

Transitional Territories Studio 2018-2020

MIND SCAPES



Healing Gardens

Nadine Walker

North Sea: Landscapes of Coexistence
Transitional Territories Studio 2018-2019

Final Report

to be presented at P.05 examination

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MINDSCAPES

& Healing Gardens

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* All drawings have been created by the author unless stated otherwise



To Noah & Len

for teaching me that true beauty lies in imperfection.

PREFACE.

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Abstract

Mental health issues are becoming ever-more common in contemporary societies as urban landscapes are over-stimulating and stress-inducing. Studies suggest that lacking access to green infrastructure may be a fundamental factor. In post-industrial cities and health care systems, nature's healing abilities are however commonly neglected and have only recently become subject to scientific research. This project explores how health is impacted by the built and natural environment.

Caused by the environmental crisis and dynamics of the global market, many European port cities are in transition leaving the territory vacant and afflicted with industrial leftovers. In Dunkerque, the former refinery grounds bordering the old harbour are such vacancy. Stricken with remnants of an industrial past, both structural and in form of contamination, they have been abandoned and become in a sense wild. At the same time, they are testimony to the city's relationship with the North Sea that has been shaped by its industrial heritage as well as historic war events drawing an invisible boundary between land and water.

Seizing the void, this project comprehends an *urban garden* and a mediator of health; environmental, socio-cultural and human health alike. As a novel form of green infrastructure it endeavours to renegotiate existing thresholds – between the inhabitant and the territory, the city and the port of Dunkerque, between land and sea – to become a piece of collective conscience of place, nature and health.

Through a sequence of gardens, the visitor is invited to reconnect to and explore the natural world present in a place so foreign to nature due to its anthropomorphic history and heritage. It is precisely this atmosphere that grants a new perspective on the vegetative actors of the place and not only stimulates a re-joining with the territory but also with the inner self. The territory itself is subject to remediation through the vegetation on site. Phytotechnologies degrade substances and allow a subtle opening of the site through time. By that, hitherto marginalised port areas and the North Sea foreshore are increasingly reconnected with the city converting the site into a link between land and sea.

Key words: bioremediation, garden, green infrastructure, industrial heritage, mental health.



Where is my Mind?

Image: *unknown*

Introduction

Where is my mind?

Too often I myself have wondered being part of a society with ever increasing requirements, higher goals and infinite standards. Long have I thought that I was a generally stressed person, have not considered the impact of the achievement-oriented, modern society I was brought up in. It was only through reflecting upon certain stress-related behaviour that I began to explore ways of stress reduction. Meditation, yoga, exercise in general... nowadays, everyone has heard of if not tried these tools to balance the challenges of every day life. Little did I know about the workings of the mind and it took until living in a metropolis like Melbourne, Australia to realise that there may be another deficit.

Nature is today often viewed as somewhat separate from us human beings. I'm particularly in urban environments, in which over half the global population is living today, nature in the form of vegetation has become an amenity. The fact that a stroll in the park around the corner (if you are lucky enough to live close to green infrastructure) is relaxing is undeniable and yet our relationship to the natural world has become rather superficial.

It is no wonder. For centuries now we as humans have colonised, utilised and depleted nature in its wild form. Agriculture, gardens, parks are all cultured versions of what the long forgotten ancient wilderness so that it is far from surprising that we no longer see ourselves as an intrinsic part of nature. As a result of this general loss of reverence, of appreciation and consideration humans have increasingly become deficient of nature.

Where is my mind? With this question I began the initial inquiry towards my graduation project almost two years ago. I had learned to look for it within through the practice of mindfulness. Though the dualism inherent in life, the search for constant balance, like yin and yang, propose to look for it without as well Where if not in nature would one be able to find it?

I am not the only one, and this drive outwards is far from novel as historical examples and recent research proof alike. The scientific basis for this connection between humans and the natural world and the so very apparent impact of nature on our health and well-being was the starting point for my theoretical exploration. Placed within the studio-specific geography of the North Sea, the most urbanised waterbody in the world, I was soon looking at health through the lens of scale, not only at humans but at the health of urban spaces, and ultimately the territory itself. This proposed to expand the spectrum of remediation from the mind to the territory, and what better case study is there than a shrinking city that exploited its land during its glorious industrial past, now left to deteriorate: Dunkerque, northern France.

So I wondered, if our health is so affected by our immediate surroundings, that is the built and natural environment, how could architecture bring together these different scales and synthesise them into a one place?

A fascination. A geography. A research question. A project. It's a garden - Mindscapes.

This book follows the path from my theoretical research to the design proposal. First it investigates the given geography; the North Sea, Dunkerque, and the former refinery grounds at the edge of the old port. Then it dives into the theoretical exploration of the three main research subjects; health, bioremediation, and gardens. And finally it orchestrates them into a proposal focussing on three main scales; landscape, architectural, and technical scale. Along the line, I introduce a myriad of actors - plants some of which have the ability to degrade petroleum hydrocarbons, others that are tolerant to the present of such contaminants, and finally those that will only thrive when the ground is rehabilitated. Concluding thoughts will look at the benefits and opportunities of the proposal and ultimately reflect on the responsibilities that we as architects have in dealing with the afflictions of our past for a more sustainable future.

Gratitude

As in life, so in design you may make a plan. But the reality is that all we plan for is a mere assumption dependent on a myriad of variables and subject to constant change. All my life, I have been making plans and many have become true, but not all. And for that I am grateful as true life cannot be planned, it can only be lived. From moment to moment, in the very present, a constant chain of changing conditions. Allowing the past to have passed and the future to remain forever unknown. I believe the infinite awe of nature to be the greatest teacher of such mindfulness. That is why nature with all its wonders is not only at the hearth of this project but should be the core of any healthy way of life.

First and foremost, I do thank my dearest Alex - you have taught me more about life than you could ever imagine and words cannot describe my gratitude for having you by my side.


With all my heart, I thank my parents for their endless love and support; for believing in me, never holding me back and being there when I did fall. And Niklas for being the greatest little brother - without your support I wouldn't have survived the past year.

Thanks to my girls for being the most wonderful constant of my life during the past ten odd years no matter where in the world you or I was.

Thanks to Fi, English Alex, Andreea, Danny, Ola for a lovely time in Delft both in and outside BK and beyond.

And finally, my sincerest gratitude goes to Taneha for being a marvellous teacher, mentor, motivator and for always always being on my side. To Nicola for his beautiful insights. To Sjaap for pushing me to unknown abilities. To Ellen for her ongoing support.

Danke. Thanks. Obrigada. Grazie. Bedankt.

A close-up photograph of Goldenrod (Solidago spp.) showing several yellow flower heads on green stems. The background is blurred, showing more of the plant. The image is overlaid with a semi-transparent grey box containing the text.

Goldenrod
Solidago spp.

RESEARCH.

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01 TERRITORIAL – NORTH SEA

Historical Context

The North Sea has greatly influenced European history being particularly accessible through its long coastline and the rivers emptying into it providing roads for commerce and conquest. Its waters have protected the British Isles from invasion from the Continent for more than a thousand years, while at the same time serving as a steppingstone for the conquest of overseas territories, making Britain one of the strongest and largest Empire until today.

The constant mixing of waters in the shallow sea basin provides a rich supply of nutrient salts upon which the lower forms of marine organisms—the basis of the sea's food chain—depend. The resulting abundance of plant and animal plankton supports a varied and rich supply of commercially valuable fish. For a long time, the North Sea has been one of Europe's most productive fisheries and provided a prominent shipping zone among European countries and between Europe and the Middle East. It was the scene of early development of maritime trade and gained particularly economic importance as extensive reserves of petroleum and natural gas were discovered beneath the seafloor.

The discovery of fossil resources beneath the seafloor began in 1959. In the following decades, natural gas production sites were constructed along kilometre-long stretches. Since then, the North Sea has become western Europe's most important oil and gas production area, yielding high-quality crude oil with a low-sulfur content. Being one of the busiest shipping areas in the world, merchant vessels must share space with fishing vessels and offshore oil and gas platforms.

Territorial Analysis

As a shared territory, the North Sea and its transition underlies the externalities, systems of relations, its thresholds and limits. These are best investigated under the lens of different subjects; most notably, its economy and flows, infrastructure, ground conditions, habitat and climate¹.

The following analysis illustrates the existing conditions of the North Sea and outlines the effects on the environment. With an eye to *health* – on a territorial scale, that is the 'wholeness' of its ecology on both land and sea – it becomes ever-more evident how the many different conditions and processes are interlinked with one another, and agents of change act across national boundaries and in turn affect the urban morphology of both the land and the sea. This is particularly visible in the southern North Sea, where industry and infrastructure have shaped the territory across scales².

Having been an economic driver above all, the North Sea has experienced an enormous and continuous growth throughout the past centuries. With the industry grew its cities and infrastructure such as roads, rail networks and most significantly ports. Though, resources have meanwhile been increasingly exploited as the level of the western European economy has risen. Along with volume of shipping still growing it generates great problems of pollution from operational discharges as well as from accidents. Land-based pollution, including the dumping of sewage and industrial wastes, is also a serious problem, particularly in the southern part of the North Sea where increasing urbanisation along the coastal fringe has consistently compromised the North Sea ecology on land and sea alike. Eutrophication³ is only one of the issues, and is most notable in the south of the North Sea where heavy industry and large urban agglomerations prevail. At the same time, industrial activities are leading to the growing of natural resources – deforestation on land, sea grass harvesting on sea; overfishing, sand, oil and gas extraction – and some of them have yet reached their limit.

¹ The North Sea and its adjoining bodies of water constitute one of the major forces of climate issues in the region. Nonetheless, the impact needs to be seen and analysed more locally, as each of these localities is impacted differently by climate change, further exacerbating issues of inequality and risk within the individual microclimates. For the scope of the present research, this subject is therefore largely disregarded and will be resumed at a later stage on a more localised scale. – adapted from *Atlas – New Geographies*, 2018.

² The initial territorial analysis was conducted prior to the selection of a project location. In light of this report and in order to gain a more project-specific evaluation, it has been revisited and adapted.

³ *Eutrophication* describes when a body of water becomes overly enriched with minerals and nutrients. This commonly leads to an excessive growth of plants and algae resulting in oxygen depletion.

Economy

Historically, the North Sea, most of all the extreme south, has been a political and socio-economic driver forming a framework for urban growth. Its economy is defined by its surface for transport, its marine life, the oil and gas lying under the sea bed, and more recently the wind currents in its atmosphere. The history of the bordering nations has been defined by their interactions with sea scale as being traders, invaders, fishermen, and extractors. Particularly during wake of the fossil fuel and the era of industrialisation, port cities experienced a paradigm development and formed an interface for trade and logistics both internationally and inter-continentially.

Today, the North Sea is yet the busiest shipping corridor and some of the most heavily fished, trawled and extracted waters in the world. While its wealth attracts people and businesses from across the world, financial centres such as London and Frankfurt and production centres such as the Rhine Industrial Region continually increase the flow of raw materials and waste across and into the North Sea making its water busier than ever before.

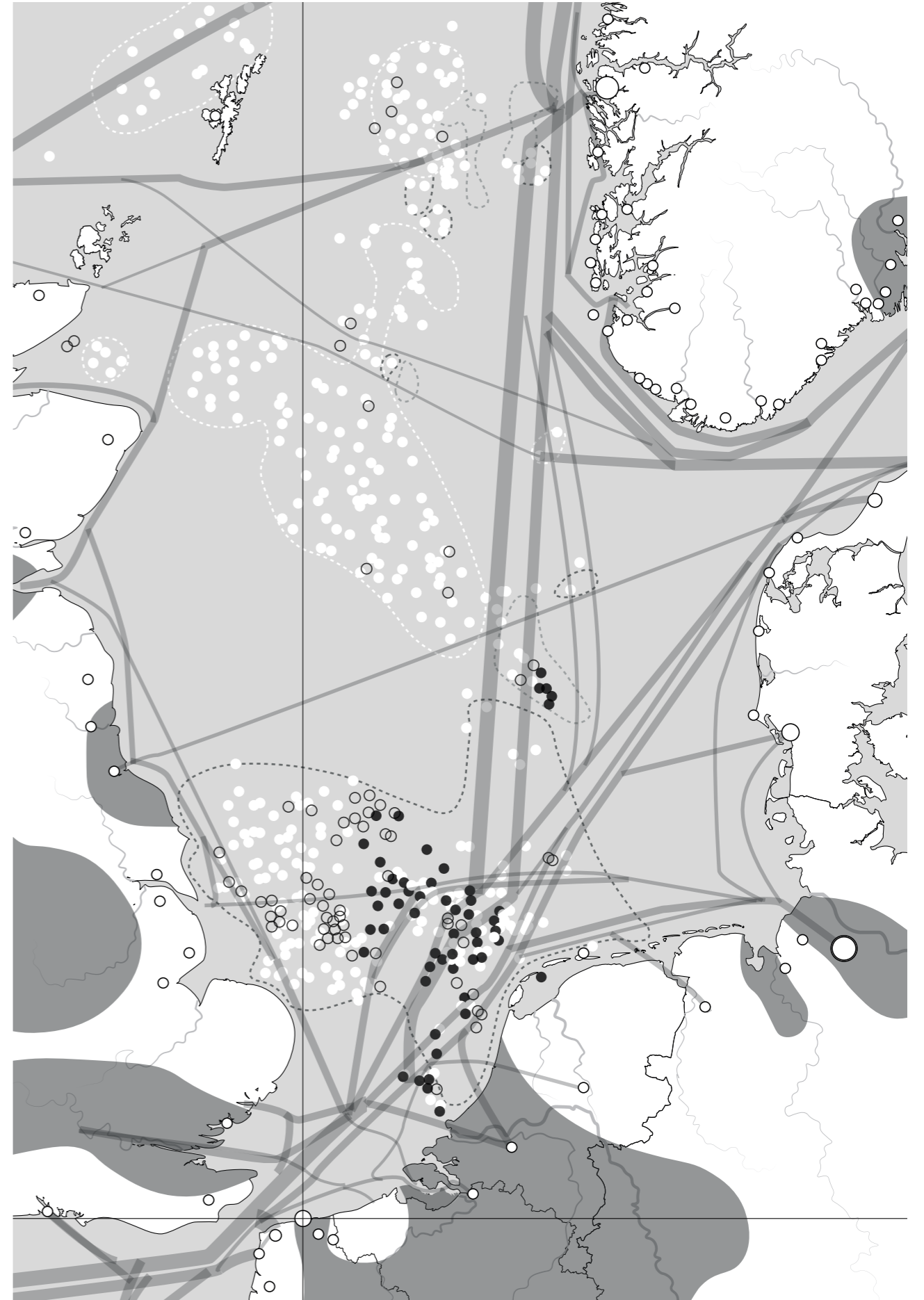
With ships growing bigger, so do the port. Out on the sea, countless decommissioned oil and gas platform remain while new ones still continue to populate the territory along with ever-increasing numbers of wind parks.

Adapted from *Atlas – New Geographies*, 2018.

Ports and Industry

1:5,000,000
 adapted from *Atlas - New Geographies* (2018)

- ▨ Industrial area
- Ports
- - Shipping route
- EEZ border
- ⋯ Oil/ gas field
- Existing oil rig
- Projected oil rig
- Decommissioned oil rig



Ecology

The destruction, pollution and exploitation of our natural landscapes is most visible on land yet not limited to. Marine environments are more than ever under threat. The ecology of the North Sea is a highly complex and interrelated system, kept in balance through the continuous adaptation of its biotic counterparts to their abiotic environment, which in turn fluctuates and is affected by external stimuli. These external conditions are often a result of anthropogenic practices – such as coastal urbanisation, mass-fishing and energy production – and climatic alterations as a symptom of the former practices. When those conditions, however, exceed ecological limits, the balance of coastal and maritime biotopes begin to degrade or even collapse.

The nutrient balance as it is directly affected by urbanisation and both industrial and agricultural run-off; the conditions of seabed habitats and their consequent reparation; fishing practices; energy generation; and economic activity, with ships being one the main sources of pollution via discharges, oil spills, and carbon emissions, and offshore oil and gas installations being subject to chronic oil spills, and eutrophication. All these, in turn, determine the North Sea's biodiversity.

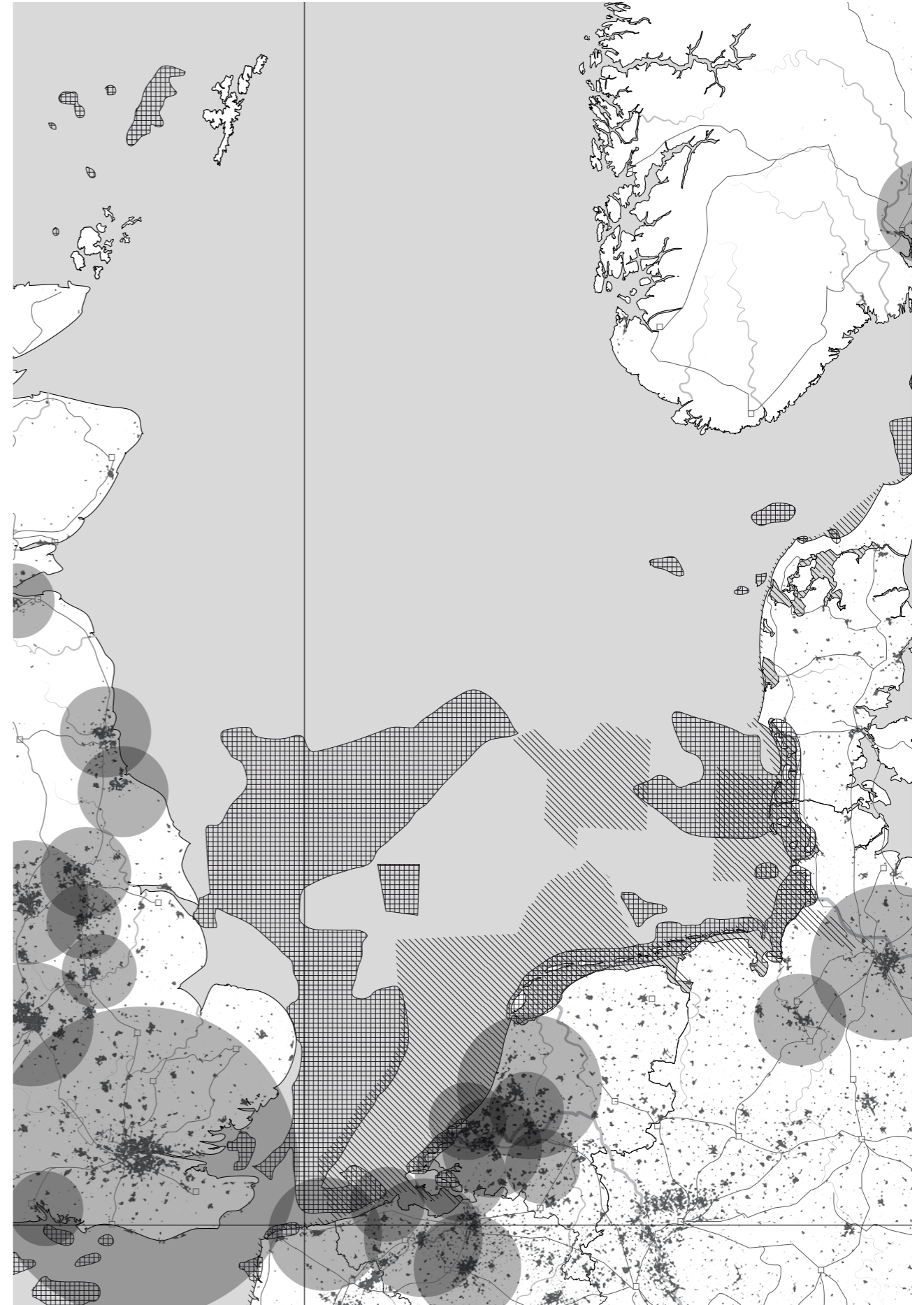
However, inactive oil and gas rigs and structures of offshore wind farms can function as a habitat for marine life, particularly certain reef species. It moreover limits fishing practices being fishing-free zones, as do Natura 2000 areas which offer a protected nature area and limits fishing to certain seasons, using only sustainable methods.

Adapted from *Atlas – New Geographies*, 2018.

Effects of Urbanisation

1:5,000,000
adapted from *Atlas - New Geographies* (2018)

- Urbanisation
- ▨ Densely populated area
- ▧ Natura 2000
- ▩ Eutrophication



Green Infrastructure

The Natura 2000 network is at the core of the European Union's green infrastructure. In France, there are 1.758 Natura 2000 sites, some 12.7 per cent of the national land area being below the EU average of 18.1 per cent¹. In total, some 167.000 km² of France's national territory is *green*, that is 26 per cent. In recent years, France has established a programme to streamline environmental conservation on a national level. In this course, 51 Regional Nature Parks (*Parcs naturels régionaux*) have been created throughout France to date, protecting rural areas with valuable landscapes, natural areas and cultural heritage. Such parks, however, rely on extensive sustainable development plans allowing the protection and promotion of their resources.

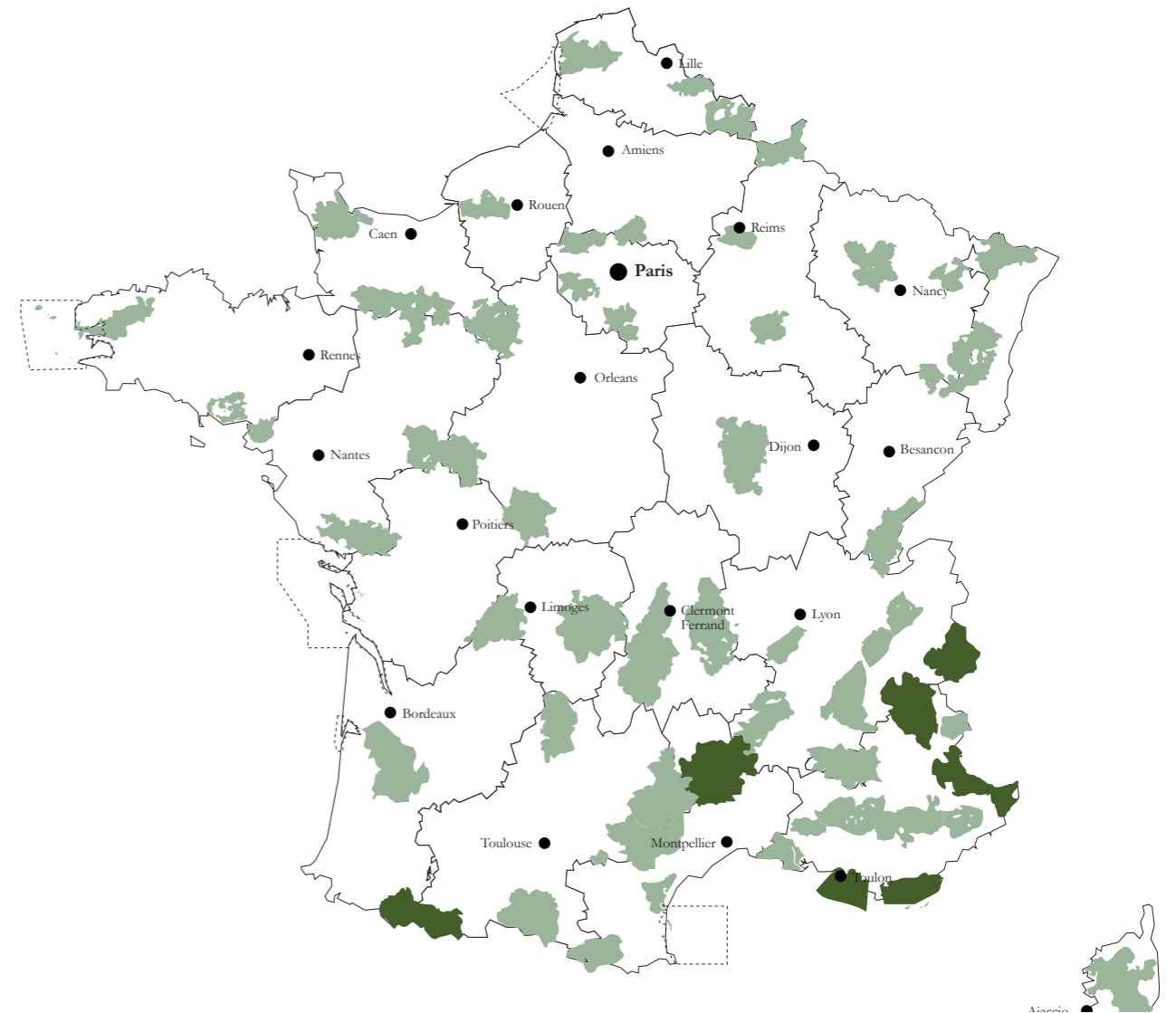
Since 1975, the *Conservatoire du Littoral*, a public administrative body, conducts appropriate land-use policies for the protection of threatened natural areas and purchases fragile or threatened land. Acquired sites are restored, i.e. dunes being stabilised, forestry restored. The organisation moreover engages in water management, guided walks, and oversees the maintenance and development of traditional activities².

In a recent survey, the top ten greenest cities in France were were Angers, Nantes, Strasbourg, Lyon and Caen, Rennes, Limoges, Nîmes, Reims, and Amions³.

¹ European Commission, 2017.

² Mazza et al., in *Biodiversity.europa.eu*, 2018.

³ World Urban Parks, 2017.



Green Infrastructure in France

adapted from *parcs-naturels-regionaux.fr*

- National Parks
- Regional Parks
- ⋯ Marine Parks



01 TERRITORIAL – NORTH SEA

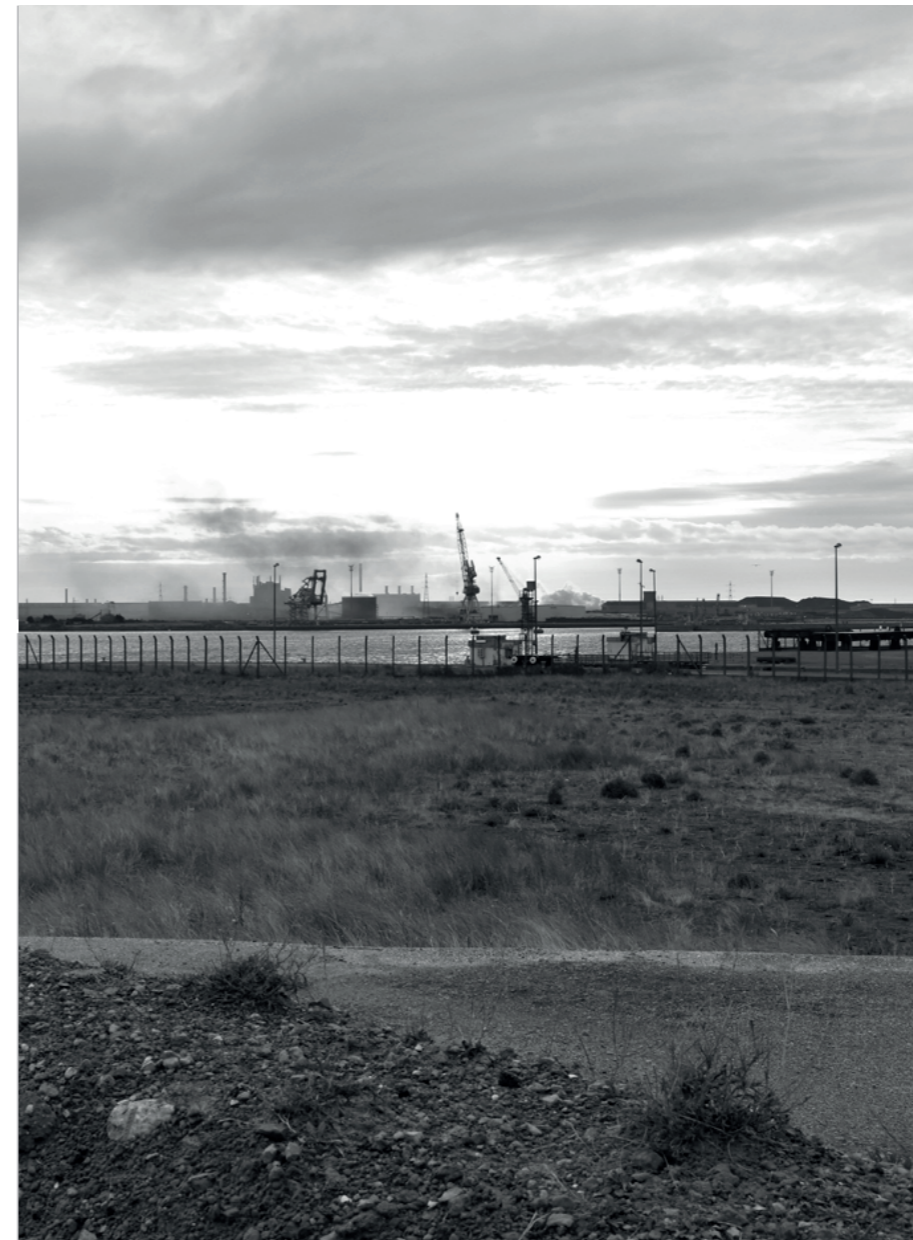
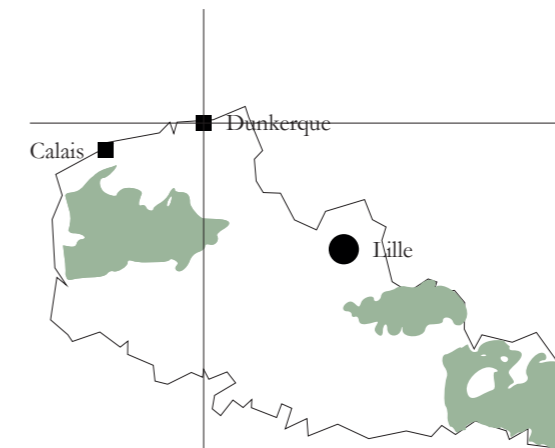
Problem Statement

As a highly urbanised waterbody, the North Sea has long formed the centre of northern Europe; politically, economically, logistically and ecological. Consequently, the once rich ecosystem and its flora and fauna is increasingly compromised, and its health threatened. Extraction, industry and coastal urbanisation result in resource depletion and pollution both on land and sea.

While about one quarter of France's territory is *green*, conservation areas remain rare and are well under the European average. National and regional parks often lack corridors to connect them with one another and with green infrastructure in urban areas. Awareness is growing, both of the significance of ecosystems and its role in maintaining a balanced, healthy environment. Yet too rarely are purely ecological visions compatible with the primary global drivers; economy and society. Therefore, projects require an economic viability which often results in large scale interventions with little room for individual adaptation.

Research Question

What kind of green infrastructure intervention can foster remediation and decontamination of the North Sea ecosystem (coastal land) while providing a wider economical benefit?



Green Infrastructure in Nord-Pas-de-Calais

adapted from parcs-naturels-regionaux.fr

■ Regional Parks

Port of Dunkerque

Industrial Landscape
Photo: *author*

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02 URBAN – DUNKERQUE

Historical Context

First mentioned as a fishing village in the 7th century, Dunkerque makes history for over a millennium. The small settlement quickly developed into a town and its port into a corsair base, and lastly, with the industrial revolution, into the city we see today. Over many centuries Dunkerque was handed back and forth between the different kings ruling over Europe, and changed from being Spanish to Dutch, to English, until in 1662, the English king finally sold the city to France. Hitherto, the city had experienced countless violent disputes, conflicts and battles leaving behind scars on territory and its people.

Since the middle of the 19th century, Dunkerque increasingly grew into a large port in order to compete with neighbouring port cities like Antwerp and Le Havre. Technological advances like the steamship and infrastructural expansion, in particular the construction of the rail line, accelerated Dunkerque's growth and shaped its town, its people and its identity. Though, its economic and infrastructural position made it a strategic aim during the world wars, leaving large parts of its port facilities completely destroyed. It was mainly through the initiative of large oil companies, that the port was rebuilt for a second time in the 1950s. From then onwards it expanded westwards and was increasingly detached from the city itself. Industry, in particular oil, remains to define the city's identity and many inhabitants are reliant on large, adjacent companies. Due to the recent shift away from heavy industry and within the energy sector, the population of Dunkerque is increasingly shrinking. This is particularly owed to a lack of jobs and perspectives for young people and a subsequent demographic transition.

Rehabilitation and regeneration of the city, its population as well as new economic perspectives are greatly dependent on the territory. This is however burdened by centuries worth of pollution and ground contamination through heavy industry and related life styles – its connection to petroleum had shaped Dunkerque to a largely car-based city. This pollution accounts for land and sea territory likewise. Eutrophication is greatest in the south of the North Sea where heavy industry and large urban agglomerations prevail. Dunkerque's relationship with the North Sea has been shaped by both its industrial heritage and historic war events drawing an invisible boundary between land and water. A closer analysis of the city and the chosen site aims to understand this relationship better and reconnect them with one another.

Urban Analysis

Dunkerque's industrial and war history is yet highly felt and visible throughout the city until today. Still a largely industrial city with meanwhile nearly 100,000 inhabitants, the city is increasingly losing in popularity. Was it yet thriving only some fifty years ago, Dunkerque has meanwhile become a shrinking and aging city. Unemployment is rising as industries move away and more and more sites are abandoned. Along with the infrastructural remnants of the past, these urban voids further compromise the urban tissue and with negative impacts on the overall well-being of its inhabitants. The offer of culture and entertainment is small as is the supply in public space, particularly green infrastructure, as illustrated in the following section.

Spatially, the city is largely disconnected from its surrounding neighbourhoods, particularly towards the east where the old port – at great parts obsolete – draws a wedge between housing and waterfront. This is even amplified by the infrastructural boundaries, roads and rail lines, that disconnect the areas from one another. In this light, above all the old docks are therefore spatially and from a regeneration point of view valuable. Also from an ecological perspective, this area has great potential. Although the former refinery grounds that adjoin dock #6, most eastward from the city centre (like many former industrial sites) are highly contaminated, an enormous array of flora and fauna has found here a new habitat since its abandonment. As a result, the grounds have been assigned a *Zone naturelle d'intérêt écologique, faunistique et floristique*¹.

¹ *Zone naturelle d'intérêt écologique, faunistique et floristique* (ZNIEFF), or 'Natural zone of ecological interest, fauna and flora' is a designation for a type of natural environment awarded on the basis of the presence of certain species within a certain area.



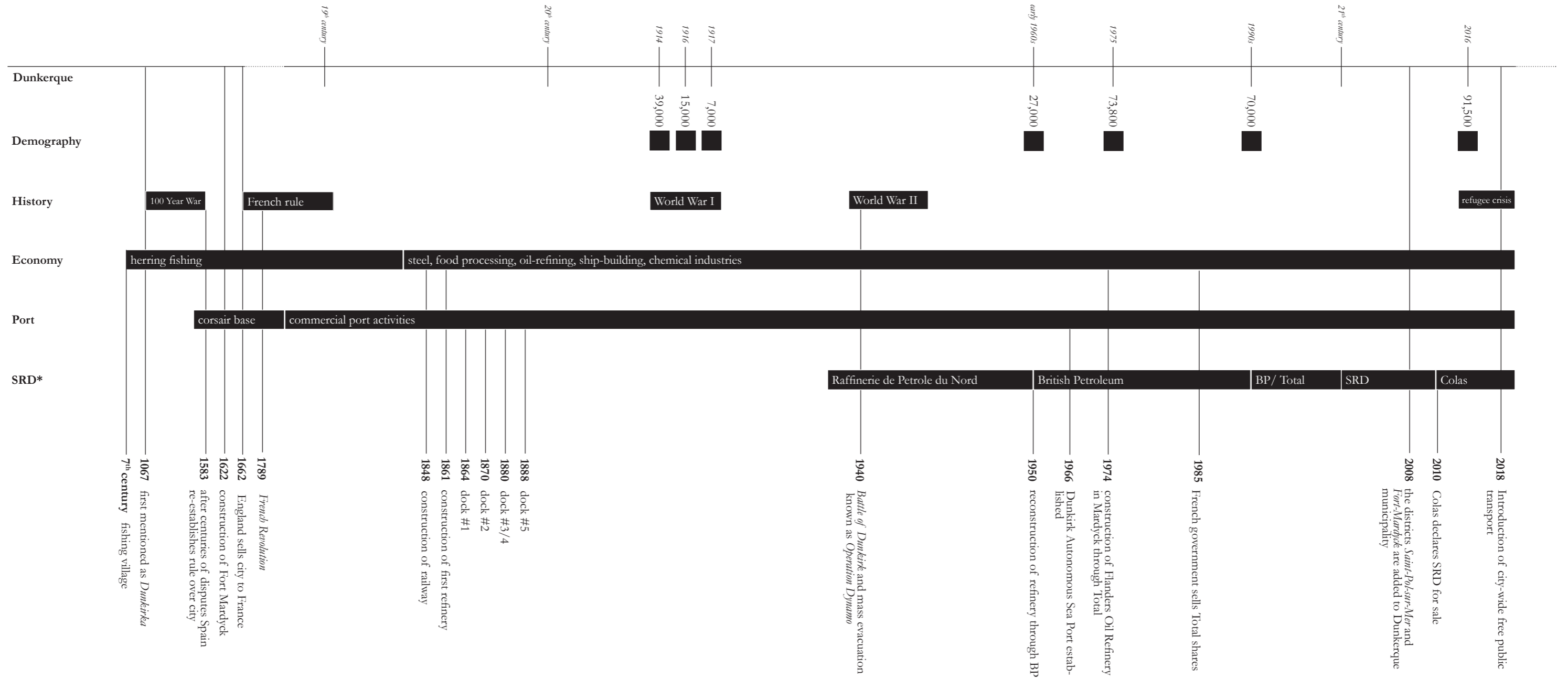
Dunkerque

Site Analysis
adapted from Google Maps (2018)

- Historic Centre
- ⋯ Site
- 01 City Centre
- 02 Town Hall
- 03 Main Train Station
- 04 Museum Dunkerque 1940 Operation
Dynamo
- 05 Sculpture Garden
- 06 Grand Port Maritime
- 07 Musée Portuaire de Dunkerque
- 08 Aquarium
- 09 Plage Malo-Les-Bains
- 10 Recreation Centre
- 11 Recycling Centre
- 12 Lighthouse
- 13 Old docks
- 14 Rubis Terminal
- 15 Societe De La Raffinerie de
Dunkerque
- 16 Arcelor Mittal
- 17 Parc Zoologique de Fort Mardyck
- 18 Total



Historic Timeline



* Societe De La Raffinerie de Dunkerque

World Wars

Due to its coastal location approximate to the borders of three European powers, Dunkerque has not only been the site of commerce and travel for many centuries but also numerous bloody battles. Between 1914 and 1918, Dunkerque was hit by over 5000 bombs hitting the docks, ships and locks. World War I damped the continuous growth of the previous century and both the draft of nearly the entire work force and the horrors of the air raids quartered the population in only a few years. After the war, the city reconstructed the destroyed port in nearly the same way as a century before.

Construction were still going when World War II broke out. In 1940, most notably, the city was almost entirely destroyed in the ongoing fights between Nazi Germany and Allies during the *Battle of Dunkerque*, which followed by the infamous evacuation of the British troops known as *Operation Dynamo*¹. Following the war, the main initiative for reconstruction came from the oil companies.

¹ worldwar2heritage.com, 2018.

Battle of Dunkirk

City is over 90 per cent destroyed.

Photo: *Etablissement de Communication et de Production Audiovisuelle de la Défense*

Operation Dynamo

Soldiers await evacuation on the beach, 1940.

Photo: *Hulton Archiv*



Infrastructure

Dunkerque's road network has largely developed during the post-war boom of the automobile and accelerated by the local oil industry. Until the early 2000s, the number of cars increase to nearly one per adult. Since September 2018, public buses are free of charge making Dunkerque 'the largest metropolitan area in France and Europe to introduce free for all on its entire bus network'¹, a response to ongoing economic decline, unemployment and a dwindling population.

Rail tracks and roads define form boundaries. Most notably is this conditions at the threshold of the city and the old docks where they were used to transport cargo to and from the port its. Today, many of these rail lines are abandoned and in a sense wild. These vacancies are both an opportunity and constraint holding spatial and aesthetic qualities and yet are often viewed negatively. For flora and fauna, those qualities lie in the present, manifesting in a realm for expansion and growth without limits – the so-called 'urban wilderness'².

For Dunkerque's inhabitants, in contrast, accessible green infrastructure such as public green spaces, parks and garden are rare.

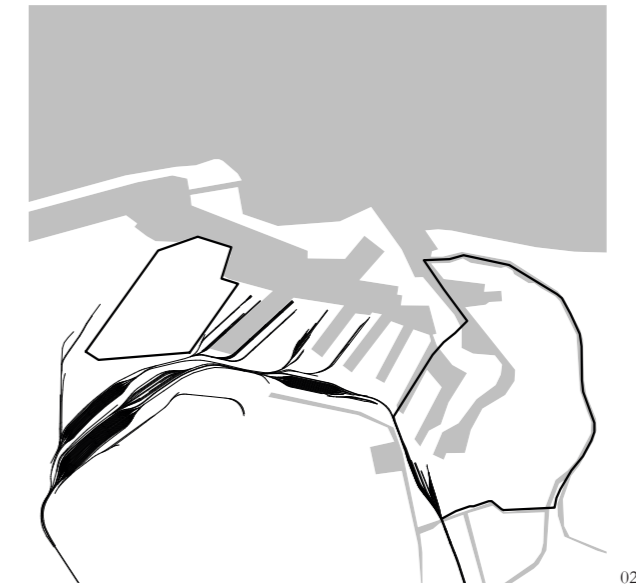
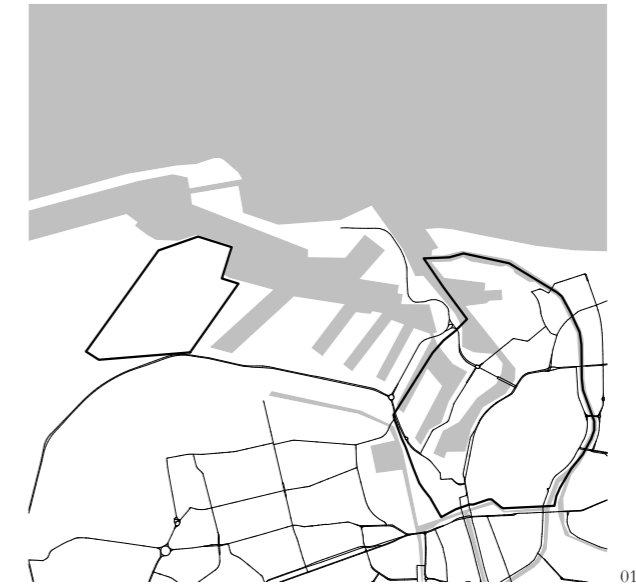
¹ Patrice Vergriete, Mayor of Dunkirk, in *eltis.org*, 2018.

² I. Kowarik, *Urban Wilderness: Supply, Demand, and Access*, 2018.

Infrastructure

Urban Analysis

- 01 Road Network
- 02 Rail Lines
- 03 Green Spaces



02 URBAN – DUNKERQUE

Problem Statement

¹ *Les Echo*, 2018.

Like many port cities, Dunkerque had its prime during the industrial era of the 19th and 20th century and is exemplary for the ongoing transitions of the North Sea territory. The continuing economic growth made the city third largest port in France providing its inhabitants with jobs and opportunities. The industrial activities of the past, on one hand, have shaped the place drawing an invisible boundary between land and sea. On the other hand, two World Wars have irrefutably left their scars. Historically, the city centre and the port have formed a unified whole; socially, economically and spatially. Though along with the post-war boom of the automobile, the vast expansions of the second half of the 20th century shifted the industrial centre westwards and drove a wedge between port and city.

Today a shrinking city, Dunkerque is increasingly confronted with the voids of its industrial history. The old port deprived of its original function as well as countless residential properties across the city have been abandoned. These voids, largely contaminated, are paradigmatic for the destruction and pollution of the natural environment throughout the last centuries. As many sites around the port, the former SDR refinery grounds are heavily polluted restricting their usability and flexibility as well as decreasing the land value. At the same time, Dunkerque has a lack of green infrastructure providing recreational spaces to its inhabitants and habitat for flora and fauna. It is not by chance the city does not even appear in the statistics for Frances most livable cities¹.

Research Question

What kind of architectural intervention can 'bridge' the invisible boundary between land and water on one hand, and between the city and the port on the other hand?

Dunkerque
Views of the harbour and the city
Photos: *unknown*



03 SITE

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03 SITE

Societe De La Raffinerie de Dunkerque

The oil refinery once was one of the most important industries of Dunkerque. Since the turn of the century, the approximately 100 ha site in the north-west of city had been occupied by a refinery. Twice – after total destruction during each world war – its facilities were rebuilt. First, in 1932, it was Belgian company PetroFina that founded here the *Raffinerie des Petroles du Nord*. In 1950, meanwhile bought off by British Petroleum, the refinery was once more rebuilt and updated. For most of its time, it specialised in the production of bases for oils and lubricants, bitumen and paraffin. However, from 1981 onwards, after the construction of a new Total refinery in Flanders, its production was reduced to only lubricants.

Today, the former refinery grounds are vacant. From 2001 onwards, it has been managed by the Dunkerque Refinery Company (SRD) until mid-2010, French civil-engineering company Colas acquired 100 per cent of share capital in the Société de la Raffinerie de Dunkerque and put it on sale. However, after the refinery did not find any takers it was closed early 2017. Since its abandonment, the site has been monitored and surveyed. Several kinds of ground contaminations have been found including hydrocarbons, chrome, copper, mercury, nickel, arsenic, lead, zinc.

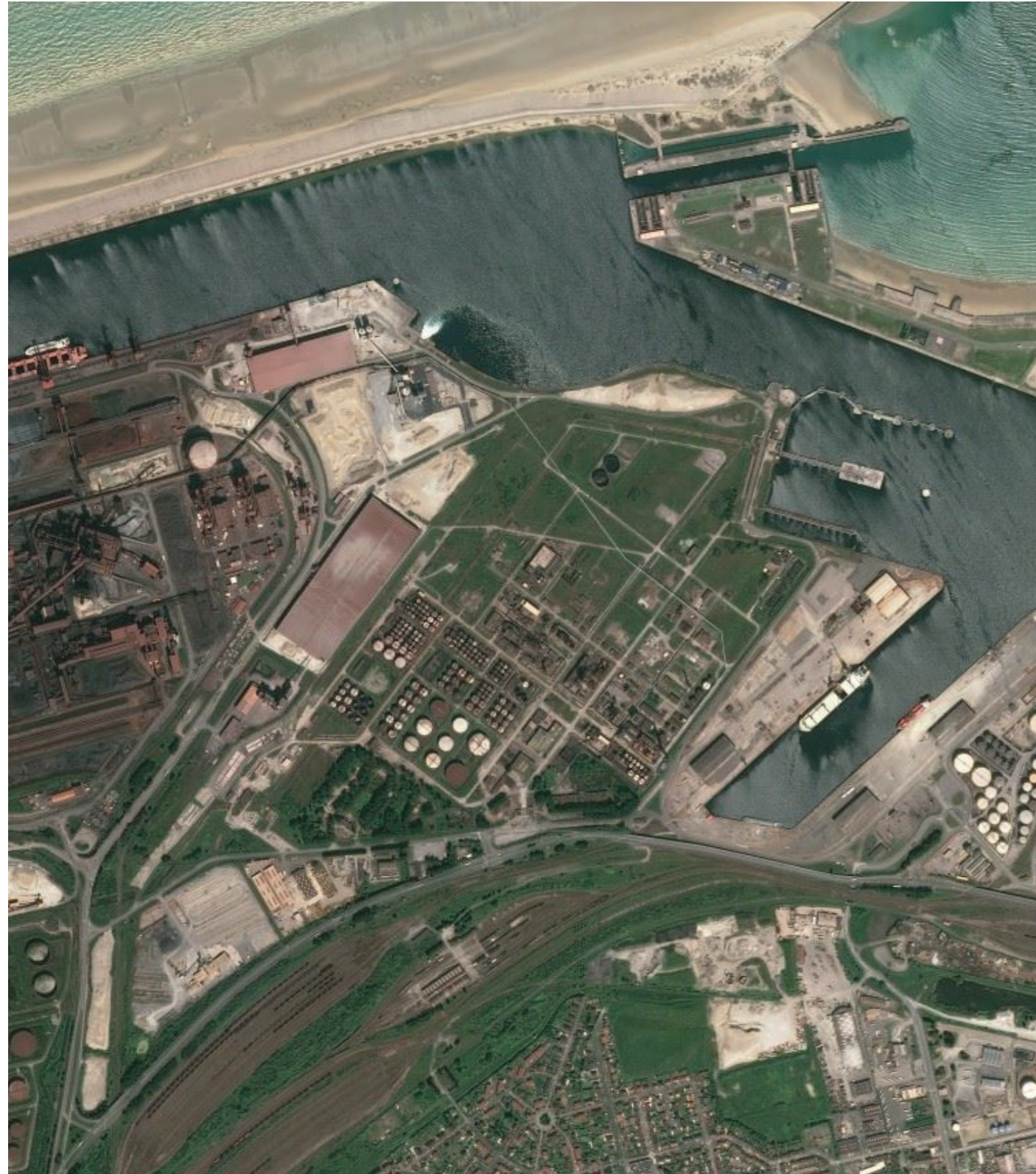
Oil Refinery

Photo: unknown

SRD during late 1950s

Photo: Marc Demeure





Aerial View
 Image: bing.com/maps



Structures
 Photographed during Site Visit.

03 SITE

Problem Statement

¹ The term 'wild' here refers to a so-called novel wilderness which naturally emerges in abandoned spaces, brown fields and urban voids.

The grounds of the *Societe De La Raffinerie de Dunkerque* have a nearly one hundred year history of oil-based production activity. This has left traces both visible and invisible: a myriad of structure above ground are left abandoned after they exceeded their use. Beneath the surface and imperceivable, one can only guess the extend of pollution as a result of industrial occupation. It can be assumed that large areas of the site are highly contaminated through petroleum hydrocarbons and likely traces of heavy metal.

Through the monopolisation, relocation and expansion of the port towards the west, however, the site's once highly economical position near the city centre and the main lock has now lost its significance. Despite Dunkerque being a dwindling city, the old port experiences a wave of rehabilitation and gentrification as more and more industries move. Though availability and usability of this newly opened up land to the public is confined and a process of transition into a once more healthy landscape must be undergone before

Research Questions

1. *To what extend can the industrial leftover structures and objects on site, both habitable and inhabitable, become integrative part of the design?*
2. *How can the existing 'wild'¹ nature and a newly created cultivated one synthesise into novel form of garden, and what would such a garden look like?*
1. *How does a health-informed programme spatially and structurally manifest within the framework of a garden?*

Dunkerque

Views of the harbour and the city
Photos: *unknown*

04 THEORETICAL

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HEALTH

[noun] from Old English *hælp* – ‘wholeness, a being whole, sound or well’

¹ World Health Organisation, 1948.

² Today, commonly experienced health issues include depression and obesity, heart disease, diabetes, asthma, migraines, allergies, pervasive near-sightedness, stress, attention deficit syndromes, anxiety and digital addictions, all of which have an enormous impact on our nervous, endocrine, and immune systems and therefore on our overall health.

