# REDESIGNING BISPEENGBUEN AS A DRIVING FORCE FOR REGIME ADJUSTMENTS OF URBAN NATURE IN COPENHAGEN

AALBORG
UNIVERSITY

STUDENT REPORT

(SOURCE: OWN PICTURE)

# TITLE PAGE

**TITLE OF PROJECT:** Redesigning Bispeengbuen as a Driving Force for Regime Adjustments of Urban Nature in Copenhagen

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# ABSTRACT

In urban development, in Copenhagen, the iconic construction of Bispeenbuen is facing a coming restoration which has led to an initiation of a design process in which alternatives are presented as a transformation of the arch and city district. The arch represents a grey infrastructure regime in which housing and transportation have been prioritized over urban nature. It has been questioned whether cities have the possibility to combat the current climate and biodiversity crisis. However, the academic literature has revealed a need for focusing on value creation in working with Nature-based Solutions through imaginaries and scenarios.

Therefore, this master thesis was conducted to challenge the field of Nature-based Solutions and urban nature has created a framework for analyzing the possibilities of creating regime adjustments. Through an empirical investigation of regime incumbent actors at the consultancy Sweco, a conceptualization of a management tool is proposed in the Nature Wheel. In conclusion, using the Nature Wheel on the transformation of Bispeengbuen has shown how it is possible to design for regime adjustments through the use of socio-technical experiments in the coming transformation of Bispeengbuen. With these socio-technical experiments, practitioners working with Nature-based Solutions in Copenhagen can learn to exploit rigid regime structures to create regime adjustments.

# ACKNOWLEDGEMENT

This thesis is written as the final project on the Master's programme in Sustainable Design Engineering, class 2020-2022 by Camilla Voergaard Kjer and Sabine Bisgaard Fredberg.

The authors of this thesis would like to use the opportunity to express to whom we are grateful, for contributing to this project.

Firstly, we want to raise a special thanks to Camilla Hvid and Amalie Rørbæk from Sweco for allocating time and resources to collaborate with us on our final project and for participation in ongoing feedback sessions and design processes, sharing their invaluable insights. Also, thanks to the employees at Sweco who took the time to contribute to our project through interviews and workshops. Thank you to the departments of 'Water and Climate' and 'Architecture and City Planning' for welcoming us into the office space.

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We would also like to thank our fellow students and soon to be graduates, whose dedication to Sustainable Design Engineering inspires us. Thanks for the feedback that you have provided to our project throughout the semester.

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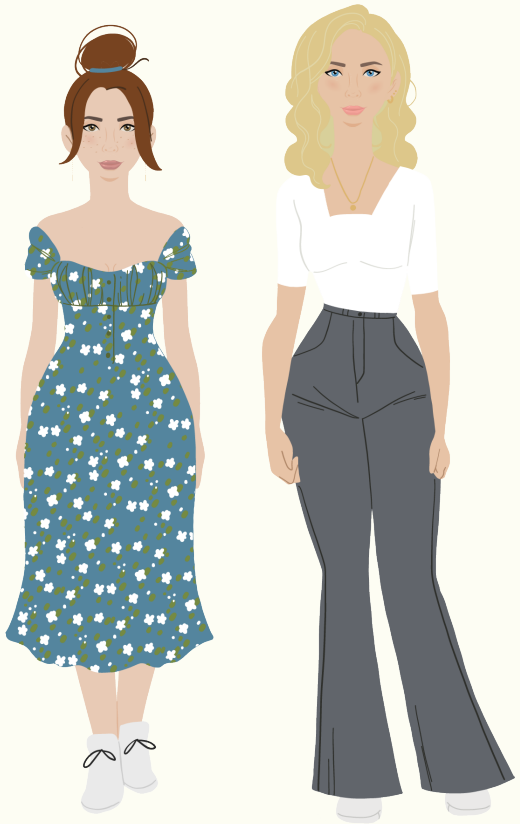

# REPORT STRUCTURE

This thesis is divided into the following ten sections: *Introduction, Research Strategy, Case – Bispeengbuen, State of the Art, Methods Applied, Theoretical Framework, Analysis, Conceptualisation, Discussion* and *Conclusion*. This division intends to provide the reader with a clear and easy overview of the project, *see illustration 1* for a full overview of the sections. As visualised in illustration 1 the sections are divided into four main chapters i.e., *Opening, Scope, The Project* and *Ending*. The entry into a new section will be indicated with a bold font and a cover page. In addition, each section will start with a short opening to give a brief description of the following content.

**1.0 INTRODUCTION:** The first section seeks to address the problem under investigation and unravel some of the complexities tied to the area of interest. Here the research question is defined along with an outline of the approach undertaken to complete the project. The purpose of this part is to make the reader understand the project and the context that makes this project relevant.

**2.0 RESEARCH STRATEGY:** The second section is meant as an explanation of how the project aims to answer the proposed research question. This is done by a description of the applied design approach, our profession as sustainable design engineers and our take on sustainability within this thesis. Furthermore, a dissection of the research question to reveal the underlying sub-questions that arise when addressing the research question.

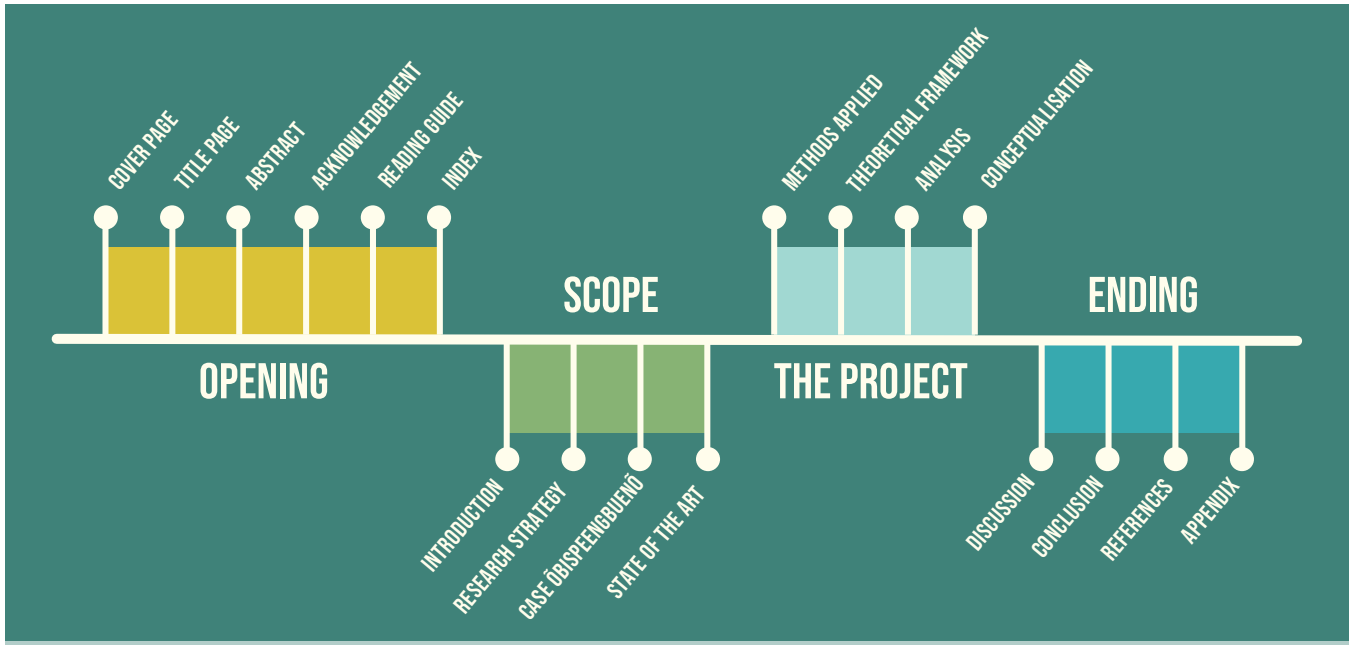


ILLUSTRATION 1:
'THE REPORT STRUCTURE'. OWN ILLUSTRATION.

**3.0 CASE - BISPEENGBUEN:** The objective of the third section is to describe our choice of case and explain why and how it is relevant. The case of Bispeengbuen demonstrates a practical example of the academic topic investigated in this thesis. Thus, this section provides historical coverage of the development of the area up until today, leading to the redesign stated in the conceptualisation.

**4.0 STATE OF THE ART:** This section provides a framework for the project by defining the terms used throughout the report. It covers an in-depth elaboration of the theme of nature and the related concepts of biodiversity, Nature-based Solutions and Nature-based Thinking providing a structure and guide for the subsequent analysis. This is leading up to an exploration of the academic field concerning urban nature as an undefined term when dealing with nature in urban development.

**5.0 METHODS APPLIED:** The fifth section is intended to provide the reader with the methods utilised through the project. The methods applied help in framing the concept based on the body of knowledge gathered around the subject. The methods are distinct in different phases of the project categorized as empirical methods and design methods.

**6.0 THEORETICAL FRAMEWORK:** This section presents the theoretical framework used to define the used theory of Multi-Level Perspective in identifying the current regime of urban nature. It is explained how the theory is applied in this thesis supported by the notion of junctions as a catalyst for discovering possible regime adjustments.

**7.0 ANALYSIS:** This seventh section presents the analytical findings of the project. First, the current regime of urban nature is established followed by an investigation of problems and barriers relating to working with Nature-based Solutions from a consultancy perspective. This is followed by a workshop focused on the barriers found. Additionally, two relevant case studies are viewed in a comparable analysis to lay the foundation for the subsequent conceptualisation.

**8.0 CONCEPTUALISATION:** This section explains how the knowledge and research obtained through the former sections are being synthesised into a final concept. The section starts with a presentation of the concept and is followed by an example of how it can be used in the form of a redesign of Bispeengbuen. The conceptualisation can thus be seen as a result of the previous analysis and is a knowledge foundation for consultancies like Sweco to further develop upon.

**9.0 DISCUSSION:** This section provides a critical view of the project and concept and contemplates the learnings that the project has provided. This is done by a reflection of the case of Bispeengbuen, evaluating its characteristics and potential in creating regime adjustments. Furthermore, discussing how the project is contributing to Sustainable Design Engineering and how it may be applied to consultancies.

**10.0 CONCLUSION:** The last section concludes the thesis in a conclusion of the project. The project is viewed in its answer to the research question and the derived findings of the empirical investigations. Additionally, a series of suggested research areas are listed as an extension of this research. Lastly, the strengths and limitations of the conducted project are summarised.

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# 1.0

# INTRODUCTION

The effect of nature and the natural environment have been scientifically shown to have a positive effect on our mental health and well-being as humans (Hojniak & Hvid, 2021). Nevertheless, most modern cities in Europe are still designed around the promise of accessibility and mobility dominated by grey infrastructure, which contradicts the recommendation of a minimum of 9 m2 of green open space per inhabitant proposed by the WHO (Russo & Cirella, 2018). Additionally, cities have globally grown by 67.800 km2 (Melchiorri et al., 2019) an area equal to that of Ireland over the last 25 years (European Commission, 2019). The consequences of this urban sprawl have not only led to a significant decrease in the mental health and well-being of inhabitants around Europe but also a loss of biodiversity (Hojniak & Hvid, 2021).

As cities and urban populations continue to rapidly expand, there is more than ever a need to rethink how public spaces are being used and experienced (European Commission, 2019). Even though most of the bigger cities in Europe are already doing an effort in an attempt to green their cities (e.g., Switzerland is the frontrunner with their green roofs in Basel (Brenneisen & Baumann, 2016)), the number of inhabitants is simultaneously growing in a pace that overtakes the rate of green areas. The result is that the greening is not happening fast enough compared to the expansion of the city borders. According to studies it is estimated that public spaces take up 2-15% of land in city centres in Europe (Hojniak & Hvid, 2021). This underlines the need for making the cities greener, by emphasising designing the future public spaces in a quality that to a greater extent accommodates the health and well-being of the people living in cities while prioritizing the restoration of biodiversity. One example of doing so is the 3-30-300 approach suggested by Cecil Van Konijnendijk, professor in Urban Forestry at the University of British Columbia. The approach indicates a standard for urban development meaning that 3 treetops must be visible from all homes, 30% tree canopy or vegetation cover must be in all neighbourhoods and 300 meters is the maximum distance to the nearest green space (Hojniak & Hvid, 2021).

According to studies, there is an unquestionable connection between a person's mental health and their proximity to natu-

re. A person living closer than 50 metres to a green area will on average visit the area between 3-4 times a week compared to a person living 1000 metres from a green area, this person will approximately visit the green area only once a week (Hojniak & Hvid, 2021; Skov & Landskab et al., 2008). While the negative impact on mental health is a critical effect of the lack of green spaces in cities, this deficiency also contributes to the increasing frequency and severity of environmental hazards and climate change e.g., heat, cloudburst, air pollution and light pollution (WWF International, 2021). These problems are seen as symptoms of the current global climate crisis where phenomena like floods, drought and forest fires are consequences of increased temperatures and extreme weather. This relates to the exploitation of the earth system manifested in the definition of the planetary boundaries framework. The framework defines the emergent scarcity of resources through nine planetary boundaries emphasising the need for re-establishing the balance between human societies and the earth system (i.e., setting the boundaries for how humanity can continue to develop for generations to come) (Steffen et al., 2015; Stockholm University & Beijer Institute of Ecological Economics at the Royal Swedish Academy of Sciences, n.d.). According to Rockström et al., 2009 we are approaching tipping points that can relate to the above-mentioned climate-related issues. To mitigate the climate crisis the world leaders have agreed on several initiatives that seek to create a consensus on a high level acknowledging the climate-related problems and the fact that we need to act upon this to ensure our common future on planet earth. Among these are the Paris Agreement (United Nations, 2022), the United Nations' 17 Sustainable Development Goals (SDGs) (Department of Economic and Social Affairs, n.d.), and the Convention on Biological Diversity (CBD – also referred to as biodiversity) (United Nations, 1992). Despite the wide range of issues (mental health, climate crisis and biodiversity crisis) tied to the lack of nature and green spaces in European cities the problem addressed in this thesis will focus on how biodiversity can play a role in the future work of urban nature described through a project in Copenhagen. But first, we need to understand how we ended up designing cities with less to no urban nature. The answer might be hiding in the past.

## 1.1 PROBLEMATISATION

The bond between humans and nature has always been present, but during the last decades, this bond seems to have faded by our constant urge for managing and controlling nature (Georg, 2017). For many years humans and nature co-existed in a mutual relation during the hunter-gatherer period. Nature was here seen as an essential part of our existence but even then, we had the urge to interfere with nature to promote desirable vegetation (National Geographic Society, n.d.). This urge for managing and controlling nature has only increased leading up to the industrialisation, where a detachment from nature occurred when we began to see areas of nature as useful areas for the expansion of societies (Røpke, 2017). Since then, the distinction between nature and cities has become sectionalised to such a degree that there is little to no interaction. A critique of this is the hypothesis of biophilia which states that humankind genetically has an innate connection with nature and a love for all living beings (Rogers, 2021). The notion of biophilia is based on a biological connection meaning that humans and nature are part of the same system.

Seen from this perspective it is thereby evident that mental health and well-being are negatively affected when we distance ourselves from nature in cities. The biophilic approach is based on an ecological view that favours the principles of biodiversity. Through this approach, it is possible to re-establish our bond with nature to restore both lost and needed ecosystems (Rockström et al., 2009; Rogers, 2021).

The loss of ecosystems and natural areas is an example of the end of an era and a shift from the Holocene epoch to the Anthropocene epoch. The first geological period where humans are known to have roamed the face of the planet is the Holocene epoch, originating from 10.000 BC until now (Pavid, n.d.). However, the human inference on our planet has resulted in a suggestion to re-evaluate the understanding of our current geological period. The transition between the two periods is said to be in the middle of the 1900s, which marks the end of the industrialisation in the western world and made the foundation for modern society and urbanisation (Carrington, 2016; Pavid, n.d.). The Anthropocene epoch being the present is gaining more and more scientific attraction due to human interference on the face of the earth on a global scale. It is a way of seeing the human species as superior and several environmentalists are using the term to stress how the survival and well-being of humanity seem to collide with the life-sustaining systems on earth (Urhammer, 2017). The development of human settlements has changed, and is still, changing the conditions on the planet and climate change and the loss of biodiversity are regarded as a result of these activities.

Thus, the past has shown that the relation between nature and humans seems to have been increasingly affected by the rapidly growing urbanization caused by the industrialisation. The possibilities offered by cities (e.g., job opportunities, educational possibilities, accessibility to shopping, cultural experiences etc.) (Rogers, 2021) mean that they are growing and already habited by 55% of the human population while it is estimated that this number will increase upwards of 68% by 2050 (United Nations, 2018). This increase in population in cities has extended the prioritisation regarding urban development meaning that nature has suffered under the grey infrastructure. The result has been a separation, that in many cases seems involuntary and driven by an economic force. Additionally, the lack of green areas seems to have reached a point where citizens of Copenhagen are demanding more nature (Københavns Kommune Teknik- og Miljøforvaltningen, 2015a), which is a direct result of the rapid expansion of the city, where nature has been regarded as an afterthought and 'icing on the cake' (Randrup et al., 2020).

## 1.2 SWECO – EUROPE'S LEADING ENGINEERING AND ARCHITECTURE CONSULTANCY

At the beginning of the project, we were given the opportunity to work in close collaboration with Sweco, Europe's leading engineering and architecture consultancy, hence the project is written from the viewpoint within the company. Sweco has a broad portfolio spanning from architecture and urban development, vision projects, construction, and sustainability to digitalization projects. The company consists of roughly 18.000 architects, engineers and specialists that together with their clients work towards

"transforming society together" (Sweco, 2022e). Sweco defines themself as consultants that together with their clients co-create solutions to address urbanization by planning and designing the sustainable communities and cities of the future: "We believe in creating the best solutions together. We have a strong local presence in order to offer our customers the combination of global expertise and local understanding of their business and context" (Sweco, 2022f). During the past years, Sweco has initiated a variety of different projects to further strengthen the company's sustainability agenda including certifications (e.g., BREEAM and DGNB), Life Cycle Assessments, university collaborations and using the SDGs as a valuable tool toward a more sustainable practice when working with urban development (Sweco, 2022b). Sweco is currently improving on incorporating the SDGs into their work strategies e.g., by conducting workshops when doing projects with external partners. During these workshops, the aim is to identify relevant SDG targets and define possible indicators customised to sustainably manage the project process. The SDG framework, thus, provides Sweco, with a tool that enables the interplay between different areas of interest by enhancing the sustainability potential of their projects (Hildebrandt, 2017).

## 1.3 CHALLENGING THE CURRENT STATE

In an attempt to break away from the current urban grey infrastructure alternative initiatives like Nature-based Solutions are proven to be a fresh approach to rethinking infrastructure developments (Cohen-Shacham et al., 2019). The core of the approach relies on a mindset applying solutions that enforce the functions of the earth system as Nature-based Solutions are defined by the European Commission as: "... solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions" (European Commission, n.d.). One radical example of a Nature-based Solution is provided by the Italian architectural firm Stefano Boeri Architetti and their concept of vertical forestry (Boeri et al., 2014). Nature is here an integrated part of the urban development since the idea is to promote the coexistence of architecture and nature in urban areas (Stefano Boeri Architetti, n.d.). Thus, to apply the concept of Nature-based Solutions to this project the focus is on how the concept is compatible with biodiversity as a means to ensure diverse urban nature. Hence, to investigate the interlink between biodiversity and Nature-based Solutions in cities this thesis uses the case of Bispeengbuen, in Copenhagen, to suggest how diverse urban nature can be achieved. To assist this issue at hand we, therefore, propose the following research question:

*"How can Nature-based Solutions be reinforced in a redesign of Bispeengbuen and challenge the current regime of urban nature."*

To answer the proposed research question, the project will start by acknowledging the current regime and the dissonance that lies in the notion of urban nature. The dissonance is a symptom of a missing terminology when addressing nature in cities. Today's lingo is based

on borrowed well-known terms e.g., park, forest and garden that already have a defined meaning (Faivre et al., 2017); however, the new use has not undergone a matching of expectations and this undefined vocabulary can thus be seen as a field for possible regime adjustments that can form the trajectory for Nature-based Solutions to become mainstream (Faivre et al., 2017; Quitzau et al., 2013). The project, therefore, takes its outset in an investigation of how nature is described in the literature leading to an understanding of the current regime. Afterwards, these learnings will provide a proposal for a redesign of Bispeengbuen that exemplifies a reinforcement of a Nature-based Solution. This master thesis is thereby suggested as a knowledge foundation for Sweco and other consultancies to implement and act upon in their current practices regarding urban development and should be seen as a contribution from Sustainable Design Engineer practice making a bridge between the academic field and consultancies.

# 2.0 | RESEARCH STRATEGY

(SOURCE: OWN PICTURE)

To set the scene this section will provide the reader with a description of how the project aims to answer the proposed research question and present the used design approach to provide an insight into how the design process was obtained. Furthermore, accounting for the profession of Sustainable Design Engineering and our take on sustainability to position ourselves in the project and provide the reader with an understanding of the standpoint from which the study was performed. The section will start by describing the design process, then move on to the description of our profession as Sustainable Design Engineers and how sustainability is interpreted in this project, and end with a dissection of the research question to describe the complexity that emerges when investigating the area of interest. The elaboration of how the research question is answered will, however, first be unfolded and described in the following sections of the report. This section will thereby function as an overview of the performed design process and underlying strategy of the project.

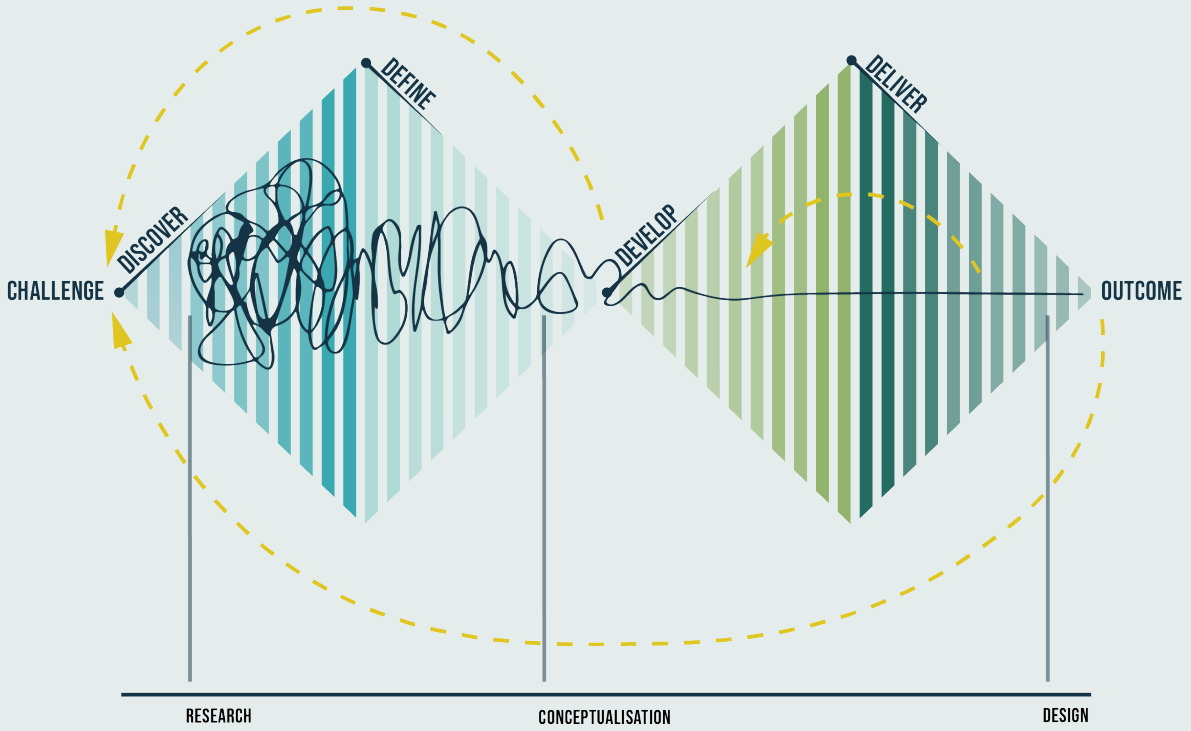



ILLUSTRATION 2:
'THE DESIGN PROCESS' IS ILLUSTRATED BY COMBINING THE DOUBLE DIAMOND WITH THE DESIGN SQUIGGLE. OWN ILLUSTRATION.
INSPIRED BY THE DESIGN COUNCIL (2022) AND DAMIEN NEWMAN (N.D).

## 2.1 DESIGN PROCESS

The project is inspired by and follows the Double Diamond model presented by the British Design Council (Design Council, 2022) in a combination with the Design Squiggle by Damien Newman (n.d.). Combining the diverging and converging processes of the Double Diamond with the Design Squiggles illustrative phases of a design process (moving from noise and uncertainty toward a problem definition and a conceptualization before ending in a design proposal) exemplifies the iterative process that the project underwent during the allocated time, *see illustration 2* above.

Even though both the Double Diamond and the Design Squiggle represent a somewhat linear design process the project follows the course of defining the problem area through an undetermined research phase at the beginning of the project which takes multiple iterations resulting in a more circular and agile process. The disorganized nature of the Design Squiggle thus illustrates the intricate process that also lies in the first part of the Double Diamond and provided us with the approach to combat prejudice and the tendency to jump to solutions.

