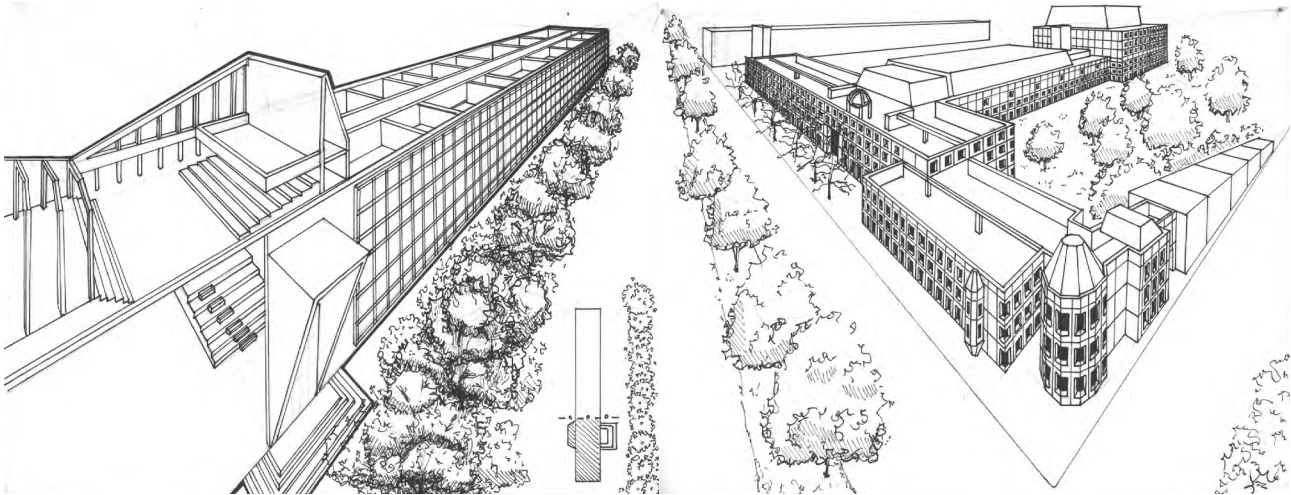


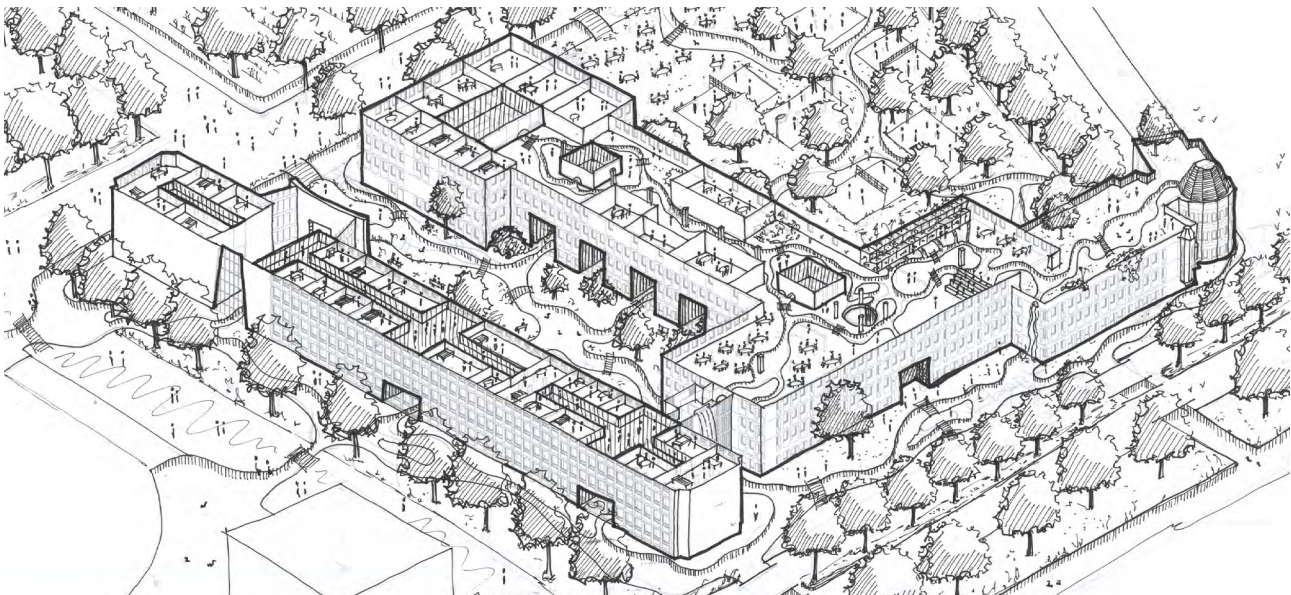


How will we live together?

Adapting 20th Century Heritage

2021/2022

Arne Boenders



Delft University of Technology
Adapting 20th Century Heritage
Vacant Police Real Estate
AR3AH105

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2021/2022
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Introduction

Most of the societal and ecological issues that we are currently facing arose in the built environment, but it is also there where I believe most possibilities for change and improvement are. Open-ended technological cycles (cycles that take resources from the natural environment and produce unusable waste) are taking place in an existing built environment. In order to control and alter these cycles, transformation of existing buildings and infrastructures is needed. In this way, trying to create a better relationship between the built and the natural environment. That is why I have chosen the studio of Adapting 20th Heritage, as it focuses on the re-design of the existing built environment and can in that way have a large impact on the way how we live together with nature.

The Adapting 20th Heritage graduation studio focuses on police buildings. Ten different police buildings were given by the police, located in Groningen, Rotterdam, Eindhoven, The Hague,

Haarlem, Warnsveld, and Middelburg. Most of these buildings will become vacant in the future as the police will no longer use them. The goal of this studio is to create a re-design strategy for these vacant police buildings, which can be used as input on the discussion about the future of these buildings. The Eenheidsbureau in The Hague was chosen as the case study for this graduation project.

Part of this studio is the Spatial Building Typology analysis, which compares the spatial aspects of the police buildings on four different scales. Later in the process, the design interventions of the different buildings are compared to research if there is a relation between the spatial typology of a building and the interventions used.

This booklet is a collection of the research and design process that is conducted for this graduation project of re-designing a police station.

Arne Boenders

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1

Motivation & Emotional mapping

30.08.2021 - 05.09.2021

Motivation of research direction

"From Ego to Eco" - Sinus Lynge & Tue Hesselberg Foged (Venice Biennale 2021)

This is an inspiring quote I saw when visiting the Biennale in Venice this year. It was part of an installation that explored how to design human communities with the principles of nature. *"By applying natural principles in design, humans can strive to close the gap that currently exists between built and natural environments, for the mutual benefit of both human and nonhuman life"* (Lynge, S. & Hesselberg Foged, T., 2021). This matched very well with my interests, fascinations, and maybe even a bit with my own future goal as an architect. Including and integrating nature into buildings, not just with some planters or a green courtyard, but more on a deeper level transforming the built environment into a new natural ecosystem.

Currently, a building forms a hard spatial border between humans and nature, as it is designed to function as a shelter from the natural elements. I believe that this boundary needs to become more transparent or maybe even broken completely. If we keep living the same way we currently are doing then it will no longer be *humans + nature* on this planet, it will, in some years (who knows how long), be just *nature*. It is important to realize that, yes, we are currently damaging nature with our actions, but it will not take long before the degradation of nature will become the end of humans, and not the end of nature. Nature will likely survive this crisis, it will find a way, as it always has, but now it is time that humans also find this way, this way of surviving the crisis.

It starts with acknowledging that humans are not something different or more important than

nature. Humans are just one of the many species on this planet and we need to start acting like it. Nature is a complex system of cycles and closed loops, where the different actors have bonds and links that tie them together and keep them alive. They are dependent on each other and need each other to stay alive and thrive. It is time to realize that we humans are just like all the other species of nature; we need nature to survive.

But does nature actually need humans to survive? What good do humans currently do to nature that truly benefits it? What would humans be able to give back to nature? How can humans become part of the cycles and links of nature? How can we again become part of the ecosystems? I believe that an important part of the answers lies in the built environment. As it is there where the disconnections from nature are made, it is there where we abuse most of the resources of nature, and it is there where there is so much space for opportunity.

But how to utilize, design, and transform this space in the built environment? What if we would transform the built environment into a new natural ecosystem, just like forests, grasslands, deserts, oceans, and rivers? How would that spatially be shaped and designed? How would we have to redesign the current built environment to accommodate the needs of both humans and the rest of nature? How would you design a building that was just meant for nature? What would the spatial requirements be? Are certain spatial typologies more suited for this approach than others?

With these questions in mind, I want to follow the Spatial Building Typology course.

Motivation of location

After visiting 4 completely different police offices throughout the Netherlands, from IJmuiden to Den Haag and Haarlem to Rotterdam, I made a top 3 of the locations based on my own preference.

Let's start with the number 3 on the list which is the Koudenhorn in Haarlem. This old building is beautifully situated next to the canal and hidden behind a green curtain of trees if approached from the station. What unfolds is a monumental closed block, where at first sight one would say it exists of four similar wings enclosing a courtyard. But the opposite is true, as each facade and the space in front of it has its own identity, its own atmosphere. The very calm facade shaded with trees bordered by the canal, the monumental facade with the main entrance and very strong rhythm enclosed by a busy road, the more closed facade in the small street, and the last facade which is covered up by this parasite-like extension of white and grey metal sheets, making it a building with 4 faces. 5 actually if you would include the courtyard, but for this site visit, it remained a part of the mystery of the building. That is maybe also why this building made it to my list; this hidden area, this enclosed space of inner peace, combined with the 4 identities surrounding something yet unknown.

The next building on my list is quite different as we go from the inner city of Haarlem to the waterfront of Rotterdam where the office building of the Havenpolitie of Rotterdam is positioned. Approaching from the north-east direction, the first recognizable feature is of course the orange tower appearing to grow out of the water. When coming closer the collection of various police boats in all forms and sizes, is laying in the water connected to the building with a network of jetties.

As we got closer we get a view, which immediately put this building in my top 3 list. It is the sight of the 3 building parts aligned in such a way that it just makes sense. A spatial storyline through history, where the old small house-shaped building, was followed up by a much larger 3 story building, which then in its turn was followed up by the orange tower, finishing this perfect line in size, height and time. This layering of time and spatial composition together with the upcoming neighborhood form great potential and inspiration for an adaptive re-use design.

The number 1 building on the list and therefore my favorite building of the site visits is the imposing Eenheidsbureau in Den Haag. Shaped like a rock with carved out holes for the windows, towers, and walls like a castle. It gives the impression of a fortress a safe, secure, and strong place to hide from your enemies. A building with a very strong monumental character, showcasing authority and discipline, but at the same time a building with a playful and almost friendly side. Caused by the arrangement of various building blocks forming the ensemble, combined with the small top-up additions on the roof, but also with the rounded corners of the concrete window cut-outs or with the round towers on one of the corners. Already from only experiencing the outside (not being able to visit the inside yet), I notice that this building has so many sides, identities, and remarkable places. It feels like I will never be able to completely understand and master each small element and detail of the building, but this overwhelming feeling of complexity, with at the same time the appearance of a very well structured building, is what makes me like and favor this challenge of re-designing this building so much.

01.09.2021-haarlem-koudenhorn

• cozy housing blocks

• window rythme in this facade seems of / weird

• most disappointing corner of the building

• tower for connettions feels misplaced

• still some steel bars in front of windows

• THE BIG MYSTERY??

• ugly addition ruins the monumental building

• double windows with sunshading

• very closed facade
• not very inviting

• nice view to windmill and koepegevangenis

• monumental front

• main entrance clearly visible

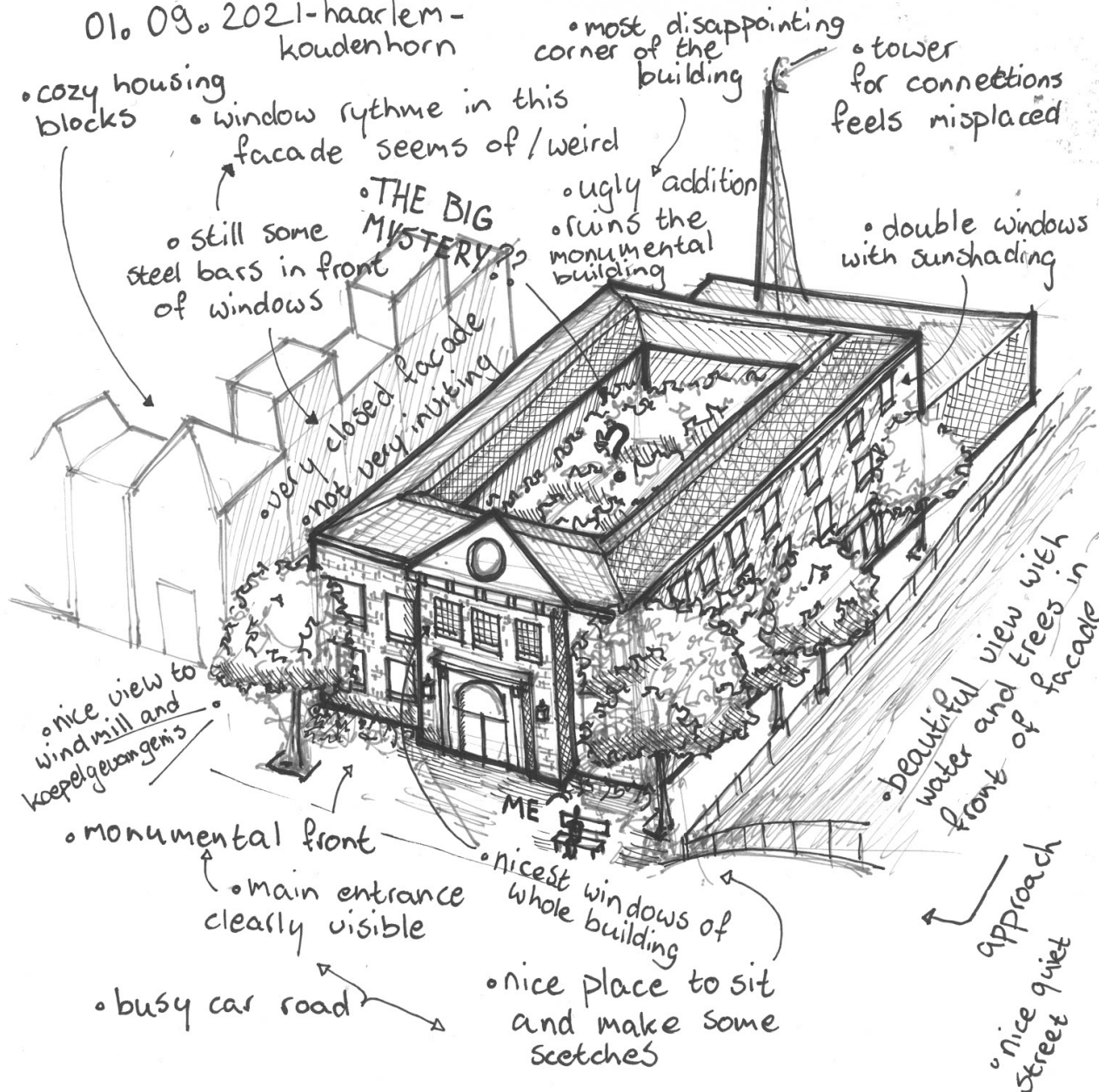
• busy car road

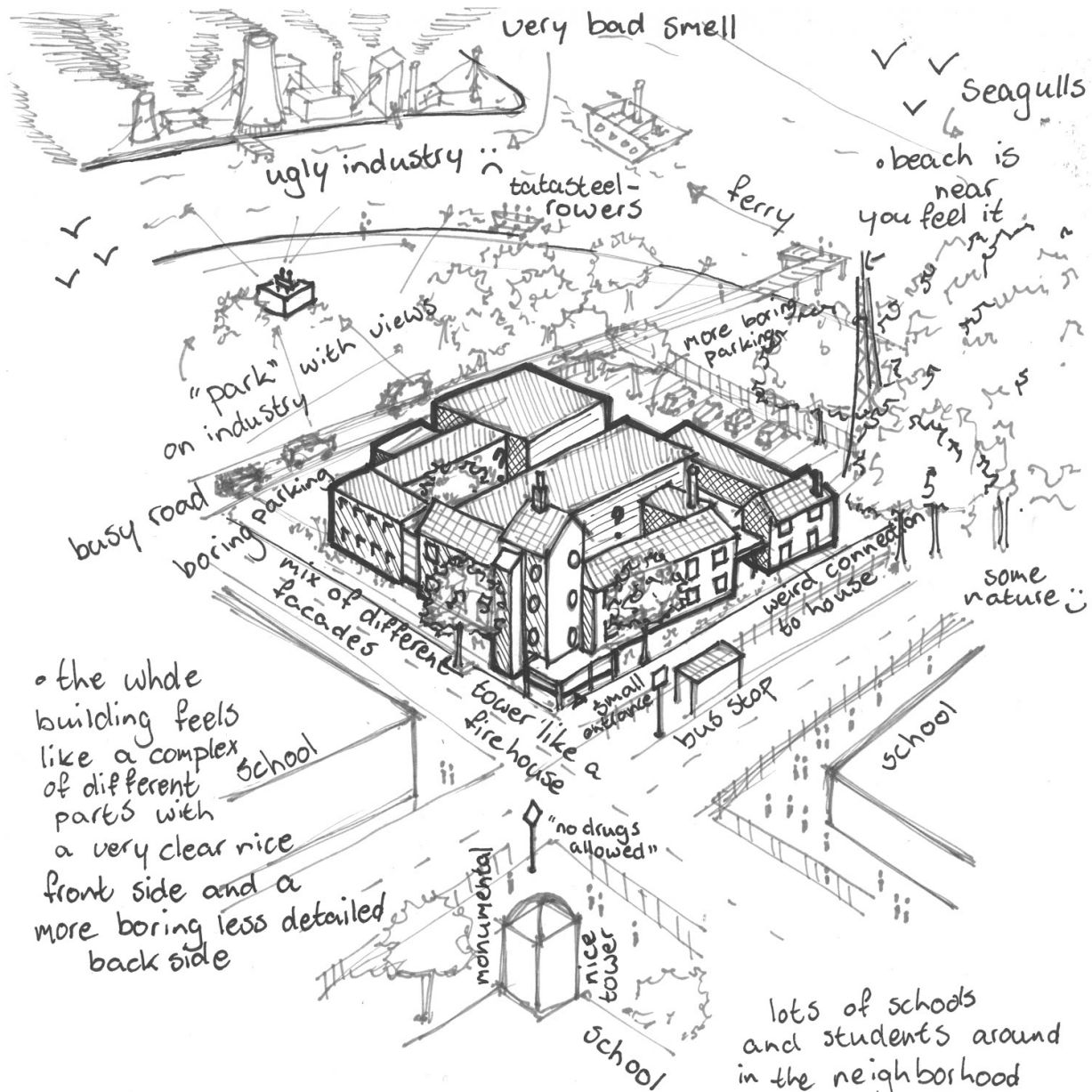
• nice windows of whole building

• nice place to sit and make some sketches

• beautiful view with water and trees in front of facade

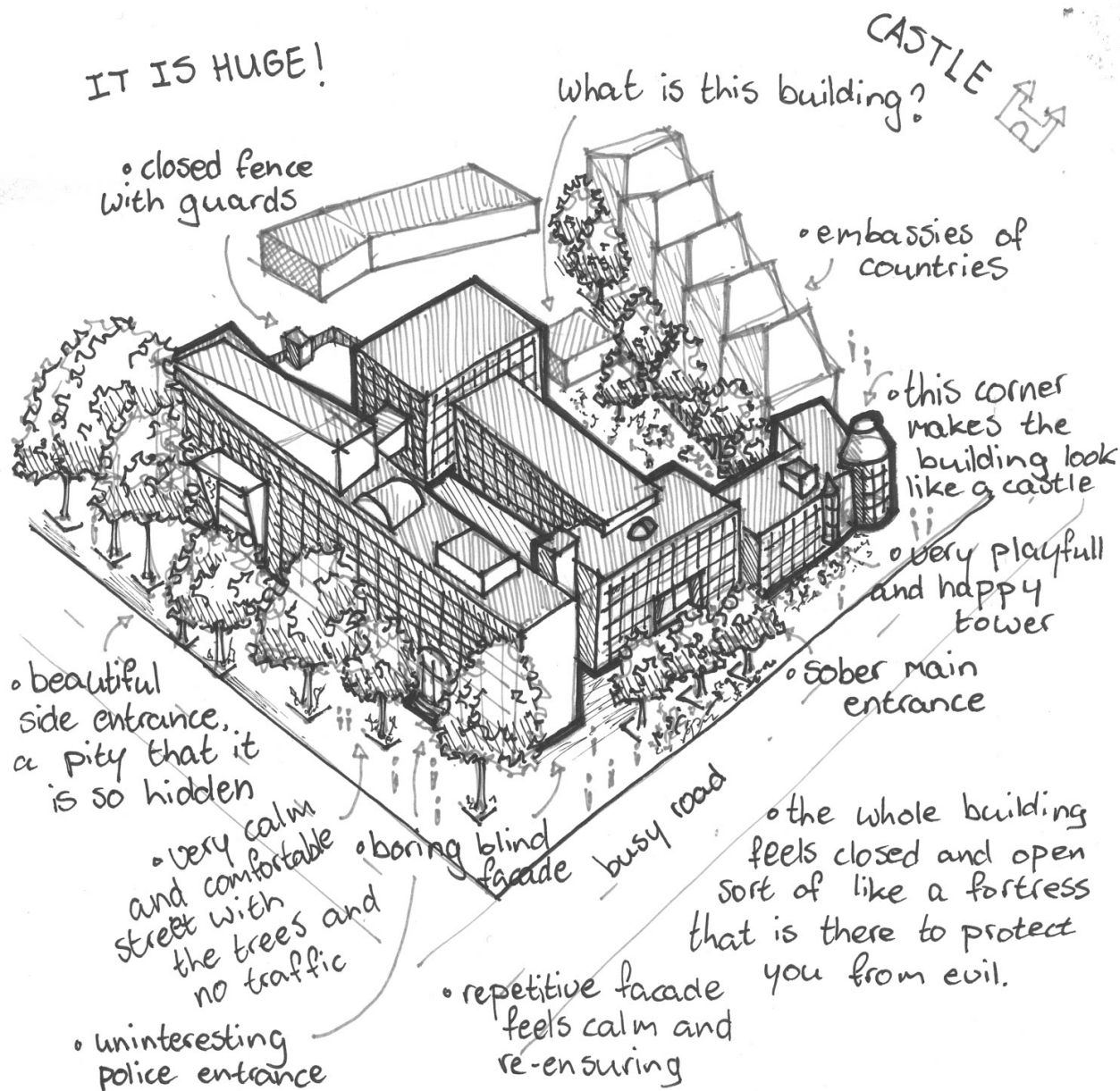
• approach
• nice quiet street





01.09.2021 - ymuiden - haven politie

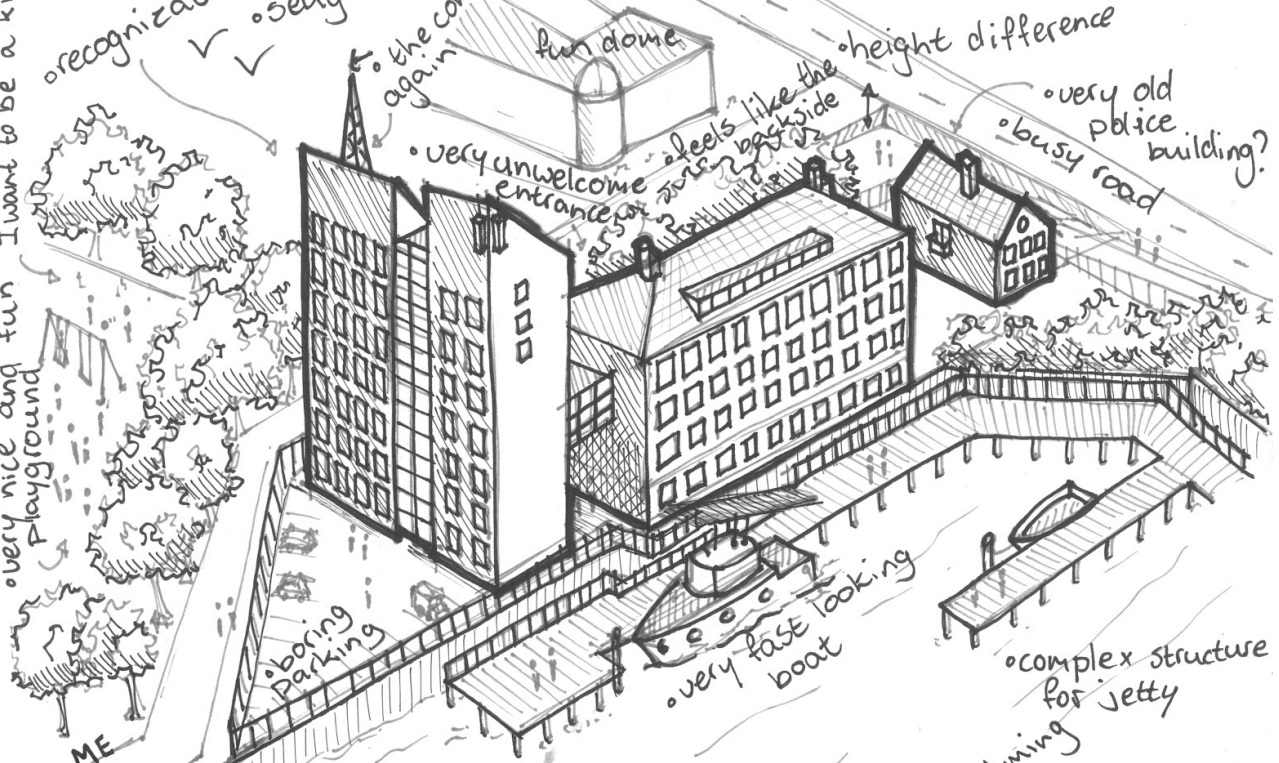
01.09.2021 - den haag - eenheidsbureau



02.09.2021 - rotterdam - havenpolitie

very nice and fun I want to be a kid again :)

recognizable towers almost like a firehouse
 • seagulls on the water
 • the connection tower
 • this time less annoying as it is already on a tower



height difference
 • very old police building?
 • busy road

fun dome
 • very unwelcome entrance
 • feels like the backside

• very calming rhythm in the facade

• angry swans

lots of nice water

• nice view to erasmustower and the floating chinese restaurant

• beautiful view from the water to these 3 buildings, each a layer of time showing expansion in time

2

Research direction

06.09.2021 - 26.09.2021

Research direction

"From Ego to Eco" - Sinus Lynge & Tue Hesselberg Foged (Venice Biennale 2021)

This is an inspiring quote I saw when visiting the Biennale in Venice this year. It was part of an installation that explored how to design human communities with the principles of nature. *"By applying natural principles in design, humans can strive to close the gap that currently exists between built and natural environments, for the mutual benefit of both human and nonhuman life"* (Lynge, S. & Hesselberg Foged, T., 2021).

Questions asked and tried to answer with this installation are:

How can buildings work like ecosystems?
Can urban communities become self-sufficient?
Can architecture help people reconnect with nature?

Based on this installation and the proposed questions, I began questioning these questions:

Ecosystems

What makes something an ecosystem?
What would happen if all buildings would become part of the ecosystems?
Would the buildings on their own form ecosystems or does this happen on a larger scale? Which scales are possible?
How would the buildings relate/communicate/exchange with the natural environment?
When did humans begin separating themselves from nature and why? Is this separation a good thing or a bad thing?

Nature

EFFEKT depicts their solutions as some buildings surrounded by nature, while currently, it is more the other way around, nature is surrounded by buildings or other built environments. It seems a bit like a Utopian way of living, right in the middle of nature. Is that realistic? Also, the including of nature seems to stop at a level of just planting some plants around and on top and in your buildings. Is that really the best we can do to give something back to nature? Is that truly reconnecting to nature? Or just making up our own "manmade" artificial synthetic nature? Again trying to recreate something, where as soon as we make it, it is no longer nature? What is nature? How is something nature? When is something natural and when is it "manmade"?

Transition / border between natural environment and built environment

How did this border develop over time? When was this border created for the first time? And why?
What happens if you overcome this border and integrate nature and building? Why would you want to integrate this? Is it needed and will it solve anything? What problems will this cause?

Frequently found words

Biophilia, Biomimicry, Ecological Design, Nature Inclusive, Green Architecture

Further research

The next pages illustrate some first literature and some initial findings.

Ego to Eco

How will we
live together?

L'umanità sta affrontando la sua sfida più grande. Considerando l'imminente pericolo del cambiamento climatico, la perdita degli habitat e l'impoverimento delle risorse naturali, dobbiamo ripensare al modo in cui viviamo su questo pianeta.

Il *Growtable* mette in mostra idee diverse per vivere, costruire, produrre, consumare e rivitalizzare gli ecosistemi dai quali dipendiamo e dei quali siamo parte.

Il tavolo risponde a quesiti urgenti come ad esempio:
Come possono gli edifici funzionare come ecosistemi?
È possibile che le comunità urbane diventino autosufficienti?
L'architettura può aiutare le persone a riconnettersi con la natura?

As humanity is facing its greatest challenge ever with the imminent threat of climate change, habitat loss and depletion of natural resources, we need to rethink the way we live together on this planet.

The *Growtable* showcases different ideas for living and building, for producing, consuming and revitalizing the ecosystems we are part of and depend upon.

It responds to urgent questions such as:
How can buildings work like ecosystems?
Can urban communities become self-sufficient?
Can architecture help people reconnect with nature?



Terminology

Ecosystem

Geographic area where plants, animals, and other organisms (biotic factors), as well as weather and landscapes (abiotic factors) work together to form a bubble of life.¹

Would the built environment fall under this definition as it is an area where organisms (mostly humans) work together and interact with abiotic factors (do buildings count as abiotic factor?) to form a bubble of life? What is the role of architecture in creating this physical boundary (a build object) between humans and ecosystems? Why do we build? Is architecture part of the reason that we might be disconnected from nature and have become a parasite on this planet, rather than living in symbiosis?

Ecology

The study of the relationship between organisms and their physical environment.²

Ecological Design

Design that minimizes environmental destructive impacts by integrating itself with living processes.³

Design that copies the laws of nature and metabolism, displaced from the domain of wilderness, applied to cities and buildings.⁴

Design that reconceptualizes the world as a complex system of flows.⁴

Biotic & Abiotic

Biotic are living factors in an ecosystem like plants, animals, organisms. Abiotic factors are non-living like water, soil, air, light, minerals, temperature.⁴

When buildings would be seen as abiotic factors, how would they be positioned in an ecosystem?

What would happen if the built environment was a connected ecosystem in which buildings as abiotic factors are influenced by both biotic and other abiotic factors, but at the same time influence these biotic and abiotic factors?

Flows

Ecosystem as a complex, interconnected, integrated, balanced system of flows. Each factor influences, directly or indirectly, every other factor in the ecosystem.

Why would the built environment need to become an ecosystem? What are the benefits and disadvantages for the built environment, but more importantly what are the benefits for the connected ecosystems? What does the built environment have to offer in an ecosystem? How would the built environment become part of this complex system of flows and create a balance?

Time, Development, Duration, Dynamics, Evolution & Transformation

Why would we see buildings as objects that can be "finished" with a design and not as growing and ever evolving entities which are guided during their timespan with interventions and transformations? How would buildings, just as ecosystems, evolve and adapt to changes of the connected factors (both biotic and abiotic)? What is the role of the architect in this transformation process of buildings that might not have an end, a clear finish?

Scales

Ecosystems have different scales, from an entire ocean to a small tide pool, both are ecosystems. Inside an ecosystem, multiple other ecosystems can exist.¹

History of Ecological Design

by Lydia Kallipoliti (2018)

"Looking back at the breadth of the history of ecological design enables an alternative, elastic understanding of the term ecology, addressing not only a new kind of naturalism and/or technoscientific standard, but also a recirculatory understanding of the world and its resources. In this context, revisiting the term ecological, rather than sustainable and green, is of the essence and may contribute to a reassessment of contemporary debates on the environment. It may be in this epistemological fusion that we can ask more of architecture and design."

"As well as a practice of minimizing the detrimental impact of buildings, ecological design is an ideational and philosophical system of viewing the world of ideas, information, and matter as flow, rather than as the accumulation of discrete objects. More than a material system, it signals the migration of life through the conversion of one thing to another."

Kallipoliti, L. (2018). History of Ecological Design. Oxford Research Encyclopedia of Environmental Science. Retrieved 13 Sep. 2021, from <https://oxfordre.com/environmentalscience/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-144>.

1. <https://www.nationalgeographic.org/encyclopedia/ecosystem/>
2. https://www.designingbuildings.co.uk/wiki/Ecology_and_the_built_environment
3. Walker, Stuart & Ryn, Sim & Cowan, Stuart. (2007). *Ecological Design*. Design Issues. 13. 87. 10.2307/1511945.
4. Kallipoliti, L. (2018). History of Ecological Design. Oxford Research Encyclopedia of Environmental Science.

The shallow and the deep, long-range ecology movement by Arne Naess (1973)

Currently only focus on pollution and resource depletion.

With Deep ecology, the focus lies more on the preservation and restoration of nature as a complex system, rather than only looking at the pollution and recourses.

Complexity, not complication

- Nature is considered complicated when looked at without seeing the unifying principles
- Nature as a multiplicity of interacting factors operating together to form a unity, a system

Deep ecology applied to humans:

- Complex economies, an integrated variety of means of living
- Combinations of industrial and manual work, specialized and non-specialized
- Work in city and recreation in nature and recreation in city and work in nature

Naess, Arne (1973). The shallow and the deep, long-range ecology movement. A summary. *_Inquiry: An Interdisciplinary Journal of Philosophy_* 16 (1-4):95 – 100.

Built environment > Built ecosystem

Research question

How to transform an existing built environment into a symbiotic ecosystem?

Sub questions

How did the relationship between nature (ecosystems) and the built environment evolve over time, including the movement of ecological design?

Which are the different components of a built environment, if it would be analysed as an ecosystem?

What are the current relationships and flows between these different components of the built environment and connected ecosystems on different scales?

How can these relationships and flows be transformed and developed in order to create closed loops and mutual beneficial relationships?

How would buildings, just as ecosystems, keep evolving and adapting to future changes?

Research Method(s)

1. Literature research & Case study analysis into the relationship between nature and the built environment over time
2. Mapping the different components in the built environment & connected ecosystems (abiotic & biotic)
3. Analyse relationships and flows between components
4. Experimenting to find matching flows and closed loops

Source(s)/ data collection

Literature (online & library): articles and books about ecological design and nature inclusive living.
Outcome: frame of reference for own research.

Case studies: define selection criteria, analyse 3/4 of them from different periods/areas.

Outcome: development of design principles and relationship between building and nature.

Mapping: chosen police building (Den Haag) as case study for a built environment, define different scales and define components with literature.

Outcome: Maps on different scales with components.

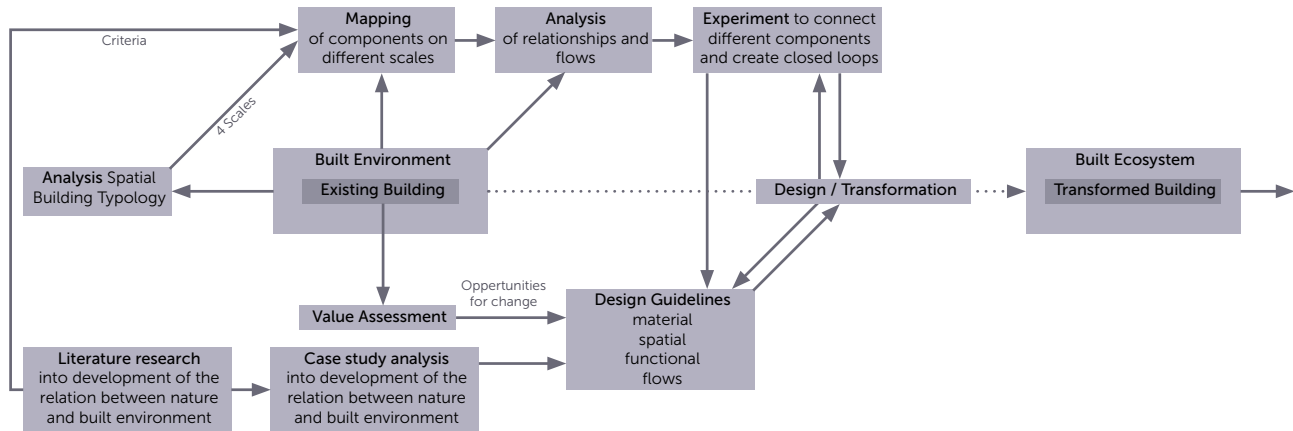
Analysis of flows and relationships: data needed about flows of materials, energy, heat, cold, water, air, CO2 of the Den Haag police station and surrounding built environment. Where can I find this?

Outcome: Diagrams showing relationships and flows between components.

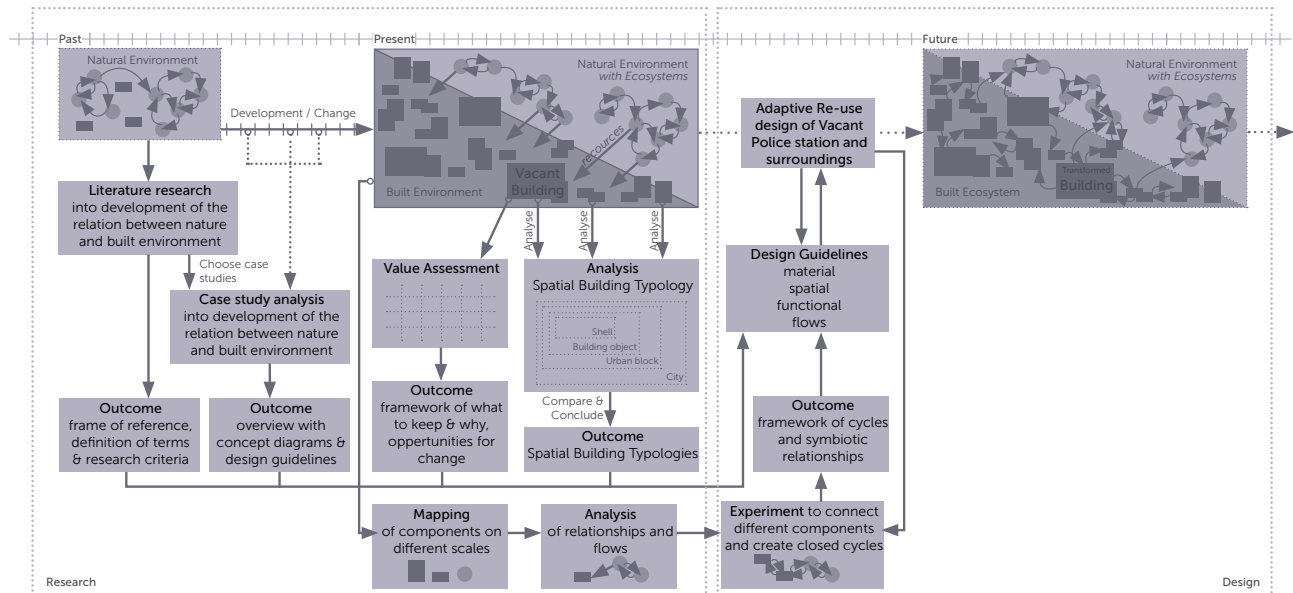
Experimenting: trying to connect different components.

Outcome: Diagrams with closed loops and design guidelines to create these loops.

Research diagrams



First concept diagram - own drawing



Second concept diagram - own drawing

3

Research plan

27.09.2021 - 31.10.2021

Preface

How will we live together?

An intriguing question which formed the central theme for this year's architectural Biennale in Venice. When visiting this Biennale, I walked through countless pavilions and saw many exhibitions, all about how humans could live together with each other, but almost more importantly, also how humans could live together with nature. There was one exhibition which especially attracted my attention. It was a large table, full of small living trees between which architectural models of ecological ways of living were displayed (see pictures below). Accompanied with this installation was this quote, which from the moment that I have read it, stayed with me:

"By applying natural principles in design, humans can strive to close the gap that currently exists between built and natural environments, for the mutual benefit of both human and nonhuman life."

Lynge, S. & Hesselberg Foged, T. (2021)



By applying natural principles in design, ...

This first part of the quote immediately touches upon a personal fascination that started a long time ago and probably has its roots in my personal experience and memories of encounters with nature, like many camping trips, and walks. A fascination for nature originating from my childhood, but still something that greatly interests me and has been a recurring topic throughout my architecture education.

... the gap that currently exists between built and natural environments, ...

This section of the quote addresses the problem, or better formulated; the challenge that we currently face as humans. A disconnection between nature and humans of which the built environment forms the ultimate representation. The natural environment exists of a complex of ecosystems all interdependent and in balance with each other. Then there is the built environment, where the open-ended cycles use resources

from the natural environment but create waste unsuitable for reuse by the ecological cycles. This imbalance and disconnection have caused climate change, destruction of the natural environment, and reduction in biodiversity. This will, in the long term, not only impact the natural environment, but also the built environment.

... for the mutual benefit of both human and nonhuman life.

The ending of the quote illustrates the relevance of this challenge, as it has not only an impact on the biodiversity of nature but also on humans themselves. If we continue living how we currently are and ignore this challenge, then it will no longer be human life and nonhuman life on this planet, it will just be nonhuman life. This has to do with the fact that currently, humans are indeed a danger for all forms of nonhuman life, but at one point the destruction of that life will become a danger for human life itself as we will make this planet inhabitable for ourselves.

With this research plan, during this graduation project and possibly even in the future of my career I will try to find possible solutions for this challenge. I will be trying to find new ways of living together.



Introduction

Disconnection between nature and humans

The history of the natural environment¹ and the built environment² goes far back. The natural environment has already existed for around 3.7 billion years, while the built environment exists for around 12 thousand years. For a long time, these two entities were in some sort of balance. But something happened, a disconnection between nature and humans emerged, the relationship between them had changed.

The main reason for this change in the relationship is the change of cycles. The natural environment consists of ecological³ cycles, which form a balanced, connected, and interdependent system of closed cycles. With the industrial revolution, a new cycle emerged in the built environment; the technological cycle. This cycle had one main difference to its ecological predecessor, it was not a cycle, as it had waste at the end which could not be used anymore by the ecological cycles. In this way, a different relationship between the natural environment and the built environment was created, as the former would be exploited for recourses used by the latter and disposed of in the form of waste not useful for the natural environment again (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). These technological cycles are causing climate change, loss of biodiversity, shortage of resources, and abundance of waste;

ultimately leading to an inhabitable planet for a great part of living species including humans.

Minimizing negative environmental impact

In current articles, policy documents, but also in academic debates about sustainability strategies, the main focus lies on the reduction and minimization of the negative environmental impact (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). With this research, I hope to contribute to the shift of this focus towards creating a positive impact on the environment. The way how the built environment currently functions needs to be transformed in order to create this positive environmental impact.

Built environment as an ecosystem

A method for guiding this transformation can be urban metabolism⁷. This term was first used by Wolman in his book *The metabolism of cities* (1965). It presents the built environment as an ecosystem⁴ with flows and processes. The concept of metabolism⁶ is used to analyse the interactions and flows of materials and energy in an urban region (Broto, Allen & Rapoport, 2012). Based on urban metabolism, interventions can be designed to create symbiotic⁵ relationships. In this way transforming the built environment in a way so it has a positive impact on its environment.

1. Natural environment: The natural environment encompasses all living and non-living things occurring naturally on Earth. Consisting of ecosystems including all living species, universal natural resources, and physical phenomena. (Johnson et al., 1997)

2. Built environment: an environment consisting of all manmade structures to support human activity (Portella, 2014).

3. Ecology: *oekologie* introduced by Ernst Haeckel from the Greek word *oikos* (home). It stands for the study of the interrelationships of organisms with their environment and each other. (Pimm & Smith, 2019)

4. Ecosystem: a dynamic complex of plant, animal and micro-organism communities, and their non-living environment interacting as a functional unit (CBD, 2010).

Importance of transformation

As explained before, most of the societal and ecological issues arose in the built environment, but it is also there where most possibilities for change and improvement are. The open-ended technological cycles are taking place in an existing built environment and in order to control and alter these cycles, transformation of existing buildings and infrastructures is needed. A question that might arise is if the current built environment causes all these problems, then why not demolish it and start over again? In other words;

Why should we transform?

The reason for transformation over demolishing and new built is related to sustainability aspects of embodied energy and material waste, but also to the preservation of heritage values as buildings are the embodiment of cultural values and historical memories (Van Hees, Naldini, & Roos; 2014). The next question could then be:

How should a building be transformed?

The heritage department has developed a value assessment tool with which a transformation framework can be created (Kuipers & De Jonge, 2017). These values are however a social construct created by humans and are mostly subjective based on the different perceptions of the stakeholders. I believe that another tool is additionally needed to

help guide an architect with the transformation of a building. This research will by no means ignore or reject the heritage value method of guiding the transformation, but rather seeks an extra tool that does not only focus on the human needs and values of the building but a tool that tries to include the needs and wishes of nonhuman actors. In this way designing a transformation that not only positively contributes to humans but also to its environment, in an effort to try and find a way of living together.

Spatial Building Typology

These two transformation tools are two different ways of analysing and guiding the design. A third method is the spatial building typology research which will be performed by the entire graduation group. The spatial aspects of the different buildings will be compared in order to formulate different building typologies. The output of this analysis will form input for the two transformation tools, both the heritage value assessment and the urban metabolism transformation tool. At the end of the studio, the re-designs of the different typologies will be compared to research the relation between the building typology and the re-design solutions.

Vacant heritage police building

The urban metabolism transformation tool will be researched and developed during the Vacant Heritage graduation studio, which focuses on vacant police buildings. The goal of this studio

5. Symbiosis: from the Greek words *syn* (together) and *biōsis* (living). It means a close connection between two entities that have a mutually beneficial relationship. (The Editors of Encyclopaedia Britannica, 2020)

6. Metabolism: the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes (Kornberg, 2021).

7. Urban metabolism: the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. Also the study of quantification of the inputs, outputs, and storage of energy, water, nutrients, materials, and wastes for an urban region. (Kennedy, Pincetl, & Bunje, 2011)

is to create a re-design strategy for these vacant police buildings, which can be used as input on the discussion about the future of these buildings.

Eenheidsbureau - The Hague

The Eenheidsbureau in The Hague was chosen as case study, mainly because of its large scale and character. When visiting the building it felt like a fortress, a safe place in which you are protected, but also like a complete village inside of a building. The large scale can be used as a way to imitate the urban scale inside of a building and apply urban metabolism on a building scale.

Research & Design

The goal of both the research and the design is to find new ways of living together with a transformation of a building that has a positive impact on both humans and their surroundings. Therefore the following questions are formulated:

Research question & Subquestions

How can an architect transform the Eenheidsbureau in order to create a symbiotic urban metabolism in the neighborhood?

How can an urban metabolism transformation framework be created?

How did the urban metabolic relationship between the natural environment and the built environment develop over time?

What are the current urban metabolic flows on different scales of the Eenheidsbureau in The Hague in relation to the spatial impact?

Design questions

How can these current urban metabolic flows be transformed in order to create closed cycles and mutually beneficial relationships, while taking the heritage values into account?

What program benefits from other program inside a building and in its surroundings in order to create symbiotic relationships?

How can the heritage value framework and the urban metabolism transformation framework be combined in order to guide the design?

Relevance

A great part of the relevance of this research is already discussed in the introduction, but a brief summary of the relevance will be given in this chapter.

Societal context

The societal challenges that are addressed with this research are related to the disconnection between humans and nature and the therefrom arising problems, like climate change, decrease of biodiversity, shortage of resources, and abundance of waste; all ultimately leading to an inhabitable planet for humans and many other species. This research and the design aim to shift the focus of the current sustainability strategies from minimizing the negative environmental impact towards creating a positive impact on the environment.

Professional context

The relevance of this research for the profession as an architect is related to the additional urban metabolism transformation tool which will be developed during the course of this research. It will add to the heritage value transformation framework in order to guide an architect during the design of a transformation of a building. This extra framework will attempt to help an architect to, next to the human values, also take nonhuman values and the environment into account while transforming a building in an effort to find ways of living together.

Theoretical Framework

In this chapter, important literature sources are selected and positioned on a timeline to show the relation between the literature and the development of the relationship between the natural and built environment (see image below). These literature sources were chosen as they present a clear overview of certain academic debates by reviewing the previous articles on a specific topic.

Ecological design

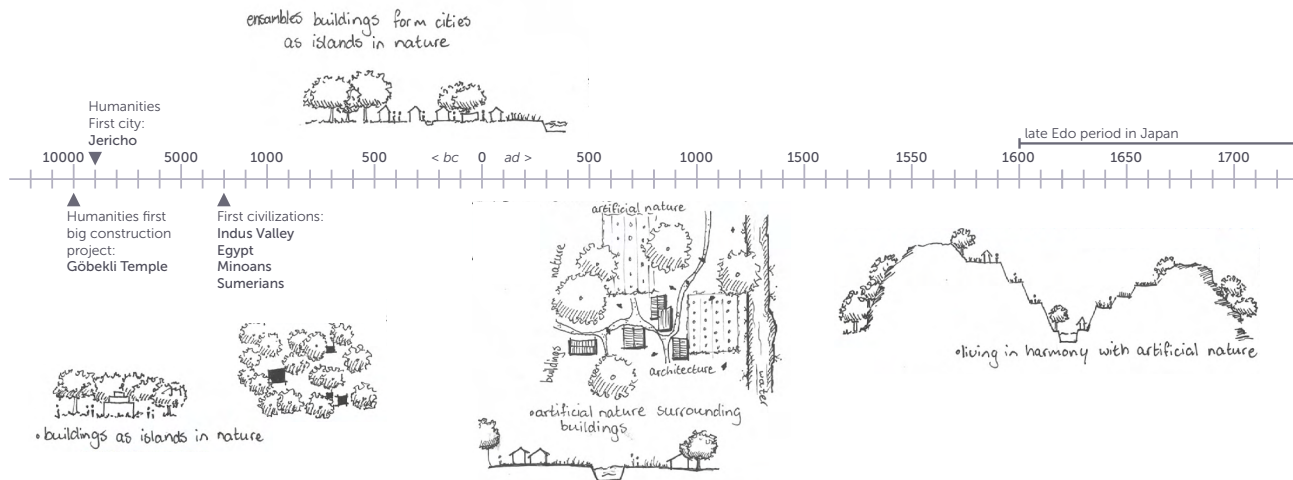
For the development of ecological design, an article by Lydia Kallipoliti (2018) will be used as she created a framework on the history of ecological design. It reflects on the different theories in this field and positions them in her framework, concluding that ecological design developed towards systems theories.

Systems theories

These so-called systems theories are further researched by Van Dijk, Tenpierik, & Van den Dobbelsteen (2014) in an article where they compare cradle-to-cradle with six different systems theories; laws of ecology, looped economy, regenerative design, industrial ecology, biomimicry, and blue economy.

Urban metabolism

Urban metabolism is further set apart in two articles written by Beloin-Saint-Pierre et al. (2016) and Kennedy, Pincetl, & Bunje (2011) which both review over 50 urban metabolism studies. The articles come to different outcomes, which is why these two studies were chosen in order to compare the different interpretations of urban metabolism.



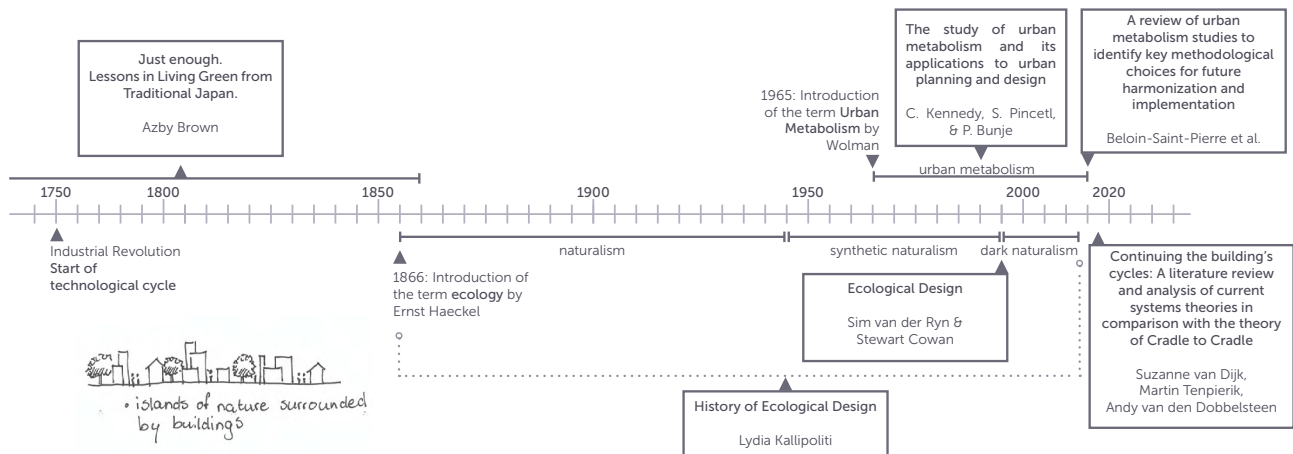
Theoretical Framework as it places the different articles and frameworks on a time line - own drawing

Heritage value assessment

The heritage value assessment framework is a combination of the shearing layers by Brand and the Rieglian values Kuipers & De Jonge, 2017) and will be used to create a transformation framework with possibilities for change while respecting the heritage values.

Spatial building typology framework

Another framework developed by the heritage department is the spatial typology framework which exists of four scales with each several spatial aspects. This framework will be used to analyse and compare these spatial aspects of the different police stations in order to define several building typologies.



Theoretical Framework as it places the different articles and frameworks on a time line - own drawing

Methodology

Literature research

Different literature sources about ecological design, systems theories, and urban metabolism will be compared. These literature sources are further defined in the Theoretical framework. Based on the existing frameworks of these topics a new framework will be made.

Outcome: An urban metabolism framework to analyse the metabolic flows and cycles on different scales.

Reflection: The creation of a new framework out of existing literature is in a way subjective, as certain elements from existing frameworks are chosen, while others are left out. These choices will be supported with literature in order to create a logical traceable process but will contain a form of subjectivity.

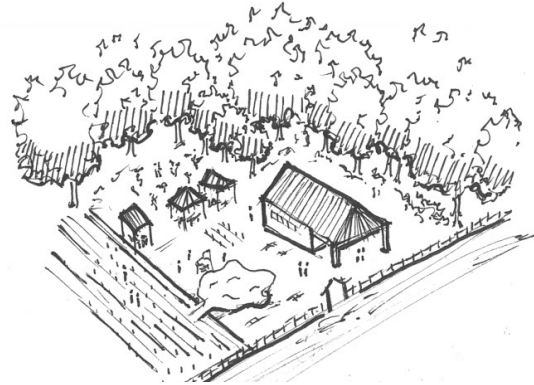
Case studies

Three different case studies are analysed that are examples of symbiotic urban metabolism. The case studies are chosen in different times in order to research how the relationship between humans and nature changed over time and if the methods that were used to create symbiosis have developed (see images on right):

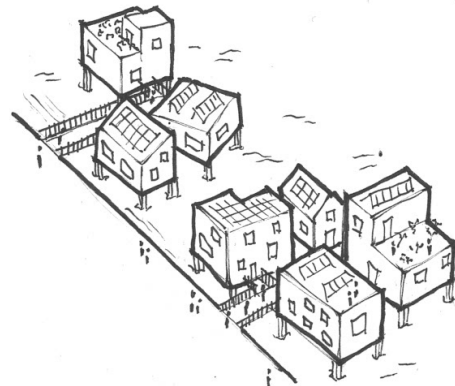
- Past: Edo period 1600-1850 in Japan with research of Azby Brown (2012)
- Present: Schoonschip - 2020 - Amsterdam
- Future: ReGen Village - Oosterwold

The analysis will be performed with the developed urban metabolism framework.

Outcome: Input to improve the urban metabolism framework and design guidelines to create symbiotic urban metabolism.



Edo period 1600-1850 in Japan - own drawing



Schoonschip Amsterdam - own drawing



ReGen Village Oosterwold - own drawing

Urban metabolism analysis Archipelbuurt

The urban metabolism framework developed in the previous step will be applied to the Eenheidsbureau and the Archipelbuurt. Previous metabolic research of The Hague will be combined with GIS data (Geographic Information System) to analyse and map the different existing metabolic flows of the neighborhood Archipelbuurt. The flows will be analysed on different scales, but the emphasis will be on the building scale and its immediate surroundings. The analysis will be categorized into water, energy, materials, and food (for a first sketch example see diagrams on the next page).

Outcome: A framework of urban metabolic cycles that are currently present around the Eenheidsbureau.

Reflection: The urban metabolism analysis will be selectively performed in order to not get overloaded with data. The primary focus of this research lays on the possible interventions on the building scale and the data will be accordingly selected. In order to have a reproducible analysis, open-source data (QGIS) and publicly available sources are used for the urban metabolism analysis. The depth and scope of this analysis will greatly depend on the availability of data and is therefore at this point still a bit uncertain.

Value assessment

The existing building will be mapped and assessed based on the heritage values framework.

Outcome: A framework of what should stay and why and at the same time a framework of what can be changed.

Spatial building typology analysis

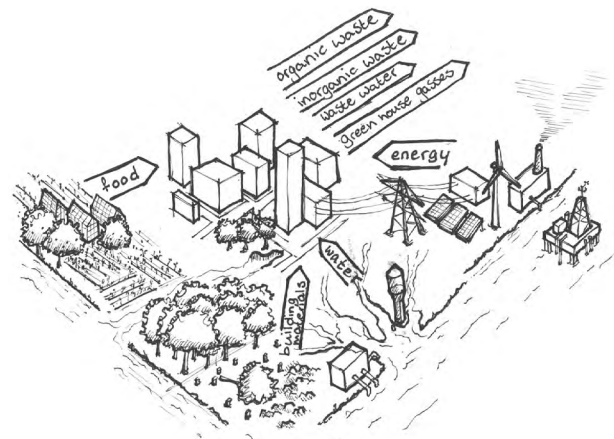
The eight case study police buildings will be analysed and compared on 4 scale levels with each several spatial aspects.

Outcome: A comparison and conclusion of different building typologies and their influence on the re-design solutions.

Design toolbox

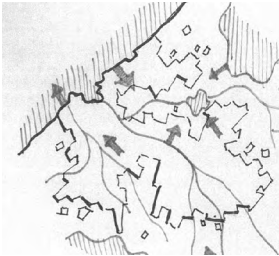
Experiments with different interventions will be done in order to create a design toolbox to create symbiotic cycles. The interventions themselves will all be on the building scale, but the impact on the other scales will be researched. The interventions will be assessed on three aspects; social (values), spatial, ecological.

Outcome: A design toolbox with different interventions to create symbiotic cycles. These interventions can be applied in the re-design of the Eenheidsbureau.

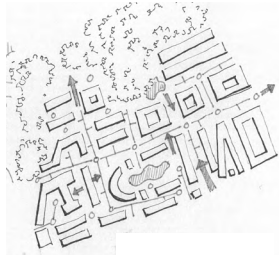


Sketch of Urban Metabolism - own drawing

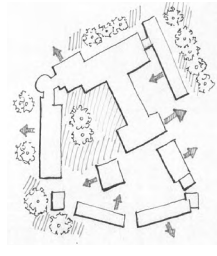
Water



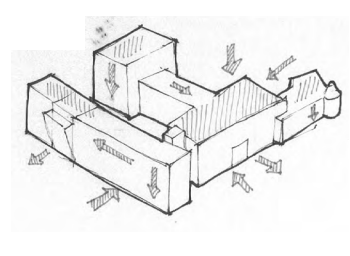
City scale



Neighborhood

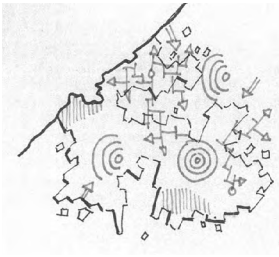


Urban block

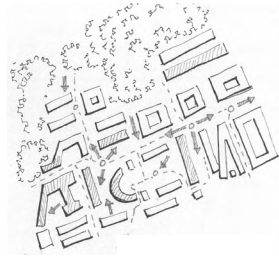


Building object / Building Envelope

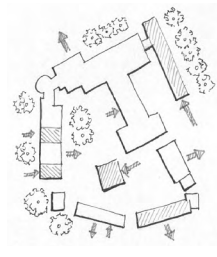
Energy



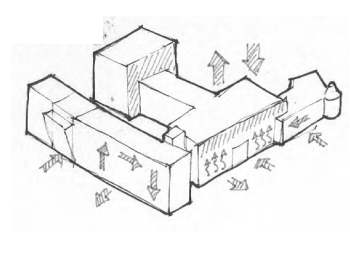
City scale



Neighborhood

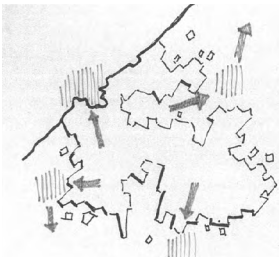


Urban block



Building object / Building Envelope

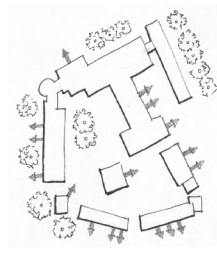
Materials



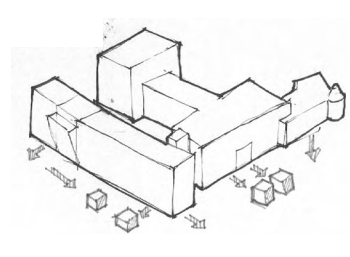
City scale



Neighborhood

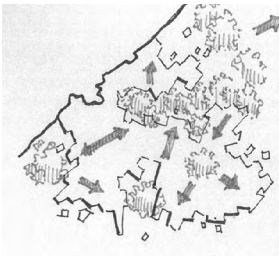


Urban block



Building object / Building Envelope

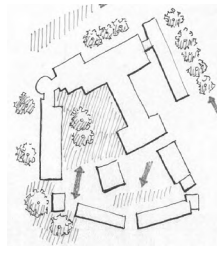
Biotic factors



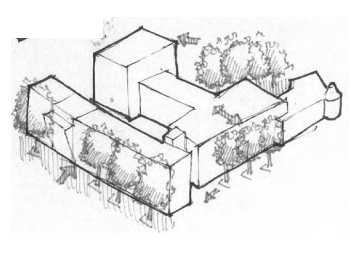
City scale



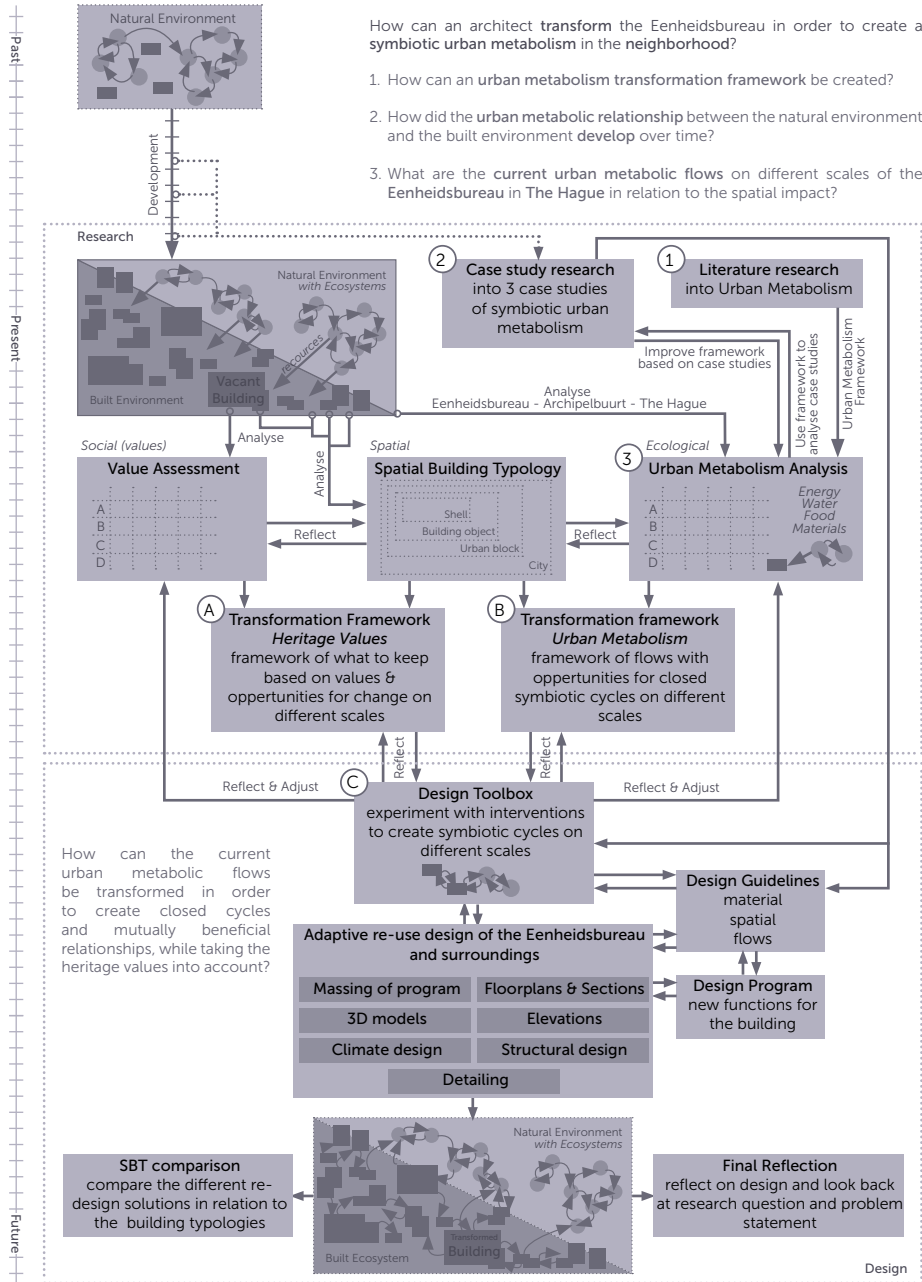
Neighborhood

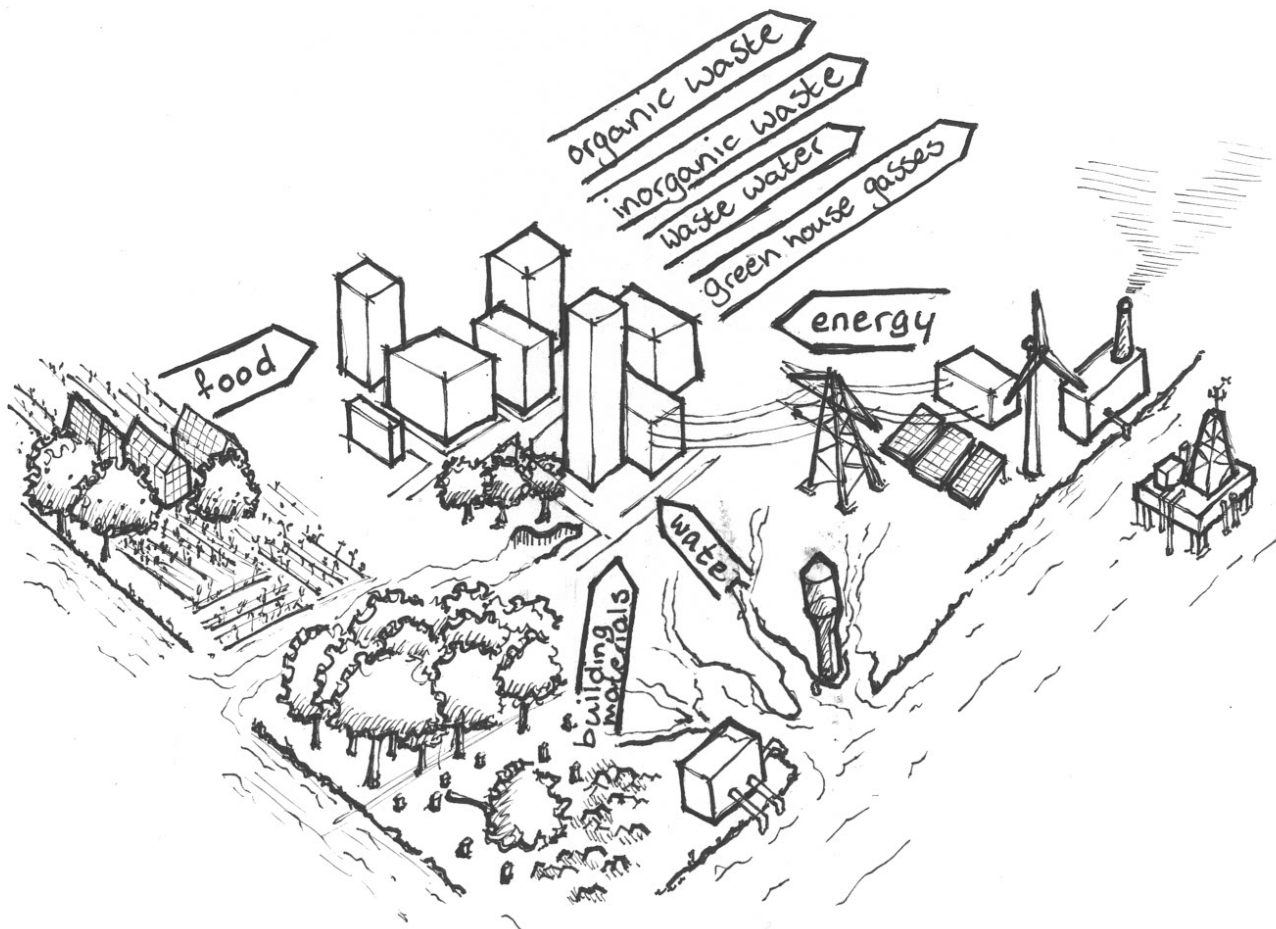


Urban block



Building object / Building Envelope





Sketch of Urban Metabolism - own drawing

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4

SBT city

27.09.2021 - 03.10.2021

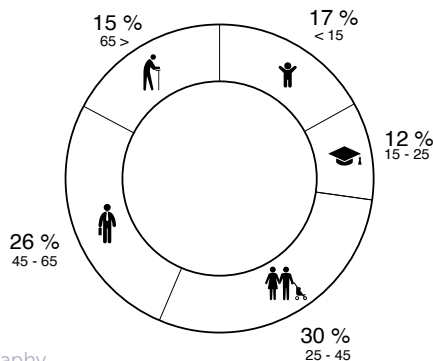
Introduction

The Hague is the third-largest city of the Netherlands with 548.320 inhabitants and it is the capital of the province Zuid-Holland. The city of The Hague started in the Middle Ages around the Binnenhof and the Hofvijver, which forms the center of today's Dutch politics. The Dutch government and parliament are located in the city, and it is the residence of the royal family. Next to that, most embassies, all ministries, and the Supreme Court are located in The Hague. The city is also home to several national and international courts, including the International Court of Justice in the Peace Palace and the International Criminal Court. It also hosted the two Hague Peace Conferences around the year 1900, where important international agreements on the law of war were reached.