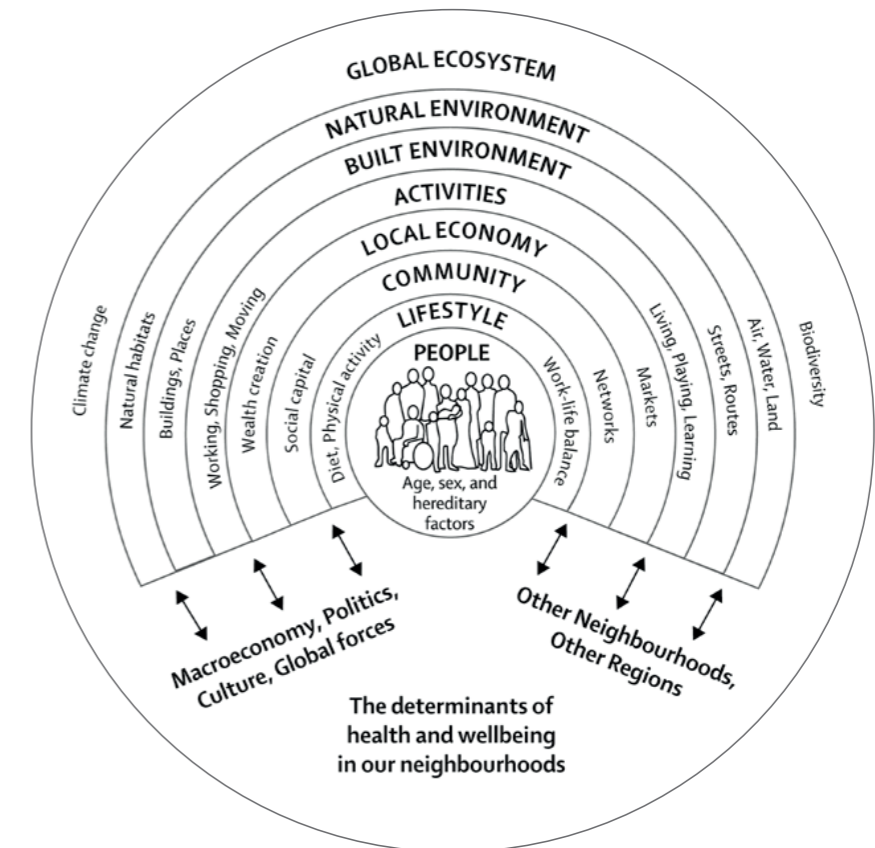
³ ‘Ethics is nothing other than Reverence for Life. Reverence for Life affords me my fundamental principle of morality, namely, that good consists in maintaining, assisting and enhancing life, and to destroy, to harm or to hinder life is evil.’
– Albert Schweitzer

⁴ C. Arvay, *The Biophilia Effect: A Scientific and Spiritual Exploration of the Healing Bond between Humans and Nature*, 2018; G. N. Bratman et al., *Nature Experience Reduces Rumination and Subgenual Prefrontal Cortex Activation*, 2015; S. R. Kellert, J. H. Heerwagen, M. L. Mador, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*, 2008; R. S. Ulrich, *View through a Window may Influence Recovery from Surgery*, 1984;

The project typically departs from the subject matter of health and well-being, and more specifically mental health, and how it is affected by the built and natural environment. Generally, the term depicts a) the condition of being sound in body, mind, or spirit, or b) the general condition of the body. As such, health is commonly described as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’¹. A shift in public health over the last century has manifested in the eradication of near all infectious diseases. Though it was a mere transposition to an equally daunting array of so-called non-communicable diseases². Mental health has become a tremendous issue in contemporary societies and cities, which are far from conducive to human, physical and mental health and well-being.

This evolution is frequently linked to urbanisation, and studies suggest that lacking access to green infrastructure may be a fundamental factor. Our independence from nature for sustenance, and general disconnection of it within urban contexts has led to a loss of ‘reverence’³, responsibility and stewardship for natural environments, and neglecting its healing benefits for ourselves. Our own health and that of environs across all scales are greatly connected with one another. The *Health Map* puts biosphere, landscape, and natural environment at the foundation of health and well-being. In an urban environment, parks and green spaces do not only immediately improve the air, water and soil quality which in turn contributes to our overall health. They more directly invite the inhabitant to spend time outdoors where sunlight provides much needed vitamin D, naturally stabilising our melatonin levels which are offset by spending long hours indoors and in front of screens. Moreover, certain colours and fractal shapes of plants trigger neuro-chemicals in our brain. In fact, any exposure to natural sounds and smells, even images, have shown to stimulate the parasympathetic nervous system, which facilitates relaxation and regeneration⁴.

On a wider scope, *health* may refer not only to humans but can be applied to different scales of interest. In the light of this project, these encompass the territorial scale (environmental/ecological health), the urban scale (socio-cultural health), and the body/ mind scale (human health).



Health Map

Barton & Grant (2006)
after a concept by Dahlgren & Whitehead (1991)

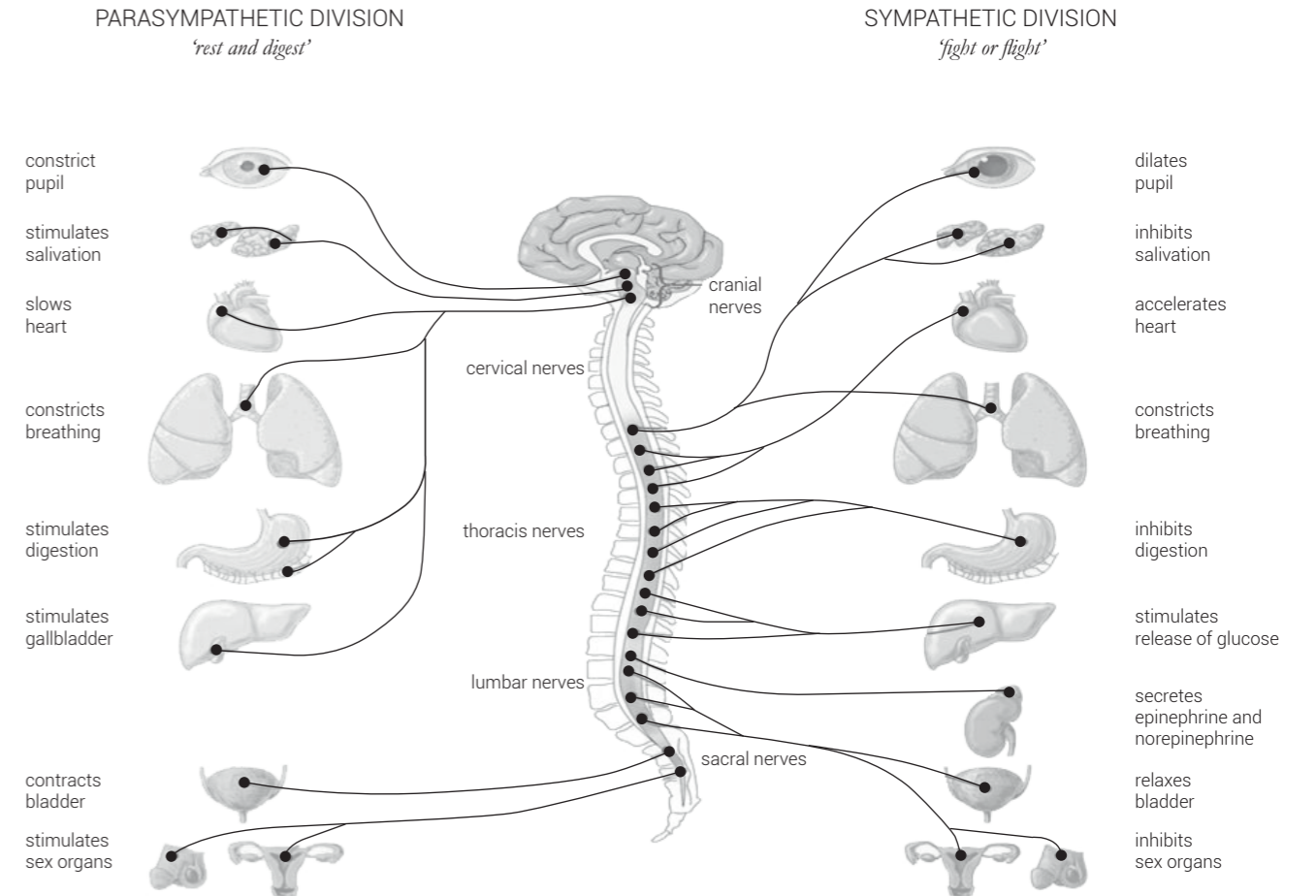
Mental Health

Non-communicable diseases are driven by environmental forces such as urbanisation and globalisation and related 'lifestyles' choices; a disease associated with the way an individual, or a group of individuals lives. Commonly experienced health issues include obesity, heart disease, diabetes, asthma, migraines, allergies, pervasive near-sightedness, depression stress, attention deficit syndromes, anxiety and digital addictions, all of which have an enormous impact on our nervous, endocrine, and immune systems and therefore on our overall health.

While some of these diseases are by definition of a mental kind, all are somewhat impacting the psychological well-being of a person whether she is experiencing an addiction or heart disease. It is difficult categorising between strictly physical or mental conditions. In the end, our nervous system is the origin for all of them.

Autonomic Nervous System

Diagram



Biophilia

Arguments towards the direct relationship between the prevalent shift in public health and human's disconnection with nature, is further provided by the biophilia theory of American biologist, Edward O. Wilson. He suggests that humans biologically tend to favour a presence of nature in their immediate surroundings¹. Some ten years before Wilson, psychoanalyst Erich Fromm coined the term biophilia – from Greek *bios* meaning 'life', and *philia* meaning '(fraternal) love' – the innate and genetically determined tendency of human beings to affiliate with any form of life. He writes, 'Man is biologically endowed with the capacity for biophilia'².

This assertion stands in direct relation to human's divergence from and systematic destruction of the natural world which has occurred in parallel with the technological developments, industrialisation and urbanisation of the past centuries. This has fundamentally changed human interactions with nature. The two phenomena, biophilia and necrophilia, as defined by Fromm, suggest a possible equilibrium, both physically and mentally, of human beings and their natural environment. Today, most notably in urban environments, this equilibrium has arguably been lost.

¹ E. O. Wilson, *Biophilia*, 1984; S. R. Kellert & E. O. Wilson, *The Biophilia Hypothesis*, 1993; S. R. Kellert, J. H. Heerwagen, M. L. Mador, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*, 2008.

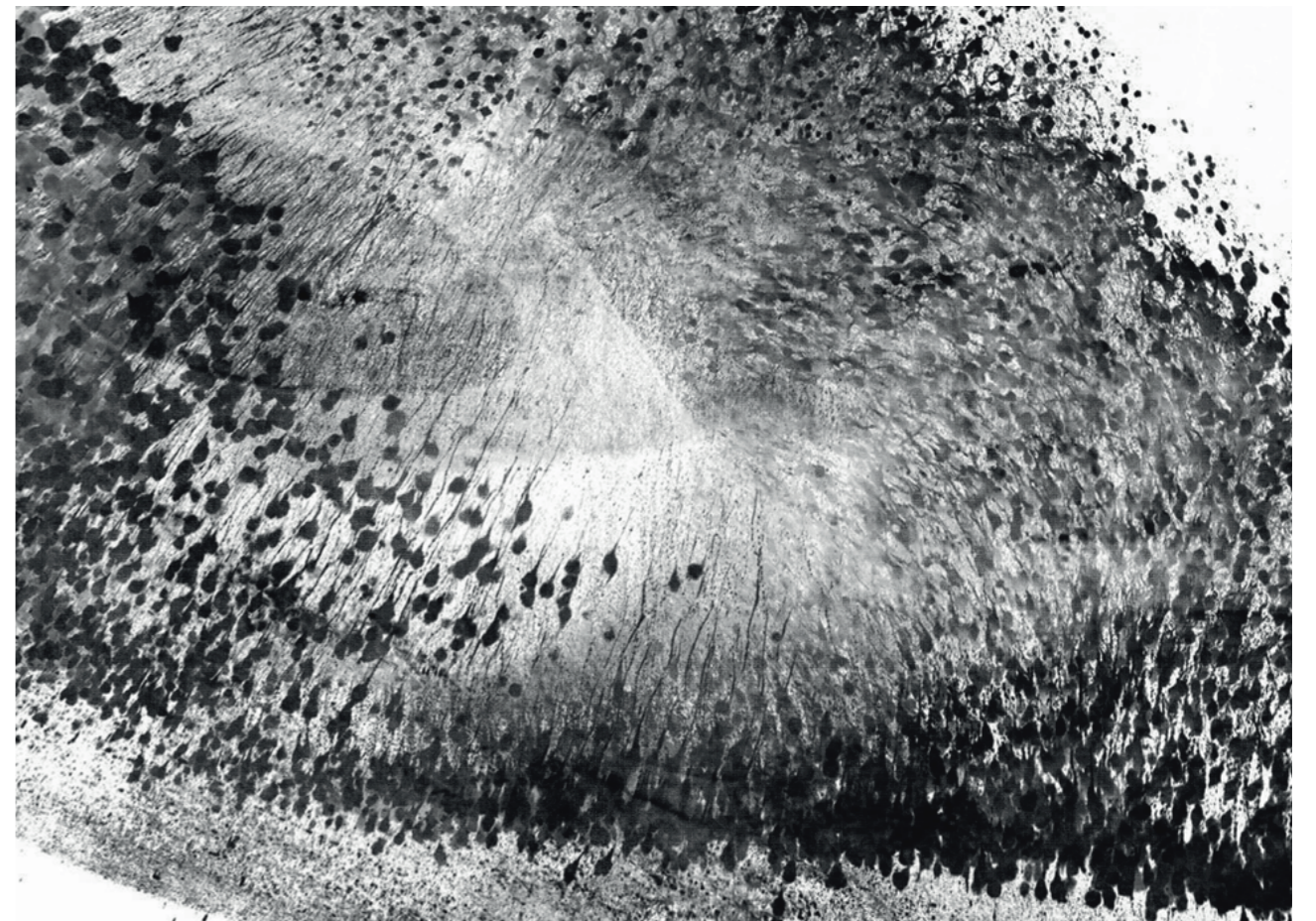
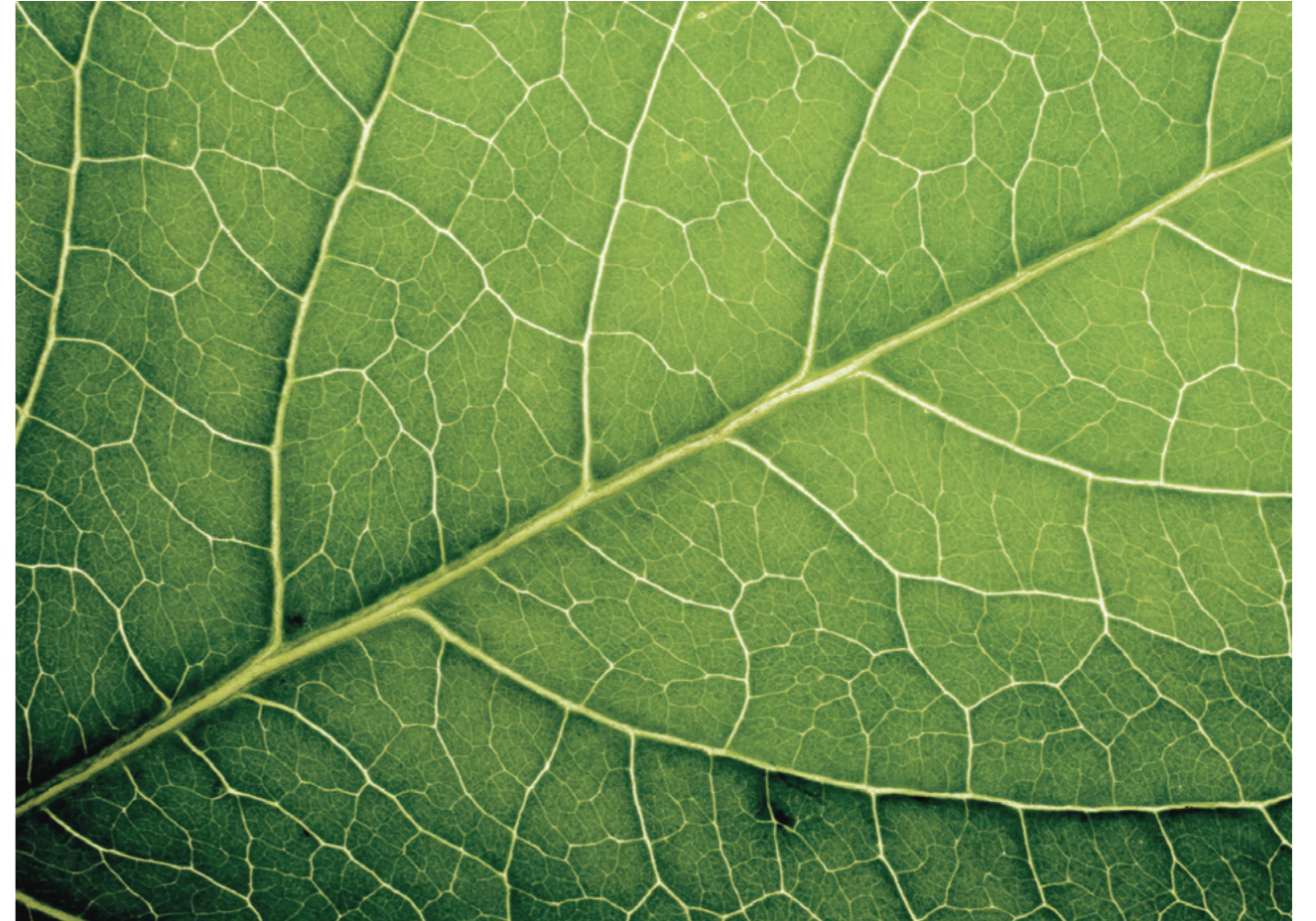
² E. Fromm, *The Anatomy of Human Destructiveness*, 1973.

Fractal Shape in Nature

Even small amounts of *nature* evidently stimulate the regenerative nervous system.

Neurons

collage



Healing Nature

The healing abilities of nature are by no means novel although often associated with nature-based remedies or medicine rather than its simple presence. However, for millions of years throughout human history, an affiliation with nature was a fact of life. Not only were we tied to the cycles of the sun and seasons, but in all entirely dependent on what nature could provide. Historic examples indicate the positive impact of nature on rehabilitation, stress recovery, adaptive behaviour as well as cognitive functions. Landscape architect Frederik Law Olmsted once said, 'It is a scientific fact, that the occasional contemplation of natural scenes of an impressive character ... is favorable to the health and vigor of men and especially ... their intellect'¹.

Though until recently, these claims were rather an intuition than a scientific fact, new research is increasingly backing him up. In one of the most frequently cited study in the field, the recovery of post-surgical patients with identical conditions was studied by placing them in hospital rooms with diverging views; one offering a natural setting, the other a brick wall. The patients with a natural view recovered significantly faster². Since the early 1980s in Japan, *shinrin-yoku* (literally 'forest bathing') has become part of the national health programme. Similar approaches are taken in various countries including South Korea and Finland as a response to high rates of depression and other mental illnesses³.

¹ F. L. Olmsted, *The Yosemite Valley and the Mariposa Big Tree*, 1952.

² R. S. Ulrich, *View through a Window may Influence Recovery from Surgery*, 1984.

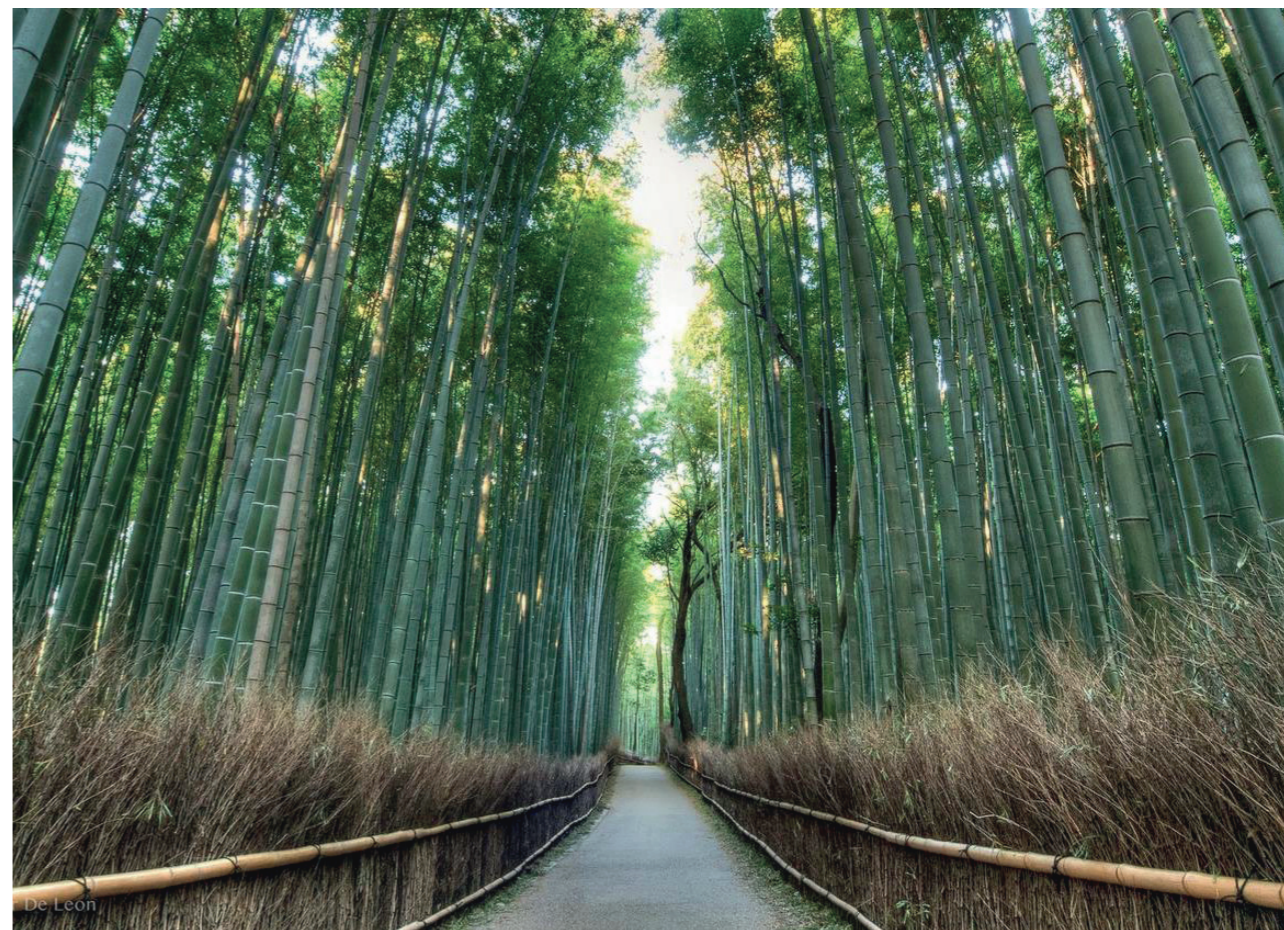
³ F. Williams, *This Is Your Brain on Nature*, 2018.

Central Park

New York, NY
Photo: telegraph.co.uk

Forest Bathing

Arashiyama, Japan
Photo: *Alexander de Leon Battista*



Horticultural Therapy

Horticultural Therapy emerged from the concepts such as *biophilia* and the philosophy that the aesthetic appeal of plants can visibly reduce signs of mental stress, fear and anger. It may treat people suffering with mental health conditions such as dementia, schizophrenia and depression. Patients are introduced to specially designed 'healing gardens' to help them find tranquillity and rest away from ever more stressful urban environments.

Therapeutic gardens address however a much wider spectrum. In cities, more and more people are living in solitude. Reciprocal gardening schemes encourage isolated or excluded individuals such as elderly, out of the confines of their homes and into green spaces. Here they have the opportunity to give back to the community through plant care and cultivation. A wealth of knowledge points out how gardening strengthens cognitive processes such as concentration and memory and generally promotes mental health through a sense of purpose and achievement. Physical health through exercise improves mobility and can even drastically speed up post-operative recovery.

At the same time, acquiring new skills fosters the chances of finding employment. As such, therapeutic gardens represent something far greater than their physical manifestation. They act as a channel for social, physical and psychological improvement, enriching our daily lives and that of our community. Practice shows that our engagement with the natural world may as well be the antidote needed to treat the array of so-called 'lifestyle diseases' increasingly suffocating our health and well-being.



BIOREMEDIATION

[noun] from Greek: *bio* – 'life', and Latin: *remedium* – 'restoring balance'

As a result of human action, concentrations of toxins in the natural environment have increased in all around the world to an extent that all living organisms are required to cope with the consequence in one way or another. Some plant species have evolved to tolerate heavy metals in such concentrations without showing symptoms of phytotoxicity, others even actively accumulate toxins.

The term *bioremediation* generally depicts the removal of pollutants, contaminants as well as toxins either from the air, water or soil with the use of either naturally occurring or deliberately introduced living organisms such as plants and microbes to consume and break down environmental pollutants. Methods include bioaugmentation, rhizofiltration, biostimulation, phytoremediation, mycoremediation, and composting, many of which are increasingly used as tool to address post-industrial, contaminated sites.

As every natural process, the remediation by biological means takes time and is partly reliant on human execution. Heavy metals, for instance, can be naturally absorbed from the contaminated soil, they are immediately fed back to it through either eluviation or finally through its degradation. In order to avoid this, these natural cycles need to be broken and plants, and with them the toxins, must be harvested and removed from the site. By burning the plants, metals remain in the ashes, are concentrated and made available for 'mining' and even recycling. Organic material such as hydrocarbons on the other hand can be degraded or decomposed. This happens either aerobically (in the presence of oxygen) or less commonly anaerobically (in the absence of oxygen). In this chain of natural processes spilled petroleum hydrocarbons or other organic waste material are degraded or broken down into nutrients that can be used by other organisms.

Fresh Kills Park, Staten Island, NY

James Corner Field Operations
Photo: Mikeric/ archdaily.com



Bioremediation Techniques

Different remediation techniques are known to deal with contamination some of which will be explored further in the following. Generally...

Natural Attenuation

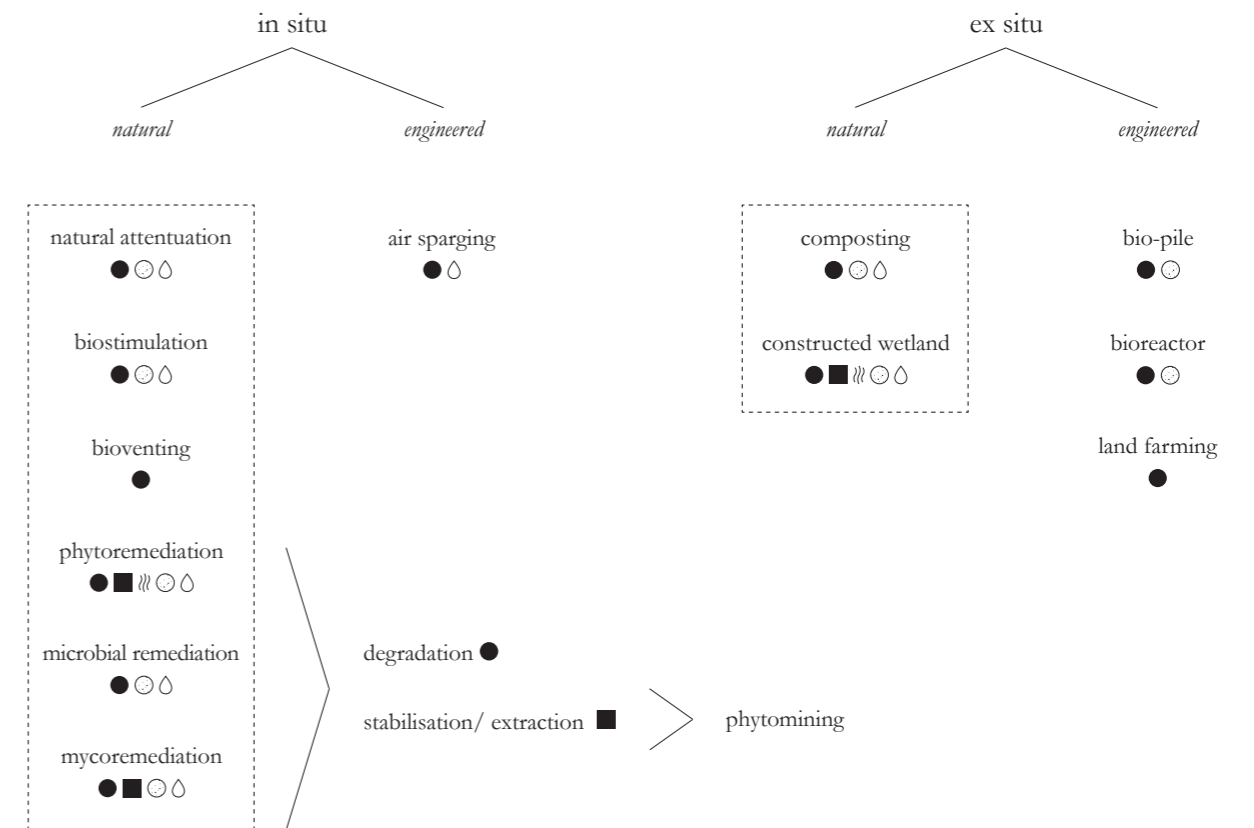
Biostimulating

Bioventing

Phytoremediation

Microbial Remediation

Mycoremediation



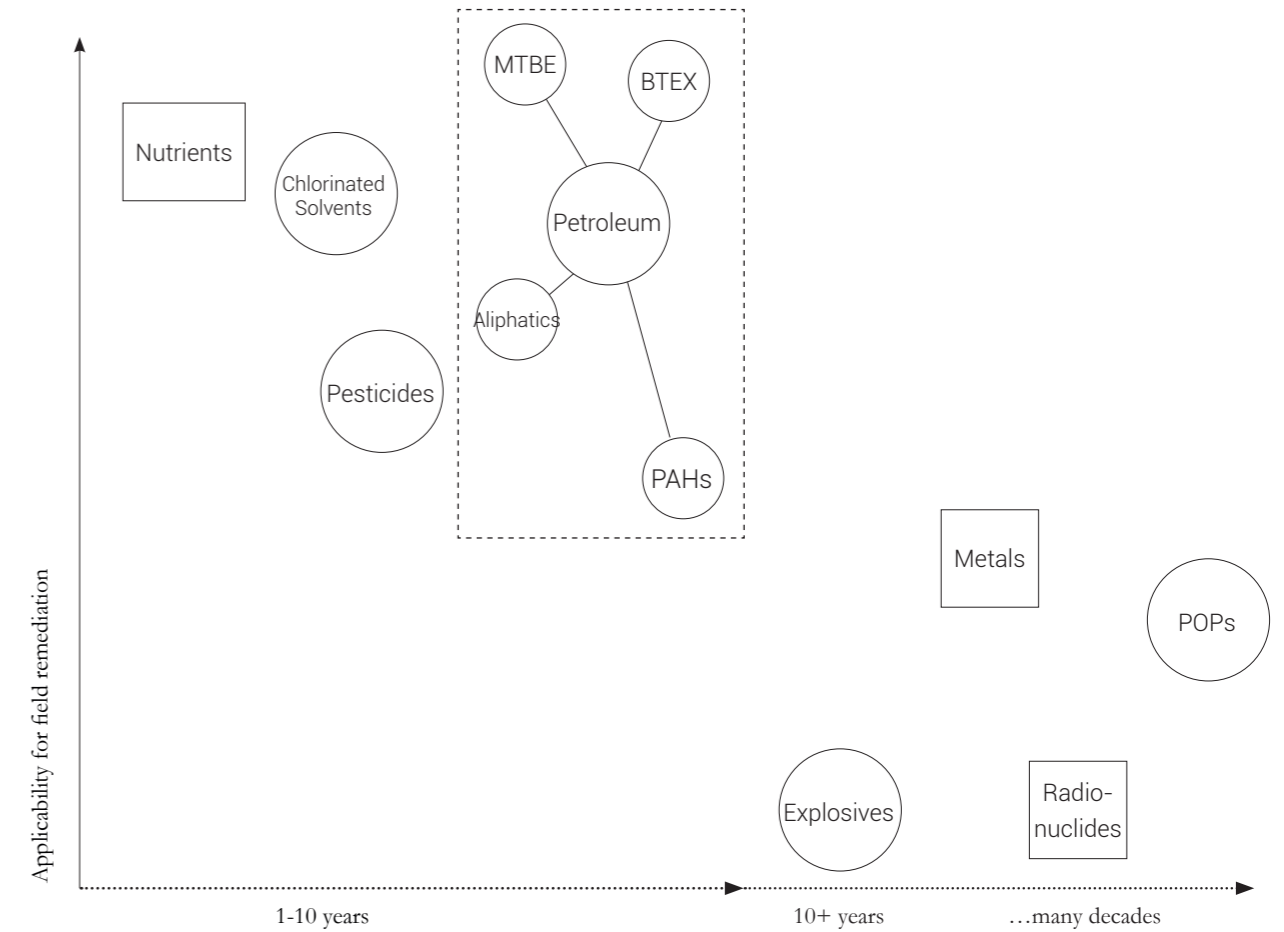
Organic and Inorganic Pollutants

Generally, it is distinguished between organic and inorganic pollutants. In the light of the investigated site, a former refinery ground, the main focus of this research lies on organic contaminants such as petroleum hydrocarbons. They have been found to be potential carcinogens, benzene and benzo(a) pyrene specifically are known carcinogens¹. Hydrocarbons are some of the most common contaminants in the world.

On the other hand, hydrocarbons naturally degrade and therefore are relatively easy to treat with phytotechnologies. The natural soil microbial activity and exposure to sun, wind and humidity volatilize or degrade them (natural attenuation). The introduction of plants merely accelerates an already occurring natural process. At the same time, through their root system plants can aid to access, contain and treat such fractions that have mobilized into the groundwater².

¹ Mueller et al., 1996.

² Kirk & Kennen, *Phyto*, 2015.



Petroleum Hydrocarbons

There are two categories; lighter fractions such as gasoline or diesel fuel which are easy to degrade, and heavier fraction from crude oil, coal tar, heating oil or PAHs¹. Lighter fractions dissolve much easier in water. The duration of the remediation process is highly dependent on the characteristics of the compound. Generally, water dissolved hydrocarbons are much quicker to be degraded than those less easily dissolved. It is therefore, that the water content in the soil plays an essential role during remediation. For that reason, wetlands and swamp areas are commonly known as natural water purification systems.

A useful determinant whether an organic pollutant can be removed from the soil by plants is the value of the $\log K_{ow}$ (octanol-water partition coefficient)². Being commonly man-made and therefore foreign to plants, organic pollutants have no transporters for uptake and the usual mechanism for uptake is passive diffusion into the plant³. The higher the $\log K_{ow}$, the more unlikely it will be that a plant-based system will be able to take up the contaminant. $\log K_{ow}$ is a measure of a pollutant's aversion to water (*hydrophobicity*).

¹ PAHs are polycyclic aromatic hydrocarbons are organic compounds containing only carbon and hydrogen that are composed of multiple aromatic rings.

² Kirk & Kennen, *Phyto*, 2015.

³ Cherian and Oliveira, 2005.



Octonal-Water Partition Coefficient $\log K_{ow}$

Typically, an organic contaminant can be taken into a plant when its $\log K_{ow}$ is between 0.5 and 3.5.

● MTBE	.94
● Benzene	2.13
● Toluene	2.73
● Xylenes	3.12-3.2
● Ethylbenzene	3.15
● PAHs	3.37-7.23

Phytoremediation

In situ technologies such as phytoremediation present an ecological technology for the removal of pollutants from both water and soil, as well as the biomonitoring of trace elements.

The transformation of both organic and inorganic contaminants through plant (*phyto*) processes is distinguished between seven mechanisms each of which describes a specific way in which a pollutant is modified by the plant¹.

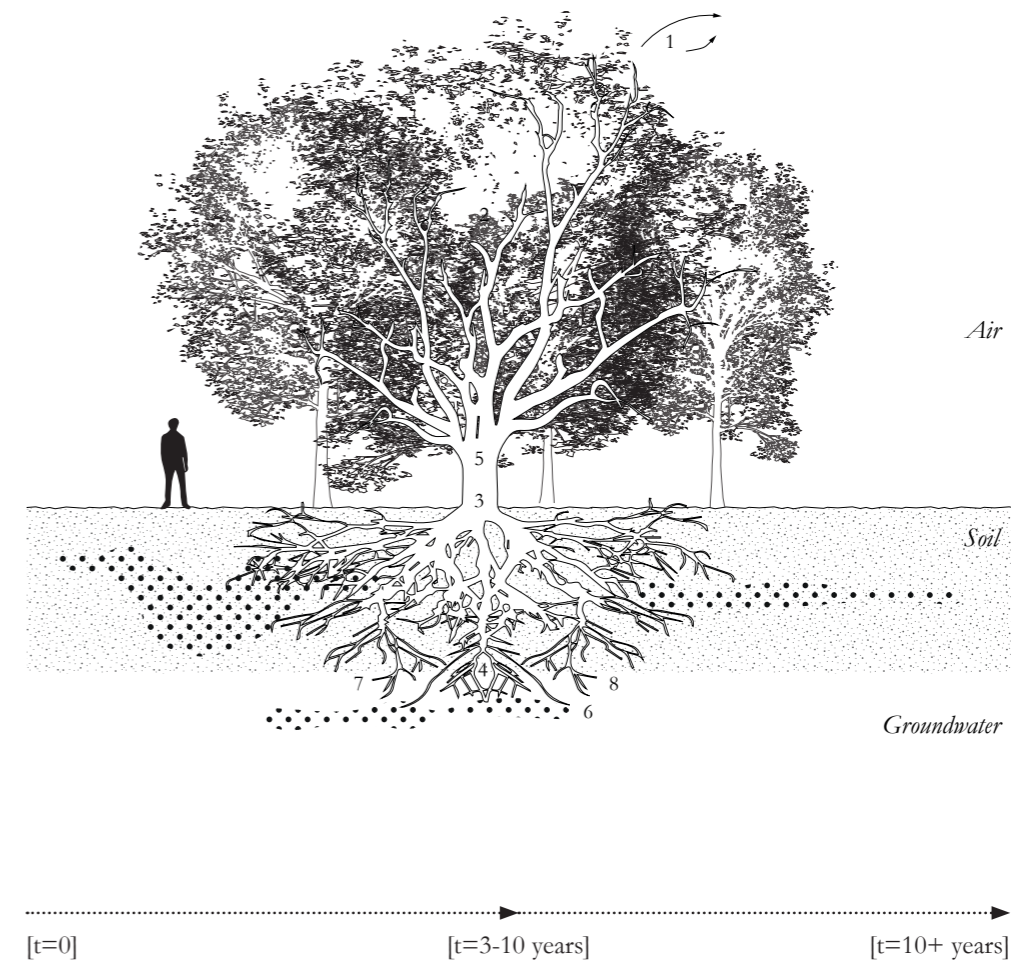
- 1 Phytovolatilisation ●■
plant turns it into gas
- 2 Phytoextraction ■
plant takes it up and stores it
- 3 Phytodegradation ●
plant destroys it
- 4 Phytostabilisation ●■
plant caps and holds it in place
- 5 Phytometabolism ■
plant uses it for growth
- 6 Phytohydraulics ●■
plant contains it with water
- 7 Rhizodegradation ●
soil biology destroys it
- 8 Rhizofiltration ■
soil microbes and roots filter from water

● organic ■ inorganic

¹ K. Kennen & N. Kirk, *Phyto*, 2015, p 34.

Phytotechnology Mechanisms

Mechanism of plants modifying pollutants



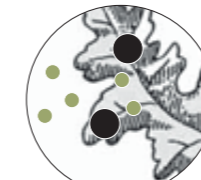
Metal-tolerant and accumulating plants

While organic contaminants such as hydrocarbons are degraded by the plant microbial activity, other pollutants and trace elements are deposited (accumulated) in the plant's tissue and soil remediation is subject to harvesting by humans.

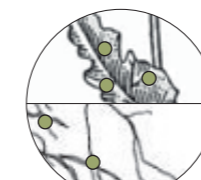
Today, more than 400 plant species are known for their enhanced metal uptake properties; some to make themselves poisonous in order to not get eaten by predators, others just as a quirk of nature¹. In the 1970s, the term *hyperaccumulator* was coined by New Zealander R. R. Brooks.

Many plants that are no *hyperaccumulators*, yet bear an unusual tolerance towards soil contamination. These plants are called 'facultative metallophytes'. Indeed, some are even confined to the presence of heavy metals in the soil, making them 'obligate metallophytes'. In the course of their nutrient uptake, they accumulate minor doses of toxic heavy metals. Although the uptake is not to their advantage, neither is it to their harm. As such they can become a useful complementary tool to bioremediation as plants can be used as indicators for the presence of certain substances.

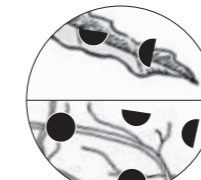
¹ Recent papers draw upon two hypotheses: Essentially, both are based upon the assumption that plants utilise their ability to take up toxins to safeguard themselves from predators and pathogens either by the accumulated substances alone (Elemental Defence theory) or in combination the plant's own chemicals (Joint Effect theory).



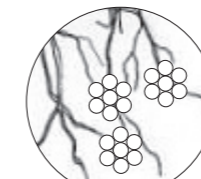
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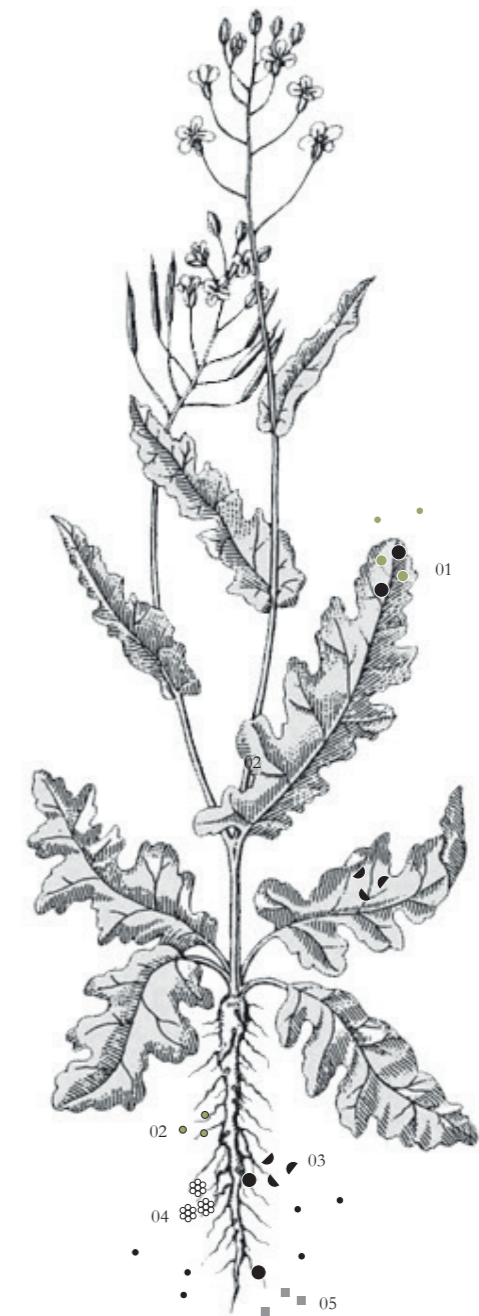
03



04



05





Cattail
Typha capensis

GARDEN

1. S. de Wit, *Hidden Landscapes*, 2018.

2. R. Aben & S. de Wit, *The Enclosed Garden: History and Development of the Hortus Conclusus and its Reintroduction into the Present-day Urban Landscape*, 1999, p. 35.

3. K. Baker, *Captured Landscape: The Paradox of the Enclosed Garden*, 2012.

4. Vittorio Gregotti, 1979 in *ibid.*

[noun] from Old High German *gart* – ‘enclosure’, and Old English *geard* – ‘fence, enclosure’; originally in Gallo-Romance *hortus gardinus* – ‘enclosed garden’

A garden is an enclosed place outside, literally meaning ‘enclosure’. Evolved from the Persian paradise gardens and the Roman peristyle, the *hortus conclusus* is considered the archetypal foundation of Western landscape and garden architecture (1). The notion of paradise, coming from Persian *pairidaeza*, meaning ‘surrounded by walls’, is hence innate of not only religious but social and cultural symbolism. ‘Each garden is an interpretation and reworking of nature and consequently a reflection of culture’ (2).

The enclosed garden can be seen as a mediator between dwelling (being the epitome of *place*) and nature and between building and landscape. It is an ‘outdoor room’ composed of a horizontal plane (ground) and a vertical plane (wall/ boundary). This creates a sense of containment and security for the occupant (3). Moreover, ‘the enclosure not only establishes a specific relationship with a specific place but is the principle by which a human group states its very relationship with nature and the cosmos. In addition, the enclosure is the form of the thing; how it presents itself to the outside world; how it reveals itself’ (4).

Yet being both infinite and finite it is innate of a paradox which reappears across different scales as assessed by Aben & de Wit:

	<i>landscape</i>	<i>building</i>	<i>garden</i>
<i>plan configuration</i>	locus – topos	centralised – decentralised	centre – periphery
<i>spatial form</i>	enclosed – open	addition – division	zenith – horizon
<i>appearance</i>	natural – artificial	unity – diversity	sensory – abstract

Pairidaeza – Paradise

Persian carpet from 17th century depicting an enclosed garden, in *Baker* (2012)



Ur-garden

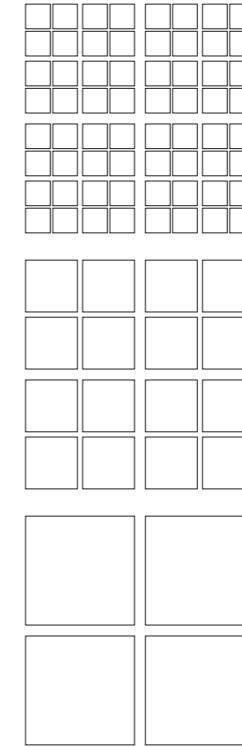
Two basic notions of the garden can be identified, the *Ur-gardens*, each representing 'not only an idea of what is pleasurable, but also an ideal of felicitous equilibrium between humankind and nature'¹.

Firstly, the *Fourfold Paradise*, an orderly pattern of four square (which in turn may again be divided in four squares) with a water source at its centre. Deriving from the Persian desert, it resembles an oasis, a safe haven, protecting from the 'unpleasant world' outside². The second, known as rock garden or Japanese Garden, brings forth the idea of union with nature rather than its overpowering. It originally comprises of sixteen elements of land and water that are asymmetrically arranged around a central *Guarding Stone*.

Having evolved and modified throughout the centuries, both garden types reappeared in varying forms across the world. The former model particularly manifest in the south of Spain and later Italy and France. Examples of the latter include garden design in China and Japan, as well as England where attempts were made to simulate and embrace nature.

¹ C. W. Moore, W. J. Mitchell & W. Turnbull Jr., *The Poetics of Gardens*, 1993, p 13.

² R. Aben & S. de Wit, *The Enclosed Garden: History and Development of the Hortus Conclusus and its Reintroduction into the Present-day Urban Landscape*, 1999, p 32.

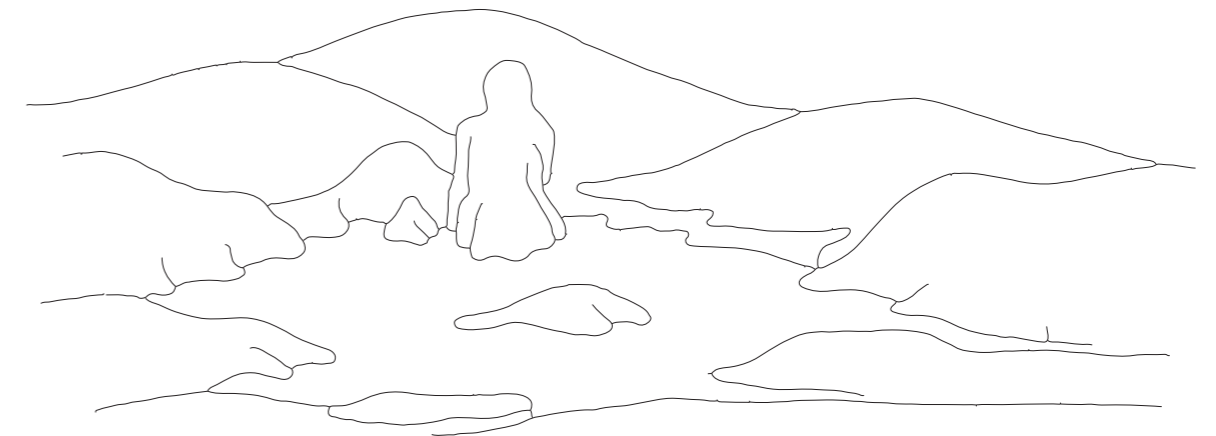


Fourfold Paradise

adapted from Moore, Mitchell & Turnbull (1993)

Guardian Rock

adapted from Crowe (1994)



Hortus conclusus

Aben & de Wit identify three basic types according to both form and programme; the *hortus contemplationis* [contemplative garden], the *hortus catalogi* [ordered garden], and the *hortus ludi* [pleasure garden]. The former, most akin to the paradise garden, developed in the context of monasteries as an abstract landscape representing the 'ideal, divine nature'. In contrast, the ordered garden was a place of production and cultivation combining nature's multiple values; aesthetic, healing, culinary, scientific and iconographic. Lastly, the pleasure garden formed a place of recreation and entertainment for the high society¹.

A contemporary interpretation of the *hortus conclusus* was designed by Zumthor in collaboration with landscape architect Piet Oudolf for the Serpentine Galleries in the UK. He writes, 'a garden is the most intimate landscape ensemble I know of. It is close to us. There we cultivate the plants we need. A garden requires care and protection. And so we encircle it, we defend it and fend for it. We give it shelter. The garden turns into a place'². The garden is a closed space, a laboratory for body and mind.

¹ P. Aben & S. de Wit, *The Enclosed Garden: History and Development of the Hortus Conclusus and its Reintroduction into the Present-day Urban Landscape*, 1999, p 37.

² Peter Zumthor, 2011.

Three Types of Gardens

adapted from *Aben & de Wit* (1999)

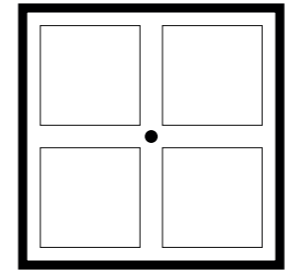
01 *Hortus contemplationis*

02 *Hortus catalogi*

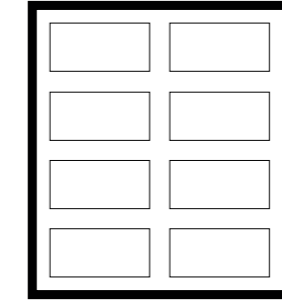
03 *Hortus ludi*

Hortus conclusus

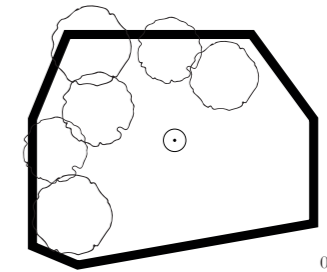
Serpentine Galleries, UK
Photo: unknown



01




02



03





‘ The wild garden, what I call the “garden in movement”, is more an intervention by humans in a territory where they interpret nature, diversity, and the synergy between these phenomena, in order to make a place for themselves, but still without destroying that diversity.

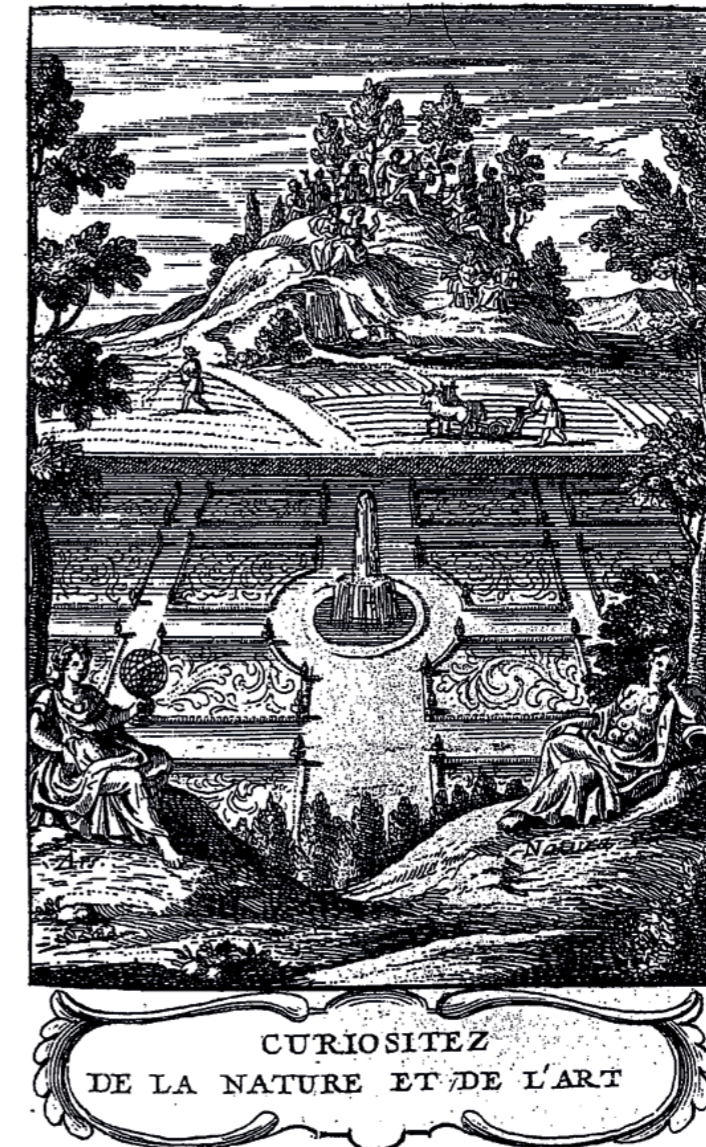
Common Sanfoin
Onobrychis vicifolia

Gilles Clément, *The Planetary Garden*, 2015.

