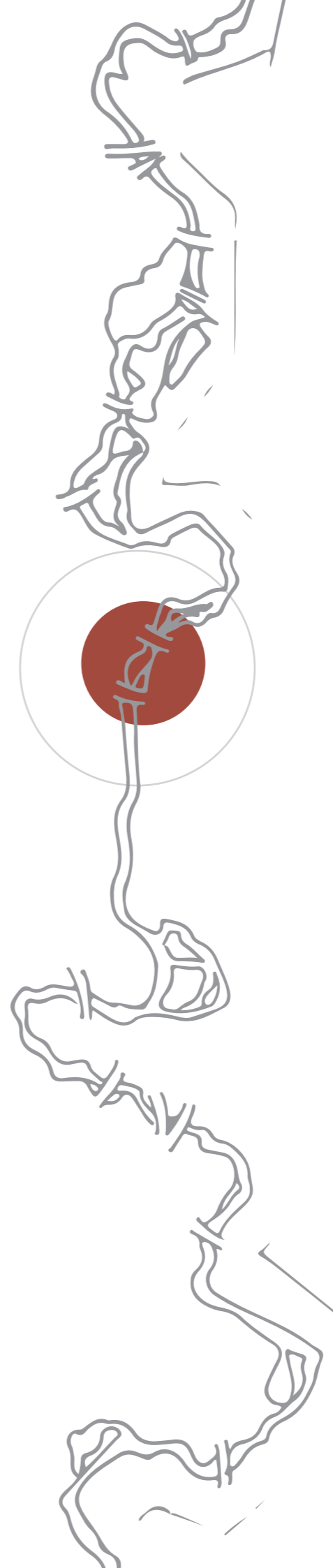
Figure 53: Site Analysis, (Author, 2020)



CHAPTER

# 05 Conceptual Development

---



# Concept Development

## First Iteration

Using the principle of different wings for the different programmes I started by separating the different programmes. This created an inherent spatial hierarchy from medial to rehabilitation based on how the form was approached.

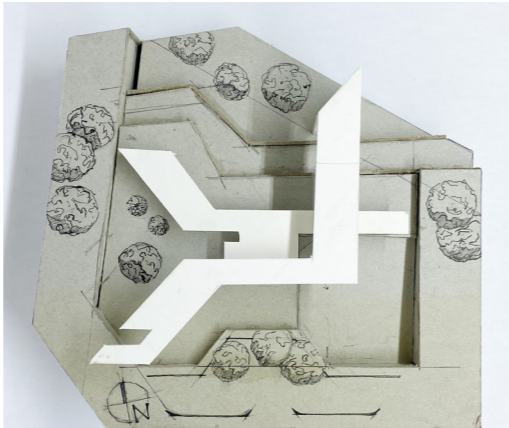
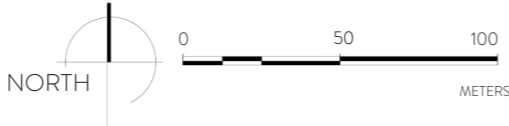


Figure 55: Maquette 1, (Author, 2020)



## Second Iteration

Addressing the larger issues identified in my first iteration, the building has been rotated to increase its energy efficiency and sun exposure. The privacy gradient also leads down towards the park and the natural contours. The patient and public flow works better as well with less interaction to improve privacy and patient interaction.

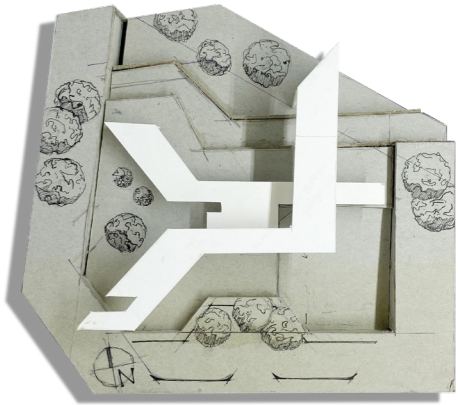


Figure 57: Maquette 2, (Author, 2020)

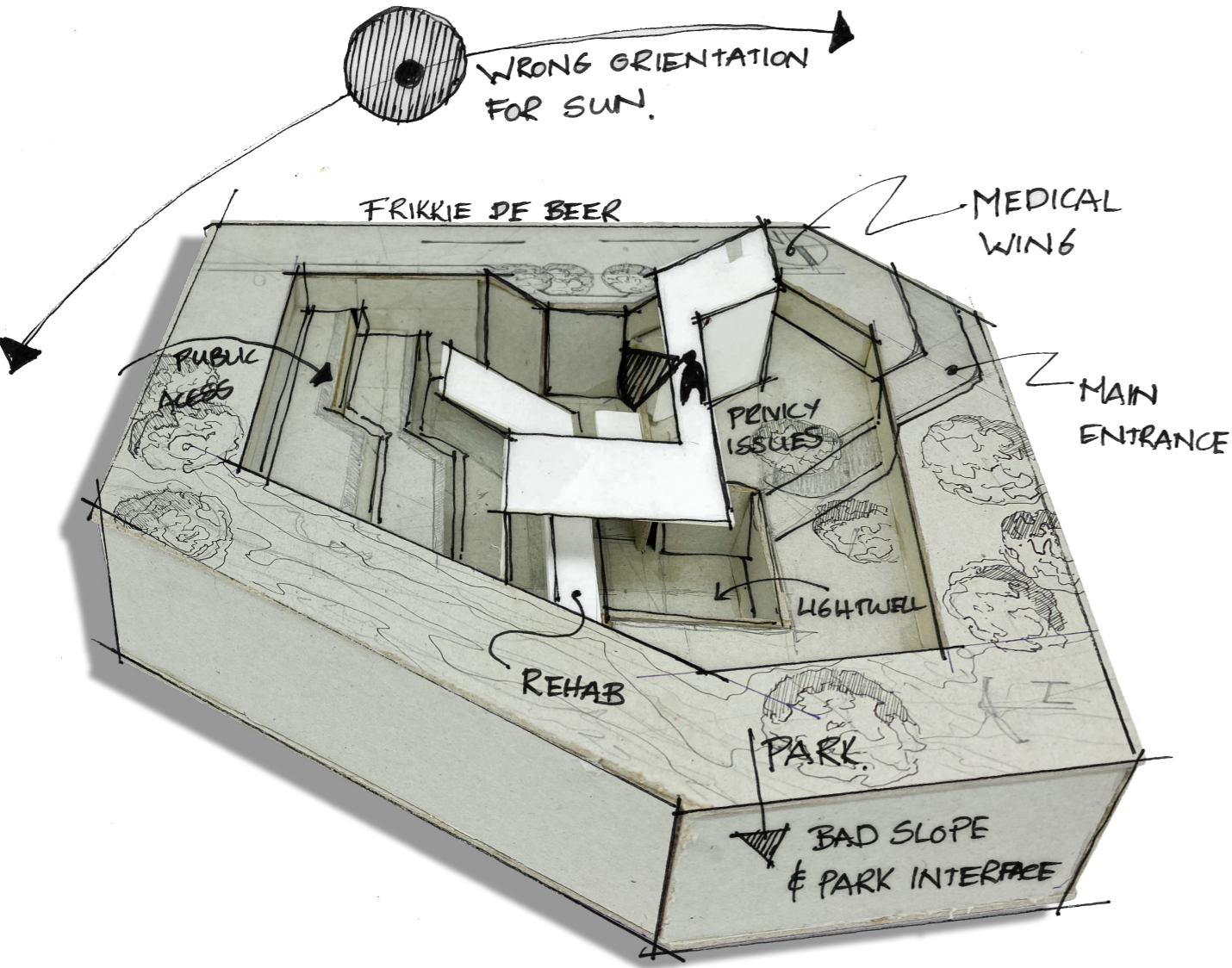
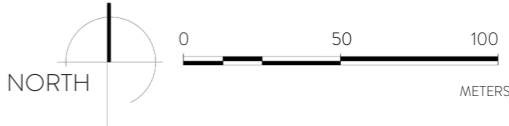


Figure 54: Progress Maquette 1, (Author, 2020)

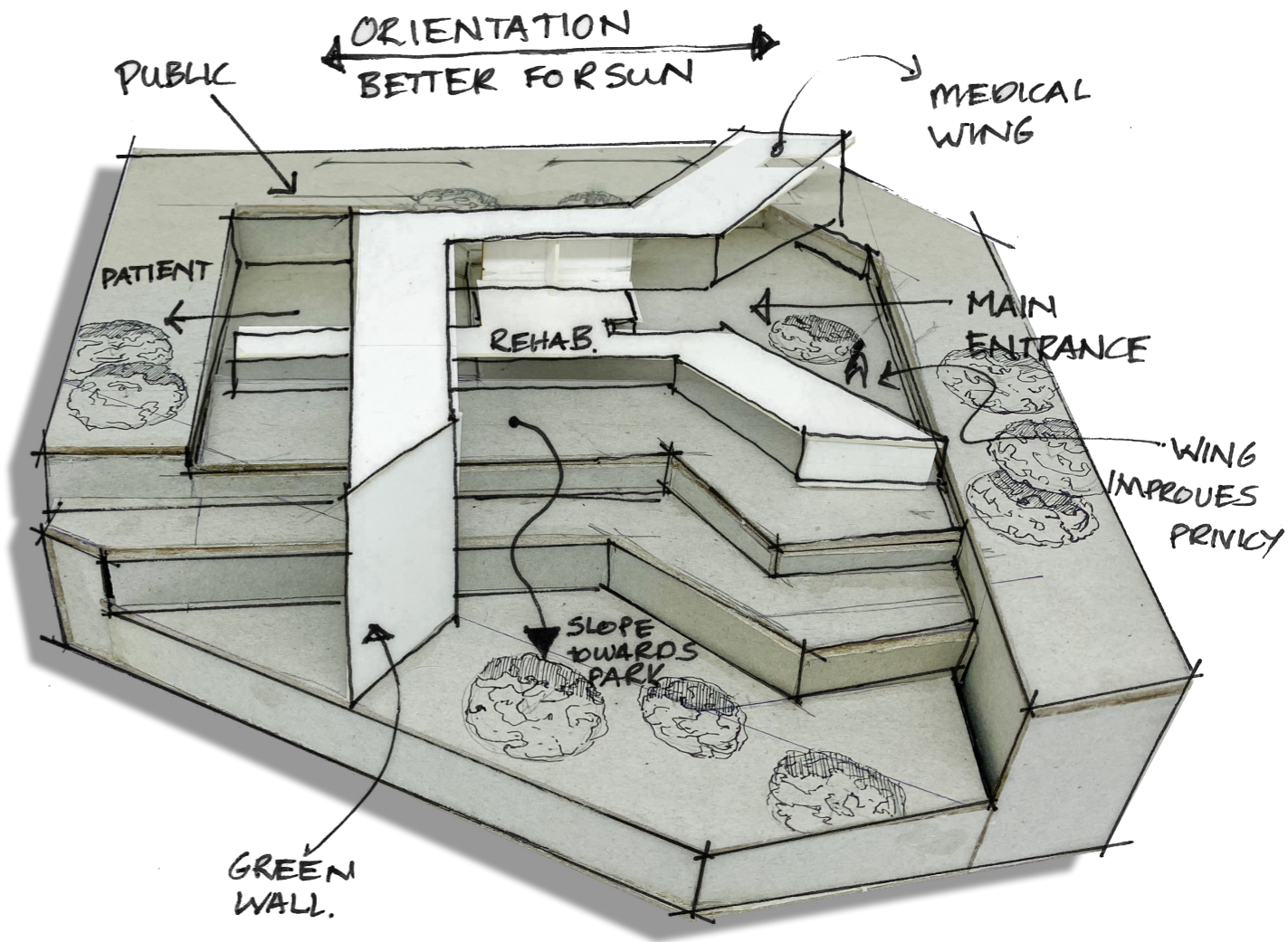


Figure 56: Progress Maquette 2, (Author, 2020)

### Third Iteration

Once the spatial and programmatic logistics have been allocated, the scale and grid system's rationalisation starts bringing the project size into perspective. This served as a good starting point to develop more intimate spaces and passive neurological rehabilitation interventions. Its core adheres to the regulatory and spatial requirements needed for a facility of this nature. However, some formalistic principles are still prevalent, that cause impracticalities in the design. These can be addressed by appropriating the medical spaces to a better grid system.

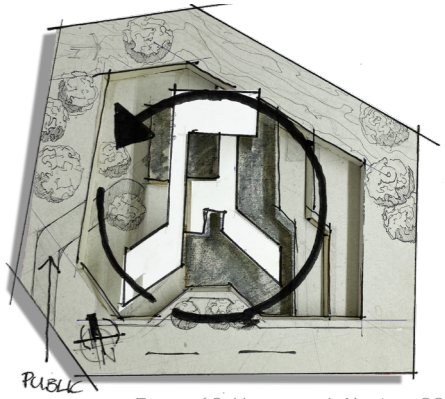
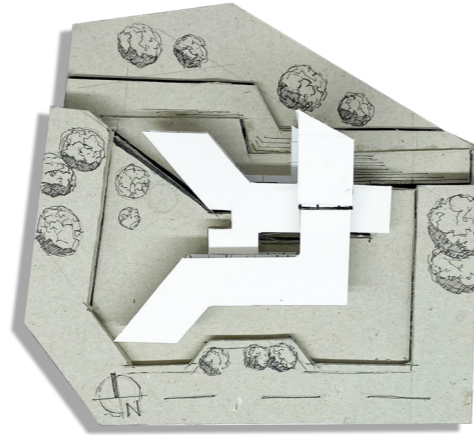


Figure 60: Maquette 1, (Author, 2020)

### Concept Resolution

#### First Iteration

- Formalist conceptualisation,
- North-South orientation, and
- Central courtyards.

#### Second Iteration

- Rationalised terracing,
- East-west orientation, and
- More practical building approach.

#### Third Iteration

- Medical Grid System,
- Straightened medical wing, and
- Thoroughfare separating rehabilitation and medical facilities.

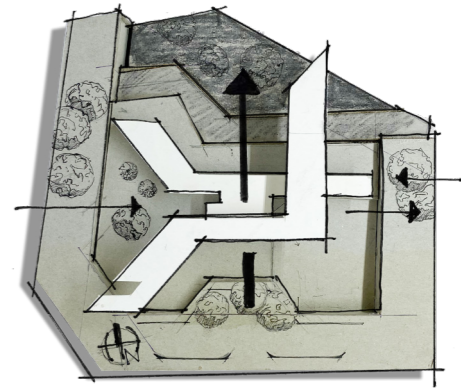


Figure 61: Maquette 2, (Author, 2020)

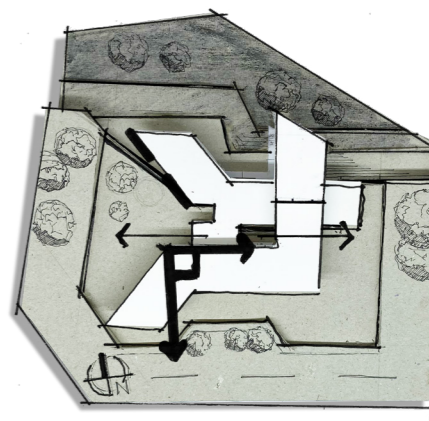


Figure 62: Maquette 3, (Author, 2020)

Figure 59: Maquette 3, (Author, 2020)

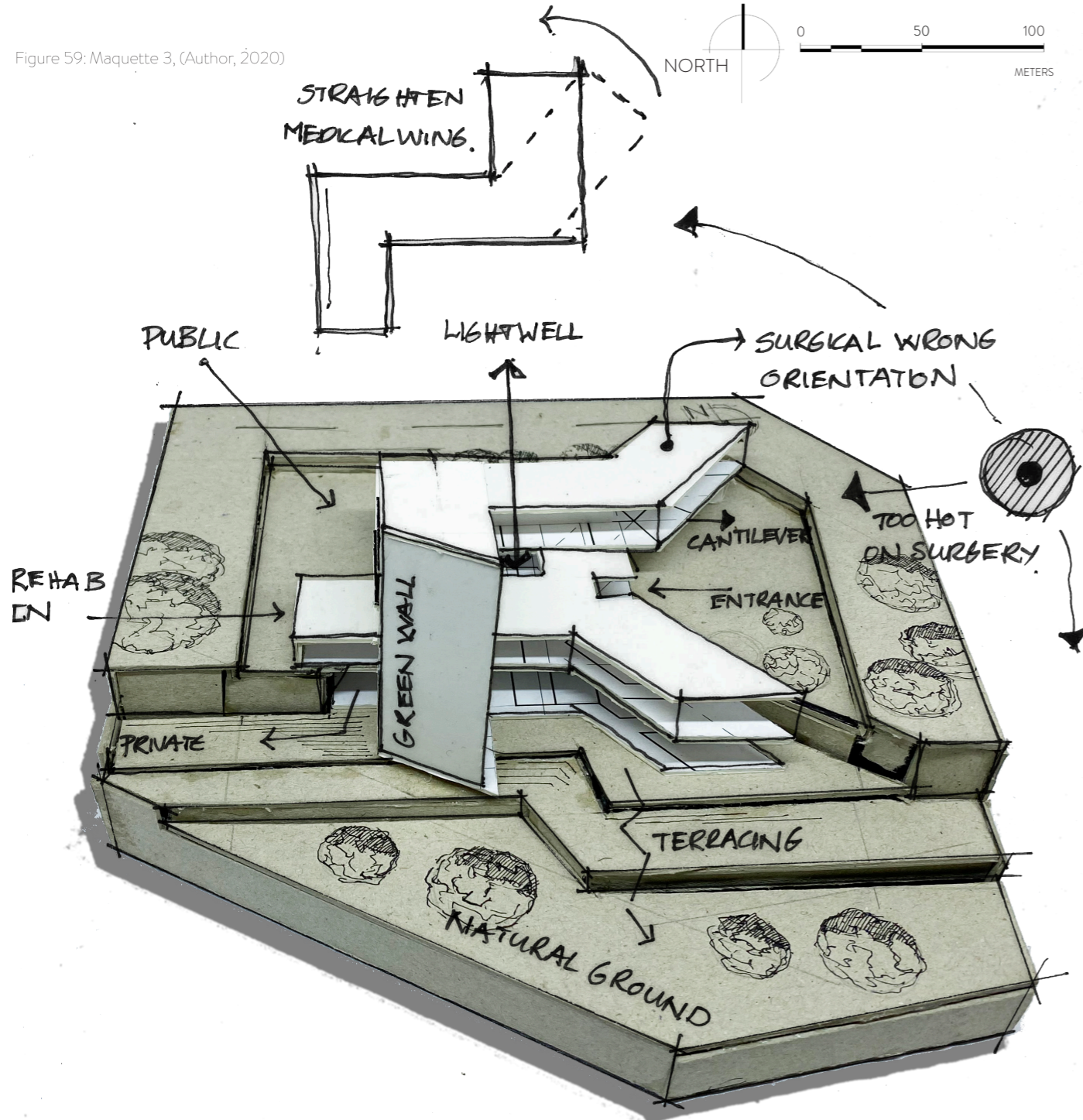
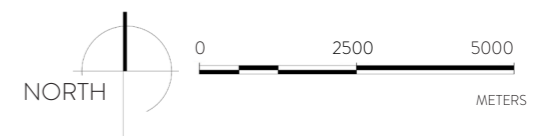


Figure 58: Progress Maquette 3, (Author, 2020)

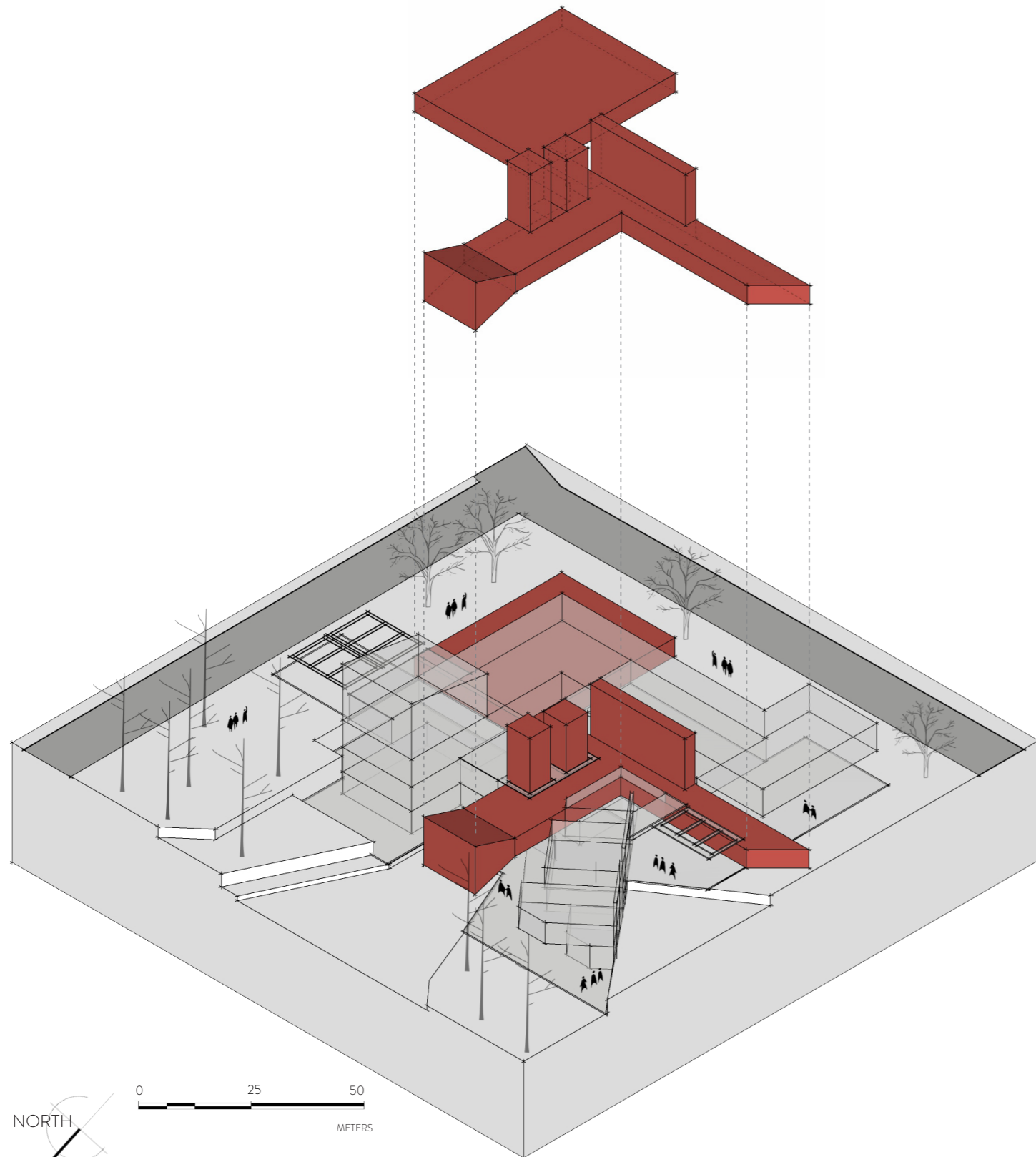


# Visual Interventions

## Patient Proprioceptive Oscillation

The visually stimulatory interventions are based around the proprioceptive principles identified in the experiments and are mainly focussed around the public areas, by creating spaces that change the user's contextual awareness by alternating between different spatial scales.

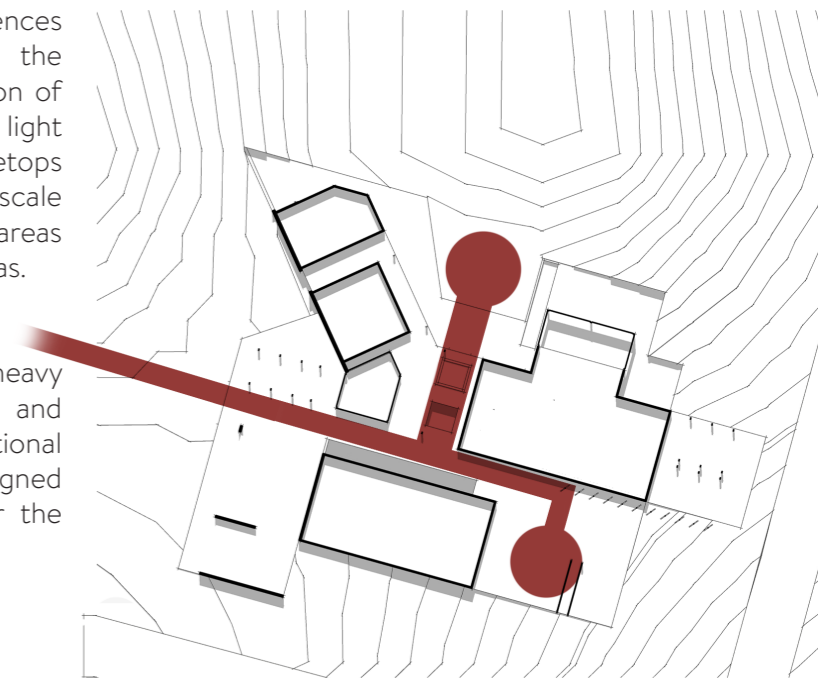
Refer to page 40 for Visual stimulation experiment.



## Spatial Experience

When approaching the building, the user experiences the thoroughfare leading towards the piazza the perpendicular views shatter the user's perception of self by showing the lower levels of the park. The light wells and planters submerge the patient in the treetops and bases as they progress. The constant shift of scale and height will stimulate the brain's various areas associated with the identified neurological traumas.

The thoroughfare ends at the piazza with a heavy cantilevering wing overhead proving shade and privacy while not exposing the patient to traditional spatial conventions. These spaces were designed to still accommodate the services needed for the programmatic needs of the centre.



## Visual Stimulation Goals

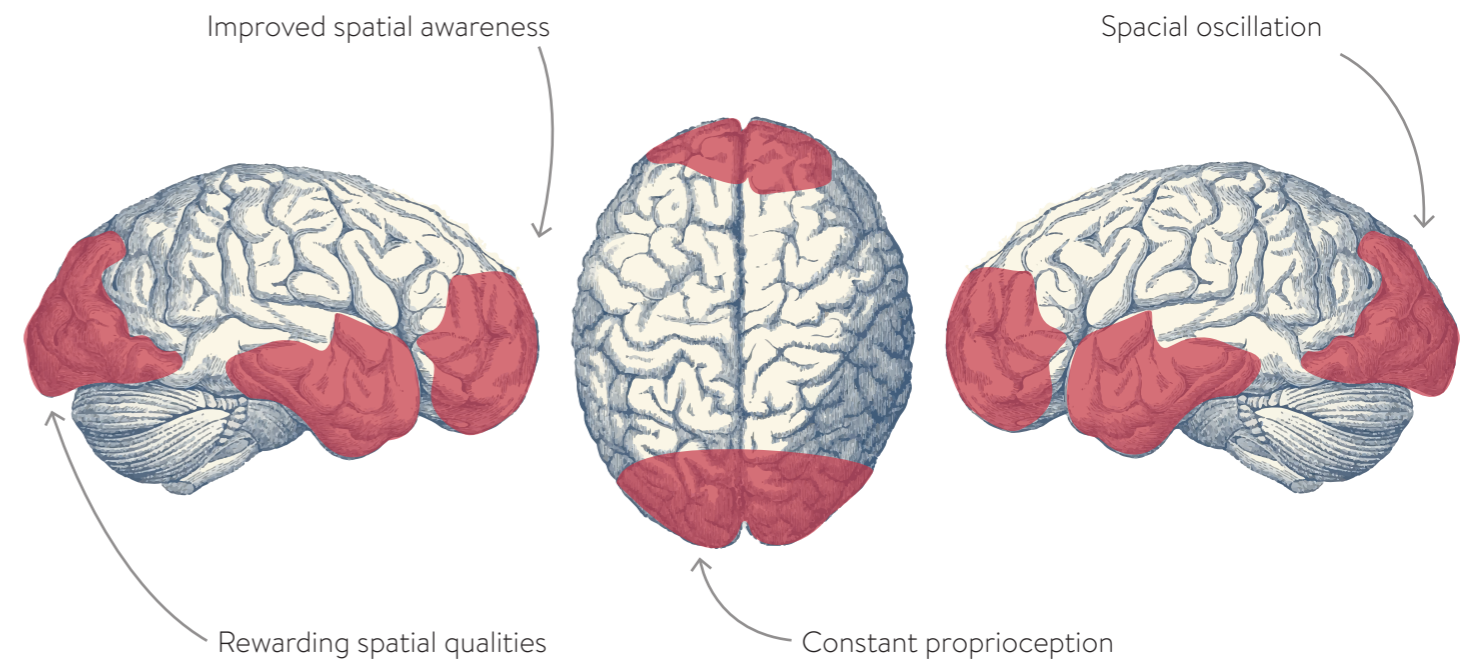


Figure 63: Visual ISO 1, (Author, 2020)

Figure 64: ISO Brain 1, (Author, 2020)

# Haptic Interventions

## Tactile Interaction

The research indicated that the best method of stimulating haptic areas of the brain is by having a range of various textures and oscillating their intensity. By doing so, the building can help improve the recovery rate of the patients interacting with it.

Refer to page 44 for Haptic simulation experiment.

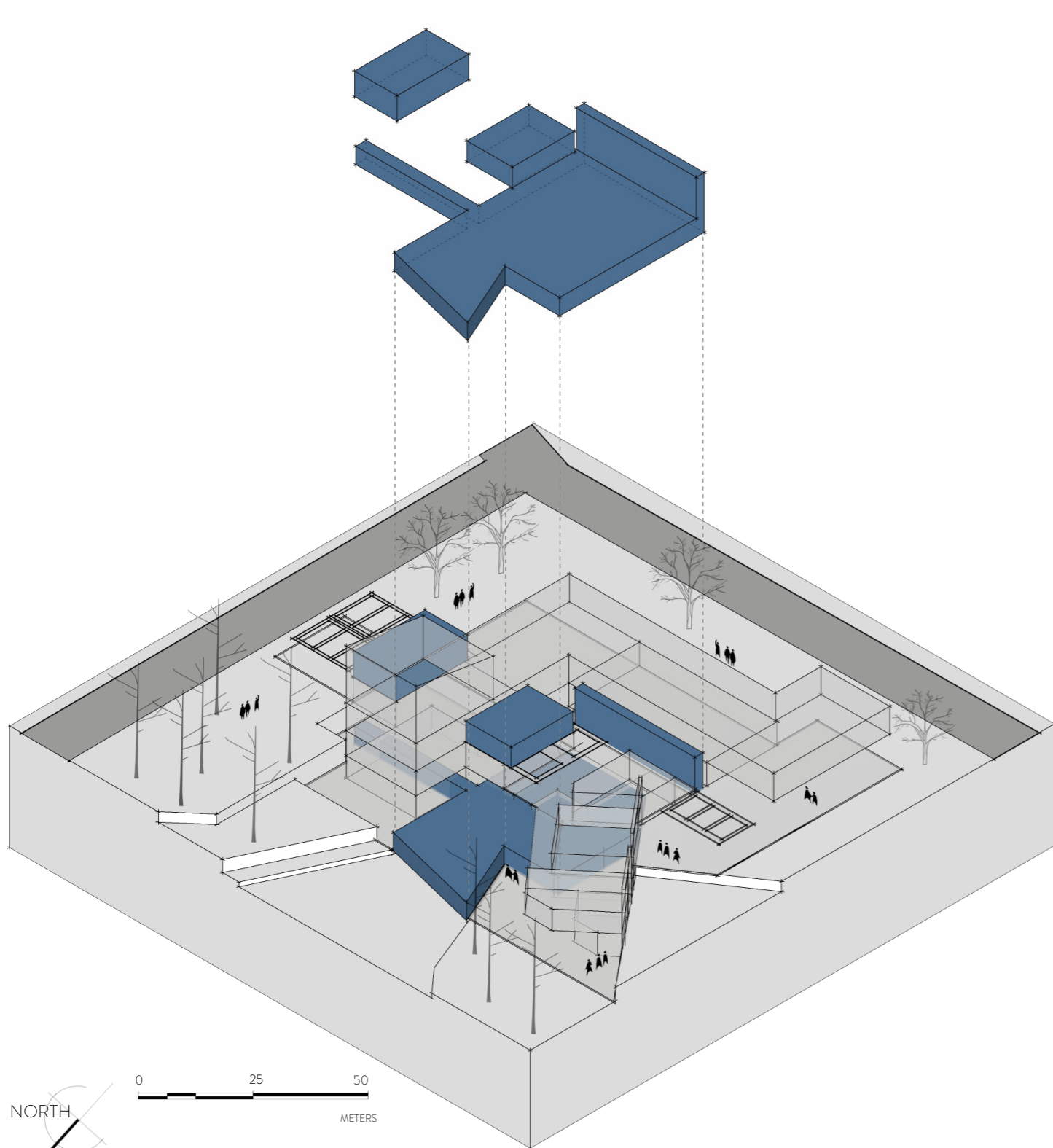
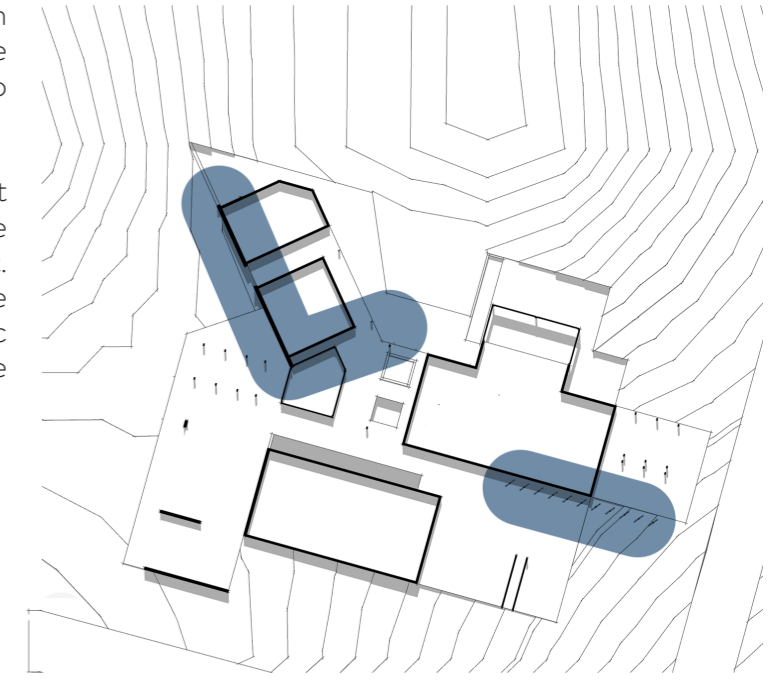


Figure 65: Haptic ISO 1, (Author, 2020)

## Tactile Application

The building was designed to promote user interaction with its various elements. The shutters and screens are manually operated with different textures exposed to the patients.

