HURRICANE RESILIENCE
& CLIMATE CHANGE ADAPTATION

A MINOR FIELD STUDY IN ROSEAU, DOMINICA

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Master Thesis Report

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"Let these extraordinary events elicit extraordinary efforts to rebuild nations sustainably. Let these extraordinary events unleash the innovation and creativity of global citizens to speak a new paradigm of green economic development that stimulates and reverses the consequences of human induced global warming."

– Prime Minister Roosevelt Skerrit, speech at the 72nd UN General Assembly, September 23, 2017, days after Hurricane Maria devastated his country, Dominica.

ABSTRACT

Dominica, the hurricane-prone island nation, experienced severe destruction in September 2017 from a category 5 hurricane named Maria. Based on research and a minor field study to the island in the Lesser Antilles, a climate change adaptive and hurricane resilient design for a specific site in the capital Roseau is proposed in this master thesis project in Sustainable Urban Design.

The project aims to mitigate storm related hazards , especially the risk of flooding, using various solutions coupled with strategies for social development. The project differentiates between flooding strategies, intended to tackle issues of flooding on different scales, and site-specific strategies for safe housing, sustainable economic prosperity, emergency and tourism logistics, as well as multifunctional urban spaces.

The flooding strategies range from landscape scale solutions to building scale mitigations. The site-specific urban design strategies consists of multifunctional design supporting tourism during normal circumstances and emergency logistics in times of distress, a physical environment that encourages pedestrian use, beach-front development opportunities that offer incentives for social development and active frontages and spaces for local commercial actors.

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PREAMBLE

1.1 IMPRESSIONS FROM A MINOR FIELD STUDY TRIP

In January 2019, I conducted a minor field study in Dominica financed by the ***Swedish International Development Cooperation Agency*** (SIDA). I spent two months in the small country during the dry season, analysing the current situation and gathering information from site visits as well as meetings with local authorities, organizations and inhabitants in order to understand how the island nation has been affected by the 2017 category 5 Hurricane Maria. Prior to my departure I was invited to a three-day workshop in Härnösand that prepared me for my trip. We were introduced to fieldwork in developing countries and received a crash course in international politics, ethics and security, information that came to be very handy.

I arrived on Martinique, a neighbouring island to Dominica, on January 12, 2019. Martinique is a department of France and thus EU territory. It was a strange experience flying nine hours to arrive in this exotic place where you text, call and browse just like home. I took a two-hour ferry to Dominica the day after and it felt like travelling back in time. Aside from the usual culture shock, it was also jarring to see many buildings still lack proper roofs, see traumatized homeless people on the streets and experience a political tension with an opposition, that seemed quite frustrated. General election was about to take place.

I wonder if the consequences of Hurricane Maria were really clear to the government even at this point—no one knew exactly how many houses were damaged or totally destroyed, how many became homeless or unemployed or how many have left the island. Many claim that it is not exactly known how many died as a result of Maria.

The storeys I heard were heartbreaking. Everyone I met told a unique story, often including deaths of friends or family members. The months after were described as the worst, even worse than the immediate aftermath. A lot of villages were completely cut off; roads vanished from massive landslides, people had to walk across the island to visit family members or receive aid in the capital, Roseau. For months there was no electricity. Water and food was scarce. Internet or phone connections were down. There was no access to proper healthcare, which led to people dying during childbirth or by treatable deceases like diabetes.

Keeping order was a difficult task; people became desperate. Homes, stores and even containers with aid were looted. Aid was unorganized and came in late and often in the wrong order—when medication and water was needed, tuna was distributed. There was a lack of emergency management and the port couldn't handle the amount of containers.

When I first arrived in Dominica, I thought I needed to do a very comprehensive study of how to build hurricane resilient roofs. However, after I knocked on the door of the local ***United Nations Development Programme*** (UNDP) office, which opened right after Hurricane Maria, I understood that this had already been thoroughly researched, with guides and leaflets already printed. As it often is, the main problem was not a lack of knowledge. Instead the biggest obstacles to rebuilding and constructing resilient roofs on the many buildings with gaping holes on top, were the difficulties of finding funding or investments coupled with poor insurance coverage with slow and bureaucratic insurance claim processes.

Nature took a big hit from the hurricane as well. The canopies in the rainforest were stripped naked—trunks were broken in half and swept down to the shore by the massive flows of water. Ground that had been protected by thick vegetation that created shade was now uncovered and sun-drenched—threatening and destroying very delicate ecosystems. Vines covering dead trees have basically taken over everything. Very old forests hurled back to primary succession.

Nonetheless, it is a beautiful island with a rich nature, even despite what happened. Dominica is called the nature island and has the most dramatic and varied nature in the entire West Indies. It is also the only islands in the region with a significant indigenous population, called the Kalinago.

Dominica is also the most mountainous island in the region and attracts the most rain. It is in the middle of the Lesser Antilles and therefore very often in the path of storms. Because of its numerous rivers, ravines and thick rainforest it is a particularly

Roseau days after Hurricane Maria

image source: https://www.theguardian.com/world/2017/sep/21/dominica-daze-hurricane-maria-island-caribbean-rescue

dangerous landscape combined with hurricanes.

The first weeks of my visit, I travelled to understand the island. I had to rent a car since public transport is limited and arbitrary. Dominicans are generally very car dependent. There are independent, collective taxis going at unscheduled times, but they usually operate mostly to and from Roseau.

Experiencing nature is what makes a visit to the island truly unforgettable. There are countless national parks with rich, thick rainforest, waterfalls, rivers, lakes, boiling lakes, natural pools, sulphur pools, mangrove habitats and mountains to climb—all accessible by hiking trails, although many trails were damaged by Maria and still not accessible at the time of my visit. The island markets itself as an ecotourism destination and there are no big hotel resort chains. Homestay is the most common lodging. Nature, their biggest asset, is also a curse. Beside hurricane risks, the island also faces threats from earthquakes and volcanic activity.

Despite hurricanes increasing in frequency, intensity and lasting longer nowadays (Levitt & Kommenda, 2018), it is not the first time Dominica has been hit by strong hurricanes, but the more built infrastructure there is, more severe damage naturally follows. Still the resilient Dominicans always manage to restore their Eden, which was something I strongly felt and was impressed by while there. Hope was kept high and it was remarkable how fast they had bounced back. After one and a half year, main roads were restored, nature seemed to be in recovery and the people kept on with their daily life. From everyone I talked to I got the impression that they were determined to push through and improve conditions. I also felt very welcomed by the Dominicans, which further fuelled my motivation to help any way I could. I really hope to revisit the island soon.

"To deny climate change is to procrastinate while the earth sinks; it is to deny a truth we have just lived."

(Skerrit, 2017)

1.2 WHAT IS THE DEAL WITH THE CRUISE SHIPS?

Many international cruise ships dock at Dominica's ports—mainly because Dominica is the biggest provider of fresh water in the region. However, when they dock, they usually arrive in the morning and leave before sunset. Some tourists get off the ship and go on organized tours to the rainforest to see waterfalls or swim in the natural pools. Very few stay in town and go for a stroll. There are three big ports in Dominica. One port is located in Portsmouth, the second biggest town in Dominica. Roseau has the two other ports: one located in the city centre and the other about one kilometre north of it. Today the northern port also operates as a container port. I have included it in my design site but propose that the current non-disaster related container activities should be moved.

A lot of things can be said about cruise ships: bad working conditions, big polluters, mass-tourism enablers et cetera, but I tried to understand them from a Dominican perspective. The majority of people I talked to shared an overall positive attitude towards them, even if they complain about and confirm many of the negative aspects. It must be kept in mind that the ships bring income opportunities to many. They are also a connection to the rest of the world for many islanders and when the first cruise ship docks at the harbour in Roseau late November it signals the end of the hurricane season.


POLICE
STOP
NO LEFT TURN
TF 380
H.P.S
Creating Beautiful Memories
448-4844
277-5167
616-8863
Open at Lunch Hour

02

BACKGROUND

2.1 INTRODUCTION

In September 2017, two category 5 hurricanes ravaged the Caribbean region. First Irma devastated the northeast region including Florida, then two weeks later Maria followed nearly the same path. The damage caused by the hurricanes was unimaginable. Total direct death toll of the hurricanes was estimated at several thousands, with Puerto Rico being hit especially hard, as reported in the Economist (2018). On Dominica in the east Caribbean, almost all buildings were damaged and at least a quarter of them totally destroyed. The agricultural sector on the island was basically wiped out. Trees and vegetation defoliated. Important infrastructure like power, phone, Internet and roads was disrupted and cut off. The total damage on Dominica was estimated to be over US $1.3 billion, which equals almost twice the Dominican GDP. (Pasch et al, 2018)

Due to climate change, scientists expect weather events like these to occur more frequently in the future (Fawkes, 2017). What used to be ordinary storms around the equator, have turned into devastating hurricanes[1] due to warmer sea temperatures. (National Ocean Service, 2018)

Roosevelt Skerrit, the Prime Minister of Dominica, days after Hurricane Maria had caused all the destruction in his country, gave an emotional speech, at the United Nations General Assembly in New York, pleading for international help and action on climate change (UN News, 2017). This speech really moved me and made me want to focus on Dominica in my master thesis project in sustainable urban design on hurricane resilience and climate change adaptation.

There is a great need for resilient rebuilding of Dominica. As Dominica's PM Skerrit has made it clear, they "did not start this war against nature [...] The war [on climate change] has come to us" (ibid). The country suffered collateral damage from climate change and needs the help of the global community.

"I come to you straight from the front line of the war on climate change. With physical and emotional difficulty I have left my bleeding nation to be with you here today because these are the moments for which the United Nations exists."

(Skerrit, 2017)

[1] Also called cyclones and typhoons in other parts of the world

2.2 THE UN GLOBAL GOALS

A project on hurricane resilience and climate change adaptation in the framework of sustainable urban design on Dominica is directly applicable to goal 11 of the United Nations Global Goals for Sustainable Development (n.d.): “Make cities and human settlements inclusive, safe, resilient and sustainable”.

Furthermore, target 11.5, 11B and 11C from the sustainable development goals directly align with aim of this project:

11.5 Reduce the adverse effects of natural disasters

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

11B Implement policies for inclusion, resource efficiency and disaster risk reduction

By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels

11C Support least developed countries in sustainable and resilient building

Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

2.3 AIM AND RESEARCH QUESTIONS

Though climate change is one of the world's greatest challenges, I believe that climate change adaptation in Dominica is possible. Recently Dominica announced the vision of becoming the first climate-resilient nation on earth (UN News, 2017). I would like to contribute to this vision.

To realise this goal, the government of Dominica created a new agency called Climate Resilience Execution Agency of Dominica (CREAD) to lead and coordinate strategic initiatives across sectors in Dominica. CREAD "aims to build strong and resilient communities, develop adaptive infrastructure, accelerate economic growth, strengthen institutional systems, enhance Dominicans' capacity to respond to local impact of global climate change, and set an example for the rest of the world on how to respond to the challenges of a changing climate" together with the business community, public services and social sector partners (CREAD, n.d.).

The National Resilience Development Strategy 2030 (Ministry of Planning and Economic Development, n.d.) contains a detailed action plan to rebuild a climate resilient and sustainable Dominica. The action plan includes economic development such as renewable geothermal and hydro energy; supporting industries such as sustainable agriculture, tourism and blue economy; investing in infrastructure, environmental management and social development, just to mention a few strategies in the report.

In order to deliver a good project in sustainable urban design, not only would research on hurricane resilience need to be applied, but local needs should also be taken into account. For this, the cultural, demographic, economic and social conditions as well as the physical environment need to be understood and analysed in order to come up with a sustainable, site-specific design proposal. Projects at the Faculty of Engineering LTH in sustainable urban design always strive for a holistic approach that combines physical and social planning with architecture and innovation. In order to investigate the topic, the following research questions have been formulated:

- **How can hurricane resilience be improved through urban design strategies in the context of Dominica?**
- **What key sites in Dominica can be developed for these strategies to be effective, and how would they look in place?**
- **Can these strategies be combined with design measures for increased social sustainability in Dominica?**

Before answering the research questions and creating a vision and strategy for the project, a field study was necessary in order to get a comprehensive picture of the current situation, for example:

- **What are the most urgent priorities that need to be addressed?**
- **What parts of the island have or have not recovered yet?**
- **What needs to be included in a comprehensive plan to ensure economic prosperity and social sustainability?**

2.4 METHOD

This field research project in sustainable urban design follows a research by design-strategy to explore possible development. The end product is an architectural proposal, that embodies and communicates sustainable and resilient design ideas.

To ground this proposal in theory, urban design research and literature on resilient construction have been surveyed see for example Taher, R (2007, 2011) and Ministry of Planning and Economic Development (2018). Interviews with relevant local contacts, such as employees from the planning office and other governmental bodies, employees from the local Climate Green Fund and various NGOs as well as affected residents have been carried out in order to understand local needs.

The research in situ was facilitated by the fact that the official language is English, thus no translator services were required to acquire practical information like planning and regulatory documents. Also, a lot of information in the form of plans and information are available online from the government's physical planning office's homepage, allowing ample material for desktop studies.

Beside this printed report that explains the aims, methodology, theory, research questions, process and reflections, the design proposal has been printed on grand posters to illustrate the analysis of the site, strategies for hurricane resilience and climate change adaptation in Dominica as well as the vision for the site. Many diagrams, drawings, illustrations, sections and plans are used to visually communicate the findings.

2.5 CONTEXT

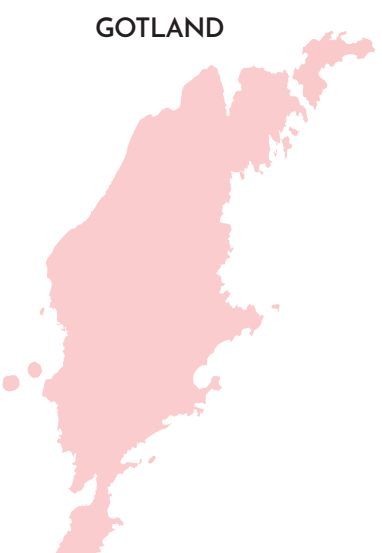
Dominica is an island nation in the West Indies located in the center of the Lesser Antilles in the Caribbean region. Dominica is not to be confused with the Dominican Republic, which is another bigger nation in the Greater Antilles.

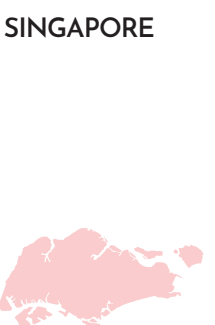
In total, the Lesser Antilles has a population of about 4 million and consists of several independent nations, as well as special territories and even some European Union territories. The islands differ a lot in vegetation and topography, qualities, cultures and wealth.

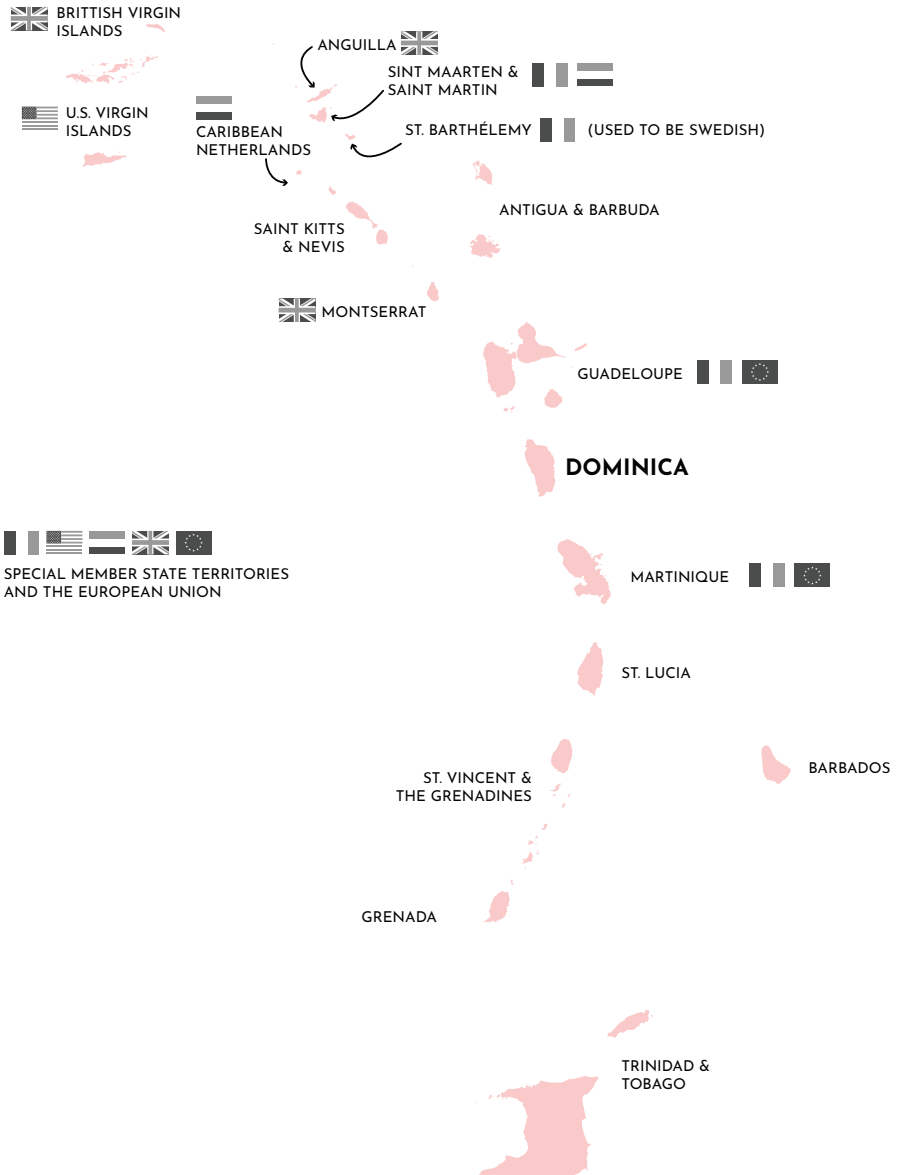
The entire region experiences hurricanes regularly. Dorian, the category 5 hurricane in September 2019, being the latest example of total destruction, this time hitting the Bahamas.