NATURE

[noun] from Old French *nature* – ‘being, principle of life, character, essence’, and Latin *natura* – ‘course of things; natural character, constitution, quality; the universe’

Nature depicts an abstract concept encompassing the entire universe and nothing at all. In most places of the world, nature no longer serves as a direct source of survival or sustenance, and as a result, urbanised societies have increasingly detached from nature. Based on historic studies three categories of landscape are defined. *First nature* being wilderness, *second nature* being the cultivated landscape, and *third nature* being the garden, a combination of nature and culture.



Curiositez de la Nature et de l'Art

Abbé Pierre le Lorrain de Vallemont 1705.

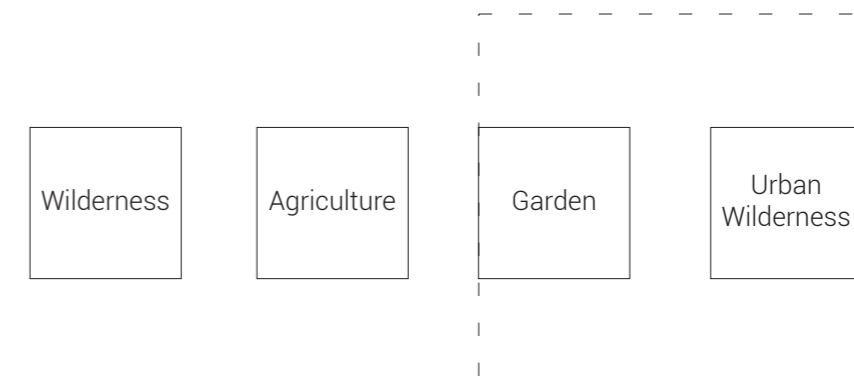
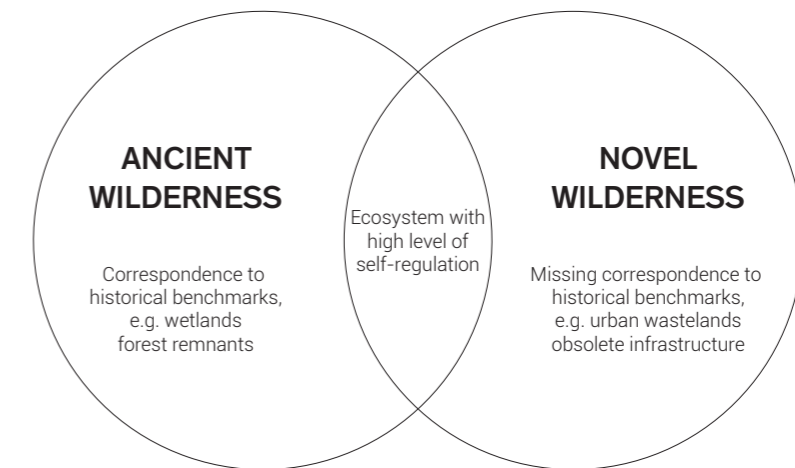
Gardened Wilderness

A 'fourth' nature is suggested to be the 'urban wilderness', a notion which refers back to increasing anthropogenic effects on biodiversity and climate in cities.¹ Although natural and urban environments have long been considered antithetical, wilderness must not be seen as an opposition of the urban territory but as an integral part of the metropolitan realm².

In the urban scape, however, this new kind of wilderness can only sustain if its somehow cultured. While the traditional garden is the human interpretation of nature and more specifically a form of culture, this new kind of wilderness thrives best by being left to itself. In an urban context this means no less an active maintenance, though not of the space itself but its boundaries. Thereby it challenges the notion of gardening and calls for a new generation of gardeners which may not even be human.

¹ Ingo Kowarik, *Urban wilderness: Supply, demand, and access*, 2018.

² S. de Wit, *Hidden Landscapes*, 2018, p 385.



Third Landscape

Roadsides, river margins, edges, shoulders and vast open spaces, most specifically those abandoned, form a biosphere for an unknown diversity of flora and fauna. Gilles Clément has given it 'the name "*third landscape*" ...; all those neglected territories, whose evident – and from now on necessary – function is to welcome those species that find no place elsewhere ...; an unresolved fragment of the *planetary garden*¹. Both the planetary garden and the third landscape can be seen as a principle to a political order and at the same time collective responsibility. Where there is no gardener, is no garden.

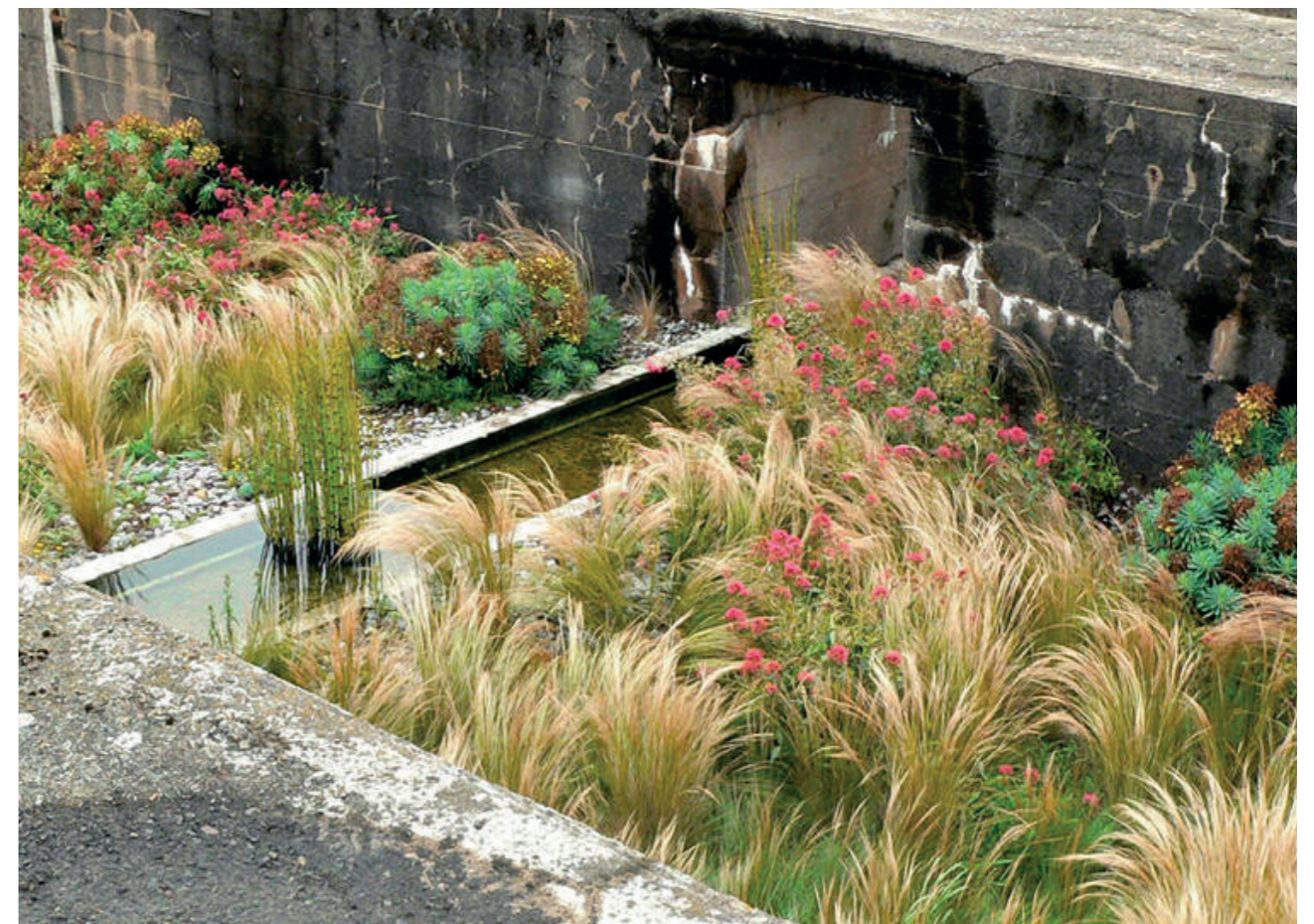
Can there be gardened wilderness? It may be the *garden in movement* which, on the other hand, defines a principle applied to the garden directly. It requires the maintenance and enhancement of the quality of water, land, air, intervening as little as possible. 'Such a state of mind leads the gardener to observe more and garden less'².

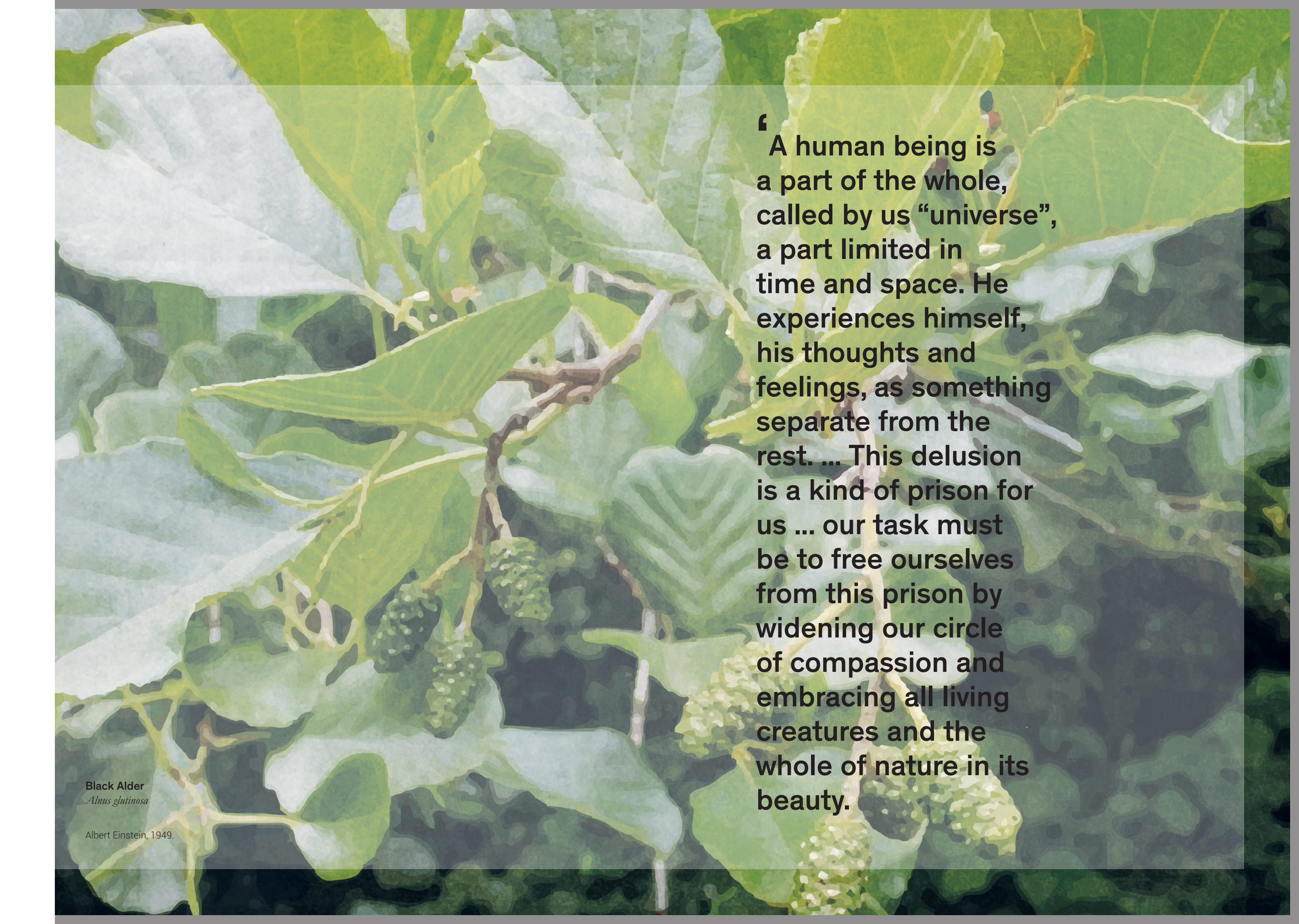
¹ Gilles Clément, *The Planetary Garden*, 2015.

² Gilles Clément, 1991.

The Third Landscape

Photos: Gilles Clément





‘ A human being is a part of the whole, called by us “universe”, a part limited in time and space. He experiences himself, his thoughts and feelings, as something separate from the rest. ... This delusion is a kind of prison for us ... our task must be to free ourselves from this prison by widening our circle of compassion and embracing all living creatures and the whole of nature in its beauty.

Black Alder
Alnus glutinosa

Albert Einstein, 1949.

ESSAY

¹ Quote one previous page

² E. O. Wilson, *The Biophilia Hypothesis*, 1984.

³ S. R. Kellert, *The Biological Basis for Human Values of Nature*, 1993.

⁴ Riley, 2005

⁵ WHO, 1948

⁶ Svalastog et al., 2017

Wholeness – Rethinking nature and health in an urban context

The ‘separate experience’ Einstein referred to¹ has manifested itself throughout modernity with great effect on all areas of life including public health. Since the beginning of industrialisation, technological and medical advances progressively prolong human lives. While today many infectious diseases are largely eliminated, the rates of non-communicable diseases, many of which are mental, have however inflated globally. These rates are frequently linked to the rapid urbanisation suggesting that nature – that is plants, animals and other human being – play a fundamental role for our health. Though, with over fifty per cent of the global population living in cities and an ever-increasing global mobility, a sense of *placelessness* has evolved resulting in a general detachment from and lack of responsibility and respect towards nature. This is harmful for our health not only because the destruction, pollution and exploitation of our planet leads to serious climate change and biodiversity loss, to name only a few effects. But nature actually has a healing impact on the human body and mind. This phenomenon has been extensively investigated and explained by Edward O. Wilson and many others based on his ‘Biophilia Hypothesis’² which postulates a ‘biologically based, inherent human need to affiliate with life and lifelike processes’³. At the same time, nature’s healing abilities – although long known amongst ancient and indigenous cultures – became subject to scientific studies with affirmative results. Not only do plants purify air, water, and soil. Their fractal shapes, certain colours and chemicals they release stimulate our parasympathetic nervous system, which facilitates relaxation and regeneration. An increasing urbanisation is not merely inevitable but arguably desirable promoting a low-carbon way of life. Therefore, we must fundamentally rethink human interactions with nature and its integration within our yet rather unhealthy cities.

Health

In the past century, advances in medicine and technology allowed human lives to prolong on average by fifty per cent⁴. Infectious diseases have been largely wiped out and life expectancy has (despite an influx in NCDs) increased significantly. On first sight, this indicates an overall improvement of health. Although these statistics refer to global numbers, for simplicity, I will predominantly refer to the context of western societies. The term ‘city’, here, refers to the average European city.

In its primary definition, health – from old English *hælp* means ‘wholeness, a being whole, sound or well’, or ‘a state of complete physical, mental and social well-being’⁵. Etymologically, the concept of health is holistic, making insufficient health synonymous to ‘lacking something’. This conception dates back to ancient Greece and was subject to extensive philosophical investigation, and later undergoing an evolution, from religious influences during the Middle Ages to being an economic category from the industrialisation onwards⁶. A more contemporary definition depicts health as an equilibrium constituted within an individual and between him or herself and their social and physical

environment⁷. Therefore, health is a dynamic, intertwined process, dependent on the immediate environment of its subject, and by default ‘ecosocial’ acknowledging that ‘process [of] the ecological and social forming and informing each other over time’⁸.

While public health has seemingly improved in the past one hundred year, an array of equally daunting NCDs have evolved simultaneously. In the light of existing research, it is obvious that modern ways of life, particularly those of western individualistic societies, are far from conducive to human, physical and mental health and well-being. Today, commonly experienced health issues include depression and obesity, heart disease, diabetes, asthma, migraines, allergies, pervasive near-sightedness, stress, attention deficit syndromes, anxiety and digital addictions, all of which have an enormous impact on our nervous, endocrine, and immune systems and therefore on our overall health. This evolution towards NCDs is frequently linked to urbanisation, and studies consequently suggest that access to nature may be a fundamental factor⁹. In 1800, some three per cent of the world’s population lived in urbanised areas. Meanwhile, cities have become a metaphor of progress and opportunity, and its abstract concepts such as prosperity and social status attract over fifty per cent of the global population and a projected seventy per cent by 2050¹⁰. It may be no coincidence that the extreme rates of health issues parallels increasing urbanisation. What, however, makes cities so unhealthy, or, as per definition, what do they lack?

Lost Connections

Nature in our environment – that is the presence of diverse plant and animal species – evidentially contribute to human well-being, both directly and indirectly¹¹. On an urban scale, the promotion of nature, from green-blue grids to rooftop vegetation and kitchen gardens provides a multitude of benefits. These include urban heat island effect mitigation and energy reduction, new habitats, improved air quality, greater soil permeability and storm water mitigation. Uncontrolled growth and expansions and the subsequent destruction of natural environments within cities and at its fringes, was and still is therefore a certain contributor to impoverished health. Nonetheless, a city’s health quality is unlikely to be confined to the mere presence or absence of plants but underlying a far more complex system.

Cities were always artificial and constructed environments. However, until the eve of modernism, cities, organically grown, were fractal and complex in shape like all living systems. Fast-growing populations and the introduction of the car have led to the ‘planned city’ imposing geometrical, anti-fractal forms. As a result, dense urban fabric disappeared, and with this, too unique, multi-scalar urban spaces such as pocket parks, pedestrian paths and (green) buffer zones¹². Today, the lives of a majority of people are, moreover, based around interior spaces; work, leisure, transport. Thus, modern city residents have been more and more robbed of opportunities to affiliate with nature which, in turn, led to a general detachment from the natural world. This has serious effects, not only on the health of humans but also that of our planet.

Globalisation and the ever-growing demands of present-day, achievement-

⁷ Sartorius, 2006

⁸ Waxman, 2018

⁹ Bratman et al., 2015

¹⁰ United Nations, 2016

¹¹ Ulrich, 2008

¹² Salingaros, 2005

¹³ Kellert, 2005

¹⁴ Wilson, 1984, Wilson, 1993, Wilson, 2008

¹⁵ E. Fromm, ... 1973.

¹⁶ ibd.

¹⁷ Waxman, 2018

¹⁸ 2000

¹⁹ Kowarik, 2018

orientated societies have, at the same time, brought upon a sense of placelessness. This social phenomenon is relatively recent and subject to investigation by urbanists, sociologists and anthropologists. It describes an absence of sense of identity towards a place by its occupants and is yet amplified by the effects of globalisation such as increased mobility and loss of neighbourhood ties¹³. Our independence from nature for sustenance, i.e. food or shelter, and general disconnection of it in urban contexts has led to a loss of ‘reverence’, responsibility and stewardship for natural environments.

Arguments towards the direct relation between the prevalent shift in public health and human’s disconnection with nature, is further provided by the biophilia theory of American biologist, Edward O. Wilson who suggests that humans biologically tend to favour a presence of nature in their immediate surroundings¹⁴. Some ten years before Wilson, psychoanalyst, Erich Fromm¹⁵ coined the term biophilia – from Greek *bíos* meaning ‘life’, and *phília* meaning ‘(fraternal) love’ – the innate and genetically determined tendency of human beings to affiliate with any form of life. He writes, ‘Man is biologically endowed with the capacity for biophilia, but psychologically he has the potential for necrophilia as an alternative solution’. The term necrophilia, customarily used to denote a sexual perversion, is here described in characterological sense as ‘the passionate attraction to all that is dead, decayed ...’ and further as ‘the passion to transform that which is alive into something unalive; to destroy for the sake of destruction; ... to tear apart living structures’¹⁶. This assertion stands in direct relation to human’s divergence from and systematic destruction of the natural world which has occurred in parallel with the technological developments, industrialisation and urbanisation of the past centuries. This has fundamentally changed human interactions with nature. The two phenomena, biophilia and necrophilia, as defined by Fromm, suggest a possible equilibrium, both physically and mentally, of human beings and their natural environment. This equilibrium has arguably been lost.

The complex, psychological dimension of nature further resonates with its very definition according to which objects of the natural environment, or more generally physical entities of biotic matter, are commonly described as nature. At the same time, the term – from Old French *nature* meaning ‘being, principle of life, character, essence’, and from Latin *natura* meaning ‘course of things; natural character, constitution, quality; the universe’ – depicts an abstract concept encompassing the entire universe and nothing at all. As language itself plays a significant role in people’s perception, a more tangible definition of nature could greatly benefit reconnecting humans and nature with one another¹⁷. Landscape theorist John Dixon Hunt¹⁸ outlined three categories based on historic studies: ‘first nature’ being wilderness, ‘second nature’ being the cultivated landscape, and ‘third nature’ being the garden, a combination of nature and culture. A ‘fourth’ nature has recently been suggested being the ‘urban wilderness’¹⁹. This new notion may be an opportunity. Particularly in those cities that had their prime during the industrial revolution and are now, against the global trend, shrinking, this new form of nature is largely existing only waiting to be recognised.

Healing Nature

The healing abilities of nature are by no means novel although often associated with nature-based remedies or medicine rather than its simple presence. However, for millions of years throughout human history, an affiliation with nature was a fact of life. Not only were we tied to the cycles of the sun and seasons, but in all entirely dependent on what nature could provide. Decades before Wilson’s Biophilia Hypothesis²⁰ claimed that our affinity to life-like processes is genetically coded, the acclaimed conservationist Frederik Law Olmsted²¹ wrote, ‘it is a scientific fact, that the occasional contemplation of natural scenes ... is favorable to the health and vigor of men and especially ... their intellect’. While, at the time, this would have been rather an intuition than a scientific fact, not only recent research is increasingly backing up his claim, but historic examples indicate the positive impact of nature on rehabilitation, stress recovery, adaptive behaviour as well as cognitive functions. Yet one of the most frequently cited study in this field is that of Roger S. Ulrich²² in which the recovery of post-surgical patients is analysed. Patients with identical conditions were placed in hospital rooms with diverging views; one offering a natural setting, the other a brick wall. The patients with a natural view recovered significantly faster.

In an urban environment, parks and green spaces do not only immediately improve the air, water and soil quality which in turn contributes to our overall health. They more directly invite the inhabitant to spend time outdoors where sunlight provides much needed vitamin D, naturally stabilising our melatonin levels which are offset by spending long hours indoors and in front of screens. Moreover, certain colours and fractal shapes of plants trigger neurochemicals in our brain. In fact, any exposure to natural sounds and smells, even images, have shown to stimulate the parasympathetic nervous system, which facilitates relaxation and regeneration²³. This proves particularly important in an urban environment in which the sympathetic system is commonly over-stimulated. What may sound like novel findings has been long known and utilised by indigenous cultures and societies around the globe.

‘The art of healing comes from nature, not from the physician’, said Paracelsus in the 16th century, and not by chance were monasteries, which often also functioned as hospitals, commonly built with regard to its natural environment. Asian societies traditionally utilise forests as therapy, and in Japan, it has become part of the national health programme since the early 1980s. Similar approaches are taken in various countries including South Korea and Finland as a response to high rates of depression and other mental illnesses²⁴.

Can Cities be Healthy?

If biophilia is an innate affinity of human beings with the natural world, it equally elucidates human’s fascination for complexity, and if the healthy city is seen as a metaphor of nature itself, it is by default complex. As the flaws of modernism and car-based city planning are omnipresent in nearly every European city, one could argue that we are still far off from planning, building

²⁰ E. O. Wilson, The Biophilia Hypothesis, 1984.

²¹ F. L. Olmsted, ..., 1952.

²² R. S. Ulrich, 1984.

²³ Ulrich, 1984, Ulrich, 2008, Bratman et al., 2015, Arvay, The Biophilia Effect : A Scientific and Spiritual Exploration of the Healing Bond between Humans and Nature 2018.

²⁴ Williams, 2018.

and living in a 'healthy city'. In order to achieve that, design choices must not merely underly an artistic expression or certain aesthetics for people to appreciate (or not) nor be driven by utilitarianism but instead become a major factor for our continued well-being. Biophilic design, which has become subject to multiple publications from a steadily growing multi-disciplinary, academic circle around aforementioned Ulrich, Wilson and Kellert, may be a solution to many modern-day health problems, providing an extensive list of benefits beyond the health aspect of individual humans. Inspired by this discourse and a general growing awareness for our environment, this design movement developed across various design disciplines including architecture and urban design. While this may provide the supply of nature in cities, it is the demand without which we lack a major driving force. In order to trigger this – that is have people demand and seek nature – nature must be redefined. Only then, natural and urban environments, despite long being considered antithetical, may form a new synthesis, not only physically but in our minds.

Healthy cities – if there are any – are 'ecosocial' and by default place-orientated, that is reacting to local conditions such as climate and topography as well as considering other forces including culture and the history of a place. There is arguably little hope for a healthy city ever being planned. However, attempts to transition towards healthier cities (which in the European context predominantly encompasses retrofitting the existing fabric) prevail and are quite viable. The first step is to simply open our eyes and acknowledge existent nature. The relationship between humans and nature is proposedly driven by a genetic code which would suggest that, once we redefined nature for ourselves, we can utilise the benefits of it and perhaps re-establish the equilibrium between one another. Although in academic circles Wilson's biophilia hypothesis is increasingly supported, more scientific data is required in order to change people's minds and change their point of view about what is normal and what may as well be a new normal.



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PROJECT

Proposition

The proposed design assignment comprehends an 'urban garden' within the former site of the Societe De La Raffinerie de Dunkerque – an existing void of the city of Dunkerque afflicted with industrial leftovers, both structural and in form of contamination. As such, it endeavours to reconnect people and their territory through nature and to become a place of healing. Based on the hypothesis that exposure to green infrastructure is highly beneficial for human well-being on one hand, and in the light of nature's ability of self-remediation on the other, the urban garden forms a synthesis of the health of the place itself and its inhabitants.

The assignment is divided in two main steps commencing with a masterplan design on an urban scale, followed by an architectural intervention within the larger framework. A strategic masterplan is postulated in response to the site's size of approximately 35 hectare, and its general condition. Due to former industrial activity, soil, water and air exhibit high levels of contamination and become subject to bioremediation. Based on this, the masterplan is innate of a temporal dimension. The redevelopment begins with the proposed design [t=0] and both progresses and expands [t=n].

After careful analysis, existing structure forms the basis for a new spatial order. The 'step by step' rehabilitation and redevelopment of the site and gradually makes it accessible for new functions; informed by the process of decontamination and reestablishment of health itself, relinking land and water and finally integrating in the urban fabric.

As urban garden, the site becomes by default public and encourages functions of collective interest. The topical umbrella of health informs the programme of structural interventions within the larger plan. A garden inevitably being a kind of laboratory has the potential to alter perceptions; of the existing and what is yet to come. The rehabilitation of mental health and well-being and with it, people's awareness, productivity and happiness, is the core objective. Different garden typologies generate spaces of rest, activity and spirituality. The architectural intervention intends to link each with one another and form sequences of diverse experiences.

Objectives

This project addresses the subject matter of health, more particular mental health, and how it is affected by the built and natural environment. The notion is translated across three main scales that each approach a specific problem field – environmental/ ecological health (*territory*), socio-cultural health (*city/ landscape*), human health (*body & mind*) – resulting in following objectives.

1. Remediate ground

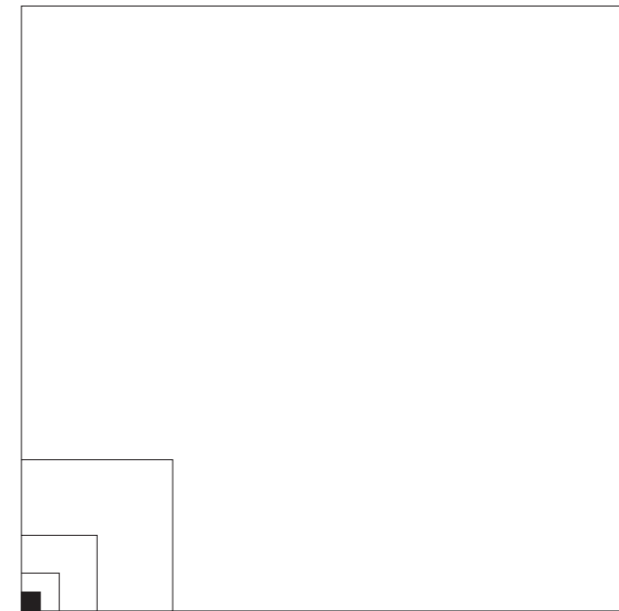
Two centuries of industrial activity have destroyed much of Dunkerque's natural environment and elsewhere left their relentless traces on soil, water and air at the expense of flora and fauna. Within the boundaries of a territorial fragment, this project creates a green infrastructure (garden) that aims to provide a framework for bioremediation of the contaminated ground. In a future scenario it is to be adapted and expanded in order to regenerate the surrounding territory, and thereby reestablish previously lost habitat for both flora and fauna, and restore biodiversity.

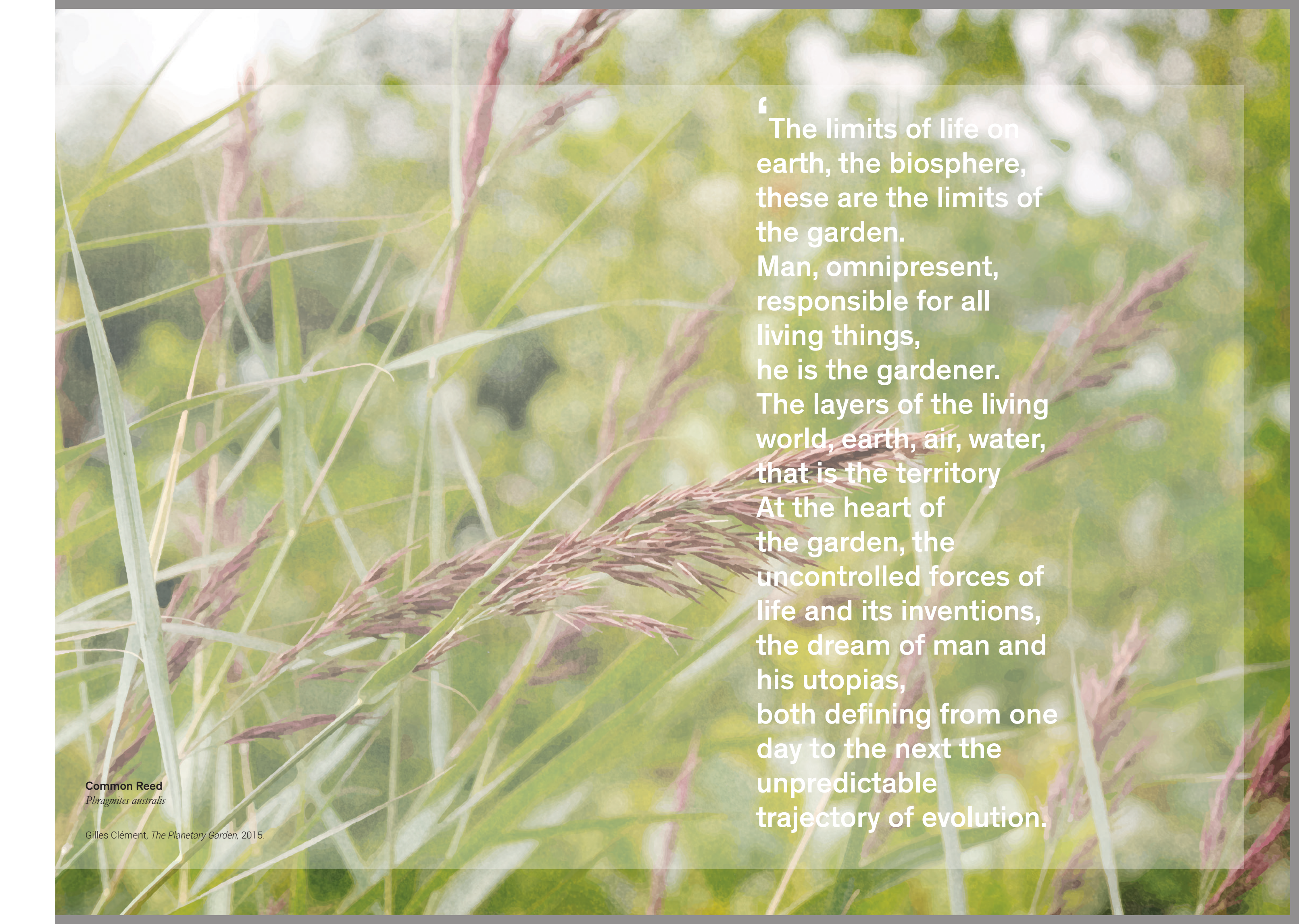
2. Redefine boundaries

The garden endeavours to form a green buffer zone between the port and the city introducing a new urban threshold. At the same time, the renaturalisation of the artificial land-sea edge of the old docks blurs the invisible boundary drawn by the city's industrial heritage and historic war events. Opening the waterfront to the inhabitants of Dunkerque offers a new perspective of the North Sea, and is perhaps the start of a new relationship with it.

3. Reconcile inhabitants and their environment

Mental health issues and a decline in general happiness are widespread problems that are frequently linked to a lack of accessible green infrastructure within urban areas. The creation of a public garden strives to reconnect Dunkerque's inhabitants with their natural environment and simultaneously generate a new awareness for the ecosystem and its abilities to heal not only itself but also the human mind. The architectural intervention endeavours a sensory experience for the visitor, allowing for an altered perception of nature and providing spaces for rest, activity and spirituality.





‘ The limits of life on earth, the biosphere, these are the limits of the garden. Man, omnipresent, responsible for all living things, he is the gardener. The layers of the living world, earth, air, water, that is the territory At the heart of the garden, the uncontrolled forces of life and its inventions, the dream of man and his utopias, both defining from one day to the next the unpredictable trajectory of evolution.

Common Reed
Phragmites australis

Gilles Clément, *The Planetary Garden*, 2015.

Spatial Concept

¹ The condition and elements of the site including existent structures are identified and briefly analysed in 2.2.

² S. de Wit, *Hidden Landscapes*, 2018.

a. Configuration and Composition

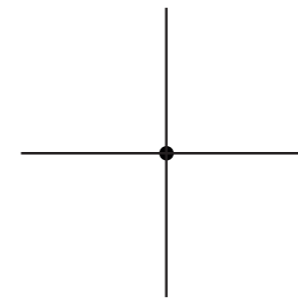
The composition of both landscape and architectural components is dictated by the existing structures¹. The linear character of the territorial fragment is translated into a fluid form of different architectural elements transitioning throughout the varying sections of the site. It resembles a path that follows a sequence of gardens and thereby re-links land and sea with one another. While doing so, it loosely draws upon a set design strategies presented by de Wit; *centring, enclosing, and articulating materials*². Ordering the space, devises a condition of 'otherness' to the exterior landscape; creates an inside and an outside. The act of enclosing is twofold and applied both around and within the space, using visible and invisible boundaries alike. Lastly, the articulation of materials is the synergy of existing and new and will be explored in the forthcoming design steps.

b. Temporal Dimension

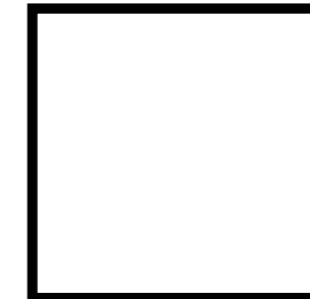
The project integrates the regeneration of the territory and the inhabitant. Based on the assumption that the presence of nature actively contributes to human health and well-being, the introduction of a green infrastructure in the form of a garden creates a healing space. At the same time, the landscape elements fulfil the purpose of environmental regeneration of the fragment through bioremediation strategies such as phytoremediation. In a future scenario, the garden has expanded horizontally across the docks attempting to reach the city's boundary, and vertically towards the existing regional parks in the south and east. All these processes share a temporal dimension of great significance yet different to each specific scale.

c. Function and Programme

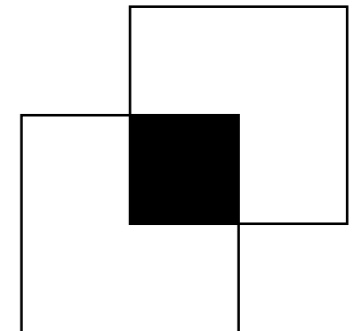
The main objective is to provide a spatial framework for the act of healing. Subsequently, both the architectural and landscape programme is informed by the notion of health and wellbeing. Three categories of gardens each resemble a 'pillar' of health. Within these establish different kinds of garden types with corresponding qualities, functions and programmes, and varying grades of engagement through the occupant.



01



02



03

Design Strategies

loosely adapted from *de Wit* (2018)

- 01 Centring
- 02 Enclosing
- 03 Articulating materials

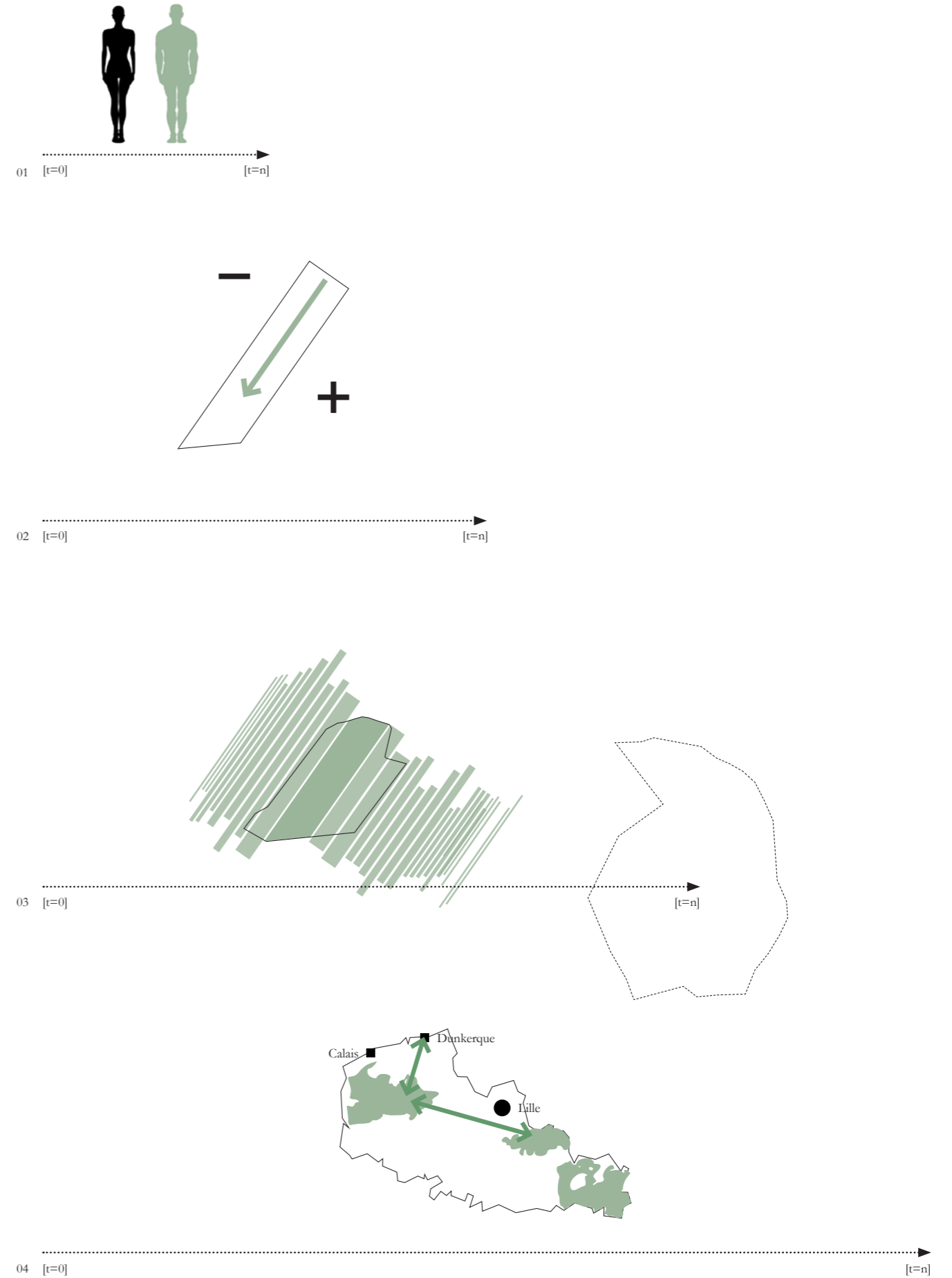
Temporal Dimension

The temporal character of remediation lies at the core of the project and varies from short to long-term processes, actions and effect. On the scale of the *body & mind*, this manifests in the experience of sensations and encounters one is exposed to along the path. Despite being a temporary event, this experience contributes to the overall well-being in the long term. Though, with the scale also changes the reckoning of time. Beginning with the project initiation, the fragment undergoes a process of remediation, though much slower than that of the inhabitant. Bioremediation processes can take multiple months to years depending on the extend of the contamination. On an urban and territorial scale, the multiplication of green infrastructure can take decades and is best regulate through long-term programmes.

Project Timeline

Depending on its scale, each remediation process is following their own temporal axis.

- 01 Body & Mind
- 02 Fragment
- 03 Urban
- 04 Territorial



Functions

Historically, the (enclosed) garden can be distinguished in the *hortus contemplationis*, the *hortus catalogi*, and the *hortus ludis*¹. A similar yet slightly different analysis is presented by Turner, who defines gardens by motivation into *rest*, *activity* and *spirituality*, a categorisation which can be applied on more contemporary examples. He moreover argues that also historically many gardens have more than one objective².

The adjoining diagram explores the garden through the lens of functions and programmes that are directly or indirectly related to the overall theme of *health & well-being*. Overlaying the concepts of de Wit and Turner forms a basic categorisation. Based on this, a number of common garden types and related functions are identified and analysed for general and project-specific qualities (cultivation, bioremediation, education, aesthetics, leisure, spirituality) and their subsequent applicability³ for the project at hand. This forms the basic framework for the programme.

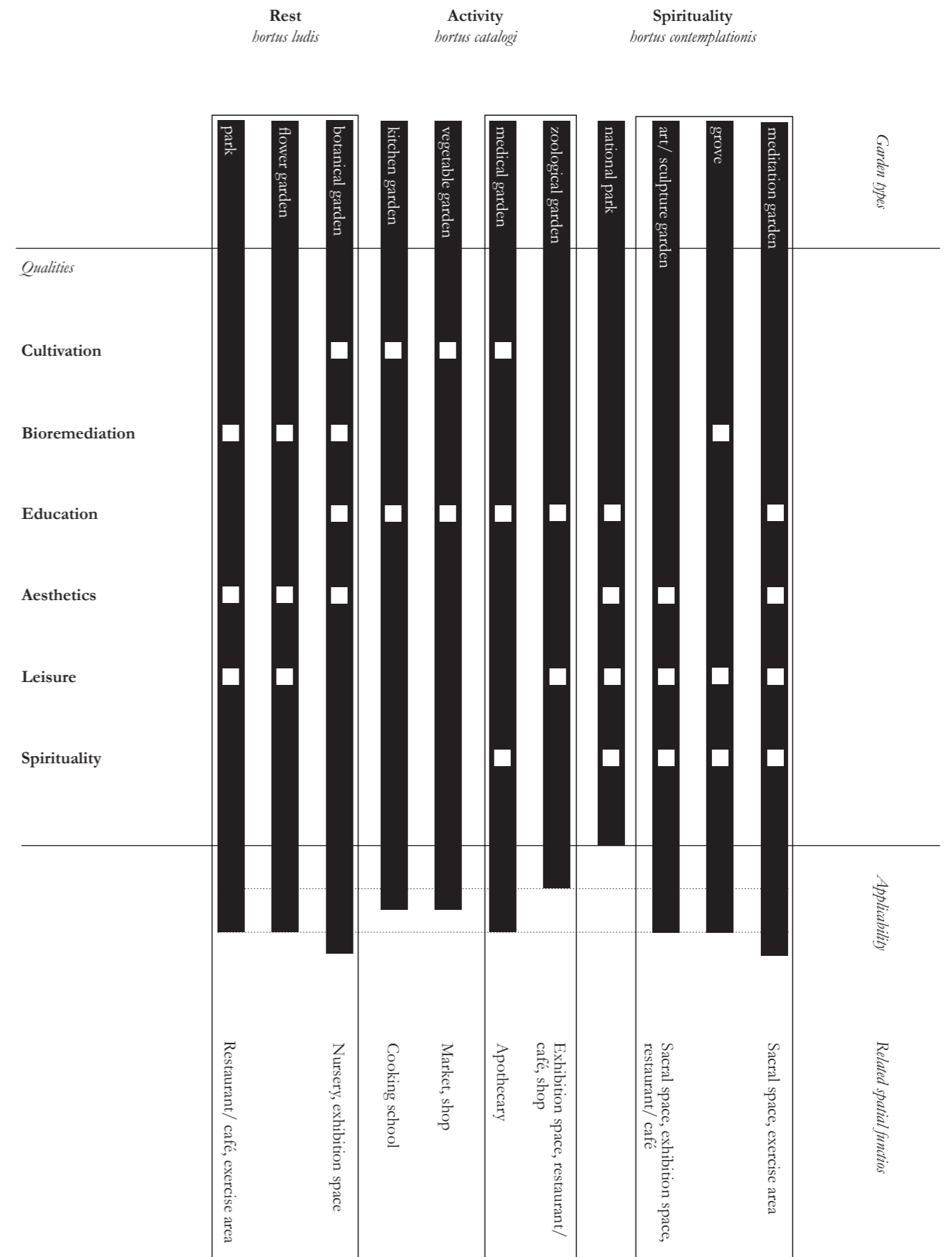
¹ R. Aben & S. de Wit, *The Enclosed Garden: History and Development of the Hortus Conclusus and its Reintroduction into the Present-day Urban Landscape*, 1999.

² T. Turner, *Garden History: Philosophy and Design 2000 BC – 2000 AD*, 2005, p 10.

³ The definition of application underlies a number of factors including *feasibility, relevance of related programmes, socio-cultural and ecological requirements*.

Garden Typologies and Related Programmes

Exploration based on preceding research analysis and personal experience.





Rose Clover
Trifolium hirtum

GARDEN SEQUENCE

Throughout the fragment a sequence of different, spatially and vegetative distinctive gardens featuring a variety of bioremediation techniques is created. A connecting *path* forms the guiding element and architectural intervention within the master plan. Through time, a network of paths and trails emerges to disclose the site to the visitor.

Each garden follows a theme based on what was found on site. The development of the master plan is based on existing vegetation and structures, natural axis and different spatial characteristics of the site.



Gardens

- 01 *Forest Garden*
- 02 *Wild Garden*
- 03 *Flower Garden*
- 04 *Water Garden*
- 05 *Therapeutic Garden*

Layers

Throughout the planning process, four guiding themes are defining for the design and form the different layers of the project.

Vegetation

Existing vegetation as well as the planting and maintaining of new plants is guiding element for the garden. Known petroleum-degrading as well as tolerant plants¹ are utilised.

Biotechnology

The majority of bioremediation takes place automatically without much human inference (natural attenuation). Indicator plants are across site to display the progress of remediation.

Architecture

The new structures understand themselves as guiding and complementing the existing. Functionally, they provide additional spaces for health-informed activities in a safe and contained environment. Moreover, the building and the inner garden act as final point of stillness.

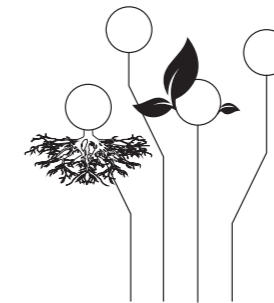
Sensory Experience

All senses are triggered throughout the site simply by the presence of the site itself, its spirit, heritage and the vegetation. However, points of interest for active engagement are given throughout the site.

¹ See Appendix D for extensive list.



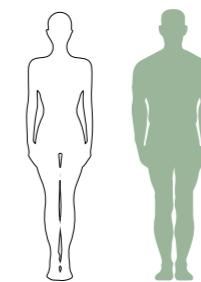
Vegetation



Biotechnology



Architecture



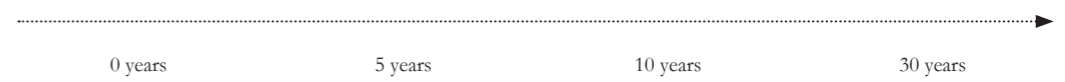
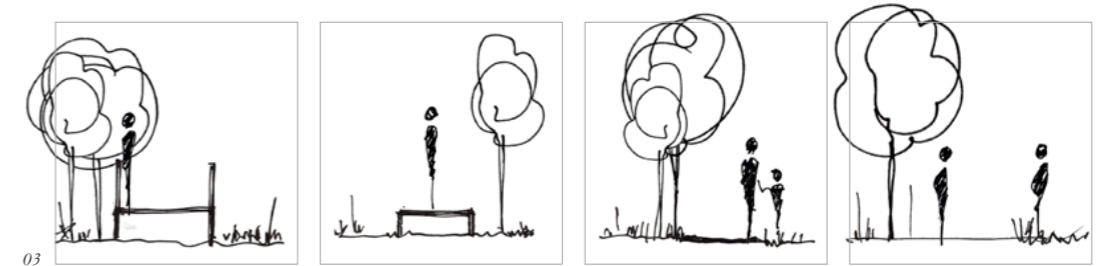
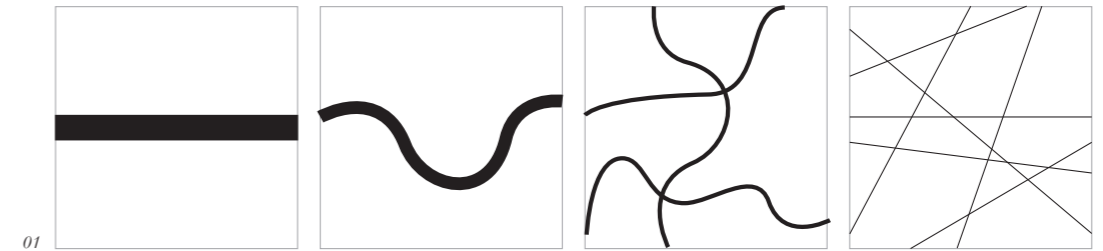
Sensory Experience

PATH

Blurring the Edge

Throughout the fragment and its sequence of different, spatially and vegetative distinctive gardens, a connecting *path* forms the guiding element and architectural intervention within the master plan. Being at the core of the proposal, the path addresses the notion of *temporality* which is inherent to the bioremediation process of both the territory and the human body and mind. Thus the path embraces the ephemerality of the place.

In a 5-year, 10-year and 30-year plan a new array of paths and trails are suggested exploring the potential of transformation of the site. Each path layer is characterised by a unique form, material and edge condition. With each stage, the path transforms from a static architectural object into a dynamic network increasingly blurring the edge between the visitor and the territory itself and disclosing new spaces through time.



Path

- 01 Form
- 02 Materiality
- 03 Edge

the garden in movement, a user's manual



September

Early October

April

Soaking seed the little rowers the water's wide edge there, you like it. It was plant.

The first seeds have sprouted. You can see the annuals and the grasses, the biennials (future wanderers) and already a few perennials.