The surface finishes alternate between the different programmes to create a unique experience for the patients changing as they progress throughout it. Restricted somewhat in the facility's clinical areas, the rest of the building is free to express the various haptic principles that can all help stimulate the patients as they progress.



## Haptic Stimulation Goals

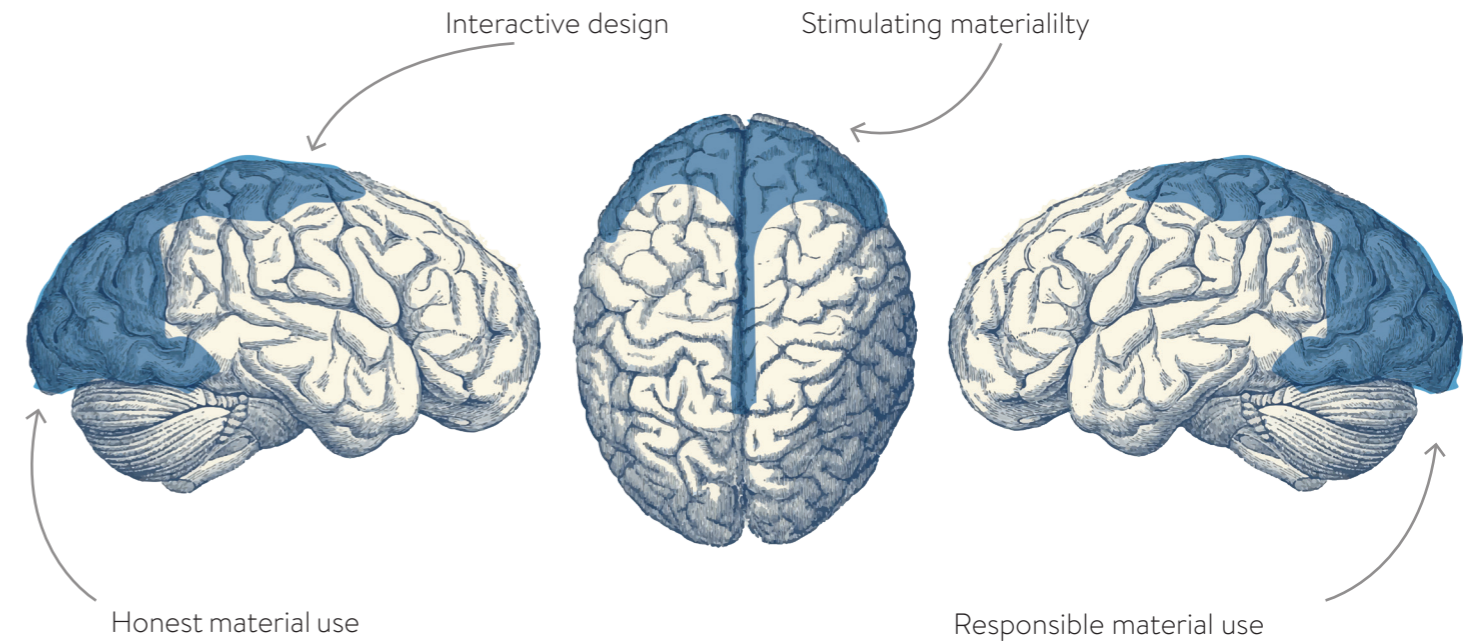


Figure 66: ISO Brain 2, (Author, 2020)

# Olfactory Interventions

## Adaptive Ventilation

The research shows the importance of having olfactory stimulation as its effects can have effects that exceed the physical stimulatory areas based on the users inherent association with certain odours. The idea is to have multiple opportunities to bring fresh air and various odours into the centre's inpatient as well as rehabilitation spaces.

Refer to page 48 for Olfactory stimulation experiment.

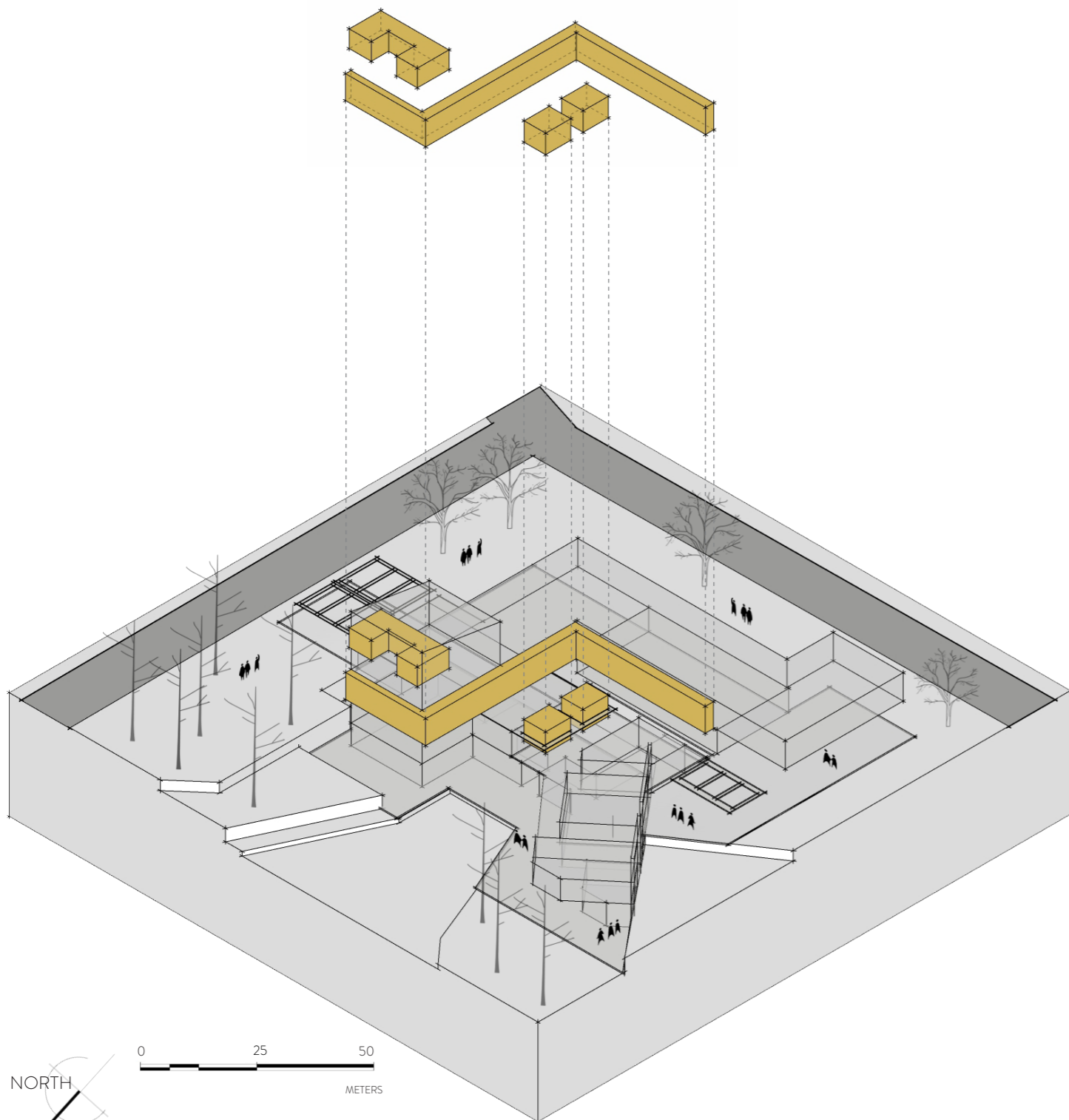
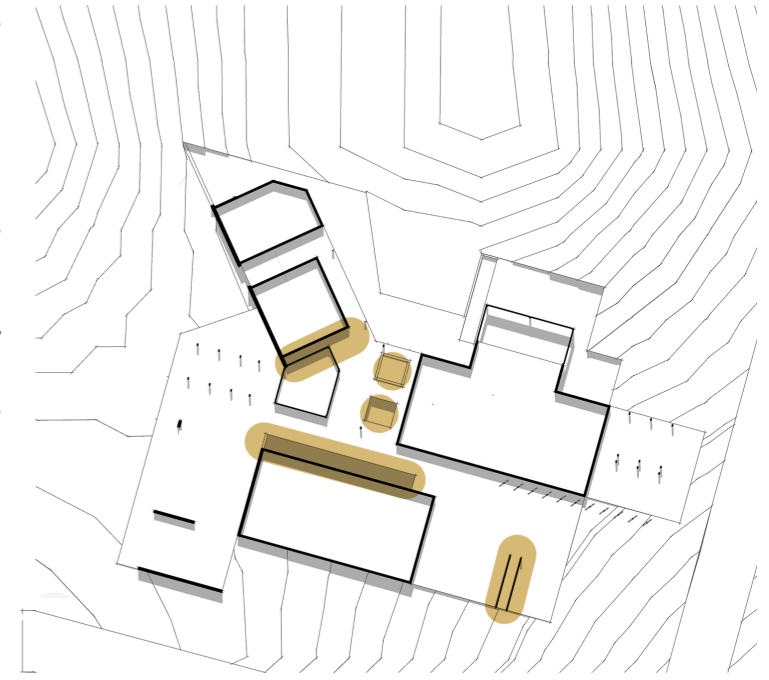


Figure 67: Olfactory ISO 1, (Author, 2020)

## Odour Manipulation

The design tries to promote as many olfactory sources as possible, incorporating water foliage and passive multi-storey ventilation systems. The light wells have planters that will expose the patient experience on the ground floor to the treetops once full-grown. The water catchment runs through the buildings northern facade through planters and creepers to activate the natural aromas associated with them.

The challenge lies in incorporating various olfactory stimulants in some of the more clinical areas. This can be achieved with cross ventilation systems with filters that allow the natural flow of air without killing all the odours associated with them.



## Olfactory Stimulation Goals

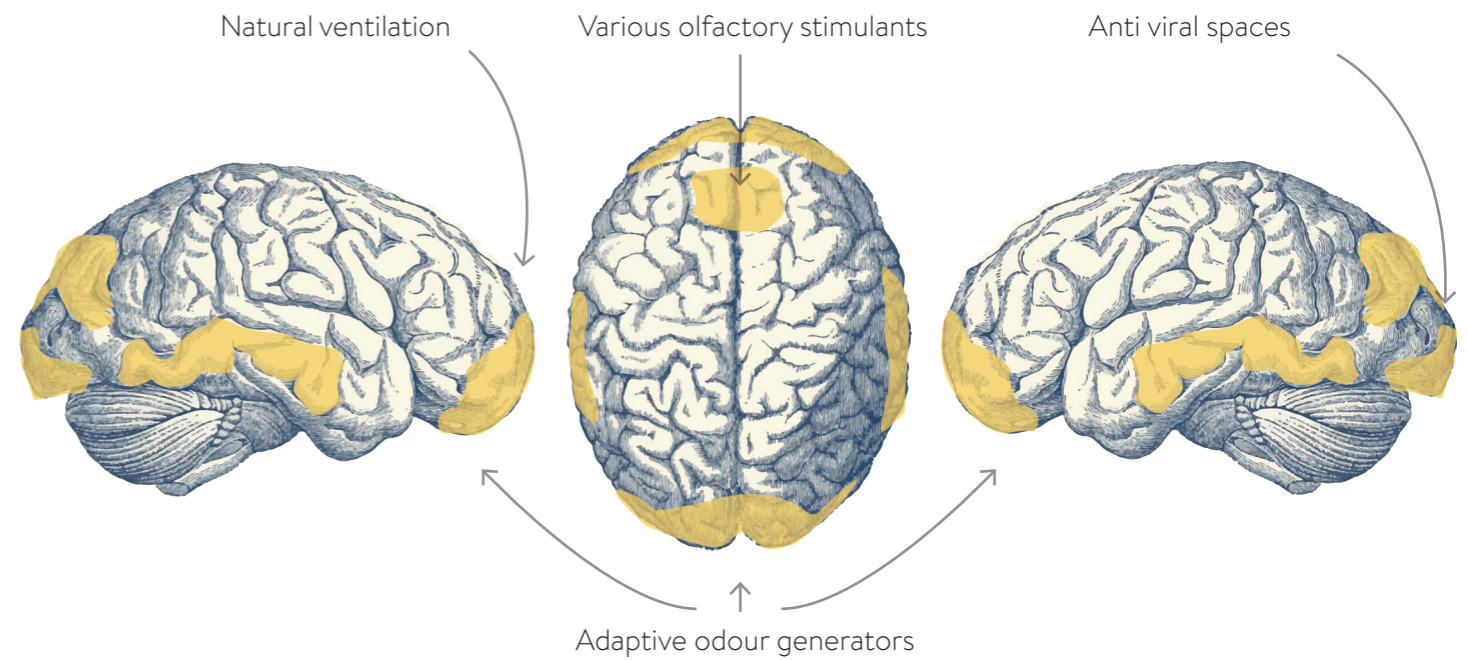


Figure 68: ISO Brain 3, (Author, 2020)

# Auditory Interventions

## Appropriate Acoustics

The auditory stimulants are challenging to control due to the various external variables; however, the spaces' acoustics can be designed to respond to the multiple programmes they host.

Refer to page 52 for haptic simulation experiment.

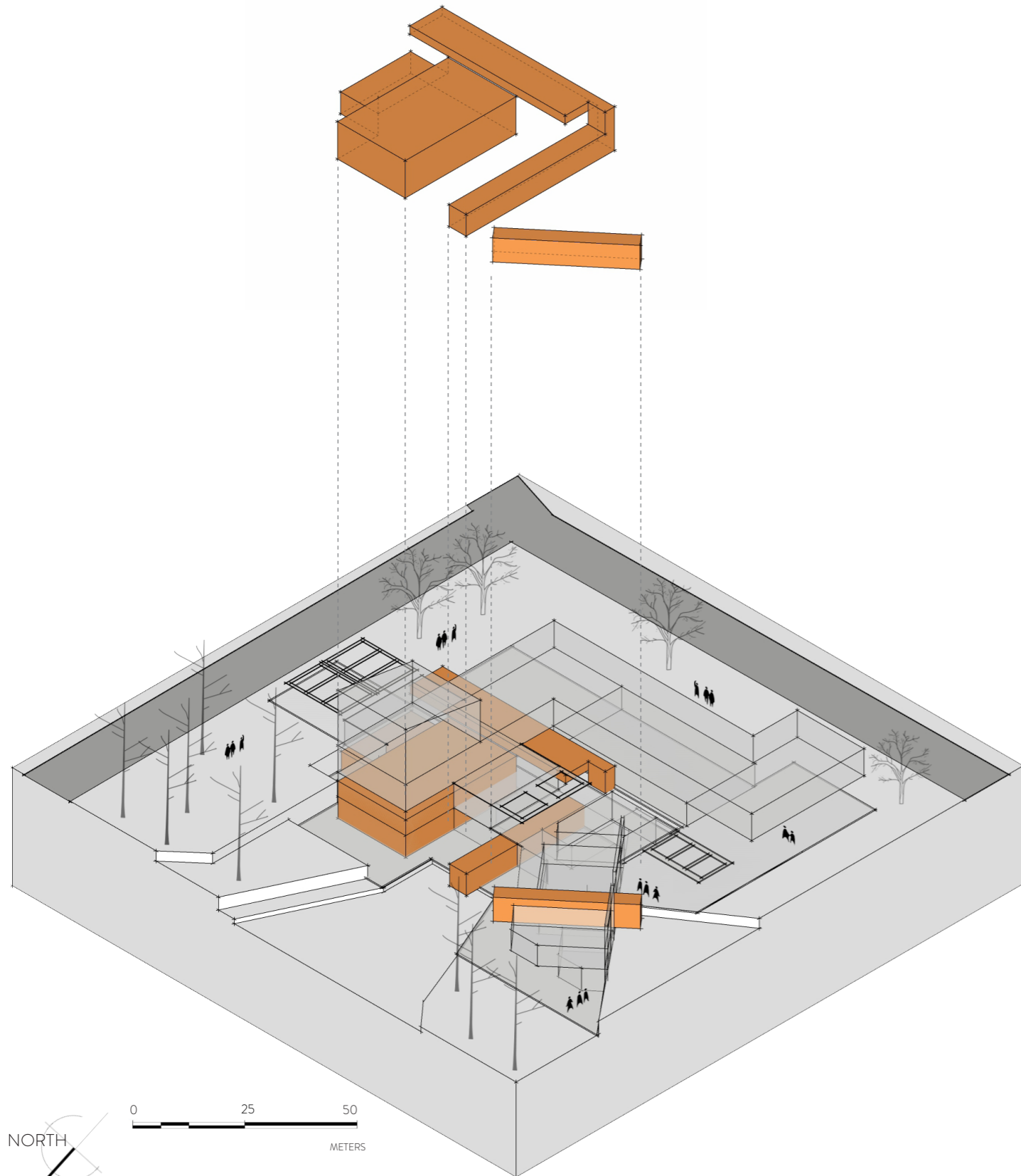
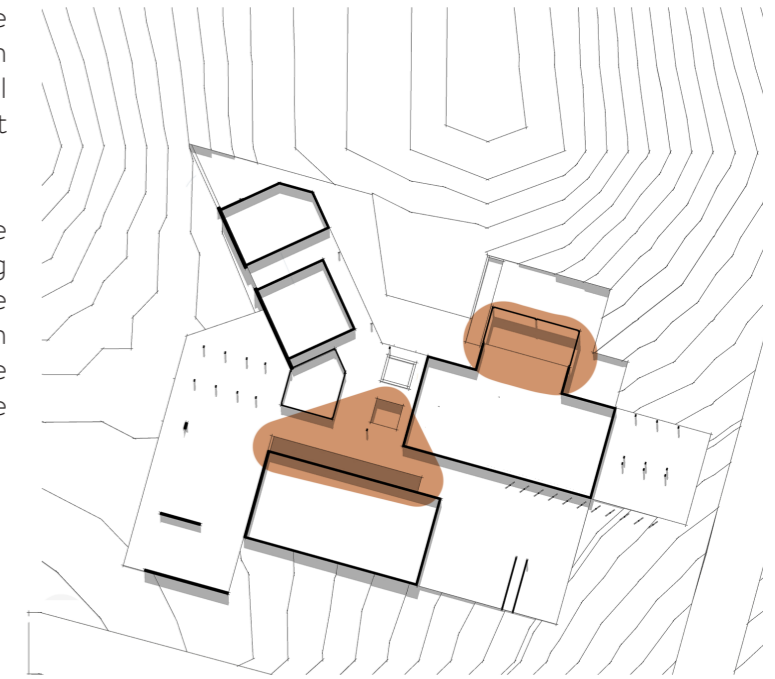


Figure 69: Auditory ISO 1, (Author, 2020)

## Responsive Acoustics

Practically the buildings acoustics are tailored to the needs and programme of the area. The building form amplifies the natural sounds of the park. The natural elements of the design are emphasised by the light wells and atriums and multi-storey lobbies.

The acoustic properties of the rooms of a more private nature are designed with sound-absorbing materials to ensure the rehabilitation facilities have the correct frequency levels to improve concentration and comfort. Similarly, the public areas and exercise areas are designed at a higher frequency to improve attentiveness and energy.



## Auditory Stimulation Goals

Appropriate acoustic levels

Complimentary acoustic design

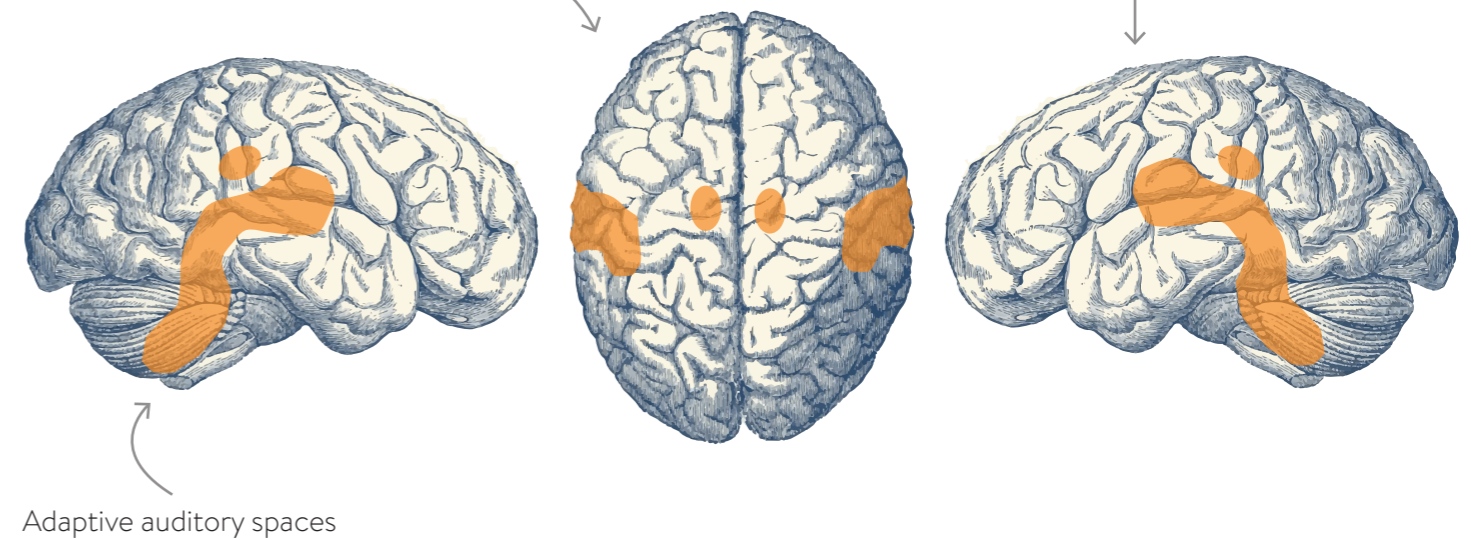


Figure 70: ISO Brain 4, (Author, 2020)

# Programmatic Application

## Neurological Research And Rehabilitation

The programmatic application that went into the rehabilitation centre was derived from neurological precedents worldwide and practically applied per Neuferts guidelines. Due to some of the programmes' sensitive aspects, the interdepartmental movement needs to be planned out meticulously to adhere to medical regulations. The patient's privacy can also be respected by avoiding unnecessary contact with the public while not being segregated completely.

### List Of Programmes

- Reception,
- Consultation,
- Restaurant,
- Rehab consultation,
- Psychology,
- Restaurant,
- Medical discharge,
- Physical therapy,
- Physiotherapy,
- Gym,
- Specialised treatment,
- Surgical theatre,
- Offices,
- Intensive care,
- Accommodation, and
- General ward.

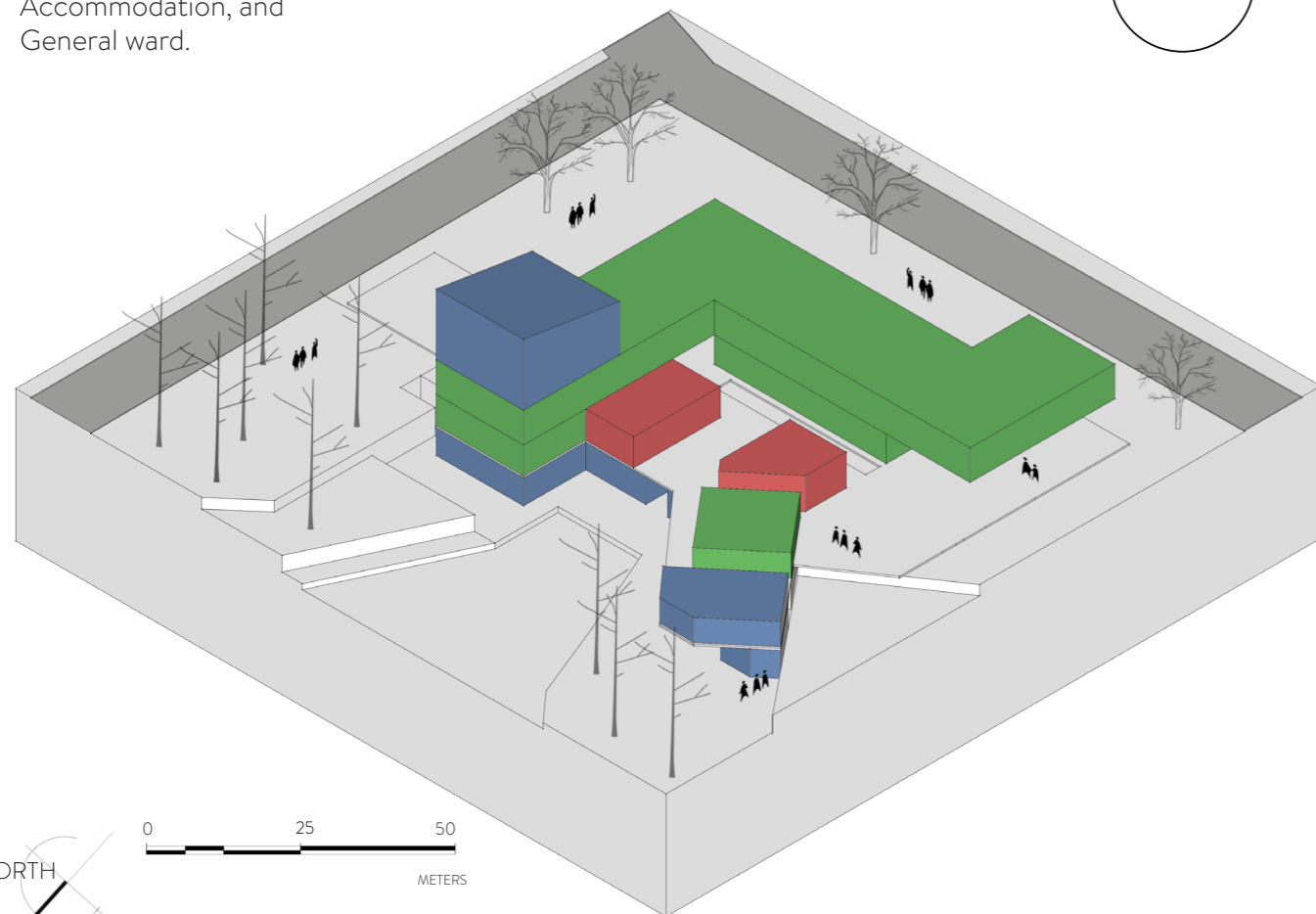
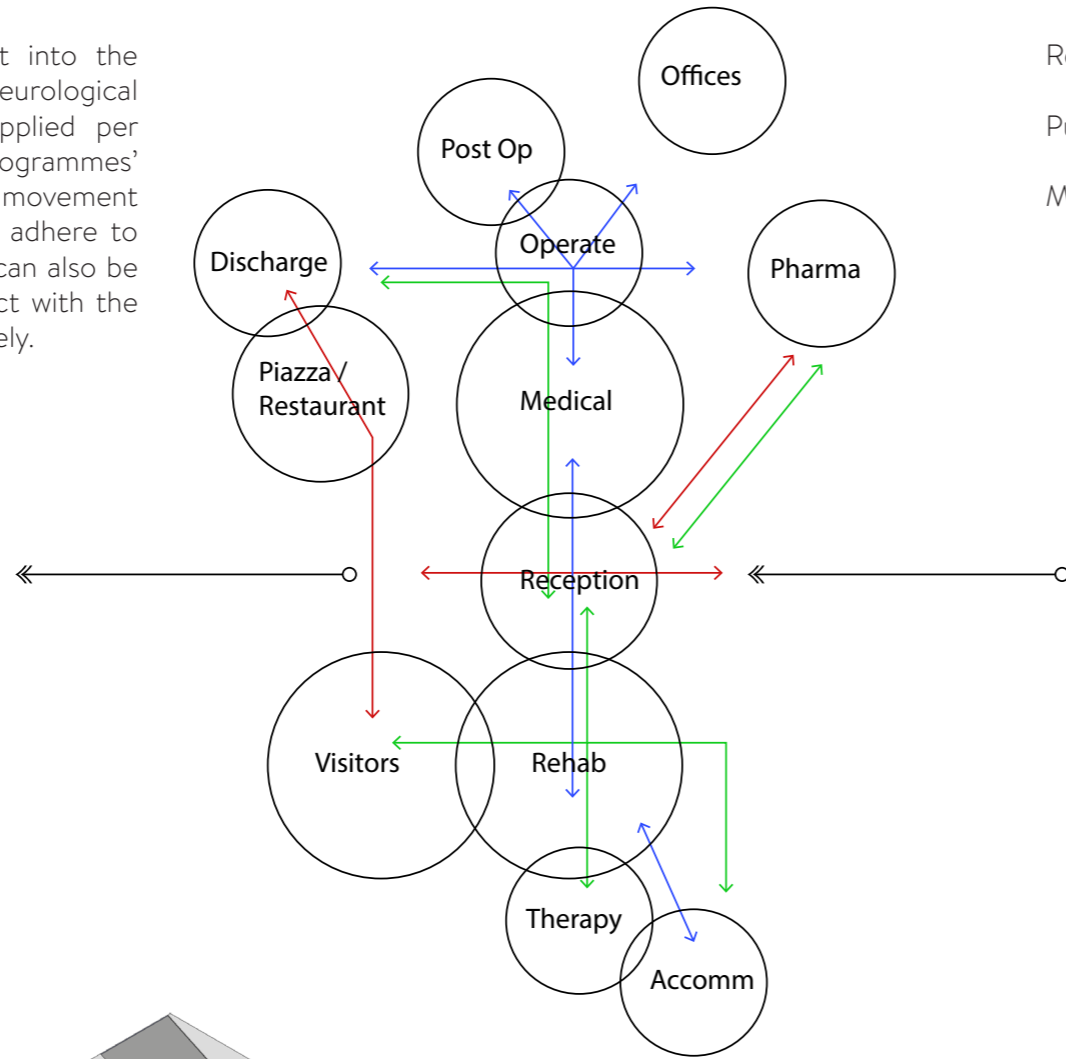


