RETHINKING PARKS IN A SHRINKING SETTING

The Marrying of Social Restoration and Nitrate Remediation for a New Urban Park Model in Parkstad Limburg

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ABSTRACT

The project is situated in Parkstad, South Limburg, an administrative region consisting of 7 municipalities, formerly known as the East Mining Region. Deindustrialisation completely transformed the region, making it the first shrinking area of the Netherlands. Shrinkage commonly refers to shrinking economy, population and increased urban vacancy. Deindustrialisation also caused serious aftermaths in terms of social problems. Many new urban park projects have started to replace vacant housings, these new parks also become ways to combat urban decay, unhappiness and crime rates. This huge need for parks is however seemingly difficult in a city that is already facing economic shrinkage. In the short run (or long run) where no new investment or residents can be expected in a shrinking area; parks rely only on government funding.

On the other hand, Parkstad faces an upcoming environmental threat of groundwater nitrate contamination which would again, lead to further financial burden for the government or for local residents. Nitrate problem is a result of both an intensified agricultural practice and Parkstad's signature soil type - Loess.

The project questions the meaning, role and value of park in Parkstad'. It addresses the two key pressing needs of Parkstad -- social restoration and groundwater nitrate remediation and argues that park can be used as a mean to tackle both of these problems. The chosen site is located in Heerlen, the capital municipality of Parkstad, the most urban, with most social problems, and one of the poorest of them all,

The proposed Azolla City park promotes the use of Azolla, an edible nitrate-fixating water-fern, and demonstrates a more self-sustaining financial model through co-ownership, azolla farming and a synegetic relationship between community and nitrate-remediation in the form of an urban park. It celebrates both the instrumental and functional values of a park and explores how these collaborations can be translated into different spatial experiences and temporality.

TABLE OF CONTENT

0. Abstract

01. Introduction

1.1 Introduction

1.1.1. It all begins at park Heilust field visit
1.1.2 Context of Parkstad

1.2 Problem Statement

1.2.1 Shrinking City - Context Problem
1.2.2 Post-mining Social Problems
1.2.3 Nitrate Contamination in Groundwater
1.2.4 'Parks' Underdefined and Underutilised
1.2.5 One-Liner Problem Statement

1.3 Position & Concept

1.3.1 Theoretic Framework
1.3.2 Project Vision
1.3.3 Research Question
1.3.4 Research Objective

1.4 Scope & Definition

1.4.1 Urban Park
1.4.2 Social Problem & Social Restoration
1.4.3 Nitrate Remediation

02. Methodology

2.1 Research + Design Method Structure
2.2 Research Framework
2.3 Research Approach & Method

03. Research Findings and Design Principles

3.1 Design Aim

3.2 Site Selection With The Layered Approach

3.2.1 Broad site analysis with the layered approach
3.2.2 The Social and Urban Layers
3.2.3 The Landscape Layers
3.2.4 Parkscape Mapping

3.3 Design Site

3.3.1 Site Study
3.3.2 Scale Comparison
3.3.3 Strategic Site Location

3.4 Expanding the Meaning of 'Park'

3.4.1 History and Park Theories
3.4.2 Park Value
3.4.3 The Proposed Meanings

3.5 Diluting Groundwater Nitrate

3.5.1 Denitrification in Landscape Approach
3.5.2 Azolla the Magical Plant
3.5.3 Pump & Treat
3.5.4 Pond Size
3.5.5 Azolla Harvest Cycle
3.5.6 Proposed Water System
3.5.7 Water Features

3.6 Strengthening Social Cohesion

3.6.1 Social Problems to Tackle
3.6.2 Identity, Employment, Empowerment
3.6.3. Principles for Socially Sustainable Community
3.6.4 Participation and Empowerment
3.6.5 Principles for Mental Wellbeing & Environmental Psychology
3.6.6 Proposed Principles Model
3.6.7
Visibility, Sense of Security & Spatial Preference

3.7 Activating An New Financial Model

3.7.1 Co-funding
3.7.2 An Azolla Park Corporate
3.7.3 Research Institutions & Start-ups
3.7.4 Funding from Water-Related Company
3.7.5 Azolla Products and Quantity

04.Results/Design

4.1 Regional Scheme

4.2 Design Concept

4.3 Azolla City Park - Masterplan
4.3.1 Water System
4.3.2 Azolla Industry Cycle
4.3.3 Masterplan Zoning
4.3.4 Azolla City Park - Azolla Industry Vision
4.3.5 Azolla City Park - Public Involvement and Participationary Roles

4.4 Site Design
4.4.1 Azolla City Park - Plan Drawing
4.4.2 Surrounding Context / Landmark & Proposed Park Zones
4.4.3 Design Analysis
4.4.4 User Analysis
4.4.5 Scots Pine as Symbols
4.4.6 Nitrogen-fixating Tree - Alnus
4.4.7 Plant Palette
4.4.7 Plant Palette
4.4.8 Water Elements
4.4.9 Small Water Elements

4.5 Spatial Experience - Two Example Routes
4.5.1 Example Route 1: City-user Water Walk Route
4.5.2 Example Route 2: Local Resident Route

4.6 Detail Design
4.6.1 Market Square
4.6.2 Interactive/ Educational Feature in Market Square
4.6.3 Nitrogen Cycle & Microecosystem
4.6.4 Temporal Change - Growth

4.7 Small Feature Design - Microcirculation Feature
4.7.1 Technical Feature

05.Conclusion & Reflection

References

01

INTRODUCTION



Park Heilust
kerkrade, parkstad, South Limburg

On-going project since 2015.
Designed by Buro Lubbers

fig 1. Park Heilust. Photo by author

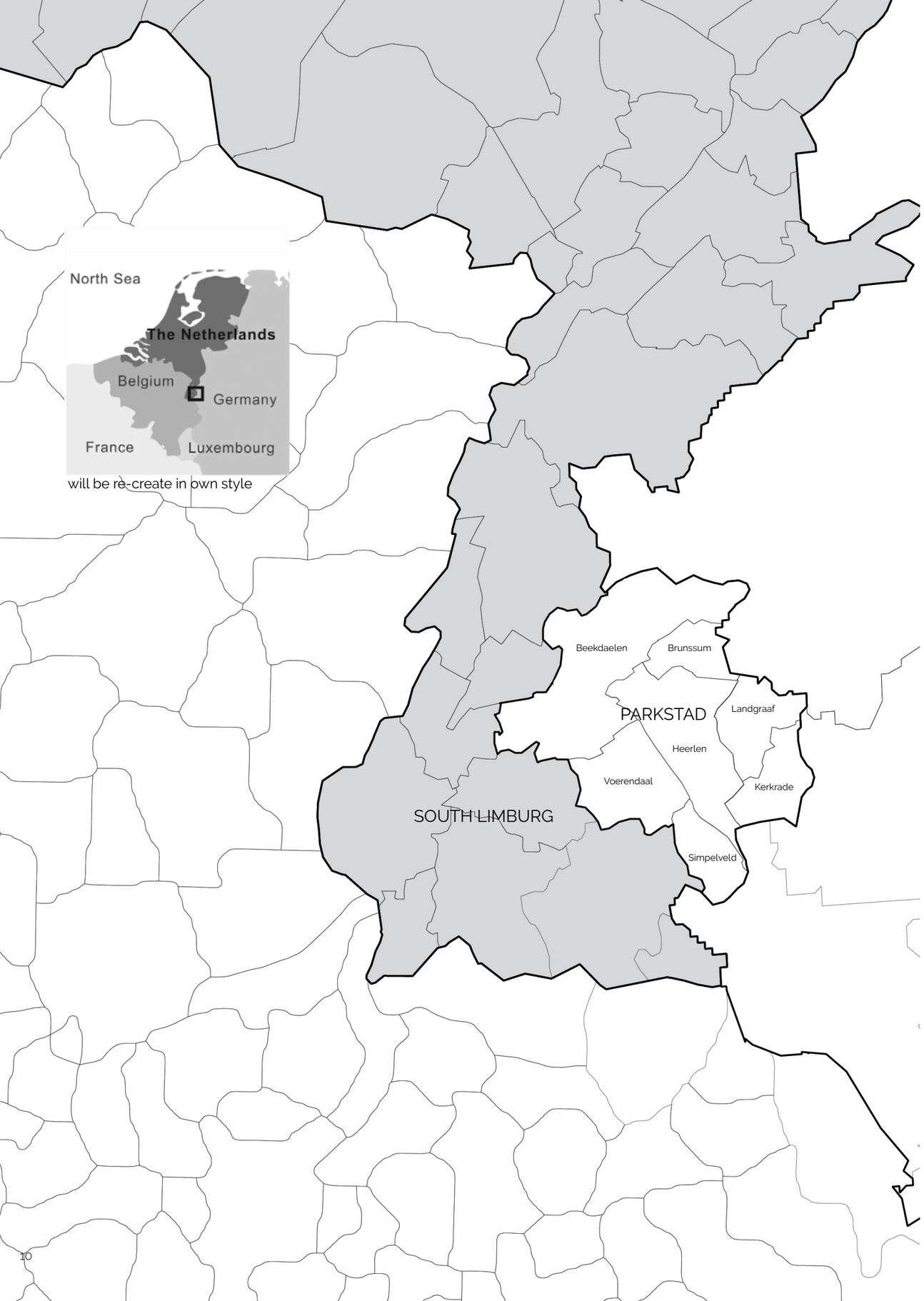
1.1 INTRODUCTION

1.1.1. IT ALL BEGINS AT PARK HEILUST FIELD VISIT

The vision started during our site visit – my heart was touched and filled with mixed feelings when the Parkstad officials brought us to a new neighbourhood park (Park Heilust, Kerkrade) situated on the ground of vacant housing demolition. According to Geert Lamers from the Parkstad department, starting from 2011 over 500 houses, amongst them 2 highrises, were demolished in Heilust. The park was built with an aim to improve the social condition of a deteriorating neighbourhood and they did succeed in doing so. So successful that 'Living in Heilust becomes a real pleasure again' (title of documentary series on Heilust's transformation, episode 1). Lamers and his colleagues went on telling us their negotiation process with the municipality government, with the bank and with other sectors. As I listened, I looked at this park and was genuinely touched; yet also somewhat saddened by the fact that they were willing to go this far for making this park happen even though the project was considered a 'negative investment', at least financially – public space projects like this park can be such a game-changer for the wellbeing of the people and for the community, it transforms a decaying outlook (psychologically unpleasing and crime inducing) into an enjoyable urban environment, it provides a platform and programmes for renewed social life, gardens and greenery for mental restoration. However, in such a shrinking area where no/ less new residents or investment could be expected, especially in the short run, are (nicely designed) parks a luxury to have?

'A successful transformation, experts now say. "As good as it is in Heilust, you don't see it anywhere in Parkstad and perhaps not in the whole of the Netherlands. Heilust has changed enormously. In a positive sense,"

says sociologist Maurice Hermans of the Neimed knowledge institute in Heerlen



1.1.2 CONTEXT OF PARKSTAD

Located in South Limburg of the Netherlands, Parkstad, formerly known as the Eastern Mining District, is an administrative region consisting of 7 municipalities (Beekdaelen, Brunssum, Heerlen, Kerkrade, Landgraaf, Simpelveld and Voerendaal).



fig 2. Parkstad Limburg . https://www.citizensrail.org/parkstad-limburg/. photograph.

Geomorphology

The geomorphological characteristic of the site is its topographic changes, formed by slopes, plateaus and valleys; It is also one of the areas with the highest elevation in the Netherlands. The dominant soil type in Parkstad is loess. During the last period of the last Ice Age (Weichselien), the loess particles were blown out of the North Sea basin and settled in South Limburg where vegetation was denser -- this caused the wind to lose strength and small particles were deposited (Kokshoorn). This type of soil is very fertile -- before the mining era Parkstad was dominant by agricultural activities.

Black to Green Morphological Transformation

The area was mainly agricultural thanks to its fertile soil, until the discovery of coal which drastically transformed the region. During the period of 1880 to 1970 mining industry transformed these cities. Not only had they filled the region with mines and industral sites, mining colonies (housing and community for workers) were also built and the urban areas expanded enormously. Inspired by the garden city movement at that time, neighbourhoods were surrounded by green, for mental restoration and food production. Initially these neighbourhoods were meant to be ‘small scale’, so to prevent large concentration of workers and the possibility of strikes. The current morphology of Parkstad’s urbanisation was shaped.

After the closure of mines in the 1970s, the area experienced yet another major transformation. The program ‘From black to green’ was launched, almost all traces of the mining past After the closure of mines in the 1970s, the area experienced yet another major transformation. The

program ‘From black to green’ was launched, almost all traces of the mining past were demolished, replaced with new developments or with greenery. In 1999, the collaboration of ‘Parkstad’ began, further pushing the region to a ‘city of parks’ development position. Today the basic morphological structure of Parkstad consists of densely urban/ suburban areas (Brunssum, Heerlen, Kerkrade, Landgraaf), surrounded by large piece of rural agricultural landscape (Beekdaelen Simpelveld, Voerendaal).

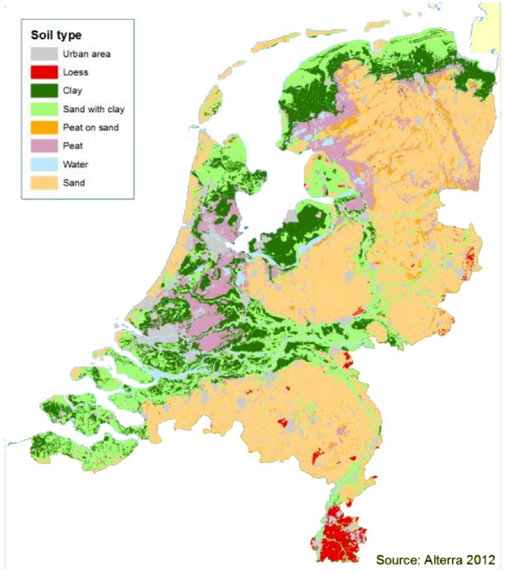


fig 3. Generalized Soil Map . Source: Alterra 2012

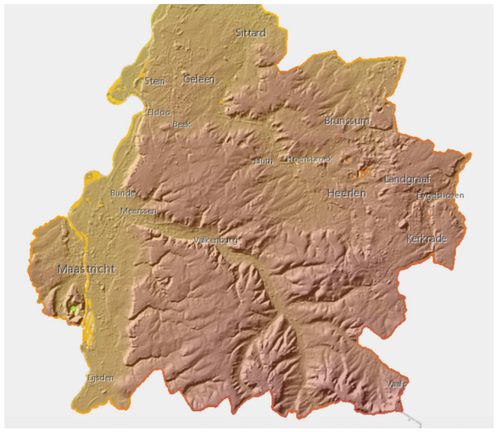


fig 4. Zoom In Elevation of South Limburg . Source: Ahn-viewer

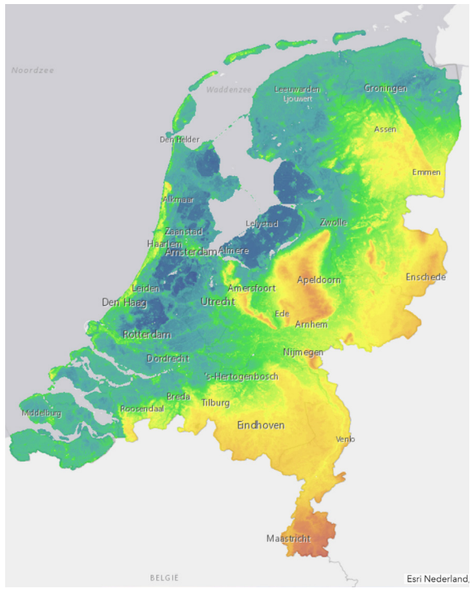


fig 5. Elevation of Netherlands . Source: Ahn-viewer



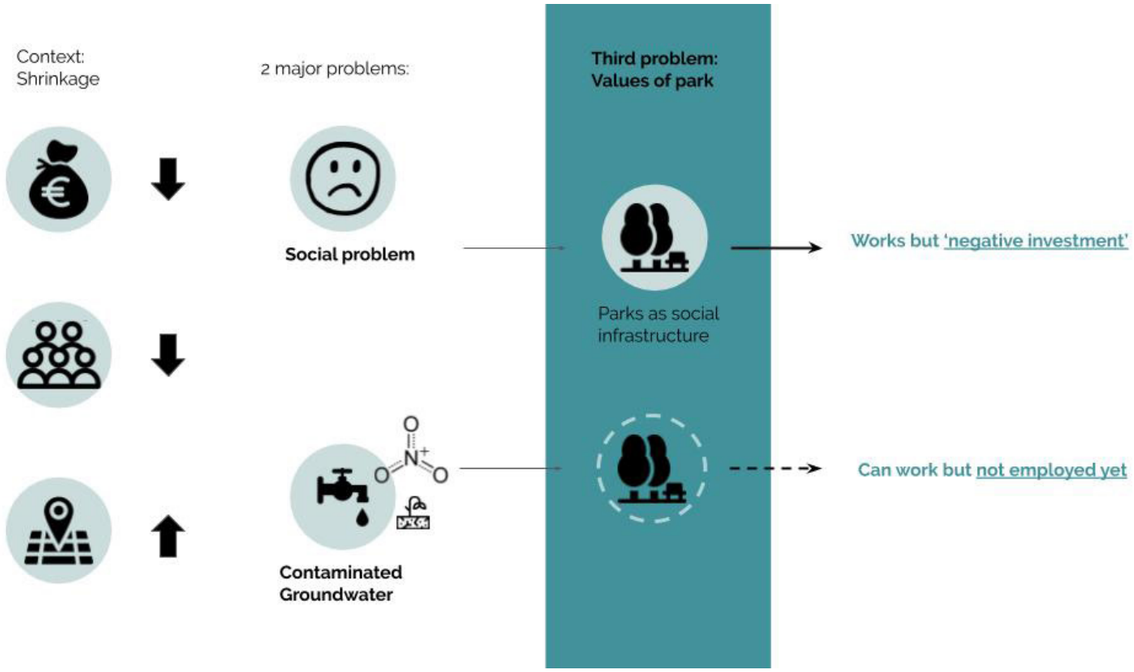
fig 6. Sarole Street with Heerlen landmark Lange Jan and Lange Lies (once tallest chimneys in the world) in the background . Source: Alterra 2012



fig 7. Demolition of the Lange Jan . Source: Bremen, M. (1976). Demolition of the Lange Jan. photograph, Heerlen; SERC. http://fotos.serc.nl/limburg/heerlen/heerlen-51958/.

1.2

PROBLEM STATEMENT



1.2.1 Shrinking City - Context Problem

Deindustrialisation descended Parkstad from being one of the richest regions to the poorest – the dominant industry vanished. Today Parkstad is one of the most representative cases of urban shrinkage (and with Heerlen being the most studied). It is among the first three regions of the country, together with Eemsdelta and Zeeuws-Vlaanderen to experience shrinkage. Parkstad has the largest number decline in population (by 39,000 ,-16%), household numbers (by 14,000, -12%) and potential labour force 48,000 (-31%) (PBL 2010). What these mean for Parkstad is population decline, demographic dependency, decaying city outlook, weakened economy, lessened investment, unemployment, decreasing property value, vacant buildings and vacant shops. To manage its urban shrinkage, 7500 houses needed to be removed to balance the housing market; most areas in Parkstad will also need to be diluted in the long term transformation plan.

1.2.2 Post-minung Social-cultural Aftermaths

The demographic-economic sector is not the only area that suffers from Parkstad's deindustrialisation. The social sector has been deeply impacted yet received less attention than the economy had (Kasper, 2012).

First of all, during the prosperous days of Parkstad, neighbourhoods were laid out by the mining companies at the beginning and later by religious/public authorities, leisure activities, social lives and social roles were also organised by both the catholic church and the mining industries – many believe that these are the causes that shaped the low-initiatives mentality (Ročak et al., 2016). Secondly, the disappearance of the once thriving mining industry signifies a loss of city identity, the devaluing of people's skillsets and experience causes lowered self-esteem. The decaying city outlook is also often linked with lowered self-esteem and perception of insecurity in many urban shrinkage studies. Unemployment and crime rates also impacted the perception of safety, leading to a lack of trust, and therefore,

also social involvement and cohesion. Recently there are more attempts in improving the social-cultural condition of Parkstad, together with the 'black to green' approach, many new public parks initiatives in the urban areas have started in hope of an improved urban outlook and a more encouraging environment for facilitating social cohesion.

Social Problems

'Social' has always been an ambiguous term, this project will be based on the definition of 'social problem' provided in Social problems: continuity and change published by University of Minnesota Libraries Publishing

"A social problem is any condition or behaviour that has negative consequences for large numbers of people and that is generally recognized as a condition or behaviour that needs to be addressed. This definition has both an objective component and a subjective component."

(2015, para 1)

In this sense, some significant social problems of Parkstad are, to name but a few

- lost and lack of collective identity
- unemployment
- feel low in control/ low self-esteem
- mental wellbeing (loneliness and unsatisfaction with environment)
- low social participation and cohesion

Loss of Identity



fig 8. 'De moord op De Lange Jan 15 08 1976'.
Source: http://parkstadtweets.blogspot.com/2015/03/de-lange-jan-en-de-lange-lies.html

Unemployment

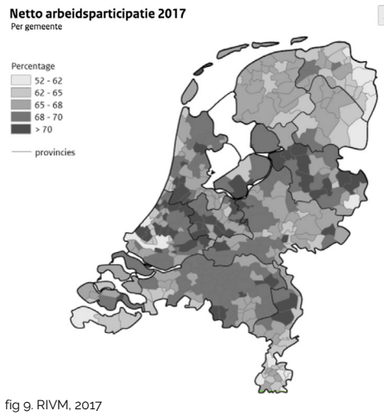


fig 9. RIVM, 2017

Loneliness/ mental wellbeing

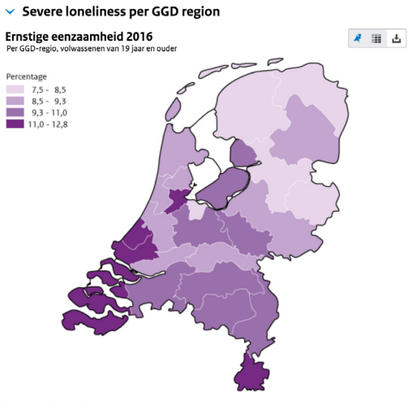


fig 10. CBS & RIVM, 2016

Mental Wellbeing

Severe loneliness indicates that social ties are loose. It also means that people are more likely to be discontent or unhappy.

Low in Social Trust

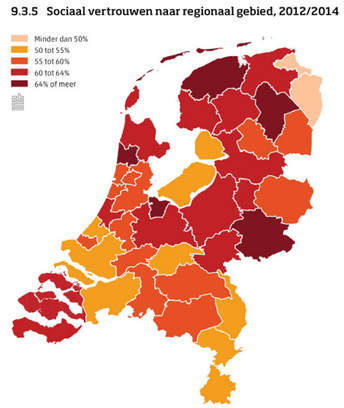
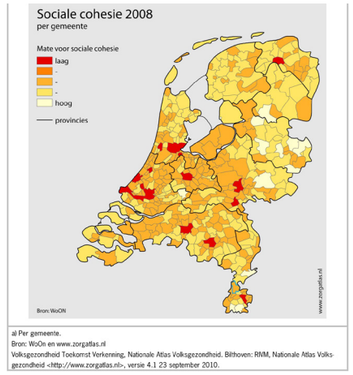


fig 11. CBS (S&W)

Low Social Cohesion



a) Per gemeente.
Bron: WoOn en www.zorgatlas.nl
Volksgezondheid Toekomst Verkenning, Nationale Atlas Volksgezondheid. Bilthoven: RIVM, Nationale Atlas Volksgezondheid <http://www.zorgatlas.nl>, versie 4.1 23 september 2010.

fig 14. WoOn and www. zorgatlas.nl

Dissatisfaction with Living Enviornment

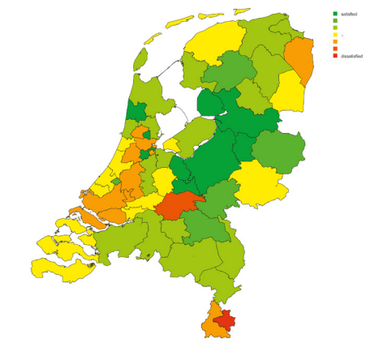
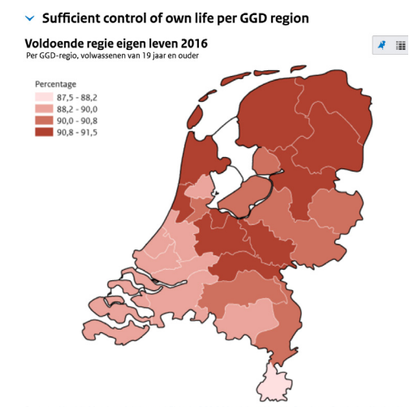


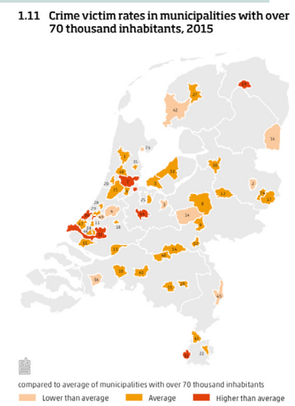
fig 12. (CBS & ministerie van VROM/WWI, 2010)

Low Control Over Life



Source: Health Monitor Adults and Elderly 2016 Municipal Health Services, Statistics Netherlan
fig 15. (CBS & ministerie van VROM/WWI, 2010)

Low Sense of Security



1. Alkmaar, 2. Almelo, 3. Almere, 4. Alphen aan den Rijn, 5. Amersfoort, 6. Amstelveen, 7. Amsterdam, 8. Apeldoorn, 9. Arnhem, 10. Breda, 11. Delft, 12. Deventer, 13. Dordrecht, 14. Ede, 15. Eindhoven, 16. Emmen, 17. Enschede, 18. Gouda, 19. Groningen, 20. Haarlem, 21. Haarlemmermeer, 22. Heerlen, 23. Helmond, 24. Hengelo, 25. Hilversum, 26. Hoorn, 27. Leeuwarden, 28. Leiden, 29. Leidschendam-Voorburg, 30. Lelystad, 31. Maastricht, 32. Nijmegen, 33. Nissewaard, 34. Oss, 35. Purmerend, 36. Roosendaal, 37. Rotterdam, 38. Schiedam, 39. The Hague, 40. 's-Hertogenbosch, 41 Sittard-Geleen, 42 Südwest Fryslân, 43. Tilburg, 44. Utrecht, 45. Venlo, 46. Vlaardingen, 47. Westland, 48. Zaanstad, 49. Zoetermeer, 50. Zwolle

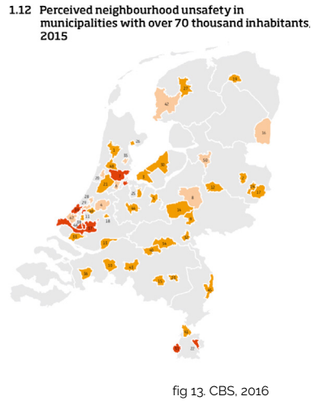


fig 13. CBS, 2016

Perceived Safety

Heerlen is the only region where perceived 'unsafety' is lower than its actual 'unsafety'.

1.2.3 Nitrate Contamination in Groundwater

1.2.3 Parkstad belongs to one of the highest groundwater Nitrate concentration regions (way above EU maximum standard), drinking water extraction points are soon to be affected. Extra cost will be needed for purification. Human and ecology health would be impacted. According to the 2015 report from the WFD, South Limburg is the most significantly impacted region in terms of groundwater quality. (see fig. 16)

According to PBL's estimation in 2018, 'It is estimated that by 2021, 50% of groundwater bodies are insufficient for terrestrial nature and 15% for drinking water extraction. Despite the improvement in the southern loess and sand area, the standard of 50 milligrams of nitrate per litre will still be exceeded there in 2027.' (Kwaliteit grondwater-PBL 2018)

What are Nitrates?

Nitrates are compounds made up of nitrogen and oxygen. They are a form of nitrogen appearing in soil and water when a process called 'nitrification' (bacteria in soil breaking down various forms of nitrogen into nitrate) happens. Naturally in the environment, nitrate is consumed by plants. however, excess nitrates leach and end up in the water system.

Nitrates are found in most fertilizers, manure, and liquid wastes. Nitrates that end up in our water system come from fertilizer and manure runoff, but can also come from leaky cesspools, sewage treatment plants, or car exhausts. It is colourless, odourless and tasteless, and is therefore undetectable in water unless tested. (Oram, n.d.)

Why Is Nitrate a Threat?

Nitrates threaten ecology when they exceed a natural balance, native species will die out. if entered into water such as a stream, nitrate can trigger algae bloom, which can suffocate aquatic life; nitrates are also a threat to human when they end up in groundwater or surface water, the source of our drinking water. When nitrate is consumed and transformed into nitrite in the digestive system, it causes health conditions such as the 'blue baby' disease in infants, impacting the ability of blood cells to carry oxygen.

Parkstad's soil type (Loess) contributes to higher nitrate concentration

Soil with finer grain size and tighter, more compacted structure, such as clay, has a higher nitrate level as water moves slower with its soil structure. On the other hand, soil type that has bigger grain size and looser structure layers, nitrate will leach into groundwater more easily. This

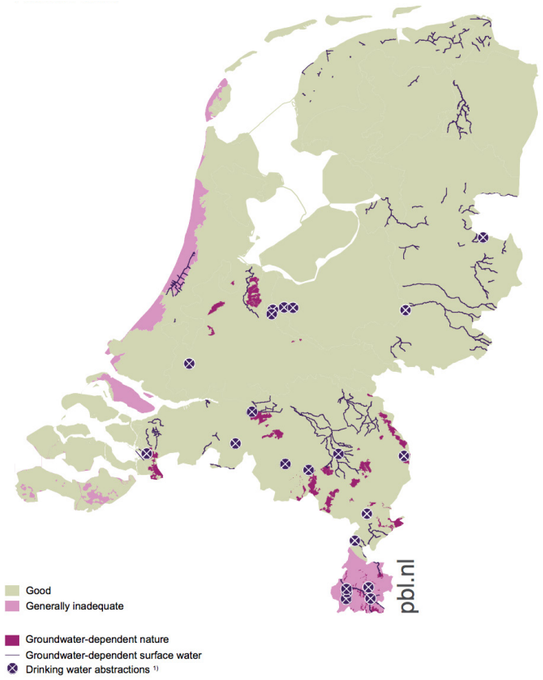


fig 16. Quality of groundwater WFD, 2015 & pbl.nl

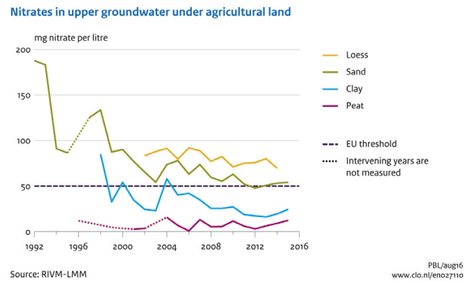


fig 17. Nitrates in upper groundwater under agricultural land.
Source: RIVM & PBL/aug16

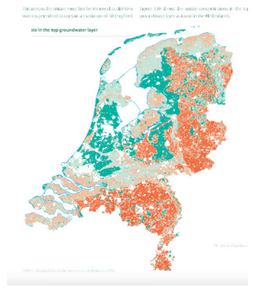


fig 18. Nitrates in top groundwater layer.
Source: Noordhoff Atlas of the Subterranean Netherlands / RIVM (Vewin, 2012, p. 67)

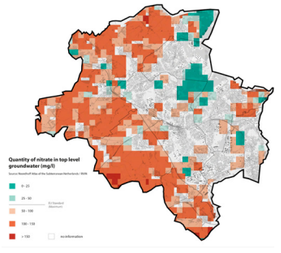
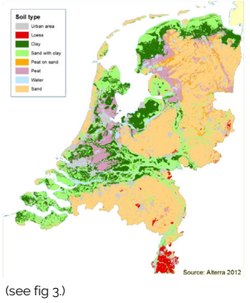


fig 19. Enlarged nitrate mapping in Parkstad
Source: Noordhoff Atlas of the Subterranean Netherlands / RIVM (Vewin, 2012, p. 67)



(see fig 3.)

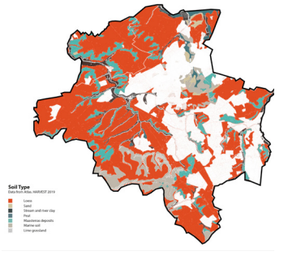
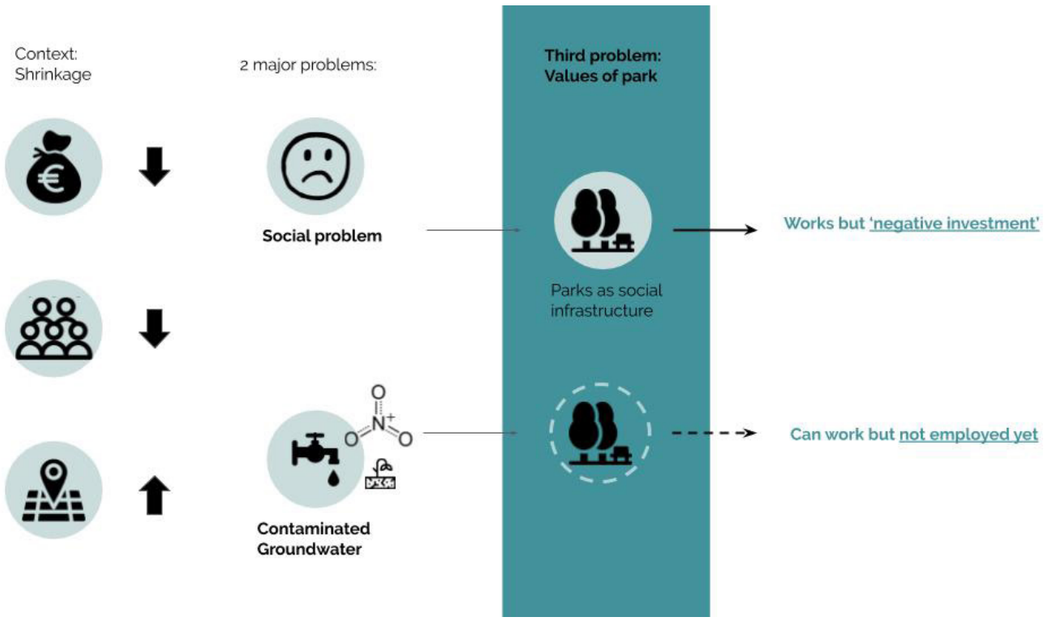


fig 20. Enlarged soil mapping in Parkstad
Source: Atlas harvest (2019)

explains partially why South Limburg accumulates a higher groundwater nitrate concentration, aside from intensive agriculture.

The main soil type of South Limburg is classified as Loess. Geologically, it is formed by wind-deposited silty or loamy material. Variants of loess include 'loessial sand, sandy loess, loess loam, and clayey loess'. The grain size of loess is bigger than that of clay (Encyclopaedia Britannica, 2010), and they 'typically have a loose honeycomb-type meta-stable structure' (Li et al., 2016).



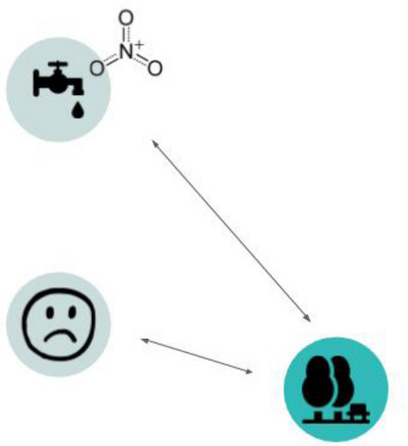
1.2.4 Problem & Potential: 'Parks' Underdefined and Underutilised

1.1.4 Bearing in mind the shrinking context of Parkstad, I see a contradictory reality in how the two key problems are being dealt with solutions that are further damaging an already falling economy.

What I want to raise here is that I feel a need to redefine the functions, values, and meanings of parks. Park is both a landscape and a social infrastructure. It has the potential to tackle the two major problems present here in Parkstad, one of landscape (nitrate threat), and one of social. The example of Speelpark mentioned earlier showed how a park can transform an urban area and improve social wellbeing of a neighbourhood. Its only problem was that the project was considered a negative investment. This reveals the underlying problems of 'park' in financial sense. Asides from social value (healthier communities, happier workers, etc). Most of the time parks generate value by being an attractor for investments and for higher property price.

As it is described by Ana Brandão and Pedro Brandão, coordinator of research project "PSSS – Public Space's Service Value as an Urban System. An integrated assessment methodology", 'much of public investment relies on the notion of the benefit of public space, often based on consumption and leisure, associated with representations of quality of life, or a "happy lifestyle". […] The idea that space generates value depends on the scope in which we locate ourselves and cannot be dissociated from the diversity of urban contexts. If it is easy to associate economic value with a notion of exchange value, we can find utility in the notion of use value in other circumstances.' (Brandão et al., 2018, p.14)

'Parkstad' as a new cooperative initiative between 7 municipalities is named Parkstad (cities of park) merely for its abundance of greenery around urban living environment, It is about time to really contemplate on what 'parks' can mean in this new urban re-branding campaign.



1.2.5 One-Liner Problem Statement

The role of parks in Parkstad is under-defined, the potential in terms of social, financial and nitrate-remediation is underutilised.

1.3 THEORETIC FRAMEWORK & CONCEPT

1.3.1 Theoretic Framework

A **New Urban Park Model** is Needed

A new model, or a new philosophy is needed to make urban park an asset in itself, that the urban values/ services it provides can directly support its existence for the social good.

I believe new parks should be useful and become in itself a form of necessary urban services for the city, a hybrid model, you may say. This idea echoes with the vision of the Public Space's Service System project (PSSS), a recently completed research project conducted by a team of 14 interdisciplinary scholars and researchers --- 'better continuity or integration [of public space] is needed to promote real meaning as urban systems and provide more social, environmental and economic value return, so as to assure time-life Public Space sustainability' (abstracted from Goal of the research project "Public Space's Service Value as an Urban System. An integrated assessment methodology", 2016-1019)

Landscape as **Mediator** in Complex Reality

It has always been my belief that the field of Landscape Architecture is a mediator between land and people, between natural systems and human system, between ecology, society, and economy. Anita Berrizbeitia, Chair of the Department of Landscape Architecture at Harvard University once wrote an article titled 'Landscape as Urban Mediator' in which she wrote ---

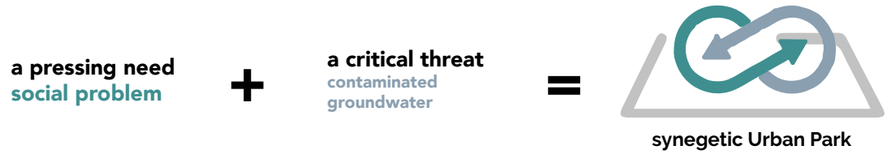
> **'Landscape architecture comes in to give organization and to mediate between existing natural processes (hydrological structures, environmental structures, ecology), the economic operations that define the city, and of course, the needs of the society that lives and works there.'**

(Berrizbeitia, n.d., para.2)

In this project I aim to position myself in the same way, my research question and approach of marrying two topics (Social restoration and nitrate remediation) in a urban landscape (urban park) reflect this attitude.

1.3.2 Project Vision

ReDefining +
ReUtilising Park



The project vision is an Azolla City Park, an example of a new urban park model that uses social life to help remediate nitrate and uses nitrate to help remediate social life. The synergetic relationship between 'social restoration' and 'nitrate remediation' will be achieved through a simple but miraculous water fern called Azolla. The project will explore the potential of using Azolla as both a social-restoring tool and a nitrate-remediating element. Not only is Azolla the most effective plant in fixating nitrate, it is also a useful crop (with a promising new industry in the rise) and an ornamental water plant. To push the idea one step further, the azolla park can also become a co-owned park cooperative, products of the park will become additional fund or income while ownerships can further facilitate community participation and responsibility.

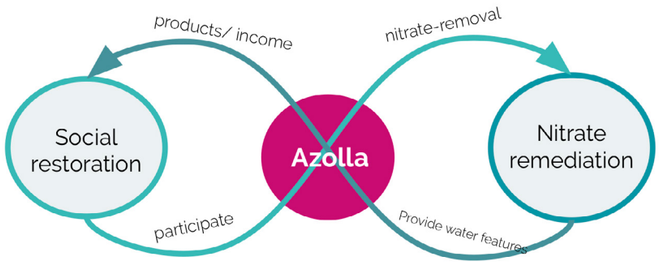
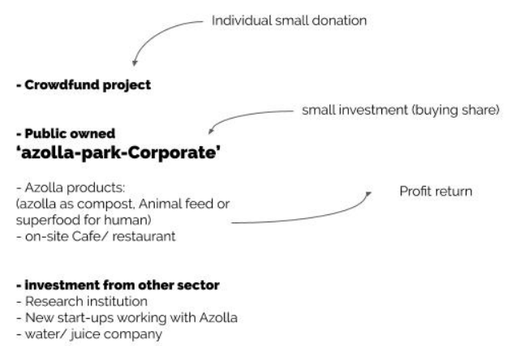




fig 21. Azolla is the smallest water fern in the world
Source: https://www.ebay.com.au/itm/Azolla-Mosquito-Fern-Fairy-Moss-Pond-Aquarium-Plant-Fish-Food-2-Cups-/152385556113



fig 22. Azolla pond
Source: http://sobhya.blogspot.com/2010/12/azolla.html



1.3.3 Research Question

How to redefine and reutilise ‘park’ through the marrying of social restoration and nitrate remediation in order to create a new urban park model that carries multiple values?

Sub-Questions

1. What are the philosophies of urban parks?

2. How can parks become social-enhancing or achieve social restoration?

3. How can landscape design help in remediating groundwater nitrate?

4. What are the overlapping opportunities between designing for social sustainability and for nitrate remediation (urban service)? In what scales or forms (public, semi-public, private; site, network, management, involvement etc)?

5. How to design synergy between nitrate-remediation and social opportunities?

6. In what way will the role of urban parks be redefined through the proposed design?

1.3.4 Research Objectives

The research objective is to find out how can urban public parks thrive even in a shrinking region; how may new public parks be created and developed in a socially and economically sustainable way, specifically in terms of the possibility of marrying social restoration with nitrate remediation services; In what way can public parks with nitrate remediating property create social opportunities that enhance social cohesion and social sustainability, and vice versa, and how philosophies of park may help revitalise the ‘garden city’ green network of Parkstad with contemporary interpretation.

1.4

SCOPE & DEFINITION

1.4.1 Urban Park

'Park' is an extremely broad concept and often ambiguous when it comes to definition - it can mean anything from a nature reserve to a garden to a patch of green and to a playground, etc. It is therefore necessary to narrow down to a focused research scope. The research will focus mainly on 'urban park'.

Sadeghian and Vardanyan pointed out that the definition of park provided by Kevin Lynch 'as pieces of land that are colored green on planners' maps' is the simplest, and that '[t]his limited, but accurate, description provides a suitable starting point in defining parks because it reveals that parks, like maps, occur at different scales.' (2015, p.121)

Generally speaking, 'urban park', also sometimes refer to city park or metropolitan park, is often defined as a piece of green open space within urban area.

Frederick Law Olmstead defined urban park as “a naturalized passive retreat” (Rutledge & Molnar, 1986, p.4), a place where urban dwellers who are not able to flee from city stress can find temporary escape and pleasure. Later, a more contemporary definition is given by urban geographers Solecki and Welch (1994). They defined urban park as 'landscape features that serve many functions as providers of passive and active recreation, environmental benefits and wildlife habitats” (p. 93).'

1.4.2 Social Problem and Social Restoration

The term 'social' is just as, if not more, broad and ambiguous than the word 'park'. Philosopher and sociologist Bruno Latour pointed out the trickiness of employing the term 'social' in his book Reassembling the Social (2005):

'Starting with a definition which is coextensive with all associations, we now have, in common parlance, a usage that is limited to what is left after politics, biology, economics, law, psychology, management, technology, etc., have taken their own parts of the associations. [...] Because of this constant shrinking of meaning [...] we tend to limit the social to humans and modern societies, forgetting that the domain of the social is much more extensive than that' (Latour, 2005, p.6)

Design projects that target social issues often connect with popular topics such as social sustainability and social cohesion. However I find these perspectives somewhat ambiguous, due to reasons suggested by Latour, and does not fully cover the issues I want to address in Parkstad.

