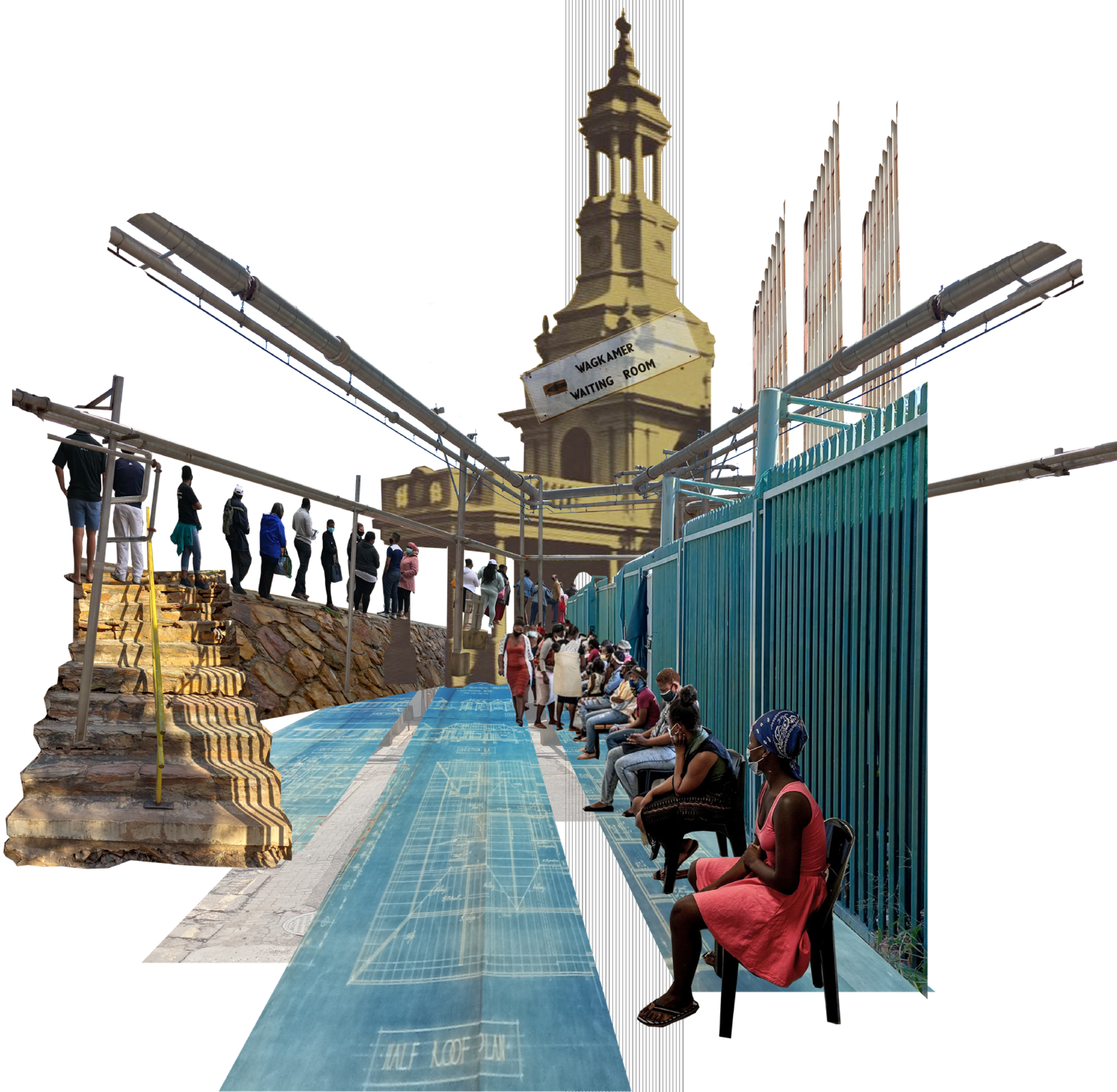
THE PLIGHT OF THE PUBLIC HOSPITAL

ARCHITECTURAL AUGMENTATION AS SPATIAL REMEDY



This dissertation project investigates the shortcomings and potential of the public health facilities in the City of Tshwane through the lens of the current diabetes epidemic. Various spatial, social, and institutional shortfalls are identified and dissected to inform possible architectural solutions. The disparate nature of services, urban sprawl, aging hospitals and lack of community engagement and education hinders healthcare for the majority of the population.

This proposal suggests a complex networked approach that envisions various architectural additions throughout the city and the existing healthcare nodes. These additions will improve service delivery and enable healthcare and community support where none existed before. To enable this network, a catalyst project is required: A core facility that researches, produces and tests these satellite interventions within a controlled environment before being deployed throughout the city.

To drive and manage the envisioned system and network, this facility will centralise administration, development, research and community engagement to effectively and radically change the healthcare fabric of the city. The centrally located Tshwane district hospital will host this facility within various underutilised existing buildings. This approach requires the adaptive reuse of significant heritage structures on a historically sensitive site. The architectural response is thus an investigation of appropriate interventions and additions within this sensitive context to achieve multiple layers of programmes. Combining the programmes of spatial research and medical services creates opportunities where user responses can be observed through multiple medical typologies. This spectrum of investigation is achieved by providing a broad set of medical services throughout the site.

The architectural technological response of the project is a combination of structural insertion into existing buildings, internal reconfiguration and the restructuring and addition of public urban space around and through the site. Radical changes to the site is achieved with the project that envisions healthcare buildings as public spaces while providing rich opportunities to drive South African healthcare forward through research and education.

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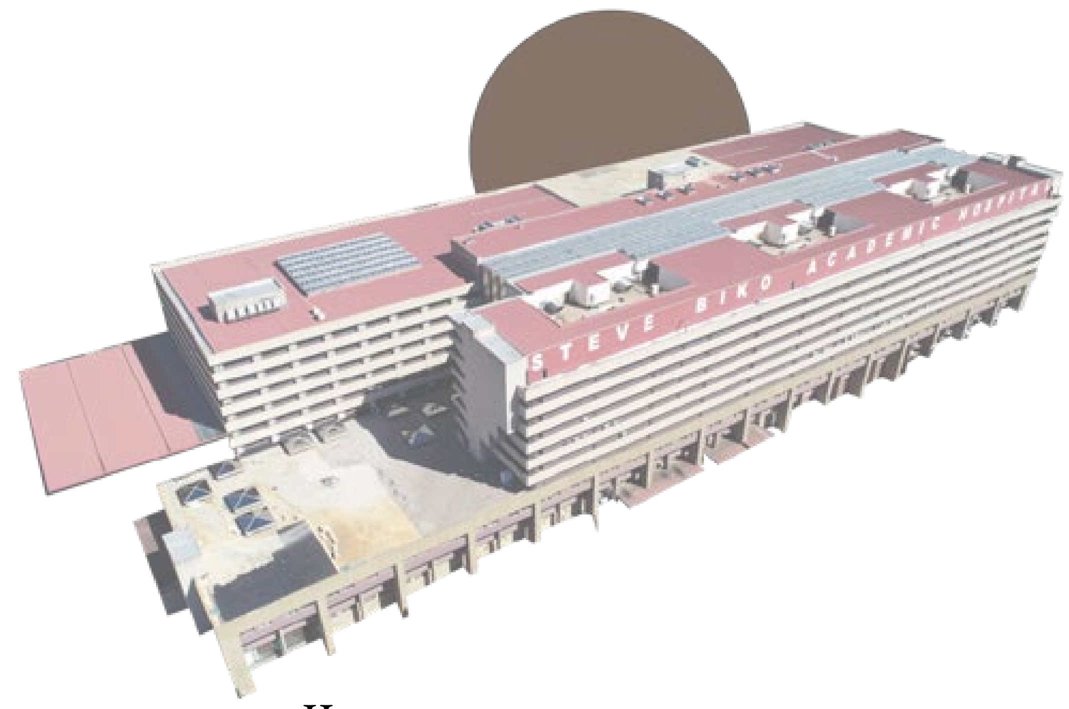
P R O J E C T   B R I E F

S O U T H   A F R I C A N   H E A L T H C A R E   S Y S T E M

As with many essential services in South Africa, healthcare is located on an unbalanced spectrum that heavily favours those who are privileged enough to make use of private enterprises. This leaves the majority of South Africans dependent on underfunded, underequipped, and inaccessible healthcare facilities.

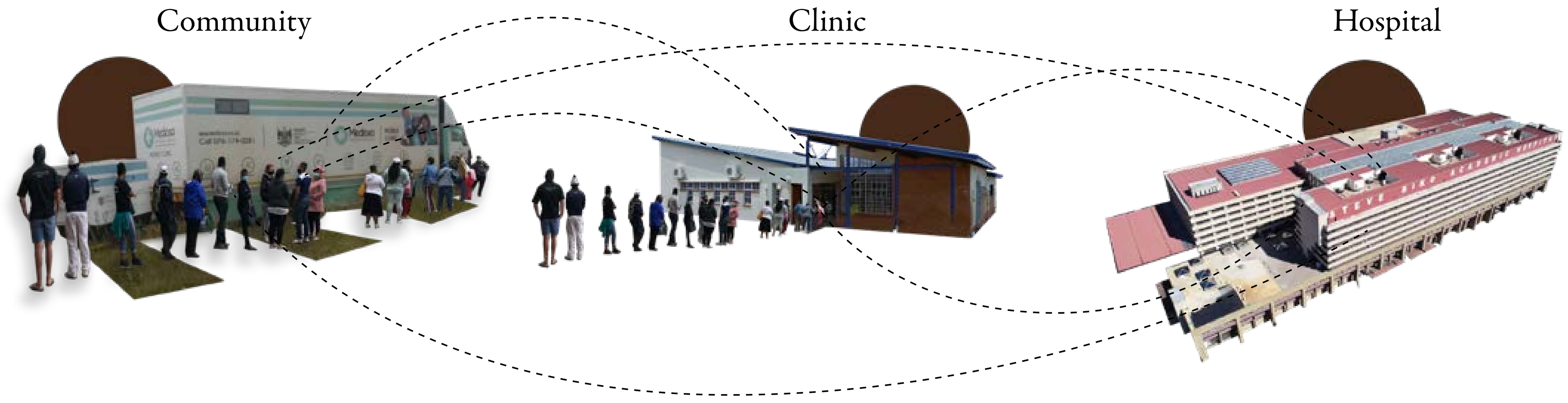
This project envisions architectural interventions across the fabric of existing healthcare facilities that will complement and empower current service networks by enabling collaboration between stakeholders within the City of Tshwane. These existing networks consist of state-provided services, infrastructure, various research groups, and non-profit organisations. This vast system of interconnected architectural additions, adaptations and interventions will address various public healthcare problems such as public education, rapid health status testing, consultation, medicine dispensing and community support.



To enable this catalyst movement, an origin point is required. A strategic insertion into the existing layer of public healthcare can enable the needed propagation. This project proposes this trigger: a central medical and research facility connected to an established hospital that enables better patient care while producing medical and architectural research through the implementation of spatial prototypes throughout the various functions of the facility. By focusing on the urban integration of, and public collaboration with multiple levels of healthcare, this project defines the core of a system that can radically change healthcare for every person in the city.

South African public Healthcare is divided into three main divisions, community healthcare, clinics, and hospitals (including district-, regional- and specialist hospitals). These levels serve the public in different ways that increase in medical complexity with every level. The resulting patient experience is a fragmented journey between facilities which are often located great distances from each other. Davis (2016) investigated the shortcomings and noted the following negative aspects of the public healthcare system:

1. Excessive travel distances
2. Excessive waiting times at all stages
3. Limited access to information and education
4. Insufficient facilities and capacity on all levels

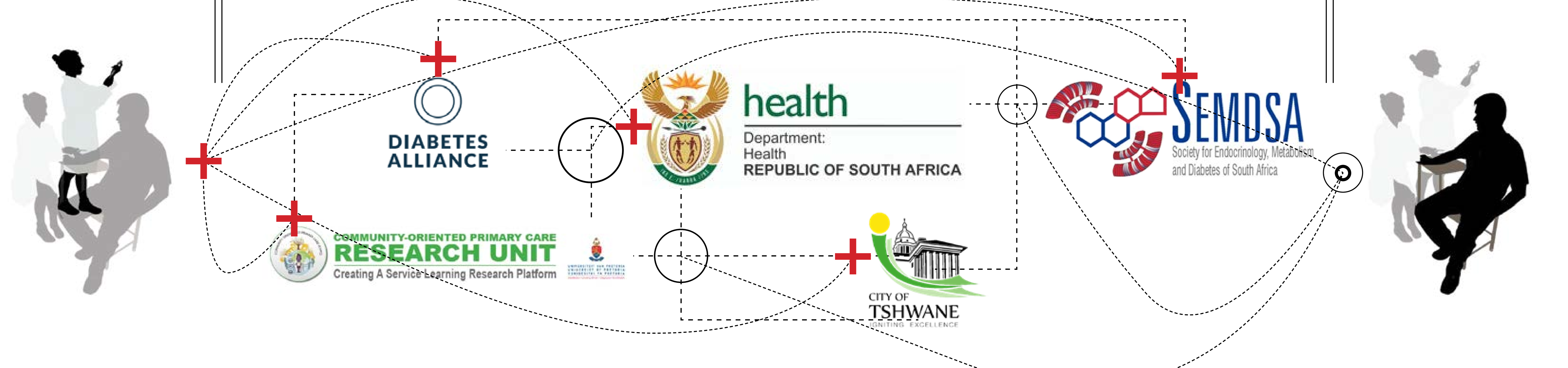


In combination with these systemic and supply problems is the fact that the public healthcare facilities are in general in an aged and worn state. The authors research project investigated the architectural heritage and conservation of hospitals in Tshwane and concluded that many of the structures are unmaintained. Other noteworthy general architectural spatial problems noted are:

Building age and condition | *Uncomfortable access and urban conditions* | *Poor spatial, lighting and ventilation conditions* | *Poor patient spatial experiences*

Various Spatial and Operational Deficiencies

The multitude of challenges in the healthcare sector results in a poor patient experience, affecting compliance and medical effectiveness. Various stakeholders are prioritizing public healthcare quality through ground-up initiatives that target healthcare at a community level. Non-governmental organisations such as the Diabetes Alliance, research groups such as the UP Community Oriented Primary Care (COPC) unit, the Tshwane Insulin Project and the Department of Health run programs that target grassroots healthcare through community action and contact. This project aims to involve these stakeholders in a combined effort to improve healthcare through research-driven architectural interventions.



Healthcare Stakeholders In The Context Of Tshwane

P R O J E C T   B R I E F

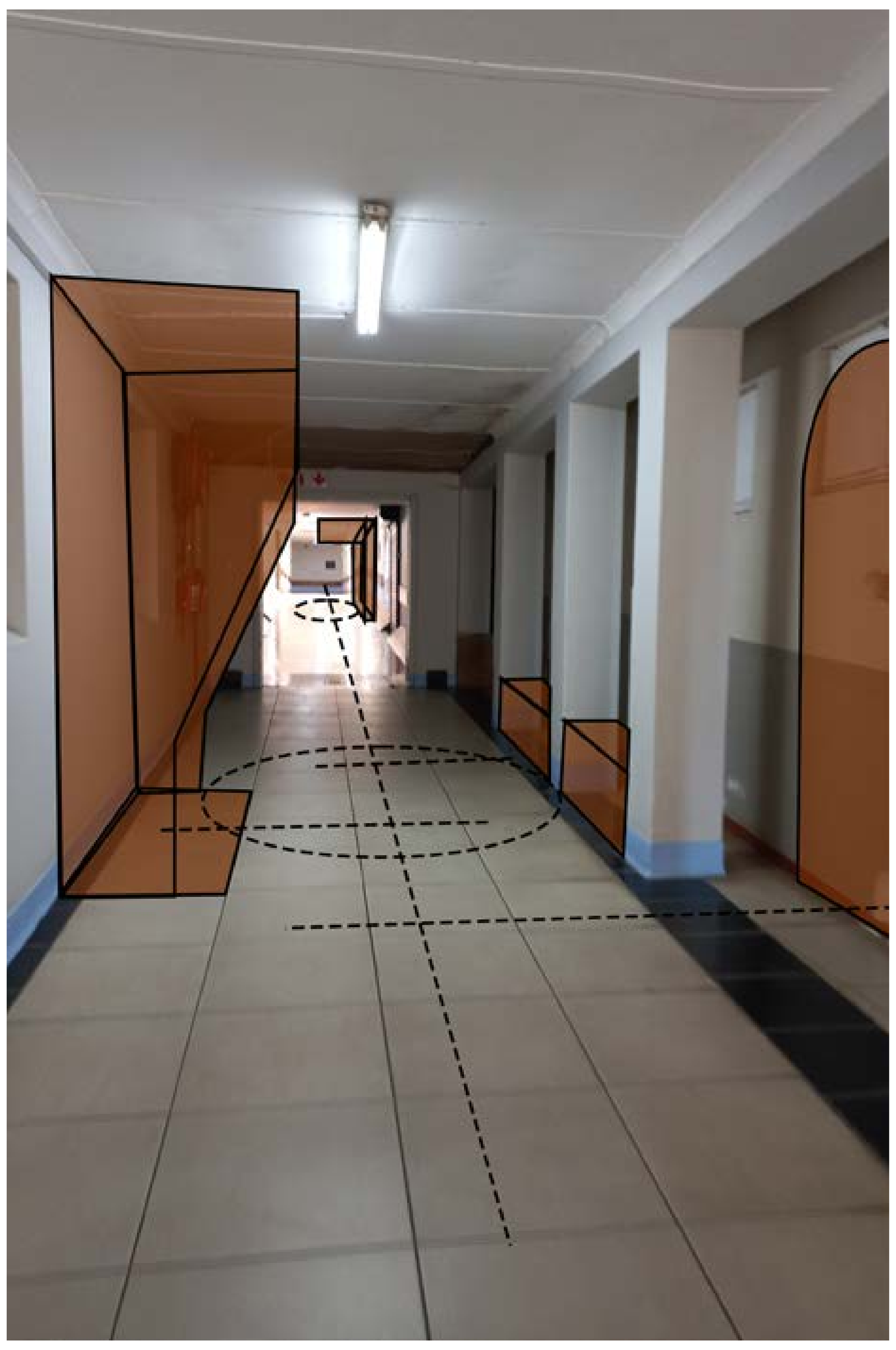
A R C H I T E C T U R A L   A U G M E N T A T I O N

To effectively combine these programs, a spatial intervention system is proposed by this project. The city-wide system consists of various architectural interventions, additions and alterations that modify existing healthcare facilities and infrastructure to align with the stakeholder aims of providing better primary, secondary and tertiary healthcare while providing the infrastructure and facilities for new ways of patient interaction and community influence. The function and form of these will be research-driven and will target relevant and current public health problems.

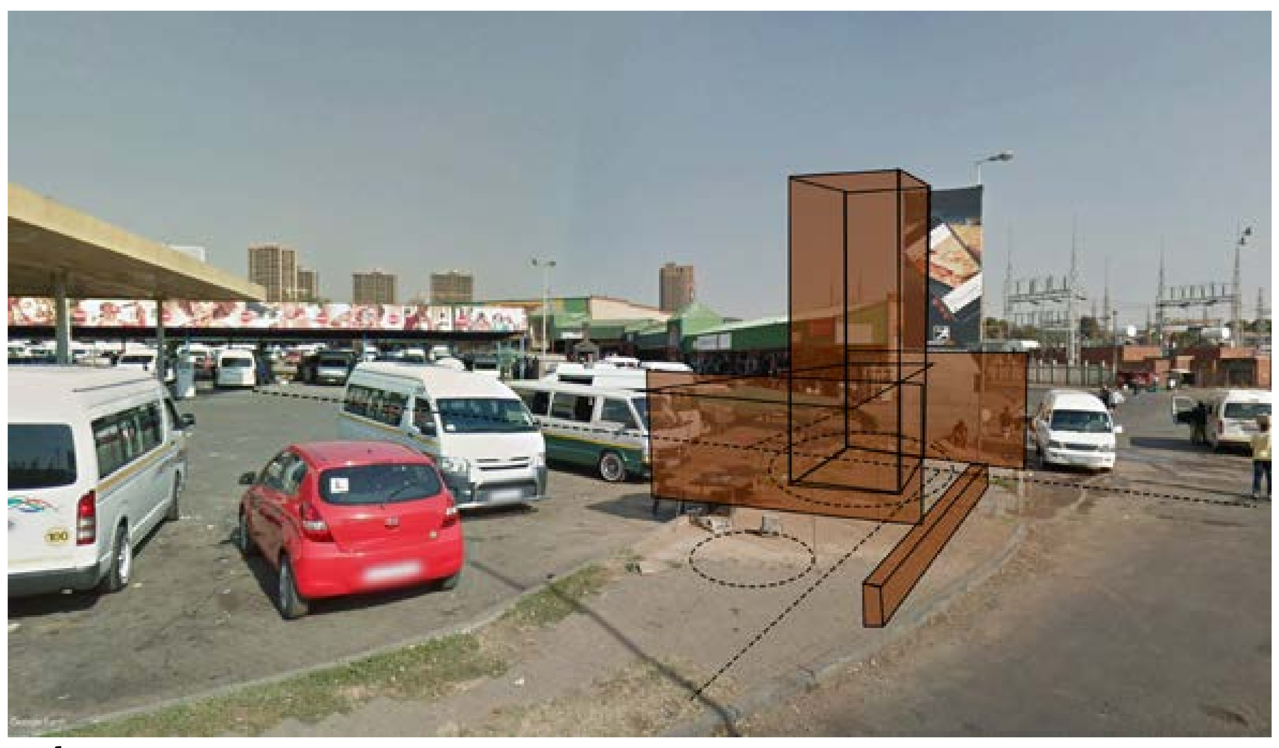
Augmentation Distribution Concept Mapping

A complex network of various programs and functions that are constantly changing in a large city-scale context requires rigorous control and development to ensure resilience. It is this gap that the project focuses on with the proposal of a central facility located at the heart of medical service and research in the city. This administrative and development core facility requires integration into existing medical procedures and systems as well as direct contact with patients, medical staff and researchers to be able to adapt and influence public medical approaches through the intervention approach. The intent of this project is thus to create a central facility that manages and develops medical architectural interventions in the city while creating a holistic medical environment on the site. This bilateral focus achieves programmatic resilience and sustainability by utilizing the complexity of the site and placing strategic programs throughout to create a comprehensive and integrated system.

Architectural Adaptations And Addition Conepts In Disparate Contexts



Hospital interiors



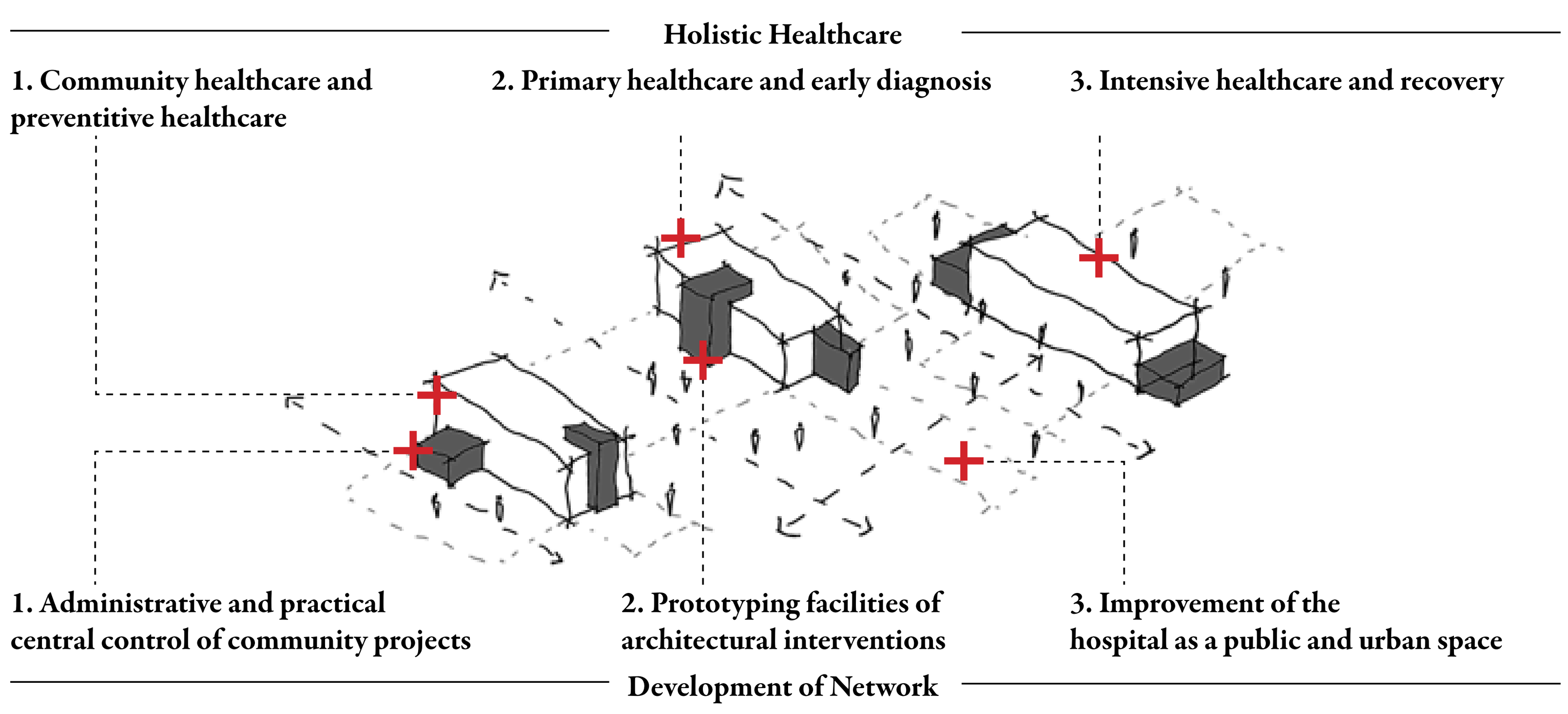
Urban spaces

Hospital Adittions

Clinic additions

Community projects

The improvement of the existing medical and supportive programs on the site reflects the existing hierarchy of healthcare services (community care, primary care, secondary care). These stages of healthcare are brought together in one location with the intent of simplifying and improving the patient experience. This project drives the development of external architectural interventions through the on-site creation and testing of spatial and architectural prototypes. These preliminary interventions are built, tested and refined on the hospital site before being implemented throughout the city. The project thus combines medical care with the research and development of medical architecture.



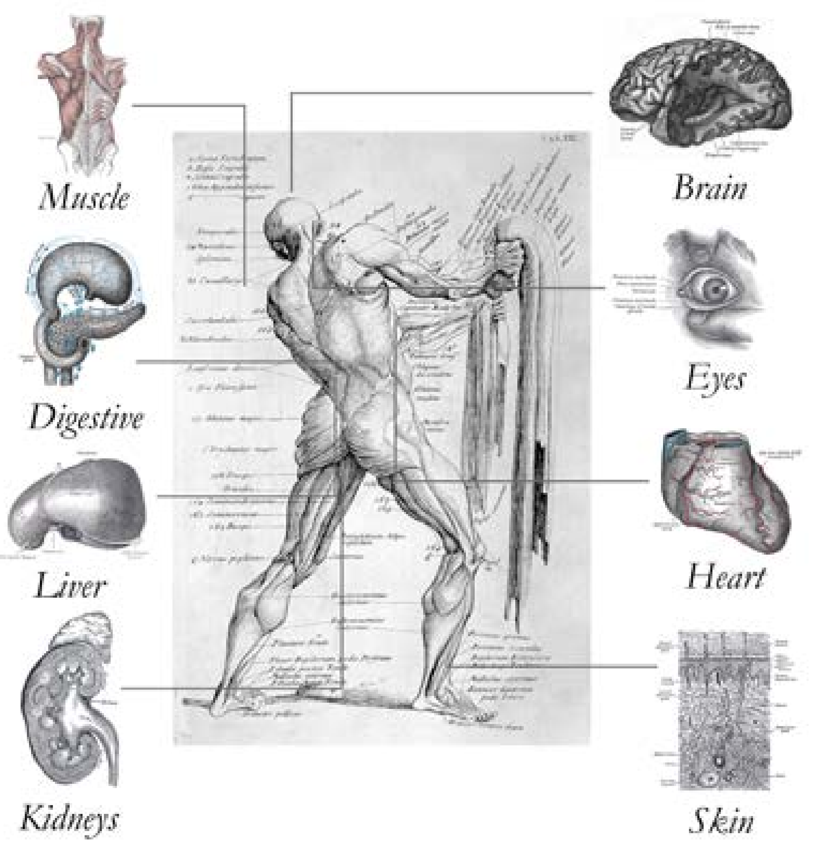
P R O J E C T   B R I E F

D I A B E T E S   E P I D E M I C   -   P R O G R A M M E   S C E N A R I O

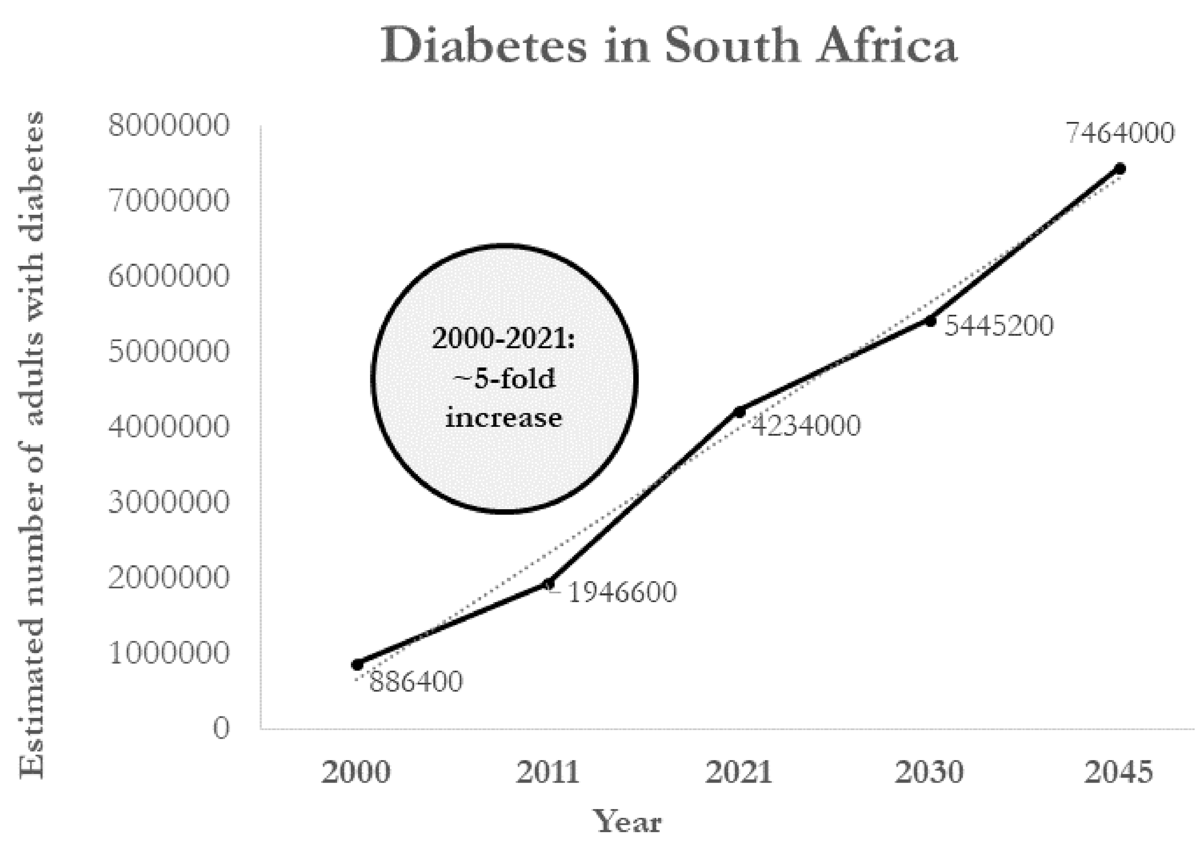
While most medical facilities provide flexible services to cover the largest possible spectrum of healthcare, the additions and alterations of this project focus on the treatment of the deadliest non-communicable disease in South Africa, Diabetes. This specificity aligns with the interests of the involved stakeholders and provides a uniquely wide scope of medical care for a specific disease. Diabetes is currently the fastest-growing non-communicable disease in South Africa. With 11.3% of the population diagnosed and a further 45% of diabetes sufferers undiagnosed, South Africa has the highest prevalence of the disease in the African continent. The effects of this disease carry a cost of R131 Billion per year in medical expenses. Most patients rely on the state healthcare system which serves 80% of the South African population and is severely underfunded and under staffed. To combat these problems, many organisations (government and non-government) focus on disease prevention and maintenance through the promotion of healthy living and medical education. This approach provides a unique opportunity where the success of these programs will benefit public health beyond a single disease as it promotes an overall healthy public lifestyle. This project aligns with these stakeholder goals and aims to provide medical facilities that can enable community and public healthcare by these stakeholders within the city of Tshwane as well as on the chosen site. Diabetes is largely a lifestyle induced disease that results in a long term journey as the effects progress over time. The medical scope involved in a patient journey starts at the community level and likely ends with palliative care and specialist intervention.

The current patient experience in the public healthcare sector is severely impacted by the physical and systematic shortcomings of the public healthcare sector. This, coupled with the systemic problems faced by vulnerable communities results in insufficient healthcare. Piotie et al. (2021) highlights a few of the problems namely:

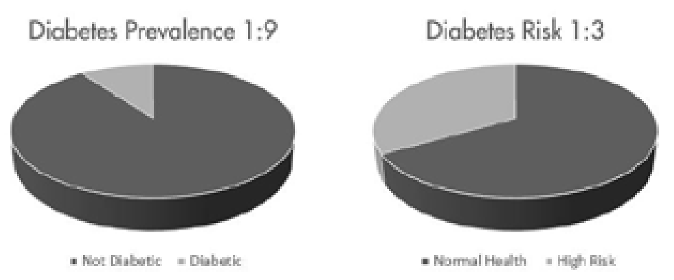
- The lack of patient involvement in better management strategies.
- Underdiagnosis of patient deterioration.
- Limited contact with healthcare professionals.
- Lack of disease education in patients and the general public.
- Poor management of patients and patient data by professionals



Diabetes Effects On The Body

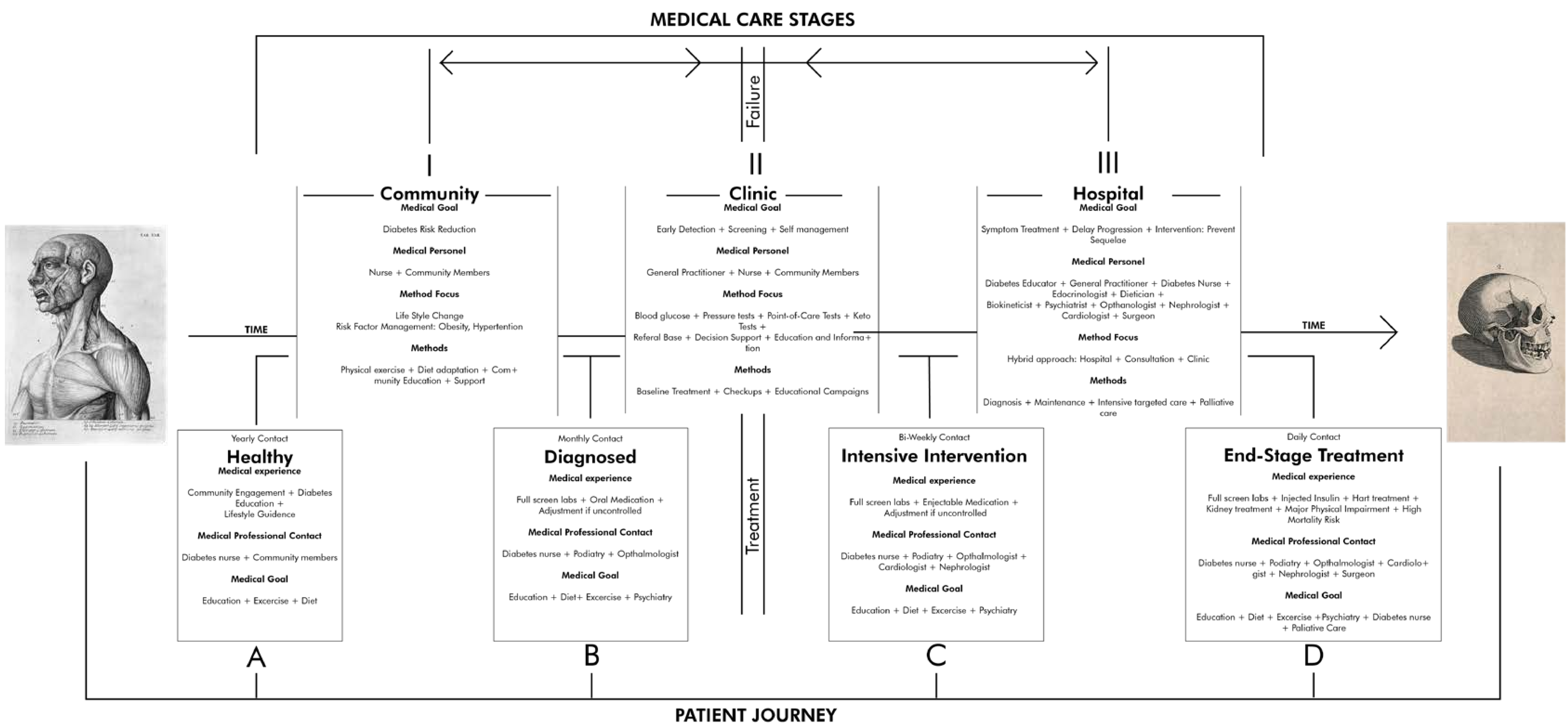


Rapid Disease Growth

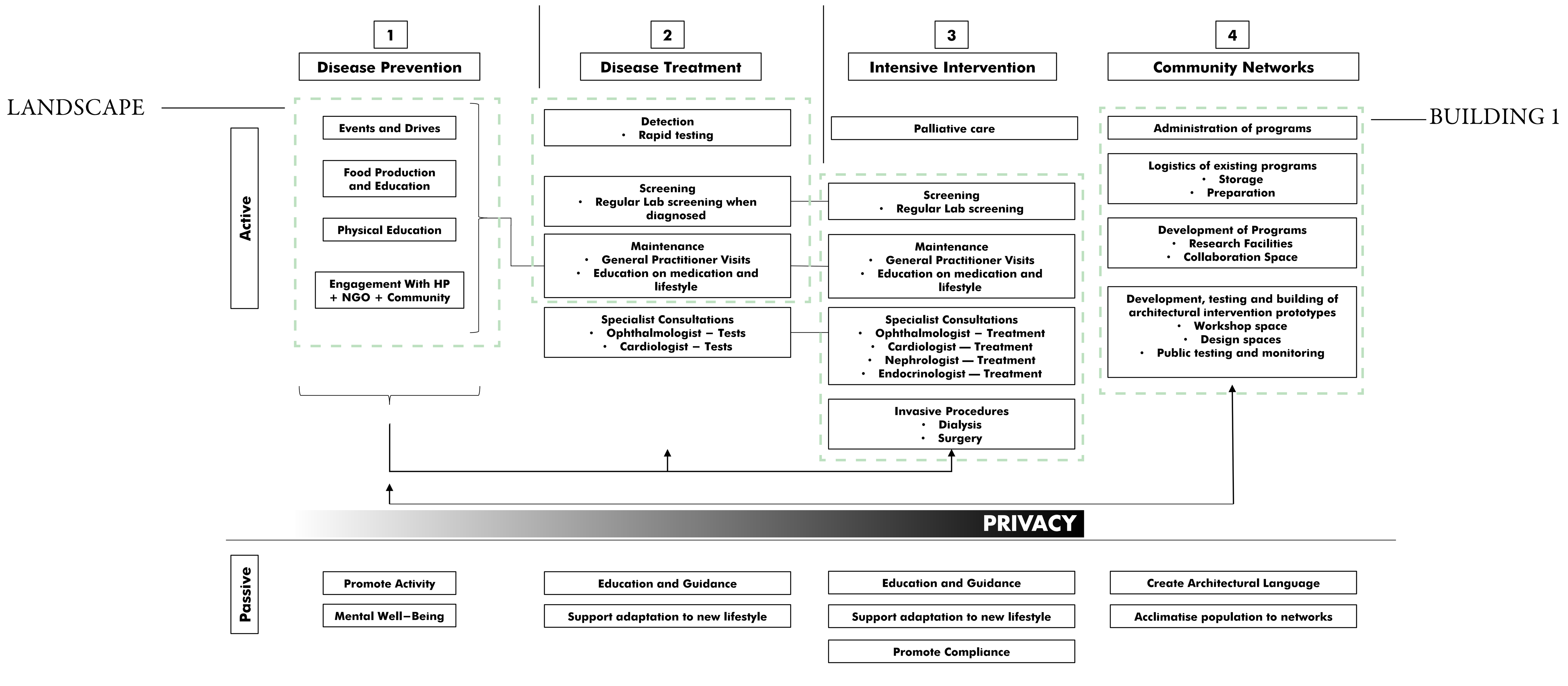


Diabetes Prevalence And Risk

The ideal diabetes patient journey within the current healthcare system (comprising of standard governmental care and NGO programs) spans the entire spectrum of available healthcare. This system forms the basis of this project's focus on improvement and augmentation by providing the majority of services on the main site and researching and developing solutions to be implemented further afield. This ideal is however rarely reached due to the mentioned problems. The reality for thousands of underprivileged and sensitive patients is unfortunately the insufficient navigation of services that are overwhelmed, disconnected and sometimes inaccessible.



The project programs form an integrated system of public education, medical services, and architectural research and development. The first layer consists of active and passive public interactions that achieve public education concerning healthy lifestyles, diabetes prevention and diabetes treatment. The second layer consists of three tiers of medical intervention, primary – secondary- and Intensive medical care. The final layer that is interwoven between the first two consists of Architectural research and prototyping. This prototyping system allows architectural interventions to be designed and tested within different spatial conditions before it is implemented throughout the city in support of existing facilities and programs.