Figure 71: Programme ISO 1, (Author, 2020)  
© University of Pretoria

## Exploded Programme Isometric

- Rehabilitation facilities ■
- Public facilities ■
- Medical Facilities ■

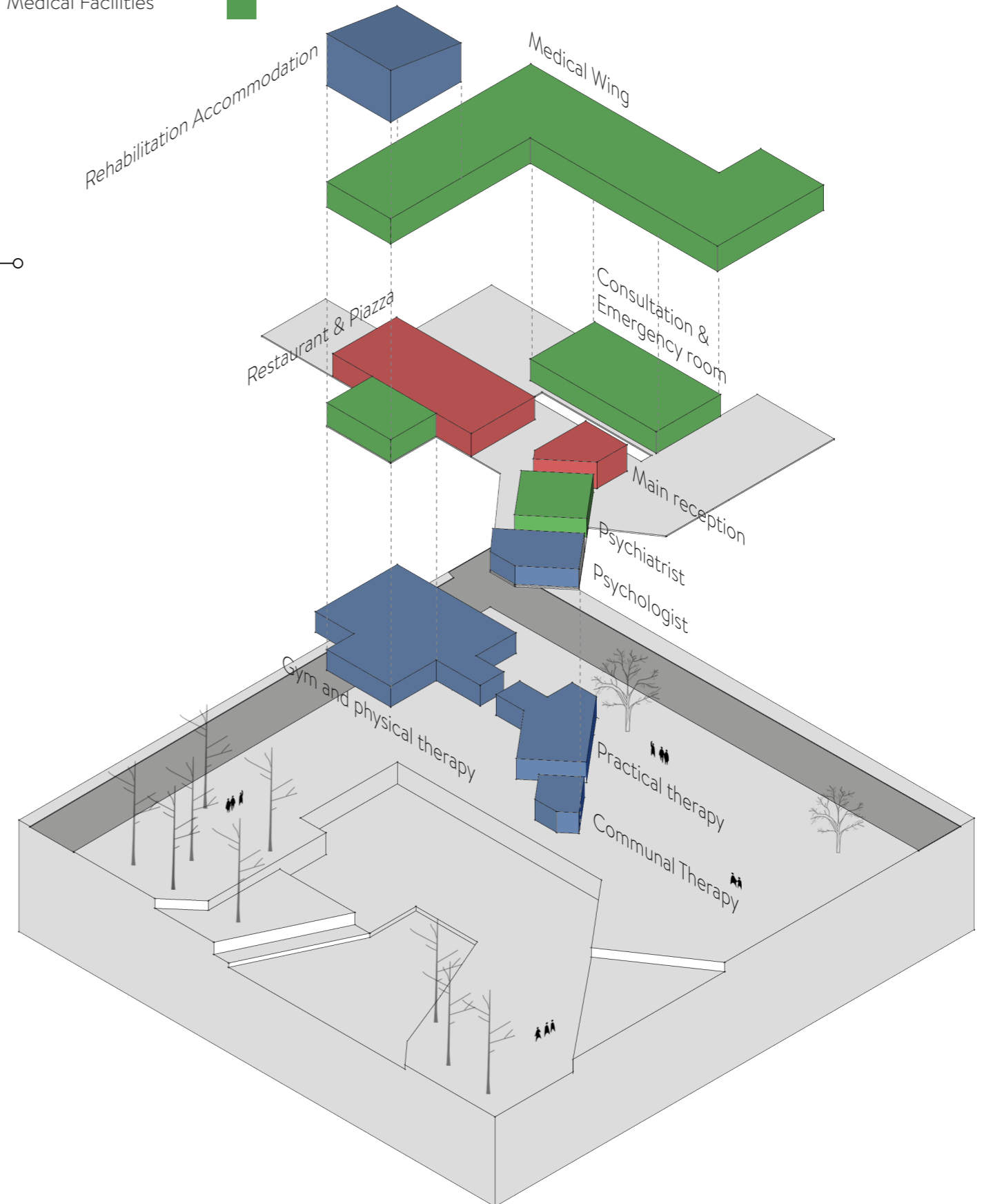


Figure 72: Programme ISO 2, (Author, 2020)

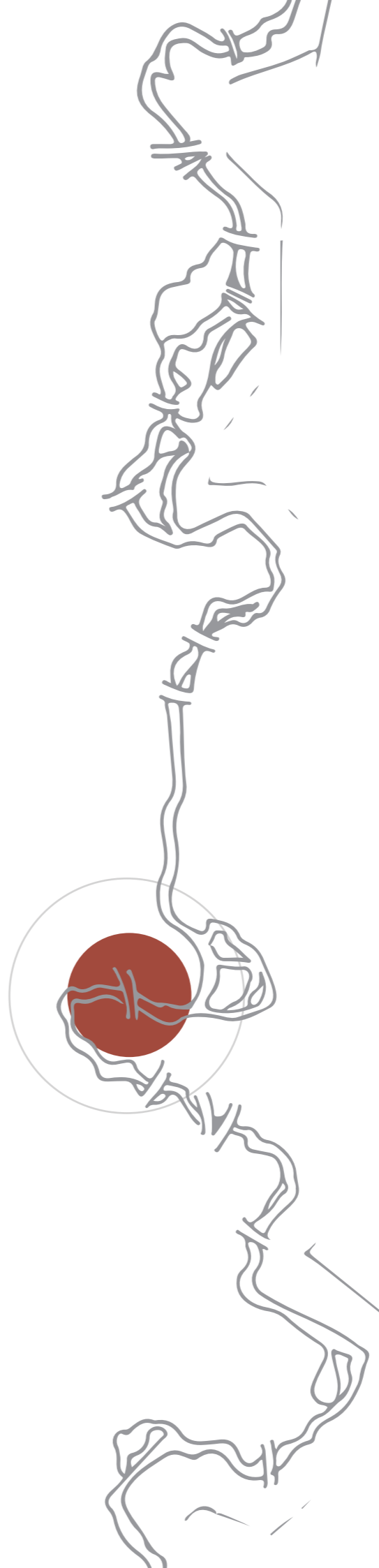


CHAPTER

# 06

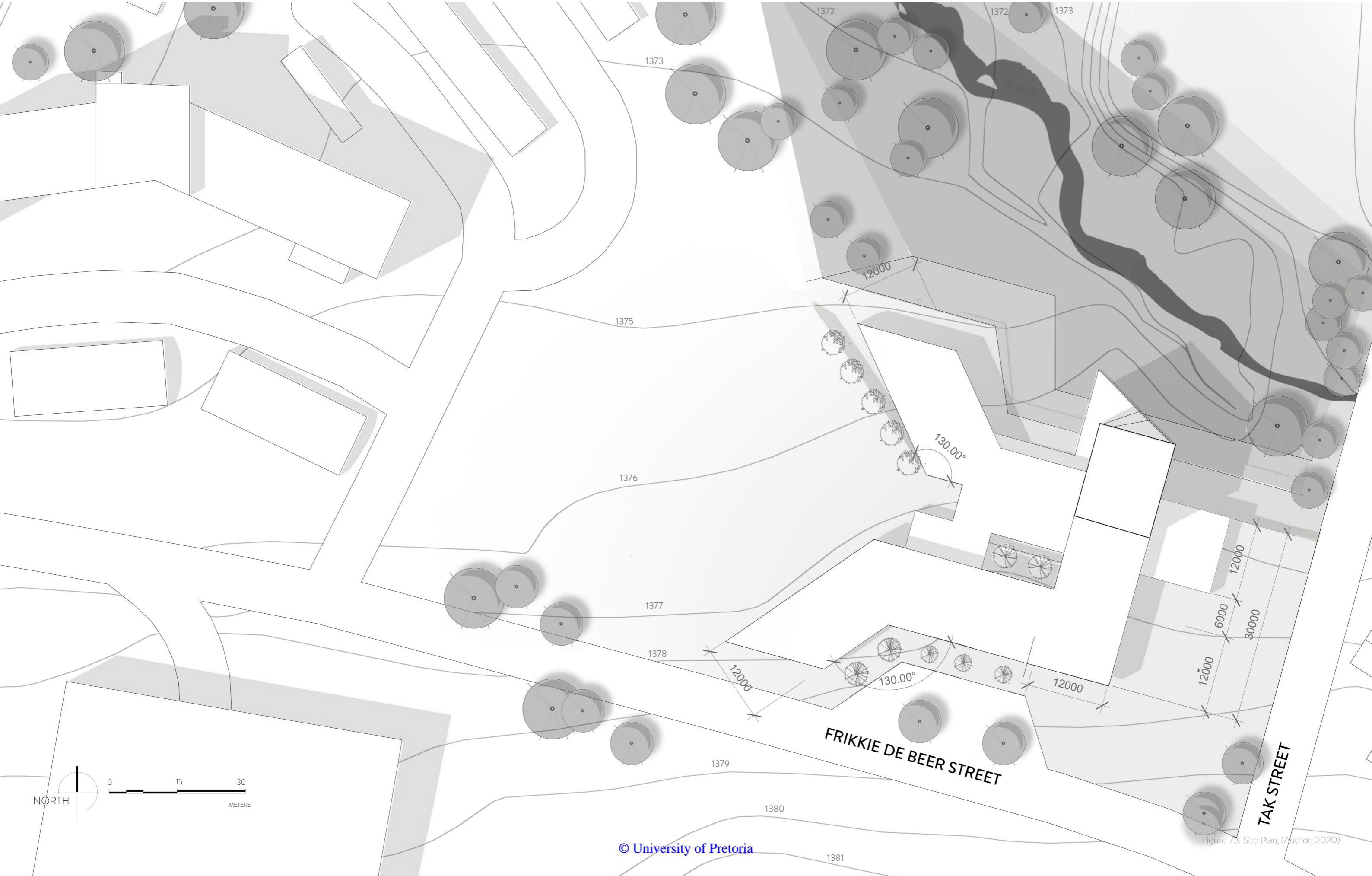
## Design Development

---

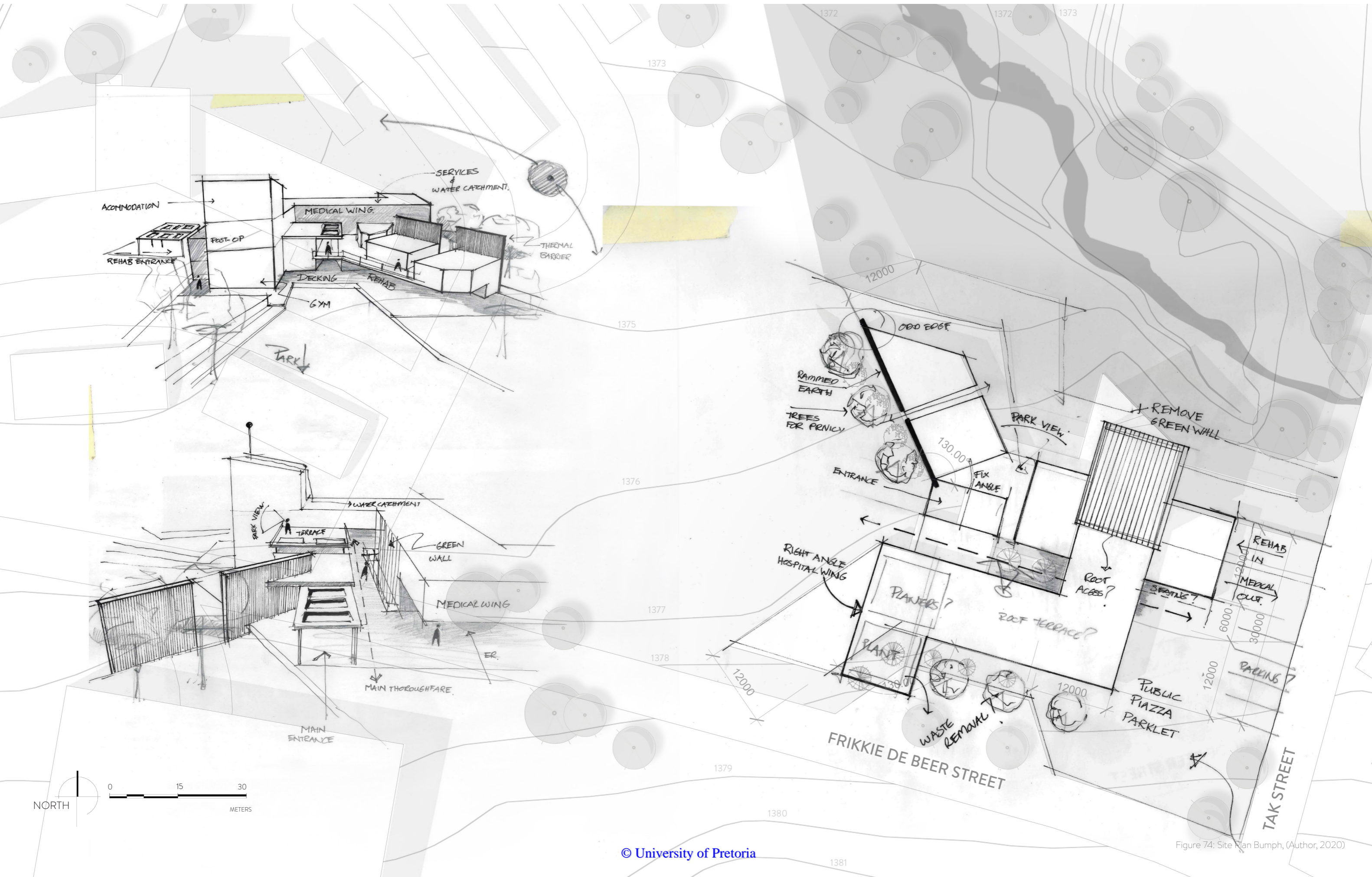


# Site Plan

## Initial Site Concept



Conceptual Development



Conceptual Site Plan Process Work

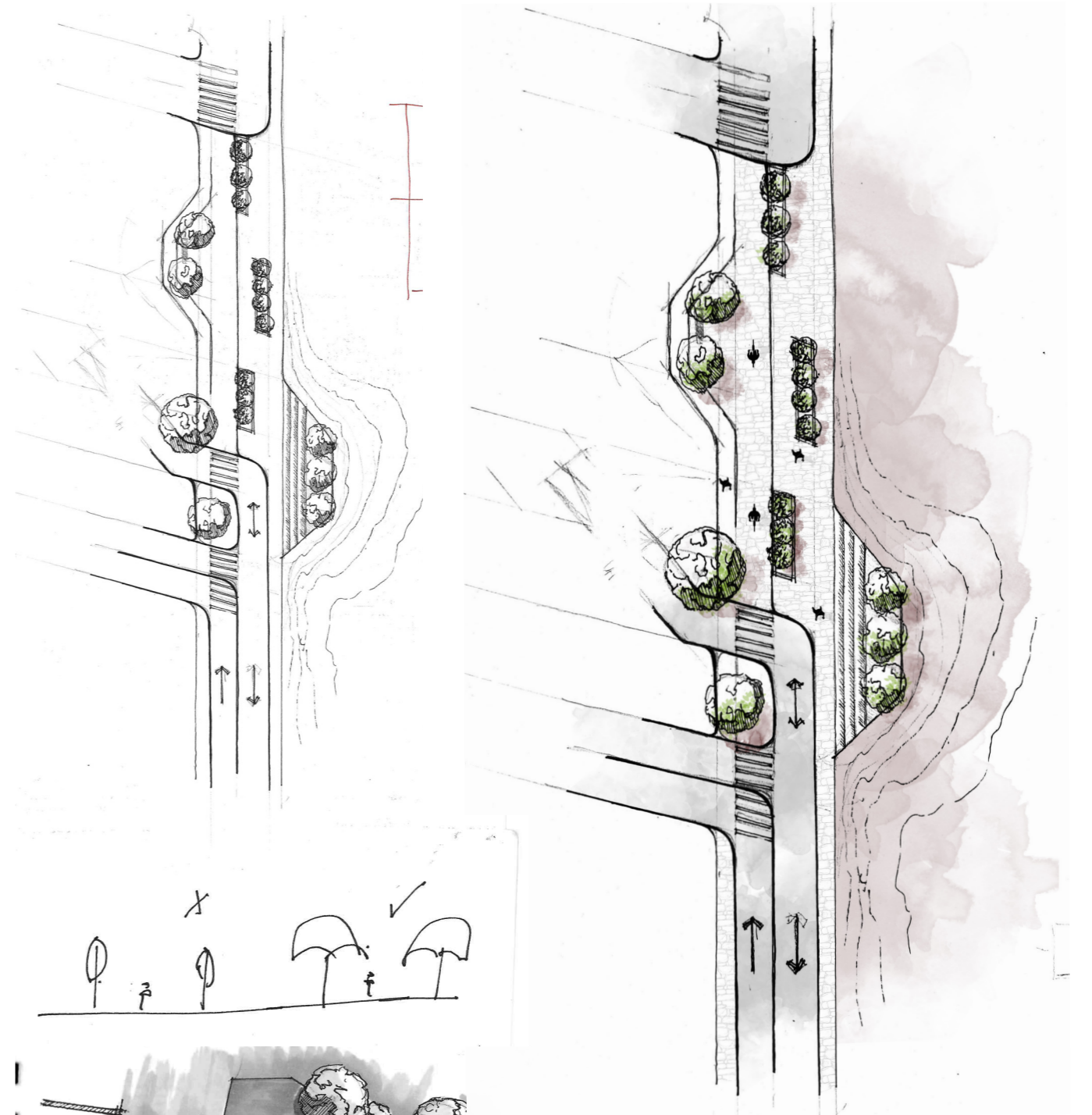
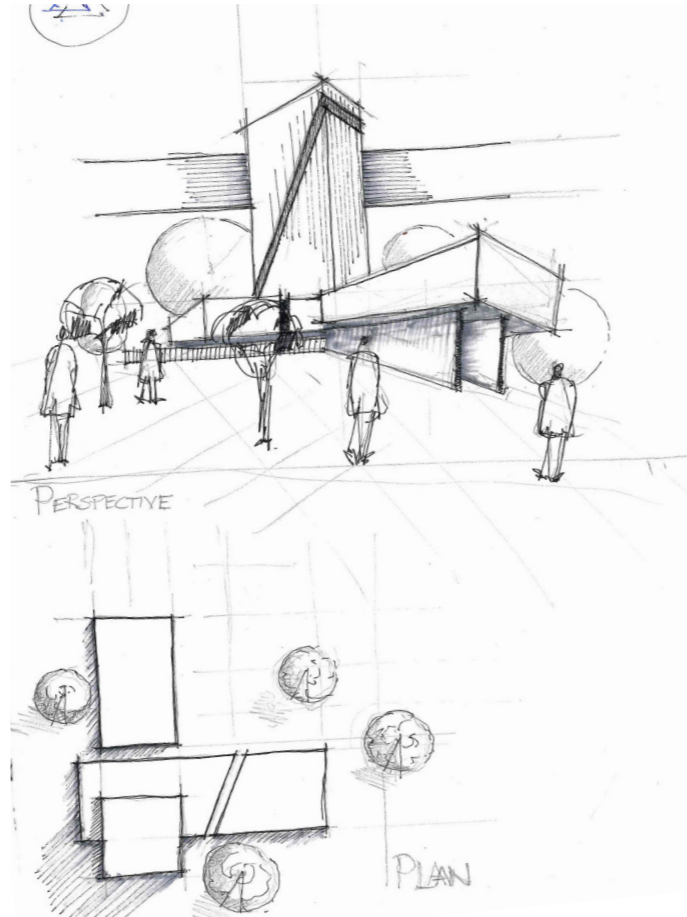
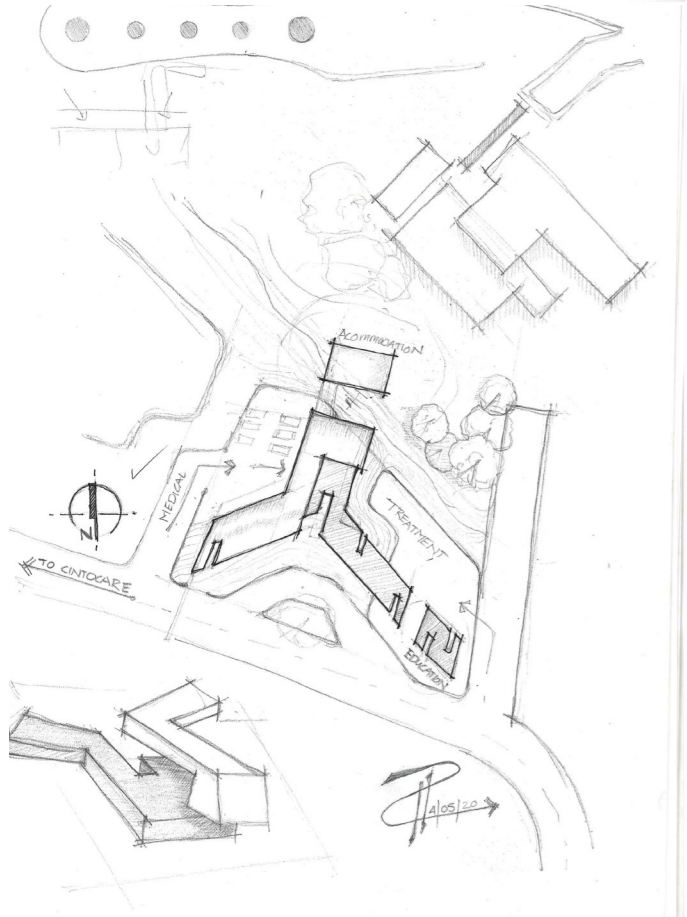
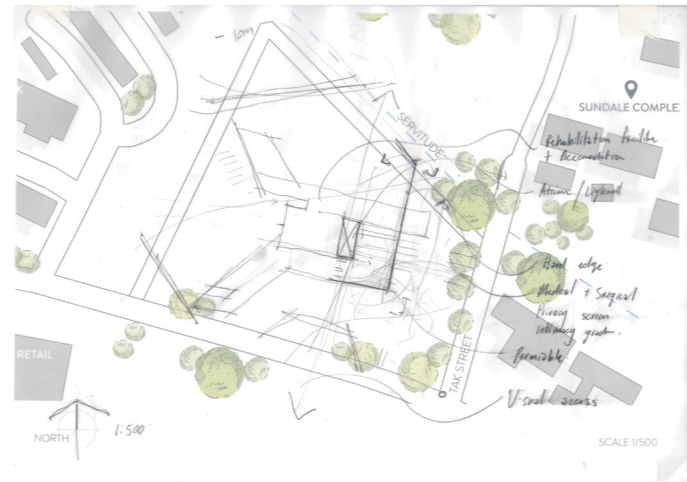
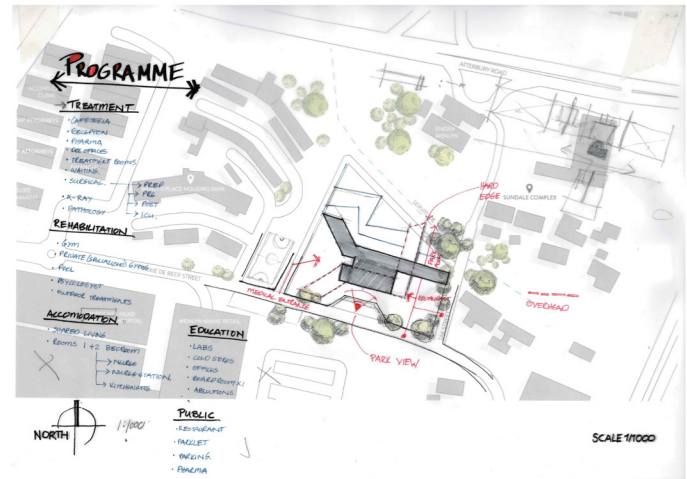
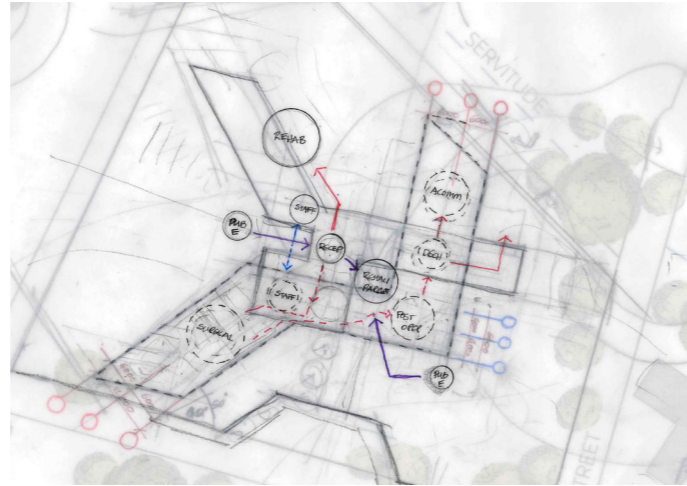
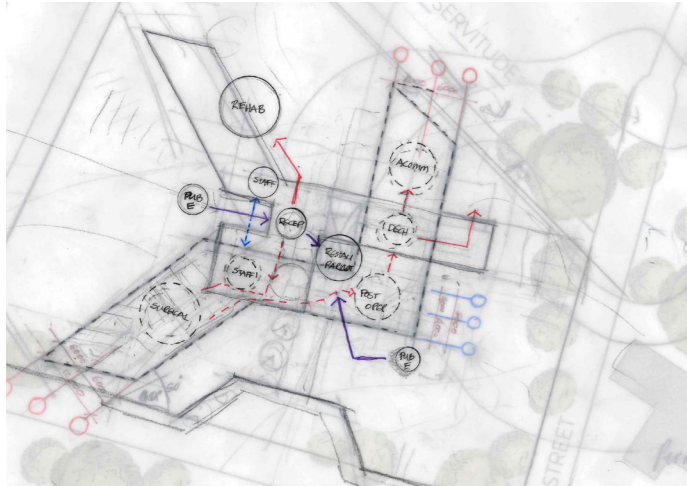


Figure 75: Progress Work, (Author, 2020)

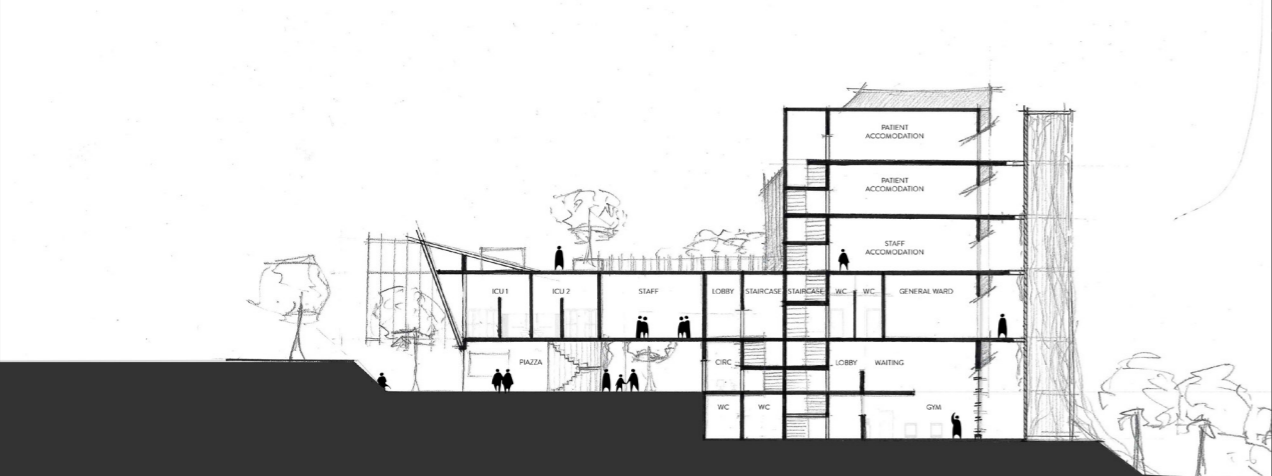
# Lower Ground Floor Plan Development

## Initial Rehabilitation Concept

Figure 76: LGFP 1 (Author, 2020)