A more direct approach is to use the following definition of 'social problem' and to define any ways of improving these social problems as a form of 'social restoration'. Social restoration can include principles of social sustainability and principles of social cohesion, but it avoids confusion of using the popular terminologies of 'social sustainability' or 'social cohesion'.

Social problem:

The definition of social problem that I will be using is from 'Social problems: continuity and change '(2005) published by University of Minnesota Libraries Publishing:

'A social problem is any condition or behavior that has negative consequences for large numbers of people and that is generally recognized as a condition or behavior that needs to be addressed. This definition has both an objective component and a subjective component.'

(Social problems: continuity and change 2015)

1.4.3 Nitrate Remediation

Nitrate in the nitrogen cycle:

Wayne Armstrong made a simple and clear explanation of the nitrogen cycle in the Wayne's Word Monthly Article 'Marriage Between A Fern & Cyanobacterium', it is stated as follow:

'atmospheric nitrogen gas (N2) is combined with hydrogen to form ammonia (NH3). This vital process along with nitrification (formation of nitrites and nitrates) and ammonification (formation of ammonia from protein decay) make nitrogen available to autotrophic plants and ultimately to all members of the ecosystem.'

(Armstrong, 1998, para 12)

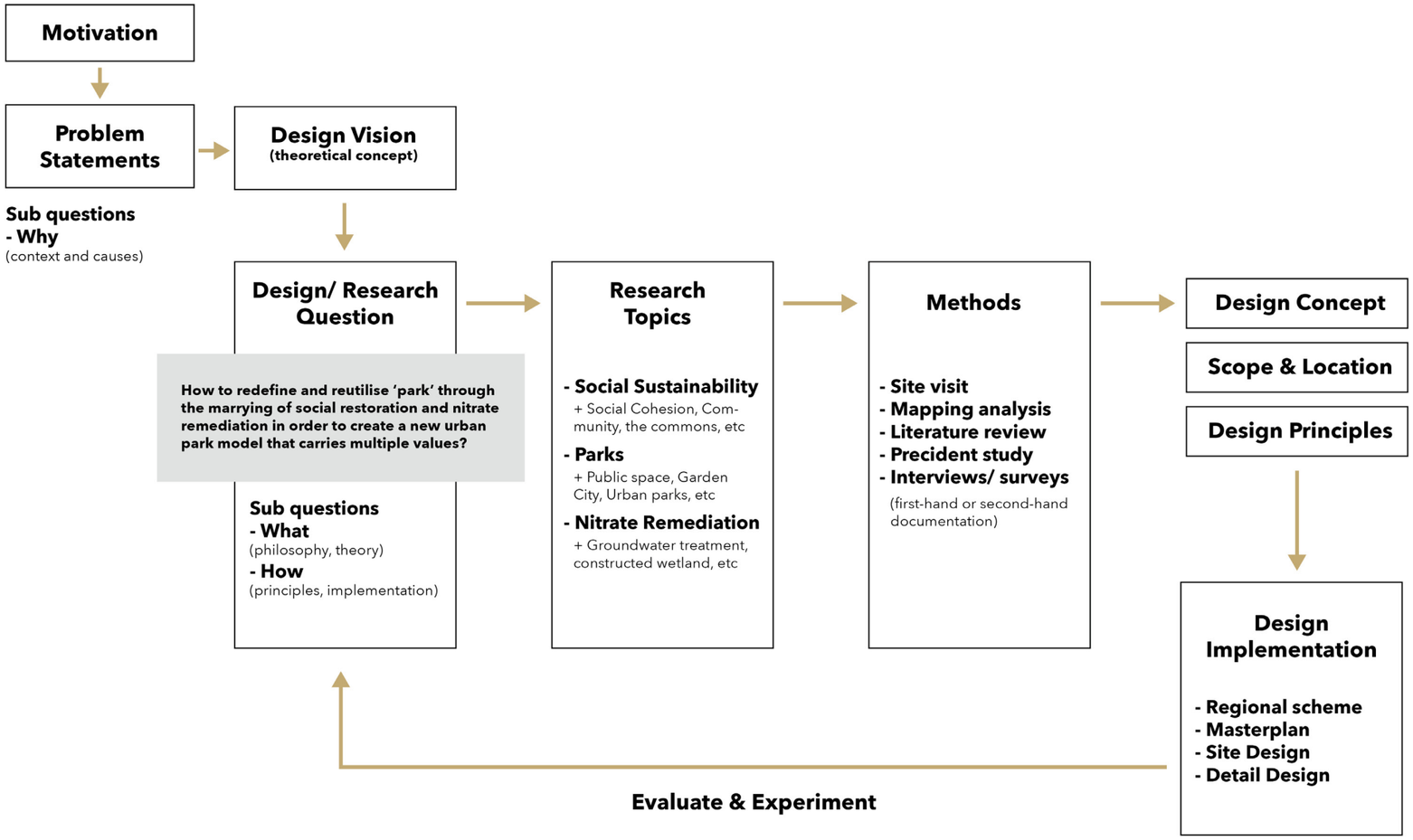
Nitrate is present in both soil and water; nitrate remediation in this project focuses mainly on the removal of nitrate in groundwater. It is not possible to remove all nitrate in groundwater, therefore, diluting nitrate-rich groundwater by taking out, and/ or filling in low nitrate water would be defined as nitrate remediation. The project only focuses on nitrate remediation done through natural (landscape) approaches.

02

METHODOLOGY

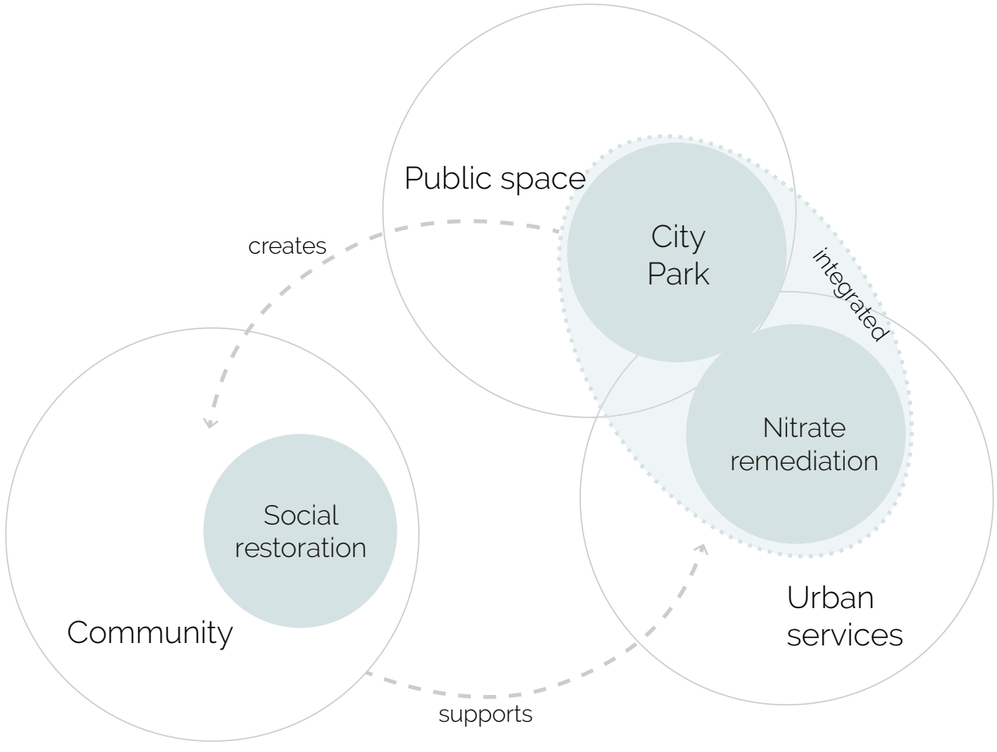
2.1

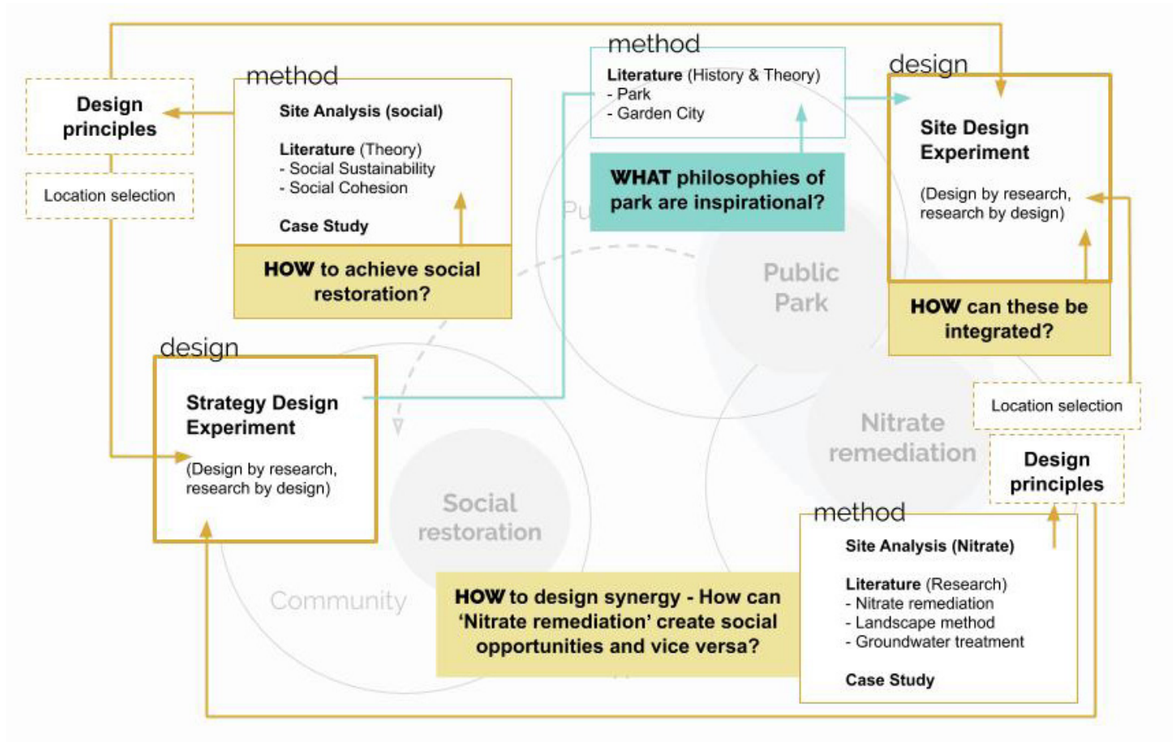
RESEARCH+DESIGN METHOD STRUCTURE



2.2

RESEARCH FRAMEWORK





2.3

RESEARCH
APPROACH+METHOD

Approach: Research by Design, Design by Research

The approach 'research by design, design by research' is used. Meaning that the development of design determines and facilitate the research -- 'design by research'; and at different stages of designing new knowledge and insights will be created and documented, hence 'research by design'.

Methodology

Mapping & Layered Analysis

Mapping analysis leads to the identification of site-specific problems and intervention opportunities, the analysis is done on several scales through mappings, Some of the data are qualitative, such as 'social cohesion', these types of data are usually calculated as an index score by the institutions, such as RIVM. These are then presented as data per municipality, making them 'mappable'.

Mapping is done on different scales for different reasons:

On context scale:

To understand the landscape condition, social condition and nitrate condition of Parkstad in relation to or in comparison with the rest of the country.

- On Parkstad scale:

To study the morphological patterns, existing park network, social condition and nitrate condition (in relation to agriculture and water system) of Parkstad as a whole.

- On city + neighbourhood scale (Heerlen):

To gain understanding of city-level problems in Heerlen, and to study the present condition and systems of the chosen site.

- Layered Analysis

After gaining understandings from these mapping analyses, a layered approach is used to better understand the correlation between different systems, and to locate problems and potential sites, This is very necessary between all systems are interrelated, water, soil, topography are related to settlement formations, agricultural activities, infrastructure; social wellbeing can be related to neighbourhood settings and ages --- every system flows into a combined reality.

Literature Review

The project will be based on literary review revolving around the three main topics of: public park, social restoration and nitrate remediation. Theories of public parks and the garden city movement help establish the philosophical backbone of the design concept while literary reviews on social restoration (e.g. social sustainability, social cohesion, environmental psychology) and scientific research paper on nitrate remediation provide the bases of design principles for water systems, features, and for azolla planting and harvest methods.

Precedent Study

Ideally, suitable precedent projects would be projects that integrate Azolla farm (nitrate remediation) with social-facilitating urban park design. However, no such projects have been present at the moment. The precedent projects that I look into are therefore projects that integrate algae/ duckweed - which are similar to Azolla with an urban park outlook, such as the 'Carbon T.A.P.// Tunnel Algae Park' by PORT Architecture + Urbanism. I also look into technical projects that deal with water management or water remediation, such as constructed wetlands and Pump&Treat method projects introduced by Engineer Frank Pels (HMVT) and Nanne Hoekstra (Deltares) in their presentation 'Constructed wetlands for cost-effective and energy-efficient remediation of plumes'(2018), I have also looked into famous crowdfunding project Luchtsingel in Rotterdam as an inspiration for a co-ownership public space model.



fig 23. 'Carbon T.A.P.// Tunnel Algae Park' by PORT Architecture + Urbanism

Qualitative Research Through Social Media

Besides conventional research, I try to grasp a closer understanding of the mentality of the locals, what to they think of their city, what do they like, are they nostalgic or future-looking. I searched through Facebook, Instagram, forums and blogs. There are a few facebook groups that are particularly active, including 'Heerlen Heële' and 'Heerlen Mijn Stad'.

'Heerlen Heële' is a facebook group where many people post photos from the past and share personal stories/ memories. 'Heerlen Mijn Stad' is a more official facebook page promoting events and current stories of the city. I focus mainly on

people's comments on this page.

Expert Consultation

For the scientific aspect of the project I have consulted with scientist and director of the TU Botanical Garden Bob Ursem; I have also consulted with John Song, a friend of mine who is an environmental engineer based in California.

First-hand Information

- Site Visit (impression, photos, videos)

During site visit I gained first-hand understanding of the area and it contributes to a personal mental impression of the site. For example, I noticed many young people gathering in informal places such as steps or outside the supermarket, Heerlen did not seem to have enough destinated public space for teenagers to hang. Many teenagers were skating in random places, even with just a side curb or a planter. There didn't seem to be enough areas for teenagers to practice their skating either.

- Site Visit (meeting with local landscape firm and Parkstad officials)

Another method of gaining first-hand information was through talking with local experts and official. Together with my fellow students we visited Landscape Architecture firm Bureau VERBEEK and got introduced to the landscape of Parkstad and several projects in the area. We also met with officials from Parkstad and gained extremely useful understanding towards the Parkstad..

- Azolla home experiment

I have just started growing my own azolla; the azolla ferns are bought online and are released to a small container of water. They however do not look very healthy, assumingly due to home tap water being too clean. I tried adding plant fertilizer to supply the water with nitrogen and phosphate, but it does not seem to make a big change. Micro-climate can also be a reason. For a long period I have placed the container next to the window for sunlight. Yet being indoor might have caused that particular spot to be way too hot for the azolla. At the moment of writing, I am still experimenting so more progress is yet to be seen.

- Facebook/ whatsapp interview

Due to language barrier I thought interviewing people through short questions on Facebook/ whatsapp would be more suitable. During our visit in Heerlen and Kerkrade, fewer people than I expected could speak English. Questions that are asked online gave people flexible time to think and answer whenever suit them best, which I think is a good and friendly method. I have set up 5 simple questions regarding parks in



fig 24. Meeting with Parkstad Officials. Photo by author.


fig 25. View from Wilhelminaberg. Photo by author


fig 26. The new Heerlen Train Station. Photo by author



fig 27. Azolla documentation photos and videos. Collection by author

Heerlen. The reason for not asking too many questions was to avoid lowering incentives for people. I then sent out these questions through facebook messages or through whatsapp with people who I have ways to contact.

Unfortunately so far I only get 4 sets of answers. I assume it has to do with the new chat setting from Facebook that puts messages from stranger in a separated, less noticeable folder.

Questions:

1. How long have you lived in Heerlen or parkstad?
(If you do not live here, how often do you come?)

2. Which park in Heerlen or near Heerlen is your favourite and why?

3. Think of an urban park that you visit frequently. How often do you go to this park? How do you reach this park? and what do you like and don't like about this park?
(e.g. daily, a few times a week, once a week, once a month, few times a year...) (e.g. on foot, by bike, by car, other transport...)

4. In general, do you think the parks in Heerlen are good places for social activities, such as to meet with friends and to connect with other people?

5. Describe your dream park for the neighbourhood you live in; and describe your dream 'central park' for the city of Heerlen.
(a. you may describe in terms of style and atmosphere: Modern / natural / wild / peaceful / energetic / iconic / scenic ...) (b. What amenities do you want it to have?)

Answers:

Answers from Robine Gielkens

1. Ik woon al 26 jaar in regio parkstad

2. Aambos is mijn favoriete groenstukje in Heerlen, water, bos, mooie bomen en gras

3. Een paar keer per jaar. Te voet

4. Ja wanneer er bijvoorbeeld picknicktafels geplaatst worden

5. Hip: leuke verlichting, picknicktafels, groen; gras en bomen, het gevoel dat je krijgt bij een foodtruckfestival

---

(Translated through Google Translate)

1. I have been living in the Parkstad region for 26 years

2. Aambos is my favorite piece of greenery in Heerlen, water, forest, beautiful trees and grass

3. A few times a year. On foot

4. Yes if, for example, picnic tables are placed

5. Hip: nice lighting, picnic tables, greenery; grass and trees, the feeling you get at a food truck festival

---

Answers from Roli

1. 82 jaar

2. het "oude" en het "nieuwe Aambos.

paar keer per jaar. te voet

3. Doordat het twee parken zijn, gescheiden door een stijle weg van 11', zijn beide parken heel verschillend, bv het oude herbergt beesten in een begrensd terrein,het nieuwe niet.

Overigens bestaat ook het nieuwe al zo lang ik weet.

Het oude veegt een diepe holle weg wat het park boeiend maakt. Nog versterkt door een brug die hoog over de hellende weg ligt.

Ik weet niets negatiefs te bedenken over beide parken. Ze worden goed onderhouden en in het oude staan enkele speeltuigen voor kleine en grotere kinderen. In het nieuwe een paar klimtoestellen.

4. In mijn jeugd was het een veelbezochte ontmoetingsplaats voor geliefden. Hoe dat nú is, weet ik niet.

Als ik er ben zie ik vaak grootouders met kleintjes.

5. eigenlijk voldoet de combinatie van beide parken aan mijn droomwandelpark: mooie bomen, echte hoogteverschillen,

banken, grote grashelling, en zelfs een beek die langs het nieuwe loopt.

Vroeger is er een paviljoen geweest, met muziek en dans.

Waarschijnlijk door gebrek aan bezoekers en lef van een uitbater is dat verdwenen.

Of dat een gemis is weet ik niet.

---

1. 82 years

2. the "old" and the "new Aambos.

few times a year.

on foot

3. Because they are two parks, separated by a steep road of 11, both parks are very different, eg the old houses beasts in a bounded area, the new not.

Incidentally, the new has also been around for as long as I know.

The old sweeps a deep hollow which makes the park fascinating. Reinforced by a bridge that is high over the sloping road.

I can't think of anything negative about both parks. They are well maintained and in the old there are some toys for small and older children. In the new a few climbing equipment.

4. In my youth it was a popular meeting place for lovers. I don't know how that is now.

When I am there I often see grandparents with little ones.

5. actually the combination of both parks meets my dream walking park: beautiful trees, real height differences,

benches, large grass slope, and even a stream running along the new.

There used to be a pavilion with music and dance.

This has probably disappeared due to a lack of visitors and the guts of a manager.

I don't know if that is a loss.

Answers from Sjef Hautvast:

1. Ik woon al mijn hele leven in Heerlen, met onderbreking van mijn studietijd en mijn tijd in militaire dienst; dus ongeveer 75 jaar.

2. Mijn favoriete stadspark in Heerlen is het Aambos.Het ligt dicht bij het centrum en vormt een verbinding met de omliggende wijken. Het is rustig, gevarieerd en overzichtelijk.

3. Ik ga zeker drie keer per week een wandeling maken door het Aambos. Dat doe ik te voet, omdat vlak bij onze woning ligt.

4. Er zijn in Heerlen niet zoveel stadsparken. Er zijn wel groengebiedjes, maar die zijn klein om als stadspark aangemerkt te worden, maar het Aambos is wel geschikt voor sociale aktiviteiten, maar dat moet dan wel gefaciliteerd worden.

Daarnaast zijn aan de rand van de stad wel grotere natuurgebieden, zoals het Imstenraderbos en het natuurgebied Terworm, maar die liggen te ver van het centrum om als stadspark te worden aangemerkt, want ik vind het kenmerk van een stadspark, dat je snel vanuit het centrum in het park bent, dat enige omvang heeft.

5. In een stadspark moet je even de hectiek van de stad, van het centrum kunnen ontvluchten. Het moet niet, zoals bij het Vondelpark in Amsterdam doorbroken worden door een drukke weg, die "overloopt" van snelle fietsers, skaters en ander snel "langzaamverkeer". In een stadspark moet het wel een beetje rustig zijn, maar rustige horeca is ook gewenst. Genieten van een lekker kopje koffie op een mooi terras; dat hoort ook bij een stadspark. Faciliteiten voor kleinschalige (muziek)activiteiten zou de aantrekkelijkheid van het stadspark kunnen verhogen, maar het moet niet zo zijn, dat er elke week een of ander popfestival plaatsvindt. Op zijn tijd een beetje reuring moet kunnen.

---

1. I have lived in Heerlen all my life, with interruption of my study time and my time in military service; so about 75 years.

2. My favorite city park in Heerlen is the Aambos. It is close to the center and forms a connection with the surrounding neighborhoods. It is quiet, varied and clear.

3. I will go for a walk through the Aambos at least three times a week. I do this on foot, because it is close to our house.

4. There are not so many city parks in Heerlen. There are green areas, but they are small to be classified as a city park, but the Aambos is suitable for social activities, but that must be facilitated.

In addition, there are larger nature areas on the outskirts of the city, such as the Imstenraderbos and the Terworm nature reserve, but they are too far from the center to be classified as a city park, because I find the characteristic of a city park, which you can quickly are in the park, which has some size.

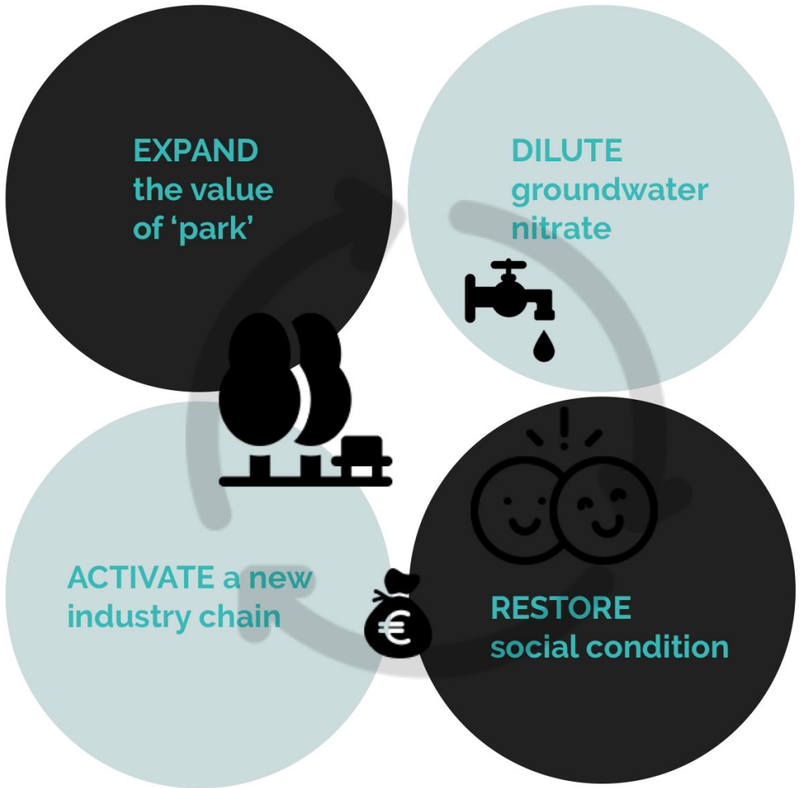
5. In a city park you have to be able to escape the hectic pace of the city, from the center. It should not, as at the Vondelpark in Amsterdam, be interrupted by a busy road, "overflowing" with fast cyclists, skaters and other fast "slow traffic". It must be a bit quiet in a city park, but quiet catering is also desirable. Enjoy a nice cup of coffee on a beautiful terrace; that is also part of a city park. Facilities for small-scale (music) activities could increase the attractiveness of the city park, but it should not be the case that some pop festival takes place every week. A bit of commotion should be possible from time to time.

03

RESULTS/DESIGN

3.1

DESIGN AIM



3.2

SITE SELECTION

WITH THE LAYERED APPROACH

3.2.1 Parkstad-scale Site Analysis With The Layered Approach

To locate a target area for site intervention, a large scale mapping analysis is needed. Mapping analysis of the whole Parkstad region is done and overlayed for a multi-layer understanding of problems and potentials.

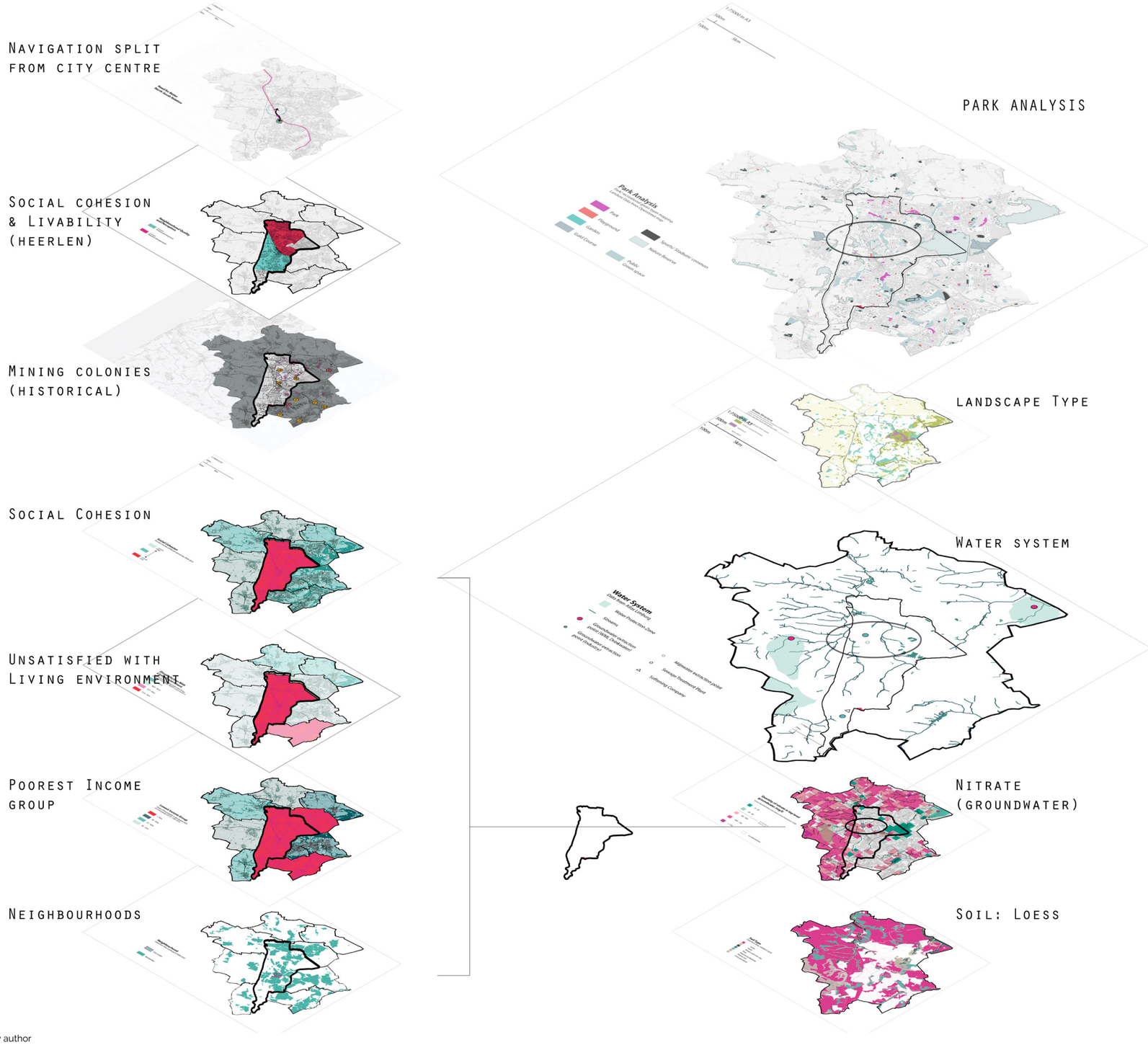
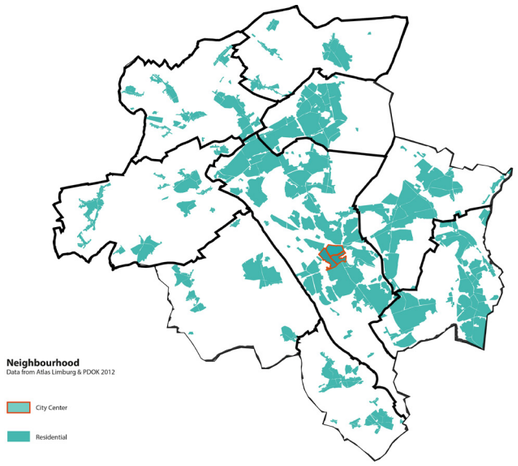
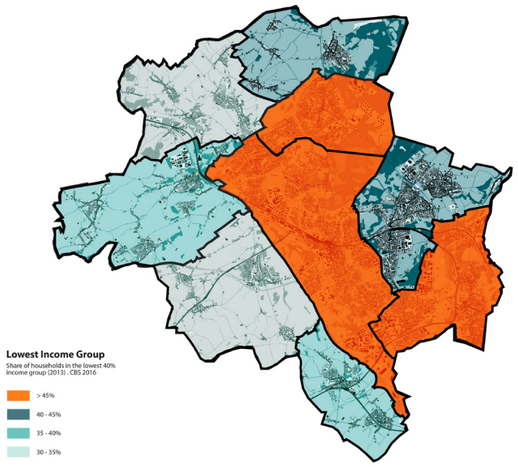
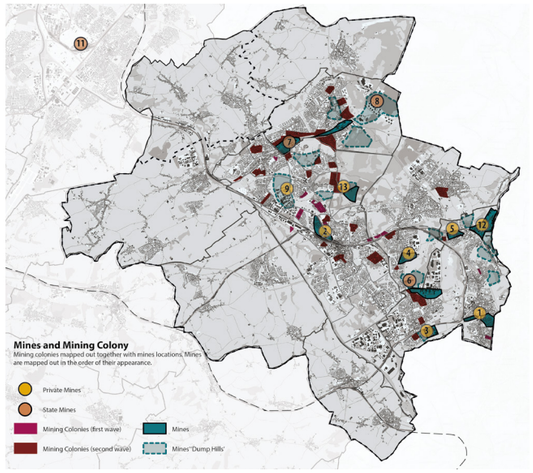


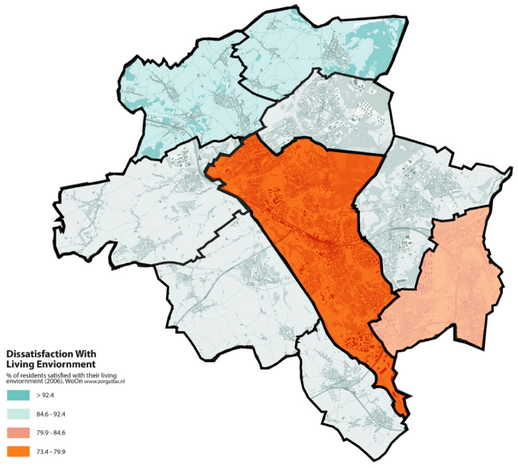
fig 28. Parkstad Layered Mapping Analysis by author

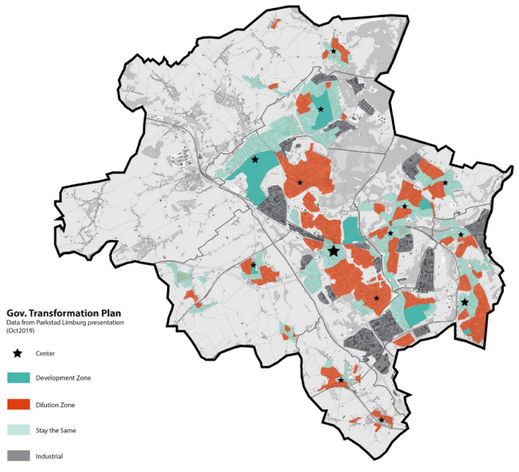
3.2.2 The Social and Urban Layers

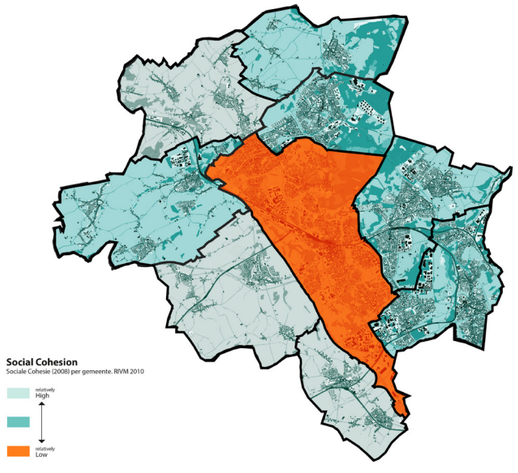












Heerlen is the focused area

In the social and urban aspect, Heerlen is identified as the most problematic municipality. It is the most urban area, the central city of Parkstad, one of the poorest and appeared to have the most social problems.

North-South Spatial Split

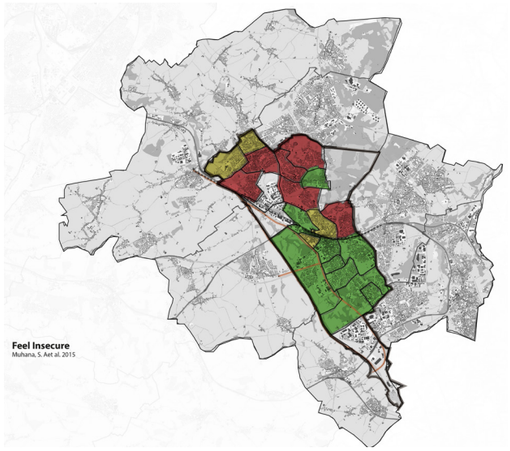
The next level of mapping analysis focuses on the municipality of Heerlen, in which an interesting North-south spatial split is found. This split refers to both a qualitative, social way -- in terms of liveability of neighbourhoods) and a navigational spatial way -- in terms of physical split caused by a major train track.

In the paper 'The transformation in functionality and liveability of Heerlen' (Muhana et al, 2015), Comparison studies were performed on all residential neighbourhoods of Heerlen. The result was that the northern side of Heerlen, which was once the mining region with earlier urban expansion, showed more social/ liveability problems. Some of the mapped data are taken from the paper and visually processed. The topics include feelings of insecurity, victimisation, housing quality, urban decay, social cohesion and nuisance.

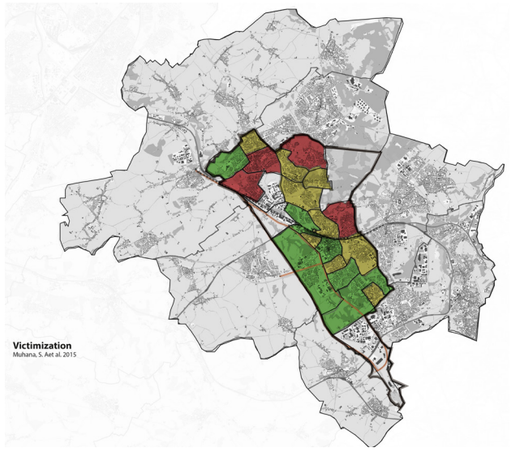
The city's major train track also geographically split Heerlen into the same two halves, with the north being the degrading areas and the south being the more positive areas.



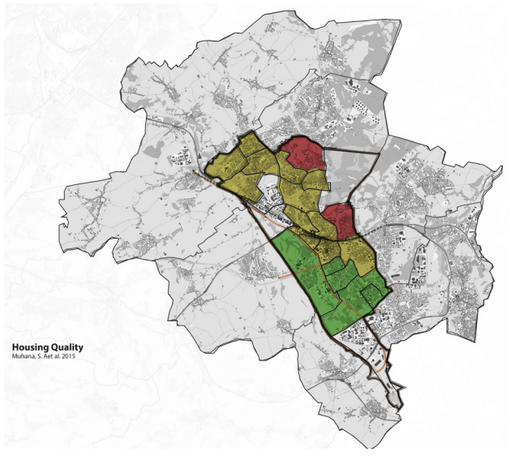
fig 29. Schoonhoven, E. (2014). Station Heerlen. photograph. https://commons.wikimedia.org/wiki/File:Station_Heerlen_-_panoramio.jpg.



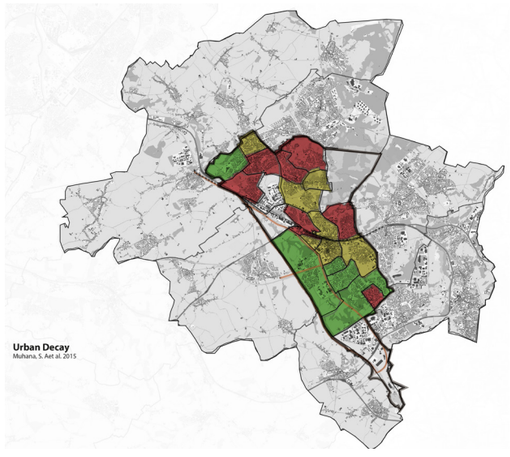
Feel Insecure
Muhana, S. Aet al. 2015



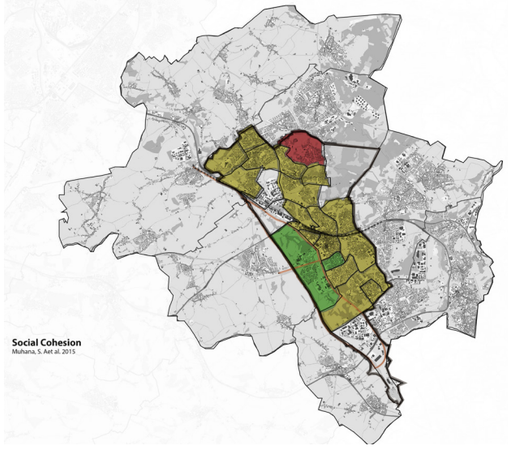
Victimization
Muhana, S. Aet al. 2015



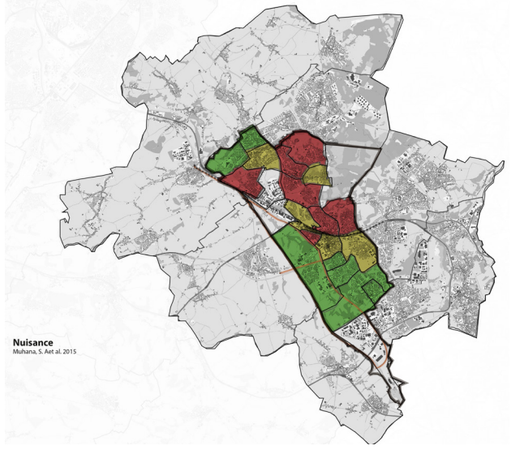
Housing Quality
Muhana, S. Aet al. 2015



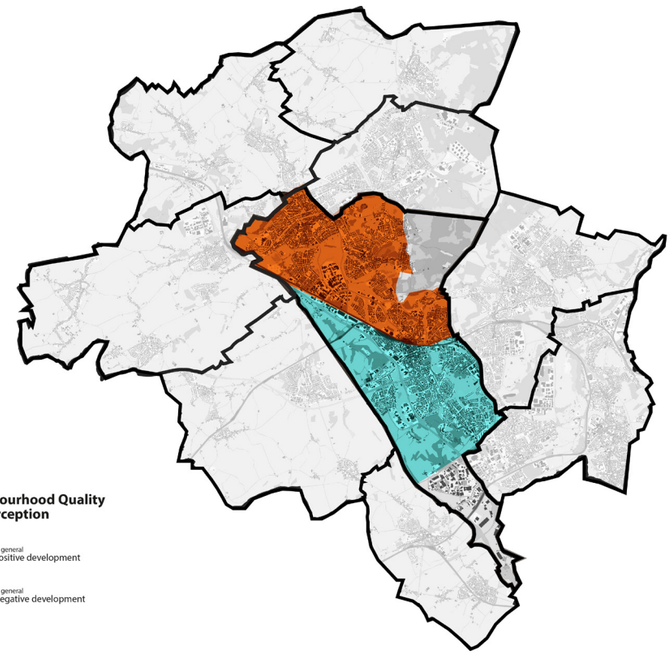
Urban Decay
Muhana, S. Aet al. 2015



Social Cohesion
Muhana, S. Aet al. 2015



Nuisance
Muhana, S. Aet al. 2015



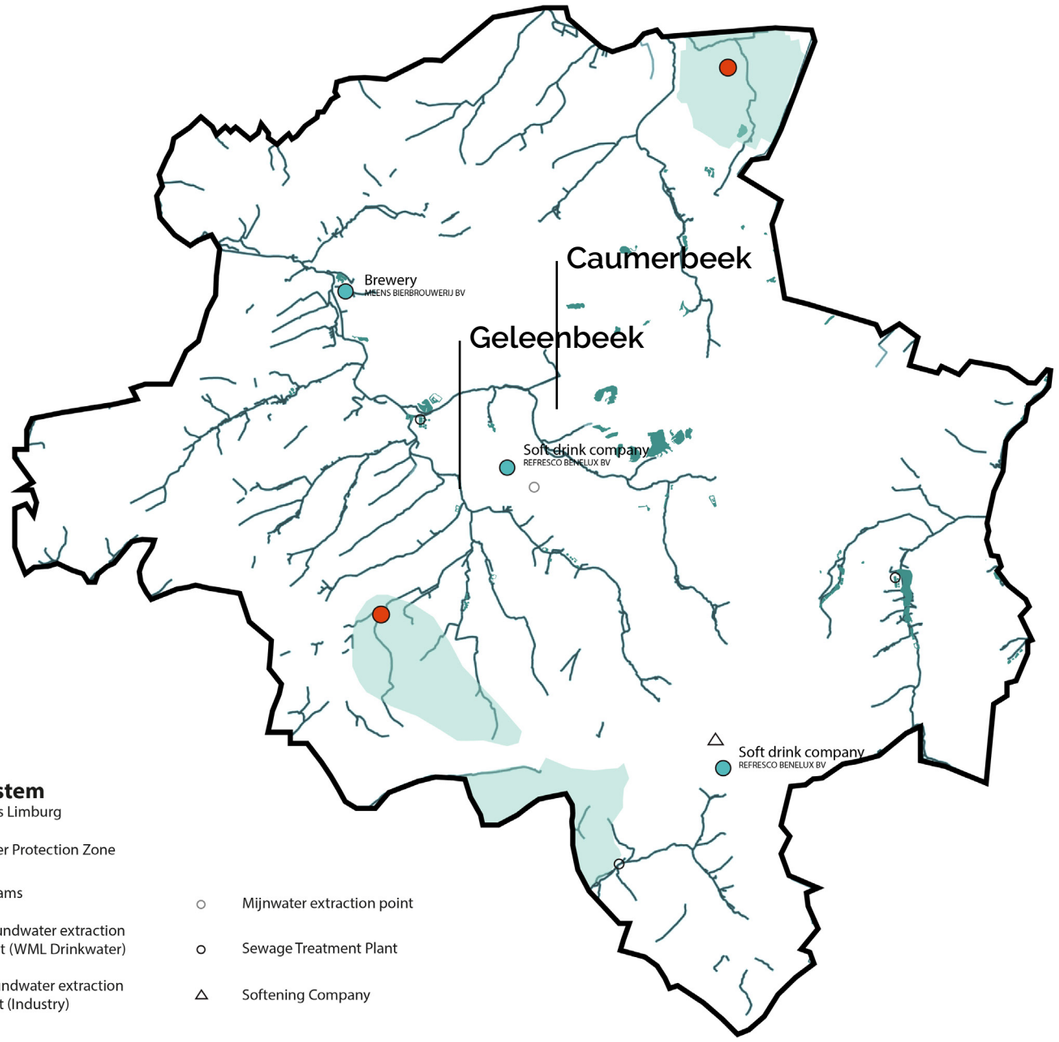
Neighbourhood Quality and Perception

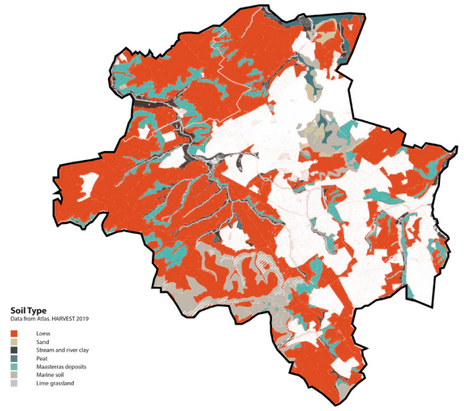
in general
Positive development

in general
Negative development



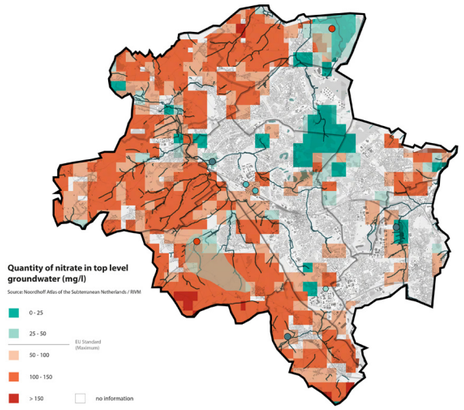
Need for Better North-South Relation





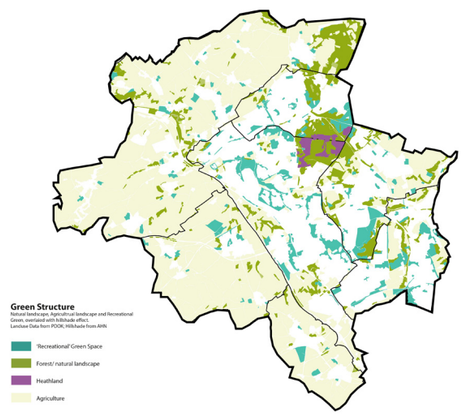
Soil and Nitrate

In the soil map as well as the nitrate map, noticeable gaps are present in most of the built area. It is important to note that these are areas with no available data. One can assume nitrate level would be similarly high in areas with high concentration nearby as groundwater travels.



