TOWARDS A CIRCULAR DELTA ENVIRONMENT

A STRATEGIC VISION TO IMPLEMENT CIRCULARITY IN THE CONTEXT OF THE SOUTH-HOLLAND DELTA REGION

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Abstract

Abstract

The changing climate pressures the resilience of cities and nature all over the world, putting the position of historically valuable urban and natural environments at risk. The province of South-Holland has economically evolved around the unique triple delta landscape. In order to keep its economically competitive position and take environmental responsibility, the province aims to be circular by 2050. However, the province is facing a number of environmental challenges that are further aggravated by the intensification of land use and climate change. At the same time, however, the region faces an enormous housing demand. Therefore, this strategic vision was created with the aim to propose a way to answer the high demand for space in South-Holland while preserving the delta environment.

Three themes were identified as key drivers: the use of an adaptive delta water management, the transformation to sponge cities and a shift towards water circularity. Implementing interventions along these themes will preserve and redefine both the natural and the urban environment. This strategic vision provides the roadmap towards a circular delta environment in 2050. This vision involves the transformation of export-oriented agricultural land into wetland area, the densification and expansion of urban areas and a shift towards a biobased port.

Keywords: reinforced delta | water circularity | climate adaptation | urban liveability | socio-environmental justice

1 Introduction

1 Introduction

1.1 Context

Six years ago, in the late months of 2015, representatives of 196 state parties got together at the twenty-first session of the Conference of the Parties to the United Nations Framework Convention on Climate Change. Their objective: to take an unanimous position on the effects of climate change and the necessity to limit further global warming, and make financial flows towards climate-resilient development consistent. The outcome of this conference has been recorded in the Paris Agreement, signed by all parties involved in the early months of 2016 (United Nations Treaty Collection, 2015).

In the Netherlands, we've adapted the goals set by the Paris Agreement and implemented them in our Klimaat Wet - climate legislation. This law sets the climate targets we need to achieve by 2030 and 2050. Goals set in this law are - among others - a reduction of 95% of greenhouse emissions in 2050 compared to 1990 and a reduction of greenhouse emissions by 49% in 2030, as well as a complete CO2-neutral energy production by 2050 (Klimaat Wet, 2019).

Ambitious goals, which require solid planning and powerful actions from both government and private parties. Goals, which at their core will transform the way we look at and handle resources and production. Goals, which desire a capable and durable vision, connecting sectors and employing our most influential regions in the Netherlands to take the initiative. To show the rest of the country, the continent and even the world how we need to rethink our economic structures towards a circular model and how our interaction with nature and water can form the basis towards a circular and sustainable environment.

The province of South-Holland is characterized by its unique triple delta structure. Since the eleventh century, the lower reaches of the Meuse and the Rhine rivers evolved into one of the most urbanised regions in Europe. The Netherlands have always been heavily reliant on trade and the towns prospering in this delta region were no exception. The marshy wetlands in this delta structure provided its inhabitants with means of transport and trade, as well as the collection of peat and natural protection by the hard to traverse landscape.

It is from the eighteenth century onwards that a more or less coherent set of ideas about the development of the physical environment started to develop. Dutch civil engineers gained control over the rivers and the sea and started to develop some kind of planning doctrine. It is with the poldering and reclamation of land of the delta landscape, that the region was able to expand and gain a foothold on international markets (Meyer, 2016).

Since the fifteenth century, the population of South-Holland has grown from a mere 200,000 inhabitants, to the 3.5 million people that live in this region today (Alle Cijfers, 2021). The delta provided inland access by water through rivers running deep landinwards into Europe and the excellent accessibility to the North Sea meant that the area, now known as the Port of Rotterdam, was able to grow to be one of the worlds most important and the largest port in Europe (Port of Rotterdam, 2020).

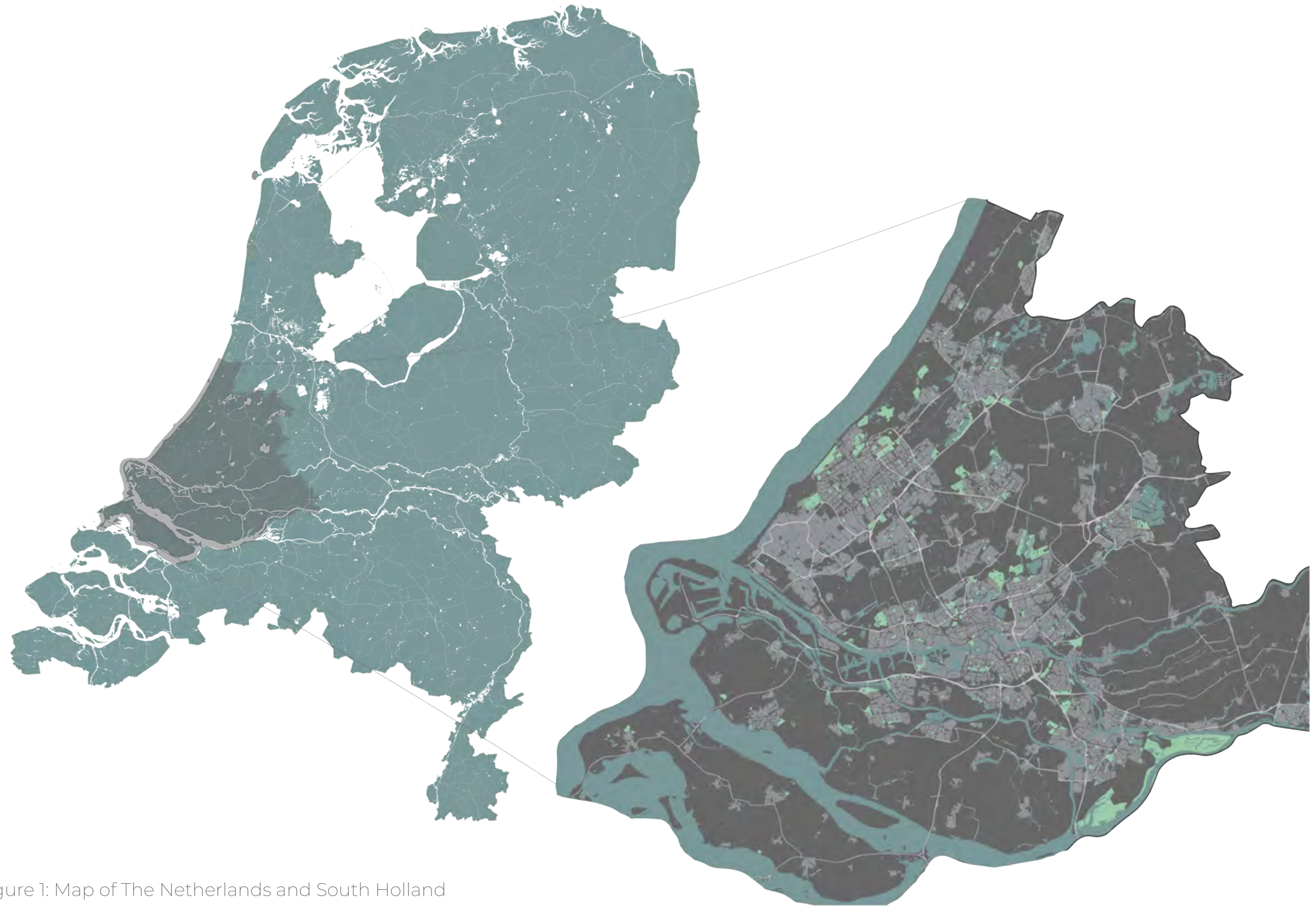


Figure 1: Map of The Netherlands and South Holland

In 1971, 170 countries signed the Convention on Wetlands, joining forces to protect the delta and wetland areas in the world and stimulate and regulate use of the wetlands. The Netherlands are known for their strong relationship with water. Not just the coastal areas, but also land inwards rivers and bodies of water. A water rich country. And compared to the rest of Europe the Netherlands have the second largest surface area of wetlands. In total they have almost 900.000 ha of wetlands in the Netherlands. 900.000 ha, which are needed to protect and care for by accurate water management. (CBS et al., 2020f)

However, the average Dutch citizen is barely aware of the challenges of water management and the risks of water in the country. The government is changing towards decentralisation and initiatives and execution of plans are more and more entrusted to society and private parties. This leads to an increasing need for different control options, partnerships and financing. Especially against the backdrop of necessary measures to be taken towards a sustainable and circular environment (Ons Water, 2021, pp. 1-13).

This strategic vision strives towards an environment where nature, agriculture, horticulture, energy, industries, the living and working environment, recreation, cultural heritage and the economy are strengthened and developed in coherence with the water challenge at hand. The ambition is to stimulate authorities, companies and civilians to become more aware of the threats and opportunities in water management and to take responsibility and work towards a circular delta environment together.

1.2 Problem Statement

The province of South-Holland is tasked with challenging a multitude of issues. For the past centuries we've made excellent use of all that the region has to offer, but the increasing weight of the way we've used these resources has put an ever growing pressure on the region. There are various challenges at hand, both presented by natural effects as well as presented by our own human-made expansion. There is ever more pressure on the densifying landscape, where the built environment rules and close access to nature and water is strained.

A multitude of the problems at hand deal with water management. One of the most prominent and well known difficulties is the fact that a large part of South-Holland is positioned beneath sea level. Without the strong dykes, 60% of the Netherlands would be flooded regularly. But only 26% is due to the fact that the area is beneath sea level. Most of the area in danger is due to the rivers and delta structures: 29% because of river flooding; 1% because of the Maas overflowing, and 3% because of construction outside of the area protected by dykes. In the areas prone to flooding without good protection, there are nine million people living there and 70% of the Dutch GDP is earned there. A serious risk if not treated carefully. (Ons Water, 2021, pp. 7-19).

Another problem at hand is the salinisation of the ground in the province. Especially the deep polders, which have been dried since the Middle Ages, play a large role in this process. Climate change and soil subsidence in the region are also important actors (Kuijper et al., 2005, p. 32). This reduction of the fresh groundwater supply in the province leads to serious concerns: 16% of the economy is dependent on freshwater, and the sectors relient on freshwater are responsible for a revenue of 193 billion euros per year. (Ons Water, 2021, pp. 21-25). At the same time, the usage of fresh water in the agricultural sector has grown significantly. The water usage in agriculture and horticulture has increased by 40% in 2018 compared to 2003. (CBS et al., 2020e)

On the borders of the province, to the west and to the east, there are also two raising challenges. In the coastal region, near the dunes and the sea, the province faces the growing problem of droughts due to climate change. A large proportion of the freshwater supply for the region is derived from this area, which may lead to problems in the future. (Climate Adaptation Services & Koninklijk Nederlands Meteorologisch Instituut (KNMI), 2017) (Drinkwater Platform, 2019). In the east of the province we have to deal with the struggle of a bad bearing capacity of the soil, as well as serious problems with soil subsidence. Limiting options for development plans, increasing the strains on water management in the region and reducing housing prices due to houses slowly 'sinking' and the need for large renovations (Climate Adaptation Services & Koninklijk Nederlands Meteorologisch Instituut (KNMI), 2017).

Finally, within the region we have to deal with a large scale housing problem. Due to the large gap between supply and demand on the housing market, there is a large socio-economic pressure on the need to build more houses in the province. This urgent construction assignment requires us to develop 230.000 new residences before 2030. Some progress has been made in the past ten years, but with 80.000 residences built, and another 150.000 still to go, we've still got a long way to go. And in 2030 we're not there yet! Because within the timeframe of the next ten years - between 2030 and 2040 - another 60.000 new houses are required to be built. Especially in the current urban and metropolitan areas the demand for houses is high, due to the process of urbanisation, still going strong. The cores of Rotterdam and The Hague have the highest demand (Province of South-Holland et al., 2015).

At the same time we also see that the housing demand shifts towards smaller households and mixed use living. A trend which, together with a growingly more international population, will persevere over the coming decades (Province of South-Holland et al., 2015). It is important to link the development of the province of South Holland's housing demand, as well as the demand for new industries and businesses in line with the need for more available jobs, together with the water management problems at hand, in order to create a coherent view towards a united and co-dependent strategic vision on the province of South Holland.

1.3 Goals

In order to confront the challenges at hand, this vision and strategy are based upon five goals which help us arrive at the coherent perspective needed to achieve our objective. With water circularity and the management of the delta landscape of the region at the core, these goals can be linked to the Sustainable Development Goals set by the United Nations in the 2030 Agenda for Sustainable Development (United Nations Publications, 2020).

Figure 2: Goals

Enforce the strengths of the delta structure

The first goal present in the vision is the enforcement of the strengths of the delta structure. On the one hand we think that, by looking at the heritage of the delta structure in the province South-Holland and using that heritage as a fundamental to work with, the delta structure delivers a compelling narrative which underlines the legitimacy of the proposed future plans. However, on the other hand, it is important to note that heritage is what it is: the ancestry of a culture. This heritage of the delta structures should be seen as a legacy, from which we can expand. Our knowledge on the subject should not be updated in line with tradition, but it should provide the stepping stone to evolve to a new concept of perspective.

In this perspective, the delta landscape can help the expansion of a sustainable urban environment and stimulate the relationship between the urban and the natural as well as (un)pave the road towards a more nature included society.

Figure 3: Sustainable Development Goals

Answer the demand for space

As has been mentioned, the province of South-Holland has to deal with a large demand for new housing. Along with this need for new residences, there is also an increasing demand for space for industries, agriculture and horticulture and businesses. Together with the virtuous position to enhance and strengthen the influence of the natural environment, it is important to strive for equal and fair distribution of space in accordance to the demand. Only together we can work towards an inclusive and sustainable distribution of space.

Figure 4: Sustainable Development Goals

Adapt to the climate

By now it is well-known that urgent action towards combating climate change is needed. In working towards more sustainable and resilient living conditions and green industries, in addition to the expansion and restoration of the natural environment, we hope to provide enough means to empower the region to adapt to a changing climate. Both for humans, animals and nature itself.

Figure 5: Sustainable Development Goals

Contribute to a circular economy

In order to achieve a sustainable economy, it is important to view the way we handle resources and how we can recycle and reuse what we already have. Large industries in South-Holland, producing a major part of emissions in the Netherlands, need to transform towards a more circular and green setting where we can work towards a more sustainable future. The current high level of emissions should not be seen as a weakness in that sense, as it can be seen as an opportunity for South-Holland to show the rest of the country, and the rest of the world, in a leading position how to transform towards a circular economy.

Figure 6: Sustainable Development Goals

Achieve socio-environmental justice

And finally, it is of importance to provide equal access to and protection from the most basic resource we have at our disposal: water. Due to the challenges at hand, concerning water management, it is crucial to envision a society where access to water and nature is equal among all and to strategize this future perspective with the inclusion of all who wish to be involved.

Figure 7: Sustainable Development Goals

2 Methodology

2 Methodology

2.1 Research Questions & Methodology

Research Questions

This strategic vision has been formed in a synergy of both research and design. Based on the problem statement and the goals that are the drivers for this vision, the following research questions were formulated. These research questions were used as a guideline for the research and analysis that form the basis for designing the vision and strategy.

How can the high demand for space in South Holland be answered while preserving the characteristic delta environment?

1. What are the spatial issues of the delta environment today and what are the challenges and opportunities with regard to circularity.
2. How can the shift towards a circular economy contribute to a resilient and redefined delta environment in which socio-environmental justice is achieved?
3. How can a circular, resilient and redefined delta environment be achieved by 2050, while considering socio-environmental justice?

Research Methodology

Exploratory research was combined with different design principles to provide an answer to the research questions.

For the first question, an analysis of the current delta environment was carried out by means of online research. Policy documents and public websites have been researched. By means of mapping, the outcomes that entailed spatial information were visualised.

An exploratory design of the region was created in order to answer the second research question. A conceptual framework was developed as a basis for this design. The concepts that were implemented have been grounded in a scientific literature study. Additionally, literature on design was used as a source of inspiration for different specific spatial interventions that fitted the theoretical concepts.

The last question was answered by developing a strategy. In the development process, theoretical concepts related to socio-environmental justice as are explained in the conceptual framework were taken into account. Additional online research on the involvement of stakeholders was carried out for specific elements of the vision: the urban expansion & densification, water and landscape management, sponge cities and the transformation of the port. Based on the outcomes a timeline, that shows the phasing of the strategy, was developed. Additionally, a stakeholder analysis was executed. In order to show the different elements of the strategy, two strategic clusters in which those elements come together were identified. Finally, an impression of what the process will look like in more detail was given by identifying three key projects.

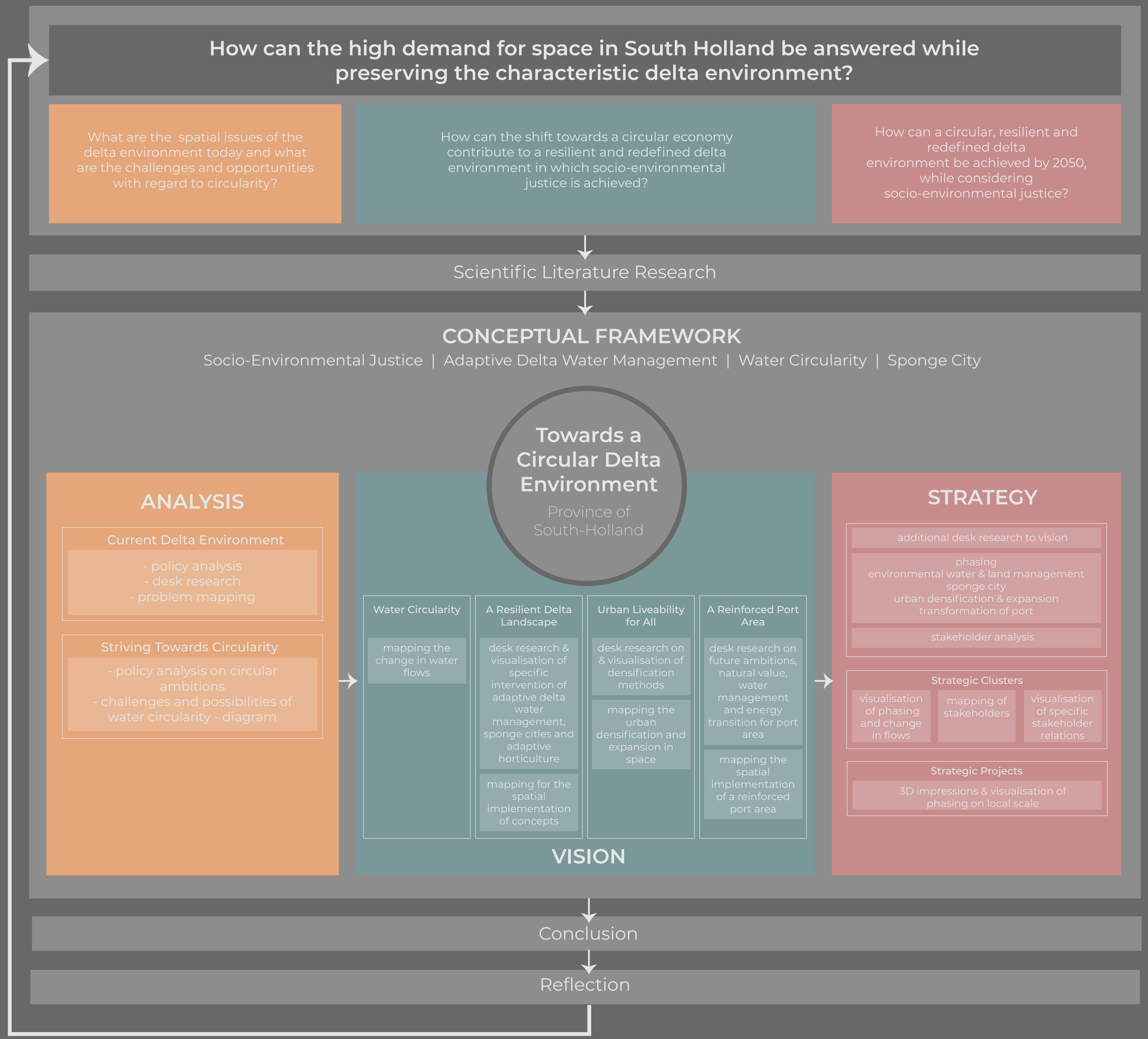


Figure 8: Research Methodology

2.2 Conceptual Framework

The enormous housing demand as well as the eco-environmental challenges of the South-Holland delta region are the key drivers for this strategic vision. However, both elements cannot be seen apart. The urban growth that results from answering the housing demand affects both the ecosystem and the urban subsystem (Liu et al., 2011), which are highly interrelated (Liu et al., 2011): "On the one hand, the urbanization with a resource shortage background will suffer from the intimidations of resources and environment and the intimidations will destroy the surrounding environment to various extents during its development process. On the other hand, the fragile eco-environment will restrict the development of cities, block the urbanization process and may even cause the ruin of cities after the eco-environmental subsystem has been destroyed (Liu et al., 2011, p. 1600)." For an integrated sustainable development and modelling the eco-environmental effects of urbanization, coupling and defining the relation between the natural and urban environment is crucial (Liu et al., 2011).

For the context of this vision, this interaction between the natural and urban subsystem is defined by the concept of water.

Water is the backbone of the delta environment. Although water is a strength of the delta environment and offers a variety of benefits, it can also be seen as a risk. The risks that are related to water have been underlined in the problem statement. Restoring the balance between the natural and urban environment is therefore about dividing the risks and resources that are related to water. This coupling relationship is the core for working towards a circular delta environment. Emerging from this core, three concepts that have the potential to restore the balance between the urban and natural were used as a basis for the vision.

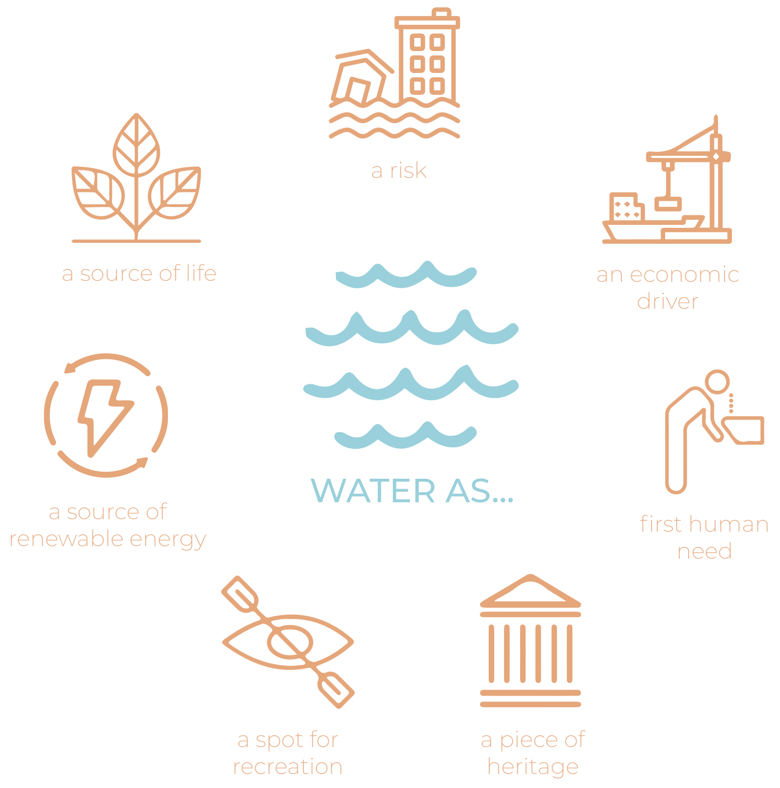


Figure 9: Definition of Water

The first theme, adaptive delta water management, primarily related to the natural environment. Adaptive delta water management is a way of managing the water that considers the complex socio-ecological character of the delta environment (Pahl-Wostl et al., 2005). The water management faces an increasing number of challenges and uncertainties due to climate change as well as changing socio-economic conditions. Adaptive water management

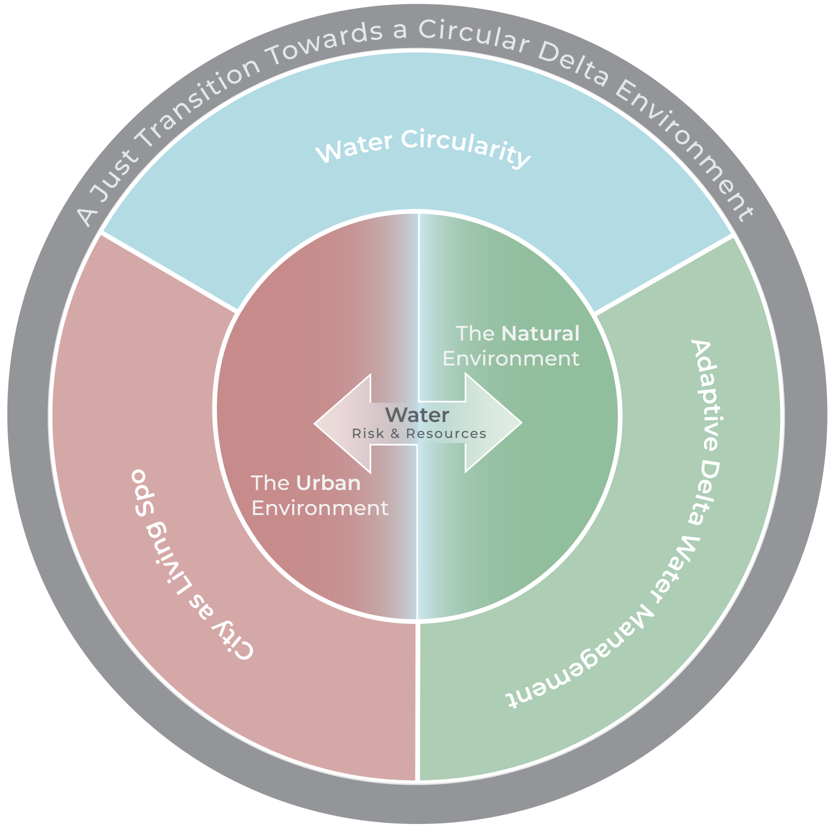


Figure 10: Conceptual Framework

is focused on increasing the ability of the water system to deal with these challenges. This means that environmental, technological, economic, institutional and cultural aspects of the river basin environment are taken into account in the development of policies and implementation of measures (Pahl-Wostl, 2007). Besides, learning from the outcomes of earlier implemented water management interventions is key in adaptive water management (Pahl-Wostl et al., 2007).

Social learning can help to improve the adaptive capacity. This involves a polycentric and horizontal governance, a cross-sectoral and multi scalar approach, open information management and a diverse set of sources for design, power and delivery . In this iterative process participatory assessments can create learning cycles that provide feedback (Pahl-Wostl et al., 2007).

As the Randstad metropole is an important element of the delta environment, adaptive delta water management does not only entail the natural landscape. Adaptive delta water management can be implemented in an urban context by use of the sponge city concept. The Sponge City is a specific integrated water management focused on urban water issues (Li et al., 2017). Sponge cities are implemented to solve water issues that result from urban growth, climate change and poor urban planning. The major related water issues are a water shortage, the risk of flooding and pollution of water. Sponge cities include a number of different ecological services: the provisioning of fresh water, the regulation of water purification, flood- and erosion control and climate adaptation, the support of natural habitats and preservation of biodiversity and finally, sponge cities have cultural value by facilitating tourism, appreciation, and recreation (Li et al., 2017). The implementation of a sponge city entails four key principles: resourcing rainwater, ecological water management, green infrastructures, such as bioretention systems and green roofs, and permeable pavements. in order to successfully implement the sponge city concept appropriate regulation and technical design, valid economic assessment and public awareness and acceptance are key (Li et al., 2017).

Finally, as water is the most vital resource of the planet, water circularity is key in restoring the balance between the urban and natural environment (Nika et al., 2020). Water circularity is based upon the principle of circular economy. A circular economy (CE) is designed to be restorative and regenerative and decouples economic growth from the depletion of resources (Ellen MacArthur, n.d.). By the shift from linear to circular flows, a CE creates economic resilience, facilitates new economic opportunities and provides environmental and societal benefits. In a CE waste and pollution are prevented by design, products and materials are re-used and natural systems are regenerated. In eco-environmental subsystems water flows are circular by nature. Human-dominated urban subsystems, however, have disrupted this hydrological cycle by linear models of economic growth (Nika et al., 2020). As the resource of water interconnects the eco-environmental and socio-economic sectors, water is in the centre of CE. However, the management of water is still very fragmented. A shift towards water circularity requires a systematic approach to water management that creates a symbiosis between the key water-related processes of the eco-environmental and socio-economic ecosystems (Nika et al., 2020).

As highlighted above, human intervention in the natural environment has led to a diversity of environmental challenges and risks. However, the negative externalities are not equally distributed among society. Further urbanisation will increase challenges on water management and the distribution of water resources (OECD, n.d.) Achievement of socio-environmental justice is therefore one of the key goals for this strategic vision and its integration is a crucial element in all aspects of the strategy. Competing water demands arises at the scale of river basins or watersheds. A resilient way of water management asks for a balancing of these water demands by inclusive water management that is carried out at an adequate scale and with involvement of all stakeholders within the river basin (OECD, n.d.). However, when socio-environmental justice and water

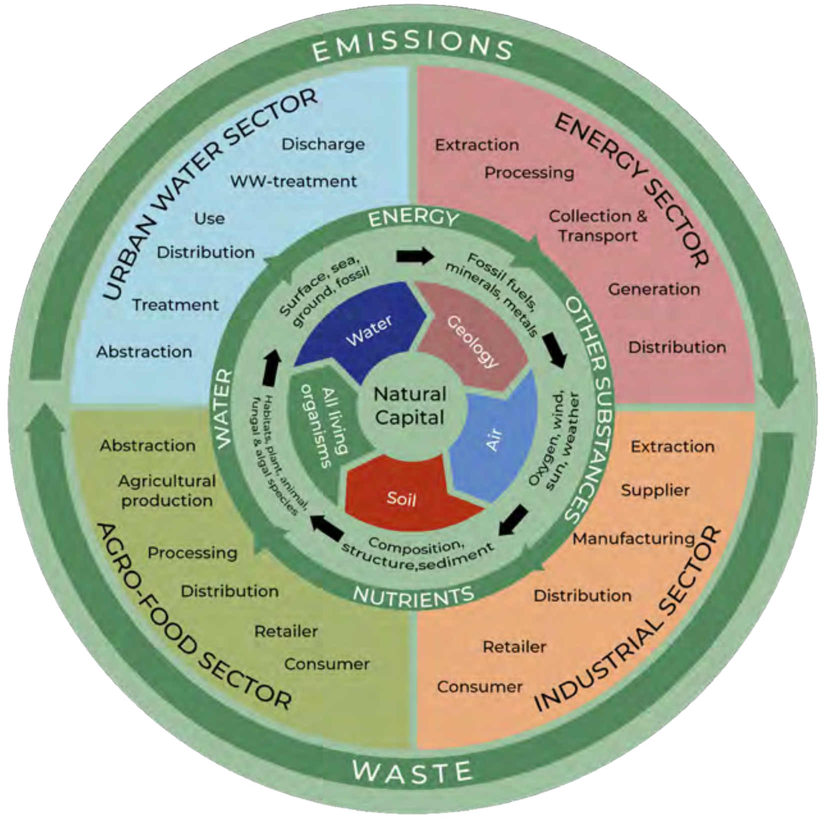


Figure 11: Circular Economy [source: (Nika et al., 2020, p. 116425)]

management are not defined at the same scale, policies on socio-environmental justice will fail and inequity of water resources are aggravated. This was shown by Sze et al. (2009), who studied how environmental justice is defined and contested in the socio-technical context of the California delta environment. This study underlines how the diffuse property of water and the multi-scalarity

impact of water management is underrepresented in the social and economic flows of power in water management and how this creates socio-environmental injustice. A shift towards an ecologically just process of water management is needed in which all the human communities that are impacted by delivering, conveying and using water are included in all scales of decision-making (Sze et al., 2009). The current approach to the planning of natural resources use (the Driving forces-Pressures-State-Impact-Response framework) prevents pluralistic discussions and participation for water governance (Fernandez et al., 2014). The addition of feedback loops of social learning that are added in adaptive delta water management enables participation. A participatory approach of delta water management does therefore not only enforce resilience, but also contributes to achieving socio-environmental justice.

Although it is a general accepted concept in academic literature, there is no common definition on socio-environmental justice. For this report, this concept is defined as the equal distribution of water related risks and resources among time, space and society through a participative approach of delta water management and spatial planning.

3 Analysis

3 Analysis

3.1 The Delta Environment Today

In order to get a better understanding of the challenges at hand in the province of South-Holland we first must make an assessment and analysis of the current situation on the matters at hand in the region. In this analysis we first look at the environmental and water usage issues present in the region. A first initiation to these problems has been put forward in the introduction chapter, in the section of the problem statement. The environmental issues are viewed on the regional scale and affect the entire province.

A second major issue at hand is that of the housing crisis, also mentioned in the problem statement. A problem affecting the region on a larger scale, yet an issue which is very personal and close to us. An issue most citizens of South-Holland, have dealt with, or will have to deal with in the (near) future. This part of the analysis will look at the spatial implementation of housing demand and spatial developments of the housing market.

Thirdly we will go more in depth on the current situation of the Port of Rotterdam and Greenport West-Holland, before analysing the circularity in the region. In this final section, about the circularity, we will first look at what positions of perspective governmental bodies take. Then we will discuss the current water flows in the region, and finish with the challenges and opportunities circularity in the province of South-Holland has to offer.

Quality of nature and water

Since 1994 the average quality of all types of natural environment in the Netherlands has been decreasing. Luckily, for the past few years, the average quality of the ecosystem in natural areas has not further been decreasing, however it also has not been improving, as can be seen in Figure 12. The figures show that the natural quality of nature of marshlands and wetlands as well as the quality of sweet water at surface level are far below the quality an intact or natural ecosystem would have (Figure 13, index = 100%). With an intact or natural ecosystem we refer to an ecosystem which has not been touched by salinisation, desiccation because of the low groundwater level and fragmentation. On average the natural ecosystems of the Netherlands are indexed at around 40% (CBS et al., 2018).

Reasons for the decline of quality are the reclamations of the natural environment, as well as urbanisation and a decline of acreage of natural ecosystems (Figure 14). In addition, the quality of the freshwater ecosystem is low because of eutrophication and pesticides released into the ecosystem by water deposition in the agricultural sector. Luckily we are slowly recovering the environmental pressure on water and natural areas. However, the question remains if current trends will eventually fully converge to a level of sustainable conservation of the natural ecosystem (CBS et al., 2016).

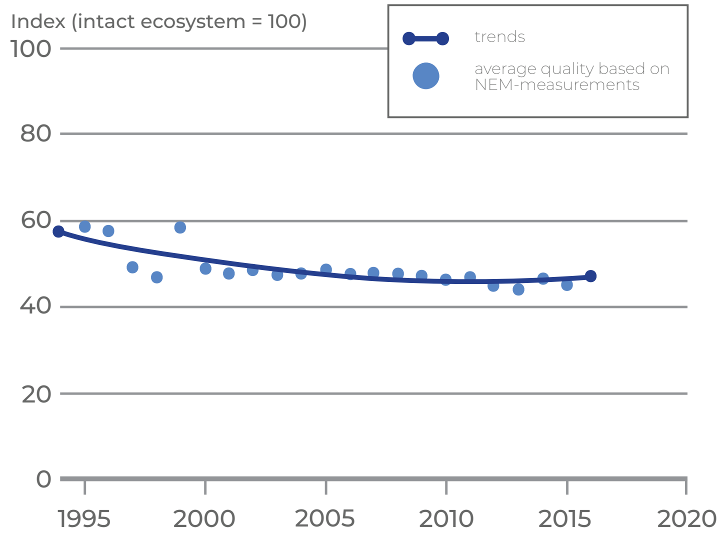


Figure 12: Appearance of characteristic species in marshlands and wetlands

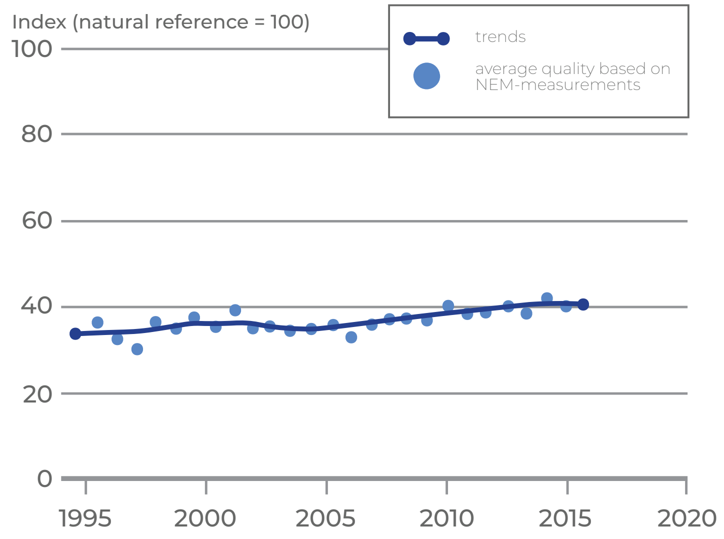


Figure 13: Average quality of fresh water

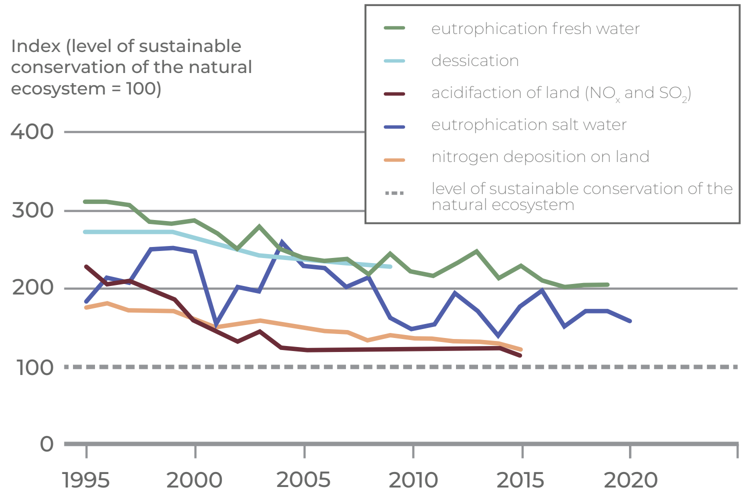


Figure 14: Environmental pressure on water and nature reserves

Water Usage

The water usage in the agricultural sector is heavily dependent on the amount of rainfall a year. Most of the water used in all forms of agriculture - land farming, horticulture, livestock farming, fruit growing - is rainwater. Only in horticulture and livestock farming, surface water and groundwater are also used more extensively. Due to climate change and the increase of more extreme weather conditions, for instance long periods of droughts in the summer, a higher water consumption is required. A cautionary situation, because in times of drought there is a water scarcity in a lot of sectors, not least of all the drinking water production. In the summer of 2018, we experienced for the first time since 2003 serious periods of drought, as can be seen in Figure 15, the water usage in 2018 compared to 2003 was 40% higher. Since the summer of 2018 we've yet to have a summer without droughts in the Netherlands, an unfortunate trend which presumably will persevere for the foreseeable future (CBS et al., 2020e).

