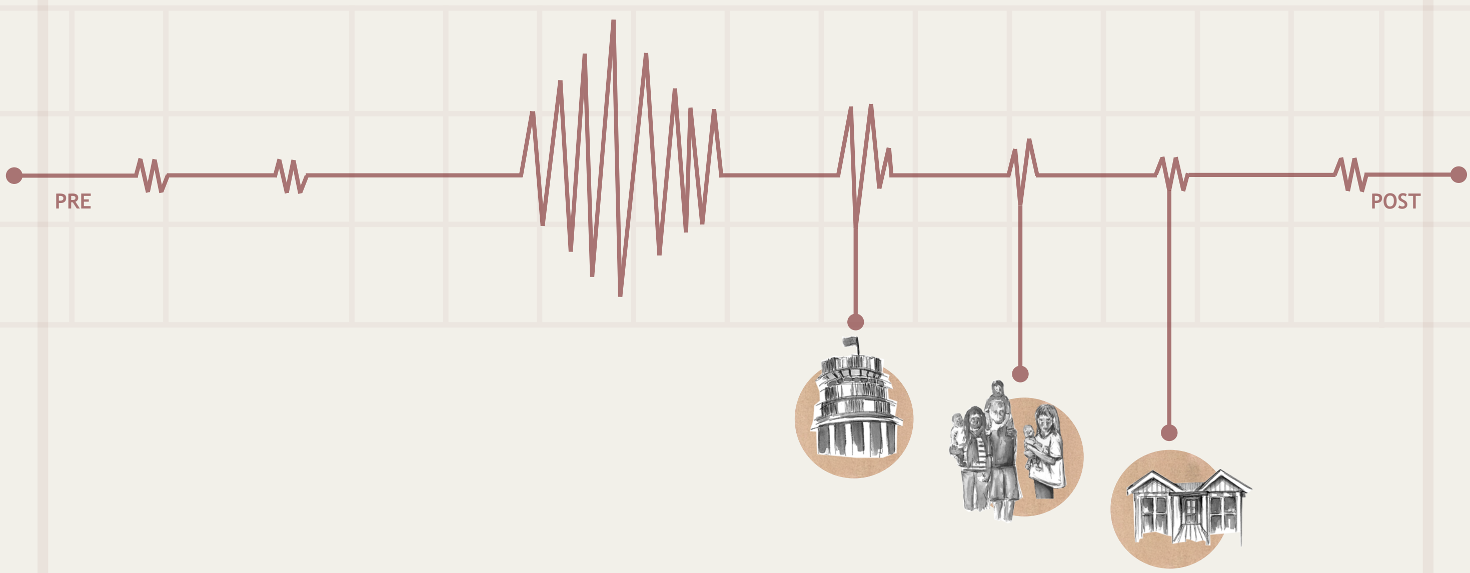
IN THE MIDST OF DISASTER

An Architectural Response to Pre-Established Disaster Relief



ABSTRACT

In the midst of a natural disaster communities look for critical help and support. Wellington city is particularly vulnerable with one main road to and from the city, where a rupture in the Hikurangi Subduction Zone could cause an AF8 scenario, cutting Wellington City off from many critical resources. Civil Defence centres were used until 2016 as a means of community support in the midst of such a scenario, however these centres have now been removed, with emphasis placed on the individual to be able to fend for themselves.

This thesis researches into how analysis of past disasters and a community's response can reveal how architecture is able to be developed with disaster relief functionality in mind. Through critical analysis into current disaster responses both nationally and internationally and how they perform when disaster strikes, it is discovered that a community is left vulnerable in the key 24-72 hours post event. Architecture has the ability to bridge serious gaps in current relief plans and through processes taken in this thesis, final research and design frameworks have been established and applied into the developed design outcome.

Taking into consideration the human condition alongside locational and demographical aspects, the need for at risk locations to be pre-prepared and for design to be developed with a secondary disaster relief functionality was highlighted. The objective of this research is to develop an architectural response that offers a means of pre-established disaster relief for the city of Wellington, opening up discussion and further critical analysis into current disaster relief responses within New Zealand. The design works alongside established government plans, and potential post-disaster relief efforts in order to produce a final design that connects with multiple responses following a disaster.

Through understanding how architecture reacts in the midst of a disaster, with research closely following alongside design a framework is achieved in order to produce a design that will support Wellington's residents both pre and post disaster. This research changes the way architecture responds to disasters and disaster relief, to provide critical support in the initial 24-72 hour period following a disaster regardless of demographics.

IN THE MIDST OF DISASTER

An Architectural Response to Pre-Established Disaster Relief

By

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Phase 2: Site Selection + Preliminary Design

Phase 3: Developed Design + Conclusions

“No one knows what to do or where to go at the moment...”

“Tell people they are alone for the next 24 hours...”

(Dudman, 2015)

PHASE ONE:

THE PROBLEM + THE PROCESS + LITERATURE

CHAPTER ONE:

THE PROBLEM + THE PROCESS

PROBLEM OVERVIEW

DISASTER → 24 HOUR → 48 HOUR → WEEK

The extent of a disaster is based on a culmination of factors that result in the extent of an event's impact on a place and its residents. Mitigation of these however, could result in potential reduction of damage and impact. Researchers have established that "disasters are a complex mix of natural hazards and human action", where in order "to understand disasters we must not only know about the types of hazards that might affect people, but also the different levels of vulnerability of different groups of people". (Blaikie, Cannon, Davis & Wisner, 2003, p.5). It is though this realisation that a look into disaster relief reveals insufficient means to support a place and its individual communities.

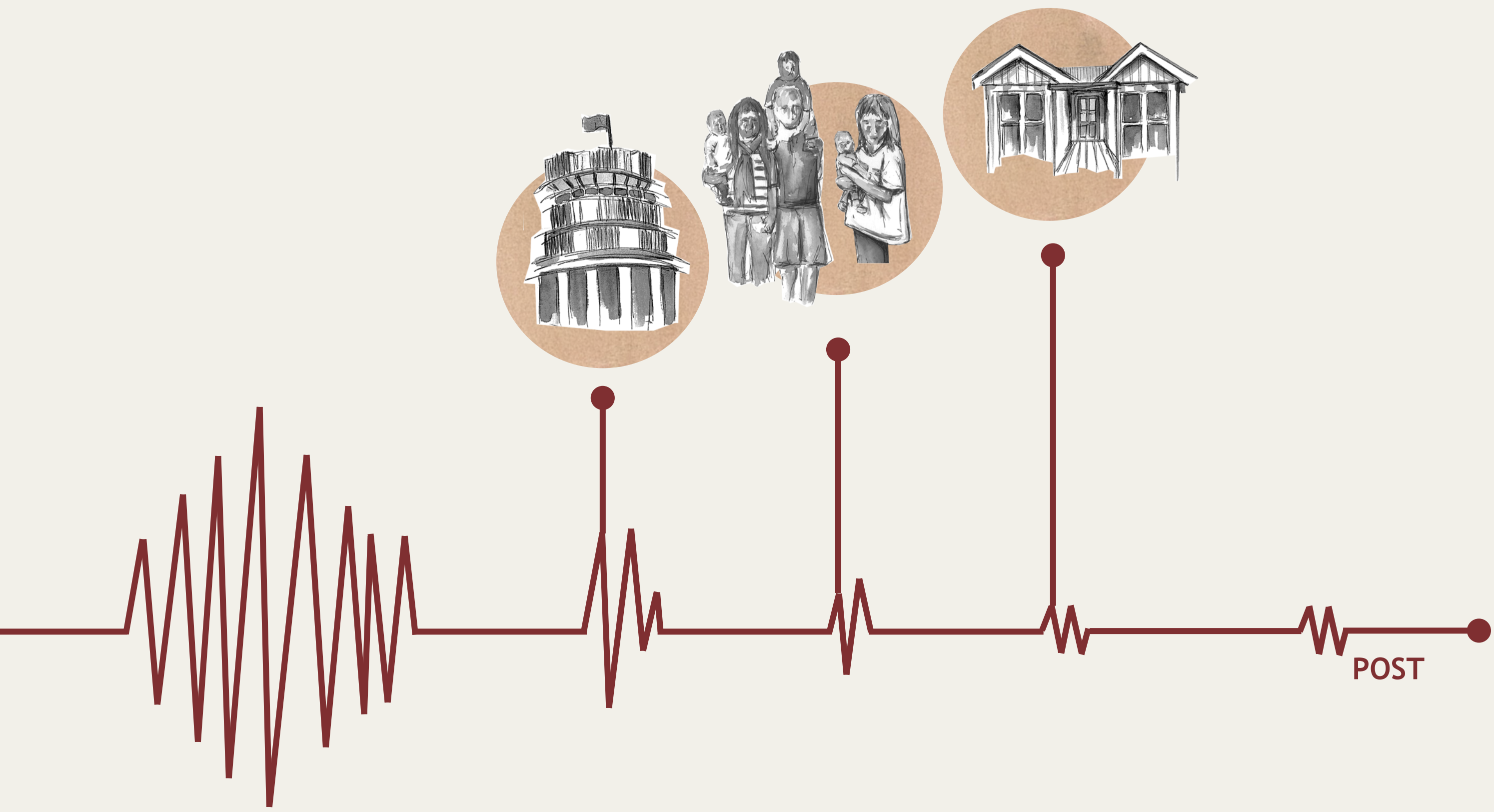
A natural disaster in a location where the residents are properly warned and prepared, will have less casualties than a place where there is little to no warning or preparation, as "dealing with a physical event which makes an impact on human beings and their environment and, unless this conjunction occurs, there will be no hazard or disaster" (Alexander, 1993, pp.4). Wellington is such a location where the likelihood of a significant earthquake impacting its residents has been emphasised by seismologists, however preparation in relation to such an event has been placed on the back burner to other concerns. Currently Wellington's residents are given a series of checklists and questions, in order to determine how prepared they are for a major earthquake or other natural disaster. Preparation of this kind, whilst helpful is not a permanent solution due to further factors in an individual's situation resulting in it being unjustifiable or unsustainable. As highlighted within the text *Resilient Post Disaster Recovery through Building Back Better*, "despite the increasing number of disasters the world is experiencing, post disaster recovery remains inefficient and poorly managed” (Mannakkara et al., 2019, p.1). With Civil Defence Centres being phased out in 2016 and replaced with Community Emergency Hubs this removed a place within the community to seek help and shelter, and replaced it with a place to gain information before having to then seek help elsewhere. (Wellington Region Emergency Management Office, 2019)

Where organisations may claim that Wellington is prepared, in fact its communities and residents are not. With the idea of individual preparedness, guidelines set in place give emphasis on communities helping each other in the initial stages post disaster. It is through guidelines such as these where it has been emphasised by local researchers that focus areas on recovery should be based on “including the community in recovery, empowering the community, providing recovery solutions based on community needs, considering social impacts of recovery, and enhancing and supporting physiological recovery (Mannakkara et al., 2019, p.15). Where introduction of these elements into the current plans set in place will provide a community with further means to support itself. Despite all this, there is still the question of the initial 24 to 72 hours post-disaster, where there is minimal support for a community until organisations are able to register and react to the extent of the disaster at hand.

Based on this concern, the following research question is addressed:

How can architecture provide pre-established disaster relief, in order to meet the needs of Wellington's residents in the midst of the predicted damaging earthquake and other imminent natural disasters?

PRE


POST

DEFINITION OF A DISASTER

In order to fully understand the extent of how a location is effected in the midst of a disaster, key factors that heighten the level of impact must be highlighted and explored. A disaster, whilst devastating in the level of damage that could occur, is further increased by the place itself not being prepared. This is worsened in cases where they either do not have the means to protect themselves, or do and choose to ignore the likelihood of a particular event occurring.

As highlighted within the text *The Changing meaning of Disaster,* "how we view adversity and pain have important implications on how society engages with the threats that it faces" (Furedi, 2007). Where people are instructed to take care of themselves and be self-prepared and sufficient in the midst of a disaster, despite knowing that the place in question is not of a demographic standing to be able to do so, defines a disaster. Whilst Wellington has not faced a disaster within the predicted scale of damage that a rupture in the Hikurangi Subduction zone suggests, this means that those who live within the area are not aware, nor seem to care about the scale of destruction and displacement that could impact their normal way of life. This delves into the human condition, where the high risk, low probability event such as a major earthquake in Wellington falls into results in residents not prioritising an event such as this with any form of urgency. This is further highlighted within statistics, where it is revealed that, "fewer than half of all Wellington households maintain survival kits or have a household plan" (Lee, N.D). The very fact that organisations such as Civil Defence and WREMO have warned Wellington's residents that they need to be prepared and fewer than half have listened and acted on it to date highlights the increase in risk of disaster that could fall upon the city.

Taking into consideration the cost of being prepared in the manner that these organisations suggest, and that a large percentage of Wellington's residents are between the ages of 20 to 34 this is not a justifiable option (IDNZ, 2018).

Thus as a result, increasing the level of impact of a significant earthquake and increasing the disaster as a whole. Taking this into consideration, though the development of an architectural response to the information that fewer than half of New Zealand's households are not prepared and are unlikely to change this, how can architecture work on this element of the human condition, in order to protect and provide refuge for residents in the midst of a disaster?

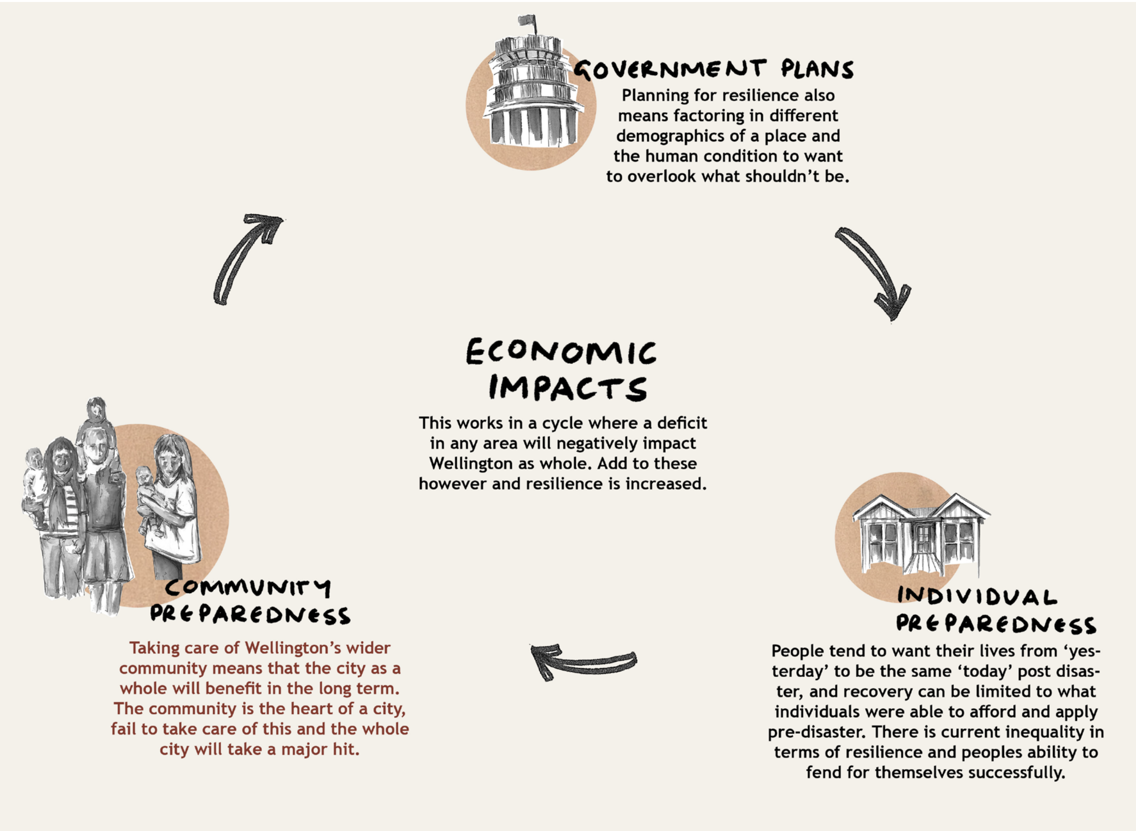


Figure 1 - Proposed Change Away From the Top Down Approach

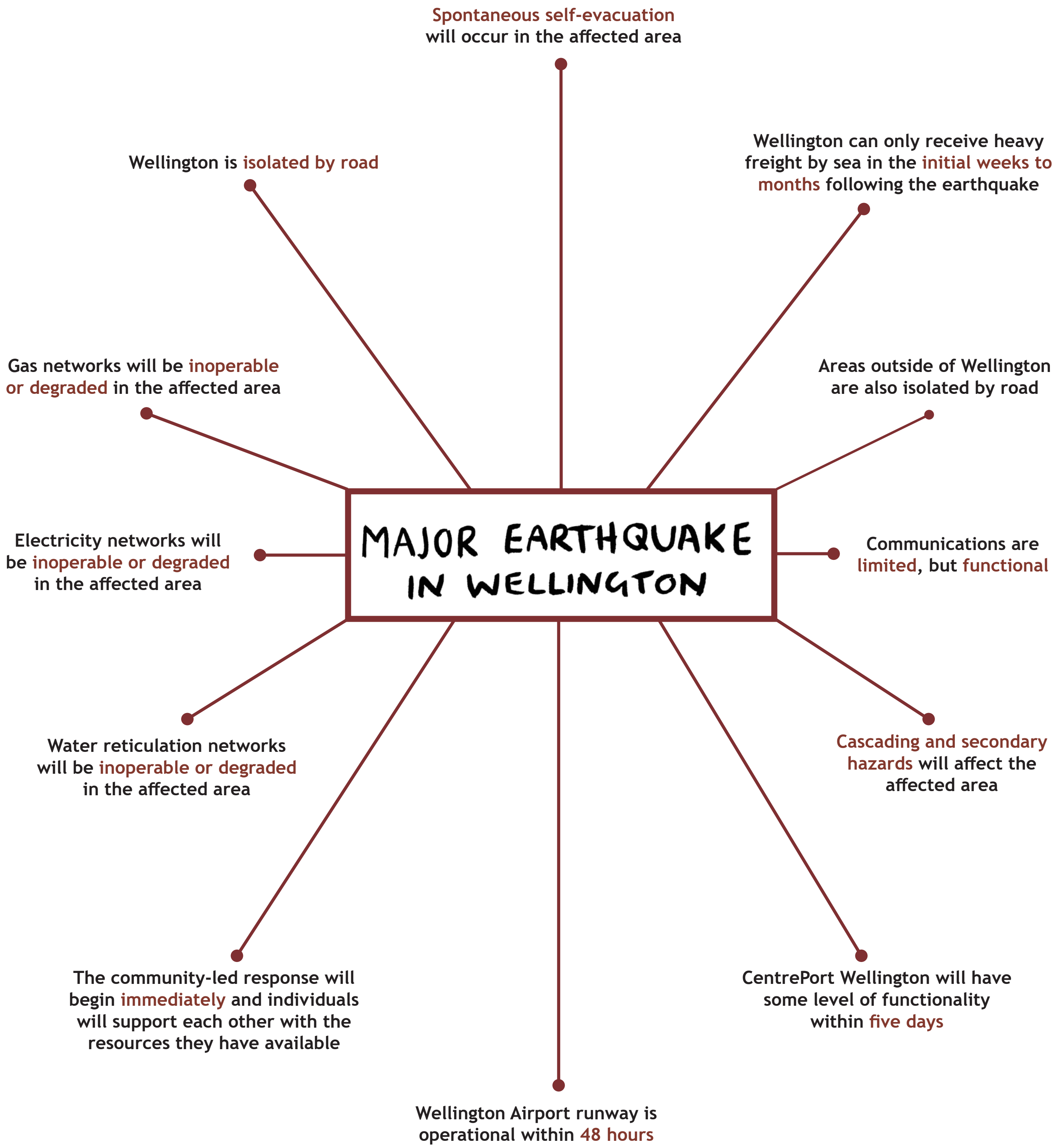


Figure 2 - Predicted Effects on Wellington in the Midst of a Significant Earthquake

THE WELLINGTON SCENARIO

The city of Wellington lies within a number of large fault lines, the most significant of which are the Wellington Fault that runs through the middle of the city, and also the Hikurangi subduction zone that runs from the east of the north island, down through the centre of the South Island. This thesis is based around the potential AF8 earthquake scenario, where a rupture in the Alpine Fault "will produce some of the biggest earthquakes since European settlement of New Zealand" and it will "have a major impact on the lives of many people" (GNS, N.D). Taking this into account the "Hikurangi subduction zone is potentially the largest source of earthquake and tsunami hazard in New Zealand" (Wallace, 2016), where the resulting impact on Wellington would be large scale and devastating. This level of disaster and impact on Wellington has been highlighted in subsequent reports on the scenario, where those such as the *Wellington Earthquake National Initial Response Plan* highlights the potential impacts and responses specific to the Wellington region.

These can be seen within figure 2 where key disruptions to Wellington have been highlighted. This scenario worsening further with the potential for secondary hazards to affect Wellington of which is not limited to but include, "aftershock, tsunami, fire, severe weather, flooding, landslide, liquefaction and subsidence" (Ministry of Civil Defence & Emergency Management, 2019).

Figure 3 - Location of the Hikurangi Subduction Zone in Relation to Wellington and Secondary Hazard Zones

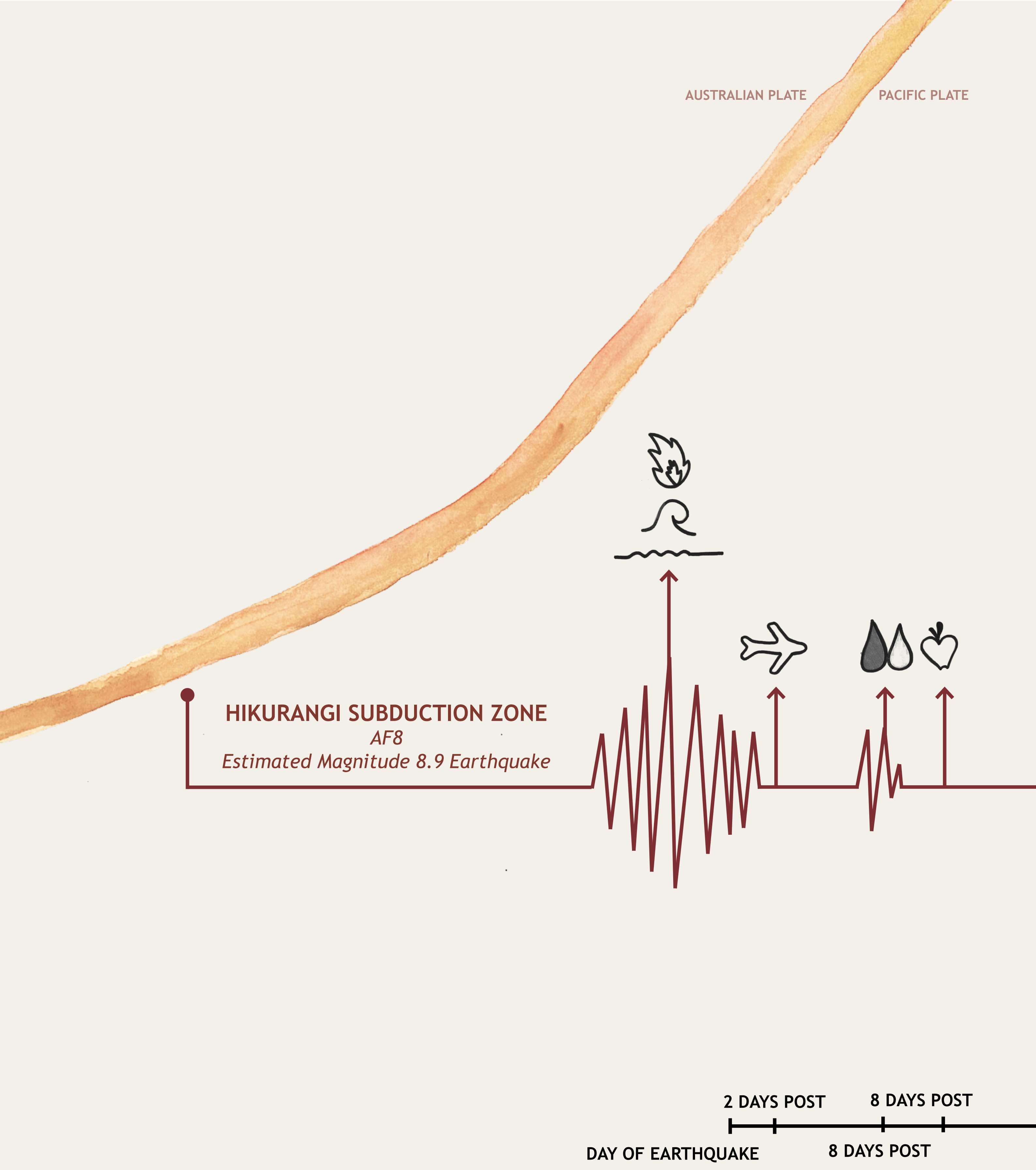
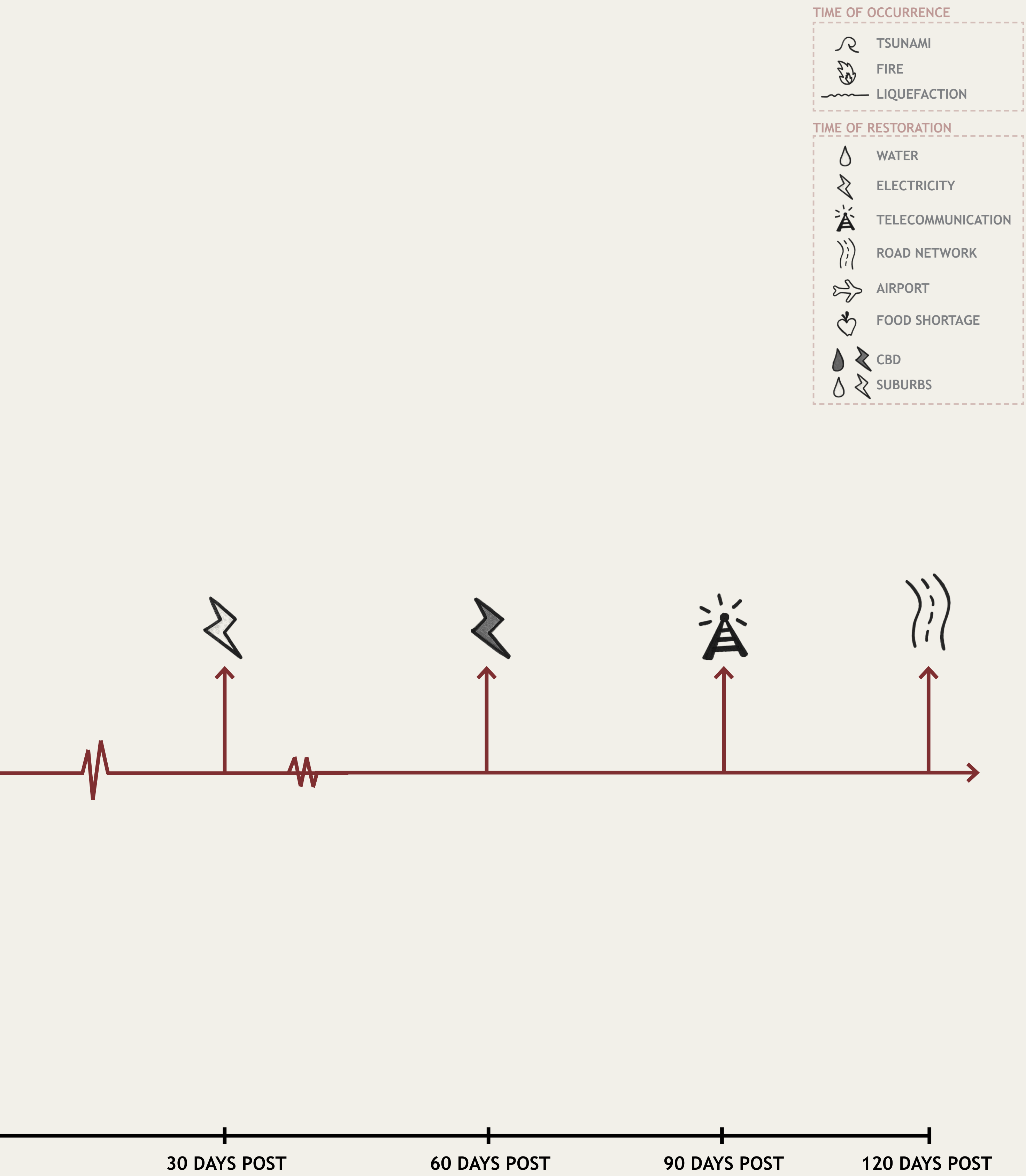


Figure 4 - Predicted Time Line for Disaster Recovery in Wellington


TIME OF OCCURRENCE
TSUNAMI
FIRE
LIQUEFACTION
TIME OF RESTORATION
WATER
ELECTRICITY
TELECOMMUNICATION
ROAD NETWORK
AIRPORT
FOOD SHORTAGE
CBD
SUBURBS
30 DAYS POST
60 DAYS POST
90 DAYS POST
120 DAYS POST

RESEARCH AIMS AND OBJECTIVES

Following on from the problems highlighted earlier within this thesis, the following research aims and objectives have been developed.

Taking all of this into consideration, an architectural response can be developed within an appropriate framework that will provide bridging between current gaps in disaster responses. At each stage defining, researching, experimenting and designing based off findings and critical development.

AIM 1

To understand how a major earthquake can impact an urban city centre, specifically within the scenario of the Wellington CBD

Objectives:

1. Gather and review literature regarding the impact of major earthquakes in urban areas.
2. Look into case studies in relation to major earthquakes both nationally and internationally. Specifically focusing on the aftermath and responses to post-disaster recovery
3. Collect information within national agencies regarding a major earthquake in Wellington, highlighting a worst case scenario and how the government and communities will respond.

AIM 2

To understand the reach of an emergency centre in such a disaster, focusing on its potentials and its limitations.

Objectives:

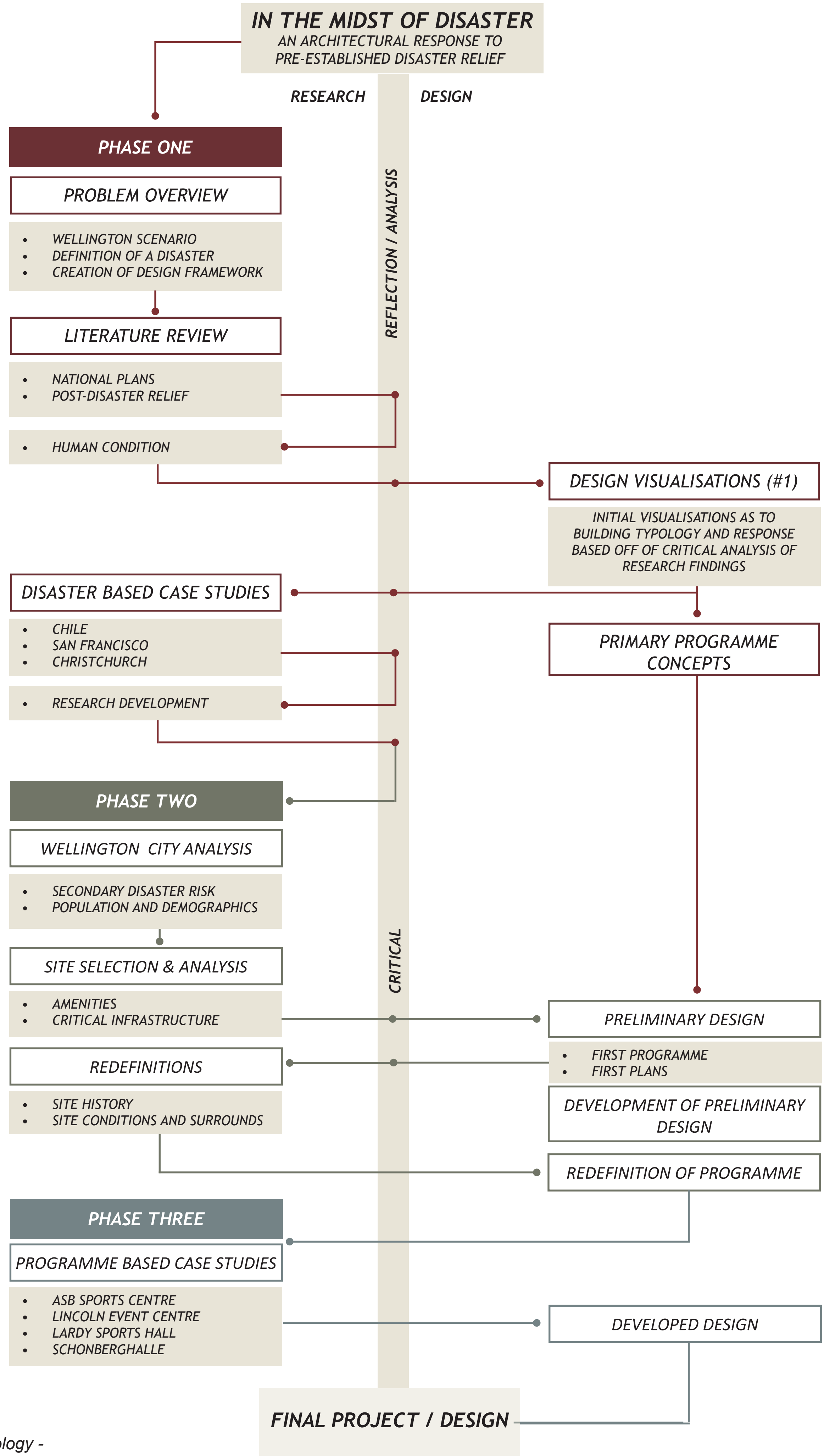
4. Gather information regarding Wellington's population and demographics in order to determine a site within the city that targets relief to an area where it is most needed.
5. Gather relevant information on the site, in order to determine an appropriate primary programme.
6. Develop the primary and secondary programmes in relation to each other, and pre/post disaster based on limitations discovered.

AIM 3

To develop an architectural response to disaster relief that has been pre-established, to provide residents in Wellington the much-needed support they require in the initial moments post-disaster.

Objectives:

7. Create a framework for design that works alongside the government's plans after a disaster, such as the community emergency hubs.
8. Work with post-disaster relief agencies and responses discovered to ensure that a community is given a broader range of support/help in the 24 hours, to week, post the disaster occurring.
9. Develop an architectural response that incorporates seismic requirements and sustainable elements that provide support to a community, whilst also informing them of the design's importance.



- **1.6:** Methodology -

METHODOLOGY

Within this thesis, research has been carried out alongside design, with the thesis itself being split into three phases. Each phase went through a process of critical analysis as seen within figure 5, in order to provide an architectural solution to the research question posed.

Phase one follows the problem, process and literature. Literature reviews and disaster based case studies are carried out, defining the research question, scope and also initial design visualisations. Findings then outlined the initial direction of design based on gaps in current disaster plans that had been critically analysed against the role architecture could then provide as a solution to these. Within this section research is used as a means to determine the direction of the architectural application, with collages and sketches used as a means of visualising potential responses to be critically analysed in relation to their validity.

Phase two follows site selection and the preliminary design established based on critical analysis of phase one. Further critical analysis based around site and post-disaster conditions determined the appropriate final location, to which a preliminary design was then developed. Following critical reviews of the primary and secondary programmes chosen, further research into site history and conditions were carried out. Based on this, redefinition of the programme was required in order to determine an appropriate primary programme that worked with and not against the secondary programme already determined.

Phase three then went into developing the design and final conclusions. Taking the programme determined at the end of phase two, programme based case studies were researched and critically analysed in order to determine an appropriate programme to be incorporated into the final architectural response. The design was then further developed in relation its application within the chosen site and seismic and sustainable requirements. The developed design has then been critically reflected on in relation to the initial research question, with final conclusions being made alongside limitations and further advancements and research suggestions.

◀ *Figure 5 - Research Timeline Working with Research Alongside Design*

CHAPTER TWO:

LITERATURE REVIEW

“Fewer than half of all Wellington households maintain survival kits or have a household plan”

(Lee, N.D)

National Plans

&

Post-Disaster Relief in New Zealand

Establishing that Wellington is at risk of a damaging earthquake that significantly disturbs daily life for its residents, further research into national plans, post-disaster relief within New Zealand must be carried out. This will highlight the greater risk to Wellington and shed light onto any gaps within the nation’s current plans and infrastructure in relation to disaster relief.

NATIONAL PLANS

Wellington when associated with natural disasters, in particular earthquakes can be detailed as a scenario where the predicted damage to the region and also critical infrastructure is significant. As highlighted within a report released from Civil Defence and the New Zealand Government in 2019, in the case of a major disaster in Wellington it would result in widespread damage where, “emergency management facilities could also be damaged or unsafe and the supporting infrastructure unavailable for extended periods” (Ministry of Civil Defence & Emergency Management, 2019). Nationally, the New Zealand government is aware of the potential impact of a significant disaster within Wellington City, however plans and regulations are in place to target the city from the top down approach. This means that whilst the government and other critical infrastructure will be targeted first, Wellington’s residents and large suburbs will be left to fend for themselves. This is highlighted within the Wellington Earthquake National Initial Response Plan, where it states “the WENIRP assumes the development of a National Action Plan by day 5” where by “this will allow a top-down planning approach, where support agencies and CDEM Groups will develop their own actions based on the National Action Plan between days 5-7” (Ministry of Civil Defence & Emergency Management, 2019). Plans such as these are targeted at the long term recovery of the city, where the initial 24 to 72 hours post disaster are left unaccounted for.

With widespread damage predicted for the region, and emphasis placed on “community-lead’ responses it leaves the question of what there is in place for the community to be able to help themselves. With the removal of Civil Defence Centres in 2016 and replaced with Community Emergency Hubs, people are given the information they need in order to help others and not much else. These hubs following the initial 72 hour period are crucial in helping a community to recover in the long term, however in the initial stages where shock and panic are setting in, there needs to be further support already in place.

This problem within Wellington and current National disaster plans is highlighted within the text “Leading in Disaster Recovery: A Companion through the Chaos”. This report states that “through disaster management and the need to develop a resilient community capable of recovering from disasters has become topical, focus until recently has been mainly on reduction, readiness and response” (Masurier, Rotimi, & Wilkinson, 2006, p.2). Action plans and documents prepared highlight the need for a community to fend for themselves in order to help the wider city to recover from a disaster. When this damage is predicted to be extensive with multiple people displaced, how can a community be expected to fend for themselves when all they had was destroyed.

Further emphasis is made on the impact to Wellington and its residents where “when they occur, the effects can be devastating on the natural and built environment” and as a result “organisations therefore need to be well prepared. Rather than rely on a reactive recovery process after an event” (Masurier, Rotimi, & Wilkinson, 2006, p.1). This further highlights the need to plan ahead for resources and organisations to be minimal and overrun, therefore emphasising the need for pre-established disaster relief. Particularly within the first 24 to 72 hours post disaster.

Overall there are serious gaps within current national plans and responses to disasters within New Zealand based around national and community resilience and for individual preparedness.

Some off these of which include the following:

- Location
- Demographics
- Level of Risk
- Perception of Risk
- Overestimation of Human Condition

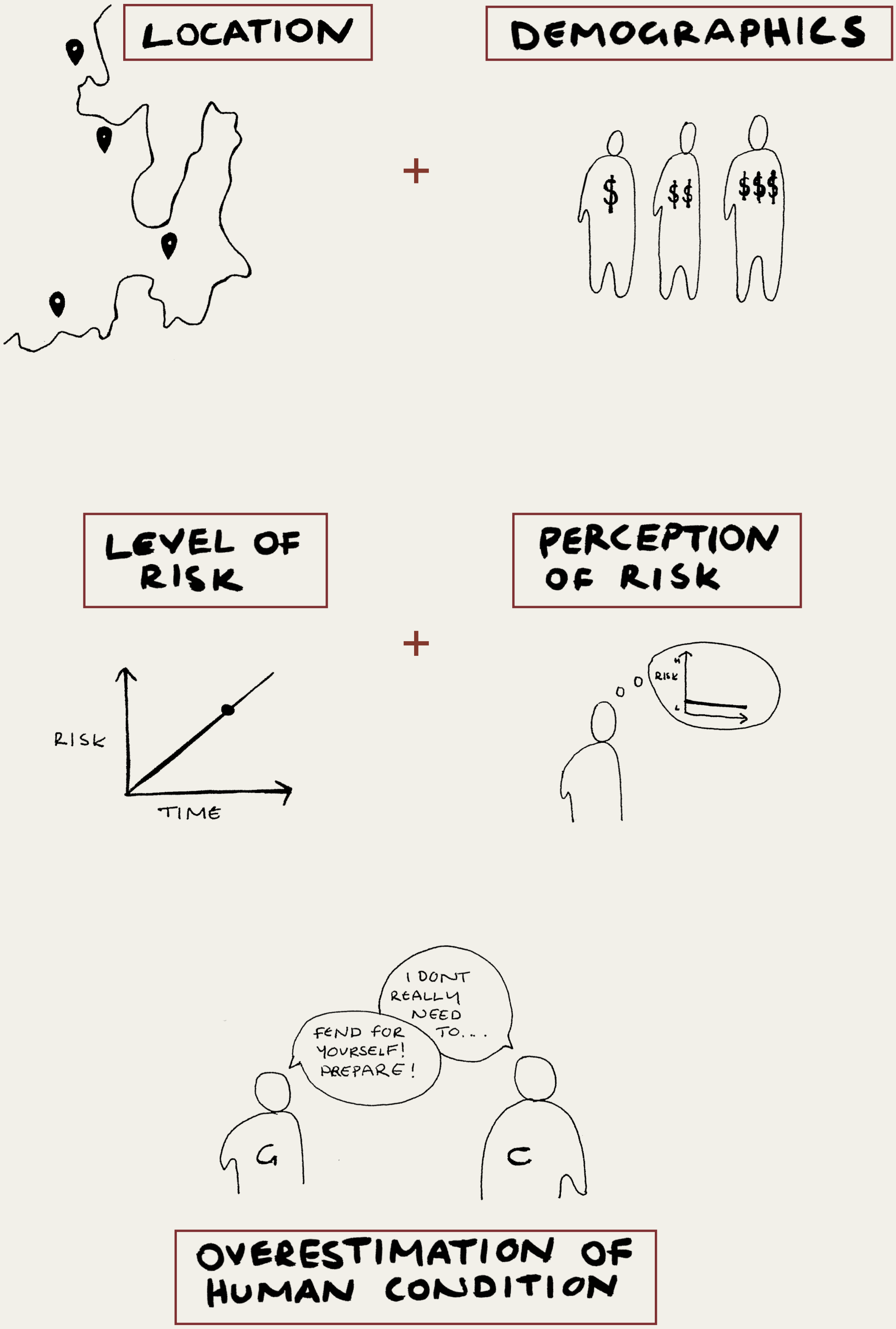


Figure 6 - Key Takeaways from Findings

Taking into consideration all of these factors within plans and responses will cover a broader range of people and also ensure that the majority of a community is provided with the much needed support that they require post disaster occurring.

Based off of all of these considerations in regards to current national plans and also the flaws that are involved, an architectural response that takes into consideration these findings is critical in bridging the current gaps in disaster relief. The bridging of these gaps would provide relief to a broader community, regardless of demographic background and perceived level of help an individual or group is placed within in the first 24 to 72 hours post disaster.

POST-DISASTER RELIEF IN NEW ZEALAND

Post disaster relief in relation to architecture is typically associated with the temporary. Using measures in order to help people recover and get back on their feet post disaster occurring, through providing them with the tools to help themselves. It is within this thinking that problems are discovered in relation to post disaster relief and architectures response.

Within New Zealand, there is concern disaster relief is based around the fact that “despite the increasing number of disasters the world is experiencing, post disaster recovery remains inefficient and poorly managed” (Mannakkara et al., 2019, p.1). Where it has been further noted that “to date, New Zealand has not adequately planned for the long-term social and economic effects of disasters” (Masurier et al., 2006), highlighting the importance of developing a pre-established response to strengthen long term recovery efforts, alongside that of the immediate. In order to further develop disaster relief, taking from the report The Regulatory Framework for Effective Post-Disaster Reconstruction in New Zealand, “there is a need in New Zealand to look more closely at the social impact of earthquakes”, where “community recovery following disaster consists of three interdependent components – social, economic and physical” (Masurier et al., 2006). Taking into consideration the social, economic and physical needs of a community post disaster, this places further stress on the idea of providing a link within the community where a place is pre-established for post disaster recovery and relief efforts. This is further backed up within the text The Social Dimension of Emergency Recovery, where it is noted that “emergencies and traumatic events have profound effects on those involved, but most people adapt to the events, if given appropriate support" (Gordon, Unknown, p.1). Further highlighting the need for infrastructure to be developed further within a community to provide critical support in the initial 24 to 72 hour period post event where there is typically little to no help provided.

Noted within the text The regulatory Framework for Effective Post-Disaster Reconstruction in New Zealand, "the rational starting point is the setting up of an institutional infrastructure for emergency management, which will formulate public policies for mitigation, response and recovery" (Masurier, Rotimi, & Wilkinson, 2006, p.2). This suggests that post-disaster relief could be further developed though efforts to ensure that in the event of a disaster there are places pre-established in order to house organisations and relief efforts. This is backed up through the following statement, highlighting that "the recovery process may present an opportunity for improvement in the functioning of the community, so that risk from future events can be reduced while the community becomes more resilient" (Masurier, Rotimi, & Wilkinson, 2006, p.3). Whilst disaster relief architecture within New Zealand is typically viewed in the form of the Community Emergency Hub, a shift away from schools and community centres that are not always up to earthquake standard, or are within tsunami zones would mean a shift in New Zealand's overall response to disaster relief itself. Though the implementation of permanent infrastructure and buildings established within in a community providing a secondary function of a building dedicated to seeking refuge post disaster, it will provide the missing link in maintaining peoples wellbeing and community when the

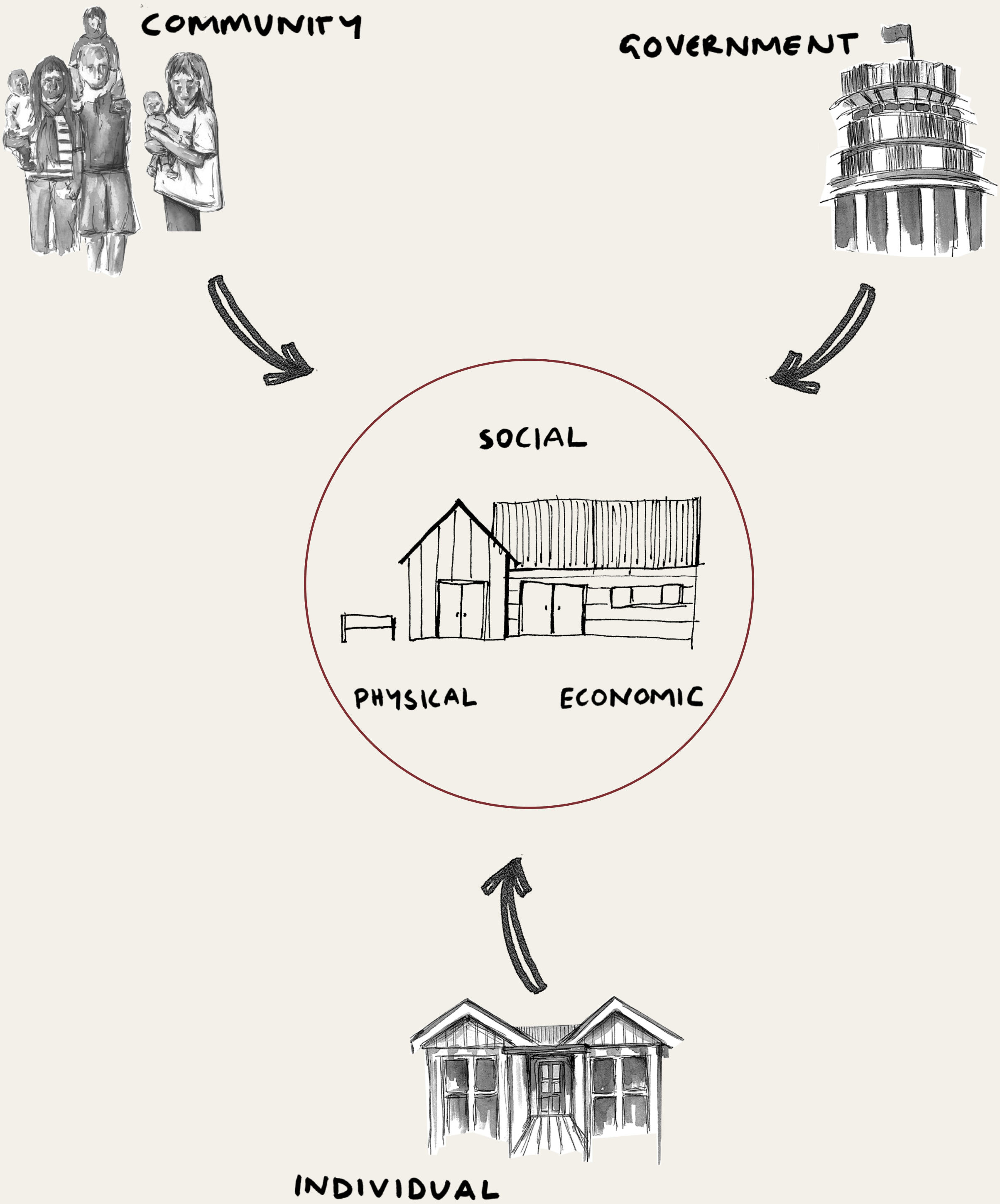


Figure 7 - Key Takeaways from Findings

surrounds itself has become unfamiliar.

In conclusion, when it comes to New Zealand and post-disaster relief there are three main components that need to be taken into consideration. Developing an architectural response in relation to social, economic and physical aspects of a community will provide groups of displaced people with the support they need in the immediate post event, and with the long term relief efforts that follow. Providing a community with a pre-established place where they can seek the support they need both in the short and long term further develops disaster relief as a whole.

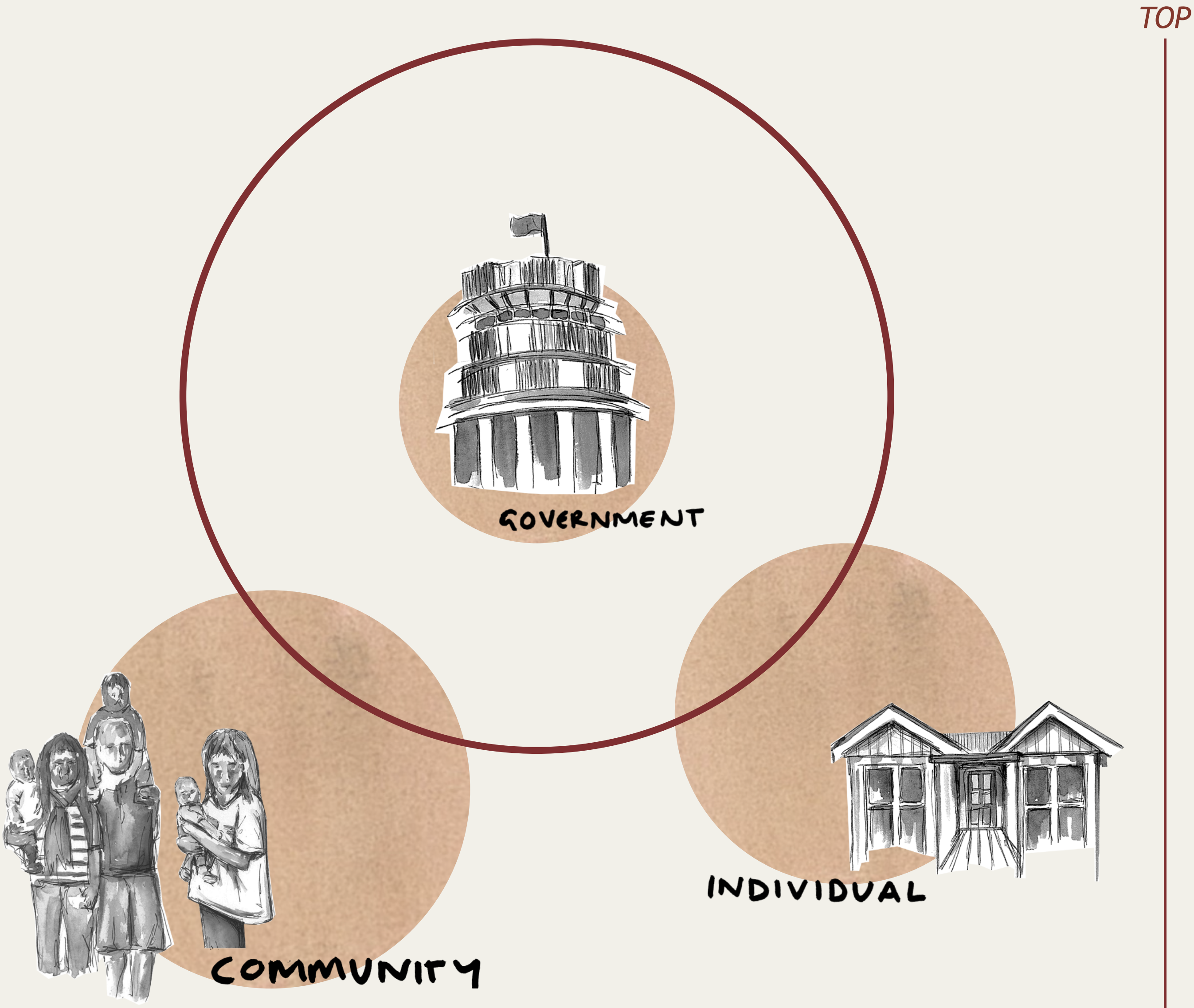


Figure 8 - Diagram on Top Down 'One Size Fits All" Approach in Terms of Those it Really Helps

CRITICAL REFLECTION OF MATERIAL COLLECTED

Current national plans and disaster-relief procedures within New Zealand are outdated and include serious gaps in relation to a nations recovery efforts. When comparing it with the Wellington scenario and the cities increased risk of natural disasters, these gaps have the potential to place further stress on local communities and decrease the city's ability to bounce back quickly.