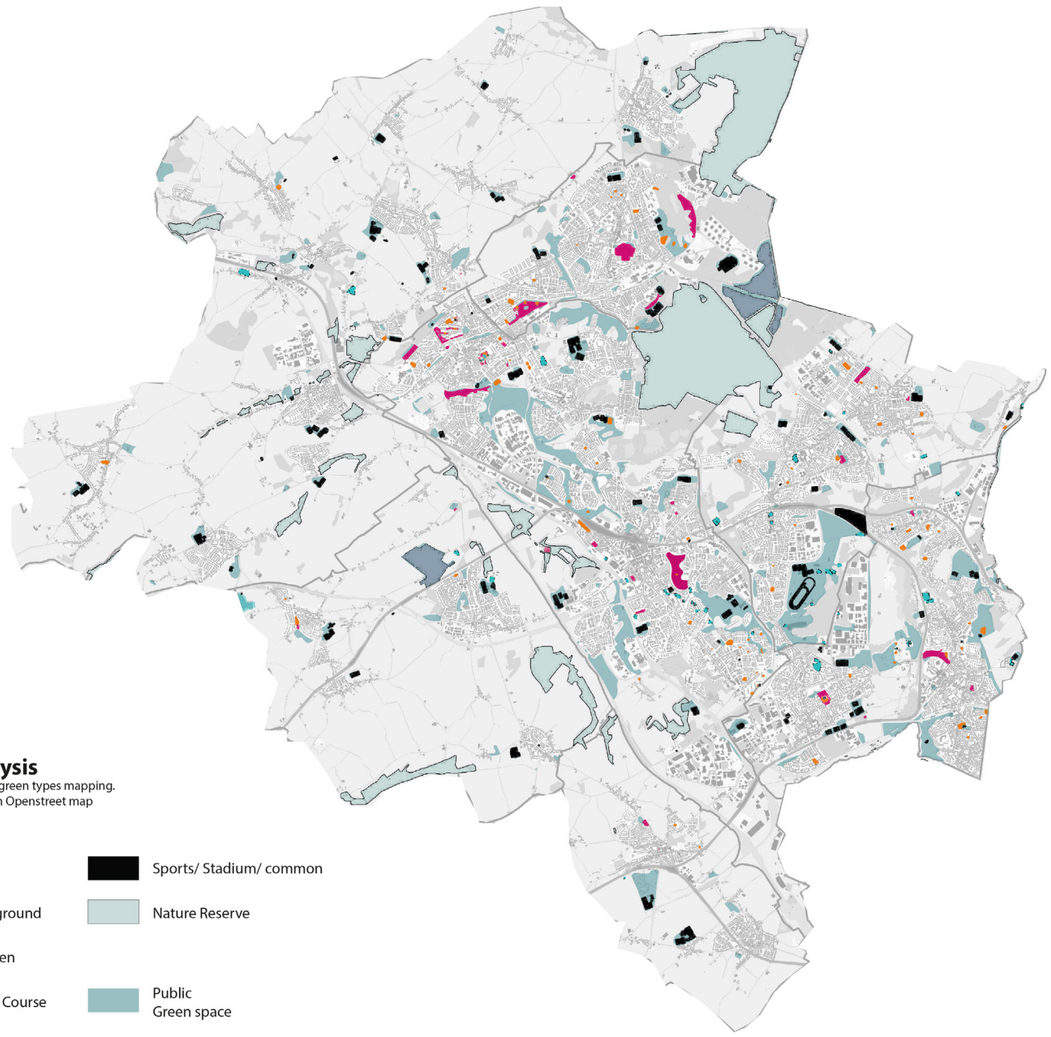
Nature Reserve

Most of the green structure consisting of agriculture in the rural agricultural municipalities of Parkstad are listed as national landscape and have to be protected.



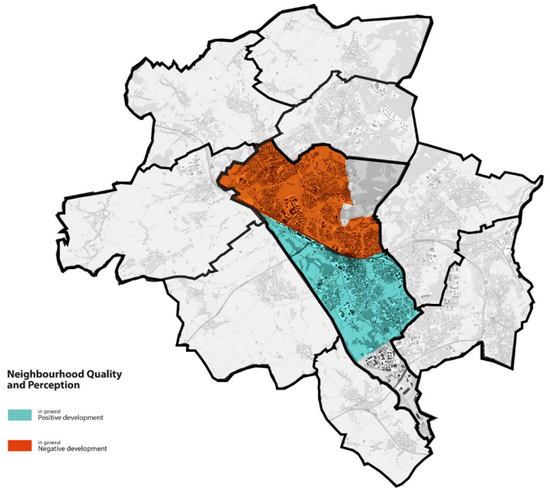
Heerlen and The Two Brooks

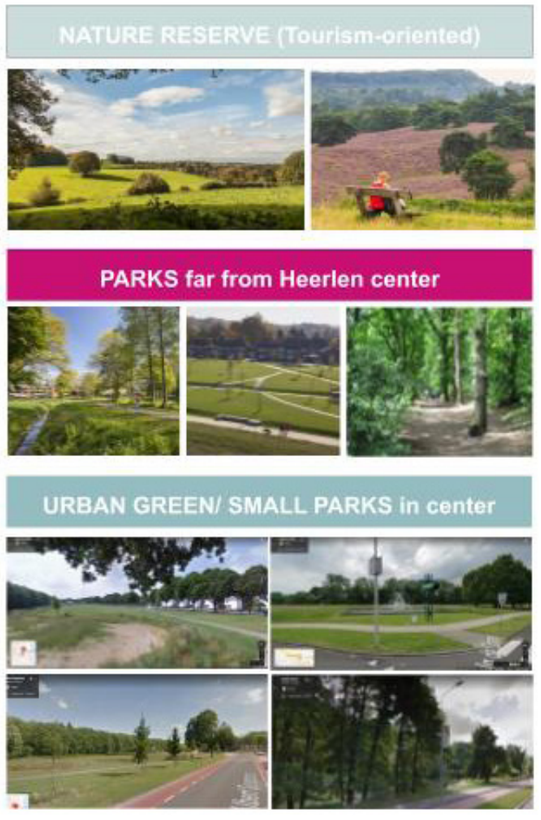
The two main brooks that make up Parkstad's water structure are the Caumerbeek and the Geleenbeek. Both of these brooks flow through Heerlen from north to east. The Geleenbeek has branches that travel to a drinking water protection zone located in the municipality of Voerendaal.



Park Analysis
Park/ recreational green types mapping.
Landuse Data from Openstreet map

- Park
- Playground
- Garden
- Gold Course
- Sports/ Stadium/ common
- Nature Reserve
- Public Green space





Park Analysis and center area

Parkstad has a lot of nature reserve, but these are parks that cater to green tourism and are therefore not socially or daily for the residents of Parkstad.

Within Heerlen, more new urban parks are implemented in the northern area where neighbourhoods are in poorer condition. In the central north area there are no parks but a large amount of public green space. Most of these green space are patches marked as 'recreational' but not designed specifically to be functioning as a 'park'.

3.3

DESIGN SITE

3.3.1 Site Study

The site is chosen as a result of a combined layered analysis that balances between social and nitrate potential/ needs.

The chosen site is located in the northern side of Heerlen station along the train track and the CBS building, the first part of the site is a small piece of open space outside of the Mine Museum, this area is connected to the train station through a newly paved path, mijnmuseumpad, the train station crosses over to the other side of the train track to where the city center is.

The following diagrams explain the strategic site potential of this location.

A more detailed site analysis will be covered later in the report together with the design.



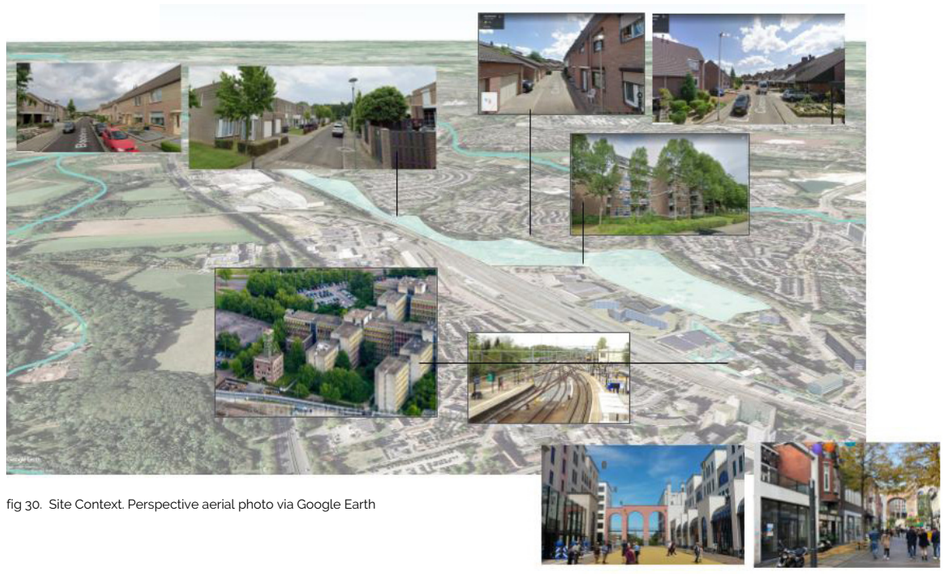


fig 30. Site Context. Perspective aerial photo via Google Earth

3.3.2 Scale Comparison



fig 31. Proposed site. Perspective aerial photo via Google Earth

The proposed design for the site is a co-owned azolla city park. It will be positioned as an urban park, a nitrate-social park prototype and a pioneer for future urban park developments in Parkstad. To get an idea of appropriate scale, a brief scale comparison has been done.



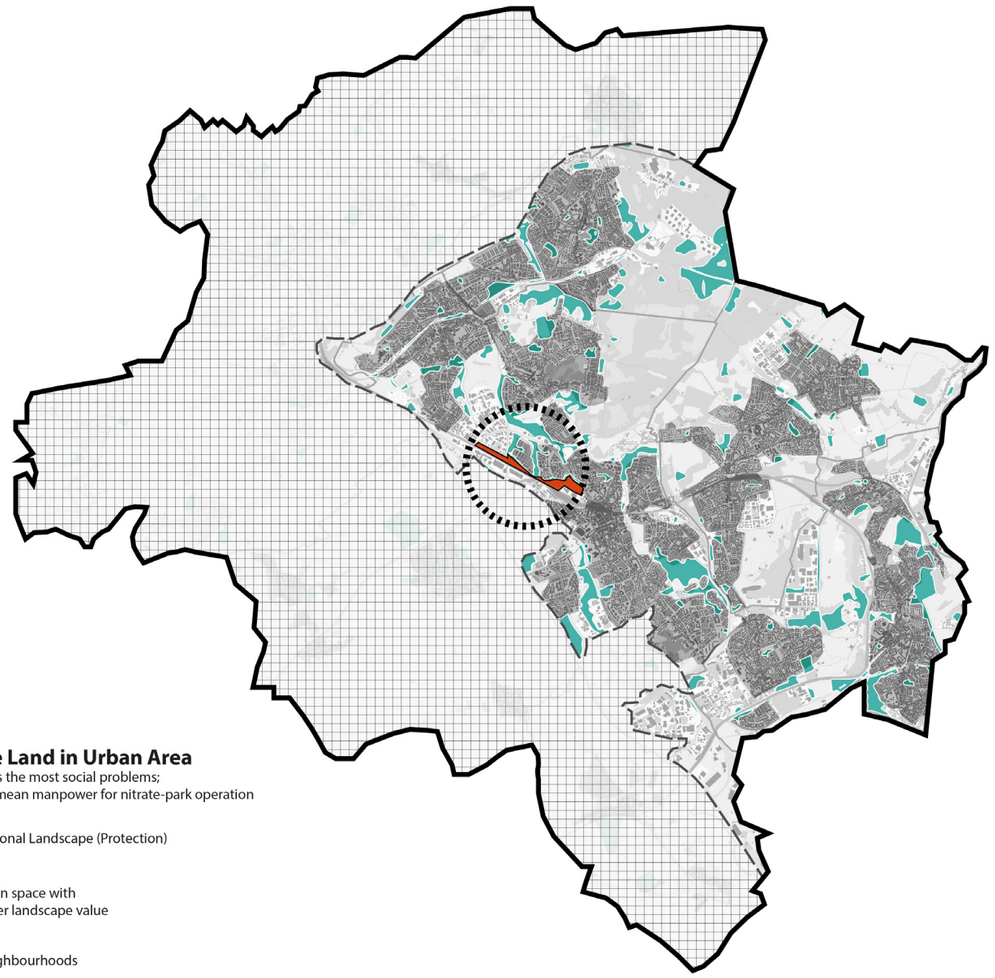
Co-owned Azolla City Park

in Heerlen

Central Park (New York): 341 ha
Maxima Park (Utrecht): 300 ha
Hamburg Stadtpark: 148 ha

Zollverein (Essen): 80 ha
Vondelpark (Amsterdam): 47 ha
Brunssummerheide (Parkstad): ~ 29 ha

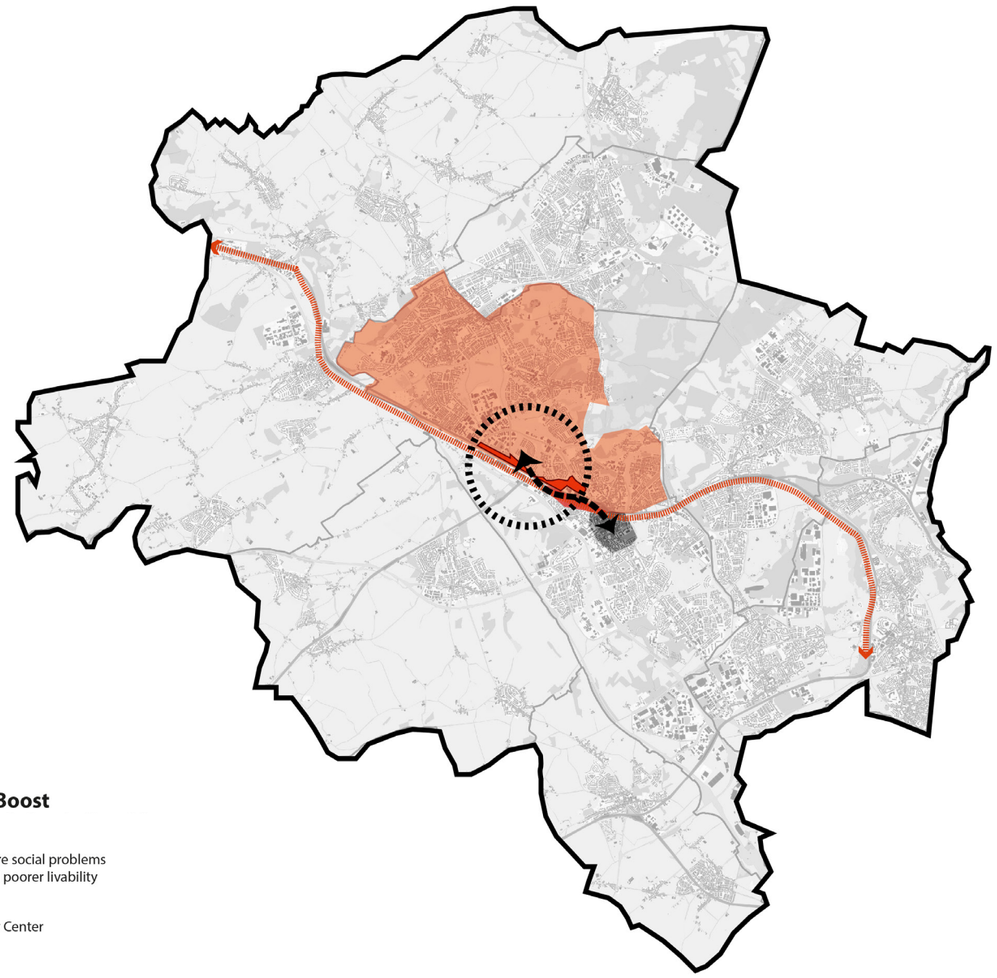
Westerpark (Amsterdam): 11.5 ha
Park spoor Noord (Antwerp): 18 ha



Available Land in Urban Area

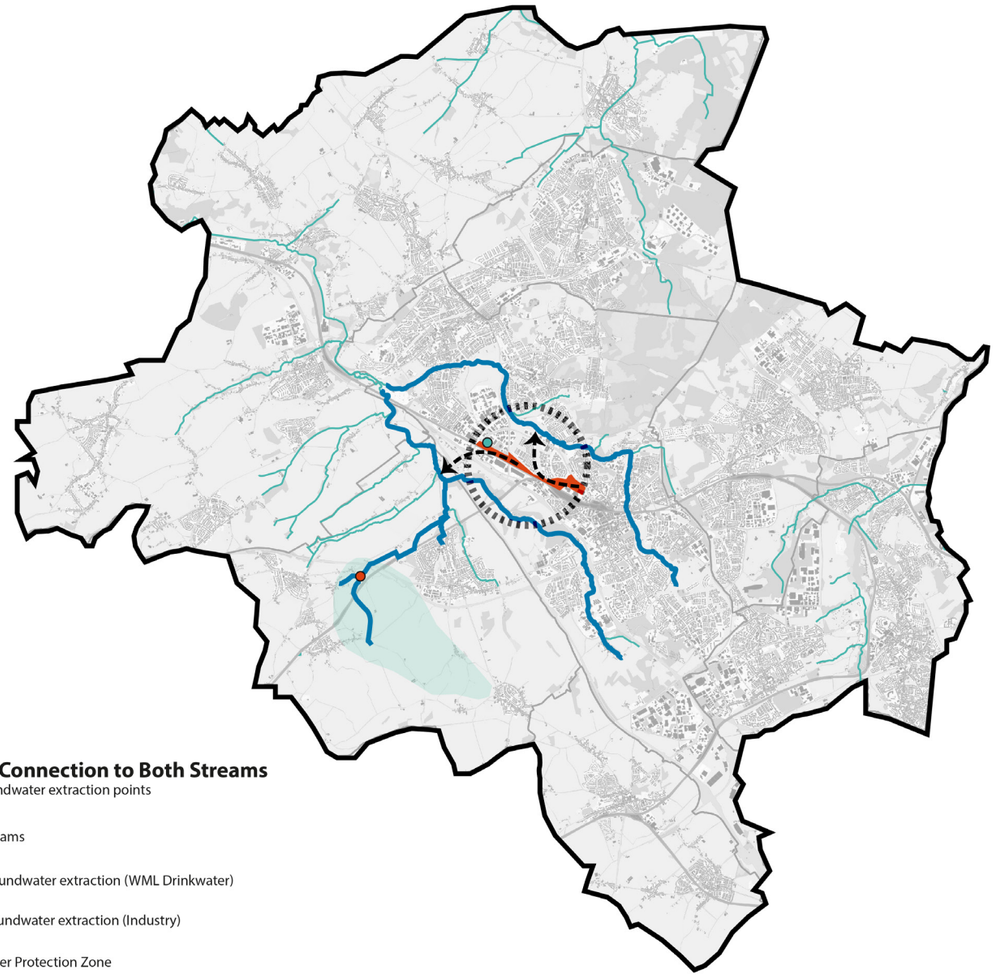
Urban area has the most social problems;
communities mean manpower for nitrate-park operation

- National Landscape (Protection)
- Open space with lower landscape value
- Neighbourhoods



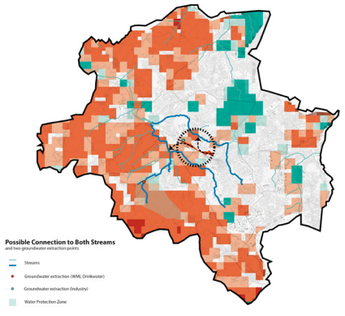
Stitch & Boost

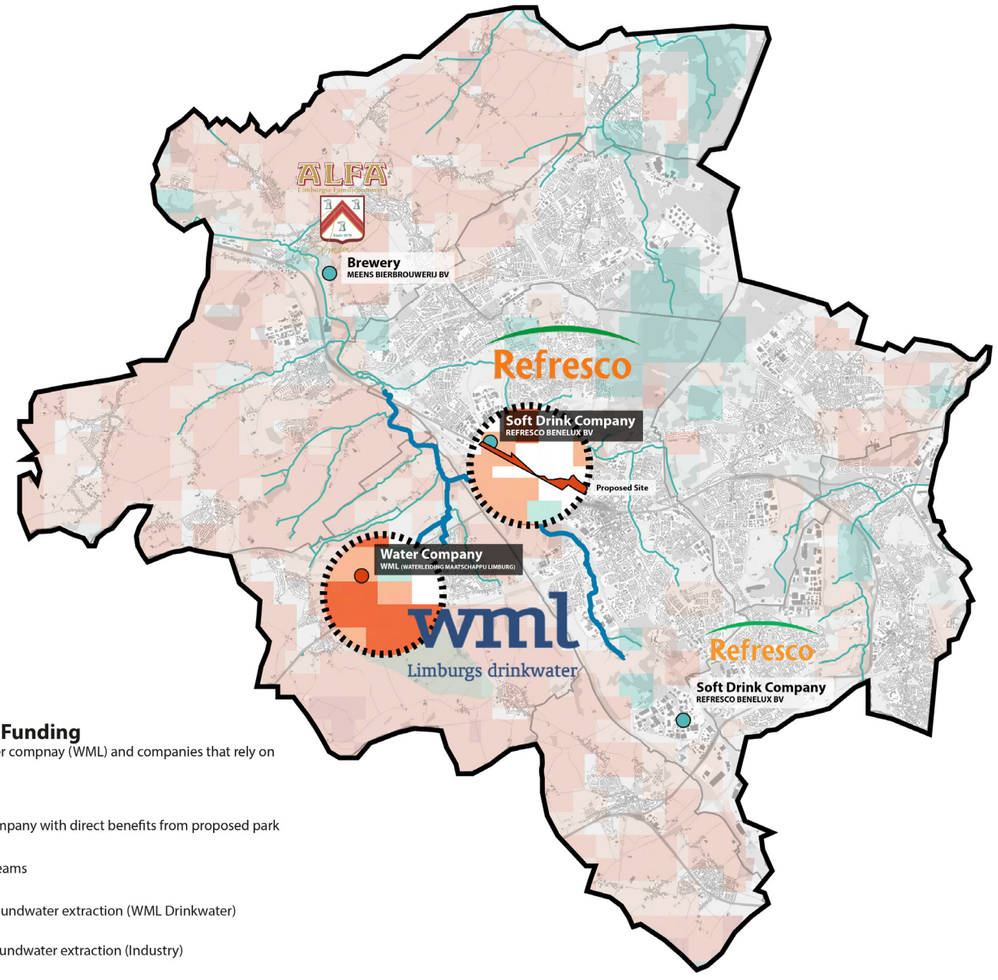
- More social problems and poorer livability
- City Center



Possible Connection to Both Streams
and two groundwater extraction points

- Streams
- Groundwater extraction (WML Drinkwater)
- Groundwater extraction (Industry)
- Water Protection Zone





Possible Funding
from the water compnay (WML) and companies that rely on groundwater

- Company with direct benefits from proposed park
- Streams
- Groundwater extraction (WML Drinkwater)
- Groundwater extraction (Industry)

3.4

DESIGN FINDINGS/ PRINCIPLES OVERVIEW

Principles Summary

Philosophical backbone & inspiration

‘Park’ philosophy

Garden city:
- ‘Cooperative commonwealth’.
- Shared profits and roles
- Stewardship
- Community life

Park Value:
- ‘Instrumental’

(‘park as ‘means to achieve human-desired outcome’)
- ‘Functional’

(‘park contributes to values without intervention of human consciousness’)

‘Social’ Principles

(Repeated) Interactions with other residents or social networks

Participation in collective community activities

Pride or sense of place

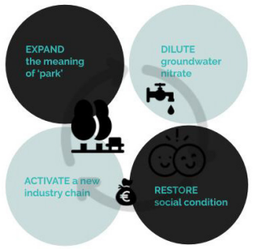
Environmental preference (psychology)

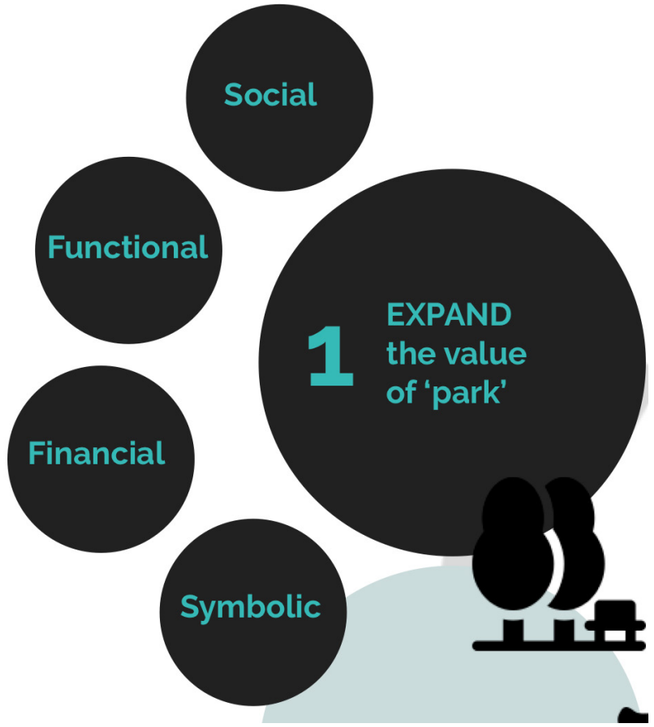
‘Nitrate’ technique

Azolla (water fern)

Alnus tree

Pump & treat method (groundwater)





" In practice, despite political preferences and the available set of instruments, green areas remain a peripheral phenomenon compared with the increasing proliferation of constructed development and traffic areas. Green areas in towns and cities remain vulnerable with their limited financial yield [...] Only by defining and protecting the functions of green areas can they be preserved, yet they are continually under pressure. [Lichtenberger, 1998] "

(Urban Green Blue Grids. para3)

3.5

EXPANDING THE VALUE OF 'PARK'

3.5.1 History and Park Theories

Park Theories

It is important to trace back historical philosophies of park before moving on to a new expansion of park values. As mentioned earlier in the report, definition of urban park is ambiguous but refers generally to open spaces destinated for human recreational purposes in urban area. Historically park/ garden is landscape manipulated by men, it has been used as representation of status and power, for example in formal garden in the 18th - 19th century. Starting from the 19th century park/ green space in urban area starts to carry the concept of mental restoration for urban dwellers; gradually, parks are associated with urban hygiene, bearing functions such as urban lung and urban cooling. Environmentalist idea such as green belt and green corridor in urban area is also on the rise.

Garden City Movement

The Garden City Movement founded by Ebenezer Howard in 1898 is an influential urban planning model aiming to provide sufficient green in a city/ neighbourhood. Parkstad's urban expansion during its industrial period is also influenced by the movement, hence the abundance of greenery in the area. Mining companies and government included green area in neighbourhood planning to provide mine workers with sites for mental restoration and food production.

It is important to note that many neighbourhoods throughout the world merely took the form of the garden city movement without taking the essence of the model.

In The Art of Building a Garden City: Designing new communities for the 21st Century (2019), it is clearly explained that the true essence of the Garden City is in its attempt of being a self-sufficient financial model. As popularity of these new towns rises, Howard intended for the model to capture land value increase and return these eared values for the benefit of the community. Some key Garden City principles are summarised as followed:

'Cooperative commonwealth':
Shared profits, participative roles

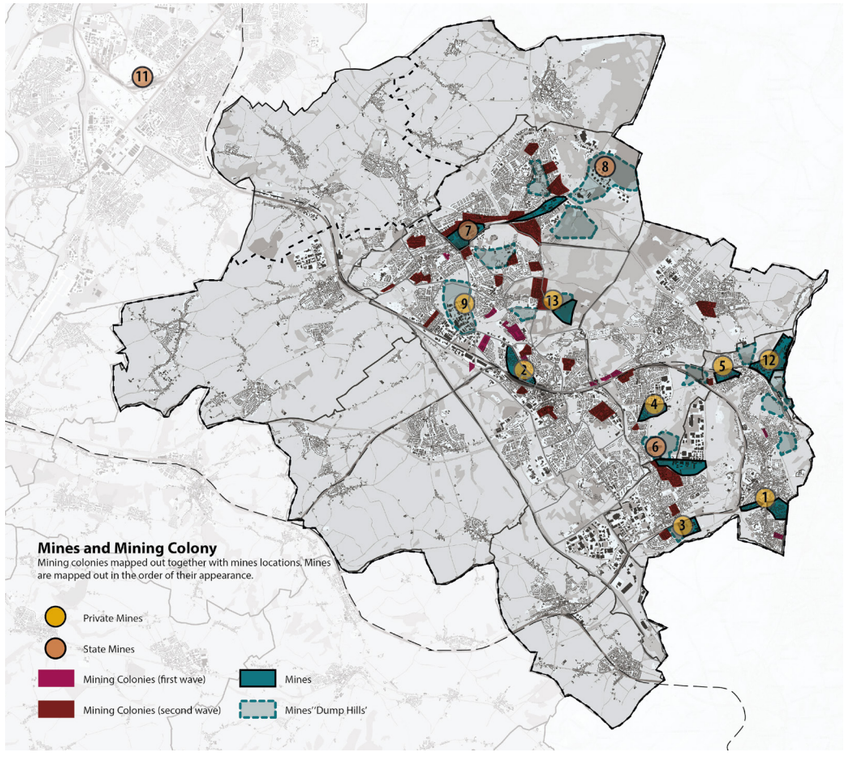
Stewardship:
Leadership, responsibility/ knowledge/ experience exchange

Community life:
Pleasant spaces for social interaction and engagement

Land Value Capture:
for the benefit of community



fig 32. Garden City planning in Parkstad. Map of Parkstad overlayed with 1974 Structure Plan of the region.
Structure Plan Source: Stadsgewest Oostelijk Mijngebied (1974). Collection SHCL. (Weijer, 2018)



3.3.2 Park Value

Geologist Professor Gregory Brown, who is the founder of the Landscape Values and PPGIS Institute referenced eight general park values: 'recreation, natural, development/ economic, social/cultural, wildlife, environmental quality, and futureóare'. He explained that park values may be **'instrumental'** where parks are seen as 'means to achieve desired outcomes' for humans such as recreation; or **'functional'**, where parks 'contribute to another value without intervention of human consciousness', such as ecological benefits for wildlife, or in our case, nitrate remediation. This does not mean 'functional' value require no human effort, it simply means that this value does not reply on 'human consciousness' such as romanticist projection or mental responses towards a park.

3.3.3 The Proposed Values

- Social
- Symbolic
- Functional
- Financial

<u>Social</u>
The park extends social values in two different layers. On one level it facilitates community participation through a new industry and ownership opportunity -- empowering locals; on another level the park also functions as site for social gathering, demonstrating parks' instrumental value as of mental restoration, which is an important prerequisite for healthy social life and sustainable community. See chapter 'Restoring Social Condition' for detail)

<u>Symbolic</u>
The design aims to restore demolished symbols as a way to honour the site's collective identity. The tunnel map is used as pattern framework for the design. Scots Pine are lined up on the ground to symbolises the mine tunnels underneath the site - Scots pine is a typical 'Mijnhout' (Mine-wood) used in constructing mine tunnels as it gives out a cracking sound early before it collaspes, giving miners enough time to escape. Small features in the design like the 'tunnel' gallery and corten steel design features also highlight the site's industrial past. The two water fountains (combined with groundwater pump, used for pond-filling, see next chapter for detail) is a poetic gesture to symbolise the two landmark chimney towers, which were once the tallest building in Europe and were significant landmark of the city.



fig 33. History of the site -- Oranje-Nassau I coal mine with the two chimneys famously known as Heerlen's landmark until their demolition.
Source: https://m.limburger.nl/cnt/dmf20170322_00038032/heerlen-krijgt-enorme-schoorsteen-lichtbundels-terug



Impression of Heerlen and the site --- mining landmark demolition, economic shrinkage, CBS office building, urban decay and vacancy.

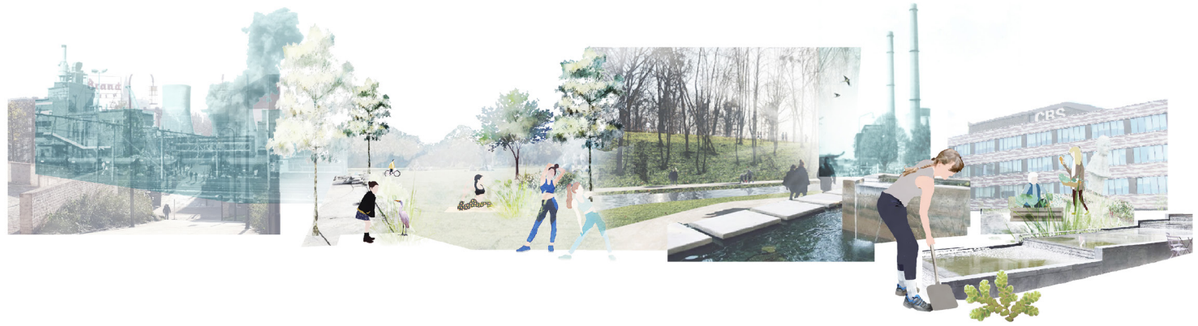
Functional

Nitrate remediation gives the park its functional value -- values without the need to involve human's mind or consciousness; it is also a value that can better define and better position the park in an economic shrinking area. The proposed model argues that a park that integrates essential function (groundwater remediation and securing future drinking water) can become an integral part of the city instead of a 'negative investment'.

The azolla production and trees dilute groundwater nitrate, with potential benefit to water company or drinks company.

Financial

Not only does the park become the platform for a completely new Azolla industry and offer employment opportunity, becasue of the possible benefits it will bring to the water company and the juice manufaction company next to the site, it adds incentives for these company to invest in the park. Additionally, azolla park is likely to attract research institution and innovative start-ups, these also contribute to the funding of the park.



The collage depicts symbol restoration, ground for mental restoration and azolla production implemented as water feature.

3.5 DILUTING GROUND-WATER NITRATE

3.5.1 Denitrification in Landscape Approach

Meeting with Bob Ursem

To seek for professional advice, on 7 Jan I had a meeting with Bob Ursem at his office. Ursem is the director of the TU Delft Botanical Garden, and also teaches in Applied Science and Bio-Technology. He has expertise across many fields including Botany, Biotechnology, Electrochemistry, Green Chemistry and Elementary Particle Physics.

According to Ursem, the two most effective nitrate solution with natural bio mean are Azolla (an aquatic fern), and Alnus (a genus of tree). Both of these plants contain useful nitrogen-fixing bacteria, such as the Rhizobium bacteria and the Frankia bacteria.

3.5.2 Azolla the Magical Plant

Azolla is a tiny floating aquatic fern. The species Azolla filiculoides is widely spread in the Netherlands. They can be found in still or slow-moving waterbody such as ponds, canals and ditches. Azolla has a symbiotic relationship with the microscopic filamentous blue-green alga, also known as cyanobacterium (Anabaena azollae), giving it its nitrogen-fixing property. Azolla can take up nitrate from water, as well as phosphate. It can therefore perform remarkably in water remediation.

Not only does Azolla perform nitrogen-removal, it is also an extremely useful crop. Azolla contains rich nutrient and it is high in protein content. It has been widely cultivated, especially in Asia, as animal feed. It can also be made into human food. Many food science research is looking into this at the moment. In 'The Azolla Cooking and Cultivation Project' (2012), Stockholm-based artist Erik Sjödin documented his experiments with azolla including small scale cultivation, food making and public tasting, he also published several azolla recipes, such as azolla pancake, azolla bread and azolla soup. As a highly nutritious and sustainable food source, Sjödin referred to Azolla as the 'green gold mine' (Erik , 2018).

Azolla is also an effective green manure, a bio-fertiliser. According to Ursem, azolla is also being manufactured into industrial glues. Utrecht University, along with many other universities in the world, is also looking into the potential of Azolla as renewable energy such as biofuel (Utrecht University, 2019).

In terms of visual effect, azolla are tiny ferns that are sometimes used to decorate ponds, they are green but changes colour to red in autumn or when there is nutrient deficiency.



(see fig 21)



(see fig 22)



fig 34. Sjödin, E. (2010). The Azolla Cooking and Cultivation Project. source: http://www.gemenskapspraktik.se/projects/theazollacookingandcultivationproject/



THE AZOLLA COOKING
AND CULTIVATION PROJECT



fig 35. Sjödin, E. (2010). Azolla bread. source: http://www.gemenskapspraktik.se/projects/theazollacookingandcultivationproject/



fig 36. Azolla as livestock feed. source: solraya.blogspot.com



fig 37. Azolla turning red. Source: Nicholls, D. (2009). Watermead Country Park. photograph. https://www.naturespot.org.uk/species/water-fern.

3.5.3 Pump & Treat with Azolla ponds/ constructed weland

Pump & Treat with Azolla ponds

'Pump and Treat' is a widely used technique for treating contaminated groundwater. In a general sense, it is a system where one or more extraction points are used to pump out groundwater that is contaminated, the water will then be brought to some form of treatment mechanisms, such as air stripping or carbon adsorption, or it can be brought to the surface for biological treatment (Brusseau, 2019). Normally, clean water is then injected back to the subsurface to dilute target area where the contaminations are.
In our case, nitrate is wide-spreading in the area's groundwater; according to Ursem, a more direct, low cost and sensible way is to release cleaned water (water with less nitrate concentration) back into natural surface water, which will ultimately enter back into the groundwater as water travels naturally through the water system.

In the proposed design, Pump and Treat will be used together with azolla production ponds.

Constructed Wetland

Constructed wetland or heliophyte ponds are also widely used as a method for water treatment. In this project they can be used as an additional way to remove nitrate. Nitrates will be absorbed as a form of nitrogen uptake by reeds or heliophytes.

3.5.4 Pond Size

Conventional Production Use Ponds

Although azolla cultivation is popular and common across the world, so far there has not been any azolla project in large production scale. Plants in similar cultivation property such as duckweed and algae however, do appear in large scale production. The project therefore reference pools design and research of duckweed farm or algae farm.

The types of open-culture pond systems for algae production are as followed: stirred or unstirred tanks, shallow big ponds, circular ponds and raceway ponds (Hallmann, 2016) Circular ponds and raceway ponds have a very industrial look, that is why in this project I want to experiment with 'tank' type ponds, to get a more friendly gesture in the setting of an urban park.

3.5.5 Harvest Method, Cycle and Nitrogen-fixation Rate

Azolla can be harvested by simply scooping them out from the waterbody with net or by hand. Large scale harvest can be done by machinery.

The following harvest methods are methods for duckweed harvesting in ponds and ditches they are documented in Wageningen UR Livestock Research 'Purifying manure effluents with duckweed': Wheeled excavators, automatic solar-powered conveyor belt, Duckweed Guzzler with belt and Aquatic weed harvesters.