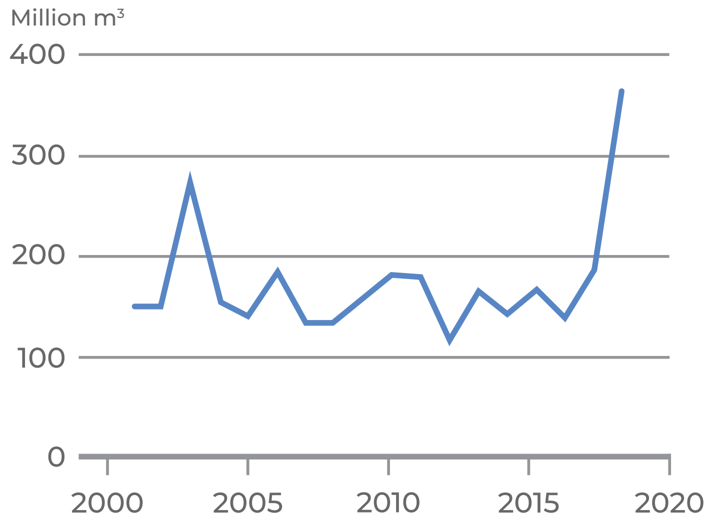


Figure 15: Water Usage in Agri- and Horticulture

An important water user in the industrial sector are the power stations. Power stations require a lot of surface water for their cooling systems. Within the region of South-Holland, the Port of Rotterdam has one of the most densified industrial landscapes, with a multitude of energy production plants. Since 2012, the usage of salt water in power stations has increased (Figure 16), due to more plants opening along the coastal front. Luckily it is now possible to use salt or brackish water for cooling systems, making it easier for the Port of Rotterdam to pump water from the nearby river Maas and lakes in the area. After their cooling purposes, the freshwater and saltwater are discharged again to nearby rivers and other locations with surface water. This water has a higher temperature, due to their cooling purpose, and it is important that not too much water with a too high temperature is discharged into nature. Especially during summer and periods of heat, the rise in water temperature can prove critical for the ecosystem. In addition to this, the residual heat in the waste cooling water is also a loss of warmth and energy. Luckily, for the past few years, there is a decline of residual heat in cooling water, due to new ways of providing this heat to third parties in the form of hot water (for example nearby city heat networks) and steam (to for example nearby industrial factories requiring steam for their production) (CBS et al., 2020b). In the area of the Port of Rotterdam Shell Pernis can be seen as an example in this. With the usage of residual heat, the refinery delivers heat to 16.000 homes in Rotterdam South, resulting in a CO2 reduction of 35.000 tons per year (Shell Nederland, 2018).

In the Netherlands, drinking water companies take care of the public water supply by delivering drinking water and semi-manufactured water (e.g. industrial water). Due

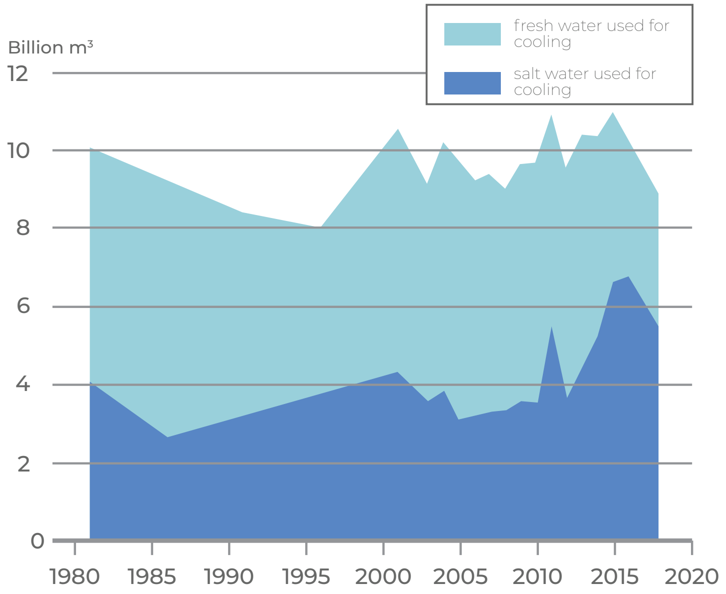


Figure 16: Water Usage by Power Stations

to tightened policies in the 'Drinkwaterwet', the drinking water law, the distribution of household water had to be put to a stop. (Household water is 2nd quality water, not drinking water.) Dutch homes are in general only supplied with drinking water, which belongs to the best quality of tap water in the world (Oasen drinkwater, 2016).

In the fifties of the previous century, around 300 million m³ drinking water was produced per year. A massive increase in drinking water production followed in the succeeding decades. At the end of the eighties, the production of drinking water increased over 4 times, to 1.200 million m³

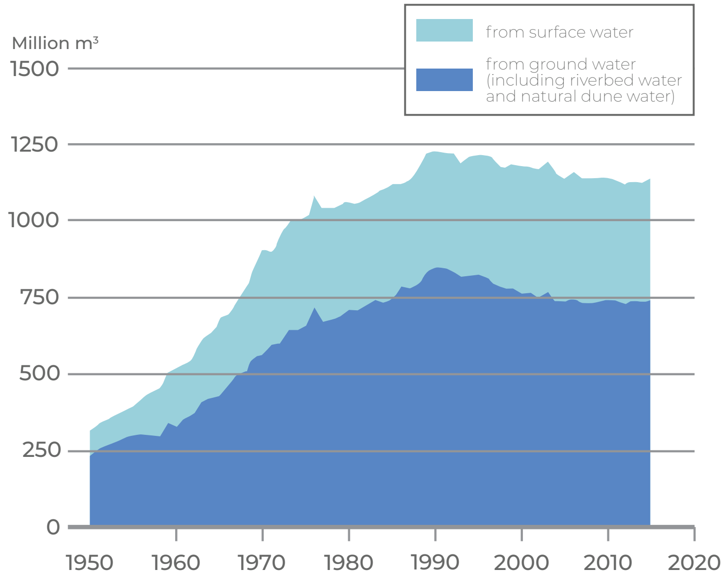


Figure 17: Production of Drinking Water

water per year (Figure 17). Luckily, despite the increase in population and the economic growth we've experienced over the past decades, the production of drinkwater has slowly been in decline in the past few years. This can be owed to a stimulance and social support to use less water and water reducing technical developments like better household machines and more efficient industrial production methods (CBS et al., 2017).

The reduction in drinking water production and usage is a good development. Especially in light of increased droughts in the summer periods. In the western part of the

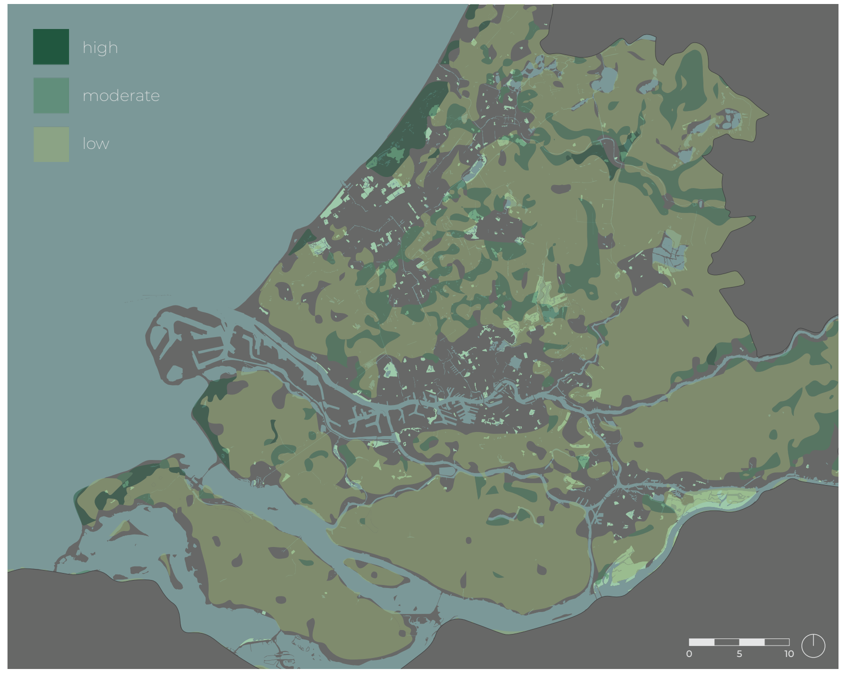


Figure 18: Risk of Drought

province of South-Holland, we have to deal with a serious problem of risk of drought. Unfortunately, this area, in the coastal region along the dunes, is also one of our primary drinking water supply locations. It is of importance to look for different groundwater and surface water locations for drinking water production, in case of extreme droughts in summers and dried up water supplies, as last summer, where water had to be led into the area from elsewhere because the pumps ran dry.

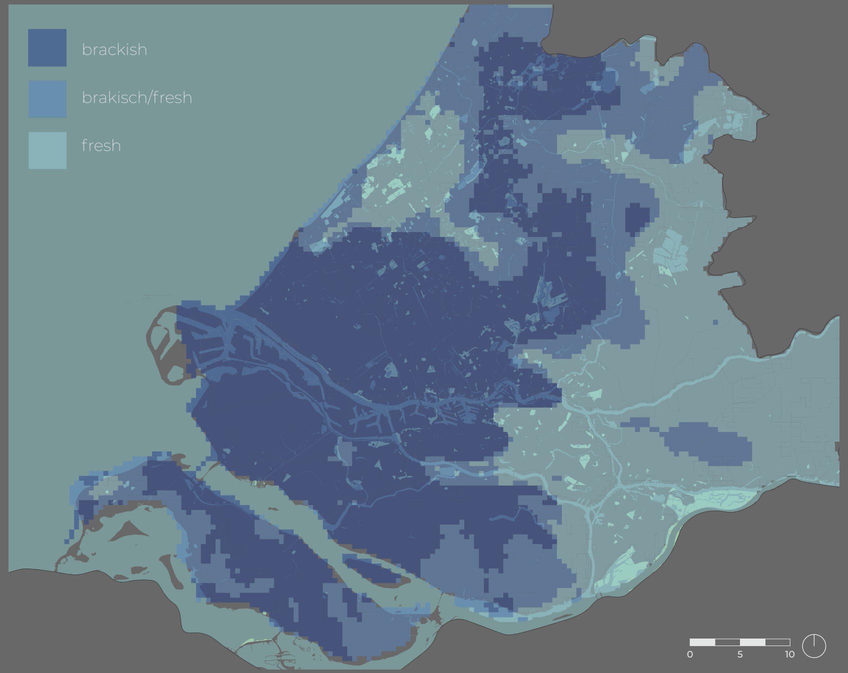


Figure 19: Salinization

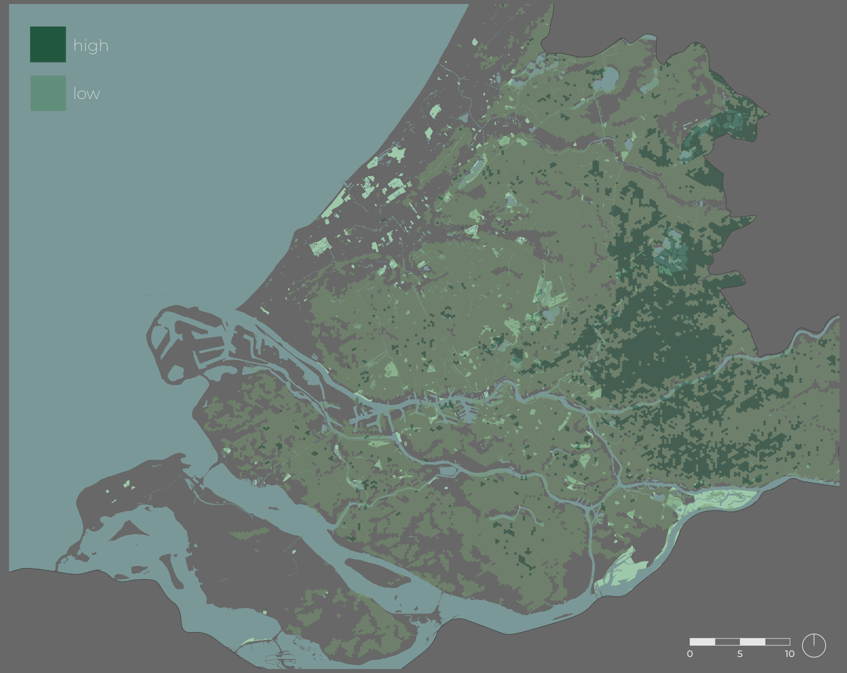


Figure 20: Soil Subsidence

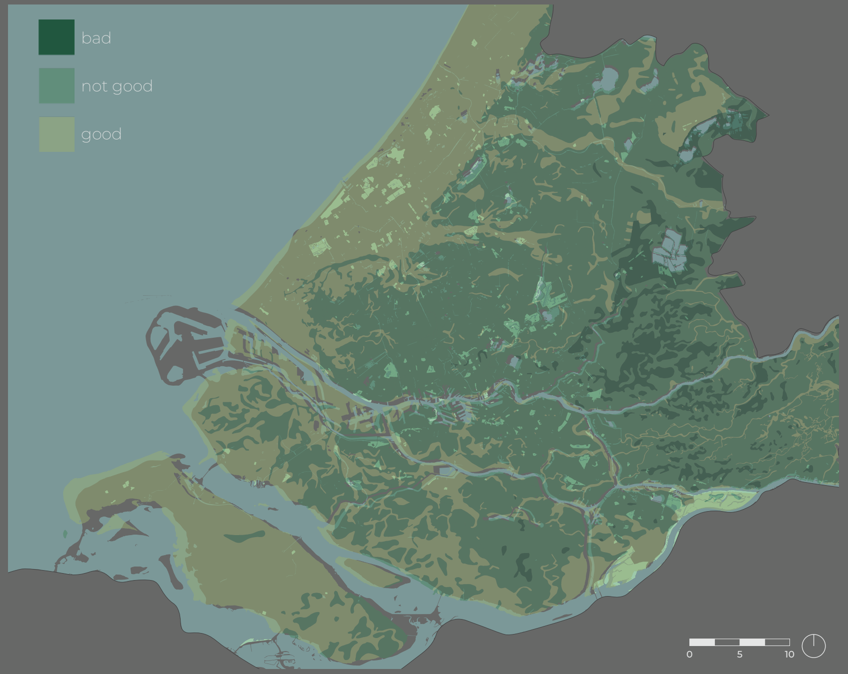


Figure 21: Bearing Capacity

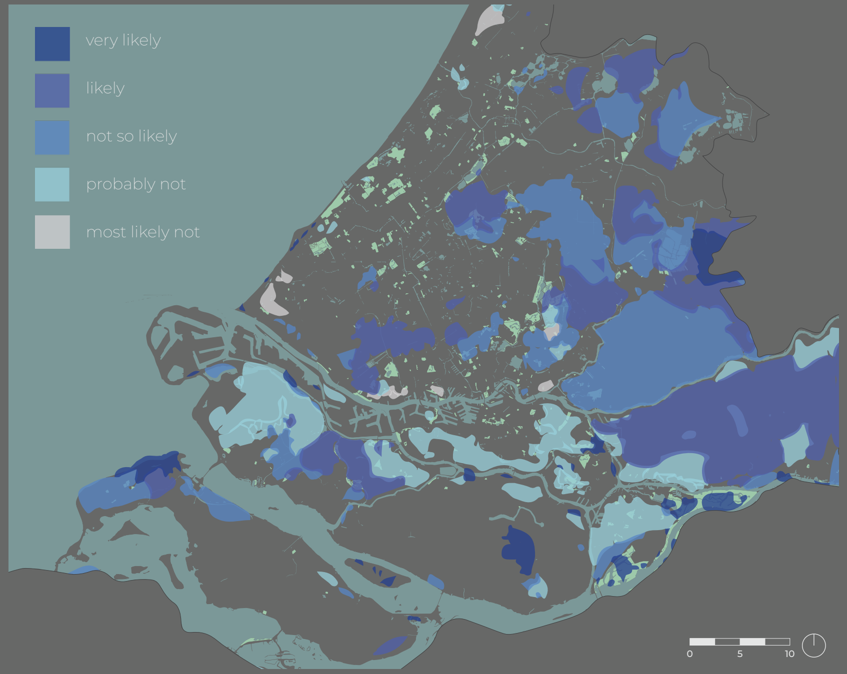


Figure 22: Risk of Flooding

Soil Problems

A major problem in the region of South-Holland is the salinisation of the ground. Especially in the agricultural areas on the western and southern side of the province (Figure 19). As has been mentioned before, in the problem statement, a large part of this salinising problem can be assigned to the deep polders that were constructed in the late medieval period. Also extensive agricultural farming plays a major role in the process of salinization of the land.

Along the eastern parts of the province, as has also been mentioned in the problem statement, we have to deal with the bad bearing capacity of the soil as well as the complication of soil subsidence (Figures 20 and 21). Due to clay and peat grounds which have been poldered, the subsidence is related to former groundwater extraction. There are two ways of competing with the decline of ground level relative to the groundwater level. On the one hand it is possible to heighten infrastructure and protection, such as bridges and dikes. On the other hand it is possible to locally lower the groundwater level, which is kept at a stable level by policies executed by the waterboards. Because the ground level is not declining in a stable fashion, with an evenly distributed and equal decline, the area would have to be split in multiple shells by dikes and waterways.

The Risk of Flooding

Finally, there is the environmental risk of flooding present within the region of South-Holland. A has been mentioned, the major risk of flooding is currently not so much by sea overflow, but by river overflow in the delta region. Throughout the province, protection from the flooding by rivers, part of the delta structure, has to be dealt with. (Figure 22)

Housing Crisis

However, the risk of flooding from river overflow does not hold us back to keep constructing new residences outside of dike protected areas. In the past twenty years we've constructed more than 2,500 houses outside of dike protection in our triple delta area (CBS et al., 2020d)

Not such a strange development: there is a massive demand for housing and a huge lack of space in the province of South Holland.

In the last five years, the Dutch population has increased with 3% to more than 17.4 million inhabitants in this relatively small - 41,543 square kilometers - country. Especially an increase in population development towards the center of the Netherlands and the Randstad areas can be noticed. In South-Holland we have the highest population density per square kilometer. Here, on average, 1374 people live per square kilometer (in comparison: the average in the Netherlands is more than two-and-a-half times lower, 517 residents per square kilometer). In the past five years, the population of The Hague grew with over 31,000 and the population of Rotterdam grew with over 28,000. (CBS et al., 2020a) Yet, as can be seen in Figure 23, the demand for new residences is still very high.

In total, almost 300,000 new residences need to be built in the province by 2050. (Province of South-Holland et al., 2015). Not a surprise, since the province has a highly attractive business climate with an excellent infrastructural web and public transport network. In the province, the travel times between home and work are the lowest in the country and the close proximity of jobs in the Randstad is indexed at

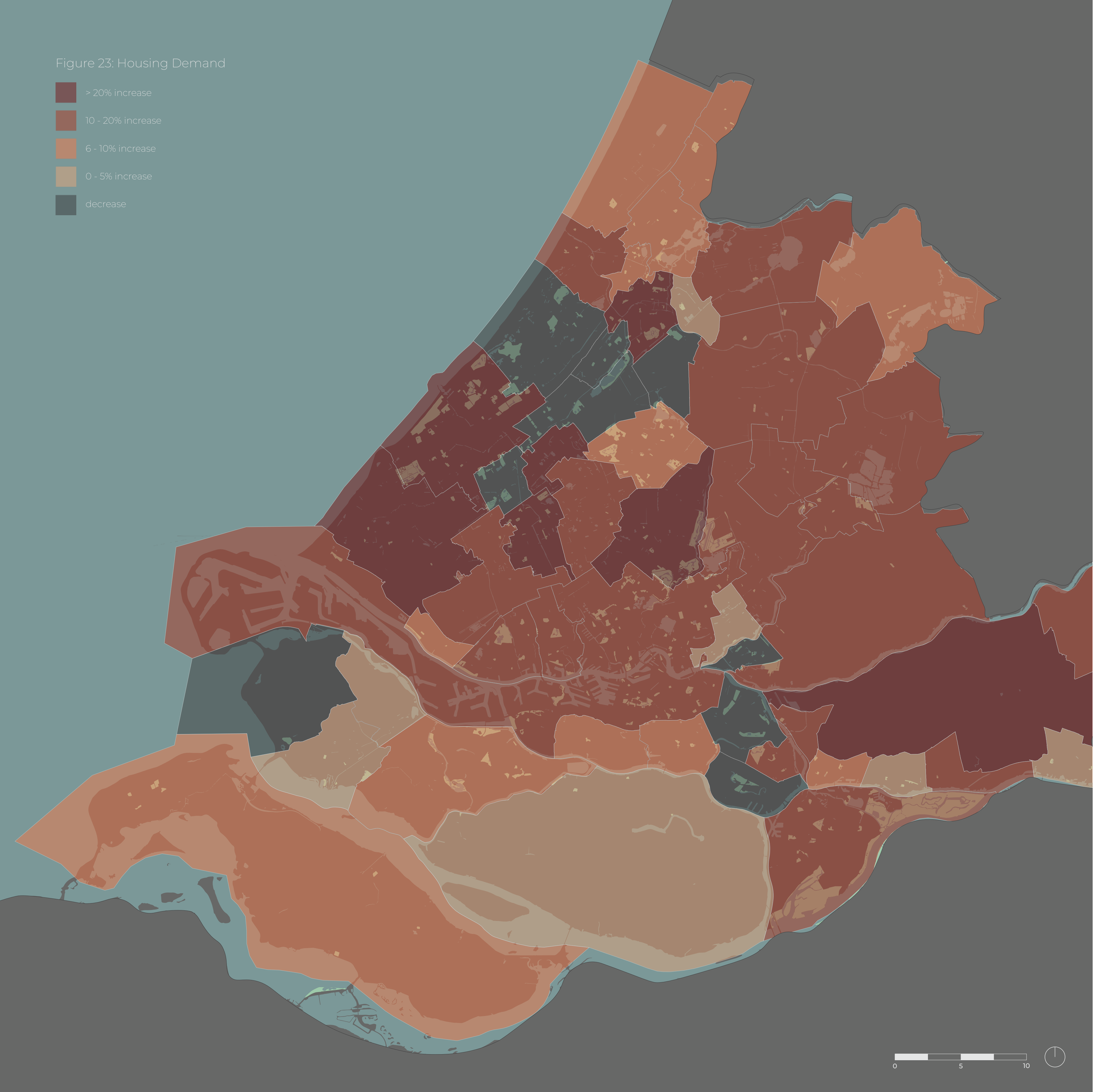


Figure 23: Housing Demand

one-and-a-half times higher than the country's average (CBS et al., 2020c)

The original plans from the government, in fulfilling the mission to develop such an abundant amount of new residences, were fully based on new construction within the current urban areas, without any expansion outside of the current city limits. However, as de Zeeuw and Keers (2020) argue, in a paper for a parliamentary hearing in October 2020, this would not be sufficient. They conclude that urban expansion, and more so densification, limited to the city limits would cause problems on three grounds. First off, the current plans for inner-city expansion are inadequate to meet the housing need. A part of the plans for development, caused by several reasons, are postponed or even cancelled. The short term housing shortage as a result leads to further price development of houses and further compromises the affordability of living. Secondly, by far most of the inner-city development plans consist of (small) apartments. However, in the inner-city, there is more demand for ground-level housing than apartments and there is a demand for more land-based homes in green residential areas near cities. A clear friction between development plans and people's demands and requirements is visible. Lastly, inner-city densification does not only provide benefits. A displacement of work functions in city cores can occur and the consequences for mobility are not always positive. Benefits are often based on assumptions and not research and good comparative research is lacking.

Port of Rotterdam & Greenport West-Holland

The Port of Rotterdam is one of the most prominent ports in the world and the largest port in Europe. Yearly 469.4 million tonnes of dry bulk, liquid bulk, containers and breakbulk are put through the port. In total 29,491 sea-going vessels and 85,969 inland vessels call at the port each year. The largest area of the port is dedicated to the petrochemical sector, with refineries, chemical-plants and power production plants (Figure 24).

Due to the port's large contribution to greenhouse emissions and the climate accord and target goals imposed by the government, the port is now at the turning point towards a new more sustainable industrial environment.

The Port of Rotterdam works towards building a sustainable port based on three guiding themes: safe and healthy environment, climate and energy, and people and employment. Especially the first two guiding themes are of importance in creating a strategic vision for the province of South-Holland. The port is, in light of the natural environment, focussing on flood risk management, enhancing the natural areas and also stimulating nature. Currently the area is surprisingly rich in animal and plant life, with a multitude of different animals residing within the port boundaries, such as several species of sea and land birds, small wildlife and also seals and dolphins. However, the total area of natural space within the port is still very limited and it is important to emphasize and expand this natural habitat in the Port of Rotterdam in the future.

On the topic of climate and energy, the Port of Rotterdam is on the eve of major changes. A switch from petrochemicals towards a biobased port is bound to happen in the coming thirty to fifty years. Also the port is working towards a CO2-neutral industry, with pipeline connections to Rotterdam and Greenport West-Holland to distribute residual heat and CO2 for other usage (Port of Rotterdam, 2021).

Currently the basis for industrial water (dominantly cooling water, demi water and raw water) is fresh water. 42% of the water needed for the port is retrieved from the Maas, 33% from the Brielse Meren, 13% from the Rijn and the Elbe and 12% from other smaller local sources. Reusing freshwater is currently cheaper and more available and used than desalting sea water or the brackish water available in the port itself (Evides industriewater, n.d.).

On the other side of the Nieuwe Waterweg, behind the North banks, Greenport West-Holland is positioned. The Greenport is the largest cluster of horticulture in the Netherlands and an important economical factor for the province of South-Holland. In February 2018, 38 involved parties signed the Innovation-pact of Greenport West-Holland, promising to share and provide knowledge, innovation, and education to the horticulture in the region (Greenport West-Holland, 2020).

Their ambitions for the coming ten years are enlarging the value and margin of the horticulture cluster, become a leader in knowledge and innovation, lead in health and happiness, work with smart and efficient logistics, and work towards a climate neutral and circular horticultural production (Greenport West-Holland, 2019).

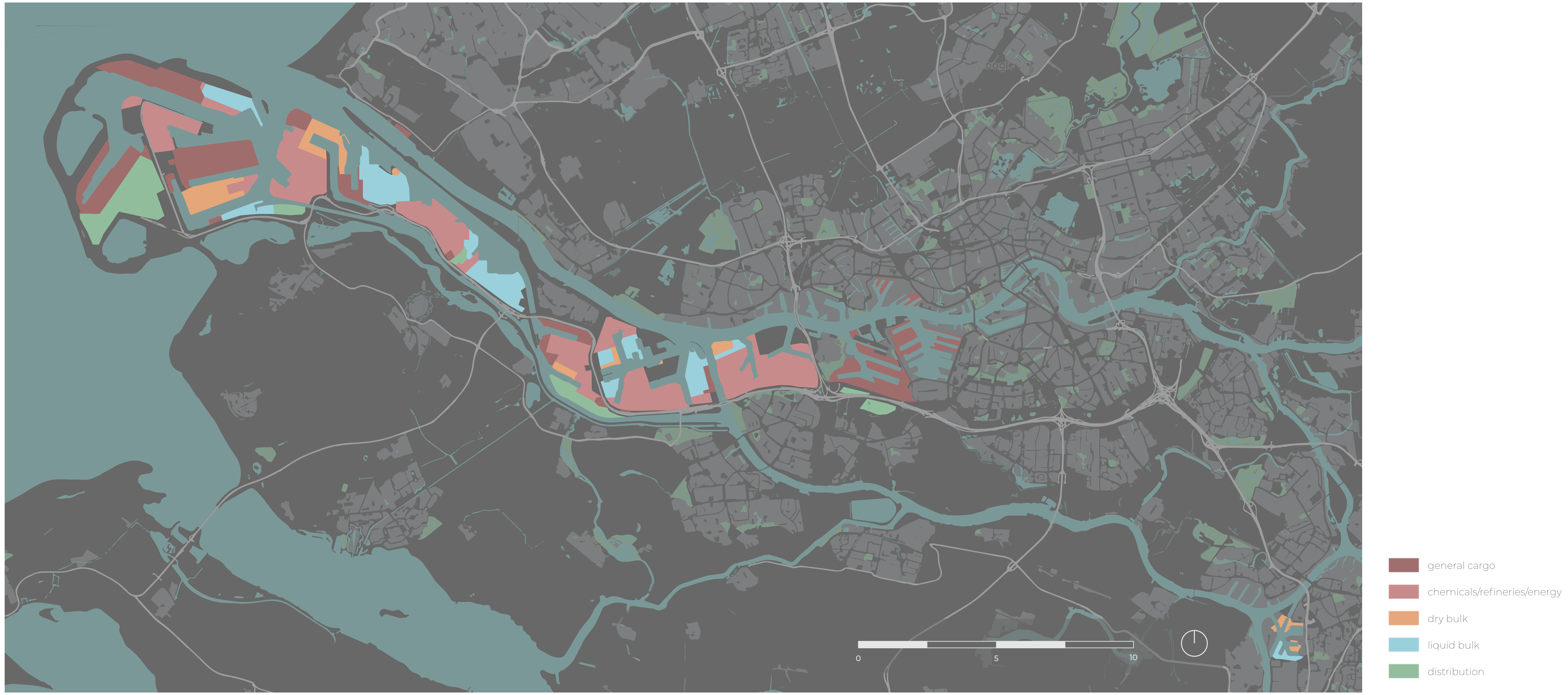


Figure 24: Port of Rotterdam

3.2 Striving Towards Circularity

Perspective from Government

On a national level, the Ministry of the Interior and Kingdom Relations has released the National Strategy on Spatial Planning and the Environment (Ministry of the Interior and Kingdom Relations et al., 2020). In which the national government presents its long-term vision on the future development of the living environment in the Netherlands. In this document four priorities are put forward in working towards this vision. These four priorities are in line with the goals of the Climate Accord of Paris and the KlimaatWet and are as follows:

1. Creating space for climate adaptation and energy transition;
2. Sustainable economic growth potential;
3. Strong and healthy cities and regions;
4. Future-proof development of rural areas.

Serious thought and effort by the national government is put into working towards a sustainable circular future. Atleast, it's on their main agenda now as a higher priority than before. However, in light of the very recent elections, it is hard to prognose what future trail will be chosen and how much energy is ultimately put into this endeavor. What can be seen is that leftwing parties of which have climate change high on their agenda, have lost several seats in the House of Representatives. For e.g. GroenLinks, which previously achieved 14 seats in the elections of 2017, has dropped significantly to a mere 8 seats (Nederlands Dagblad, 2021). A bitter blow for the party and potentially also for the momentum working towards a circular future.

On a more regional level, the province of South-Holland released a vision on a Circular South-Holland, accelerate together (Programmateam Circulair Zuid-Holland, 2019) in December 2019. The province acknowledges the need to transform to a circular economy and sees a lot of potential because of the major (raw) resource flows through the province. By working towards a circular economy they hope to achieve future proof development and to preserve their competitive position on the market.

The province wants to stimulate the transition by taking the role as a connector between businesses and also knowledge institutions. They see potential in stimulating and facilitating chain cooperation. At larger scale initiatives, the province has noted that it would like to support financially and help with upscaling of projects. Their main focus, however, is in boosting and sharing the spread of knowledge on sustainable and circular ideas. Both internally, to prepare policies based on new scientific findings and externally, to supply the market with the adequate information. Here, they see a role as authorised supervision in project development, for instance in the tender of construction of road and water infrastructure as well as building construction. Also they present themselves in helping start-ups with valuable circular ideas.

In 'closing the loop' in circular flows, waste management is an important factor. The province acknowledges that current legislation and policies are not yet adequate to provide possibilities for circular flows in each sector. Based on the report send to the House of Representatives by the Secretary of State, Van Veldhoven, at 10 October 2019 (Unie van Waterschappen, 2019), the province is aware that the obstacles in growing towards a circular economy are not always found in the laws and regulations, but also in the application of these laws and regulations. Here they find themselves looking for new possible margins and widening current potentialities. (Programmateam Circulair Zuid-Holland, 2019)

In envisioning a transition to a circular economy, the province of South-Holland closely relates the transition to two other major transitions: the transition in energy supply and the digitalization. These two other themes can be used to support the transition to a circular economy and can be deployed to discover the opportunities in strategizing and implementation. (Programmateam Circulair Zuid-Holland, 2019)

When investigating water management, it is important to also differentiate the several tasks of involved governments in water management. The separate tasks of different governmental bodies are recorded in the Waterwet (2020). The central government is responsible for the national policy and national measures. The central government is also responsible for the protection and water safety of the primary flood defenses. These are the dunes and rivers protecting the land from the sea and the major rivers in the country.

Secondly, there is the provincial government. The province is responsible for the translation of the national water policies to the regional implementation of those policies. They also are responsible for the management of the groundwater quality according to the Soil Protection Act. (Wet Bodembescherming, 2017)

Next up in zooming in, are the municipalities. The municipalities are responsible for the groundwater within the urban area. They are also responsible for the drainage of excess rainwater via the sewage system. (Waterwet, 2020) (Wet milieubeheer, 2021)

Aside from these three scales of governmental bodies, there are also two more parties involved in the water management. The first party involved is Rijkswaterstaat. Rijkswaterstaat is responsible for the management of the larger water bodies in the country, like the sea and the major rivers. Rijkswaterstaat informs the (local) government(s) for high tides or storms at sea. They are also responsible for maintenance on dikes, dams, weirs and storm surge barriers. Lastly they are also responsible for the rivers kept in shape outside of the riverbeds, for instance by deepening the floodplains or creating secondary flowing channels on the side.

The final party involved in the Dutch water management system are the Waterboards. The Waterboards are a very powerful regional governmental body and are responsible for the regional waters, such as the channels and polder waterways. They make sure the water is of good and clean quality, as well as protect natural water life. They are responsible for the correct cleaning and purification of sewage water, provide farmers with the adequate amount of water for watering crops and protect the land against floods by maintaining dikes on a local level. They are voted for by the population within the board's area and raise taxes locally to finance their responsibilities. (Ministerie van Infrastructuur en Waterstaat, 2019)

Current Water Flows

It seems so easy: you open the tap of your sink, and fresh clean drinking water comes out. As mentioned previously, in the Netherlands we are one of the countries with the highest quality of our drinking water. The same water that flows from the tap, is also used for your shower and even your toilet is flushed with the cleanest of water. What many do not realise however, is the extensive route this water has taken before it ends up in your glass.

Spread throughout the region there are on the one hand drinking water production companies and on the other hand wastewater sanitation companies. Drinking water companies use pumped up groundwater and surface water to create drinking water, which they in turn supply to residences and industries. They either pump up the groundwater in the coastal areas, or use local water bodies and rivers to supply them with surface water. Wastewater sanitation companies receive the outflow of sewage by industries and residences, as well as any rainwater captured and sanitate and purify the water before releasing the water to nearby surface water, such as local water bodies and rivers (Figure 25).

Even though water is - in it's ultimate sense - a circular resource, the current system of (drinking) water management is not very circular. There are small scale projects within cities where for instance, greywater is separated from black sewage water and reused to flush toilets and other flows of household water. But any large scale circular projects are yet to be implemented.

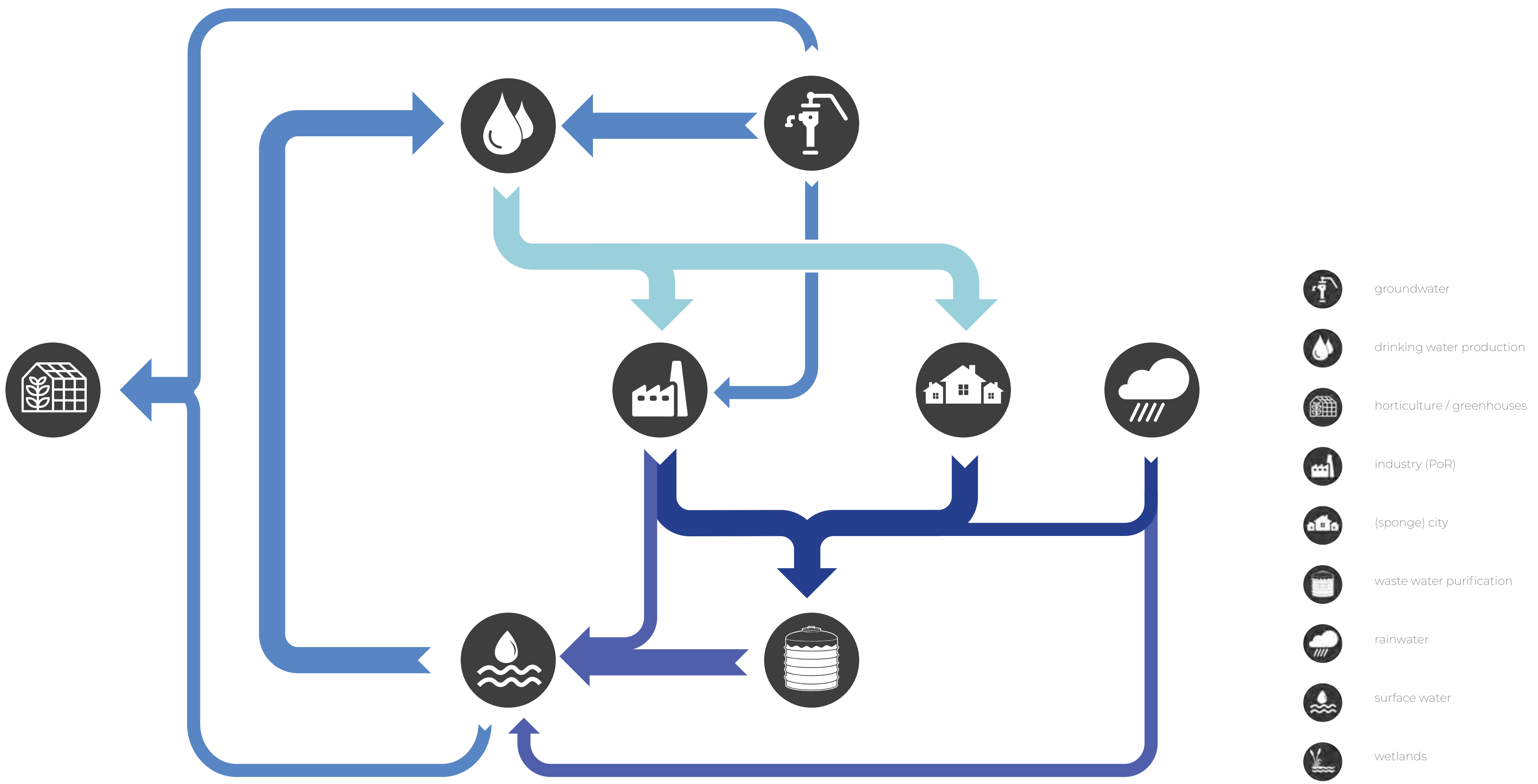


Figure 25: Water Flows

Challenges and Opportunities

There is a lot of potential in working towards a circular water management which involves the delta landscape. However, there are also a lot of challenges. One of the main complications is assessing water circularity in a circular economy framework. Currently available circularity methodologies are not easily transferable to the water sector. The methodologies fail to evaluate water circularity by both considering human-managed and nature-managed systems (Nika et al, 2020). Corona et al. (2019) add another three major challenges of current circularity metrics. It is difficult to measure the circular economy goals in all the sustainability dimensions. The circular flows of water are much broader across different layers of resources and are difficult to map. Secondly, the evaluation of the scarcity of used materials, and thirdly, the under-representation of multiple cycles and the consequences of material downcycling are not well enough incorporated. A difficult to grasp consideration, since the downcycle on water is a very enigmatical concept to approach.