## 2.2 SUSTAINABLE DESIGN ENGINEERING

The foundation of our profession as Sustainable Design Engineers is rooted in a combination of classic engineering, design, and anthropology (Aalborg Universitet, 2020), *see illustration 3*. The DNA of our educational origin is thereby based on a combination of approaches from the three different disciplines. This interdisciplinarity affects the way we access and understand a problem when working with complex projects. According to Clausen et al., (2009), the competencies and self-understanding of classic engineering rely on technical aspects like product development and construction combined with the creative work of innovation. Anthropologists on the other hand are focused on the scientific study of humanity by observing and understanding the various aspects of the human experience. This is done using a holistic approach to problem-solving, starting with identifying a problem, to then understanding the relationship between all the parts of the problem (Hill, 2022). When combining the technical aspect of engineering with the social aspects of anthropology we get the so-

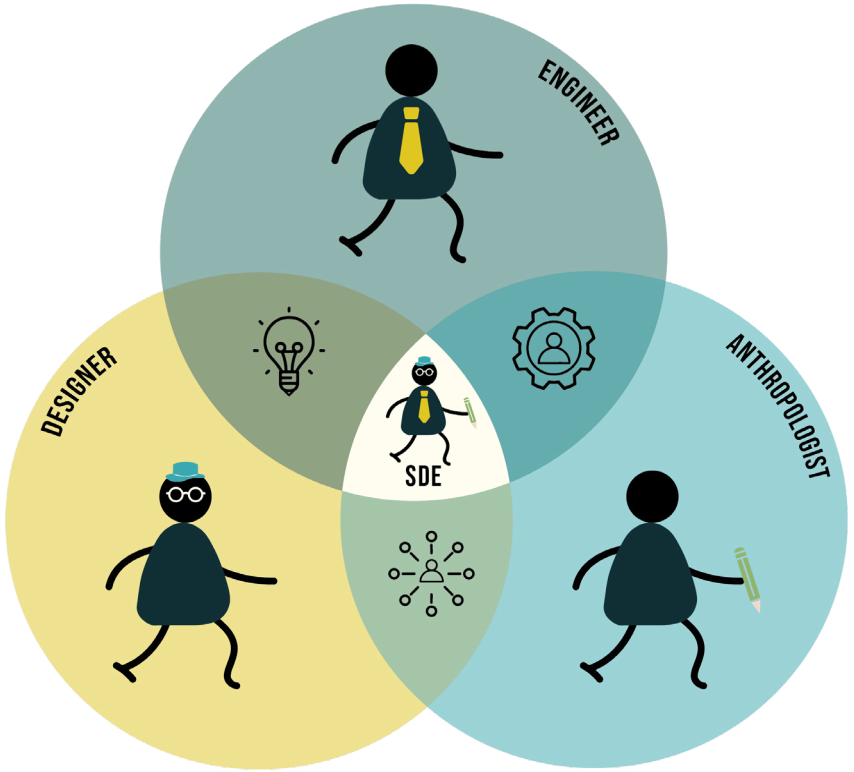



ILLUSTRATION 3:
'SDE DIMENSIONS', ILLUSTRATING THE THREE DISCIPLINES OF ENGINEER, DESIGNER, AND ANTHROPOLOGIST THAT FORM THE FOUNDATION OF OUR PROFESSION AS FUTURE SUSTAINABLE DESIGN ENGINEERS. OWN ILLUSTRATION.

cio-technical approach emphasizing that *"the design and performance of any organisational system can only be understood and improved if both 'social' and 'technical' aspects are brought together and treated as interdependent parts of a complex system."* (University of Leeds, 2022) The socio-technical approach thus includes interdisciplinary components from social science and technology studies and provides us with the capability of approaching a system (or problem) in its entirety. Additionally, the last and third discipline concerning the designer, Carlgren et al., (2016) account for a designer being a profession that is taught to approach problem-solving with the use of ideation, visualizations, rapid prototyping, and customer ethnography. Thus, the connection between the engineer and the designer is the creative and innovative approach to a project. Creativity and design practices are vital tools for exploring possible solutions to a problem but can be addressed in different ways. Where an engineer would design for functionality, a designer would focus on the aesthetics and useability of the design (Clausen et al., 2009). Lastly, the link between the anthropologist and the designer is found in the focus on humans and their practices. Though there is a difference in the way these disciplines interact with humans, whereas the designer involves humans in their design process to co-create and get feedback, the anthropologists would make use of observations and study practices from a distance (Carlgren et al., 2016; Hill, 2022). Illustration 3 is thus an attempt to empathize that within the field of Sustainable Design Engineering we are operating with a socio-technical approach combined with the creative mindset of the design discipline making us a hybrid in a transdisciplinary field. The addition of sustainability not only adds the frame and boundaries to which our profession can unfold but also address the imminent wicked problems that our world is facing.

## 2.3 OUR TAKE ON SUSTAINABILITY

To some degree, the term sustainability is still a fluid term, though this paragraph aims at explaining our take on sustainability throughout the project. Sustainability is usually referred to as the three-pillar conception (social, economic, and environmental). Despite the last decades rise in publications within the field of sustainability, Purvis et al. (2019) acknowledge that the concept still: *"… remains an open concept with myriad interpretations and context-specific understanding"* (Purvis et al., 2019, p. 681). Taking this perspective, the study performed by Purvis et al. (2019) finds that the origin of the pillars is a product of the origin of sustainability as a concept. Therefore, the concept of sustainability can be seen as a concept containing different levels of abstraction. Since our project is written in collaboration with the consultancy Sweco our take on sustainability is based on how initiatives like the Sustainable Development Goals (SDGs) can contribute to enhanced sustainability when dealing with Nature-based Solutions and urban nature in an interdisciplinary field.

As mentioned in the introduction the current political point of orientation on sustainable development is the initiatives of the Paris Agreement and the SDGs, which are rooted in the Brundtland Report from 1987. The Brundtland Report defines sustainable development as being: *"… development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987, p. 16). The initiatives of the Paris Agreement and the SDGs thus reflect the global climate crisis with national, regional, and to some degree local goals that a broad array of world leaders have committed to (UNDP's nordiske kontor i Danmark et al., n.d.). The SDGs succeeded the Millennium Development Goals in 2016 as the global strategy for future development. With their introduction, a set of 169 targets and a preliminary list of 330 indicators followed, however, they had a mixed welcome. In the years up until the reveal and acceptance of the SDGs, it was evident in the scientific community that the indicators would play an important role in operationalizing the coming work (Hák et al., 2016). Consulting engineers, among these Sweco, and Statistics Denmark collaborated on defining indicators that could relate specifically to Denmark and be measured through their existing surveys and methods. The task was commissioned by the Danish Parliament and the result was a comprehensive list of 197 indicators published in a report entitled *´Make the Sustainable development goals to our goals – 197 Danish measurers for a more sustainable world´* (Sweco, 2022d). The report defines a common frame of reference for coming actions in the industry. Having measurable indicators is tied to the fairly recent goal of reducing Danish emissions by 70% before 2030 (Socialdemokratiet et al., 2019). This commitment ties into the international actions on climate change and the Paris Agreement. Contrary to the SDGs the Paris Agreement is not an action itself but a context for action, meaning that the mechanism of the Paris Agreement is to continuously set higher targets for climate progress thus inspiring countries to constantly improve. According to Hoffmann (2022), the Paris Agreement is working as intended, this is evident in the 70% reduction goal agreed by the Danish Parliament, but we still have a long way to go due to the lack of an appertaining plan of action. As a consulting company Sweco uses the SDGs as a framework to strengthen the company's sustainability agenda. The goals used for many of their projects are goals 6, 11, 13, 14, and 15 (Sweco, 2022c), where the SDGs 11, 13, and 15 often prove most relevant when addressing urban development. SDG 11 ("Make cities and human settlements inclusive, safe, resilient and sustainable"), and specifically target 11.3 focuses on enhancing inclusive and sustainable urbanization, meaning that efficiency of land use is key in the conflict of the ratio of land consumption rate compared to the population growth rate (United Nations, 2016a). SDG 13 ("Take urgent action to combat climate change and its impact") specifies the need to uphold the goals of the Paris Agreement, limit global warming to 1,5 degrees above preindustrial levels, and ensure a reduced total greenhouse gas emission per year (United Nations, 2016b). SDG 15 ("Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"), and specifically target 15.5 has an emphasis on reducing the degradation of natural habitats and biodiversity and to prevent the extinction of

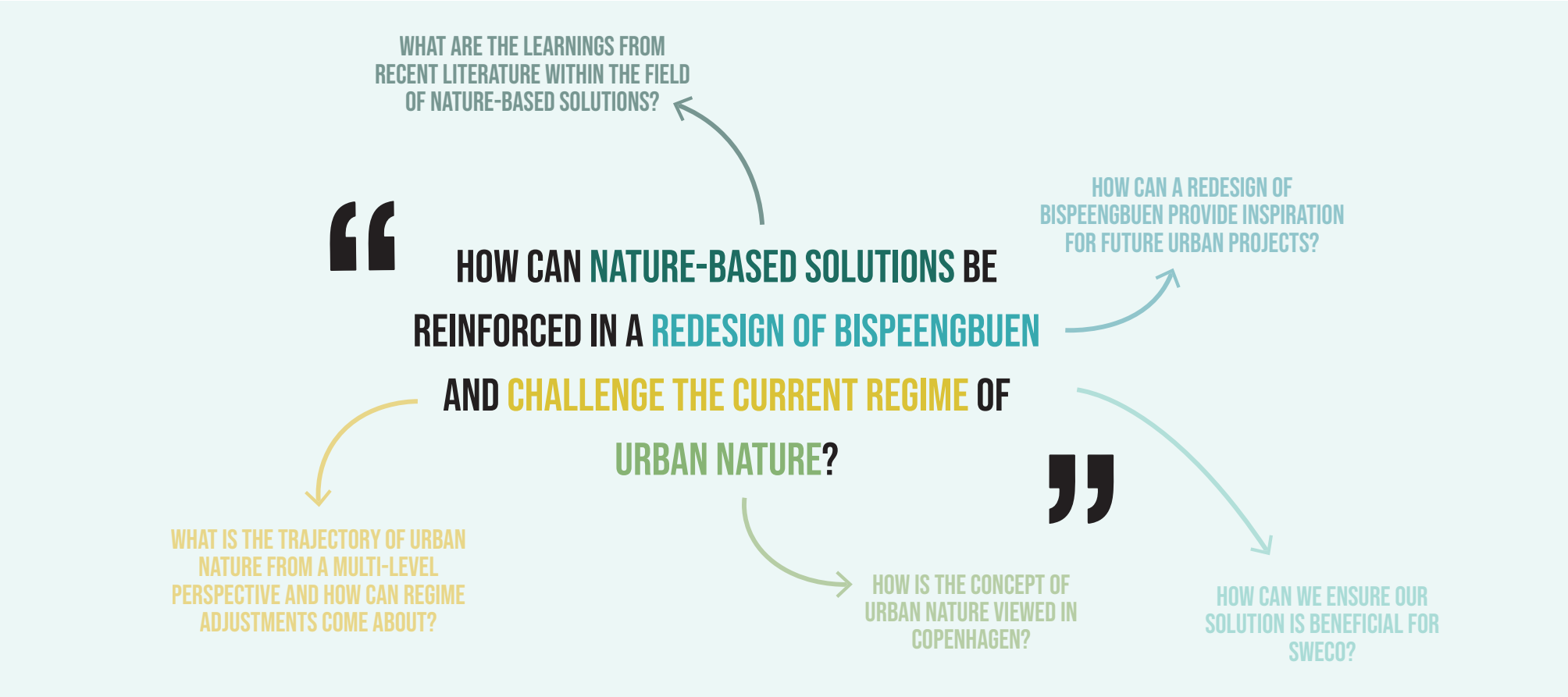



ILLUSTRATION 4:
'DISSECTION OF THE RESEARCH QUESTION AND THE EMERGING SUB-QUESTIONS'. OWN ILLUSTRATION.

threatened species (United Nations, 2016c). Our point of departure is thereby using the SDGs as a reference point when dealing with Nature-based Solutions from a consultancy perspective. In doing so the case of Bispeengbuen is used to show how cities and urban development have the potential to reverse land degradation and halt biodiversity loss.

## 2.4 DISSECTING THE RESEARCH QUESTION

As part of conducting the study, the point of departure of the research strategy is the research question. The research question has been formulated with several appertaining sub-questions that have been identified to underpin the complexity of the project visualized in *illustration 4*. With this research question, the objective of the thesis is to provide a report that can serve as inspiration to consultancies to reinforce Nature-based

Solutions in urban development. In doing so to understand the underlying aspects of Nature-based Solutions and identify whether the configuration of the current regime within urban nature, allows for a more diverse incorporation of nature in Copenhagen.

Throughout the thesis, the sub-questions are guiding the analysis and provide clear intention in each section. From this perspective, the project has been defined by the questions that, thus, sets the stage for the research. Since the project is concerned with a redesign of Bispeengbuen the thesis will firstly investigate the historical traits and current vision of the area to serve as a point of reference for the later conceptualization by using the proposed concept/tool. But before moving into the actual redesign a 'State of the Art' will be provided to combine knowledge and learnings from the field within urban nature and the related concepts of biodiversity, Nature-based Solutions and Nature-based Thinking. A knowledge and framing of the concept of nature and the societal constructions in which it appears are moreover investigated to narrow down the concept of nature in the definition of urban nature. From this framing, the theoretical framework will shed light on urban nature as socio-technical systems that can challenge path-dependent trajectories through regime adjustments. Using Multi-Level Perspective provides an approach to understanding the dominant regime, in this case, the nature in cities that are characterized by grey infrastructure and aesthetic planned nature. This project thus seeks to look at how this can be challenged by understanding the underlying structures of urban development including the actors within the field of urban development whom this report is intended for. Hence the thesis is a design example of a paradigmatic case since it breaks with the existing practice of car-dominated grey infrastructure.

The foundation of the empirical data of this project is provided by a collaboration with the engineering company Sweco enabling access to actors within different professional occupations. Being situated in their office gave opportunities for insightful observations. As Sweco does not work on the visions and project development of Bispeengbuen their expertise is based on general knowledge of urban development without a specific focus on the location. Since Sweco has not been involved in defining the scope of the project it is possible to remain impartial concerning their contribution and knowledge. Authorities within the municipality of Frederiksberg were furthermore consulted about how they understand the project between actors and the current ideas and discourse of Bispeengbuen. This project constellation provides a bridge between the education of Sustainable Design Engineering and the industry of urban development, as a contribution to how sustainability can be incorporated in future Nature-based projects in urban development.


# 3.0 | CASE - BISPEENGBUEN

(SOURCE: OWN PICTURE)

The objective of this section is to describe our choice of case and explain why and how it is relevant. As mentioned in the introduction our case has its point of departure in Bispeengbuen, the iconic and large grey concrete bridge that winds at the entrance to Copenhagen between Frederiksberg and Nørrebro, *see picture 1*. The case of Bispeengbuen is relevant due to its pending maintenance making it the object of renewed possibilities. The municipalities of Frederiksberg and Copenhagen have joint forces in investigating new visions for converting the area of interest with the intention of changing the grey infrastructure into urban space and housing (Frederiksberg Kommune, 2021). Using Bispeengbuen demonstrates a practical example of the academic topic investigated in this thesis. Thus, this section will provide a historical coverage of the development of the area up until today, leading to the redesign stated in *section 8.0*.

## 3.1 UNCOVERING THE HISTORY

Historically, Bispeengbuen is placed on top of the old meadow called Bispeengen, which is still the name of one of the streets located under the bridge. The area at Bispeengbuen has been characterized by great biodiversity and fauna before the extensive expansion of Copenhagen (Jensen, 2022). Bispeengen was a recreational place with an emphasis on nature and play where the creek Ladegårdsåen was a focal point, originally built to ensure drinking water for Copenha-

PICTURE 1:
BISPEENGBUEN SEEN FROM ABOVE. (SOURCE: MIKKELSEN, 2021)

gen's growing population around the 16th century. One of the last remains from the creek's heyday is found on Åboulevarden, a pointed rock that measured the water level in the creek. Despite this monument still being present, many people today are unaware that the creek is still running under the main roads of Ågade and Åboulevarden (Jensen, 2022).

Ladegårdsåen is a part of a bigger network of creeks starting at Bispeengen where Grøndalsåen and Lygteåen meet. During the expansion of Copenhagen in the 20th century, the area around Ladegårdsåen was gradually included in the city planning and the creek became part of an open sewer system, but due to public health considerations, the creek underwent pipework in the years between 1896-1962 (Jensen, 2022). However, until the 1960s, Bispeengen was still maintained as a green oasis in the city, but with the increasing car ownership, it was transformed into the main road in the form of the construction of Bispeengbuen and the last part of Ladegårdsåen was piped, *see illustration 5* for the gradually piping of the creek. Although Ladegårdsåen continues to run from Bispeengen to Peblinge Sø it has not been a part of the sewer system for the last decades, hence it still supplies water to Peblinge Sø when needed (Jensen, 2022).

Today the area is dominated by Bispeengbuen which is one of the few expressways entering the municipality of Copenhagen. Each day 50,000 cars drive over

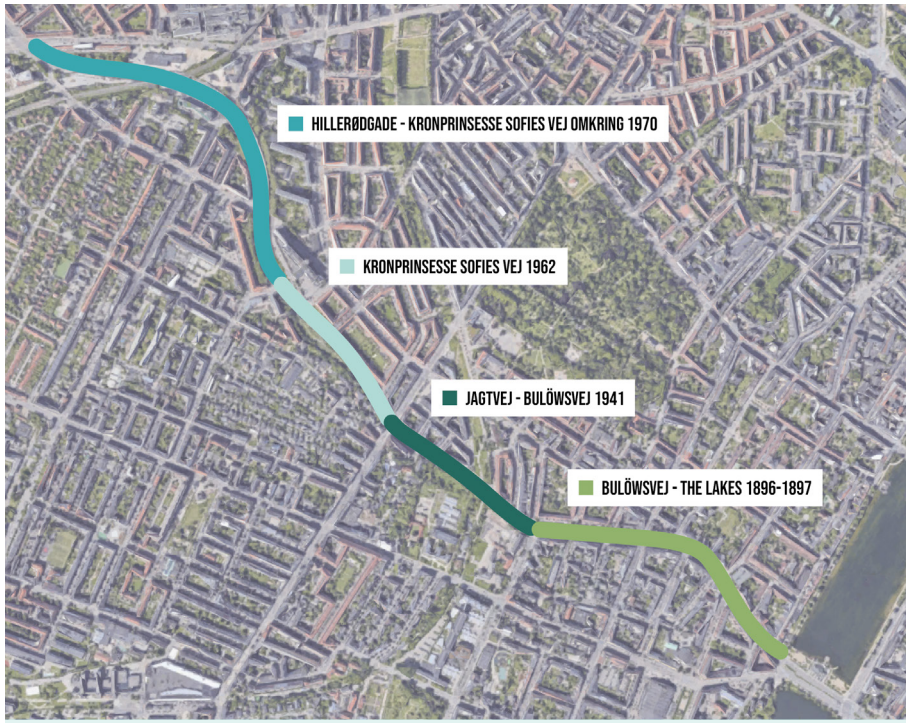



ILLUSTRATION 5:
'THE GRADUALLY PIPING OF LADEGÅRDSÅEN FROM 1896-1970'. OWN ILLUSTRATION.
(SOURCE: GOOGLE MAPS, 2022A; JENSEN, 2022)

Bispeengbuen, thus, the bridge function as one of the direct routes to the inner city (Lehrskov, 2021). It was built in 1970-72 and is part of the overall scope for the infrastructure development in the capital area, *see illustration 6* of the timeline of Bispeengen from 1500-today on pages 28-29. The overall concept was to create five main arterial roads connecting the suburbs of Copenhagen with the city centre, referred to

as the Finger Plan. The plan was to ensure access to and from the capital while reserving the space between the arterial roads for green wedges (Bolig- og Planstyrelsen, 2020). The establishment of Bispeengbuen was thus an attempt to provide expressways throughout the city centre to accommodate the rise in private car ownership (Jensen, 2022). Due to the constant opposition by the public, the original intention was dismissed leaving Bispeengbuen as a remnant of an alternative vision for Copenhagen. Hence, the historical traits of the area at Bispeengbuen went from being ruled by nature to being controlled and ending in a state without any nature left. This progression seems to be the result of a lack of emphasis and understanding of the natural environment.

## 3.2 THE AREA UNDERNEATH BISPEENGBUEN

The arch that forms the bridge of Bispeengbuen creates a large grey area underneath primarily occupied by parking lots. The area surrounding Bispeengbuen is characterized by traffic hubs (i.e., Nordre Fasanvej and Borups Allé), a dense population as well as multiple shopping facilities. The bridge is the physical barrier that divides Frederiksberg in two, on the northern part of the bridge the area is dominated by industrial traits like the buildings of Novozymes compared to the southern part where the family-friendly traits of Frederiksberg manifest themselves, *see illustration 7*. However, today the area is used by a diverse range of


ILLUSTRATION 7:
'THE AREA OF BISPEENGBUEN'. OWN ILLUSTRATION.
(SOURCE: GOOGLE MAPS, 2022B)


The aqueous system in Copenhagen was established during the 1500 century by combining Grøndalsåen and Lygteåen with Ladegårdsåen to provide drinking water to the citizens.

## 1500

## 1800

Up until the 1800th century, the large green area surrounding Ladegårdsåen was used for recreational purposes.

The meadow of Bispeengen seen from Borups Allé, mainly dominated by Ladegårdsåen.

## 1927

## 1947

The Finger Plan was created as a foundation for the city development of Copenhagen and the surrounding cities.


The meadow of Bispeengen seen from Borups Allé. The meadow area has decreased due to settlements.

## 1949

**APPROX.**
## 1890-1960

During this period Ladegårdsåen was underground in pipework due to public health issues.

ILLUSTRATION 6:
'HISTORICAL TIMELINE OF BISPEENGBUEN'. OWN ILLUSTRATION.
(SOURCE: HISTORIE & KUNST; KØBENHAVNS KOMMUNE, 1910, 1927, 1949, 1960, 1972; LEMBERG & HARDING, 2013; MILJØPUNKT NØRREBRO, 2022; OWN PICTURE)

# HISTORICAL TIMELINE OF BISPEENGBUEN

## 1960

Bispeengen was beginning to be occupied by vehicles and infrastructure.

Bispeengen was characterized by diverse biodiversity and fauna.

## 1960'S

## 1970-1972

Bispeengbuen is build to accommodate a rise in car ownership as a direct result of the Finger Plan from 1947.

Bispeengbuen and the area surrounding it are today characterized by an urban landscape of grey infrastructure.

## TODAY

actors and for various purposes such as festivals, workshops, flea markets, skating rinks, and basketball courts all managed by the cultural hub of URBAN 13 and referred to as *"Bispeengbuen - the outdoor culture house"* (Frederiksberg Kommune, 2015; URBAN 13, n.d.). Urban 13 is an urban lab experiment driven by passionate pioneers from the local community who has generated a new atmosphere in the area, *see picture 2*. This has resulted in an increased feeling of security for locals. The area thereby attracts various actors for interacting with the different possibilities that the area offers. This includes citizens, entrepreneurs, volunteers, municipal actors, students, artists, staff, sports enthusiasts, and guests (URBAN 13, n.d.). The present cultural hub that has emerged in recent times shows the possibilities of what grey infrastructure can offer and underlines that every cloud has a silver lining and shows that the area is transforming into a vibrant and nuanced community, *see pictures 3 to 7*, on the next page.

Despite its growing use, Bispeengbuen is a controversial topic in the municipalities of Frederiksberg and Copenhagen, as many citizens and politicians find the


PICTURE 2:
THE DIVISION OF URBAN 13. (SOURCE: OWN PICTURE)

bridge unattractive and describe it as a distinct eyesore (Mikkelsen, 2021). The case of Bispeengbuen is thus relevant as its coming restorations are approaching. With this immense expense of the construction emerging, momentum has been created for the local community to push the idea of resurfacing the Ladegårdså and the former nature of the area. In recent times the local political governments in both Frederiksberg and Copenhagen have moved together and a will to investigate potential possibilities for the area has grown. In 2021 a correlation of professions (Vandkunsten Architects / KOMMON / Skaarup Landskab / ViaTrafik / Bactocon / LNH Water / Realise) won the contest of a strategic vision of the area (Valdimarsson, 2021). This vision has now been detailed in three suggestions representing different scenarios, namely: 1) a tunnel with green urban space on top, 2) a tunnel with housing and green urban space on top, and 3) a partial demolition and green urban space next to the remaining bridge, *see pictures 8-10* on page 32. Hence, all visions sustain the car and mobility as a feature. The spring of 2022 thus marks an important time in the process as the politicians are deciding on one of the three

visions. Afterwards, phase two begins proceedinguntil the summer of 2023 designing in detail the chosen scenario. Lastly, the local governments of Frederiksberg and Copenhagen will make the final decision on whether the project is to be realized or not (Københavns Kommune, n.d.).