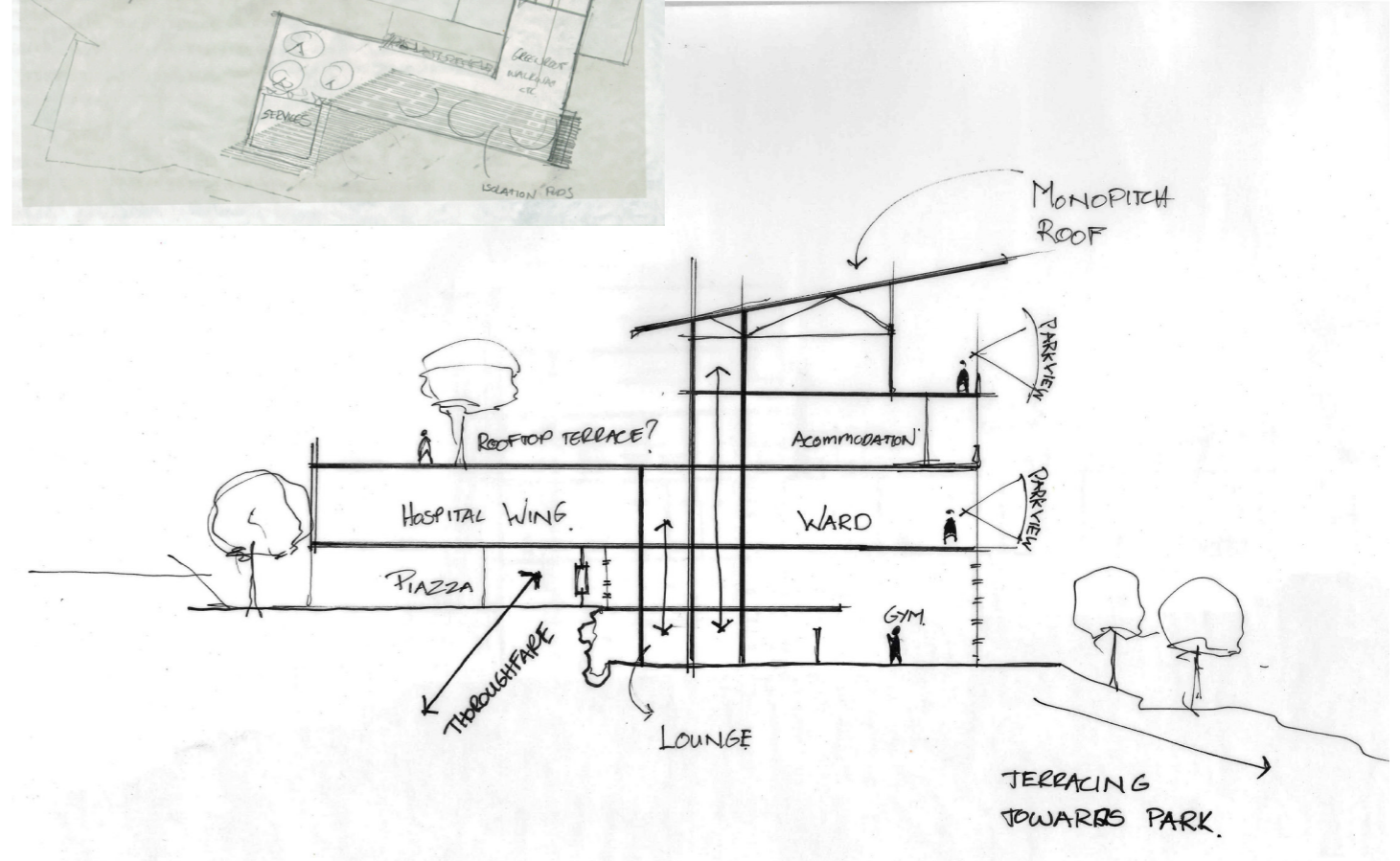
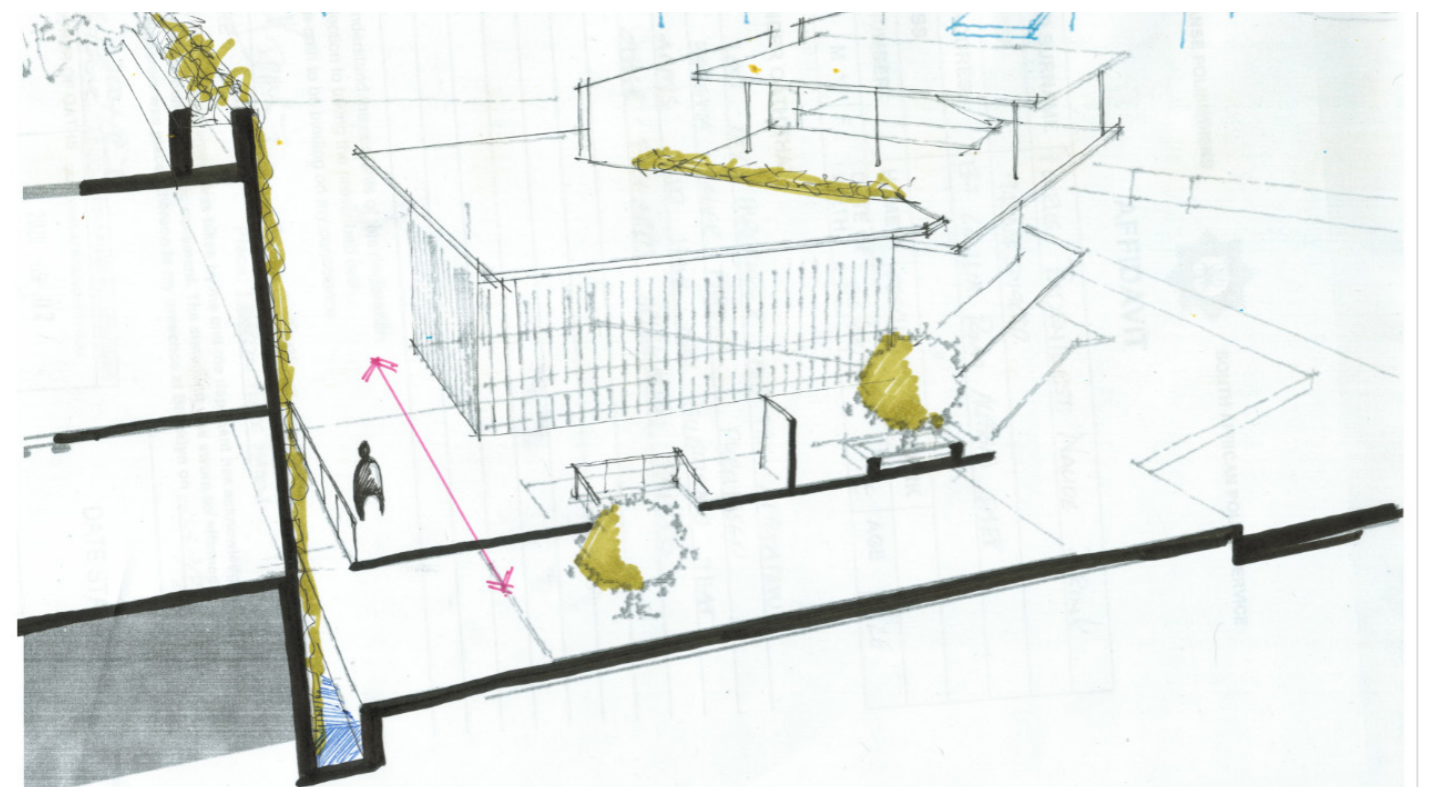
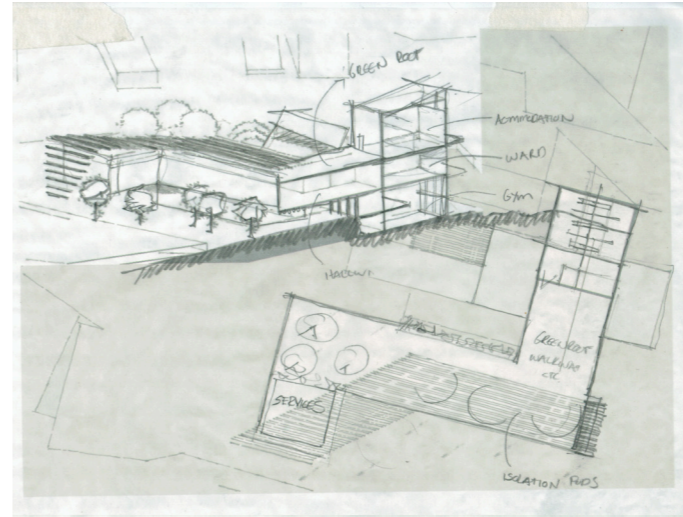
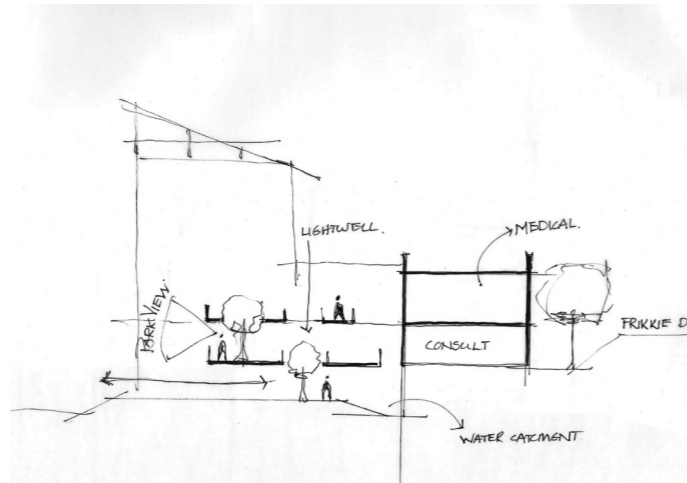
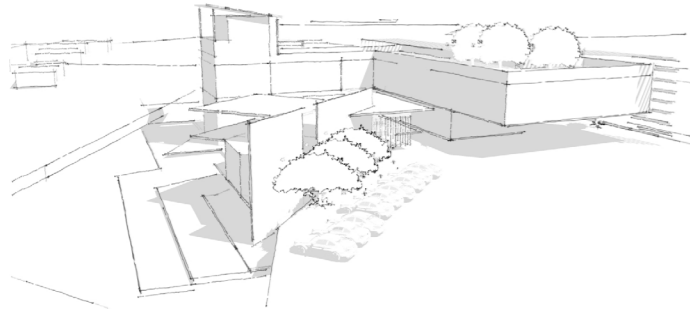
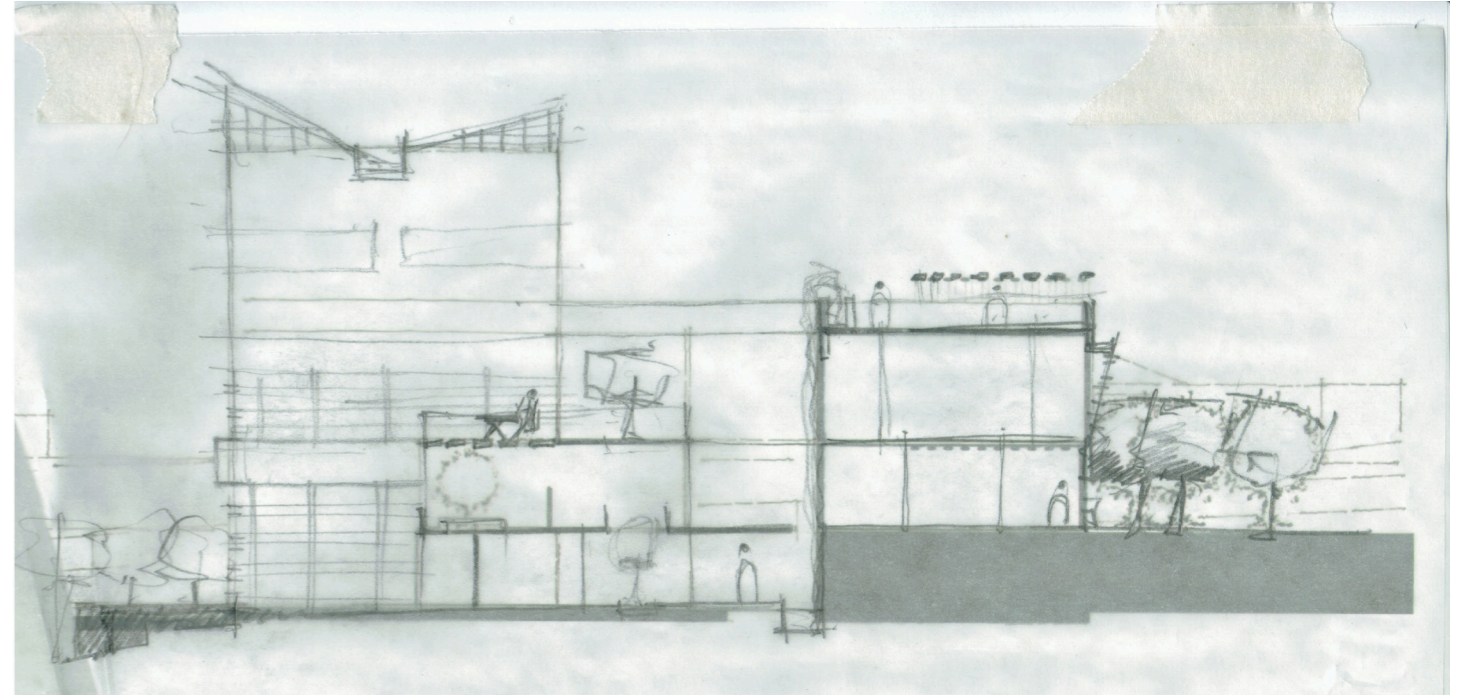
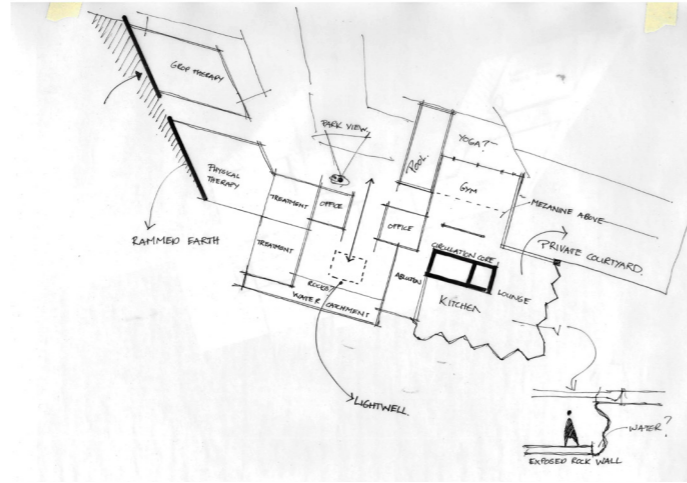
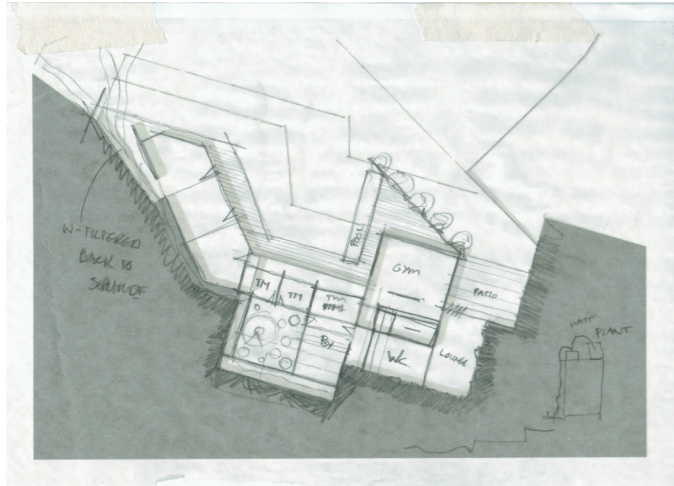
The lower ground floor has been assigned to host most of the rehabilitation facilities. Bordering on the park to the north it is the ideal space to create a healthy environment for patient recovery. The programmes range from a gym, therapy rooms, psychology room, physiotherapy, and shared communal areas for patients staying in the facility.

The various forms of rehabilitation have been assigned based on successful neurological facilities worldwide who all believe in a holistic rehabilitation process that heals the body and mind to provide the best patient experience.





Conceptual Lower Ground Floor Plan Process Work



# Ground Floor Plan Development

## Initial Rehabilitation Concept

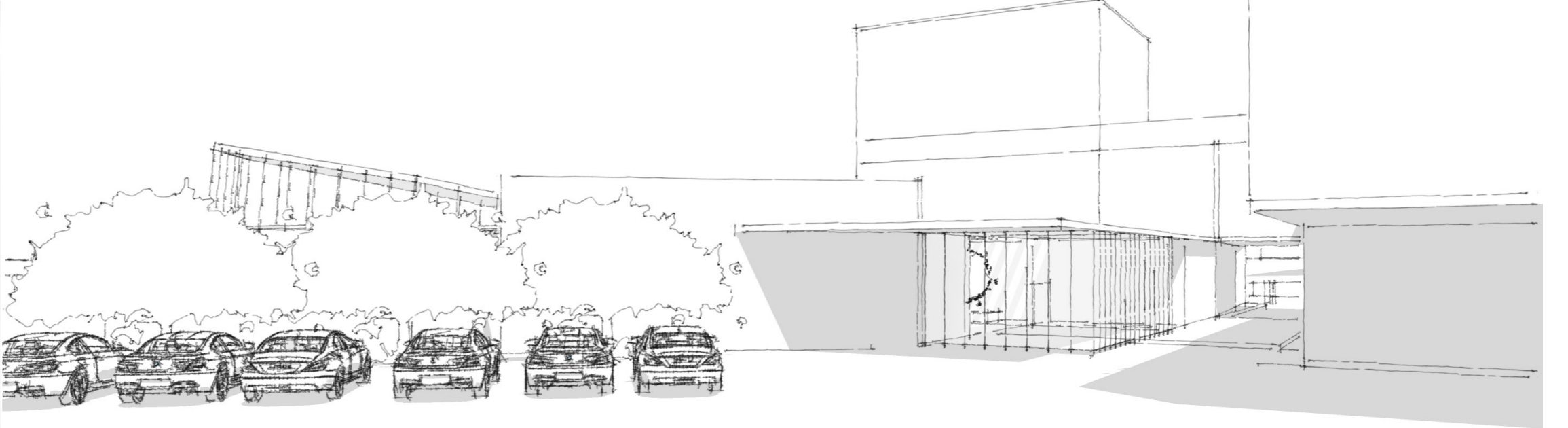
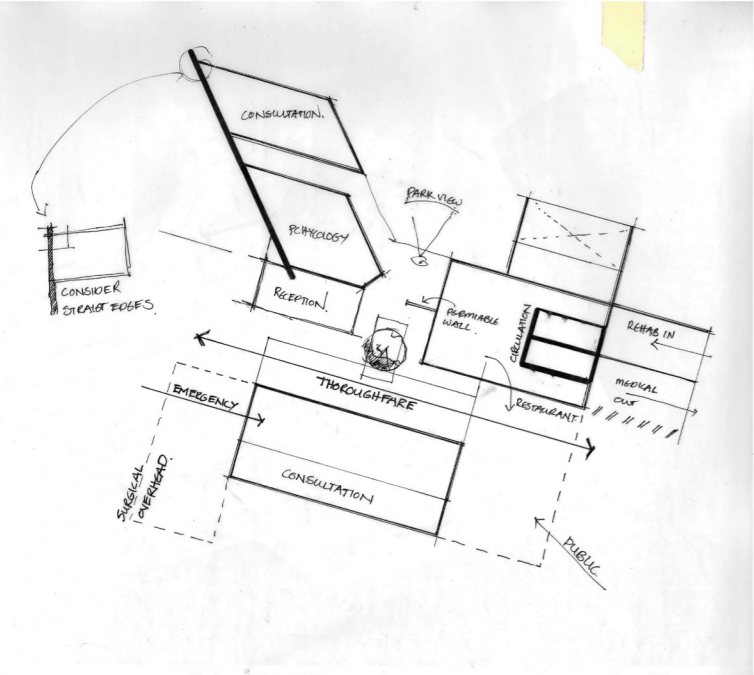
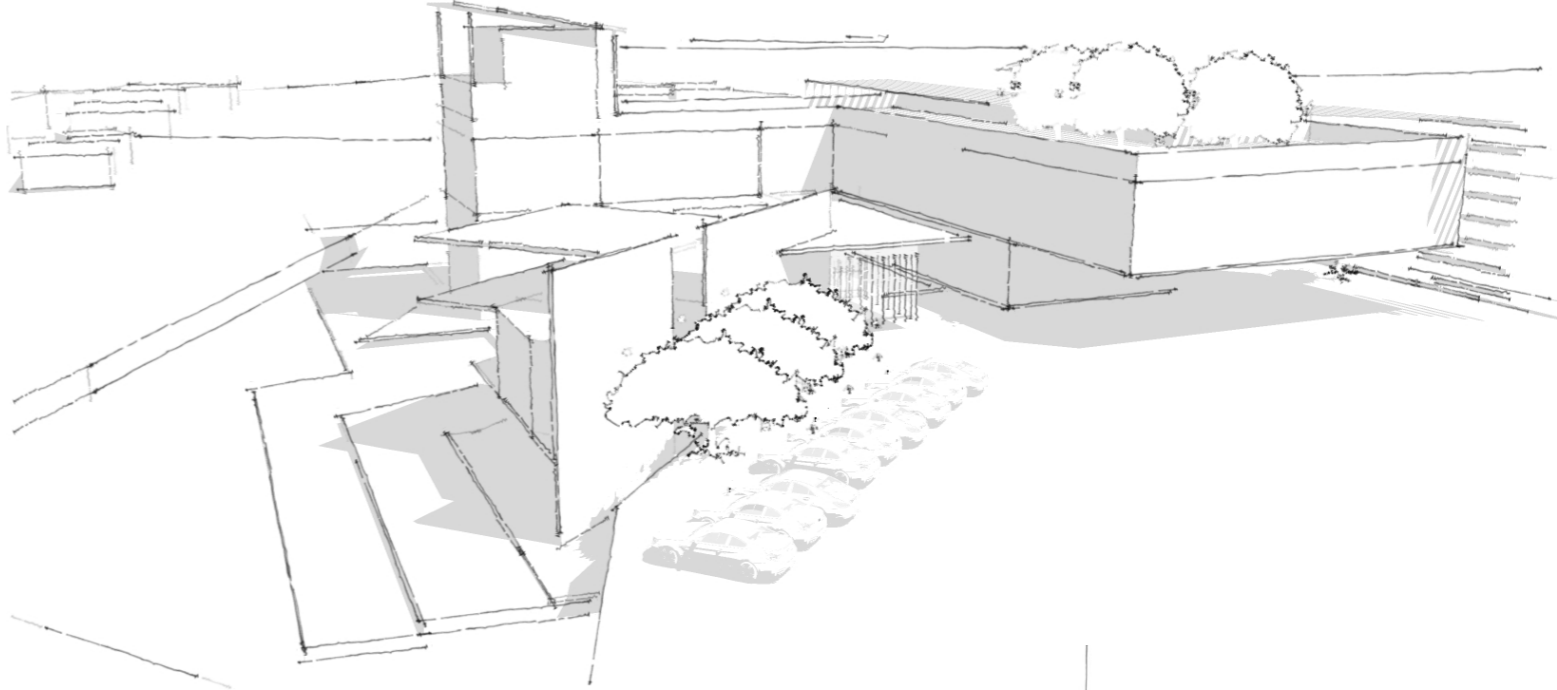
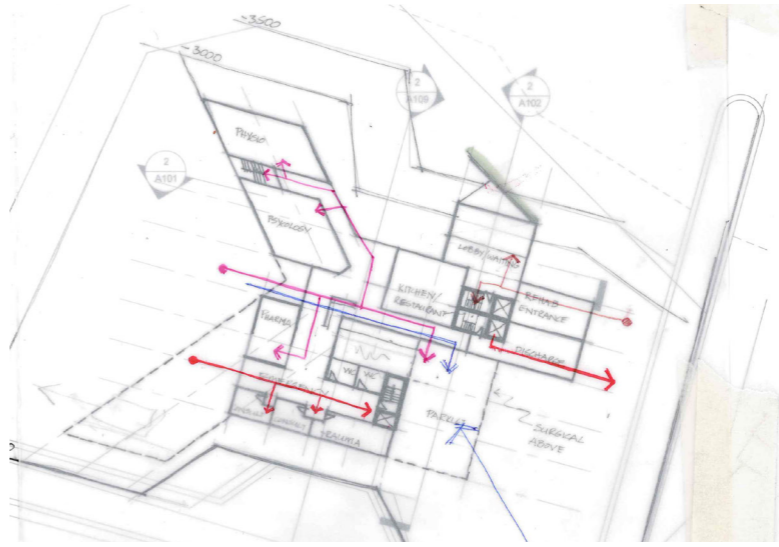
Figure 79: GFP 1, (Author, 2020)

The rehabilitation centre's ground floor serves as a guidepost and user interface for all that the building offers. From medical facilities, public-serving programmes to the rehabilitation centre.





Conceptual Ground Floor Process Work



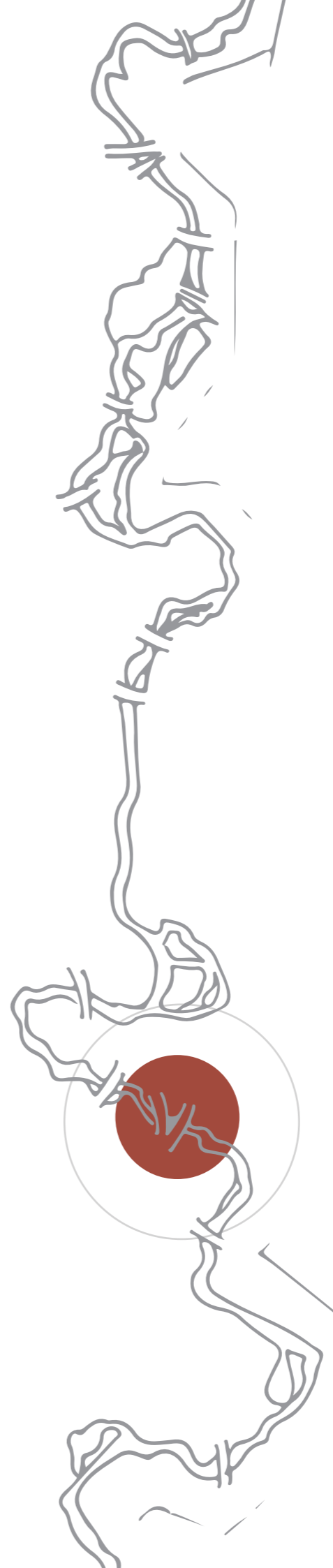


CHAPTER

# 07

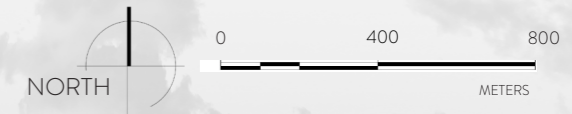
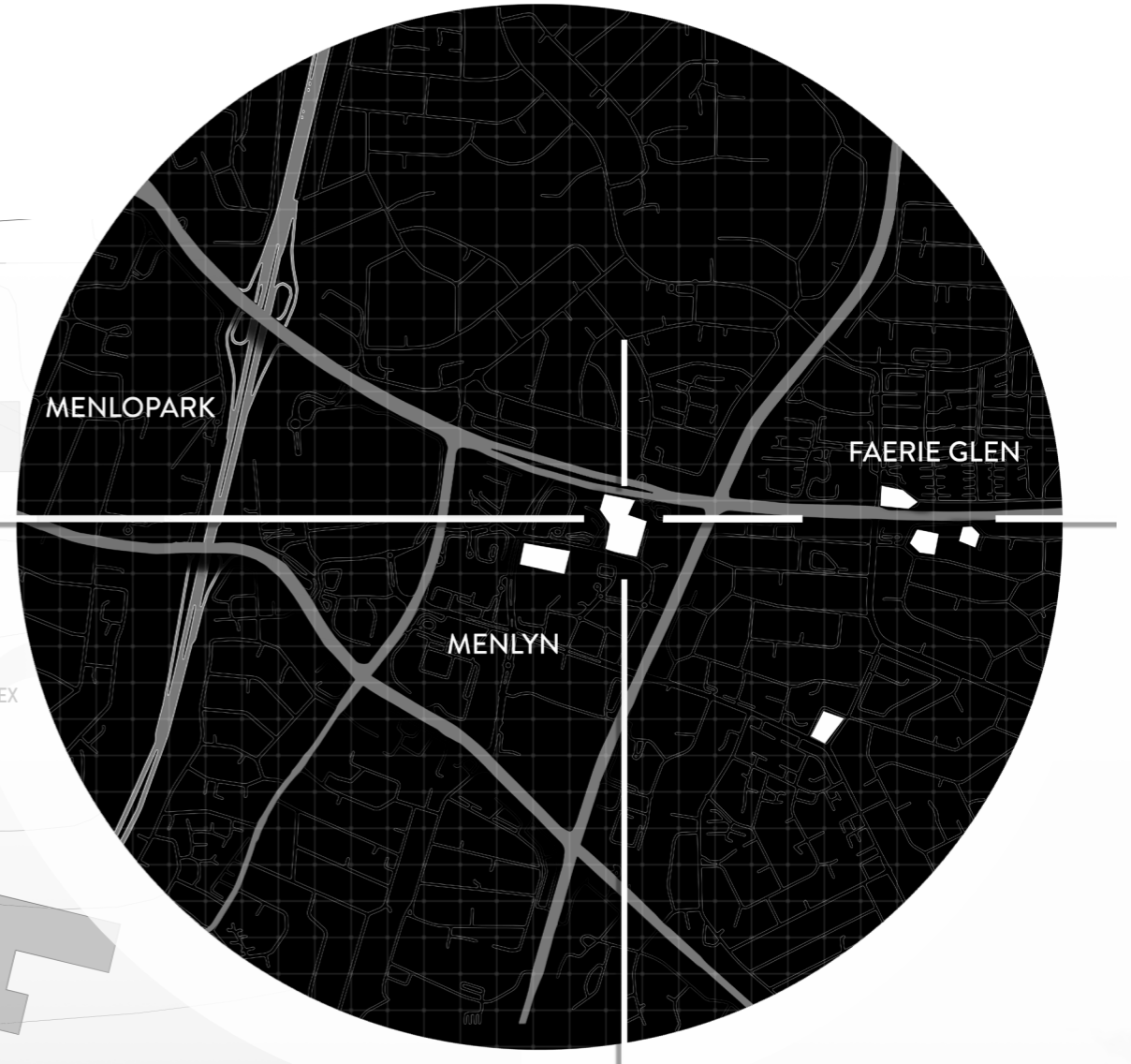
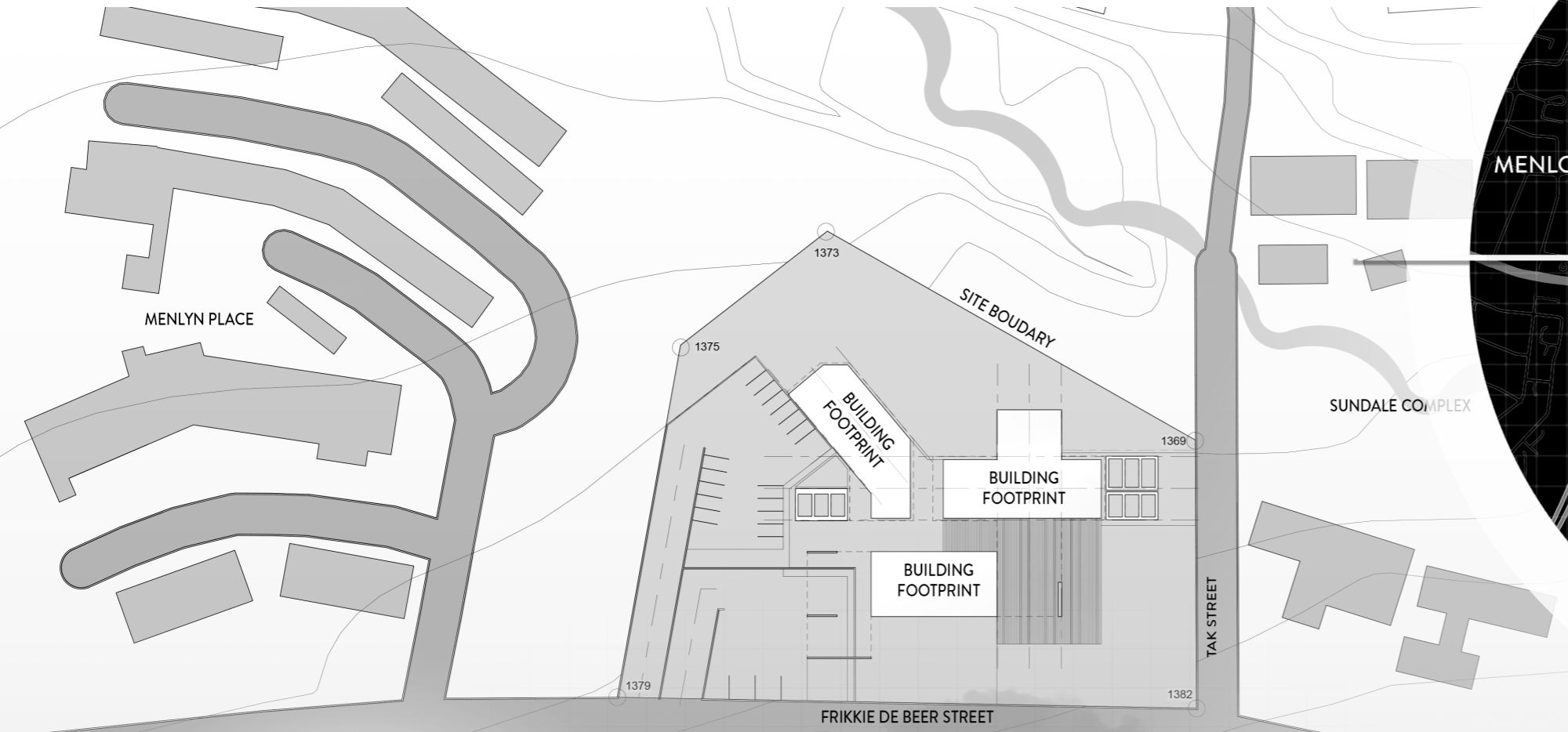
## Design Resolution