When critically analysing national plans, it reveals that there needs to be further consideration in locational aspects and demographics of communities and suburbs. Current plans gloss over the fact that there is not one certain demographic of people residing within the cities confines, therefore a one size fits all approach to disaster preparedness and recovery will always fail to meet the needs of those most at risk. Post-disaster relief procedures in New Zealand approach things from the top down, meaning those on the communal level are left with the pre-established plans to fend for themselves. Regardless of background, everyone is in charge of their own recovery and survival efforts before aid is available in the following days. Factoring in demographics into this approach reveals that those who will feel the disasters effects the greatest are those who are not in a financial position to be able to prepare themselves in the first place.

It is based on these observations that a pre-established approach to disaster relief that targets all demographics within a community that will provide relief to those who are requiring it most in the first 24 to 72 hours post disaster. Through architecture that provides relief and is based at the social level of a community this is directly targeting those who require it the most. Working alongside what a community associates with and connects to easily, and combining this with a secondary function also aimed at supporting a community will further solidify the need to pre-establish disaster relief in order to bridge the current gaps. Therefore human condition must be researched to understand how a community might react pre and post disaster, to develop an appropriate response.

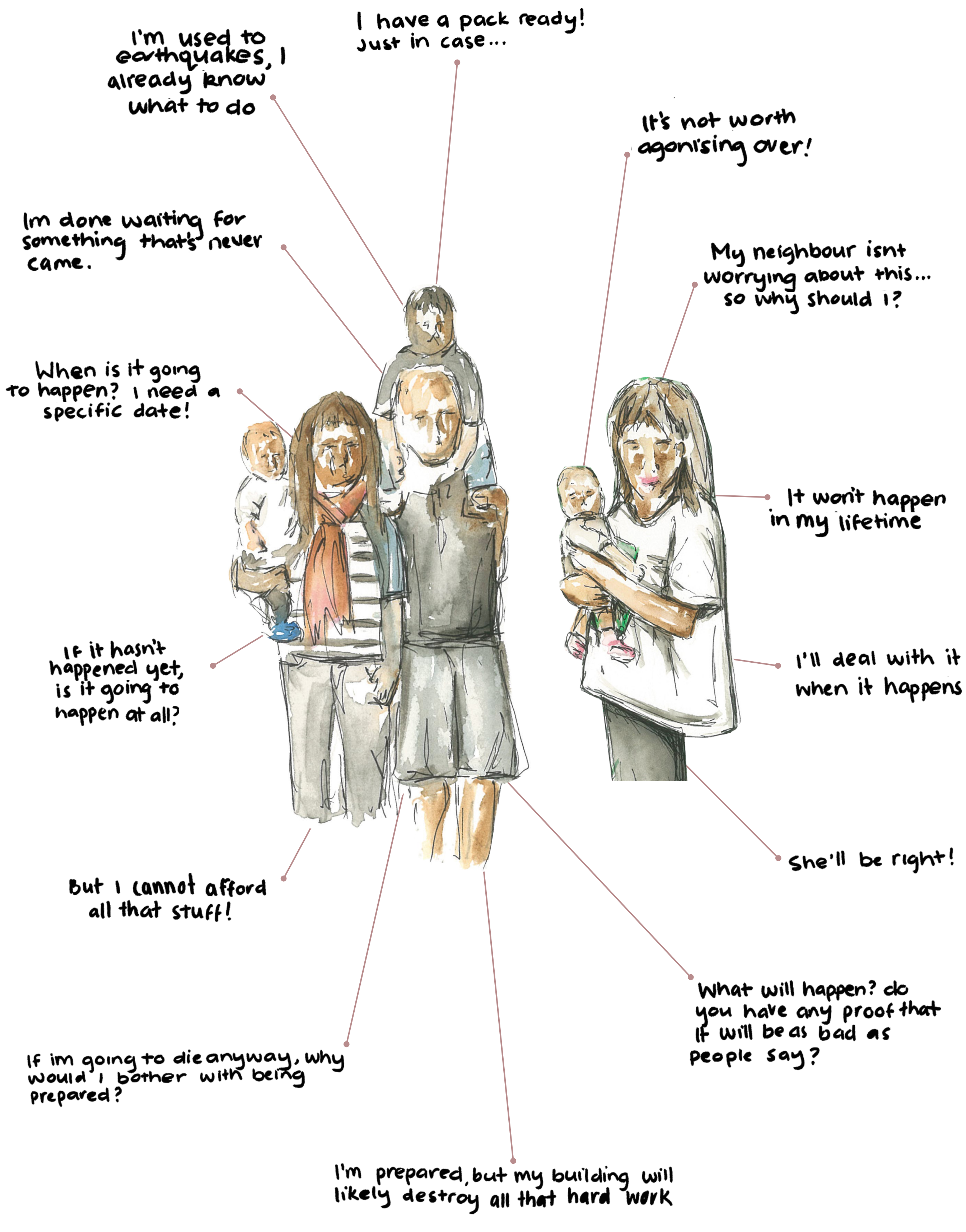


Figure 9 - Brainstormed Responses to the Predicted Damaging Earthquake

THE HUMAN CONDITION

The human condition follows the natural inclination of people and their responses to events based on the likelihood of it happening and other factors that result in people either listening to warnings or ignoring them. Through delving deeper into how people operate in relation to disaster relief and preparedness, an architectural response can be properly established.

Dennis Mileti is a sociologist at the University of Colorado, and follows closely with the human condition in regards to disasters. Within his text Disasters by Design he notes, “Research has shown that people are typically unaware of all the risks and choices they face. They plan only for the immediate future, overestimate their ability to cope when a disaster strikes, and rely heavily on emergency relief” (Mileti, 1999, p.6). This highlights the need for responses in relation to disaster, and also disaster preparedness to be based more on what the natural inclination of people is and not on what is expected of them. Whilst it is not sustainable for everything to be left up to architecture or the government to provide, when it has been noted in both previous disasters nationally and internationally that a community is not as prepared as it should be then disaster relief needs to be targeted in relation to this fact. Further noted by Meleti in his interview with Haznet he stated that, “the single most influential spokesperson to motivate the public to prepare are other people in their life. Their friends, their relatives, and neighbours” (Haznet, 2017). He also goes on to state that the “Government isn’t the best spokesperson to motivate preparedness, it’s the people you know and love, admire, trust, and are a part of their everyday life” (Haznet, 2017). Basing off of this observation, when delving into the notion of pre-established disaster relief in relation to architecture, community infrastructure where people are naturally inclined to interact with their peers, would provide space to establish a place for people to gather post disaster. By placing a primary and secondary programme within the singular piece of architecture, and providing it with elements that are easily transformed pre and

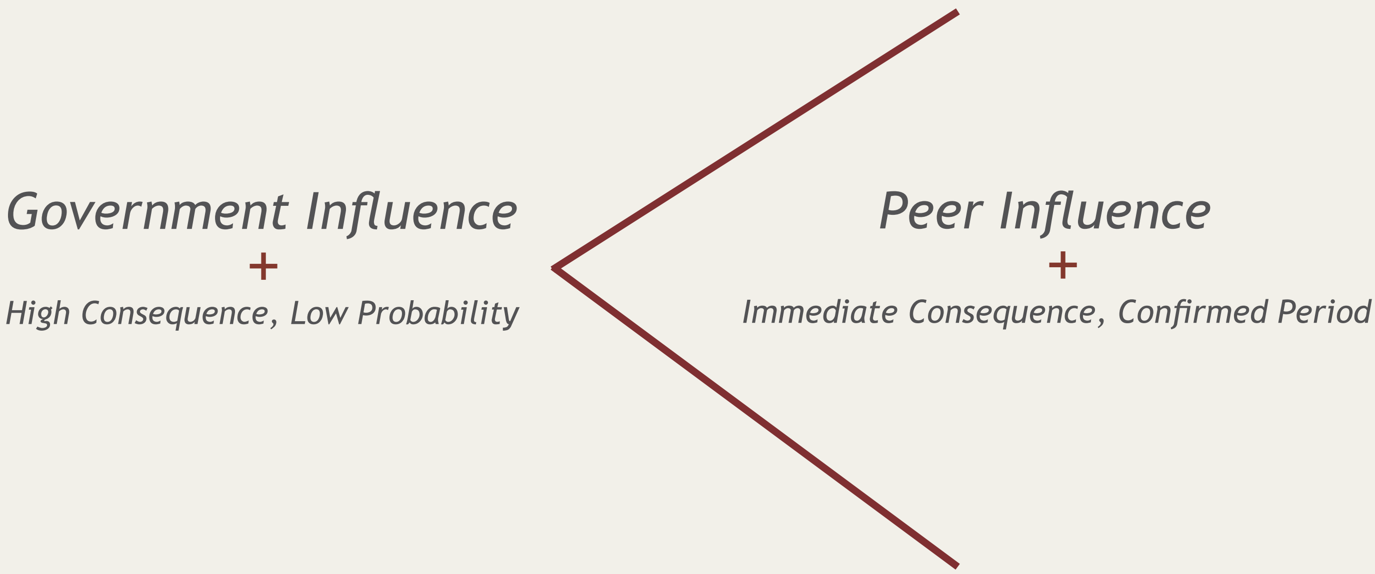


Figure 10 - Summary of Human Condition Theory

post event, this develops architectures ability to support disaster relief efforts within the short and long term.

Delving into the human condition in relation to post disaster responses it has also been noted that, “behaviour in the aftermath initially involves seeking information, contacting loved ones and community members. However, information is often incorrect or unavailable, continuing the isolation or initiating stress” (Gordon, N.D, p.9). Through the lack of information provided and passed on through a community post event, this increases stress and tensions that could otherwise be avoided. Providing a link that has been established in a community before the event itself happens, and placing it within a programme that is used on the daily, this will work alongside human condition, further establishing the building for post disaster relief. Through word of mouth, information can be transferred between large groups of people, thus setting up a place for people to travel to, in order to gain support that they may require especially within that initial 24 – 72 hour period.

In conclusion, working with the natural inclination of people to not listen to warnings from the government about being self-prepared and working instead with people listening to their peers, pre-established disaster relief can be further developed. Through providing a place within a community that people are familiar with not only for its primary function day to day, but also it’s secondary function as a place for relief, this bridges a gap currently seen within disaster relief plans in New Zealand. Through not placing sole belief that people will heed warnings for disasters that are not directly imminent, and instead basing it around the natural human condition to not worry about it till the time comes, pre-established disaster relief in the form of architecture will provide much needed relief for those left displaced and helpless when they need it.

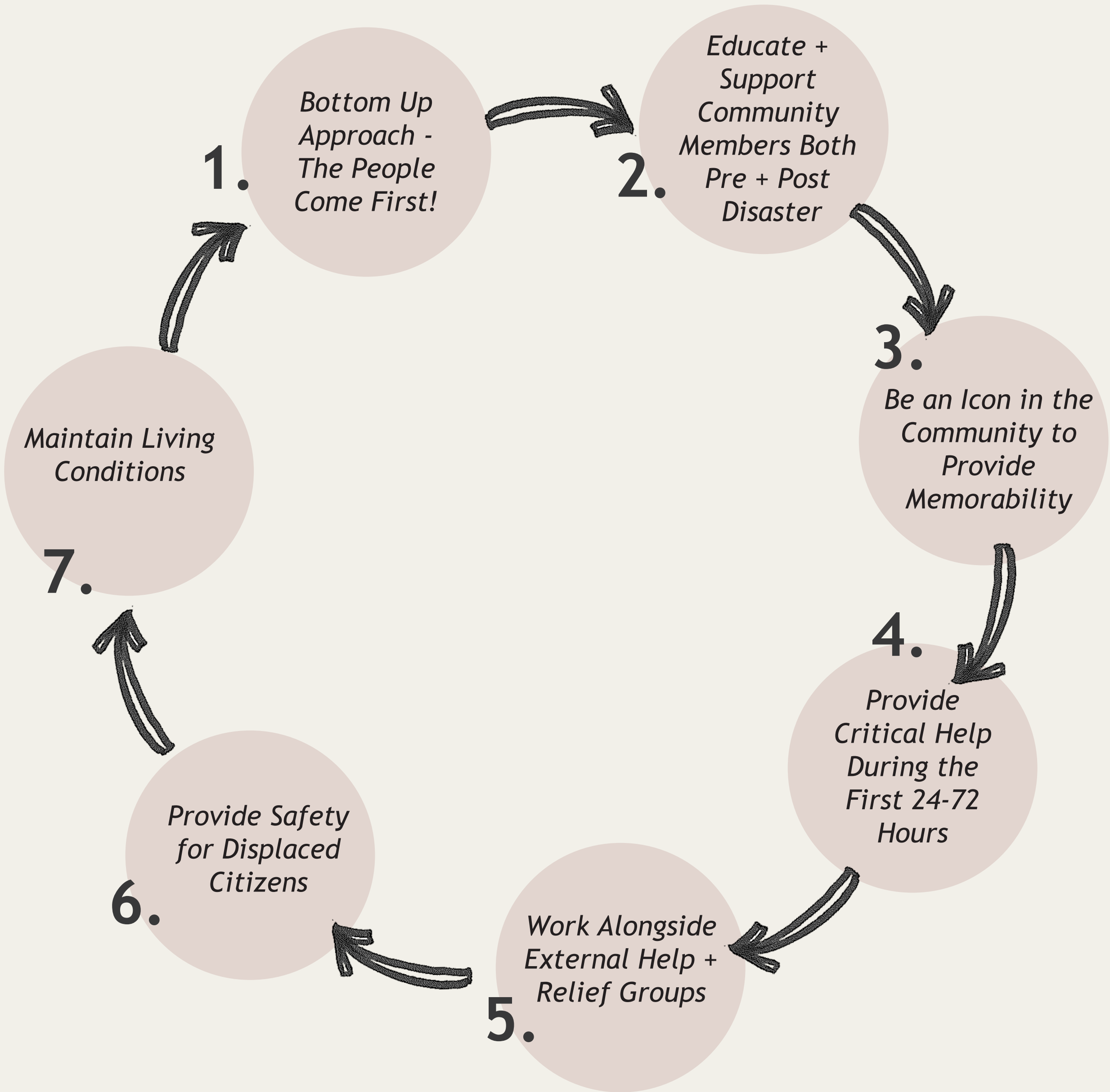


Figure 11 - Design Framework

FRAMEWORK FOR DESIGN DEVELOPMENT

DEFINE + RESEARCH + EXPERIMENT + DESIGN

Following on from research into national plans, post disaster relief in New Zealand and the human condition the following design framework has been established.

1. Taking a bottom up approach to the design response where the people come first
2. Educate and support community members both pre and post disaster
3. Provide an architectural solution that is an icon within a community to provide memorability
4. Provide critical help during the first 24 – 72 hours post a disaster occurring
5. Work alongside external help and relief groups to provide support to those who are coming in to also help the wider community
6. Provide safety for displaced citizens
7. Maintain living conditions and a sense of normality when the immediate future is unclear

Closely following these within the stages of research and design development will ensure that the final outcome is one that will achieve the set aims and objectives.

Design is to be taken through a process where specific problems are defined and critically analysed through research. Experimentation is then carried out and the design developed, alongside further critical analysis to ensure a final outcome is achieved that meets the established framework for this specific project.

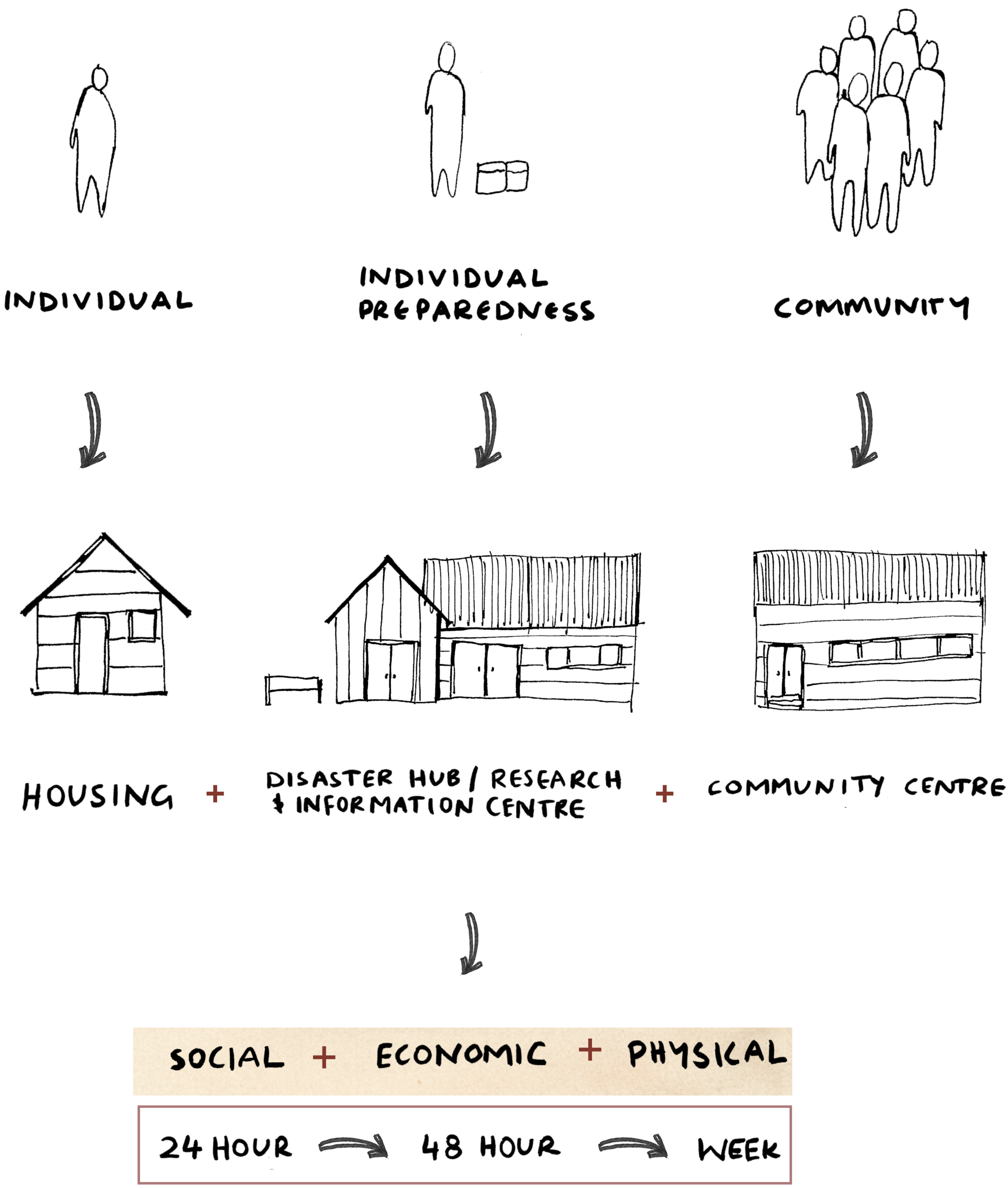


Figure 12 - Potential Architectural Applications Based on Research Findings

INITIAL DESIGN VISUALISATIONS

Based on research conducted, the following design visualisations have been considered. Critical analysis of research on the individual, individual's ability to be prepared and also the community have been highlighted. These have been visualised into three potential design directions where a secondary programme of a relief centre could be combined with these primary programmes. All three designs target different approaches to disaster relief from a pre-established point of view that also factor in social, economic and physical needs of Wellington's residents.

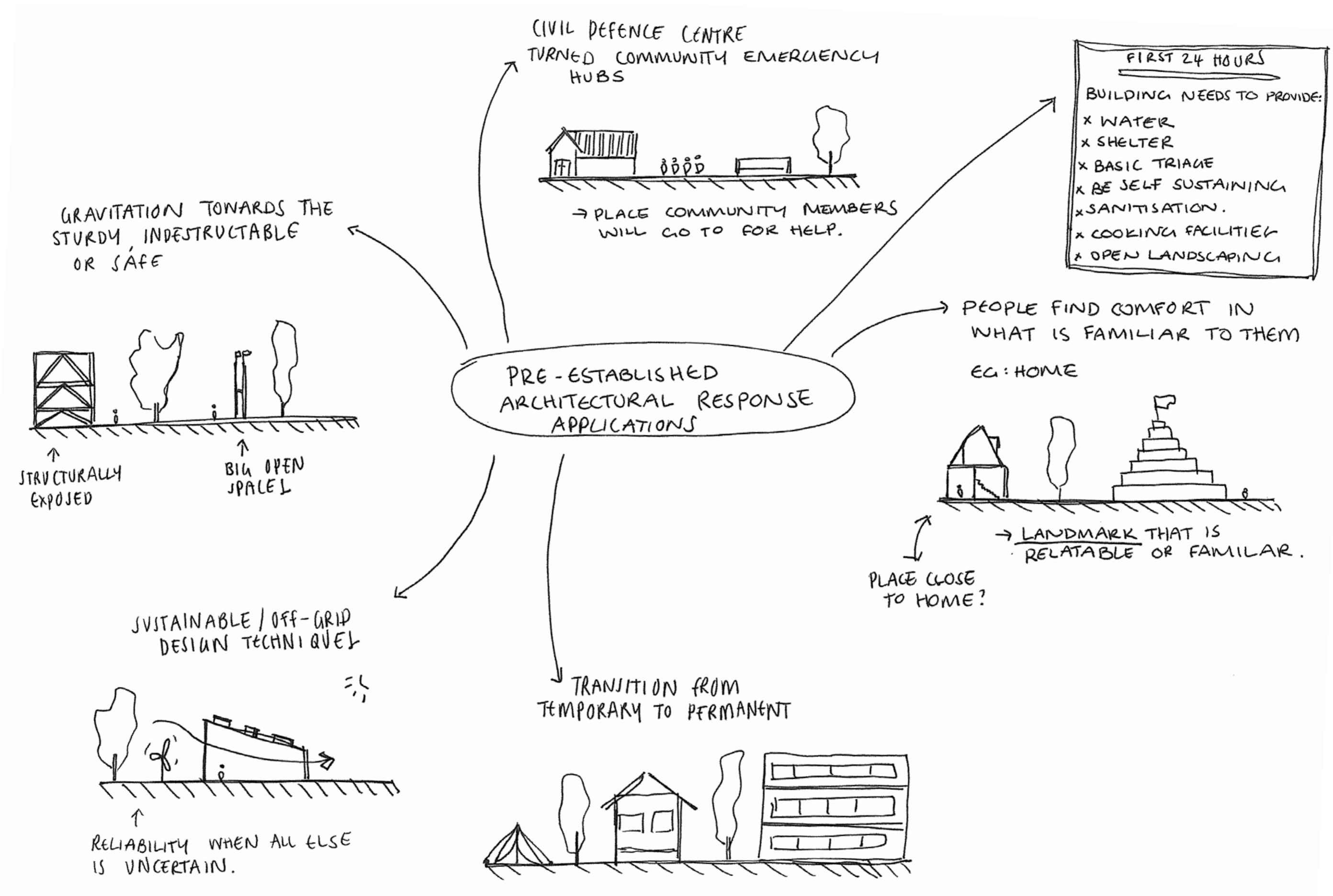


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Figure 13 - Design Visualisation #1 - Permanent

DISASTER HUB / RESEARCH & INFORMATION CENTRE + COMMUNITY CENTRE

The architectural application of a building providing both a primary and secondary programme not only targets the individual, but also the wider community it is placed within. Taking the original concept of the civil defence centre and applying this to a permanent architectural solution to disaster relief the disaster hub has been conceptualised. The community is provided with a place that is not subject to change or be phased out, whilst also providing a pre-determined place for people and relief organisations to gather efficiently. Limitations of this option however resides in determining a primary programme that is able to function over a long period of time, with the potential for the secondary programme to not be used within the building’s lifetime. Therefore the primary programme would have to be further developed and proposed in such a manner that this option is a viable one.

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Figure 14 - Design Visualisation #2 - Pre-Established Temporary

HOUSING + COMMUNITY HUB

The architectural application of pre-established housing and community hubs on the individual scale would target people in areas where they directly live. This would take into consideration suburbs where housing is either earthquake prone, or demographically susceptible to significant economic downfall following a significant earthquake. This application, whilst targeting those where they live directly, is one that on the wider Wellington city scale would not be as economically viable. Whilst in cases like Christchurch where many people were displaced, the areas surrounding their houses were also further impacted by secondary disasters. This would make this option one that has the potential to not be as efficient at providing relief in that initial 24-72 hour period.

CHAPTER THREE:

DISASTER BASED CASE STUDIES

PREPAREDNESS + DISASTER + COMMUNITY

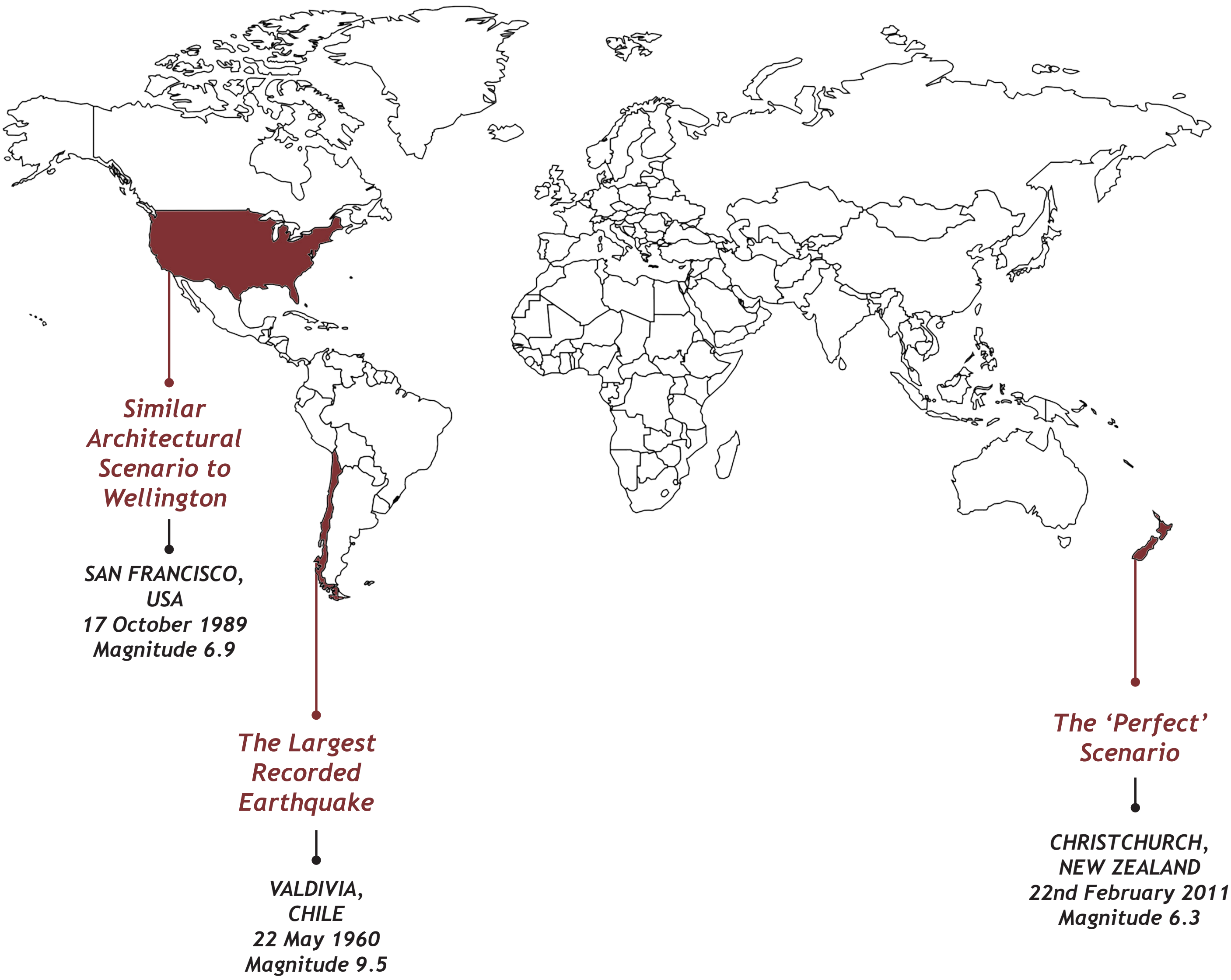

Figure 15 - Disaster Based Case Studies

CASE STUDY OVERVIEW

Disasters are a culmination of events and external factors, that when combined define the extent of impact to regular daily life. In order to fully understand a disaster and the particular series of events immediately following, three different earthquake case studies have been analysed. These include the preparation of a place for this specific natural disaster, the extent of damage and also the impact on a community as a result. The case studies carried out for the purpose of this thesis, is the magnitude 9.5 earthquake in Chile, the magnitude 6.9 earthquake in San Francisco, and the magnitude 6.3 earthquake in Christchurch. Taking these three events within Chile, San Francisco and Christchurch as a worst case scenario, a similar architectural scenario and a previous national 'best case scenario' respectively.

All three events have had significant damage on the locations they occurred within and all resulted in further secondary disasters and events occurring. Through analysing the preparedness and also responses to these events, the degree of which architecture can be developed in order to help communities in the post-disaster recovery process can be determined.

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Figure 16 - Aftermath of the 1960 Great Chilean Earthquake

VALDIVIA, CHILE
22 May 1960
Magnitude 9.5

Chile has been referred to as "perhaps the most highly seismic region in the world" (Lomnitz, 1970, p.957), with the largest earthquake recorded worldwide being that of the great Chilean earthquake on the 22 May 1960. Measuring at a magnitude of 9.6 and also combined with other significant earthquakes on the same day, this earthquake resulted in "around 3,000 deaths in southern Chile" (Lomnitz, 2004, p.374). Due to Chile's susceptibility and frequency of significant earthquakes, it is important to look into Chile's response following the 1960 earthquake and how the country has since developed their emergency management plans in relation to earthquake preparedness.

Observations made within the text Major Earthquakes and Tsunamis in Chile during the period of 1535 to 1955 revealed "a clear warning to Chilean development planners" (Lomnitz, 1970, p.957) due to the frequency of significant earthquakes within the region. Observations were also made in relation to the fact that, "as the population density increases so does the earthquake risk" (Lomnitz, 1970, p.957). As Wellington is also susceptible to earthquakes and also poses a higher risk of significant shakes due to its proximity to the Hikurangi Subduction Zone, warnings revealed within Chile should also be applied. In relation to architecture and the increasing population of the region of Wellington, it is becoming more and more crucial to heed warnings and prepare for a significant event that causes widespread damage. As revealed within this text, developers are warned due to the nature of Architecture being able to either protect or injure those who occupy it at the time of disaster, therefore looking directly towards architectures response during and following a disaster.

In more recent years, and as a result of further deadly earthquakes in the region, Chile has established disaster relief programmes that work alongside "programmes already underway in the city" (Center for Excellence in Disaster Management & Humanitarian Assistance, 2017,

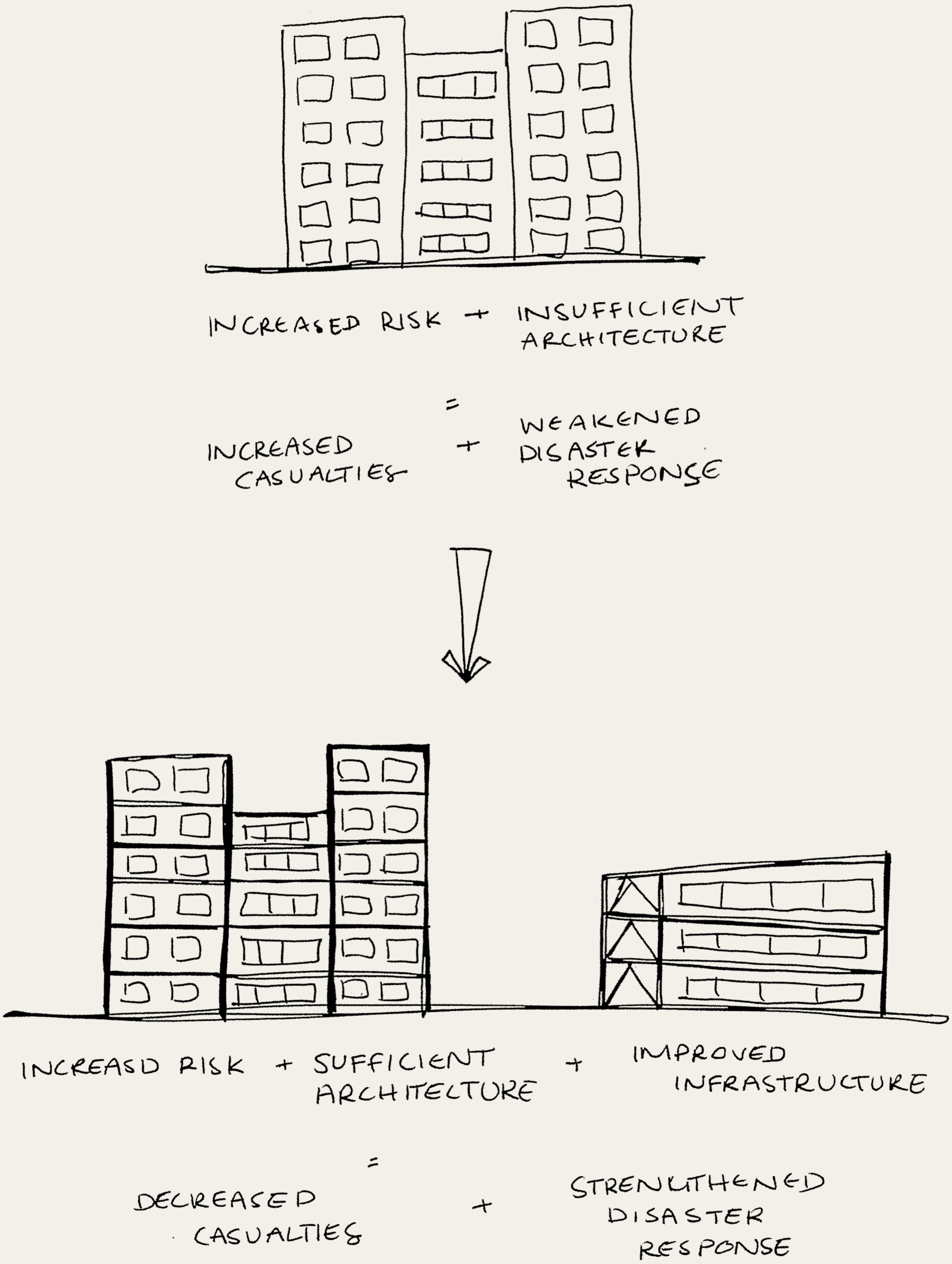

Figure 17 - Architectural Observations

p.12). It is also noted that “the Ministry of Housing and Urban Development has incorporated criteria for disaster management risk reduction with its reconstruction program, with the aim of having communities that are more resilient” (Center for Excellence in Disaster Management & Humanitarian Assistance, 2017, p.12). Taking this into account and comparing it with New Zealand’s own infrastructure and criteria’s, further development in relation to disaster relief and organisational connections within the city will help provide a critical link that is currently missing within the current Community Emergency Hubs. As noted within the Chilean Disaster Management Reference Handbook, “In the case of Chile, local populations are well prepared; regional cooperation is effective; warning and response mechanisms are efficient” (Center for Excellence in Disaster Management & Humanitarian Assistance, 2017, p.62). However it is further noted that “this requires constant efforts to develop, test and improve systems and to raise awareness” (Center for Excellence in Disaster Management & Humanitarian Assistance, 2017, p.62), with work still needing “to be done to increase the resiliency of the nation and its people during a time of disaster” (Center for Excellence in Disaster Management & Humanitarian Assistance, 2017, p.62). This highlights the need for continual development in relation to disaster relief and emphasising the Wellington scenatio.

Concluding from looking into Chile as a case study and resulting response following the significant 1960 earthquake, the following observations are made. Where there is an increased risk of a disaster occurring due to existing conditions, there is a need to look into Architecture and infrastructure in order to strengthen disaster relief and recovery efforts. Overall, architecture plays a pivotal role within a city and community, with it often resulting in either protection or casualties following a disaster. Through development of infrastructure to be more resilient and also provide a link between current organisations based around relief, further relief is provided to people immediately at risk.

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Figure 18 - Rescuers Searching Destroyed Buildings

SAN FRANCISCO, USA
17 October 1989
Magnitude 6.9

San Francisco and Wellington are both cities that hold many parallels. Not only are they both within close proximity to two bordering tectonic plates, but Wellington's architecture is also very similar to that of San Francisco. Taking into account the level of risk of a significant earthquake occurring and also vulnerability of buildings, looking into the Loma Prieta earthquake is important in understanding a response specific to Wellington that needs to be achieved.

The Loma Prieta earthquake resulted in "63 people dead, largely the result of the collapse of a bridge, an overpass, and homes built on unconsolidated fill" (Zoback, 2014, p.283). In the case of this event, people have turned to the insufficiency of architecture and engineering within the city, and how the failure of these resulted in deaths that could have been avoided. A report following the performance of building structures during the 1989 earthquake revealed that "there is an acute need to better evaluate structural and site characteristics in developing earthquake resisting designs of building structures" (Celebi & Holzer, 2014, p.C73), revealing the prevention of potential building failure, by taking into consideration a number of varying seismic and built environment factors, overall risk can be mitigated.

The state of California lies on and alongside the "boundary between two major tectonic plates – the Pacific and North American – which move past each other at the rate of two inches per year" (Brown Jr & Ghilarducci, 2017, p.9). Following on from this, "more than 70 percent of California's population resides within 30 miles of a fault where strong ground shaking could occur in the next 30 years" (Brown Jr & Ghilarducci, 2017, p.10), to which highlights the risk to communities within the wider region, as "although infrequent, major earthquakes have accounted for and continue to have the greatest potential for loss of life, injury, and damage to property" (Brown Jr & Ghilarducci, 2017, p.10). Due to the higher risk of natural disaster in the region, and following on from the devastating Loma Prieta earthquake, the state of

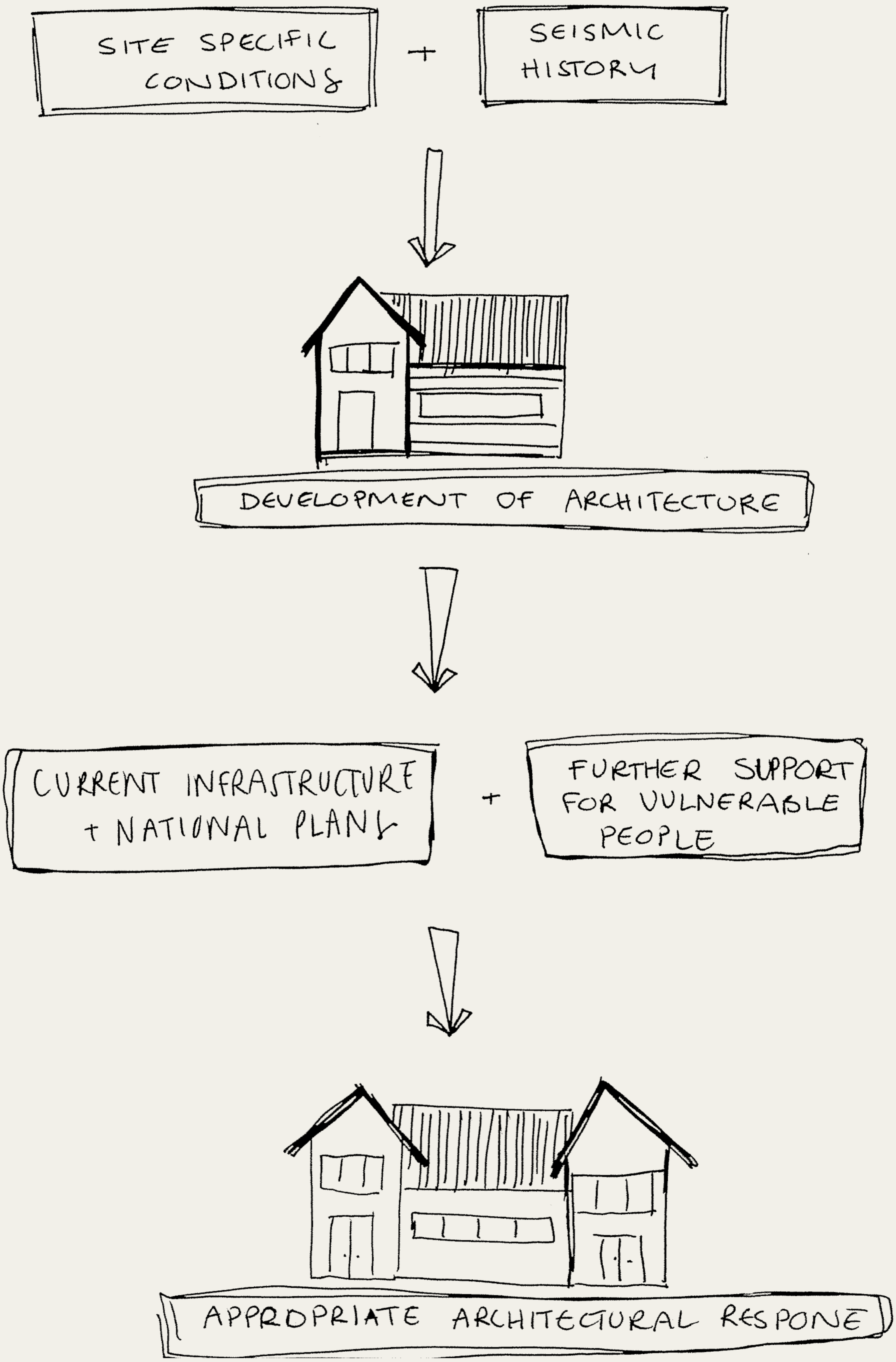

Figure 19 - Architectural Observations

California has put into place multiple plans to which “it is the responsibility of the government and the emergency management community to plan and prepare for emergency response with the whole community in mind” (Brown Jr & Ghilarducci, 2017, p.31). It has also been noted when reviewing the 1989 event, that “providing the public with actionable risk reduction measures; and forming regional governmental community alliances to implement science-informed policy are relevant to communities at risk everywhere” (Zoback, 2014, p.283), where the acknowledgement of risk and application of measures to minimise the extent of damage can prove pivotal in a communities resilience and ability to bounce back faster.

Overall, whilst not a particularly large earthquake on the Richter scale, due to inadequate buildings in regards to seismic structure and performance, and the number of people living within close proximity to potential epicentres, the 1989 earthquake impacted the state of California far greater than it should have. Following on from this disaster, multiple reviews have been carried out since revealing areas of improvement in order to minimise damage. Key takeaways from this disaster are highlighted on governmental plans in order to support its communities, and also improvement in the overall care in regards to the design of buildings when seismic factors are given to be an issue.

In conclusion, from the 1989 earthquake it is important to take into consideration site specific conditions and seismic history, when planning the structure and makeup of a building. Also infrastructure and plans should be not only targeted at the notion of a community being able to help itself post disaster, but also providing them with the critical infrastructure the need in order to be further supported post disaster.

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Figure 20 - (Top) People in the Inner City Post Earthquake
Figure 21 - (Bottom) Father With his Daughter Post Earthquake

CHRISTCHURCH, NEW ZEALAND
22nd February 2011
Magnitude 6.3

On the 22nd February 2011 Christchurch, New Zealand, faced a magnitude 6.3 earthquake resulting in the death of 185 people (McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.18). Despite the extensive damage and displacement caused as a result of this earthquake, this event has been dubbed as the 'Ideal Earthquake' in subsequent reports on responses and recovery efforts.

Christchurch is classed as an ideal earthquake within the context of New Zealand, due to varying factors in how the event happened, where it happened and the response of support communally, nationally and internationally. As stated within the report Civil Defence Emergency Management Response to the 22 February Christchurch Earthquake, "Christchurch was well placed geographically to deal with an earthquake" where, "its air and sea ports were accessible and usable after the earthquake" (McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.20). Despite this event being classed as ideal, the impact of the 2011 earthquake has been extensive and the city of Christchurch is still recovering from its effects 8 years post event.

On 4 September 2010, Christchurch faced a large earthquake of which caused damage but thankfully did not claim any lives. It was as a result of this initial earthquake that "emergency management and some organisations had significantly improved their level of preparedness for disasters" however in reviews of the following 22 February earthquake it was found that in reality little had been implemented in the wider city of Christchurch and "overall the Civil Defence Emergency Management structure was as dysfunctional as at 4 September" (McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.30). Taking this into account, considering the level of preparation and warning put in place though the occurrence of the initial September earthquake, within the first 24 to 72 hour period, little support was given to those who had been displaced. Whilst disaster relief was immediately initiated within

Christchurch emphasis was on recovery efforts, where those who were merely displaced were left to fend for themselves. Despite there being plans in place in relation to Civil Defence Centres, where people were told to travel to in the event of a disaster, what couldn't be prepared for was the large scale of destruction rendering a number of these buildings insufficient to house people and therefore were inoperable. Leaving people with nowhere to go and little to no communication as to what to do.

As a result of the 2011 earthquake there were a number of major impacts on the city of Christchurch further than that of the physical harm, some of which are as outlined below:

- Discomfort and great inconvenience from lack of sanitisation facilities
- Damaged schools, universities and training centres
- Disruption to almost every kind of social activity
- Churches, sports grounds, theatres, clubs and bars severely damaged resulting in the social activities dependent on these facilities being severely hampered.

(McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.20)

Not only was the earthquake damaging to homes and businesses, but it was also damaging in regards to the disruption it caused for the people of Christchurch's everyday lives. Facing not only the obvious physical effects of the earthquake, communities also faced the distress and displacement from their lives as they had lead them up until that moment. It is the disruption from this day to day life that has some of the greatest impact. Whilst emergency plans are targeted at the recovery of a place in the long term and from the top down approach, in order to help a community recover fully and minimise the effects of displacement and disruption, implementation of a response from the bottom up should be developed.

Arising from the 2011 earthquake also came the question of demographics in relation to the ability to recover post disaster. Brought up within the report was the lower income suburbs of Christchurch and how “lower income suburbs between the CBD and the sea were amongst those hard hit” where “people on lower incomes and less well connected into society had less resources to cope” (McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.125). This further brings up the question of demographics in relation to disaster planning and preparedness.

Learning from the disaster in Christchurch the question has arisen based on the validity of the rest of New Zealand in regards to emergency preparedness of a similar magnitude earthquake. As highlighted within this report, “the question for the government in determining policy on emergency management is whether or not an event with such huge impact as the 22 February earthquake occurs sufficiently often as to requite specific preparation” (McLean, Oughton, Ellis, Wakelin, & Rubin, 2019, p.22). Through comparisons however between the different factors that went into the Christchurch earthquake and then taking the predicted situation within Wellington, the effects of such a major earthquake without the ideal situations that were present in Christchurch would potentially result in larger scales of displacement, disruption and damage to everyday life. Whilst this something that can only be assumed however, this brings up the conversations around New Zealand’s and Wellington’s responses to disaster and whether planning enough in advance would result in a different outcome to that already seen within Christchurch in 2011.

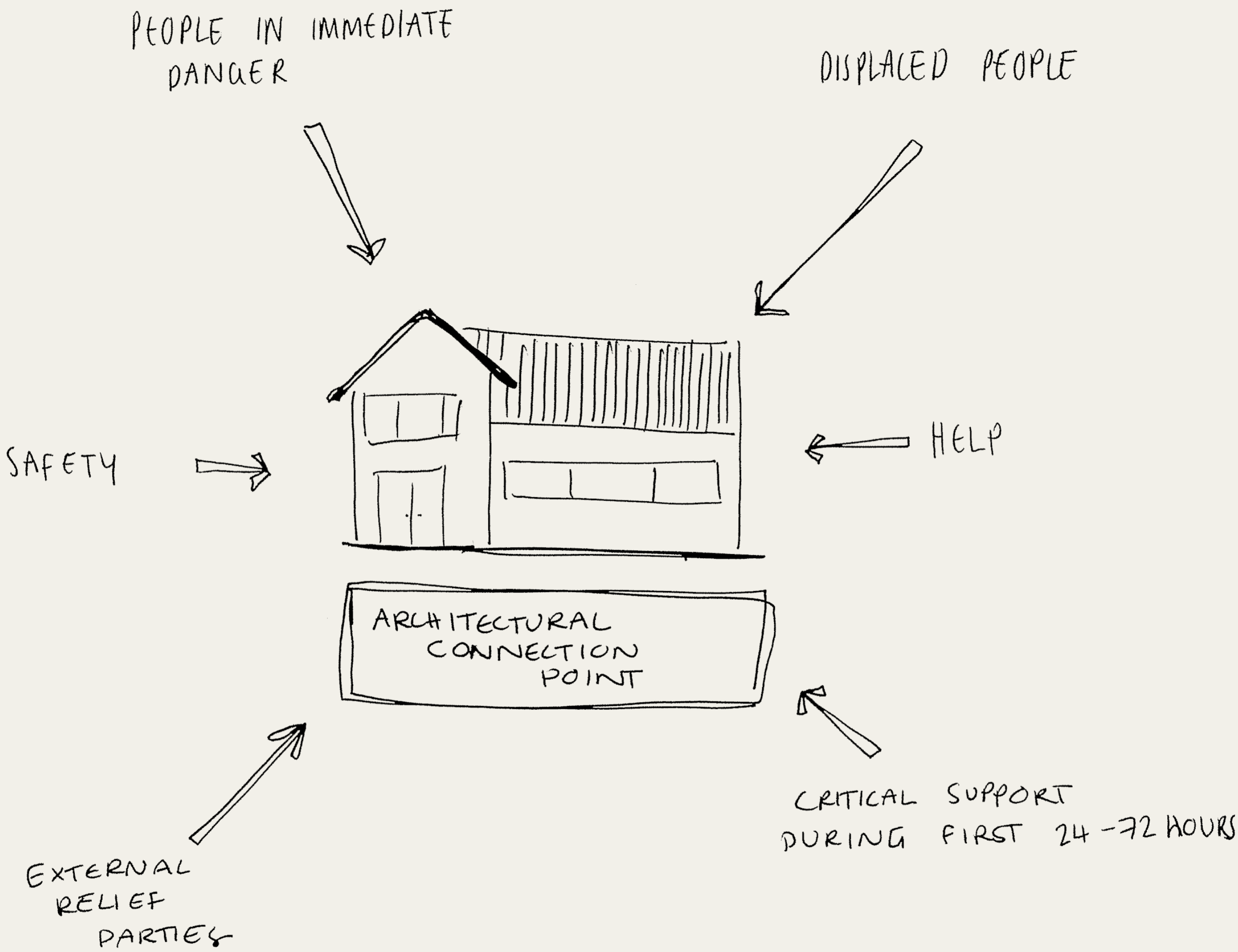


Figure 22 - Architectural Observations

Based on looking into the preparation, response and damage caused by the 2011 earthquake in Christchurch, there are a number of key takeaways to take into consideration regarding a pre-established plan for a similar event in Wellington. Whilst there is not a lot that can be planned for in relation to the exact extent of damage, pre-established measures made available to a community can be. In order to allow for help to be provided to those who are in immediate danger, and those who are merely displaced, a connection point in a community is a viable option. An architectural response developed of this kind would provide people with the necessary help and safety they require within the first 24 to 72 hours post disaster.

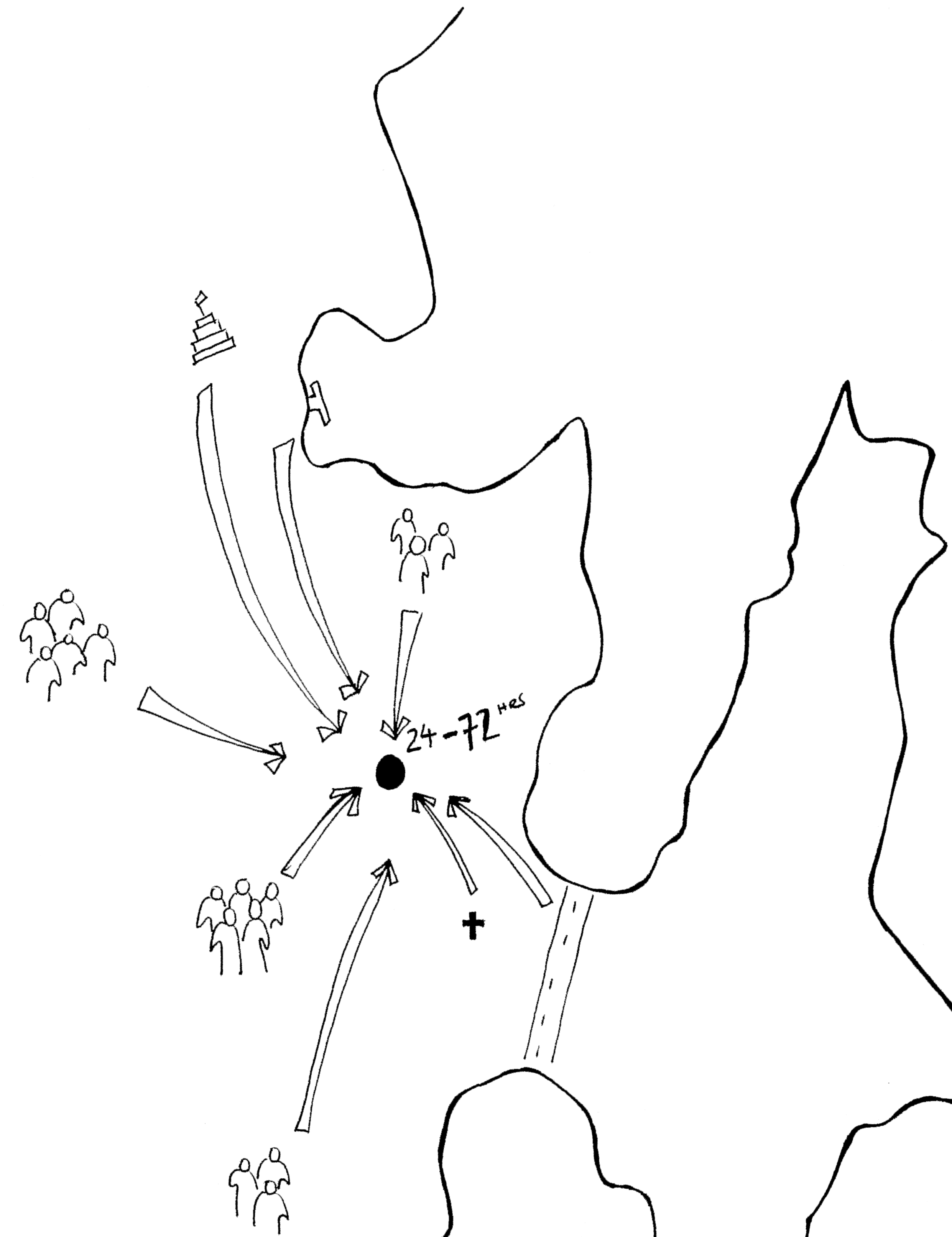


Figure 23 - Connectivity of Elements

RESEARCH DEVELOPMENT

Taking from the events of the significant earthquakes of Christchurch 2011, San Francisco 1989 and Chile 1960, the following observations have been made in relation to architectures response to natural disasters. When developing pre-established disaster relief in Wellington, it is important for the following to be applied:

- *Providing a connection point in a community*
- *Providing a place where critical help needed within the first 24 – 72 hours post disaster occurring.*
- *Providing critical infrastructure within a city to support its community, alongside plans for them to be able to fend for themselves.*
- *Providing a pre-established connection point for disaster relief organisations to be able to coordinate more efficiently post disaster and help those most at risk.*

Through developing disaster relief architecture that is pre-established within a community to encompass all these attributes, Wellington will connect current gaps highlighted within disaster relief plans. Therefore, the architecture developed within this thesis must aim to achieve all these highlighted points, in order to meet the aims and objectives set out earlier in this thesis.