PICTURE 3 TO 7 ILLUSTRATES THE VIBRANT AND NUANCED COMMUNITY THAT IS PRESENT UNDER BISPEENGBUEN

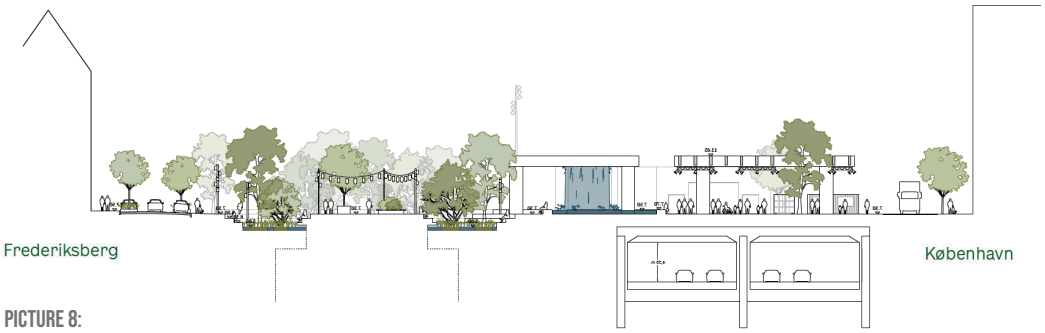
PICTURE 3:
BASKET UNDER THE ARCH. (SOURCE: D. SAMAROV, 2020)

PICTURE 4:
CARPARK FESTIVAL UNDER THE ARCH. (SOURCE: J. BILL, 2019)

PICTURE 5:
PARKING LOT UNDER THE ARCH. (SOURCE: OWN PICTURE)

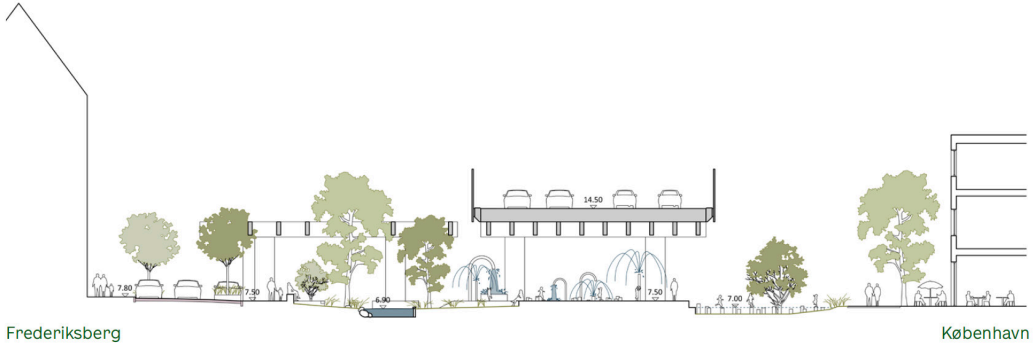
PICTURE 6:
VERAS 'FLEA' MARKET UNDER THE ARCH. (SOURCE: VERAS, 2019)

PICTURE 7:
ARTIFICIAL LIGHT UNDER THE ARCH. (SOURCE: MOTO MUTO, 2018)




PICTURE 8:
VISION 1, A TUNNEL WITH GREEN URBAN SPACE ON TOP.
(SOURCE: TEGNESTUEN VANDKUNSTEN; KOMMON; SKAARUP LANDSKAB; VIATRAFIK; BACTOCON; LNH WATER; REALISE, 2022)


PICTURE 9:
VISION 2, A TUNNEL WITH HOUSING AND GREEN URBAN SPACE ON TOP.
(SOURCE: TEGNESTUEN VANDKUNSTEN; KOMMON; SKAARUP LANDSKAB; VIATRAFIK; BACTOCON; LNH WATER; REALISE, 2022)




PICTURE 10:
VISION 3, A PARTIAL DEMOLITION AND GREEN URBAN SPACE NEXT TO THE REMAINING BRIDGE.
(SOURCE: TEGNESTUEN VANDKUNSTEN; KOMMON; SKAARUP LANDSKAB; VIATRAFIK; BACTOCON; LNH WATER; REALISE, 2022)

## 3.3 MAIN TAKEAWAYS

As documented by this section the area of Bispeengbuen has undergone various transitions ranging from an unaffected meadow to a domesticated green area with man-made creeks and is now a symbol of how the expanse of car ownership has influenced the city development of Copenhagen during the 60s and 70s. As time went by Bispeengbuen has repeatedly been an object of discussion and with the forthcoming restoration approaching it yet again becomes the topic of conversation. Even though Bispeengbuen is looking at a likely transformation there are still many considerations to be accounted for in the process. This includes future prospects of demography as well as infrastructure developments. Looking at Bispeengbuen as a case for this thesis is thereby interesting as it is attributed to renewed relevance. This project is about knowing the different functions of the area and how they are an integrated part of the holistic and conceptual process. However, all cannot be considered on equal terms and for this study, the emphasis is on the current state of the area, *see pictures 11 to 19* on the next page, and reversing the former development, going from grey to green infrastructure with specific attention to biodiversity.

PICTURE 11:
BISPEENGEN - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

PICTURE 12:
ÅGADE - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

PICTURE 13:
BISPEENGEN - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

PICTURE 14:
UNDER THE ARCH - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

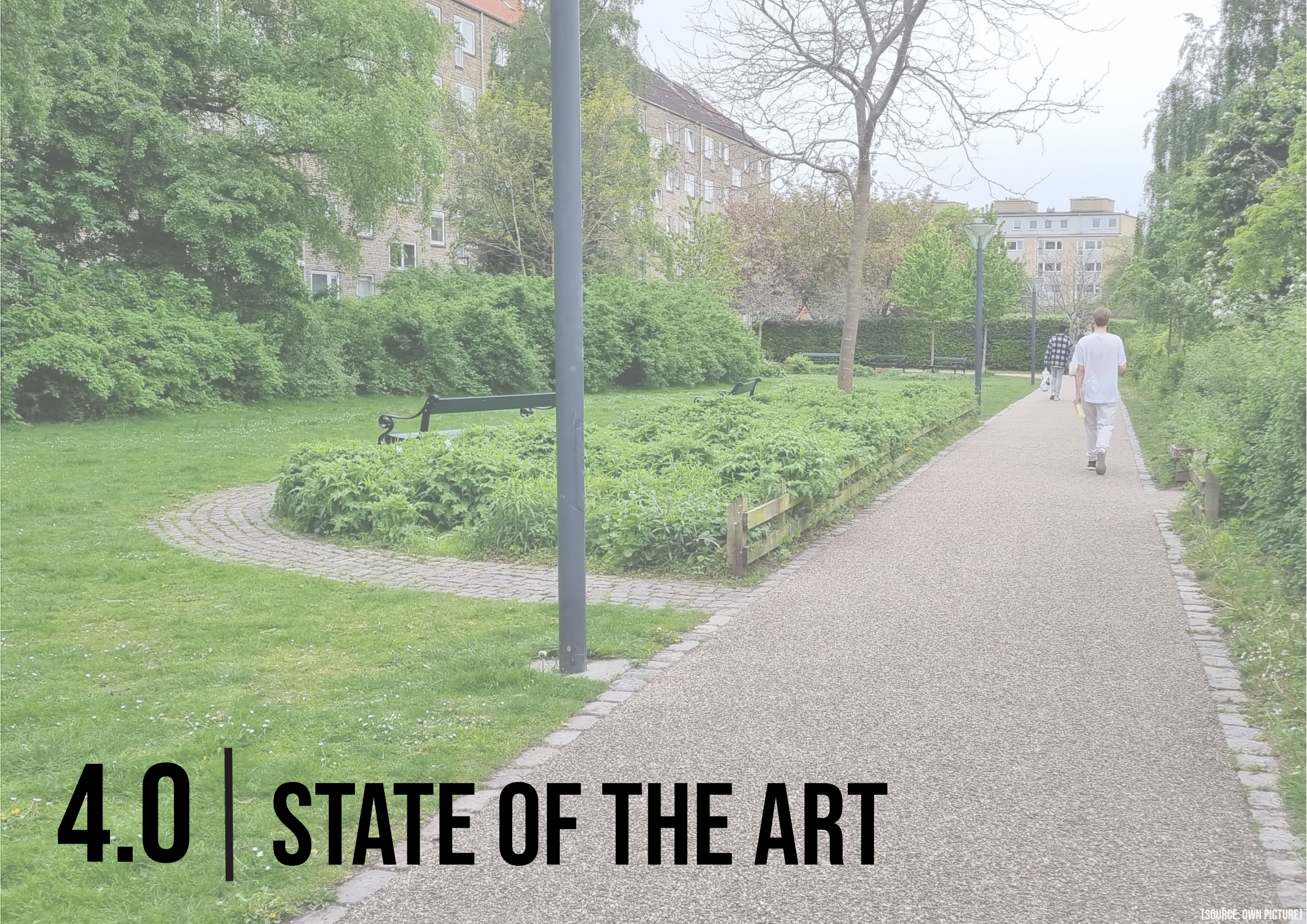
PICTURE 15:
UNDER THE ARCH - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

PICTURE 16:
ÅGADE - 15TH OF MAY. (SOURCE: OWN PICTURE)


PICTURE 17:
ÅGADE - 15TH OF MAY. (SOURCE: OWN PICTURE)

PICTURE 18:
ÅGADE - 15TH OF MAY. (SOURCE: OWN PICTURE)

PICTURE 19:
BISPEENGEN - 15TH OF MAY. (SOURCE: OWN PICTURE)



# 4.0 | STATE OF THE ART

[SOURCE: OWN PICTURE]

A literature review is provided as an essential step towards identifying the current knowledge concerning the area of interest and provides a structure and guide for the subsequent analysis and the redesign of Bispeengbuen. The first paragraphs of this section provide a point of departure for the project in an in-depth elaboration of the theme of nature including the concepts of biodiversity, Nature-based Solutions and Nature-based Thinking. In this literature review, a gap in creating and adding new knowledge is highlighted in the undefined term of urban nature when dealing with nature in urban development. The last paragraph of the section is a presentation of relevant design projects that demonstrates the broad use of Nature-based Solutions when dealing with urban nature and exemplifies that they can vary in size, shape and impact. This section thus recognises the many design strategies and approaches that underlie Nature-based Solutions and the broad use of the concept. The review allowed for an examination of the state of the art to be conducted through an investigation of the emergence of Nature-based Solutions in relation to urban nature.

## 4.1 THE RELATION BETWEEN MAN & NATURE

Nature is the foundation for life on earth and is evident in every part of the world. It takes on different forms and shapes and contains immense forces. Its natural resources have always provided opportunities for life to unfold and evolve. Today is no different. Humans have depended on the services provided by nature (also known as ecosystem services) to provide oxygen, freshwater, and food (The National Wildlife Federation, n.d.). As humans began to conquer nature its natural resources have been depleted in an unsustainable fashion that has broken the fundamental balance that is needed to maintain the earth as a friendly environment for humans to continue evolving (Ahern, 2013). As a result, Marsh (1864) wrote a ground-breaking book about "Man and Nature" in 1864, with a conceptualisation of the relationship between man and nature. With his book, he contemplated the inexhaustibility of the earth and our human influence on nature. "Man and Nature" (1864) shows that man has moulded the society we know today and warns that the continuous misuse of earth's resources may result in ever-emerging self-destruction (Marsh, 1864). Even though it in modern societies is well known that the human evolution is at the expense of nature the fundamental relationship between man and nature that George Perkins Marsh (1864) explains is still, if not more, relevant today.

A critique of the last decade's separation between humans and nature is stated in the hypothesis of biophilia. The hypothesis is originally proposed by Edward Osborne Wilson a biologist stating that humans have a biological longing for nature and that the love of nature is in our genes as we grew up with it (evolutionary) (Wilson, 1986). Additionally, it states that our reaction to changing seasons and the natural experiences

of birds singing, rain and sunlight is coded in our DNA and essential to a happy life and well-being (Beatley, 2017; Wilson, 1986). Biophilia is still a grass-roots movement that in recent times has influenced the field of design and created the concept of biophilic design that in line with concepts of eco-design and bio-mimicry seeks to incorporate natural elements in design practices (Nordic Biomimicry, 2020; Rattner, 2016). This biophilic design has emerged in urban development as an integrated approach that seeks to reframe nature in cities as essential for human well-being and highlights the need for green infrastructure that integrates cities and humans with multipurpose nature (Panlasigui et al., 2021). The abundance of nature is, thus, essential for human well-being and following this reasoning the lack of green areas and nature in the city is a plausible explanation for high-stress levels and the declining mental health of citizens living in cities (Bak Sørensen et al., 2019).

In recent times the link between biophilia and biodiversity has become increasingly pervading and through Panlasigui et al. (2021) it is suggested that biodiversity can advance the useability of biophilic design objectives in creating biophilic cities: *"a partnership between cities, scholars and global stakeholders working for an understanding of the value and contribution of nature in cities to the lives of urban residents."* (Randrup et al., 2020, p. 922). Biodiversity is from the UN definition (1992) stated as the biological diversity referring to the *"variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."* (United Nations, 1992, p. 3). By this definition it is made possible to measure the current biodiversity crisis through the number of habitats, species and ecosystems and the rate at which they decline. This definition on biodiversity represents an ecological perspective that thereby gives specific design requirements on what to design for in terms of biodiversity in general. The ecological perspective has been an approach in designing practices and the scientific community since the early 1990´s through the ecosystem approach. The approach is adopted by the Convention on Biological Diversity as a strategy promoting biodiversity through conservation and an integrated management of land, water and living resources (Convention on Biological Diversity, 2021). Though it is important to note that the general discussion among biologists relies on how cities can contribute to biodiversity. Here recent literature adheres to the perception that biodiversity in cities is *"far from being ecological lost causes"* (Lambert & Donihue, 2020, p. 903), meaning that cities are incubators for adapted ecosystems providing opportunities for biodiversity conservation (Lambert & Donihue, 2020).

Thus, the literature on the relation between man and nature encompasses different views, that somewhat all are concerned with nature's role in society. From this, the biological aspect has been reviewed to create a foundation for the further investigation of what nature is in an urban setting. Therefore, we move on to the elaboration of the undefined term urban nature, but before digging into the concept of Nature-based Solutions.

## 4.2 DEFINING (URBAN) NATURE

The definition of nature can be found in a division of different understandings re-

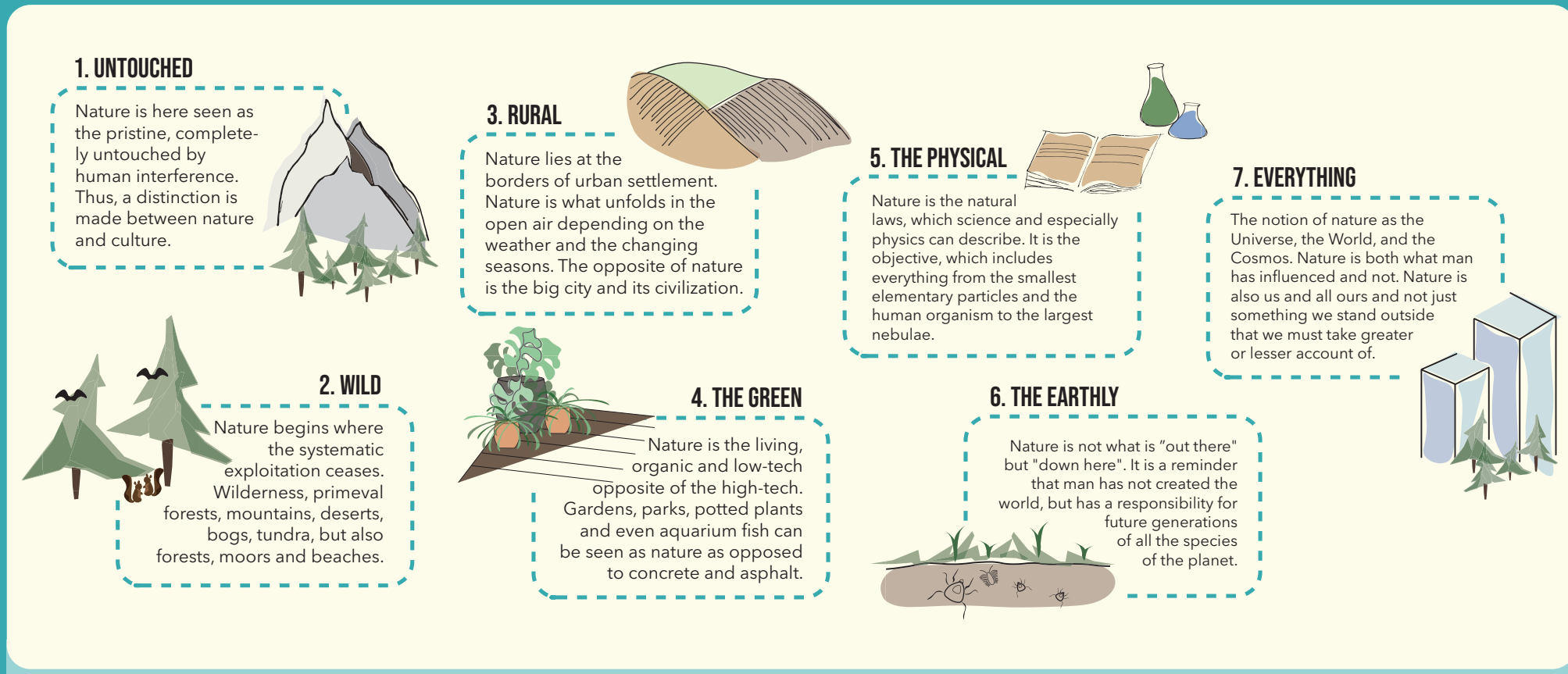



ILLUSTRATION 8:
'THE SEVEN NOTIONS OR CONCEPTS OF NATURE'. OWN ILLUSTRATION. INSPIRED BY PHILOSOPHER HANS FINK (2003).

lated to its use and functions. The variation of the term has been categorized into seven understandings by Fink (2003), 1) Nature as untouched 2) Nature as wild 3) Nature as rural 4) Nature as "the Green" 5) Nature as "the Physical" 6) Nature as the earthly 7) Natures as everything, *see illustration 8* for a clear overview of the categories. The complexity tied to our language and understanding of nature is highlighted in these categories and underlines the difficulty when designing for urban nature. What is most striking in these categories is that the first six create a boundary that limits what nature is, whereas the seventh is all-encompassing creating no boundary (*see illustration 8*). The term is furthermore curious as the physical limitations are not defined by the seven categories and another view is thereby needed.

In close relation, Petersen & Nielsen (2011) discuss how the blue and green areas of the city are part of people's everyday life in the concept of *'bynatur' - 'urban nature'*. Here the term *'nature'* is once more modified in both language and meaning insinuating a boundary using the word *'urban'*, thereby adhering to the same procedure as the first six categories as posed by Hans Fink (2003) *see illustration 8* on the previous page. The compound meaning of urban nature seems to be a complete contrast between nature and the urban setting, however, this is disproven as it is described that *'urban nature'* must entail all that is nature from existing green areas to rural landscapes but also blackbirds on rooftops and dandelions that grow from cracks in the pavement (Petersen & Nielsen, 2011). With the introduction of urban nature, the concept of nature in cities is defined and put in relation to urban life.

In the city of Copenhagen, the interlink between nature and people is emphasized in various strategies guiding urban development. The term urban nature has thus become the overall strategy to create coherence throughout the city. Urban nature in the municipality of Copenhagen has its origin in Fællesskab København (2015), a strategy from 2015 to 2025 that sets the stage for a vision of Copenhagen in 2025 as an inclusive city by and for its citizens (Københavns Kommune Teknik- og Miljøforvaltningen, 2015b). From these visions, the urban setting and green areas of the city are emphasized as an integrated part of transportation in form of cycle paths, social communities and the global responsibility that cities must claim by 2025 (Københavns Kommune Teknik- og Miljøforvaltningen, 2015b). To ensure these visions a strategy has been created around the notion of urban nature. In this strategy it is acknowledged that urban nature in Copenhagen often is planned, planted, refined, and tamed to accommodate the environment in the city and the limited vacant areas (Københavns Kommune Teknik- og Miljøforvaltningen, 2015a) and thereby not primarily untouched, wild, or rural (*see illustration 8*). Still, it is emphasized that urban nature is a prioritized element in the composition of Copenhagen ensured by the continued strategy that upholds the persistence of green and blue areas in the city.

Urban nature has always been a subject in urban development, but the current understanding of the term can be dated back to the early 2010s (Petersen & Nielsen, 2011). Before then the Fingerplan was guiding the understanding of nature in the regional development of Copenhagen and the surrounding cities. From the Fingerplan there is a contrast between cities and nature visualized as nature being the wedges between the fingers where the city unfolds (Egnsplankontoret, 1947). With the Fingerplan the focus was to ensure mobility from the inner city to the development areas in the suburbs (the fingers). Thereby designing densely populated areas in the five flows where public transportation binds the city districts across the wedges. Since the original Fingerplan, the

overall scope for the physical development of Copenhagen has been through an iterative process but the core principles of separation between nature and local communities in the gaps and cities with infrastructure connections in the fingers persist (Bolig- og Planstyrelsen, 2020). The placement of Copenhagen being situated at the palm of the Fingerplan meant that nature has not been part of the regional development since the introduction of the plan. Even then Copenhagen had a size and a growth rate that left little room for nature. In the inner-city nature was thereby left to allocated parks which should not increase in size but should be accessible throughout the city districts (Egnsplankontoret, 1947).

In this section, the development of the term urban nature is shown relative to its current meaning. With this established the approach of creating urban nature is now investigated with emphasis on Nature-based Solutions as the newest framework used both in practice and academic studies.

## 4.3 THE EMERGENCE OF NATURE-BASED SOLUTIONS

Working in engineering, practice, and policy within the field of environmental management and sustainable design the emergence of new approaches and terminologies is a regularly encounter. Since the introduction of sustainable development in the 1980s, the UN has continuously provided frameworks and approaches to environmental management that can ensure sustainable development (WCED, 1987). The most recent contribution to this lingo is the approach 'Nature-based Solutions' which was introduced primarily to promote solutions to climate mitigation and adaptation challenges using nature as a means (Cohen-Shacham et al., 2016). The concept is driven by the European Commission as a pragmatic approach to the Sustainable Development Goals as an attempt to tackle the fact that they are deeply interwoven and share many of the same drivers (Faivre et al., 2017; Seddon et al., 2020).

Both the International Union for Conservation of Nature (IUCN) and the European Union (EU) have provided a definition of Nature-based Solutions that to some extent is comparable, *see table 1* on the next page. From these definitions, it is stated that *"Nature-based Solutions are solutions that are inspired and supported by nature […] must benefit biodiversity"* (European Commission, n.d.). They can be seen as sustainable solutions to combat environmental, social, and economic challenges, however, the concept can appear vague with such a broadly defined scope. From recent iterations the scientific society is increasingly adhering to an elaboration of this definition as a concept that seeks to address the current challenges posed by the Anthropocene epoch which can be reduced to three main topics: climate mitigation and adaptation, protection of biodiversity and ensuring human well-being (Seddon et al., 2020).

**TABLE 1. DEFINITIONS OF NATURE-BASED SOLUTIONS**

| | International Union for Conservation of Nature (IUCN) | European Union |
|---|---|---|
| Definition/Reasoning | *"Concerns the application of IUCN's knowledge to sustainable development, empowerment and poverty reduction. Resilient nature is fundamental to societal and economic resilience. The Programme focuses on nature-based solutions as IUCN's particular strength, not because nature provides the only solutions, but because this specialization allows IUCN, in partnerships with others, to address a wide range of global development challenges. Nature-based solutions offer multiple benefits simultaneously and therefore efficiently […] focuses initially on nature-based solutions to climate change (including disaster risk reduction), food security, and economic and social development…"* (IUCN, 2012, p. 5) | *"They are actions inspired by, supported by or copied from nature; both using and enhancing existing solutions to challenges, as well as exploring more novel solutions, for example, mimicking how non-human organisms and communities cope with environmental extremes. Nature-based solutions use the features and complex system processes of nature, such as its ability to store carbon and regulate water flows […] These nature-based solutions ideally are resilient to change, as well as energy and resource efficient, but in order to achieve these criteria, they must be adapted to local conditions"* (European Commission, 2020, p. 24) |

TABLE 1:
'DEFINITIONS OF NATURE-BASED SOLUTIONS'. OWN ILLUSTRATION. INSPIRED BY IUCN, 2012 & EUROPEAN COMMISSION, 2020.

Since its introduction, the concept of Nature-based Solutions has been implemented in policies at both the IUCN and in the EU with integrations of other concepts such as biodiversity and ecosystem services as well as the ecosystem approach, ecosystem-based adaptation/mitigation, and green and blue infrastructure (European Commission, 2020; IUCN, 2012). The foundation of Nature-based Solutions is thus various ecosystem-based approaches dating back to the 1970s from the field of conservation biology to assert the importance of biodiversity and nature in relation to human well-being. Within the ecosystem approaches several appertaining concepts have emerged as issue-specific ecosystem related approaches (Cohen-Shacham et al., 2016) including ecosystem-based; restoration, adaptation, mitigation and protection. These branches of ecosystem-based approaches have guided urban development and reflect the outbreak of climate-related issues. Nature-based Solutions are thereby emerging as an umbrella concept entailing various assumptions from the above-mentioned approaches (Cohen-Shacham et al., 2019). To further investigate what Nature-based Solutions involve the development is reviewed in a mapping of the various concepts that have influenced and formed what the approach of Nature-based Solutions entails.