---



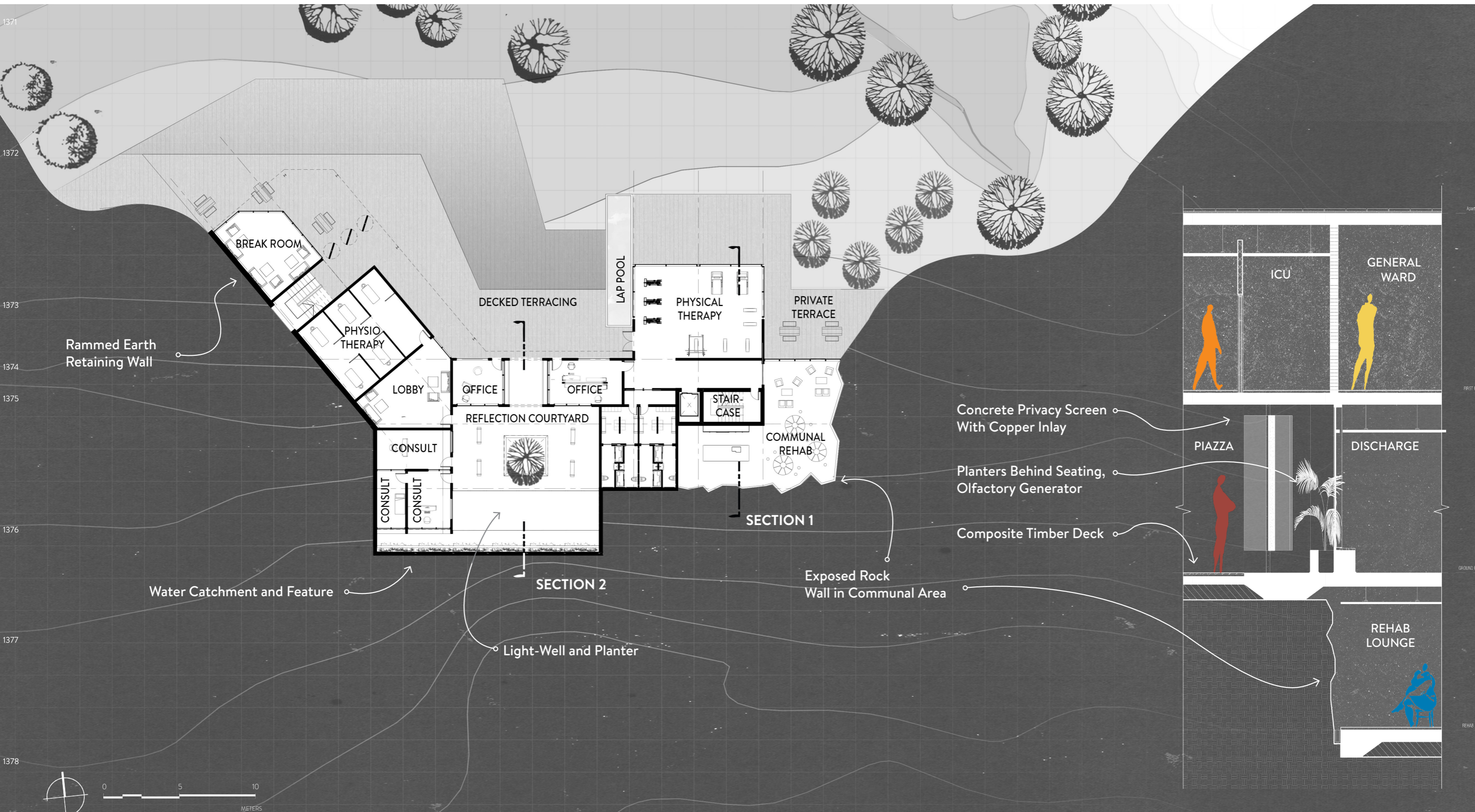
# Site Plan

# Medical Proximity Map

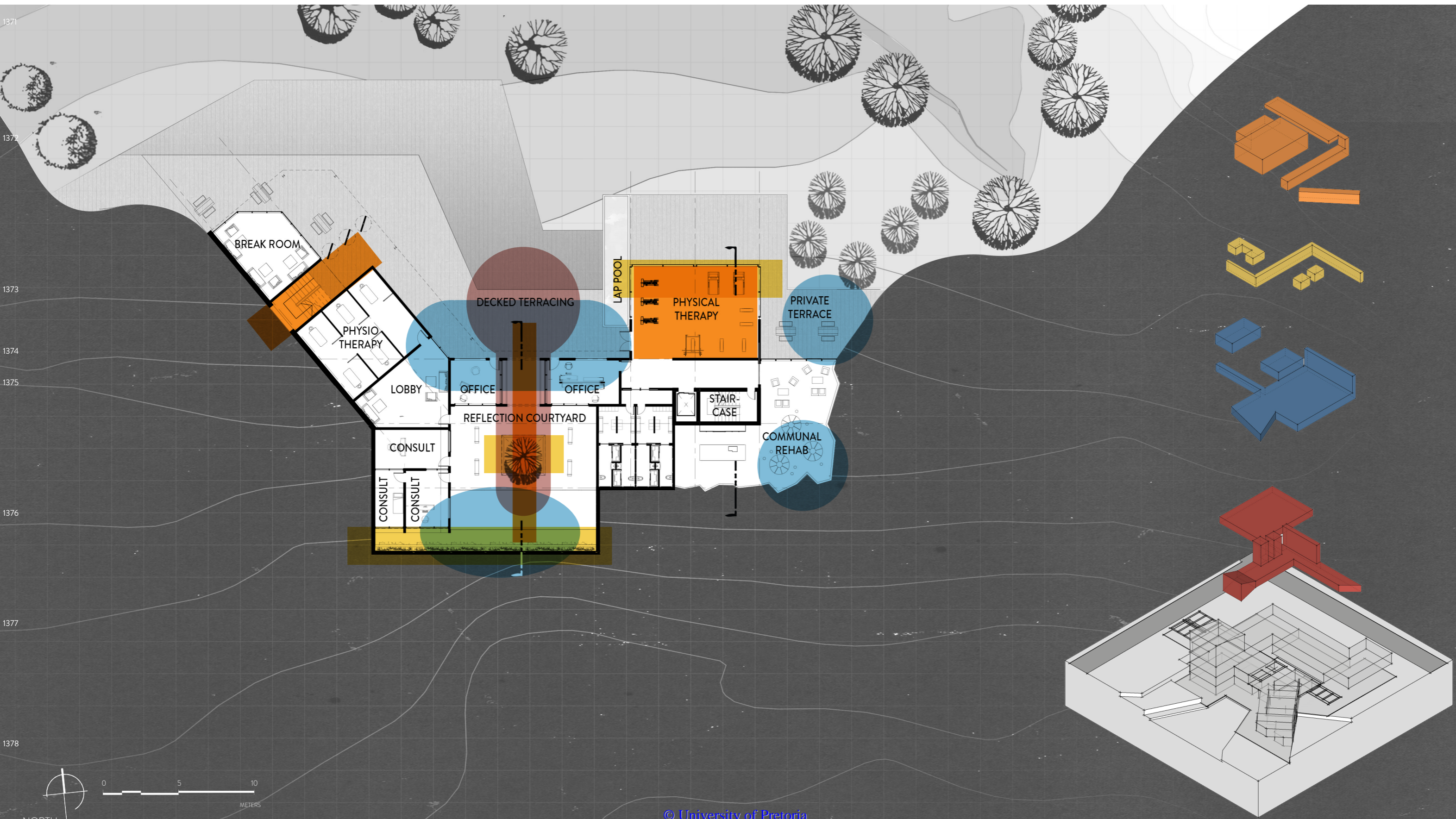


# Lower Ground Floor Plan

# Strip Section 1

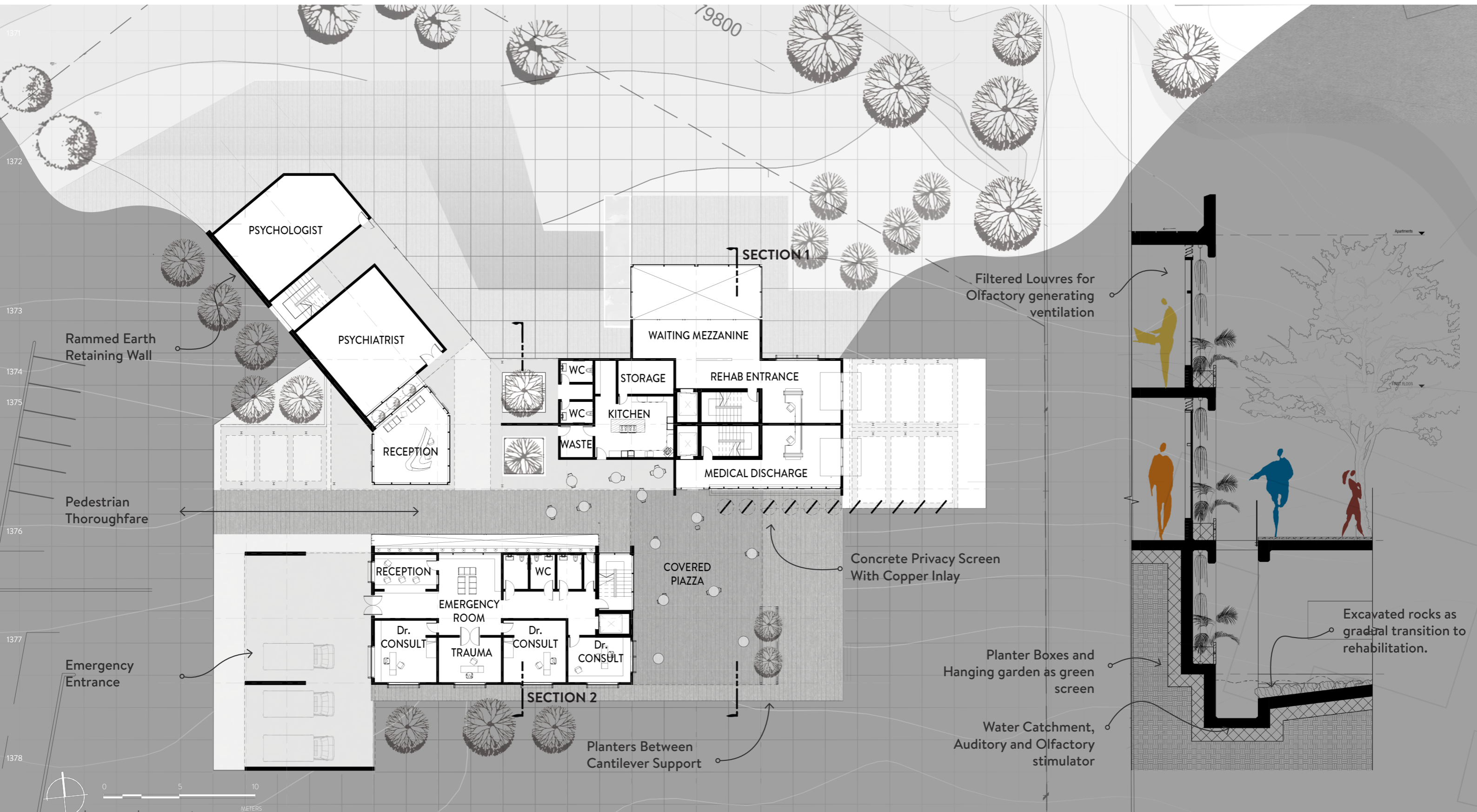


# Research Application

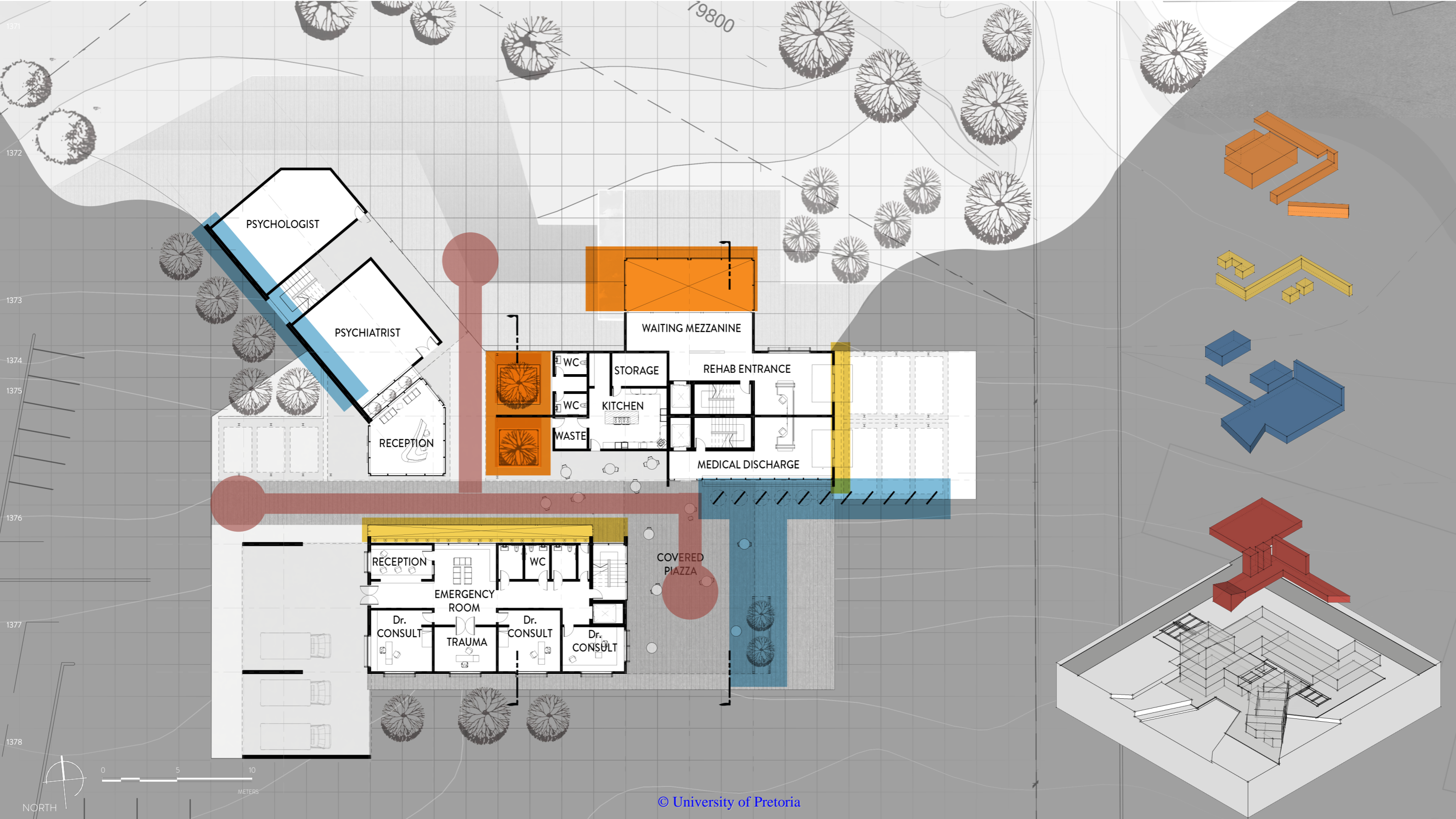


# Ground Floor Plan

# Strip Section 2

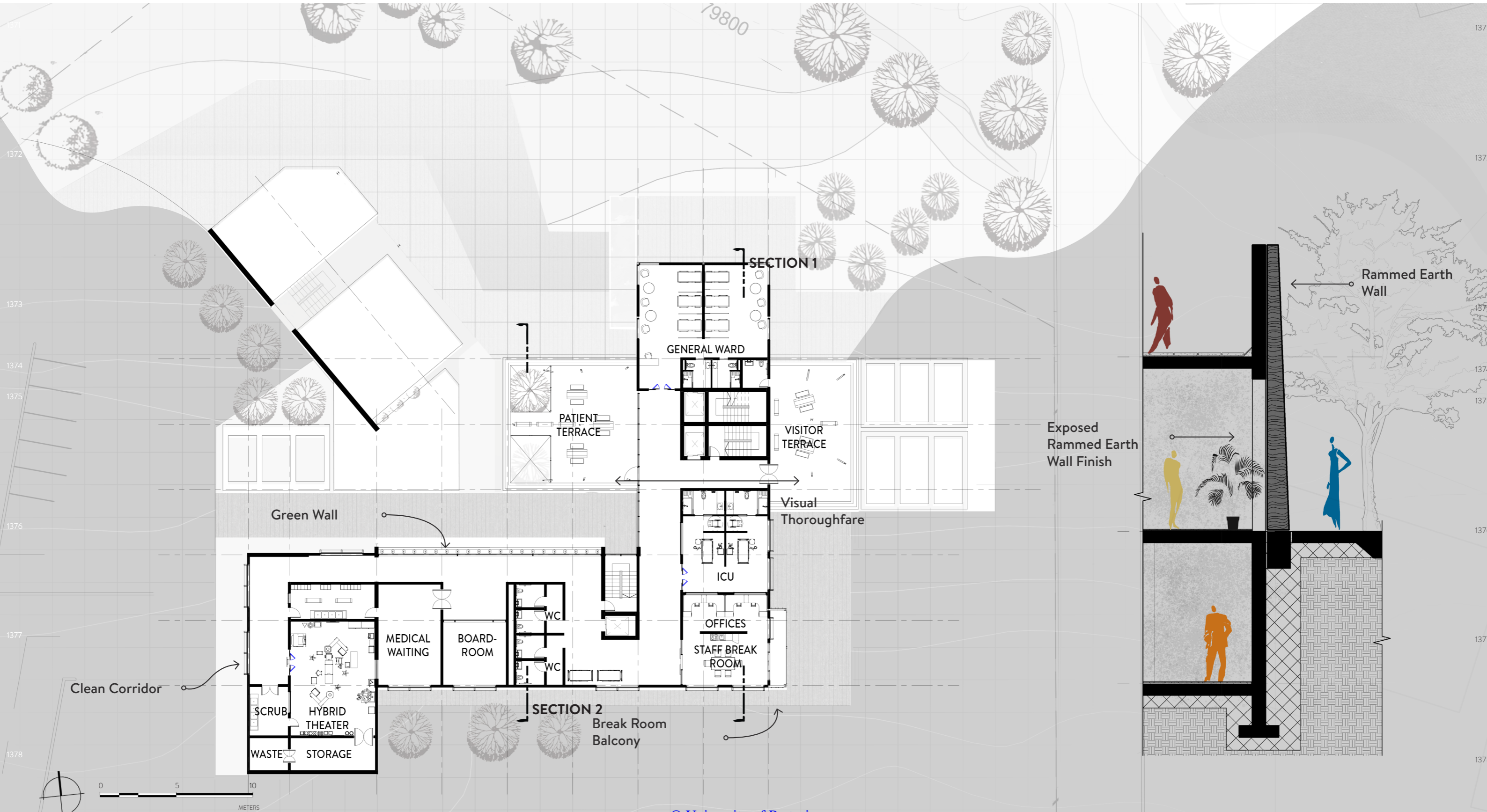


# Research Application

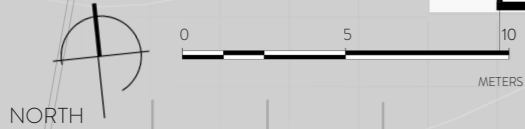
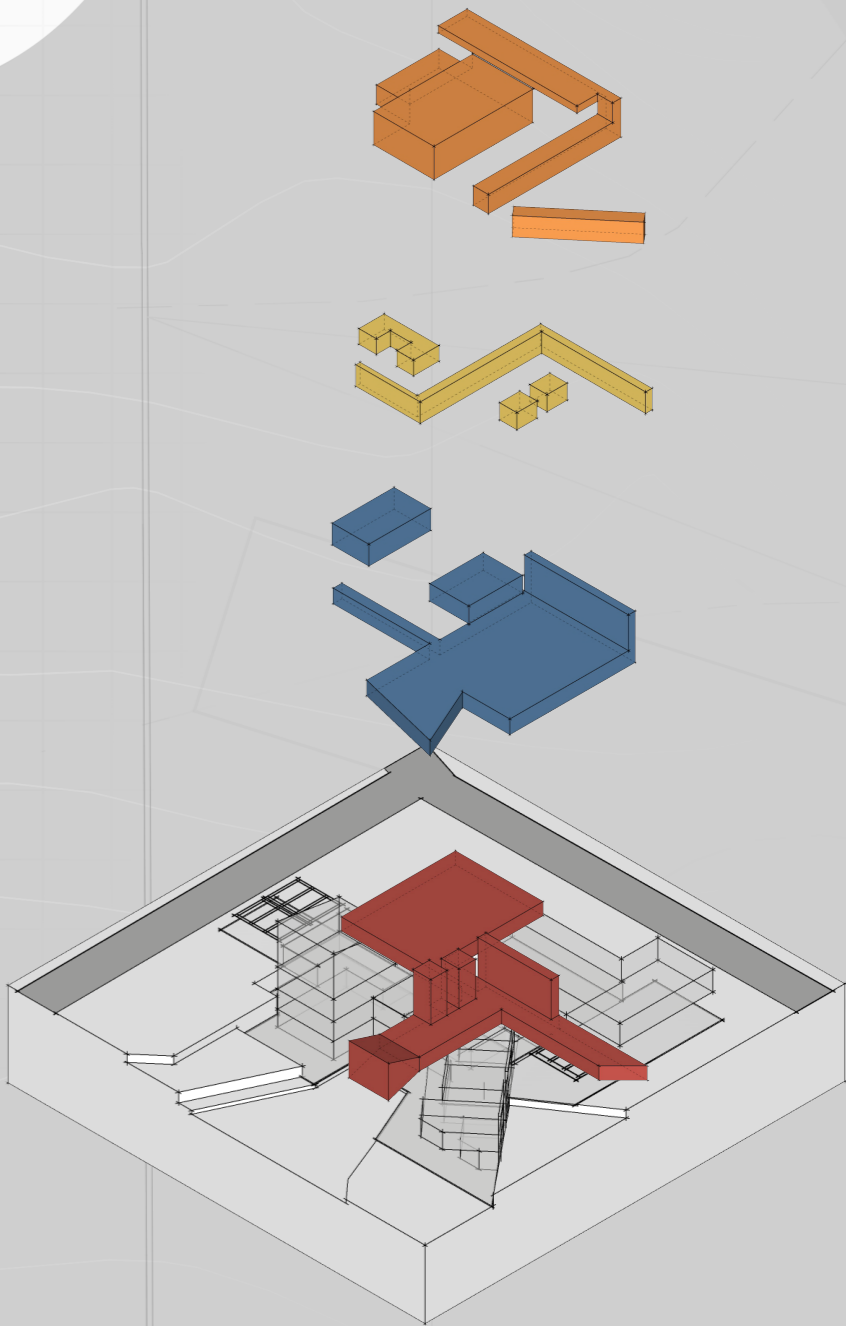
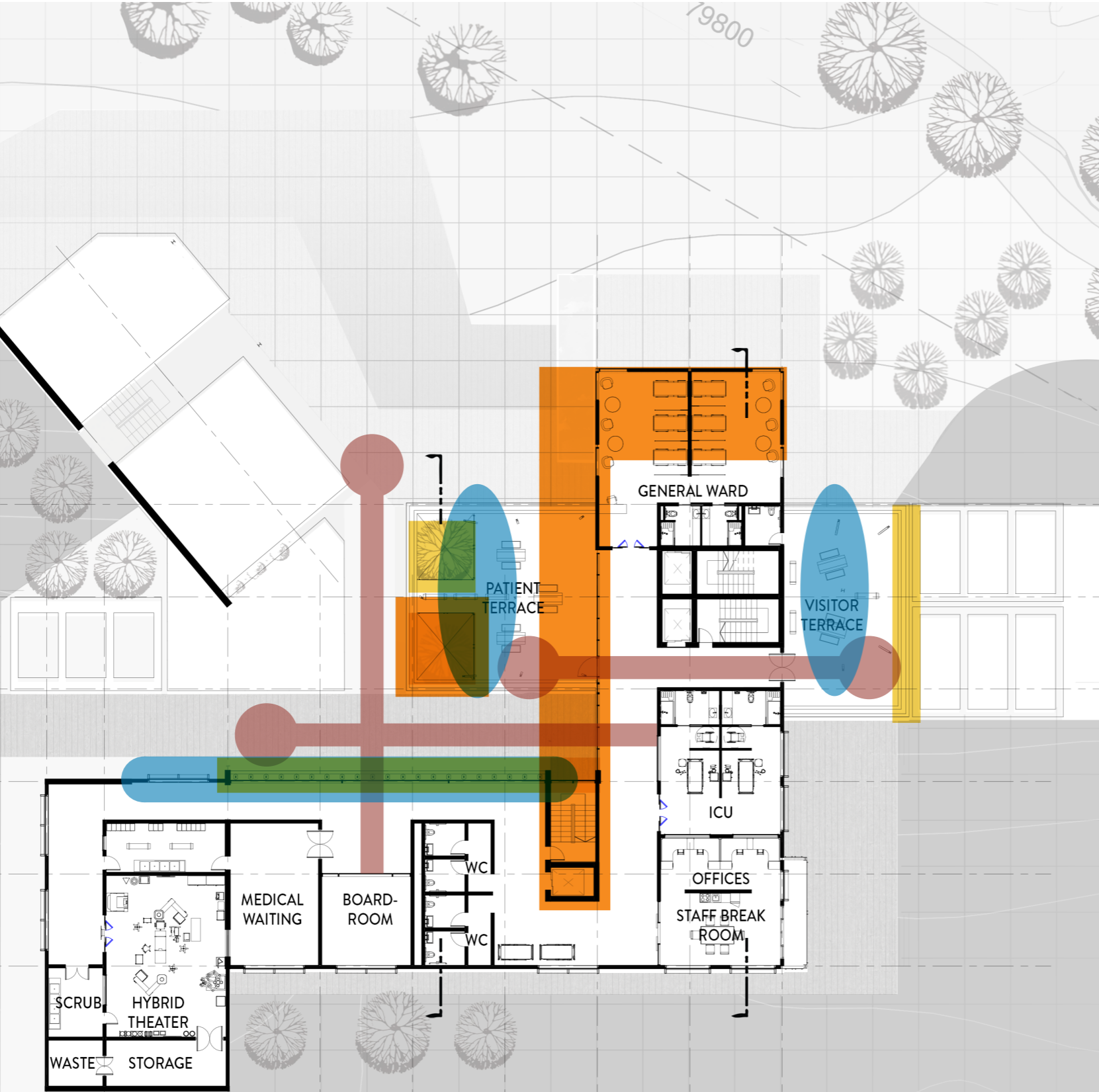


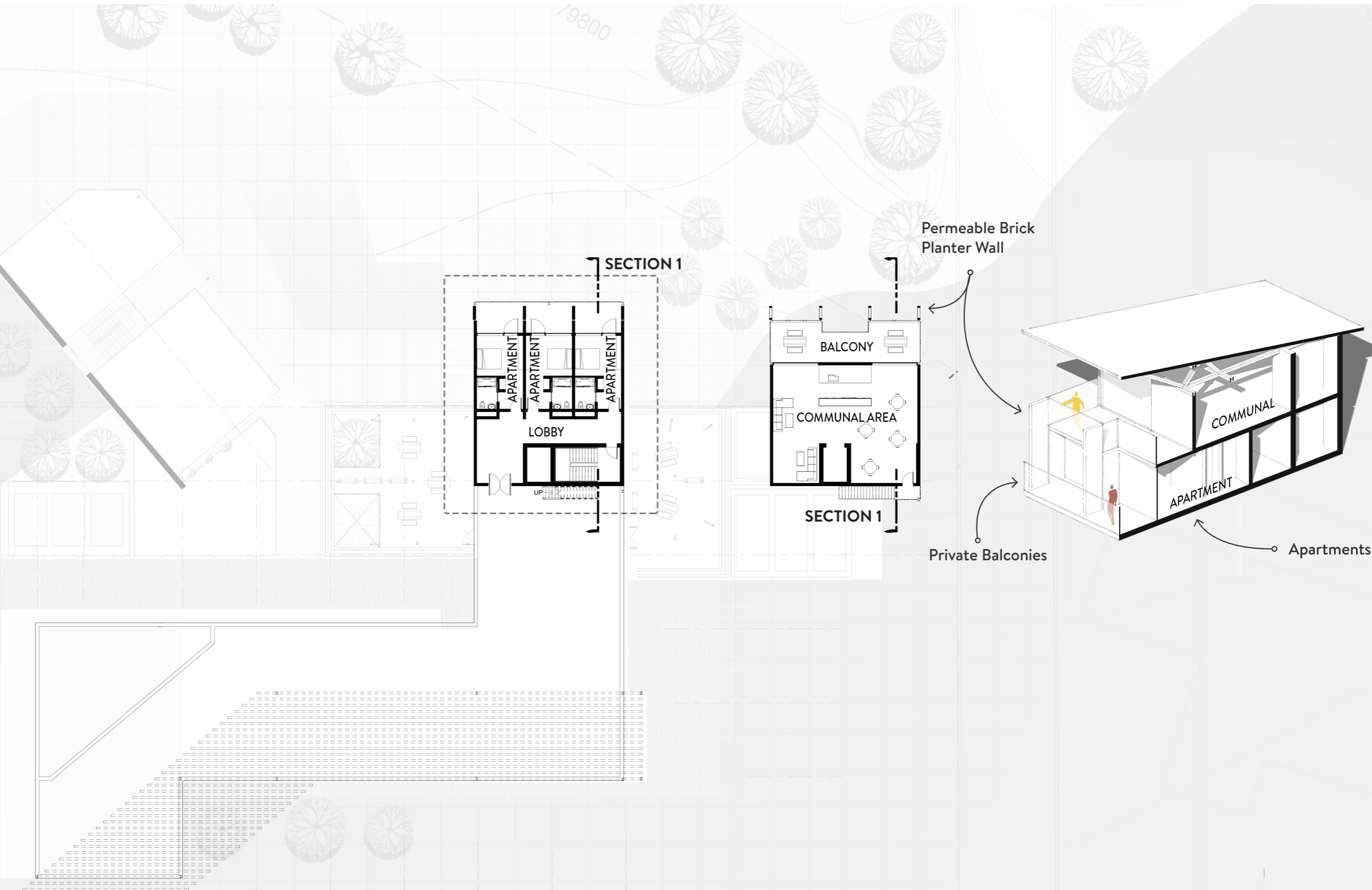
# First Floor Plan

# Strip Section 3



# Research Application





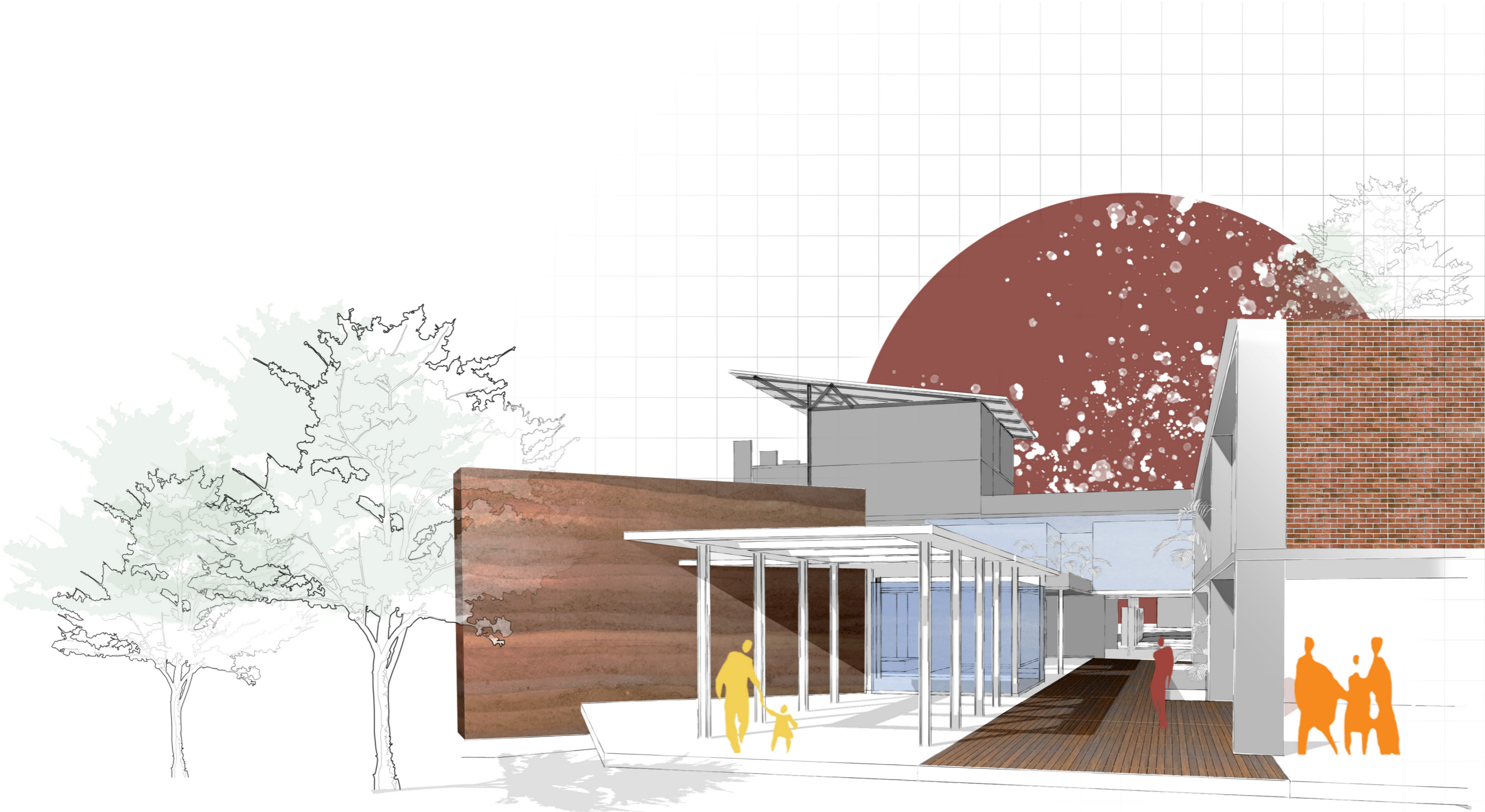
# Section 1



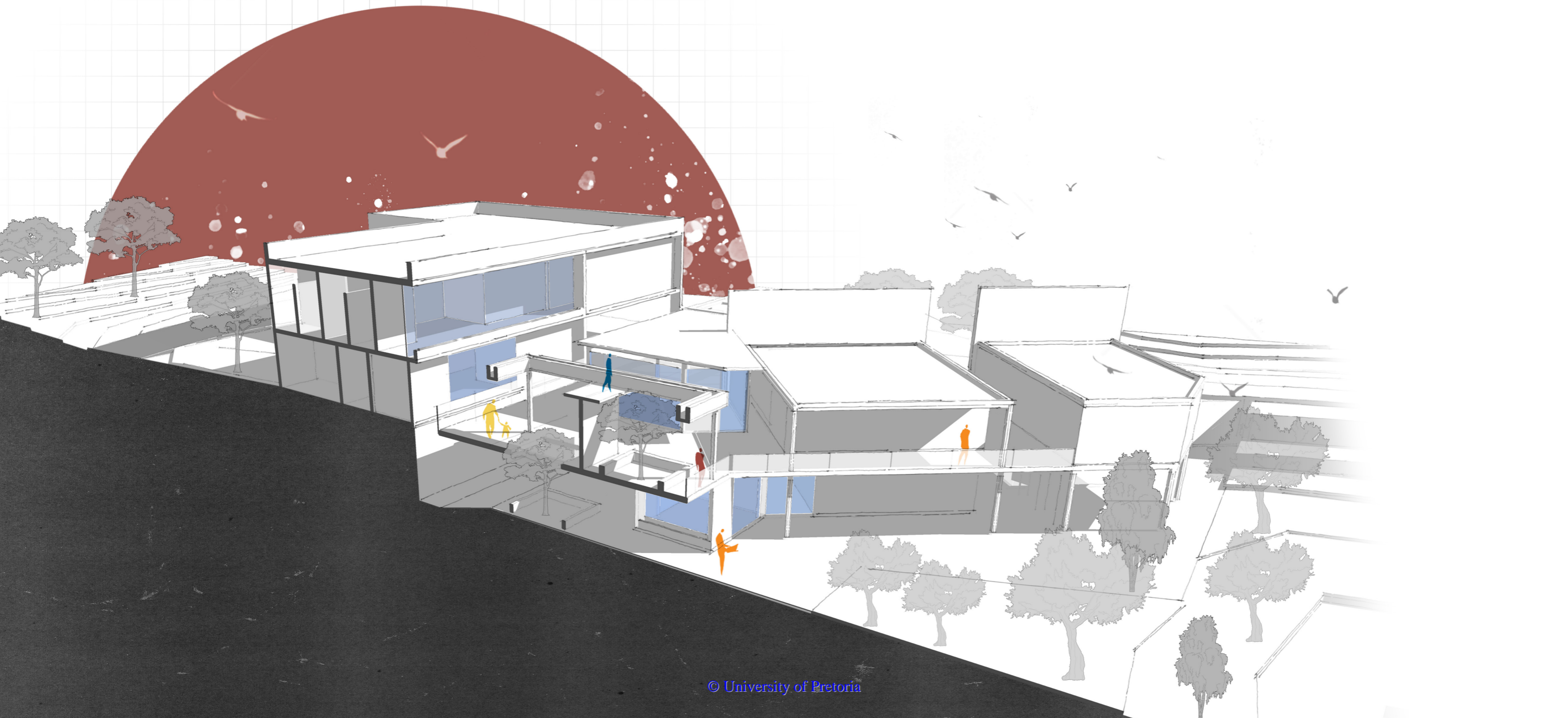
# Section 2



Entrance Perspective



# Sectional Perspective

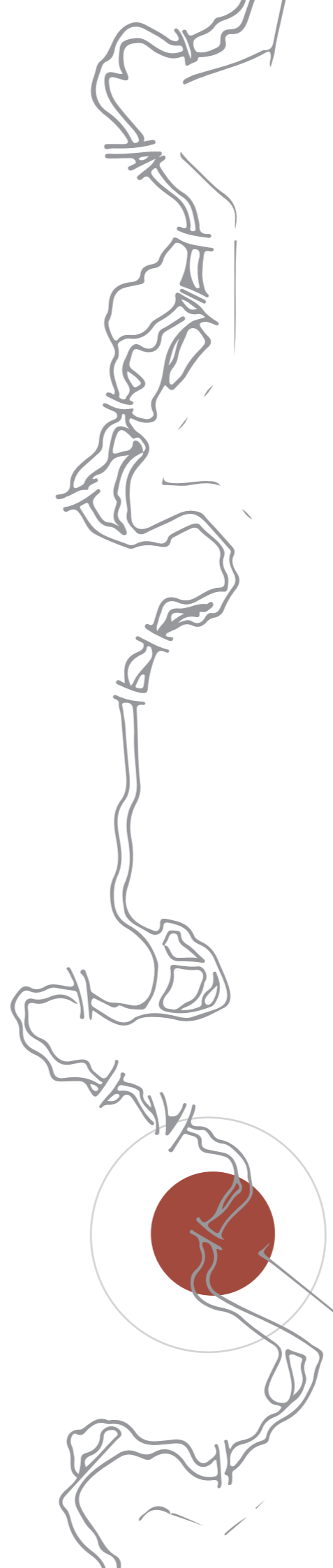




CHAPTER

# 08 Technical Resolution

---



# Site Plan

Scale 1:500 @A1

## Conceptual Application

### Spatial

The building programme becomes more intimate as you move northwards changing from a medical programme to a rehabilitative one. From my research I identified the importance of oscillating the spacial experience. My structure allows the implementation of light wells and atrium to constantly challenge the users spatial perception.

