



Where Two Worlds Meet

*Reconnecting Land, Community, and Reef
Through Bonaire's Boulevard*

Chaz Sweers

Where Two Worlds Meet

Reconnecting Land, Community, and Reef Through Bonaire's Boulevard

Chaz Sweers

5100658

MSc Architecture, Urbanism and Building Sciences

Graduation Studio: Explore Lab

Supervisors: Suzana Milinović & Roel van de Pas

Foreword	7
Introduction	8
- Divers paradise - Tourism pressure - Vital ecosystems globally - No time to wait - Five greatest risks to the island's coral reefs - Coral reproduction lab - Downtown Bonaire (Playa)	
Approach	18
- Extensive fieldwork - Literature & course (reef renewal outplanting) - Connecting with local organizations - Research by design - Consulting reference projects	
Results	20
Goals of the project - Reef renewal facility - Educational facility - Architecture as a positive contribution to nature - Preserve and enhance social and historical features Field work - Urban runoff - Hard edge - Coral growth and human water access - Shade is a necessity - Effects of sun-shade rhythms - Three main outlets - Outlet Kas di Arte - All natural rhythms are intertwined Program & location choice - The outlet - Ocean front island owned - Parke Tului - Central location Location value - Kas di Arte - Parke Tului & sea pool	20 20 22 32 34
Program organisation & building identities - Infrastructural interventions - From coral-focused to human-centered - Architectural 'sisters' - From climate-controlled to naturally ventilated - Integrating & extending Parke Tului - Breaking the hard edge - Marine life brought in - Separating accessibility Filtering the outlet - Filtration function - Seawater intake - Purposely visible Construction, adaptable facades, material - Shutterdoors - Indoor climate control - Open connecting structure - Wood, stone and tiles - Spout gable structures	38 52 56
Conclusion	70
Appendices	74
01 Fieldwork & research 02 Location Analysis 03 Research by design 04 Reference projects 05 Bibliography	78 114 140 186 202



Foreword

This project is set on Bonaire, Dutch Caribbean, more specifically, on the edge of land and water in the oldest part of town: the boulevard. Here two worlds meet: the underwater world, in older days rich with corals and marine life, and the public boulevard, a stone-built barrier that keeps the water out while serving as a social hub for gathering and connection.

Right now, the boulevard and the underwater world collide with a harsh divide. Here, the water crashes against a massive wall, and the coral appears damaged and ignored, while the boulevard remains spotless, neatly edged, and untouched.

Instead of a harsh divide, a sense of synergy could be created if the water and the boulevard would blend in to one another. Illustrating how life above and below the waterline could be linked, how inclusive, accessible public spaces on land might coexist with efforts to

regenerate coral and preserve marine habitats underwater. If so, the boulevard would still be social, but, would become more alive, inspiring and more natural.

Growing up on Bonaire, I spent much of my childhood beneath the ocean's surface. Marine preservation and coral restoration are very personal to me; I've witnessed how delicate these ecosystems are and how devastating neglect can be. The boulevard on Bonaire is the last publicly accessible stretch of waterfront in the built environment. It is a space of connection, yet just below it, the reef has nearly disappeared.

This project reflects an intertwined relationship at the edge of land and sea, a reminder of both the damage that can occur when these worlds are separated and the potential harmony that emerges when they are allowed to meet.

Introduction

Let me take you to my beautiful island. Situated just off the coast of Venezuela, labeled a diver's paradise, Bonaire is renowned for its vibrant coral reefs. People from all over the world travel here to dive, snorkel, and enjoy the crystal-blue waters.

Divers paradise

This admiration for Bonaire's marine environment is nothing new. In 1979, the island became one of the first places in the world to establish a National Marine Park, only four years after the establishment of the Great Barrier Reef as a national marine park. Since then, Bonaire has repeatedly been ranked among the top dive destinations worldwide. Its reefs are not only beautiful but also form the backbone of a major tourism industry, generating significant income for the island.

Tourism pressure

Bonaire itself is rather small, and home to just over 26,500 residents. However, during high season (December till March), monthly tourist arrivals can reach nearly 80,000, causing the island's population to quintuple. (CBS, 2025) As shown in the diagram on the next page, the number of tourists arriving by plane remain relatively stable throughout the year, while cruise tourism peaks during the European winter months.

While tourism provides vital economic benefits, it also places immense pressure on Bonaire's coral reefs.

Vital ecosystems globally

Coral reefs are surpassing local importance; they are vital globally. Healthy coral reefs are one of the most valuable ecosystems on earth. They host over a quarter of all known fish species on Earth and the vertebrate species' density (number of species per unit area) is far

greater than that of rain forest. Making it really important for biodiversity. (Van Den Hoek & Bayoumi, 2017)

Almost 40% of the world population now live within 100 kilometres of the coast and many people in these areas depend on reefs. All over the world coral reefs provide a huge income in environmental and economic services, such as coastal protection, tourism and food. (Van Den Hoek & Bayoumi, 2017)

Yet today, our coral reefs are under a threat.

"We are at a crossroads, with humanity draining the life from the ocean." (Nowlan et al., 2025) The worldwide growth in population, tourism and overfishing are not the only thing threatening the underwater world. Our oceans are more polluted and diseases are found more frequent. The world wide change in climate brings bigger and more destructive cyclones and creates rising ocean temperatures, causing corals to bleach.

"We can no longer talk about tipping points as a future risk, the first tipping of widespread dieback of warm water coral reefs is already under way."

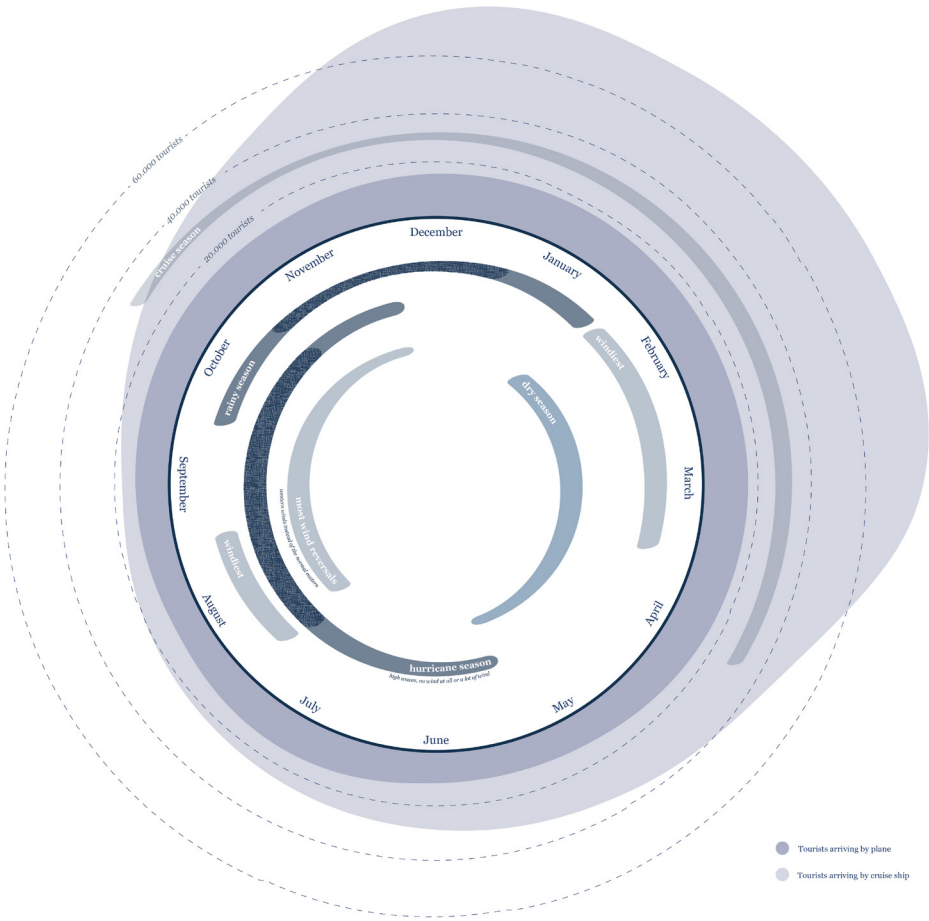
- Prof Tim Lenton (Readfearn, 2025)

No time to wait

There is no time left to wait. The ocean is essential to life on our planet and one of our strongest defenses against climate change. Its declining health would make you lose any sense of hope, were it not for a powerful discovery...

"The ocean can recover faster than we can ever imagine. It can bounce back to life."

- David Attenborough (Nowlan et al., 2025)



Bonaire's seasons (CBS, 2025)

Five greatest risks to the island's coral reefs

Despite the ocean's remarkable capacity for recovery, the pressures facing coral reefs cannot be ignored. On Bonaire, the decline of reef health can be traced to specific stressors that act both independently and in combination. Understanding these threats is essential for recognizing why intervention is urgent and where conservation efforts must be focused.

According to Reef Renewal Bonaire (n.d.), five major factors currently pose the greatest risk to the island's coral reefs: diseases, degraded water quality, loss of long-spined sea urchins, coral bleaching and hurricanes.

While it would be ideal to stop rising temperatures, natural disasters, and climate change altogether, these challenges require global action. What is striking, however, is that all five threats are closely linked to water quality and pollution. Increased amounts of polluted water entering the ocean introduce diseases, excess nutrients, and sediment, placing additional stress on coral reefs.

And this, this is a pressure we can prevent!



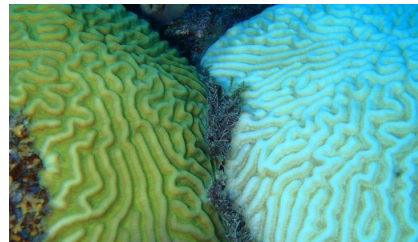
Heavy rainfall runoff | (Waterschap Rijn en IJssel, 2023)



Hurricane Omar | (Daisy, n.d.)



Long spined sea urchins | by author (2025)



Coral bleaching | (Johnson, 2021)

Coral reproduction lab

While diminishing polluted water entering the ocean, we can actively add coral by reproduction in labs.

On the island Reef Renewal Foundation Bonaire (RRFB), is focussed on outplanting and restoring the reef. I myself took the reef renewal specialty course to get a look into the process, and help plant out coral. RRFB works with two main ways to restore the coral reefs.

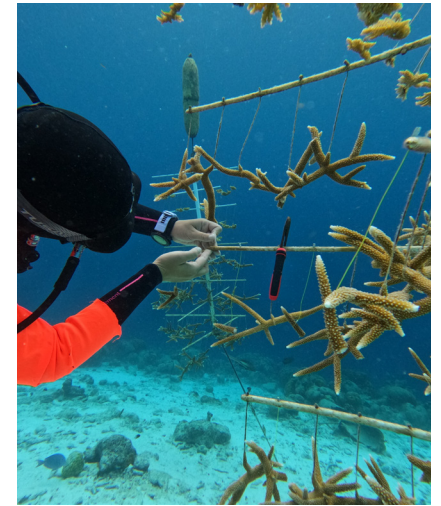
Fragmentation

Fragmentation is based on asexual reproduction, the ability of coral polyps to reproduce themselves via budding. Coral restoration via fragmentation involved propagating coral fragments in underwater 'in situ' nurseries, and then outplanting them back on the reef.

Larval propagation

Contrastingly, larval propagation is based on sexual reproduction. As they are animals, the majority of coral reproduce by releasing gametes (bundles of sperm and egg cells) into the water column during seasonal events, called spawning.

For larval propagation to improve RRFB is busy setting up their first wet lab. Wet labs for reef restoration tend to prioritize proximity to the water, reliable access to seawater and utilities, and logistical efficiency between field operations, holding systems, and staff workspaces. To find such a location is not that easy yet. This project aims to resolve that problem.



coral fragments in on-site nursery | by author (2025)



gametes collection of spawning coral | (Reef Renewal Foundation Bonaire, 2025)

Downtown Bonaire (Playa)

Downtown Bonaire (Playa) is the most densely built part of the island and, unfortunately, also the area with the poorest water quality. Although Reef Renewal Bonaire (RRFB) is outplanting with great success on the island, when RRFB first began its restoration efforts on the island, corals were planted in the downtown bay, yet here none survived, highlighting the severity of local environmental conditions.

Historically, Playa’s waterfront consisted of a pebble beach bordered by lots of shallow-water corals and long-spined sea urchins. In 1988, the construction of the boulevard transformed this coastline, removing nearly all of the pebble beach except for Playa Lechi and Cha Cha Beach (see map on next page). Beyond creating a promenade, the boulevard was designed to function as a protective barrier against September storms, which can cause significant damage to Playa’s bay area. (Sweers, 2025)

1. Social significance

In an earlier study, I examined the social significance of the boulevard and its role in community interaction. A survey of 114 local participants revealed overwhelming appreciation for the public waterfront: 96% considered it highly valuable, and 97% emphasized the importance of preserving the boulevard.

“As coastal privatization keeps increasing and the tourism industry keeps growing, preserving its public waterfront is crucial. Bonaire’s boulevard should continue to prioritize inclusivity, accessibility, and community involvement to maintain its role as a key social and recreational space for residents and visitors alike.” (Sweers, 2025)

Today, the boulevard is used for diverse activities exercise, play, relaxation, and spontaneous social encounters. Features such as benches, the floating pool, and Parke Tului facilitate optional and social activities and are actively used throughout the day.

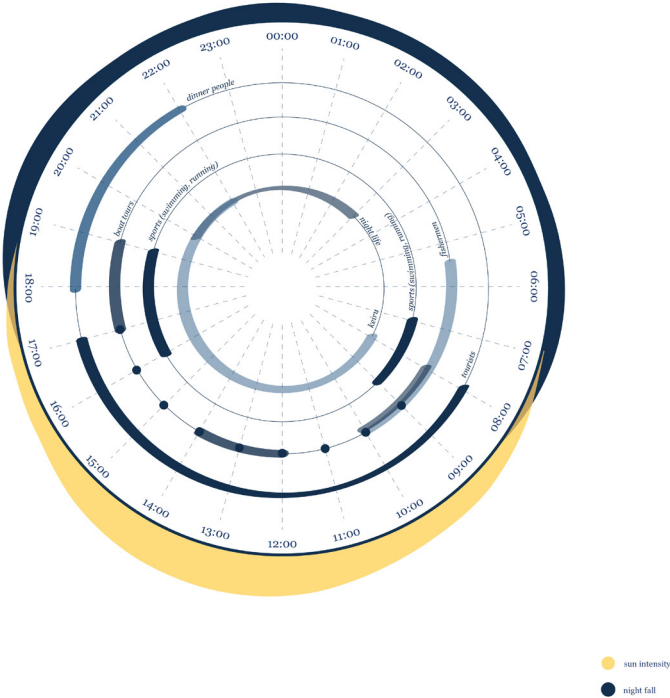
As a result, the boulevard has become one of the island’s primary social hotspots, used continuously by a diverse group of people; from fishermen in the early morning, to tourists during the heat of the day, runners at sunset, and nightlife activity after dark. This intensity of use is further amplified by cruise tourism, as all cruise ships dock at the cruise harbor, introducing approximately 60.000 cruise tourists per month during high season directly into this space. (see diagram)

2. Where two worlds meet

The boulevard functions as both a division and a connection between land and sea. It forms a physical and symbolic buffer between Playa and the ocean, precisely where water quality is at its worst and thus where intervention is most needed. At the same time, it is a highly visible and communal space, making it an ideal location to raise public awareness, integrate ecological solutions into daily life, and position environmental restoration at the heart of the community.

This project researches: **how can the public waterfront on Bonaire enhance the conditions to allow coral reefs to thrive?**

Here, at the edge of land and sea, where two worlds meet, is where synergy can and needs to happen.



Daily use of the boulevard (by author, 2025)

Playa Lechi

Yellow submarine pier

Oubaas pier

Fishermen pier

Runoff outlet

Sea pool | Parke Tului

Nautico Marina

Karel's Beach Bar

North Pier

Cruise Harbor

Cha Cha Cha beach

The boulevard (by author, 2025)



the waterfront before the built of the boulevard | FuKuHiBo & Antion (n.d.)



the boulevard now | by author (2025)



full boulevard existing situation | by author (2025)



full boulevard existing situation | 1:1000 model

Approach

The main research question of my project is:

How can the public waterfront on Bonaire enhance the conditions to allow coral reefs to thrive?

Extensive fieldwork

To address this question, I investigated both the public waterfront above water (the boulevard) and the coral reefs below the surface. The relationship between these two environments, as well as the tensions between them, form the core of my research. I examined how the construction and design of the boulevard influences the underwater environment, and vice versa. In addition, I explored how human use of the boulevard impacts life beneath the surface.

Although I grew up on Bonaire and I am very familiar with the boulevard, it was essential to approach the site with an objective and analytical perspective. This required careful, detailed observation on both the overall scale as smaller zoomed in area, and a conscious effort to look beyond my personal familiarity with the place.

Because the aim of my project is to support the underwater ecosystem, my fieldwork focused at least just as much on what happens below the waterline. Observation and participation were my main research methods. I repeatedly walked, swam, and snorkeled along the boulevard, documenting my findings on site and continuously looking for the connection. This immersive approach allowed me to discover connections and influences that I had not previously been aware of.

Literature & course
(reef renewal outplanting)

Although I have prior knowledge on coral reefs and restoration, this part of my research required more literature. Along side the literature I took part in reef renewal outplanting course and helped outplanting myself.

Connecting with local organizations

To deepen my understanding about coral loss along the boulevard and perfect conditions for corals, I was in contact with local organizations, including STINAPA, Reef Renewal Foundation Bonaire, and Klimaattafel Bonaire. The knowledge shared by these organizations, combined with insights gained through observation and participation, helped me define a clear motive and focus for the project.

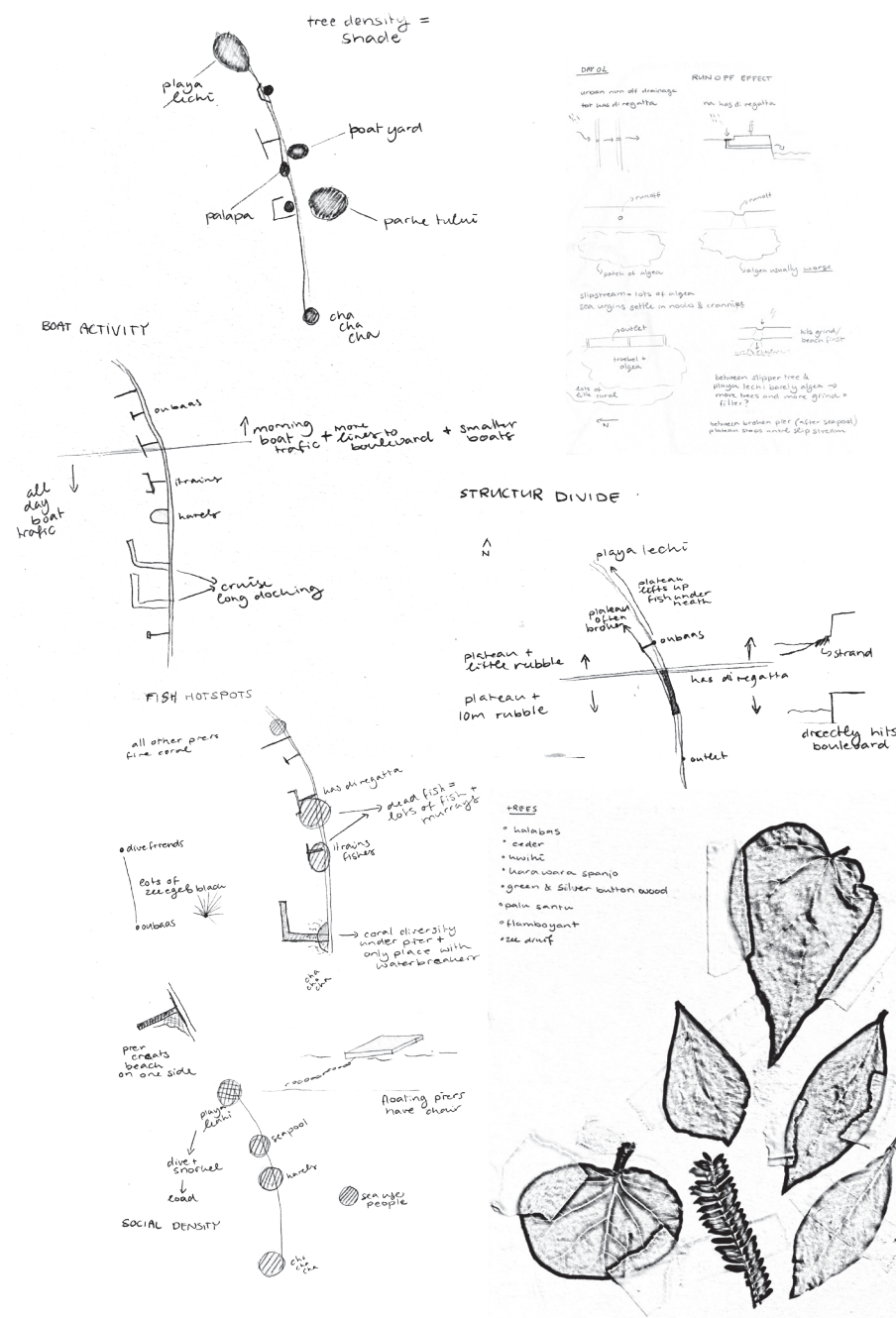
Research by design

As the project moves forward into the design phase, the methodology shifts towards research through design and experimentation. I explored with which elements the boulevard is able to enhance ecological conditions and how these elements can be integrated. Always switching between the bigger urban scale and the smaller scale.

By testing and comparing different design options, I aim to evaluate their impact and ultimately arrive at a cohesive strategy that best supports both the public waterfront and the coral reef ecosystem.

Consulting reference projects

Throughout the design phase reference projects have been consulted whenever I encountered a challenge, or developed an idea that I wanted to test for feasibility. These references provided both inspiration and practical insights into how similar design strategies have been implemented elsewhere.



Results

goals of the project

Placing this project along the boulevard, at the edge of land and sea, where two worlds meet, creates a unique opportunity for synergy, but it also introduces significant challenges. Designing architecture that gives space back to coral and nature is already complex; doing so within a predominantly socially and historically context, where these qualities must be preserved and not diminished, makes the task even more demanding.

The boulevard is not only of great local social importance, but it also hosts an increasing number of tourists each year. This growing influx must be carefully considered to ensure that the waterfront remains public, accessible, and inclusive for everyone.

There are several reasons why this effort is essential, despite its difficulty. It is crucial to protect the only public oceanfront access within the built environment and to ensure that it remains in the hands of the people of Bonaire, rather than being overtaken by rising tourism pressure. Positioned at the heart of this social hub, the project offers a powerful opportunity to raise awareness among a wide audience. At the same time, it is vital to revive coral ecosystems and restore the connection between land and sea, allowing the area to become viable and full of life. By bringing together coral, history, and community, the project can strengthen the cultural and historical identity of a place that truly belongs to its local residents.

In this context, the project is guided by four main goals.

1. Reef renewal facility

The first is to expand coral restoration efforts, not only within Playa Bay but across the entire island, by establishing a larger scale reef renewal facility that includes a wet lab.

2. Educational facility

The second is to educate people about coral restoration while actively involving them in the process, creating an inclusive program that engages diverse groups within the community.

3. Architecture as a positive contribution to nature

The third goal is to demonstrate how architecture and urbanism can positively contribute to nature and the underwater world, without enforcing a harsh separation between the built environment and ecological systems.

4. Preserve and enhance social and historical features

Finally, the project seeks to preserve, and where possible enhance, the social and cultural-historical structure of the site, ensuring that its identity remains rooted in and shaped by the local community.



the boulevard | by author (2025)

Results

fieldwork

The design of the boulevard can be divided in three clear zones. The construction and design of the boulevard directly influences the underwater environment of Playa Bay in two significant ways, directly affecting both coral integrity and water quality in Playa Bay. See Appendix O1 for supported research.

Urban runoff

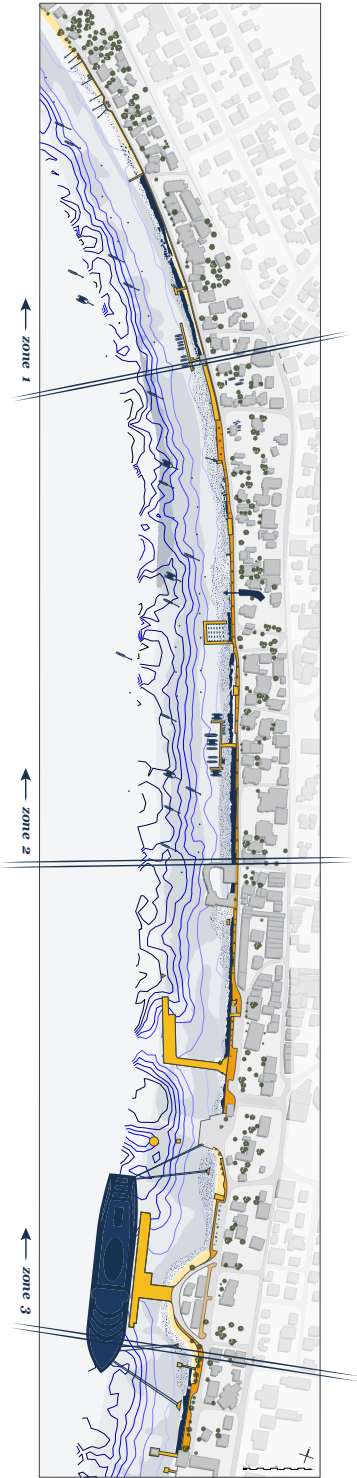
First, urban runoff has a direct effect on algae growth. Where runoff enters the ocean directly of the hard edge, algae growth is directly visible under the outlet, whereas runoff that filters through the pebble beaches attached to the boulevard in zone 1 has a far milder impact.

Hard edge

Second, a similar relationship can be observed in the effect of waves that strike the flat surface of the boulevard directly. Here rubble underwater increases noticeably, indicating that wave action contributes to coral breakage. In contrast, in zones one and three where waves are buffered by pebble beaches and breakwaters, the impact reduces.

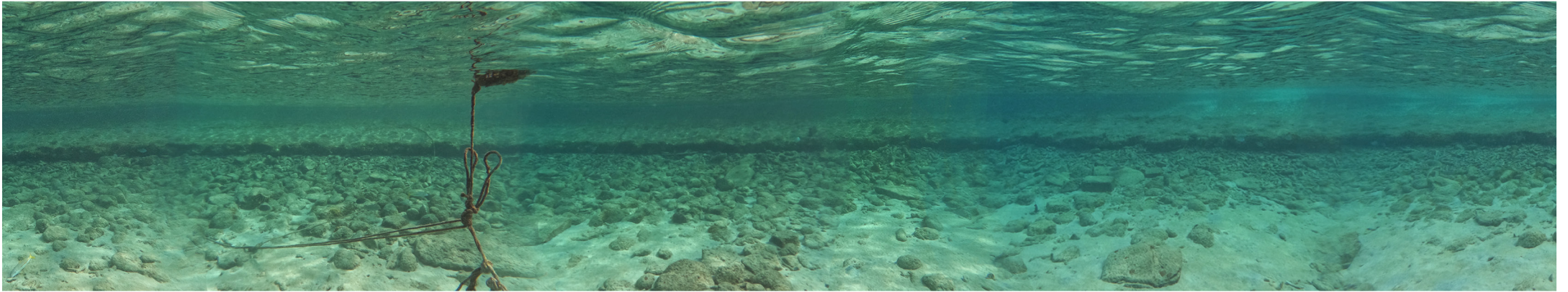
Coral growth and human water access

The boulevard establishes a strong linear movement, one that is only interrupted at specific points such as swimming spots, piers, and slipways. Maintaining access to the water at these locations is essential; however, where human activity directly enters the sea, coral growth becomes increasingly difficult. This creates a clear spatial distinction: in the stretches between these access points, where the shoreline remains undisturbed, there is a valuable opportunity for coral outplanting and ecological restoration.

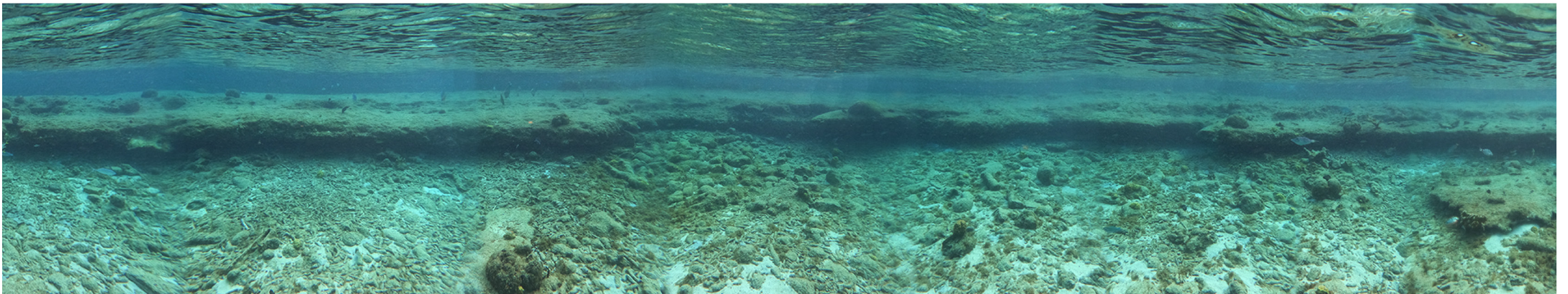


swimming spots & slipstreams

coral outplanting opportunities



View underwater between Playa Lechi and Yellow Submarine | zone 1



View underwater between Karel's and Nautico Marina | zone 2



shaded areas above and underwater | by author (2025)

Shade is a necessity

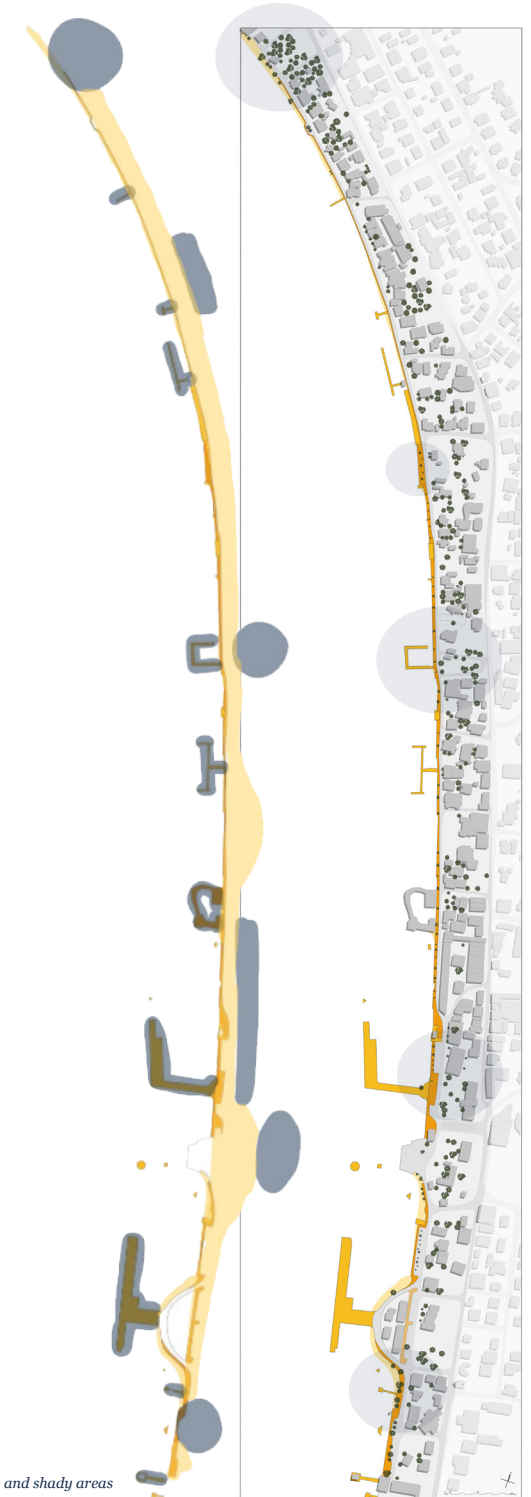
The intensity of the sun on Bonaire is extremely high, reaching an average UV index of 11 at the hottest point of the day. Shade is therefore not a luxury, but a necessity. Along the boulevard, several areas provide relief from the sun, including Playa Lechi, Kas di Regatta, Parke Tului, Wilhelminaplein, and Cha Cha Beach. These shaded spaces are shaped by local, ocean-resistant vegetation such as kwihi trees and green and silver buttonwood (see ocean-resistant trees in Appendix 01).

Effects of sun - shade rhythms

Shaded areas strongly influence how the boulevard is used. Locals tend to avoid the heat of the day and are drawn to these cooler, protected spaces, while tourists are generally more tolerant of the sun, often walking, swimming, or spending time outdoors even at midday. As a result, the rhythm of activity along the boulevard is shaped by the movement of the sun: locals are most active in the early morning and late afternoon, while tourists are more present during the hottest hours of the day.

Sun and shade also play a crucial role beneath the water's surface. Structures such as piers create shaded conditions that attract fish, offering both shelter and comfort. During the hottest parts of the day, many fish retreat to shaded environments, under the plateau, beneath piers, or within small crevices and protected spaces.

The rhythm of sun and shade shapes the rhythm of both life on land and life underwater. It influences when people use the boulevard and where fish seek shelter, creating an activity pattern across these two environments.



sunny and shady areas

Three main outlets

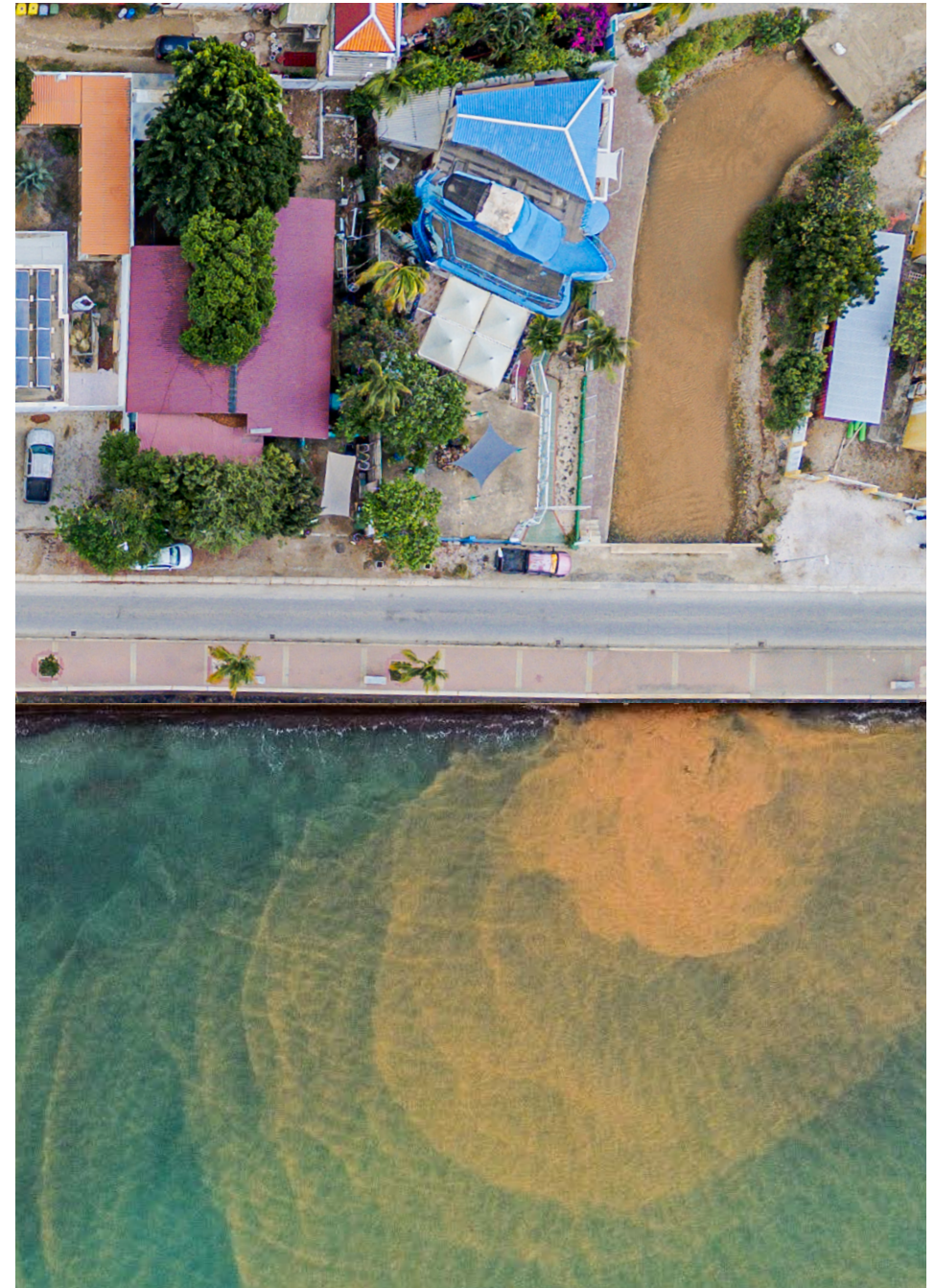
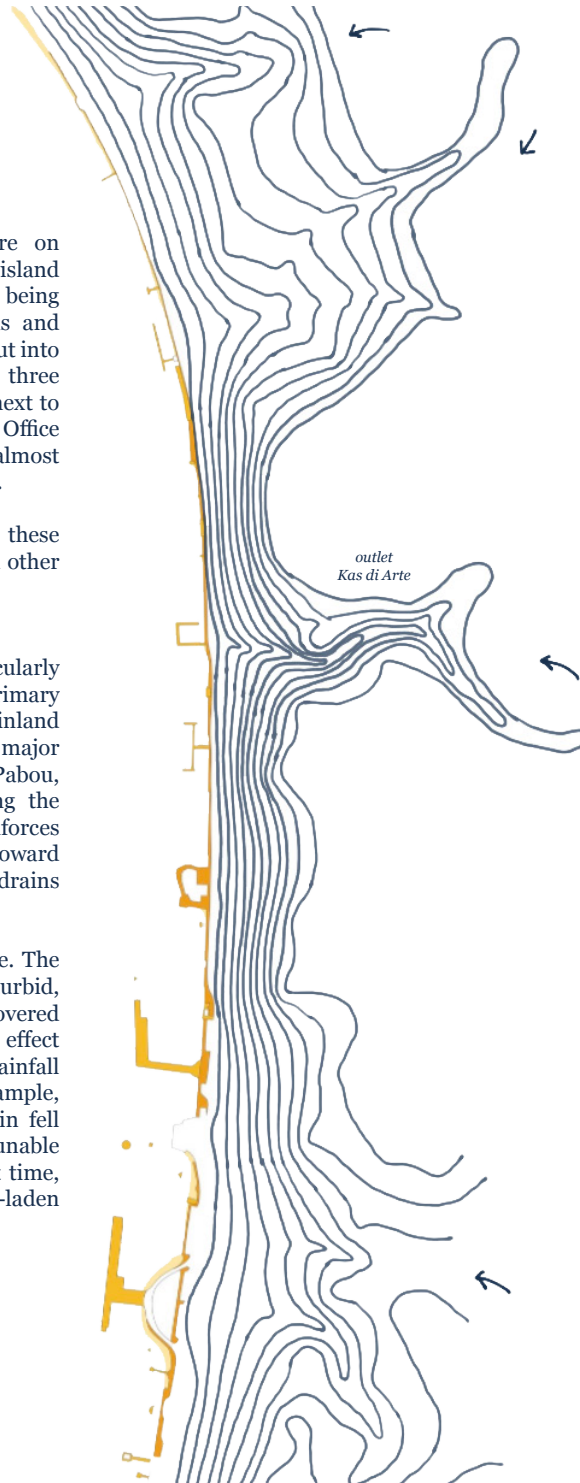
Rain water is not collected. Nowhere on Bonaire. Rain water from all over the island flows down into different directions, being collected in lower laying areas, salinas and lagoons. From there it eventually flows out into the ocean. Within Kralendijk there are three such outlets: Saliña di Vleit, the outlet next to Kas di Arte and one next to the Harbor Office (which is closed). Together they collect almost all the water from the built environment.