Developing architecture around the failings and learnings of past disasters, ensures the architectural response is one that responds to site specific conditions, whilst also highlighting structure to emphasise to communities that it is

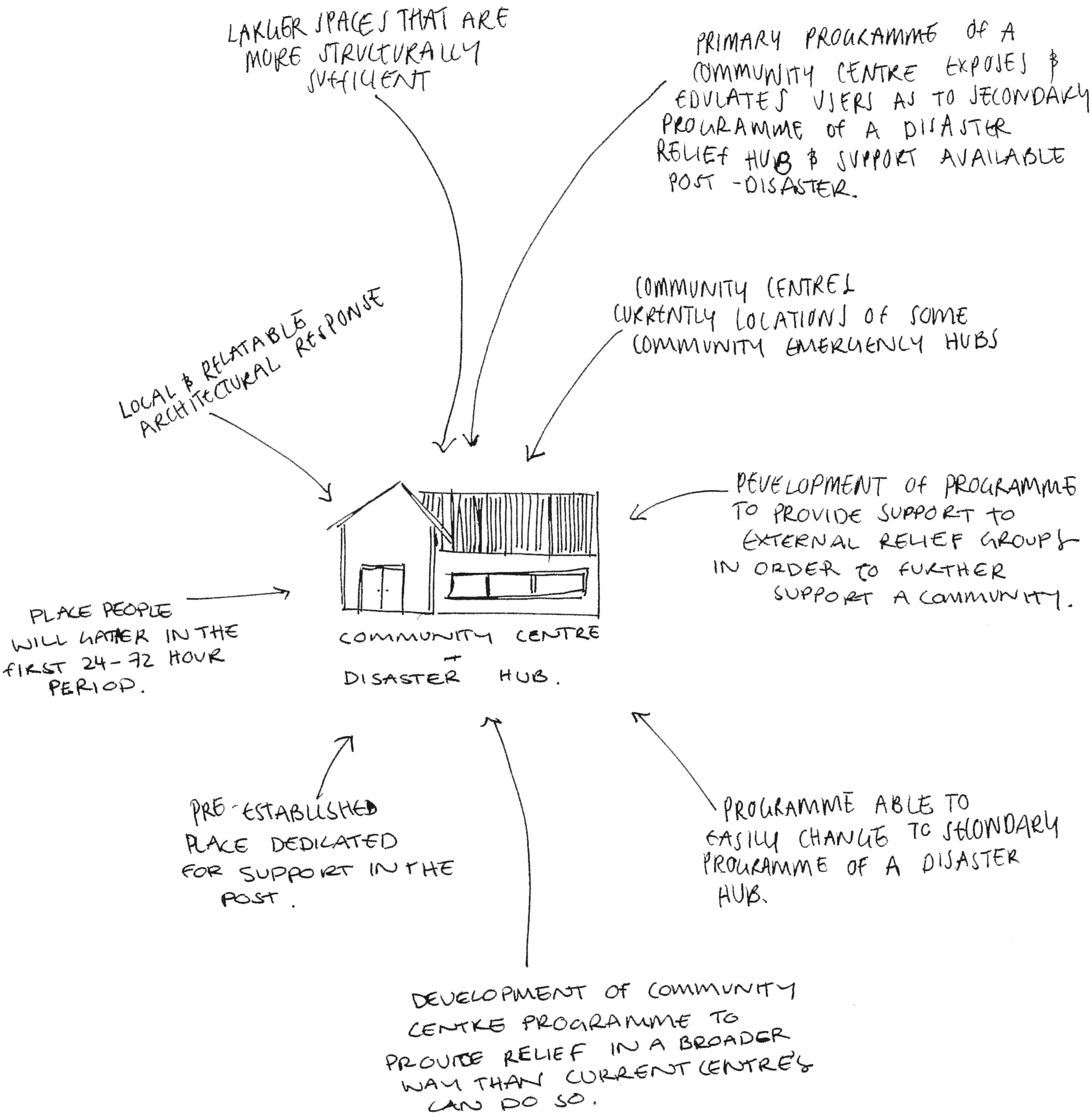


Figure 24 - Community Centre Brainstorm

safe for them to travel to and rely on the design for support in the critical window that they require it.

Based on these Initial explorations into an appropriate architectural application points towards communal architecture as an appropriate programme to host alongside a disaster hub. Following on from research findings and also working alongside current community emergency hubs, this type of architecture proves appropriate to host disaster relief efforts. As seen within figure 24, brainstorming lead to a community centre and disaster hub being a potential solution to the research question initially posed.

PHASE TWO:

Site Selection + Programme Determination

CHAPTER FOUR:

SITE SELECTION + ANALYSIS

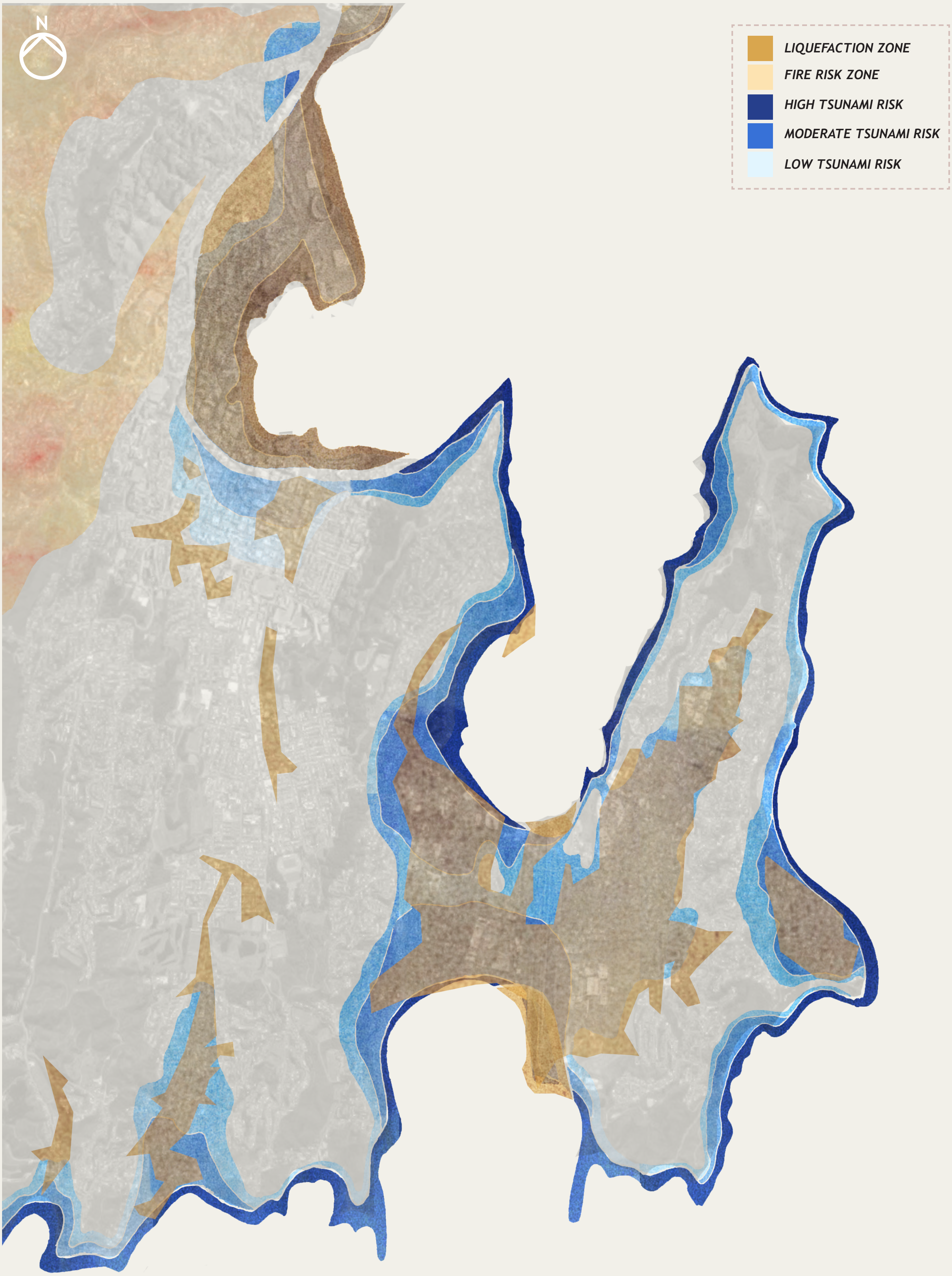


Figure 25 - Secondary Hazards in the Wellington Region

GREATER WELLINGTON REGION RISKS

Within the Wider Wellington Region there are a number of natural disaster risks. Some of these secondary risks following a significant earthquake are tsunamis, liquefaction and fire. The location of these can be seen within figure 25.

Tsunami

According to WREMO, it is advised to the people of Wellington to "evacuate all of the tsunami zones if you feel an earthquake that is either longer than a minute OR strong enough that it's hard to stand up, as soon as the shaking stops" where it is further noted that "the earthquake may be the only warning of a tsunami, so do not wait for further instructions, notifications or advice, evacuate immediately after the shaking has stopped" (WREMO, 2020). As seen within figure 25, tsunami zones within the city follow the coast and also the lower lying areas of the city.

Fire

In past significant earthquakes within New Zealand, the secondary hazard of fires has caused further risk to a community past that of the initial earthquake. This was seen in the 1931 Hawke's Bay Earthquake where "fire broke out in Napier's business district shortly after the earthquake, and once the reservoir emptied, firefighters were powerless" (Ministry for Culture and Heritage, 2017). It has also been noted in past reports on the hazard that "fire following earthquakes have caused the largest single loss due to earthquakes and in most cases have caused more damage than the quake itself" (Rahmanian & Ismail, 1992), where it has been further noted in reports within New Zealand that in relation to architecture, "any discussion of post-earthquake fire must take into account structural and non-structural damages, initial and spreading fire, wind, water availability, and emergency responses" Rahmanian & Ismail, 1992).

Taking into consideration Wellington, it has been noted by the Wellington Region Emergency Management Office that, "after a large earthquake,

Figure 26 - Suburbs with Low Secondary Hazard Risk in the CBD

there is likely to be damage to buildings and infrastructure. This can mean that there is more opportunity for a fire to start and spread. On rare occasions, a fire which starts following an earthquake can develop into a serious emergency” (WREMO, 2020). Building on this, a site should be chosen outside of this risk area, due to the seriousness of the secondary hazard and its likelihood of spreading within these areas with minimal containment, further increasing impact and displacement within communities.

Liquefaction

Liquefaction has the potential to impact a vast majority of Wellington city, as highlighted within figure 25. It has been noted within the report Recurrent liquefaction in Christchurch, New Zealand, during the Canterbury earthquake sequence that, “liquefaction-induced ground deformation may result in severe infrastructure damage” and that “understanding the seismologic and geologic conditions under which liquefaction occurs and the preservation potential of liquefaction-induced features in the geological record are important for reducing societal vulnerability to earthquakes” (Quigley et al., 2013). Given the vast majority of land being within this zone, potential displacement due to the occurrence of this secondary hazard would further increase vulnerability. Therefore, placing the site outside of these highlighted areas would ensure that the architecture is able to support those who will be further impacted within the city.

Taking into account the AF8 scenario in the event of a rupture of the Hikurangi Subduction Zone, placing the site outside of these areas will ensure the safety of the centre should a tsunami be triggered following this event. As diagrammed in figure 26, suburbs within the inner city that are the least as risk are Mount Cook, Mount Victoria and Newtown. Whilst these suburbs still contain secondary hazards, a large proportion of them are within safe zones in the inner city,

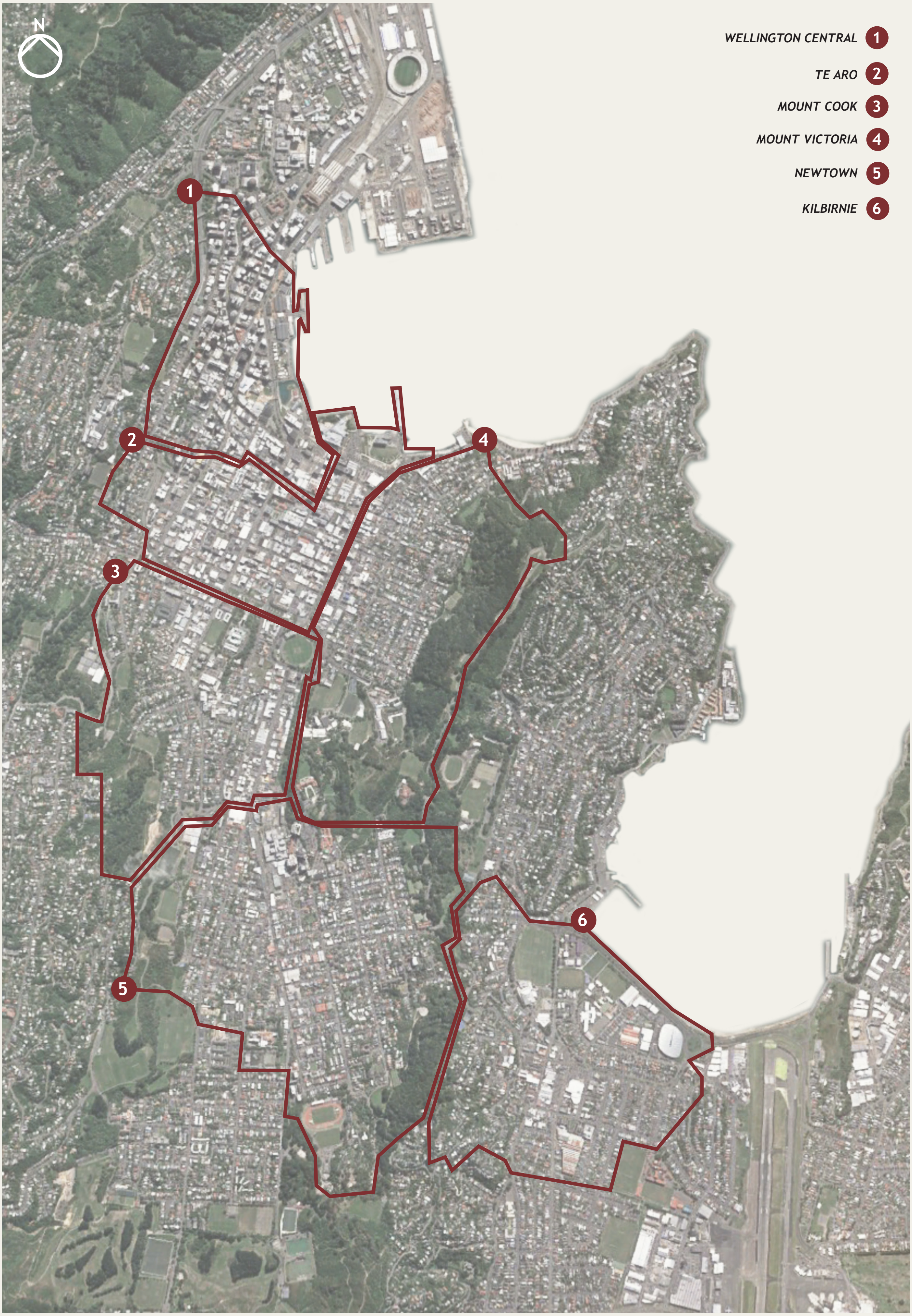


Figure 27 - Wellington Suburb Locations

WELLINGTON POPULATION AND DEMOGRAPHICS

As it is the government's current plan for a community and individuals to be self-sufficient and responsible for their own disaster preparedness, it is those who are not in a financial position to do so that are at the greatest risk in the immediate aftermath. When choosing an appropriate site, research has been made into population numbers and employment rates. From this it can be seen the suburbs of Wellington Central and Mount Cook are at the greatest risk with unemployment percentages over 10%.

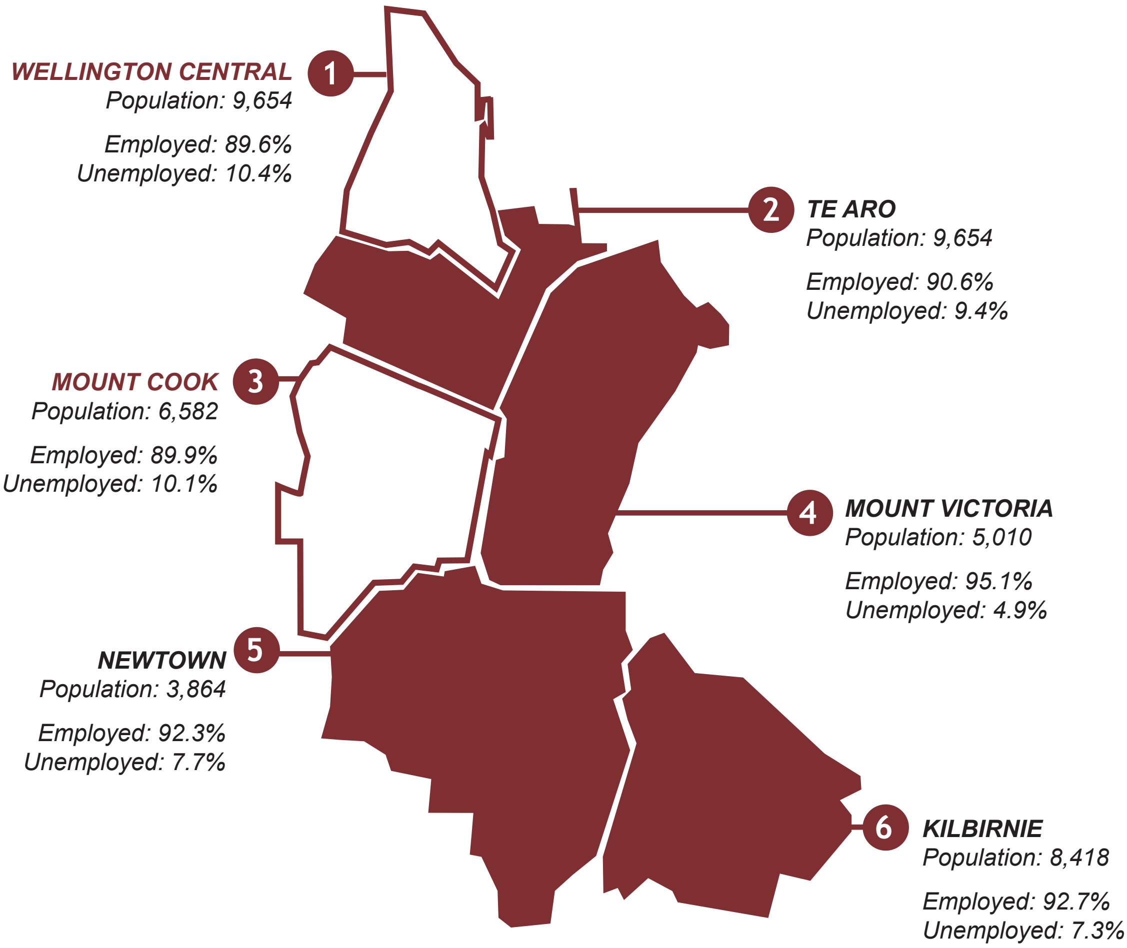


Figure 28 - Wellington Suburb Populations and Employment

Figure 29 - Chosen Site and Key Routes

FINAL SITE - MOUNT COOK

Factoring in demographics and risks of secondary disasters, the final site location is within the suburb of Mount Cook, on the corner of Tasman and Rugby Streets. This is also located in close proximity to the Basin Reserve, where it has been noted by a WREMO official, that people will naturally gravitate to in the event of a disaster only to find that there will be absolutely no help provided to them from that location. Factoring in with earlier research into the human condition and taking into account where people are predicted to travel towards, locating the architectural application on this site is appropriate for the aim to provide relief to those who require it within the first 24 to 72 hour period post event. This location is also outside of potential secondary hazard zones for tsunamis, fire and liquefaction, therefore providing a safe location for the design to be placed, where impact from secondary hazards are at a minimum.

"We have a running joke around the office. That people are going to gather at the Basin Reserve, only to find that there isn't going to be anything for them there!"

Therefore, working with initial research and key discoveries in relation to the human condition and also communal and governmental responses to past significant earthquakes within New Zealand, a final site has been chosen. This site is currently sitting empty and resides on the corner of Rugby and Tasman Streets in Mount Cook, Wellington City.

Figure 30 - Location of Key Infrastructure in Relation to Site

CRITICAL INFRASTRUCTURE POST DISASTER

Taking into consideration earlier research into impacts on Wellington City, walking distances to critical infrastructure post disaster has been diagrammed. As seen within figure 30 the following locations have been highlighted in terms of walking distances in kilometres and also time in minutes to walk:

- *Massey University*
- *Wellington High School/ Field*
- *Parliament*
- *Seaport*
- *Wellington College/ Field*
- *Wellington Hospital*
- *Airport*

These figures have been based off of google map estimates using main routes where streets are wide and less likely to be obstructed, however these routes and times are subject to change with the individual user and actual damage caused post-event. Large open green spaces have been highlighted due to the human nature to gather in large open spaces following a disaster, where it is most likely that post-disaster recovery agencies and groups will set up relief stations. Key infrastructure where help is also likely to be brought to such as the seaport and airport have been diagrammed as, probable points of collection for services that might operate from the building placed on the Mount Cook site.

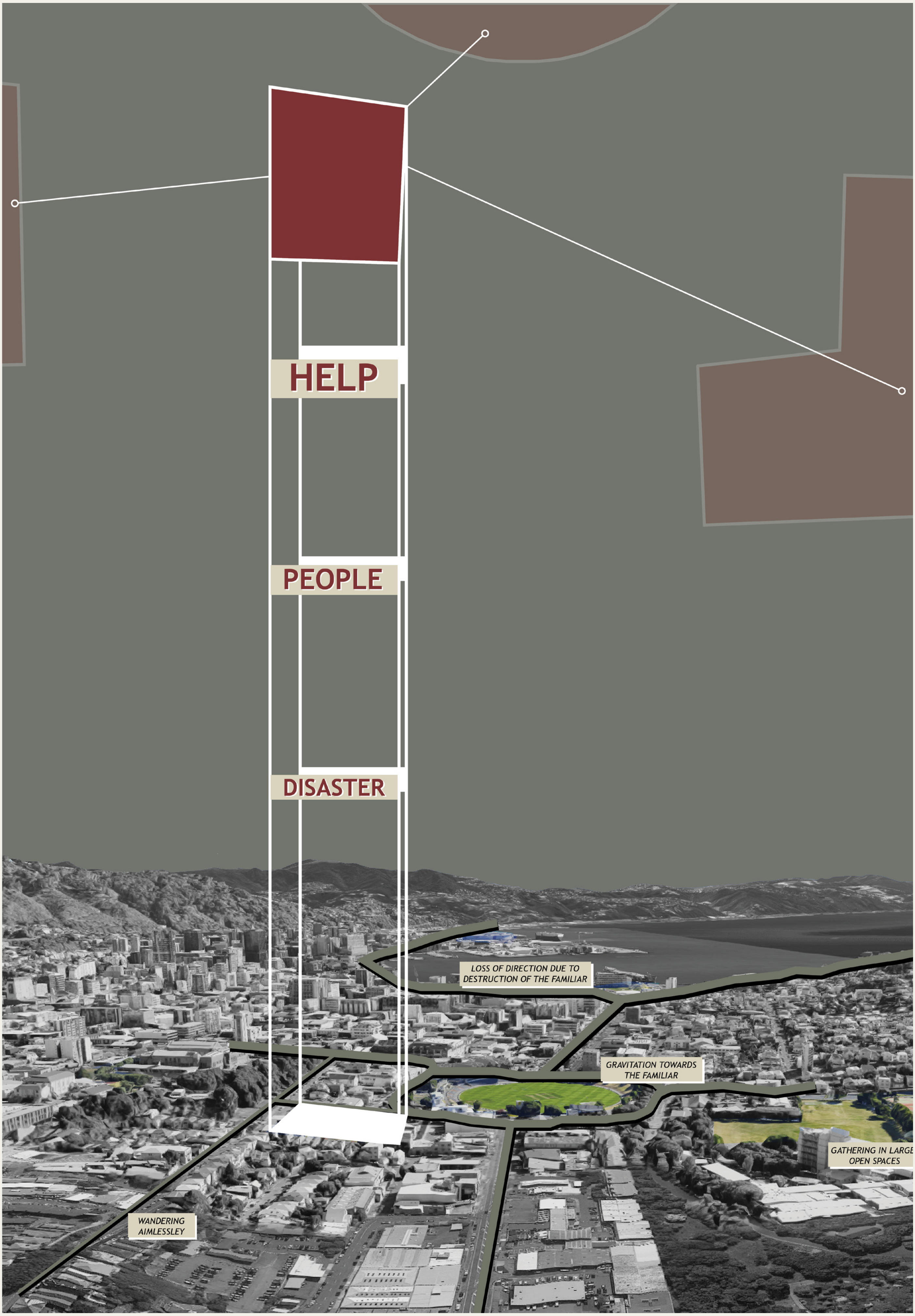


Figure 31 - Site in Relation to Post Disaster Factors

SITE REASONING

Based on earlier research it was found that providing a community with a place they are able to relate to on a daily basis that also provides support when it is critically needed, will help to reduce a community's level of vulnerability post-disaster. Providing a place of connection to open spaces, that's also connected to main routes within the central city will also act in drawing people in, to obtain the support they need when the help itself is not yet established. This then provides a solution to the gaps currently seen in relation to the initial 24-72 hours post-event further providing relief to a community regardless of demographics, and also working with the human condition to ignore low probability, high risk events.

Therefore the architectural response to the research question should cover these elements, whilst providing a space for people to use and connect to pre-event. This will ensure a place of connectivity within Mount Cook, to which the users will be aware of the buildings secondary function. Taking the human condition research highlighted by Denis Mileti earlier, people are more inclined to listen to the advice of their peers in relation to disaster preparedness, so working with this theory and combining it with word of mouth, the reach of the buildings support should span further than those in the immediate area or who use it on a day to weekly basis. The placement of the site is within a safe location in relation to secondary disasters and resides within a lower demographic area to target those who might need the most help.

"Have you heard of that building in Mount Cook by the basin? Apparently following an earthquake we can go there to find help!"

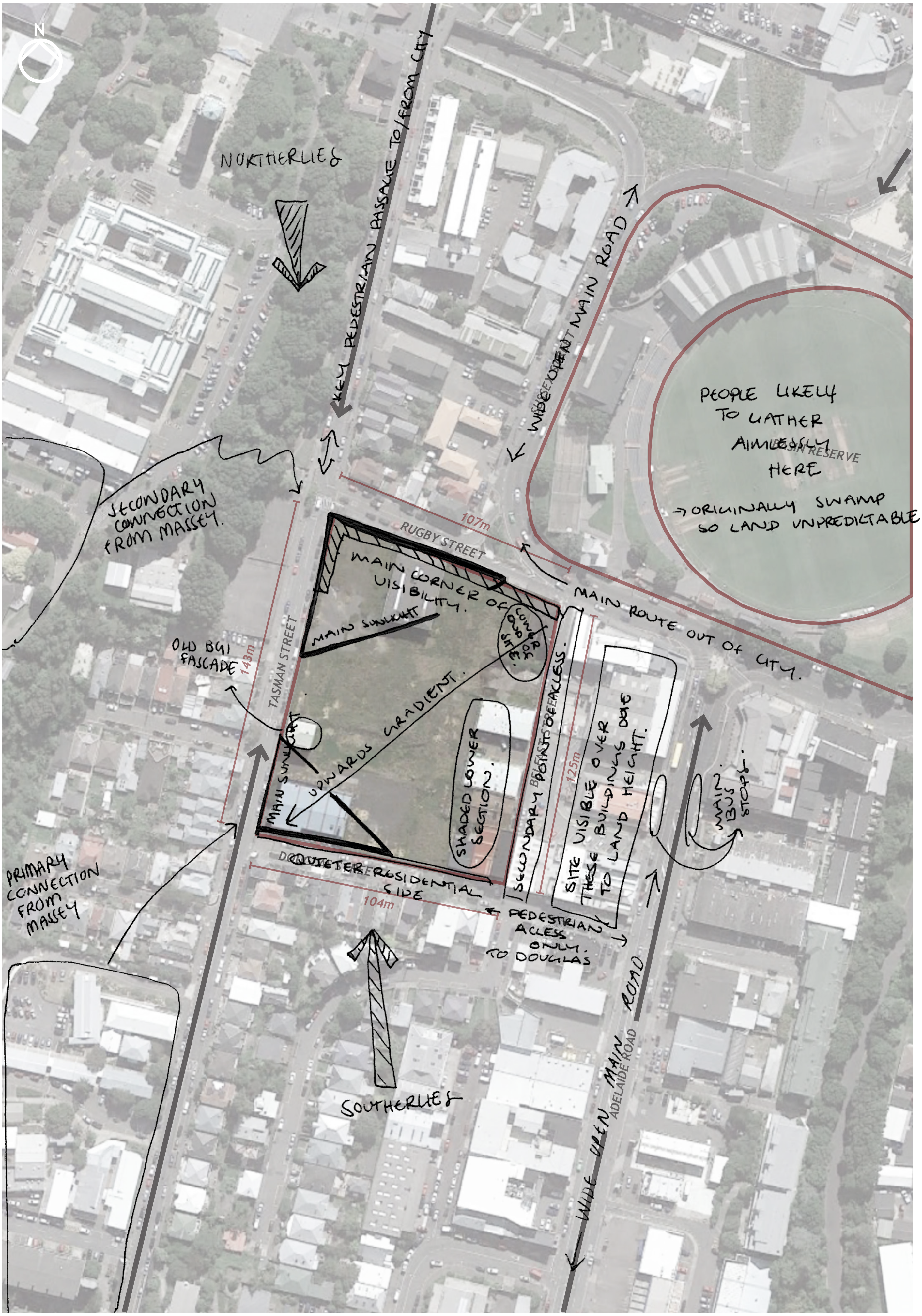


Figure 32 - Wider Site Analysis

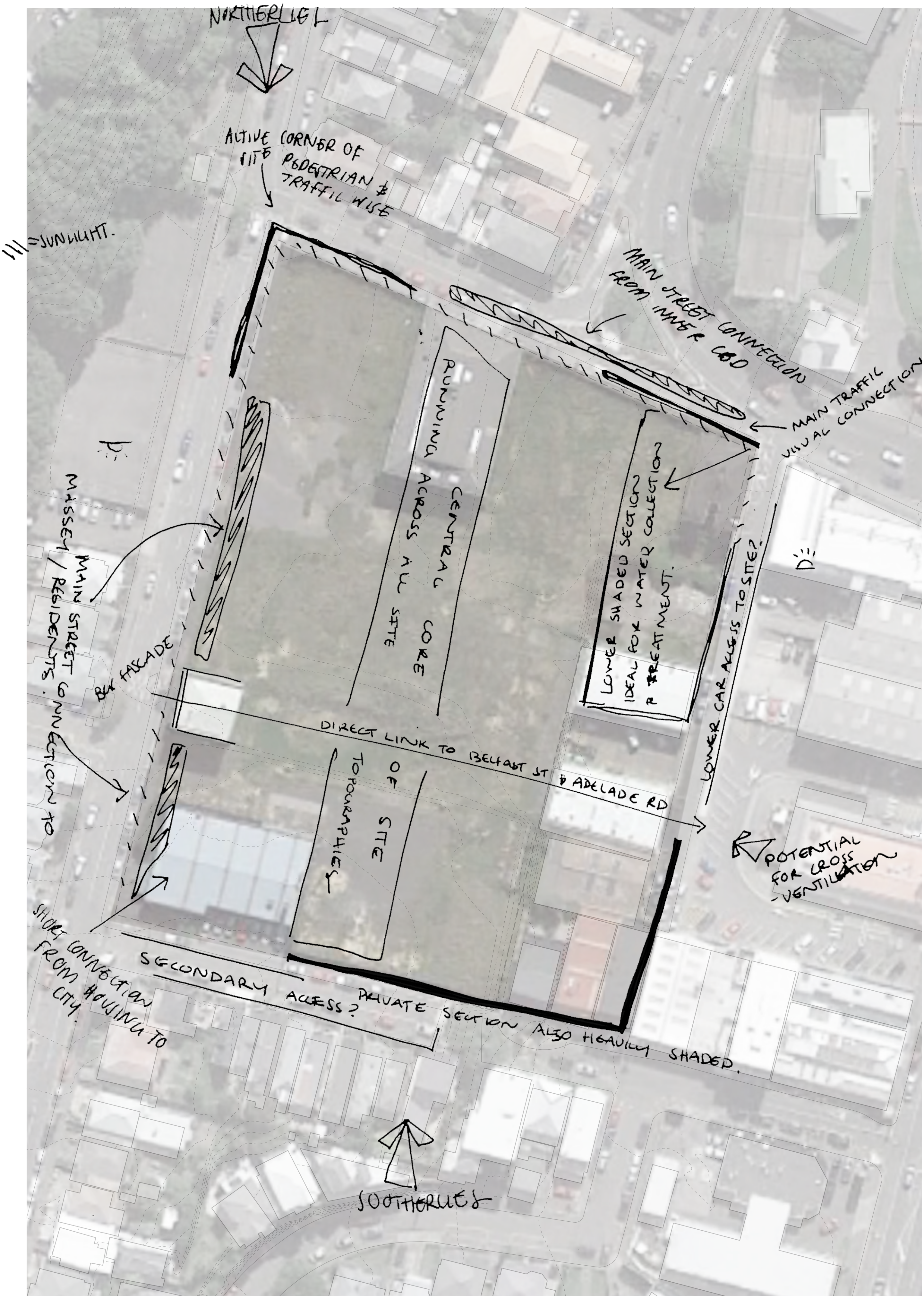


Figure 33 - Immediate Site Analysis

CHAPTER FIVE:

PRELIMINARY DESIGN

DISASTER RELIEF GROUP SPECIFICATIONS

Post disaster, relief groups are critical in aiding communities in responding to a disaster through providing support to those in need. With responses for help being made at such short notice, there is a delay time before resources from these groups are made available and the extent of disaster is clearer to those outside the effected region. Depending on the scale of disaster, internal spaces can be minimal for groups to set up shelter and a base to operate from, thus highlighting a need for space that is pre-established in a prone area to be developed. Following on from this, research into relief groups has been carried out and their needs highlighted to ensure spaces within the final design are sufficient to provide help. Helping those who in turn help others with further enhance the effectivity of the design, further establishing that connectivity point in a community.

The following relief groups and their needs/ requirements are as follows, with secondary programme spaces to be developed to support these functions post disaster.

Red Cross

- Maintain warehouses with critical supplies
- Provide tarpaulins, water containers, tools and shelter kits
- Help to rebuild infrastructure, housing and water systems
- Maintains an information and technology and telecommunications emergency response unit.

(New Zealand Red Cross, N.D)

Salvation Army

- Staff and volunteers work alongside civil defence and local council
- Rescue and emergency workers on ground
- Welfare provided (food, furniture, clothing)
- Emergency accommodation
- Post- disaster counselling

(The Salvation Army, 2020)

In the 2011 Earthquake provided a further:

- 27,000 meals at welfare centres
- 20,900 chemical toilets
- 3 x mobile shower units
- 6,500 care packages
- 11,006 food parcels

(The Salvation Army, 2014)

Oxfam

- Provide emergency food items
- Provide safe drinking water
- Set up temporary shelters
- Construct emergency latrines

(Oxfam New Zealand, 2019)

Community Emergency Hub Specifications

- Information coordination desk
- Public information board
- Communications
- Coordination area

(Civil Defence, 2020)

Following on from relief group specifications, from earlier research into disasters and relief responses the following critical amenities post disaster are to be addressed in the secondary programme elements:

- Hygiene – toilets, showers, cleaning station
- Water – drinking, cleaning, sanitisation
- Food – hot food, cooking facilities, distribution, storage, supply
- Shelter – Protection from the elements, temporary shelter, internal and external spaces.

Taking all of these into consideration, the secondary programme can be developed alongside the primary programme to provide flexible spaces that further support disaster relief efforts. Through development of spaces to be flexible and mixed use in their primary functions, this will allow for ease of adaptability in the post disaster programme to air relief groups and other organisations to set up spaces as they are required and not be limited to what is currently set up.

DISASTER HUB + COMMUNITY CENTRE

COLLECTION STATION
EMERGENCY WATER SUPPLY
ELECTRICITY GENERATION

PUBLIC INFORMATION BOARD
CLEAR SIGNAGE

STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM

COOKING FACILITIES
COVERED SLEEPING AREA
NURSES OFFICE
ORGANISATION ROOMS
SPACE FOR RELIEF GROUPS
COMMUNITY MEETINGS

WATER STORAGE + TREATMENT
ELECTRICITY GENERATION
BIKE SHARE
CARPARK
MEMORIAL
COMMUNITY GARDEN
PARK

ENTRANCE
RECEPTION
CRUSH SPACE
PUBLIC INFORMATION BOARD
BUILDING CORE
CLEAR SIGNAGE
SELF COMPOSTING TOILETS

OFFICES
STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM

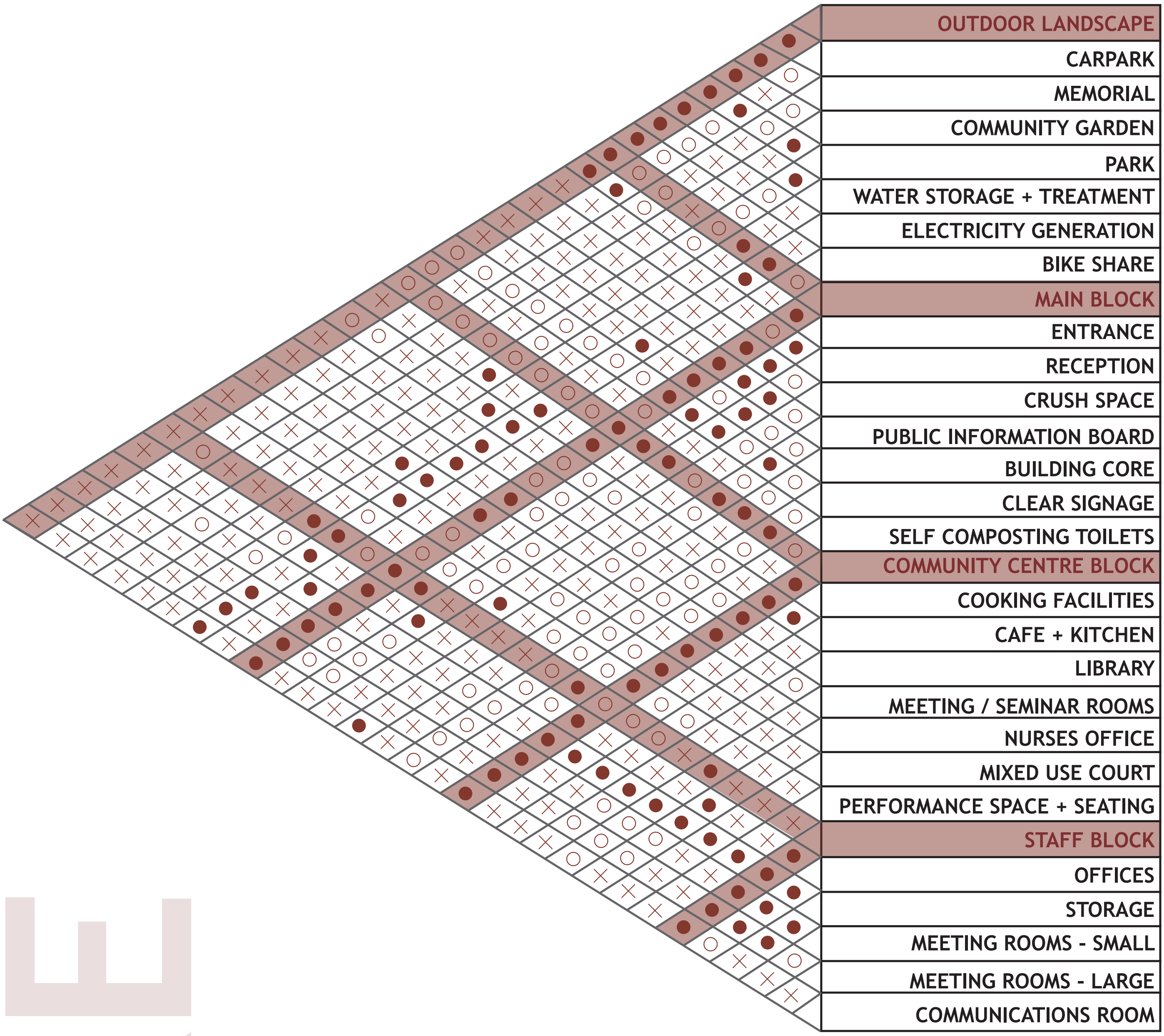
COOKING FACILITIES
CAFE + KITCHEN
LIBRARY
MEETING / SEMINAR ROOMS
NURSES OFFICE
MIXED USE COURT
PERFORMANCE SPACE + SEATING

Figure 34 - Pre and Post Programme Areas

FIRST PROGRAMME

Taking from earlier research into current disaster relief and past responses, an initial preliminary architectural solution to the research question of *"how can architecture provide pre-established disaster relief, in order to meet the needs of Wellington's residents in the midst of the predicted damaging earthquake and other imminent natural disasters?"* has been conceptualised.

The conceptual design has been based off of the primary function of a community centre and the secondary function of a disaster hub. This is achieved through the plans being developed to accommodate flexible floor plans that can easily and readily change function when required to. Through extensive research of what key spaces are required for both a community centre and also the current community emergency hubs, plans have been developed for both programmes. As seen within the following pages, spaces have been developed in how they relate to each other and also their importance in terms of direct, indirect or no link at all as seen within figure 35. Through following this process, each space has been developed in relation to height factors, and where within these limitations each programme component can be placed.


OUTDOOR LANDSCAPE
CARPARK
MEMORIAL
COMMUNITY GARDEN
PARK
WATER STORAGE + TREATMENT
ELECTRICITY GENERATION
BIKE SHARE
MAIN BLOCK
ENTRANCE
RECEPTION
CRUSH SPACE
PUBLIC INFORMATION BOARD
BUILDING CORE
CLEAR SIGNAGE
SELF COMPOSTING TOILETS
COMMUNITY CENTRE BLOCK
COOKING FACILITIES
CAFE + KITCHEN
LIBRARY
MEETING / SEMINAR ROOMS
NURSES OFFICE
MIXED USE COURT
PERFORMANCE SPACE + SEATING
STAFF BLOCK
OFFICES
STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM

PRE

POST

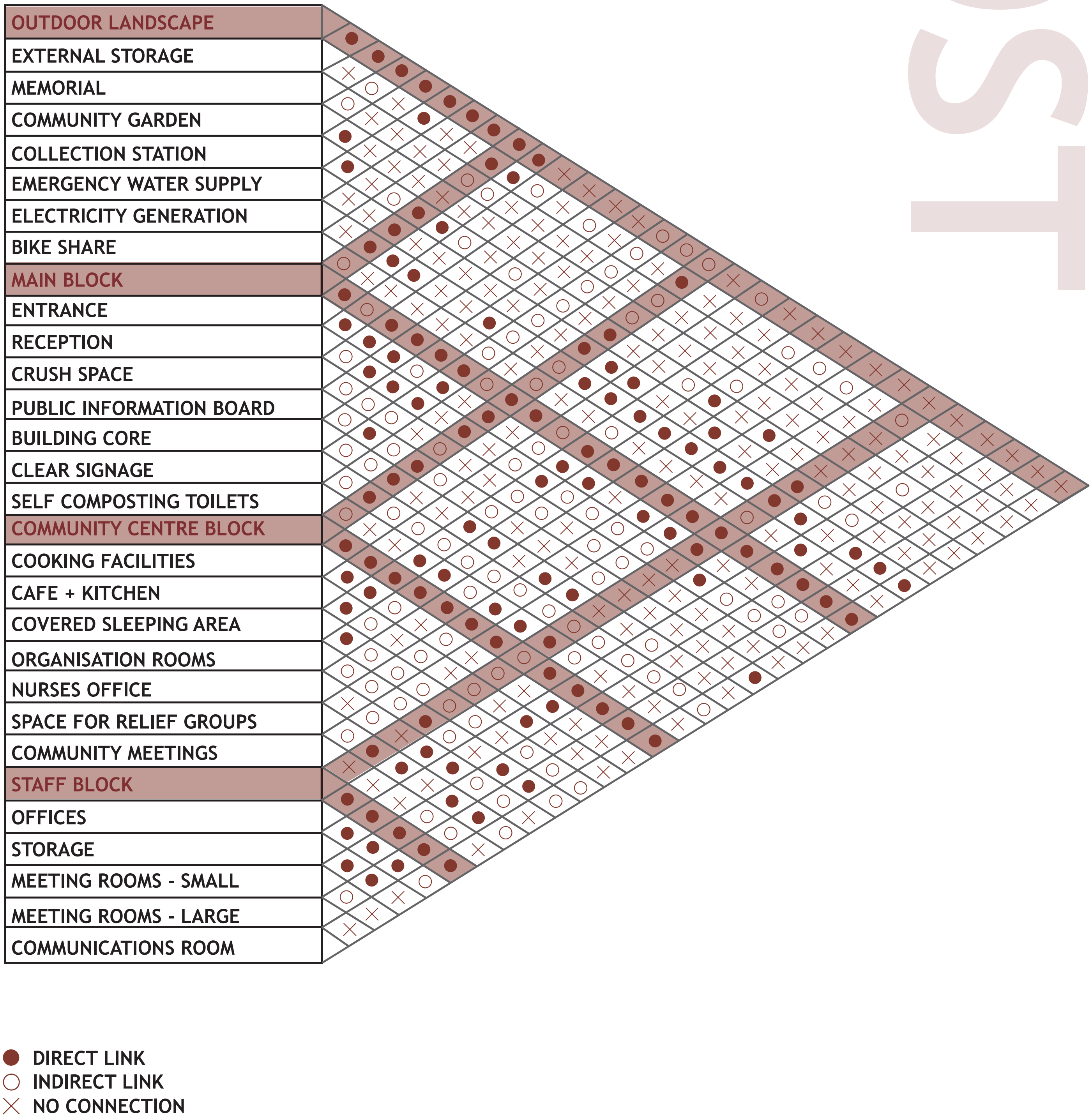


Figure 35 - Pre and Post Programme Matrix

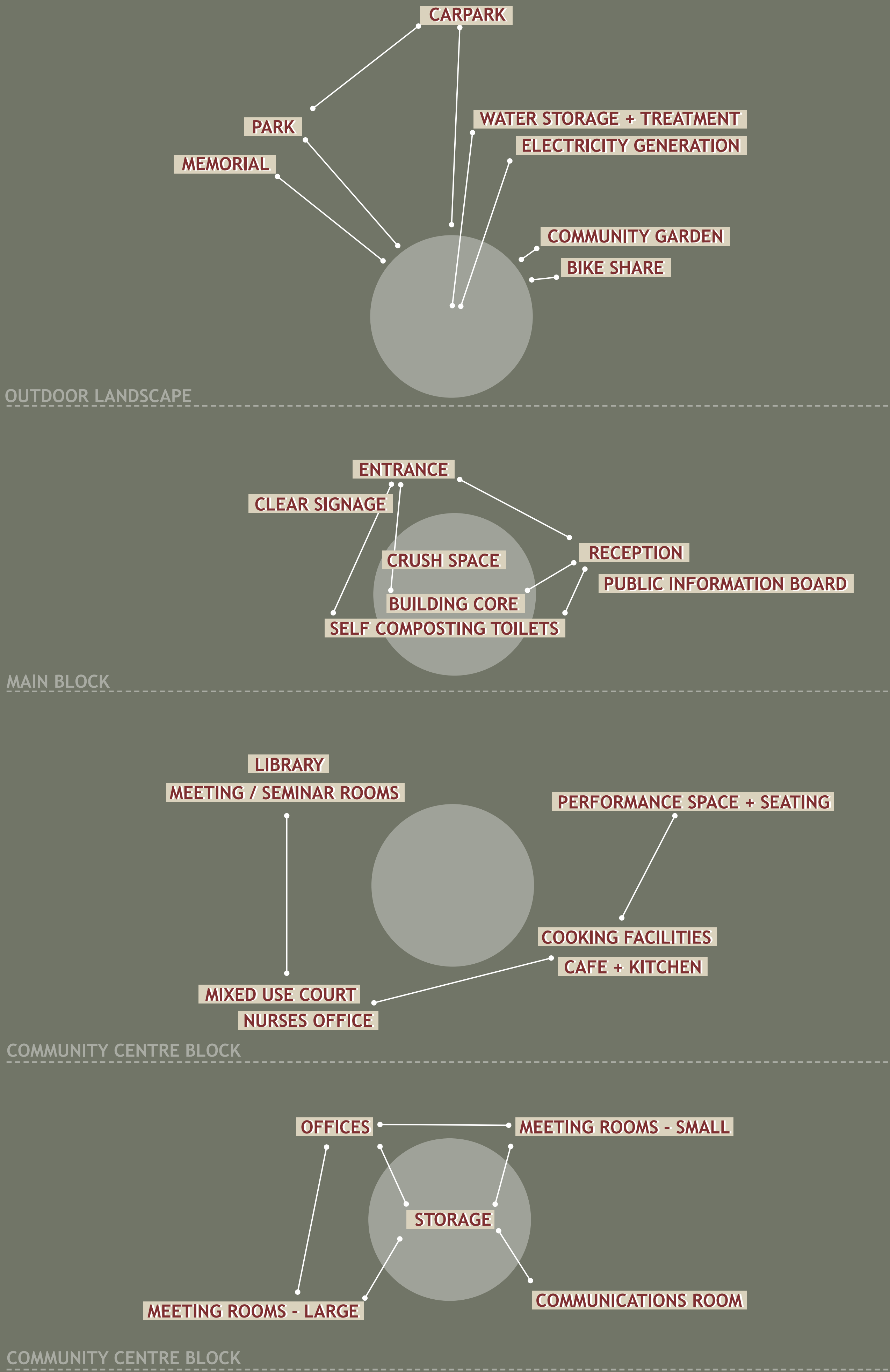
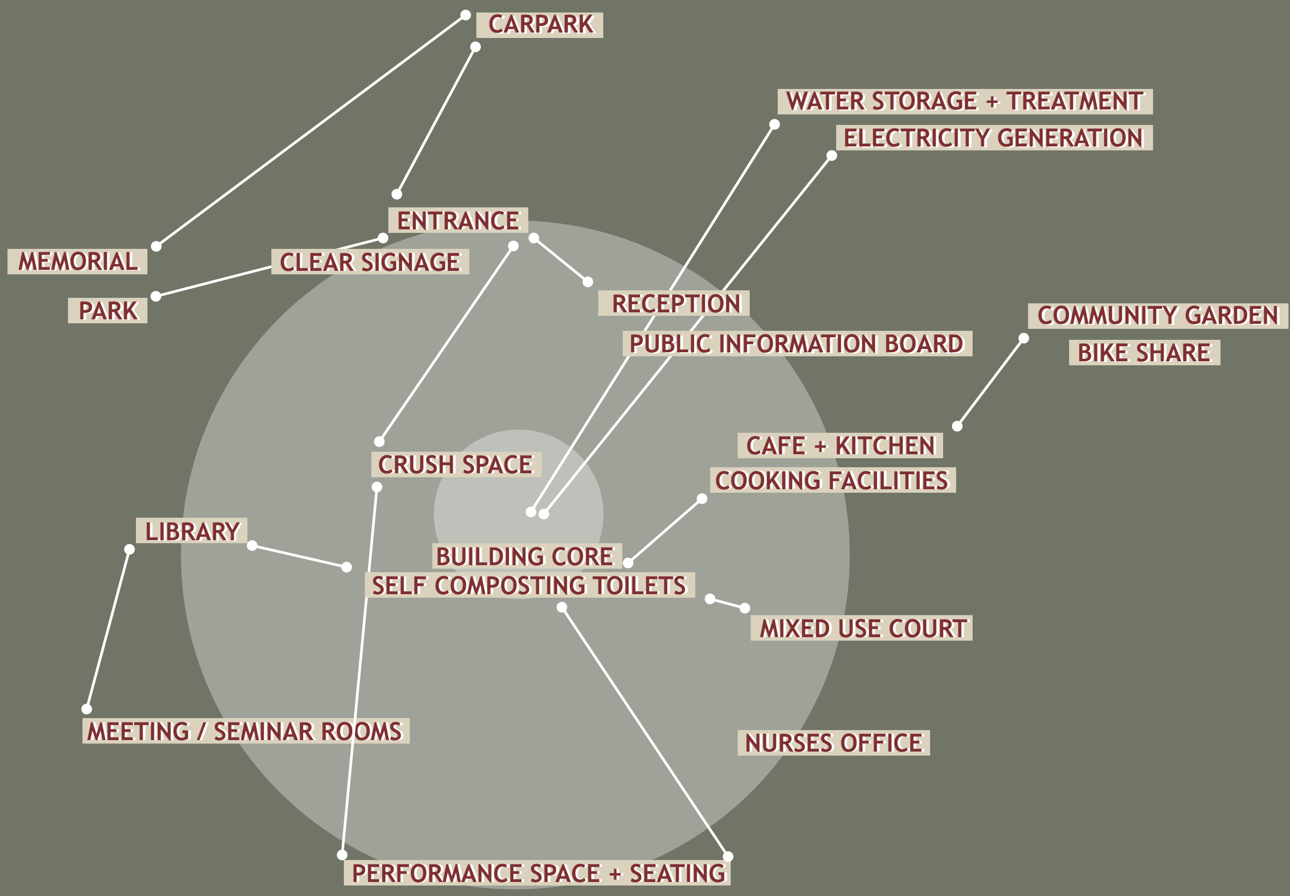
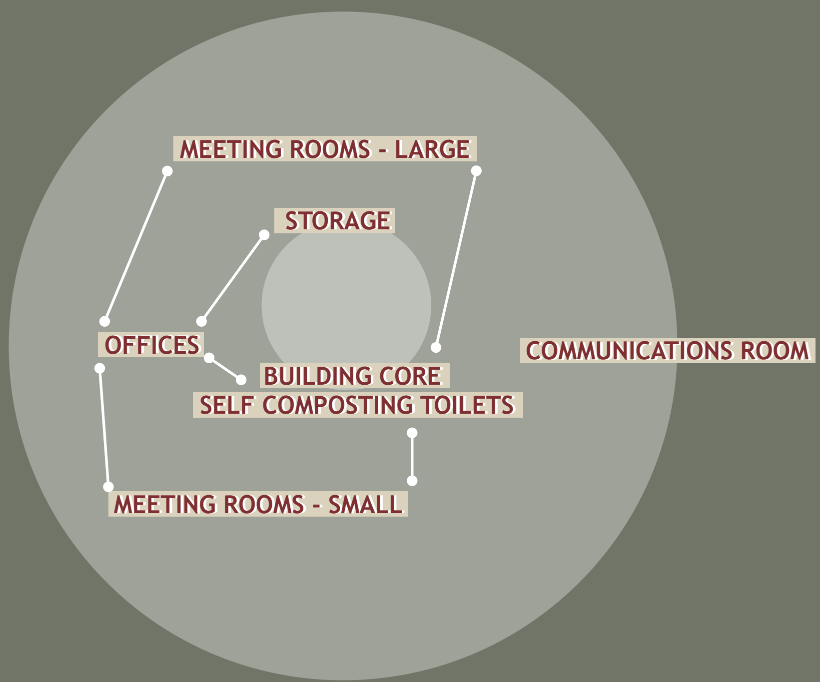


Figure 36 - Block Programming



GROUND FLOOR



FIRST FLOOR

Figure 37 - Floor Programming

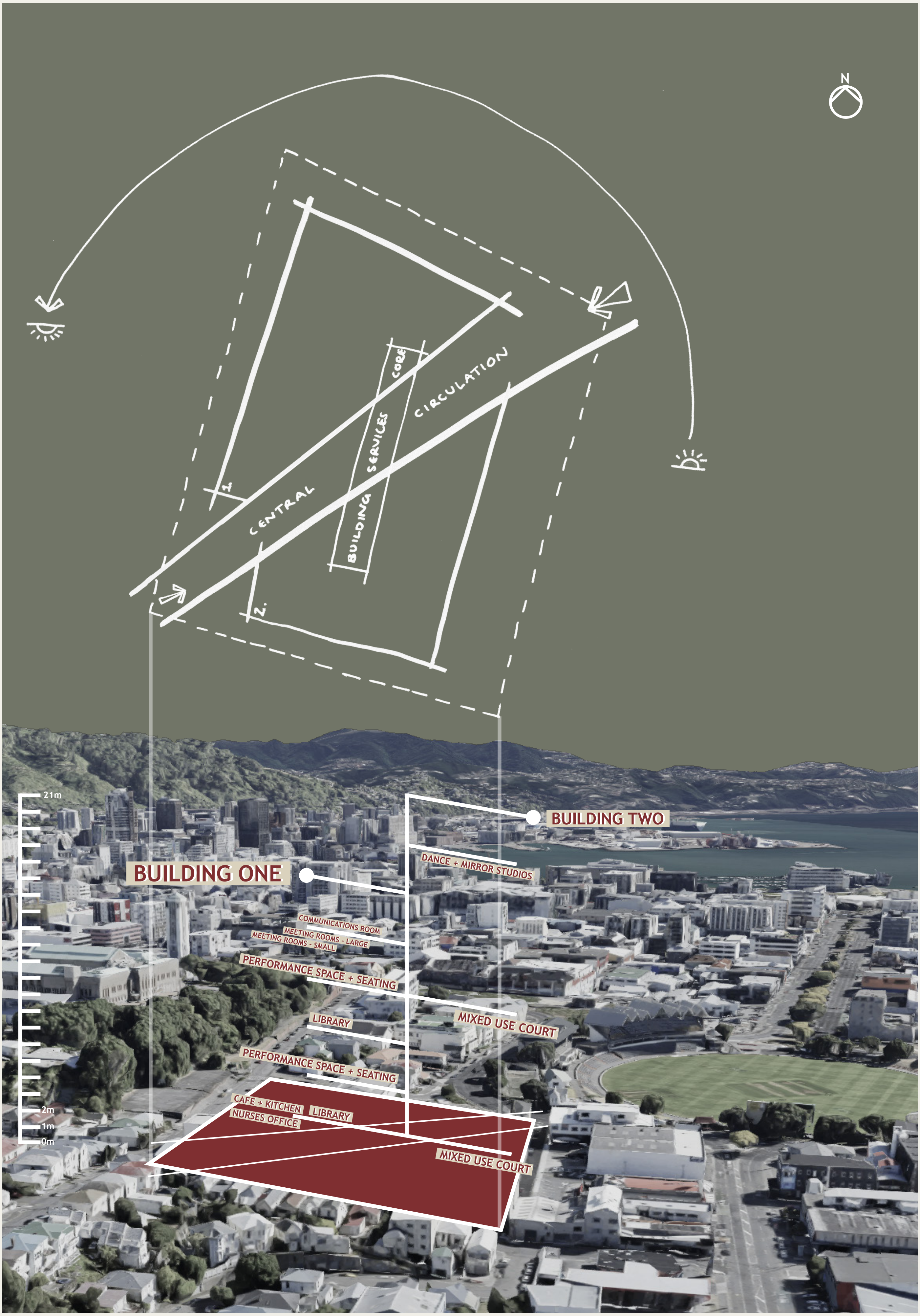


Figure 38 - Initial Planning Diagram

FIRST PLANS

Developing on from programme planning, a concept has been designed around two main blocks on the site with a central core and circulation route through the centre of the site. The two main blocks allow for a passage way between the residential area of Mount Cook, through to the Basin Reserve, a place where people are likely to travel towards following a disaster. Working with the human condition to travel to large open spaces and not head warnings to be pre-prepared, the design develops on this natural passage to create a beacon close to the basin.