THE PLIGHT OF THE PUBLIC HOSPITAL

The improvement of public health through Architectural interventions

CURRENT HEALTHCARE SYSTEM IN SOUTH AFRICA

COMMUNITY

- Health Drives
- Mobile Clinics
- Ward-Based Outreach Programs

<u>**Focus on prevention and maintenance**</u>

CLINICS

- Established Clinic Buildings
- Primary Healthcare Provision

<u>**Focus on diagnosing and referral**</u>

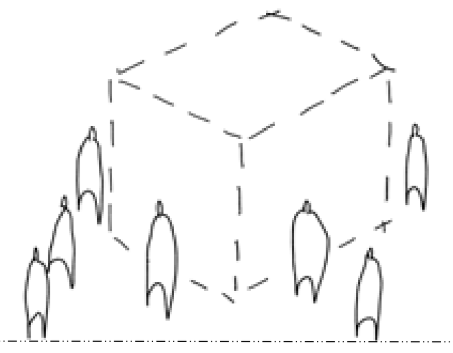
HOSPITALS

- Established Medical Precincts
- Specialised Healthcare Provided

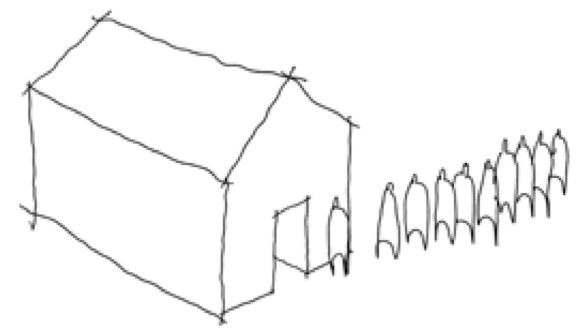
<u>**Focus on intensive medical intervention**</u>

CURRENT SHORTCOMINGS

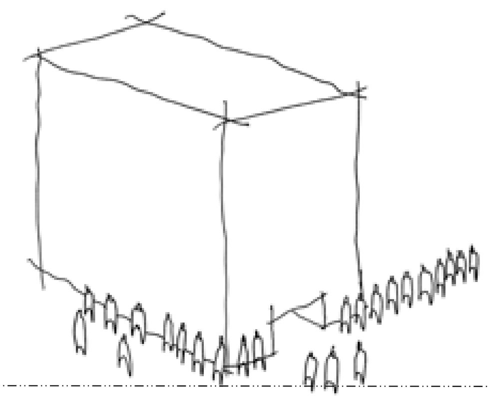
- Temporary presence
- Health workers lack supporting infrastructure
- Limited scope of services provided



- Limited patient capacity
- Centralised distribution of services
- Minimal flexibility



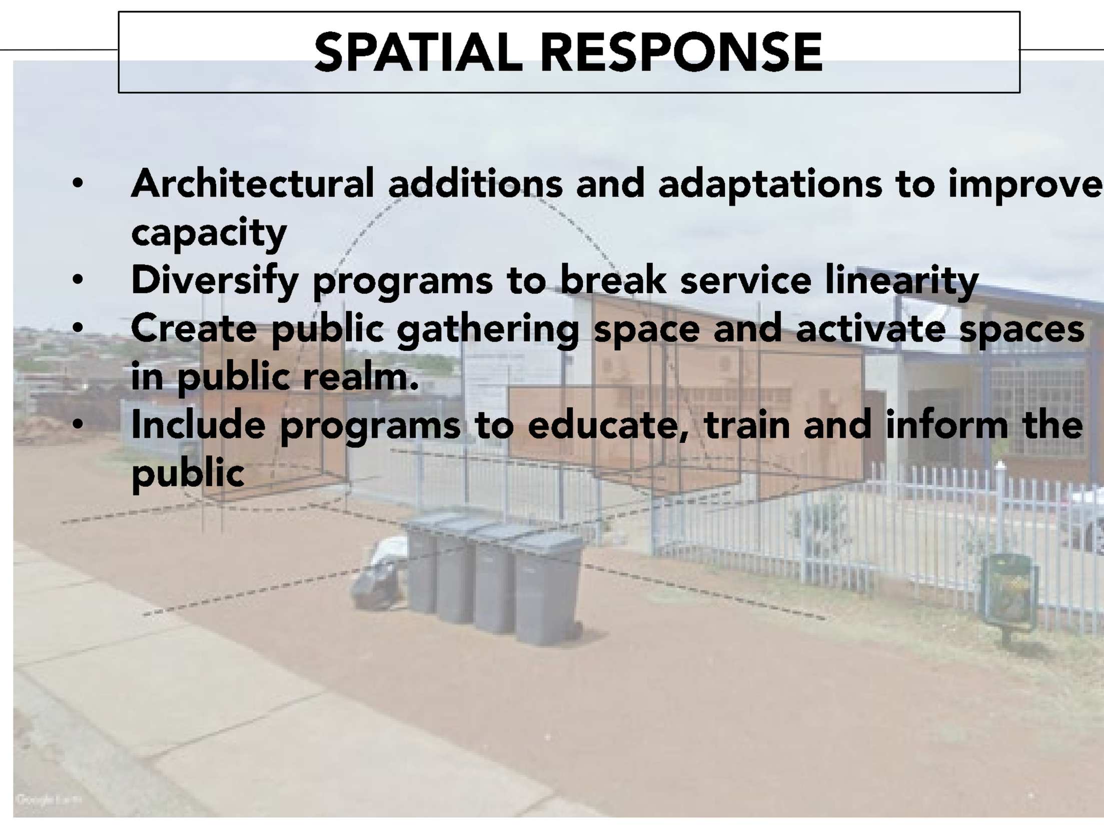
- Limited patient capacity
- Centralised distribution of services
- Minimal flexibility
- Isolated from communities
- Lacking patient support



SPATIAL RESPONSE

- Permanent / Semi-permanent community infrastructure built
- Facilities for HCW dispersed through communities
- Expand programs to include lifestyle education, activity spaces, meeting spaces, medicine dispensing and first-line emergency contact

A



- Architectural additions and adaptations to improve capacity
- Diversify programs to break service linearity
- Create public gathering space and activate spaces in public realm.
- Include programs to educate, train and inform the public

B

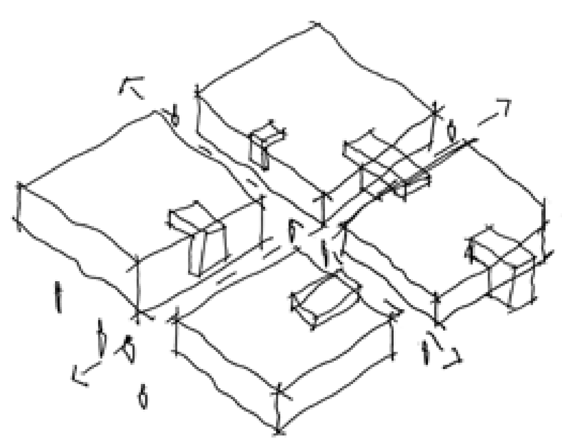
- Specific architectural adaptations to complement existing systems and services
- Create a new hierarchy of services to better the flow of patients
- Create healing environments through the promotion of exterior and public space
- Adapt architecture at multiple scales.
- Integrate community and clinic functions to create a holistic treatment facility.

C

DEVELOPMENT OF STRATEGIES

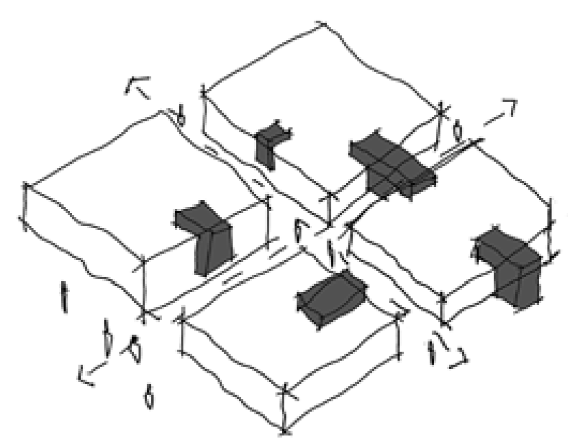
I

Create a central node for the development and testing of spatial interventions within a working medical context



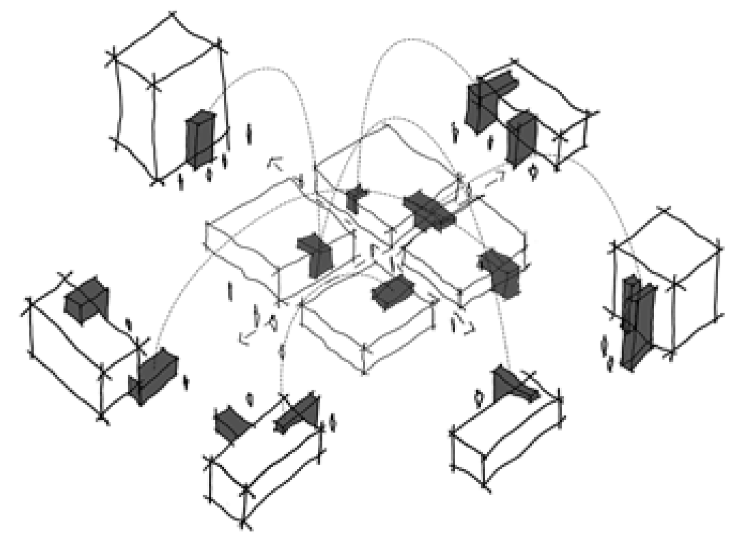
II

Develop prototypes that can be tested and iterated at various scales and in complex spatial and urban conditions



III

Implement the designs on larger scales throughout the city's healthcare infrastructure and communities.



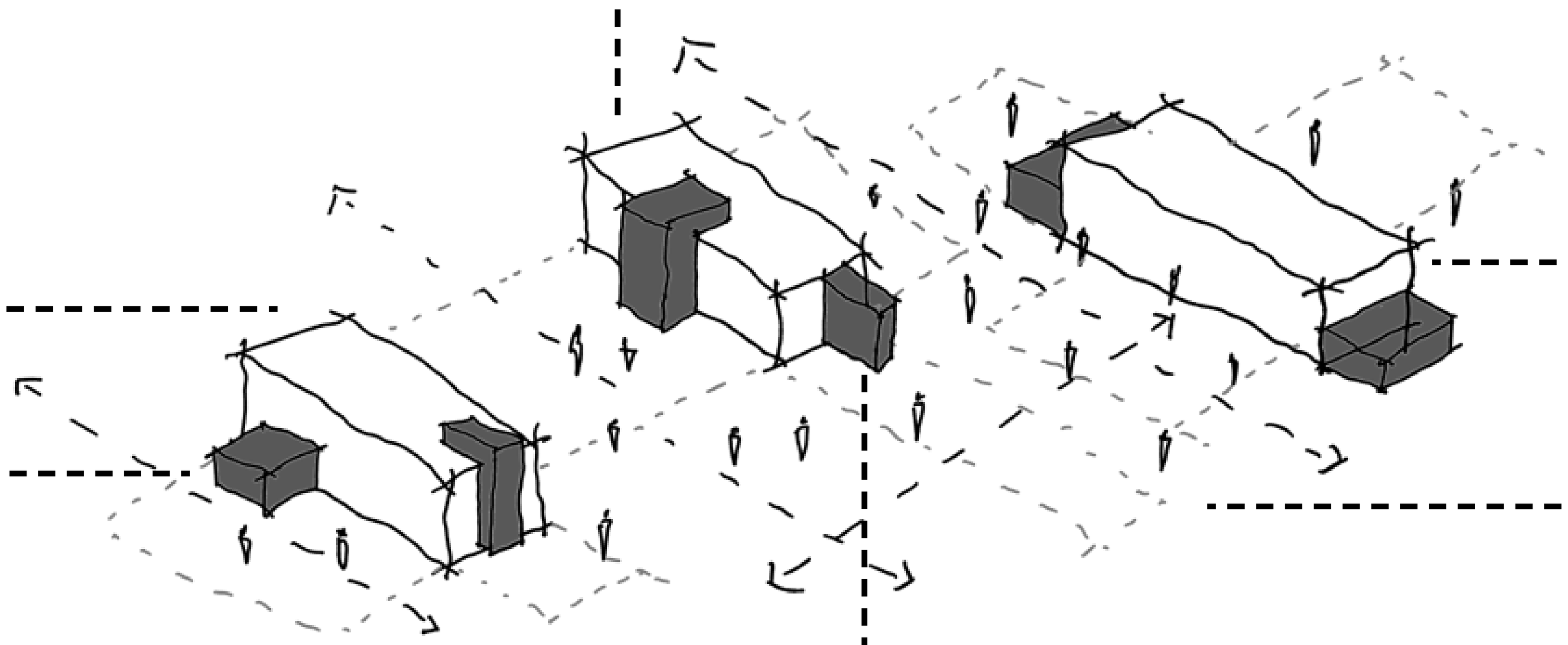
PROJECT FOCUS

HOLISTIC HEALTHCARE

1. Community healthcare and preventative healthcare

1. Primary healthcare and early diagnosis

1. Intensive healthcare and recovery



1. Administrative and practical central control for community health projects

1. Prototyping facilities of architectural interventions

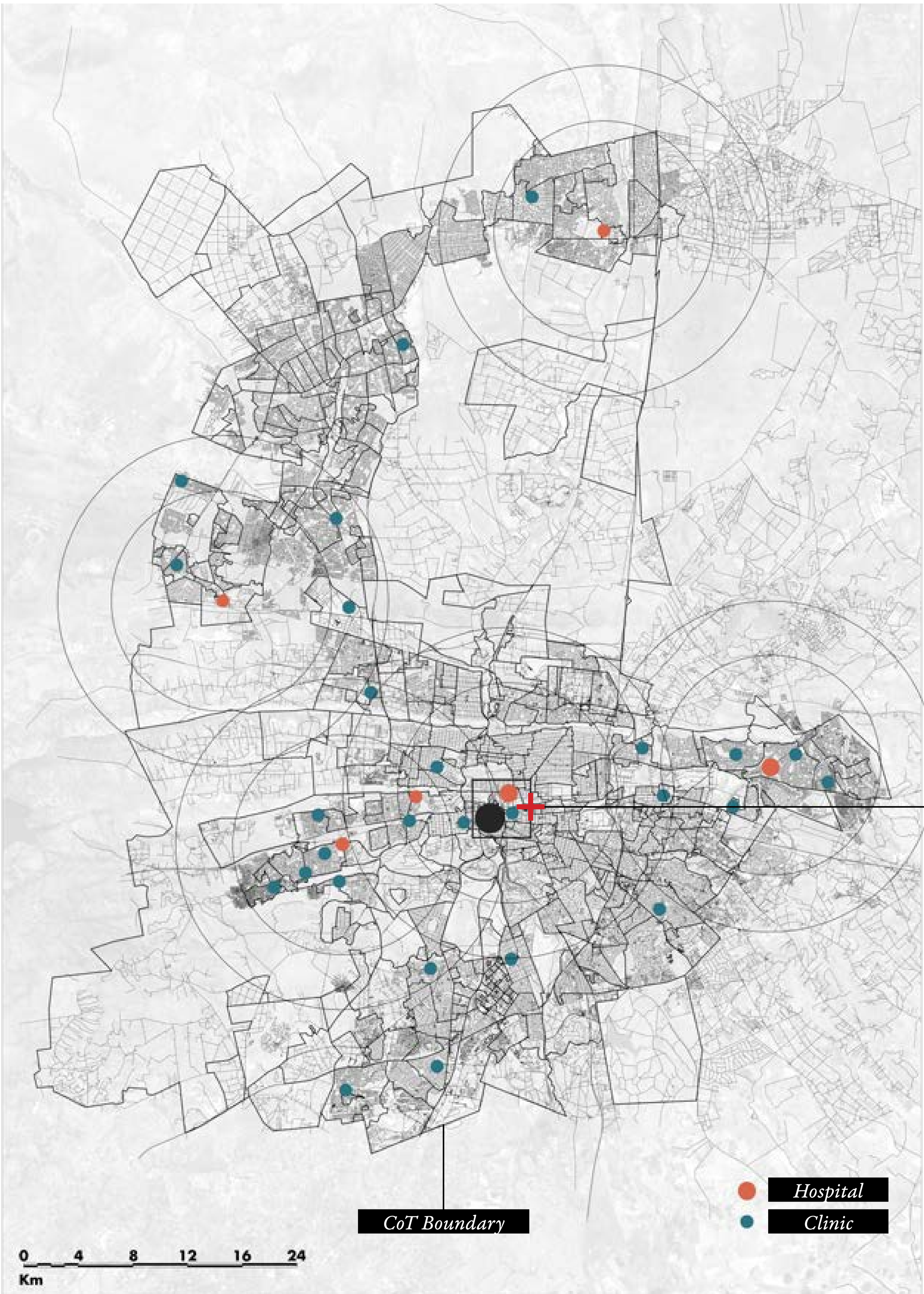
1. Improvement of the hospital as public and urban space

DEVELOPMENT OF EXTENDED HEALTHCARE

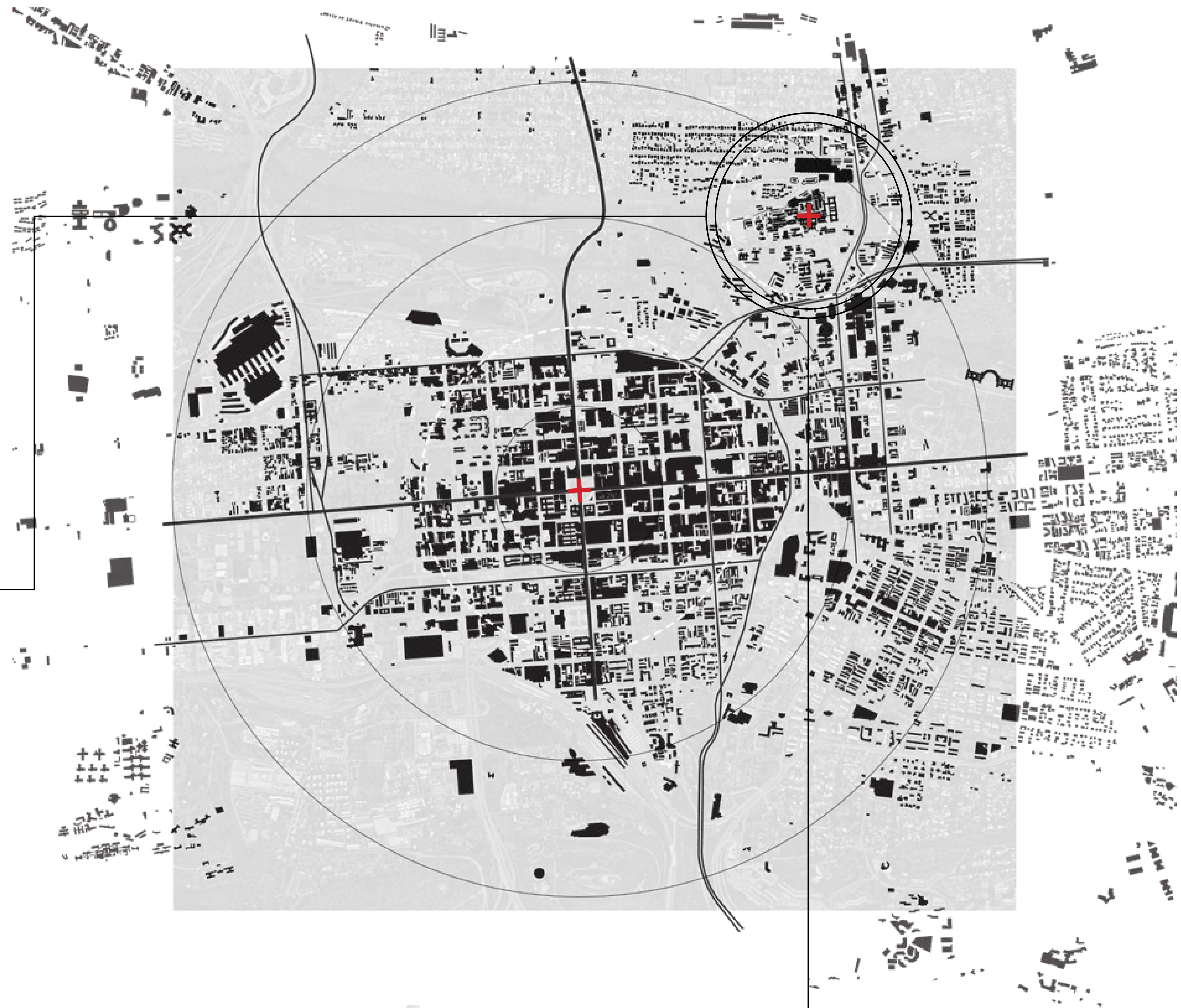
P R O J E C T   L O C A T I O N

S I T E   L O C A T I O N   A N D   C O N T E X T

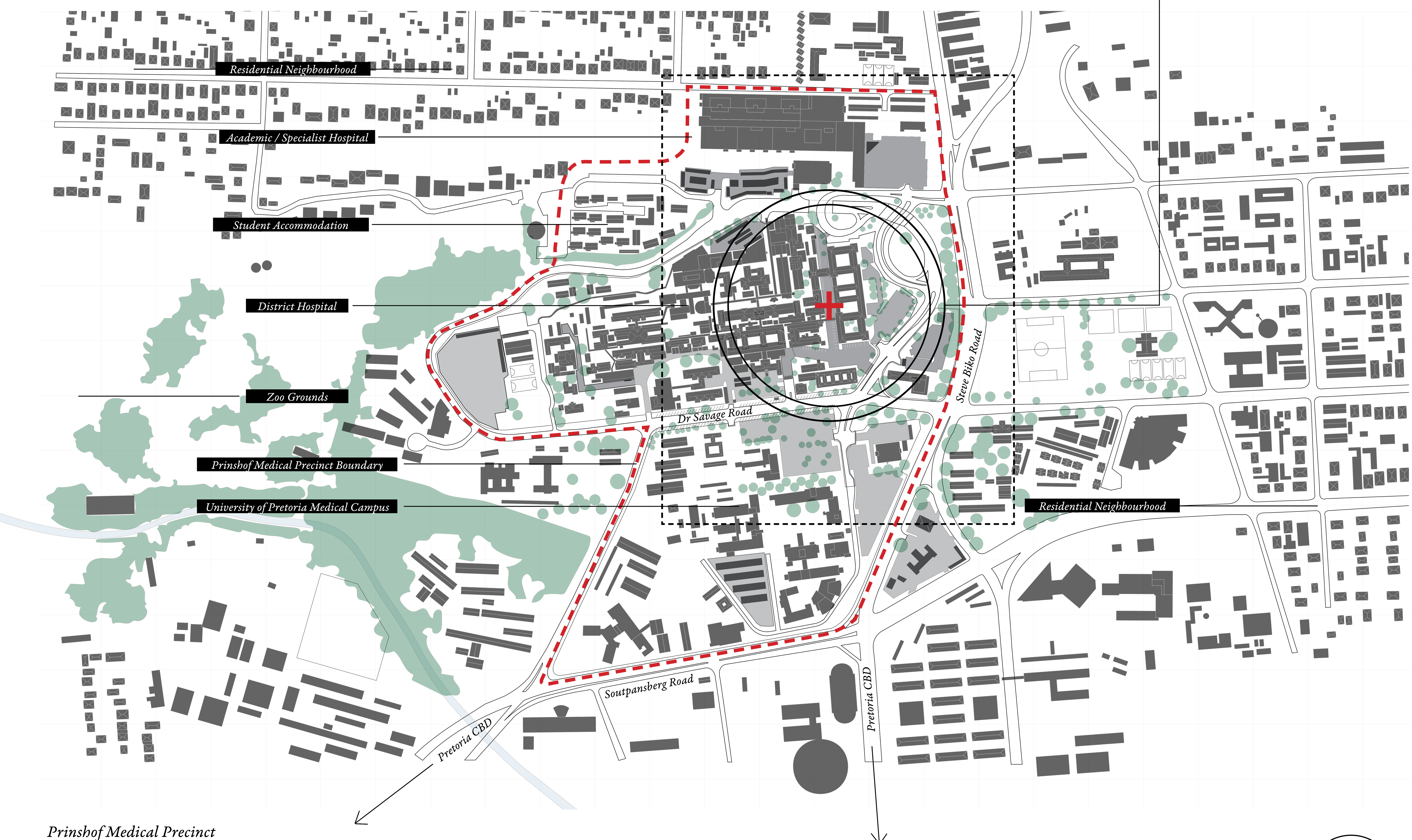
The conceptual and programmatic centrality of the project requires a well established existing medical-focused site that houses the complex and varied functions required to achieve the aims of improving the public healthcare system. While the city contains multiple large public state hospitals as revealed in the authors research, one precinct stands out in potential and suitability. The Prinshof medical precinct located North of the city CBD was chosen as the location of the project. This precinct contains the Tshwane District Hospital, Steve Biko Academic Hospital and the University of Pretoria's medical campus. The majority of the institutional stakeholders involved with the project are located within the precinct. The combination of medical facilities, research programs and public engagement sets the ideal context for cross olination of programms and productive collaboration.



City of Tshwane



Pretoria CBD



Prinshof Medical Precinct

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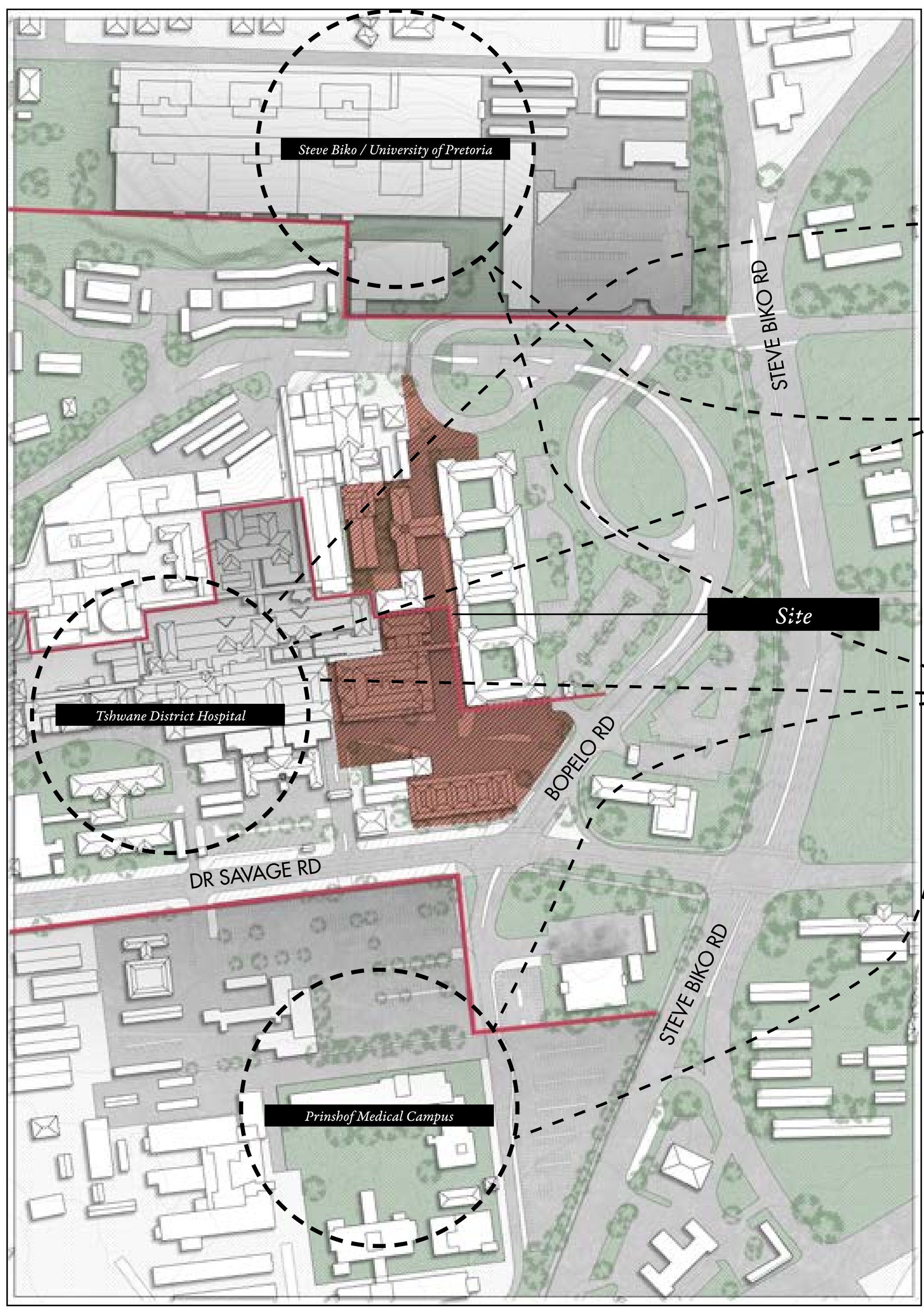
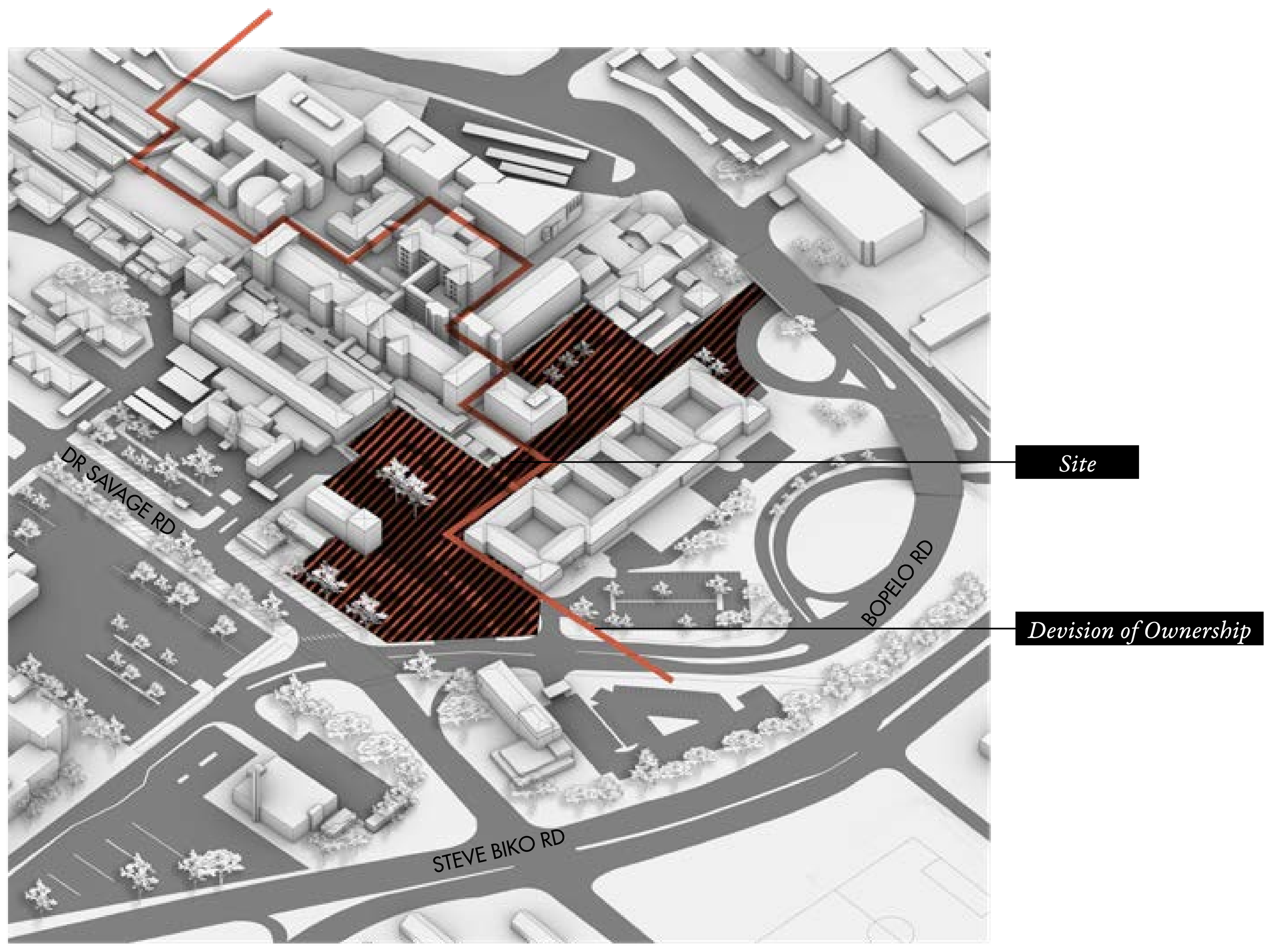
Ownership Boundaries and Site Location