The transition to circular water systems would require the redesign of the water infrastructure as we know it today. The utilization of recent developments in technology shifts us towards the integration of nature-based ecosystems (O'Hogain & McCarton, 2018). Priority objectives of wastewater treatment imperatively remain the water recycling, water sanitation and environmental protection. In treating the water, physical-chemical and biological methods are used for the removal of (bio)solids, organics, and nutrients. Possible on a relatively small scale due to engineered processes.(Weissbrodt et al., 2020)

Weissbrodt et al. (2020) also state that biological methods most often provide technological opportunities that offer substantial savings in capital and operational expenditures. However their performance relies on the design of a robust and resilient ecosystem composed of specialized metabolizing populations of microorganisms and would only reach full functional capacity at a scale much larger than is currently needed. Due to the natural and more organical process of treatment, the process is less space optimised and a large area of available land is needed in order to house these forms of treatment.

This can also be seen as an opportunity. For the reason that the treatment of wastewater happens in a more 'natural' environment, which can be used in a different function as a way of enjoying the green environment by people. Thereby creating more available space for nature and at the same time creating awareness on the circular process of water management to the general public.

Figure 26: Wastewater Flows

Figure 27: Drinking Water Flows

3.3 To Conclude

The quality of our natural environment has been at an all time low, however for the past few years it is finally slowly recuperating. Also the environmental pressure on water in the natural environment has been declining. Especially the agricultural and industrial sector have a high water usage. The average water usage is decreasing, but due to summer droughts, the agricultural sector is requiring immense peaks of water during these times. Water discharged by the industrial sector, used in cooling, can be harmful to the environment. With the heat that is stored in this water, the local temperatures of water bodies to where the water is discharged can dangerously alter, affecting plants and water life. Intercepting and reusing this water and residual heat in local urban areas and in horticulture could provide a solution.

On a larger scale, major environmental challenges are present within the region of South-Holland. On the one hand the soil problems and on the other hand the risk of flood. Complications such as salinity and soil subsidence are hard to confront on any scale. The only way to seriously attempt to prevent further developments by these problems is to heavily alter the landscape as we know it today. Something which might not be desirable. The risk of floods are, especially in our focus, mostly present along the major rivers and the triple delta structure in the province. Possible solutions could be an increase in the quality and quantity of the current dike structures, creating more parallel side channels and increasing the size and frequency of floodplains.

In the province of South-Holland there is a large housing demand. Almost 300.000 new residences need to be built by 2050. Only densifying within the city limits might not prove as desirable as thought. Densification brings complications in terms of a difference in qualitative demand and time related lack of quantity. Expansion outside city limits therefore might still be a necessity.

The Port of Rotterdam is on the eve of change. They are transitioning to a CO2-neutral industrial environment, with a focus on biobased energy production and see themselves as a leader in hydrogen production and distribution, by becoming a major hydrogen hub on this continent. At the same time, the horticulture of Greenport West-Holland has the ambition to enlarge their value and margin in the horticulture cluster, become a leader in knowledge and innovation, work with smart and efficient logistics and work towards a climate neutral and circular horticulture production.

Governmental bodies are also working towards a climate neutral and circular future. In line with the Climate Accord of Paris and the KlimaatWet, national, regional and local governments are working to provide the right visions paired with more flexible policies to succeed in transitioning to a circular economy. They all have a strong vision on what needs to be done, however any spatial implication on where and any form of durable stakeholder involvement is still lacking.

Finally, the transition towards a circular water system would require a redesign of the water infrastructure as we know it. Much more space would be required if we plan to naturally treat waste water in an ecological surrounding. Drastic alteration of our landscape might prove to be a successful proposition towards a circular delta environment.

4 Vision

4 Vision

4.1 Vision

Vision Statement

In 2050 the realisation of a circular South-Holland will redefine the strengths of the South-Holland delta region. Both the demand of housing will be answered and the landscape will be climate resilient by restoring the balance between the urban and the natural environment. A transformation of the urban areas into 'living sponges' and an adaptive management of the ecological landscape can enhance the optimisation of water flows and solve water-related risks. The right of housing will be attained for all and the benefits of water are equally divided among society. A just transition towards a flourishing and redefined South-Holland that encompasses circular water flows will result in a delta environment that is adaptive to social and environmental needs, that includes a reinforced port area and that secures urban liveability for all by 2050.

The map in figure 28 indicates what the redefinition of the South-Holland region will look like spatially. The current urban cores are transformed to cities that function as living sponges. In order to fulfill the demand of housing, new housing opportunities are created through urban densification as well as urban expansion. The facilitation of living along the water is taken as a starting point for where the urban area is expanded. The recovery and redefinition of wetlands evokes a significant change of the current landscape. The wetlands do not only bring back the beautiful characteristic polder landscape, but are also the most fundamental element in the shift towards water circularity. As a nature-based water purification structure between the urban cores, the wetlands allow the inflow of urban waste water and the extraction of freshwater to fulfill the drinking water demand. Besides, the demand for drinking water and the outflow of wastewater is decreased because of urban water reuse as indicated on the map as well. Blue-green corridors that run through the area, including the urban areas, connect the wetlands between themselves and to the existing watersheds. This creates the opportunity to ecologically transport water in times of high water levels and decrease flooding risk. Besides, this blue-green network stimulates the biodiversity within the area. Finally, the port area will be somewhat smaller as the in- and export of flows is minimised in a circular economy. However, the port will have a strong competitive position internationally, as a hydrogen hub and as a leader in the energy transition.

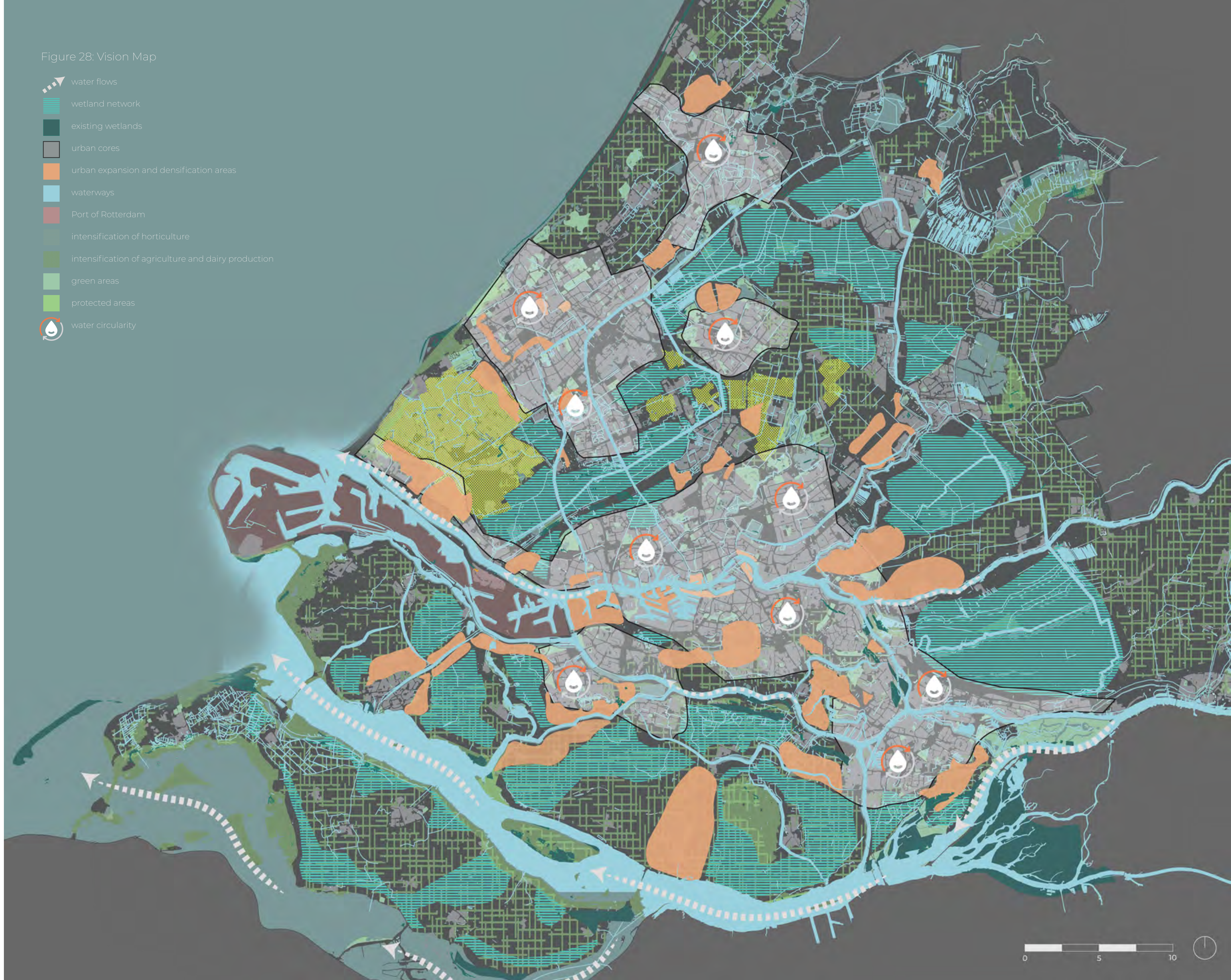


Figure 28: Vision Map

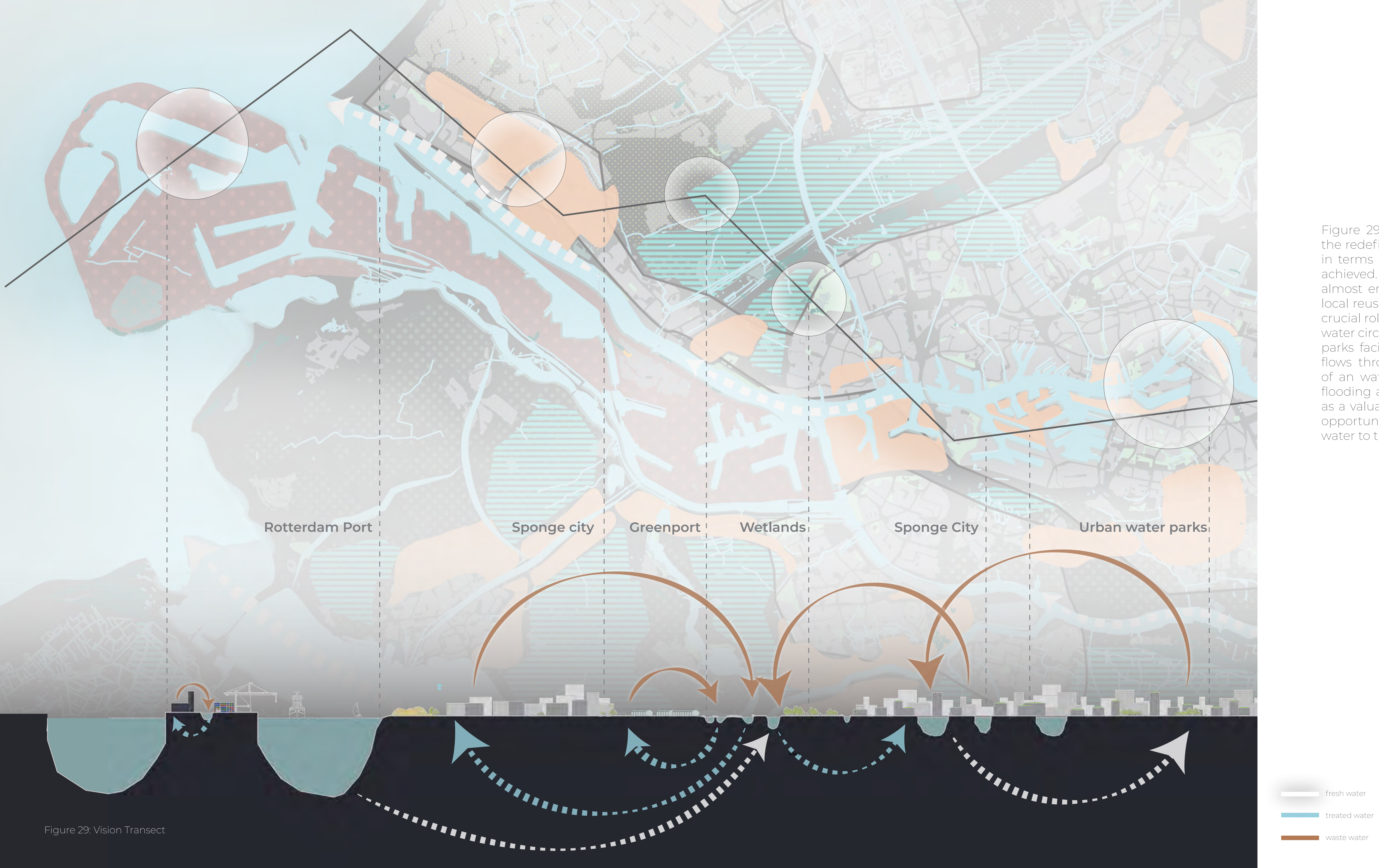


Figure 29: Vision Transect

Figure 29, shows how the different sectoral elements of the redefined delta environment are related to each other in terms of water flows and how water circularity will be achieved. Both the port as well as the greenports are almost entirely water circular in themselves through the local reuse and purification of water. The figure shows the crucial role that the wetlands play in the transition towards water circularity, especially for the urban areas. Urban water parks facilitate closing the loops in environmental water flows through the function of water retention. In times of an water overflow, the parks collect water to prevent flooding and in times of drought, the stored water serves as a valuable water resource. Finally, the figure shows the opportunity of the blue-green network to transport river water to the wetlands in times of excess river water.

4.2 Closed Water Loops

As the key of the transition to water circularity, wetlands and sponge cities are introduced to the South-Holland environment. As can be seen in the schematic overview of the water flows in Figure 30, the concept of water circularity relies on separated waste streams in cities, where for instance a large proportion of grey water can be reused and a smaller proportion of wastewater is led out the city to wastewater treatment plants. At the same time, for a large part wetlands take over the role of purification of wastewater and turn that into clean water. Do take note that in the figure the more greyed-out flows are still present, yet in a less prominent position.

Drinking water is a fundamental resource for urban areas and industries. Within the city drinking water is primarily used for the tap, showers, toilets and any other faucets in a home. In the new model for water flows, grey water is separated from wastewater and reused within the city to replace and reduce the role of drinking water in the system. Water usage only requiring second hand quality water, such as water used to flush the toilets, is now hooked to a new grey water system.

Wastewater

Any residual wastewater flows are, in reduced size, lead to wastewater treatment plants (WWTPs)(see Figure 32). A decrease in wastewater provides possibilities for WWTPs to invest more into biological means of treatment and implement new systems. There is a scale five difference between the daily load of wastewater and the peak load wastewater treatment plants can take. Reduction of the general wastewater flow does not lower the emergency peak load. However, rainwater is intercepted and led to local wetland structures within the city and retained for longer and thereby reducing water peaks during storms.

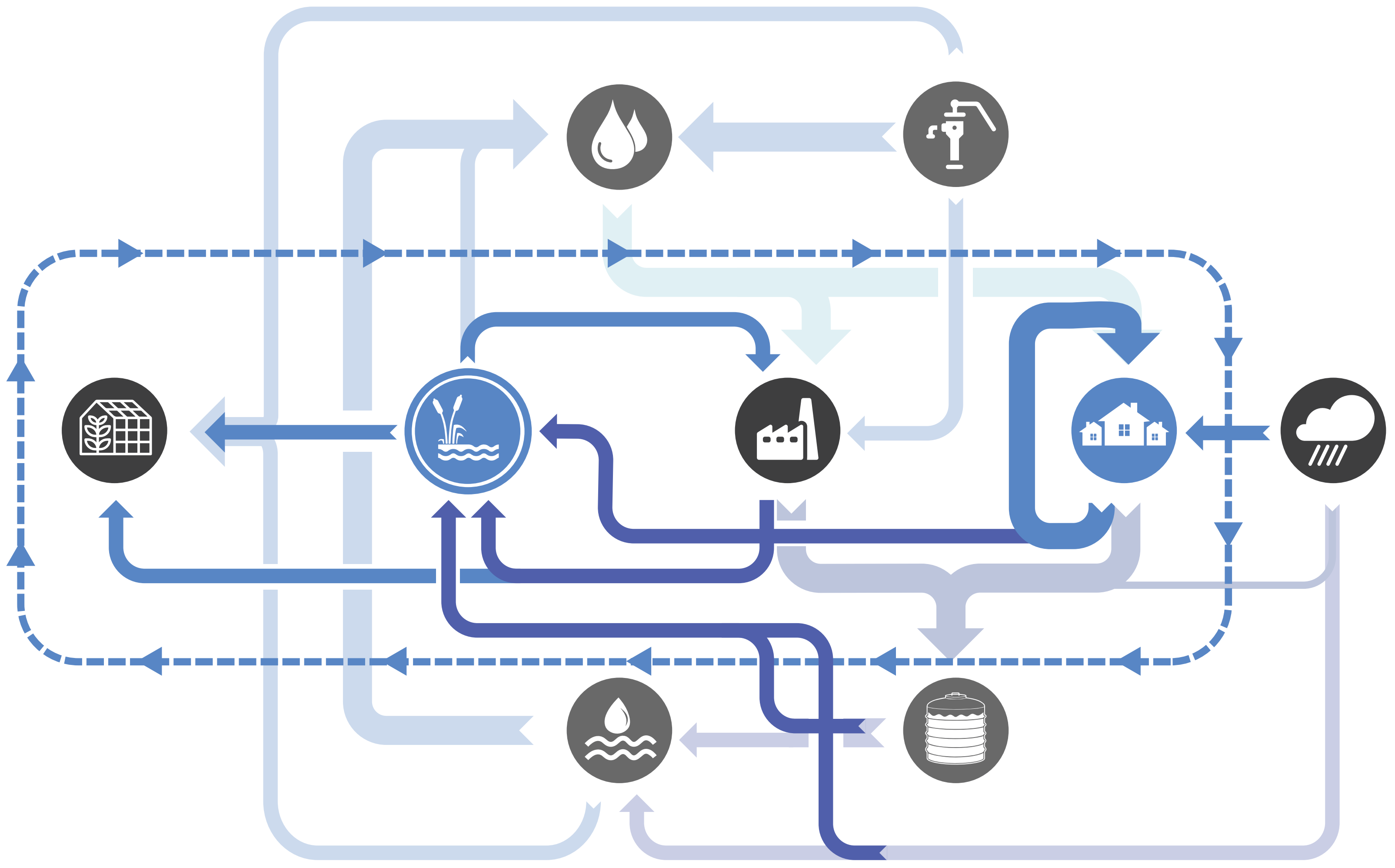
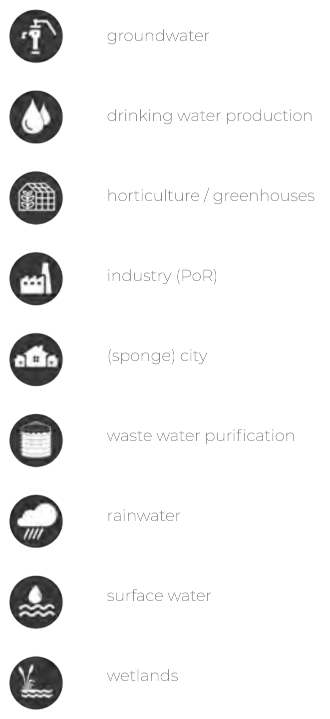


Figure 30: Water Flows



This offers future resilience for WWTPs and their capacity as well as provide enough space for them to implement larger biological treatment instead of chemical treatment.

The wastewater undergoes a primary treatment and after that, a small proportion of the water is led back to local surface water bodies. The majority of the wastewater is led to a nearby wetland, to undergo the second phase of sedimentation and purification.

Drinking water

A part of the cleaned water by the wetlands can now be directly used in agriculture, horticulture and industries. The quality can be seen at the same level as general surface water and the water is sufficiently clean for watering crops and plants and to be used as industrial water (for instance cooling water) within the port area.

The water from the wetlands can also be used within the cities as a supply of grey water to households, whenever the local circular grey water flow is insufficient. By using the wetlands as a water buffer and backup to the grey water system within the cities, a constant pressure can be upheld, significantly reducing smell and other forms of discomfort.

The clean water from the wetlands is not directly suitable for drinking. Therefore, spread out through the region, a number of new drinking water locations are to be constructed, as can be seen in Figure 33. These new locations are of much smaller scale and operate locally: they take clean water from wetlands in close proximity, to minimize water transport, and purify this water to drinking water. From there, the drinking water is supplied to local city regions or, in need of larger scale water supply, the local water supplies can be combined. In periods of droughts large quantities of water are no longer needed to be pumped from a single location, but the burden on water supply can be evenly spread across a larger region. Thereby reducing risk of water shortage and retaining a steady water supply.

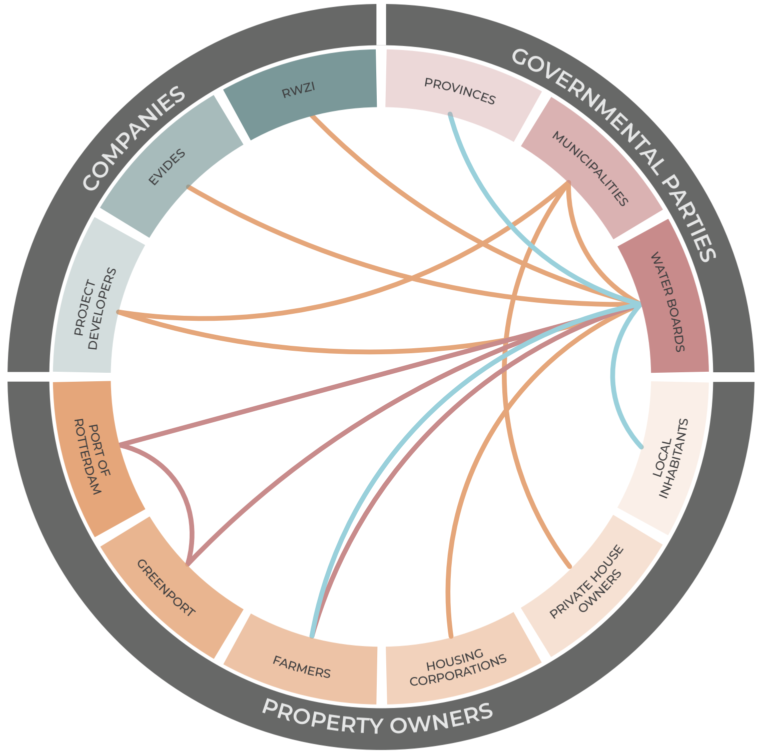


Figure 31: Stakeholders Water Circularity

urban water circularity

circular water management of port, greenport and agriculture

creation of wetland area

Stakeholders

In working towards a circular water management system, there are a lot of stakeholders involved. Some of them are more involved than others (See Figure 31). As becomes clear right away, the waterboards are one of the most involved stakeholders, linked to a lot of the other stakeholders and at the same time influencing all three of the circular water transition themes: the urban water circularity, the circular water management of the port, greenport and agricultural locations and the creation of wetlands in the area. It is important to work together between governmental bodies and locally invested stakeholders, as well as provide the means possible to involve local parties, such as residents or farmers, in bottom-up approaches for new initiatives.

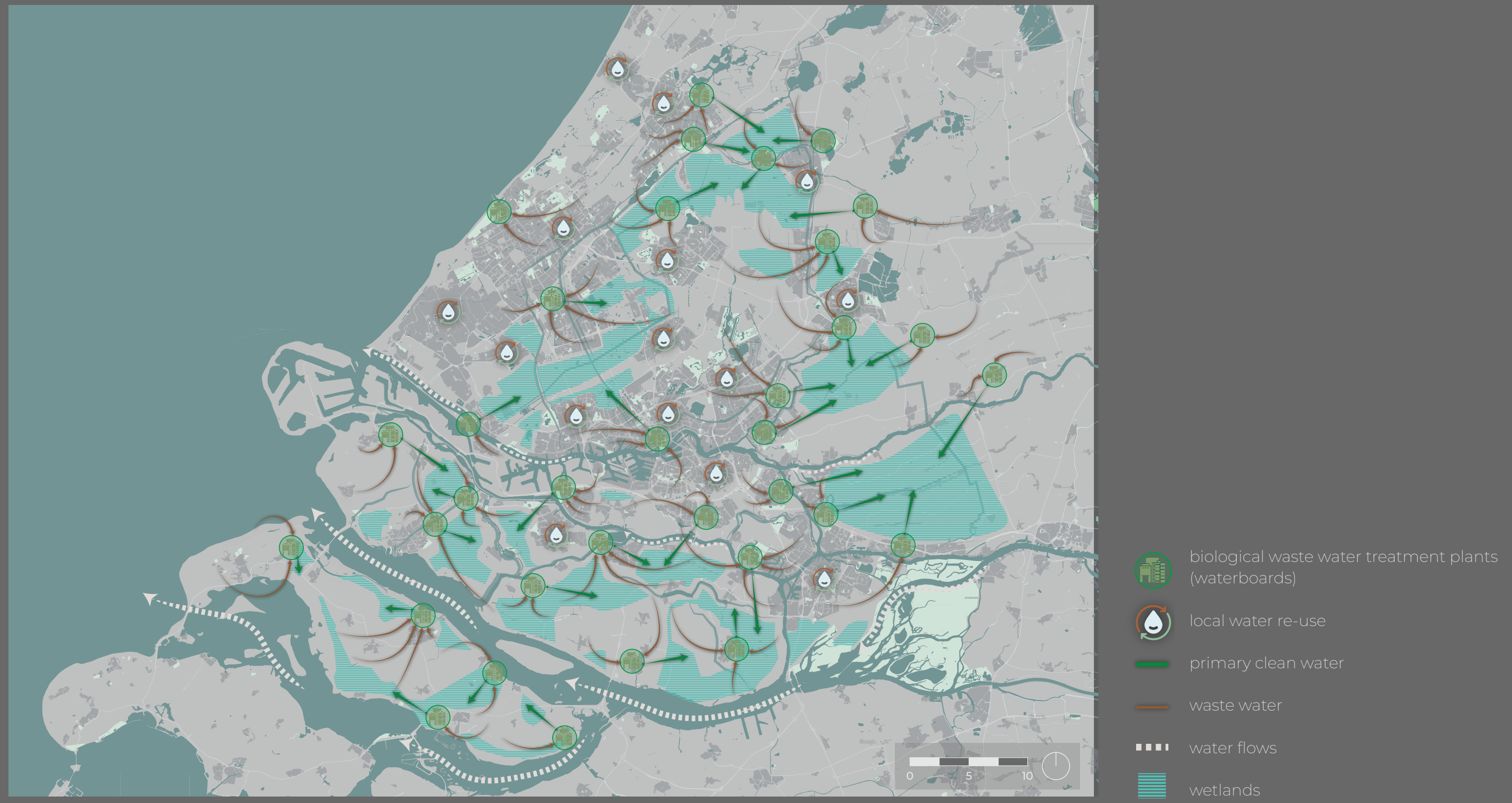


Figure 32: Wastewater Fows

Figure 33: Drinking Water Flows

4.3 A Resilient Delta Landscape

As highlighted in chapter 1.2, the urban and the natural landscape in the province of South-Hollands suffer from a variety of environmental issues related to land and water quality. Intensification of land use and climate change, further aggravates these pressures. However, both urbanisation as well as climate change are inevitable. Adequate land and water management is an absolute necessity to secure the future of the region. The impact of both trends are however covered by a blanket of uncertainty. A resilient delta landscape is a landscape that secures the future safety, viability and liveability regardless and has the ability to deal with future challenges in any of the possible scenarios. A resilient delta landscape will be created through the implementation of adaptive delta water management, adaptive agricultural land-use and the implementation of sponge cities.

Adaptive Water Mangement

The province of South-Holland has been vastly urbanised over the past seventy years. Yet, it has been able to retain a lot of its characteristic natural areas. For example, in the North of the province, there are a multitude of lakes surrounded by nature and the 'green heart' of the Randstad is positioned for the most part within the province of South-Holland. Between the large cities of Rotterdam and The Hague the protected authentic Midden-Delfland positions nature between two large urban cores and the province has two national parks: the dunes along the coast called the Hollandse Duinen and the Bieschbosch, one of the last extensive areas of freshwater tidal wetlands in Northwestern europe.

This vision plans on expanding this natural environment in the form of wetlands, as has been previously mentioned. The expansion of wetlands will be primarily done along the rivers within the triple delta structure and along an axis leading from the Nieuwe Waterweg and Westland Northwest deep into the green heart of the Randstad. As can be seen in Figure 34.

The map indicates a massive transformation of the natural landscape as we know it today. Since the fifteenth century we have been reclaiming land from the wetlands previously present in this area. We did so, so that we could cultivate the land for agricultural uses. In the past hundred years we have transformed these agricultural lands into urbanised areas, greatly expanding the built environment. These alterations of land use are in line with paradigms associated with them. Now it is time to work towards a new paradigm, where the resilience of water and landscape and thereby the resilience of our built environment is reinforced.

These wetlands play a vital role in the adaptive water management in the region. As has been mentioned in the paragraph on water circularity, the wetlands will prove to perform a vital role in our freshwater supply. In addition, the wetlands - and green corridors from these wetlands, stretched into city cores - will also justify a social environmental discrepancy, by providing close access to a natural environment in the ever urbanising landscape and contribute to equal close access to fresh water and locally produced drinking water. Special designated wetland areas along the rivers and waterways will be constructed to optimally clean waste water by letting the water from the river flow through the wetland area along several different filtering zones, as can be seen in Figure 35.

While offering numerous uses of wetlands, as a recreational function for local residents, as a habitat for small and larger wildlife, where food and space will be in abundance, or as an area for resting for migratory birds, it also offers protection (Figure 35) . Protection against several environmental issues.

Figure 34: Map Adaptive Resilient Delta Landscape

Aside from lowering chances of drought in the region, it also counters salinization in the area. In addition, the wetlands are also a response to soil subsidence, where local urban areas adjacent to wetlands will be less exposed to the bad bearing capacity and soil subsidence, by directing and storing water in the wetlands.

Lastly, the wetlands form a direct protection against the risk of flooding by rivers. Due to climate change, the occurrence and the intensity of extreme weather conditions will be increased. Leading to a higher possibility of river flooding in the delta area. As displayed in Figure 34 , there is a strong dike system in place along the rivers in the triple delta structure. The proposed wetlands can, in an extension to this rigid form of protection, offer a flexible form of protection by acting as floodplains in times of river overflow. Dikes around existing urban structures and planned urban expansions will be reinforced and even within the high density urban areas of Rotterdam, where the river banks are part of the built environment, the green corridors leading from the wetlands can serve as floodplains and water buffers in case of river overflow.

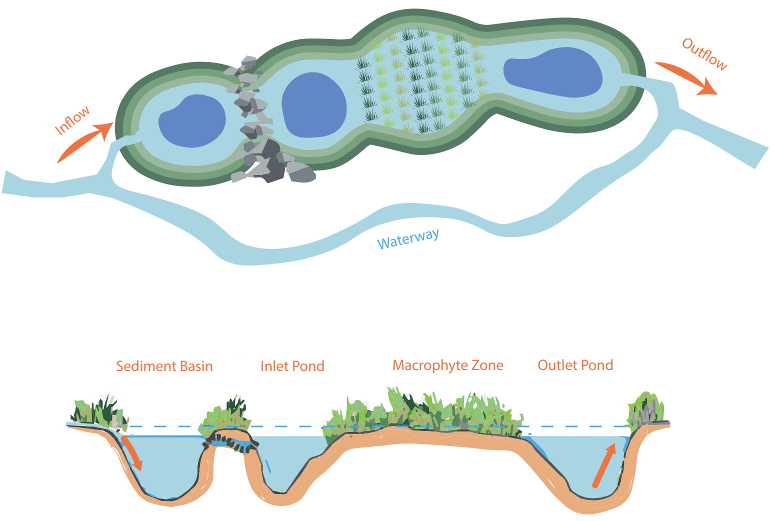


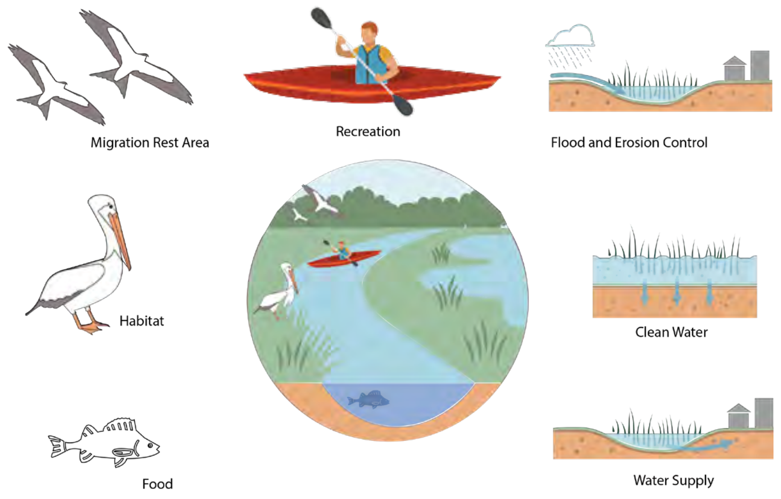
Figure 35: Wetland Principle & Functions

Adaptive Agriculture

The province of South-Holland has a lot of space dedicated to forms of agriculture. Both in farming and livestock as in greenhouses and horticulture. The core of horticultural practises is centered around Westland and Oostland, together rebranded as Greenport West-Holland. Near the village of Boskoop there is a high density of horticulture cultivating woody plants and perennials.

The vision on adaptive agriculture, and specifically the horticulture sector, is primarily focussed on achieving water circularity and greenhouse emissions neutrality. A proportion of agricultural land, mostly dedicated to livestock breeding in the central regions of the province and agricultural farming on the islands of Voorne-Putten and Goeree-Overflakee, is transformed to wetlands. The remainder of areas available for agri- and horticulture are intensified. Explicitly the transformation of the horticultural sector towards water circularity is concentrated on.

As shown in Figure 37, water circularity in the horticulture sector of Greenport West-Holland is directed at four



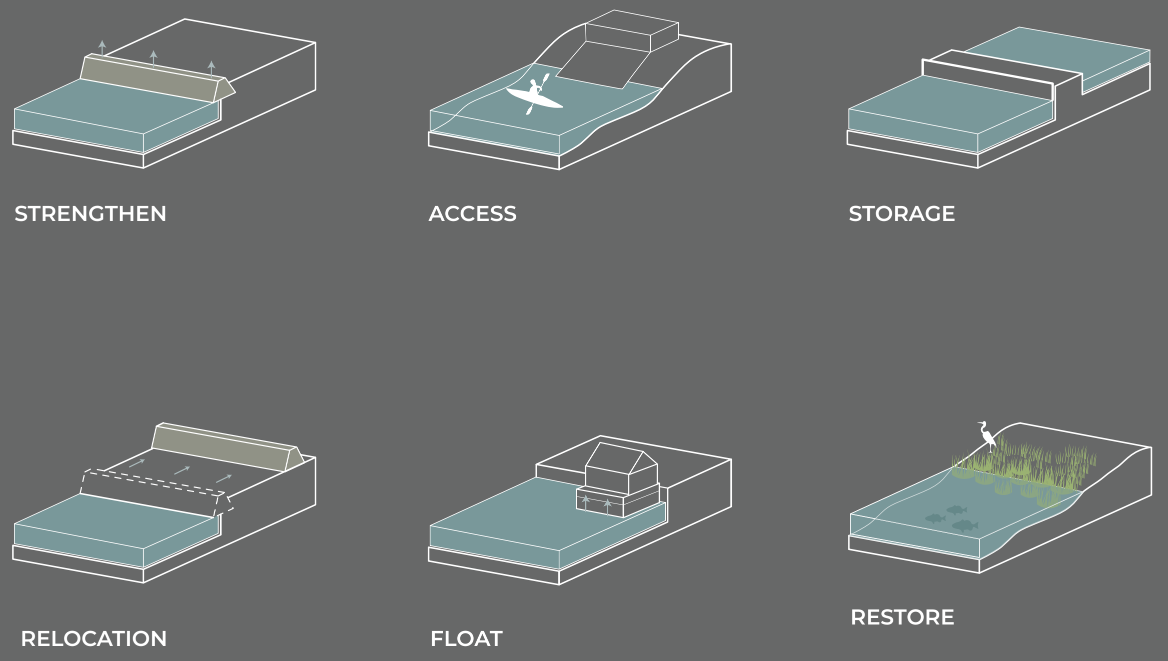


Figure 36: Waterfront Adaptive Landscape Strategies

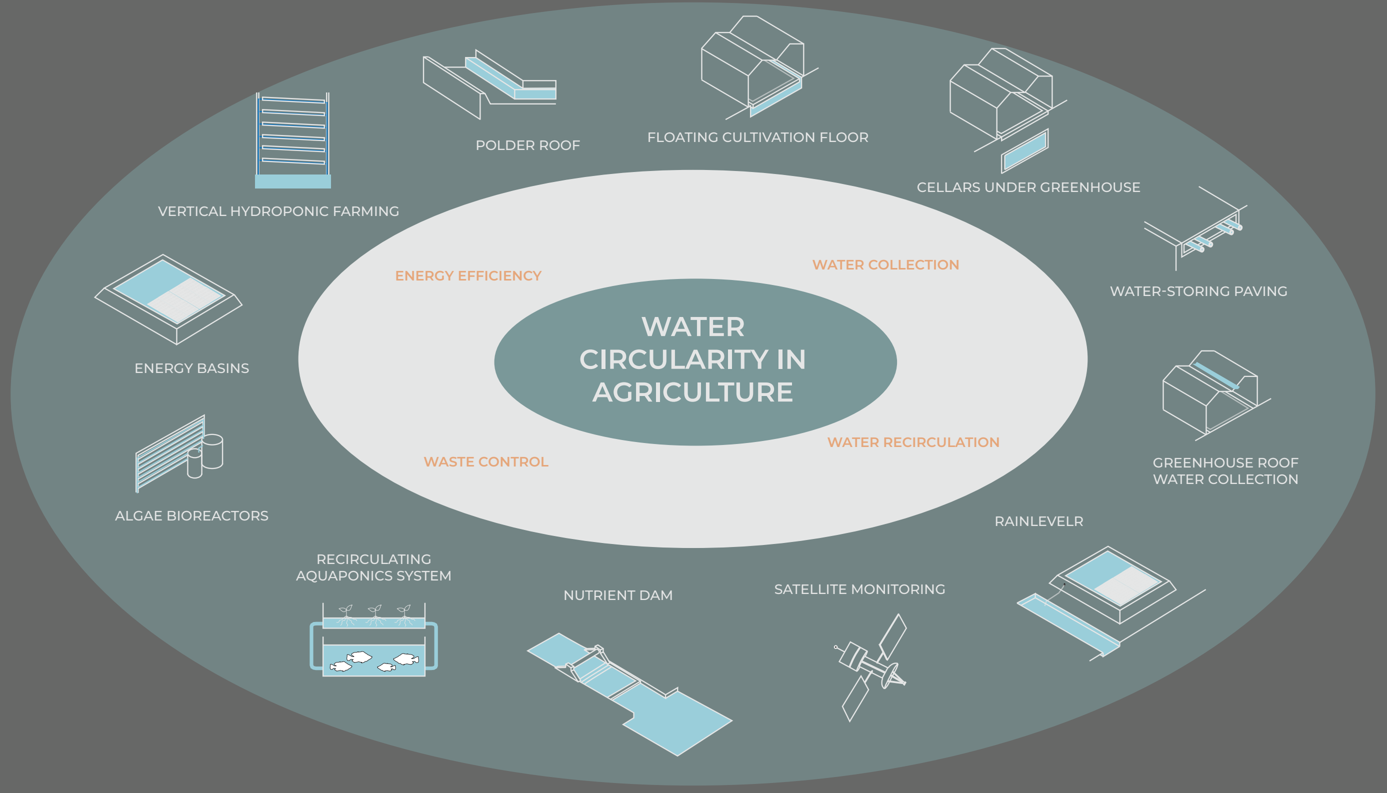


Figure 37: Water Circularity in Agriculture

guiding principles: energy efficiency, water collection, water recirculation and waste control. New ways of smart management of energy and developing towards vertical horticultural farming are the main ways to efficiently handle energy consumption. These changes can be alterations to existing greenhouse structures or, in the case of vertical farming, drastically alter the traditional form of greenhouse production. Therefore this transition is definitely a long-term investment.