The water that enters the ocean at these outlets is filled with sediment, sand and other pollutions it has collected along the way.

Outlet Kas di Arte

The outlet near Kas di Arte is particularly significant. It acts as one of the primary channels for runoff originating as far inland as Lagun, passing through several major neighborhoods (including Playa Pabou, Nikiboko, and Sabana) before reaching the coast. The surrounding topography reinforces its importance: the land slopes steeply toward this outlet, indicating the large area it drains and the scale of its influence.

Underwater, the impact is clearly visible. The water in front of the outlet is highly turbid, and the seabed is dominated by rubble covered in algae. During the rainy season, this effect intensifies. In a heavy rainy season the rainfall is often both sudden and extreme, for example, in 2020, approximately 100 mm of rain fell within just 1.5 hours. The ground is unable to absorb such volumes in such a short time, causing large quantities of sediment-laden water to flow rapidly into the ocean.



sediment flowing in the ocean during a heavy rainy season | (De Meyer et al., 2022)

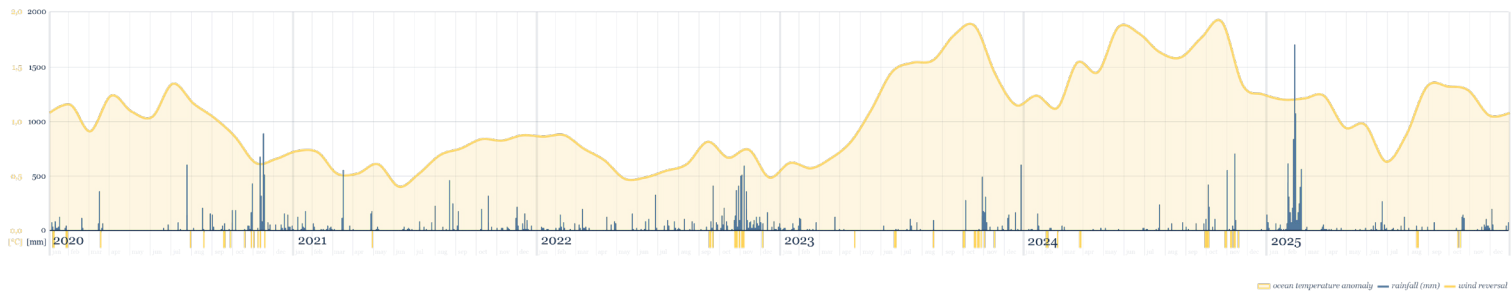
All natural rhythms are intertwined

The natural rhythms such as rainfall, tide, water temperature and coral spawning shape this location. These rhythms operate at multiple temporal scales. On the right, three different time frames are illustrated: six years, two years and one month. Within each of these periods, different environmental elements influence how the site functions.

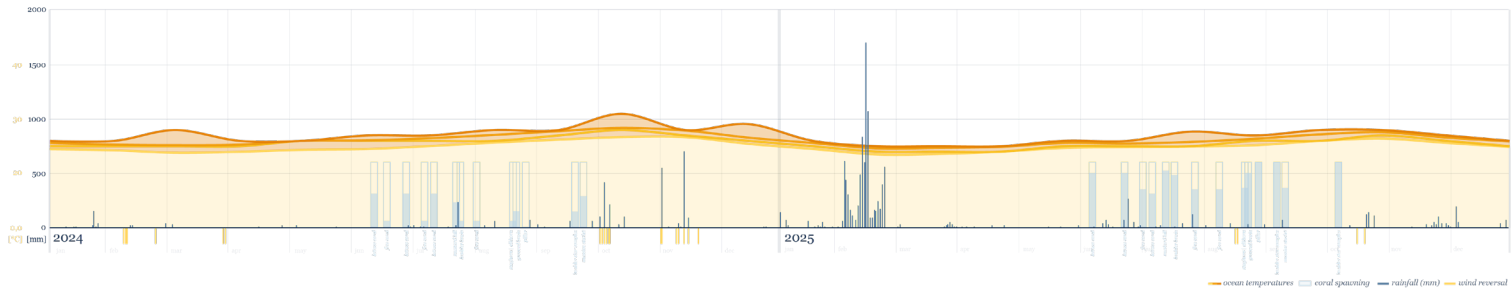
In the longer time frames (six years and two years), rainfall patterns become visible. Rainfall on Bonaire is not consistent but occurs in short, intense bursts. When it rains, it is often during brief but heavy showers, frequently coinciding with wind reversals. The six-year diagram also highlights the severe coral bleaching seasons of 2023 and 2024, during which ocean temperatures remained almost 2.0 °C higher than usual for an extended period.

Coral spawning forms another important rhythm. During this event, corals release their eggs and sperm into the water. Spawning is seasonal and typically occurs between June and September. However, it is not only tied to the season: it is also closely connected to lunar cycles and sunset times. Corals generally spawn around five days after the full moon and approximately thirty minutes after sunset.

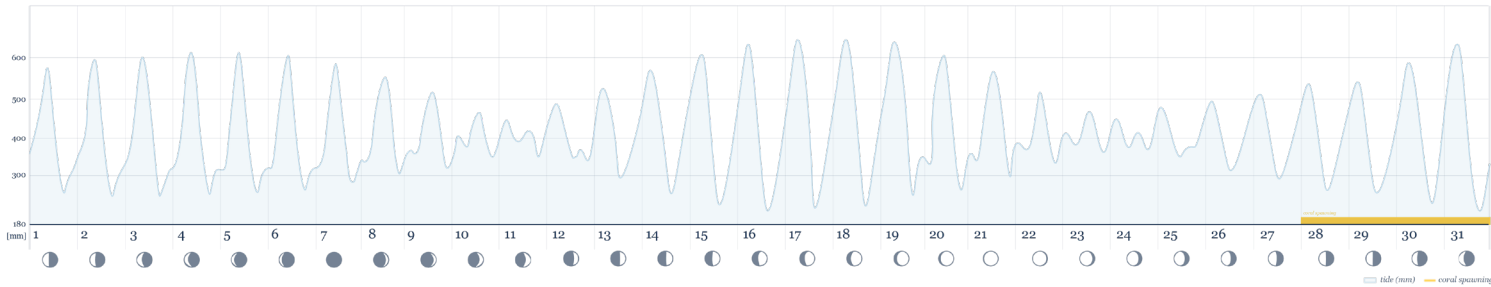
The moon also influences tidal movements. Although the tidal range on Bonaire is relatively small, around 30 cm, it is still noticeable at the outlet next to Kas di Arte, where the tide enters the outlet on certain days of the month.



6 YEARS | rainfall, ocean temperatures and wind reversals



2 YEARS | rainfall, ocean temperatures, wind reversals and coral spawning



ONE MONTH | tide, coral spawning and moon cycles

Results

program & location choice

The design program, reacts directly on three of the design goals. The first focuses on expanding coral restoration efforts and biodiversity research, not only within Playa Bay but across the entire island. This is achieved through the creation of a larger-scale reef renewal facility, functioning as a central hub. The program includes a wet lab, dry lab, research center, diving and docking facilities, and an educational center or museum, bringing together scientific research, practical restoration, and public engagement in one place.

The educational center and museum are closely tied to the second goal: raising public awareness and actively involving people in the process of coral restoration, creating an inclusive program that engages diverse groups within the community.

For corals to return and thrive in Playa Bay, improving the water quality is the first step. This requires addressing urban runoff and preventing pollutants from entering the bay. To achieve this, the water running through the large outlet next to Kas di Arte must be filtered, as do the numerous 'street outlets' and the existing hard shoreline edge needs to be rethought.

These interventions relate to the third goal: demonstrating how architecture and urbanism can actively contribute to ecological health. Rather than maintaining a strict separation between the built environment and the underwater world, the design seeks to create a more integrated relationship; one in which urban systems support, rather than undermine, marine ecosystems.

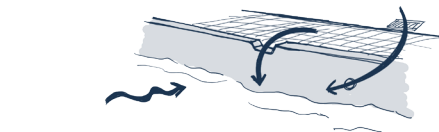
WET LAB

improving and expanding coral restoration and biodiversity
educate and raise awareness



FILTER OUTLET

clean the water and restore water quality



RETHINK HARD EDGE

clean direct urban runoff and reduce effect of wave action

There are a few reasons why Kas di Arte is the best place to integrate the program.

1. THE OUTLET

This outlet is one of the largest in the city centre of Bonaire and the biggest along the boulevard. While it primarily channels land-based runoff toward the ocean, the existing infrastructure also creates the possibility for water to move in the opposite direction: from sea to land. This condition could be strategically used as an inlet for the wet lab, allowing seawater to be brought into the facility without the need to construct a new intake system.

2. OCEAN FRONT & ISLAND OWEND

Kas di Arte and Parke Tului are both ocean front and government owned properties, making it perfect to be maintained in the interest of the island and helps safeguard it from excessive commercialization. The two have the ability to merge because the road currently separating Parke Tului and Kas di Arte is not essential infrastructure, presenting an opportunity to repurpose this space and strengthen the physical connection between the two.

Here lies the possibility to connect the ocean with the social and cultural-historical qualities of Kas di Arte and Parke Tului.

3. PARKE TULUI

Parke Tului is a unique public space on Bonaire, with few comparable locations elsewhere on the island. It serves as a vibrant social hub and an important gathering place for locals. Integrating the program within this context can strengthen its social role and further enhance its value to the community.

4. CENTRAL LOCATION

Kas di Arte and Parke Tului are situated right in the centre of the boulevard. This is not only very practical, but this also means it is connected to a zone 2 boulevard with a hard edge. Creating a opportunity to rethinking the hard edge

Results

location value

Kas di Arte

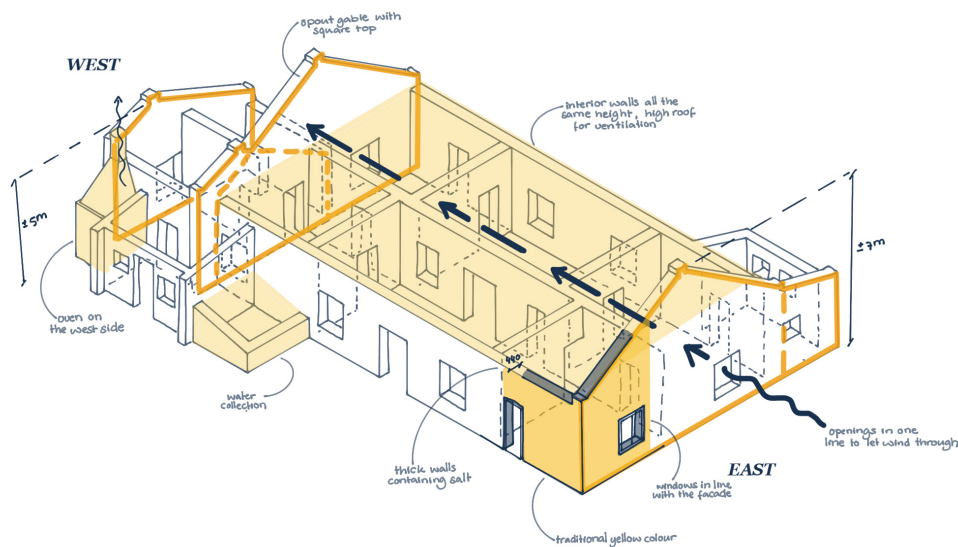
Kas di Arte is a vernacular building constructed in the traditional Kas di Hala (wing house) style. Several of its characteristics hold significant cultural and architectural value that needs to be preserved in my opinion, and can inform or be reinterpreted in new design interventions.

Firstly, the building is oriented east to west and openings are in line with each other to let wind flow through the whole building. This way the wind can cool off the building. For the same reason the walls of the building are as thick as they are and the interior walls don't run all the way to the top of the roof, so that wind can flow from one room to another.

The building also displays a distinctive element typical of the Kas di Hala typology. Its spout

gables with squared tops are characteristic features. Another valuable characteristic is the ochre-yellow facades that strongly define traditional Bonairean architecture. This color, introduced during the Dutch colonial period, remains widely used across the island today. The facade composition is further defined by the placement of windows, which are aligned with the outside of the facade.

Finally, Kas di Arte incorporates traditional domestic elements such as a fornu (oven) and a rainwater collection system. The oven is positioned on the western side of the building, allowing for natural extraction of heat and smoke.



Important qualities | existing situation



traditional yellow colour and spout gables with square top | by author (2025)

Parke Tului & sea pool

Parke Tului is one of the main social hotspots along the boulevard, although this has not always been the case. The park was established in 2014 following strong community advocacy to ensure that the previously vacant plot remained public, rather than being sold to private developers. This origin is still reflected in the way the space is used and valued today.

A key factor in the park's success is the abundance of shaded areas, which make it comfortable even during the hottest parts of the day. The presence of local, salt-resistant trees plays an essential role in this, providing both protection from the sun and a strong sense of place. Preserving these existing trees is therefore of great importance.

Another strength of Parke Tului lies in its spatial composition. The park is organized into several smaller zones, allowing multiple groups to use the space simultaneously without conflict. A variety of seating areas accommodates different group sizes and activities, supporting a wide range of uses—from sports classes and birthday gatherings to barbecues, casual meetings, and moments before or after swimming.

The park includes a small service building with public toilets, an outdoor shower, and indoor changing rooms. Although these facilities are often inaccessible due to being locked, they remain highly valuable, particularly for visitors using the adjacent sea pool.

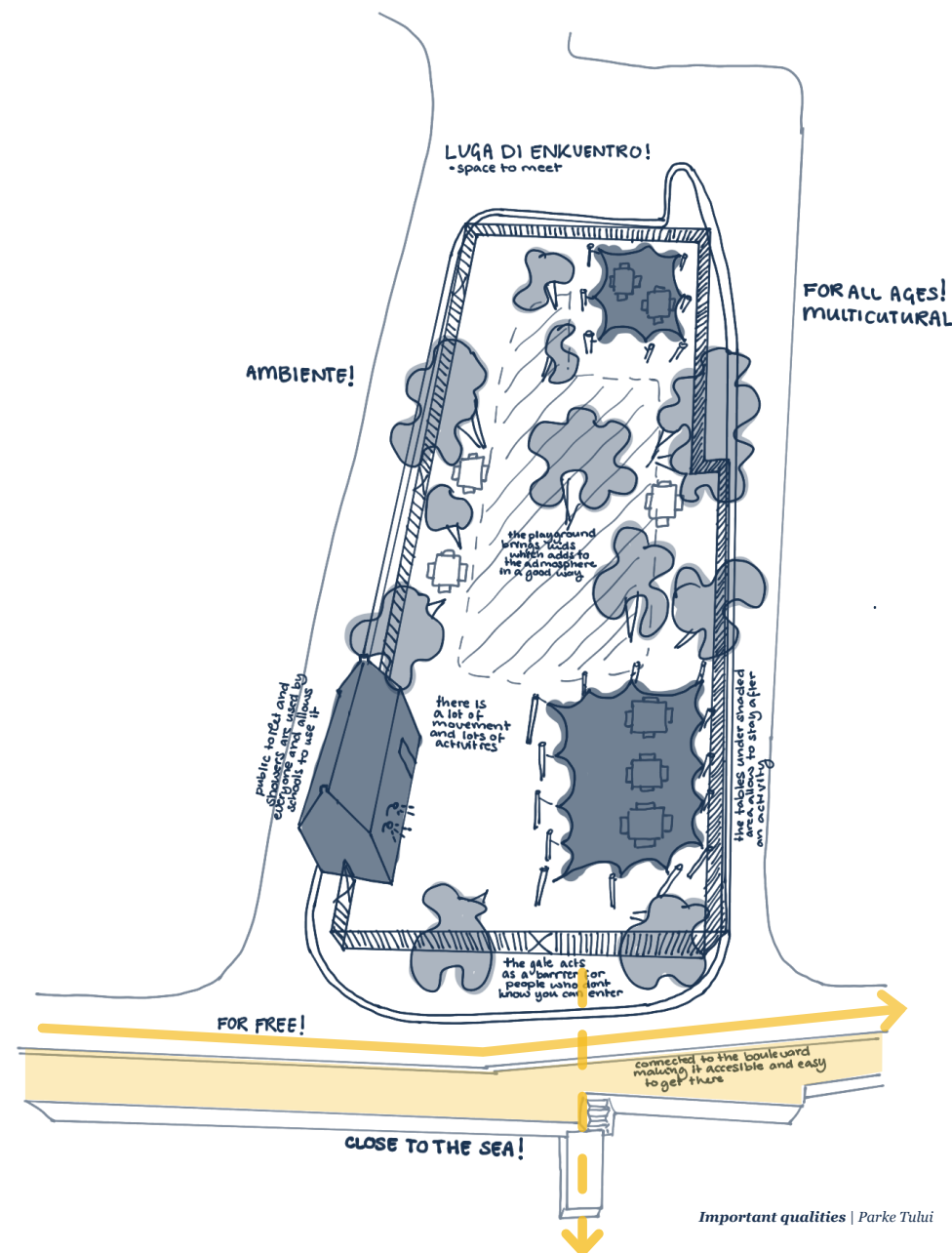
A low fence encloses the park, allowing children to move freely while remaining safely separated from traffic. At the same time, this boundary may have a secondary effect: for tourists unfamiliar with the space, it can appear more private than intended, potentially

discouraging entry into what is in fact a public place.

In 2024, a floating sea pool was added, providing easy and inviting access to the water and quickly becoming a popular feature. Additionally, the sediment accumulation around the original stone pier has formed a small beach, allowing for a gradual and accessible entry into the sea.

The floating structure is composed of modular elements that can be assembled and disassembled, making it adaptable and easy to reposition when conditions such as strong winds require it. This flexible connection to the water is a key quality of Parke Tului and should be preserved.

Finally, the boulevard itself runs directly through the site, bringing a constant flow of pedestrians and *keiru* (passing cars). Here, movement slows. People pause to watch swimmers, sit in the park, or stop for food. The linear motion of the boulevard softens into moments of pause and interaction, making this interface between movement and stillness one of the most important drivers of spontaneous social encounters.



Results

program organisation & building identities

Integrating the program into the site while preserving the value of both Kas di Arte and Parke Tului required extensive experimentation. The full research process is documented in Appendix 03.

Infrastructural interventions

Starting from the existing situation, only the elements considered most valuable to the site were retained. This resulted in Kas di Arte losing almost all of its annexes, with only the old kitchen and fornu remaining. In this way, the iconic structure and form of the building are preserved. The road separating Kas di Arte and Parke Tului was removed, creating opportunities for synergy between the two areas. In addition, all existing trees were retained. These trees are most valuable for providing shade, and because trees grow slowly on Bonaire, mature native specimens should be preserved whenever possible.

The third intervention is the breaking of the hard edge (appx. 3.3), creating a flowing line allowing for the sea to enter into the site creating more space for coral growth, as well as attention for the site and its purposes.

The building program was then integrated into this newly formed landscape. One of the key findings from the program organization research (appx. 3.1) was that the wet lab should be positioned directly above the outlet. This enables the outlet to simultaneously function as an inlet, providing a continuous supply of fresh seawater for the aquaria. As a result, the wet lab is directly connected to Kas di Arte and follows its orientation.

From coral-focussed to human-centered

The remaining new buildings reinterpret the form of Kas di Arte while aligning with the waterline and Kaya Gobernador Debrot. All

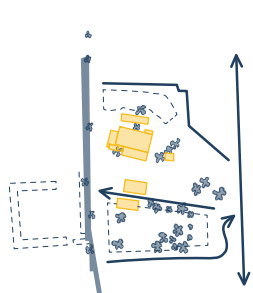
new structures are positioned on a 4.5-meter grid, carefully arranged to avoid the existing trees. The more social functions are located closest to Parke Tului, creating a gradual transition across the site from coral-focused activities to human-centered spaces.

Architectural ‘sisters’

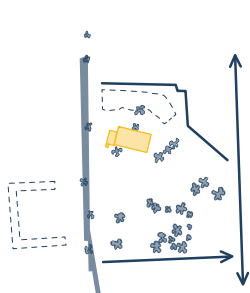
All buildings share the same basic form. However, the ridgeline of all new buildings is positioned 50 cm lower than that of Kas di Arte, allowing the historic building to remain the dominant architectural element. The only exception is the series of open structures that connect the different buildings; these maintain the same ridge height as Kas di Arte to reinforce continuity across the site. (appx. 3.6 & 4.1)

From climate-controlled to naturally ventilated

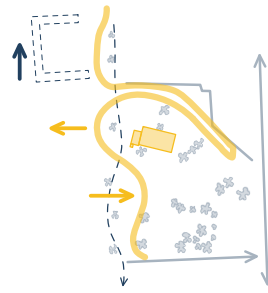
Just as the program gradually transitions from coral-centered to human-centered functions, the architecture follows a similar progression in openness; from diving facilities, wet lab, research center, educational center, to multipurpose hall. The same goes for less freely accessible to welcoming for all. The sequence begins with the enclosed and climate-controlled wet lab and gradually becomes more open, culminating in the fully open and naturally ventilated multipurpose hall. As visitors move toward the park, the buildings increasingly merge with the surrounding landscape, blurring the boundary between architecture and nature.



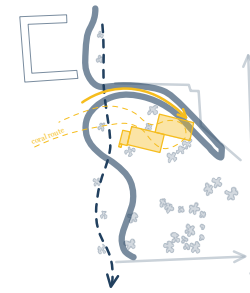
Kas di Arte & Parke Tului now



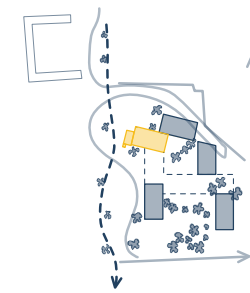
Eliminating the road, annexes and retaining the existing trees



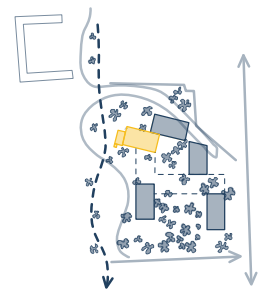
Breaking the hard edge, moving the sea pool and creating space for coral



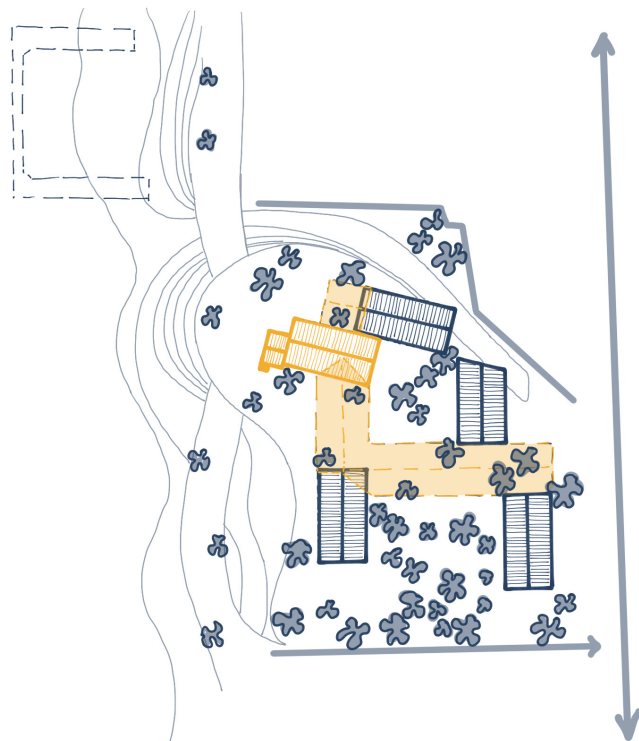
Wetlab on top of the outlet, easy coral route and sea water inlet



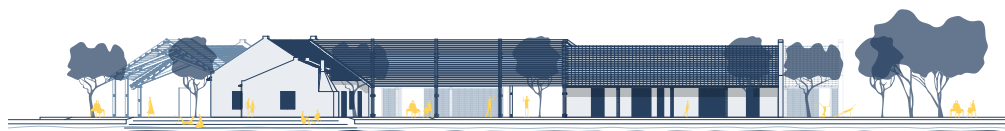
New buildings follow waterline, connected by shaded structures



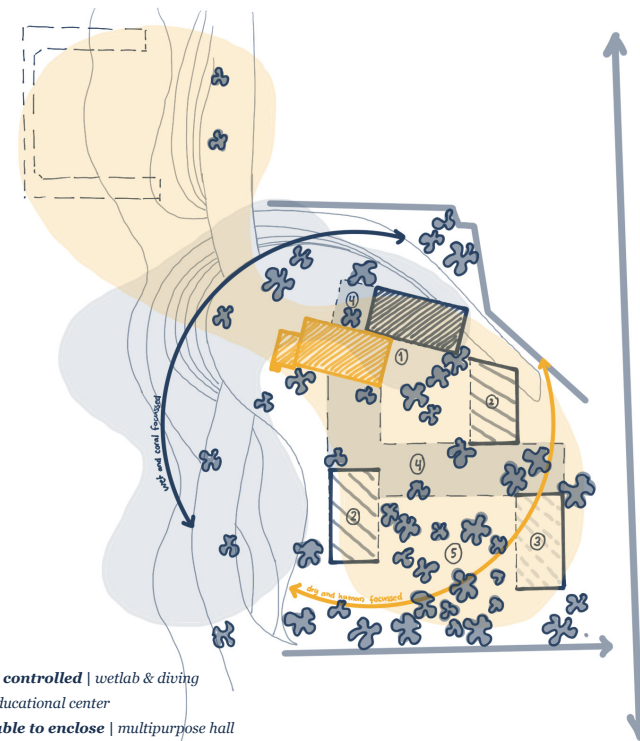
New native trees are planted, creating one big park



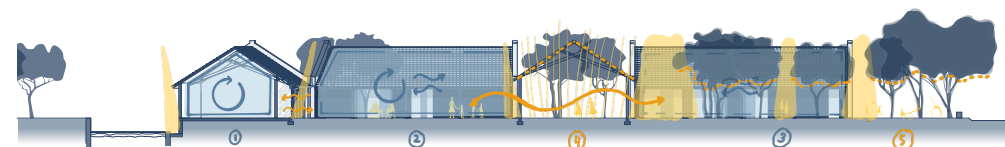
- **Kas di Arte & shaded structures** | ridge height 6.8 m
- **New buildings** | ridge height 6.3 m



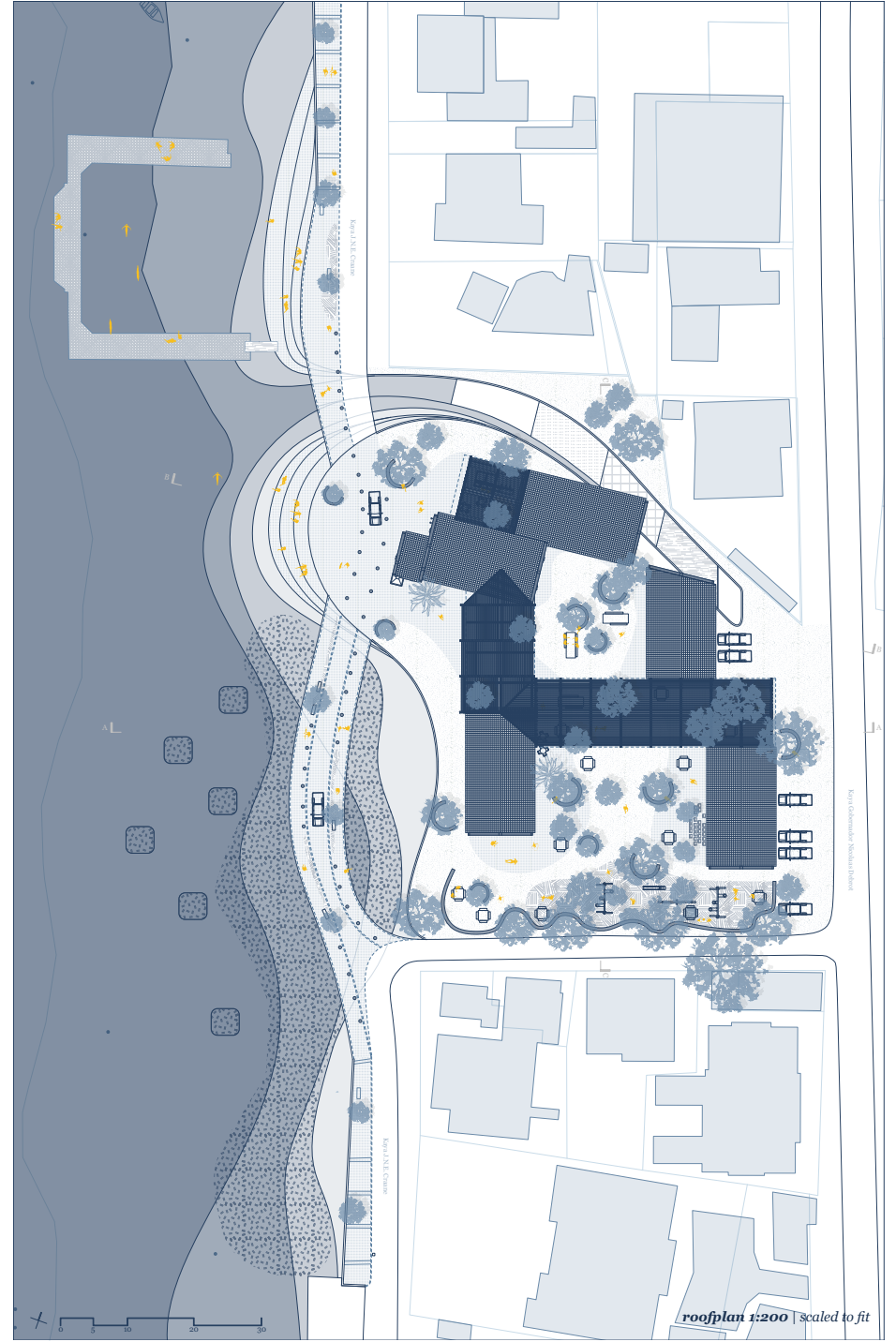
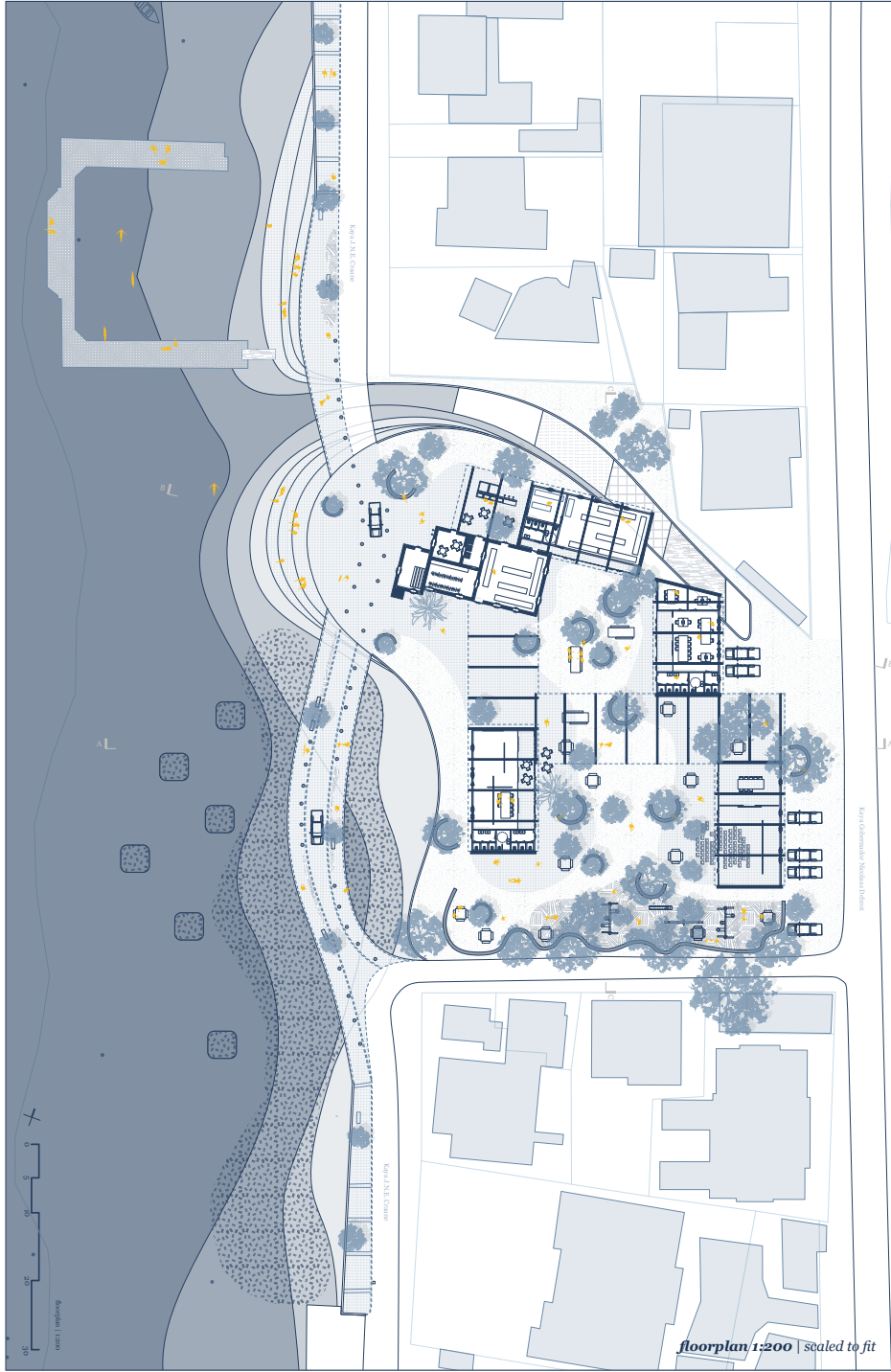
elevation seaside 1:200 | scaled to fit



- 1 ● **Fully enclosed & climate controlled** | wetlab & diving
- 2 ○ **Partially open** | office & educational center
- 3 ○ **Not climate controlled, able to enclose** | multipurpose hall
- 4 ● **Open with wooden canopy** | shaded structures
- 5 ○ **Fully open** | the park landscape



climate section cc 1:200 | scaled to fit





Integrating & extending Parke Tului

Parke Tului has not become smaller at all. By removing the road, the park now extends all the way to Kas di Arte. It retains all the flexibility needed to host the activities that make it so socially valuable, including sports classes, birthday parties, barbecues, and community events.

Not only have all the existing shade-providing trees been preserved, but a new shaded structure has also been added, along with many additional trees throughout the park. Public toilets remain integrated into the design and are easily accessible from within the park. The playground is also retained and is enclosed by a low wall, helping to prevent children from accidentally running into traffic. In addition, because the boulevard now runs over the water, the water itself forms an extra protective barrier along this edge of the park.

Rather than paving the entire area, the park is designed with a base of compacted gravel, interspersed with planted soil areas for trees and vegetation. Paving is used only where necessary for accessibility and everyday use, resulting in a greener, more natural, and more pleasant public space. (appx. 4.10 & 4.11)

Breaking the hard edge

By breaking the hard edge of the coastline and gradually stepping the ocean floor up to land level, wave energy is dissipated before reaching the boulevard. This significantly reduces the impact of wave action and limits the potential damage caused during rough sea conditions.

Marine life brought in

The road running along the waterfront is retained, allowing people to walk and keiru (drive) along the boulevard. However, the boulevard is partially interrupted where the design allows the ocean and marine life to become the dominant presence within this section of the site. Here, the road transforms into a bridge, creating an opportunity for visitors to look down over the edge and observe

the reef below. This also takes away the need to enter the water and witness these corals.

Within this area, it is important that access to the water does not feel easy or inviting, in order to protect the reef ecosystem and discourage direct entry into the ocean. To achieve this, the transition from the site to the first terrace level includes a drop of 1.2 meters. In addition, the surface of the first terrace is intentionally rough and uncomfortable to walk on barefoot. This terrace is only submerged during high tide, allowing shallow pools of seawater to remain behind as the tide recedes. Over time, these pools can become habitats for sea urchins, snails, and other marine organisms.

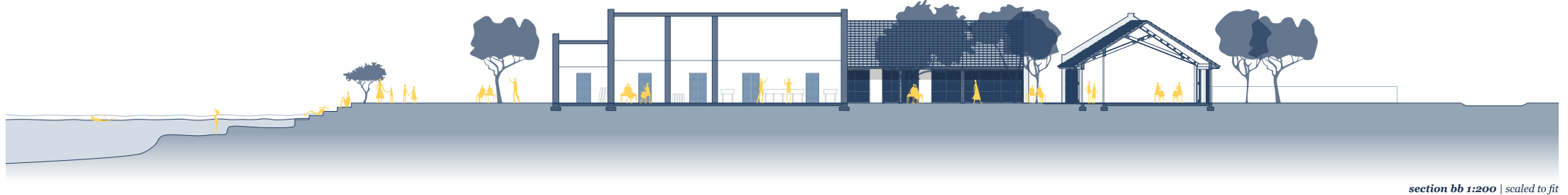
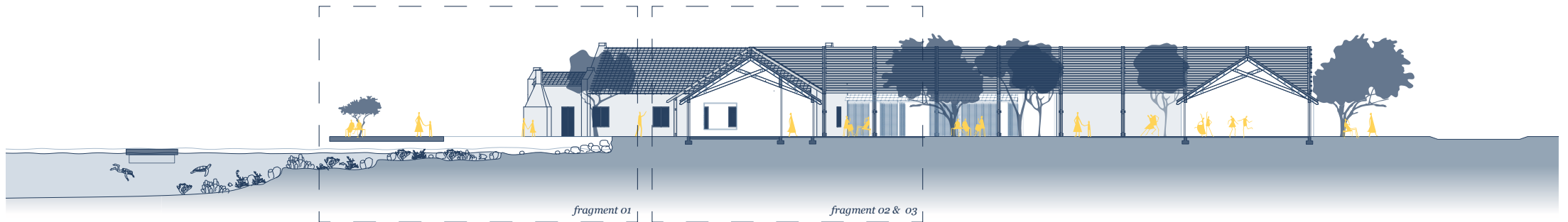
All terraces are constructed from big stones with an uneven surface that encourages coral attachment while providing shelter for fish, sea urchins, eels, and other marine life within its many crevices and cavities in between the stones.

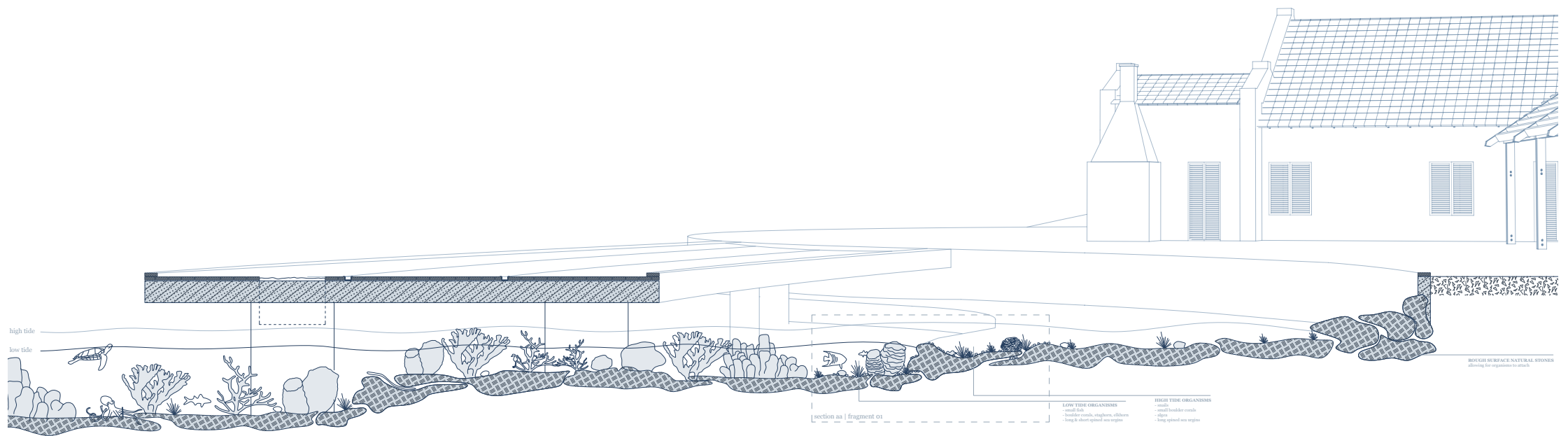
Separating accessibility

Near the Wet Lab and Kas di Arte, the site extends further into the sea, where accessible stairways provide comfortable and direct entry into the water. This area is intended to serve as the primary point of ocean access and the proposed location for the coral nurseries. Reef Renewal divers can enter the water directly from this location, which is closely connected to the Wet Lab. The steps above sea level

are designed at a comfortable sitting height, allowing the space to function not only as an access point but also as a place to sit, gather, and watch the sunset.

