EMERGENCY RELIEF STATION

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By

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Figure 0.0 Image of author at the end of year master exhibition.

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Figure 0.1 Speculative rendering of Wellington Airport visualising ships and aircraft in a crisis.

ABSTRACT

This thesis explores the potential large public architecture offers for efficient transformation into a relief station in post-disaster situations. The increase in catastrophic disasters globally has demonstrated a widespread lack of preparedness in these situations. There is a shortage of safe, comfortable, and self-sufficient hubs for coordinating relief activity, for sheltering temporarily and providing emergency care to disaster victims, and relief personnel.

Disaster relief generally involves the urgent dispatching of medical supplies, food, water, blankets, sanitation systems, temporary shelters, and relief personnel to affected locations. Following the recent devastating spate of earthquakes and flood disasters in New Zealand makeshift relief centres were set up in public parks, schools, and community facilities to house displaced victims. These were set up to function as efficient relief stations. The facilities also depend heavily on deployed relief supplies and the public for donations and support. In addition, these relief hubs are quickly overwhelmed and in adverse weather conditions, they are inadequate for providing warm, dry, hygienic, and safe environments for sheltering large numbers of people including the injured and the sick.

This thesis explores how an airport may be designed for a dual purpose and the feasibility and complexity of planning and designing public space for transformation into a disaster relief station.

CONTENTS

	<i>Acknowledgements</i>	V
	<i>Abstract</i>	VII
01	INTRODUCTION	01
	<i>Introduction / Problem</i>	03
	<i>Proposal</i>	04
	<i>Research question, aims and objectives</i>	11
02	LITERATURE	15
	<i>Self-sufficient</i>	19
	<i>Perception problems</i>	21
	<i>Non-structural shelters</i>	23
	<i>Coherent connections</i>	25
	<i>Adapting airports</i>	27
	<i>Service systems</i>	29
03	PRECEDENT	33
	<i>Christchurch Justice and Emergency Precinct</i>	37
	<i>Los Angeles Operation Centre</i>	39
	<i>Tokyo Rinkai Disaster Prevention Park</i>	41
	<i>Kansai International Airport</i>	43
	<i>Sabiha Gokcen Airport</i>	45
	<i>Maderia Airport</i>	47
04	SITE	51
	<i>Site location</i>	53
	<i>Site analysis maps</i>	55
	<i>Site heights</i>	61
	<i>Earthquake hazard maps</i>	63
	<i>Airport scale</i>	67
	<i>New Zealand airports</i>	69
	<i>Alternative airport location</i>	71
	<i>Wellington relief hubs</i>	73
	<i>Population</i>	75
05	PROGRAMME	77
	<i>Programme</i>	79
	<i>Dual purpose</i>	81

06	DESIGN	87
	<i>Terminal</i>	89
	<i>Circulation study</i>	93
	<i>Sketch exploration</i>	97
	<i>Elevated</i>	99
	<i>Submerged</i>	101
	<i>Form exploration</i>	103
	<i>Initial design</i>	115
	<i>Refined design</i>	121
 07	 OUTCOME	 123
	<i>Plans</i>	129
	<i>Axonometric</i>	137
	<i>Elevation</i>	143
	<i>Section</i>	145
	<i>Renders</i>	147
 08	 DISCUSSION	 155
	<i>Emergency relief station</i>	157
	<i>Airport + station</i>	159
	<i>Form justification</i>	163
	<i>Structure</i>	169
	<i>Logistics</i>	171
	<i>Circulation</i>	173
	<i>Existing plan</i>	175
	<i>Public vs private</i>	177
	<i>Expansion</i>	179
	<i>Future trends</i>	181
 09	 CONCLUSION	 183
	<i>Limitations</i>	185
	<i>Findings</i>	186
	<i>Further research</i>	187
	<i>Importance</i>	188
	 <i>Bibliography</i>	 191
	<i>List of figures</i>	195

01

INTRODUCTION

Chapter one

This chapter provides an overview of the problem and proposal of the research. It outlines the research question, aims, scope and method.

INTRODUCTION

Wellington City, the Capital of New Zealand, is situated within the Pacific ring of fire, a region known for much of the world's tectonic activity. The city lies on the earthquake generating collision zone between the Australian and Pacific tectonic plates. There are many active geological faults situated under the city, one being the Wellington fault (GNS Science). Geoscientists estimate the Wellington Fault last ruptured between 300 - 500 years ago generating a magnitude 7.6 earthquake. This fault produces a large earthquake every 500 - 1000 years (GNS Science). Throughout the past decade, New Zealand has experienced a great deal of seismic activity including magnitude 7.8 & 7.0 earthquakes, which have affected Wellington in 2012 and 2016. The Christchurch Earthquakes in 2010 & 2011 has brought to light Wellington's unique vulnerabilities and lack of preparedness to withstand and cope with the emergency requirements after a major earthquake.

PROBLEM

A council report on Wellington's resilience has predicted a magnitude 7.5 earthquake could cut off the Capital's main transport routes for months, cut power, and water for weeks and cut telecommunications for days (Mowll). All major transport infrastructure such as road, train, ferry and airport terminal is built near active fault lines and surrounded by water. In the event of a major earthquake, the residents of the city can only evacuate in two directions, North by motorway or South towards the airport. There is a high risk of the transport arteries becoming fragmented and the residents in the city being left stranded with no way in or out of the capital.

SEISMIC VULNERABILITY

Figure 1.0 Map of Wellington City overlaid with primary and secondary fault lines showing blockage of exit routes from the city.

VITAL LIFELINES

An earthquake with a magnitude 7.5+ on the Richter scale would have a devastating impact on key infrastructure within the Wellington Region. Figure 1.3 shows key restoration times in days for key transportation and utility lifelines for the region.

The airport and state highway 1 and 2 will be used the most to evacuate the city in a crisis. The airport is estimated to be operational for military and turbo prop use in 7 days and fully operation after 120 days. State highway 1 and 2 could take up to 120 days for road access to be restored after landslides and tunnel blockages. The rail access will be affected similarly to the road network as it follows state highway 1 and 2. The port is estimated to be partially operational in 7 days. Large barge ships will dock in the harbour if the port is not functional with small boats bringing supplies to shore (Wellington Lifeline Group, Restoring Wellington's transport 5).

To reach operational levels for power it would take 3 months to reconnect Wellington CBD, 60 days for the eastern, western, and northern suburbs. It could take 60 to 70 days for Hutt City and 40 days for Porirua. Water will take 70 days to reconnect Wellington eastern suburbs, 55 days for the western suburbs, CBD, 45 days for the northern suburbs and 25 days for Hutt city. In addition, it would take Gas 3 months to reach operational levels.

The hilly terrain of the Wellington Region makes the provision of emergency sewage disposal challenging, to reach basic operational levels will take months. Restoration of telecommunication services will take 10 days (Wellington Lifelines Report, Lifeline Utilities Restoration 24)

120

*7 days partially operational
(military and turboprop only)
120 days fully operational*

120

*120 days for state highway to be
restored*

120

*120 days rail access will be
affected similarly to the road
network*

95

*3 months for Wellington CBD,
60 days for eastern, western &
northern suburbs
60 -70 days for Hutt City
40 days for Porirua central*

80

80 + days for the region

70

*70 days for Wellington east
55 days for Wellington CBD
and western suburbs
45 days for the northern suburbs.
25 days for Hutt City*

60

60 + days for the region

10

10 days to operational level

7

7 days partially operational

^

Figure 1.2 Infographic showing recovery times of vital infrastructure from Wellington Lifeline group reports.

PROPOSAL

As in many cities in the world, the airport serves as the main gateway in and out of a city. During a significant crisis, the airport is used to bring in emergency personnel to the city and evacuate the injured. Wellington airport due to its placement at the southernmost point of the city is an important evacuation point for its residents. In a disaster situation and a compromised airport, the residents of the city would be forced to go north placing unnecessary pressure on an already congested and fragile transportation infrastructure network with thousands trying to vacate the city in the same direction.

The need to design airport terminals that can survive a major disaster during a crisis is increasingly becoming the primary design criteria. It offers the opportunity to explore the potential of transforming a highly valuable public resource to an emergency relief hub. This design thesis will generate architectural design ideas for a resilient airport and the reuse of its day-to-day functional spaces. It will identify through design pre-disaster planning methods for transforming the architecture of an airport into efficient and functional emergency architecture. This is a speculative exploration of what could or might be done to better prepare airports and utilise the infrastructure and resources of airports.

*Wellington Airport located in
the southern point of the city*

*State Highway 1
Wellington's main way in
and out of the city*

Figure 1.3 Aerial view over Wellington CBD showing the airport in the background and motorway in the foreground.

Q U E S T I O N

How might an airport terminal be transformed into an emergency relief station, during a disaster situation while maintaining its primary function?

A I M S

- This research seeks to develop a new airport terminal designed to be resilient in a major earthquake.
- To investigate through design the adaptability of an airport terminal, to an emergency relief station, in the event of a disaster.
- To further enhance the pre-disaster planning of airports in cities around the world.
- To explore how pre-disaster planning and design of airports can be incorporated to disaster resilience.

SCOPE

This research focuses on Wellington Airport and the passenger terminal building. It does not involve any other airport support buildings such as freight, fuel, catering, and any other diverse air support structures. A limitation to the research is that there is no consultation with airport design specialists and professionals. This is a purely speculative design project which seeks to explore the potential an airport offers for dual function in a disaster. The findings and strategies could be applied to other airports in New Zealand and possibly around the world.

METHOD

This thesis begins by looking at Wellington and the earthquake risks associated with the site. A literature review helps to inform key ideas about emergency response and facilities. It also helps to inform current airport trends and identify emergency aspects of an airport, which can be used during a crisis. The precedent study helps to inform key design decisions which can aid with the design of a new terminal. The site analysis, literature review, and precedent study all help to inform the programming of the design. The research then tests ideas, explores a design, and produces an outcome. Throughout this stage, the design is explored from a macro to micro scale. A conclusion discusses key findings and suggests/identifies research improvements.

Figure 1.4 Thesis method diagram showing cyclical research stages.

02

L I T E R A T U R E

Chapter two

This chapter analyses literature on emergency response and facilities. It also analyses airport future trends and facilities which can aid in the event of an emergency.

L I T E R T U R E R E V I E W

The literature review analyses and explores relevant literature on 4 key topics, these are:

Emergency response

In New Zealand, disaster response teams arrive at an airport in the event of a major emergency from different regions of the country and overseas to provide relief assistance. An airport relief station can provide vital facilities for these teams to begin and carry out work.

Emergency facilities

Analysing emergency facilities in New Zealand and around the world can help identify the shortcomings and develop the understanding of how they operate.

Airport trends

In order to design an airport for the future, an analysis of the latest trends shows what directions airports design is heading in and how these might be integrated into the design.

Airport facilities and systems

To utilise an airport as a relief station, it is important to understand what emergency infrastructure the airport currently uses and how they may be utilised or improved on.

This is then translated into six key ideas.

01

Self-sufficient

Emergency response

02

Perception problems

Emergency facilities

03

Non-structural shelters

Emergency facilities

04

Coherently Connected

Airport trends

05

Adapting Airports

Airport facilities and systems

06

Systems & Staff

Airport facilities and systems

^

Figure 2.0 Diagram of the literature review into six key ideas.

SELF SUFFICIENT

During an emergency crisis, the public look to evacuate the city and emergency response teams arrive to provide aid and assistance. An understanding of how these teams operate can aid the design of a new terminal.

The “New Zealand defence force” [NZDF] will be deployed in a natural, man-made, national, local or state emergency. The NZDF can arrive into a crises situation and be “completely self-sufficient”. They can arrive by sea, air, rail and road with the “intention not to impose any further burden on an already stressed scene”. The commander of joint forces would ensure a military response is sufficient in terms of transport, communications, health, rationing and accommodation. The military response is based around agile task units which can be added to, withdrawn, and reassigned dependent upon the scope and level of the response required (Headquarters Joint Forces New Zealand 21).