Water collection and water recirculation are heavily intertwined with the development of wetlands around the horticultural area. Aside from interception and collection of rainwater within the horticultural sphere, where water is collected and stored locally, the wetlands will provide the sector with the main supply of needed water, as well as provide means of cleaning wastewater flows and store large amounts of fresh water. The wetlands also provide other means of agriculture with a water supply. The natural landscape can also prove to become the ground for more biological ways of free-range livestock breeding.

The future of farming in horticultural fashion shows a lot of potential. In combination with aquaculture, algae bioreactors can be used to create green energy to provide horticulture in Greenport West-Holland. Another important link lies with the Port of Rotterdam. Residual heat and CO2 emissions are transported to the greenport, where they will be used in stimulating plant growth.

One more promising technique is the recirculating aquaponics system. In this system, a natural ecosystem is recreated in an artificial environment. Fish-farming tanks are linked to greenhouses for growing plants. It produces minimal waste, requires limited energy inputs and delivers positive impacts to the environment. It also provides local city consumers with year-round access to quality, locally sourced food products. The core of this technique lies in a bacterial process, with microorganisms filtering and breaking down the ammonia in fish manure, producing nitrates that provide the plants with nutrients to grow. The future of horticulture in combination with wetlands is, circularity-wise, very promising.

The Sponge City

In addition to an adaptive delta landscape and adaptive agriculture, where water circularity plays a key role, the goal of this vision is to also construct a resilient urban landscape, with water circularity as a core value. In this, the concept of the sponge city is introduced. The sponge city focuses on urban water-resource management, urban flood and climate risk mitigation, ecological enhancement and social wellbeing (Chan et al., 2018, p. 776). As explained in the second chapter of this report, the sponge city relies on four key principles: resourcing rainwater, ecological water management, green infrastructures and permeable pavements. (Li et al., 2017)

The concept of the sponge city is not implemented exclusively on a specific location, but can be seen as a guiding perspective to the way we (re)develop our cities of all sizes. As a guide, this vision proposes to strengthen the resilience around the metropolitan areas of Rotterdam and The Hague, as well as the separate clusters of Spijkenisse, Zoetermeer and Leiden (see Figure 38).

The city as a sponge has a very close relationship to the surrounding wetlands. Green corridors from the wetlands are pulled in from the city limits to the downtown areas. An example for this is the city of Rotterdam. As can be seen in Figure 39, the green corridors lead into the city and connect wetlands locations and parks in a network of natural environments. The green corridor provides breathing space for local residents, connects small wildlife habitats and forms the base of urban regeneration. With the green

Figure 38: Map Sponge Cities

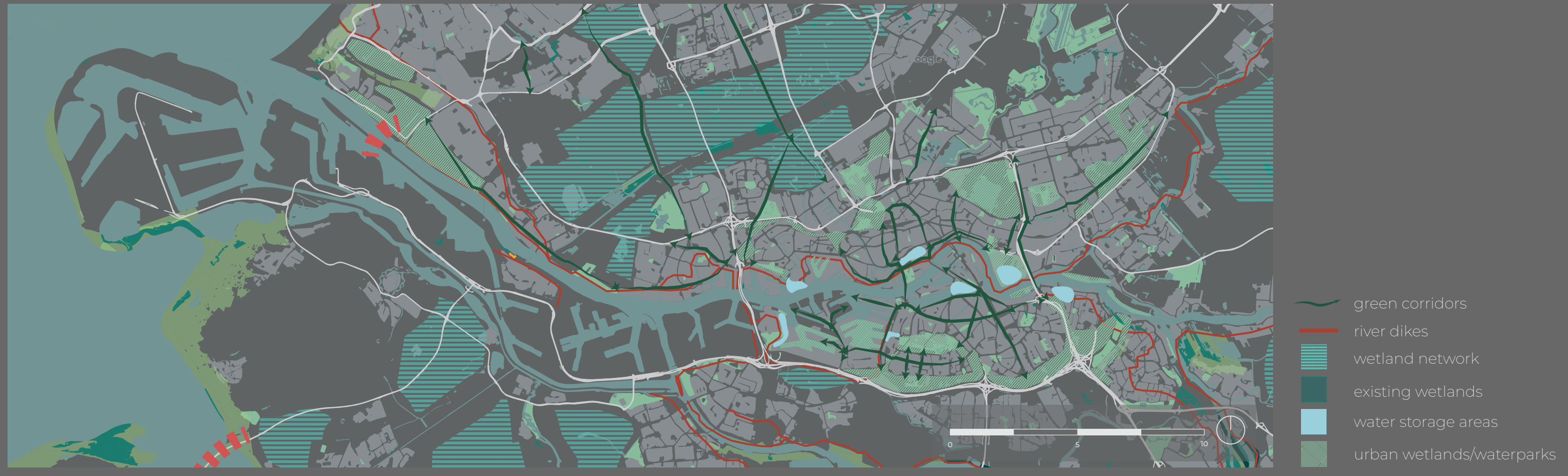


Figure 39: Map Urban Green Areas

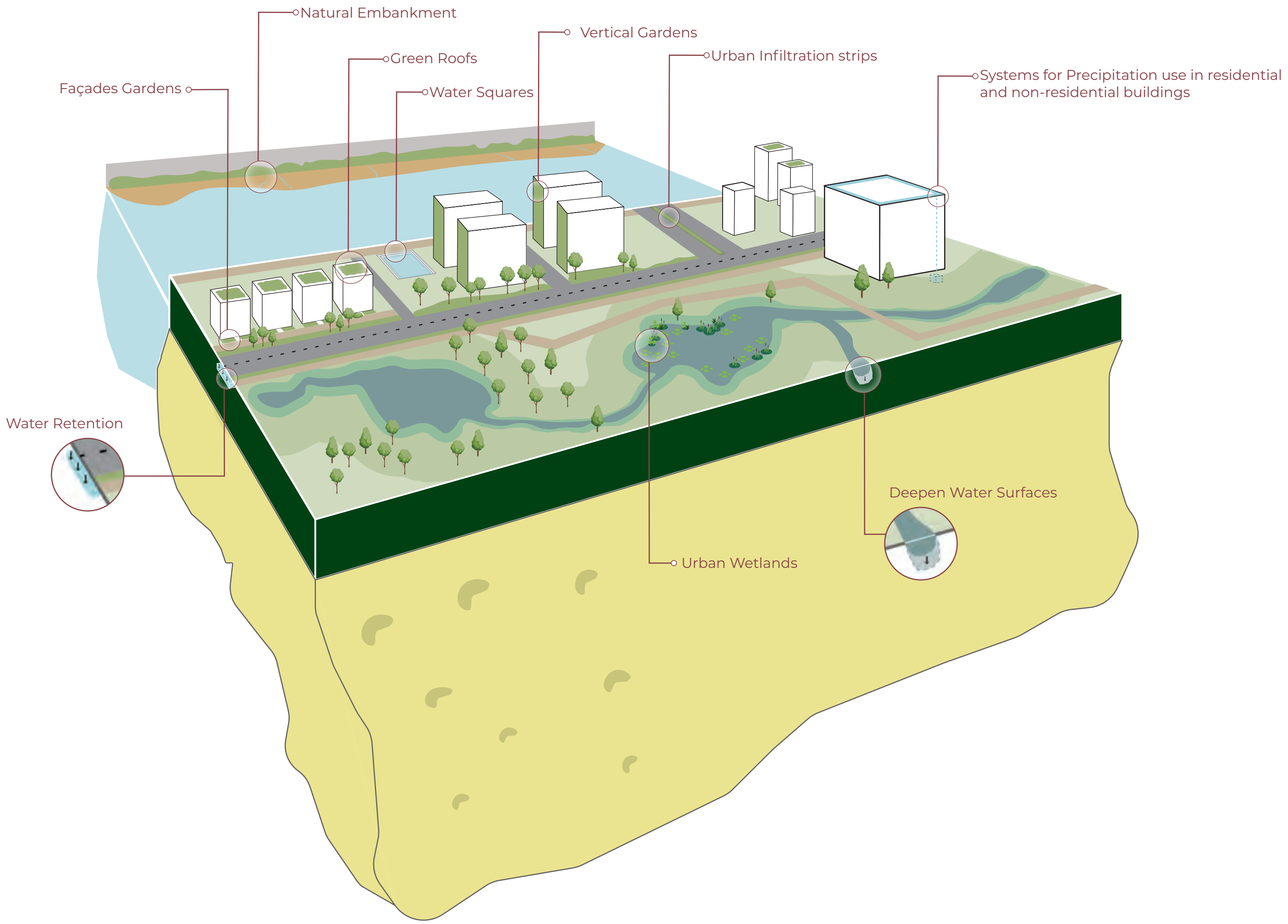


Figure 40: Sponge City Concept

corridors as links between nodes, the nodes are the urban wetlands and waterparks. Additional wetlands within the city limits are created where possible and existing park structures in the city are transformed to be able to store water and function as water parks.

In accordance with the plans of urban expansion and densification, the transformation of the built environment and the sponge city concept will focus on specific interventions on water retainability of buildings. In new development plans separated water systems will be implemented, so that grey water can be reused within the city. Policies will steer towards the utilization of green roofs and facades and small scale urban farming will be stimulated. The sponge city is very versatile, and also infrastructure will be transformed. Creating water storage buffer blocks underneath roads and parking garages, as well as a higher percentage of permeable pavement in contrast to nonpermeable paving are a few examples of possible implementations (Figures 40 and 41).

By reusing grey water within the city, storing water abundance and reducing the water footprint, and combining the water purification from waste to fresh water by wetlands and from fresh to drinking water on a local scale, this vision aims to create water circularity within the city's borders.

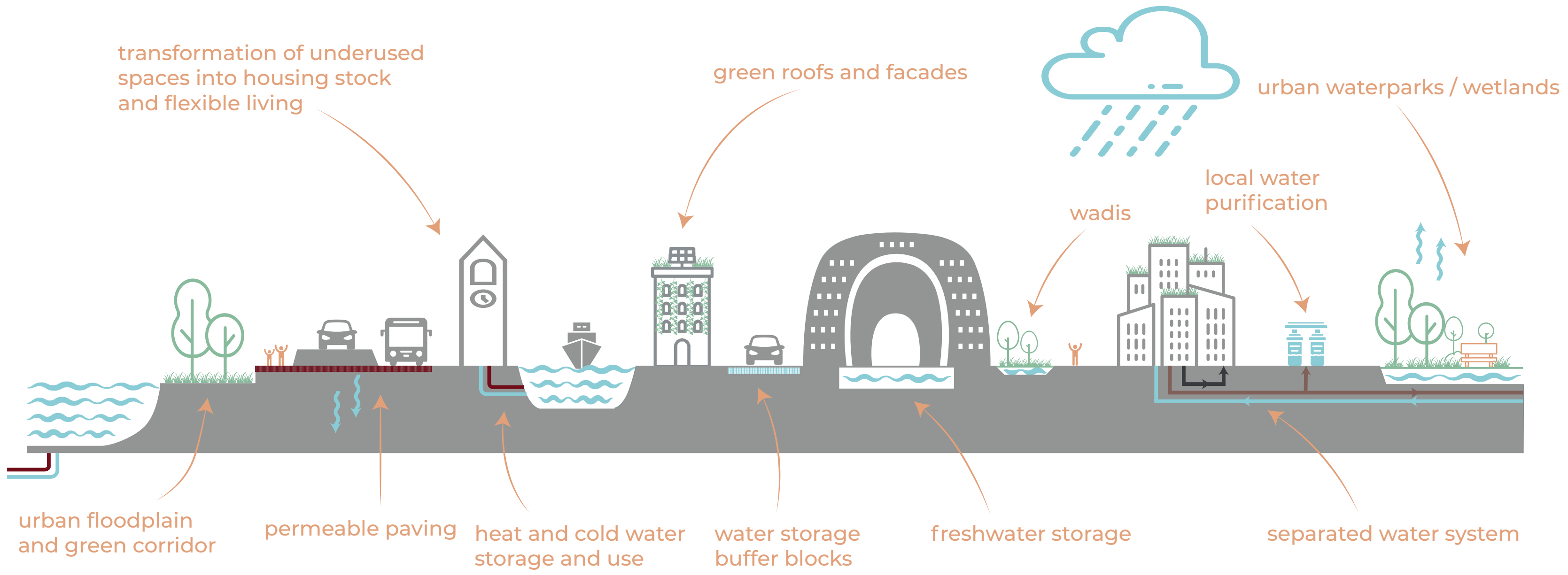


Figure 41: Sponge City Section

4.4 Urban Liveability for all

“Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including the right to housing.” This has been stated in Article 25 of the Universal Declaration of Human Rights (UN General Assembly, 1948). Answering the enormous housing shortage is therefore one of the key objectives of this project. Both urban densification as well as urban expansion will be needed to create enough supply of housing. In order to be inclusive and not exclude anyone from the right of housing, also the affordability of housing will be taken into account. This chapter shows what it means to secure the right to housing for all in more detail.

Urban Densification

The first approach towards a fulfilled housing demand is the densification of the existing urban cores. In this project, four methods of urban densification are being used. The first method is the transformation of urban space. A study in 2016 highlighted the potential of urban transformation in fulfilling the housing demand (Van Duinen et al., 2016). It was shown that at that time there was still plenty of space to create new housing within existing city borders. This potential was particularly found for the transformation of empty or underused spaces into housing and to a lesser extent for transforming the current housing stock. Especially underused business parks that could also be used for housing have great potential for transformation. Transforming the housing stock is not only efficient, it also preserves the characteristic identity of the area. Although, this study showed that the main potential is for transforming underused area it can also be argued that the transformation of existing housing stock can alleviate the burnt out housing market. The demographic situation of the Netherlands is changing and the increase in households is mainly caused by singles (ABF Research, 2020). The new urban housing supply therefore does not require family sizes. Instead, more and more smaller spaces are needed. Therefore, the next method of urban densification is to split larger apartments or houses into multiple smaller apartments. Furthermore, urban densification can be reached by building new space within the city in underused areas. As shown in Figure 42, this can be done by means of infilling or topping of current built structures.

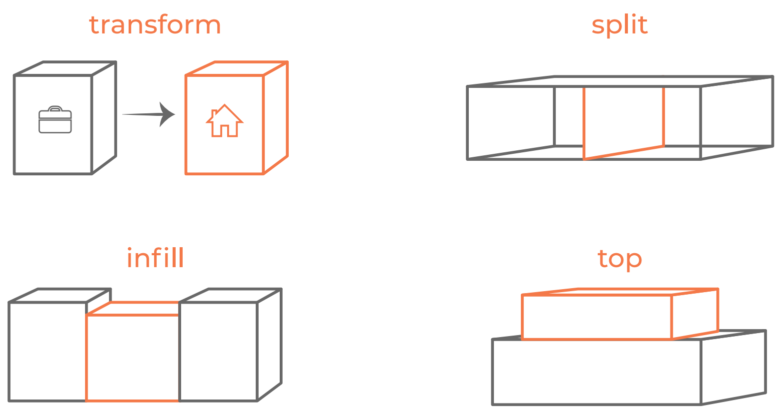


Figure 42: Densification Principles

Figure 43 shows where urban densification can be executed. In general, urban densification will be executed along the existing urban contours. More specifically, a large part of Rotterdam-South is proposed as a possible location for densification. The densification in this area can be part of the national program Rotterdam Zuid (NPRZ). This program is a partnership of among others the municipality and housing corporations to improve the liveability in this area.

Urban Expansion

Although preserving the natural landscape is another key objective besides answering the demand for space, urban expansion cannot be avoided in order to secure the right of housing to all (De Zeeuw & Keers, 2020). In order to enhance liveability and to contribute to the aim of distributing the benefits of water, living along the water is the starting point for all urban expansion. Figure 45, shows what this means in terms of space. As also shown in Figure 43, urban expansion is mainly located around the current urban cores and as a connection between the current urban cores. Additionally to this expansion, new housing will be created on the Southern part of the Maas, along the river and green areas as well as along the Northside of the Meuse. The expansion has been shown in more detail in Figure 44, to highlight the principles of expansion. The first principle is based on a research executed for the Province of South-Holland on stimulating urban living (Provincie Zuid-Holland, n.d.). One of the results was a Dutch version of the Transit Oriented Development (TOD). This is an approach of urban development towards transit oriented locations. This area of

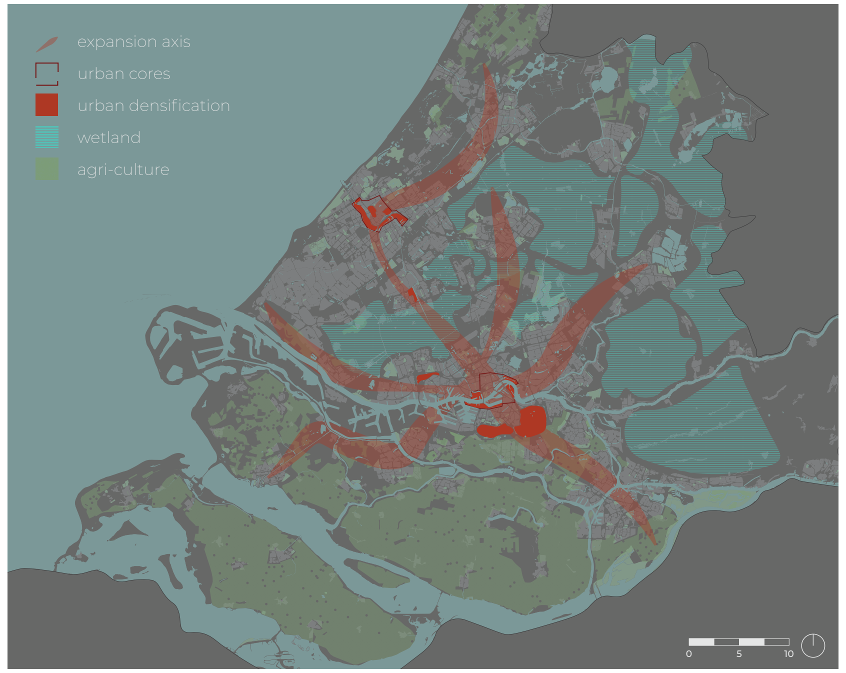


Figure 43: Urban Densification

urban expansion is located on a current existing metroline. Besides, a main road is located on the upper side of this area. The second principle that this example of urban expansion shows, is the expansion principle of living along the water. Water is the backbone of this entire project. Living along the water does not only create opportunities for recreation and transport, it also indirectly stimulates mental and physical

Figure 44: Expansion Principle

health through the following pathways (White et al., 2020). The water mitigates the effects of aerosols, noise, air pollution, solar irradiance and the urban heat island effect. The water instorates physical activity, positive relationships and nature connectedness. And finally, the water reduces stress and leads to cognitive restoration.

An important aspect to the expansion and densification strategies put forward in this vision is socio-spatial justice. By expanding along waterfronts and by guaranteeing close access to nature as well as creating green corridors within city borders, it is often expected that housing prices will rise and gentrification will occur. By establishing strong regulations and involving housing corporations, it is the aim to make affordable (social) housing available for everyone. Where there is a fair share in nature's qualities and protection from water, in addition to equal access to drinking water for the future to come. In chapter 5, the policies and relationships that are set are explained in more detail.

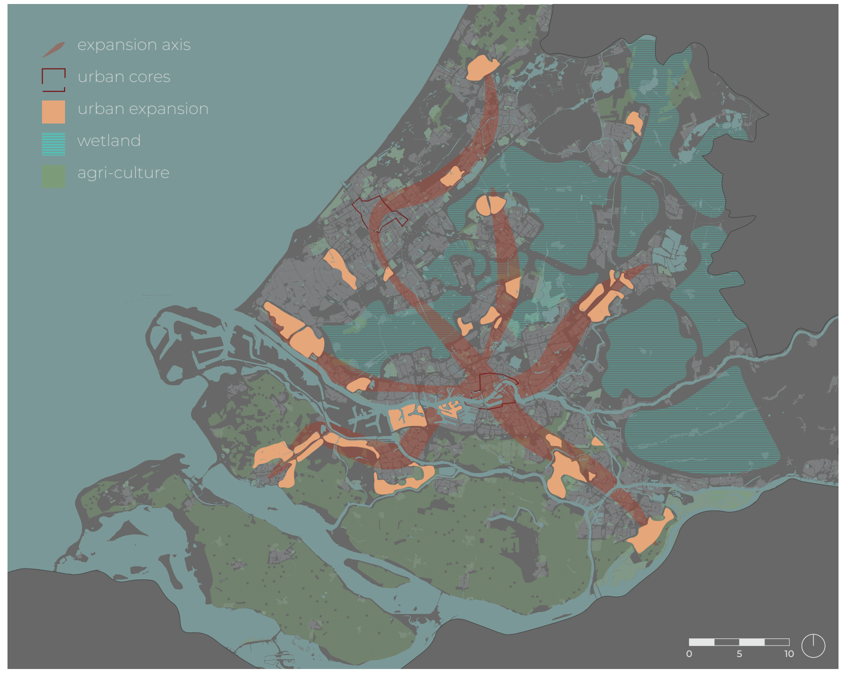


Figure 45: Expansion Principle

4.5 A Reinforced Port Area

The Port of Rotterdam is one of the important locations in the Province of South-Holland. A large proportion of the revenue in the province is dedicated to this area and there are hundreds of jobs affiliated with the port. In our vision, the port of Rotterdam transitions to a green and energy neutral area, where nature and industry come together and thrive. For the past decades, the port has been expanding towards the estuary with the North Sea, taking more and more natural space and transforming it into industrial zones. In this vision, the expansion of the Port of Rotterdam further into sea, by the Maasvlakte I and Maasvlakte II, is not succeeded by the expansion of a Maasvlakte III. Adhering to the Natura 2000 area (see Figure 49) makes further expansion into sea impossible. At the same time, the areas of the port within the city limits of Rotterdam and enclosed by urban areas, will be transformed to mixed-use living. We envision the port to give audience to the Genius Loci, the authentic and prevailing character, of the former estuary and reinforce the natural side of the area along with transitioning the port to a circular and blue-green industry.

An Emission Neutral Port Area

In working towards a circular future, the port is connected with projects regarding circularity in Greenport West-Holland - both in Westland and Boskoop - the wind energy hub at sea, the natural environments to the south of the port, as well as the city of Rotterdam. All in a different manner.

The first and foremost goal for the port is to create an emissions neutral area. A relative short-term plan, to limit the current CO2 emissions and reuse residual heat exhausted by the industries in the port. CO2 and residual heat produced is intercepted and reused. As can be seen in Figure 46, residual heat is distributed to both Greenport West-Holland in Westland, where it can be used in greenhouses in horticulture. Also heat produced by the petrochemical plants, and later the bio-based plants, to the more Eastern part of the port, is distributed to the local heat network in Rotterdam South as part of the transition to energy neutrality in Rotterdam.

CO2 in the port is intercepted and transported by pipelines to Greenport West-Holland in both Westland and Boskoop. The CO2 there can be used excellently in boosting plant and crop growth inside the greenhouses. Any remaining CO2 can be stored in empty gas fields in the North Sea. Pipeline infrastructure to the North Sea is also part of the energy transition plans and the wind parks at sea which will be connected to a hydrogen network.

In the Western part of the port ultra-deep geothermal heat can be used. A promising technology to make the heat demand in the area CO2 neutral. Ultra-deep heat is extracted at a depth of over 4km underground and the prospects are that the port in the future will rely on 30% of its energy demand by using this geothermal energy source.

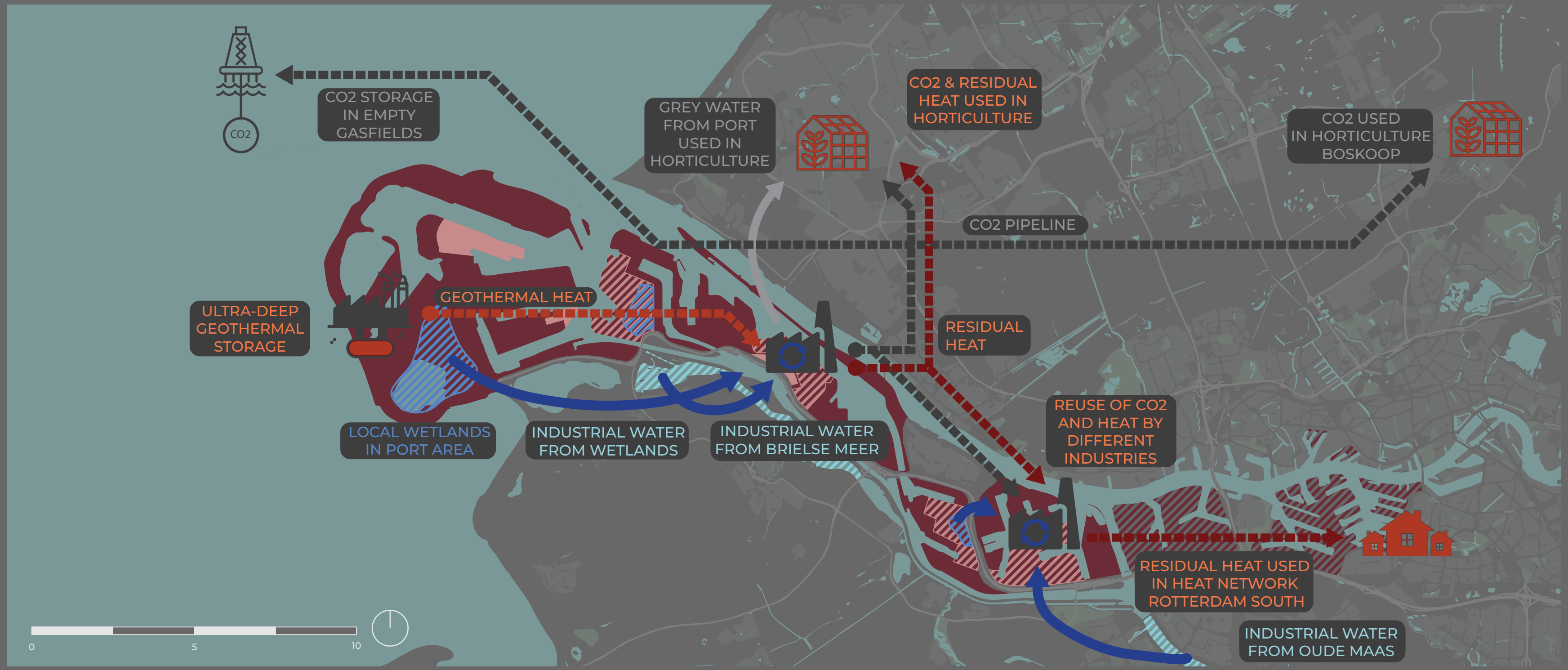


Figure 46: Water Heat and CO_2 in the Port

Energy Transition

The Port of Rotterdam is currently working towards a switch from petrochemical to bio-based industries. The well known refineries in the area will be transitioned to bio-refineries and the port projects to take a leading role in both bio-based material import and distribution and bio-based energy production. This second theme is also in line with the construction of new wind parks at sea by the North Sea Wind Power Hub project. The port hopes to take a leading position in energy and hydrogen management and this vision is in line with these thoughts. Having the Port of Rotterdam as a hydrogen hub profits the entire region, and especially the city of Rotterdam and Greenport West-Holland can profit from this situation (Figure 48).

Energy produced by the North Sea Wind Power Hub project is sent to the port where it is transformed to hydrogen by two 2GW conversion stations by, among other parties, Shell. A smaller proportion of energy is directly linked to the energy network in Westland, providing energy for residences and horticulture in the area (Figure 47).

The conversed energy to hydrogen then can be more easily moved and stored. The hydrogen can be used in heat networks; in hydrogen requiring industries, and it can easily be stored in both short term small scale local storage as well as long term large scale storage in empty gas fields in the North Sea. The excellent availability for large sea-going vessels in the Port of Rotterdam, and the backbone of inland water structures as well as the available space for hydrogen and bio-based transition, makes it that the Port of Rotterdam in the future will function as a hub for production and transshipment of both hydrogen and bio-based resources and materials.

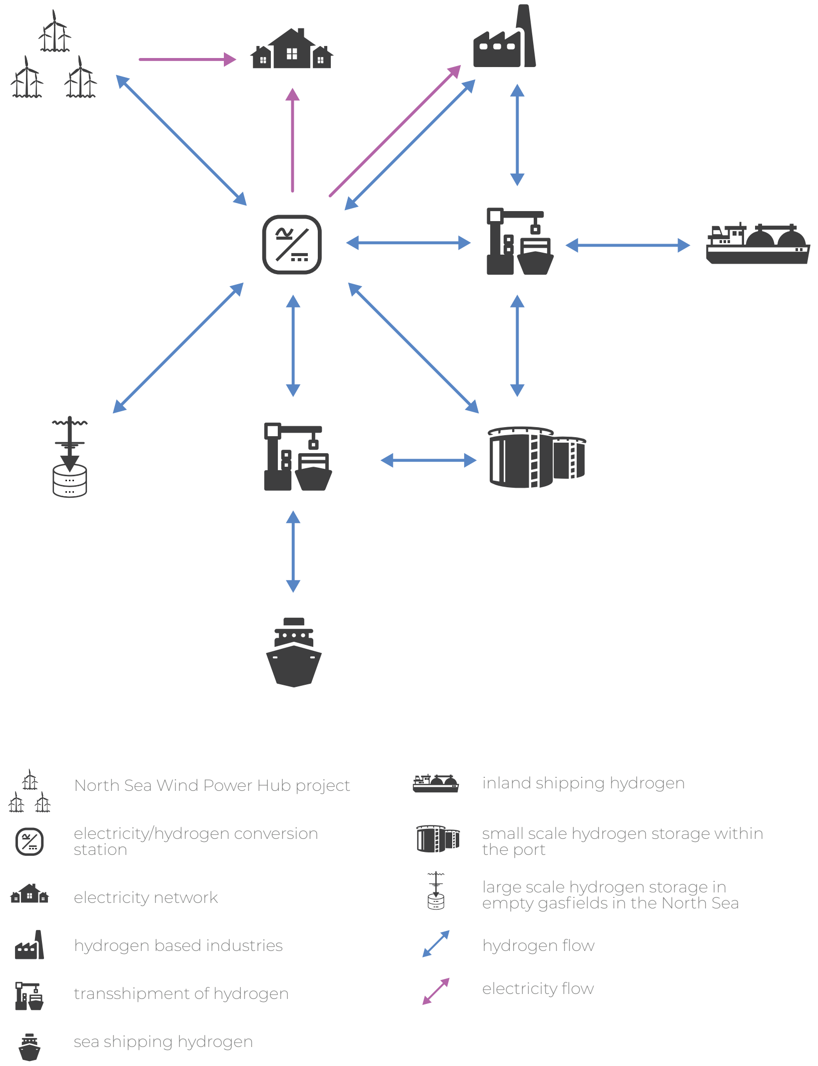


Figure 47: Hydrogen Management in the Port of Rotterdam

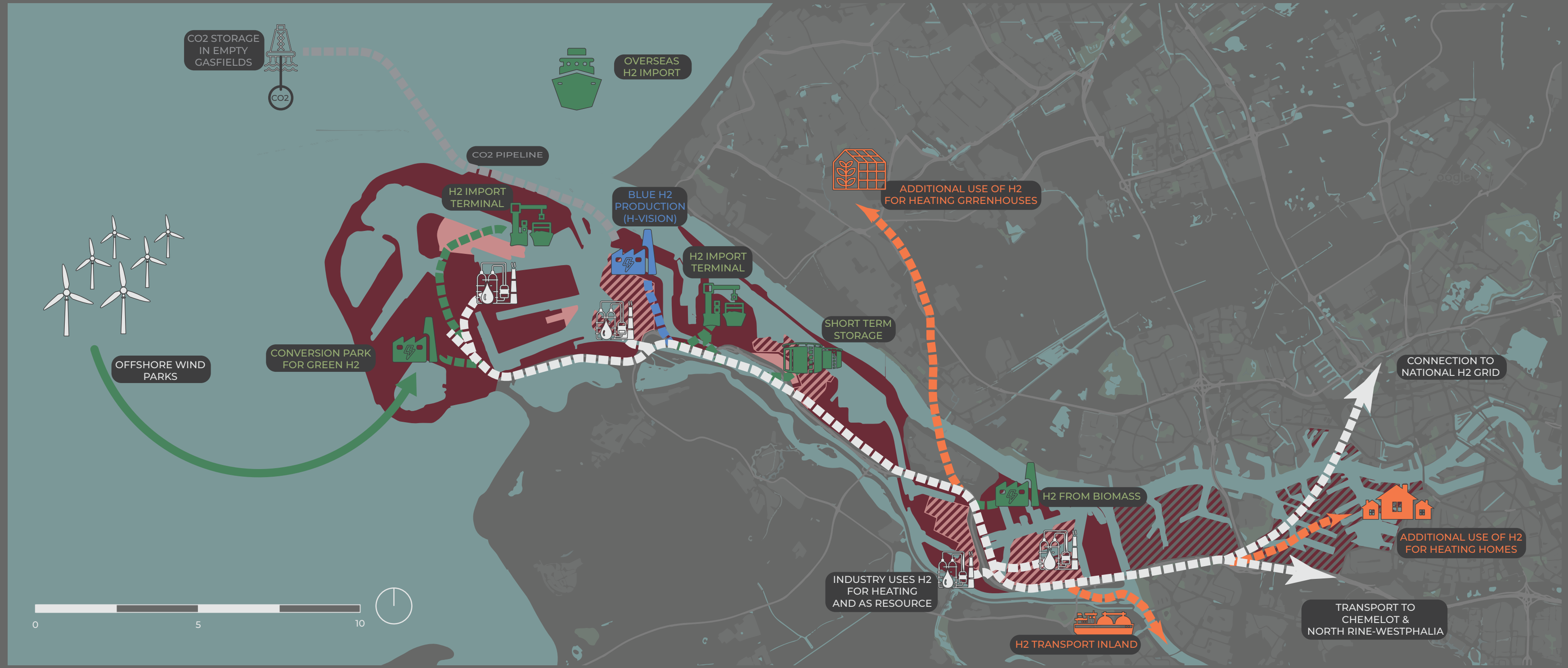


Figure 48: Map Hydrogen Management in the Port of Rotterdam

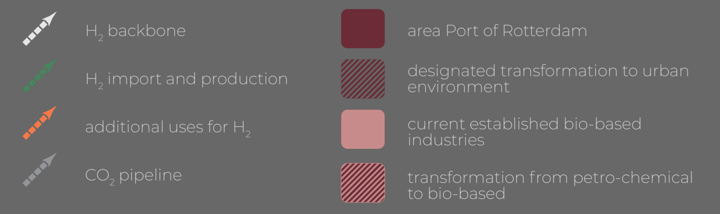


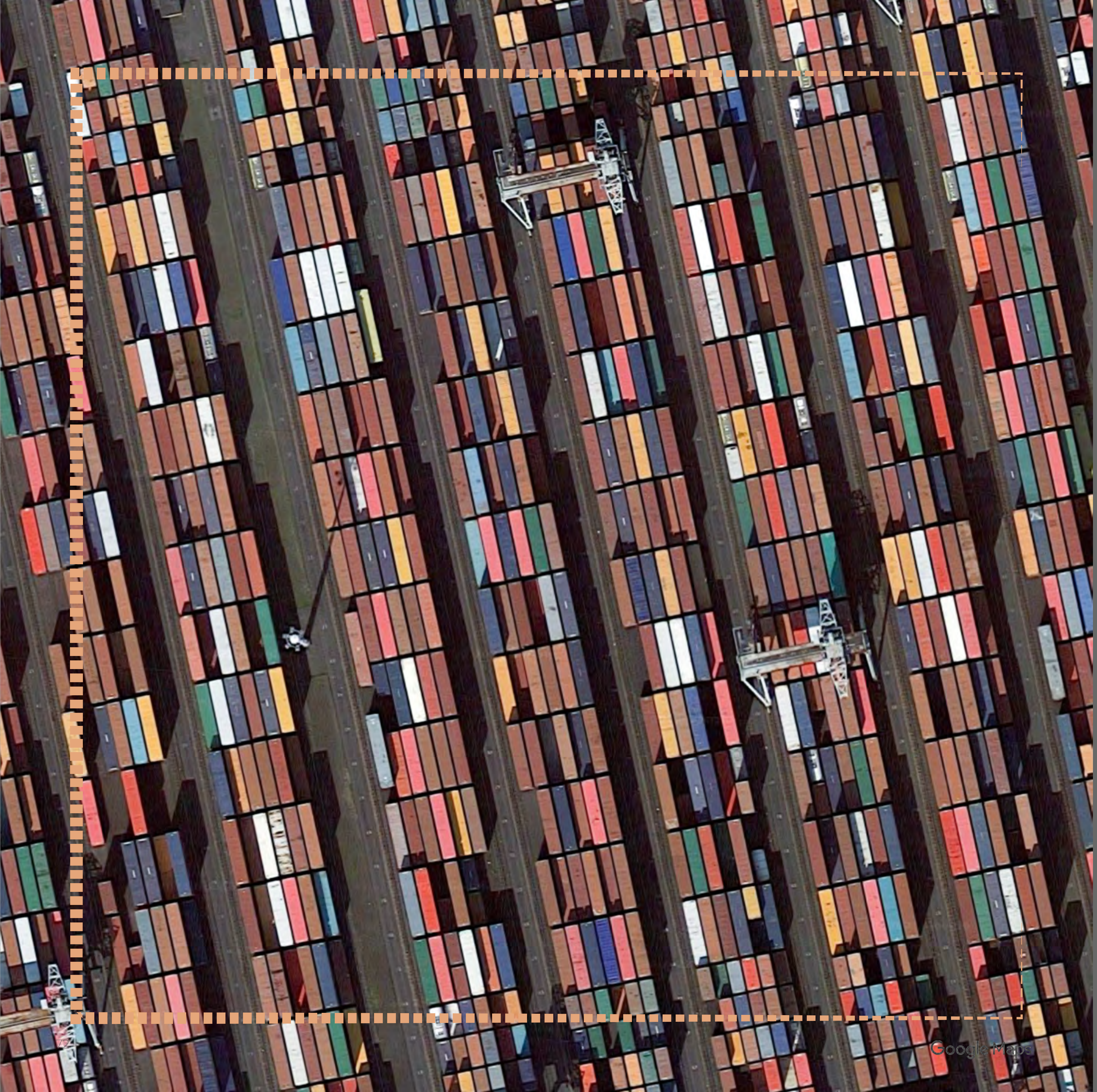
Figure 49: Nature Inside the Port Area

Figure 50: Impression Environmental Transition in the Port of Rotterdam

Environmental Transition

The Port of Rotterdam has quite a diverse plant and animal wildlife. However, there are very little actual natural areas within the port and most of the patches of nature are spread out and not interconnected. This vision aims to create a more spacious and diverse natural scene within the port. By connecting the current patches of nature to the natural environments along the Brielse Meer and Oostvoornse Meer, the movement possibilities for small and perhaps even medium wildlife can be emenced and can flourish (see Figure 49).