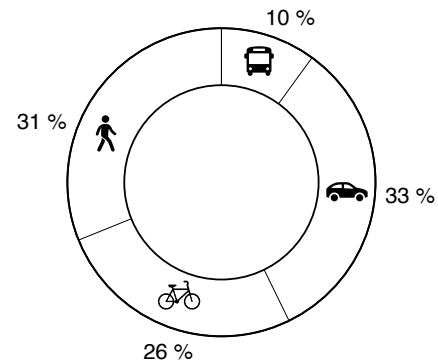
The demography of The Hague is quite mixed with the biggest group being between 25-40 years old. The most used form of transport in The Hague is the car with 33% followed by walking with 33 and then the bike with 26%. Only 10% of the traveling is done with public transport.



Topography



Demography



Mobility

Infrastructure



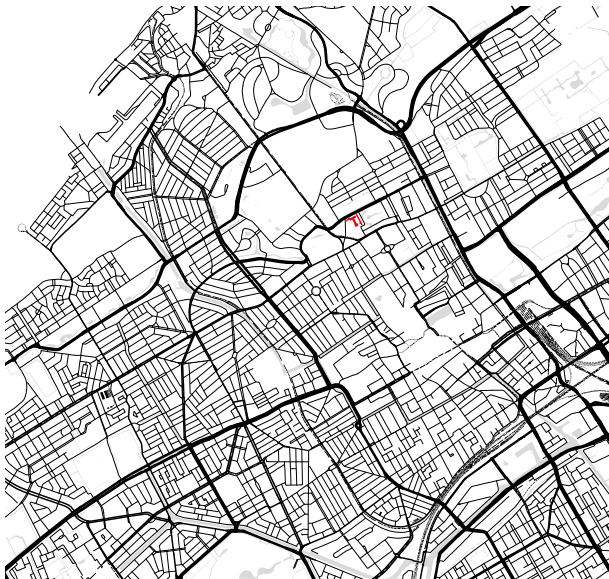
primary roads



secondary roads



tertiary roads



all roads

Historic development



1300



1500



1800



1900

Based on information from Haags Historisch Museum, Haags Gemeentearchief, Monumentenzorg en Welstand, Afdeling Archeologie & Natuur- en Milieueducatie. (z.d.). Haagse Kaart. Retrieved 10 October 2021, from <http://www.haagsekaart.nl/>. - own drawings



2000

5

SBT urban block

04.10.2021 - 10.10.2021

Urban block



Historic development



1945-1952



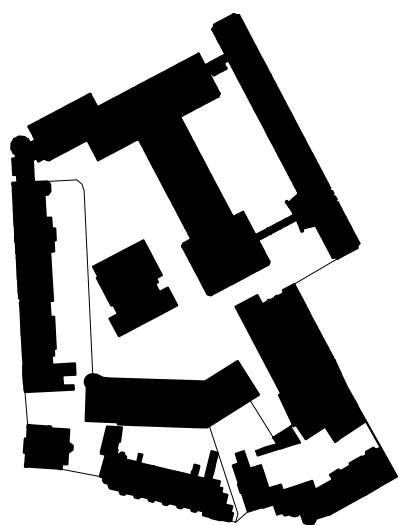
1952-1959



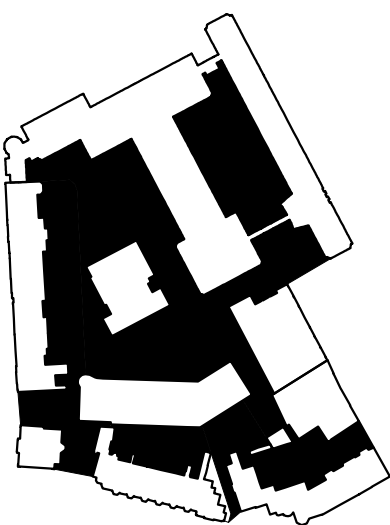
1981-2021

Based on information from Haags Gemeente Archief - Gemeente Politie Den Haag
Underlay from © OpenStreetMap-contributors - own drawings

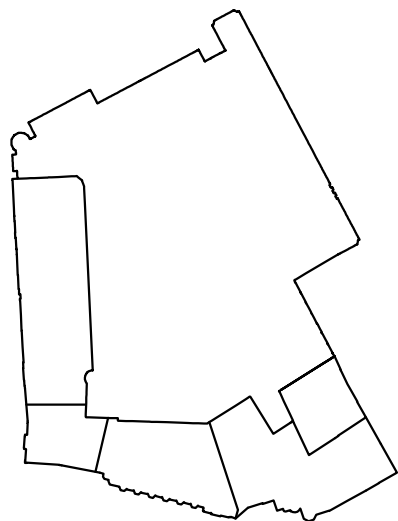
Urban block information



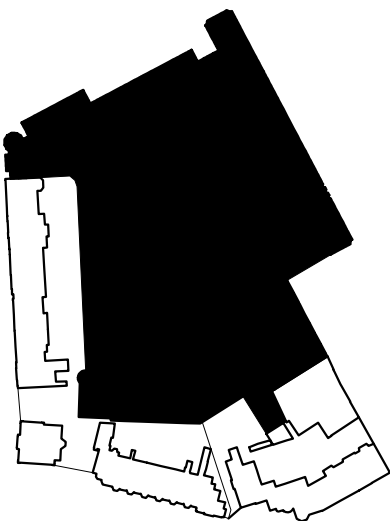
15.366 m² built area



13.800 m² empty area

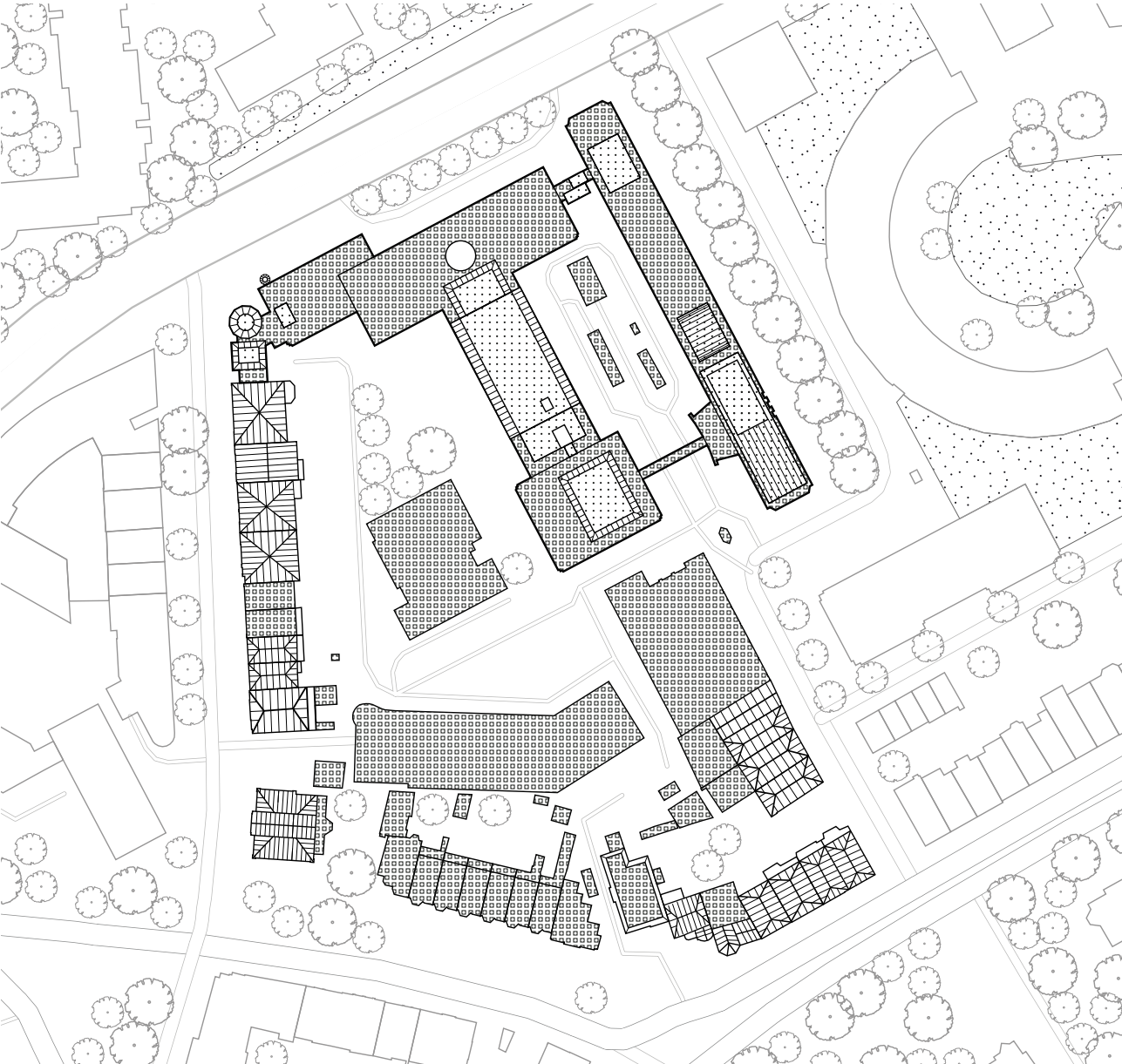


6 parcels



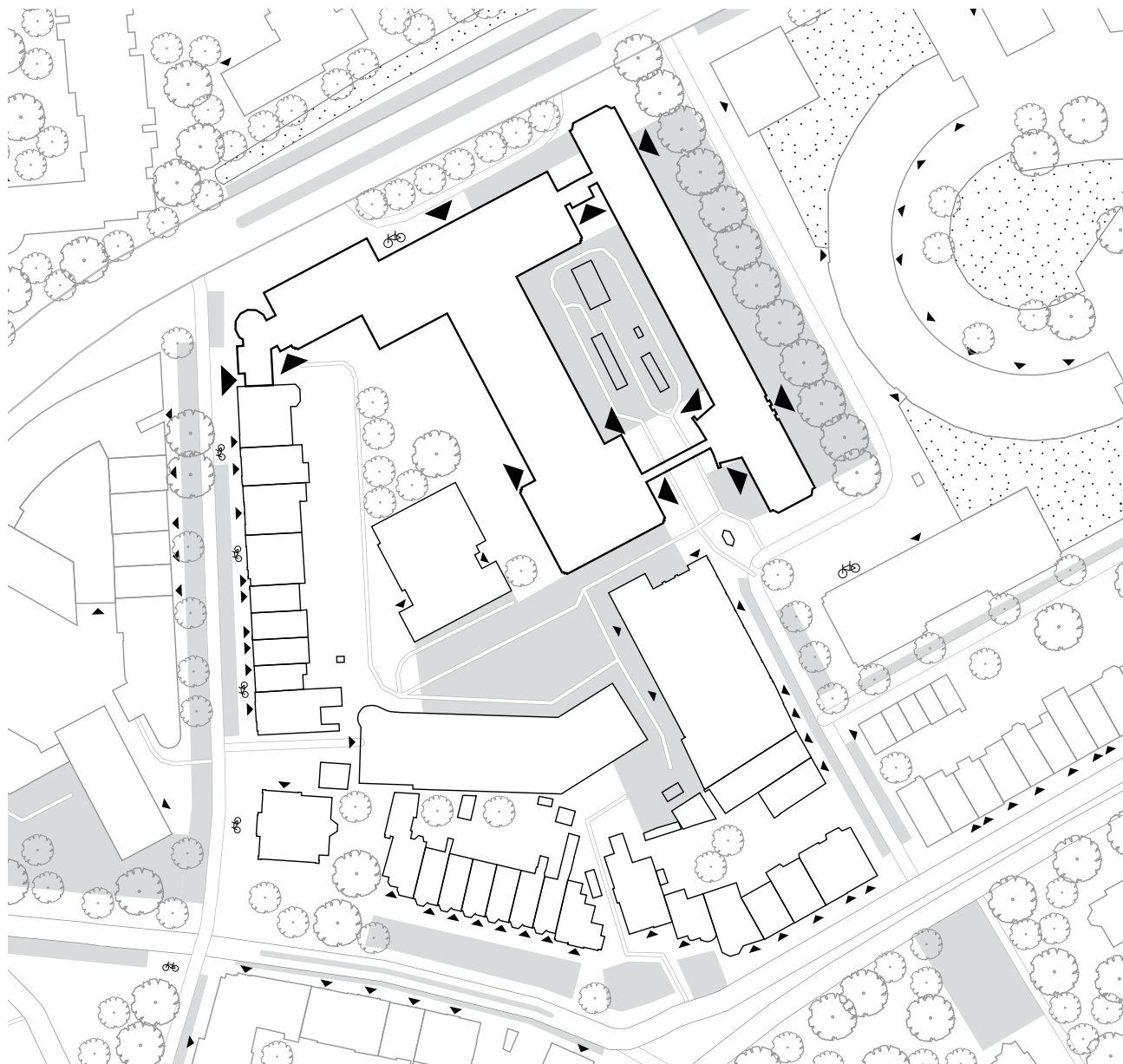
18.756 m² police real estate

Roof structure



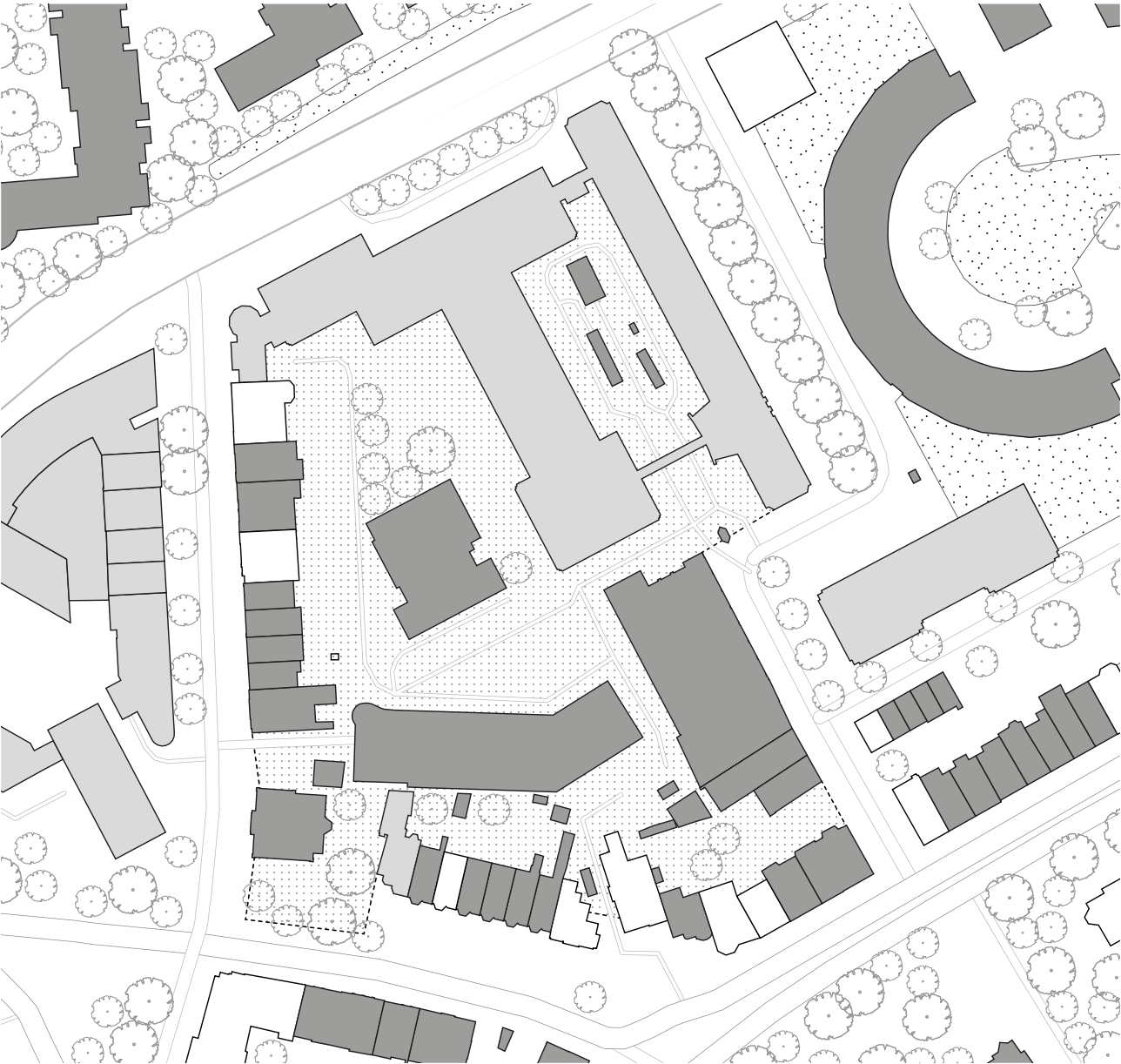
Parking & entrances

parking ■

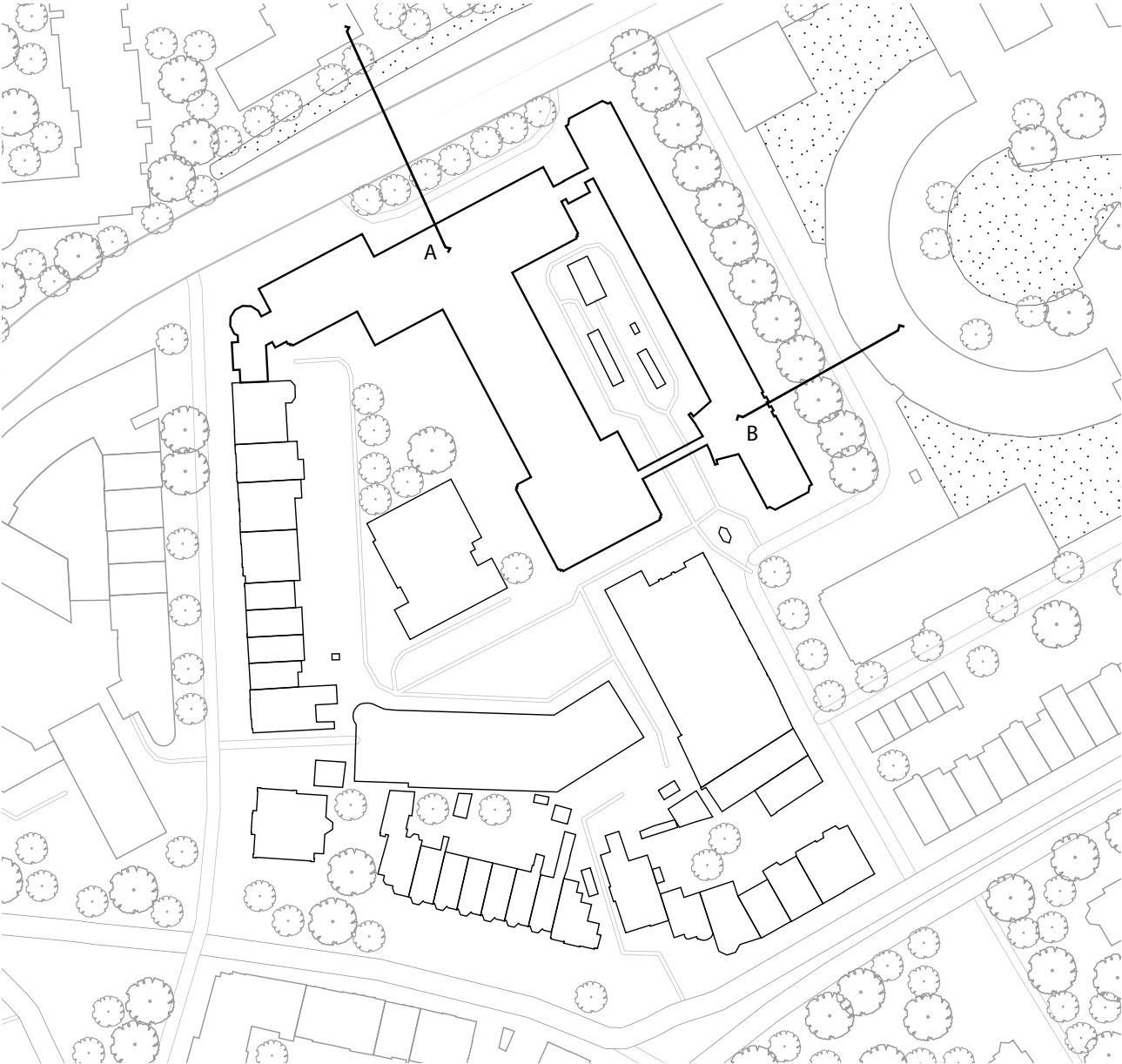


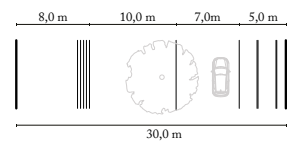
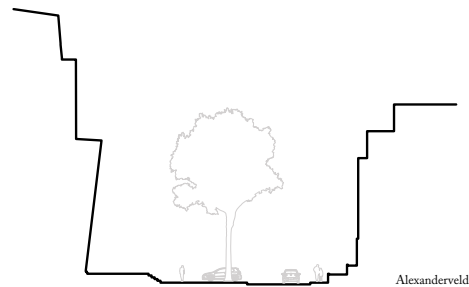
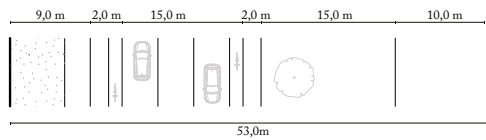
Public & private

public ☐ semi-public ☐ private ☐



Streets



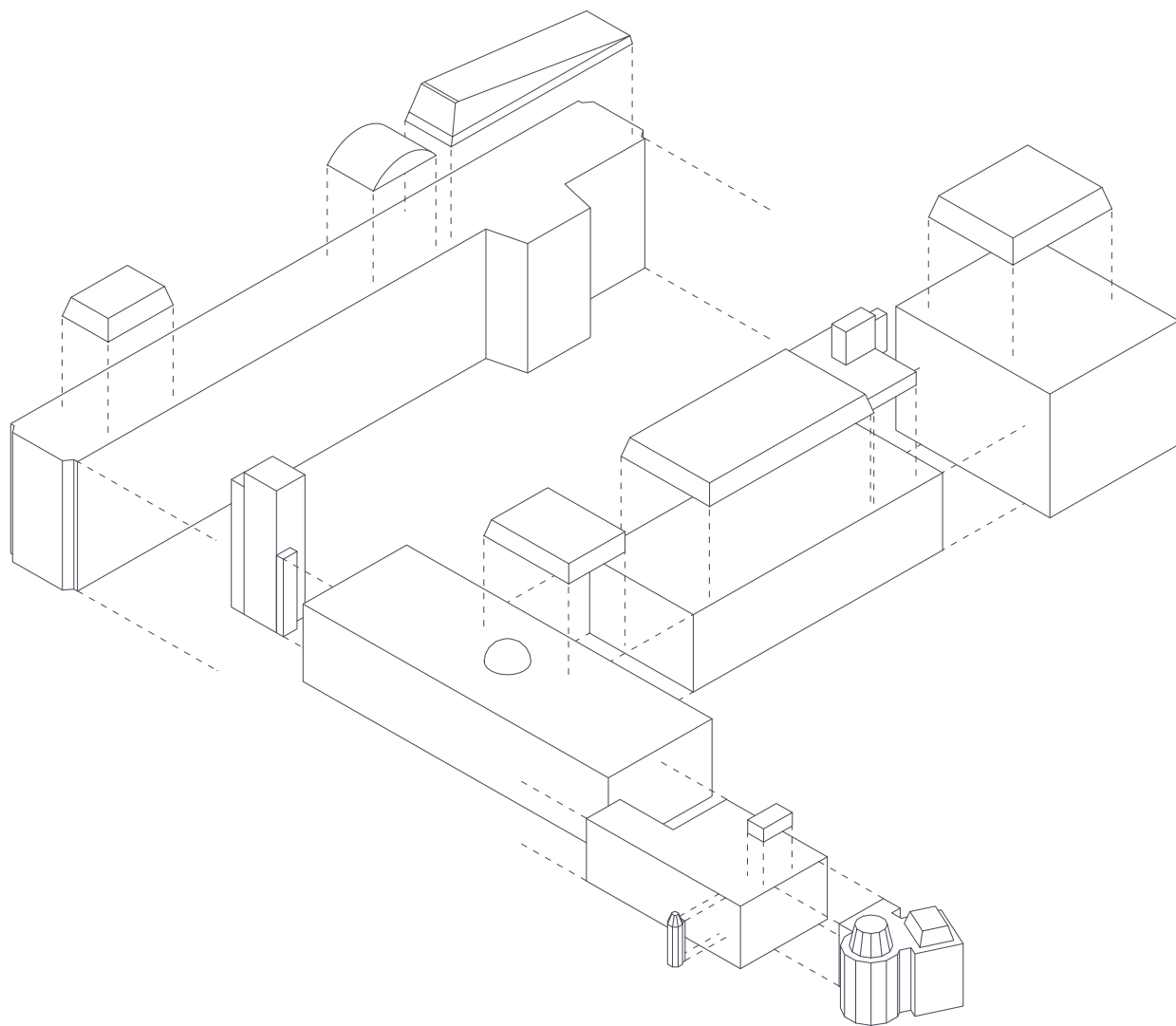


6

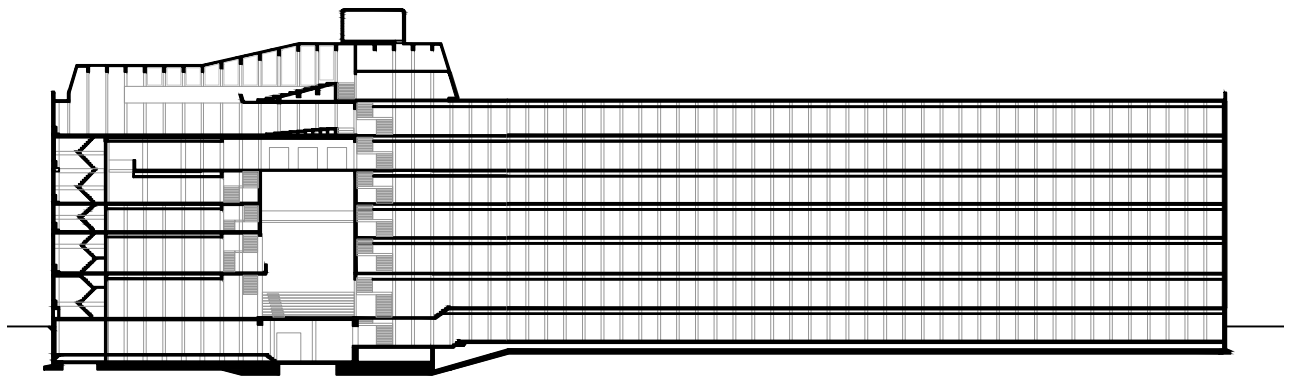
SBT building object

11.10.2021 - 17.10.2021

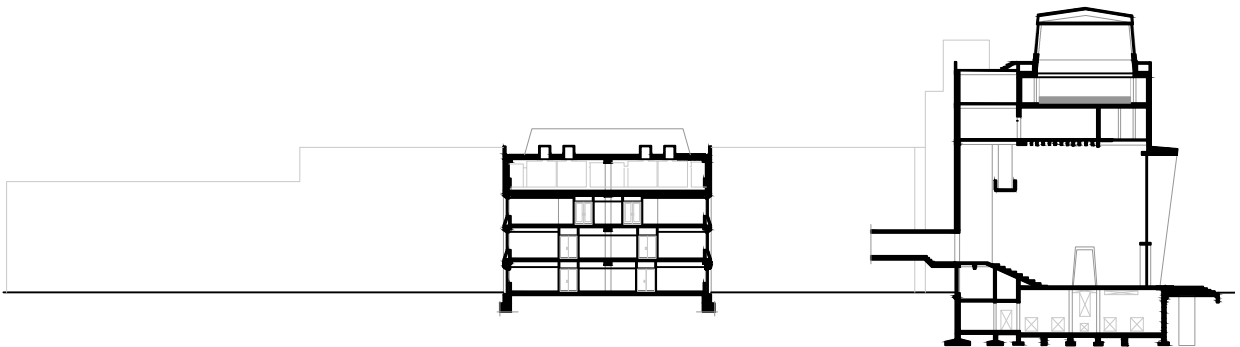
Spatial configuration



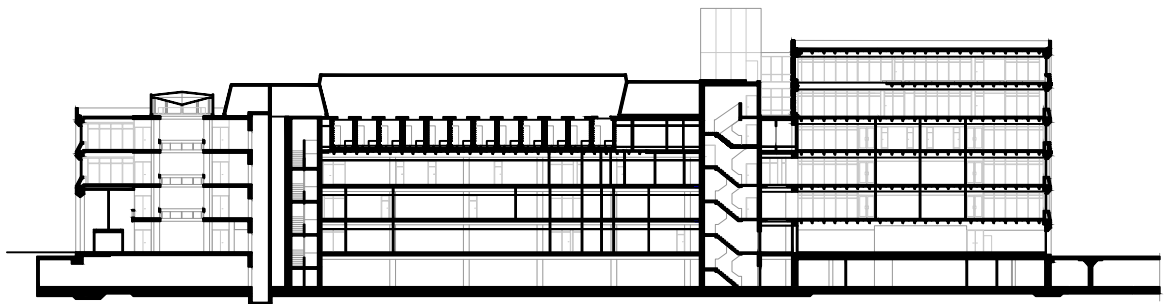
Sections



Section A



Section B

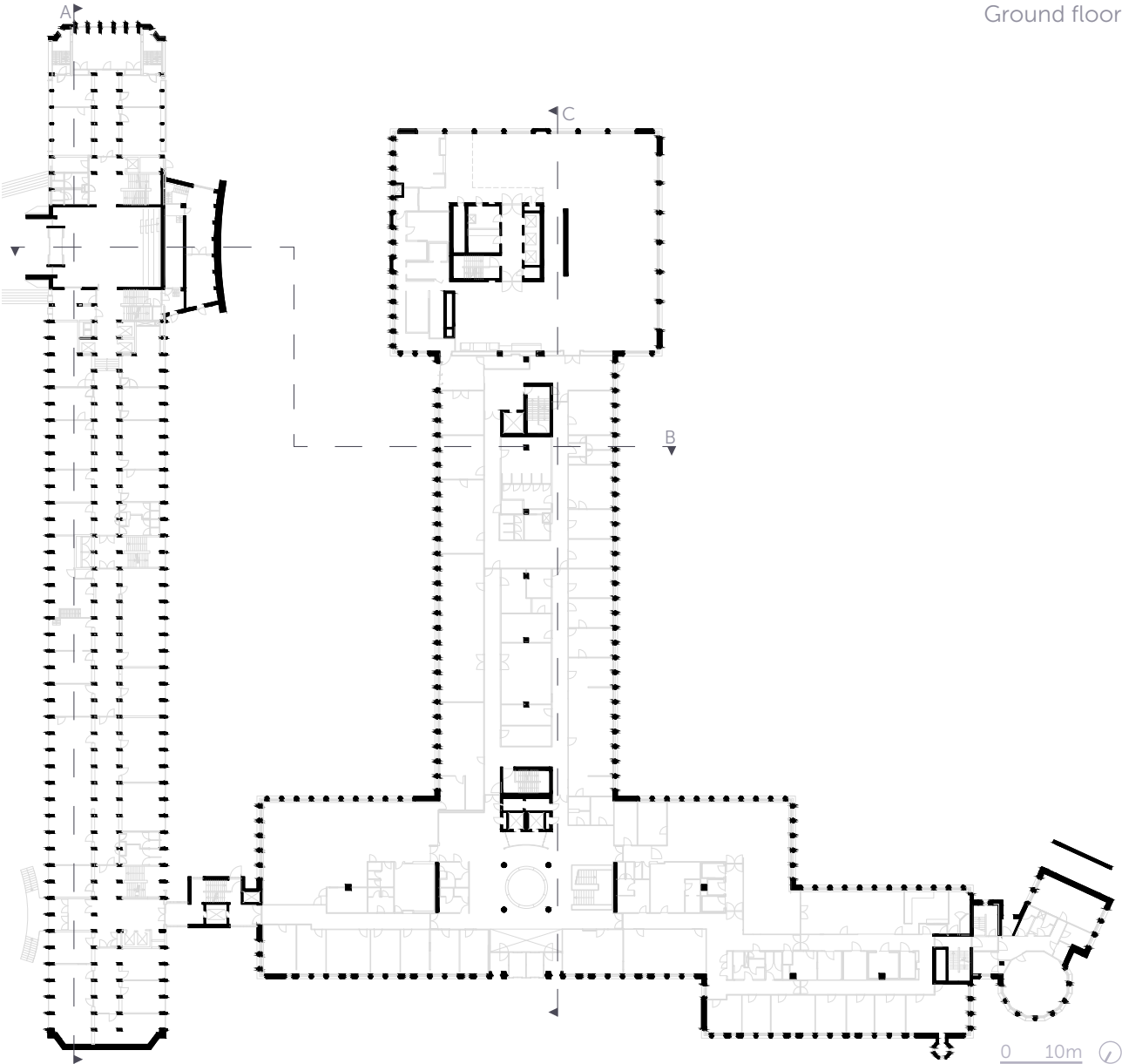


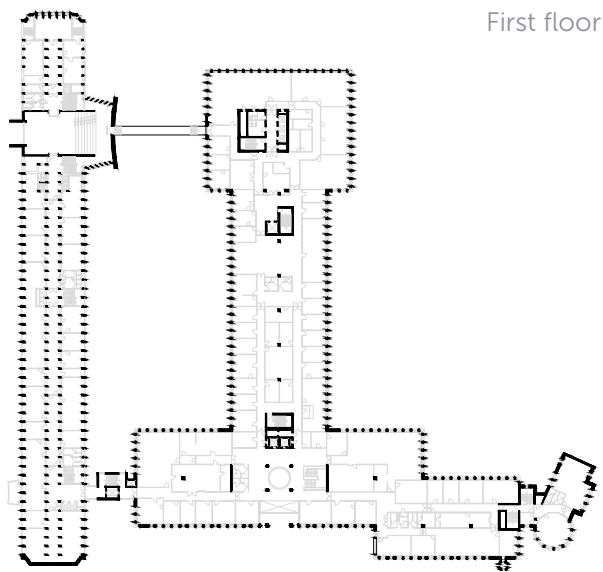
Section C

0 10m

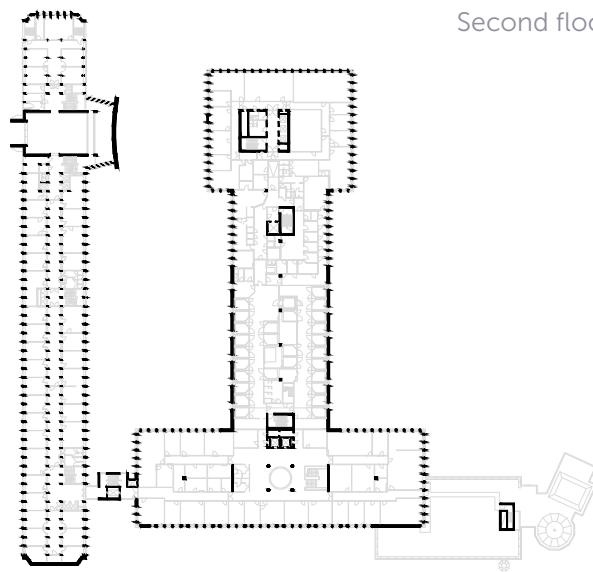
Floor plans

Ground floor

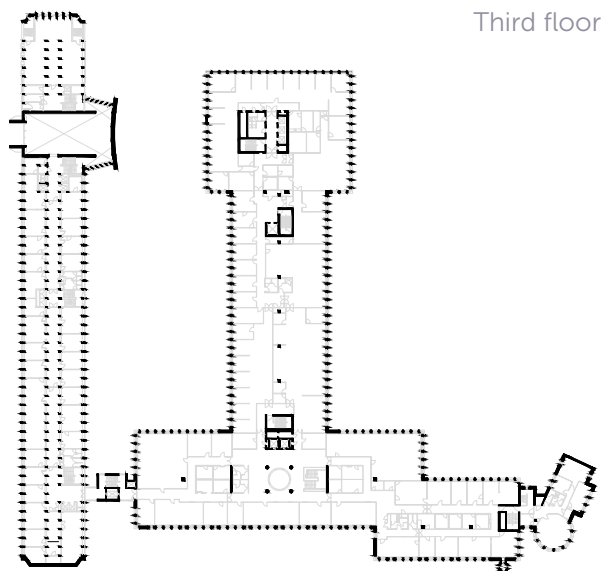




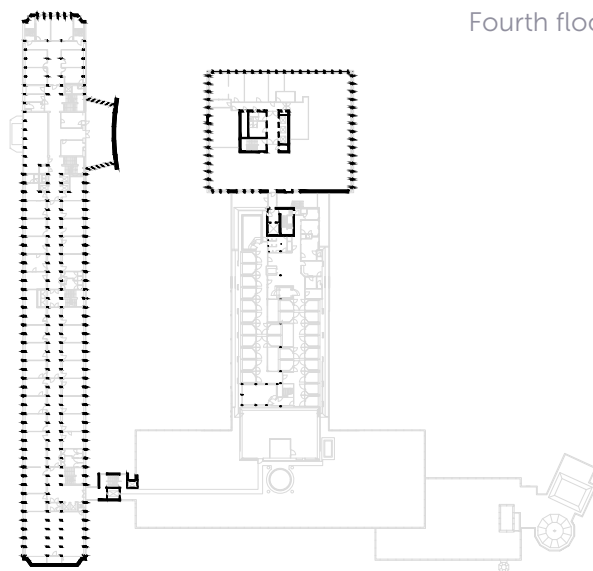
First floor



Second floor

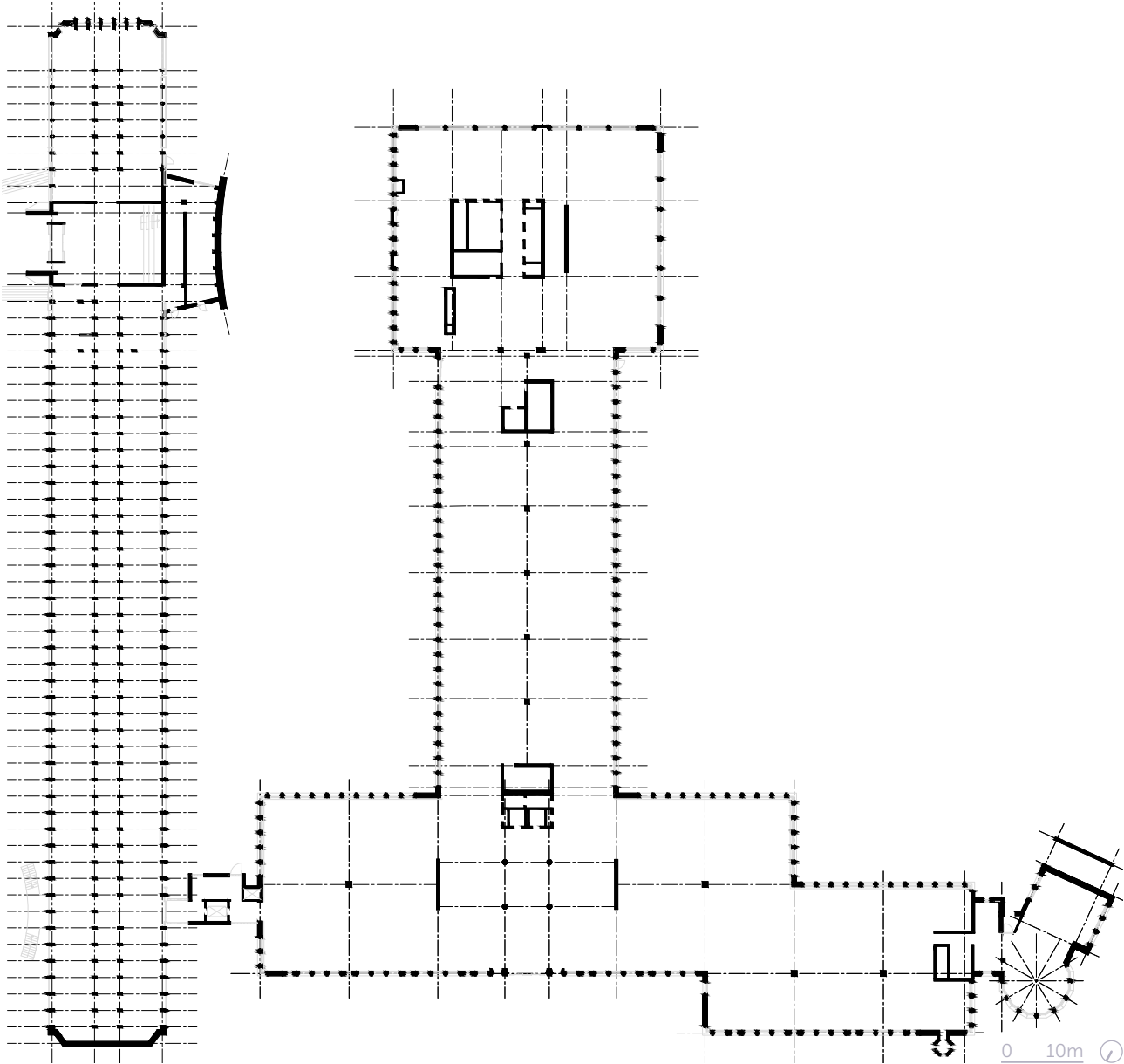


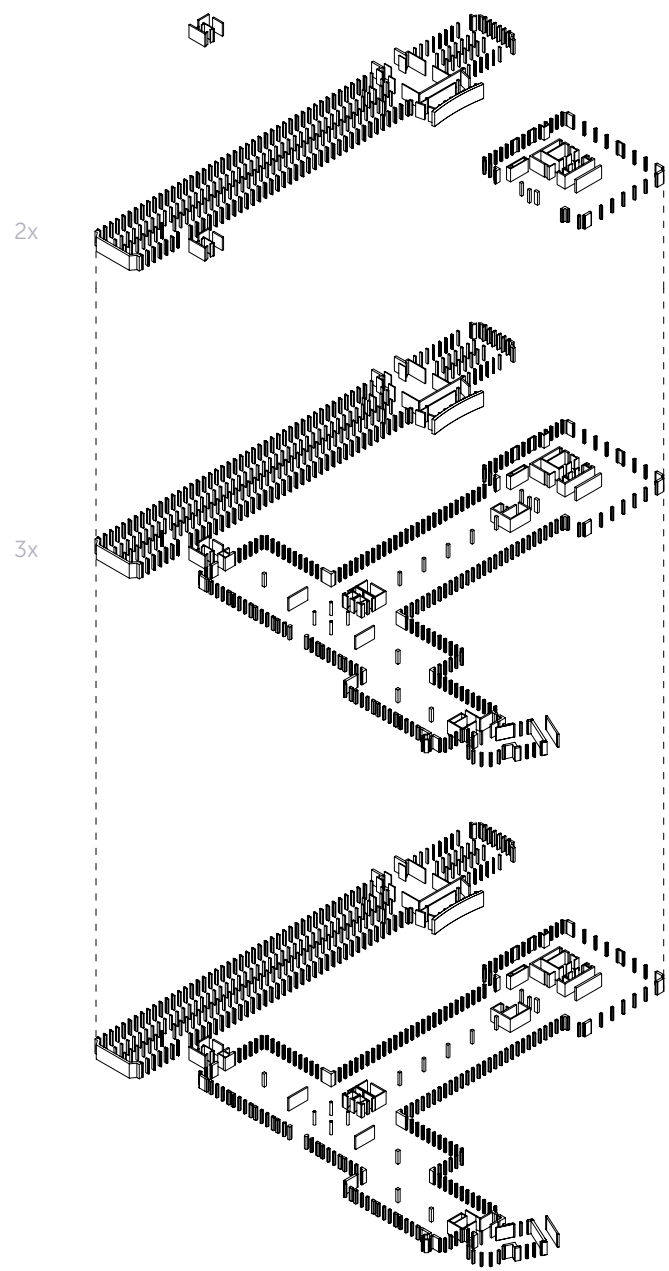
Third floor



Fourth floor

Structure





7

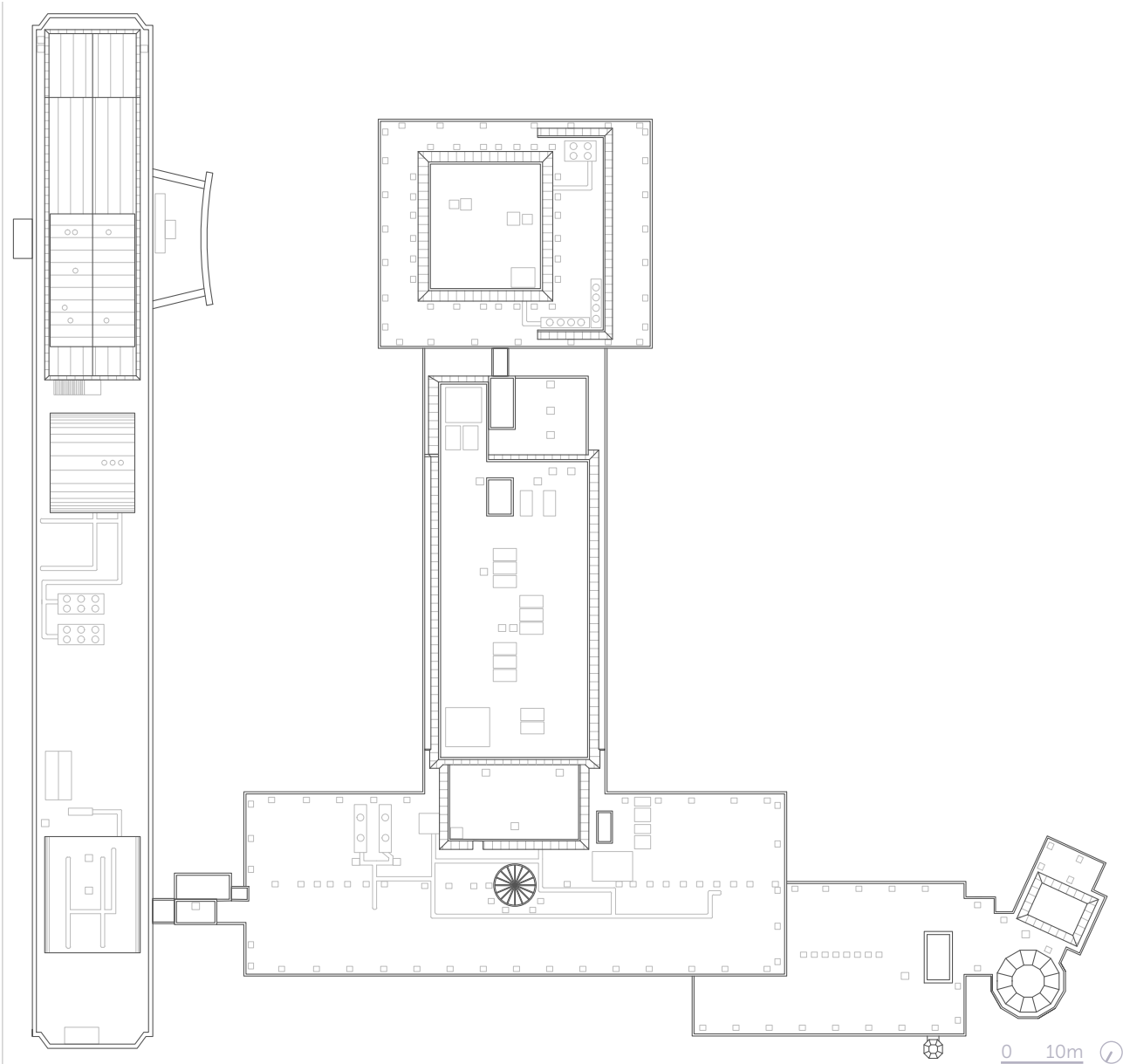
SBT building envelope

18.10.2021 - 24.10.2021

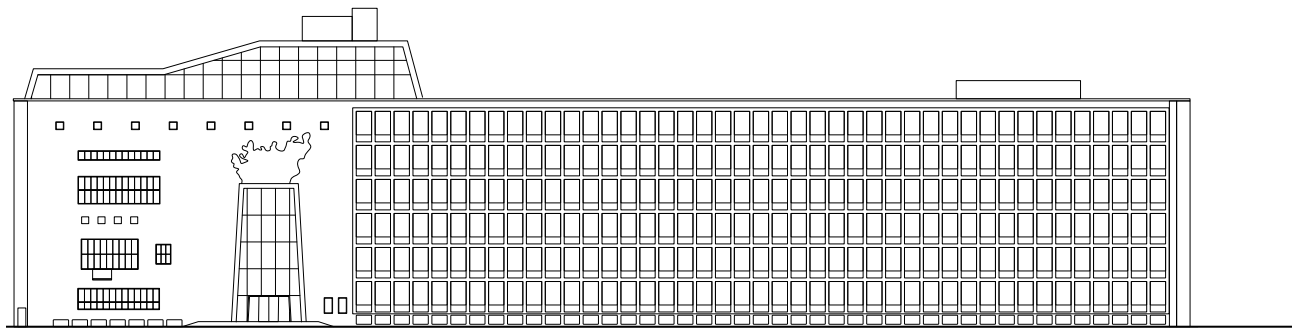
Fragment



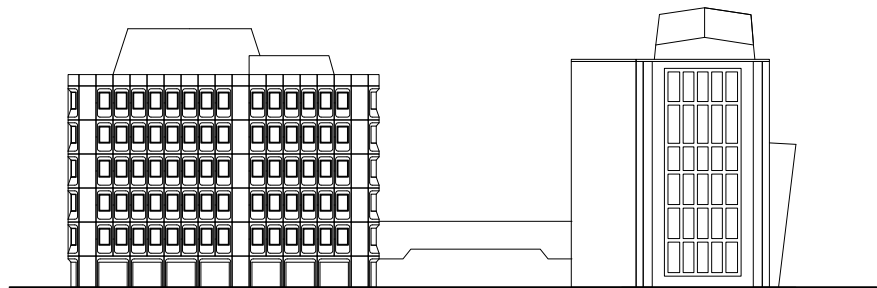
Roof plan



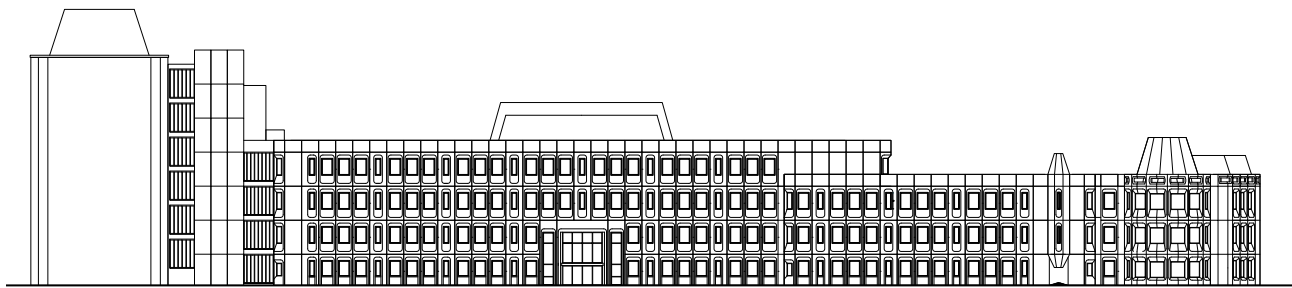
Elevations



North-East facade



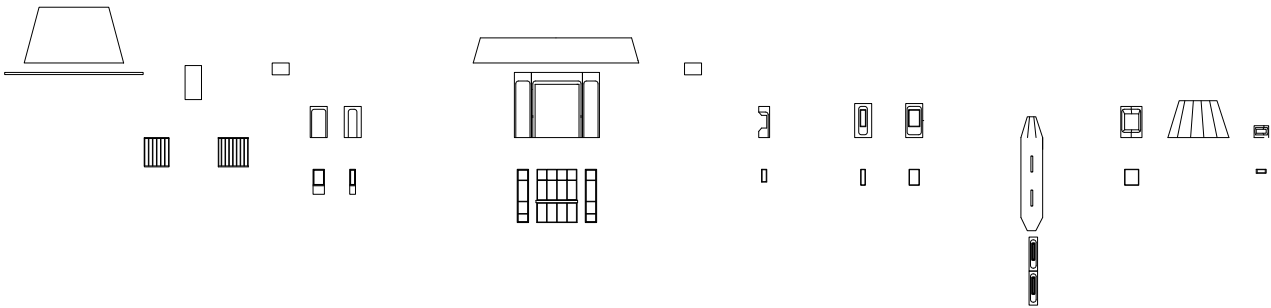
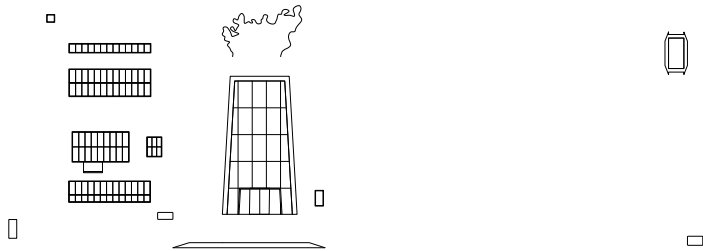
South-East facade



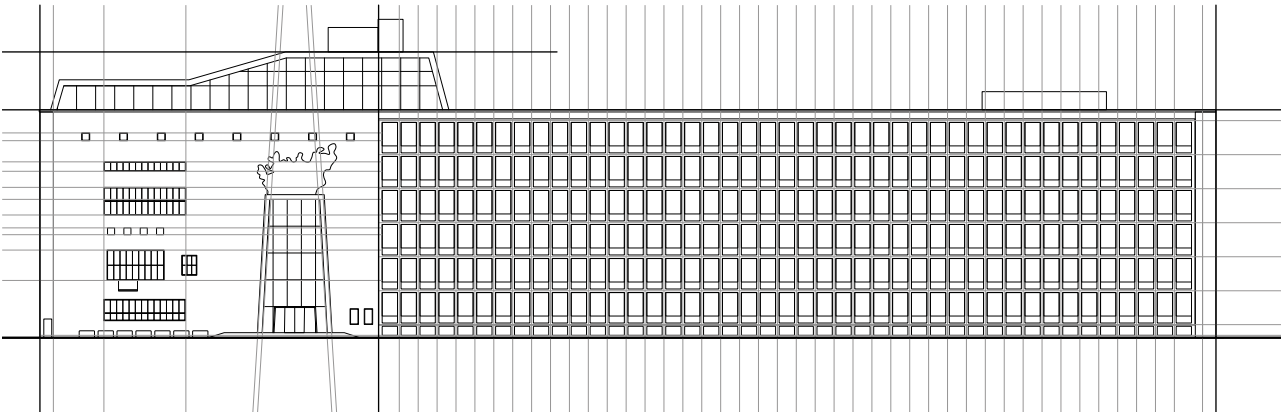
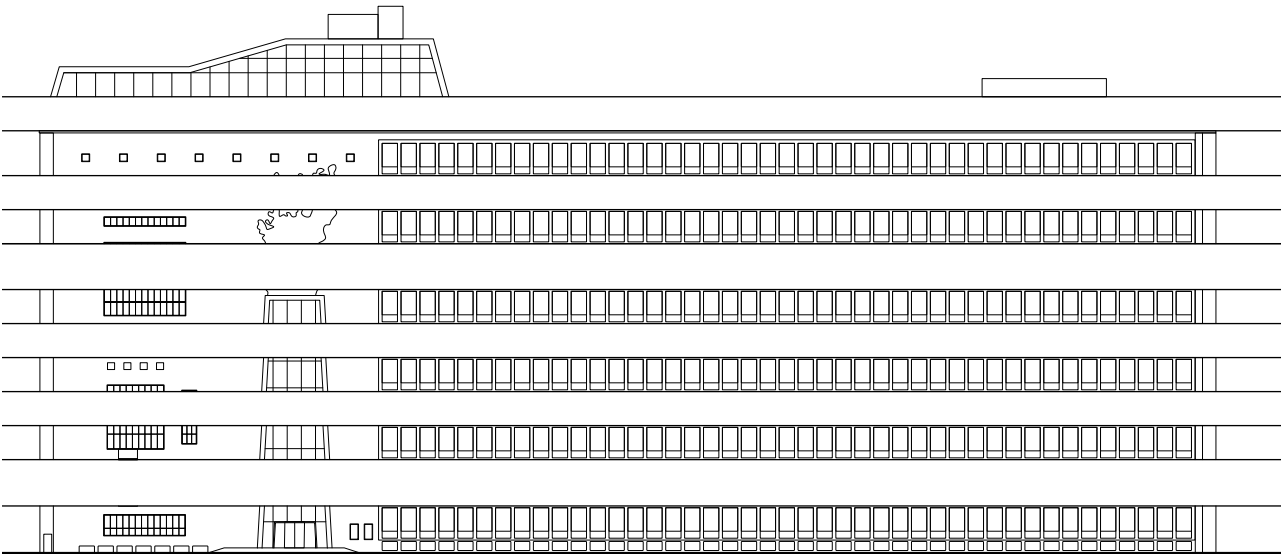
North-West facade

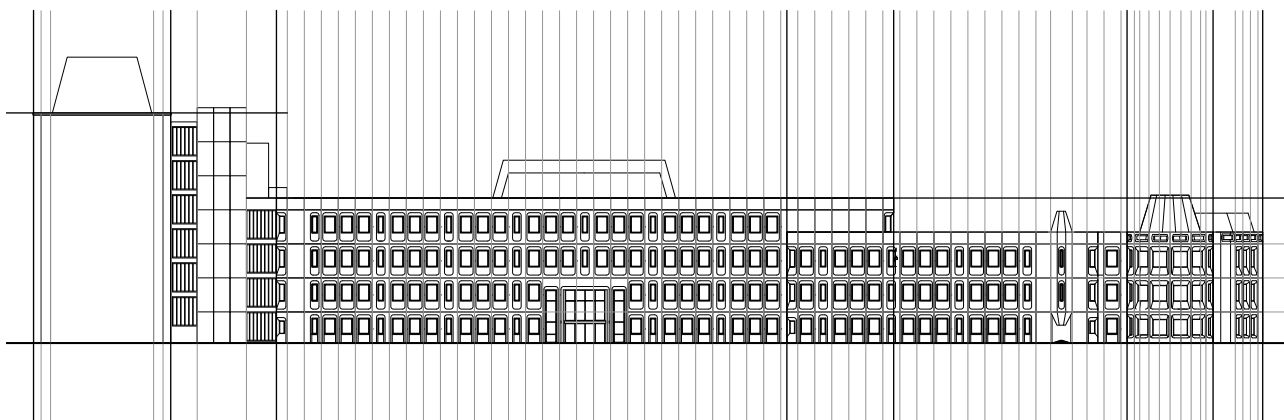
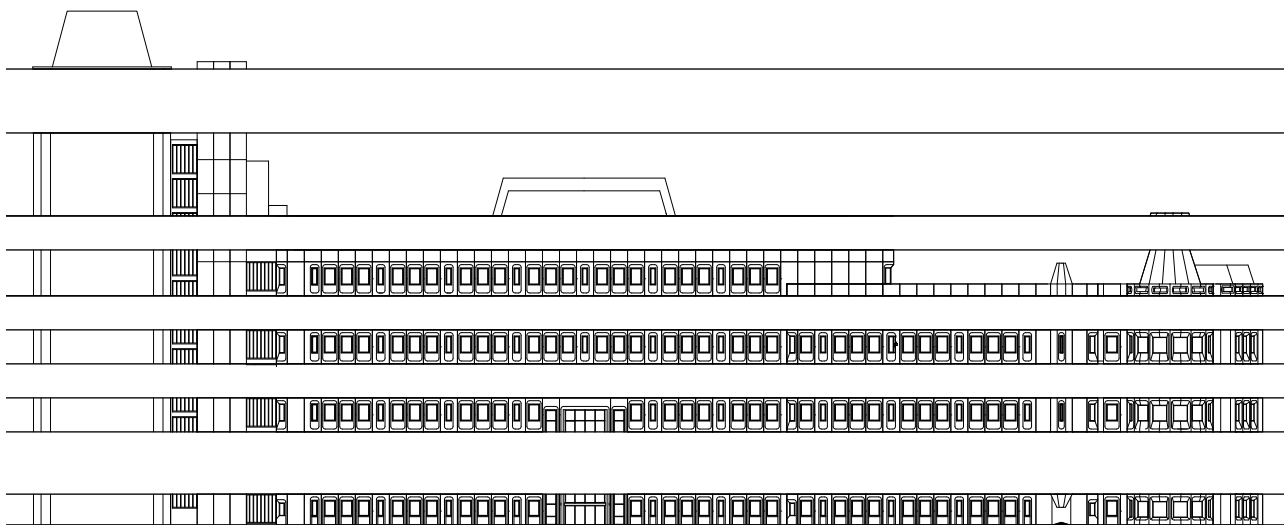
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Elements

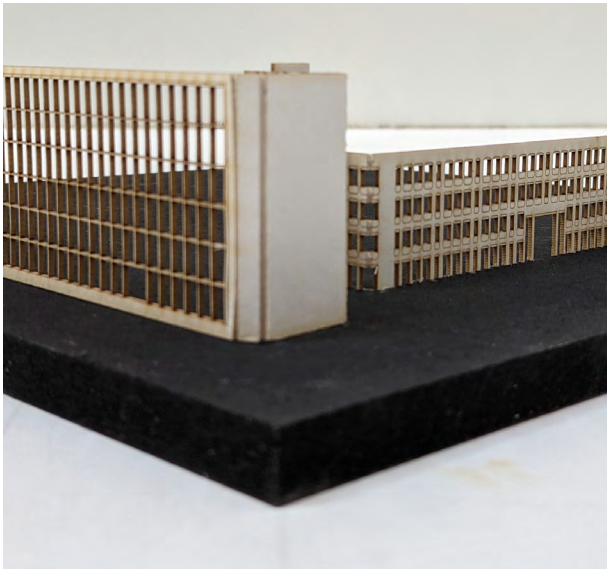
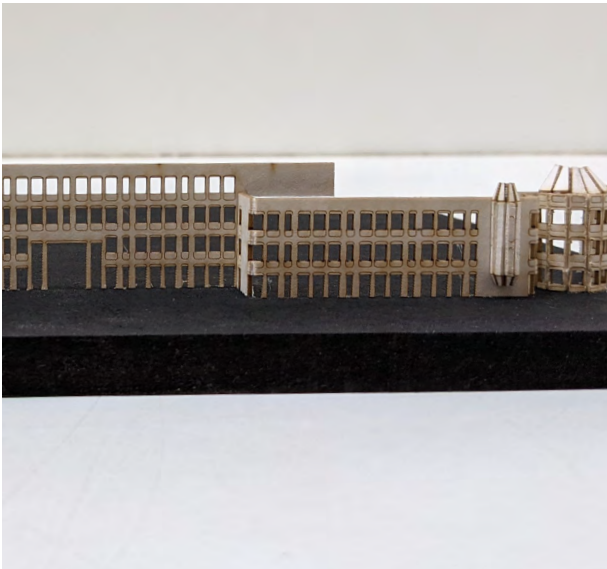
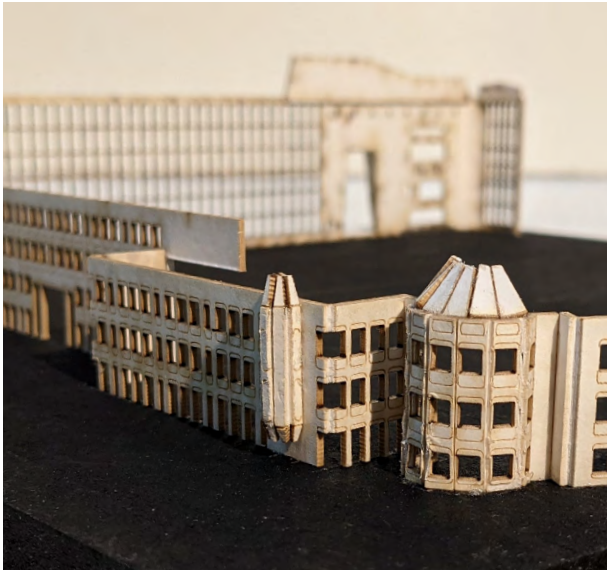
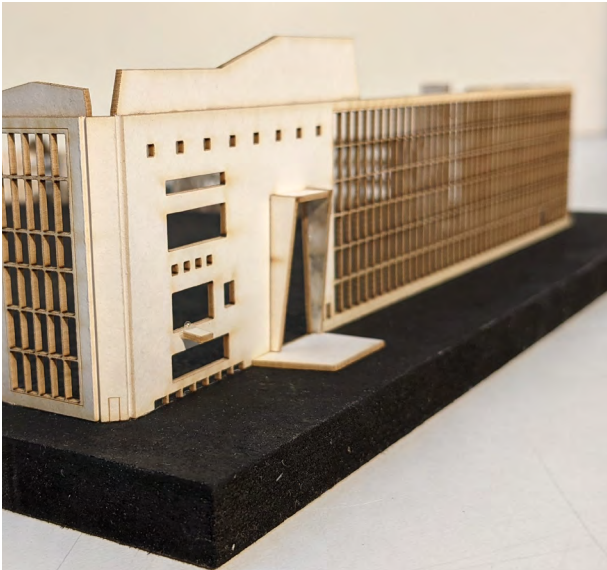


Composition & rythm



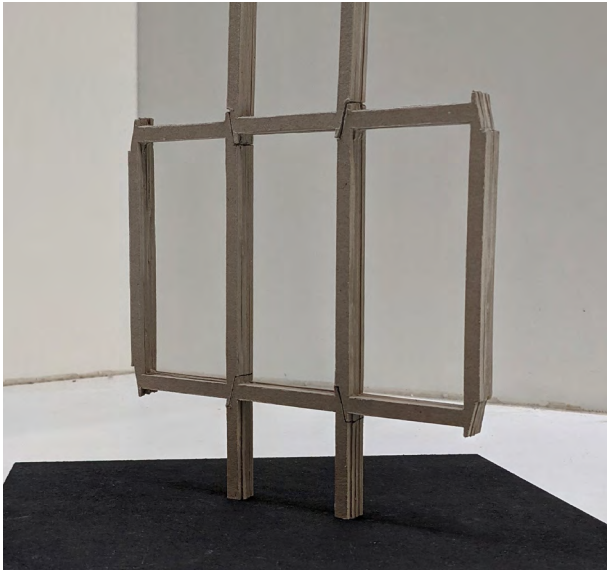


Essence models





Essence models





8

P1 presentation

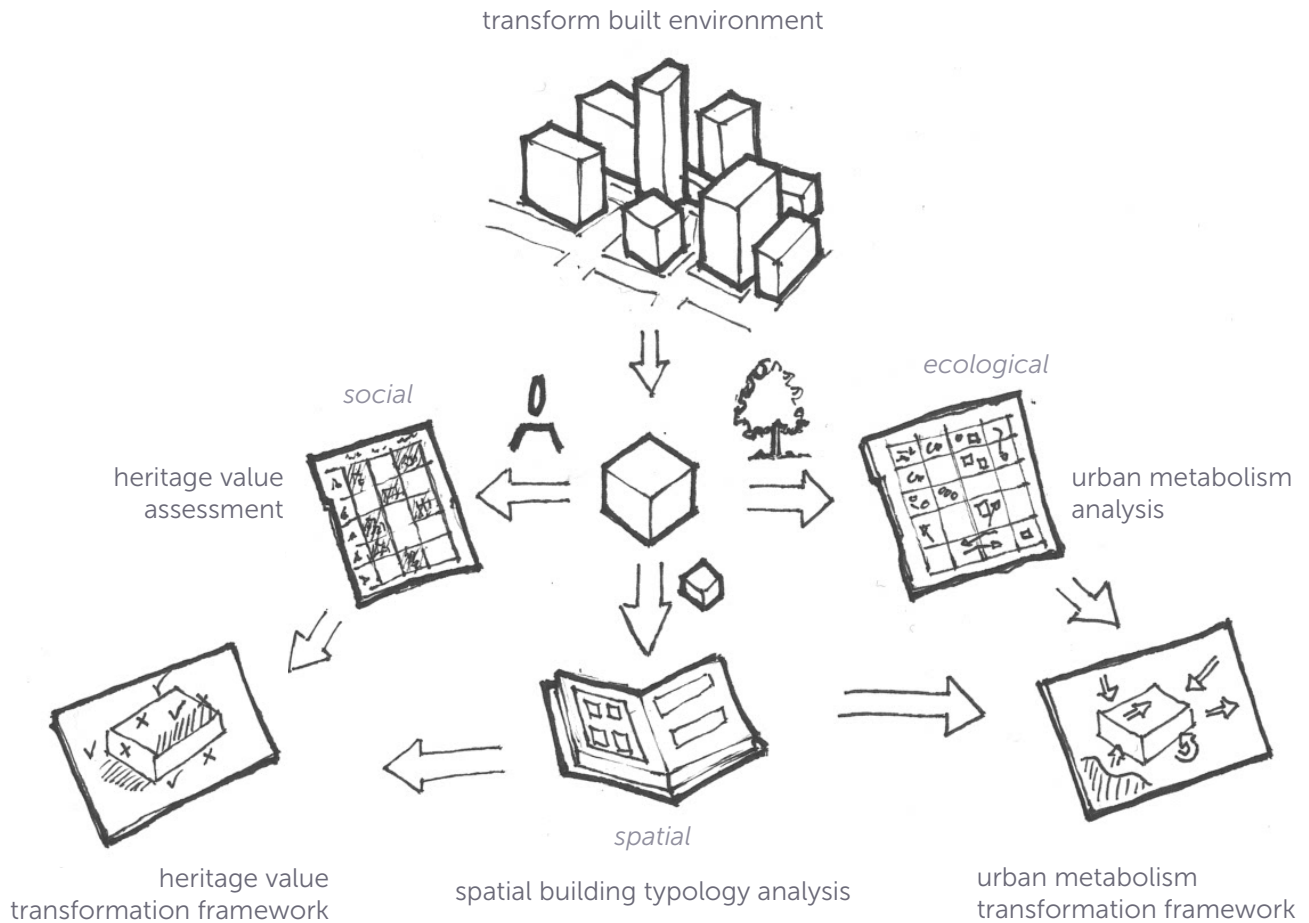
01.11.2021 - 07.11.2021

How will we live together?