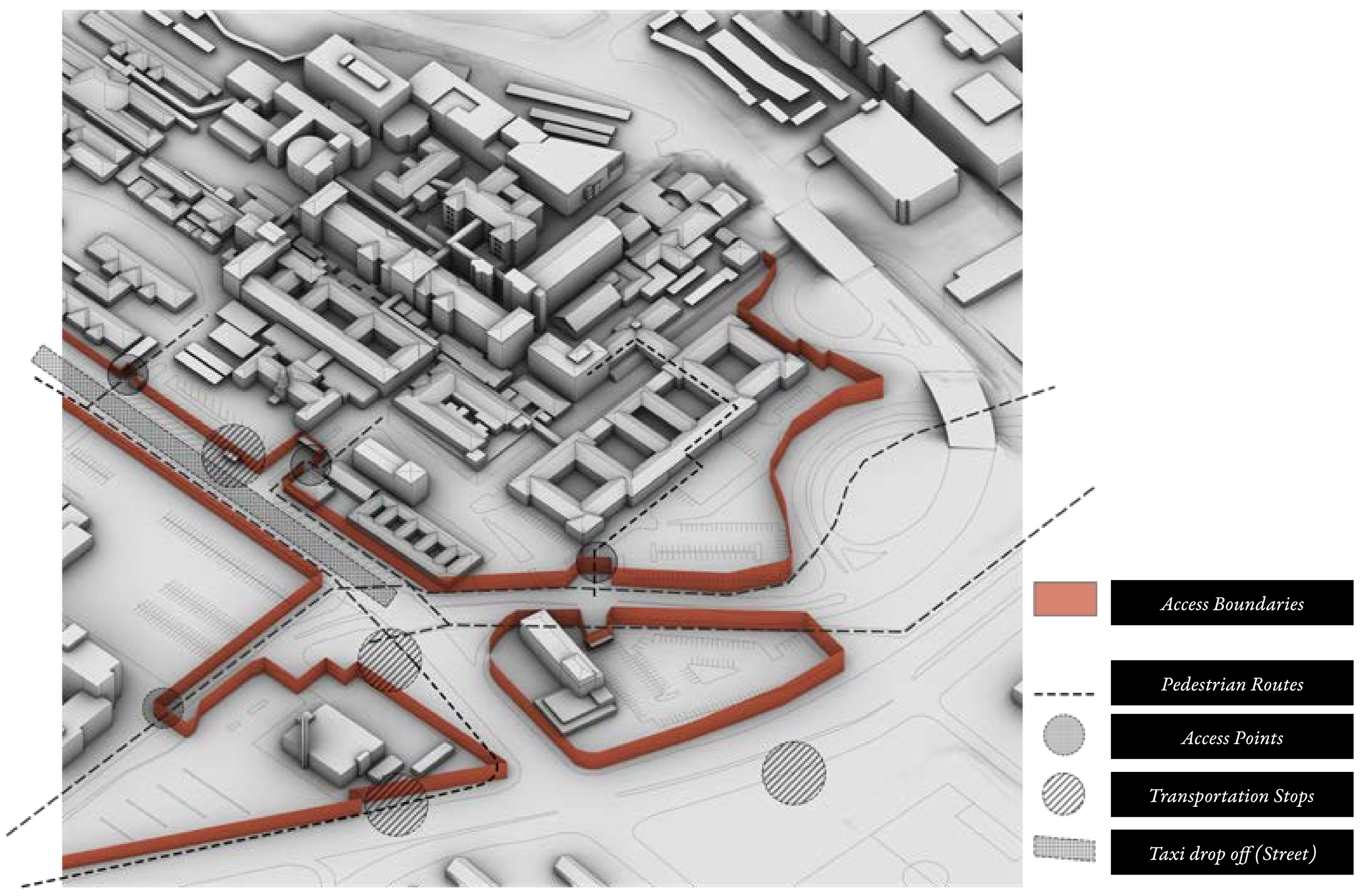
CITY OF TSHWANE
IGNITING EXCELLENCE

health
Department: Health
REPUBLIC OF SOUTH AFRICA

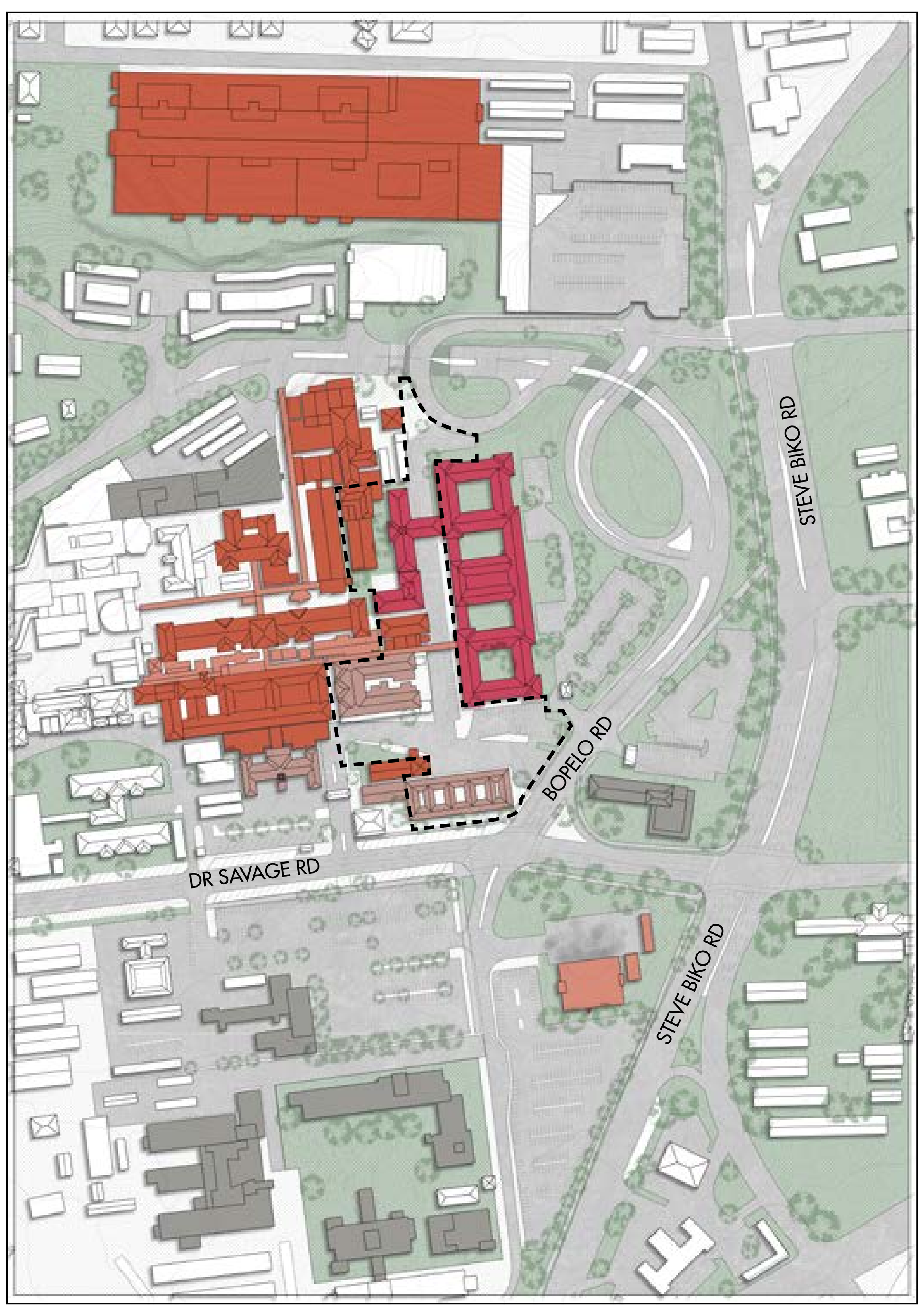
RESEARCH UNIT

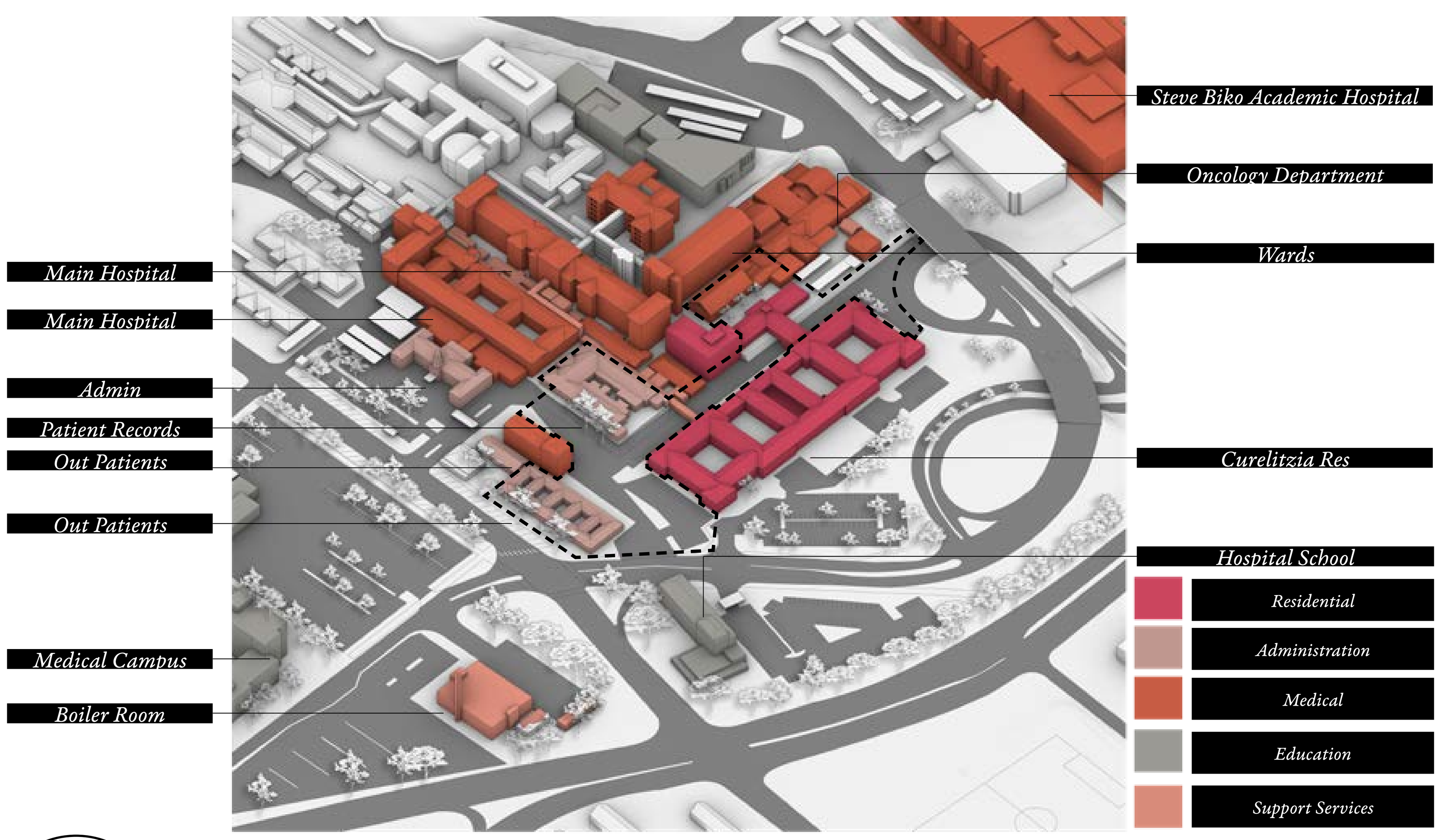


Ownership Boundaries and Site Location



Existing Programmes





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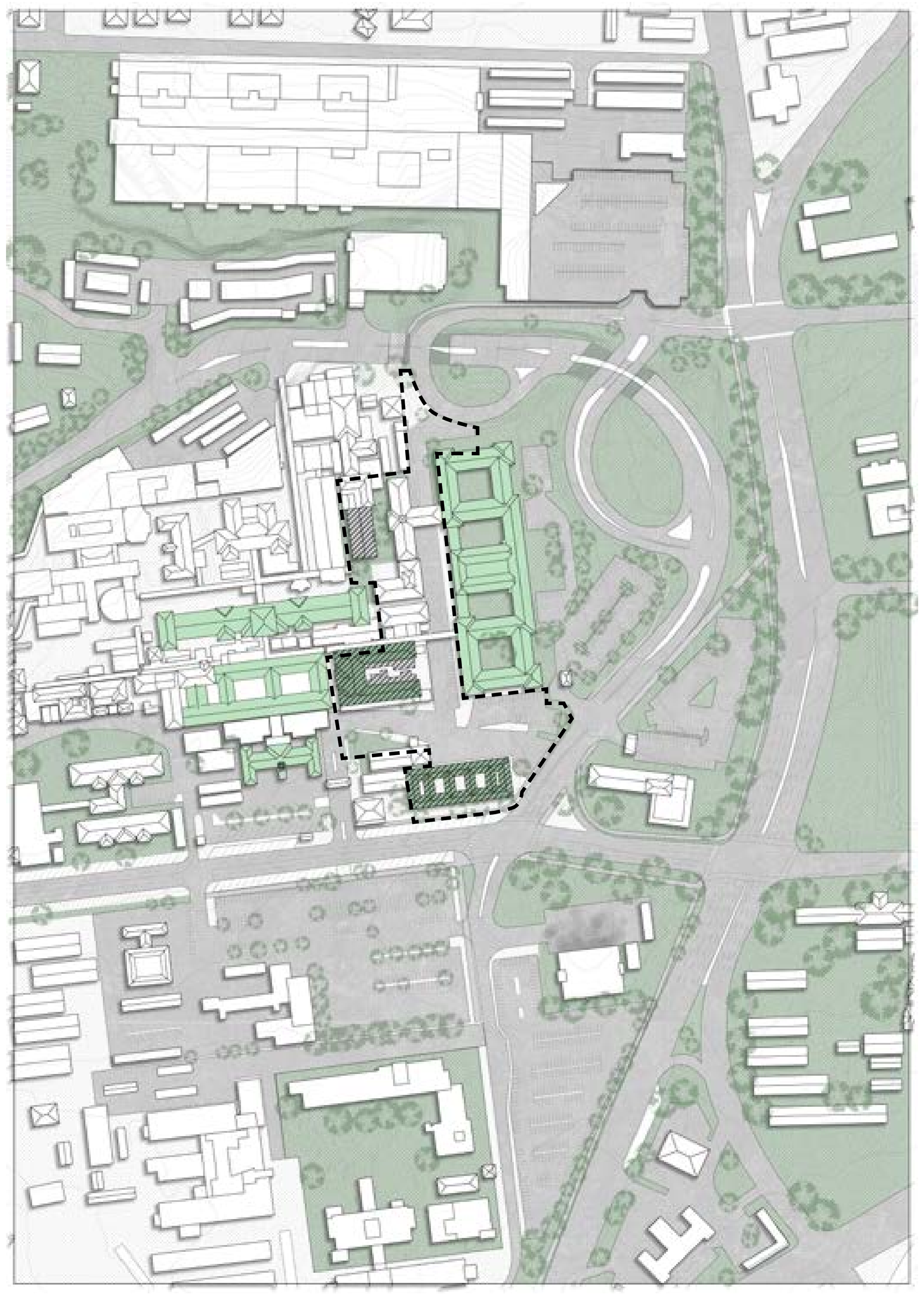
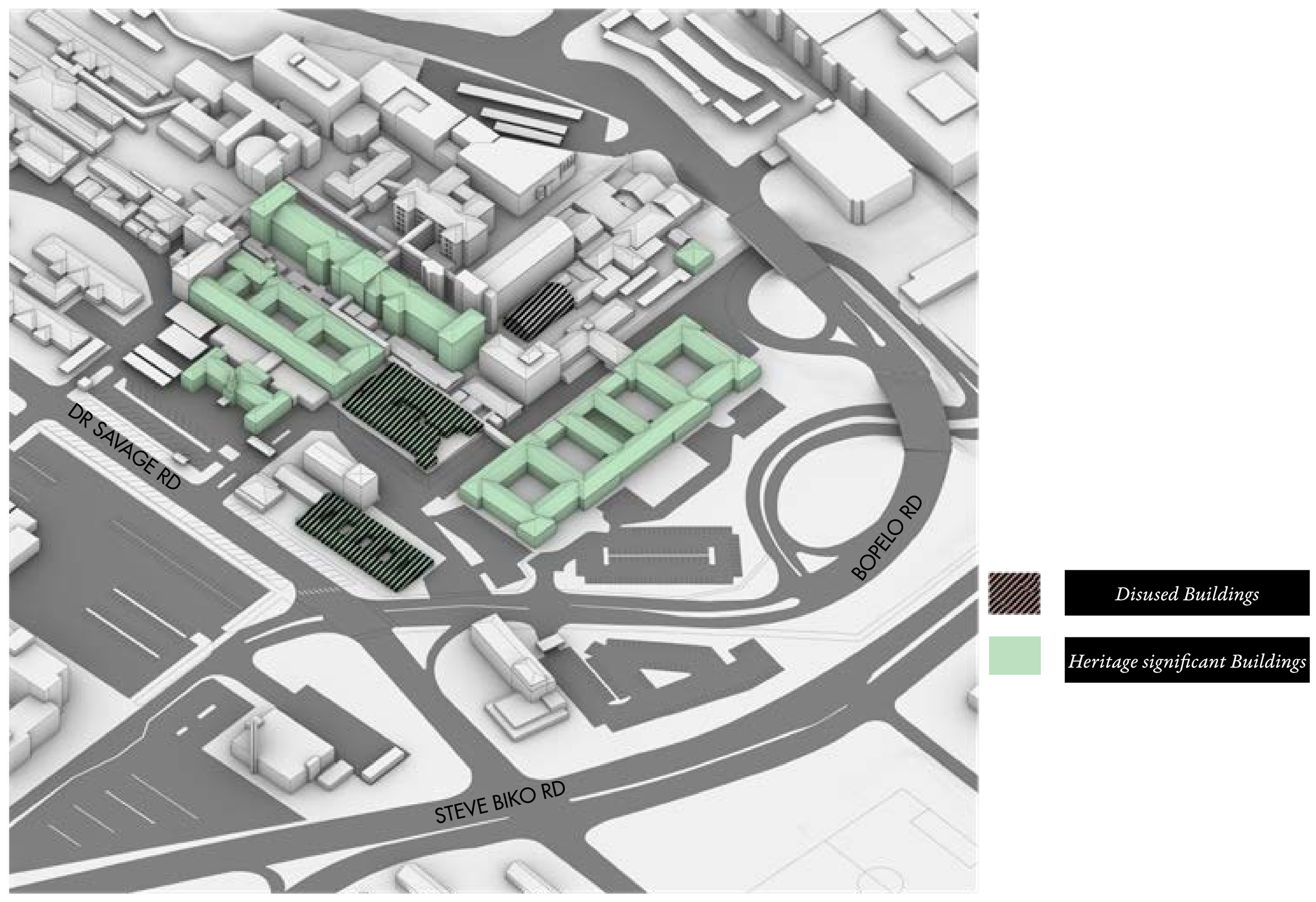
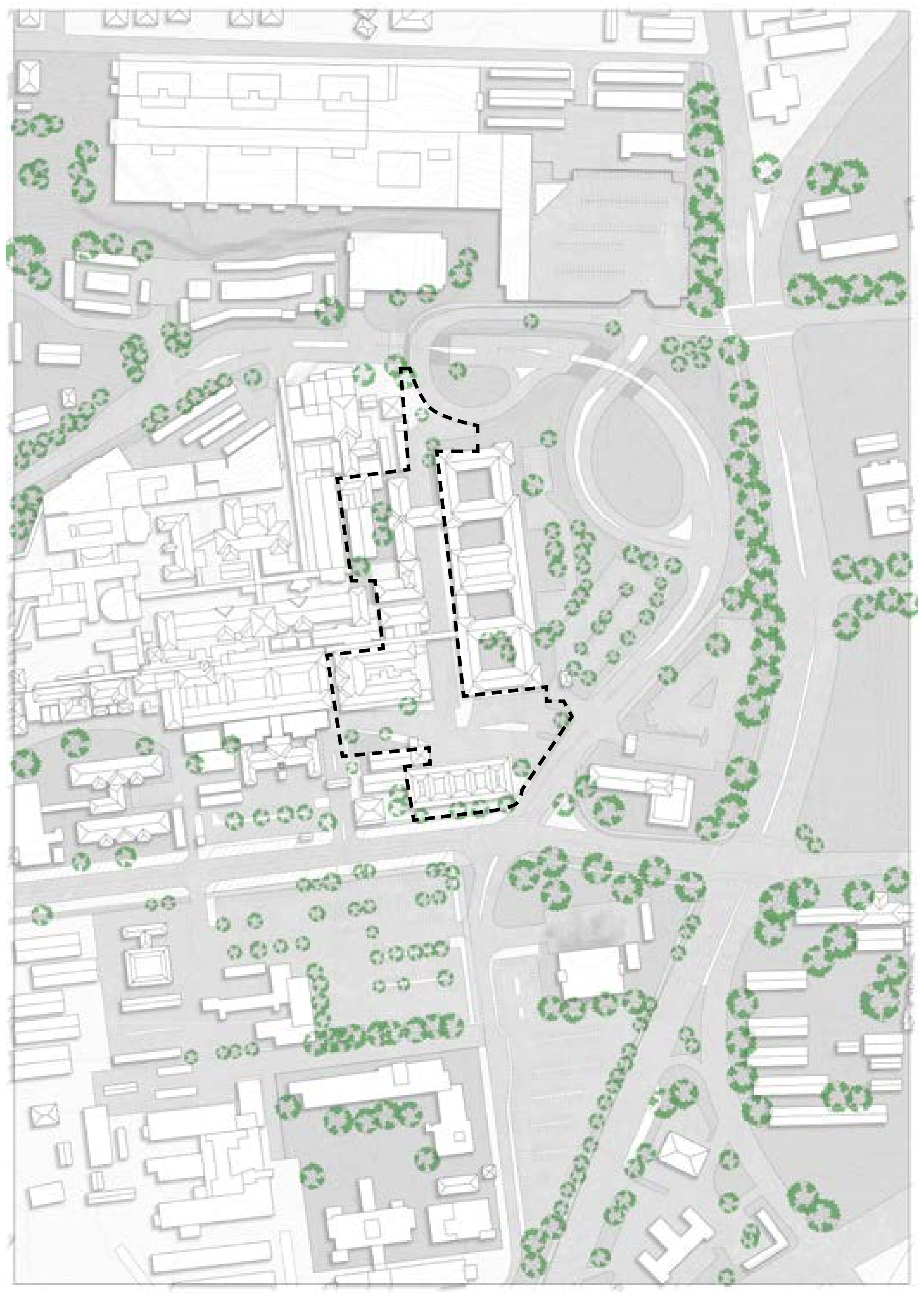
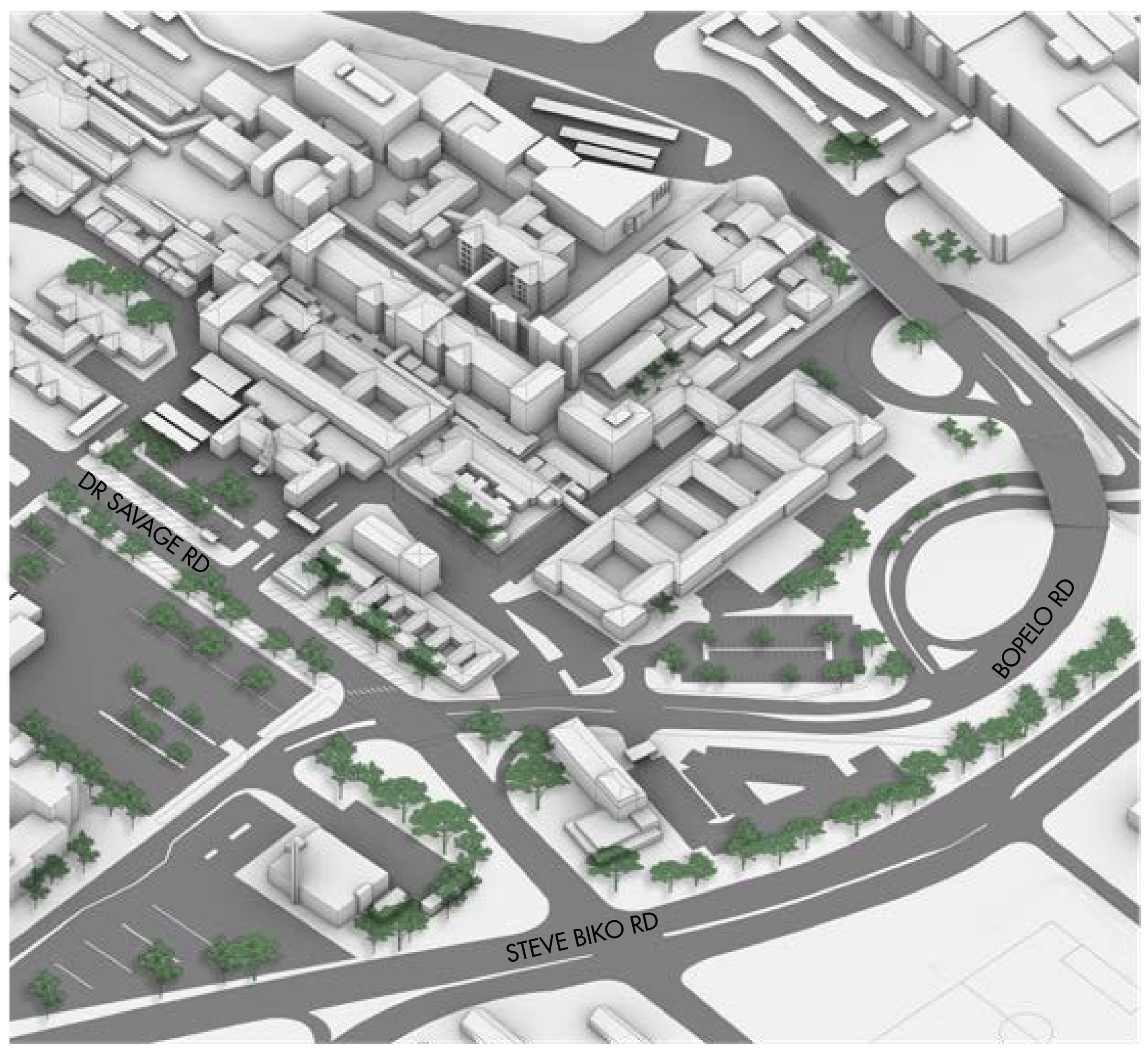
Heritage Status And Building Use



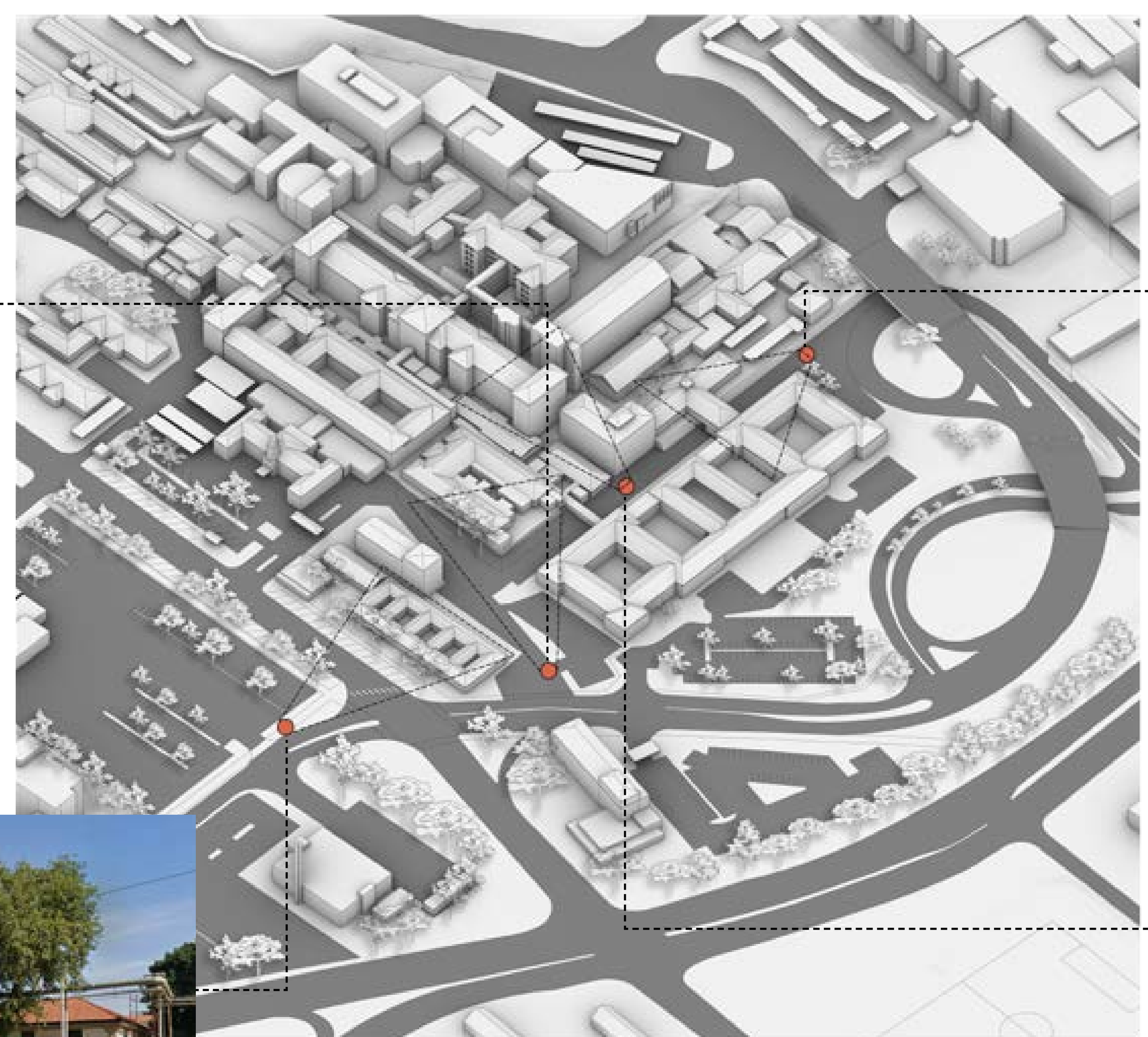


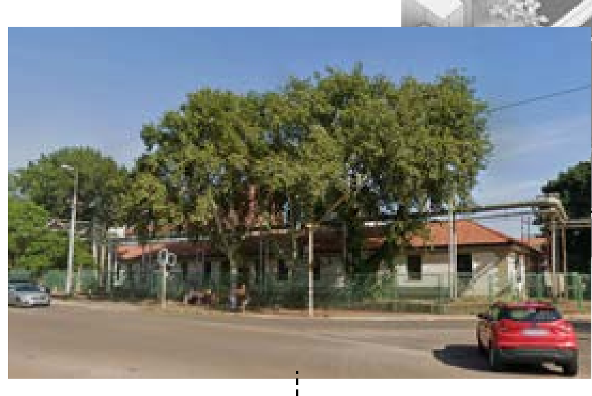
Trees And Vegetation

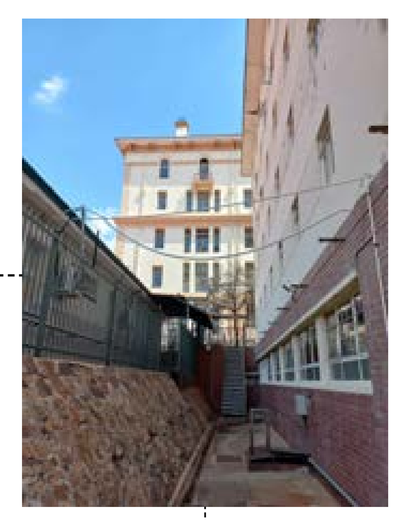




Ownership Boundaries and Site Location







PROJECT LOCATION

SITE LOCATION AND CONTEXT

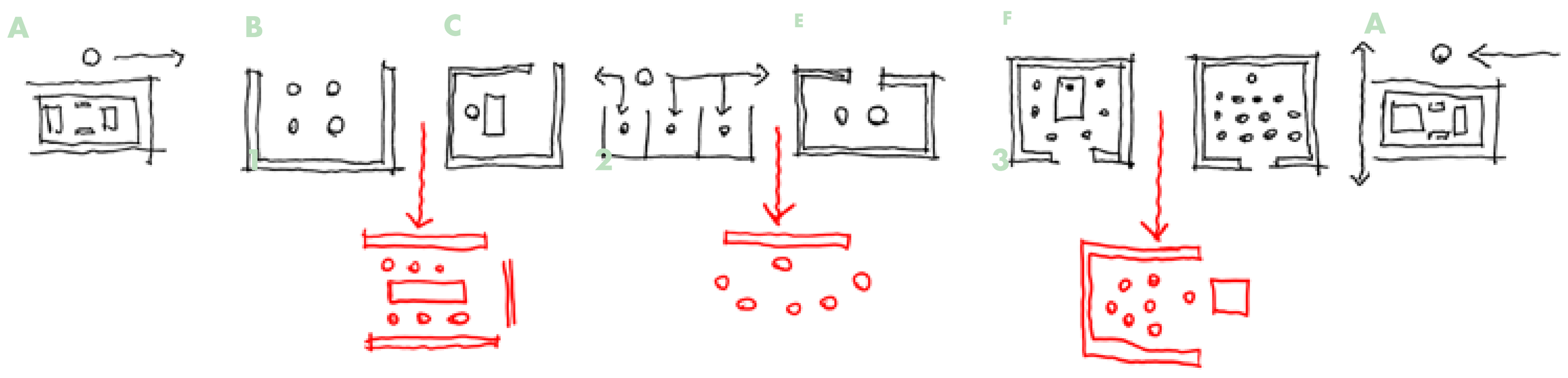
P R O J E C T   L O C A T I O N

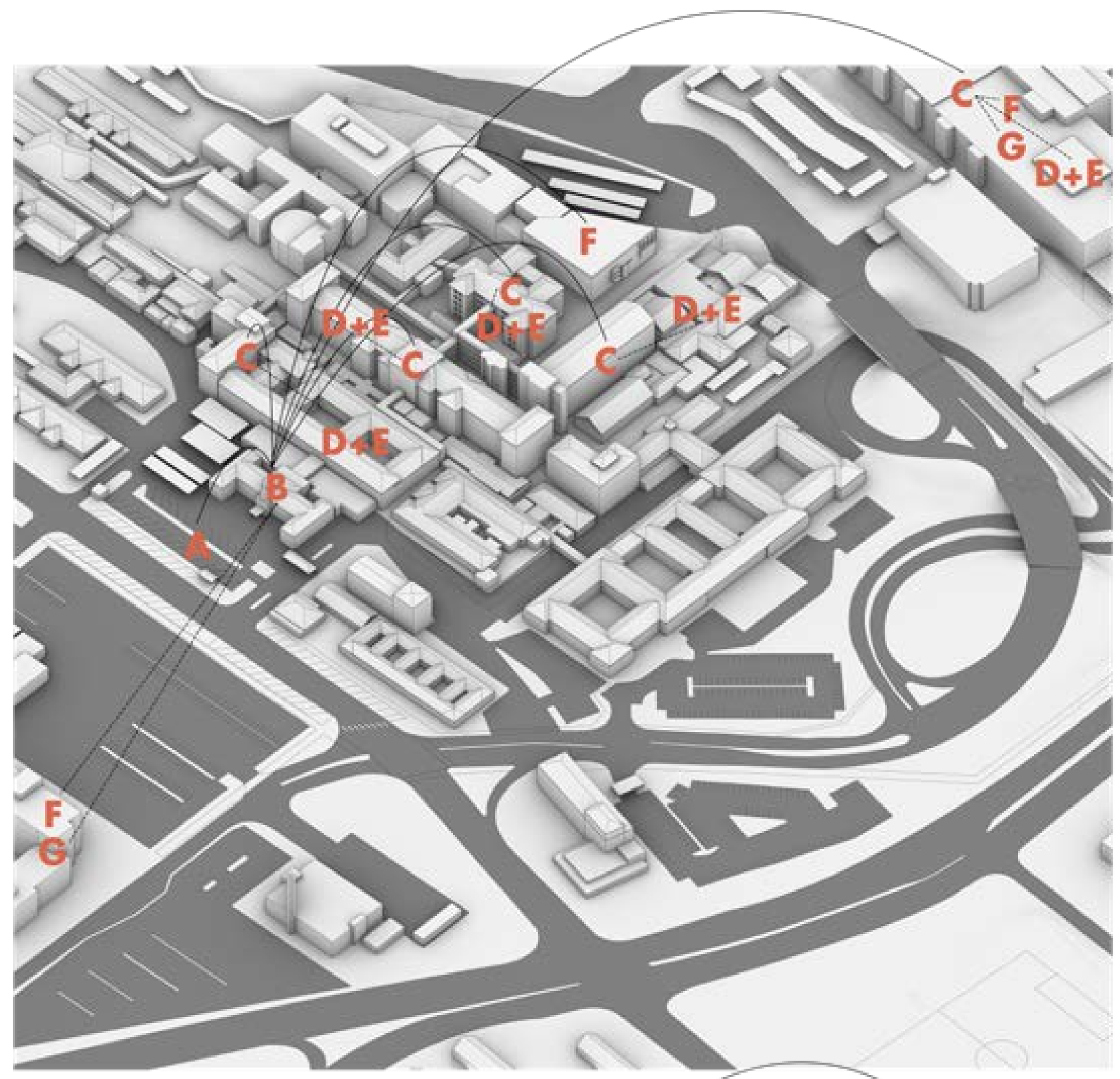
S I T E   L O C A T I O N   A N D   C O N T E X T

Users - Health Practitioners

A : Arrive / Depart (Private Transport)
B : Group meeting
C : Office work
D : See patients
E : See isolated patients
F : Teach medical practical
G : Teach class / seminar

1 : Join research efforts
2 : Engage with public
3 : Teach through research

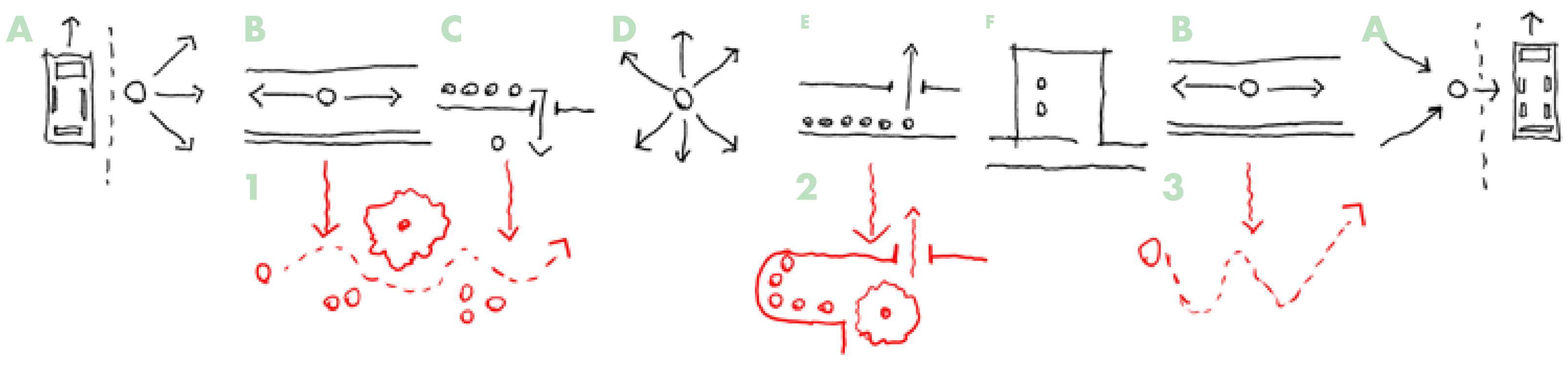


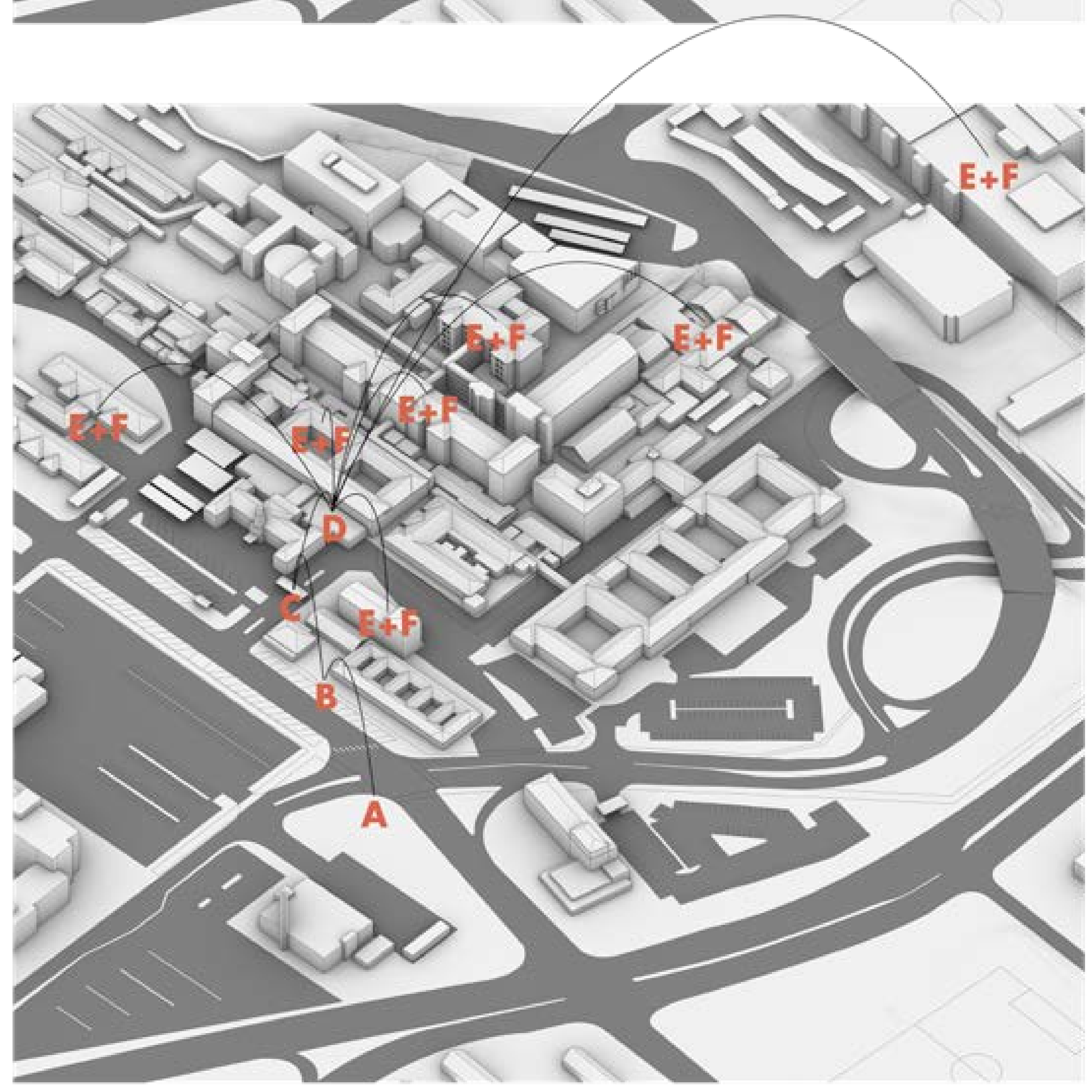


Users - Patients

A : Arrive / Depart (public transport)
B : Walk along boundaries
C : Wait for site entry
D : Directed
E : Wait for medical service
F : Receive medical service

1 : Green public space walk
2 : Healthy waiting spaces
3 : Green public space walk

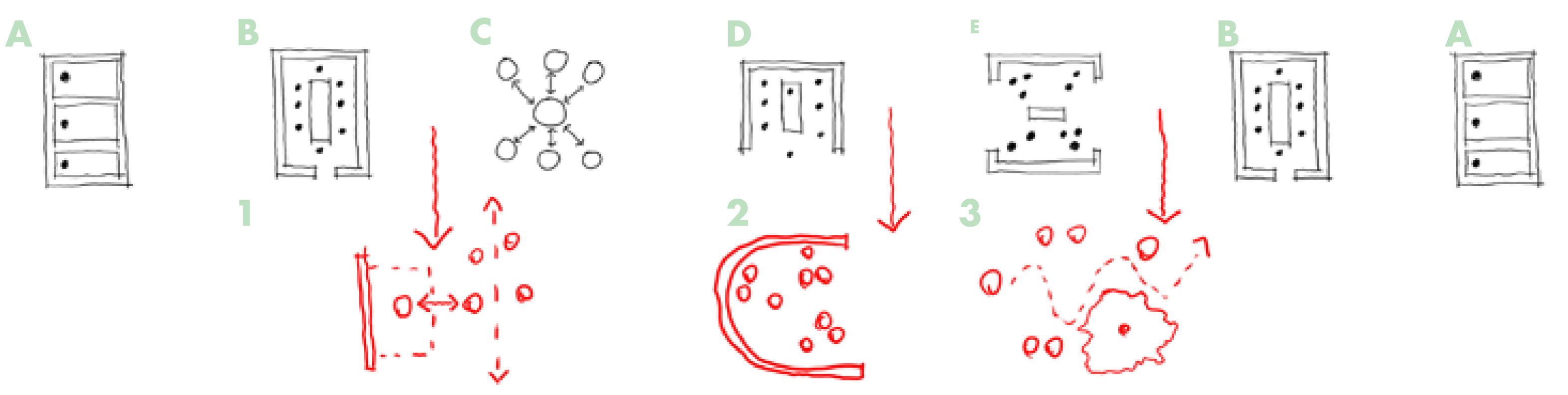


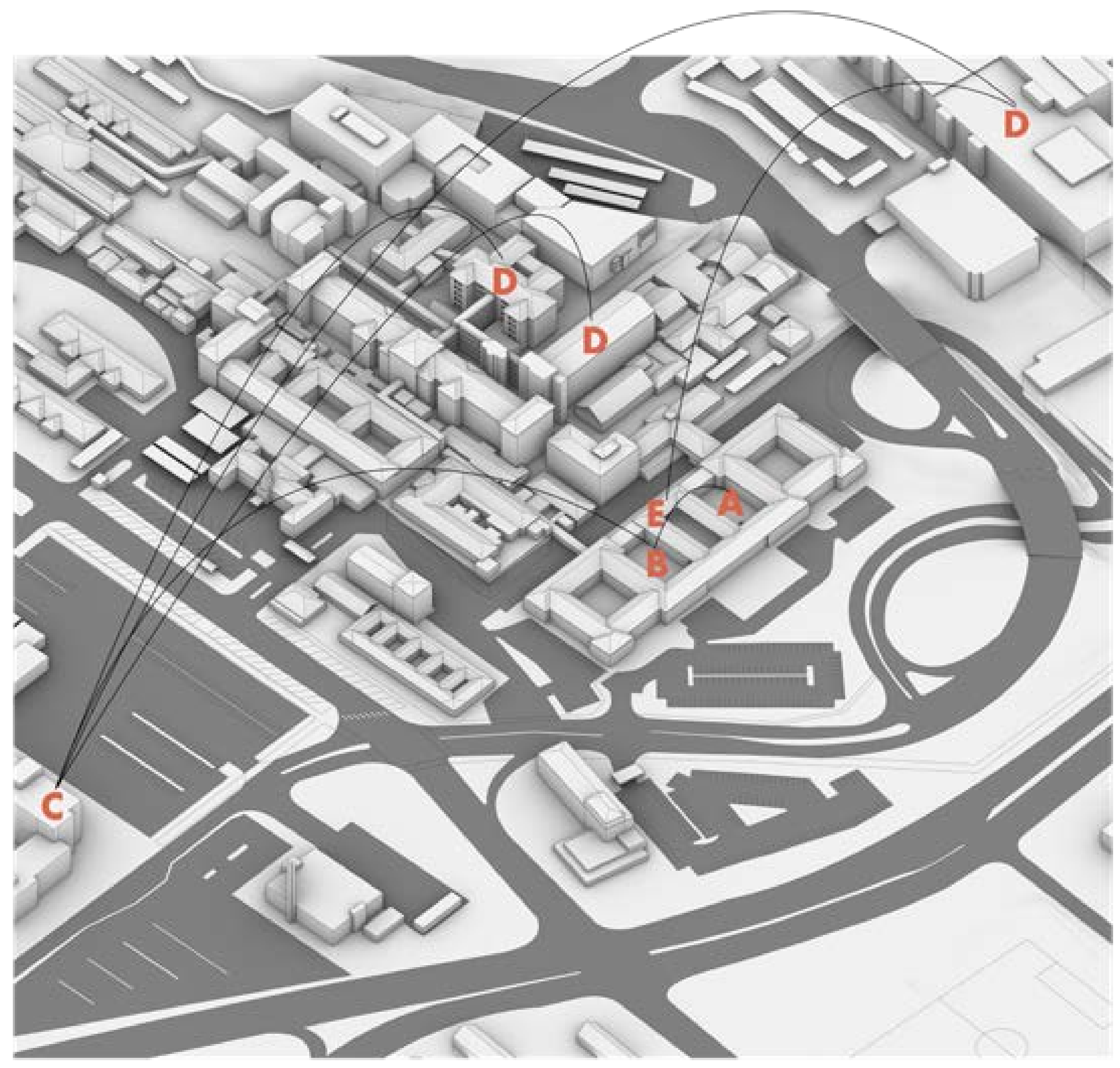


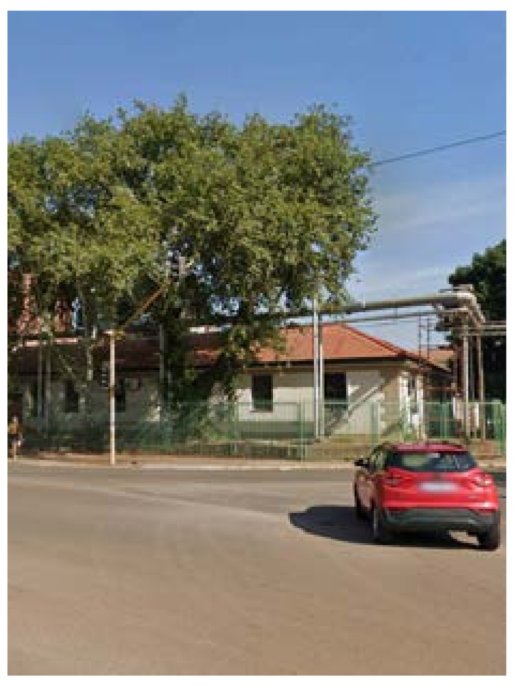
Users - Students

A : Private Room
B : Communal dining
C : Various Classes
D : Medical classes with patients
E : Socialising

1 : Community work
2 : Community engagement and learning
3 : Green public space







Site/street interface bordered by existing building

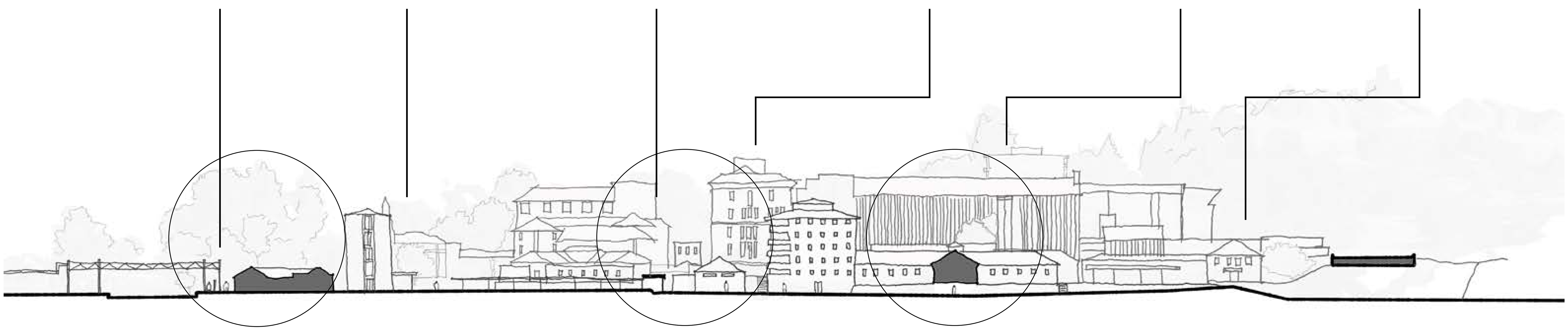
Open space in front of tall ODP building

Covered walkway blocking axis

Narrow alleyways and scale differences

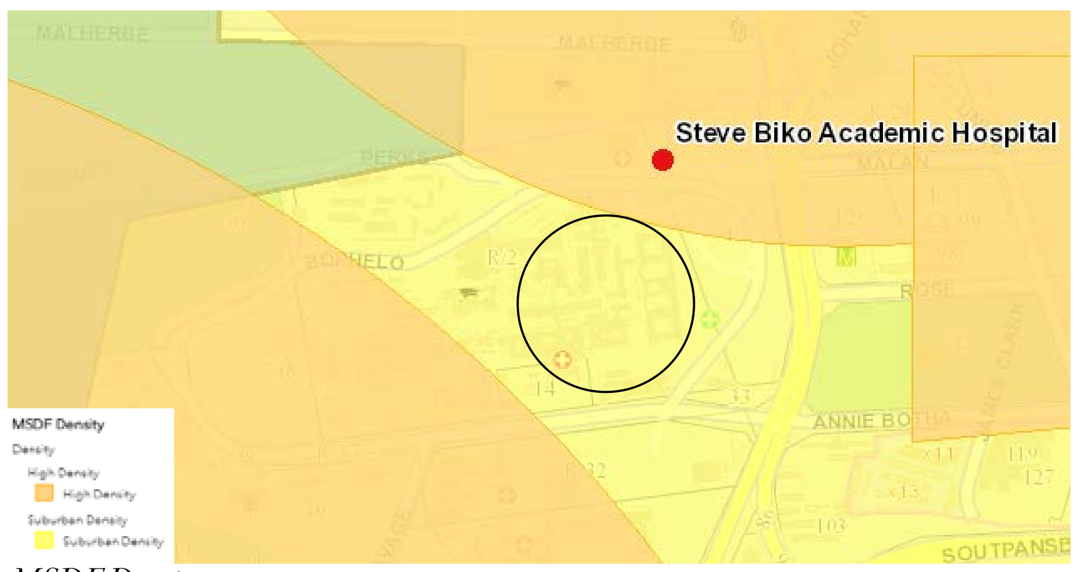
Level differences

End of axis terminating in public road leading to Steve Biko entrance

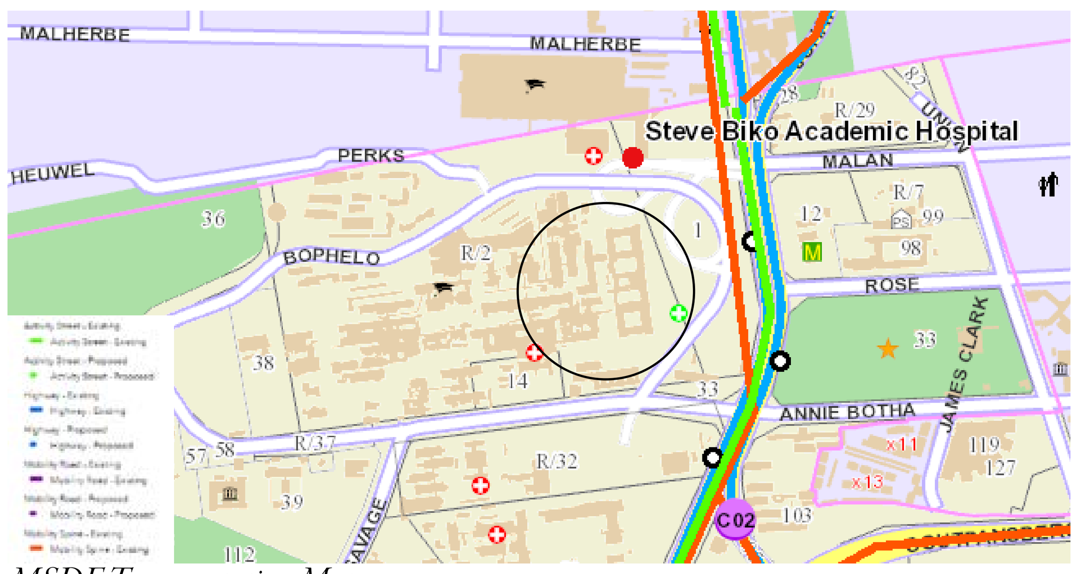


URBAN FRAMEWORK

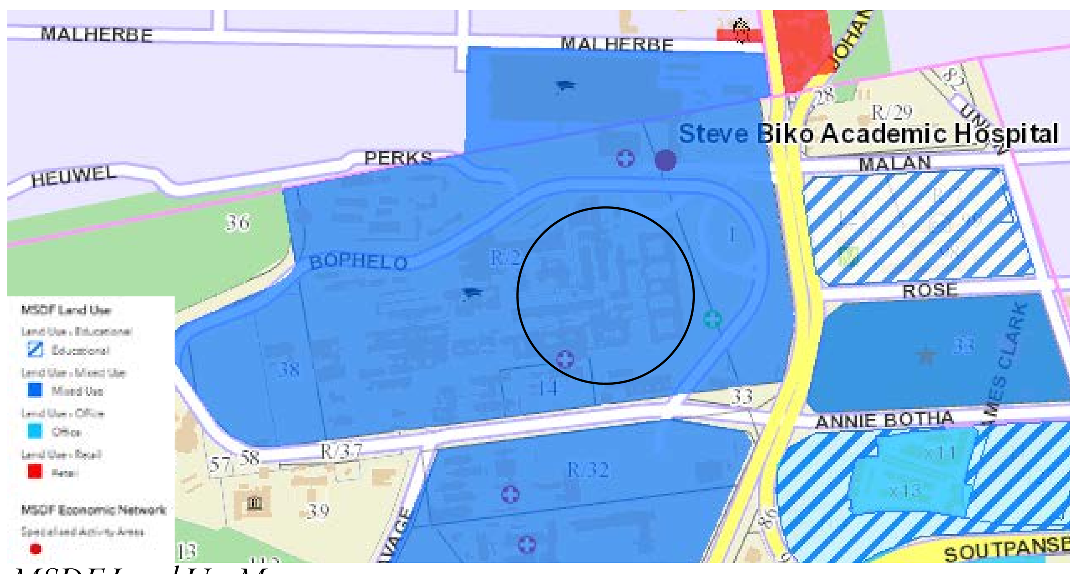
EXISTING AND NEW URBAN CONDITION



MSDF Density map

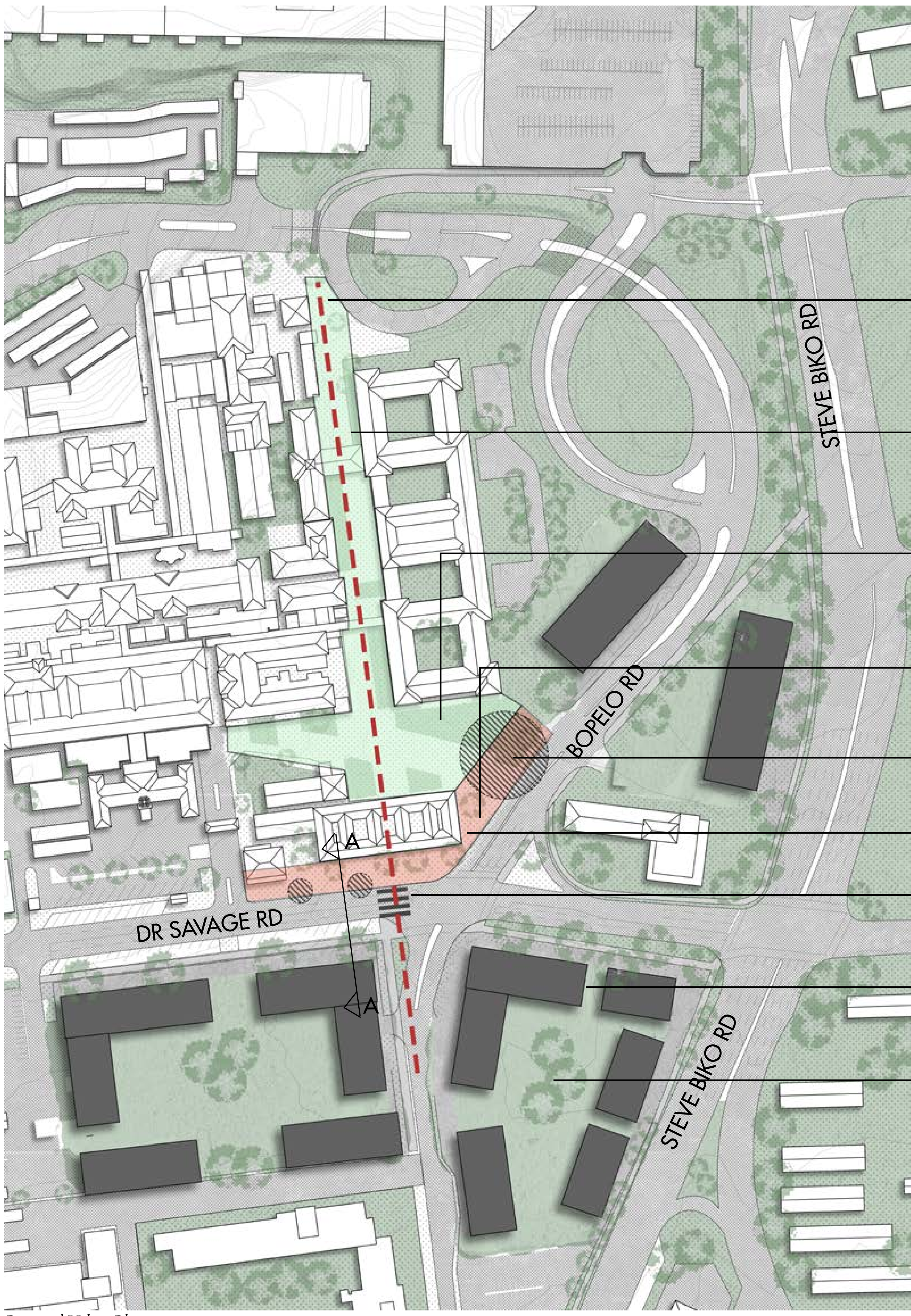


MSDF Transportation Map



MSDF Land Use Map

MSDF Nature Conservation Map



Pedestrian axis through the site connecting the medical campus with the academic hospital