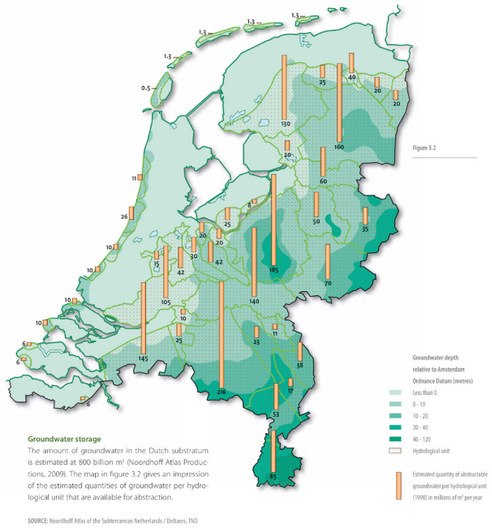
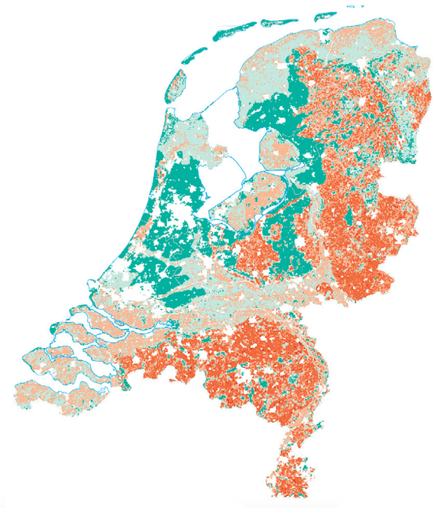
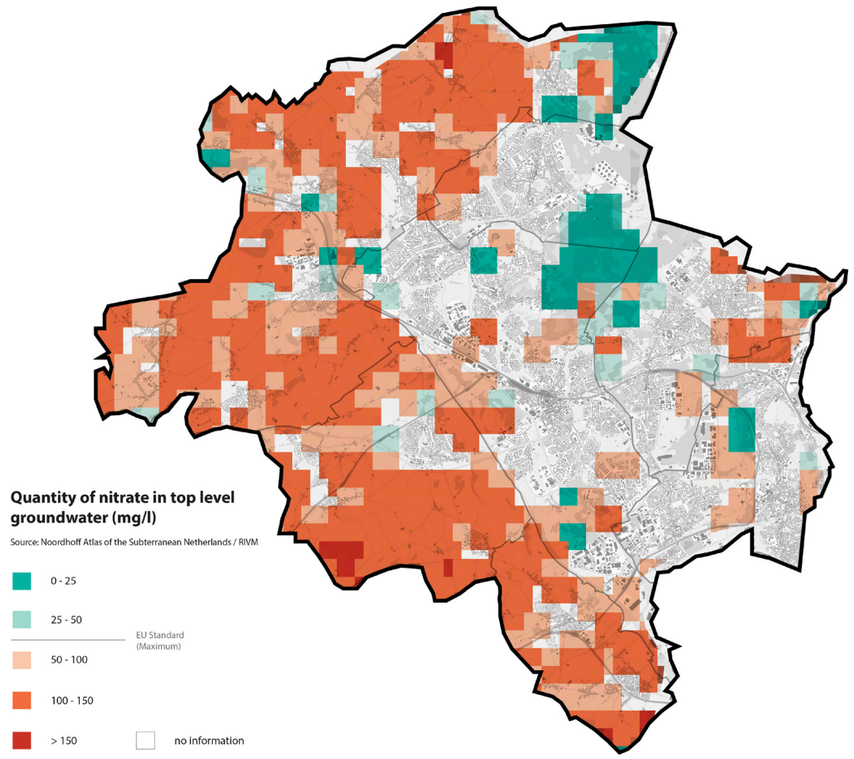


fig 38. Deltares, TNO



(see fig. 18)



(see fig. 19)





fig 39. Harvesting with aquatic weed harvester. 'Purifying manure effluents with duckweed', p.16



fig 40. Azolla harvest with net. Source: http://www.xinhuanet.com/english/2019-08/07/c_138289430_7.htm



fig 41. Paddling in fern-filled water. Source: https://www.dailymail.co.uk/sciencetech/article-3161195/Would-eat-pond-scum-Protein-rich-powder-duckweed-help-feed-world.html

Harvesting cycle

Azolla is a fast-growing fern. According to Ursem, azolla spread easily in water and double in mass every two week. The harvest cycle suggested by Ursem is to take azolla out (azolla harvest) **once they have filled up a pond**, each time we harvest we should leave some percentage of the azolla ferns so they will reproduce and fill up the pond again. During my research I have found other harvesting cycles, such as **harvesting small percentage of azolla on a daily basis**. Both of these methods would work so there is a flexibility in terms of harvest frequency, park users' interaction with the azolla culture, and in terms of visual/ colour effect.

For simple calculation, if we follow the harvest frequency suggested by Ursem, it would mean starting azolla cultivation in any pond size with a 25% full azolla culture mass, in four weeks time pond will be filled to a 100% coverage and can then be harvested (harvest 75%; the remaining 25% will repopulate the ponds).

Nitrogen Fixation rate

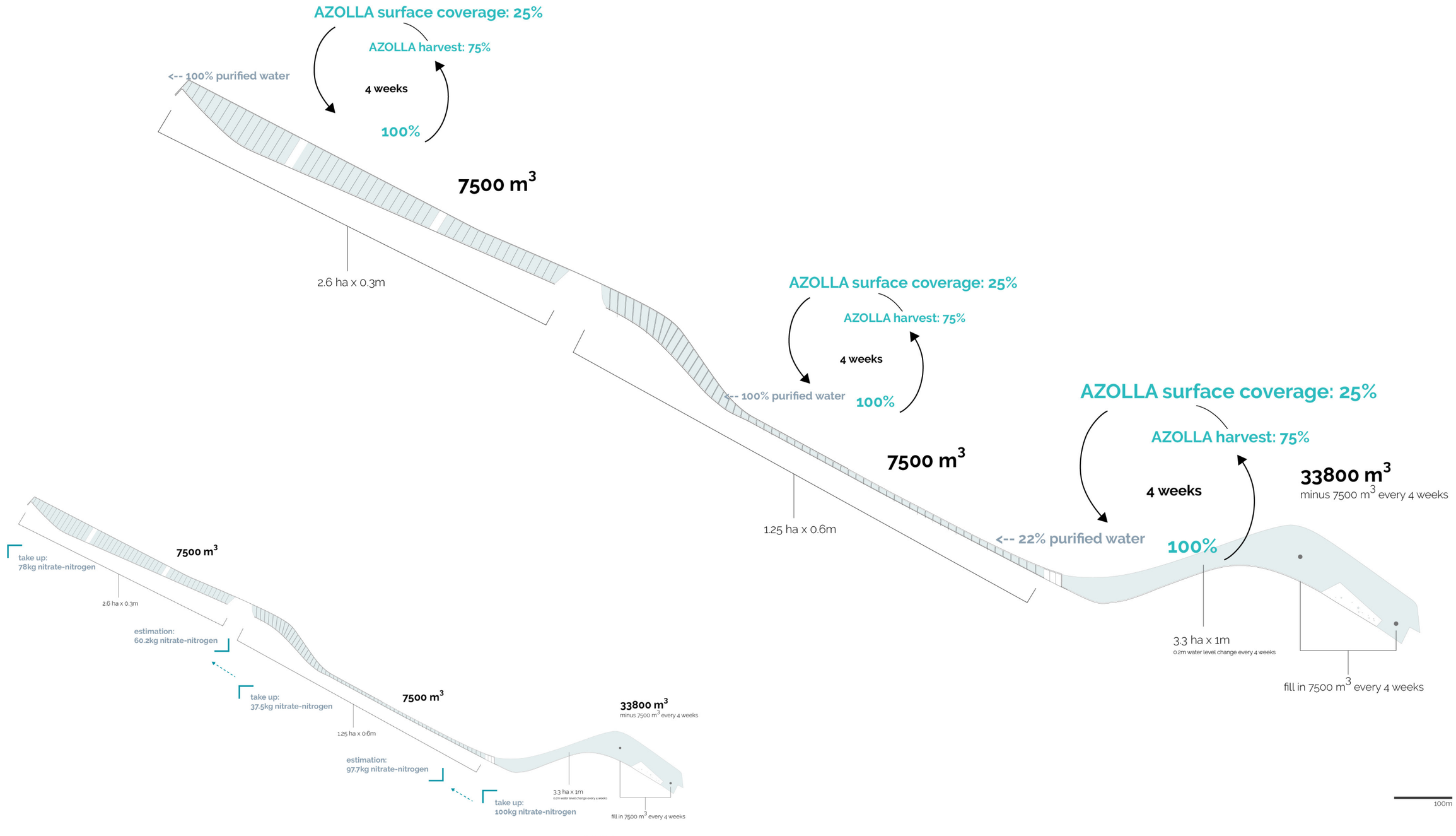
As for nitrogen-fixation rate with Azolla, Ursem has provided me with a simple formula: 30 kilograms of nitrogen per hectare per two weeks, or 480 kg of nitrogen per year (assuming about 8 months growth period).

The following excel table (fig.42) documents my calculation and experimentation with different pond size and depth. The level of nitrate-nitrogen (nitrogen content in nitrate) is converted based on top level groundwater nitrate data from the Dutch Drinking Water Statistics report (2012).

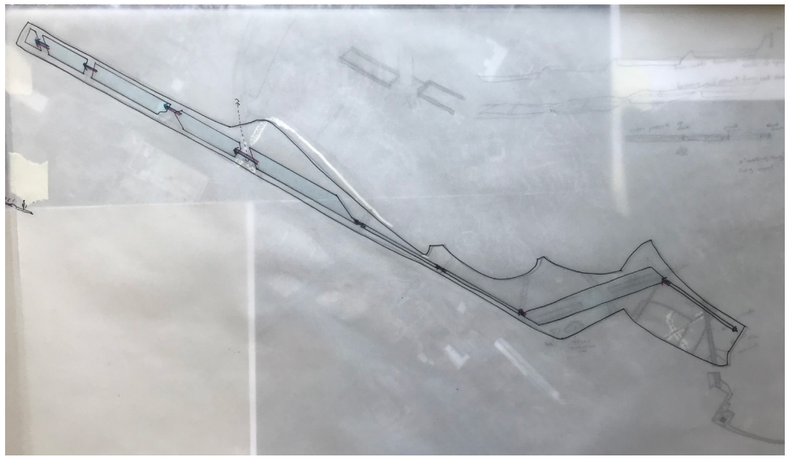
pond size and mass double rate					amount of water	Nitrate concentration		Nitrogen concentration	Nitrogen fixation (kg)			1year	2years	
	height	m2	ha	m3	L	(assuming 75mg/l)	kg of nitrate	kg of nitrate-nitrogen	in 4 weeks (1 month)	in 5 months	in 4 months	in 8 months (512 weeks)		25% Azolla coverage (m2)
new testing1		2500000000	250000		1m3 = 1000L				7500000			62000000		625000000
one of the ponds	1m	158721	15.8721	158721	158721000	11904075000	11904.075	2618.8965	476.163	2380.815	1904.652	3809.304	7618.608	39680.25
	2m								18%	90.90%	72.73%			
	1m	71920	7.192		71920000	5394000000	5394	1186.68	215.76			1726.08	3452.16	17980
		2000	0.2	2000	2000000	150000000	150	33	6	30	24	48	96	
									18%	90.91%	72.73%			
	0.5m			1000	1000000	75000000	75	16.5	only **2 to 3 months**					
	0.2m	900	0.09	180	180000	13500000	13.5	2.97	2.7	13.5	10.8			
									only **4 weeks**	454.55%				
		7500	0.75	7500	7500000	562500000	562.5	123.75	22.5	112.5	90	180	360	1875
		1000												
		38505	3.8505	38505	38505000	2887875000	2887.875	635.3325	115.515	577.575	462.06	924.12	1848.24	9626.25
									90% in 4 to 5 months					
big pond	1m	33871	3.3871	33871	33871000	2540325000	2540.325	558.8715	101.613	508.065	406.452			
									18.18%					
						12886363.64		457.2585						
small ponds	0.3m (original)	700	0.07	210	210000	15750000	15.75	3.465	2.1	10.5	8.4			
small ponds	0.3m (new nitrate rati	700	0.07	210	210000	1286363.64	12.88636364	2.835	2.1	10.5	8.4			
		250	0.025	75	75000	5625000	5.625	1.2375	0.75	3.75	3			
		250	0.025	62.5	62500	3835227.273	3.835227273	0.84375	0.75	3.75	3			
small ponds together		41010	4.101	12303	12303000	754956818.2	754.9568182	166.0905	123.03	615.15	492.12			
		26888	2.6888	8066.4	8066400	604980000	604.98	133.0956	80.664	403.32	322.656			

fig 42. Excel form for calculation. By author

Azolla harvest cycle + Nitrogen remediation



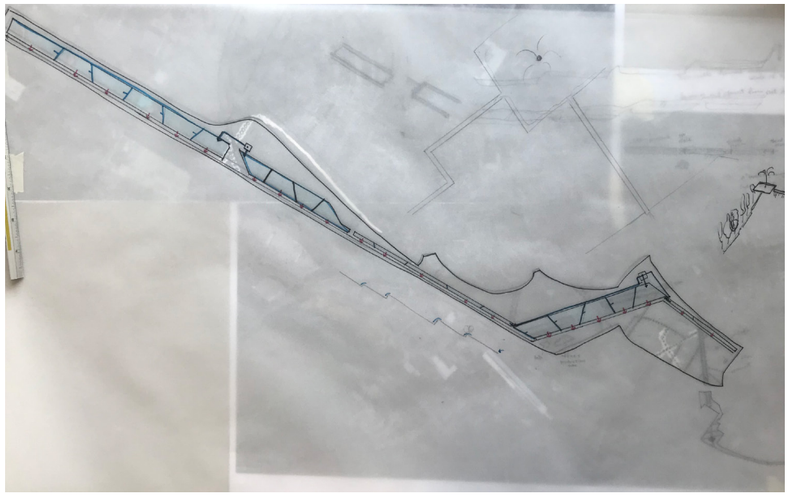
Big Ponds (Lake) Pros and Cons



- Azolla harvest frequency is the same with any pond size; but deeper depth means more azolla cycles to perform significant nitrogen-removal in water with high-level nitrate.

- 1m deep for paddling.
- Big lake/ 'Grand Canal' scenic effect and recreational
- Harder harvest (need to use boat/ machine)

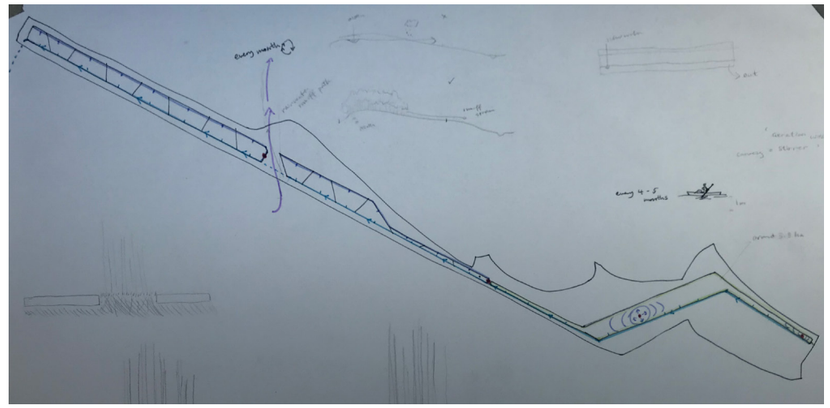
Small Ponds Pros and Cons



-_Azolla harvest frequency is the same, shallower depth means less cycle required to to perform significant nitrogen-removal in water with high-level nitrate.

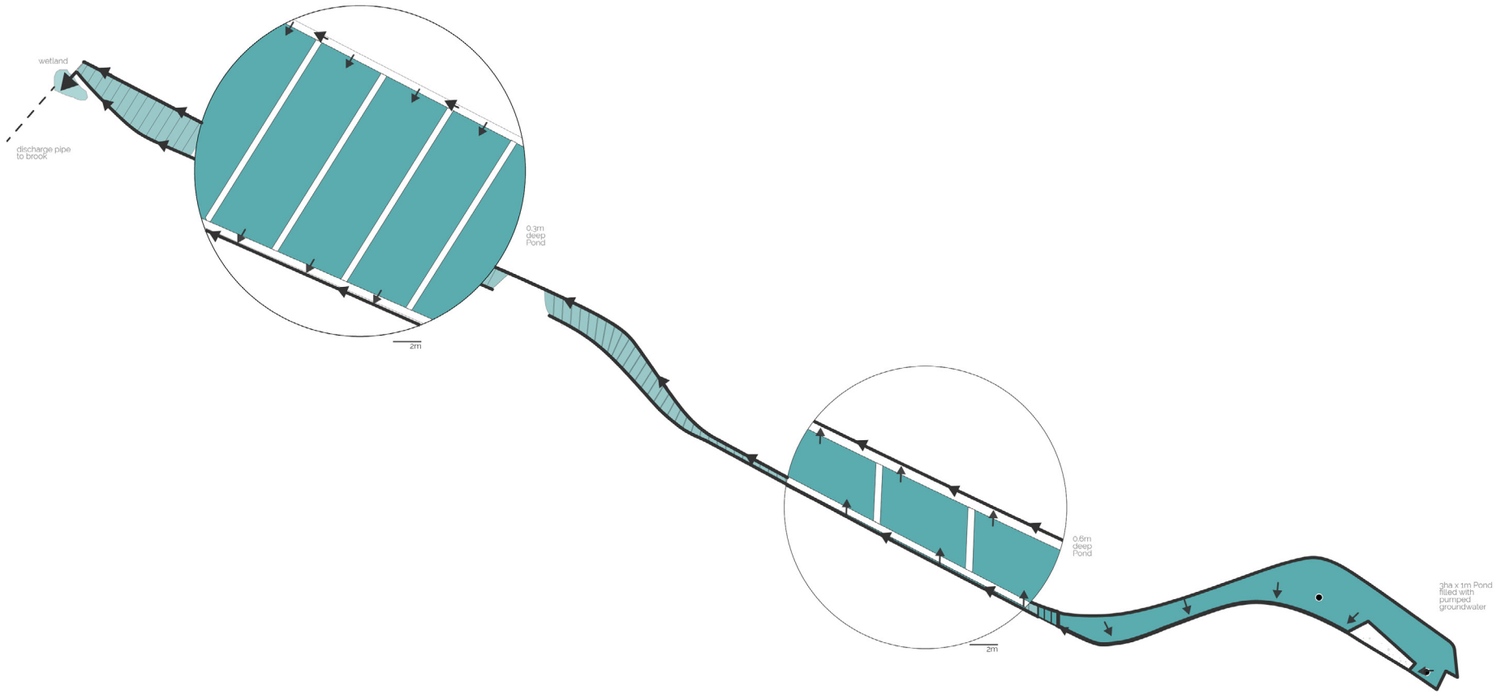
- 0.3m deep
- Better control and easier harvest
- 'intensive-looking'
- more shallow -> frequent water change (water feature)

Combined Proposal



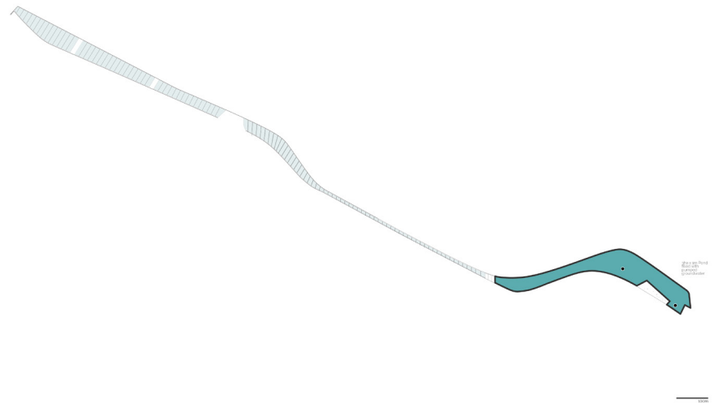
Design decision: a combined version for more diverse spatial effect and benefits. Big pond provides additional recreation opportunity. Ponds height: 1m / 0.6m / 0.3m

3.5.6 Proposed Water System



Water Systems demonstrated in steps

1



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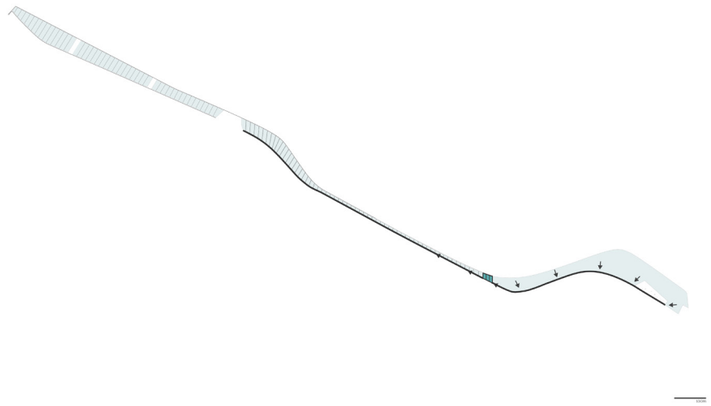

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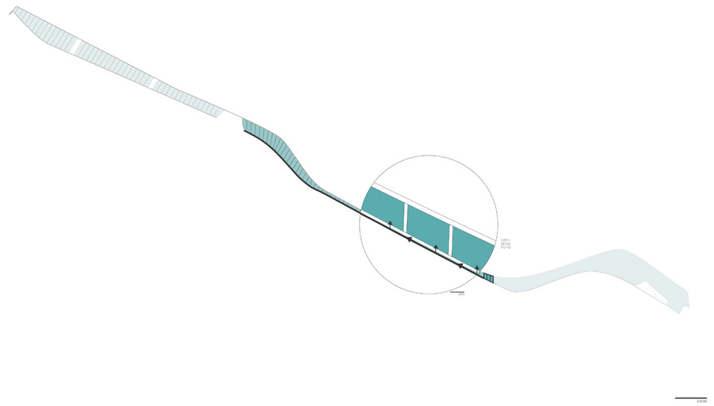

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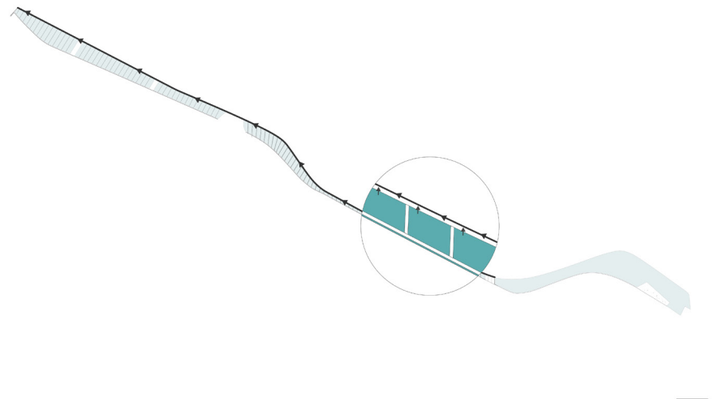

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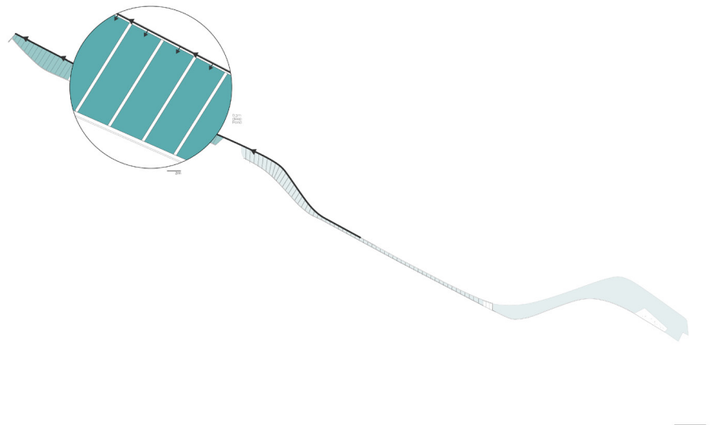

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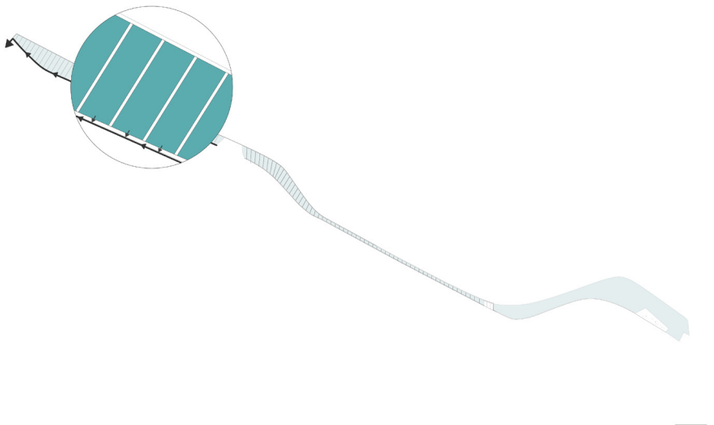

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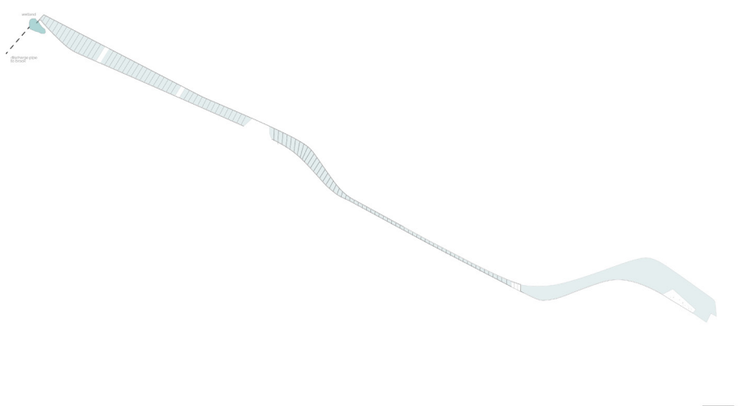
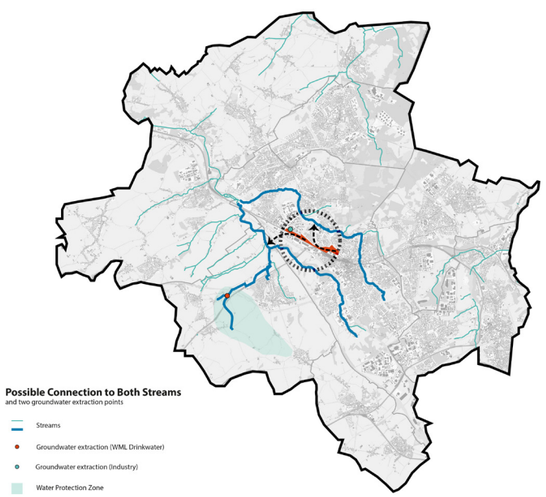




Possible Connection to Both Streams
and two groundwater extraction points

- Streams
- Groundwater extraction (WML Drinkwater)
- Groundwater extraction (Industry)
- Water Protection Zone

3.6

RESTORING SOCIAL CONDITION

3.6.1 Social Problems/ Conditions to Tackle

As mentioned in the chapter 'Scope & Definition', the definition of social problem is– 'any condition or behavior that has negative consequences for large numbers of people and that is generally recognized as a condition or behavior that needs to be addressed. This definition has both an objective component and a subjective component.' (Social problems: continuity and change, 2015)

Below are a summary of social problems in Heerlen that the design aim to address:

- lost of identity

- unemployment

- feel low in control

- mental wellbeing (loneliness and unsatisfaction with environment)

- low social participation and cohesion

3.6.2 Identity, Employment, Empowerment

The proposed management model of the park is a co-funded and co-owned public space, It is also a hybrid form of park and a community cooperative. This gives new identity and to the people, and it empowers the people to take more control, and a more personal relationship with the 'common'.

The morphological and spatial decision of the design address also another form of identity. The design aims to honour the site's past identity (industry - Coal mine) while at the same time introducing a new identity (industry - azolla production).

3.6.3 Principles for Socially Sustainable Community

In the article 'Searching for Social Sustainability: The Case of the Shrinking City of Heerlen, The Netherlands' (2016), Ročak, Hospers and Reverda dug deep into the topic of social sustainability, They summed up the most frequently discussed areas that are combined in the discussion of social sustainability, such as 'sense of place, trust, participation and resources, empowerment, cultural identity, and quality of life'. They gave a very thorough analysis on Heerlen in terms of social sustainability, in which they cover areas from social demographics, local culture/ mentality, identity associated with social-economic status and city image/ urban decay, trust, participation and empowerment, and argues that, based on academic and policy literature, the following three aspects are most likely to help sustain communities, especially those in shrinking condition **'interaction with other residents or social networks, participation in collective community activities, and pride or sense of place'**

Resources	Empowerment	Participation
•Trust: people feel they can trust their co-residents and local organizations responsible for governing their area. •Place attachment: people feel connected to their co-residents, their home area, have a sense of belonging to the place and its people.	•People feel they have a voice thatis listened to. •People are involved in the processes that affect them. •People can themselves take action to initiate changes.	•People take part in social and community activities. •People cooperate with each other through formal and informal groups to further their interests. •Interaction with family and friends and other residents or social networks. Support given and received when needed.

Figure 1. Social capital indicators in the context of urban shrinkage (based on: Bramley and Power [62], Colantonio and Dixon [65] and Forrest and Kearns [71]).

fig 43. 'Social capital indicators in context of urban shrinkage (Ročak et al., 2016, p.5)

3.6.4 Participation and Empowerment:

In the book Palaces For The People (2018), Eric Klinenberg, professor of sociology wrote about 'how social infrastructure can help fight inequality, polarization and the decline of civic life', he also stated the importance of (repeated) 'interaction' and participation -- 'social cohesion develops through repeated human interaction and joint participation in shared projects, not merely from a principled commitment to abstract values and beliefs. Not only have these findings highlighted the importance of spatial and programme design (for a desired place that enables 'repeated interaction' and 'pride or sense of place'), they have also led me into developing a management/ financial model as part of my design, in an attempt to achieve community empowerment (the management/ financial model will be covered in the next chapter).

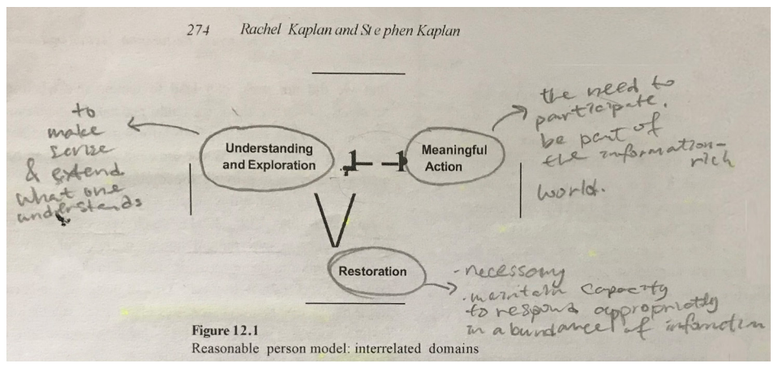


fig 44. the RPM model with author's notes. Diagram from (Barlett et al., 2005, p.274)

3.6.5 Principles for Mental Wellbeing & Environmental Psychology

With an aim to increase chance of interaction and pride/ sense of place, it is essential to understand what makes an environment attractive to people. This leads to research in the area of environmental psychology. Rachel and Stephen Kaplan are one of the most influential figures in this area, From a 'cognitive information-processing perspective' they developed the Reasonable Personal Model (RPM), stating the three domains of informational needs: Exploration and understanding', 'Restoration', ad 'meaningful action'. They also developed the environmental preference matrix that is still widely used today:

	UNDERSTANDING	EXPLORATION
Immediate	**Coherence** Organization – Ease in which the environment can be read or understood	**Complexity** Richness – Variety of objects [*rather than the number of objects*]
Inferred	**Legibility** Wayfinding – Ease of understanding orientation	**Mystery**[5] Sustained interest – Potential for more information

figX. Kaplan & Kaplan Preference Matrix Model (Kaplan&Kaplan, 1992)(Jennings)

3.6.6 Proposed Principles Model

To summarise and translate these research into usable design principles and ingredient, I developed the following social-restoration principle models based on my personal understandings and interpretations. My theory is that the bottom foundation layer should be firstly fulfilled in order to further advance to the next layer of social-restoration goal.



fig. 45. Community Empowerment principles by author

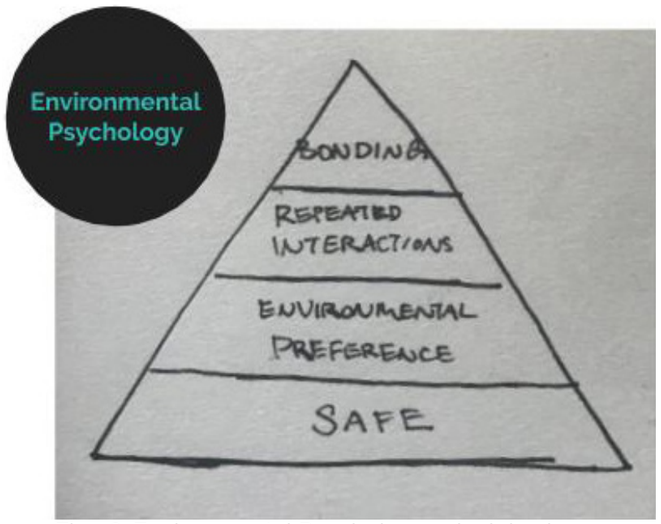
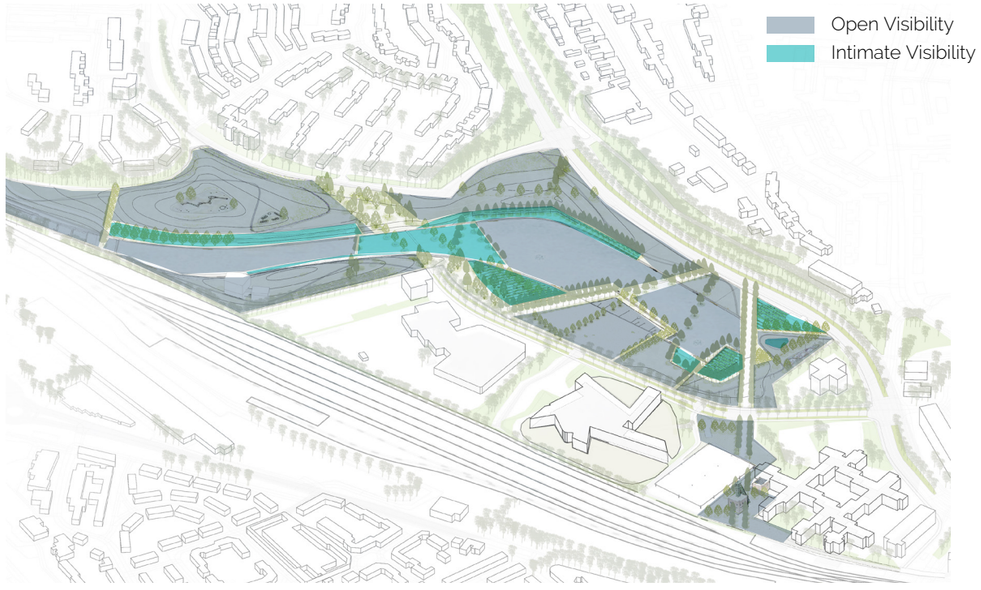
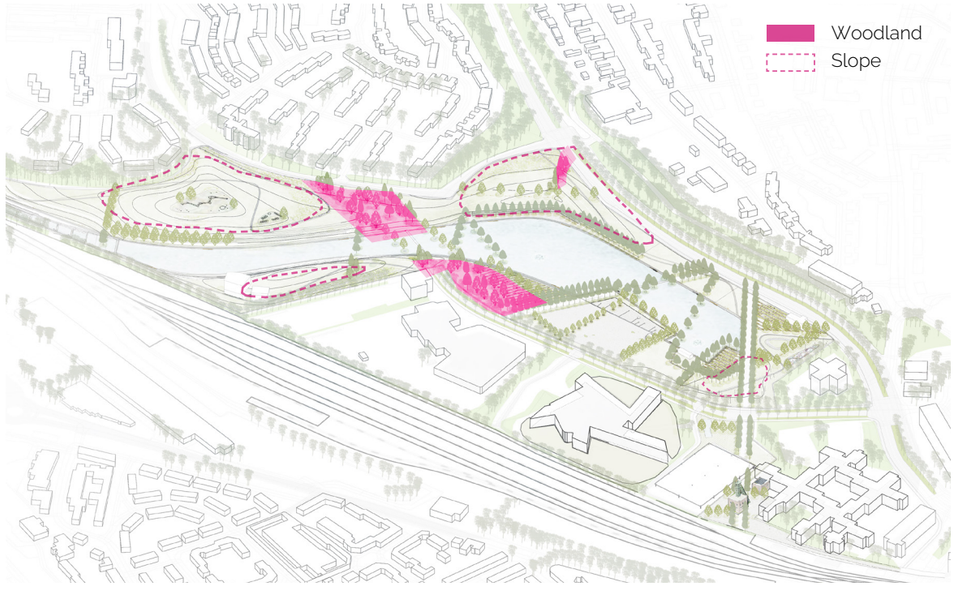


Fig 46. Environmental Psychology principles by

3.6.7 Visibility, Sense of Security & Spatial Preference

Perception of safety is an important factor in the design. Heerlen has a negative perception of safety, this will decrease people's incentive in using public spaces. The park ensures high visibility but contains some 'narrow woodlands' or nature escape areas, including slopes, to add in zones of curiosity and romantic escape. Such mixture of visibility and curiosity is designed based on Kaplan & Kaplan environmental preference matrix principles.





3.7

ACTIVATING
A NEW FINANCIAL MODEL

3.7.1 Co-funding

Co-funding, or crowd-funding is an emerging urban project financial model. I look into the successful crowdfund project Luchtsingel, Rotterdam as an inspiration to come up with this management model.

3.7.2 Azolla Park Cooperative

One step further than crowd-funding is co-ownership. I propose to position this productive azolla park as a co-owned park Co-Op, locals will be given the opportunity to buy a small share of the park, and the profits this park make will be given back to all individual investors.

<u>Products, Urban Farming</u>
Azolla is nutrient rich and can be made into organic compost. This becomes products to be purchased by the agricultural sector or within the park in urban farm areas.

<u>Restaurants, Cafe</u>
The restaurant and cafe in the park can on one hand grow produce using azolla compost, and on the other hand prepare azolla food.

3.7.3 Research Institutions and Start-ups

As mentioned earlier in the report, azolla is a new rising hit in the research and innovation realm. The new azolla park provides spaces for institutions and start-ups with a destinated lab and start-up office building. These would also mean funding or rent-profit for the park corporate.

3.7.4 Fundings From Water-Related Company

With the park's groundwater-cleaning property, water company and other water-related company such as the juice manufacture company next to the site, it will increase incentives for these companies to invest in the park.



Fig 47. Donater's name will be engraved in the Luchtsingel's bridge. Source: http://www.morethangreen.es/en/luchtsingel-pedestrian-bridge-crowdfunding-urbanism-in-rotterdam/



Fig 48. Luchtsingel, Rotterdam. Source: http://www.morethangreen.es/en/luchtsingel-pedestrian-bridge-crowdfunding-urbanism-in-rotterdam/

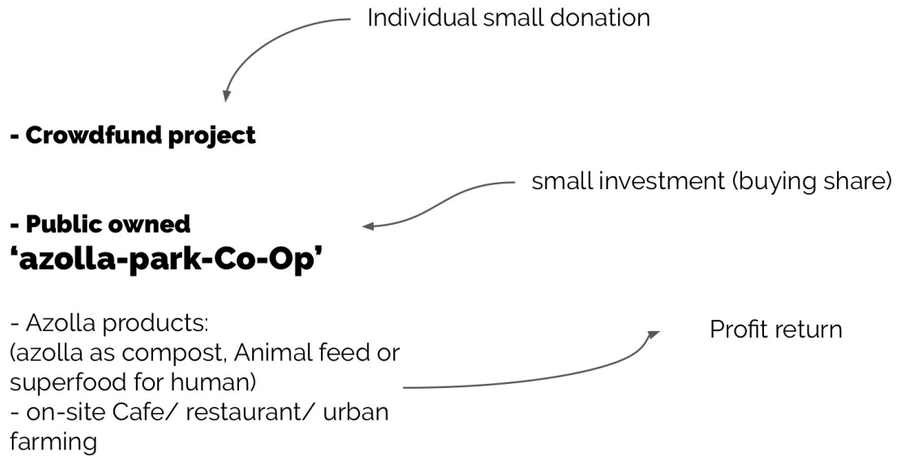




Fig 49. Urban Azolla Production, Market and Production. Initial collage by author

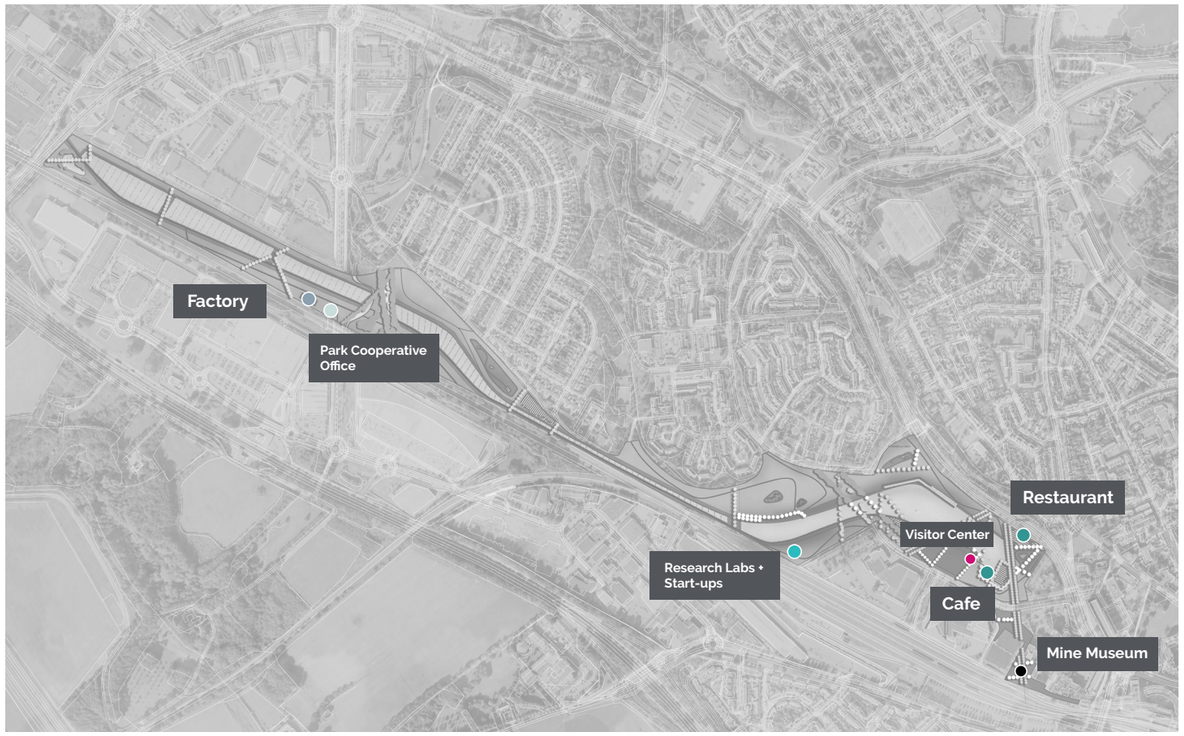


Fig 50. Building facility in Azolla City Park



Fig 51. Urban Farming and Market Square

3.7.5 Azolla Products and Quantity (example: quantity to product translation)

Azolla Products

Formula:
Every 1 m^2 = 0.15 to 0.5 kg (per day)

Every 1kg = 1 dairy cow supplement (per day)
9kg = 100 chicken supplement (per day)

Quantity of Site:
Total water surface: 7.15 ha (71500 m^2)

10725 kg to
35750 kg fresh azolla (per day)

"An area of 4-4.5 m^2 and 10-15 cm deep can produce about 2 kg/d of fresh azolla, enough to supplement 2 dairy cows." (per day)

https://www.feedipedia.org/node/5661#:~:text=An%20area%20of%204%2D4.5,to%20supplement%20two%20dairy%20cows.

'A poultry farm with 100 birds will require about 9 kg of fresh Azolla/day to replace 20% of the commercial feed'
(Subudhi & Singh, 1978)

Subudhi, B & Singh, P. 1978. Nutritive value of the water fern Azolla pinnata for chicks. Poultry Science. vol. 57. pp. 123-124.