Across from the outlet, the waterfront stairs continue along the shoreline. The sea pool is relocated to this area, ensuring that swimmers remain separated from the coral-dominated zones while still being within easy walking distance of swimming storage facilities in Kas di Arte and the recreational spaces of Parke Tului.





section bb 1:20 | fragment 01 | scaled to fit



breaking the hard edge

Results

filtering the outlet

The design of the outlet is based on two important principles.

Filtration function

First, it is essential that rainwater runoff is not given a direct path into the ocean. To address this, the outlet is divided into five consecutive sections, each positioned slightly higher than the previous one. This stepped system ensures that small amounts of rainfall can be absorbed and filtered before reaching the sea, while still allowing excess water to overflow safely during heavy storms.

Each of these five sections forms part of a different filtration strategy. The first three rely on permeable surfaces:

1. *Bulky waste collection* through a coarse metal grid that captures larger debris.
2. *Natural infiltration*, where water slows down through vegetation and poles, allowing it to gradually infiltrate into the ground.
3. *Gravel and sand infiltration*, consisting of layered gravel and sand beneath a metal grid that filters water as it percolates through the system.

The final two sections use impermeable surfaces:

4. *Small boulder filtration*, where water flows between and through large stones, further reducing debris and sediment.
5. *A final fine filtration* stage before the water eventually flows into the ocean.

Seawater intake

Second, the outlet is designed not only as an outlet for rainwater, but also as an inlet for seawater used by the Wetlab. Seawater is collected and transported via a large pipe leading toward the Wetlab. After being used in the aquaria, the residual water is returned to the outlet filtration system before re-entering the ocean.

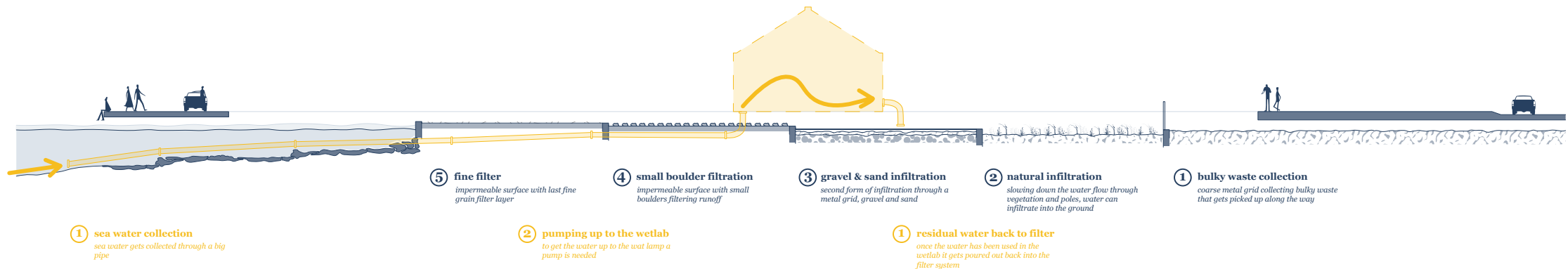
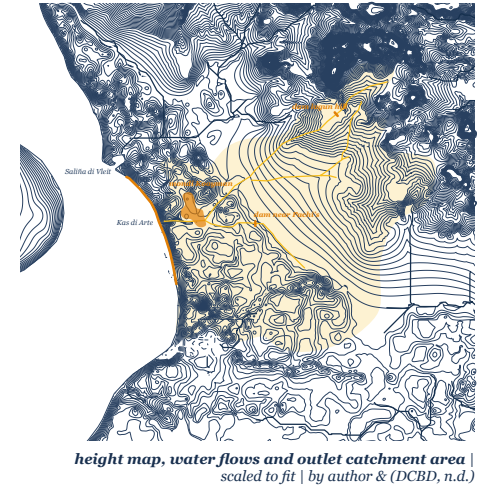
Purposely visible

An important aspect of the design is that the technology behind these systems should remain visible and understandable. For this reason, the pipeline and filtration elements are intentionally exposed, allowing visitors and users to see, understand, educate and potentially even participate in maintaining the system themselves.

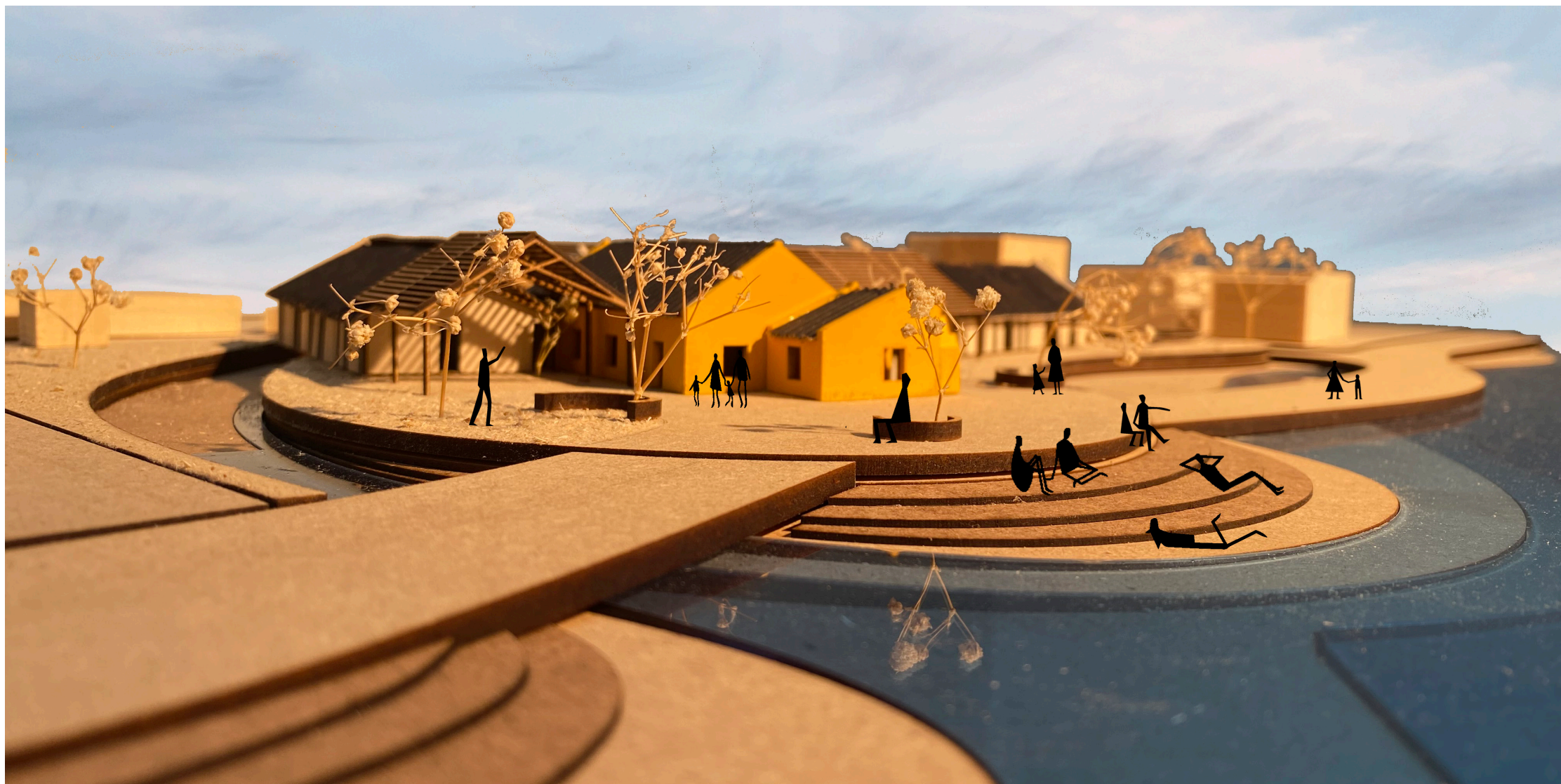
This solution can only function effectively if runoff along the entire watershed is also slowed, infiltrated, and filtered before reaching the coastline. Fortunately, this is already an area of focus for the Government of Bonaire.

The catchment area that ultimately drains toward the outlet at Kas di Arte is shown on the map. Along this drainage path, several dams have already been constructed to reduce flow velocities and mitigate the impacts of heavy rainfall events. These interventions help retain water upstream and reduce sediment transport toward the coast.

However, for the proposed system to function without becoming overloaded, additional measures are required downstream of the dam at Pachi's Place. Beyond this point, the watershed becomes increasingly urbanized, resulting in runoff that carries higher concentrations of pollutants and sediments. Therefore, urban runoff should be slowed, infiltrated, and filtered at least once before entering the site.



schematic outlet section



outlet, inlet and stairs to the water

Results

construction, adaptable facades & material

To be able to create architecture that follows a progression in openness from an enclosed and climate-controlled wet lab to a gradually more open educational center, culminating in the fully open and naturally ventilated multipurpose hall, the facade needs to be adaptable.

To accommodate this each building is composed of the same architectural elements: a timber structure with wooden trusses, stone spout gables, and adaptable infill facades in between the columns.

Shutterdoors

The facade facing the park is constructed entirely from wooden shutterdoors. These shutterdoors can be opened individually, allowing users to control the degree of openness, ventilation, as well as the degree of sunlight entering depending on the climate and activity within the building. (appx. 4.6, 4.7, 4.8 & 4.9)

The shutter facades form an outer layer around each building, with a secondary layer positioned behind them. The nature of this inner layer depends on the identity and climatic requirements of the specific building. In the Wetlab, the second layer consists of an insulated wall system, while in the office and educational center, it is formed by sliding glass doors.

Indoor climate control

The shutter facades not only allow for varying degrees of visual openness, but also serve an important climatic function by filtering direct sunlight before it reaches the inner facade, particularly the glazed surfaces. The space created between these two layers functions as a transitional “porch” zone: an intermediate

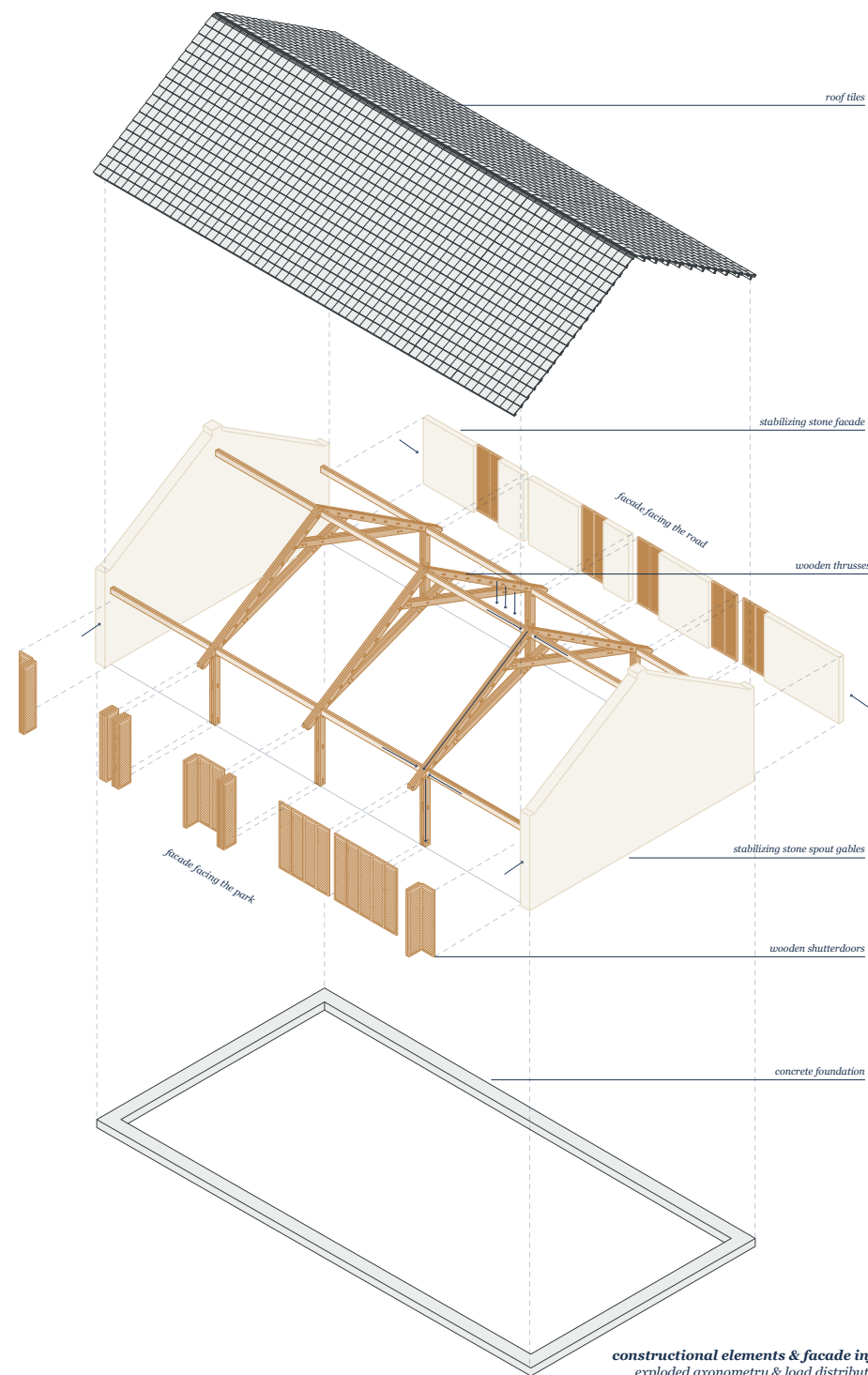
space between inside and outside that remains thermally comfortable while still allowing natural ventilation and visual connection to the surroundings.

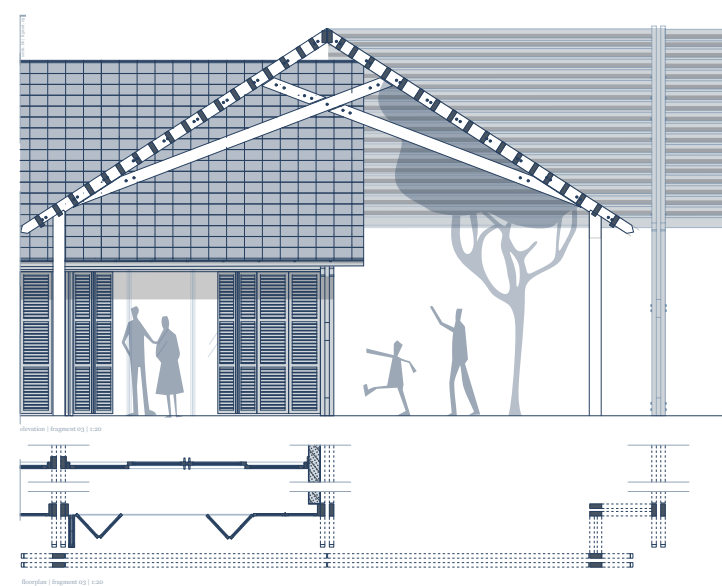
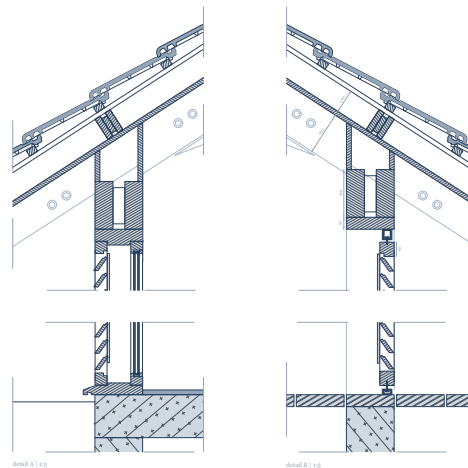
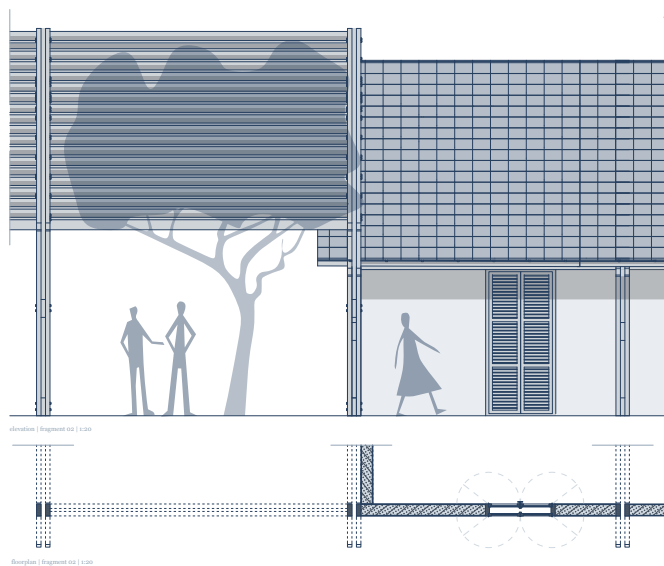
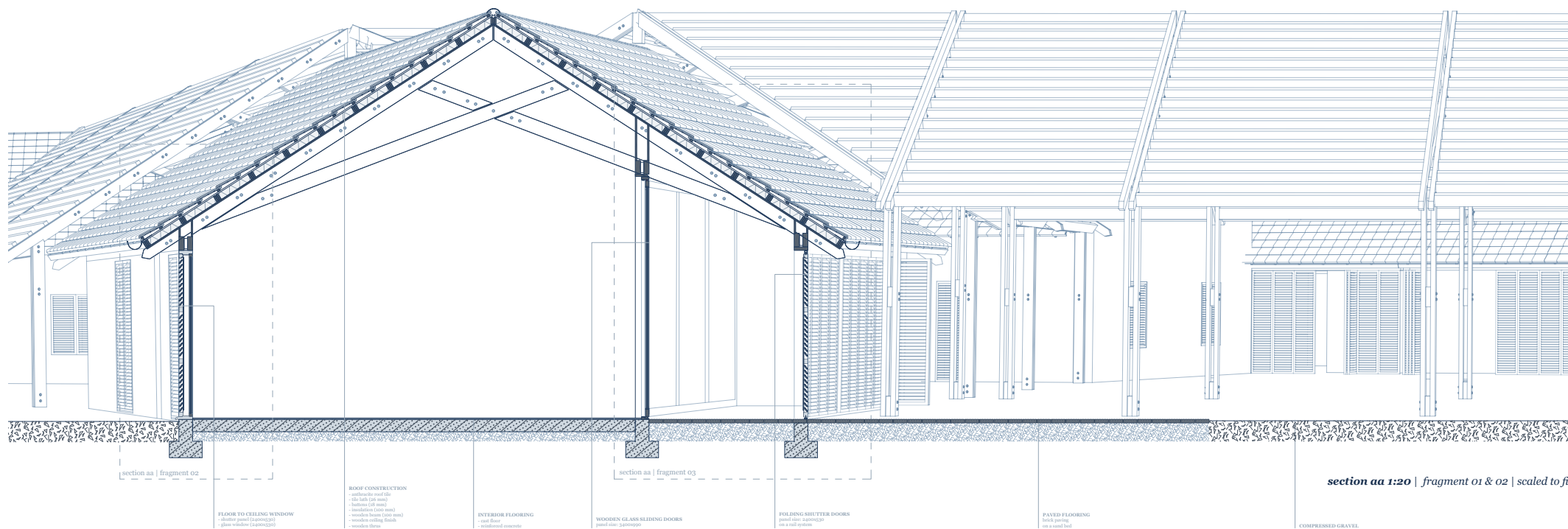
On the more enclosed facades facing the road, all openings are designed as double-layered systems consisting of both wooden shutters and glass windows. Because each layer can be opened independently, the buildings can adapt to different climatic conditions and desired levels of ventilation or air conditioning.

In contrast, the facade facing the road is designed to be more enclosed combining stone surfaces and wooden shutters. The stone material of the spout gables continues here, creating a U-shaped form of the buildings. This configuration also contributes structurally, helping to stabilize both the spout gables and the wooden truss system.

Open connecting structure

The same trusses are used in open shading structures that connect the different buildings. (appx. 4.5) It consists of a series of repeating wooden trusses linked together by beams. The primary purpose of this structure is to provide shade within the outdoor gathering space. By placing the beams horizontally, following the pitch of the roof and given sufficient depth, they block a significantly large amount of sunlight while requiring fewer structural elements (appx. 3.8). In Bonaire’s climate, where the sun is positioned almost directly overhead around midday, effective shading is essential.





elevations 1:20 | fragment 01 & 02 | scaled to fit



shading wooden canopy

Wood, stone and tiles

As stated before the construction is fully made out of timber, on Bonaire its is essential to use a hardwood against termites and other insects. I chose Garapa hardwood, which is lighter in colour. This wood is applicable for both the construction as the window frames and shutters. Kas di arte its window frames will be replaced with shutters to match the new buildings.

The spout gables will be made out of plastered and painted stone. I have chosen to keep Kas di Arte in its iconic yellow colour. The new buildings will be painted in a creme colour.

The closed roofs will be made out of anthracite roof tiles. The roofing on Kas di Arte will also be replaced to match the new buildings.



elevation seaside | scaled to fit



elevation kaya gobnador gebrot | scaled to fit

Spout gable sculptures

The spout gables form one of the most striking architectural elements within the project. They are always solid and appear as end pieces attached to the ends of each building structure, imitating the iconic shape with a square top. Rather than functioning purely as technical or structural elements, the intention is for these gables to act as architectural sculptures within the site.

The inspiration for these forms comes from the intricate textures of coral. Corals possess delicate surface patterns and details that are often almost invisible to the naked eye. While on Bonaire, dead coral fragments found on the beach were pressed into clay to capture these textures. When these impressions were studied in black and white, the richness and complexity of the coral patterns became highly visible.

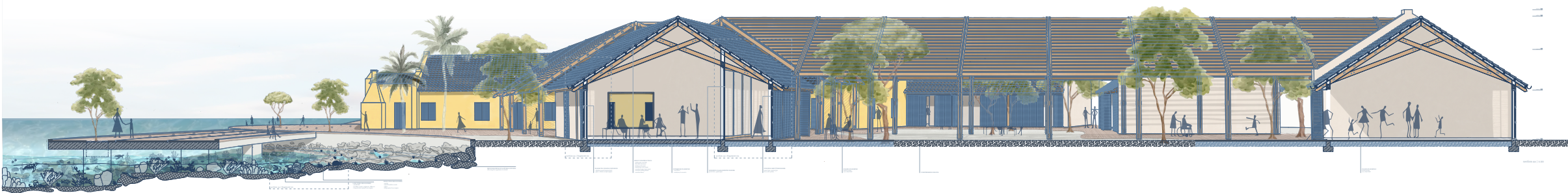
From this process emerged the idea of translating coral textures into architecture by enlarging them to an architectural scale and applying them to the spout gables. In this way, the textures become tactile and physically perceptible to visitors moving through the site. The gables therefore serve as an abstract expression of the marine ecosystem that lies at the center of the project.



coral and shell imprints in clay | by author (2026)



spout gable structure



section aa 1:20 | scaled to fit

Conclusion

At a time when we should all be advocating for the future of coral reefs; awareness, involvement, and action are urgently needed. This project explores what architecture can contribute to the protection and regeneration of underwater ecosystems. At its core is the meeting of two worlds: land and sea. Where these worlds intersect, a zone of tension emerges, and the project explores how architecture can enhance the ecological conditions within this in-between space.

Looking back, my main research question was quite single layered: “how can the public waterfront on Bonaire enhance the conditions to allow coral reefs to thrive?” Not an easy task in itself, but such a question has at least a single layered focus.

Bonaire, the Bonairean people and culture are very dear to my heart. I was born and raised there; I’m one of them. From the start of this project it was crystal clear to me that my design should only add:

- » add to the coral growth and variety in the Bay of Kralendijk,
- » add to the natural environment above sea level at the Boulevard,
- » add to the important communal function of the Boulevard,
- » add to a sense of historical pride

My design was definitely not going to diminish any of those!

Next to my research question I formulated four main goals, the first two being: design a reef renewal facility and an educational facility. The latter predominately to raise public awareness. This facility thus needs to be both welcoming and needs to stand out to be noticed. This all with respect to my other two goals: architecture as a positive (thus: more than

neutral) contribution to nature and preserving and enhancing social and historical features.

It’s easy to see that this ‘wanting it all’ reveals quite a number of tensions.

It starts from the understanding that the structures we place in and along the water inevitably influence the livability of underwater ecosystems. Waterfront design should become far more nature-focused, creating space not only for corals, but also for sea urchins, small fish, eels, snails, and countless other species that depend on these environments to feed, hide, attach, and coexist.

Through fieldwork and research it became clear that to create a waterfront that functions as a habitat for marine life, several conditions are essential. Wave action must be reduced to create calmer environments for coral growth. Urban runoff should not flow directly into the ocean, but instead be infiltrated and filtered before reaching the sea. Equally important is limiting unrestricted human access to the water, preventing damage to fragile coral ecosystems caused by trampling and disturbance.

Creating a coral-inclusive waterfront in a pristine natural setting could be relatively straightforward. It’s easy to state to aim for coral reefs to thrive alongside the downtown Boulevard, but how do you arrange that in a predominantly social and infrastructural environment?

The value of this project lies in demonstrating that such an approach is also possible within a highly social, touristic, and urban environment. Nature can be given the space it needs to thrive without sacrificing the social, cultural, and

historical value of the waterfront.

Kas di Arte and Parke Tului provide the ideal setting to explore these tensions. The aim is to create something new, but all while preserving the area’s social and historical significance. At the same time, the project seeks to raise awareness of what currently remains largely invisible: the underwater world and the outlet. And, Parke Tului already functions as an important gathering place for local communities. The challenge, therefore, is to maintain this public and social character while also welcoming visitors and allowing tourism to become a source of income.

In this context, architecture becomes a tool for guidance. Through research by design, testing spatial design, material choices, and varying degrees of comfort and accessibility, people are subtly directed towards places where they are welcome, invited to observe, learn, and engage, while more sensitive ecological areas remain protected. Rather than relying on barriers, the architecture itself communicates where human occupation is appropriate, and where nature should take precedence.

The project is not only concerned with the relationship between the sea and the urban edge, but also with the connection between nature and architecture more broadly. On Bonaire, life largely takes place outdoors, preferably beneath the shade of a tree. Nature therefore acts as the leading designer. This principle is reflected in the park design, where existing trees are retained and buildings adapt to the landscape rather than the other way around. Hard surfaces are introduced only where necessary for human use, while the remaining ground is kept permeable, allowing natural processes to continue uninterrupted.

This approach is equally visible in the transition between inside and outside. In a climate such as Bonaire’s, this boundary should be blurred rather than rigidly defined. The design embraces this condition through adaptable façades that allow users to adjust their level of enclosure while maintaining a constant connection to the surrounding environment. Natural ventilation is always able to flow through the buildings, while sunlight is filtered to create comfortable shaded spaces. In this way, the architecture responds to both climate and culture, creating spaces that feel neither fully indoors nor outdoors, but comfortably situated between the two.

This way of designing extends beyond the boundaries of a single building or waterfront intervention. It suggests a broader shift in architectural thinking: from designing solely for human occupation towards designing for the coexistence of human and ecological systems. The project therefore raises a larger question about the role of architecture in addressing environmental challenges, not as a passive observer, but as an active contributor to ecosystem health and resilience.

From the smallest architectural details, the focus now shifts back to the larger scale. While

the proposal is developed for a specific location along the boulevard, the principles behind it are applicable on a much broader scale. Rather than treating ecological considerations as constraints, the project positions them as drivers of design. This suggests a broader opportunity for the architectural profession: to shape urban environments that not only minimise environmental impact, but actively contribute to ecological regeneration.

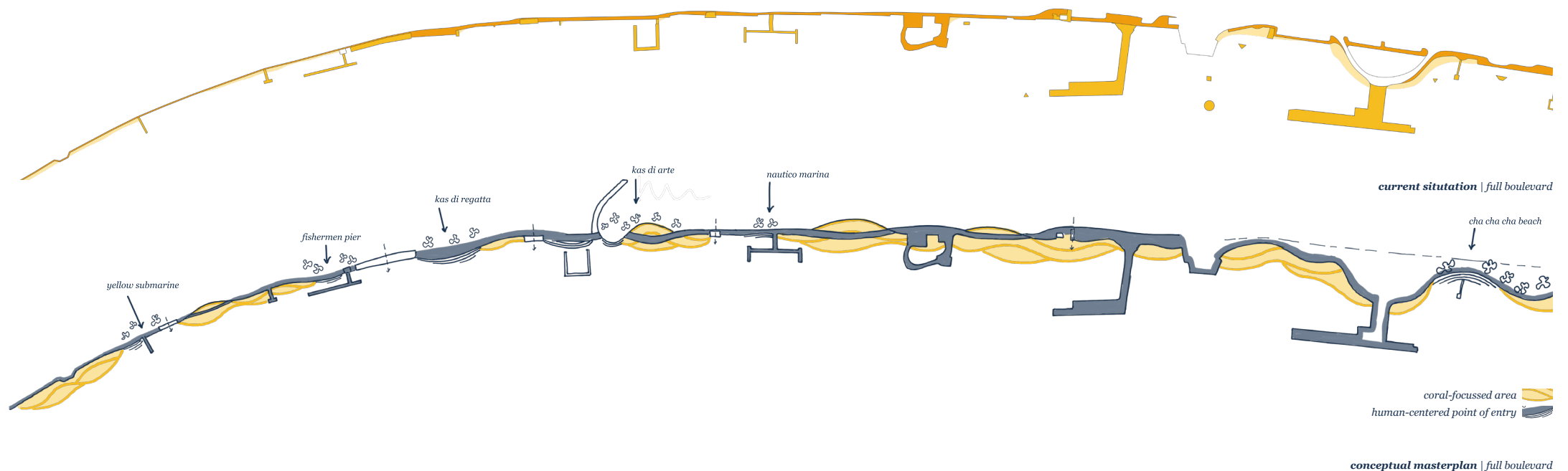
If similar interventions were implemented at multiple locations, or even throughout the entire boulevard, the relationship between

people and the marine environment could be fundamentally redefined. Through architecture and urban design, access to the water can be carefully guided towards designated entry points, while other areas are allowed to develop as protected marine habitats. In this way, coral reefs are given more space to grow and recover with minimal human disturbance.

The conceptual masterplan below illustrates how the boulevard could evolve if these principles were applied at a larger scale. Rather than treating the waterfront as a hard boundary between land and sea, it becomes

a gradual transition zone where ecological restoration, recreation, and urban life coexist. Through a series of connected interventions, the boulevard has the potential to become an active contributor to the health and resilience of Bonaire's coastal ecosystem.

While rooted in Bonaire, the project ultimately argues that waterfronts around the world should no longer be designed solely for human use, but as environments where ecological regeneration and public life coexist.





APPENDICES

01	Fieldwork & reserach	78
	Boulevard design Car traffic Functions Ocean front resistant trees Fisheries & boat traffic Swimming hot spots Plateaus & rubble Qualities & opportunities Rhythms through time Urban runoff	Five greatest risks to the islands coral reefs Coral restoration Boulevard's design affects corals High communal value Crossroads Design program Enhance water quality Reef renewal hub + educational center Breakwaters & filters
02	Location Analysis	114
	Kas di arte Vernacular building Parke tului & sea pool Tensions	
03	Research by design	140
	01 Program organization Four variants Variations clustered by theme 1. Wetlab on top of the outlet 2. Synergy between Kas di Arte and Parke Tului 3. Floating nursery and seapool 4. Routing of different users Variations, themes & tensions combined 02 Form studies Architectural sisters Variations of building- & roof orientation Separated yet coherent whole Ground level studies Conclusions program organisation 03 Site design principles Breaking the hard edge Bring the ocean inward Differentiation in accessibility	04 Park design Preserve qualities & values Relationship between landscape and architecture 05 The outlet Filtration function Seawater intake Purposely visible 06 Building identities The wetlab The office and educational center The multipurpose hall The open structures The park landscape 07 Adaptable facades 08 Shaded structure 09 Spout gable sculptures
04	Reference projects	186
05	Bibliography	202



FIELDWORK & RESEARCH

From December 6th till 26th 2025, I conducted field research on the boulevard on Bonaire. During this period, I collected data and spoke with several local organisations to better understand the area. To study the boulevard, I adopted a simple observational approach: I walked along the boulevard and then swam back along the coastline. I repeated this route on four different occasions, discovering new details each time. The observations and findings from this fieldwork are presented in this chapter.

Boulevard design

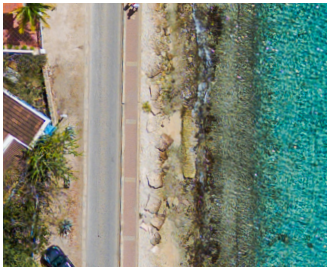
The boulevard on Bonaire runs from Playa Lechi beach until Cha Cha Cha beach and is about 2 km long. The boulevard is physically blocked on both these ends with a building, after which the waterfront becomes private or owned by hotels. Within the built environment, the boulevard is the only stretch of public water front that still exists. The boulevard can be divided in three clear zones. These zones are defined by a few things: the construction, the underwater scene and its on land functions.

- Zone 1;** from Playa Lechi to the Fishermen pier
- Zone 2;** from the Fishermen pier to Karel's
- Zone 3;** from Karel's to Cha Cha Cha beach

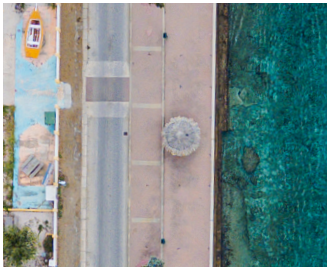
In zone 1 the walkway is the narrowest and lies lower than the road. The sea does not hit the boulevard here directly, most of zone one still has a small pebble beach. In this zone, most of the plateau under water is broken and the amount of rubble is only about 2 meters wide. The majority of small boats moored on the boulevard are here in zone 1.

In zone 2 the walkway widens, with its widest part at Kas di Regatta. The pebble beach completely disappears and the sea hits the boulevard directly. The width of the rubble underwater immediately increases after the fishermen's pier to about 10 meters wide, leaving the underwater scene look way worse in zone 2.

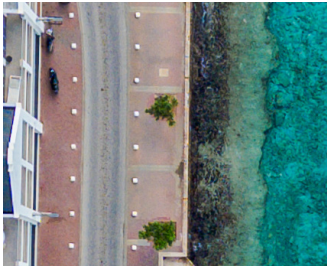
Zone 3 is the harbor zone, swimming is not allowed here. The construction of the boulevard is the same as in zone 2, with the addition of breakwaters at the cruise harbor pier. The amount of algae and rubble seems less here.



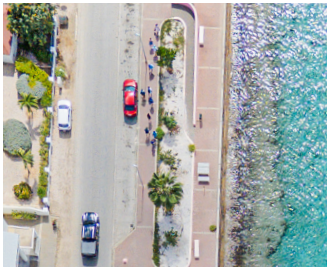
top view 1 | near yellow submarine (zone 1)



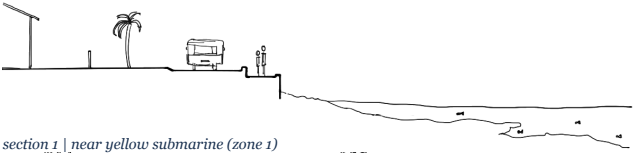
top view 2 | near kas di regatta (zone 2)



top view 3 | near luciano's (zone 3)



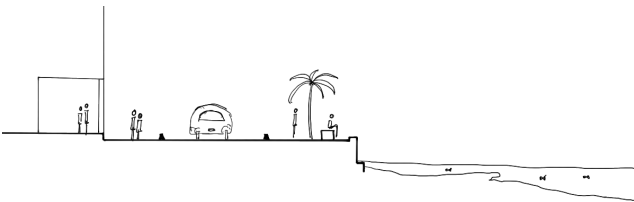
top view 4 | near capriccio (zone 3)



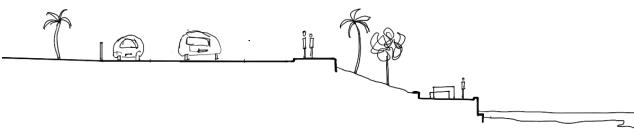
section 1 | near yellow submarine (zone 1)



section 2 | near kas di regatta (zone 2)



section 3 | near luciano's (zone 3)



section 4 | near capriccio (zone 3)





zone 1 | oubaas pier



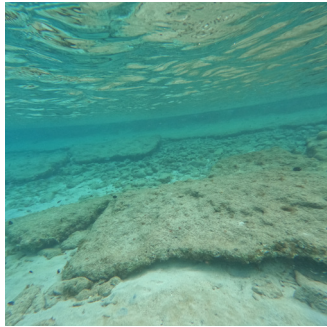
zone 1 | yellow submarine pier



zone 1 | slipper tree



zone 1 | boat moorings



zone 1 | broken plateau



zone 1 | algae growth on plateau



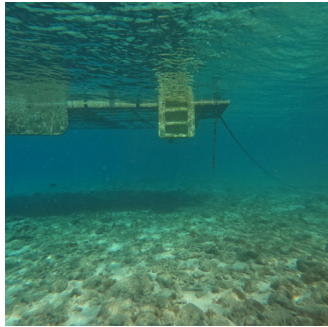
zone 2 | kas di regatta



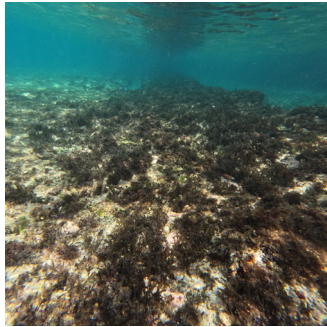
zone 2 | slipstream



zone 2 | karel's beach bar



zone 2 | seapool



zone 2 | algae growth



zone 2 | plateau and rubble



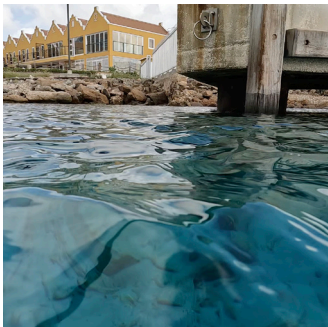
zone 3 | luciano's



zone 3 | plasa machi mimi



zone 3 | cruise harbor



zone 3 | cha cha cha docking block



zone 3 | north pier break water



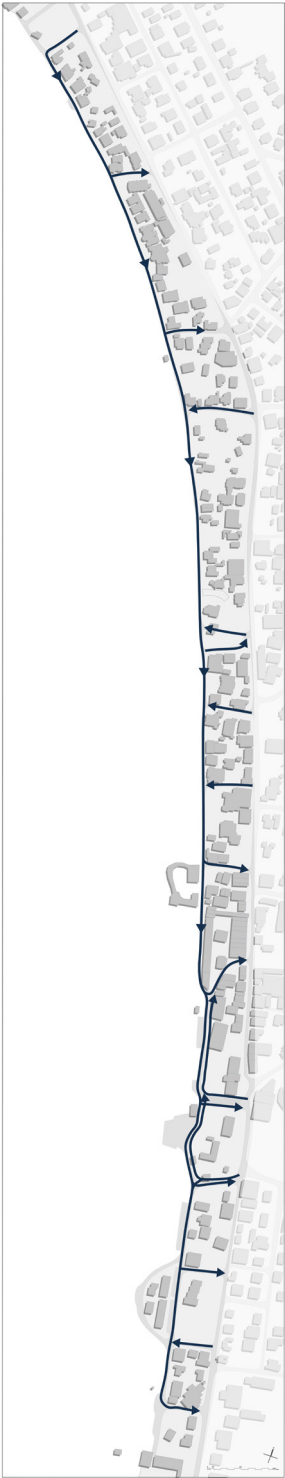
zone 3 | small patch of algae

Car traffic

Almost the entire boulevard functions as a one-way street running from north to south. There are only a few points for entering and exiting the boulevard, and all intersecting roads are also one-way. And while there is one piece where the road becomes a two way stream the main flow of the traffic is always north to south.