Pedestrian public space between the hospital buildings

Green spaces replace pavement and parking spaces

Removal of fences to open the public plaza

Transportation node to ease patient acccess to the hospital

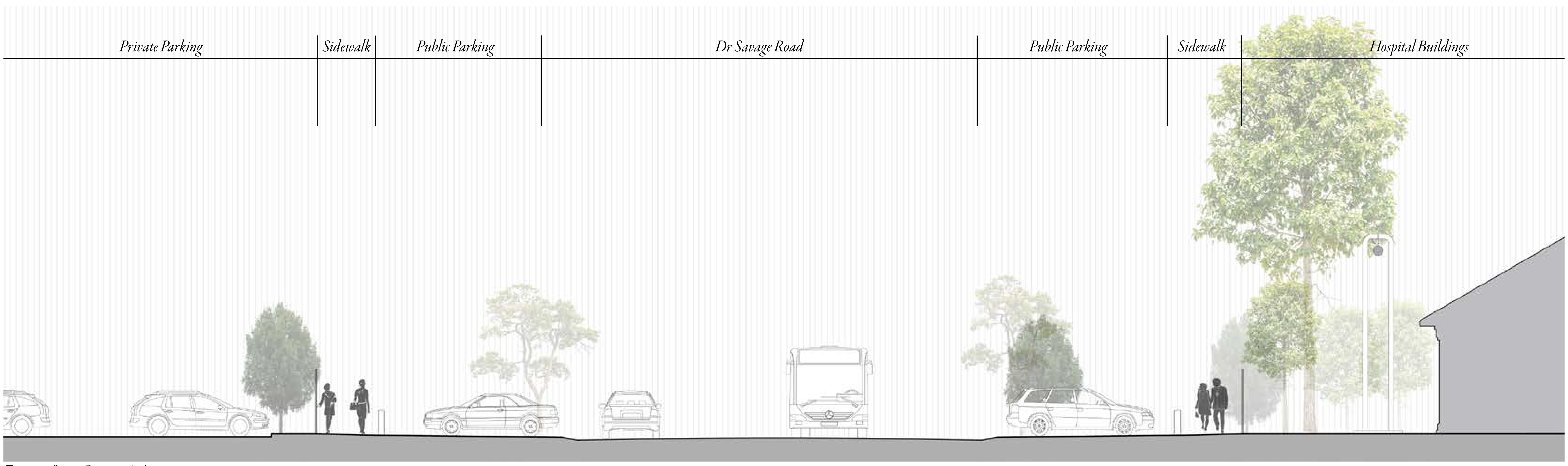
Street facing public space intergrating the buildings with pedestrian activity and routes

Improved pedestrian infrastructure

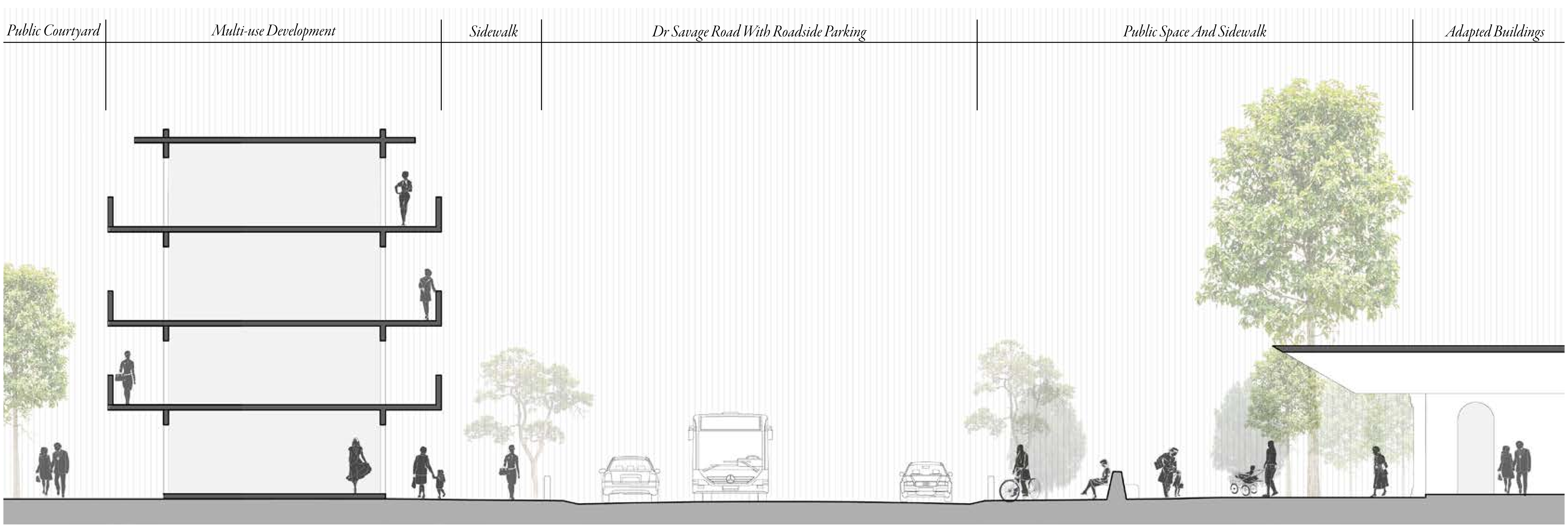
New mixed use developments (small retail and residential) in the place of underutilised parking spaces

Removal of the antiquated boiler room

Proposed Urban Plan



Existing Street Section A-A



Proposed Street Section A-A

E X I S T I N G   C O N T E X T

H E R I T A G E   A N A L Y S I S

The architectural and urban changes seen on the site are extensive and for the most part insensitive to the existing heritage and architectural narrative. The original hospital buildings on the site date back to 1932 and contain elements of significant heritage value. The buildings chosen for re-use harbor less historical importance while containing high usage value, value which is highly beneficial and sustainable if used correctly. The site contains noticeable layers of development forming a rich palimpsest that results in a fine-grained spatial quality of combined architecture, industrial infrastructure, and leftover spaces. The approach to this layered site is one of tabula plena, that celebrates the existing and preserves the narrative of the site.

1916
The site is chosen for the new Pretoria general hospital.

1927
The hospital, designed by J.S Cleland starts construction.

1932
The hospital is completed with future plans of expansion.

1943
The University of Pretoria Department of Medicine is established and the hospital gains academic status.

1947
First major additions are constructed.

1967
The hospital name is changed to the H.F Verwoerd Hospital following the treatment of the President after an assasination attempt.

~1977
The hospital celebrates its 70th anniversary. Multiple buildings are added to site and additions and alterations made.

1994
Apartheid laws are ended along with race segregation in healthcare

1997
The hospital name is changed to the Pretoria Academic Hospital

1980 - 2000
Major infrastructure changes are made around the hospital. The hospital complex is fenced off.

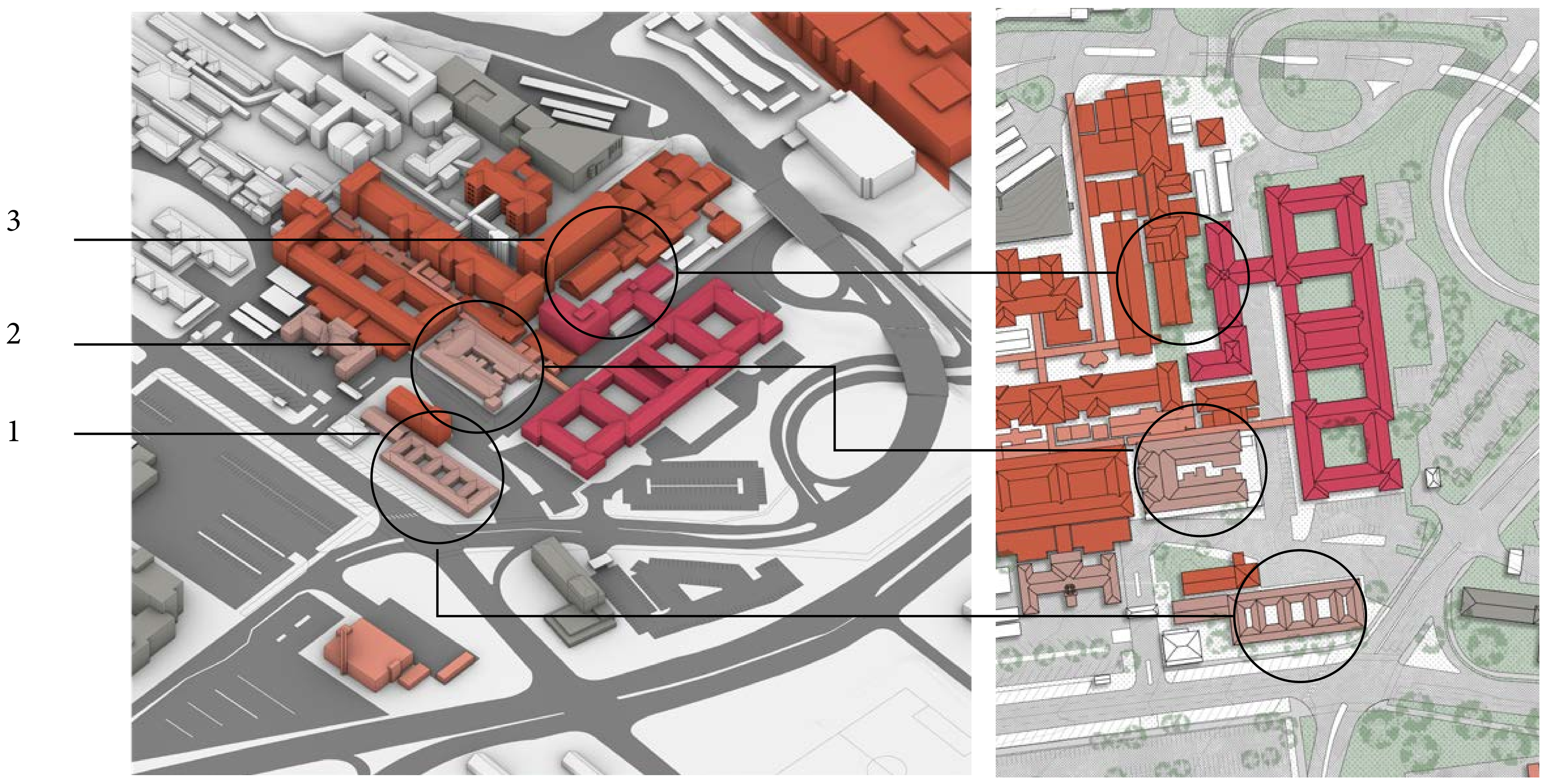
2008
The hospital name is changed to the Tshwane District Hospital. Many academic functions are moved to the new Steve Biko Hospital

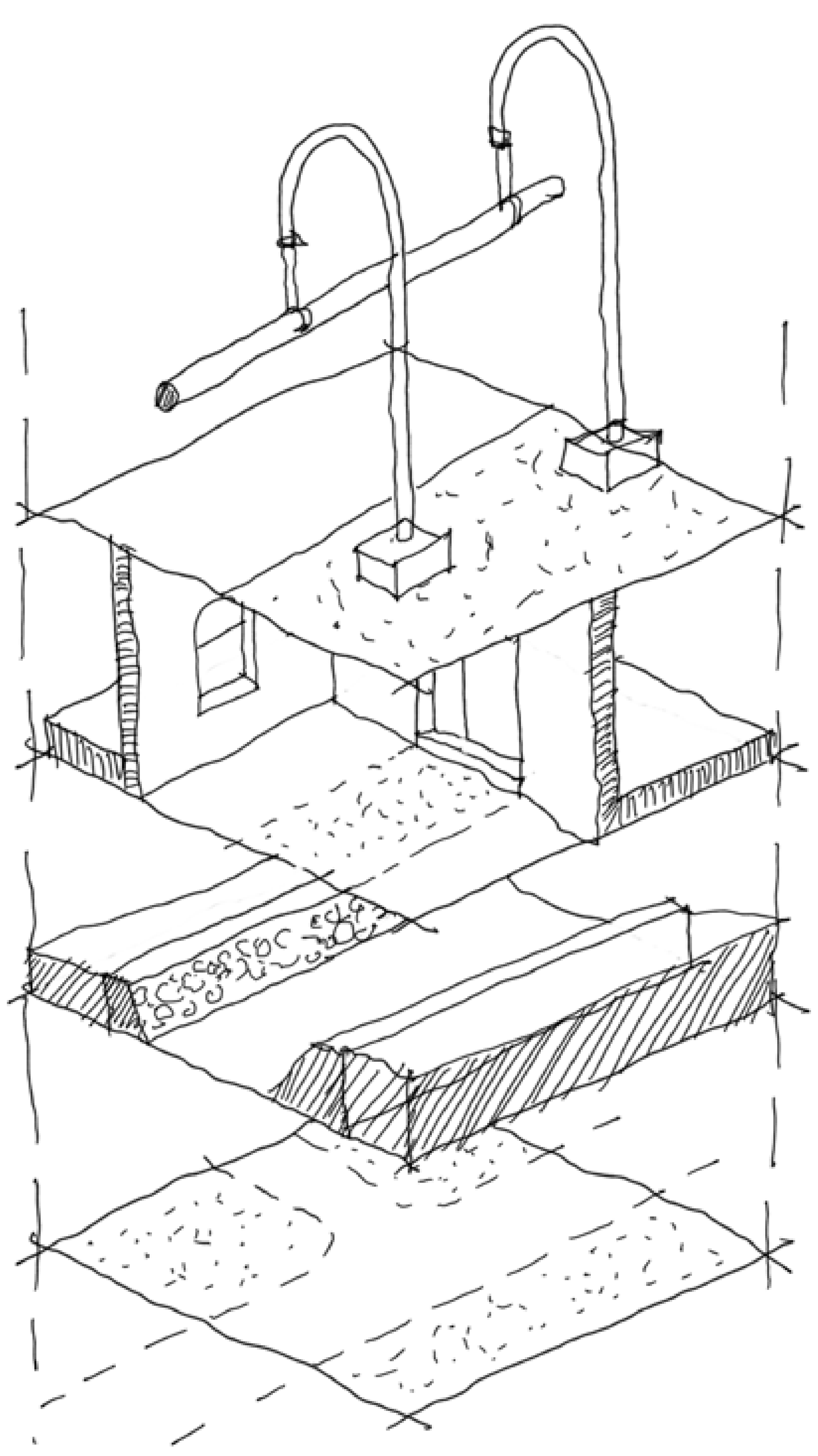
Racial Segregation

Academic Focus

Open Public Space

Development of the site over time. The complexity of the site increased over time and the urban intergration was negatively impacted with major infrastructure changes.



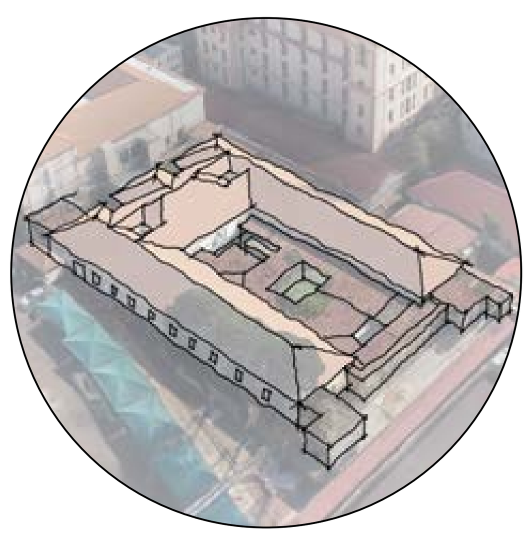


The heritage value and the use value of the existing buildings on the site provides opportunities for sustainable reuse that will add to the spatial quality of the site. The three main usable buildings are located in a sequencial order from South to North.

1

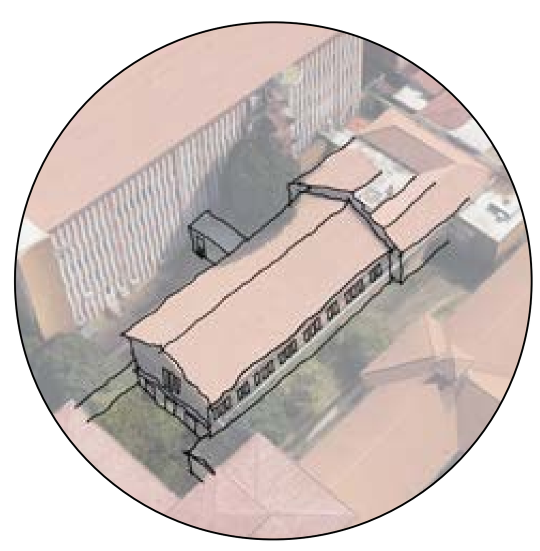
Building 1 is a part of the original complex constructed in 1932. It is half-used as an outpatient facility housing general practitioners and supporting functions.

2



Building 2 is also a heritage structure. It is currently unused and in poor condition.

3

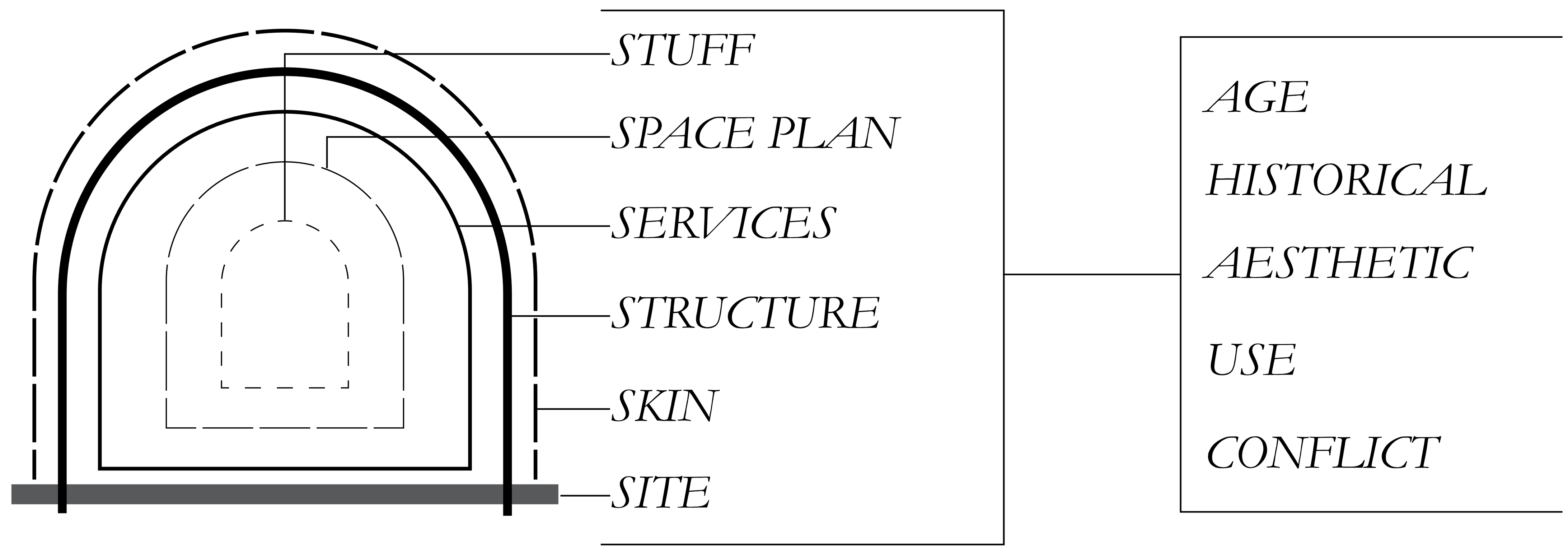


Building 3 was a part of the site expansion in the 1970s. It was formerly used as an Oncology section but is currently unused.

The site has clearly developed a great deal over time and now consists of multiple layers that was added to increase the effeciency of the services provided. This results in a complex site that interspersed with fragmented spaces and isolated buildings.

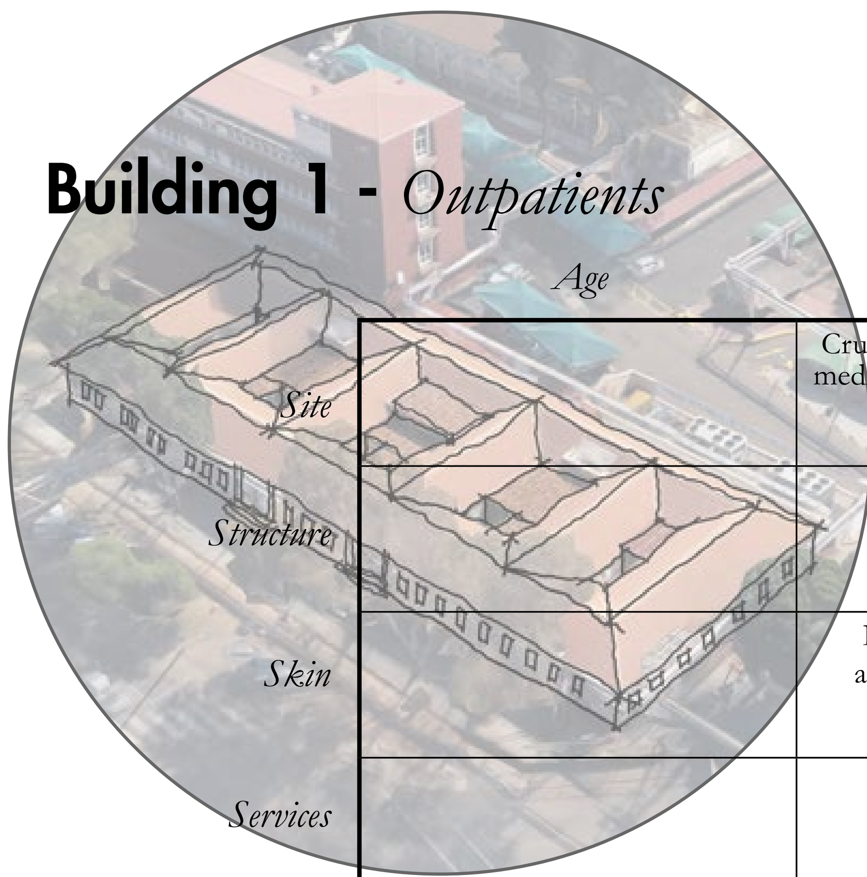
EXISTING CONTEXT

HERITAGE ANALYSIS



The architectural and urban changes seen on the site are extensive and for the most part insensitive to the existing heritage and architectural narrative. The original hospital buildings on the site date back to 1932 and contain elements of significant heritage value. The buildings chosen for re-use harbor less historical importance while containing high usage value, value which is highly beneficial and sustainable if used correctly. The site contains noticeable layers of development forming a rich palimpsest that results in a fine-grained spatial quality of combined architecture, industrial infrastructure, and leftover spaces. The approach to this layered site is one of tabula plena, that celebrates the existing and preserves the narrative of the site.

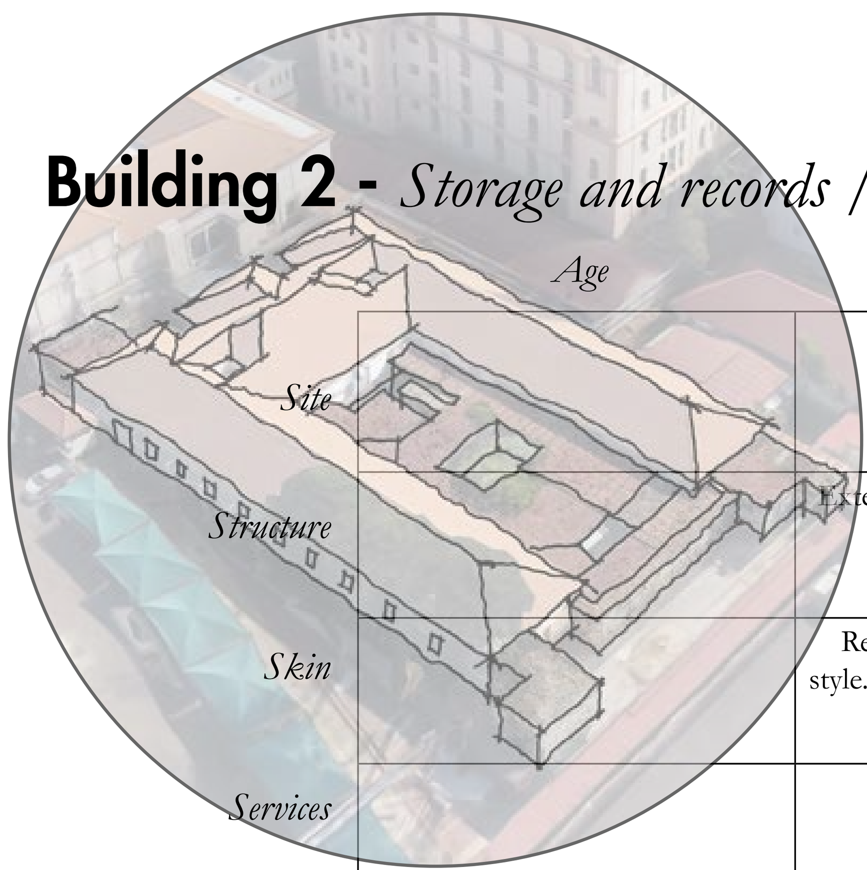
Building 1 - *Outpatients*



	Age	*Historical*	*Aesthetic*	*Use*	*Conflict*
Site		Crucial part of historically open medical campus. Was surrounded by pleasant public space	Greenery: the surviving trees create pleasant connections and spaces on the street facade	Critical location to connect the hospital to the streetscape	Current site conditions show conflict between public and organisation
Structure			Traditional masonry wall and timber roof construction. Thicker walls than normal	Structure is in tact	
Skin		Representation of Union architectural style with less embelishment	Details on facade: Plinth, pilasters, eave detailing	Building facade usable and adaptable	
Services					
Space Plan		Reflecting of the historical focus on the use of courtyards, hallways and formal entrances	Courtyards create focus sapces	Courtyard typology and linear plan layout carries potential for reuse	Original segragated entrances are bricked up but still decernable.
Stuff		Original furniture and windows present.	Unique built in furniture		

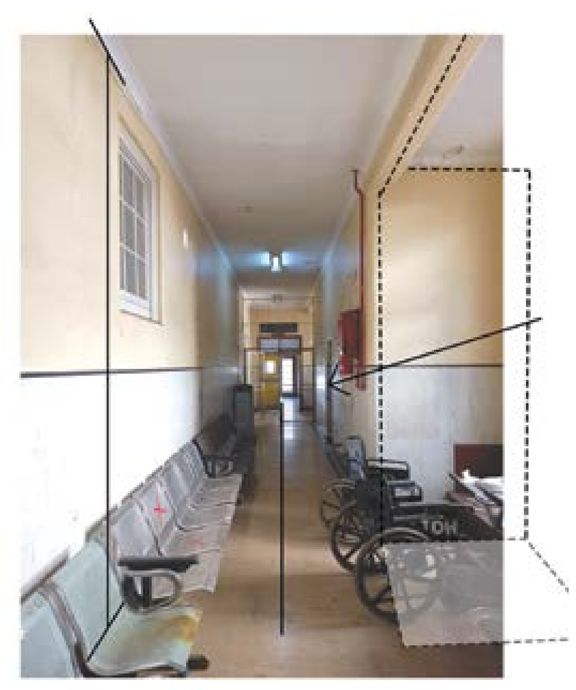
The outpatient building has been completely disconnected from the surrounding urban context when the street front was fenced off. The building entrance is now solely through neighbouring buildings as the original (racially segregated) entrances were bricked up. The valuable heritage elements are the facade paterns and orignal windows, facade details and courtyards. The courtyards were mostly roofed over.

Building 2 - *Storage and records / Disused*

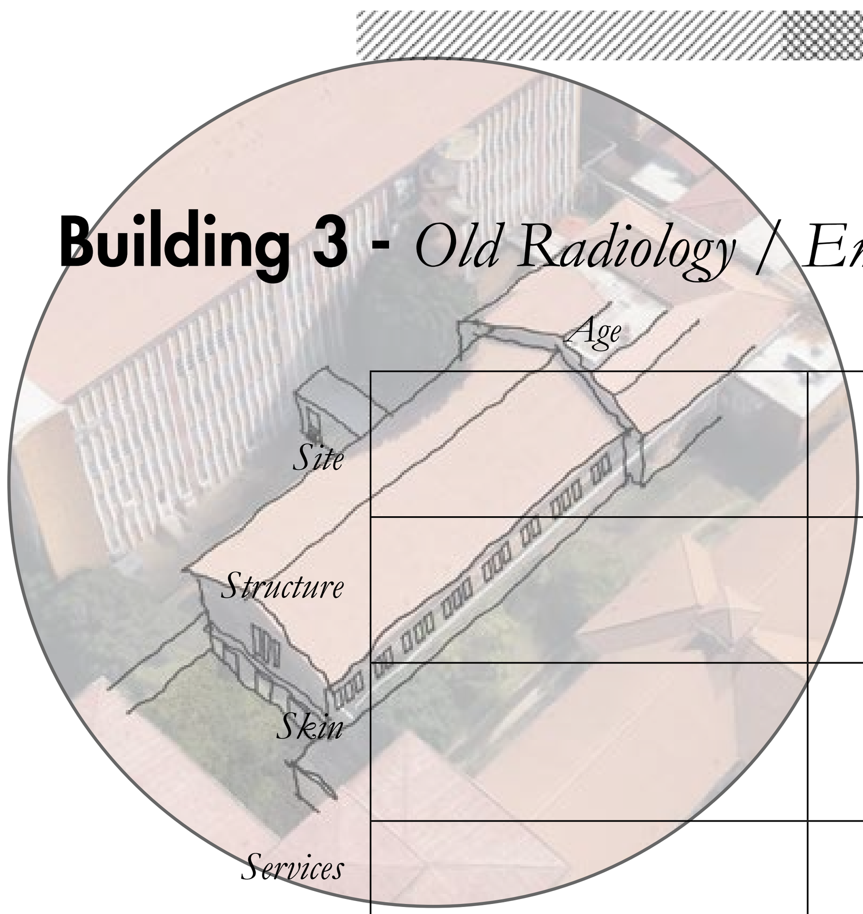


	Age	*Historical*	*Aesthetic*	*Use*	*Conflict*
Site			Building set on a retaining wall plinth	Site location is perfect for a primary maedical facility. Centrality and corner presence highlights the building	Spatial conflict created by retaining wall limiting access
Structure		Extensive changes were made to the building	Traditional masonry wall and timber roof construction. Thicker walls than normal	Structure is in tact	
Skin		Representative of the Union style. East facing patios are closed up	Details on facade: Plinth, pilasters, eave detailing	Skin intact and usable. Courtyard facades to be replaced	
Services					
Space Plan		U shaped courtyard was historically used for ventilation and natural light	Long and high hallways through out the building.	Courtyard design and room layouts reflec the historical focus on ventilation and natural light	
Stuff		Built in furniture ans original windows		Windows and furniture can be re-used	

Building 2 currently serves as storage only and has no medical use. The facade rythm, original interior elements and the impressive interior verticallity are valuable characteristics of the building. An original large courtyard has been filled in with structures which cuts off natural light and ventilation in parts of the building. The building sits atop a retaining wall which isolates it within the site.

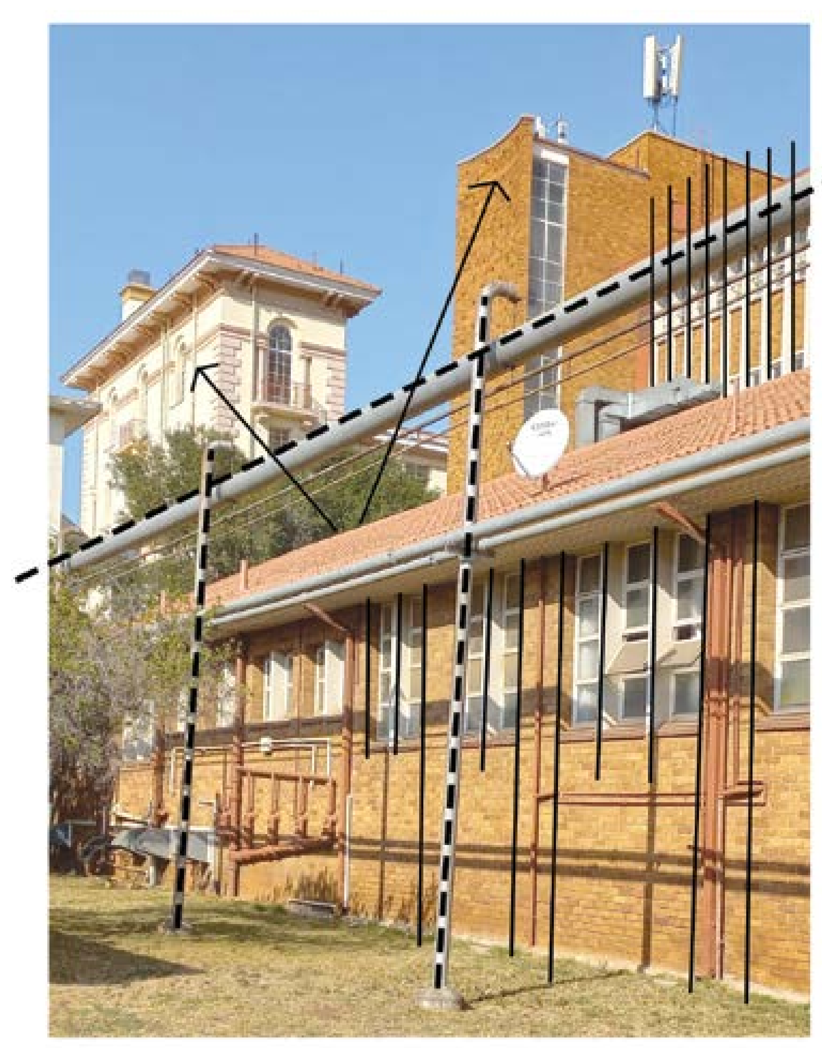


Building 3 - *Old Radiology / Empty*



	Age	*Historical*	*Aesthetic*	*Use*	*Conflict*
Site			Isolated site in the complex with trees and greenery	Isolated site condusive to private programmes. suncken courtyard connected to building	
Structure				Masonry walls, timber truss roof and concrete floor slab useable. Semi basement useable	
Skin			Building facade references Ward building to the east. Materiality reflect Pretoria vernacular architecture	building facade can be adapted	
Services					
Space Plan				Central hallway typology can be used and adpted	
Stuff					

While the old oncology building does not contain remrkable heritage elements, it is positioned in a unique setting on the site. It is located in a quiet corner of the site, surrounded by greenery (which is sparce elsewhere) and is connected to a sunken courtyard with a half-basement level. The floor level of the building is significantly higher than the natural ground level providing the opportunity for private spaces.

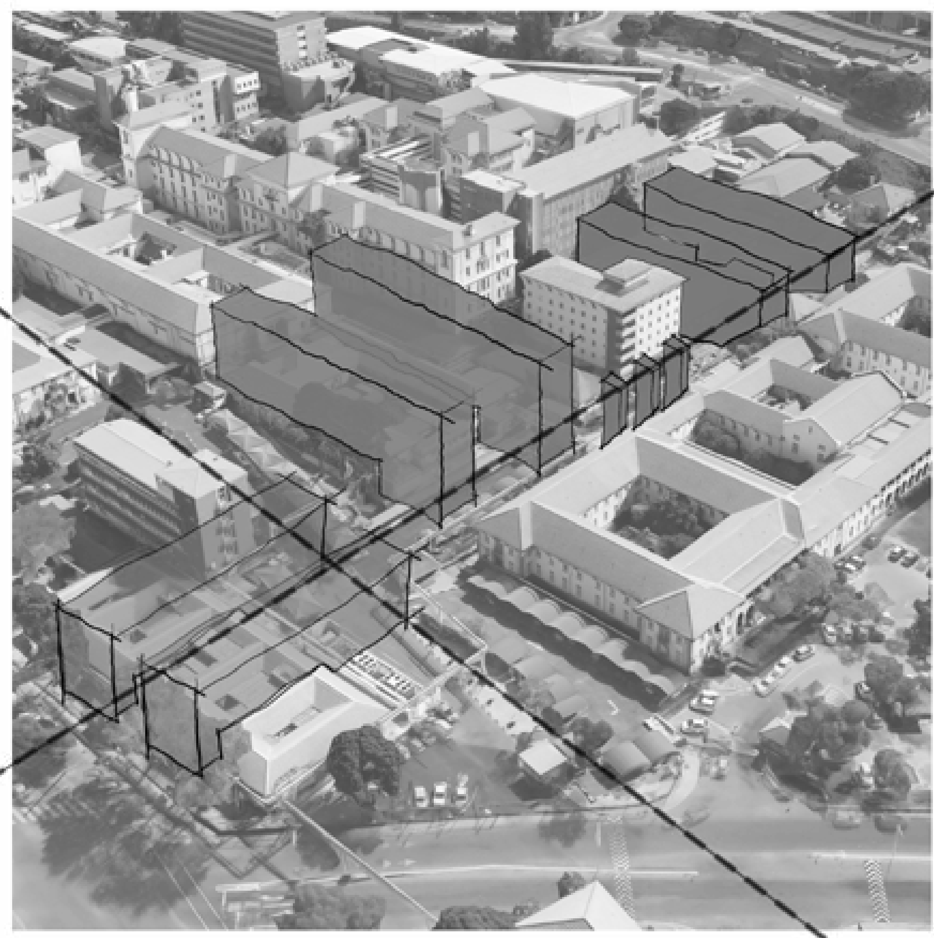


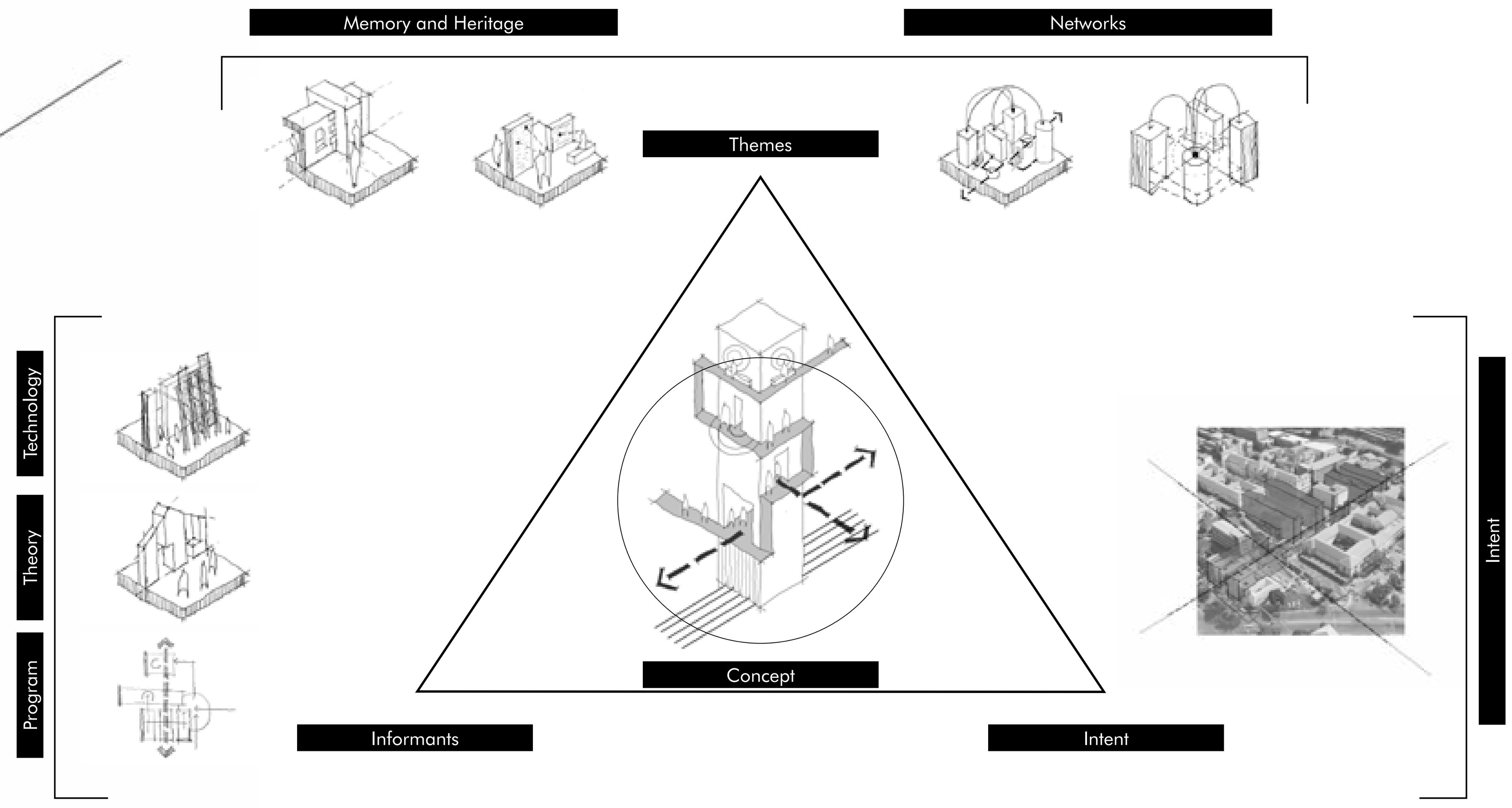
DESIGN ITERATION: FIRST

The first design iteration focused on the larger-scale usage of the site. The complex program involving various medical intervention levels and prototype research and manufacturing facilities was organized on the site and integrated with public space.