The way nature can be incorporated in the port, is by creating the wetlands principle as discussed previously and expanding this along the spacious infrastructure, along borders between different companies and throughout the broadly separated storage facilities. These wetlands in return can also function as a source of water. Reducing the high water demand of the port on the Brielse Meer and Oude Maas and reducing the distance water is needed to be transported. The local water from the purifying wetlands can be used as industrial water, as for instance cooling water. The water can afterwards be separated between reusable grey water for the Greenport West-Holland (see Figure 46) and non-usable water to be pumped back into the wetlands for purification.



5 Strategy

5 Strategy

5.1 Regional Strategy

Rome was not built in one day. Similarly, a circular delta environment cannot be reached tomorrow. Working towards a circular environment in 2050 is a process of change that requires strategic thinking. This chapter gives an illustration of this process of change and explains how the vision can be turned into reality. First, a structured set-up of the regional process over time is developed by means of general phasing. Additionally, the stakeholders that are related to this process on a regional scale are identified. A more detailed overview of the process is explained through two strategic clusters in which the different aspects of the strategy come together. Finally, an impression of how the process plays out on a local scale is given through three key projects.

Engaging Stakeholders

The engagement of stakeholders is crucial in the process towards a circular delta environment. Engaging stakeholders in water management can decrease fragmentation of the water sector, increase accountability and facilitate a result-oriented approach. For this strategy, stakeholder engagement is a governance instrument rather than an objective, as it can help to increase the efficiency, sustainability and equity of water management (OECD, n.d.). The power of the Province is limited to the public domain. Involving private actors therefore enhances the scope of impact. A participatory approach increases the effectiveness of climate adaptation strategies, it decreases the cost, removes barriers (Waterschap Schieland en Krimpenerwaard, 2020). Besides, it has been highlighted that a resilient delta landscape requires participatory feedback in the delta water management and that an equal distribution of the risks and benefits of water asks for involving people at stake at all scales of decision-making (chapter 2.2). Finally, stakeholder participation can lead to increased social cohesion and local support (Waterschap Schieland en Krimpenerwaard, 2020).

The role of a stakeholder depends on their power as well as their interest (Pichler, 2015). Powerful parties that have a high interest in this plan are important players in the strategy. They are the ones, actually shaping the process of change. Collaborating with those stakeholders is therefore a crucial part of the strategy. The stakeholders that have a limited power are being easily overlooked in a development process. However, in order to secure an equal distribution of risk and resources and create a wide support base, those stakeholders that do have a high interest in the process and that are a subject to the change need to be empowered. The stakeholders that have high power, but low interest might not contribute to the plan themselves. Consultation of these stakeholders can help to set the right context. In order to understand how the different parties that are at stake in the process towards a circular delta environment need to be engaged, they have been outlined along the axises of power and interest 51. Water boards are crucial players in the achievement of a circular delta environment. Water boards are a group of decentralised governmental bodies that are responsible for regional water management. Water safety, water quality and adequate water quantity are their core responsibilities (UvW, n.d.). As the outcomes of implementing this strategic vision belong to their core business, they have a high interest. Moreover, water boards raise their own taxes, with which they finance their jobs. Therefore, the water boards are more powerful on the aspect of water management, compared to the province and municipalities that rely on financiation by the Rijksoverheid. Thus, water boards do not only have high interest but also

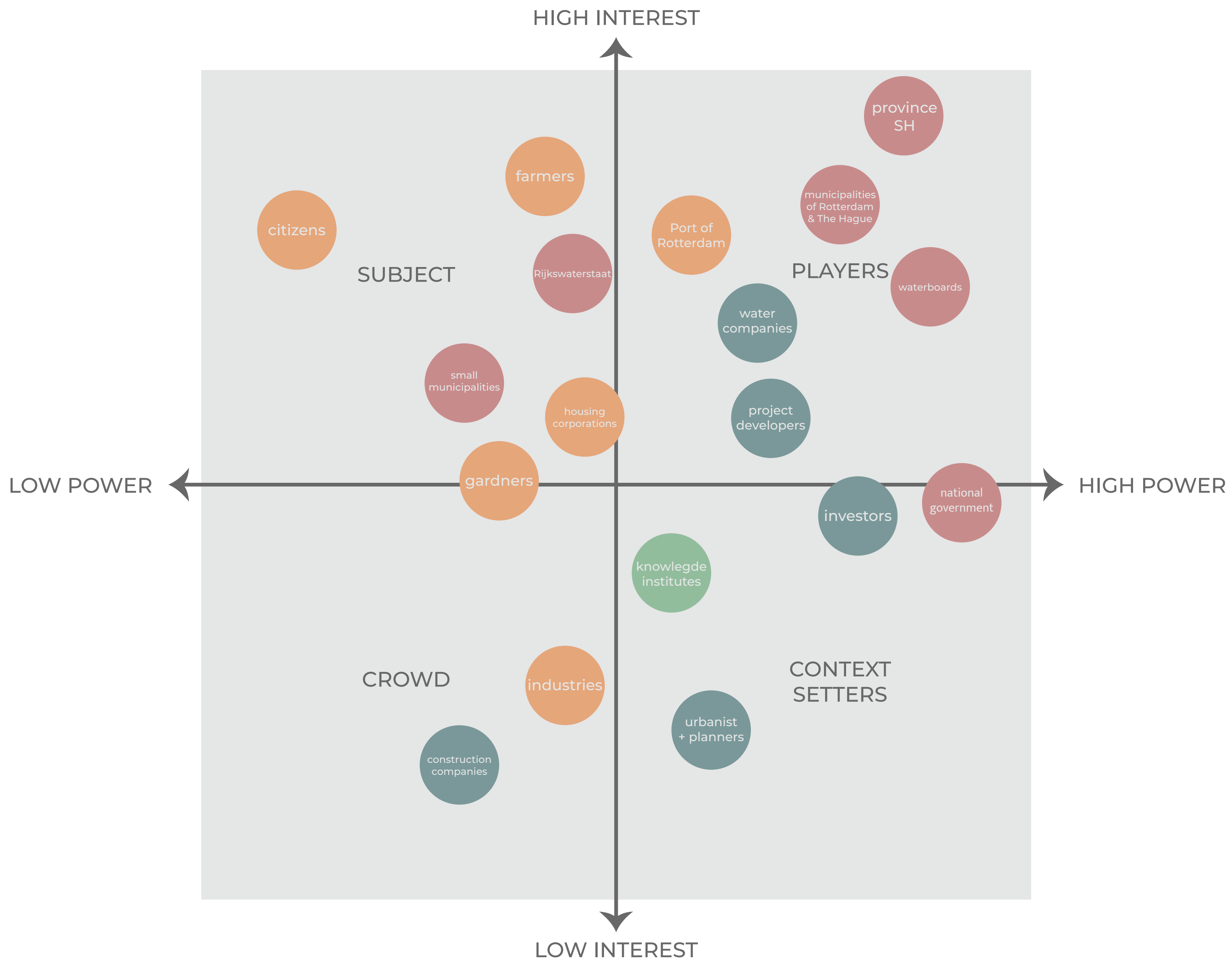


Figure 51: Stakeholder Matrix Regional Strategy

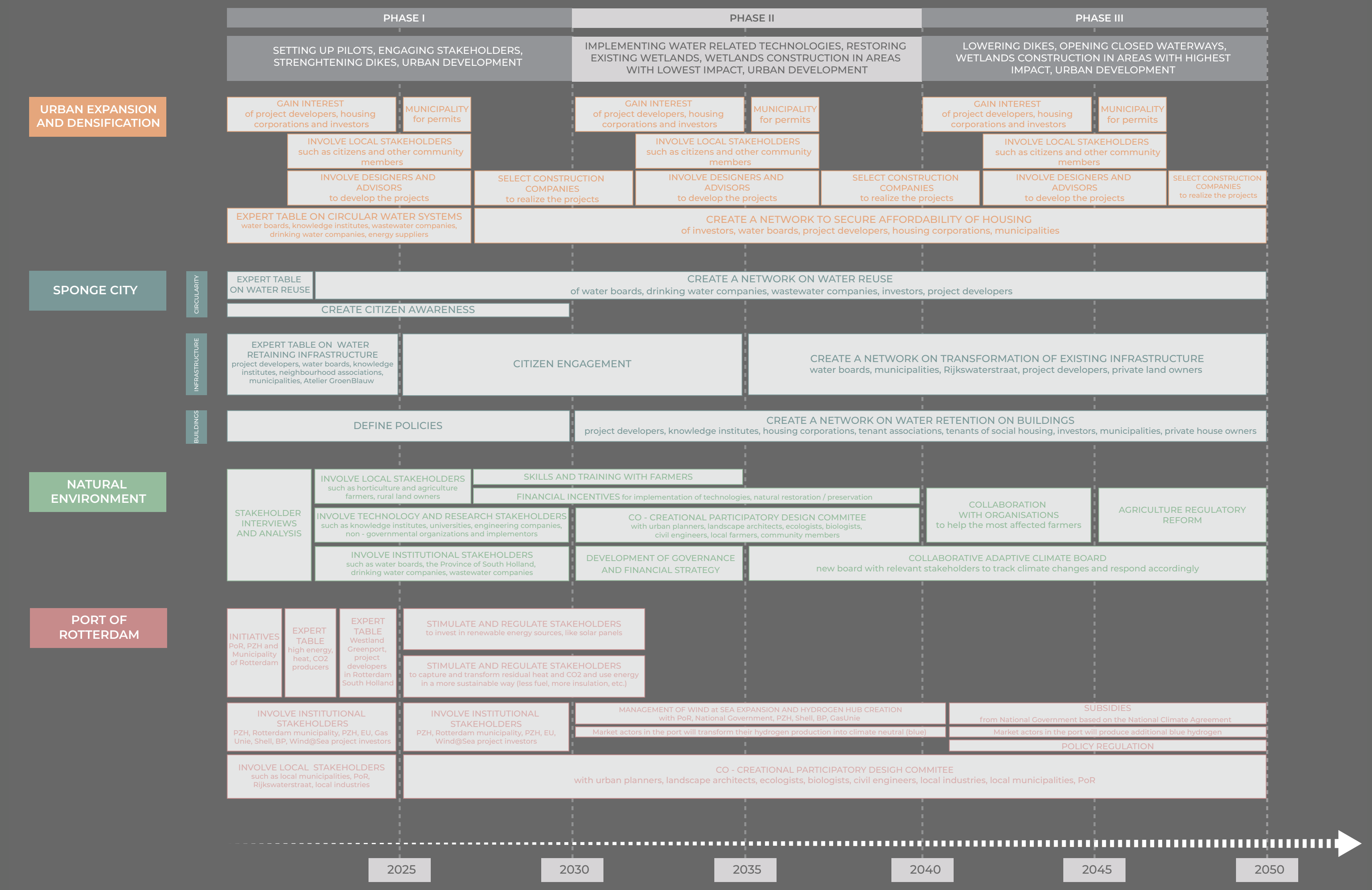


Figure 52: Timeline Stakeholder Involvement

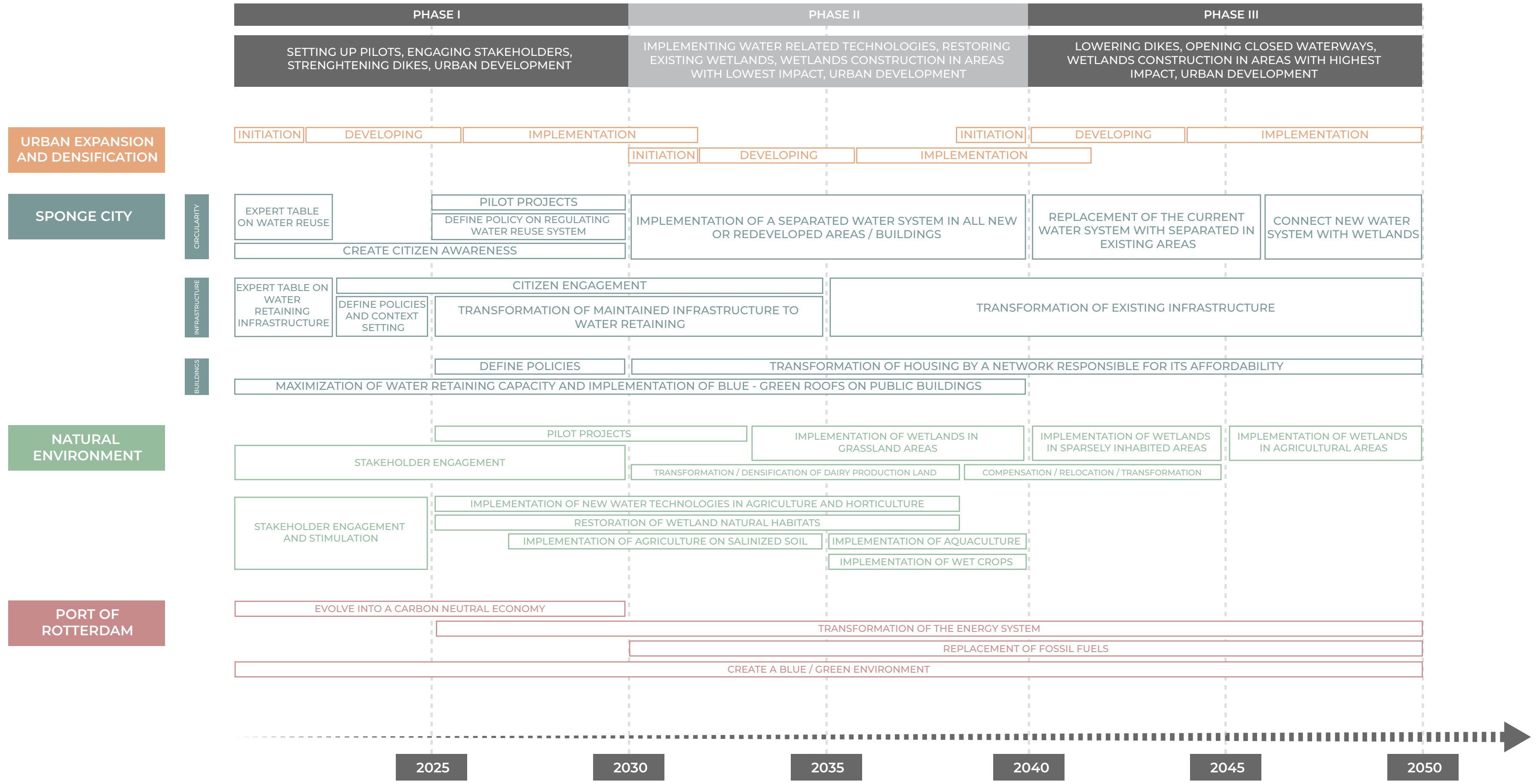


Figure 53: Timeline Regional Strategy

have high power. Collaboration with the water boards is therefore a key aspect of the strategy. In Figure 52 is shown which stakeholders are involved when and in what way. The development of this timeline as well as more details on the phasing of interventions is explained in the next section.

Phasing

The regional phasing of the strategy was developed for four different arenas of change: environmental water & land management, the sponge city, the port area and the expansion & densification. In the timeline above, the different phasing strategies for those arenas of change are combined. The process is split in three different phases. The first phase is focused on engaging stakeholders, reinforcing current strengths and doing pilot projects. The second phase is about the implementation of interventions by a diverse network of stakeholders. In the last phase the most fundamental changes that connect the different areas of change are being implemented.

Environmental Water & Land Management

The first arena of change is focused on a change in environmental water & land management. In order to secure financial viability and encourage a high level of participation, payments will be set. The plan is to blend public and private funding and finance, including through mechanisms such as reverse auctions and marketplaces for ecosystems services that offer both public and private benefits. This plan involves four main programs, which are based upon an environmental recovery program of England (Department for Environment Food & Rural Affairs, 2020).

The first program is the Water Sustainability Farming Incentive. This program will focus on the implementation of technologies for the efficient use of water. It involves the payment of farmers for actions of water circularity and smart water management. Some of the actions that will be compensated are: Irrigation water collection, Energy efficiency, Water control and water recirculation. Besides, the program increases investment in innovation and research and development schemes which bring together researchers, farmers, growers and other agri-food businesses to deliver practical solutions to water circularity.

The second program is the Local Wetland Nature Recovery Incentive. This program pays farmers for actions that support local wetland nature recovery. The program will encourage collaboration between farmers that share the same natural environment. This program will compensate farmers for the restoration of coastal habitats such as wetlands and salt marsh. Some of actions that will be compensated are: creating, managing and restoring wetlands, freshwater and coastal habitats, connecting isolated habitats to form networks, natural flood management, species management, recreation infrastructure, education infrastructure, events

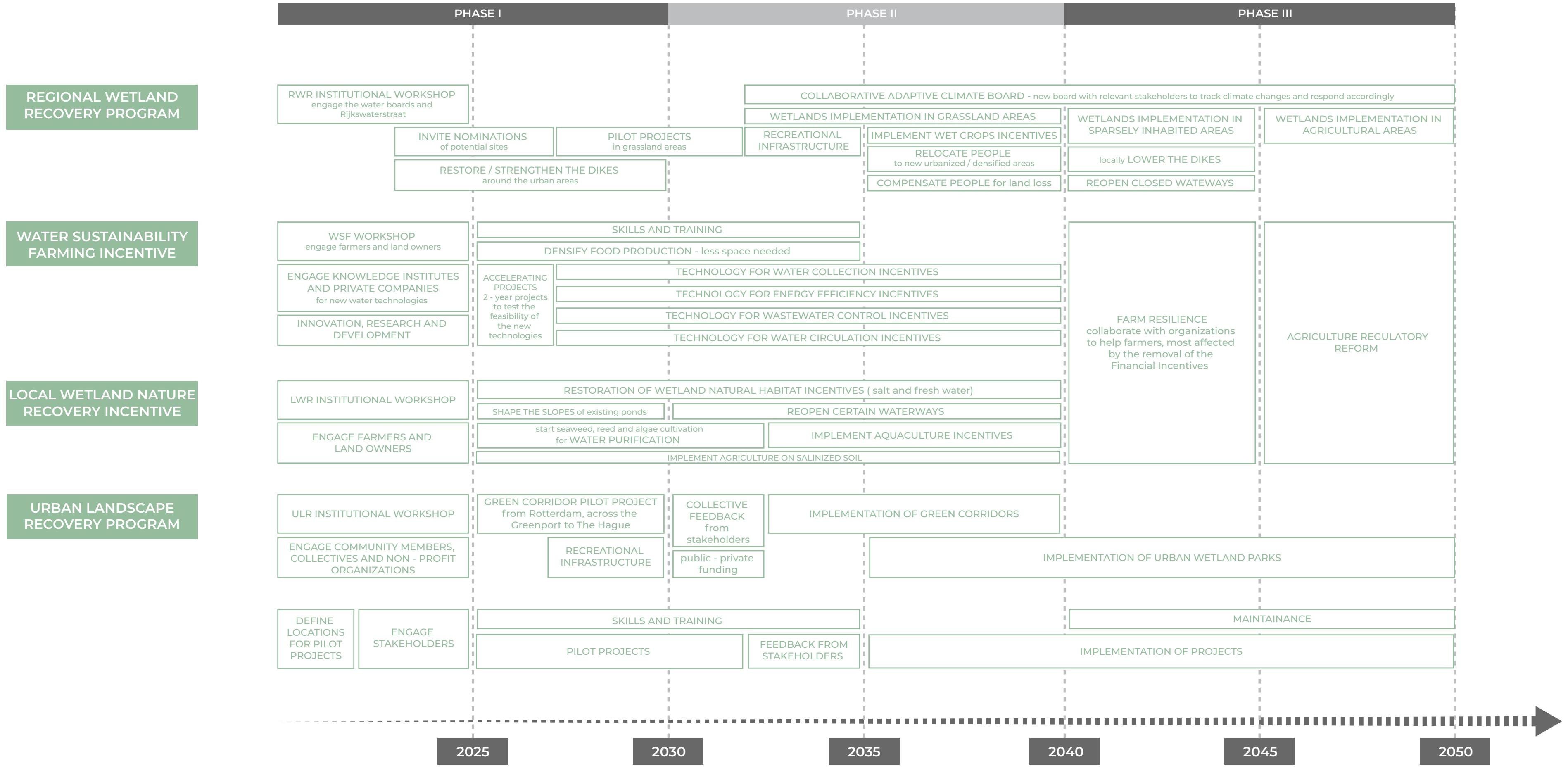


Figure 54: Timeline Environmental Water & Land Management

and services and algae cultivation. Smaller agile projects up to 2 years, to test the feasibility of new technology and demonstrate new methods to the farming community, will be carried out to accelerate adoption. These projects will be farmer-led and focused on finding practical solutions to immediate on-farm productivity challenges.

Wetland Regional Recovery is the third program. It involves land-use changes, of grasslands in specific, to allow the restoration of wetlands in the region. Suitable sites will be provided by groups of farmers, individuals, or organisations such as Non-Government Organisations. In this process, it is important to consider how to best safeguard these valuable new sites for the future. One way to do so is statutory protection, designating the sites as National Nature Reserves. In recognition of the importance of food production and farming, the aim is to avoid delivering these projects on high-value agricultural land. Waterboards are paid to take responsibility in the maintenance of these natural landscapes.

The fourth program is Urban Landscape Recovery. This program will focus on the implementation of urban wetland parks and green corridors within urban areas. The program aims to engage collectives, non-profit organisations and private companies to be part of the implementation and maintenance of the urban wetlands system and green corridors. It will encourage a collaboration between community members and local authorities in transforming the existing public places and developing new ones (e.g. waterparks in former petrochemical areas of the Port of Rotterdam), in recognition of the importance of restoring and upgrading the value of the area.

The Sponge City

The process towards the realisation of sponge cities is split into three main programs. These programs incorporate the implementation of the key principles, as managed in chapter 2.2, of a sponge city (Li et al., 2017). The first program is about the realisation of 'sponge buildings'. This entails the incorporation of green infrastructures, such as blue-green roofs and facades, the decoupling of rainwater to enable reuse and the implementation of grey water systems. The second program for the realisation of a sponge city is the realisation of water-buffering infrastructures. Besides, the implementation of blue green corridors as highlighted above, greenblue structures will be integrated within for example roads, bicycle lanes or tram lanes. This process is started with for the areas that are to be maintained. The third program is focused on water circularity by means of the implementation of a separated water system. A separated water system allows the reuse of grey water on a local scale. The last phase of this program is to connect the separated water system to the wetland water.

With achieving socio-environmental justice being one of the key goals for this strategic vision, the involvement of stakeholders is crucial in this process. A European cross border action on co-creation and implementation

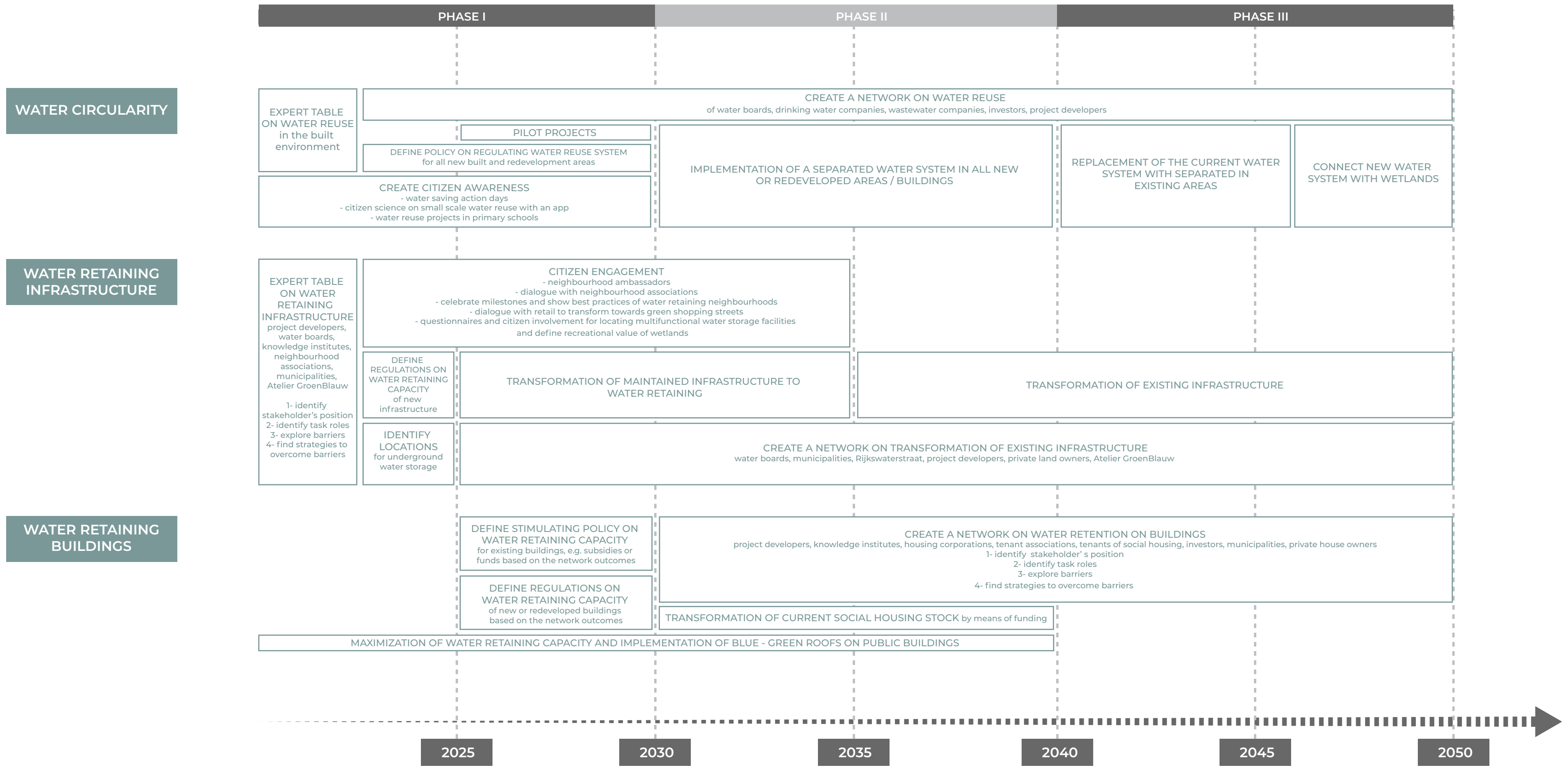


Figure 55: Timeline the Sponge City

of innovative, participative climate adaptive solutions in densely built areas, identified three main steps towards a participative approach to sponge cities (Waterschap Schieland en Krimpenerwaard, 2020): The first step is to encourage and enthuse, the second is to make use of pilot projects and last, but not least, is the actual implementation of the stakeholder engagement within policies. These steps are integrated in the first phase of this strategy. This project, which is called Sponge 2020, was specifically focused on water buffering and the integration of the sponge city concept for reaching climate-resilience in urban areas. One of the most important outcomes of this project was a website on urban green-blue grids for resilient cities (https://www.urbangreenbluegrids.com/). Besides a guide for fitting measures of urban climate adaptation, this website also provides a toolbox with proven practices and insights on stakeholder engagement (Atelier Groenblauw, n.d.). The methods of stakeholder engagement that are presented in this timeline, are based upon this toolbox. Within the different methods towards stakeholder engagement 5 steps were identified to come towards a successful agreement: identify stakeholders, listen and inform, exchange ideas, integrate interests and common agreement.

The Port Area

The transformation of the port includes four different transitions: evolving into a carbon neutral economy, changing the energy system, the replacement of fossil fuels and creating a green-blue port environment. The strategy of the transformation of the port area was based on the current ambitions and goals of the Port as hydrogen hub (Port of Rotterdam, 2020).

The process of evolving into a carbon neutral is planned to be finished first and will be started immediately. In a carbon neutral port the residual heat as well as CO_2 emissions are captured and reused. Residual heat can be reused in the urban expansion areas close to the port and in Greenport West-Holland. Currently, residual heat is already used in Rotterdam. CO_2 can be reused in the industry sector itself and in the greenports. This process also includes the increase of renewable energy production and making a start with the construction of a hydrogen-electricity network.

The change of the energy system will be started in 2025. This process is about the implementation of a blue as well as a green hydrogen network. Besides, the possibilities for renewable energy storage & production will be developed and the hydrogen electricity network will be finished. From 2030 onwards, the replacement of fossil fuels with biofuels, biochemicals and bioenergy will be executed.

Finally, throughout all phases the port will be transformed into a green-blue environment. The integration of green structures and wetlands within the port area will stimulate biodiversity and can help to achieve water circularity within the port. The first step is to create internal green structures by designating 'empty' spaces and connecting animal inhabited zones. The second step is to connect green structures. This involves connecting internal green structures and creating a green corridor between the Brielse Meer area and the port area. Finally, green design can be integrated within the transition to bio-based industries and wetlands will be implemented between storage silos.

Urban Expansion & Densification

The strategy of urban expansion and densification is also split in the three different phases. In the first phase, that is focused on learning from stakeholders and doing pilot projects, small scale urban densification projects will be executed and the urban expansion along city will start. In the following 10 years the first part of the large scale densification projects are executed and the urban expansion will be further developed at different locations. The last phase is about connecting the urban axises through the last urban expansion projects and the implementation of the second part of the large scale urban densification projects.

The phasing of the urban expansion and densification process is based on the phasing that is used in development projects. A building development project entails the following steps: initiation, definition, design, permit, tender, construction preparation and execution. The specific requirements for the urban densification and expansion of this strategy are implemented within these steps. Within

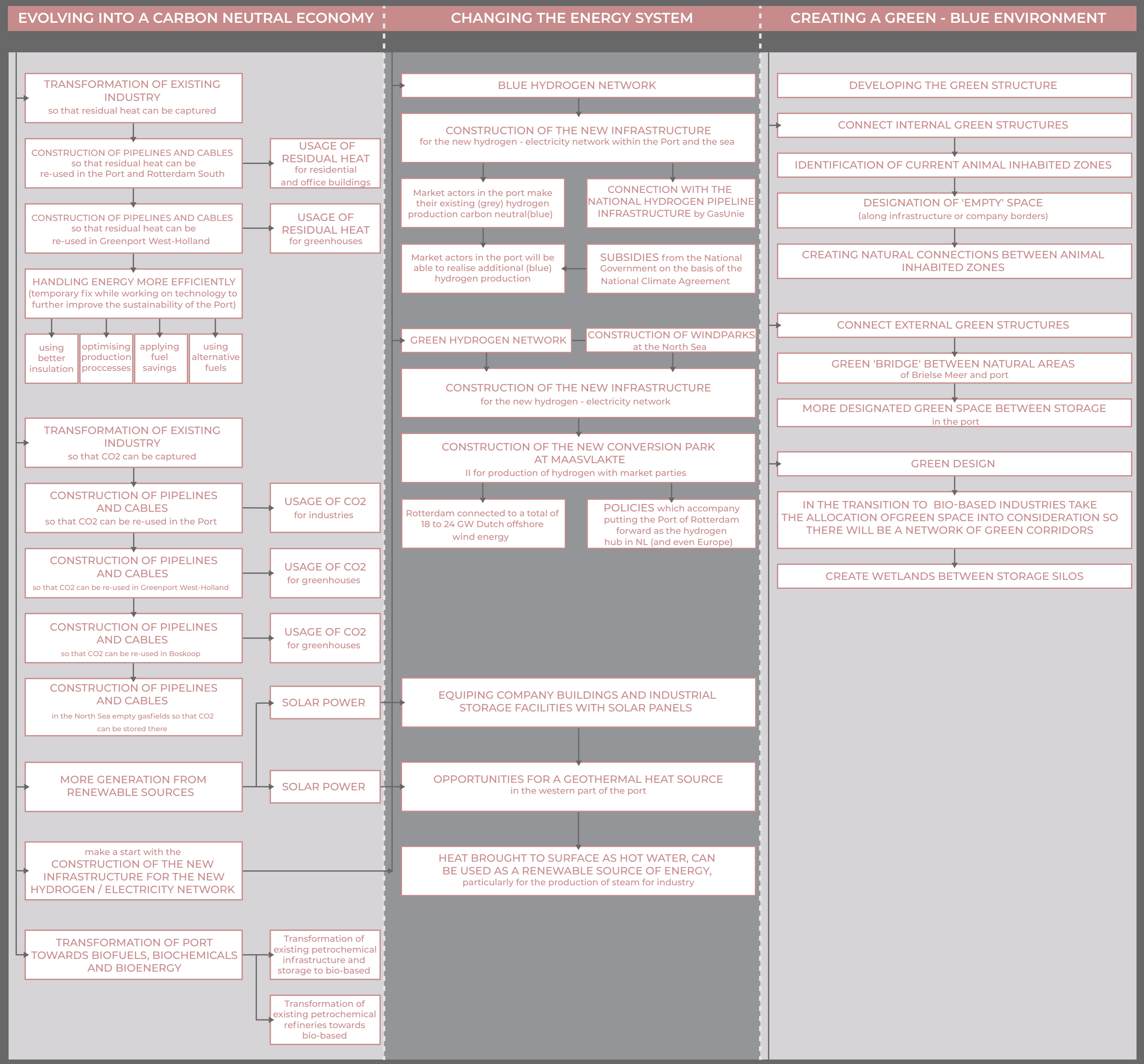


Figure 56: Phasing the Port Area

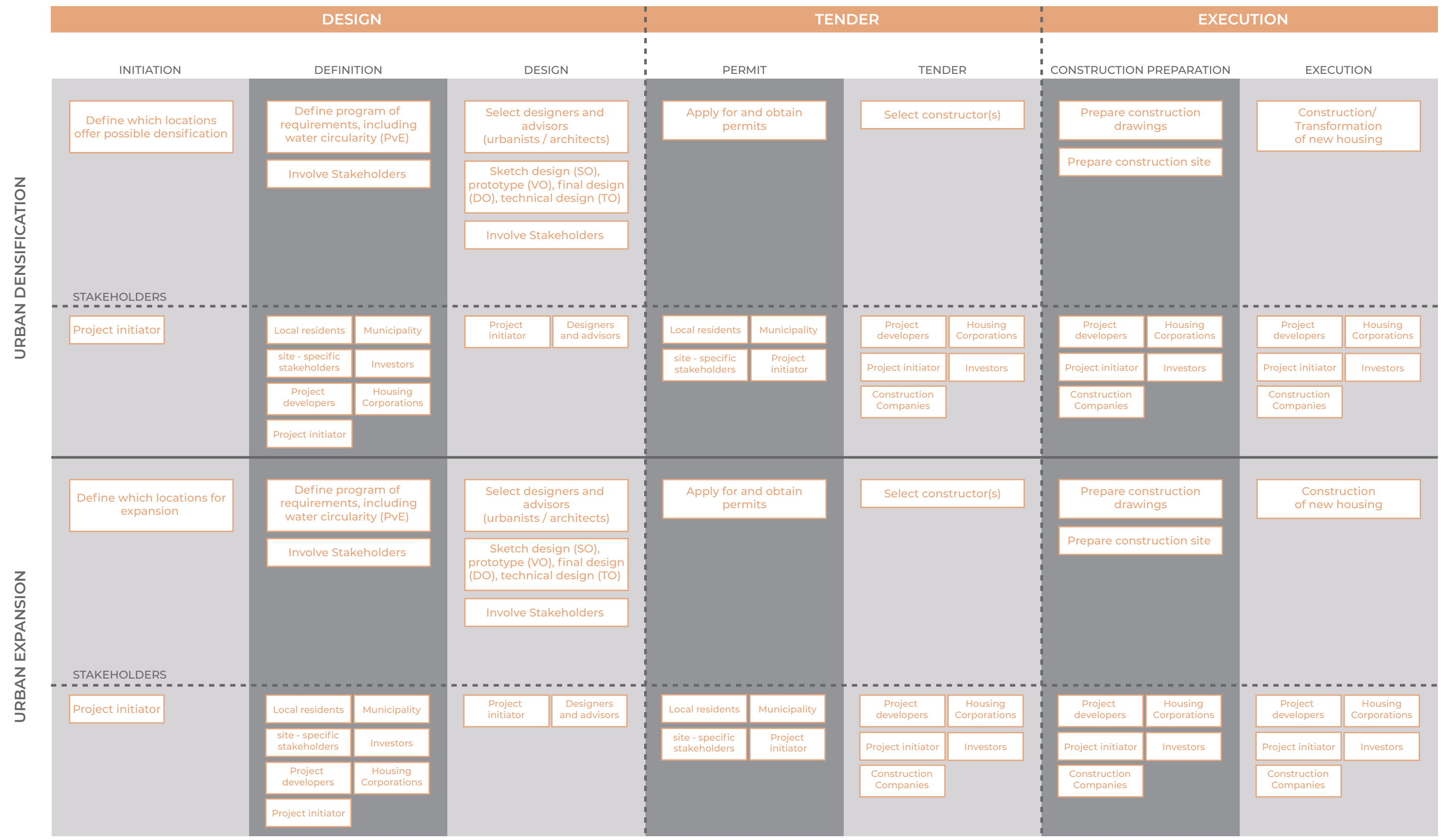


Figure 57: Phasing Urban Expansion & Densification

the initiation phase, the specific locations of expansion and densification on a more local scale are identified. In order to integrate socio-environmental justice and to adjust the projects to the specific sponge city concepts as well as the specific demands of future inhabitants, a wide range of stakeholders is already involved in the definition phase. In addition to involving stakeholders early in the development process, socio-environmental justice will be strived for by focusing on affordable housing. A network of relevant stakeholders, for example investors and housing corporations, will be created in order to secure that all societal groups can benefit from the increase of housing opportunities.