The maximum speed is around 10 km/h, which encourages a slow pace. Rather than serving as a direct route from one place to another, the boulevard is used by people to drive leisurely along the water, enjoying the view and stopping to greet people along the way. In Papiamentu, there is a specific word for this activity: keiru (kuieren).

The boulevard is rarely used as the fastest way to reach a destination. Instead, people choose it precisely to keiru; to slow down, to linger, and to enjoy the experience.

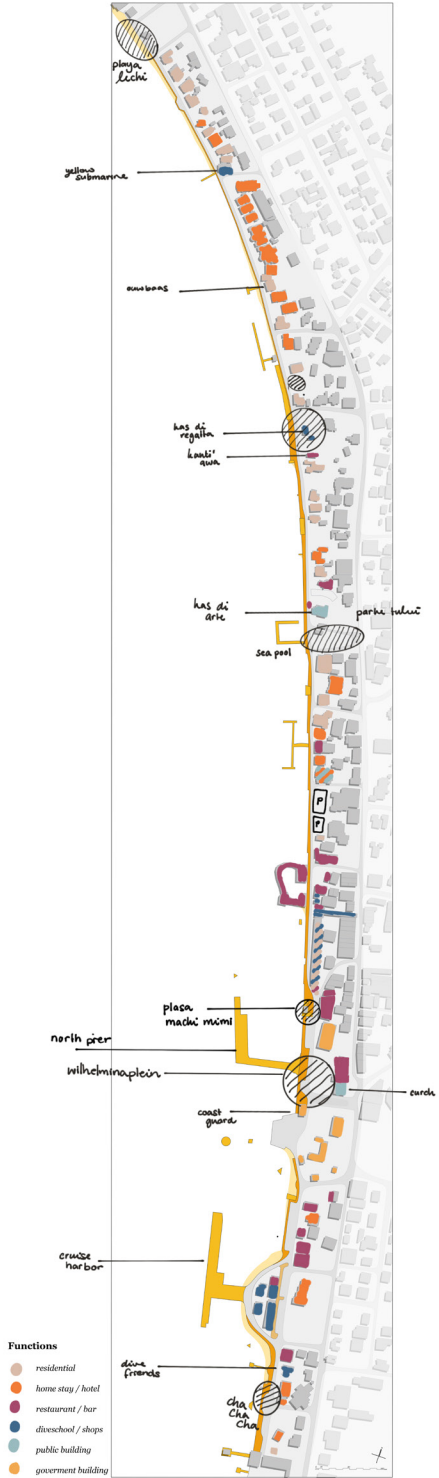


Functions

The waterfront accommodates a wide range of functions, from residential and commercial uses to government buildings. Historically, this area was where most people lived, and where this settlement once started. Today, however, this is no longer the case. Nearly all of the remaining historic houses are rented out to tourists, or are replaced by multi level apartment buildings, or used as part-time residences. While a small number of people still live along the waterfront, most residential housing on the boulevard is now concentrated in zone 1.

From the Nautico Marina southward, the area becomes increasingly commercial, with buildings primarily housing restaurants and shops. Around the North Pier—where the town originally developed—government buildings are still located, preserving the area’s administrative function.

Only a few buildings along the waterfront are truly public in nature. These include Kas di Arte, a traditional building used for public events; Oubaas, a facility that can be rented affordably by large groups, such as for school trips; and the church.



Ocean front resistant trees

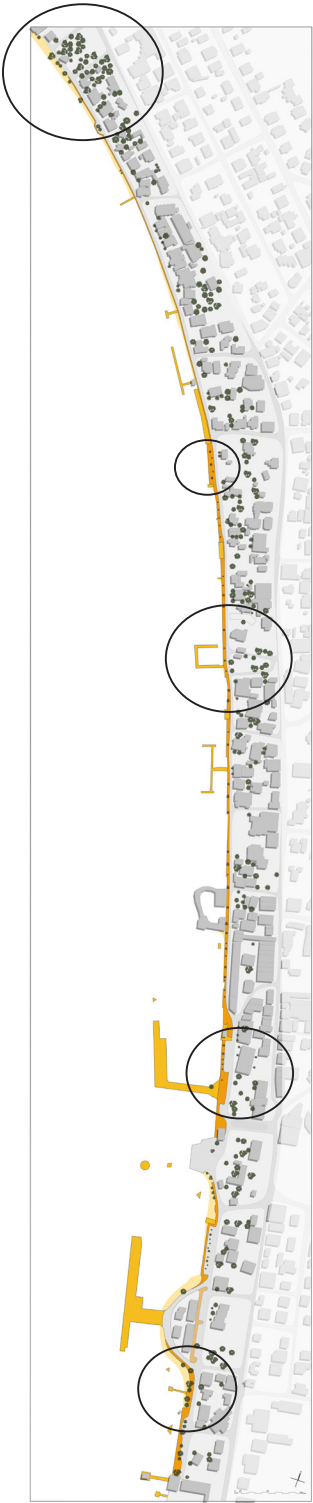
From the Fishermen Pier to Cha Cha Cha Beach, trees are incorporated into the design of the boulevard. Originally, they consisted mainly of palm trees. While palms can withstand ocean conditions, they are not native to the island and provide very little shade. A few years ago, these were replaced with local, ocean-resistant tree species. Although they are still relatively small, they are expected to grow and eventually offer substantial shade. See the next page for native ocean resistant trees.

For now, however, much of the boulevard remains exposed and becomes very warm during the day. Only a few areas provide sufficient shade, including Playa Lechi, Parke Tului, Wilhelmina Plein, and Cha Cha Cha Beach. In these locations, fully grown trees create cooler, more comfortable spaces.

At Kas di Regatta, palapas (palm-leaf parasols) were recently installed above existing benches and tables along the boulevard. Their popularity is immediately visible: people naturally gather beneath them, seeking relief from the sun and demonstrating the strong demand for shaded public spaces.



palapas at Kas di Regatta | by author (2025)



zeedruif



green button wood



palu santu



kalabas



coco (palm tree)



karawara spaño



silver button wood



kwihi tree



flamboyant



people gathered on the benches | by author (2025)



the slipper tree | by author (2025)

Fisheries & boat traffic

Next to the large ships docking at the official harbor on the North Pier and Cruise Harbour, the rest of the boulevard is lined with smaller private and commercial boats. Along this stretch are two main docking piers: the Fishermen Pier and the Nautico Marina.

Fishermen Pier

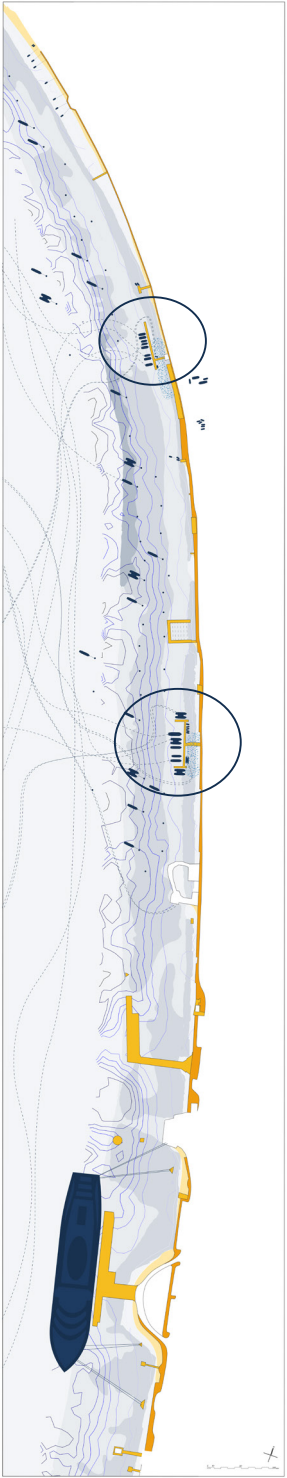
The Fishermen Pier is used almost exclusively by local fishermen. Every morning in the early hours, they depart to fish around the island. On Bonaire, fishing is only permitted using traditional methods such as rod-and-line fishing or small nets. Around 10:00 or 11:00 in the morning, the first boats return with the catch of the day. Fish can be purchased directly on the pier, where it is weighed and cleaned on the spot. The leftover parts (heads, guts, etc) are thrown straight back into the ocean.

This place is more than a place of work, the fishermen hang around here all day to chat and relax.

Nautico Marina

The Nautico Marina accommodates larger private vessels, fishing charter boats, and snorkel tour boats. This pier has a more commercial character and remains active throughout the day, with tours frequently departing to take visitors around the island. Fish are also caught here and cleaned immediately, with the remains similarly discarded into the sea.

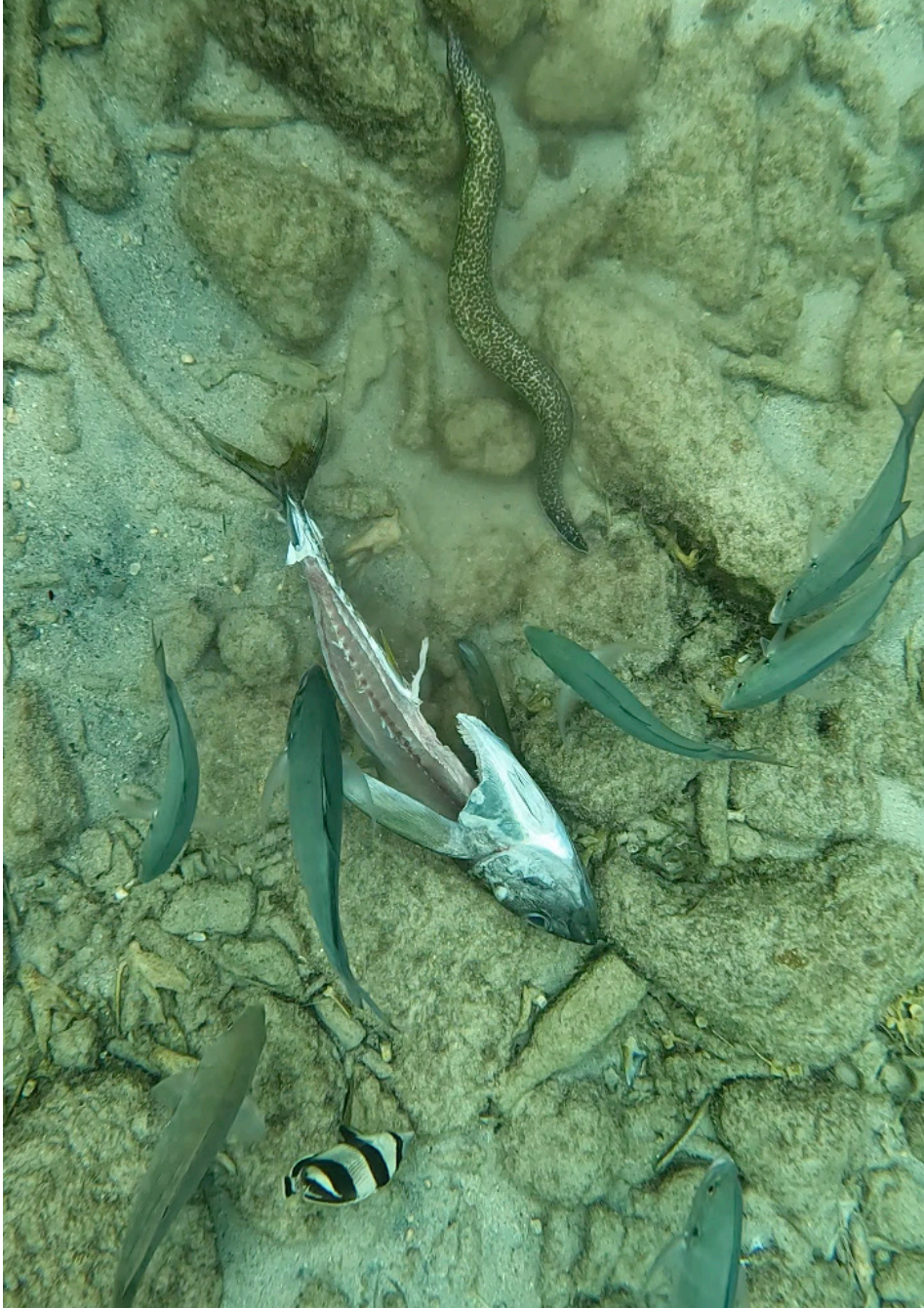
At both piers daily catch is sold to local residents and restaurants. Beneath them, the ocean floor is scattered with fish carcasses, which are quickly consumed by other fish and eels.



local fishermen pier | by author (2025)



Nautico Marina | by author (2025)



remains being eaten by fish and eels | by author (2025)



fish being cleaned at the fishermen pier | by author (2025)

Swimming hot spots

Access to the water along the boulevard is not evenly distributed. Only a few locations are commonly used for swimming. Playa Lechi and Cha Cha Cha Beach are the most popular spots, serving both recreational swimmers and shore divers. As the only left over true beaches, they offer shade, making them comfortable places to spend time by the water.

Yellow submarine, a Dive Friends dive shop marks another frequently used entry point. Many divers enter the water here, either for leisure dives or as part of their dive training courses.

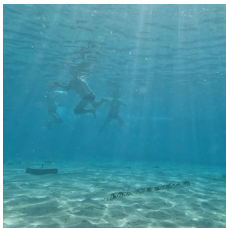
The Sea Pool is another major swimming hotspot. This floating 25-meter pool is used not only by swim teams for training, but also by the public throughout the day. People gather to dive into the water, relax on the floating structure, and take part in a wide range of other sport activities. The pool is connected to Parke Tului, a well used leisure ground, where a shower allows swimmers to rinse off after their time in the sea.



diving at yellow submarine



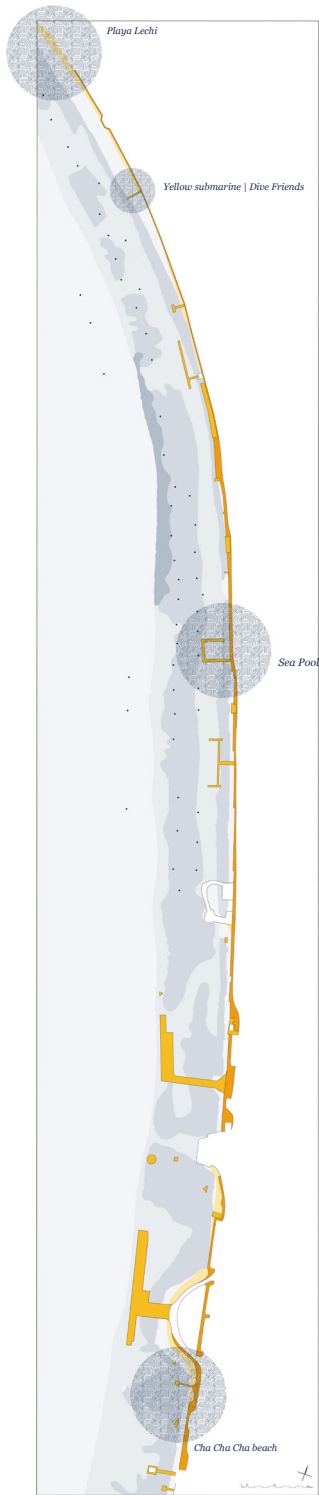
swimming at playa lechi



water polo at the sea pool



swimming at the sea pool



Plateaus & rubble

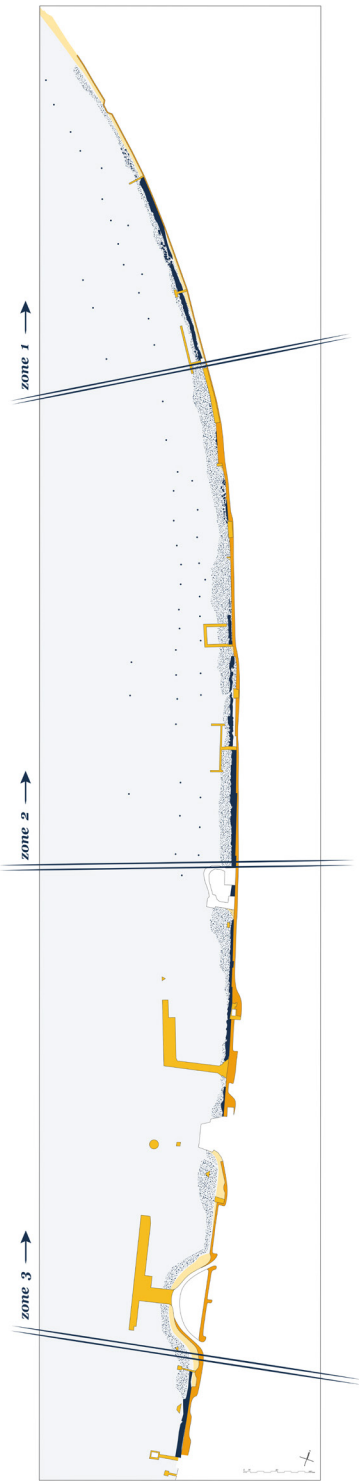
Most of the ocean floor close to the boulevard consists of flat plateaus followed by fields of rubble. These plateaus once served as stable foundations for corals such as staghorn and elkhorn to grow.

Today, the plateaus are no longer continuous and are broken in several places. The same is true for the rubble zones: in Zone 1, the rubble layer is relatively narrow, while in Zone 2 it can extend up to ten meters. The primary factor for the broken plateaus and rubble is hurricane and wind reversal activity. When hurricanes such as Lenny and Omar strike the island, the normally calm wave conditions become extremely rough. Powerful waves lift material from the ocean floor and drive it towards the boulevard, breaking apart whatever they carry.

The rubble found both underwater and along the beaches consists largely of broken coral. While hurricanes and wind reversals play a major role, coral that has been weakened by disease, pollution, or bleaching breaks more easily and contributes further to the rubble. Because the ocean impacts the boulevard structure directly in Zone 2, while wave energy is buffered by pebble beaches in Zone 1, a greater accumulation of rubble is found in Zone 2.



broken plateau and rubble | by author (2025)



Qualities & opportunities

There are six key qualities that offer opportunities: the topographic height and its influence on urban runoff, the presence of sun and shade both on land and in the water, the quality of views towards the sea, opportunities for swimming and coral outplanting, the distribution of paved and unpaved areas, and the balance between residential and commercial functions.

The topographic analysis shows that there are four locations along the boulevard where the terrain becomes lower, suggesting that urban runoff is likely to flow into the ocean at these points. Among these locations, the outlet next to Kas di Arte is clearly the largest and most significant.

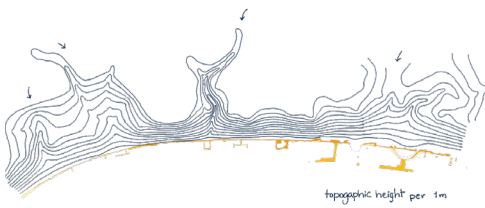
The boulevard is almost always in full sunlight. Shaded areas strongly influence how the boulevard is used. Locals tend to avoid the heat of the day and are drawn to these cooler, protected spaces, while tourists are generally more tolerant of the sun, often walking, swimming, or spending time outdoors even at midday. As a result, the rhythm of activity along the boulevard is shaped by the movement of the sun: locals are most active in the early morning and late afternoon, while tourists are more present during the hottest hours of the day.

Sun and shade also play a crucial role beneath the water's surface. Structures such as piers create shaded conditions that attract fish, offering both shelter and comfort. During the hottest parts of the day, many fish retreat to shaded environments, under the plateau, beneath piers, or within small crevices and protected spaces.

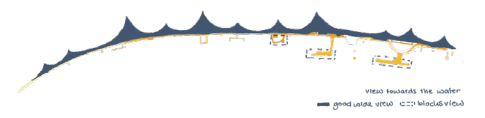
The view on the boulevard is almost always oriented towards the sea. This view only gets blocked in certain areas: in the harbor where the cruise ships dock and at Karel's Beach bar.

The boulevard establishes a strong linear movement, one that is only interrupted at specific points such as swimming spots, piers, and slipways. Maintaining access to the water at these locations is essential; however, where human activity directly enters the sea, coral growth becomes increasingly difficult. This creates a clear spatial distinction: in the stretches between these access points, where the shoreline remains undisturbed, there is a valuable opportunity for coral outplanting and ecological restoration.

Another interesting observation is the clear division that exists along the boulevard. Roughly in the middle, the area shifts from predominantly paved to predominantly unpaved surfaces, which also corresponds with a transition from mainly commercial uses to more residential areas.



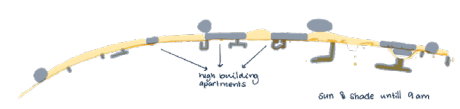
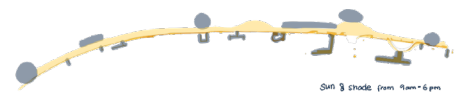
topographic height | oddly low areas



view points | hiding spots for fish



paved and unpaved



sun and shade | influence social and fish activity



swimming points | coral outplanting opportunity



residential and commercial

Rhythms through time

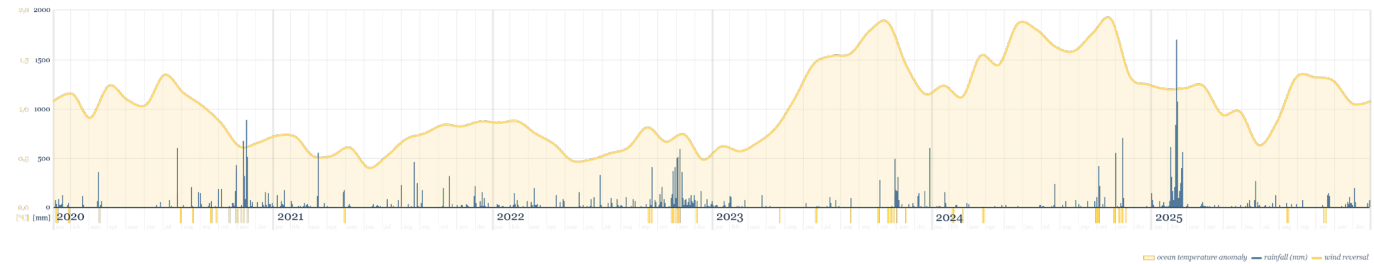
Different rhythms shape this location over time. These rhythms operate at multiple temporal scales. On the right, four different time frames are illustrated: six years, two years, one month, and one week. Within each of these periods, different environmental elements influence how the site functions.

In the longer time frames (six years and two years), rainfall patterns become visible. Rainfall on Bonaire is not consistent but occurs in short, intense bursts. When it rains, it is often during brief but heavy showers, frequently coinciding with wind reversals. The six-year diagram also highlights the severe coral bleaching seasons of 2023 and 2024, during which ocean temperatures remained almost 2.0 °C higher than usual for an extended period.

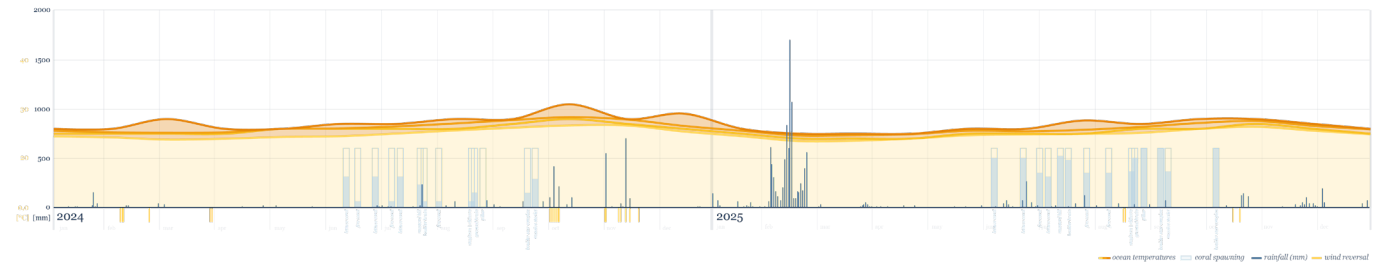
Coral spawning forms another important rhythm. During this event, corals release their eggs and sperm into the water. Spawning is seasonal and typically occurs between June and September. However, it is not only tied to the season: it is also closely connected to lunar cycles and sunset times. Corals generally spawn around five days after the full moon and approximately thirty minutes after sunset.

The moon also influences tidal movements. Although the tidal range on Bonaire is relatively small, around 30 cm, it is still noticeable at the outlet next to Kas di Arte, where the tide enters the outlet on certain days of the month.

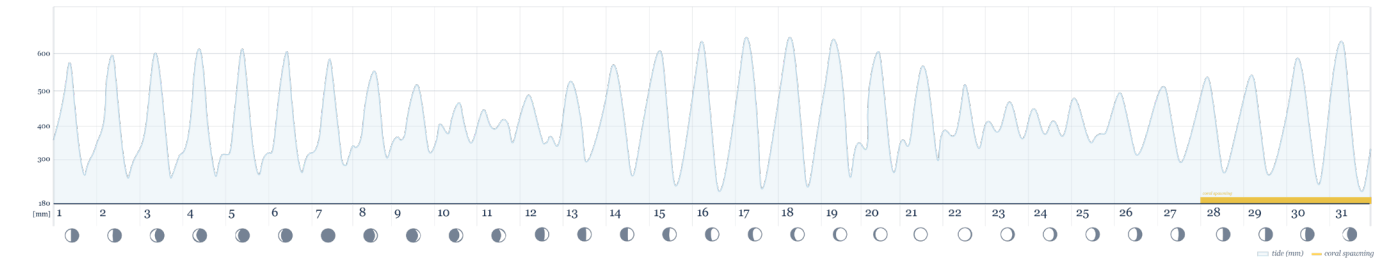
Finally, sunlight and UV intensity strongly affect how people use the space. In the early morning and late evening, when temperatures are lower, locals are most active outdoors. Tourists, however, are often present even during the hottest hours of the day.



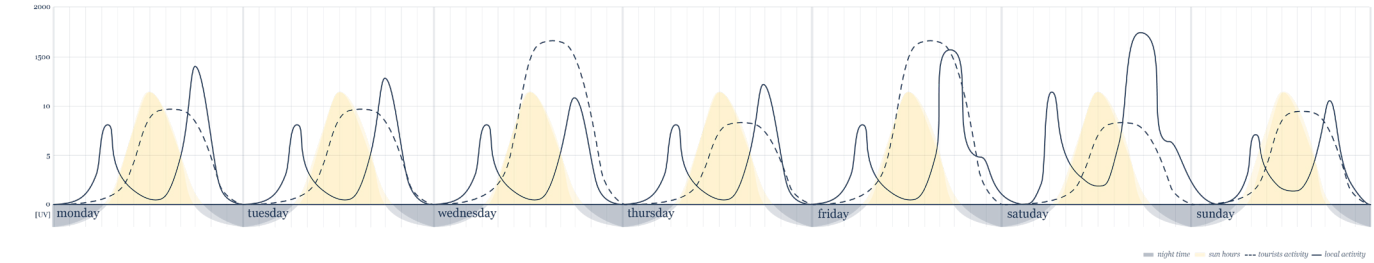
6 YEARS | rainfall, ocean temperatures and wind reversals



2 YEARS | rainfall, ocean temperatures, wind reversals and coral spawning



ONE MONTH | tide, coral spawning and moon cycles



ONE WEEK | sun intensity, local and tourist activity

Urban runoff

Historically all houses on Bonaire had their own cesspool. Since the 1990's new buildings were designed with their own septic system. Now, the first kilometer land inward from the waterfront is equipped with a sewage system. Still, all surface runoff flows directly into our ocean, especially in town (along the boulevard) as a lot of this area is paved. Urban runoff brings a lot of nutrients in our ocean, which corals do not like and algae love.

Zone 1

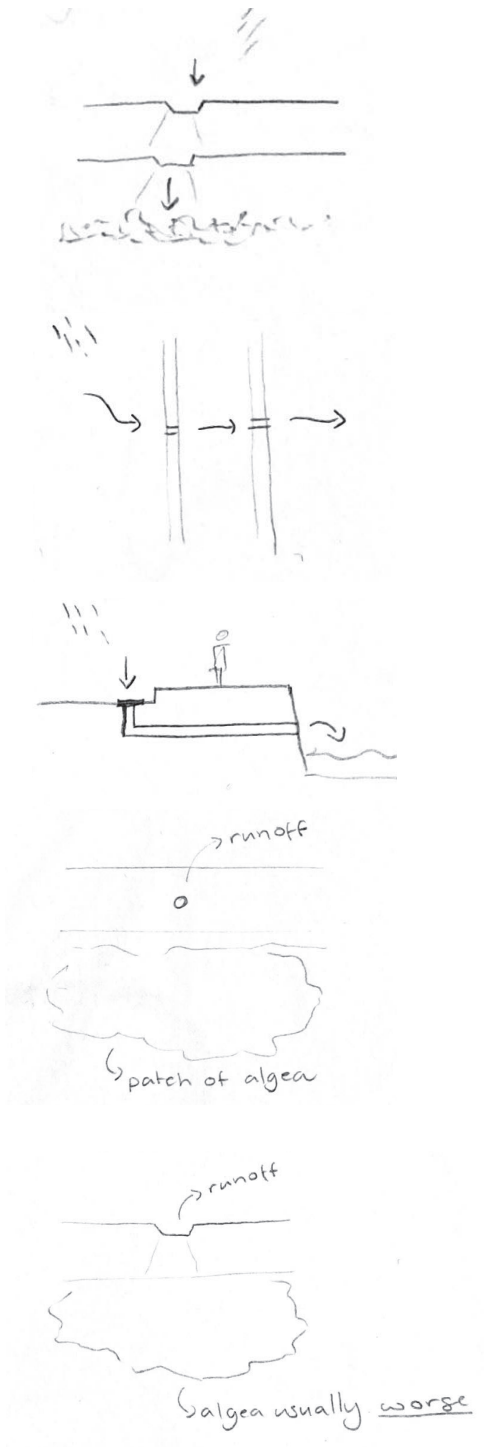
As the walkway is already lower than the road, the runoff is guided simply through cutouts in the curb. A remarkable finding, after my numerous snorkel trips along the boulevard, is that the bigger the pebble beach along the boulevard, the less algae under water. At Playa Lechi (a pebble beach with trees) the algae is almost neglectable.

Zone 2 & 3

Here there are two outlet systems, the simple cutouts still exist, but because the walkway lies higher than the road, a drainage system was made. Both still end up directly in the ocean. Along the whole boulevard in zone 2, the points where the urban runoff hits the ocean are detectable underwater. Under each outlet there is a clear algae patch. The algae in these patches is usually worse or more when its underneath a cutout in the curb.

Zone 3

In zone 3 there are two areas with breakwaters, here there seems to be barely any algae. As if the breakwaters slightly filter the urban runoff before it hits the water.



zone 1 | cutouts



zone 1 | algae growth underneath cutout



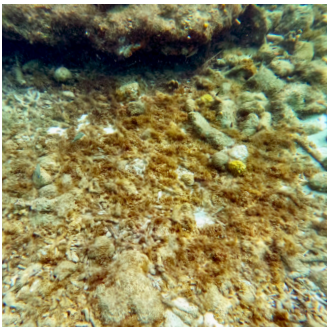
zone 1 | runoff stains on the boulevard



zone 2 | drainage system



zone 2 | drainage system outlet



zone 2 | algae patch under outlet

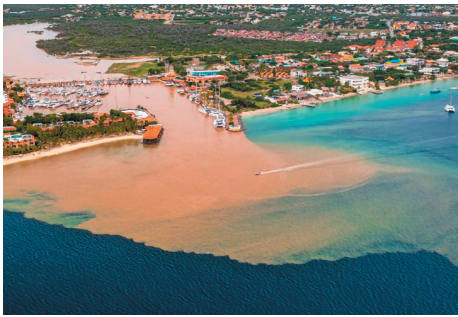


Rain water is also not collected. Nowhere on Bonaire. Rain water from all over the island flows down into different directions, being collected in lower laying areas, salinas and lagoons. From there it eventually flows out into the ocean. Within Kralendijk there are three such outlets: Saliña di Vleit, the outlet next to Kas di Arte and one next to the Harbor Office. Together they collect almost all the water from the built environment.

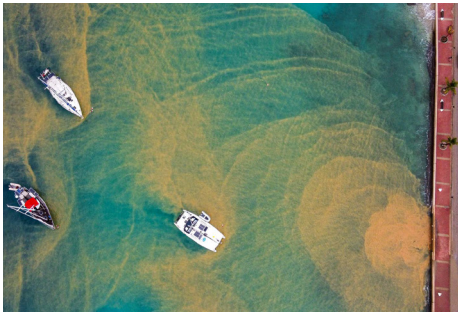
The water that enters the ocean at these outlets is filled with sediment, sand and other pollutions it has collected along the way.

The one next to Kas di Arte is an important outlet, one of the main sources transporting all the runoff from at least three bigger neighborhoods (Playa Pabou, Nikiboko and Sabana) off into the sea.

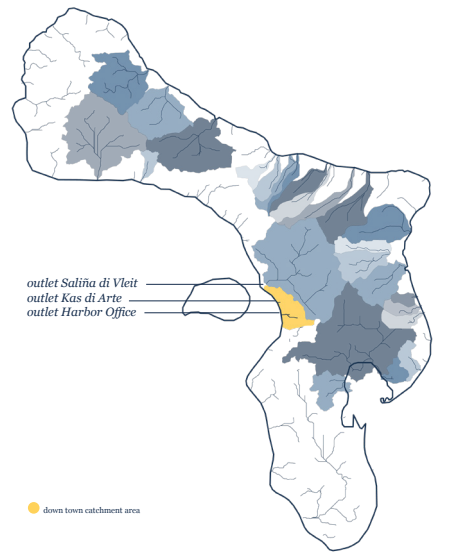
Underwater right in front this outlet it is horribly turbid. And there is lots of algae growing on the rubble.



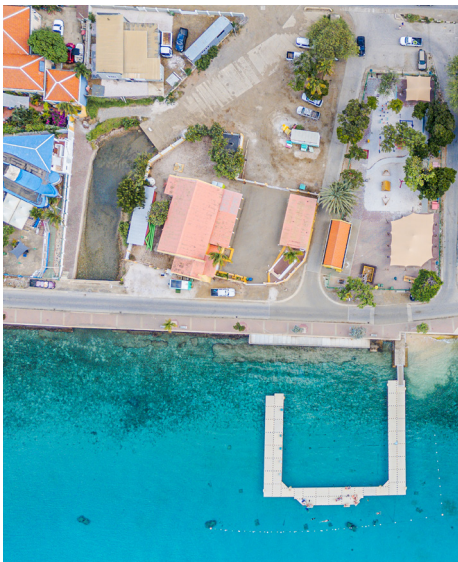
Outlet Saliña di Vleit (Waterschap Rijn en IJssel, 2023)



Outlet next to Kas di Arte during rainy season (De Meyer et al., 2022)



catchment and water flows



Outlet Kas di Arte | by author (2025)

Five greatest risks to the islands coral reefs

Despite the ocean's remarkable capacity for recovery, the pressures facing coral reefs cannot be ignored. On Bonaire, the decline of reef health can be traced to specific stressors that act both independently and in combination. Understanding these threats is essential for recognizing why intervention is urgent and where conservation efforts must be focused.

According to Reef Renewal Bonaire (n.d.), five major factors currently pose the greatest risk to the island's coral reefs.

1. Diseases

The frequency of coral diseases appearing has increased significantly over the last 10 years, causing widespread mortality amongst almost all reef-building coral species. Many scientists believe the increase is related to deteriorating water quality associated with anthropogenic pollutants (pollution caused by human activity) and increased sea surface temperatures.

The two most often occurring diseases on Bonaire now are: White Band Disease, mostly affecting Staghorn and Elkhorn coral, and SCTLD (Stony Coral Tissue Loss Disease), which had effected over 30 species of corals. Both diseases spread over the coral leaving behind bleached tissue.

2. Degraded water quality

Water quality near highly developed coastlines is constantly degrading. Excessive nutrient release by extensive agriculture, poor wastewater management and runoff have a direct effect on water quality and, consequently, all aquatic organisms living in the region.

3. Loss of long-spined sea urchins (*Diadema antillarum*)

Sea urchins are some of the most efficient grazers of the reef, making them a key stone herbivore. In the early 1980's, a virulent epidemic spread through the Panama Canal and was carried by currents into the Caribbean, killing 98% of all long-spined sea urchins in the region.

The urchin die-off resulted in the exponential growth of macro algae, boosted by nutrient-rich waters acting as fertilizer. Algae compete with corals for space and nutrients, stifling coral population growth by preventing coral larvae from settling on the reef.

In 2022 a new die-off started in the U.S. Virgin Islands, caused by a species of ciliate. As of today, the sea urchin population is still very low. However, a hopeful comeback appears in various locations.

4. Coral bleaching

Coral bleaching occurs when corals expel their zooxanthellae (symbiotic algae) when exposed to pollution or temperature stress. Zooxanthellae give corals their vibrant colors and help catching food in the water column, and when they leave the tissue of their host, the coral colony turns white, as if bleached.

This phenomenon can be triggered by a decline in zooplankton concentration, increased solar irradiance, changes in water chemistry, increased sedimentation, bacterial infection and more. But the most common cause are abrupt changes in water temperatures.

Most corals have the ability to recover (the return of zooxanthellae) if the temperature returns to seasonal averages within a couple of weeks.

5. Hurricanes

Hurricane season lasts from June to November, the period in which the surface sea temperature is the warmest. With climate change the sea levels rise, the intensity of tropical storms and hurricanes are increasing, causing the rainfall to produce great volume of runoff water.

The latest devastating storms to hit Bonaire were hurricane Lenny in 1999 and hurricane Omar in 2008. As the ABC islands (Aruba, Bonaire and Curaçao) are outside the hurricane belt, they are, for the most part spared from the worst impacts of hurricanes. However, hurricane season can still bring high wave energy, heavy rain and periods of wind reversal leading to very strong surge on the west coast, which also represent risks to coral reefs.

While it would be ideal to stop rising temperatures, natural disasters, and climate change altogether, these challenges require global action. What is striking, however, is that all five threats are closely linked to water quality and pollution. Increased amounts of polluted water entering the ocean introduce diseases, excess nutrients, and sediment, placing additional stress on coral reefs.

And this, this is a pressure we can prevent!



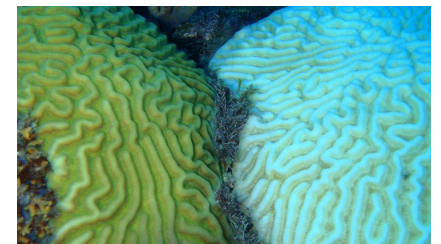
Heavy rainfall runoff | (Waterschap Rijn en IJssel, 2023)



Hurricane Omar | (Daisy, n.d.)



Long spined sea urchins | by author (2025)



Coral bleaching | (Johnson, 2021)

Coral restoration

On the island Reef Renewal Foundation Bonaire (RRFB), is focussed on outplanting and restoring the reef. I myself took the reef renewal specialty course to get a look into the process, and help plant out coral. RRFB works with two main ways to restore the coral reefs.

1. Fragmentation

Fragmentation is based on asexual reproduction, the ability of coral polyps to reproduce themselves via budding. Coral restoration via fragmentation involved propagating coral fragments in underwater ‘in situ’ nurseries, and then outplanting them back on the reef.