"By applying natural principles in design, humans can strive to close the gap that currently exists between built and natural environments, for the mutual benefit of both human and nonhuman life."

Lynge, S. & Hesselberg Foged, T. (2021)

Relevance of heritage - additional transformation framework

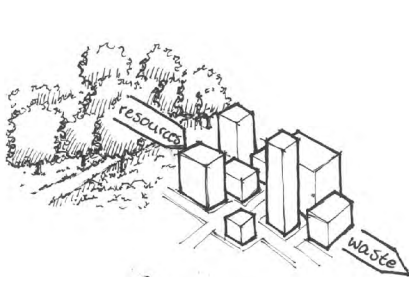




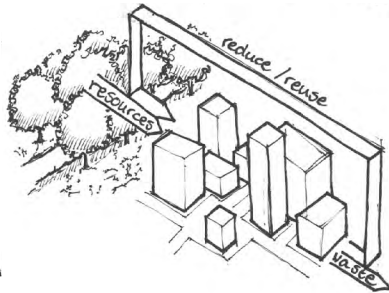


Global sustainability strategies - towards a positive impact

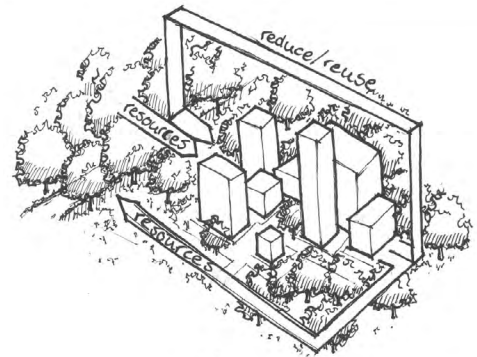
resources exploited and turned
into unprocessable waste



minimize negative
environmental impact



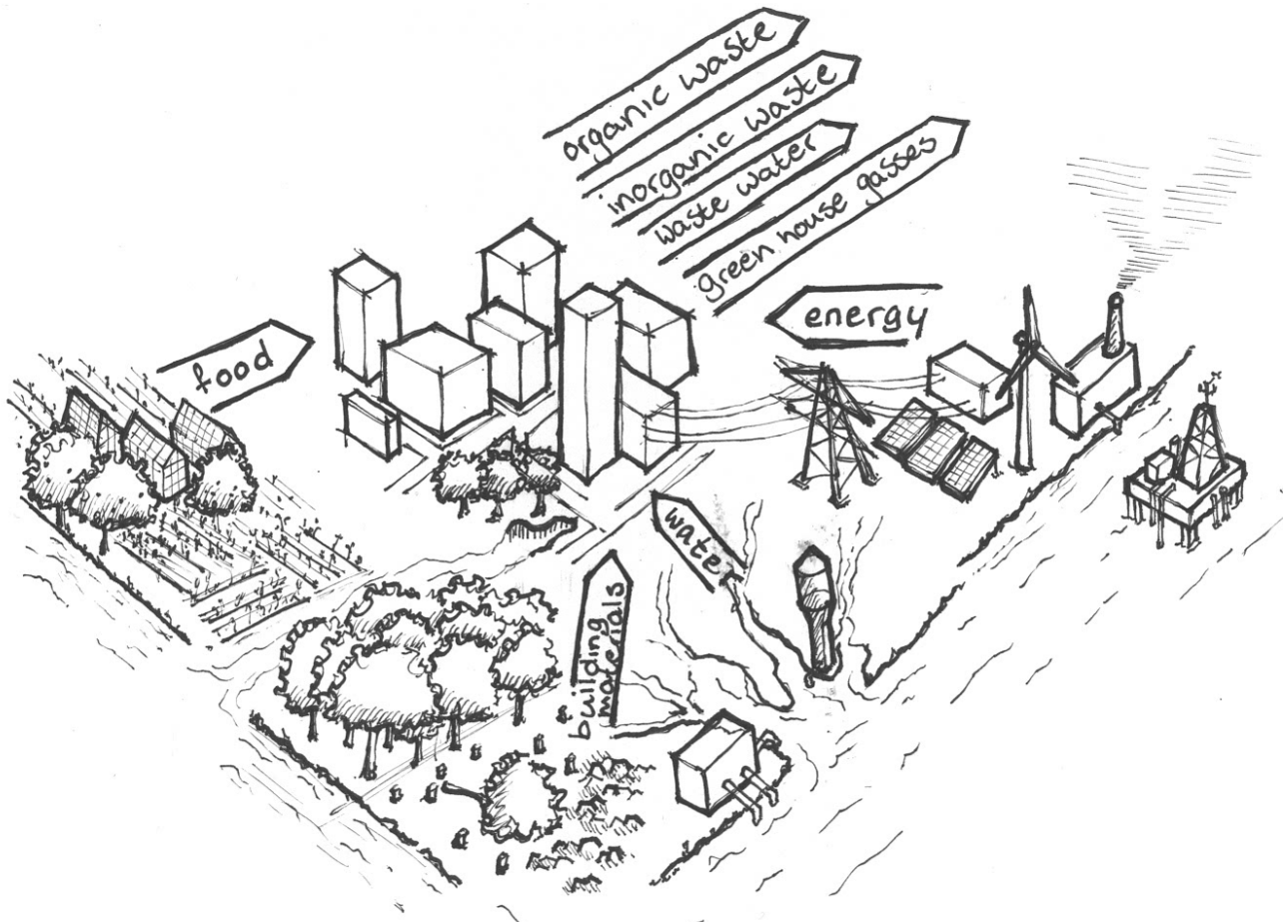
create positive impact for
environment



+++++ past +++++ present +++++ future +++++

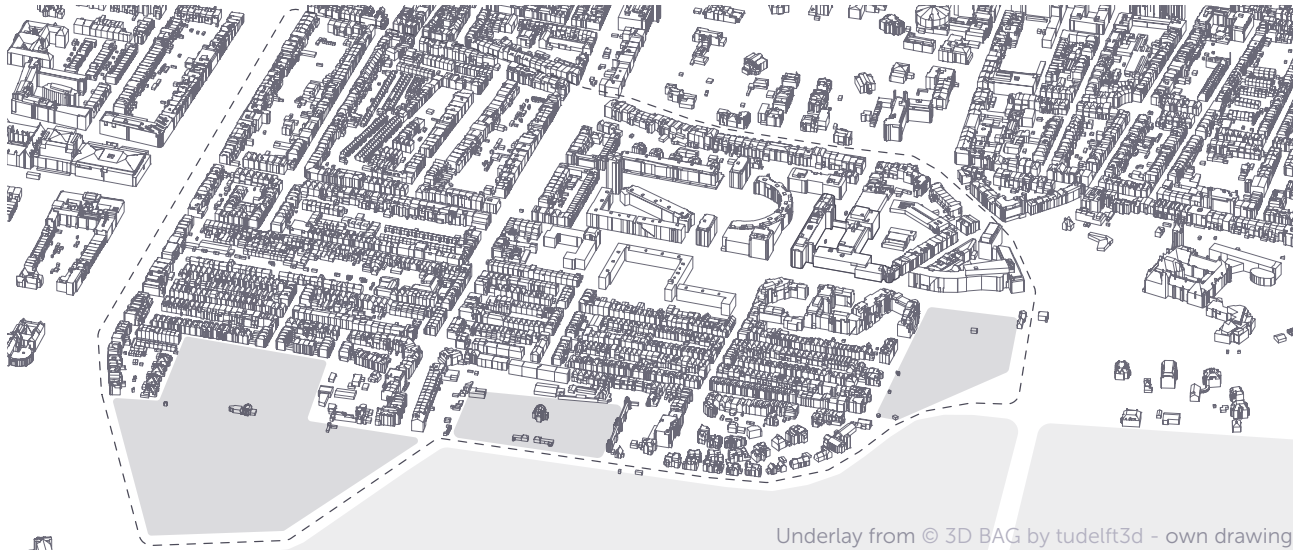
Based on information from Van Dijk, S. Tenpierik, M. & Van den Dobbelsteen, A. (2014). Continuing the building's cycles: A literature review and analysis of current systems theories in comparison with the theory of Cradle to Cradle. *Resources, Conservation and Recycling*, volume 82, 21-34. - own drawings

Urban Metabolism - built environment as an ecosystem



Based on information from Kennedy, C., Pincett, S. & Bunje, P. (2011). The study of urban metabolism and its applications to urban planning and design, *Environmental Pollution*, 159 (8–9), 1965–1973. - own drawing

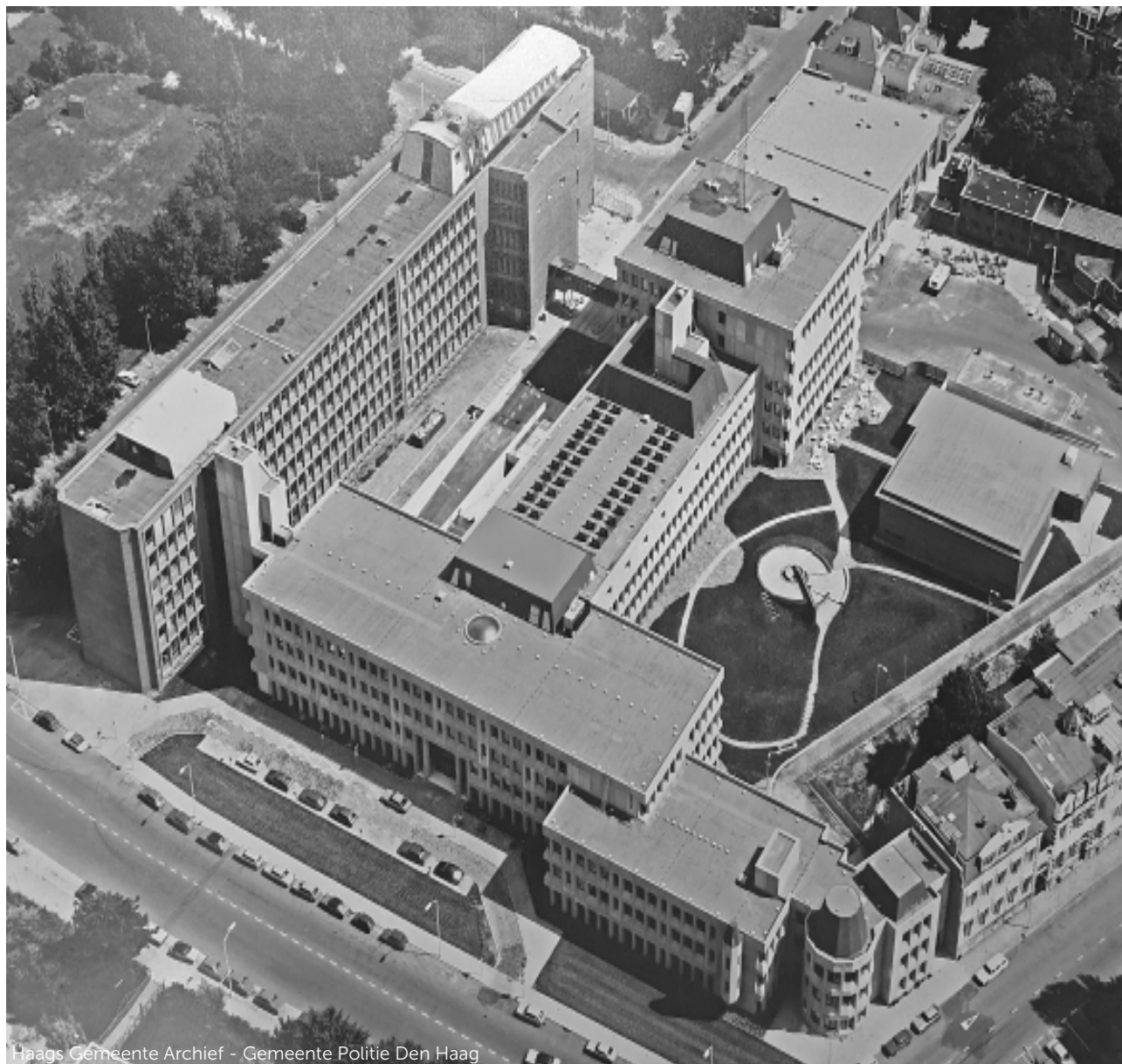
Neighborhood - Archipelbuurt



Urban block - Burgemeester Patijnlaan

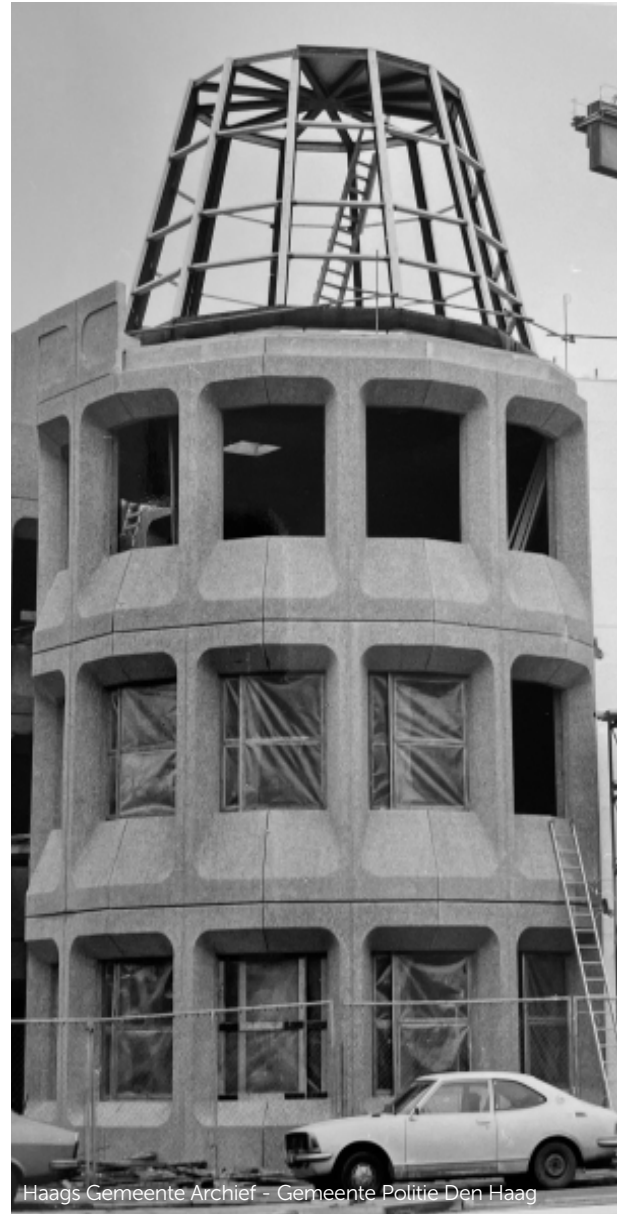


Eenheidsbureau - The Hague



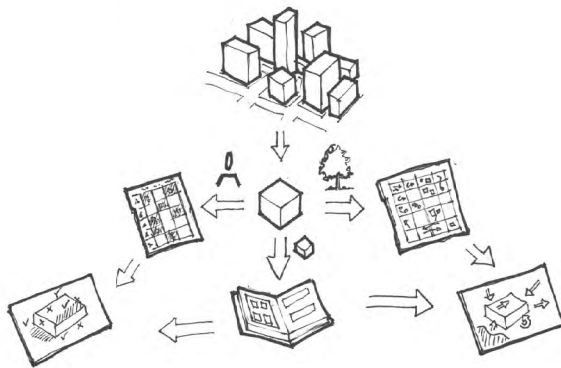
Haags Gemeente Archief - Gemeente Politie Den Haag

Building Envelope - Eenheidsbureau

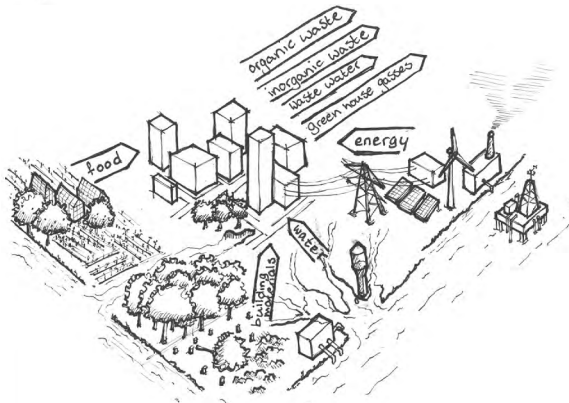




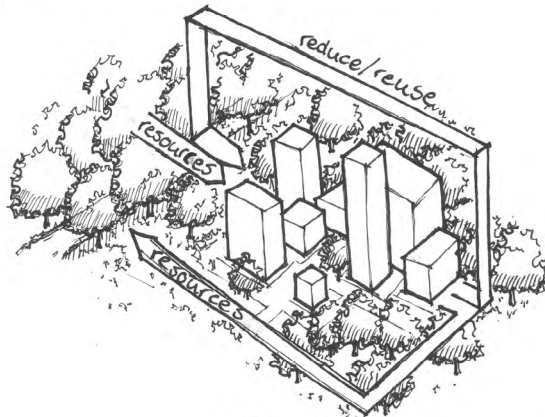
How can an architect **transform** the Eenheidsbureau in order to create a **symbiotic urban metabolism** in the **neighborhood**?



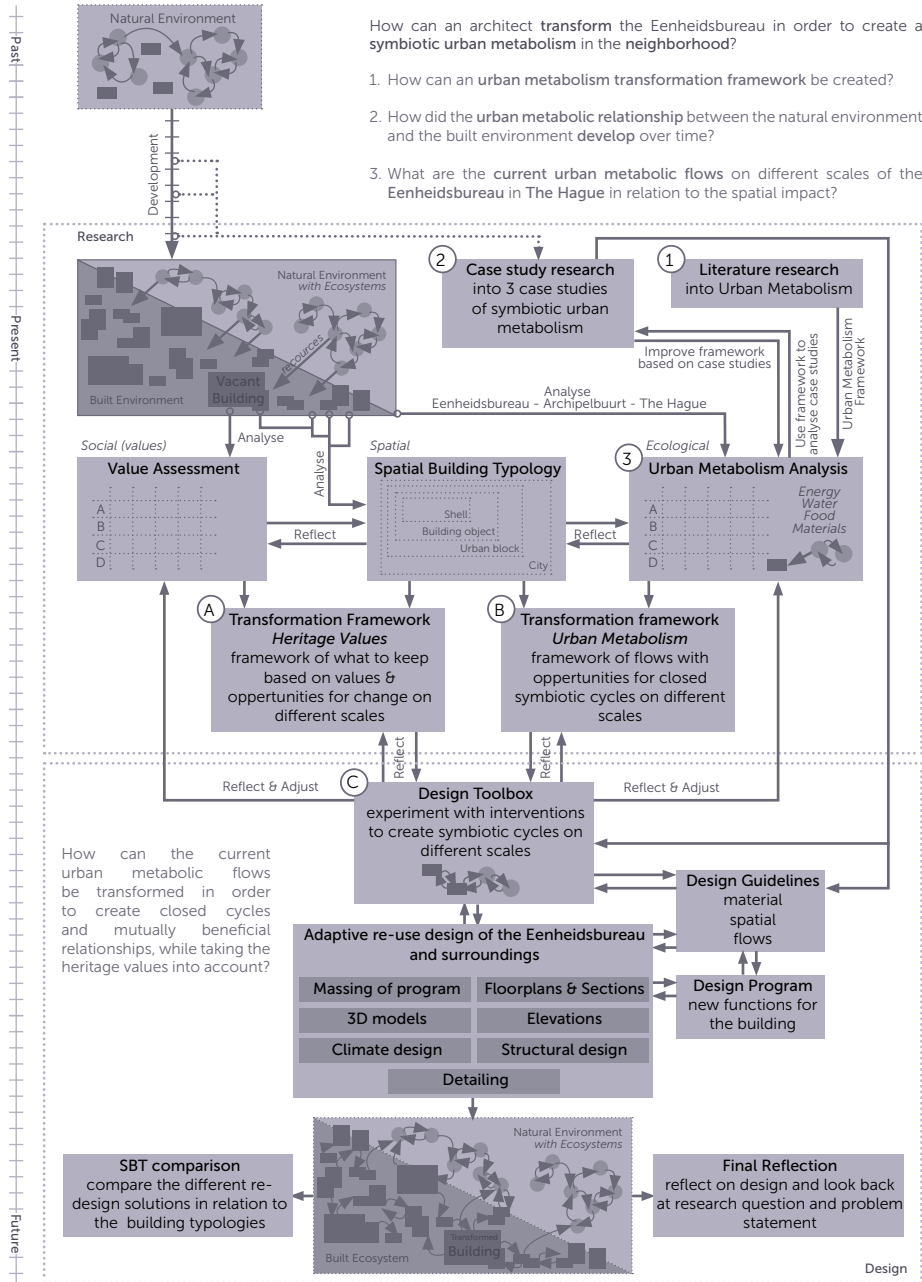
develop an additional transformation framework



analyse built environment like an ecosystem with urban metabolism

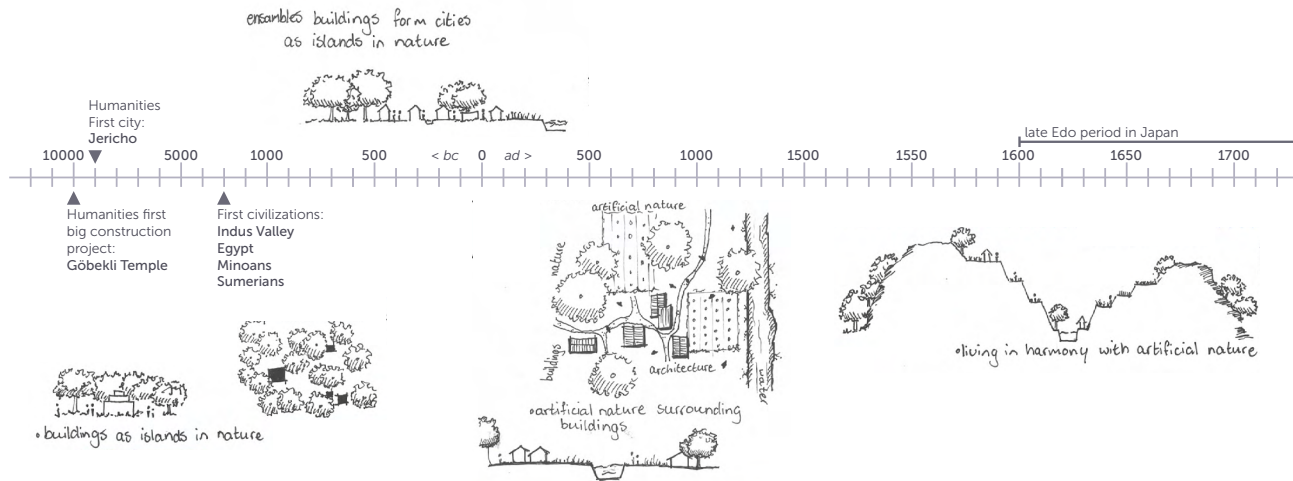


transform a building to create positive environmental impact

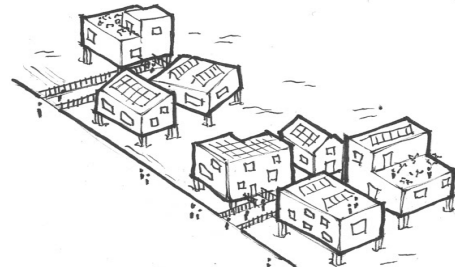


1. Literature research

How can an urban metabolism transformation framework be created?



Edo period 1600-1850 in Japan - own drawing



Schoonschip Amsterdam - own drawing

1. Ecology: *oekologie* introduced by Ernst Haeckel from the Greek word *oikos* (home). It stands for the study of the interrelationships of organisms with their environment and each other. (Pimm & Smith, 2019)

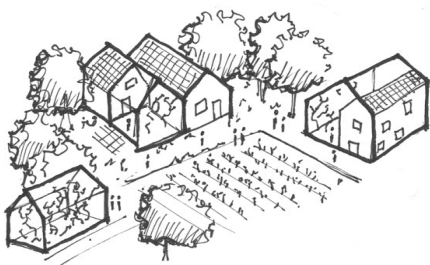
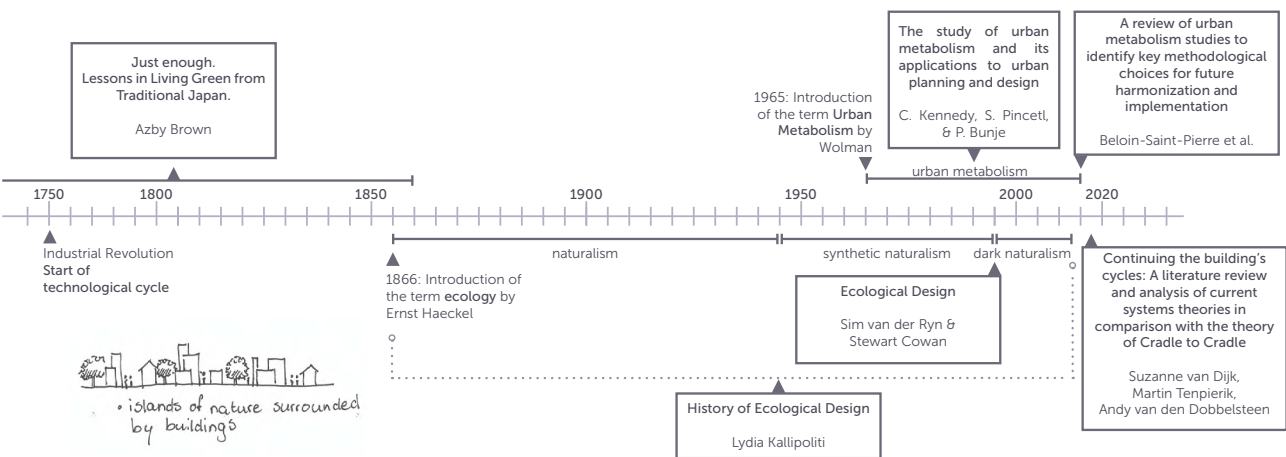
2. Ecosystem: a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (CBD, 2010).

3. Natural environment: The natural environment encompasses all living and non-living things occurring naturally on Earth. Consisting of ecosystems including all living species, universal natural resources and physical phenomena. (Johnson et al., 1997)

4. Built environment: an environment consisting of all manmade structures to support human activity (Portella, 2014).

2. Case studies

How did the urban metabolic relationship between the natural environment and the built environment develop over time?



ReGen Village Oosterwold - own drawing

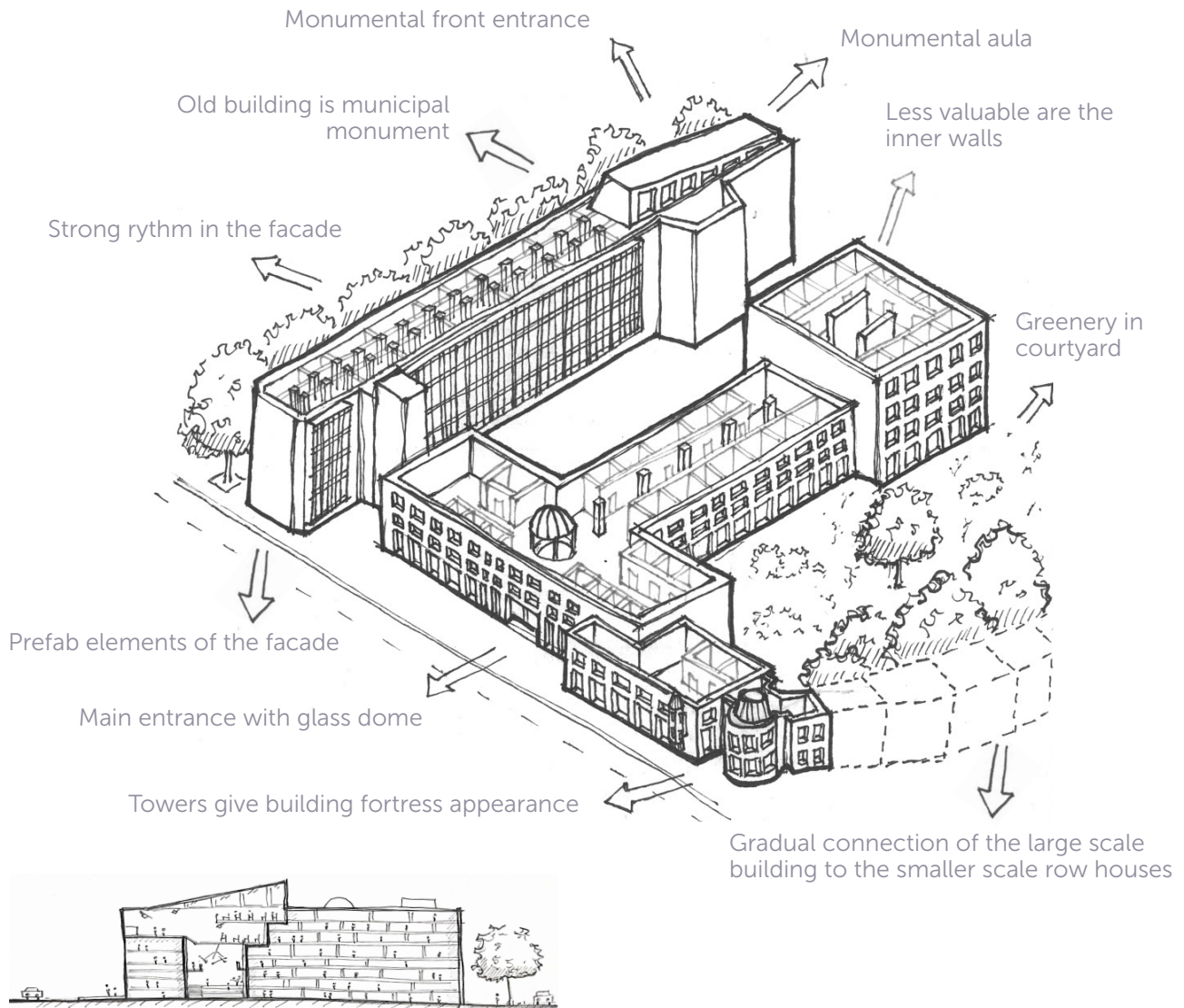
Urban Metabolism Analysis	Water	Energy	Materials	Biotic factors
	groundwater surface water rain water drinking water grey water black water	electricity heat cold greenhouse gasses	biobased non-biobased organic waste inorganic waste	soil plants animals food
City scale	sources of drinking water & waste water treatment for Eenheidsbureau	sources of electricity production & presence of heat network	waste treatment of waste from Eenheidsbureau	connection of Archipelbuurt green networks in relation to larger green networks
Neighborhood scale	drinking water and waste water networks & estimation of water usage and waste water	estimation of electricity usage and related greenhouse gas emissions	waste collection points & estimation of the amount of waste	green networks & presence of plants and animals & presence of food production
Urban block	amount of rain water and infiltration in soil or hard surface	need or abundance of heat or cold based on function	estimation of the amount of waste categorized	green networks & presence of plants and animals & presence of food production
Building object	amount of water used and waste water produced & current water system	electricity usage & heating and cooling demand & current climate systems	estimation of the amount of waste categorized	relation with surrounding nature
Building envelope	amount of rain water & catchment or removal	thermal properties & thermal mass of envelope		

5. Symbiosis: from the Greek words *sýn* (together) and *biósis* (living). It means a close connection between two entities which have a mutually beneficial relationship. (The Editors of Encyclopaedia Britannica, 2020)

6. Metabolism: the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes (Kornberg, 2021).

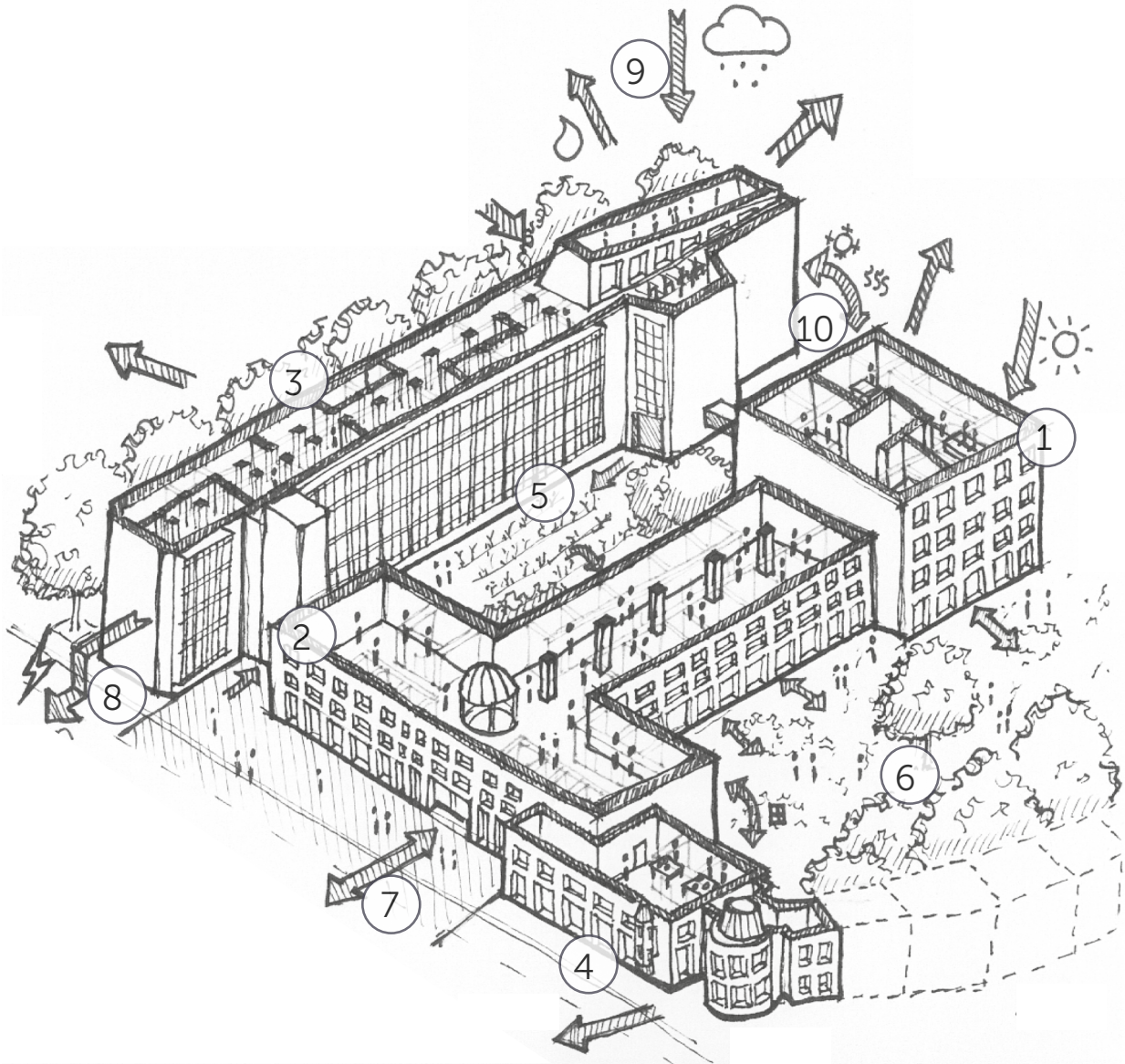
7. Urban metabolism: the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. Also the study of quantification of the inputs, outputs and storage of energy, water, nutrients, materials and wastes for an urban region. (Kennedy, Pincett, & Bunje, 2011)

Heritage value assessment - Initial thoughts



essence section (old building)

First design direction



1. housing / 2. cultural / 3. offices / 4. commercial / 5. food / 6. park / 7. relation to surrounding buildings and parks / 8. excess energy to smart grid / 9. capture rain water / 10. exchange flows between functions

9

Research introduction

08.11.2021 - 21.11.2021

Preface

How will we live together?

An intriguing question which formed the central theme for this year's architectural Biennale in Venice. When visiting this Biennale, I walked through countless pavilions and saw many exhibitions, all about how humans could live together with each other, but almost more importantly, also how humans could live together with nature. There was one exhibition which especially attracted my attention. It was a large table, full of small living trees between which architectural models of ecological ways of living were displayed (see pictures below). Accompanied with this installation was this quote, which from the moment that I have read it, stayed with me:

"By applying natural principles in design, humans can strive to close the gap that currently exists between built and natural environments, for the mutual benefit of both human and nonhuman life."

Lynge, S. & Hesselberg Foged, T. (2021)



By applying natural principles in design, ...

This first part of the quote immediately touches upon a personal fascination that started a long time ago and probably has its roots in my personal experience and memories of encounters with nature, like many camping trips and walks. A fascination for nature originating from my childhood, but still something that greatly interests me and has been a recurring topic throughout my architecture education.

... the gap that currently exists between built and natural environments, ...

This section of the quote addresses the problem, or better formulated; the challenge that we currently face as humans. A disconnection between nature and humans of which the built environment forms the ultimate representation. The natural environment exists of a complex of ecosystems all interdependent and in balance with each other. Then there is the built environment, where the open-ended cycles use resources

from the natural environment but create waste unsuitable for reuse by the ecological cycles. This imbalance and disconnection have caused climate change, destruction of the natural environment, and reduction in biodiversity. This will, in the long term, not only impact the natural environment, but also the built environment.

... for the mutual benefit of both human and nonhuman life.

The ending of the quote illustrates the relevance of this challenge, as it has not only an impact on the biodiversity of nature but also on humans themselves. If we continue living how we currently are and ignore this challenge, then it will no longer be human life and nonhuman life on this planet, it will just be nonhuman life. This has to do with the fact that currently, humans are indeed a danger for all forms of nonhuman life, but at one point the destruction of that life will become a danger for human life itself as we will make this planet inhabitable for ourselves.

With this research I will try to find possible solutions for this challenge. I will be trying to find new ways of living together.



Introduction

Disconnection between nature and humans

The history of the natural environment¹ and the built environment² goes far back. The natural environment has already existed for around 3.7 billion years, while the built environment exists for around 12 thousand years. For a long time, these two entities were in some sort of balance. But something happened, a disconnection between nature and humans emerged, the relationship between them had changed.

The main reason for this change in the relationship is the change of cycles. The natural environment consists of ecological³ cycles, which form a balanced, connected, and interdependent system of closed cycles. With the industrial revolution, a new cycle emerged in the built environment; the technological cycle. This cycle had one main difference to its ecological predecessor, it was not a cycle, as it had waste at the end which could not be used anymore by the ecological cycles. In this way, a different relationship between the natural environment and the built environment was created, as the former would be exploited for recourses used by the latter and disposed of in the form of waste not useful for the natural environment again (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). These technological cycles are causing climate change, loss of biodiversity, shortage of resources, and abundance of waste;

ultimately leading to an inhabitable planet for a great part of living species including humans.

Minimizing negative environmental impact

In current articles, policy documents, but also in academic debates about sustainability strategies, the main focus lies on the reduction and minimization of the negative environmental impact (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). With this research, I hope to contribute to the shift of this focus towards creating a positive impact on the environment. The way how the built environment currently functions needs to be transformed in order to create this positive environmental impact.

Built environment as an ecosystem

A method for guiding this transformation can be urban metabolism⁷. This term was first used by Wolman in his book *The metabolism of cities* (1965). It presents the built environment as an ecosystem⁴ with flows and processes. The concept of metabolism⁶ is used to analyse the interactions and flows of materials and energy in an urban region (Broto, Allen & Rapoport, 2012). Based on urban metabolism, interventions can be designed to create symbiotic⁵ relationships. In this way transforming the built environment in a way so it has a positive impact on its environment.

1. Natural environment: The natural environment encompasses all living and non-living things occurring naturally on Earth. Consisting of ecosystems including all living species, universal natural resources, and physical phenomena. (Johnson et al., 1997)

2. Built environment: an environment consisting of all manmade structures to support human activity (Portella, 2014).

3. Ecology: *oekologie* introduced by Ernst Haeckel from the Greek word *oikos* (home). It stands for the study of the interrelationships of organisms with their environment and each other. (Pimm & Smith, 2019)

4. Ecosystem: a dynamic complex of plant, animal and micro-organism communities, and their non-living environment interacting as a functional unit (CBD, 2010).

Importance of transformation

As explained before, most of the societal and ecological issues arose in the built environment, but it is also there where most possibilities for change and improvement are. The open-ended technological cycles are taking place in an existing built environment and in order to control and alter these cycles, transformation of existing buildings and infrastructures is needed. A question that might arise is if the current built environment causes all these problems, then why not demolish it and start over again? In other words;

Why should we transform?

The reason for transformation over demolishing and new built is related to sustainability aspects of embodied energy and material waste, but also to the preservation of heritage values as buildings are the embodiment of cultural values and historical memories (Van Hees, Naldini, & Roos; 2014). The next question could then be:

How should a building be transformed?

The heritage department has developed a value assessment tool with which a transformation framework can be created (Kuipers & De Jonge, 2017). This value assessment combines the Brand layers with the values of Riegl. These values are however a social construct created by humans and are mostly subjective based on the different

perceptions of the stakeholders. I believe that another tool is additionally needed to help guide an architect with the transformation of a building. This research will by no means ignore or reject the heritage value method of guiding the transformation, but rather seeks an extra tool that does not only focus on the human needs and values of the building but a tool that tries to include the needs and wishes of nonhuman actors.

Another assessment tool, proposed by Tarrafa Pereira da Silva & Pereira Roders (2012), consists of eight primary values and does include the ecological values. These ecological values, further divided into spiritual, essential, and existential, are however not very clearly defined or measurable.

This research can therefore be seen as an additional tool or extension of both the Kuipers & De Jonge framework and the Tarrafa Pereira da Silva & Pereira Roders framework to create a method of mapping the ecological values. In this way designing a transformation that not only positively contributes to humans but also to its environment, in an effort to try and find a way of living together.

5. Symbiosis: from the Greek words *syn* (together) and *biósis* (living). It means a close connection between two entities that have a mutually beneficial relationship. (The Editors of Encyclopaedia Britannica, 2020)

6. Metabolism: the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes (Kornberg, 2021).

7. Urban metabolism: the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. Also the study of quantification of the inputs, outputs, and storage of energy, water, nutrients, materials, and wastes for an urban region. (Kennedy, Pincetl, & Bunje, 2011)

Content of research

Research questions

The goal of the research and the design is to find new ways of living together with a transformation of a building that has a positive impact on both humans and their surroundings. Therefore the following research question is formulated:

How can an architect transform the Eenheidsbureau in order to create a symbiotic urban metabolism in the neighborhood?

To answer this research question, some subquestions are formulated. These will be answered in the following chapters.

1. How can an urban metabolism transformation framework be created?

This first part of the research consists of literature research and can be found in Chapter 10 of this booklet. Different articles and books about urban metabolism and ecological design will be compared and combined into a framework to analyse urban metabolism.

2. What are the current urban metabolic flows on different scales of the Eenheidsbureau in The Hague?

The second part of the research (Chapter 11) consists of an urban metabolism analysis of the neighborhood the Archipelbuurt in The Hague. The framework created in part one of the research will be used to conduct this analysis, giving a clear understanding of the flows and cycles on different scales in the neighborhood.

3. How can urban metabolic flows be transformed to create closed cycles?

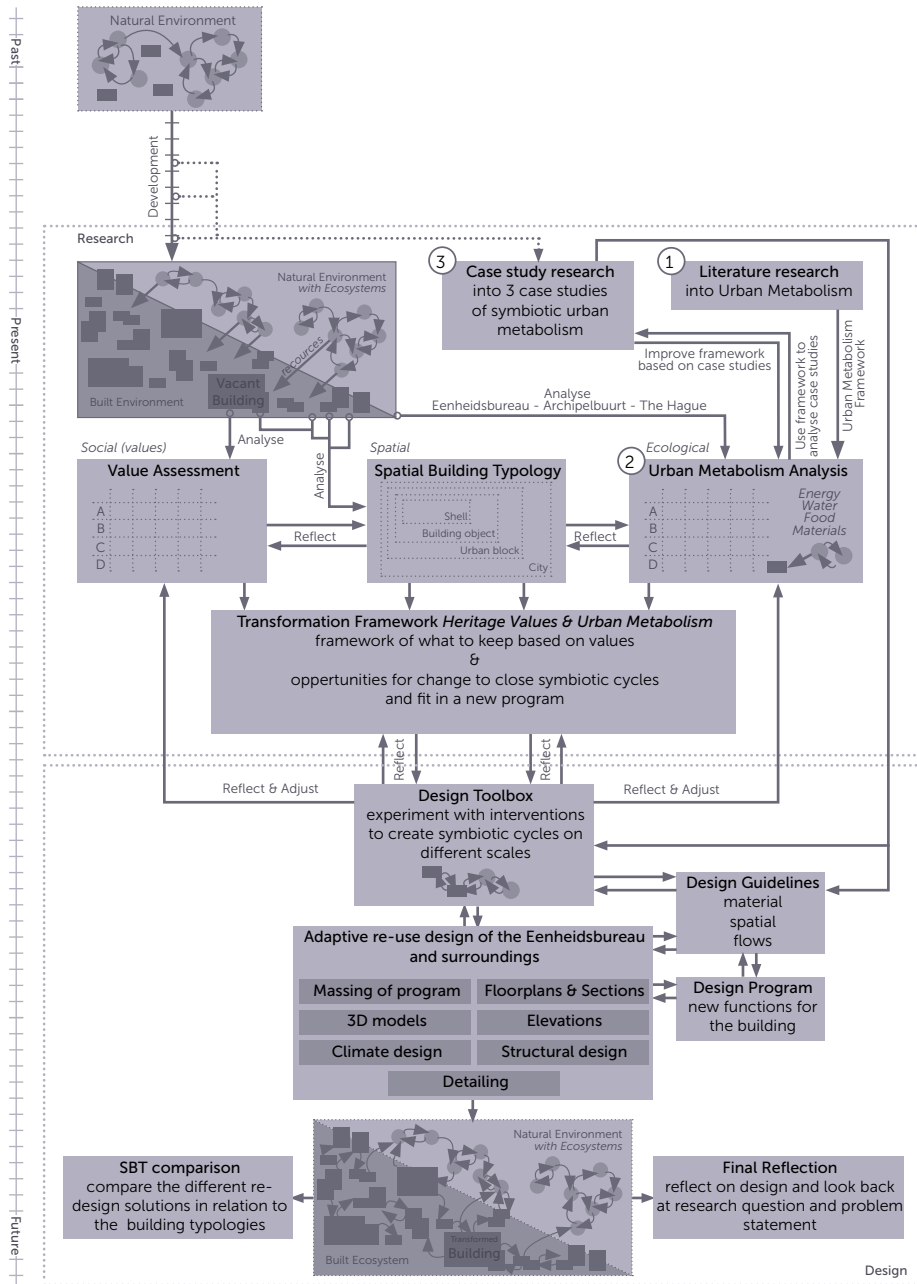
The third part of the research, located in Chapter 12 of the booklet, uses case study research to find examples of closed urban metabolism cycles. These will be used to create design guidelines for the re-design of the police station and function as input for the transformation framework.

4. Heritage value assessment

A heritage value assessment is conducted in Chapter 13, using a combination of the Kuipers & De Jonge method and the Silva & Roders method. The input for this assessment is the spatial building typology (Chapters 4-7) and a heritage building analysis (separate booklet).

5. Conclusion

To conclude this research the outcome of the urban metabolism analysis and the heritage value assessment are combined to create a transformation framework that can be used to guide the design. This can be found in Chapter 14.



10

Research part 1 - literature research

22.11.2021 - 28.11.2021

Introduction

Goal and scope of focus

The literature research forms the bridge between the broader context of the societal problem stated in the introduction and the in-depth urban metabolism research conducted later in this booklet. The different literature sources are organized in such a way that it narrows down the scope of focus throughout this chapter. This change in focus is illustrated in the diagram on the next page, which shows how the research starts from a wide context in the introduction and narrows down with the literature research. Later in the conclusion, this scope of focus is expanded again.

Content of literature research

The literature research itself starts with a short summary of the societal problem of the disconnection between humans and nature. After this, the research will go more in-depth on a way of solving this challenge with ecological design. From there a couple of theories inside ecological design are highlighted; the so-called system theories. From these system theories, one is chosen, called urban metabolism. With the use of different articles, the method of urban metabolism will be further defined and a framework will be created. This framework can be used to analyse the urban metabolism in the neighborhood of the design case study. This analysis forms the second part of the research.

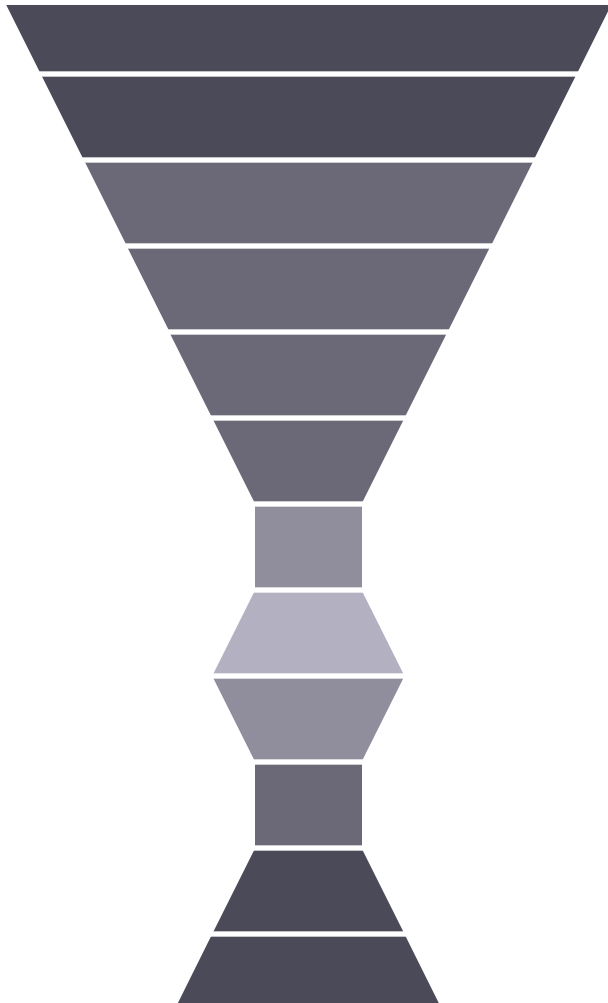
Disconnection between humans and nature

As explained in the introduction, the disconnection between humans and nature was mainly caused by a different cycle that emerged with the industrial revolution; the technological cycle. An open-ended cycle with waste at the end, causing

a disbalance between the natural environment and the built environment (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). The disbalance is still increasing, as last year a historic crossover point was passed where the global human-made mass is larger than all living biomass on the planet (Elhacham, Ben-Uri, Grozovski, Bar-On & Milo, 2020).

This disconnection between humans and nature is causing climate change, loss of biodiversity, shortage of resources, and abundance of waste; ultimately leading to an inhabitable planet for a great part of living species including humans.

These problems are currently being tackled, but in most articles, policy documents, and academic debates about sustainability strategies, the main focus lies on the reduction and minimization of the negative environmental impact. This focus is however beginning to shift towards creating a positive impact for the natural environment (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). Taking nature into account while designing is a way of creating this positive impact. In literature, this kind of designing is called ecological design. The next chapter will further elaborate on ecological design, from the origin to the different theories and movements inside ecological design.



Introduction:

broader context, disconnection humans & nature

Introduction:

relevance of the built environment and heritage

Literature research:

ecological design

Literature research:

system theories

Literature research:

urban metabolism

Literature research:

urban metabolism analysis framework

Urban metabolism analysis:

The Hague, Archipelbuurt, Eenheidsbureau

Case study research:

cyclifiers & intermediate conclusions

Literature research:

heritage value assessment with ecological values

Heritage value assessment:

Cultural value assessment of Eenheidsbureau

Conclusion:

combine urban metabolism with heritage values

Conclusion:

general method for ecological and cultural values

Scope of focus throughout the entire research - own drawing

Ecological design

History of ecological design

The origin of ecological design goes back to the introduction of the term *ecology* in 1866 by Ernst Haeckel (Pimm & Smith, 2019). But even before that, there was always a relationship between the natural environment and the built object. The diagram below illustrates the history of ecological design and relevant articles. An article written by architect, engineer, and scholar Lydia Kallipoliti (2018) summarizes the history of ecological design and organizes it into three movements; naturalism, synthetic naturalism, dark naturalism.

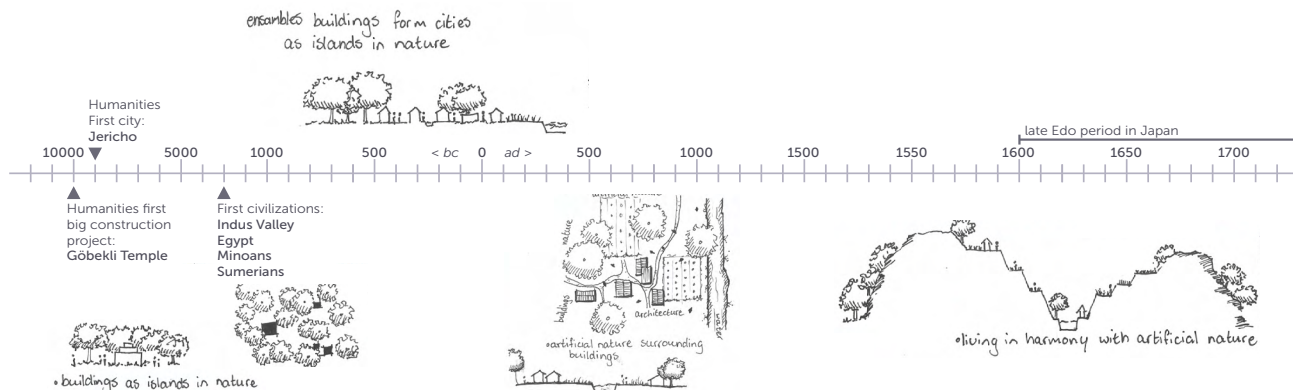
Naturalism

This first movement advocates the seamless integration of human activities with natural processes (Kallipoliti, 2018). The famous book *Ecological Design* by architect Sim van der Ryn and doctor applied mathematics Stewart Cowan falls under this movement as it provides a framework for integrating human design with living systems (Van der Ryn & Cowan, 2007). It uses ecology as the basis for design on all scales, from the smallest details to buildings, to entire cities.

Another tool, which is more locally oriented to the design case study, is the point list for nature-inclusive building from The Hague (Klasberg, 2018). With this list, the municipality is attempting to integrate living fauna and flora into buildings. The aim of this movement is, with the seamless integration, to avoid a negative environmental impact and live in harmony with nature.

Synthetic naturalism

This movement stands for the displacement of laws of nature and metabolism from the natural environment to the built environment (Kallipoliti, 2018). It uses the principles from nature to analyse and design the systems in the built environment. The term urban metabolism was introduced by Wolman (Kennedy, Pincetl, & Bunje, 2011), but it went further than just the material and technology aspect, as the Norwegian philosopher Arne Naess wrote about deep ecology. A philosophical ecological worldview to experience the interconnection of all life forms, advocating for a holistic approach to the science of ecology (Naess, 1973).

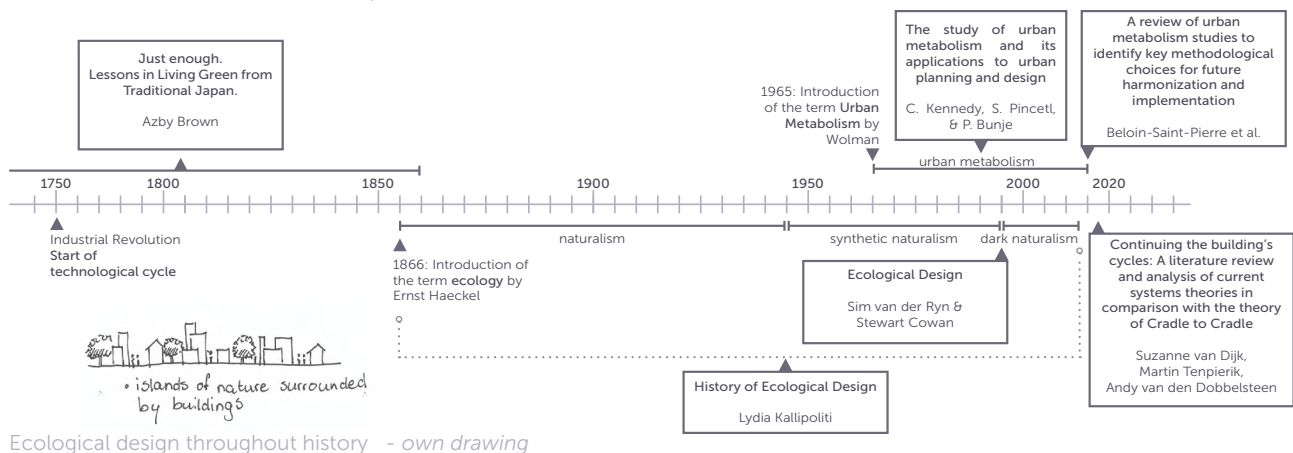
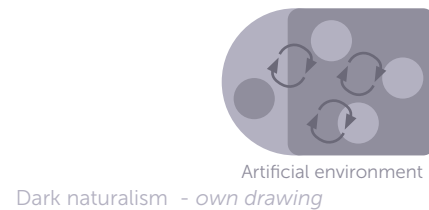
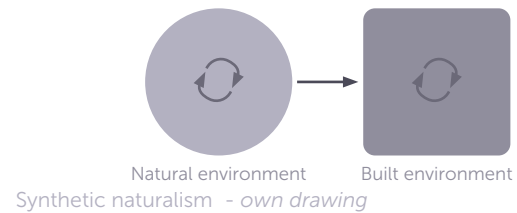
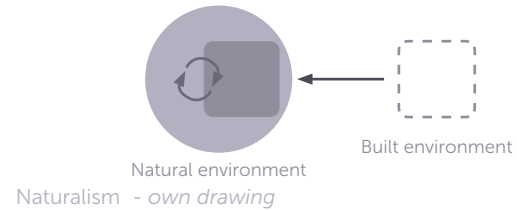


Ecological design throughout history - own drawing

Dark naturalism

The starting point of this movement is the *Anthropocene*, introduced by ecologist Eugene F. Stoermer, claiming that we are living in a world where human activity has reformed the geophysical properties of the planet. The clear division between the built and natural environments is no more, as nature has been influenced by humans it has become an artificial environment, closely intertwined with human life. The movement rejects the idealized version of whole environments and healthy ecosystems and advocates human interaction with (artificial) nature in order to protect and improve it (Kallipoliti, 2018). In her film, architect Neri Oxman showcases these symbiotic relationships between animals and the built environment, as animal-made materials are used (Oxman, 2020).

Kallipoliti concludes that ecological design has evolved to the designing inside a complex system of flows (Kallipoliti, 2018). A group of theories related to this approach, the systems theories, will be researched in the next chapter.



Systems theories

Systems theories

As explained in the chapter before there are different movements of ecological design and within these movements, there are theories to guide the design process (Kallipoliti, 2018). A group of these theories related to the approach of the world as a complex system of flows are the so-called systems theories. Seven of these systems theories are compared in an article written by Van Dijk, Tenpierik, & Van den Dobbelsteen (2014). These theories are; Laws of ecology, Looped economy, Regenerative design, Industrial ecology, Biomimicry, Blue economy, and Cradle to cradle.

Closed loops

The main principle of all these seven theories is the idea of closed loops, which finds its origin in nature. It are systems where waste does not exist and everything is related to something else (van Dijk, Tenpierik, & van den Dobbelsteen; 2014).

In this article, cradle to cradle was seen as the most complete theory, as almost all the guiding principles of the other six theories are included (Van Dijk, Tenpierik, & Van den Dobbelsteen; 2014). The guiding principles of the cradle to cradle theory are; waste equals food, use current solar income, and celebrate diversity (Braungart & McDonough, 2002). With these guiding principles closed cycles and a positive environmental impact can be created, but the principles are hard to literally apply in the design process of buildings (van den Dobbelsteen, 2008).

New stepped strategy

In order to make the cradle to cradle theory more applicable for the design of buildings, Andy van den Dobbelsteen has updated the Trias Energetica theory with the cradle to cradle philosophy. This

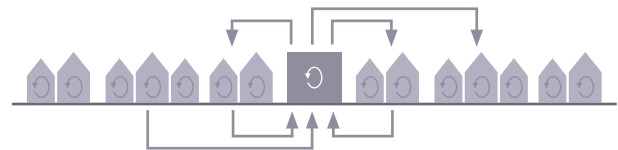
resulted in the following eight steps, illustrated on the next page (van den Dobbelsteen, 2008). These steps can be used to create an ecological and environmental positive building and will therefore be used as guiding principles for the re-design of the Eenheidsbureau in The Hague.

Urban scale

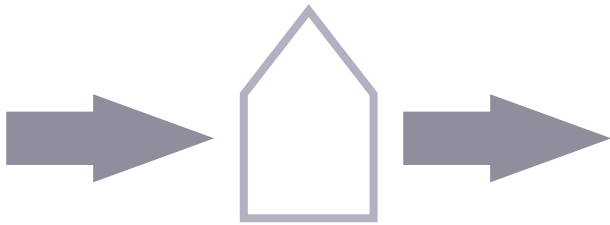
Instead of focussing on a building, the urban scale should be explored to close cycles and use the stepped strategy. This scale of the neighborhood seems optimal for local self-processing of material, water, and energy cycles, allowing for communal investments and short distances (van den Dobbelsteen, 2008) (Van Timmeren, 2006).

This scale is also promoted by the municipality of The Hague in their energy transition vision (Gemeente Den Haag, 2020). Separate plans for the neighborhoods will be created, adjusting the strategy to the specific situation. Especially for older monumental neighborhoods like the Archipelbuurt in The Hague, this scale is crucial in order to become sustainable. Certain buildings in the neighborhood could redistribute flows and help out the older buildings which are harder to insulate (see diagram below).

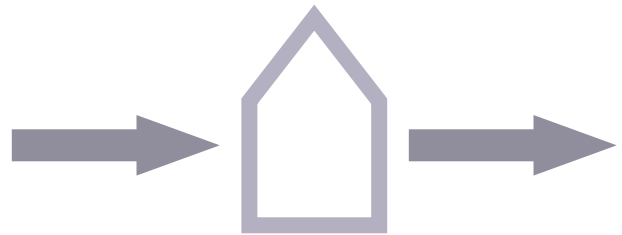
To analyse the current situation of the urban scale, according to the first step of the new stepped strategy, the concept of urban metabolism is used.



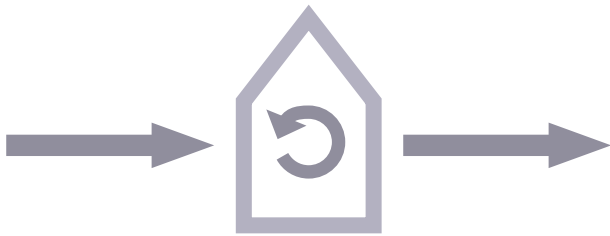
Urban scale of closed loops - own drawing



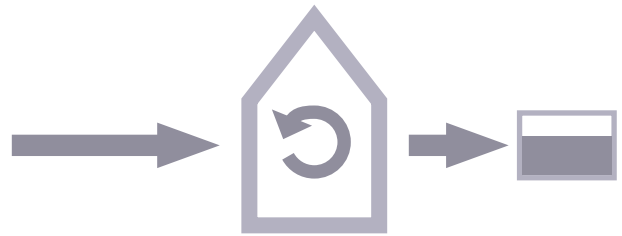
0. Analyse existing situation



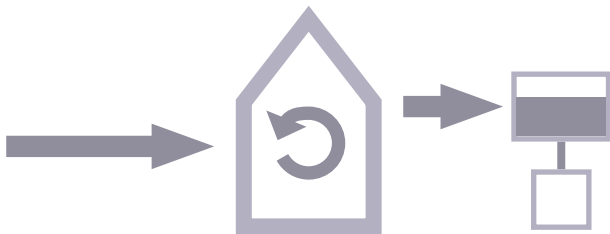
1. Reduce demand



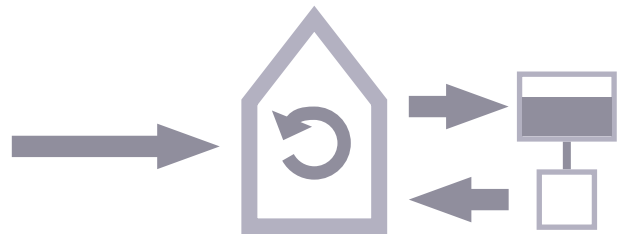
2. Recycle internally



3. Collect waste water & waste material



4. Process waste water & material in a central treatment plant



5. Re-use the effluent of this in the building



6. Supply resuming demand sustainably



7. Waste equals food

The eight steps of the New Stepped Strategy to close the building cycles - based on van den Dobbelsteen (2008)

Urban metabolism

Urban new stepped strategy

In the last chapter, different systems theories were compared and a combination in the form of the New stepped strategy was chosen as guiding theory for the design. The scale of this strategy will however be applied on both the urban scale and the building scale since the closing of energy, material, and water cycles is more ideal on this scale and since it ties in with the energy strategy of the municipality of The Hague. To analyse the current situation of cycles in the neighborhood, a concept called urban metabolism is used.