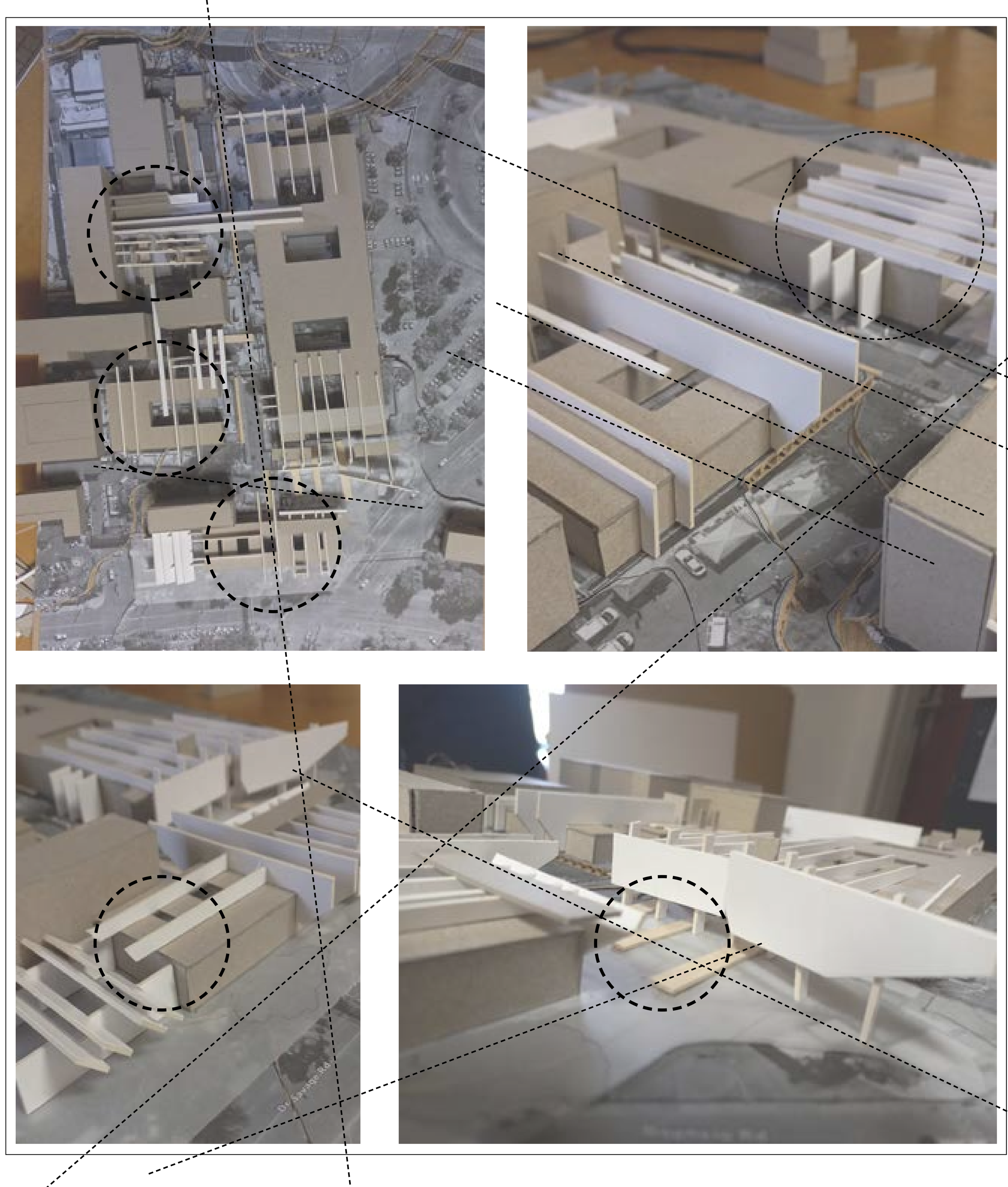
The public spaces were zoned to create boulevards and plazas between the hospital buildings. The function of these was to improve urban space articulation and provide flexible spaces where public activities could take place to improve public health education. An axis through the site was defined to connect other programs within the precinct and to improve urban circulation.

The programs were organized on the site by the hierarchy of medical intervention intensity along the internal boulevard that spans the North–South axis. This allows for varying levels of privacy for the buildings. The buildings that were to be used as re-used structures were identified and the conceptual response to the existing fabric was investigated.

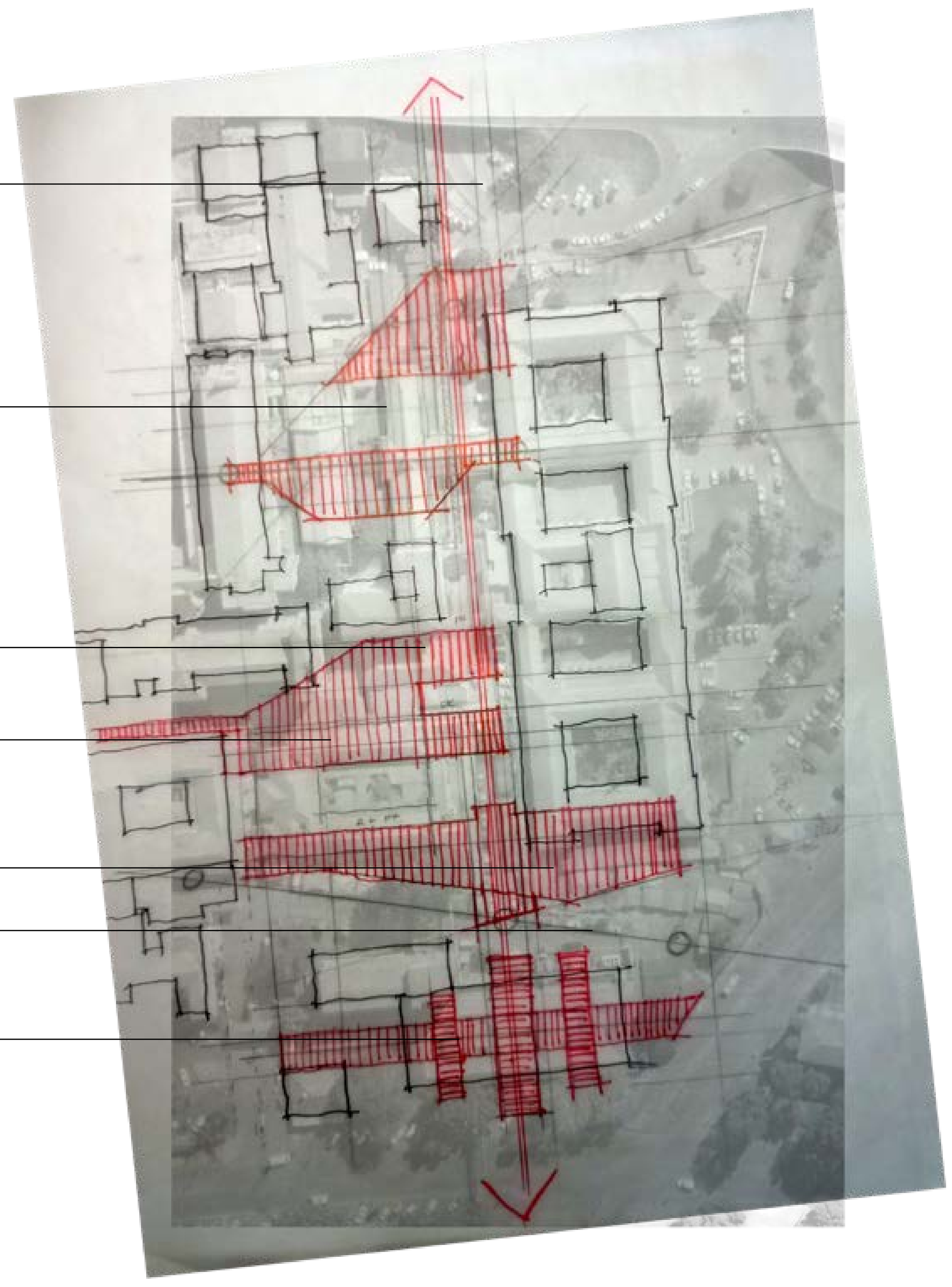




To create a holistic healing and research environment by utilising existing built infrastructure and networks through the adaptive reuse of healthcare infrastructure



Public Threshold and Interaction
Intensive Intervention
Memorial
Disease Treatment
Public Threshold and Interaction
Public Green Space
Community Health Research and Prototyping



Version 1

Public Threshold and Interaction
Intensive Intervention
Memorial
Disease Treatment
Public Threshold and Interaction
Public Green Space
Community Health Research and Prototyping

Version 3

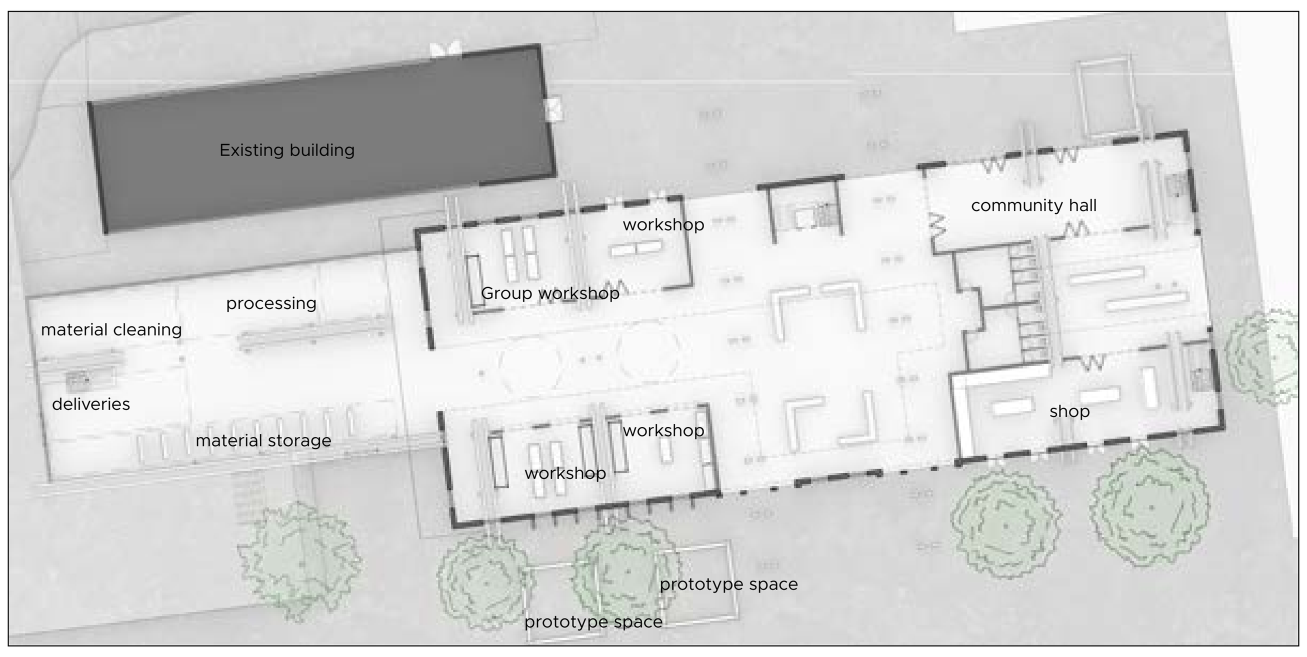
Public Threshold and Interaction
Intensive Intervention
Memorial
Disease Treatment
Public Threshold and Interaction
Public Green Space
Community Health Research and Prototyping

Version 2

Reflection: The zoning allocated for the programs was too large for the intended use. The construction technology that will be used needs to integrate with the existing building fabric as opposed to contrasting.

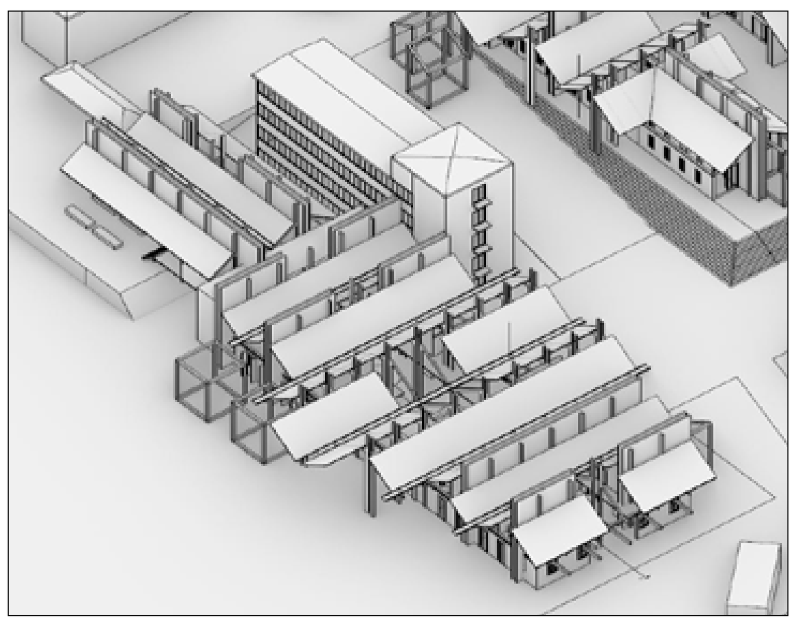
DESIGN ITERATION: SECOND

The second design iteration reduced the scope of the project and focused on the reuse of structures and materials and the construction system to be used. The concept developed focused on the insertion of spaces into the existing buildings by hollowing out the structures and reusing the internal materials and roof materials to compile a new structural system. This system is centred around cavity walls that serve as spatial and service anchors that cut through the existing buildings. The roof and first floor structure consist of mass timber frames and slabs fixed to the core walls. The buildings were programmed to have open and accessible ground floors with private functions on the first floor which was a new addition. The ground floor external walls of the existing buildings were to be kept as heritage elements of importance. The form exploration focused on the existing façade patterns and rhythm and the new roofs followed the existing roof angles. The programs were detailed for each building and the result was a clear definition and hierarchy in privacy and intimacy of the programs throughout the buildings. The Southern building housed the prototyping research offices, community meeting spaces, relocated shops and workshops. The central building on the site housed doctor's consultation rooms, rapid testing facilities, physio rooms and a laboratory. The final Northern building housed physio rooms, specialist consultation rooms and a dialysis clinic. The prototype manufacturing facility was placed on the main street façade to enable public interaction and recognition and to highlight its importance.



Building 1 Ground Floor Scale 1:500

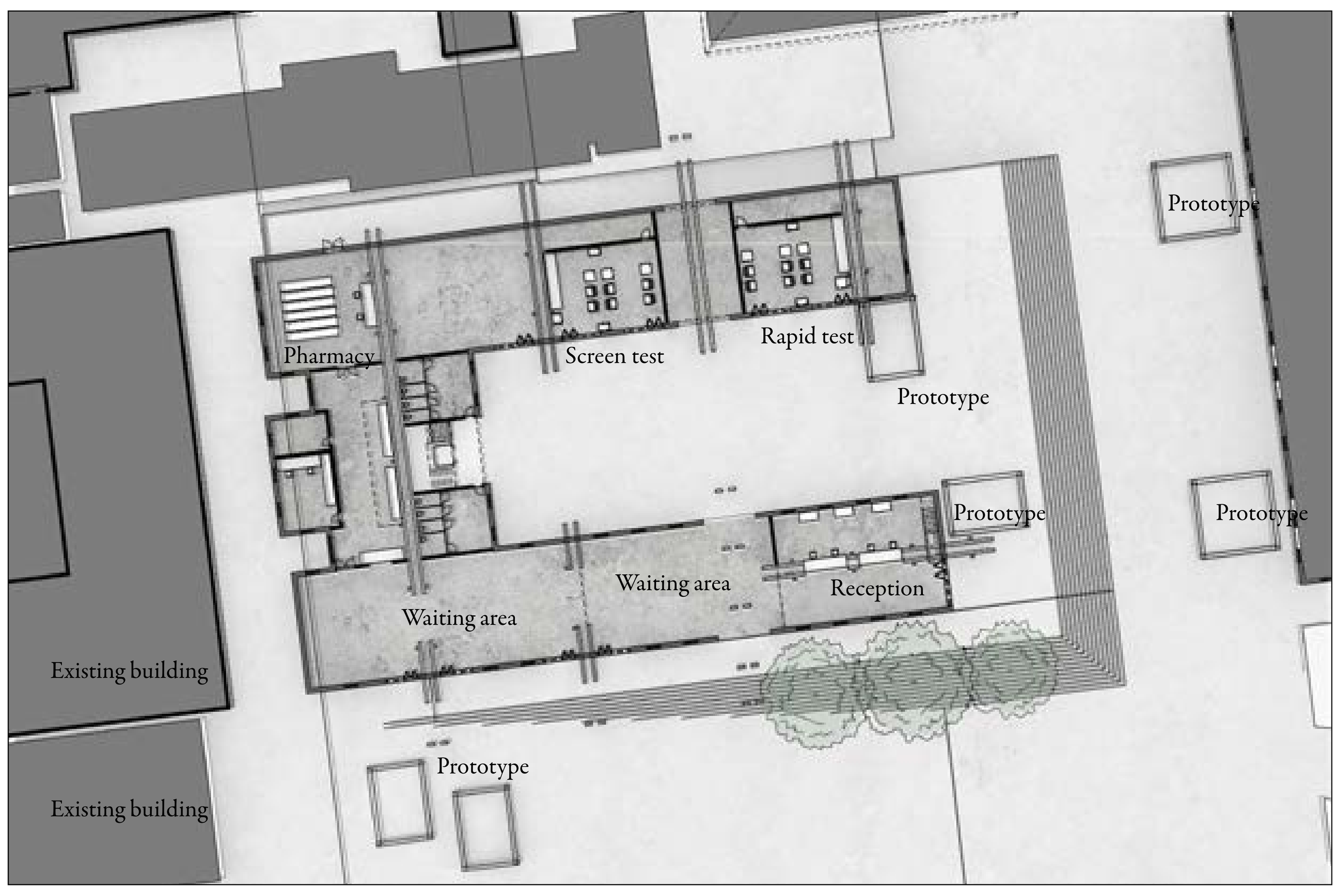
Building 1 First Floor Scale 1:500



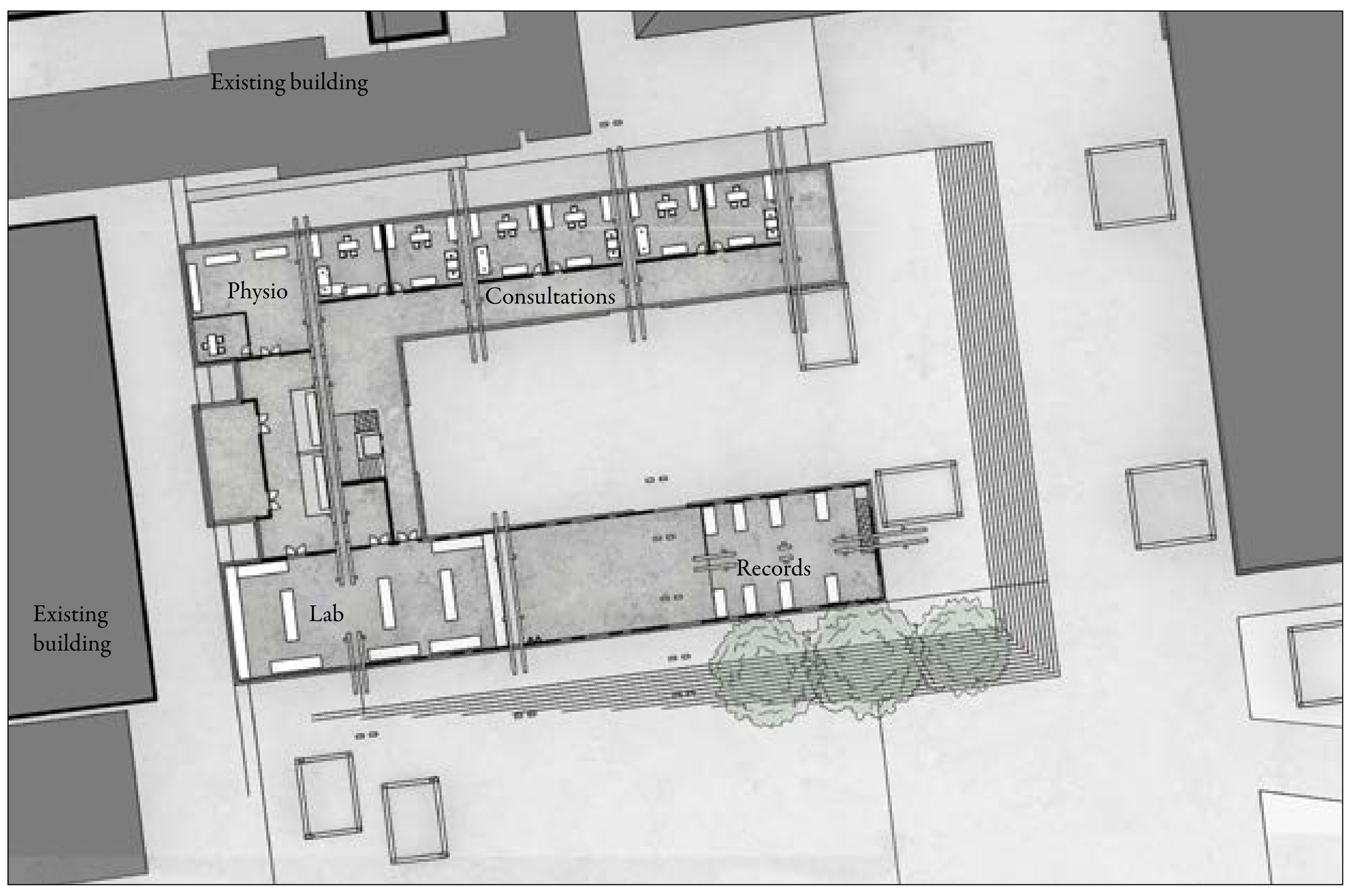
Axonometric of Building 1

1 Building 1 houses the community healthcare and intervention program offices and workspaces.

Site plan indicating buildings adapted and prototype testing stations Scale 1:1000



Building 2 ground floor Scale 1:500

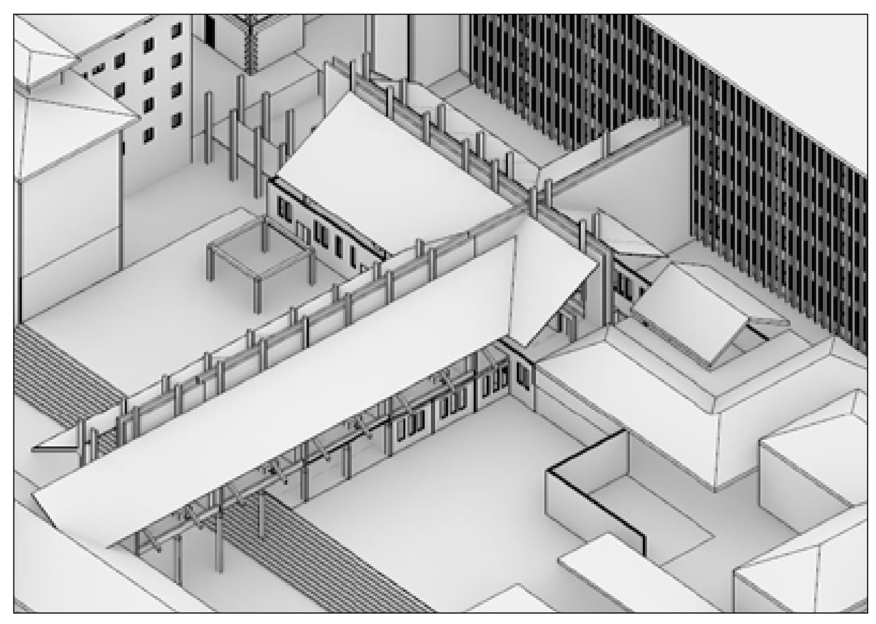


Building 2 first floor Scale 1:500

2 *Building 2 provides the first line of medical services. Basic testing and general consultations are provided*

Building 3 ground floor Scale 1:500

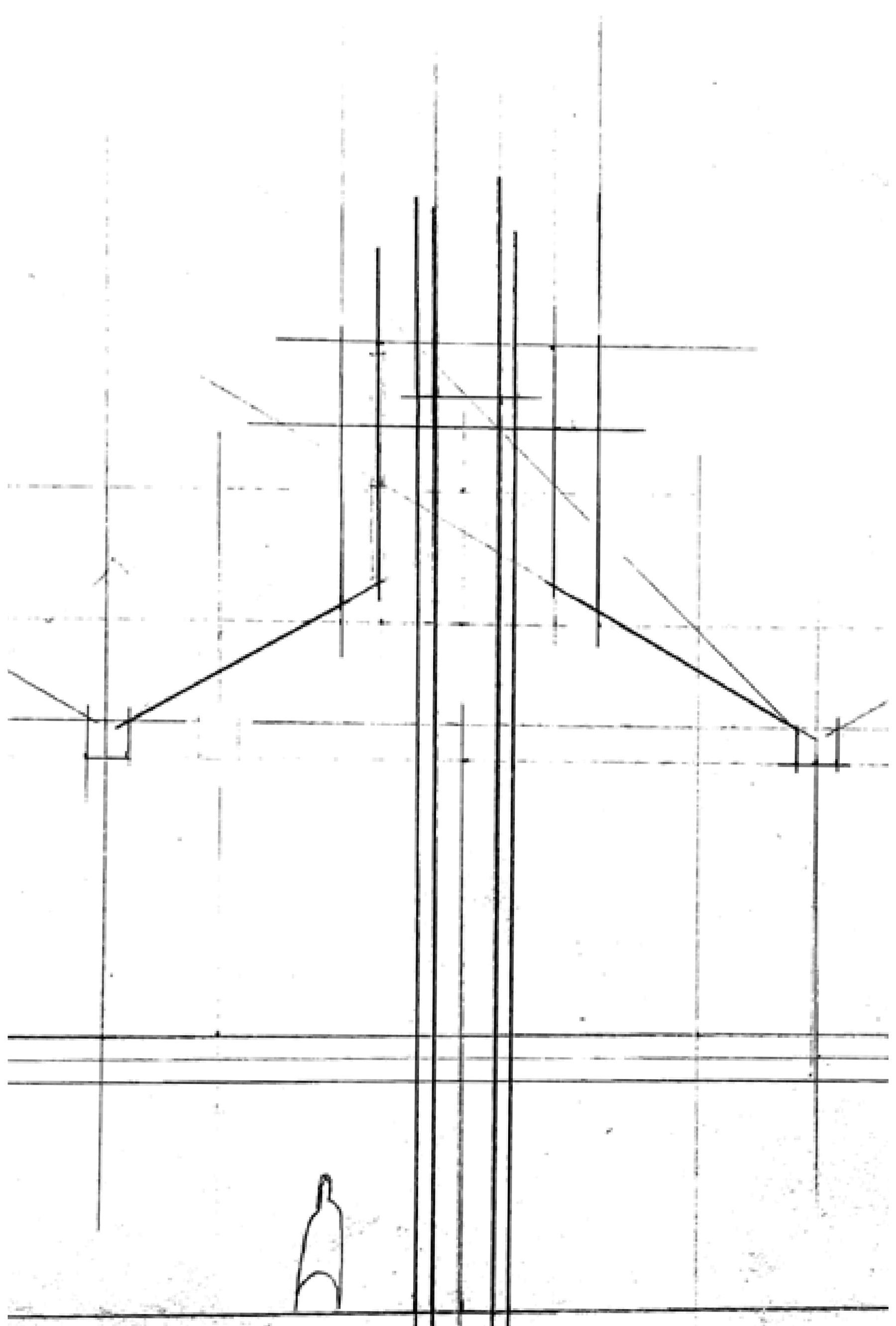
Building 3 first floor Scale 1:500

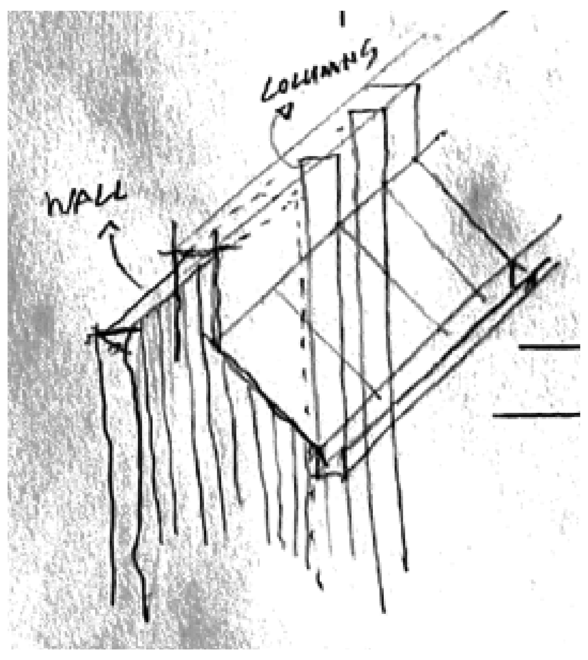


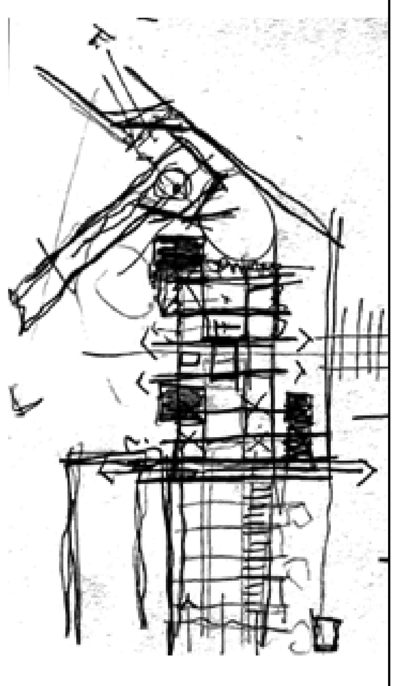
3 *Building 3 provides more intensive medical services. Specialist consultation, therapy and dialysis are programmed for the space.*