The nurseries on Bonaire adapt in different forms depending on the coral species. Corals hang from branches, are attached to ropes, or grow on cards, plugs and trays. Once the corals are big enough they are outplanted on the reef. Coral fragmentation is a well-established method with quick results.

2. Larval propagation

Contrastingly, larval propagation is based of sexual reproduction. As they are animals, the majority of coral reproduce by releasing gametes (bundles of sperm and egg cells) into the water column during seasonal events, called spawning.

RRFB collects gametes from a variety of coral species, which are brought on land where they are mixed to start the fertilization process. Newly fertilized embryos are reared in aquaria or in-situ pools to grow into larvae. These larvae settle on provided substrates, which are wedged in the reef a few weeks after their settlement.

Larval propagation is still in full development, but is really important for biodiversity. In fragmentation the same genotype gets multiplied, while in larval propagation new genotypes are created.

For larval propagation to improve RRFB is busy setting up their first wet lab. Wet labs for reef restoration tend to prioritize proximity to the water, reliable access to seawater and utilities, and logistical efficiency between field operations, holding systems, and staff workspaces. To find such a location is not that easy yet.

Coral reproduction in labs is not a completely new idea. In Breda a duo started a pilot factory called Branch Foundation. In cooperation with Wageningen University they are growing coral that is resistant to higher temperatures. The pair got inspired after helping the reef restoration organization on Curaçao. Their dream is to establish coral farming factories in places like Curaçao, Kenya, or the Maldives. These factories could be maintained by local staff and produce a continuous flow of corals that would be planted on the reef. (Oerlemans, 2025)

Labs should not take over, but they are a great tool to bring coral restoration to a higher level and make a greater impact.



coral fragments in on-site nursery | by author (2025)



gametes collection of spawning coral | (Reef Renewal Foundation Bonaire, 2025)



Boulevard's design affects corals

The design of the boulevard influences the underwater environment of Playa Bay in two significant ways, both contributing to the absence of coral in this area. First, in locations where waves strike the flat surface of the boulevard directly, rubble increases noticeably, indicating that wave action contributes to coral breakage. In contrast, zones one and three are buffered by pebble beaches and breakwaters, which reduce this impact. Second, a similar relationship can be observed in the effect of urban runoff on algae growth. Where runoff enters the ocean directly, algae levels increase substantially, whereas runoff that filters through the pebble beach has a far milder impact. Together, these factors show that the boulevard's design directly affects both coral integrity and water quality in Playa Bay.

These underwater consequences are deceptive, as they remain invisible from shore. The water appears clear and inviting, perfect for swimming, yet it no longer provides conditions suitable for coral survival.

High communal value

Although the boulevard generally creates a hard edge between land and sea, this boundary becomes blurred in areas of intense human use and social interaction. *The boulevard plays a crucial role in local social cohesion*, hosting a wide range of activities such as sunset watching, barbecues, strolling, swimming, birthday celebrations, and community gatherings. It is also where fishermen land their catch and where sailing and swimming schools operate. In these areas, the dominant vertical separation between land and water is interrupted by horizontal movement and exchange. As the last public waterfront within the built environment, the boulevard is

heavily used and deeply valued by locals. Its accessibility and multifunctional role therefore deserve careful attention and preservation.

These blurred zones offer a unique opportunity to create visibility and stronger connections between land and ocean. Despite this potential, the impact of the runoff outlet often goes unnoticed, and the underwater world remains largely hidden from view. Given that the boulevard is such a visible and communal space, it is an ideal location to raise public awareness, integrate ecological solutions into everyday life, and place environmental restoration at the center of the community.

Reef Renewal Foundation Bonaire (RRFB) focuses on coral outplanting and reef restoration and is currently planning to establish its first wet lab. Such facilities require close proximity to the water, reliable access to seawater and utilities, and efficient logistics between field operations, holding systems, and workspaces. While RRFB has achieved significant success elsewhere on the island, early restoration efforts in the downtown bay failed entirely, underscoring the severity of the local environmental conditions.

Crossroads

At Kas di Arte, located at the heart of the boulevard, all these conditions converge. It is one of the most socially active and historically significant locations along the waterfront, situated within a zone two boulevard design and directly adjacent to the most polluted point: the outlet.

This is where the solution lies. **Yet one crucial group remains unaccounted for: the corals. The design must be for them.**

Design program

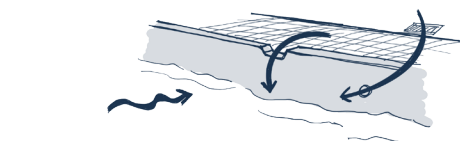
Enhance water quality

Through this design program, I aim to create an environment that enhances coral growth in general and specifically in the bay. For corals to return and thrive in Playa Bay, the water quality must first be improved. This requires addressing urban runoff and preventing pollutants from entering the bay. To achieve this, I propose filtering the large outlet next to Kas di Arte, filtering the numerous ‘street outlets’ and rethinking the existing hard shoreline edge. These interventions will help clean direct urban runoff while also reducing the impact of wave action. Possible strategies for the filter system and the redesigned shoreline are explored on the following page.

Reef renewal hub + educational center

However, improving water quality alone is not enough to restore coral ecosystems. Human activity has played a significant role in coral decline, and it is crucial that we become more aware of our impact and actively contribute to coral recovery. For this reason, I propose the creation of an integrated “Reef Renewal Hub.” This hub would include a wet lab, dry lab, research center, diving and docking facilities, and an educational center or museum. Together, these functions would support coral restoration and biodiversity research while also educating visitors and raising public awareness.

For the Reef Renewal Hub, a detailed spatial program has been developed to accommodate the different functions. Within the wet lab, not only the circulation of people and coral specimens is important, but also the way water flows through the building. Both the program and the relationships between these interconnected functions are illustrated on the right.



RETHINK HARD EDGE

clean direct urban runoff and reduce effect of wave action



improving and expanding coral restoration and biodiversity
educate and raise awareness

WET LAB

Main wet lab / bench area
Quarantine & holding tanks
Closed-system aquaria & nursery
Larval propagation/hatchery room
Cold storage walk-in
Autoclave/glassware prep.
Office for labstaff
Equipment storage
Seawater treatment & filtration house
Waste handling

DIVING & DOCKING

Dock piers & immediate platform
Gear rinse & don/doff
Compressor room & gas storage
Locker & changing room + showers
Laundry & dive gear drying
Diver briefing & training room

DRY LAB | DATA & RESEARCH OFFICES

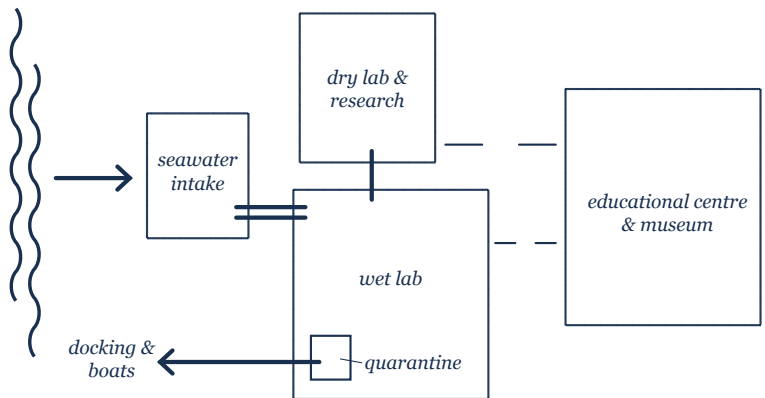
Dry lab & data-analysis
Private research offices (2x12)
Open plan offices & tech bench
Small seminar / group meeting room
Large lecture / multi purpose hall

EDUCATIONAL CENTRE | MUSEUM

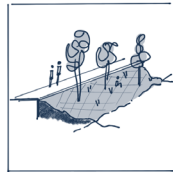
Exhibition galleries
Interactive classrooms (2x60)
Makersspace | student lab
Restrooms

UTILITIES

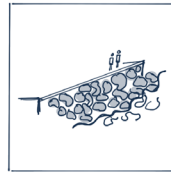
Restrooms
Parking facilities
Circulation



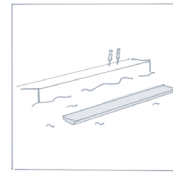
BREAKWATERS



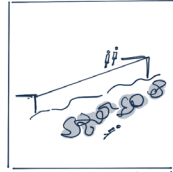
living shoreline / beach or park



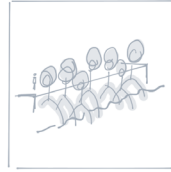
living/permeable breakwaters



floating breakwater



divergent reef with man-made modules

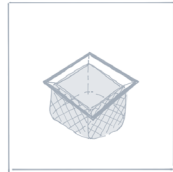


mangrove shore line



initiate natural beach edge

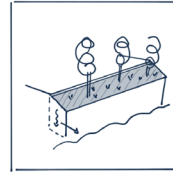
SMALL RUNOFF FILTERS



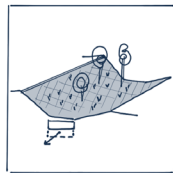
trash catching storm sack



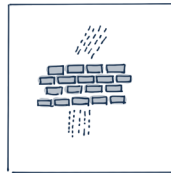
"Vortceptor": hydrodynamic separator
(captures pollutants, sediment, oil)



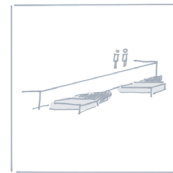
prefab waterfront bio retention system



bio retention swale / rain garden

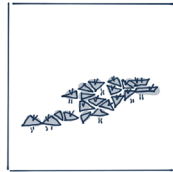


permeable pavements

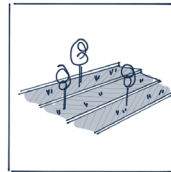


create beaches by building piers

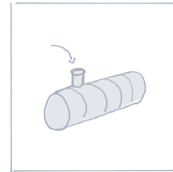
BIG OUTLET FILTERS



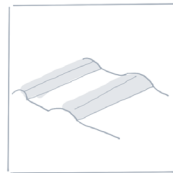
floating wetland



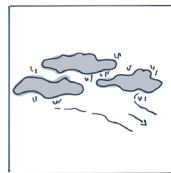
living terrace / shoreline
functioning as retention



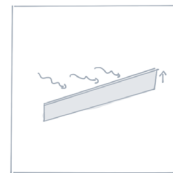
active storage



dike system / slowing the water



constructed wetlands



automated gates

There are many possible strategies for filtering urban runoff and creating breakwaters. To the left, I have compiled a catalogue presenting six potential solutions for breakwaters, small runoff filters, and filters for the large outlet.

Breakwaters:

To effectively reduce wave energy, the hard edge of the shoreline should be redesigned. Instead of maintaining a vertical 90-degree wall, the edge should be tilted and fragmented rather than consisting of one solid concrete block. Ideally, the interventions added to achieve this should be natural in character and contribute to increased biodiversity.

Three of the six options respond particularly well to these ambitions. Permeable breakwaters, such as the Living Seawalls by REEF DESIGN LAB, reinterpret traditional breakwater boulders by incorporating surface textures and cavities that provide habitat opportunities for intertidal species and coastal infrastructure environments (Living Seawalls | REEF DESIGN LAB, n.d.). Biodiversity can also be enhanced through the creation of a living shoreline, for example by introducing a beach or park landscape, or by adding man-made reef structures such as the Artificial Reef Units by REEF DESIGN LAB (n.d.).

Although a mangrove shoreline would also significantly improve biodiversity, it would completely block the view of the water. This would remove an important spatial and visual quality of the boulevard.

Small runoff filters:

There are many possible ways to collect and filter waste from urban runoff using technical systems such as the Stormsack or the "Vortceptor." However, when focusing on

more blue-green solutions, strategies such as bioswales, retention tanks, and permeable pavements provide more integrated and environmentally responsive alternatives.

Recent innovations further expand these possibilities. For example, Climate Innovation Window has developed a modular vertical waterfront bioretention system that retains and purifies rainwater while also protecting against flooding and erosion. In addition, it supports biodiversity, cools urban environments, and helps revitalize waterfront areas (Climate Innovation Window, 2025). Such systems are particularly interesting to consider for application along the boulevard in Bonaire.

Big outlet filters:

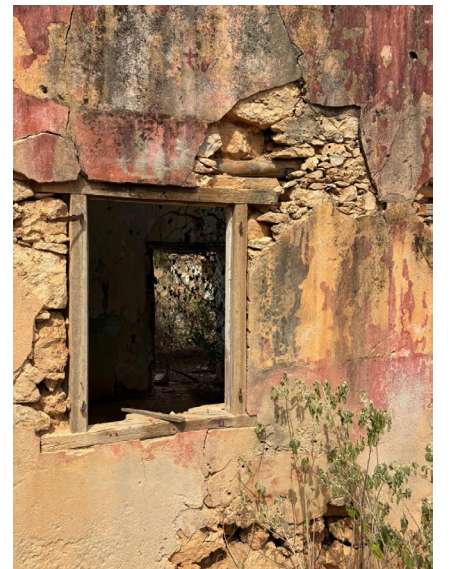
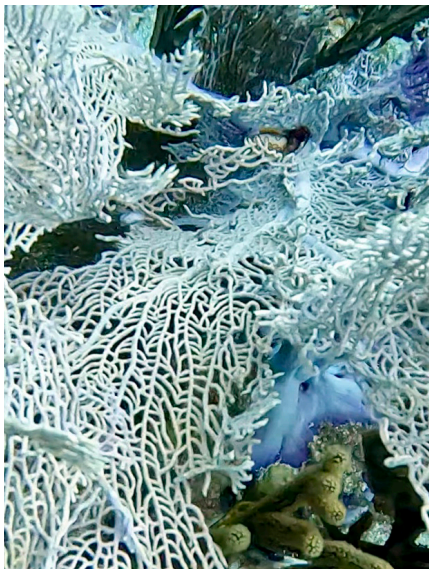
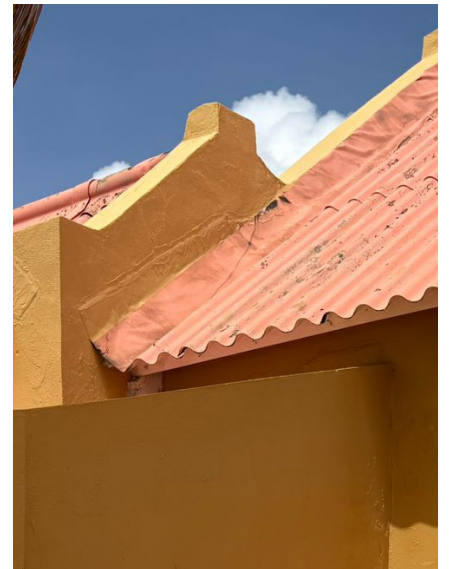
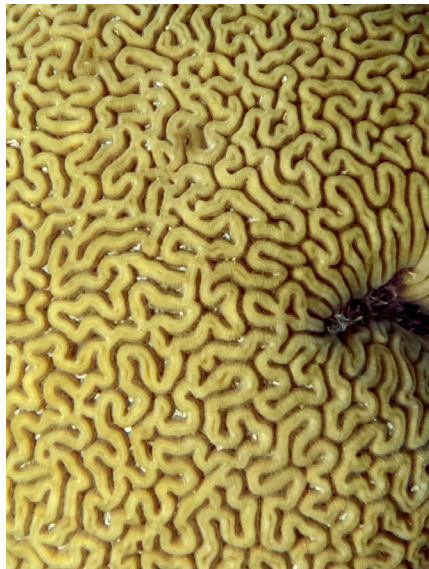
Blue-green solutions for the large outlet can take the form of retention landscapes such as wetlands and living shorelines. A key challenge in this context is the highly variable water flow: during peak rainfall events large volumes of water must be managed, while during the dry season there may be little to no flow at all. Because the water flow is not continuous, it is essential to slow the water down so that it has sufficient time to pass through the filtering system before entering the ocean.

For this project, it is important that the chosen strategy is natural, blue-green, and capable of increasing biodiversity. A purely technical, human-centered solution would not be sufficient; the intervention should function as part of a broader ecological system that supports both water purification and habitat creation.



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

The selected site currently consists of Kas di Arte and Parke Tului. A thorough site analysis was conducted to examine the existing structures, spatial relationships, tensions, and the social and historical significance of the area. Understanding these qualities is an essential first step in the design process, as it helps ensure that the proposal responds appropriately to the character, history, and needs of the place.



Kas di Arte

In the middle of the boulevard, alongside the large urban runoff outlet and Parke Tului, stands a traditional building known as *Kas di Arte*. Its name suggests that it once functioned as an art house (*kas* meaning house, *arte* meaning art). While it may indeed have served this purpose in the past, the building is now rarely used.

Kas di Arte and its annexes are enclosed by a fence, with a plaza situated between the buildings. This outdoor space is occasionally activated for community events, though during these moments there is usually little to no activity inside the buildings themselves.

The property is owned by the island of Bonaire, it currently houses a simple museum and appears to be designated as a monument. This status is fitting, as the building is constructed in one of Bonaire's well-known vernacular architectural styles: the *Kas di Hala*, or "wing house."

I selected this location because of its unique position between two contrasting yet interconnected environments. On one side lies a social hotspot (Parke Tului and the sea pool) while on the other side sits a large urban runoff outlet. Together, these elements form both a social and infrastructural connection between land and water.

Kas di Arte occupies the space between these two conditions. It acts simultaneously as a connector and a divider. The social hotspot is highly visible and actively used, whereas the urban runoff outlet remains largely overlooked, despite its significant impact on the underwater life.



Vernacular building

Kas di Arte is a so called Kas di Hala (wing house), this vernacular building type first appeared just before the middle of the nineteenth century. First as coverment buildings, and later as a residential house with a shop or storage.

You can recognize a Kas di Hala because it has spout gables ('tuitgevels') and one or two 'wings'. Although it is in the name, earlier versions of Kas di Hala can have no 'wings' at all, Kas di Arte does not. It has many windows, to let a lot of air through. In a Kas di Hala doors and windows are usually placed symmetrically in the facade. The windows in the interior and exterior walls are always in line with each other, so that light and air are brought in the core of the house. (Groenenboom, 2021)

The house is built in a east-westerly direction, 'on the wind', with the kitchen on the west side. This gives the kitchen a natural extractor hood.

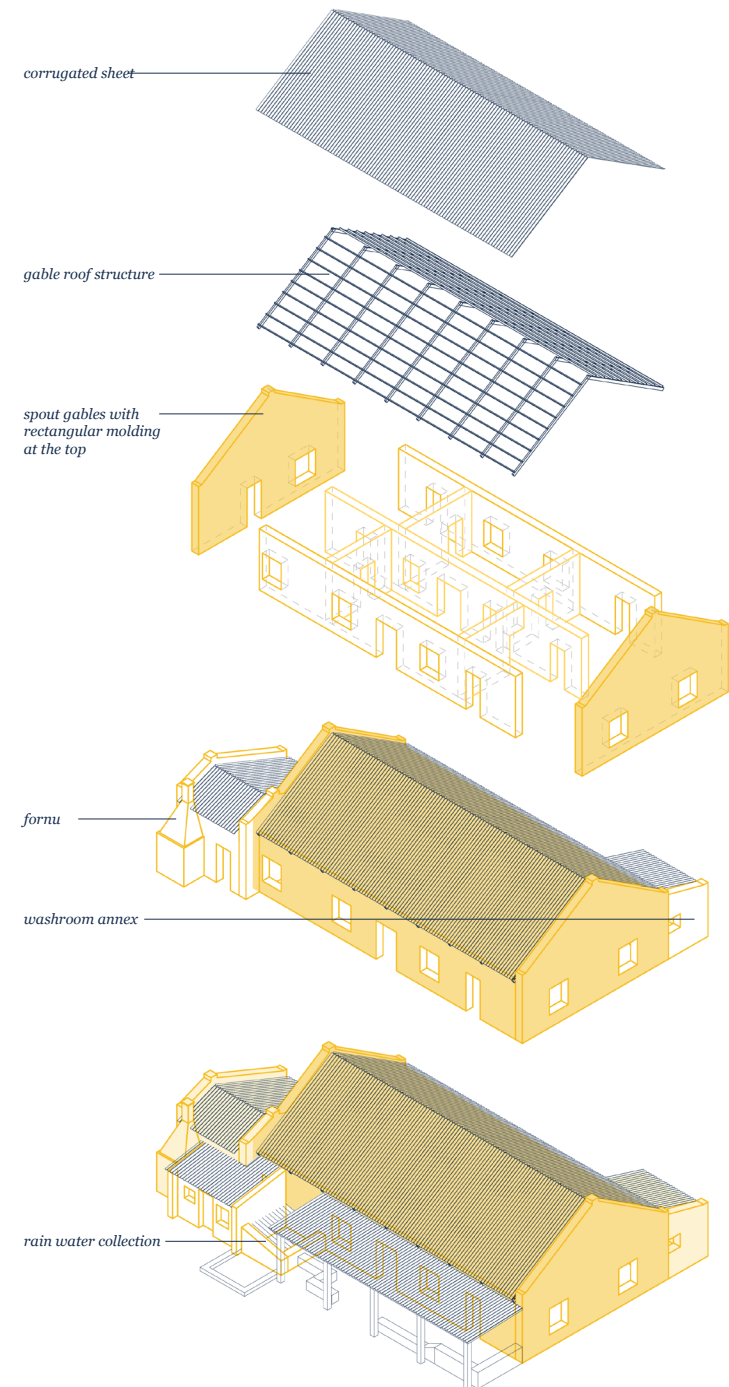
It has a gable roof structure, which runs from one facade to the other and is made out of wood and covered with roof tiles or corrugated sheets. The facade may have a roof moulding, which continues in one line into the gutter bearer. At the top of the spout sits a rectangular moulding, called pediment, which is sometimes crowned with a arch. (Groenenboom, 2021)

The thick walls are typically constructed from

coral stone, bricks, or, in later periods, blokkis or poured cement incorporating coral fingers within a formwork. These walls are finished with a painted plaster layer. This construction method reflects a vernacular building technology in which materials are locally sourced. In buildings of this type, lintels are often made from the core of a cactus, as shown in the images on the next page.

Floor finishes vary depending on the homeowner's budget and may consist of wooden planks, cement tiles, or polished cement. In some cases, colorants are added to the cement, giving the floors a distinct coloration.

In addition to symmetrically placed windows that promote cross-ventilation, the interior walls do not extend fully to the height of the roof. This design allows heat to rise and enables air to circulate freely between different interior spaces.





cactus lintel, stone wall and plaster finish | by author (2026)



wooden lintel, stone wall and plaster finish | by author (2026)



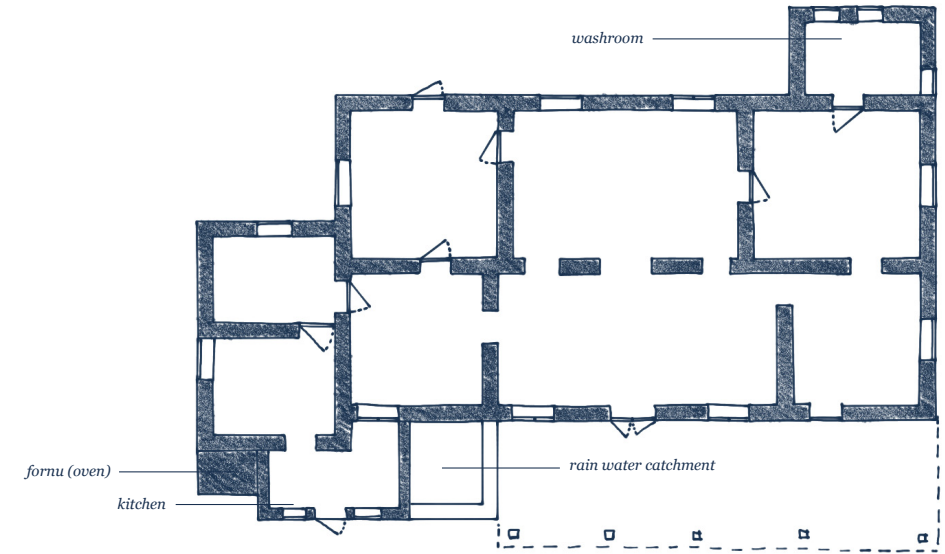
coral stone wall | by author (2026)



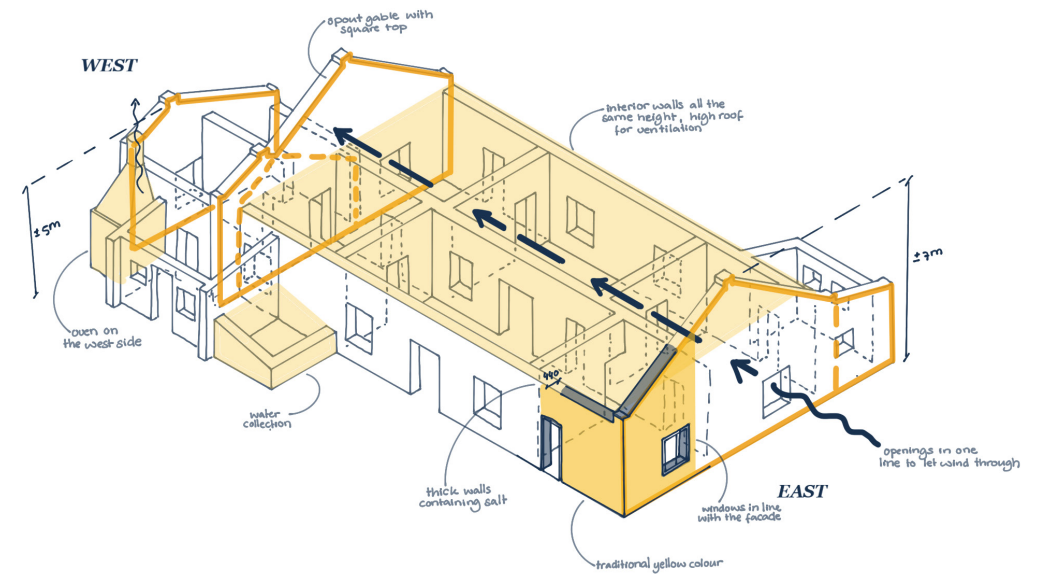
gable roof and wall hight | Groenenboom (2021)



Kas di Arte throughout the years | FuKuHiBo & Antion (n.d.) and by author (2025)



Floorplan | existing situation



Important qualities | existing situation



traditional oven | by author (2025)



traditional yellow colour and spout gables with square top | by author (2025)

Parke Tului & sea pool

Parke Tului is one of the main social hotspots along the boulevard, though this has not always been the case. The park was established in 2014 after strong community advocacy to ensure that the then-empty plot remained a public space rather than being sold to private developers.

Today, the park offers ample seating, generous shaded areas, and a playground for children. It functions as a meeting place for a wide range of activities, including sports classes, birthday parties, barbecues, casual gatherings, before and after swimming, and play. Parke Tului is active throughout the day, from early-morning swim groups to late-night celebrations.

Much of the park's success can be attributed to the abundance of shaded areas, which make it a comfortable place to spend time even during the hottest parts of the day. The park is enclosed by a low fence, allowing children to move freely while remaining safely separated from traffic. A small service building provides public toilets (unfortunately often locked), an outdoor shower, and indoor changing rooms (also frequently inaccessible). Despite these limitations, the facilities are widely used by visitors swimming in the adjacent sea pool.

The sea pool itself was added in 2024 and has since become a social hotspot. It provides easy and inviting access to the water and is therefore used frequently. In addition, the sediment of the original stone pier has created a small beach, allowing people to gradually walk into the sea.

Although the floating structure includes only a few benches, its primary social value lies in the diversity of swimming groups that gather there. People come to aquajog, float on

noodles, learn to swim, train for competitions, play water polo, and participate in many other water-based activities.

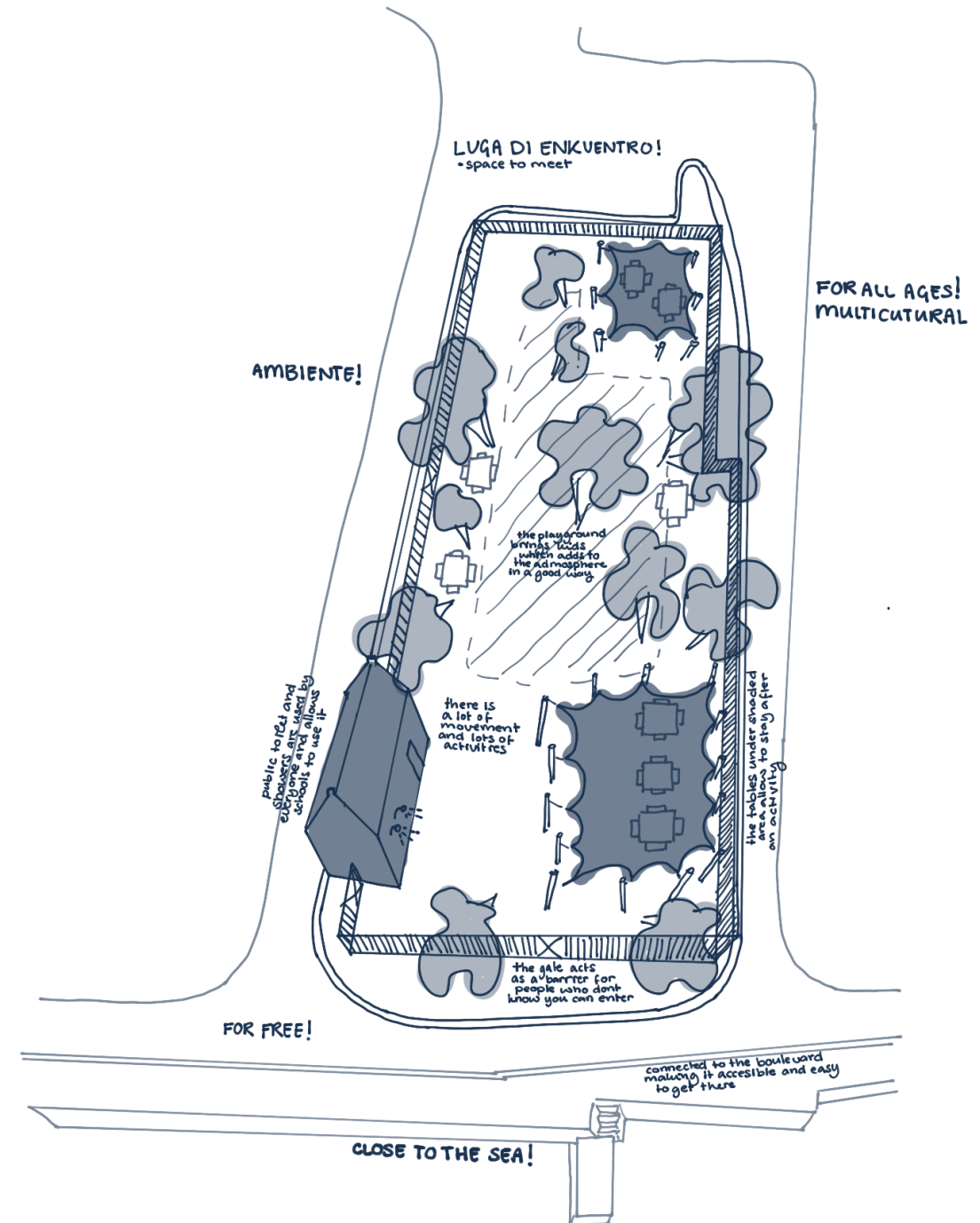
Following the installation of the sea pool, a ramp was added to improve accessibility for people with disabilities. However, the design is poorly executed, as the ramp ends abruptly on a block in the ocean, preventing smooth and safe access to the water.

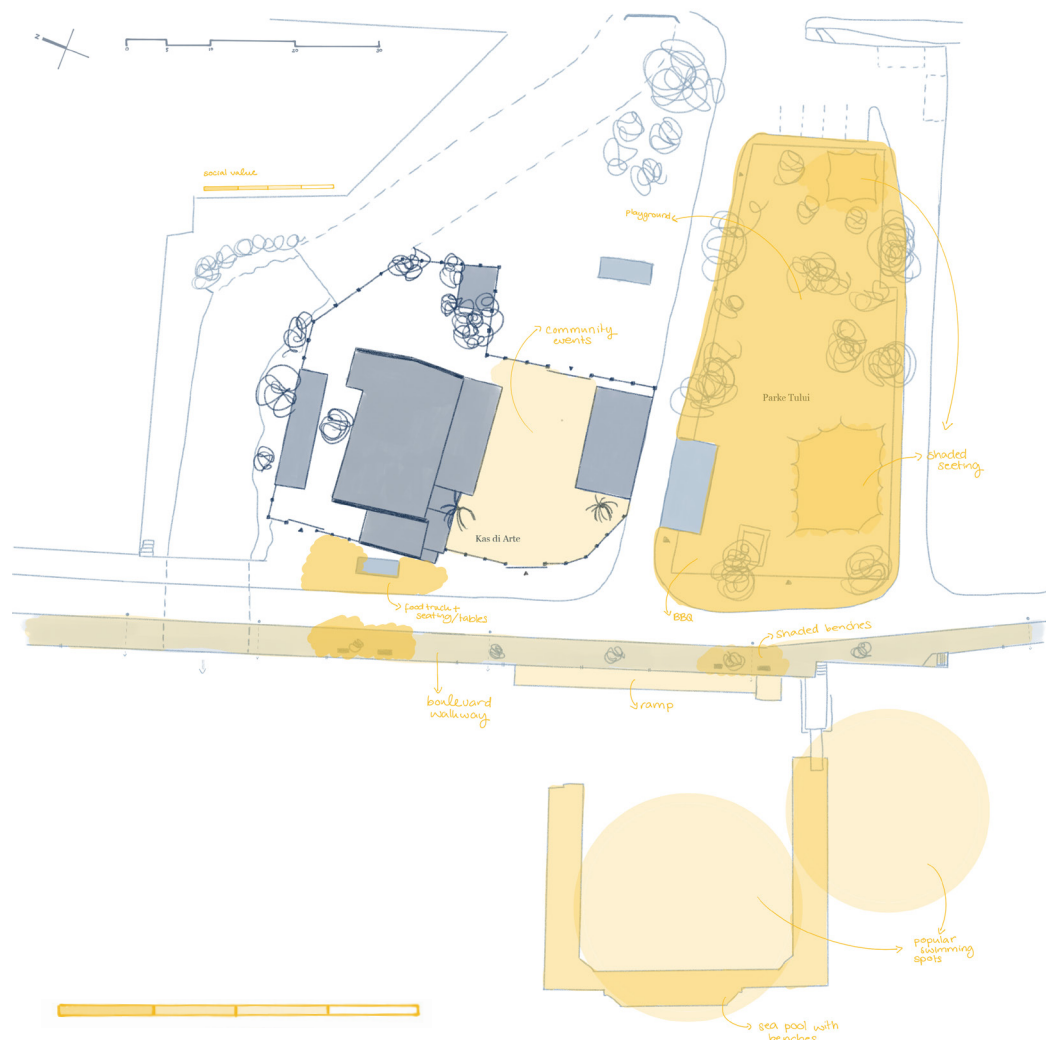
On weekends and on days when cruise ships are in port, a food truck located near Kas di Arte opens to sell simple drinks and snacks. They have created their own informal seating along the boulevard, encouraging people to linger, eat, and converse.

Finally, the boulevard itself runs directly through this area, bringing a constant flow of people who walk and *keiru* along its path. Here, movement along the boulevard slows down. People pause to watch swimmers, sit in the park, or grab a bite to eat. The movement of the boulevard pauses here.



Parke Tului





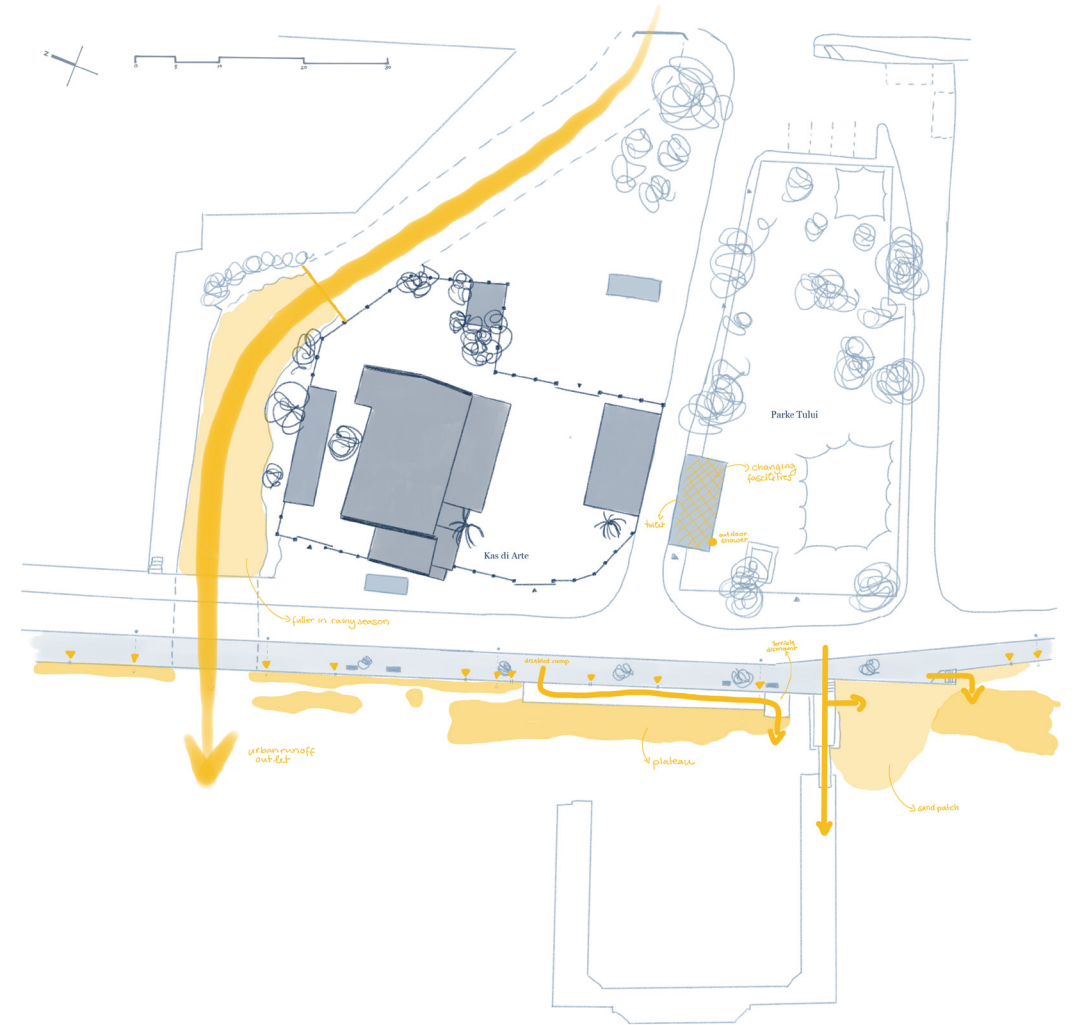
Social value (by author, 2026)



foodtruck in front of Kas di Arte | by author (2025)



sea pool | by author (2025)



Connection to the water (by author, 2026)

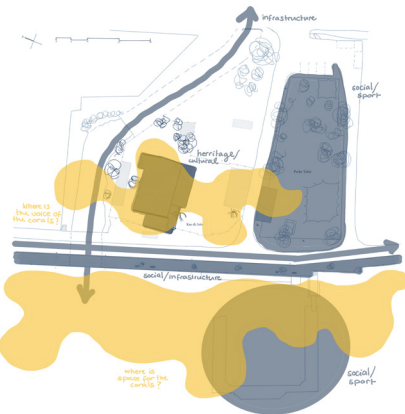


Tensions

One of the greatest strengths of the area around Kas di Arte and Parke Tului is the way many different elements come together in a single place: social activity, sport, locals, tourists, children, adults, sun and shade, as well as historical and infrastructural layers. This combination creates the atmosphere that makes the location special. At the same time, introducing new elements into such a complex setting inevitably creates tensions between these different themes. When considering the future program for Kas di Arte and Parke Tului, five key themes emerge from these tensions.