Urban metabolism

The term urban metabolism (UM) was first used by Wolman in his book *The metabolism of cities* (1965). It presents the built environment as an ecosystem with flows and processes. The concept of metabolism is used to analyse the interactions and flows of materials and energy in an urban region (Broto, Allen & Rapoport, 2012). Another definition for urban metabolism is that it is the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. It is about the study of quantification of the inputs, outputs, and storage of energy, water, nutrients, materials, and wastes for an urban region (Kennedy, Pincetl, & Bunje, 2011). A first sketch of the concept of urban metabolism is shown on the next page. But how is this concept exactly used to model the environmental sustainability of a specific urban region?

Modeling urban metabolism

There are different modeling approaches to urban metabolism, based on the desired information and availability of data. An article written by Beloin-

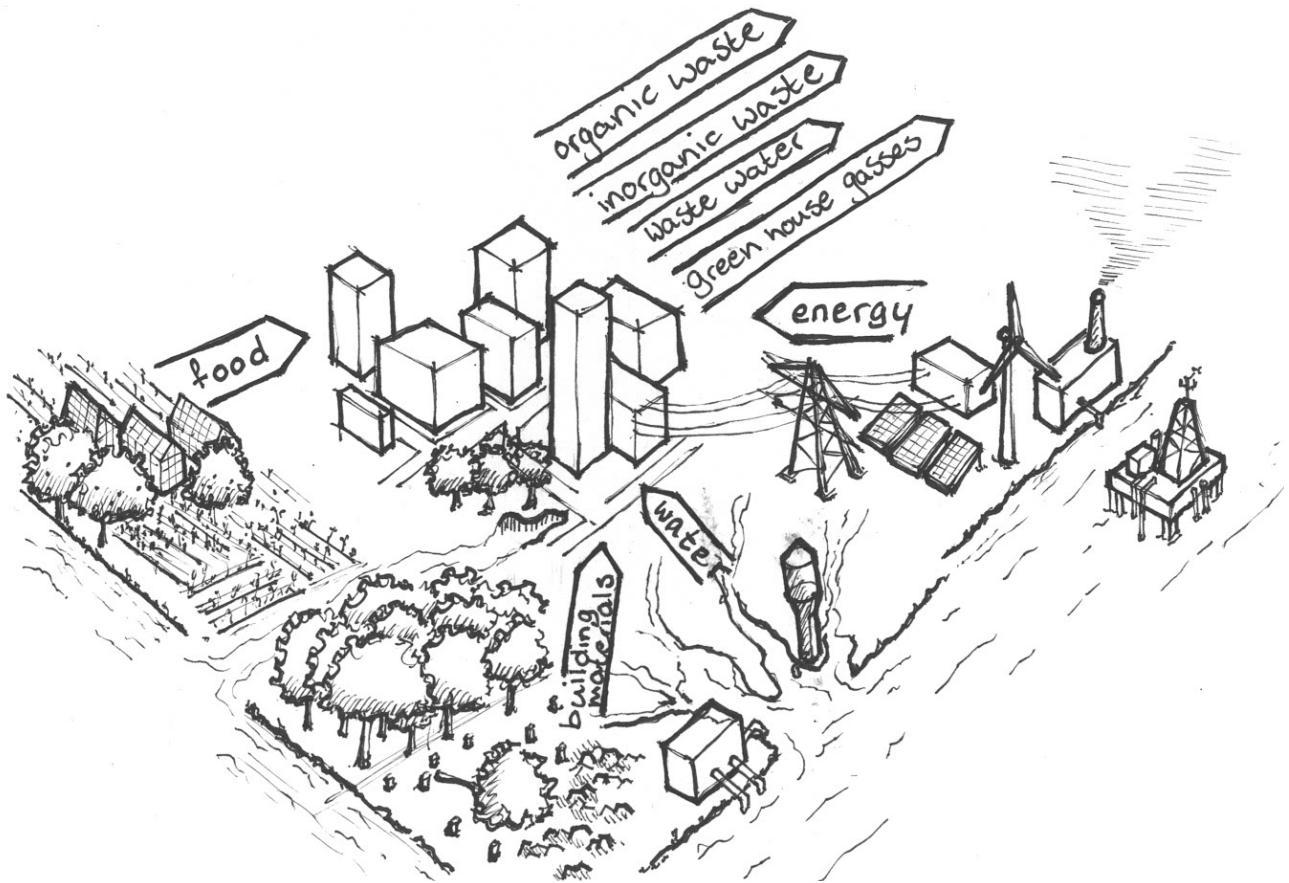
Saint-Pierre et al. (2016) has compared over 50 articles written about urban metabolism and has concluded that there are three approaches to model urban metabolism. These approaches are the black-box, grey-box, and network (see diagram on the bottom of next page). The main difference between these approaches is the level of detail of the analysis. The black-box approach only models the total input and the total output of the flows. The grey-box method splits these inputs and outputs into different components and thus gives more information about the specific flows going in and going out. The network approach is the most detailed approach and therefore also requires the most data and time as it not only models the different inputs and outputs into components, but it also models the relationship between these components.

For the urban metabolism analysis of the Archipelbuurt in The Hague, the grey-box approach will be the most commonly used. It forms a good balance between the level of detail of the method and the required time and data.

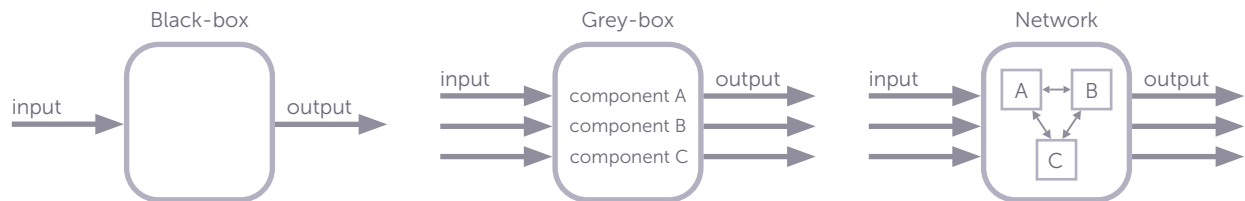
Categories of urban metabolism

Different categories can be researched with an urban metabolism analysis, but the most used categories are energy, water, material, and biotic factors. By comparing 10 urban metabolism studies Jelier (2011) found that these four categories recurred, with each study at least containing one, but often more of the categories.

The grey-box approach and these four categories will form the basis of the urban metabolism analysis of the Archipelbuurt, which will be further defined in the next chapter.



Sketch of urban metabolism - based on Kennedy, C., Pincetl, S. & Bunje, P. (2011)



Three modeling approaches for urban metabolism - based on Beloin-Saint-Pierre et al. (2016)

Urban metabolism analysis

Archipelbuurt - The Hague

As defined in the last chapter the grey-box method and the categories water, energy, materials, and biotic factors are used for the urban metabolism analysis. This analysis will be conducted on the Archipelbuurt in The Hague with as main focus the police station Eenheidsbureau since that is the building that will be re-designed within this project. This approach and method can be used on other locations, but for this research, the focus is on this specific neighborhood.

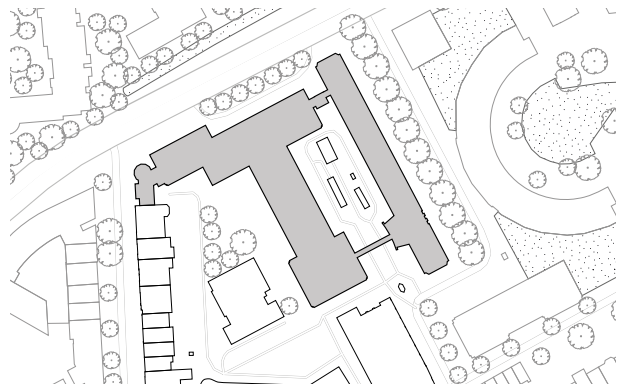
Urban metabolism scales

This analysis will take place on different scales, defined in the earlier introduced Spatial building typology analysis. An additional scale of the neighborhood is added, resulting in the five scales of city, neighborhood, urban block, building object, and building envelope (diagram on the right).

Urban metabolism approach

In the table on the next page, an overview is created with the different topics that will be covered in this urban metabolism analysis of the Archipelbuurt. Two methods are used in the analysis; the grey-box or flow diagram (fd) is used to get an overview of the amount of the flows and the division of components. The other method that is used is mapping (map) to analyse and define the spatial aspects of the flows and cycles.

In the next part of this booklet, the urban metabolism analysis of the Archipelbuurt is conducted.



Different scales of urban metabolism analysis - own drawings

Urban Metabolism Analysis	Water	Energy	Materials	Biotic factors
	<i>groundwater surface water rain water drinking water grey water black water</i>	<i>electricity heat cold greenhouse gasses</i>	<i>biobased non-biobased organic waste inorganic waste</i>	<i>soil plants animals food</i>
City scale		sources of electricity production (fd)		Archipelbuurt green network in relation to larger green networks (map)
Neighborhood scale	waste water network (map) & estimation water usage and waste water (fd)	estimation of electricity and gas usage and related greenhouse gas emissions (fd)		green networks & presence of plants and animals (map)
Urban block	amount of rain water (fd & map)			green networks & presence of plants and animals (map)
Building object	amount of water used and waste water produced (fd)	electricity, heating and cooling demand (fd)	source of new building materials & destination of demolished materials (fd & map)	relation with surrounding nature (map)
Building envelope			source of new building materials & destination of demolished materials (fd & map)	

Table with the different urban metabolism studies for the Archipelbuurt and Eenheidsbureau

11

Research part 2 - urban metabolism

29.11.2021 - 12.12.2021

Urban metabolism Archipelbuurt

Urban metabolism

In the previous chapter, a framework for the analysis of the urban metabolism in the Archipelbuurt in The Hague has been created. In this chapter, the analysis will be performed, starting with the energy, then the water, and last the biotic factors. The material category will be researched during the design process itself as it relates to the construction materials used for the new design and the reusing of the demolished materials.

Data collection

The data that is used to conduct this urban metabolism analysis is all open source and available for everyone. For the data about the amount and area of different functions in the neighborhood the Archipelbuurt the database from Den Haag In Cijfers is used (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, & Dienst Stedelijke Ontwikkeling; 2021).

The data about the usage of energy, gas, and water is a combination of exact data of the municipality about that neighborhood and more general research about the usage for specific functions.

Set up of analysis

Each of the categories will start with an introduction of the topic, describing how the analysis is conducted and how the data is acquired. After the introduction, each category will have a series of flow diagrams or maps ending with a written conclusion per topic. The amount and ratio between flow diagram and map differ per category and is depended on the more suitable way of collecting and visualizing the data.

Energy - introduction

Urban metabolism - energy

For the category energy, a couple of aspects are studied, starting with the heating and cooling demand and the electricity and gas usage of the different buildings in the neighborhood Archipelbuurt. After this, the related greenhouse gas production is calculated. Down below a written explanation of the analysis can be found, which is visualized in diagrams on the next pages.

Heat and cold demand

The heating and cooling demand of the different functions are analysed. The utility buildings their demands have been calculated with the use of a table from a document called *Energiekentallen utiliteitsgebouwen Vesta 2.0* (Leguijt, Schepers, Naber, van den Wijngaart; 2015). Here the hot tap water, space heating, and space cooling demands for the different functions were given per square meter. These numbers are multiplied with the total square meter of area per function and then divided by the number of buildings of that function, to give the demand per building.

Electricity & gas consumption

The yearly electricity and gas usage of the houses of the Archipelbuurt is taken from the database of the municipality with accurate numbers for this neighborhood resulting in an average electricity consumption of 2460 kWh and gas consumption of 1400 m³ (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, Dienst Stedelijke Ontwikkeling, Stafafdeling Programmamanagement, & Strategie en Onderzoek; 2021).

The yearly electricity and gas consumption of the other functions are not included in the database

of the neighborhood and are therefore calculation with average numbers of each function per square meter. These average numbers are taken from a document written by Sipma & Rietkerk (2016) defining the average gas and electricity use for a wide range of utility buildings. These numbers are multiplied by the total square meter of area per function and then divided by the number of buildings of that function to give an average yearly consumption of gas and electricity per building of each function.

Electricity production

In the Archipelbuurt there are 1909 m² of solar panels installed on roofs, which will produce around 286.350 kWh yearly (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, Dienst Stedelijke Ontwikkeling, Stafafdeling Programmamanagement, & Strategie en Onderzoek; 2021).

The rest of the electricity is produced by different electricity suppliers. There was no data available on how the electricity specifically for the Archipelbuurt was produced, so the ratio of production methods of the Netherlands was used to determine the source. The different sources are gas, coal, other, wind, sun, biomass (CBS, 2021a) (CBS, 2021b).

Greenhouse gasses

For the greenhouse gas emissions CO₂, CH₄, and N₂O are expressed as CO₂ equivalence. The greenhouse gasses that are generated during the production of electricity are calculated with numbers from this research by Louwen (2011). This gives the amount of CO₂ per kWh of electricity produced with natural gas (464.61 g CO₂ eq / kWh)

and coal (984.86 g CO₂ eq / kWh). The greenhouse gas emissions of biomass are calculated as well resulting in 49 g CO₂ eq / kWh (Spath & Mann, 2004).

The burning of natural gas inside the building itself, either with a gas boiler or during cooking, also produces greenhouse gasses. For this calculation, a CO₂ emission of 1.8 kg per m³ gas is used (Zijlema, 2020).

Vision Energy transition

The municipality of The Hague has created a vision document in order to make the energy transition by moving away from gas and using sustainable sources for energy (Gemeente Den Haag, 2020). A short summary of the relevant items for the Archipelbuurt will be given.

The most important aspect is the scale that The Hague wants to tackle the challenge on; the neighborhood scale. This ties in closely with the chosen scale for this re-design project. Based on a first study the municipality is thinking of creating a heat network with a low-temperature source in the Archipelbuurt.

The first focus of the vision is to insulate the houses. In the Archipelbuurt the following energy labels are present (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, Dienst Stedelijke Ontwikkeling, Stafafdeling Programmamanagement, & Strategie en Onderzoek; 2021):

Label A ⁺ - A ⁺⁺⁺ :	0
Label A:	122
Label B:	375

Label C:	573
Label D:	305
Label E:	343
Label F:	820
Label G:	1.141
Label unknown:	24

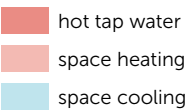
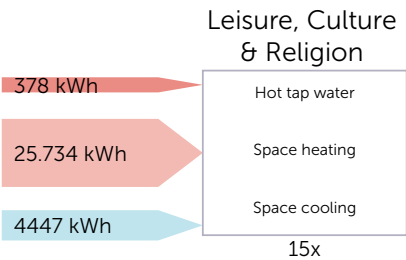
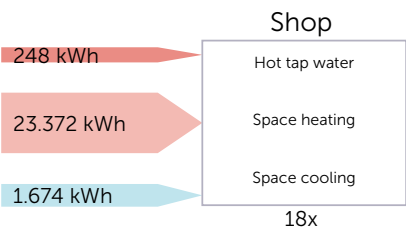
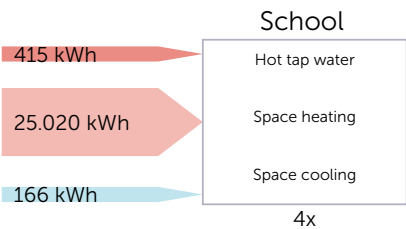
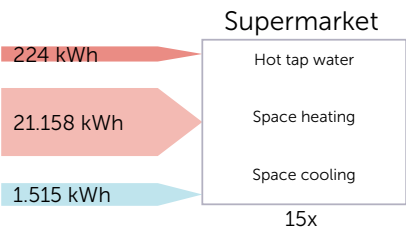
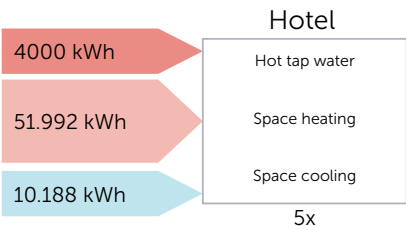
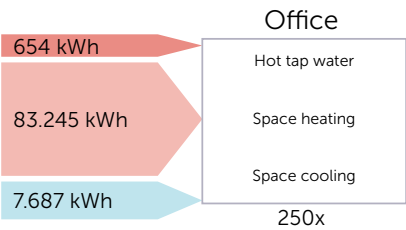
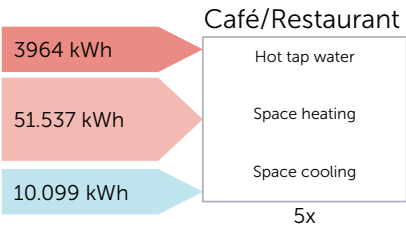
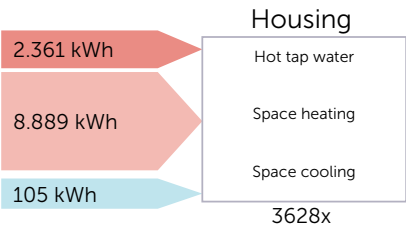
As can be seen from this list, is that a large amount of buildings has a low energy label, meaning a high loss of energy.

The municipality has defined different methods for the sustainable production of the energy, these are; geothermal (winning heat from the soil to supply a high-temperature heat to be used for the buildings where insulation is not easily installed), aqua thermal (gaining heat from surface water, wastewater, and sewage water supplying a low-temperature heat more suitable for well-insulated buildings), solar (either on a small or larger scale using the sun to produce electricity and heat), and wind (the least favorable option for The Hague because of its density and lack of space for windmills).

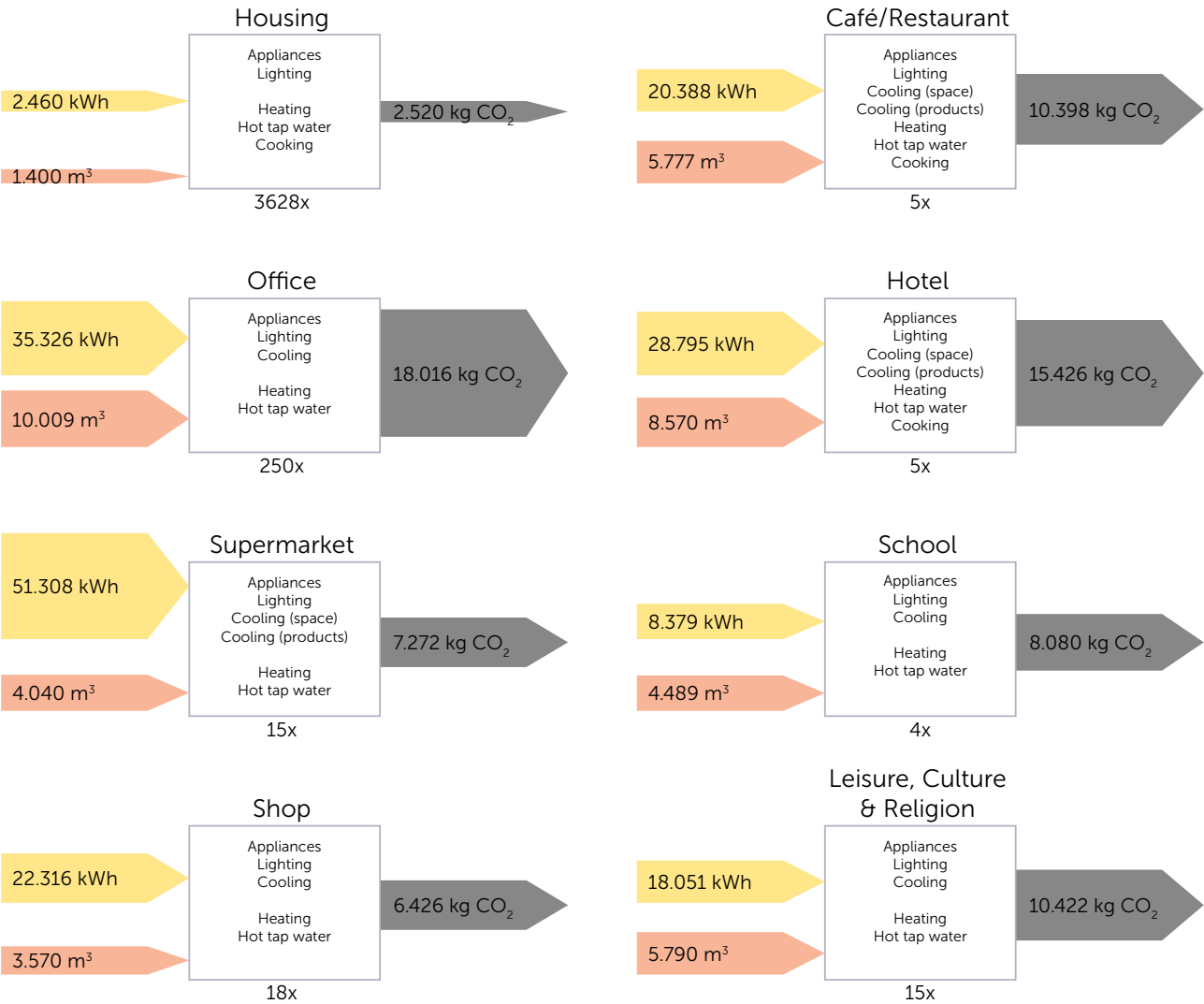
The Hague also recognizes the importance of storage of energy as the demands often do not align with the production times of sustainable energy. Both individual, as well as larger communal, storage methods are encouraged for both electricity, heat, and cold.

On the next pages, the urban metabolism study of energy in the Archipelbuurt is visualized in the form of diagrams and drawings.

Energy - heat and cold demand

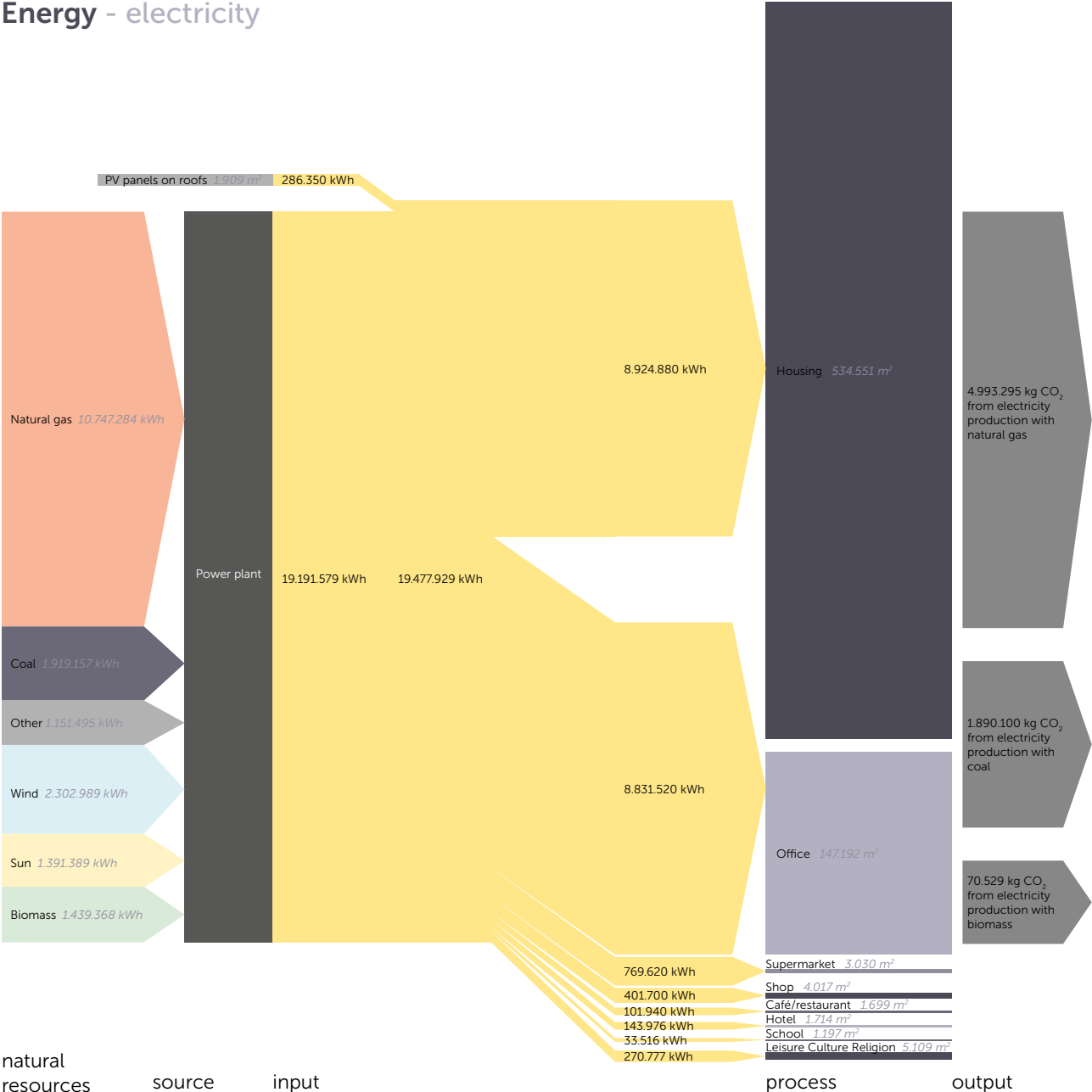


Energy - electricity & gas usage

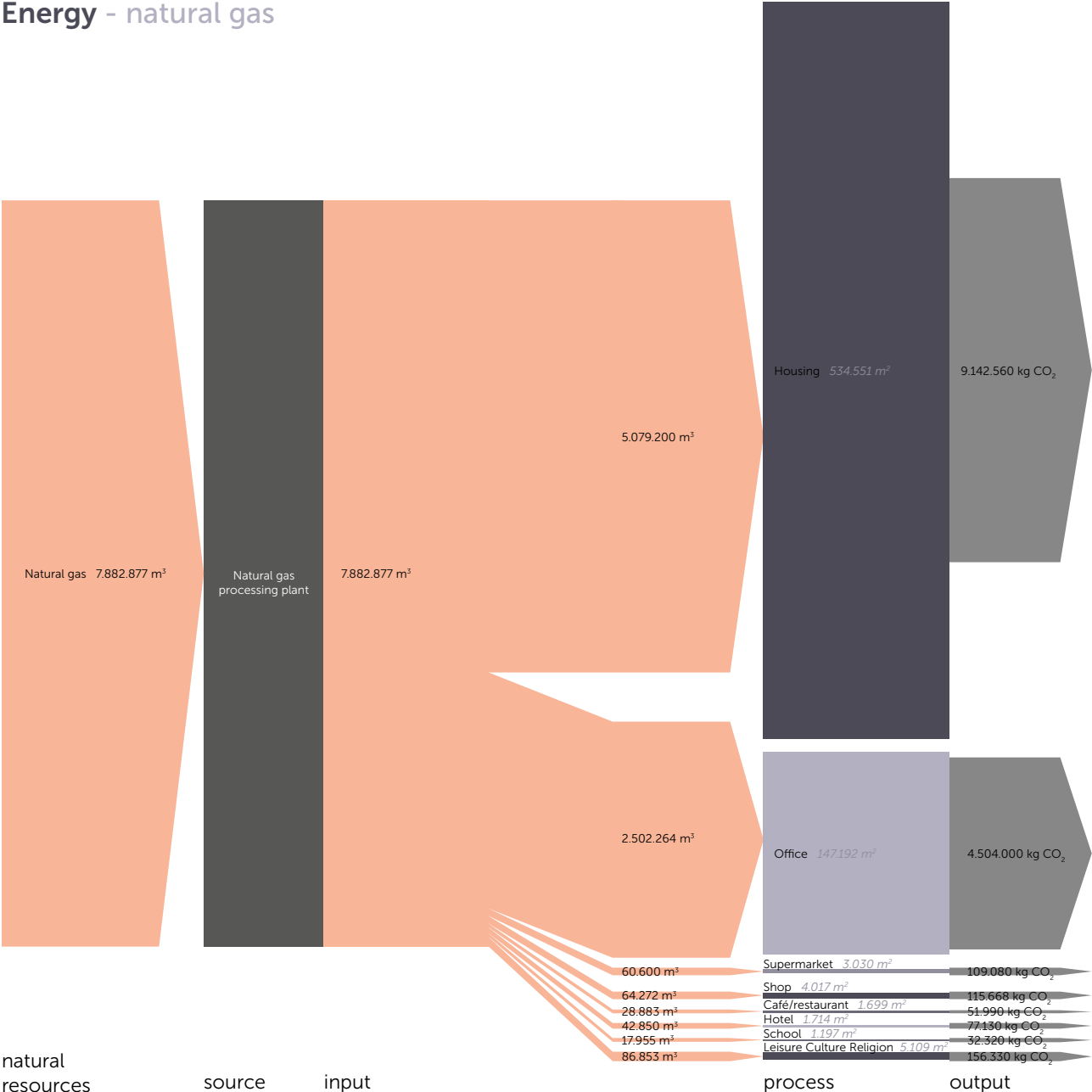


■ natural gas
■ electricity
■ CO₂ from cooking and gasboiler

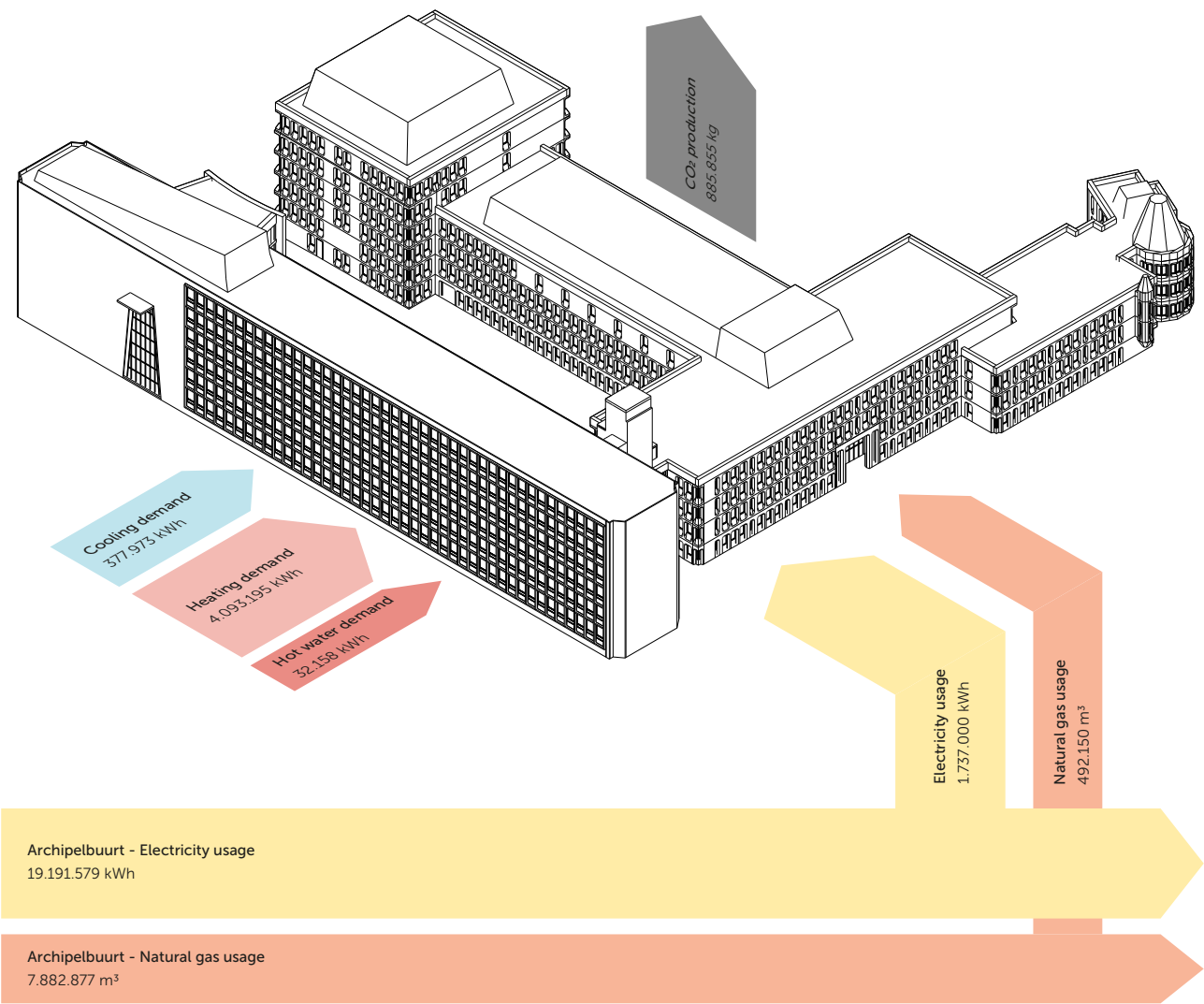
Energy - electricity



Energy - natural gas



Energy - Eenheidsbureau



Energy - conclusion

Heating and cooling demands

For the urban metabolism of the category energy, different aspects have been researched. Starting with determining the space heating, space cooling, and hot tap water demand for the different functions in the neighborhood. The highest demand was that of the space heating followed by the cooling and hot water demands. This research was closely related to the analysis of energy labels in the neighborhood. The police station itself has an energy label of G, which is the lowest label possible. There is no insulation in the building and as the facade exists of concrete panels a lot of thermal bridges are present. The estimated demands are illustrated on the drawing on the left.

Electricity and gas usage

Another aspect that was researched was the electricity and natural gas usage in the neighborhood for the different functions. The offices were one of the functions with on average the highest consumption of both these resources. The specific demands for the Eenheidsbureau are given in the diagram on the previous page. The production of electricity in the Netherlands mostly still comes from unsustainable sources like natural gas and coal, there is however a rise in the contribution of sustainable energy sources. The natural gas in the buildings is used for heating up the water for space heating and hot tap water and for cooking. The CO₂ that is produced with this burning of the natural gas inside the building is indicated on the drawing on the left.

Energy transition

The municipality of The Hague has created a vision for the transition towards sustainable

energy focusing on geothermal, aqua thermal, and solar energy. Either locally or more communal produced. The municipality recognizes the importance of storage of the energy as the production time does not always meet the highest demand time. Opportunities for this storage can be explored with this building for the neighborhood scale, which follows the vision of The Hague for the neighborhood energy plans.

The building could participate in the production of the required energy in the neighborhood, but more importantly, it could function as a storage for electricity, heat, and cold in order to balance the production with the demand and relieve the overloaded electricity network.

Water - introduction

Urban metabolism - water

The urban metabolism study of water starts with the water flows of the different functions in the Archipelbuurt. It determines the input (water consumption) and the output (wastewater) per year. Then these separate functions are combined and scaled based on the amount of area in the neighborhood into a flow diagram of all the water in the Archipelbuurt. After this, more spatial aspects are researched like the sewage system and the rainwater on the land. The study ends at the building scale of the Eenheidsbureau with a conclusion. Down below a written explanation of the analysis can be found, which is visualized in diagrams on the next pages.

Water flow house

For the water flow of houses this document from Vewin (2020), the association of water companies in the Netherlands, is used, which gives the water consumption of 120L per person per day, divided over different categories from showering to toilet use. This number is multiplied by the average household number which is (6.090 inhabitants / 3.628 houses) 1,68 resulting in a water consumption of 73.500L per house. The wastewater from the toilet is considered black water, all other wastewater is considered grey water.

Water flow office

For the water flows of the offices, a table from a Waterwerkblad (InfoDWI, 2015) is used. This describes a water usage of 20L per employee per day. According to the database of the Archipelbuurt (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, & Dienst Stedelijke Ontwikkeling; 2021) there are around 4.000

employees divided over 250 offices, resulting into (20L x 4.000 employees x 365 days / 250 offices) 116.800L per office. 16L of the 20L per day is for flushing toilets (Amsterdam Rainproof) and will therefore be considered black water, the rest of the wastewater is considered grey water.

Water flow supermarket & shop

The water flow of the supermarkets and shops is also taken from the table of the Waterwerkblad (InfoDWI, 2015), describing 25L per employee per day. The database of the Archipelbuurt (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, & Dienst Stedelijke Ontwikkeling; 2021) estimates the employees working in shops, hotels, and restaurants at 420 divided over 42 buildings resulting in an average of 10 workers per shop. This gives a water consumption of (25L x 10 employee x 365 days) 91.250 per shop. The grey and black water are calculated by taking the same ratio as the office building between the grey (20%) and black (80%) water.

Water flow café/restaurant

Again the Waterwerkblad (InfoDWI, 2015) is used giving a water consumption of 20L per costumer per day. From the 1700m² of restaurant area in Archipelbuurt (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, & Dienst Stedelijke Ontwikkeling; 2021) about 60% of that area will be used for costumers (Hofman, 2020) which is 1.020m² resulting in 100 costumers on average per day divided over 5 restaurants. The water consumption is then (20L x 100 costumers x 365 days / 5) 146.000L with the same ratio as the office building between the grey (20%) and black (80%) water.

Water flow hotel

For the water consumption of hotels, a table from SenterNovem (2007) is used resulting in 150L per guest per day. The hotels of the Archipelbuurt combined have 80 beds divided over 5 hotels. With an occupancy of 60%, this means 10 beds per hotel resulting in a water consumption of (150L x 10 guests x 365 days) 547.500L with the grey (70%) and black (30%) ratio similar to housing.

Water flow school

The water flow of schools are calculated with the Waterwerkblad (InfoDWI, 2015), giving 10L per student. With 1200m² of school area (DHIC, Centraal Bureau voor de Statistiek, Gemeente Den Haag, & Dienst Stedelijke Ontwikkeling; 2021) the Archipelbuurt houses around 340 students (Overheid.nl, n.d.) divided over 4 schools. The water consumption is (10L x 340 students x 365 days / 4 schools) 310.250L with the same ratio as the office building between the grey (20%) and black (80%) water.

Water flow leisure, culture & religion

The water consumption of leisure, culture & religious buildings, taken the same as schools, 10L per user per day (InfoDWI, 2015). With 1000 users per day divided over 15 institutions, the water consumption is (10L x 1000 users x 365 days / 15) 243.000L with the same ratio as the office building between the grey (20%) and black (80%) water.

Water flow Archipelbuurt

These water flows of the different functions are combined into a total water flow diagram of the Archipelbuurt. The water used in the neighborhood is treated by Dunea and taken from the dunes (Dunea, n.d.).

Sewage systems

To remove all the wastewater from the buildings, there is a network of sewage systems. The most common type of sewage system in the Archipelbuurt is the mixed sewage pipe, which collects both grey, black, and rainwater. Only in a small part, there is a separate system with a waste sewage pipe for grey and black water and a separate pipe for rainwater which is connected to surface water nearby (Gemeente Den Haag, n.d.).

Rainwater

The amount of rainwater is calculated on three different scales and with different intensities of rainwater (Stichting RioNed, n.d.).

normal rain:	0.1 L - 3 L per m ²
heavy rain (1% of time):	3 L - 10 L per m ²
yearly:	800 L per m ²

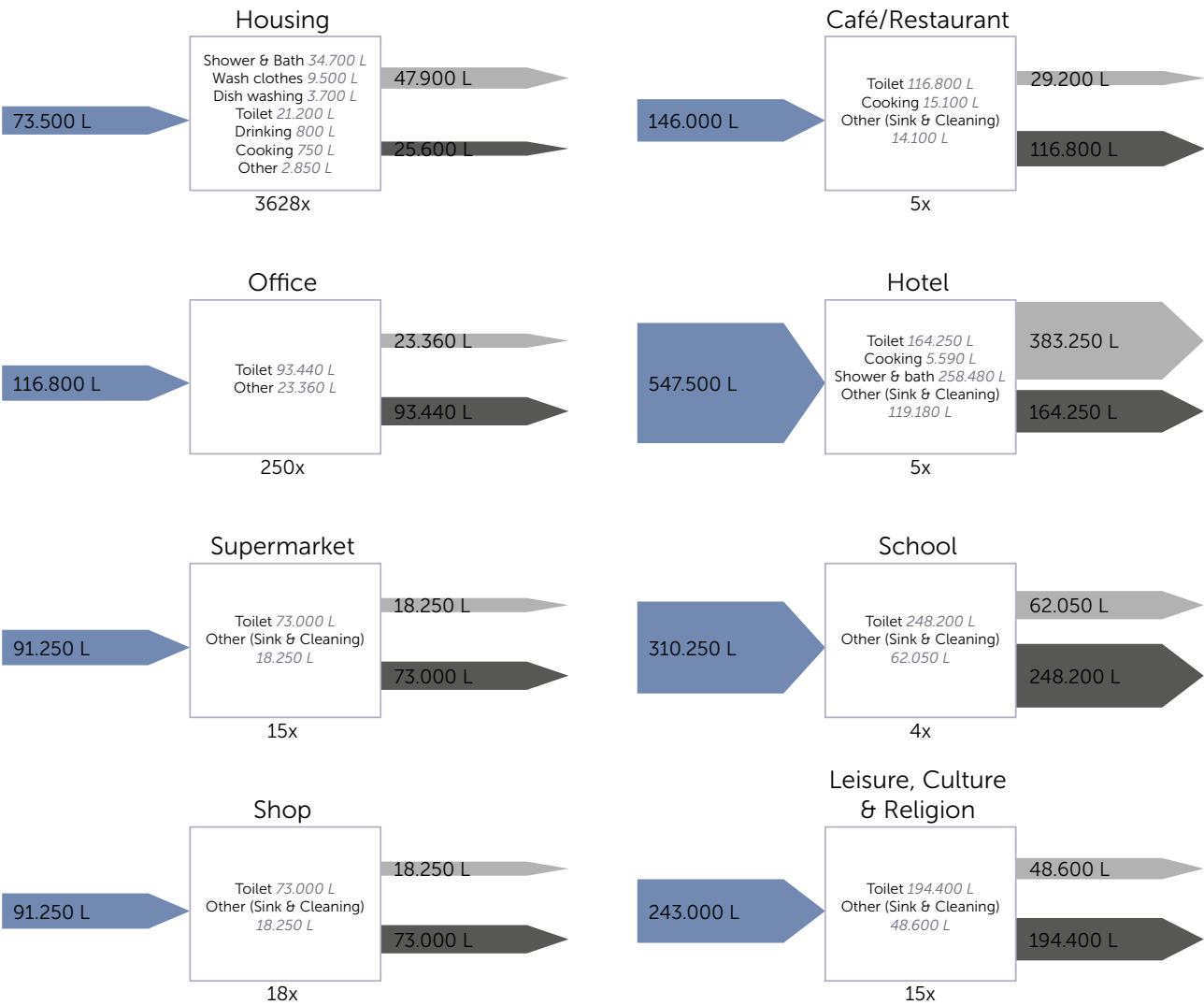
Neighborhood (838.000m ²):	
normal rain:	2.514.000 L
heavy rain:	8.380.000 L
yearly:	670.400.000 L

Entire plot (22.530 m ²):	
normal rain:	67.590 L
heavy rain:	225.300 L
yearly:	18.024.000 L

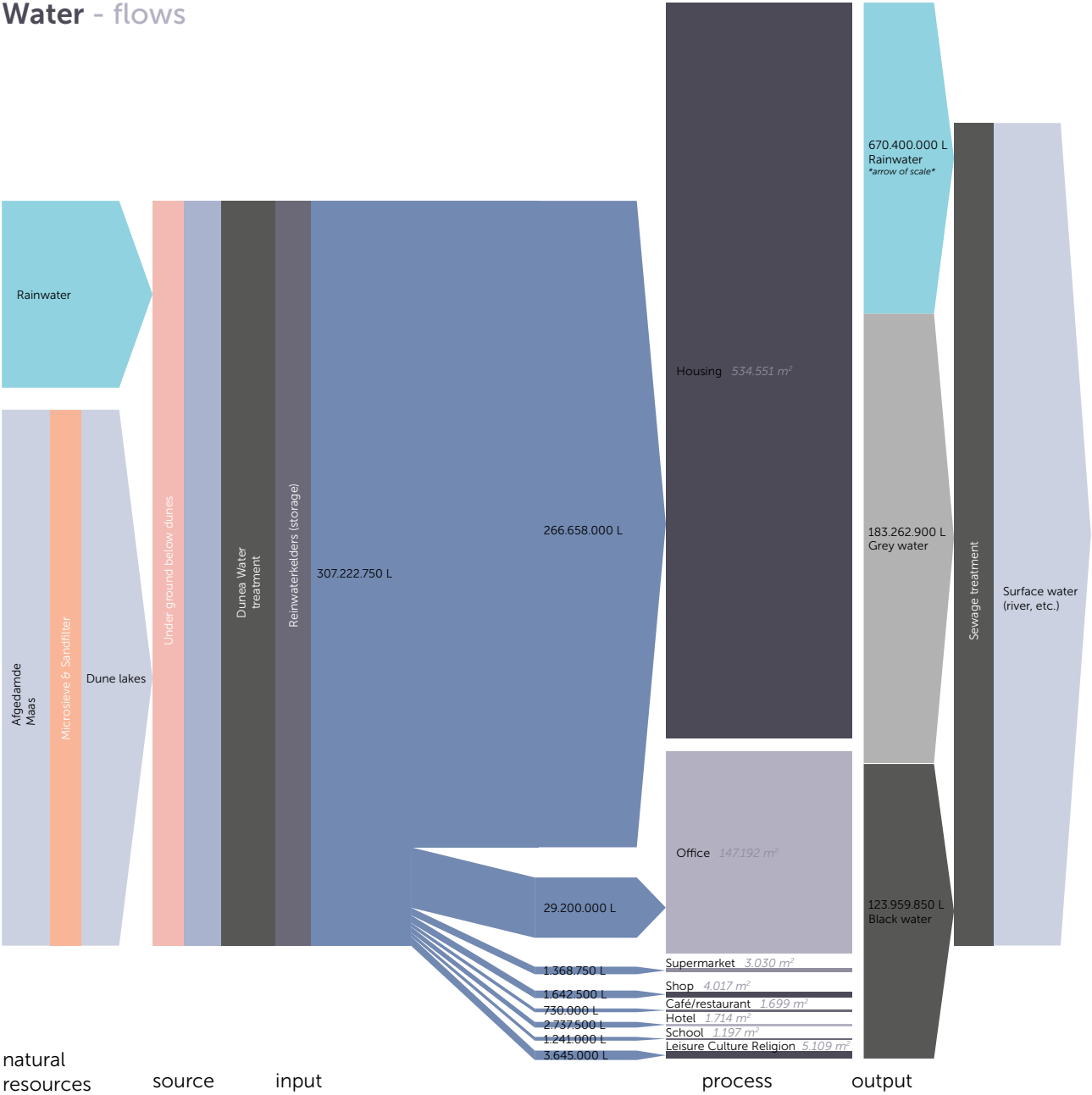
Roof building (6.000 m ²):	
normal rain:	18.000 L
heavy rain:	60.000 L
yearly:	4.800.000 L

On the next pages, the diagrams of the water flows and maps can be found.

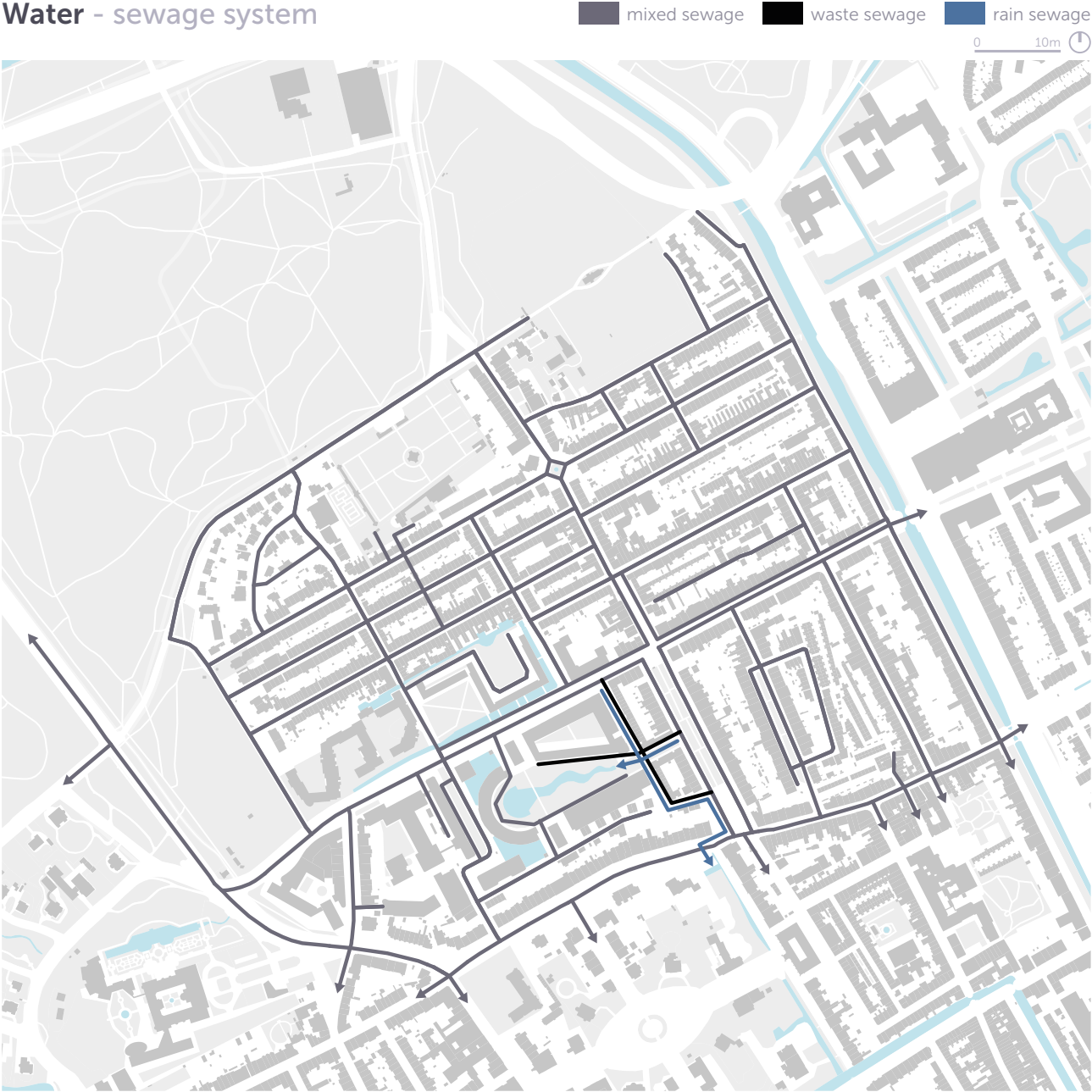
Water - flows



Water - flows



Water - sewage system



Water - rainwater



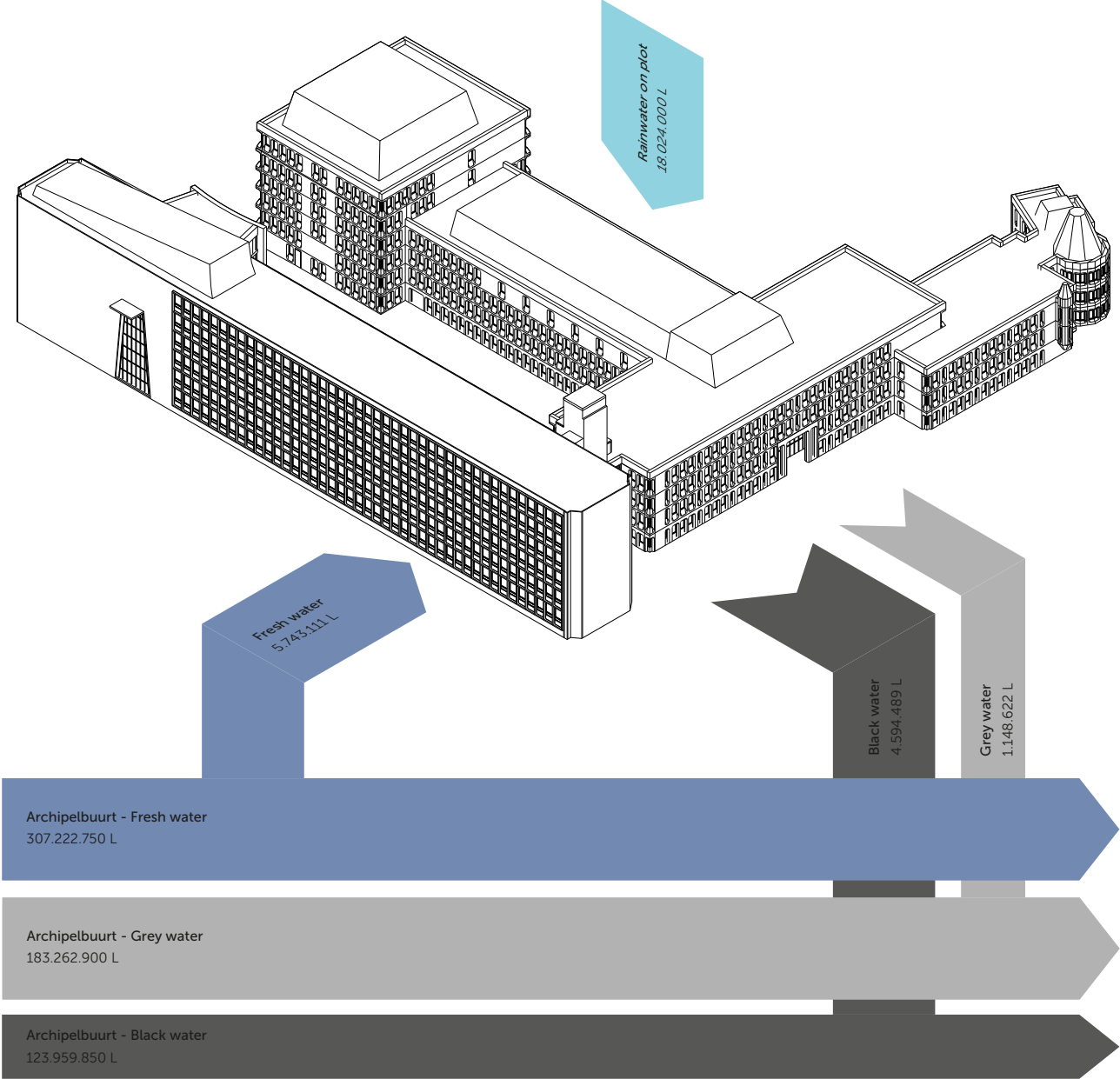
Neighborhood (838.000m²):
normal rain 2.514.000 L
heavy rain 8.380.000 L
yearly 670.400.000 L

Plot (22.530 m²):
normal rain 67.590 L
heavy rain 225.300 L
yearly 18.024.000 L

Roof building (6.000 m²):
normal rain 18.000 L
heavy rain 60.000 L
yearly 4.800.000 L



Water - Eenheidsbureau



Water - conclusion

Water

The urban metabolism study of the water in the neighborhood the Archipelbuurt analyzed the water flows of the different functions. The water used in the neighborhood is treated by Dunea and taken from underground lakes at the dunes.

Wastewater

The wastewater flows are divided into two categories; grey water and black water. This division is made based on the method of recycling and filtering of the water. The black water consists of the wastewater from the toilet. The grey water consists of all the other wastewater from a building.

Currently, all wastewater and even rainwater are collected into a mixed sewage system. This mixed system does however have a higher chance of overloading especially during heavy rainfall. It also is a waste of energy as clean rainwater is treated together with the wastewater. In some parts of the neighborhood a separate sewage system is installed, where the rainwater and the sewage water are separately collected in different pipes. The rainwater is brought to nearby surface water, while the wastewater from buildings goes to a sewage treatment.

Eenheidsbureau

The fresh water usage of the police station is estimated in the drawing on the left. As this building is currently used as an office, there is a larger production of black water from the toilets compared to the grey wastewater. The yearly rainfall on the whole plot is also indicated in the drawing.

The amount of rainfall per year is triple the amount for the current demand of fresh water, showcasing that with the proper storage methods a lot of the demand of fresh water can be met with rainwater (rainwater is allowed for cleaning, irrigation, and flushing toilets).

Both grey and black water can be treated locally in order to filter the water and reuse it again for cleaning, irrigation, or flushing the toilet. For this to happen on a larger neighborhood level, an urban intervention is needed where the current mixed sewage pipe is replaced by separate pipes for grey water, black water, and rainwater.

If this urban intervention would take place, the police station could become a local water treatment in order to filter and reuse the wastewater, reducing the pressure on sewage treatments and helping out Dunea, which is experiencing increasing shortages of fresh water. Another important role that this building could play is the storage of rainwater, relieving the urban rain network and creating a buffer for more frequent droughts.

Biotic factors - introduction

Urban metabolism - biotic factors

The biotic factors are analysed on four different scales; the city scale, the neighborhood scale, the urban block scale, and the building object scale. For this urban metabolism analysis both the fauna and flora are researched with the use of maps from the Gemeente Den Haag (2017). Down below a written explanation of the analysis can be found, which is visualized in drawings on the next pages.

City scale

The urban metabolism analysis of the biotic factors starts with research into the different types of green in the city of The Hague and the immediate surroundings. The city is on two sides connected to Natura 2000 area, which is highly protected nature with a great amount of biodiversity. The city itself has a patchwork of a variety of smaller and larger green areas. These green areas differ from grass fields to parks full of trees. These patches of greenery are connected with ecological corridors throughout the city. In this way, the greenery forms a connected network so that humans and animals can freely travel from one green area to the other.

In the next analysis, the birds in the city are the focus points. Two types of birds are analysed; the swift (gierzwaluw) and the house sparrow (huismus). An interesting finding is that the nests of these birds are mostly located in urban settings and less in the green parks. Another animal that is analysed is the bat, where both the nests and the flying routes have been documented. Most of the flying routes of the bats are between the different parks, whereas the nests are spread over the entire city.

Neighborhood scale

On the neighborhood scale, the different kinds of greenery are analysed. The neighborhood the Archipelbuurt is surrounded on two sides by public parks with lots of trees and biodiversity. There are also three cemeteries in the neighborhood which exist of a mix of grass fields, small bushes, and trees. The other border of the neighborhood is a canal with a line of trees on both sides, forming an essential ecological corridor for the fauna. There are two private green areas, one of which is the gardens of the Peace Palace with an abundance of flowers, small bushes, grass fields, and trees. The other private green area is Plein 1831, which houses some ambassies and other functions surrounded by grass, small bushes, and old monumental trees. The last type of greenery in the neighborhood are the collective green areas around buildings. These areas are open to the public but will mostly be used by the inhabitants of the building. Couperusduin and the Burgemeester de Monchypark are the two largest of these collective areas. The Couperusduin gardens are inspired by the dune landscape, whereas the Monchypark has a large area of surface water surrounded by grass and trees.

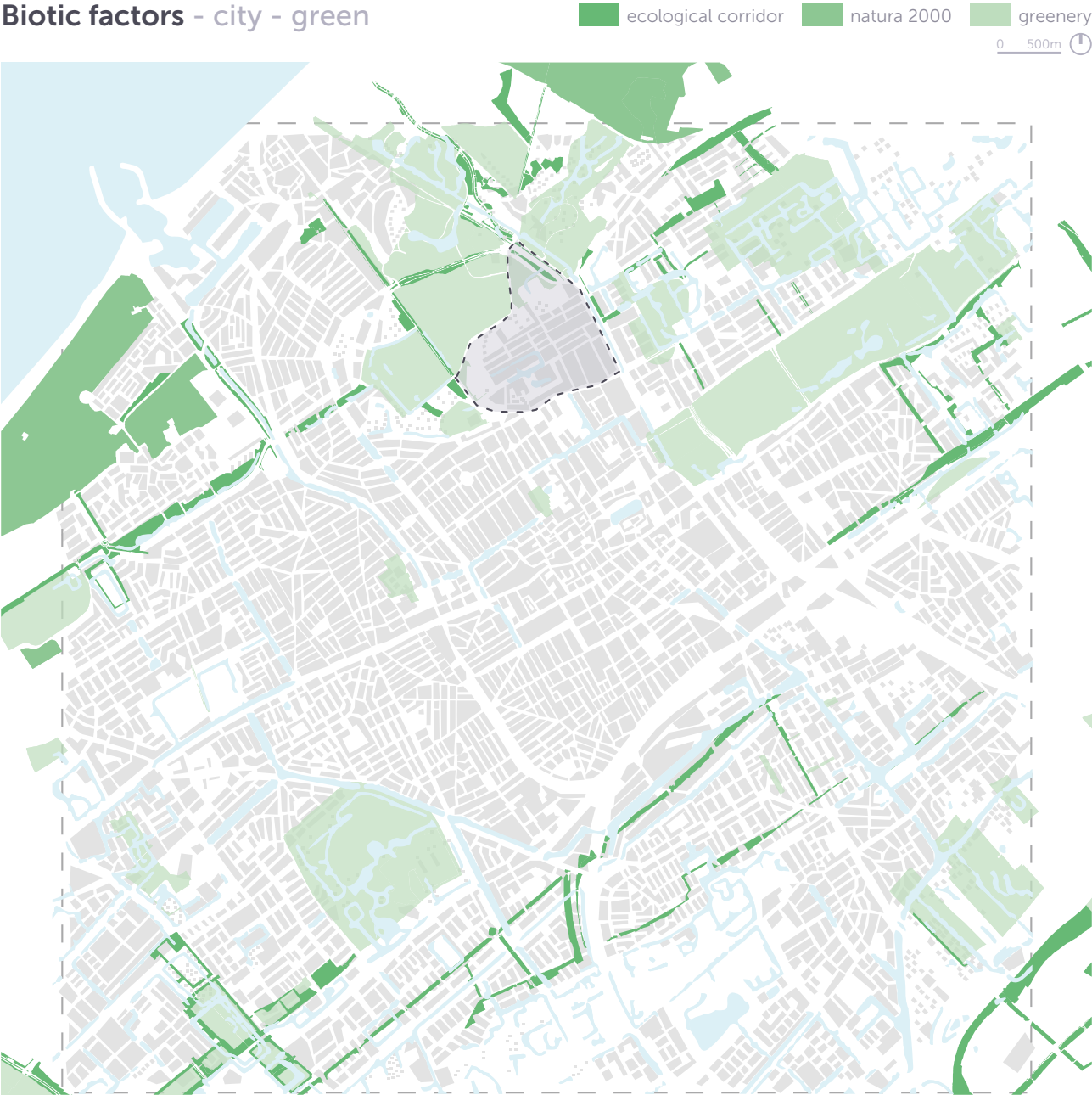
Urban block scale

On the urban block scale, the trees in the surroundings are carefully mapped, creating a drawing that gives a good overview of the nearby trees of the urban block.

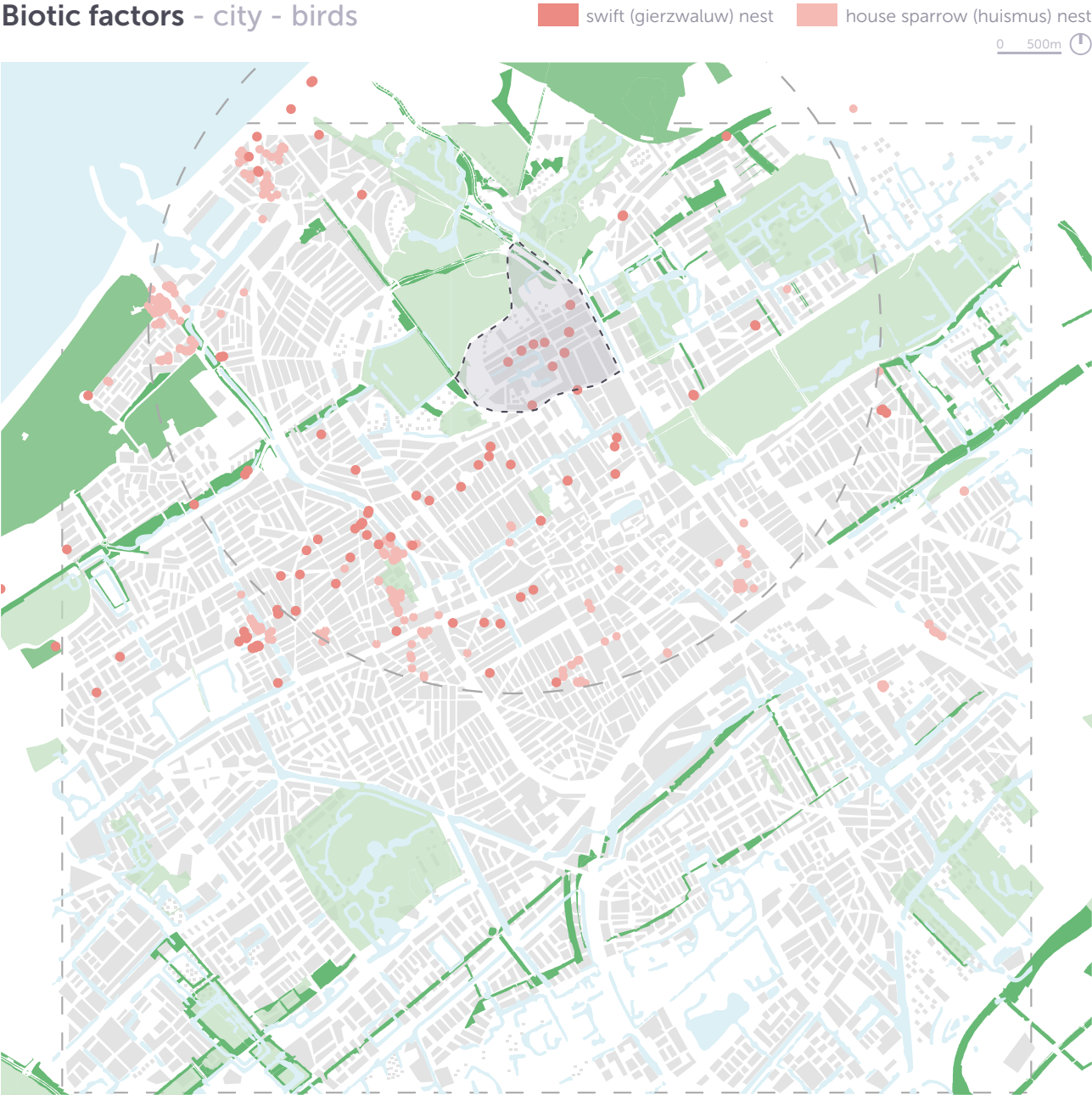
Food

Food is another biotic factor, but will later in the design process be researched in detail.