### 4.3.1 THE PREVALENCE OF NATURE-BASED SOLUTIONS

In understanding the emergence of Nature-based Solutions the starting point is a mapping of the underlying approaches and the terms and concepts that affect the development of the Nature-based Solutions concept, *see illustration 9* on the next page. From illustration 9, an overview of the predecessors to Nature-based Solutions is provided with framing of how they interlink with Nature-based Solutions and the aforementio-

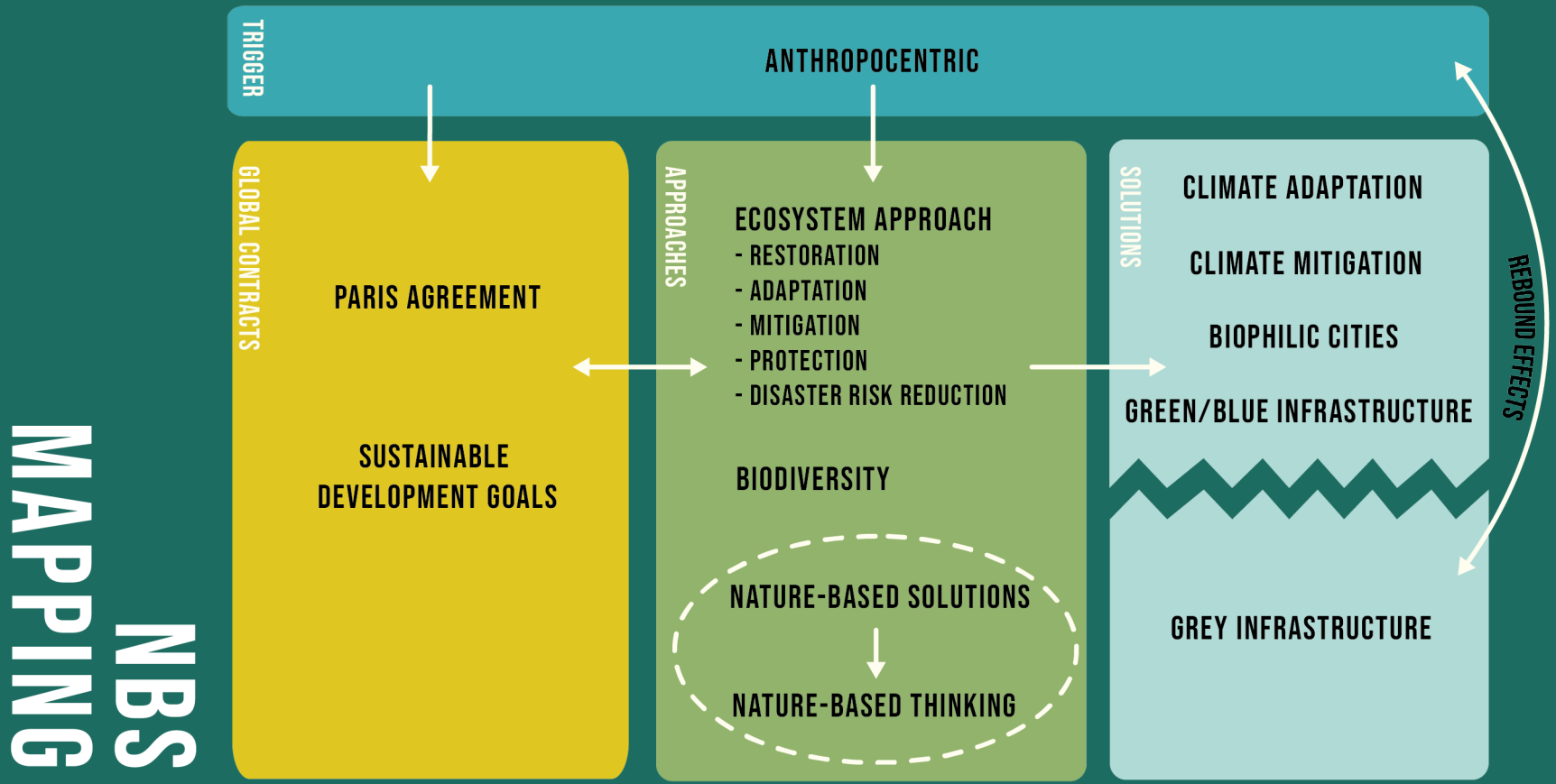



ILLUSTRATION 9:
'NBS MAPPING'. OWN ILLUSTRATION. INSPIRED BY THE LITERATURE USED THROUGHOUT THE LITERATURE REVIEW.

ned concepts. At the top the illustration, the trigger is placed, as the Anthropocentric issues that modern societies are facing. In the middle, the umbrella of Nature-based Solutions is visualized through its predecessors. To the left, the global contracts are placed i.e., the Paris Agreement and the Sustainable Development Goals. To the right, the solutions are divided into traditional solutions at the bottom and alternative solutions at the top. From the bottom rebound, effe-

cts from former infrastructure solutions have accumulated in the Anthropocentric present enforcing the current societal issues.

Through the concept of Nature-based Solutions, various environmental measurements are paving the way for an integrated concept that has a holistic understanding of sustainability (Cohen-Shacham et al., 2019). These measurements originate from the ecosystem approach wherein related initiatives have been advanced by the European Commission including ecosystem-based adaptation, green infrastructure, ecosystem-based disaster risk reduction and natural water retention measures (Cohen-Shacham et al., 2019). The strength of Nature-based Solutions lies in the integrated take on solving societal challenges through nature and natural systems (Faivre et al., 2017). The emphasis on natural systems as a key element in Nature-based Solutions marks a shift away from traditional engineering where technical solutions dominated. These solutions are still present in climate adaptation and disaster risk reduction projects where engineered solutions still define urban areas and waterfronts (Martin et al., 2021). Through Nature-based Solutions, the European Commission is actively pushing for an extensive transition toward ecosystem approaches in European countries and worldwide (Cohen-Shacham et al., 2019).

Through EU's research and innovation funding programme Horizon 2020 detailed case studies of Nature-based Solutions projects have been documented across Europe in their contribution to the scientific knowledge on Nature-based Solutions (Hezelburcht, 2020). The programme was running from 2014 to 2020 and one of the most frequent questions found when researching the concept of Nature-based Solutions was the cost-effectiveness of Nature-based Solutions contrary to engineered ones. This dilemma raises the question of the value and limits of Nature-based Solutions (Seddon et al., 2020). Climate mitigation and adaptation are one of the challenges where the dilemma between Nature-based Solutions and engineered ones is heavily debated. From this debate Seddon et al. (2020) argue that the social-ecological effectiveness of Nature-based Solutions is difficult to measure due to a lack of appropriate indicators and metrics. It is thus suggested to prepare context-specific metrics and measurements that can entail both social and ecological aspects of the solution. The methods around Nature-based Solutions in cities target this debate by applying an inclusive and democratic approach where citizens and local communities are recognized actors in city planning and area renewal (Frantzeskaki, 2019). Thereby adopting the biophilic approach of inclusivity to ensure that the creation of Nature-based Solutions also promotes biophilic infrastructure and attitude in the population. The learnings provided by Frantzeskaki (2019) show the local communities often comprise a wide range of resourceful and creative citizens who if given the right tools and guidance can prove invaluable for ensuring

that Nature-based Solutions can be both environmental and socially beneficial.

### 4.3.2 NATURE-BASED THINKING

As a further elaboration and broadening of the definition of the Nature-based Solutions concept, (Randrup et al., 2020) suggest contributing to the transition towards sustainable cities by proposing the new concept of Nature-based Thinking. The concept is inspired by nature's cyclical and long-term ecological processes and contrary to Nature-based Solutions the concept of Nature-based Thinking encompasses the aspect of nature with people, rather than nature for people. Nature-based Thinking seeks to look at relations between cities and nature, and thereby accommodate the critique pointed at Nature-based Solutions for including technological imitations of nature: *"The dominance of keywords such as 'solutions' and 'services' in NBS discourse and practices has a strong performative effect on our thinking […] speaking of solutions or services [...] may explicitly or implicitly downplay attention for nature's contributions or processes that are not seen as a solution or a service."* (Randrup et al., 2020, p. 921). The terminology concerned with Nature-based Solutions thus needs refocusing on how we think and talk about nature-based approaches. The concept of Nature-based Thinking might be one suggestion to this, by acknowledging that nature not only provides solutions for urban challenges but also recognizes that to create a social-ecological approach for greening our cities more room needs to be handed over to wilder nature. The cyclical process of Nature-based Thinking (i.e., planning, designing, constructing, and managing urban green spaces) hence relies on less manicured urban green areas, by creating more room for 'wildscapes', which is done by working transdisciplinary. Since Nature-based Thinking is concerned with the interaction between humans and nature on an individual and community level it could then be linked up with other approaches that place more value on nature itself, such as that of biophilic cities. Randrup et al. (2020) further argue that the aim of Nature-based Thinking is: *"… reconnecting people with the natural world, by expanding the opportunities for urban populations to experience the unpredictability and heterogeneity of nature. Such experiences are crucial for the philosophical and emotional connections to nature that are considered the deepest leverage points for initiating systemic change towards sustainable cities."* (Randrup et al., 2020, p. 922). This ties into the philosophy of biophilia and human biological longing toward nature and providing as inspiration for rethinking the traditional linear logic of planning, design, construction, and maintenance of urban nature. Nature-based Thinking thus consists of the following three dimensions the ecological-, the community- and the economic dimension. Though it is important to note that to obtain a truly holistic approach the interlink between them needs to be examined. This will expand the focus from conventional and often economically driven logic of Nature-based

Solutions to a deeper conceptualization of nature, in which nature can prevail. As an example, Randrup et al. (2020) state that in relation to Nature-based Thinking urban vegetation like street trees should be planted in a nature-inspired manner and: *"... where there is room for growth, instead of systematically where technical solutions are needed. This will create natural conditions and require a minimum of maintenance."* (Randrup et al., 2020, p. 923). Leaving nature by itself will challenge the current way of 'controlled' and planned urban nature, which is driven by technological solutions like green roofs and structural soils. Nature-based Thinking is thereby a new way of thinking when addressing urban nature, and the complexity associated with it.

From the review of Nature-based Solutions and Nature-based Thinking, it is evident that Nature-based Solutions is an umbrella concept that despite its origin in the ecosystem approach still entails solutions that are inspired by technological advancements. The concept of Nature-based Thinking is hereby an attempt to further develop a more nature value-based approach and introduce new terminology that moves beyond solutions and services to promote nature's cyclical processes. Having established the framework used in this thesis the next section will describe different ways of implementing nature in urban areas to exemplify the broad range of existing Nature-based Solutions.

## 4.4 EXAMPLES OF NATURE-BASED SOLUTIONS

From the literature it becomes evident that there is a tendency that the solutions can, broadly speaking, be categorized into four different types: restoring projects, incorporated projects, preservation projects, and add-on projects (Faivre et al., 2017; Frantzeskaki, 2019; Randrup et al., 2020). A brief description of the four types will now be provided. *Restoring projects* refer to projects where the historical trait of nature is investigated and used as a tool for designing/ recreating the area (e.g., re-establishing former green areas), here the emphasis is to go back in time and recreate some of the lost nature. *Incorporated projects* describe processes where nature is included in the equation from the beginning, the emphasis is here that nature is a vital part of the solution if not the solution itself. *Preservation projects* highlight the importance of retaining some of the existing nature. Lastly, *add-on projects* seem to be the preferred approach in many cities as an attempt to create quick green oases in already well-established urban areas. Nature is here implemented as an afterthought or demand for recreational spaces. The following paragraphs will provide concrete examples of some of the different types most relevant to the urban setting, to show the range of the various possibilities.

### 4.4.1 VERTICAL FORESTRY

An example of the approach of incorporated projects, is vertical forestry which refers to a new approach or architectural device that integrates nature into urban development (Stefano Boeri Architetti, n.d.), *see picture 20 and 21* on the next page. The name originates from the project called Bosco Verticale (Vertical Forest) in Italy in 2014 (Boeri et al., 2014). The project consists of two towers which are covered by trees and plants, that produce oxygen and mitigates smog in the Porta Nuova district of Milan. It's being described as a way of promoting: *"the coexistence of architecture and nature in urban areas, and the creation of complex*

PICTURE 20:
VERTICAL FOREST IN MILAN. (SOURCE: ETERNO IVICA, 2018)

PICTURE 21:
VERTICAL GARDEN IN MILAN. (SOURCE: NETWORK NATURE, N.D.)

*urban ecosystems."* (Stefano Boeri Architetti, n.d.).

Vertical forestry has multiple purposes. One is the diversity of plants, that helps build micro-climates and filter dust particles in the urban setting. Moreover, it protects humans from harmful sun rays, creates humidity, produces oxygen, and absorbs CO2 and acoustic pollution. The possibility of mixing plants and trees creates the base for rich biodiversity. The combination of architecture and nature is an attempt to solve the environmental challenges that the contemporary, as well as the future cities, are facing. The implementation of greenery in the cities not only provides the citizens with a healthier environment but also contributes to new job opportunities. This can be seen concerning the new kind of gardeners, that must be familiar with climbing and heights to take care of the plants covering the buildings, referred to as flying gardeners (Boeri et al., 2014). The concept of vertical forestry is starting to get more attention and recognition and recent examples can be seen in both Amsterdam and Singapore (Arch2O, n.d.; Dewolf, 2016). Vertical forestry not only provides the eyes with some greenery to look at in an urban context but also a point of reference for urban policies to include a more diverse nature in a man-made urban context. Projects such as green roofs or green walls are other smaller-scale examples of incorporated projects, which are more prevalent in the city landscape (Faivre et al., 2017).

### 4.4.2 POCKET PARKS

A way of adding nature to cities as an afterthought or add-on can be seen in the example of pocket parks. Pocket parks or mini-parks are described as small outdoor spaces created in 'empty' urban areas, *see picture 22*. These parks are often created to have a break and have a design that leads to a function of use and for people in the local community to gather (National Recreation and Park Association, 2012). The definition of a park

PICTURE 22:
KOLONOS POCKET PARK IN ATHENS.
(SOURCE: MUNICIPALITY OF ATHENS, 2021)

is *"… a protected area, in its natural or semi-natural state, or planted, and set aside for human recreation and enjoyment, or for the protection of wildlife or natural habitats."* (Kara et al., 2011). Even though the word park gives association to big green areas this can be misleading since most pocket parks are not focused on vegetation but more on benches and spots for relaxation. The concept of pocket parks differs from the normal understanding of a park, by emphasizing on incorporating unused urban space into the city planning and thereby making it more attractive to use as small oasis in the city. The formal size of pocket parks is said to be no more than ¼ of an acre (National Recreation and Park Association, 2012), which in comparison correspond to 1/6 of a soccer field. Pocket parks are usually located in between houses, on rooftops, in abandoned alleyways, or on top of small lots, where there is a lack of space for people to relax and enjoy the outdoors (Stoffel, 2022). Virtually most of these unused or leftover spaces could be considered good candidates for pocket parks, since they don't require a lot of planning, due to the limited area that they provide. One example from Copenhagen is the newly opened pocket park 'Bodil Kochs Have' located in Frederiksberg, functioning as small lungs of the city, *see picture 23*. The park is named after the Danish politician and social debater Bodil Koch and is established at a former parking lot (Frederiksberg Kommune, 2022). According to the National Recreation and Park Association (NRFA), a pocket park is considered successful if the following four elements are achieved:


PICTURE 23:
THE INAUGURATION OF 'BODIL KOCHS HAVE'.
(SOURCE: OWN PICTURE)

- They are accessible.
- They let users engage in activities.
- They are comfortable spaces with a good image.
- They are sociable places where people meet each other and take visitors.

The benefits of pocket parks thus seem to be their immediate and uncomplicated implementation process and their ability to among other things revitalize neglected and blighted areas, make communities safer and more sociable and tell a story of the local history and heritage (Stoffel, 2022).

## 4.5 RECAP OF THE SECTION

The intention of this section, State of the Art, was to provide a framework and foundation for the project by defining the terms used throughout the report. The terms of relevance are biodiversity, urban nature, Nature-based Solutions and Nature-based Thinking. These terms will be addressed according to the theme of nature and provide a structure and guide for the subsequent analysis. The section thus ended with a description of actual examples of how nature can be applied in an urban setting.

# 5.0 | METHODS APPLIED

(SOURCE: OWN PICTURE)

Before heading to the analysis, this section is intended to describe the methods utilised through the project. The applied methods helped in framing the concept based on the knowledge gathered around the subject and are categorized as empirical methods and design methods. To investigate the complexity of the academic knowledge related to this project various empirical methods have been utilized providing both quantitative and qualitative results. In the conceptualization phase, design methods have created a creative space providing a conceptualization grounded in acquired knowledge. The methods have been selected in their usability and interaction with the chosen theoretical framework.

## 5.1 EMPIRICAL METHODS

The empirical data retrieved for this project is inspired by anthropological studies in using ethnographic methods such as field studies including observations, photographs, interviews, and writing notes while investigating the location. Ethnography is a social science in which communities of practice, cultures and social settings are investigated as the primary source for data collection. From this approach, the situated reality is documented as first-hand knowledge limiting bias from blurring the data (Schensul & LeCompte, 2010). This puts a lot of responsibility on the researcher as data collection from these methods often adhere to a researcher's independent experience and procedure let alone cultural presuppositions (Burrell & Morgan, 1979; Lave & Kvale, 1995). Our position has thus already been defined to this thesis as described in *paragraph 2.2*. It is also important to be open to changing perspectives while doing anthropological studies as the outcome of field studies rely on choices of what seems relevant at the time. The same study can thereby lead to different nuances of the investigation (Lave & Kvale, 1995).

### 5.1.1 OBSERVATIONS & PHOTOGRAPHY

An inherent method in field studies is to use our senses and thereby observe the reality of what is investigated. The method of observation in research can be divided into three categories 1) the naturalistic- 2) the participant- and 3) the structured observation (Delve, 2020). These are ranging in the level of intrusion to the observed environment from the naturalistic observation being situated at the investigated phenomena without interfering with it. In the approach of the participant-observer, the researcher takes on an active role in the observed phenomena and is thereby a part of his or her own observation. The structured observation is on the other hand a fabricated reality or enactment of a practice being observed in a sterile environment (Flyvbjerg, 2006). In this project, a combination of the above-mentioned approaches has been used in their ability to provide different data to the project. The participant observation seemed straight forward however the collaborating partners at Sweco are not currently involved with the case of Bispeengbuen and the actors working specifically on the case were of limited availability. The case is thereby studied within a competing firm in a forced setting making most observations structured in everyday observations at the office and in semi-structured interviews.

### 5.1.2 INTERVIEWS

The method of interviewing actors is a practice of qualitative research. For this study, the approach of the semi-structu-

red interview was used. The interviews were compiled of a series of predetermined open-ended questions with the possibility of additional questions emerging thereby creating a dialogue between the interviewer and interviewee. The questions were related to the interviewee's role concerning nature and biodiversity both professionally and personally. With this take the case of Bispeengbuen was separate from the interview situation and a more general opinion was obtained. The design of the interview questions was a series of personal yet broad questions to limit the risk of the interviewee detecting the interviewer's agenda and thereby giving answers that they think the researcher wants to hear (Thagaard, 2004). As mentioned by Lave & Kvale, (1995, p. 12) *""Interviewing" in ethnographic contexts, becomes a kind of collaboration"* however, the interviews in this project were planned and structured in the sense that they took place separate from practices that were discussed and the ethnographic context. To still get qualitative data from this method, it thereby comes to the researcher to make the interview setting a confidential atmosphere where the interviewee is not only an informant but a collaborator in the creation of knowledge (Thagaard, 2004).

Supplementary to the face to face interview an e-mail interview was conducted with an actor involved in the actual case of redesigning Bispeengbuen. In this interview, the questions were slightly different as the case could not be separated and there was no possibility of conducting a conversation and asking additional questions. By doing e-mail interviews the take of creating a confidential atmosphere is left to the interviewee as they can answer at their own time and level of detail thereby choosing how much they wish to participate (Hawkins, 2018).

During the face to face interviews, the conversations were recorded to ensure full documentation of what is being said (Thagaard, 2004). Additionally, we were able to split up so that one interviewer was taking notes while the other performed the interview. The data was afterwards transcribed and by following the same interview guide the answers were comparable.

### 5.1.3 TAKING NOTES

An ongoing method for researchers to structure data collection from different interviews, observations or other activities is taking notes. By doing so the experi enced atmosphere and body language can be described (Lave & Kvale, 1995). Through this method, the researcher also has the ability to clear his or her mind and forget what has been written in the notes so that new knowledge can come into focus. Taking notes furthermore creates a chronological registration of the data collection in the design process.

### 5.1.4 DESK RESEARCH & LITERATURE STUDY

The knowledge base needed to conduct this design

project was obtained through a comprehensive desk research and literature study. The process of gathering information through published work is known as desk research where the field of interest is investigated, and knowledge is obtained (Albrechtsen, 2020). The desk research gave an insight into specific examples of urban development projects where nature was at the centre of the design. From here the academic literature was reviewed in knowledge on Nature-based Solutions and the scientific knowledge on greening in cities among other things. The desk research method was the first task in this project as it, in the beginning, inspired the project by framing and providing a direction. This method has been used throughout the project to keep being informed on the field of interest. The use of desk research requires fewer resources than doing fieldwork and the method thus ensures that the actual fieldwork (observations and interviews) was conducted on an informed basis providing new learnings and yielding a more focused outcome (Albrechtsen, 2020).

## 5.2 DESIGN METHODS

As mentioned in *paragraph 2.1* the project is conducted in a combination between the Design Squiggle and the Double Diamond approach as a visualization of the design process. Supplementary to this approach, the design process is inspired by the approach of Design Thinking in its five modes: emphasize, define, ideate, prototype, and test (Carlgren et al., 2016). The three approaches have the core idea in common namely that the design process should not be seen as a sequence of steps but rather stages of the design process that can occur simultaneously and out of order in an iterative fashion (Carlgren et al., 2016; Design Council, 2022; Newman, n.d.; Yu Siang & Interaction Design Foundation, 2002). What Design Thinking contributes with is a user-centric approach that emphasizes the use of tests and user involvement throughout the project (Yu Siang & Interaction Design Foundation, 2002). Similar to this, is the notion of Co-design and Participatory Design where the role of the designer is reevaluated as a facilitator for design rather than an expert (Vaajakallio & Mattelmäki, 2014). These design approaches are core values in the Sustainable Design Engineer education and serve as an integrated mindset in the performance of this thesis. A series of appertaining design methods have thus been utilized to conduct the complex investigations within the project in the creation of a concept through the conceptualization.

### 5.2.1 WORKSHOP & BRAINSTORMING

In the facilitation of Co-design processes, the emphasis lies in an understanding that various actors can contribute to the design process (Vaajakallio & Mattelmäki, 2014). In doing so relevant situations and forums must be created to support the facilitation of Co-design. In this project, the use of workshops created the physical setting of the Co-design where the

participants were centred around the object of reaching a co-constructed understanding of the design problem rather than having a final design as the outcome (Vaajakallio & Mattelmäki, 2014). Within the workshop, the participants are introduced to a predefined task and an allocated time span. The workshop must thus be planned in a balance between structure and room for creativity that reflects the purpose of the workshop. Also formulated as *"workshops should be structured enough for the participants to feel on track. But loose enough to let people be creative and not feel trapped"* (MethodKit, n.d.). Within the workshop, the participants are creating and sharing knowledge through text, drawings and conversations through a brainstorming method where loose ideas and thoughts are being put out there to be iterated upon in collaboration. Brainstorming is also a method that can be used in other aspects of a project in the face of a dead-end or the need to reconfigure the project development.

### 5.2.2 SCENARIOS

As a next step in the conceptualization, the use of scenarios can function as prototypes or detailing of ideas provided in workshops or brainstorms. Where scenarios are often used in product design as an initial test that exemplifies the product (Anggreeni & van der Voort, 2008), the use of scenarios can broaden functioning as a storytelling tool (Design Methods Finder, n.d.). The function of scenarios is to describe a sequence of acts, from the actors' point of view described in a narrow or rich scope (Anggreeni & van der Voort, 2008). A scenario can thus describe a use scenario or a larger systemic context that the use entails. Scenarios are thereby convenient to use when designing concepts or redesigns. The creation of scenarios can be both written and visualized but the designer should reflect the actors it pertains to meaning that some elements of the design will be presented in the foreground and others in the background (Anggreeni & van der Voort, 2008). In doing so the core idea of the design should be precise and understandable so the relevant elements of the design can be mediated. In this project, a scenario is introduced as a storytelling of the use and function of the proposed concept.

# 6.0 | THEORETICAL FRAMEWORK

(SOURCE: OWN PICTURE)

This project will investigate and unfold the mechanisms at play within urban development, Nature-based Solutions and urban nature from a Multi-Level Perspective to understand the current regime and how regime adjustments can come about. Therefore, the theoretical extension of the Multi-Level Perspective described as regime adjustments has been adopted (Geels, 2002; Quitzau et al., 2013). This section will explain the Multi-Level Perspective and how it is applied in this thesis supported by the notion of junctions as a catalyst for discovering possible regime adjustment opportunities.