- Milk yield increases 15 - 20%
- Milk quality improvement

As Supplement feed for 35750 dairy cows (per day)



- Egg quality + quantity improvement

As Supplement feed for 400000 chicken (per day)

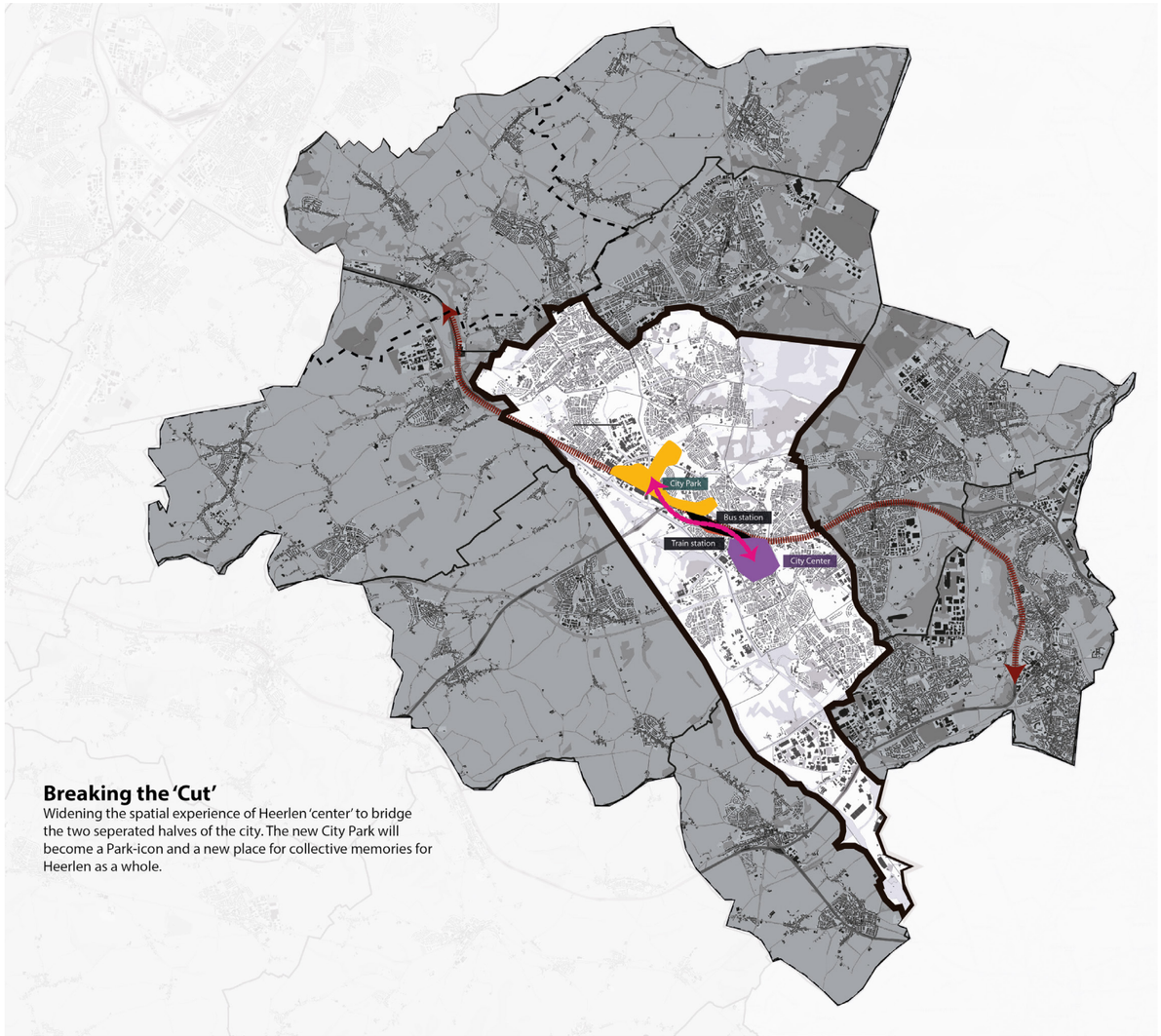


04

RESULTS/DESIGN

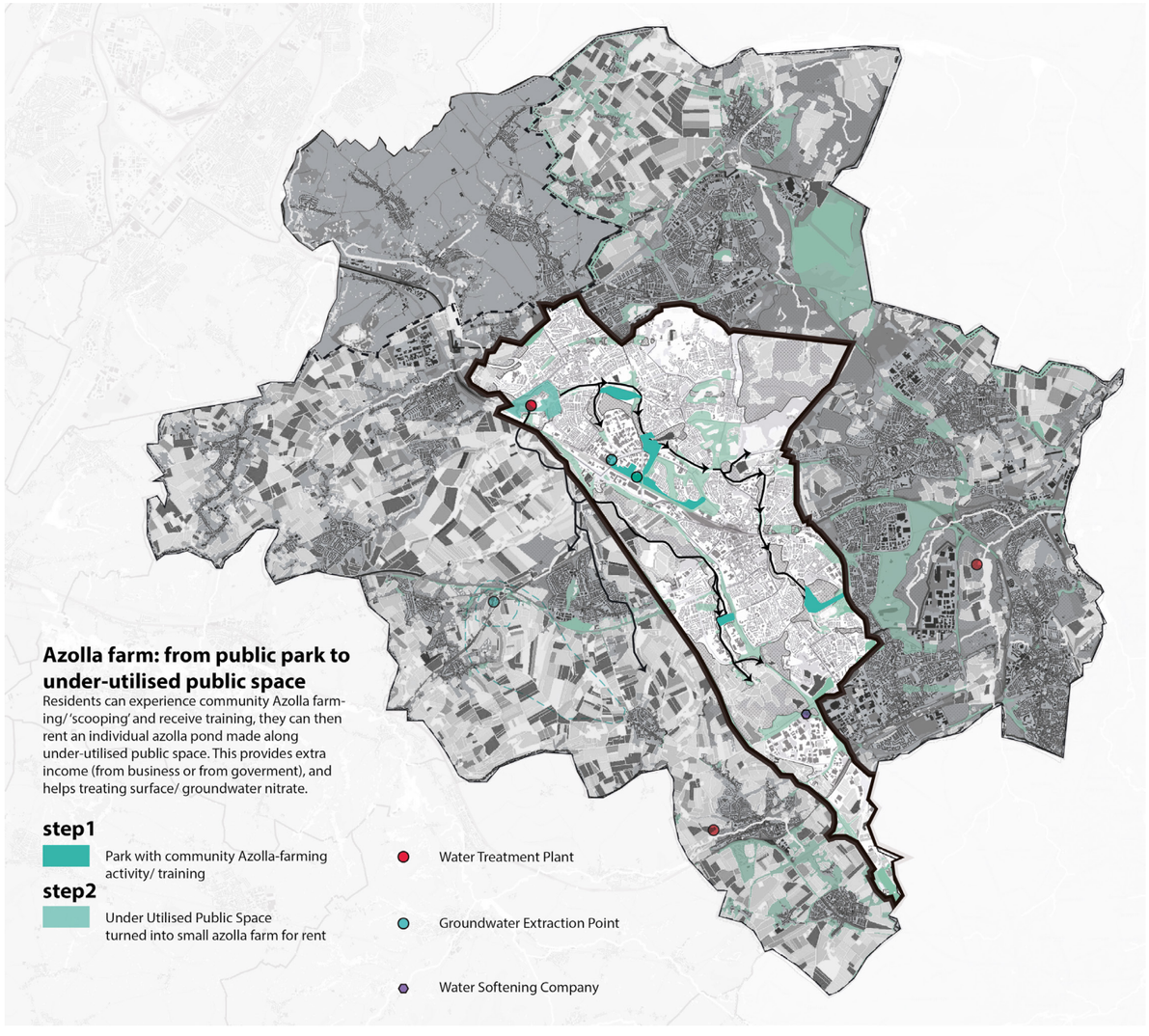
4.1

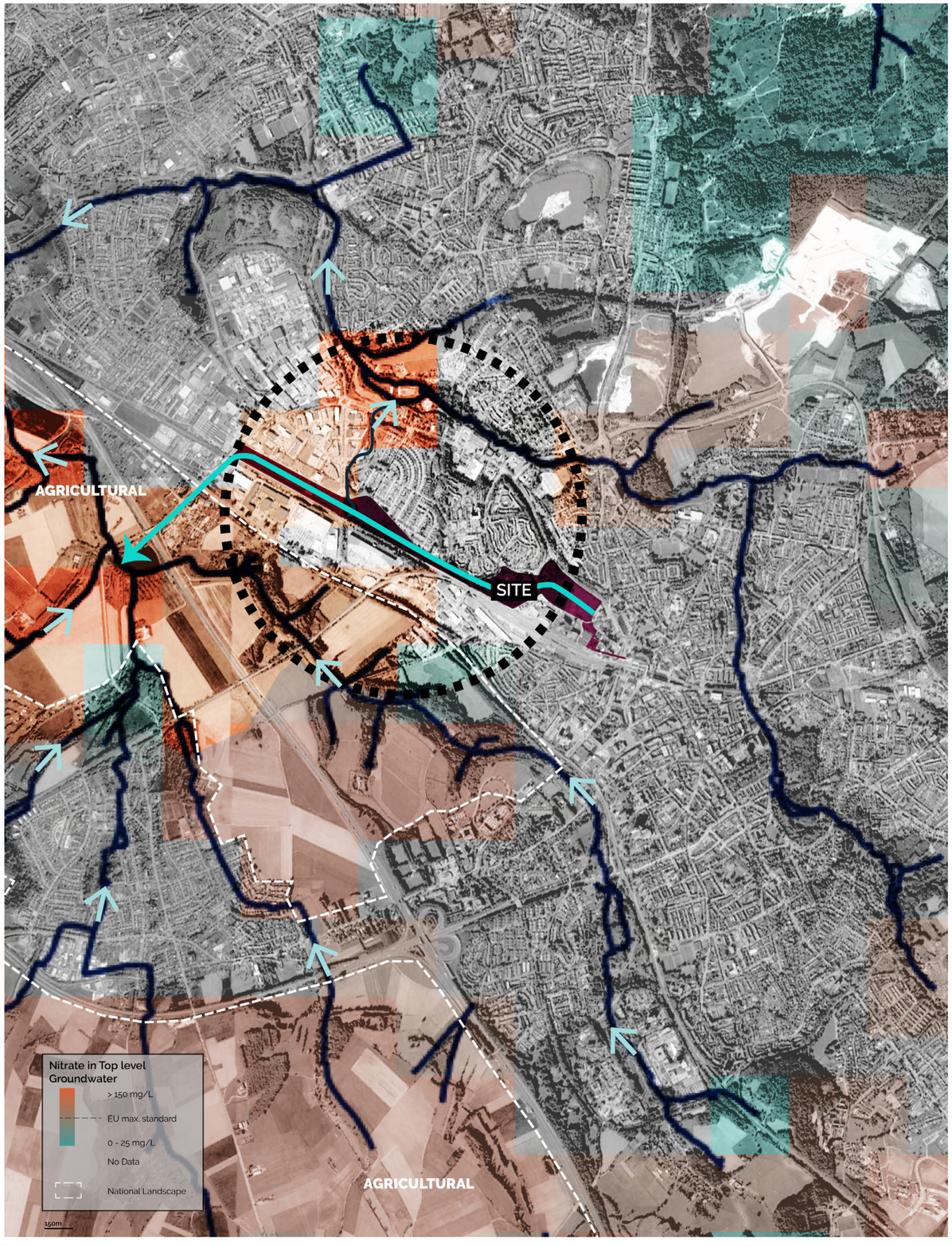
REGIONAL SCHEME



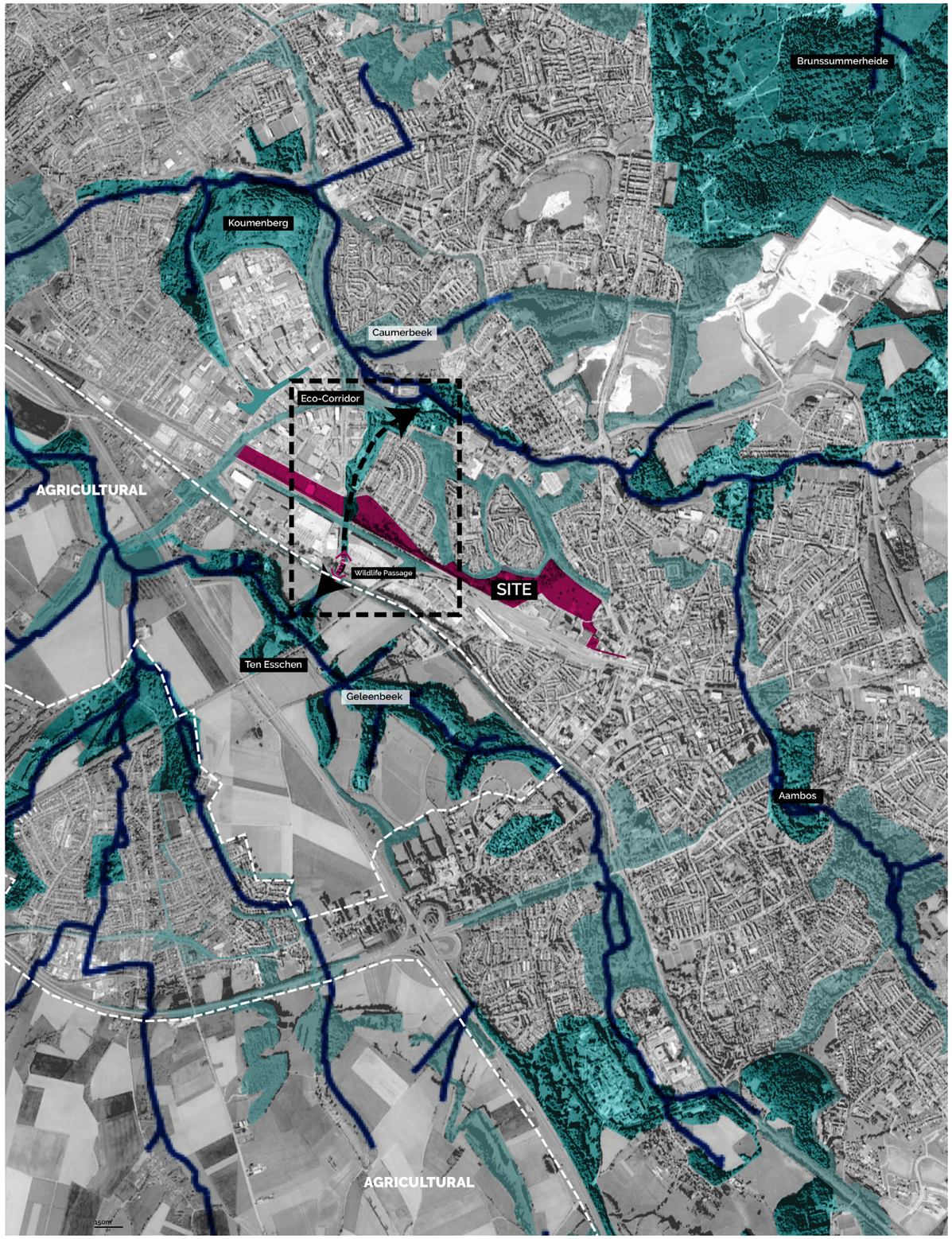
Breaking the 'Cut'
Widening the spatial experience of Heerlen 'center' to bridge the two seperated halves of the city. The new City Park will become a Park-icon and a new place for collective memories for Heerlen as a whole.




Azolla farm: from public park to under-utilised public space
Residents can experience community Azolla farming/'scooping' and receive training, they can then rent an individual azolla pond made along under-utilised public space. This provides extra income (from business or from goverment), and helps treating surface/ groundwater nitrate.
step1
Park with community Azolla-farming activity/ training
step2
Under Utilised Public Space turned into small azolla farm for rent
Water Treatment Plant
Groundwater Extraction Point
Water Softening Company


AGRICULTURAL
SITE
AGRICULTURAL
Nitrate in Top level Groundwater
> 150 mg/L
EU max. standard
0 - 25 mg/L
No Data
National Landscape
150m


Hoensbroek
Business Park
Business Park
(Car Companies)
AGRICULTURAL
Nieuw-Husken
Grasbroek - Musschemig - Schandelen (GMS)
IKEA
'Living' Retail
(Woonboulevard)
Zeswegen
Musschemig
Grasbroek
SITE
Government Office
Office Building
Schandelen
Eikenderveld
City Center
Residential
Neighbourhood
Key Nature Reserve
or Naturalistic Parks
National Landscape/
Protected-face
AGRICULTURAL


Brunssummerheide
Koumenberg
Caumerbeek
Eco-Corridor
AGRICULTURAL
Wildlife Passage
SITE
Ten Esschen
Geleenbeek
Aambos
AGRICULTURAL
150m



The city park acts as a new core to surrounding colony-neighbourhoods, replacing and reactivating the relationship between the ON1 Coal Mine and the Mining colony housing neighbourhoods.

4.2 DESIGN CONCEPT

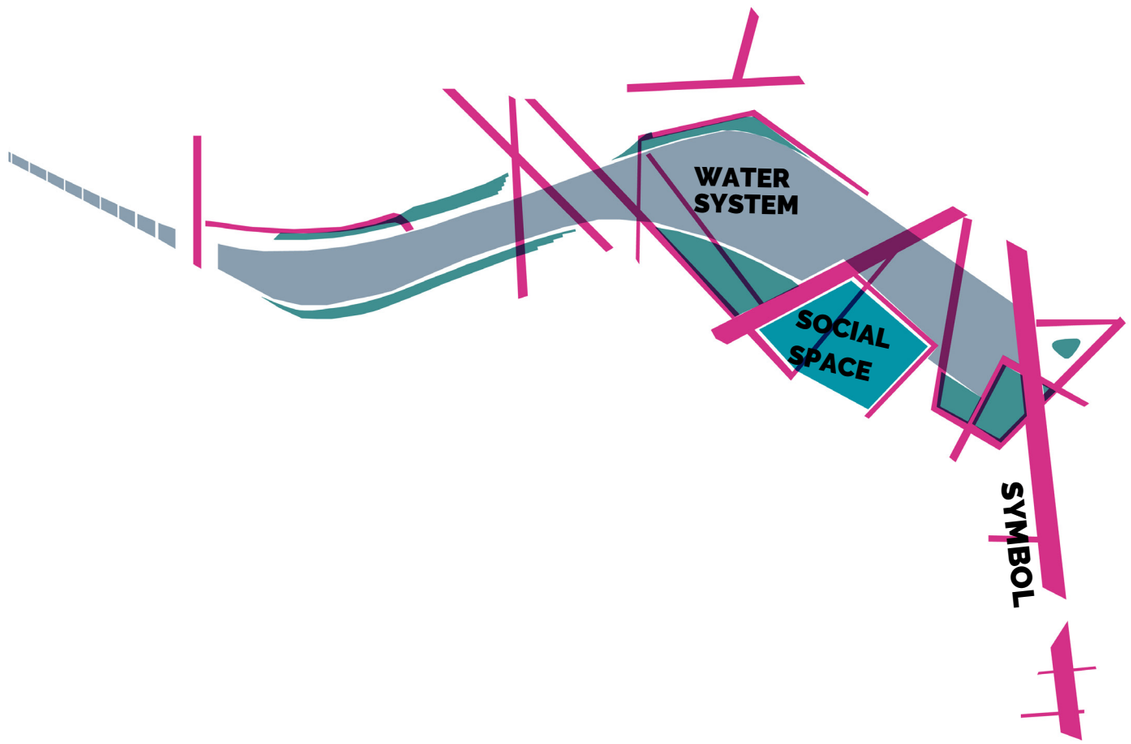
Design Implementation Concept

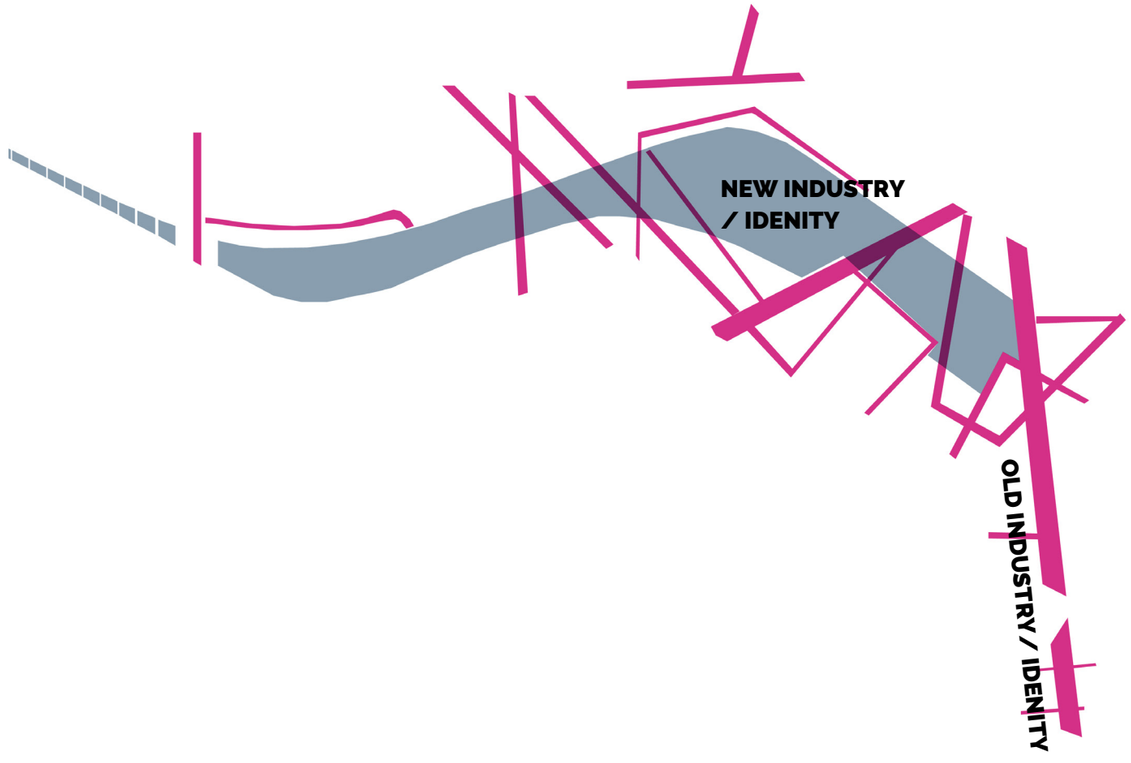
The design implementation is an exploration to **redefine and reutilise 'park' through the marrying of social restoration and nitrate remediation,**the design product is a park model that carries multiple values.

In terms of design morphology and design language, the following key-words sum up the design concept of the park -- COEXISTENCE and RHYTHM. Coexistence refers to symbolic and spatial experience of overlapping layers -- social layer, nitrate-remediation layer, past and present layer, surface and underground layer. Rhythm refers to rhythm of water system, azolla harvest cycle and rhythm of spatial experience, such as sound of water flow, water spectacles and programme.

COEXISTENCE ——— of 'Social' life and Nitrate-remediation system

RHYTHM ——— of water system and park users' spatial experience





DESIGN CONCEPT

Redefining a new industry in the shadow of an old industry

Utilising site's history and landform

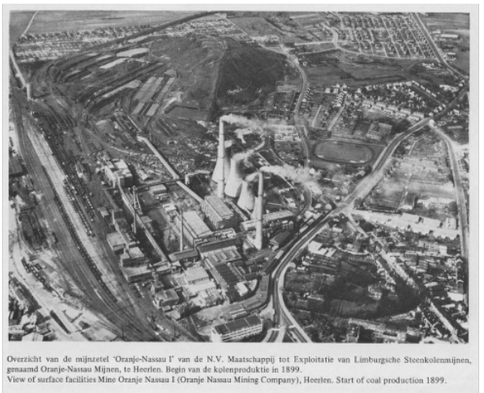


Fig 52. Source: https://repository.tudelft.nl/view/MMP/uuid:99bd9b89-d6f2-4207-bb0d-3281b3446a82

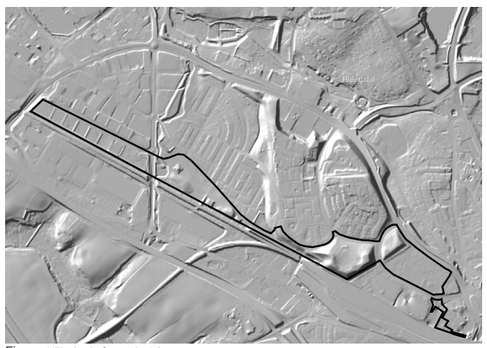
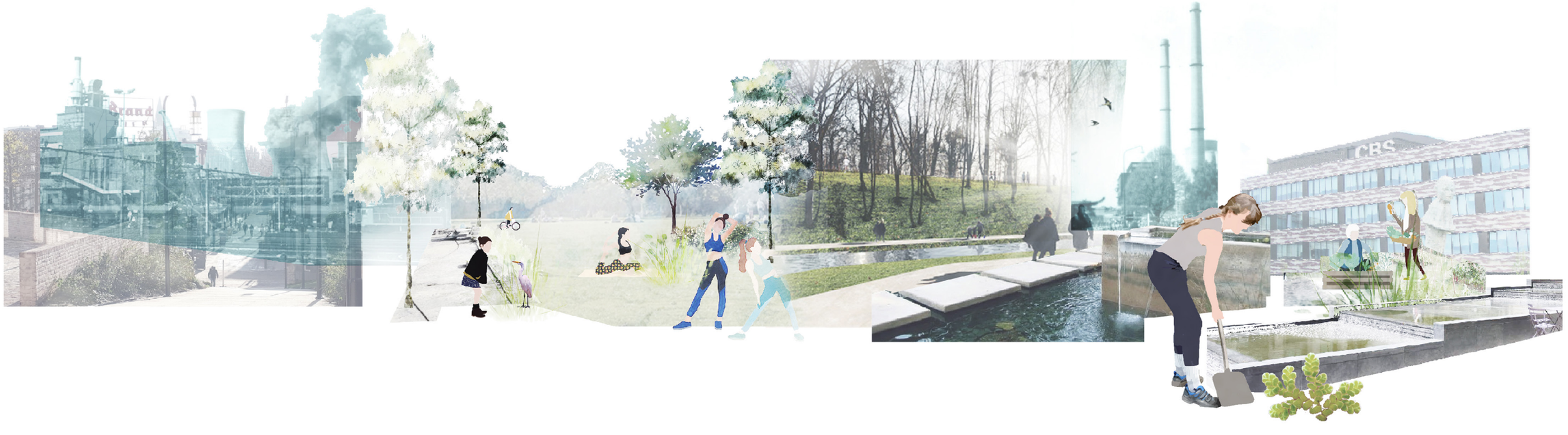


Fig 53. Hillsshade from Ahn Viewer

Utilising the overlapping potential of 'Social' and 'Nitrate'



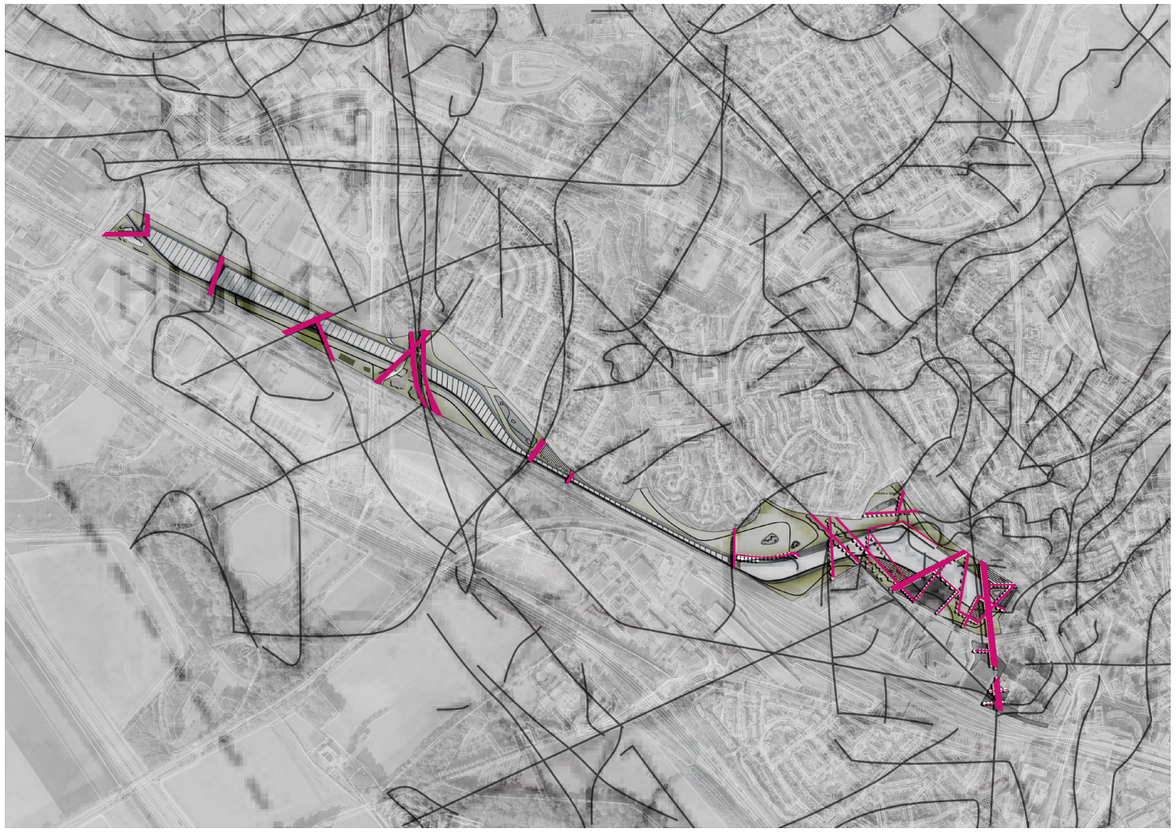


Fig 54. Mining tunnel mapping overlaid with masterplan design

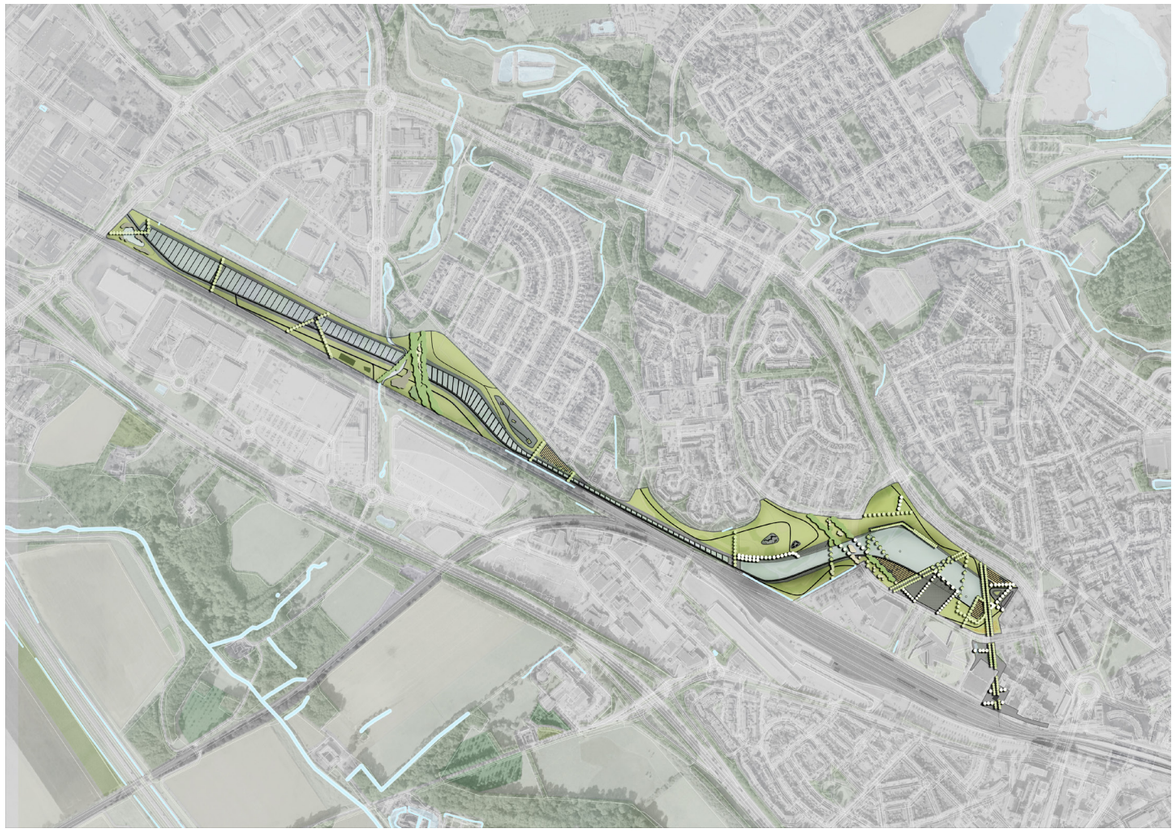
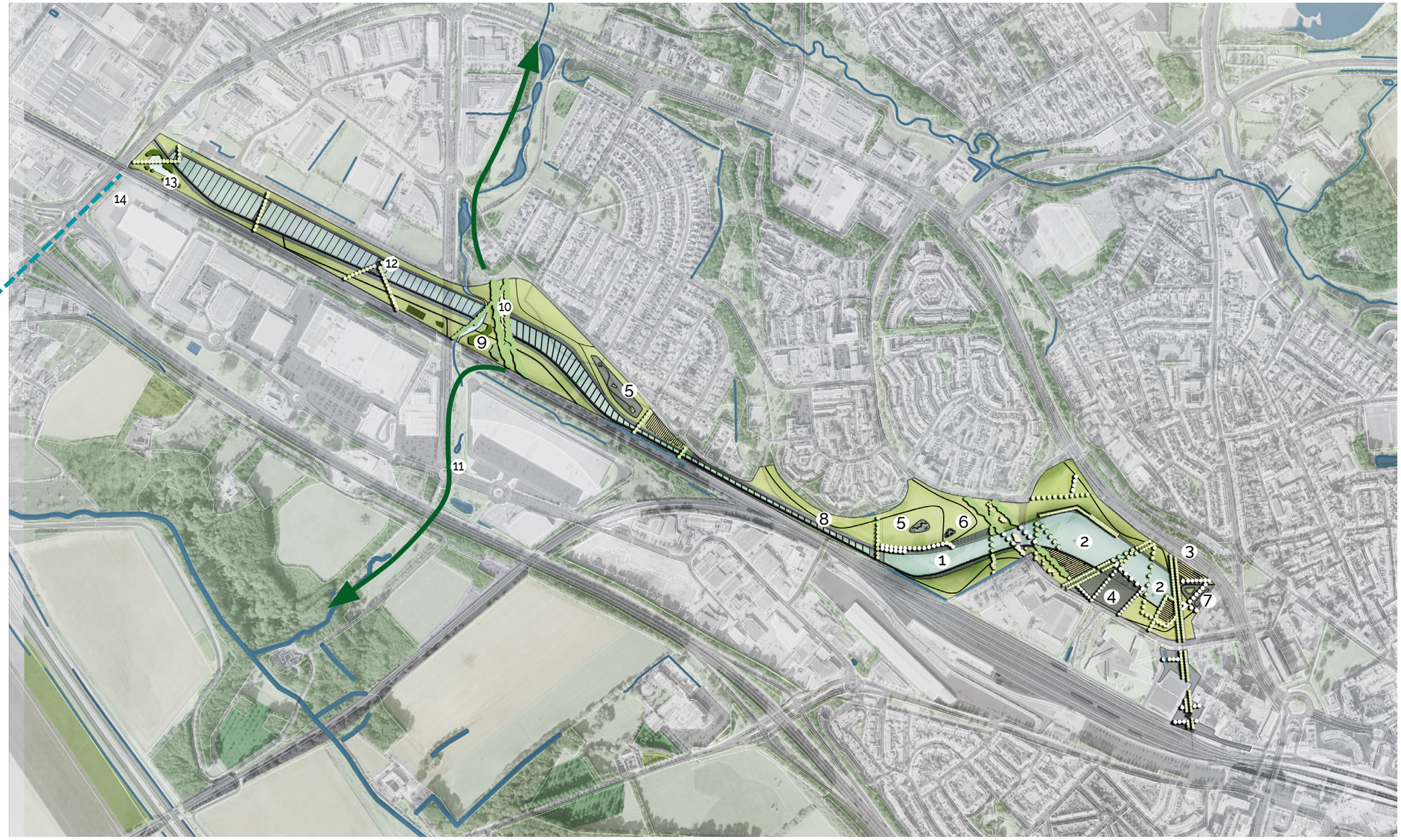


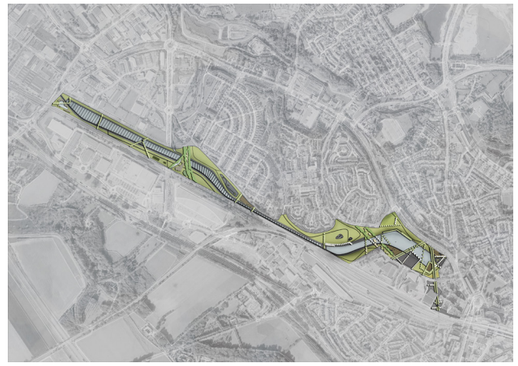
Fig 55. Masterplan with green and blue context

4.3

AZOLLA CITY PARK
MASTERPLAN

RHYTHM
Azolla ponds becomes is the main feature of the park, this water feature has a monthly changing rhythm of colour and texture according to the growth and harvest of Azolla.





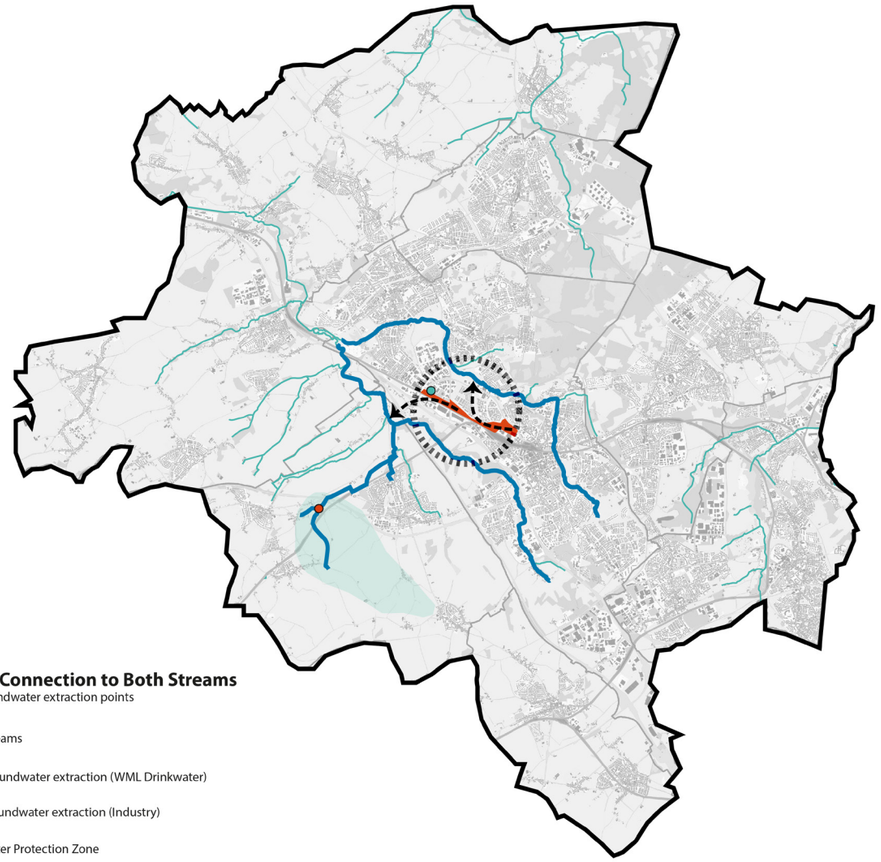




ANNOTATION

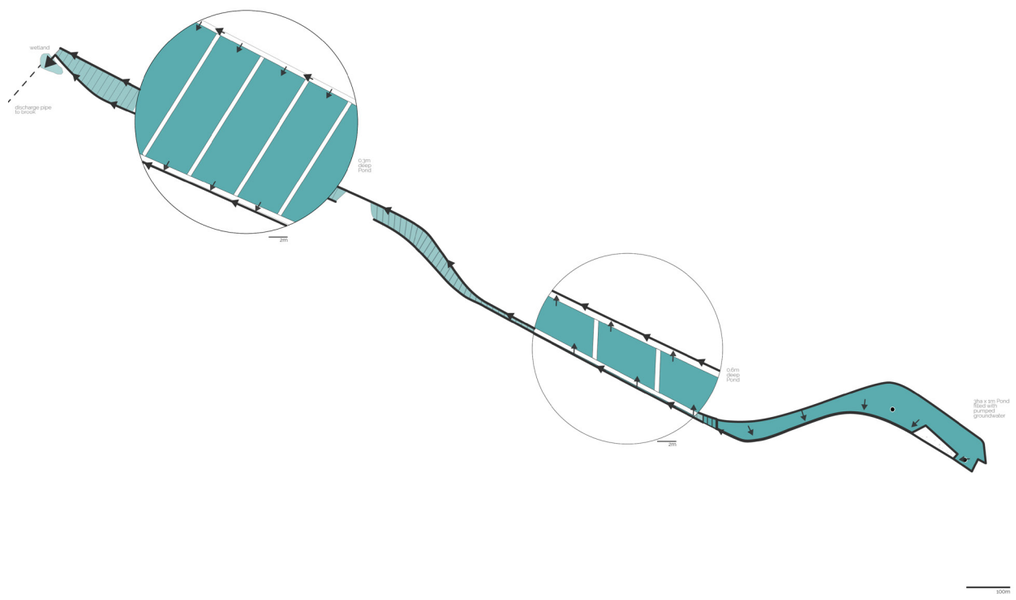
1. Grand Azolla Pond
2. 'Chimney'-fountain (Groundwater pump)
3. Urban Farming
4. Market Squar
5. Playground
6. Outdoor Gym
7. Skating Area
8. Small Azolla ponds
9. Wetland
10. Ecological Corridor
11. Existing Ecological Corridor
12. Existing Mijnwater project pump (water harvested for heating purpose)
13. Wetland
14. Discharge pipe to Geleenbeek