New Zealand has various arrangements with other countries to assist in resource management of emergencies. “Urban search and rescue [USAR] teams” are an example of this prearranged assistance (McLean, Oughton and Ellis 64). According to the International Search and Rescue Advisory Group, USAR teams which are deployed internationally “must be self-sufficient”. This is “to ensure they are at no time a burden to the already overwhelmed country they are trying to assist” (International Search and Rescue Advisory Group 35). During the Christchurch earthquakes of 2010 and 2011, New Zealand USAR teams worked alongside many international USAR teams (Civil Defence 5). The teams are arrive prompted prepared and ready to be deployed.

^

Figure 2.1 New Zealand Defence Force arriving into Kaikoura after magnitude 7.8 earthquake in 2014.

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Figure 2.2 Urban Search and rescue team from Japan assist in Christchurch after magnitude 6.2 earthquake in 2011.

PERCEPTION PROBLEMS

In New Zealand, each region has its own pre-identified emergency facilities for public use in the event of a crisis. These facilities are commonly known as “Civil Defence Centres or Welfare Centres”. These facilities are in “local primary schools, community centres, and other community gathering spaces”. Opened by local Civil Defence volunteers the facilities provide basic shelter, food and aid. After the 2010 and 2011 Christchurch Earthquakes, the Wellington Region Emergency Management Office [WREMO] changed the centres in the Wellington region to “Community Emergency Hub”. This change has come from what was seen in “Christchurch and other disasters around the world). People naturally come together and help each other. A reason for this change is that authorities are not realistically able to keep Civil Defence Centres “freshly topped-up”. Previously ageing survival supplies such as old blankets and stretchers had been distributed in volumes too small to sustain entire communities. According to “WREMO there are “perception problems” around the old Civil Defence centres”. The public viewed them as “Cold War-style bunkers”. In addition, there is an “expectation in some regions Civil Defence will sort out everything after an after Emergency” (Shadwell). This may have contributed to unrealistic expectations and widespread disappointments during a crisis.

Figure 2.3 Comparison between Civil Defence Centre and Emergency Community Hub.

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Figure 2.4 Supplies within the Emergency Community Hubs.

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Figure 2.5 Radio communication devices in Emergency Community Hubs.

NON - STRUCTURAL SHELTERS

In recent years, many countries use different emergency shelters for temporary use during a crisis. Many of these shelters are improvised and used as a last resort to protect people.

During Hurricane Katrina in 2005 thousands of people did not obey the mandatory evacuation order in New Orleans. Shelters of last resort such as the Superdome and New Orleans Convention Centre were used out of “sheer necessity and improvisation”. The city had “no comprehensive database of available shelters which complicated relief efforts”. As with most natural disasters, some evacuees only needed short-term shelter and were able to return home after the immediate crisis passed (Select Bipartisan Committee 311). During hurricane Katrina, the super dome proved to be an ineffective shelter as the “roof suffered extensive wind damage”. Many residents who took refuge there found conditions “unbearable” (312).

During the Japan Earthquake of 2011 “twenty-one temples and shrines” were identified through a series of interview surveys conducted in three municipalities as having been converted into evacuation centres (Okubo 6.3.1.1). Sixteen converted indoor space into sleeping areas with tatami [traditional Japanese straw floor] mats. Many already had existing toilet facilities and eleven had pre-existing indoor areas for providing meals. There were widespread power outages, but candles used for religious ceremonies kept in storage were used for light (6.3.1.2).

The Central African Republic experienced an escalation in violence and tension from the end of 2012 to 2013. People took refuge in buildings such as “churches, schools, and improvised camps”. The shelters were used at night from 6 pm to 6 am to protect people from the violence. This allowed people to live in dignified conditions, without threats to their personal safety. Security was maintained by high boundary walls, flood lighting and the presence of international peacekeeping troops (Leon, Scales and Saunders 4,5).

In conclusion, many different types of buildings are used as disaster shelters and temporary accommodation, these include schools, community halls, recreation centres, churches, shrines, temples, stadiums and convention centres. Some of these spaces are not structurally designed to withstand an earthquake and multiple aftershocks, they are not self-sustaining, and they are not designed to cater as temporary accommodation post-disaster.

^

Figure 2.6 Hurricane evacuees huddle inside the Superdome.

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Figure 2.7 Shelters used in the internal conflict in Africa.

COHERENT CONNECTIONS

To design an airport for the future it is important to understand the current trends and direction airports are headed in. Airports in the 21st century are evolving fast and becoming more streamlined with the use of new technology.

Air travel today is defined as “seamless travel” moving from point A to B without issue. Seamless travel uses technology to ensure check-in and security checks are as quick and efficient as possible. There is a move towards automation in the passenger processing industry with online check-in already a commonplace. Self-service kiosks, self-bag drops, and electronic passport scanning are now becoming more widespread (McKenna). New security technology such as biometric facial recognition, the use of face scanning instead of using a passport allows the passenger to “seamlessly travel” through the airport faster. Avoiding long check-in and screening times (International Airport Review). Rising terrorist activity and regional tensions also place the spotlight on airport security. Along with new technology already in use, there are new airport security screening technologies emerging (McKenna). The airport of the future is utilising technology to speed up and eliminate the security boundary. The new technology is also trying to make the airport safer for future passengers.

Air travel is now available to many more people than ever before and in its relatively short history. As a result, passengers are now seen as a captive market for airport retailing (Pearman 10). With seamless travel, faster security and short check-in times passengers now have a longer time to spend in airport retail. Airports today are used for more than just transport they are part factory, part shopping mall and part distribution centre (25) An airport “combines elements of several other building types of today” airport terminals are “hybrids”(Pearman 14).

Airports have evolved considerably over the last century and now are hubs that entertain dazzle and enhance the passenger experience. With the airport continuing to grow and increasing its programming by adding, retail, food and beverage and it can also need to increase its emergency facilities.

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Figure 2.8 Automated immigration gate at Singapore Changi International Airport terminal 4.

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Figure 2.9 Arrival Hall at Singapore Changi International Airport terminal 4.

ADAPTING AIRPORTS

All airports provide and use facilities for emergencies these include a command centre, airport clinic, fire and police stations.

These facilities are used around the airport to ensure order and safety the modern airport uses a “sophisticated command centre” which has a variety of sensors, surveillance devices, and other data streams for monitoring the airport and flights every day (Ferreira). The command centre is the beating heart of the airport. In an emergency, the centre will manage all emergency action to ensure smooth operation. With millions of passengers travelling around the world every year airport passengers become sick or injured at the airport or on flights. At small airports, a trained staff member provides medical assistance. Some airports provide a “first aid room” and it is recommended that an “airport medical clinic” be available when employee’s number 1,000 or more. The clinic is already included in the community emergency services organization and planning. In the event of a large-scale emergency, the clinic can function as the coordination site for incoming passengers which need medical assistance during a crisis (Leonard 59).

Airports are equipped with fire stations situated outside of the terminal, their prime responsibility is to minimize the loss of life. The Wellington fire service team has 27 staff who are trained in “Airport Rescue Fire Fighting best practice standards” and Civil Aviation Authority requirements. Firefighters are “trained in delivering emergency care, use of defibrillator equipment, resuscitation and attend medical emergencies” within the airport area (Wellington Airport). Airports also have police stations located inside the terminal for dealing with immigration issues and general safety. Within Wellington airport, all employees are required to complete an “airport safety induction course” before starting work. Half of all the airport employees work in “official safety roles” (Wellington Airport). The staff employed at the airports have a wealth of knowledge and training to provide aid and initial emergency response to passengers at the airport.

As safety is a priority at airports all around the world on-site fire brigades, staff with medical knowledge, police officers and staff with safety training is an asset for an emergency relief station. The airport is one of the only forms of public architecture where fire police and medical are present together.

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Figure 2.10 Wellington Airport fire station.

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Figure 2.11 Wellington Airport fire truck.

S E R V I C E S Y S T E M S

The advancement in technology has equipped airports with sophisticated services and systems. These systems can pass information on to passengers, staff, security personnel, and government agencies daily.

Airports are equipped with a state of the art “mass notification system” passengers can be notified of important information throughout the passenger terminal. The airport’s “public address system” displays messages visually through the airport display screens and broadcast either pre-recorded messages or real-time messages. Advances in speaker and audio measuring technology ensure audible messages are intelligible and loud enough to be heard over the ambient crowd noise. “For international airports, messages are often broadcast in multiple languages”. These systems are used to communicate flight information such as boarding calls, flight delays cancellations and can be used in a crisis to broadcast messages to passengers. These information systems are used to maintain order and draw attention to vital information for efficient management of large crowds of people, emergency situations and to ensure general safety and wellbeing of passengers and staff (Ferreira).

Airports use a technology called “dynamic exit signage” this refers to exit signage, which changes state during an emergency event. The simplest dynamic signs sign flashes a portion of light that requires passenger attention, thereby increasing its visual attractiveness to draw attention to the information it wants to convey. More complicated dynamic signage can change the direction of movement indicated on the sign or can identify the path of travel from a trail of lights. Dynamic signage can be used to direct people from the airport to evacuation areas or gathering spaces (Ferreira).

Many airports today offer free wireless internet connections. San Francisco International Airport has become the first airport in

the United States to issue “Wireless Emergency Alerts”. These can be issued to any mobile phone located on airport grounds. Staff can quickly reach airport employees, passengers, and members of the public on airport grounds to provide critical information in an emergency (International Airport Review).

Airports are becoming well connected, safer and technologically sophisticated hubs that can serve people and communities more efficiently during an emergency crisis.

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Figure 2.12 Airport display screen.

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Figure 2.13 iPhone displaying airport wireless alert.

REVIEW CONCLUSION

- Emergency response teams arrive from diverse destinations fully equipped and self-sufficient and ready to be deployed immediately.
- New Zealand has pre-arranged response teams locally and internationally already in place to respond in a crisis.
- In New Zealand, there are perception problems over what aid and assistance Civil Defence Centres and Community Emergency Hubs provide.
- Wellington is the first regions in New Zealand to remove Civil defence centres and implement community emergency hubs.
- There is a need for structurally designed shelters suited for the emergency and accommodation needs of large numbers of people and for use in large-scale crisis situations.

- Airport trends are moving in the direction of self-service.
- Airports have advanced technological systems that would benefit people in an emergency.
- Airports have vital emergency facilities such as fire police and medical built into its safety systems.
- At Wellington airport half its staff are trained in emergency areas.

03

PRECEDENTS

Chapter three

This chapter provides examples of how architects and engineers have designed emergency infrastructure and airports on sites with constraints. An analysis of the different methods used can aid with the design.

P R E C E D E N T S

To understand the current problems, countermeasures and programming requirements for a disaster facility and airport, two types of precedents were analysed. The first being emergency facilities used during disaster situations the second being airports with earthquake countermeasures. The precedents come from regions with earthquake hazards such as Japan, California, Istanbul and Christchurch.

The precedent study is broken down into two parts. The first is airport designs built to withstand conditions on their site. The second is emergency buildings built to use in a time of crises.

Two types of precedents were analysed

1. Emergency operation buildings.
2. Airports established on challenging sites.

A reflection on these precedents will help inform structural design techniques, programming and generate flexible design ideas for seismic resistance.

Emergency operation buildings

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Figure 3.0 Christchurch Justice and Emergency Precinct.

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Figure 3.1 Los Angeles Operation Centre.

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Figure 3.2 Tokyo Rinkai Disaster Prevention Park.

Airports established on challenging sites

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Figure 3.3 Kansai International Airport.

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Figure 3.4 Sabiha Gokcen Airport.

^
Figure 3.5 Madeira Airport.

CHRISTCHURCH JUSTICE & EMERGENCY PRECINCT

*Architect: Warren and Mahoney, Cox Architecture
and Opus Architecture*

Engineers: Holmes Consulting Group

Location: Christchurch, New Zealand 2017

Built as a response to the 2010 and 2011 Christchurch earthquakes the precinct brings together all justice and emergency services into one purpose-built precinct in Central Christchurch. The precinct is made up of three separate buildings that include The Justice Building, Emergency Services Building and a car park for operational vehicles. Each building is connected by overhead bridges with a total area of 40,000m² over five floors. It is built to a New Zealand Importance Level 4 standard ensuring the precinct will withstand significant seismic events. The entire building is base isolated, using a combination of lead-rubber bearings and PTFE sliders. These are placed within the seismic isolation plane formed at the underside of Level 1. The primary structure is formed with a structural steel two-way movement-resisting frame, while a facade system encapsulates the buildings (Fletcher Construction). To stop liquid fraction 20,000 cubic metres of soil was excavated, mixed with 2,500 tonnes of cement and placed back in the ground to support a heavy-duty 1.2m thick concrete base (Collins). The precinct is heated and cooled using aquifers located beneath this allows the precinct to remain self-sufficient in the event of a disaster.