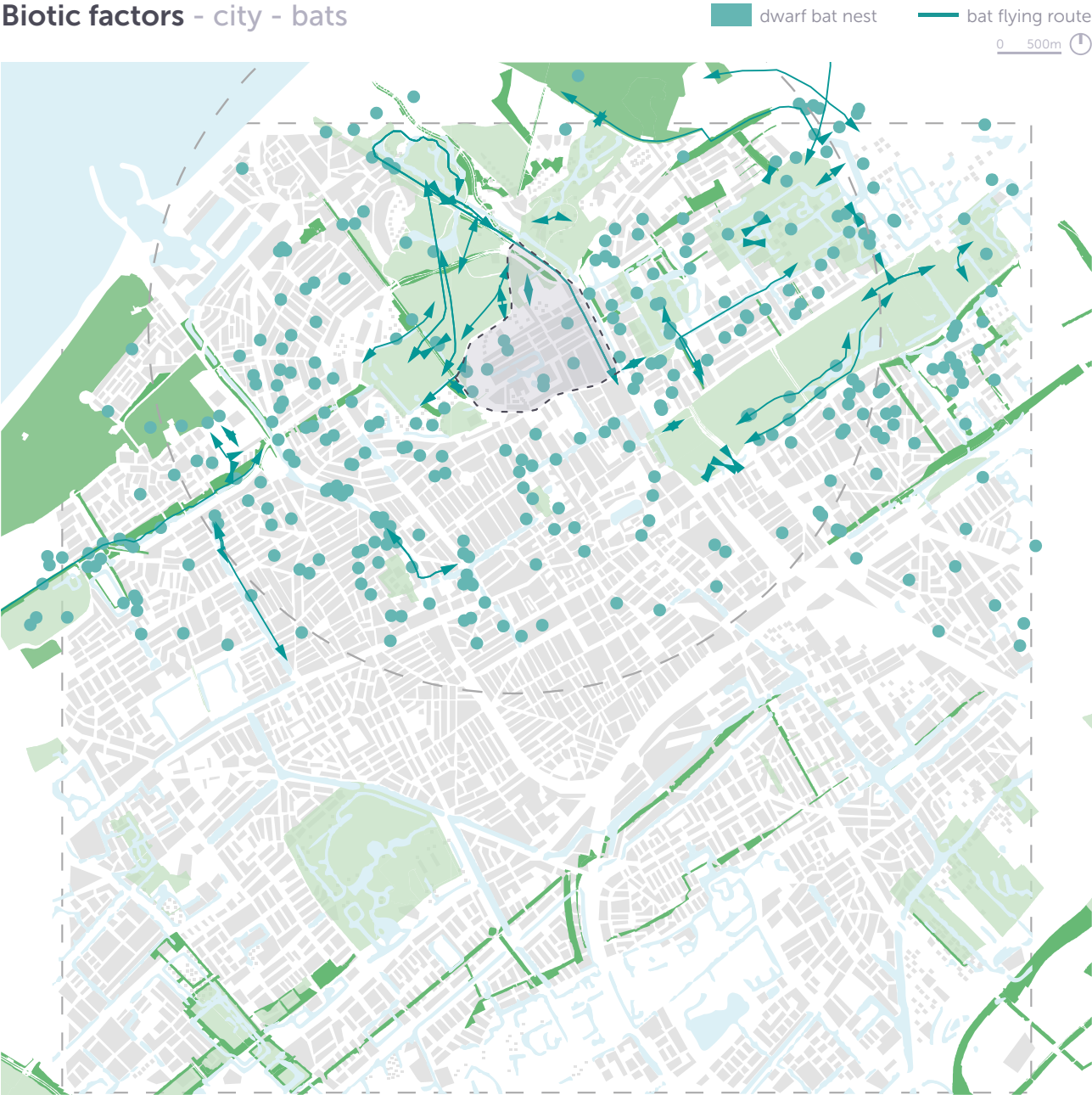
Biotic factors - city - green



Biotic factors - city - birds



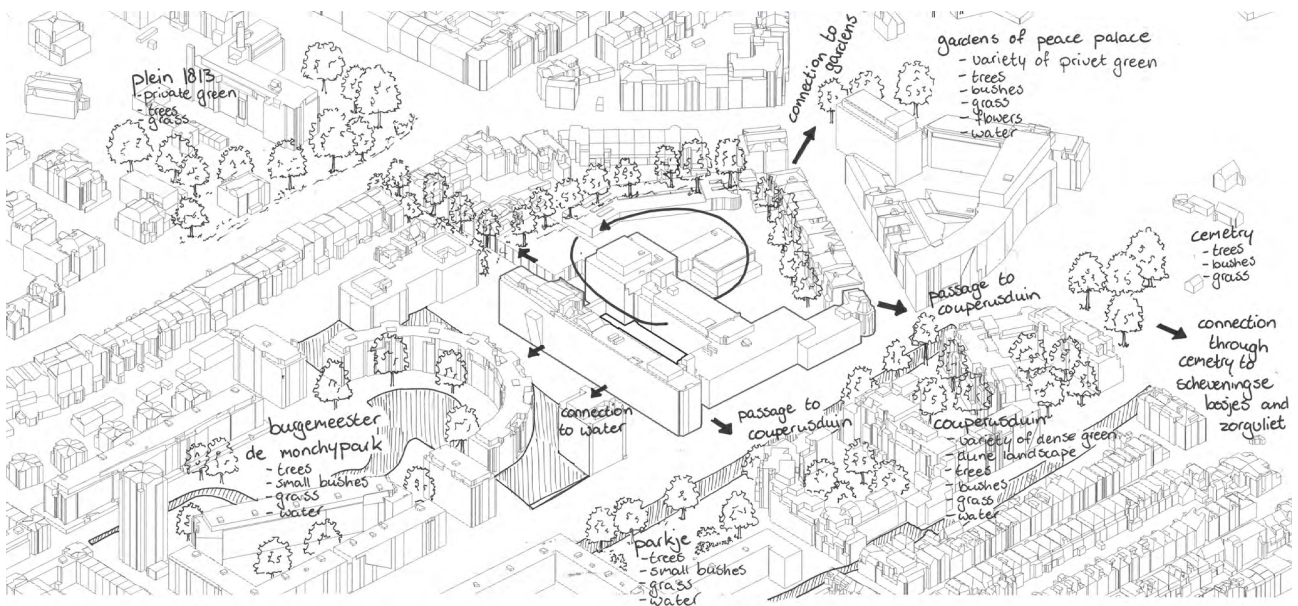
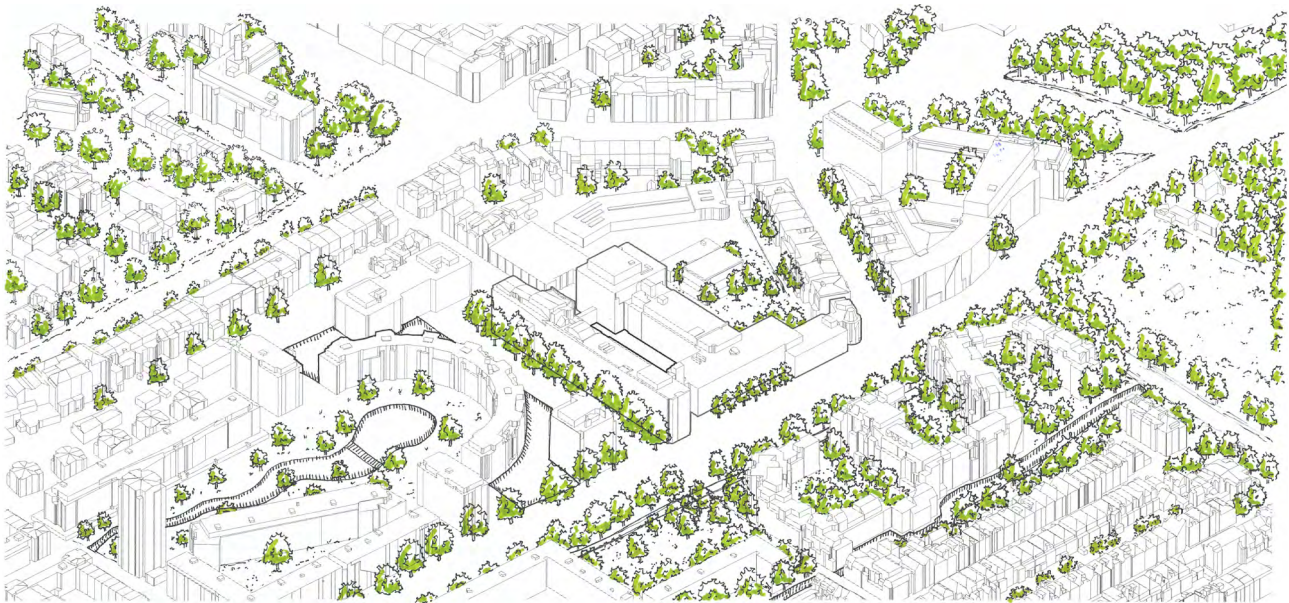
Biotic factors - city - bats



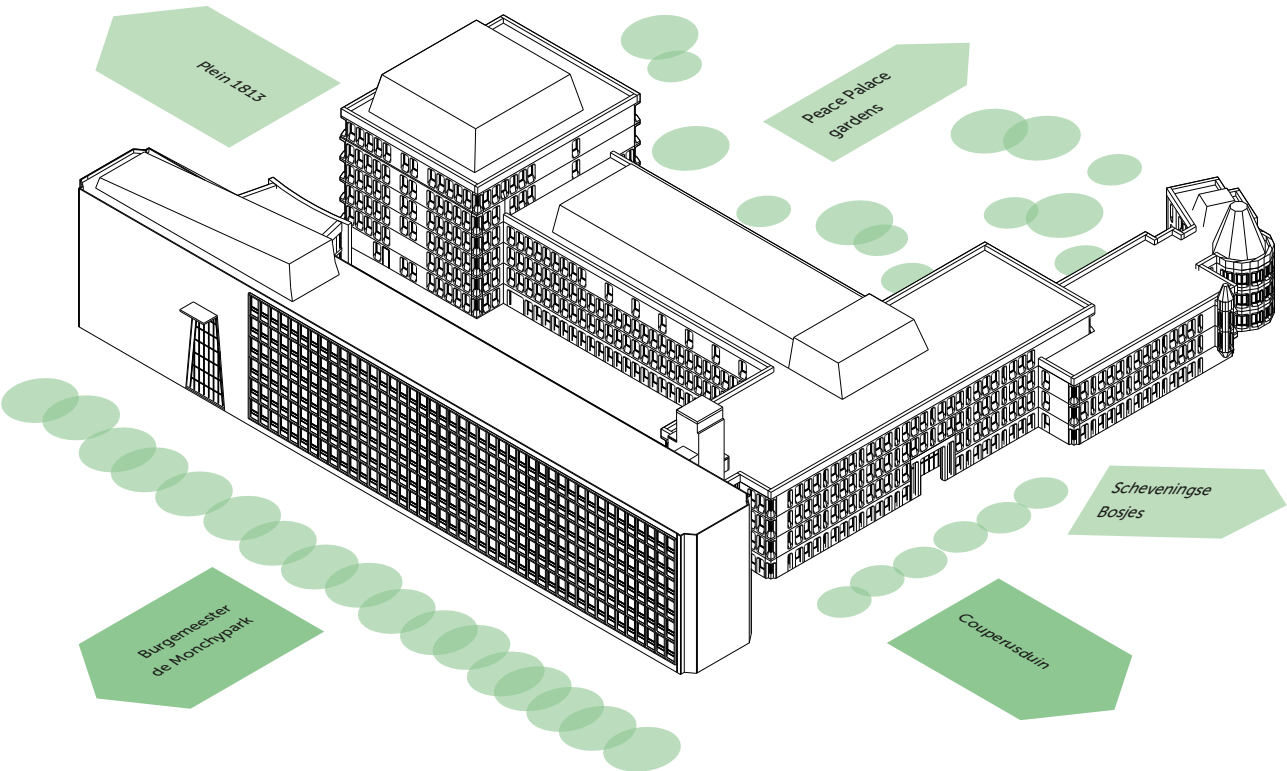
Biotic factors - neighborhood - green



Biotic factors - urban block - trees



Biotic factors - Eenheidsbureau



Biotic factors - conclusion

Ecological networks

Based on the urban metabolism analysis of the biotic factors, it can be concluded that The Hague exists of a patchwork of green areas connected to each other and to the two Natura 2000 areas with ecological corridors, creating a large connected network. There are however still areas that are not as well connected as other, creating gaps and dead-ends in the network.

Fauna

These ecological corridors form important routes along which fauna travels through the city. The city The Hague and especially the surroundings of the Archipelbuurt house a lot of bird and bat nests. In order to further improve the biodiversity of the fauna living in and around the city, these natural routes of the animals must be strengthened.

Food production

As explained in the introduction of this chapter, the food production will be later in the process further developed and researched, but it is mentioned here as it will form an important link between the users of the building and the natural environment with its biotic factors.

Eenheidsbureau

The police station is located near one of the largest parks of The Hague (Scheveningse Bosjes). The police station, therefore, forms an important link in the ecological network. Currently, however, the Eenheidsbureau is a dead-end and does not connect the surrounding green areas in the neighborhood with the larger public park.

By improving its function as a crossing point of the ecological networks in the surrounding,

it can strengthen the connection between the surrounding smaller green areas and the large public park. The police station can in almost all directions be connected to a surrounding ecosystem, with the right architectural and urban interventions.

This was the last category of the urban metabolism research. In the following chapter different case studies will be analysed to research how these existing flows can be transformed so that symbiotic relationships arise and cycles are closed.

12

Research part 3 - case studies

13.12.2021 - 19.12.2021

Case study research

Goal of case study research

The goal of the case study research is to analyse situations where cycles are closed and symbiotic relationships are created. This research will then be used to create design guidelines and result in a transformation framework for the urban metabolism aspect. The analysis will define the different elements that are used by the case study to close the cycles, when available quantitative data will also be included.

Chosen case studies

The three chosen case studies for this analysis are ReGen Village from Effekt architects (2016), de Ceuvel in Amsterdam from Metabolic, and Schoonschip in Amsterdam from Metabolic (Metabolic, 2013). These case studies have been chosen because they are all communities with closed cycles and symbiotic relationships. Next to that proper data and information were available for these case studies in order to make this analysis.

In the future design process, more case studies will be conducted on smaller aspects, like specific systems or cycles. For these case studies, this database of Cyclifier can be used (cyclifier, n.d.). This website includes lots of projects where cycles were closed by buildings, these buildings are called cyclifiers.

Cyclifier

The goal of the re-design of the police station is to transform it into a cyclifier; a building that facilitates a new connection between excess resource flows in the neighborhood. This is also based on the new stepped strategy of Andy van den Dobbelsteen where the reusing of cycles is a key aspect (van den Dobbelsteen, 2008).

Since the case studies mainly focus on housing, also other research is used on combining different functions. This research has been conducted on heat and energy cascades in order to close cycles (Tillie, Van den Dobbelsteen, Doepel, de Jager, Joubert & Mayenburg; 2009).

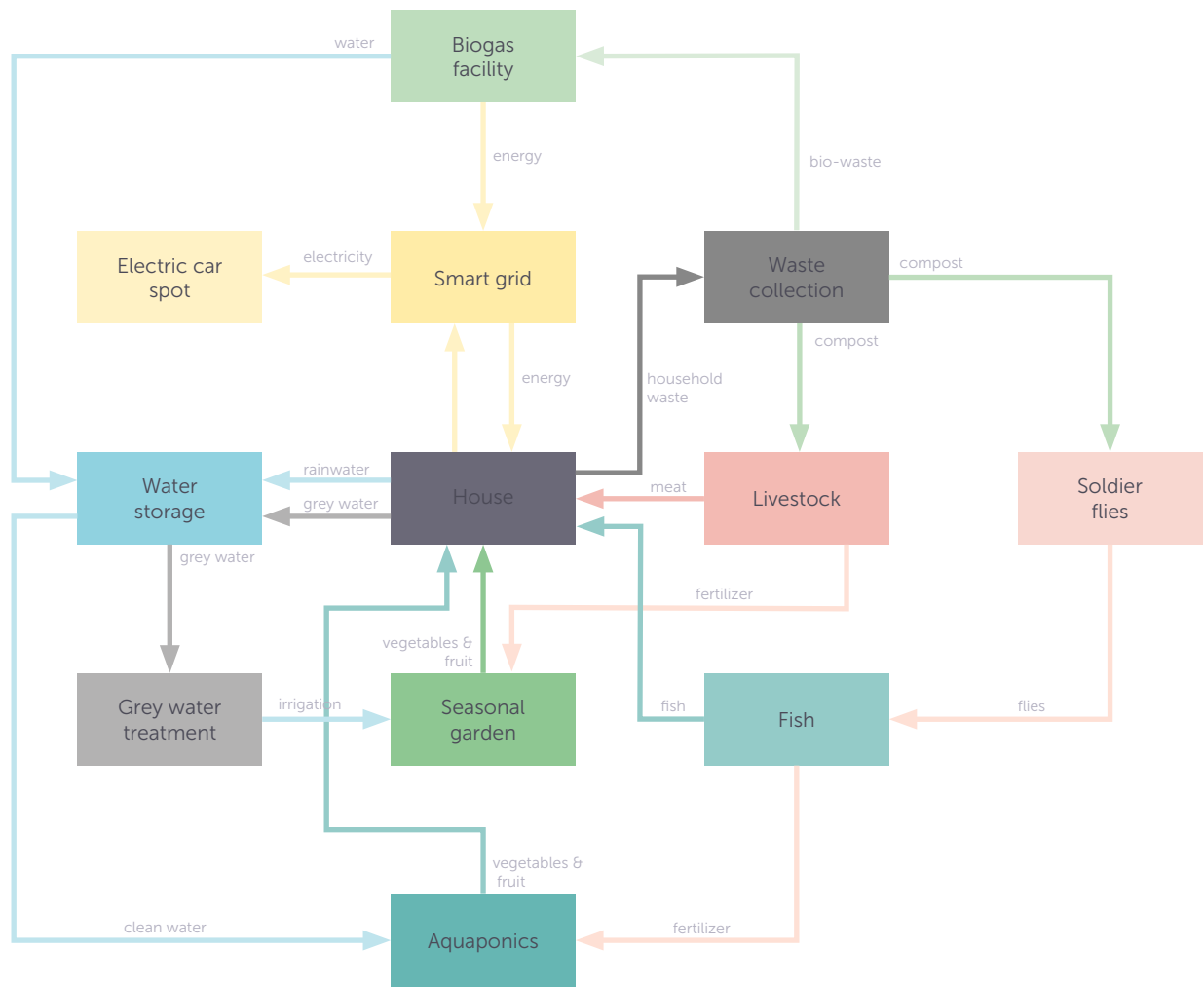
Transformation framework

The outcome of the case study research (conducted on the next three pages) will result in a transformation framework to guide the urban metabolism aspect of the re-design.

Some reoccurring elements in the analysis are the *production of energy* connected to *energy storage* (electricity / heat / cold). There is *water treatment* (grey water / black water) with *water storage*. And there is an *organic waste treatment* used for fertilizing the *food production*.

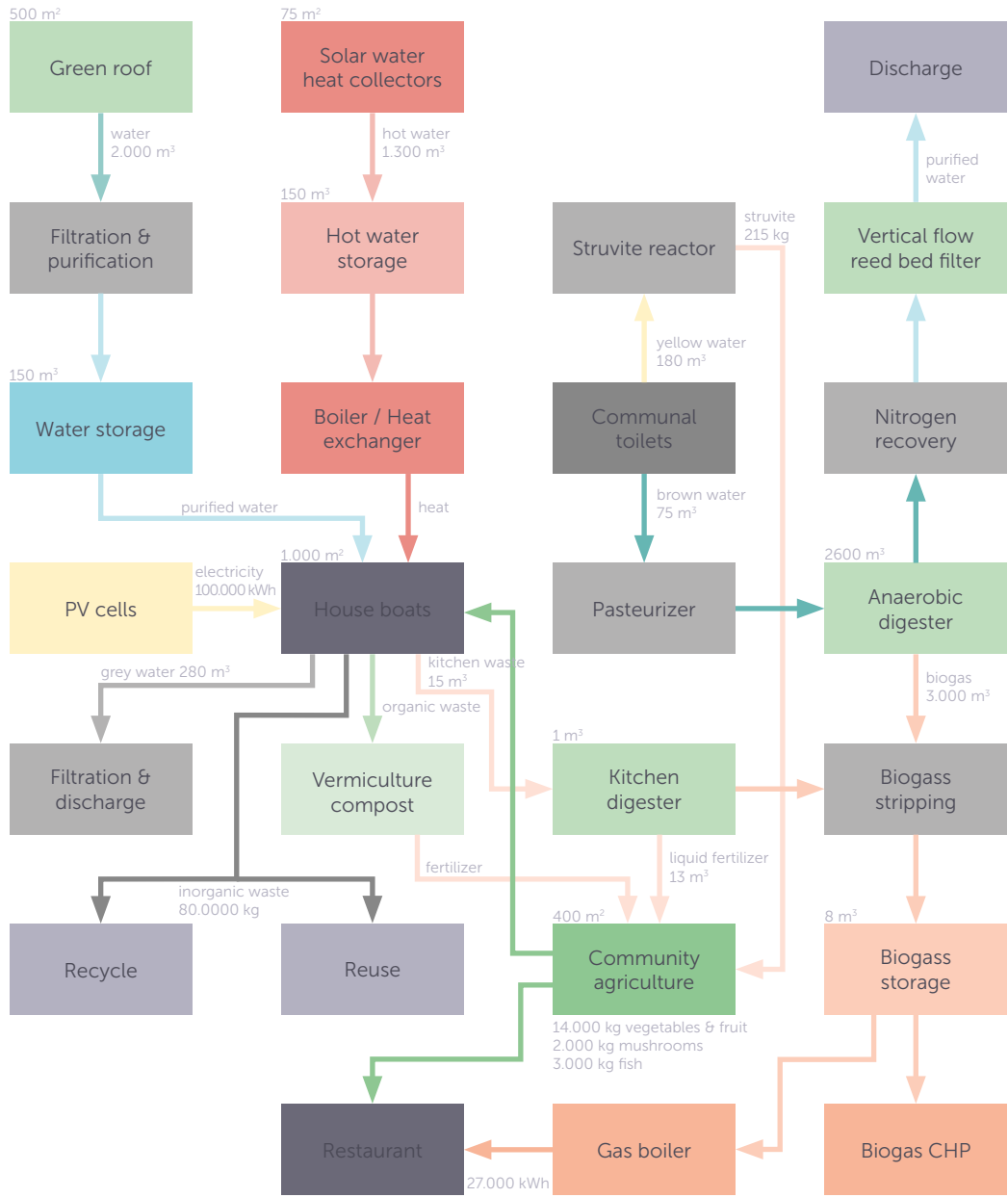
These elements correspond with the three categories defined in the urban metabolism research: energy, water, and biotic factors. What is evident from the case studies is that these three cycles interact with each other. The water is for example used for the house itself, but also for aquaponics, which provides food production. The organic waste is used as fertilizer for the gardens, but also as biogas for the production of energy which then also generates water again.

These outcomes are summarized in the urban metabolism transformation framework which can be found at the end of this chapter. It is here visualized in two different ways, one more abstract as a diagram, the other transformation framework is the diagram but then in the shape of the building (the placement of the functions is done random).



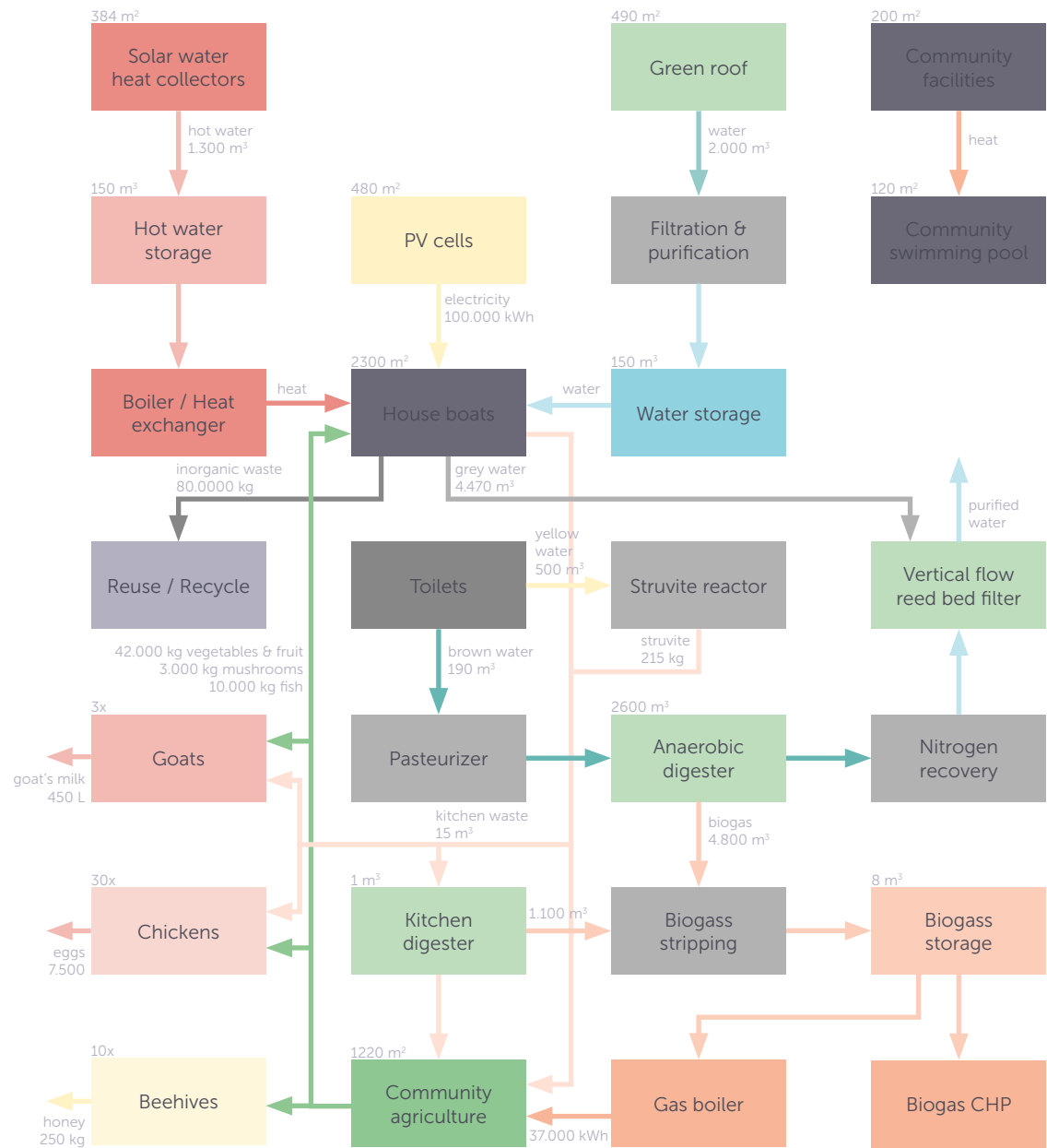
De Ceuvel - Metabolic

based on Metabolic (2013)

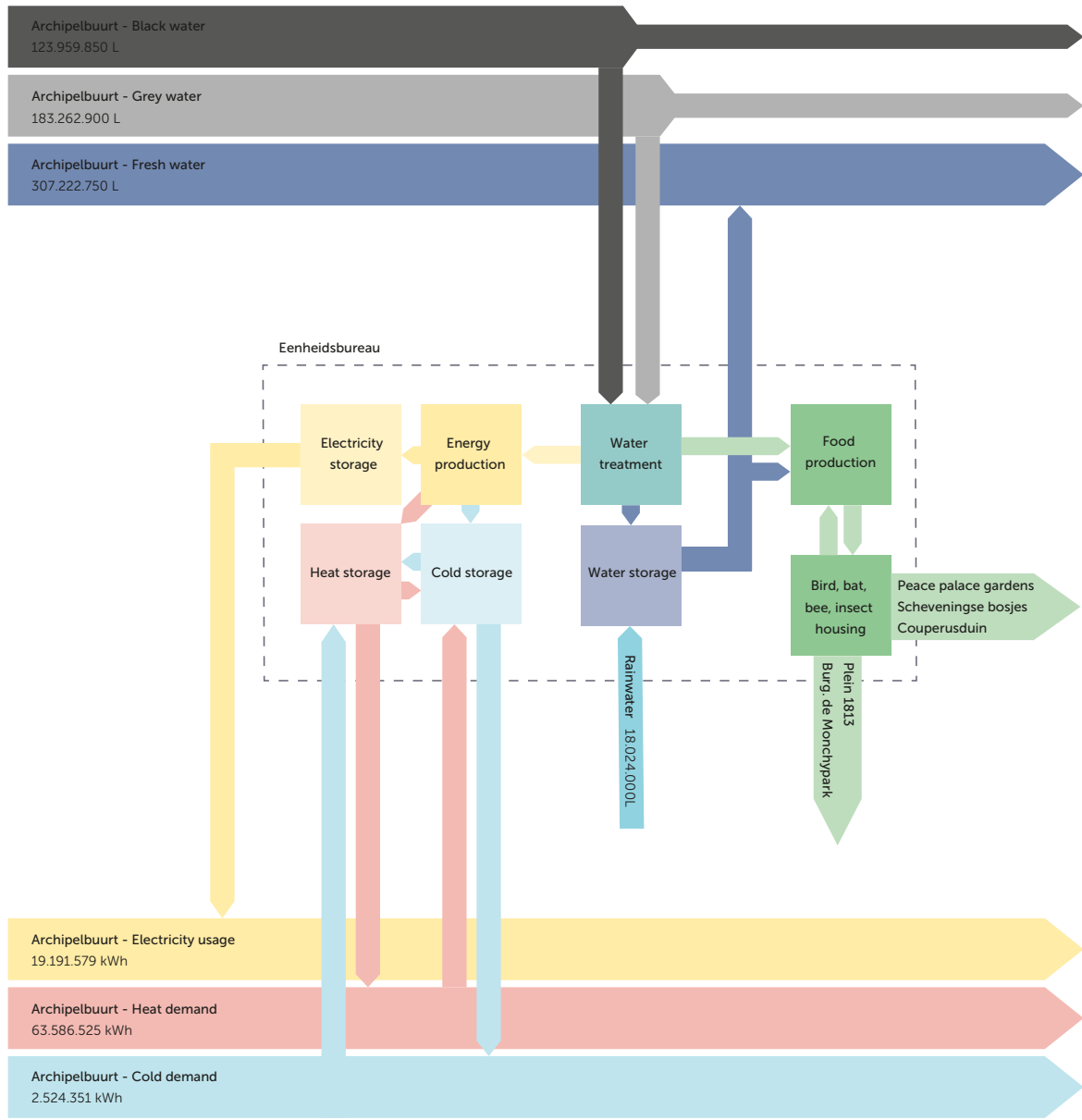


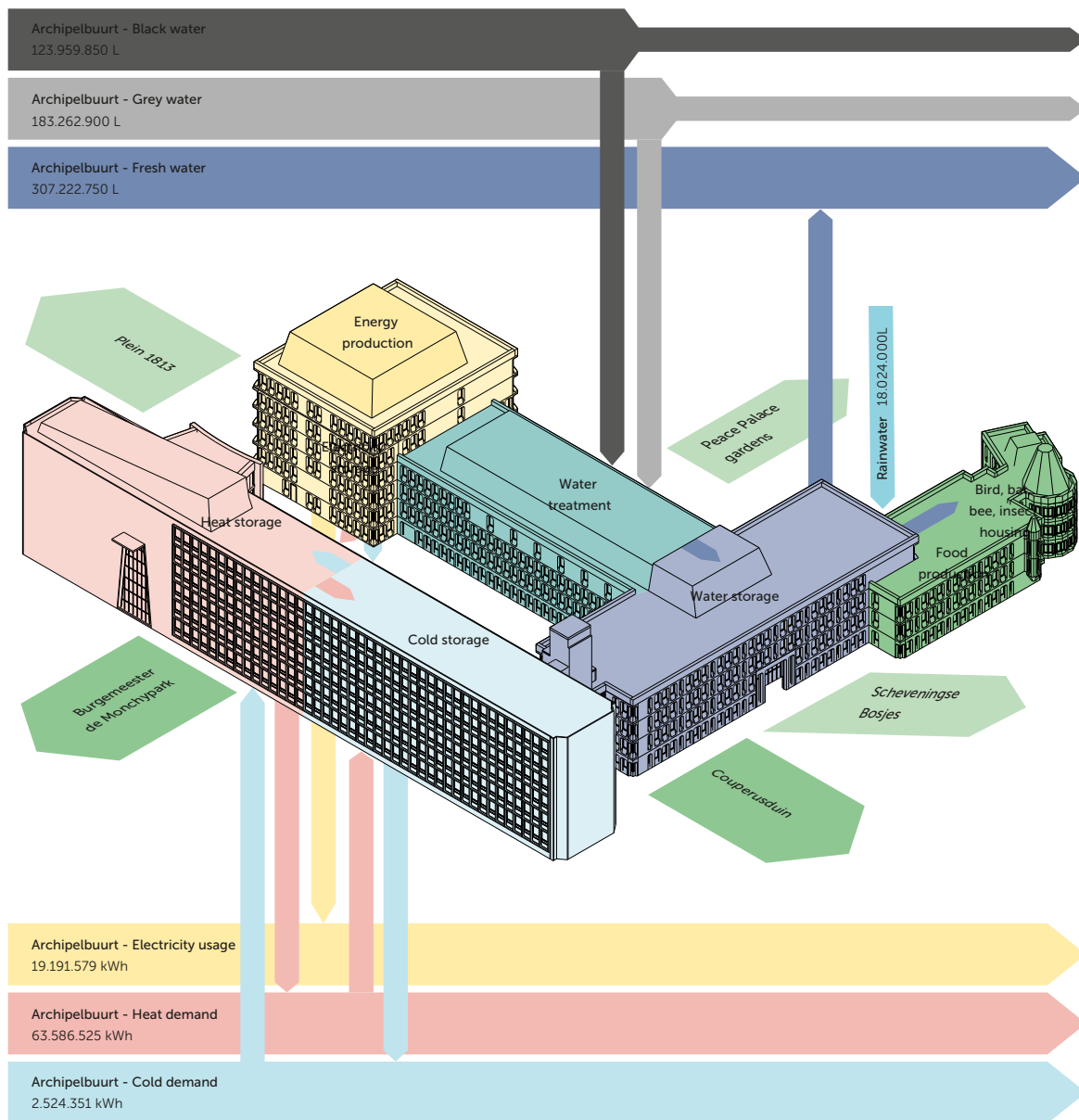
Schoonschip - Metabolic

based on Metabolic (2013)



UM transformation framework





13

Heritage value assessment

20.12.2021 - 26.12.2021

Heritage value assessment

Relation between nature and culture

The relationship between the built environment and the natural environment has been researched with the literature research, urban metabolism analysis, and case studies. Another relationship with the built environment is related to culture. The relation between these three entities is illustrated in the diagrams on the right (Haberl, Fischer-Kowalski, Krausmann, Weisz, & Winiwarter; 2004)(Dos Santos Gonçalves, Mateus, Silvestre, & Pereira Roders; 2021). These two diagrams were combined in order to position the research, shown in the bottom diagram. The material & energy flows have been researched before in the urban metabolism analysis and the values will be researched in this chapter.

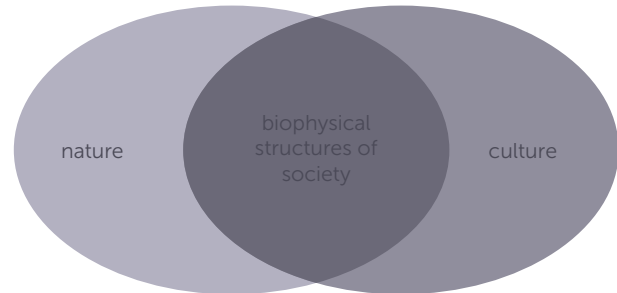
Assessment framework

Two frameworks for the assessment of heritage values are the one with the Brand layers and Riegl values from Kuipers & De Jonge (2017) and the eight primary values from Tarrafa Pereira da Silva & Pereira Roders (2012). These two frameworks are combined, taking the eight primary values, as they are more elaborate, combining it with the Brand layers, to relate the values with spatial aspects.

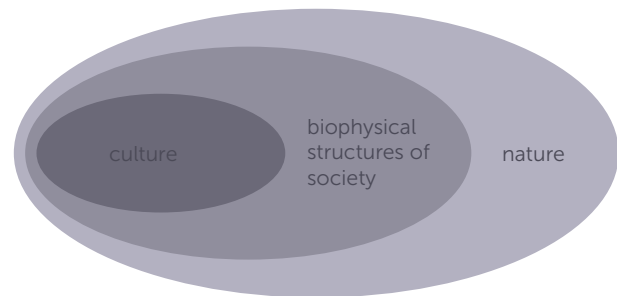
Transformation framework

Based on the heritage value assessment a transformation framework will be created to define which elements of the built object should be maintained and preserved and which elements are open for change. This framework is created by ranking the values based on their significance.

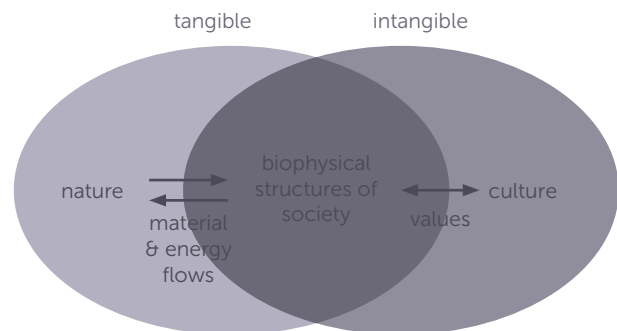
The value assessment starts with two portraits made of the building, after which the combined value assessment framework is filled in.



Relation heritage, nature and culture - based on Haberl, Fischer-Kowalski, Krausmann, Weisz, & Winiwarter (2004)



Relation heritage, nature and culture - based on Dos Santos Gonçalves, Mateus, Silvestre, & Pereira Roders (2021)

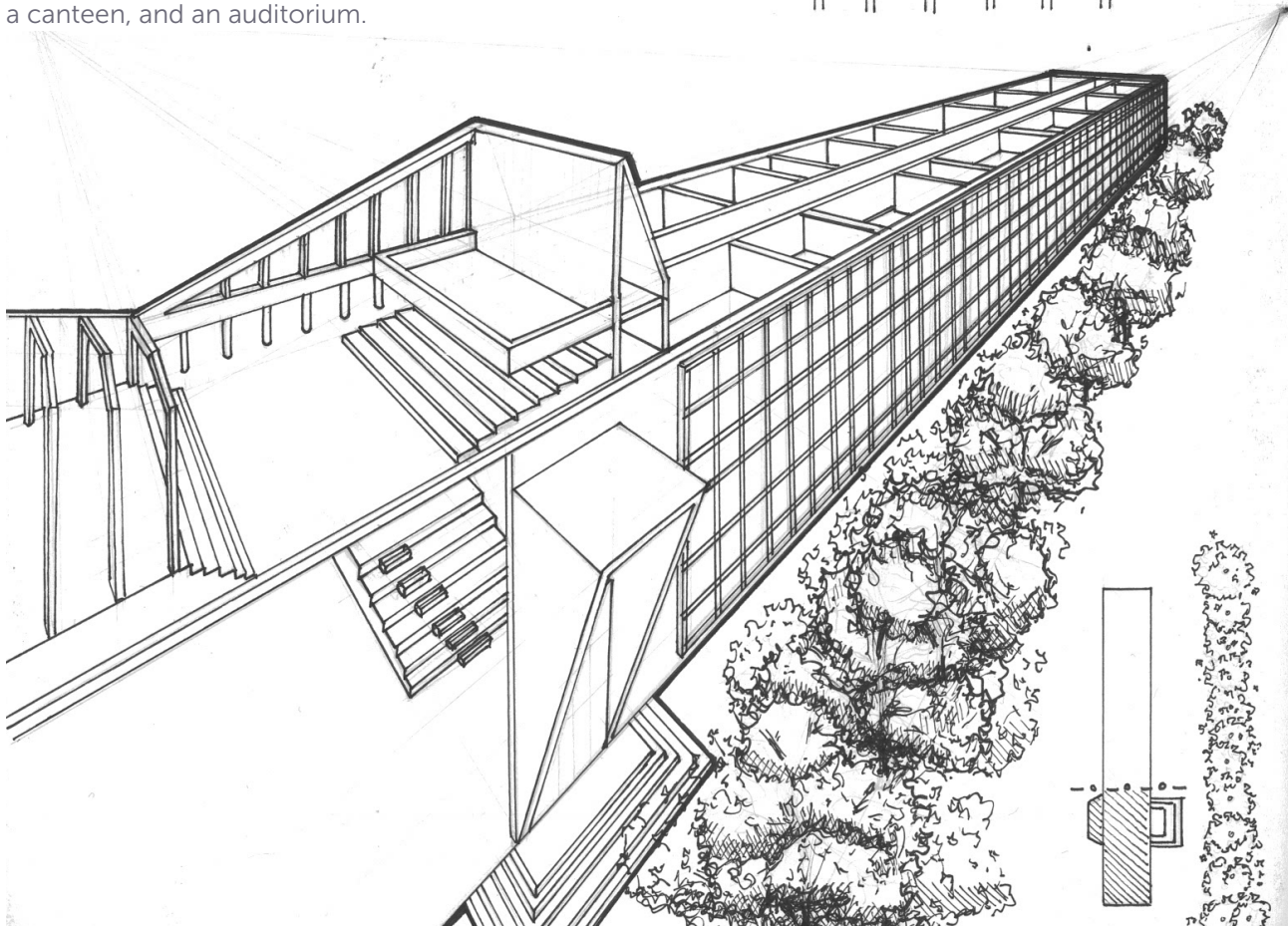
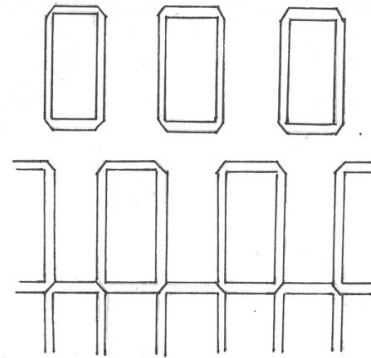


Relation of UM analysis and value assessment - own drawings

Portrait 1959 building

Rythm, prefab schokbeton, art, auditorium

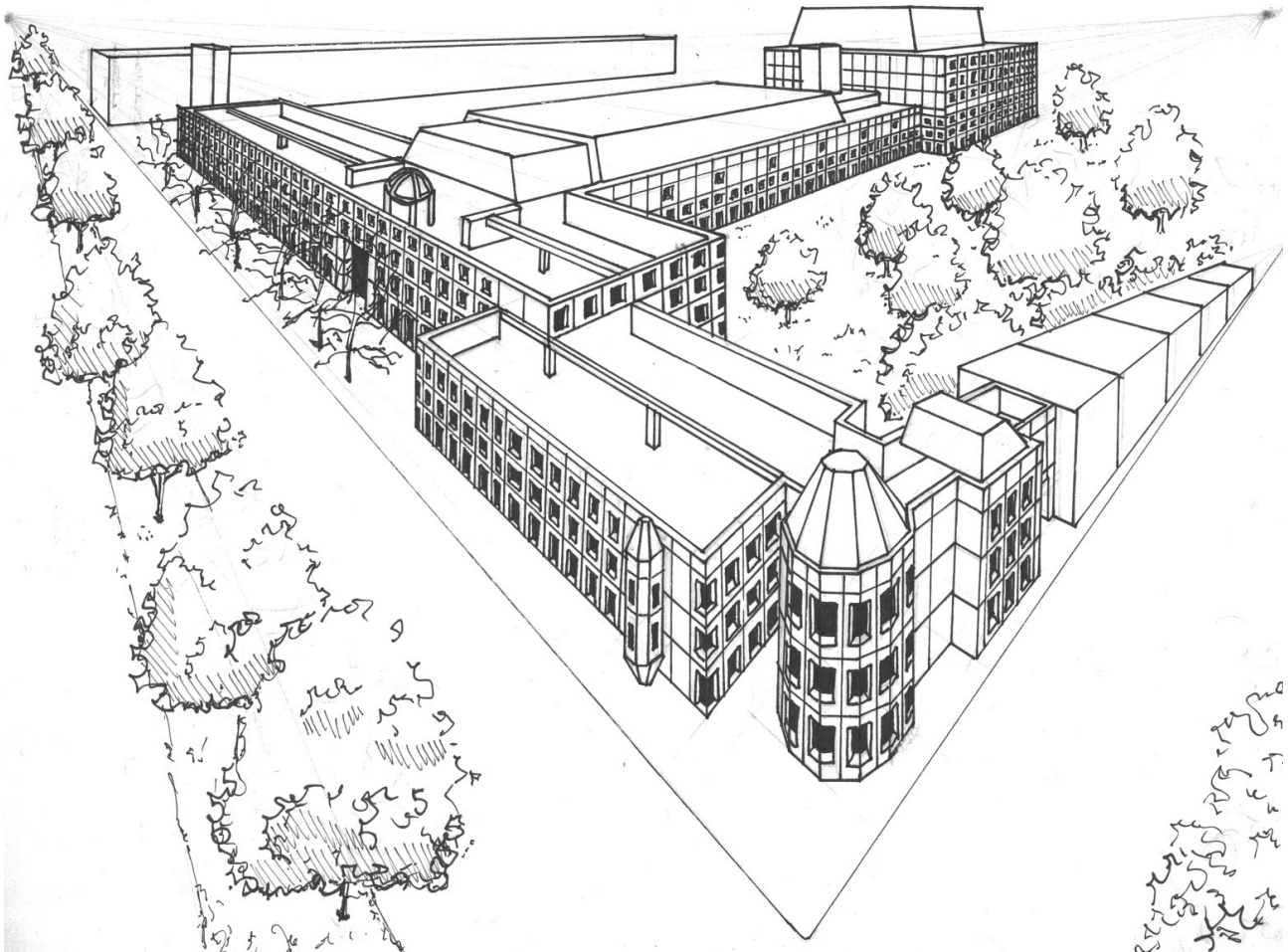
Some key elements of the 1959 building are the strong rhythm of the prefab schokbeton facade elements that cover the office part, which has a dense column structure creating boxes on either side of a central corridor. The representative part of the building is covered with brick and exists of a number of large open spaces like an entrance hall decorated with artworks engraved in the concrete, a canteen, and an auditorium.



Portrait 1981 building

Castle, urban ensemble, open structure, prefab

The 1981 building is formed by an ensemble of building blocks all made of the same prefab facade elements, decorated at one corner with towers creating a castle-like appearance. The building, with its large span and open structure, shape the surroundings into different urban spaces.



1959 building	Social	Economic	Political	Historic
	Spiritual Emotional individual Emotional collective Allegorical	Use Non-use Entertainment Allegorical	Educational Management Entertainment Symbolic	Educational Historic-artistic Historic-conceptual Symbolic
Surrounding / Setting	1A Allegorical: social hierarchy in the neighborhood with housing for both rich at the wide streets and poor in narrow streets		3A Educational / symbolic: the police station is located in The Hague, the international city for peace and justice nearby the Peace Palace	4A Educational / symbolic: the police station is located in The Hague, the international city for peace and justice nearby the Peace Palace
Site			3B Symbolic: the scale of the building on the site represents the power of the police and authority over the people	4B Educational: building reacts to the now-demolished town hall of The Hague, displaying the architectural style of that period
Skin	1C Allegorical: social hierarchy of the police as a strict and admonishing constitution represented in the facade	2C Use: facade clearly represents the use of the different building parts with schokbeton for offices and brick for representation	3C Symbolic: the rhythm and sober appearance of the facade represents the power of the police and authority over the people	4C Historic-conceptual: the facade has some key characteristics of Nieuwe Bouwen and is the height of the genre of WS van de Erve
Structure		2D Use: structure relates to function as offices have a dense repetitive column structure and representative spaces have larger open spans		
Space Plan		2E Use: the offices are made of smaller rectangular boxes and the representative spaces are larger irregular spaces		4E Historic-conceptual: the sober staircases are typical of the sober architecture from the '50s
Surfaces	1F Spiritual: reliefs engraved in the walls display the function and position of the police in society through history	2F Use: for the representative spaces more luxurious finish materials with integrated reliefs are used		4F Historic-artistic: the integrated reliefs and the art form a unity with the building, a clear characteristic of Nieuwe Bouwen
Services				
Stuff	1H Spiritual: artworks around the main entrance display the function and position of the police in society through history	2H Use: the reliefs and artworks display the use of the building as a police station		4H Historic-artistic: the integrated reliefs and the art form a unity with the building, a clear characteristic of Nieuwe Bouwen
Spirit of Place	1I Emotional individual/collective: the presence of the police creates an atmosphere of social safety and protection			

Aesthetical	Scientific	Age	Ecological
Artistic Notable Conceptual Evidential	Workmanship Technological Conceptual	Workmanship Maturity Existential	Spiritual Essential Existential
5A Evidential: the neighborhood Archipelbuurt exists of a lot of houses before 1900 with an eclectic style			
			8B Spiritual: the relation between the building and the monumental row of trees in front of the main facade
5C Notable / evidential: the building is one of the last still standings of WS van de Erve and represents the Wederopbouw architecture	6C Technological: the facade exists of prefab schokbeton elements	7C Workmanship: the facade exists of prefab schokbeton elements only made in a very specific time period	
5F Conceptual: the reliefs form an integral materialization of conceptual intentions and are in unity with the building			8F Spiritual / essential: the reliefs in the main entrance hall display fish and birds creating a relation with nature
5H Artistic: the integrated reliefs and the art form a unity with the building and are created by RDE Oxenaar and JH Kuipers	6H Workmanship: the integrated reliefs and the art	7H Workmanship: the integrated reliefs and the art form a unity with the building typical of the Wederopbouw architecture	

1981 building	Social	Economic	Political	Historic
	Spiritual Emotional individual Emotional collective Allegorical	Use Non-use Entertainment Allegorical	Educational Management Entertainment Symbolic	Educational Historic-artistic Historic-conceptual Symbolic
Surrounding / Setting	1A Allegorical: social hierarchy in the neighborhood with housing for both rich at the wide streets and poor in narrow streets		3A Educational / symbolic: the police station is located in The Hague, the international city for peace and justice nearby the Peace Palace	4A Educational / symbolic: the police station is located in The Hague, the international city for peace and justice nearby the Peace Palace
Site			3B Symbolic: the shape of the ensemble of the block represents a castle or fortress representing power and authority	
Skin	1C Allegorical: social hierarchy of a police station like a castle or fortress protecting the society		3C Symbolic: the repetition, large scale, and towers of the facade create the appearance of a castle	
Structure		2D Use: structure relates vision for offices of that time with large spans and flexible system walls to create a flexible layout		4D Historic-conceptual: the structure represents the office typology of the '80s with large spans and system walls creating a flexible space plan
Space Plan		2E Use: space plan relates vision for offices of that time with large spans and flexible system walls to create a flexible layout		4E Historic-conceptual: the space plan represents the office typology of the '80s with large spans and system walls creating a flexible space plan
Surfaces				
Services				
Stuff				
Spirit of Place	1I Emotional individual/collective: the castle atmosphere creates a feeling of safety but also intimidation			

Aesthetical	Scientific	Age	Ecological
Artistic Notable Conceptual Evidential	Workmanship Technological Conceptual	Workmanship Maturity Existential	Spiritual Essential Existential
5A Evidential: the neighborhood Archipelbuurt exists of a lot of houses before 1900 with an eclectic style			
			8B Spiritual: the relation between the building and the enclosed courtyard creates a visual connection with nature
5C Artistic: the two towers are a creative highlight one the repeating facade and are strongly responsible for the castle image of the building	6C Technological: the prefab loadbearing facade elements		8C Spiritual: the facade sculpted like a sandcastle with natural like materials and organic forms in the window openings and towers

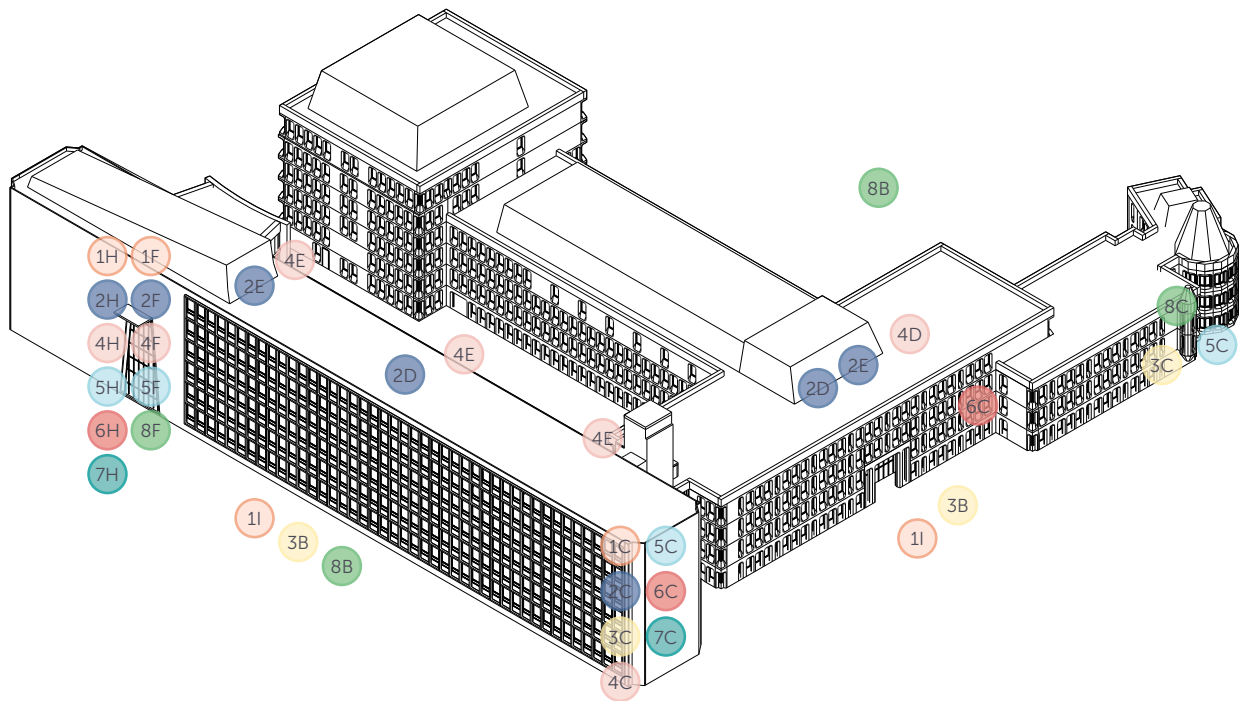
Heritage values - Exterior

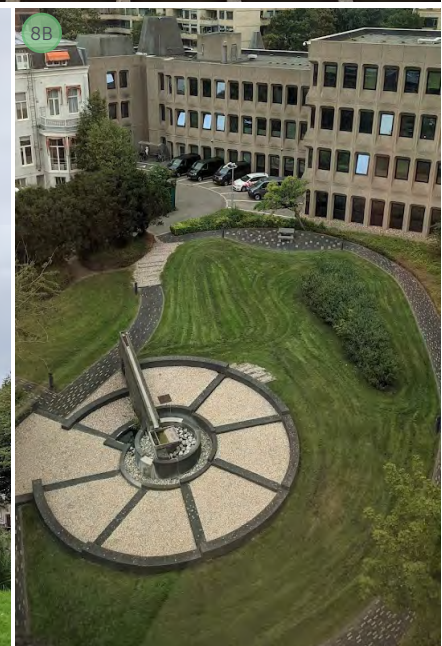
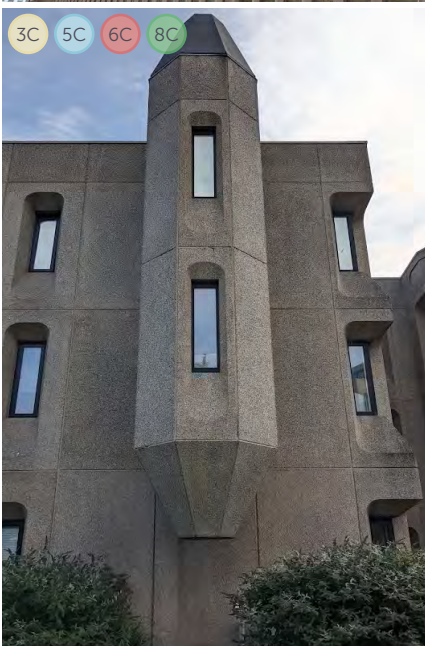
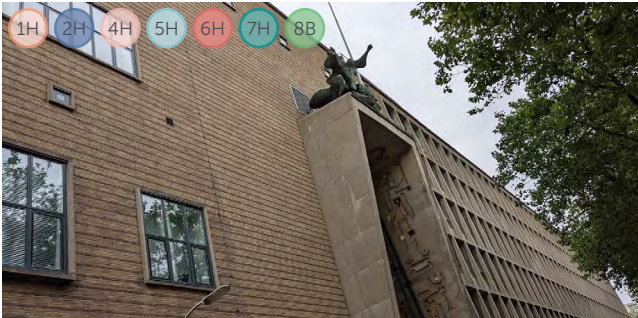
Heritage value assessment

The heritage value assessment of the Eenheidsbureau is first conducted with the combined frameworks of Kuipers & De Jonge (2017) and Tarrafa Pereira da Silva & Pereira Roders (2012). This table is split up into the two building parts, 1959 and 1981, since these two parts each have their own identity and values. The tables give a textual explanation of the values per layer and per value. Each cell of the table has been given a code of a number (value) and a letter (layer). These codes are used to place these values into the spatial element itself; the building. In

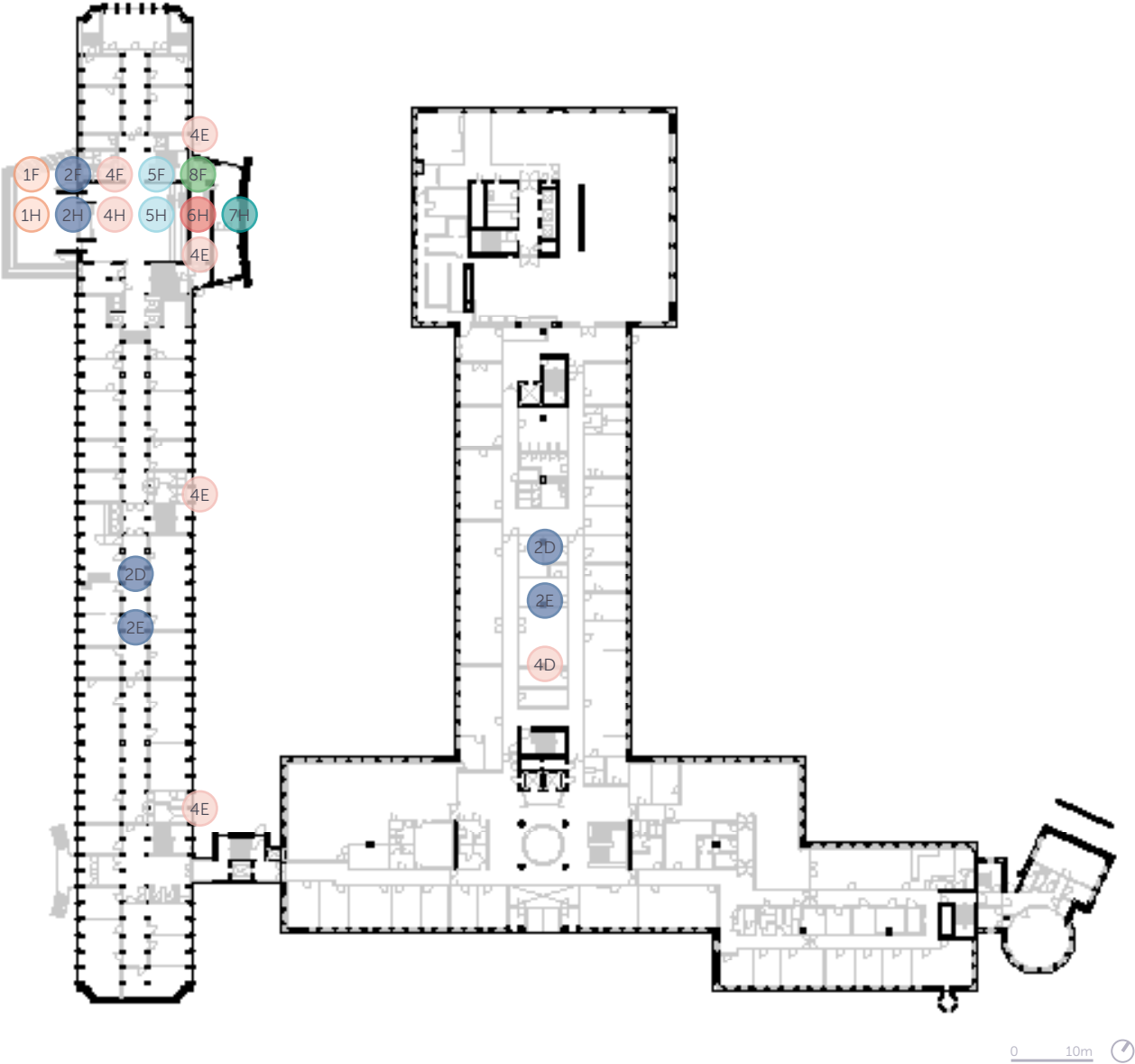
this way assigning specific spatial elements and characteristics to certain values. This has been done for both the exterior (isometric diagram below) and the interior (floorplan on next page) of the building. Accompanied with these drawings are pictures to further define and visualize how these values relate to the built object.

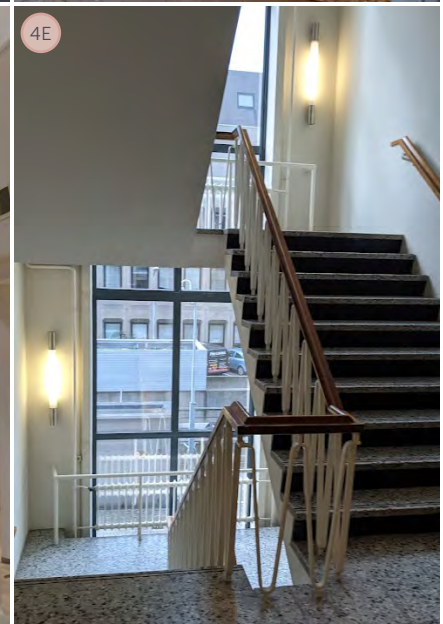
Based on this value assessment, certain elements of the building have more significant value than others. This difference in significance forms the basis of the heritage value transformation framework.





Heritage values - Interior





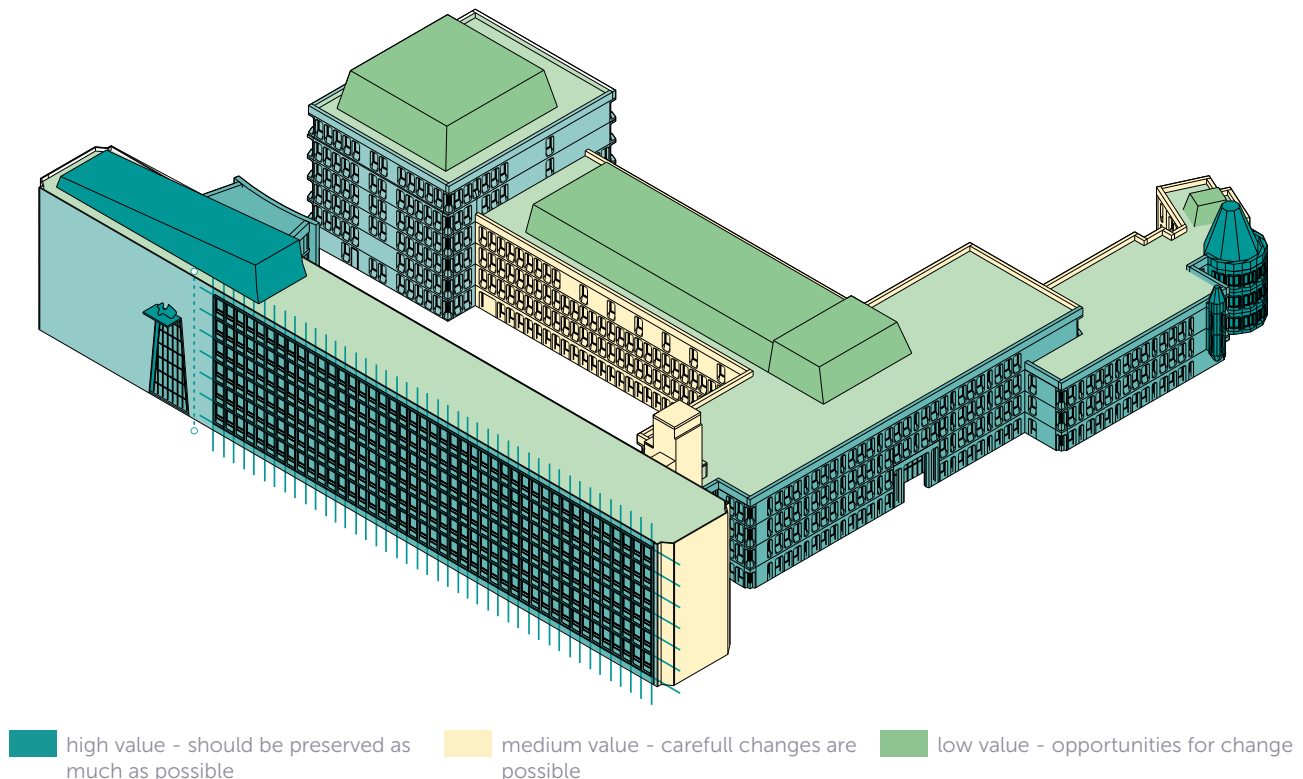
Value transformation framework

Opportunities for change

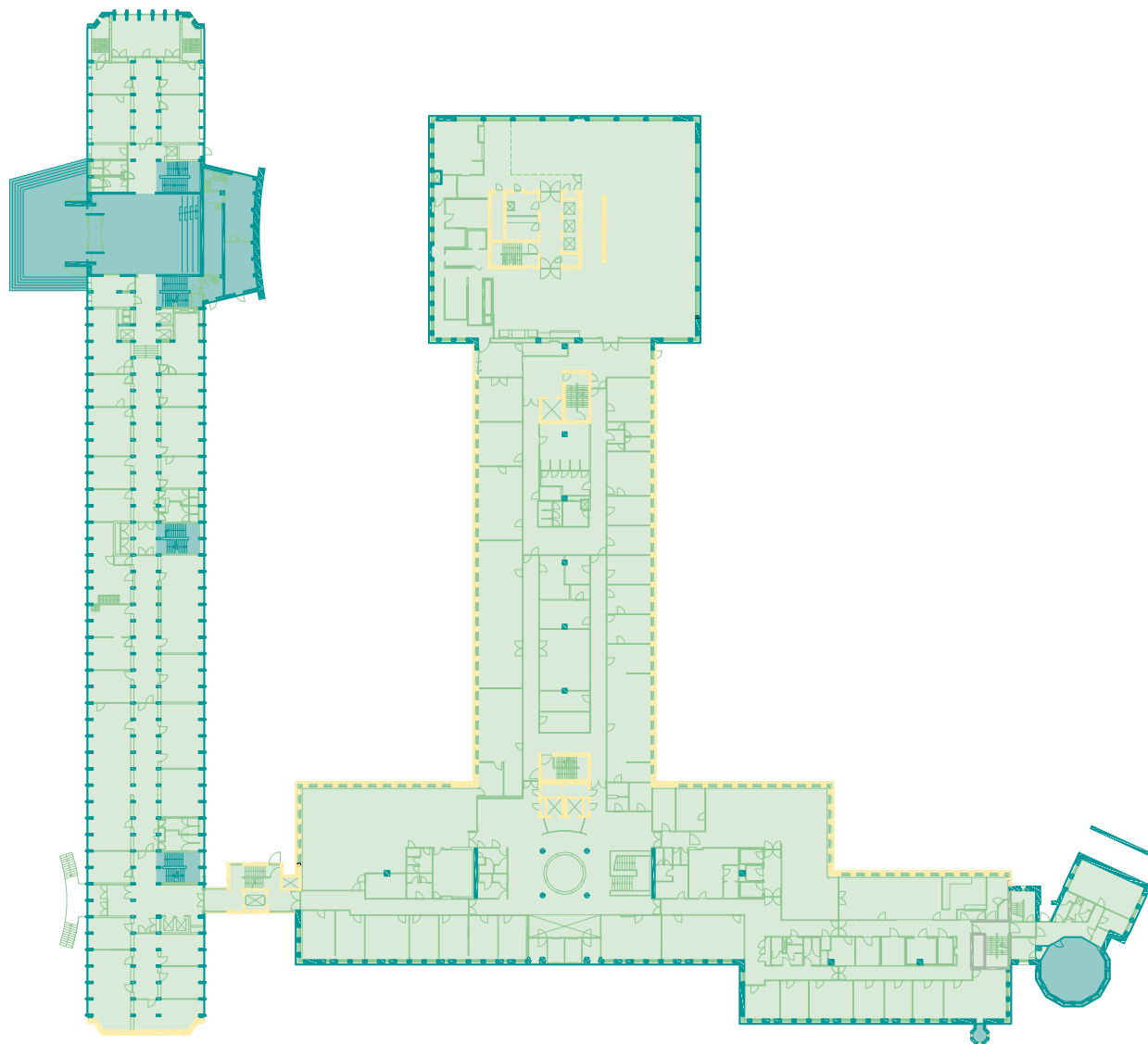
The heritage value assessment is used to create a transformation framework indicating which elements of the building should be preserved and which elements of the building can be changed without losing much value. This has been defined based on the significance of the values, and the significance of the spatial elements for the manifestation of these values.