### Material

The Structural, technological and material concept changes from the southern to northern edge of the site as the programme and function allows. The Southern edge has more strict regulatory restrictions for the medical and surgical functions and as you move northwards towards the rehabilitation facility the materiality and structure becomes more honest and less processed.

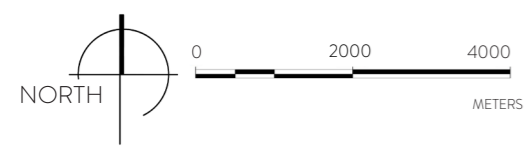
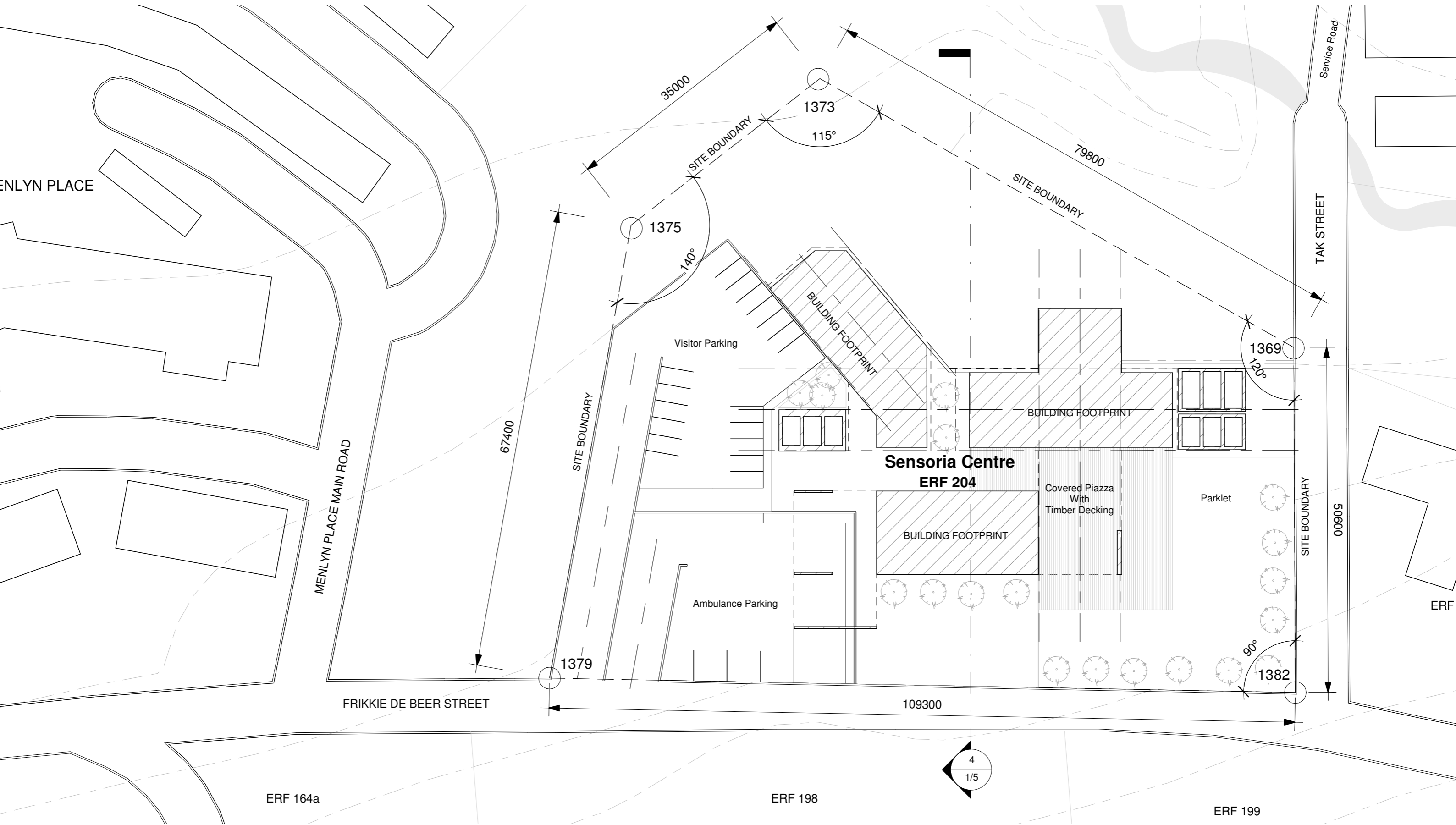
### Environmental

The Programme has strict regulations on the souther edge where the humidity temperature and ventilation needs to be up to medical standards, i want to achieve these goals while adhering to my design concept and research findings by incorporating some natural ventilation and biophilic design principles to contribute to patient wellbeing.



# Site Plan

Scale 1:500 @A1



# Lower Ground Floor Plan

Scale 1:200 @A1

## Programmes

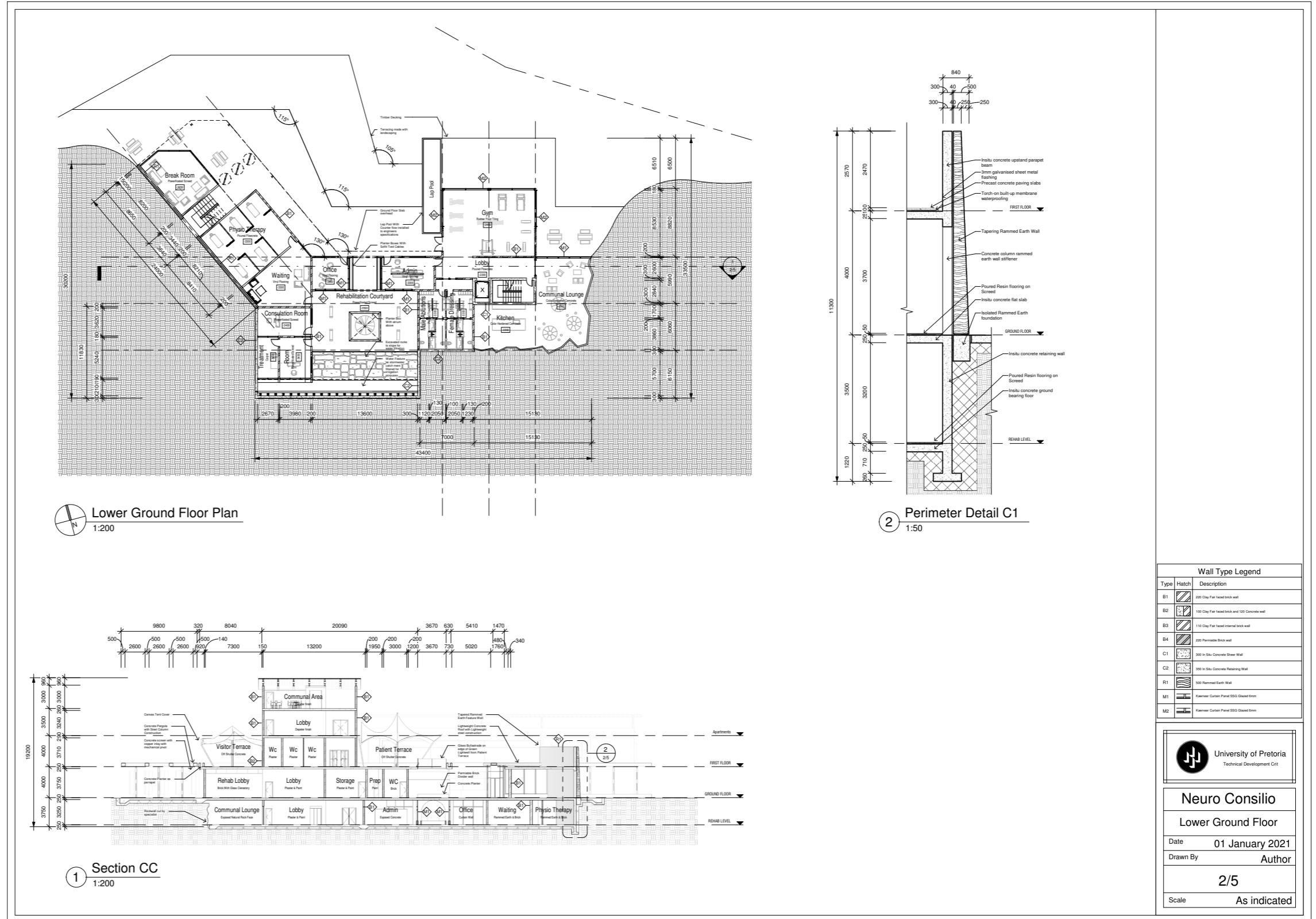
- Consultation,
- Rehab consultation,
- Psychology,
- Physical therapy,
- Physiotherapy,
- Gym,
- Specialised treatment,
- Offices.

## Structure


The southern edge consist mostly of retaining structure with the tectonic becoming lighter as you move northwards with steel columns and cantilevering slabs.

## Environmental

The lower ground floor plan hosts the water catchment services as they water the green wall. The foundations of the rammed earth wall also serves as a thermal barrier for the western edge. The light wells serves as a natural ventilation system promoting stack ventilation in the rehabilitation courtyard.



Wall Type Legend		
Type	Hatch	Description
B1	[Hatch]	120 Clay Far faced brick wall
B2	[Hatch]	100 Clay Far faced brick and 100 Concrete wall
B3	[Hatch]	110 Clay Far faced internal brick wall
B4	[Hatch]	200 Permeable Brick wall
C1	[Hatch]	300 In-Situ Concrete Shear Wall
C2	[Hatch]	300 In-Situ Concrete Retaining Wall
R1	[Hatch]	300 Rammed Earth Wall
M1	[Hatch]	Aluminium Curtain Panel 550 Glazed Form
M2	[Hatch]	Aluminium Curtain Panel 550 Glazed Form


**University of Pretoria**  
 Technical Development Unit

---

**Neuro Consilio**  
 Lower Ground Floor

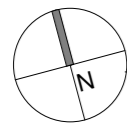
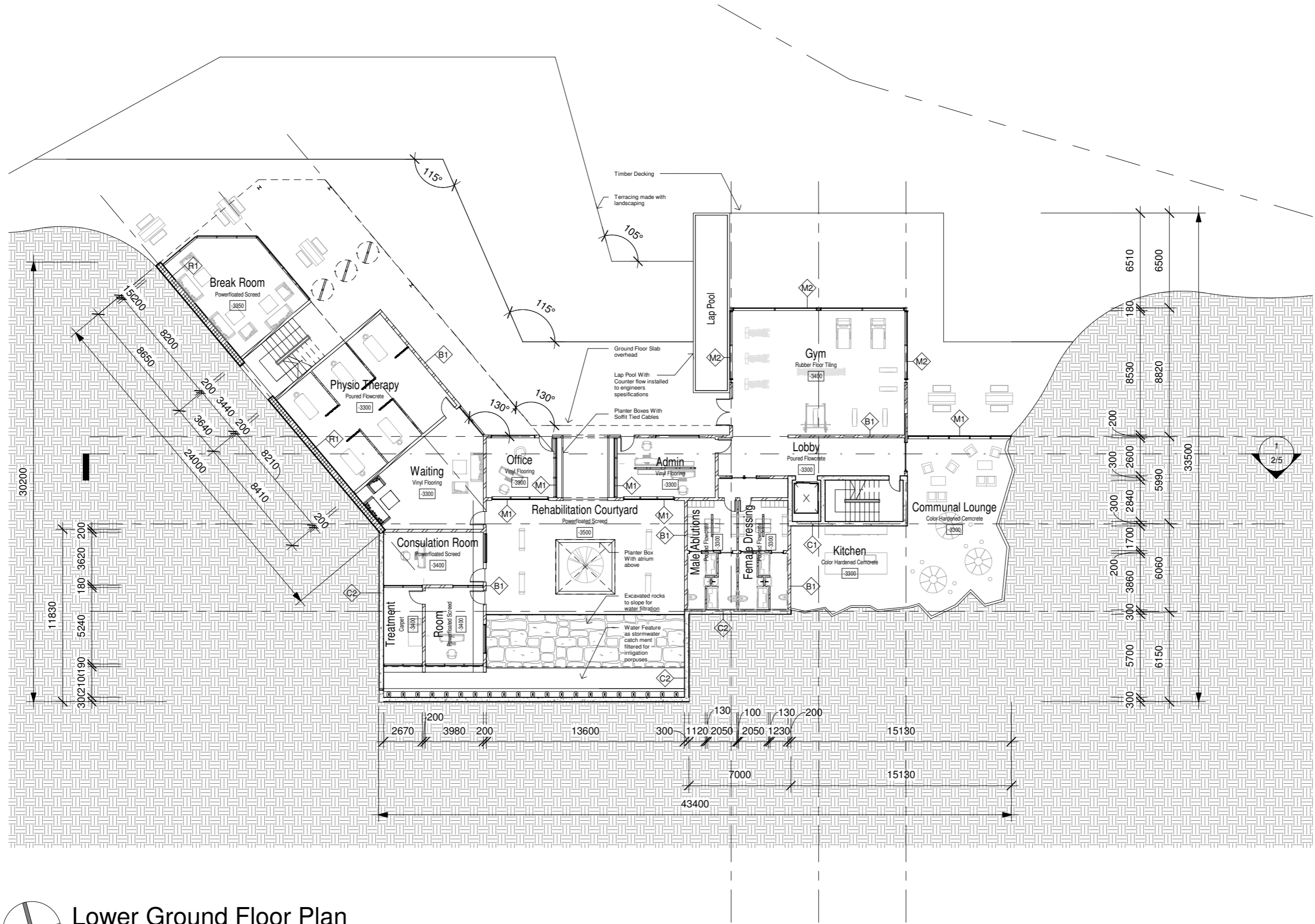
Date: 01 January 2021  
 Drawn By: Author

---

2/5  
 Scale: As indicated

# Lower Ground Floor Plan

Scale 1:



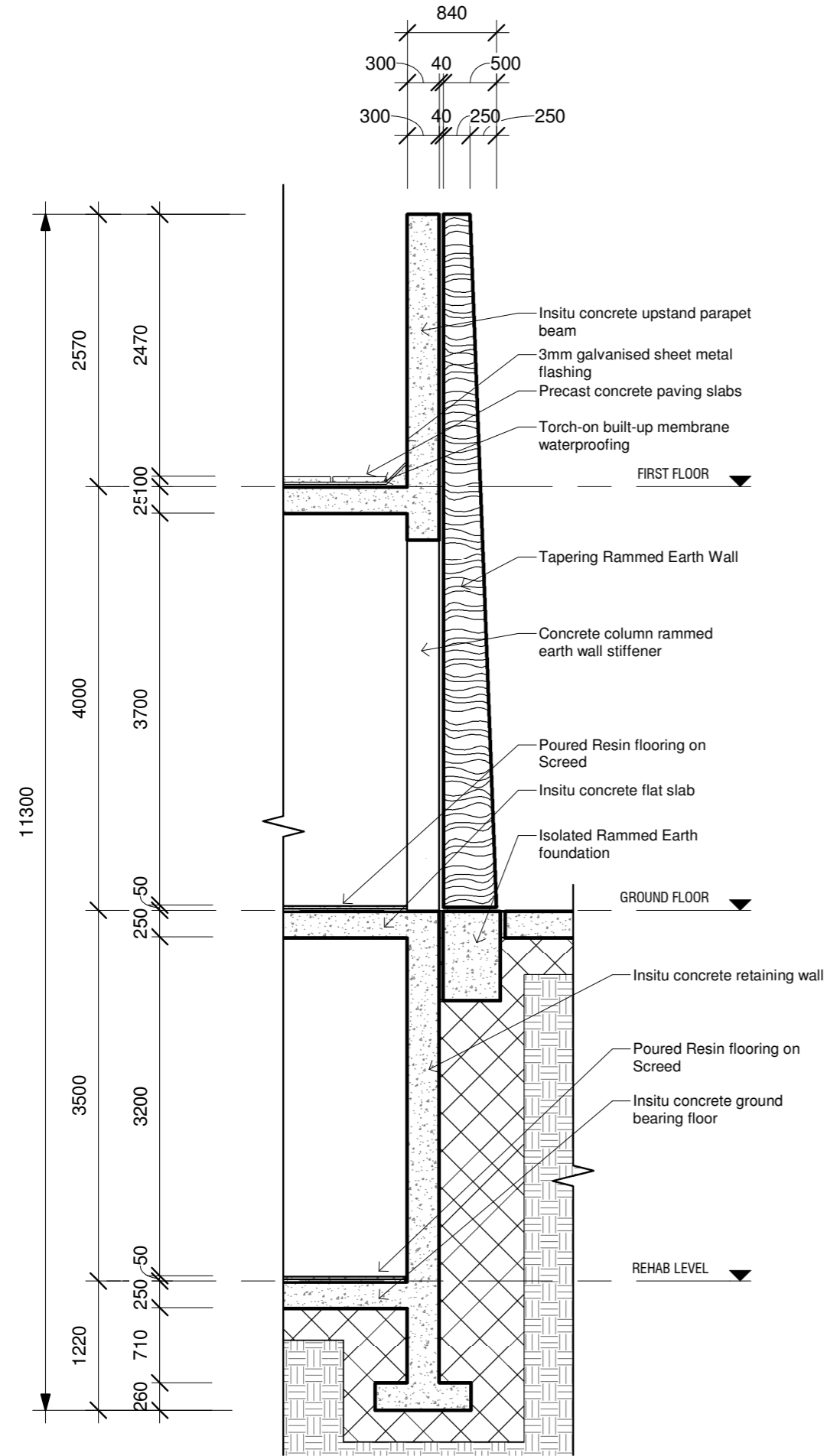
## Lower Ground Floor Plan

1:200



# Perimeter Detail C1

Scale 1:50 @A1

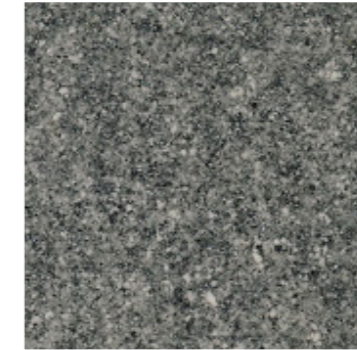


# Material Palette

Rammed Earth



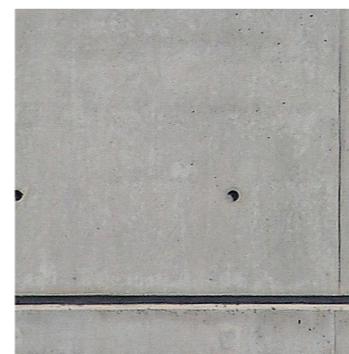
Poured Epoxy



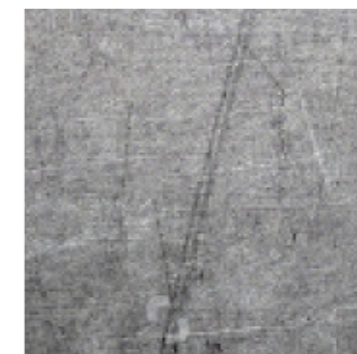
Asphalt



Off shutter concrete



Steel

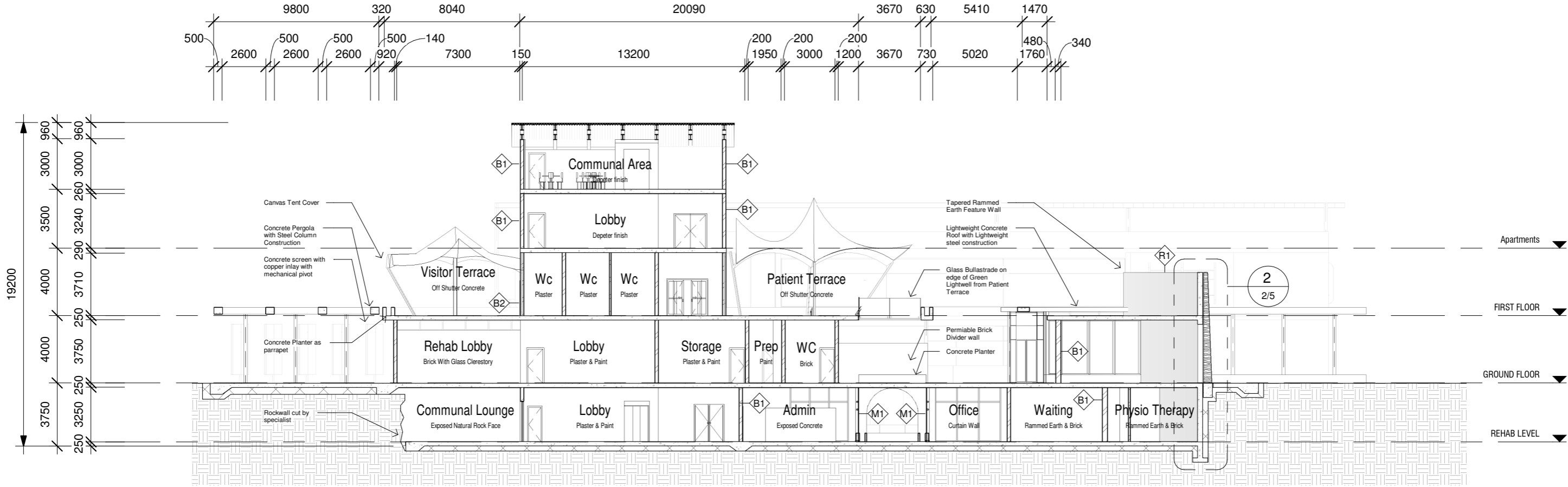


Rough Plaster



# Section CC

Scale 1:200 @A1



# Ground Floor Plan

Scale 1:200 @A1

## Programmes

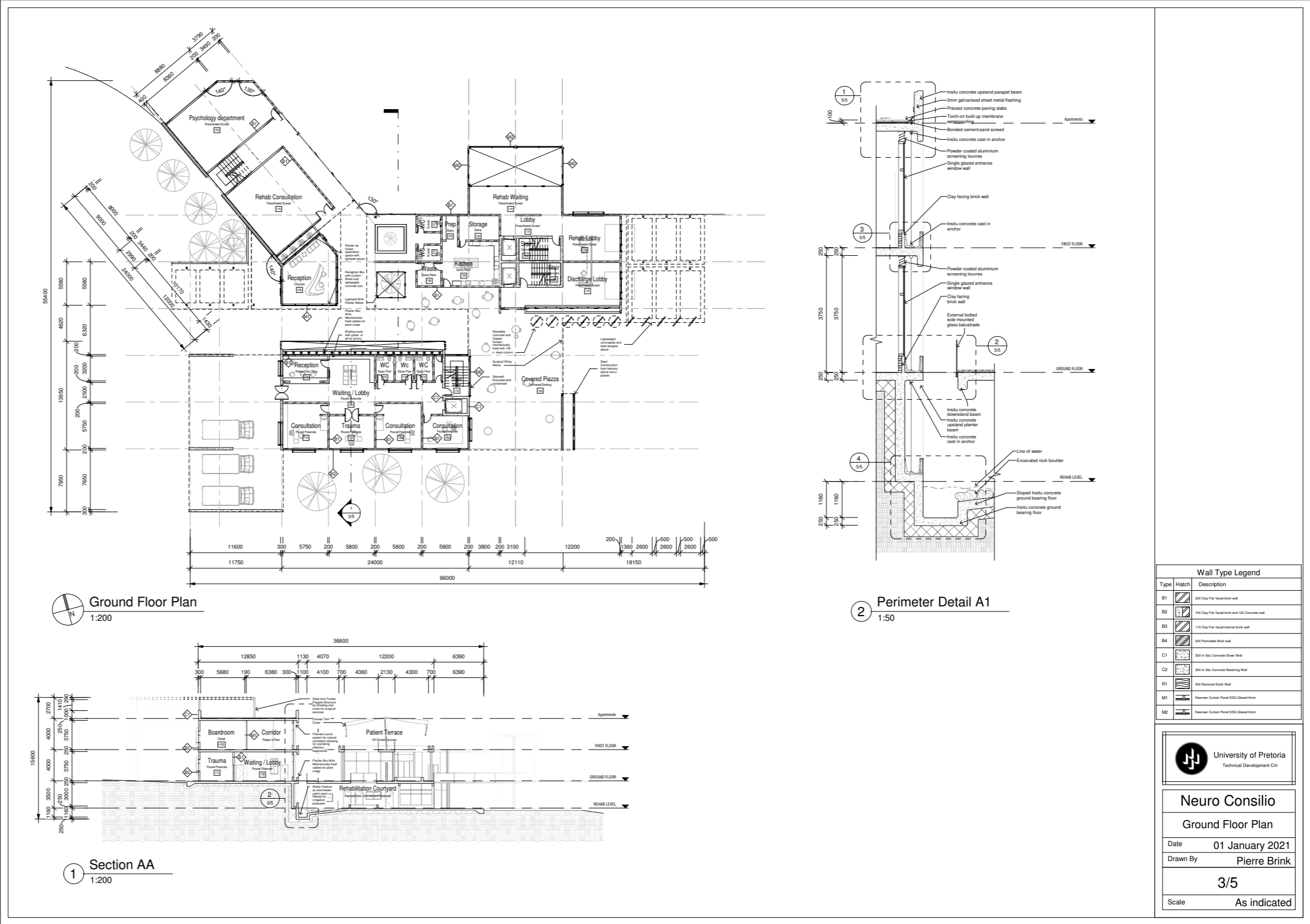
- Reception,
- Consultation,
- Rehab consultation,
- Psychology,
- Restaurant,
- Medical discharge,

## Structure

The structure has a gradient shift from north to south with the southern structure supporting the medical wing above and the courtyard typology northwards has steel structure and less load bearing walls.

## Environmental

The building orientation and height are optimised to promote natural ventilation and sun exposure to reduce the amount of mechanical cooling and heating needed.