The Justice Building has 19 courtrooms encompassing the High Court, District Courts, Family, Youth, Maori, Land, Environment and other special jurisdictions and legal functions. The Emergency Services Building encompasses police, ambulance, fire, corrections, and civil defence agencies. They provide a state-of-the-art emergency response capability for local, regional, and national incidents. The Emergency Operations Centre is where police, fire, ambulance, and civil defence types will gather to command a natural disaster response, and day-to-day police and fire responses. The building provides 72-hour resilience in a crisis and is supported by backup services these include (Harvie).

Figure 3.0 Christchurch Justice and Emergency Precinct.

Seismically isolated buildings.

Underground aquifer as a water source.

Generator power in emergency.

Base-isolated at level one.

1.2m thick concrete slab foundation.

Calming courtyard space.

Figure 3.6 Diagrammatic sketches showing key case study findings for Christchurch Justice and Emergency Precinct.

LOS ANGELES EMERGENCY OPERATION CENTRE

Architect: Fluor/HOK

Engineers: Saiful Bouquet

Location: Los Angeles, United States

The Los Angeles emergency operation centre houses the city's emergency, police, the fire department in one secure facility. The building is 2 stories' high with a basement level and covers 7,500m². Officials can coordinate the city's response to major disasters such as fire, flood, earthquakes, terrorism and large public events (City of Los Angeles EMD). The building is constantly monitored with 24 hours on site guard's, video and surveillance systems (HOK).

The building is connected to the ground on 40 suspension points. These points use base-isolated friction pendulum technology which enables the building to withstand a magnitude 8.0 Earthquake. This structural system allows the building to move side to side by a meter and move up and down by half a meter. All gas, power, water, sewage, and communication pipes are designed with flexible connections and with a lot of slack to accommodate ground movement. The stairs are also raised off the ground and connected to the ceiling above allowing them to freely move during an earthquake (Malkoff). The floor was raised 400mm to accommodate the underfloor air technology, as well as the extensive cabling required for emergency operations (HOK). The building is set back 9m from the street, with high-performance metal and stone exterior surfaces which are blast-resistant (HOK). The entire building is self-sufficient and supported by emergency backup generators, a centralized uninterrupted power source, reserve water storage tanks, redundant heating/ventilation/air conditioning systems and reserve sewage storage tanks (Malkoff)..

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Figure 3.1 Los Angeles Operation Centre.

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Figure 3.7 Diagrammatic sketches showing key case study findings for Los Angeles Operation Centre.

TOKYO RINKAI DISASTER PREVENTION PARK

Location: Tokyo, Japan

The Park acts as a central base of operations for a disaster situation in Tokyo, Japan. The park is made up of a disaster prevention base, which provides emergency response services. The entire facility is established on a base isolated system, including the transmission antenna tower. There are conference rooms and an operations room where important decisions are made about a disaster and coordination efforts. There is also a learning centre open to the public. The facility is fully self-sufficient and features 2 emergency power generators, kerosene operated, with 90,000 litres of fuel in stock making it operate able for three days. This facility also has 139 tons of stored water in 2 networks of water tanks, 6 tons of water dedicated to drinking, 133 tons dedicated to showers and other water systems. In addition, it has 7 days' worth of food and bottled water in stock. Emergency sleeping rooms, showers and during an emergency the park may be used as temporary shelters.

The park features an outdoor area used as a base camp for response teams, medical care and a helipad. During a standard day, relevant organizations exchange disaster-related information, run simulations and training to prepare for future disasters. The outdoor plaza is where emergency response teams such as police, firefighters and other teams can set up camp. In the park, 11 lampposts are equipped with electrical and internet connections. There are 4 shelters, 4 drainage facilities for temporary toilets, 6 benches that double as stoves and all park lights are powered by solar energy. Many manholes are provided, and these are ready to be covered for use as toilets (The Tokyo Rinkai Disaster Prevention Park).

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Figure 3.2 Aerial view of Tokyo Rinkai Disaster Prevention Park.

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Figure 3.8 Diagrammatic sketches showing key case study findings for the Tokyo Rinkai Disaster Prevention Park.

KANSAI INTERNATIONAL AIRPORT

Architect: Renzo Piano.

Engineers: Ove Arup & Partners

Location: Kansai Japan 1994

The airport is built on an artificial island and designed to meet stringent seismic and wind loading criteria. The soft Holocene clay sea floor had to be reinforced. The engineers drove a million sand piles 20m long and 400mm diameter at 2.5m intervals into the ground. This helped to absorb the moisture in the alluvial clay (Kansai International Airport Land Company).

The main terminal building sits on 900 pillars which are each designed to enable height adjustment through jack up operations. The adjustable pillars are lifted using a hydraulic jack and iron plates are inserted underneath to maintain the adjustments. (Kansai Airports).

Kansai Airport is surrounded by an environmentally friendly seawall made of stones. The seawall helps to block abnormally high waves during high tide and typhoon swells. The height of the walls and the waves were established through the study of the highest sea level recorded in the history of Osaka Bay.

The terminal building is designed to be light weight with flexible joints and serpentine fuel pipes are used to ensure there are no pipe tears or leaks (Margherita).

The external smoothness of the airport is a direct response to the typhoons. There are no lips eaves, skylights, or parapets to catch the wind (Ibid).

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Figure 3.3 Kansai International Airport.

*Seawall protection
from high wave..*

*Layout of airport
in precincts.*

*Adjustable
columns.*

*Asphalt runway
Surface.*

*Sand piles to
strengthen
foundations.*

*Smooth exterior
surface for wind flow.*

^
Figure 3.9 Diagrammatic sketches showing key case study findings for Kansai International Airport.

SABIHA GOKCEN AIRPORT

Architect: Tekeli-Sisa Architecture Partnership

Engineer: ARUP Istanbul & ARUP Los Angeles

Location: Istanbul, Turkey 2009

Sabiha Gokcen Airport uses a base isolation device to respond to the regular earth movements caused by earthquakes. An understanding of this device and how it is used can be applied to the design of a new terminal in Wellington due to the seismic nature of this site.

Located near the North Anatolian Fault Sabiha Gokcen Airport terminal is designed to withstand an earthquake as strong as a magnitude 7.5 (ARUP). The terminal uses a building technology called “triple friction pendulum isolators”. The terminal sits on 300 isolators enabling it to move in a controlled manner absorbing seismic energy in the event of an earthquake (Mara).

The building is made from a steel structure with a simple rectangular plan dimension of 160m x 272m. The height is 32.5m with 4 stories above and a basement floor below the isolation plane. Typical floor heights are 6m at ground floor and 5m at upper levels (ArcelorMittal).

The isolated superstructure resists lateral seismic loads through a system of steel moment frames with rigid horizontal 16 x 16 diaphragm joints (Mara). The superstructure is composed of concrete filled steel decks, composite steel beams and composite steel columns. The framing for the stairs and elevators below the isolation plane is suspended from and braced by the isolated super structure above (ArcelorMittal).

^
Figure 3.4 Sabhia Gokcen Airport.

Simple square building.

16 x16 grid moment frame.

Lightweight roof.

Triple Pendulum Base Isolator.

Elevator framing connected to ceiling.

Composite steel columns and beams.

^
Figure 3.10 Diagrammatic sketches showing key case study findings for Sabhia Gokcen Airport.

MADEIRA AIRPORT

Engineer: Andrade Gutierrez

Location: Madeira, Portugal, 2000

A third of Madeira's Airport runway is built to a length of 1020m and 180m wide. Built on reclaimed land the structure is made of reinforced concrete and consists of an array of large portal frames with circular columns and beams. The foundations are through large concrete footings, concrete foundation piles in areas reached depths up to 60 metres (IABSE).

The runway can accommodate wide-body airliners such as the Boeing 747. When an aeroplane lands, the shock of the landing is absorbed through the concrete columns then transferred through to the ground (ibid). The runway is made of segments joined together and connected by expansion joints allowing each segment to move up to 300mm (FPC Italia). The land underneath the runway extension is accessible used for roadways, parking lots, Skateboard Park and multi-use sports courts which overlook the ocean.

Bridge

<i>Above sea height</i>	<i>57m</i>
<i>Length</i>	<i>1020m</i>
<i>Width</i>	<i>180m</i>
<i>Deck Thickness</i>	<i>1.0m - 1.7m</i>
<i>Number of Piles</i>	<i>180</i>
<i>Column Diameter</i>	<i>3m</i>
<i>Span</i>	<i>32m</i>

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Figure 3.5 Madeira Airport..

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Figure 3.11 Diagrammatic sketches showing key case study findings for Madeira Airport..

PRECEDENT CONCLUSION

- All Emergency buildings bring together vital services into one location.
- These facilities are self-sufficient with off the grid power, water, sewage, and food.
- All emergency buildings have a similar main control centre where everyone can gather.
- All emergency facilities have a dual-purpose use, there is a day to day function and emergency function.
- Most buildings analysed were base isolated in response to site conditions.
- All buildings are relatively new and built in the last 20 years except for Kansai International Airport which was built in 1994.

Precedent findings

Figure 3.12 Diagrammatic sketches showing key case study findings for all precedent studies.

04
S I T E

Chapter four

This chapter introduces the site chosen for this study and an analysis of the context. It includes information on the existing airport building, services, transport, and future planning. Maps and diagrams aim to convey information important to the research that informs the project.

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

Wellington International Airport
Stewart Duff Dr, Rongotai
Wellington, 6022
New Zealand

Wellington International Airport is the test site chosen for this exploration. The scale of the airport is small allowing for manageability of the project and providing a level of flexibility with planning, designing and without the constraints of a large airport.

Wellington Airport is situated at the south western tip of the North Island on raised land along the Rongotai isthmus. This is a stretch of low-lying ground between Wellington and the Miramar Peninsula. The airport is surrounded by water on both ends, Evans Bay to the north and Lyall Bay to the south. The airport sits directly above the Evans Bay fault line making it vulnerable to earthquakes. An engineering study for Wellington Airport shows some areas of the runway may incur damage following any seismic event above magnitude 4.1. The runway is presently expected to be operational for helicopter and military aircraft within hours after a large earthquake.

Figure 4.1 Aerial map of Wellington Airport overlaid with 2030 master plan.

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Figure 4.2 Aerial map of Wellington Airport overlaid with transport routes.

AIRPORT TRANSPORT ROUTES

There are two main routes to access the airport, one from the south and one from the north. State highway one is the main route to and from the airport. This road provides a car, bus, motorbike, and pedestrian access. An underground road crosses the centre of the runway to the airport fire station. This roadway can be used to serve emergency vehicles in an emergency. Many roads are situated in the tsunami risk zone.

Key

- Main road
- Street and collector roads
- ... Underground roads

Not to scale

^
Figure 4.3 Aerial map of Wellington Airport overlaid with trunk service lines.

SITE HEIGHTS

The site sections show the heights of the surrounding landscape next to the sea. The runway and airport terminal are built on land which is raised 10m above sea level. The sections are taken from three points for a possible tsunami or high wave. The first section is from Cobham Dr north of the airport, the second is from Moa point road west of the airport and the third is from Moa Point Road south of the airport. All sides are braced with stone seawalls. The north and south side is raised by 10m, the western side is raised by 5m due to the shallow depth of Lyall Bay.

^

Figure 4.4 Aerial map of Wellington Airport showing section locations.

1. Cobham Dr north of the runway

2. Moa Point Road west of the runway

3. Moa Point Road south of the runway

Figure 4.5 Site sections around Wellington Airport.

HAZARD MAPPING

Earthquake ground shaking

Ground shaking will be most severe around low lying areas by the airport, seatoun and the coastline of the CBD.

^

Figure 4.6 Map of Wellington City showing earthquake ground shaking.