The soil is decidedly "firmer" than it was at the start of the winter. New species have appeared. The terrain starts to fill up. You look for the best way to make paths. The perennials have grown so much that you cannot conserve them all.

guidelines for the planetary garden



July

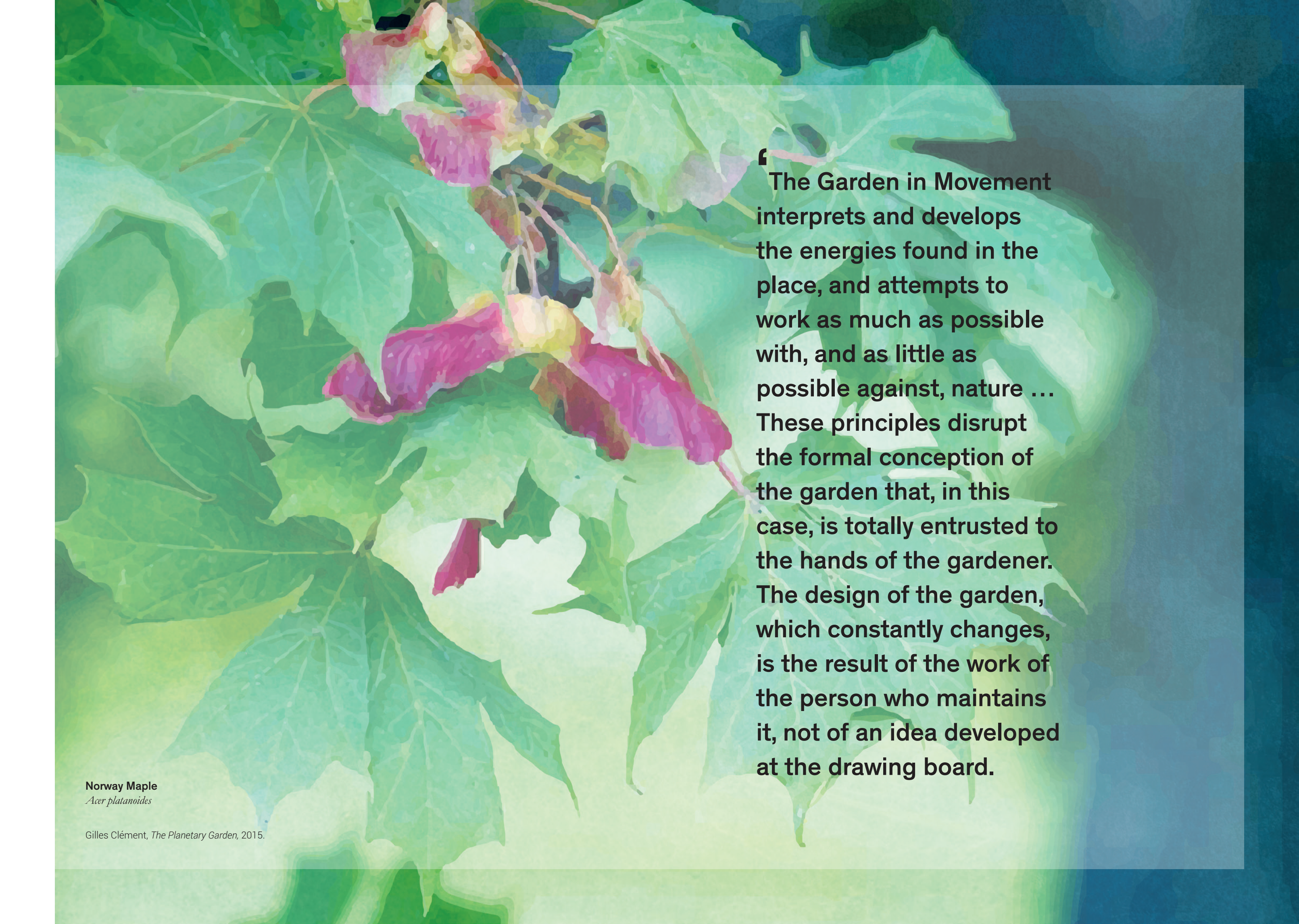
Two years later

The years to follow

With an appropriate machine, you have traced the contours of the islands. In certain parts the islands shrink, in other points they gain ground. The arrows indicate these movements.

The tree you liked so much shades the grass, which dies. Elsewhere, in the midst of the islands that have repeatedly changed their forms and proportions, young trees are growing. You are perplexed: the place is becoming a forest.

The size of the flowering islands has diminished. The shade of the young trees is still not strong enough to eliminate the grassy ground-cover, but it soon will be, and you have gone ahead, isolating the trees in the meadow. In one or two years you will have to decide: whether to remove them, for a return of light and flowers, or whether to let the woodland take form.



“ The Garden in Movement interprets and develops the energies found in the place, and attempts to work as much as possible with, and as little as possible against, nature ... These principles disrupt the formal conception of the garden that, in this case, is totally entrusted to the hands of the gardener. The design of the garden, which constantly changes, is the result of the work of the person who maintains it, not of an idea developed at the drawing board.

Norway Maple
Acer platanoides

Gilles Clément, *The Planetary Garden*, 2015.

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SITE CONDITION

Fragment

Within the subject site a linear fragment is chosen for closer investigation and the subsequent translation into a master plan. The fragment is marked by different sectors each with a characteristic set of structures, components and attributes. Most notably, the site exhibits two contrasting conditions – populated and dense versus vast and open

The south-west corner of the fragment accommodates an agglomeration of old trees amidst which there were once a number residential buildings housing refinery officials. This grove transitions into a sector containing manifold storage tanks of varying sizes (between 50 and 8.5 metres in diameter) and connected by a dense system of pipelines. A grid of pathways divides it in largely subsided parcels.

Large parts of the inoperative and abandoned refinery are located towards the centre of the fragment. Structures occupy the entire horizontal length and make up the highest artificial point. As such, they form a spatial and visual boundary within the site.

Opening views towards the harbour basin and the North Sea beyond, the largest sector comprises of mostly unused land. It unfolds towards the water line along the basin of the old port. The essentially flat grounds are partly covered with shrubs as well as remnants of connecting infrastructure such as pipes.

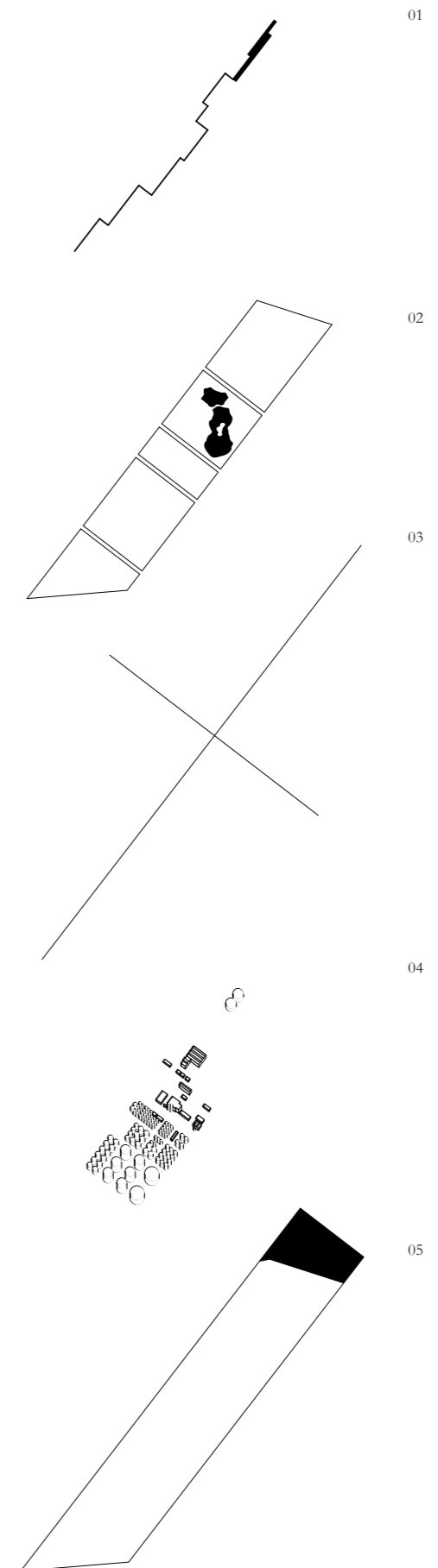
Layers

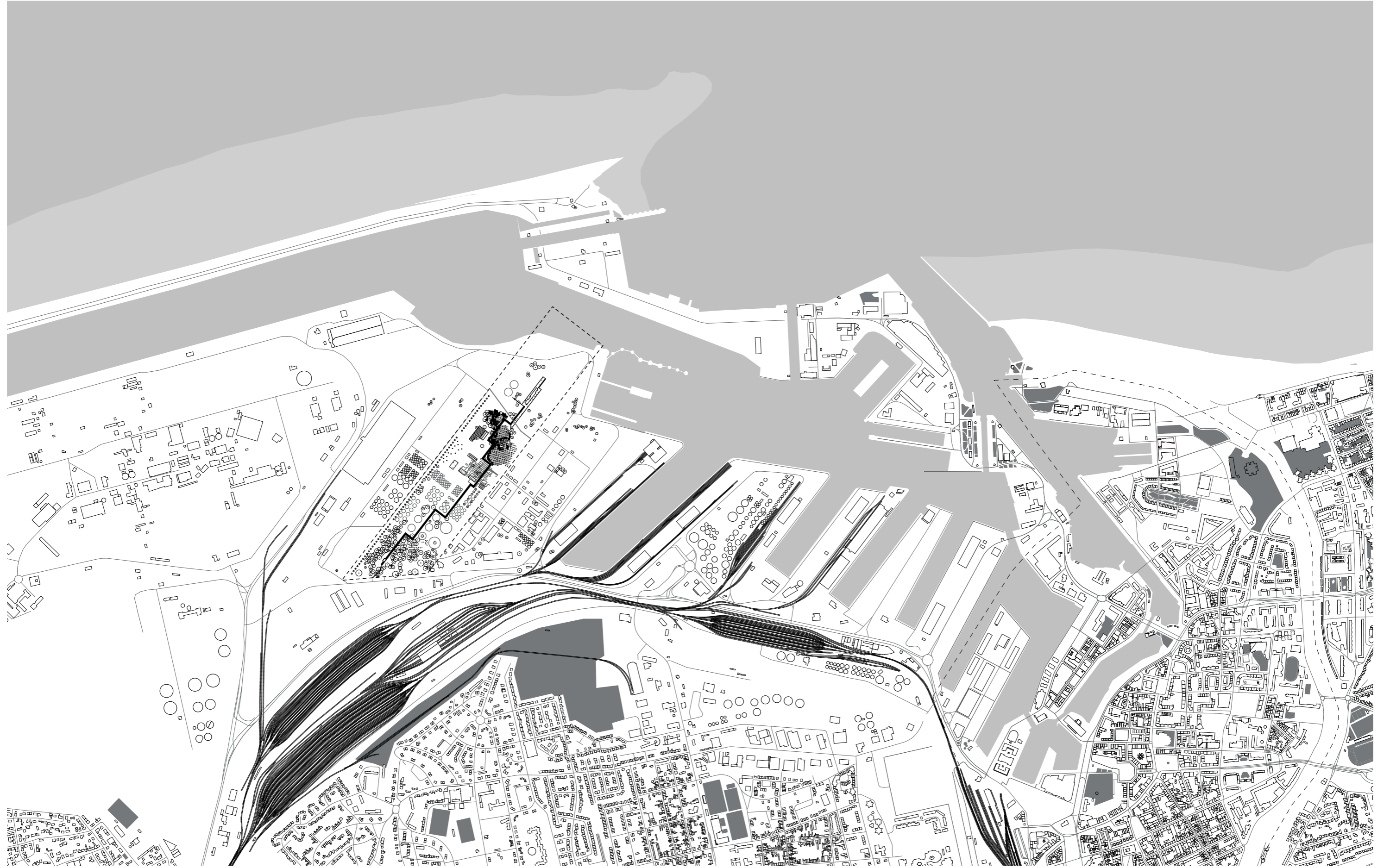
- 01 *Architecture*
- 02 *Gardens*
- 03 *Axis*
- 04 *Structures*
- 05 *Fragment*

Next page:

Context

Master plan 1-15,000





Access

The site is connected to both the city centre of Dunkerque and the outskirts through a major road. An existing bus line provides free public transport to the former entrance of the refinery which now serves as main access to the site. An extension of the route along an existing circular road contributes a second point of arrival near the architectural intervention.





Parking spaces with electrical loading stations adjacent to the building allow visitors and staff to arrive by car. Further street parking is found along the entry road.

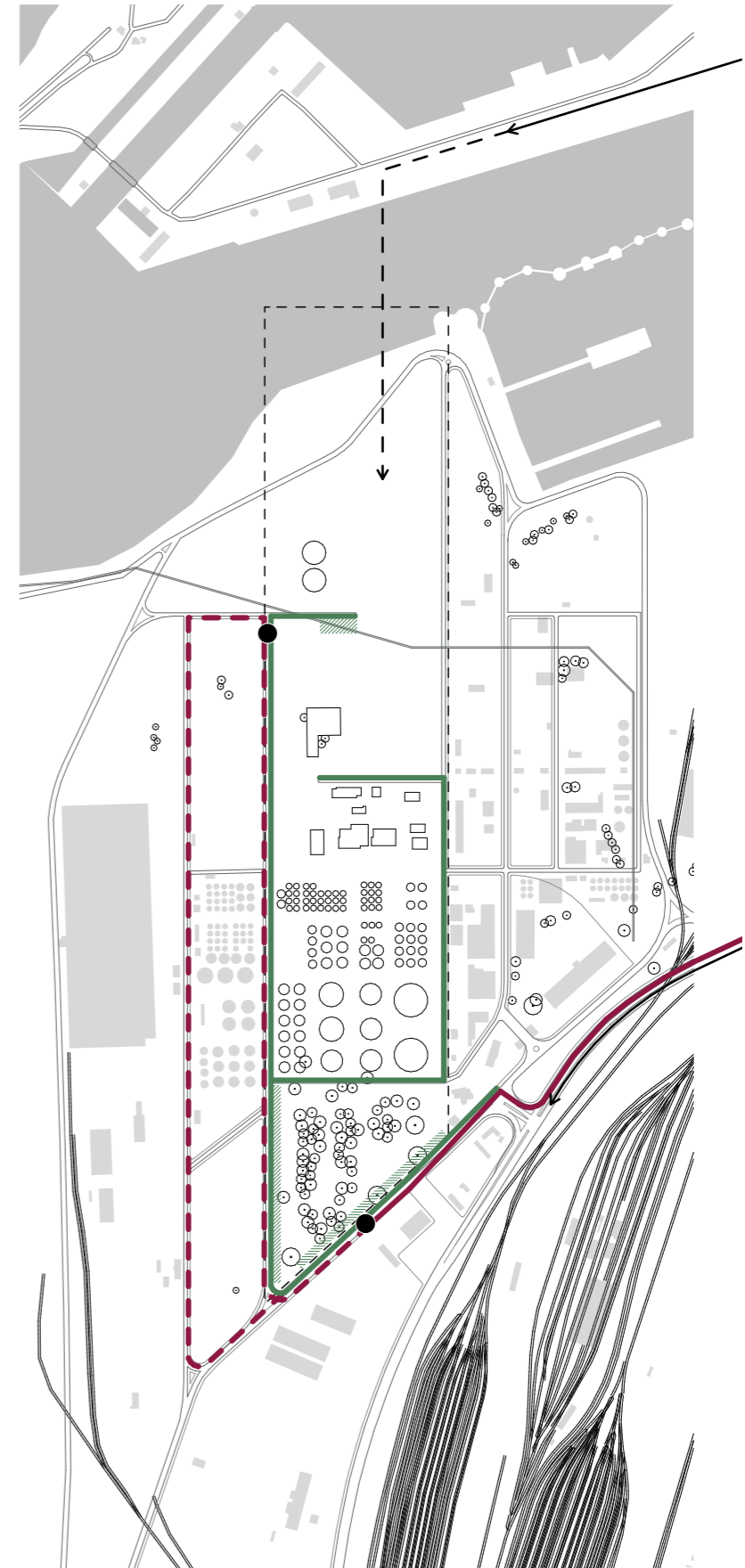
The site can be reached by bicycle via a new cycle path along the abandoned railway line linking the edge of the old port with the Dunkerque Central Station at the edge of the city centre.

Moreover, there is potential for a pedestrian bridge connection across the harbour basin once all industrial activity has ceased or moved towards the new port west of Dunkerque as a result of gentrification. This linkage could provide an continuous loop between the project site and the city centre.

Current Condition

Infrastructure

-  Service Roads
-  Existing Bus Line
-  New Bus Line
-  Bus Stop

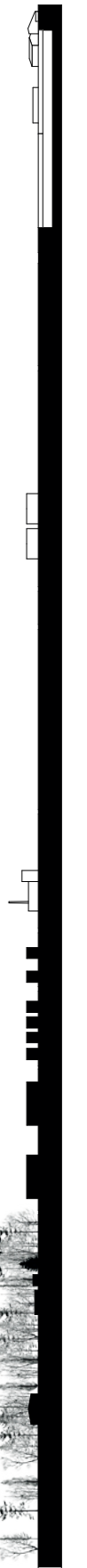
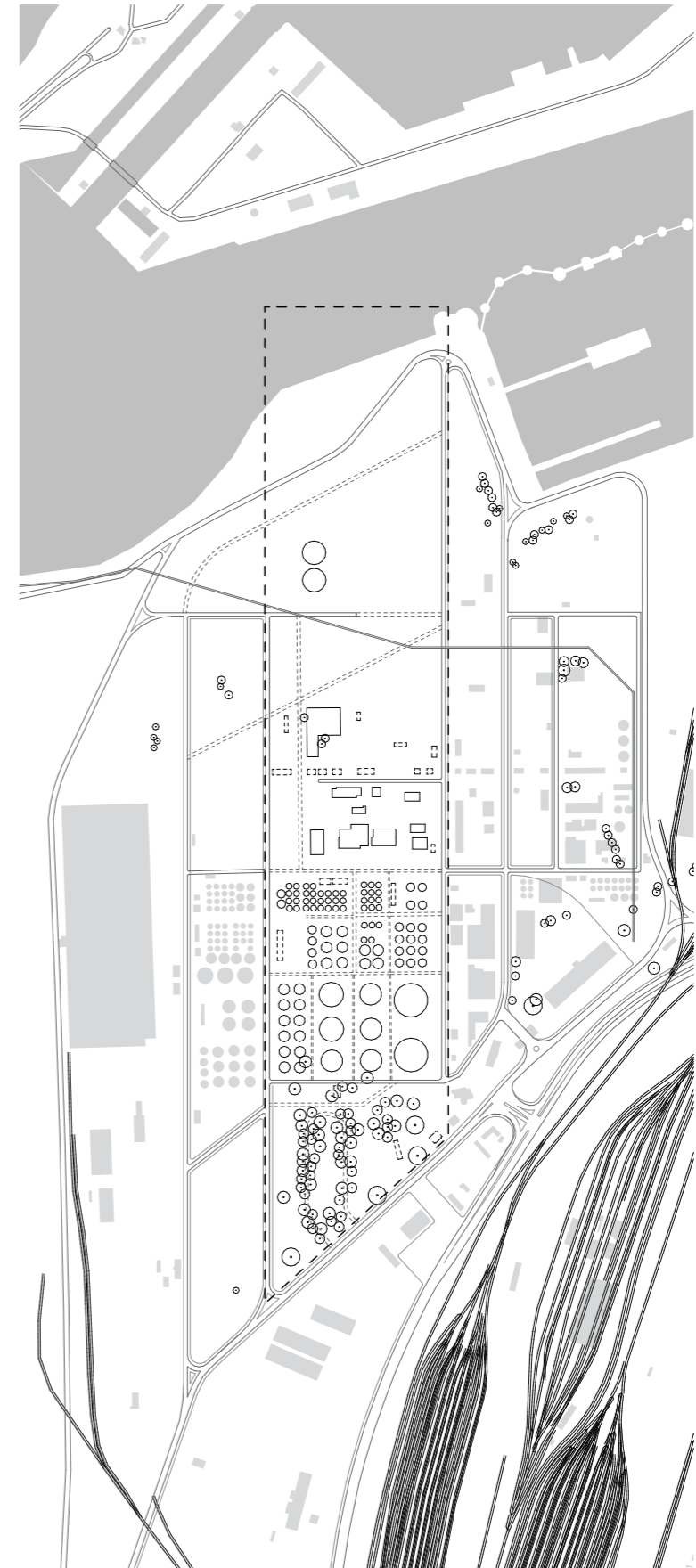


Structures

The site is occupied by a myriad of uninhabited and abandoned structures. Varying from large and small storage tanks, numerous smaller brick buildings and sheds to the colossal steel structures of the refinery itself, traversed by a warren of pipelines. A small group of housing has already been demolished after being long abandoned and gave way to reforestation. While some structures, like the former residences, are taken down to make room for the new occupation, the majority of existing structures remains on site. Some find new purpose for storage for garden maintenance tools and vehicles, other are left to be overgrown and deteriorate as a perpetual reminder of the past.

Current Condition

Structures



06 URBAN GARDEN

Sequence

The site's fragmentation into different functional sections suggests a sequence of different spaces. These are connected by the initial main path and through an increasingly extending path network that evolves as the landscape is remediated.

a. *Forest Garden*

An existing accumulation of old trees at the south-west corner of the fragment forms a grove. Perforated by a clearing-like opening towards the site boundary, it suggests an entry point where the path commences. New trees are added to create a thick covert. Trees are particularly efficient at degrading or binding pollutants due to their expansive and deep-growing root systems. At the same time, they release organic compounds into the air that have a relaxing effect on the human nervous system.

b. *Wild Garden*

The grove expands into the second sections where countless silos varying in diameter form a forest of their own. After an initial planting this garden is largely left to itself and allowed to grow and spread according to an ever-changing condition. Certain plants can be used as indicator for specific ground conditions such as type and grade of contamination. Allowing natural growth to occur best assists the re-establishment of a functioning ecosystem and also invites non-human visitors such as birds, insects and small mammals to colonise.

c. *Flower Garden*

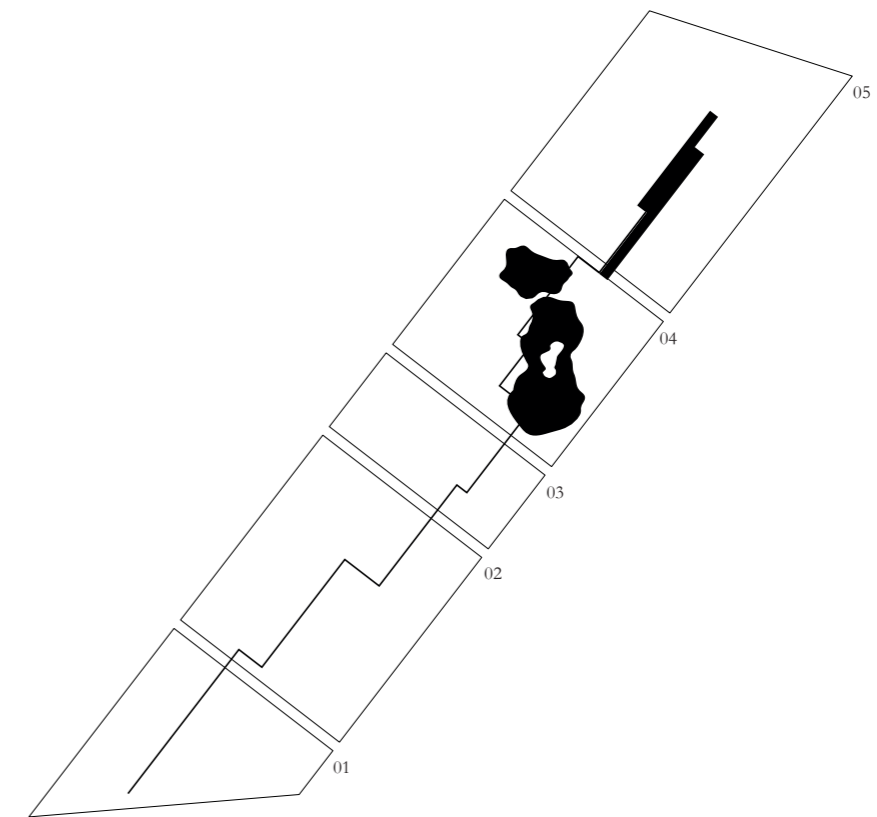
A swath is formed into the abandoned refinery structures which occupy the next sector across its entire horizontal length. Flowering shrubs and trees that are either petroleum degrading or tolerant create a colorful contrast to the industrial structure throughout this sector. Here the intervention becomes more concrete to not only provide a more direct approach of remediation but to form a direct response from an aesthetic point of view.

d. *Water Garden*

At its centre, the site reaches a turning point from existing to new – water is the source of the life and the fuel for new beginnings. A newly constructed water reservoir accommodates a helophyte filter system that acts as bioremediator, purifying and storing water for on-site utilisation while being aesthetic feature alike.


e. *Plain Garden*

The final garden climaxes with the juxtaposition of prospect and refuge as it unfolds outwardly across the open land towards the harbour basin and inwardly into the heart of the inhabited structure. Here, the architectural intervention forms a second point of arrival and with its amenities and servicing functions a counterpart to the garden that lead hereto.



Gardens along Path

- 01 *Forest Garden*
- 02 *Wild Garden*
- 03 *Flower Garden*
- 04 *Water Garden*
- 05 *Plain Garden*



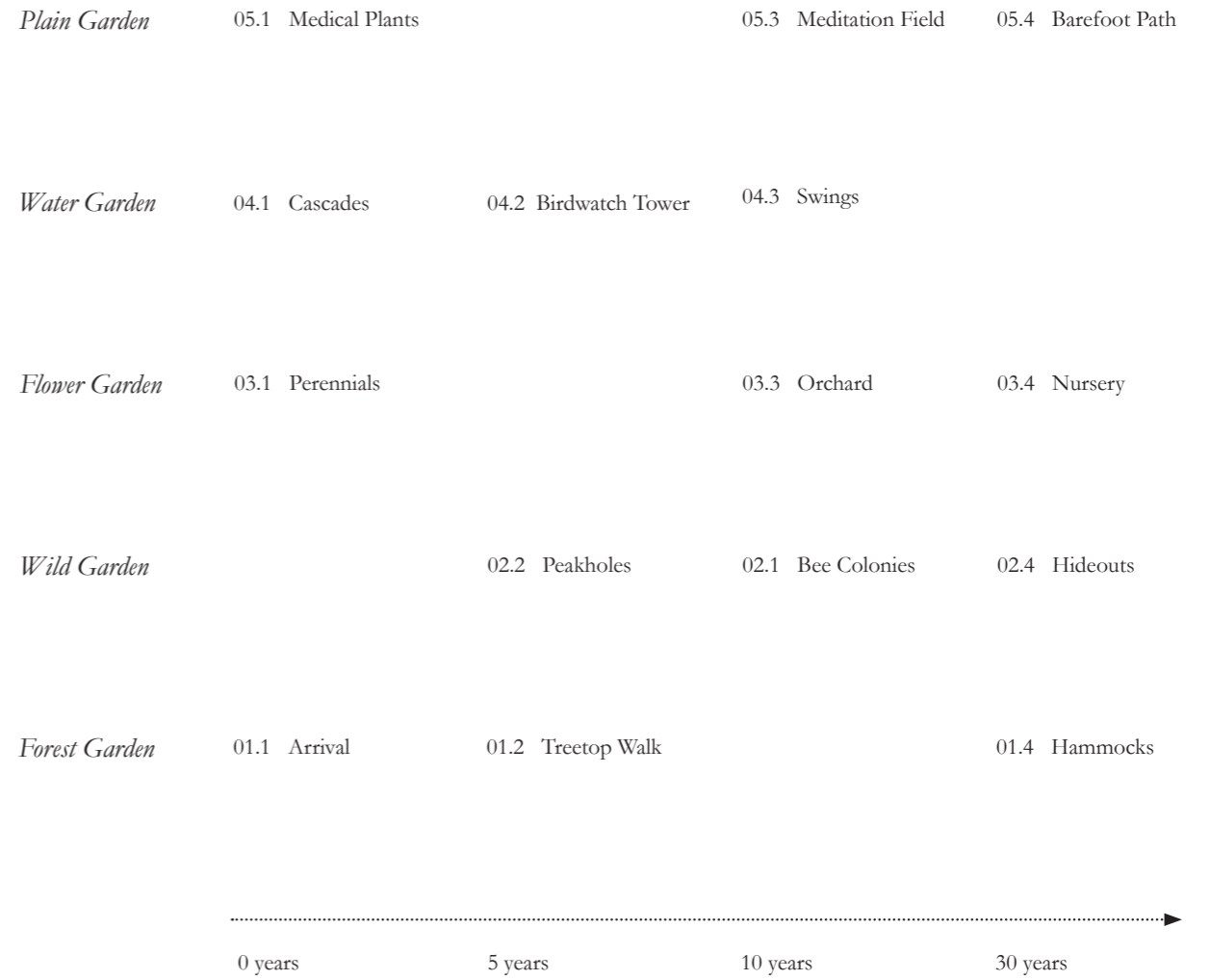
‘ Gardens should be stimulating environments – both mentally and physically – and can be designed to provide a rich sensory experience. Sight tends to dominate, but sometimes all you need to do is close your eyes and wait for the other senses to wake up and provide an unexpected new appreciation of the garden you never knew you had!

Moments along the Path

The site comprehends itself as an endless chain of changing conditions which are experienced along the network of paths that unravels through time. During the first stage, the path is rigid and sternly transects through the site as though its primary motive is to merely bring the visitor from one end to another. Yet as time passes, new paths open up like branches of a tree, allowing more or more fluid networks to emerge and the visitor to dive deeper into the landscape.

Across the site, an array of places are brought into being and by means of the ever-expanding path network disclosed to the visitor. These I call *Moments*, as each of these places unfolds uniquely to each explorer, depending on the time of day, the season, the state of the mind. Some are physically interactive, others invite to rest, and some foster one's inward journey.

So we may reach a point and hold. We tune into the space, our surroundings, the depths of this place we arrived at. We are in the present, here in this moment. And yet in the blink of an eye things move on, as nature never stand still. An ever-so endless chain of change.



06.3 PLANT CATALOGUE

¹ K. Kennen & N. Kirk, *Phyto*, 2015.

Bioremediation occurs naturally and while there are multiple technologies to accelerate the process it can be enough to sow the right plants and observe them through time. Numerous petroleum degrading plants, herbaceous, trees and wetland plants, have been identified¹. They make up the colours and textures of the garden. Additionally, an array of petroleum-tolerant plants complements them creating great biodiversity.

Knowing ones plants, the gardener or curious visitor can understand much about the landscape and its state of contamination. Where those plants known to be intolerant to petroleum hydrocarbons begin to thrive you are sure the land has been remediated.

Herbaceous

- 01 *Avena sativa*, Oat
- 02 *Brassica juncea*, Indian Mustard
- 03 *Bromus inermis*, Smooth Brome
- 04 *Dactylis glomerata*, Orchardgrass
- 05 *Elytrigia repens*, Couch Grass
- 06 *Festuca arundinacea*, Tail Fescue
- 07 *Festuca pratensis*, Meadow Fescue
- 08 *Festuca rubra*, Red Fescue
- 09 *Kochia scoparia*, Burningbush
- 10 *Leymus angustus*, Altai Wildrye
- 11 *Linum usitatissimum* L., Flax
- 12 *Lolium multiflorum*, Annual Rye
- 13 *Lolium Perenne*, Herbaceous Ryegrass
- 14 *Lotus corniculatus*, Birdfoot Tail
- 15 *Melilotus officinalis*, Sweet Clover
- 16 *Onobrychis viciifolia*, Sainfoin
- 17 *Phalaris arundinacea*, Reed Canary Grass
- 18 *Solidago* spp., Goldenrod
- 19 *Trifolium hirtum*, Rose Clover
- 20 *Trifolium pratense*, Red Clover
- 21 *Trifolium repens*, White Clover
- 22 *Triglochin striata*, Three-Rib Arrowgrass

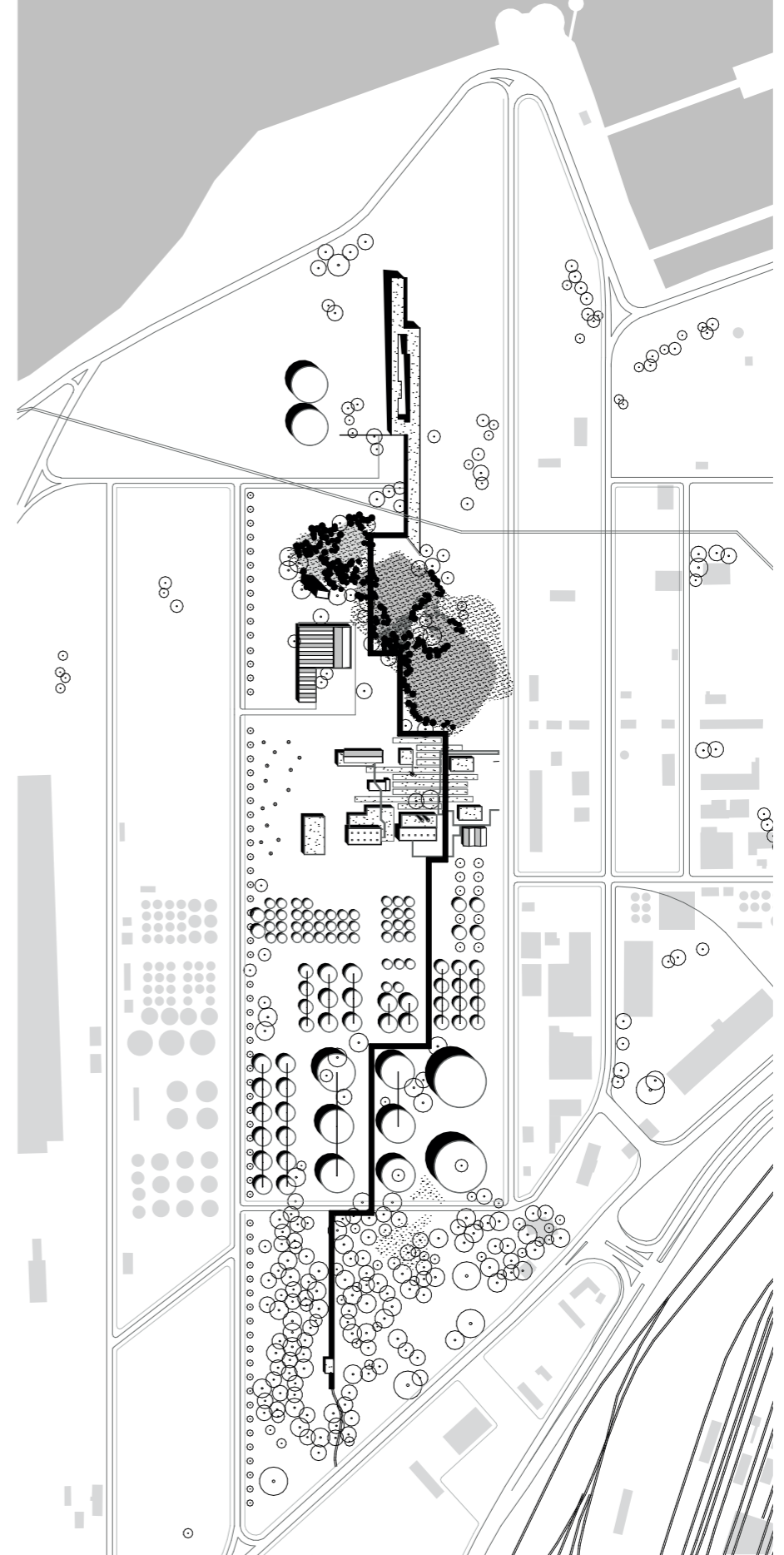
Wetland

- 23 *Phragmites australis*, Common Reed
- 24 *Scirpus* spp., Bulrush
- 25 *Lemna minor*, Common Duckweed
- 26 *Spartina maritima*, Small Cordgrass
- 27 *Eichhornia crassipes*, Common Water Hyacinth
- 28 *Typha* spp., Cattail

Trees

- 29 *Acer platanoides*, Norway Maple
- 30 *Alnus glutinosa*, Black Alder
- 31 *Betula pendula*, European White Birch
- 32 *Pinus* spp., Conifers
- 33 *Pinus sylvestris*, Scots Pine
- 34 *Salix alba*, White willow
- 35 *Salix viminalis*, Basket willow



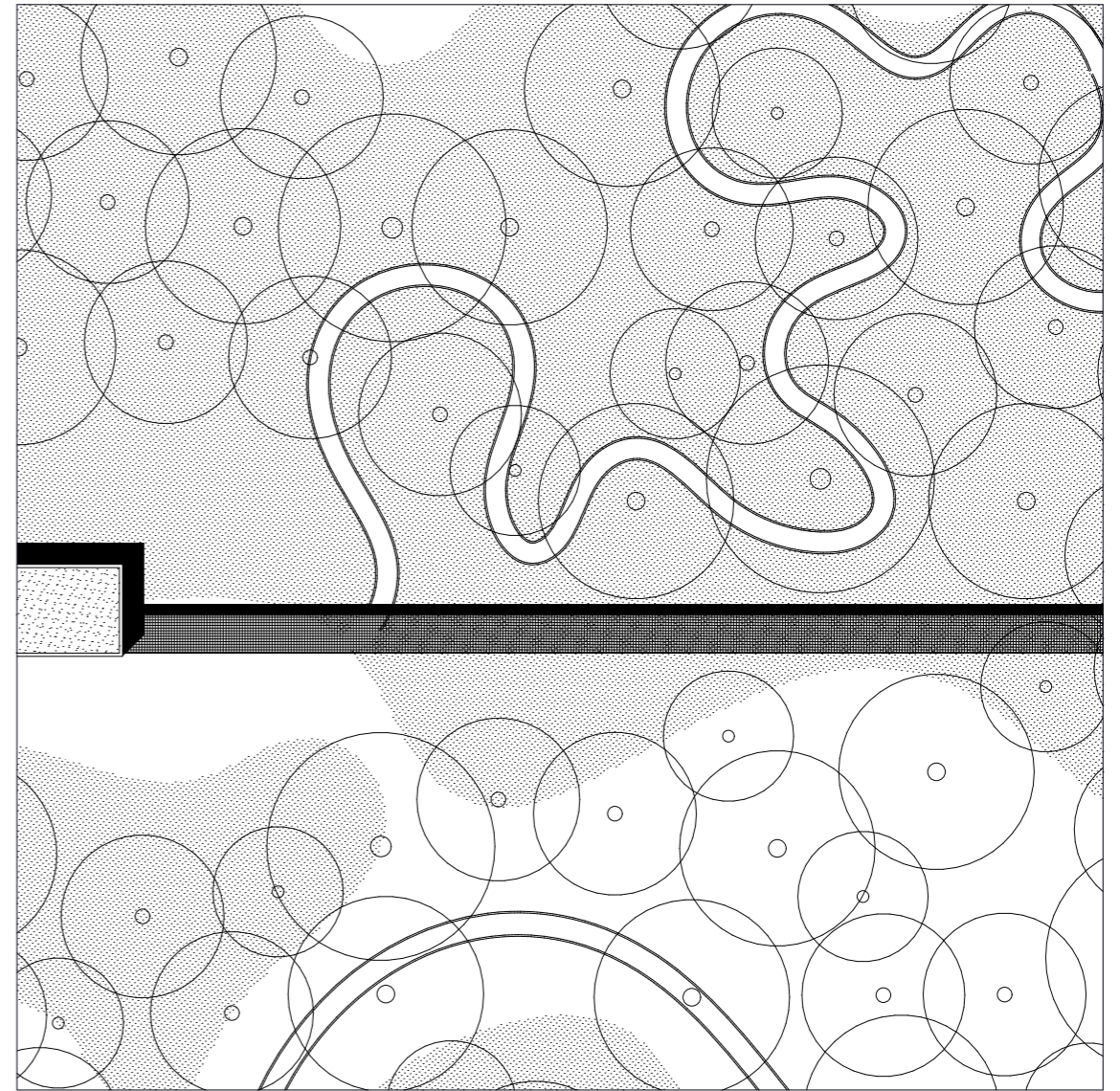




Point of Arrival

Forest Garden – 0 years





Treetop Walk

Forest garden – 5 years

0 5 10 20 m

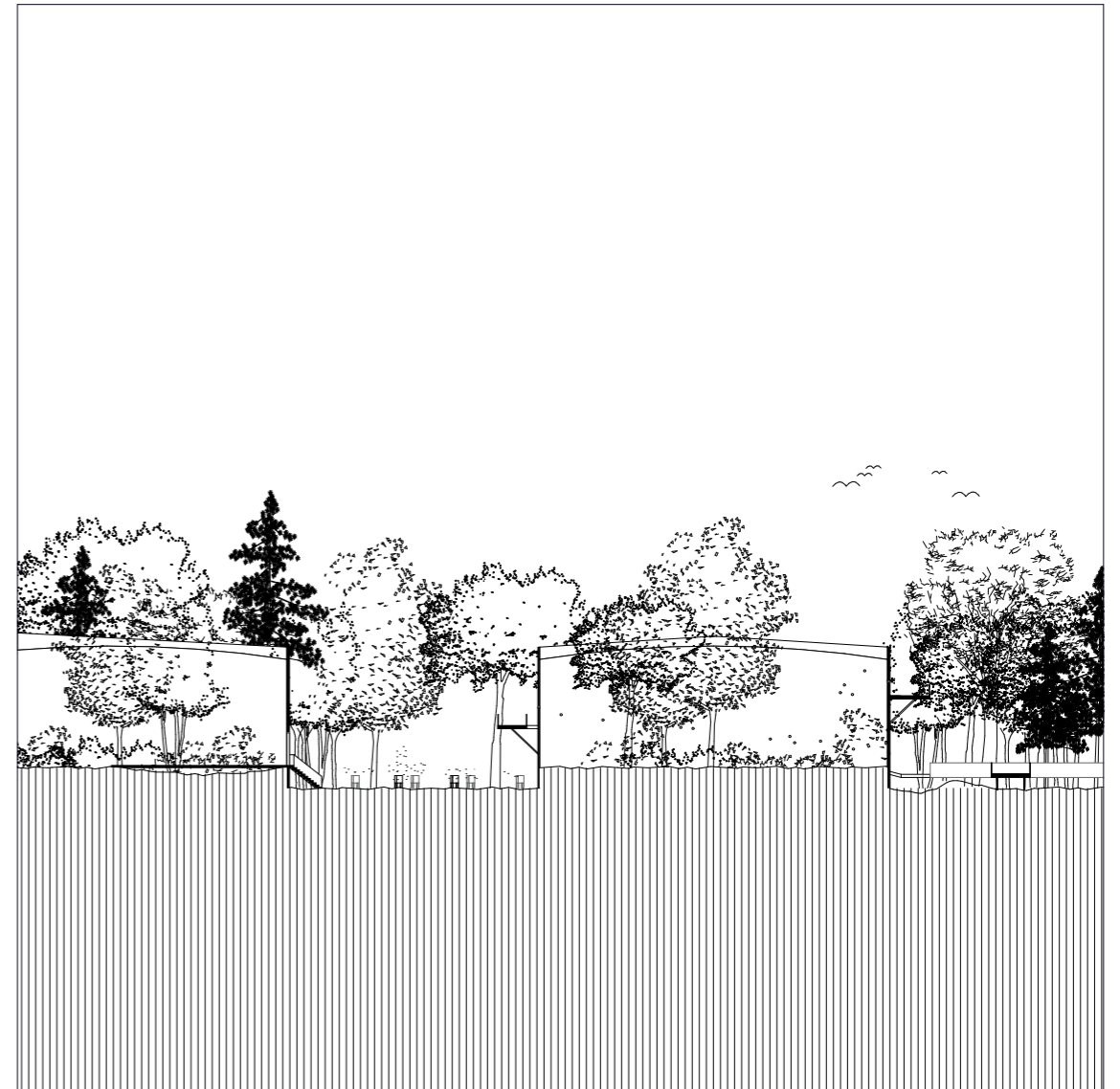




Hammocks
Forest garden – 30 years



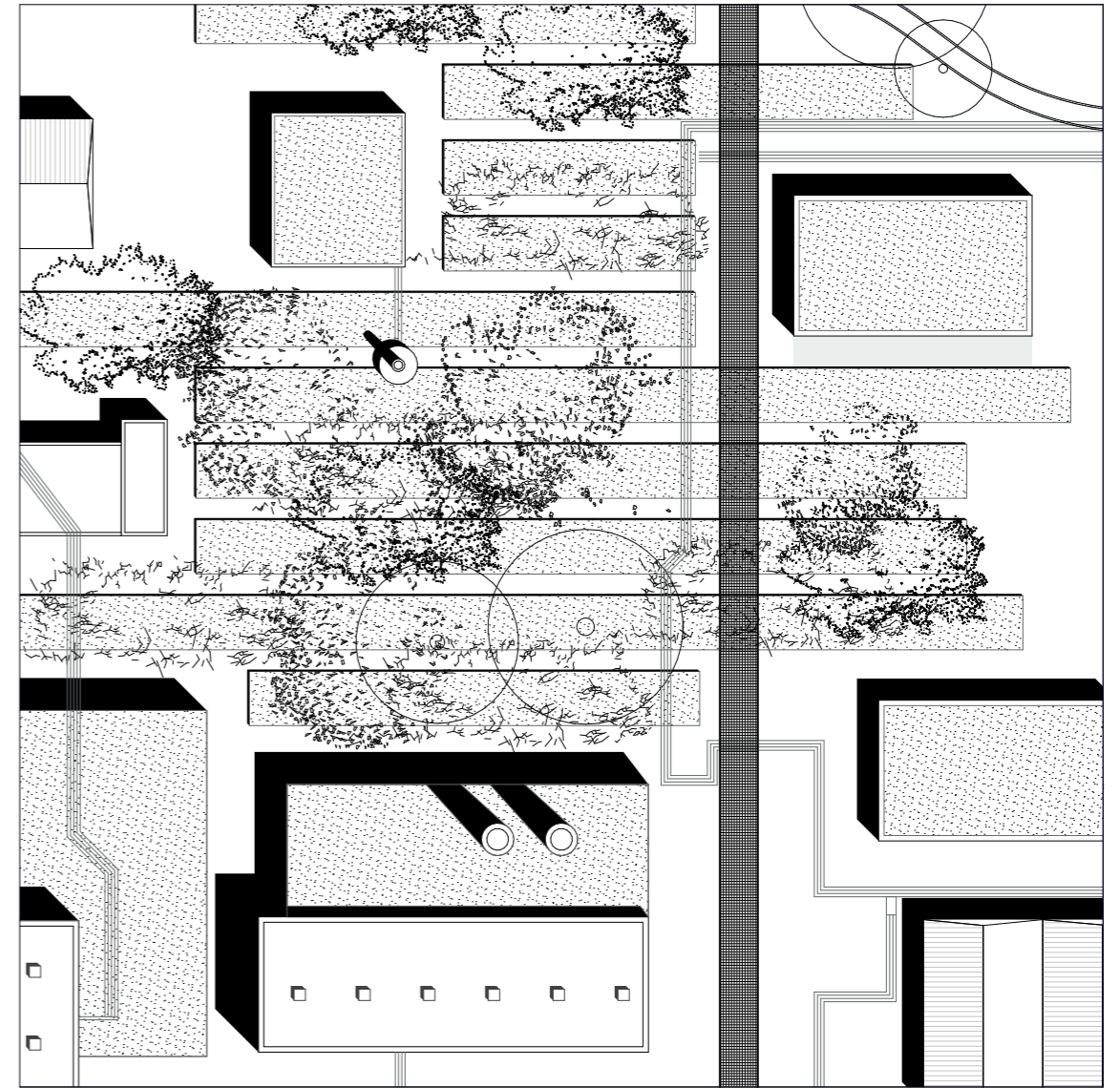
Peak Hole
Wild Garden – 5 years



Hideout

Wild Garden – 30 years





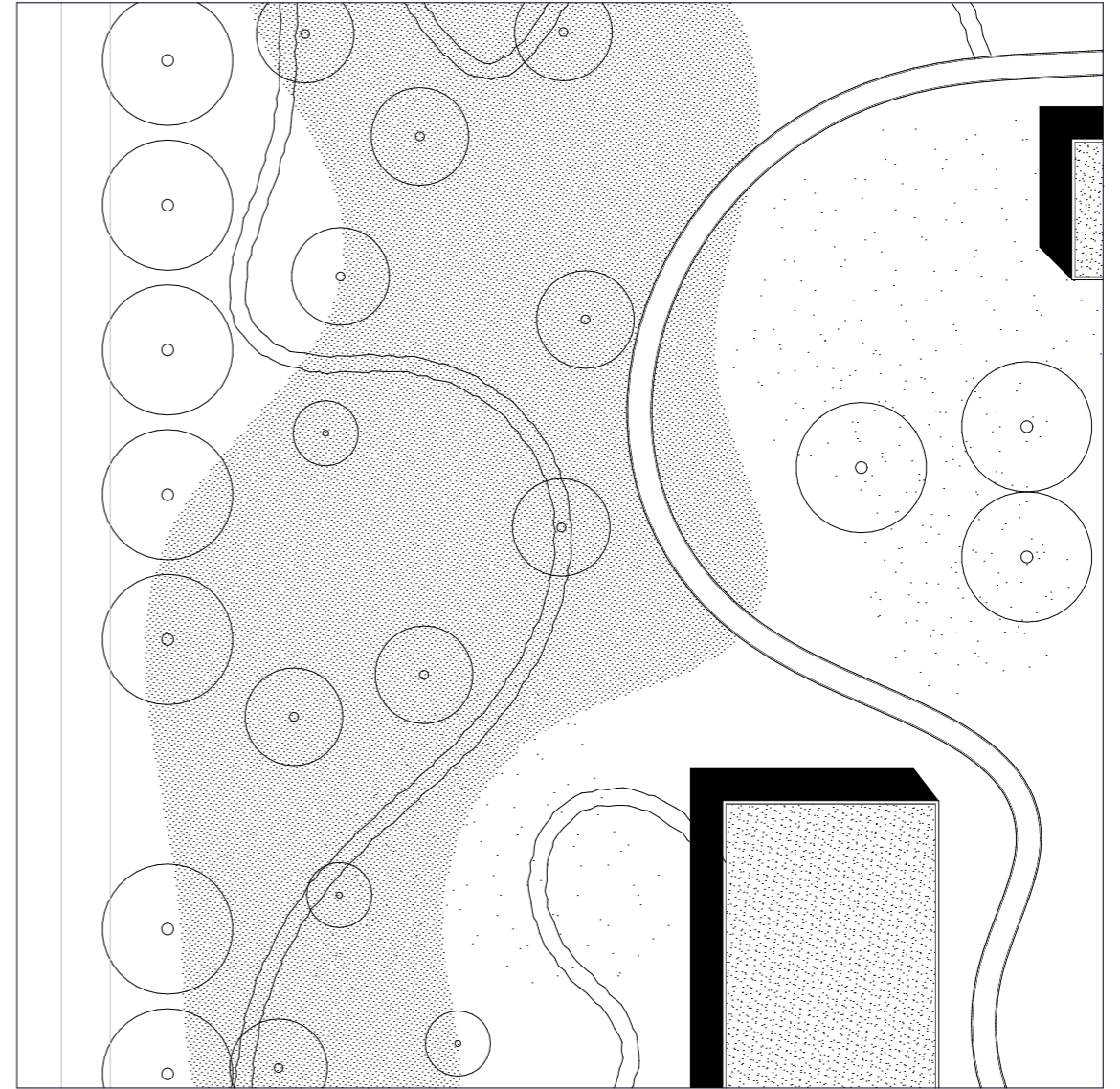
Perennials
Flower Garden – 0 years

Next page:
Walk along Refinery Structure
Flower Garden – 5 years

0 5 10 20 m





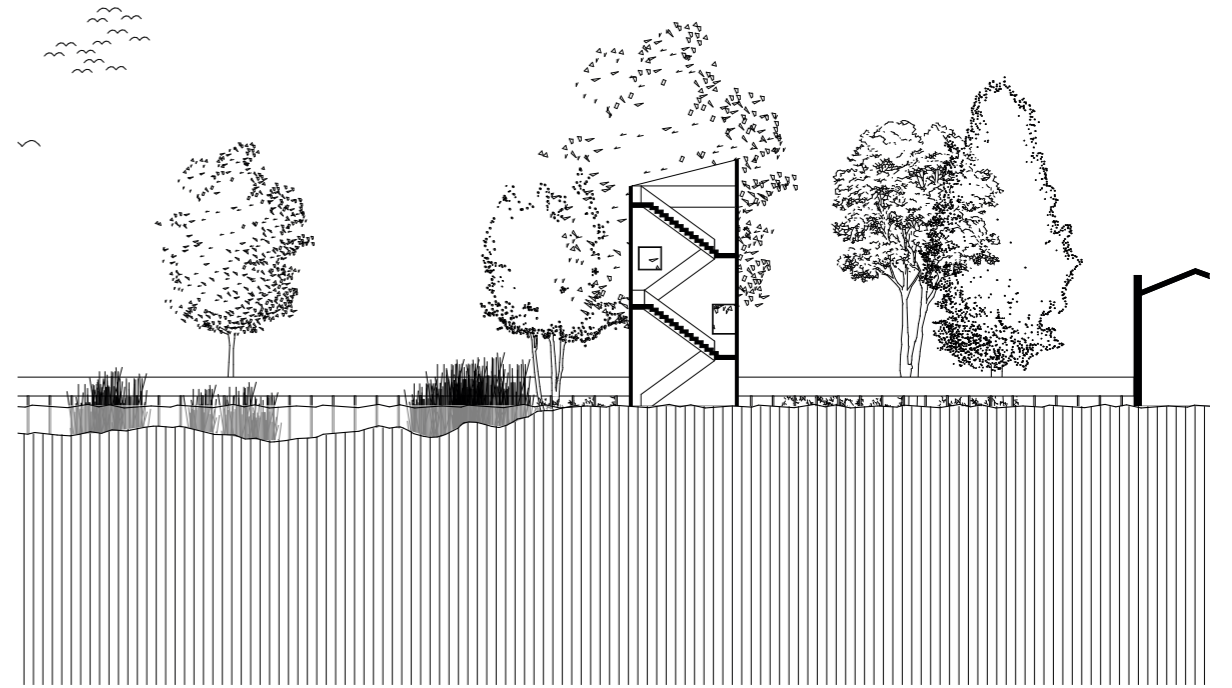


Orchard

Flower Garden – 10 years

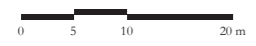
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Birdwatching Tower