As seen within figure 38 the two sections of the building consist of one taller side with all recreation facilities, and a second slightly shorter side with community centre elements and private spaces. This follows with the concept that post-disaster the recreation side will provide people with a place to stay that is separate from the community centre and business building, with opposing programme functions. This minimises disruptions to both sets of programmes, through separating them whilst still keeping them connected through the main circulation and services core.

The proposed conceptual plans for both pre and post programmes can be seen on the following pages, where spaces are easily able to change functions. Retaining flexibility of space was a main driver when designing spaces, due to the need to change programme to a disaster hub at any given moment and following on from findings discovered in critical analysis of past disasters and current relief procedures.

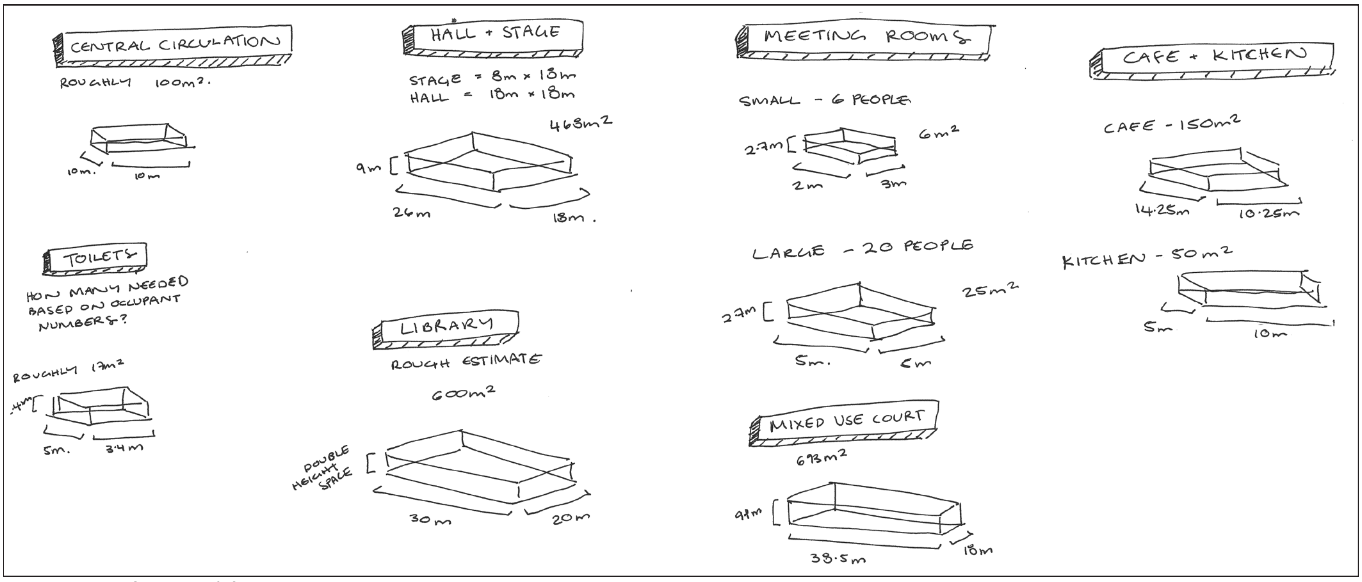


Figure 39 - Sizing of Spaces

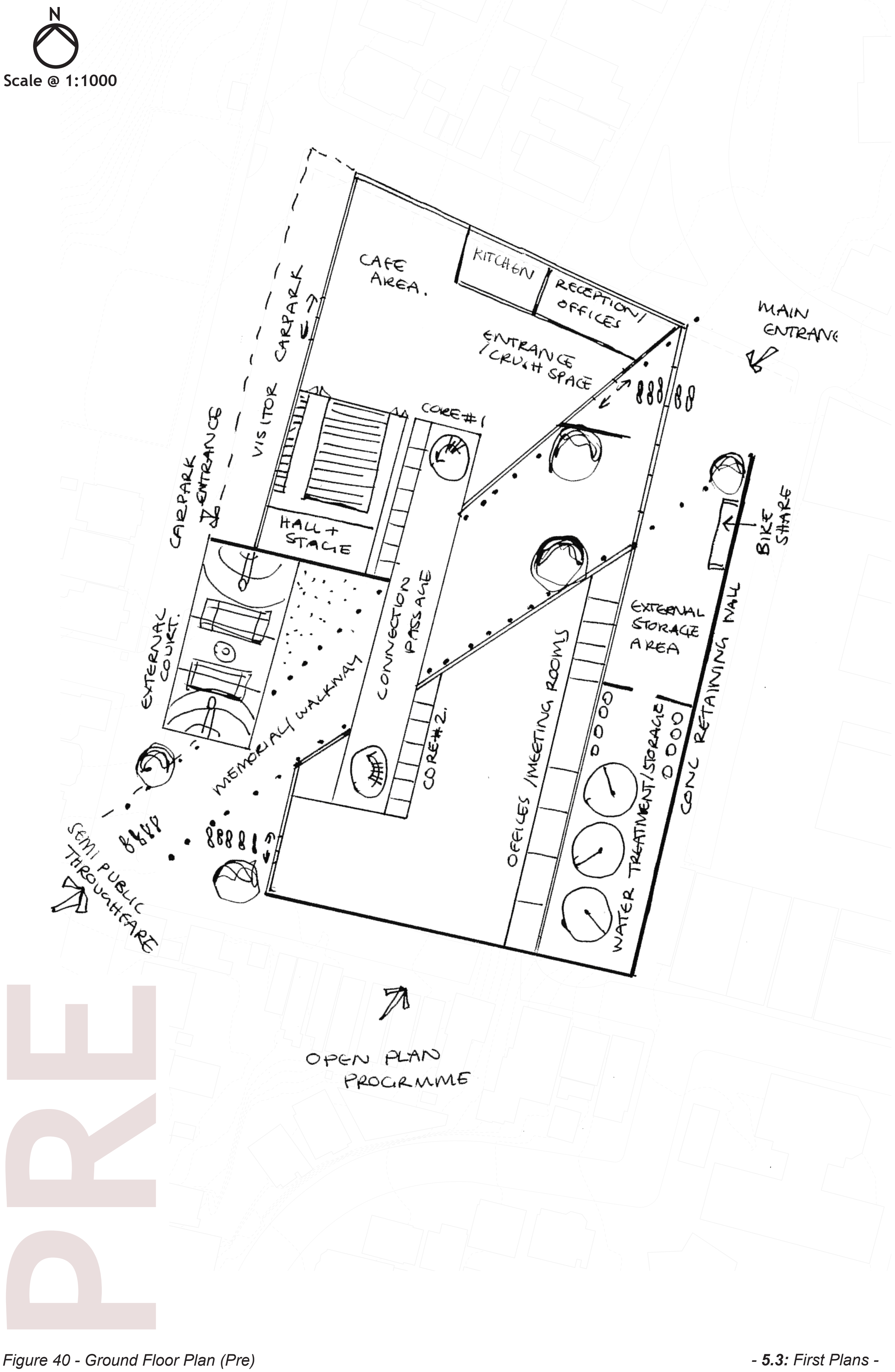


Figure 40 - Ground Floor Plan (Pre)

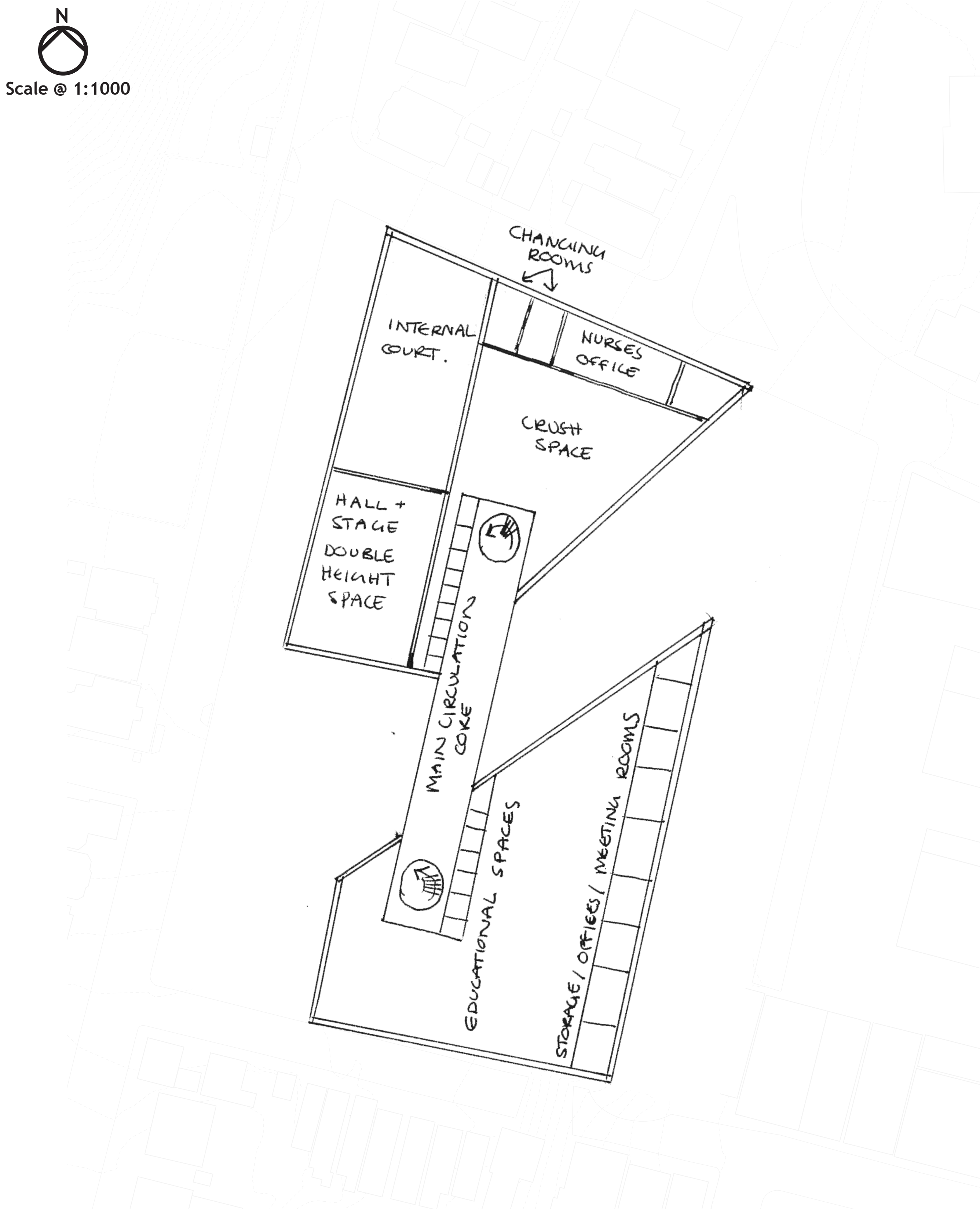


Figure 41 - First Floor Plan (Pre)

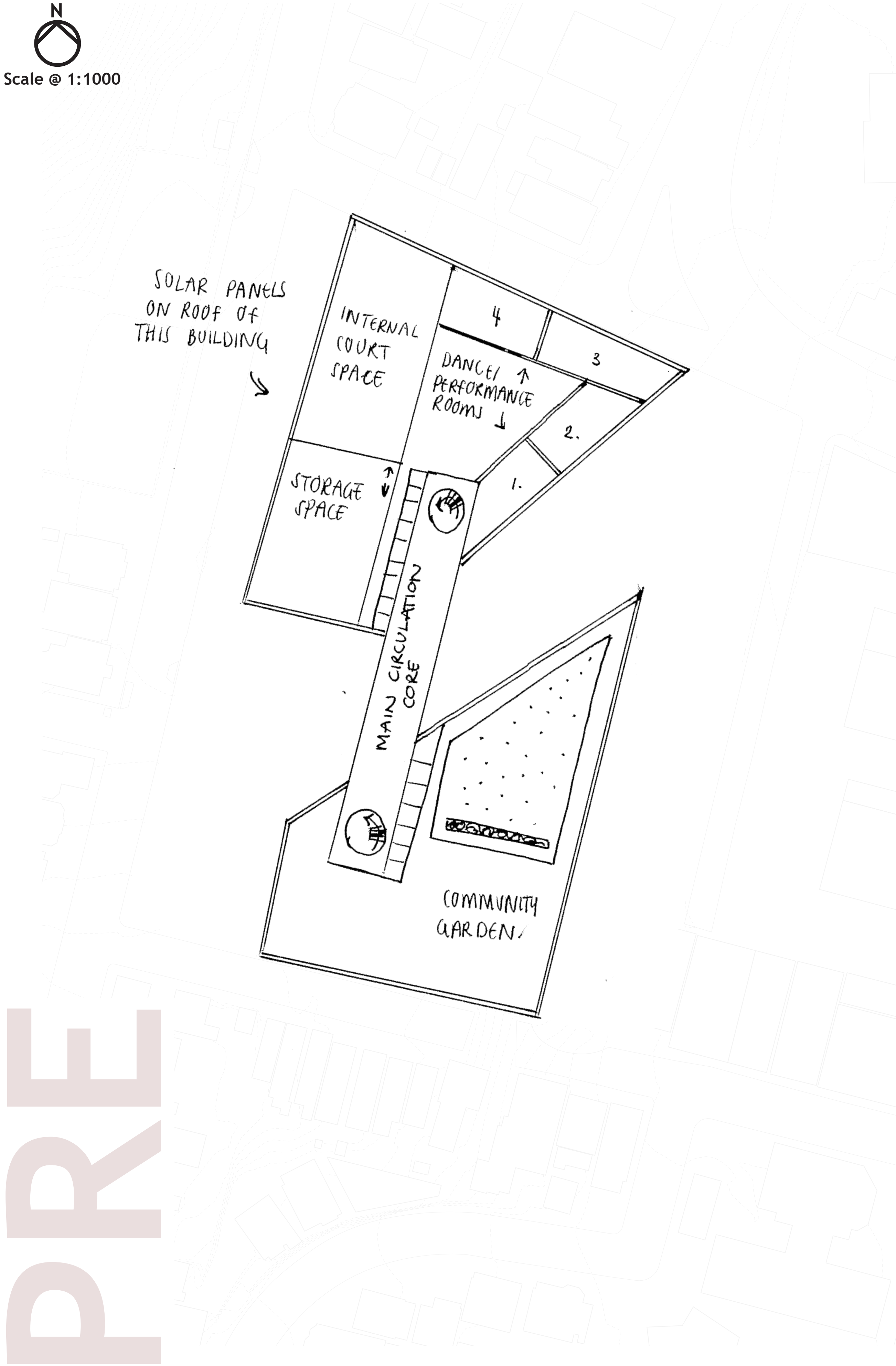


Figure 42 - Second Floor Plan (Pre)

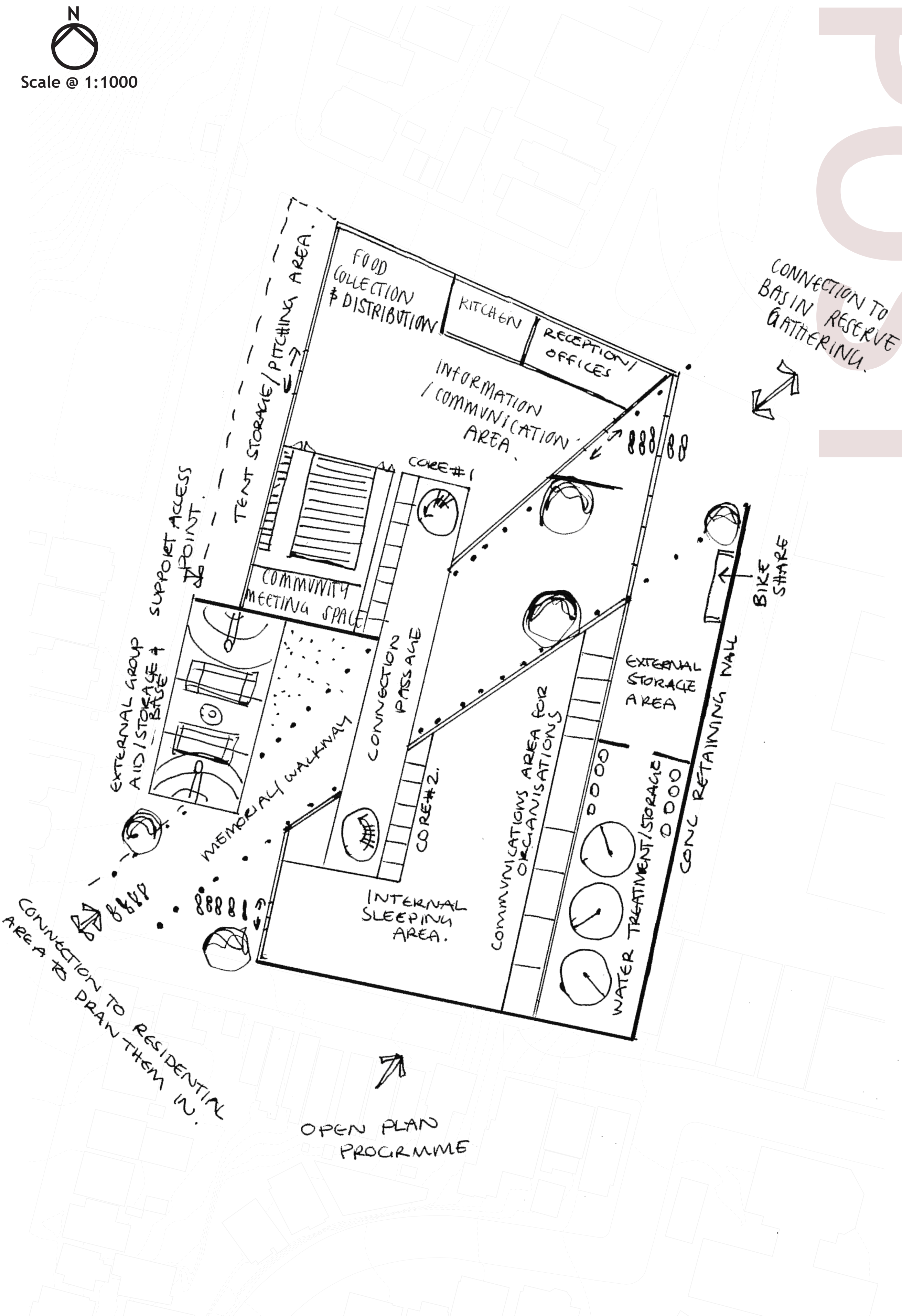


Figure 43 - Ground Floor Plan (Post)

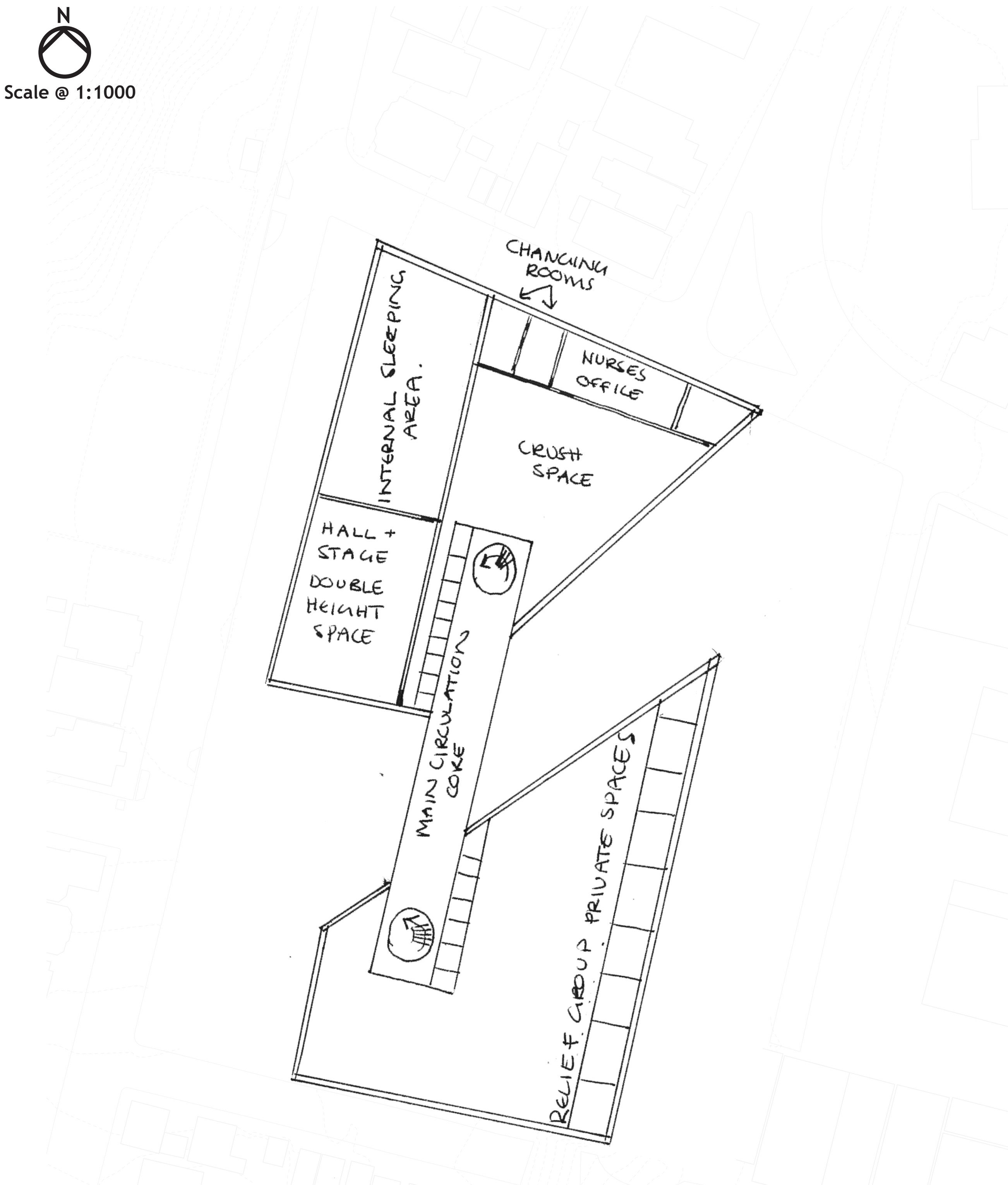


Figure 44 - First Floor Plan (Post)

Scale @ 1:1000

POST

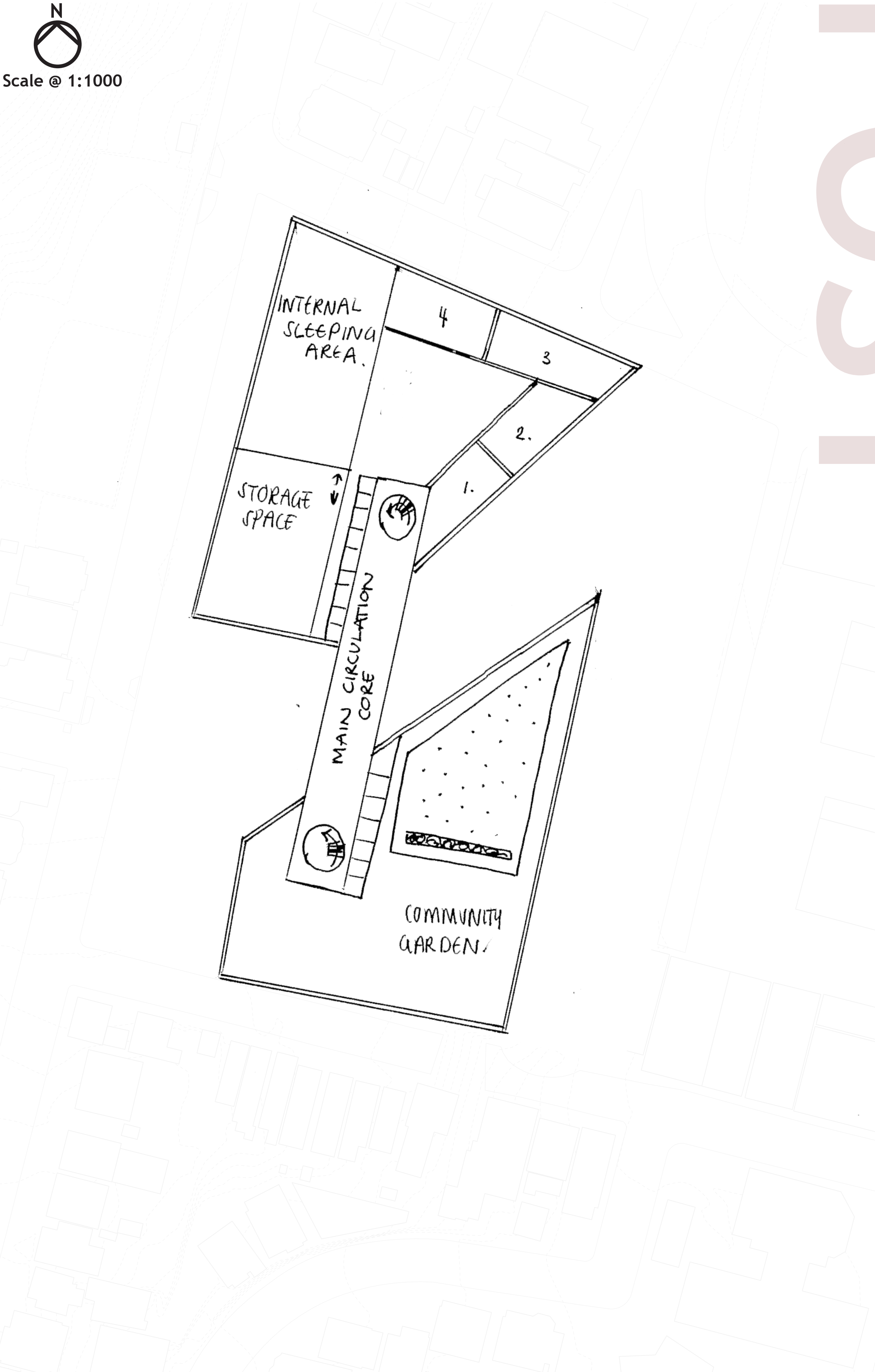
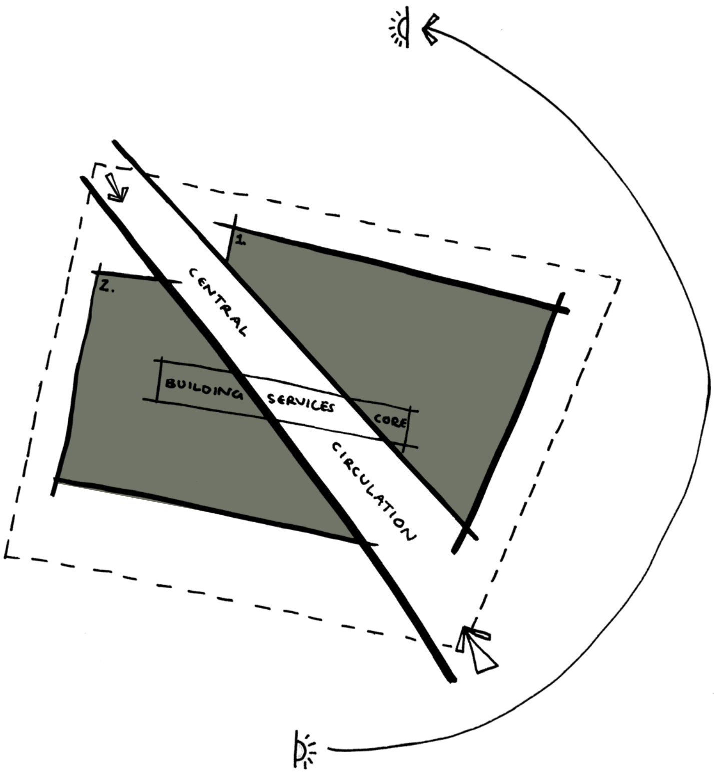
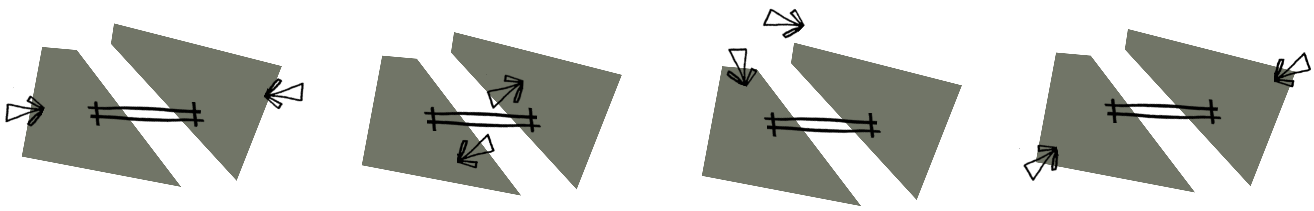


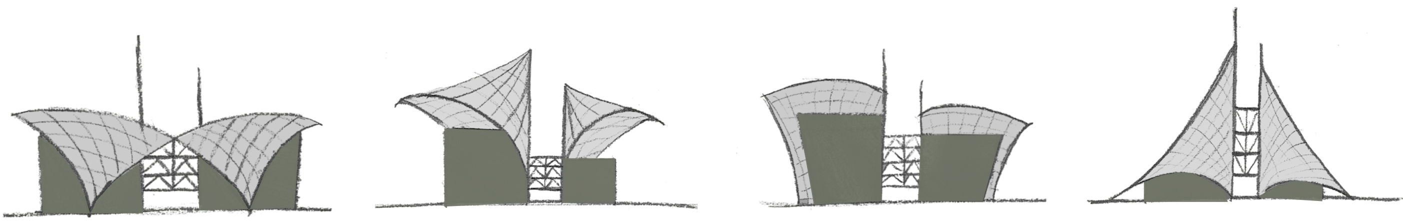
Figure 45 - Second Floor Plan (Post)



BUILDING BLOCKS AND CENTRAL CIRCULATION



TENSILE GEOMETRY BASED ON GROUND CONNECTIONS



ROOFING CONNECTIONS TO GROUND

Figure 46 - Facade Developments

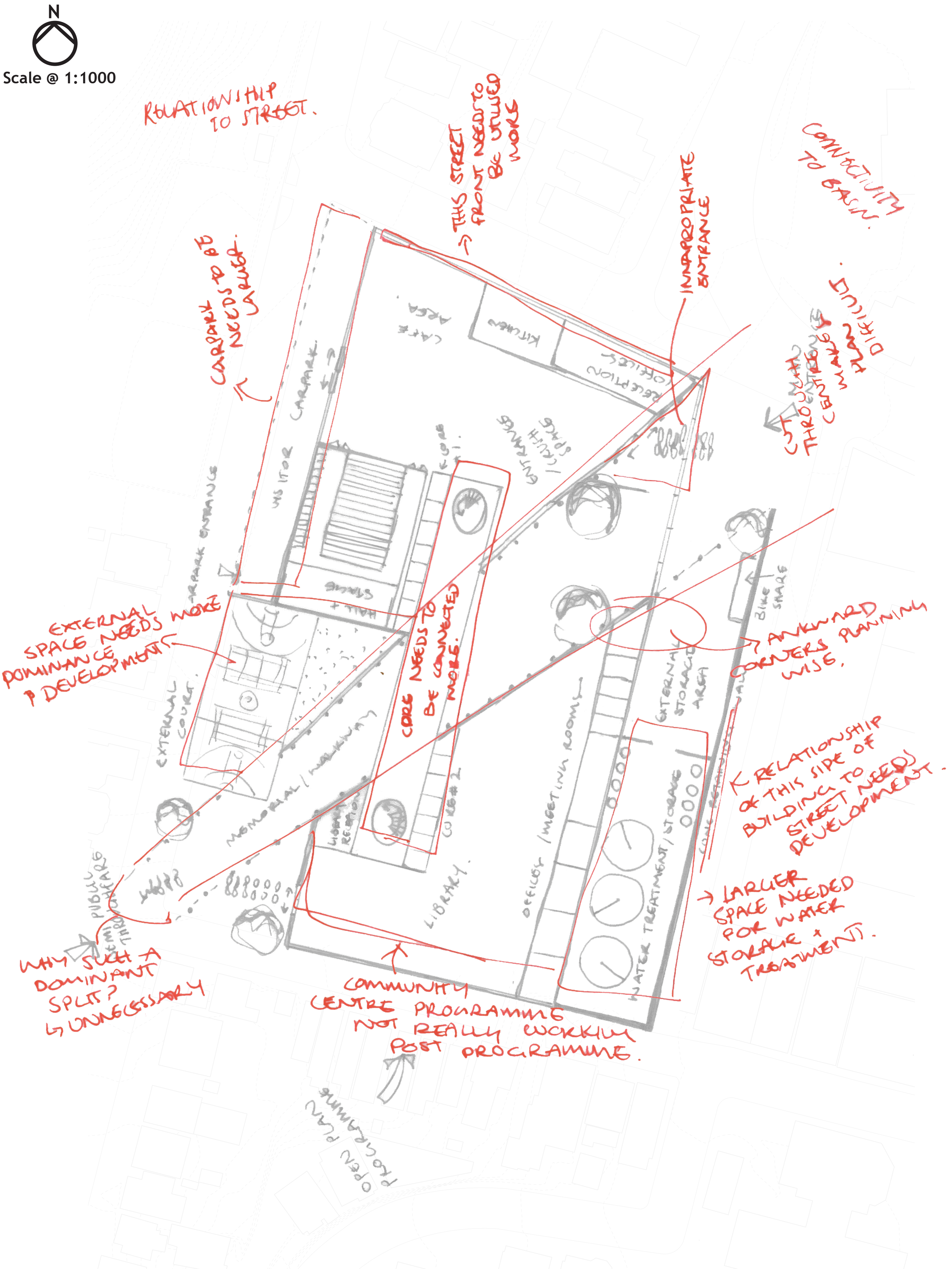
CONCEPT VISUALISATIONS

Based on earlier research, the first concept was visualised based around creating a beacon for people to be able to gather to when they are actively seeking support. The facade has been conceptualized in this design direction accordingly, with structure used as a means to emphasise the secondary programme in a statement that is not typically seen within Wellington. This design approach explored with different ways to connect to the ground whilst also providing shelter.

The Final visualisation whilst dominant, detracts from the over arching nature of the building and creates something visually memorable but heavily dominating its surrounds. The relationship to the street and also how structure is highlighted needs to be further developed within the final design outcome to provide a place where people can connect to whilst also being memorable in a manner that is not relied as heavily on the external composition. This will in turn create a space where people can relate to in the primary programme as well as function in the secondary programme.

TE HAUMARU

Figure 47 - Te Haumaru (Safety) Visualisation



N
Scale @ 1:1000
RELATIONSHIP TO STREET.
THIS STREET FRONT NEEDS TO BE UTILISED MORE
INNAPROPRIATE ENTRANCE
CONNECTIVITY TO BASIN.
CARPARK NEEDS TO BE LARGER
CUT THROUGH MAKES CENTRAL PLAN DIFFICULT.
EXTERNAL SPACE NEEDS MORE DOMINANCE & DEVELOPMENT
CORE NEEDS TO BE CONNECTED MORE.
AWKWARD CORNERS PLANNING WISE.
RELATIONSHIP OF THIS SIDE OF BUILDING TO STREET NEEDS DEVELOPMENT.
LARGER SPACE NEEDED FOR WATER STORAGE + TREATMENT.
WHY SUCH A DOMINANT SPLIT? UNNECESSARY
COMMUNITY CENTRE PROGRAMMING NOT REALLY WORKING POST PROGRAMMING.
CAFE AREA
KITCHEN
OFFICES
RECEPTION
CARPARK
VISITOR CARPARK ENTRANCE
CARPARK ENTRANCE
STAIRS
HALL
CORE #1
CORE #2
ENTRANCE / YOUTH SPACE
EXTERNAL COURT
MEMORIAL / WALKWAY
LIBRARY
OFFICES / MEETING ROOMS
EXTERNAL STORAGE AREA
WATER TREATMENT / STORAGE
BIKE SHARE
PUBLIC THOROUGHFARE
OPEN PLAN PROGRAMMING

CRITICAL REVIEW OF DESIGN

Based on research conducted and findings critically analysed the primary programme of a community centre and secondary programme of a disaster hub were established and explored on the chosen site. When developing this specific programme alongside applications within the site, it was discovered that this particular programme was not appropriate for the over arching intentions for the design to be developed.

As seen within figure 48, a number of elements within the floor plan were inadequate or detracted from both pre and post programme components. The plans as a result became very busy and did not utilise space, resulting in the conceptualised architectural response failing to meet the design framework, aims and objectives outlined earlier.

As a result a primary programme of a community centre is not appropriate on this particular site, resulting in disaster relief elements failing to meet specifications outlined in the initial design framework. Therefore further research needs to be conducted to determine the appropriate architectural solution for the site and secondary programme elements.

Critically analysing the primary programmes failings brings up the following areas to be further researched and analysed:

- Site History – What was the site used for in the past, and does this shed light onto what programme is most appropriate for this specific site?

- Programme Based case studies – Critical analysis of programme based case studies with spaces that are appropriate in accommodating the secondary programme components.

- Site conditions and surrounds – What does the site reveal about potential design directions and also what services areas does the site have that could shed light onto how to respond architecturally?

CHAPTER SIX:

REDEFINITIONS

Figure 49 - Wellington Boys' Institute As it Stands in 2019

SITE HISTORY: WELLINGTON BOYS' INSTITUTE

Residing on the Tasman Street side of the site, is what remains of the original Wellington Boy's Institute. For a number of years this Institute provided key facilities to the youth of Mount Cook and the wider Wellington region. However in recent years only a small portion of the original Institute remains, where as seen within figure 49 it has been left derelict and vandalised. The key to unlocking the pre-determined programme of the disaster relief hub however, lies within the history of what this Institute provided to the community of Mount Cook and the wider Wellington Region.

The Wellington Boys' Institute (later renamed The Wellington Boys' and Girls' Institute), was "founded in 1883 by a group of young people associated with St John's Church in Wellington City, who were looking for an organisation through which they could work to benefit other young people in their community" (BGI, 2016). Following on from this desire, the Tasman Street building was erected to provide a "pool facility, a gymnasium, workshops, a hall and a boarding home" (Gallagher, 2013) to the male youth of the surrounding suburbs. Over the years of its operation, the Institute "acted as a billboard of sorts, showing the community that through honest virtue and good living people could overcome disadvantage and find honour, service and even distinction" (Gallagher, 2013), providing a key curriculum to enhancing the lives of the male youth within the city of Wellington.

Over the years of its operation, a key programme within the institute was that of its indoor pool. Whilst the "pool was covered over in the early 1930's" it then was "reopened in the 1960's" (Cooke, 2006) providing the community with a facility that was well used. Unfortunately, the land was later bought by Foodstuffs, where the TSW Swim School, still running within the institute, closed on the "21st December 2007" (Burgess, 2007) to make way for the then proposed Pack 'N Save. The land since 2008 has been left empty, aside from a few buildings that still remain on the outskirts of the site, one of these buildings being the remaining façade of the Boys' Institute.

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Figure 50 - Original Fascade

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Figure 51 - Gym Use

Upon the swimming pools closure, there was uproar caused regarding the location of the “1800 learner swimmers” (Burgess, 2007) to which the school provided “designated swimming tuition for children aged from six months” (Burgess, 2007). The location of the school at the Boys’ Institute was “preferable to programmes held at council-run pools, which have only a small area put aside for swimming lessons” (Burgess, 2007). This left a gap for this form of communal infrastructure, to which over the years has been filled by the surrounding schools and institutions. These locations of which are not open to the public during the normal business hours.

Leading on from the history of the site in relation to the Wellington Boys’ Institute and the key provision of the pools facilities within the Mount Cook and wider Wellington community, there remains a need for a building within the Tasman Street site to provide for the greater youth of Mount Cook and Wellington city. The application of a building targeted at youth and relevant social and physical activities would fill a current gap in the area, whilst also working to re-establish a hub for youth to gather.

Taking into consideration earlier research in relation to current gaps within disaster relief from the bottom-up approach, application of this form

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Figure 52 - Gym Use

This Image has been removed by the author of this thesis for copyright reasons

Figure 53 - Tasman Street View

of programme and related infrastructure would be appropriate for establishing a critical and memorable location within the community. The relationship of space when designed with the post-disaster programme in mind, further diversifying space and enhancing the longevity of the overall building.

Overall the buildings programme should be further developed in relation to a design where the original swimming school can be re-established to reconnect the surrounding facilities. This would then further solidify the relationship between the community and architecture, providing a space where people relate to and use often enough to become aware of its secondary function, that of a community disaster relief hub. Through changing the relationship between disaster relief architecture and a community, attitudes in relation preparing for a disaster will also change alongside the response post disaster. Through placing the secondary programme within a primary programme that is relevant to a wider group of people, the second nature of the building will also come as a second nature to those who it is widely used by. Thus as a result minimising the negative impact to a community in the first 24 to 72 hours post disaster.

Figure 54 - 59 - Site Images, Corner of Rugby and Tasman Streets

SITE CONDITIONS AND SURROUNDS

Locational aspects of the final site allow for aims of the project to be met and the overall target of sufficient pre-established relief to be provided to the immediate area. Whilst this site is providing relief to only a few suburbs close to the CBD, principles can also be taken and applied to other locations.

Taking in site conditions, sustainable design elements can be addressed and applied further within the final architectural application. As a result, further detailed analysis has been carried out in relation to the site in order to gain as much knowledge as possible to ensure the design is efficient in carrying out both primary and secondary programmes throughout its use. Detail in relation to wind, solar, rain and topological characteristics of the site can be seen as follows.

The site sits within two different wind zones, with the south western section being in a medium wind zone and the north eastern section being in a high wind zone (Wellington City Council, N.D). As a result, appropriate shelter should be provided on the north eastern section of the site with cross ventilation being achievable in a sufficient manner due to the increased exposure to wind, that is not so extreme to become a hazard.

Average sunlight exposure to the site in W/m2 is as follows for various times of the year with each overage taken at 12pm each month.

January = 735W
February = 677W
March = 618W
April = 506W
May= 394W
June = 361W
July = 385W
August = 449W
September = 561W
October = 631W
November = 676W
December = 687W (NIWA, 2019)

Figure 60 - 65 - Site Surrounds

Taking these averages, the site is exposed to roughly 557W on average at the highest point in each month. Due to the site also being unrestricted by other large buildings, its ability to produce electricity and be exposed to sunlight throughout the day is ideal. However, its proximity to a hill sheltering it from sunlight from the west in the winter months is not ideal in exposure and production for if a disaster were to occur at those times of year. A detailed analysis of solar analysis can be accessed in appendix 1.

Rainfall within Wellington is at an average of 1,000mm to 1,250mm per annum (Statistics New Zealand, N.D). This places it within the median of rainfall within the country, where there is a significant amount of rainfall on the site. Due to the current layout of the site there is varying levels of moisture retained once significant rainfall has occurred, also caused due to the gradient and drop on the south eastern side of the site. This can be seen within figures 54-59. Significant rainfall and the gradient of the site allow for utilisation of water storage and treatment to occur on site throughout the year.

Following on from rainfall above the site sits at a gradient of 5m, with the lowest point at the north eastern side of the site 15 meters above sea level and the highest point of the site at the south western side of the site 20 meters above sea level (Google Earth, N.D). Utilising the steep gradient in sustainable design applications will enable for aims to be met within the final design application.

Surrounding the site are various schooling institutions and amenities to go alongside these, the location being ideal in following on from what research into the site's history suggested in relation to a recreation facility. Following on from this observation, service areas of the site to these forms of educational facilities in the immediate area will further determine the distance from the site the primary programme will be able to reach. This therefore determines a rough estimate as to how effective this form of architecture could be following a disaster based on its primary programme.

Figure 66 - Educational Facilities in Relation to Site

PRE PROGRAMME SERVICE AREAS

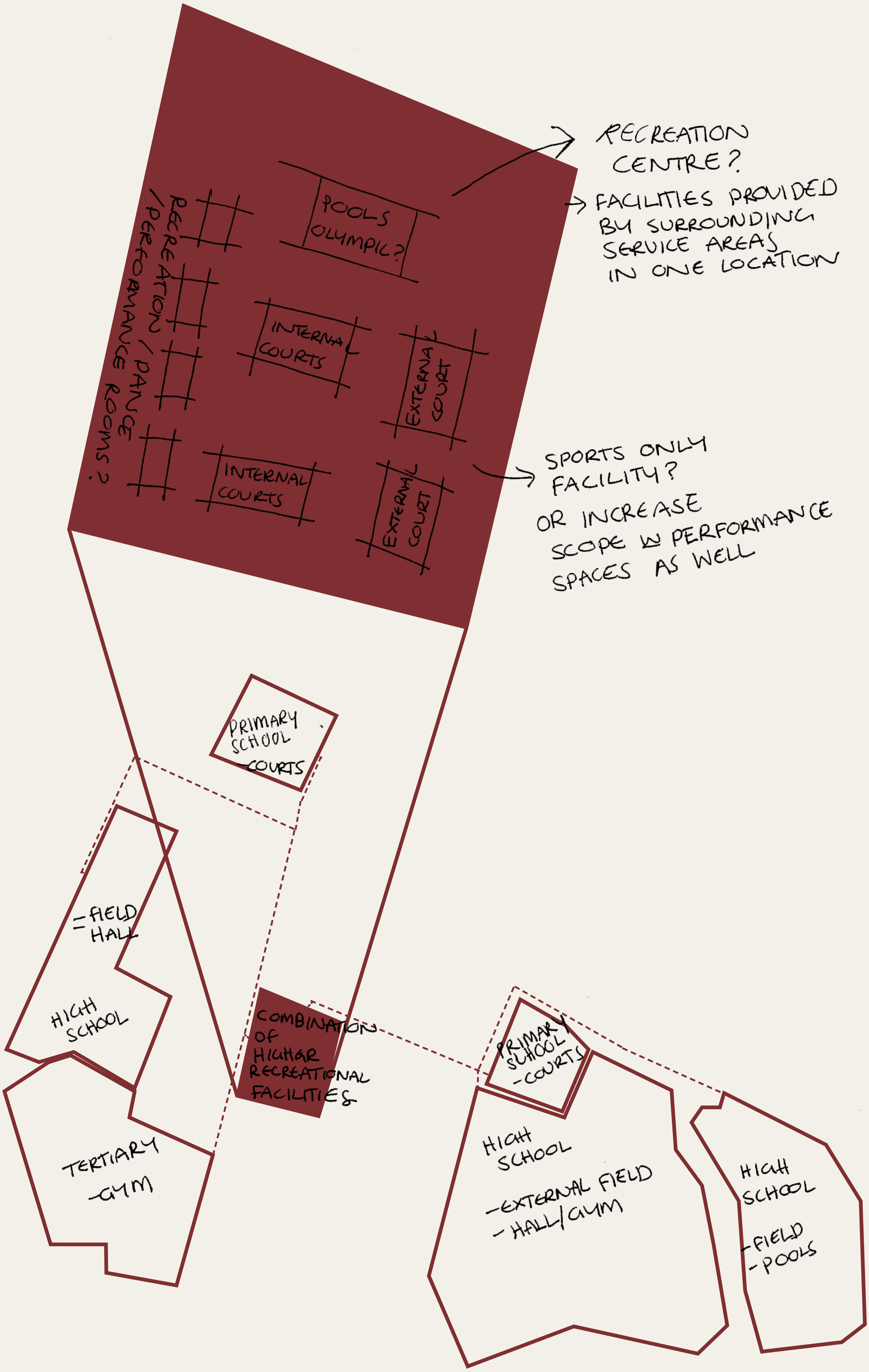
Based on research into the site's history and previous services that it provided to the Mount Cook community, the following service areas have been determined:

- Massey University
- Wellington High School/ Field
- Mount Cook School
- Saint Marks
- Wellington East Girls
- Wellington College

The service areas highlighted are all schooling centres due to redefinitions being that based around a shift to a recreation centre, similar to that which once resided on the site and was of high demand. These service areas are alongside critical infrastructure identified earlier in this thesis, with schooling providing connections in relation to the primary programme and critical infrastructure relating to the secondary programme.