Liquid faction potential

Liquid faction correspondences with the earthquake ground shaking areas by the airport, and the coastline of the CBD.

^

Figure 4.7 Map of Wellington City showing liquid faction potential.

Tsunami evacuation zones

There is a risk of the southeastern suburbs being isolated from the rest of Wellington in a major tsunami.

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Figure 4.8 Map of Wellington City showing tsunami evacuation zones.

Flooding potential

Flood water build-up will occur mostly in low lying areas around the suburbs of Newtown, Kilbernie, Mirrimar and airport.

^
Figure 4.9 Map of Wellington City showing flooding potential.

AIRPORT SCALE

Airports in New Zealand have a wide range of scales. The role of New Zealand airports can be broken into three distinct scales. The three scales are “Hub”, “International” and “Regional”.

HUB

Auckland International Airport [AKL]

Hub airports carry all commercial long-haul international and domestic passengers. They are the gateways into the nation and provide connections to airports around the country and continent. This airport has all the airport amenities and operations available. Hub airports accommodate all types of aircraft such as Boeing 777-200 and are the only airports in New Zealand which can accommodate Airbus 380. In emergency Hub, airports can accommodate military aircraft.

International

Wellington International Airport [WLG]

International airports carry commercial short-haul international and domestic passengers. International passengers arrive after a hub connection or direct if a transferral through a hub is not needed. These airports have the most amenities and operations available. International airports cater for medium to small sized aircraft such as Airbus A320. In an emergency, an international airport may accommodate smaller military aircraft.

Regional

Invercargill Airport [INV]

Regional airports only carry domestic commercial passengers. They are used as a destination or a starting point on a journey. The airport contains the simplest forms of amenities and operations. In New Zealand regional airports only accommodate small aircraft. Most of the time these are ATR72-500 or Bombardier Q300 aircraft.

Hub, international and regional airport types in New Zealand

Figure 4.10 Map of New Zealand showing three airports with different scales.

NEW ZEALAND AIRPORT LOCATIONS

There are 2 international Hub airports in New Zealand these include Auckland and Christchurch. There are 4 International airports in New Zealand these are in Wellington, Queenstown, Dunedin and Rotorua. The Royal New Zealand air force in Ohakea is also an international airport. Auckland Airport carries 75% of international passenger traffic while Christchurch is the main gateway into the South Island. Wellington, Hamilton, Dunedin & Queenstown provide short haul international air services (NZLC Delivery Team 28).

Emergency capability

Auckland, Christchurch, Wellington and Queenstown are airports identified as Nationally Significant Infrastructure. Without these airports operating there is a significant loss of national service (5). Airports and runways are designed to withstand seismic events; however, the damage is still likely to occur in a major disaster event. Queenstown is notably in an area of high seismic risk and some airports are prone to liquefaction such as Wellington and Dunedin. Auckland and Christchurch are the only two hubs which provide International Urban Search and Rescue assistance in an emergency.

Other Vulnerabilities with Airports include

- Volcanic ash falls disrupting flights
- Technological disruptions
- Dependence on jet fuel
- Aircraft accident, criminal or terrorism activity
- Tsunami, storm waves & sea-level rise
- Hazard impacts on road access (28).

New Zealand passenger airport locations

Figure 4.11 Map of New Zealand passenger airports.

ALTERNATIVE AIRPORT LOCATIONS

Airbiz on behalf of Wellington International Airport Limited prepared a report for potential alternative sites for Wellington Airport. The key drivers for moving the airport is the ability to meet growing demand, a potential site could also be developed into a second major commercial airport for the future. Seven sites were identified following the review of the region's topography to find a feasible site (AIRBIZ 2). The sites needed to be suitable for domestic and international travel. This accommodates large aircraft requiring a runway of 3,000m and a total of 200 hectares. The study analysed key airport requirements such as operation, airspace, access, noise, viable typography environmental and social issues (8). The conclusion of the report supported retention of Wellington Airport at its Current location. The report suggested the new airport sites are less practical and viable. The current site is optimal due to existing infrastructure cost, access and economic development to Wellington. There are no current plans to move the airport as it has all the existing facilities to support greater passenger demand beyond 2035 (16).

Alternative Wellington Airport locations

Figure 4.12 Aerial view of the Wellington Region showing alternative airport locations, principle non-operational, operation fixtures, & construction costs.

WELLINGTON RELIEF HUBS

New Zealand has always been vulnerable to natural disasters. Each region in New Zealand has their own emergency facilities. The most common are Civil Defence Centres or Welfare Centres. Due to the spike of recent earthquakes in New Zealand, these facilities are now being updated and the Wellington Region now use Community Emergency Hubs. The Wellington Region the first region to use the new facilities. The main difference between the Civil Defence Centre and Emergency Community Hub is the perception associated with the previous Civil Defence Centre which was viewed as shelters stocked with food supplies. The new Emergency Community Hubs bring the community together, so the people can provide and receive aid from the community.

Most emergency shelters in New Zealand are in community centres and schools. The majority in Wellington are in suburbs and residential areas away from the city. An airport that serves as a relief station can work alongside these centres and contribute to better management and coordination of relief efforts and reduce the overwhelm these centres experience. The role of a relief station is to provide temporary relief and work alongside the already existing Community Emergency Hubs.

Emergency Community Hubs in Wellington

Figure 4.13 Aerial map of Wellington City showing Community Emergency Hub locations & civil defence offices.

POPULATION EVACUATION

Figure 4.16 illustrates the population of Wellington suburbs in 2018, this has been separated into 4 main areas. The figure provides an estimated number of residents which can use the airport to evacuate in a crisis.

The first area includes the northern suburbs with an estimated population of 77,796 people living in this area. In the event of an earthquake, they will be the first to exit the city via state highway 1.

Wellington CBD is in the centre of the city surrounded by many tall buildings. There is an estimated population of 21,201 people living there. Following the magnitude 6.5 earthquake in 2013 and magnitude 7.8 earthquake in 2016, Wellington CBD had been closed and parts of the CBD were evacuated and cordoned off. If a large earthquake occurred near the centre of the city the CBD will be cordoned off as a public exclusion red zone. This occurred in Christchurch after the February 22nd earthquake in 2011. This would leave 21,201 people stranded and with nowhere to go. Many of the city's residents will choose to evacuate north via state highway or south towards the airport.

The central suburbs located around the CBD have a population of 64,501 people. These people will evacuate the city north via state highway 1 and some will choose to travel south to the Airport.

The southern suburbs located south of the city are the closest to the Airport. There is an estimated population of 48,313 people living in this area. Much of the population in this area will choose the airport to evacuate.

Population of Wellington suburbs (2018)

	823	<i>Ohariu - Makara - Makara Beach</i>
	15,381	<i>Tawa - Grenada North - Takapu Valley</i>
	7,552	<i>Churton Park - Glenside</i>
	6,165	<i>Grenada Village - Paparangi - Woodridge - Horokiwi</i>
<i>Northern</i>	11,440	<i>Johnsonville</i>
<i>Suburbs</i>	8,173	<i>Newlands - Ngauranga</i>
77,796	10,737	<i>Kaiwharawhara - Khandallah – Broadmeadows</i>
	7,959	<i>Ngaio - Crofton Downs</i>
	3,844	<i>Wadestown</i>
	5,722	<i>Northland – Wilton</i>
<i>Wellington</i>	4,775	<i>Throndon - Pipitea</i>
<i>CBD</i>	3,970	<i>Wellington Central</i>
21,201	12,456	<i>Te Aro</i>
	15,616	<i>Karori</i>
	4,704	<i>Kelburn</i>
	3,805	<i>Aro Valley - Highbury</i>
<i>Wellington</i>	6,936	<i>Brooklyn</i>
<i>Central</i>	7,852	<i>Mt Cook</i>
<i>Suburbs</i>	5,683	<i>Mt Victoria</i>
64,501	3,389	<i>Roseneath - Oriental Bay</i>
	6,842	<i>Hataitai</i>
	9,674	<i>Newtown</i>
	3,204	<i>Kingston - Mornington - Vogeltown</i>
	3,889	<i>Berhampore</i>
	9,090	<i>Island Bay - Owhiro Bay</i>
<i>Southern</i>	4,197	<i>Southgate - Houghton Bay - Melrose</i>
<i>Suburbs</i>	2,814	<i>Lyall Bay</i>
48,313	5,286	<i>Kilbirnie - Rongotai - Moa Point</i>
	11,763	<i>Miramar – Maupuia</i>
	4,061	<i>Strathmore Park</i>
	4,009	<i>Seatoun - Karaka Bays - Breaker Bay</i>
	211,809	<i>Total Wellington City</i>

^

Figure 4.14 List of suburban population in Wellington.

05

PROGRAMME

Chapter five

This chapter introduces the programming for the design. It provides an analysis of airport and emergency programming and identifies dual-use spaces.

AIRPORT TERMINAL PROGRAMMING

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Figure 5.0 Diagram showing airport programming.

DISASTER RELIEF PROGRAMMING

^

Figure 5.1 Diagram showing disaster relief programming.

DUAL PURPOSE

An airport program was established using books focused on airport design, airport manuals, airport maps and existing plans for Wellington Airport. It was soon found airports have a large amount of programming and functions, which made this design exploration very complex. A airport day to day running and emergency disaster situation program was established from the literature review and precedent analysis. The established airport and disaster relief programming was arranged on a Venn diagram to try to find spaces required for both an airport and crises situation. The exercise proved successful and helped establish many spaces which could be used for a dual purpose, flexibility and contingency are key for this design to work.

Airport & emergency programming Venn diagram

Figure 5.2 Venn diagram identifying possible dual use programming.

WELLINGTON AIRPORT

Archived plans of Wellington Airport and the 2030 Airport master plan from Wellington City Council were analysed to understand the existing and future programming of Wellington Airport. This aided the design development for the design of a new terminal. The analysis identified,

- Expanding the terminal building to accommodate more passengers and expanding the layout of the apron to accommodate more aircraft.
- The airport site is extremely small by international standards for an airport which handles 5 million passengers annually.
- Passenger numbers are expected to double by 2030 while the airport remains on its contained current site.
- Along with passenger increase, annual aircraft movement is also expected to increase.
- The airport is situated on raised land.
- A runway extension is needed to accommodate larger aircraft.
- The archived plans identified airports are very programme heavy. There are many functions and operations an airport needs to function.
- The airport is proposing to add a hotel connected to the main terminal building.
- A new parking building is proposed this will be constructed on the front side of the terminal.
- The Airport is predominantly used for domestic travel.

Figure 5.3 Diagram of runway length expansion overtime.

Figure 5.4 Line graph of annual passenger forecast of Wellington Airport till 2030.

PASSENGER PROCESSING

The airport has a program of processing and handling passengers. The passenger processing system depends on the direction of travel. International travel requires most processing with security screening and passport checks at departure and on arrival. Domestic requires departing security screening and regional requires minimal to no screening. In New Zealand, security screening is restricted to planes with 90 seats or more (Civil Aviation Authority of New Zealand).

The passenger processing occurs between landside and airside spaces. The landside [Before check in] contains all public activity such as retail, food, beverage and entertainment this is where all passengers can freely congregate. The airside [after check in] contains the same amenities but less in a space which is private and exclusively for travelling passengers. It is a transitional space between the terminal and aircraft. More dual purpose and emergency functions can take place before transitioning to the airside because of the vast amenities and public space being accessible to everyone.

Airport departure and arrival passenger processing

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Figure 5.5 Diagram of passenger processing for international, domestic, departures and arrivals.

06

DESIGN

Chapter six

The chapter explores design ideas, it provides an analysis which tested the potential of locating the airport on higher ground or along the sea. It provides an analysis of initial design sketches, test ideas, and iterations.