## 6.1 MULTILEVEL PERSPECTIVE

The Multi-Level Perspective emerged as a framework to describe long-term technological developments that were neglected by the Actor-Network Theory where socio-technical changes are described through a micro-focus of specific elements in a network (Callon, 1986; Latour, 2005). Both the Multi-Level Perspective and Actor-Network Theory describes the interlink between social and technical elements as an assembly that creates stability within the network or technological regime (Callon, 1986; Geels, 2002). Actor-Network Theory focuses on the local networks and relations within the network where the emphasis of the theory is to describe how shifting constellations form and reform the network in pursuit of stability (Callon, 1986). Thus, designers can guide network assemblages through design interventions such as objects and renegotiations of relations (Pedersen, 2020). On the other hand, the Multi-Level Perspective is a holistic investigation where the different levels provide an analytical frame to understand the long-term stability and incremental change within socio-technical configurations as a system of landscapes, regimes and niches (Geels, 2002; Schot & Geels, 2008).

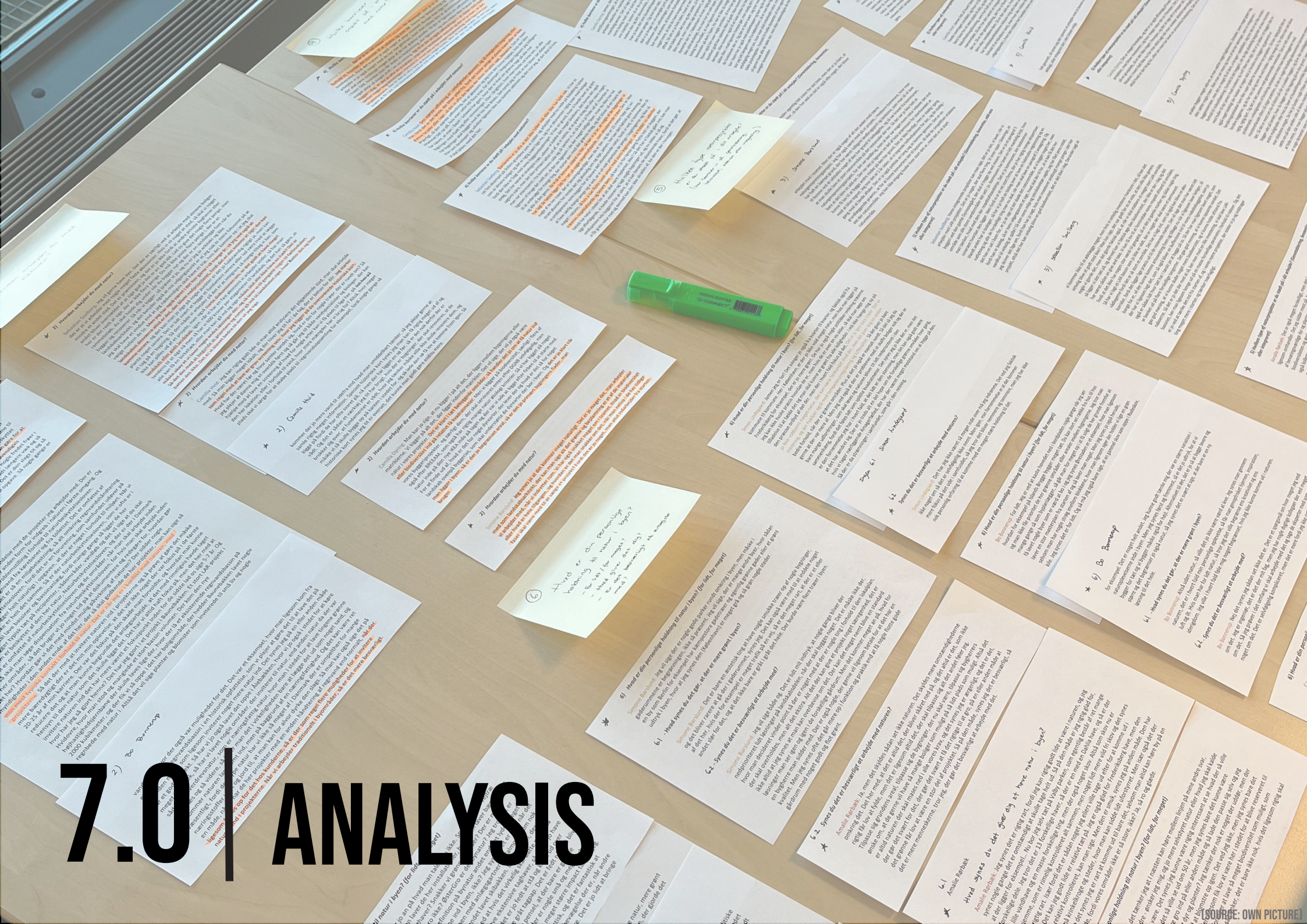
The stability of socio-technical configurations is found through heterogeneous elements and is a result of linkages between these elements. Activities within and between social groups are creating aligned elements and linkages which the social groups thus reproduce to uphold the stability of the socio-technical configurations. The coordination of activities within social groups forms developmental trajectories (e.g., technological trajectories (Geels, 2002)) as steppingstones for the creation of regimes. From this perspective, it is possible to analyse the evolution of regimes and anticipate the current trajectory of incremental innovation. Geels is furthermore elaborating on the semi-coherent set of rules that social groups adhere to as the meso-level called *socio-technical regimes*. At this level, the existing technological development has created stability and indicators of the current technological trajectories are visible. The technological trajectories are embedded in the macro level or the *landscape* of *socio-technical regimes* as the structural foundation of incremental innovations and whereas landscapes do change, they do so slower than regimes (Geels, 2002). Landscape structures are characterized by slow changes and external forces that modify the inclination of regime trajectories. But the landscape level is also subject to shocks of radical character that result in sudden regime transformations. On the opposite end, radical innovations are found in the micro-level of *niches* where innovation often evolves in a protected market separated from the rules of the regime (Geels, 2002; Schot & Geels, 2008). It is also within the niches that new social gr-

oups emerge and build new networks. The niches are thereby a relevant level in understanding grass-root movements and a place where translations are vital to the survival of new niche developments (Schot & Geels, 2008; Smith, 2007). The use of the three concepts in the Multi-Level Perspective is understood as a nested hierarchy where niches are embedded within regimes which are in landscapes. The prominent claim of the Multi-Level Perspective is that transitions occur as slow processes of emerging niches and incremental changes in the socio-technical landscape (Geels, 2002). But in the study of urban development transitions have emerged that do not fit with the established process and an extension to the theory has been suggested as regime adjustments (Quitzau et al., 2013).

## 6.2 REGIME ADJUSTMENTS

Following the logic of the Multi-Level Perspective, all transitions occur as an outcome of slow and deliberate, long-term transition processes (Jensen et al., 2015) or strategic facilitation of technological niches (Schot & Geels, 2008). However, the established socio-technical regime is proven to have some room to manoeuvre. Working within this space is a process where incumbent regime actors are performing regime adjustments (Quitzau et al., 2013). Thus, incumbent regime actors can exploit the ambiguities, contradictions, and conflicts, within the existing regimes to strategically challenge the established socio-technical regimes (Quitzau et al., 2013). This view has been exemplified specifically in the field of urban development and sustainable transition proving that the rigidness of reproducing regime reinforcing elements can be used to advance regime adjustments (Jensen et al., 2015; Quitzau et al., 2013). It is also noted that socio-technical systems are configured by *"endogenous tensions and ambiguities"* (Jensen et al., 2015) where urban functions are subject to challenges and thus redefined by social groups enacting productive micropolitics. The urban functions are furthermore elaborated in three concepts of junctions, navigation, and transition mediators as specifics to the urban context (Jensen et al., 2015). In this study, junctions are referenced to describe the location of the case study as junctions are place-specific areas that are multifunctional as they are used in different ways. Junctions are characterized by intersections where interdependent socio-material assemblages of the urban fabric meet in tensions and contradiction causing a troubled relationship that conflicts (Jensen et al., 2015).

Building on the above-mentioned theoretical assumptions this thesis investigates sustainable transition in cities as a Sustainable Design Engineering project. The Multi-Level Perspective is therefore a central theoretical frame for understanding how sustainable regime adjustments can take place in the coming redesign of Bispeengbuen. It furthermore allows for an analysis of the current regime and put a spotlight on regime reinforcing structures that can be exploited to promote sustainable adjustments.



# 7.0 | ANALYSIS

(SOURCE: OWN PICTURE)

Having framed a relevant knowledge base within the academic literature and outlined the theories and methods for this project this section presents the analytical findings. First, the current regime of urban nature is established followed by an investigation of problems and barriers relating to working with Nature-based Solutions. This is investigated through the collaboration with the consulting company Sweco in which different actors from Sweco were mobilized in a feedback group. In two sessions the actors were involved, first in an interview to provide a broad understanding of their point of view in working with nature and Nature-based Solutions. Secondly, a joint workshop focused on brainstorming on the barriers found in the interviews will be presented. Additionally, two relevant case studies are viewed in a comparative analysis. The projects are 'Ålebækken Ruinpark – from a treatment plant to a recreational park' and 'Baunebakken – from threat to opportunity'. Lastly, the findings are summarized before digging into the conceptualization in *section 8.0*.

## 7.1 THE CURRENT REGIME – URBAN NATURE

Drawing on the academic use of urban nature and the knowledge base of *section 4.0 State of the Art* the actual urban nature of Copenhagen is investigated to analyse the current regime. The analysis is performed from empirical data collected from publicly available material such as newspaper articles, municipal strategies, statistics and observations. The observations provided four crucial findings regarding the regime of urban nature in Copenhagen. The first finding concerns the geographical placement of larger areas of urban nature as the appearance of it varies from district to district. Copenhagen has at the moment, about 100 green spaces (not including Frederiksberg) consisting of parks, cemeteries, green paths and other green areas wherein three areas are characterized as nature (i.e., Amager Fælled, Kalvebod Fælled and Utterslev Mose) next to these the two biggest parks are Valbyparken and Fælledparken meaning that the larger green areas are excluded from the inner city and district centres. As *illustration 10, on the next page,* shows it is visible that the larger green areas are spread out in the different districts of the city, but the north-western part of Copenhagen stands out as the green areas in this district are mostly placed at the city borders away from the centre. The second finding regards the variety of urban nature besides the larger areas visible in *illustration 10*. Looking at the more than 100 green areas of the city it is evident that natural areas also include trees along cycle paths (Københavns Kommune Parker Kirkegårde og Renhold, n.d.). For instance, the cycle path connecting Nørrebro with Valby known as 'Den Grønne Sti' (the green path) is an example of a green area integrated with the infrastructure (Rathsach & Bang, n.d.). Additionally, pocket parks, gardens and nature from residential streets are also promoted as green areas of the city which broaden the level of nature found in the urban setting. These examples showcase another take on


ILLUSTRATION 10:
'LARGER GREEN AREAS OF COPENHAGEN'. OWN ILLUSTRATION. (SOURCE: GOOGLE MAPS, 2022C)

green areas and the diversity they represent, *see illustration 11* on the following pages for a visual representation of the variating types of nature found in Copenhagen. The third observation is that there is a tendency to be an increased focus in both Frederiksberg and Copenhagen on the importance of green areas as both municipalities have introduced and opened new parks in both existing residential areas as well as new development areas, during this project. In this observation, it is noted that there is a holistic approach to adding urban nature to residential areas and that it is integrated into urban development from the beginning (Københavns Kommune Teknik- og Miljøforvaltningen, 2009). The last finding is not specific to Copenhagen but important as it regards the variety in visual expression relative to the changing seasons. This finding was somewhat surprising but was emphasized by chance as the project period ranged from February to May, *see pictures 24 and 25* on page 60.

The regime of urban nature is formed by the general development of cities where both transportation regimes and housing expansions are prominent. It is thereby relevant to look at these regimes as well when investigating the current regime of urban nature in Copenhagen, which will briefly be described in the following paragraphs.

### 7.1.1 TRANSPORTATION

Looking at statistics there has been a constant rise in private car ownership since the beginning of the cen-

tury only interrupted by the economic crisis of the late 2000s and the COVID-19 epidemic in recent years, *see appendix 1*. From 2010 till now the number of cars has risen almost 20%, and it is not only the total number of cars that is increasing, more and more are buying a second, third and even more cars per household expanding on the availability of cars within households and families (Brinch-Pedersen, 2022; Danmarks Statistik, n.d.). Following this development, the number of kilometres driven has increased concurrently and there has been a general rise in traffic of 14% since 2010 (Brinch-Pedersen, 2022). In Copenhagen, this rise has exceeded 40% and especially highways are experiencing a rise in traffic (Brinch-Pedersen, 2022). Roads and infrastructures have also follow-


ILLUSTRATION 11:
'NATURE IN COPENHAGEN'.
A THREEFOLD DIVISION OF HOW URBAN NATURE IS DESIGNED. THE ILLUSTRATION SHOWS A DIVISION OF NATURE IN COPENHAGEN PLACED RELATIVE TO THE SCALE (URBAN - INTEGRATED - NATURE) AND THE SURROUNDING IMAGES.
OWN PICTURES.
THE ILLUSTRATION IS INSPIRED BY COPENHAGEN MUNICIPALITY TECHNICAL AND ENVIRONMENTAL ADMINISTRATION, (2015)







RATED NATURE

ed this development but whereas public roads make up 5% of the Danish Road network they carry almost half of all traffic (Vejdirektoratet, 2022). This means that the average commuting distance is increasing with the use of highways. Looking at average commuting distances per municipality they range from 11,7 to 35,5 km with a national average of 22 km to and from work. In the short end, the citizens of Frederiksberg and Copenhagen are with the distances of 11,7 and 12,6 (Vejdirektoratet, 2022) insinuating a mismatch between commuting distance and traffic rise.

### 7.1.2 HOUSING

The other regime that influences urban nature is regarding housing and in particular urbanization and population density in cities. The municipality of Copenhagen expects an increase of 10.000 citizens per year from 2015 to 2025 and this demands new housing accommodation and urban development (Københavns Kommune Teknik- og Miljøforvaltningen, 2015b). There are currently five major development areas in Copenhagen namely Nordhavn, Carlsberg, Ny Ellebjerg, and Sydhavn as well as a contin-

uous extension of Ørestaden (Samson & Anthon Andersen, 2019). These areas mark the ongoing transition of Copenhagen from an industrial city to a knowledge city but by doing so existing rural nature is being underprioritized resulting in critique and resistance from the population (Samson & Anthon Andersen, 2019). An example of this is Amager Fælled and the development in Ørestaden. In 2019 the preservation order of tree areas of Amager Fælled was lifted to make way for housing projects (Nyholm & Malling Beck, 2019). The constant prioritization of housing over nature emphasises the old ways of thinking of nature and city separated and shows how the macro-level decision in other regimes are influencing the development of the urban nature regime.

PICTURE 24:
WINTER AT ÅGADE - 22TH OF FEBRUARY. (SOURCE: OWN PICTURE)

PICTURE 25:
SPRING AT ÅGADE - 15TH OF MAY. (SOURCE: OWN PICTURE)

### 7.1.3 NESTED REGIMES

This structure is visualized in a Multi-Level Perspective illustration of the landscape-, regime-, and niche level, *see illustration 12* on the next page. The umbrella of the infrastructure regime is viewed through the historical development of urban cities that has created a dominantly *grey infrastructure* that favours *housing* and *transportation* over *urban nature*. Approaches such as Nature-based Solutions are with their focus on addressing societal challenges by sustainably managing ecosystems influencing this regime from the niche-level in a change towards a *blue/green infrastructure*, *see illustration 12*. From this visualization, the current development has been mapped according to the trajectory of path dependency yet shows how Nature-based Solutions have the potential to move into the regime as a result of stabilizations in the niche developments. At the landscape-level urbanization represents the overall structural trends that have defined the current development. Within this everything that upholds the current regime is entailed (e.g., laws and regulations within planning, economic developments in cost

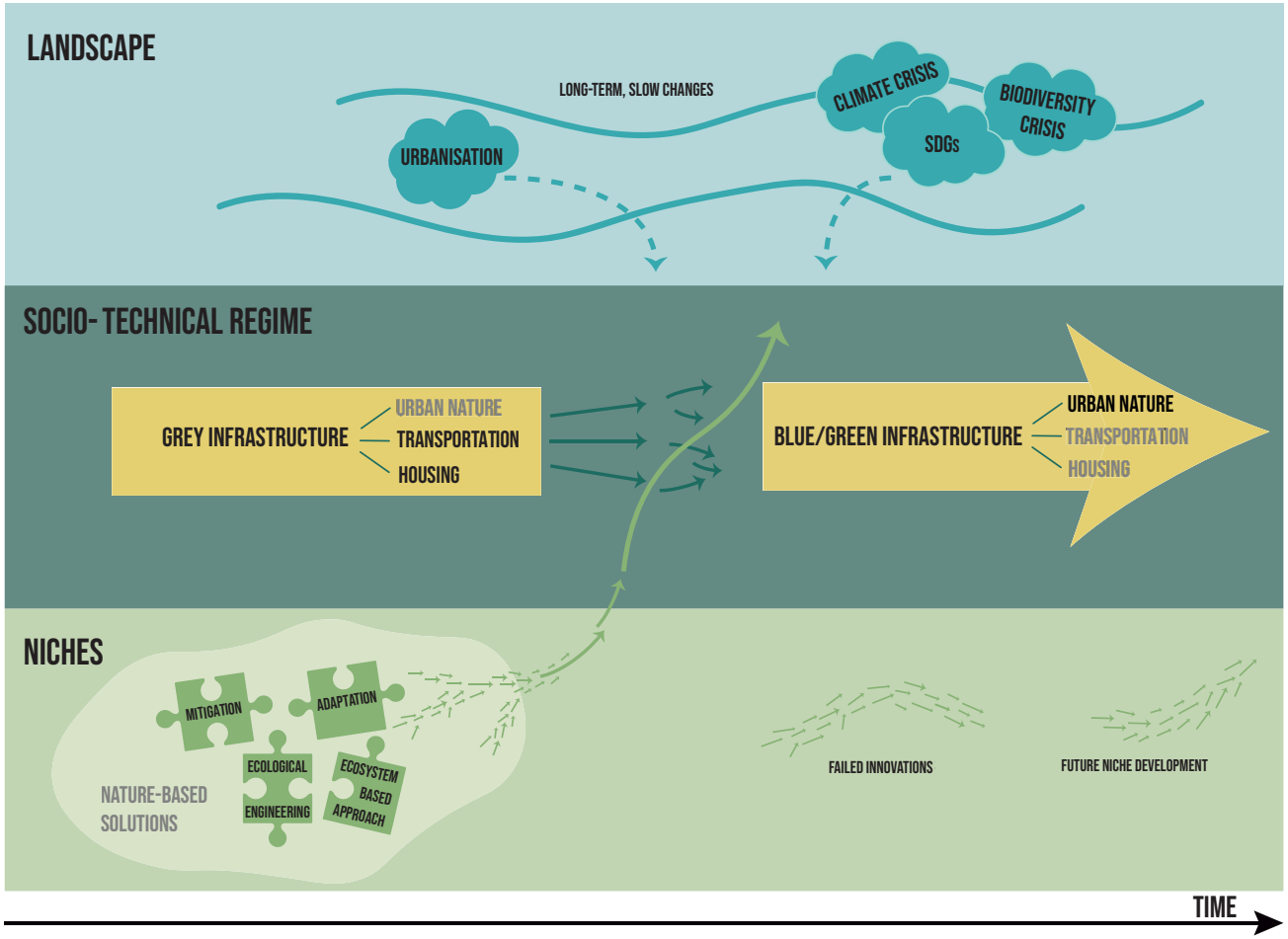



ILLUSTRATION 12:
'NESTED REGIMES IN A MLP'. OWN ILLUSTRATION. INSPIRED BY GEELS, (2002).

etc.). To the right, at the landscape-level, the elements that have emerged in more recent decades are the climate crisis, biodiversity crisis and the SDGs which put pressure on the current regime and create openings for innovations at the niche-level.

The current regime of urban nature is grounded in former strategies framing nature as being parks and larger green areas separated from the urban context. However, there are slow changes visible in the current strategies e.g., by using knowledge on mental health to push the green agenda as well as expanding on the understanding of urban nature and how it can look (Københavns Kommune Teknik- og Miljøforvaltningen, 2015a; Petersen & Nielsen, 2011). But there are still many concerns, to consider in urban development. The next section will thus investigate how the current regime is halting the formation of urban nature and green infrastructure seen from a consulting perspective.

## 7.2 INTERVIEWS

In this paragraph, the regime incumbent actors are investigated in reference to their profession, daily work and how they encounter and work with nature. Our collaboration with Sweco provided an insight into the consulting practice where empirical data was collected through seven semi-structured face to face interviews where employees were interviewed separately. The interviews were conducted to understand the current practice of consulting companies when working with various engineered solutions in the

**TABLE 2. DESCRIPTION OF INTERVIEWEES**

| Title | Professional background | Department in Sweco |
|---|---|---|
| Specialist | Engineer in technical hygiene, specializing in drainage management | Water, Energy, and Industry - Water and climate |
| Landscape Architect | Sketching landscape architect, making ideas and sketch proposals | Architecture and city planning - Landscape |
| Urban Planner | Urban planner mainly focused on making site plans, providing input to DGNB certifications and in charge of creating a sustainability compass | Architecture and city planning - City planning |
| Structural Engineer | Regional manager for sustainable construction, with focus on the sustainability on construction projects by use of certifications | Construction - Sustainable construction |
| Architect | Creative director of public housing, developing public housing and the architecture of the housing renovations | Architecture and city planning - Housing |
| Biologist | Biologist, deal with environmental tasks and environmental screenings that assess the impact on the environment | Water, Energy, and Industry - Environment |
| Generalist | Engineer, landscape architect, DGNB consultant & sustainability manager | Water, Energy, and Industry - Water and climate |

TABLE 2:
'DESCRIPTION OF INTERVIEWEES'. OWN ILLUSTRATION.

urban fabric. An overview of the interviewed actors is provided in *table 2*, and the full transcribed versions of the interviews can be found in *appendix 2*. The aim of this section is thus to provide a more specific understanding of the current regime and what regime incumbent actors view as barriers when working with urban nature.

From the interviews three questions are emphasized in this analysis and their respective answers, *see illustrations 13, 14 and 15* on the following pages. The first question lays the foundation of how each actor views their daily work with nature. From this question, the actors can roughly be divided into two groups; those who look at nature from the beginning of the project, and those who look at nature once they are in conflict. In this division, the specialist and architect mention nature as a problem in doing their job, *see illustration 13* on page 64. Examples emerge of difficulties in prioritizing nature in tight budgets but also in rules and legislations interfering with how to approach it, to begin with. In dealing with economic limitations the general approach is to cut out non-essential elements where everything within the construction is seen as essential, thus nature considerations are left non-essential. From the specialist's point of view, water management is his field of expertise and it has a frequent interface with nature, however, it is often affected by rules and legislations that counteract each other (e.g., the Nature Preservation Act and the Environmental Protection Act) *see illustration 16* on the next page.

*"... when it (stormwater reservoir) has been out there for a while, then nature takes over these lakes, and then it suddenly becomes covered by section 3 of the Nature Conservation Act, and that says, you must not make changes to the condition, because now what was a technical facility, has become a natural area. So, nature occupies things, and this means, among other things, [...] that when rainwater enters, there are some sediments in this rainwater, i.e., some particles, and when they come out to a rainwater basin, they precipitate and contaminate the bottom, and it builds up over time. The pool must be cleaned every five to ten years. But suddenly you cannot because now a salamander or something lives nearby, and then it is suddenly protected. [...] when nature has taken it, then they cannot be allowed to clean the pool, because there is the other law that says well, now it is nature now you cannot just do what you want, so there is a schism, between the Environmental Protection Act, which requires it to be cleaned, and the Nature Conservation Act, on the other hand, which says, okay, now it's nature, so there are rules for what you can do."*

ILLUSTRATION 16:
'QUOTE FROM SPECIALIST'. OWN ILLUSTRATION. (SOURCE: INTERVIEWS AT SWECO).

In the other group those who have a complaisant approach to nature mention working with it as a starting point but also in terms of limiting the damage. It is highlighted that preserving nature is often not an option and that it is, therefore, important to look at the area and make a note of existing fauna and flora to try to make room for them once the construction is done. Some of the advantages of doing so have proven that slight adjustments in the placement of ponds, plants and buildings can boost the existing vegetation. But it is still mentioned that working with nature is on the building's terms and that it must comply instead of having its own terms and conditions. In this group, it is furthermore visible that those in favour are looking beyond nature itself in searching for argument and validation of nature in a given project. In this regard, the focus is placed on certifications, historical maps and biodiversity as arguments that voice the concerns of nature.