Walking distance and estimated walking times are highlighted as these are key for both the primary and secondary programmes. Providing a space where educational facilities who are closest to the site is key to connecting various people within the community. As site history and further site analysis revealed, through the primary programme providing a place that youth can come to and connect in various sporting activities it will provide a place where people can relate to. Through this it then highlights the buildings secondary programme and further emphasises the use post disaster. Working with post disaster elements, alongside youth will also provide another connection in educating what to do in a disaster and what is provided to help.

As all the service areas for the primary programme are within 1km to the site it is easily accessible for those it targets to travel to and from.


RECREATION CENTRE?
FACILITIES PROVIDED BY SURROUNDING SERVICE AREAS IN ONE LOCATION
POOLS OLYMPIC?
INTERNAL COURTS
EXTERNAL COURT
INTERNAL COURTS
EXTERNAL COURT
RECREATION / DANCE / PERFORMANCE ROOMS?
SPORTS ONLY FACILITY?
OR INCREASE SCOPE W PERFORMANCE SPACES AS WELL
PRIMARY SCHOOL
-COURTS
-FIELD
-HALL
HIGH SCHOOL
TERTIARY
-GYM
COMBINATION OF HIGHER RECREATIONAL FACILITIES
PRIMARY SCHOOL
-COURTS
HIGH SCHOOL
-EXTERNAL FIELD
-HALL/GYM
HIGH SCHOOL
-FIELD
-POOLS

REDEFINITION OF PROGRAMME

Through further research and analysis being carried out, the primary programme of the design has been shifted to that of a recreation facility. Through research and analysis of the site and using this to determine what the specific area needs in relation to communal infrastructure, the community centre design originally determined was not an appropriate architectural direction. Readdressing the over arching design framework, aims and objectives, service areas of a potential primary programme in the direction of a recreation centre has been highlighted. Where the original design direction failed to meet the needs of both primary and secondary programme elements and the overarching disaster relief element of the design was being neglected for the primary elements, redefinition of the programme will shift the focus of the design to successfully achieve these.

As site history suggests the need for a recreation type centre in the suburb, working with this history to develop the design direction will also in turn aim to achieve framework goals 2, 3, 5 and 6. Due to the preliminary design failing to meet these, the secondary function of the building would have been unsuccessful due to failing to meet the needs of the community following a significant disaster, further amplifying the problem instead of reducing it. Failing to meet the design framework, aims and objectives would result in a similar architectural response as highlighted within New Zealand's current approach to disaster relief, and would hinder the ability to provide a pre-established place for communities to seek refuge in the critical 24-72 hour window.

Based on these factors, and to work with earlier research to achieve all the design goals, aims and objectives, further analysis has been carried out following the redefined primary function. Developing the primary function further to enhance the secondary function, and also work with the site conditions and surrounds to design a response to the notion of pre-established disaster relief using the suburb of Mount Cook Wellington as a way to develop a set of design parameters that could also be applied in other areas of Wellington, or even New Zealand.

PHASE THREE:

Developed Design + Conclusions

CHAPTER SEVEN:

PROGRAMME BASED CASE STUDIES + PROGRAMME & DESIGN DEVELOPMENT

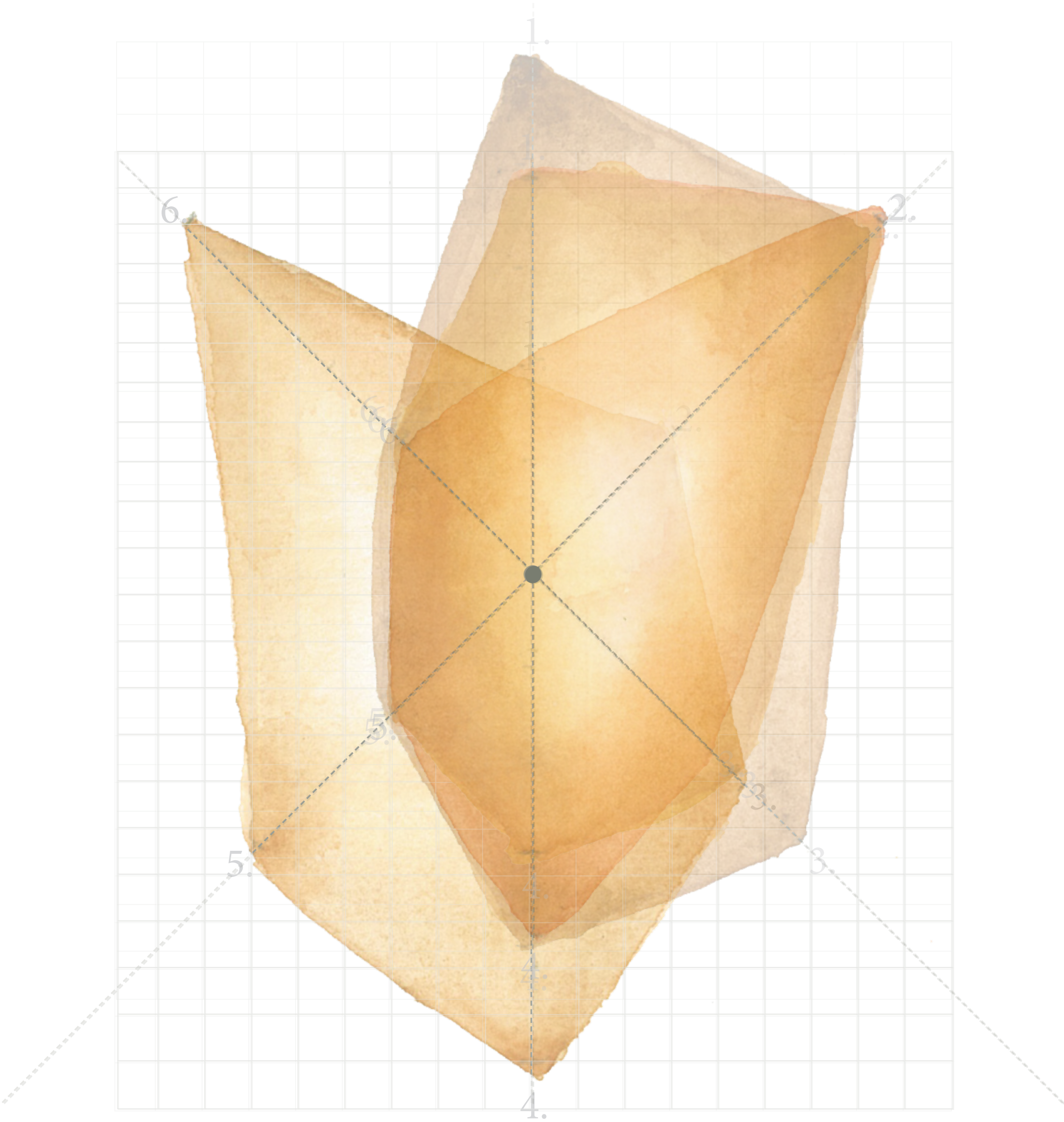


Figure 67 - Diagram of Overlaid Building Analysis'

CASE STUDY OVERVIEW

Based on earlier research, the final preliminary programme is to be that of a recreation centre, with the inclusion of swimming pools. In order to ensure that the final preliminary programme has been developed to include appropriate programme components to function at a high performance pre-disaster, architectural case studies have been critically analysed. The ASB Sports Centre, Lincoln Event Centre, Lardy Sports Hall and the Schonberghalle have all been analysed, with layout and programme components reflected on.

The precedents have also been visualised based on the following points based off of analysis findings, key to ensuring success of the final developed design:

1. Ease of circulation
2. Maximisation of floor area
3. Sustainable infrastructure/elements
4. Adaptability of space
5. Internal/external balance
6. Welcoming nature of design

It is then from the analysis of these precedents that the final programme components have been developed in relation to both pre and post disaster responses on site.

EASE OF CIRCULATION 1

MAXIMISATION OF FLOOR AREA 2

SUSTAINABLE INFRASTRUCTURE/ELEMENTS 3

ADAPTABILITY OF SPACE 4

INTERNAL/EXTERNAL BALANCE 5

WELCOMING NATURE OF DESIGN 6

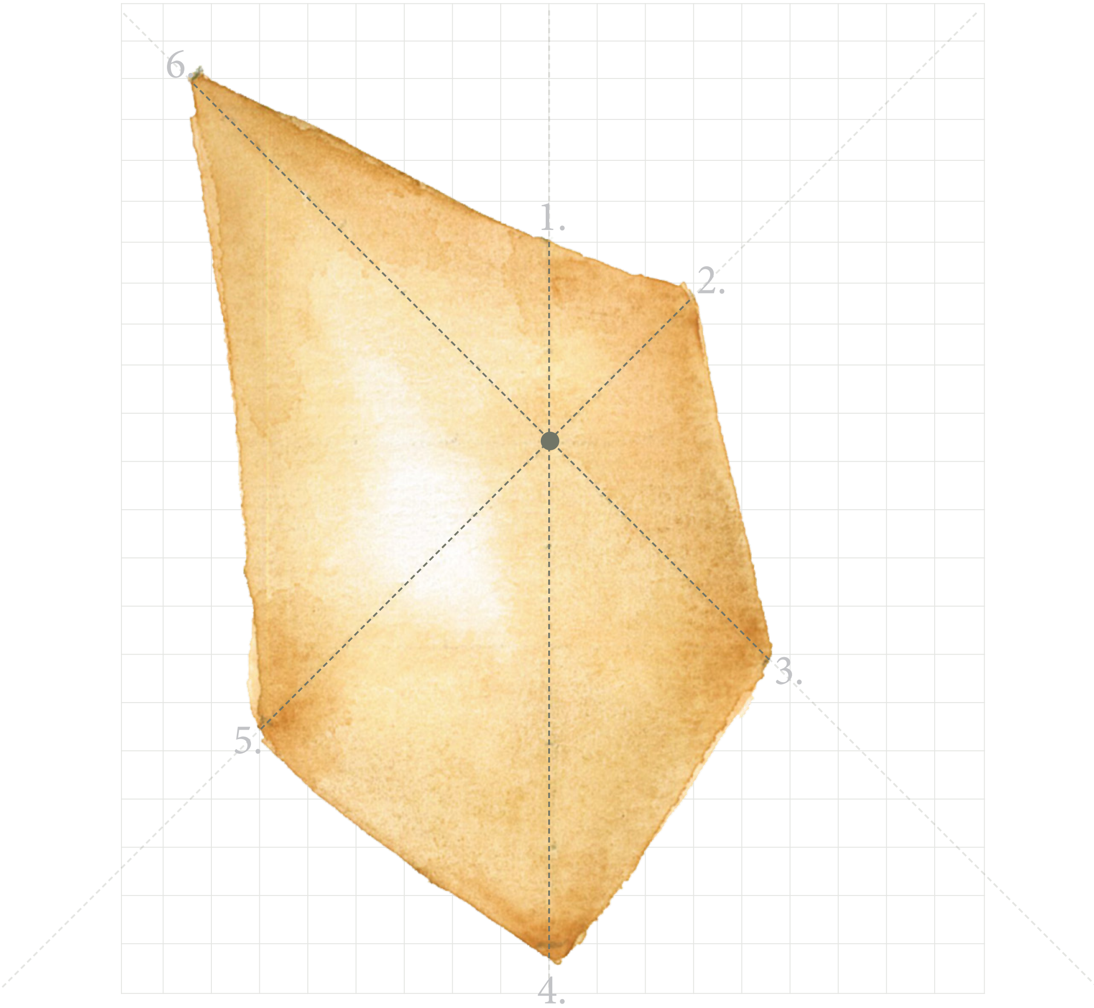


Figure 68 - Diagram of Building Analysis

ASB SPORTS CENTRE

Mixed Use Sports Centre

Wellington, New Zealand

Tennent + Brown Architects

2011

Size Unknown

The ASB Sports centre in Wellington, New Zealand is Wellingtons primary mixed used indoor sports facility. It hosts a range of different sports, with the centre satisfying “a need for community indoor court space to cater a number of sports” and also catering for “high performance sports” (ArchDaily, 2013). The centre also aims to “provide a high performance indoor sports space with a high degree of permeability to light, air and connectivity to its context” (ArchDaily, 2013).

PROGRAMME COMPONENTS

- Single courts x 12
- Café/ Kitchen
- Toilets x 2 (per gender)
- Changing rooms x 5
- Services room
- Offices (private)
- Reception
- Storage x3
- Services core
- Meeting rooms
- Function rooms
- Private rooms

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Figure 69 - Analysis of ASB Sports Centre Plans

STRENGTHS

- Includes multiple indoor sports courts (12 Individual, 6 mixed use)

- Includes sustainable elements within its design features such as natural ventilation and light

- Wellington's primary indoor sports venue, where the closest building type is outside of the city

- Placed within a location where it provides an indoor venue to a vast number of southern Wellington schools and other sports organisations

WEAKNESSES

- Room for further development of sustainable elements

- No permanent stands for public viewing of activities

- Natural lighting inappropriate at certain times of the day/year for the activities the sports centre holds

- Courts placed in close proximity to each other, resulting in poor divisions when multiple activities happening at the same time

- Insufficient number of changing rooms for number of courts/ activities in centre

- Public rooms placed in back of building and private in front. Normally you would plan these the opposite way around

EASE OF CIRCULATION 1

MAXIMISATION OF FLOOR AREA 2

SUSTAINABLE INFRASTRUCTURE/ELEMENTS 3

ADAPTABILITY OF SPACE 4

INTERNAL/EXTERNAL BALANCE 5

WELCOMING NATURE OF DESIGN 6

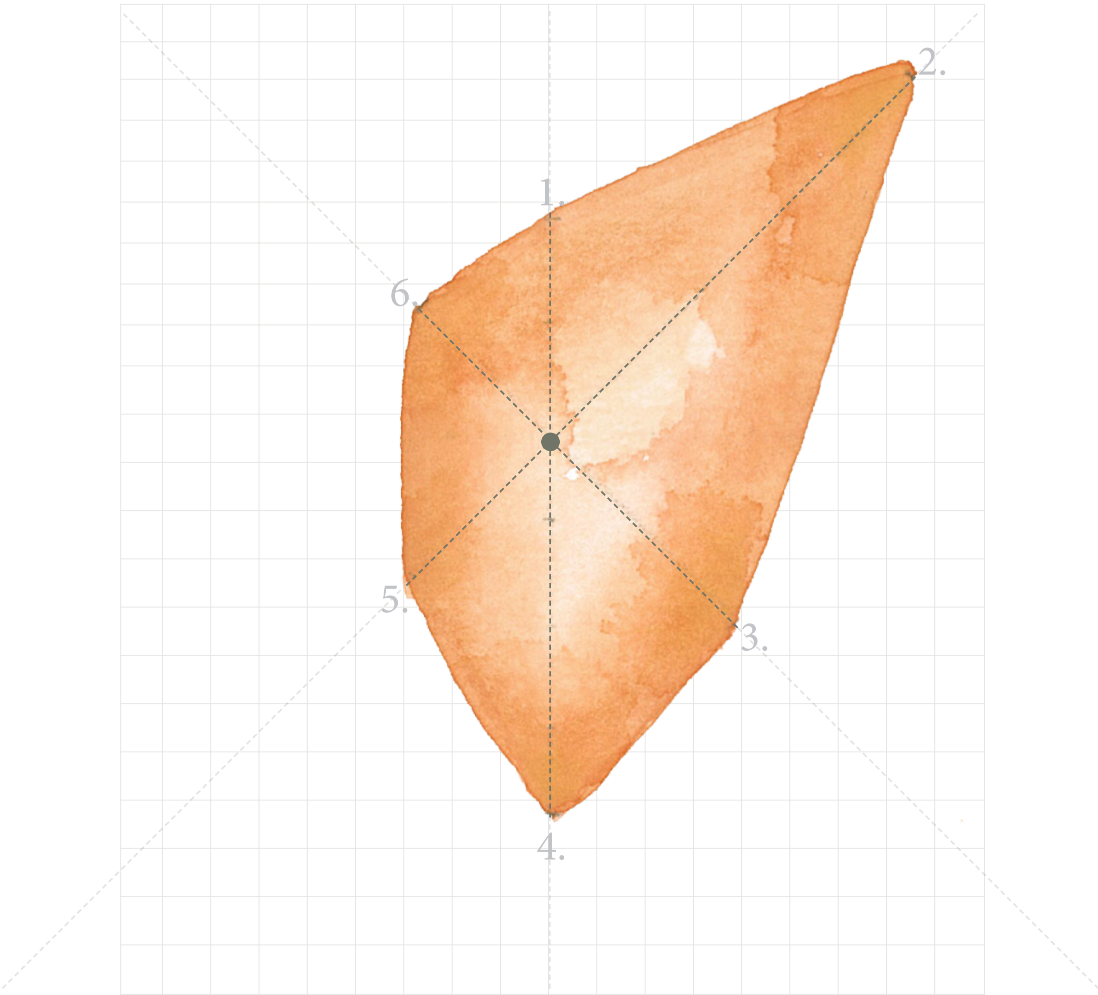

Figure 70 - Diagram of Building Analysis

LINCOLN EVENT CENTRE

Event and Sports Centre

Selwyn, New Zealand

Ian Krause Architects

Date Unknown

Size Unknown

The Lincoln Event Centre is a “multi-purpose venue” (Selwyn District Council, Unknown) just outside of Christchurch. It hosts both public and private events, and provides space within Selwyn for the community to gather and connect with each other.

PROGRAMME COMPONENTS

- Toilets x 2 (per gender)
- Changing rooms x 2 (per gender)
- Kitchens x 4
- Store rooms x 10
- Admin office
- First aid room
- Stage
- Hall
- Mixed use court
- Lounges/conference rooms x 2
- Projection room

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Figure 71 - Analysis of Lincoln Event Centre Plans

STRENGTHS

- Mixed use court well planned and laid out in relation to changing rooms and stands
- Adequate natural ventilation
- Natural lighting planned well and appropriate for activities carried out in each space
- Diverse programme
- Adequate storage spaces throughout building

WEAKNESSES

- Poor planning and circulation
- Toilets not central to building and places in the back of the building
- Only one access point to changing rooms
- Only one access point to toilets
- Entrance in relation to carpark incorrectly placed for circulation and entry
- Sound proofing between spaces inadequate

EASE OF CIRCULATION 1

MAXIMISATION OF FLOOR AREA 2

SUSTAINABLE INFRASTRUCTURE/ELEMENTS 3

ADAPTABILITY OF SPACE 4

INTERNAL/EXTERNAL BALANCE 5

WELCOMING NATURE OF DESIGN 6

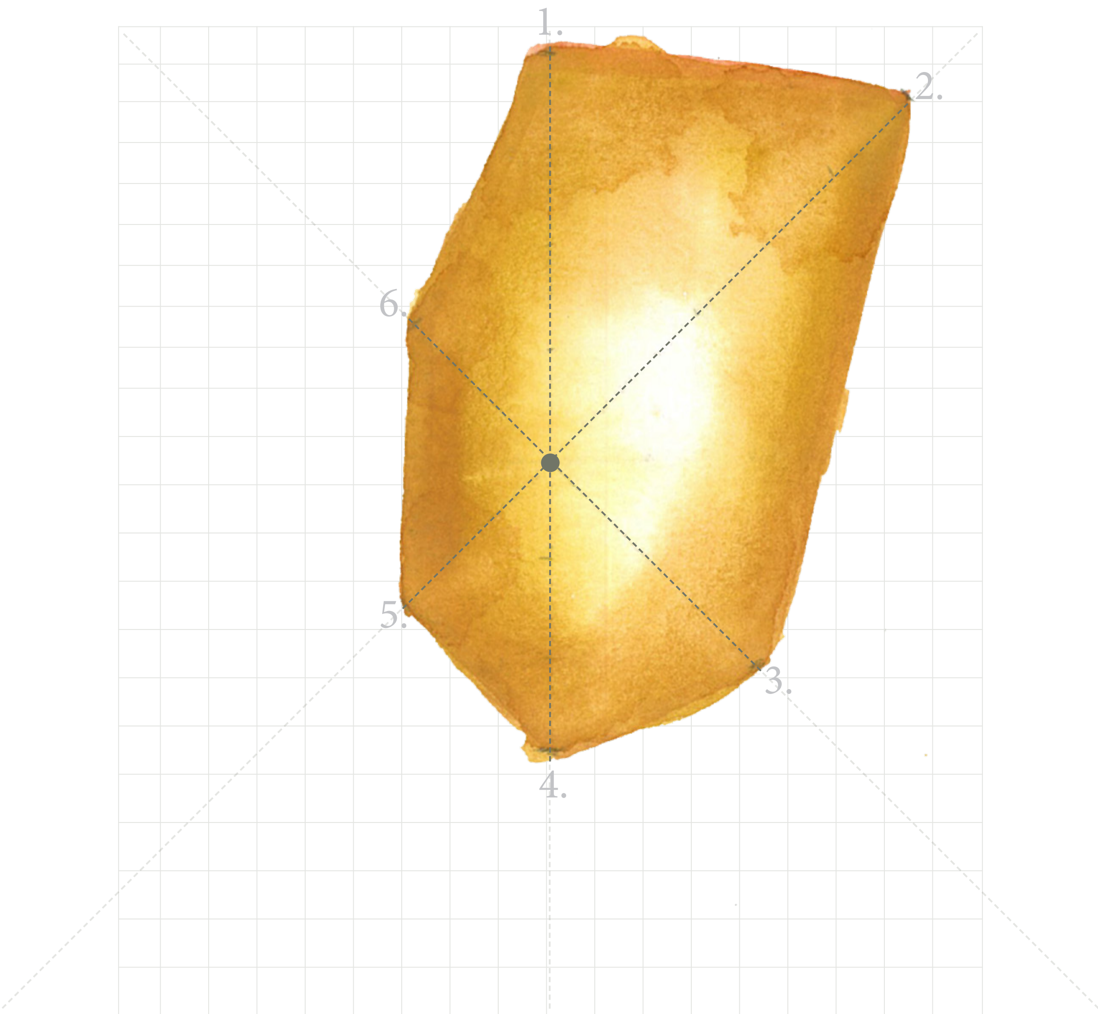

Figure 72 - Diagram of Building Analysis

LARDY SPORTS HALL

Sports Centre

Ollainville, France

Explorations Architecture

2012

3000m2

The Lardy Sports Hall in Ollainville, France is focused around three key spaces, “a multi-sport gymnasium and bleachers / support spaces / multispace room” (ArchDaily, 2014). Taking into account the open landscape surrounding the building, it utilises a glazed curtain wall and ‘a natural wood screen wrapping around the building” (ArchDaily, 2014) providing spaces of privacy for the occupants of the facility.

PROGRAMME COMPONENTS

- Mixed Use Court
- Climbing Structure
- Grandstand
- Dance Hall
- Locker (Changing) rooms
- Caretakers Lodge
- Toilets

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Figure 73 - Analysis of Lardy Sports Hall Plans

STRENGTHS

- Lighting in relation to court
- Diffusion of natural light within dance studio
- Simple and well planned layout of space and circulation
- Integrated landscaping into overall layout
- Diffused natural lighting on areas of building with facing direct sunlight
- Multiple access points to changing rooms and toilets, making them easily accessible.
- Sufficient grandstand seating

WEAKNESSES

- Lots of wasted negative space around court and grandstand
- Roofing structure and development in relation to complete building lacking
- Main entrance not clear in relation to the “shell” design of the building
- Double height spaces in relation to wall and roofing integration lacking
- Shell surrounding building blocks it from site surroundings, closing it off from the public
- High levels of natural lighting from one side of the mixed use court, leaving the levels of light unbalanced
- Grandstand seating facing glass wall, distracting from the court

EASE OF CIRCULATION 1

MAXIMISATION OF FLOOR AREA 2

SUSTAINABLE INFRASTRUCTURE/ELEMENTS 3

ADAPTABILITY OF SPACE 4

INTERNAL/EXTERNAL BALANCE 5

WELCOMING NATURE OF DESIGN 6

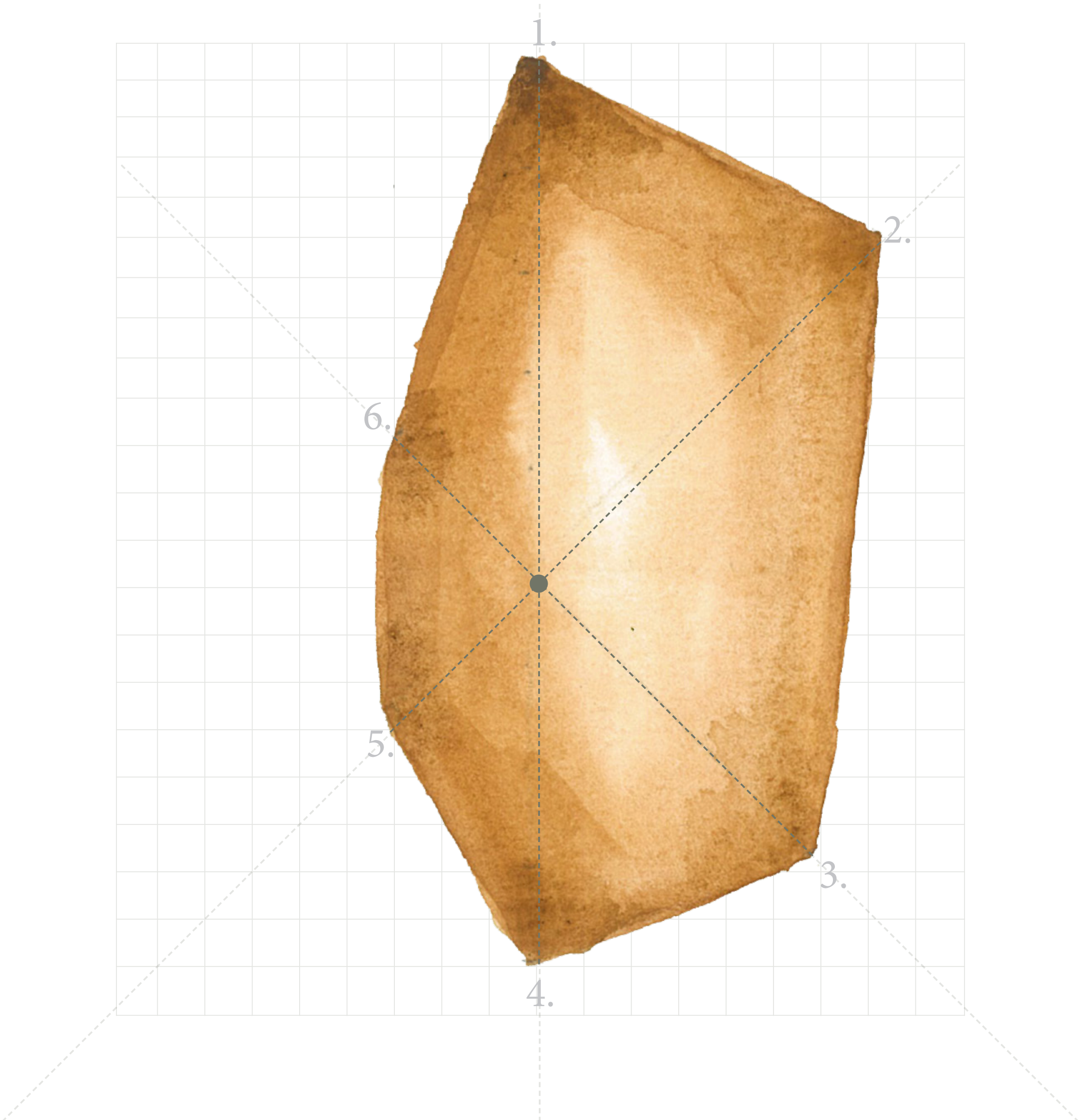

Figure 74 - Diagram of Building Analysis

SCHONBERGHALLE

Sports Centre

Pfullingen, Germany

Herbert Hussmann Architekten

2016

3080m2

The Schonberghalle in Germany, utilises the stepped landscape in order to separate spaces for athletes and spaces for spectators. The “main access for athletes is found on the lower level, together with the playing field and the changing rooms” and the “entry for visitors” placed on the upper level (ArchDaily, 2017).

PROGRAMME COMPONENTS

- Control room
- Services rooms x 3
- Changing rooms x 6
- WC Rooms x 9
- Caretaker rooms
- Instructor change rooms x 2
- Gym
- Kitchen
- Public Gallery
- Technological Room

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Figure 75 - Analysis of Schonberghalle Plans

STRENGTHS

- Clear circulation and programme layout
- Function of spaces easily changed
- Natural lighting from either side of mixed use court
- Use of access points in relation to slope of sites landscape
- Sufficient grandstand seating

WEAKNESSES

- Structure intersecting with passageways and rooms, directly in the middle
- Unclear entrance from external composition
- Layout of changing rooms In relation to mixed use court and access points
- Closed off from external surroundings

CRITICAL ANALYSIS OF CASE STUDY FINDINGS

Analysis of case studies reveal that programme are not appropriately designed with the users in mind, with floor plans being unpractical and often hindering use of space. Following on from analysing the case studies strengths and weaknesses, the following areas are to be developed within the final design and programme in order to ensure current weaknesses are improved.

Sustainable Elements

The application of sustainable elements are often left under utilised with one element applied and other critical elements neglected in the final designs. Analysing sustainable applications revealed that day lighting and natural ventilation are commonly used within recreation centres, however their use in relation to courts and what direct/ indirect lighting is needed does not correlate. Due to the final design also doubling as a disaster relief centre, sustainable elements should not only work with the programme of the recreation centre, but also be appropriate for the post disaster functions as well. This means that additional sustainable elements such as water storage, treatment and electricity generation should be paired alongside day lighting and natural ventilation.

Grandstands

It was discovered that grandstands were either inappropriately placed or not included at all within the recreation centres analysed. The placement of these should take both traditional and non-traditional use of court use, with lighting direction and levels considered in relation to seating location as well. This will provide comfortable arrangements with users, ensuring the addition of permanent grandstand seating is utilised.

Circulation

Circulation in a number of the case studies were poor and hindered the programme of the building. Ease of use of space and also between key spaces were neglected, with the overall composition and shape of the building taking precedent over a practical and easy to use floor plan.

Court Placement

Court placements often saw them too close together, with minimal room between courts. Either courts were reduced with more space between, or a large number of courts were included with minimal space between each. To be developed in the design is the relationship between courts, their relationship to the grandstand and circulation as well.

Public/Private Rooms

Placement of public and private rooms should be designed in regards to importance of use in relation to proximity to key spaces. Sound proofing between these spaces should also be sufficient so that each activity can be carried out without disturbance. When planning, locations of these opposing spaces should be heavily taken into consideration.

Toilets and Changing Rooms

Correlating toilet and changing room numbers in relation to the number of courts and spaces included within the complete building. Where these are insufficient it creates hindrance for users resulting in the plans not flowing and spaces to become clogged. Placement of these within case studies were in areas where they we hard to access, causing further hindrance for users between each of the spaces.

Structure

Structure placement in relation to spaces within some case studies were inappropriately placed, hindering the use of space. As seen within the ASB Sports Centre, where structure is highlighted and integrated into other elements of the overall design it is able to add further detail to the overall composition of the building. This element when developed in the final design will highlight the safety of the building, further emphasising the secondary programme.

DISASTER HUB + RECREATION CENTRE

COLLECTION STATION
RELIEF SUPPORT BASE
RELIEF VEHICLE STORAGE

PUBLIC INFORMATION BOARD
CLEAR SIGNAGE
DISTRIBUTION AREA
EMERGENCY WATER SUPPLY
INTERNAL SLEEPING AREA
COOKING FACILITIES
NURSES OFFICE
COMMUNITY MEETINGS

STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM
RELIEF GROUP PERSONAL ROOMS

CARPARK
MEMORIAL
WATER STORAGE + TREATMENT
OUTDOOR COURTS x 2

ENTRANCE
RECEPTION
CRUSH SPACE
PUBLIC INFORMATION BOARD
BUILDING CORE
CLEAR SIGNAGE
SWIMMING POOL
INDOOR COURTS x 4
COOKING FACILITIES
CAFE + KITCHEN
MIXED USE RECREATION ROOMS
MEETING / SEMINAR ROOMS
NURSES OFFICE
TOILETS
CHANGING ROOMS
STORAGE

OFFICES
STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM
MIXED USE RECREATION ROOMS

WATER STORAGE + TREATMENT
COMMUNITY GARDEN
ELECTRICITY GENERATION
BUILDING SERVICE ACCESS

Figure 76 - Pre and Post Programme Areas

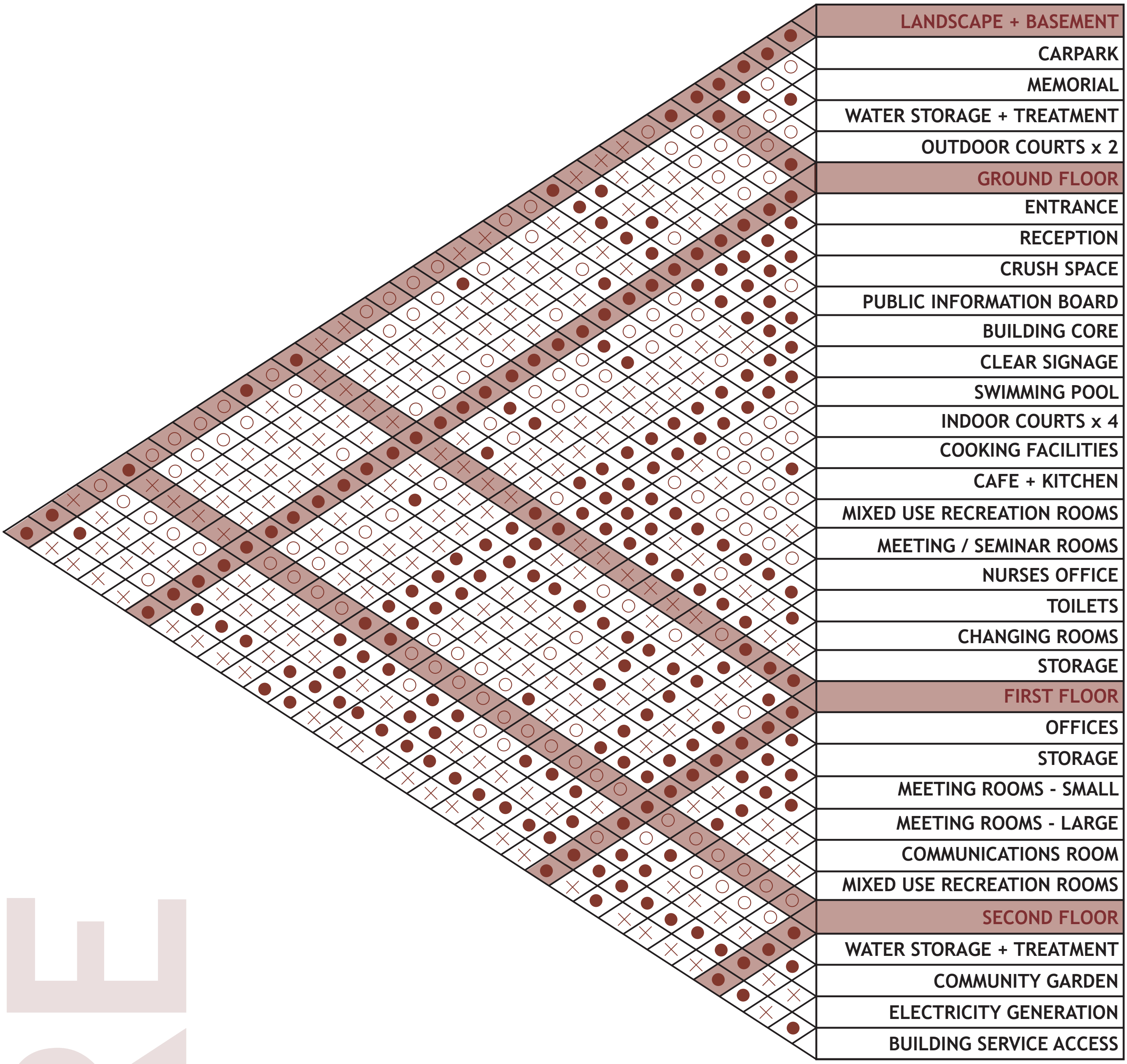
PROGRAMME DEVELOPMENT

Based on analysis of programme based studies the following spaces should be included in the final floor plans:

- *Toilets (Male/female)*
- *Changing Rooms*
- *First Aid Room*
- *Reception*
- *Admin Office*
- *Offices*
- *Function Rooms*
- *Private Rooms*
- *Meeting Rooms*
- *Offices*
- *Storage*
- *Cafe/ Kitchen*
- *Services Room*
- *Dance Hall*
- *Grandstand*
- *Mixed Use Courts*

Application of these alongside observations and critical analysis carried out in the literature reviews, disaster based case studies and site analysis produced the final programme elements for pre and post functions of the building. These can be seen within figure 76 where the disaster hub and recreation centre specific spaces are highlighted.

Within figures 77-79 these spaces have been developed in relation to placement to each other in pre and post use of each programme. Public spaces have been placed within the lower levels and private spaces in the upper two levels. This works with public/private planning techniques and allows for key public spaces to be easily accessed by users. The relationship of these spaces can be seen in detail in figure 77 where their links to each other have been established to ensure plans are cohesive.


LANDSCAPE + BASEMENT
CARPARK
MEMORIAL
WATER STORAGE + TREATMENT
OUTDOOR COURTS x 2
GROUND FLOOR
ENTRANCE
RECEPTION
CRUSH SPACE
PUBLIC INFORMATION BOARD
BUILDING CORE
CLEAR SIGNAGE
SWIMMING POOL
INDOOR COURTS x 4
COOKING FACILITIES
CAFE + KITCHEN
MIXED USE RECREATION ROOMS
MEETING / SEMINAR ROOMS
NURSES OFFICE
TOILETS
CHANGING ROOMS
STORAGE
FIRST FLOOR
OFFICES
STORAGE
MEETING ROOMS - SMALL
MEETING ROOMS - LARGE
COMMUNICATIONS ROOM
MIXED USE RECREATION ROOMS
SECOND FLOOR
WATER STORAGE + TREATMENT
COMMUNITY GARDEN
ELECTRICITY GENERATION
BUILDING SERVICE ACCESS

PRE

POST

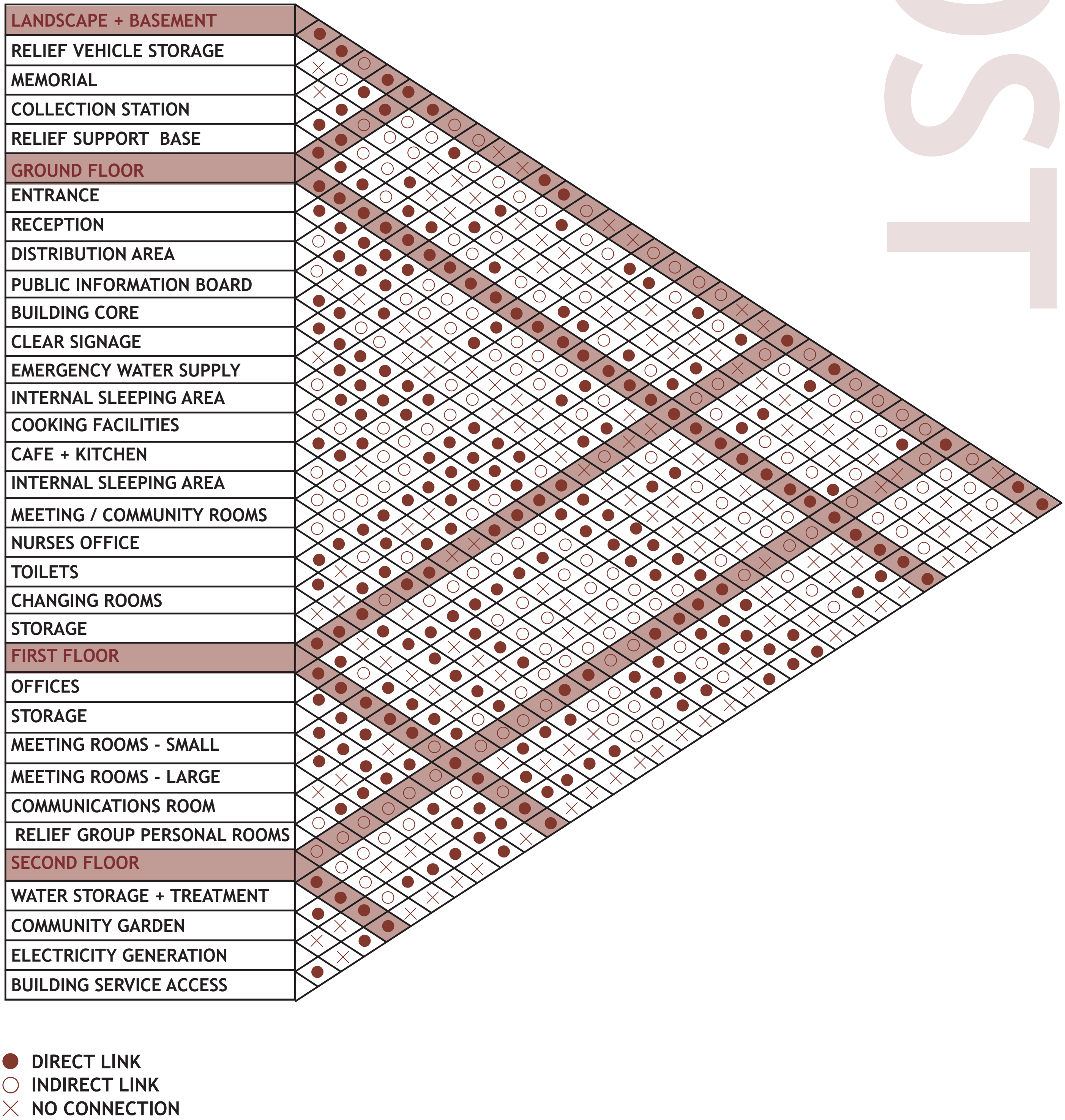
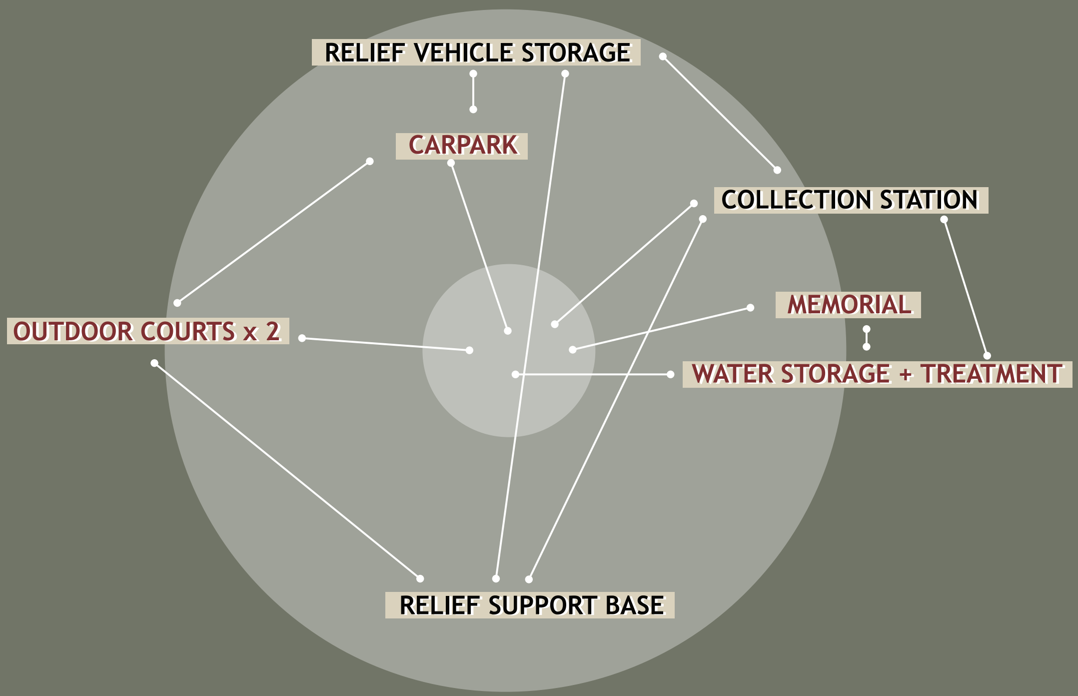
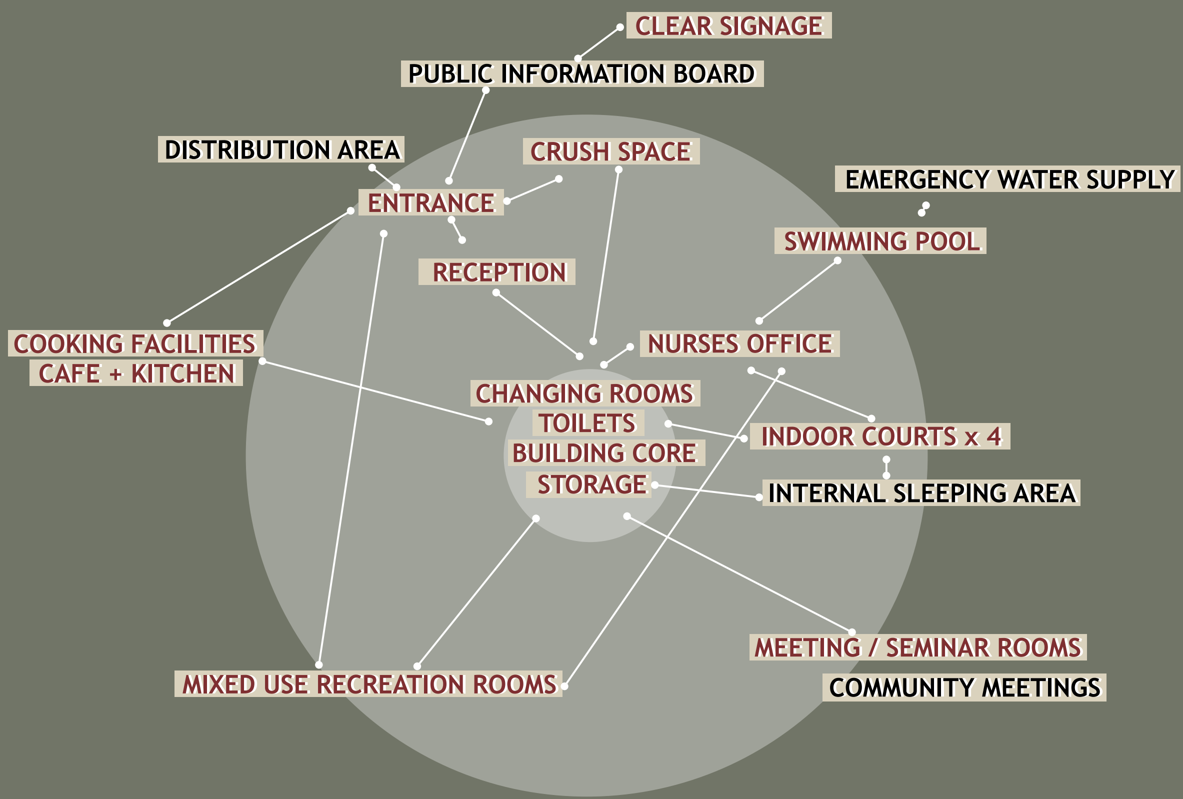


Figure 77 - Pre and Post Programme Matrix

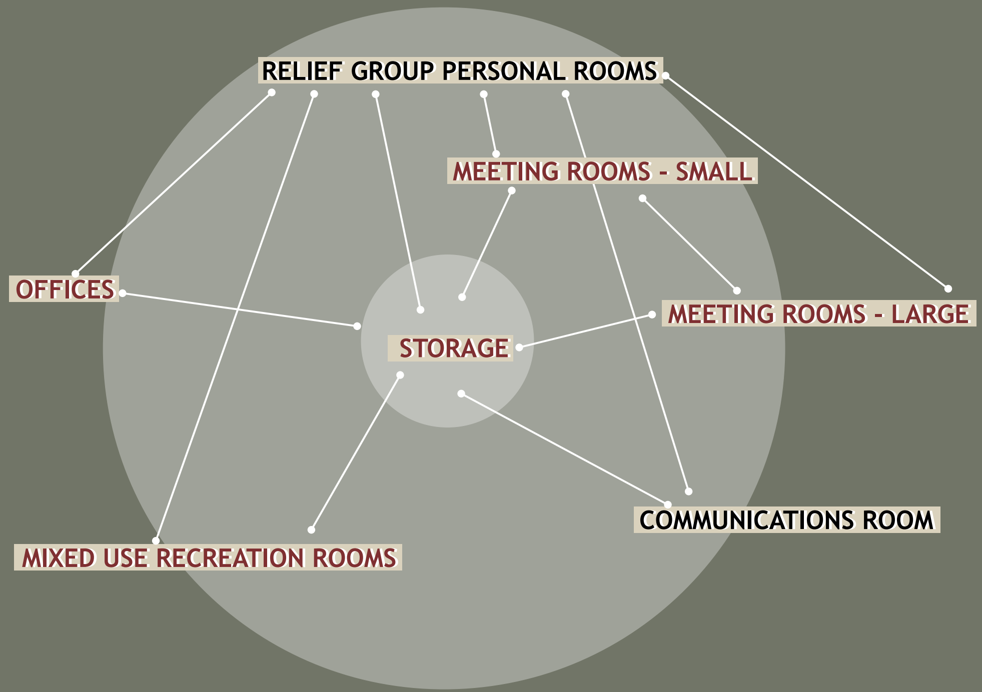


BASEMENT

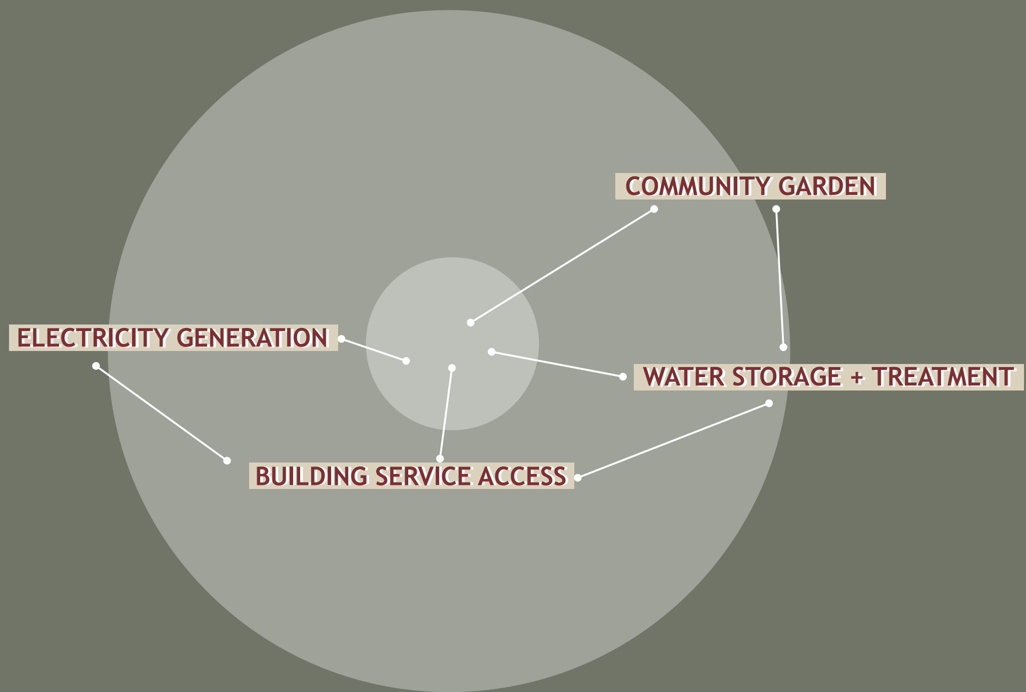


GROUND FLOOR

Figure 78 - Block Programming



FIRST FLOOR



SECOND FLOOR

Figure 79 - Floor Programming

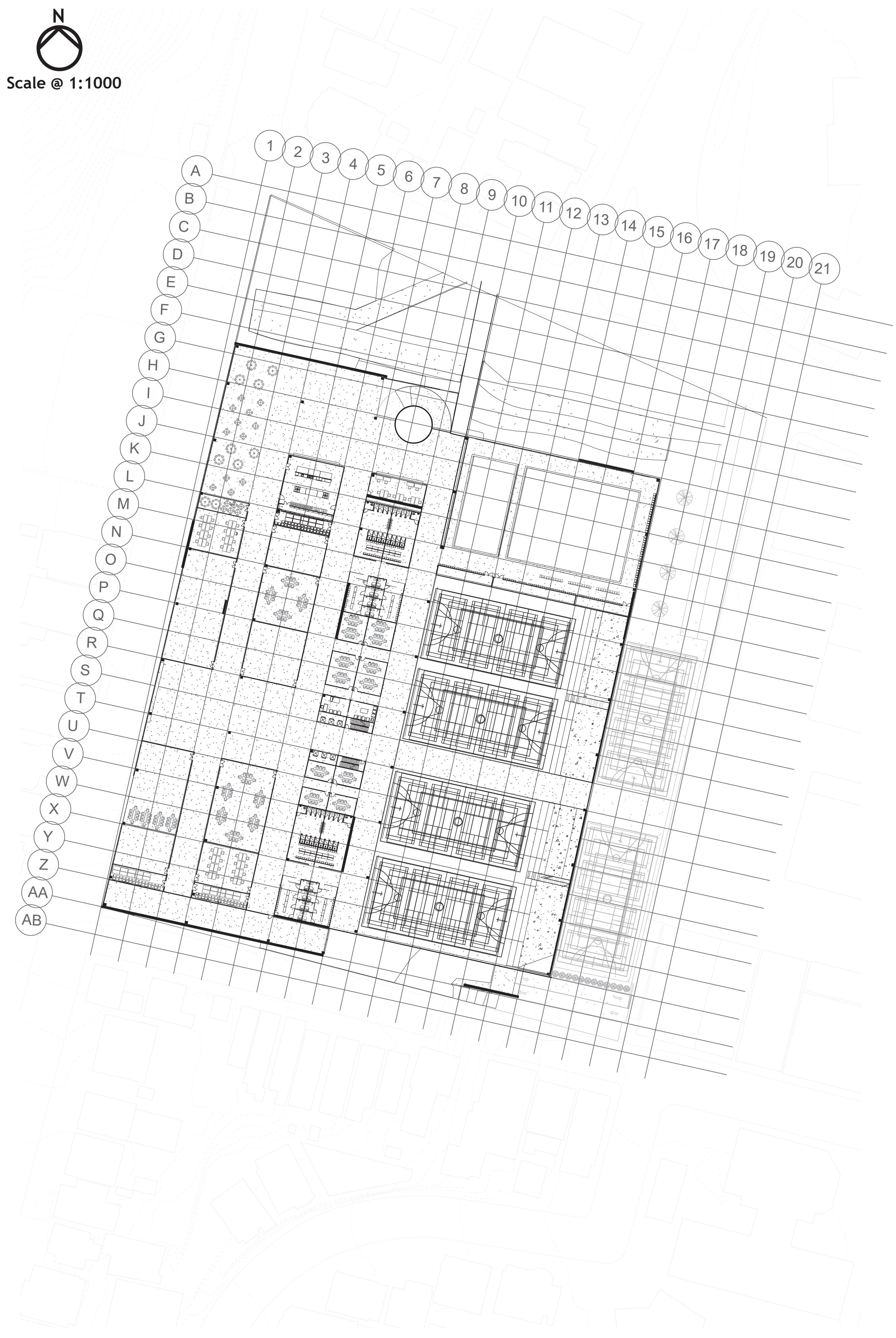


Figure 80 - Ground Floor Plan with Planning Grid

Planning Grid and Plan Development

Following on from programme planning, each element was developed based on a 6m x 6m grid. This can be seen within figure 80 where the floor plan with spacial elements have been placed in relation to this plan to allow for ease of use. Due to the large scale of the site this proved an appropriate spacing size for structural elements to then be developed around, to which would not hinder the layout of spaces.