TERMINAL TYPES

	<i>Positives</i>	<i>Negatives</i>
<i>Linear</i>	<ul style="list-style-type: none"> • Short walking distances. • Clear orientation. • Simple construction. • Lower baggage system costs. 	<ul style="list-style-type: none"> • Duplication of terminal. • Less flexibility on tarmac. • Longer walking distances. • Duplication of airport amenities.
<i>Pier</i>	<ul style="list-style-type: none"> • Centralized resources. • Economical to build. • Efficient use of land. 	<ul style="list-style-type: none"> • Kerbside congestion. • Limited expansion. • Reduced aircraft circulation. • Limited future development.
<i>Transporter</i>	<ul style="list-style-type: none"> • Easy aircraft manoeuvrability. • Ease of aircraft stand expansion. • Simple and smaller terminal. • Cost saving. • Easy future development. 	<ul style="list-style-type: none"> • High maintenance costs. • Kerbside congestion. • Higher passenger delays. • Increase vehicular movements. on airside with aircraft.
<i>Satellite</i>	<ul style="list-style-type: none"> • Passenger management. • Centralized resources. • Additional satellites can be designed for future development. 	<ul style="list-style-type: none"> • Kerbside congestion. • High maintenance, operating cost. • Limited expansion capability. • Requires high technology. underground services.

^
Figure 6.0 Diagram of airport terminal types.

TERMINAL FLOW

Many large airports distribute the passenger flow over several levels within the airport terminal. The primary purpose of doing this is to separate the flow of arriving and departing passengers and to support the functions of airport services such as ground handling.

1. A single level terminal is used at small regional or domestic airports. All passengers are on the same level and used at airports with small aircraft.
2. Two story terminal allows for ground handling to be located to the back of the terminal. This is used at international airports and allows for the boarding of larger aircraft.
3. Two level roads allow for ground handling at the back of terminal and split arrivals and departing passengers. Minimises departing passenger level changes. This is used at international and hub airports and at Wellington International airport.
4. Two ground level roads can split departing and arriving passengers on the same level. This allows for departure passengers to be placed on upper levels. This is used at international and hub airports.
5. The multi-level terminal is used at large airports to split passenger traffic among different levels. All ground handling occurs on the ground floor and public amenities occur on top floors. This is used at international and hub airports.

1. Ground level road, one-story terminal

2. Ground level road two-story terminal

3. Two level road two-story terminal

4. Ground level road two-story terminal

5. Multi-level terminal

Key

Departures>

Arrivals ———>

^

Figure 6.1 Airport terminal flow types.

CIRCULATION STUDY

The circulation paths of three New Zealand airports of different scale have been analysed, this is to help design the circulation of a new airport. Queenstown, Christchurch, and Wellington Airport have been analysed due to their different scale. The circulation study has shown international and domestic passenger flow is separated, regional passenger flow is also sometimes separated from domestic. Both international and domestic passengers use the same space for check-in, both use the same entry and exit points at the airport

Figure 6.2 Plan circulation study of Queenstown Airport.

Christchurch Airport

Figure 6.3 Plan circulation study of Christchurch Airport.

Wellington Airport

Key

Domestic		International	
Departures		Departures	
Arrivals		Arrivals	

^

Figure 6.4 Plan circulation study of Wellington Airport.

INITIAL DESIGN IDEAS

The initial sketches began with a focus on trying to implement different methods of transport to the airport. This is to allow easier access for evacuating passengers to the airport during a crisis response. During an earthquake, a passenger may arrive by car, bike, boat or helicopter. The initial sketches try to provide access to the airport from both the east and west sides as opposed to just the existing east side. It also tests boat access from Lyall Bay.

The next idea focused on a curve design with a looped road at the front to allow easy passenger and goods drop off. Iterations of this were done to fit the desired programming. It was found a simple curved terminal did not provide enough plane parking space and needed piers to allow for the desired number of gates. One pier each would be used for regional, domestic, and international.

The next stage increased the number of piers and began to separate airport programming into separate buildings, this provided a basis for developing a modular system. This was done in a more circular form with the intention of the airport design responding to the contextual rock and the quirky identity of Wellington city informed by Peter Jackson.

ELEVATED

To develop a resilient design alternative airport sites were looked at within the site investigation phase of the project. The design was tested on a higher location by Moa Point. Situated just beyond the current airport it provides access to all the services and systems. The idea was to embed the main terminal building into the hill to provide protection from a Tsunami wave. The terminal building would be on the edge of the hill providing views over the runway. The building was designed as a curved massed then into small parts to allow for easier programming layout and structural and seismic reasons.

This idea resulted in complications because the terminal building requires direct access to ground services and the runway to fully function. Without direct access to the runway, the airport would simply not function efficiently. To maintain the placement of the terminal building on the hillside the entire airport needs to be elevated. Such a move would have meant the relocating of the entire airport to a location that is outside the tsunami risk zone. This would have required extensive structural and site rehabilitation to accommodate the airport and in response to the safety concerns related to ground instability and potential landslides particularly in the event of earthquakes. Significant and costly groundworks would have to be done to ensure the elevated runway and the terminal was on stable foundations.

Figure 6.6 Elevated design test sketches.

S U B M E R G E D

Many airports in Japan have been built out at sea the precedent study of Kansai International Airport demonstrated the viability of designing an airport at sea in a country prone to earthquakes and tsunamis. There is a monumental amount of planning, designing, and engineering which makes this possible and it is very costly.

The intention of designing a terminal in water was to reduce the impacts of a tsunami wave hitting waves damaging the airport and to enable ships to dock with ease particularly in a crisis and the city was inaccessible to rescue teams by land or water. Such an airport would not only remain fully functional in a disaster but also become a vital hub for gathering and transporting the injured and sick out of the city and for providing them with emergency care. To protect the airport from the large swells likely to come from the Cook Strait it would need to be in the naturally protected Wellington Harbour area.

The design followed ideas from Kansai International Airport by arranging the layout in precincts. The design began with a rectangular island and evolved into a circle allowing water to pass around without hitting a massive wall.

The difficulties related to this design idea is the difficulty of access for everyday use. The airport would need to be linked to the land by a bridge which could have rail access built into it the same as Kansai Airport. Alternate access would have to be by ferry, boat or helicopter and in the aftermath of a large earthquake these access routes could sustain major damage and become unusable or inaccessible.

Figure 6.7 Submerged design test sketches..

FORM EXPLORATION 1

A circular form was explored with the idea of minimising travel distances to gates and increasing efficiency by not having long piers. The design tested different, check in layouts, gate layouts, baggage-handling layouts, retail layouts, and lounge seating. A radial moment frame was chosen, and the spaces were arranged around this structural grid.

The tests looked to utilise the central space as a gathering area during a crisis. The design also responded to the idea of water from a large and powerful Tsunami wave that reaches the airport being able to flow around the circular form. In addition, the symmetry of the circular form allows for a symmetrical structure which reduces the effects of torsion.

Figure 6.8 Initial form exploration sketches.

FORM EXPLORATION 2

The circular form was further explored and took into consideration the additional space requirements for regional, domestic, and international gates. This increased the size of the layout of the airport and resulted in the formation of piers. Aircraft gate lounges were placed in the piers, for domestic travel a separate pier would be used for a different airline.

The programming throughout the airport was chosen and grouped carefully, entertainment, retail, seating, check in and many public amenities were placed in the main terminal. The gate lounges and security checks were placed on the piers. In a crisis, some piers could be switched off completely as the main airport amenities and check in procedures were located in the main terminal.

Figure 6.9 Developed form sketches.

FORM EXPLORATION 3

The design continued to evolve through the testing of more layouts and configurations. This was the most difficult phase of the design exploration. A change to one building would mean a change to the program and this would alter the layout of the aircraft gates and affect the entire layout of the airport. This made it difficult to fit in the airport program and try to implement disaster relief functions. The design exploration at this point felt limited due to the size and scale of the airport being too large for the site, as a result, all airport amenities such as retail and entertainment were placed in the main terminal and away from any piers.

To develop a structurally resilient design, the layout also considered structure each additional circle in plan represents a seismically separated building with its own structure. The buildings are connected by overhead bridges these would be attached on one end and free to move about at the other to allow flexibility and movement in the event of an earthquake.

Figure 6.10 Further developed form sketches.

ELEVATION FORM EXPLORATION

After a layout in plan was established, the design was explored through section and elevation. The circular form was carried through to the 3D experience and resulted in a curvilinear dome like form. This continued with the circular form established from the layout explorations. The exploration tested different levels of passenger flow. It also explored the idea of using a rock like form relating to the existing international terminal at Wellington Airport. A grid was also established vertically with the use of a moment frame structure. Airport designs are usually done on a grand scale and futuristic feel was desired. Materials such as white concrete, glass fibre reinforced polyester would be used to achieve this aesthetic.

The design explored the idea of having private spaces on higher levels and public spaces on lower levels. This was to allow emergency functions in the Airport command centre and offices to remain away from the public and provide ease of access to emergency personnel. Areas such as the conference centre and airline first class lounges were also placed on the same level as these were semi-private spaces and could serve as dual-purpose spaces during a crisis. The conference centre can be used as meeting spaces and the first-class lounges can be used as office workspaces or resting spaces for emergency personnel.

Figure 6.11 3D Form exploration sketches.

DETAILING FORM

An established form was chosen and developed in more detail. The form produced a futuristic aesthetic, which was the desired outcome. The control tower, main terminal, small piers, and platforms were designed to have a cohesive aesthetic.

The design would use strip lighting around the edges of the eaves of the main terminal and pier. This would help the station to be distinctive and visible in the dark. As identified in the precedent studies Kansai international airport used a smooth exterior surface with no lips and eaves to minimise any part of the building catching in the wind from typhoon winds. This is particularly important in Wellington as it is a windy city and the same principle has been applied. The piers were tested with eaves and no eaves to minimise parts of the building catching in the wind and providing suitable sun protection.

Figure 6.12 3D developed and detailed form sketches.

C O N T R O L T O W E R

Wellington airport is currently in the phase of redesigning its control tower. It is currently situated away from the airport. The control tower was combined into the main terminal, as it would support emergency functions during a crisis. The control tower would navigate incoming emergency relief aircraft and outgoing aircraft with the injured and sick as well as outgoing passengers being evacuated. With the tower being placed in the centre of the main terminal, it would be used as a structural share wall and help support the roof.

^
Figure 6.13 Control tower exploration sketches.

INITIAL DESIGN

A circular building form was developed with the main terminal in the centre and piers branching off the main building. All passengers arrive and depart the airport through the main terminal building. The passenger flow is split as passengers move into the piers to their gates. The programming layout of the airport was informed by the plan of the existing airport and the 2030 master plan. The domestic gates were positioned towards the runway, as they would be used the most. The regional and international gates were positioned in the same place to allow easy access to the existing airport ground handling and services. The regional layout of the 2030 masterplan used an efficient use of space for the plane parking, this was also implemented into this design. The check in areas, baggage claim, retail, entertainment, first-class lounge, first aid room, is in the central terminal. The airport command centre, airport offices, conference centre, & police station is located on the top level. The private spaces have been placed on the top level and public areas in the lower levels. This provides privacy and separates the spaces used for staff, emergency personnel and passengers during a crisis. The security check points, departure lounges, and arrival gates are in the smaller terminals.

^

Figure 6.14 Rendered aerial view of the station from the domestic pier.

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Figure 6.15 Rendered aerial view of the station from the southern side.

INITIAL DESIGN VIEWS

Figure 6.16 shows the main terminal with a first-class lounge cantilevering off the front of the airport. The idea was to use this space as a private room for airport staff and emergency personnel during a crisis. This space provides a view over the airport and includes areas such as private workspaces, lounge spaces, kitchenette, toilets, and showers, figure 6.17 shows the regional terminal walkway at a human scale. The station is designed as a large multi-level building with private spaces on the top and public spaces in the middle and ground handling on the ground floor.

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Figure 6.16 Rendered view of first class lounge.

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Figure 6.17 Rendered view of regional terminal walkway.

DESIGN ITERATIONS

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Figure 6.18 Rendered view of initial relief station design.

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Figure 6.19 Rendered view of simplifying piers.

^
Figure 6.20 Rendered view of simplifying pier bridges.

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Figure 6.21 Rendered view of testing dome piers.

^

Figure 6.22 Rendered view of simplifying entire design form.

^

Figure 6.23 Rendered view of outcome.