Ground Floor Plan  
1:200

Section AA  
1:200

Perimeter Detail A1  
1:50

Wall Type Legend		
Type	Hatch	Description
B1	[Hatch]	100 Clay Face brick wall
B2	[Hatch]	100 Clay Face brick and 100 Concrete wall
B3	[Hatch]	110 Clay Face internal brick wall
B4	[Hatch]	200 Permeable Brick wall
C1	[Hatch]	100 In Situ Concrete Shear Wall
C2	[Hatch]	100 In Situ Concrete Retaining Wall
R1	[Hatch]	100 Reinforced Earth Wall
M1	[Hatch]	Aluminium Curtain Panel 550 Glazed 5mm
M2	[Hatch]	Aluminium Curtain Panel 550 Glazed 6mm


**University of Pretoria**  
 Technical Development Cell

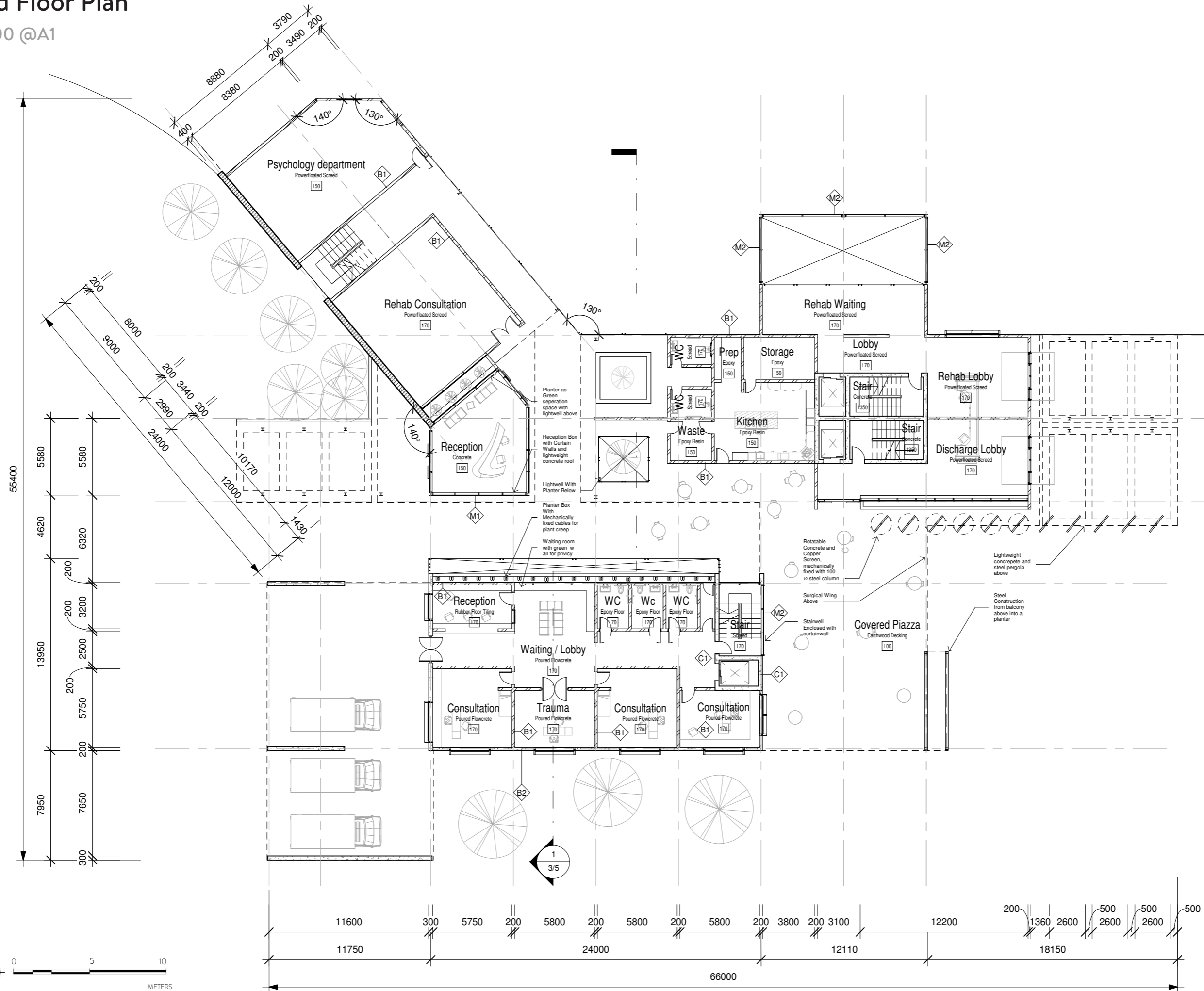
**Neuro Consilio**  
 Ground Floor Plan

Date: 01 January 2021  
 Drawn By: Pierre Brink

3/5  
 Scale: As indicated

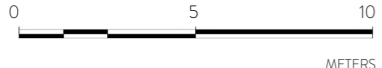
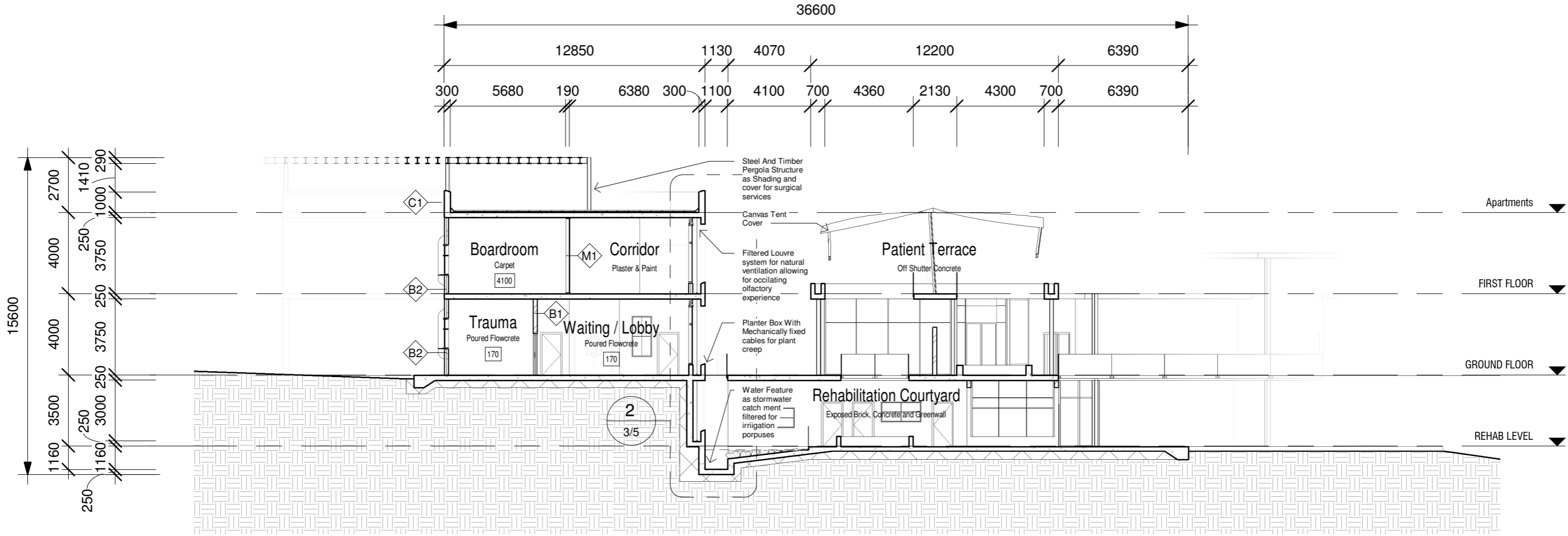
# Ground Floor Plan

Scale 1:200 @A1



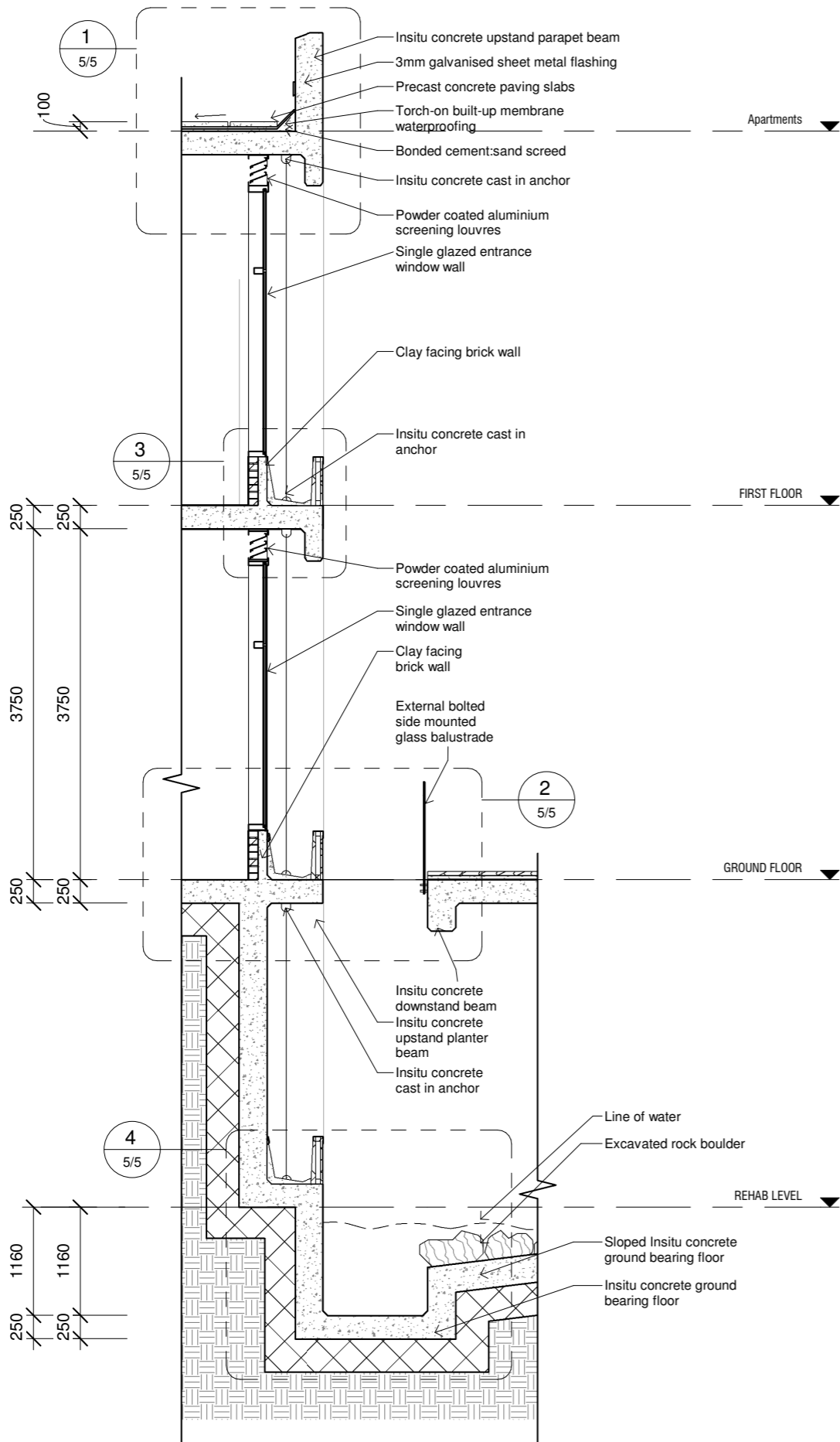
# Section AA

Scale 1:200 @A1



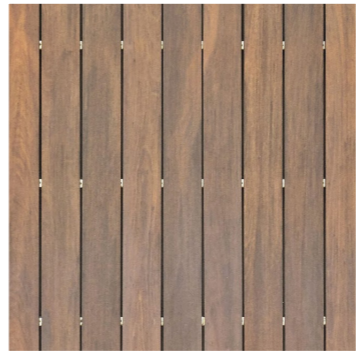
# Perimeter Detail A1

Scale 1:50 @A1

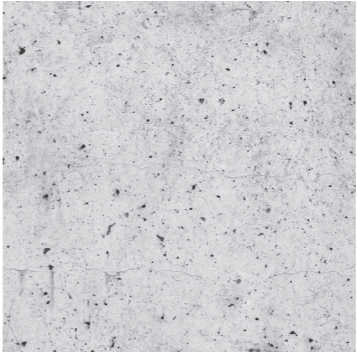


# Material Palette

Composite Timber Deck



Cast in-situ Concrete



Rubber Surgical Floors



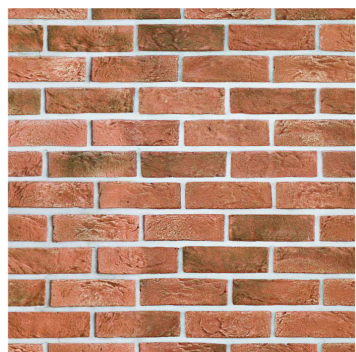
Excavated Rock



Pre Cast Pavers



Brick



# First Floor Plan

## Programmes

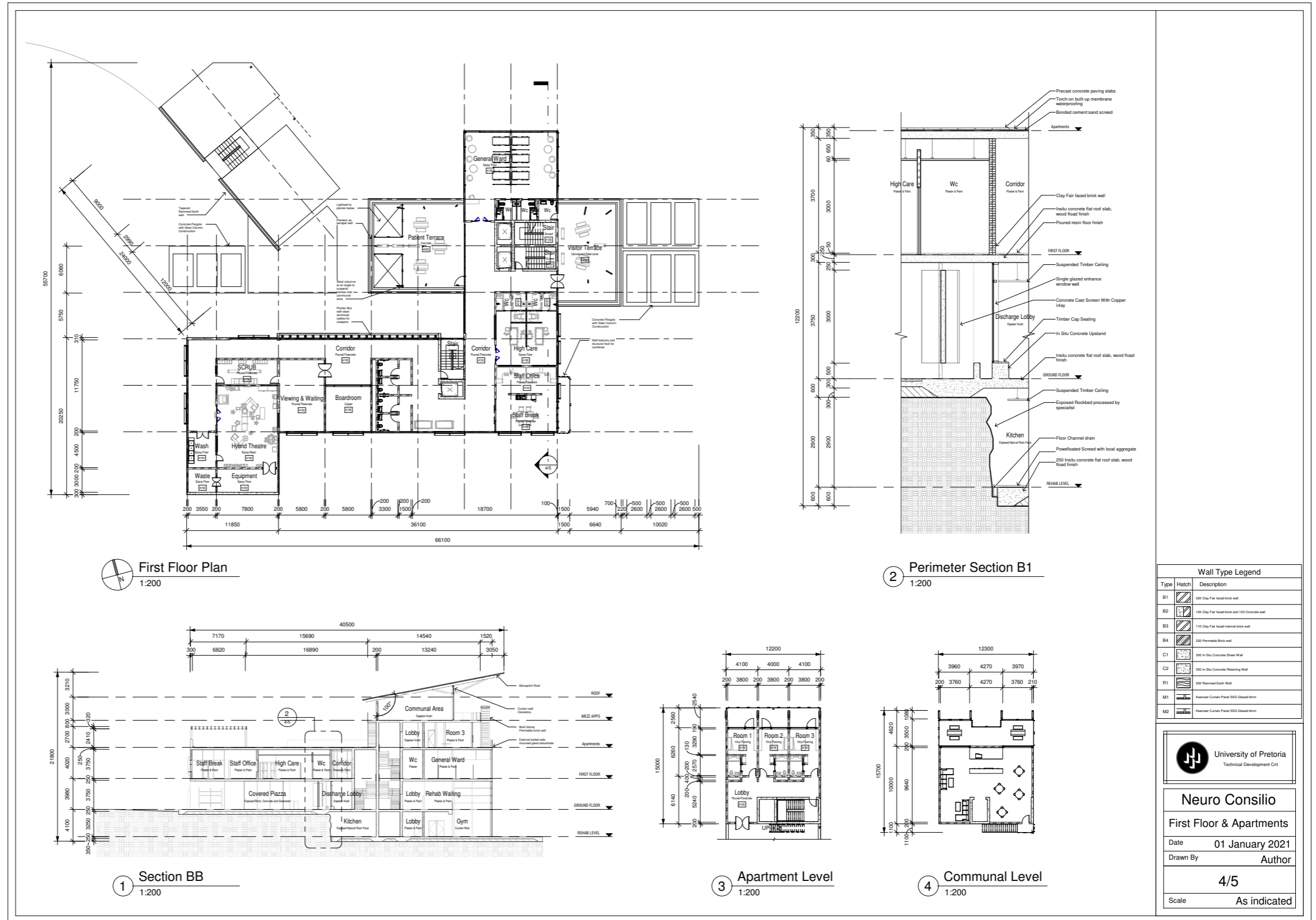
- Surgical theatre,
- Offices,
- Intensive care,
- Boardroom
- Staff amenities
- Visitor areas, and
- General ward.

## Structure

The materiality implemented in the medical wing is designated and modeled after R158 - Labour Administration Recommendation, 1978 (No. 158) guidelines for medical facilities. This is to ensure clinical design and compliance.

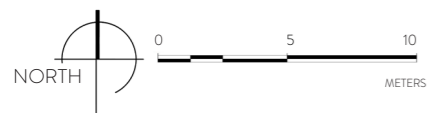
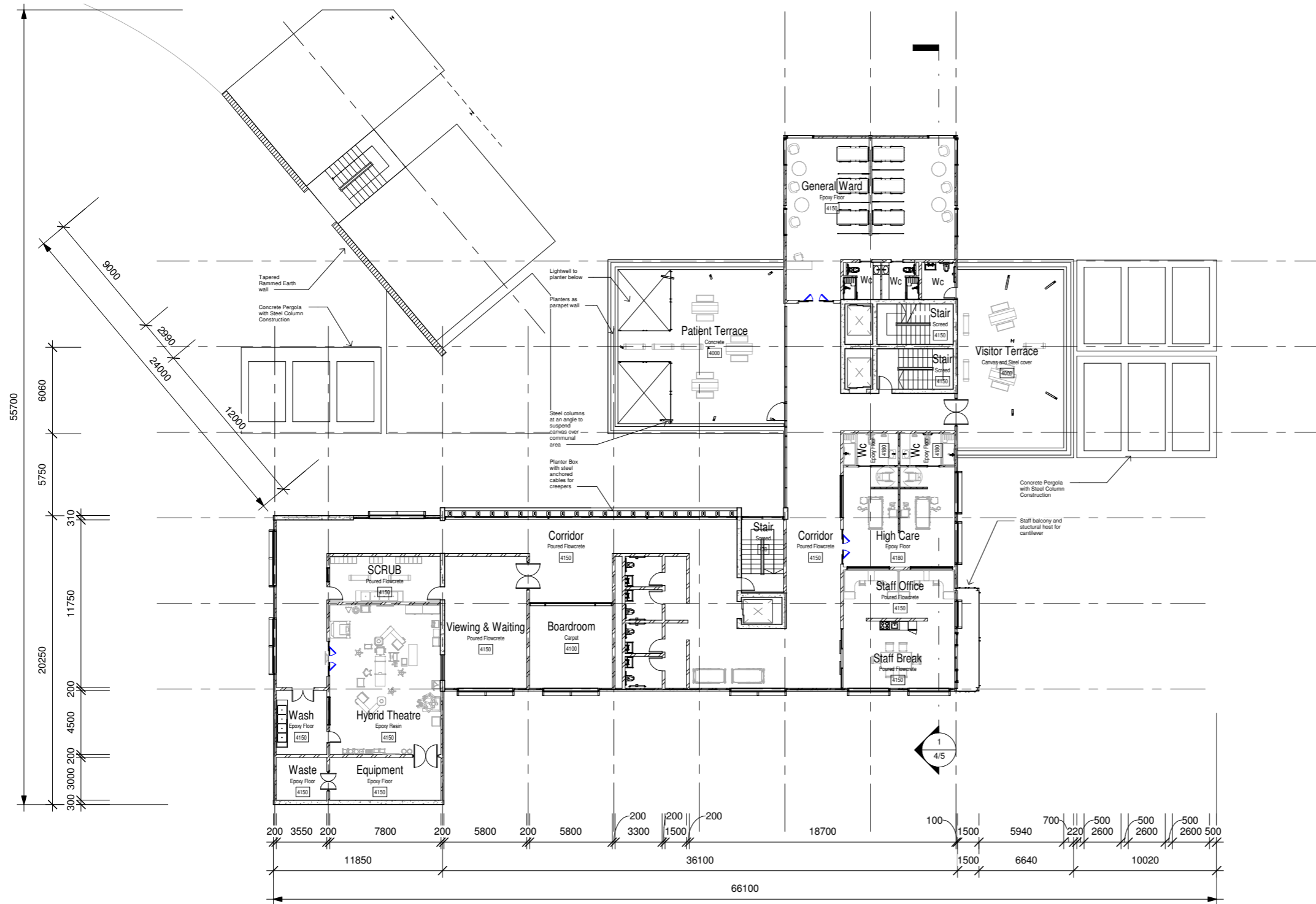
## Environmental

The introduction of filtered cross ventilation and a linear hospital typology not only reduces the mechanical ventilation costs but reduces viral transmissions as well.



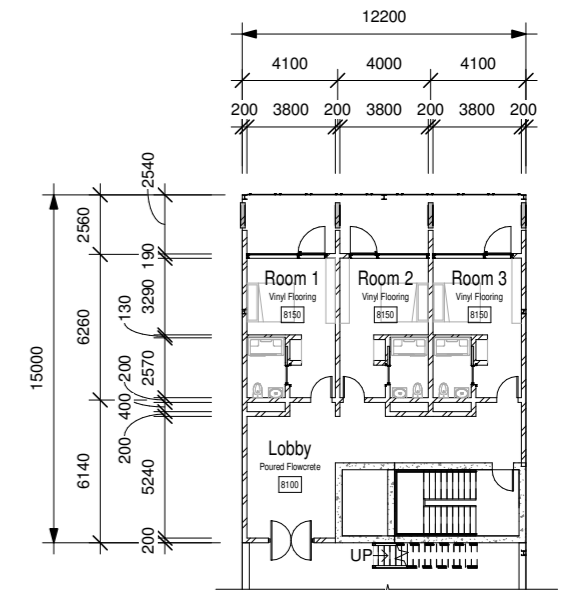
# First Floor Plan

Scale 1:200 @A1



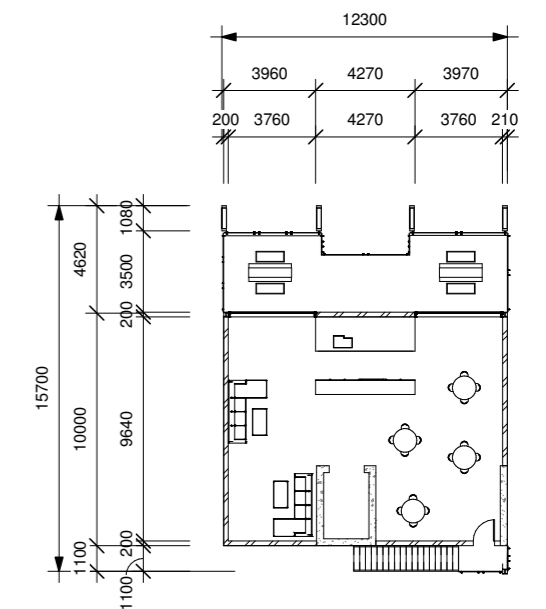
# Apartment L01

Scale 1:200 @A1



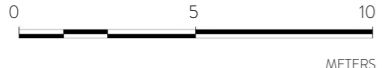
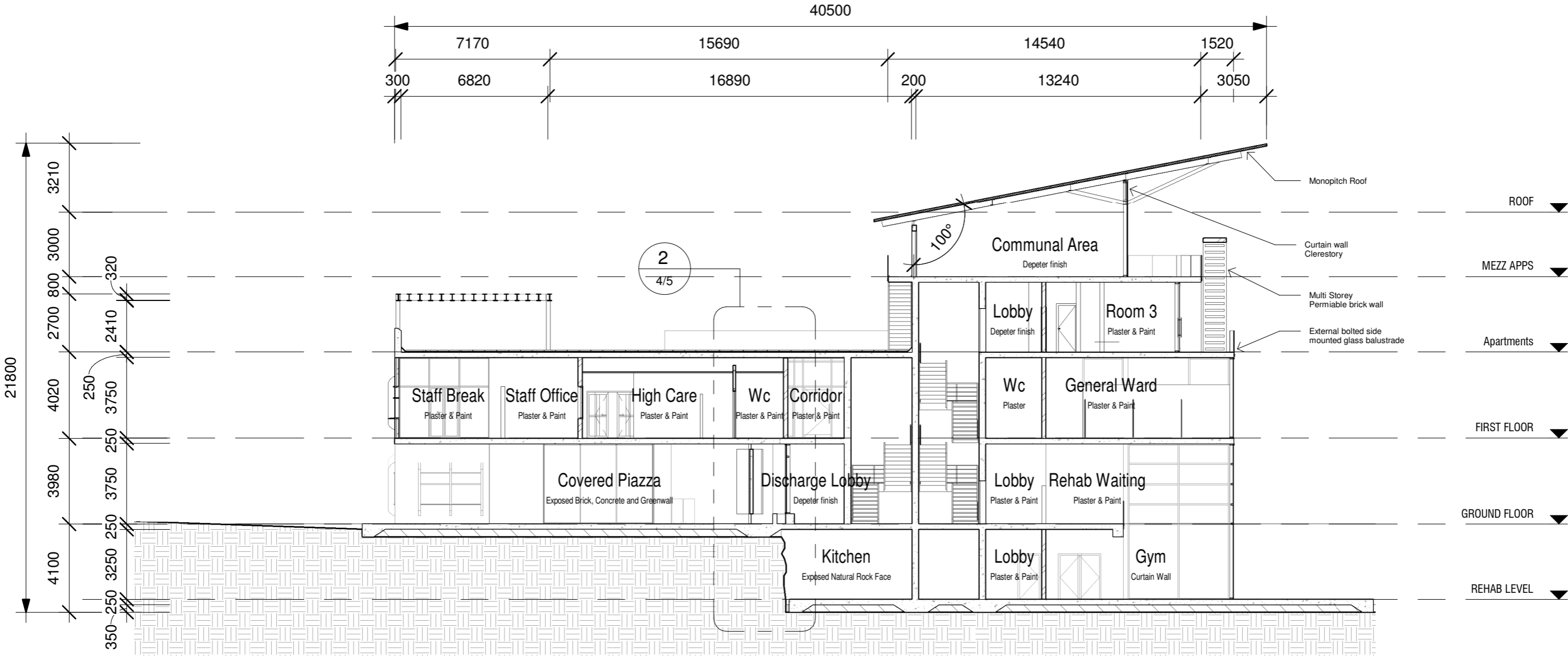
# Apartment L02

Scale 1:200 @A1



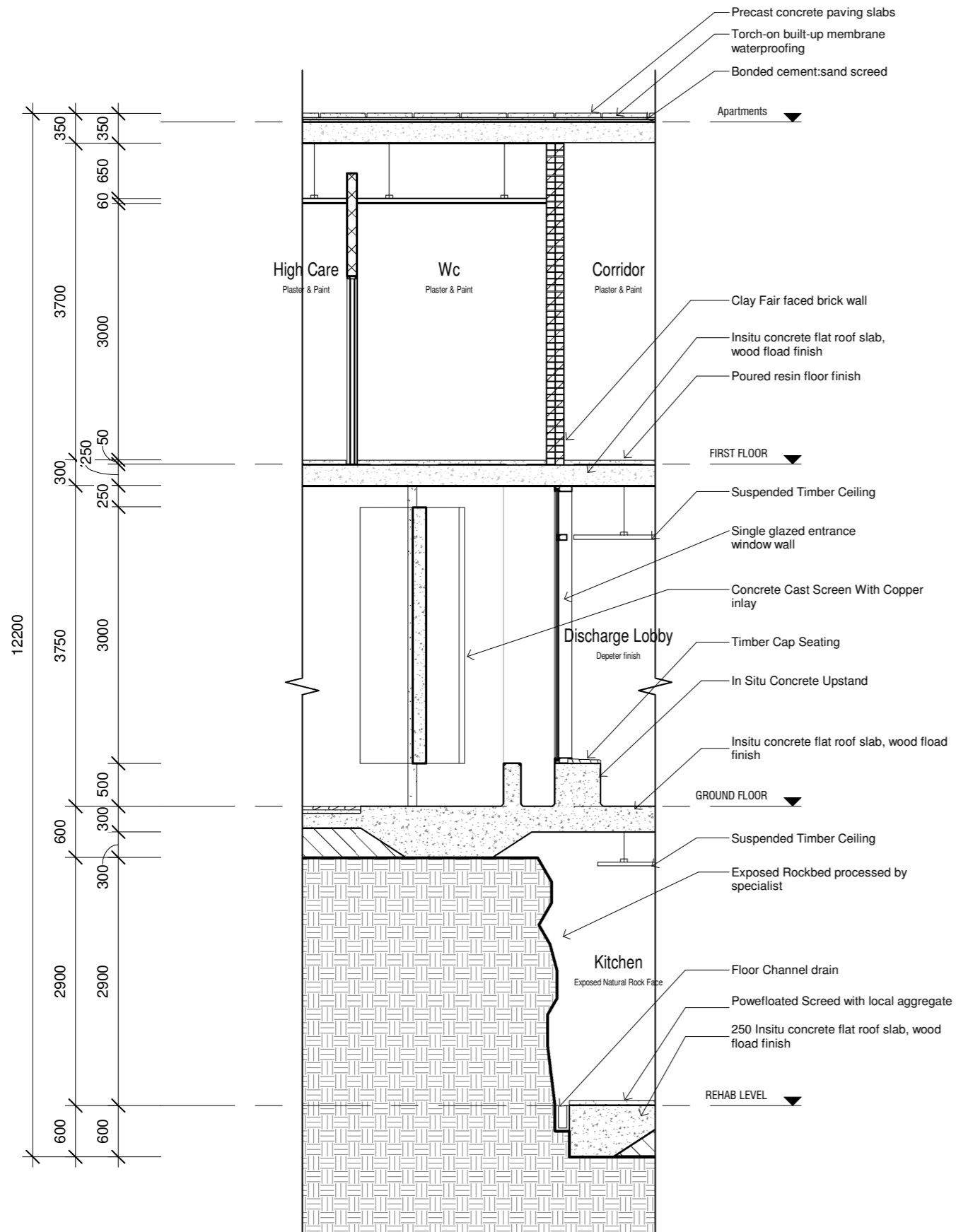
# Section BB

Scale 1:200 @A1



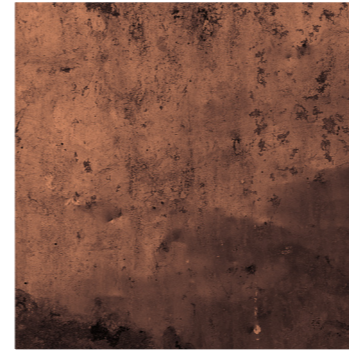
# Perimeter Detail B1

Scale 1:50 @A1

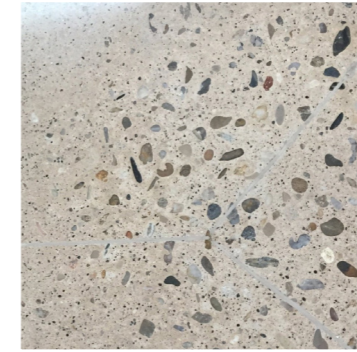


# Material Palette

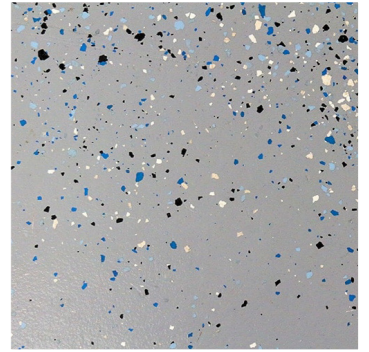
Copper



Textured Screed



Tarkett Vinyl



Composite Timber Deck



Pre Cast Pavers



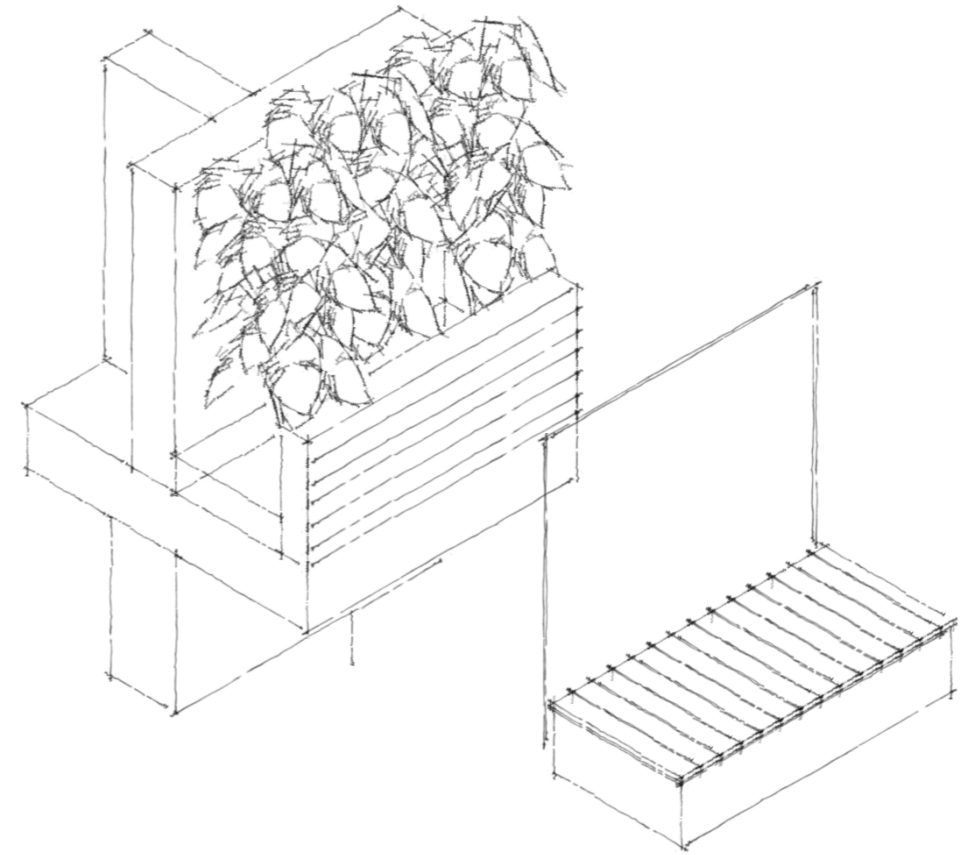
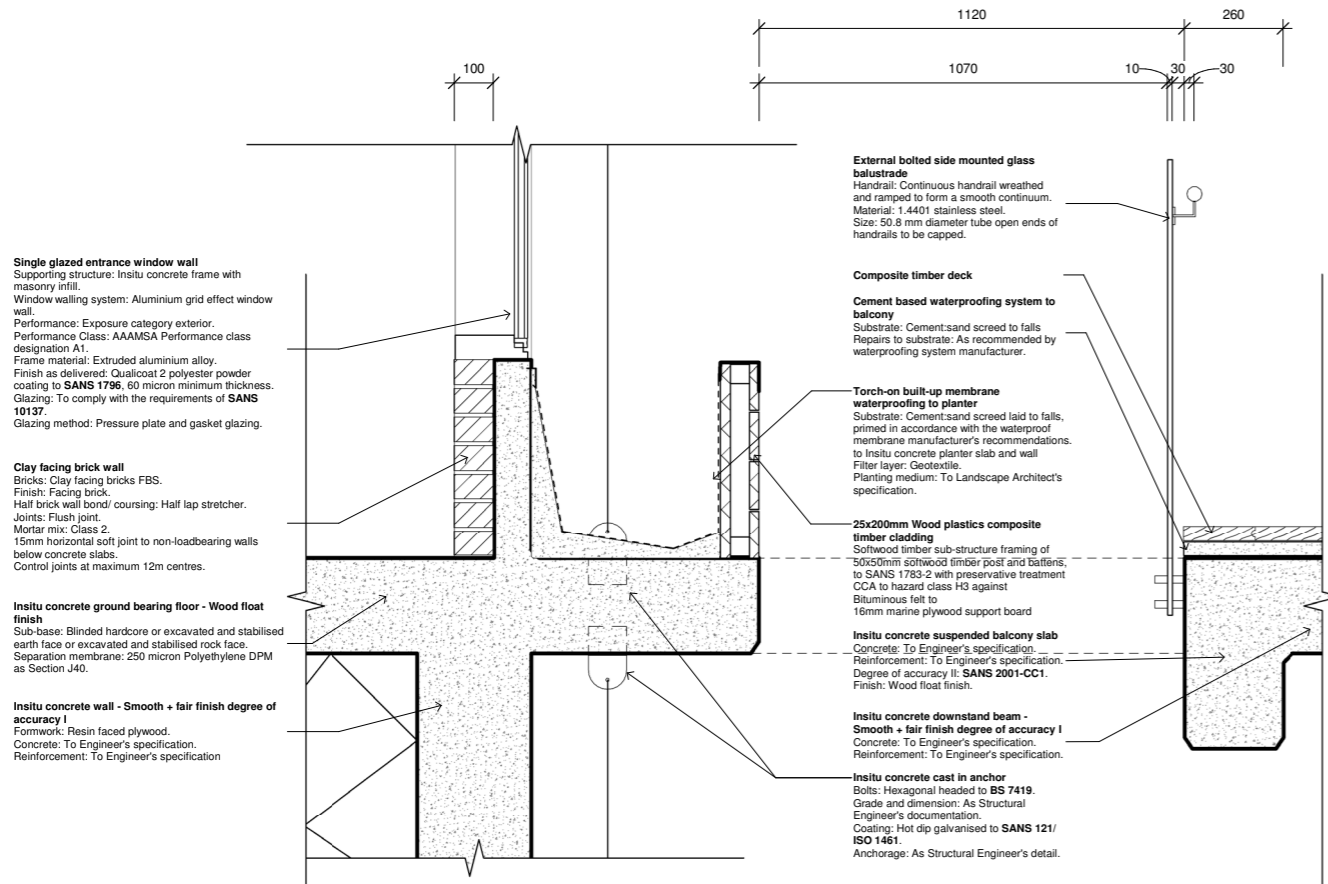
Teak Ceilings Strips