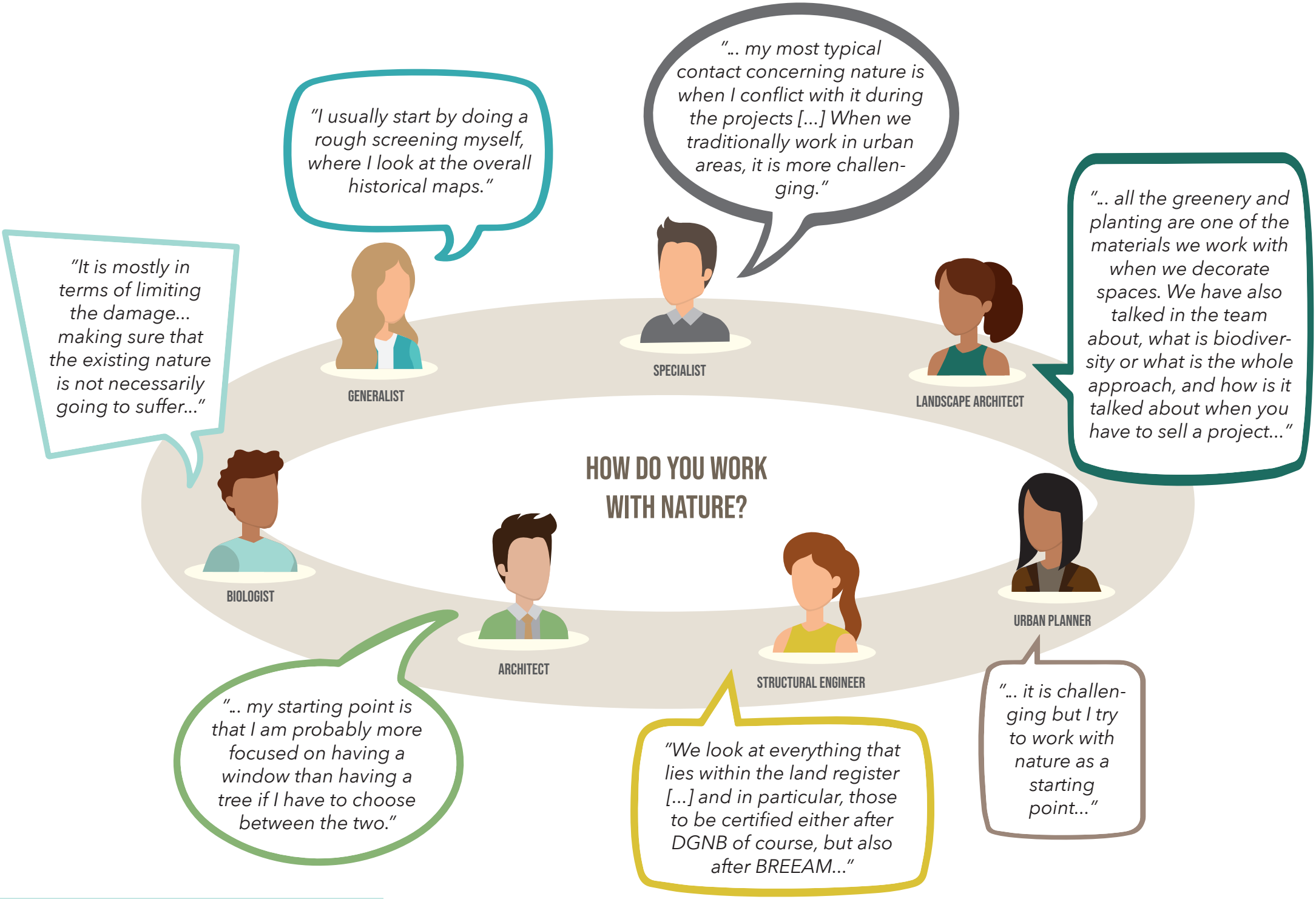



ILLUSTRATION 13:
'QUESTION 1'. OWN ILLUSTRATION. (SOURCE: INTERVIEWS AT SWECO).

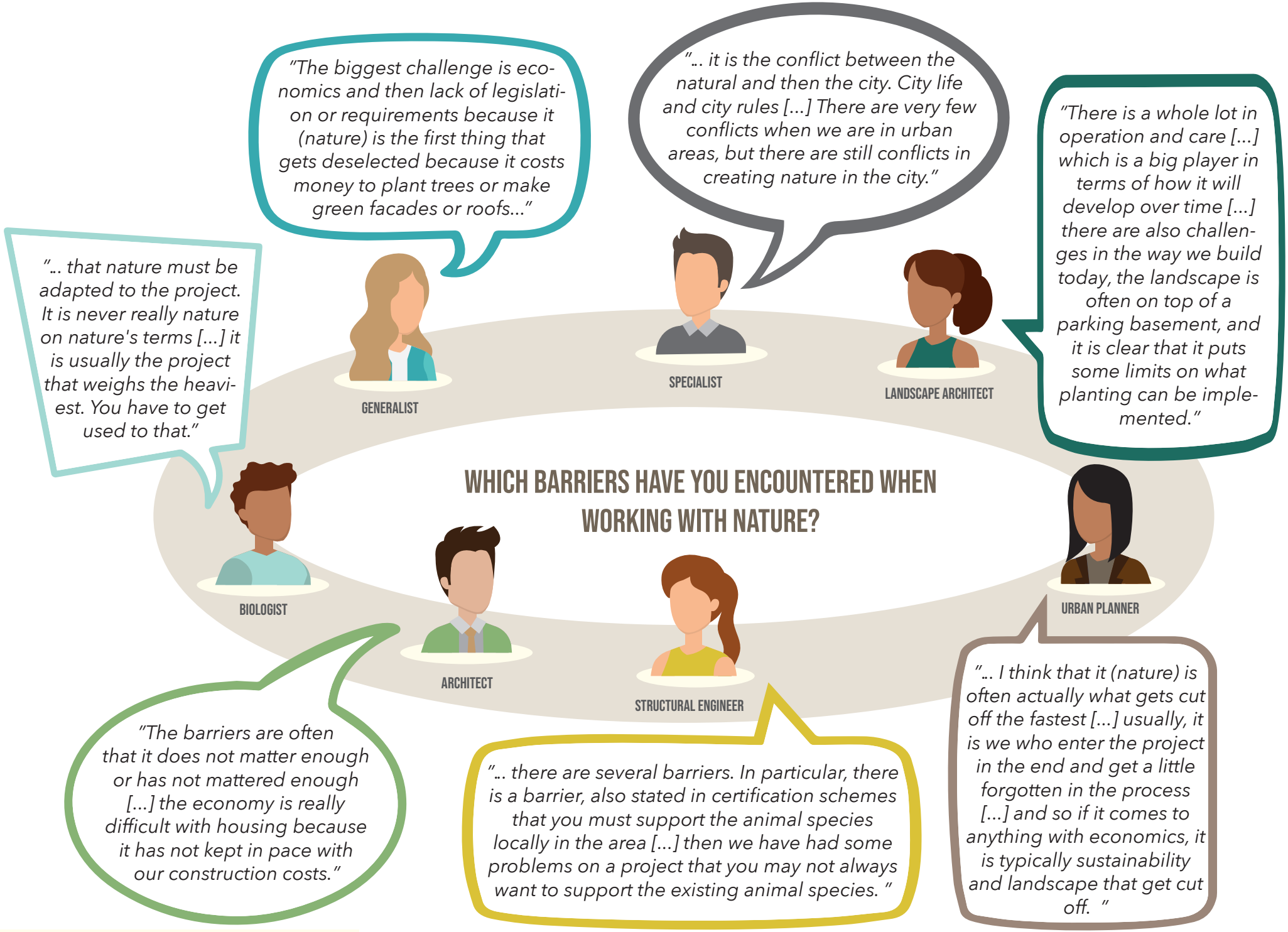



ILLUSTRATION 14:
'QUESTION 2'. OWN ILLUSTRATION. (SOURCE: INTERVIEWS AT SWECO).

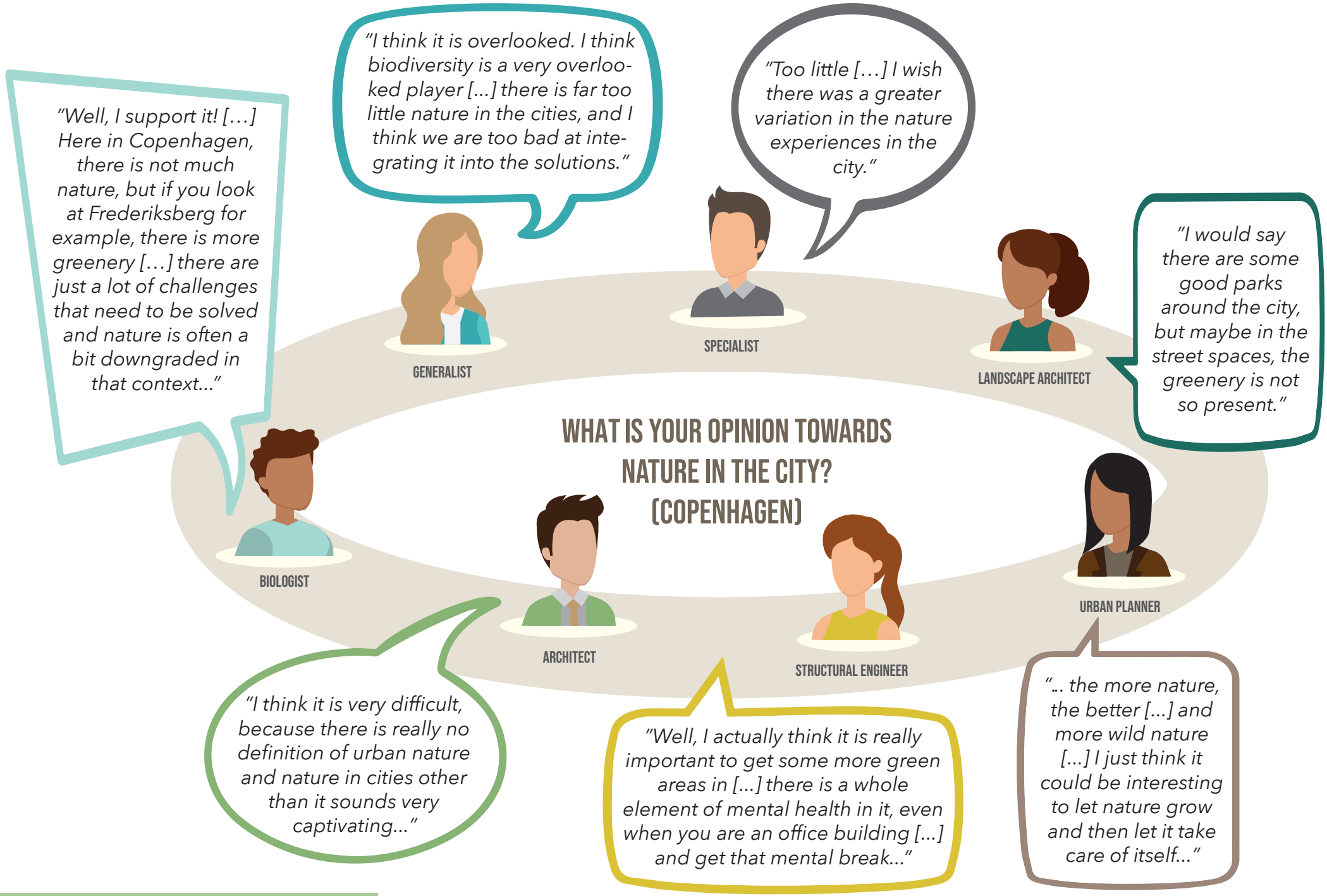



ILLUSTRATION 15:
'QUESTION 3'. OWN ILLUSTRATION. (SOURCE: INTERVIEWS AT SWECO).

The second question is building on the prior answers in the elaboration of experienced barriers when working with nature. From these answers, the above-mentioned experiences are repeated by different actors than before although with an alternative perspective. An example of this is found when viewing the generalist's answer stating that there is a lack of legislation or requirements when wanting to design for nature, *see illustration 14* on page 65. This provides a positive attitude to the above-mentioned experience regarding the conflict between the Environmental Protection Act and Nature Conservation Act. Another simile is the perception that when working with nature there is always a compromise. This is especially noted by the biologist, but the landscape architect also mentions an example in the way that landscape is generally planned to be on top of parking basements limiting the possibilities when designing the landscape. The new findings that this question provided was the barrier that lies between the urban setting on one hand and nature on the other hand. This is brought to life using examples of how existing species might not be welcome after a new building is constructed as they risk conflict with the intended use. However, the value of adding nature to urban development is viewed as greater than in rural and suburban cities, thus emphasizing that there are both advantages and disadvantages of nature in the city and that managing these often results in conflicts. On top of these barriers, the recurrent barrier mentioned by more than half of the interviewees is the element of the economy. Nature and landscape design in urban development and construction has a reputation of being expensive and thereby quickly neglected to save on expenses.

The last question was concerning the actor's personal opinion towards nature and specifically the current state of urban nature in Copenhagen. An interesting point from these interviews was provided by the architect who quickly contemplated the notion of urban nature questioning what it is and means, *see illustration 15* on the previous page. This point relates to the notion of nature and the perception of it in the city as the lack of 'wild nature' was mentioned along with a wish for a greater variation. The general opinion across all actors was that nature in the city is important and has a variety of desirable elements to contribute to the city landscape but also in terms of a source for mental energy and creativity. Another tendency in the received answers is the opinion that there simply is not enough urban nature and that the integration between buildings, infrastructure, and nature could be improved.

### 7.2.1 MAIN TAKEAWAYS

From these interviews, the current regime is even more detailed and viewed from a consulting perspective. In this, three main points were noted as the current challenges, namely: economy, working with interdisciplinary solutions, and ensuring continued nature in the following operations phase. The barrier to the economy was directly mentioned by several of the actors and concerns the need for prioritizing the economy on behalf of the prioritization of nature. The barrier thereby concerns the need for prioritizing or showing the value of nature. The barrier of working with interdisciplinary solutions emerged as the participants expressed that prioritization was essential in all projects and that they were primarily focused on their professions and doing what they use to even though a budget is tighter or there are other possibilities

at hand. The operations barrier came primarily from those working directly with nature but also in its duality of maintaining both technical facilities and natural environments. These three topics (i.e., economy, interdisciplinary, and operations) were later used in a brainstorming workshop, *see paragraph 7.4*. Though, before moving on to the workshop, two cases will be investigated as these were mentioned repeatedly during the interviews as examples where nature had been given a significant role and where different parties of the project had learned something valuable that they could use in the future work. The cases were Ålebækken and Baunebakken.

## 7.3 REAL-LIFE CASES

The following paragraph will outline two specific examples of completed projects performed by Sweco. The projects are examples of emphasizing nature however neither represent urban nature but the incorporation of Nature-based Solutions. The focus will be on why the projects came about and how nature was dealt with in the respective projects. Both projects were undertaken by the department of water and climate in Sweco, which focuses on the management of water and climate adaptation. The two cases will briefly be described in separate info boxes, on the next pages, followed by a comparison of the two cases highlighting the main takeaways from the projects concerning the aspect of working with Nature-based Solutions.

The steps that are recurring in both projects is the level of creative freedom that provided a space for alternative solutions based on the existing area and natural environment. In this regard, a holistic approach to biodiversity was integrated into both projects on a larger and smaller scale respectively. This is shown by the dissimilarity of the two projects whereas the first project (Ålebækken Ruinpark) was a nature project, and the second project was a relocation of a water reservoir. In this respect, it might seem obvious that Nature-based Solutions and focus on the existing natural environment defined the case of Ålebækken Ruinpark. However, the main focus was still that the area could reduce overflow into the neighbouring Mølleåen and reduce obnoxious smell so that the area could be opened as a public park. The traditional approach would thus have been to level the ground, build the two underground water reservoir tanks and plant new vegetation. But an early focus on the characteristics of the area as well as an analysis of preservation potentials made it possible to reuse soil and preserve selected trees.

In the other case of relocating a water reservoir the main focus was again on adaptational character but with a new solution as the old tank was in the way of the new train line. The “easy” solution would once more be to find a new place for the underground water reservoir but by including the residents of the area in the project it was possible to create a sustainable drainage system using their private and shared green

## ÅLEBÆKKEN RUINPARK – FROM A TREATMENT PLANT TO A RECREATIONAL PARK

One of the newer finished preservation and restoring projects performed by Sweco is Ålebækken Ruinpark in Brede. The project originated from the renewed interest that the municipality of Lyngby-Taarbæk and the public utility of Lyngby-Taarbæk had for the area of the disused treatment plant, Ålebækken (Sweco, 2022a). The idea was to integrate the area into the local community, by transforming it into a welcoming recreational park, making it accessible and open to the public.

Since Sweco functioned as the consulting engineer on the project, the first step in the process of redesigning the area was therefore understanding the location and history under investigation. Ålebækken is located close to the historical museums Frilandsmuseet and Brede Værk in a scenery characterized by the history tied to the creek Mølleåen and all its watermills. It had been closed to the public for over 40 years due to safety reasons (Hvid et al., 2016). A design/concept proposal was composed to visualize the vision for the transformation of the area. Most of the work considered the treatment of water and the contaminated soil in the area (Lyngby-Taarbæk Forsyning, n.d.). Still, nature played an essential role in the project since the emphasis was placed on connecting the area of Ålebækken with the surrounding natural resorts.

The identity of the area was influenced by the untamed nature that had been given free rein after many years of being left alone. This had created a new and interesting type of landscape combining the rigid man-made structures of the disused treatment plant with the wild and untamed nature of the area, referred to as an industrial ruin park (Hvid et al., 2016). Hence, the three key elements of the redesign process were reuse, preservation, and historical traits. Vegetation, stones and soil were restored in the park, as well as the replacement of salamanders captured in reservoirs (Hvid et al., 2016).

The project was influenced by the historical surroundings and the request to combine a modern climate adaptation plant with a recreational park, where nature and elements from the disused treatment plant could thrive (Lyngby-Taarbæk Forsyning, n.d.). Throughout the project, sustainability was the core area of focus.

| | |
|---|---|
| **LOCATION** | Virum |
| **PROJECT TIMESPAN** | Spring 2019 - Summer 2021 |
| **CLIENT** | Public utility of Lyngby-Taarbæk |
| **SDGs** | 3, 9, 11, 13 and 15 |

## BAUNEBAKKEN – FROM THREAT TO OPPORTUNITY

Another project recently finished by Sweco concerns sustainable drainage systems in a residential area - Baunebakken in Hvidovre (DNNK, n.d.). This project came to be as a new high-speed train line was to be built between Copenhagen and Ringsted. The train line was thus crossing an area where an existing water reservoir was placed, and a new climate adaptation solution was needed (Hofor, n.d.). At the beginning of the project, the employees from Sweco were given creative freedom in designing nature-based rainwater solutions.

The project was to create a drainage system where rainwater is guided away from the sewer system, in a Nature-based Solution were nature and greenery are used as an alternative to a traditional water reservoir (DNNK, n.d.) it was done so by integrating nature in three ways:

1) Along with the housing, there were small rainwater beds integrated into the pathways in the residency. The rainwater beds were receptors for excess water from roof surfaces.

2) Next to parking lots, there were small hollows and traditional engineered water reservoirs to collect excess water from impermeable surfaces.

3) In the eastern end of the area, the water is led through a playground in small creeks and a larger hollow in the football field where water can be held back in case of cloudbursts.

In this project, the residents of the area were included in the rainwater management project to put their characteristics in the visual expression of the rainwater beds as they were on the individual properties (Frederiksen & Nielsen, 2015). The rainwater beds were, therefore, left for the residents to maintain, and they were thus given a choice between beds with fauna and nature or grass with a lowering. From an inclusive approach, roughly 110-120 of the 155 residents chose the rainwater beds with a wild planting.

| | |
|---|---|
| **LOCATION** | Hvidovre |
| **PROJECT TIMESPAN** | 2013 – 2015 |
| **PROJECT COLLABORATORS** | Project owner and Contractor HOFOR, Consultant SWECO with GHB landscape architect, Contractor Ebbe Dalsgaard A/S |

spaces. Another takeaway from these cases is the changing perception of how nature is allowed to look. In the case of Ålebækken, some of the existing structures were kept as they provided habitats for animals and wild vegetation had grown around them. The finish of the area is thereby formed by the historical traits as well as the natural will of the vegetation providing a wild expression to some elements of the park. This is the same finding that the choice of flower bed expresses in the case of Baunebakken. However, as the division shows around 30-40 residents were not ready to have a wild flowerbed as a water reservoir. Nature is thereby still seen as an aesthetic element that can be moulded to look good. Hence there is a mismatch between nature looking good and when it is diverse and can contribute to ecosystems. The cultural ecosystem services can however be influenced so that they match with the natural ecosystem services and the two described cases show that it is possible to move the perception of cultural ecosystem services by having nature in mind from the beginning of a project and that it is possible across scales.

## 7.4 BRAINSTORMING WORKSHOP WITH FEEDBACK GROUP

In this paragraph, the second session with the feedback group is presented. In this workshop, four actors were gathered at a joint session to brainstorm solutions within the three barriers: economy, interdisciplinarity and operations. The workshop intended to explore the possible solutions within the current regime to have the regime incumbent actors contemplate the potentials that could result in potential regime adjustments. The participants consisted of four women two of whom had been interviewed previously (the generalist and the urban planner). The two new actors were a specialist similar to the one interviewed and a geographer. The duration of the workshop was an hour where the participants were to read and be inspired by the interview illustrations, *see illustrations 13, 14 and 15* on the previous pages, and afterwards brainstorm on the three barriers identified by answering the supporting questions, *see illustration 17* and *appendix 3* for workshop material.

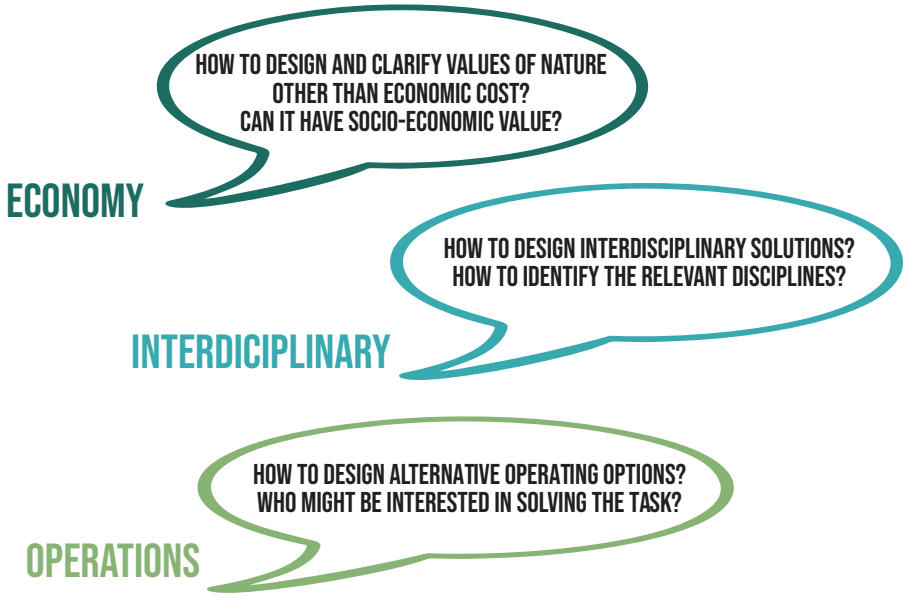



ILLUSTRATION 17:
'BRAINSTORM ELEMENTS USED IN THE WORKSHOP'. OWN ILLUSTRATION.

PICTURE 26:
SEEKING INSPIRATION. (SOURCE: OWN PICTURE)

PICTURE 27:
BRAINSTORMING. (SOURCE: OWN PICTURE)

PICTURE 28:
IDEAS ON THE TABLE. (SOURCE: OWN PICTURE)

Following the course of the workshop, the participants were located at two tables during the facilitation, *see pictures 26, 27 and 28*. The analysis of the workshop will be divided into the three barriers and their respective outcome from the workshop and concluded with a summation of the main takeaways.

### 7.4.1 BARRIER 1 – ECONOMY

The first barrier to be solved in the workshop was the element of the economy and the perception that Nature-based Solutions are expensive and thereby not prioritized. To get the participants to brainstorm on this subject two supporting questions were visual on the brainstorming paper *'How to design and clarify values of nature other than economic cost'* and *'Can it have socio-economic value?'*. In this brainstorm, it is mentioned to use the existing academic studies and literature to highlight the derived effects nature can have on mental health, housing prices, and more. It is noted that many of these values are seen as tacit knowledge that makes it difficult to document. In talking about this dilemma, a suggestion is brought to the table of doing before and after surveys. They would however be on

a leap of faith, to begin with, as it is a matter of predicting the outcome of the projects. But surveys of mental well-being, sick days, children's happiness, and general happiness were some of the ideas mentioned to indicate a possible improvement or it is possible to investigate by citizens providing their own estimates. This approach is supported by another valuation model such as valuating the life of bees or butterflies. In doing so they could enter into socio-economic politics as a design parameter in an argument for more nature in cities.