Dominica, a former British colony part of the commonwealth, is independent and a member of CARICOM, the Caribbean Community, together with other Caribbean nations, like Saint Kitts, Antigua and Barbuda and many other small island nations. Dominica with its 750 square kilometers is one quarter of the size of Gotland but is similar in size to Singapore. While size, climate and vegetation unites Dominica and Singapore, but when it comes to GDP, density and topography, they could not be more different.

Dominica has a population of about 74,000. A density of 105 people per square kilometer on average, a GDP of about $7,600 per capita. The highest point on Dominica, despite its size, is 1,500m above sea level. Singapore on the other hand, has a population of over five million, a density of 7,800 per square kilometers, a GDP of $98,000 per capita and the highest point is only 178m above sea level.






BRITTISH VIRGIN ISLANDS
ANGUILLA
SINT MAARTEN & SAINT MARTIN
U.S. VIRGIN ISLANDS
CARIBBEAN NETHERLANDS
ST. BARTHÉLEMY
(USED TO BE SWEDISH)
ANTIGUA & BARBUDA
SAINT KITTS & NEVIS
MONTSERRAT
GUADELOUPE
DOMINICA
SPECIAL MEMBER STATE TERRITORIES AND THE EUROPEAN UNION
MARTINIQUE
ST. LUCIA
BARBADOS
ST. VINCENT & THE GRENADINES
GRENADA
TRINIDAD & TOBAGO

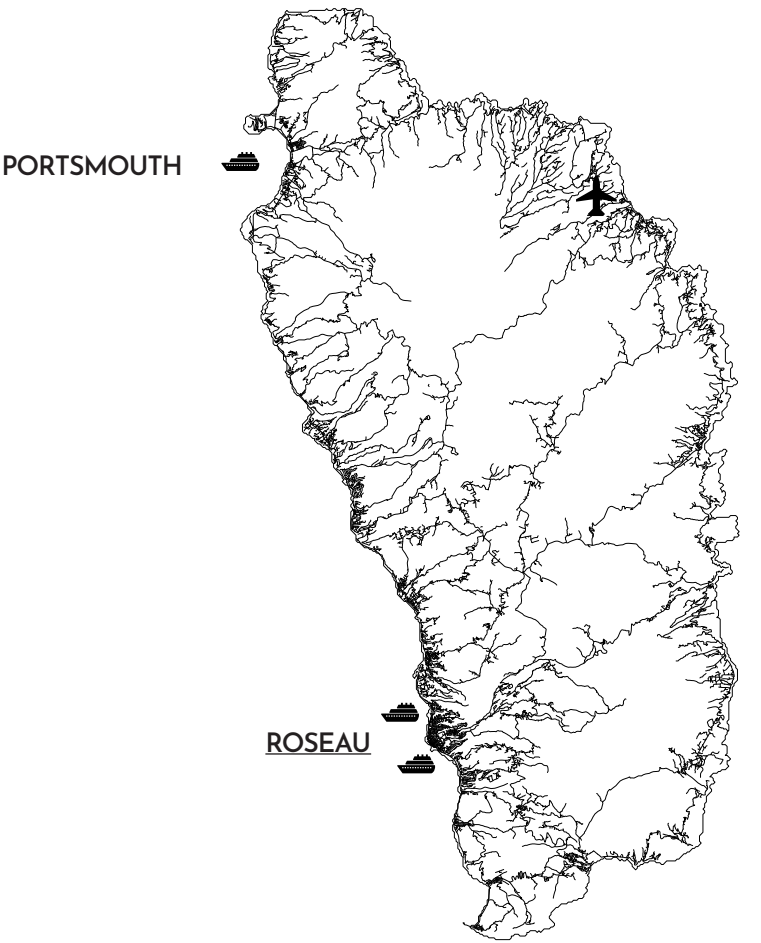
2.6 COMMUNICATION

From a map, it is obvious that most settlements are located along the shoreline. The result of multiple factors, but primarily flat land is the driver.

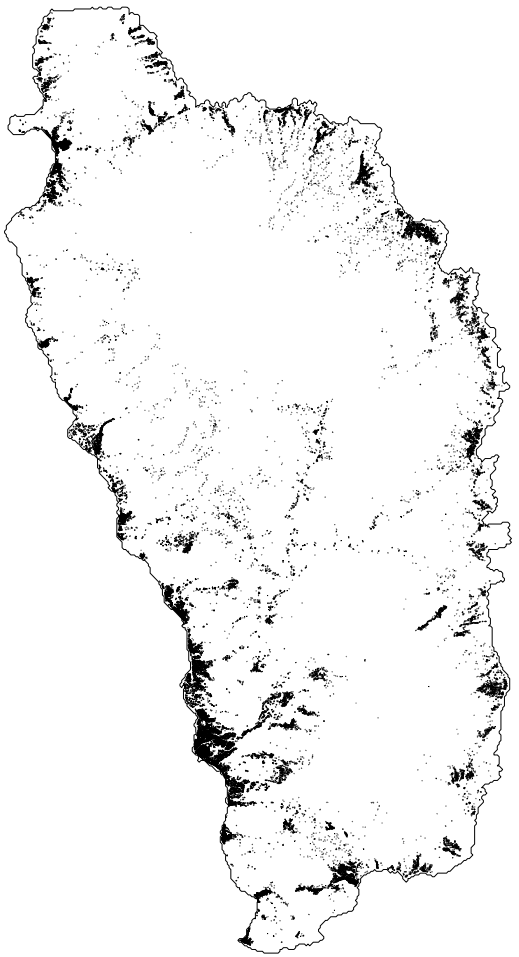
The road network on the island follows the path of the shoreline. There are only few intact roads that cross the island. The main airport, Douglas–Charles Airport, is situated on the north east side of the island and an hour drive away from the capital. The airport is fairly small and used only by regional airlines. International travellers from other continents usually fly to Guadeloupe or Martinique and then arrive by boat in Roseau.

As been mentioned, public transportation is limited and people are generally very car dependent. There are collective taxis and it is possible to travel from one part of the island to the other relatively cheap, but they usually leave at unpredictable times as they are independent and leave when fully occupied.

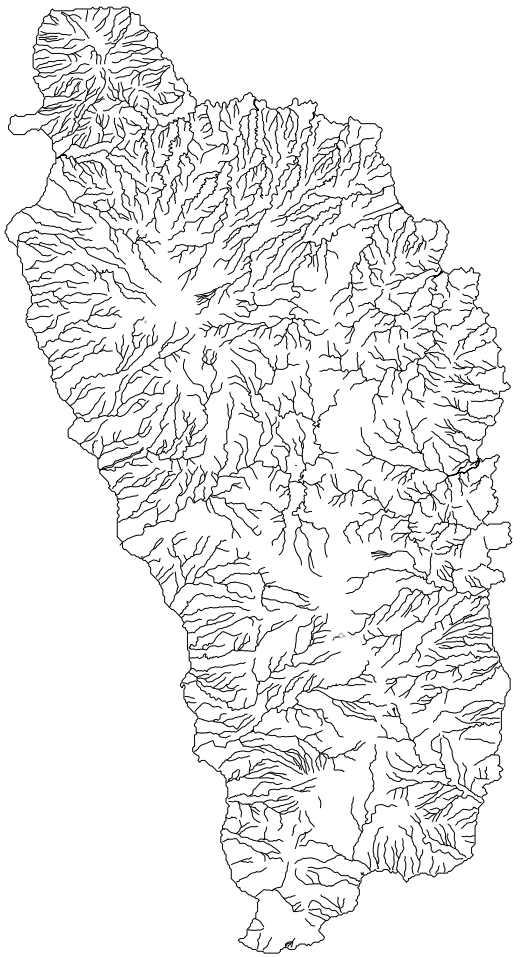
ROAD NETWORK



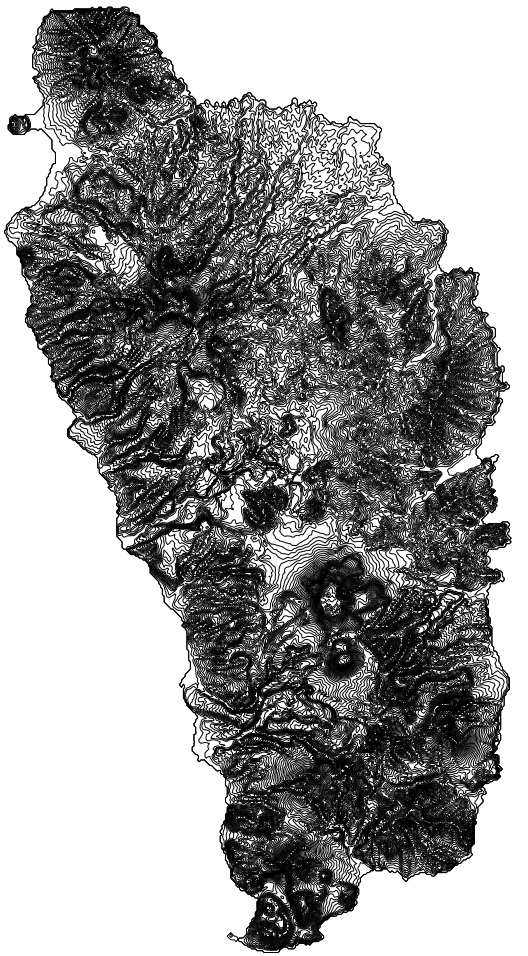
SETTLEMENTS



RIVERS



20M HEIGHT CURVES



2.7 BRIEF HISTORY

Dominica has a long history of European colonisation, but the island was populated before. Research indicate that there have been people on the island as early as 5,000 BC, but very little is known about who they were. (Honychurch, 1975)

From what is known, the Ciboney were early settlers who came from the north, todays Cuba, Haiti and Dominican Republic, then the Arawaks, from the Orinoco River valley in what is Venezuela today, followed by the Caribs who drove the Arawaks out. Carib is a name Christopher Columbus gave them though—their original name is Kalinago and they called the island Wai'tu kubuli, which means "Tall is her body." They are descendants from the mainland Kalina (Caribs) in South America. (Ibid)

The first time Christopher Columbus disembarked on Dominica, in 1493 on his second voyage to the West Indies for the Spanish, was on a Sunday, and thus named the island so. After that, Spanish colonisers tried to settle on the island, but the Kalinago put up strong resistance and pushed them out. In 1632, the French claimed the island, but never occupied it physically. The French and English agreed in 1660 to leave Saint Vincent and Dominica to the indigenous, but both went there and harvested timber still. In the 1690s the French permanently settled on the island to supply the French islands Martinique and Guadeloupe with a steady supply of timber. They also brought the first African slaves. (Ibid)

Most slave trade was brought to the West Indies, not the US or Brazil as often assumed. Around 4.2 million slaves were brought in total to the region by the licensees, i.e. asiento, from Portuguese traders operating in West and central Africa. (Mohammed, 2015)

In 1715, Dominica officially became a French colony after a local government was installed. The French imported more slaves, making the people of African decent the majority population on the island. (Honychurch, 1975)

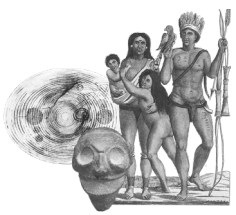
Martinique and Guadeloupe were more suitable for sugarcane plantations due to their flatter topography, while coffee plantations were more common on Dominica. (Ibid)

In 1763, the French lost the seven-year war against the British and had to give up Dominica. Subsequently, the French tried to reconquer it several times, unsuccessfully. (Ibid)

In 1833, slavery in the British West Indies was abolished. In Dominica 14,200 slaves were freed. In French Martinique and Guadeloupe slavery was not abolished until 15 years later, which led to many slaves from the neighbouring islands fleeing to Dominica. (ibid)

After the emancipation, labour costs increased and as a result indentureship was introduced. This meant that workers from abroad were offered contracts for a period time in the Caribbean at a minimum wage. In the British Caribbean, labour was brought from India. Even today, one can find Caribbean Indians in the region adding diversity to local society, culture and cuisine. (Mohammed, 2015)

Until 1978, Dominica was considered as a special territory of the British. Then on November 3, 1978, the Commonwealth of Dominica was finally granted independence as a republic. (Honychurch, 1975)



5000 BC

Cibonedy, Arawaks, Kalinago

1493

Christopher Columbus arrives on Dominica

1690

The French move in

1763

The British take over

1833

Emancipation in the British West Indies

1978

Independence

2.8 CLIMATE & VEGETATION TYPES

Despite its size, Dominica has a great variety of climate and vegetation types due to its topography. Climate and vegetation varies a lot between the west and the east, and also altitude differences lead to variations in temperature and rainfall patterns. The lowest vegetation types are dry scrub woodland on the west leeward side, and littoral woodland, including swamp forest, on the east windward side. The next level is seasonal forest, then rainforest, then montane forest and at the very top: elfin forest. (Honychurch, 1975)

The mountains, along the centre vertical axis of the island from south to north, act as sharp dividers. The average height of the mountains is approximately 1,000 meters. The mountains force winds from the Atlantic Ocean to rise before reaching the other side of the island. Moist air and heavy clouds are formed and shower the island on the windward side. Most rain falls over the central mountain peaks. By the time the wind reaches the west leeward side, the clouds are no longer as moist, resulting in a dry, rain shadow coastline. (ibid)

The precipitation of the windward east coastline is 2,500–3,800 millimetres per year and on the leeward west coastline approximately 1,200–2,500 millimetres per year, whereas up in the mountains the precipitation is over 5,100 millimetres per year. (ibid) For comparison, the yearly precipitation in Malmö is around 620 millimetres. (Miljöförvaltningen Malmö stad, 2019)

Agriculture on Dominica is an important sector and accounts for approximately 20 percent of GDP and 40 percent of the labour force. Many residents are self-sufficient in agricultural food production. The climate and terrain on Dominica makes it well-suited for tree crops: Vanilla, bananas, coconuts, citrus fruit, cocoa, coffee, passion fruit, guava, papaya, sapote and paw-paw are some of the most common ones. Essential oils, patchouli and soap are other important commodities. Root crops such as cassava, dasheen, taro and sweet potato are traditional crops and are increasingly produced. (Honychurch, 1975)

The montane forest atfter hurricane Maria.

Dasheen farming up on Morne Diablotins

2.9 TOURISM

Tourism in Dominica is in very early development compared to the neighbouring islands. Due to the island's few white sand beaches as well as the rugged terrain, it has not traditionally attracted as many stayover tourists. Instead, the island is marketed as the nature island of the Caribbean to attract eco-tourists. An early realisation was that it would be difficult to preserve the delicate ecosystems if faced with mass-tourism. (Jacob, 2016) Still, new hotels are constantly built, but not well-known international hotel chains.

The three big ports in Dominica receive around 200 cruise ships with 300,000 passengers yearly, compared to only 80,000 stayover visitors per annum. (Jacob, 2016) Cruiseship passengers usually stay for the day and don't spend as much as stayover visitors would spend.

Some of the famous attractions on the island are the natural attractions such as natural pools and hot springs, waterfalls, and the world's second largest boiling lake. Additionally there are many diving spots and mountains to hike as well as the Indian river, a mangrove habitat where some scenes from one of the Pirates of the Caribbean-movies was filmed.

One of the many natural pools,
Emerald Pool

Mangrove habitat, Indian River

2.10 ECONOMY

Dominica has recently become an international financial hub with offshore services as one of its main sources of income. Despite the offshore services, Dominica has so far managed to not be blacklisted by the OECD. The main export partners are Japan, Jamaica and Antigua. The main imported goods are manufactured goods, machinery and equipment, food and chemicals imported from Japan, USA, China and the EU.

In Dominica, there is also a citizenship by investment (CBI) programme that entitles citizenship to applicants who invest in the country. This controversial programme is fairly transparent, and helped the country to recover from Hurricane Maria. Applicants either donate money to the Economic Diversification Fund or invest in designated real estate. Some of the exclusive hotels on the island have been built with funds from the CBI programme, such as the luxurious Jungle Bay Villas and Secret Bay. One of the biggest projects by the CBI programme is a housing project providing 5,000 new hurricane resilient homes to communities across the island. (Citizenship By Investment Unit, n.d.)