Space for coral

Within this predominantly social, historical, and infrastructural environment, coral currently has little presence or representation. The question becomes how space can be created for coral both on land and underwater.



SPACE FOR CORAL
Giving a voice to coral in a social, historical and infrastructural dominant world

Wet and dry | clean and dirty

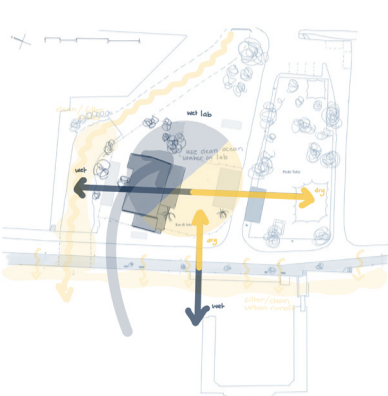
Situated at the boundary between land and sea, the transition between wet and dry is currently very abrupt. If the outlet also begins to function as an inlet, where do wet and dry meet in the new design? And how does the wet lab position itself within this gradient?

Old and new | architectural connection

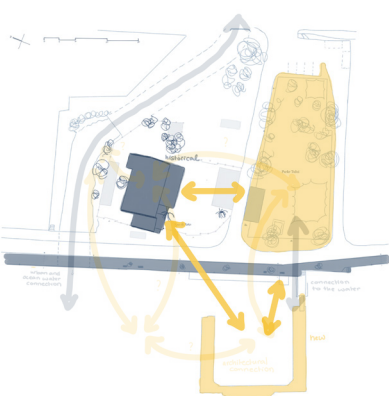
Accommodating the program requires the construction of new buildings. How can these relate to the existing structures? To what extent should vernacular architecture be present? And how can architecture strengthen the connection between Kas di Arte and Parke Tului?

Hidden and visible

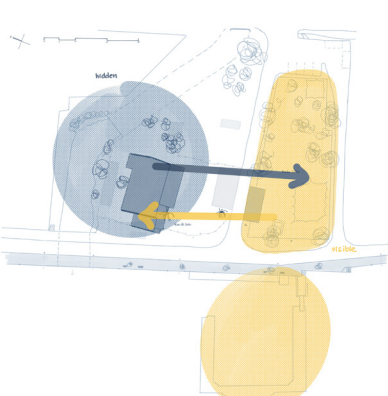
At the moment, both the outlet and Kas di Arte remain relatively unnoticed, while Parke Tului



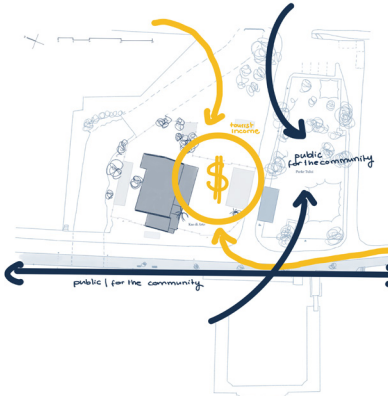
WET | DRY
Where does wet and dry come together? And how is the wetlab situated in this?
CLEAN | DIRTY
Where is the clean and dirty?



OLD | NEW
Is old and new connected? How present is the vernacular architecture?
ARCHITECTURAL CONNECTION
How can architecture strengthen the connection between Kas di Arte and Parke Tului?



HIDDEN | VISIBLE
What hidden aspects need to be highlighted? And what needs to be more private?



TOURIST | LOCAL
How can we maintain the public function, while integrating tourists and allowing tourist to become a source of income?

and the sea pool immediately attract attention. Which elements should be highlighted, and which should remain more private or concealed?

Locals and tourists

Parke Tului functions as an important gathering place for locals. How can this public and social character be maintained while also welcoming tourists and allowing tourism to become a source of income?

The questions raised by these tensions form the foundation of the design process. Through research by design, these themes repeatedly reappear, gradually guiding the search for a balance between them, or, in some cases, revealing how embracing a tension rather than resolving it can strengthen the project.



RESEARCH BY DESIGN

Every design decision is informed by a research-by-design approach. Throughout the process, different design options were tested, compared, and evaluated based on their impact and their contribution to the four main project objectives. The extensive design investigations and iterations that underpin the final proposal are documented in detail in this third appendix.

01 | program organisation

The different functions can be organised in relation to one another in various ways while integrating the full program. At this stage, the total required floor area is considered only roughly. In the diagrams, the blue functions represent wet programs, while the yellow shapes indicate primarily dry functions.

Four variants

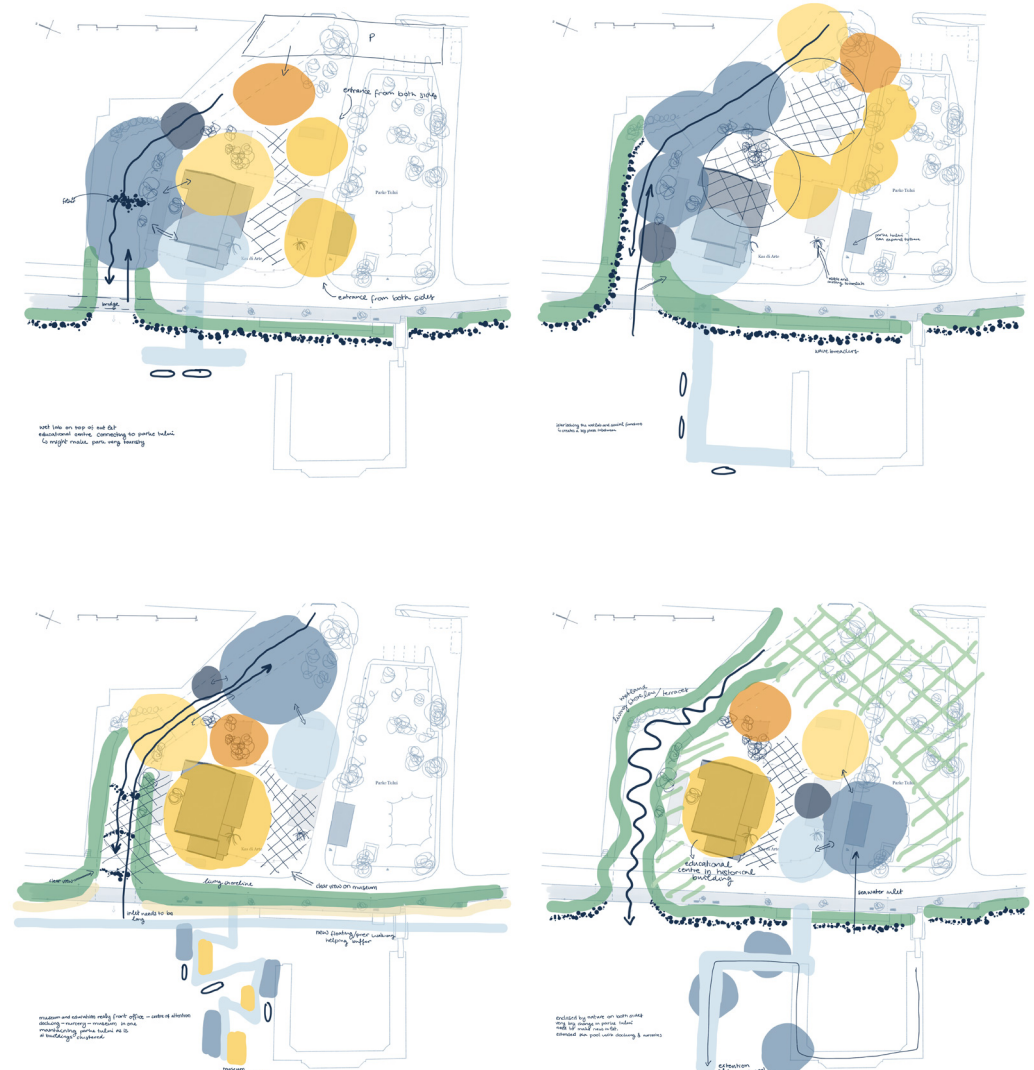
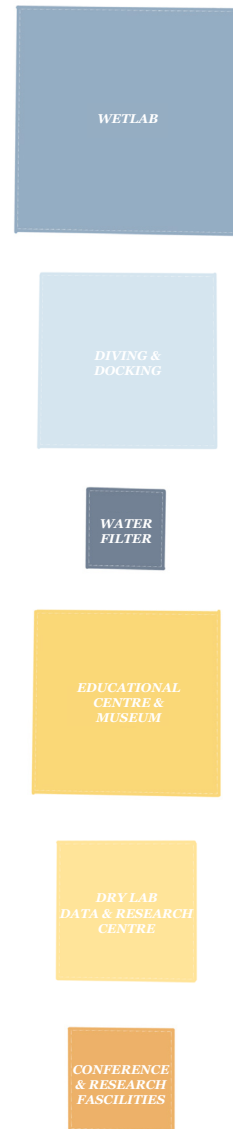
Using this approach, four variants were developed. Each organises the functions in a slightly different way while also exploring ideas.

Some variants explore the possibility of combining docking facilities, a coral nursery, and a museum into a single floating structure in the water, or extending the existing sea pool to incorporate docking areas and nurseries. Other proposals focus on strengthening the presence of Kas di Arte by turning it into the visual focal point along the boulevard, making it a landmark that attracts attention as people walk past.

Another idea shows how nature could enclose the site. In this scenario, a green filtration system is introduced at the outlet, while vegetation wraps around Parke Tului.

In other variations the wet lab is placed directly above the outlet, avoiding the need to construct a new inlet elsewhere, or creating a large public plaza between the wet and dry functions to strengthen the public character of the site.

To better understand the impact of these initial ideas, the next pages clusters them by theme, relating them to the larger scale of the boulevard and the environmental rhythms that shape the site.



Variations clustered by theme

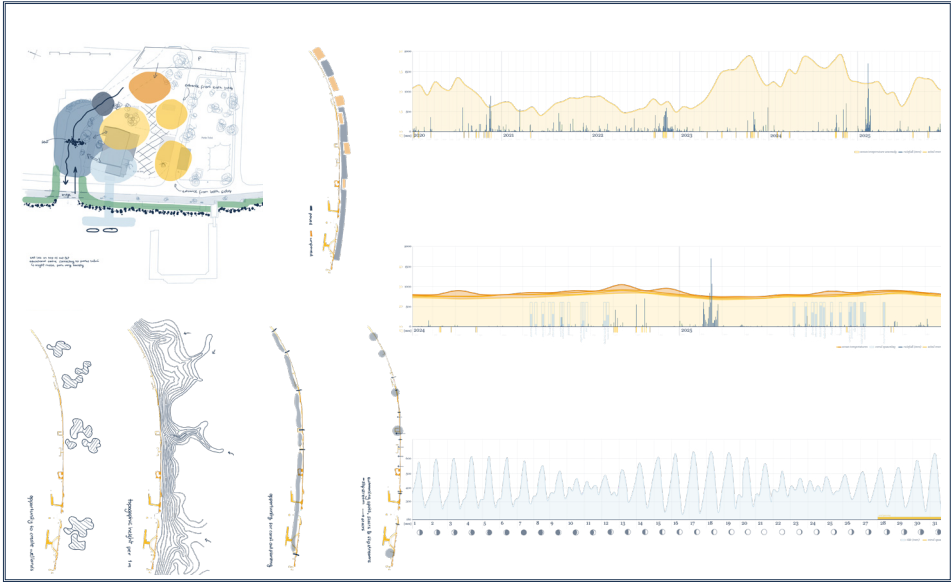
1. Wetlab on top of the outlet

First, placing the wet lab directly on top of the outlet is the most logical solution. This approach avoids the need to construct a new inlet elsewhere and allows the design to work with the natural rhythms of both rainfall and coral spawning. A consequence of this decision, however, is that the wet lab becomes less directly connected to Parke Tului, making it also more ‘private’, allowing employees of the wetlab to have their own place.

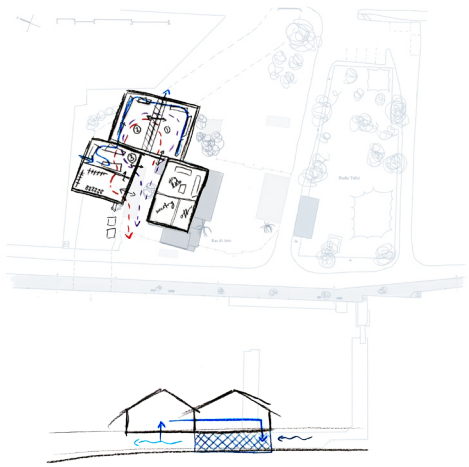
The studies on the next page explore how the wet lab could be positioned on top of the outlet. Internal routing of both people and coral within the wetlab becomes crucial, particularly

in relation to docking and diving activities. The dive gear room, for example, needs to be located both at the beginning and the end of the coral route to support the process of bringing in and outplanting coral.

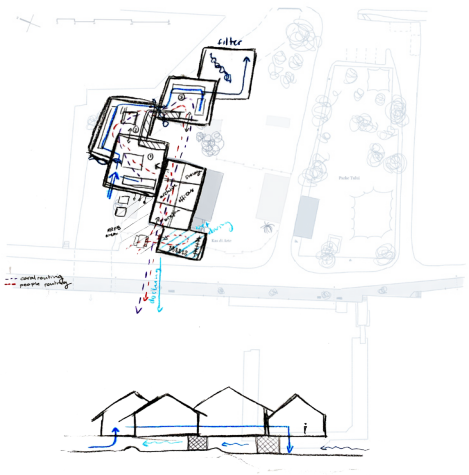
Placing the wet lab on the outlet also creates a small, more private plaza between Kas di Arte and the new building, providing a quieter space for staff separate from the larger public plaza. The filtration system beneath the outlet currently remains hidden and should become more visible for the public as part of the design. Through making it more visible it is easier to raise awareness among people.



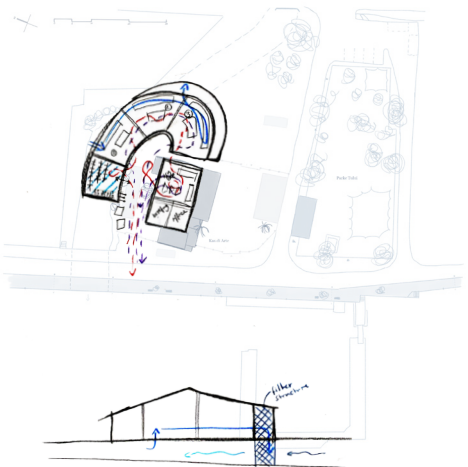
wetlab on outlet | connection to the boulevard and rhythms



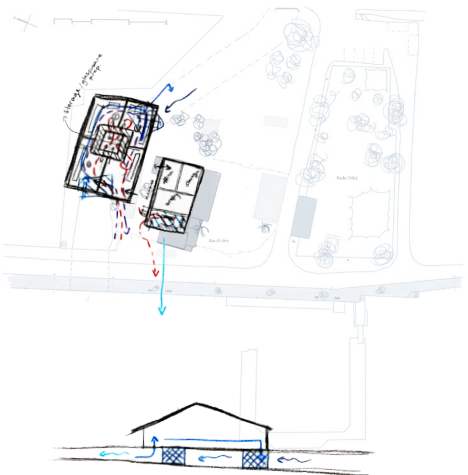
pro's: a clustered routing, wet diving room first
con's: one big filter



pro's: one room for every step of the process, a private plaza arises
con's: wet room in the existing building, smart?



pro's: one flow from one room to another, building follows the flow



pro's: one routing with a practical core, double filter system
con's: wet room in existing building

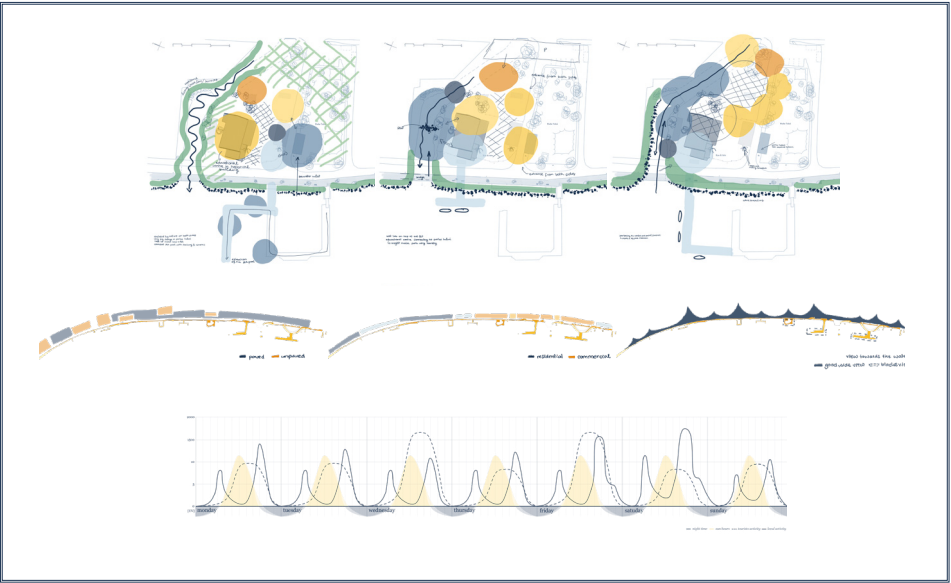
2. Synergy between Kas di Arte and Parke Tului

Second, the road between Kas di Arte and Parke Tului currently functions mainly as a divider. When this separation is removed, the two areas begin to operate as a single space. This not only creates more room to spread out the buildings, but also allows public activity to extend towards the new reef renewal hub.

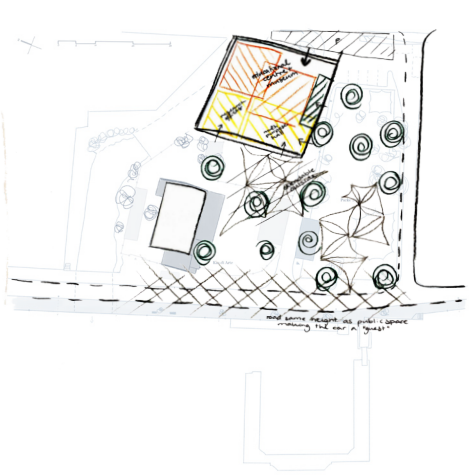
The size and placement of buildings strongly influence the amount and quality of public space. One of the strengths of Parke Tului is

the presence of several smaller areas that allow multiple groups to use the park at the same time. This quality risks being lost if the space becomes one large, undivided park.

With the wet lab positioned on the outlet, the educational facilities become more closely connected to Parke Tului. This creates opportunities for shared use, for example by allowing the multipurpose hall to function as a community space that can open up directly towards the park.



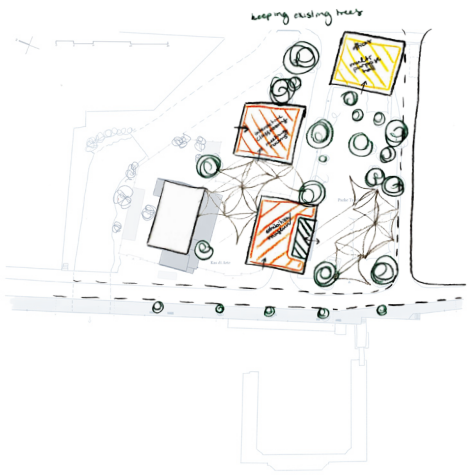
eliminating the road | connection to the boulevard and rhythms



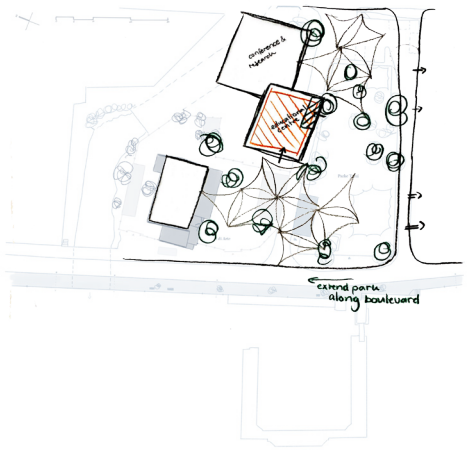
pro's: multi purpose hall towards the park, extensible outside
con's: one very big plaza



Every function in a separate building
con's: creates a harsh divide between park and Kas di Arte



pro's: maintaining the existing trees, multi purpose hall hidden
shattered building typology



pro's: park completely on the boulevard/ocean side
have to pass through park to get to museum/educational centre

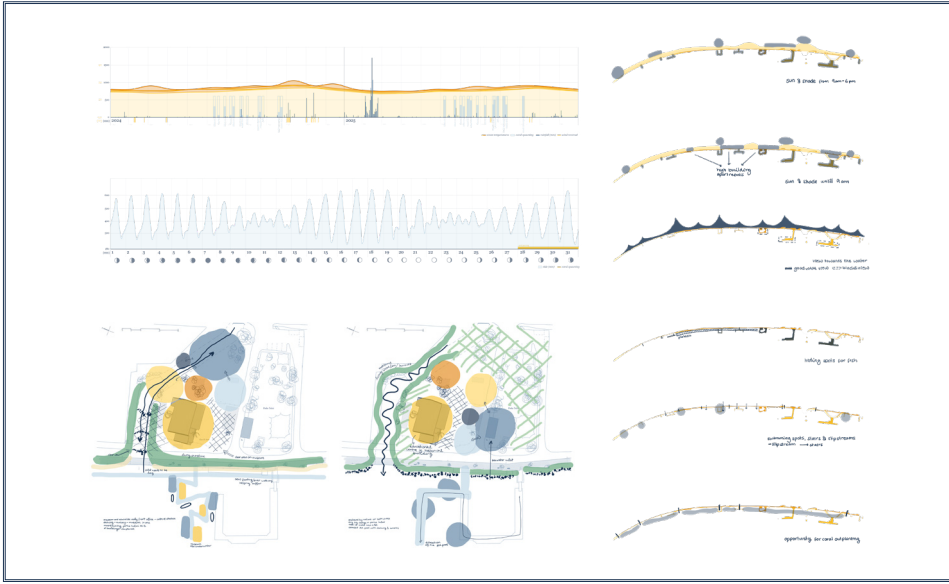
3. Floating nursery and sea pool

Third, creating opportunities for diving and docking requires a direct connection to the water. A floating structure could be an effective solution, as it can adapt to seasonal changes. At the same time, an important question remains: should this new structure connect to the existing sea pool, or would it be more effective for them to function as two separate piers?

When the floating nursery and sea pool are directly connected, there is a high chance that people will jump into the nursery area. A more

flexible system therefore seems preferable: a nursery composed of modular floating elements that can be attached, removed, or repositioned depending on seasonal conditions and demand.

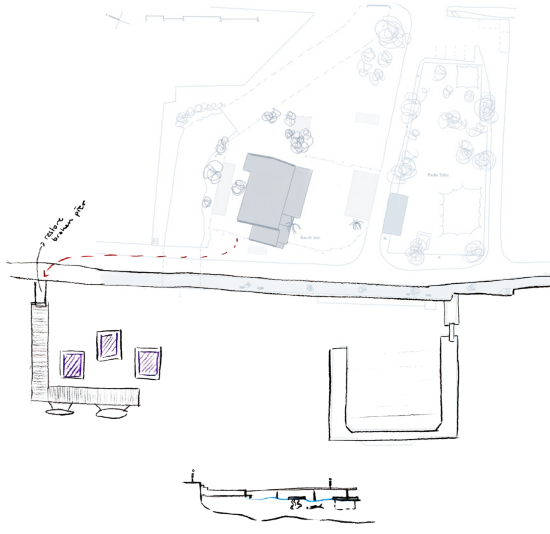
This way the area where the nurseries are can be fully coral focussed and the area where the sea pool would be can be wholly human focussed.



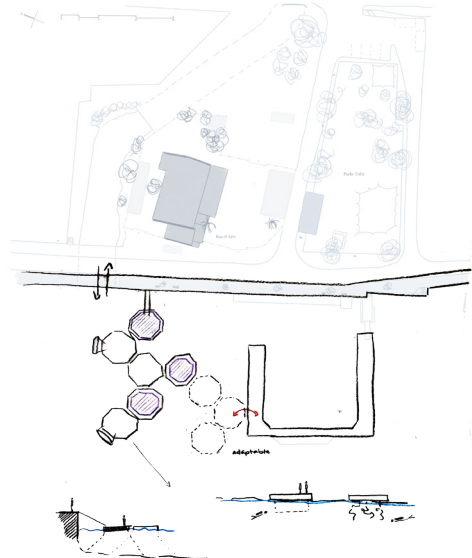
extend the seapool | connection to the boulevard and rhythms



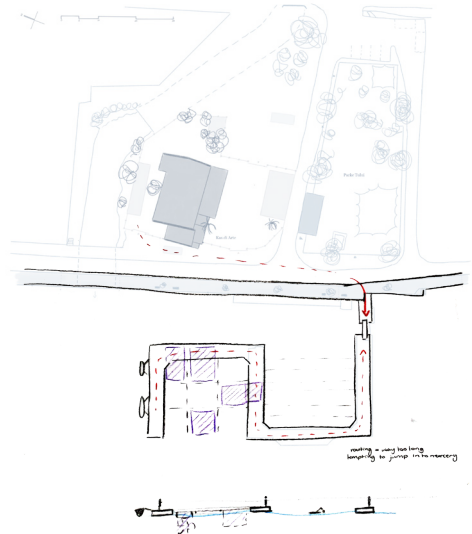
pro's: one integral system
con's: have to make another pier, too easy to jump into the nursery



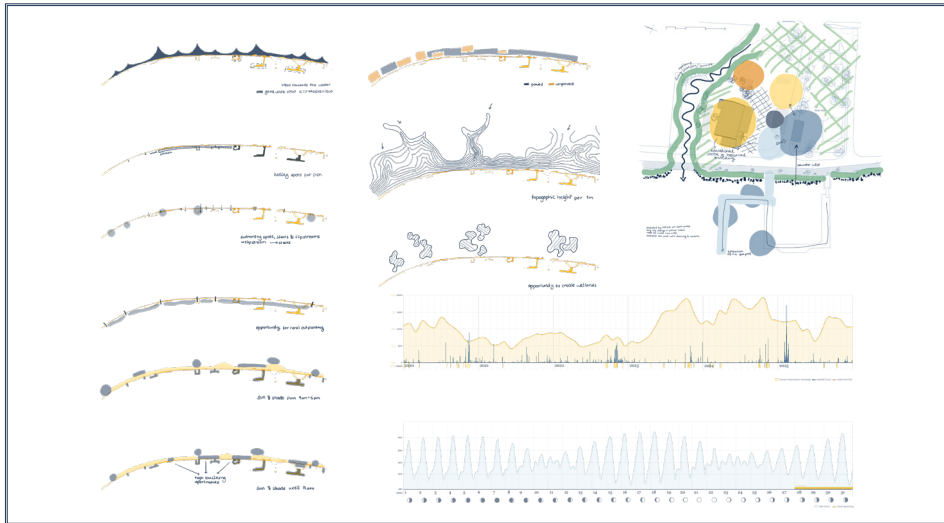
pro's: fix up the existing broken pier, completely separate the two
con's: need to walk longer



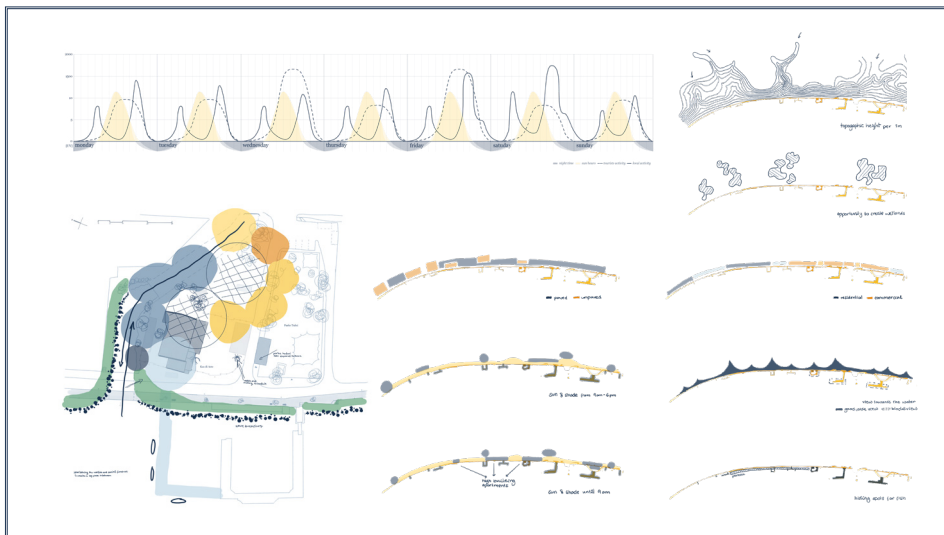
pro's: adaptable and movable system, can grow and shrink when needed
can it be used for the pool?



pro's: keeping existing pier
con's: very long routing, very easy to jump into the nursery



surrounded by nature | connection to the boulevard and rhythms



one big plaza | connection to the boulevard and rhythms

4. Routing of different users

Fourth, the entire site should feel like an extension of Parke Tului, a park with a few buildings in it, rather than a collection of buildings surrounded by landscape. That is why being surrounded by nature and creating one large plaza are such important aspects of the design. It helps connect the site to the boulevard and creates a valuable public space for everyone to use.

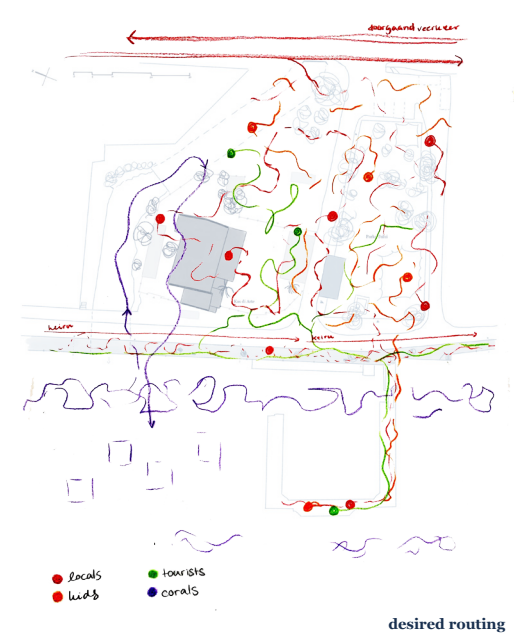
Below, the existing and desired movement patterns of the four main users of the site; locals, children, tourists, and coral, are

shown. In the current situation, coral has little presence within the area. The proposed routing therefore aims to strengthen its role while also extending activity towards Kas di Arte. At the same time, it is important that tourists do not dominate the space at the expense of locals, children, or the coral-related functions.

The design is not only intended for the people who work there. It should feel open and accessible, allowing everyone to move through the site freely and make use of the space in their own way.



existing routing



desired routing

Variations, themes & tensions combined

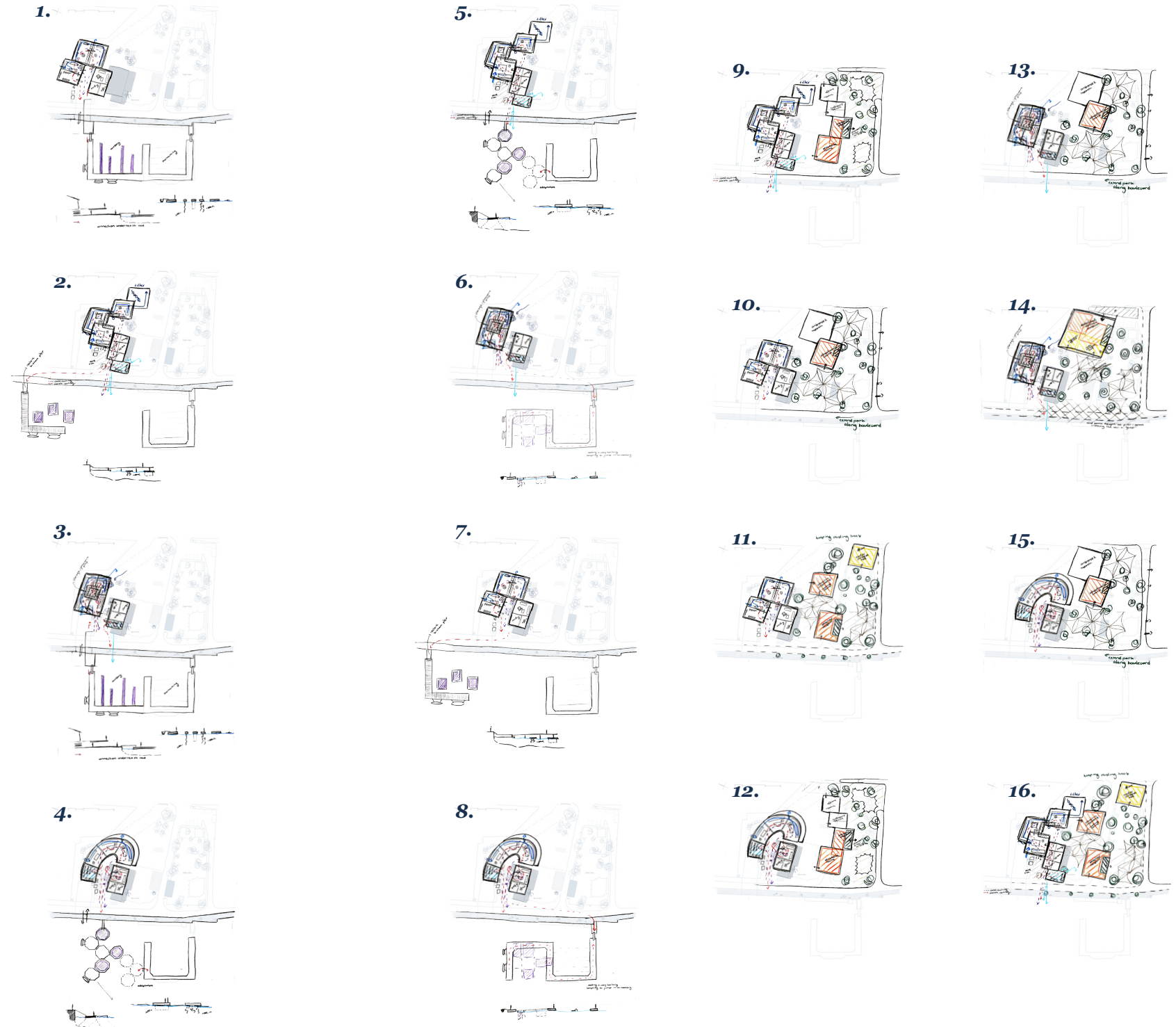
The strength of this strategy lies in exploring the different aspects individually and then overlaying them in multiple combinations. The drawings here show this process: eight variations of how the floating nursery could connect to the wet lab (1-8), and eight variations of how the wet lab could relate to the spatial relationship between Kas di Arte and Parke Tului (9-16).

Ideally, the more 'private' plaza next to the wet lab is located close to both the docking area and the nursery. This allows a clear and efficient route: from the interlinked floating nurseries to the private plaza, into the dive gear room, and then into the wet lab (1,3,4,5). If the internal circulation of the wet lab also returns to this plaza, the process of outplanting coral becomes equally direct and efficient.

The filtration system beneath the outlet currently remains hidden, and throughout the design process it becomes important to give this element a more visible role.

Overlaying the studies of the wet lab with the spatial relationship between Parke Tului and Kas di Arte also generates several form explorations. Three general building strategies emerge in relation to the preserved Kas di Arte: working with a similar building scale and linking several smaller volumes together (9,10); placing a number of separate buildings across the site (13,16); or clustering the remaining functions into a smaller number of larger new buildings (13,14,15).

A similar range of possibilities appears in the design of the public space: a single large plaza (14), two distinct plazas (9,12), or a sequence of several smaller ones (10,11,13,15,16).



02 | form studies

To further explore the form of the new buildings in relation to Kas di Arte, the plazas that emerge from different building configurations, and the possibility of giving the outlet filtration system a stronger presence within the overall plan, physical models were used.

Architectural sisters

Four variations of building orientation were developed. Three of these work with a similar building scale to Kas di Arte, which is an important principle for the project. The new buildings should not overshadow Kas di Arte; instead, they should relate to it, almost like architectural “sisters”: similar in atmosphere but clearly new additions.

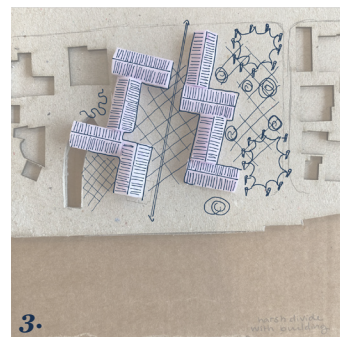
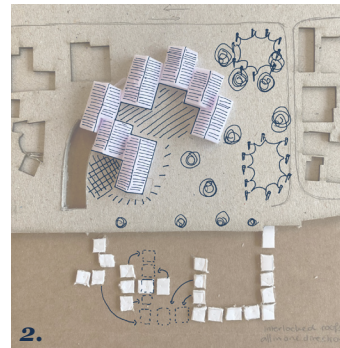
Variations of building- & roof orientation

These form studies also explore the orientation of the roofs. Kas di Arte is oriented east–west, a direction that is maintained in the new proposals, although the roof orientation itself can rotate. In options 1 and 3, for example, the changing roof directions create a series of smaller niches and spaces within the plazas.

Option 3, however, introduces a strong division between the functions, almost creating the feeling of a road running through the site. This degree of separation feels too harsh. Option 2 produces one large plaza with a clearly defined internal courtyard, making the buildings read as a single ensemble. Option 1, on the other hand, generates many smaller plazas, which makes the buildings feel more fragmented.

Separated yet coherent whole

A combination of options 1 and 2 appears most promising: several smaller plazas that remain visually connected to one another, while the buildings still read as a coherent whole.

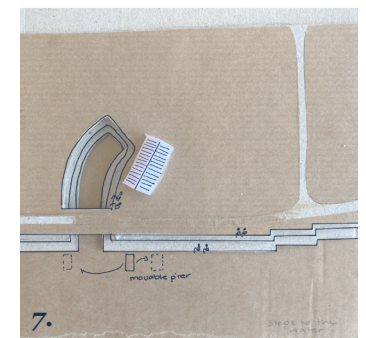
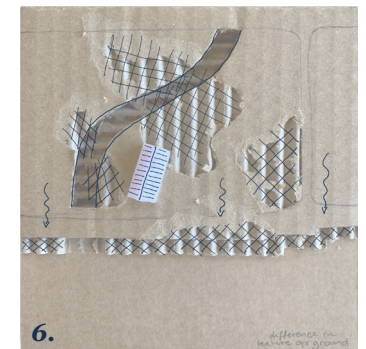


Ground level studies

Models 5–7 focus on the ground level of the site. These studies explore how subtle spatial interventions can define areas and functions: small height differences and steps that structure the space (5), variations in surface textures to distinguish zones (6), and stepped edges that bring people closer to the water (7).

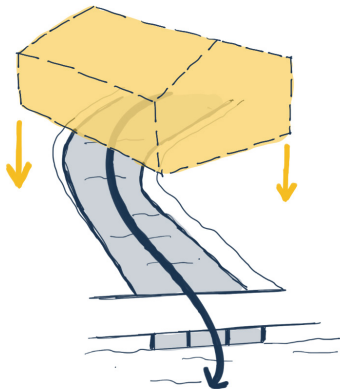
In the first two models, the outlet is opened up and runs through the entire site. In these variations, buildings can still partially span the outlet, but it may also remain visible as it moves through the plaza. This creates an opportunity to highlight the filtration system and potentially make it visible, accessible, or even interactive. However, the outlet is not always filled with water, which means its role during the dry season must also be carefully considered.

The final model explores a continuous set of steps along the water’s edge. These steps create a social edge where people can sit and gather, while also allowing the adaptive, movable nurseries to connect to the boulevard at multiple points. Although this stepped edge offers strong social potential, it also raises an important question: how might unrestricted access to the water affect coral growth and protection? This balance between accessibility and ecological care requires further consideration.