Water Garden – 5 years

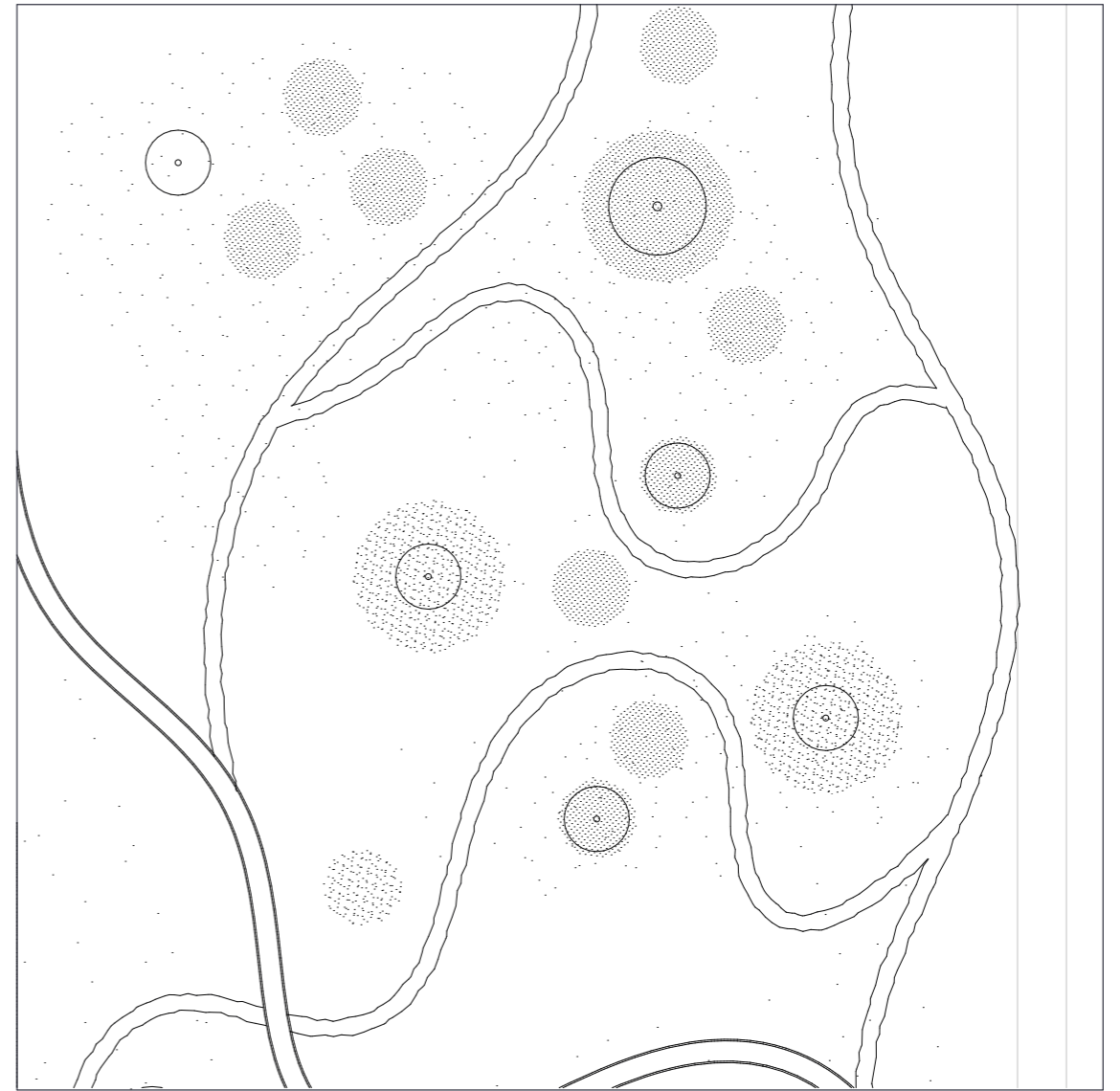




Swings

Water Garden – 10 years





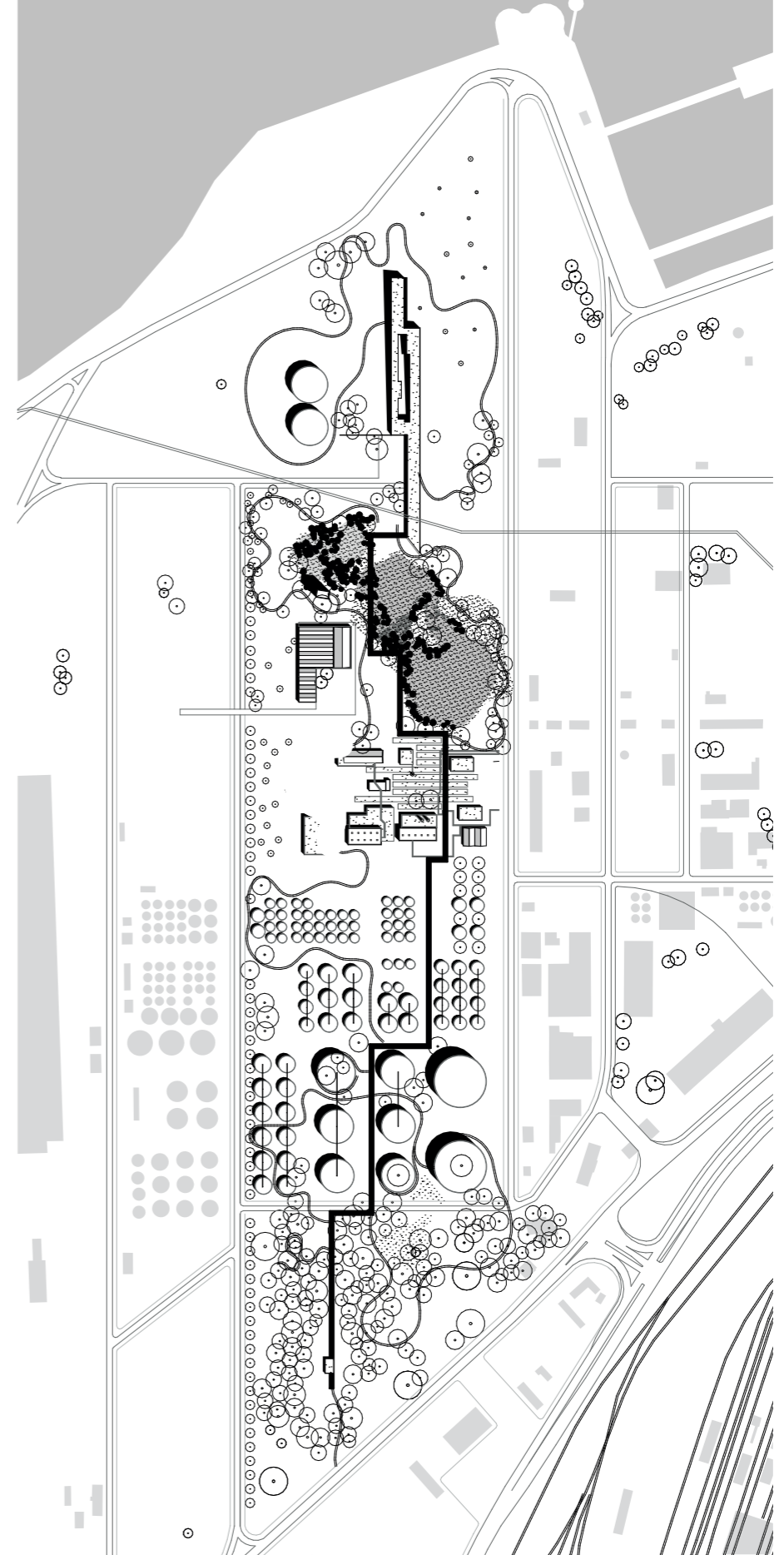
Meditation Field

Plane Garden – 10 years



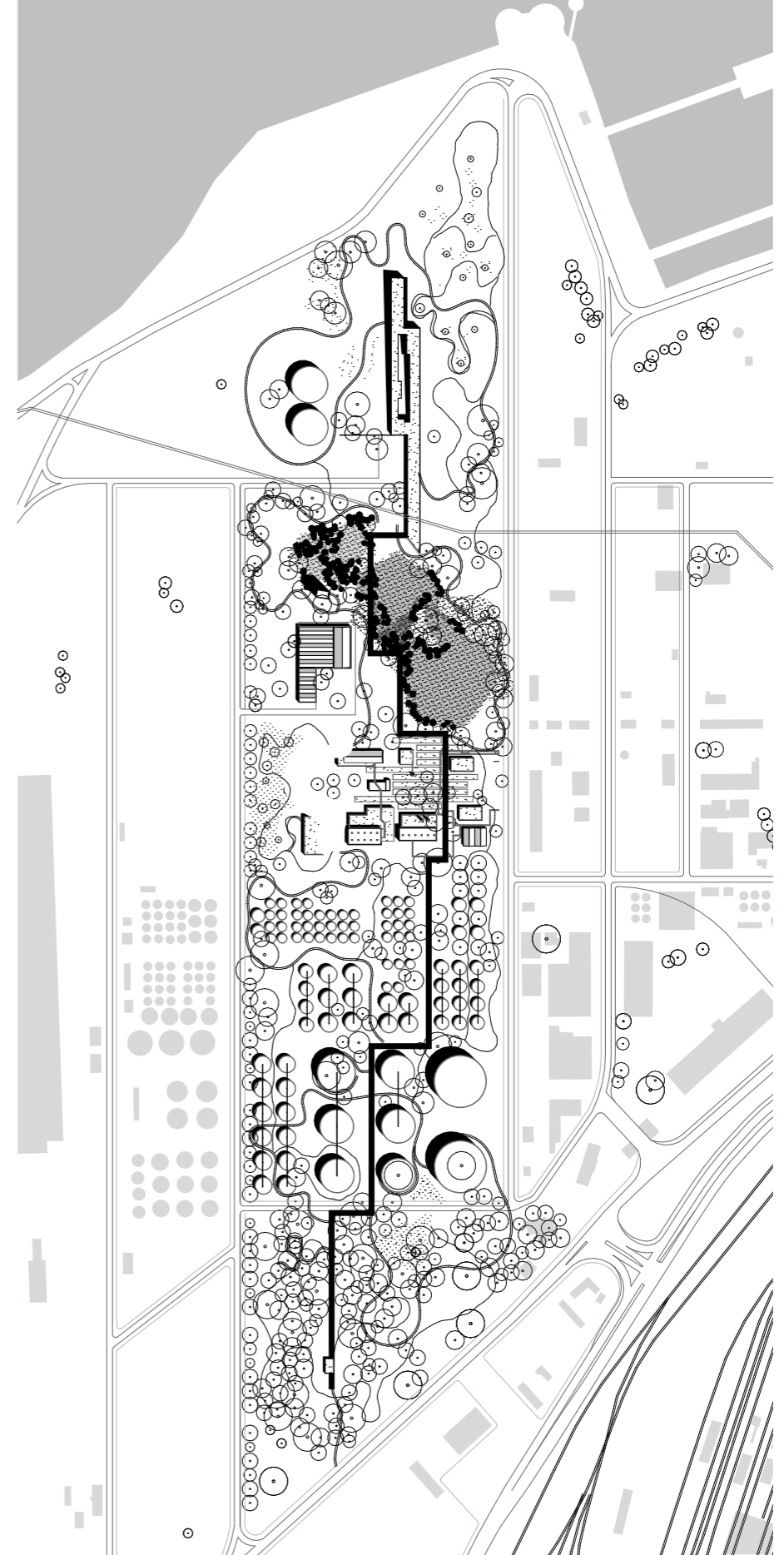
Meditation Field
Plain Garden – 30 years





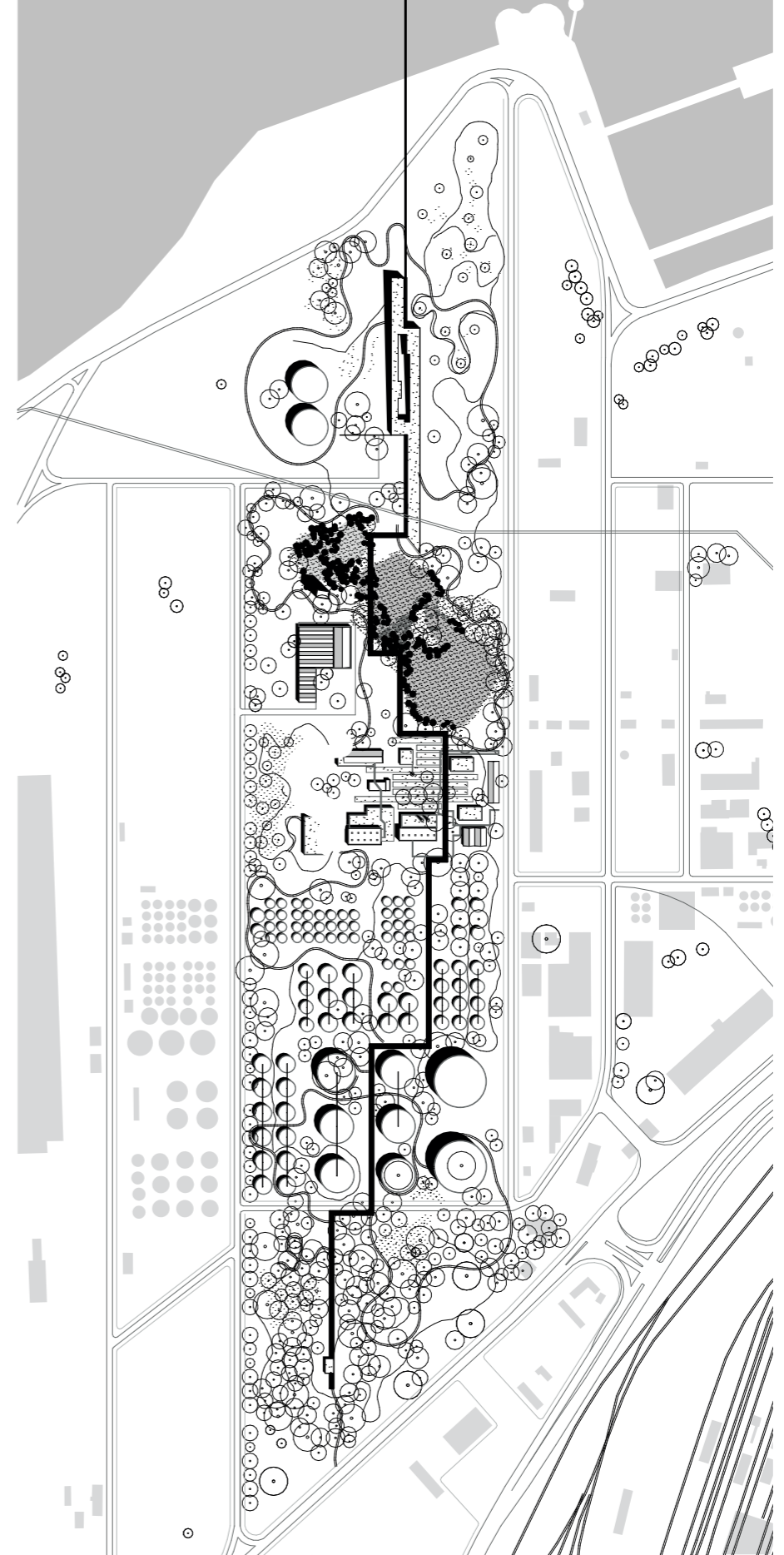
Stage II

Assumption after 5 years



Stage III

Assumption after 10 years



Stage IV

Assumption after 30 years



07 ARCHITECTURE

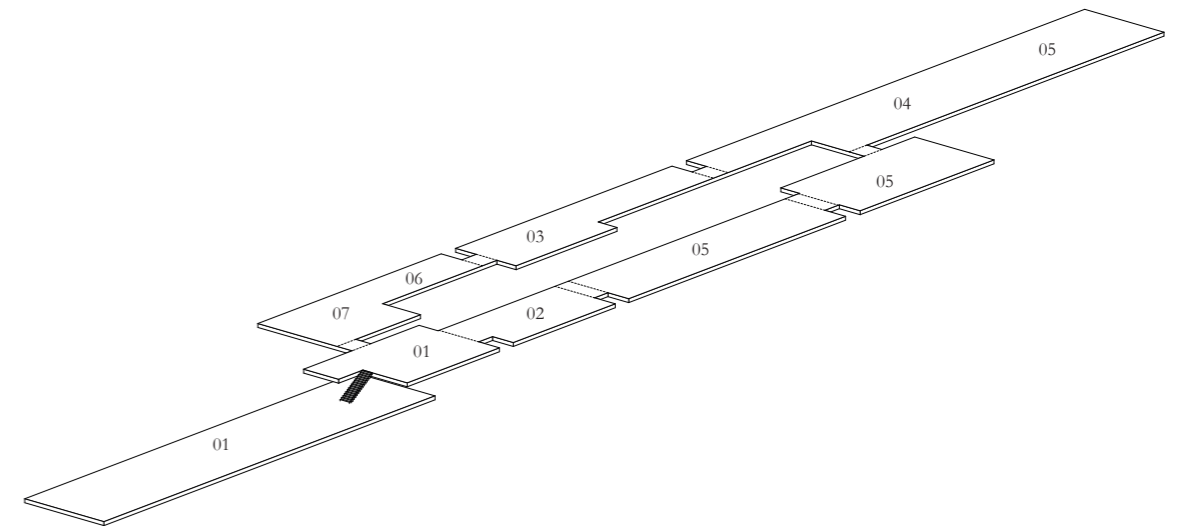
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Programme

The architectural intervention comprehends a visitor centre with supporting functions such as a restaurant, a small shop, exhibition and multi-purpose spaces. Additionally, it provides spaces for health-related activities in the form of studios and workshop spaces.

The built form follows a clear distinction between public and semi-public functions, each arranged within a separate body. Visitors are led through the continually linked public spaces while the semi-public areas directed at specific participants

The walkway, being the guiding motive throughout the gardens, continues its path through the ground floor and allows external access to the balconies that float along the facade.



Programme

- 01 Café
- 02 Shop
- 03 Exhibition
- 04 Workshop
- 05 Studios
- 06 Administration
- 07 Storage

Built Form

The architectural form evolves from the path that transects the site. In continuation of the linear element, in the final garden, the path is accompanied by a wall that, leading towards the building. The building itself originates from this simple line.

In order to allow functions to take place, the wall widens creating an interior space – the simple wall becomes an inhabited wall. The programme suggest a separation into public and semi-public functions. Now constituting of two main bodies, the intervention describes an *other* space. The inner space, neither inside nor outside, becomes the heart of the structure. A still centre is created, enclosed by the building and yet open to the sky – an *other* garden, the final garden: *hortus conclusus*.



wall



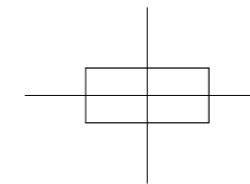
'inhabited wall'



public – private



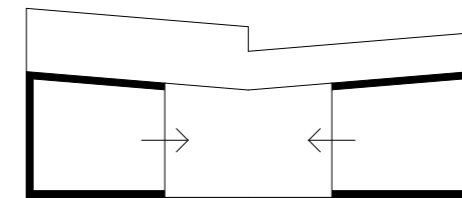
enclosing



centering

Refuge – Prospect

The duality of the garden as a whole retranslates on the building scale by proposing a the state of refuge on one hand and inviting prospect on the other hand. The inner garden forms a still centre. Here the visitor feels contained and safe. In contrast, the roof angle forms a slope upwards and towards a somewhat state of unknown. From the rooftop one overlooks the sea which serves as a synonym for a long lost wilderness.



Built Form

Roof angle



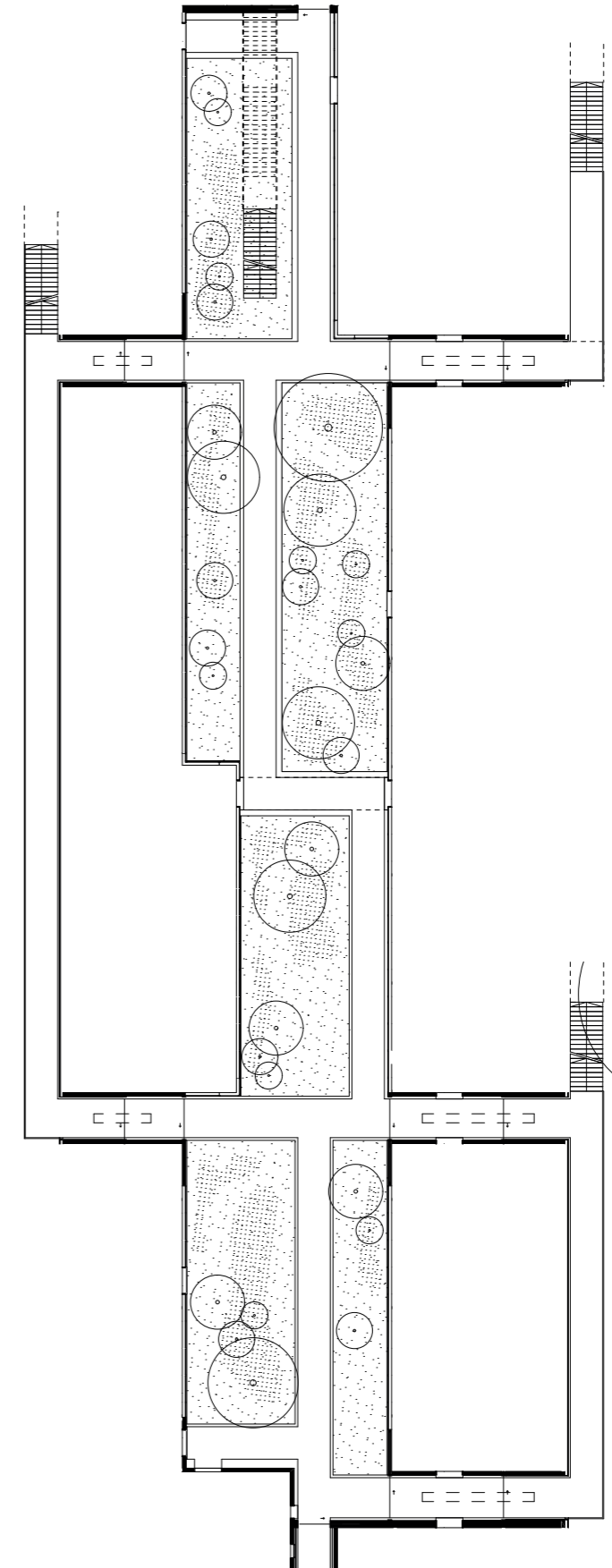
Still Centre

...

*'And so we encircle it, ... The garden turns into a place'*¹

The first space upon entering the newly erected structure is therefore not only the final garden, but the focal point of the built form itself, the heart of the building and still centre. We take a deep breath.

¹ Peter Zumthor, Hortus Conclusus, 2011.



Inner Garden

Plan 1-500

Next page:

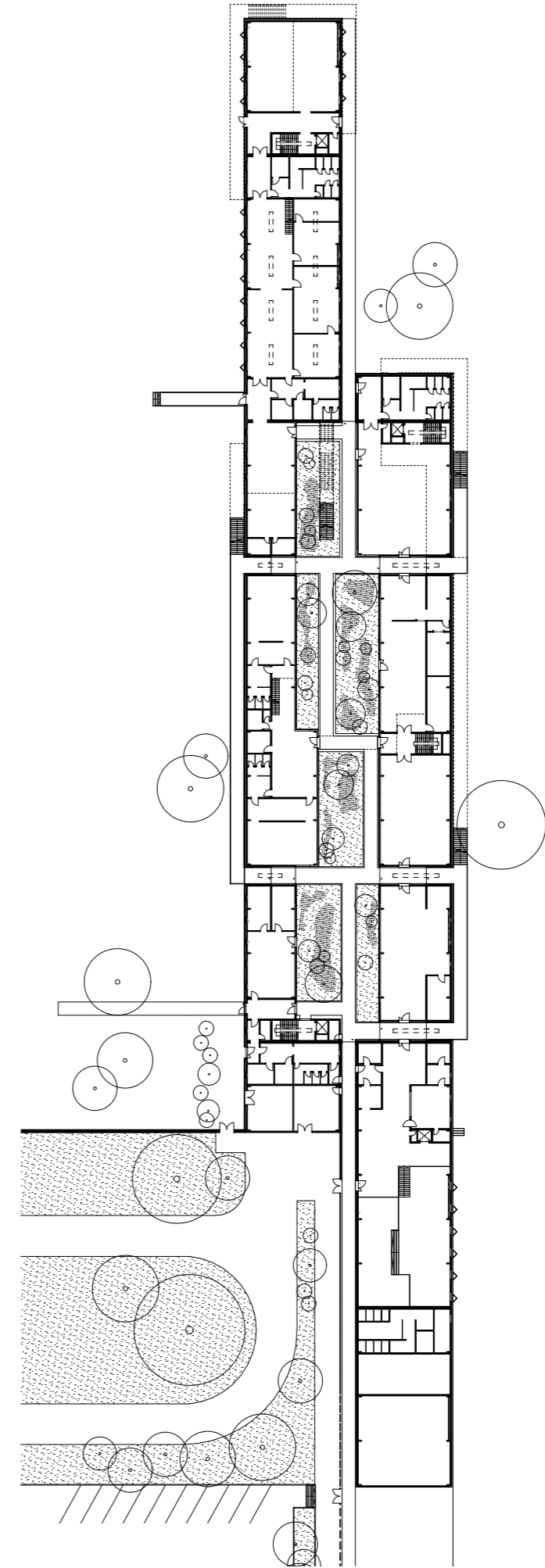
Hortus Conclusus

View into courtyard



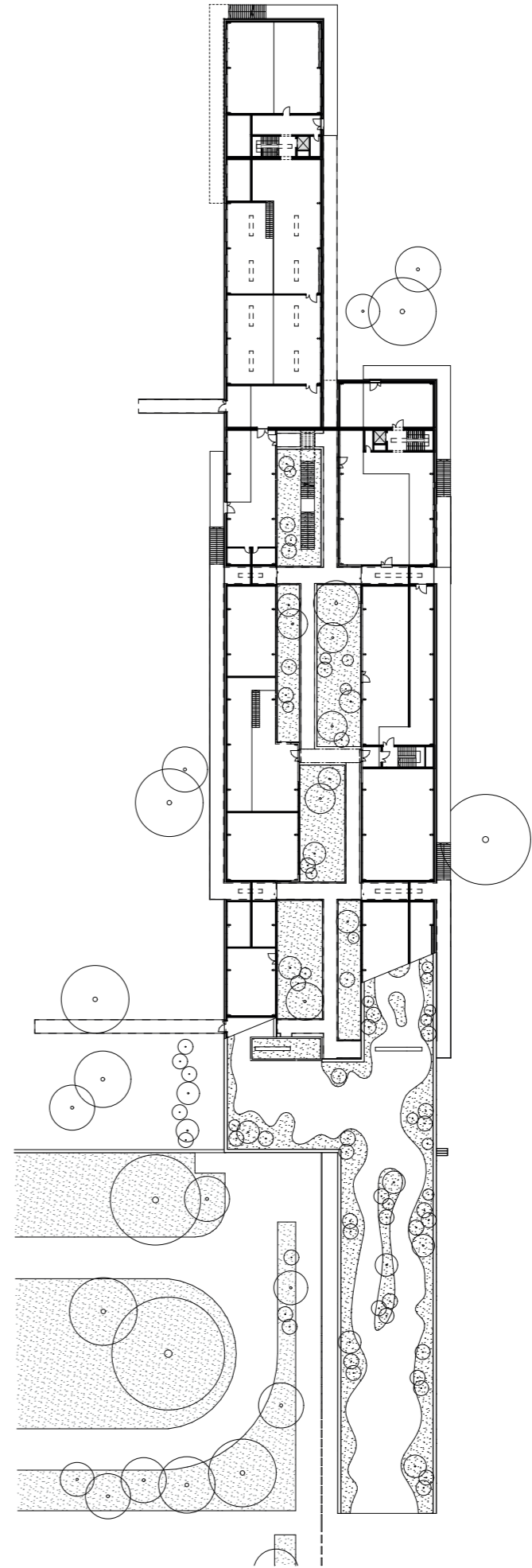
Ground Level

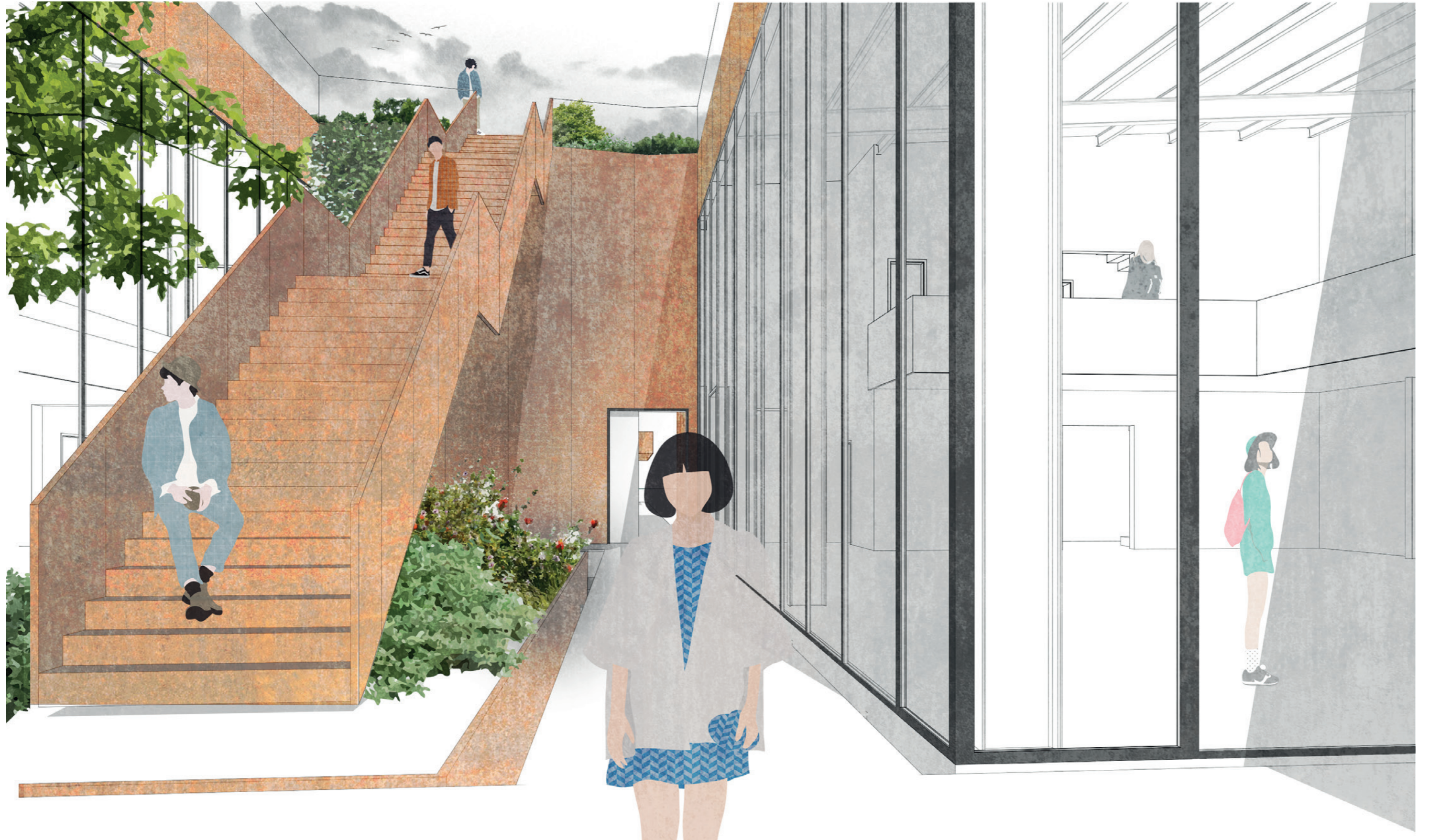
Plan view



Mezzanine

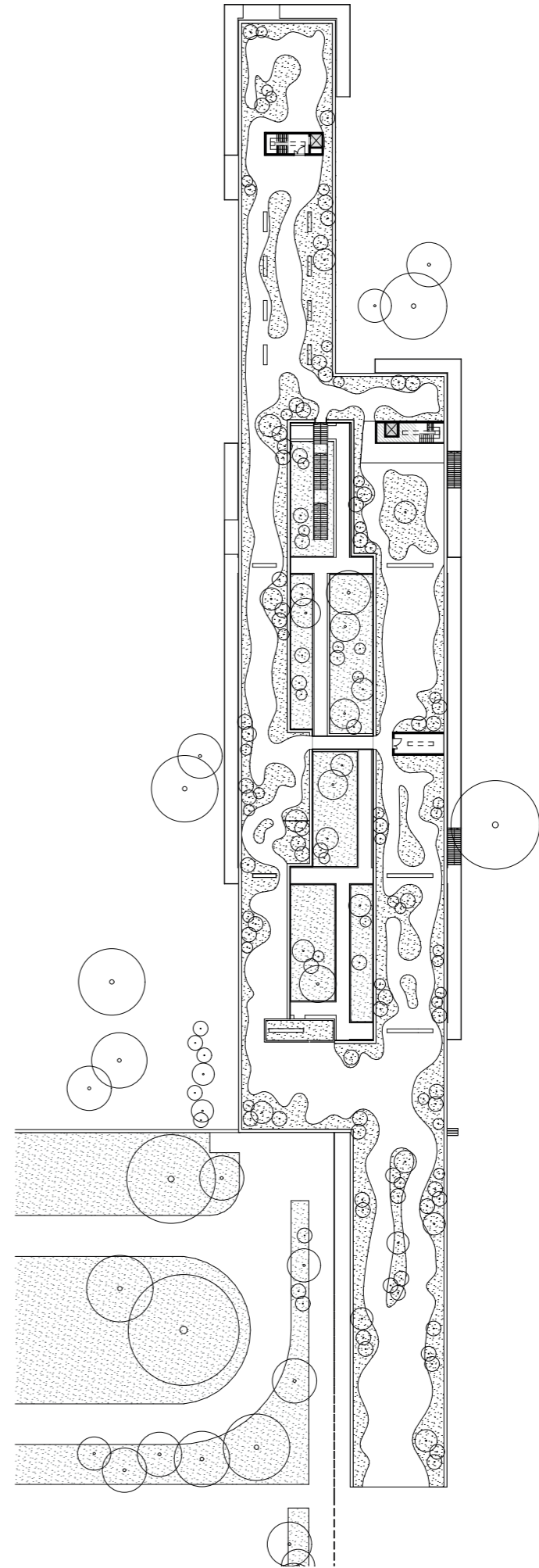
Plan view






Roof Garden

Plan view

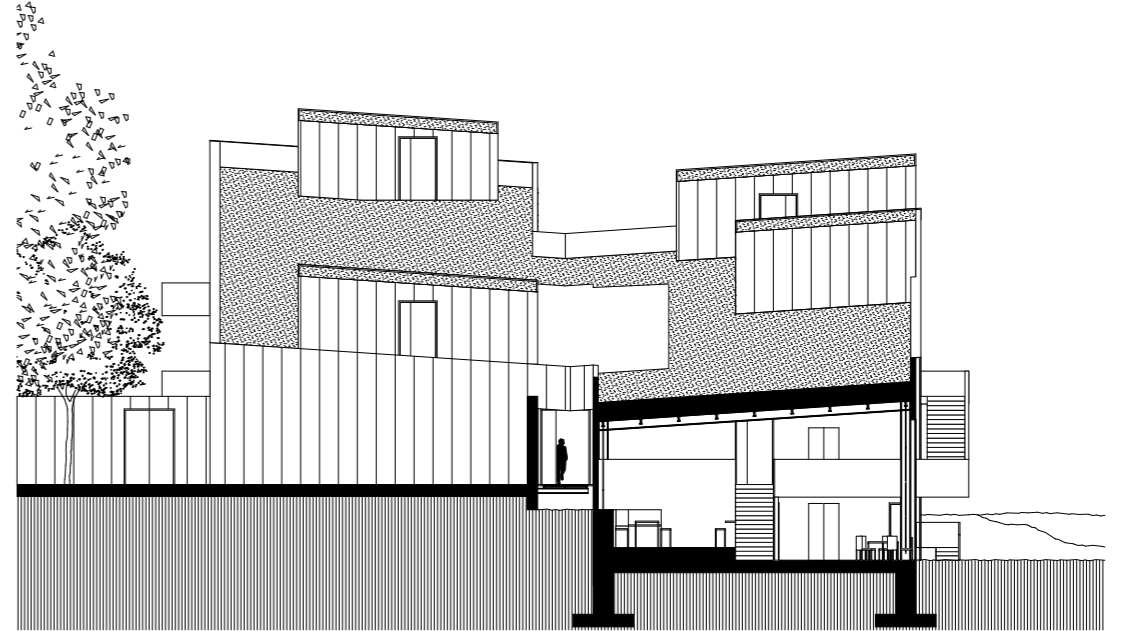
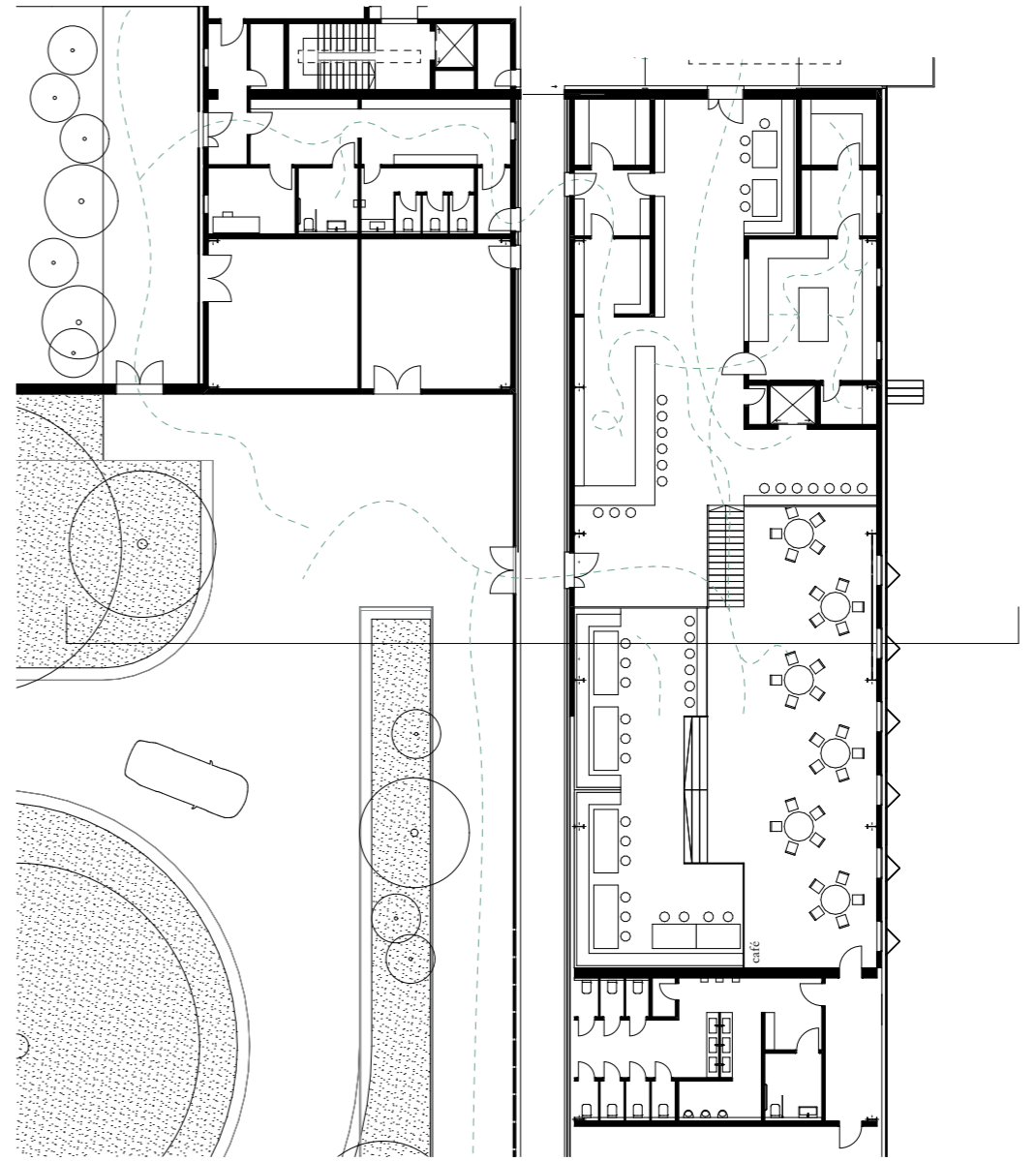




‘ The Garden is both a dwelling place ... and a representation of natural space; a synthesis of architecture and nature.

Common Oat
Avena sativa

Saskia de Wit, *Hidden Landscapes*, 2018.