Global Community, Global Citizenship (n.d.),
Source: https://cbiu.gov.dm

2.11 THE HOUSING REVOLUTION PROGRAMME

The Housing Revolution Programme financed by the CBI is a project aiming to create 5,000 new hurricane resilient homes across the country in various communities. These homes are built according to standards to endure strong hurricanes in order to provide better safety for families in vulnerable situations, such as families that lost their homes during the tropical storm Erica in 2015. And it has been developing impressively fast, despite the nine-month interruption by Hurricane Maria. In April 2019, 52 units were handed over to families in Petite Savanne, an entire community relocated to the Bellevue Chopin Housing Project. (Housing Dominica, n.d.).

Bellevue Chopin Housing Project
Source: https://housingdominica.com/

2.11 THE HOUSING REVOLUTION PROGRAMME FROM A SUSTAINABLE URBAN DESIGN PERSPECTIVE

During my field study on the island, I visited the Petite Savanne project and also analysed where the new Roseau City Square Housing Project was about to be built. I saw qualities in these projects, but also shortcomings I was able to identify using knowledge from my studies.

In order to do a well-structured analysis of the projects, I have chosen to analyse and benchmark them against the UN global goals for sustainable development. After all, the UN global goals are part of Dominica's National Resilience Development Strategy 2030 (Ministry of Planning and Economic Development, n.d.).

The UN global goals were agreed to by world leaders in 2015 in order to create a better world by 2030. The goals consists of 17 interconnected goals each with their own targets. Therefore it is difficult to just focus on one goal without taking others into account too. Goal 11 Sustainable cities and communities, for example, is difficult to satisfy without taking other goals into account, such as goal 1: no poverty, goal 7: affordable and clean energy, goal 8: decent work and economic growth, goal 9: industry, innovation and infrastructure, goal 10: reduced inequalities and goal 13: climate action, which serves to illustrate the complexity (United Nations Global Goals for Sustainable Development, n.d.)

However, to limit the scope of this paper, I focus on goal 11 and its targets: Sustainable cities and communities:

The Housing Revolution Project can without doubt fulfil several of the targets of the goal (see right), especially when it comes to safety, such as target 11.1: safe and affordable housing, target 11.5: reduce the adverse effects of natural disasters, and target 11.7: provide access to safe and inclusive green and public spaces. The other targets, however, are up for discussion.

A common feature of all the proposed housing projects is that they lack connections to the physical surroundings, but also to social environments. Beside the Roseau City Square Housing Project all projects seem to be satellite projects, remote, isolated, and not part of the existing communities, infrastructure and social life. Satellite, made up communities do not tend to be sustainable in the long run. There are many examples in Europe alone. See for example: The Million Homes Programme: a review of the great Swedish planning project by Thomas Hall and Sonja Vidén (2005).

By building satellite communities, several aspects of the Housing Revolution Project are in conflict with the targets of goal 11: Sustainable Cities and Communities. The main issues relate to segregation, physical accessibility, access to economic and social functions, cultural and social inclusiveness.

In this light, target 11.2 is not fulfilled since projects like the one for Petite Savanne are remote from economic and social activities in the existing communities and would lead to further car dependency for an already financially strained population. Affordable, timely and sustainable transport systems would be difficult to put in place for a small community.

By building only one type of accommodation clustered together, a separation of poor and wealthy will increase the risk of segregation, which conflicts with target 11.3, Inclusive and sustainable urbanisation. Neighbourhoods with wealthier populations will enjoy greater access to resources and income, higher home values and quality municipal services, better schools, more cultural activities et cetera. People in segregated areas tend to be far away from where job opportunities are located. In order to reduce segregation, it is imperative to provide more diverse housing in each community. Equal opportunity is what makes societies prosper, children growing up in remote and segregated areas tend to miss out on those opportunities.

Target 11.6, Reduce per capita the environmental impact of cities, is difficult to meet if the population is encouraged to be car dependent. Also, basic infrastructure such as water, electricity, Internet, roads, waste management, are much more difficult to manage if remote from existing and functioning communities, especially in times of climate disasters. The fact that Dominica has invested in rebuilding safe housing for its population is great, but housing

SAFE AND AFFORDABLE HOUSING

By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

AFFORDABLE AND SUSTAINABLE TRANSPORT SYSTEMS

By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

INCLUSIVE AND SUSTAINABLE URBANIZATION

By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

PROTECT THE WORLD'S CULTURAL AND NATURAL HERITAGE

Strengthen efforts to protect and safeguard the world's cultural and natural heritage.

REDUCE THE ADVERSE EFFECTS OF NATURAL DISASTERS

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

REDUCE THE ENVIRONMENTAL IMPACT OF CITIES

By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

PROVIDE ACCESS TO SAFE AND INCLUSIVE GREEN AND PUBLIC SPACES

By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

STRONG NATIONAL AND REGIONAL DEVELOPMENT PLANNING

Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.

IMPLEMENT POLICIES FOR INCLUSION, RESOURCE EFFICIENCY AND DISASTER RISK REDUCTION

By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels.

SUPPORT LEAST DEVELOPED COUNTRIES IN SUSTAINABLE AND RESILIENT BUILDING

Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.

projects of this scale are more than just building homes after standards. Projects like these can have long and lasting effects on societies and need greater planning and research, they need to be analysed at a grander scale and involve more aspects of the society. Also, taking people out of their context of daily routines and familiar places and putting them in a new setting can be disorienting. I think Dominica is in a great position of learning from experiences of other countries when housing was scarce, instead of repeating the mistakes of the Swedish government, for example.

I aim for my proposal in the following chapters to cover the targets. By grounding design suggestions in the targets, not only am I forced to find physical solutions to hurricane related hazards, but also to include social sustainability and economic prosperity aspects.

George Town Housing Project: Reminiscent of one of the many social housing projects in Europe with issues related to segregation and lack of diversity.
Source: https://housingdominica.com/

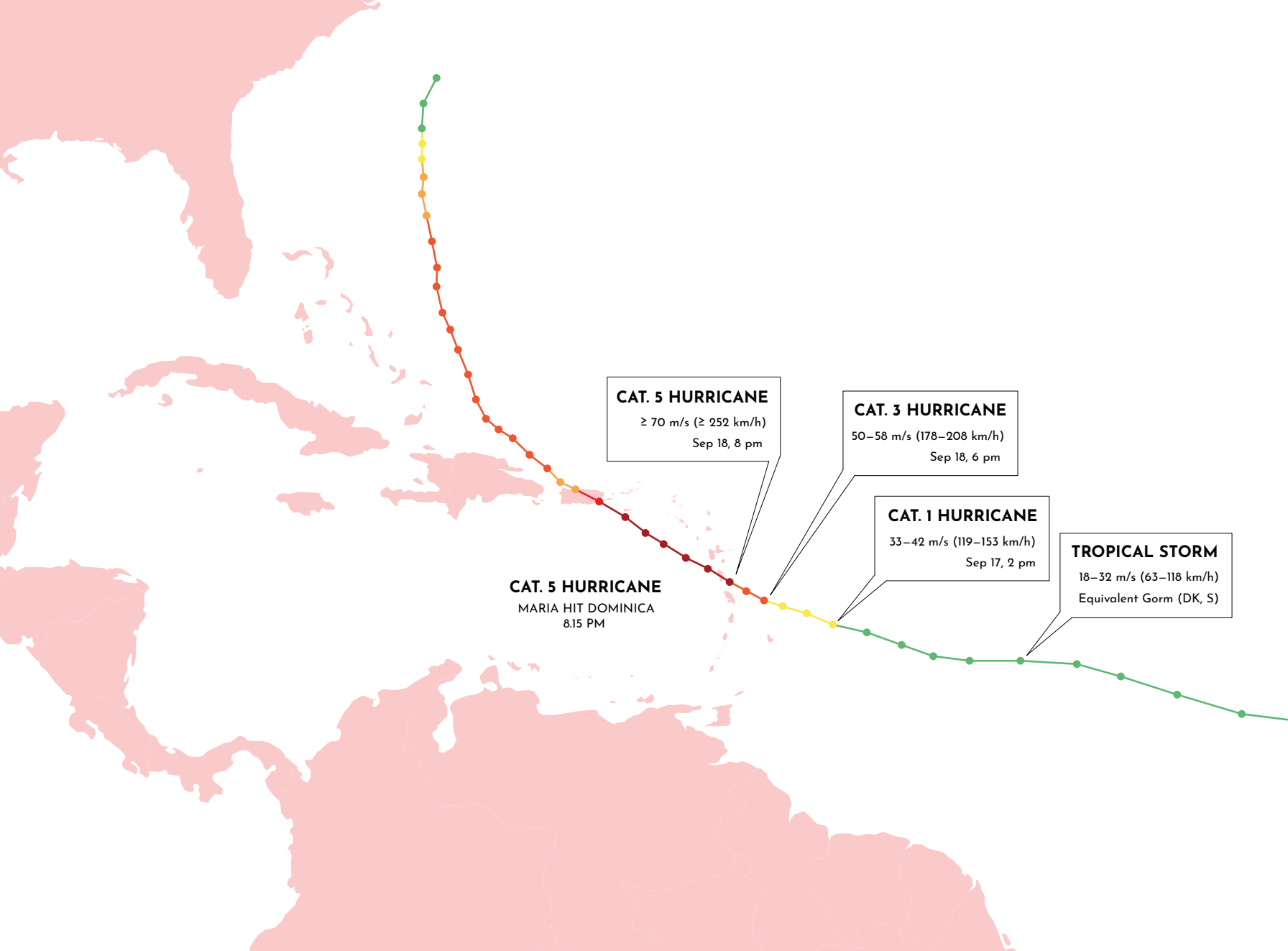
Segregated social housing in Rinkeby, north Stockholm
Source: https://www.svt.se

East Coast Housing Project
Source: https://housingdominica.com/

03

HURRICANE MARIA


Office


CAT. 5 HURRICANE
≥ 70 m/s (≥ 252 km/h)
Sep 18, 8 pm
CAT. 3 HURRICANE
50–58 m/s (178–208 km/h)
Sep 18, 6 pm
CAT. 1 HURRICANE
33–42 m/s (119–153 km/h)
Sep 17, 2 pm
TROPICAL STORM
18–32 m/s (63–118 km/h)
Equivalent Gorm (DK, S)
CAT. 5 HURRICANE
MARIA HIT DOMINICA
8.15 PM

3.1 WHAT HAPPENED

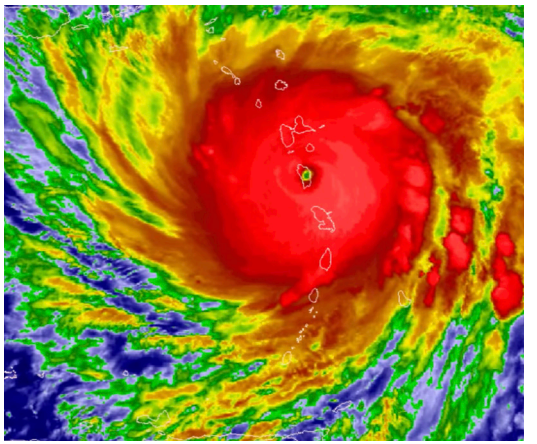
In September 2017, the two category 5 hurricanes Irma and Maria hit the Caribbean region. First hurricane Irma, with Hurricane Maria following it two weeks later causing massive damage.

On September 16, Hurricane Maria was still only a tropical storm in the middle of the Atlantic Ocean and indication showed that the storm was heading towards Dominica. The tropical storm had a speed of about 32 meters per second, equivalent to the storm Gorm which hit south-west Sweden and Denmark in 2015. (Johansson et al, 2015)

A day later, the storm was upgraded to a category 1 hurricane, and few hours later to a category 3. There was no longer doubt that the hurricane was about to make landfall on Dominica and as precaution the electricity was shut down and the population braced themselves for a hurricane with wind speeds of around 58 meters per second. Only an hour later Maria was upgraded to a category 5 with wind speeds over 75 meters per second, surprising the unknowing population who expected a category 3 hurricane with little chance to receive this information as electricity was already off. It was also a population still in recovery from previous storms. Maria took the longest and most destructive path imaginable across the island, entering south-east and then making an L shape towards the northern shore. Hurricane Maria has been by far the strongest recorded hurricane on Dominica ever. (Pasch et al, 2018)

In addition to its furious winds, the hurricane produced enormous amounts of rain. Dominica experienced rains from Maria of 580 millimetres in just a couple of hours (Pasch et al, 2018). To put that in perspective, the rain that caused extreme harm in Malmö 2014 was estimated at 100 millimetres. (SMHI, 2014)

In Dominica a vast amount of trees were stripped naked, pushed over and broken in half. Electricity poles were pulled out of the ground, building lost their roofs, windows were smashed and doors blew out. Cars were turned upside-down and streets were filled with debris. Roads vanished by massive landslides, bridges were destroyed by debris in rivers and many buildings flooded. On the east and south side of the island, communities along the shoreline experienced massive storm surges as well.



The eye of the hurricane right over Dominica (NOAA, 2017)


Rentals
TM349

3.2 STORM SURGE

A common risk associated with hurricanes is the risk of storm surges. A storm surge is a coastal flooding phenomenon that occurs when strong wind pushes water up the land beyond its normal levels. Combined with high tide, the sea level can reach extreme levels. (NOAA, n.d.)

Many cities and communities are situated on the coast, and with the general rise in sea level due to climate change, as well as the risk of storm surge in hurricane-prone areas, these communities are almost doomed to be victims to flooding, one way or another.

Is there then any reason to develop in Dominica, for example next to the coast in Roseau? Both the risk of storm surge as well as general sea level rise has been carefully examined. According to the Caribbean Disaster Emergency Management Agency (CDEMA) and the UK charity MapAction, the risk of storm surges in Roseau is relatively low. This is due to Roseau's strategic position on the leeward Caribbean Sea side of the island and its fairly steep elevation. The Caribbean Sea is also one of the few seas in the world that has next to no tide. Some areas of Roseau are at higher risk, for example the fishers market in the city centre, but this is due to low elevation and its position right next to river. As for the location of the proposed site in lower Goodwill, due the elevation, a general sea level rise up to two meters can be tolerated.
(MapAction, 2018)

3.3 HAZARDS IN ROSEAU AND HOW THE RIVER FLOODS

Despite Roseau not being subject to neither significant storm surges nor tides, the capital city was severely affected and damaged by flooding. The Roseau River flows out into the Caribbean Sea straight through Roseau on the west side of the island. The source of the river is in the centre of the island, high up in the mountains in the national park Morne Trois Pitons. It flows continuously west through the Roseau Valley before it reaches Roseau, in which it makes a sharp turn right before the city centre. There are four main bridges that connect the southern and northern parts of city. Seen from above, the river is a sharp divider between the two neighbourhoods.

As Hurricane Maria entered Dominica it brought strong winds and an immense amount of precipitation, as much as 580 millimetres in only a few hours (Pasch et al, 2018). Up in the mountain trees were ripped up with roots. The river came rushing down the mountains with immense power, carrying all debris from the forests, while causing massive landslides along the way as well, sweeping buildings and roads in its way with it. By the time it reached the capital, the river was way over capacity. All debris it carried down to the city got stuck under the bridges; forming dams that made the water spill out on the sides, flooding the large swathes of the city.

During such extreme rain bursts, it is difficult enough to deal with the amount of water rain brings locally, let alone a flooding river. Planning and urban development need to be pushed to the limit. These are challenges I face and address in my urban design proposal for Roseau.