Based on this grid, seismic and sustainable elements have been further developed, changing the composition of each space to appropriately fit with both primary and secondary programmes. The plan was then taken and further developed in relation to elements in elevation to ensure cohesion of the overall developed design produced.

Figure 81 - Ground Floor Plan Highlighting Seismic Structure

SEISMIC REQUIREMENTS AND FINAL APPLICATION

Due to the secondary programme of the building, design has been developed around seismic forces to ensure structure is sufficient. Designing for this also ensures that post disaster the design is able to perform as intended and provide a place of refuge. Following on from initial research into past disasters it was highlighted that structure is important in not only the safety of the building itself, but highlighting it also provides clarity for users that the building is going to keep them safe. Structural systems have been highlighted in figure 80 to the left in red.

Based on structural calculations made on RESIST, the following seismic elements have been added into the design. Located in both the x and y direction, reinforced concrete shear walls at a length of 12m and thickness of 500mm have been placed. These are highlighted in red and are spaced throughout the building where the torsion of the building is minimised to reduce the overall stress, through the centre of rotation and the centre of mass being close in proximity. These shear walls are highlighted throughout the design and are exposed to provide subconscious reassurance to occupants on the structural stability of the design.

Secondary structure for gravitational loading and forces are spaced between steel columns

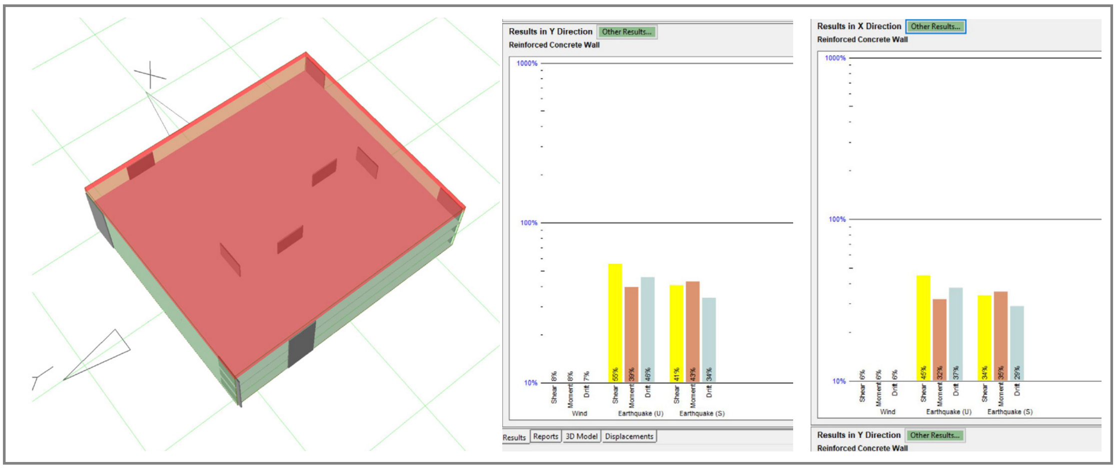


Figure 82 - Resist Model and Results

of 600mm thickness on a 12m x 12m grid, with primary and secondary steel beams spanning between at thicknesses of 700mm x 350mm and 500mm x 270mm respectively. Beams have been hidden within the ceiling structure between levels, however columns are left exposed. Supporting the roofing are howe trusses at a depth of 3mm and are also left exposed in order to provide a transparent structural system for the users to clearly see when using the building.

The site is also to be seismically isolated underneath the building and water reservoir to provide further relief in a disaster, ensuring the building is designed to withstand a significant earthquake as outlined in an AF8 scenario this thesis is based around.

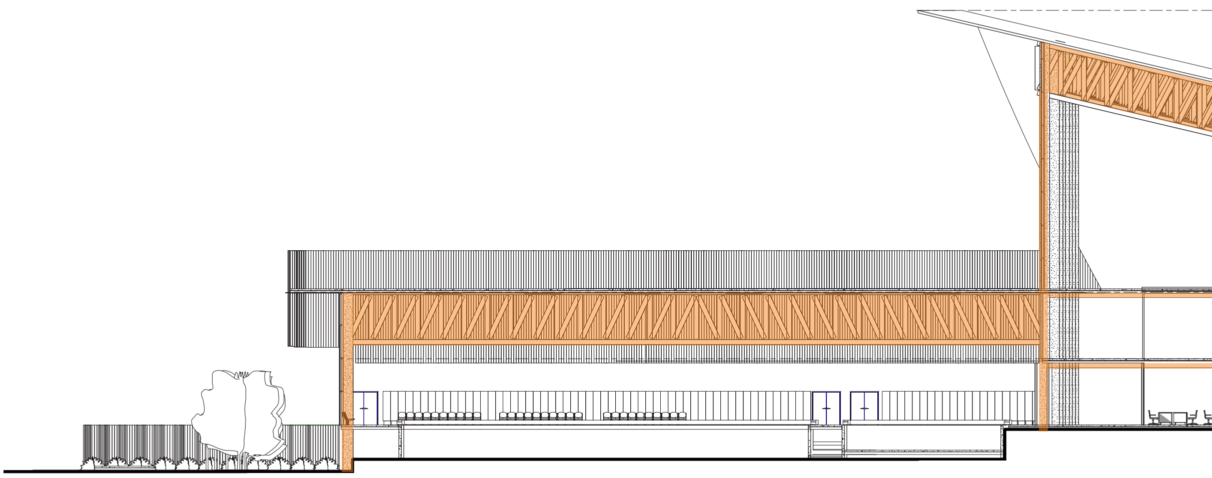
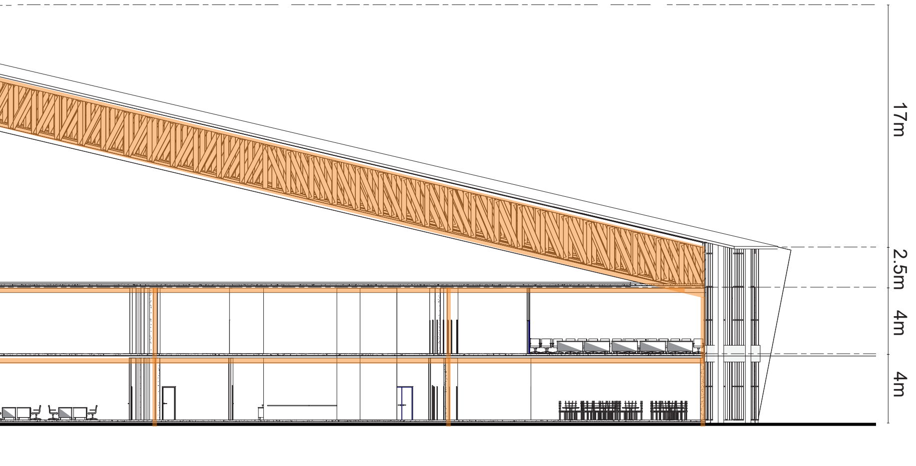


Figure 83 - Section A-A' Highlighting Structure

Scale @ 1:500


17m
2.5m
4m
4m

SUSTAINABLE DISASTER REQUIREMENTS

Highlighted within earlier research, following a rupture of the Hikurangi subduction zone it is predicted that multiple critical resources will be either inaccessible or limited for a significant amount of time. As a result it is important that the final design works with sustainable elements in order to provide significant relief to those that it is supporting. The design itself is targeted to comfortably support roughly 1% of the Wellington City population, which equates to a total of 2,146 people. Taking the targeted number of people to support and using this as a benchmark the following results have been estimated in order to determine sizing and application of elements into the final design. These calculations are as follows and determine the minimum requirements to be developed and designed alongside.

Water

Based on the total Wellington City population and recommendations from the Wellington Region Emergency management office, the total amount of water to be stored on site will be calculated based on one percent of the total Wellington City population and the recommend amount of water per person, per day.

The total population of Wellington predicted for 2020 is 214,537 (IDNZ, 2019), therefore one percent of that is 2,146 people. Taking recommendations from Civil Defence and WREMO, it is recommended that each individual will need their own “supply of emergency water for the first 7 days” each the recommended amount being “20 litres per person per day’ and the minimum being “3 litres per person per day” (WREMO, 2020). With the predicted time line for water being restored in the city at eight days as outlined in the Wellington scenario, preparing for a worst case situation, the estimation for the building has been placed at 14 days, or two weeks.

Minimum amount of water to be stored at any given time on site, based on 3 litres a day per person:

14 days x (2,146 people x 3 litres)

14 days x 6,438 litres

= 90,132 litres minimum

= 90.132m^3 required storage

Recommended amount of water to be stored on site based on a worst case scenario, and 20 litres a day per person:

14 days x (2,146 people x 20 litres)

14 days x 42,920 litres

= 600,880 litres recommend

= 600.88 m^3 required storage

Electricity

Total area of building to be powered = Roughly 10,168m2

Available roof space = 7,822m^2

Panel Size = 1.63 m^2

Total Panel capacity = 4835 (1,450,500W max)

Total average sunlight throughout the year = 557W/h (NIWA, 2019).

Average electricity production of one solar panel = 300W (New Zealand Solar Power Ltd, N.D)

1000 Panels x 300W = 300 Kw/h

Food

2.5kg food per day, per person:

2,146 people x 2.5kg

=5,365kg food needed in first 24 hours

Fuel

9kg bottle per person for cooking:

2,146 people x 9kg

=19,314kg gas per person per day.

Disaster Requirement Overview

The final requirements will meet disaster needs in the initial 72 hours:

- Water storage of at least 90.132m^3 .
- Hourly Electricity generation of 300Kw/h (1,000 Panels).
- 16,095kg of food storage space.
- 57,942kg of gas storage space.

Figure 84 - Water Storage and Treatment on Site

Water

Design has been developed in relation to the recommend amount of water to be stored on site based on a worst-case scenario. This is to a total storage of 600,880 litres, at an overall required storage size of 600.88m^3. Based on this a combination of water storage and treatment has been added to the site, with this also integrated into the design of the landscape, memorial and central circulation. These elements have been integrated together to provide transparency to users and further expose them to the capabilities of the developed design to provide critical resources post-disaster, reducing stress on providing for large numbers of displaced people in the critical period post-disaster.

Water storage has been placed on the northern end of the site, working with the downwards gradient in this direction. This utilises gravity to collect water, further reducing the need to use electricity to pump water against its natural flow. The combination of the water tower and reservoir and treatment systems integrated into the design, not only adds to the buildings overall ability to self-sustain but makes it a long-term sustainable option to the design where water use and conservation is a common issue.

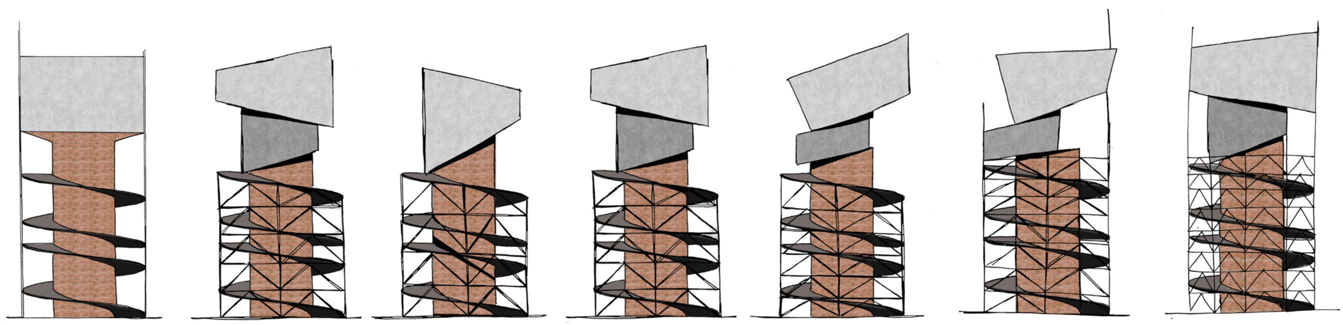


Figure 85 - Iterations of Water Tower and Circulation Integration

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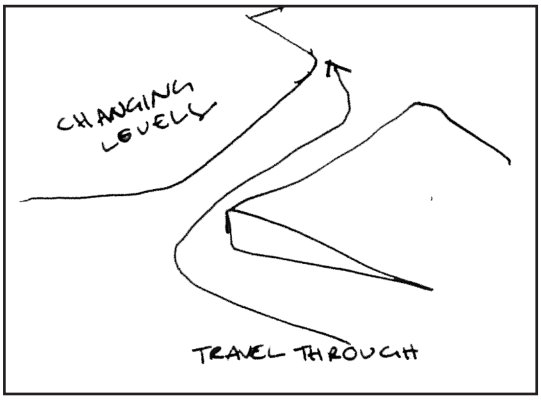

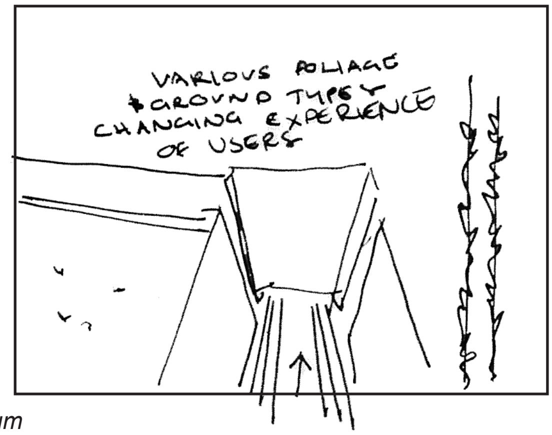

Figure 86 - Wenchuan Earthquake Memorial Museum

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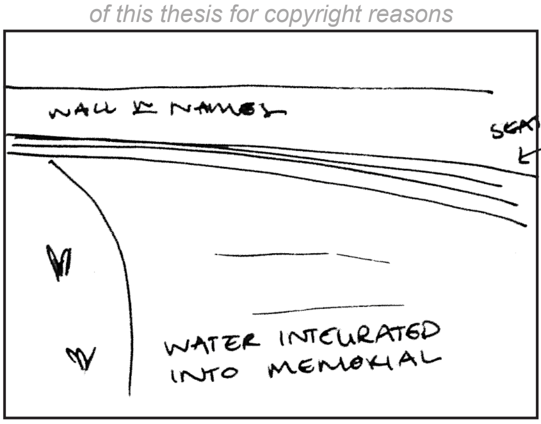

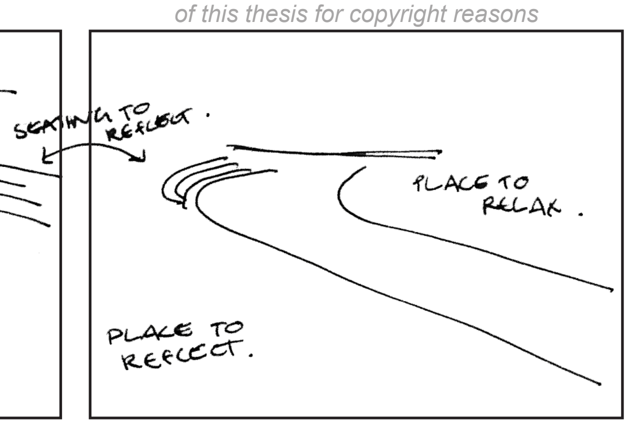

Figure 87 - Canterbury Earthquake National Memorial

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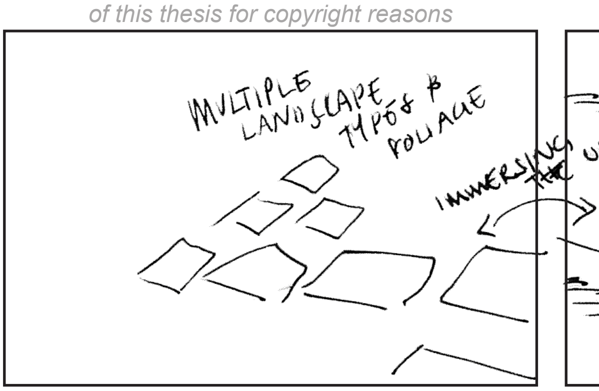


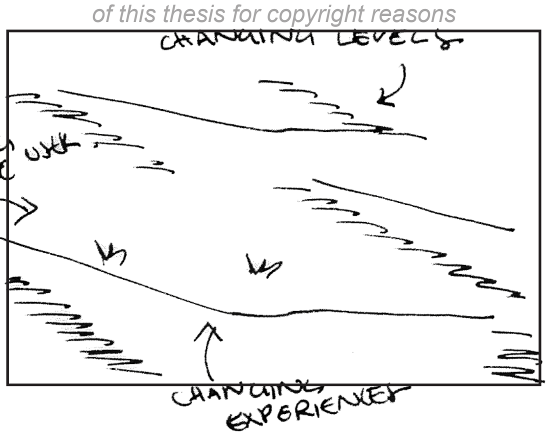
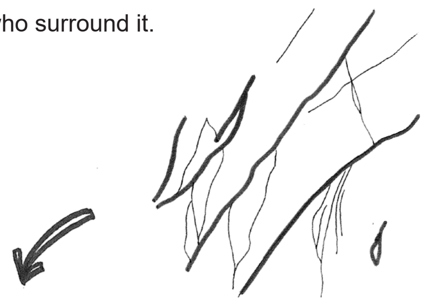


Figure 88 - Awaji Yumebutai Hyakudan-en Garden

Water + Memorial

In order to meet the third aim of the design, a memorial has been added into the final programme in order to further inform users and passers by of the intention of the building, and to reflect on those who have passed away in past earthquakes in New Zealand. As the building also needs a water reservoir for storage and treatment post event, this can be integrated into the landscape and memorial design for further exposure to primary and secondary uses of the final design.

Analysis of the Whenchuan Earthquake Memorial Museum, Canterbury Earthquake National Memorial and the Awaji Yumebutai Hyakudan-en Garden revealed techniques to integrate landscapes into successful earthquake memorials. Each reflect on significant earthquakes within the areas they are placed and work with various mediums to create an immersive environment for the user. Taking principles highlighted in each of these and working with the water reservoir and tower, a final landscape application was developed. The final design aiming to achieve an environment that expresses the disaster that earthquakes can cause and how the building has been designed in response to this in order to protect the people who surround it.



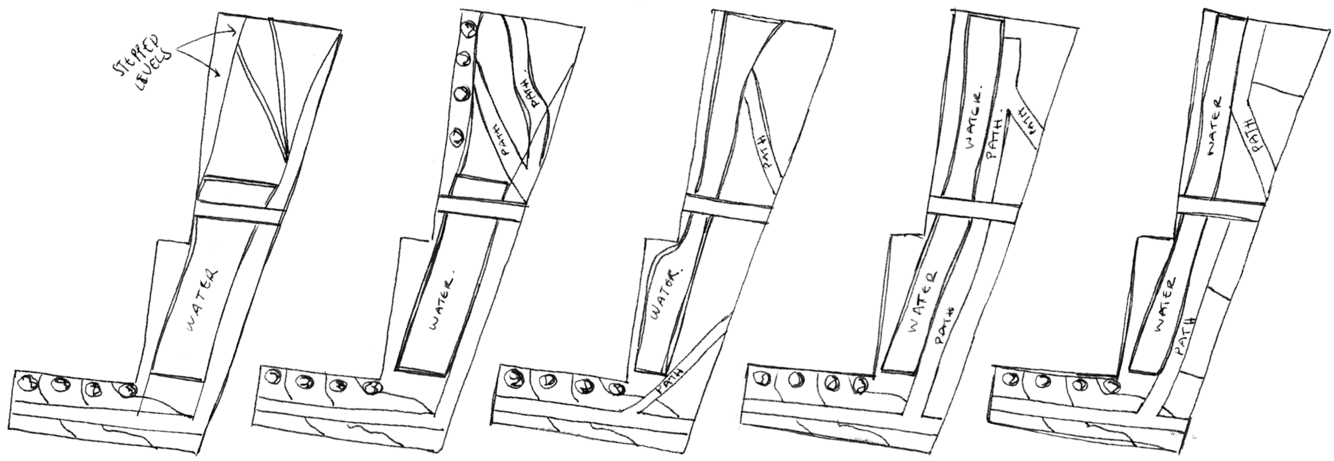


Figure 89 - Concept Sketches of Water + Memorial Integration

Figure 90 - Passive Design Techniques

Electricity + Passive Design Elements

Taking into consideration impacts to the grid following an AF8 scenario, electrical and passive design elements have been implemented to minimise the stress on the building and occupants. These elements have been done in a manner where the eastern, northern and southern sides of the design have been developed alongside the available sunlight to the site, given its unrestricted during these times. The only time of year where sunlight is restricted, is during winter on the western elevation of the building on the lower levels.

Where needed, double glazing is utilised on sides of the design where sunlight is undisturbed on site, with spaces such as the pool and courts utilising day lighting to provide the appropriate lighting levels, with electrical lighting used to back this up where necessary. Through utilising day lighting, this minimises the need for grid-based lighting further reducing the need to rely on the grid when it is not available post-disaster. With the calculated ability of the total roofing area to house solar panels, sufficient electricity can be produced to power the building at reduced but functioning capacity.

Cross ventilation has also been incorporated through the placement of passageways and opening elements of the design to reduce the need to heavily heat and ventilate the building. This in conjunction with maximising the use of the large central circulation shaft and the thermal mass of the water to retain heat and distribute it between levels, also reduces the need to rely on heating when electricity is needing to be conserved.

Through use of passive techniques throughout the design, the building is able to function post-disaster if the grid is to fail as outlined in reports on an AF8 scenario. This works to then provide critical help and infrastructure to community residents in the 24 -72 hour period post disaster when it is required, and not typically available.

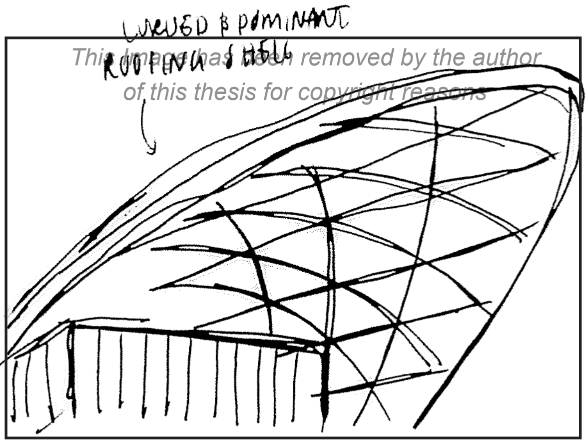


Figure 91 - Canary Wharf Crossrail Canopy

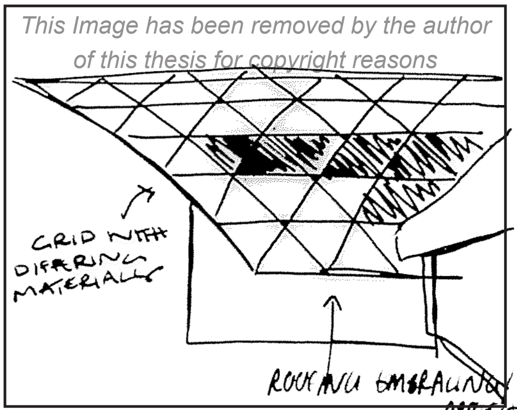


Figure 92 - Canary Wharf Crossrail Size Profile

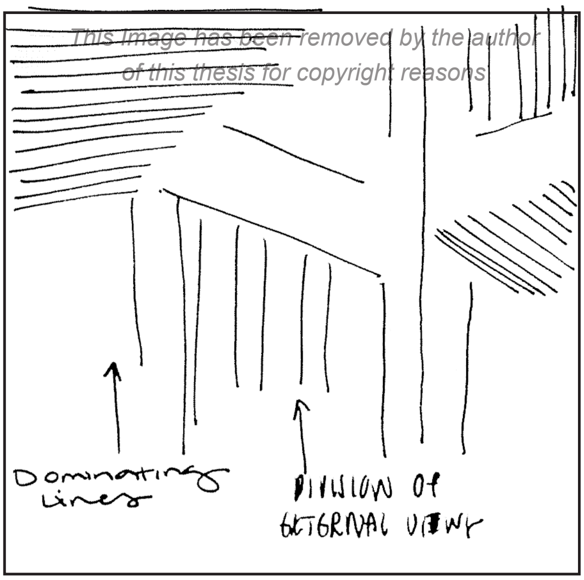


Figure 93 - Asakusa Building Interior

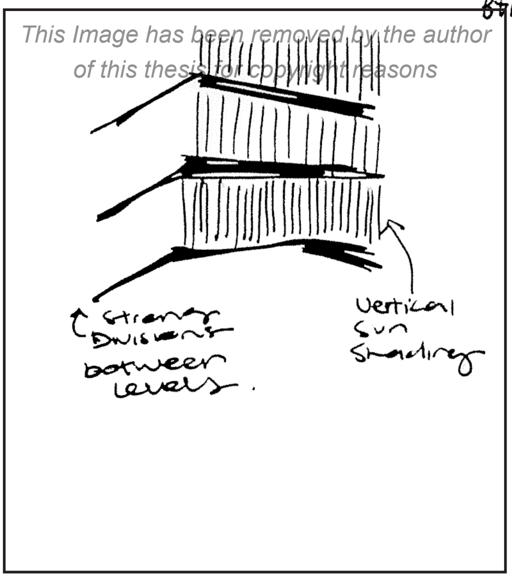


Figure 94 - Asakusa Building Exterior

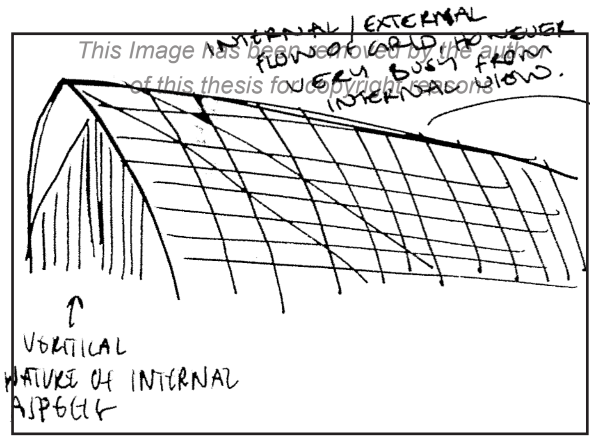


Figure 95 - Musashino Forest Sport Plaza Exterior

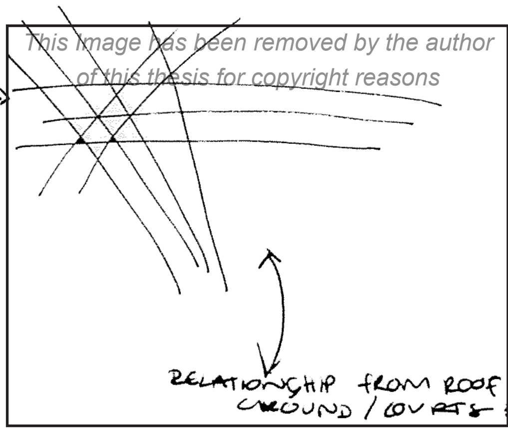


Figure 96 - Musashino Forest Sport Plaza Interior

DEVELOPMENT OF EXTERNAL COMPOSITION

Visual Precedents

Taking earlier research into the human condition and providing a memorable place in the community for people to associate, the exterior of the developed design focused on highlighting structure and sustainable elements, whilst also providing a memorable facade. This means that the users are able to clearly see the complete composition of the building, reassuring them of their safety within the designs confines, whilst also creating an architectural beacon within the suburb of Mount Cook. Visual precedents have been explored based on their use of grids and strong lines, in order to accentuate structure in a visually memorable way, whilst also providing sun shading on the northern and eastern facades. These precedents are the Canary Wharf Crossrail, Asakusa Culture and Tourism Centre and the Musashino Forest Sport Plaza, and were chosen based on their use of a visually dominating exterior alongside an open plan interior. Based on these, the exterior facade was then developed based on the use of strong structural elements as seen within the sketches below, and figure 98.

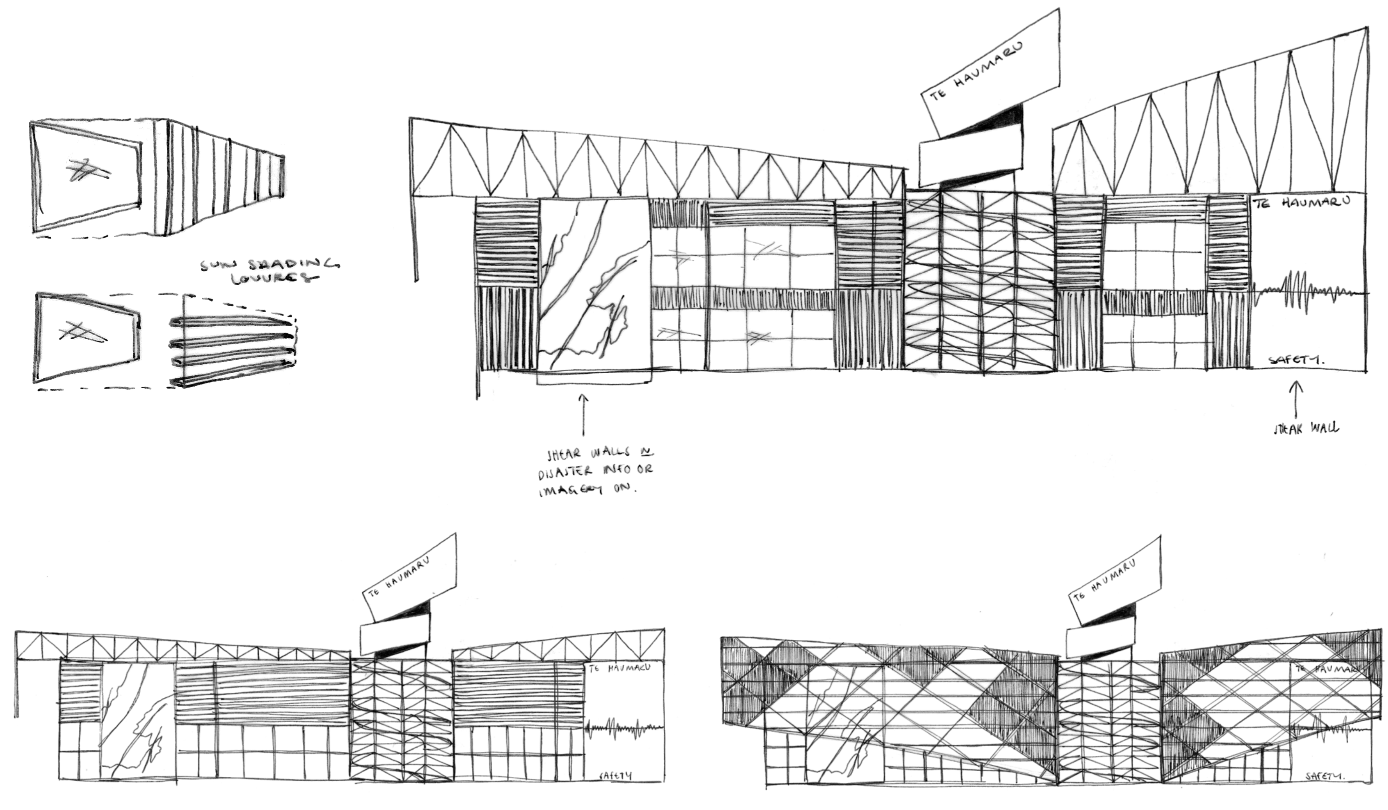
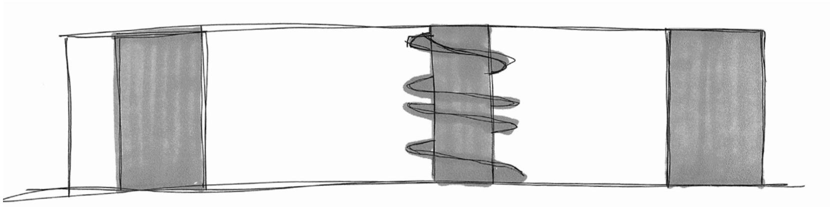
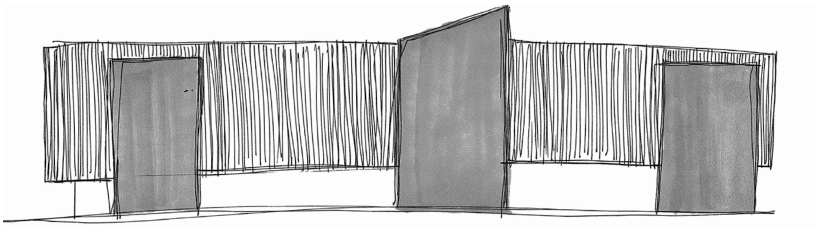


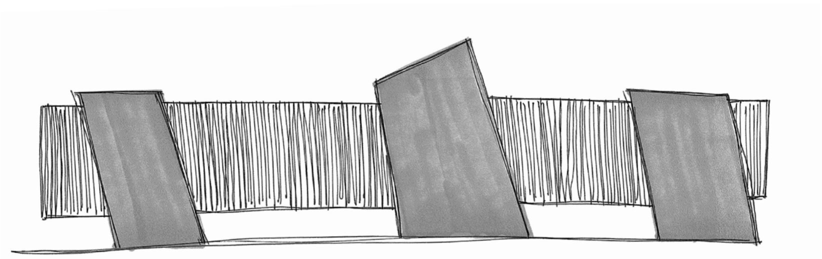
Figure 97 - Concept Sketches of Northern External Facade



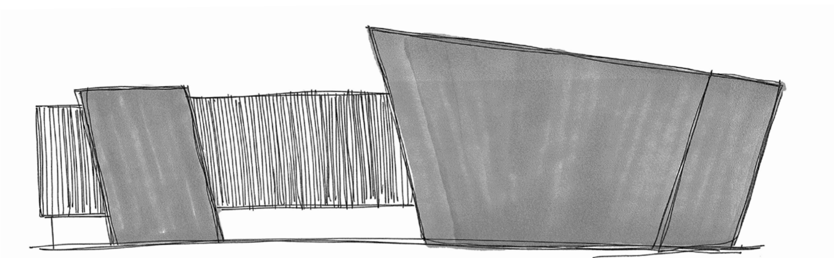
Blank Facade with Shear Walls and Water Tower/ Central Circulation



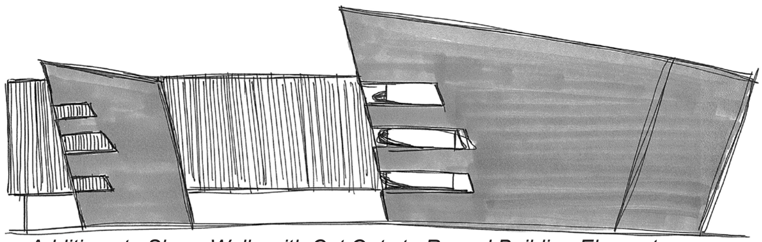
Shear Walls with Sun Shading



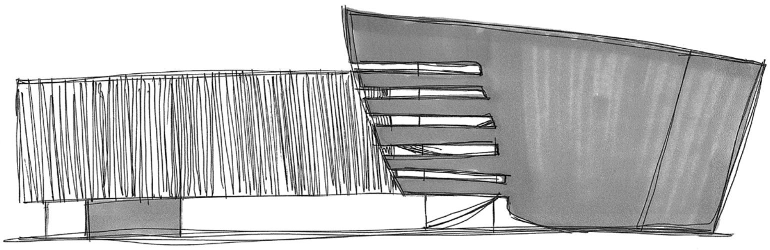
Visual Emphasis of Shear Wall Integration



Development of Shear Wall Dominance



Additions to Shear Walls with Cut Outs to Reveal Building Elements

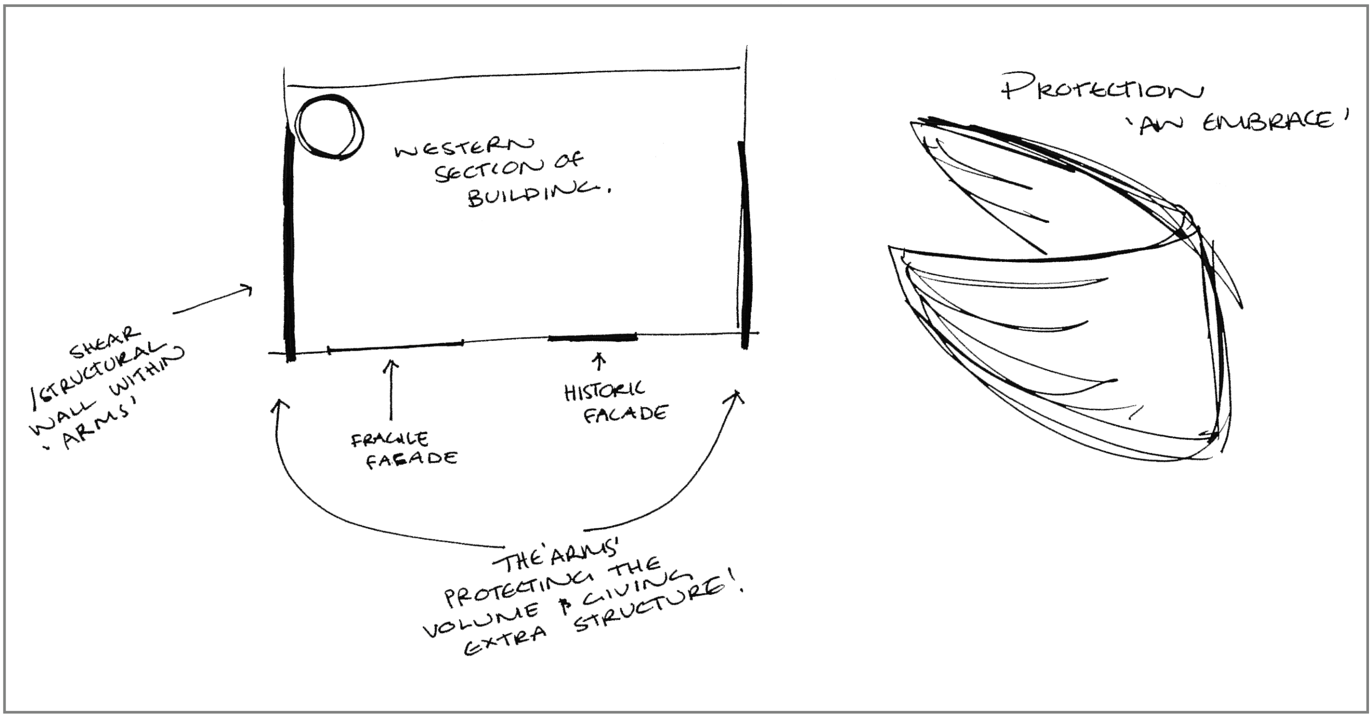


Emphasis of Western Shear Wall and Central Circulation

Figure 98 - Development Sketches of Northern External Facade Based on Shear Walls

Facade Development

Through highlighting structure, the buildings secondary programme of a disaster relief centre is able to be emphasised. It is this idea of working with the necessary shear walls included throughout the design that the following sketches were produced. Working with the shear walls, and embracing these to the complete building means that whilst giving visual emphasis on the strength and overall resistance of the building to earthquakes, it still holds an air of softness within the current contextual surroundings. It is from the development of this concept that the final northern, eastern and southern facades have been developed into the final architectural application. This also develops on earlier research into past disasters, where through the visual structure of the building, it provides subconscious reassurance to the user that they will be safe within its confines.



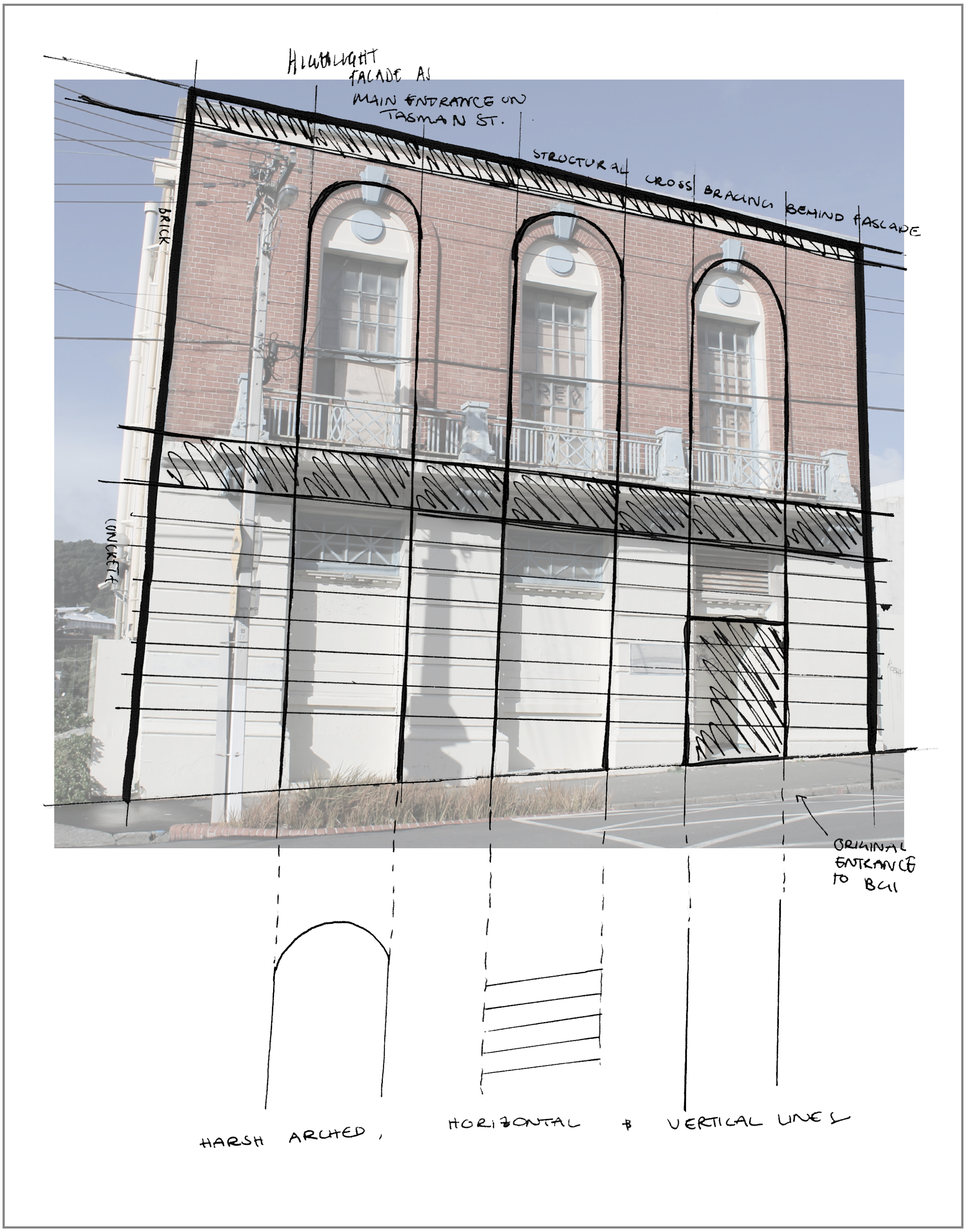


Figure 99 - Analysis of BGI Facade

Integration of Old and New

Integration of the existing BGI façade on the site has been done in a manner where it is highlighted against the new design behind it. Using lines, geometry and materiality the western façade has been developed to work with the original façade and entrance, to continue to be an access point on the Tasman street facade. This entrance also has been designed alongside direct circulation to key spaces within the plans, right through to an entrance/exit on the eastern façade to the external courts.

In order to retain structural stability, the BGI facing is structurally strengthened, with the remainder of the building removed to merge seamlessly with the developed design. This façade is also seismically separated to the rest of the building to reduce stress. Working with the building that resides on the site as opposed to removing it completely means that those within the community who used the building and facilities before they were closed in 2007 are able to reconnect with something familiar before being introduced to the new.

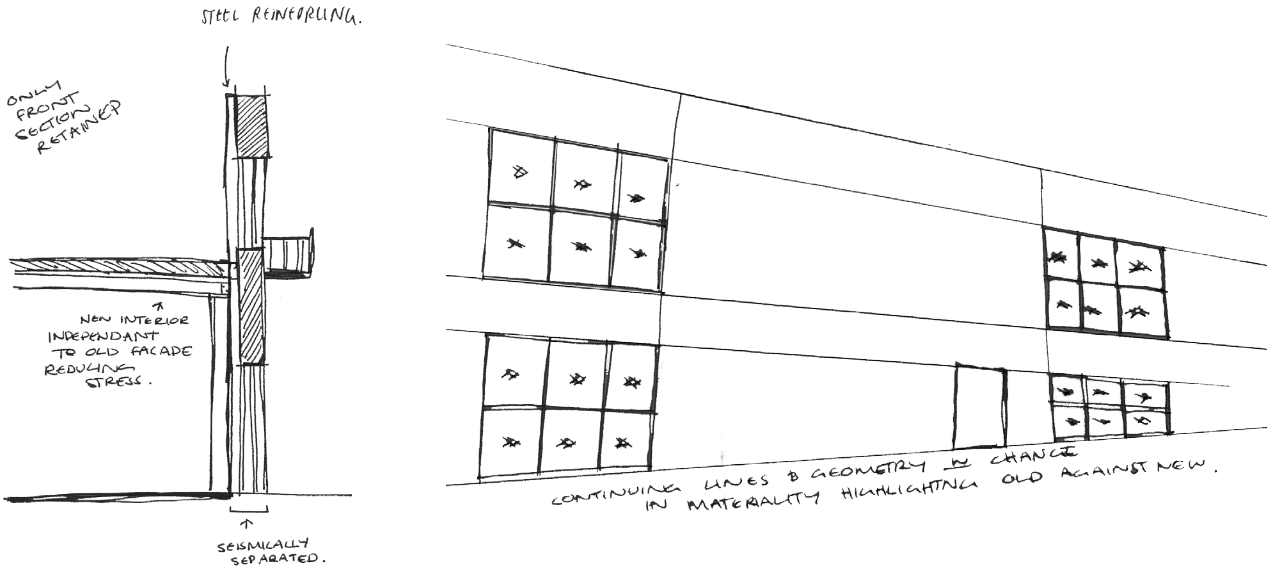


Figure 100 - Structural Analysis of BGI Facade

CHAPTER EIGHT:

DEVELOPED DESIGN

Te Haumaru
"Safety"

Developed Architectural Application Responding to Pre- Established Disaster Relief

The final architectural application is one that takes both the primary and secondary programmes and blends them in a manner that both programmes are highlighted and apparent. Based on earlier research and design experimentation, a primary programme of a recreation centre has been developed alongside the secondary function of the disaster relief centre to provide an architectural solution to the following research question:

How can architecture provide pre-established disaster relief, in order to meet the needs of Wellington's residents in the midst of the predicted damaging earthquake and other imminent natural disasters?

Te Haumaru directly translates into 'safety' and through this and other architectural applications designed to target the human condition and natural inclinations of a community, messaging in relation to a place providing support for them in the critical time following a disaster is communicated. The design emphasises it secondary function through emphasis on seismic and gravitational structure, alongside spaces designed to easily shift function. Te Haumaru provides a place pre-disaster for people to connect with and provides a place of safety and refuge post-disaster to support its community.

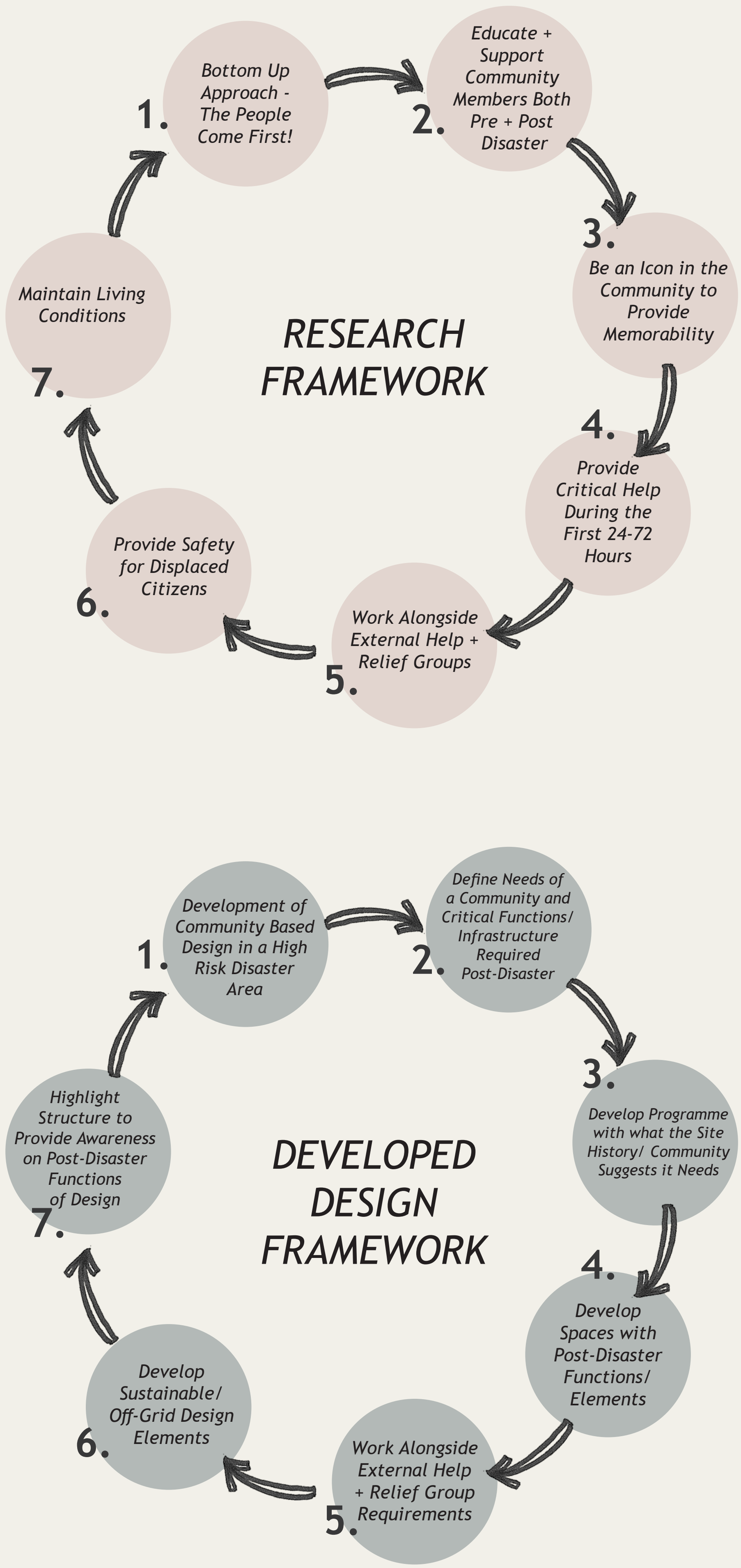


Figure 101 - Design Framework to Developed Design Framework

DEVELOPED FRAMEWORKS

Research into current post-disaster responses both in New Zealand and also past disasters internationally revealed that there is a gap in post-disaster relief for architecture to provide a form of pre-established disaster relief. A framework was developed following the initial research to ensure design was developed to respond to key factors that are currently missing within disaster responses in New Zealand. Through extensive research into Wellington, the predicted impacts on the city and the vulnerability of its community, design has been developed in relation to site specific factors that produce a framework for design allowing pre-established architecture to be placed in areas that are already targeted as vulnerable to disasters. Design experimentation was carried out alongside research findings to come to a final framework that can be applied to designs in areas of a city where the people are identified as vulnerable to severe impacts to daily life following a disaster. The framework developed is as follows and can be seen within figure 101.