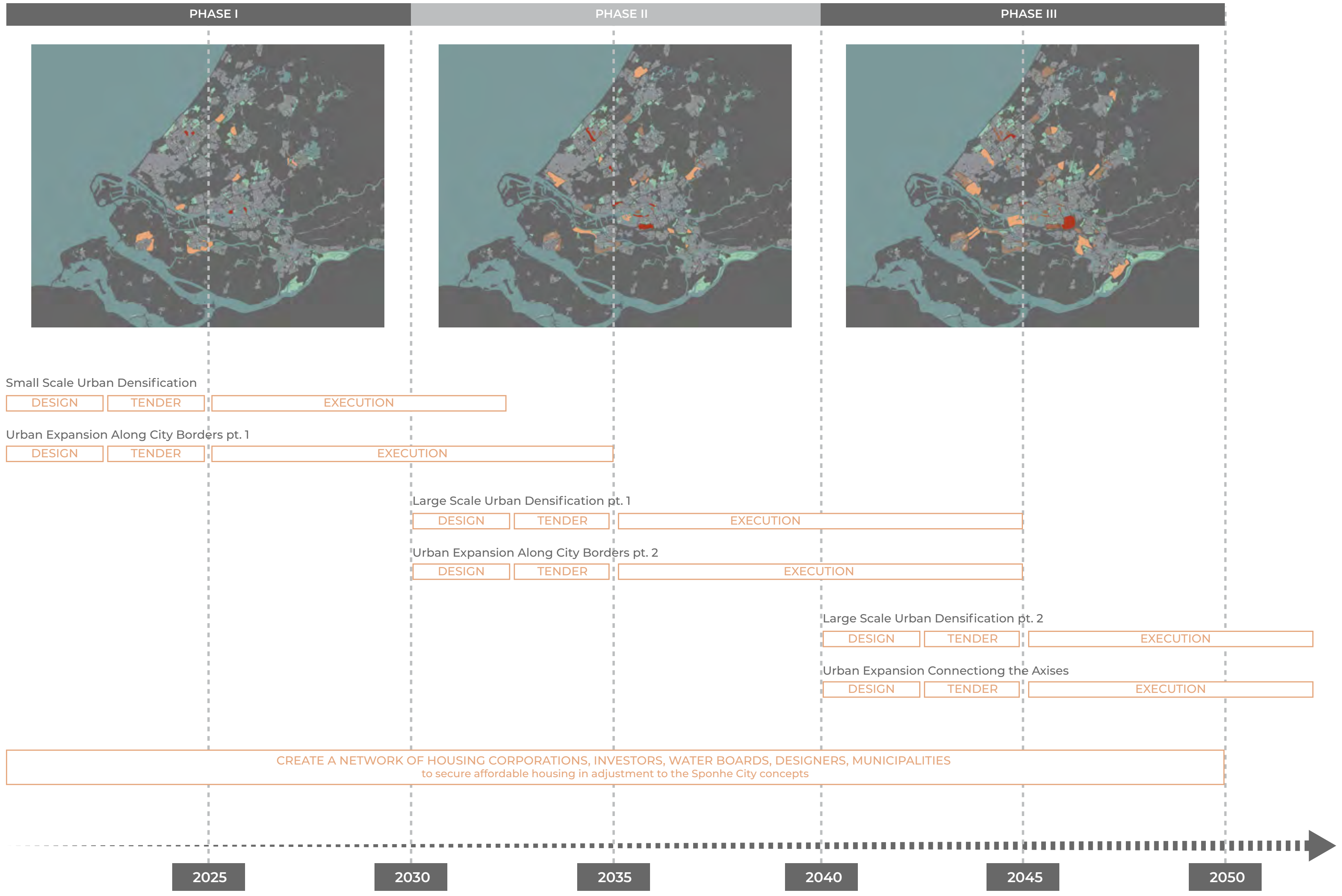


Figure 58: Timeline Urban Expansion & Densification

5.2 Strategic Clusters

This chapter shows the strategy in more detail by two spatial clusters within the region: the productive cluster and the urban cluster. The productive cluster shows the transformation of the port and horticulture in relation to the urban expansion as well as the wetland area. The urban cluster shows how urban liveability for all is combined with the transformation of agricultural activity and the implementation of the city as a living sponge.

Productive Cluster

The productive cluster represents a spatial line between the Brielse Meren and the future wetland area. This cluster includes the Port of Rotterdam, Greenport West-Holland and a new urban expansion project along the water.

Phasing

Figures 60-63 show how the specific interventions that are taken over time impact the different flows of water and energy. The figure shows how the transformation of the port, which includes the production and storage of renewable energy, contributes to the energy transition. This renewable energy stock as well as the residual heat and CO2 from the bio-based industry sector in the port are used to fulfill the energy demand of the greenport and the urban areas. The shift towards circular water flows, that is also illustrated in this figure, is the key objective for this strategic vision. In the current situation, drinking water is the main source of water for the port and the urban area. The drinking water companies that are at stake in this area are DUNEA and Evides. The port also extracts water directly from the Meuse and from the precious fresh water resource of the Brielse Meren. Greenport West-Holland also extracts water from the Meuse, which is stored in a water basin before use. All used water is via drainage systems transported to wastewater treatment plants (RWZI). From there, the water is discharged to surface water again. The different spatial interventions in the landscape that are shown in the figure create a change in this regime of water management. Although the development of urban expansion increases the fresh water demand, a separated water system and facilities for grey water use to save the demand for drinking water are integrated from the start. Similarly, the implementation of smart water technologies within Greenport West-Holland enable the optimisation of water flows and a shift towards water circularity. The wetlands that are starting to be implemented in the second phase serve as a new resource of fresh water. In-port wetlands therefore decrease the extraction of fresh water from the Brielse Meren by the port. The large-scale wetland area that is implemented in the natural landscape at Midden-Delfland creates a sustainable and renewable fresh resource for the drinking water companies. The wetlands therefore help to overcome the problem of depleting fresh water resources in combination with an increasing water demand because of urbanisation. The water from the wetlands can also serve as an extra resource for grey water use in the new urban area. The implementation of water reuse facilities within the urban area, the greenport as well as in the port lead to a decrease in the amount of wastewater. However, not all water can be reused locally. Think for example of water that is used to flush the toilet, also called brown water. In the new situation, these flows of wastewater will still be transported to the wastewater treatment plants. However, the process of purification is less extensive as the water is discharged in the wetlands for a secondary purification. Thus, as wetlands serve both as a fresh water resource and as a nature-based purification system, the implementation of wetlands facilitates a shift towards water circularity.

Figure 59: Location Productive Cluster

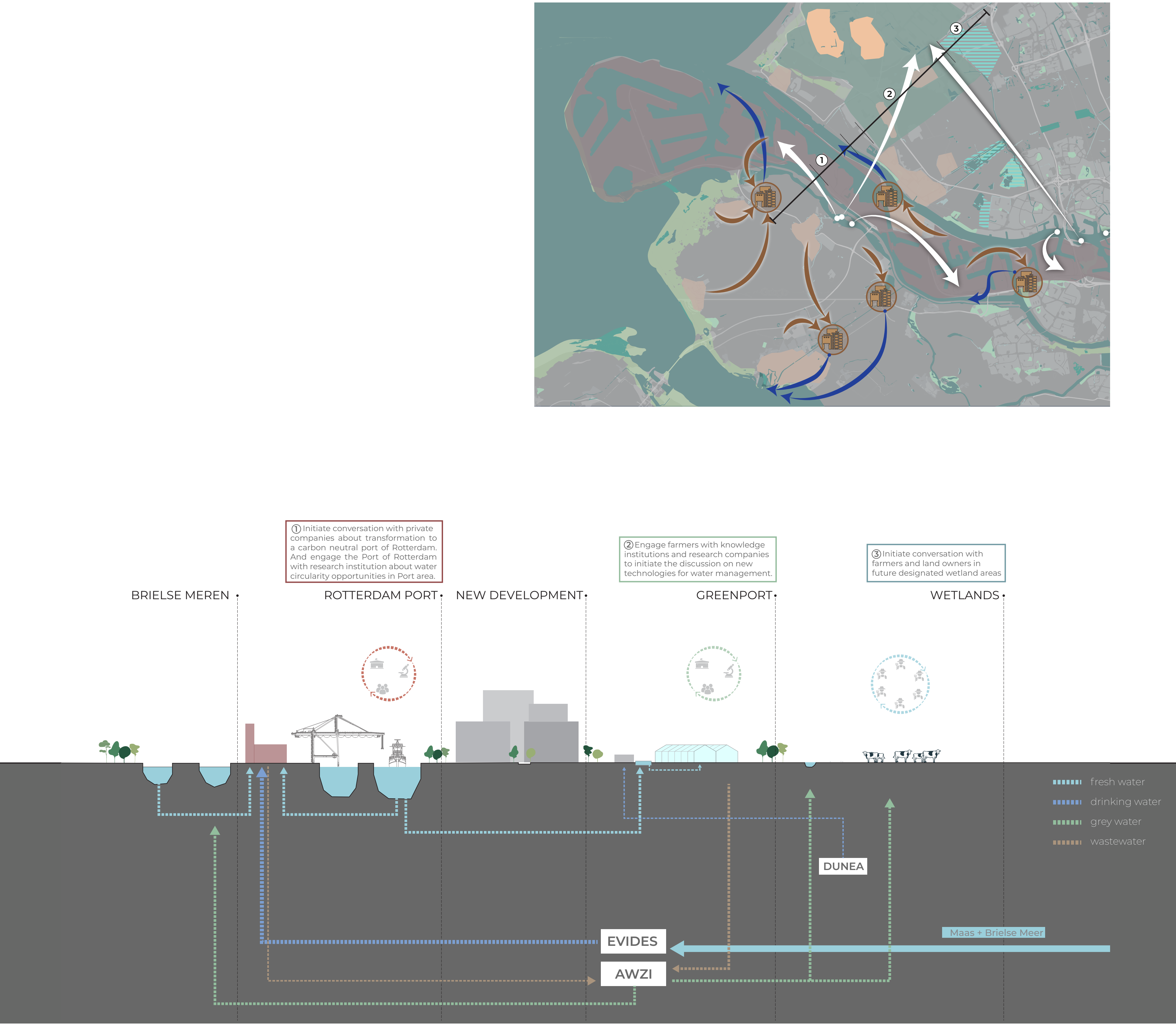


Figure 60: Phasing Productive Cluster 2021

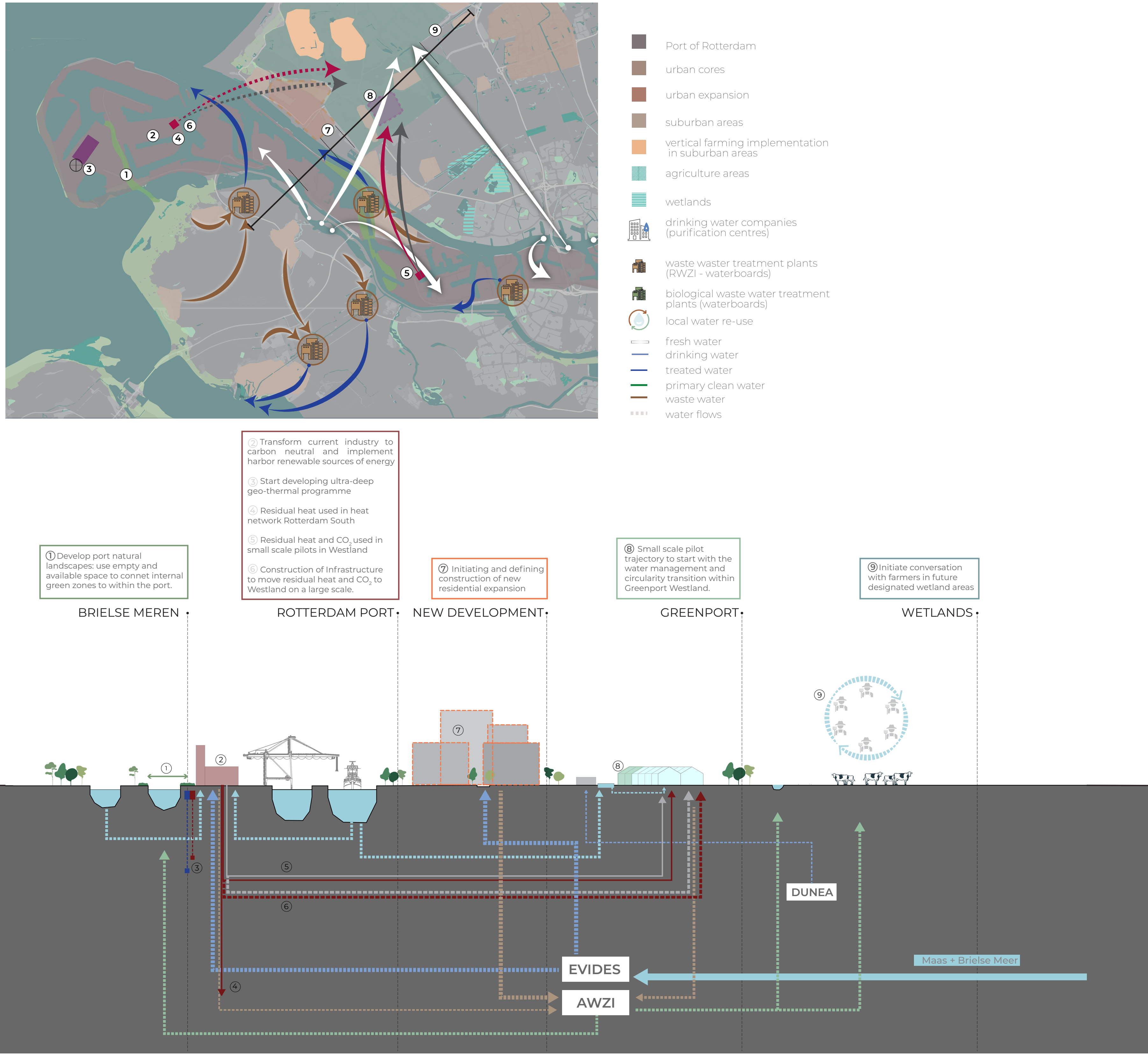


Figure 61: Phasing Productive Cluster 2030

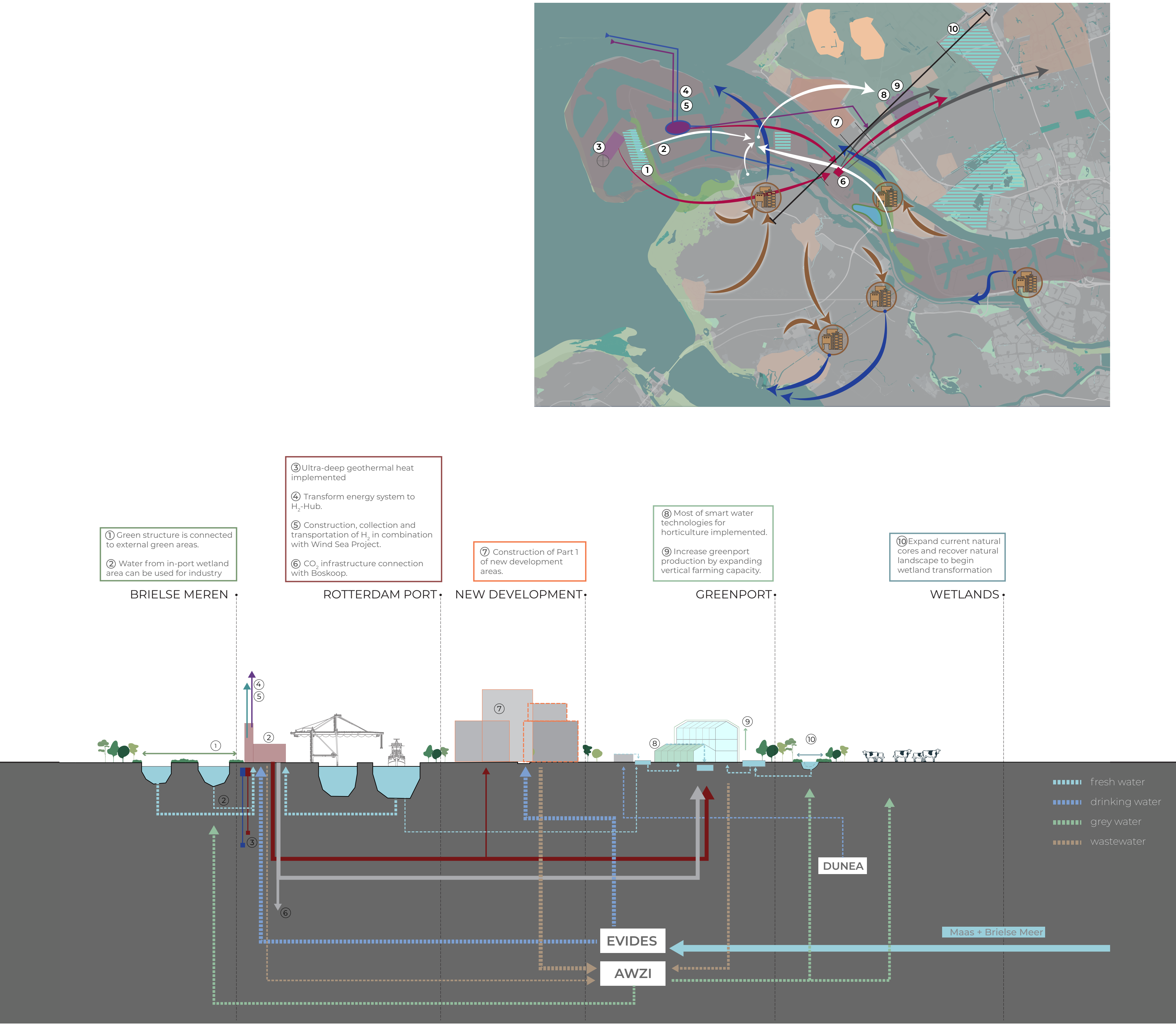


Figure 62: Phasing Productive Cluster 2040

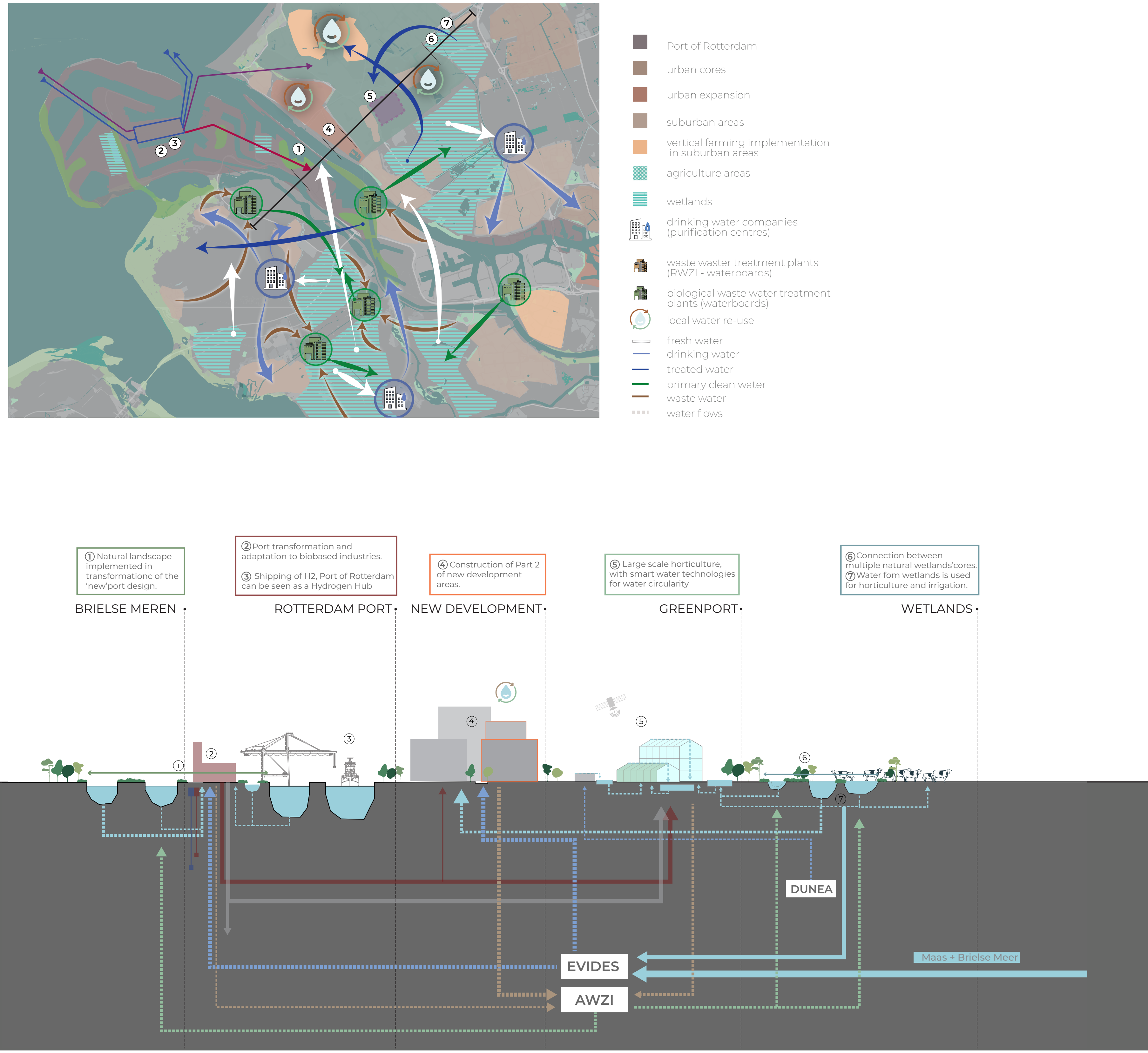


Figure 63: Phasing Productive Cluster 2050

Figure 64: Stakeholder Matrix Productive Cluster

Stakeholder

In Figure 64, the most important networks and stakeholder relations for the changes within the productive cluster are shown. First of all, the opportunities that are created within the port area to stimulate and facilitate the energy transition is in the interest of a number of different stakeholders that will be engaged in this process. Due to the important international position of the port and the strong ambitions on climate mitigation of the EU, also the European Union will be involved as a facilitator of this transformation. Secondly, the transformation of the port into a blue-green environment that facilitates water circularity is realised through a collaboration of the port with the other different parties that have an interest in this transition.

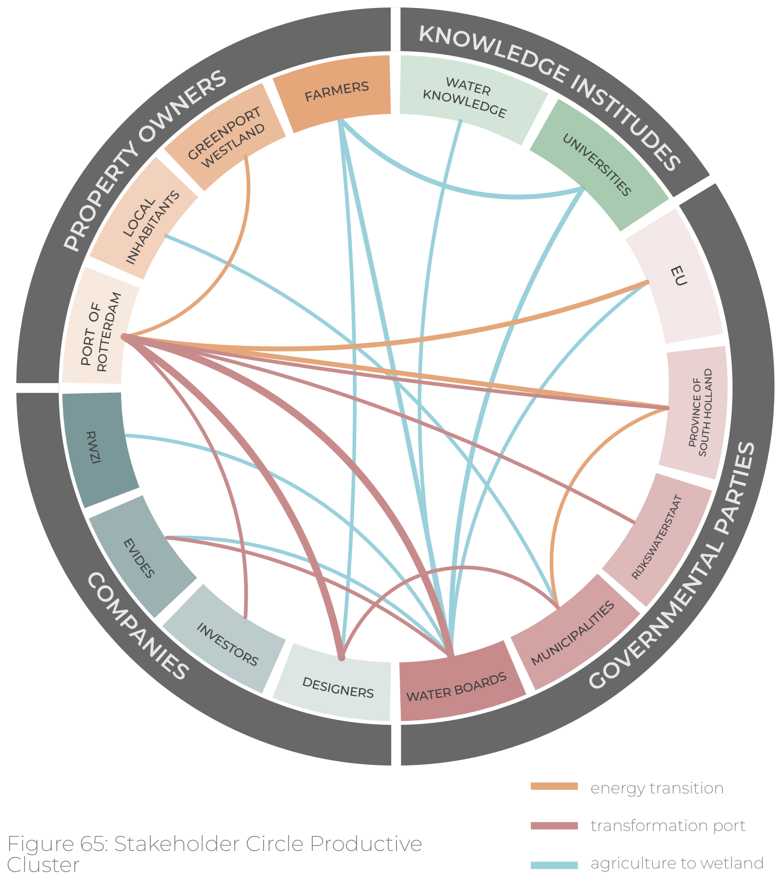


Figure 65: Stakeholder Circle Productive Cluster

The transformation of the current agricultural landscape at Midden-Delfland into a water providing wetland area is implemented by means of adaptive delta water management (chapter 2.2). In the participatory approach, all stakeholders are involved in the process. Farmers are empowered to adopt new ways of farming by the engaged knowledge institutes and they, as well as other local inhabitants are motivated to move out of the area by giving them new housing opportunities to their own preference in collaboration with designers and municipalities. With regard to the opportunities that wetlands provide in terms of water purification and fresh water storage and the shift towards water circularity, water boards and knowledge institutes work together with wastewater companies, drinking water companies and urban developers or designers. The water

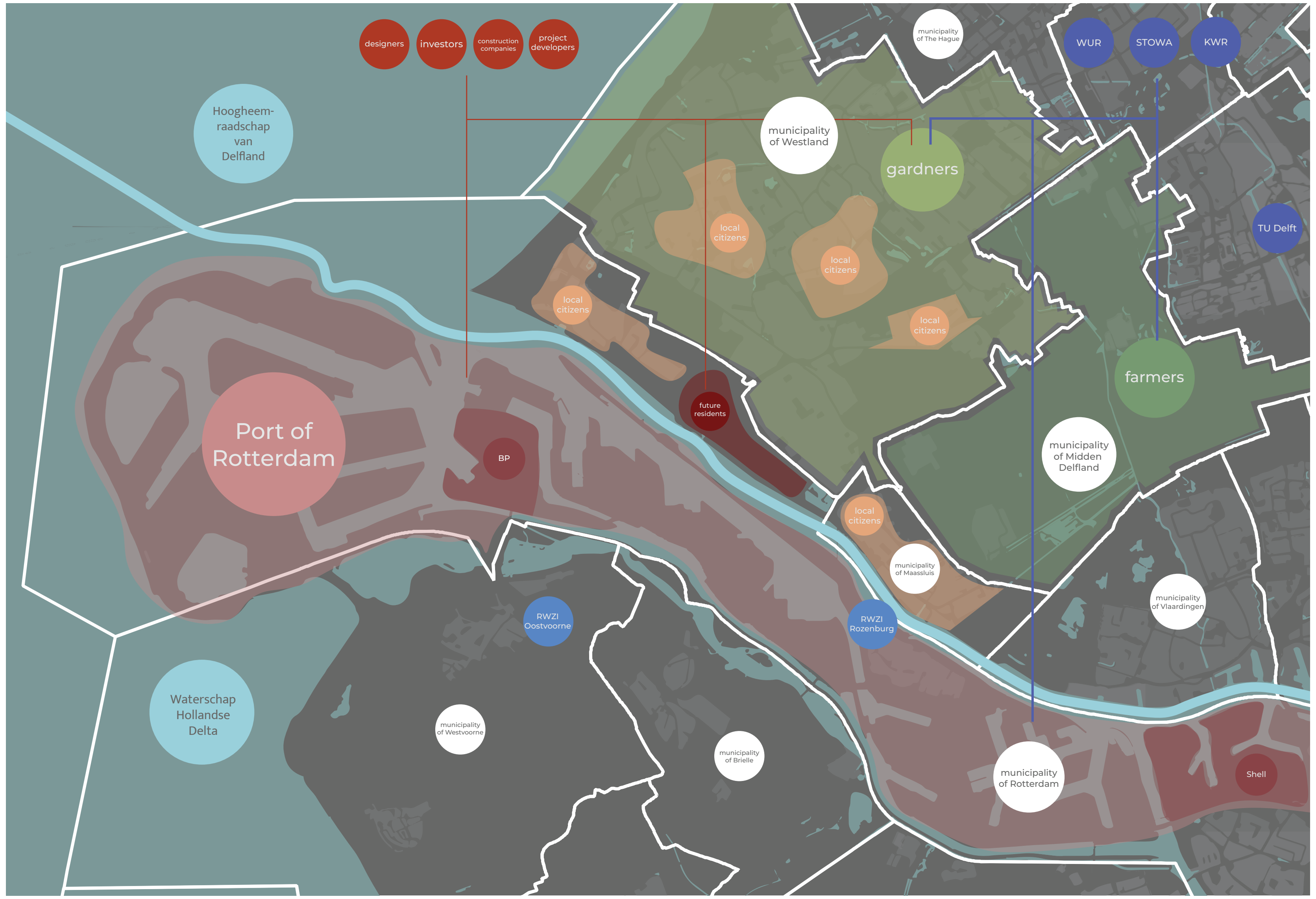


Figure 66: Stakeholder Map Productive Cluster

boards are an important player in both transitions that are related to water circularity, the realisation of a blue-green port environment and the wetland area. Figure 66, shows the spatial scope of power for the different stakeholders that play a role in this area.

Urban Cluster

The urban cluster covers the area from the agricultural area of Goudswaard to the centre of Rotterdam. This strategic cluster combines the concepts of the city as a living sponge, adaptive water management, circular economy and socio-environmental justice through the densification and transformation of Rotterdam, the implementation of different types of wetlands and a shift to water circularity (Figures 68-71) .

Phasing

Similarly as in the productive cluster, drinking water is the main water source which is after use processed by urban wastewater treatment plants and discharged to surface waters again. Besides the agricultural sector has significantly increased their use of drinking water (chapter 1.2), farmers extract water directly from the ground as well. However, the extraction of groundwater in agricultural areas further increases the pressing problems of soil subsidence and decreased bearing capacity (Van den Akker et al., 2013). A decreased bearing capacity makes the area more vulnerable to flooding as the soil is not capable of processing high amounts of water. Next to agricultural cultivation, urban cultivation causes exactly the same problems. The higher the density of buildings and infrastructure, the higher the pressure on the soil and the lower the water run-off capacity. As in this urban cluster, both agricultural as well as high-dense urban cultivation play a role, alleviating the soil is crucial in this area. In order to recover the agricultural land, wetlands will be implemented. Wetlands allow for the water to infiltrate in the soil. However, this means that farmers need to change their current practices. Aquaculture and vertical farming within the urban area between Hoogvliet and the Akkers are offered as an alternative. The remaining agriculture will have to implement techniques of water circularity in order to decrease the water demand. The relocation of farming into the urban area does entail a densification of land use. And the enormous housing demand asks for urban densification of a scope that is much larger than just providing a home to the farmers. In order to create new possibilities of urban expansion in this area, Heijplaat, that is currently used by the port, will be transformed into housing. The increased water demand that is caused by this urban expansion and densification is relieved by the implementation of a separated water system and water reuse systems. Implementing the sponge city concept will alleviate the environmental issues that occur from urban cultivation. In a sponge city, permeable surfaces increase natural water infiltration that can help to restore the soil and resourcing of water will decrease the risk of flooding. One intervention that can help to resource the water and alleviate the soil is the implementation of green corridors and urban wetlands. Although urban wetlands will not be used for purification because of the smell, the stored water can be reused as grey water and the urban wetlands are suitable for recreational purposes. In the first phase, a recreational wetland will be implemented in the Rhoonse Grienden as a pilot project. In the last phase, the large-scale wetlands will be implemented in the area towards Goudswaard as well as at Midden-Delfland. The wetlands in the agricultural area facilitate a new way of farming with circular water flows. Both wetland areas can also be used for secondary purification of urban waste water and as a source of fresh water to supply in the increased water demand. In this way, the wetlands contribute towards water circularity in the urban cluster. Moreover, a network that facilitates the use of surface water as a source of energy will be implemented in urban expansion areas as an extra opportunity. Aside from facilitating water circularity, the wetlands can therefore also help to answer the increased energy demand within the urban cluster.

Figure 67: Location Urban Cluster

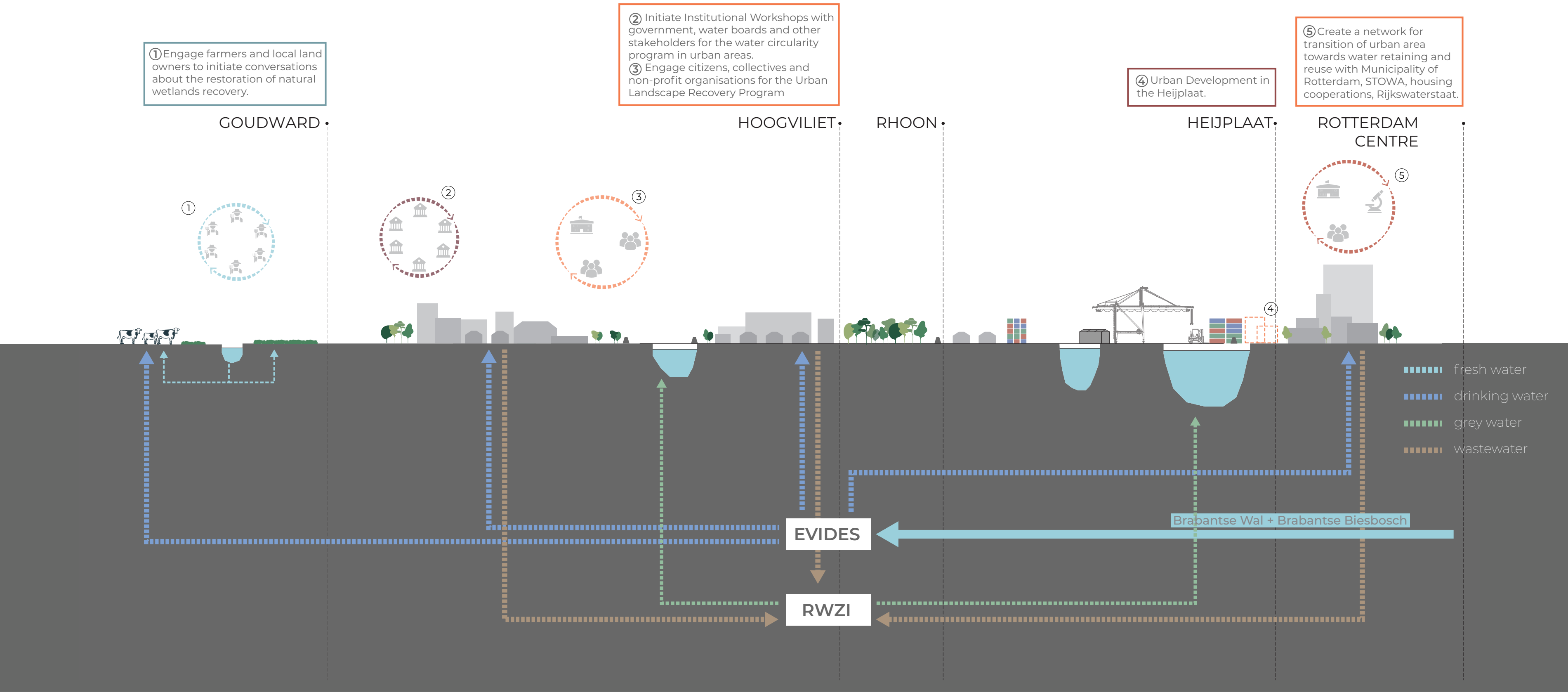
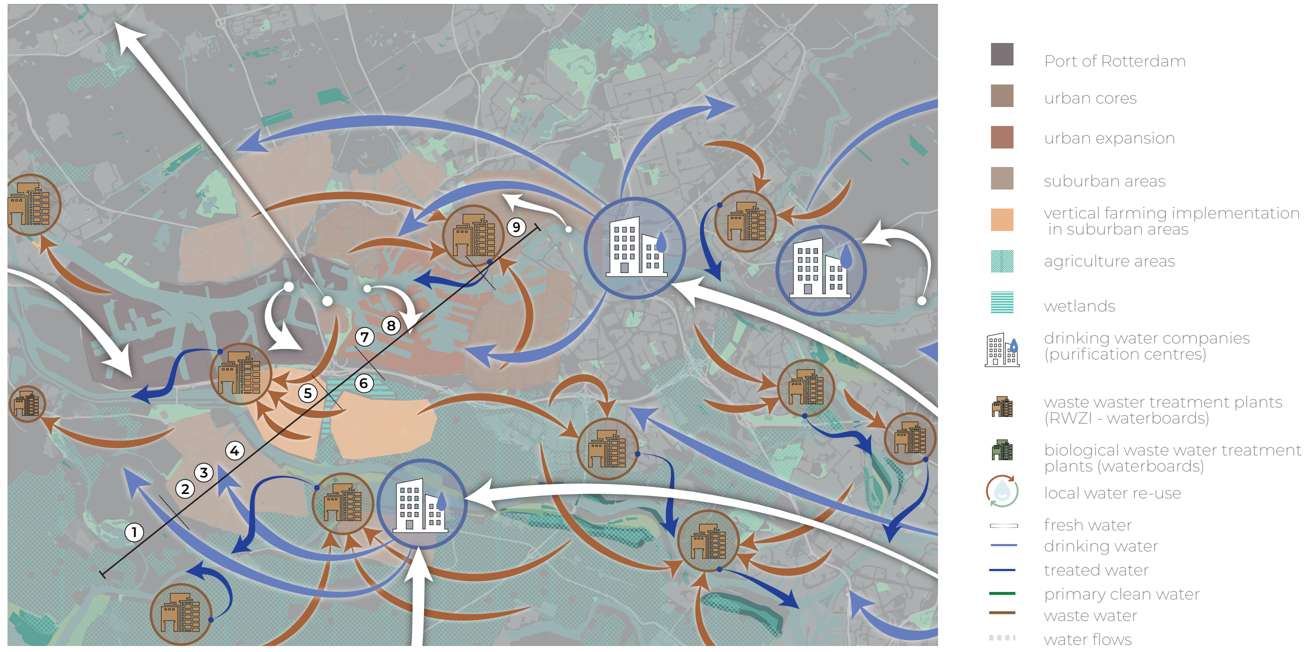