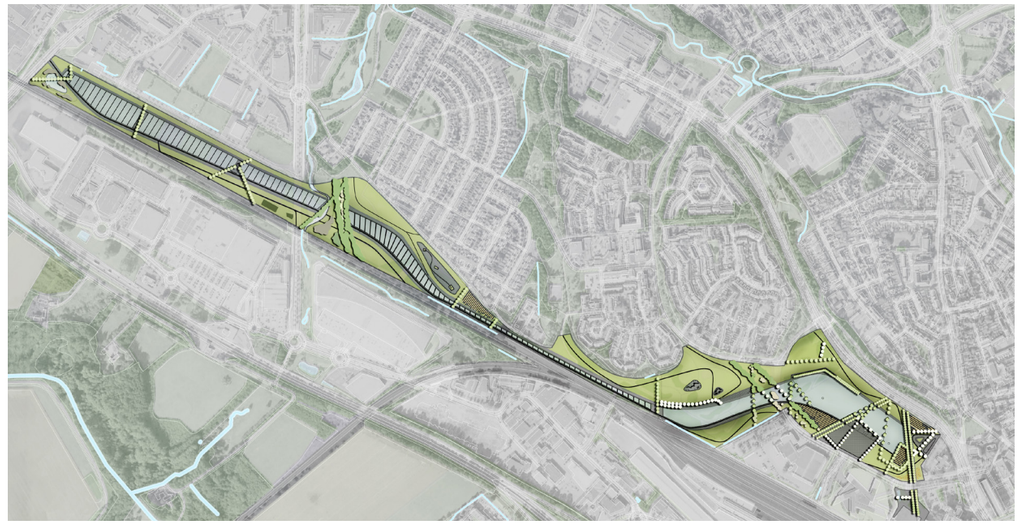
4.3.1 Water system

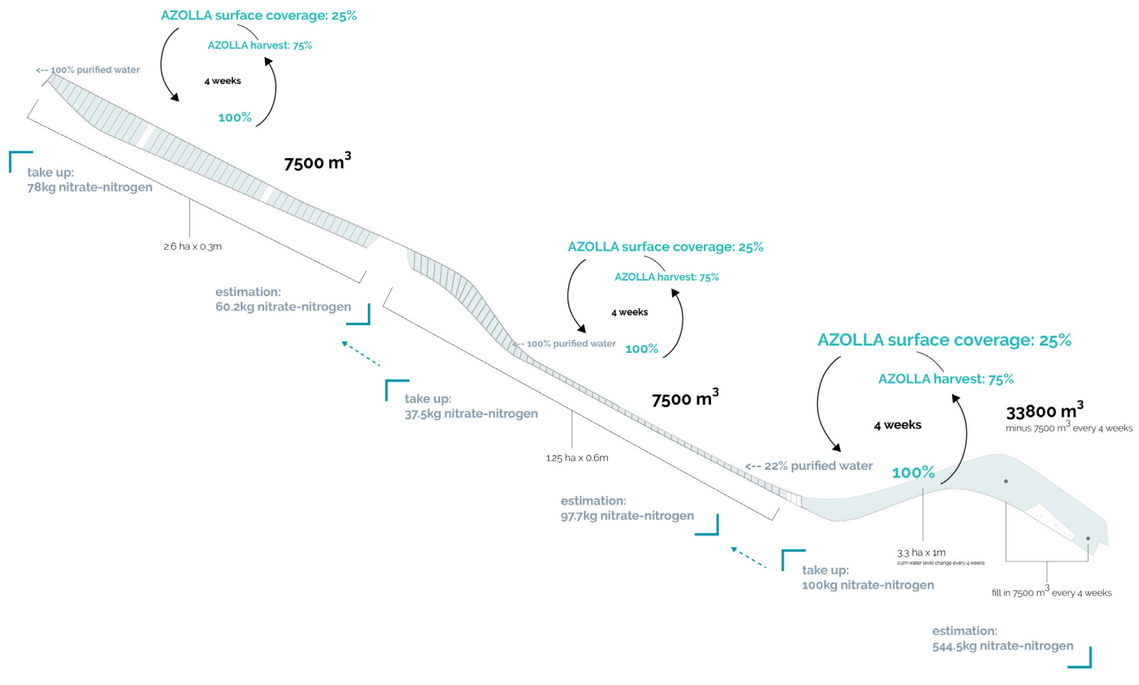


Possible Connection to Both Streams
and two groundwater extraction points

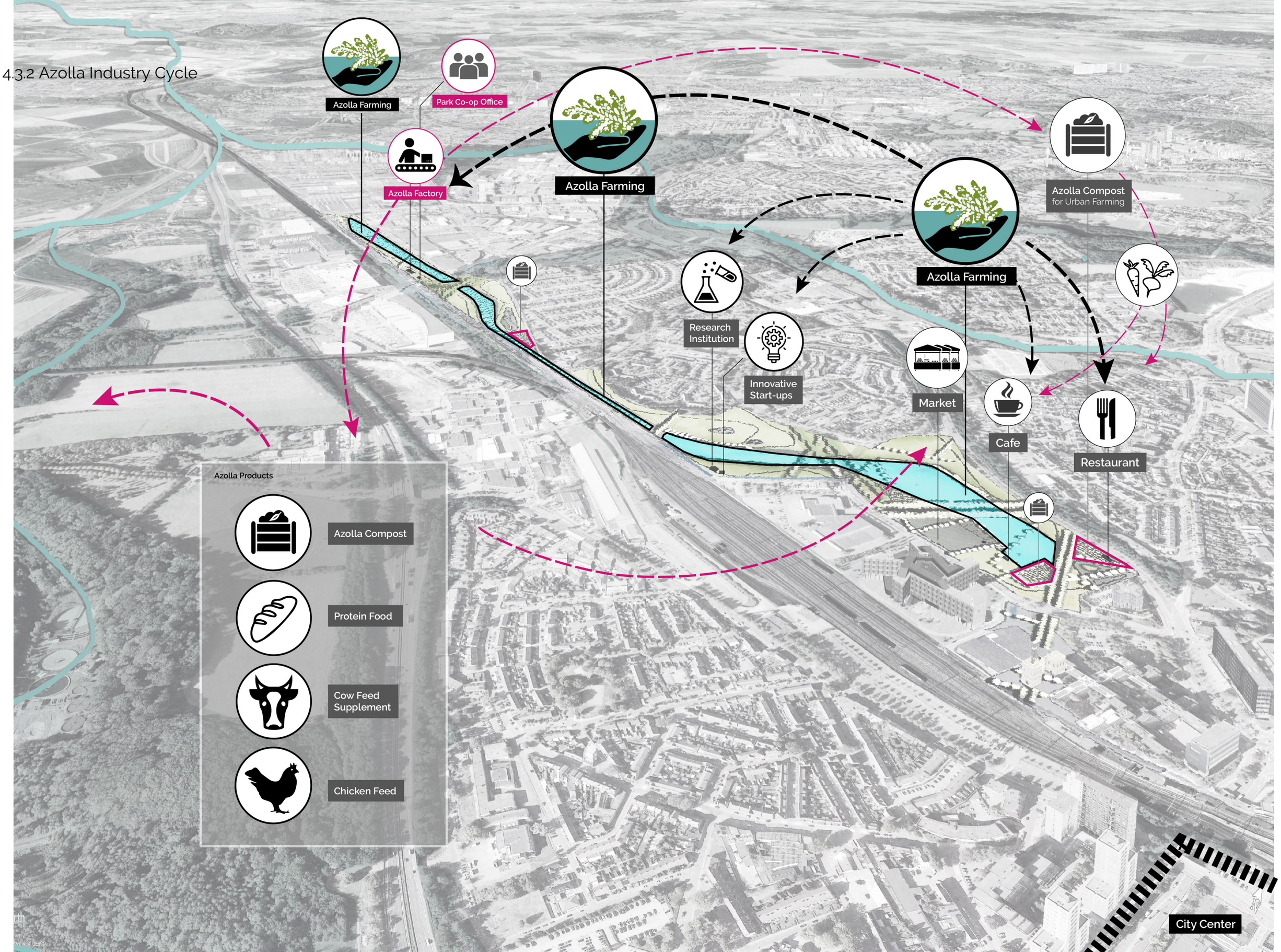
- Streams
- Groundwater extraction (WML Drinkwater)
- Groundwater extraction (Industry)
- Water Protection Zone



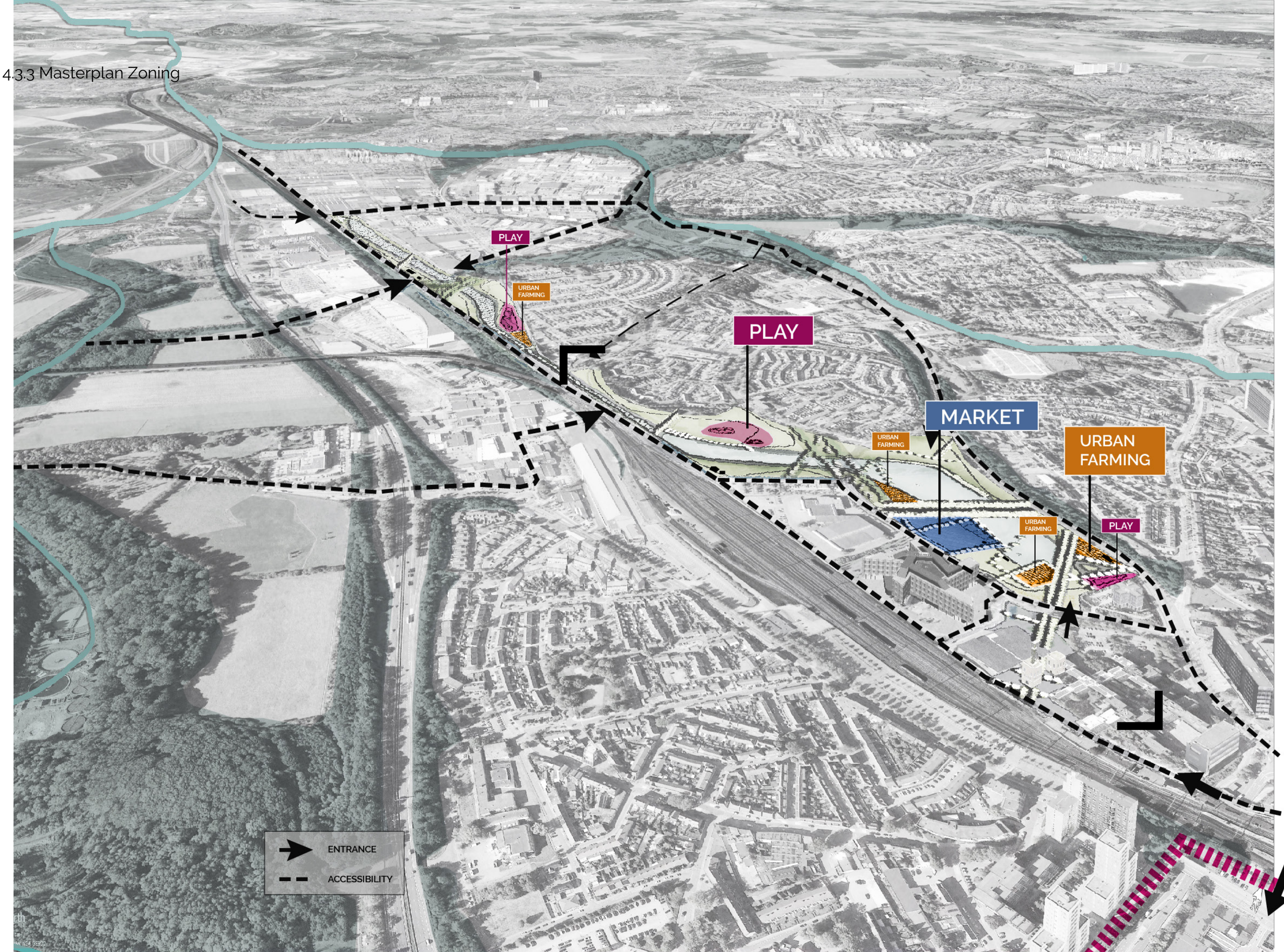


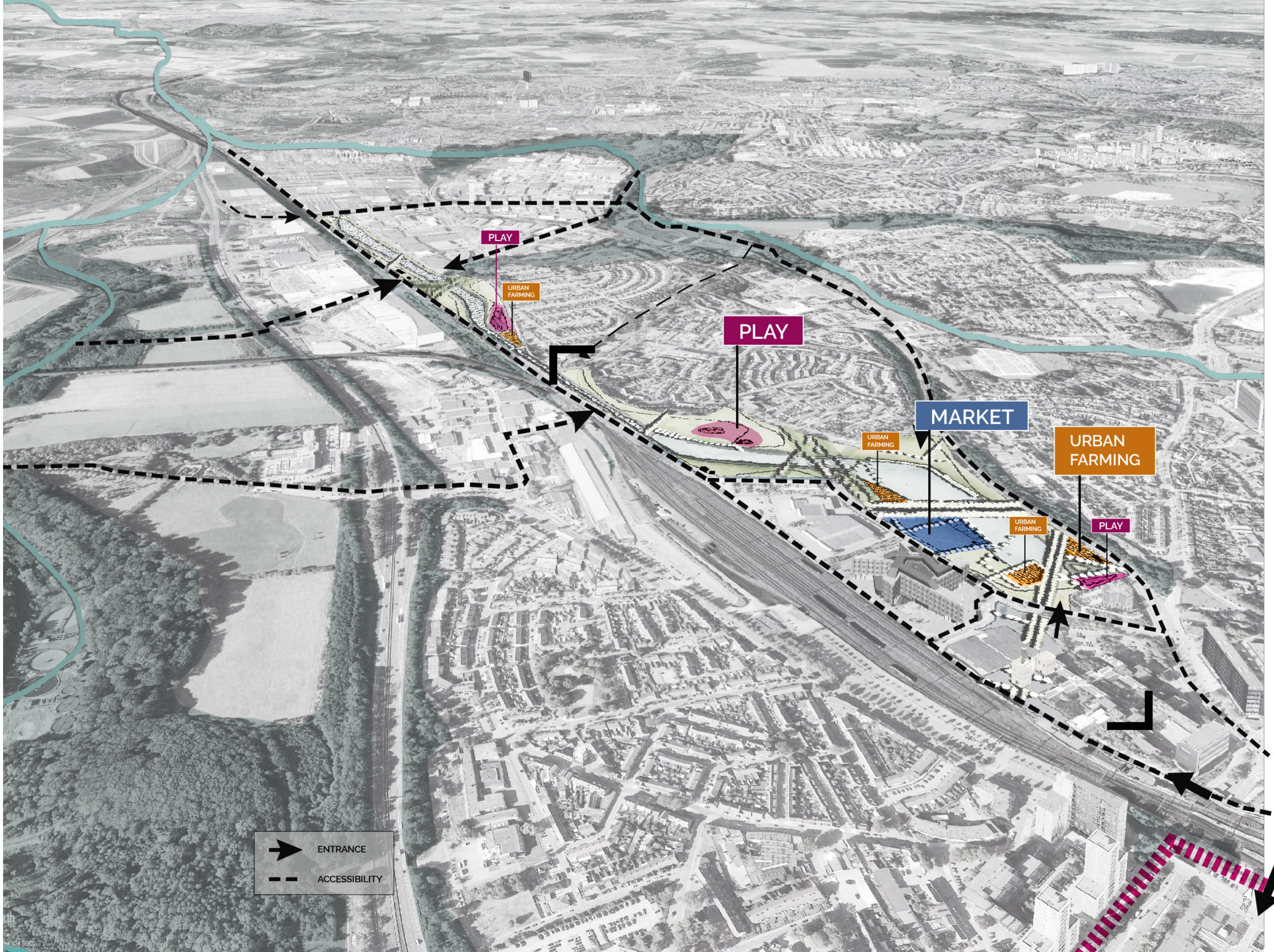


4.3.2 Azolla Industry Cycle

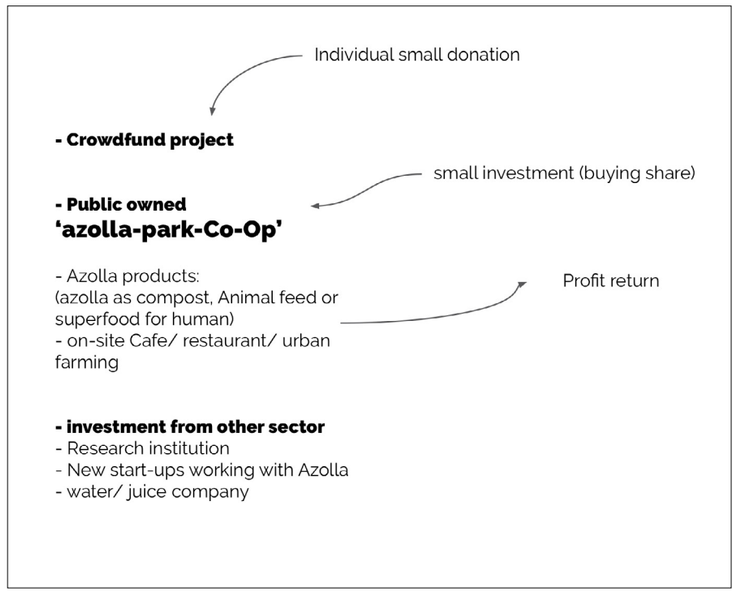


4.3.3 Masterplan Zoning




PLAY
URBAN FARMING
PLAY
MARKET
URBAN FARMING
URBAN FARMING
PLAY
ENTRANCE
ACCESSIBILITY

4.3.4 Azolla City Park - Azolla Industry Vision



Azolla Park Co-Op Financial Model



4.3.5 Azolla City Park - Public Involvement and Participationary Roles

Donator



Co-op Investor



Co-op Committee



Co-op Worker



Park Volunteer

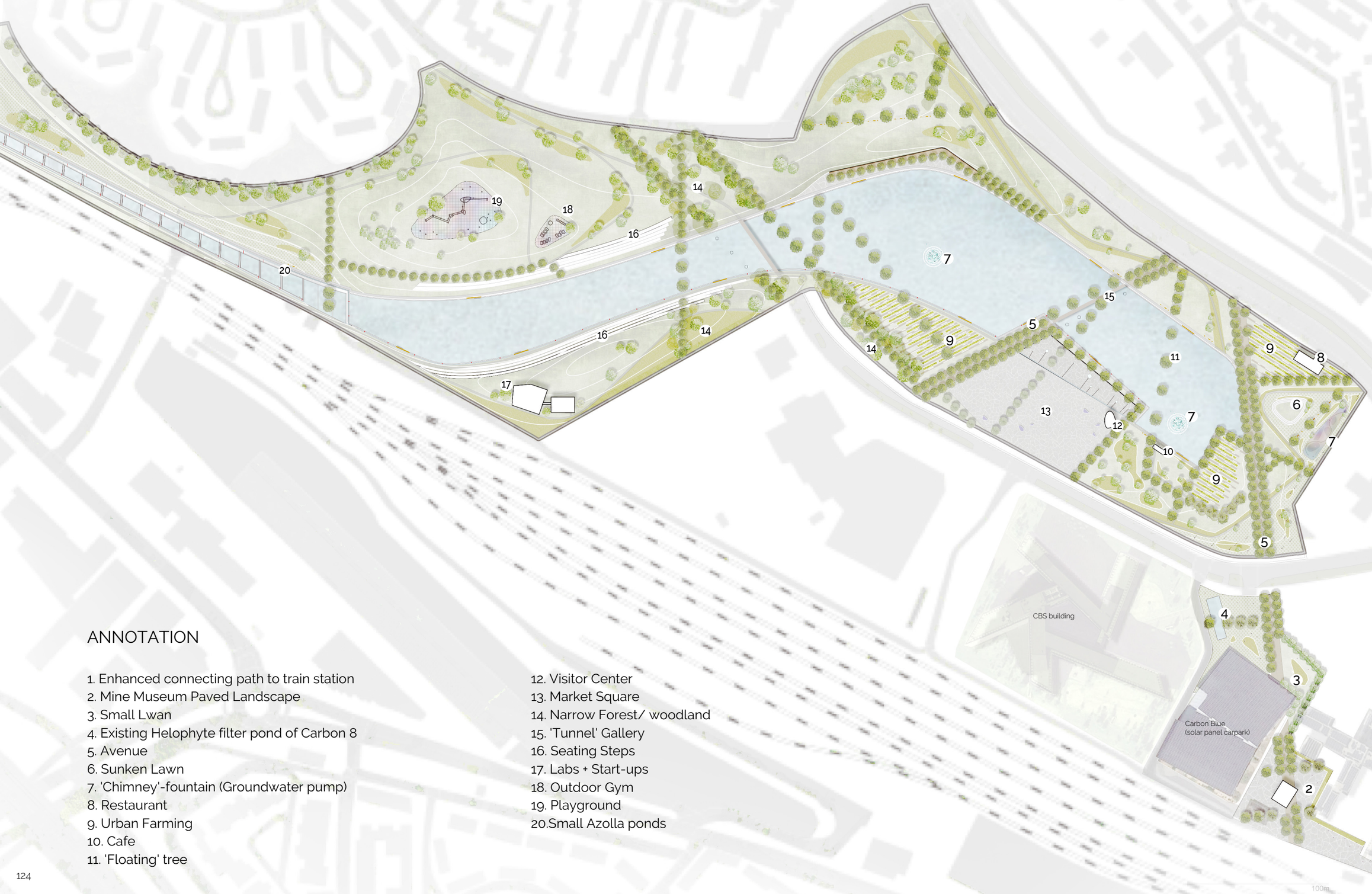


Park User



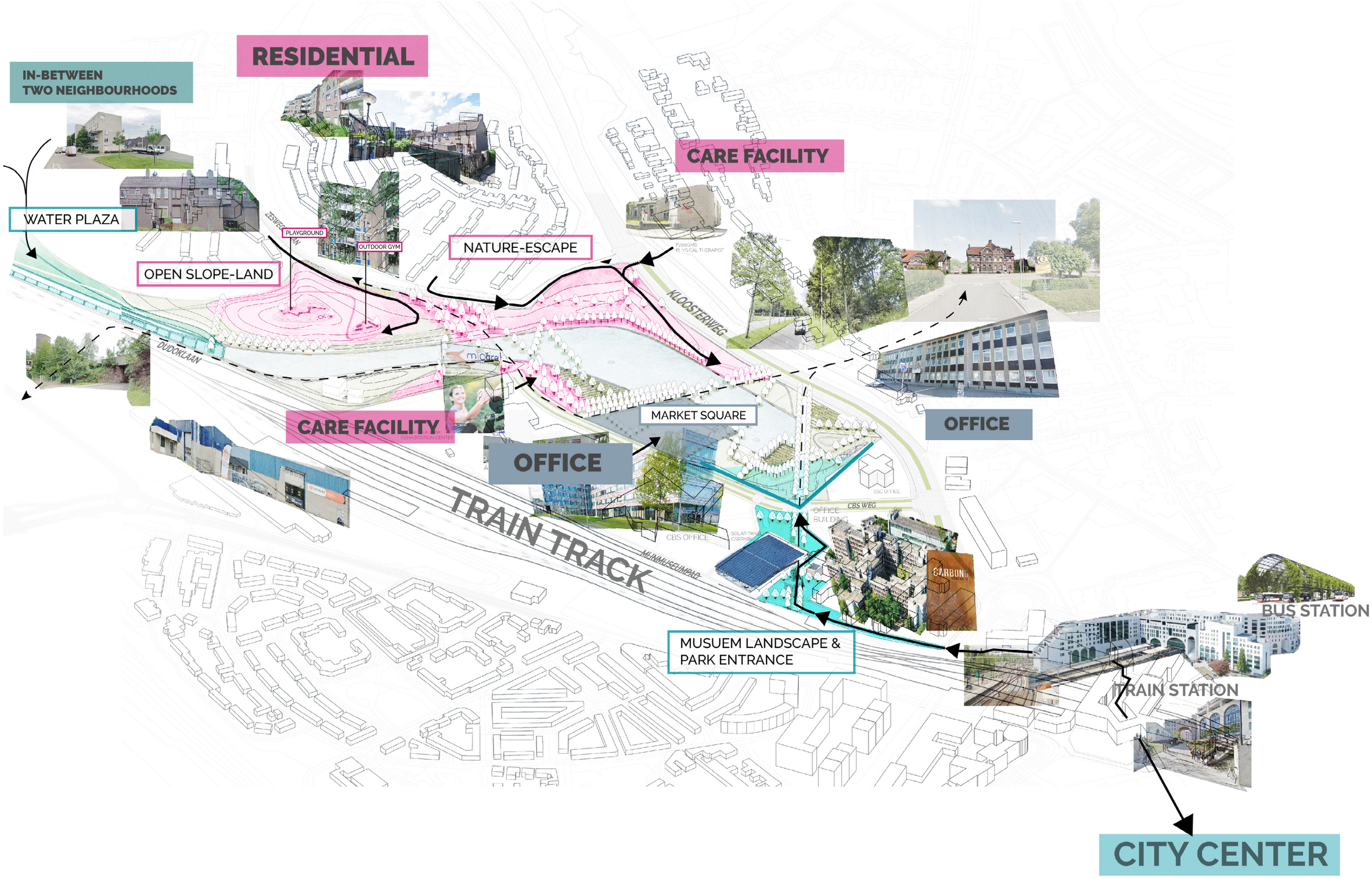
4.4.1 AZOLLA CITY PARK
PLAN DRAWING





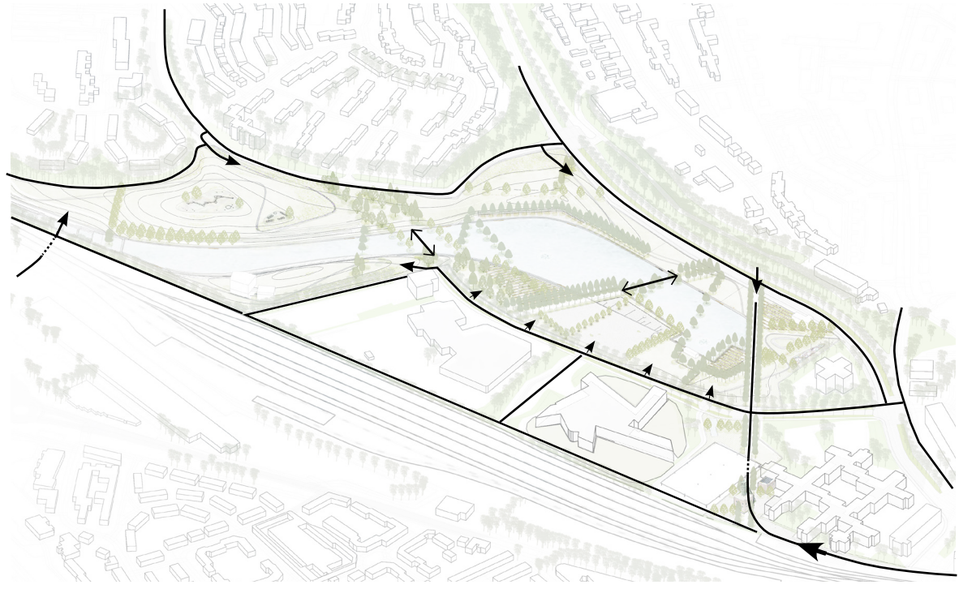
ANNOTATION

1. Enhanced connecting path to train station
2. Mine Museum Paved Landscape
3. Small Lwan
4. Existing Helophyte filter pond of Carbon 8
5. Avenue
6. Sunken Lawn
7. 'Chimney'-fountain (Groundwater pump)
8. Restaurant
9. Urban Farming
10. Cafe
11. 'Floating' tree
12. Visitor Center
13. Market Square
14. Narrow Forest/ woodland
15. 'Tunnel' Gallery
16. Seating Steps
17. Labs + Start-ups
18. Outdoor Gym
19. Playground
20. Small Azolla ponds

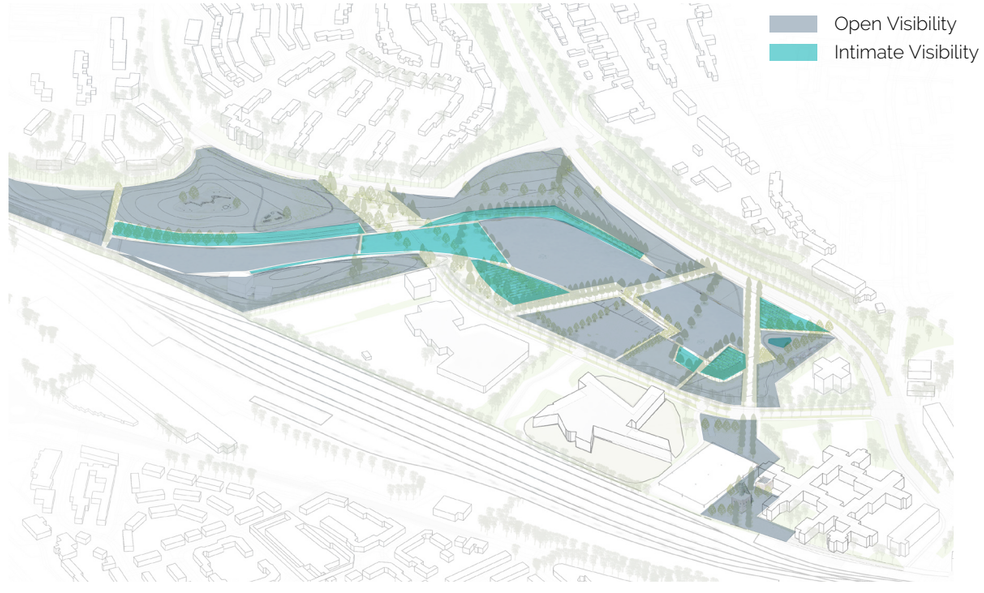

RESIDENTIAL
IN-BETWEEN
TWO NEIGHBOURHOODS
WATER PLAZA
OPEN SLOPE-LAND
PLAYGROUND
OUTDOOR GYM
NATURE-ESCAPE
CARE FACILITY
KLOOSTERWEG
DUIDOKLAAN
MARKET SQUARE
OFFICE
CARE FACILITY
REHABILITATION CENTER
OFFICE
TRAIN TRACK
CBS OFFICE
OFFICE BUILDING
CBS WEG
SSC OFFICE
MUSEUM LANDSCAPE &
PARK ENTRANCE
BUS STATION
TRAIN STATION
CITY CENTER

4.4.3 Design Analysis

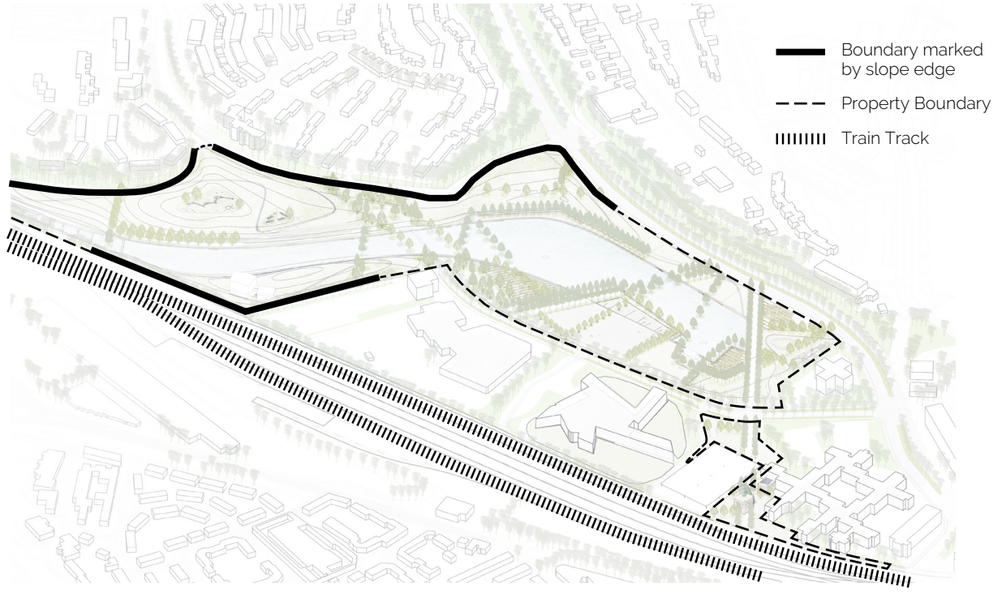
Connection/ Accessibility



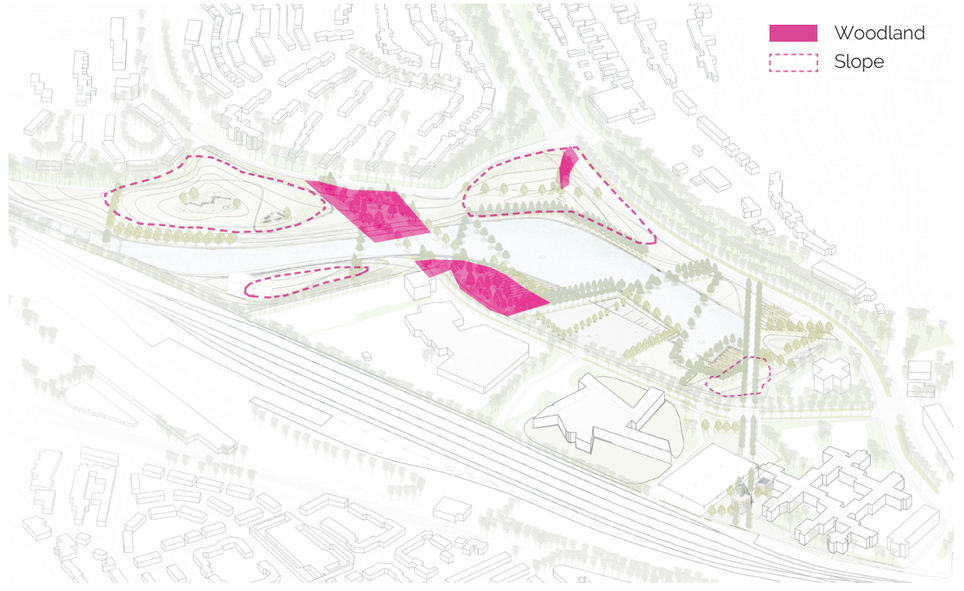
Visibility



Types of Boundary/ Edge



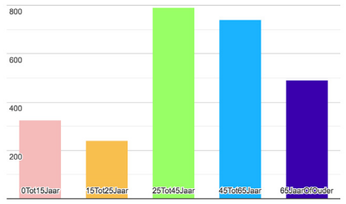
Nature-escape + Slope



4.4.4 User Analysis

Zeswegen

Residents by age in the neighborhood of Eikenderveld



Population, age groups: number and percentage of inhabitants on 1 January 2019 per age category.

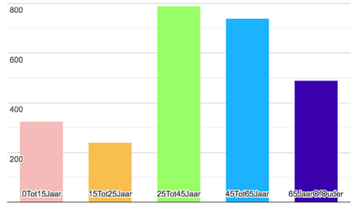
Source: https://allecijfers.nl/

Average income per inhabitant:

€ 16400

Eikenderveid

Residents by age in the neighborhood of Eikenderveld

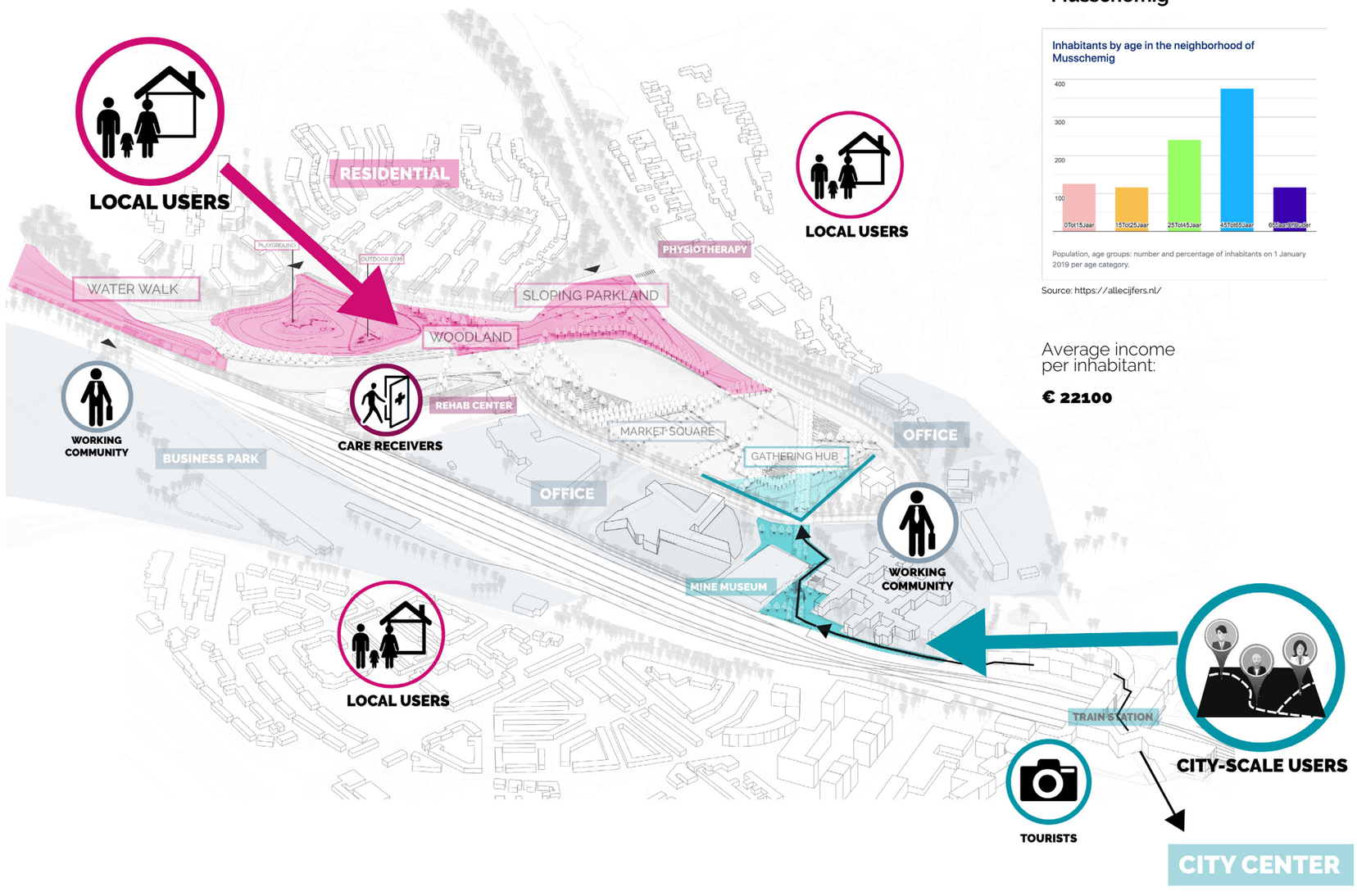


Population, age groups: number and percentage of inhabitants on 1 January 2019 per age category.

Source: https://allecijfers.nl/

Average income per inhabitant:

€ 20800



Musschemig

Inhabitants by age in the neighborhood of Musschemig

Population, age groups: number and percentage of inhabitants on 1 January 2019 per age category.

Source: https://allecijfers.nl/

Average income per inhabitant:

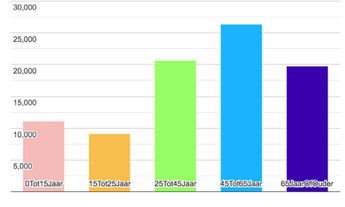
€ 22100

HEERLEN
overview

Average income per inhabitant:

€ 22900

Residents by age in the municipality of Heerlen



Population, age groups: number and percentage of inhabitants on 1 January 2019 per age category.

Source: https://allecijfers.nl/



Scots Pine

Scots Pine is a tall, straight evergreen conifer. Mature trees can grow up to 35 meter. Outlook of a Scots Pine varies during different ages of the tree. Young Scots pine has a typical conical pine tree appearance, as it matures it develops into irregular pyramidal form in various ways. (Iowa State University of Science and Technology) (The Editors of Encyclopaedia Britannica, 2020)

Scots Pine has a significant symbolic meaning in the design as it signifies the coal mine history of the site. Scots Pine is one of the most typical 'Mijnhout' (Mine-wood) used in constructing mine tunnels, that is because it gives out a cracking sound early before it collapses, giving miners enough time to escape. Many Mijnhout forests were constructed for the mining industry.



Scots Pine (10 - 20 years)



Scots Pine (30 - 50 years)









Pinus sylvestris
(Scots Pine)

Crown shape: pyramidal

Crown structure: semi-open

height: 25 - 30m

Width: 10 - 15m



Source: https://www.ebben.nl/en/treeebb/pisylves-pinus-sylvestris/#?search%5B0%5D=Pinus%20sylvestris

Pinus sylvestris 'Watereri'
(Dwarf Scots Pine)

Crown shape: wide pyramidal

Crown structure: dense

Height: 3 - 5 m

Width: 3 - 5 m



Source: https://www.ebben.nl/en/treeebb/piswater-pinus-sylvestris-watereri/

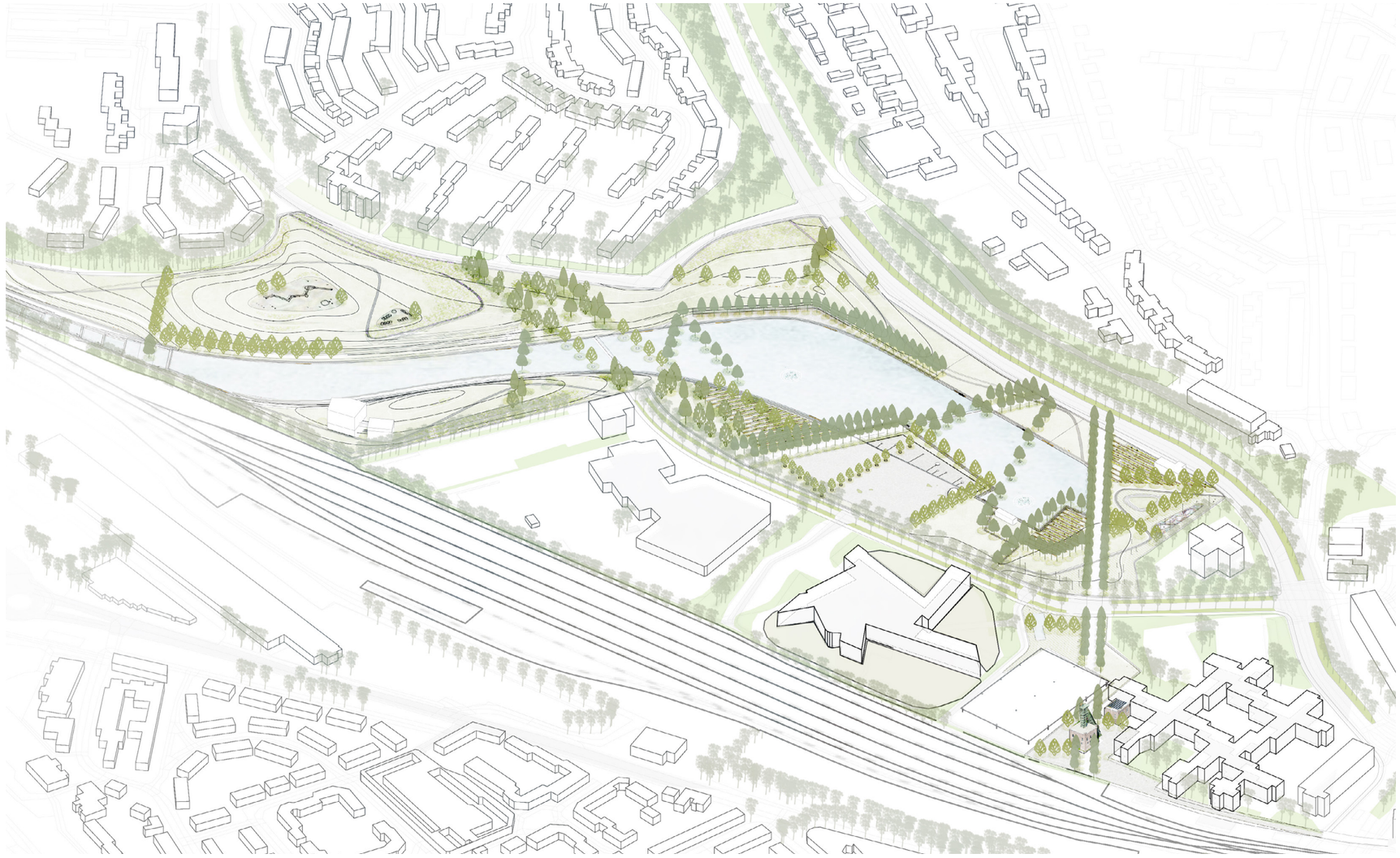
Tree tells story -
Scots Pine marks out the underground mine tunnels

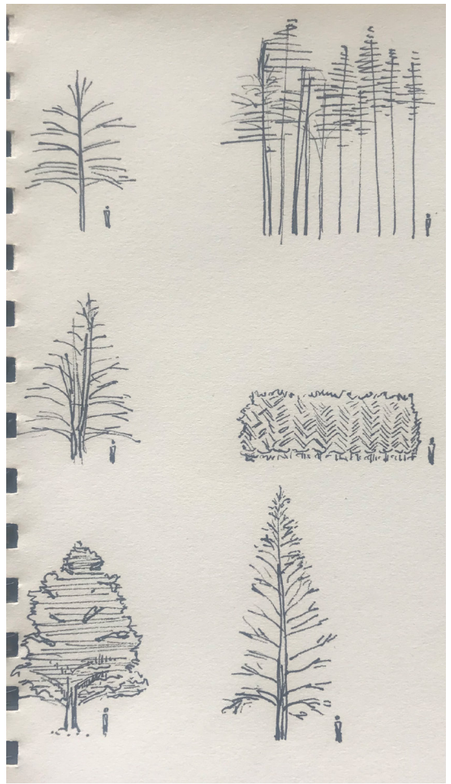


Mine Tunnel Timber. Source: http://sleutelspoor.nl/projecten/mijnhout/



Mine Tunnel Timber. Source: http://www.timberiq.co.za/

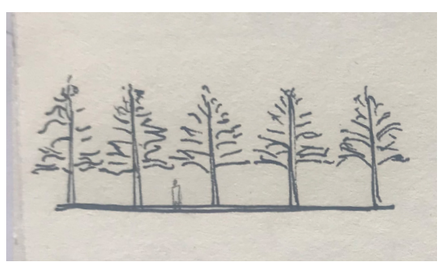




Alder Trees

Alnus contains useful nitrogen-fixing bacteria, the Frankia bacteria. and is therefore used as the main tree species in the project. They are effective in absorbing nitrogen from air and soil, through nitrogen fixation they would also improve soil quality for other species.