1. *Development of a community based design in a high risk area*
2. *Define needs of a community and critical functions/ infrastructure required post-disaster*
3. *Develop programme with what the site history/ community suggests it needs*
4. *Develop spaces with post disaster functions/ elements*
5. *Work alongside external help and relief group requirements*
6. *Develop sustainable/ off grid design elements*
7. *Highlight structure to provide awareness on post disaster functions of design*

Following this process, the final design has been developed to address problems highlighted in regards to disaster relief and provides a way of approaching new builds to be developed to incorporate disaster relief into the approach. Through designing to provide a secondary programme that supports a community both pre and post disaster, relief can be made available in the critical 24 to 72 hour period. The developed design is a potential approach to how a recreation centre, based in Mount Cook, Wellington can be designed to support its residents following a AF8 earthquake scenario.

BASEMENT + LANDSCAPE

1. CARPARK
2. MEMORIAL
3. WATER STORAGE + TREATMENT
4. MIXED USE OUTDOOR COURTS
5. STORAGE

GROUND FLOOR

6. ENTRANCE
7. MAIN CIRCULATION
8. RECEPTION
9. CRUSH SPACE
10. PUBLIC INFORMATION BOARD
11. BUILDING CORE
12. SWIMMING POOL
13. MIXED USE INDOOR COURTS
14. COOKING FACILITIES
15. CAFE + KITCHEN
16. MIXED USE RECREATION ROOMS
17. MEETING / SEMINAR ROOMS
18. NURSES OFFICE
19. TOILETS / CHANGING ROOMS - MALE
20. TOILETS / CHANGING ROOMS - FEMALE
21. DISABLED TOILETS / CHANGING ROOMS - MALE
22. DISABLED TOILETS / CHANGING ROOMS - FEMALE
23. STORAGE
24. MEETING ROOMS - SMALL
25. MEETING ROOMS - LARGE

FIRST FLOOR

26. MAIN CIRCULATION
27. BUILDING CORE
28. COMMUNICATIONS ROOM
29. MIXED USE RECREATION ROOMS
30. MEETING / SEMINAR ROOMS
31. TOILETS / CHANGING ROOMS - MALE
32. TOILETS / CHANGING ROOMS - FEMALE
33. DISABLED TOILETS / CHANGING ROOMS - MALE
34. DISABLED TOILETS / CHANGING ROOMS - FEMALE
35. STORAGE
36. MEETING ROOMS - SMALL
37. MEETING ROOMS - LARGE

SECOND FLOOR

36. MAIN CIRCULATION
37. WATER STORAGE
38. COMMUNITY GARDEN
39. ELECTRICITY GENERATION
40. BUILDING SERVICE ACCESS

PRE

Figure 102 - Floor Plan Key (Pre)

POST

BASEMENT + LANDSCAPE

1. RELIEF VEHICLE STORAGE
2. MEMORIAL
3. COLLECTION STATION
4. RELIEF SUPPORT BASE
5. STORAGE

GROUND FLOOR

6. ENTRANCE
7. MAIN CIRCULATION
8. RECEPTION
9. DISTRIBUTION AREA
10. PUBLIC INFORMATION BOARD
11. BUILDING CORE
12. EMERGENCY WATER SUPPLY
13. INTERNAL SLEEPING AREA
14. COOKING FACILITIES
15. CAFE + KITCHEN
16. MIXED USE RECREATION ROOMS
17. MEETING / COMMUNITY ROOMS
18. NURSES OFFICE
19. TOILETS / CHANGING ROOMS - MALE
20. TOILETS / CHANGING ROOMS - FEMALE
21. DISABLED TOILETS / CHANGING ROOMS - MALE
22. DISABLED TOILETS / CHANGING ROOMS - FEMALE
23. STORAGE
24. MEETING ROOMS - SMALL
25. MEETING ROOMS - LARGE

FIRST FLOOR

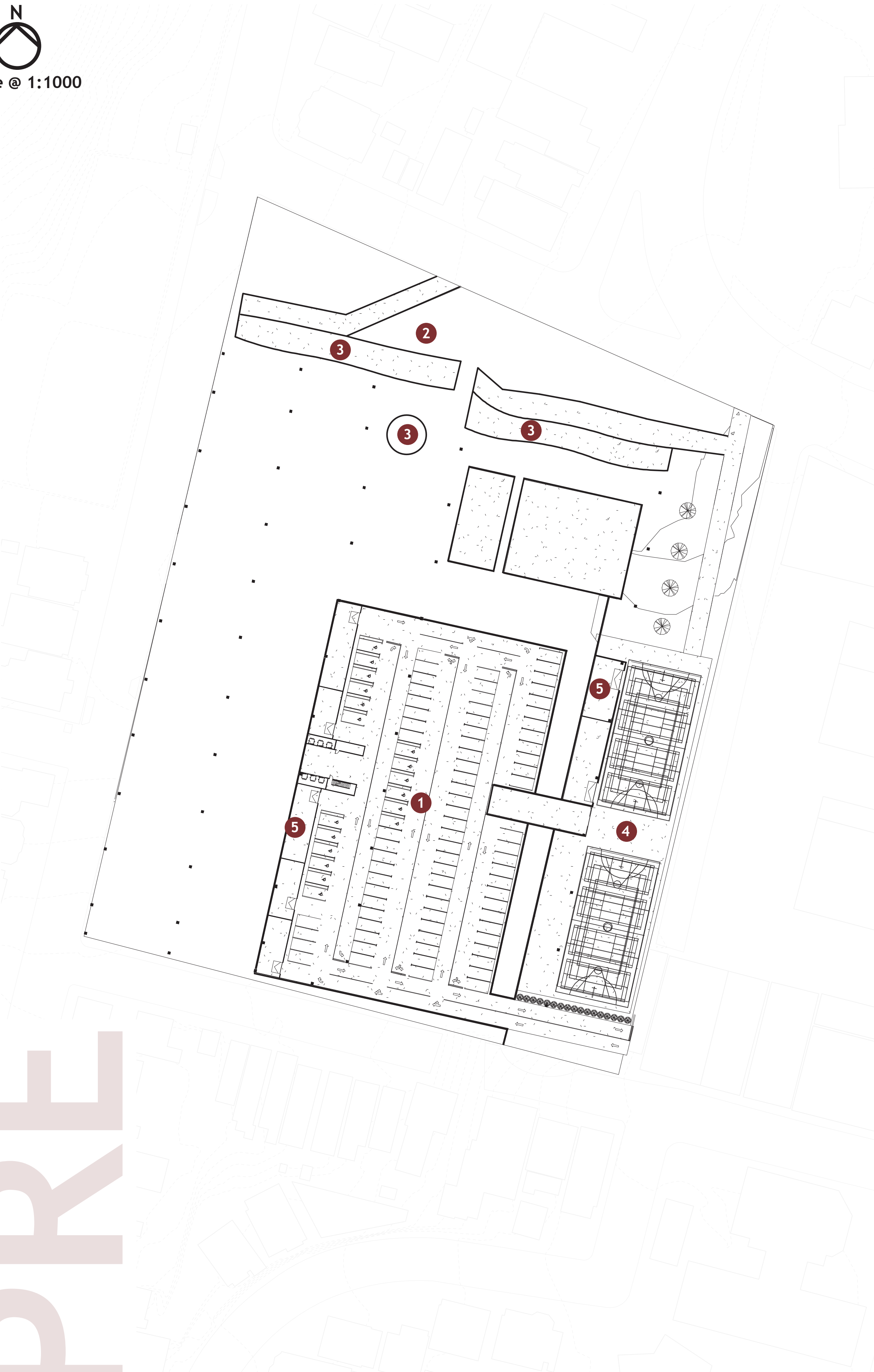
26. MAIN CIRCULATION
27. BUILDING CORE
28. COMMUNICATIONS ROOM
29. RELIEF GROUP PERSONAL ROOMS
30. MEETING / SEMINAR ROOMS
31. TOILETS / CHANGING ROOMS - MALE
32. TOILETS / CHANGING ROOMS - FEMALE
33. DISABLED TOILETS / CHANGING ROOMS - MALE
34. DISABLED TOILETS / CHANGING ROOMS - FEMALE
35. STORAGE
36. MEETING ROOMS - SMALL
37. MEETING ROOMS - LARGE

SECOND FLOOR

36. MAIN CIRCULATION
37. WATER STORAGE
38. COMMUNITY GARDEN
39. ELECTRICITY GENERATION
40. BUILDING SERVICE ACCESS

Figure 103 - Floor Plan Key (Post)

N
Scale @ 1:1000

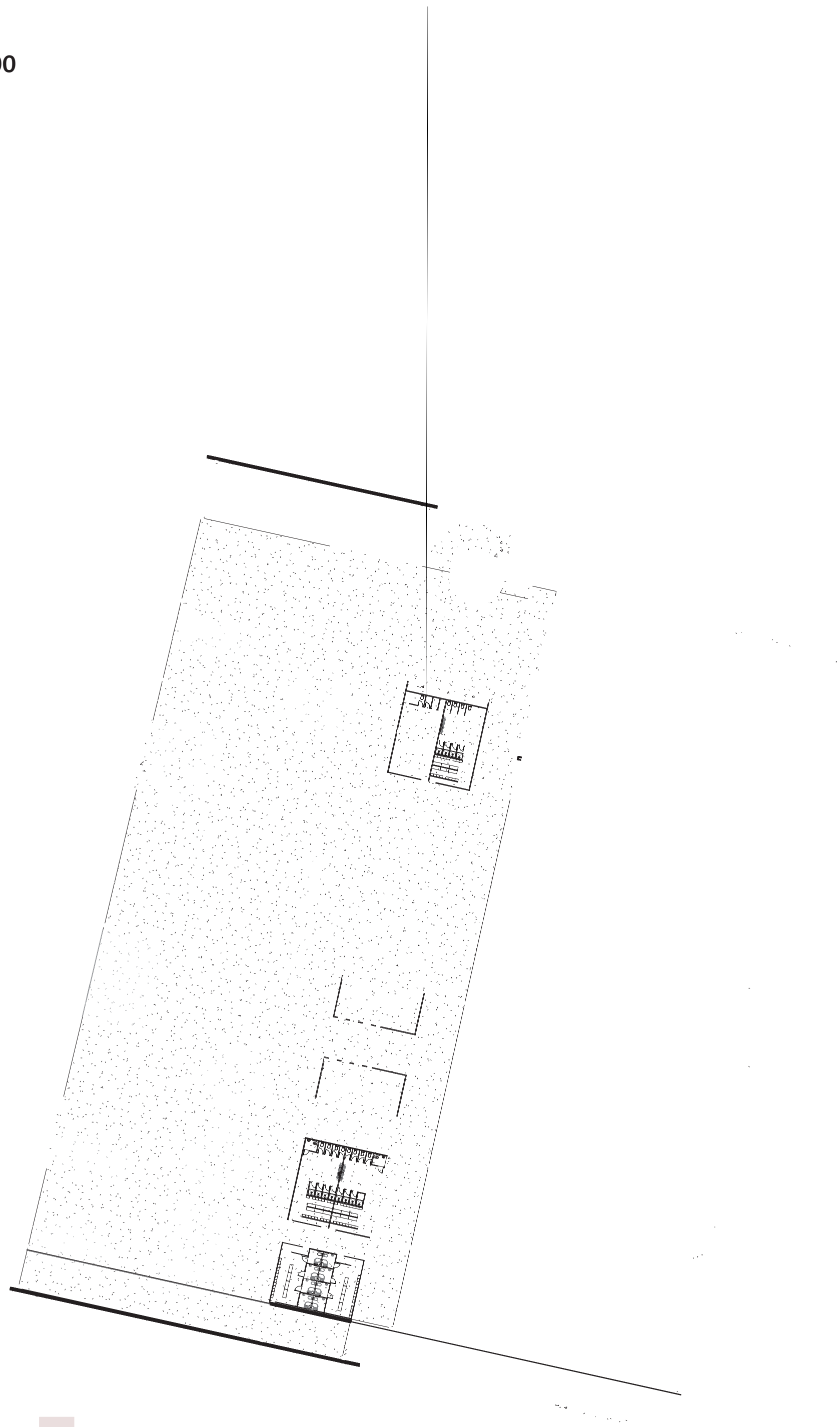


PRE

Figure 104 - Basement Floor Plan (Pre)

Figure 105 - Ground Floor Plan (Pre)

Scale @ 1:1000



PRE

Figure 106 - First Floor Plan (Pre)

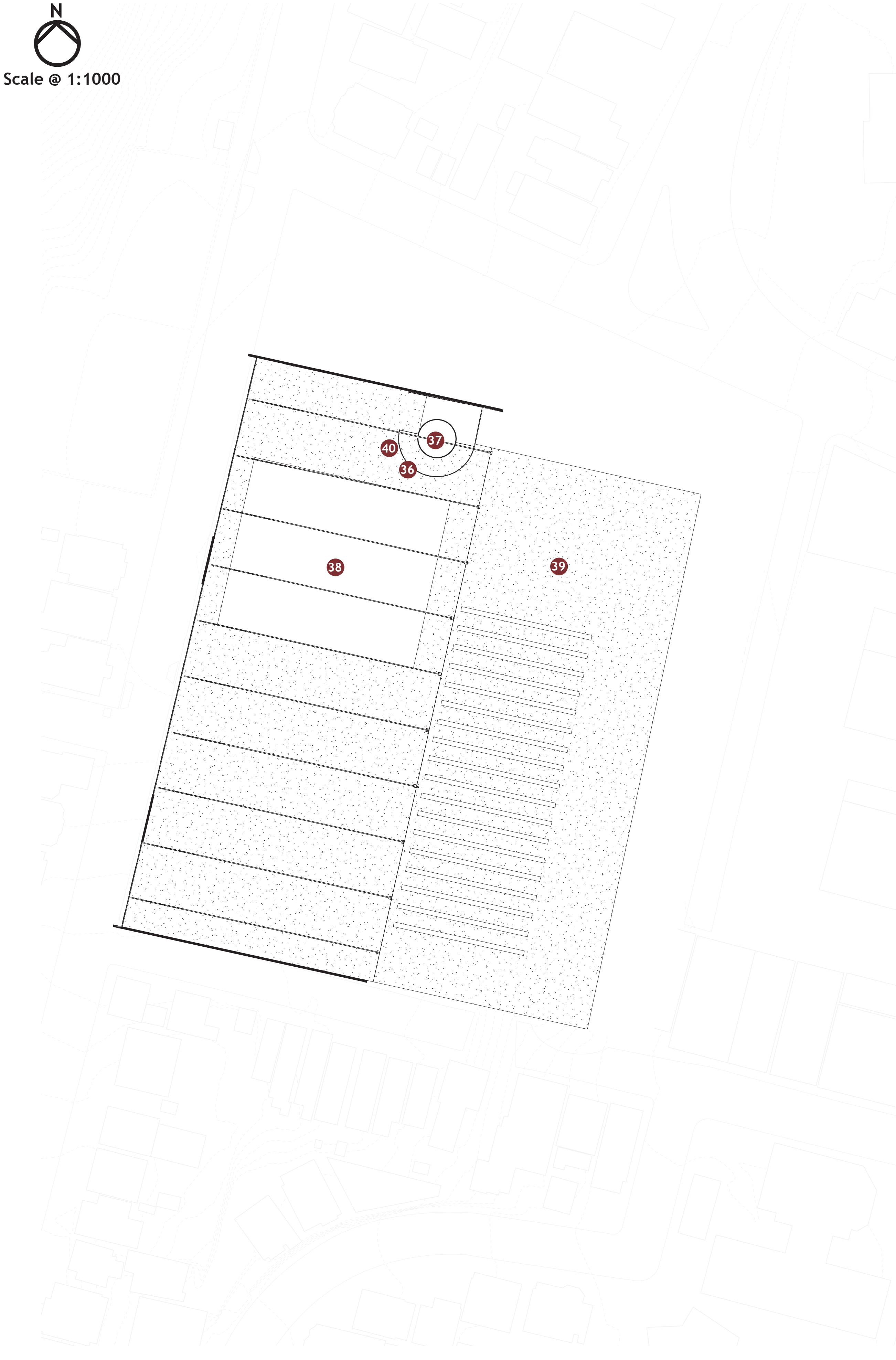


Figure 107 - Second Floor Plan (Pre)

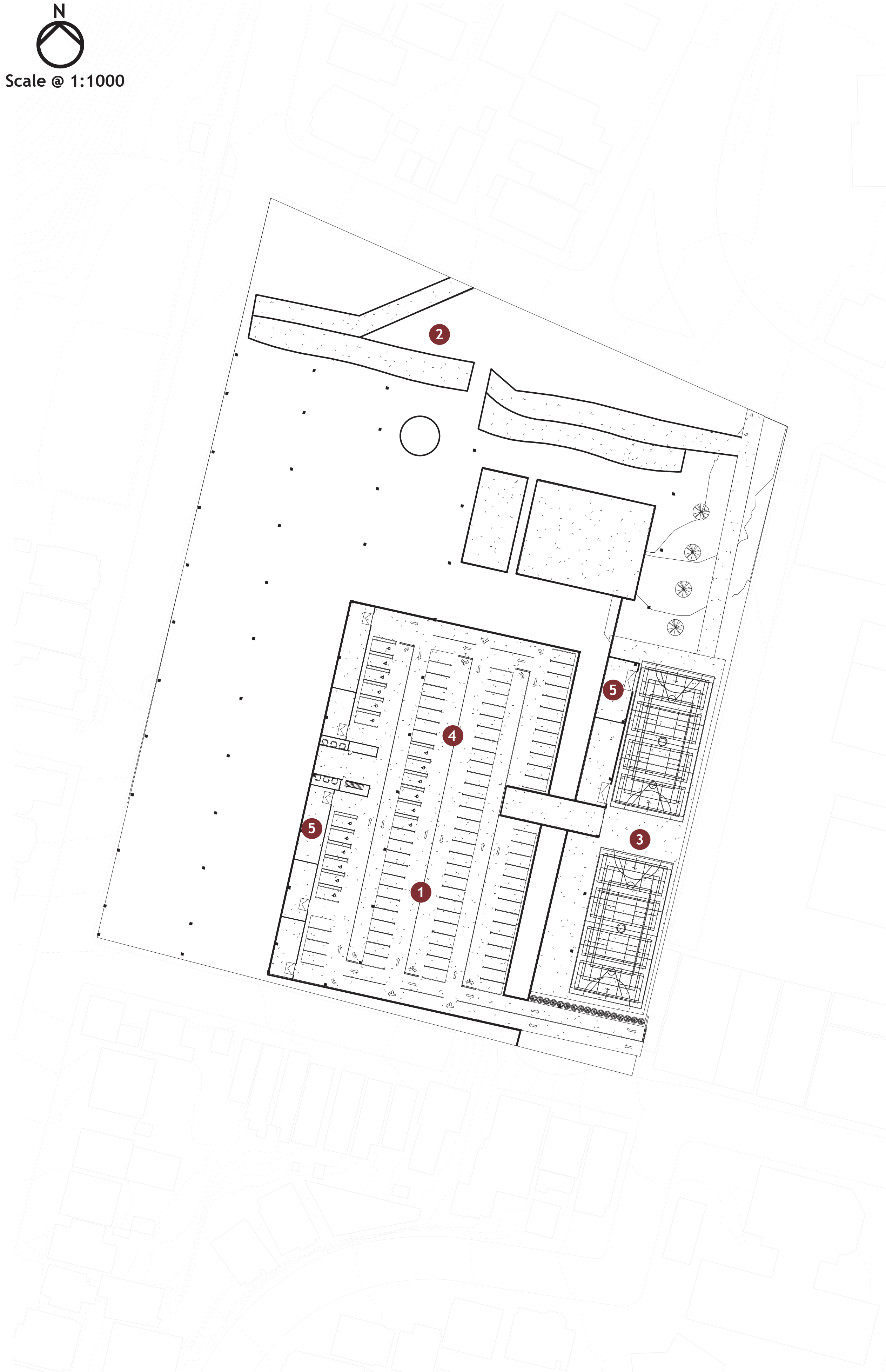


Figure 108 - Basement Floor Plan (Post)

Figure 109 - Ground Floor Plan (Post)

Scale @ 1:1000

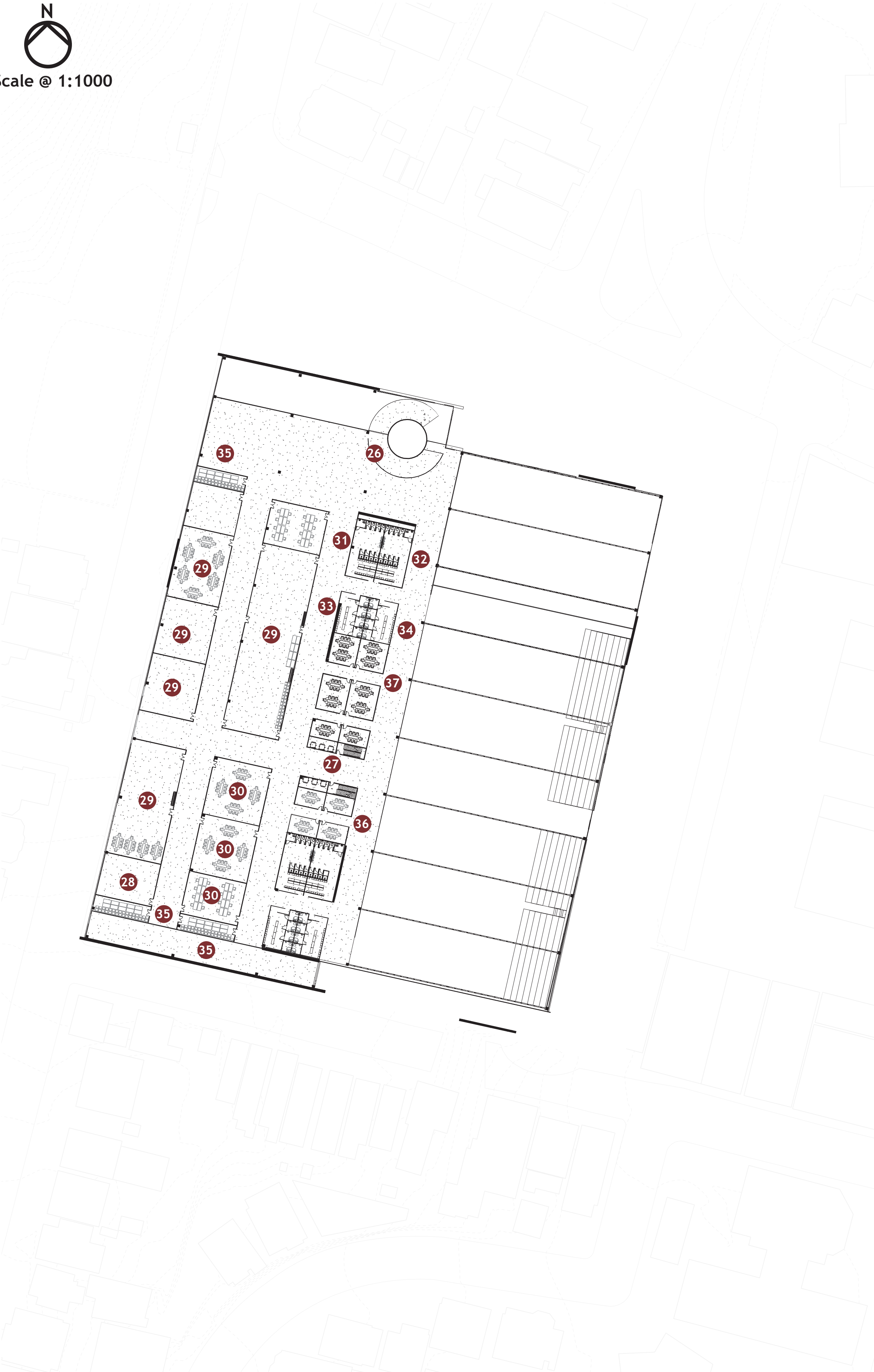


Figure 110 - First Floor Plan (Post)

POST

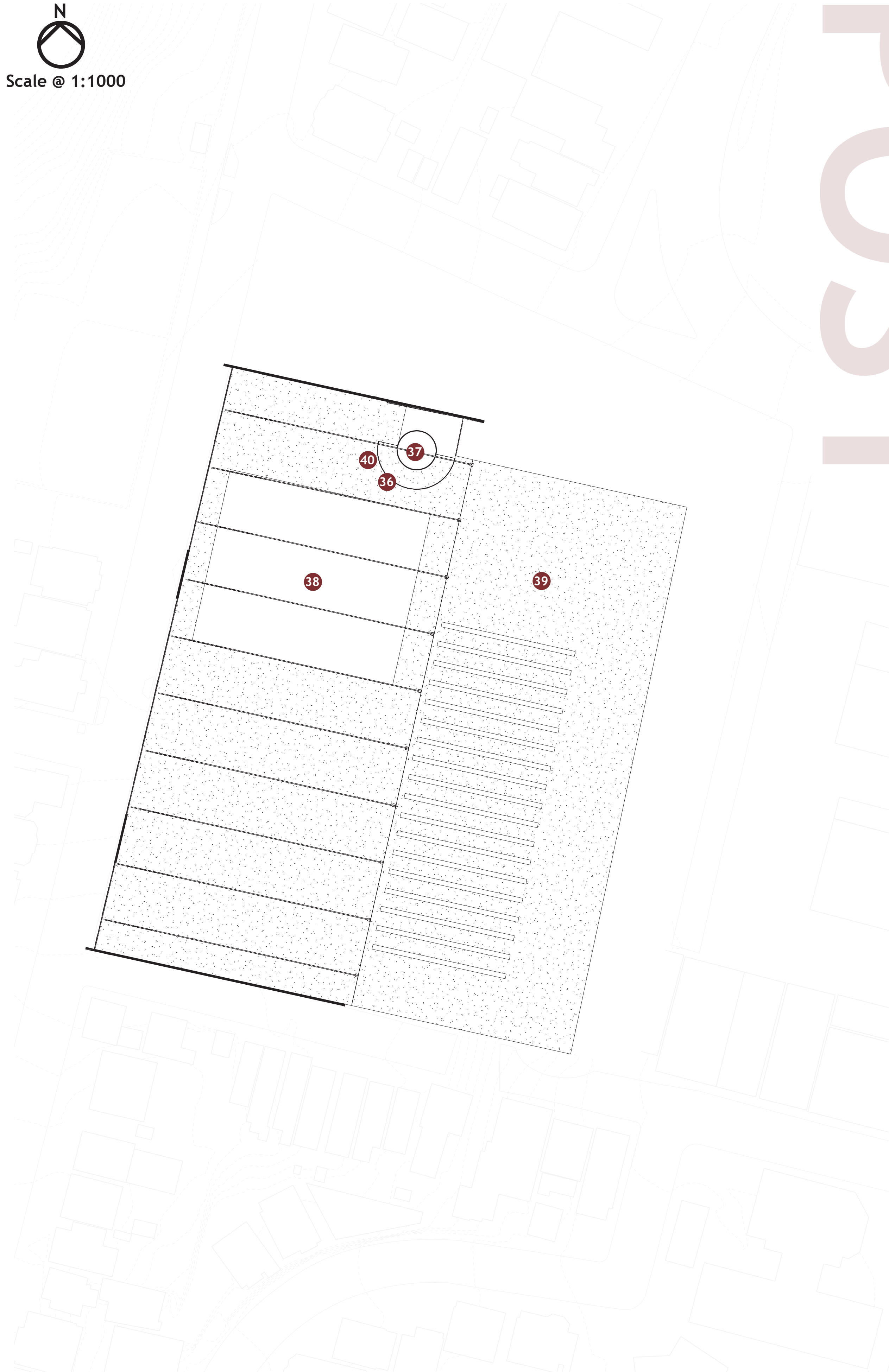
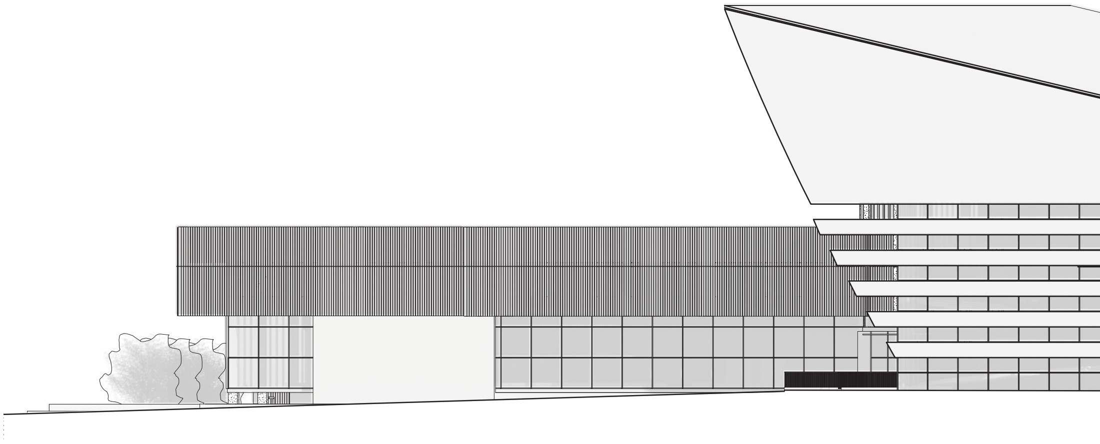


Figure 111 - Second Floor Plan (Post)

Scale @ 1:1000

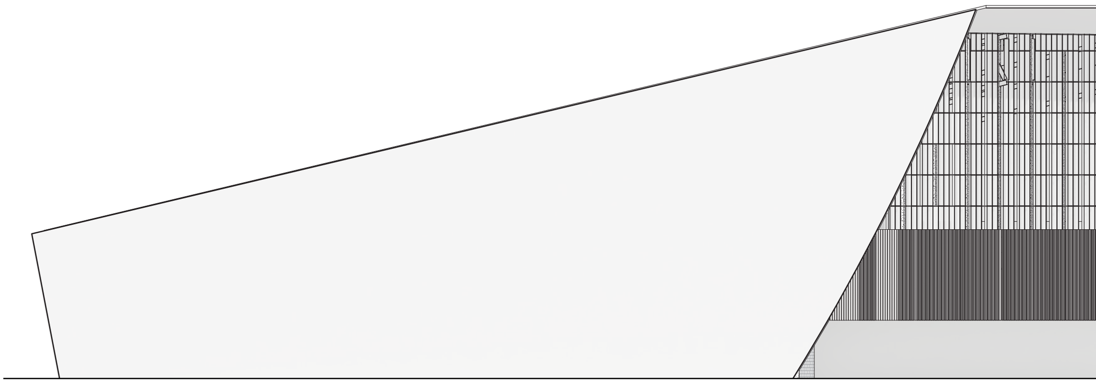
Figure 112 - Final Site Plan


SUSSEX STREET
BASIN RESERVE
RUGBY STREET
107m
39m
8m
113m
BELFAST STREET
125m
ADELAIDE ROAD
REET



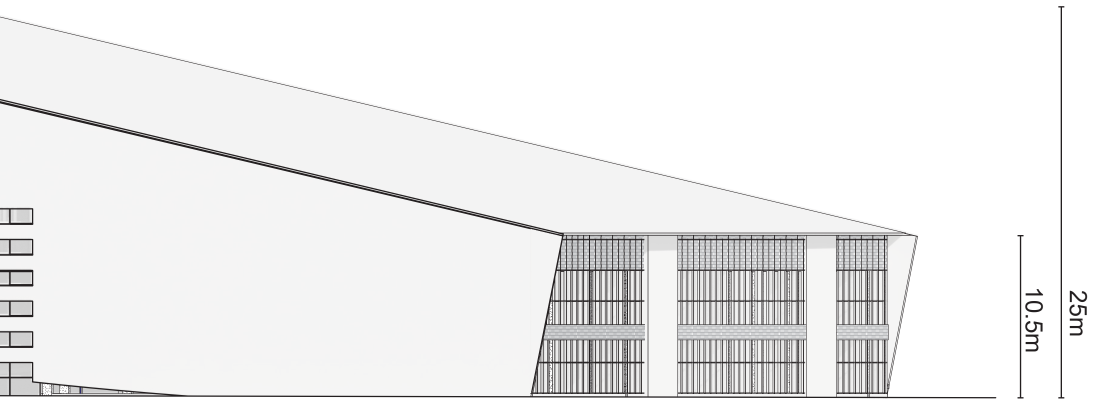
Scale @ 1:500

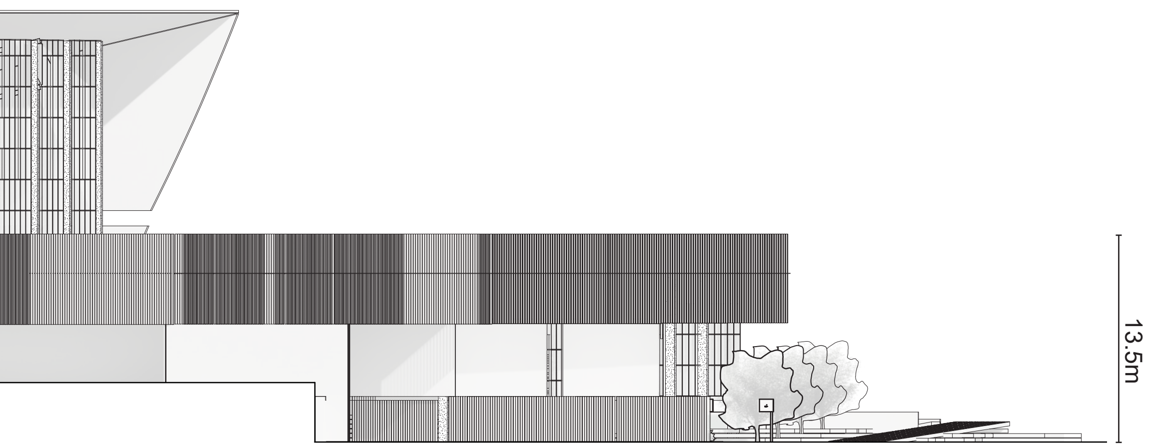
Figure 113 - Northern Facade

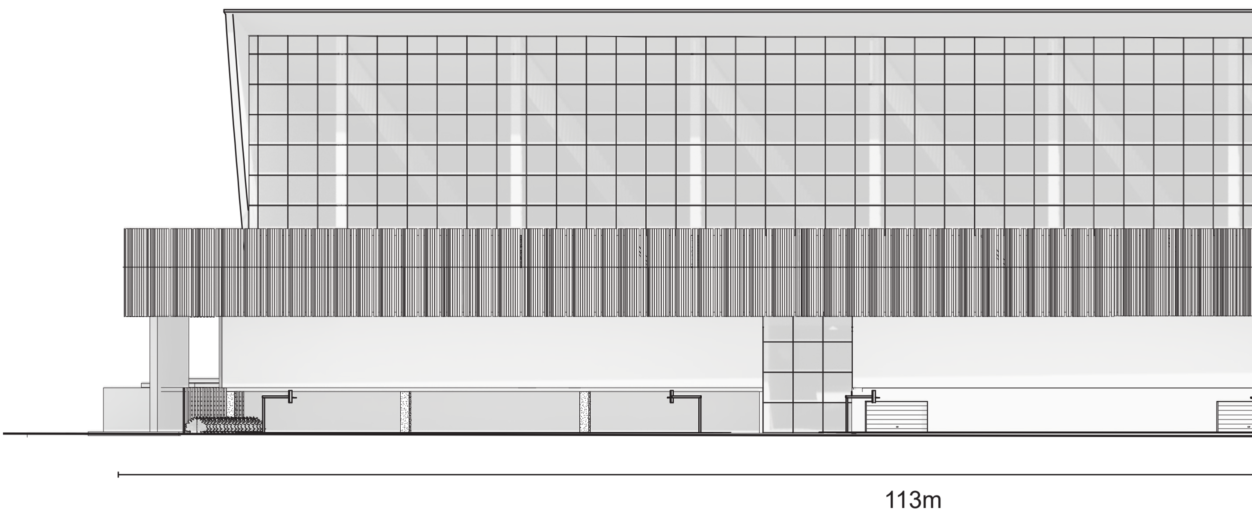


Scale @ 1:500

Figure 114 - Southern Facade

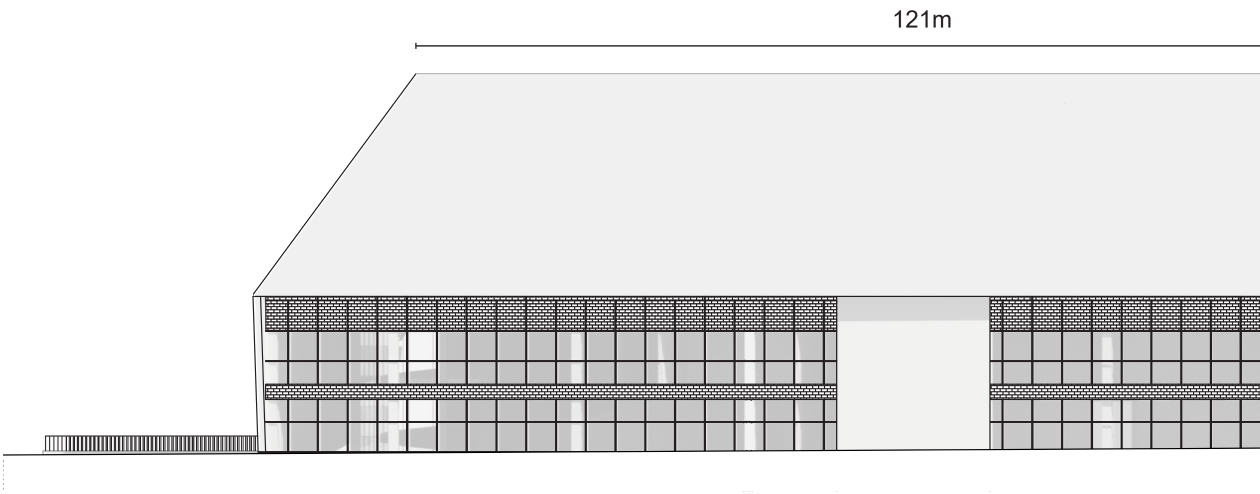

25m
10.5m


13.5m



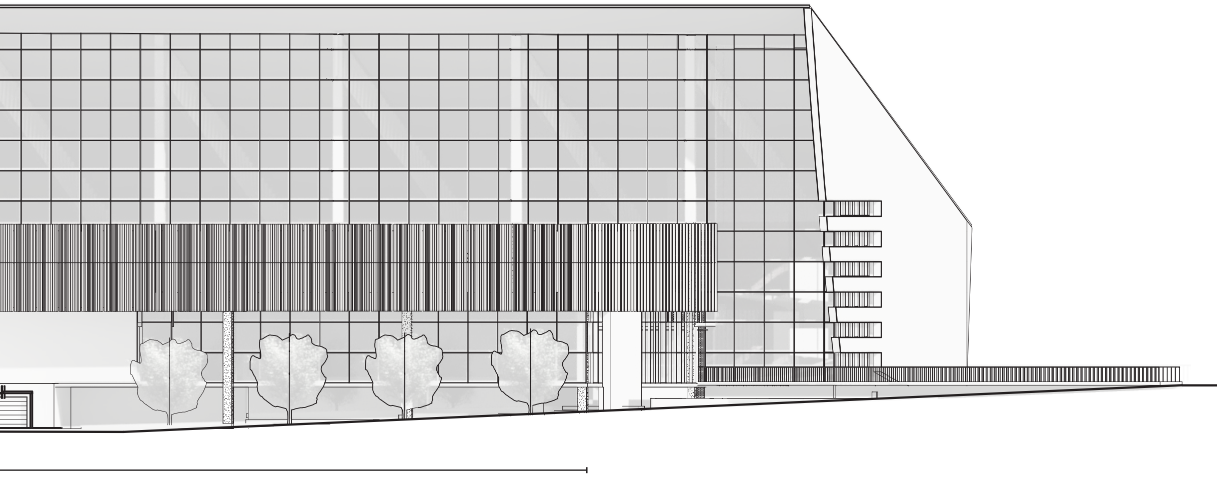
Scale @ 1:500

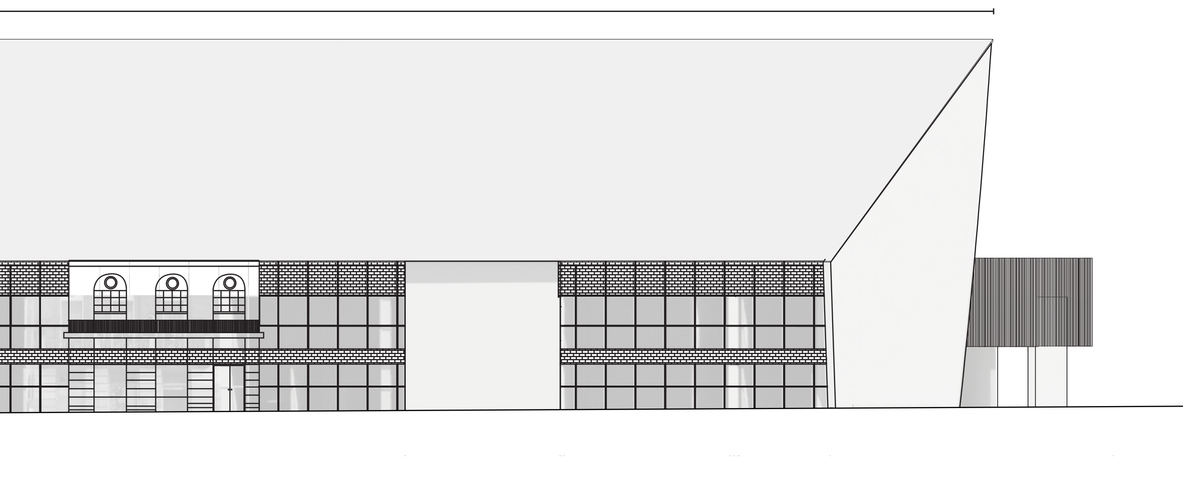
Figure 115 - Eastern Facade

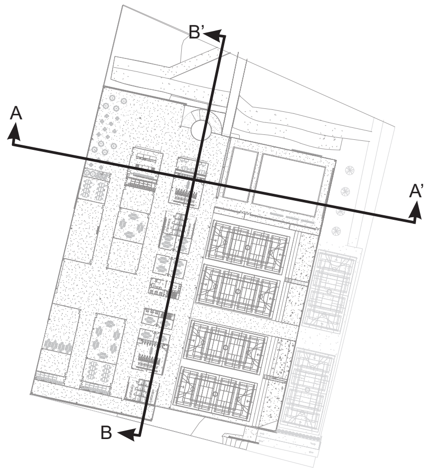


Scale @ 1:500

Figure 116 - Western Facade







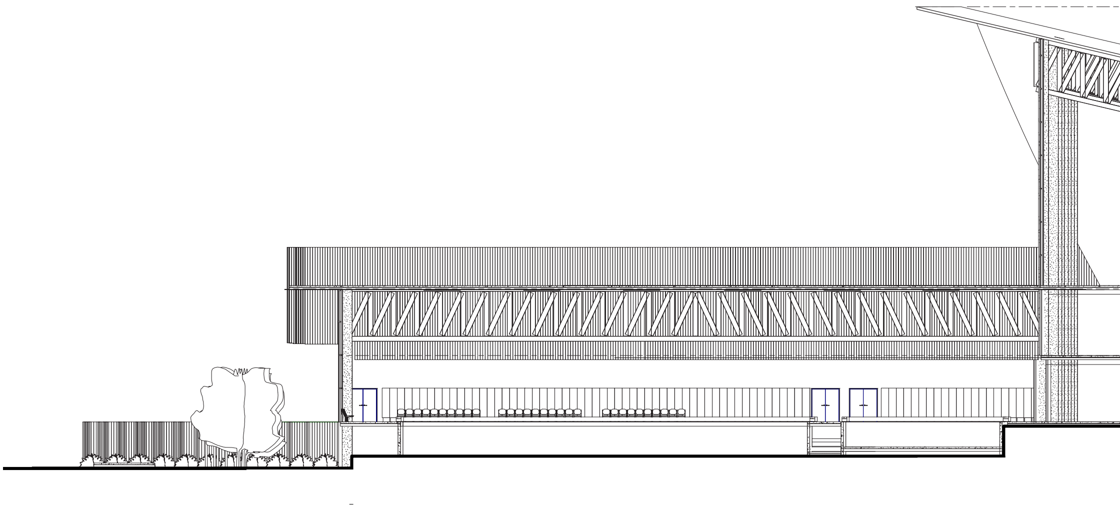


Figure 117 - Section A-A'

Scale @ 1:500

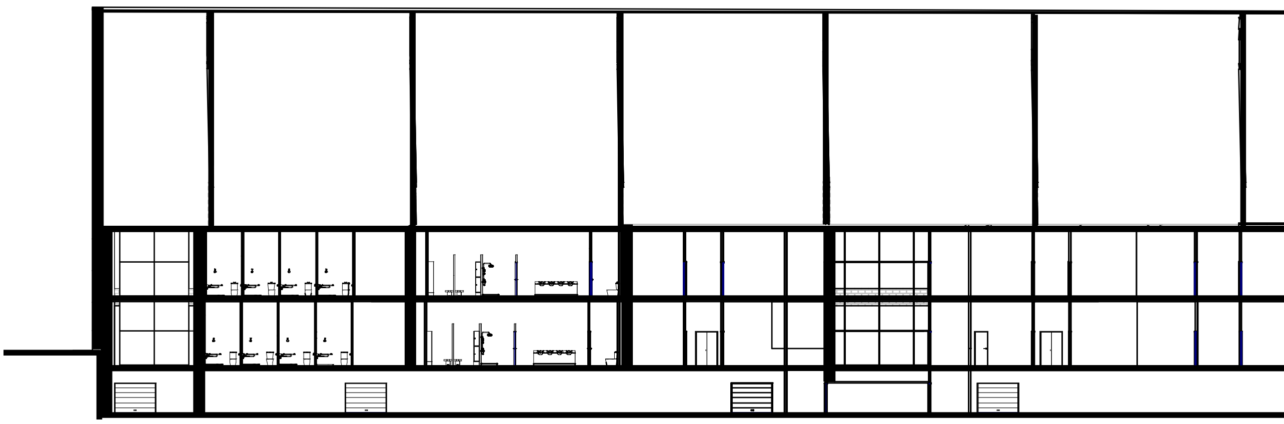
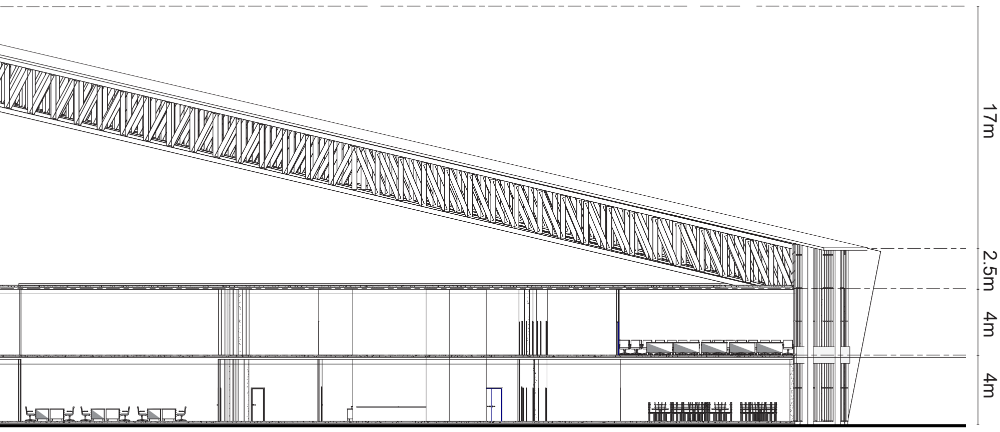


Figure 118 - Section B-B'

Scale @ 1:500


17m
2.5m
4m
4m

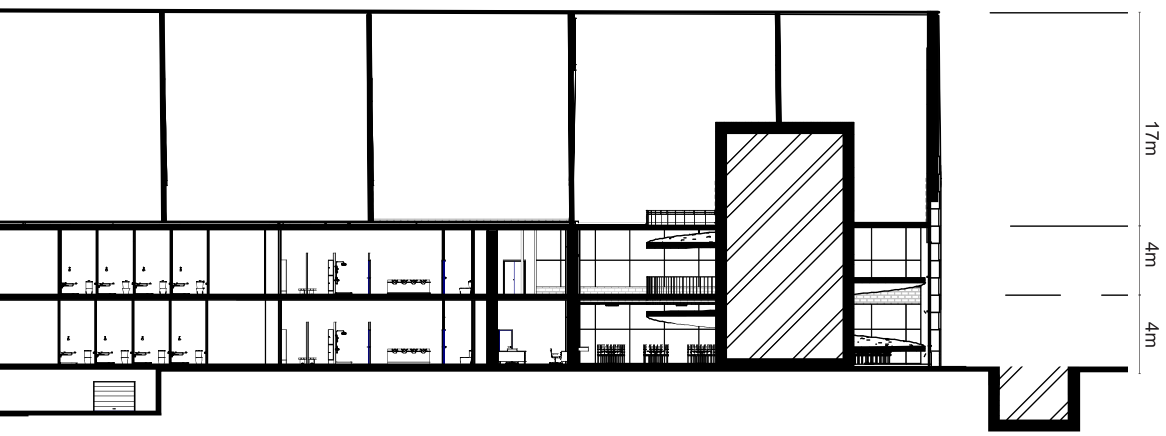

17m
4m
4m

Figure 119 - Pool Area (Pre Programme)

Figure 120 - Roof Garden (Post Programme)

Figure 121 - Indoor Courts (Pre Programme)

Figure 122 - Indoor Courts (Post Programme)

Figure 123 - Mirror/ Dance Room (Pre Programme)

Figure 124 - Organisation Room (Post Programme)

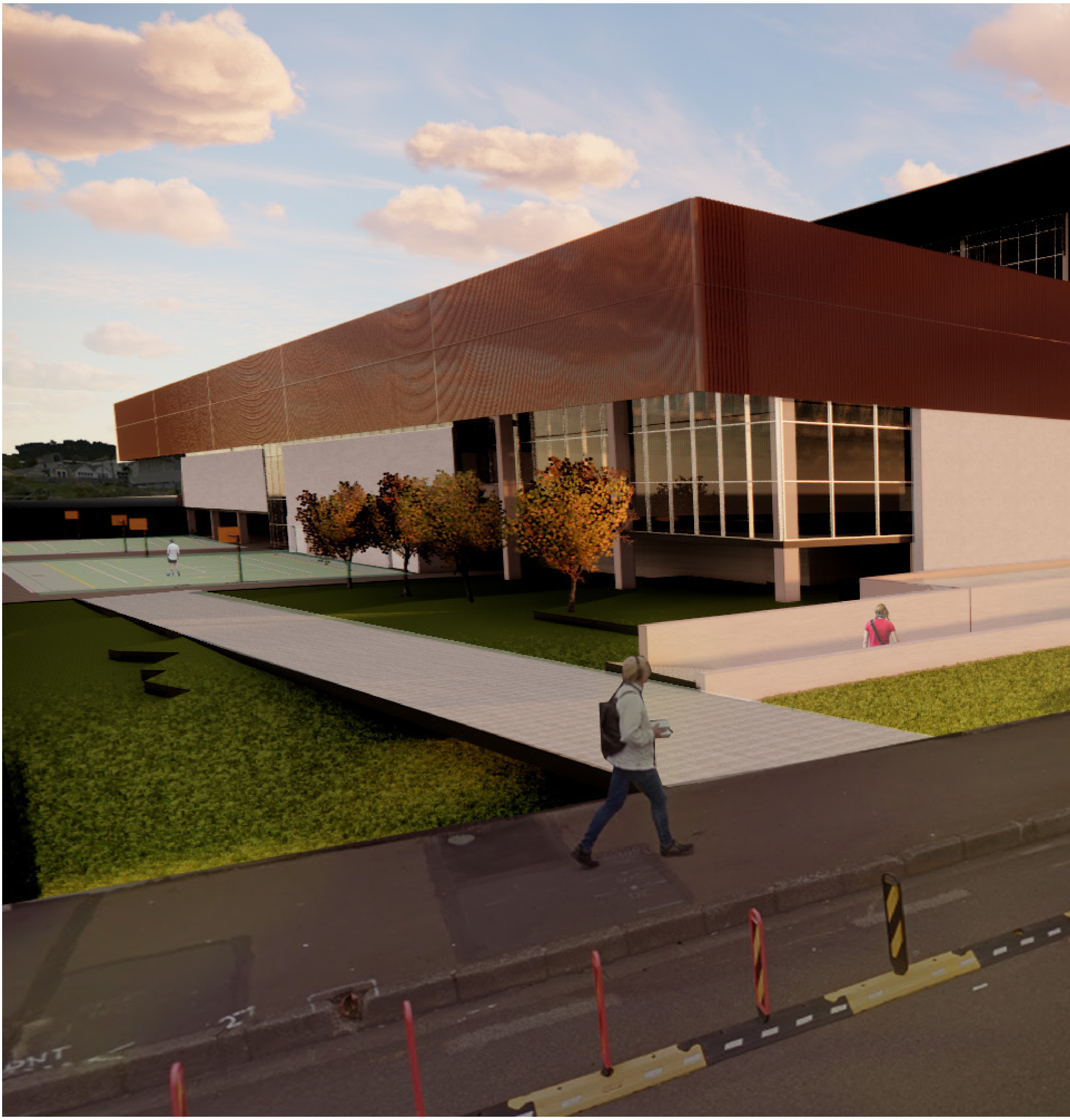
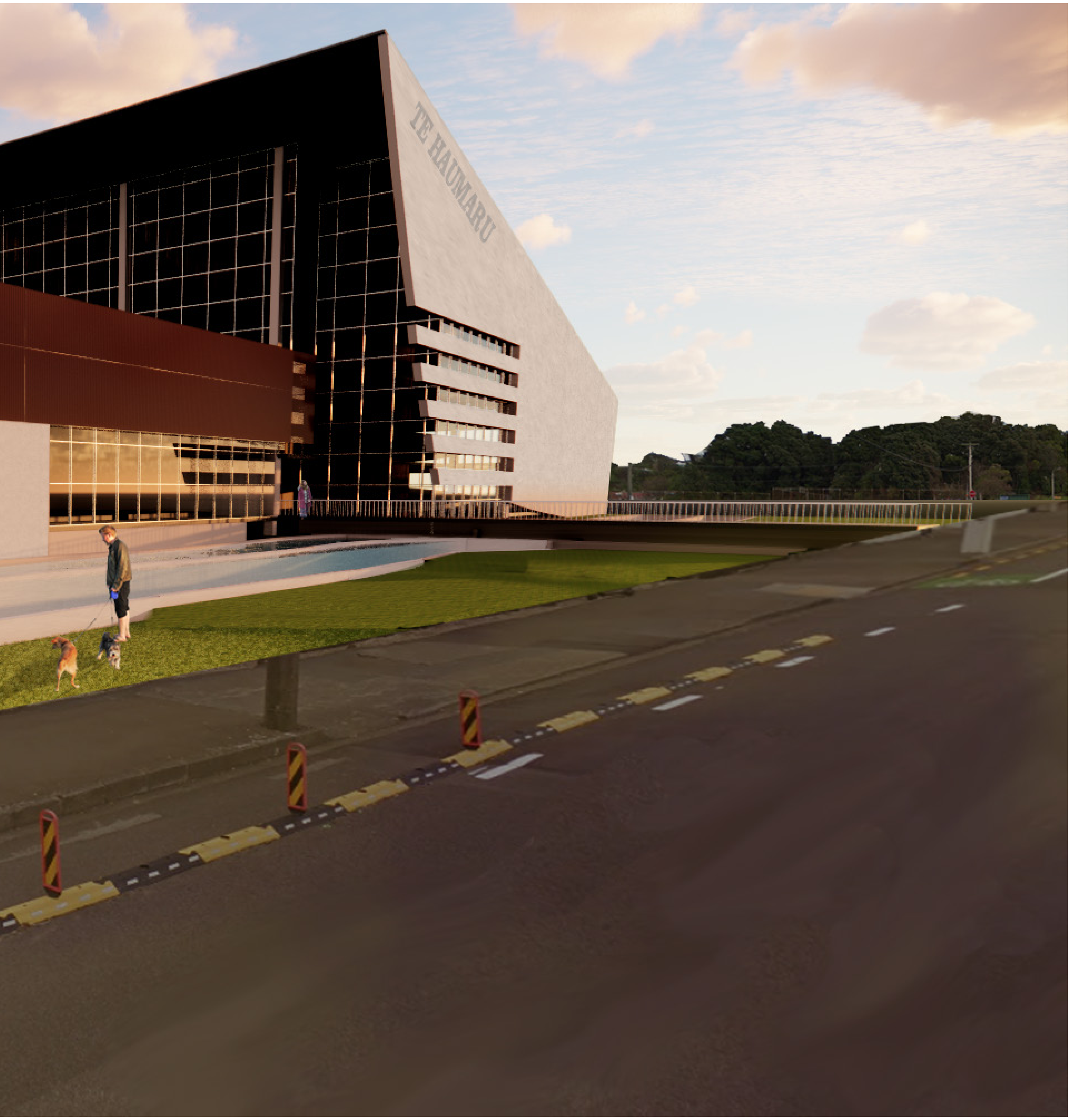
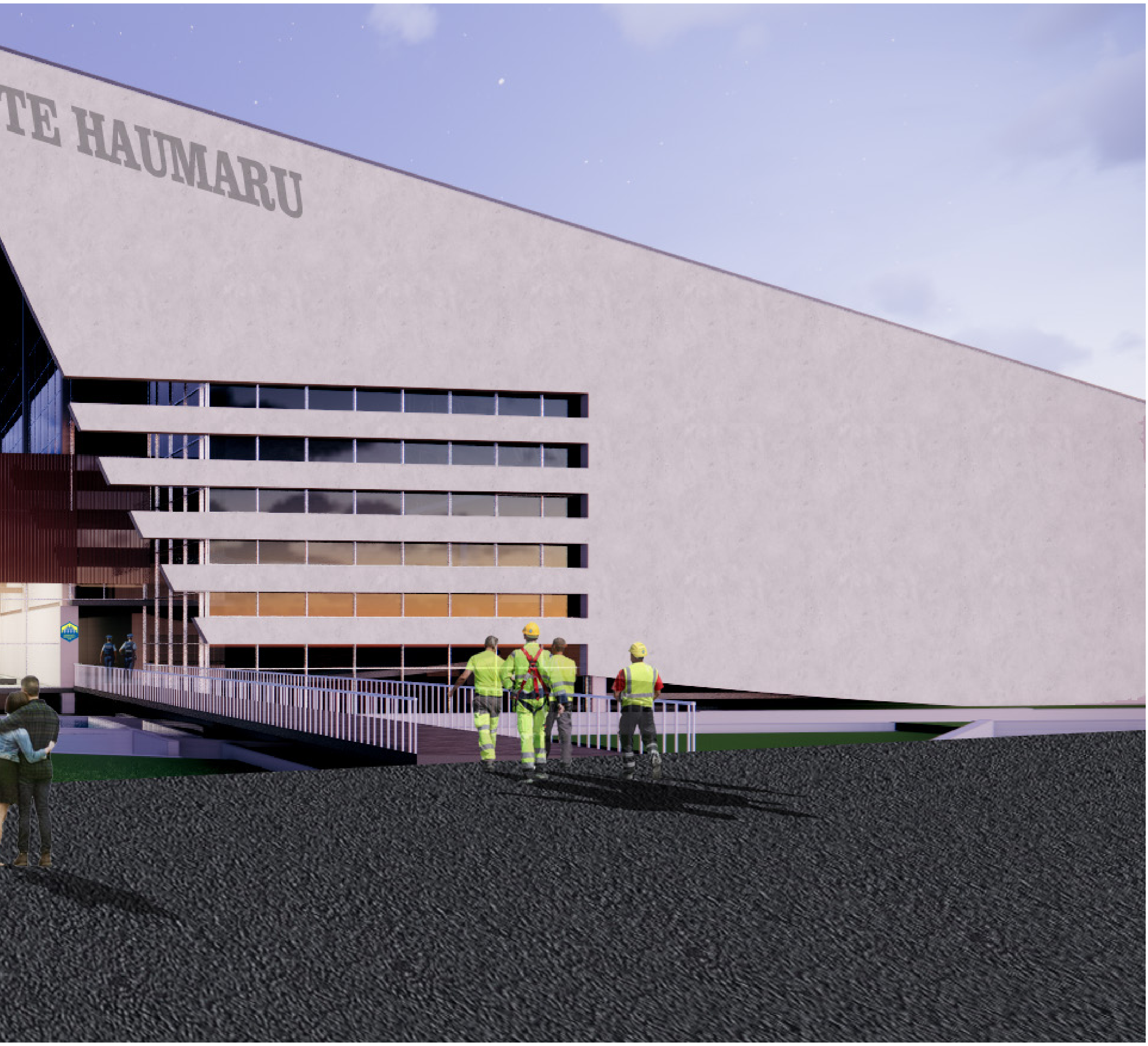


Figure 125 - Rugby Street Exterior (Pre Programme)



- ***8.5:*** *Renders of Final Architectural Application* -

Figure 126 - Rugby Street Exterior (Post Programme)


TE HAUMARU

CHAPTER NINE:

CONCLUSIONS + CRITICAL REFLECTIONS

CONCLUSIONS

Research conducted throughout this thesis addressed three research aims, and their correlating objectives. Gaps in current disaster relief plans highlighted a need for architectural designs to address, where support is provided to a community regardless of demographics.