Aerial photo of Roseau, just days after Hurricane Maria (DFID, 2017)
Source: https://www.flickr.com/photos/dfid/37361025335/

04

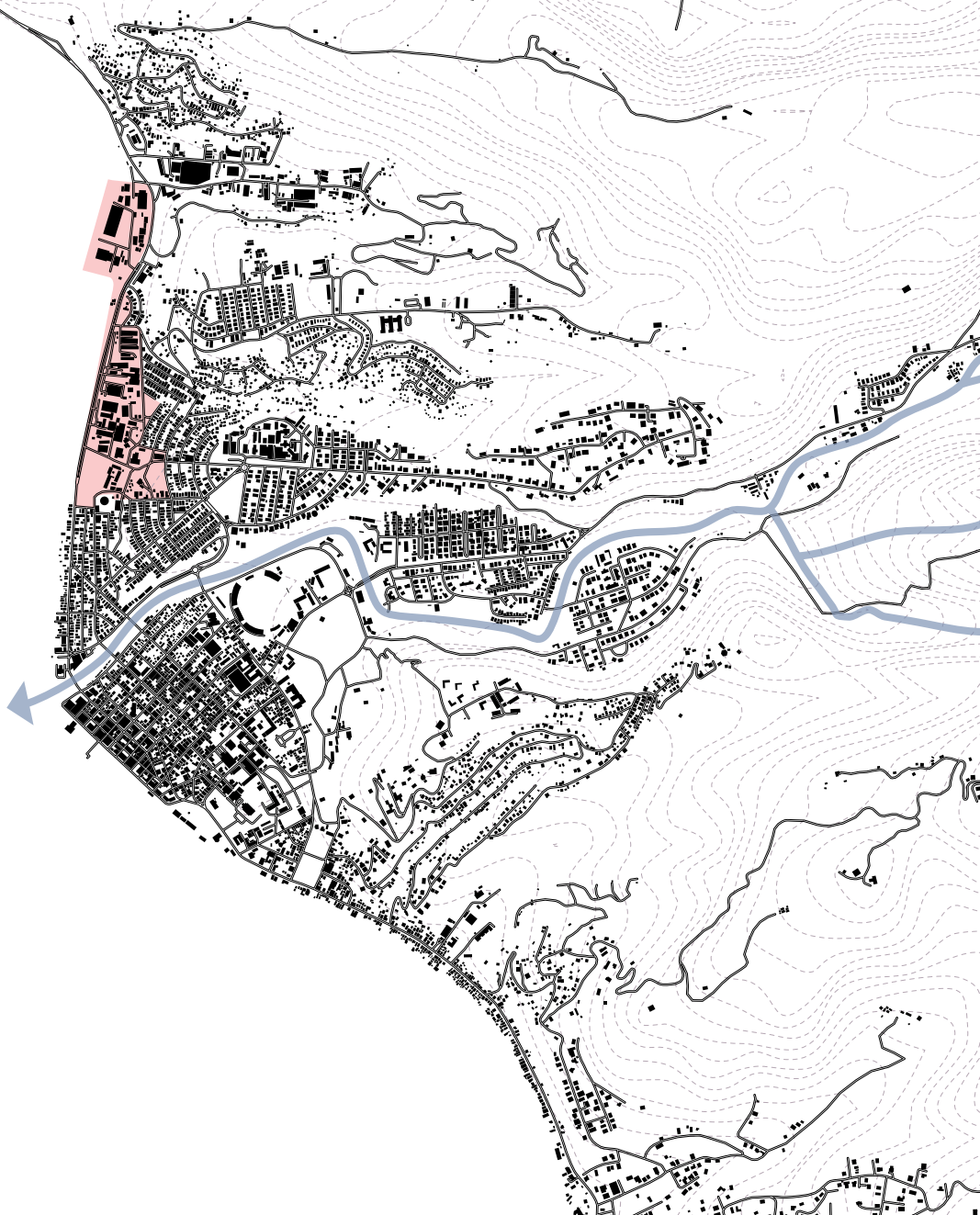
THE SITE

4.1 WHY ROSEAU

After Hurricane Maria brought destruction to the entire island, many places needed rebuilding in a more sustainable way to withstand strong hurricanes. Starting in Roseau would be strategic, as basic infrastructure already exists, like roads, power and sewage, as well as public functions like schools, universities, hospitals and institutions. It is also where most of the shops and work opportunities on the island can be found. The main port is also situated in the city, which means that during tourist season, this is where economic opportunities are given, and during states of emergency, this is where aid arrives and inhabitants of the city can reach it by foot, not being dependent on roads surviving landslides. The port is also the main connection to the neighbouring islands.

The sites position right next to the beach is also one of the bigger driver and have the potential of becoming a very beautiful public place for everyone, both for locals and tourist, if designed properly. This site have the potential to give back to the entire city of Roseau, potentially the entire island and I consider it to be the most valuable site on the island. This is why I have chosen to work with it.

The site includes Woodbridge bay and what I call lower Goodwill. It stretches all the way down to Juiceman and Saint Alphonsus Church. In the site selection process, I try not to design where people live and that defines the southern and eastern boundary.



4.2 COLONIAL CITY PLANNING AND ARCHITECTURE

Roseau is located on an alluvial fan that was formed hundreds of years ago by the Roseau River. Inhabitants of different groups have settled in this area since long time, but it was first when the Europeans arrived in the 17th century, that the city took the shape it has today. A small settlement was established by the French who named the place after the reed plant Roseau that was growing on the riverbank. The settlement was planned and built in a typical French colonial manner where streets extended from a central point which is known today as the Old Market. Later when the British arrived in the early 19th century, they built a fort, introduced the grid street system with clear blocks and variation in length and width, and created new neighbourhoods north and south of the town. (Lipsanen, 2001)

Today, Roseau is a dense and lively little town. Few live right in the city centre and urban sprawl has led to many commuting to town by car, causing often congestions. The plots are relatively small and there are only about 1060 lots in the inner city with an average size of 290 square meters. Approximately half of them are as small as 90 square meters. Most buildings, in vernacular style, are built of wood and thus fire hazards. Still, they give the city a unique character. (Lipsanen, 2001)

There are many different styles of houses represented in Dominica, but the typical Dominican houses have verandas, balconies and gable roofs that let both the heavy winds of the hurricanes and more gentle breezes of the trade winds pass the house, without ripping the roof of its holding. During my field study, I observed that the older buildings with steep gable roofs had withstood the hurricanes to a greater extent than the flatter newly built houses. It is also not uncommon to see unfinished houses in Roseau. Many simply have a flat concrete roof, with the top floor still not built. Due to the risk of earthquakes, buildings are rarely built wall to wall in case one building would collapse.

The Dominican culture, very colourful and vivid, is also present in the way they paint their buildings. Pastel colours dominate and add to the Caribbean feeling. Almost everywhere where there is a change in structure or material, the opportunity to colour it in a different colour is seized upon.

Gardening is an integral part of the Dominican lifestyle. Everything grows everywhere and everyone grows anywhere. Stick a branch into the ground and it will start growing there. Balconies and the street in front of buildings are packed with plants. It is also common for families to have kitchen gardens on the countryside to grow basic food crops, a necessity but also a passion. This is a phenomenon common in the entire Caribbean region. As many people have moved from the city centre to the suburbs, commercial buildings have replaced many city gardens. There are fewer courtyards than before. (Lipsanen, 2001)

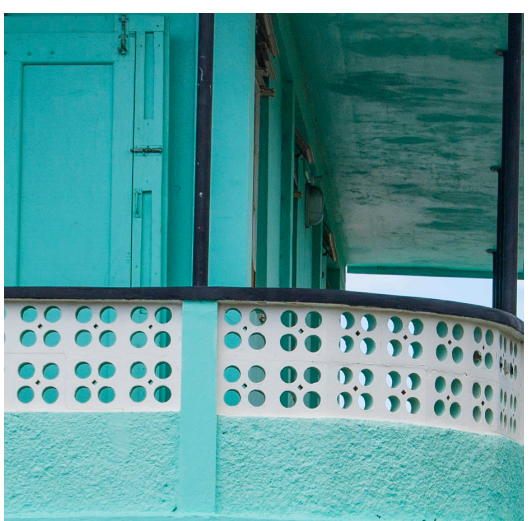
A vast botanical garden, built by The Royal Botanical Gardens of Kew, takes up almost a third of the city and is situated east of the city centre. The garden was established in 1891 to introduce new species to Dominica. Today however, its more an arboretum with a few old trees scattered on a vast lawn than what is usually known as botanical garden. It is mostly used for sports activities for children. Many schools are located around the garden. Other than this garden, Roseau has few parks, with the exception of some abandoned lawns. No park or walk has direct contact with the sea. (Lipsanen, 2001)

Every other street in Roseau is a wide commercial street, intertwined with smaller and narrower lanes with more housing and other functions. Small shops on ground floors can be found all over the island. Shops are mostly a room with a counter.

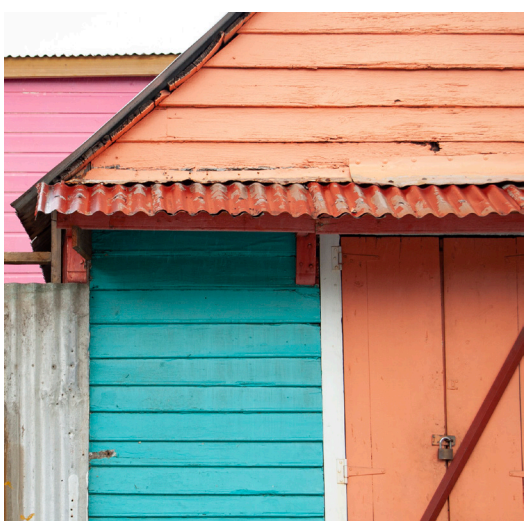
Walking in Roseau is somewhat of a challenge. Sidewalks are usually narrow, in bad shape and often quite elevated over the street level. Open storm water systems can also make it difficult to cross the streets. There are many cars densely parked along most, if not all, streets in the city, often blocking pedestrian flows. Wheelchair accessibility seems to be non-existent—despite the fact that disabled persons in wheelchairs are not an uncommon sight. One can only surmise what herculean task day-to-day life is for the impaired. In many cases, stairs to the ground floor are partly extending on the sidewalks, also limiting accessibility. These stairs, however, often become a social point where people

sit and chat, eat or play. They even function as displays for street vendors who put their products for sale on them. The streets of Roseau are very lively—a charming chaos of animals, people, colour, vegetation, sound and traffic, which altogether brings happiness and a unique character to this town. These are cultural qualities that I try to cater for in my proposal.

The botanical garden and its vast lawn




FORT LANE



4.3 PHOTO ANALYSIS IN ROSEAU

In order to come up with site-specific design elements, substantial time has been spent on analysing the architecture and understanding spatial qualities. The following pages help to illustrate some of the analysis performed.

OPEN STORM WATER SYSTEMS

Walking Roseau's narrow sidewalks, in bad shape, quite elevated over the street level, can be challenging. There are cars densely parked often blocking pedestrian flows. Open storm water systems can also make it difficult to cross the streets. However, open storm water systems can be a great tool to bring greenery and add to street qualities if designed appropriately.

ACTIVE GROUND FLOORS

In many cases, the ground floors are used for small businesses. The homes located above and reachable via stairs on the outside.

SEPARATION OF BUILDINGS

Due to risk of earthquakes, buildings are rarely built wall-to-wall in case one building would collapse. Ventilation shutters are instead put in these narrow passages and stairs that reach the upper floors are also often on the outside of the building.

OUTSIDE STAIRS TO SECOND FLOOR

A very common sight in Dominica is space between buildings utilized for access to the second floor via stairs. This way, valuable space indoors can be maximized, and in case of fire or earthquake, emergency exit is accessible.

VERANDAS AND BALCONIES

Dominicans love verandas and balconies. Suggesting designs on this island without them is unimaginable. They are used for restaurant activities, filled with vegetation and add to the street life when populated. They also provide shelter for sudden rainfall.


Heineken
PREMIUM QUALITY
Happy Birthday

ELEVATED GROUND FLOORS

In many cases, stairs to the ground floor are partly extending on the sidewalks, limiting accessibility. Buildings were probably built this way as a precaution to flooding. Elevated first floors is a proven method to limit flooding damage, but stairs and ramps need to be included in urban planning in order not to compromise accessibility for pedestrians and traffic.

ELEVATED GROUND FLOORS

These stairs often become a social point where people sit and chat. They even function as displays for street vendors who put their products for sale on them, thus adding to the unique and vivid street life.


PV 316

4.4 THE DESIGN SITE

The site I chose for my design is situated in the northern fringe of Roseau, more specifically, adjacent to an unused beach, the big container and secondary cruise ship port, approximately 1 kilometre from the city centre. It is bordering to low-income neighbourhoods in lower Goodwill and Pottersville.

When there is already a ship in port in the city centre, larger cruise ships dock the northern port. Passengers need to traverse first lower Goodwill then Pottersville to reach the city centre after disembarking.

The Goodwill district was planned and built in the 1950's under the so-called Pottersville Slum Clearance Scheme. (Lipsanen, 2001) The structure of this district is based on two major axes, Federation Drive and Charles Avenue. The structure is reminiscent of a baroque network model based on a system of curved lanes that correspond more carefully to the topographical character of the terrain. (Lynch, 1981) The lanes follow horizontal contour lines and axes are built in parallel direction with the slope. This structure inspired me to introduce a street network that takes advantage of the natural slope of the site to handle vast amounts of storm water.

Pottersville used to be where many fishermen settled. It is, historically, the part of town where emancipated slaves settled in the 19th century. Three streets, Elliot Ave, Potter St. and Steber St, go towards the city centre through the area. Many buildings are built directly on the beach and streets are not pedestrian friendly.

I spent many hours on Elliot Ave and at Juiceman, analysing flows and user activities. Many cruise ship passengers arrive in port, disembark, start strolling along an endless sun-drenched walkway right by the heavily trafficked highway in a pretty unkempt industrial area. Due to this unpleasant walk, many quickly turn back, never reaching the city centre nor the lively and rowdy yet charming part of Pottersville with bars blasting local music, some scattered shops and the Juiceman, running his Juice-shack by day, local night club come night. Locals enjoying Juicemans beverages and foods by day mostly arrived by car and ordered take away, rarely stopping to sit on his terrace on the beach. A sad observation of the car dependent lifestyle of the Dominicans.

Today, the site is primarily characterised by the heavily trafficked highway that separates the beach from the town. There are only few trees providing shade. On the site itself there is a hardware store, supermarket and a primary school. There are many roofless and abandoned buildings on the site and plots are mostly used for storage and the whole area has a distinct industrial character. There seem to be no residents on the site, or at least I was not aware of any when analysing it.

The site can be divided into two parts: the port and lower Goodwill. The port has dimensions of 190 meters in width, and 315 meters in length, which is approximately 5.8 hectare. Lower Goodwill is on average 200 meters wide and 600 meters in length, approximately 12 hectare.

The highest point of the site is at 22m above sea level. Both parts of the site have almost perfect south-north direction allowing horizon sunset sight-lines from perpendicular streets.

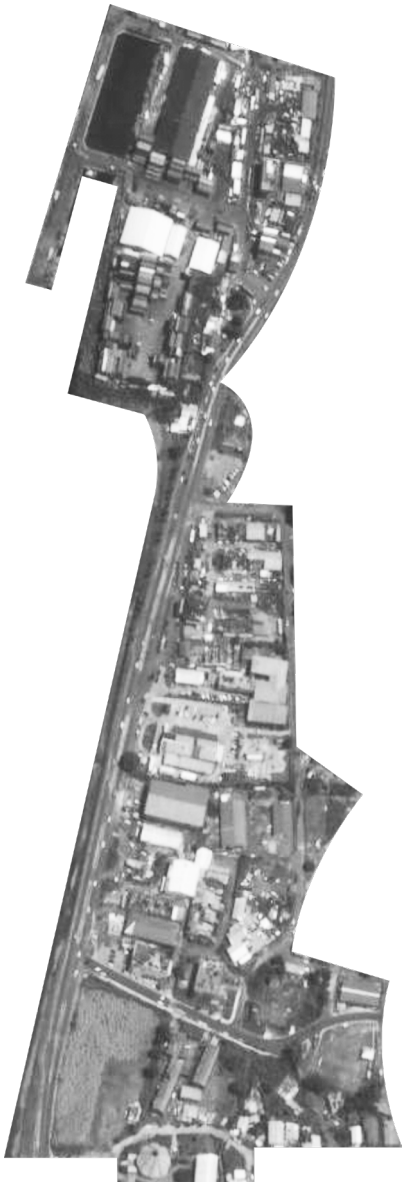

NORTHERN PORT
LOWER GOODWILL
JUICEMAN
POTTERSVILLE
BOTANICAL GARDEN
CITY CENTER
CITY PORT

This is an aerial photo of the site towards the container port. A cruise ship is docking and remnants of abandoned buildings can be seen. In the focal centre of the picture a primary school, a hardware store and a supermarket are found.

This is the current beach-front. It is heavily trafficked, there are few trees providing shade, and the access to the beach is limited. The 600 meter walk on this beach-front towards Roseau city centre is rather unpleasant.

The container port is already used for cruise ships. In my design, the container port activities are being moved.

These are three streets that connect the site to the city centre. In the background, a cruise ship that is docking at the city port can be seen.



This is a satellite cut-out of the site. It illustrates how scattered the existing urban fabric is, but also how underused the space is.

This is the same cut-out but placed over the city centre to illustrate how much could be fit into the site. The density of the site could be increased a lot more, without being disproportionate to the rest of the city.

See part 7, the detailed design, for the density estimations of the proposed design.

MASTER PLAN 1:2000

In the master plan 1:2000, the position of the site in the city, its closeness to the city centre, the long beach stretch and the proposed layout of the redefined harbour and lower Goodwill are detailed.


GUADELOUPE
MARTINIQUE
NEW TOURIST CENTRE
FLEXIBLE OPEN PUBLIC SPACE
600 M NEW CAR-FREE BEACHFRONT
HOSPITAL AREA
SITE SECTION
230 M
ROSEAU RIVER
STADIUM
BOTANICAL GARDEN
CITY CENTRE

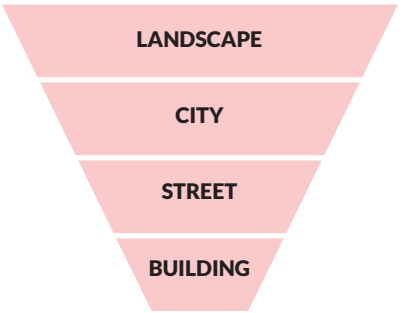
05

FLOODING STRATEGIES

Before suggesting or introducing any design strategies, the risk of flooding must be considered and mitigated. If not done carefully, development in Roseau would make very little sense. Flooding of the Roseau River in the context of the design site is not only a local issue, but goes all the way up to landscape scale. My flooding strategies can be divided into actions needed on four different scales

- Landscape scale
- City scale
- Street scale
- Individual building scale

I have based my flooding strategies on an idea of redundancy with a four step backup system that starts on a grand scale as the landscape scale, continue narrowing it down to city scale, street scale and last to the smallest scale the building scale. This backup system is supposed to back up if the previous system fails, there for providing fourfold security.