### 7.4.2 BARRIER 2 – INTERDISCIPLINARY

In brainstorming about the second barrier i.e., the fact that working with nature and Nature-based Solutions are interdisciplinary and require an interdisciplinary approach, the supporting questions for this barrier were *'How to define interdisciplinary solutions?'* and *'How to identify the relevant disciplines?'*. This brainstorm came as a natural extension of the previous as biologists were mentioned as natural allies in trying to put a price on the life of an insect and that they know what species would be relevant to look at in the given area. What permeated the brainstorming was thereby the simple yet important task of ensuring that a project manager from the start is objective in his/her field and includes various professionals from the beginning, ensuring that the team jointly could decide the relevant perspectives of the project. As an added effect the participants argued that the inclusion of other professions would provide a personal element to the project by making sure that the different professions knew who to ask for help in the different departments. Debating this the main view was that even though the company have an interdisciplinary approach it should be practised more and earlier before knowing who is necessary throughout the project. The emphasis in this line of thought was a joint start and mutual respect for each profession and an inclusive mindset of doing the project in close collaboration, since each point of view is needed, and the project cannot be solved alone.

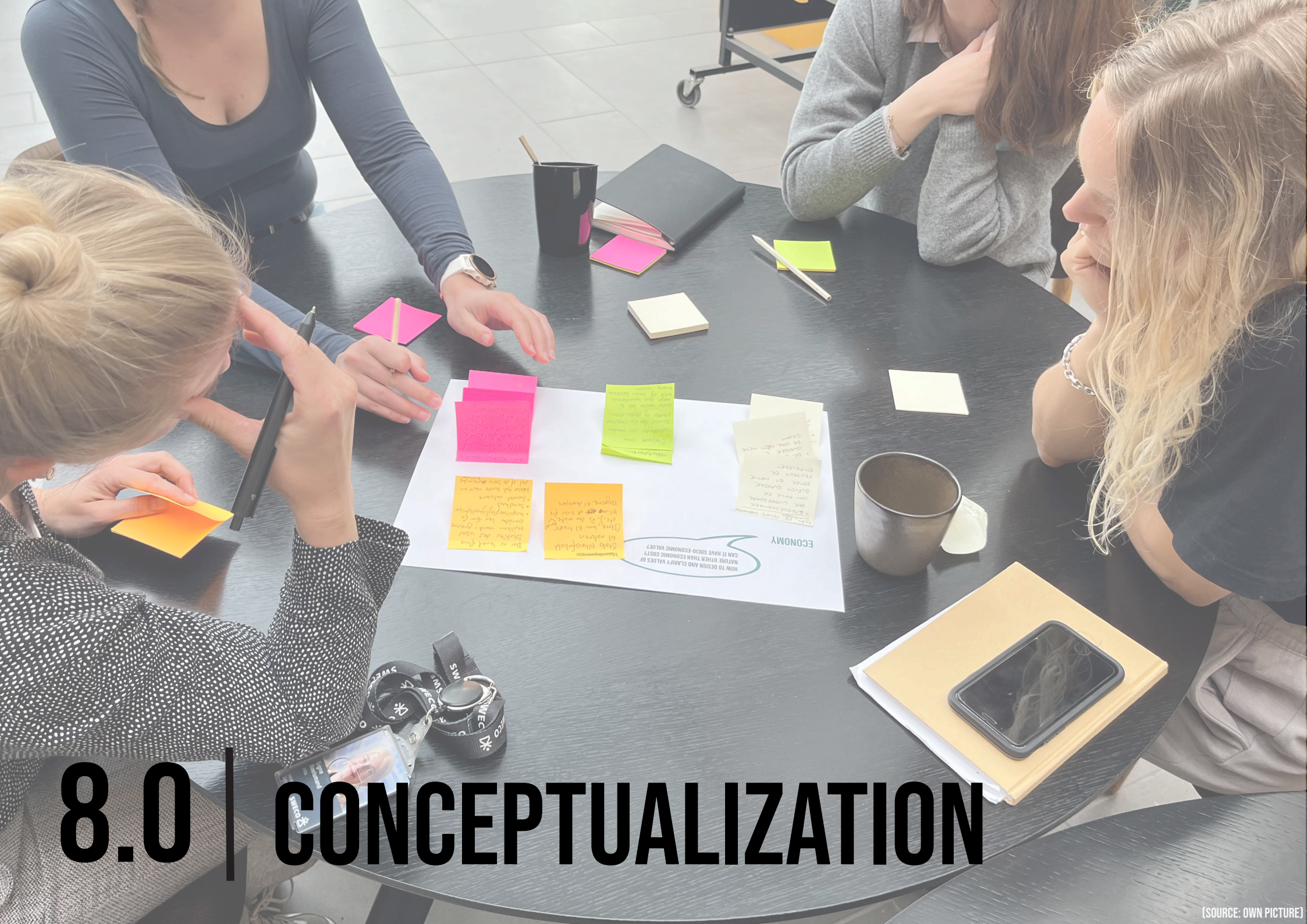
### 7.4.3 BARRIER 3 – OPERATIONS

In the last barrier, the element of operations and continued care of the project outcome is debated. To guide this brainstorming the supporting questions were *'How to design alternative operating options?'* and *'Who might be interested in solving the task?'*. In this section, the intention was to have the participants contemplate their current view on operations as the consultants often leave the project before the operation and maintenance begins. Like the previous sessions, this topic came as a natural extension of the interdisciplinary discussion where the participants noted how maintenance crew are often neglected in the project and that their point of view would be appreciated in this workshop. Apart from this, the element that dominated the discussion was concerned with the willingness to take risks in alternative maintenance and crew. Here it was mentioned that the responsibility of maintenance is divided between maintaining nature and technical facilities. But it was suggested to group the different tasks in collaboration with the responsible actors and to suggest a looser approach to nature maintenance for example by a brief maintenance stop as a test. Another suggestion was about dividing tasks among volunteers or local communities as an alternative method of maintenance. Parallel to these ideas it is mentioned that a communications campaign is needed to

engage the local community in the alternative maintenance plan and that inclusion of their expectations could enhance not only nature's chance of survival but also their willingness to allow a more rustic look.

### 7.4.4 SUMMATION OF THE WORKSHOP

The structure of the workshop was performed as brainstorming on how to solve the current barriers within the given regime as an alternative to demanding political changes or larger budgets. In doing so solutions are being highlighted as possibilities that the actors can do themselves or specify for someone else to do within the current limits but with a preceding need. For instance, it is mentioned that Sweco could develop a method for valuating the life of different species so that it could be an integrated part of their business and consulting strategy. Another example concerns the communication of maintenance and measuring of expectations and outcomes. Generally, it was suggested to team up with companies that are familiar with surveys and have them do a before and after screening so that the mental health effects can be documented and that there is a follow-up with each project. From this analysis, the knowledge foundation about the potential solutions within the current regime has been established and it is now possible, along with the findings from the three previous paragraphs of the analysis, to move on to the conceptualization phase.




# 8.0 | CONCEPTUALIZATION

(SOURCE: OWN PICTURE)

The knowledge obtained through the literature review and the analysis created the foundation for the conceptualization phase. This phase shows the manifestation of a concept and following test hereof in a redesign of Bispeengbuen. The concept that will be presented is developed in the light of the design workshop and is a translation of the ideas that the participants uttered. This section will thus provide the creation of the concept and a detailed description of its intention. Lastly, the concept is tested in a proposed redesign of Bispeengbuen.

## 8.1 CREATING A CONCEPT

From the interviews, it was made clear that three barriers were present in working with or in relation to nature in urban development. Since then, these barriers became the focal point for designing and framing the solution space and lay the foundation for the subsequent workshop. The design workshop proved insightful in showing that solutions are possible within the current limits but that there is a need for more structure to emphasize the possibilities that lie within each project. Following the suggestions from the design workshop, the interdisciplinary element stands out as the participants contemplated their internal workflows rather than actual interdisciplinary solutions. It thus suggests that before creating interdisciplinary solutions a more interdisciplinary work tool is needed. Additionally, the aspect of having a start-up meeting in every project group was mentioned repeatedly to ensure consistency across project groups. The idea of creating a facilitation tool was thereby given as a natural outcome of the design workshop and builds on the three barriers and their outcome.

## 8.2 THE CONCEPT

The concept is called 'the Nature Wheel', *see illustration 18* on the next page, and is a facilitation tool that forces a project group to agree on the previously mentioned barriers which are now rewritten as Interdisciplinary, Value Creation, and Operations and represent a guide for ensuring that a project group can debate possible solutions regarding the specific project. The overall intention of this tool is that a project group can identify alternative solutions that promote Nature-based Solutions with an emphasis on the biological quality of nature. The three elements comprise a circle where the name of the project is written in the centre. The round shape has been chosen to accommodate the equality of each element as well as the abstinence of an order. It is thus possible to start with either, without compromising the effect of the tool. The shape is additionally designed for the workshop setting of a group sitting around a table. The three sections of the circle are designed according to the element of debate having the topic with a sentence of intention in the outer circle and room for drawing and writing in the larger area. Using the Nature Wheel is to identify the criteria from each profession represented in the project group (interdisciplinary) to define potential value creation and monitoring, and to visualize the project after the end in the following operations. To do so a user guide has been developed as a supplement to assist the use of the Nature Wheel.

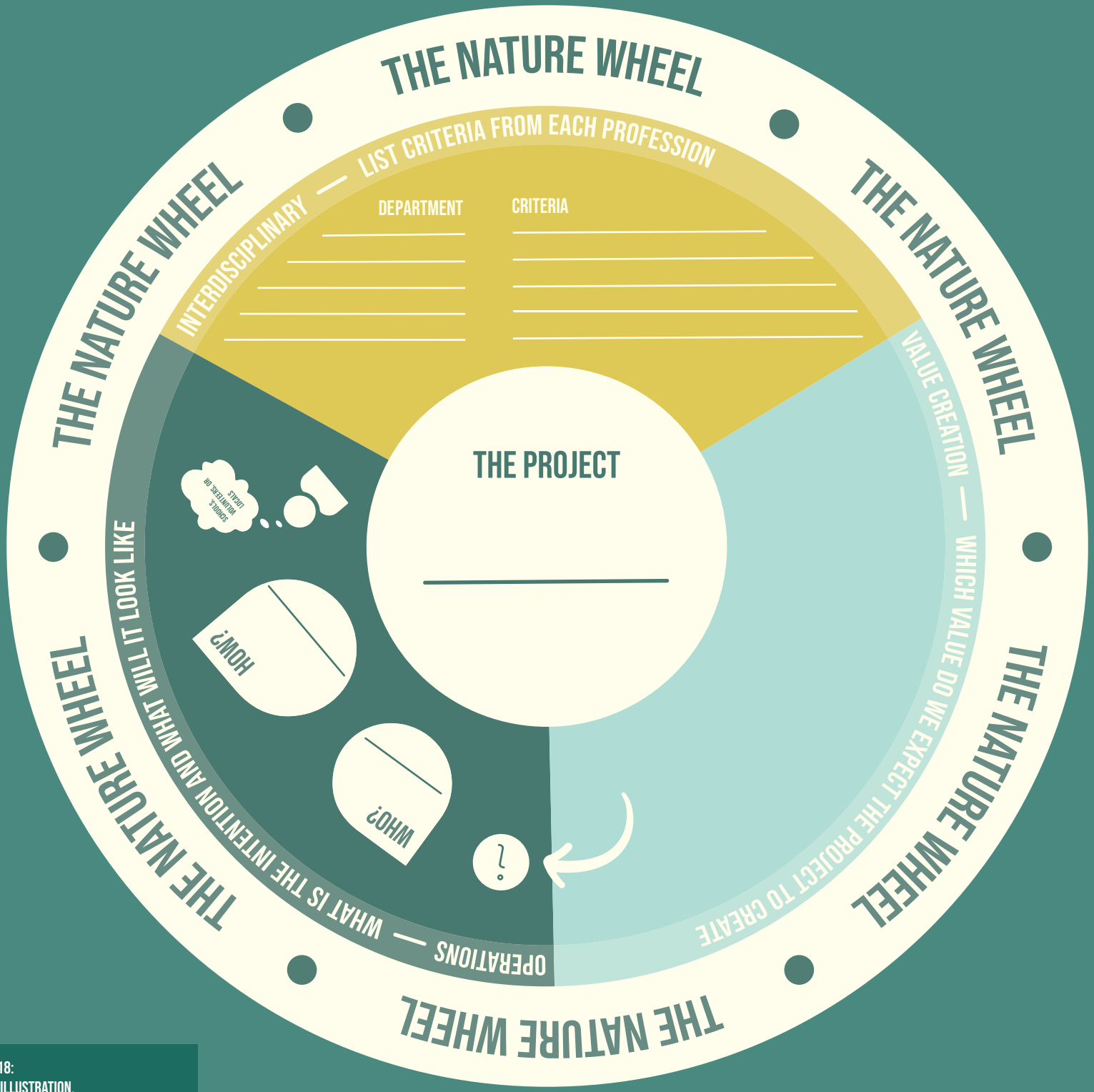



ILLUSTRATION 18:
'THE NATURE WHEEL'. OWN ILLUSTRATION.

## 8.3 USER GUIDE

*Before the workshop.*

Before using the Nature Wheel, every project group member should be familiar with the project in question and come prepared with considerations that must be considered along with an open mind for finding compromise and new solutions.

*At the Workshop*

Begin by writing the name of the project in the middle of the board in the inner circle. You are now ready to go through the three sections of the Nature Wheel to identify possibilities within your project regarding nature as a key element. The three sections will be described in the following.

*Interdisciplinary – List criteria from each profession*

In the yellow section, the lines on the wheel should be filled with criteria from each profession present at the workshop. On the left, the department name is written, and, on the right, the criteria are written and explained to the rest of the group. In this exercise, it is important to note that the intention is to understand each other's professional backgrounds and contribute with their own knowledge. Some criteria could thus be challenged by alternative views, but some would also prevail. The outcome of the list should be seen as part of a design specification for creating a place-specific analysis based on the listed concerns.

*Operations – what is the intention and what will it look like*

In this section, the project group members are pushed to think beyond the project duration and imagine the end of the project. This is not to say that the outcome of the project is decided at this workshop but an exercise to think about the maintenance plan. In doing so the section of the circle entails two questions that should be answered, *who* and *how*? The how symbolizes the maintenance plan but the who defines who it is intended for. Does the project for instance allow for different maintenance plans and different actors? Ideas and possibilities should be written on the board and debated in the group.

*Value Creation – Which values do we expect the project to create*

In this section, brainstorming is performed to show possible values that nature in this project can bring. Values can be of a monetary or non-monetary character and be targeted at different actors. Inspiration for this brainstorming could be: does it bring value to the local community? When will the value emerge? and how can it be evaluated? The ideas in this section should generate a monitoring method e.g., calculations or before and after surveys and it is thus important to decide on a relevant set of values and appertaining monitoring strategies. These values should be considered in the creation of the maintenance plan and as an element in communications with the local community.

After the start-up workshop, the Nature Wheel can serve as a continued element in the project as it might change during the project timeline. As a start-up element, the outcome of the wheel should be integrated into the following project plan to ensure that the ideas and criteria are built into the project.

Having defined the concept of the Nature Wheel the next paragraph will show how it works being used in the redesign of Bispeengbuen. The following exemplification is scenario-based as close to reality as possible without a direct collaboration with the actors working on the project. However, the analysis will be complemented by conversations held with an urban planner from the municipality of Frederiksberg and a landscape architect both involved in the project of transforming Bispeengbuen.

## 8.2 REDESIGN OF BISPEENGBUEN – A SCENARIO

As a precondition for this exemplification, the current state of the Bispeengbuen project is adopted cf. *section 3.0*, meaning that the initial visions have been through a political process deciding on the third vision of partial demolition and creation of green urban space next to the remaining bridge. The following paragraph will provide a scenario description of the use of the wheel where the concerns and views of the project group members are imitated based on the knowledge obtained through observations and interviews in the collaboration with Sweco. Thus, as the project group in charge of creating design proposals consist of a constellation of architectural firms, landscape architects, engineering consultants e.g., traffic planners, water specialists etc., the imaginary project group is envisioned to be consisting of an architect, a water specialist, a green generalist, a structural engineer, a biologist, a landscape architect, and a traffic planner. From this imaginary project team, the Nature Wheel is visualized to be filled in accordingly, *see illustration 19* on the next page.

As the Nature Wheel has been filled out it is possible to create a redesign scenario of Bispeengbuen. From the yellow section, *see illustration 19*, the concerns of the different professions have been exemplified and it is thus possible to create a place-specific analysis of flora and fauna in the surrounding area. This analysis is based on the existing observations available through Danmarks Miljøportal. Using this portal, a map of the area is defined using a radius of approximately 4 km, in doing so a list of observed species (flora and fauna) is created. Afterwards, the list was reduced by deleting duplicates in collaboration with a biologist from Sweco as it was agreed that just the appearance was of importance rather than the quantity, *see appendix 4*. The list thus concludes with about 300 species and categorization of European directives concerning habitats, and bird protection, along with indications of inversive, protected, endangered or vulnerable species. From the list, it is visible that around 25 species are invasive and thereby shouldn't be included in the design concerns. Additionally, 51 of the observed species are noted as protected wherein eight of them are included in the habitat directives. Having these 51 species existing in the area surrounding Bispeengbuen it is beneficial to create habitats for them in the redesign to strengthen their population and thereby create a more diverse nature. Included in the 51 spe-

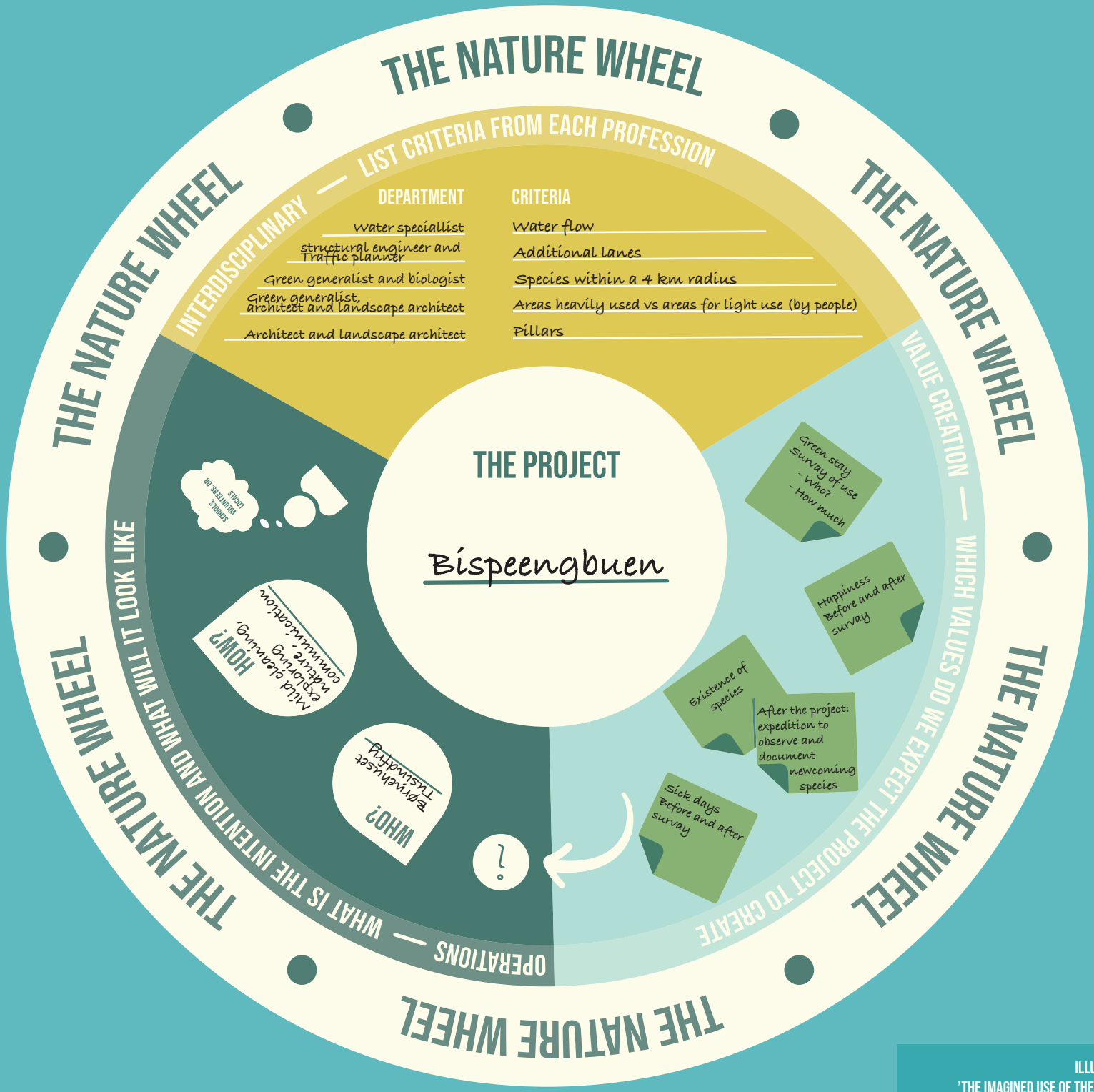
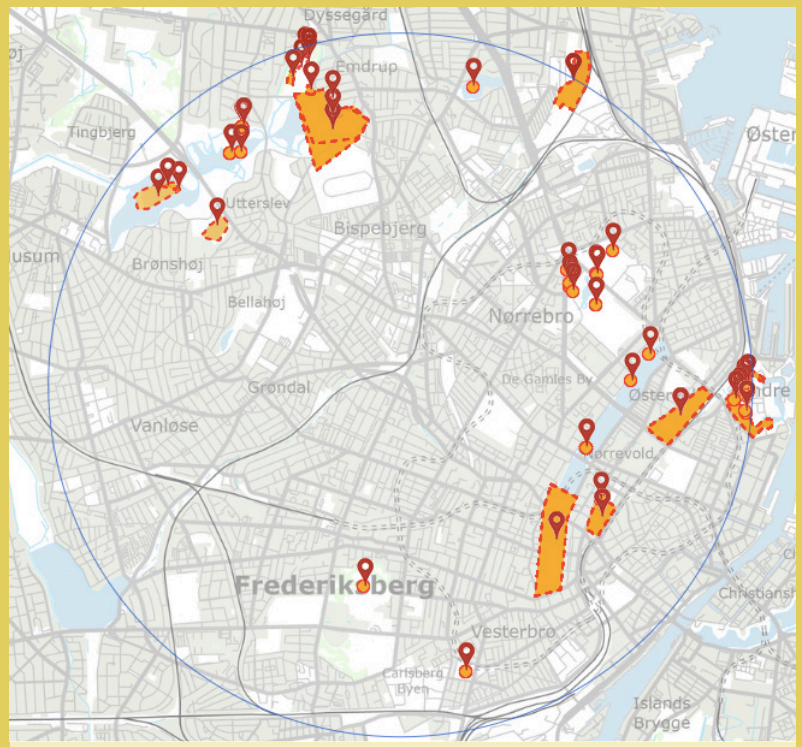



ILLUSTRATION 19:
'THE IMAGINED USE OF THE NATURE WHEEL'. OWN ILLUSTRATION.

cies are bats, frogs, birds and ducks and their observation site can be seen in *picture 29*. From this map, Bispeengbuen is at the centre and it is evident that the protected species have been observed in areas including or near water and within larger green areas. In trying to accommodate these species the restoration of Ladegårdsåen (or part of it) seems necessary. Additionally in keeping half of the arch the pillars might serve as habitats for bats if they are designed to imitate old trees which function as the natural habitat of bats. Relevant to this line of thought the pillars of the other part of the arch might prove valuable to keep while integrating flora and fauna in the heights (e.g., with inspiration from vertical forestry) and as a reminder of the former use. As for the rest of the concerns listed i.e., water flow and additional lanes they primarily reflect the remaining part of the arch and while this is relevant in the entirety of the project, they do not affect the place specific analysis of flora and fauna.

Moving to the other sections of the Nature Wheel the ideas mentioned at the design workshop have been placed along with suggestions as to how measurements could take place. What is interesting to note is the repetition of before and after surveys. This indicates the importance of imagining possible value creations already at the beginning, so it becomes possible to do both a before and after survey. In the last section the element of operations, maintenance, and care have been envisioned where the neighbouring kindergarten serves as an example of an alternative approach. By including them in the project they might gain ownership of the indented green area beneath the bridge and use it with the children. Their tasks of maintenance could thus be reduced to mild cleaning and garbage collecting.




PICTURE 29:
'SPECIES WITHIN A RADIUS OF 4 KM OF BISPEENGBUEN'. (SOURCE: DANMARKS MILJØPORTAL, 2022)

Having imagined a scenario of a redesign of Bispeengbuen using the Nature Wheel, it is not impossible to suggest that the area could look like the proposed design idea, *see picture 30*. However, there are specific elements in designing e.g., habitat for bats which must be seen as an integrated yet separate project. Additionally, the idea of an alternative maintenance plan is not visible from the picture. As there are many elements still unanswered the next section presents a discussion of the concept and design project.

PICTURE 30:
'THE CURRENT VISION OF TRANSFORMING BISPEENGBUEN'. (SOURCE: TEGNESTUEN VANDKUNSTEN; KOMMON; SKAARUP LANDSKAB; VIATRAFIK; BACTOCON; LNH WATER; REALISE, 2022)

# 9.0 | DISCUSSION & REFLECTION

(SOURCE: OWN PICTURE)

In this section, we take a critical view of the project and concept and contemplate the learnings that the project has provided. This is done by a reflection on conversations with an urban planner from the municipality of Frederiksberg, and a landscape architect that is directly involved with the ongoing project transforming Bispeengbuen. Additionally, the project is reviewed in reference to the Sustainable Development Goals (SDGs) and how they are represented in the concept. The case of Bispeengbuen is furthermore evaluated in its characteristics and potential in creating regime adjustments. Lastly, the contribution of this thesis is discussed in reference to sustainability, society, and the field of Sustainable Design.