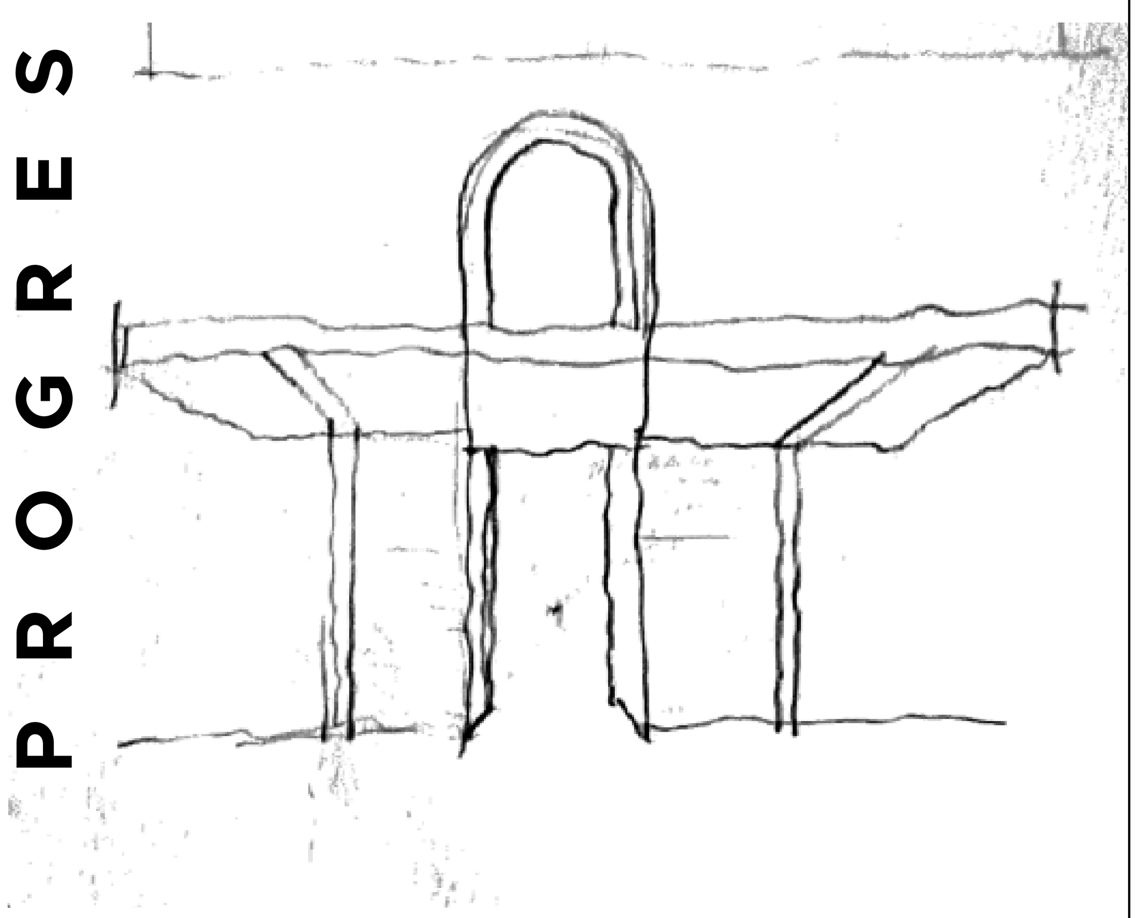
DESIGN ITERATION: SECOND

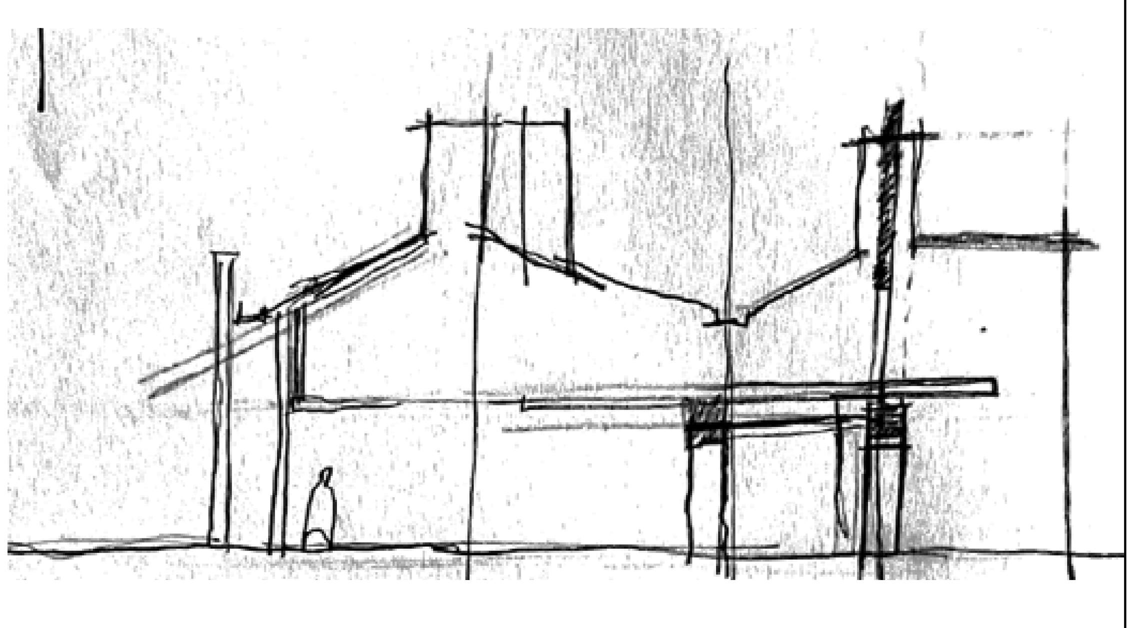
PROGRESS SKETCHES

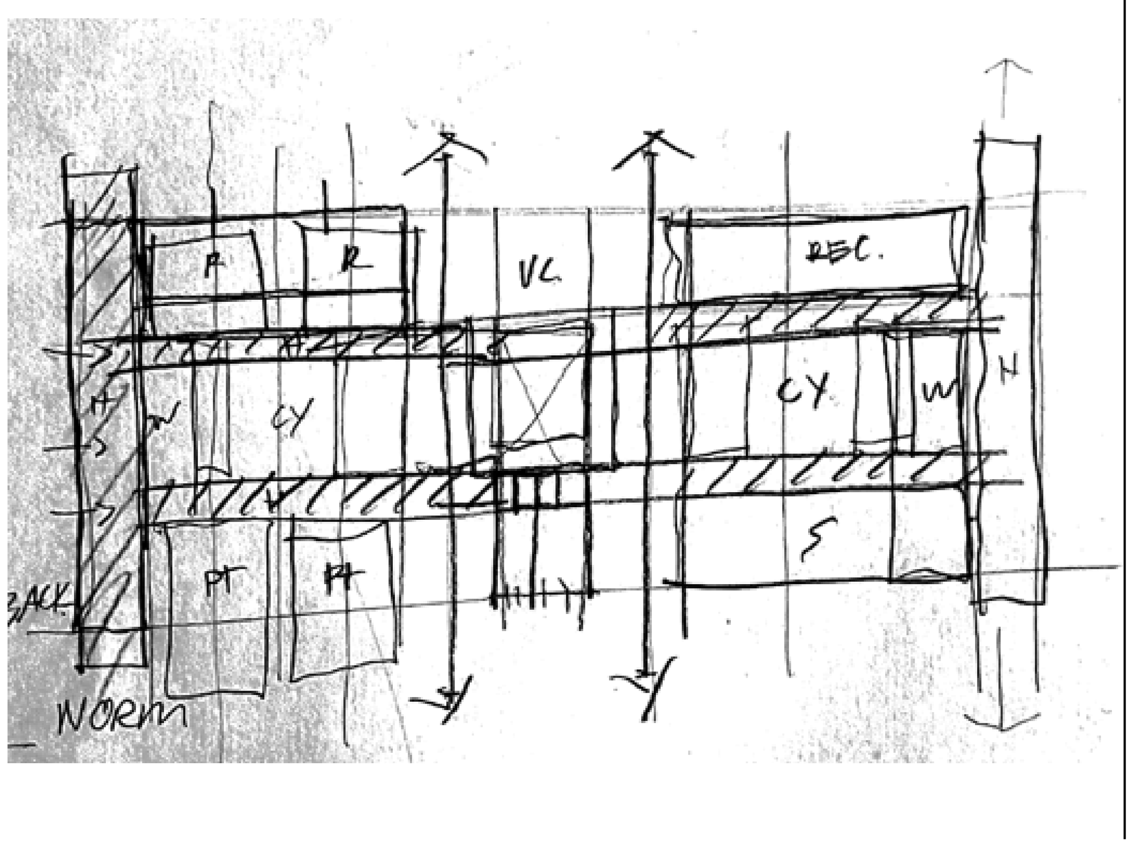


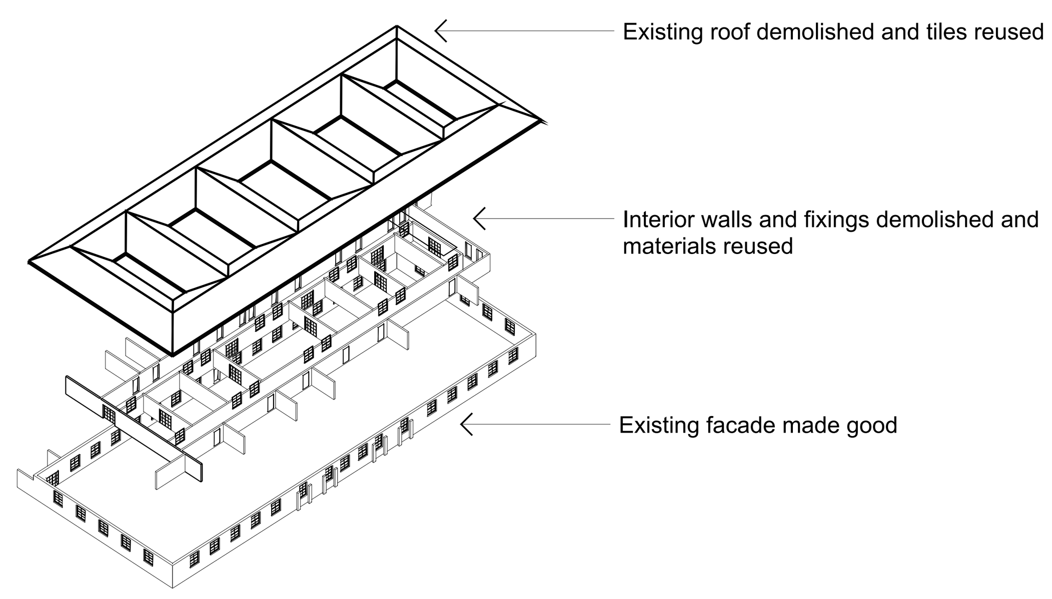




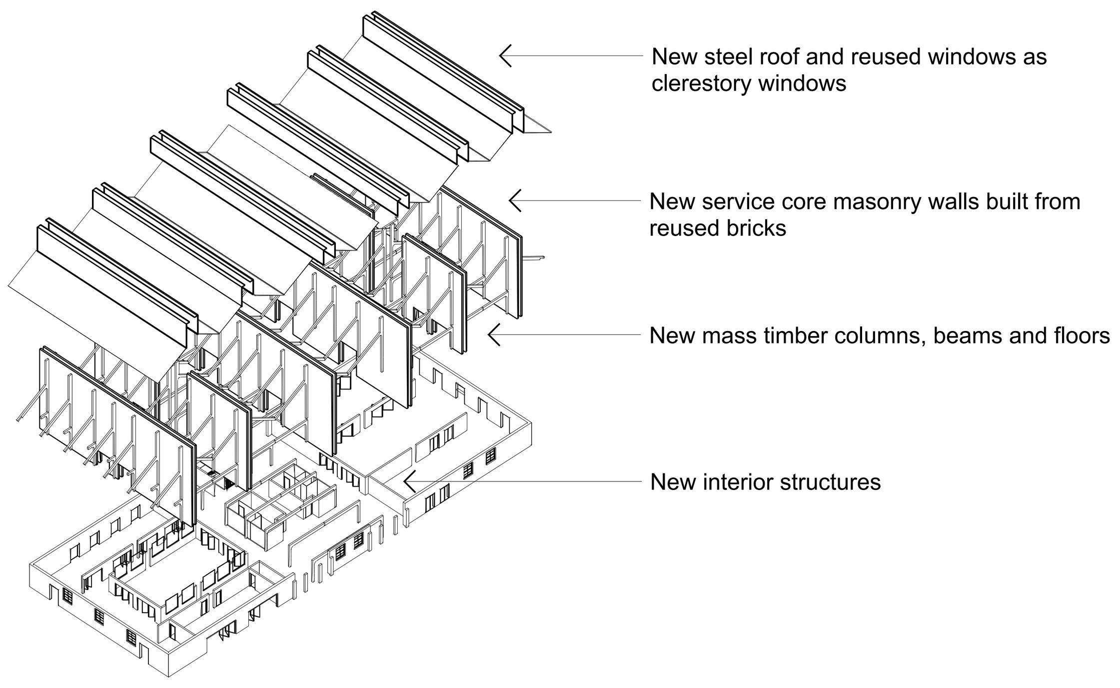




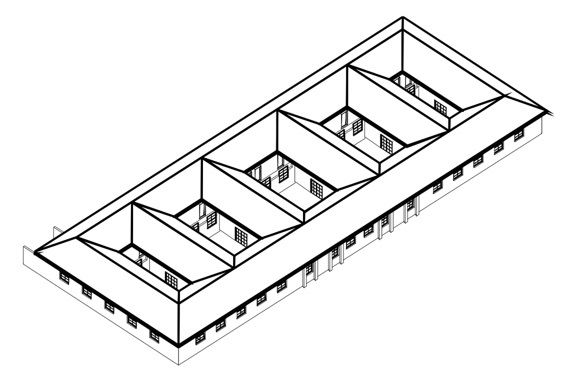




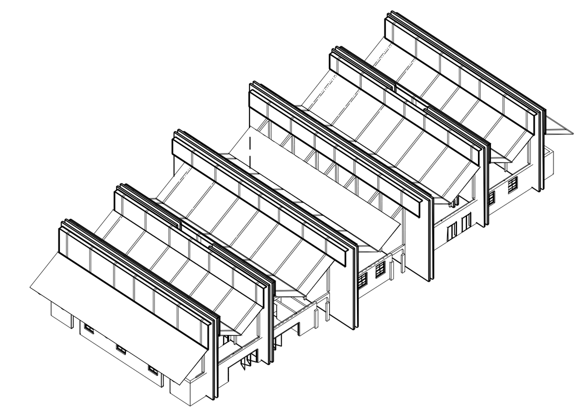
Isometric view of removed structures



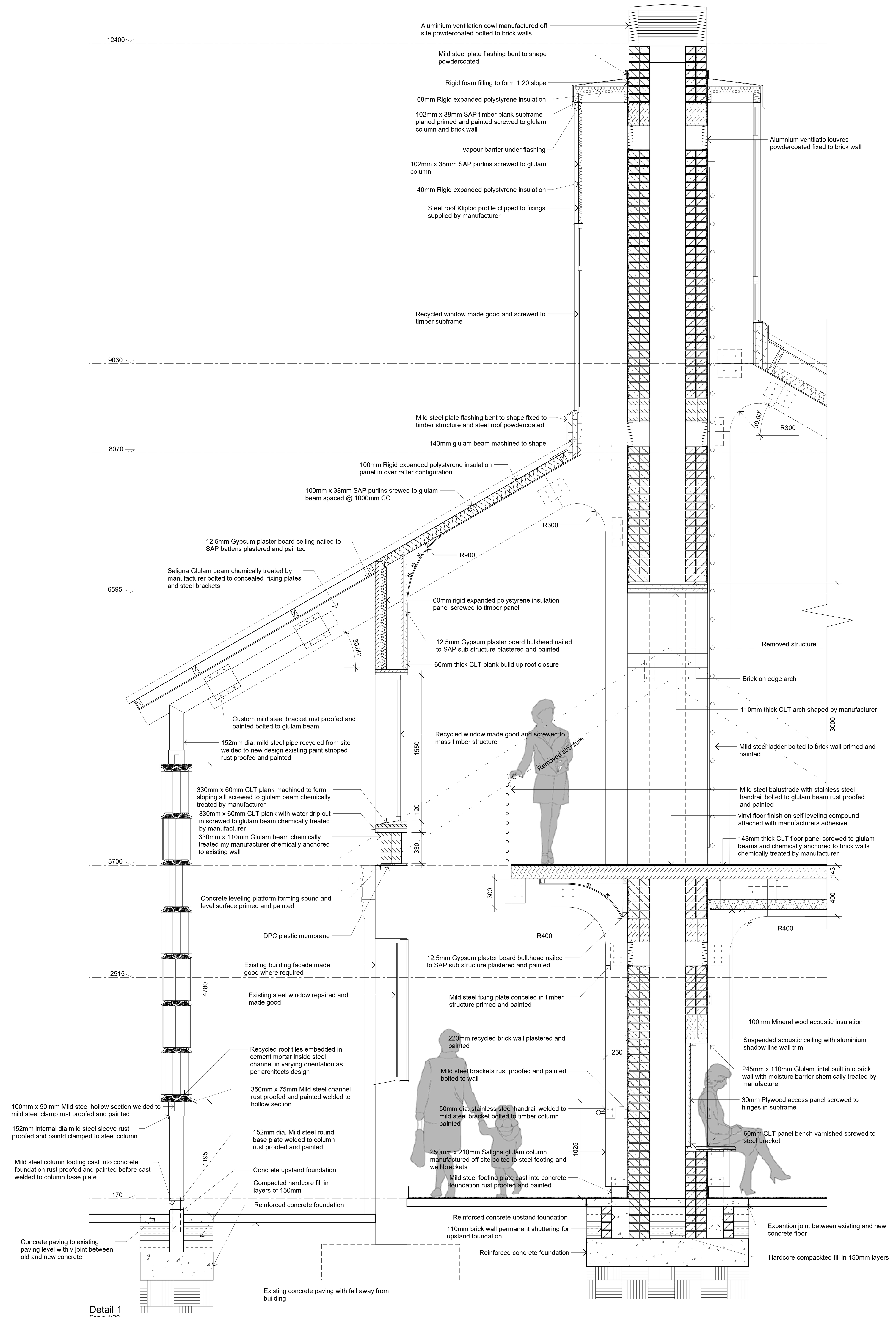
Isometric view of new elements



Isometric view of existing

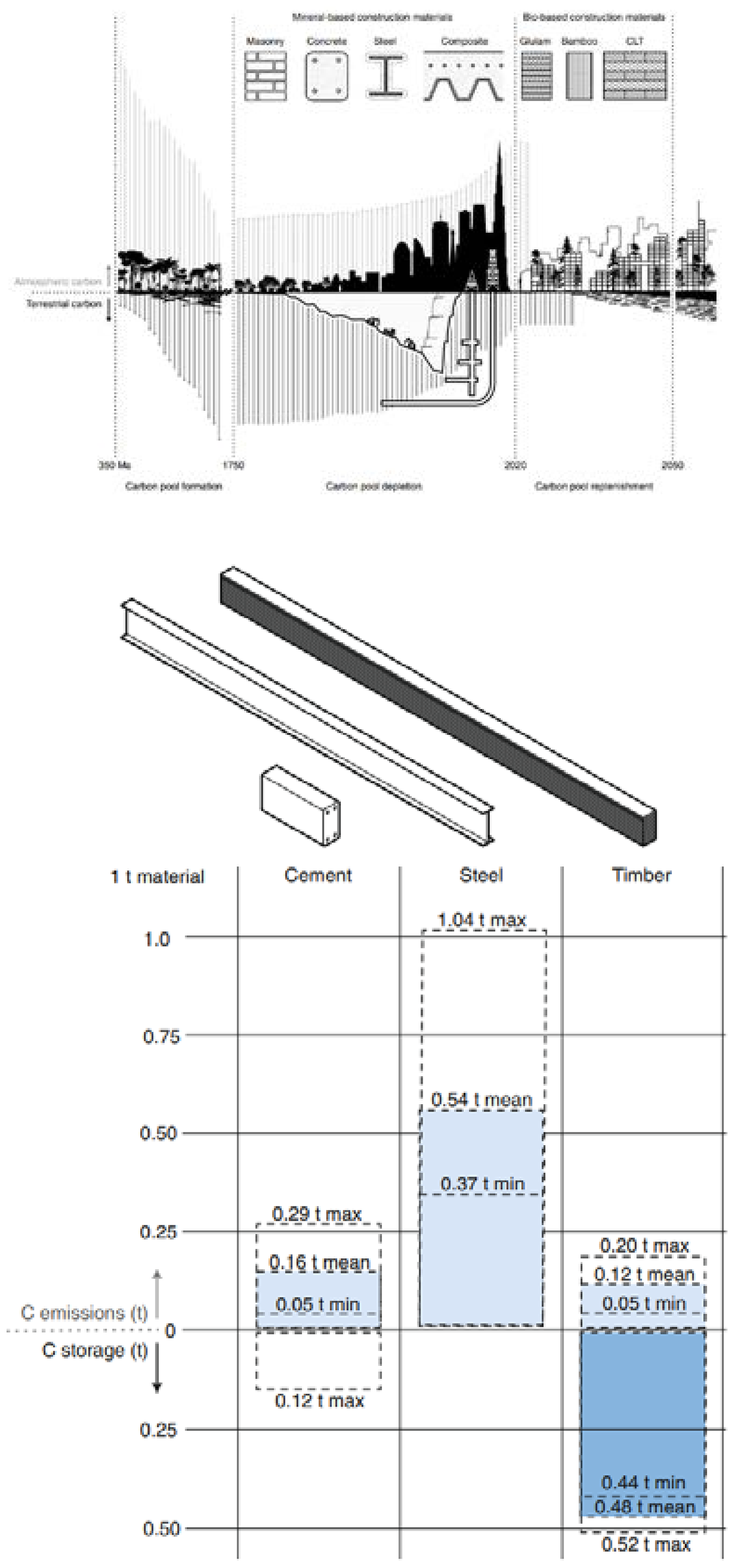


Isometric view of completed adapted building



Detail 1
Scale 1:20

DESIGN ITERATION: SECOND



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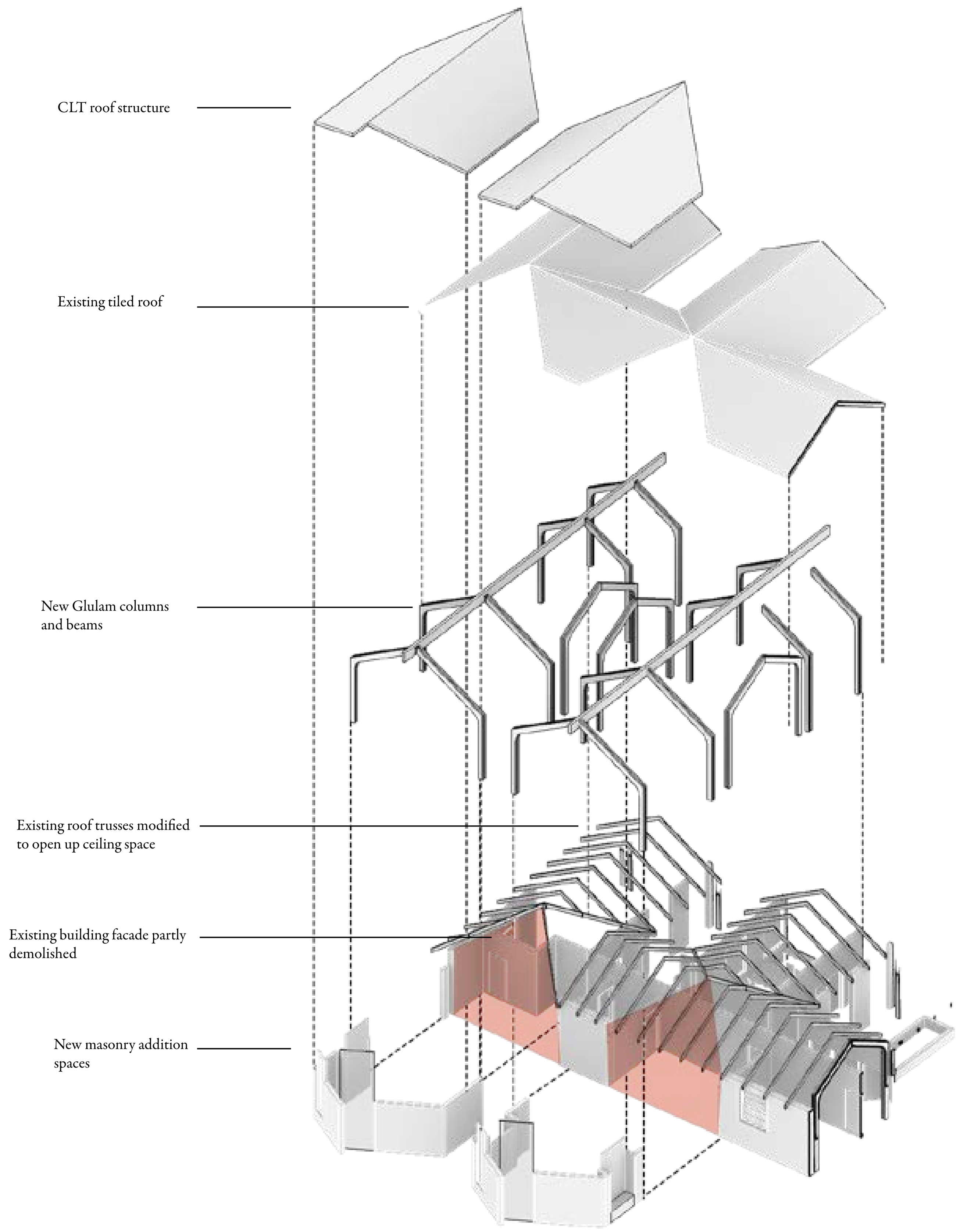
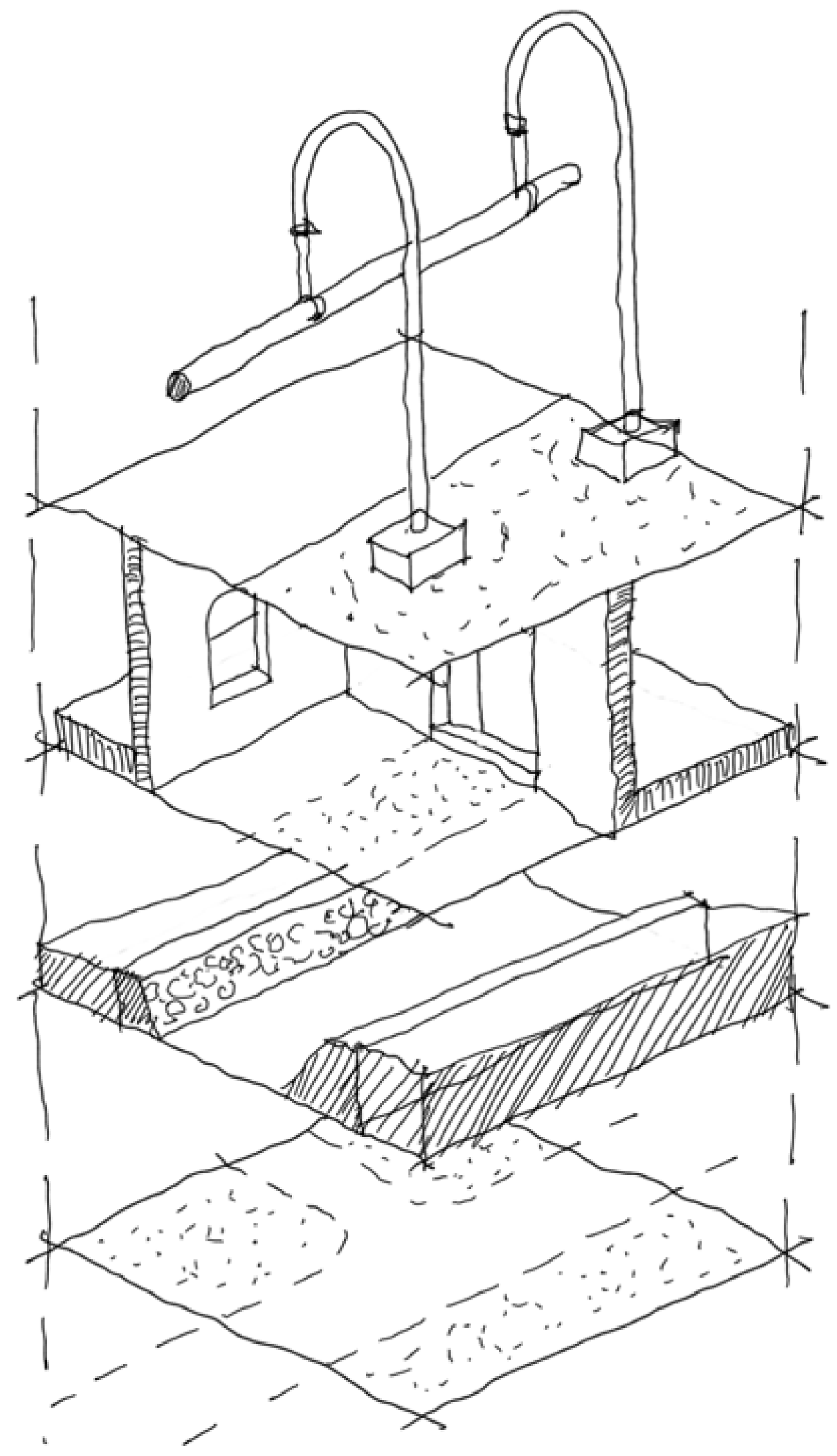
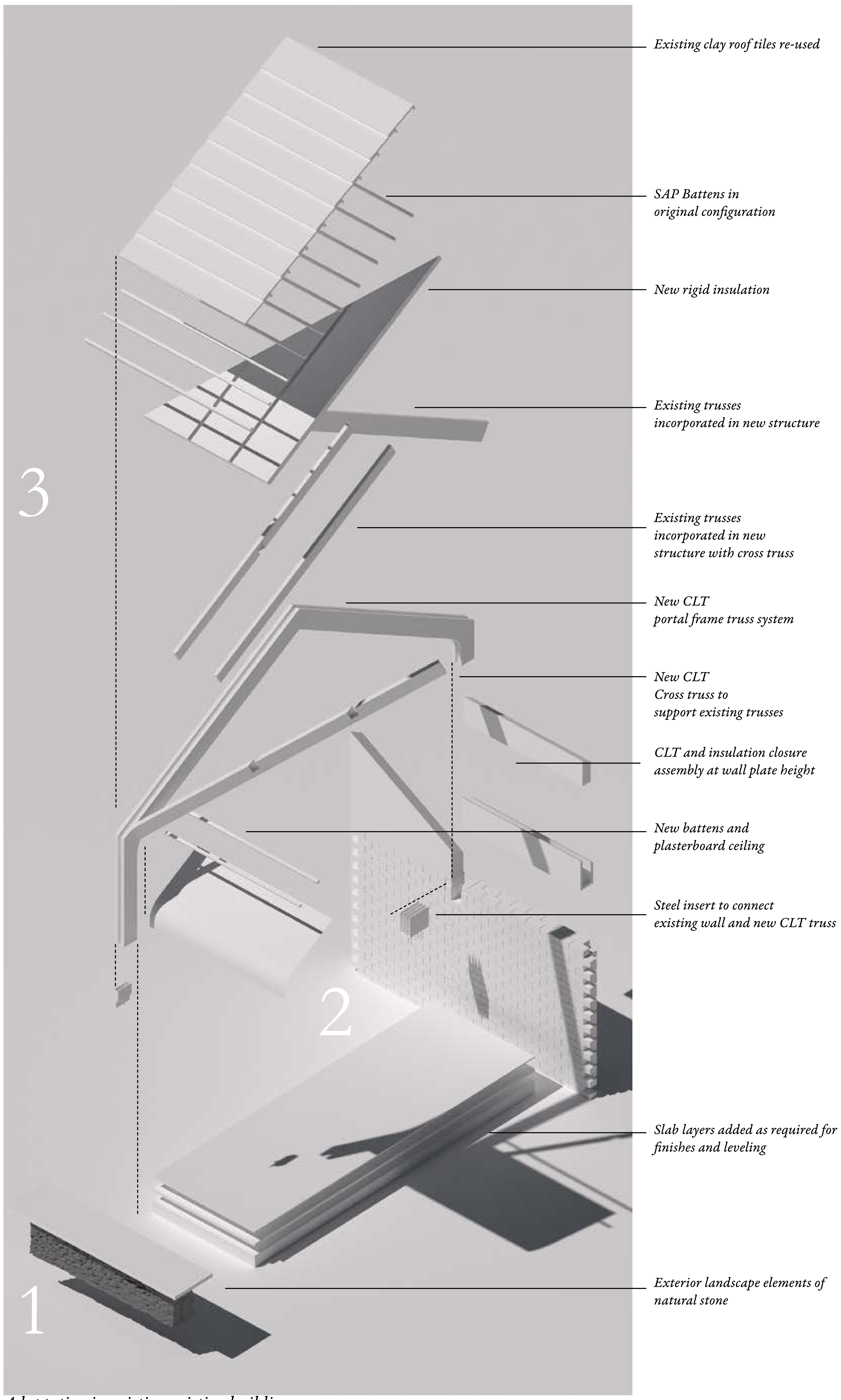


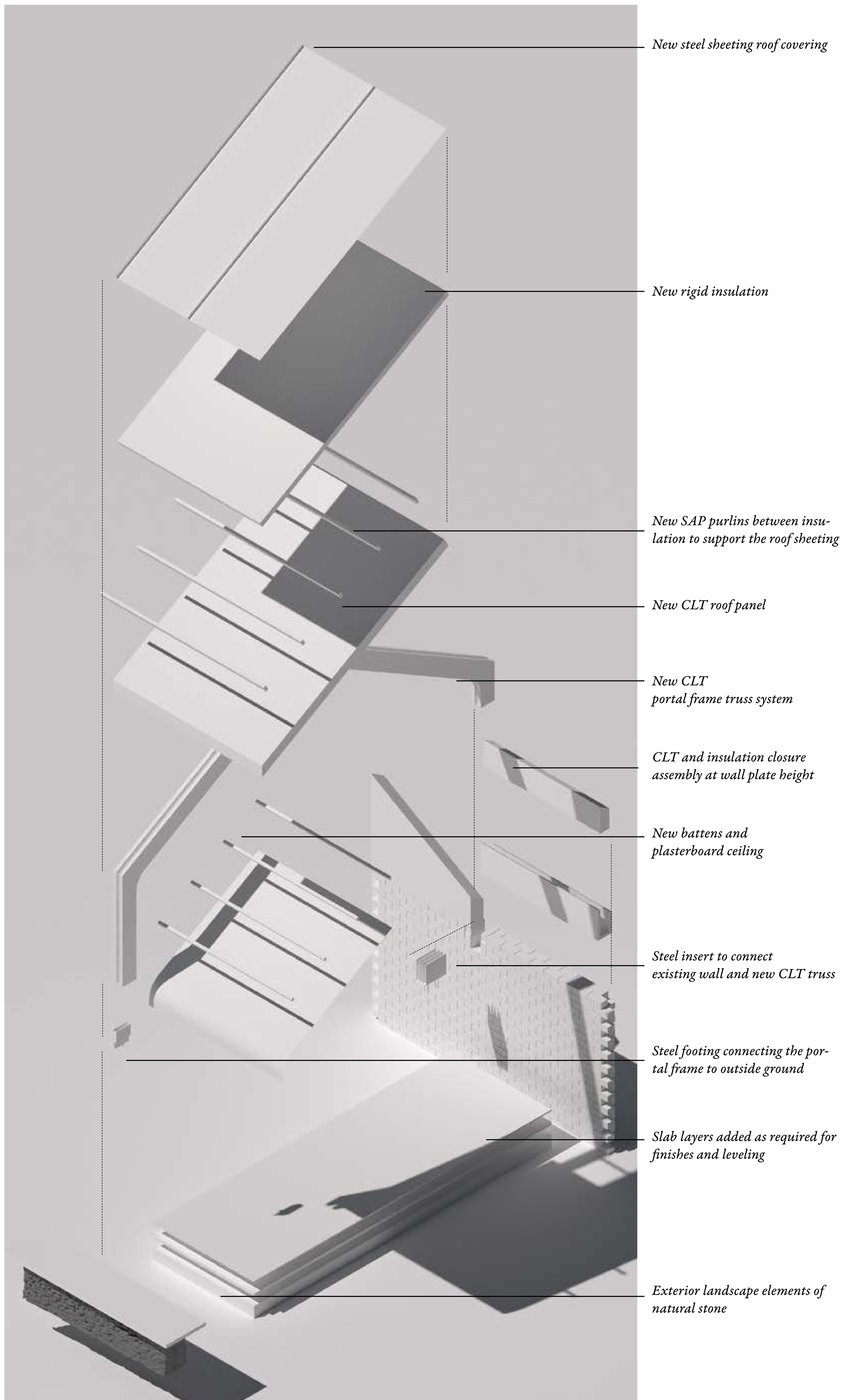
Addition construction system based on CLT construction methods



Existing buildings and site layers

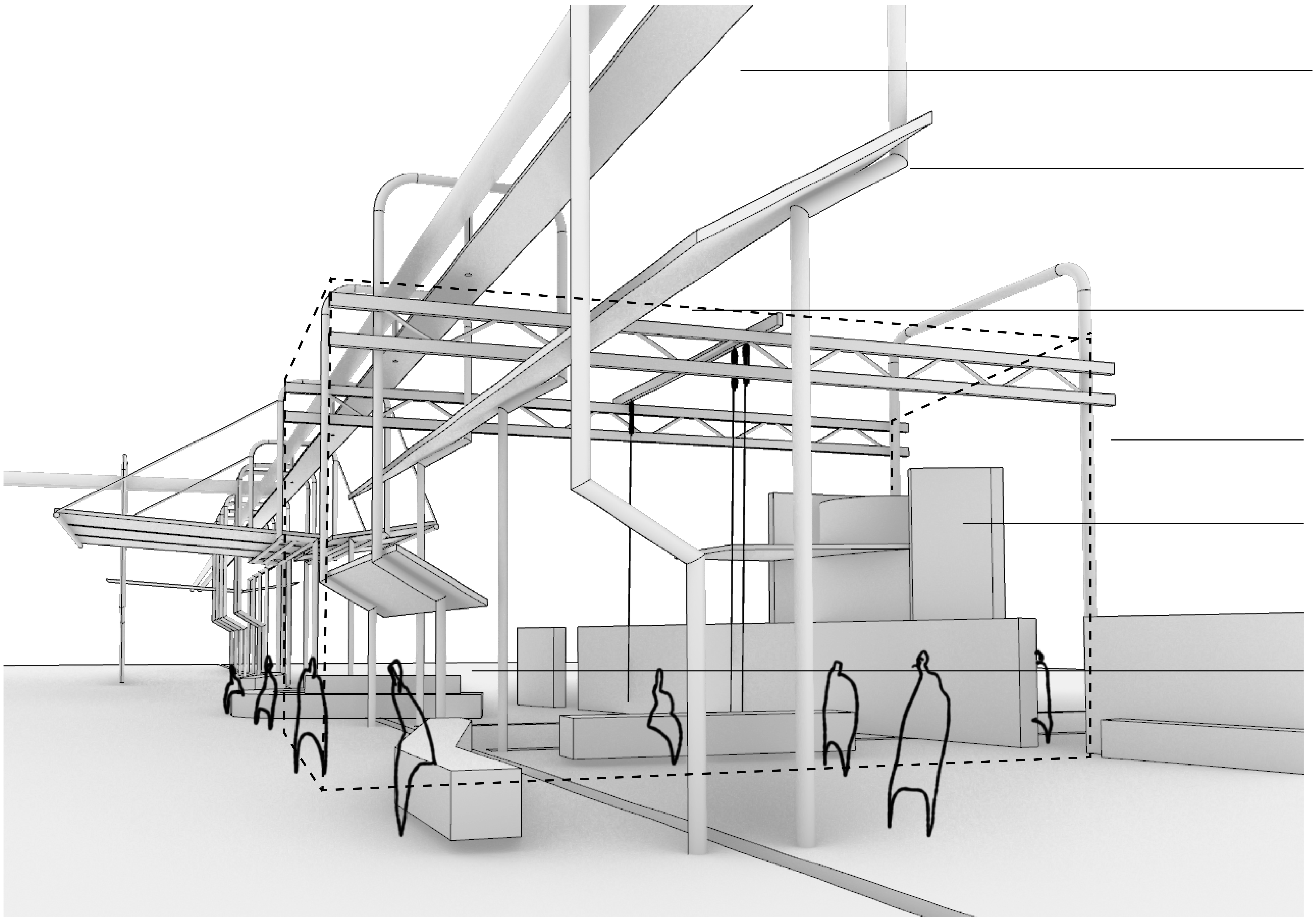


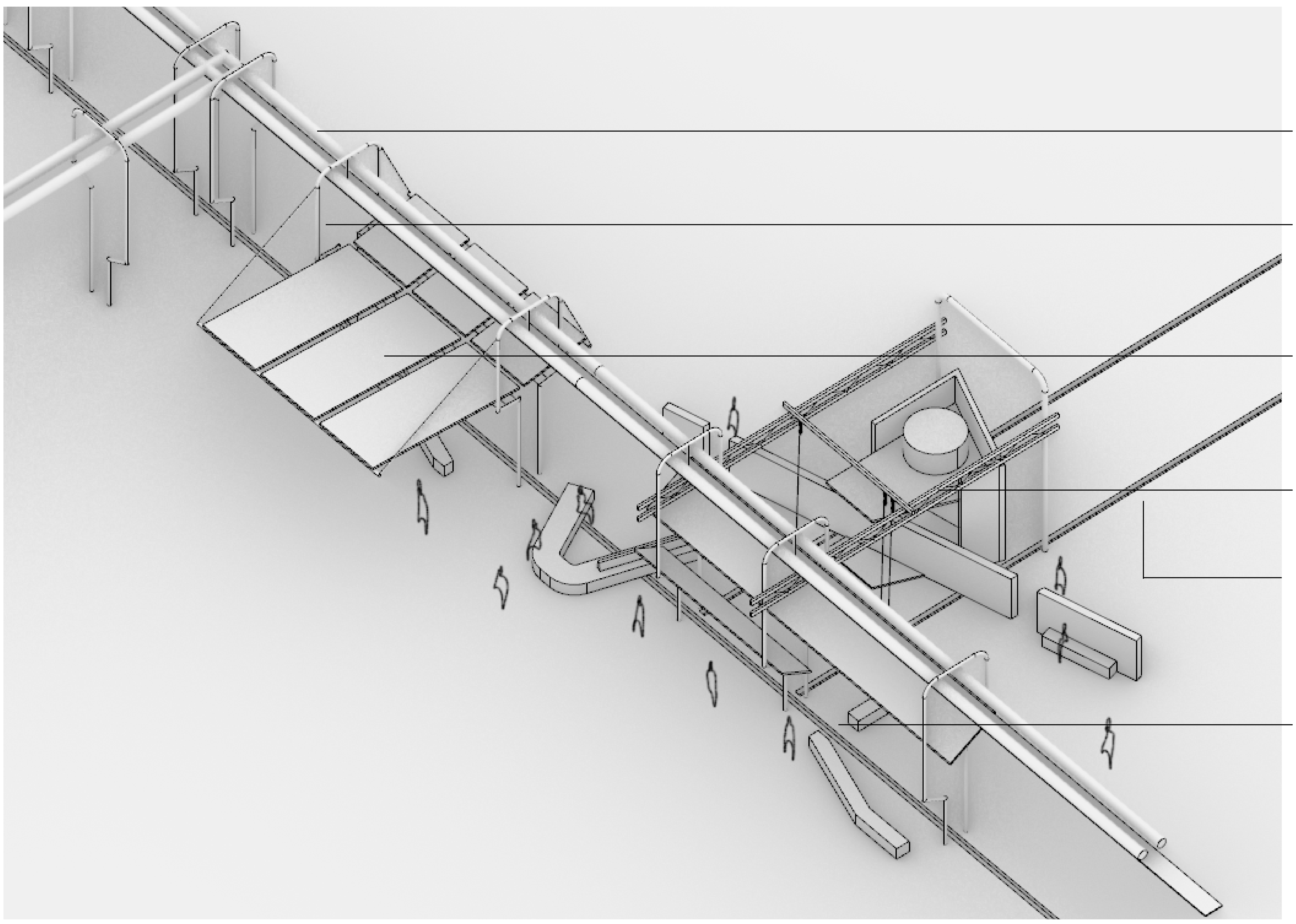
Adaptation in existing existing buildings



New Additions

DESIGN ITERATION: SECOND





Services intergration with prototype testing

BUILDING PERFORMANCE ANALYSIS
NATURAL VENTILATION IN MEDICAL FACILITIES

Introduction

Ventilation in healthcare buildings has changed over time due to the realisation of the patient benefits and the advancement of technology that improved air conditioning feasibility. Artificial ventilation enabled architects to design larger spaces that are interconnected which are seldom connected to the outside. This advancement led to the current medical facility prioritising artificial ventilation over natural ventilation with rooms supplied solely with fresh and temperature-treated air. This prioritisation of artificial ventilation led to problematic climatic conditions in many spaces in healthcare buildings. Circulation, gathering and consultation areas often do not have adequate ventilation as the energy expenditure focus of artificial ventilation is used for areas such as wards and surgeries.

Natural ventilation for healthcare buildings was prioritised in the design of 19th-century hospitals. It was noted that natural air circulation and natural light decreased patient healing time and increased well-being while reducing communicable disease infections. These observations are backed by contemporary science which also highlights various advantages of natural ventilation such as energy efficiency, comfort, odour control, functional resilience, emergency preparedness and sustainable principles.

This investigation attempts to integrate natural ventilation into new architectural additions at the Tshwane District Hospital thus replacing and avoiding artificial ventilation for the project.

Standards and Status-quo

The South African standards for building ventilation are dictated by the SANS 10400 part-O regulations. The regulations specify detailed requirements for healthcare buildings. The additions to the building can be classified as examination rooms which require 12 air changes per hour (SANS, 2011: 18). Other requirements can be obtained through literature, the comfortable air velocity should be between 1 – 2m/s (Roghanchi, Kocsis & Sunkpal, 2016). The standards of air changes per hour do however not paint the complete picture of airflow through a room. Other methods such as "local mean age of air" (LMA) (indicating the time air remains in position) and "local air change effectiveness" (indicating how well the air is flowing through the space) (ACE) provide much more detailed images of the movement of air through a room.

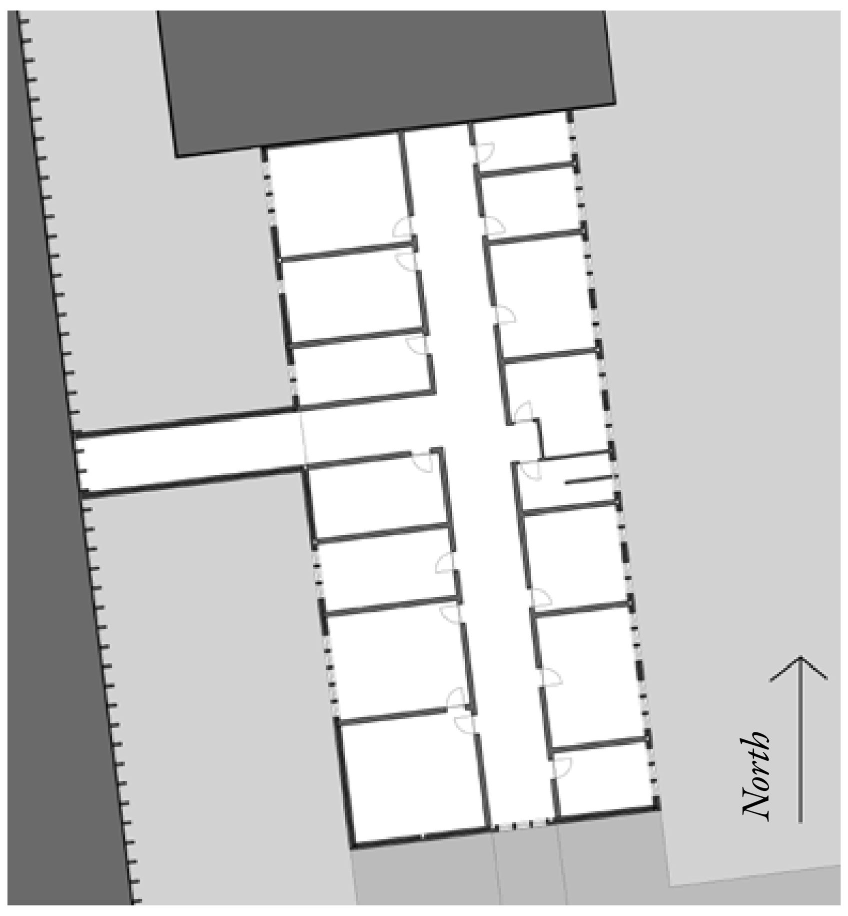
Combining these metrics provides us with the requirements of: *(12 air changes)/(60 minutes) =1 air change every 5 minutes (LMA)*

Context and existing building fabric

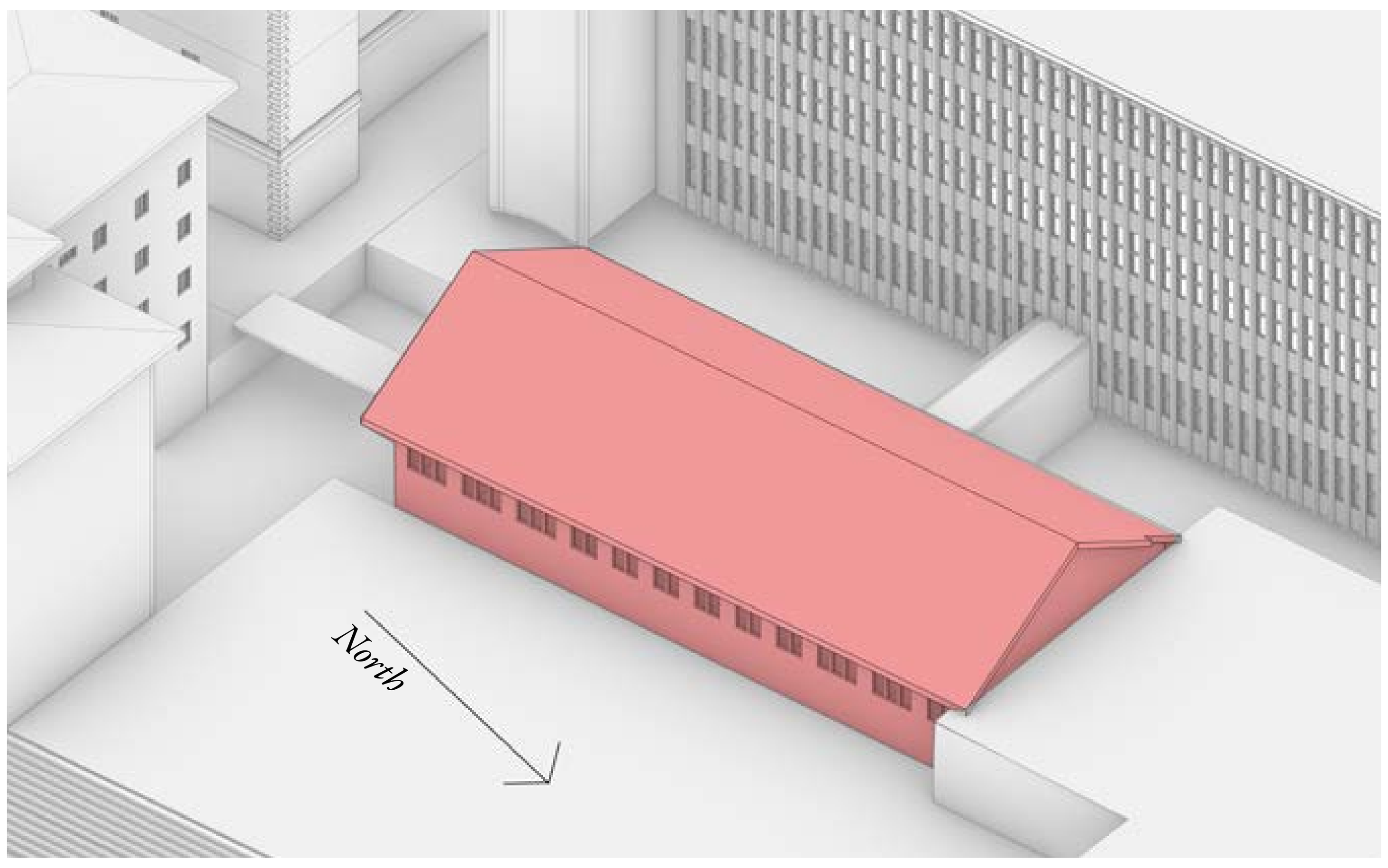
The existing radiology building is located on the Northern end of the Tshwane district hospital site. The building is oriented from North to South with longer facades facing East and West. The existing floor plan is divided with a central hallway with the only natural light being on the end of the hallway. The room windows are located on one side of all rooms limiting cross ventilation. No mechanical ventilation is present.

Site photos from East

Site photos from East



Existing Plan



Existing Building

Testing Methodology

The methodology followed during the investigation focused on the schematic representation of the existing and new spaces within simulation software to determine the following metrics where possible:

- *Air velocity (between 1 and 2 M/s)*
- *LMA (higher is better)*
- *ACE (closest to 1 is better)*
- *Direction of air movement (from clean to dirty)*
- *Distribution of heat (away from usage spaces)*

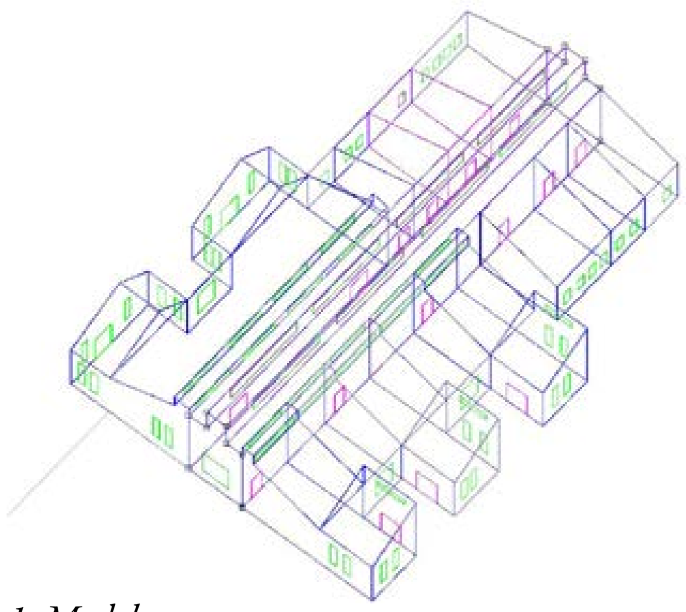
The simulation software used is IES-VE with local weather files provided by IES.