Café

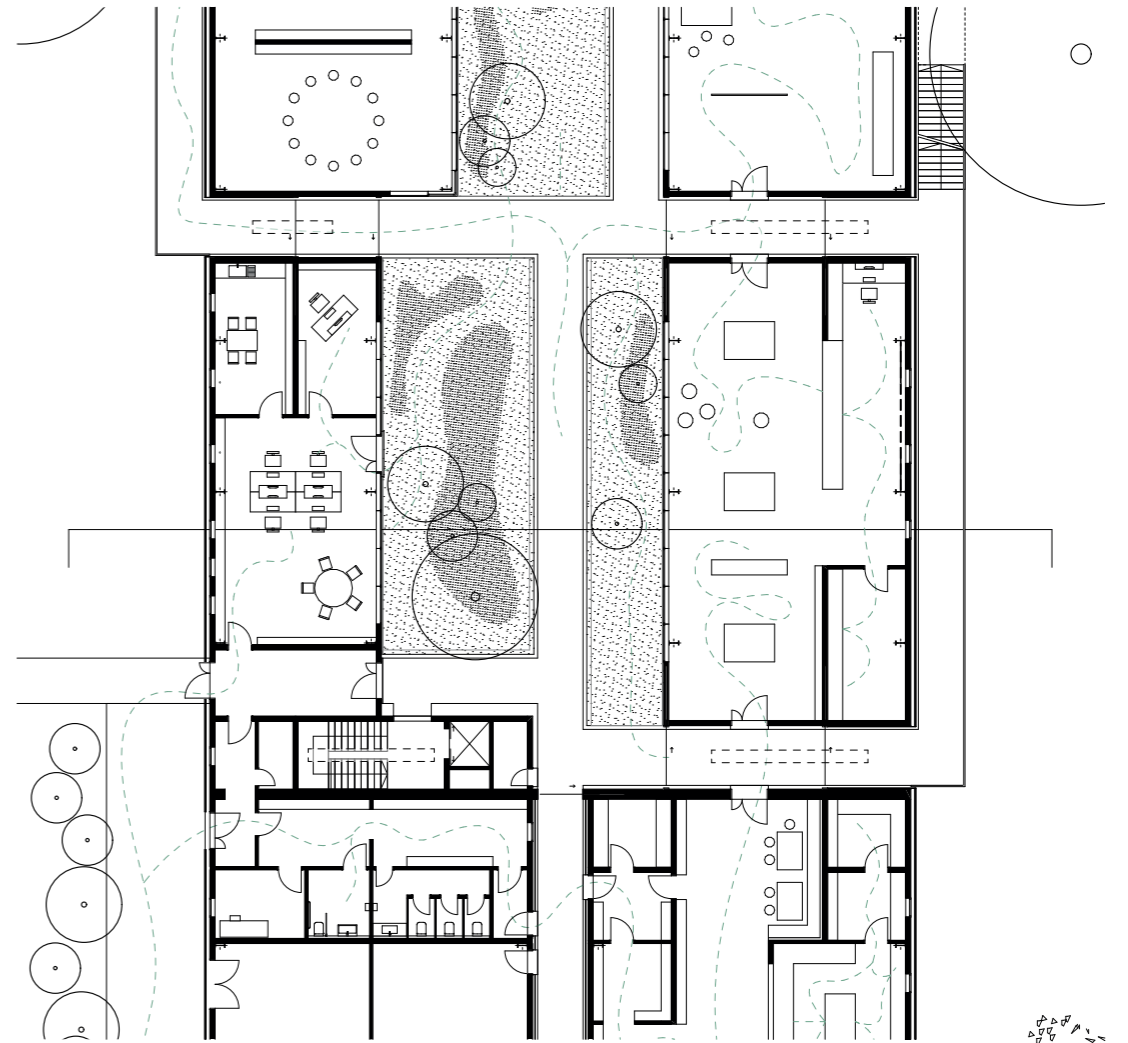
Plan view

Section c-c

View onto Green Roof

0 5 10 20 m



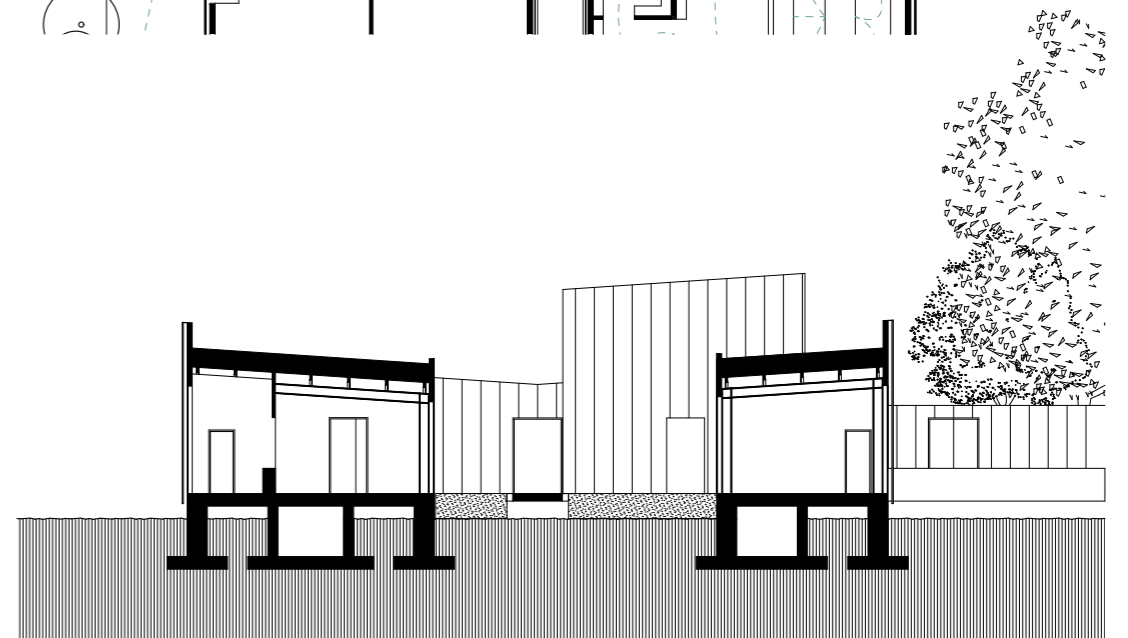


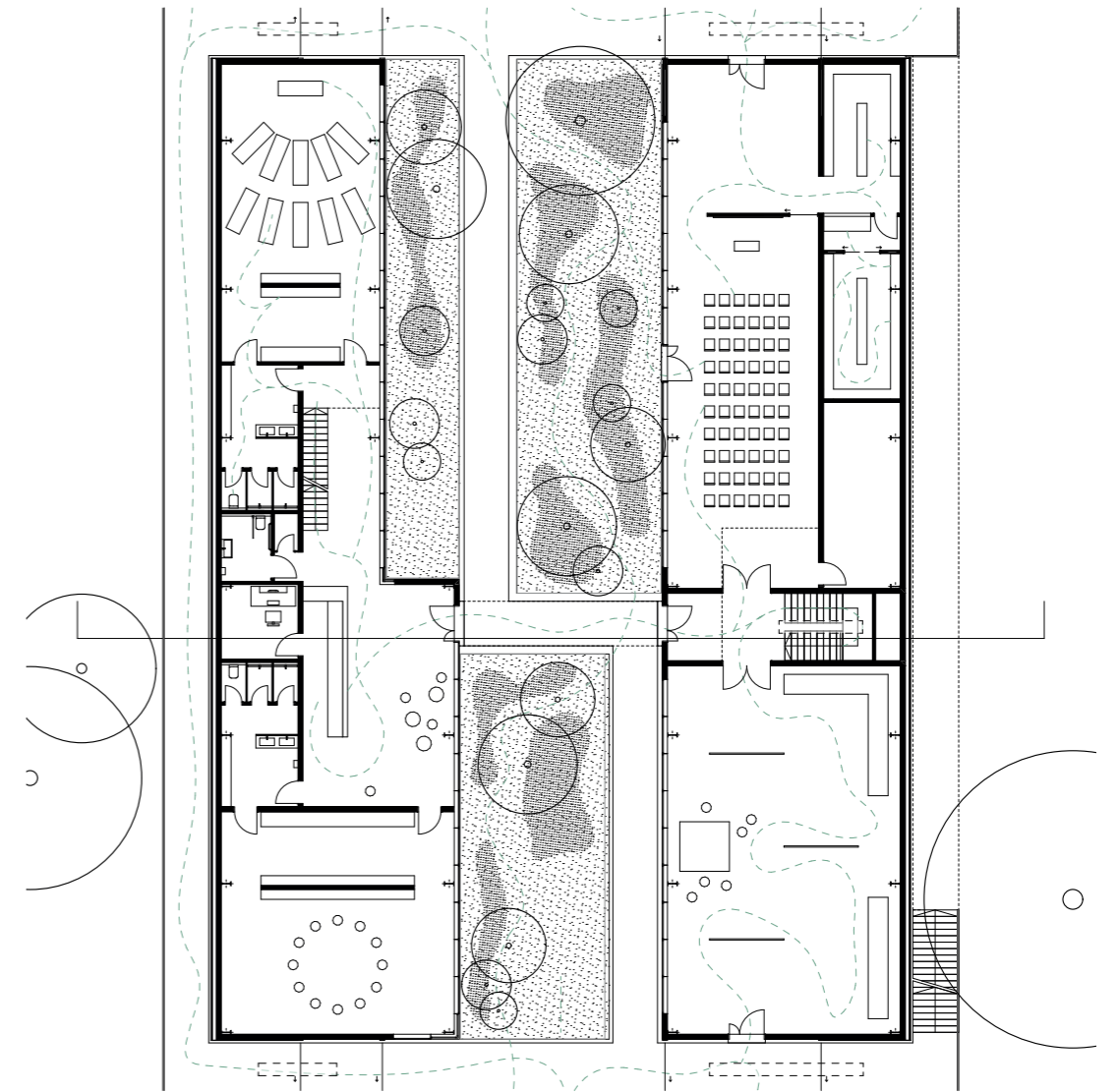
Shop

Plan view 1-300

Section d-d

View onto Green Roof



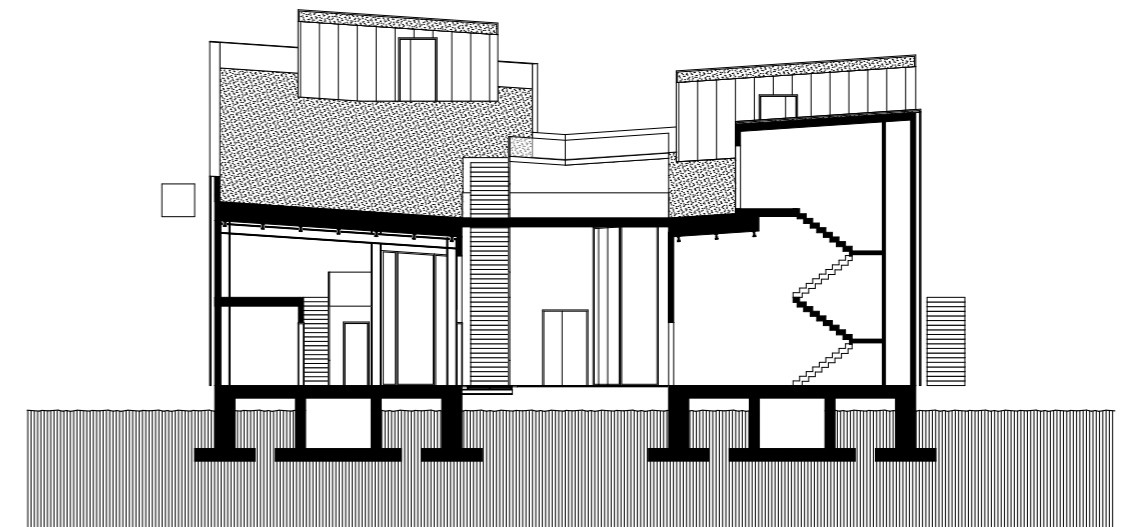


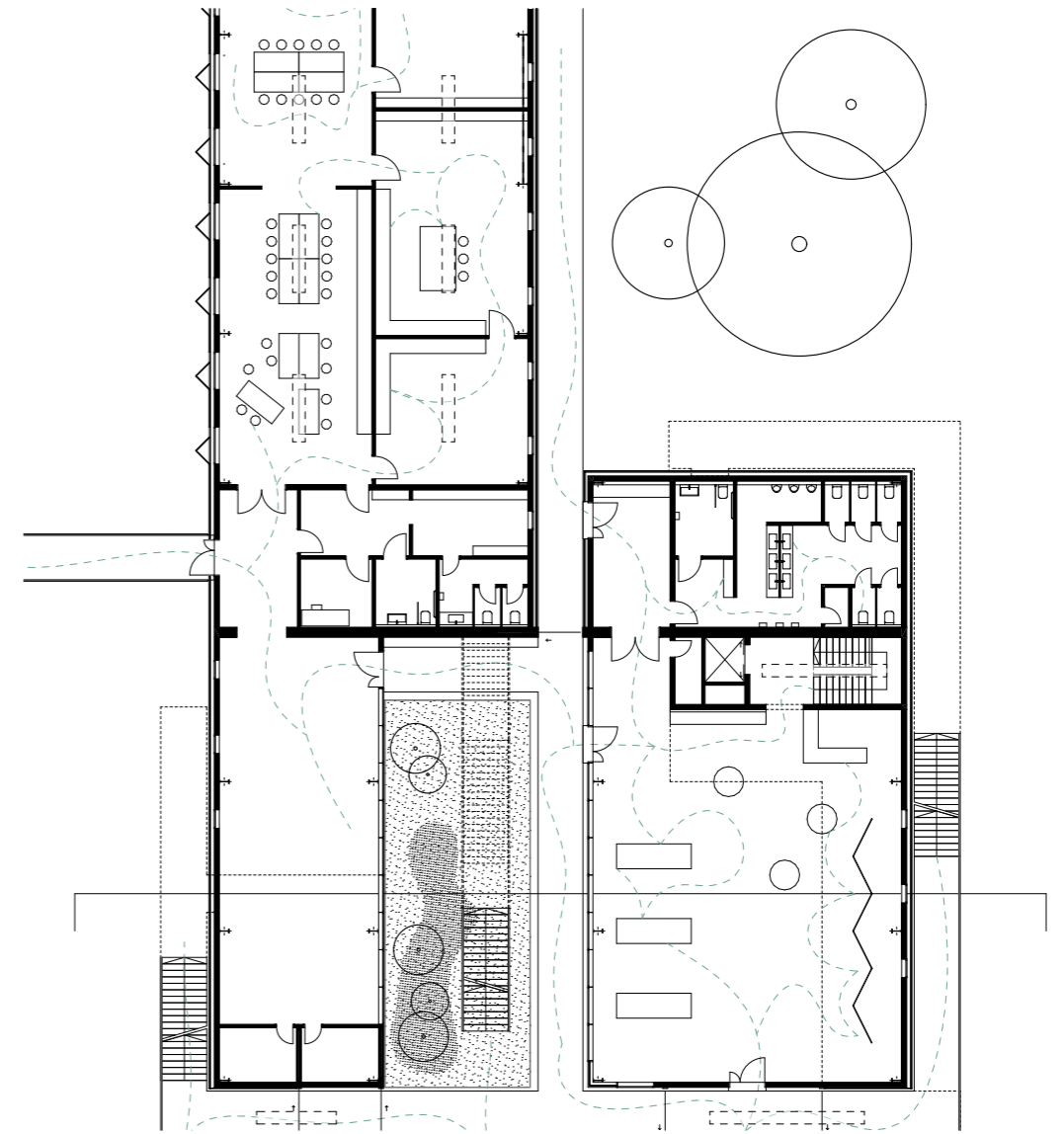
Studios

Plan view 1-300

Section c-c

View onto Green Roof



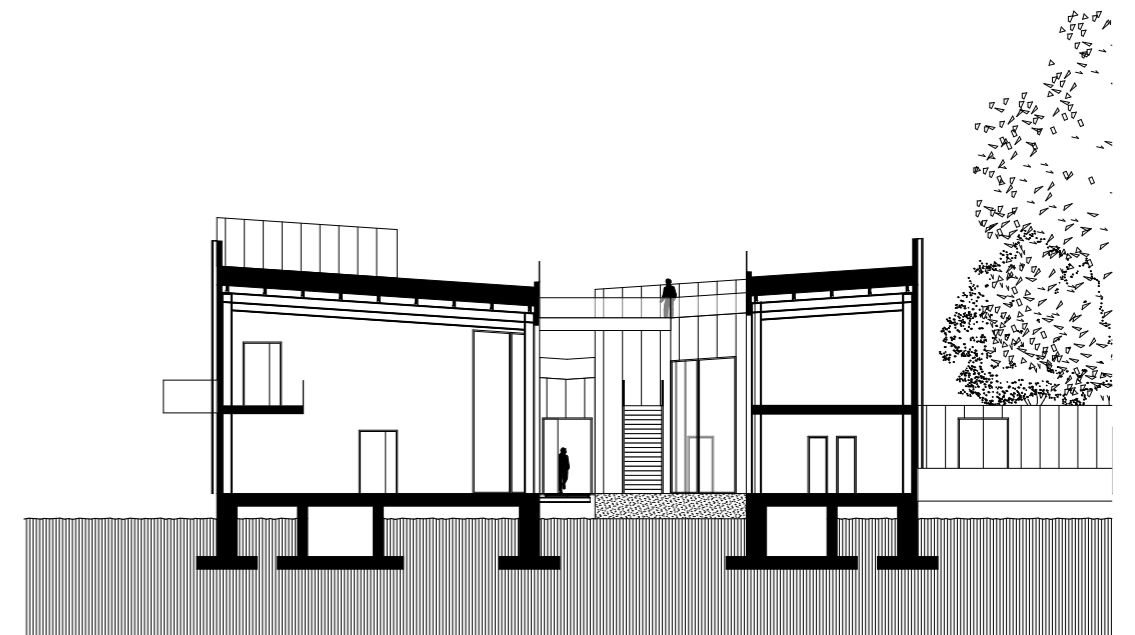


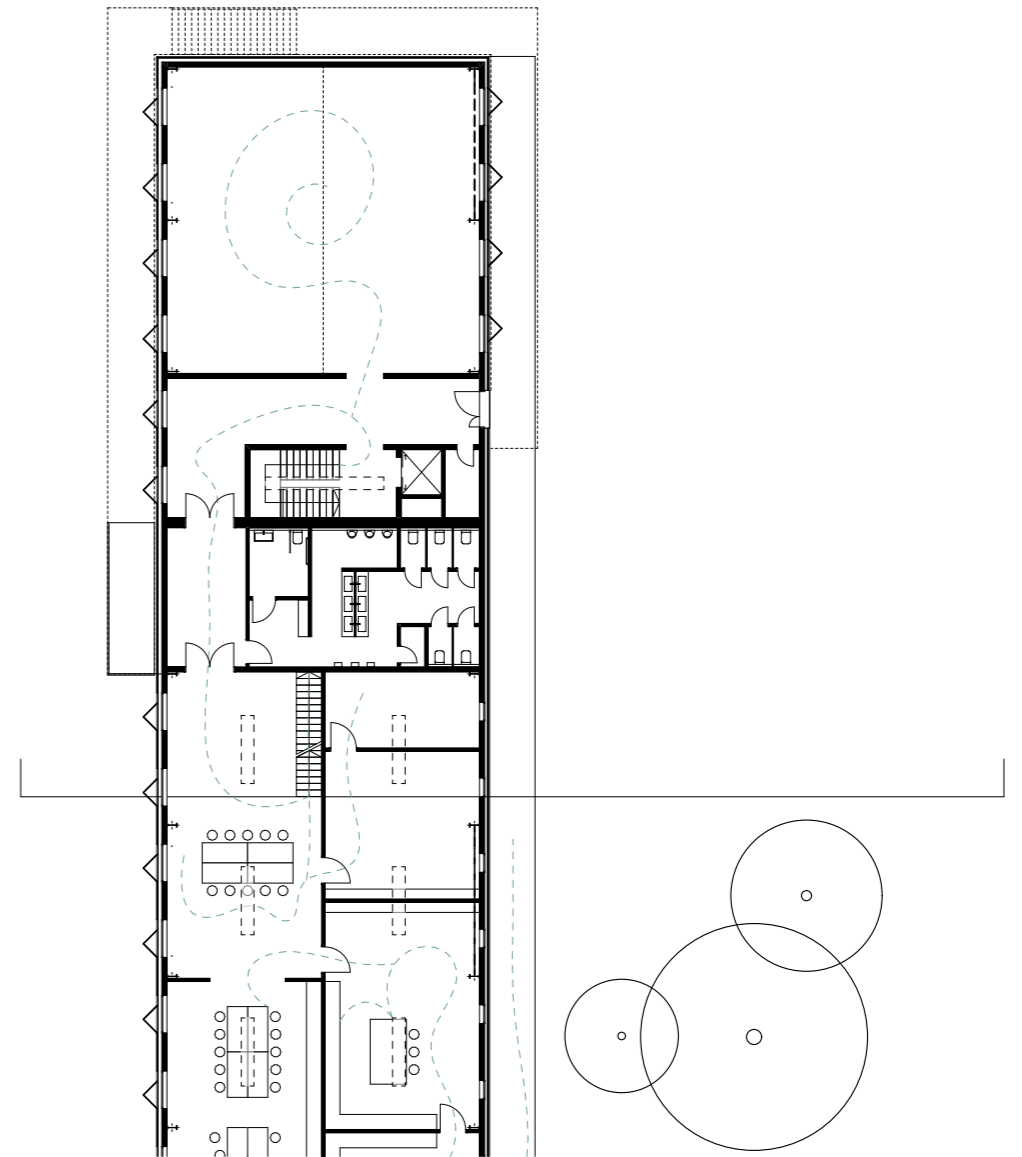
Exhibition

Plan view 1-300

Section c-c

View onto Green Roof



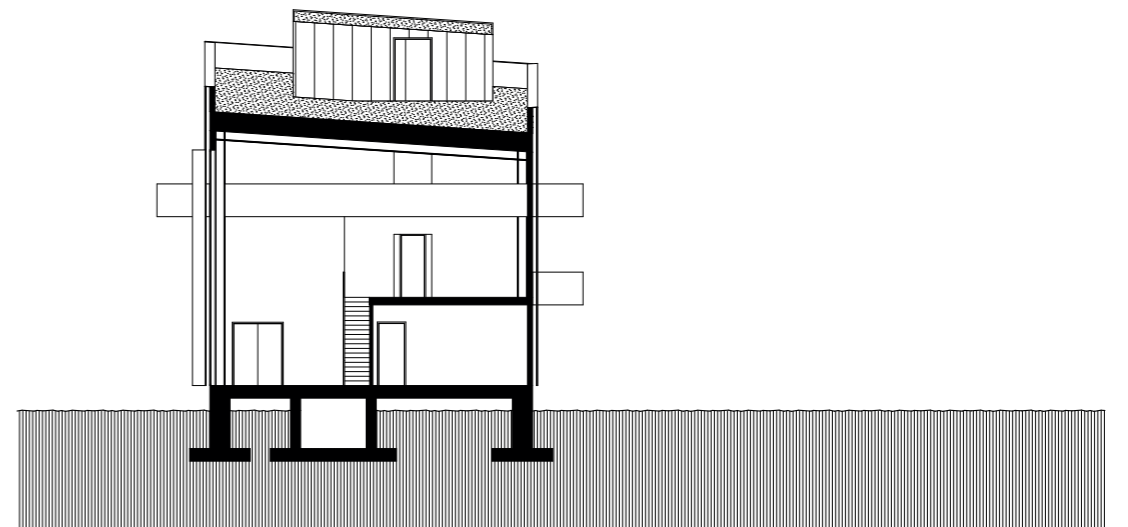


Workshop

Plan view 1-300

Section c-c

View onto Green Roof



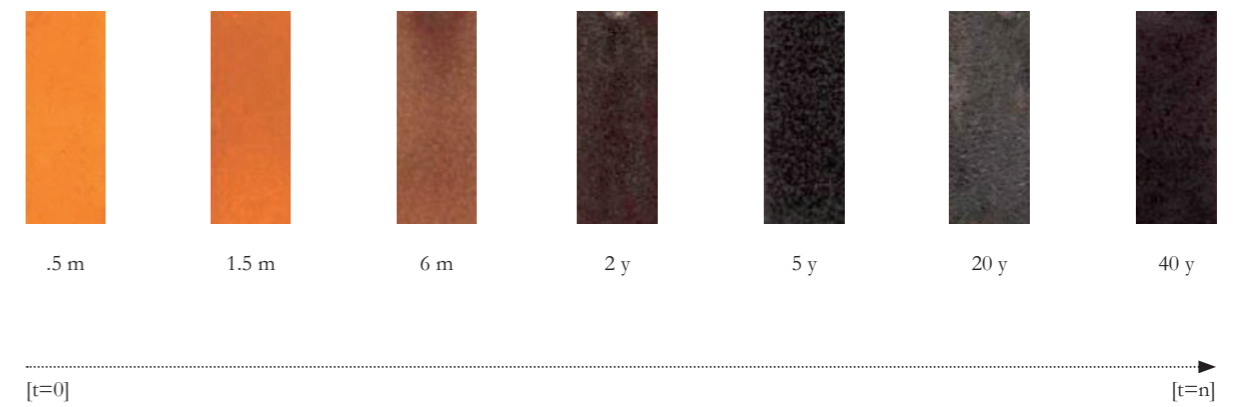
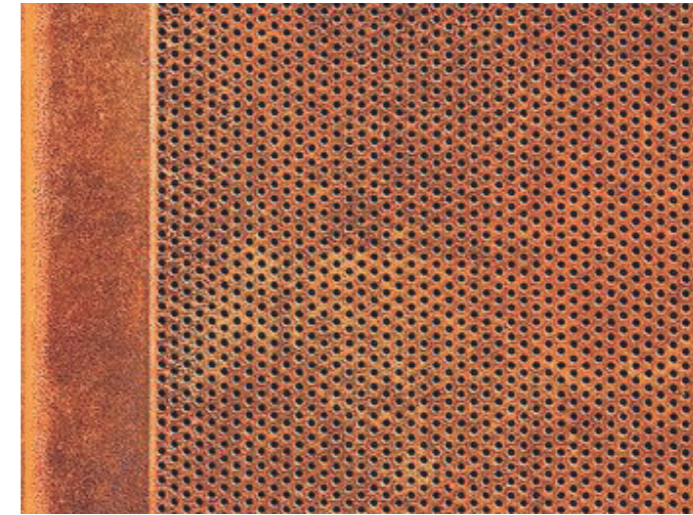


Materiality

"The dialogue between nature and industrial decay can be seen as a healing process. ... The structures, often monumental in scale will return to the earth."¹ writes Kate Baker about the *Landschaftspark Duisburg Nord*, one of the best known examples for post-industrial landscape regeneration and adaptive reuse. In order to achieve an aesthetic synergy, new architectural elements and materials attempt to form a contrast to the existing. The paradox of the enclosed garden is translated into an aesthetic juxtaposition with clear lines and geometric forms opposing the roughness of nature and decay.

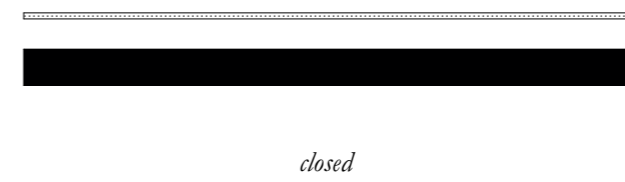
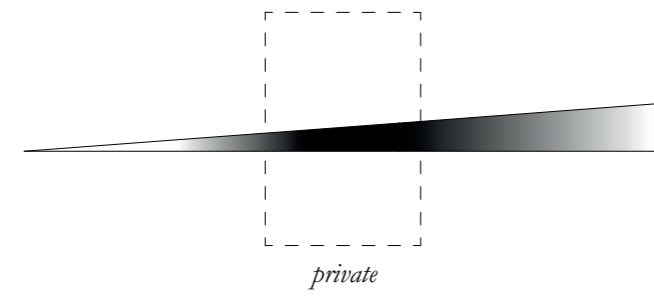
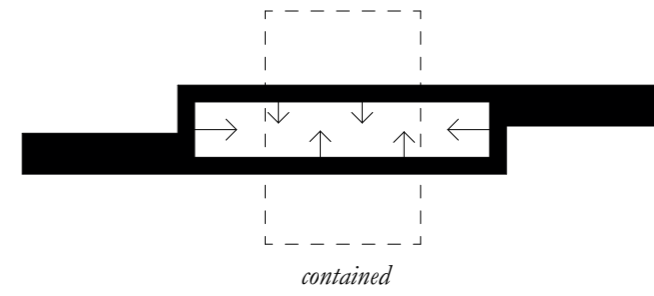
The building itself as inhabited structure acts as a mediator between internal space and the landscape outside. As such, it becomes filter for the senses of the visitor.

¹ K. Baker, *Captured Landscape: The Paradox of the Enclosed Garden*, 2012, p. 32.



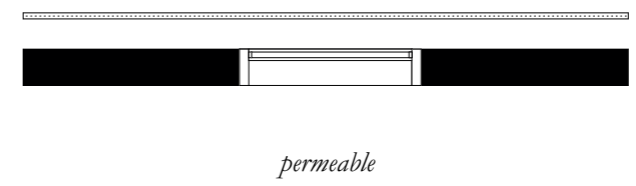
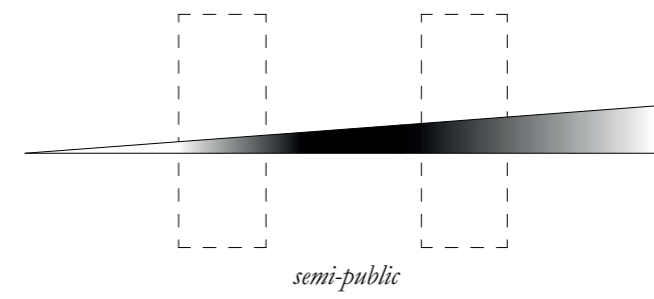
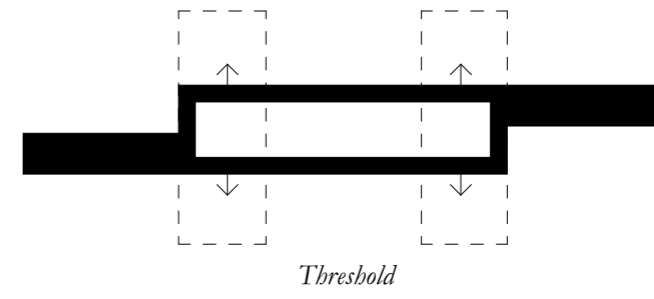
Emphemerality in Material

Changing condition of weathering steel



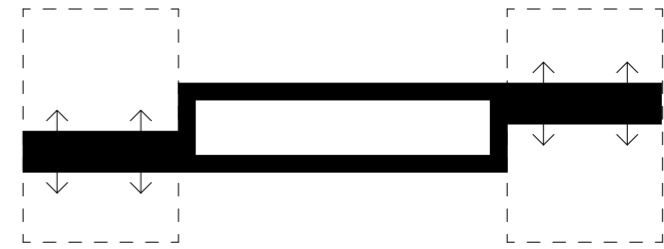
Inner Garden

The inner heart and still centre of the building.

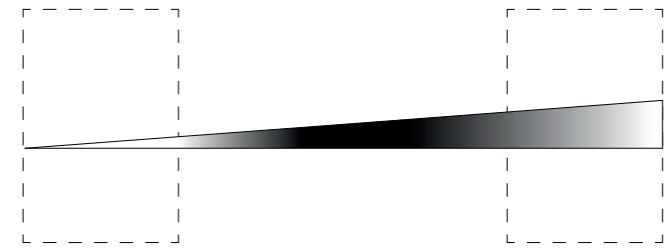


Threshold

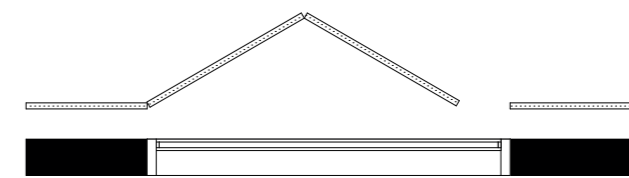
The boundary from outside to inside.



inviting



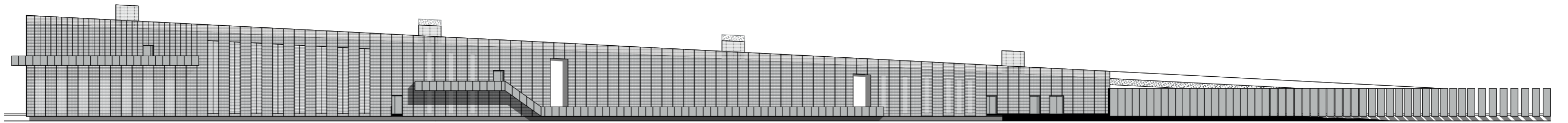
public



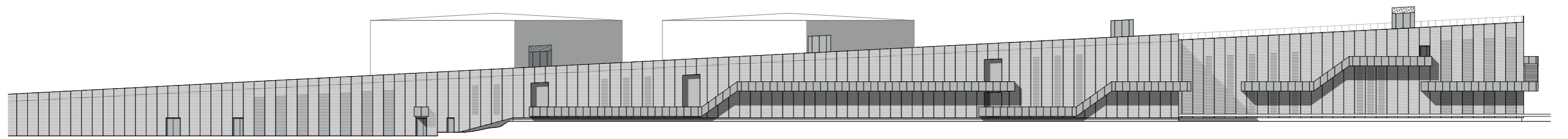
open

Blurred Edges

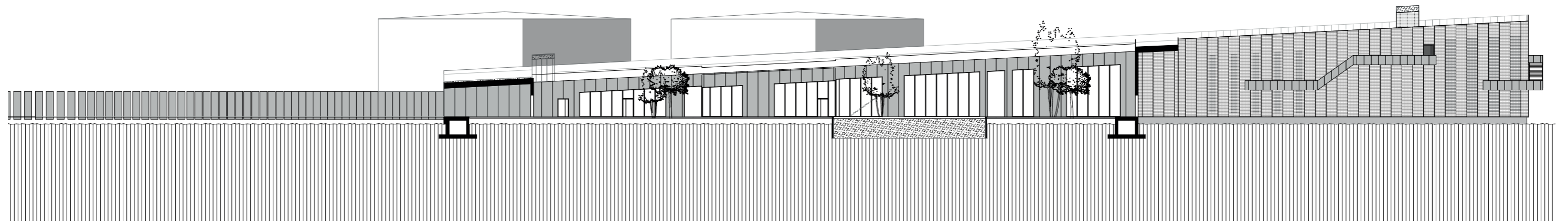
Opening towards the exterior landscape.



North-West Façade
Elevation



South-East Façade
Elevation



Interior Façade
Elevation

TECHNOLOGY.

08	Climate	234
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08 CLIMATE

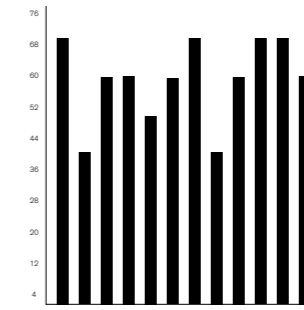
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08 CLIMATE

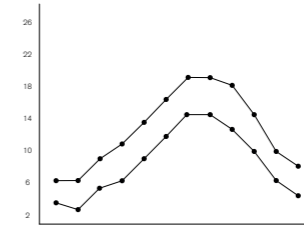
Local Conditions

Dunkerque is located in the region of Hauts-de-France on the North Sea coast not far from the Belgian border. The climate being oceanic is generally cool and wet, rainy and windy all year round, but particularly in autumn and winter.

The average temperature of the coldest month (January) is of 5 °C, that of the warmest month (August) is of 18.4 °C. Precipitation amounts to 700 millimeters per year ranging from 40 mm in the driest month (February) to 80 mm in the wettest month (November). So even in the driest month, Dunkerque receives a great amount of rainfall.



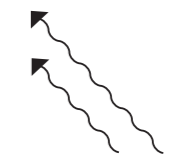
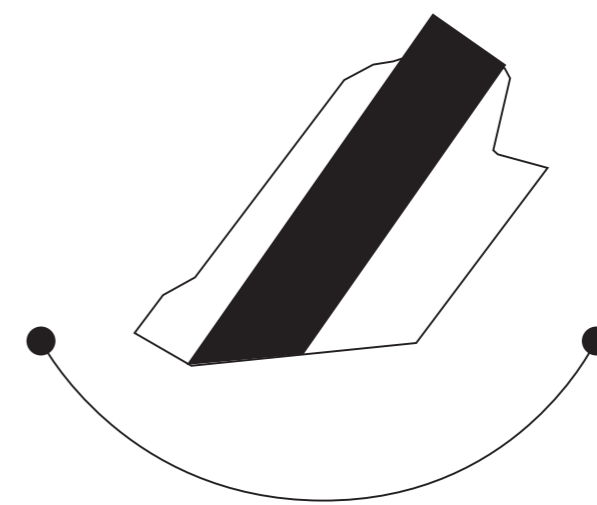
a.



b.



c.



d.

Climate

Statistics

- a. Precipitation
- b. Temperature
- c. Wind
- d. Orientation

Water

¹ Helophytes are a perennial marsh plants that have their overwintering buds under water.

The site including both gardens and building are built upon an near autarkic water supply system. As such, the largest percentage of water required to maintain both is recycled.

Stormwater can be collected on the vast amount of existing surfaces throughout the site as well as on the rooftop of the proposed building itself. From here it is directed towards a retention basin that is created in the centre of the site as part of the *Water Garden*. By means of an artificial wetland encompassing a helophyte¹ purification system the collected water is filtered in order to be serve for irrigation purposes as well as grey water supply within the building (toilets). Black and grey water from the building is filtered through a fat filter and a septic tank before being discharged into the artificial wetland.

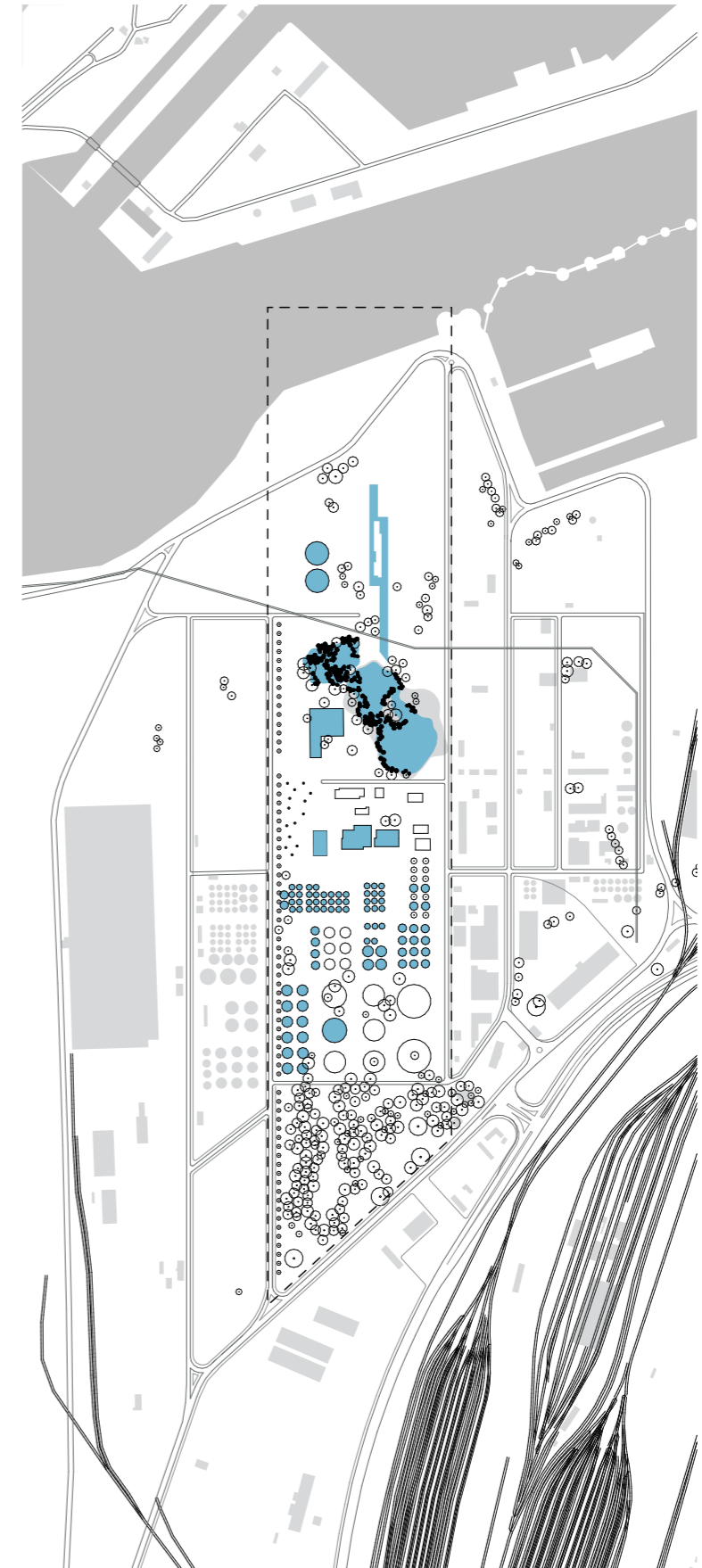
Water Collection

Site plan

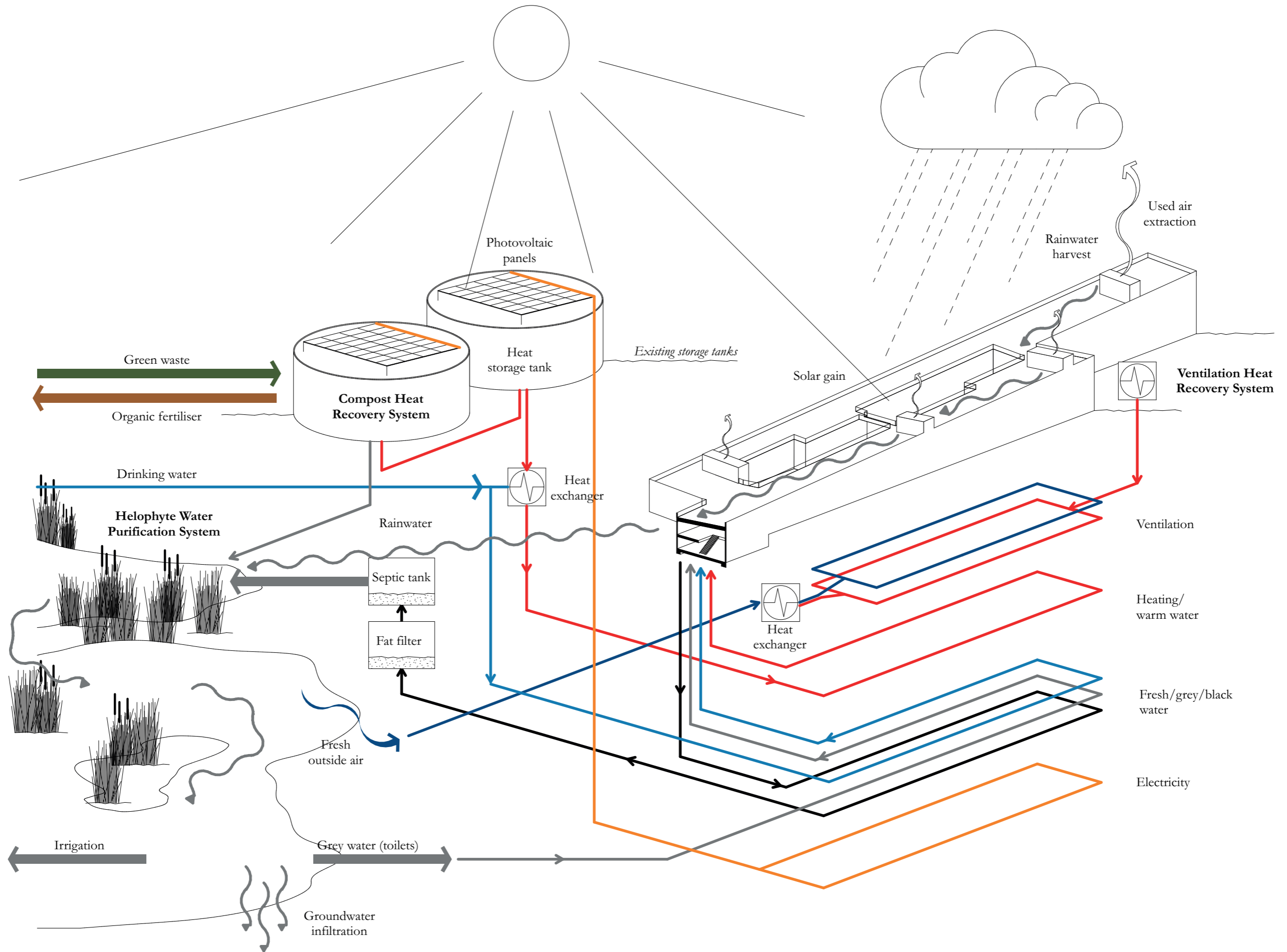
Next page:

Climate Scheme

Flow Diagram



Climate Scheme

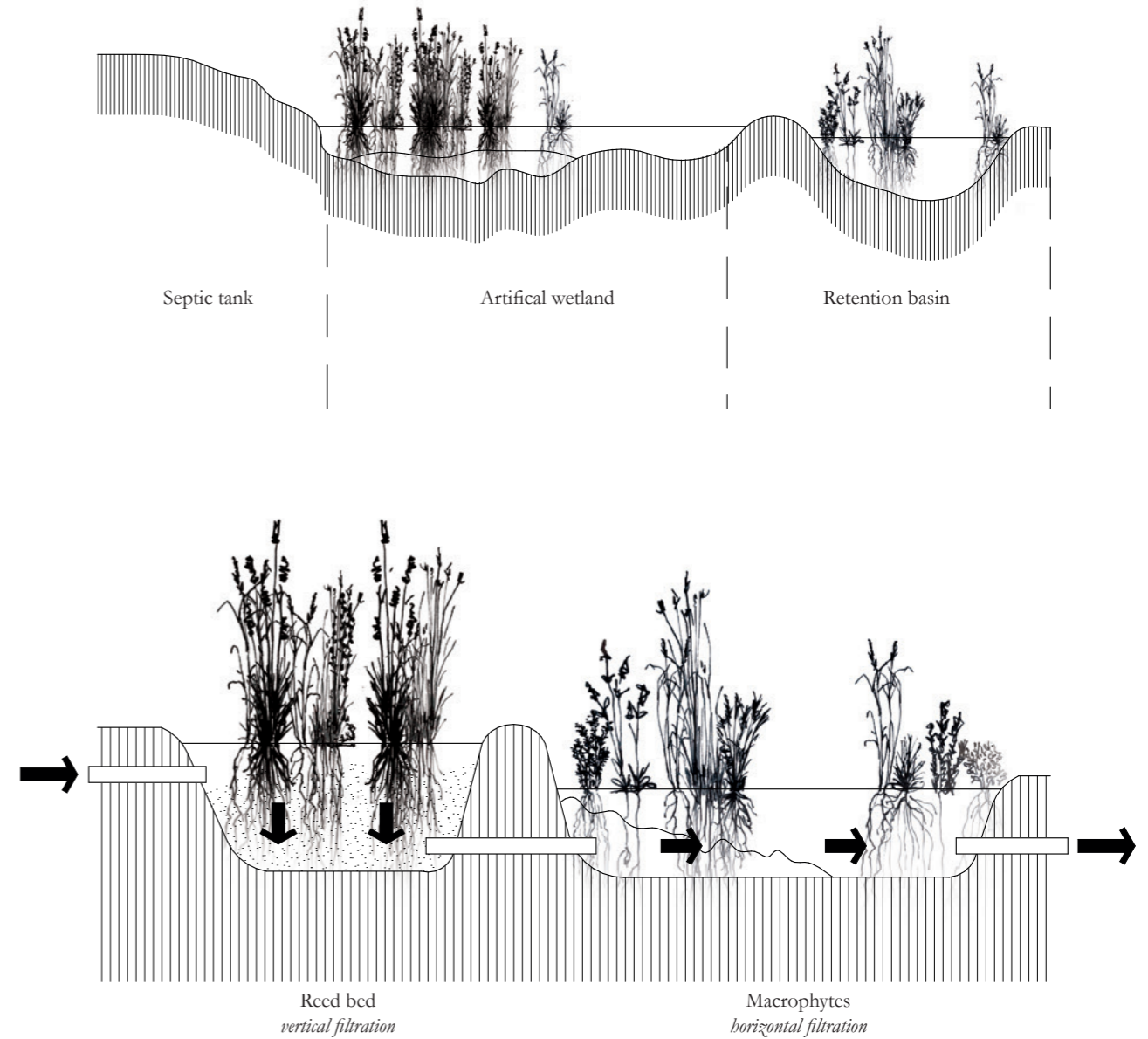


Constructed Wetlands

Artificial wetlands are engineered systems that treat wastewater by using natural remediation principles through vegetation, soil and organisms. They can purify on-site wastewater after primary treatment (fat filter, septic tank).

Acting as a biofilter, constructed wetland can remove a range of pollutants such as organic matter (petroleum hydrocarbons), nutrients, pathogens and heavy metals from the water as do their natural counterpart. By means of a helophyte filter, a sand filter that is generally planted with reeds wastewater is spread just below surface and purified through root bacterial activity. This prevents unpleasant odours.

Thereafter, the water is passed through a basin which various macrophytes (aquatic plants) where additional filtration occurs. The remediation time frame of water-solved pollutants is comparably short. Afterwards, the water is retained for reuse.



Helophyte Filter System

Artificial wetland

Energy

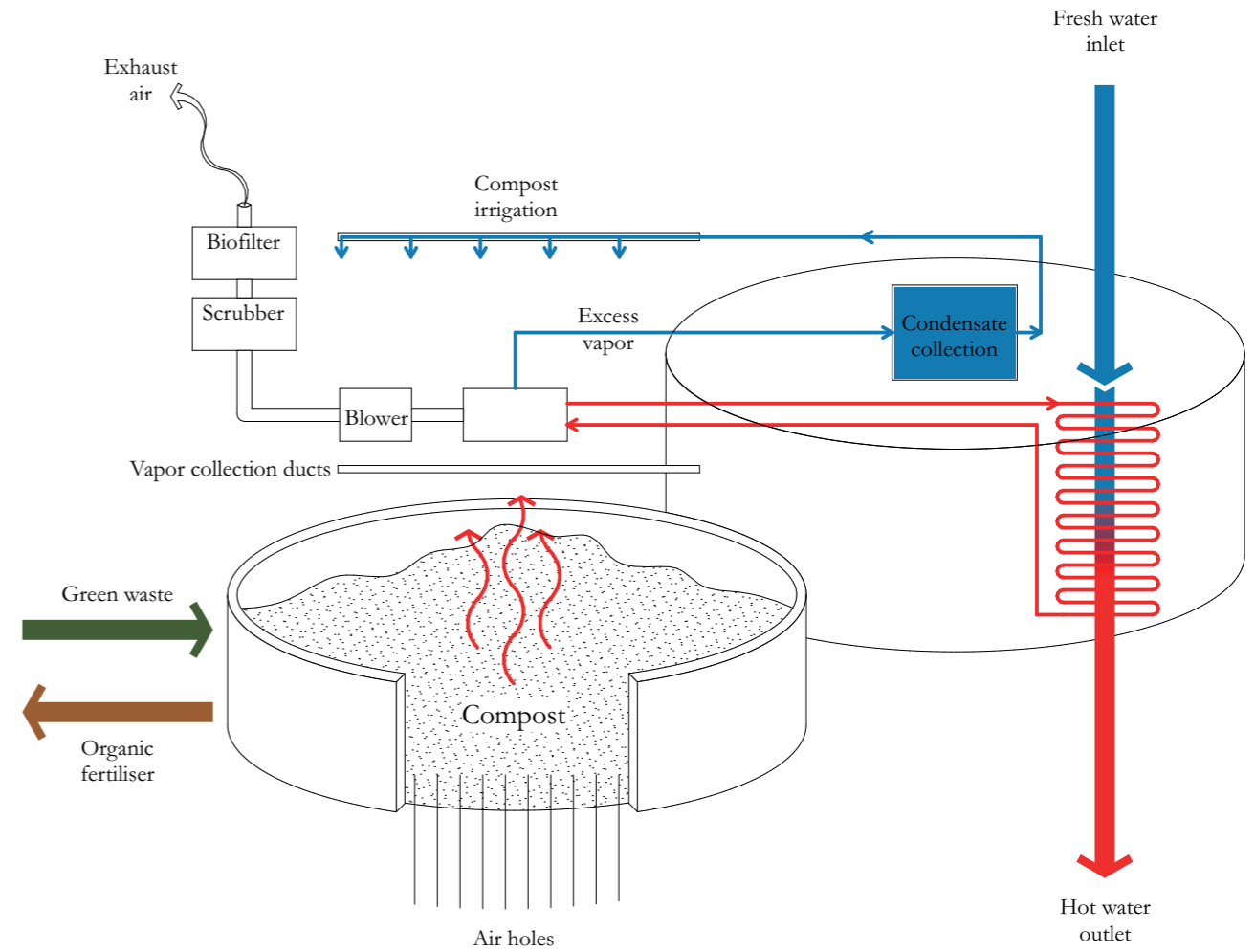
¹ Matthew M. Smith, John D. Aber & Robert Rynk, *Heat Recovery from Composting: A Comprehensive Review of System Design, Recovery Rate, and Utilization*, 2017.

The city of Dunkerque and more specifically the project site itself are intrinsically linked to the notion of Energy. The original purpose remains apparent through the left-over structures that inhabit the site. At the same time, the site is testimony that the petroleum age is slowly being replaced by a new era. Its former use not only degraded the territory on which the refinery was built on but beyond – where the oil originates from and where it was delivered to, and finally the entire planet’s atmosphere.

As a response to the heritage of the site and in line with the project-specific notion of remediation, a new form of energy production is explored; *Compost Heat Recovery*. As a known ex-situ bioremediation technology, composting is utilised for heat recovery. Aerobic composting produces a substantial amount of thermal energy and different systems have been known and applied for more than a thousand years¹. Through the process, organic materials are biologically decomposed with main products next to heat being simply compost (organic fertiliser), carbon dioxide and water. A well-known example is the Pain method... *Biomeiler...*

In recent decades, advances have been made to improve systems across scales, from the family home to commercial use. A general trend goes towards compost vapour exchange through latent heat using an air-to-water heat exchanger. ...

Two existing storage tanks in direct proximity to the building are utilised for this purpose; one for the bioreactor itself and the other one for heat storage. Additionally, storage tank surfaces are fitted with photovoltaic panels (see *Climate Scheme*).



Compost Heat Recovery System

adapted from ...

Building Climate

Heating & Ventilation

The public nature of the building and its diverse programme implicates specific requirements to the thermal comfort which are best met through an all-encompassing mechanical ventilation system.

Fresh outside air is extracted from near the Water Garden and heated (*winter scenario*) or cooled (*summer scenario*) by means of a heat exchanger. The air is distributed through an overpressure system via ducts located in an underground service trench connecting all spaces. Stale air is sucked through vents in the ceiling. A heat recovery unit in each stairwell recovers heat and feeds it back into the system before releasing the used air through the roof into the atmosphere.

The garden within the inner courtyard functions as an 'outdoor room'. The architectural form and materialisation allows increased solar gain while the building forms an enclosure sheltering from wind and strong rain. The multiple entrances leading the path in and out of the building can be electively closed or open flexibly or permanently in response to the prevalent climate.

Thermal Requirements

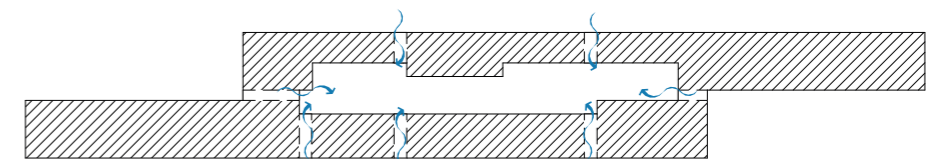
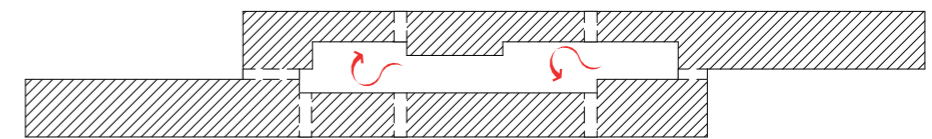
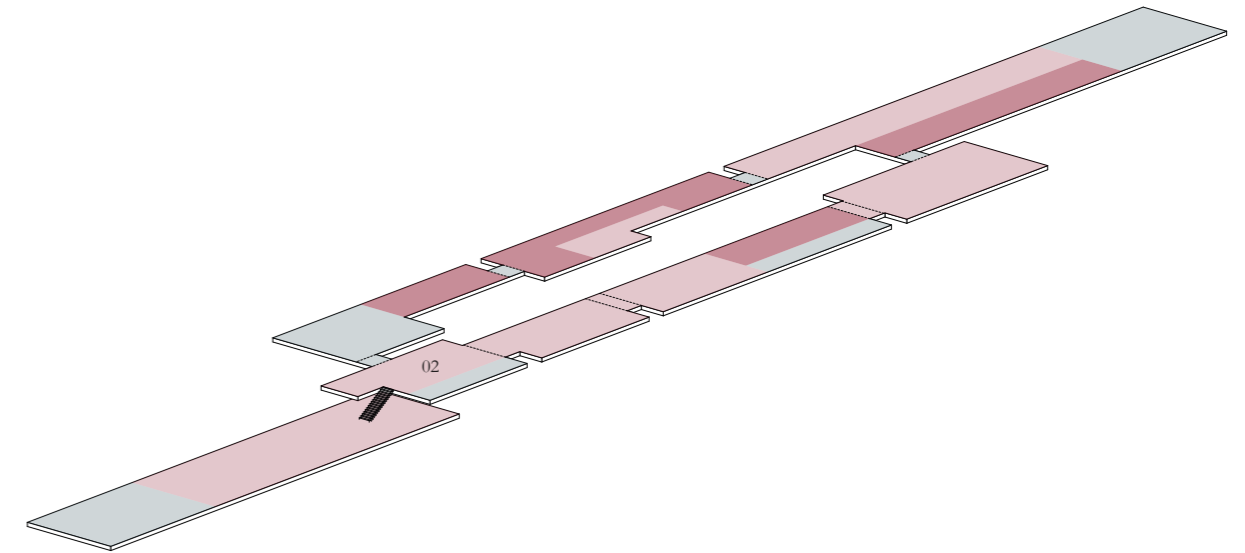
- 16 °C
- 18 °C
- 20 °C

Programme

- 01 Café
- 02 Shop
- 03 Exhibition
- 04 Workshop
- 05 Studios
- 06 Administration
- 07 Storage

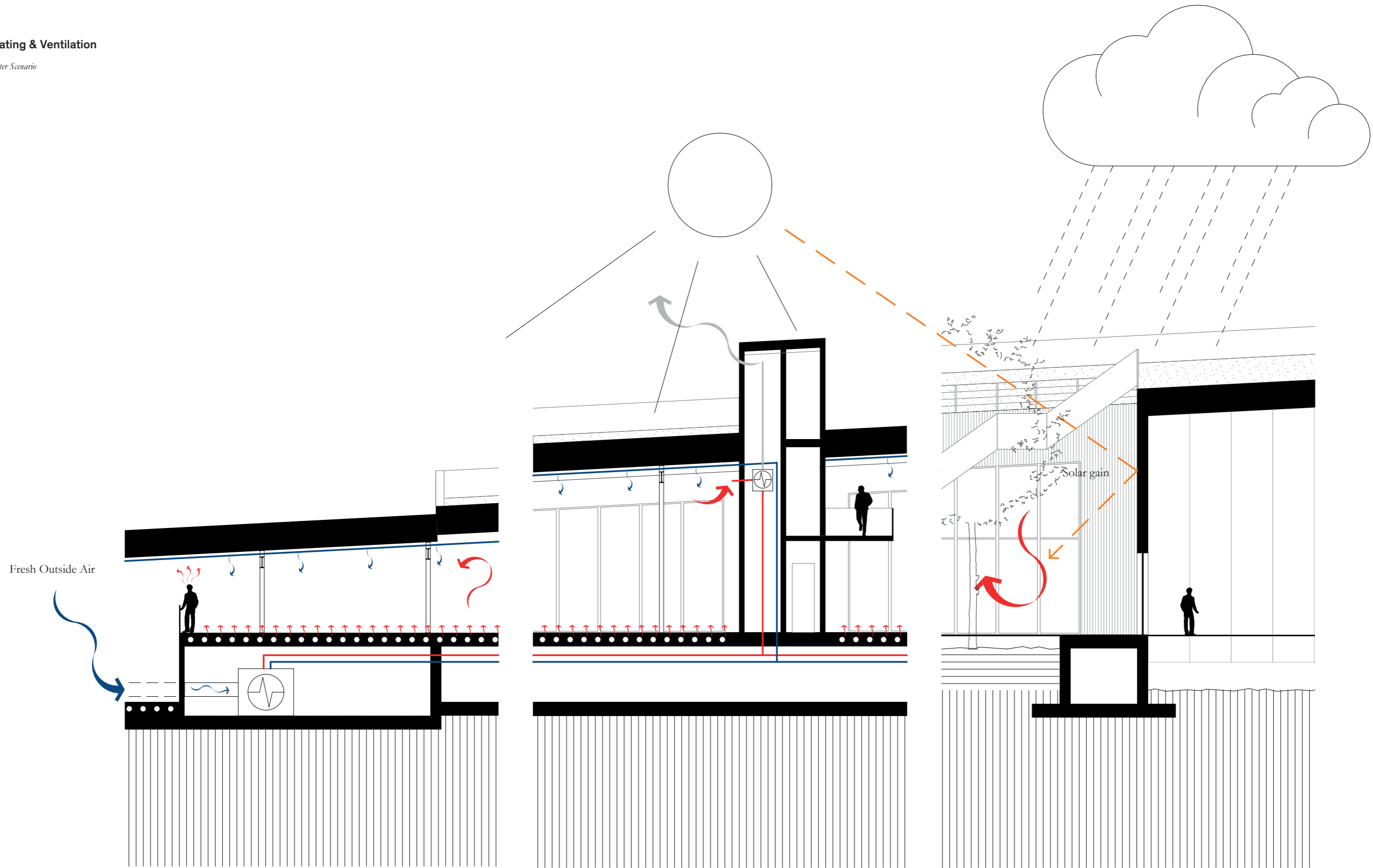
Inner Garden

Natural Ventilation



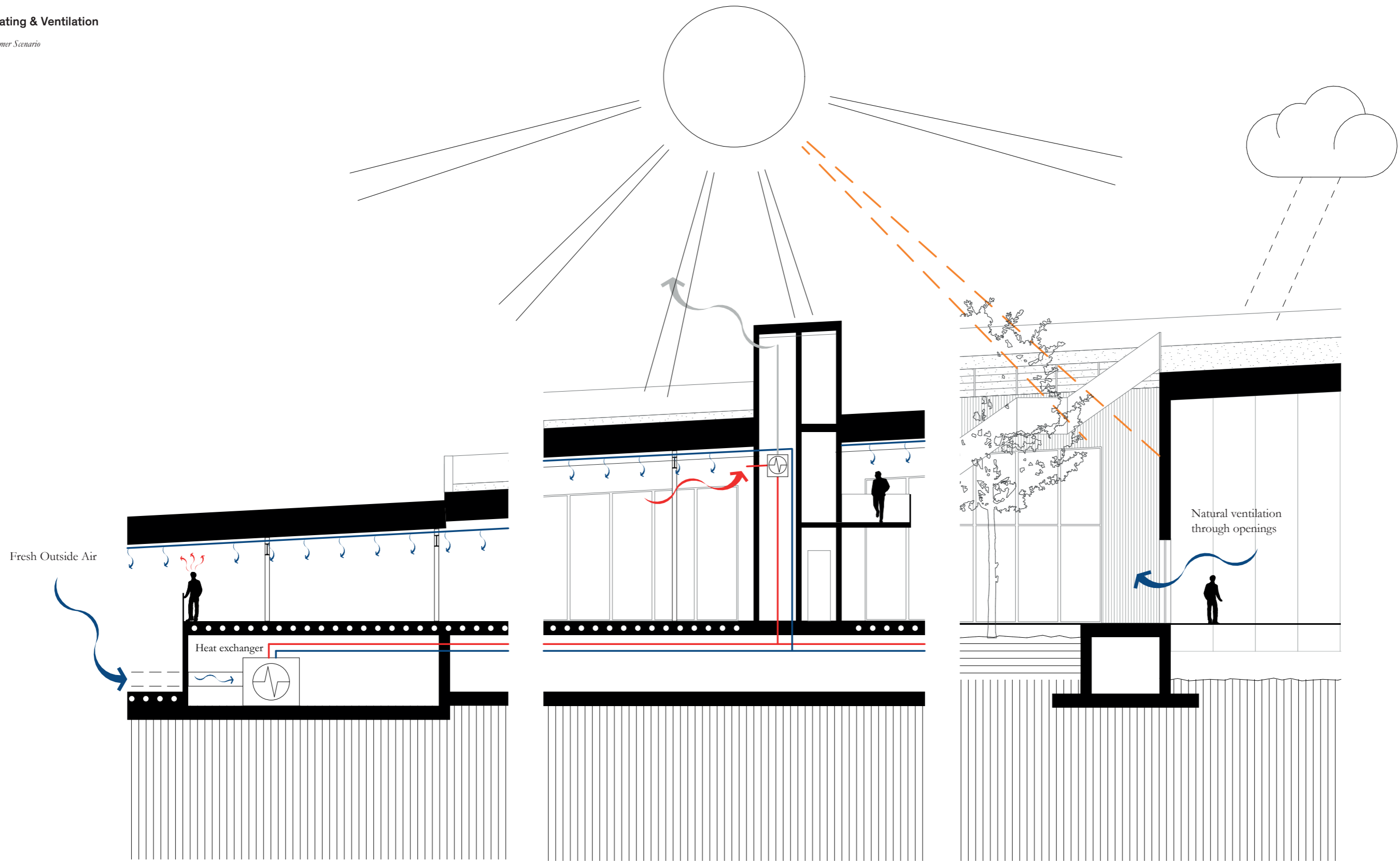
Heating & Ventilation

Winter Scenario



Heating & Ventilation

Summer Scenario

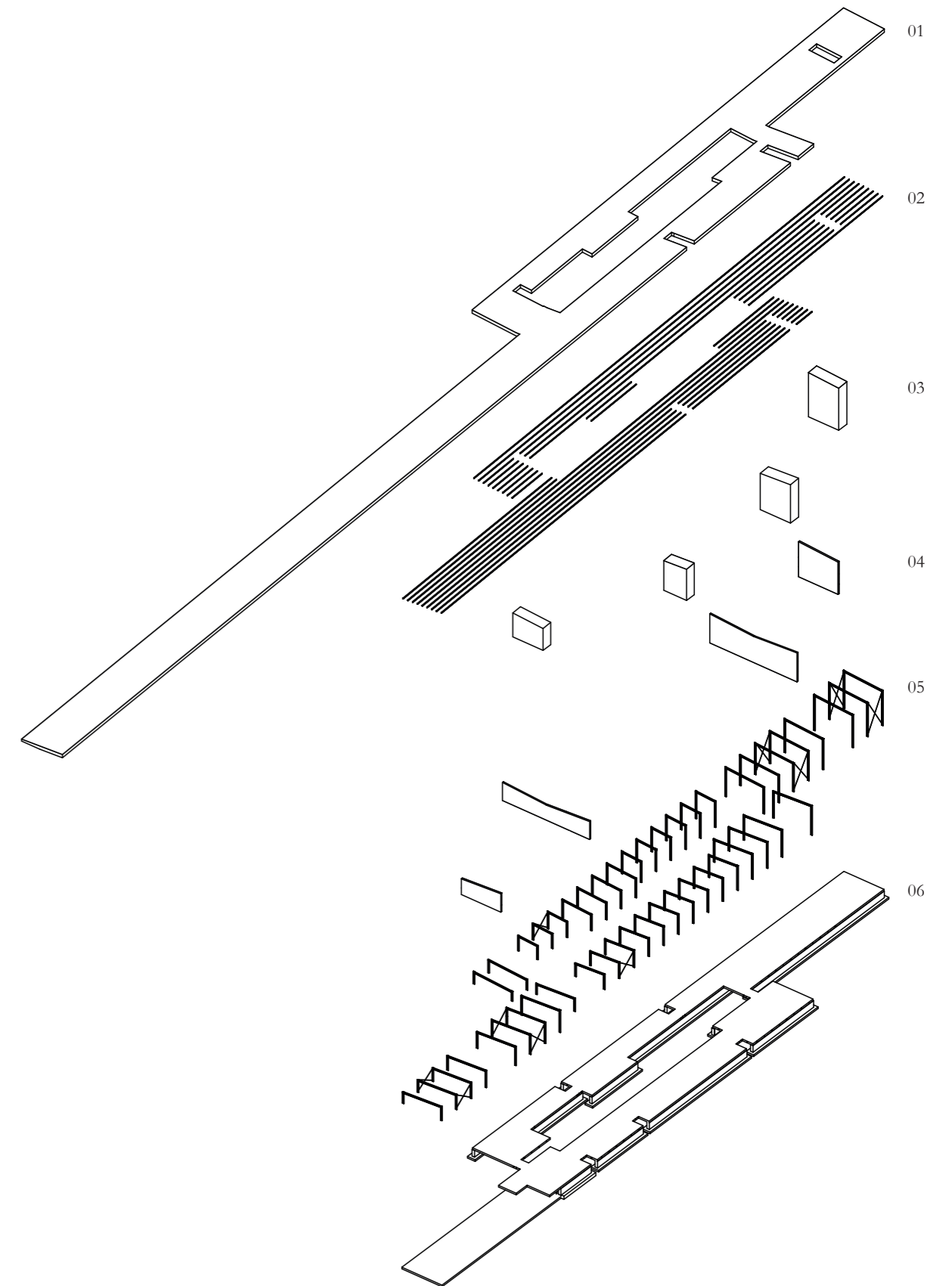


09 STRUCTURE

Scheme	256
Green Roof	258

Structural Elements

- 01 Roof slab
Composite roof with intensive vegetation
- 02 Secondary Structure
Steel beams IPN 400
- 03 Core with Stairwell
Reinforced concrete
- 04 Sheer wall
Reinforced concrete
- 05 Primary structure
*Prefabricated steel frames IPN 400
w selective cross bracing*
- 06 Foundation
Reinforced concrete



Structure Scheme

Axonometric

Green Roof

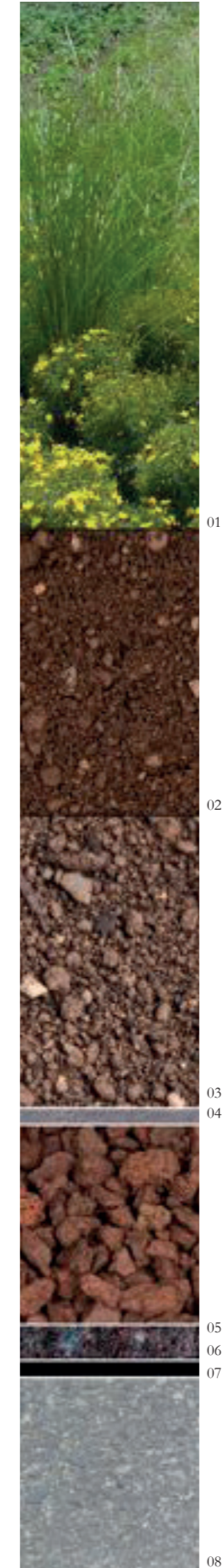
As intensive green roof the walkable rooftop acts not only as a continuation of the garden itself but grants an array of climate-related benefits to the building. Vegetated roofs naturally insulate. As such they decrease solar gain in summer and heat loss in winter. At the same time, they aid stormwater mitigation through retention and provide filtration for grey-water re-use. Intensive green roofs feature grasses, herbaceous plants, shrubs and bushes as well as small trees.