## 9.1 UNCERTAINTY IN SCENARIO IMAGINATION

Having the primary collaboration with Sweco has provided valuable access to investigate regime incumbent actors in the field of consulting regarding urban development. However, their role regarding the redesign ends there as another actor constellation is responsible for the actual redesign and visions of Bispeengbuen. From that constellation, it has been possible to conduct an email interview with one of the landscape architects, whose answers can be found in *appendix 5*. In the interview, the quality of nature was investigated i.e., the level of biodiversity considerations in the ideation phase. In these answers, it is noted that there is no biodiversity specialist (e.g., a biologist) present in the project team but that the landscape architect tries to incorporate biodiversity to the best of one's ability. However, the place-specific analysis of the current biodiversity in the surrounding area is not a part of the project and neither is a review of the original vegetation of the area. The lack hereof is justified by saying that it is simply too early in the project because the infrastructure alternatives are to be decided first, *see appendix 5*. This answer exemplifies one of the main findings of the project, that is, that nature is neglected and must adapt to the rest of the project. On the other hand, it is mentioned that the project team has focused on creating an oasis that can counteract the density of population in the city, *see appendix 5*. The intention is thereby to make the area as green and blue as possible and to make it resistant to economic interest by *"enabling a structural plan and a strong architectural story"* (see appendix 5 – question 3), thus, the aspect of nature is presented as an element in the architecture, and it is mentioned that creating urban nature necessitates a strong argumentation to be resilient towards economic interest. Along with this, it is mentioned that the landscape architect specifically uses the recreational areas to implement initiatives that can strengthen nature which can contribute to biodiversity through incremental steps. In this, the possibilities lie in creating a place for life to move into, in the future and to push to people's perception of how nature can look, *see appendix 5*.

Another point relates to the role of nature in urban development and the possibilities that exist. Here the notion of urban nature ('bynatur') is once more reflected and mentioned as a complex term that often is exploited as a means to promote a project, *see appendix 5*. The meaning is also contemplated and assessed to be without a clear definition or at least difficult to understand, thus the landscape architect prefers to use known terms such as nature, biodiversity, and sustainability. This furthermore suggests that our concept of the Nature Wheel could

prove useful in urban development projects as a starting point to initiate a holistic project plan that includes nature from the beginning. As this is not the case the imaginary scenario presented in *paragraph 8.2* must be dismissed and viewed only as an exemplification of one way to approach the redesign of Bispeengbuen. However, the position of the landscape architect does not necessarily dismiss the possibility of having a focus on biodiversity in the redesign of Bispeengbuen but simply suggests that the primary focus lies elsewhere at this point in the project. Since water management is a specified term as well as the reorganization of infrastructure, the focus simply is on the technological possibilities and costs. Alternatively, to this approach, our project and the Nature Wheel seek to show value creation by thinking of Nature-based Solutions first and then relate the value creation to the technological solutions (e.g., using bee bricks in the architectural construction thereby creating value in the living conditions for the bees (Green & Blue, n.d.). With the Nature Wheel, value creation can be imagined at an early stage in the development project and being proactive is exactly what has been shown to create regime adjustments (Quitzau et al., 2013).

Viewing the historical development in the public attitude towards Bispeengbuen a local network of actors has been keen on showing a different expression of the car-dominated infrastructure from Bispeengbuen to Åboulevarden. The community of 'Åbn Åen' (Open the Creek) has thus in 2017 gathered enough support to order a report on a redesign suggestion where the traffic is led through a tunnel beneath Åboulevarden and with gradual restoration of Ladegårdsåen with a green park on what is now Åboulevarden. The report is based on preliminary reports from 2014 and 2016 all on the premise of ensuring the current service level in the tunnels and with the above laying area as a capacity for cloudburst management. These scenarios have visualized the possibilities beyond the restoration of the bridge and led to the current state of the project mobilizing the municipality of Copenhagen and Frederiksberg to initiate a holistic development project. What is interesting about the current actor constellation is that the technological development of a tunnel is at an expensive level compared to the societal movements regarding private car ownership and increased use of home offices. Thus, the politicians adhere to the third scenario to await how the regime of private car infrastructure is developing over the next years[1]. But this strategy already pushes the trajectory of the regime as it will reduce the number of lanes from six to four meaning that there will be an added pressure on the roads leading to more congestion which might result in some commuters choosing alternative transportation (e.g., public transportation, bikes or shared rides). If the transformation of Bispeengbuen is already positioned in a middle ground where the path-dependent technological development is unfeasible the project could instead fun-

[1]Meeting with Jacob Dahl-Hesselkilde from the municipality of Frederiksberg on the 18th of March.

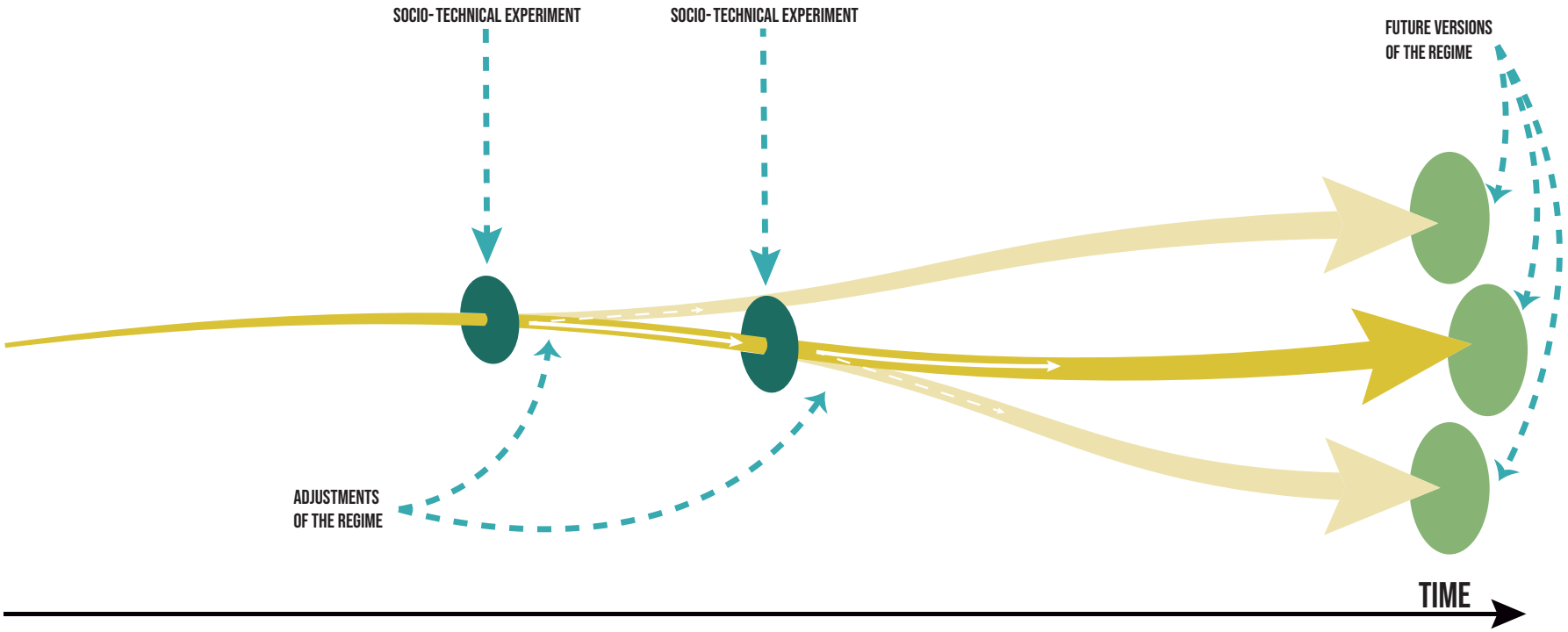



ILLUSTRATION 20:
'SOCIO-TECHNICAL REGIME'. OWN ILLUSTRATION. INSPIRED BY CESCHIN (2014).

ction as a socio-technical experiment in Nature-based Solutions. Using socio-technical experimentation as a design strategy is a way of challenging the regime and imagining a transition path that favours the development posed by the experiment (Ceschin, 2014). As suggested by Ceschin (2014) the use of socio-technical experimentation can create regime adjustments on various scales that can influence the niche developments, *"The project vision was not a static outcome to be achieved; it was continuously adjusted as a result of changes in internal and contextual conditions and as a result of what was learnt by actors during the societal embedding process"* (Ceschin, 2014, p. 19). The mentioned adjustments refer here to the project vision and reformation of actors in the project network but applying the strategy to the regime of urban nature through the redesign of Bispeengbuen can bring context-specific examples of a reconfiguration of the trajectory of urban development and the related regimes of transportation (through private car ownership) and housing. These adjustments have been visualized in a representation of how socio-technical experiments can adjust the trajectory of the regime development, *see illustration 20* above. In this visualization, two adjustments have been visualized with

an indication of the socio-technical experiment as the instigator for the adjustment working as a living lab. The redesign of Bispeengbuen must thereby express a sequence of experimentation that enables labs in which innovation is created in the context of urban nature and Nature-based Solutions in urban development created between collaborations with researchers, companies, end-users and other relevant actors (Ceschin, 2014). From this illustration, it is possible to view the ongoing regime adjustment and how it can lead to regime transformation in the long term. This analogy is adopted from Ceschin, (2014) as it is argued that continuous adjustments can occur through socio-technical experiments. Stating that this is possible in the case of Bispeengbuen lies within the type of case study in which the transformation is viewed as.

## 9.2 TYPE OF CASE STUDY

It is previously mentioned that the transformation of Bispeengbuen is viewed as a paradigmatic case meaning that it is of such magnitude that it will define a time and place in history. Whether this is significant on a scale of urban development, or specific to the development in Denmark or Copenhagen is uncertain and will depend on its impact on the trends of the period. Additionally, what is challenging with a paradigmatic case is that they cannot be defined by a set of rules but relate to a glow and a manifestation through instinct (Flyvbjerg, 2006). As a comparison, the Fingerplan is an example of a paradigmatic case related to planning and urban development as the structure of Greater Copenhagen is known for exactly the Fingerplan in architectural communities around Europe (USGS, n.d.). The position that the transformation of Bispeengbuen is viewed as a paradigmatic case is based on three aspects 1) the size and statue of the construction (for many commuters and visitors northwest of Copenhagen the arch is a symbol of entering the capital) 2) The mobilization of local actors campaigning for a reestablishment of Ladegårdsåen throughout Åboulevarden, and 3) the increased political focus following the emerging restoration.

Having the transformation become a paradigmatic case will furthermore ensure its position in creating radical changes in the long term but also in the ongoing adjustments of the practices and mindset of regime incumbent actors. Visualizing this development in relation to the Multi-Level Perspective and the regime levels (landscape, socio-technical regime and niche) the trajectory of the development in urban nature can be seen through *illustration 21*. In this illustration, the regime adjustments have been integrated into the nested hierarchy of the three levels and the Nature Wheel has been placed in the niche level adjacent to Nature-based Solutions. The Nature Wheel is a tool that helps apply a Nature-based Thinking mindset before designing the solution to explore the possibilities of creating Nature-based Solutions that emphasizes nature as a key feature. Its influence on the regime trajectory is represented in the incremen-

tal stage as the arrows emerging from the niche into the regime, *see illustration 21*.

## 9.3 DESIGN FOR SUSTAINABILITY

From a consultancy perspective, the SDGs are often seen as the favoured sustainability framework and as mentioned in *paragraph 2.3* the goals most relevant to this thesis and the topic of sustainable urban development are 11, 13, and 15. With this in mind, the Nature Wheel should be seen as a tool that supports the realization of these goals and emphasizes the possibilities that lie within the urban development as labs for experimentation. The Nature Wheel is thus a supporting tool derived from the inspiration of the three goals and is thereby not meant as an alternative to the SDGs.

What is important to remember about sustainability is the ambiguity in the nature of the term and the importance of a holistic mindset. However, the three chosen SDGs are not chosen only in their relevance to the project but also in reference to Design for Sustainability (DfS) and the evolution of the field. As Ceschin & Gaziulusoy (2019) suggests the future

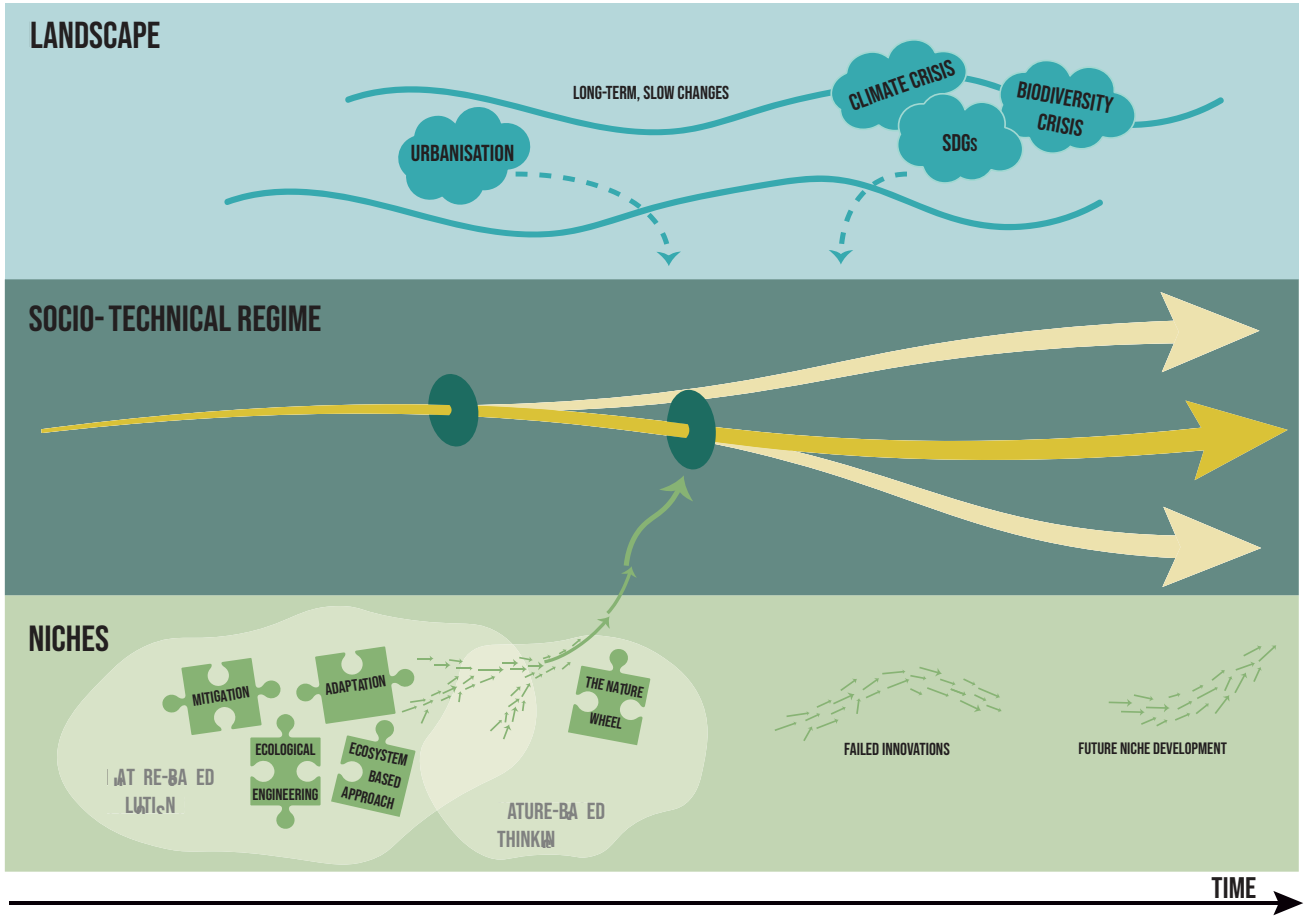



ILLUSTRATION 21:
'MLP OF THE FUTURE OF URBAN NATURE'. OWN ILLUSTRATION. INSPIRED BY CESHIN, (2014) & GEELS, (2002).

of transition design poses two pressing questions one concerned with the occurrence of transitions and the other with the reality of a post-transition context. This is conceptualized through the DfS innovation framework to be the earth-centric socio-technical-ecological systems level, *see illustration 22* on page 89.

Using the redesign of Bispeengbuen as a lab for socio-technical experimentation the urban development of Copenhagen can be tested and developed in a context that is imbued with sustainability through Nature-based Thinking. With an emphasis on regime adjustments, the use of the Nature Wheel can strengthen sustainable transitions towards an earth-centric mindset in creating socio-technical-ecological urban development. This is seen by the way the Nature Wheel is trying to create a foundation for an interdisciplinary approach enabling nature as a key feature at the beginning of projects in urban development. The contribution of this thesis is navigated between the socio-technical and the socio-technical-ecological level as it has been shown that cities essentially are socio-technical systems (Ceschin & Gaziulusoy, 2019). In working within the urban fabric that makes up sustainable development in cities this thesis is a contribution to the Sustainable Design Engineering education and profession as a knowledge creation in a scenario-based imaginary of a transition design process of a redesign of Bispeengbuen. Furthermore, the Nature Wheel is a contribution to consultancies and other practitioners working with urban development and Nature-based Solutions.

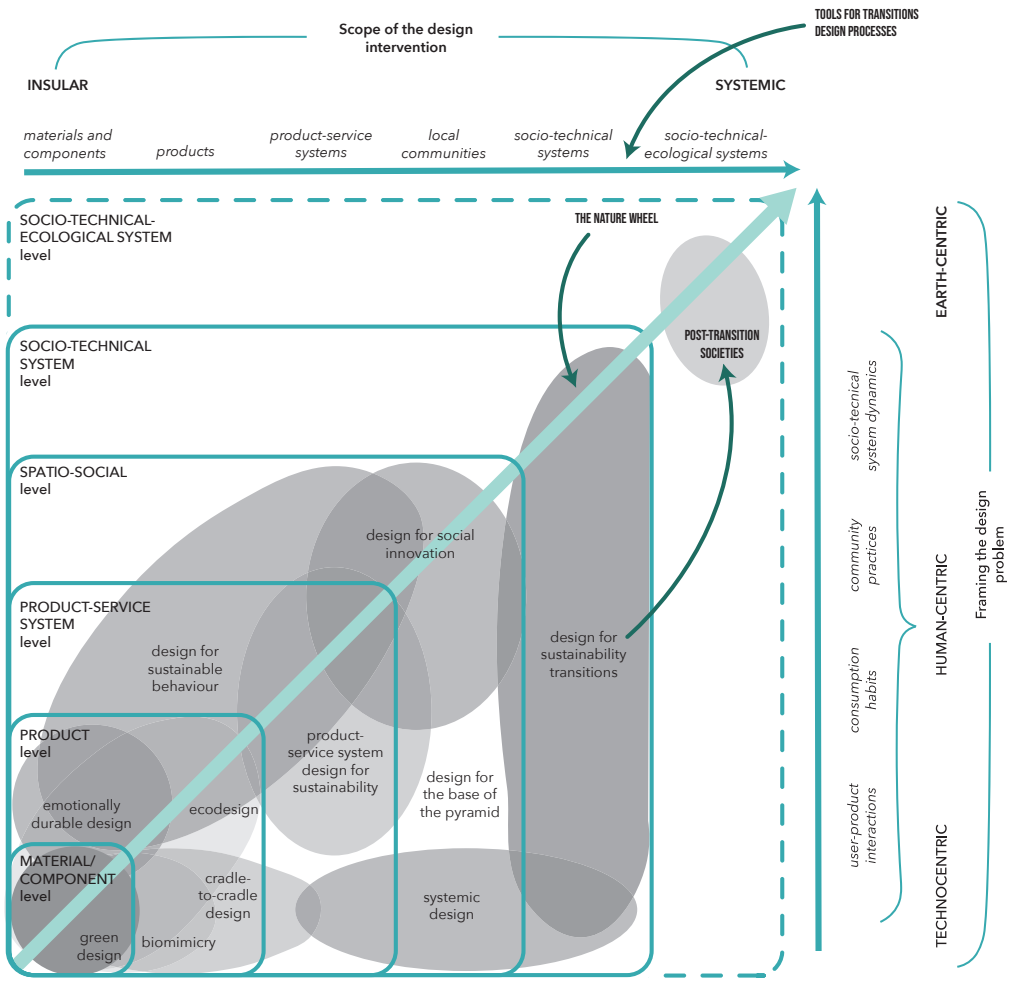



ILLUSTRATION 22:
'SUGGESTED ADDITION TO THE DFS FRAMEWORK'. OWN ILLUSTRATION. INSPIRED BY CESHIN & GAZIULUSOY (2019).

# 10.0 | CONCLUSION

(SOURCE: OWN PICTURE)

This thesis intended to answer the proposed research question and appertaining sub-questions as a contribution to the knowledge of Nature-based Solutions in urban development in Copenhagen. Following this investigation, the newest scientific addition to the field was adopted in the mindset of Nature-based Thinking as a precondition for reaching the full potential of Nature-based Solutions. From this investigation, the obtained knowledge provided a framework and foundation for the project by defining the terms used throughout the report. Additionally, the study has investigated the notion of urban nature as a local phenomenon in the context of Copenhagen. The regime of urban nature and the related regime of housing and transportation has been illustrated in the nested hierarchy that currently favours housing and transportation in the grey infrastructure regime.

Through the empirical work of this project, it was made possible to pose a regime development that exploits the rigid structures of the current regime to create adjustments that favour the emergence of Nature-based Solutions. In the empirical investigation, a collaboration with Sweco was formed as the main source for investigating the current structures of the regime that consultants must navigate within. The design concept of this project has thereby been created as a direct result of the learnings and possibilities that arose and the creation of the concept of the Nature Wheel is a contribution to Sweco as a management tool when working with urban development and Nature-based Solutions. As the findings of this project have been obtained from consultants who are regime incumbent actors the concept of the Nature Wheel is suggested as a general contribution to a broad array of consultancies and other practitioners working with urban development and Nature-based Solutions.

Through the concept of the Nature Wheel and a case study of Bispeengbuen, an imaginary scenario has been created to show the possibilities of regime adjustments through Bispeengbuen as a socio-technical experiment. The use and function of the Nature Wheel have furthermore been elaborated through the scenario as a tool for consultancies and practitioners in the future for working with urban development and having nature as a focus for design. What this study concludes is the importance of a proactive approach to the possibilities that nature can provide in a project. Through the empirical findings, a series of three main barriers have been identified in an investigation across professions at Sweco. The three barriers lie within *Economy, Interdisciplinarity*, and *Operations* and a workshop showed that the three barriers are solvable at an abstract level which was then transformed into a tool in the Nature Wheel, that can guide future design projects within the field of urban development. This thesis thus points toward a reimagination of the regime incumbent barriers that hinder Nature-based Solutions from fulfilling their true potential in urban development through socio-technical experimentation in the redesigned case of transforming Bispeengbuen. In relation hereof, this project contributes to the academic field of Design for Sustainability as a recognition of the need for an earth-centric development within transition design.

## 10.1 SUGGESTIONS FOR FUTURE PROJECTS

Having concluded this thesis, the research area is still available for further investigation. As a direct continuation of

this project, the design and function of the Nature Wheel could serve as a topic of investigation. In such a project the useability in other projects would be especially relevant to carry out as well as the anchorage of the outcome of the Nature Wheel throughout the project duration. Following this iteration of the Nature Wheel, the refinement of the concept would ensure suitable customization of the tool as well as the processes that it will enter. In this investigation, the focus should be on transition management and the role of management tools in consultancies and urban development projects. Adjacent to these projects further research is possible in the design and development of strategic planning of socio-technical experiments that can be conducted through the transformation of Bispeengbuen. In the continuous project development, further regime adjustments can be investigated within other areas such as municipal project management. The listed investigations are recommended to be initiated as an expansion of knowledge within the use of design objects as management tools in transition management to identify regime lock-ins that can be exploited in socio-technical experiments as windows for creating regime adjustment.

## 10.2 STRENGTHS AND LIMITATIONS

The concept and findings of this project have illustrated one way of imagining the transition of Bispeengbuen within the current regime while designing for regime adjustments as a means to show how Nature-based Solutions can create values in the urban development of Copenhagen. The strengths of this project lie in the ability to investigate a relevant and present case in the preliminary steps towards a transformation of Bispeengbuen. In doing so the empirical investigation was possible through a collaboration with Sweco and with their variation of professions it was possible to investigate the structures of the current regime from different professions' points of view. From this study, it was however not possible to follow the creation of ideas posed by the winning correlation of professions, or the urban planners of the municipality as the timing did not allow for resources or a relevant context of an investigation. This thus stands as a limitation in realizing or testing the posed regime adjustments and investigating whether the regime structures are viewed alike from a municipal and urban planner perspective. Form this limitation on the general time of the thesis has put practical constraints on what was obtainable within the given period.

# 11.0

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