Figure 68: Phasing Urban Cluster 2021



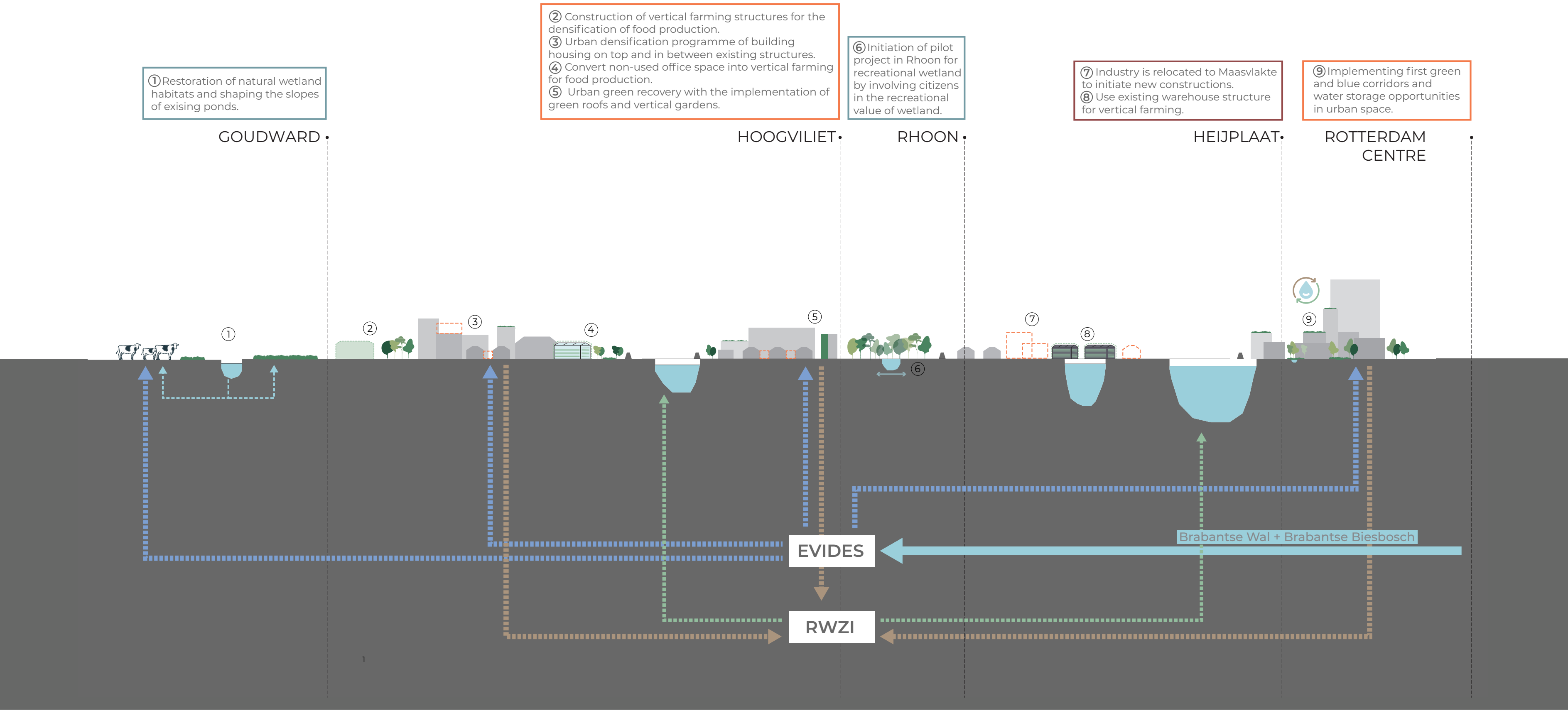


Figure 69: Phasing Urban Cluster 2030

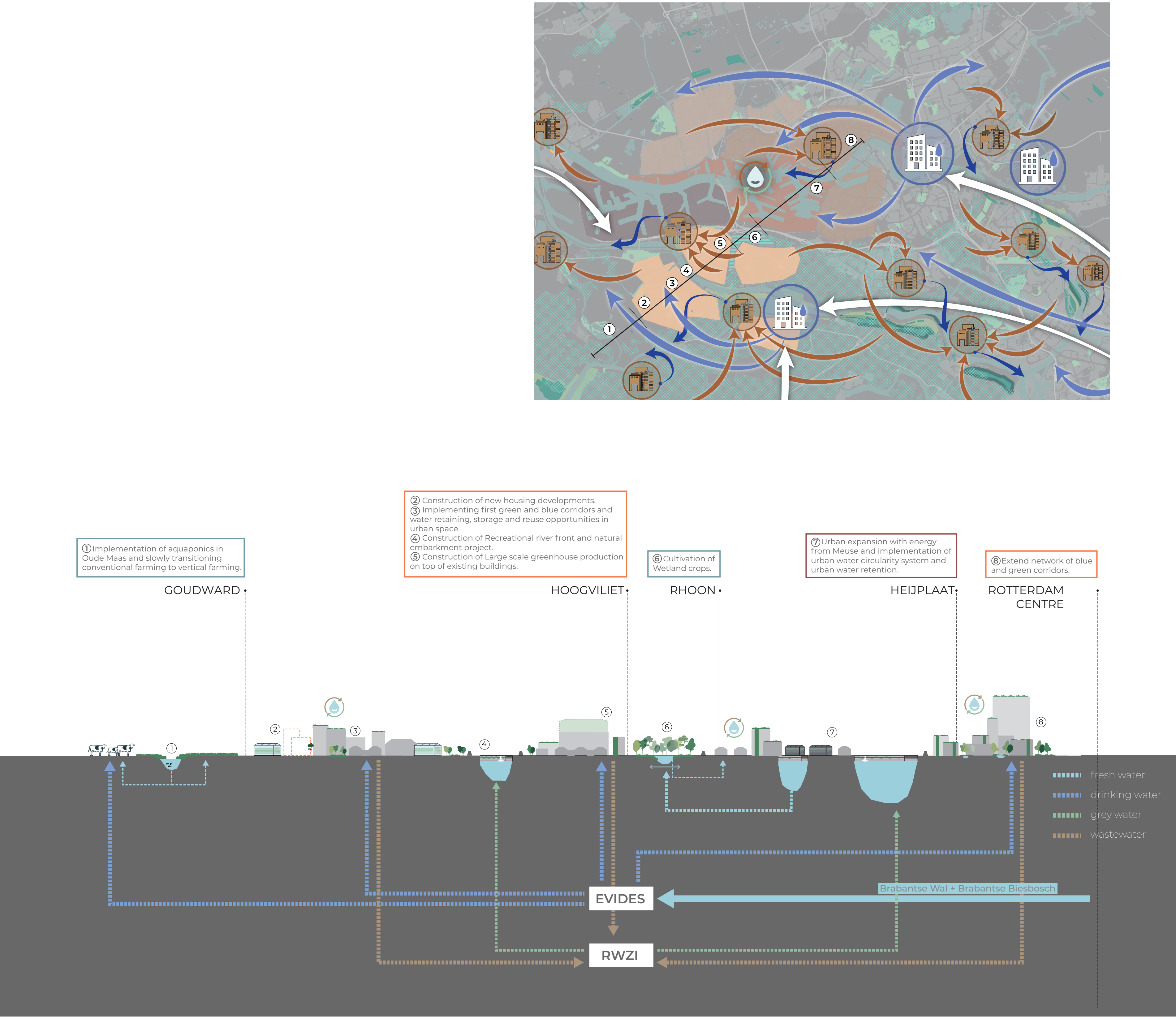


Figure 70: Phasing Urban Cluster 2040

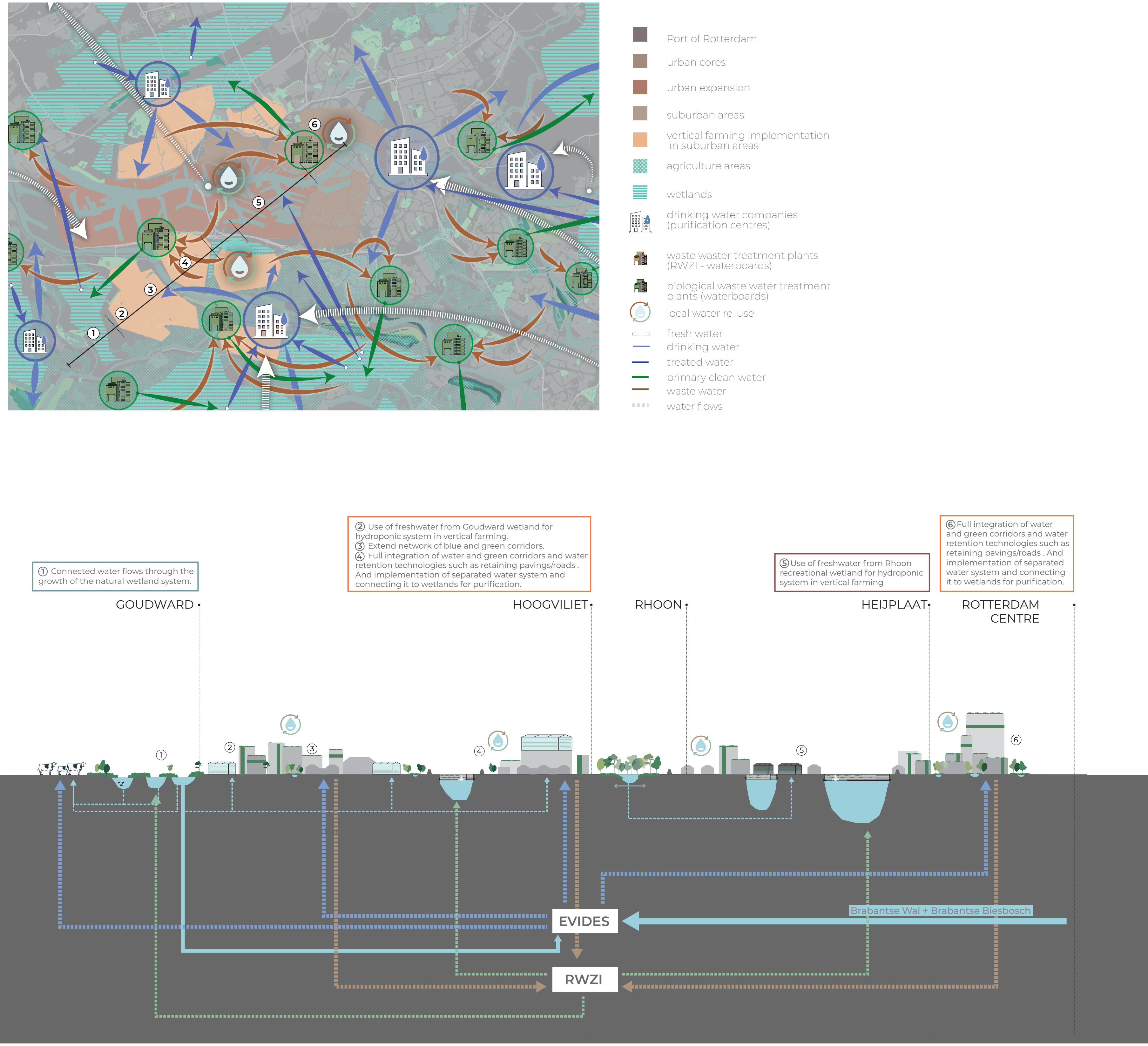


Figure 71: Phasing Urban Cluster 2050

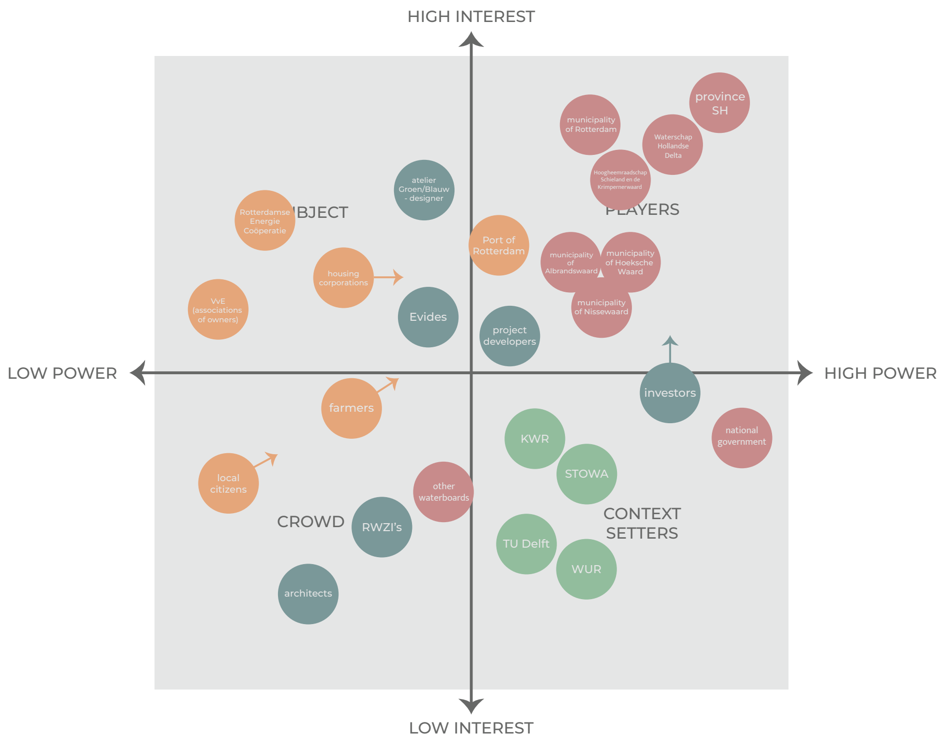


Figure 72: Stakeholder Matrix Urban Cluster

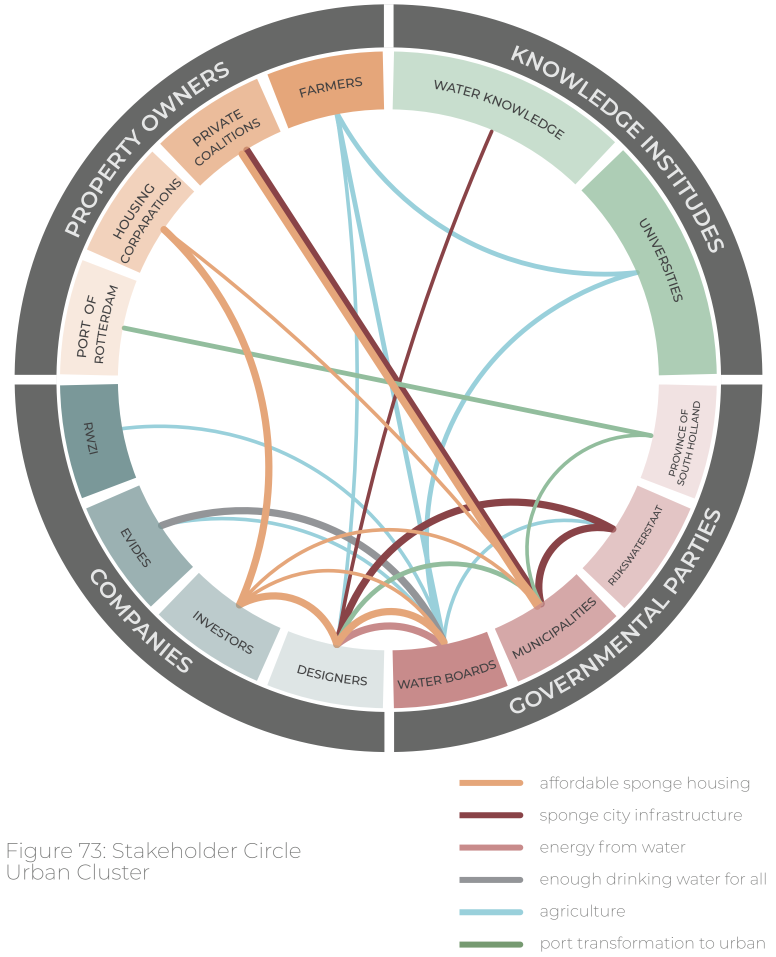


Figure 73: Stakeholder Circle Urban Cluster

Stakeholders

Figure 73, shows the stakeholder relationships that are needed for this transformation of the urban cluster. Figure 74 shows the spatial area in which the different stakeholders have influence. In order to secure that the increased supply of housing that integrates water buffering facilities, serves all groups of society and is affordable, a network between property owners, including housing corporations, investors and developers will be created. For the implementation of water buffering infrastructure that allows for water infiltration and water retention, civic coalitions will be deployed for small scale changes and a collaboration between Rijkswaterstaat, developers and designers is initiated. An important designer of blue green urban structures within the area is Atelier GROENBLAUW. The realisation of creating energy from water involves a collaboration between the water manager and the real estate owner (Van Schaik et al., n.d.). In this case, this means a partnership between the project developers and the local water boards, which are Hoogheemraadschap van Schieland & Krimpenerwaard and Waterschap Hollandse Delta. Evides is involved in the realisation of wetlands to facilitate the supply of drinking water. Finally, the shift in agricultural practices and the transformation of current agricultural land will be done in collaboration with the farmers. They will be empowered by a network with

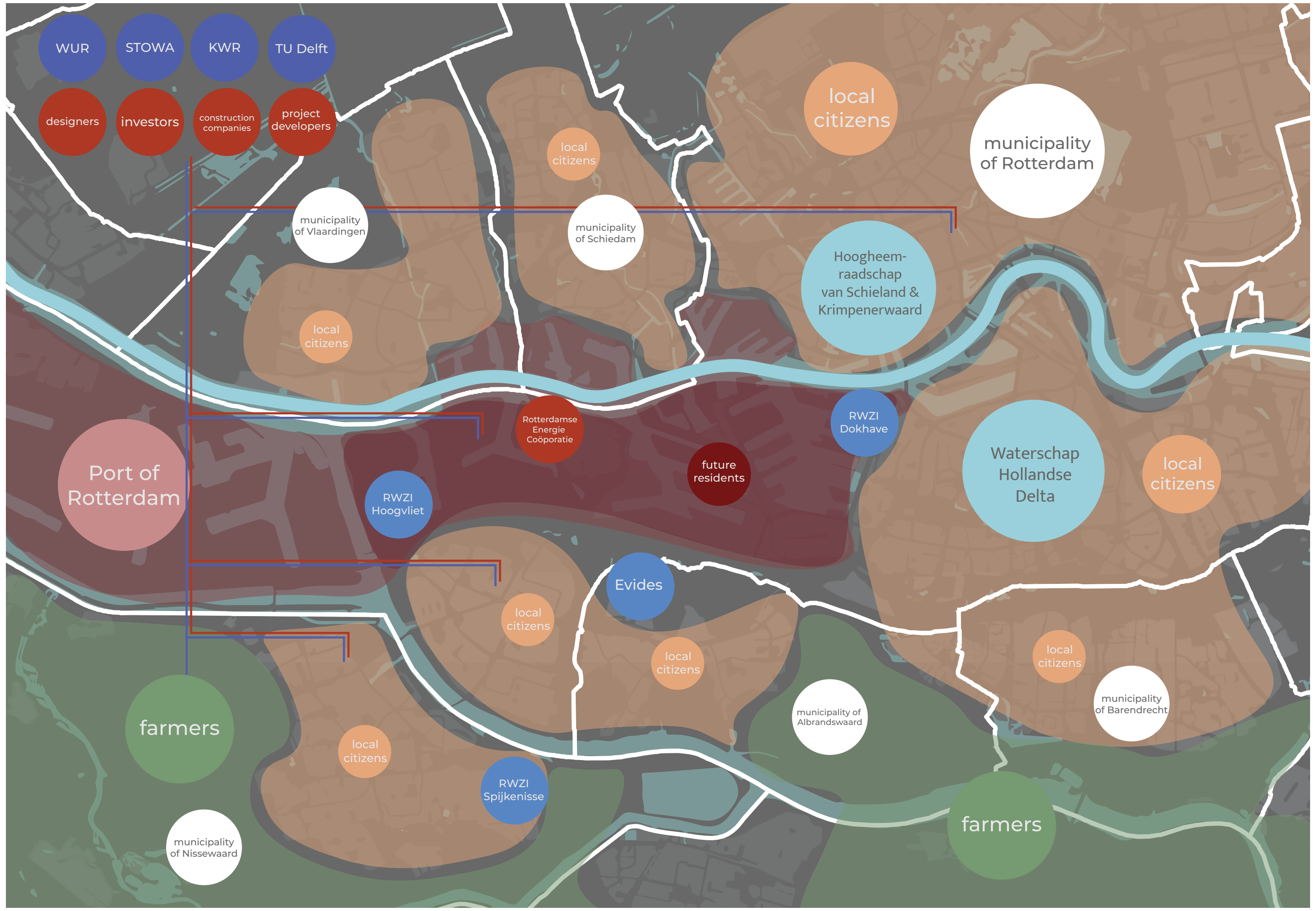


Figure 74: Stakeholder Map Urban Cluster

municipalities, developers and knowledge institutes in order to help them transition to urban farming and living or other new agricultural practices.

5.3 Strategic Projects

In this last chapter of the strategy, three smaller scale areas were selected, in which the key projects are going to be realized, Eemhaven Rotterdam, Binnenrotte Rotterdam and an agricultural area in Midden Delfland.

Each area has very different landscape characteristics and serves as a good example of how the strategies can be translated into concrete interventions and how these interventions can be then implemented in different places. Eemhaven shows the transformation of the industrial port into a residential area in relation to recreational, urban wetlands. Binnenrotte Rotterdam shows the implementation of the city as a living sponge and Midden Delfland shows the transformation of agricultural and horticultural activity in relation to the urban expansion and the wetland implementation.

Figure 75: Locations Strategic Projects

Eemhaven

Eemhaven is one of the port areas, in which by 2050, all industrial activity will be relocated to Maasvlakte. The unused area and empty industrial shells, present a chance for urban expansion within the city borders.

After the gradual relocation of containers and heavy industrial infrastructure, new residential houses, normal and floating, will be constructed in order to help answer the enormous housing demand of the area, together with the development of public spaces and buildings and different kinds of supportive amenities to create a fully functional, mixed – use neighbourhood. Vertical farming is also going to be integrated in the area, presenting new job opportunities and helping to 'bridge' the distance between production and consumption. The increased water demand that is caused by this urban expansion can be relieved by the implementation of a separated water system and water reuse system, together with green roofs, facades and the use of permeable materials.

A green recreational waterfront will also be implemented, softening the edges between water and the built environment and serving as a floodplain, which will decrease the risk of flooding. The construction of small scale urban wetlands across the area will help to 'buffer some of the run-off from precipitation and slow the rate at which it drains away' (Atelier GroenBlauw, n.d.), while at the same time improve the quality of surface water.

Across the port, where a lot of small suburban neighbourhoods are located, Rhoonse Grienden presents a great opportunity for a bigger scale pilot project of wetland implementation in the area, which will be suitable for

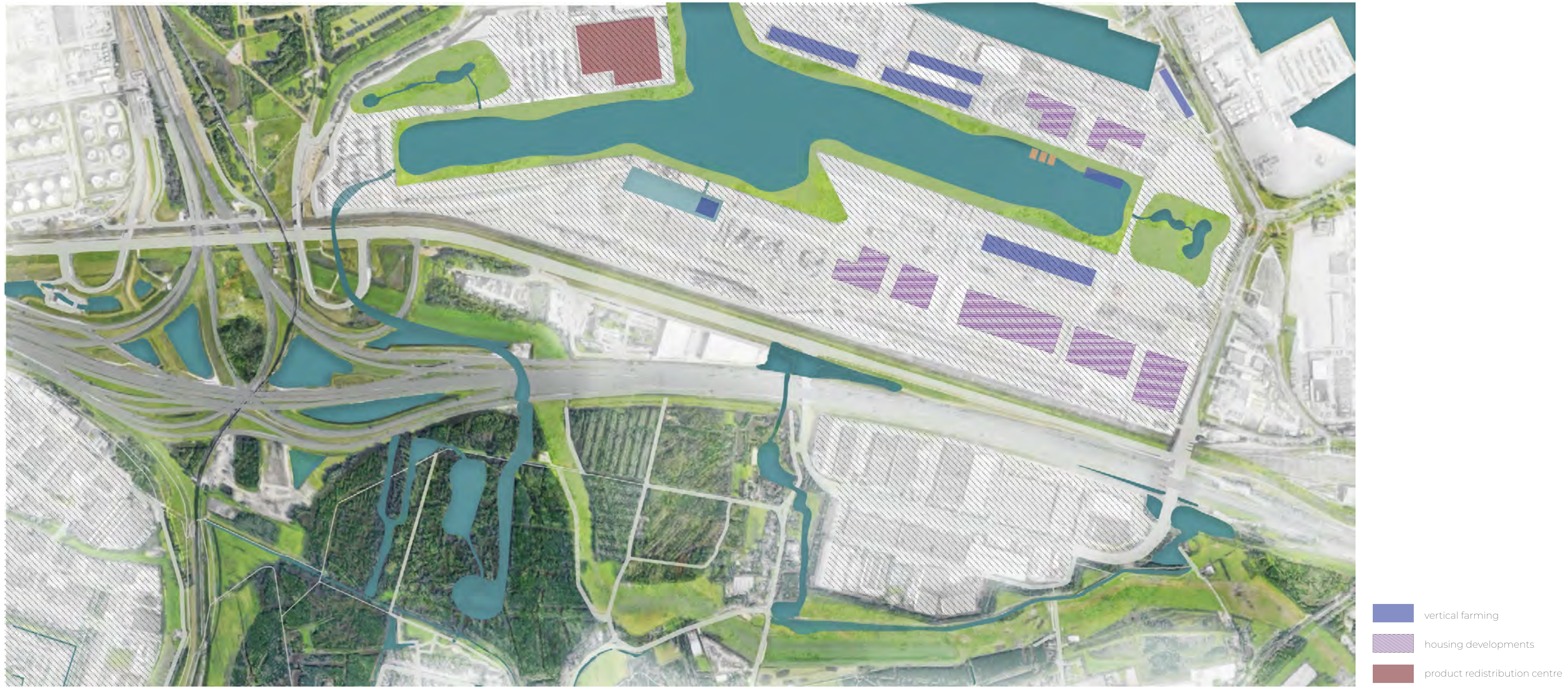


Figure 76: Map Eemhaven

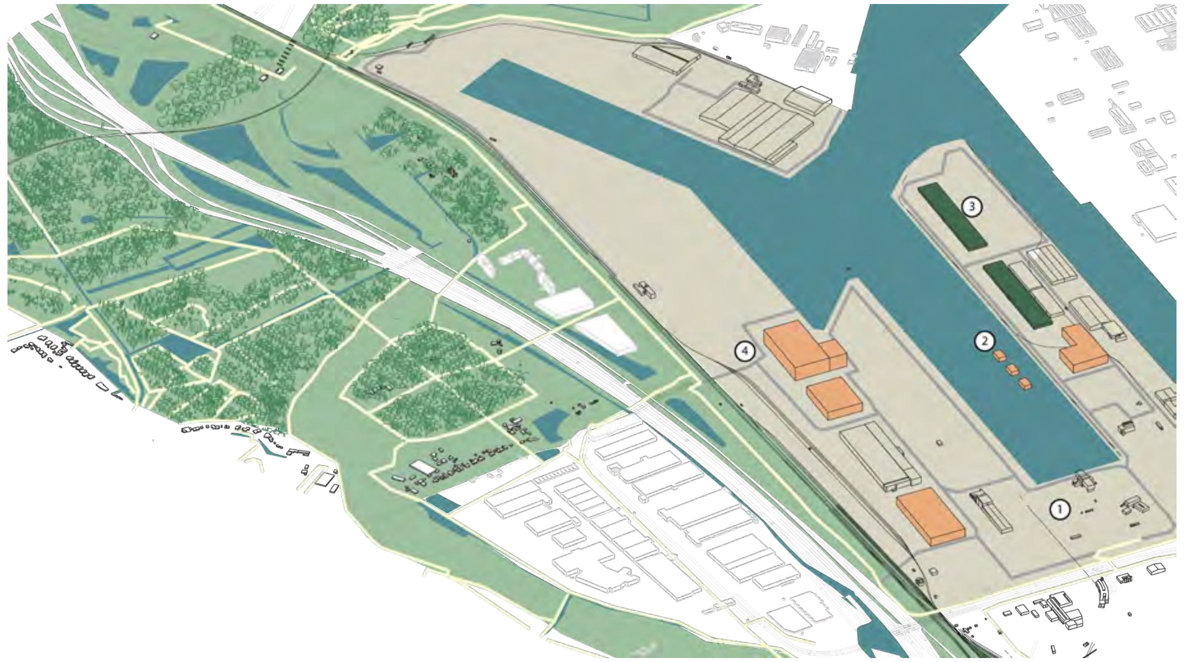


Figure 77: Phase 1 Eemhaven

1. relocation of industrial activity
2. first floating houses
3. small scale transformation of industrial buildings into vertical farming
4. small scale construction of residential buildings

Figure 78: Phase 2 Eemhaven

1. floating houses
2. expansion of residential buildings
3. small scale construction of public and mixed use buildings
4. expansion of vertical farming areas
5. implementation of a green recreational waterfront
6. expansion of waterfront recreational wetland parks
7. first public areas

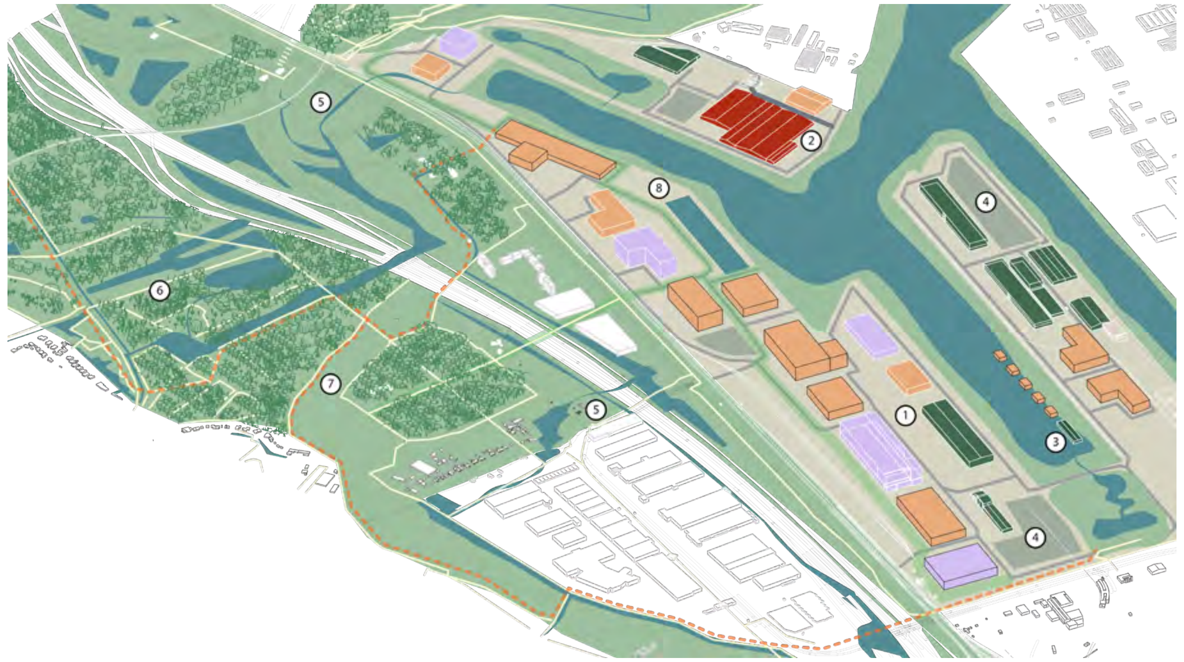


Figure 79: Phase 3 Eemhaven

1. full development of the new mixed use residential area
2. creation of a product distribution centre
3. implementation of floating farming expansion of vertical farming areas
4. public spaces
5. enlargement and connection of water streams
6. creation of the recreational wetland in Rhoonse Grienden
7. new walkways and bike paths
8. implementation of energy basins in the port

recreational purposes but also function as a source of fresh water supply, in order to contribute to water circularity. The already existing ponds could be shaped and connected with the various water streams, to create a network, capable of retaining excess water when needed, as shown in figures 77 - 79. These wetlands will increase biodiversity and restore the value of the land.

These two areas, the urbanised port and the suburban part, apart from the water and wetland links, will also be connected to each other by a new network of pedestrian paths and cycleways, constructed of permeable materials to allow water infiltration.

In the last phases of the creation of this new urban area, energy basins for renewable energy production and a product distribution centre for water – based transportation of materials, for recycling, redistribution, replacement, reuse and repurposing around the city and products from the new vertical farming centres, will be implemented to contribute to circular economy.

Figure 80: Impression Eemhaven

Figure 81: Waterflows Eemhaven

Binnenrotte

Binnenrotte is a neighbourhood, located in Rotterdam centre, a dense urban core. This area poses opportunities for densification, as well as the implementation of the sponge city principles.

Former office spaces of relocated companies will be transformed into social housing stock, flexible student housing or vertical farming centres, together with all other underused or unused buildings. Many areas are also suitable for 'skyborn', 'infill', 'transformation' and 'water' densification methods (Tillie N., et al, 2018). Green roofs and facades with solar panels are going to be implemented, to capture rainwater and use it as grey water inside the buildings, while at the same time also become energy autonomous. A separated water system, combined with water reuse systems and underground freshwater storage tanks, will relieve the increased water demand caused by this densification and contribute to the circularity of the water flows.

Permeable surfaces, which are a crucial part of the sponge city concept, where possible, increase water infiltration that can help to restore the soil, decreasing simultaneously the risk of flooding. Such surfaces, apart from the transformed pavements, are also the green corridors and the urban wetlands. The area gives opportunities for the implementation of a network of green – blue corridors, which can function as bioswales and store water in underground tanks. These corridors will be then connected, through surface or underground water streams, to larger green or open areas that can be turned into urban wetlands, which will not be used for purification, because of the odour, but for recreational and storage purposes. This green network

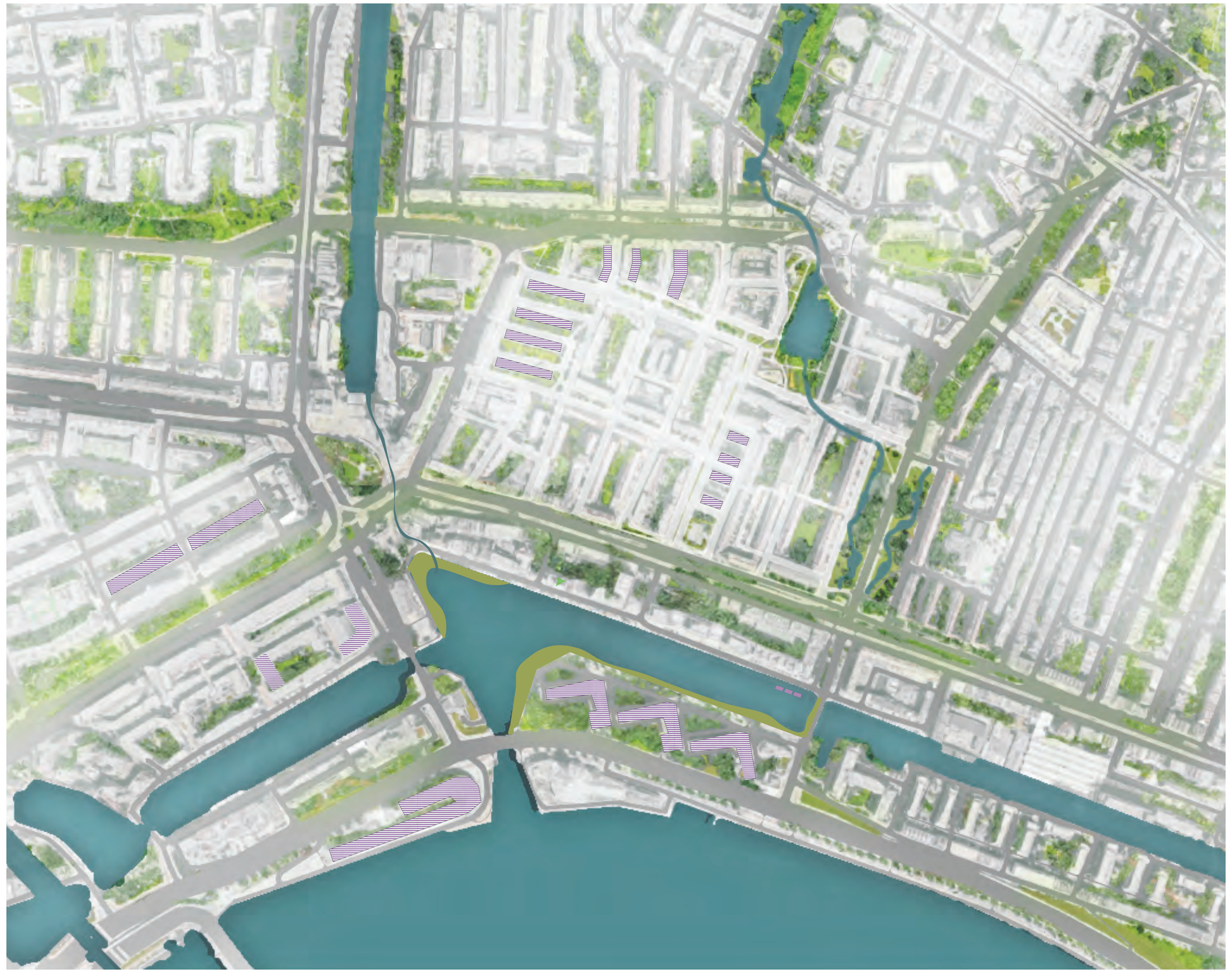


Figure 82: Map Binnenrotte

can ensure the enhancement of biodiversity in this and other similar densely built areas.

A recreational waterfront – floodplain area and a product distribution centre, for the transformation of products and materials, as described on the first key project of the Eemhaven area, will be implemented in this area as well.