The built form comprehends a ramp slanting up three degrees towards the waterfront. Thereby, it provides landmark and viewpoint alike. From here, the visitor can see the gardens, the port of Dunkerque, the edge of the city centre and the sea.

Intensive Vegetation

Section

- 01 *Vegetation*
- 02 *Substrate*
- 03 *Mineral layer*
- 04 *Filter*
- 05 *Drainage layer*
- 06 *Membrane*
- 07 *Root protection*
- 08 *Structure*

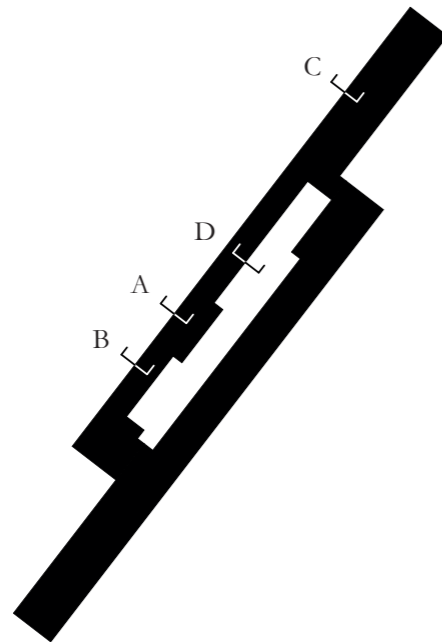


10 FAÇADE

Scheme	262
Plan Study	264

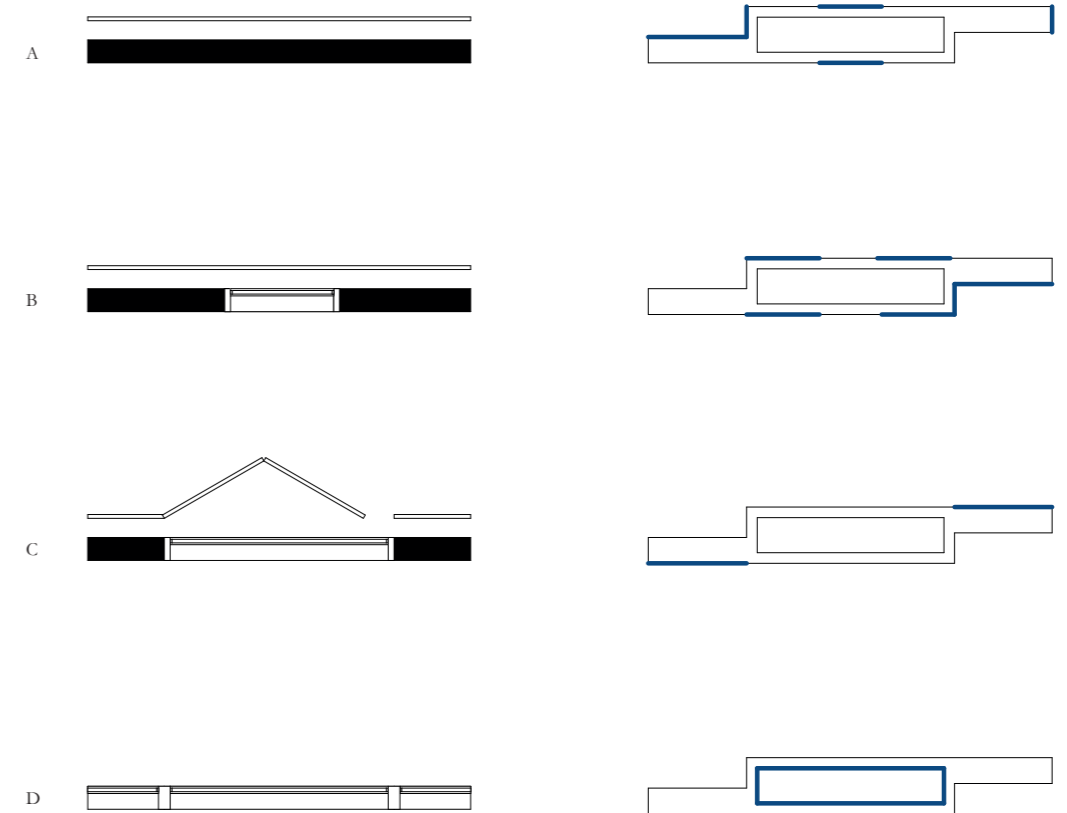
Façade Scheme

The following plan study explores the technicalities of the building façade by means of four reoccurring schemes. These form a gradient of perforation according to the underlying function.



Façade Schemes

- A *closed*
- B *perforated*
- C *openable*
- D *transparent*



Intensive Green Roof

Intensive vegetation	
Substrate	min. 150 - max. 400 mm
Sheet barrier root protection	2 mm
Filter mat	
Retention layer <i>expanded clay aggregate</i>	
Waterproof membrane	1.5 mm
Thermal insulation	200 mm
Supporting structure	IPN 200 IPN 400

Exterior wall

Primary structure <i>prefabricated steel portal</i>	IPN 400
Sandwich panel w insulation	200 mm
Façade <i>weathered steel perforated panels</i>	

Mezzanine Floor

Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Sound insulation	30 mm
Composite decking	
<i>55 mm trapezoidal-section ribbed metal sheeting</i>	100 mm
Secondary structure	IPN 200

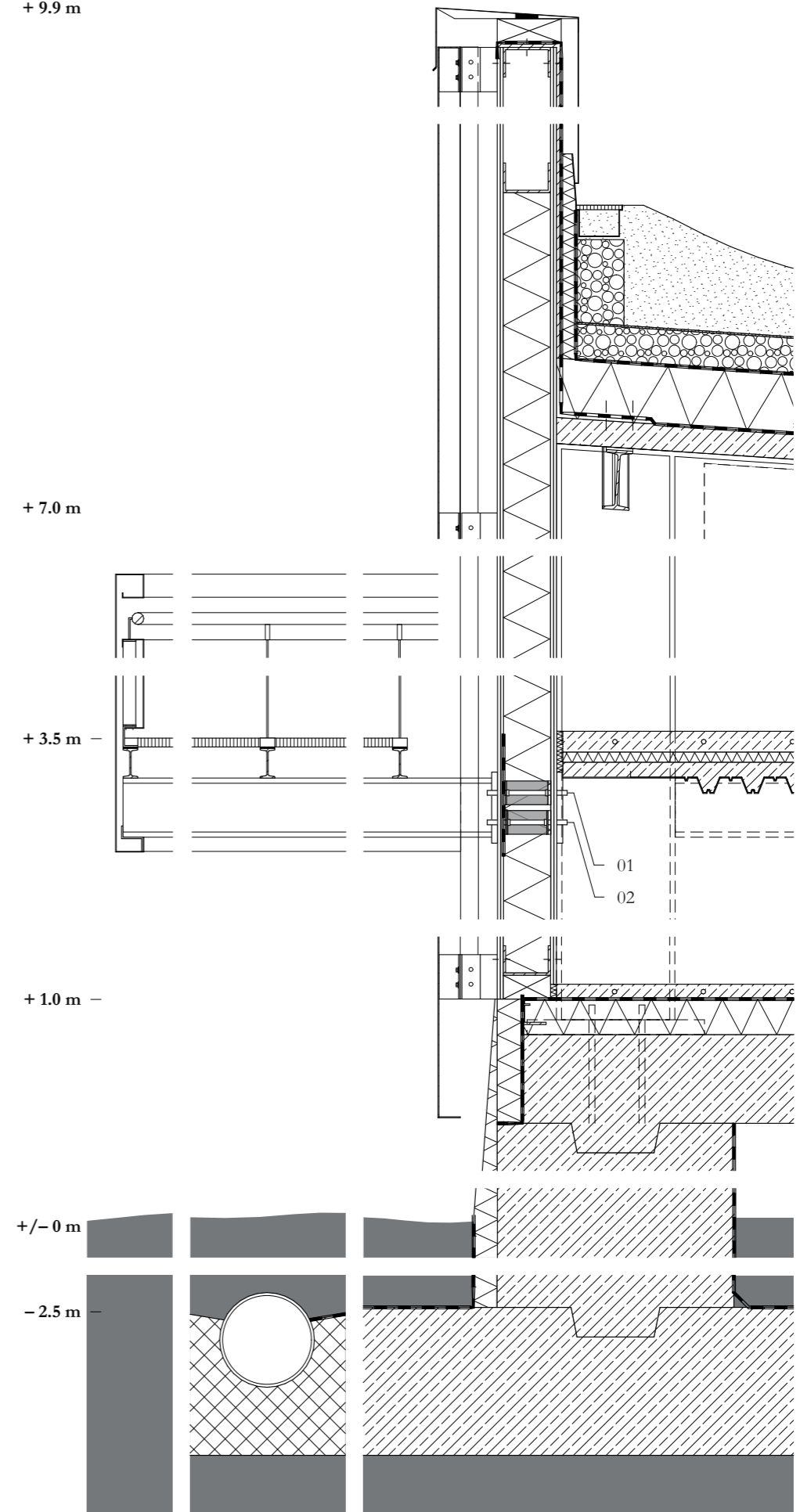
Foundation

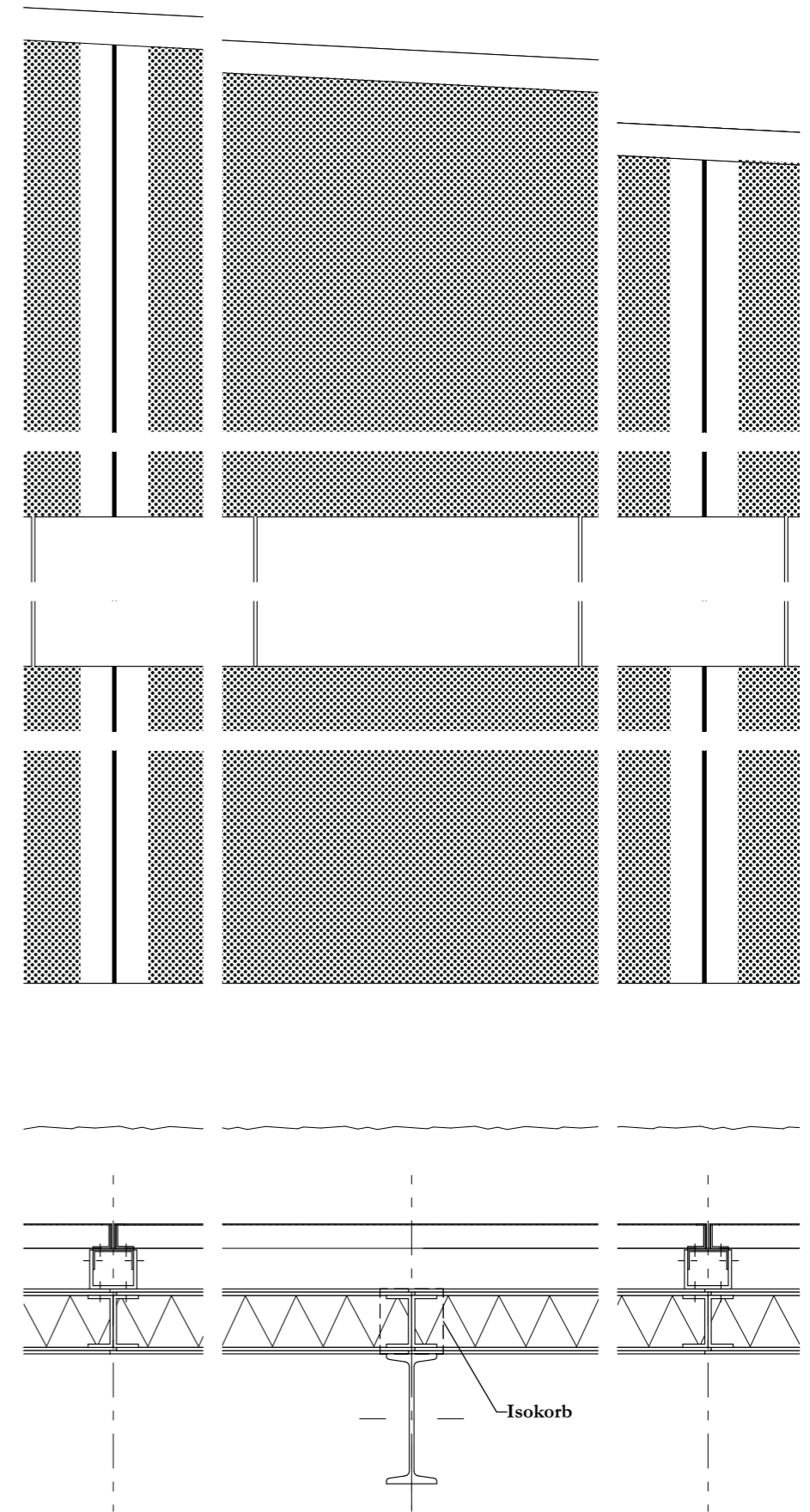
Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Thermal insulation	120 mm
Waterproof membrane	
Concrete slab	300 mm

- 01 Isokorb KSTQ
- 02 Isokorb KSTZ

Exterior Façade A

Section 1-20





Exterior Façade A

Elevation 1-20

Horizontal Section 1-20

Exterior wall

Primary structure *prefabricated steel portal*
Sandwich panel w insulation
Façade *weathered steel perforated panels*

IPN 400
200 mm

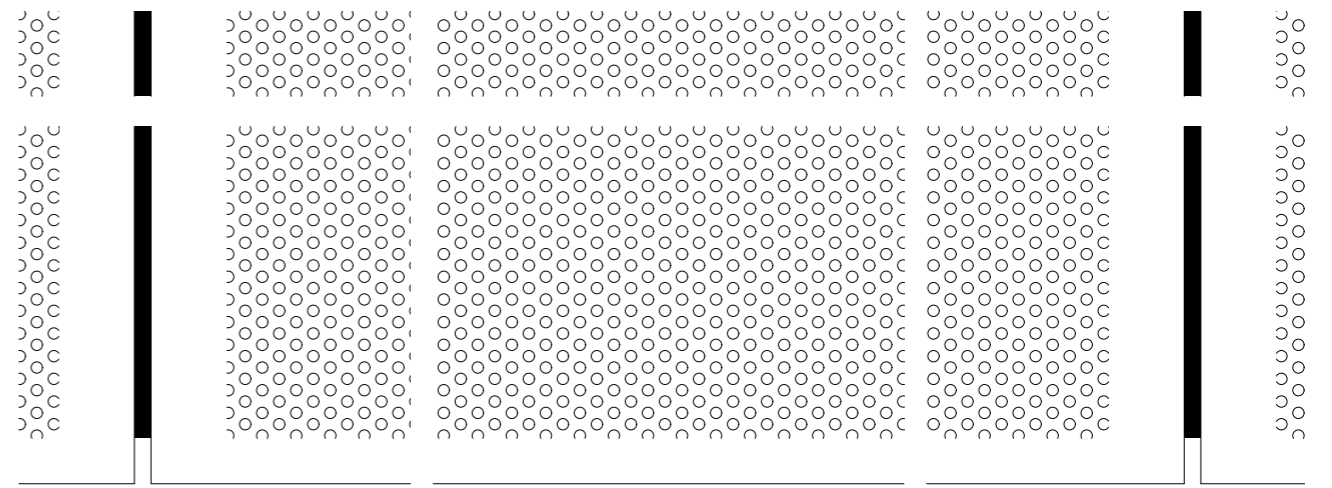
01 Isokorb

D.04 – Façade

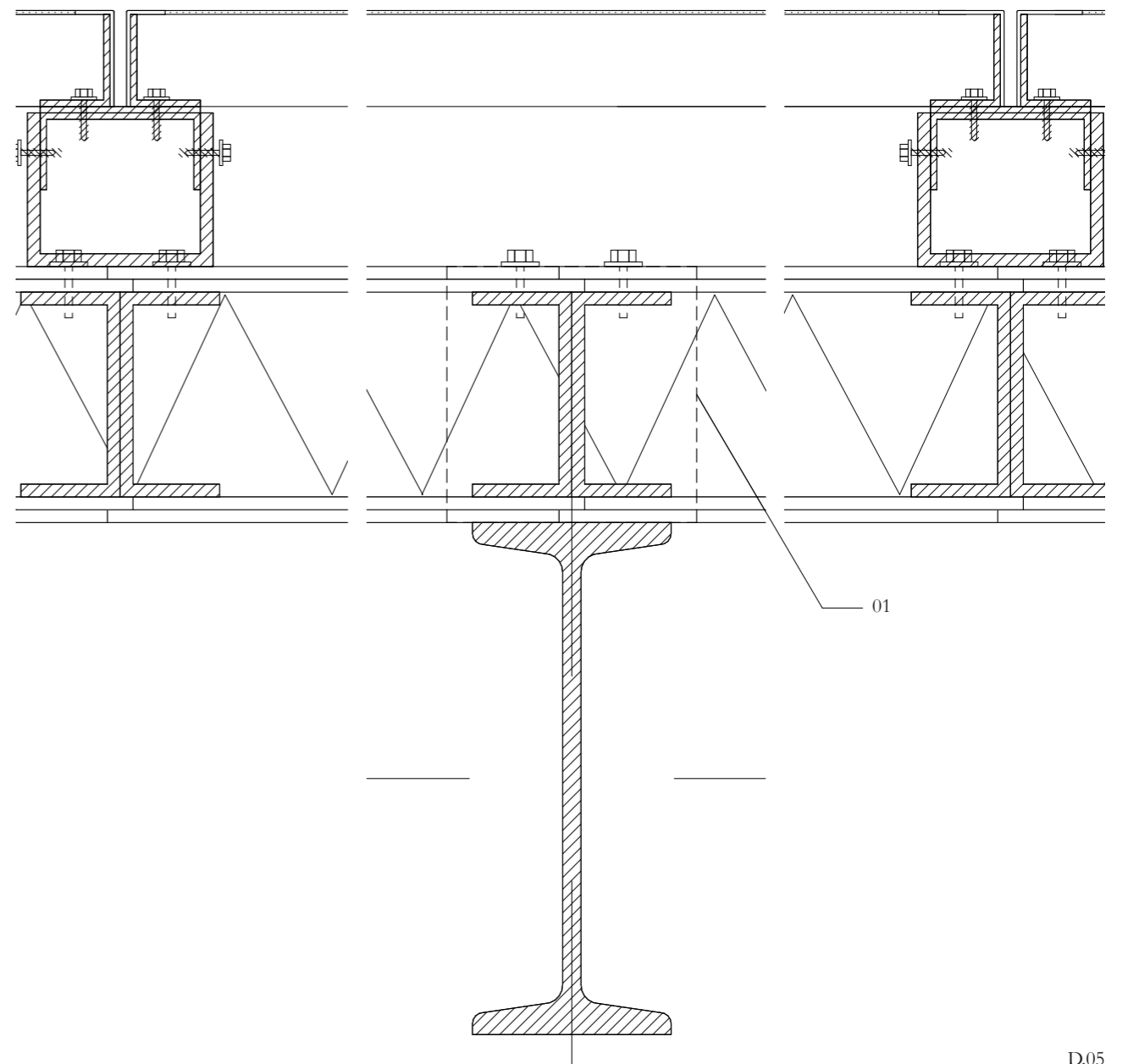
Elevation 1-5

D.05 – Façade

Horizontal Section 1-5



D.04

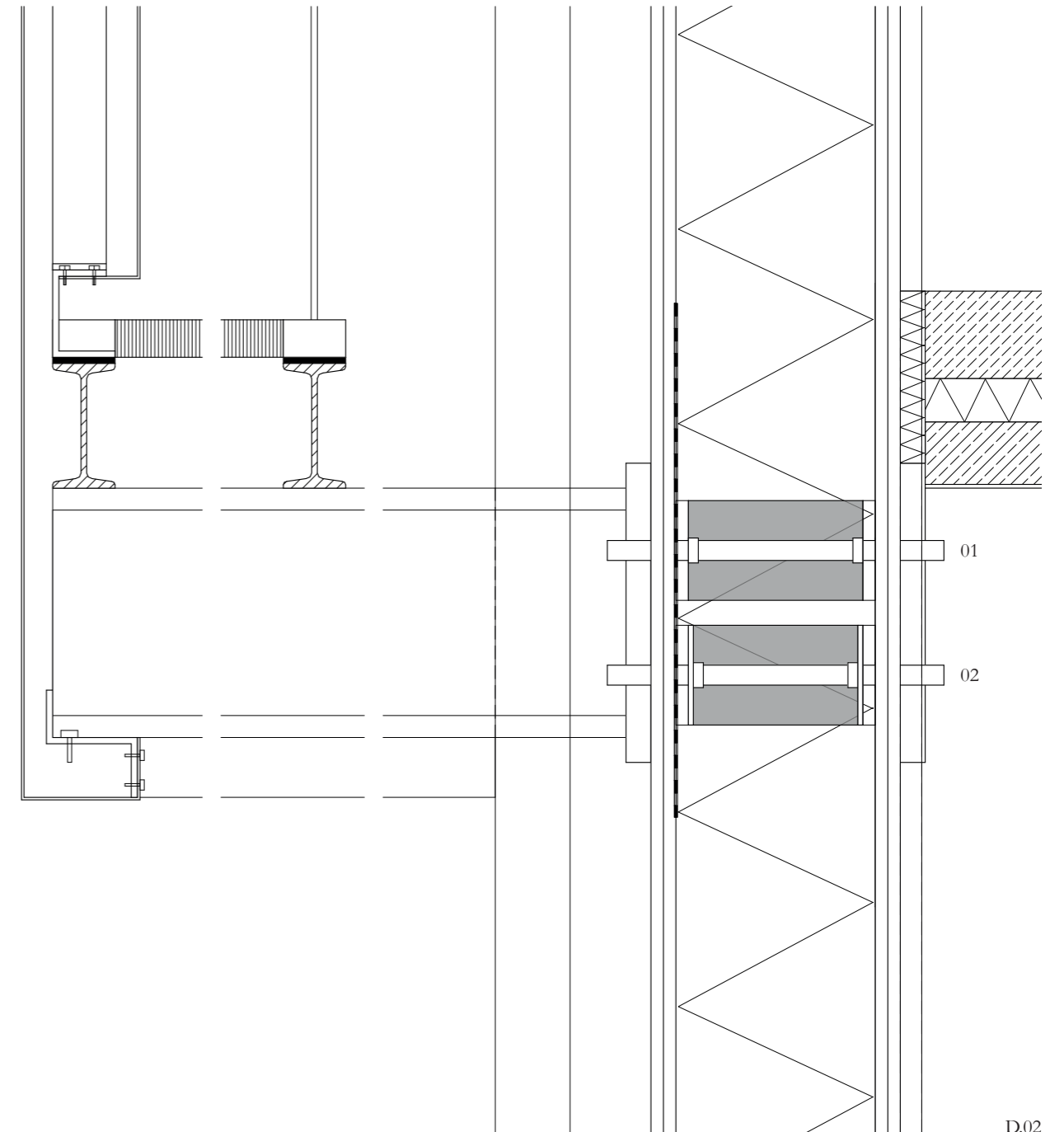


D.05

Mezzanine Floor

Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Sound insulation	30 mm
Composite decking	
55 mm trapezoidal-section ribbed metal sheeting	100 mm
Secondary structure	IPN 200

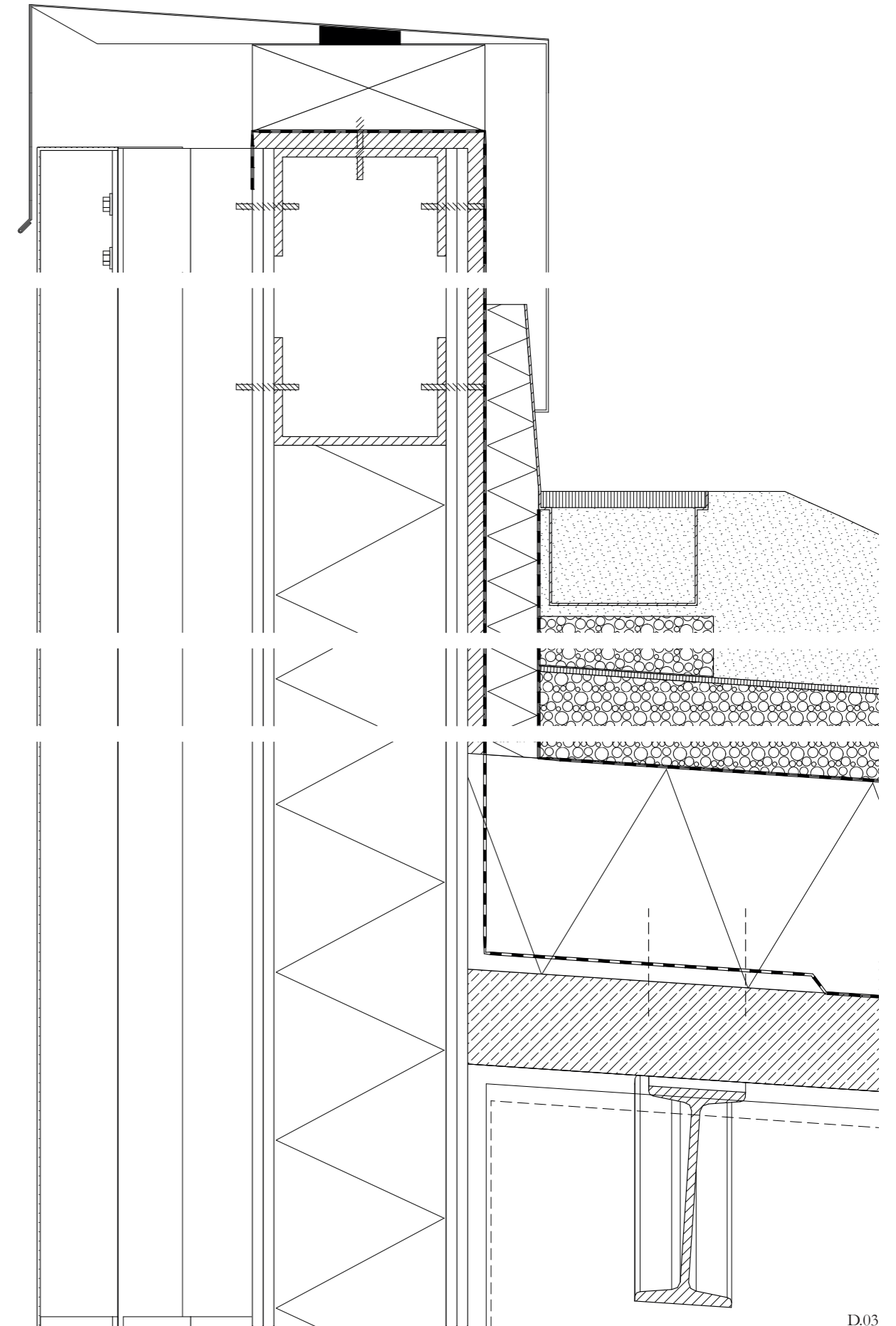
- 01 Isokorb KSTQ
- 02 Isokorb KSTZ

**Detail Balcony**

Section 1-5

Intensive Green Roof

Intensive vegetation	
Substrate	min. 150 - max. 400 mm
Sheet barrier root protection	2 mm
Filter mat	
Retention layer <i>expanded clay aggregate</i>	
Waterproof membrane	1.5 mm
Thermal insulation	200 mm
Supporting structure	IPN 200 IPN 400



Detail Roof

Section 1-5

Intensive Green Roof

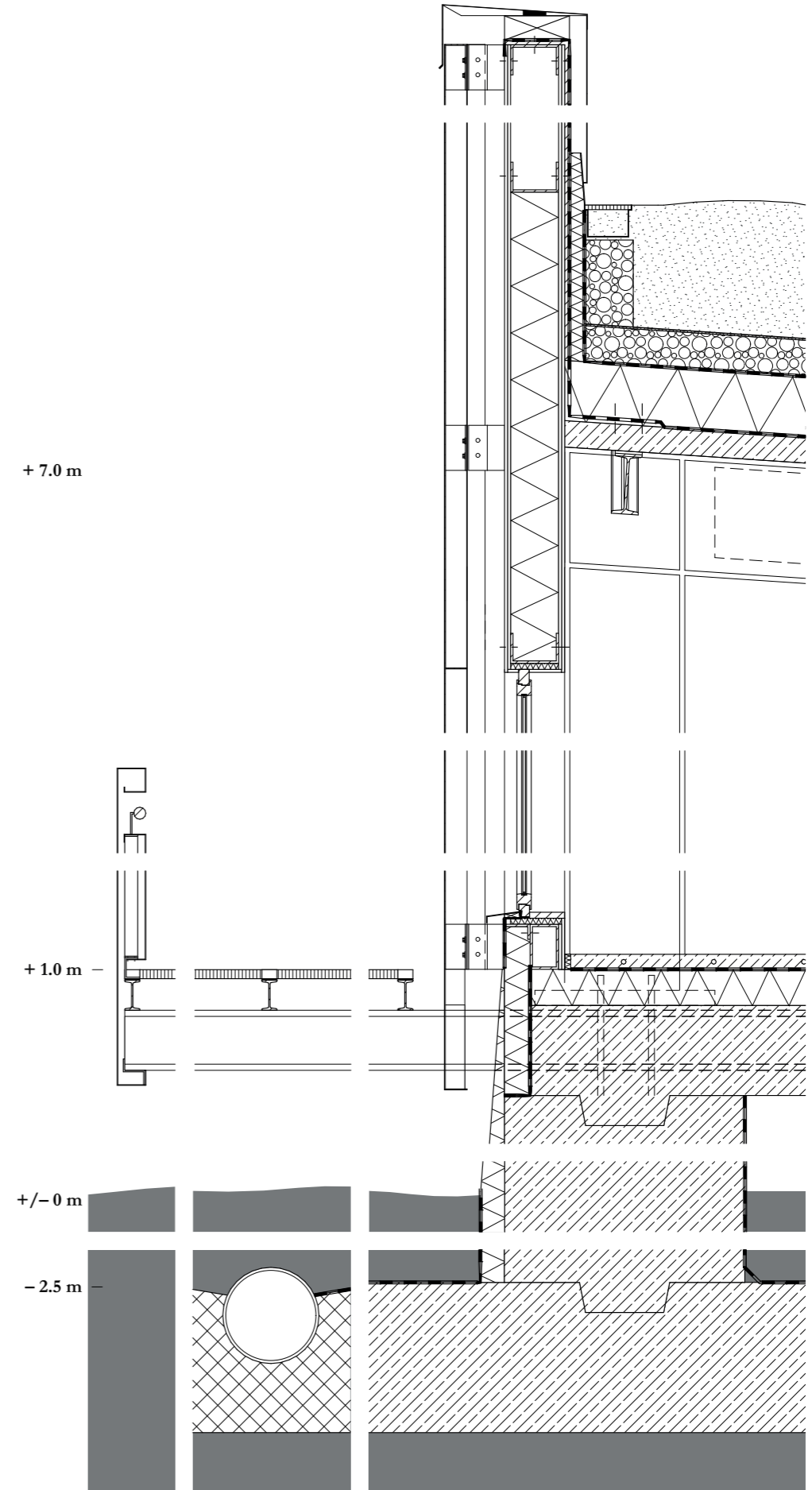
Intensive vegetation	
Substrate	min. 150 - max. 400 mm
Sheet barrier root protection	2 mm
Filter mat	
Retention layer <i>expanded clay aggregate</i>	
Waterproof membrane	1.5 mm
Thermal insulation	200 mm
Supporting structure	IPN 200 IPN 400

Exterior wall

Primary structure <i>prefabricated steel portal</i>	IPN 400
Sandwich panel w insulation	200 mm
Façade <i>weathered steel perforated panels</i>	

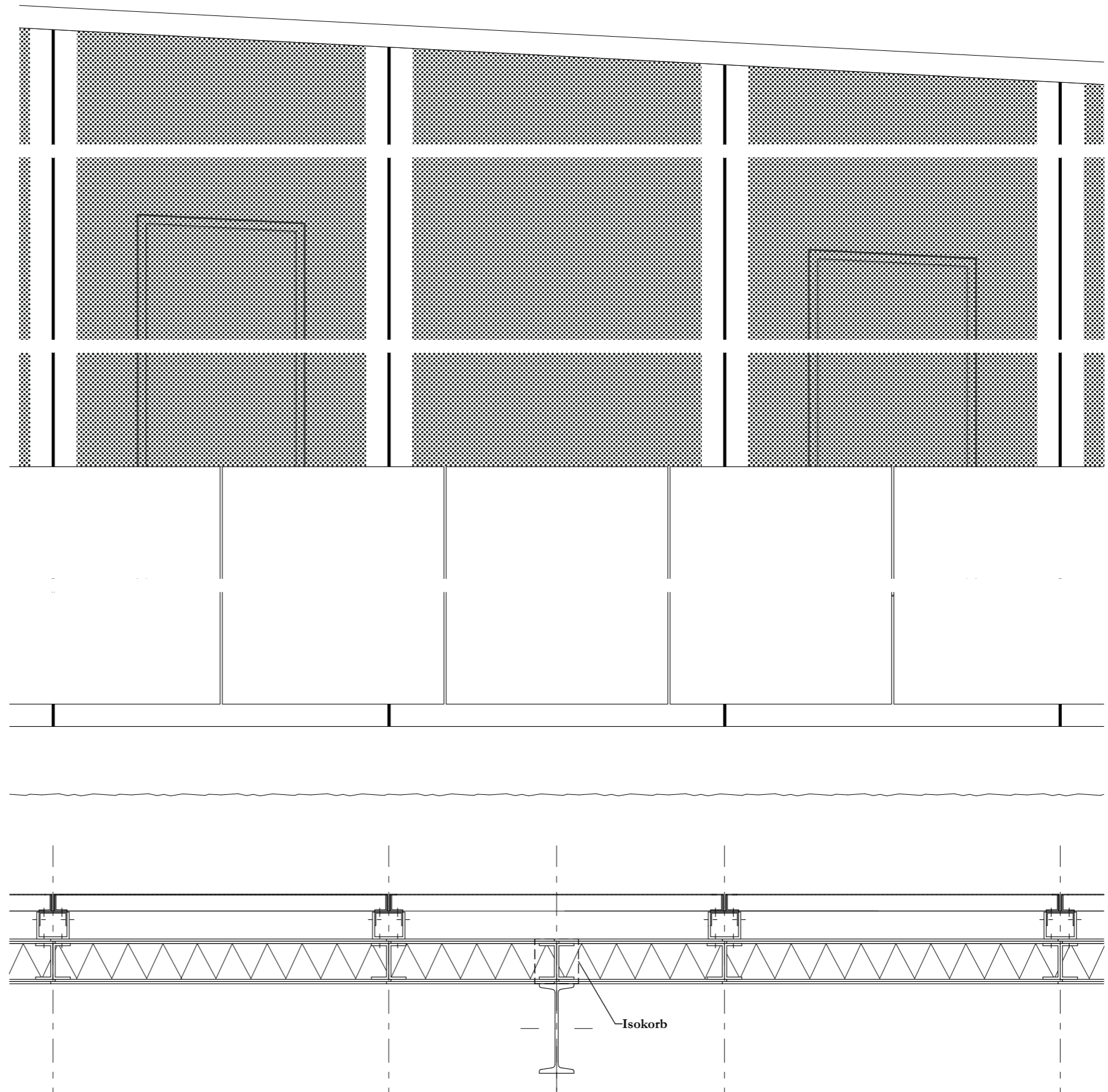
Foundation

Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Thermal insulation	120 mm
Waterproof membrane	
Concrete slab	300 mm



Exterior Façade B

Section 1-20



Exterior Façade B

Elevation 1-20

Horizontal Section 1-20

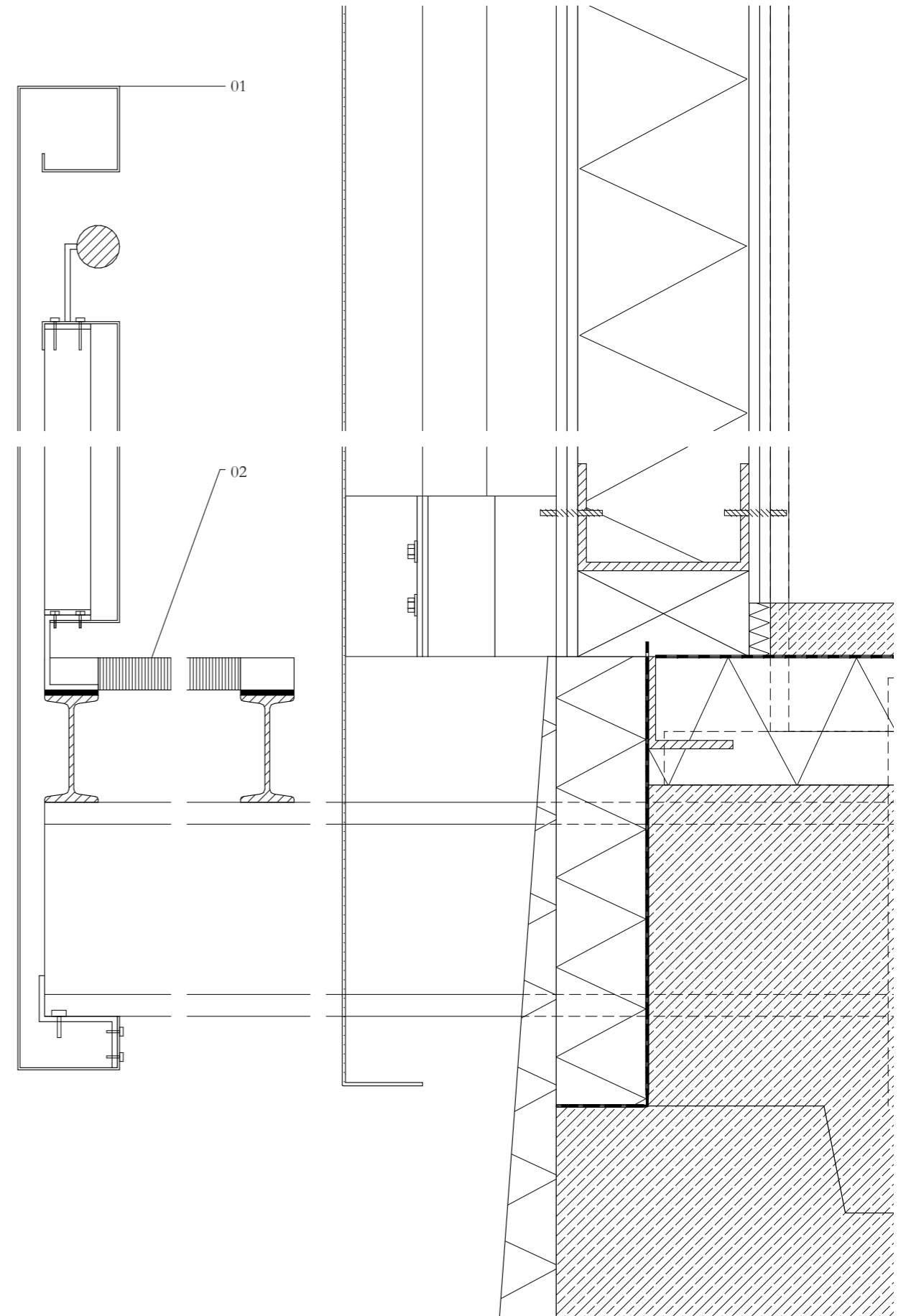
Exterior wall

Primary structure <i>prefabricated steel portal</i>	IPN 400
Sandwich panel w insulation	200 mm
Façade <i>weathered steel perforated panels</i>	

Foundation

Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Thermal insulation	120 mm
Waterproof membrane	
Concrete slab	300 mm

01 Balustrade w Handrail *weathered steel folded panels*
 02 Path *weathered steel grate*



Detail Balustrade

Section 1-5

Intensive Green Roof

Intensive vegetation	
Substrate	min. 150 - max. 400 mm
Sheet barrier root protection	2 mm
Filter mat	
Retention layer <i>expanded clay aggregate</i>	
Waterproof membrane	1.5 mm
Thermal insulation	200 mm
Supporting structure	IPN 200 IPN 400

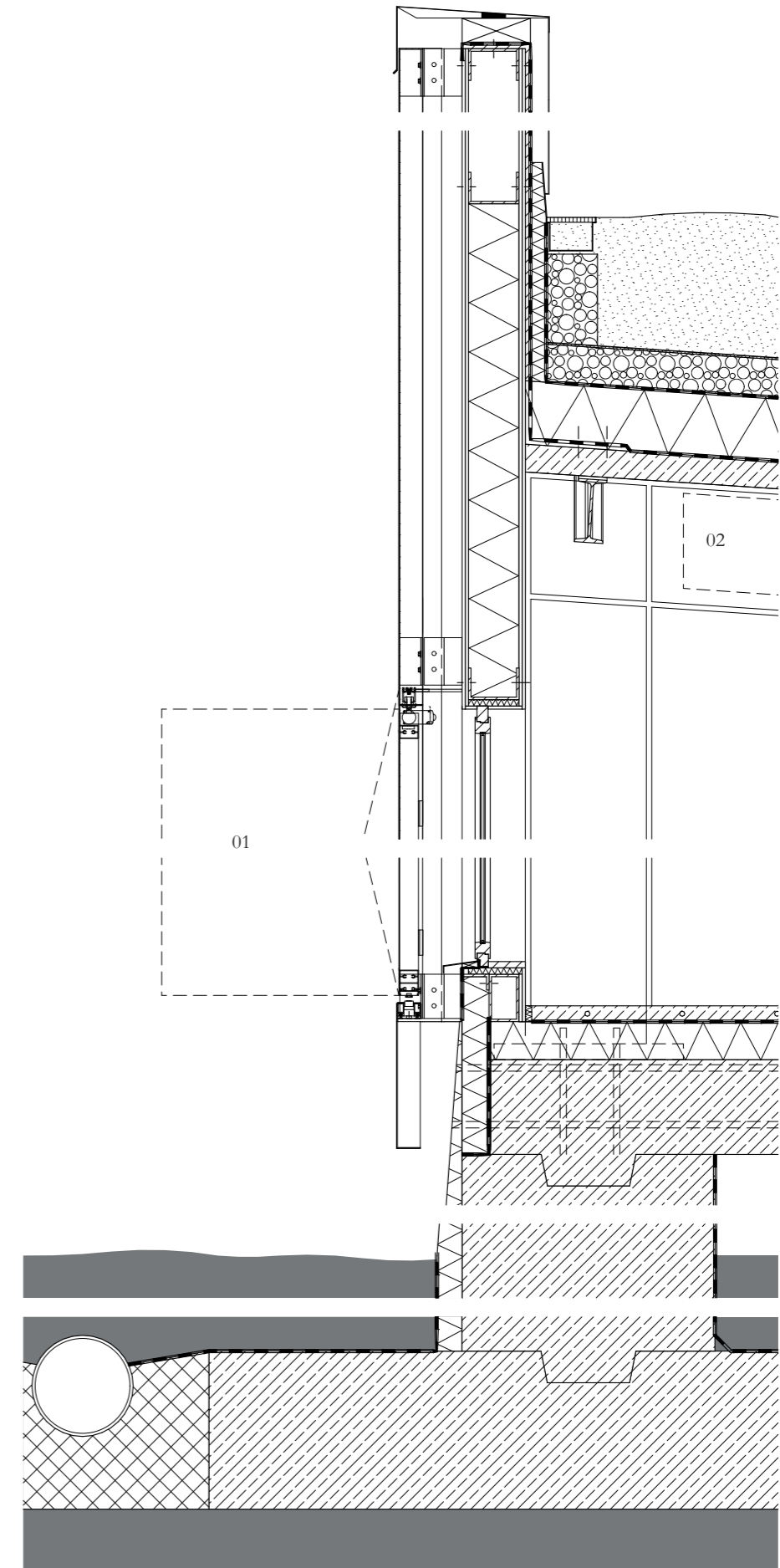
Exterior wall

Primary structure <i>prefabricated steel portal</i>	IPN 400
Sandwich panel w insulation	200 mm
Façade <i>weathered steel perforated panels</i>	