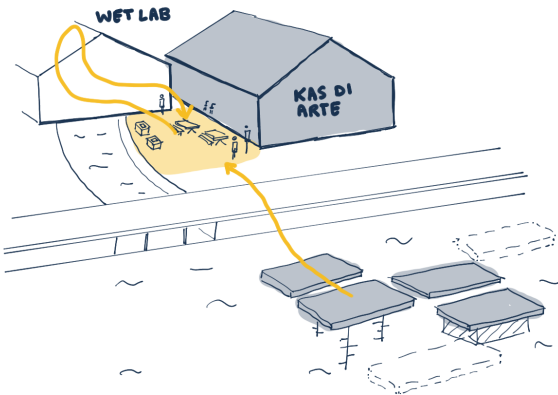


Conclusions program
organisation

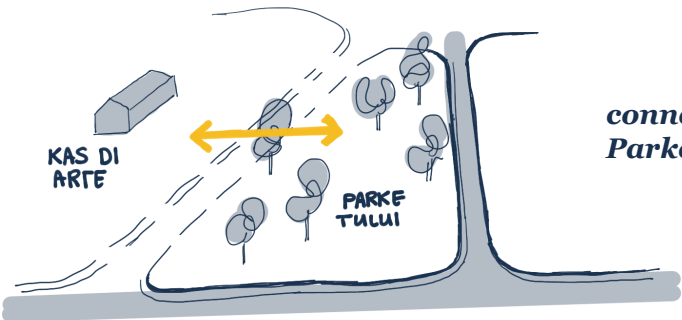
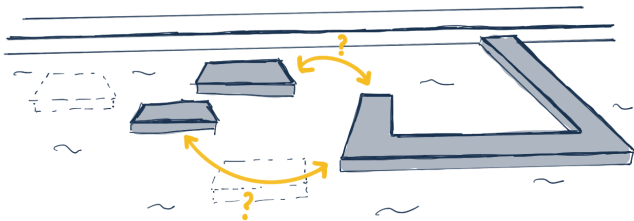
wetlab on outlet



efficient route &
'private' plaza

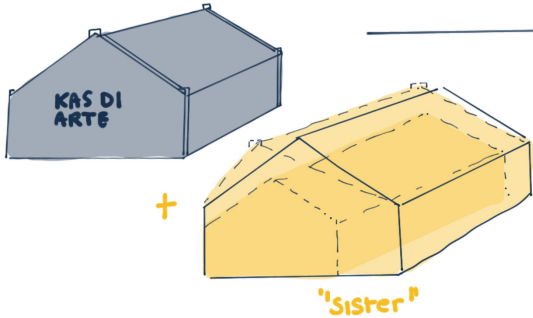
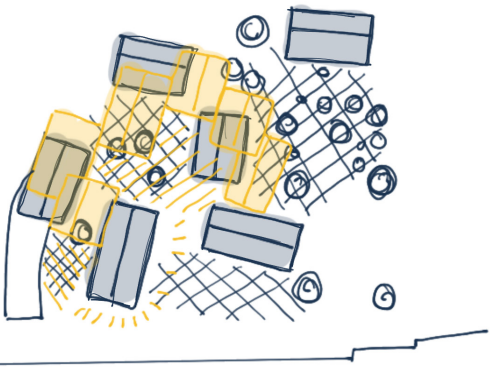


fragmented floating nursery



connect Kas di Arte and
Parke Tului

combination model 1 & 2



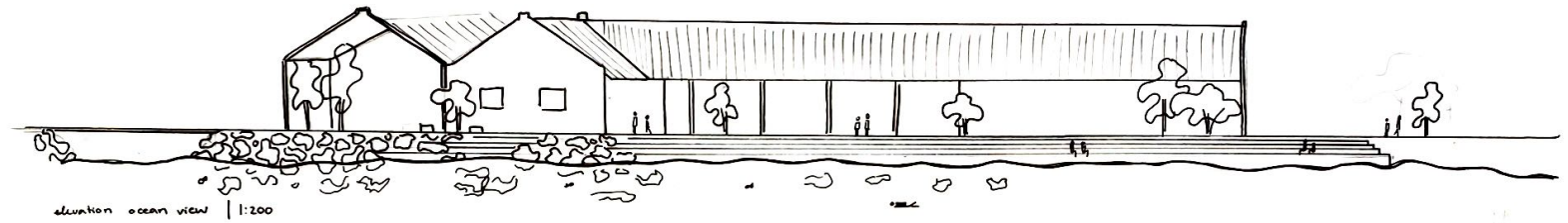
architectural 'sister'



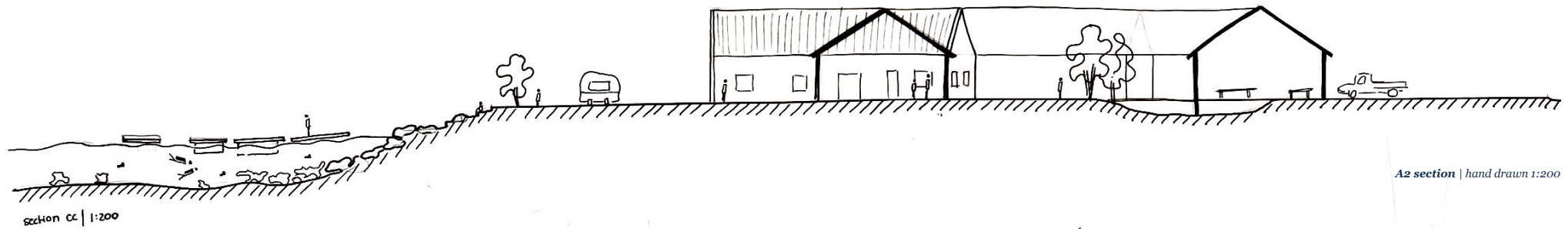
grid orientation | hand drawn 1:200



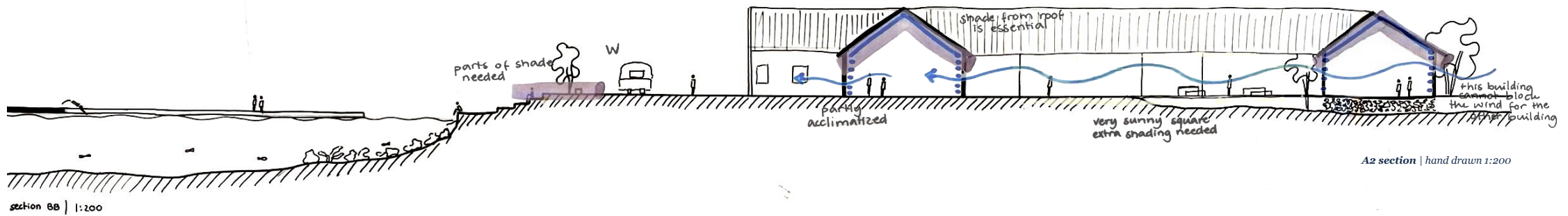
A2 floorplan | hand drawn 1:200



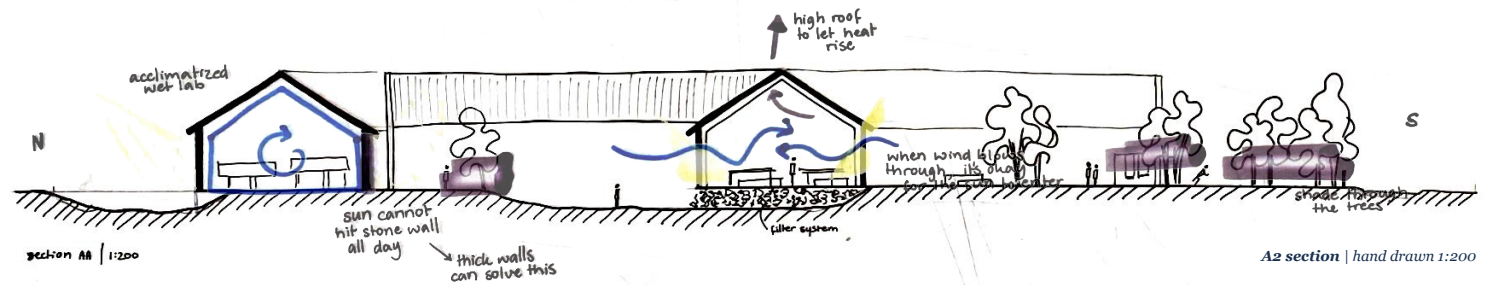
A2 elevation | hand drawn 1:200



A2 section | hand drawn 1:200



A2 section | hand drawn 1:200



A2 section | hand drawn 1:200

03 | site design principles

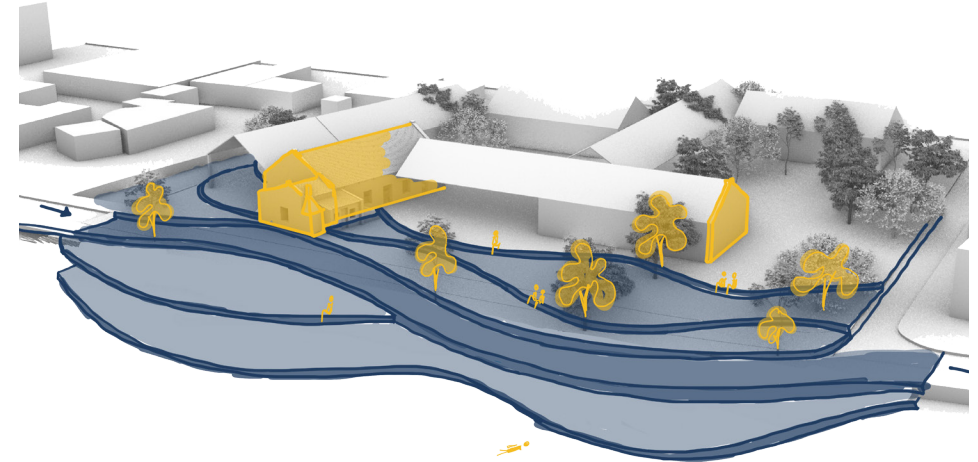
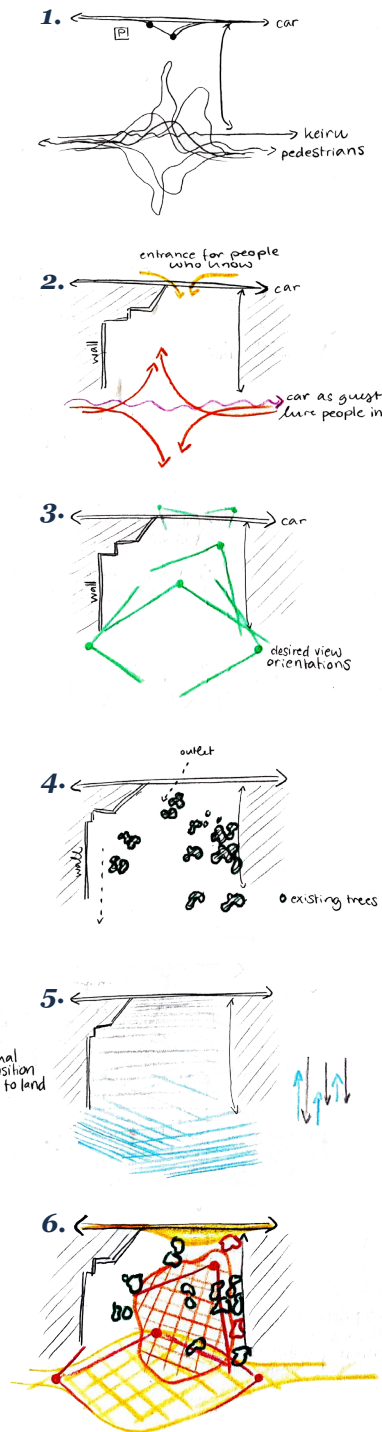
The site is bordered by a major road (Kaya Gobernador N. Debrot), a smaller access road, and the boundary wall along the property line. At present, the boulevard also creates a physical and visual barrier along the waterfront, this needs to be interrupted.

The design of the site is guided by six main principles, illustrated in the diagrams on the right:

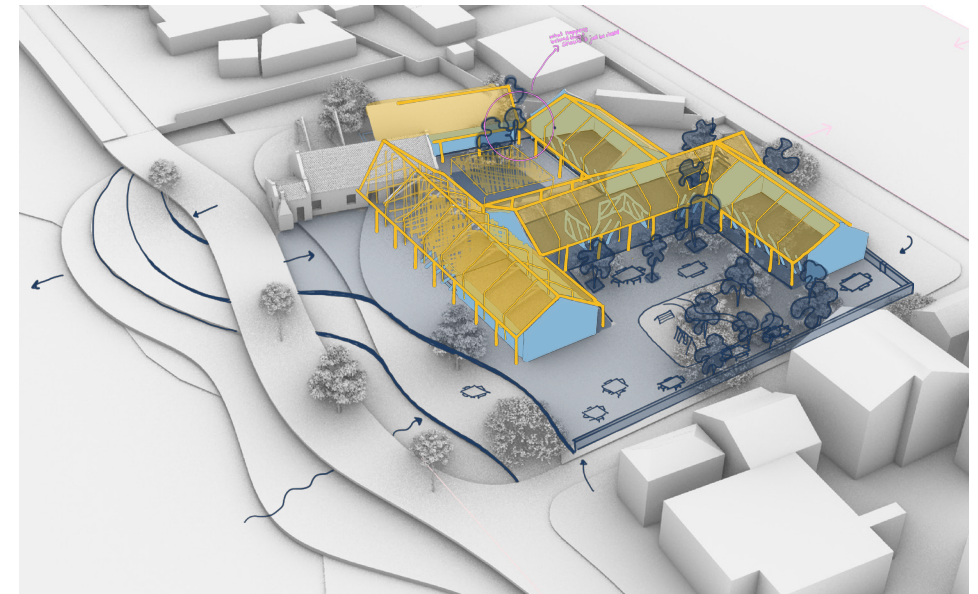
1. Pedestrian movement should extend beyond the linear path of the boulevard.
2. Visitors and tourists should be naturally drawn in from the seaside, while access via Kaya Gobernador N. Debrot should primarily serve employees and returning visitors familiar with the site.
3. Preserving and enhancing view corridors toward the ocean, as well as views from the waterfront into the site, is of primary importance.
4. Existing trees on the site should be retained.
5. The transition between land and sea should feel gradual.
6. Parke Tului should remain and, if possible, be expanded.

Breaking the hard edge

Principles 1, 2, and 5 all relate to interrupting the linear character of the boulevard and creating more space for the ocean within the site. Rather than allowing the waterfront to be defined by rigid, man-made edges, it is important to give the sea a stronger presence and create a softer, more natural transition between land and water. This strategy explores ways of breaking down the hard boundary condition and integrating the ocean more directly into the spatial experience of the site.



sketch 01 | road as bridge, sea flows into site with terraces



sketch 02 | sea flows in partly and site extends partly to wards ocean with steps

Because maintaining the possibility to drive, walk, and stroll along the waterfront is essential, the road along the boulevard must remain in place. Continued access to the site from the boulevard is also an important requirement, which is why Sketch 01 was ultimately not successful.

Bring the ocean inward

To address this, the proposal only interrupts part of the boulevard where it allows the ocean and marine life to become the dominant presence within this section of the site. Here, the road transforms into a bridge, creating the opportunity to look down over the edge toward the reef below.

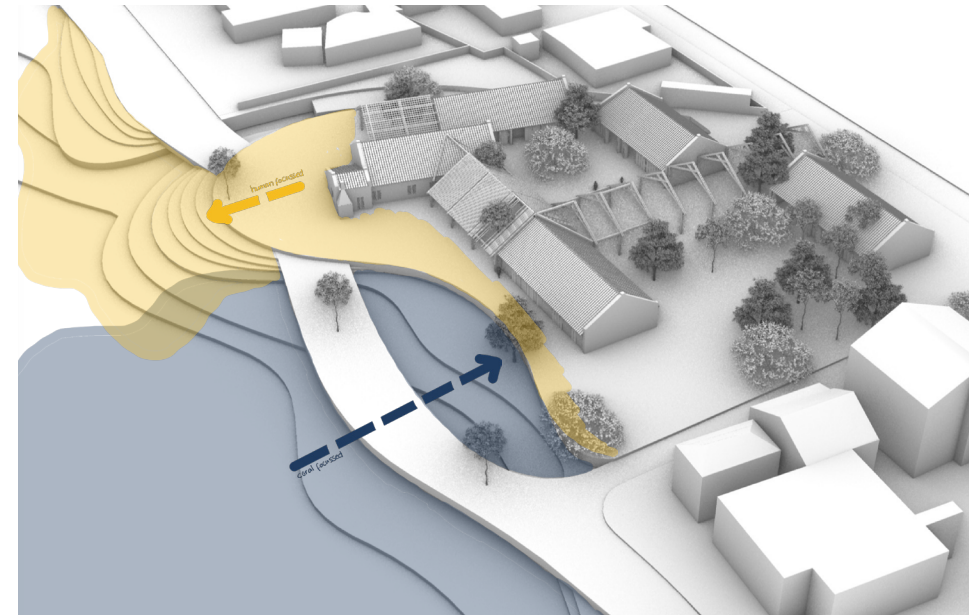
Differentiation in accessibility

At the same time, it is important that access to the water in this area does not feel too easy

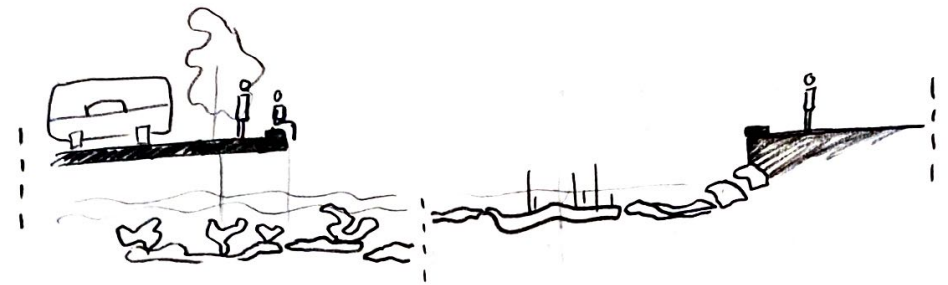
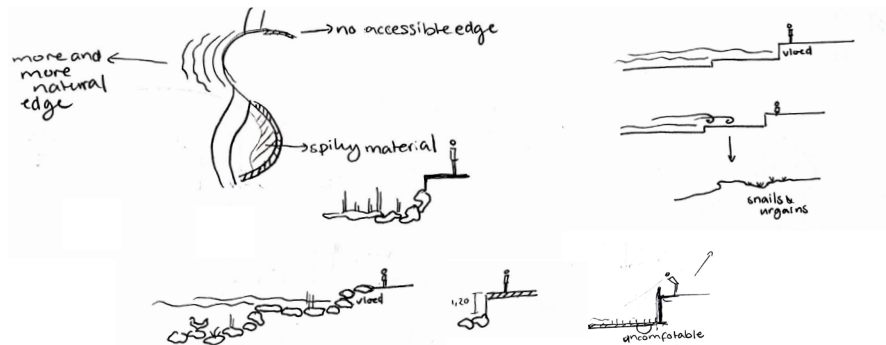
or inviting, in order to protect the reef and discourage direct entry into the ocean. To achieve this, the transition from the site to the first terrace level includes a drop of 1.2 meters, while the surface material of the first terrace is intentionally rough and uncomfortable to walk on barefoot.

Near the Wetlab and Kas di Arte, the site extends further into the sea, with accessible stairways providing easy and comfortable entry into the water. This area is intended to function as the primary point for ocean access and also the proposed location for the coral nurseries.

Across from the outlet, these waterfront stairs continue. The sea pool is relocated to this area so that swimmers remain separated from the coral-dominant zones.



final terrace design | road gets interrupted there where the site extends into the sea



section | coral dominant area

04 | park design

Preserve qualities & values

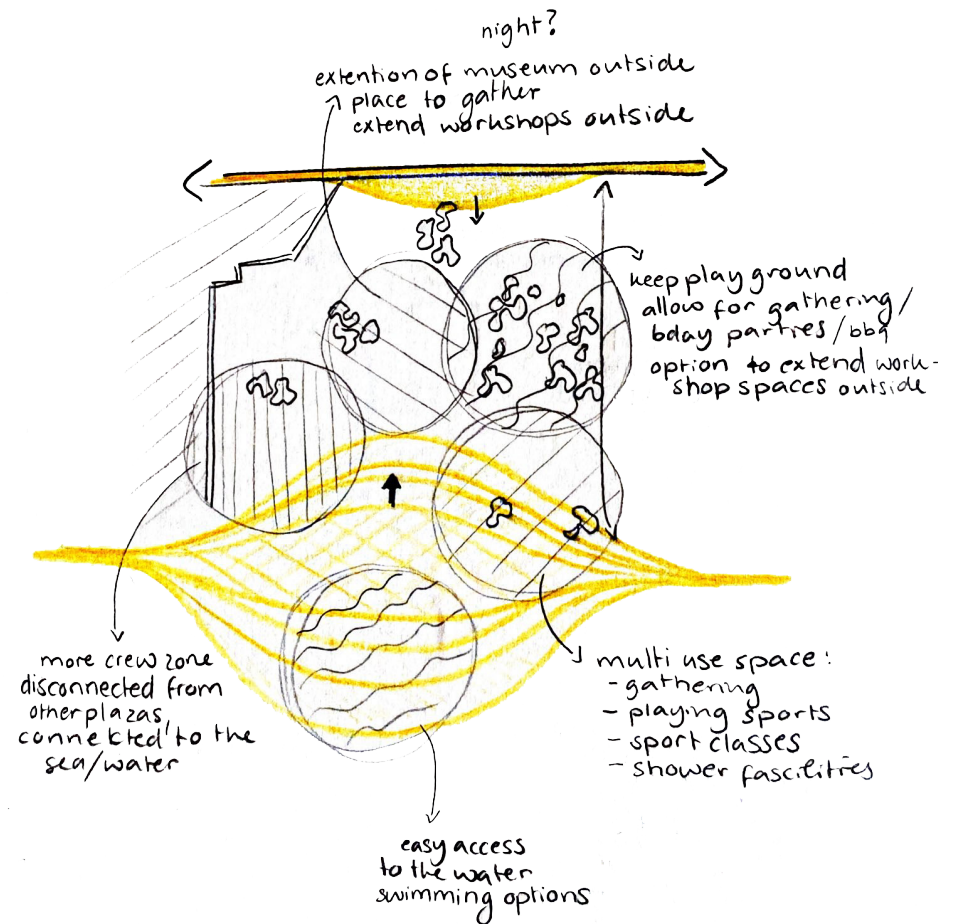
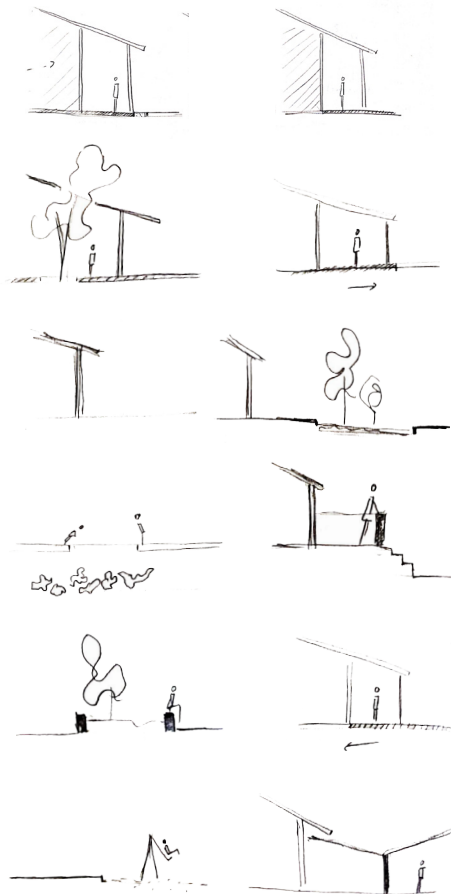
One of the goals of the project is that the qualities and values of Parke Tului should be preserved within the new park design. Rather than becoming restricted or fragmented by the introduction of new buildings, the intention is for all open spaces between the buildings to continue to feel like part of a continuous park landscape.

Within this landscape, several zones can accommodate different activities and user groups (see sketch on next page):

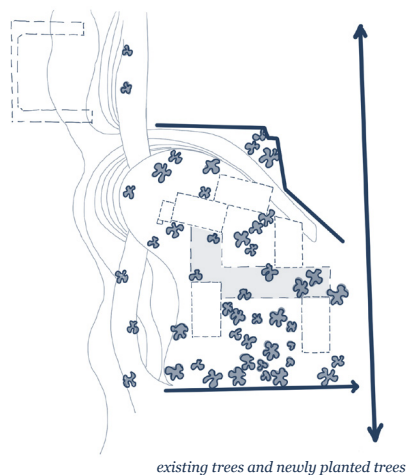
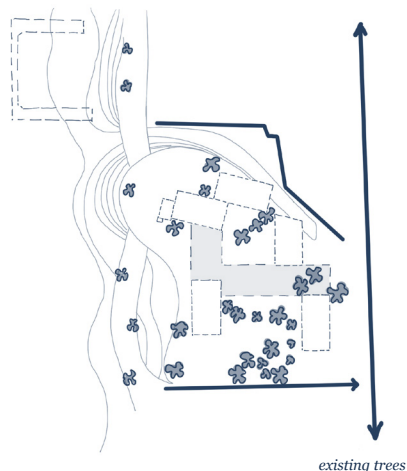
- ① A more secluded area where the Wetlab crew can gather, prepare for dives, and comfortably use the space in swimwear without being directly exposed to the entire park.
- ② A shaded outdoor space where the educational center and workshop areas can extend their activities into the landscape.
- ③ A flexible multi-use area with semi-paved surfaces that can support gatherings, sports, and public events.
- ④ The existing playground should remain, while also allowing space for informal gatherings, birthday parties, and barbecues.

Relationship landscape and architecture

An important aspect of the design is that the park should not simply stop at the edge of the buildings. Instead, the relationship between landscape and architecture should vary depending on the function and openness of each building. (appx. 4.2 & 4.3) More open and public buildings may allow the park materials and landscape to flow into the interior spaces, while more private or technical buildings, such as the Wetlab, may require a clearer and more defined edge.



park zoning | by author

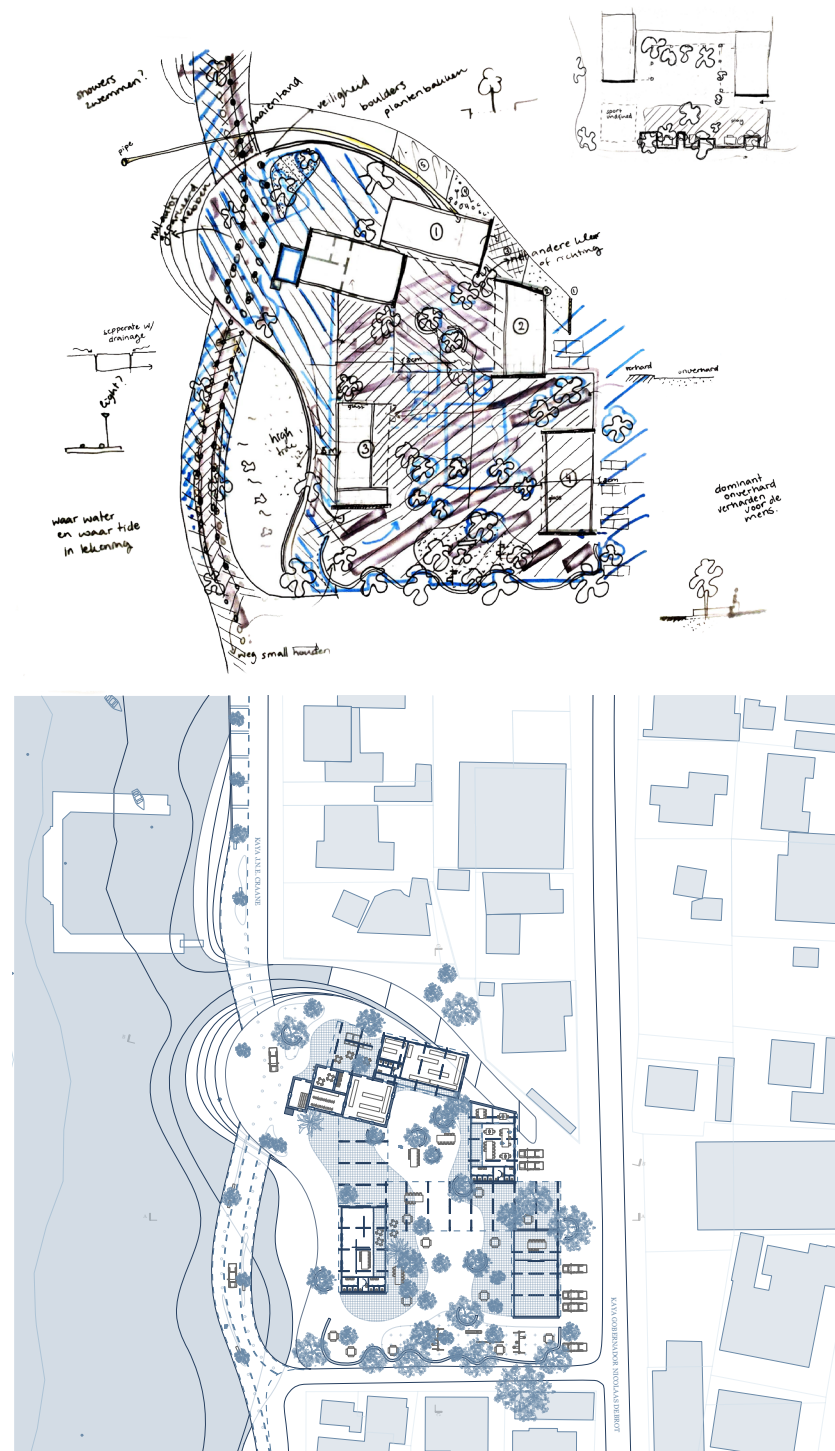


One of the main principles of the design is the preservation of all existing trees on the site. The placement of the buildings is therefore carefully organized around them. (appx. 4.4) The highlighted roof structures function solely as shaded canopies, without enclosed buildings beneath them, enabling the park to continue seamlessly underneath these structures.

However, these roof structures alone do not provide enough shade to make Parke Tului comfortable throughout the day. For this reason, additional trees will be planted across the site to strengthen the park character and improve thermal comfort. Because the highlighted canopy structures are fully open, the landscape and park materials can continue through them without interruption, reinforcing the feeling of a continuous public space.

As this is fundamentally a park landscape, the primary ground material will remain unpaved and permeable. Only areas that require harder surfaces for human use will be paved. The main permeable surface will consist of compacted gravel, which remains comfortable to walk on even during rainy conditions. These gravel surfaces are interrupted by softer planted zones that provide space for trees and vegetation.

Within the site design, rainwater management is also an important consideration. Rainwater should not flow directly toward the sea, but instead first move through planted areas and ultimately toward the beginning of the outlet system. In this way, all urban runoff falling on the site can be naturally filtered before entering the ocean, helping to protect the surrounding marine ecosystem.



05 | the outlet

The design of the outlet is based on two important principles.

Filtration function

First, it is essential that rainwater runoff is not given a direct path into the ocean. To address this, the outlet is divided into five consecutive sections, each positioned slightly higher than the previous one. This stepped system ensures that small amounts of rainfall can be absorbed and filtered before reaching the sea, while still allowing excess water to overflow safely during heavy storms.

Each of these five sections forms part of a different filtration strategy. The first three rely on permeable surfaces:

1. *Bulky waste collection* through a coarse metal grid that captures larger debris.
2. *Natural infiltration*, where water slows down through vegetation and poles, allowing it to gradually infiltrate into the ground.
3. *Gravel and sand infiltration*, consisting of layered gravel and sand beneath a metal grid that filters water as it percolates through the system.

The final two sections use impermeable surfaces:

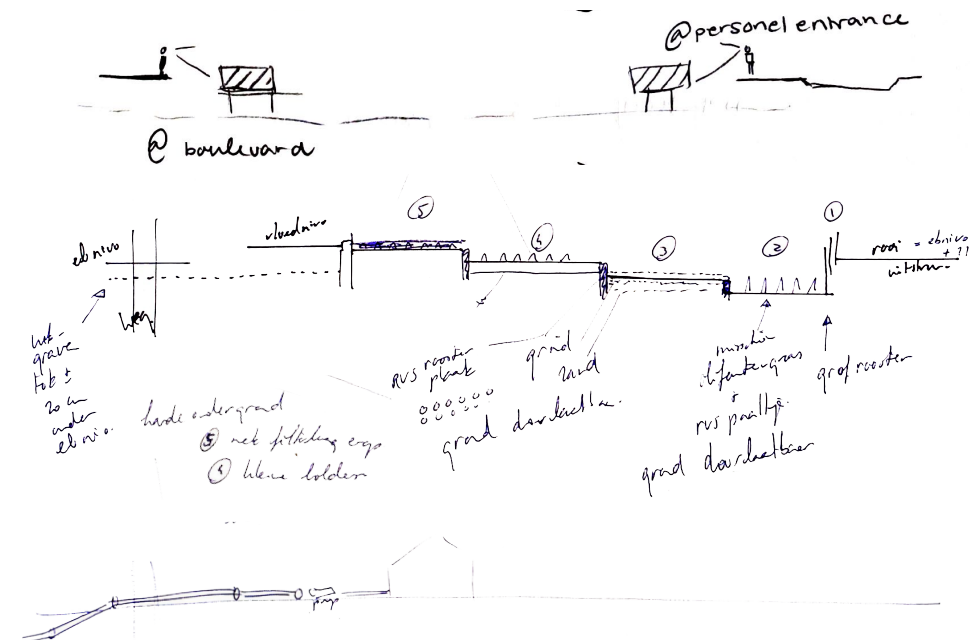
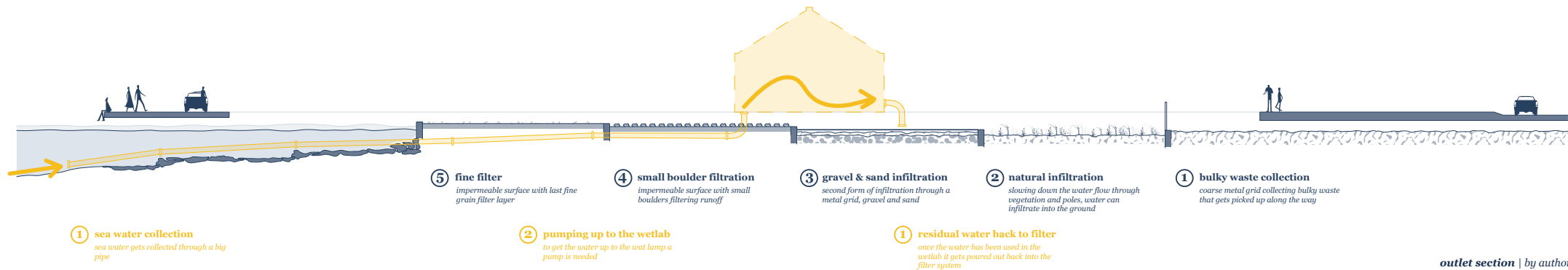
4. *Small boulder filtration*, where water flows between and through large stones, further reducing debris and sediment.
5. *A final fine filtration* stage before the water eventually flows into the ocean.

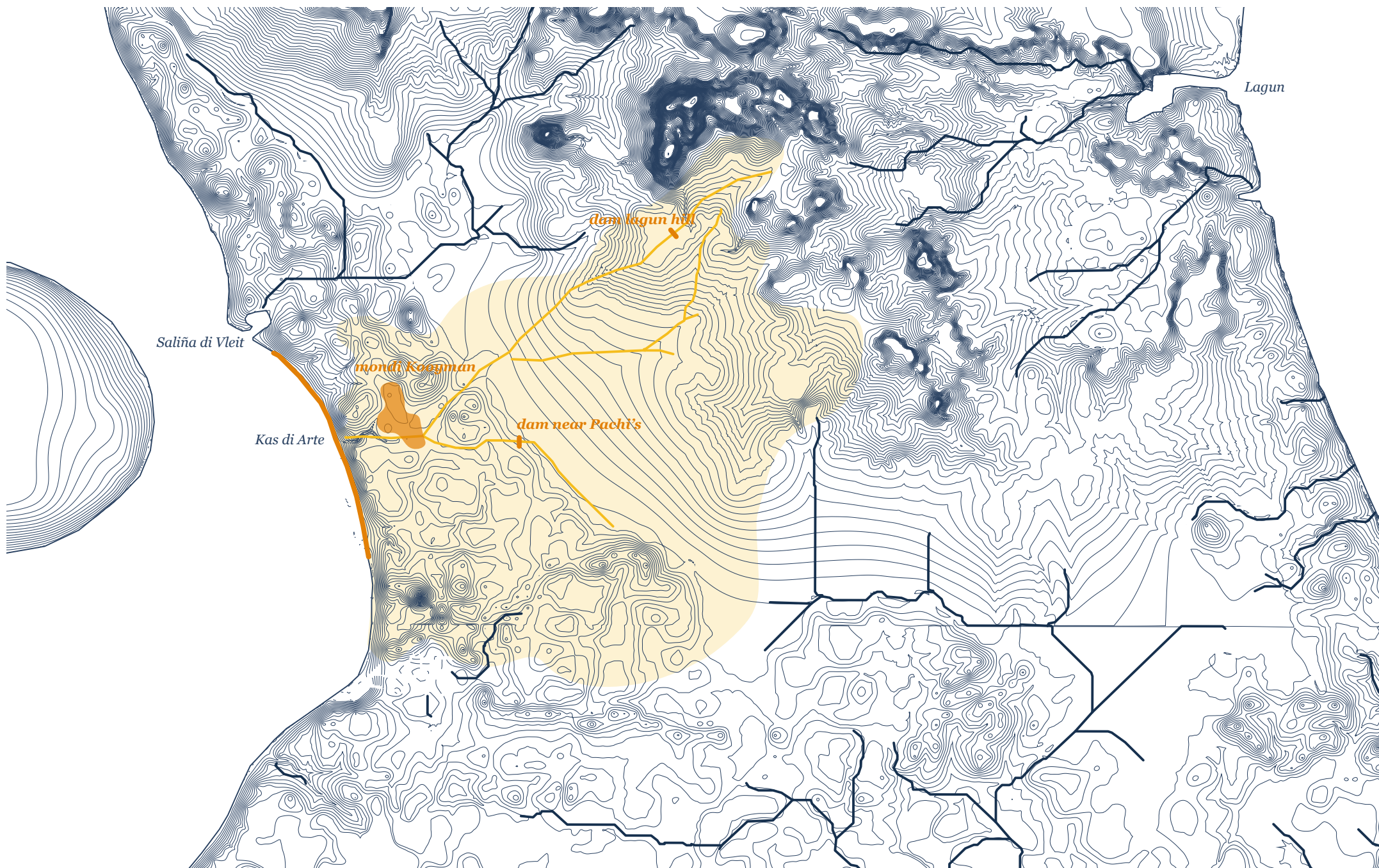
Seawater intake

Second, the outlet is designed not only as an outlet for rainwater, but also as an inlet for seawater used by the Wetlab. Seawater is collected and transported via a large pipe leading toward the Wetlab. After being used in the aquaria, the residual water is returned to the outlet filtration system before re-entering the ocean.

Purposely visible

An important aspect of the design is that the technology behind these systems should remain visible and understandable. For this reason, the pipeline and filtration elements are intentionally exposed, allowing visitors and users to see, understand, educate and potentially even participate in maintaining the system themselves.





height map, water flows and outlet catchment area | by author & (DCBD, n.d.)

o6 | building identities

Within the site, it is important that Kas di Arte retains its distinct identity and continues to stand out. Its iconic yellow colour will therefore be preserved. The new additions, the 'architectural sisters' will be lighter toned. To further define old from new, all new buildings follow the same dimensions as Kas di Arte, but are designed with a ridge height that is 50 cm lower than that of Kas di Arte. The fully open structures (4), however, share the same ridge height as Kas di Arte, creating a visual connection between the existing and new architecture through a wooden roof structure.