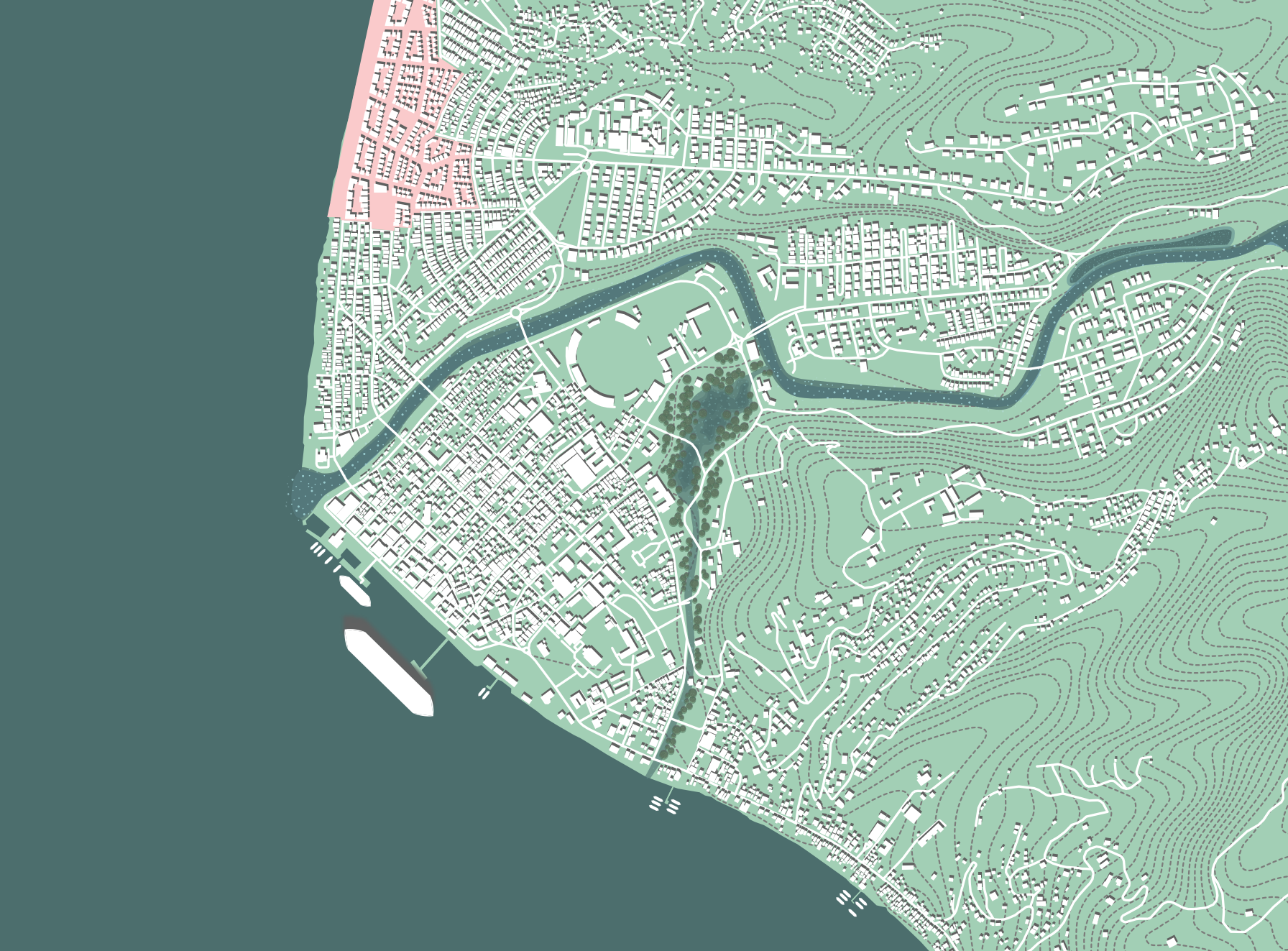
5.1 LANDSCAPE SCALE – STORE AND SLOW IT DOWN

In a 1:10,000 plan, the path of the Roseau River with all of its branches and how it flows down to the city from the mountains can be seen. Flat areas around the river that could handle vast volumes of water during floods supported by weir pool constructions have been identified. By introducing these areas of temporary expansion, it is possible to store the water from the river and slow it down further upstream in times of heavy rainfall. (See Clemmens, 2001)

LANDSCAPE

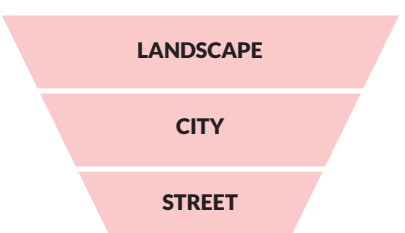
5.2 CITY SCALE – AN ADDITIONAL ROUTE

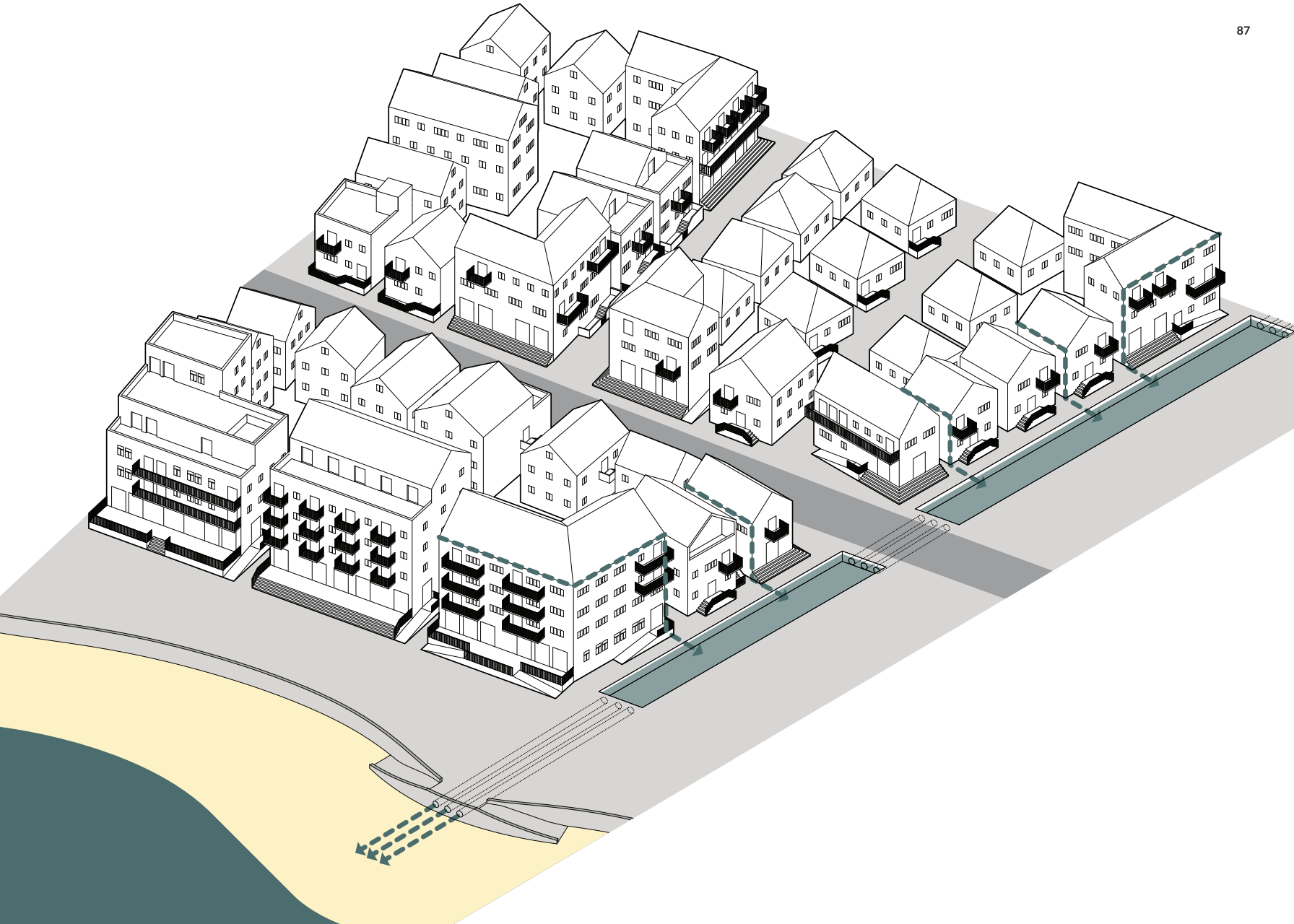
If the river in Roseau reaches a critical level, there should also be a possibility for the river to take a controlled additional route, instead of spilling out in the city. The botanical garden could be repurposed to become a wetland park that could hold and redirect excess water south of the city into the Caribbean Sea. By letting water find its way above ground, instead of redirecting it in channels underground, the risk of congestion and dam formation by the debris is limited. Vegetation that can live in partly dry conditions and partly flooded condition could be chosen from naturally occurring habitats on the island, as the park would be dry during the dry season. Besides providing flood reduction services, wetland parks also provide important ecoservice systems. (See Talbot et al, 2018, Acreman & Holden, 2013)

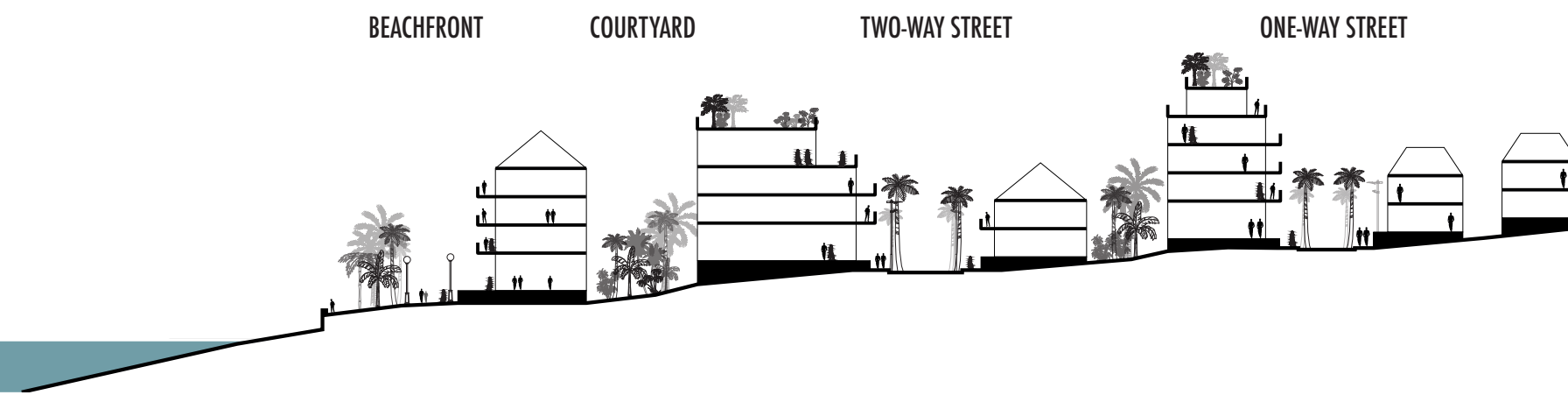


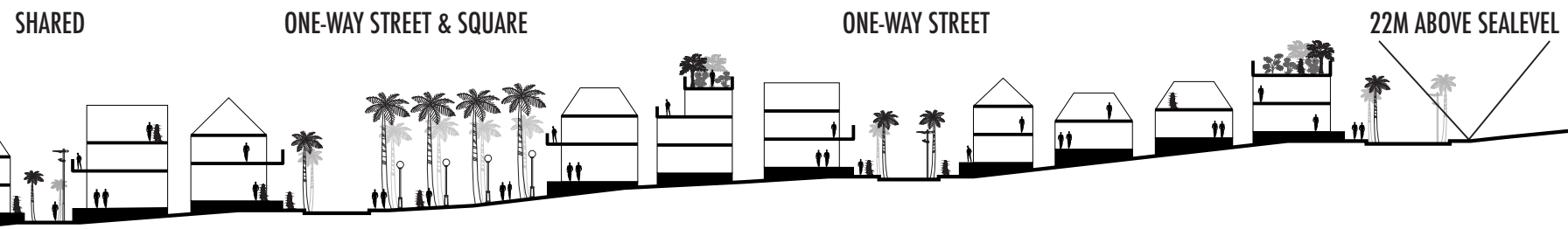
5.3 STREET SCALE – QUICK RUN-OFF

Considering the street scale of the proposed design site, streets need to be in perpendicular direction of the natural slope of the site so that excess water quickly can wash out to sea. Though the slope of the site is hardly noticeable, the height difference is up to 22 meters. These streets also need to be wide enough to fit bioswales that can cope with the amount of water in times of flooding and cloudburst. (O'Donnell and Thorne, 2018) Underground channels where crossing streets run, should support the water flow while not compromising accessibility. The canals can be filled with moist environment vegetation, which can help to absorb excess water, but also contribute to the micro climate and add greenery to the street.






BEACHFRONT
COURTYARD
TWO-WAY STREET
ONE-WAY STREET



SITE SECTION

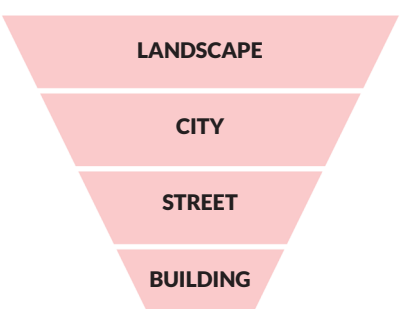
SLOPE OF SITE MAKES RUN-OFF POSSIBLE
(0-22 M ABOVE SEA LEVEL)

5.4 BUILDING SCALE – BUFFER

On the final and smallest scale, flooding is dealt with on individual building scale. All buildings having a buffer zone of minimum one meter raised ground floors. Entrances can be reached via ramps and stairs in multiple configurations. These buffer slabs can vary in design given the function of the building and future inhabitants.

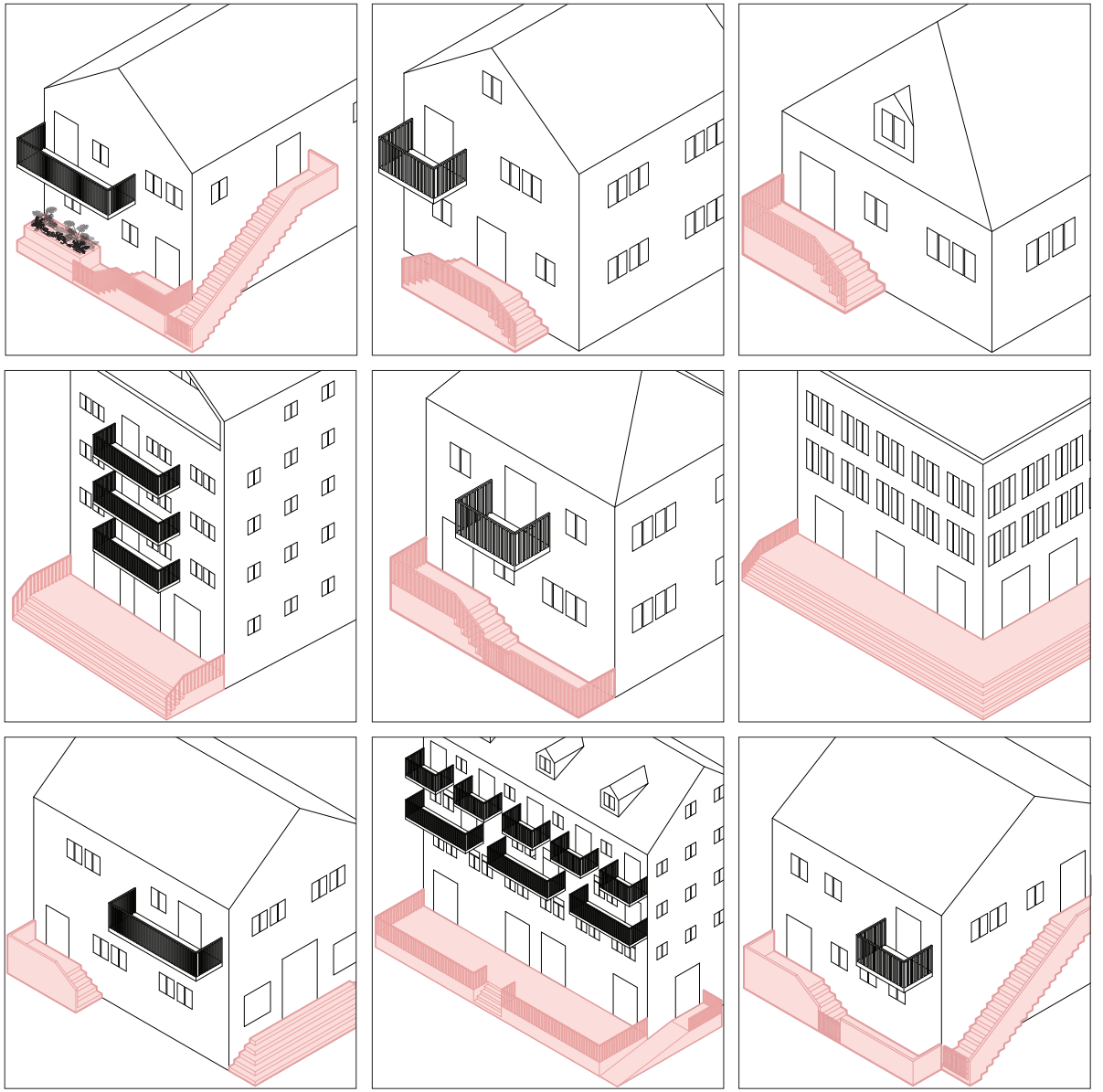
The space for these buffer slabs have been calculated into every single plot, therefore they do not affect accessibility of the sidewalk or the street in front of them. These kinds of buffers are not new to Dominica, but lack of proper planning has led to walk-ability issues and they are not ubiquitous.