Alnus is fast-growing , medium-sized trees. The size and form of Alnus varies depending on the specific species, the form also demonstrates range of variety, they are multi-stemmed, but can also be planted as single-stemmed. They very tolerate to pruning, and can also be trimmed as tall hedges. When planted closely together, like many other trees, they would grow thin and tall. Below are the chosen Alnus species:





Nitrogen-fixation Plant

Alnus glutinosa
(Common Black Alder)

Crown shape: wide pyramidal

Crown structure: semi-open

height: 10 - 20m

Width: 6 - 12m



Source: https://www.instanttreenursery.com.au/tree/common-alder-alnus-glutinosa/

Nitrogen-fixation Plant

Alnus Incana
(Grey Alder)

Crown shape: egg-shaped

Crown structure: semi-open

Height: 12 - 18 m

Width: 6 - 10 m



Source: https://www.vdberk.com/trees/alnus-incana/

Nitrogen-fixation Plant

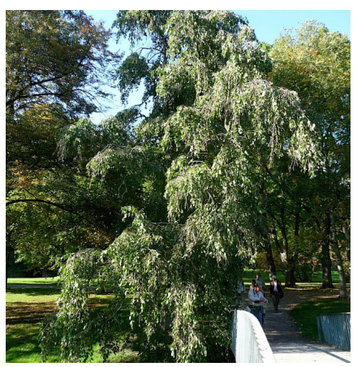
Alnus incana 'Pendula'
(Weeping Grey Alder)

Crown shape: wide weeping

Crown structure: semi-open

Height: 6 - 8 m

Width: 3 - 5 m



Source: https://www.vdberk.com/trees/alnus-incana-pendula/

Nitrogen-fixation Plant

Alnus Incana 'Aurea'
(Golden Alder)

Crown shape: egg-shaped

Crown structure: semi-open

Height: 5 - 10 m

Width: 3 - 6 m



Source: https://www.gardenersdream.co.uk/alnus-incana-aurea-tree-p3985

4.4.7 Plant Palette

Lawn:

Lolium perenne
(perennial ryegrass)



Source: https://www.elkmoundseed.com/elk-mound-seed/perennial-ryegrass-89-50/

Shrub:

Syringa vulgaris
(Common lilac)



https://burtsgh.com/product/syringa-vulgaris-common-lilac/

Winter Flowering
(Mar - Apr)

Prunus spinosa
(Blackthorn)

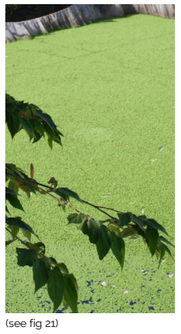


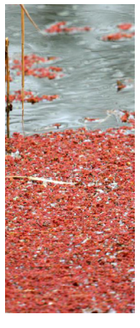
Source: https://frustratedgardener.com/2015/04/28/spring-flower-candy-prunus-spinosa/

Water Fern:

- Turns red in autumn
- Nitrogen-fixation plant

Azolla filiculoides
(Azolla/ Mosquito fern/ Fairy Moss)





(see fig 21)

Groundcover/ Flower:

Long Flowering Period

Bellis perennis
(Common Daisy)



- flowering:
April - September,
December - March

- 5 - 15 cm

(https://www.floravannederland.nl/planten/madeliefje/

Source: http://www.freenatureimages.eu/Plants/Flora%20A-B/Bellis%20perennis%2C%20Daisy/index.html

Centaurea cyanus
(Cornflower)



- flowering:
June - August

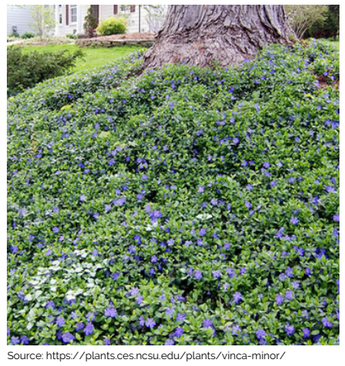
- the species has deteriorated sharply due to modern intensive arable farming and herbicides

- reaches a height of 30-60 cm

(Flora of the Netherlands, https://www.floravannederland.nl/planten/korenbloem/)

Source: https://www.lensculture.com/projects/2377-poppies-cornfield-weeds

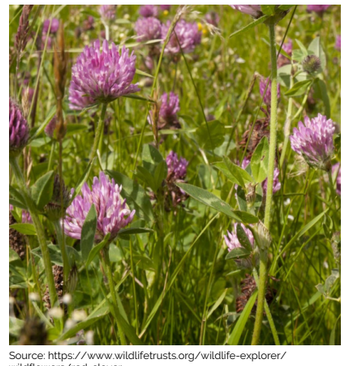
Vinca minor
(Common Periwinkle/ Myrtle)



Source: https://plants.ces.ncsu.edu/plants/vinca-minor/

Nitrogen-fixation Plant

Trifolium pratense
(Red Cover)



- Flowering:
May to August

- nitrogen-fixation property

- up tp 50 cm

(Flora of the Netherlands, https://www.floravannederland.nl/planten/rode_klaver/)

Source: https://www.wildlifetrusts.org/wildlife-explorer/wildflowers/red-clover

Papaver dubium
(Pale poppy)



- flowering:
May - August

- the species has deteriorated sharply due to modern intensive arable farming and herbicides

- 20-60 cm

(Flora of the Netherlands, https://www.floravannederland.nl/planten/bleke_klaproos/)

Source: https://www.gardenia.net/plant/papaver-rhoeas-common-poppy

Cichorium intybus
(Wild chicory)

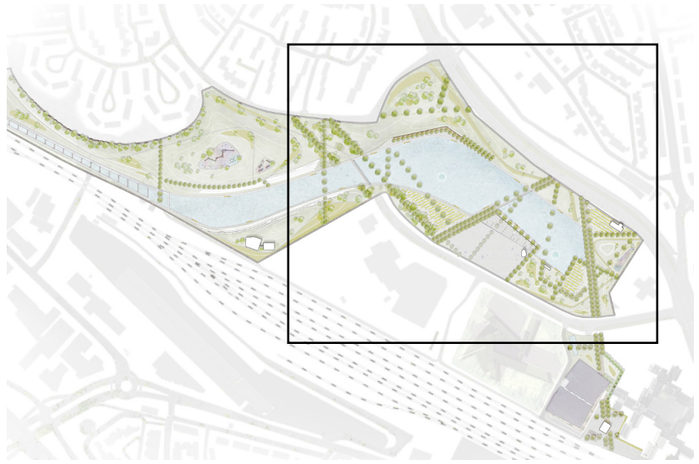


- Flowering:
July to August

- 30 - 120 cm

(Flora of the Netherlands, https://www.floravannederland.nl/planten/wilde_cichorei/)

Source: https://eattheplanet.org/chicory-street-side-salad-greens-and-tea/



BIG AZOLLA POND

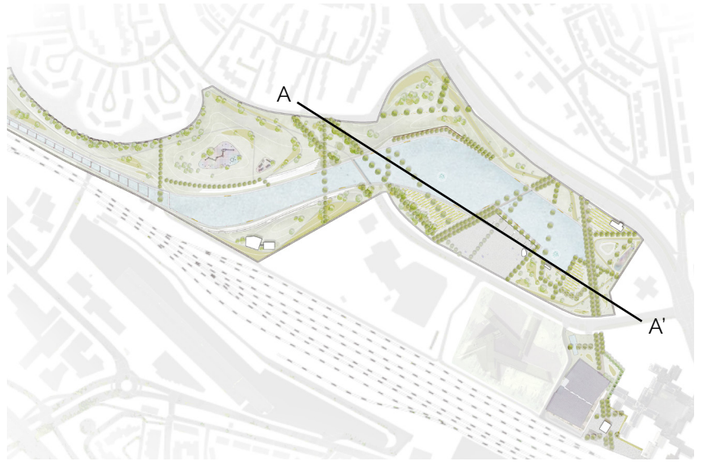
Main Park Entrance - Gathering Hub with cafe, market, restaurant, skating area and gallery



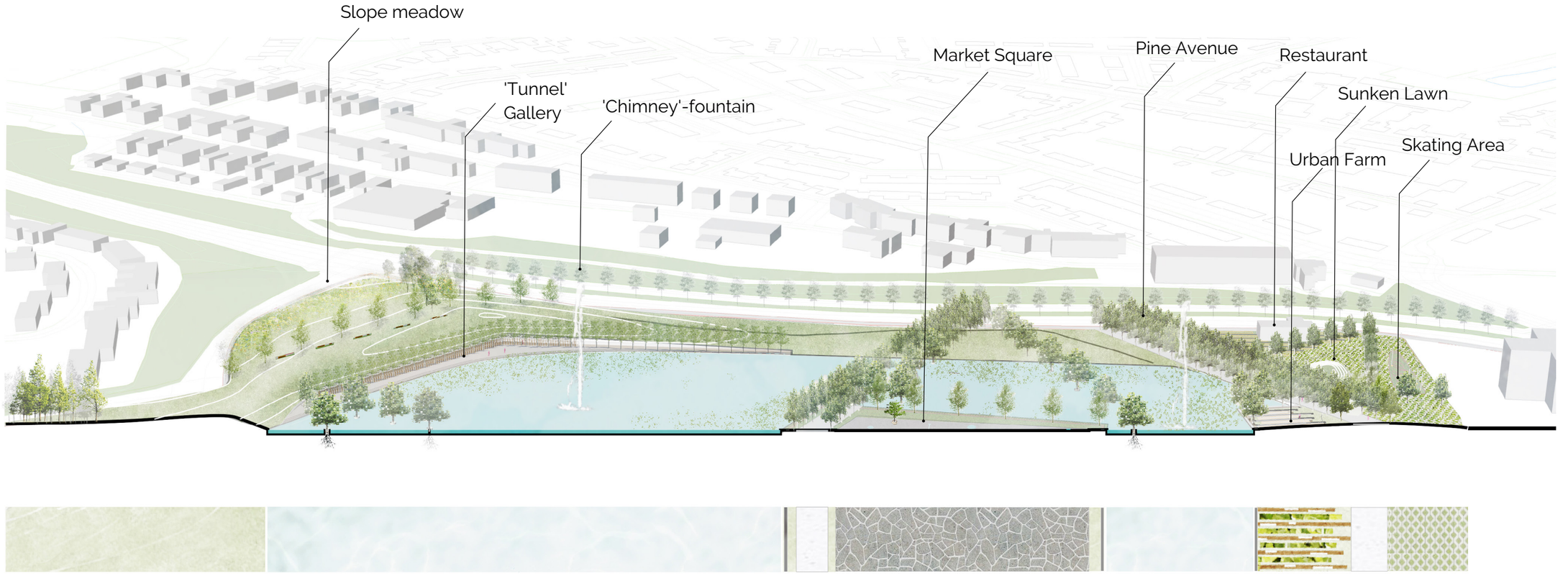
BIG AZOLLA POND



Long Perspective Section - Big Azolla Pond

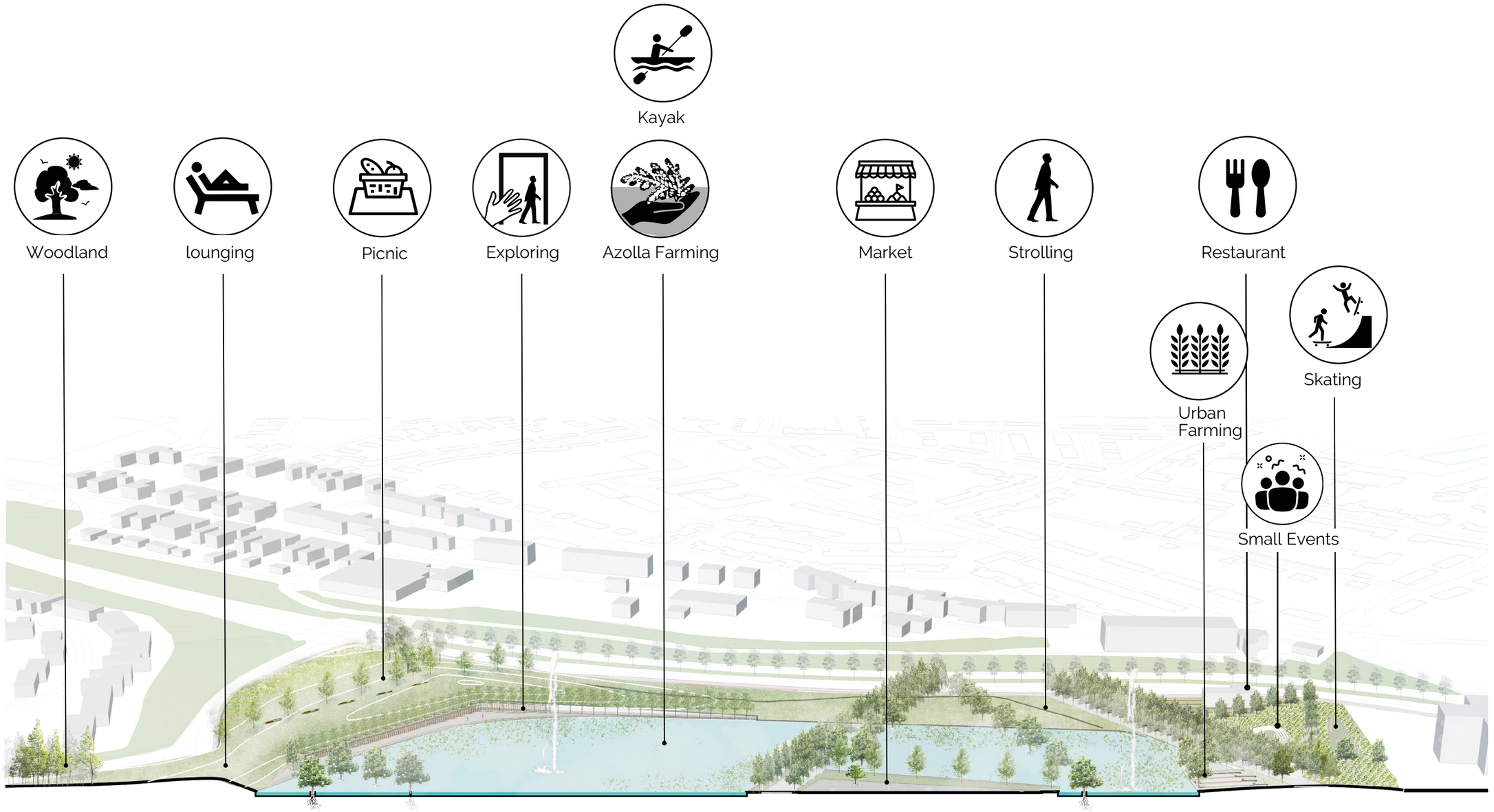


Section AA'



1m
5m

Long Perspective Section - Big Azolla Pond



WATER WALK (AZOLLA PONDS)

Entrance near residential neighbourhoods - Cascading azolla ponds





20m

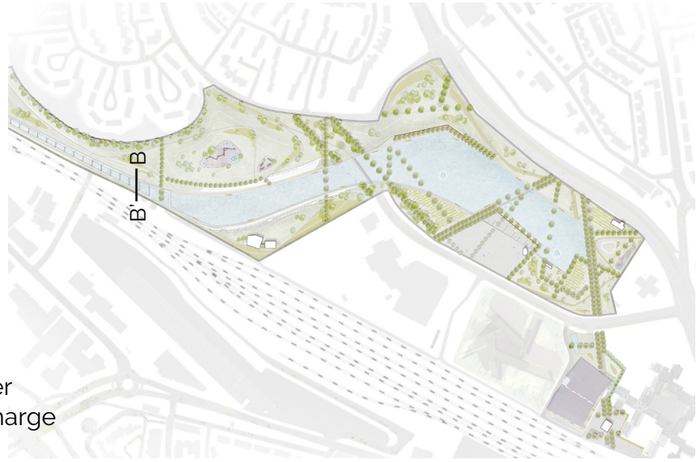
Small Azolla Pond System

WATER WALK (AZOLLA PONDS)

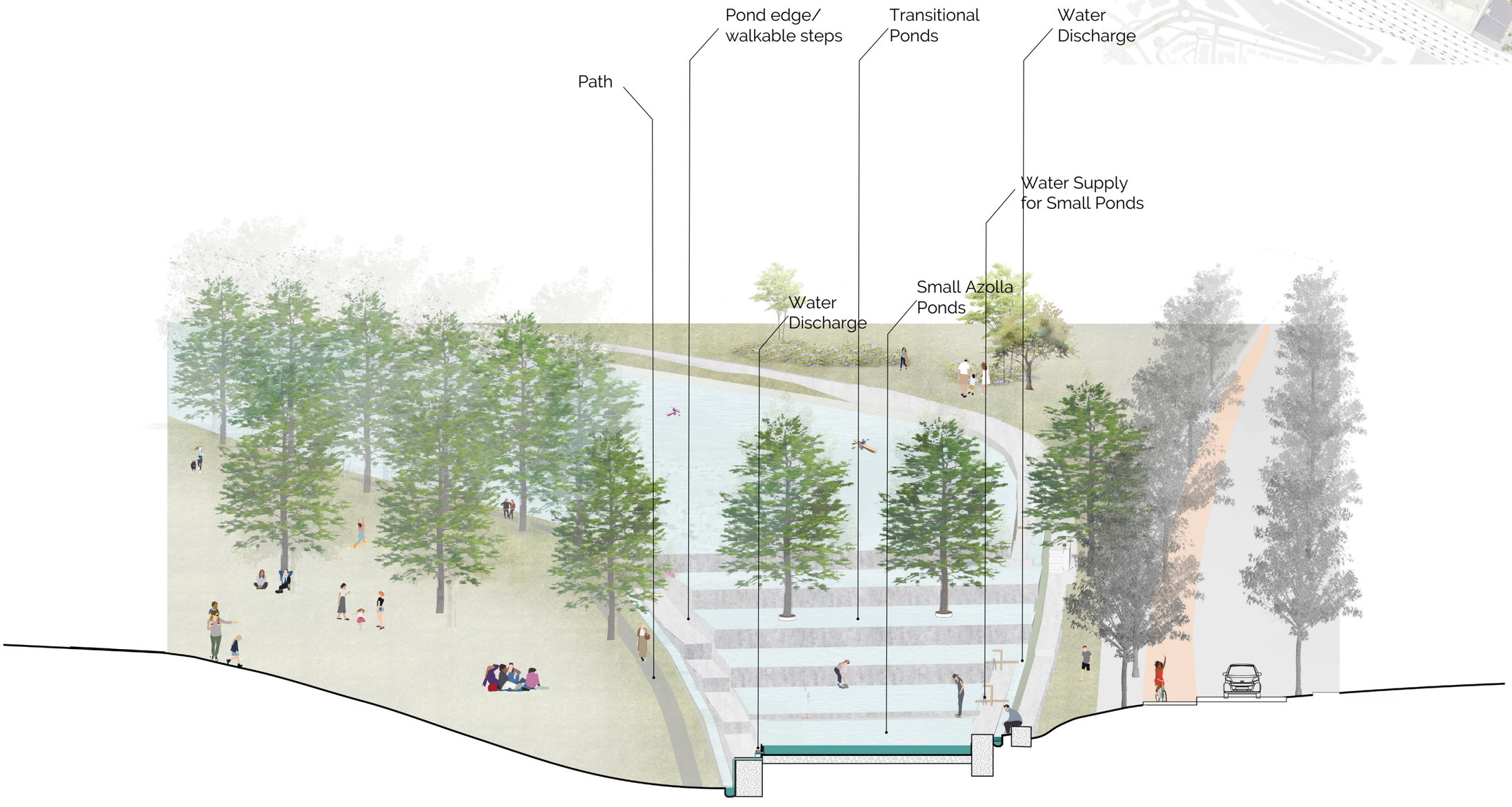
Entrance near residential neighbourhoods - Cascading azolla ponds



Perspective Section - Small Azolla Pond System



Section BB'

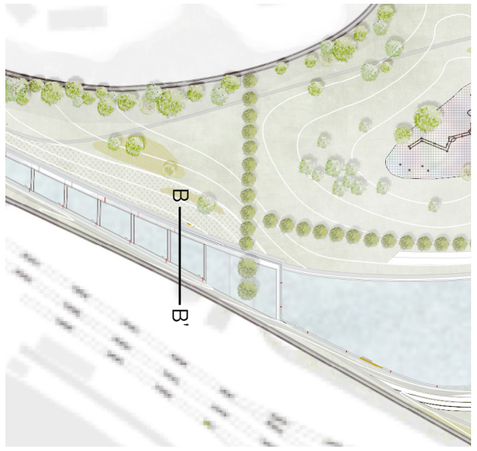


1:100 A3

5m

Perspective Section - Small Azolla Pond System (Programme)

Section BB'

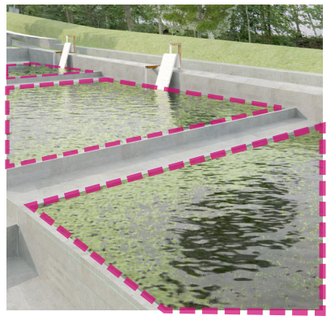


4.4.9 Small Water Elements

Azolla Pond:
(Lake)



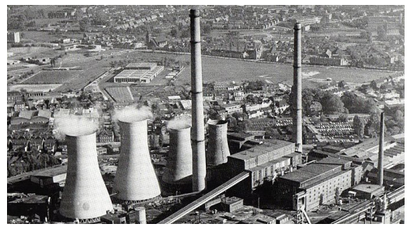
Azolla Pond:
(Small Ponds)

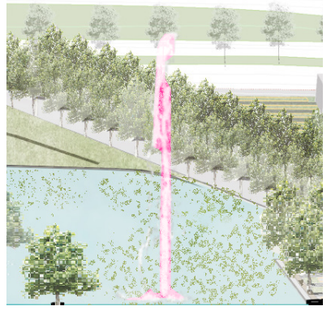


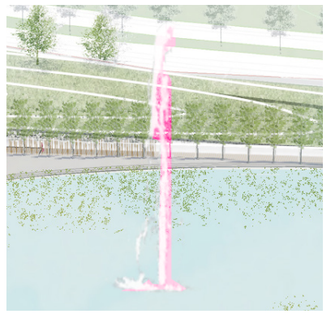
Groundwater
Pump:



Monthly Groundwater fountain symbolises lost landmark



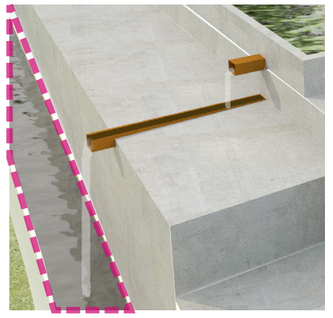




Micro Water
Discharge:

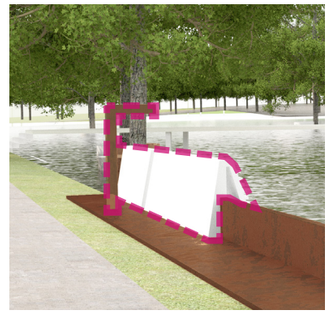


Main Water
Discharge:

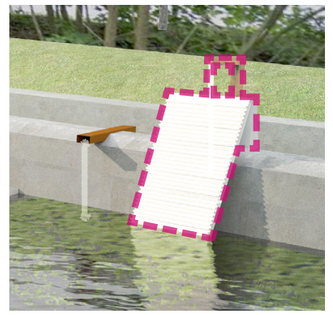


Micro Water-
Circulation Device:

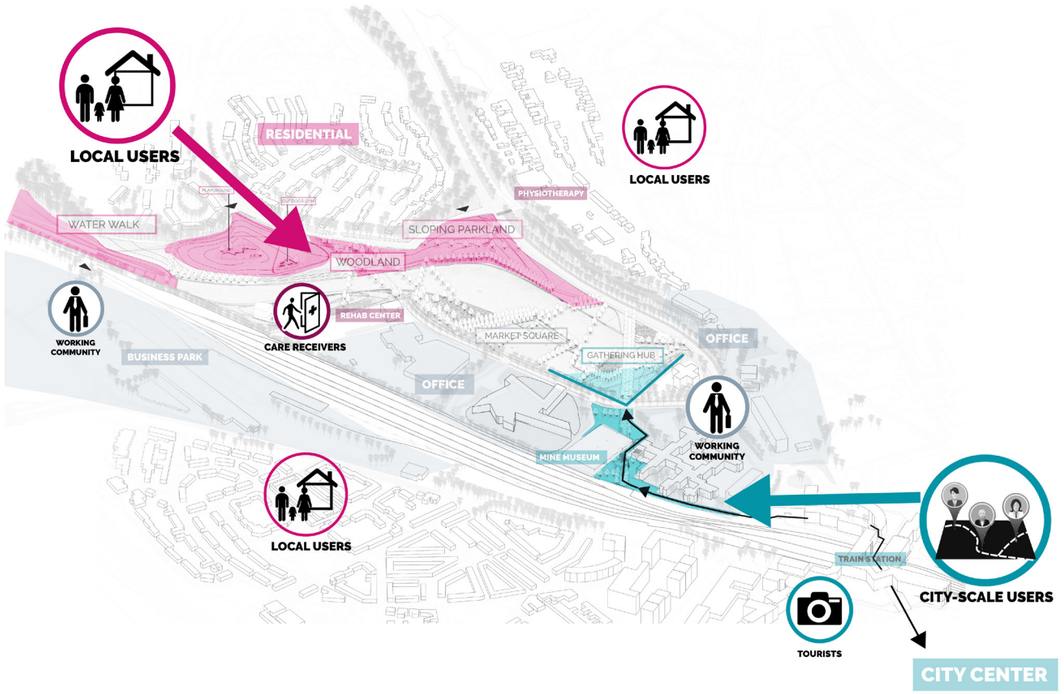
Version 1



Version 2

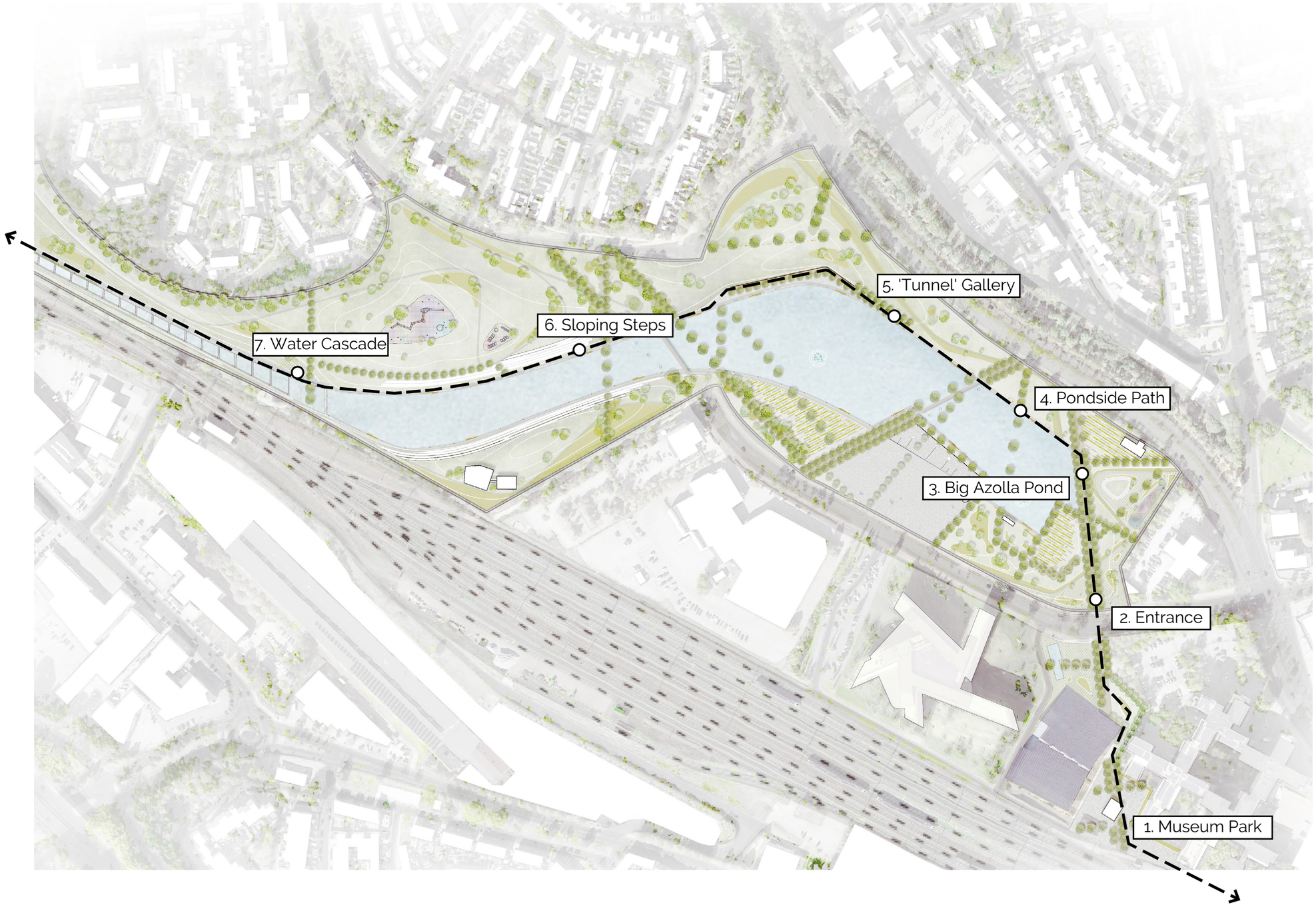


4.5 SPATIAL EXPERIENCE
TWO EXAMPLE ROUTES



4.5.1 Example Route 1: City-User Water Walk Route

CITY-SCALE USERS



MUSEUM PARK

Open space outside of the existing Mine Museum acts as important connector between the train station and the main park area







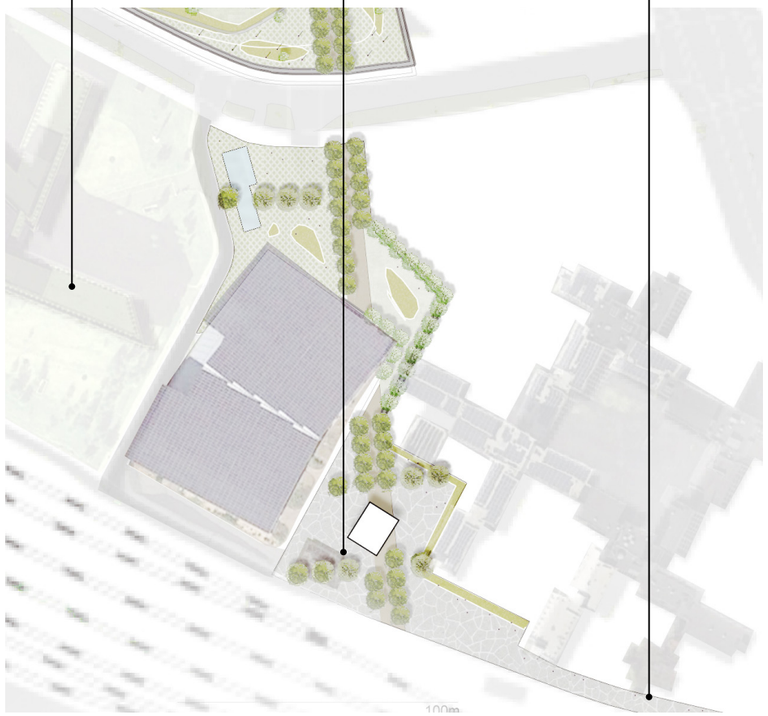










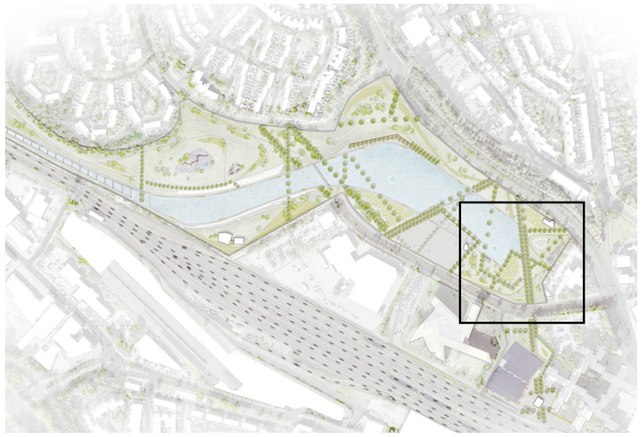




Impression Collage

ENTRANCE - PINE AVENUE

Existing topography creates inviting scenic slope effect

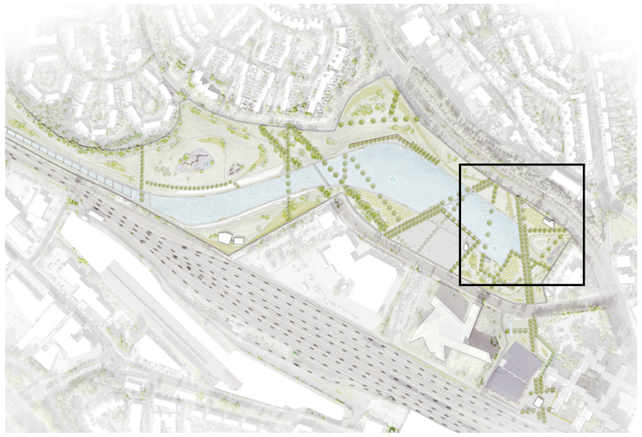






BIG AZOLLA POND

with scenic view of Azolla pond and 'floating' trees

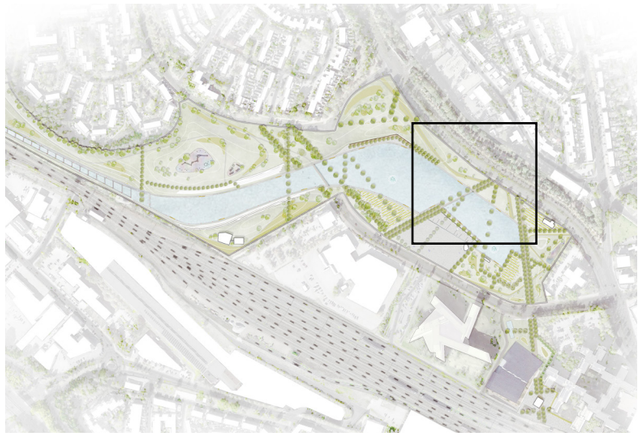


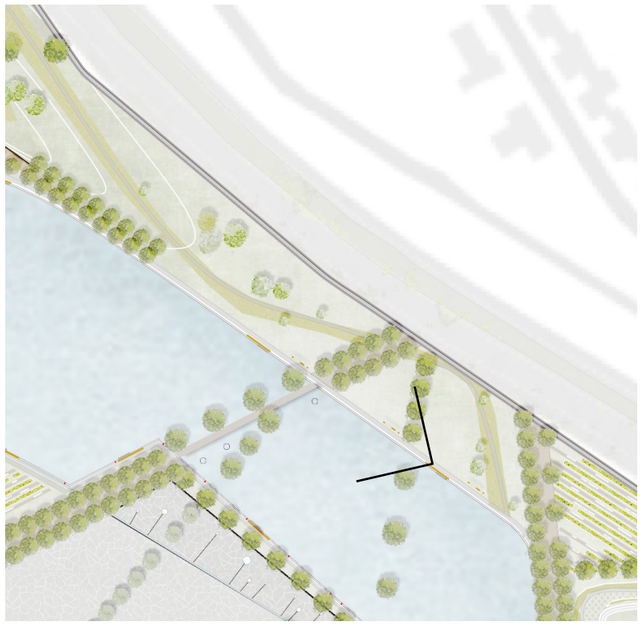




PONDSIDE PATH

a continuous path along the azolla pond



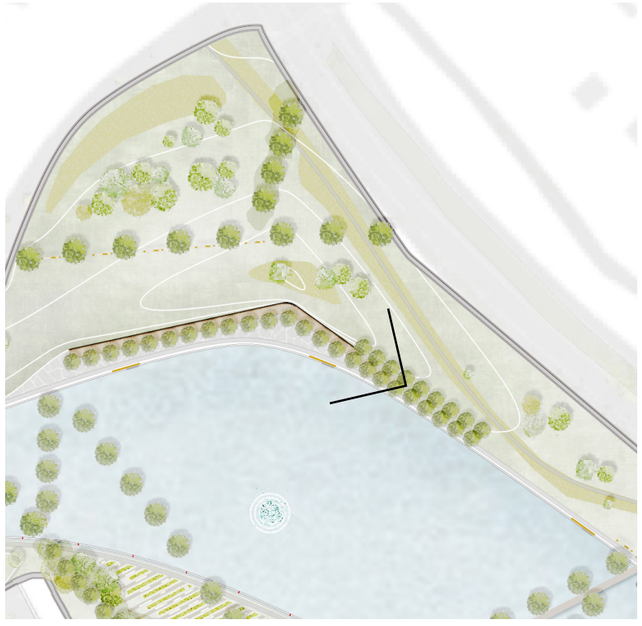




‘TUNNEL’ GALLERY

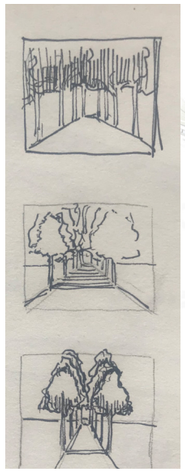
a gallery carved into the exisiting slope, offering a semi-enclosed spatial expereince. The Gallery showcased a more literal tunnel metaphor

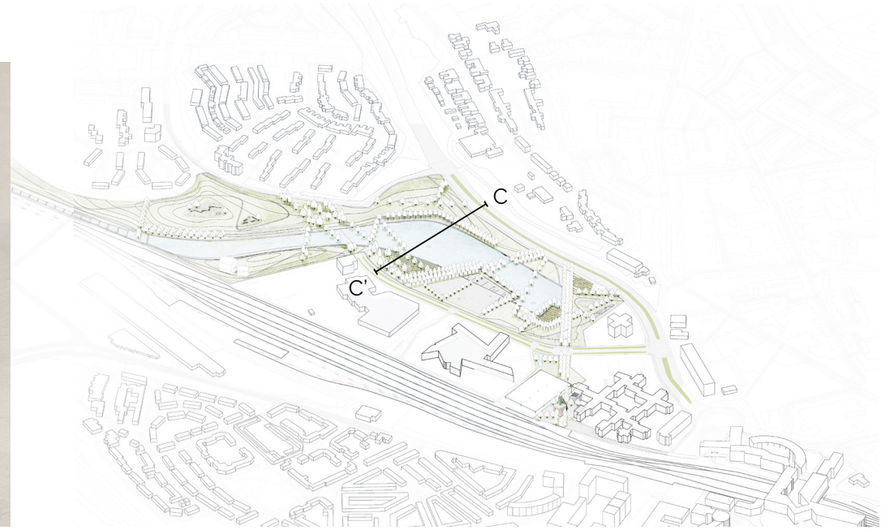






‘tunnel’ gallery Section





‘TUNNEL’ GALLERY

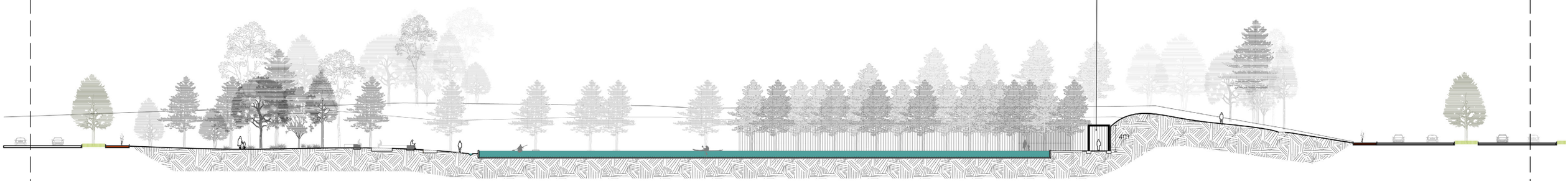
a gallery carved into exisiting slope; acts as a semi-enclosed spatial expereince. The Gallery showcased a more literal tunnel metaphor



Mine Tunnel. Source: www.rhcl.nl



Section CC’





10m

1:400 A3

‘TUNNEL’ GALLERY

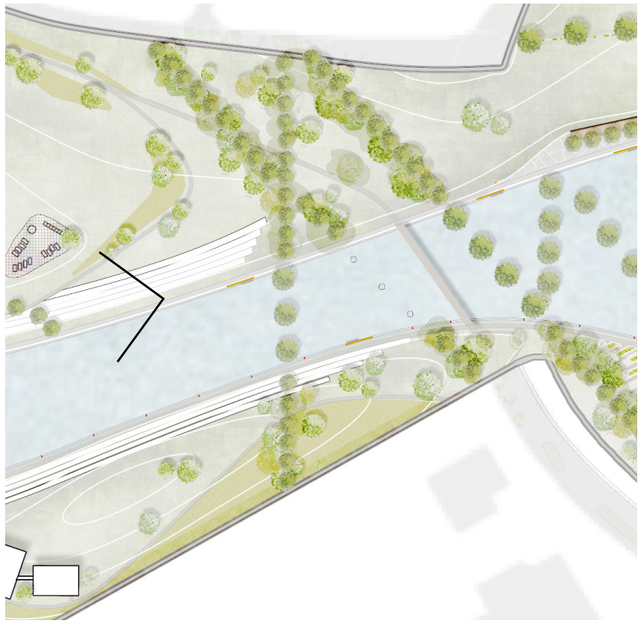
a gallery carved into exisiting slope; acts as a semi-enclosed spatial expereince. The Gallery showcased a more literal tunnel metaphor



SLOPING STEPS

Path along azolla pond in the sloping parkland zone







WATER CASCADE

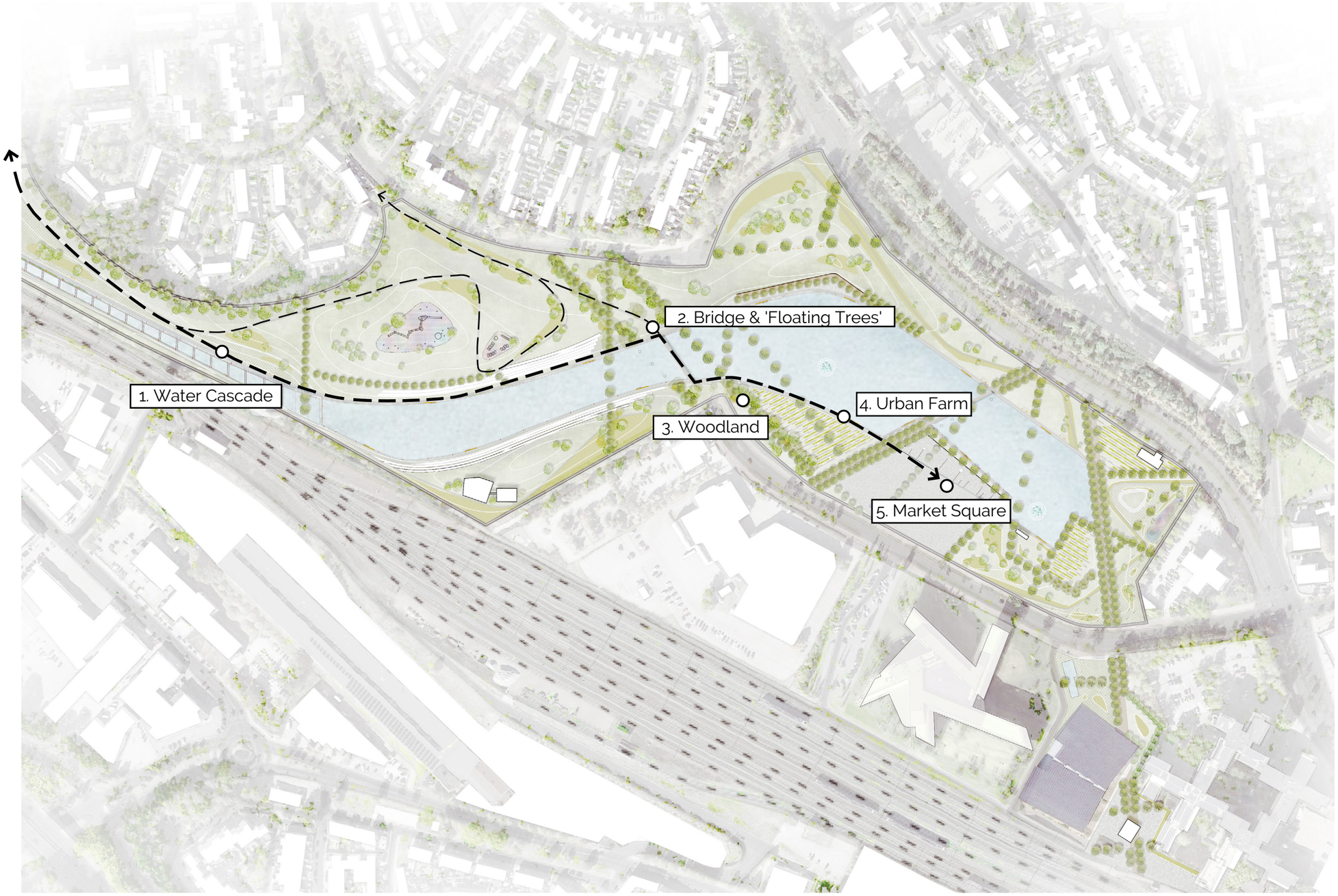
A different spatial expereience with series of cascading azolla ponds