While the new buildings share a common material language, each develops its own identity through its function and climatic strategy. Across the site, the buildings gradually transition from enclosed and climate-controlled spaces to fully open structures, as illustrated in the sequence from 1 to 5 in the drawing.

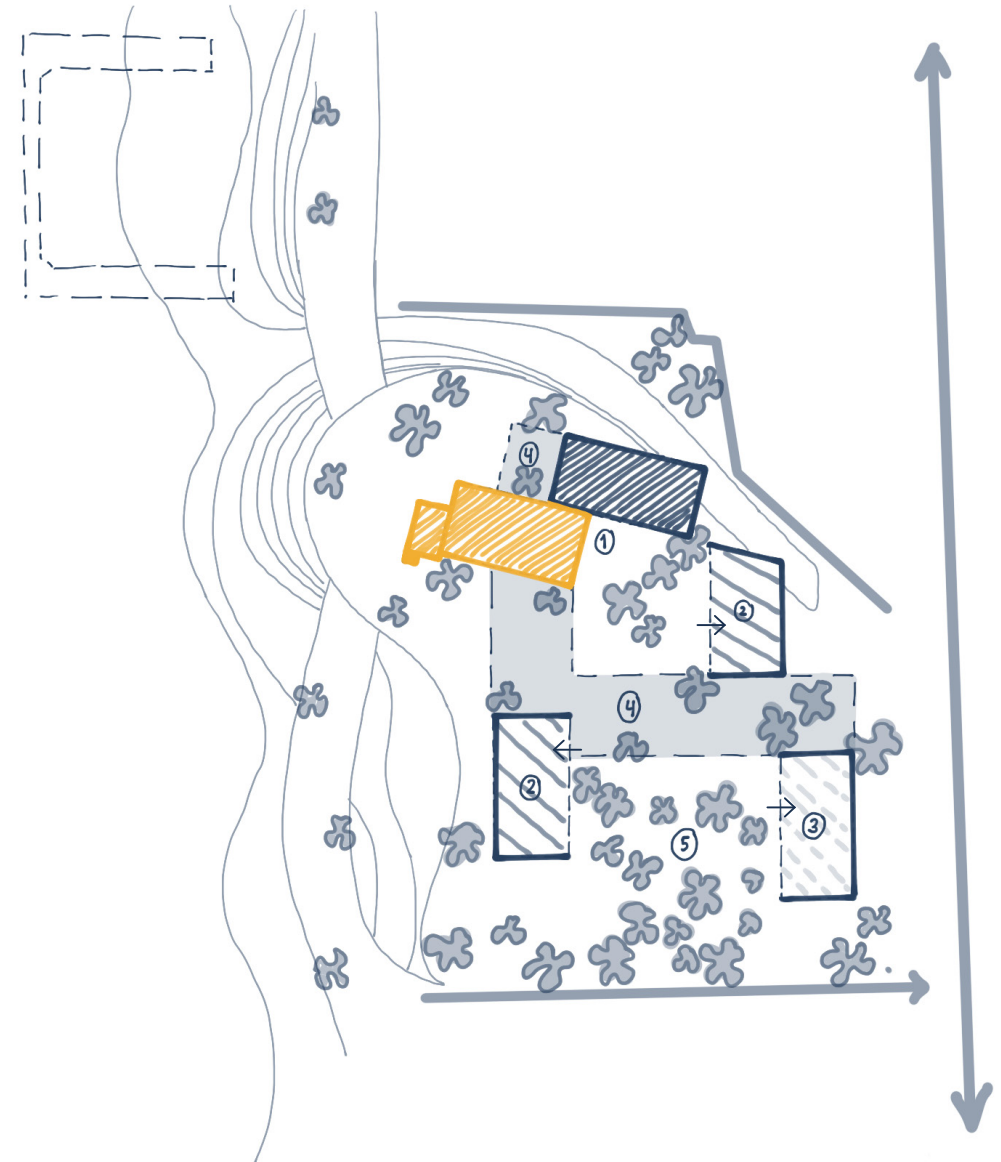
1. The Wetlab is fully enclosed and climate-controlled. Because laboratory conditions require stable temperatures, the structure is insulated and air-conditioned.

- 2. The office and educational center** are partially open. Although these spaces can still be cooled mechanically, they also maintain a strong connection to the plaza and remain comfortable to occupy without constant air conditioning.
- 3. The multipurpose hall** is designed to extend directly into the plaza, allowing activities to flow between inside and outside. This space is not climate-controlled, but it can be enclosed when necessary.
- 4. The open structures** consist only of a wooden roof canopy without enclosed walls. Rainwater passes directly through these structures, making them essentially shaded outdoor spaces within the park.
- 5. The park landscape** itself remains fully natural and open.

The structural system of the new buildings is consistent across the site. All buildings are designed as U-shaped structures that open toward the plaza. The extent to which the plaza flows into each building varies depending on the desired degree of openness. This creates a gradual transition, also following the sequence from 1 to 4.



difference in ridge height | by author



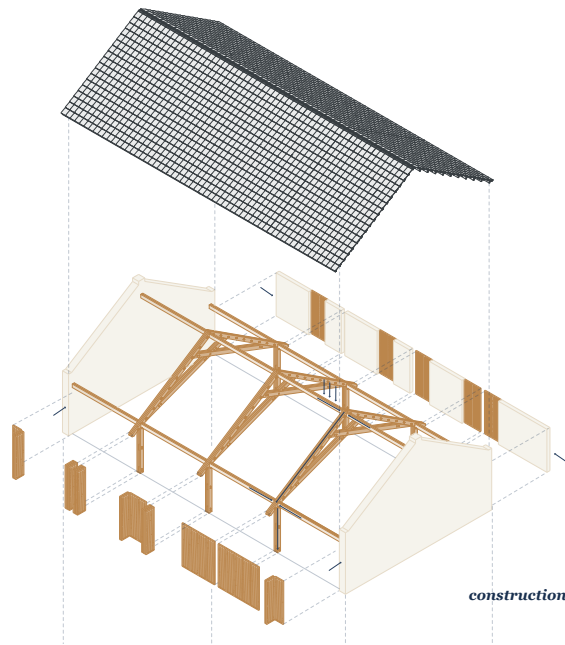
07 | adaptable facades

Each building is composed of the same architectural elements: a timber structure with wooden trusses, stone spout gables, and adaptable infill facades.

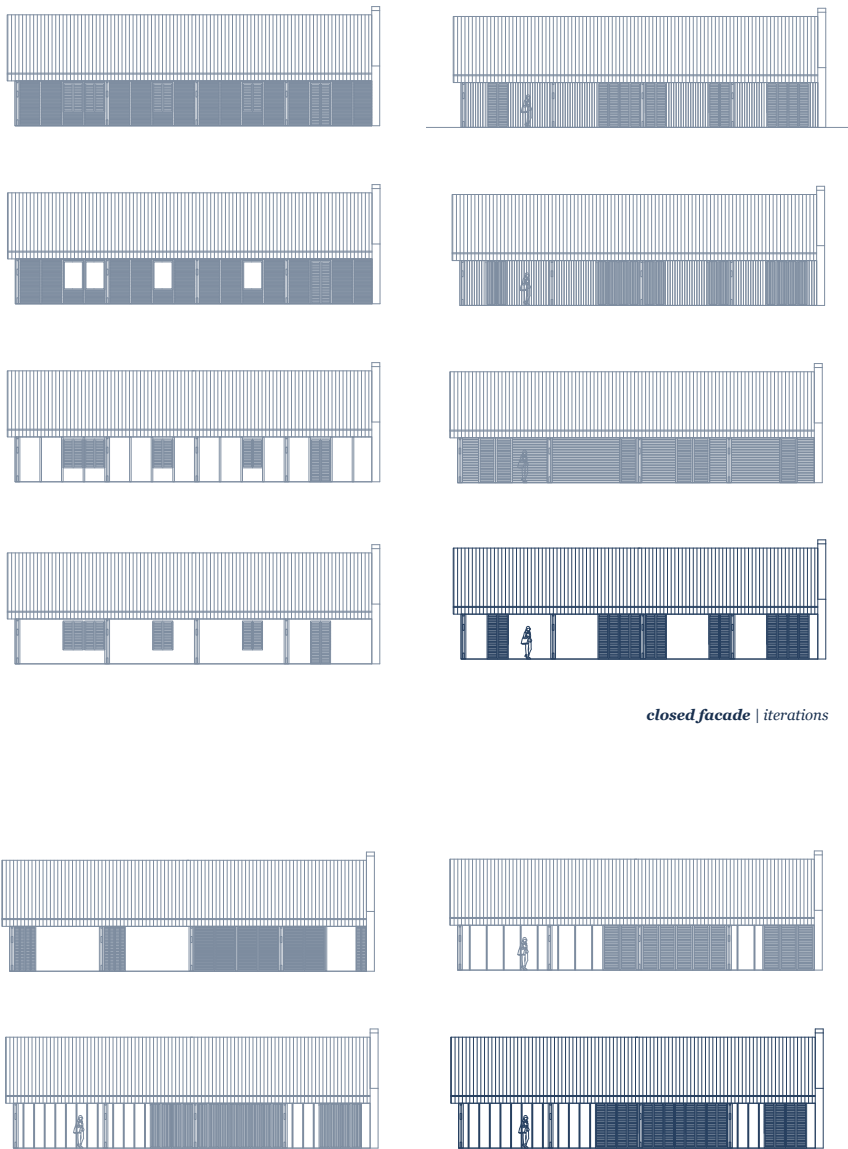
The facade facing the park is constructed entirely from wooden shutters. These shutters can be opened individually, allowing users to control the degree of openness, ventilation, as well as the degree of sunlight entering depending on the climate and activity within the building. In contrast, the facade facing the road is designed to be more enclosed. The facade studies and iterations for this condition

are shown on the following page, with the selected design combining stone surfaces and wooden shutters.

The stone material of the spout gables continues into these more enclosed side walls, emphasizing the U-shaped form of the buildings. This configuration also contributes structurally, helping to stabilize both the spout gables and the wooden truss system.

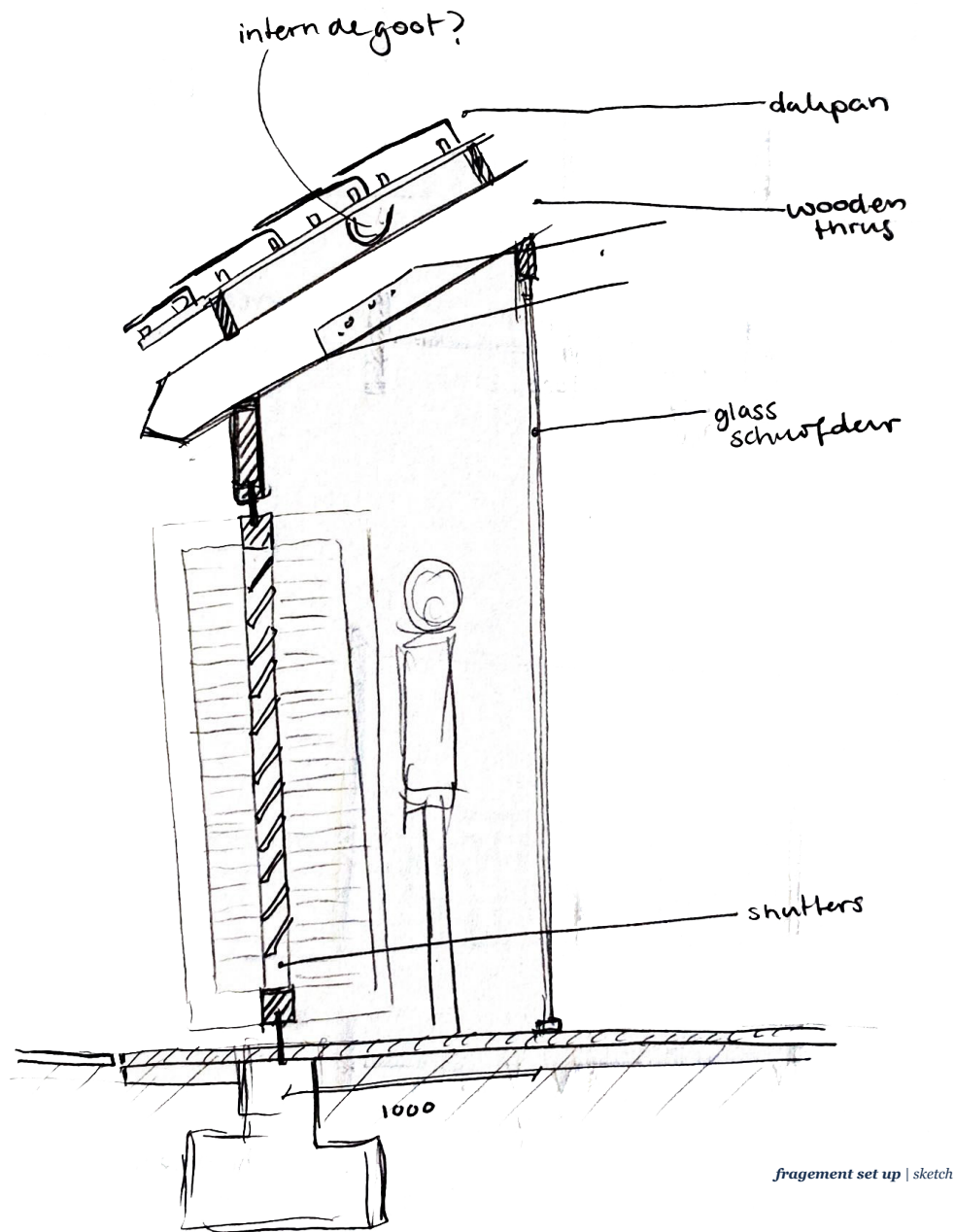


constructional elements & facade infill
exploded axonometry



closed facade | iterations

open shutter facade | iterations

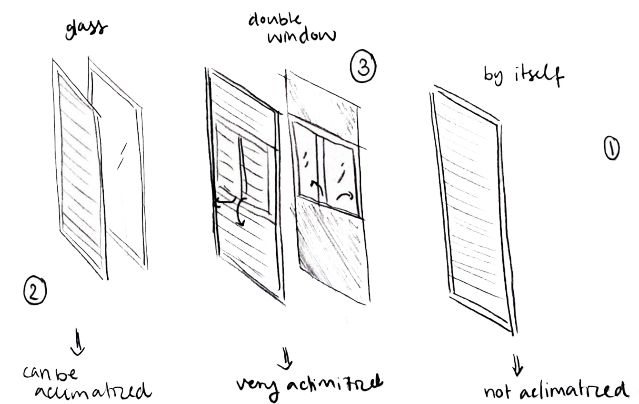
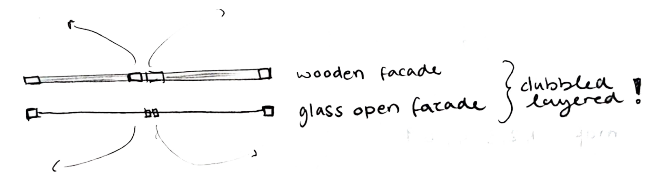


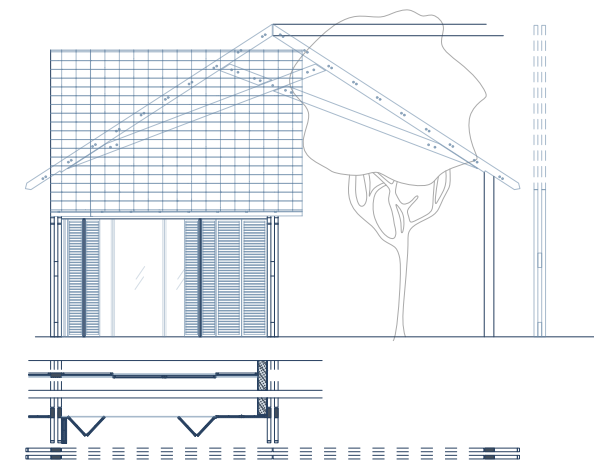
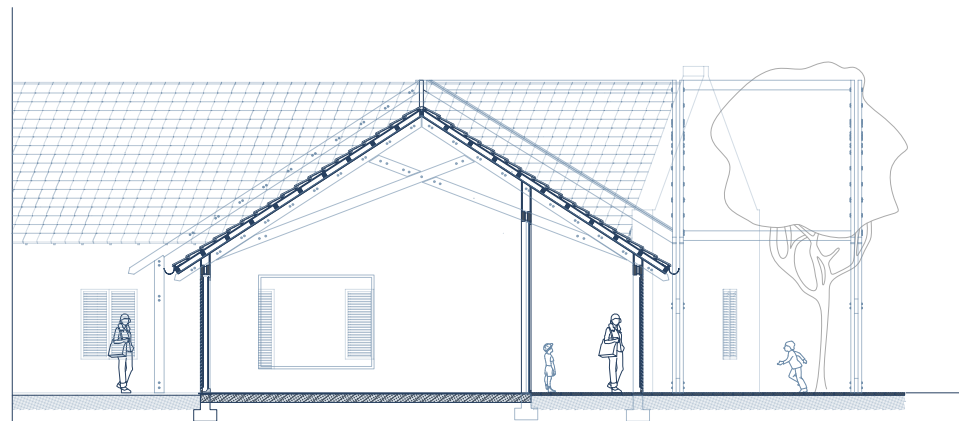
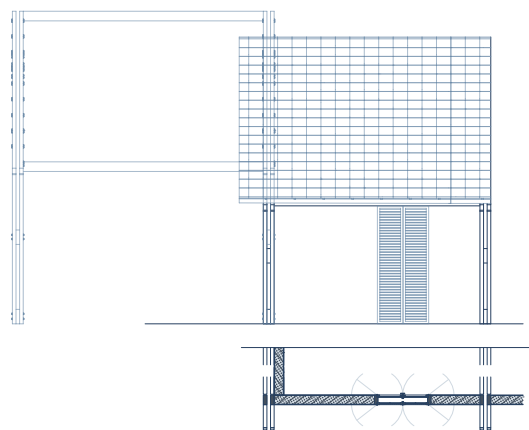
The shutter facades form an outer layer around each building, with a secondary layer positioned behind them. The nature of this inner layer depends on the identity and climatic requirements of the specific building. In the Wetlab (1), the second layer consists of an insulated wall system, while in the office and educational center (2), it is formed by sliding glass doors.

The shutter facades not only allow for varying degrees of visual openness, but also serve an important climatic function by filtering direct sunlight before it reaches the inner facade, particularly the glazed surfaces. The space

created between these two layers functions as a transitional “porch” zone: an intermediate space between inside and outside that remains thermally comfortable while still allowing natural ventilation and visual connection to the surroundings.

On the more enclosed facades facing the road, all openings are designed as double-layered systems consisting of both wooden shutters and glass windows. Because each layer can be opened independently, the buildings can adapt to different climatic conditions and desired levels of ventilation or air conditioning.





1:20 facade fragment | scaled to fit

o8 | shaded structure

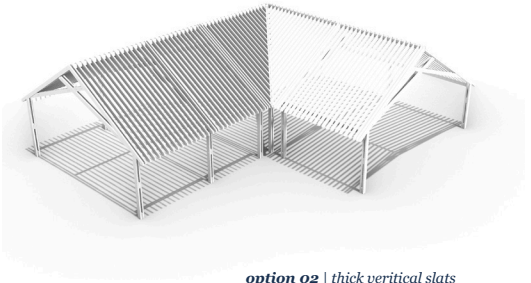
The shaded structure that connects the buildings is entirely constructed from timber. It consists of a series of repeating wooden trusses linked together by beams, which provide stability and create a cohesive architectural element across the plaza.

The primary purpose of this structure is to provide shade within the outdoor gathering space. Given Bonaire’s climate, where the sun is positioned almost directly overhead around midday, effective shading is essential. The shade studies demonstrate that when vertical slats are used, sunlight can pass through relatively easily, creating only partial shading. In contrast, when the beams are positioned horizontally, following the pitch of the roof and given sufficient depth, they block a significantly larger amount of sunlight while requiring fewer structural elements. For this reason, the third option performs best in terms of shade provision.

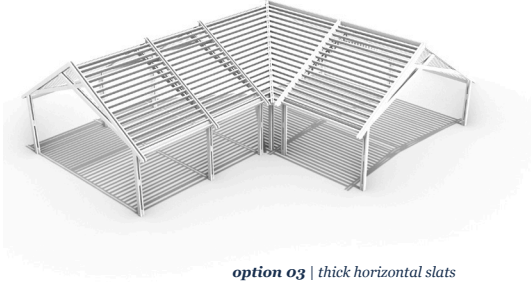
In addition to improving thermal comfort, the horizontal beams also influence the visual experience of the space. In elevation, they partially screen views of the surrounding buildings, allowing the structure to establish its own identity and spatial character without being dominated by the architecture beyond.



option 01 | thin vertical slats



option 02 | thick vertical slats



option 03 | thick horizontal slats



option 01 | in elevation



option 02 | in elevation



option 03 | in elevation

o8 | spout gable sculptures

The spout gables form one of the most striking architectural elements within the project. They are always solid and appear as end pieces attached to the ends of each building structure, imitating the iconic shape with a square top. Rather than functioning purely as technical or structural elements, the intention is for these gables to act as architectural sculptures within the site.

The inspiration for these forms comes from the intricate textures of coral. Corals possess delicate surface patterns and details that are often almost invisible to the naked eye. While on Bonaire, dead coral fragments found on the beach were pressed into clay to capture these textures. When these impressions were studied in black and white, the richness and complexity of the coral patterns became highly visible.

From this process emerged the idea of translating coral textures into architecture by enlarging them to an architectural scale and applying them to the spout gables. In this way, the textures become tactile and physically perceptible to visitors moving through the site. The gables therefore serve as an abstract expression of the marine ecosystem that lies at the center of the project.



coral and shell imprints in clay | by author (2026)

REFERENCE PROJECTS

Fourteen reference projects have informed and inspired the design process. Each of these projects is documented in this fourth appendix, accompanied by a brief reflection explaining the aspects that were particularly inspiring and how they influenced the development of the final design.

<i>architectural 'sister'</i>	1.
<i>blurred boundary inside and outside</i>	2-3.
<i>building around trees</i>	4.
<i>shaded structures</i>	5.
<i>shutterdoor facade</i>	6-9.
<i>plaza design</i>	10-11.

FRAC Dunkerque

Lacaton & Vassal

The exhibition centre FRAC Grand Large serves as an inspiring example of how a new building can connect to an existing structure while establishing its own identity. Although the architectural style itself is not the direction I aim to pursue, the project demonstrates how a contemporary addition can echo the form and rhythm of the original. The result is a kind of “architectural sister”: a building that clearly belongs to the ensemble, yet confidently expresses itself as something new.



facade FRAC Dunkerque | (Aguilar, 2021)

1.

Casa Mérida

Ludwig Godefroy Architecture

2.

Casa Mérida is a compelling example of how architecture can blur the boundary between inside and outside. The house is repeatedly “interrupted” by open-air spaces, creating a sequence of transitions rather than a strict division. Through the use of pivoting doors and the continuation of roofs and floors beyond the enclosed interior, spaces gradually shift from inside to semi-covered outdoor areas and finally to fully open exterior environments. Exploring and designing these fluid thresholds is something I aim to incorporate into my project, particularly in the context of Bonaire, where outdoor space is used just as much as, if not more than, the interior.



casa merida | (Ott, 2024)

Cabin ANNA

Casper Schols

Cabin ANNA by Caspar Schols is a compact dwelling defined by two movable layers: a solid outer shell and an inner glass structure, both of which can slide open and closed. This system allows the cabin to adapt to changing weather conditions and spatial needs, transforming the relationship between enclosure and openness. With the bed positioned at the center, fully opening the layers creates the experience of sleeping directly under the open sky. This ability to continuously redefine what is inside and outside is what makes Cabin ANNA particularly inspiring for my project.



cabin ANNA | (Anna, n.d.)

3.

House, Cap ferret

Lacaton & Vassal

4.

What stands out in this design of Lacaton and Vassal is their decision to preserve all existing trees on site and design the house around them. The tall trees pass directly through the building, almost reading as a natural extension of its structural columns. This approach offers a compelling example of how architecture can allow nature to take the lead, embracing and integrating existing conditions rather than overriding them.



cap ferret | (Lacaton & Vassal, n.d.)

Talaricheruvu Rural School CollectiveProject

5.

What stands out in Talaricheruvu Rural School is the thoughtful approach to shading the open spaces between the buildings. The use of a thread-like canopy system creates a soft, dappled shade that feels natural and breathable rather than fully enclosed. Because these structures do not provide complete coverage like a solid roof, they form an intermediate layer in the gradient between inside and outside. This results in spaces that appear both comfortable and inviting, offering protection while still maintaining a strong connection to the open air.



talaricheruvu rural school | (Abdel, 2025)

Las Tejedoras Natura Futura & Juan Carlos Bamba

6.

Centro de Desarrollo Productivo Comunitario Las Tejedoras caught my attention mainly because of its touch and feel. The use of materials feels natural and simple, yet it does not come across as improvised. Another aspect that stands out is the use of sliding shutters and doors, which allow the building to open up completely.



Centro de desarrollo Productivo Comunitario Las Tejedoras | (Zapico, 2025)

NKU Orkidstudio

NKU is a new home for disadvantaged and abandoned children. What makes this project particularly interesting is that it was built together with a diverse group from a small Kikuyu community in the rapidly developing agricultural outskirts of Nakuru, Kenya (Orkidstudio NKU, 2026).

The project uses a relatively simple structural system, which is then infilled with wooden shutters that can open in different ways. This creates a flexible facade that can adapt to climate, light, and ventilation.



NKU | (Orkidstudio · NKU, 2016)

7.

Bass Coast Farmhouse Wardle

This holiday house by Wardle caught my attention because of the way it gives a contemporary interpretation to a form that is clearly inspired by traditional farmhouses. The design feels modern while still maintaining a strong connection to familiar rural building typologies. The inner courtyard, visible in the photograph, is lined with an elegant system of sliding wooden panels.



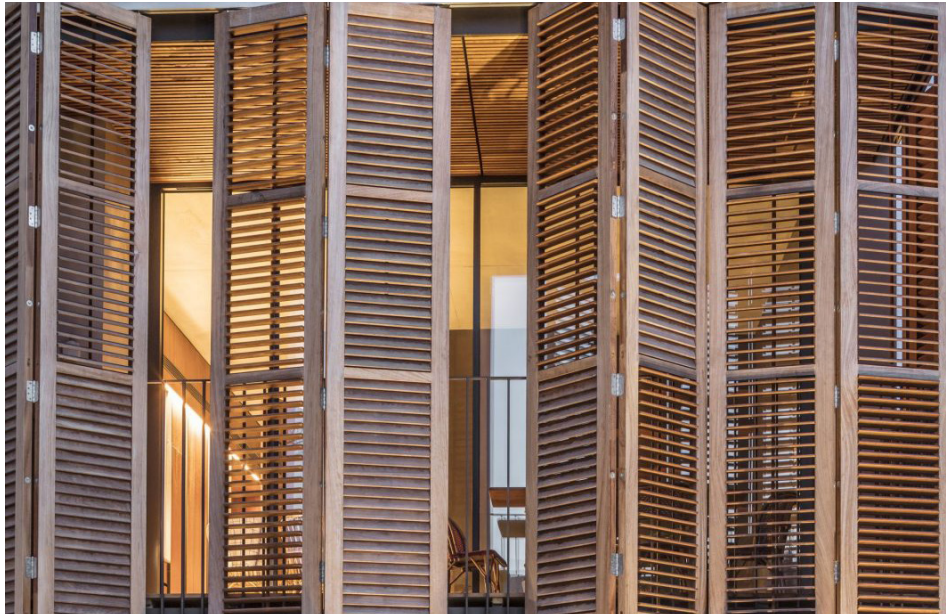
Bass Coast Farmhouse by Wardle | (Taylor, 2023)

8.

4 Friends' Apartment

Lola Domènech, Lussi + Partner AG

This apartment building in Barcelona uses the same facade system as the one proposed in my design. It demonstrates that panels of this height and slenderness can be successfully constructed and mounted on a railing system. The project also shows how the panels can be connected in pairs, allowing the shutter doors to slide and open efficiently while maintaining both functionality and visual consistency across the facade.



4 Friends' Apartment | (Domènech, 2023)

9.

Marine Education Center

Lake | Flato Architects

Apart from its inspiring function, the Marine Education Center also stood out to me because of its construction. What I find particularly compelling is how the timber frame structure is fully exposed rather than concealed. The structural system becomes an architectural feature in itself, drawing attention to the craftsmanship and the connections between the different elements. Another aspect that inspires me is the circulation throughout the site and the way the different buildings are connected. Lake|Flato Architects carefully

10.

choreograph the experience of moving through the terrain, creating alternating moments of being outdoors in nature, walking on compacted gravel paths, moving under sheltered roofs, and entering fully enclosed interior spaces.



Marine Education Center | (Lake, Flato Architects, n.d.)

Landhuis Karpata

Bonaire

Landhuis Karpata is a colonial-era building that is now abandoned and in ruins. What struck me most about this place, however, is the plaza between the buildings. It has a warm, cosy atmosphere that invites you to stay longer, and it's easy to see its potential. I think this feeling comes from the amount of greenery, as well as the relatively small scale of both the plaza and the surrounding buildings.



landhuis karpata | by author (2025)

11.

Plastic bottle shade

Otrobanda, Curaçao

In Otrobanda, Curaçao, a shaded area has been created using plastic bottles. What I find most compelling is the idea behind it. It's simple, yet highly effective, and it fits perfectly with the colourful atmosphere that is so characteristic of the Caribbean island.

12.



otrobanda Curaçao | by author (2024)

Parke Isidel Bonaire

13.

The space most comparable to Parke Tului is Parke Isidel. This park is also located along the waterfront and is equipped with barbecues, a playground, and shaded areas. The main difference is that part of Parke Isidel has been developed into a beach area, with tables and loungers available for rent, as well as a café/bar. As a result, not all of the park is free of charge. Aside from that, it serves as a gathering place for locals, who come together for birthday parties and other social activities.



parke isidel | by author (2026)

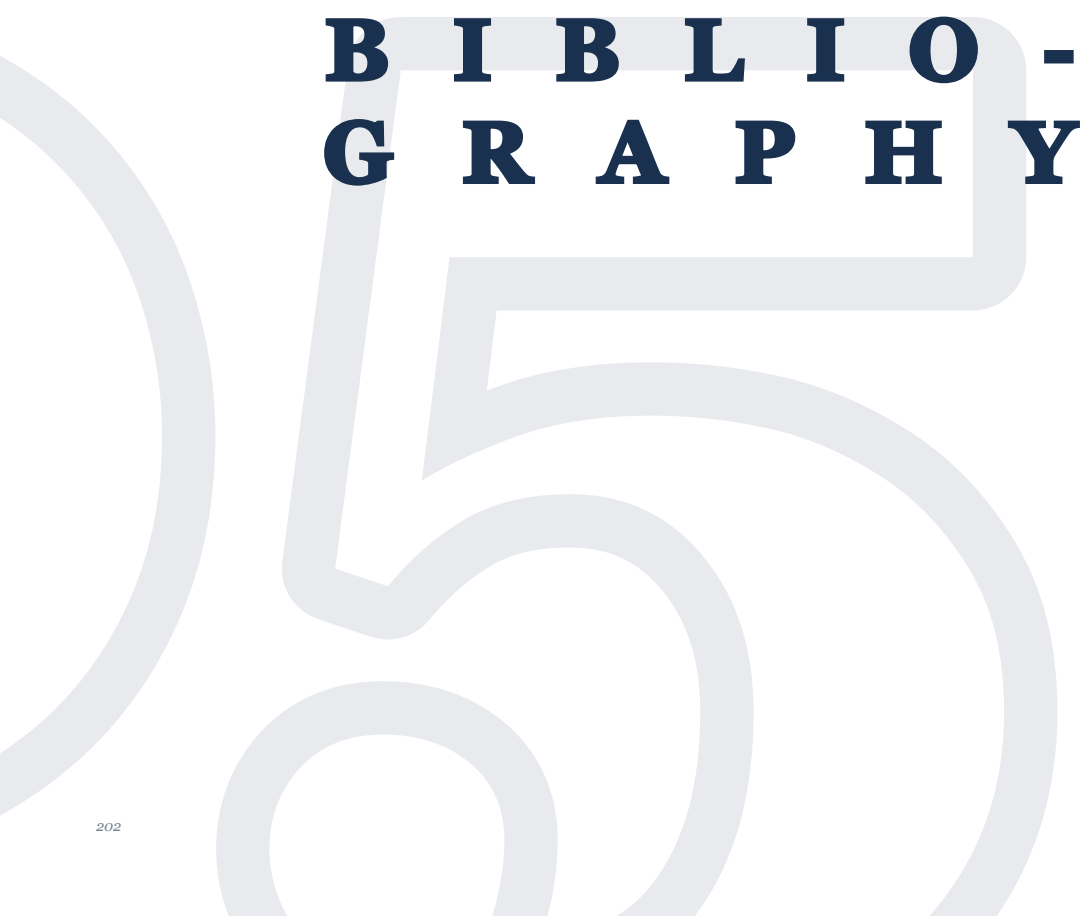
SACA Bonaire

14.

SACA (Stichting Art Centre Antriol) is the only example on Bonaire where new and existing architecture are integrated within a single project. On the island, new buildings are typically constructed in a similar style, or older structures are completely replaced. Although the very straight, square modern architecture is not to my taste, the spatial quality of the plaza, connecting the buildings through a shaded structure, is particularly interesting.



otrobanda Curaçao | by author (2024)



B I B L I O - G R A P H Y

Abdel, H. (2025, May 28). *Talaricheruwu Rural School / CollectiveProject*. ArchDaily. <https://www.archdaily.com/1024609/talaricheruwu-rural-school-collectiveproject>

Aguilar, C. (2021, March 12). *FRAC Dunkerque / Lacaton & Vassal*. ArchDaily. <https://www.archdaily.com/475507/frac-of-the-north-region-lacaton-and-vassal?auth=hadid>

Anna, C. (n.d.). *ANNA Around the World - Cabin ANNA*. Cabin ANNA. <https://www.cabin-anna.com/portfolio>

Artificial Reef Units for Fish Habitat | REEF DESIGN LAB. (n.d.). REEF DESIGN LAB. <https://www.reefdesignlab.com/artificial-reef-units>

CBS. (2025, May 19). *Caribisch Nederland; bevolking; geslacht, leeftijd, burgerlijke staat*. Centraal Bureau Voor De Statistiek. <https://www.cbs.nl/nl-nl/cijfers/detail/83698NED>

Climate Innovation Window. (2025, August 8). *Climate Innovation Window - Modular vertical waterfront bioretention system*. <https://climateinnovationwindow.eu/innovations/modular-vertical-waterfront-bioretention-system/>

Daisy, H. M. / A. (n.d.). *Hurricane Omar, Bonaire 2008*. <https://daisyatsea.blogspot.com/2010/05/hurricane-omar-bonaire-2008.html>

DCBD. (n.d.). Dutch Caribbean Biodiversity Database. Retrieved November 30, 2025, from <https://www.dcbd.nl/>

De Meyer, K., MacRae, D. R., Raming, J., Eckrich, C., & Van Der Ploeg, J. (2022).

Bonaire National Marine Park Management Plan 2022-2028. STINAPA.

Domènech, L. (2023, October 2). 4 Friends' Apartment | Lola Domènech, Lussi + Partner AG. Arch2O.com. <https://www.arch2o.com/4-friends-apartment-lola-domenech-lussi/>

FuKuHiBo, & Antion, B. (n.d.). *Collectie*. Archive Bonaire. <https://www.archivoboneiru.com/>

Groenenboom, W. (2021). *Monument Bonaire* [Print version]. Blue Jay Holding Bonaire B.V.

Johnson, J. (2021, July 13). *Coral monitoring finds annual coral bleaching on Bonaire*. DCNA. <https://dcnanature.org/coral-bleaching-study/>

Johnson, J. (2022, May 9). *Blue Marine Foundation launches new partnership with Dutch Caribbean Nature Alliance - DCNA*. DCNA. <https://dcnanature.org/blue-marine-foundation/>

klimaattafel bonaire. (2025). *Intenshon di klima Boneiru*.

lacaton & vassal. (n.d.). <https://www.lacatonvassal.com/index.php?idp=21>

Lake, Flato Architects. (n.d.). *Marine Education Center at the Gulf Coast Research Laboratory*. Archello. <https://archello.com/project/marine-education-center>

Living Seawalls | REEF DESIGN LAB. (n.d.). REEF DESIGN LAB. <https://www.reefdesignlab.com/living-seawalls-boulders>

Nowlan, T., Scholey, K., & Butfield,

C. (Directors). (2025). *Ocean with David Attenborough* [Film]. Silverback Films; Open Planet Studios; National Geographic.

Oerlemans, A. (2025, May 21). In Breda wordt straks in een fabriek koraal gekweekt om wereldwijd stervende riffen te redden. *Change Inc*. <https://www.change.inc/ict/deze-start-up-wil-in-fabrieken-genoeg-koraal-kweken-om-overal-ter-wereld-stervende-riffen-te-redden-41343>

Orkidstudio · NKU. (2016). Divisare. <https://divisare.com/projects/319076-orkidstudio-nku>

Ott, C. (2024, July 4). *Merida House / Ludwig Godefroy Architecture*. ArchDaily. <https://www.archdaily.com/939016/merida-house-ludwig-godefroy-architecture>

Readfearn, G. (2025, October 13). Planet's first catastrophic climate tipping point reached, report says, with coral reefs facing 'widespread dieback.' *The Guardian*. <https://www.theguardian.com/environment/2025/oct/13/coral-reefs-ice-sheets-amazon-rainforest-tipping-point-global-heating-scientists-report>

Reef Renewal Bonaire. (n.d.). *REEF RENEWAL DIVER*.

Reef Renewal Foundation Bonaire. (2025, January 22). *Coral Breeding - Reef renewal Bonaire*. Reef Renewal Bonaire. <https://www.reefnewalbonaire.org/our-work/propagating-larvae/#1626975798270-4eed47cc-5179>

Sweers, C. N. (2025). *A perspective on community interaction in public waterfront spaces on Bonaire* [MSc Thesis, TU Delft - Architecture and the Built Environment].

https://repository.tudelft.nl/record/uuid:e3a18615-10ab-4842-a669-338aa3c68d0c?fbclid=IwczJoYwZhcHBfaWQQMjIyMDM5MTc4ODIwMDg5MgABHjvJtaa8sVhUmYnhfFpXM-Z_r7rlhTFEdq_

Taylor, B. (2023). *An Off-Grid Bass Coast farmhouse, designed for the elements*. The Design Files. https://thedesigndesignfiles.net/2023/08/architecture-bass-coast-farmhouse-wardle?utm_source=Pinterest&utm_medium=organic

Van Den Hoek, L. S., & Bayoumi, E. K. (2017). Importance, destruction and recovery of coral reefs. *IOSR Journal of Pharmacy and Biological Sciences*, 12(02), 59–63. <https://doi.org/10.9790/3008-1202025963>

Veron, J., Hoegh-Guldberg, O., Lenton, T., Lough, J., Obura, D., Pearce-Kelly, P., Sheppard, C., Spalding, M., Stafford-Smith, M., & Rogers, A. (2009). The coral reef crisis: The critical importance of <350ppm CO₂. *Marine Pollution Bulletin*, 58(10), 1428–1436. <https://doi.org/10.1016/j.marpolbul.2009.09.009>

Waterschap Rijn en IJssel. (2023). *INTEGRATED WATER MANAGEMENT ON BONAIRE: End report*. In *Klimaatadaptatienederland*. https://klimaatadaptatienederland.nl/publish/pages/221788/en_eindrapport_integraal_waterbeheer_op_bonaire_februari_2023-2.pdf

Zapico, B. (2025, June 13). *Centro de desarrollo Productivo Comunitario Las Tejedoras / Natura Futura + Juan Carlos Bamba*. ArchDaily En Español. <https://www.archdaily.cl/cl/999634/centro-de-desarrollo-productivo-comunitario-las-tejedoras-natura-futura-arquitectura-plus-juan-carlos-bamba>