A clear conclusion from the assessment is that the facades of the two parts, especially the schokbeton facade of the 1959 building have significantly the

most value of the building and should therefore be preserved as much as possible. The inner facade of the 1981 building is however not part of the urban landscape and street view and does therefore not hold the same significance as the other sides. The structure of both buildings holds high value as it represents the vision for offices at that specific time. In the 1959 part there are a few interior spaces with high value; the entrance hall, the auditorium, and staircases. The rest of the interior of both buildings has low value and therefore creates opportunities for change in the re-design of this police building.



high value - should be preserved as much as possible
 medium value - careful changes are possible
 low value - opportunities for change possible



0 10m

14

Research conclusions

20.12.2021 - 26.12.2021

Conclusion

Summary of research

The goal of the research is a transformation framework to guide the re-design from both an ecological perspective and a social cultural perspective. Including both the natural and the cultural human environment in the design, to find a new way of living together. The research starts with a literature study into ecological design, systems theories, and urban metabolism, resulting in a framework for an urban metabolism analysis of the Archipelbuurt. Based on this urban metabolism studies case studies are analysed to research how the current cycles can be closed and symbiotic relationships can be created. This results in an urban metabolism transformation framework. The social cultural perspective is researched with a value assessment, which results in a heritage value transformation framework.

Ecological design & systems theories

The conclusion from the literature research about the ecological design and systems theories is that the new stepped strategy from Andy van den Dobbelsteen (2008) is the best systems theory to guide the design. The scale on which this method is applied should however be expanded to the neighborhood level to close cycles more efficiently. To find out which flows are present in the neighborhood, the concept of urban metabolism is used.

Urban metabolism analysis

The urban metabolism analysis is conducted on the Archipelbuurt in The Hague. The defined categories of energy, water, biotic factors, and materials are researched and visualized in flow diagrams. This analysis gives the current status of the flows in the Archipelbuurt.

Urban metabolism framework

With the analysis of case studies, elements were defined that could close cycles. These elements are the *production of energy* connected to *energy storage* (electricity / heat / cold), a *water treatment* (grey water / black water) with *water storage*, and an *organic waste treatment* used for fertilizing the *food production*. Based on these elements, a urban metabolism transformation framework is created in order close the cycles in the Archipelbuurt.

Cultural value framework

The social cultural perspective is analysed with a value assessment. The input for this assessment is the spatial building typology research and a detailed building analysis, both can be found in a separate booklet. The assessment itself is structured according to a combined framework with eight primary values in relation to nine spatial layers. This assessment results in transformation framework by signifying the values and the related spatial elements. This transformation framework determines the amount of change that is possible with the re-design. Elements that have a high value should be preserved as much as possible, while elements with low value are opportunities for change, in this way maintaining the important cultural values of the building.

Combined transformation framework

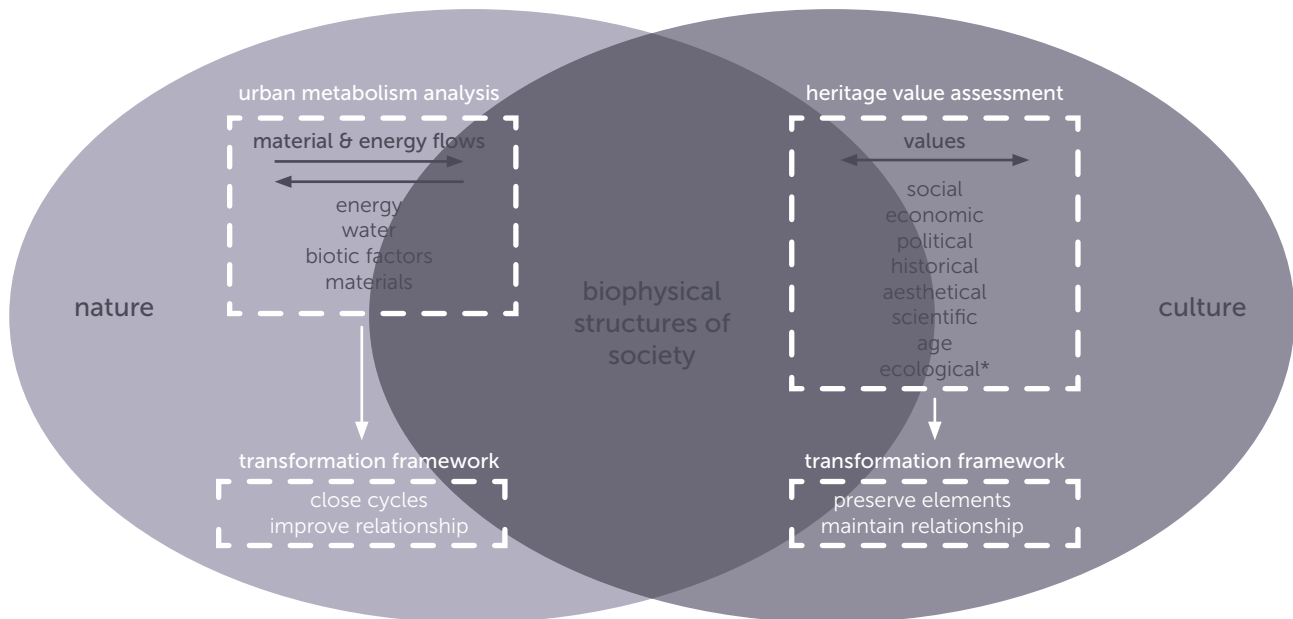
These two transformation frameworks each react on a different relationship that the biophysical structures of society has with nature and culture. These relationships and the position of the analysis and frameworks is visualized in the diagram on the next page. The two frameworks are combined on the two pages after the next page, and include the

new stepped strategy as a leading methodology. The frameworks guide the design in different ways, as the urban metabolism framework determines functions that are needed to close the cycles in the neighborhood, while the heritage value framework determines which elements have opportunities for change and which elements should be preserved in order to maintain the values.

Reflection & recommendations for future research

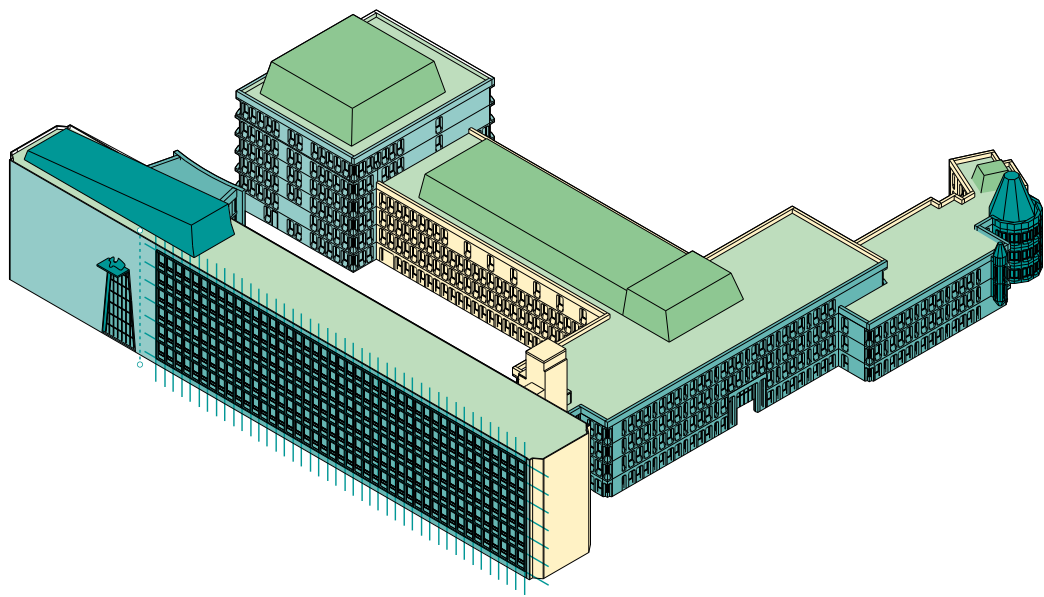
Relating urban metabolism flows in a neighborhood to the re-design of an individual building is quite unique, but a process that needs to become more common in the transformation of buildings. The benefits of this method could contribute to both societal and environmental problems.

During this research a lot was learned about the two perspectives of nature and culture, but a full integration of the two is still missing. Due to time limitations a complete combined transformation framework of both urban metabolism and heritage values could not be created and therefore is represented as the two frameworks side by side, just as how they would be used in the design. Further research into the relation between these two should be conducted. The aspect of ecological values is interesting and fitting topic for this and was not researched in its fullest potential yet.



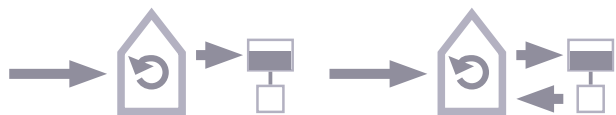
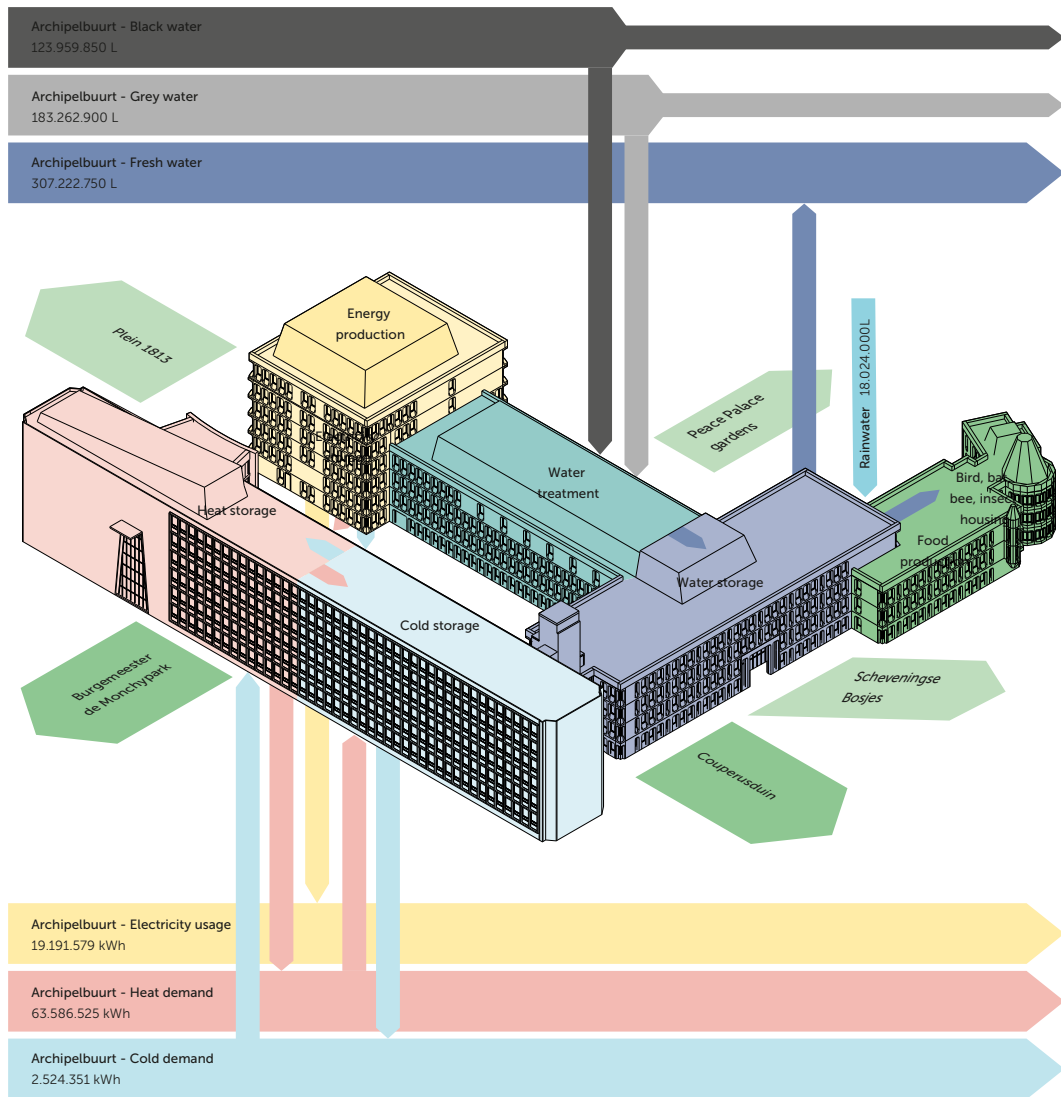
Relation between the urban metabolism analysis and the heritage value assessment - own drawing

Combined transformation frameworks



■ high value - should be preserved as much as possible ■ medium value - careful changes are possible ■ low value - opportunities for change





4. Process waste



5. Re-use the effluent



6. Supply demand sustainably



7. Waste equals food

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15

Program development

08.11.2021 - 19.12.2021

Program workshop

Mixed program

This building is built at two different times and this is also visible in the internal structure and circulation of the two buildings. This big difference in structural density in combination with the large scale of this building (53.000m²) creates an ideal setting for a mixed program. The old building has a dense structure and is, therefore, more suitable for a program that requires smaller human-scale spaces, like housing or offices.

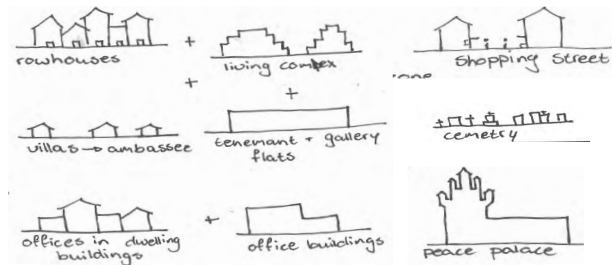
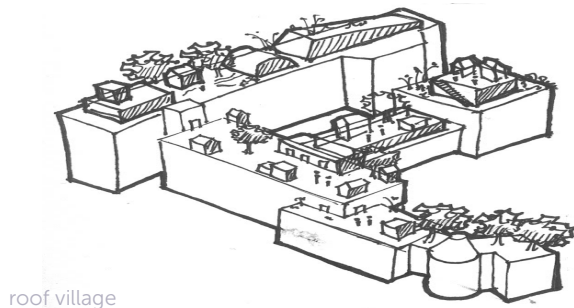
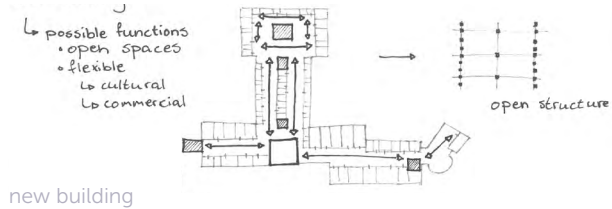
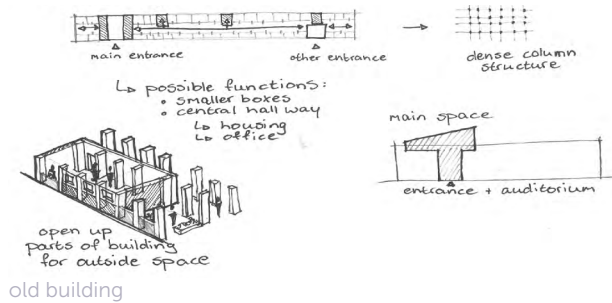
The new building has a very open structure with only a couple of columns in the middle of the space and a load-bearing facade. This open space is suitable for a more flexible program of both smaller and bigger spaces, but in order to use the fullest potential more commercial or cultural program could be placed in this part.

Roof village

If additional square meters would be needed, the roof of the building would be the most suitable place. There have already been made some roof extensions, but these have no clear relationship with the building below. While adding extensions, a new roof village can be created in relationship with the building below.

Symbiotic program

The program of the building will follow the theme: how will we live together? in order to create a better connection between humans and nature. The mixed program in the building can benefit from the presence of each other, both inside of the building and of the surrounding program. A very brief and quick overview of surrounding functions are sketched on the right.

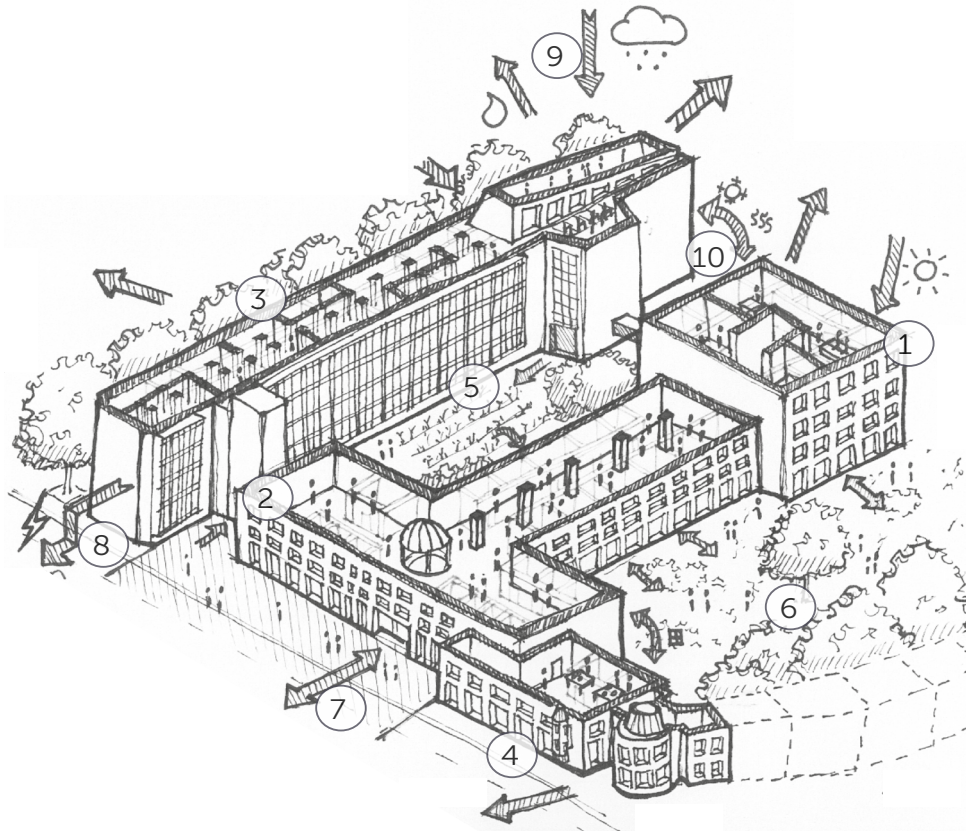


surrounding program

The program will also react to the vision of The Hague for both the building and the neighborhood, as it is located in the international zone for peace and justice. The vision of The Hague is therefore that this building should house an international company that advocates peace and justice.

The existing function of the building as police station will also be taken into account while choosing the program. As it currently maintains public order

and safety. Combining this with the vision of The Hague and with the aim to connect humans with nature, a goal for the program can be formulated as to advocate ecological safety and ecological justice. Combining this with the international focus of the neighborhood and the potential of the building for mixed use, results in an ecological living lab with a mixed symbiotic program. See the diagram on the right.



1. housing / 2. cultural / 3. offices / 4. commercial / 5. food / 6. park / 7. relation to surrounding buildings and parks / 8. excess energy to smart grid / 9. capture rain water / 10. exchange flows between functions

Housing & community centre

Housing crisis

A large societal problem in the Netherlands at this moment is the housing crisis, a huge shortage of houses, causing the housing prices to rise to historic high levels. This crisis is caused by many reasons, but the main cause is the shortage of housing, that is why the Dutch government has set the goal of building 1.000.000 new houses by 2030. To reach this goal a lot of new space has to be found for these housing, part of the solution for this challenge can be the renovation of existing buildings into housing. This re-design will aim to be part of the solution for this societal challenge, by transforming a large part of the building into housing.

Balanced neighborhood

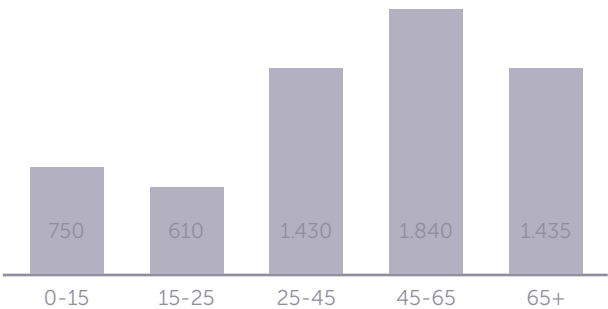
An analysis of the Archipelbuurt has been conducted on the inhabitants, researching the demography, income, and housing types in the neighborhood. An interesting finding is that the demography or age division of the inhabitants is currently quite in balance, as can be seen in the diagram below. To remain this balance with the addition of new program, mixed housing is chosen with different types suited for age groups from the entire spectrum, from starters to young couples, to families, to elderly.

Live together

The aim and main theme of this re-design is living together, that is why next to the housing, additional program is added to stimulate the formation of communities. This is also a translation from the value of the police as they symbolize social safety and protection of society in order to live together. These communities will be supported on three scale levels, starting with the building scale where

shared collective facilities for the inhabitants can create a bond between them. The next scale is the neighborhood level by housing public functions in the building that serve the use of the entire Archipelbuurt. The last scale is to stimulate an international knowledge community, related to the location of the building in the international zone and the vision of the municipality of The Hague for this building to house an international organization. Next to creating a social community between humans, the phrase live together goes further by also including other natural live and ecology into the community. In order to create this ecological community, facilities will be placed in the building to close neighborhood cycles and increase biodiversity.

In the next parts of this chapter, each of the three aspects of the program is further researched and defined, starting with the housing aspect, then the social community facilities, and as of last the ecological community facilities.



Demography Archipelbuurt - based on Allecijfers.nl (2021). Archipelbuurt. Retrieved on 04.12.2021 from <https://allecijfers.nl/buurt/archipelbuurt-den-haag/>

Housing types

Wellbeing

The purpose of finding ways of living together is to improve the wellbeing of both humans and non-human life. Currently, there are some societal problems that influence this wellbeing. These problems are loneliness and the disconnection between humans and nature. This later problem will be further elaborated in the part about facilities for ecological communities. The problem of loneliness will be addressed with the different housing types.

Target groups

The wide variety of target groups is based on the analysis of the neighborhood, which should remain in balance with this re-design. The target groups are starter, student, young couple, small family, large family, divorced with children, divorced without children, elderly. In order to house this wide variety of target groups with all different wishes and needs, three housing types are defined: the typical 1,2,3 bedroom apartments, work-living apartments, and co-housing. The idea is that a person can grow in the building and in all its different lifephases have a place in the building and in the community. In this way making it easier for people to move and prevent people from living in a house that is either too small or too big for them.



Typical 1, 2, 3 - bedroom housing

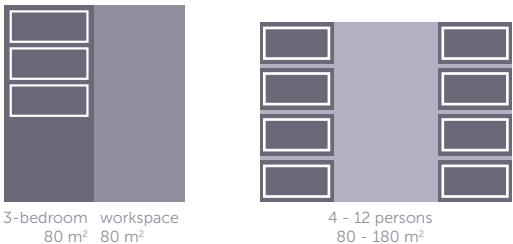
The first housing type is the more conventional division of apartments based on the number of bedrooms, starting with a studio up to 3-bedroom apartments (see diagram below).

Combined work-living housing

Another housing type applied in this building is working combined with living. This follows a rising trend, especially because of covid, of working at home. By accomodating this need for additional work area close to home, the street in front of the house is also activated. In this way creating a more spread out landscape of smaller hubs with social activities in a neighborhood.

Co-housing

The last housing type is a direct response to the societal problem of loneliness and is named co-housing. This means that multiple persons share facilities and form a small community. This co-housing can be inhabited by all age groups, but will especially form a good solution for students, starters, and elderly as the problem of loneliness in these groups is the most evident.



Social community facilities

Community for social wellbeing

In order to create a social community different functions are integrated in the building.

Care

daycare 200 m²
 care centre 500 m²
 - physical health
 - mental health
 indoor sport facilities 500 m²
 outdoor sport facilities 10.000 m²

Retail

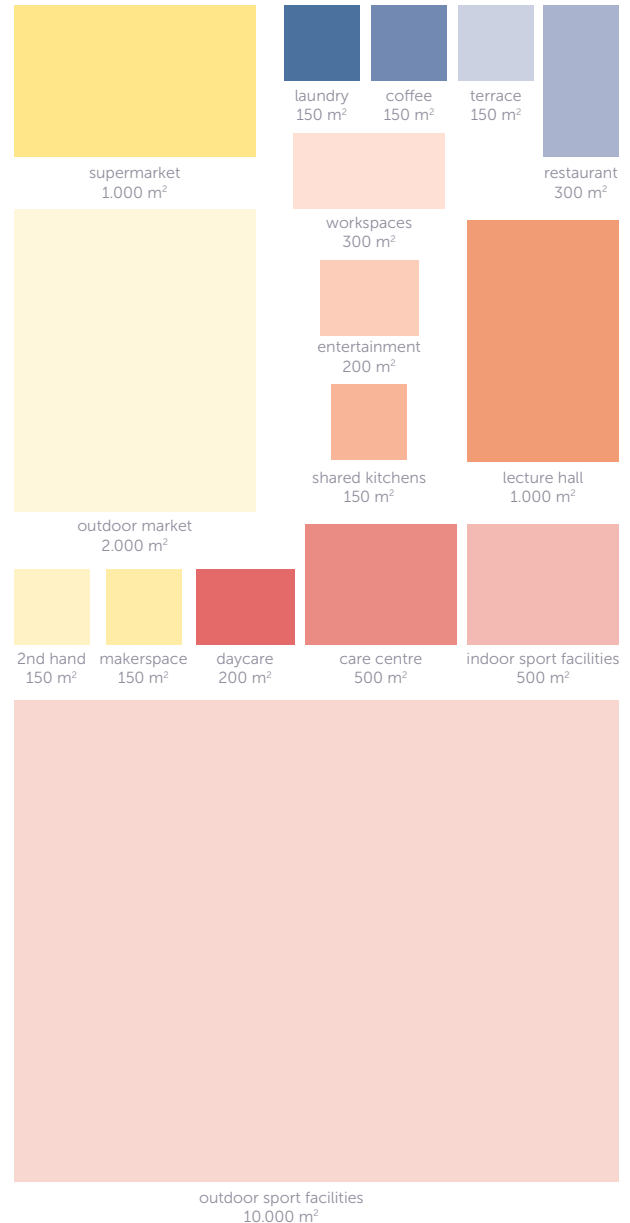
supermarket 1.000 m²
 makerspace 150 m²
 second hand shop 150 m²
 outdoor market 2.000 m²

Work & leisure

workspaces (with library) 300 m²
 entertainmentspaces 200 m²
 shared kitchens 150 m²
 lecture hall 1.000 m²

Other

laundry 150 m²
 coffee corner 150 m²
 restaurant 300 m²
 terrace for restaurant 150 m²
 roof garden



Ecological community facilities

Food

urban farming 10.000 m²
aquaponics 1.000 m²
livestock 1.000 m²
food storage 150 m²

Fauna

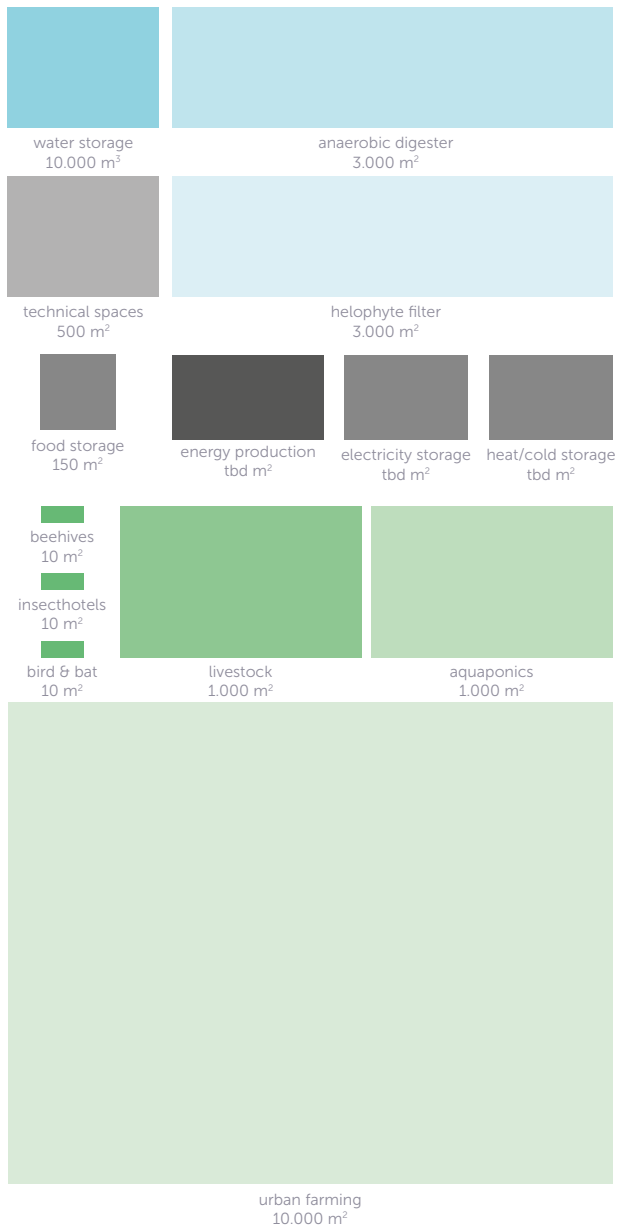
bird & bat housing 10 m²
beehives 10 m²
insect hotels 10 m²

Water

grey water treatment (helophyte filter) 3.000 m²
black water treatment (anaerobic digester) 3.000 m²
water storage 10.000 m³

Energy

energy production tbd m²
electricity storage tbd m²
heat/cold storage tbd m²
technical spaces 500 m²



16

Concept design

15.11.2021 - 07.02.2022

Design process

Program and design

In this chapter the design process up to the P2 presentation is described, starting with a textual explanation followed by numerous sketches and drawings. The design follows from the process of choosing a program which is described in the previous chapter. These two processes were intertwined and interdependent.

Initial sketches & first concept program

The design process started with sketches of initial ideas and explorations. Completely free from any required program, these sketches are a mix of initial design guidelines, and impressions of the given site, defining the challenges and opportunities. After this, a first concept program was defined as a mix between housing, collective functions, and education. For the housing, different types were defined to house a wide variety of target groups and make sure that a person can grow in the building and stay part of the community. The housing is placed in the office part of the 1959 building and the tower of the 1981 building. To further stimulate the community, collective spaces are introduced in the representative part of the 1959 building as this part has the spatial qualities for this function. The other part of the 1981 building is used for education about sustainable living and the education about living together with nature.

Program in floorplans & development of program

In the next stage of the design process, the program was further defined and placed into floor plans. The program now mainly consisted of housing, with a wide variety of housing types. The ground floor plan was developed into more detail to also design the relationship between inside and outside. The main concept of the routing was

internal corridors and some circulation cores for vertical movement. These circulation cores are also used to bring green into the building. A study is done to research the possibility for a gallery instead of an internal corridor, but further research into routing is still needed.

Relation with surrounding greenery

Simultaneously with fitting in the program in the building, the relation with the surrounding greenery is also explored with the design. First, an analysis is made to see where the surrounding green areas are. The conclusion is that the building can become the ecological center point of the neighborhood connecting the different ecosystems in the neighborhood.

Outside space around building

For the building to become the ecological center point, the outside space around the building will have to be carefully designed. An initial design for the urban block is created where different functions are assigned to the surrounding outside spaces. These functions are urban farming, market, terraces, recreational green, water treatment, and sports facilities. Green connections are created to the neighboring green areas. Then the ground floor is further designed with this ecological perspective creating a continuous water element connecting inside and outside with each other.

The two courtyards are currently separated by the 1981 building, creating an ecological dead-end. To improve the relationship between the two courtyards, different interventions are designed to explore how a continuous green space can be created.

Transformation frameworks

Two transformation frameworks are created to guide the design. The first one is the urban metabolism framework, which is created after analysing the cycles of energy, water, and biotic factors in the Archipelbuurt. This framework guides the design by determining functions that close cycles in the neighborhood. The other framework is based on the cultural heritage value assessment and guides the design by determining which elements of the buildings manifest values. Both these frameworks will be used to guide the re-design of the police station.

Evolved program (plans, sections, isometrics)

The program has further evolved based on input from both the research and the design itself. The housing types are further defined, with additional work-living and co-housing. The social community functions and floor areas are defined, as well as the ecological community functions defined in the urban metabolism framework. These functions are placed in the floor plans, sections, and isometrics.

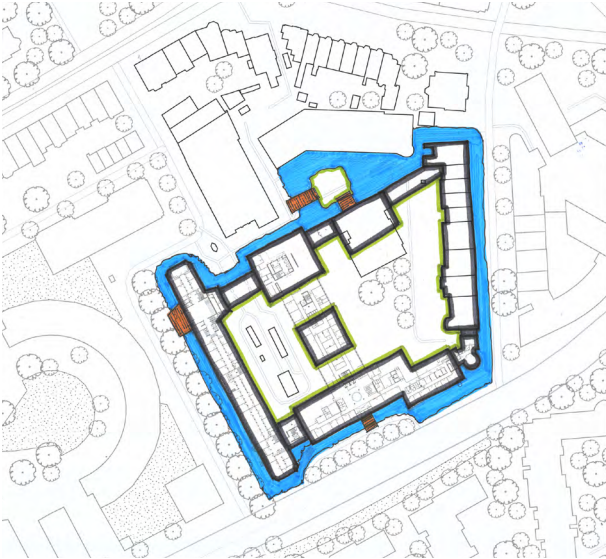
The social community functions are mostly placed on the ground floor, so they are accessible for not only the inhabitants of the building, but also the other inhabitants of the neighborhood. The basement and middle part of the 1981 building are used to house most of the ecological community functions, becoming the beating heart of the building and the neighborhood. The housing types are divided over the two building parts based on the spatial qualities of the different buildings. The split-level basement and ground floor of the 1959 building are used for the work-living apartments, activating the street in front of the building and

creating a local market. The typical 1,2,3-bedroom apartments are placed in the office part of the 1959 building, as this part has a dense structure in which these apartments fit perfectly, creating a mixture of these apartments to keep the neighborhood in balance. The rest of the 1981 building is used for co-housing as the open structure creates large open flexible spaces which are ideal for the collective spaces in co-housing. The roof of the building is used for energy production and a collective roof garden for the inhabitants of the building. The outside around the building is used for urban farming, a market, sports facilities, water treatment, and housing for animals.

Energy concept

The energy concept of the building is closely related to the energy concept of the neighborhood. To reduce the energy demand, insulation will be installed on the inside of the facade, to maintain the value of the facades. Sunshades will be placed on the east, south, and west facades and a green roof will be constructed to keep the building cool in summer. Energy will be produced on the roof of the building. This energy will be stored in the form of electricity, heat, and cold in the basement of the building and is in connection with the local energy grid of the neighborhood. Rainwater will be captured on the roof, as well as grey water and black water, which will be treated using a helophyte filter and an anaerobic digester. This digester produces biogas, that can be used for heating, and fertilizer to be used for urban farming. The circulation cores will house all the technical equipment (heat pumps and ventilation units) and waste chutes for the separation and collection of waste.

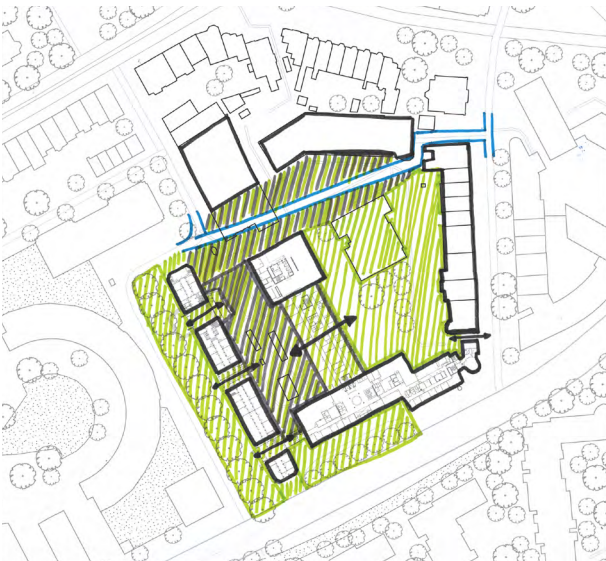
Initial sketches



The building as castle: exaggerating the original concept



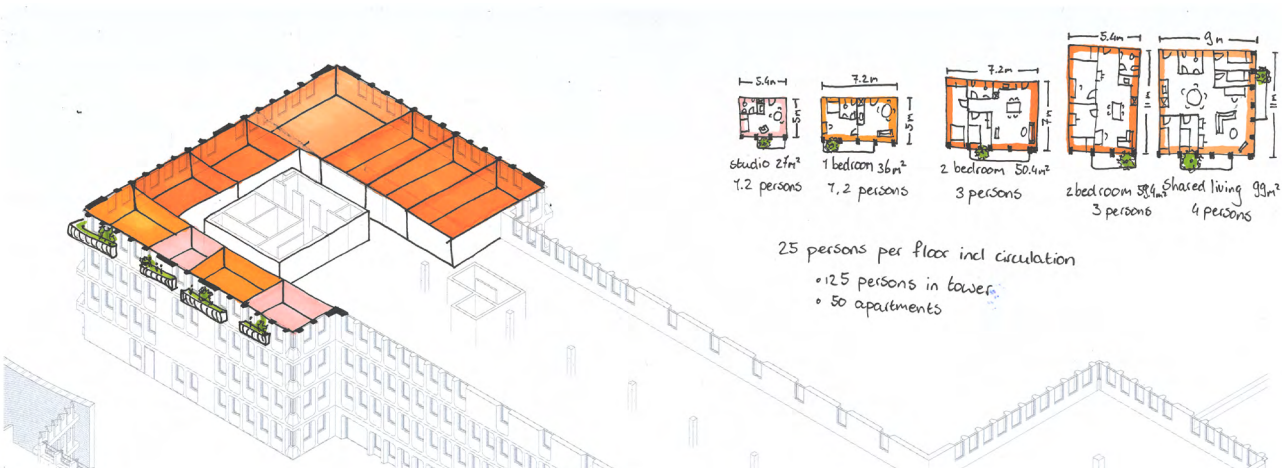
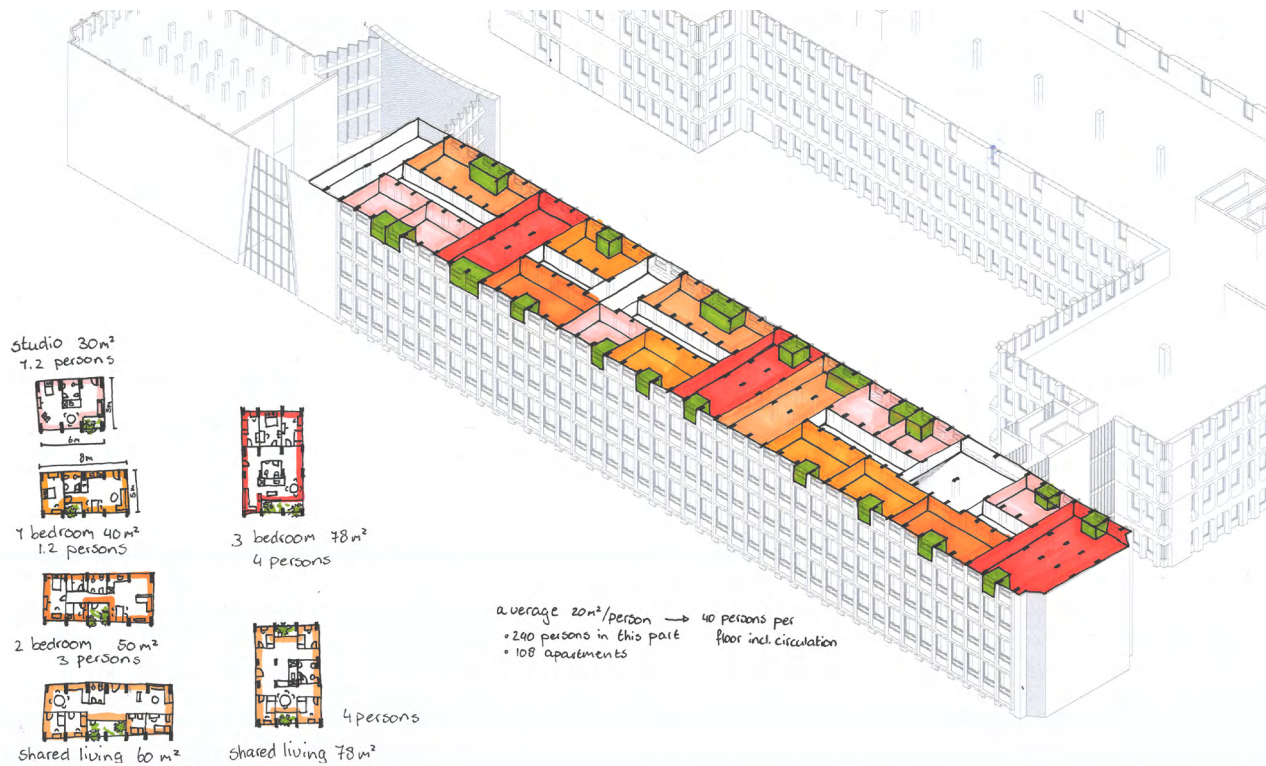
Village created on top of the existing building



Connecting the courtyards by removing parts of the building

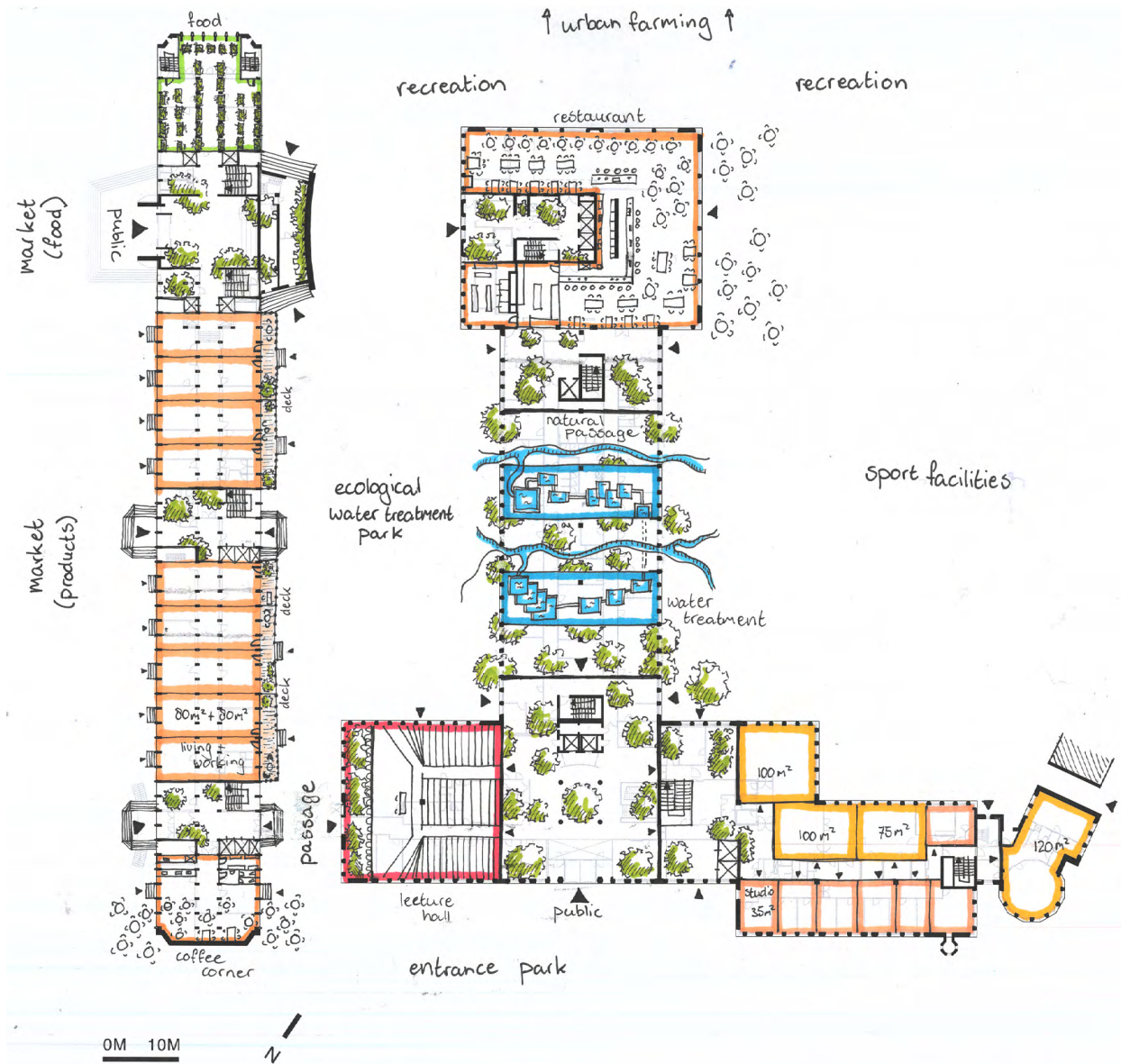


Concept of connecting the different flows in the neighborhood

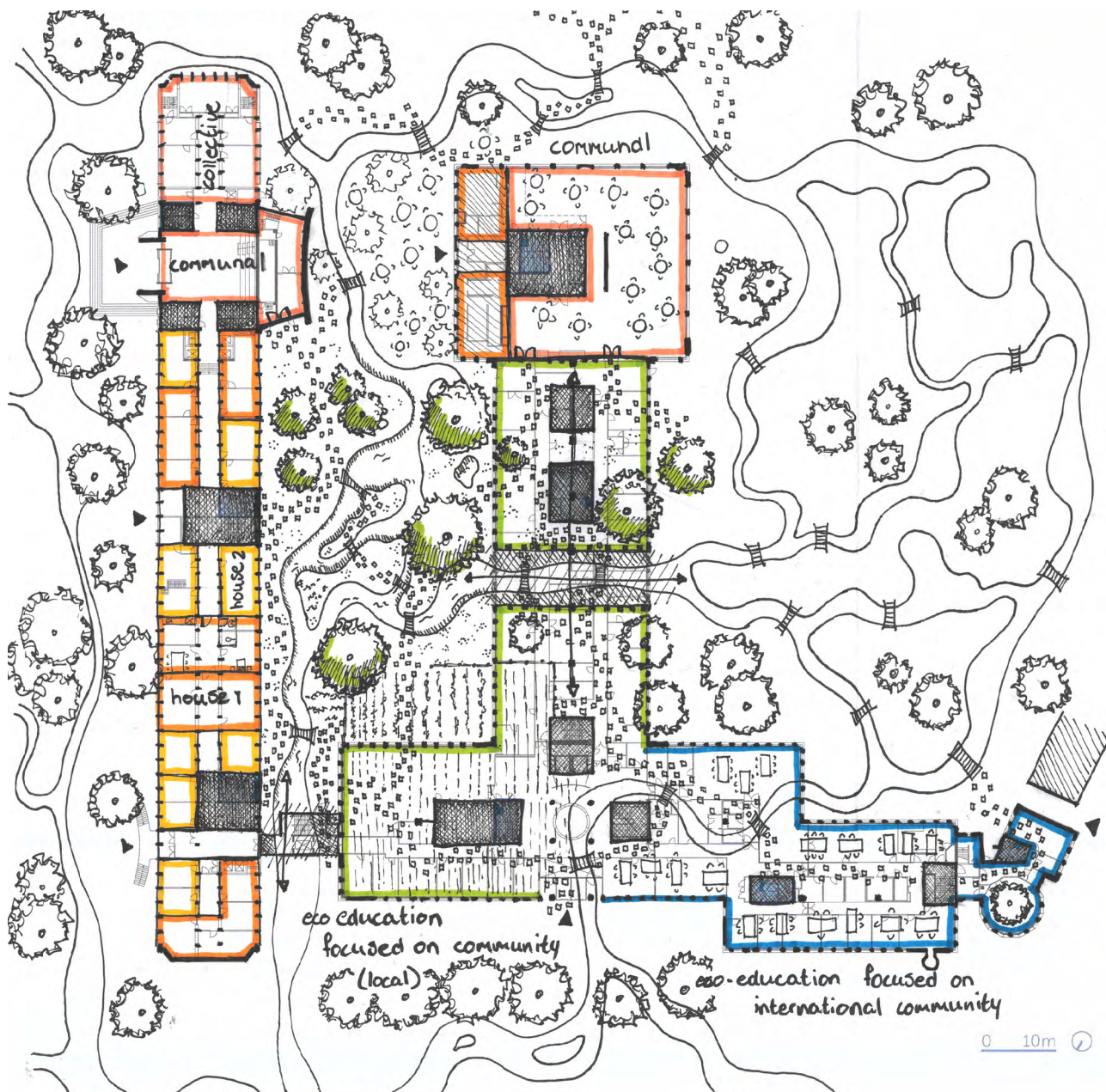


Different housing types placed into the 1959 building (top) and the 1981 building (bottom)

Program in floorplans

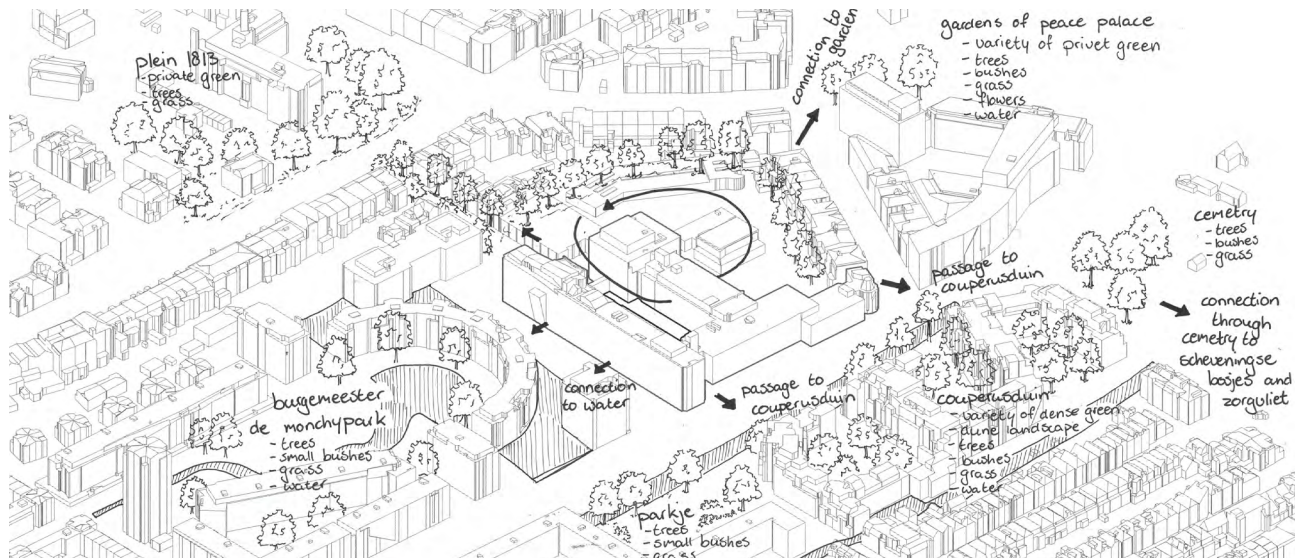


Placement of the program into the floorplans



Design for the courtyards with a connecting water stream throughout the site and even through the building

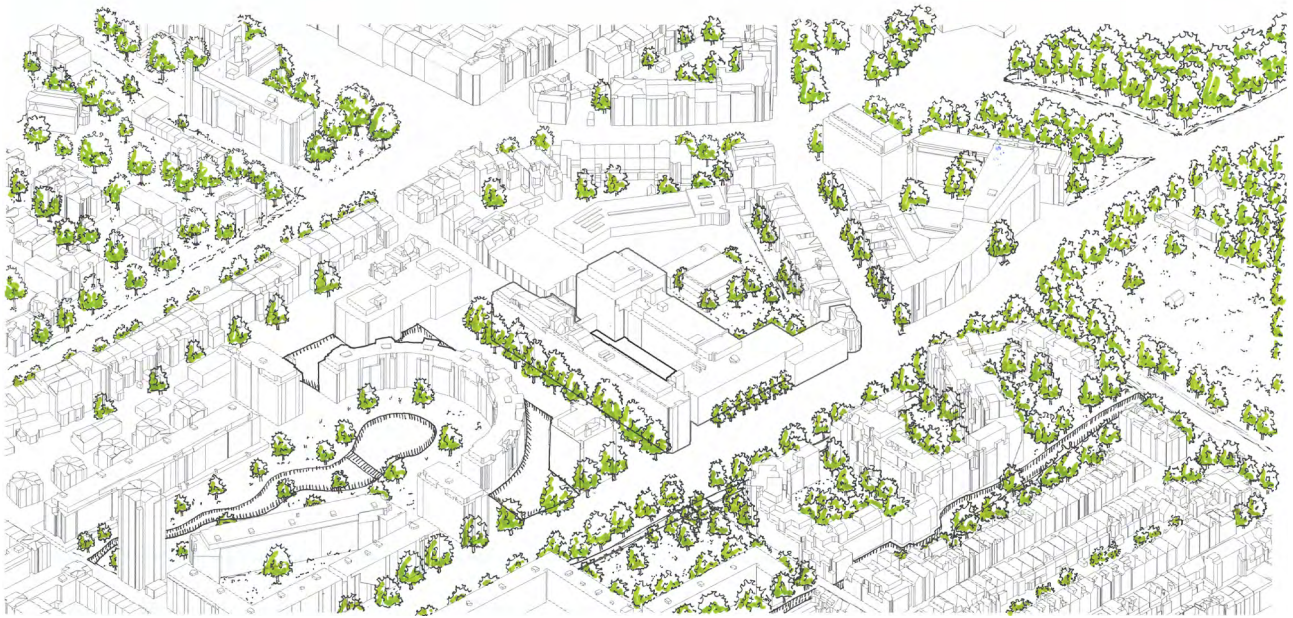
Relation with surrounding greenery



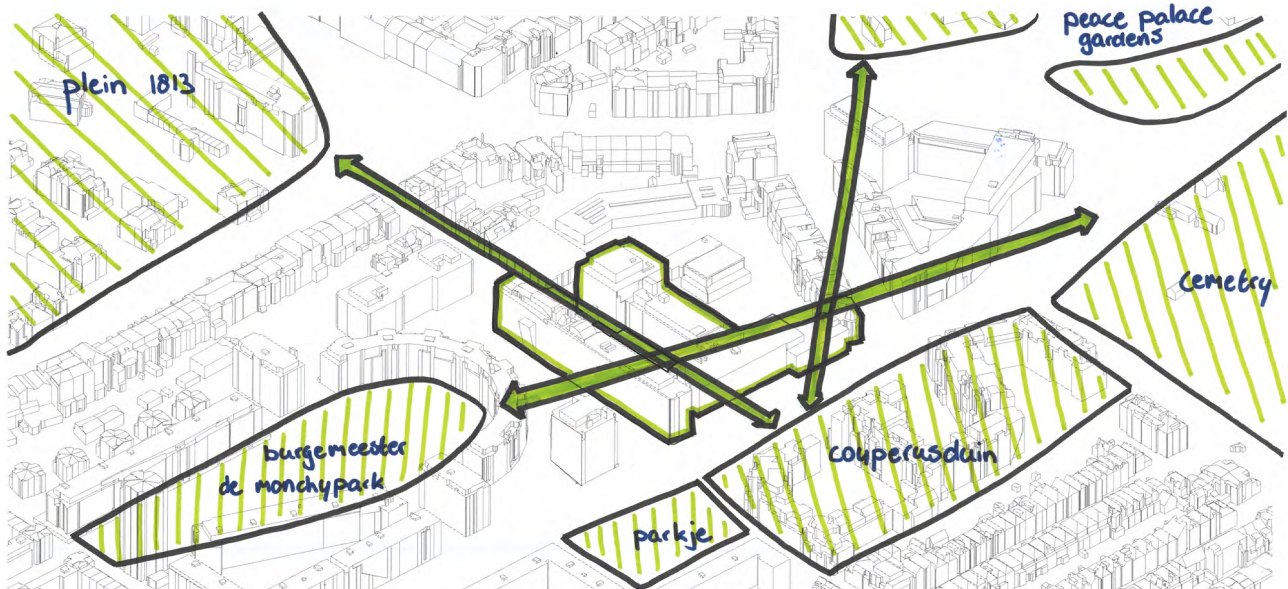
Building as ecological centre point



Important greenery and other functions in the Archipelbuurt

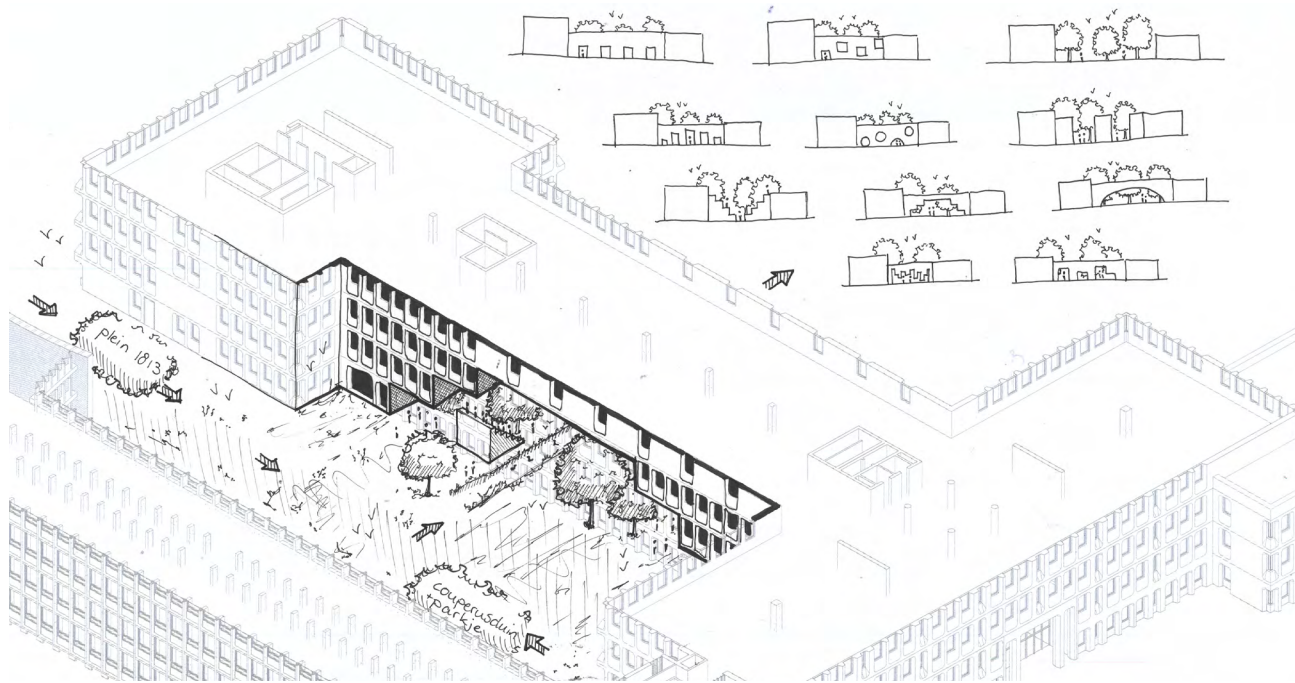


Trees and water in the surroundings of the Eenheidsbureau

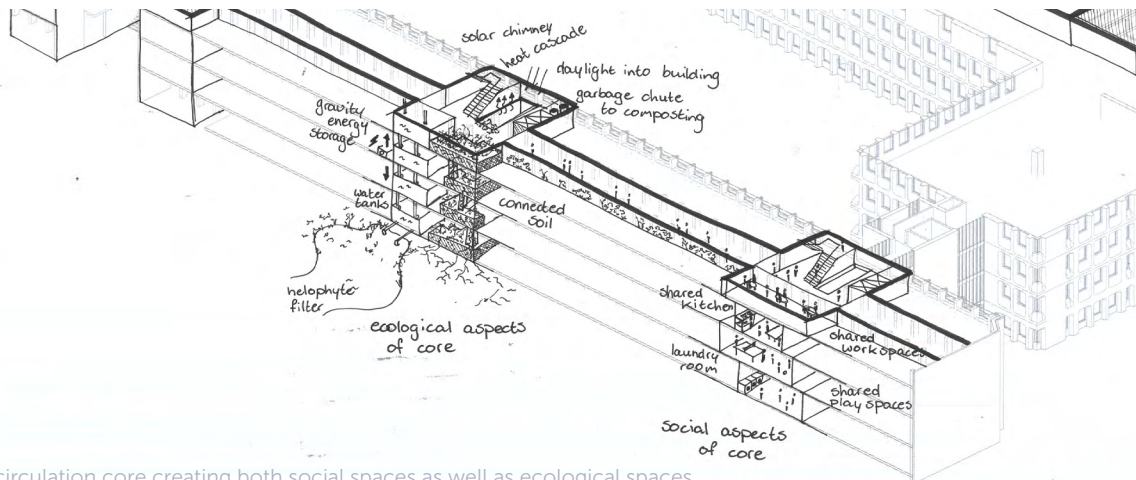


The building as a connection point for the different ecosystems in the neighborhood

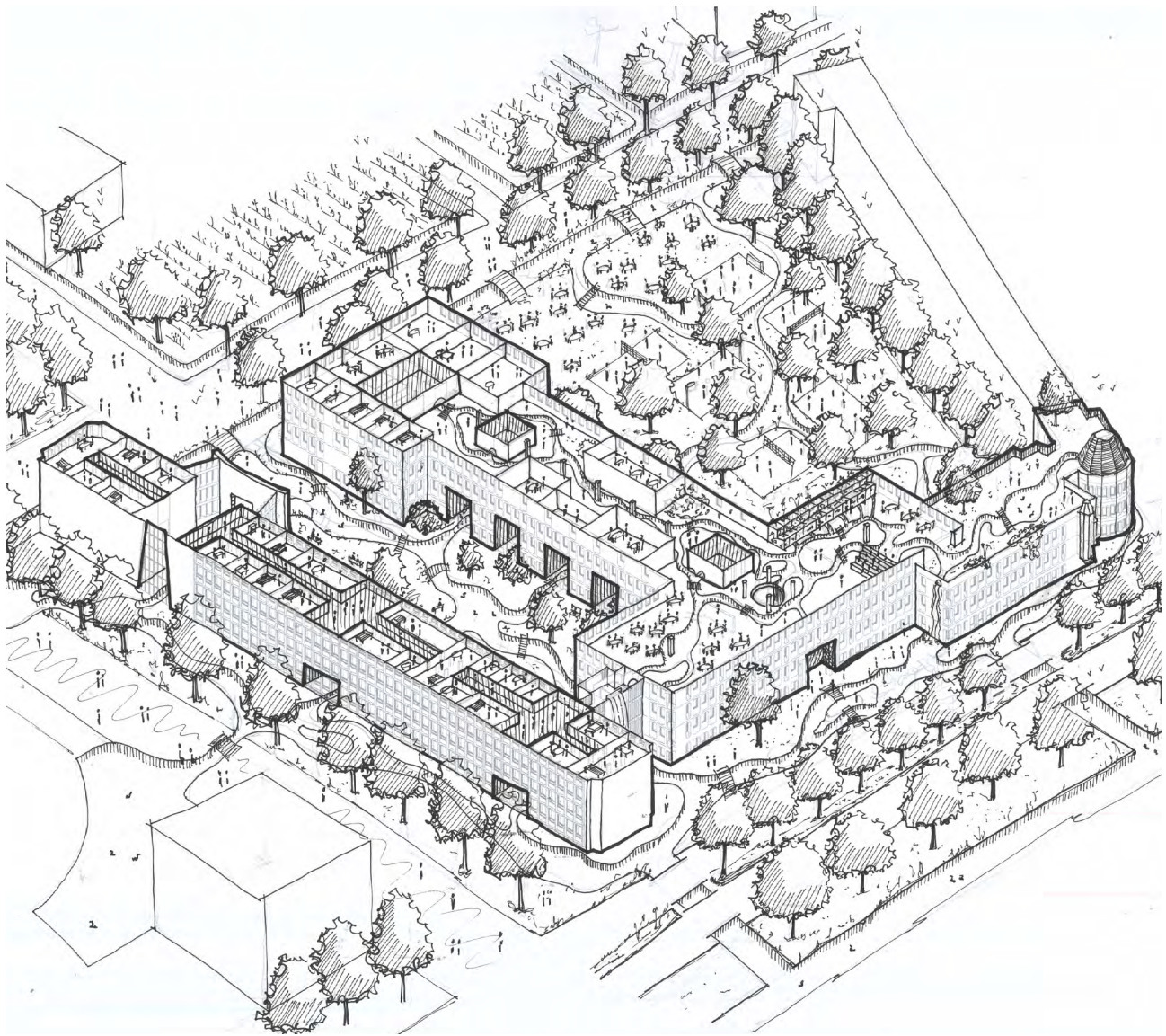
Connecting the outside and inside



Study into the possibilities for the connection between the two courtyards

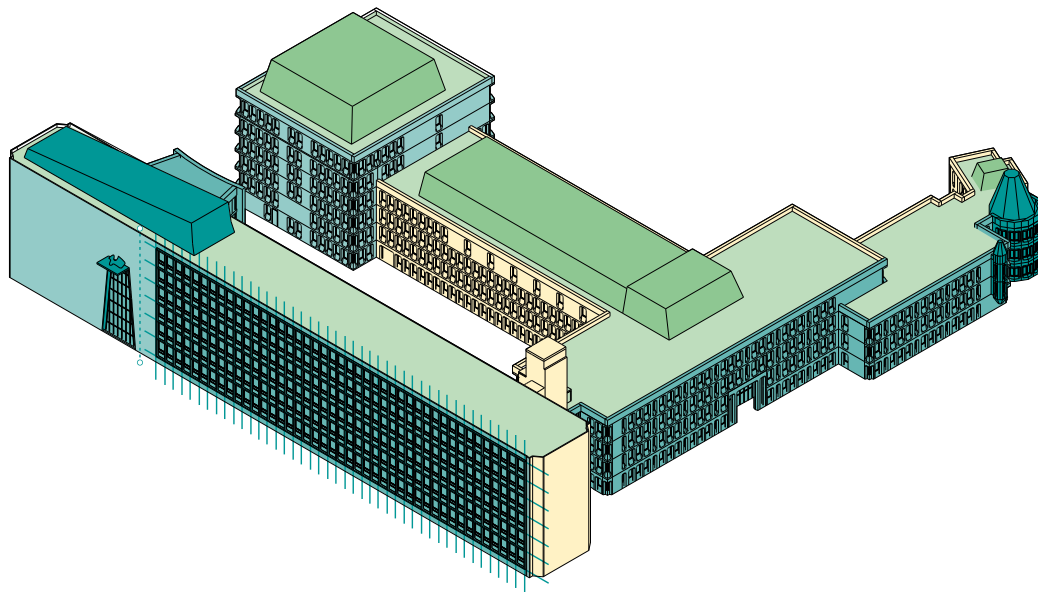


Design for the circulation core creating both social spaces as well as ecological spaces



Isometric of the integration between the inside and outside of the design creating one continuous space