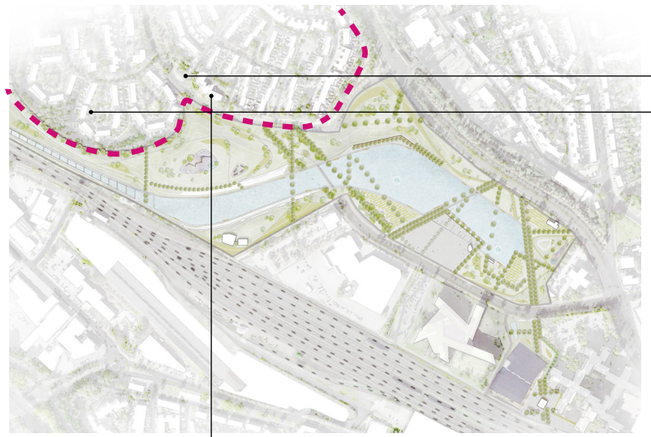
4.5.2 Example Route 2: Local Resident Route



LOCAL USERS

WATER CASCADE

One of the entrances from surrounding residential neighbourhood









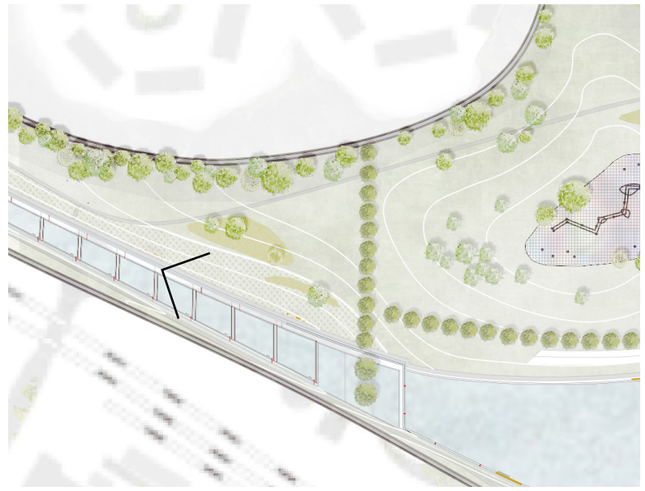










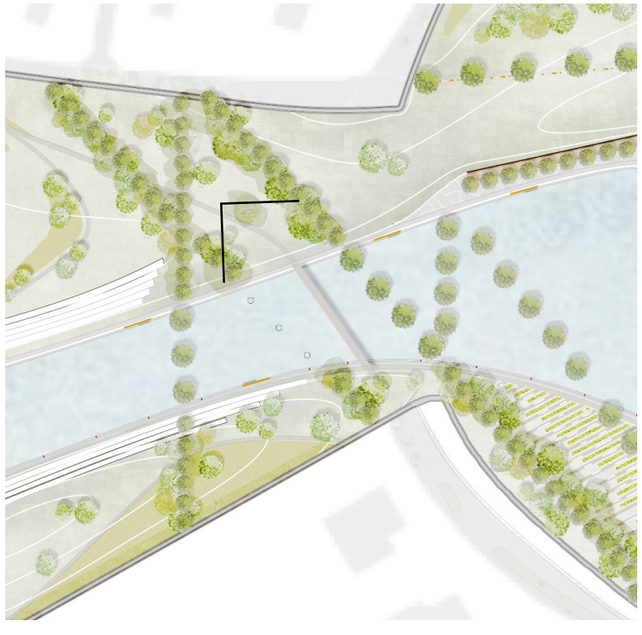


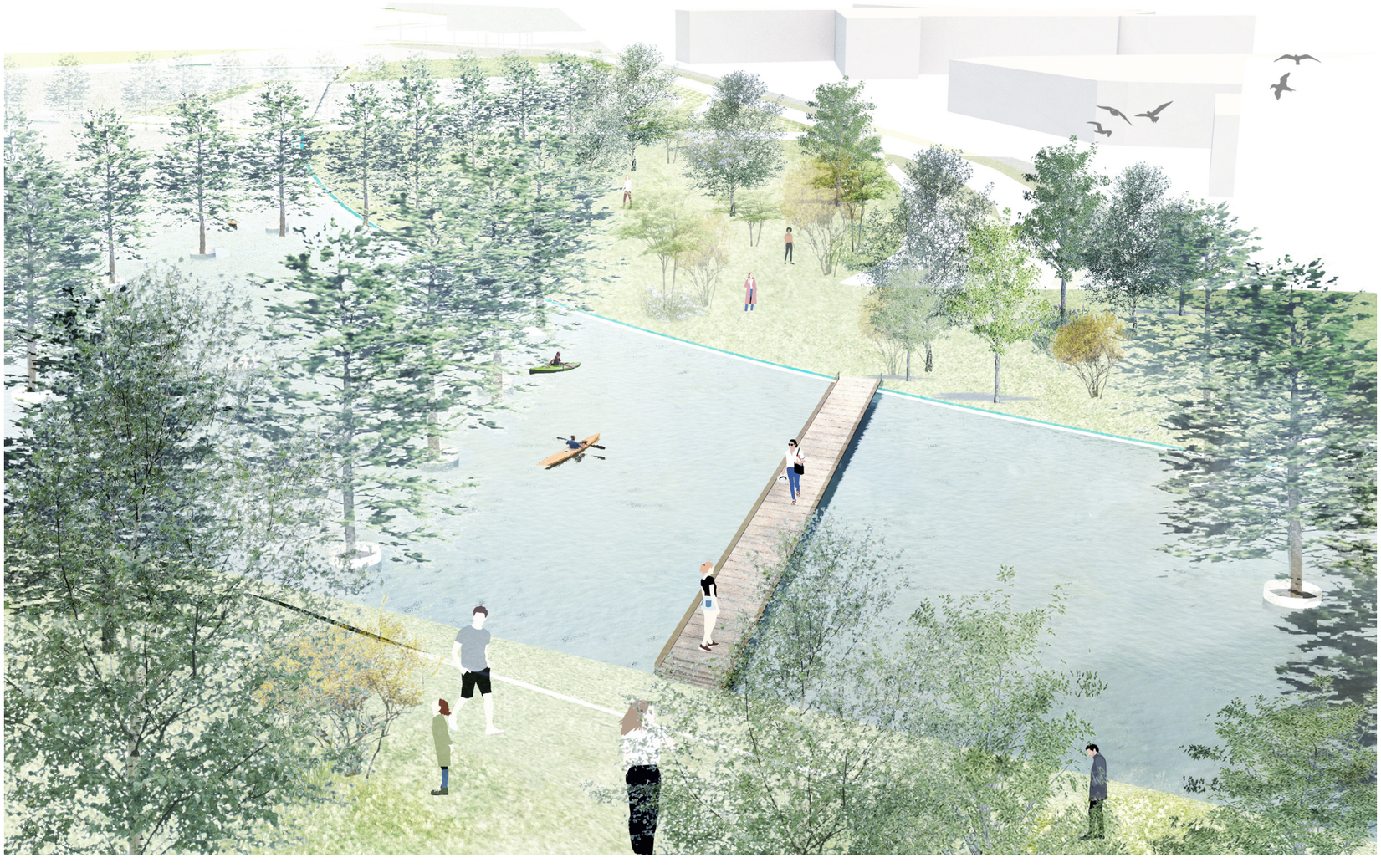


BRIDGE & ‘FLOATING TREES’

Birdeye view of the bridge crossing and the ‘floating trees’



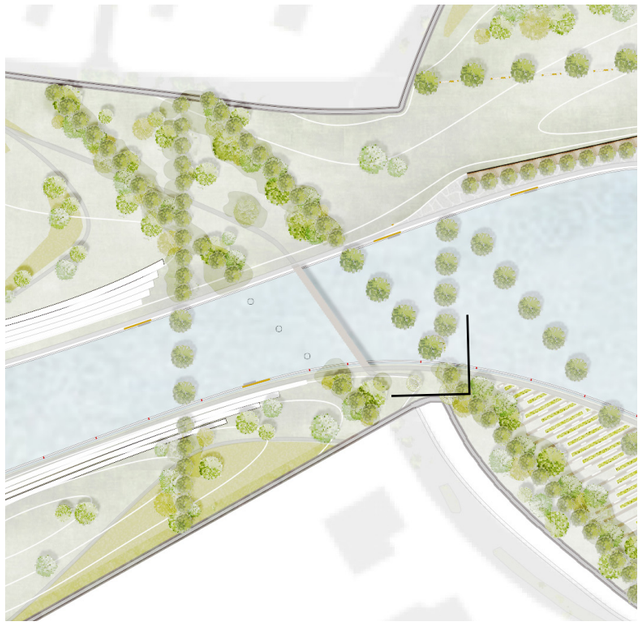




WOODLAND

Existing sloping topography gives a
scenic nature-escape experience

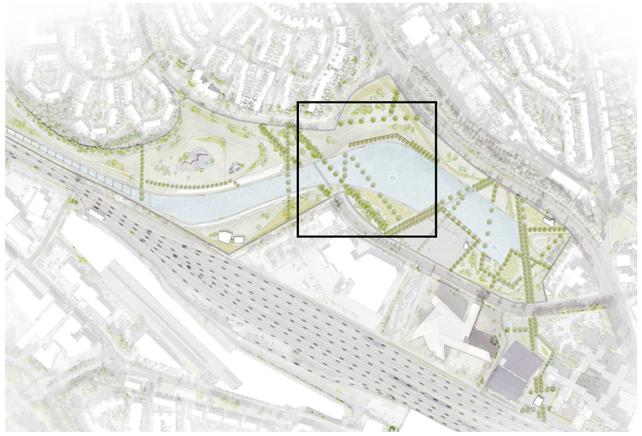


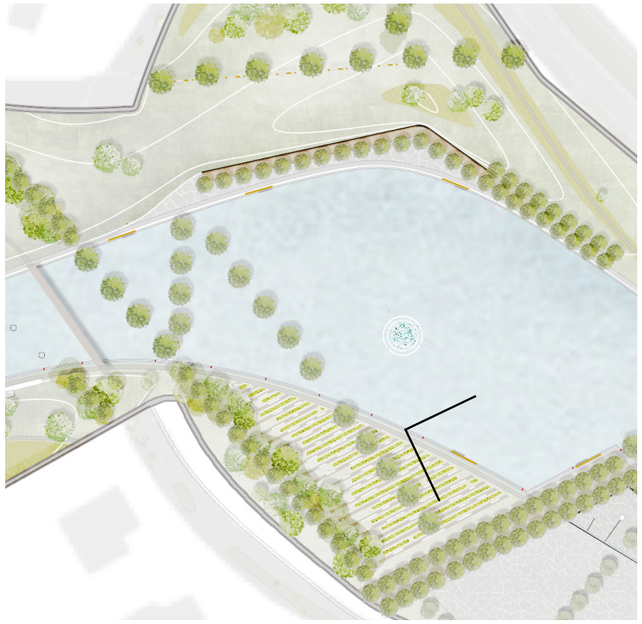




URBAN FARMING

Some of the azolla ferns that are made into composts are used in the Urban Farming zones. These Urban Farming pocket spaces also provide bences for gathering.

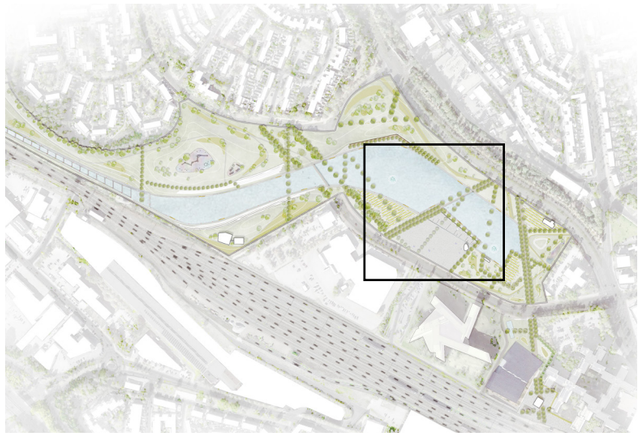






MARKET SQUARE

The Square offers large scale social opportunities such as markets or events. The weekly market will be one of the places to promote azolla products.



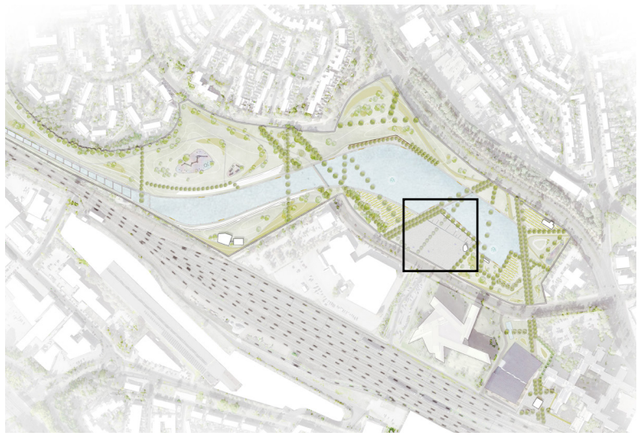


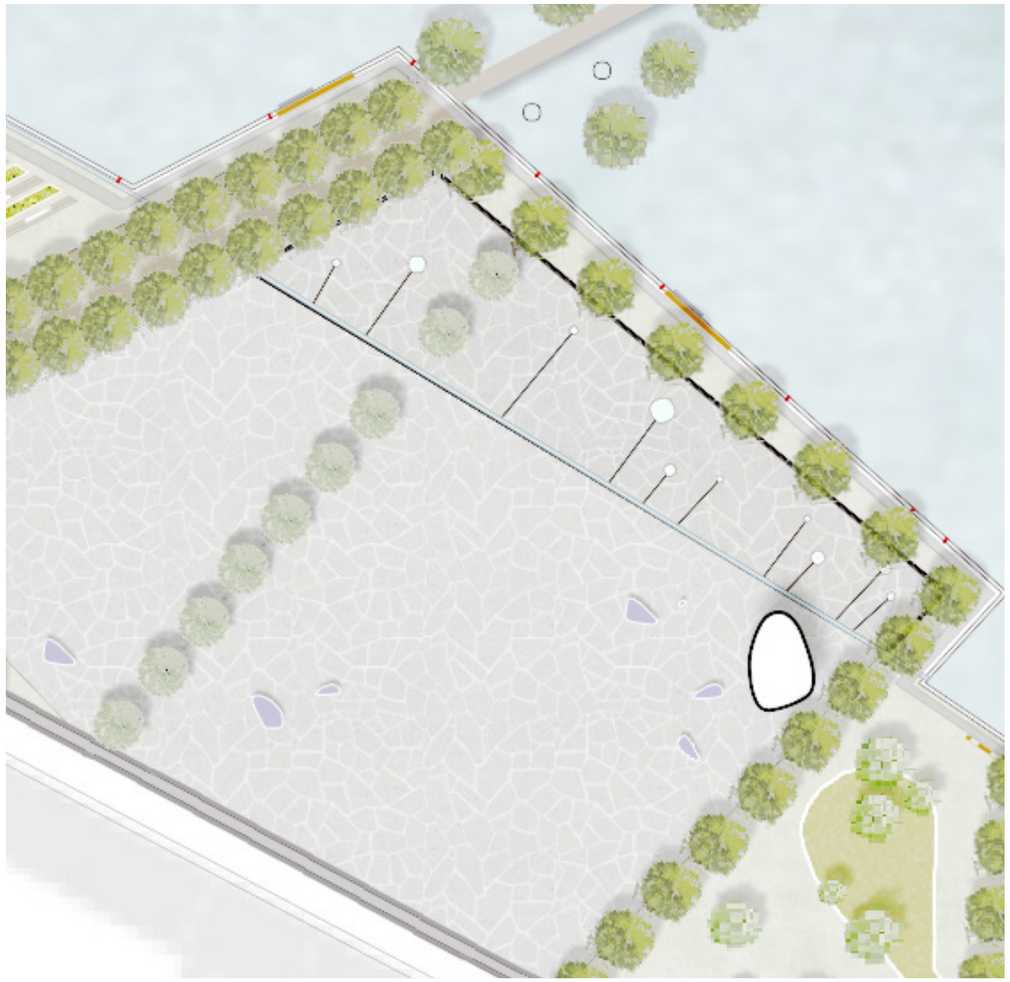


4.6

DETAIL DESIGN

EDUCATIONAL PLAYING FEATURE IN MARKET SQUARE





MARKET SQUARE

The square features an educational playing area, and a flexible use space for market and events.



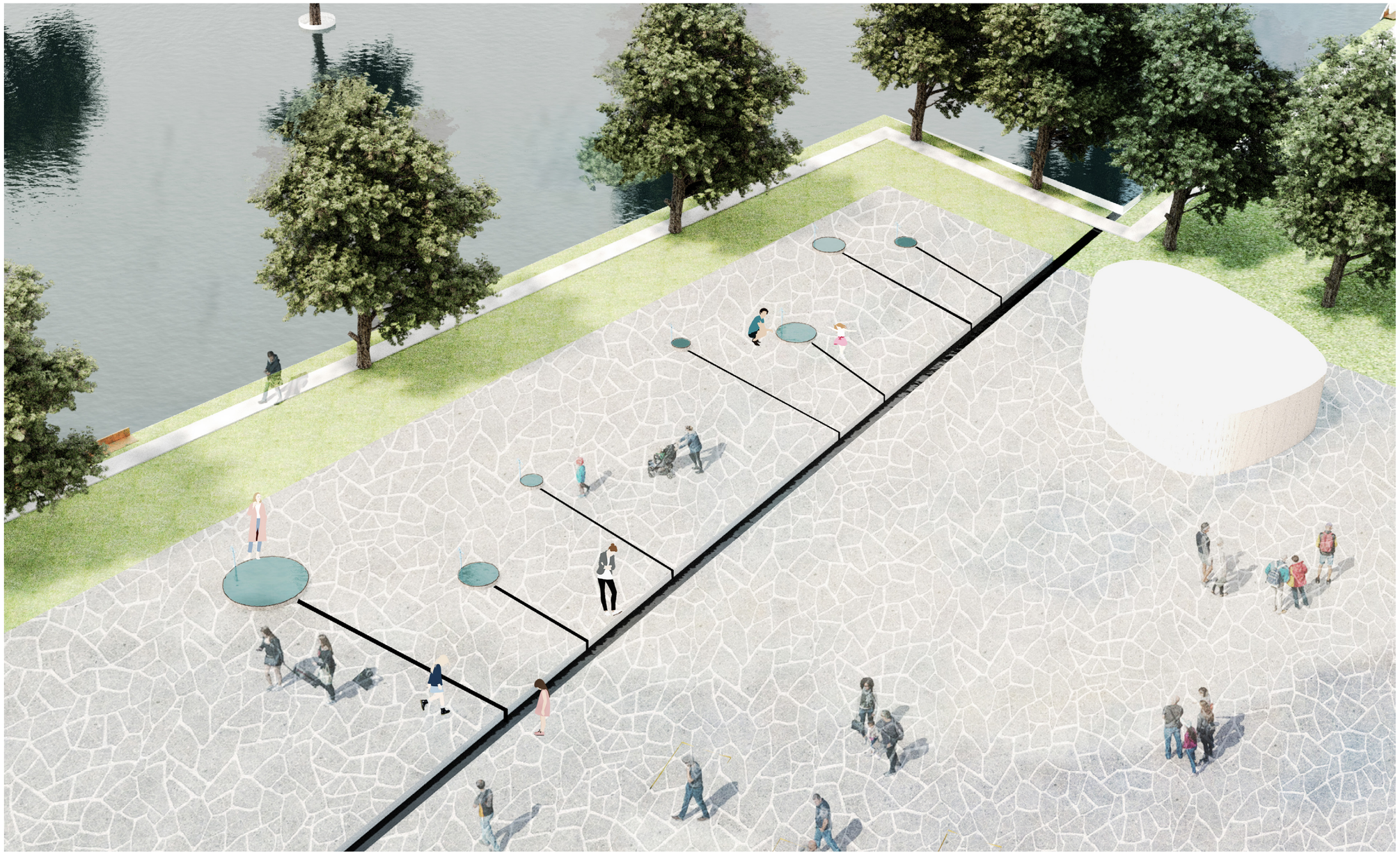
Market Square

MARKET SQUARE

The square features an educational playing area, and a flexible use space for market and events.



Market Square with flexible use

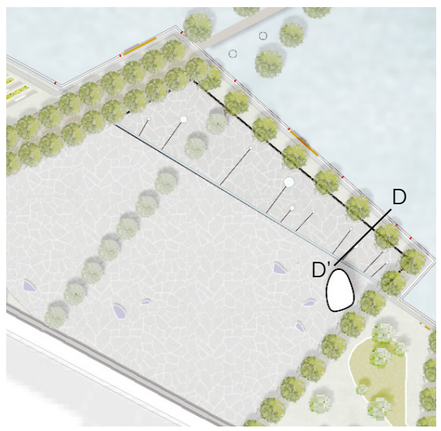


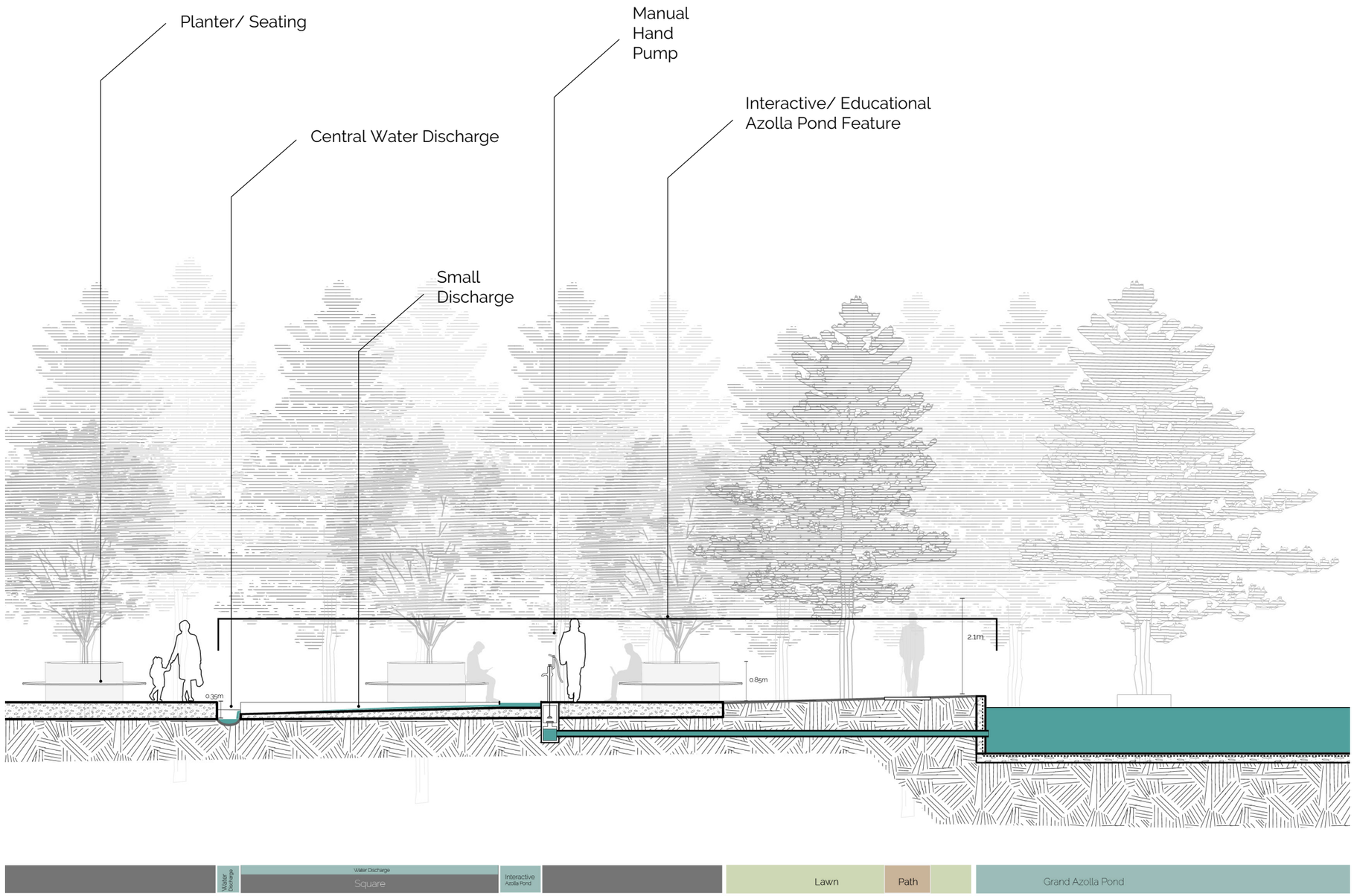
Birdeye View showing educational 'mini azolla ponds' features

4.6.2 Interactive/ Educational Feature in Market Square

A hand pump is used to draw the water from the big pond into the the mini ponds . One can then scoop out some azolla from the big pond with hands or with tools, and put them into the mini pond. Since azolla doubles quickly, in a day or two whoever passes by can take out these newly filled azolla, and bring them to the visitor center for a small reward or treat. The water will be discharged to the central discharge stream.





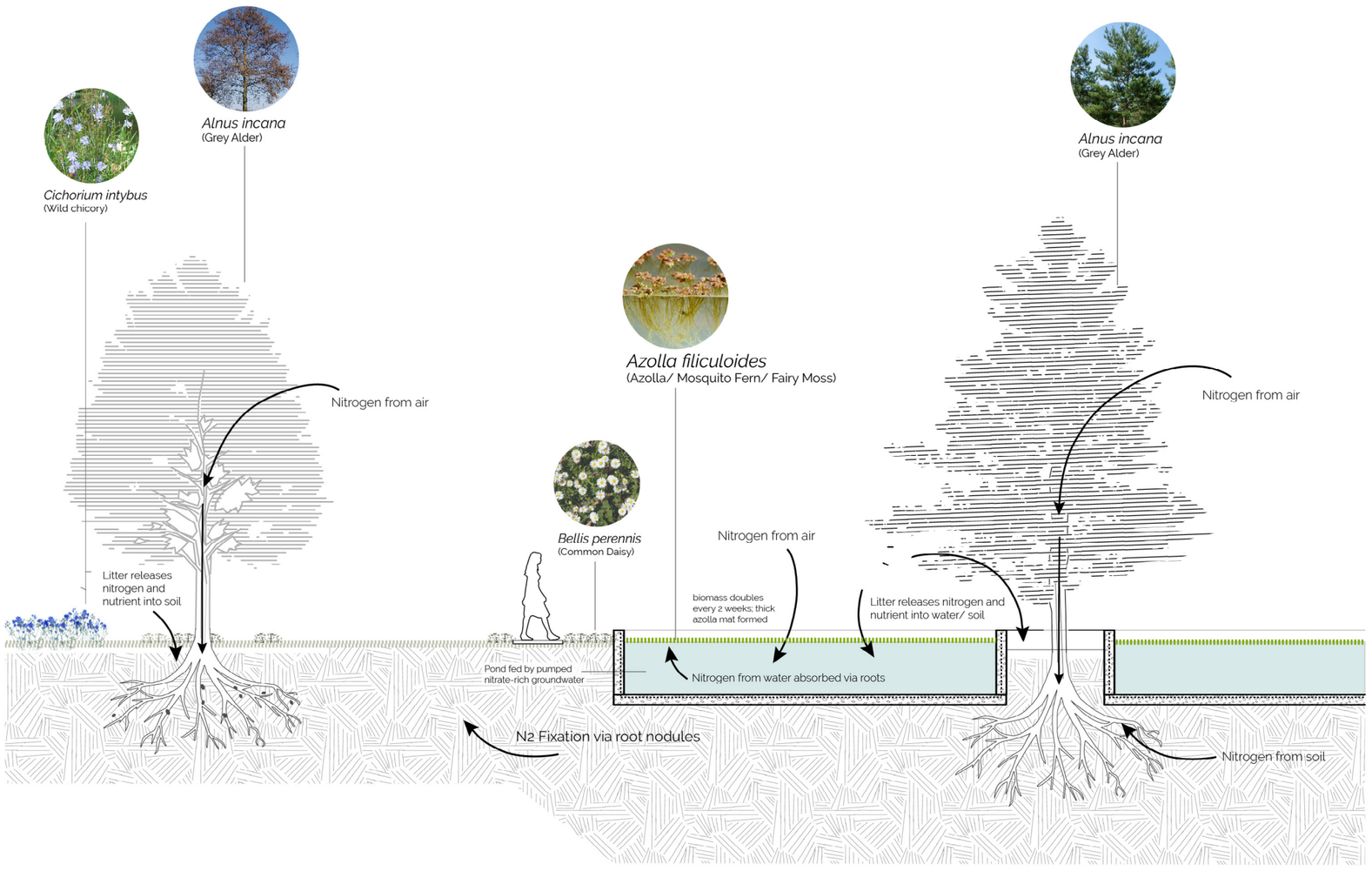


Section DD'

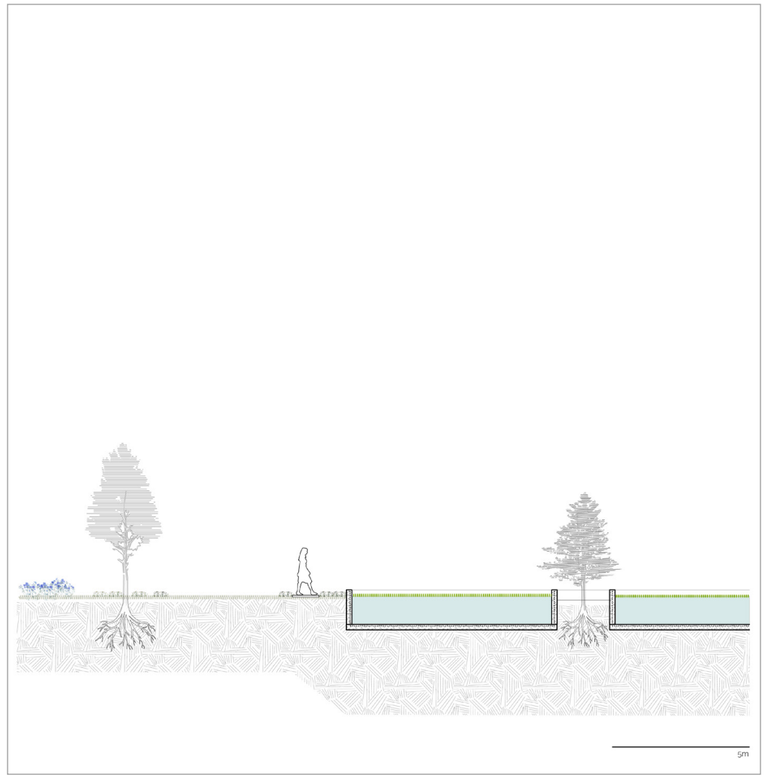
Section 1:100 in A3

4.6.3 NITROGEN CYCLE & MICROECOSYSTEM

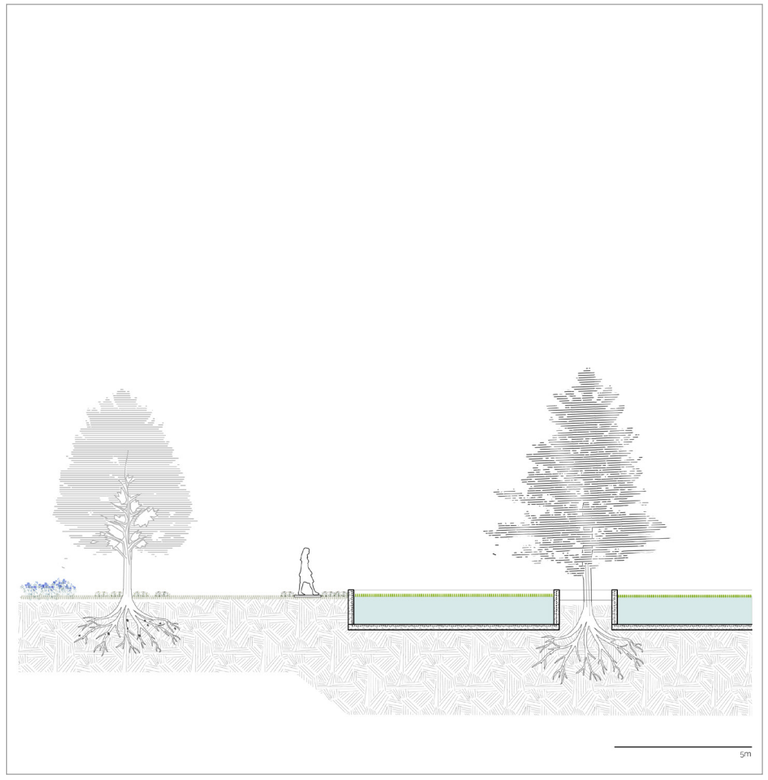




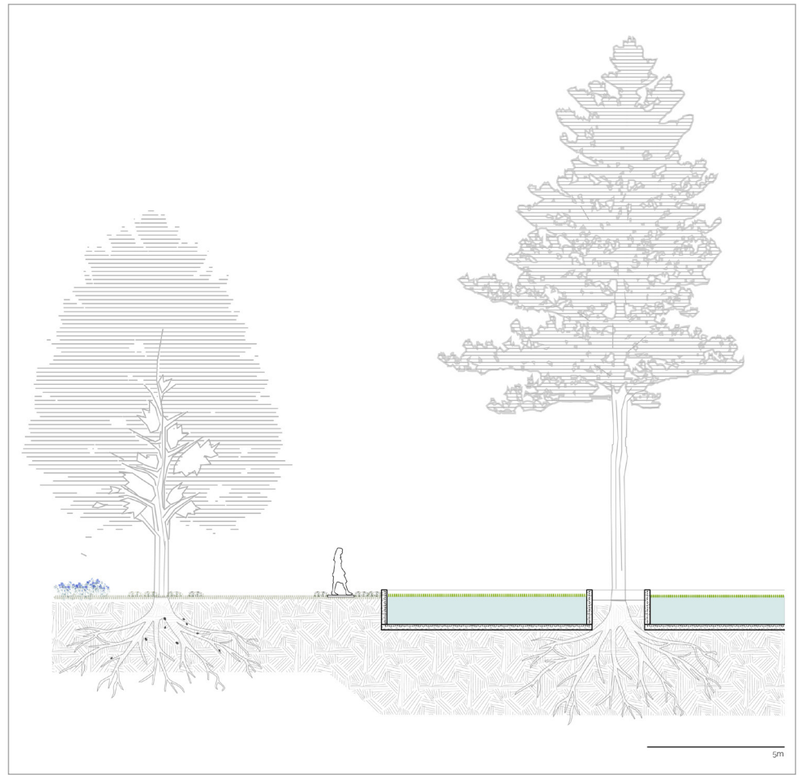
4.6.4 Temporal Change - Growth



Start year



10 - 20 years



30 - 50 years

4.7

SMALL FEATURE DESIGN

MICROCIRCULATION FEATURE



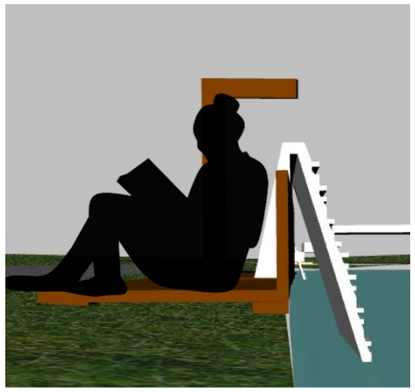
4.7.1 Technical Design

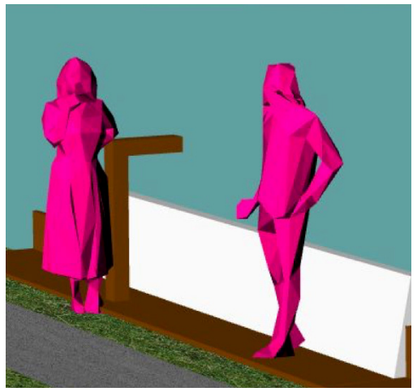
Social:
informal seating opportunity
Symbolises industrial memory

water: micro-circulation

This feature is a micro-circulation device for aerating pond water and provides constant water flow effect for visitors. The mechanism of the device references Alan J. Marshall's doceumentation of his own Azolla filtration water system published on the website of the Azolla Foundation.

Constant water rhythm - sound of water flow







Corten Steel

Carbon-neutral Concrete*
(e.g. Hempcrete) /

Recycled Concrete**
(e.g. Superlocal, Parkstad)

Wood

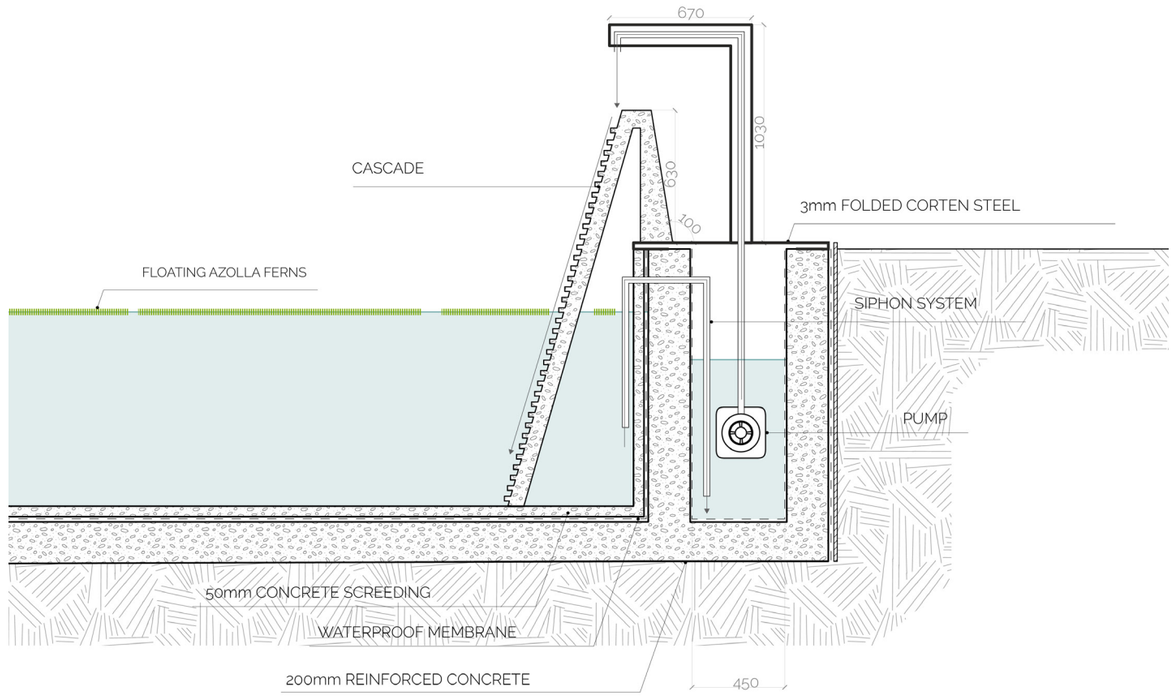




* Recycled concrete (from demolished buildings) experimental project in Kerkrade Parkstadm developed by Superlocal.



** Source: https://www.astm.org/standardization-news/?q=features%2Fgreen-building-hempcrete-ma20.html



4.8 RHYTHM CALENDAR

Flowing Spectacles

Every 1 or 2 months

Large scale water change

'Chimney-fountain' appears

Azolla Harvest



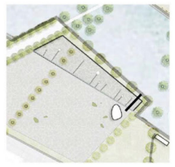


Daily

Interactive water feature

Small Azolla Harvest





Constant

Micro water-circulation





Winter

Option:

- Water feature without Azolla

- Big Pond: Ice-Skating Rink

- Small Ponds:
partially emptied for pop-up features, e.g. for different artist

05

CONCLUSION & REFLECTION

CONCLUSION & REFLECTION

The project questions the values of park, and more specifically the meaning of park in a shrinking city, Heerlen. It explores the possibility of marrying social restoration and nitrate remediation - two pressing needs of Parkstad, in the form of an urban park. The resulting design is on one hand a model of social-nitrate synergy through azolla (water fern), and on the other hand a park cooperative facilitating the azolla industry and the operation of an urban park. Urban farming, food industry, research, innovative businesses and water company can all contribute in increasing the financial yield of the park. The designing of the Azolla City Park is an attempt to deliver such coexistence of the social layer and the functional nitrate-remediating layer. It also aims to bring these multi-layer rhythms to life. Collective identity of the past is juxtaposed with the site's new function and identity. Azolla is the new coal, you may say. In the way coal mining used to give Heerlen its pride, businesses, social life and culture, so would the proposed azolla-city park create ripples of possibilities in the urban fabric of Heerlen.

Designing, is in all ways, researching. It is the understanding of the site, it is the external inquiry of knowledge, insight, inspiration; and it is the constant internal evaluation on, and the insights gained through, every personal design exploration. It is through these multiple layers of research that a design gains sensitivities in our complex reality. With the help of mapping analysis of geomorphology, landscape structure, soil, settlements, comparative study of social-economic statistics, literature review, historical studies, field visits and face to face conversations with local officials and designers, key problems and needs are identified: Social restoration, groundwater nitrate remediation, and the reutilisation of parks in the midst of these mentioned problems.

The project aims to explore on the topic of 'park', 'social wellbeing of individuals/communities', and 'nitrate remediation'. It asks the question of 'how'. How can these 3 dimensions be integrated in a spatial design? Different research methods have been chosen according to the nature of the quest.

Literary review has been very important in the sense that it supplies knowledge, insights and a theoretical framework for the project. Theories of public parks help establish the philosophical backbone of the design concept while literary reviews on social sustainability and scientific research paper on nitrate remediation provide the basis of design principles and tools. Precedent studies such as crowdfunding project Luchtsingel have also helped in providing a range of possible strategies that the project could employ.

Under the topic of 'social wellbeing of individuals and communities,' I have looked into theories of environmental psychology, social cohesion and social infrastructure. For the topic of nitrates, scientific director of the TU Delft botanical garden and renowned scientist Dr. Bob Ursem is consulted. Ursem has a background in biology, chemistry and Physics. The basis of my groundwater nitrate-remediating design by using large area of azolla ponds with a pump and treat technique has been discussed and approved by Ursem. Pond size, nitrogen-fixation speed and azolla growth rate are mostly based on the formula/ calculation Ursem provided.

'Research by design' is also another design method that has been used. Different scenarios such as water systems scenarios, pond sizes, tree distances etc. are proposed/designed and evaluated, this builds up a catalogue of different implementations and generates better understanding of different possibilities.

The relevance of my project in the larger social, professional and scientific field is that it concerns a new urban issue that most cities are, or yet to be, facing – the shrinking city phenomenon. I believe a new urban park model that extends to topics such as social value, urban services value, ownership and management will be beneficial to most shrinking cities. The specific angle of nitrate remediation and azolla filiculoides in this project, on the other hand, will contribute in research of integrating these elements with public and daily settings/designs, since not many projects have been done in this regard. The result of my project will help promote the use of azolla filiculoides or the need to create nitrate-remediating public spaces, and to hopefully provide an example of how these can be spatially implemented.

I see Landscape Architecture as a mediator between all the many different sectors in this world, between men and nature, the social and the economic, earth and surfaces. Parks are in the same regard a mediator between all these, and with this an enormous responsibility has been bestowed upon them.

A park should never be single purposed, especially in a shrinking city. It should actively take on roles other than social restoration, roles such as infrastructural role or financial role. The azolla city park is an attempt to utilise these possibilities, and a statement to argue that parks can be redefined as a multidimensionally valuable element of a financially-shrinking and mentally-suffering city.

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