The investigation steps were as follows:

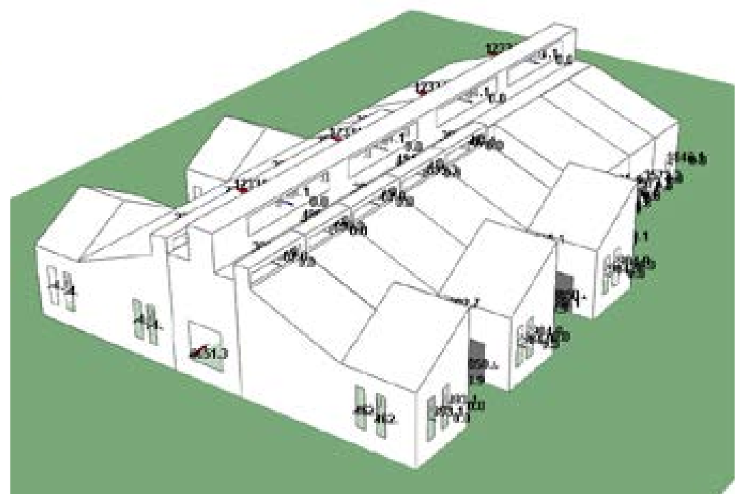
1. *Model the existing building and simulate to determine the existing state.*
2. *Model the first iteration of the additions and simulate to determine shortcomings.*
3. *Model the second iteration and simulate to confirm if the adjustments were sufficient and that the required ventilation levels were achieved.*

The questions guiding the assessment for the iterations were obtained from the World Health Organisation guide to natural ventilation (2009: 8):

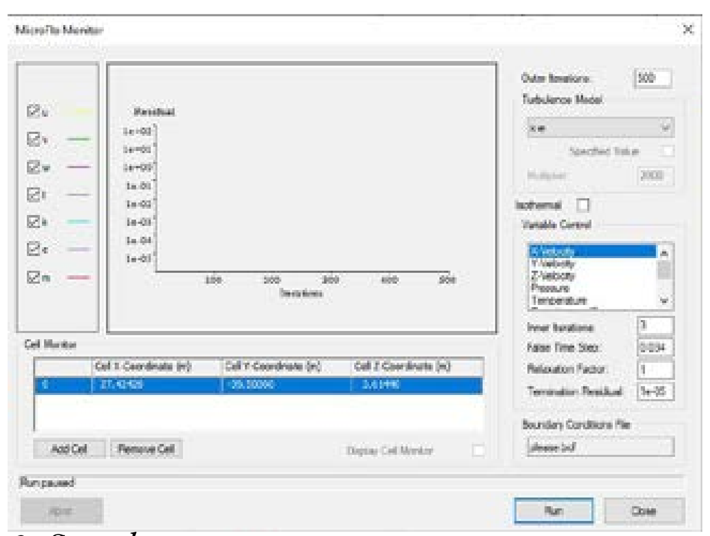
1. *Does the system provide sufficient ventilation rate as required?*
2. *Is the overall airflow direction in a building from clean to dirty zones (e.g. isolation rooms or areas of containment, such as a laboratory)?*
3. *How efficient is the system in delivering the outdoor air to each location in the room?*
4. *How efficient is the system in removing the airborne pollutants from each location in the room?*



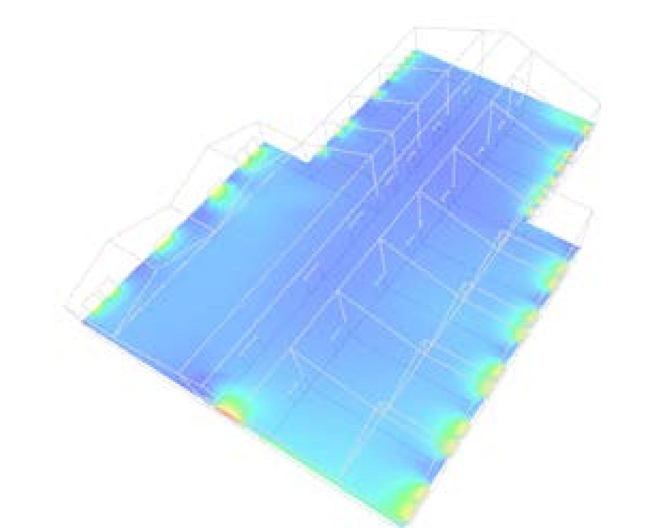
1. Model



2. Gather environmental information



3. Simulate

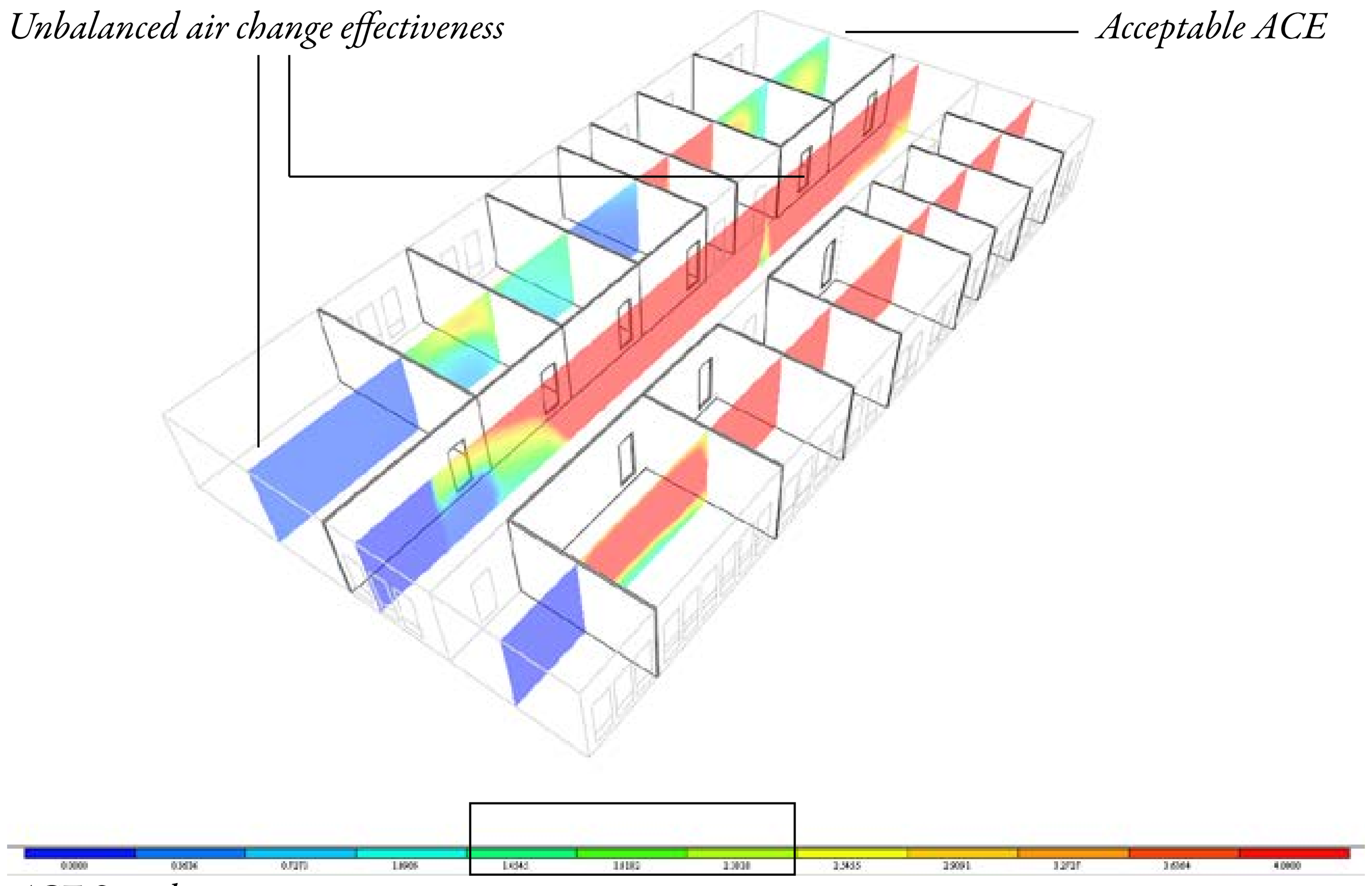


4. Visualise

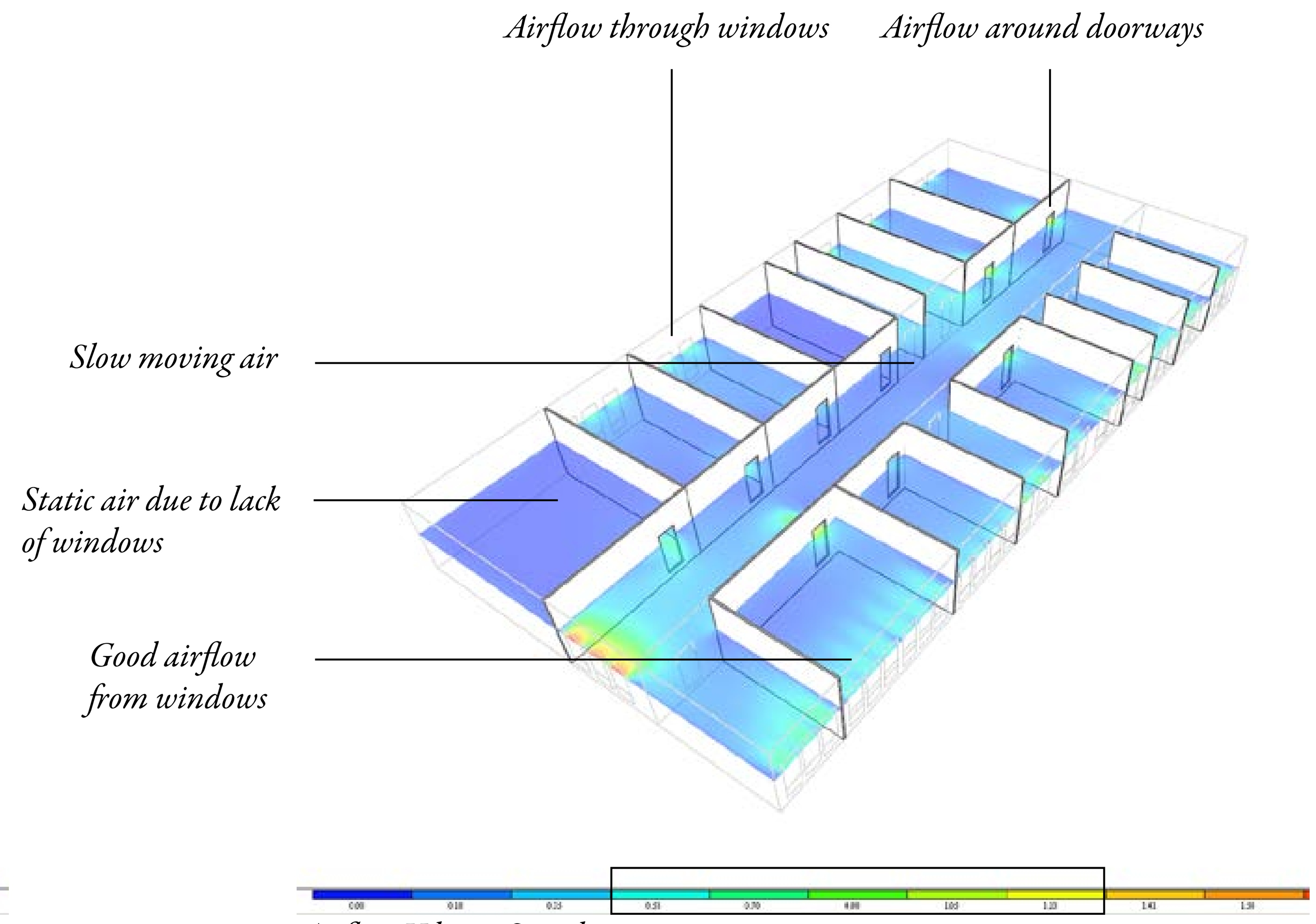
Existing Building

The simulation of the existing building shows a clear lack of ventilation, cross ventilation and air exchange. This is due to the positioning and size of the windows, the lack of cross ventilation fenestration and a hallway that cannot be naturally ventilated. The Eastern facade of the building ventilates remarkably better due to the prevailing winds on site from the East.

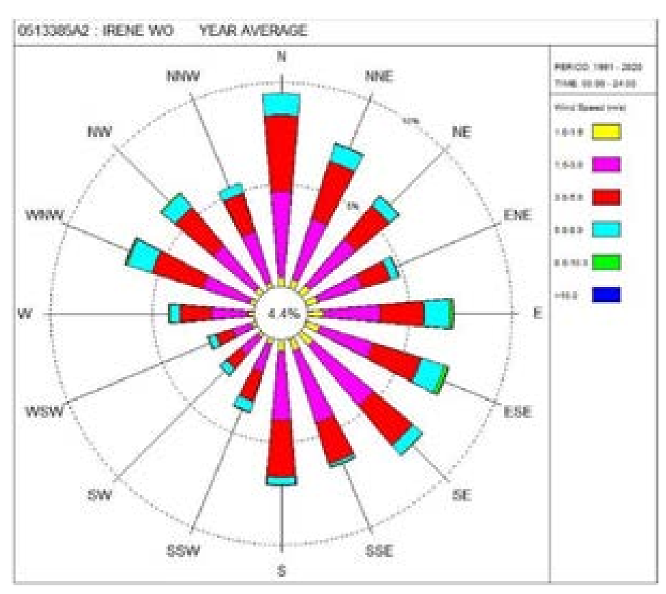
The results indicate that any intervention would need to address the lack of ventilation in the existing building.



ACE Simulation



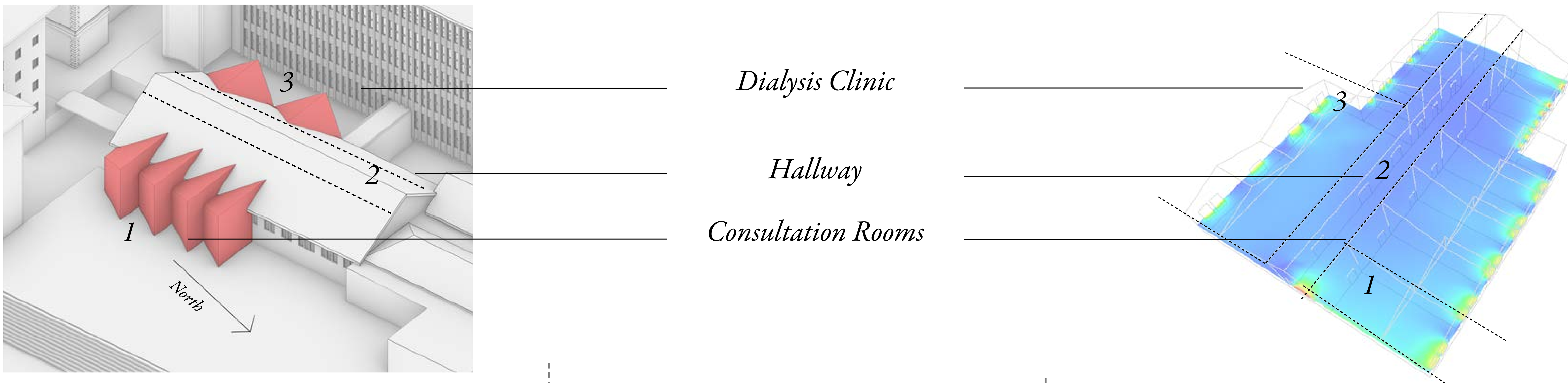
Airflow Velocity Simulation



Yearly average wind direction on site

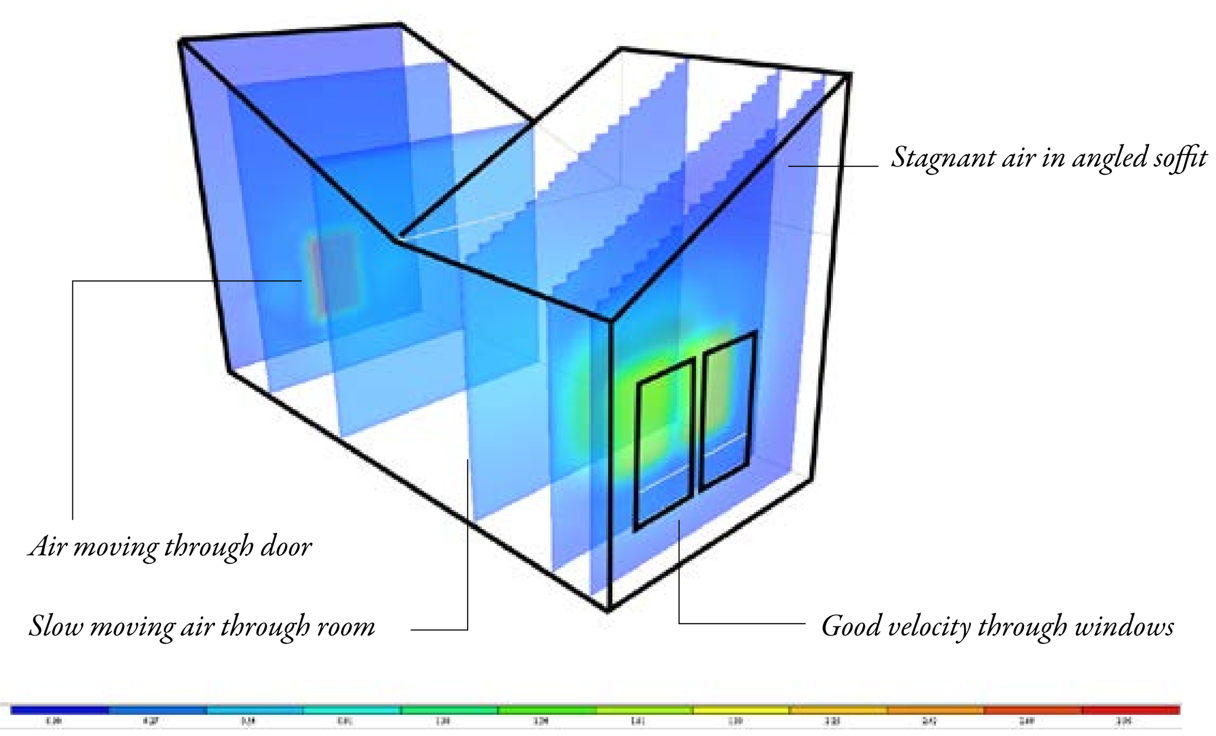
First Iteration

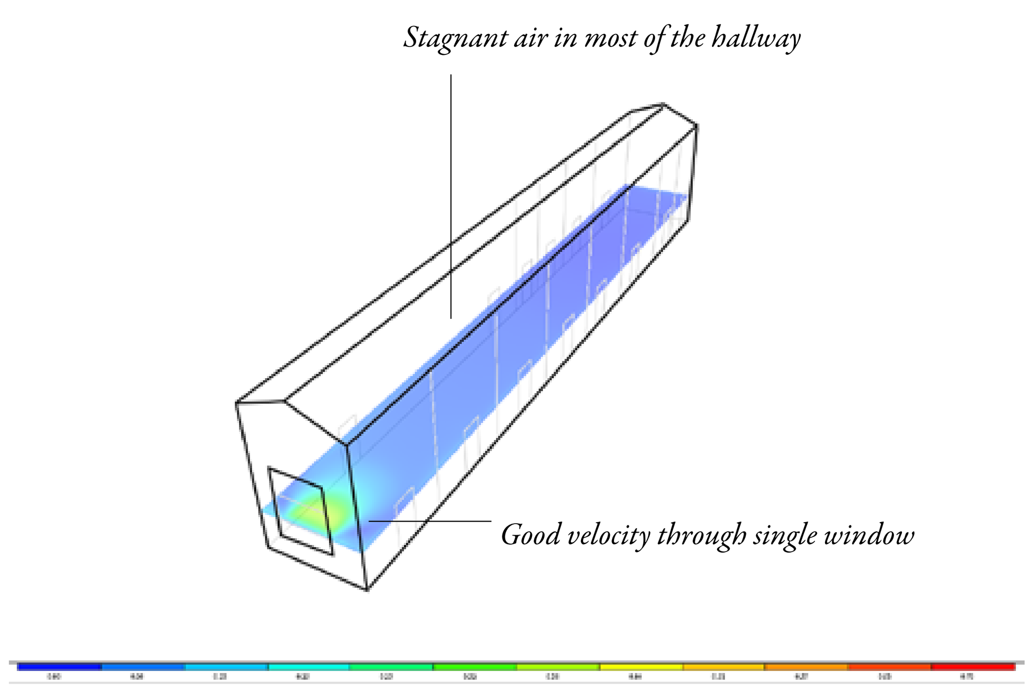
The first iteration removes the interior ceiling while adding consultation rooms on the Eastern facade and a dialysis clinic on the Western facade. Preliminary window and door openings are added to enable testing.

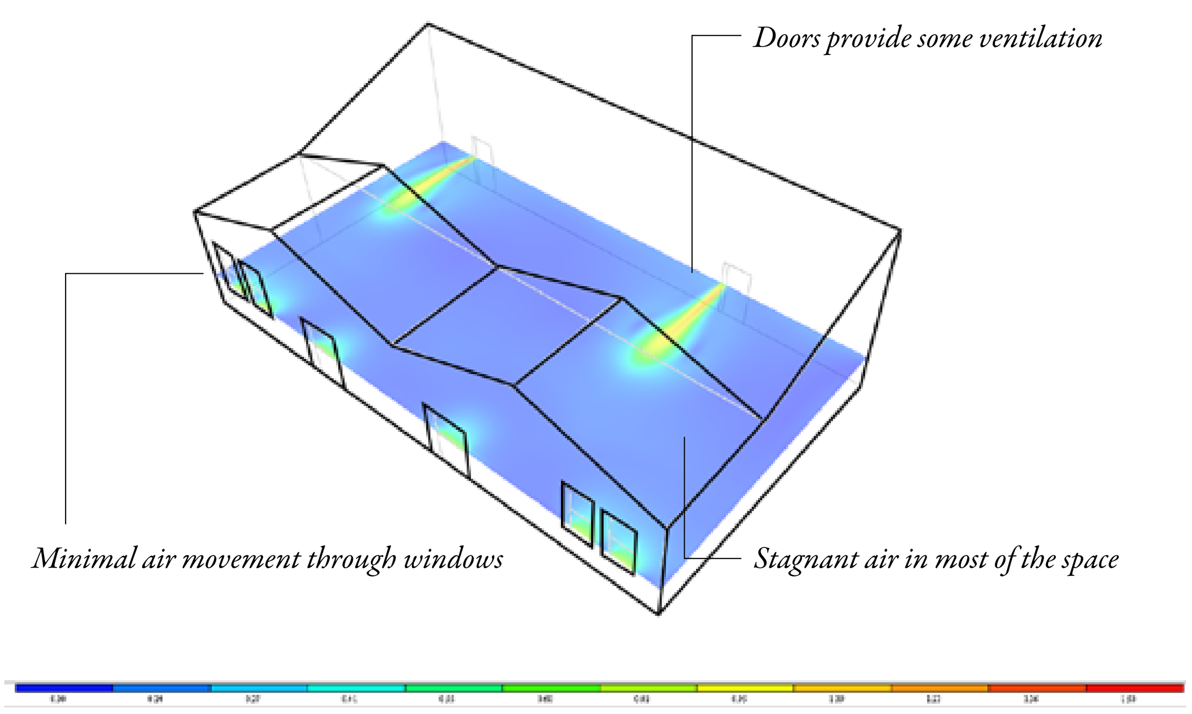


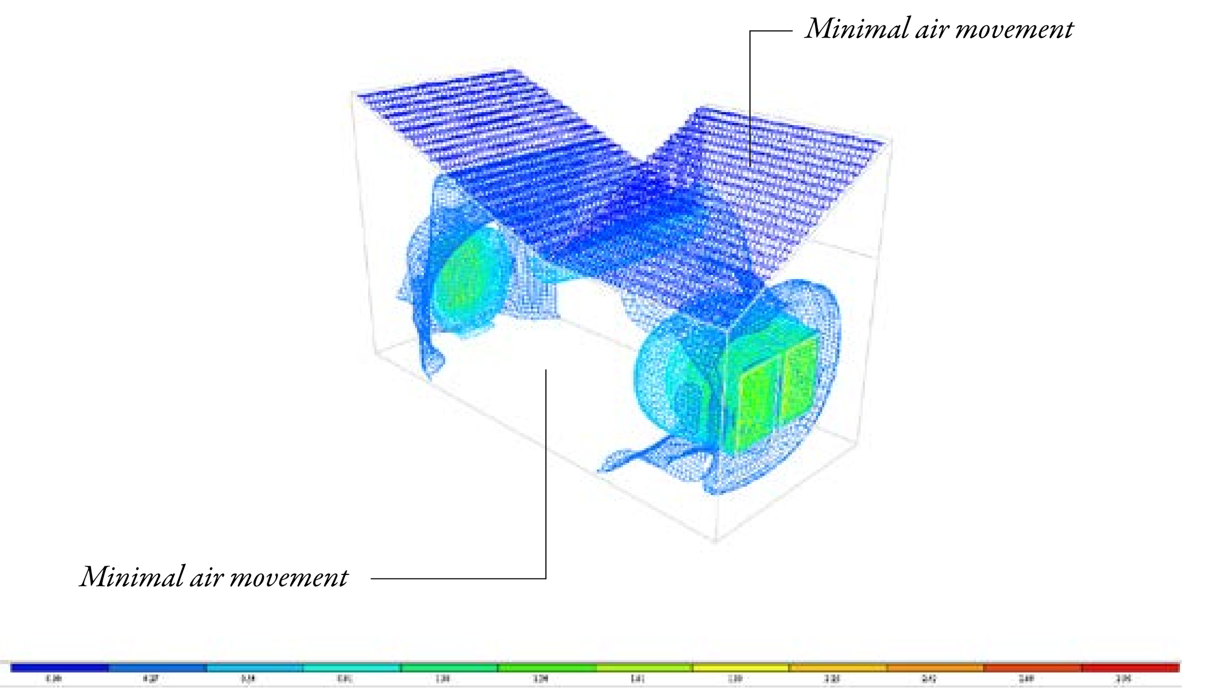
Consultation Rooms 1 | Hallway 2 | Dialysis Clinic 3