Green roofs on some buildings with flat roofs lessen the pressure on storm water systems as vegetation can absorb local rain fall and release water through evaporation. In the long run, green roofs also mitigate the so-called urban heat island effect. (See Susca et al, 2011, Hua-peng Qin et al, 2013)



Courtyards are reintroduced to Roseau. The number of city gardens in Roseau have decreased due to ongoing urban sprawl, but in my proposal I bring back those green urban lungs. The courtyards consist of permeable surfaces that let rainwater filtrate into the ground, reducing flooding and surface run-off, even if only by a little. (See Maochuan et al, 2018)

Not only do green roofs, green courtyards mitigate the urban heat island effect, they also provide shady, cool places for people to meet and perhaps develop urban growing interests.



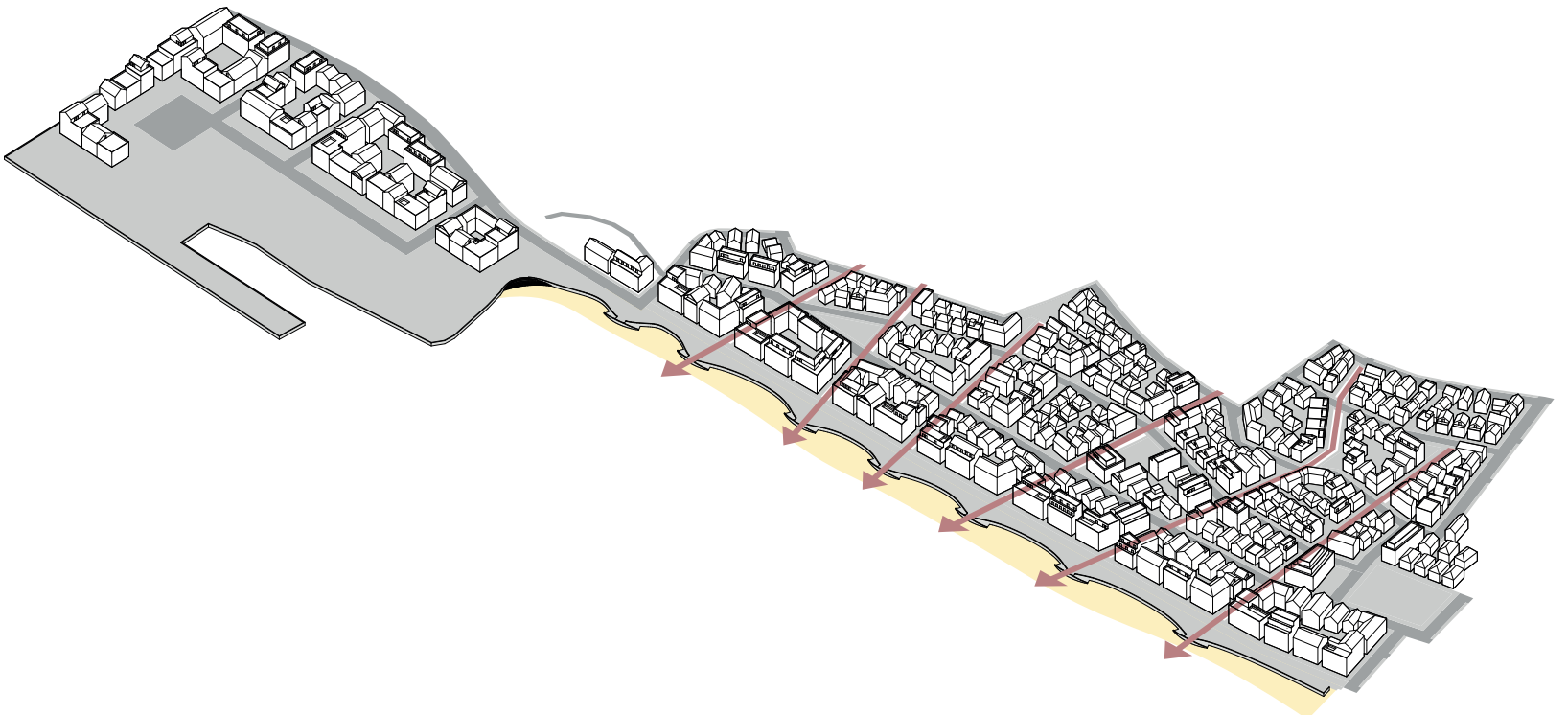
06

SITE SPECIFIC STRATEGIES

As mitigation of flooding risk has been researched and addressed, there are further site-specific strategies that can be applied.

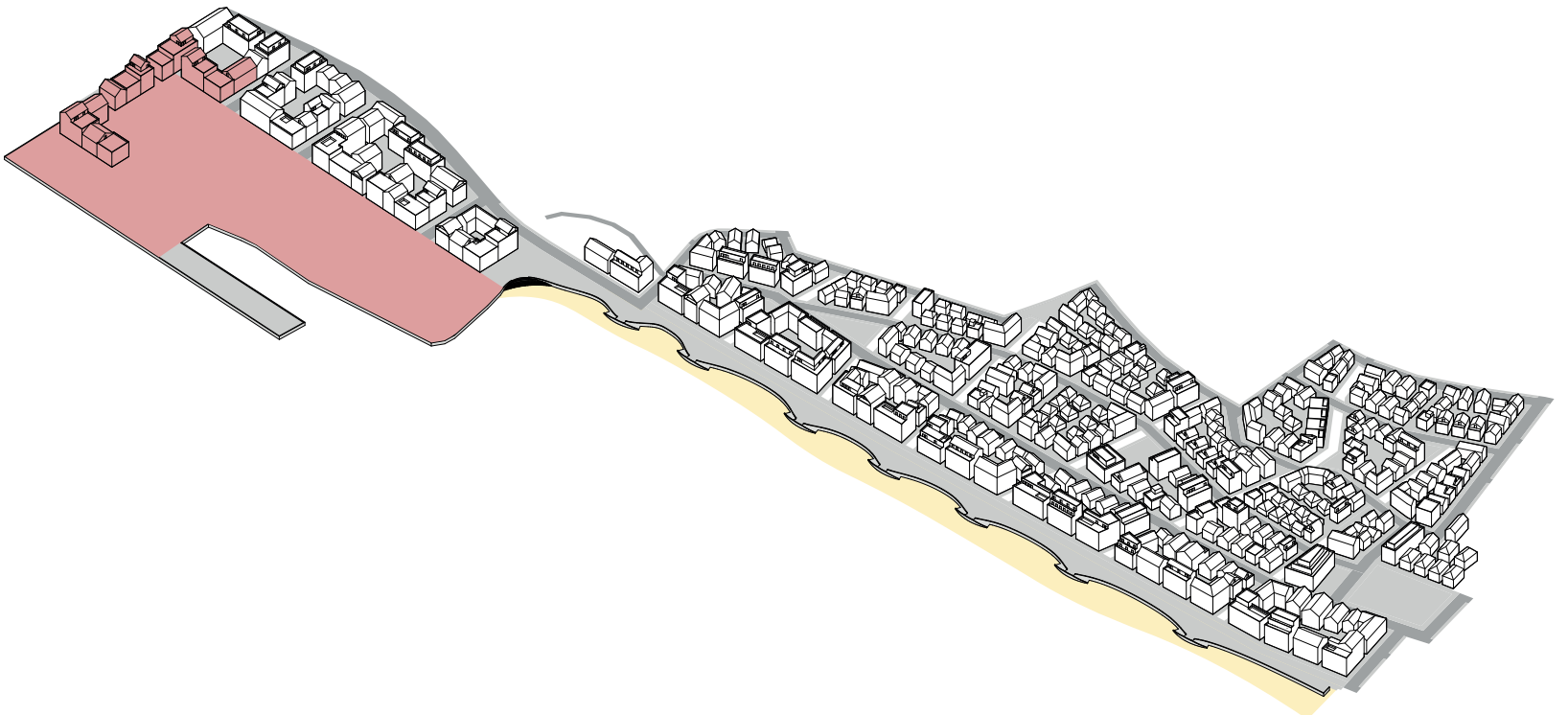
The site has a lot of challenges beside flooding but also ample opportunities that I try to exploit in my design strategies. All-in-all I propose five site-specific strategies

- Climate adaptive urban fabric
- Emergency & tourism logistics
- Pedestrian friendly beach-front
- Attractive beach-front units as incentives
- Active ground floors for local businesses



6.1 CLIMATE ADAPTIVE URBAN FABRIC

Block formation and the directions of the streets were designed to be climate change adaptive. Street hierarchies and traffic planning ensure quick run-off as part of a flooding strategy, which in turn defines the site formation, with accessibility taken into account.



6.2 EMERGENCY & TOURISM LOGISTICS

The harbour is designed with dual functions so that it can support emergency logistics during distress and generously offer economic opportunities, event spaces and tourism logistics in its normal state.

In case of another catastrophe, a vast surface is left open in order to provide better emergency logistics. For maximum disaster relief efficiency, the space needs to fit containers, helicopters, big groups of people, emergency tents et cetera.

Buildings related to tourism information and activities are intended to be multifunctional as well, as it can house offices for emergency management during difficult times.

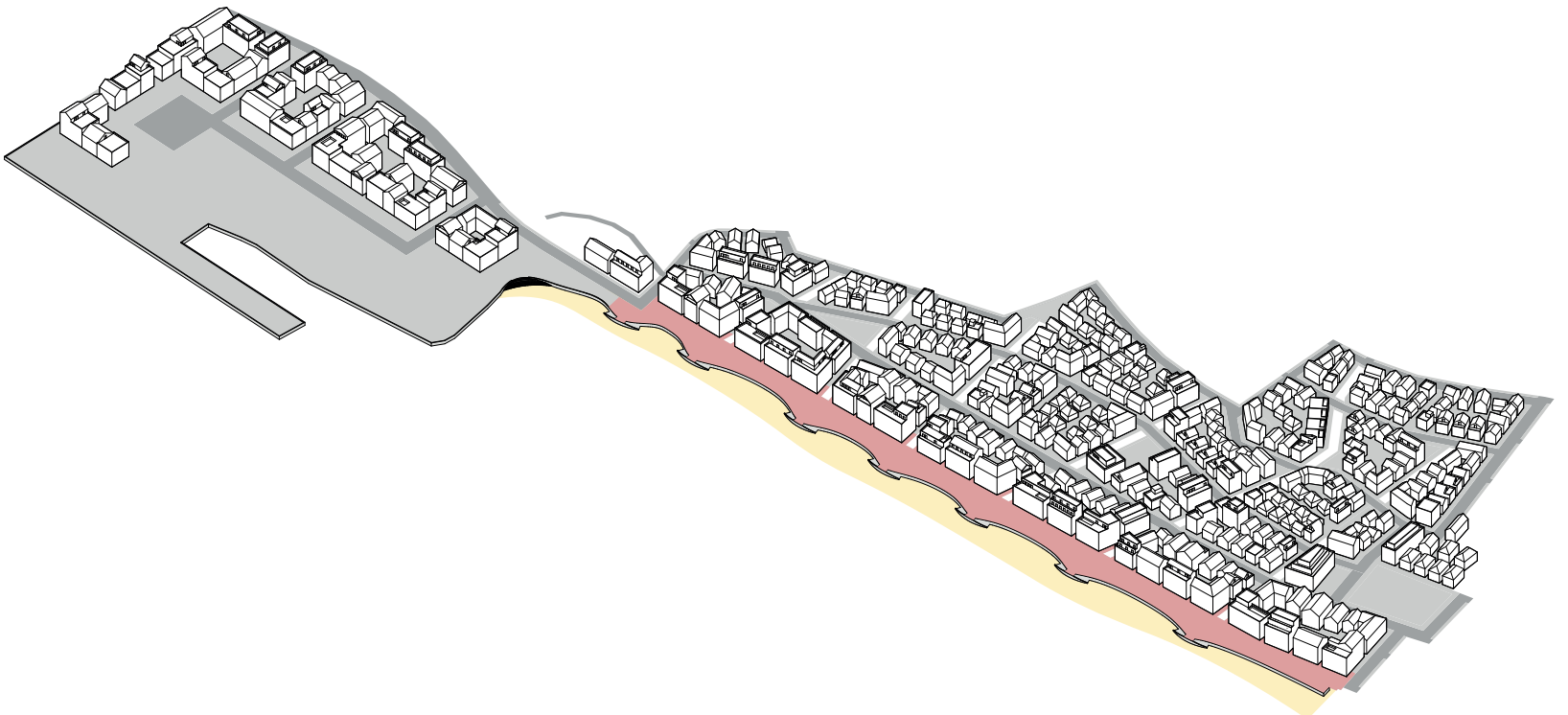
Under normal circumstances, the harbour needs to be able to welcome up to 3,500 passengers when a cruise ship docks. The space is designed to help the local community better capitalise on tourism with space for street vendors, food stalls, parking and markets as well as attractive business locations and an information centre connecting tourists to local guides.

Culture and music events such as the carnival, Dominica's World Creole Music Festival, the calypso elimination competitions, Bouyon Day could utilise the vast space to host events with large audiences.

The space offers plentiful parking as the local tour guides usually operate out of minibuses. Cruise ships usually take a steep cut when organising tours but providing better tourist services on the island can tilt the scale in favour of Dominicans so that they are able to retain a higher share of the spend from tourists.

HARBOUR – NORMAL STATE


HARBOUR – STATE OF EMERGENCY



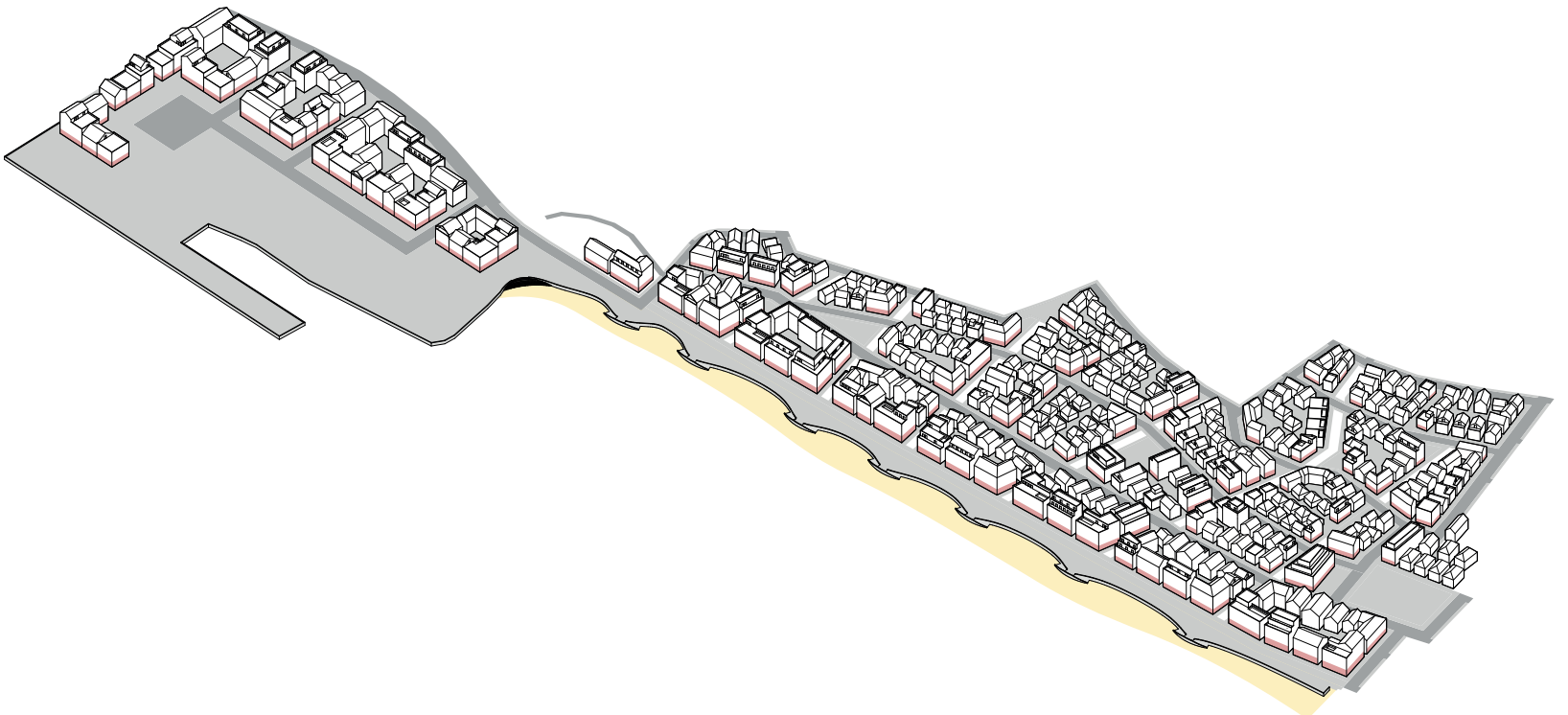
6.3 PEDESTRIAN FRIENDLY BEACH FRONT

Sandy beaches are quite scarce on Dominica, and not using the beach on the site would be a lost opportunity, both for tourists and locals. The heavy roads next to the beach need to be redirected to the next street after the first row of blocks to make beach visits more enjoyable and the board-walk and the accessibility of the beach more pedestrian friendly. A proper board-walk, would not only increase the quality of life for the inhabitants, it will also invite more cruise ship passengers to explore the city by foot and increase the chances of the passengers contributing more to the local economy.