Foundation

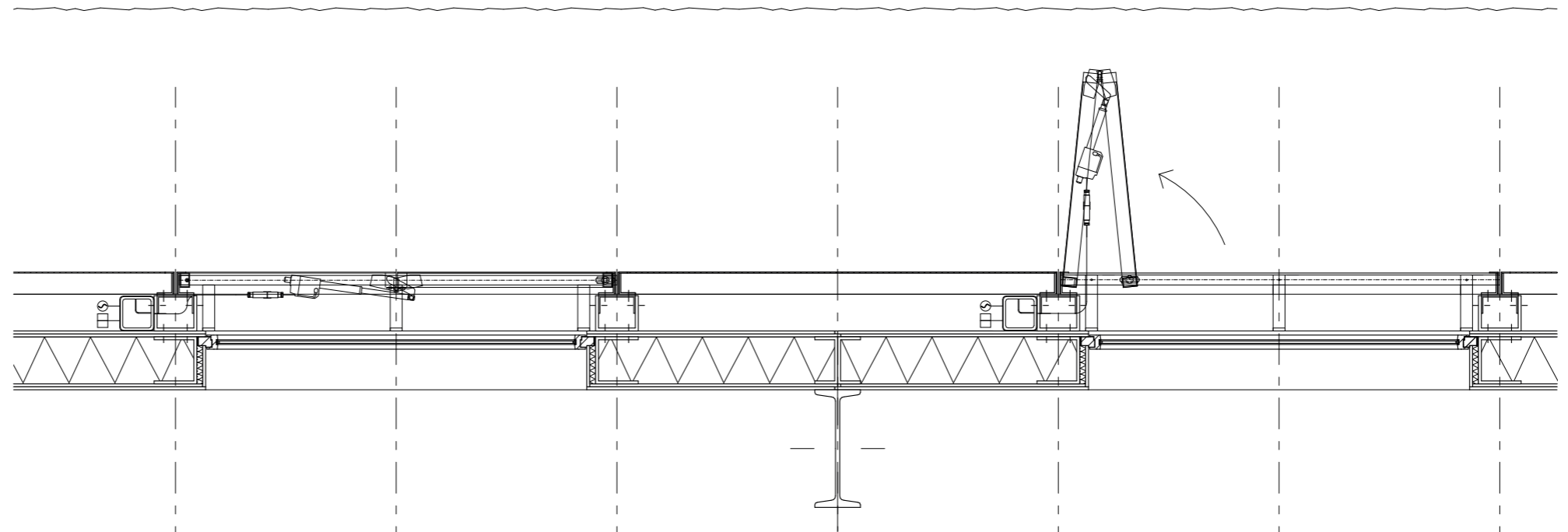
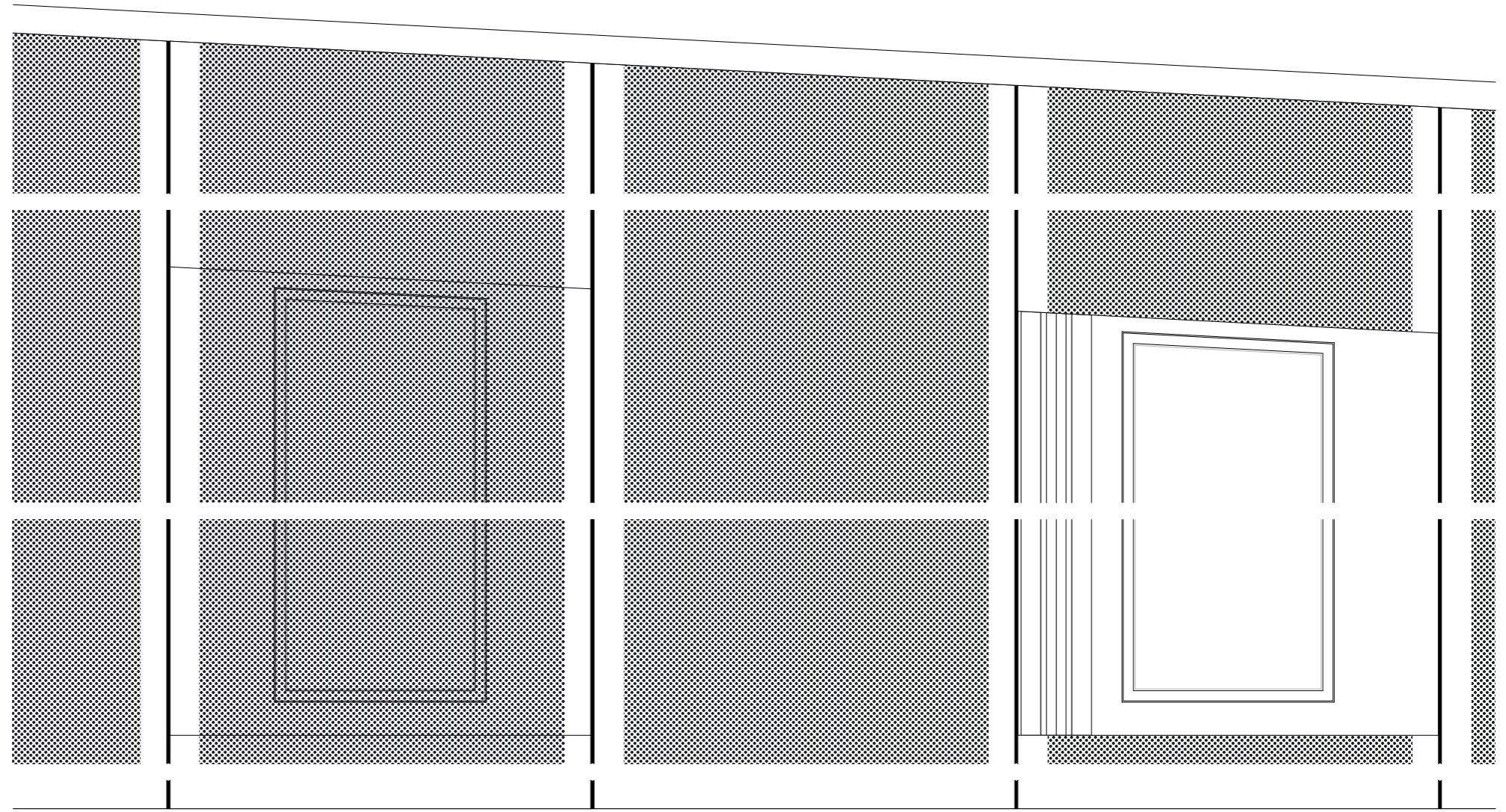
Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Thermal insulation	120 mm
Waterproof membrane	
Concrete slab	300 mm

- 01 Louver panel integrated into façade
- 02 HVAC duct



Exterior Façade C

Section 1-20



Exterior Façade C

Elevation 1-20

Horizontal Section 1-20

Intensive Green Roof

Intensive vegetation	
Substrate	min. 150 - max. 400 mm
Sheet barrier root protection	2 mm
Filter mat	
Retention layer <i>expanded clay aggregate</i>	
Waterproof membrane	1.5 mm
Thermal insulation	200 mm
Supporting structure	IPN 200 IPN 400

Exterior wall

Primary structure <i>prefabricated steel portal</i>	IPN 400
Sandwich panel w insulation	200 mm
Façade <i>weathered steel panels</i>	

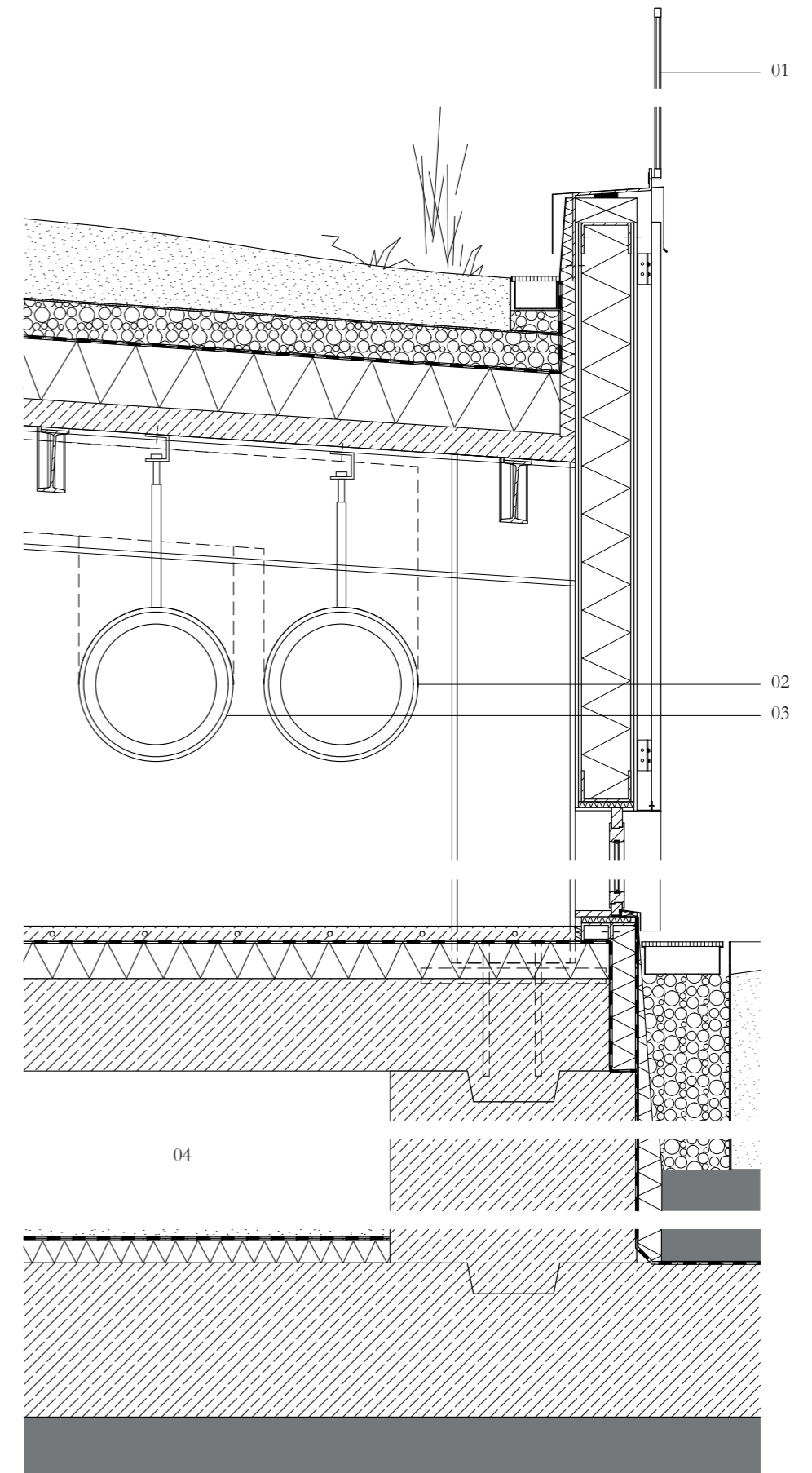
Foundation

Fair-faced screed w underfloor heating	70 mm
Vapor barrier	
Thermal insulation	120 mm
Waterproof membrane	
Concrete slab	300 mm

- 01 Ballustrade *glas panels; steel frame*
- 02 HVAC Outlet Duct
- 03 HVAC Inlet Duct
- 04 Underground service trench

Inerior Façade D

Section 1-20



CONCLUSION.



HEALING GARDENS

Any garden can be healing. Research proves that deeply transformative experiences can be facilitated in gardens whether they are specifically designed for healthcare purposes or not. By providing a spaces within nature, people who may be dealing with disruptions in their lives or those simply seeking a stress-free asylum, gardens in their pure form attend to dynamic and exponential shifts in people's life and become a place for potential transformation. Beyond that, iterative processes of engaging people are an important tool to create meaningful connections between human and landscape and likewise amongst people. Opportunities for individual exploration are as significant as are places of gathering, sharing and collective learning.

Extended Value

With the synergy between environmental and human health at its core, the project points at a subject of immense actuality that deserves evermore attention as mental health problems become ever more common in western individualistic societies while at the same time the depletion of our ecosystems through urbanisation has reached a new climax. Recent findings frequently interlink the growing rates with people's immediate environs, characterised by a lack of green infrastructure within a largely urbanised world. The supposed disconnection of human and nature is increasingly discussed in academia and the effects of flora and fauna on our health both physically and mentally have become subject to countless studies and publications with a shared conclusion: our health and our immediate environment are inextricably connected with one another.

While ecological and so-called 'biophilic design' gradually establish themselves in common architectural practice (albeit often arguably owed to the inherent marketing value), developments are yet highly reliant on market-driven demand through growth. In contrast, the example of Dunkerque is only one of many cities across Europe that is shrinking rather than growing. Primary reason is a shift in industry and increasing monopolisation. As a result, territories deprived of their former use become abandoned; exploited, deserted and transformed into unrecognisable states of contamination and decay. As such, the project, located on a former industrial site, becomes a kind of laboratory for the remediation of the territory and its inhabitants alike.

Following three main objectives, a number of direct benefits (ecological and socio-cultural) and rather indirect ones (economical) are achieved:

1. Remediate ground – Through the application of bioremediation techniques, in particular phytoremediation, the chosen site undergoes a process of decontamination, transforming the site from a brownfield to greenfield without costly mechanical land remediation techniques. As a result, through time, it increasingly becomes available for new socio-cultural functions such as public rehabilitation and leisure for Dunkerque's inhabitants. The proposed amenity on site implicates a recreational, health-informed programme introducing the approach of nature therapy to the broader public. At the same time, the transition of the site invites other forms of life – plants and wildlife – to colonise and form a symbiosis with the territory itself. As such it forms a great contribution to the reestablishment of formerly deprived ecosystems of the North Sea foreshore and can reduce costs for nature conversation. Once the process of remediation is completed, the ground will have increased substantially in economic value as would the immediate surroundings.

2. Redefine boundaries – The old port, already in transition today, gains in overall-significance and value with the potential to become a new economic driver for the city of Dunkerque. With a new green infrastructure at its edge, the wedge that was driven between the city centre and the port as industries increasingly monopolised can be bridged. The spatial re-appropriation makes place for local economies to be stimulated through new functions with more sustainable business models and for the city to extend and redefine its borders. As the old port gains new functions, the edge between land and water – between the city of Dunkerque and the North

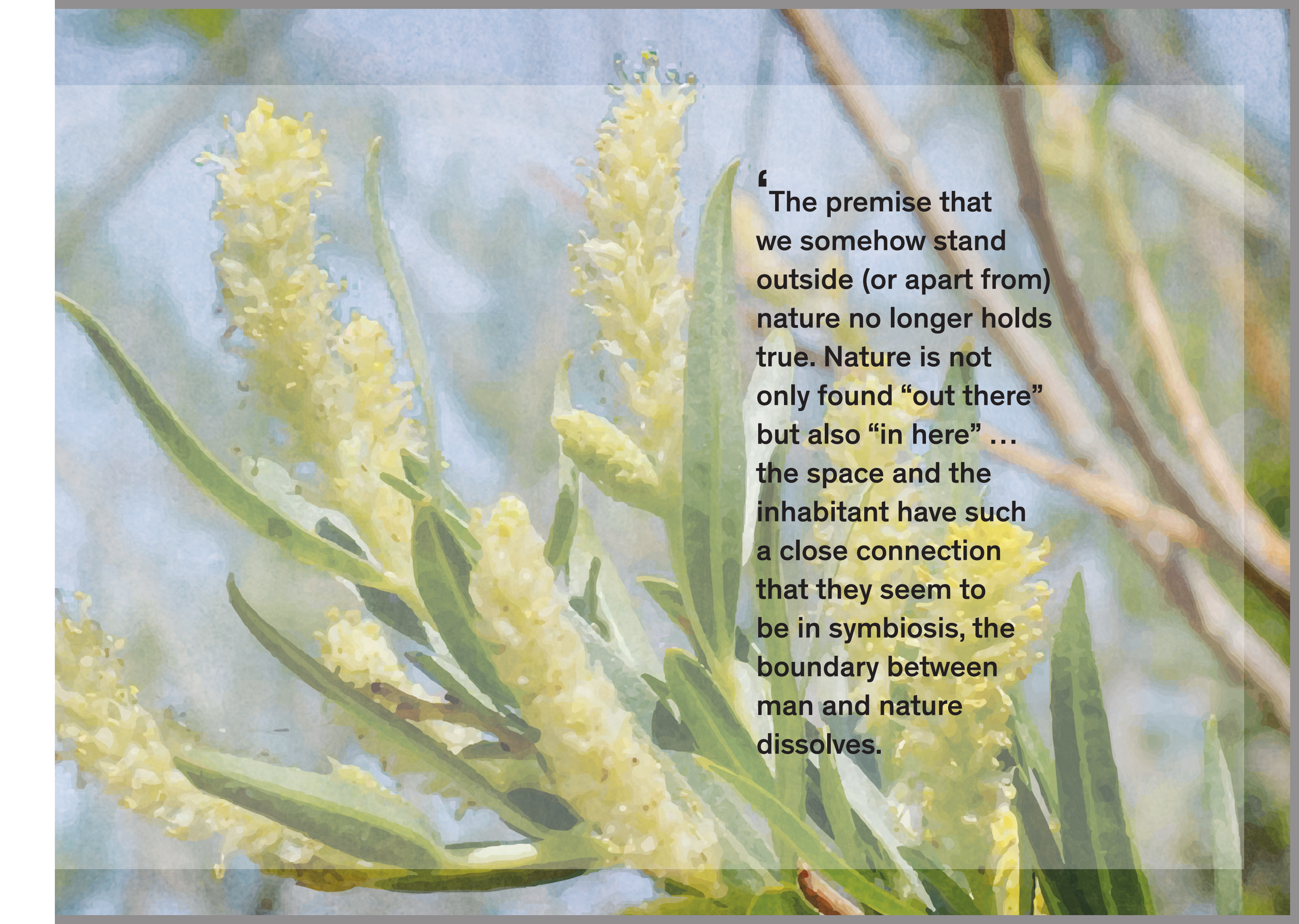
Sea – is increasingly blurred as previously marginalised areas of the foreshore are rendered back into the public realm. Simultaneously, the decommission of the harbour basin and the eventual elimination of large ships permits an actual, infrastructural connection in the form of a foot bridge that links the project site with the headland which connects back to the city centre.

3. Reconcile inhabitants and their environment – On a more human scale, the provision and accessibility of green infrastructure in the urban realm contributes to the overall health of Dunkerque's inhabitants. This in turn leads to a general improved satisfaction of the population through greater well-being, productivity and general happiness and can more specifically reduce the cost for public health care. Such indirect benefits may only be evident through a long-term perspective. However, particularly in the case of Dunkerque, the anticipated coexistence attempts to heal more than just that lost connection; it rather strives to bring new life in a dwindling city. The shared concern for health has the ability to reunite and reidentify humans not only with flora and fauna but also with one another and at the same time let them realise that they are really part of nature rather than being isolated from it.

Unexpected Opportunities

From an architectural point of view, the assignment offers an opportunity to combine nature and culture. Designing in partnership with nature – the sea, flora and fauna – in the context of a heritage of enormous place-specific cultural importance, requires careful mediation and understanding of existing phenomena and the territory itself. This also includes the integration of heritage and acknowledgement of spirit inherent to a place. The project site has for almost two centuries been a place closely connected to the energy sector. The exploration of a new form of occupation automatically imposes the question for a more sustainable approach towards energy and waste as in the form of compost heat recovery. It is the programme of a garden itself that prompts the integration of a renewable energy system based on the green waste occurring through garden maintenance. This not only suggests the implementation of a near-zero waste system but contains potential for an expansion towards the city of Dunkerque. More specifically, household waste may be collected and converted in exchange for energy shares or inhabitants trade for organic humus as a by-product of the composting process which can be used to manure one's private garden. Finally, the project intrinsically commands an educational value not only for the singular person that is privately visiting the garden for leisure but also on a larger scale. The scope of knowledge to be conveyed reaches from health awareness over plant-specific insights to practical horticultural approaches.

While the subject of regeneration and decontamination of land becomes ever more relevant as we proceed in an era of Anthropocene – an era in which territories are continually transitioning through the many human forces – also the rehabilitation of the human being, her physical body and her mind has come to the fore. It is not least up to architects and designers to create and disclose the spatial requisite for this to happen. The reintegration of human with their natural environment by acknowledging and synthesising with existing built environments (such as the uninhabited structures of the refinery grounds) one extrapolates a myriad of possibilities and opportunities for new occupations and an ultimate increased value of the territory in question.

The background of the slide is a watercolor-style illustration. It features several vertical spikes of small, bright yellow flowers. The flowers are attached to green stems with long, narrow, lance-shaped leaves. The background is a mix of light blue and pale green washes, suggesting a sky or a natural setting. The overall style is soft and painterly.

‘ The premise that we somehow stand outside (or apart from) nature no longer holds true. Nature is not only found “out there” but also “in here” ... the space and the inhabitant have such a close connection that they seem to be in symbiosis, the boundary between man and nature dissolves.

APPENDIX.

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B	Timeline	296
C	Reflection	298
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A Methodology

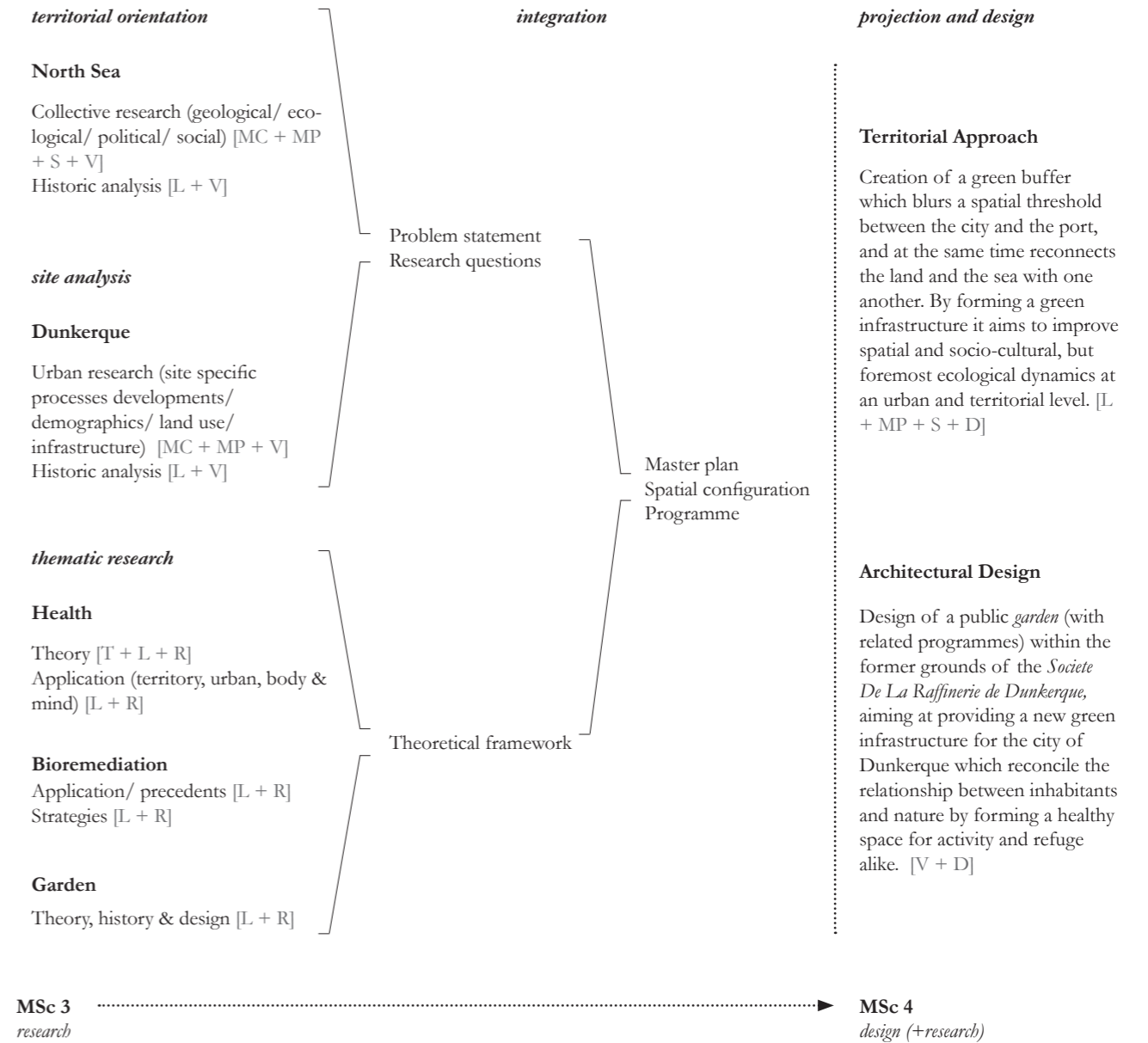
A.1 Research Framework

The trans-scalar approach of the studio prescribes a distinctive order of investigation from the wider context – the territory of the North Sea – to one’s project-specific research subject. This naturally proposes a varying body of methods and techniques to be employed. The foundation forms the collective research of the North Sea through different lenses (geological, ecological, political, and social) and the translation of scientific data into maps documenting the current state and future projections. The formulation of scenarios proposing varying ‘futures’ enables a broadened understanding of certain trends and its effects.

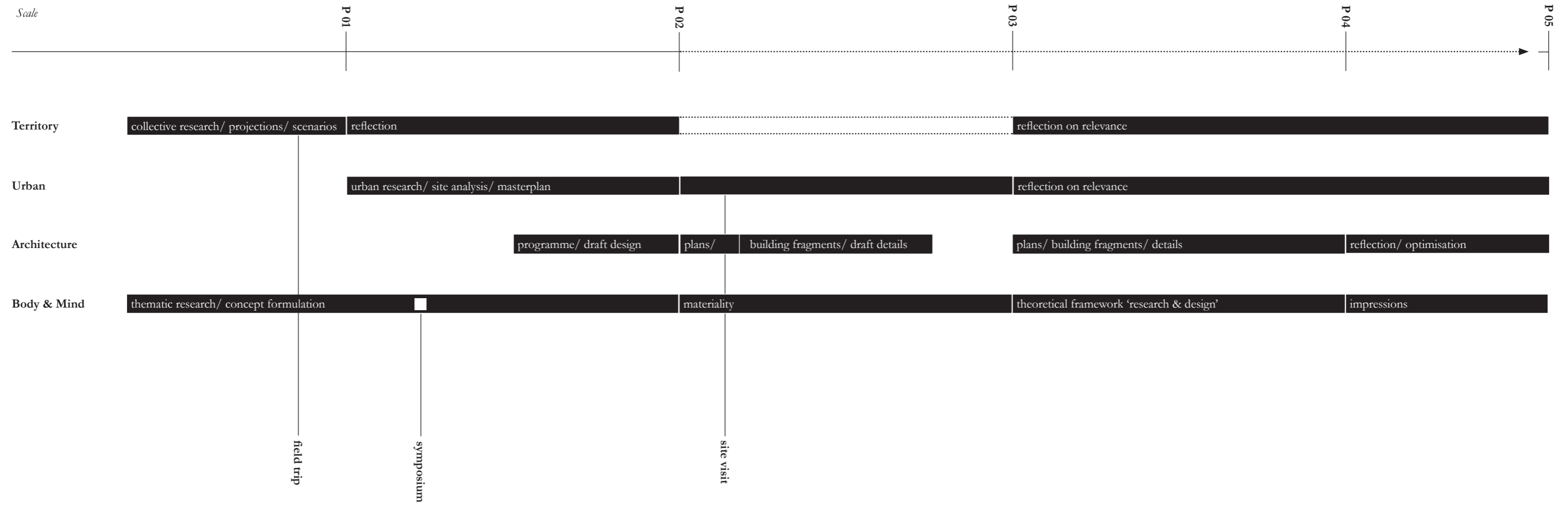
Zooming into the individual project scale increasingly shifts the focus from the territorial to the site-specific. The data collection about Dunkerque is informed by literature and on-site inquiry. Hereby, one relies on different means and methods depending on the scale of investigation. These include mapping, drawing and collage, text, film and photography, and collection of samples. In practice, a large area of interest often exceeds one’s research capabilities. A useful method is therefore the ‘transect’, a composition of multiple techniques depicting one’s findings along a selected path. Revisiting this path yet enables the gathering of ephemeral attributes, temporal dynamics and atmospheres, and is therefore a value means for phenomenological inquiry.

Parallel to the first steps, a literary inquiry about *health* and the environment (and more specifically the growing body of literature discussing the ‘biophilia’ phenomenon), *garden* theory and history as well as *bioremediation* is undertaken. Literature review provides broad knowledge and specific insights on history and theory of the subject and forms the basis for a heuristic ‘research by design’ approach. Within the broader context of landscape and garden, I gave particular attention to the history Persian gardens, as well as more contemporary blue-green infrastructures. A complementary research method is moreover provided by case-study analysis. Multiple examples (see below) illustrate the various ways of dealing with industrial heritage and brownfield regeneration and remediation in a functional, ecological and poetic manner.

The transitional character of a place, before and after a design implementation, is best depicted by a series of projections. By means of ‘backcasting’ one begins with a future scenario which comes close to the anticipated, ideal state and from there dissects backwards into individual steps. ‘Research by Design’ – an inquiry in which design is an essential part of the research process – is applied as a common strategy. It relies on continual reflection and reframing to be made throughout the design process, perpetually testing and adapting to new potential futures.



B Timeline



C Reflection

¹ 'Nature' is generally and falsely understood as merely plants and animals, though it as much includes other human beings and really anything that derives from it.

² The sequence proposes a (1) Forest Garden, (2) Wild Garden, (3) Flower Garden, (4) Water Garden, (5) Plane Garden. Please refer to P.4 Report for detailed plans and descriptions.

The P.4 presentation is largely focussed on disclosing the architectural design as the final outcome of the research undertaken during the journey of my graduation project. At the same time, it is a moment of reflection. As such, this paper elaborates and reflects on the project proposal, its contextualisation within my master programme (Architecture) and the *Transitional Territories studio*, and my research and design approaches in consideration of both my mentor's feedback and issues encountered along the path. Relevance and transferability of my project results are elucidated with an eye to current discourses before concluding and positioning myself within the larger context of the architectural field.

Research and Design

Departing from the notion of 'health and well-being', my graduation project 'Mindscapes & Healing Gardens' explores how particularly mental health is affected by our immediate surroundings, that is the built and natural environment. Within the studio-specific framework of the North Sea territory, health functions as a broad term and is the overarching theme translated across various scales and fields of interest; environmental/ ecological health (*territorial*), socio-cultural health (*urban/ landscape*), human health (*body & mind*).

In the course of my research the subject was split into three sub-topics that derive or closely interrelate with this overall notion of health; (1) mental health and its interdependency with the natural environment, (2) bioremediation, the ability of nature to remediate itself and reverse man-made contamination characteristic for post-industrial landscapes, and (3) the garden as constructed nature, its history, typologies and social relevance. In reciprocity of my own research and the studio-specific territorial analysis, the design proposal comprises of an urban garden on the site of a decommissioned oil refinery in the coastal city of Dunkerque in northern France. Based on the hypothesis that exposure to green infrastructure is highly beneficial to human well-being, the project's primary endeavour is to create a place of healing that, at the same time, reconnects people and their territory through nature. In the light of nature's ability of self-remediation, the urban garden further forms a synthesis of the health of the place itself and its inhabitants. The extensive research of gardens on one hand and of bioremediation on the other hand forms the basis of the design.

The assignment is divided into two main steps; (1) a master plan on an urban and landscape scale that addresses the site's location and its specific in relationship to its context, and (2) an architectural intervention placed within this larger framework. *Connectivity* is a guiding notion across all scales and manifests on the landscape scale in form of a path transecting a fragment of the refinery grounds. This path leads through a sequence of five gardens that invites the visitor to reconnect to and explore the natural world present in a place so contrarious to nature¹ due to its anthropomorphic history and heritage, now abandoned and void. Though, it is precisely this atmosphere that grants a new perspective on the vegetative actors of the place and not only stimulates a re-joining with the territory but also with the inner self. At the same time, hitherto marginalised port areas and the North Sea foreshore of Dunkerque are reconnected with the city centre. As such, the site becomes a link between the land and the sea.

The landscape concept of sequential gardens is deduced from both existing structures and vegetation on-site and complemented by a variety of known biotechnologies that support the second notion, *remediation*. Again, acting across scales, plants remediate the contaminated ground as well as the visitor's body and mind. Motivated by my research, specific themes are given to each garden; from a wild grove to the healthcare-specific typology of a therapeutic garden². The path becomes the guiding element throughout, a journey and a transition; resembling the studio's guiding notion. This gradual shift through the site links various polarities; from wild to domesticated, from extrovert to introvert, refuge and prospect. Simultaneously, the path is an architectural intervention in itself, that ultimately crests in a building that accommodates supporting functions for the various gardens. In a spatial sense, the role of the architecture remains subtle and abstract, nevertheless of great significance for the comprehension of the site.

At the same time, the building acts as the ultimate garden by forming an enclosure. The enclosed garden is the *ur*-form of the garden itself, in the deepest sense of the word³. The built form and architectural formulation of the design is therefore closely intertwined with the preceding and continuing research and its final form the result of an on-going dialectic between research and design.

Finally, both path and building address the third notion of *temporality*. With the temporal dimension inherent to the bioremediation process of the territory and the mind likewise, the path is embracing the ephemerality of the place. The different scales relate to varying time frames, from a bare thirty second it requires for the human nervous system to experience the benefits of plants to a decade long remediation process of the contaminated territory the project is built on. A 5-year, 10-year and 30-year plan each suggests a new array of paths and trails exploring the potential transformation. Through time, the path transforms from a static architectural object into a dynamic network increasingly blurring the edge between the visitor and the territory itself; opening new spaces through time. As such it much rather discloses an already existing place than creating a new one.

Academic Integration

The self-imposed assignment, the remediation of a brownfield into an urban garden providing health-related and recreational functions, corresponds to the framework of my master programme at the Faculty of Architecture, Urbanism and Building Sciences. The Transitional Territories studio accommodated an open learning environment that acknowledges how various knowledge fields are closely intertwined and the subsequent significance of collaboration across disciplines in practice and academia alike. This position was effectively translated into the studio's structure uniting architecture and urbanism students into interdisciplinary groups. Collective work promoted discourse and exchange, and fostered thinking and designing beyond one's familiar scales. As such, the studio offered an exploration beyond the architectural track; in urbanism and landscape architecture although unfortunately no students from the latter track participated in the course. The concept of the multidisciplinary studio to embrace the intersection of different fields of design (and beyond) is translated into my project. It combines the scale of the territory with that of body and mind, and through design investigates the interface of architecture and landscape. The design of an urban garden ties into this investigation. Being both 'a dwelling place and a representation of natural space' the garden understands itself as 'a synthesis of architecture and nature'⁴, thus integrates the territorial scale as much as the human scale.

Methodology and Scientific Relevance

In line with the studio-specific curriculum, the research phase made up the larger, first part of my project design and continuously informed the subsequent design phase. A literature review provided a broad knowledge and specific insights on the history and theory of the main subjects of investigation (mental health, gardens, and bioremediation) and formed the basis for a heuristic 'research by design' approach. A large body of literature discussing the relationship of health and the environment (including the ground-laying theory of the 'biophilia' phenomenon) can be borrowed from social sciences, environmentalism and emerging field such as eco-psychology. Simultaneously, a literary inquiry of garden theory and history as well as plants and more closely bioremediation techniques was undertaken. From the broader context of these knowledge fields, a catalogue of biotechnologies and green-blue infrastructures was made and applied to the specifics of the site. This ongoing technical investigation was of great significance as it not only formed the basis for the design proposal but moreover provides the scientific counterpart to the poetic narrative.

³ A garden is an enclosed space outside, literally meaning 'enclosure'. Evolved from the Persian paradise gardens and the Roman peristyle, the *hortus conclusus* is considered the archetypal foundation of Western landscape and garden architecture.

⁴ Saskia de Wit, *Hidden Landscapes*, 2018, p 382.

⁵ Being subject to deconstruction in the course of its recent decommissioning, the site was locked up and highly secured and as such inaccessible for on-site investigation.

⁶ Case studiesw include but are not limited to: Landschaftspark Duisburg-Nord, Latz + Partner; High Line, New York, James Corner Field Operations, Glenorchy Art and Sculpture Park, Glenorchy, Australia, Room11 / McGregor Coxall; Matisse Park, Lille, France, Gilles Clément..

⁷ ‘The Landscape is a Detail of the Garden’ conversation with Gilles Clément in: Alessandro Rocca (ed.), *Planetary Gardens – The Landscape Architecture of Gilles Clément*, 2007, p 54-77.

The data collection about Dunkerque and the project site, the former ground of the *Société de la Raffinerie de Dunkerque* was predominantly informed by online research and on-site inquiry. The site analysis relied on different means and methods with varying scales of investigation including mapping, drawing and collage, text and photography. In practice, a large area of interest often exceeds the research capabilities proposing the means of the ‘transect’, a composition of multiple techniques depicting one’s findings along a selected path and very useful method for a large site. Revisiting this path enables the gathering of ephemeral attributes, temporal dynamics and atmospheres, and is therefore a valuable means for the phenomenological inquiry. The inaccessibility of the site⁵ limited my abilities to closely explore the selected path along my fragment. The inquiry was thus constrained to an investigation through the camera lens from a distance. A useful and complementary research method was therefore provided by case-study analysis. Multiple examples⁶ illustrate the various ways of dealing with industrial heritage and brownfield regeneration and remediation in a functional, ecological and poetic manner, some of which were visited and investigated as part of the research process. This research method was immediately linked to the coincident and complementary course *Aspects of Water Related Design*. The respective project analysis exercise focussed on the understanding of a site and how this translates into the key elements of the design and its relationship with the surrounding landscape.

Finally, as a way of organising all research results and bridge them towards the design process I chose the method of literary reflection. The findings are illustrated in the form of the imagined project; through writing one cannot only describe the project with all its technicalities but also reveal sensations and emotions that are imagined to be encountered upon a visit, as put forward by French landscape architect Gilles Clément⁷ who with his literary and design works acted as an instrumental reference throughout the different stages of my project development. At the same time, contradictions may become evident and design decisions can be re-evaluated in order to eliminate what is not needed and refocus on things worth retaining. The words are part of the design process and are continuously revisited and distilled. Thus, they are not only complementary to the architectural and landscape plan but a kind of guide that reconnects back to the project’s narrative and poetic dimension. Informed by the wealth of health-related findings, they propose a sensory experience of the path itself tying closely into the body and mind scale and exploring the essence of the project.

Relevance and Transferability

Topically, my project identifies itself with the overall studio theme and specific topic ‘North Sea – Landscapes of Coexistence’. On one hand it departs from the territorial context of the North Sea, and on the other hand, it addresses a subject very specific yet separate from place; my personal fascination health. Mental health-related issues are increasingly escalating throughout global society, not least caused by the immense impacts of globalisation, the current climate crisis and the changing dynamics on land and sea. Being one of the most urbanised waterbodies in the world, the North Sea and its surrounding coastal area are precedent to alarming ecological issues caused by human action throughout our industrial past and present. These include sea level rise, pollution, excessive resource extraction and subsequent loss of habitat for flora and fauna. Awareness has increased significantly during recent years and instigated a shift in politics and industry that goes in line with the present days’ rapid technological advances. This shift manifests for instance in the commencing energy transition, changing urban dynamics of growth and shrinkage caused by shifts in economic sectors, and a general reconsideration of ecological values and the importance of our (increasingly depleted) natural environment. On a territorial, urban and architectural level, this becomes evident among others in an accumulation of post-industrial left-over spaces, abandoned and deprived of their original use and meaning; voids within the metropolitan landscape. It will be a task of utmost importance to a generation of future architects and planners to address these realms and find new purpose and meaning for them.

My graduation project is directed at a number of those highly topical subjects that have gained

great significance in the current time of transition. Foremost, public health and more specifically mental health having grown to be a major concern in contemporary cities and societies. The close relationship between our well-being and our immediate environment is undeniable and has in recent years become subject to countless scientific studies and research within various fields including architecture and the built environment as well as social sciences, medicine, psychology, environmentalism and others. It is above all the measures⁸ connected to the current corona-pandemic that demonstrate the significance of available green space in order to maintain mental and physical well-being of the wider public. The impacts of the lack thereof may have repercussions on the national health systems that exceed and outlast the latest struggles.

As such, the topic of green infrastructure touches upon a current scientific and societal discourse and the project results anticipate to be of great relevance to potential future developments within both architectural research and practice. On the other hand, climate change and resulting transitions within the energy sector, industry and a growing awareness of pressing environmental issues call for a careful re-evaluation of the existing spatial order. The North Sea territory and in this context the city of Dunkerque are exemplary for these ongoing transitions. The industrial activities of the past have greatly shaped the place with the city centre and the port once forming a unified whole; socially, economically and spatially. Though, the vast expansions of the 20th century shifted the industrial centre westwards and drove a wedge between port and centre. Today a shrinking city⁹, Dunkerque is increasingly confronted with the voids of the old port many of which are afflicted with industrial leftovers both structural and in form of contamination. This phenomenon appears more and more across Europe and many other places in the world. With over fifty per cent of the global population living in cities, it is above all these metropolitan spaces that need to be addressed and become testing ground for new forms of living and for a healthier environment and city.

Positioning

With the synergy between environmental and human health at its core, the project points at a subject of immense actuality that deserves evermore attention as mental health problems become a common condition in western individualistic societies. Ecological and so-called ‘biophilic design’ are gradually establishing themselves in common architectural practice albeit often arguably owed to the inherent marketing value as developments remain highly reliant on market-driven demand through growth. Being located on a post-industrial site, my graduation project moreover acts as a case study – a laboratory – for bioremediation for the territory and its inhabitants alike. The shared concern for health has the ability to reunite and reidentify humans with flora and fauna; let them realise that they are really part of nature rather than being isolated from it. Economic benefits¹⁰ may only be evident through a long-term perspective. However, particularly in the case of Dunkerque, the anticipated coexistence attempts to heal more than just that lost connection; it rather strives to bring new life in a dwindling city.

Despite being a student of architecture, I largely position myself at the intersection between architecture and landscape. The integration of different knowledge fields and professions has become ever more important in times when the vast wealth of research exceeds the comprehension of a single mind. Likewise, architecture cannot be seen strictly as an isolated element but as an interaction between everyday needs and its natural environment. From an experiential point of view, different layers of meaning provide room for interpretation for a broader audience of potential users. In the case of my project, one visitor may just see a public green space for leisure; someone else might enjoy the sensual experience along the path while others understand the place as a reinterpretation of a post-industrial landscape, and again others appreciate the biotechnical component of remediation. As the environment becomes an active agent, the complexity of meaning makes the poetry of the project visible and accessible to a

⁸ The measures refer to recent lock-downs and contact restrictions across the globe in order to confine the spreading of the Novel Coronavirus (SARS-CoV-2).

⁹ The population of Dunkerque decreased by some 12.5 per cent in less than 45 years, from 99,776 in 1975 to an estimated 87,353 in 2017. Dunkerque in *citypopulation.de*, 2020.

¹⁰ Benefits are likely to result from reduced costs for public health care and nature conservation, abandonment of costly mechanical land remediation techniques, stimulation of local economies through new functions with more sustainable business models, as well as improved satisfaction of population through increased health, productivity and general happiness to name only a few.

much larger public, the underlying concept of rehabilitation of the body and mind is inherent in either experience as an automated body-response to the exposure to nature. This notion ties back to my most pressing concern as an architectural designer, to ultimately arrive back at the human scale

The extensive period of research and the subsequent design has taught me a great deal of where I would like to position myself in the professional field but has also opened up insights and knowledge that inspired my life beyond the architectural realm. I truly believe that research is an intrinsic and invaluable part of a successful and meaningful design and of great merit for the respective project and many more to come.

D Plant Catalogue

Petroleum Tolerant Plants¹

¹ As found in BP study undertaken in 2003: Tsao, K., and Tsao, *Analysis of Phytoscapes Species for BP Retail Sites*. BP Group Environmental Management Company, 2003 in K. Kennen & N. Kirk, *Phyto*, 2015.

Latin	Common	Variety evaluated	Vegetation Type
<i>Agapanthus africanus</i>	Lily-of-the-Nile		Perennial
<i>Arbutus unedo 'compacta'</i>	Compact Strawberry Bush		Shrub
<i>Bulbine frutescens</i>	Snake Flower	Orange	Groundcover
<i>Bulbine frutescens</i>	Snake Flower	Yellow	Groundcover
<i>Cassia corymbosa</i>	Senna		Shrub
<i>Cercis canadensis</i>	Eastern Redbud	Oklahoma	Tree
<i>Cistus × purpureus</i>	Purple Rock Rose	Firescaping Plant	Shrub
<i>Cytostoma callistegioides</i>	Lavender Trumpet Vine		Vine
<i>Diets irioides</i>	Fortnight lily	(Moraea) bicolor	Shrub
<i>Enonymus coloratus</i>	Purple Leaf Wintercreeper		Groundcover
<i>Ficus pumila</i>	Creeping/ Climbing Fig		Vine
<i>Fraxinus pennsylvanica</i>	Green Ash	Patmore	Tree
<i>Hedera helix</i>	English Ivy		Groundcover
<i>Heemerocallis hybrid</i>	Daylily, dwarf yellow	Happy Returns	Perennial
<i>Heemerocallis hybrid</i>	Daylily	Scarlet Orbit	Perennial
<i>Ilex cornuta</i>	Dwarf Burford Holly	Burfordii Nana	Shrub
<i>Ilex cornuta</i>	Carisa Holly	Carisa	Shrub
<i>Ilex vomitoria</i>	Yaupon Holly	Nana	Shrub
<i>Juniperus procumbens</i>	Juniper	Green Mound	Shrub
<i>Lagerstroemia indica</i>	Dwarf Crape Myrtle	Tightwad Red	Shrub
<i>Lantana monteridensis</i>	Creeping Lantana	New Gold	Groundcover
<i>Ligustrum japonicum</i>	Waxleaf Ligustrum	Texana	Shrub
<i>Liriope muscari</i>	Aztec Grass	Ophiopogon	Groundcover
<i>Liriope muscari</i>	Lily Turf	Giant	Groundcover
<i>Macfadyena unguis-cati</i>	Yellow Trumpet Vine		Vine
<i>Millettia reticulata</i>	Evergreen Wisteria		Vine
<i>Moraea bicolor</i>	Fortnight Lily		Shrub
<i>Moraea iridioides (D. iridioides)</i>	African Iris		Shrub
<i>Nandina domestica</i>	Heavenly Bamboo	Jaytee Harbor Belle	Shrub
<i>Nerium oleander</i>	Oleander		Shrub
<i>Phormium tenax</i>	New Zealand Flax	Wings of Gold	Shrub
<i>Photinia fraseri</i>	Red Tip Photinia		Shrub
<i>Picea pungens</i>	Dwarf Globe Blue Spruce		Shrub
<i>Pinus mugo pumilo</i>	Dwarf Mugo Pine		Shrub

<i>Pistacia chinensis</i>	Chinese Pistachio		Tree
<i>Pittosporum tobira</i>	Pittosporum	Variegata	Shrub
<i>Podranea riscaliana</i>	Pink Trumpet Vine	Sprague	Vine
<i>Pyrus calleryana</i>	Bradford Flowering Pear	Holmford	Tree
<i>Raphiolepis indica</i>	Indian Hawthorne	Snow	Shrub
<i>Rumobra adiantiformis</i>	Leather Leaf Fern		Perennial
<i>Sabel minor</i>	Palmetto Bush		Shrub
<i>Sedum mexicana</i>	Sedum		Groundcover
<i>Spiraea spp.</i>	Neon Flash		Shrub
<i>Strelitzia reginae</i>	Bird of Paradise		Shrub
<i>Tecomaria capensis</i>	Cape Honeysuckle	Orange	Shrub
<i>Thuja occidentalis</i>	Rheingold Arborvitae		Shrub
<i>Trachelospermum asiaticum</i>	Asian Jasmine		Groundcover
<i>Tulbaghia violacea</i>	Society Garlic		Perennial
<i>Veronica spicata</i>	Spiked Speedwell	Sunny Blue Border	Perennial
<i>Viburnum obovatum dentata</i>	Compact Walter's Viburnum		Shrub
<i>Viburnum odoratissimum</i>	Sweet Viburnum	Spring Bouquet	Shrub
<i>Washingtonia filifera</i>	California Fan Palm		Tree
<i>Yucca hesperaloe parvifolia</i>	Red Yucca		Shrub
<i>Yucca recurvifolia</i>	Yucca	Soft Leaf Yucca	Shrub

¹ As found in BP study undertaken in 2003: Tsao, K., and Tsao, *Analysis of Phytoscapes Species for BP Retail Sites. BP Group Environmental Management Company*, 2003 in K. Kennen & N. Kirk, *Phyto*, 2015.

Petroleum Intolerant Plants¹

Latin	Common	Variety Evaluated	Vegetation Type
<i>Abelia × grandiflora</i>	Glossy Abelia		Shrub
<i>Abelia mosanensis</i>	Bridal Bouquet Abelia	Monia	Shrub
<i>Abutilon hybridum</i>	Pink Flowering Maple	Roseus	Shrub
<i>Acer rubrum</i>	Red Sunset Maple	Frank's Red	Tree
<i>Arecastrum romanzoffianum</i>	Queen Palm		Tree
<i>Artemisia spp.</i>	Wormwood	Powis Castle	Shrub
<i>Asparagus densiflorus</i>	Asparagus Fern	Sprengeri	Perennial
<i>Aspidistra elatior</i>	Cast Iron Plant		Perennial
<i>Berberis thunbergii</i>	Barberry	Crimson Pygmy	Shrub
<i>Bougainvillea cvs.</i>	Bougainvillea		Vine
<i>Buxus microphylla</i>	Boxwood	Winter Gem	Shrub
<i>Carissa macrocarpa</i>	Natal Plum	Fancy	Shrub
<i>Cassia splendida</i>	Senna	Golden Wonder	Tree
<i>Cedrus deodara</i>	Golden Deodar Cedar	Aurea	Tree
<i>Chamaecyparis pisifera filifera</i>	Dwarf Gold Thread Cypress		Shrub
<i>Cornus kousa chinensis</i>	Chinese Dogwood		Tree
<i>Cotoneaster apiculatus</i>	Cranberry Cotoneaster		Shrub
<i>Cuphea hyssophylla</i>	Mexican Heather		Perennial
<i>Cycas revoluta</i>	King Sago Palm		Tree
<i>Delosperma cooperi</i>	Yellow Ice Plant	Aurea	Groundcover
<i>Distictis buccinatoria</i>	Scarlet Trumpet Vine		Vine
<i>Elaeagnus × ebbingei</i>	Ebbinge's Silverberry		Shrub
<i>Escallonia × exoniensis</i>	Pink Princess Escallonia	Frades	Shrub
<i>Euryops pectinatus</i>	Green-Leaved Euryops	Viridis	Shrub
<i>Gardenia jasminoides</i>	Gardenia	August Beauty	Shrub
<i>Gelsemium sempervirens</i>	Carolina Jessamine		Vine
<i>Grevillea × Noell</i>	Noell Grevillea		Shrub
<i>Hemerocallis hybrid</i>	Daylily	Stella d'Oro	Perennial
<i>Jacaranda mimosifolia</i>	Jacaranda		Tree
<i>Juniperus chinensis</i>	Chinese Juniper	Spartan	Shrub
<i>Juniperus chinensis</i>	Chinese Juniper	Sea Green	Shrub
<i>Juniperus communis</i>	Alpine Carpet Juniper	Mondap	Shrub
<i>Juniperus horizontalis</i>	Andorra Juniper	Youngstown	Shrub

<i>Juniperus scopulorum</i>	Gray Green Juniper	Gray Gleam	Shrub
<i>Lagerstroemia indica</i>	Crape Myrtle	Raspberry Sundae	Tree
<i>Lavendula dentata</i>	Toothed Lavender	Goodwin Creek Gray	Shrub
<i>Leucophyllum frutescens</i>	Texas Sage	Compactum	Shrub
<i>Limonium perezii</i>	Sea Lavender		Perennial
<i>Loropetalum chinensis</i>	Chinese Loropetalum	Rubrum 'Purple Majesty'	Shrub
<i>Maesadylenea unguis-cati</i>	Yellow Trumpet Vine or Cat's Claw		Vine
<i>Magnolia grandiflora</i>	Southern Magnolia	Little Gem	Tree
<i>Mabonia aquifolium</i>	Oregon Grape Holly	Compacta	Shrub
<i>Mabonia bealei</i>	Leatherleaf Mahonia		Shrub
<i>Nandina domestica</i>	Heavenly Bamboo, dwarf	Firepower	Shrub
<i>Olea europaea 'Mowbray'</i>	Fruitless Olive	Majestic Beauty	Tree
<i>Osmanthus fragrans</i>	Sweet Olive		Shrub
<i>Perovskia atriplicifolia</i>	Russian Sage		Shrub
<i>Picea abies</i>	Nest Spruce	Nidiformis	Shrub
<i>Plumbago auriculata</i>	Plumbago	Imperial Blue	Shrub
<i>Prunus cerasifera</i>	Purple Leaf Plum		Tree
<i>Rosa banksiae</i>	White Banksian Rose	Alba Plena	Vine
<i>Rosmarinus officinalis</i>	Rosemary	Benenden Blue	Shrub
<i>Rosmarinus officinalis</i>	Huntington Carpet Rosemary		Shrub
<i>Salvia leucantha</i>	Mexican Bush Sage	Santa Barbara	Shrub
<i>Spiraea cantoniensis</i>	Spiraea	Double Bridal Wreath	Shrub
<i>Syringa meyeri</i>	Dwarf Korean Lilac	Palibin	Shrub
<i>Taxus × Media</i>	Spreading Japanese Yew		Shrub
<i>Thuja occidentalis</i>	Emerald Arborvitae		Shrub
<i>Trachelospermum jasminoides</i>	Star or Confederate Jasmine		Vine
<i>Viburnum rhytidophyloides</i>	Allegheny Viburnum		Shrub
<i>Washingtonia robusta</i>	Mexican Fan Palm		Tree

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