Combined transformation frameworks

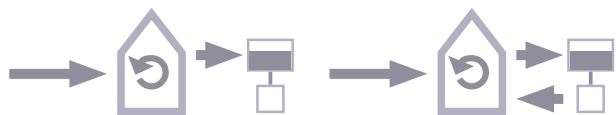
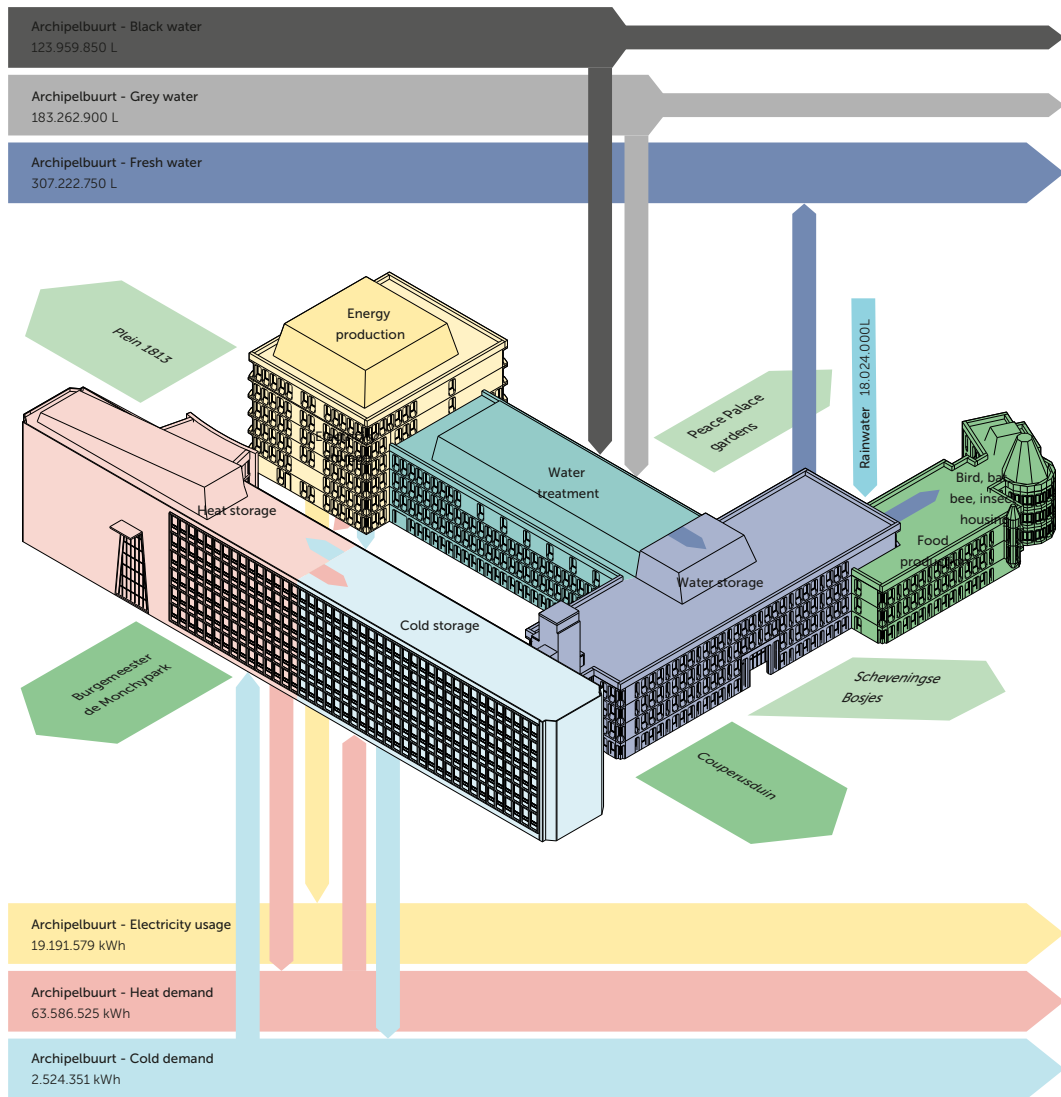


high value - should be preserved as much as possible

medium value - careful changes are possible

low value - opportunities for change





4. Process waste



5. Re-use the effluent

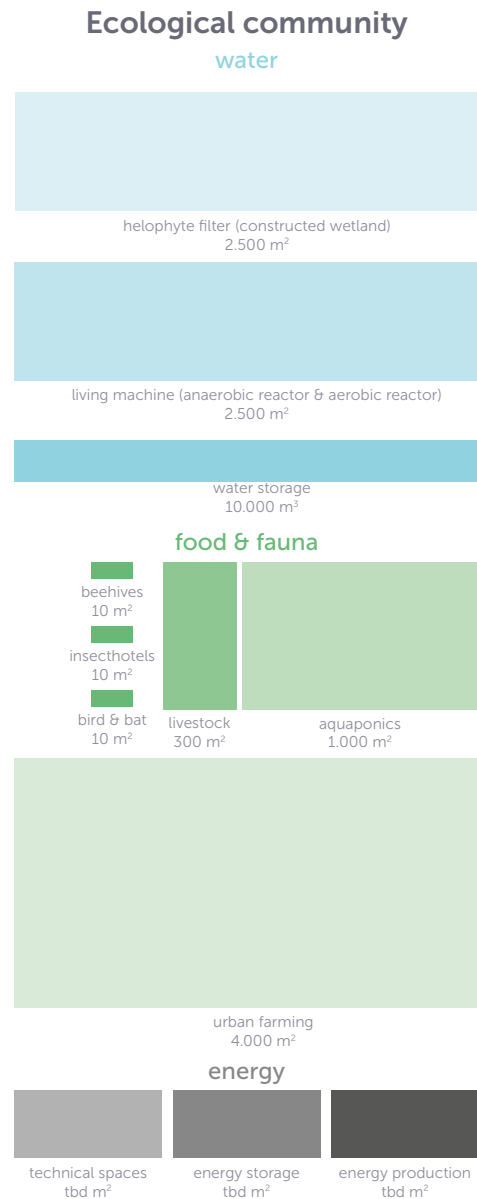
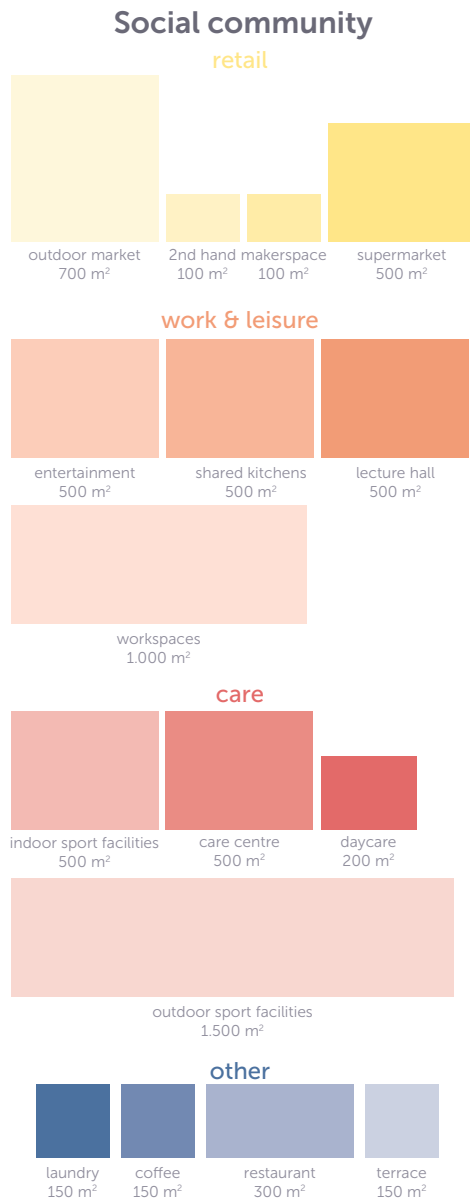


6. Supply demand sustainably



7. Waste equals food

Evolved program of requirements

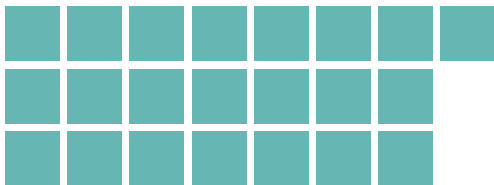


Housing

1,2,3 - bedroom apartment



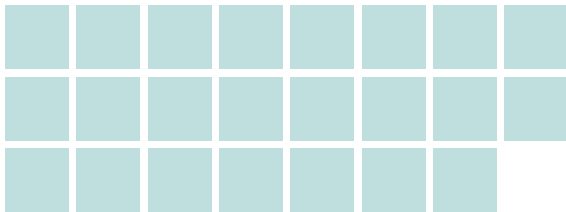
studio (13x)
30 m²



1-bedroom (22x)
55 m²

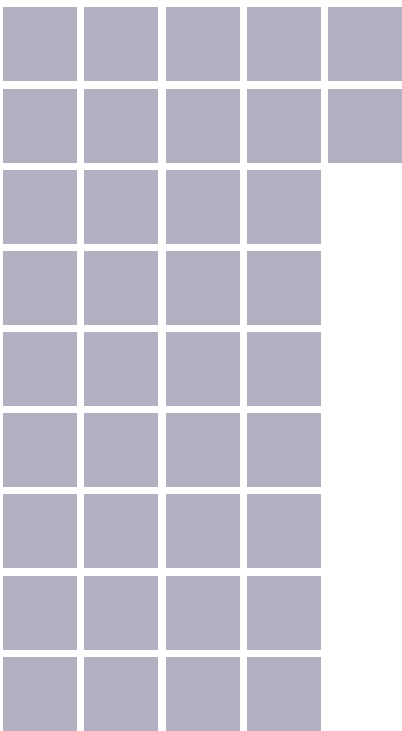


2-bedroom (13x)
75 m²



3-bedroom (23x)
85 m²

co-housing



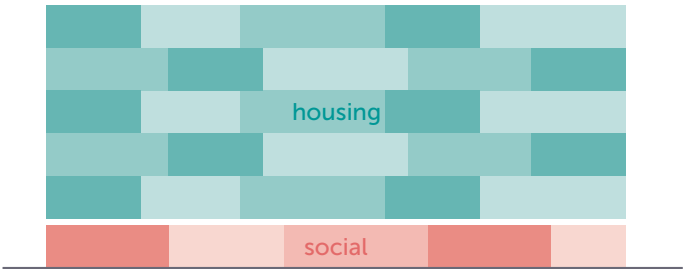
4 - 12 persons (38x)
100 - 200 m²

work-living apartment



3-bedroom (9x) workspace (9x)
80 m² 80 m²

Design guidelines



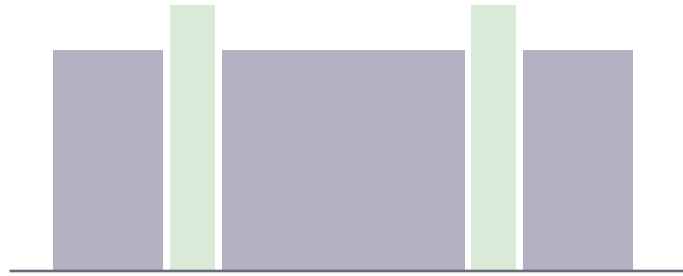
social interactive ground floor with housing on top



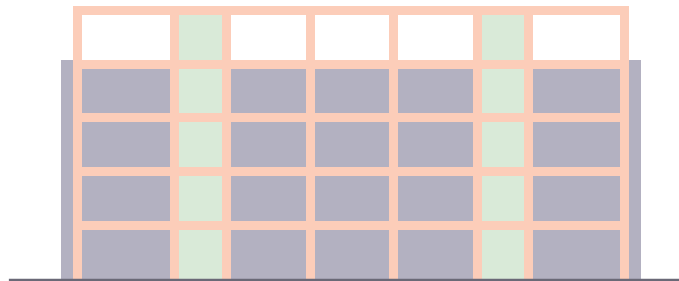
housing types based on values of structure



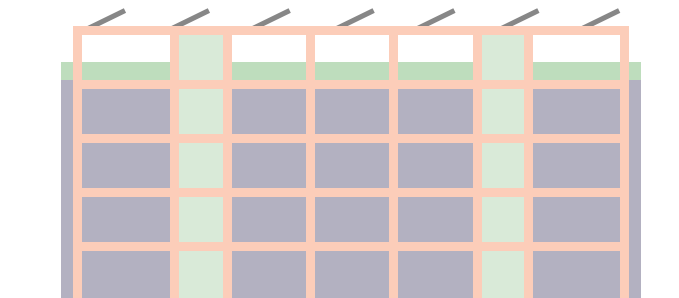
living machine as heart of the building



circulation cores house social and ecological spaces
and connects the houses with the living machine



a gallery and balconies are added for accessibility,
social interaction & ecology



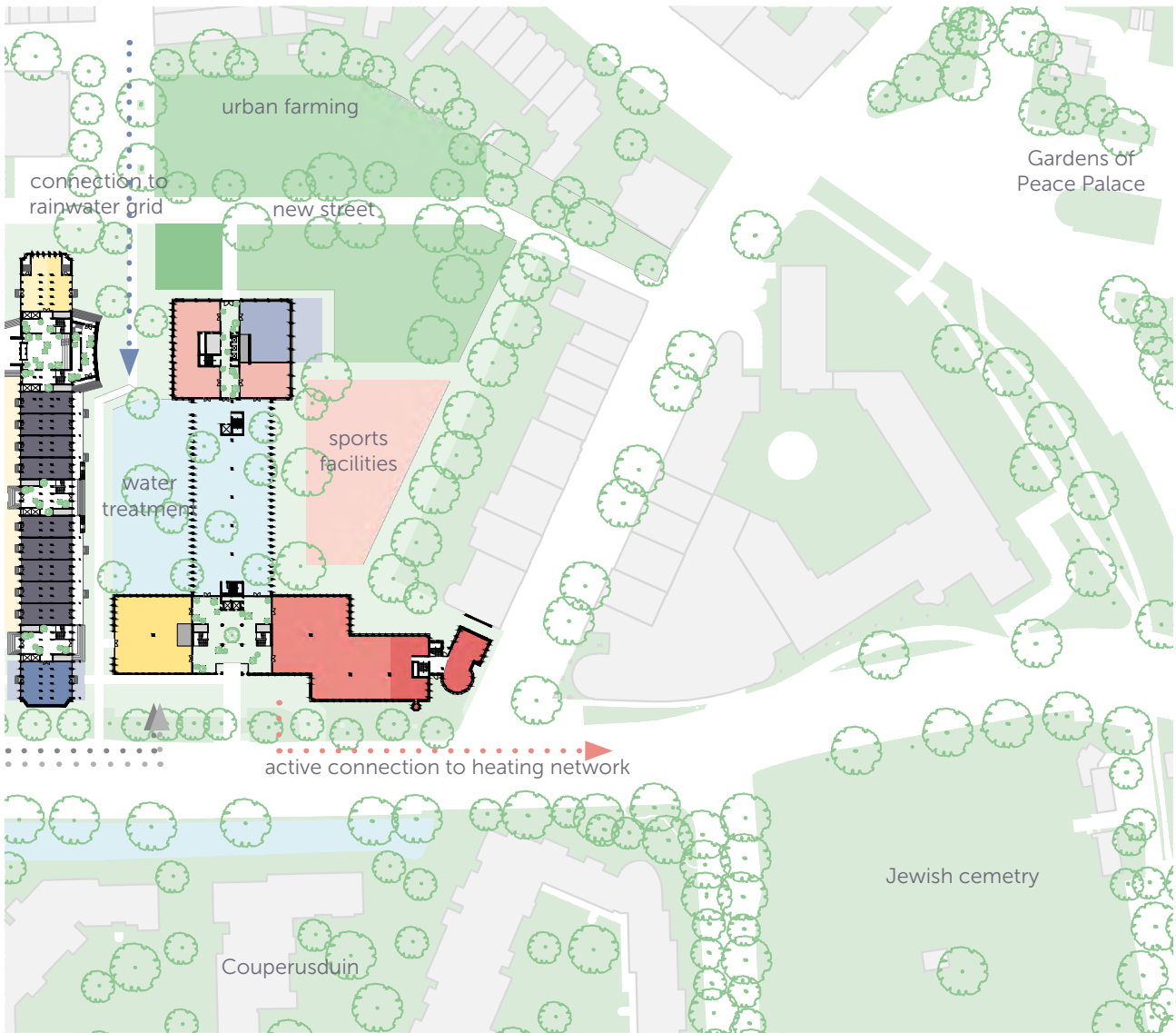
roof used for energy, social space and natural habitat

Site plan



other actors
urban planner
landscape architect

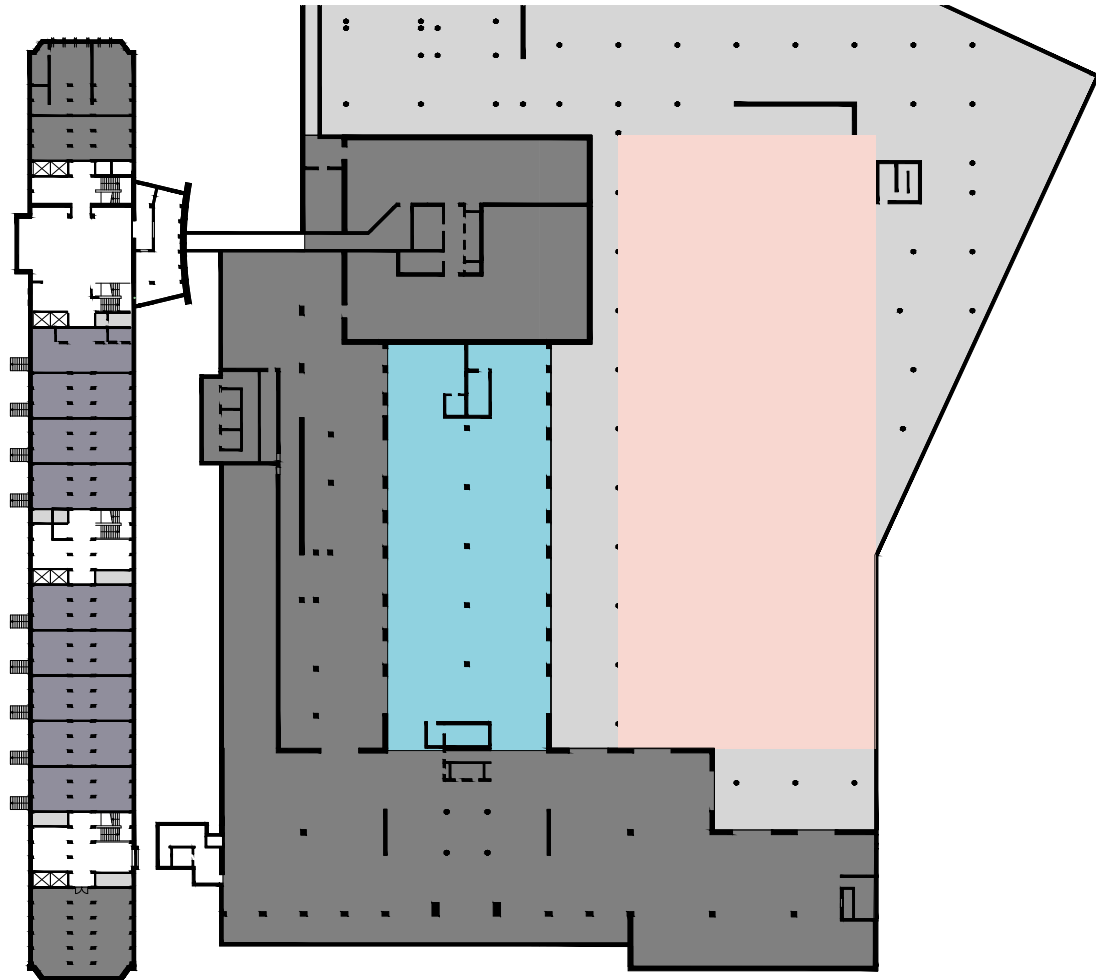
redesign of grid networks in neighborhood
knowledge of flora & fauna



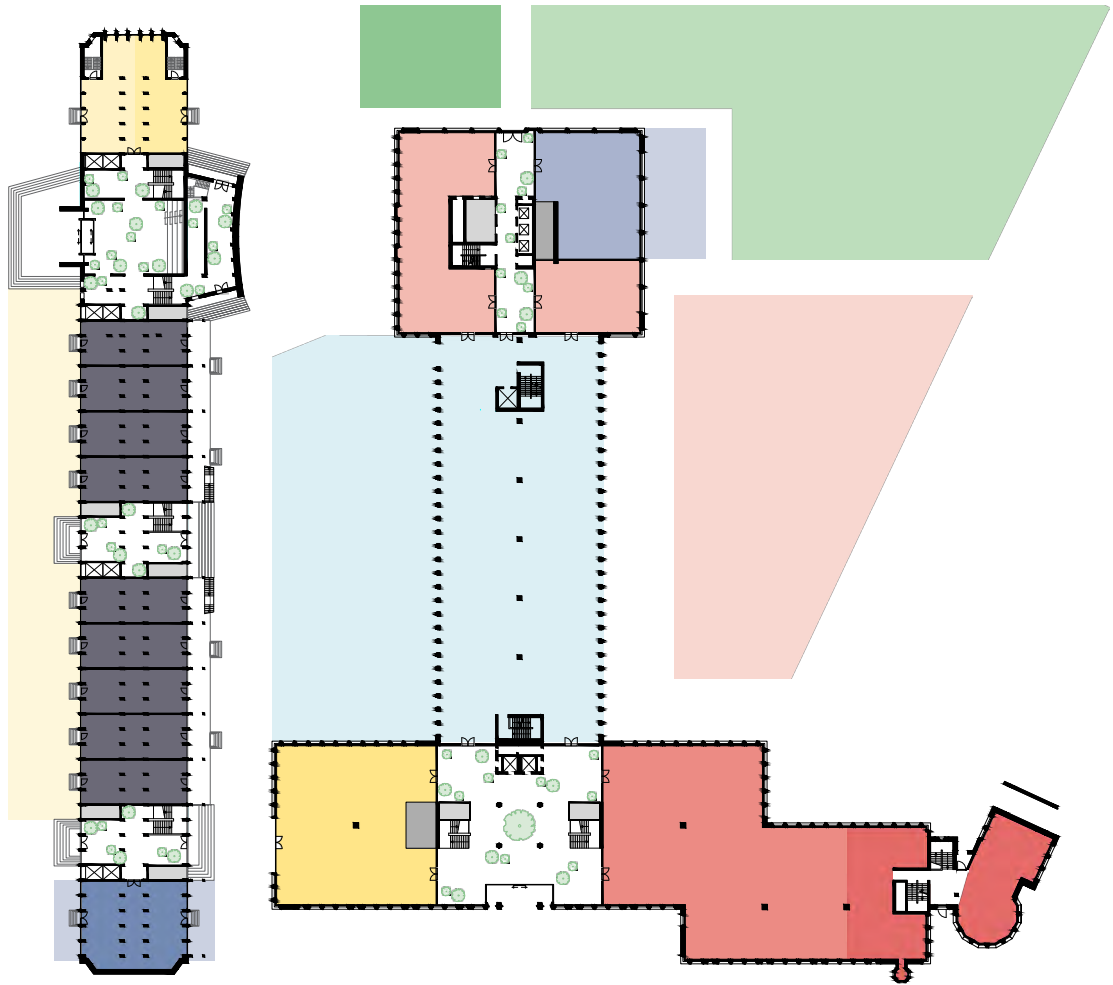
The Hague
Dunea

responsible for public space & sewage system
responsible for fresh water

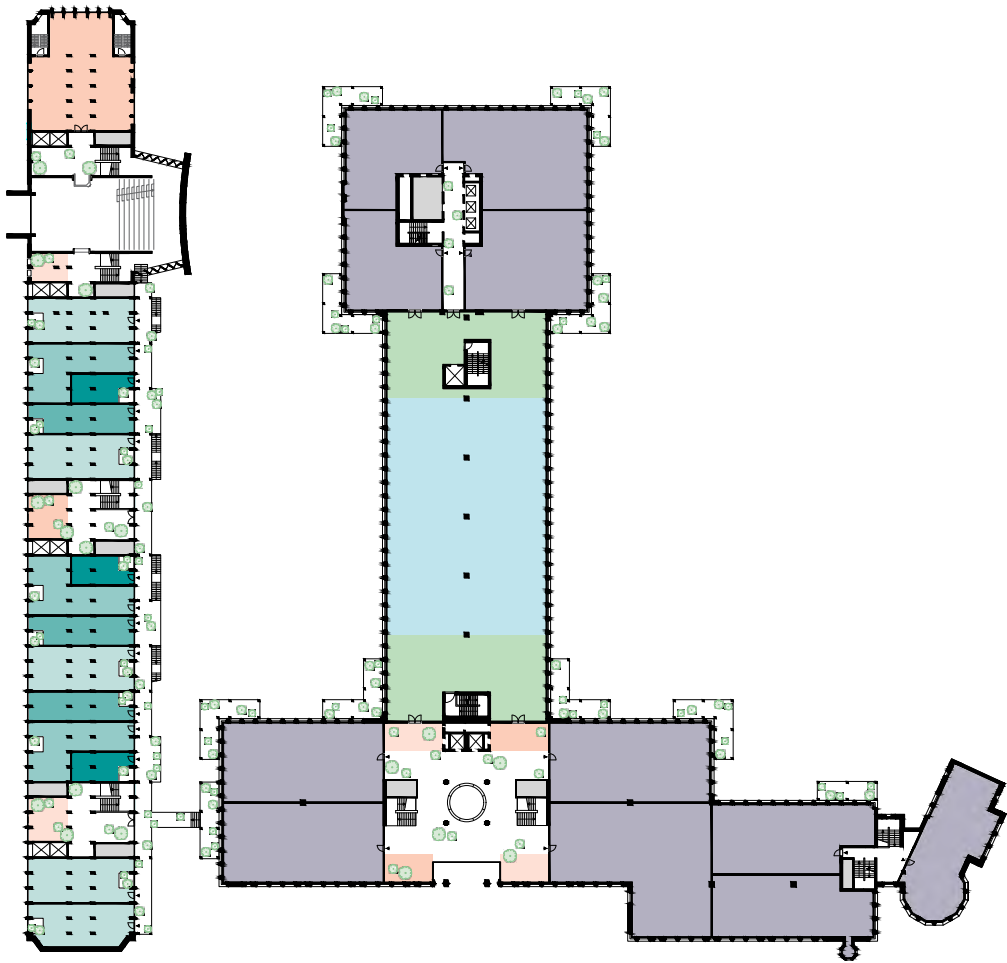
Stedin responsible for gas & electrical
Eneco responsible for heat



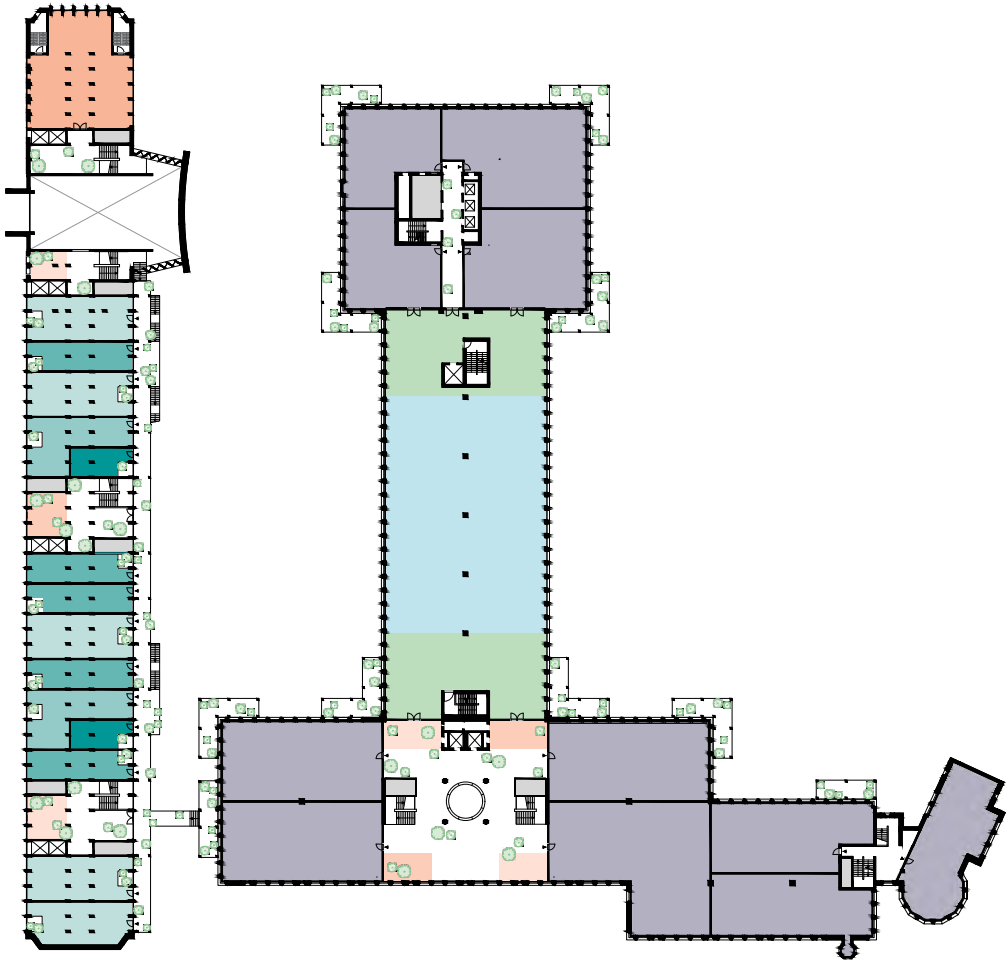
- | | | |
|---|---|---|
|  work-living apartment |  market |  2nd hand shop |
|  technical space / heat & cold storage |  maker-space |  supermarket |



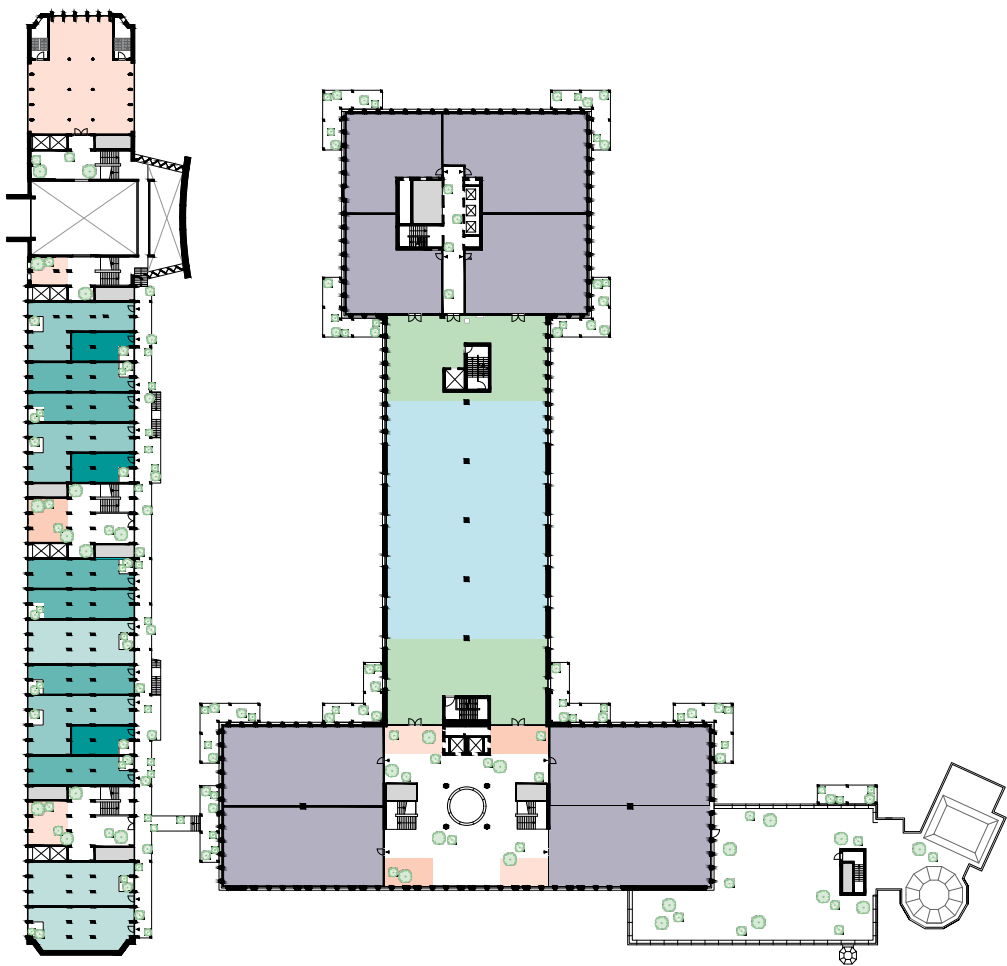
- | | | | | |
|---------------------------|---------------|---------------|------------------|---------------|
| outdoor sports facilities | care centre | coffee corner | restaurant | urban farming |
| indoor sports facilities | child daycare | terrace | helophyte filter | livestock |



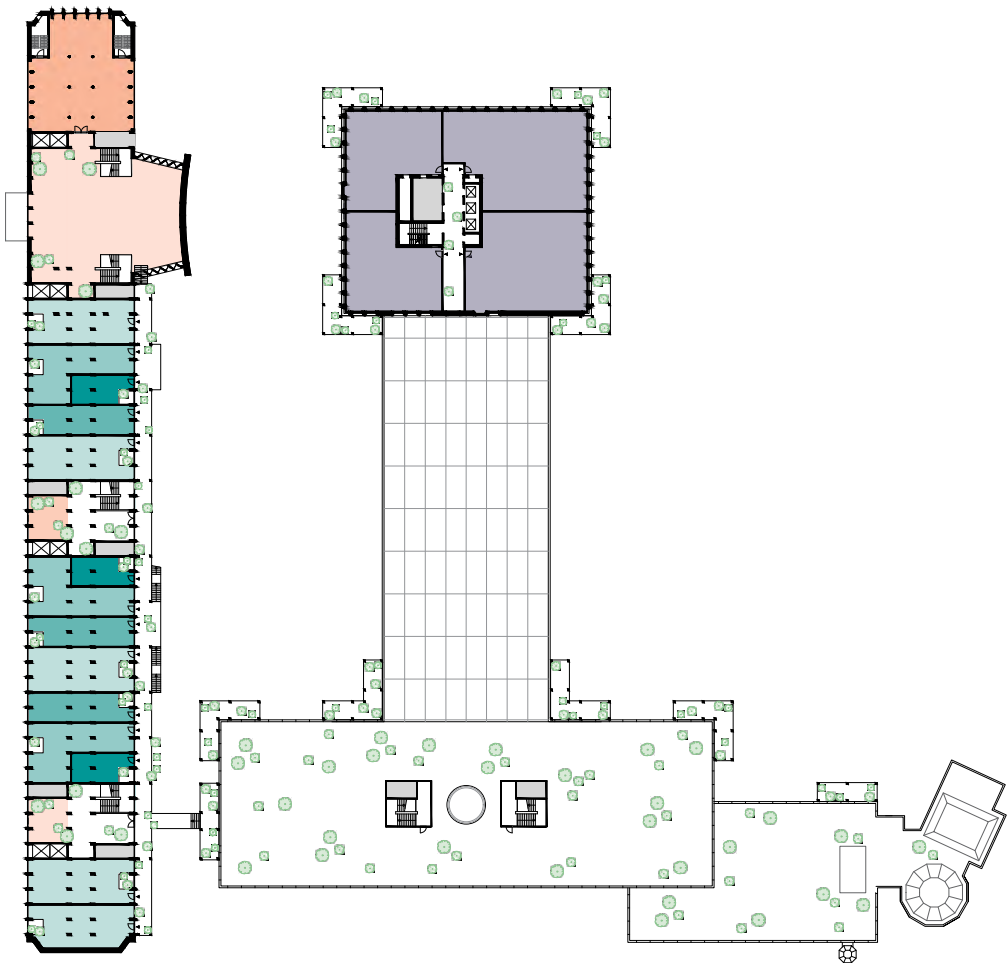
- | | | | |
|-----------|-----------|-----------------|-----------------------------------|
| studio | 1-bedroom | co-housing | aquaponics |
| 2-bedroom | 3-bedroom | technical space | living machine (aerobic digester) |



- workspace
- lecture hall
- entertainment space
- shared kitchen



- | | | | |
|-----------|-----------|-----------------|-----------------------------------|
| studio | 1-bedroom | co-housing | aquaponics |
| 2-bedroom | 3-bedroom | technical space | living machine (aerobic digester) |

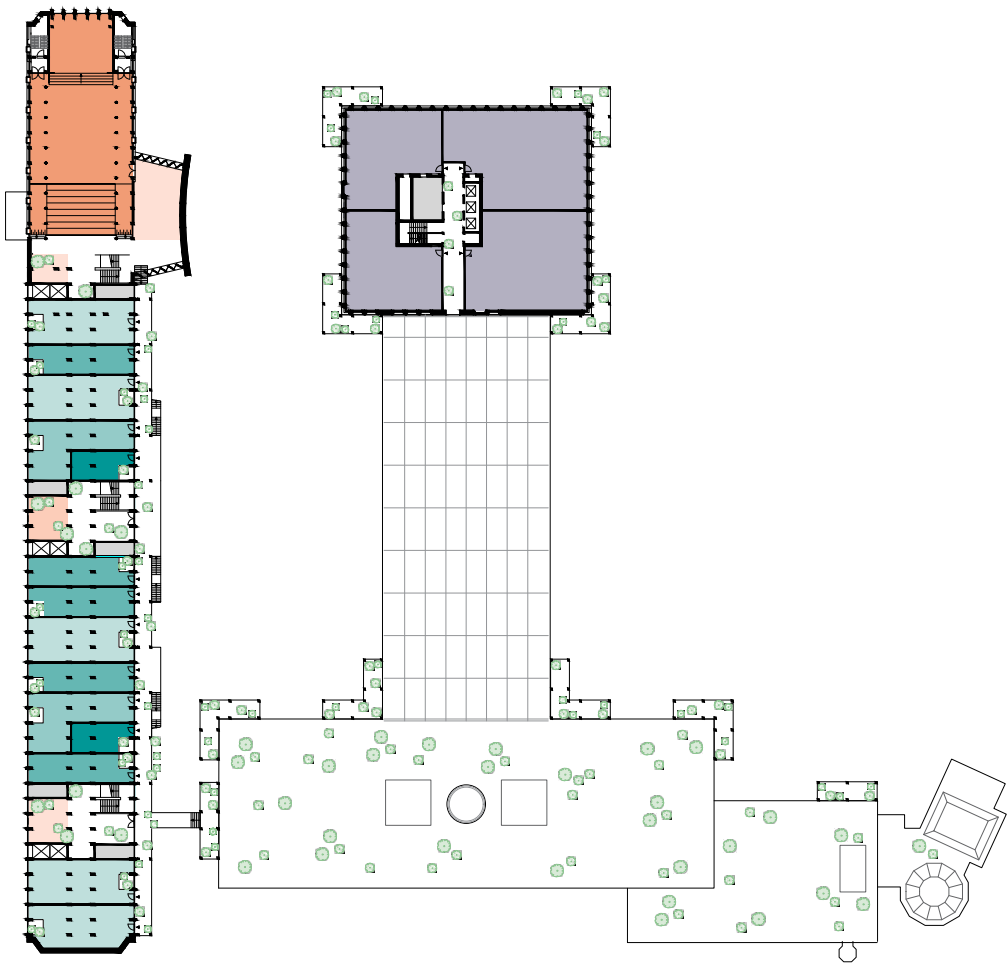


workspace

lecture hall

entertainment space

shared kitchen



studio

1-bedroom

co-housing

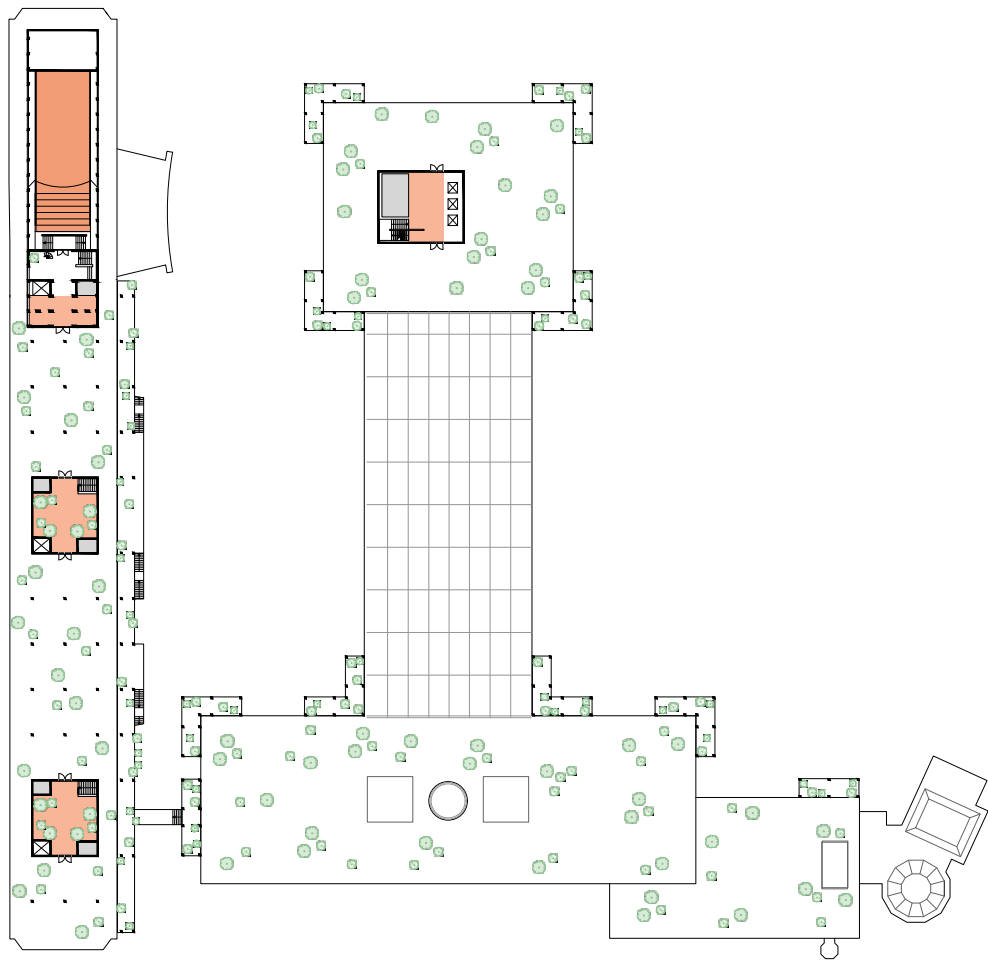
aquaponics

2-bedroom

3-bedroom

technical space

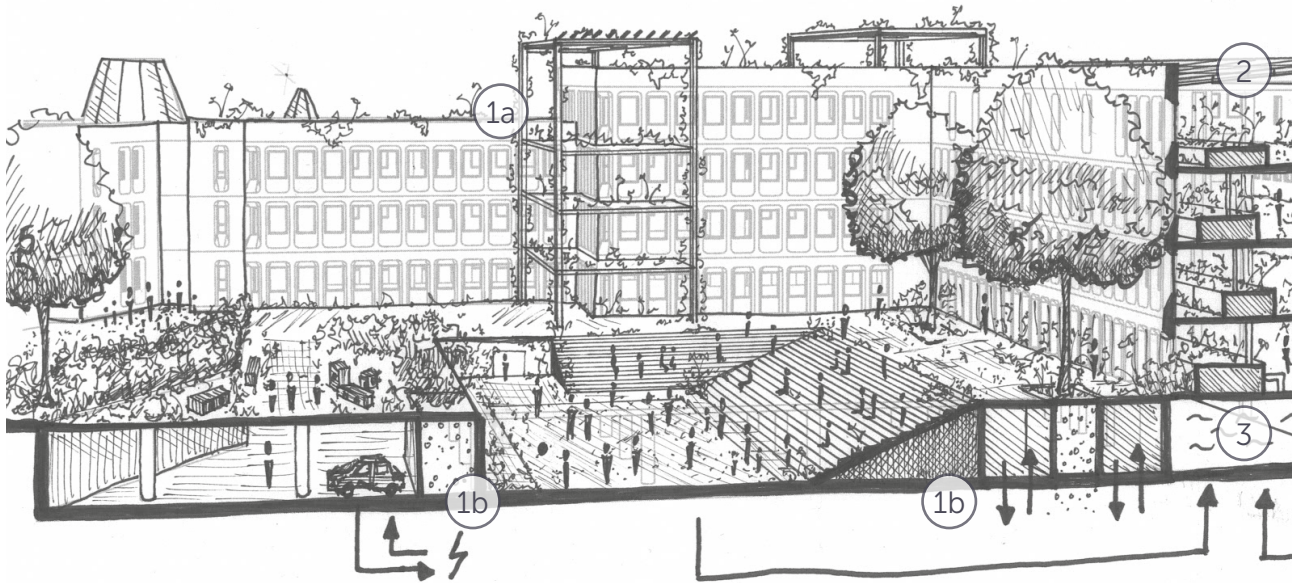
living machine (aerobic digester)



- workspace
- lecture hall
- entertainment space
- shared kitchen

Energy concept

- 1a. insulation, sunshading, green roof
- 1b. storage of water, heat/cold, electricity
- 2. heat cascade from cooling, heat from living machine



0. Analyse existing situation



1. Reduce demand



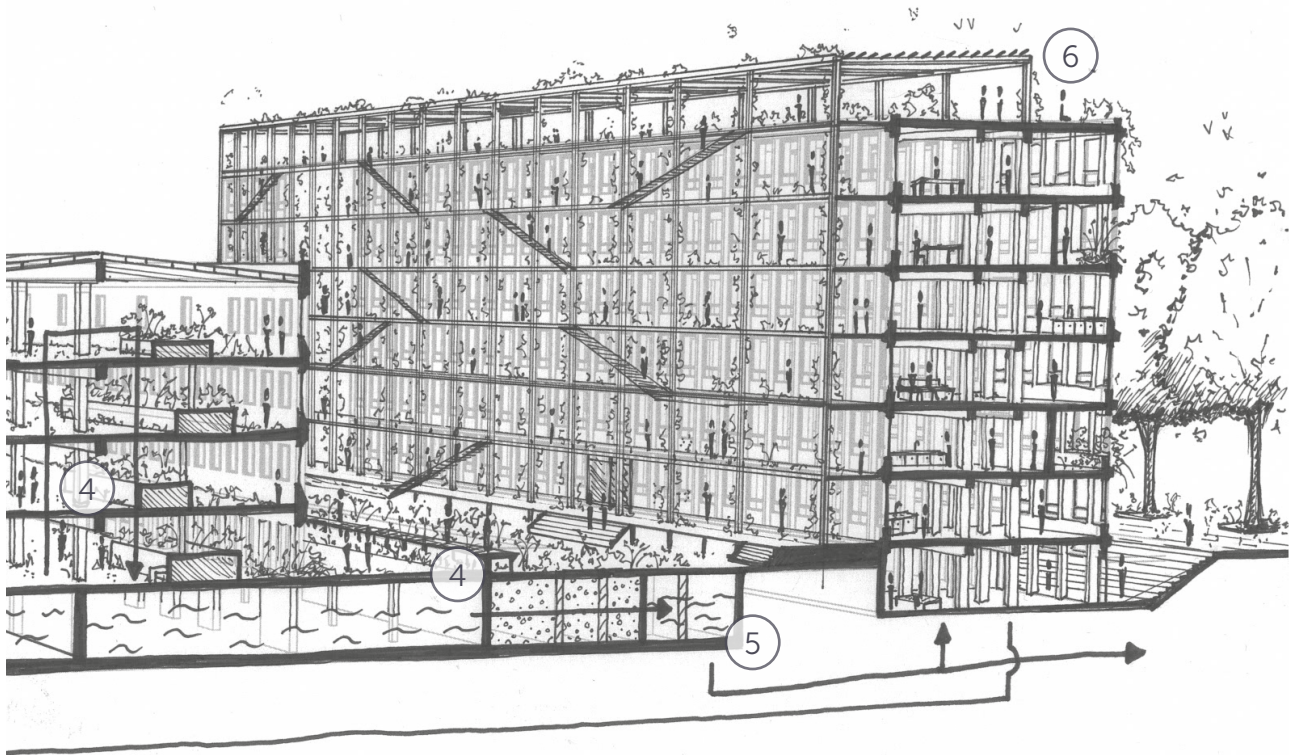
2. Recycle internally



3. Collect waste

- 3. collection of waste water, waste chutes in cores,
- 4. treatment of water with living machine
- 5. water & energy reused in building & neighborhood

- 6. pvt panels on roof & CHP
- 7. organic waste into fertilizer



4. Process waste



5. Re-use the effluent



6. Supply demand sustainably



7. Waste equals food

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Design development in 5 elements

29.08.2022 - 08.12.2022

Design process

Design core idea

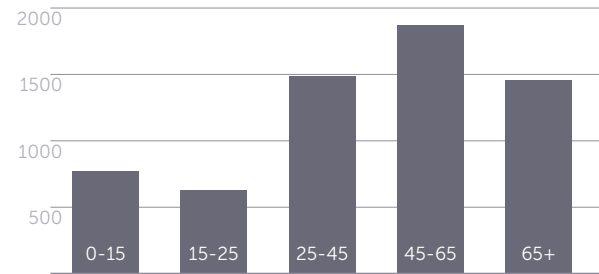
The main question of the research and the design is how we will live together. This concept has been split into three aspects of humans + nature, humans + humans, and humans + buildings. Each of these aspects has their own research direction. The aspect of humans + nature is researched with the urban metabolism research, while the aspect of humans + buildings is researched with the Spatial Building Typology research and the heritage value assessment. The aspect humans + humans is based on healthy living for a wide range of target groups.

Defined target groups

The chosen target groups for the redesign of the building are based on the current demography of the neighborhood as well as the current societal needs. This resulted into a wide range of target groups with the concept of growing within the building.

Design goals

The three different research directions each resulted into a program as well as design goals. The design goals are visualized on the next page and grouped for each of the research aspects, humans + nature, humans + humans, and humans + buildings. These design goals have been used to guide the design and make decisions during the process. These goals are not completely fixed and have evolved during the research and design process of the entire project. The program of the redesign of the Eenheidsbureau is visualized on the next couple of pages.



current demography Archipelbuurt



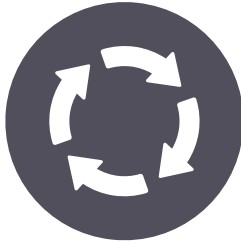
current societal needs



concept of growing within the building

Design goals

humans + nature



Contribute to closing the **water, energy, and material cycles** for the **building** as well as the **neighborhood**



Connect to surrounding **blue/green structures**



Create **awareness, appreciation,** and provide **education** on relation with nature

humans + humans



Stimulate **social interaction** and **cohesion** of **inhabitants** and **neighborhood** to prevent loneliness



Stimulate **healthy living**



Create a building suited for a wide **mix of target groups**, allowing **growth** within the building

humans + building



Respect high value elements, allowing change in low value elements



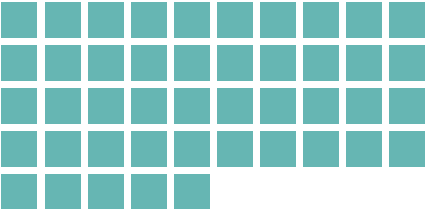
Utilize characteristics and potential of existing building for placement of **program**

Program

bedroom apartments



studio 30 m² (20x)



1-bedroom 55 m² (45x)



2-bedroom 75 m² (20x)

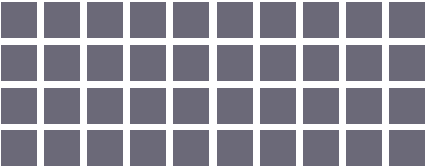


3-bedroom 85 m² (15x)

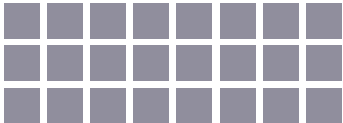
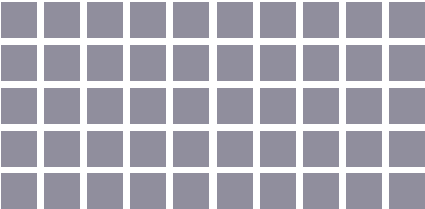
co-housing



3 apartment houses 100 m² (10x)



4 apartment houses 150 m² (10x)



5 apartment houses 200 m² (15x)



6 apartment houses 250 m² (3x)

work-living apartment



work-living apartment 160 m² (12x)

Program

energy



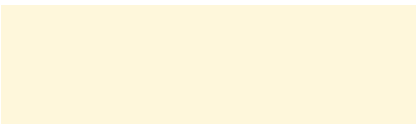
photovoltaic-thermal (PVT) panels 4800 m²



combined heat-power plant (CHP) 100 m²



heat exchanger roof 200 m²



seasonal heat & cold storage 2000 m²

health care & sports



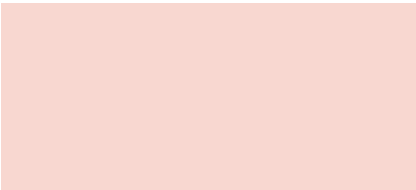
health care centre 800 m²



child daycare 400 m²



indoor sport facilities 300 m²



outdoor sport facilities 2400 m²

water



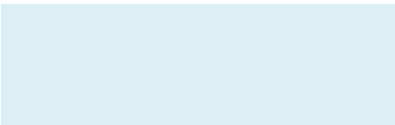
water treatment indoor 2500 m²



water treatment outdoor 1250 m²



water storage 1000 m²



natural water for biodiversity 2000 m²

work & leisure & education



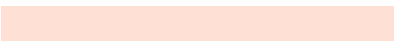
workspaces 800 m²



shared kitchens 800 m²



entertainment spaces 800 m²



education spaces 400 m²

flora & fauna



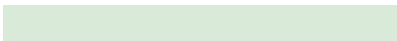
urban farming 4000 m²



habitat for fauna 400 m²



digester 100 m²



organic waste chutes 100 m²

food & drinks



supermarket 400 m²



restaurant 400 m²

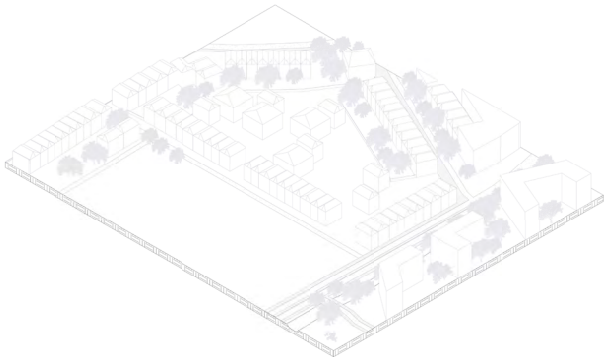


café/coffee corner 120 m²

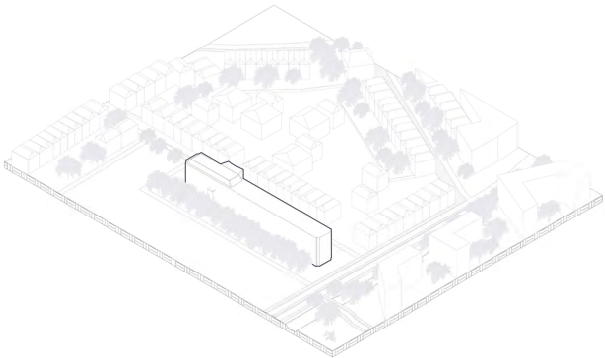


terrace 800 m²

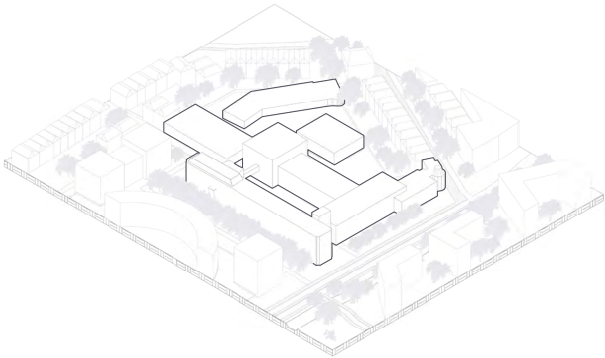
Existing



1900

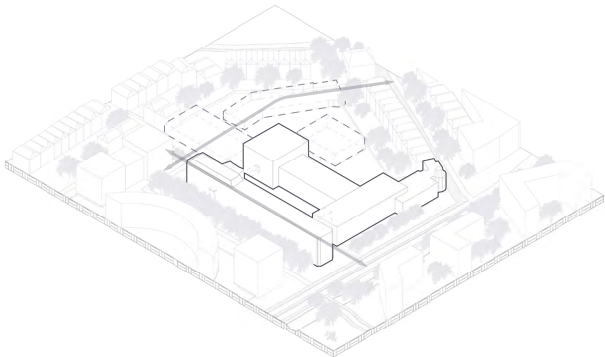


1959

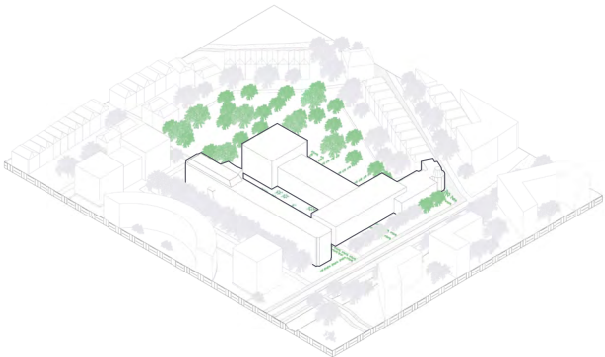


1981

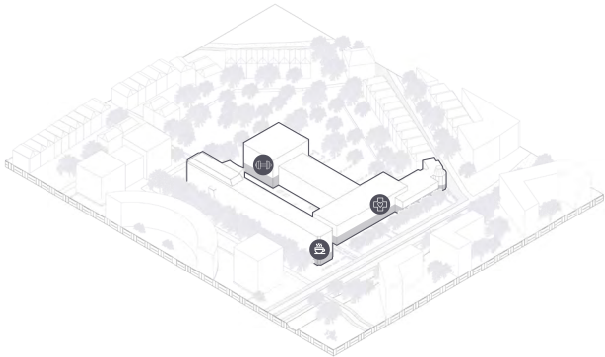
Design proposal



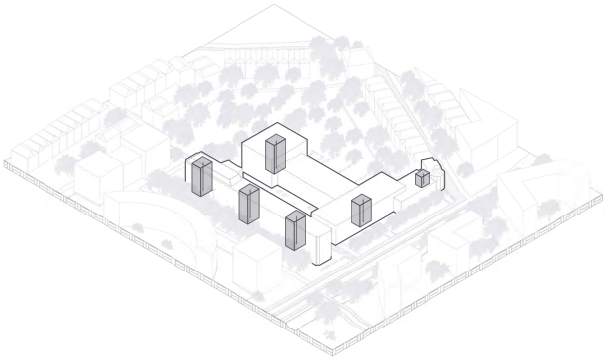
open urban block



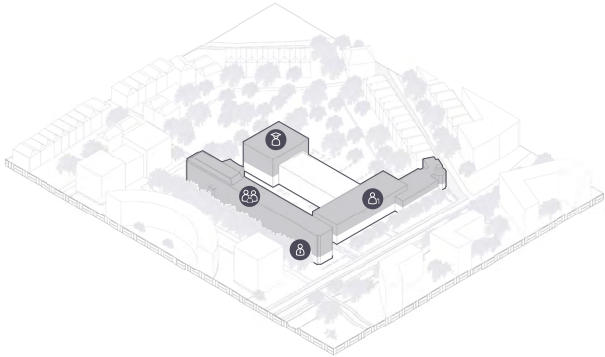
connection with green/blue structures



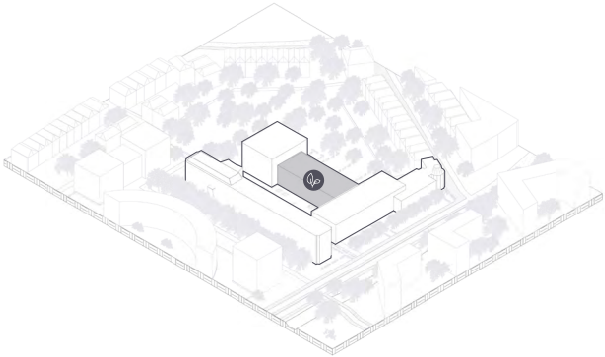
public function on ground floor



circulation cores



variety of housing types

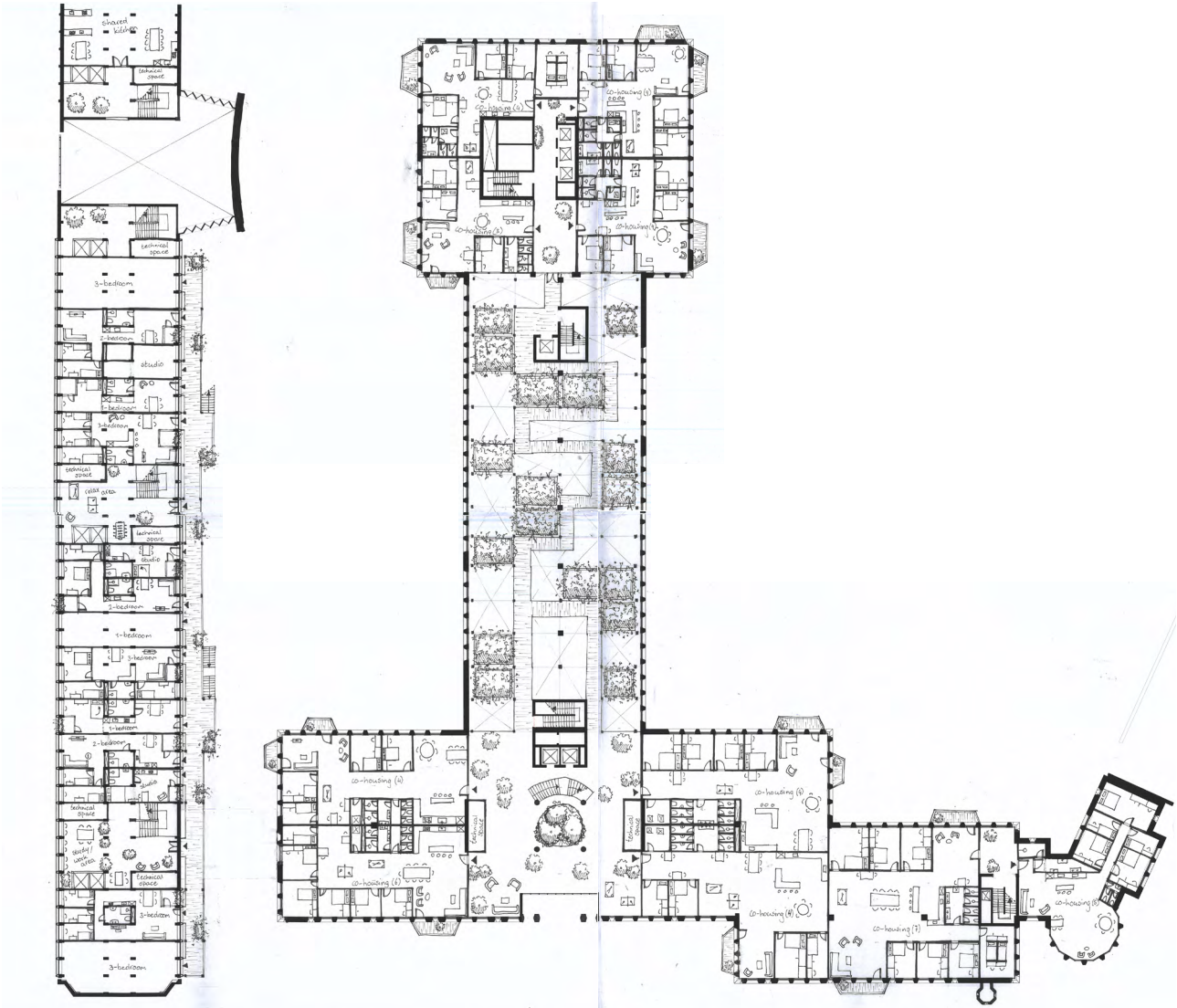


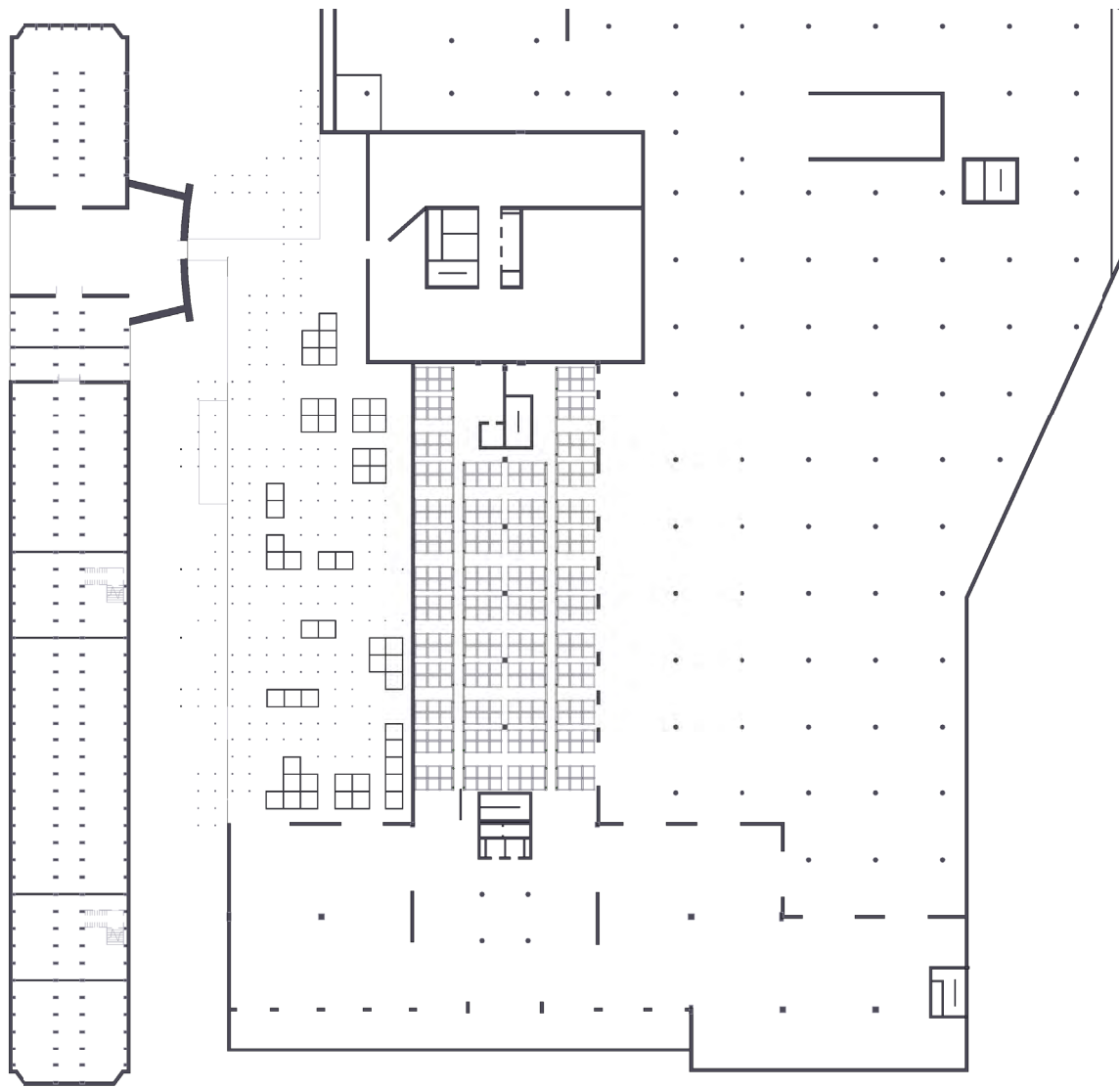
living machine as beating heart

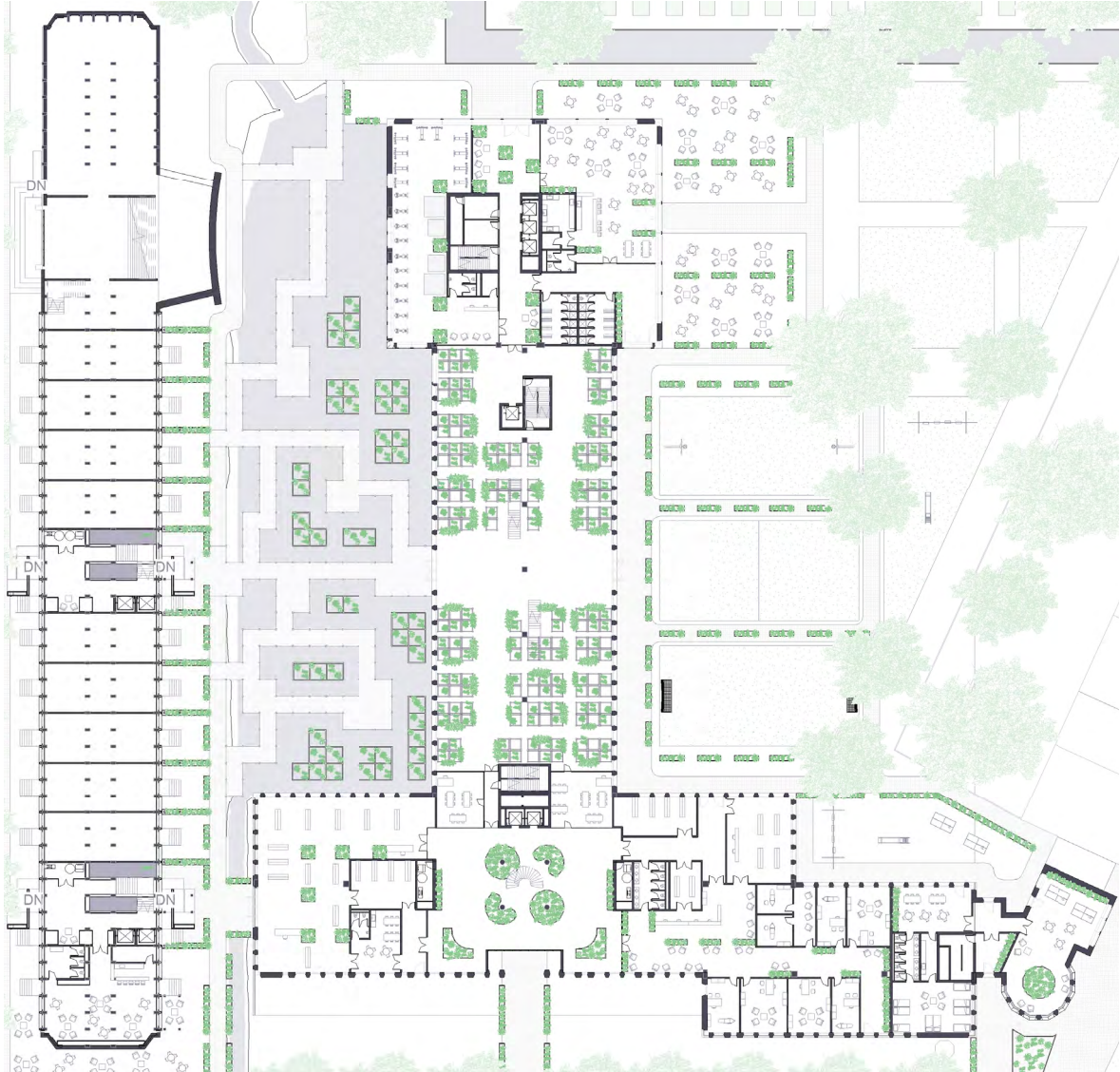
Architectural site plan showing a large residential complex with various courtyards, green spaces, and building footprints. Key areas include:

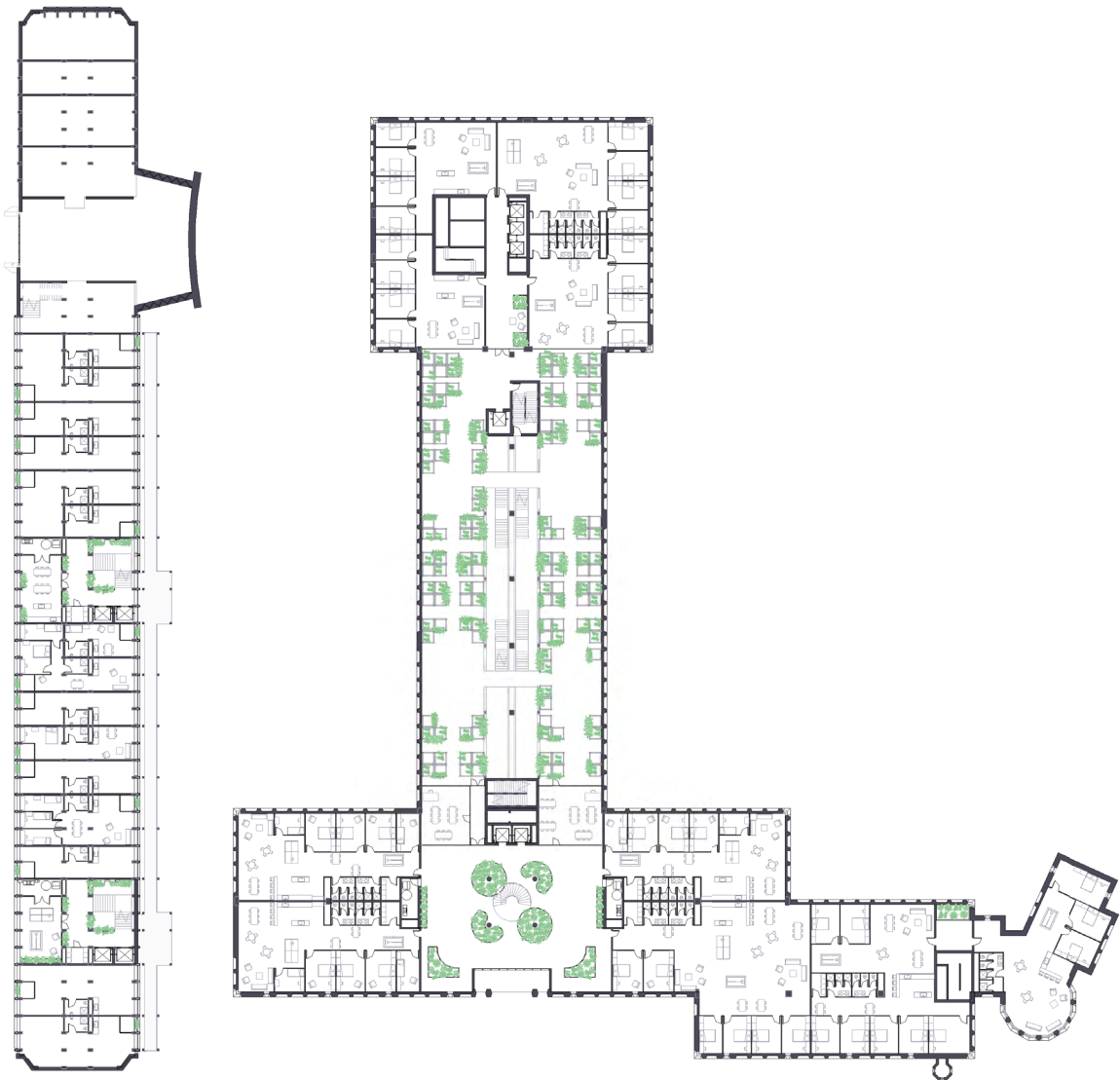
- Entrance and Living Areas:** Entrance, living area, kitchen, bath, office, and storage.
- Central Courtyards:** Waterfall, picnic/tea/sport field, and several tennis court or sport field areas.
- Commercial and Community Spaces:** Supermarket, pharmacy, dentist, psychologist, child care, and storage.
- Landscaping and Greenery:** Trees, shrubs, and paths throughout the site.
- Other Features:** Water storage, waste storage, and various utility areas.