REFINED DESIGN

The outcome of the design had been refined and simplified. A critical reflection of the design resulted in the first-class lounges being moved into the piers closer to the gate lounges, this also allowed easier access to loading zones. The lounge could not be used for complicated airport functions unless the technology from the main terminal is connected. No parts of the building would be cantilevering as this would result in asymmetrical structure resulting in torsional effects on the building. The pier bridges were simplified and are only used as security transition points. Small piers for small aircraft were added to the sides of the main terminal these would also be used as emergency fire exits and a way to bring goods into the building. The station now has a uniform dome aesthetic which is the same across all buildings.

^
Figure 6.18 Rendered view of initial relief station design.

^
Figure 6.23 Rendered view of outcome.

07

OUTCOME

Chapter Seven

This chapter presents the outcome of the design phase. It presents plans, section, elevation and renders to visualise the emergency relief station.

*Airport fuel
storage*

*Roadway under airport can be privately
used for emergency vehicles*

*Roadway must be fortified as
there is a risk of a tsunami
on state highway 1*

^
Figure 7.0 Design proposal aerial site plan.

*Petrol station serves
emergency vehicles going
to and from the station*

*Wellington sewage
treatment plant
located near to the
airport*

AERIAL SITE PLAN

*Emergency plane &
helicopter parking*

*Emergency plane
parking*

*Seawall fortifications may
be needed to ensure high
waves stay off airport*

*Runway extension is
needed to allow larger
planes to land into
Wellington this includes
international USAR teams*

Not to scale

EXTERIOR
PLAN VIEW

Figure 7.1 Rendered exterior plan view of the station.

GROUND FLOOR

Figure 7.2 Ground floor plan.

FIRST FLOOR

Figure 7.3 First floor plan.

SECOND FLOOR

Figure 7.4 Second floor plan.

Scale 0 10m 30m

0. Main entry
1. Core services / toilets/ lift / stairs / services
2. Plaza (outdoor tent space)
3. Ground handling and storage (emergency services location)
4. Baggage claim hall
5. Car rentals
6. International departures
7. International arrivals
8. International security checkpoint and duty-free
9. Domestic departures (gathering & seating space)
10. Domestic arrivals
11. Domestic security point
12. Regional departures & arrivals (gathering & seating space)
13. First class lounge (private seating and workspace)
14. Central atrium (gathering and seating and information space)
15. Perimeter walkway (seating space & resting space)
16. Sickbay (medical room)
17. Retail / shopping
18. Food + beverage (gathering space)
19. Check-in counters
20. Conference rooms (private meeting space)
21. Airline command centre (Emergency command centre)
22. Control tower (operations centre)
23. Hotel (accommodation, gathering space, meeting room)
24. Small aircraft pier (service lift for goods and fire exits)

PLAN OVERVIEW

^

Figure 7.6 All floor plans.

AXONOMETRIC

^

Figure 7.7 Axonometric exterior rendering of Emergency Relief Station.

AXONOMETRIC CUTAWAY

The axonometric cutaway shows the interior of the station outlining the critical spaces used for dual purpose in brackets.

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Figure 7.8 Axonometric cutaway rendering of Emergency Relief Station.

AXONOMETRIC SECTION CUTAWAY

The section drawing shows the multi-level airport

- The ground floor used for ground handling
- The first floor is used for arrivals
- The second floor is used for departures
- The third floor is used for airport administration

^

Figure 7.9 Axonometric section cutaway rendering of Emergency Relief Station.

ELEVATION

Domestic terminal

Central

^

Figure 7.10 Elevation of Emergency Relief Station.

terminal

Domestic terminal

SECTION

Figure 7.11 Section of Emergency Relief Station.

*Airport control tower
and central terminal*

Figure 7.12 Exterior rendering of emergency relief station.

Domestic terminal

Domestic terminal

Figure 7.13 Exterior rendering showing regional terminal walkway.

*Airport control tower
and central terminal*

Airport hotel

Planting providing an aesthetically pleasing and relaxing atmosphere inside the central space of the terminal.

Airport passenger announcement systems can broadcast important information relating to the disaster situation.

Figure 7.14 Interior rendering of central terminal gathering space.

Conference rooms can be used as meeting rooms these are located upstairs. It can be used as completely private space.

Airline command centre which can also be used as an emergency command centre located on third floor private circulation.

Seating located around central atrium.

LOU

TO BE LANDMARK EVENT
CHH

Figure 7.15 Interior rendering of central terminal perimeter walkway.

Furniture is chosen to
allow people to lie down
and receive treatment.

08

DISCUSSION

Chapter eight

This chapter discusses key areas of the design and explains how the airport and emergency relief station work together.

EMERGENCY RELIEF STATION

The Emergency Relief Station is designed to function as a building which provides temporary relief during a crisis. The building is designed structurally to resist earthquakes with a dual-purpose design of an airport with adaptable emergency spaces. During a crisis, passengers can temporarily rest, sit and receive aid at the airport terminal. Within hours evacuating passengers will flock to the terminal, emergency personnel, USAR teams, government officials, media and aid will begin to arrive, this was observed during the Christchurch earthquakes of 2011. The airport hotel provides a place for passengers to sleep, shower, and eat if needed. Certain spaces within the airport will be shut down for the station to function efficiently. For example, the international pier will be shut down and the domestic terminal will be used to evacuate passengers. International passengers and tourists will have to evacuate to Auckland and Christchurch. The entertainment space within the central terminal becomes a gathering, resting and seating space for passengers wanting to evacuate. The station works alongside other emergency relief hubs located around Wellington city and serves as a major relief point for the southern suburbs. Figure 4.13 shows there are no emergency relief hubs within the airport area.

^
Figure 8.0 Emergency relief station design.

$\wedge$

Airline command centre (private)

Airport hotel

Central entertainment space

Central entertainment space

Gate lounge seating

Gate lounge seating

159

Figure 8.2 Diagram showing airport conversion into emergency relief station.

- Tent and first aid area
- Airline and emergency operations (private)
- Meeting space & work areas (private)
- Temporary accommodation
- Central gathering, resting and seating space
- Resting and seating space
- Passengers evacuation seating area
- Emergency aid arrival area

TRANSITION OF SPACES

Refer to figure 8.0, 8.1 and 7.8

Airport

Station

Drop-off pickup and plaza

Outdoor Plaza is used as seating and dwelling space outside the terminal. Ground handling is located on ground floor allowing easy access for goods and services. Arrivals is located on 1st floor to allow easy access for pickup. Drop off area is located 2nd floor to allow easy access to departing passengers.

Plaza is used as a first aid area and tent spaces. Ground handling is located on the ground floor allowing easy access for aid to arrive. Emergency personnel arrive on the 1st floor to allow easy access for pickup. Evacuating passengers drop off area is located 2nd floor to allow easy access to the station.

Main terminal level 1 and 2 central space

The central space is used as an entertainment area with shopping retail, food court and seating area.

This area is used as seating, gathering, and napping. The lounge furniture in this area is chosen to be flat allowing people to sleep and rest.

Main terminal level 2 perimeter seating area

This area is used as a seating area for passengers waiting to enter the piers to the gate lounges.

This area is used as seating, gathering, and napping. The lounge furniture in this area is chosen to be flat allowing people to lay down.

Main terminal level 3

The top floor is used as an airline operation centre, a police station and conference centre.

The top floor is used as an emergency operations centre. The conference centre is used as a meeting area for emergency personnel and airport staff.

Airport

Station

Hotel

Ground level is used for ground handling operations delivery vehicles area. Level 1 is used as a reception, restaurant, bar area a connection is provided to the main terminal. Level 2 is used as a conference room and function room area. Level 3 to 6 is used as hotel rooms.

Ground level is used for ground handling operations delivery vehicles area. Level 1 is used as seating gathering space. Level 2 is used as an additional conference room if required. Level 3 to 6 is used as accommodation.

Domestic Pier

Ground level is used for airport ground handling. Level 1 is used for departing passengers coming down from the second floor and arriving passengers. Level 2 is used for departing passengers and passengers using the first-class lounge.

Ground level is used for ground handling and the location of the power generator and water tanks and. Level 1 is used for evacuating passengers, the seats in the gate lounge can lie flat allowing passengers to rest more comfortably. The first-class lounges are located on level 2 and are used for elderly passengers, women, and children who need a place to rest.

Regional Pier

Ground level is used for ground handling operations. Level 1 is used as gate lounge for departing passengers and arriving regional passengers. Level 2 is used for departing passengers and regional first-class lounge.

Ground level is used for ground handling operations. Level 1 is used for evacuating passengers to small aircraft. Level 2 is used as the first-class lounges are used for elderly passengers, women, and children. This provides lounge seating areas.

International Pier

Ground level is used for ground handling operations arriving passengers. Level 1 is used as a gate lounge and retail for departing passengers. Level 2 is used for departing passengers, duty-free and passengers using the international first-class lounge.

The international pier will be shut down to save power and resources. International passengers will travel domestically to hub airports.

FORM AND SHAPE

Many airports around the world use long piers to fit the number of desired gates for aircraft this increases passenger travelling times within the airport. A circular form helps to shorten the walking distances to desired gates by avoiding travelling along long piers.

In a tsunami, the circular form also allows the water to flow around the form instead of a linear surface which provides a flat wall with a large surface area for water to hit. As identified in the precedent study Kansai International Airport uses a smooth exterior surface with no lips, eaves, or parapets allowing typhoon winds to flow smoothly over the building. The relief station uses this idea and uses a smooth exterior surface for the wind to pass over this is particularly important in a windy region such as Wellington.

Figure 8.3 Diagram comparing linear and curvilinear form.

SELF SUSTAINABLE POWER AND WATER

The literature review and precedent analysis identified self-sustainability as being a necessity in a crisis. All emergency buildings analysed within the precedents were all self-sufficient in their own way. Each building utilised local resources and was adequately prepared for a key service to go down. Airports already have some self-sufficient aspects including power generators and stored fuel for aircraft.

As identified in the precedent study Kansai International Airport and The Christchurch Emergency Precinct both use standby generators to power the building in an emergency. In Kansai International Airport the generator is attached to the ceiling to allow it to move with the rest of the building in the event of an earthquake. The airport is also implementing a solar farm on the side of the runway and small wind turbines on the landside of the terminal to help partially power the airport. The selected method of powering the station in an emergency is by using standby generators. This is located on the ground floor and attached to the ceiling allowing it to move in an earthquake. Solar power panels can be placed on top of the building or implemented next to the runway.

As identified in the precedent study the Christchurch Emergency Precinct use water from underground aquifers for emergency water supply and for heating and cooling the building. Around Wellington, the Wellington City Hospital is planning to build a water reservoir as an emergency backup water supply in a nearby park. The Wellington Regional Councils are currently searching for an aquifer under Wellington Harbour as a potential water supply during an earthquake. Another method is to build a desalination plant next to the airport to treat the nearby seawater and turn into drinking water. The selected option for the station is to store water in tanks for immediate use after an earthquake.

Power

- *Standby diesel generators*
- *Solar power*
- *Wind power*
- *Wave power*

Water

- *Water tanks*
- *Bottle water from arriving aid*
- *Desalination plant*
- *Water reservoir*
- *Underground aquifers*

^

Figure 8.4 Diagram showing possible self-sustainable implementations for power and water.

SELF SUSTAINABLE FOOD WASTE AND FUEL

Airports have flight kitchens preparing meals for aircraft, specialist knowledge of how the flight kitchen operates could be utilised to provide meals for stranded or evacuating passengers during a crisis. The Christchurch emergency precinct has stored food which is enough to last for at least 72 hours. The airport hotel and retail areas and first class lounge all store food and have food preparation areas. In the event of a crisis the station can utilise this to produce food for the public. In private areas such as the command centre and offices this will have stored food ready for emergency personnel to use.

As identified in the precedent study the Tokyo Rinkai Disaster Prevention Park provides man holes in the park as a way of draining wastewater. Port a loo can be placed directly over top and connected. This same idea can be implemented in the front plaza area of the station. Storage tanks can be used to store wastewater but need to be located in an accessible place to be emptied. The station is also located near the city's sewage treatment plant, upgrading the sewage treatment plant to withstand earthquakes can provide a long-term sustainable option to remove waste water.

Airport fuel is delivered and stored in Wellington joint oil facility 1km away from the airport this is then piped and supplied to the airport. Kansai international airport and the Los Angeles emergency operation centre use flexible serpentine pipes with a lot of slack to reduce service pipes from cracking and breaking in the event of an earthquake. The selected method for the station is to use storage tanks closer to the station with flexible pipe connections to avoid breaking.