The board-walk is also designed to protect the area in the rare event of a high tide and storm surge. The beach is accessible by ramps from the board-walk. The ramps are also located at the end of every street with large run-off capacity so if the bioswales would overflow, the excess water would easily find its way directly to the sea. The board-walk itself is primarily intended for pedestrians and bicycles, but it is wide enough to fit vehicles in case of emergencies, but also for delivery of goods.

6.4 ATTRACTIVE BEACH FRONT UNITS AS INCENTIVE

Developments directly on the board-walk with views towards the sea will become the most profitable and attractive for investors; some of these buildings can be developed as hotels for example. These plots should be given to any investor who understands the need to improve life for everyone and is willing to invest in the public beach-front, run-off streets, public squares and buildings, such as schools, or social housing in less attractive parts of the site. Attractive plots can thus serve as incentives for investing in quality-of-life improving social and public developments on the site. This strategy could be extra effective if combined with design measures for increased social sustainability.



6.5 ACTIVE GROUND FLOORS FOR LOCAL BUSINESSES

To support and boost local economic growth and prosperity, as part of sustainable urban design, active ground floors are proposed. These active ground floors vary in size to fit a spectrum of activities and budgets.

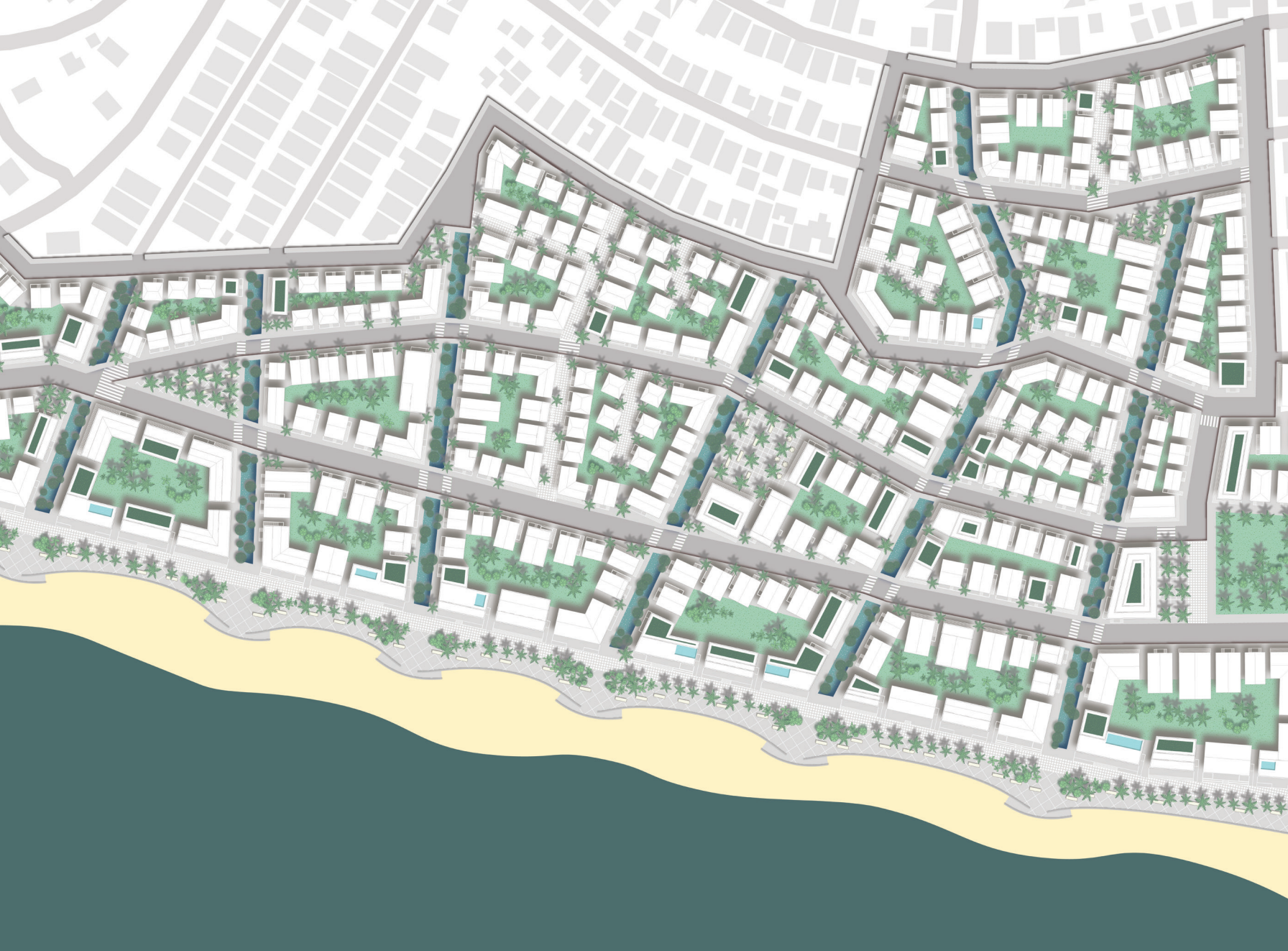
07

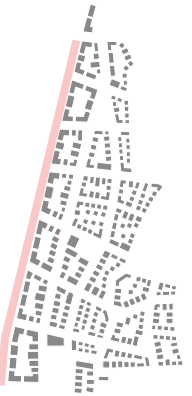
THE DETAILED DESIGN

This section functions as a zoom-in into the details of the design, in order to provide a better understanding of the richness of the options this design offers.

7.1 THE DETAILED PLAN

The detailed plan illustrates the design proposal of lower Goodwill in greater detail. The block structure with surrounding streets, houses and the run-off streets with bioswales can be identified. Different sized squares and shared spaces are scattered across the site as well as green roofs and semi-private courtyards. The sizes of buildings vary across the site for diversity and variation. The larger complexes are intended for schools and other public functions. Considering the risk of earthquakes, buildings are free-standing and built separately.

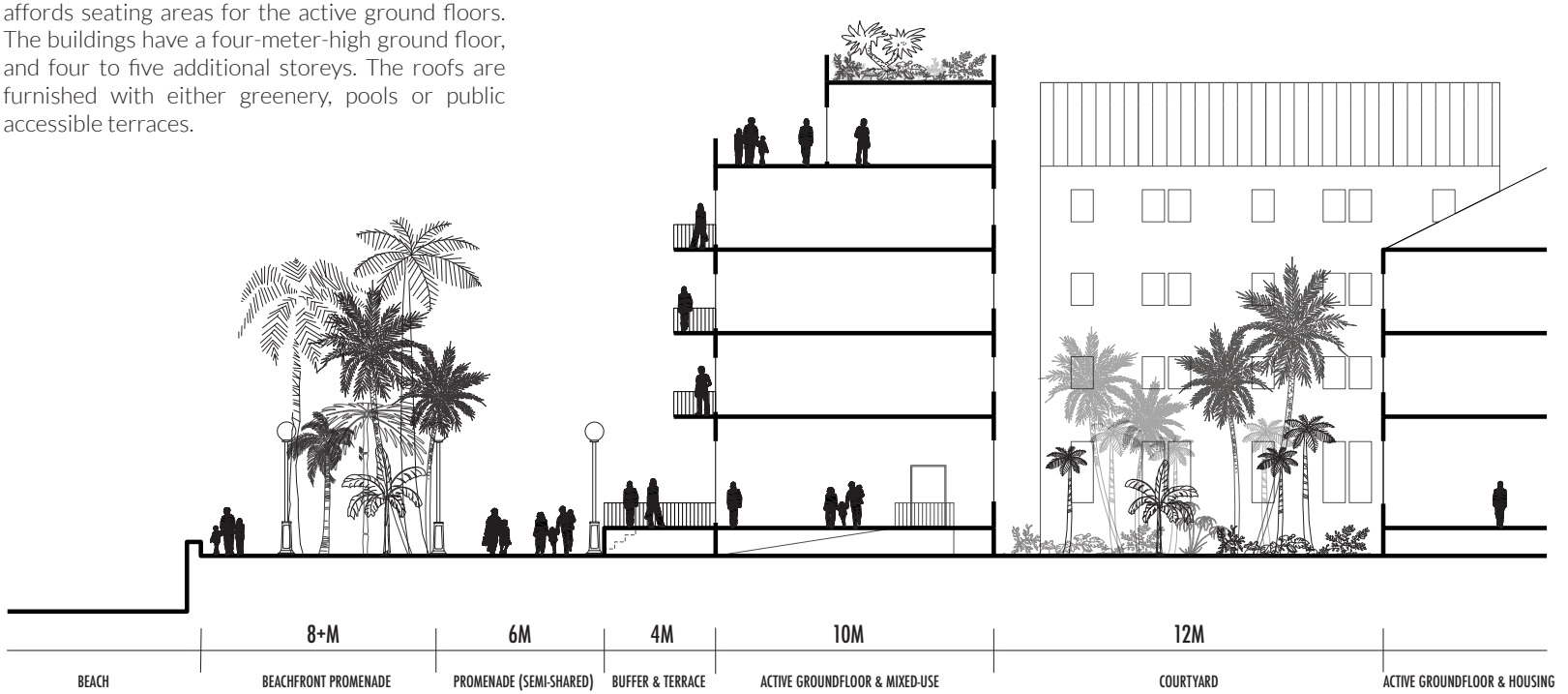




7.2 STREET SECTIONS

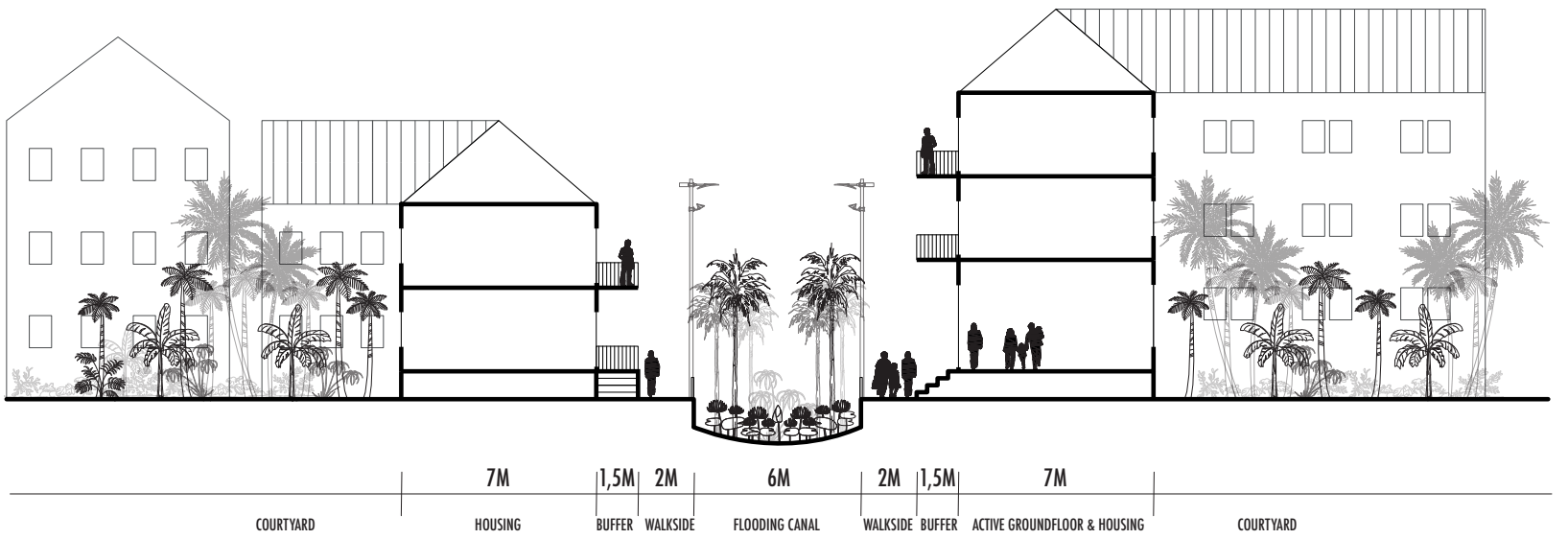
BEACH-FRONT

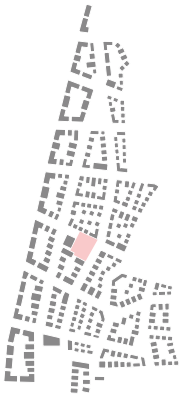
The beach-front offers a promenade of six meters and an additional zone of at least eight meters in varying size for vegetation and pedestrians. The buildings are ten meters wide and have a four meters wide one-meter-in-height flood-prevention buffer. The buffer can function as a terrace that affords seating areas for the active ground floors. The buildings have a four-meter-high ground floor, and four to five additional storeys. The roofs are furnished with either greenery, pools or public accessible terraces.



CANAL STREETS

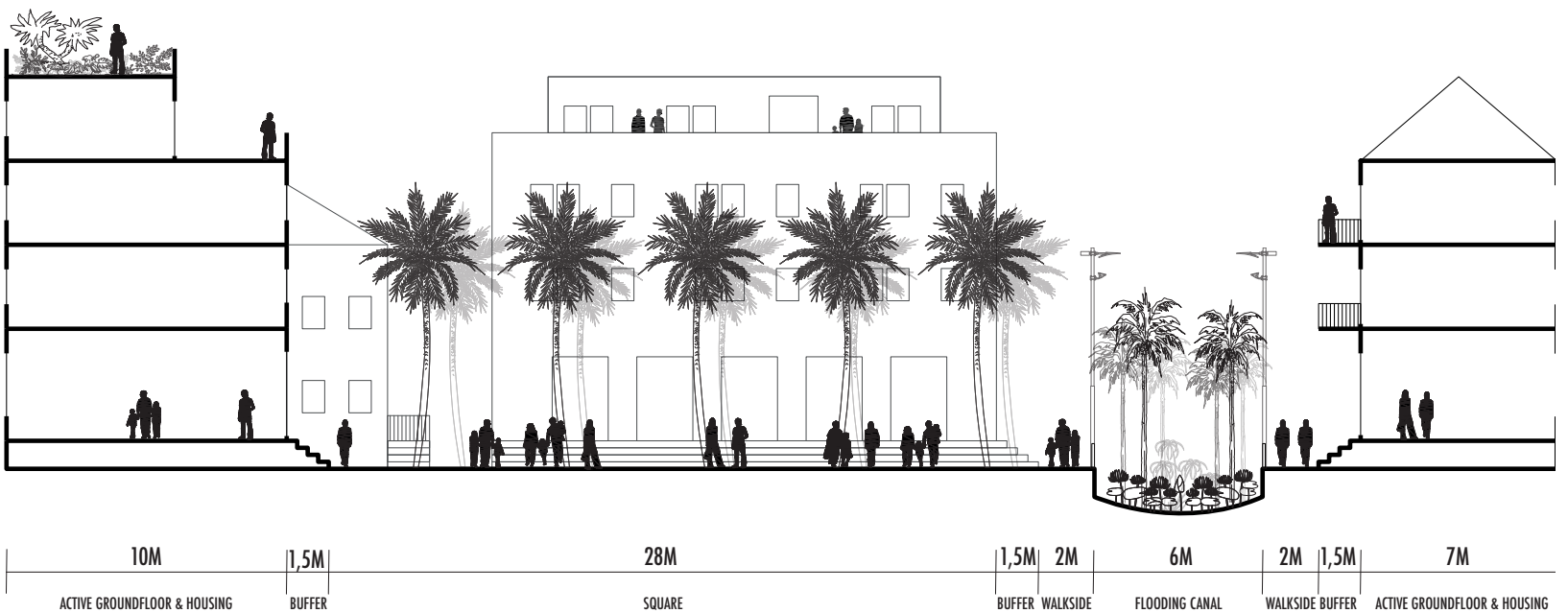
The section of a canal street illustrates the relationship between buildings, buffer and entrance zones of the building to the height of the buildings. These buffer zones are 1.5 meters wide and the sidewalks are two meter each on both sides. The canals/bioswales are six meters wide and are filled with vegetation contributing to the local micro-climate. A few larger buildings also have active ground floors. The buildings are at most three storeys including the ground floor.