# Detail 1

Scale 1:20 @A1

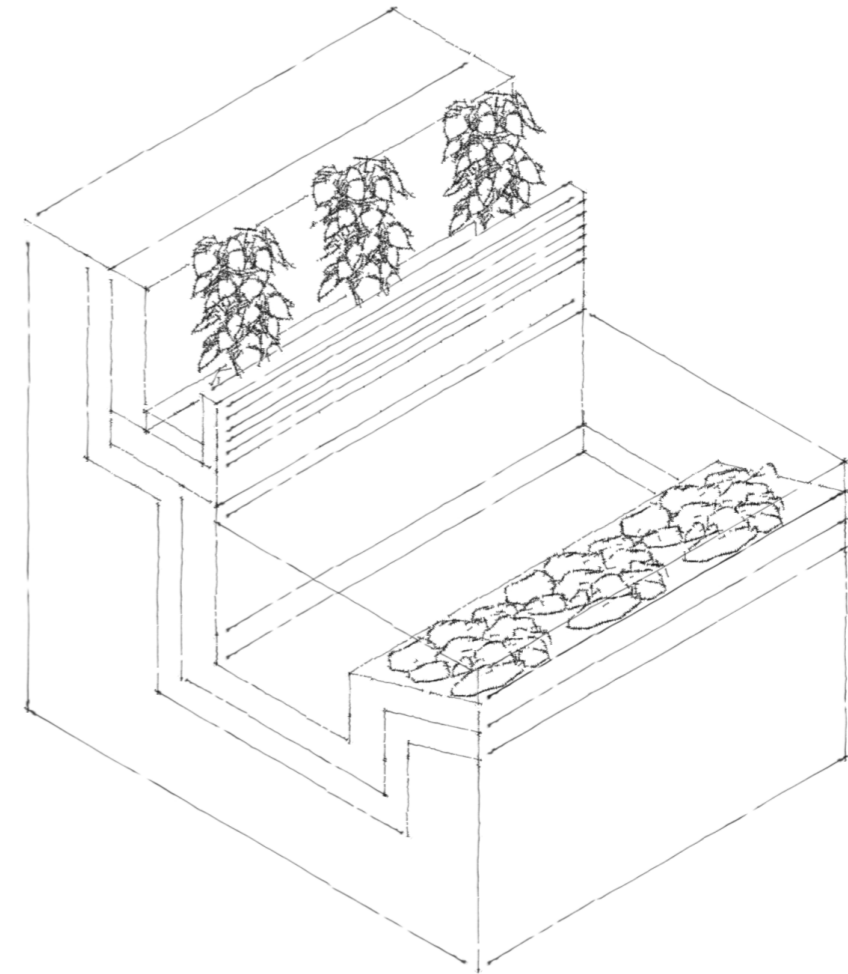
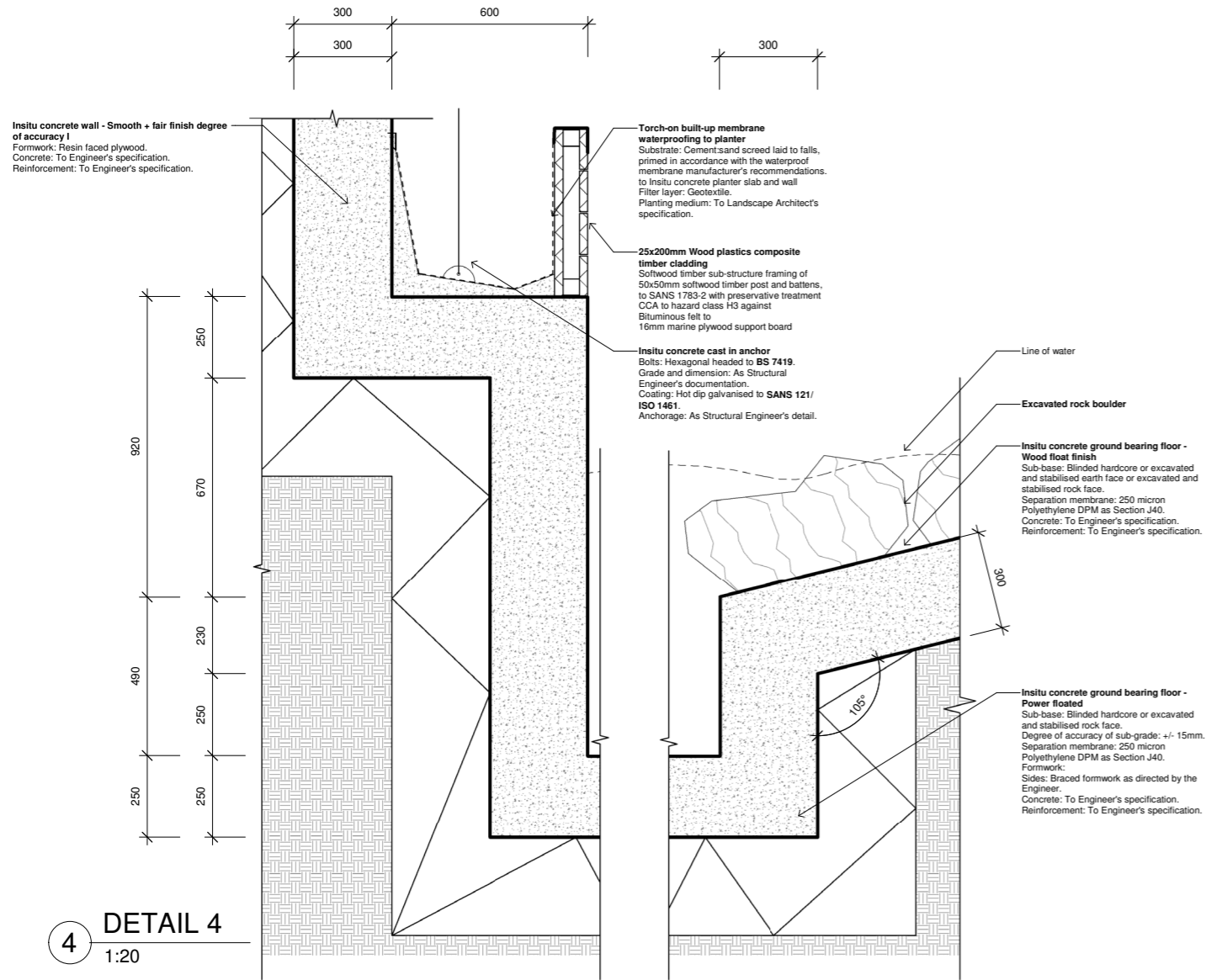
# Isometric Concept



# Detail 2

Scale 1:20 @A1

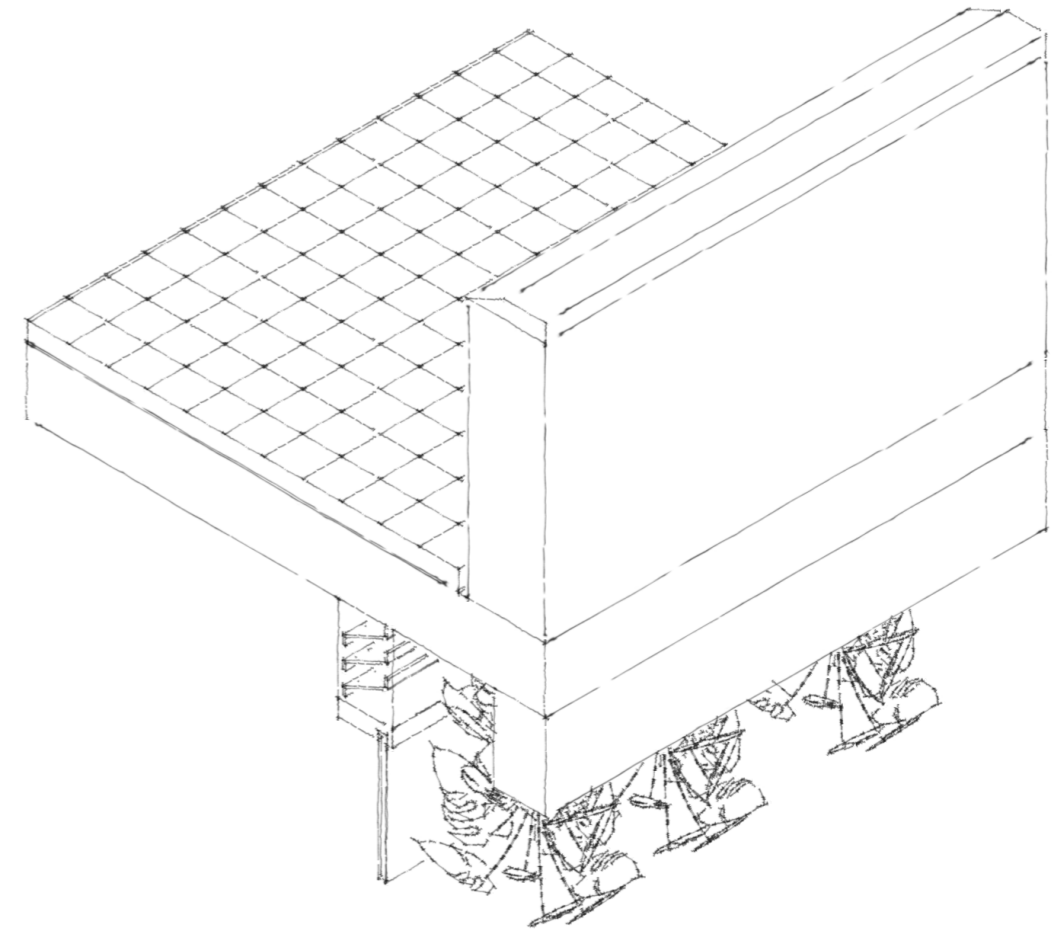
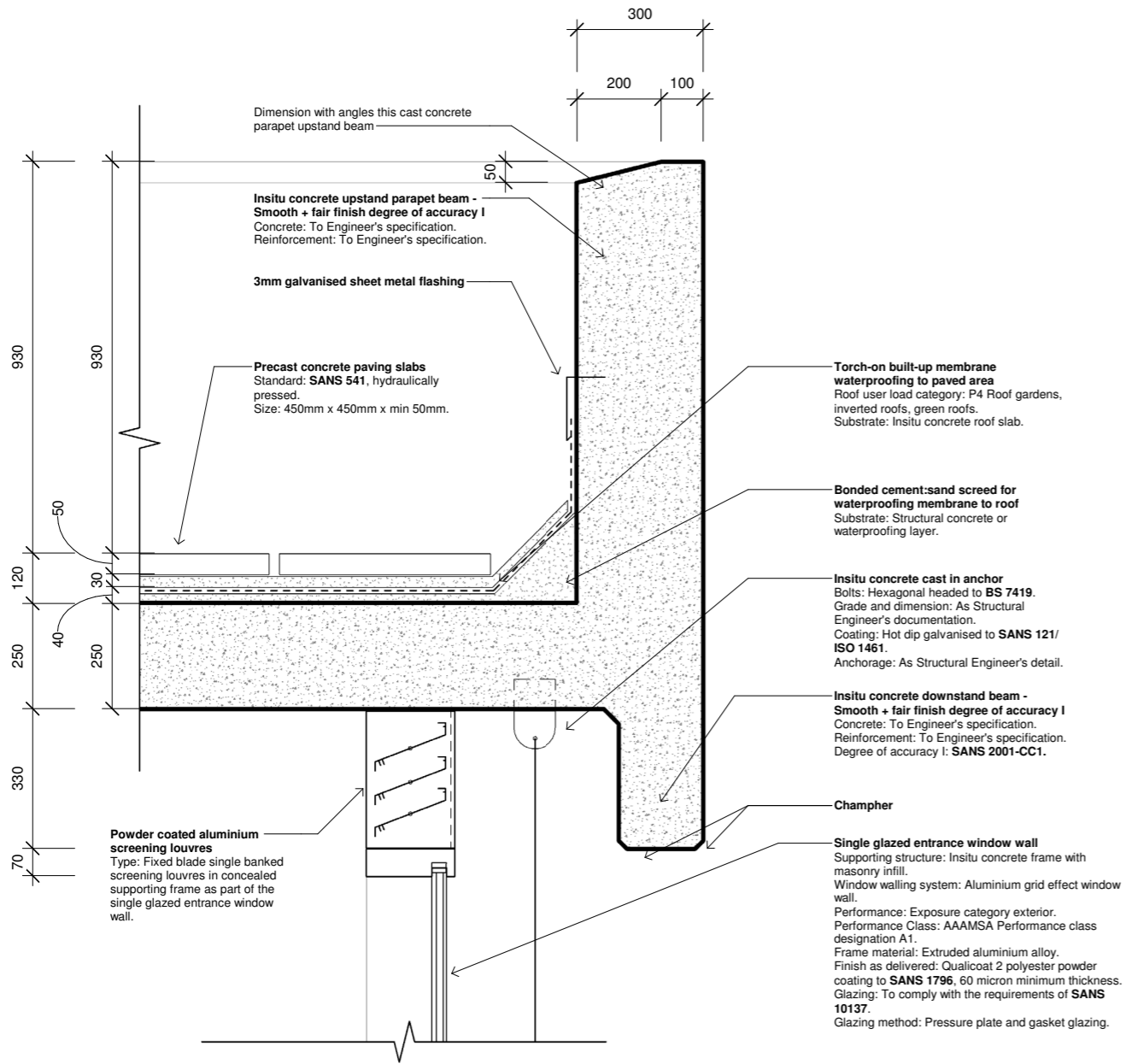
# Isometric Concept



# Detail 3

Scale 1:20 @A1

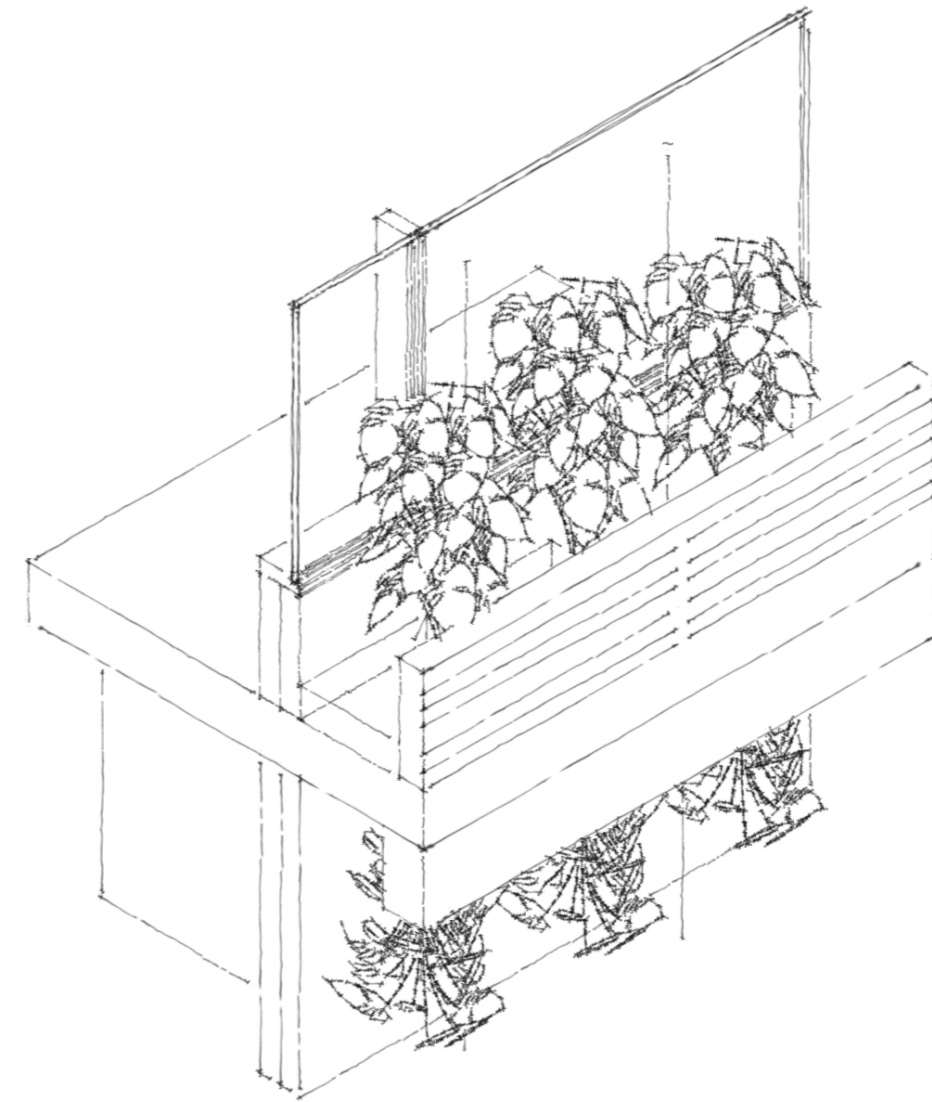
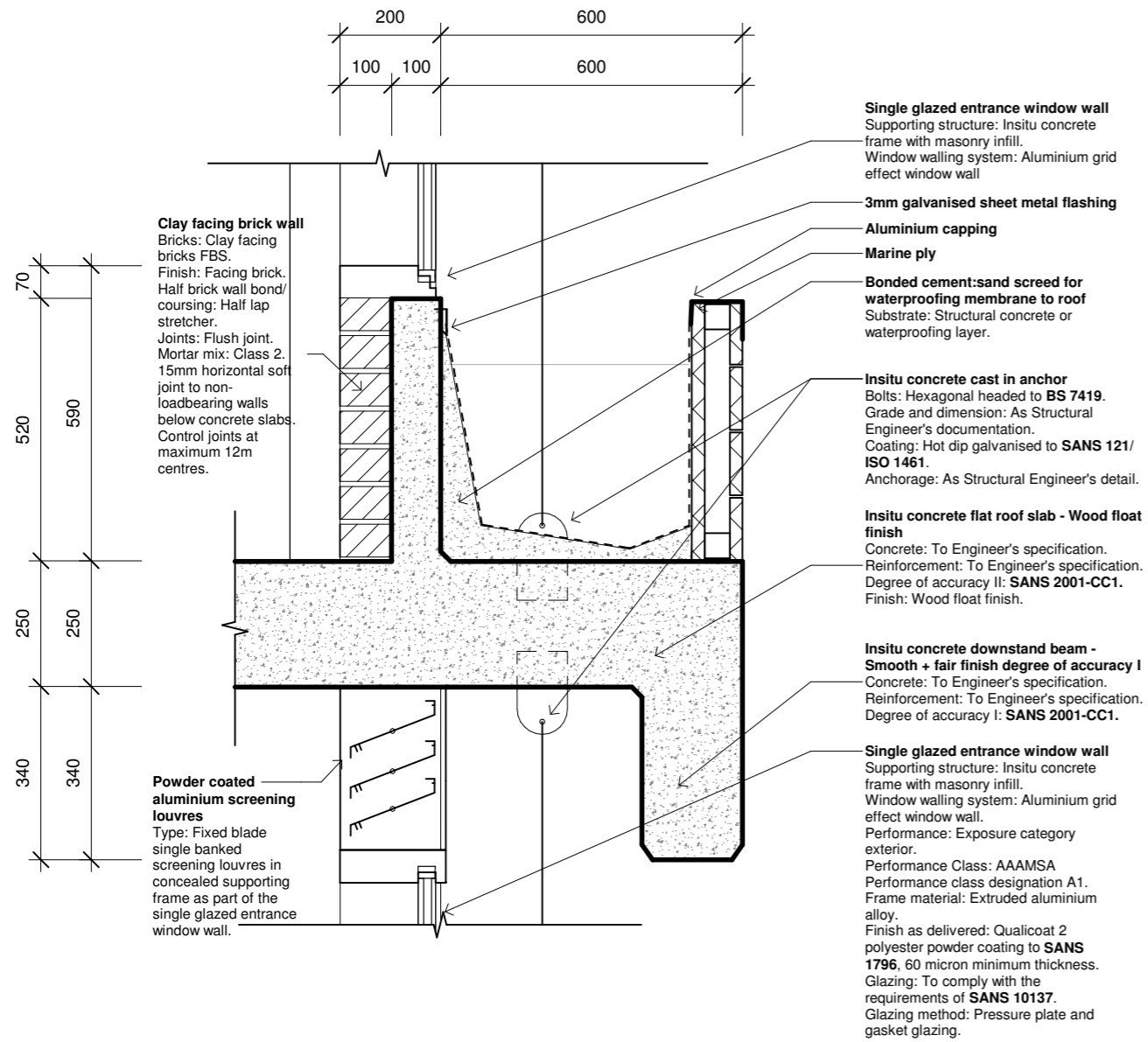
# Isometric Concept



# Detail 4

Scale 1:20 @A1

# Isometric Concept

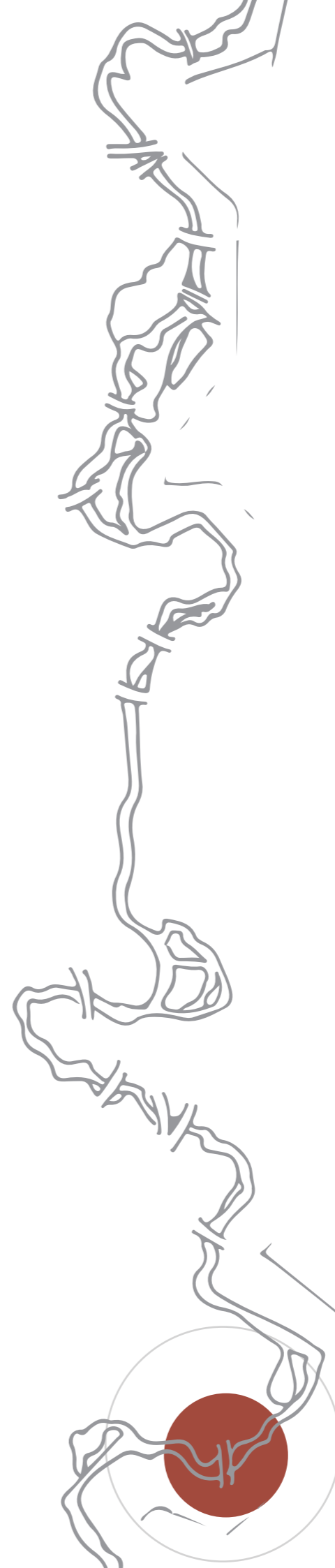




CHAPTER

09

Conclusion



## Conclusion

### Reflection

Throughout this project, I've managed to do a lot of self-improvement. I had the opportunity to truly reflect on my design principles and how they can be improved. The medical readings were challenging and often times not written for non-medical professionals which hinders the value of the information and its accessibility.

If given a chance, I would have consulted medical professionals in practice to get their insight on the flow of a medical facility and how it can be improved. Despite my limitations, I feel that I have done my research intentions justice and if given the opportunity, implement the findings in practice.

### Conclusion

Once deconstructed and analysed, I was able to identify clear spatial principles that provided clear architectural drivers. I used these drivers to fuel my design, continually reflecting on them throughout the process.

I have to acknowledge that the experiment was limited in the number of neurological disorders analysed due to my time constraints. The biggest challenge was overcoming the medical writing; however, once deciphered, I feel that I provided the research centre with clear passive rehabilitation principles.

*fin*

# Bibliography

- ALMAMALIK, L. 2019. The system dynamics as a tool for modeling healthcare system. *Environmental research and public health*.
- ALP, M. A. & ALTINÇEKIÇ, H. 2015. *Accessible design in landscape architecture*, Mairea Libros Publishers.
- ANDERSON, C. 2018. Dr Ncumisa Jilata: Africa's youngest neurosurgeon. [Online] Available: <https://www.brandsouthafrica.com/people-culture/dr-ncumisa-jilata-africas-youngest-neurosurgeon> [Accessed: 12 January 2020].
- BLAIR, D. 2021. *The memory of smells*. Oxford Academy
- BLANCHE, E. & GUNTER, J. 2019. Sensory Processing Disorders. *Reference Module in Neuroscience and Biobehavioral Psychology*.
- BROWN, L. 1995. Biofeedback: Mind Over Body. *Complementary Health Practice Review*. Vol. 1. Pp. 185-186.
- CINTOCARE. 2019. *Who we are*. [Online] Available: <http://cintocare.com/about-us/> [Accessed: 21 September 2019].
- CRUNELLE, M. 2019. Sense of smell. *Architecture and odours*.
- SMITH, P. D. A. J. M. 2015. Design as a rehabilitative tool for people with acquired brain injury: Mapping the field. *Journal of Interior Design*. Vol. 1. Pp. 39.
- EL HAJ, M. & LARØI, F. 2020. Olfactory hallucinations in Alzheimer's disease. *Acta neuropsychiatrica*. Pp. 1-26.
- FORMISANO, E., KIM, D., SALLE, F., VAN DE MOORTELE, P.F., UGURBIL, K. & GOEBEL, R. 2003. *Mirror-symmetric tonotopic maps in human primary auditory cortex*. *Neuron*. Vol. 40. Pp. 859-69.
- GOLDBERG, I., HAREL, M. & MALACH, R. 2006. When the brain loses its self: prefrontal inactivation during sensorimotor processing. *Neuron*. Vol. 50. Pp. 329-39.
- HEADWAY. 2018. About headway Gauteng. [Online] Available: <https://headwaygauteng.co.za/about-headway/> [Accessed: 26 March 2020].
- IOVTCHEVA, R. 2014. *Hedonic Architecture*. M Arch Architecture. Syracuse University.
- IWANO, K. & MURASE, A. 2013. Hearing aid and hearing aid system. *The Journal of the Acoustical Society of America*.
- KWAN, J., TSE, M. & LI, L. 2017. *Neurological rehabilitation*. Oxford textbook of geriatric medicine.
- LEIGH, S. 2017. Brain's Wiring Connected to Sensory Processing Disorder [Online]. UCSF. Available: <https://www.ucsf.edu/news/2016/01/401461/brains-wiring-connected-sensory-processing-disorder> [Accessed: 26 April 2020].
- LIEBER, J. & BENSMAIA, S. 2019. High-dimensional representation of texture in somatosensory cortex of primates. *Proceedings of the National Academy of Sciences*. Vol. 116.
- MANCHESTER, A. 2013. Lack of empathy destroys nursing's essence. *Pubmed*. Vol. 19.
- MARRERO-GONZÁLEZ, P., IRANZO, A., BEDOYA, D., SERRADELL, M., NIÑEROLA-BAIZÁN, A., PERISSINOTTI, A., GAIG, C., VILASECA, I., ALOBID, I., SANTAMARÍA, J. & MULLOL, J. 2020. Prodromal Parkinson disease in patients with idiopathic hyposmia. *Journal of Neurology*. Pp. 267.
- MUKHINA, T. S., SHAROVA, E., BOLDYREVA, G., ZHAVORONKOVA, L., SMIRNOV, A., KULIKOV, M., ALEKSANDROVA, E. V., CHELYAPINA, M., MASHEROV, E. & PRONIN, I. N. 2017. The neuroanatomy of active hand movement in patients with severe traumatic brain injury: Analysis of functional magnetic resonance imaging data. *Nevrologiâ, Nejropsihiatriâ, Psihosomatika*. Vol. 9. Pp. 27-33.
- MUNSAMI, A. 2018. *A need for better awareness of mental health*. [Online] Available: <https://www.iol.co.za/sunday-tribune/opinion/a-need-for-better-awareness-of-mental-health-15070333> [Accessed: 18 February 2020].
- NETCARE, M. N. A. M. O. B. O. 2010. *Africa's most advanced neurosurgery centre launched*. [Online] Available: <https://www.netcare.co.za/Articles/ArticleID=565> [Accessed: 19 February 2020].
- PALLASMAA, J. 1996. *The eyes of the skin*. Wiley-Academy. Great Britain
- PEER, M. 2019. Processing of different spatial scales in the human brain. *eLife*.
- READ, H., WINER, J. & SCHREINER, C. 2002. Functional architecture of auditory cortex. *Current opinion in neurobiology*. Vol. 12. Pp. 433-40.
- SA, S. 2019. City of Tshwane. [Online] *Department of statistics SA: Stats SA*. Available: [http://www.statssa.gov.za/?page\\_id=993&id=city-of-tshwane-municipality](http://www.statssa.gov.za/?page_id=993&id=city-of-tshwane-municipality) [Accessed 9 August 2020].
- SAHRAIE, A., CEDERBLAD, M., KENKEL, S. & ROMANO, J. 2019. Efficacy and predictors of recovery of function after eye movement training in 296 hemianopic patients. *Cortex*. Pp. 125.
- SANLAS. 2020. *Private Hospital Laßnitzhöhe - Private Clinic and Nursing Home*. [Online] Available: <https://sanlas.at/en/facilities/private-hospital-lassnitzhoehe> [Accessed: 6 June 2020].
- SHARMA, Y., BALAMURUGAN, B. & SREEJI 2020. Healthcare analytics. *Blockchain and Machine Learning for e-Healthcare Systems*
- SINGHA, S. 2020. *Future Healthcare Design*. University of Tokyo.
- SZALADOS, R., LEFF, A. & DOOGAN, C. 2020. The clinical effectiveness of Eye-Search therapy for patients with hemianopia, neglect or hemianopia and neglect. *Neuropsychological Rehabilitation*. Pp. 1-12.
- TANYA LEWIS, S. W. 2018. *Human Brain: Facts, Functions & Anatomy*. [Online] Available: <https://www.livescience.com/29365-human-brain.html> [Accessed: 29 July 2020].
- TARIQ, M. 2020. *Universal design*. CECOS University.
- UCT. 2018. Work starts on state-of-the-art Neuroscience Centre at Groote Schuur Hospital. *Faculty of Health Sciences*. [Online] Available: <http://www.health.uct.ac.za/news/work-starts-state-art-neuroscience-centre-groote-schuur-hospital> [Accessed: 14 April 2020].
- WENGER, E. & KÜHN, S. 2016. Chapter 11: *Neuroplasticity. Cognitive Training*. Springer international publishing.