Food

- *Stored food (Private spaces)*
- *Food from arriving aid*
- *Utilizing kitchens inside the terminal*
- *Utilize the flight kitchen*

Wastewater

- *Storage tanks*
- *Port -a-loos in outdoor plaza*
- *Treatment plant*

Fuel

- *Storage tanks*
- *Shipping fuel to airport*

^

Figure 8.5 Diagram showing possible self-sustainable implementations for food, wastewater and fuel.

STRUCTURE

All major airports in New Zealand should be structurally designed as airports are recognised as a vital lifeline infrastructure. The structure must stand up against earthquake forces to function in a crisis. The structural adaptation was considered through the entire design phase. Key structural moves have been made which influence the entire design of the airport. These include seismically separating buildings, symmetrical layout to reduce torsion, the use of centrifugal moment frame to allow circulation in between. Share walls in the centre of the design housing important building services. Sliding bridges join between the central terminal and regional, domestic and international terminals. Trusses run along the top of the roof supporting the glass above and each building is base isolated using triple friction base isolators.

The seismically separated buildings allow the building to move as a single mass and resists its own inertia forces (Charleson). Arranging the structure symmetrically helps to centre the buildings centre of mass reducing the effects of torsion. Each building uses its own independent structure and does not influence the performance of any other building. All terminal buildings use a centrifugal moment frame, which is arranged in a radial layout and connected to share walls in the centre of the building. This allows large open spaces for circulation within the terminal and main services core to be placed in the centre of each terminal building. Each terminal is connected by bridges that are fixed at one point and slide at the other. Steel trusses run up the entire length of the terminal buildings creating a uniform pattern which is symmetrical and transfers all roof loads into the ground. This allows the bridge a level of flexibility and allows it to move out of phase with the two connecting structures.

Seismically Isolated Structures

Moment frame arranged in a radial layout

Sliding Pier Bridges

^

Figure 8.6 Diagram showing three key structural moves.

LOGISTICS

Emergency logistics is a major activity in disaster response. Logistics is part of the initial response phase and continues operating for a long period for time. Logistics is vital to sustain the basic needs of people in a crisis. As identified in the literature review, Emergency Community Hubs [formally Civil Defence Centres] in Wellington will no longer store food and aid. This is because it is not feasible to keep storing small amounts of outdated food for entire suburbs to rely on. Instead, Civil Defence New Zealand urges people to be self-sufficient for at least 72 hours by storing their own food and water. As identified in the precedent study emergency operation buildings also store food for at least 72 hours. This is because it may take up to 72 hours for aid to arrive in a city. The airport is one of the first points of contact when emergency aid arrives, this aid can be utilised at the airport.

The relief station is designed to receive and quickly distribute aid inside of the main terminal building. Four service points are located around the main terminal, three on the tarmac, they also serve as gates for passengers travelling on small aircraft such as private jets or small Cessna. One is located at the front of the terminal for access by road. These points are fitted with an emergency staircase and a large elevator. The staircases serve as a fire escape if there is a fire in the terminal and the large elevator function as a service elevator to get goods and services in and out of the tarmac to the inside of the central terminal building easily and efficiently.

Figure 8.7 Diagram showing key logistical service points where aid is received.

CIRCULATION

The circulation of the central terminal is one which mimics a roundabout with outer circulation and inner seating areas. The outer terminal buildings use an inner circulation and outer seating area. The main entrance brings passengers in from the roadway outside the central terminal inside to the perimeter walkway, this has walkways branching off to the outer terminal buildings. The walkways are spaced around the central terminal at regular intervals breaking up the flow of passenger traffic and allowing people to reach their designated boarding gates with minimal walking distances. This also allows for the separation of regional, domestic, and international passengers. The walkways to the piers clearly mark the boundary from landside to airside with all security functions taking place between these transitions of space. The centre of the main terminal building is a gathering and entertainment space with a light-filled atrium through three floors.

In an emergency, the flow of passengers can be diverted so only one pier can be in use. The main terminal has a symmetrical layout with check-in areas on both sides. This type of layout allows some parts of the airport to be shut down. One terminal building can be used solely to evacuate passengers and treat injured people while another can be used to bring in emergency personnel and aid. Each terminal can be shut down without affecting the other terminal buildings as they each have their own services core.

Airport circulation

Station circulation

Figure 8.8 Diagram comparing airport and station circulation paths.

EXISTING PLAN

The arrangement of the airport programming followed the existing plan of Wellington Airport. The domestic gates were positioned towards the runway, one for each airline. The regional terminal was placed to the right. This followed a similar layout to the existing 2030 masterplan and current airport and the international terminal was positioned on the left in the same area as the current airport. The aircraft layout of the airport has been left largely the same. The domestic gates have been positioned towards the runway as they are used to the most. The international gates and regional gate have been left the same, as this would be most feasible with the surrounding services.

Current wellington airport plan

2030 Masterplan

Emergency Relief station

^

Figure 8.9 Diagram comparing existing airport layout, 2030 masterplan and designed station layout.

PRIVATE AND PUBLIC SPACE

Airports have many public and private spaces for security reasons. They play a major role at airports including the separation of airside and landside areas. The airport has been designed for the public and private spaces correlate during a crisis. The precedent study identified three emergency operation buildings, they were used as private spaces solely for emergency personnel and staff. They were all self-sustainable and stocked with food and water to last at least 72 hours. The literature review identified emergency shelters these were used as public spaces and relied on logistical aid for food and water.

The main terminal areas such as the airline command centre, airline offices and conference centre have been placed on the third floor to minimise contact with the public. During a crisis, this space will be used by emergency personnel and staff. The airline command centre will be the only area, which will store food and aid. It is important to keep this space in private and out of the view of the public. This is essential for the staff to perform their roles and to avoid conflict with people receiving food and water. In the terminal buildings, the first-class lounges have been positioned on the second floor to provide a hierarchy with the best views, and close to the gates. This allows ease of access for the public but also keeps the space private. This space can be used as private working areas for staff or other emergency personnel without interfering with any of the airport layouts.

Airport private spaces

Figure 8.10 Diagram showing private and public space.

E X P A N S I O N

Airports around the world continue to grow and expand, this airport is designed with a central terminal and separate connecting piers. The piers act as modules that can be duplicated and arranged differently if this exploration was tested on a different site. The connecting bridges provide technological and mechanical service connections to the main terminal, this can be done overhead or underground. Smaller terminals can branch off the connecting piers and their positions can be rearranged because they contain their own services. Each module can be used to serve a different purpose, for example, one could be used as an airport clinic, police station, sleeper lounges, retail aircraft gates, lounges or entertainment.

Designed emergency relief station

Aircraft parking expansion

Key

Expansion

Existing station

^

Figure 8.11 Diagram showing possible method of expansion.

FUTURE TRENDS

Some future airport concepts designed for the year 2040 are beginning to use modular designs. Many are also integrating self-sufficiency sustainability and advanced technology. The designs correlate with the design exploration with circular modular building and layouts arranged radiating out from the centre. With the increase in passengers, airport designers are now thinking of new ways to design a more efficient layout to help airports providing a seamless service to passengers for years to come.

The London Britannia concepts by Gensler use modular platforms connected to float on water. The aircraft stands are separated and located away from the main terminal. These designs are being tested to increase the number of aircraft stands available and to make use of large available space on the water. The Stanford University design innovation course by APH [airport parking and hotels] use the idea of having a central hub connecting to outside aircraft piers. As airports become larger both concepts treat the terminals as sophisticated processing buildings with retail entertainment and hotels. The airside areas are treated as waiting and parking area for aircraft this follows the same ideas as the design exploration.

*Modular terminal
platforms
floating on water
connected to
runway and
aircraft stands.*

^

Figure 8.12 London Britannia Airport by Gensler.

*Modular terminal
with remote
aircraft stands.*

^

Figure 8.13 London Britannia Airport by Gensler in partnership with TESTRA.

*Central terminal
with modular
aircraft stands
radiating out from
the centre
connected by
walkway.*

^

Figure 8.14 Airport 2040 by APH (Airport Parking and Hotels).

09

CONCLUSION

Chapter nine

This chapter provides a conclusion and reflection of the final outcome. It discusses the findings, limitations future research and importance to the discipline.

CONCLUSION

This thesis has explored the possibility of an airport terminal serving as a relief station during a crisis. The design considered the structural resilience of an airport and design solutions that may enable it to withstand a significant earthquake. In New Zealand, there are no public buildings that are designed for both structural resilience and to shelter and provide relief to the public during a major crisis. The final design provides an insight on how airports could be designed for safety and to be transformed in to a temporary relief station.

LIMITATIONS

This exploration was limited to the site of Wellington Airport, but it can easily be tested on many different sites. Specialist airport design knowledge is needed to develop many aspects of the design further. For example, an airport has a flight kitchen and the first-class lounges have facilities for preparing meals for outgoing passenger planes and passengers. Specialist knowledge to understand how these facilities operate can be utilised post disaster to provide food to the stranded, injured and relief personnel. The final design proposal is informed by knowledge gathered from literature, airport planning books, manuals, and assumptions. To develop an airport successfully requires the consultation of many different experts at no point has an airport expert been consulted throughout the duration of the exploration. In the real world a team of airport planning experts, specialists and consultants would be designing the airport together. This combined collaboration of knowledge can allow the use of other airport services such as flight kitchen, freight, fire emergency, hangars, fuel, and other airport services that are not directly connected to the passenger terminal building.

FINDINGS

The exploration has resulted in a range of insights

- There are no permanent structurally safe public emergency shelters or temporary relief centres available for immediate access after a major earthquake or similar disaster.
- Airports are not just used for as transition points from city to city, they are an important part of the national infrastructure. During an emergency, they become vital infrastructure and they should always be designed to withstand earthquakes and other disasters.
- An airport has many primary functions and is very program heavy; this makes it difficult to implement emergency aspects into the design.
- Logistics is important for the functioning of both day to day running and emergency aspect of the airport and need to be carefully considered when designing for resilience and adaptation to emergency situations
- The Wellington airport terminal could be moved to higher ground but needs direct and clear access to other nearby airport services and to the runway, which has to remain where it is currently for logistical reasons and provide fast, efficient and safe service
- The domestic and regional terminals of Wellington Airport involve fewer security measures. This proved easier for the implementation of emergency functions into its design than the international terminal.

FURTHER RESEARCH

The knowledge and findings presented in this thesis offer an opportunity for a lot of further research. This exploration has only addressed one specific site, similar studies carried out at other airports of varying scales and locations would reveal many of their own constraints and opportunities. This exploration can also be done on other public buildings; it will enable the development of building guidelines for the design and adaptation of large public buildings as emergency shelters. The exploration can be developed further, continued in detail, through consultation with experts in related fields. The terminal is essentially many different buildings, which come together. A selected area of the terminal could be looked at in more depth for example the control tower or international terminal can be a focus on its own. Further explorations similar to this thesis are not limited to airports other public architecture such as museums, shopping malls, railway stations, seaports, schools, universities and government buildings could be looked into. These buildings could serve as relief stations around a city if planned and designed with emergency infrastructure in mind and form a network of easily accessible post disaster relief hubs within a city.

IMPORTANCE

This research and design exploration address a very real scenario for Wellington in the future. If the airport is not functional immediately after the event of an earthquake there is a real risk of aid not arriving into Wellington promptly and residents unable to evacuate the city from the south. Wellington Airport is considered as a vital lifeline and a key piece of infrastructure for the Wellington region and New Zealand in a major crisis. Many airports around the world are also located in earthquake hazard zones. The findings and research done in this thesis can contribute to the design of an airport, which can be more resilient in the event of a crisis and serve as an important relief management hub and emergency relief centre. The findings are not limited to airports they can also be considered within the framework of other large public architecture to provide relief stations all over the city.

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and

FIGURES

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LIST OF FIGURES

All figures not attributed are author's own.