Application of the problem addressed to the context of Wellington City and its current exposure to significant earthquake scenarios, allowed for research and design frameworks to be established. Through conducting design alongside research, a solution is provided where a secondary disaster relief programme is able to be designed alongside a primary programme.

In conclusion, architecture has the ability to provide pre-established disaster relief though development of proposed design frameworks to incorporate the secondary programme of a disaster hub into the final design outcome. Through development of design to provide this secondary function a community will be supported in the current 24-72 hour period post-disaster where they are asked to fend for themselves. This will reduce stress on communities pre and post disaster and enhance a city’s ability to recover. Through implementation of the processes taken and application of frameworks established, architecture is able to provide pre-established disaster relief to support a community.

CRITICAL REFLECTIONS

AIM ONE (PHASE ONE)

Aim One: To understand how a major earthquake can impact an urban city centre, specifically within the scenario of the Wellington CBD

Objectives:

1. *Gather and review literature regarding the impact of major earthquakes in urban areas.*

2. *Look into case studies in relation to major earthquakes both nationally and internationally. Specifically focusing on the aftermath and responses to post-disaster recovery*

3. *Collect information within national agencies regarding a major earthquake in Wellington, highlighting a worst case scenario and how the government and communities will respond.*

Through addressing these objectives and critical analysis of findings it was concluded that in the case of Wellington, the predicted damaging earthquake would be an AF8 scenario where infrastructure would be damaged significantly. Limitations within research exists in the nature of research conducted, due to the potential impact to Wellington in such a scenario can only be predicted. This means that whilst design has been developed around key infrastructural and site problems outlined, the resultant outcome could be either better or worse than predicted. Therefore research into past disaster responses was carried out in order to predict a potential outcome in the case of Wellington to further design development and outcomes. The timeline of the design and likelihood is also another limitation due to it not being a proven outcome till an AF8 scenario happens. Based on this, the human condition was additionally explored in order to understand how a community will respond with a low risk, high consequence scenario such as Wellingtons. Whilst predictions do not have grounding till they either occur or not, the basis of this thesis is on theoretical events. This however does not change the grounding of research and still highlights the findings of significant gaps in disaster relief and the ability for a change in design techniques to bridge these. Whilst current plans are based on the individual, a communal response was developed with research based around this form of architecture.

AIM TWO (PHASE TWO)

Aim Two: To Understand the reach of an emergency centre in such a disaster, focusing on its potentials and its limitations

Objectives:

4. Gather information regarding Wellington's population and demographics in order to determine a site within the city that targets relief to an area where it is most needed.

5. Gather relevant information on the site, in order to determine an appropriate primary programme.

6. Develop the primary and secondary programmes in relation to each other, and pre/ post disaster based on limitations discovered.

Addressing these objectives and critically analysing findings concluded an appropriate primary programme to develop alongside the secondary programme was that of a community centre. Through research and findings conducted in phase one and based around current community emergency hubs being set up in locations such as community centres, this seemed to be an appropriate programme to develop alongside the secondary programme.

Through research into the greater Wellington risks in relation to secondary hazards and demographic factors, the final site in Mount Cook was determined. The site residing outside any potential secondary hazards, and also with a low demographic area that is close to the CBD in order to target a community that is likely to require it the most. The site also fit with earlier research findings, suggesting that a developed response in this location would positively impact the community of Mount Cook and people in surrounding suburbs that it could service.

Development of the primary programme of a community centre revealed that this in fact was not an appropriate architectural solution to combine with the secondary programme. Attempts to develop this concept only detracted further from the secondary programme and hindered post-disaster functionality. As a result this architectural solution that was developed through initial research in phase one was inappropriate in addressing and answering the research question and further research was required.

Additional redefinitions were carried out, delving into the site's history, conditions and surrounds in order to determine a primary programme that would work with the area and also provide community support both pre and post-disaster. As a result, it was determined that an appropriate primary programme was that of a recreation centre, as the surrounds and site history highlighted the communities use of such facilities in the past and their current need for similar facilities. This programme also tied in with initial research and did not detract from the secondary programme, providing key spaces that could easily shift programme without hindering the overall construction of the building.

AIM THREE (PHASE THREE)

Aim Three: To develop an architectural response to disaster relief that has been pre-established, to provide residents in Wellington the much-needed support they require in the initial moments post-disaster

Objectives:

7. *Create a framework for design that works alongside the government's plans after a disaster, such as the community emergency hubs.*

8. *Work with post-disaster relief agencies and responses discovered to ensure that a community is given a broader range of support/ help in the 24 hours, to week, post the disaster occurring.*

9. *Develop an architectural response that incorporates seismic requirements and sustainable elements that provide support to a community, whilst also informing them of the design's importance.*

In phase three development of the recreation centre programme was carried out alongside the secondary programme of a disaster hub. Through research and critical analysis of programme based case studies, the final programme elements were developed into an overall programme that could also provide adaptable spaces for the outlined post-disaster functions. Planning of spaces followed critical needs of both programmes, before being critically analysed and developed further in relation to sustainable and seismic requirements. Within design development, plans took precedence to the external composition resulting in elevational elements requiring further development. Due to the nature of the research and final outcome, visual elements of spaces were delved into but not analysed as critically as planning components. Further development of this would be necessary for the final design, in order to further highlight programmatic elements.

Further limitations were discovered in the ability to develop the detail of sustainable elements in relation to off grid design. Research suggested the need for the design to operate off grid based on disaster predictions, however programme development took precedence. Sustainable elements in relation to water storage and use were outlined in more detail than that of electricity and food due to the detail required to place a design of such scale off grid. As a result whilst the design is able to function at reduced capacity when the grid fails, it was not able to achieve the original intent to be able to function at the same levels pre and post disaster.

In relation to disaster relief agencies, further development could have been carried out though engagement with Wellington specific groups such as WREMO. This would have further critically analysed the design to engage directly with those who would impact directly from the designs application. Further development in this manner would also ensure the feasibility of the design in a ‘real-world’ scenario.

Using the scenario of Wellington and the specific natural disaster of an earthquake a design outcome was reached, with research and design frameworks established. Applications of these of which change the way architecture responds to pre-established disaster relief.

FURTHER RESEARCH

Research can be further developed and carried out in relation to how research can be applied in a change of location and/ or disaster. Sustainable elements have the ability to be developed further in relation to how to large scale designs such as the proposed developed design could function off grid.

Implications of development in this manner would ensure the feasibility of implementation of such an approach to disaster relief and change future approaches to designing in disaster prone locations such as Wellington City.

WORKS CITED

Alexander, D. (1993). *Natural Disasters*. Routledge. https://books.google.co.nz/s?hl=en&lr=&id=wnt0DwAAQBAJ&oi=fnd&pg=PT11&dq=A+natural+disaster+in+a+location+where+the+residents+are+properly+warned+and+prepared,+will+have+less+casualties+than+a+place+where+there+is+little+to+no+warning+or+preparation+&ots=owCijKxAaK&sig=i920J02UqziypUUTwd1hm4u-0Sk#v=onepage&q&f=false

Allan, P., **Bryant**, M., **Hill**, M., **Neely**, D., & **Smith**, J. (2016). *The role of open space for Post-Disaster Recovery in Wellington's city centre* (pp. 1–73). Victoria University of Wellington.

ArchDaily. (2013, August 5). *ASB Sports Centre / Tennent+ Brown Architects*. ArchDaily. https://www.archdaily.com/405384/asb-sports-centre-tennent-brown-architects

ArchDaily. (2014, January 7). *Lardy Sports Hall / Explorations Architecture*. ArchDaily. https://www.archdaily.com/464098/lardy-sports-hall-explorations-architecture?ad_source=search&ad_medium=search_result_projects

ArchDaily. (2017, December 16). *Schönberghalle / Herbert Hussmann Architekten*. ArchDaily. https://www.archdaily.com/882302/schonberghalle-herbert-hussmann-architekten?ad_source=search&ad_medium=search_result_projects

Benson, C., & **Clay**, E. J. (2004). *Understanding the Economic and Financial Impacts of Natural Disasters*. The World Bank.

BGI. (2016). *The History of BGI*. Wellington Boys & Girls Institute. http://www.bgi.org.nz/History

Blaikie, P., **Cannon**, T., **Davis,** I., & **Wisner,** B. (2004). *At Risk: Natural Hazards, Peoples Vulnerability, and Disasters* (Second). Routledge.

Brown Jr, E. G., & **Ghilarducci**, M. S. (2017). *State of California Emergency Plan*. Governors Office of Emergency Services.

Burgess, D. (2007, June 11). Learner Swimmers Cast Adrift. *Dominion Post*, A3.

Celebi, M., & **Holzer,** T. L. (2014). *The Loma Prieta, California, Earthquake of October 17, 1989—Building Structures* (Professional Paper No. 1552). U.S. Geological Survey.

Center for Excellence in Disaster. (2017). *Chile Disaster Management Reference Handbook*.

Civil Defence. (2018). *Wellington Earthquake National Initial Response Plan*. New Zealand Government. https://www.civildefence.govt.nz/assets/Uploads/WENIRP-2.0-Final-for-publication.pdf

Civil Defence. (2020). *Setting up*. Civil Defecne. https://getprepared.nz/my-community/hub-guide/setting-up/

Cooke, P. (2006). *Mt Cook, Wellington—A history*. Wellington City Council. http://mtcookmobilised.pbworks.com/f/MtCook_History-COOKE.pdf

Dellow, G. D., **Perrin**, N. D., & **Ries**, W. F. (2019). *Liquefaction Hazard in the Wellington Region* [GNS Science Report]. GNS Science. http://data-gwrc.opendata.arcgis.com/datasets/9d2074c4bc5b40e1b4352abd1f2e1ebf_10

Dudman, C. (2015). *The Day that Changed My Life*. TVNZ. https://www.tvnz.co.nz/shows/the-day-that-changed-my-life/episodes/s1-e1

Fritz Institute. (n.d.). *Hurricane Katrina: Perceptions of the affected*.

Furedi, F. (2007). The Changing Meaning of Disaster. *Area*, *39*(4), 482–489.

Gallagher, P. (2013, February 7). *The Wellington Boy's Institute: A Charitable Instrument of War*. The Pantograph Punch. https://www.pantograph-punch.com/post/the-wellington-boys-institute-a-charitable-instrument-of-war

GNS. (n.d). *Alpine Fault* [Organisation]. GNS Science. https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Major-Faults-in-New-Zealand/Alpine-Fault

Google Earth. (n.d). *Elevation Profile*. https://earth.google.com/web/@-41.30131878,174.77805864,16.62901013a,404.89523126d,35y,0h,0t,0r

Gordon, R. (n.d). *The Social Dimension of Emergency Recovery D5*.

Haznet. (2017). *Interview with Dennis Mileti, Director Emeritus of the Natural Hazards Centre*. Haznet: The Magazine of the Canadian Risks and Hazards Network. http://haznet.ca/interview-with-dennis-mileti-director-emeritus-of-the-natural-hazards-centre/

IDNZ. (2018a). *Aro Valley Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=100

IDNZ. (2018b). *Kilbirnie Central Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=420

IDNZ. (2018c). *Kilbirnie East Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=420

I**DNZ. (2018d).** *Mount Cook East Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=540

IDNZ. (2018e). *Mount Cook West Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=550

IDNZ. (2018f). *Mount Victoria Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=560

IDNZ. (2018g). *Newtown North Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=590

IDNZ. (2018h). *Newtown South Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=590

IDNZ. (2018i). *Newtown West Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=610

IDNZ. (2018j). *Wellington Central Employment Status* [Government]. ID Community. https://profile.idnz.co.nz/wellington/employment-status?WebID=840

IDNZ. (2018k). *Wellington City Age-Sex Pyramid* [Government]. ID Community. https://profile.idnz.co.nz/wellington/nz-age-sex-pyramid

IDNZ. (2019, November). *Wellington City Population Forecast* [Government]. Population Forecast. https://forecast.idnz.co.nz/wellington/home

Lomintz, C. (2004). *Major Earthquakes of Chile: A historical survey*. *75*(3).

Mannakkara, S., **Potangaroa**, P., & **Wilkinson**, S. (2019). *Resilient Post Disaster Recovery Through Building Back Better*. Routledge.

Masurier, J. L., **Rotimi**, J. O. B., & **Wilkinson**, S. (2006). *The Regulatory Framework for Effective Post-Disaster Reconstruction in New Zealand*.

McLean, I., **Oughton**, D., **Ellis**, S., **Wakelin**, B., & **Rubin**, C. B. (2019). *Review of the Civil Defence Emergency Management Response to the 22 February Christchurch Earthquake*.

McMorrough, J. (2006). Notes on the Adaptive Re-use of Program. *PRAXIS*, *8*, 103–110.

Mileti, D. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Joseph Henry Press.

Ministry for Culture and Heritage. (2017, April 8). *Hawke's Bay Earthquake Strikes: 3 February 1931* [Government]. New Zealand History. https://nzhistory.govt.nz/hawkes-bay-earthquake-0

Ministry of Civil Defence & Emergency Management. (2019). *National Disaster Resilience Strategy*. New Zealand Government. https://www.civildefence.govt.nz/assets/Uploads/publications/National-Disaster-Resilience-Strategy/National-Disaster-Resilience-Strategy-10-April-2019.pdf

New Zealand Red Cross. (N.D). *Responding to disasters and crises*. Red Cross. https://www.redcross.org.nz/what-we-do/overseas/responding-to-disasters-and-crises/

New Zealand Solar Power Ltd. (N.D). *Hyundai Solar Panels*. Solar Panels. https://www.nzsolarpower.com/solar-panels/

NIWA. (2019). *Solarview*. Solarview Calculations. https://solarview.niwa.co.nz/

Oxfam New Zealand. (2019). *Emergencies*. What We Do. https://www.oxfam.org.nz/what-we-do/emergencies/

Quigley, M. C., **Bastin,** S., & **Bradley**, B. A. (2013). Recurrent liquefaction in Christchurch, New Zealand, during the Canterbury earthquake sequence. *Geology*, *41*(4), 419–422. https://doi.org/10.1130/G33944.1

Rahmanian, F., & **Ismail**, I. (1992). *Fire After Earthquake* (Engineering No. 712; pp. 1–22). University of Canterbury. https://ir.canterbury.ac.nz/bitstream/handle/10092/8465/rahmanian_ismail_report_Redacted.pdf?sequence=1&isAllowed=y

Risberg, E. (2019). *Rescuers search destroyed houses in San Francisco's Marina District in the aftermath of the Loma Prieta earthquake in 1989* [Photograph]. https://www.insider.com/san-franciscoo-earthquake-bay-area-loma-prieta-1989-2019-10

Selwyn District Council. (Unknown). *Lincoln Event Centre: Facilities and Floorplan*. Selwyn District Council. https://www.selwyn.govt.nz/recreation-And-facilities/halls,-event-And-community-centres/lincoln-event-centre/facilities-and-floor-plan

Statistics New Zealand. (N.D). *Average Annual Rainfall*. https://statisticsnz.shinyapps.io/average_annual_rainfall/

Te Ara. (2017, November 1). *Story: Historic Earthquakes* [Government]. Te Ara: The Encyclopedia of New Zealand. https://teara.govt.nz/en/historic-earthquakes

Tennent Brown Architects. (Date Unknown). *ASB Sports Centre* [Architecture Firm]. Tennent Brown Architects. http://tennentbrown.co.nz/asb-sports-centre

The Salvation Army. (2014, February 24). *Christchurch: Three years on*. Church Community. https://www.salvationarmy.org.nz/christchurch-three-years

The Salvation Army. (2020). *Emergency Services*. Get Help. https://www.salvationarmy.org.nz/get-help/emergency-services

Walker, A. (2016, August 2). *Natural Ventilation* [Government]. Whole Building Design Guide. https://www.wbdg.org/resources/natural-ventilation

Wallace, L. (2016). *Hikurangi Subduction Earthquakes and Slip Behaviour* [Organisation]. GNS Science. https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/New-Zealands-Largest-Fault

Wellington City Council. (N.D). *Wind Zones* [Government]. Wind Zones. https://gis.wcc.govt.nz/LocalMaps/Viewer/?map=50f1b8e3d8594e3098b65d698a7713a4

WREMO. (2020a). *Fire* [Government]. Wellington Region Emergency Management. https://wremo.nz/hazards/fire/

WREMO. (2020b). *Store Emergency Water* [Government]. Get Prepared. https://getprepared.nz/households/store-emergency-water/

WREMO. (2020c). *Tsunami Evacuation Zones—Wellington Region* [Government]. Wellington Region Emergency Management. https://wremo.nz/hazards/tsunami-zones/

Zoback, M. L. (2014). “Epicenters” of Resilience. *Science Mag*, *346*(6207), 283.

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Berkeley University of California. (2015). Today in Earthquake History: Chile 1960. https://seismo.berkeley.edu/blog/2015/05/22/today-in-earthquake-history-chile-1960.html

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McGregor, I. (2011). A photographer's recollection of February 22 [Photograph]. http://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/76765761/a-photographers-recollection-of-february-22

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Gallagher, P. (2013, February 7). The Wellington Boy's Institute: A Charitable Instrument of War. The Pantograph Punch. https://www.pantograph-punch.com/post/the-wellington-boys-institute-a-charitable-instrument-of-war

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McCredie, P. (2015). ASB Sports Centre [Photo]. https://www.archdaily.com/405384/asb-sports-centre-tennent-brown-architects/51ed37b2e8e44e67170000d3-asb-sports-centre-tennent-brown-architects-photo

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Selwyn District Council. (Unknown). Lincoln Event Centre: Facilities and Floorplan. Selwyn District Council. https://www.selwyn.govt.nz/recreation-And-facilities/halls,-event-And-community-centres/lincoln-event-centre/facilities-and-floor-plan

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ArchDaily. (2014, January 7). Lardy Sports Hall / Explorations Architecture. ArchDaily. https://www.archdaily.com/464098/lardy-sports-hall-explorations-architecture?ad_source=search&ad_medium=search_result_projects

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ArchDaily. (2017, December 16). Schönberghalle / Herbert Hussmann Architekten. ArchDaily. https://www.archdaily.com/882302/schonberghalle-herbert-hussmann-architekten?ad_source=search&ad_medium=search_result_projects

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LAUD8. (2018). Wenchuan Earthquake Memorial Museum. https://laud8.wordpress.com/2018/11/05/wenchuan-earthquake-memorial-museum/

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Canterbury Earthquake National Memorial. (n.d.). https://www.otakaroltd.co.nz/anchor-projects/canterbury-earthquake-memorial/

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Patowary, K. (2015). The 100 Stepped Garden of Awaji Yumebutai. https://www.amusingplanet.com/2015/08/the-100-stepped-garden-of-awaji.html

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ArchDaily. (2012). Asakusa Culture and Tourism Centre / Kengo Kuma & Associates [Photograph]. https://www.archdaily.com/251370/asakusa-culture-and-tourism-center-kengo-kuma-associates/

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APPENDIX

Appendix 1: SolarView Calculations

NIWA SolarView Calculations
6 May 2020

Descriptior	Custom location	
Latitude	-41.3	
Longitude	174.78	
Panel Tilt	41	
Bearing	0	
Ground Alb	0.1	
Climate Sta	3385	Wellington Kelburn
Years of Da	24	

Month & h	Elevation	Azimuth	Hourly W/r	Cumulative	Cloudless W/m2
Jan 0:00	-28.6	-179.5	0	0	0
Jan 1:00	-27.1	164.7	0	0	0
Jan 2:00	-22.8	149.9	0	0	0
Jan 3:00	-16	136.8	0	0	0
Jan 4:00	-7.5	125.3	0	0	0
Jan 5:00	2.2	115.1	10	0.01	15
Jan 6:00	12.7	105.7	53	0.06	38
Jan 7:00	23.8	96.5	182	0.24	244
Jan 8:00	35	86.7	344	0.59	484
Jan 9:00	46.1	75.3	501	1.09	711
Jan 10:00	56.5	59.9	618	1.71	896
Jan 11:00	65	36.5	704	2.41	1018
Jan 12:00	68.7	1.4	735	3.15	1062
Jan 13:00	65.4	-34.4	717	3.86	1023
Jan 14:00	57.2	-58.6	644	4.51	907
Jan 15:00	46.9	-74.3	523	5.03	726
Jan 16:00	35.8	-85.9	359	5.39	500
Jan 17:00	24.5	-95.7	190	5.58	260
Jan 18:00	13.4	-104.9	59	5.64	46
Jan 19:00	2.8	-114.3	10	5.65	18
Jan 20:00	-7	-124.4	0	5.65	0
Jan 21:00	-15.6	-135.8	0	5.65	0
Jan 22:00	-22.5	-148.8	0	5.65	0
Jan 23:00	-27.1	-163.5	0	5.65	0
Feb 0:00	-37.7	-178.5	0	0	0
Feb 1:00	-36.2	163.1	0	0	0
Feb 2:00	-31.4	146.3	0	0	0
Feb 3:00	-24.1	131.9	0	0	0
Feb 4:00	-14.9	119.6	0	0	0
Feb 5:00	-4.7	108.9	0	0	0
Feb 6:00	6.3	99	25	0.02	29
Feb 7:00	17.5	89.2	133	0.16	218
Feb 8:00	28.7	78.8	284	0.44	467
Feb 9:00	39.4	66.5	434	0.88	706
Feb 10:00	49	50.9	558	1.43	902
Feb 11:00	56.4	29.6	638	2.07	1033
Feb 12:00	59.5	2.3	677	2.75	1083
Feb 13:00	57.1	-25.6	673	3.42	1046
Feb 14:00	50.3	-47.9	614	4.04	928
Feb 15:00	41	-64.3	496	4.53	740
Feb 16:00	30.3	-76.9	327	4.86	505
Feb 17:00	19.2	-87.5	158	5.02	256
Feb 18:00	7.9	-97.3	36	5.05	42
Feb 19:00	-3.1	-107.1	1	5.05	0
Feb 20:00	-13.5	-117.7	0	5.05	0
Feb 21:00	-22.9	-129.7	0	5.05	0
Feb 22:00	-30.7	-143.7	0	5.05	0
Feb 23:00	-36	-160.2	0	5.05	0
Mar 0:00	-48.5	179.5	0	0	0
Mar 1:00	-46.3	157.5	0	0	0
Mar 2:00	-40.3	138.5	0	0	0
Mar 3:00	-31.7	123.2	0	0	0
Mar 4:00	-21.7	110.7	0	0	0
Mar 5:00	-10.9	99.9	0	0	0
Mar 6:00	0.4	89.8	5	0.01	2
Mar 7:00	11.6	79.8	101	0.11	203
Mar 8:00	22.4	68.9	249	0.35	458
Mar 9:00	32.4	56.3	397	0.75	699
Mar 10:00	40.8	40.8	511	1.26	893
Mar 11:00	46.7	21.6	585	1.85	1018
Mar 12:00	48.7	-0.6	618	2.47	1060
Mar 13:00	46.4	-22.7	609	3.07	1013
Mar 14:00	40.4	-41.6	536	3.61	884
Mar 15:00	31.8	-56.9	407	4.02	686
Mar 16:00	21.7	-69.4	244	4.26	444
Mar 17:00	10.9	-80.2	89	4.35	189
Mar 18:00	-0.4	-90.2	4	4.35	0
Mar 19:00	-11.6	-100.2	0	4.35	0
Mar 20:00	-22.5	-111.1	0	4.35	0
Mar 21:00	-32.5	-123.7	0	4.35	0
Mar 22:00	-41	-139.2	0	4.35	0
Mar 23:00	-46.8	-158.4	0	4.35	0
Apr 0:00	-60.1	175	0	0	0
Apr 1:00	-56.5	147.7	0	0	0
Apr 2:00	-48.8	126.9	0	0	0
Apr 3:00	-39	111.6	0	0	0
Apr 4:00	-28.1	99.7	0	0	0
Apr 5:00	-16.9	89.3	0	0	0
Apr 6:00	-5.7	79.6	0	0	0
Apr 7:00	5.1	69.7	35	0.04	26
Apr 8:00	15.3	58.9	202	0.24	413
Apr 9:00	24.2	46.5	337	0.57	649
Apr 10:00	31.3	31.9	441	1.02	833
Apr 11:00	35.8	15.1	492	1.51	945
Apr 12:00	37	-3.1	506	2.01	973
Apr 13:00	34.6	-21	475	2.49	915
Apr 14:00	29.1	-37.1	410	2.9	777
Apr 15:00	21.3	-50.8	284	3.18	573
Apr 16:00	11.8	-62.6	141	3.32	323
Apr 17:00	1.4	-73	12	3.34	11
Apr 18:00	-9.6	-82.8	0	3.34	0
Apr 19:00	-20.9	-92.6	0	3.34	0
Apr 20:00	-32	-103.3	0	3.34	0
Apr 21:00	-42.7	-116.1	0	3.34	0
Apr 22:00	-52	-132.9	0	3.34	0
Apr 23:00	-58.6	-156.2	0	3.34	0
May 0:00	-68.5	171.9	0	0	0
May 1:00	-63.7	138.6	0	0	0
May 2:00	-54.8	117	0	0	0
May 3:00	-44.2	102.6	0	0	0
May 4:00	-33	91.6	0	0	0
May 5:00	-21.8	82	0	0	0
May 6:00	-10.8	72.8	0	0	0
May 7:00	-0.3	63.2	4	0	0
May 8:00	9.2	52.8	124	0.13	321
May 9:00	17.4	41.1	248	0.38	563
May 10:00	23.8	27.6	338	0.71	741
May 11:00	27.7	12.6	380	1.09	847
May 12:00	28.6	-3.4	394	1.49	871
May 13:00	26.4	-19.1	365	1.85	812
May 14:00	21.4	-33.5	306	2.16	674
May 15:00	14.1	-46.2	195	2.35	469
May 16:00	5.3	-57.3	69	2.42	191
May 17:00	-4.7	-67.2	1	2.42	0
May 18:00	-15.4	-76.5	0	2.42	0
May 19:00	-26.5	-85.8	0	2.42	0
May 20:00	-37.8	-95.8	0	2.42	0
May 21:00	-48.8	-107.9	0	2.42	0
May 22:00	-58.9	-124.7	0	2.42	0
May 23:00	-66.6	-151	0	2.42	0
Jun 0:00	-72.1	174.3	0	0	0
Jun 1:00	-67.2	136.4	0	0	0
Jun 2:00	-58	113.9	0	0	0
Jun 3:00	-47.2	99.7	0	0	0
Jun 4:00	-36	89	0	0	0
Jun 5:00	-24.7	79.7	0	0	0
Jun 6:00	-13.9	70.8	0	0	0
Jun 7:00	-3.6	61.6	0	0	0
Jun 8:00	5.8	51.5	83	0.08	231
Jun 9:00	13.9	40.2	200	0.28	495
Jun 10:00	20.2	27.4	295	0.58	679
Jun 11:00	24.1	13.2	343	0.92	790
Jun 12:00	25.3	-1.9	361	1.28	821
Jun 13:00	23.4	-16.9	330	1.61	769
Jun 14:00	18.8	-30.8	262	1.87	639
Jun 15:00	12	-43.2	163	2.04	437
Jun 16:00	3.6	-54.2	37	2.07	138
Jun 17:00	-6.1	-64	0	2.07	0
Jun 18:00	-16.6	-73.1	0	2.07	0
Jun 19:00	-27.6	-82	0	2.07	0
Jun 20:00	-38.8	-91.5	0	2.07	0
Jun 21:00	-50	-102.8	0	2.07	0
Jun 22:00	-60.5	-118.5	0	2.07	0
Jun 23:00	-69.1	-144.3	0	2.07	0
Jul 0:00	-69.4	178.1	0	0	0
Jul 1:00	-65.5	142.4	0	0	0
Jul 2:00	-56.9	119.1	0	0	0
Jul 3:00	-46.4	103.9	0	0	0
Jul 4:00	-35.2	92.6	0	0	0
Jul 5:00	-24	82.9	0	0	0
Jul 6:00	-12.9	73.8	0	0	0
Jul 7:00	-2.4	64.4	0	0	0
Jul 8:00	7.3	54.2	104	0.1	263
Jul 9:00	15.7	42.8	222	0.33	519
Jul 10:00	22.4	29.7	323	0.65	709
Jul 11:00	26.7	15	374	1.02	827
Jul 12:00	28.1	-0.7	385	1.41	865
Jul 13:00	26.4	-16.4	365	1.77	819
Jul 14:00	21.9	-31	302	2.08	694
Jul 15:00	15	-43.9	201	2.28	500
Jul 16:00	6.5	-55.3	82	2.36	235
Jul 17:00	-3.3	-65.3	0	2.36	0
Jul 18:00	-13.9	-74.7	0	2.36	0
Jul 19:00	-24.9	-83.9	0	2.36	0
Jul 20:00	-36.2	-93.7	0	2.36	0
Jul 21:00	-47.3	-105.3	0	2.36	0
Jul 22:00	-57.7	-121	0	2.36	0
Jul 23:00	-65.9	-145.4	0	2.36	0
Aug 0:00	-61.2	177.1	0	0	0
Aug 1:00	-57.8	148.8	0	0	0
Aug 2:00	-50.2	127.3	0	0	0
Aug 3:00	-40.4	111.7	0	0	0
Aug 4:00	-29.5	99.7	0	0	0
Aug 5:00	-18.3	89.4	0	0	0
Aug 6:00	-7.1	79.7	0	0	0
Aug 7:00	3.8	69.9	23	0.02	22
Aug 8:00	14	59.2	150	0.17	386
Aug 9:00	23	47	271	0.44	626
Aug 10:00	30.2	32.7	366	0.81	814
Aug 11:00	34.9	16.2	420	1.23	932
Aug 12:00	36.4	-1.8	449	1.68	967
Aug 13:00	34.3	-19.6	422	2.1	916
Aug 14:00	29.1	-35.7	356	2.46	784
Aug 15:00	21.4	-49.5	255	2.71	584
Aug 16:00	12.2	-61.4	128	2.84	337
Aug 17:00	1.8	-71.9	8	2.85	13
Aug 18:00	-9.1	-81.7	0	2.85	0
Aug 19:00	-20.4	-91.4	0	2.85	0
Aug 20:00	-31.5	-102	0	2.85	0
Aug 21:00	-42.2	-114.6	0	2.85	0
Aug 22:00	-51.7	-131.1	0	2.85	0
Aug 23:00	-58.6	-154	0	2.85	0
Sep 0:00	-49.7	174	0	0	0
Sep 1:00	-46.4	152	0	0	0
Sep 2:00	-39.5	133.7	0	0	0
Sep 3:00	-30.4	119.1	0	0	0
Sep 4:00	-20.1	107.1	0	0	0
Sep 5:00	-9	96.6	0	0	0
Sep 6:00	2.2	86.6	12	0.01	16
Sep 7:00	13.4	76.5	127	0.14	256
Sep 8:00	24.1	65.3	273	0.41	511
Sep 9:00	33.7	52.2	400	0.81	744
Sep 10:00	41.6	36	495	1.31	924
Sep 11:00	46.6	16.2	552	1.86	1031
Sep 12:00	47.6	-5.8	561	2.42	1052
Sep 13:00	44.4	-27	529	2.95	985
Sep 14:00	37.8	-44.9	452	3.4	838
Sep 15:00	28.9	-59.4	329	3.73	628
Sep 16:00	18.7	-71.5	178	3.91	379
Sep 17:00	7.7	-82	53	3.96	128
Sep 18:00	-3.5	-92	0	3.96	0
Sep 19:00	-14.7	-102.1	0	3.96	0
Sep 20:00	-25.4	-113.3	0	3.96	0
Sep 21:00	-35.2	-126.6	0	3.96	0
Sep 22:00	-43.2	-143	0	3.96	0
Sep 23:00	-48.3	-163.3	0	3.96	0
Oct 0:00	-38.1	172.4	0	0	0
Oct 1:00	-34.9	154.5	0	0	0
Oct 2:00	-28.6	138.7	0	0	0
Oct 3:00	-20.3	125.4	0	0	0
Oct 4:00	-10.4	113.9	0	0	0
Oct 5:00	0.2	103.7	4	0	1
Oct 6:00	11.4	93.9	63	0.07	102
Oct 7:00	22.6	83.9	191	0.26	336
Oct 8:00	33.7	72.8	339	0.6	585
Oct 9:00	44	59.2	469	1.07	807
Oct 10:00	52.7	41.1	559	1.63	975
Oct 11:00	58.2	16.8	616	2.24	1068
Oct 12:00	58.7	-11.6	631	2.87	1076
Oct 13:00	54.1	-37	590	3.46	999
Oct 14:00	45.9	-56.2	500	3.96	844
Oct 15:00	35.8	-70.5	364	4.33	630
Oct 16:00	24.9	-82	218	4.54	384
Oct 17:00	13.6	-92.2	85	4.63	143
Oct 18:00	2.5	-101.9	10	4.64	17
Oct 19:00	-8.3	-112	0	4.64	0
Oct 20:00	-18.3	-123.2	0	4.64	0
Oct 21:00	-26.9	-136.2	0	4.64	0
Oct 22:00	-33.6	-151.4	0	4.64	0
Oct 23:00	-37.4	-168.9	0	4.64	0
Nov 0:00	-28.8	173.7	0	0	0
Nov 1:00	-26	158.1	0	0	0
Nov 2:00	-20.6	143.9	0	0	0
Nov 3:00	-13	131.5	0	0	0
Nov 4:00	-3.8	120.6	0	0	0
Nov 5:00	6.3	110.8	22	0.02	29
Nov 6:00	17.1	101.5	91	0.11	115
Nov 7:00	28.3	92.1	231	0.34	345
Nov 8:00	39.6	81.8	380	0.72	584
Nov 9:00	50.5	69	509	1.23	797
Nov 10:00	60.3	50.9	613	1.85	958
Nov 11:00	67.1	22.7	678	2.52	1048
Nov 12:00	67.9	-14.8	676	3.2	1057
Nov 13:00	62.2	-45.8	641	3.84	984
Nov 14:00	52.8	-65.7	561	4.4	838
Nov 15:00	42.1	-79.3	429	4.83	634
Nov 16:00	30.9	-90	271	5.1	398
Nov 17:00	19.7	-99.5	122	5.22	162
Nov 18:00	8.8	-108.8	35	5.26	33
Nov 19:00	-1.6	-118.4	2	5.26	0
Nov 20:00	-10.9	-129	0	5.26	0
Nov 21:00	-18.9	-141.1	0	5.26	0
Nov 22:00	-24.9	-154.9	0	5.26	0
Nov 23:00	-28.2	-170.2	0	5.26	0
Dec 0:00	-25.2	177.1	0	0	0
Dec 1:00	-23.2	162.1	0	0	0
Dec 2:00	-18.5	148.3	0	0	0
Dec 3:00	-11.5	136	0	0	0
Dec 4:00	-3	125.1	0	0	0
Dec 5:00	6.7	115.4	23	0.02	30
Dec 6:00	17.3	106.3	81	0.1	78
Dec 7:00	28.3	97.4	211	0.32	298
Dec 8:00	39.5	87.8	358	0.67	533
Dec 9:00	50.7	76.3	496	1.17	748
Dec 10:00	61.1	60.2	611	1.78	916
Dec 11:00	69.5	33.4	668	2.45	1018
Dec 12:00	72	-8.4	687	3.14	1043
Dec 13:00	66.8	-45.4	679	3.81	988
Dec 14:00	57.3	-67.1	594	4.41	859
Dec 15:00	46.5	-81	475	4.88	671
Dec 16:00	35.3	-91.6	320	5.2	445
Dec 17:00	24.1	-100.8	166	5.37	210
Dec 18:00	13.2	-109.7	54	5.42	39
Dec 19:00	3	-119	9	5.43	19
Dec 20:00	-6.4	-129.1	0	5.43	0
Dec 21:00	-14.4	-140.5	0	5.43	0
Dec 22:00	-20.5	-153.4	0	5.43	0
Dec 23:00	-24.3	-167.7	0	5.43	0

Appendix 2: Resist Report

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cawdromeli 16:20

RESIST 4.0.0.2475

RESIST(NZ) - Preliminary Lateral Load Design Architectural Report

RESIST is an application for the simplified evaluation of the structural performance of lateral load-resisting systems in a building under seismic and wind loads. It is designed to be used in educational settings as a guide for the sizing of lateral load resisting systems for Architectural and Civil Engineering students. RESIST should not be used as a final preliminary design; a full, complete preliminary design should be carried out by a structural engineer.

Project: **Te Haumaru**
Modeller: **cawdromeli**

Analysis Results

Results are percentage of max. allowable: <= 100% is OK; > 100% is Failure.
U=Ultimate Limit State, S=Serviceability Limit State (for smaller earthquakes that occur more frequently).

X-Direction: Reinforced Concrete Wall

	Wind	Seismic (U)	Seismic (S)
Drift	6%	37%	29%
Shear	6%	45%	34%
Moment	6%	32%	35%

Y-Direction: Reinforced Concrete Wall

	Wind	Seismic (U)	Seismic (S)
Drift	7%	46%	34%
Shear	8%	55%	41%
Moment	8%	39%	43%

Wind Vibrations

The building does not appear to be susceptible to wind vibrations or other serviceablility problems caused by wind. $H^{1.3}/M$ = 0.11 (should be less than 1.60; where H=building height (m) and M=Mass of building per unit height of building (tonnes/m))

Building Construction

Building Importance category	Normal structures
Number of storeys	3
Total height	30 m
Floor plan points	(-47.5, -54), (47.5, -54), (47.5, 54), (-47.5, 54)
Floor plan properties	Area: 1.026e+04 m^2; Perimeter length: 406 m; Centroid: (0, 0) m; Bound lengths: (95, 108) m
Inter-storey height	9 m
Floor	Weight type: heavy, Dead load: 5.30 kPa, Live load: office (3.00 kPa)

Interior wall	Weight type: light, Dead load: 0.30 kPa (over floor area)
External wall	Weight type: medium, Dead load: 1.26 kPa (over wall area)
Roof	Weight type: light, Weight type: light, Height: 3 m, Dead load: 0.40 kPa (over floor area), Live load: 0.25 kPa (over floor area)
Structure in X direction	Reinforced Concrete Wall (x 6) Locations: (-43.06, 53.36), (41.2, 54.21), (-40.45, -54.09), (40.98, -54.09), (-7.832, 26.71), (-6.553, -41.51)
Structure in Y direction	Reinforced Concrete Wall (x 4) Locations: (-47.61, 24.52), (47.18, 29.63), (0.2684, -25.31), (-14.87, 3.896)

Wind and Terrain Information

Design code	AS/NZS 1170.2:2002
Wind Region	W
Terrain category	Suburban
Lee effect zone	Outer
Site elevation	15 m

Regional 3 sec Gust Wind Speed

The regional 3 second gust speed (V_R) depends on the wind region, building design working life, building importance, and the limit state under consideration.

Limit State	Ultimate	Serviceability (SLS1)
Recurrence interval (yrs)	500	25
Regional 3s gust wind speed, V_R (m/s)	51	43

Seismic Information

Design code:	NZS 1170.5:2004
Hazard factor, Z:	0.45
Soil:	Medium soil (C)
Recurrence interval years:	500 (U) ; 25 (SLS1)
Return Period factor, R:	1.0 (U) ; 0.25 (SLS1)

Lateral Load Structure, X Direction

Type	Reinforced Concrete Wall
Design method	Limit-state
Number of walls	6

Wall length	12.000 m
Wall thickness	500 mm
Foundations	Foundation beam: centre-line distance between pads: 9.60 m, square pad width: 7.20 m, pad depth: 1.45 m To anchor the lateral resisting component against tensile uplift, provide 900 mm diameter tension resisting piles. These piles will probably have bulbs or bells at their bases to provide the tension resistance.
Penetrations in structural walls	Penetrations for doors, windows and services up to 15% of the wall length at ground floor, and greater above are allowed.
Minimum thickness	The minimum thickness to prevent wall buckling is 491 mm. The current thickness of 500 mm is sufficient.

Lateral Load Structure, Y Direction

Type	Reinforced Concrete Wall
Design method	Limit-state
Number of walls	4
Wall length	12.000 m
Wall thickness	500 mm
Foundations	Foundation beam: centre-line distance between pads: 9.60 m, square pad width: 7.80 m, pad depth: 1.58 m To anchor the lateral resisting component against tensile uplift, provide 1000 mm diameter tension resisting piles. These piles will probably have bulbs or bells at their bases to provide the tension resistance.
Penetrations in structural walls	As the wall shear stress is high, only very small penetrations for services (max. 300 mm) are allowable for the greater of one storey or a height equal to the wall length. Above this level larger penetrations are possible.
Minimum thickness	The minimum thickness to prevent wall buckling is 491 mm. The current thickness of 500 mm is sufficient.

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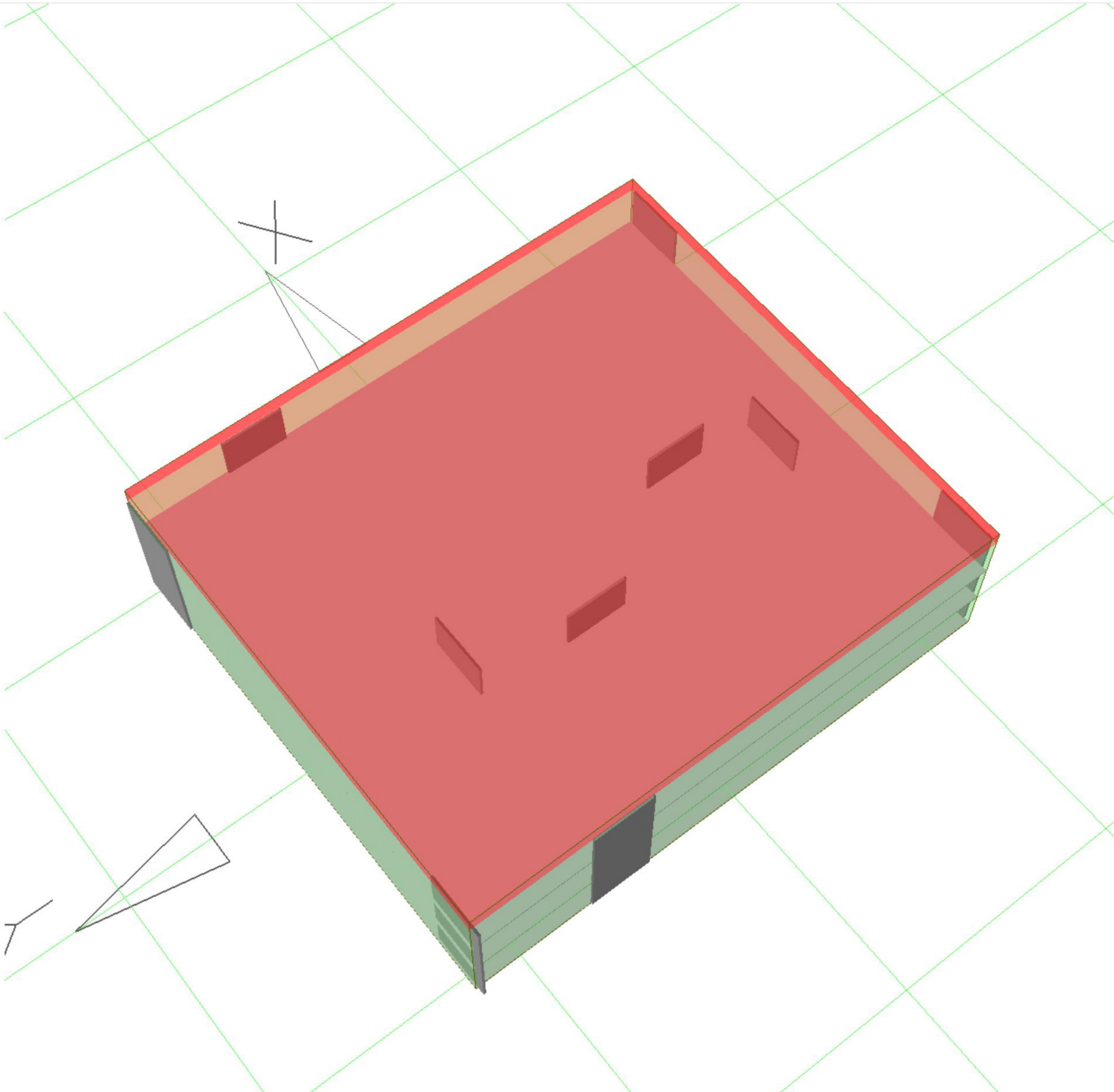

RESIST Limitations

RESIST has been designed as an education tool, primarily for Architecture students, as a means for initial sizing of lateral resisting elements for wind and earthquake loading.

RESIST may be used as a small part of the overall design process:

1. Initial preliminary design. RESIST can be used as a way of initial sizing and testing options, providing a point of discussion between architects and engineers.
2. Once a conceptual design has been formulated, the Structural Engineer will carry out another preliminary design, where ALL assumptions and initial sizes are re-evaluated for accuracy and appropriateness. RESIST cannot be used as a substitute for a complete preliminary design by a Structural Engineer.

3. Final design will follow from the structural engineer's preliminary design, and the results from RESIST should have no influence on this stage of the structural design.

RESIST does not analyse or design the following:

- Floor diaphragms are not evaluated by RESIST. It is assumed that the floor diaphragms have sufficient rigidity and strength to transfer loads to all the resisting elements. They are assumed to be rigid. The floor plan editor allows non-rectangular floor diaphragms, which if highly irregular will require careful design by the Structural Engineer.
- Connections within the resisting elements and the rest of the building are not analysed or designed by RESIST. Such connections are critical to the performance of the building, and are assumed by RESIST to be have sufficient strength to ensure the expected performance of the resisting elements.
- RESIST assumes the lateral structure to be uniform for the full height of the building. In practise section sizes will reduce with height, but this requires careful design by the Structural Engineer.
- The design of Steel Eccentric Braced Frames (EBF) requires careful design to ensure they behave as expected. RESIST only carries out an initial assessment of the design of the EBF; there are many other aspects to the design of EBF that will require design by the Structural Engineer.
- RESIST uses an elastic approach for evaluating torsion effects. Generally torsion effects should be evaluated by taking into account inelastic deformations.
- RESIST does not carry out a design of gravity load support system, e.g. columns and beams, floor system.
- The lateral resisting systems provided by RESIST are only representative of the possible choices currently available. New technologies such as buckling restrained braced frames, base isolation, and other systems may be a suitable choice for a building. The Structural Engineer will provide guidance.
- Fire protection of members is not accounted for by RESIST. If required this may require an increase in the overall size of the members.
- RESIST does not analyse hybrid resisting systems where different resisting systems are used in the same direction, e.g. walls and frames.
- RESIST allows only resisting systems aligned to X and Y axes.