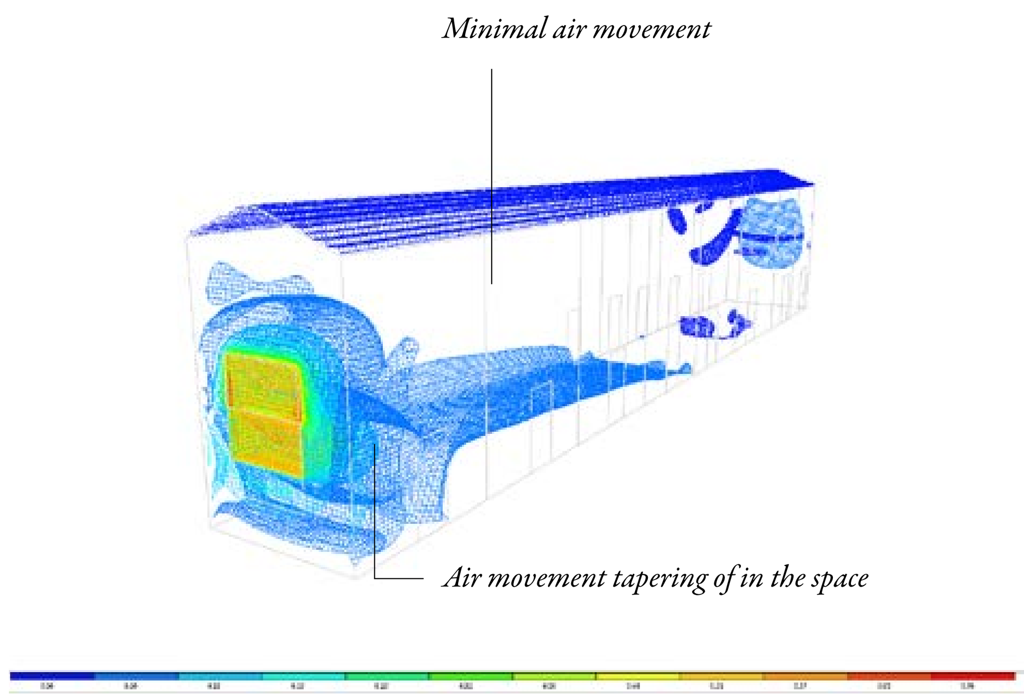
Air velocity simulation

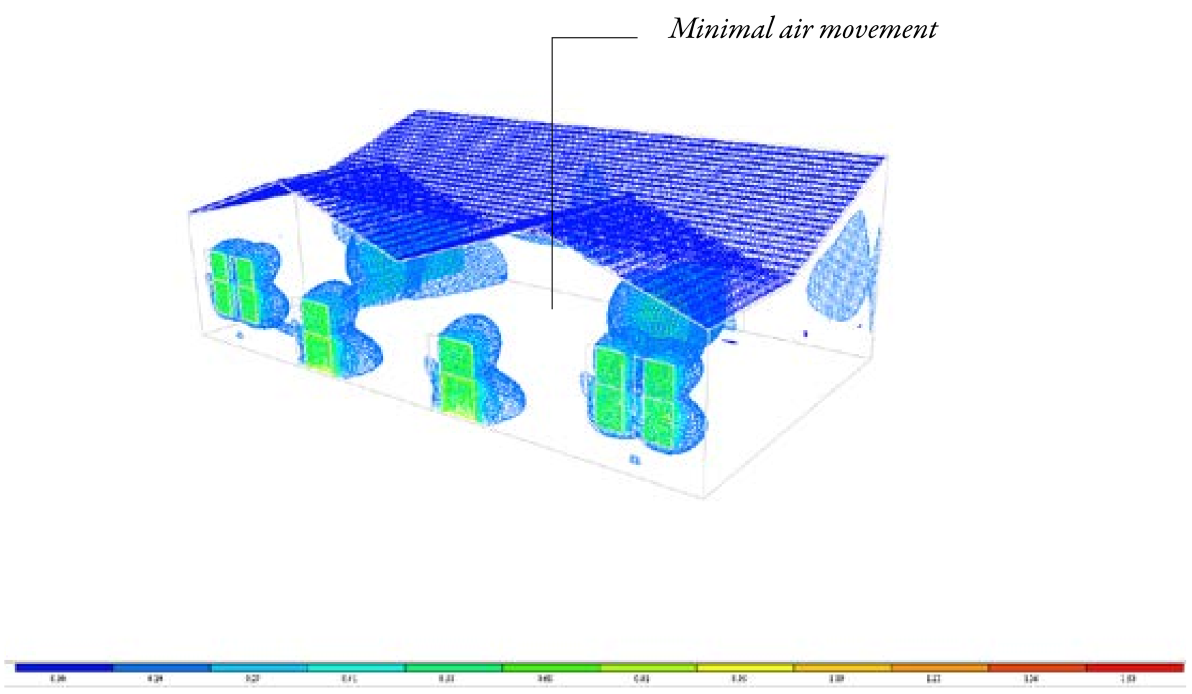




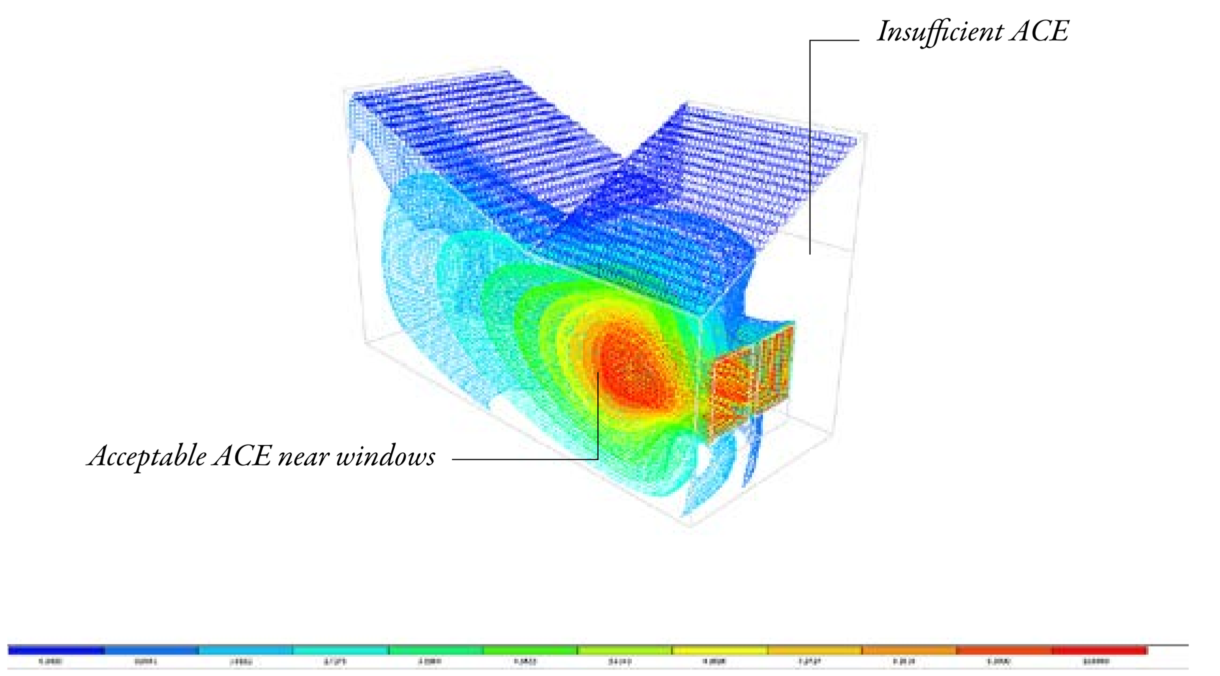


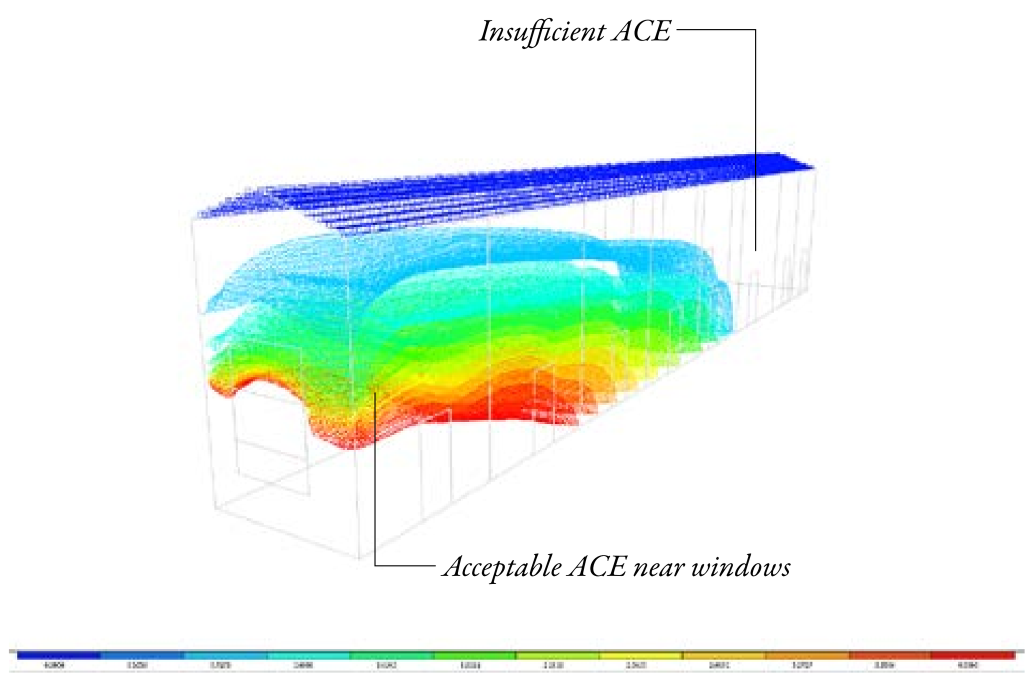


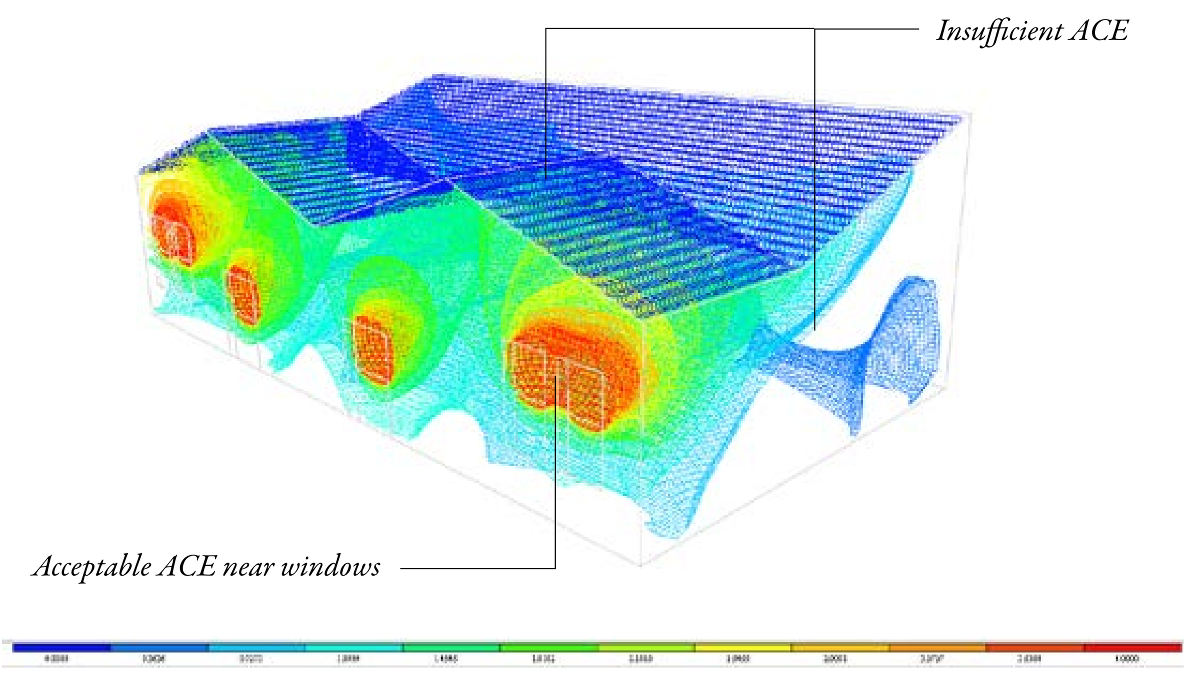




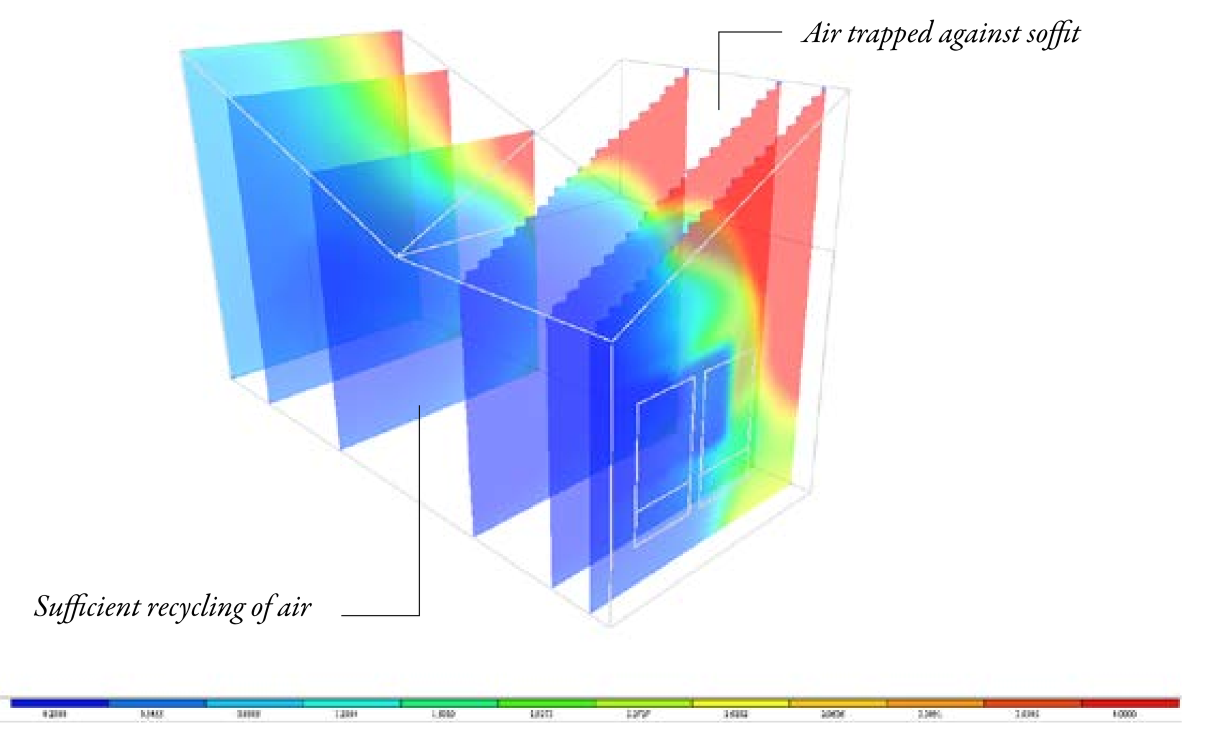
ACE simulation

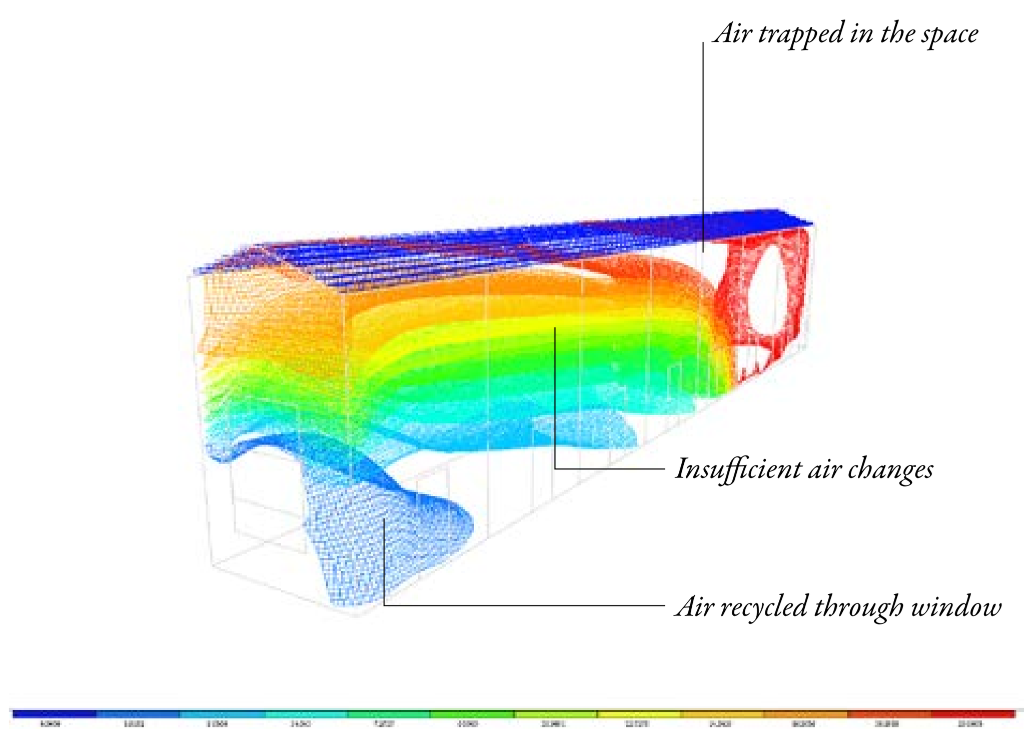


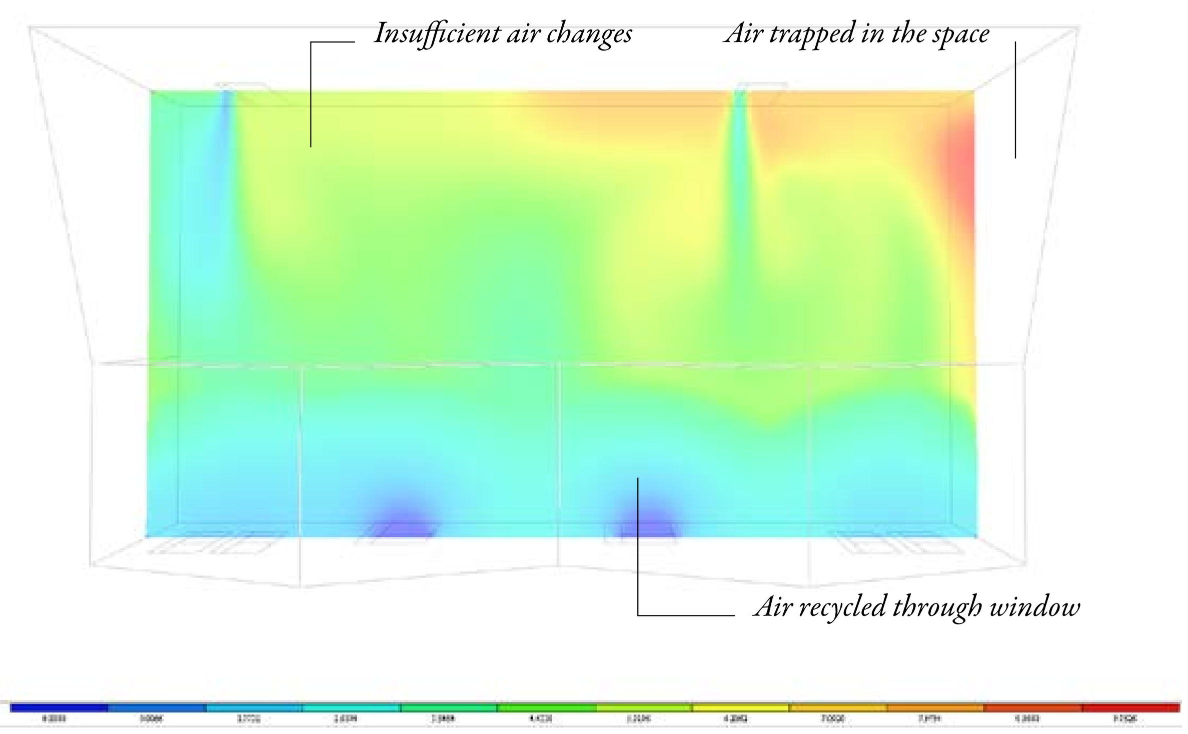


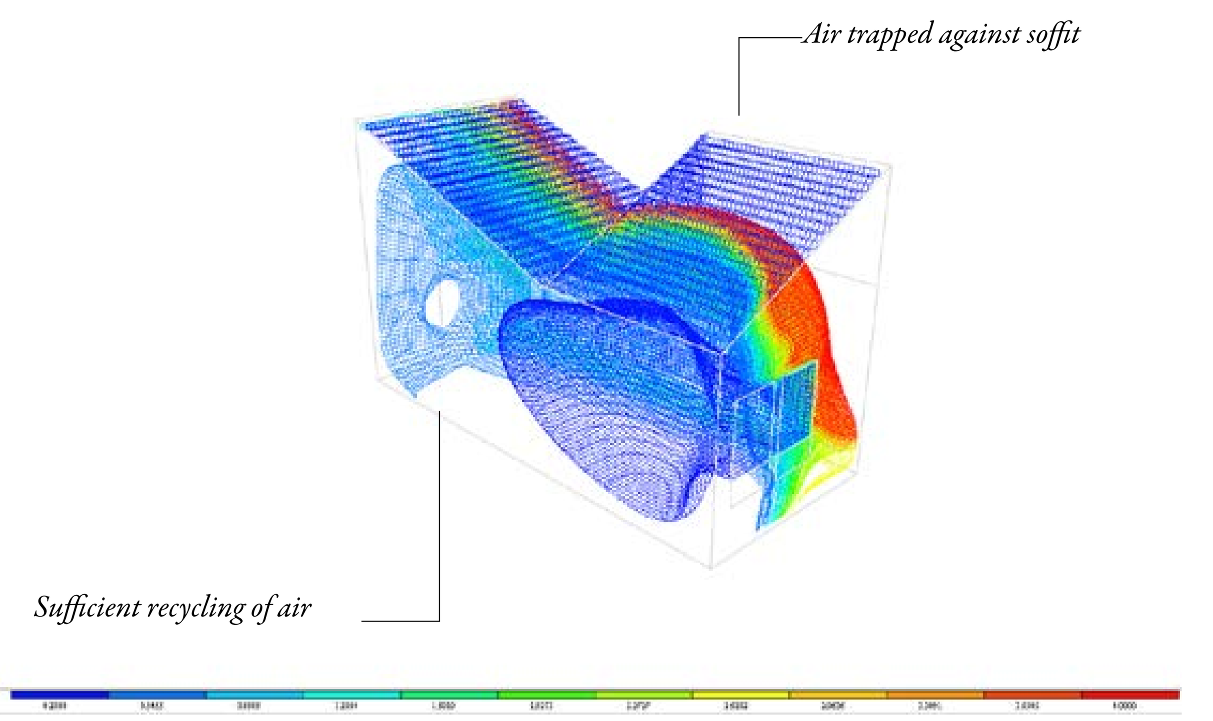


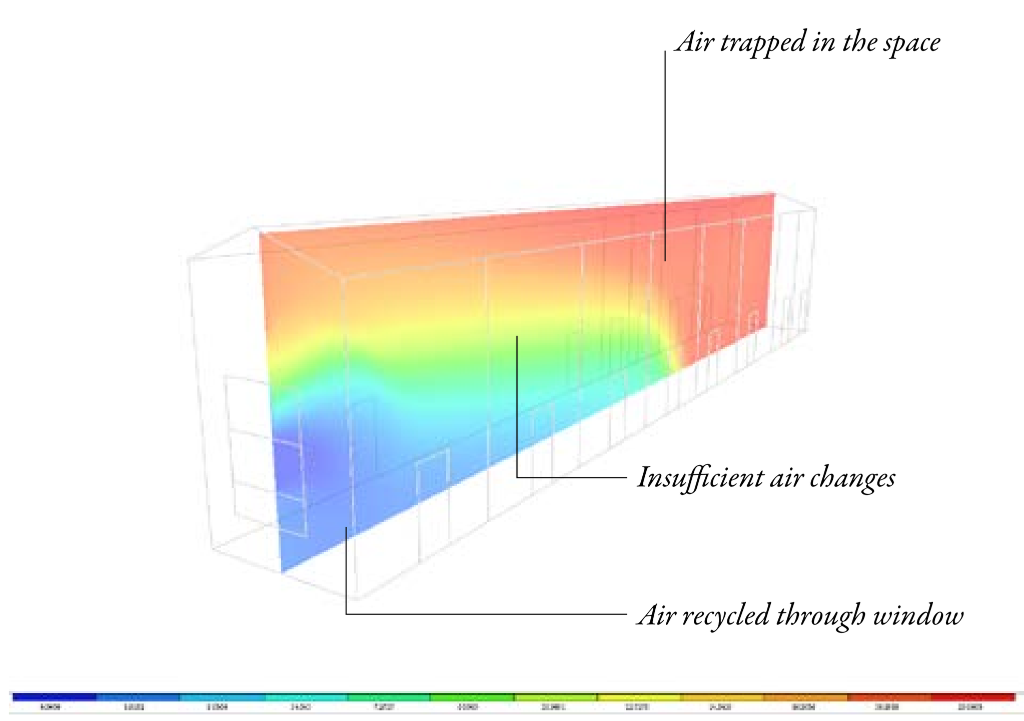
LMA simulation

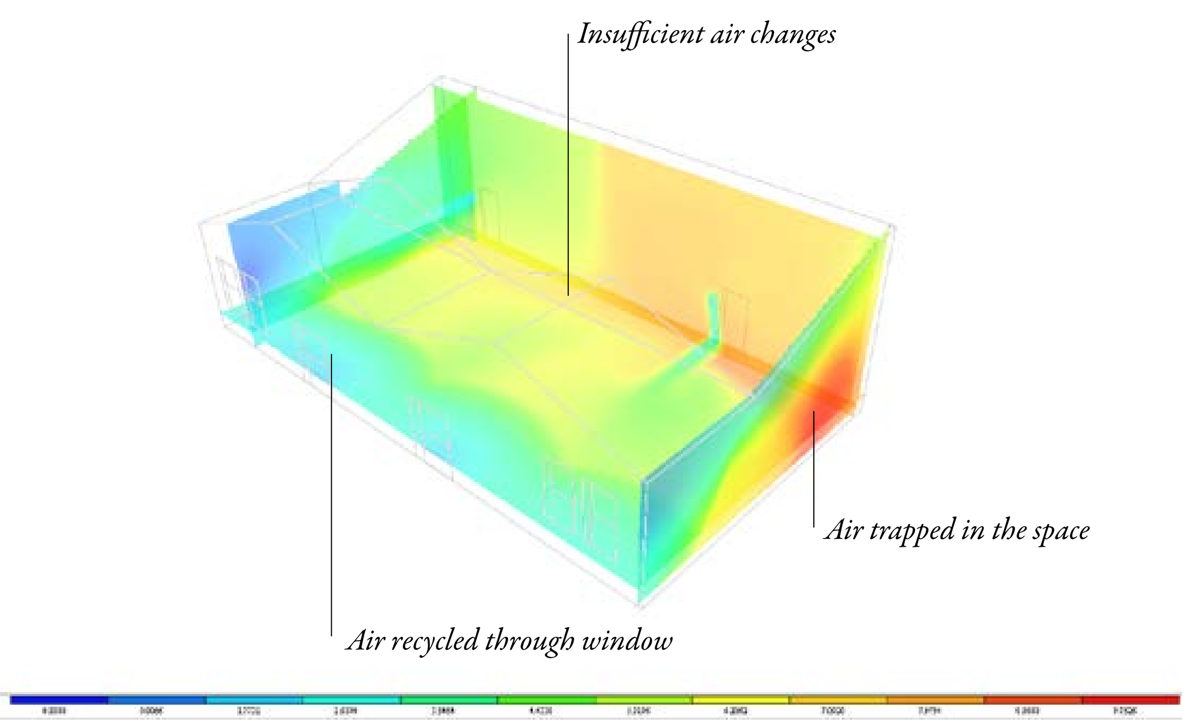






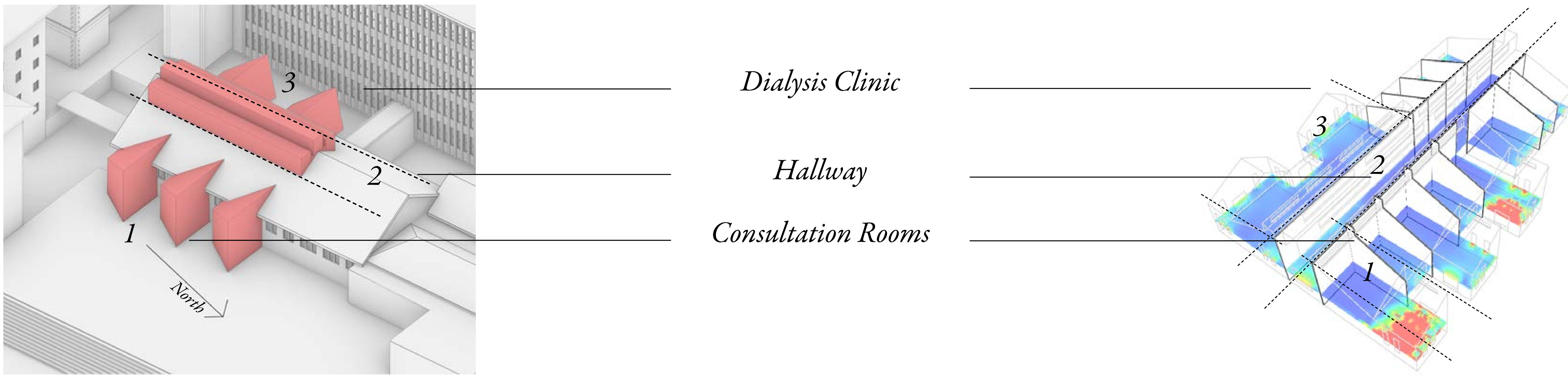






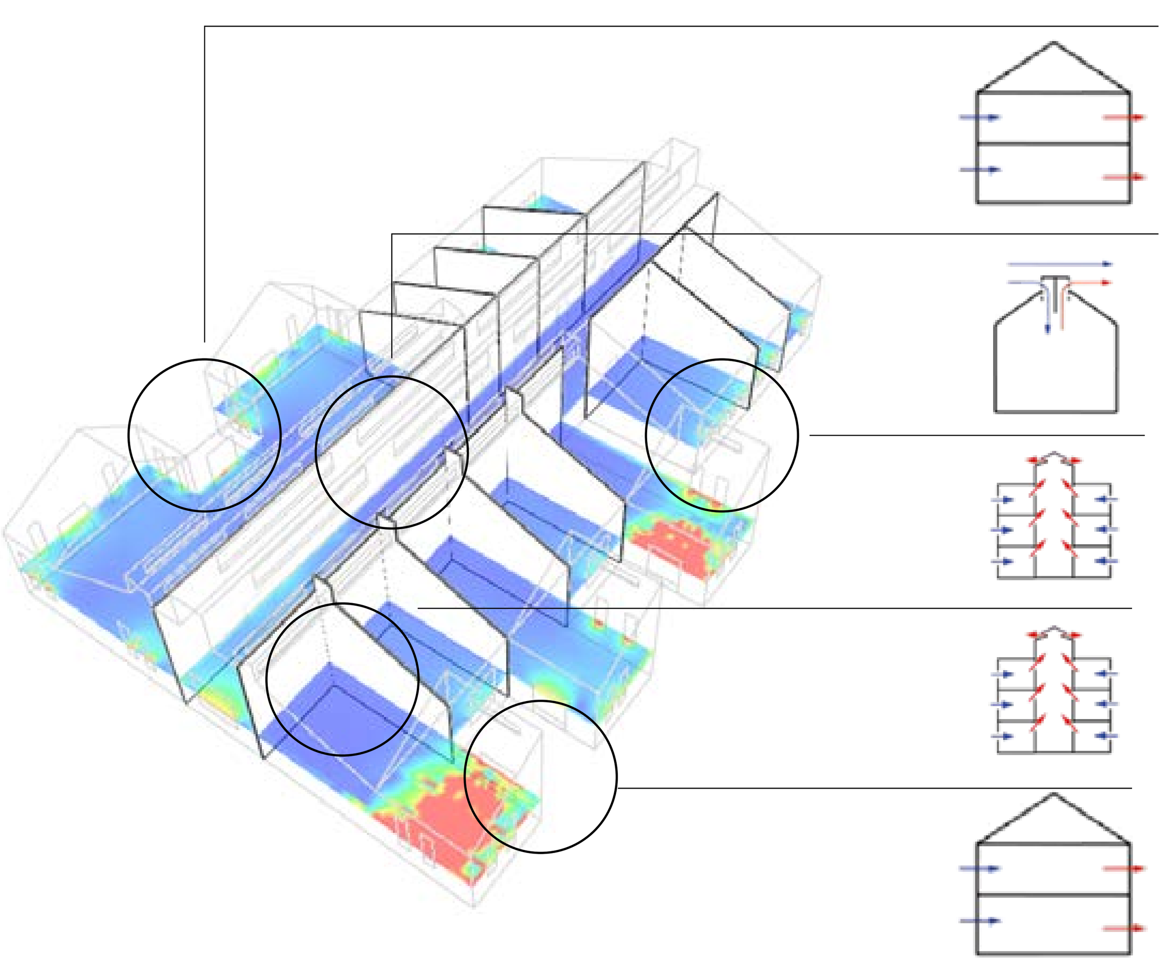
Second Iteration

The second iteration focuses on refining and improving the schematic design of the three mentioned spaces through various strategies.



Improvement Strategies

The three investigated spaces fall short of the required ventilation performance of medical facilities. The improvement of these spaces were done in accordance with the recommended natural ventilation strategies proposed by the World Health Organisation. While the strategies include natural and hybrid systems, only natural ventilation systems were employed in the iteration namely: Cross ventilation, wind towers and stack ventilation.



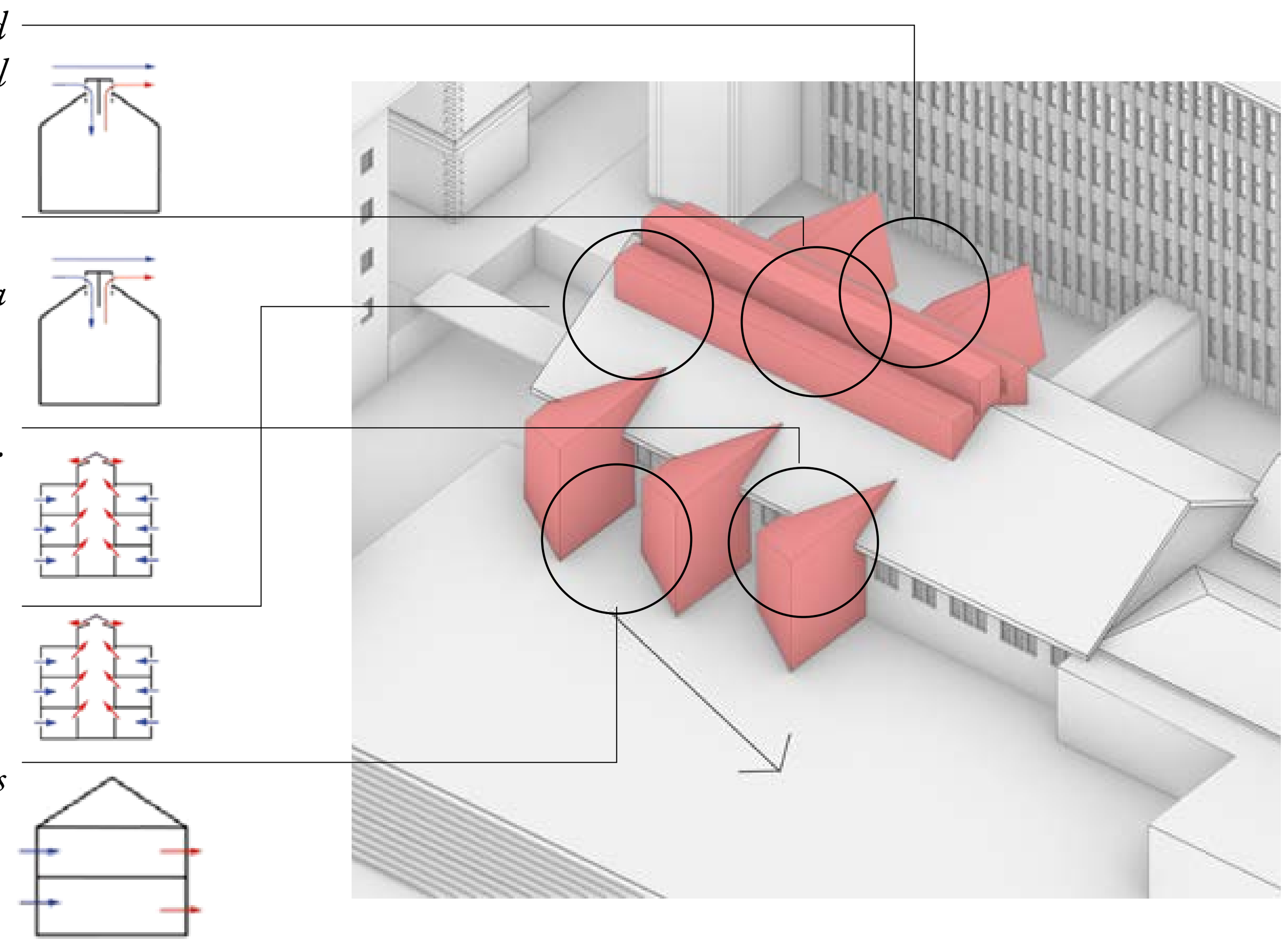
The dialysis clinic can benefit from added cross ventilation and improved exterior surface area. A small courtyard is provided. To improve vertical air exchange, a clerestory is added to create a stack ventilation effect.

The hallway has problematic airflow throughout as there is only one Opening on the southern side. The verticality of the space suggests that a wind tower would be beneficial by improving vertical air circulation.

The consultation rooms have notable stagnant sections in the roof spaces. This can be remedied with clerestory windows that promote stack Ventilation

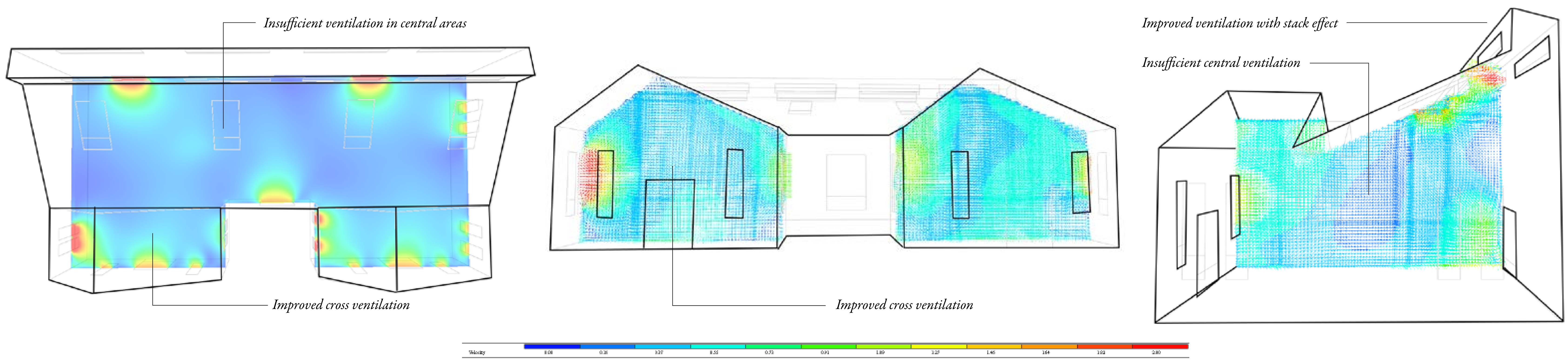
The highest point of the consultation room can benefit from stack Ventilation to ensure no stagnant air remains in the space.

Separating the spaces provides semi-courtyards which can improve cross ventilation and provide more surface area for openings.

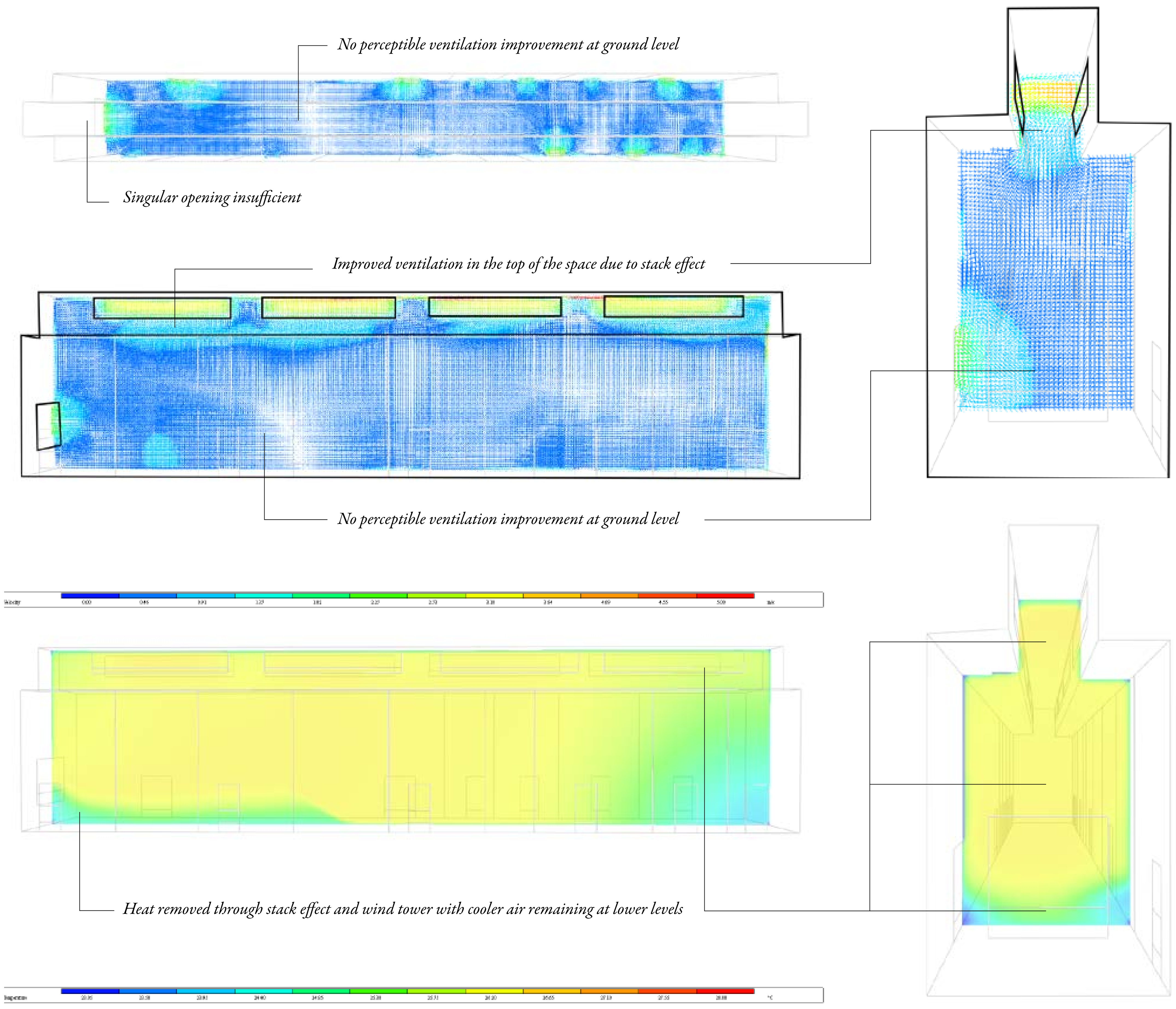


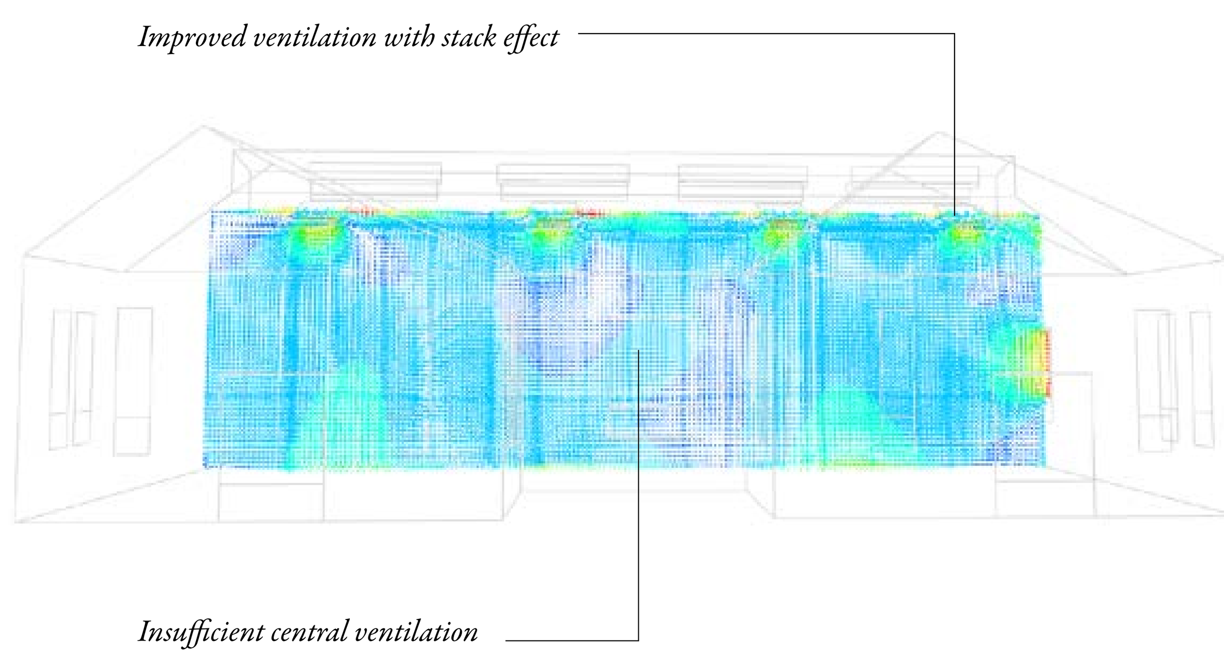
Simulation Results

Dialysis Clinic



Hallway

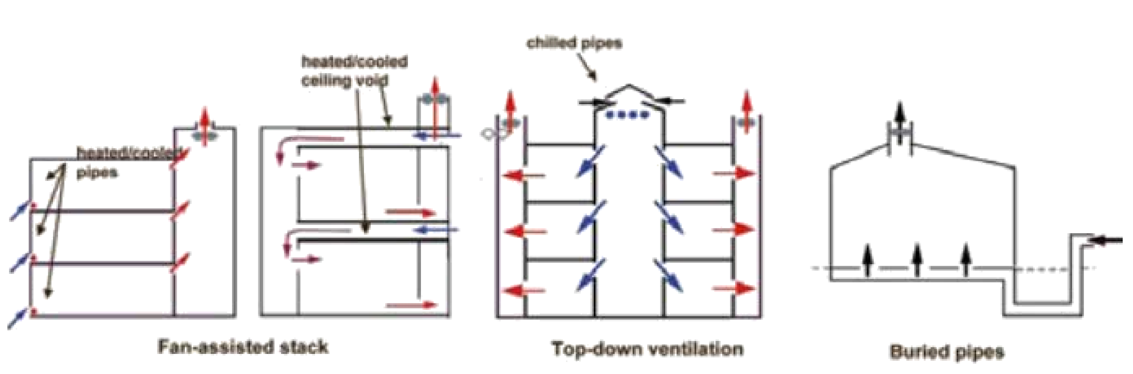




Observations

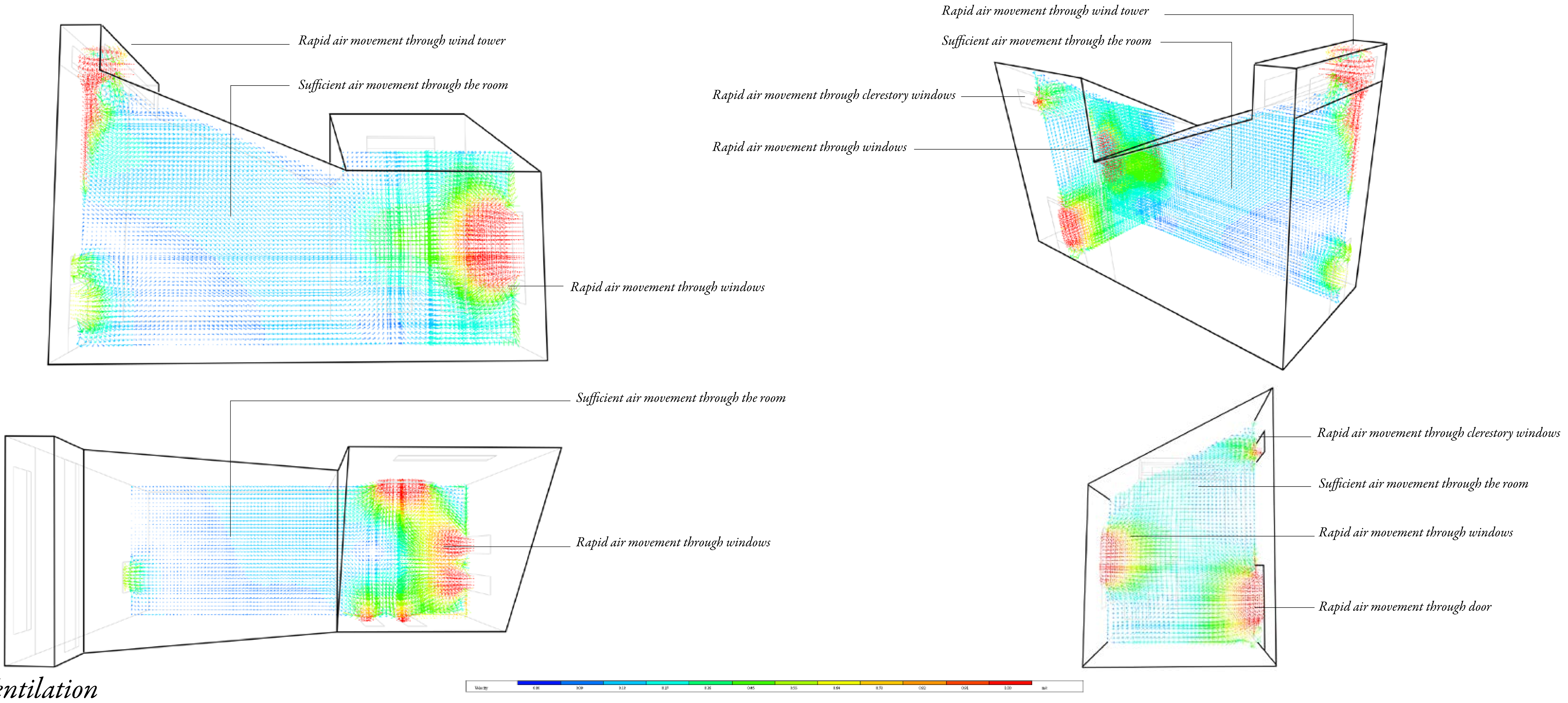
Initial observations of the two spaces tested indicates that the implementation of natural ventilation strategies performed less than ideal. The dialysis clinic remains under ventilated due to the position of the facade openings. Due to the prevailing wind direction, minimal input and thus through flow of air is seen. The depth and size of the space are also potential draw backs.

The hallway similarly experiences insufficient airflow with the wind tower addition. It can be speculated that the ground level air input is not enough to create sufficient cross ventilation and vertical air movement. Due to the position of these spaces, hybrid solution will have to be investigated to achieve the desired ventilation metrics. Buried air supply pipes and fan assisted stack ventilation are possible solutions.

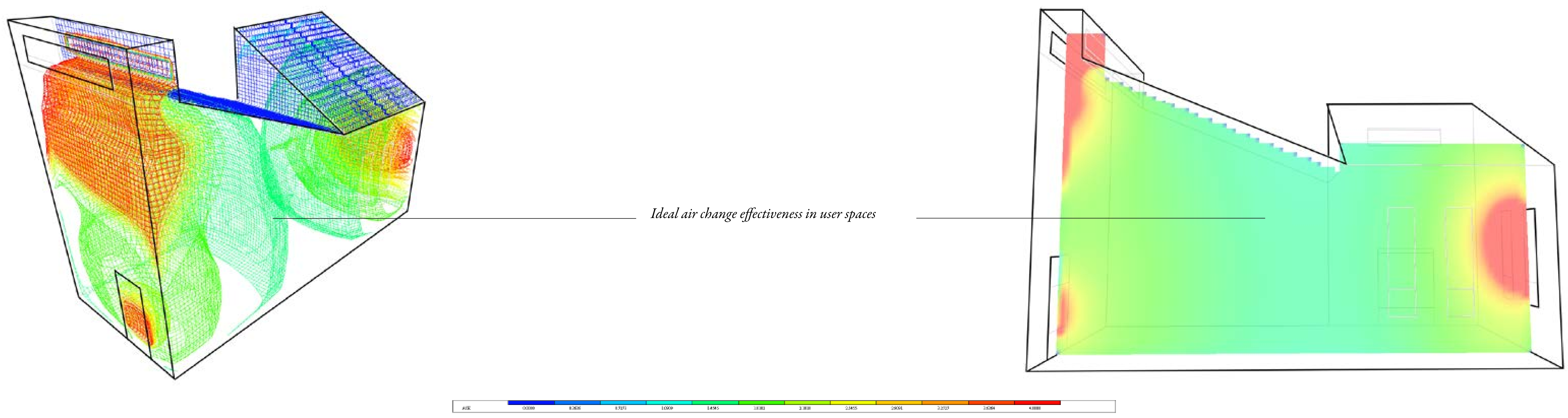


WHO recommended hybrid systems

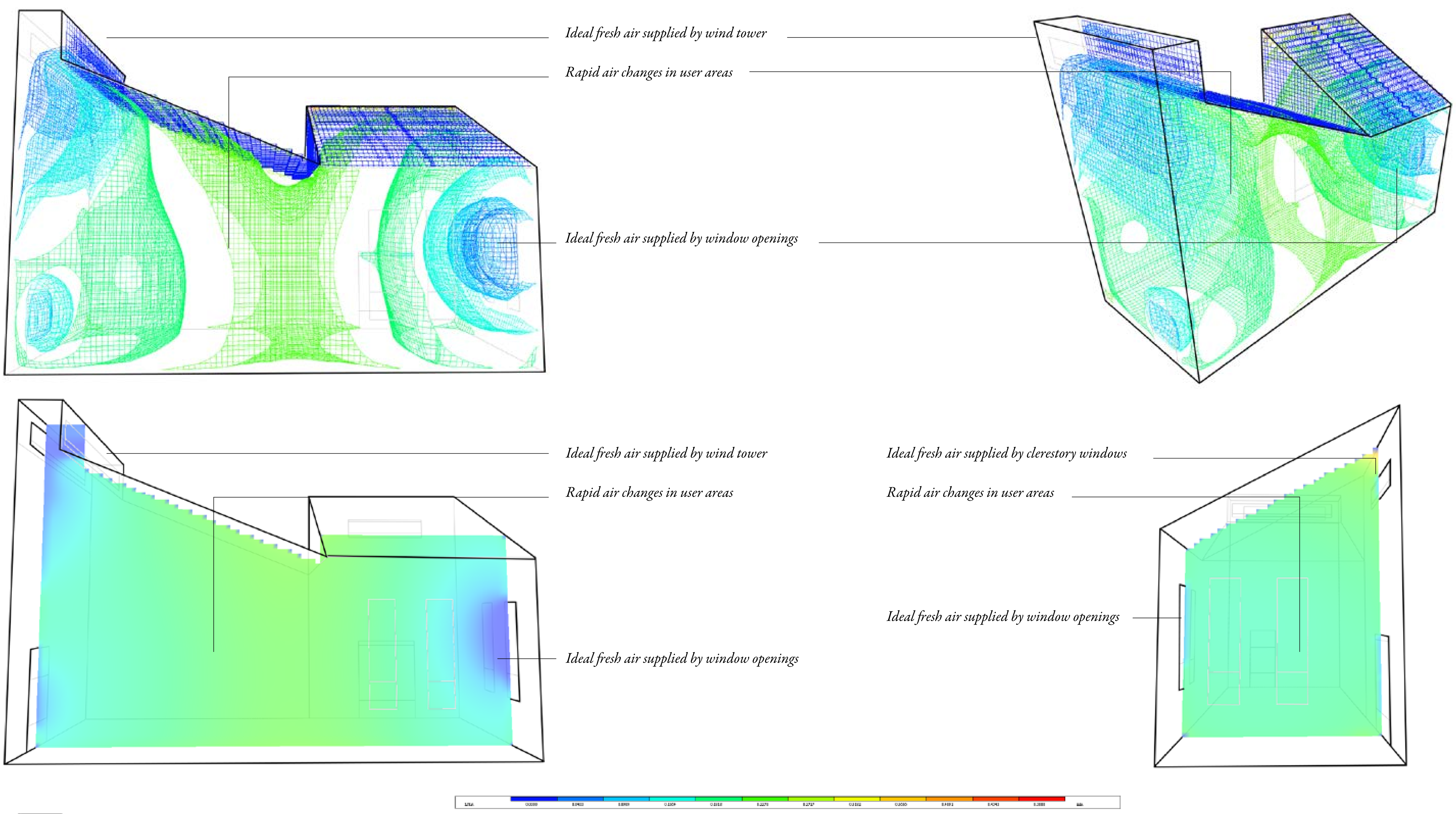
Consultation Rooms



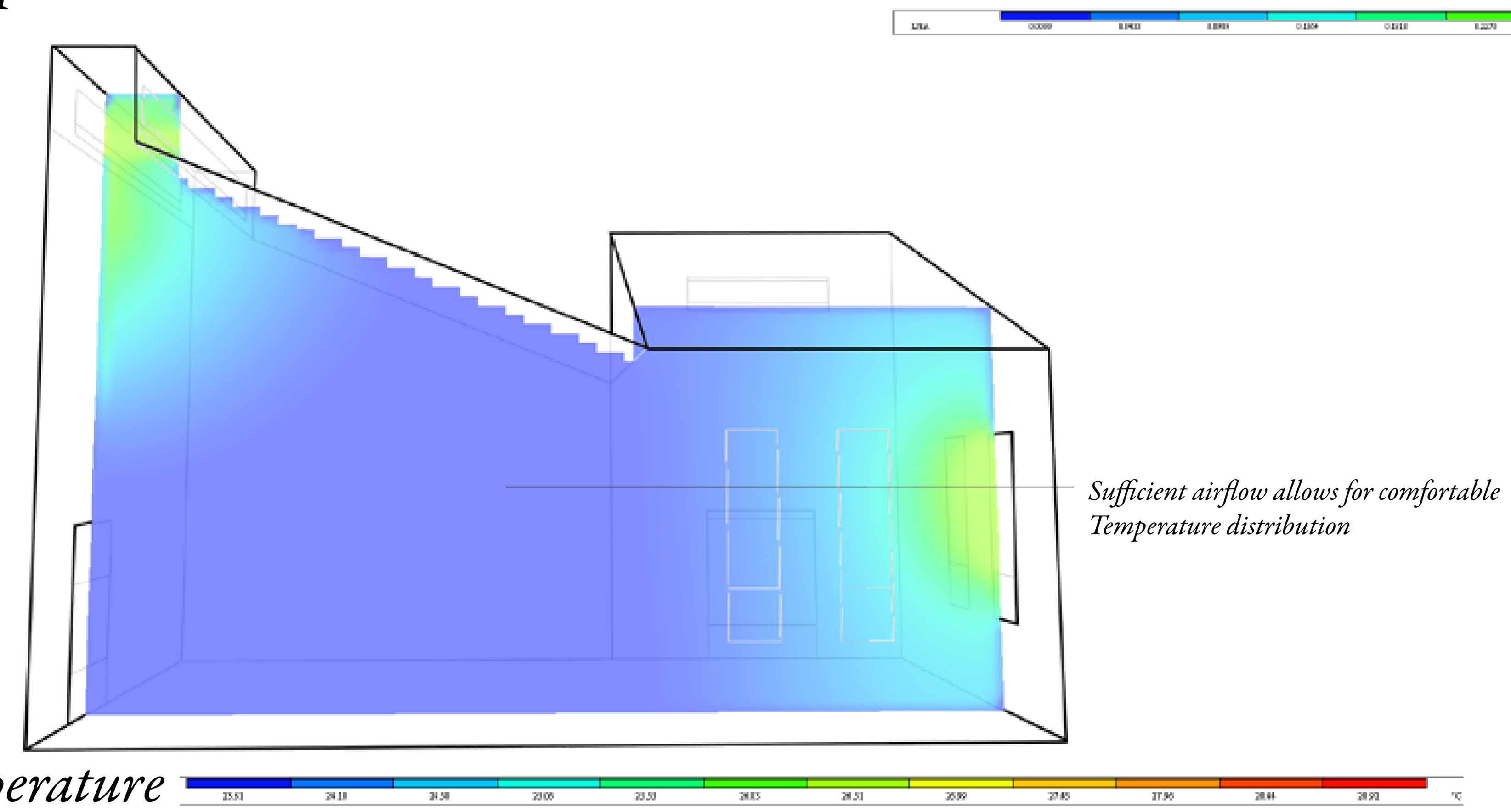
Ventilation



ACE



LMA



Temperature

Observations and Conclusion

The iterations to the consultation rooms were remarkably more successful than the other rooms. Improved cross ventilation and stack effect due to the courtyards, clerestory windows and wind towers ensures that the air changes in the space is well within the desired range.

The improvement of natural ventilation of a building is a complex undertaking that requires an in depth approach. The realisation that ventilation consists of more that "air changes per hour" results in complex solutions that combines strategies according to the individual room requirements and spatial context. Further investigation into natural ventilation solutions are required for context with less than ideal conditions such as rooms that are not within the wind path or do not have exterior facing boundaries.

Hobday, R.A. & Dancer, S.J. 2013. Roles of sunlight and natural ventilation for controlling infection: historical and current perspectives. Journal of Hospital Infection. 84(4):271–282. DOI: 10.1016/j.jhin.2013.04.011.

Roghanchi, P., Kocsis, K.C. & Sunkpal, M. 2016. Sensitivity analysis of the effect of airflow velocity on the thermal comfort in underground mines. Journal of Sustainable Mining. 15(4):175–180. DOI: 10.1016/j.jsm.2017.03.005.

SANS. 2011. The application of the national building regulations. Part O, Lighting and ventilation. Pretoria: SABS Standards Division.

World Health Organization. 2009. Natural ventilation for infection control in health care settings. Available: https://iris.who.int/handle/10665/44167 [2023, October 19].


Site Plan
Scale 1:300
Public excersice space
Res connecting bridge
Specialist Medical Care
Covered seating areas
Pharmacy
Primary and
Secondary medical care
Covered event space
R&D, Shop,
Workshop
Public green space
Services, Reception,
Changing rooms
Oncology
Wards
UP Residence
Main Hospital
UP Residence
Hospital
Casualties
Out-patients
Bopelo Road
Dr Savage Road
B
C
C
A
A
B

Building 1: Research and development.
Floor Plan

Scale 1:100

Building 4: Specialist Treatment Ground Floor Plan

Scale 1:100

Building 4: Physio and Psycological care

Scale 1:100


Section A-A
Scale 1: 100
Workshop
Pause area
Office
Courtyard with wind tower
Open Circulation
Public canteen
Shop


Section B-B
Scale 1: 200
Building 1: R&D
Building 2: Medical Care
Event Space
Pharmacy
Residince
Building 4: Specialist Medical Care
Bridge
Excercise space

Section C-C

Scale 1: 20


Prototype Space
Toilet and change
Toilet and change
Boiler Room
Reception
Building 2: Reception & Services
Scale 1:100

Building 3: Primary and Secondary Medical Care

Scale 1:100