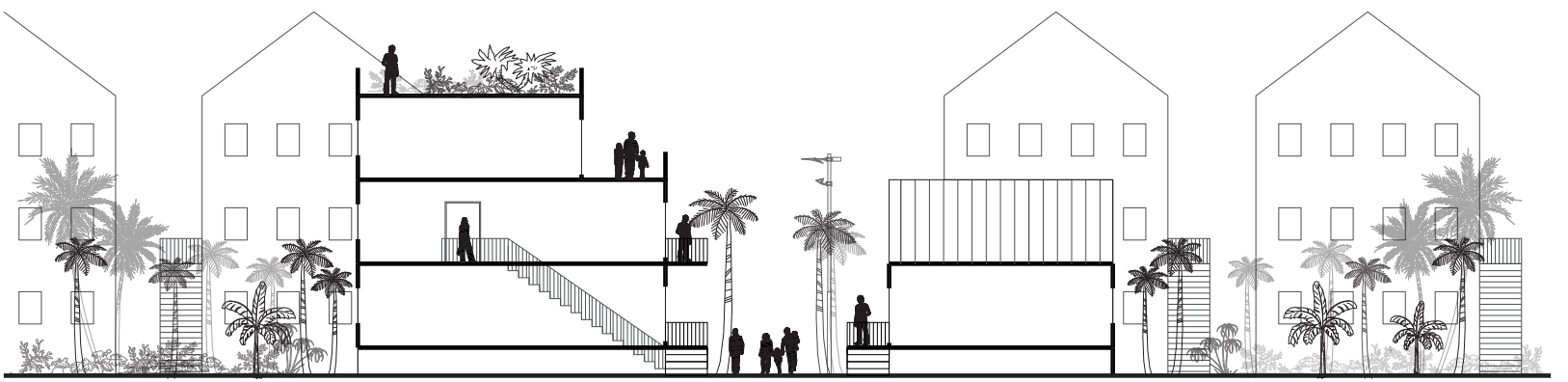
CANAL STREET WITH SQUARE

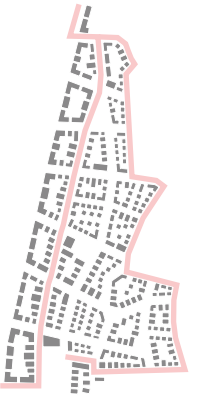
This section details one of the bigger squares of the site. Most of the buildings have active ground floors four-meters-in-height with an additional two to three storeys above. The square is 28 meters wide and 35 meters long, and can fit various activities under the shade of trees.



SHARED STREETS

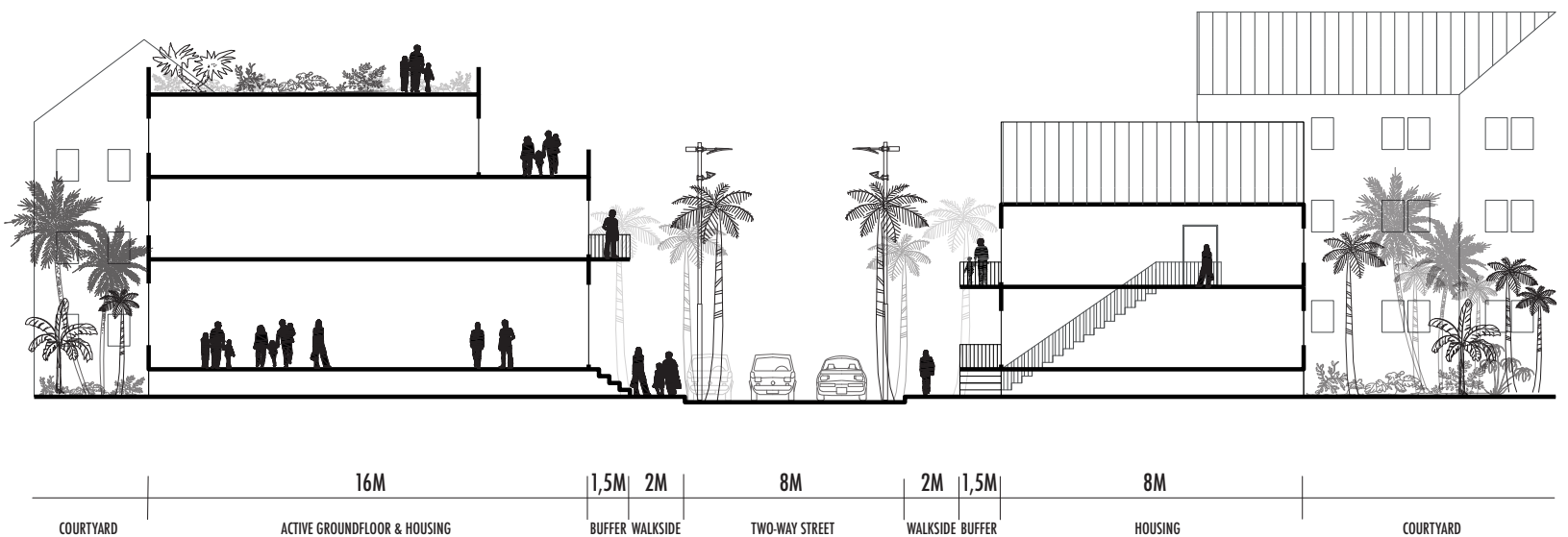
There is at least eight meters in distance between the buildings on shared streets, with three meters reserved for the flood prevention buffer on individual buildings. This leaves five meters for pedestrians and, if needed, motorised vehicles. Shared spaces and streets is an urban design approach that minimizes the segregation between road user modes. Pedestrian usage is encouraged, but motorised vehicles are allowed. On these streets I suggest smaller units to be built. This street section also shows second floor access via stairs from the outside, making it possible for more families to comfortably share a building.





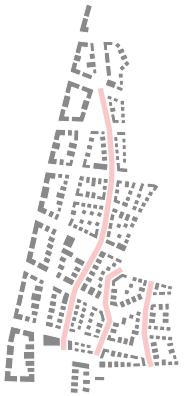
TWO-WAY STREETS

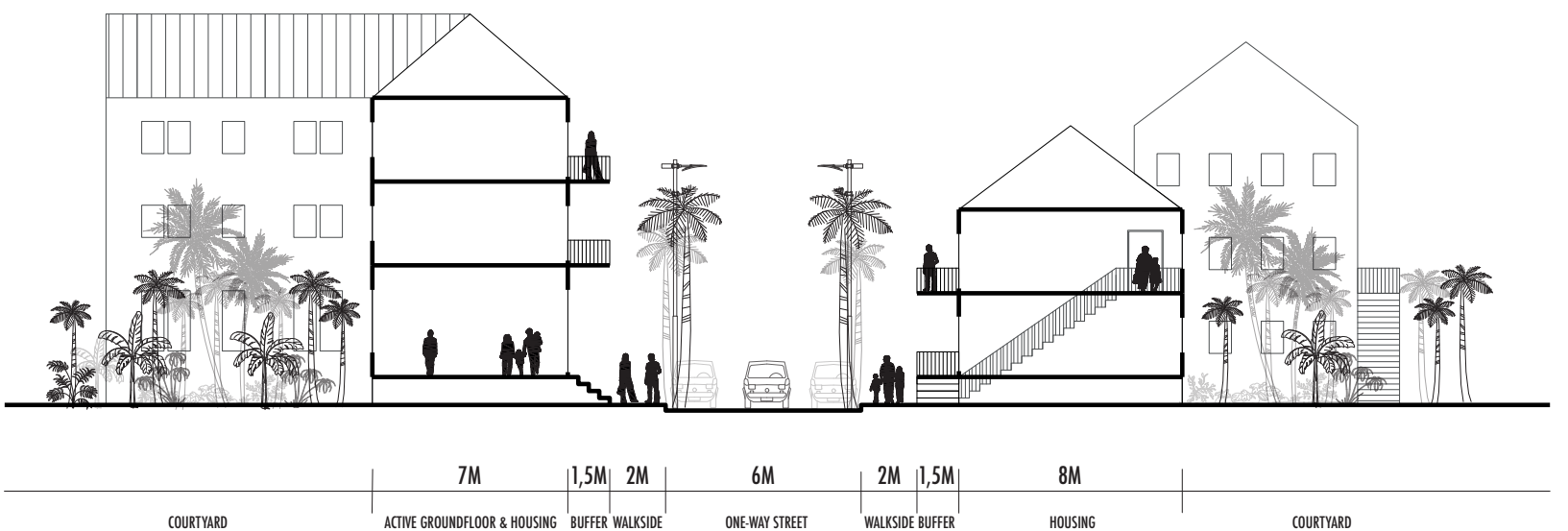
The two-way street is the busiest street on the site. Many bigger buildings with larger ground floor areas are proposed here. The buffer and walking zones remain similar to the one-way streets but the car road itself is eight meter wide with two lanes for driving and one for parking with vegetation and streetlights in intervals.



ONE-WAY STREETS

Streets that permit motorised vehicles are one-way, except for the elongated two-way street. The idea is that traffic should be allowed, but pedestrian use always encouraged. The one-way streets have similar dimensions as the canal streets but with a lane for driving and two for parking with vegetation and street-lights in intervals, instead of the canals/ bioswales.





7.3 ESTIMATIONS

	HARBOUR	LOWER GOODWILL
# Hotel and/or exclusive buildings	17	25
Total square metres All proposed floors included.	16186	27175
# Apartments Based on apartments of an average size of 80 m^2, excluding exclusive developments, offices, public buildings, active ground floors.	205	762
# Maximum inhabitants 25 m^2 living space per person on average.	650	2438
# Active ground floors	37	140
Total square metres Including hotel lobbies, public buildings, office entrances.	6800	21230
Total square metres of offices/public buildings All proposed floors included.	6400	6750

08

CONCLUDING REMARKS

In this final part, thoughts on possible practical phasing of the project as well as conclusions are presented.

8.1 PHASING–FROM THEORY TO PRACTICE

This has been a theoretical master thesis project anchored in real problems yielding a strategic design solution. As the author, I am proud of it, but I also see short-comings. Therefore it is my responsibility to reflect on how the projects could be realised in practice.

All designs have been based on height data from satellites and data from open street maps. Before considering any further steps, a precise measures of the site, including fine-grained height data, needs to be collected and merged with the master plan. Landscape engineers, hydrologists and engineers from different fields should also be consulted as this master thesis project has been focused mainly on architecture and sustainable urban design aspects.

None of the site-specific design suggestions, or any other development in Roseau for that fact, would be effective or make sense if the flood hazards of the Roseau river has not been dealt with first, for example using the suggested flooding strategies presented in this master project.

The next step would be to involve the general public and land-owners, and evaluate whether the project can be further improved from their feedback. With buy-in from the general public, production of detail, planning and regulatory drawings can be carried out.

I propose the project should be phased, in order to test assumptions like the efficacy of the bioswales before full commitment.

In phase one, the most urgent aspect of the project is developed, namely enabling the harbour area to accommodate emergency logistics to improve preparedness for the next major hurricane.

In phase two, the beach-front would be developed. Regardless if other parts of the design site would be realised, the city lacks a public and accessible beach-front. The beach-front would increase the life quality of the city-dwellers and potentially attract more cruise ship passengers to the city, contributing to the local economy. The promenade can be built with beach ramps and prepared with run-off constructions beneath it. The promenade could also accommodate vehicle traffic until additional infrastructure and alternative routes have been built.

In phase three, which would be somewhat of a pilot project, I propose construction of one of the run-off streets with a bioswale and adjacent blocks—to test the run-off strategy in practice.

In phase four the attractive beach-front units are to be developed in non-occupied blocks without any current activities, thus excluding the plots of the hardware store, the supermarket or the school.

In phase five, projects in the remaining unoccupied blocks inwards land can be carried out.

In phase six, the activities of the hardware store, supermarket and the school can be moved to new developments and in their place, the remaining development can be carried out.

Step 1: get precise measurements, consult landscape engineers and hydrologists

Step 2: flood-prevention

Step 3: public buy-in

Phase 1: harbour development: emergency logistics and improved preparedness for the next major hurricane

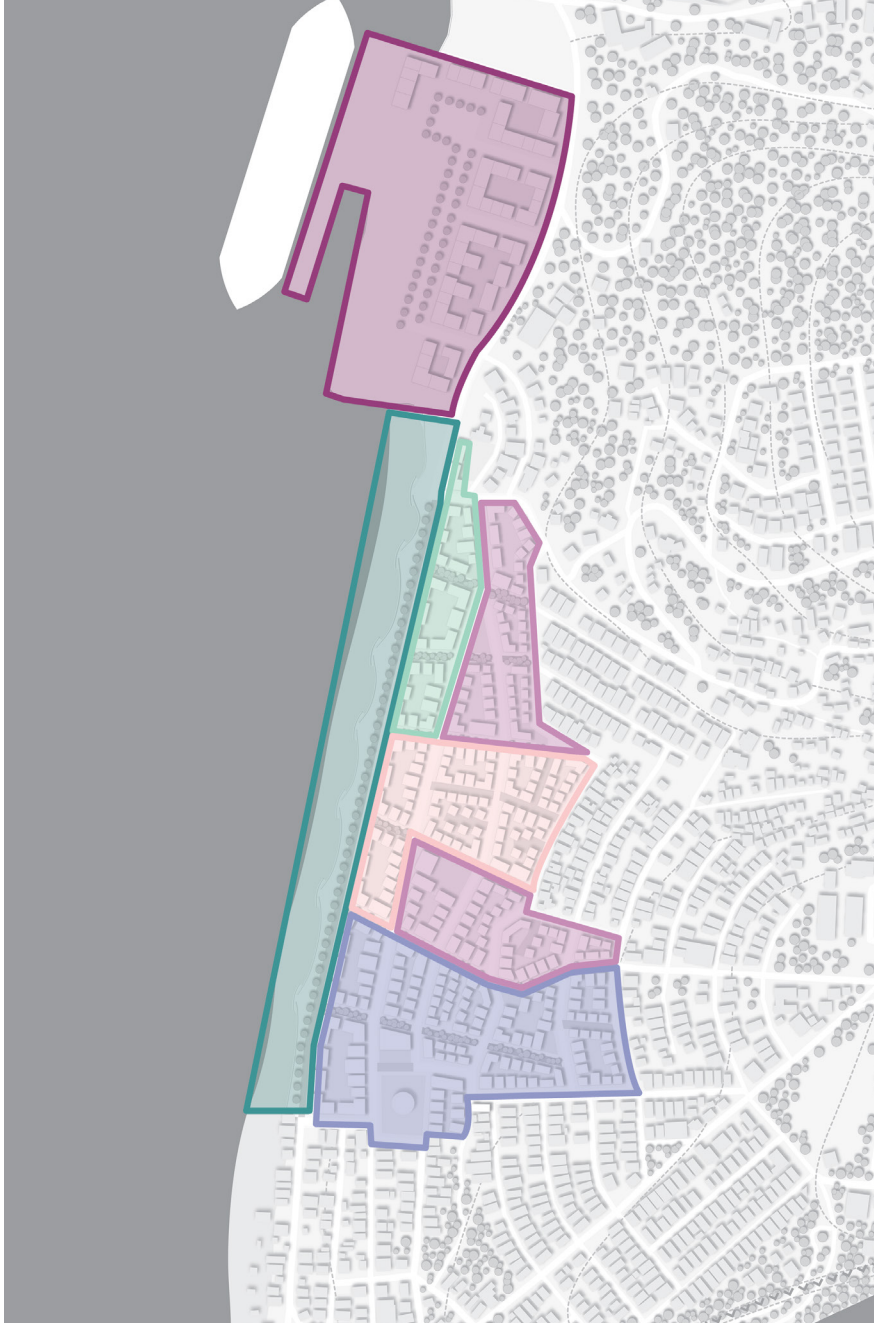
Phase 2: development of beach-front

Phase 3: pilot project

Phase 4: development of non-occupied beach-front blocks

Phase 5: development of non-occupied inwards blocks

Phase 6: development of remaining blocks



8.2 CONCLUSIONS

To conclude I try to answer my three research questions.

How can hurricane resilience be improved through urban design strategies in the context of Dominica?

I can conclude that most sites on the island are hurricane prone. Depending on the geographic situation and the surrounding landscape, risks will vary: from storm surges to floods to landslides causing isolation due to cut off roads, to mention a few.

Sustainable urban design cannot solve all issues, but with strategic site selection and investigations of site-specific issues, the damage can be minimized. In this thesis, I argue that it is reasonable to start developing contingent on simultaneously applying the proposed design strategies in different scales to mitigate flooding risks.

What key sites in Dominica can be developed for these strategies to be effective, and how would they look in place?

Roseau is strategically a good starting point for sustainable development given the city's position on the leeward side of the island and as the capital where emergency aid first arrives, basic infrastructure is already in place and economic opportunities already exist.

Can these strategies be combined with design measures for increased social sustainability in Dominica?

As for increased social sustainability, I am proposing to use attractive developments as an engine for investment in social housing and multifunctional public spaces.

By developing units of different sizes for different budgets and uses, the proposed design aims to increase diversity and decrease segregation.

The surrounding neighbourhoods, like Pottersville, are mostly low income neighbourhoods. These neighbourhoods would also profit from development in terms of an increased flow of denizens and cruise ship passengers, ideally contributing to the local economy.

The proximity to public spaces, work opportunities and social services would increase the life quality of many in these neighbourhoods. An upgrade of the streets and public spaces would be naturally followed by increased property value.

Presentation posters, defense date 2019-09-21

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