Figure 0.0	Image of author at the end of year master exhibition.
Figure 0.1	Speculative rendering of Wellington Airport visualising ships and aircraft in a crisis.
Figure 1.0	Map of Wellington City overlaid with primary and secondary fault lines showing blockage of exit routes from the city.
Sourced from the the LINZ Data Service < https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/ > and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence.”
Figure 1.1	Aerial view of Wellington overlaid with primary and secondary fault lines.
Homer, Lloyd. Wellington fault lines. 21st July 2007. Web. 5th April 2018.
< https://www.sciencelearn.org.nz/images/345-wellington-fault-lines >.
Figure 1.2	Infographic showing recovery times of vital infrastructure from Wellington Lifeline group reports.
Figure 1.3	Aerial view over Wellington CBD showing the airport in the background and motorway in the foreground.
Figure 1.4	Thesis method diagram showing cyclical research stages.
Homer, Lloyd. Wellington fault lines. 2001. Web. 4th April 2018.
< https://www.sciencelearn.org.nz/images/345-wellington-fault-lines >.
Figure 2.0	Diagram of the literature review into six key ideas.
Figure 2.1	New Zealand Defence Force arriving into Kaikoura after magnitude 7.8 earthquake in 2014.
Jasper, Nijland. New Zealand Defence Force helps Kaikoura in hour of need. 20th January 2017. Web. 5th April 2018.
< https://www.stuff.co.nz/national/87630355/New-Zealand-Defence-Force-helps-Kaikoura-in-hour-of-need >.
Figure 2.2	Urban Search and rescue team from Japan assist in Christchurch after magnitude 6.2 earthquake in 2011.
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< http://www.stuff.co.nz/national/8059838/CTV-royal-commission-finds-deficiencies >.
Figure 2.3	Comparison between of Civil Defence Centre and Emergency Community Hub.
Figure 2.4	Supplies within the Emergency Community Hubs.
Shadwell, Talia. Wellington's Civil Defence Centres reformed into 'Community Emergency Hubs', which won't stock survival supplies. 16th September 2016. Web. 5th April 2018.
< https://www.stuff.co.nz/dominion-post/news/84349936/wellingtons-civil-defence-centres-reformed-into-community-emergency-hubs-hich-wont-stock-survival-supplies >.
Figure 2.5	Radio communication devices in Emergency Community Hubs.
Shadwell, Talia. Wellington's Civil Defence Centres reformed into 'Community Emergency Hubs', which won't stock survival supplies. 16th September 2016. Web. 5th April 2018.
< https://www.stuff.co.nz/dominion-post/news/84349936/wellingtons-civil-defence-centres-reformed-into-community-emergency-hubs-which-wont-stock-survival-supplies >.

- Figure 2.6 Hurricane evacuees huddle inside the Superdome.
Daily Mail. New Orleans' iconic stadium renamed Mercedes-Benz Superdome after multi-million dollar deal. 5th October 2011. Web. 5th April 2018.
<<http://www.dailymail.co.uk/news/article-2045276/New-Orleans-Louisiana-Superdome-renamed-Mercedes-Benz.html>>.
- Figure 2.7 Shelters used in the internal conflict in Africa.
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<http://shelterprojects.org/shelterprojects2013-2014/Shelterprojects_2013-14_Lowres_WEB.pdf>.
- Figure 2.8 Automated immigration gate at Singapore Changi International Airport terminal 4.
Thomas, Sujun. Changi Airport's all set to open Terminal 4 on Oct 31 after more than 100 trials. 2017. Web. 5th April 2018.
<<http://www.businessinsider.sg/changi-airports-all-set-to-open-terminal-4-on-oct-31-after-more-than-100-trials/>>.
- Figure 2.9 Arrival Hall at Singapore Changi International Airport terminal 4.
Changi Airport Group. Arrival Hall. 5th November 2013. Web. 5th April 2018.
<<http://www.changiairport.com/corporate/media-centre/newsroom.html#/images/arrival-hall-239436>>.
- Figure 2.10 Wellington Airport fire station.
- Figure 2.11 Wellington Airport fire truck.
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- Figure 2.12 Airport display screen.
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<<https://www.irishtimes.com/life-and-style/travel/ryanair-flight-cancelled-here-s-how-to-get-there-anyway-1.3227653>>.
- Figure 2.13 iPhone displaying wireless alerts.
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- Figure 3.0 Christchurch Justice and Emergency Precinct.
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- Figure 3.1 Los Angeles Operation Centre.
Hok. Emergency Operations in an Earthquake-Proof Building. 2018. Web. 5th April 2018.
<<http://www.hok.com/design/type/justice/los-angeles-emergency-operations-center/>>.
- Figure 3.2 Tokyo Rinkai Disaster Prevention Park
The Tokyo Rinkai Disaster Prevention Park . About the park. 2011. Web. 5th April 2018.
<<http://www.ktr.mlit.go.jp/showa/tokyorinkai/english/index.htm>>.1

- Figure 3.3 Kansai International Airport.
Hotel AGORA Renegcy OSAKA Sakai. n.d. Web. 5th April 2018.
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- Figure 3.4 Sabhia Gokcen Airport.
5 Safest Places on Earth. 7th February 2018. Web. 5th April 2018.
<<http://www.anisoftmedia.com/5-safest-places-on-earth/>>.
- Figure 3.5 Madeira Airport.
Zwerdling, Robert. Restricted operations. 1st September 2014. Web. 5th April 2018.
<http://aeromagazine.uol.com.br/artigo/operacoes-restritas_1700.html>.
- Figure 3.6 Diagrammatic sketches showing key case study findings for Christchurch Justice and Emergency Precinct
- Figure 3.7 Diagrammatic sketches showing key case study findings for Los Angeles Operation Centre.
- Figure 3.8 Diagrammatic sketches showing key case study findings for the Tokyo Rinkai Disaster Prevention Park.
- Figure 3.9 Diagrammatic sketches showing key case study findings for Kansai International Airport.
- Figure 3.10 Diagrammatic sketches showing key case study findings for Sabhia Gokcen Airport.
- Figure 3.11 Diagrammatic sketches showing key case study findings for Madeira Airport.
- Figure 3.12 Diagrammatic sketches showing key case study findings for all precedent studies.
- Figure 4.0 Aerial view of Wellington Airport with the runway situated in centre off Lyall Bay.
Wellington International Airport Limited. Extending Wellington's Runway. 23rd November 2015. Video on Web. April 5th 2018. <<https://www.youtube.com/watch?v=GYDV5giPjxQ>>.
- Figure 4.1 Aerial map of Wellington Airport overlaid with 2030 master plan.
Sourced from the the LINZ Data Service <<https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/>> and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence."
- Figure 4.2 Aerial Map of Wellington Airport overlaid with transport routes.
Sourced from the LINZ Data Service <<https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/>> and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence."
- Figure 4.3 Aerial Map of Wellington Airport overlaid with trunk service lines.
Sourced from the LINZ Data Service <<https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/>> and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence."
- Figure 4.4 Aerial Map of Wellington Airport showing section locations.
Sourced from the LINZ Data Service <<https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/>> and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence."

Figure 4.5	Site height sections around Wellington Airport.
Figure 4.6	Map of Wellington City showing earthquake ground shaking.
Figure 4.7	Map of Wellington City showing liquid faction potential.
Figure 4.8	Map of Wellington City showing tsunami evacuation zones.
Figure 4.9	Map of Wellington City showing flooding potential.
Figure 4.10	Map of New Zealand showing three airports with different scales.
Figure 4.11	Map of New Zealand passenger airports.
Figure 4.12	Aerial view of the Wellington Region showing alternative airport locations, principle non-operational, operation fixtures, & construction costs. Sourced from the LINZ Data Service < https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/ > and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence.”
Figure 4.13	Aerial map of Wellington City showing Community Emergency Hub locations & civil defence offices. Sourced from the LINZ Data Service < https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/ > and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence.”
Figure 4.14	List of suburban population in Wellington.
Figure 5.0	Diagram showing airport programming.
Figure 5.1	Diagram showing disaster relief programming.
Figure 5.2	Venn diagram identifying possible dual use programming.
Figure 5.3	Diagram of runway length expansion overtime.
Figure 5.4	Line graph of annual passenger forecast of Wellington Airport till 2030.
Figure 5.5	Diagram of passenger processing for international, domestic, departures and arrivals.
Figure 6.0	Diagram of airport terminal types.
Figure 6.1	Airport terminal flow types.
Figure 6.2	Plan circulation study of Queenstown Airport.
Figure 6.3	Plan circulation study of Christchurch Airport.
Figure 6.4	Plan circulation study of Wellington Airport.
Figure 6.5	Initial design sketch exploration.
Figure 6.6	Elevated design test sketches.

Figure 6.7	Submerged design test sketches.
Figure 6.8	Initial form exploration sketches.
Figure 6.9	Developed form sketches.
Figure 6.10	Further developed form sketches.
Figure 6.11	3D Form exploration sketches.
Figure 6.12	3D developed and detailed form sketches.
Figure 6.13	Control tower exploration sketches.
Figure 6.14	Rendered aerial view of the station from the domestic pier.
Figure 6.15	Rendered aerial view of the station from the southern side.
Figure 6.16	Rendered view of first class lounge.
Figure 6.17	Rendered view of regional terminal walkway.
Figure 6.18	Rendered view of initial relief station design.
Figure 6.19	Rendered view of simplifying piers.
Figure 6.20	Rendered view of simplifying pier bridges.
Figure 6.21	Rendered view of testing dome piers
Figure 6.22	Rendered view of simplifying entire design form.
Figure 6.23	Rendered view of outcome.
Figure 7.0	Design proposal site plan. Sourced from the LINZ Data Service < https://data.linz.govt.nz/layer/51870-wellington-03m-rural-aerial-photos-2012-2013/ > and licensed by Wellington Regional Council for re-use under the Creative Commons Attribution 4.0 International licence.”
Figure 7.0	Design proposal site plan.
Figure 7.1	Rendered exterior plan view of the station.
Figure 7.2	Ground floor plan.
Figure 7.3	First floor plan.
Figure 7.4	Second floor plan.
Figure 7.5	Third floor plan.
Figure 7.6	All floor plans.

Figure 7.7	Axonometric exterior rendering of Emergency Relief Station
Figure 7.8	Axonometric cutaway rendering of Emergency Relief Station.
Figure 7.9	Axonometric section cutaway rendering of Emergency Relief Station.
Figure 7.10	Elevation of Emergency Relief Station.
Figure 7.11	Section of Emergency Relief Station.
Figure 7.12	Exterior rendering of emergency relief station.
Figure 7.13	Exterior rendering showing regional terminal walkway.
Figure 7.14	Interior rendering of central terminal gathering space.
Figure 7.15	Interior rendering of central terminal perimeter walkway.
Figure 8.0	Emergency relief station design.
Figure 8.1	Diagram showing day to day running of airport spaces.
Figure 8.2	Diagram showing airport conversion into emergency relief station.
Figure 8.3	Diagram comparing linear and curvilinear form.
Figure 8.4	Diagram showing possible self-sustainable implementations for power and water.
Figure 8.5	Diagram showing possible self-sustainable implementations for food, wastewater and fuel.
Figure 8.6	Diagram showing three key structural moves.
Figure 8.7	Diagram showing key logistical service points where aid is received.
Figure 8.8	Diagram comparing airport and station circulation paths.
Figure 8.9	Diagram comparing existing airport layout, 2030 masterplan and designed station layout.
Figure 8.10	Diagram showing private and public space.
Figure 8.11	Diagram showing possible method of expansion
Figure 8.12	London Britannia Airport by Gensler. Chalcraft, Emilie. 5th September 2012. Web. 2018 April 2018. < https://www.dezeen.com/2012/09/05/london-britannia-airport-by-gensler/ >.
Figure 8.13	London Britannia Airport by Gensler in partnership with TESTRA. Gensler. London Britannia Airport. 2018. Web. 5th April 2018. < https://www.gensler.com/projects/london-britannia-airport >.
Figure 8.14	Airport 2040 by APH (Airport Parking and Hotels). APH. The airport of 2040: Biometric tickets, ultra-fast security scanners - and no more queues. 2016 November 22. Web. 5th April 2018. < https://www.mirror.co.uk/news/uk-news/airport-future-stunning-concept-biometric-9307829 >.