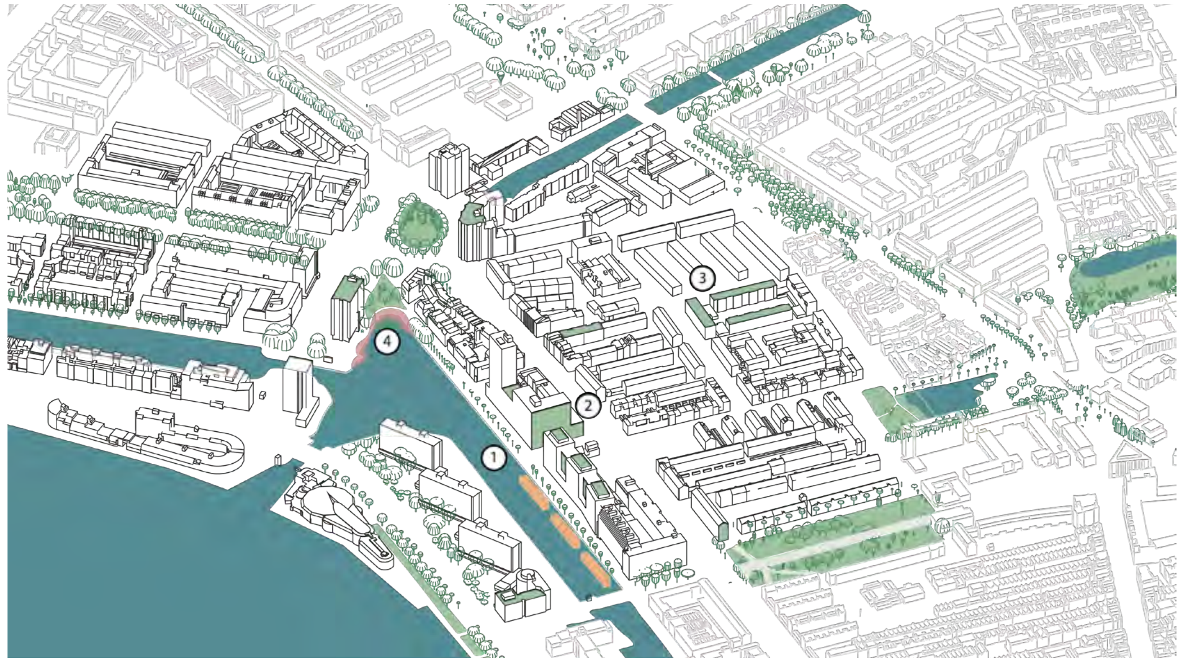


Figure 83: Phase 1 Binnenrotte

1. creation of floating houses
2. implementation of green facades
3. implementation of green roofs
4. creation of a recreational waterfrontv

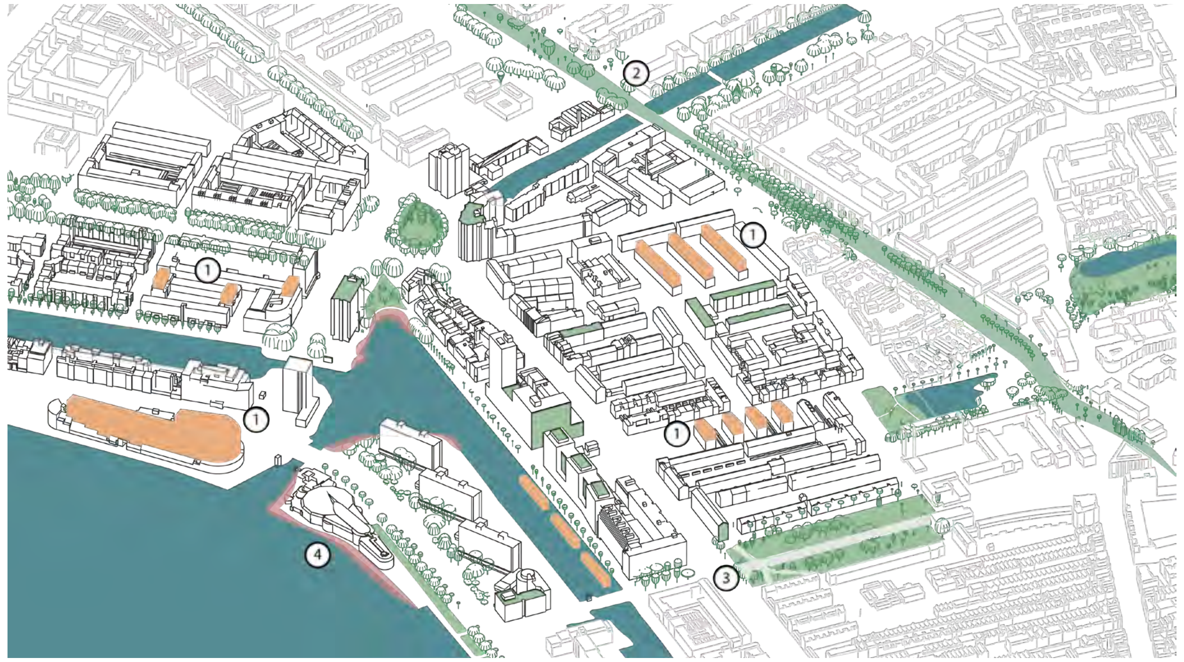


Figure 84: Phase 2 Binnenrotte

1. small scale densification and housing stock transformation
2. implementation of first green corridor
3. implementation of permeable pavements
4. expansion of the recreational waterfront

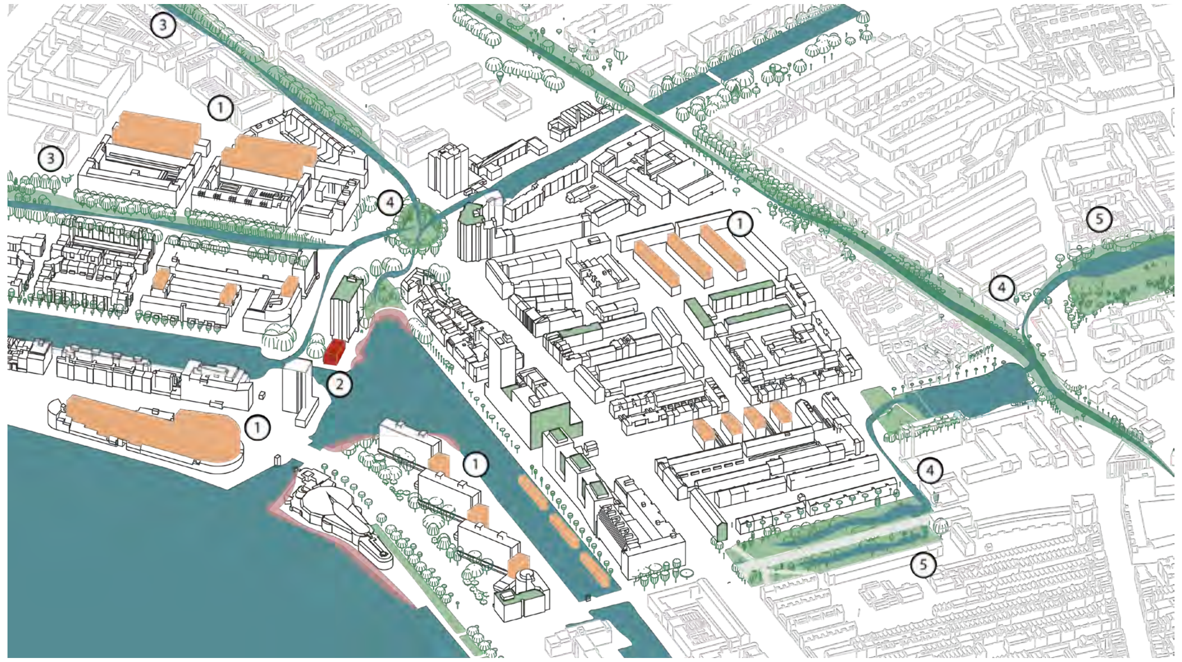


Figure 85: Phase 3 Binnenrotte

1. large scale densification
2. creation of a product distribution centre
3. implementation of green corridors - bioswales
4. connection of the water streams
5. creation of urban wetlands

Figure 86: Impression Binnenrotte

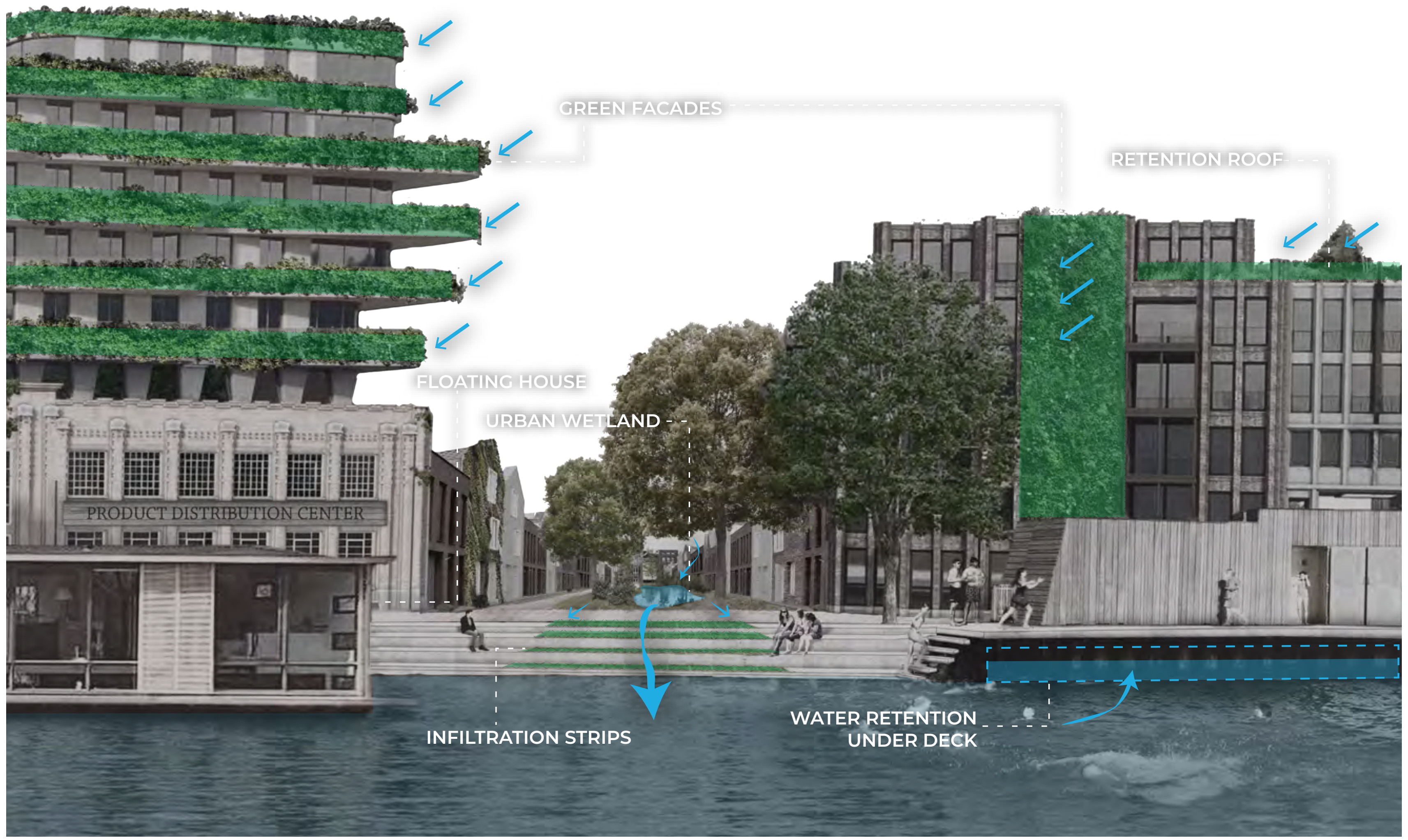


Figure 87: Waterflows Binnenrotte

Midden Delfland

The areas of Midden Delfland, are a characteristic example of the traditional Dutch landscape, combining agricultural land, horticulture and suburbanisation. All three different sectors consume a vast amount of drinking water, while also directly extracting groundwater, especially for agriculture. This increases the problem of soil subsidence and decreases the bearing capacity (Van den Akker et al., 2013), increasing in that way the flooding risk and thus making the traditional Dutch landscape vulnerable to extinction in the future. The nature – based transformation of these areas could be a more sustainable solution for their restoration. In order to recover the agricultural land, wetlands will be implemented.

This transformation of the agricultural land into a wetland area needs to be gradual and allow an appropriate period of adjustment. The farmers and horticulturists, through a number of incentives and proper training, will shift towards a more sustainable farming, by implementing water related technologies, such as the use of solar panels to cover water basins and produce energy, the integration of fish – farming tanks to greenhouses or the transformation of underused warehouses and greenhouses into vertical farming, within the area, to intensify the production and optimise the water flows, making water circularity possible.

With the help and guidance of the farmers that know their land better, the slopes of the new ponds will be realised and the dikes in very specific places will lower to allow water from the river to insert the area, while at the same time, the dike around the residential area of Schipluiden will be enforced, giving opportunities for further expansion and densification along this line. The farmers then can start implementing wet and damp crops in and around the

Figure 88: Map Midden Delfland

ponds, which in case of extreme downpours will retain the excess water there, preventing the rest of the area from flooding. The wetlands, which will later start expanding, will form a network, recovering and redefining the traditional swampy land of the Netherlands.

They will serve as a freshwater resource, but will also function as second – base natural purification systems, providing abundant water to the agricultural areas and thus decreasing the excess wastewater which is led to surface water, but also the need for groundwater extraction. Paths could also be created along this network, to give a recreational feeling to it.

Figure 89: Phase 1 Midden Delfland

1. densification of horticultural and agricultural production
2. energy basins
3. enforcement of the dike along the residential area

Figure 90: Phase 2 Midden Delfland

1. small scale urban expansion
2. shaping the slopes of the new ponds
3. lowering the dike to let water in the new wetland area
4. implementation of wet and damp crops
5. implementation of small scale wetlands

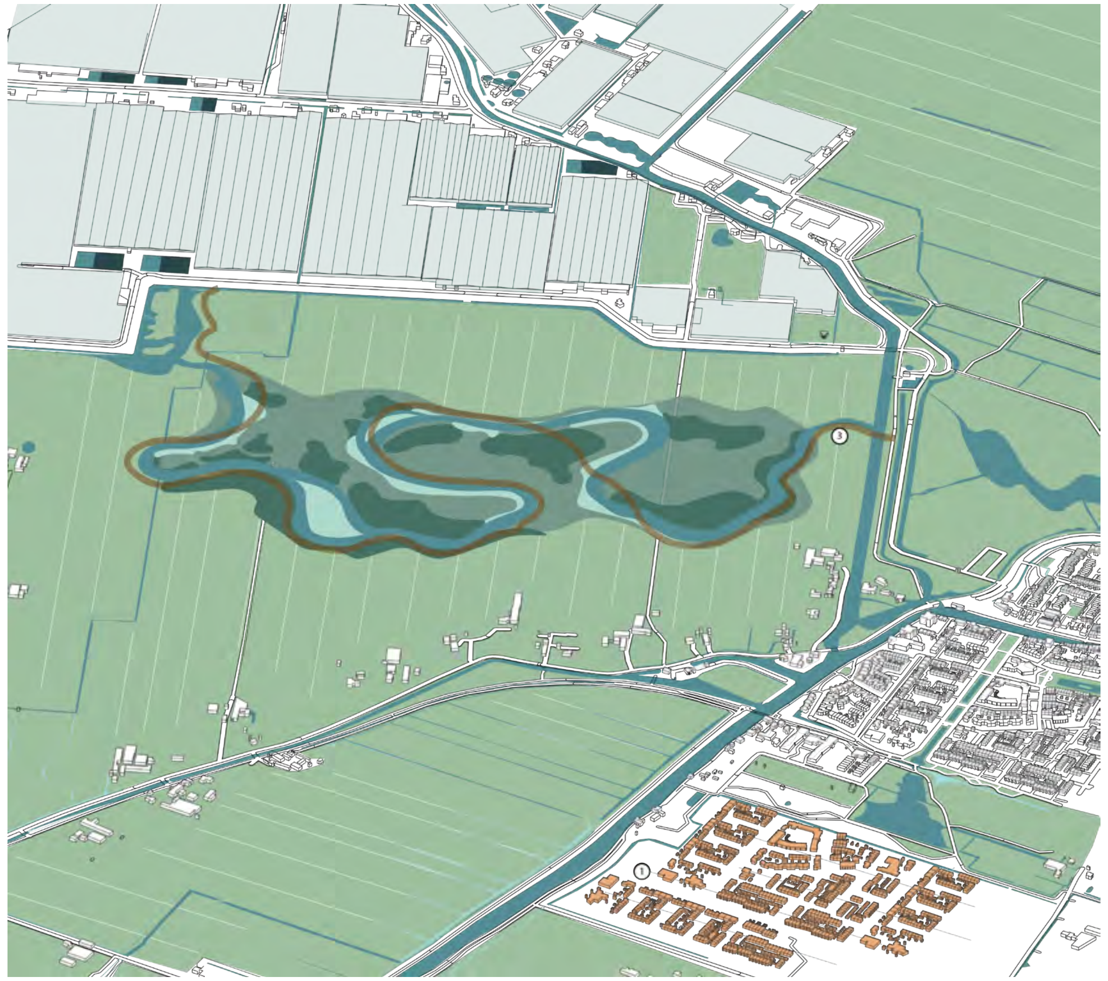


Figure 91: Phase 3 Midden Delfland

1. large scale urban expansion
2. creation of the wetlands
3. wooden path along the wetland

Figure 92: Impression Midden Delfland

Figure 93: Waterflows Midden Delfland

6 Conclusion

6 Conclusion

6.1 Conclusion

The Province of South-Holland aims for a circular economy by 2050. This project was executed with the key objective of finding a way how, in the process towards a circular South-Holland, the enormous demand of housing can be answered while at the same time preserving the characteristic delta structure. This asks for a restoration of the balance between the natural and the urban environment and an equal distribution of the risks and resources of water.

Three themes were identified as the main tools to create this balance. First, adaptive delta water management was identified as the key to preserve the delta landscape. Both urbanisation and climate change increase the current water related-risks and increase the pressure on water resources. In order to preserve the landscape, a resilient delta environment that can adapt to those challenges is crucial. Adaptive delta water management creates resilience by a continuous improvement of the water management through social learning.

Secondly, the implementation of sponge cities enables a way of urban expansion and densification that does not put a pressure on the ecological environment and that resists environmental threats. The use of permeable surfaces alleviates the soil and diminishes environmental threats. Resourcing water decreases the water demand and depletion of resources by urban areas.

Thirdly, the balance between the natural and the urban environment will be restored through circular water flows. Currently, the high water demand of urban areas pressures the natural resources. Water circularity is a tool to not only alleviate this pressure, but it allows to turn water-related threats into opportunities. The transition towards water circularity can be enhanced by the use of adaptive delta water management and sponge cities, in which the implementation of wetlands is found to be the key.

Thus, implementation of adaptive delta water management, sponge cities and water circularity can reinforce the balance between the natural and the urban environment. However, this does not avoid inequity on a more local scale, within the urban or natural environments. In this project therefore, securing the transition towards a circular delta environment to be just was integrated as a main objective. The integration of socio-environmental justice means that the risks and resources of water are not only equally distributed environmentally, but socially as well. In the context of this project, achieving socio-environmental justice also means urban liveability for all.

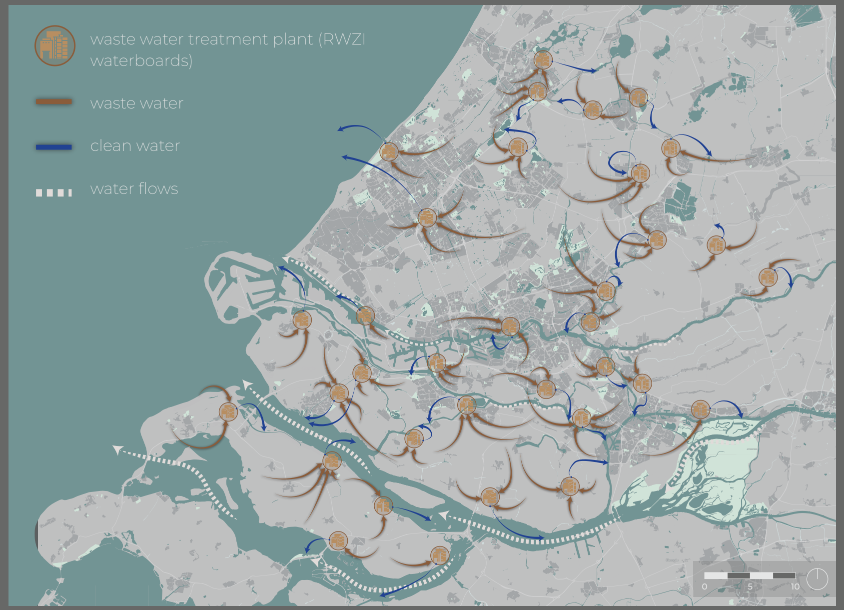


Figure 94: Wastewater Flows Before

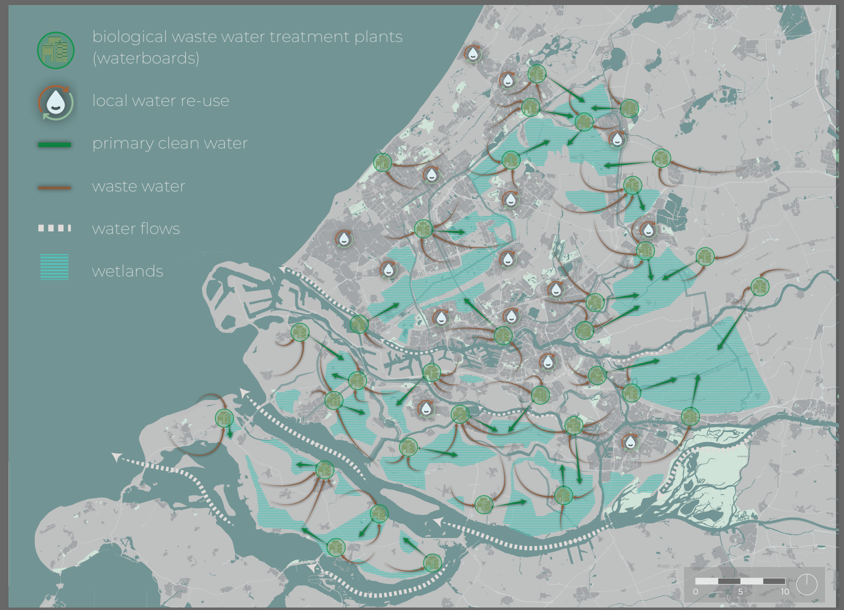


Figure 95: Wastewater Flows After

Figure 96: Drinking Water Flows Before

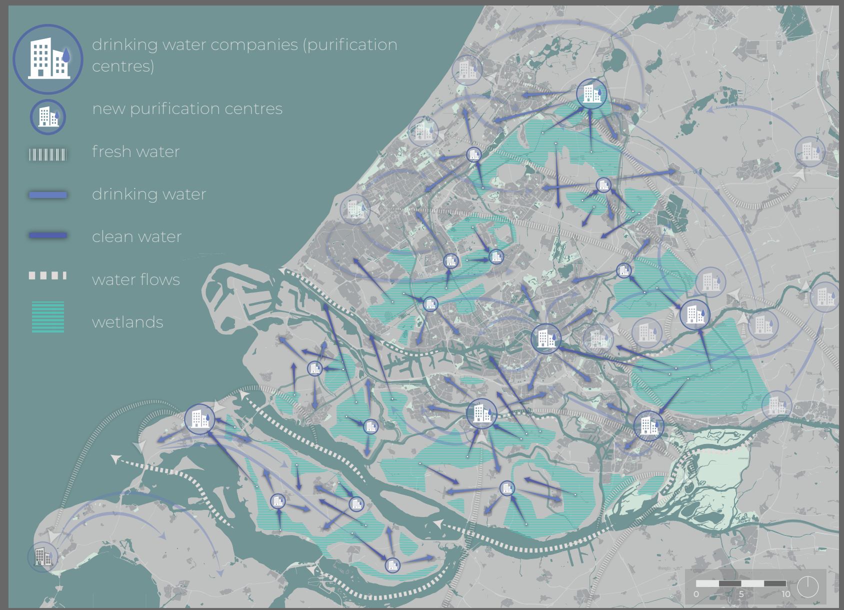


Figure 97: Drinking Water Flows After

6.2 Reflections & Discussions

In this project, societal value is strived for by integrating both sustainability and social justice within regional and urban planning. Scott Campbell (2013) stated that planners must recognise the tension that exists between those urgencies. In this project, planning for sustainability entails a climate-adaptive water management in the urban and ecological context as well as the strive towards circular water flows. Sustainability in this context can be defined as a balance between the urban and the natural. Social justice is integrated through participative planning methods that aim for an equal distribution of resources among society and by considering both water and housing as public goods to which all people should have equal access. However, both concepts, sustainability and social justice, are related to a different scale and to different levels of management. As already mentioned in chapter 2.2, this gap poses the risk that the integration of socio-environmental justice will fail (Sze et al., 2009). In this project, for example, integrating the sponge city concept in urban planning might lead to increased housing prices and the rise of gentrification. Besides, regional planning for urban expansion and the implementation of wetlands as a measure of water management puts the position of farmers at risk. In order to prevent this gap, multi-scalar participation in planning and water management is needed (Sze et al., 2009). Communicative planning is an approach to planning in which stakeholders are being involved for effectiveness and impact of planning policies. Based on this approach, the DIAD (Diversity, Interdependence and Authentic Dialogue) theory is used as a tool of effective stakeholder involvement (Machler & Milz, 2015). In this theory, diversity of interests, interdependence of interests and an authentic dialogue are identified as requirements for communicative planning. This involves the full inclusion of all stakeholders, the recognition of stakeholders that their interests are interdependent and the engagement in face-to-face conversations.

In this project, a participative approach of water management is introduced through the implementation of adaptive delta water management . Water boards are the most important players in striving for sustainable water management and will therefore be involved. However, finding ways to integrate exactly those local stakeholders that are subject to public planning and the actions of powerful players, such as farmers and local citizens, is crucial to create spatial justice. The way in which networks on urban planning and water management and the involvement of stakeholders in the development of policies are proposed in this strategy allow for fulfilling the requirements. However, it must be recognised that overruling of local stakeholders by powerful players is still a risk also within those networks. For the planning of the natural landscape, mutual recognition of interdependence by farmers and water boards might be facilitated through the proposed dialogues.

Besides recognising the tension between sustainability and spatial justice, the political imbalance between both must be confronted (Campbell, 2013). In the context of this project, this point of Campbell is highly relevant. This report has been written in the period around the Dutch national elections of 2021. The outcomes of these elections again limit the power left-wing parties that stand for social justice and increase the power of the parties that come up for middle-class citizens. Moreover, recently a scandal on surcharges showed how particularly the lower classes of society are most impacted by political failures and imperfections. Although political reforment is out of the scope of this project, recognising the political landscape is important and must be acknowledged.

This project was executed with the aim to add a positive environmental and social impact on society. The societal impact is mainly focused within the province of South-Holland. Implementation of this strategic vision will have social, environmental and economic impact. Environmental impact is created by an improved water and soil quality, enhanced biodiversity, a reduced pressure on environmental water resources and a shift towards biobased industries and renewable energy. Economic value is created by an increase in job opportunities in the building sector, an attractive business climate through revitalized cities and more people, a balanced housing market and due to circularity new economic opportunities arise and the economy will be resilient. Finally, social value is created as the risks of water are diminished and equally distributed, water safety is secured, (affordable) housing for all is created, recreational opportunities have increased, urban liveability is enhanced and socio-environmental justice is achieved. Some societal impact can also be contributed to a broader scope. Answering the demand for housing will also alleviate the overheated housing market in other parts of the country. By contributing to the SDGs, as highlighted in chapter 1.3, the project contributes to the global development. Especially, the shift towards biobased industries and the energy transition will be of large impact through the mitigation of climate change. Finally, as the port serves as a hydrogen hub and the Netherlands will be a global leader in the energy transition, other economies can profit from it.

This project was executed partly as a research project. The results of this project contribute to scientific knowledge on the implementation of CE. Fidélis et al. (2021) highlighted that in current CE action plans concerns related to water and land are often depreciated or neglected. The design of a new narrative on CE that incorporates water and land resources is needed to show the embeddedness of action plans related to CE (Fidélis et al., 2021). By doing exactly this, this project can help to overcome barriers for new water loops, create opportunities for a more eco-centric and inclusive approach to CE and to empower stakeholders.

Although this project was focused on the province of South-Holland, the results and designs can also be of use for a broader scope. The synergy between adaptive water management and sponge cities towards a reinforced and circular environment can be implemented in any context. The external validity is even higher for other delta environments as more specific interventions related to riversheds, such as urban water parks and living along the water, can also be used. The strategy is not as generalisable as the vision, because the policies and phasing of interventions are strongly connected to specific stakeholders. For example, the large role that is given to the water boards is specific to the context of the Dutch water management system. However, when a local stakeholder analysis is executed, also the strategy can be of interest for policy makers and regional governments.

Finally, some points of discussion on internal validity as well as recommendations for further analysis are to be made. This project was carried out by university students that have a background in Architecture and social science. The experience with regional and urban planning as well as specific technological knowledge on water & land management is therefore limited. External sources have been used to substantiate the planning of the region. Furthermore, this project was executed within a limited timespan. The depth of the analysis and design is therefore also limited. Therefore, a more specific analysis on how this strategic vision can be further aligned to the policies and visions that are currently in place can enhance the effectiveness of this project. Finally, the design of this strategic vision is still based on theoretical knowledge. A detailed and scientific evaluation of the implementation of this project, can facilitate an even more effective implementation of this vision when applied in another context.

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7 References

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Figure 96-97: Drinking Water Flows
https://thenounproject.com/
' Company' icon created by Alice Design
' Water' icon created by Jordan Alfarishy

8 Appendix

8 Appendix

Reflection

Dieuwertje Den Hartog 5409160

Working on this strategic vision towards a circular delta environment triggered me in multiple ways. As a social scientist, I am still a newbe to urban development and design. In this project I learned a lot from working together with four students with an architectural background. Whereas I am used to adopt an analytical and theoretical approach to research projects, I learned the value of looking to a spatial project through a visual window. I learned how visualisations can help to create spatial understanding and lead to persuasive and efficient communication. This change in mindset is something that I will take with me throughout my future career.

The course Spatial Strategies for a Global Metropolis, is an elective of my MSc program, Metropolitan Analysis, Design and Engineering. I started this master's program after the BSc Health & Society. During my bachelors I learned academic skills and gained understanding in societal issues related to health and liveability. By choosing this master, I aimed to put my analytical skills into practice in order to create a positive societal impact. I am driven to contribute to a more healthy and sustainable living environment within the discipline of urban development. It was exactly this drive that triggered my enthusiasm and motivation in this project. I liked to use my creativity in envisioning a transition in which economic, social and environmental is secured. I also liked to use and apply my academic skills to enhance and substantiate our strategic vision and strategy. The socio-spatial inequity related to health, that I learned about during my bachelors, motivated me to integrate socio-environmental justice.

The fact that this project was focused on the context of South-Holland triggered my motivation and enthusiasm even more. The project area, is the area in which was born and raised. Although currently not living in the area, this area still feels like home to me. The beautiful characteristics of the area, fulfil me with a certain proud. For example, I am proud of the economic and social value that is created within this area and the hard working mentality of the Rotterdam region. Therefore, ensuring the strong economic position of the region was something that stuck with me during the project. I feel like knowing the area and feeling emotionally connected to the area helped to actually know how to reinforce the characteristic strengths of the area, while also transitioning towards an entirely redefined environment.

Finally, the positive dynamics within our group enhanced the pleasure and motivation of working on this project. The current time in which this project was developed can be quite pressing due to the situation around COVID-19. The inability to meet in person to brainstorm posed a challenge. However, the supportive, motivated and complementary ambiance within the group helped us to make the most out of the situation and to be able to come to the final product as it is. I am more than satisfied with the strategic vision that we developed and I really hope that it can be of inspiration for the province of South-Holland in the shift towards a circular delta environment in which environmental, economic and social resilience will be achieved.

Reflection

Faidra Ntafou 5138299

"In time and with water, everything changes"
Leonardo da Vinci

The never ending demand for space, led, on the one hand, by the enormous increase of the population and on the other hand, by the equally rising demand for resources, was what prompted us to develop our strategic vision for the Province of South Holland. The built environment has dominated the natural and the traditional swampy landscapes of the area have given their place to artificial land over time, in order to ensure that the Netherlands are not going to lose valuable ground. And in this constant conflict between natural and man – made, water has always been the driving force, the main catalyst behind all changes, operating as a resource but also as a risk. Water is the backbone of the Delta environment and therefore also the backbone of our project.

With the concept of water, we addressed the need for a shift towards a circular economy, by first of all addressing the need for a circular water management. Making the water flows circular, reducing the length of the production, purification and distribution chains, and making local re – use of the it, were some of the goals we set in order to redefine the delta landscape and give it a new identity, based on the principle of restoring and expanding the wetlands to form a network throughout the region, so that it can become more resilient.

As an international student, coming from a neo – liberal country that never really engages in such kinds of visions and plans on a circular transition, in the beginning I struggled a lot to understand how all these principles could really be integrated in an urban or regional plan. However, the SDS and Capita Selecta lectures were pretty enlightening and these aspects were clarified, in addition to why regional planning is, or should be, of great importance if we want to achieve and ensure a better, circular future. The processes of the analysis and design became clearer in that way and made this whole 'journey' a bit less chaotic and stressful. The workshop on analyzing the water flows, given by Alex Wandl and the transition managers of PZH, for instance, really made us understand how to translate our research and analysis into something concrete and spatial, as, I personally for example, never had done a systemic section or a water flows map or diagram before.

With interventions at specific areas we aimed at showing the way of how our vision could be translated into a strategy. These interventions have a regional impact, because they work as activators or key projects, to demonstrate how the vision could be implemented. Because of the nature of the main elements of our proposal, such as the implementation of the wetlands and the sponge city concept, a great challenge was posed, on how to ensure socio – spatial justice. In this context, the SDS lectures about phasing and governance really helped us understand how crucial it is to engage both the powerful but most importantly the local stakeholders, in our case farmers and community members and ensure that they have a voice in the whole process.

That is why we tried to introduce a participatory approach in our strategic spatial planning, by forming networks, engaging them in dialogues, participatory planning workshops and feedback sessions in all steps of the process, as described in previous chapters. That doesn't mean however that there is no risk of overruling, or that despite our intentions, all these water related interventions will be affordable, or that we have thought about all possible challenges, obstacles, possibilities and effects of what we are proposing in our project. Given more time, a lot of things could have been thought of in more depth and could have been planned better. All in all, this quarter was really intriguing and inspiring, it pushed me out of my comfort zone and made me realise the importance of planning and designing in such intricate scales.

Reflection

Joell ten Hove 4430395

“The city is a means to a way of life. It can be a reflection of all our best selves. It can be whatever we want it to be. It can change, and change dramatically.” C. Montgomery, Happy City (2015, p. 6)

In designing a strategic vision, it is sometimes hard to envision all the possible proposed changes for yourself. I take my bike through the fields of Midden-Delfland, along the Nieuwe Waterweg and look at the skyline projected by the Port of Rotterdam, and think to myself: “Is it really possible? Is it realistic? And most of all, stating that it all is, in what position would I personally be in and how would the world be shaped around us?”

It is difficult to work together with a group of five people towards such a comprehensive and detailed project as this. It is important to manage your attention well. On the one hand, there are general group discussions where the main course of our strategic vision is discussed. And on the other hand, there is a certain individual aspect to the work when defining specific interventions and ideas. You’re not always on top of what exactly is going on at all fronts. That’s just a fact. A part of the teamwork, in such a research and design trajectory as has been initiated and followed through the past weeks, is about catching up. Especially in the last few weeks, for me personally this has been proven a difficulty.
Another difficulty in such extensive teamwork is losing your narrative. With individual separation on tasks, it can prove challenging to keep the core principles, which define the project and the narrative, in line with each other. Yet, I believe that even in the extensiveness of this report, these core principles are followed through and the narrative is safeguarded.

During this project we have been under the restrictions put on us due to the COVID-19 pandemic. An observant eye might have noticed that the pandemic is not mentioned anywhere through the report. This has been done deliberately because, for us, working on this project was a means of escaping the constant current of news on the lockdown situation regarding COVID-19 and focusing on a brighter future where this pandemic has long ceased to exist.

The past months we have been in lockdown and any form of physical meeting between group members and between the group and tutors have therefore also not been possible. Digital meeting as an only means in a design trajectory is very hard. A five-person team size is quite large for any equal and fair discussion to be held, where all parties involved have put their arguments forth. I think we did really well on this aspect. Within the group we have had very little true contradictions in our goals and concessions were easily met. An excellent team, where each member strengthens the whole and where we got to the final product in the form of this report on a strategic vision for the province of South-Holland together. Much thanks to my fellow group members and the tutors helping us achieve this vision.
On a final note. An interesting side effect of working on this report for the past several weeks can be found in my political preference. Near the final weeks of the project, the Dutch national elections of 2021 were held. Due to in-depth research and gaining knowledge on the importance of circularity and the devastating prospects of climate change if we do not take action now, my personal vote for the elections has translated far more left, voting in favor of drastic action towards tackling climate change.

Montgomery, C. (2015). Happy City: Transforming Our Lives Through Urban Design. PENGUIN UK.

Reflection

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“God created the world but the Dutch created The Netherlands”

This old Dutch saying is very relevant when looking at the strategy “Towards a Circular Delta Environment”. For centuries the Dutch have worked against and with the water and they are worldwide known as water management experts. This is ironic when looking at the analysis of this report which shows that nowadays there are still most certainly water related risks and problems. In order to create a circular Delta environment which enforces their strengths and is climate adaptive while both answering the demand for space and achieving social spatial justice (see 1.3 Goals) requires a, as the Dutch say, watertight strategy.

I feel like we as a group have done a good job in achieving such a strategy, although it might not be 100% watertight. Of course there is limited time in which we had to come to a complete strategy which makes it crucial to set clear boundaries and prioritize. This is something we could have done better because we tended to include many aspects in our strategy: The Port, Greenport, Agri-culture, Sponge Cities, expanding, densifying and all aspects related to water circularity. Of course this is easy to say afterwards, but if we would have prioritized better and defined our goals more clearly we could have gone into more depth on specific topics.

Regional research and design focuses on a scale that I had not worked on before. It required some effort to get a good grip on the assignment and scale, but after I did, I enjoyed it a lot. The multidisciplinary process was very interesting and it was challenging to integrate all the interests of the different stakeholders. In my opinion, working with the stakeholders and solving conflicts is a very important aspect of regional planning and we could have gone into more depth on this.

The dynamic in the group was good which made me feel comfortable and confident enough to give my input and be critical on the project. However, sometimes we did not discuss every aspect well enough in my opinion, but this was due to the online communication. Discussing and brainstorming online requires a lot of energy and patience which caused me sometimes not to say what I thought because it was difficult to intervene. Nevertheless I enjoyed working with this group a lot, and I am sure that if we were able to meet on campus that we would have had an even better time together.

Overall I am very satisfied with the process and result of this project. These courses really contribute to my knowledge and skills as an urban designer. Besides this, I feel like our strategy contributes to the process of creating a circular Delta environment in the province of South Holland.

Reflection

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The Spatial Strategies for a Global Metropolis course has exceeded my expectations in all senses. It has been more insightful and gainful as I could have expected, yet even more challenging. I have aspired to become an urban planner during the entire course of my bachelors in architecture, however I opted for the masters in Metropolitan Analysis, Design & Engineering as it offered an innovative perspective and would open my path to new possibilities. Therefore, it has been an incredible opportunity to take Spatial Strategies as my elective course. During the 8 weeks I have learned about the different complexities involved in regional and spatial planning.

The course focus is in the plans for Circular South Holland, which is extremely exciting as it addresses the concept of circular economy which Dutch planners are in the lead. In Helmut Thole's lecture about South Holland I gained insight on the multilevel approach to solving the regional problems in the province and the aim to become a network metropolitan-region. I learnt that the Province is now at a stage of building a link between the already made initiatives to achieve Sustainable Development and the ambitious goals of the Paris Climate Agreement. A memorable insight has also been in Jeroen van Schaick's lecture when he described the roles of regional design as a practice to connect and identify, then structure and signalize to eventually envision and put on the agenda. This made me approach regional planning as a process of: (i) envisioning the desirable scenario; (ii) studying the probable outcome through scientific predictions and; (iii) planning for achieving the possible and best case scenario considering the economic, social and ecological constraints. I believe we have successfully achieved this course of action in our report "Towards a Circular Delta Environment".
Since the very first stage of our project, our group was refraining from focusing on simply one aspect of the circular transition, as we were interested in the relationship between the high level of demand for space and the environmental risks due to urban densification. As we were heading towards the theme of construction and demolition, we had an insightful studio meeting where we decided to focus our project on an element that integrated the different aspects of a circular transition; water. In my opinion, this was a bold decision that opened multiple opportunities, however it also increased the level of complexity as water management is one of the most challenging agendas for sustainable development.

I am very satisfied with our final vision and strategy for a circular delta environment. Eventhough our proposal of allowing water to flow in-land, forming natural wetlands, is disruptive I believe the timeline provides a realistic scheme on how to achieve this transition towards water circularity in South Holland. I would have liked to have a longer period to explore the different opportunities of water circularity, especially water-based transportation for the redistribution of materials on a local and regional scale and also the water flows in the chemical industry.

Overall this has been an enriching opportunity in which I have gained knowledge and experience in developing a transitional strategy for regional planning, considering stakeholder engagement and social environmental justice.