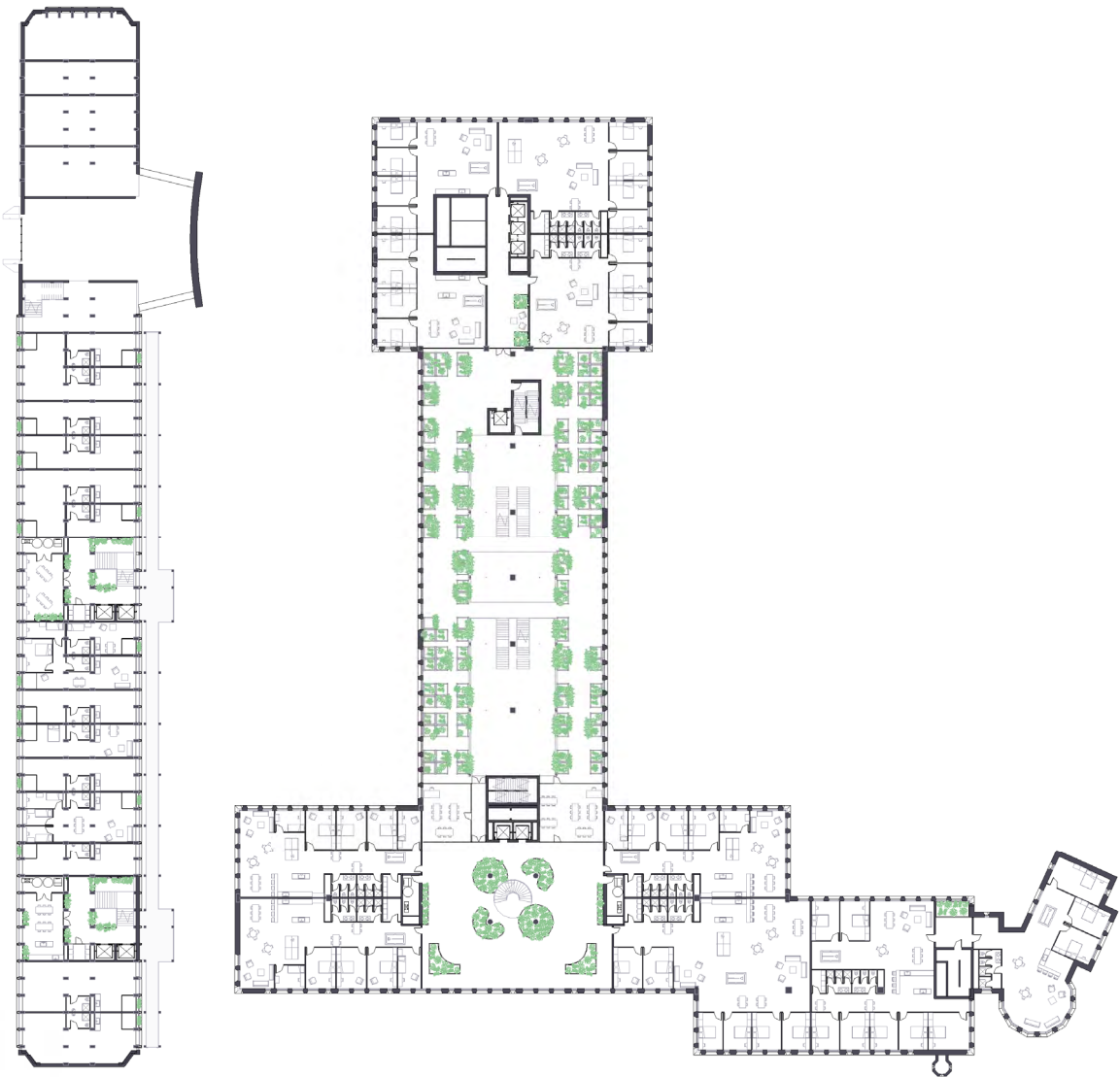
Upper floors

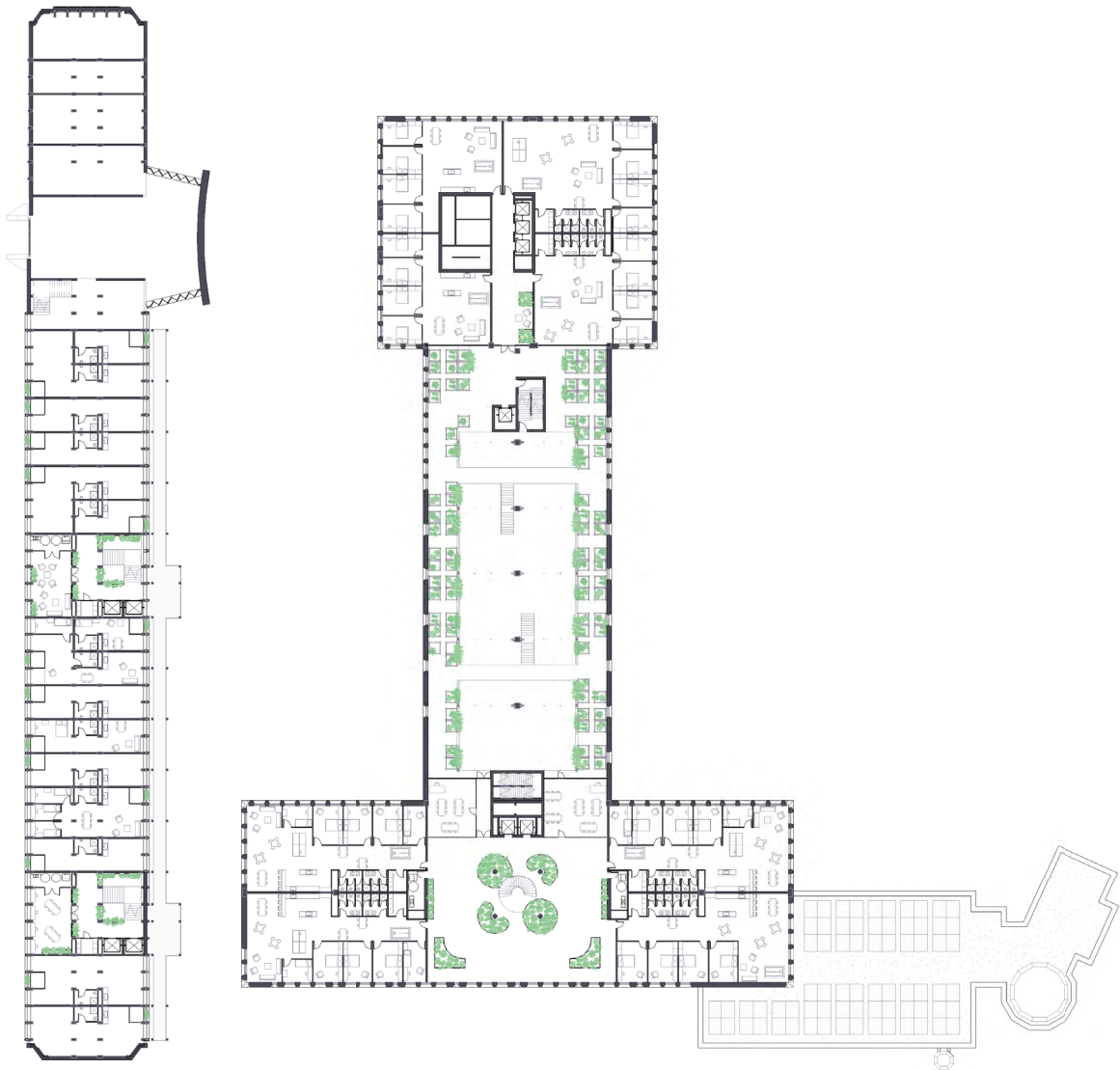


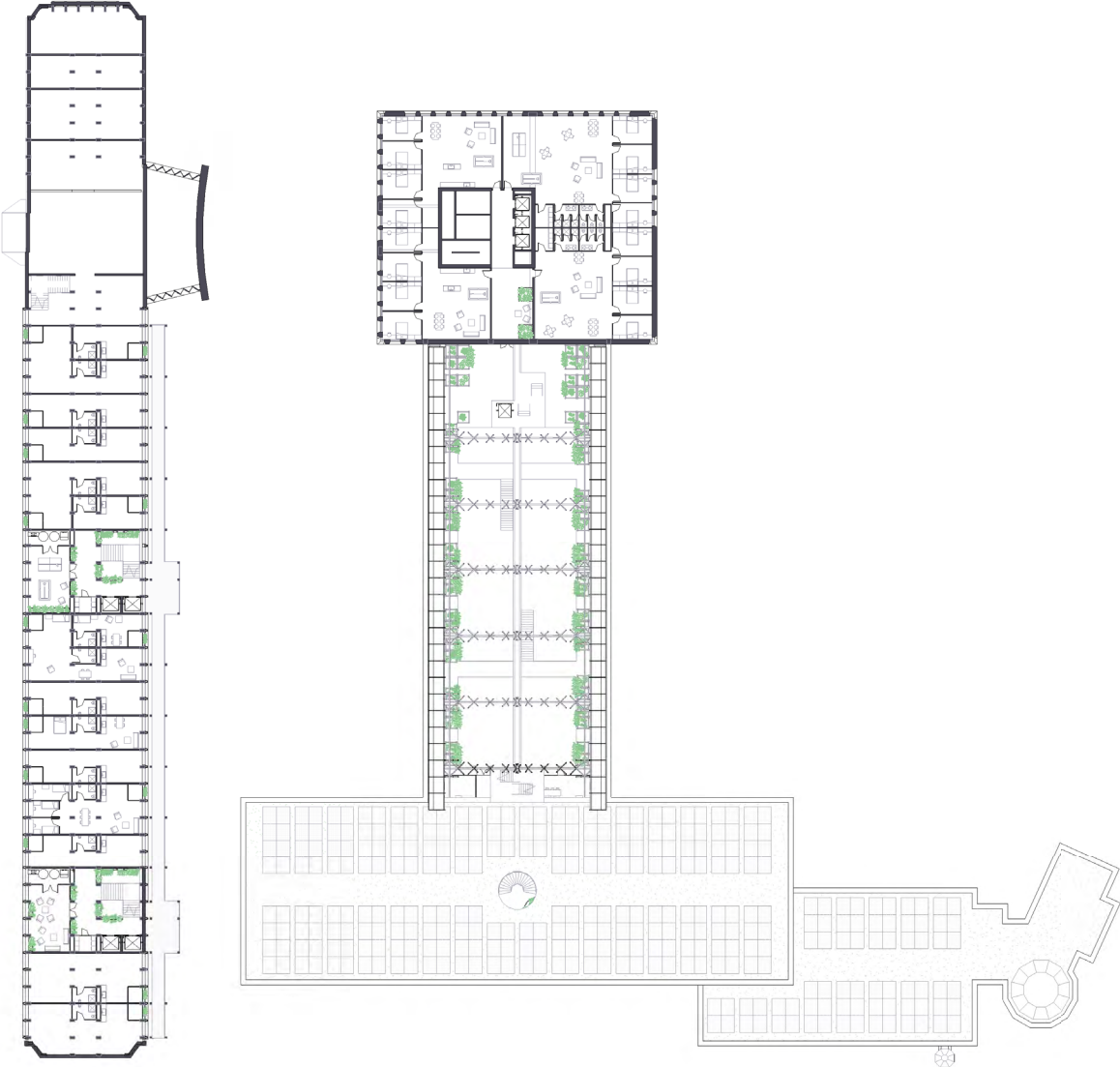


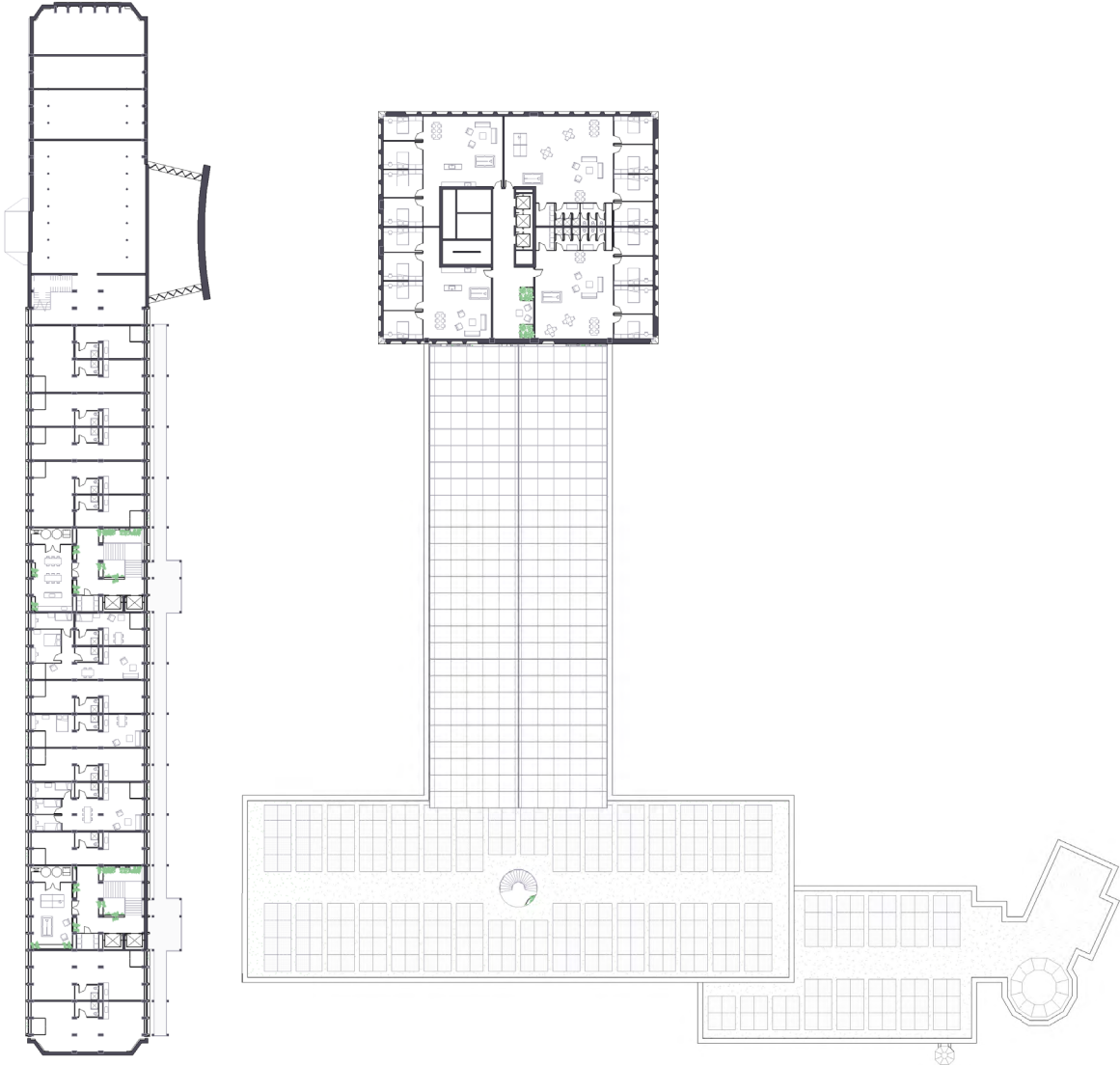


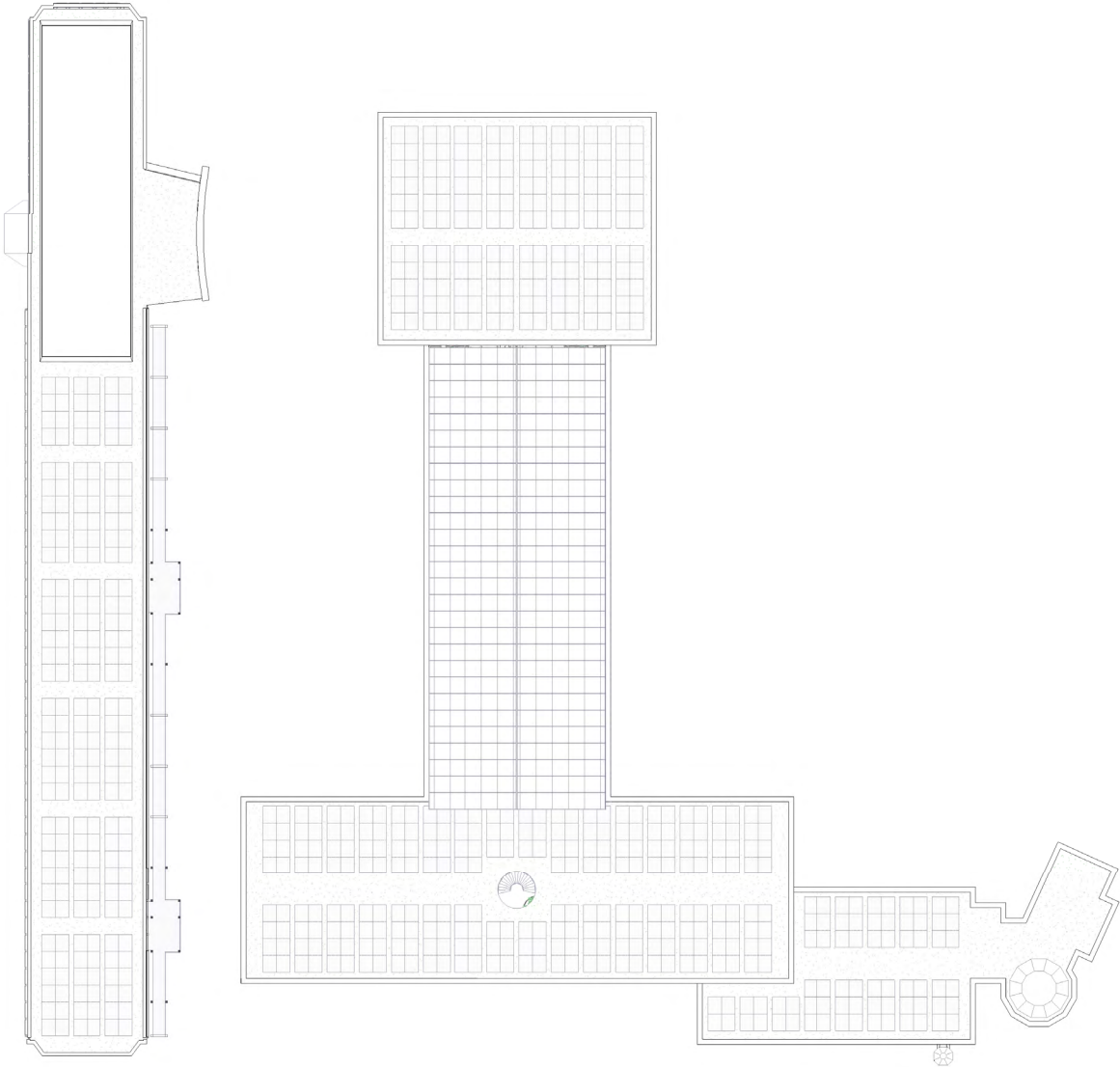












Design elements - how will we live together?

Design elements

As the size of the building was substantial compared to the given time to graduate, it was important to start defining focus points. In this way certain elements are tactically chosen to be worked out and represent a solution for the larger building. The key objective is to find the core meaning of the design; the story of the project and built the design and the presentation around this core idea.

Design core idea

The main question of the research and the design is how we will live together. This design concept has been developed in more detail with these 4 aspects; urban context, transition spaces, homes, and systems. A short description of the aspects will be given, and the following chapters of this booklet follow the same structure.

Urban context

The first aspect is the urban context, where the larger neighborhood scale is connected to the human scale. In this scale the urban exterior spaces are designed with elements as greenery, pavement, and water. The urban context exists of a shopping street, a water square, an urban farm park, a sporting square, and an entrance park. These different urban spaces all have their own identity and atmosphere. The urban context further continues with the program of the ground floor of the building, which

Transition spaces

The second aspect are the transition spaces, which are spread out over the building at strategic places. These spaces are not only practically used for vertical transportation, but also facilitate

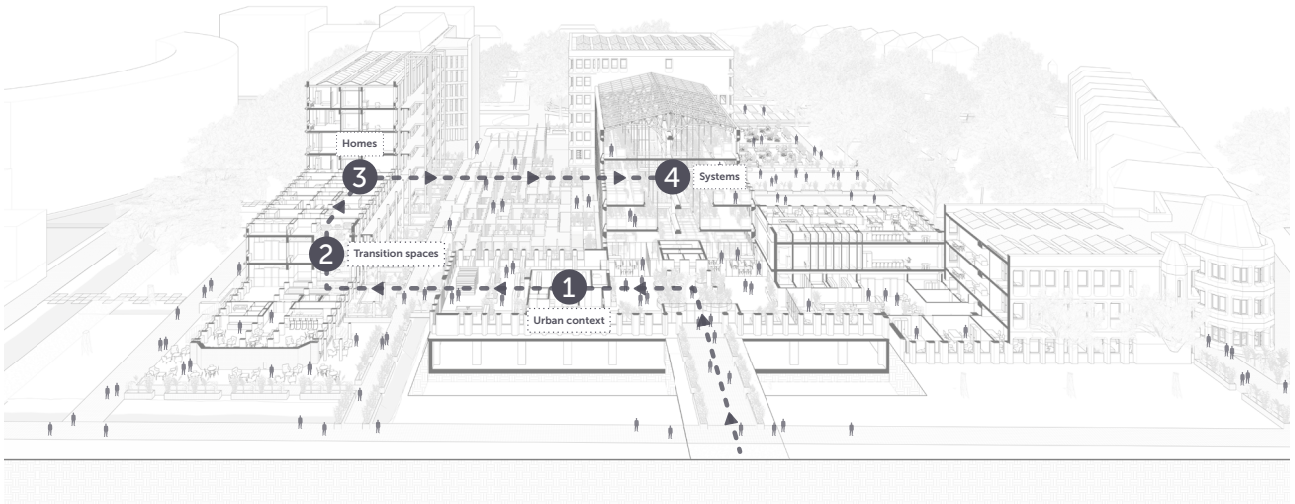
spontaneous social interaction between the inhabitants. The spaces house a variety of common spaces, such as shared kitchens, study spaces, and relax spaces.

Homes

The second

Systems

The second



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Urban context

29.08.2022 - 08.12.2022

Main street

two main entrances to building
connection to nature of couperusduin
bike / car / pedestrian
lots of traffic, busy
parking for car & bike / entrance to underground parking



Shopping street

secondary entrances to building
shops / ateliers
bike / pedestrian
parking for bike
connection to water of neighboring building



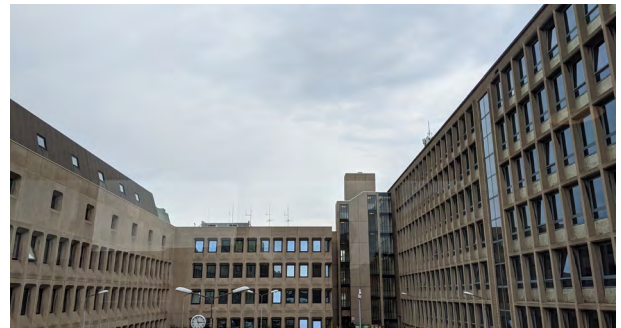
Urban Farm lane

urban farming
ecological
pedestrian
biodiversity
tree lane



Water square

helophyte filter
ecological corridor
inhabitants / pedestrian
relaxing / enjoying nature
biodiversity

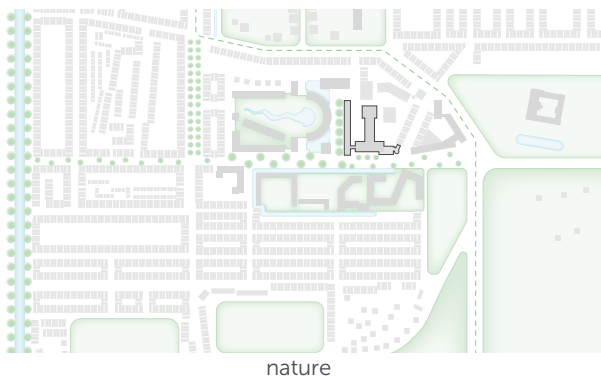
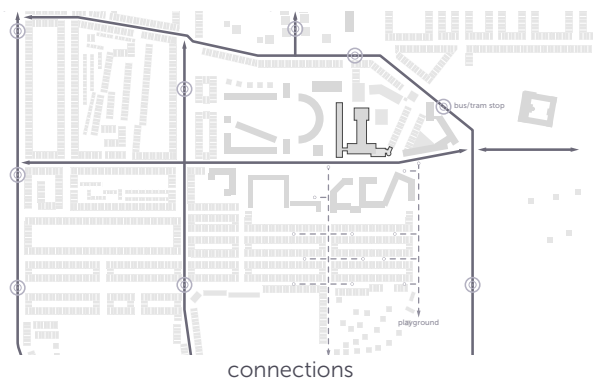
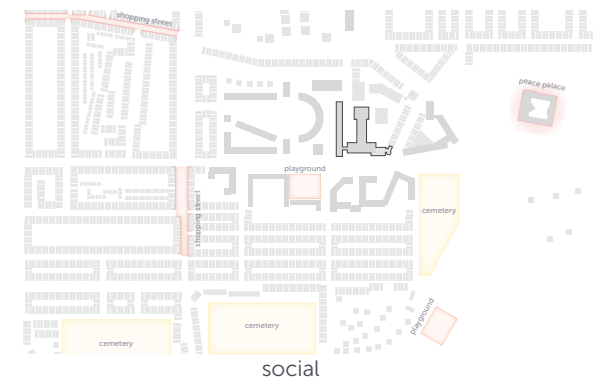


Site visit

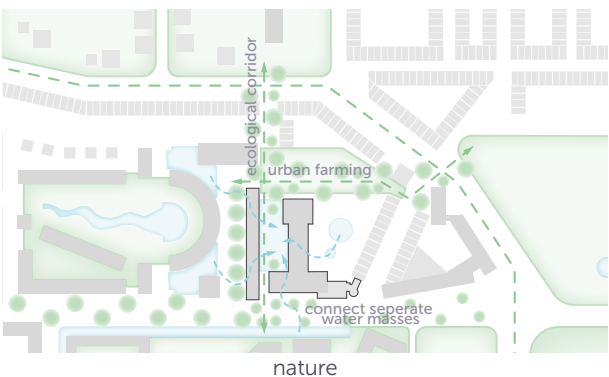
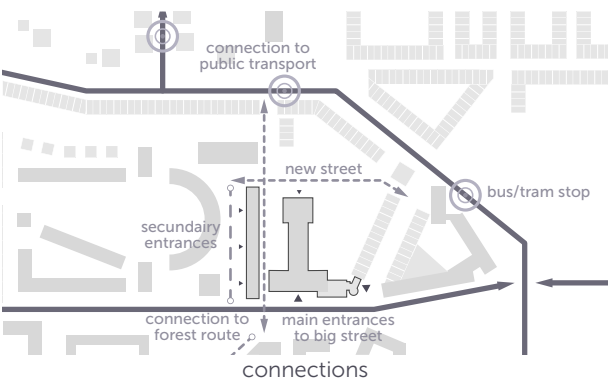
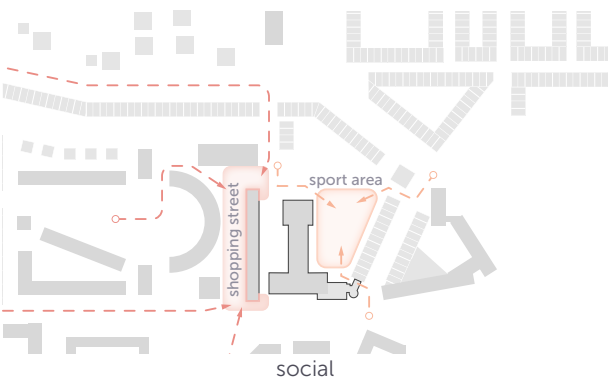


Site analysis

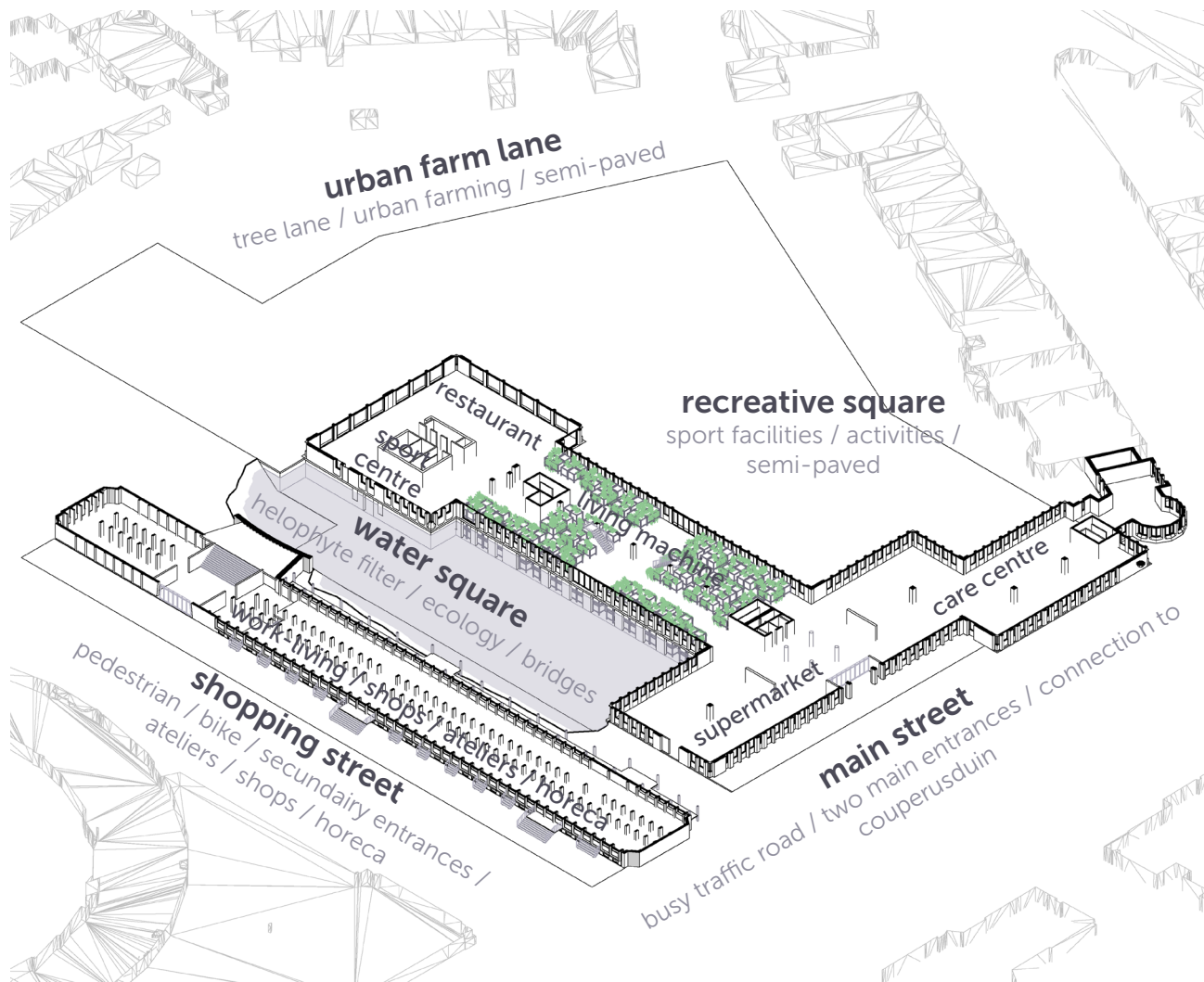
Existing situation



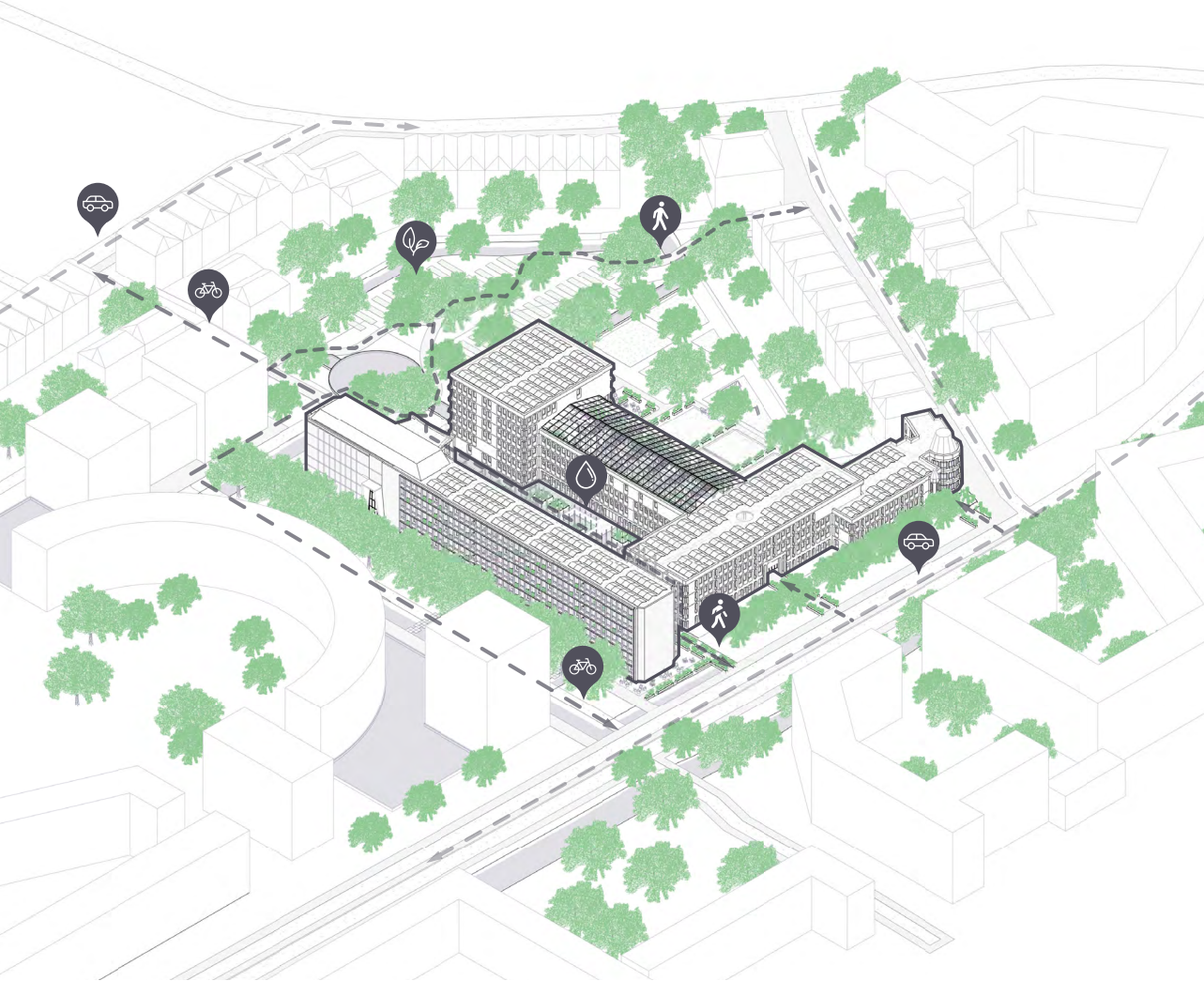
Goals



Initial urban context design

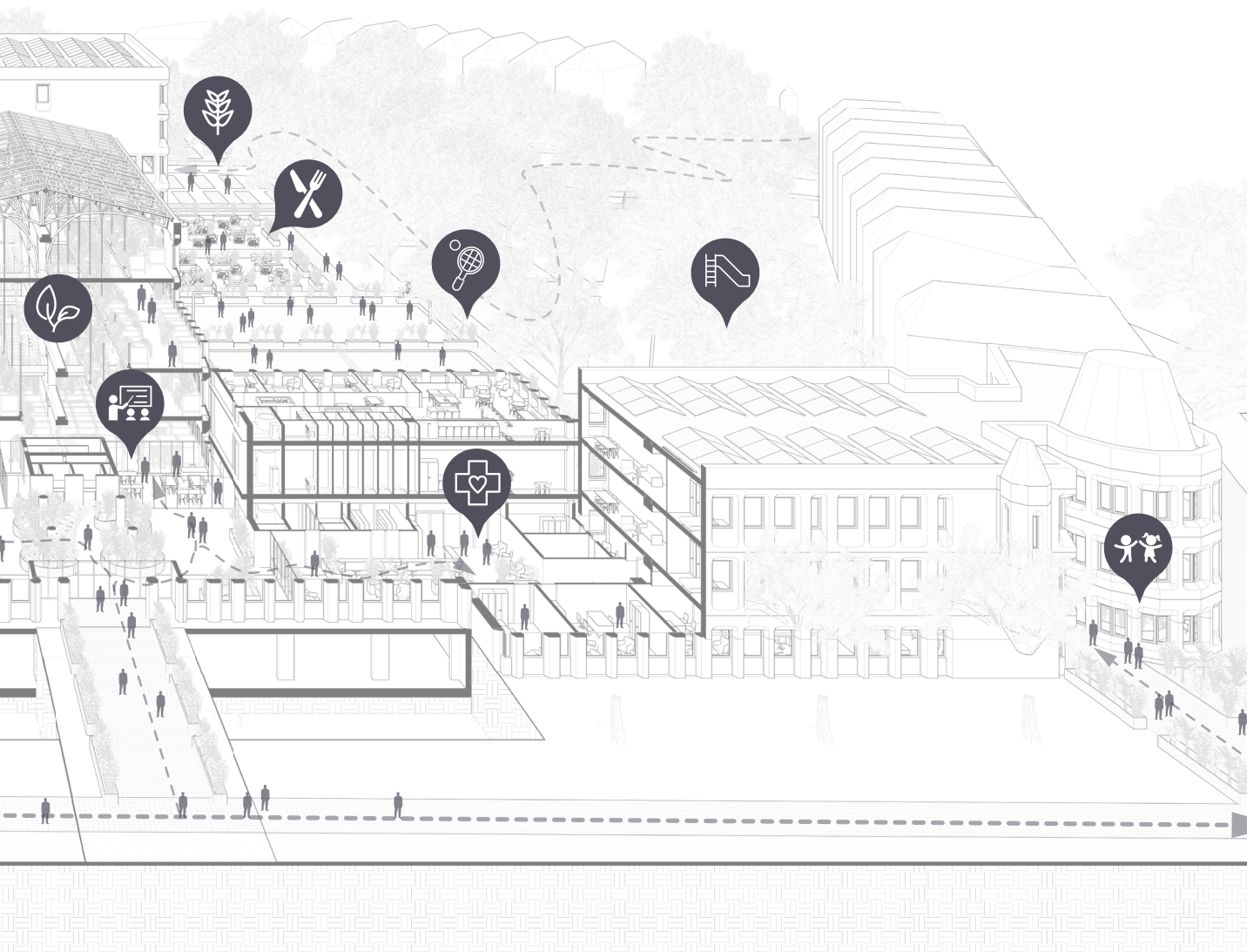


Mobility plan



Social public functions

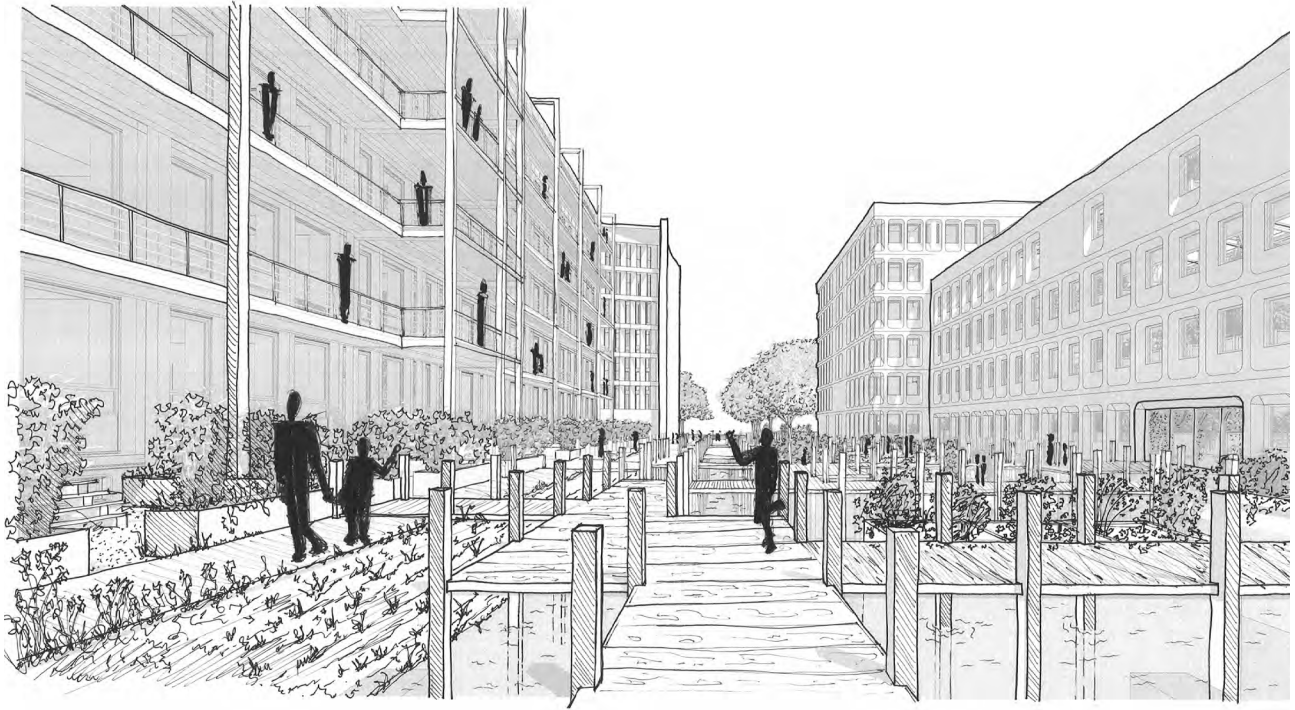




Street corner impression



Water square impression

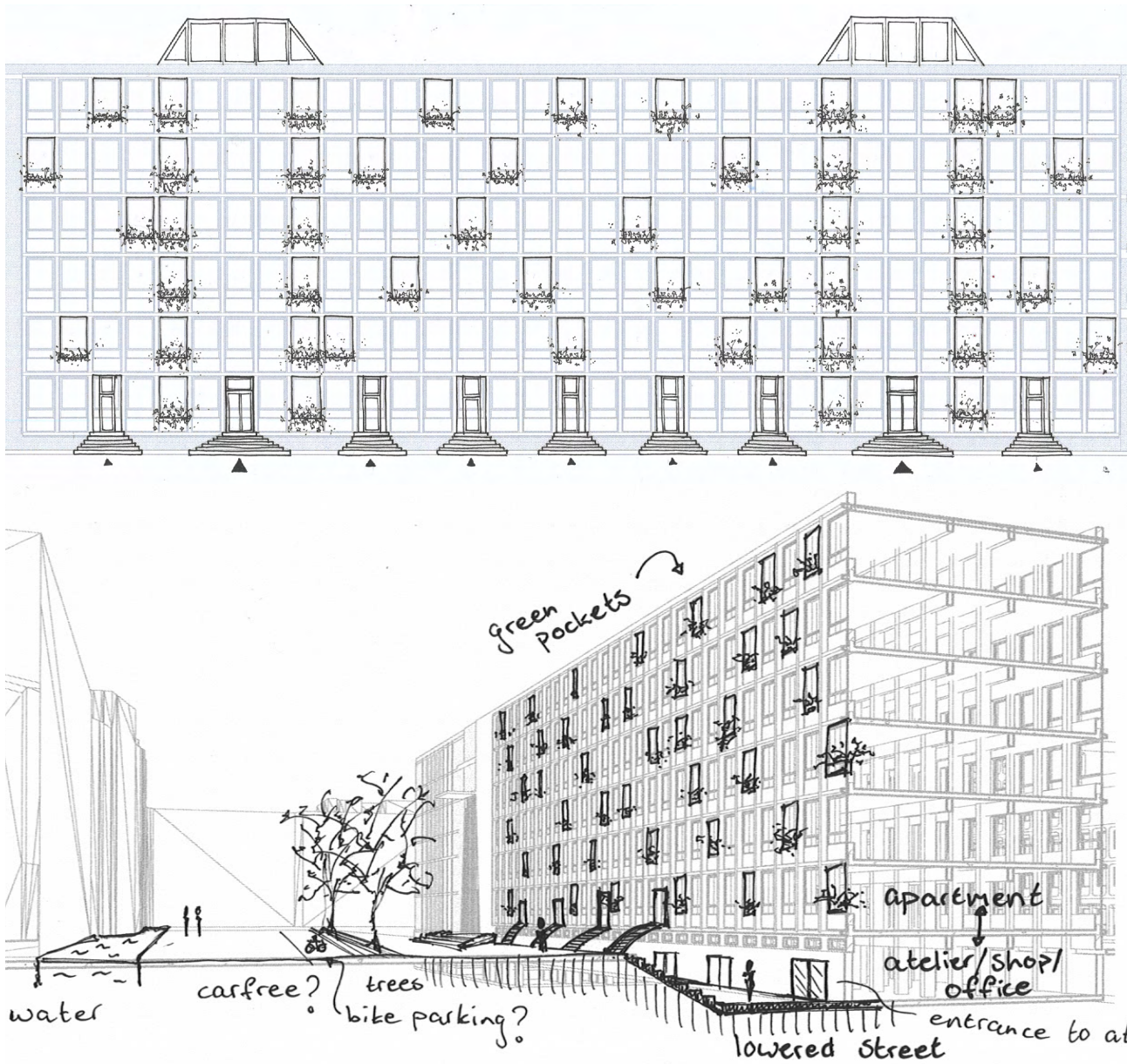


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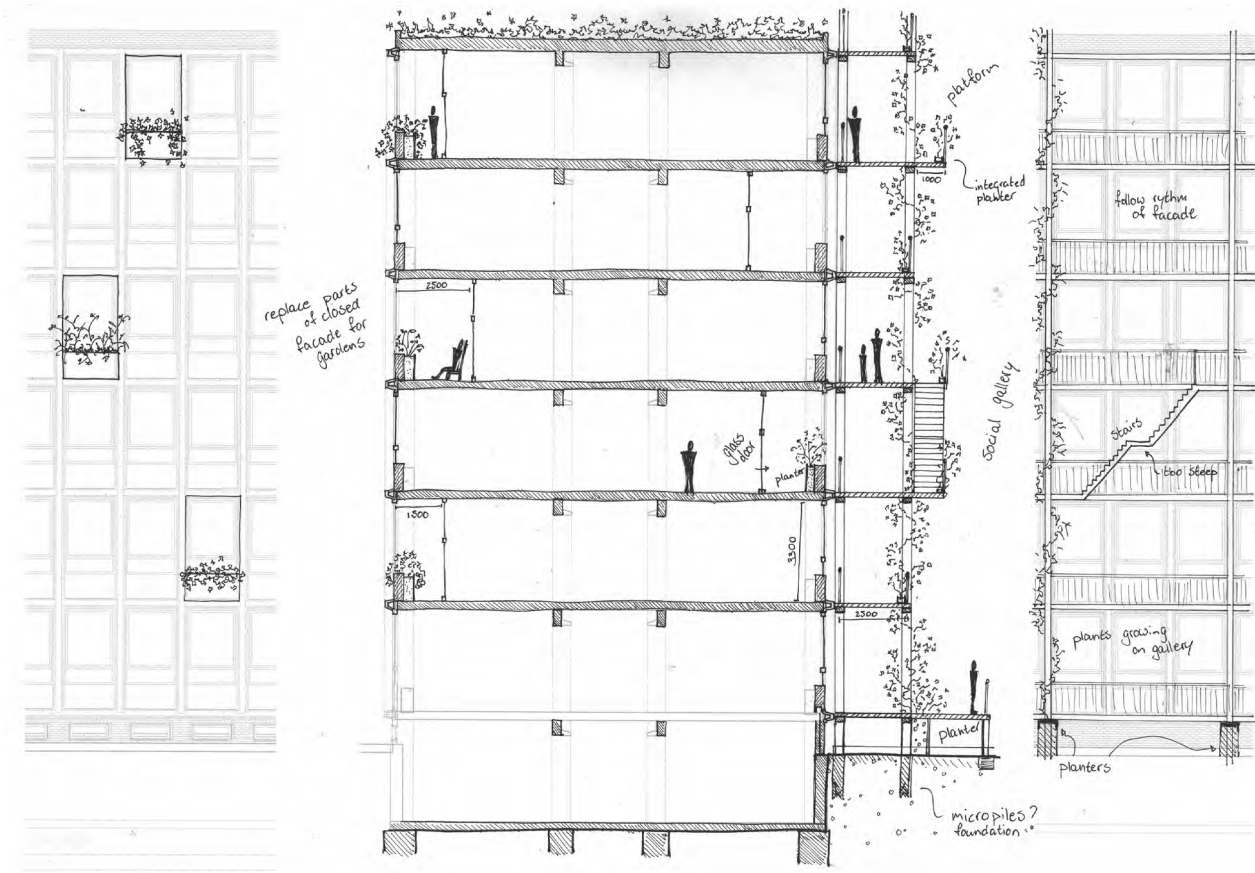
Transition spaces

29.08.2022 - 08.12.2022

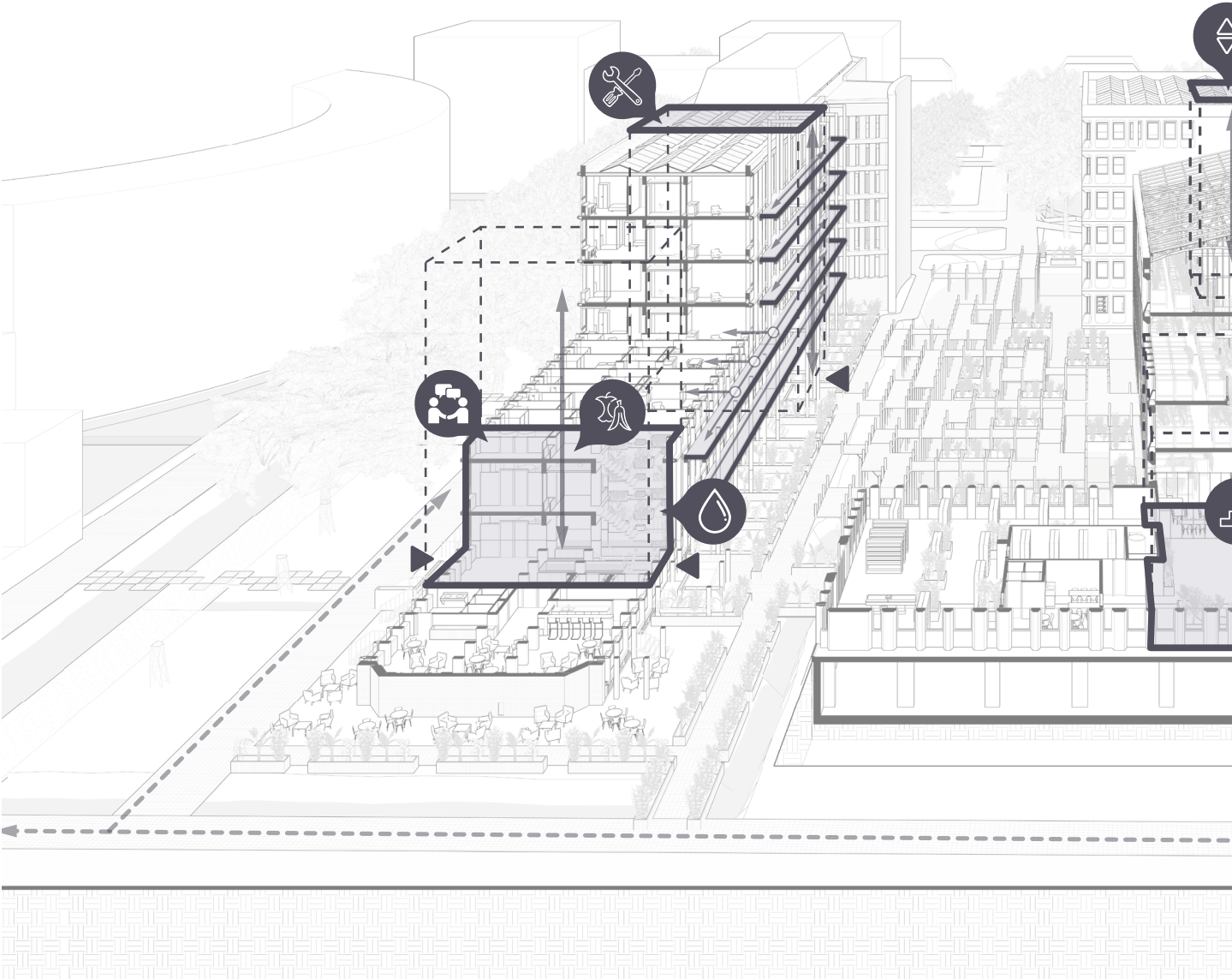
Initial sketches

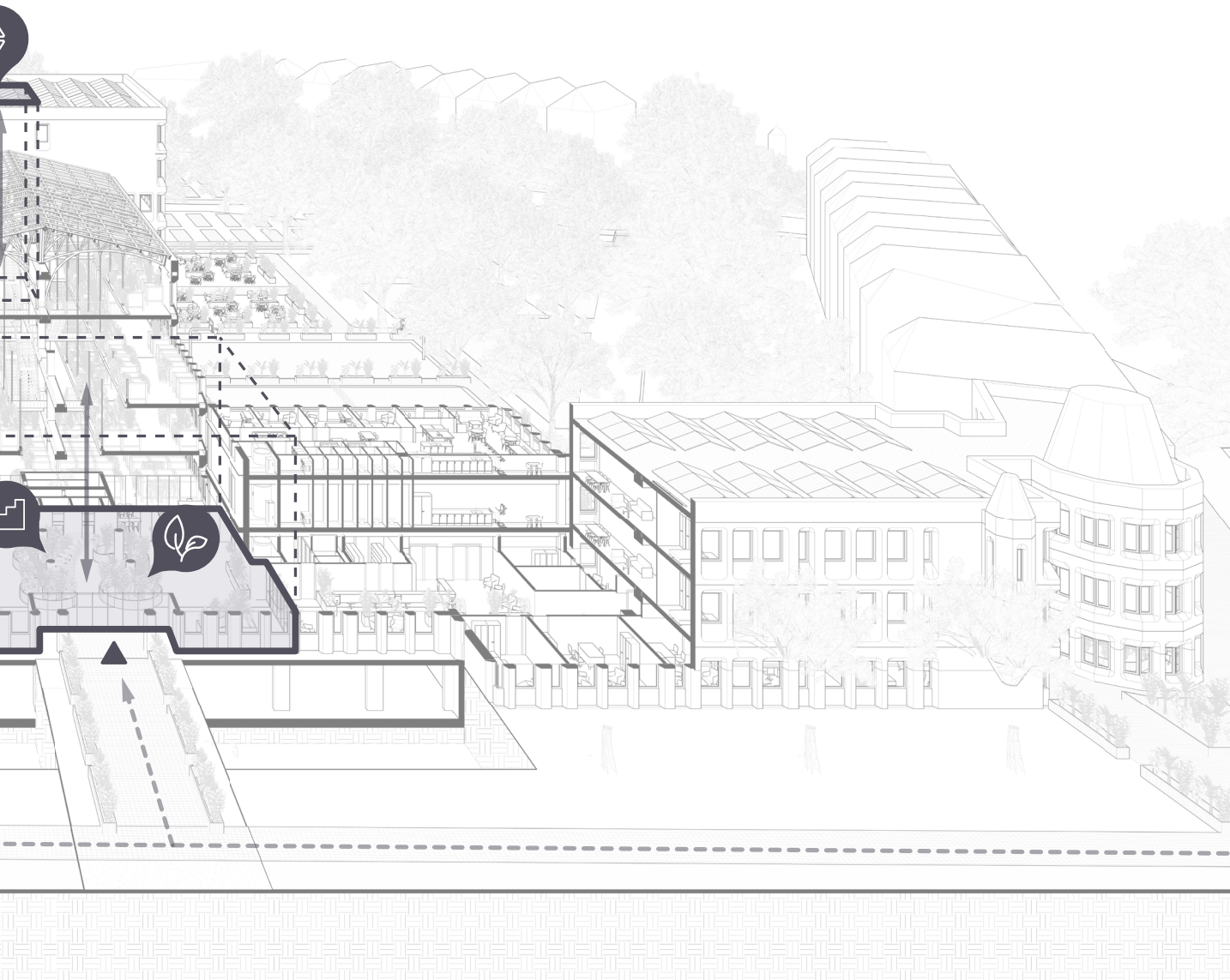


Initial sketches

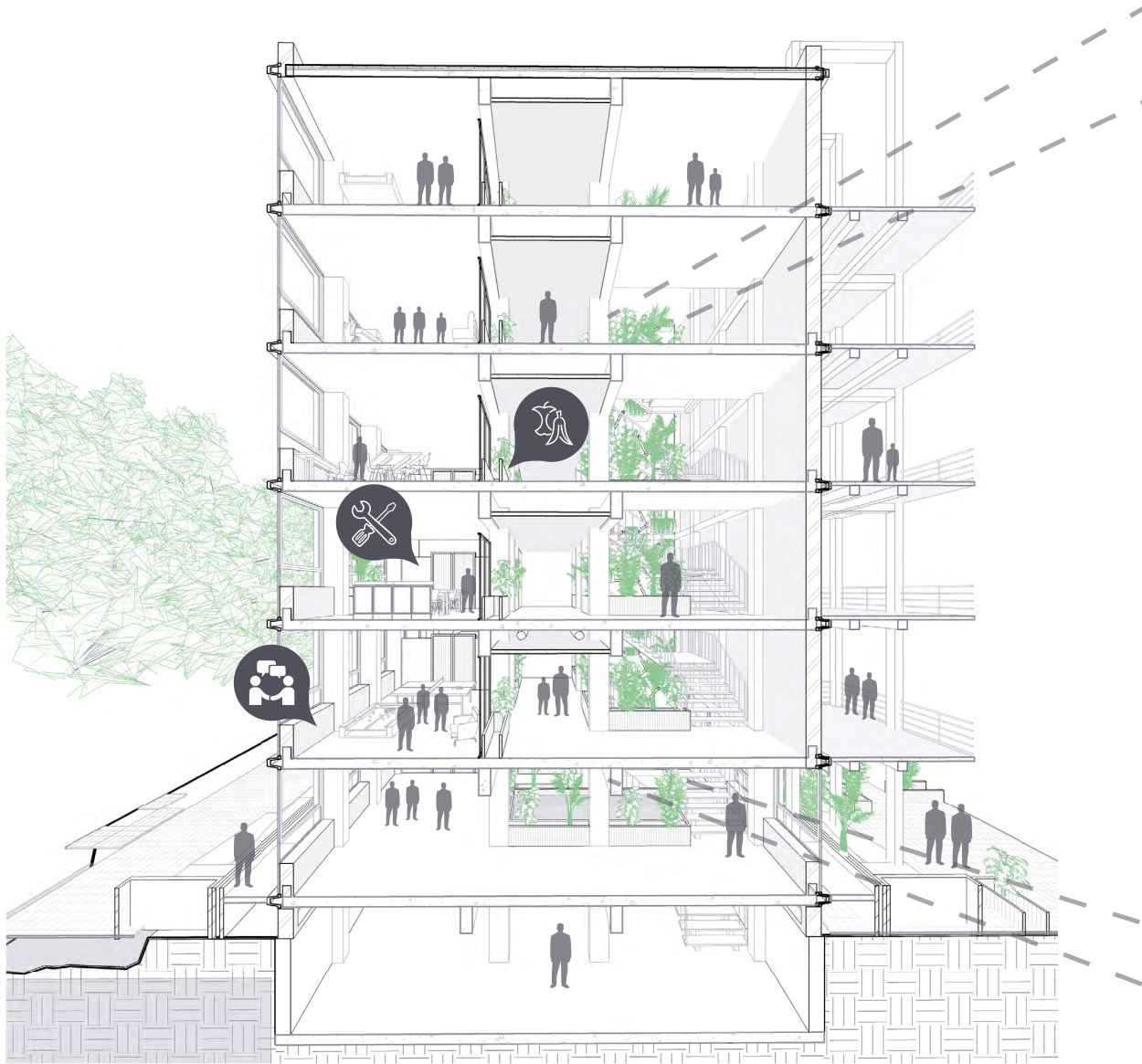


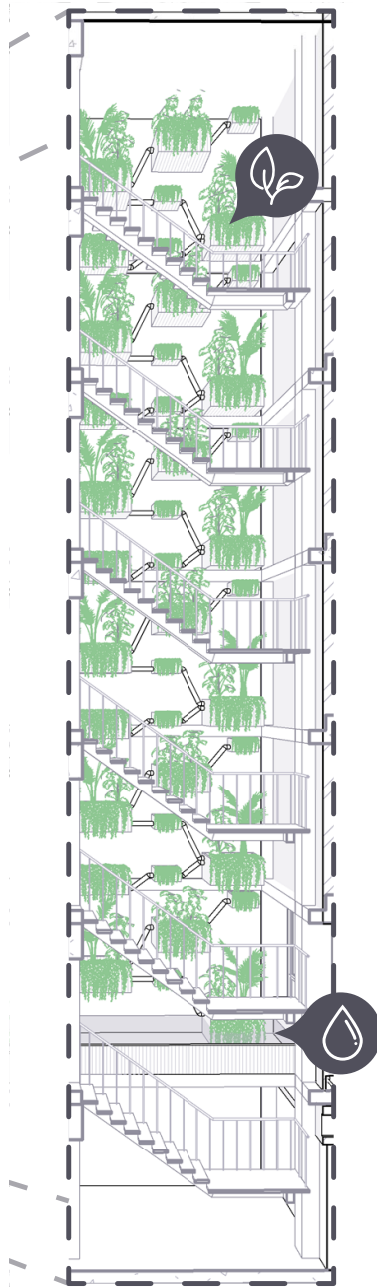
Transition space concept



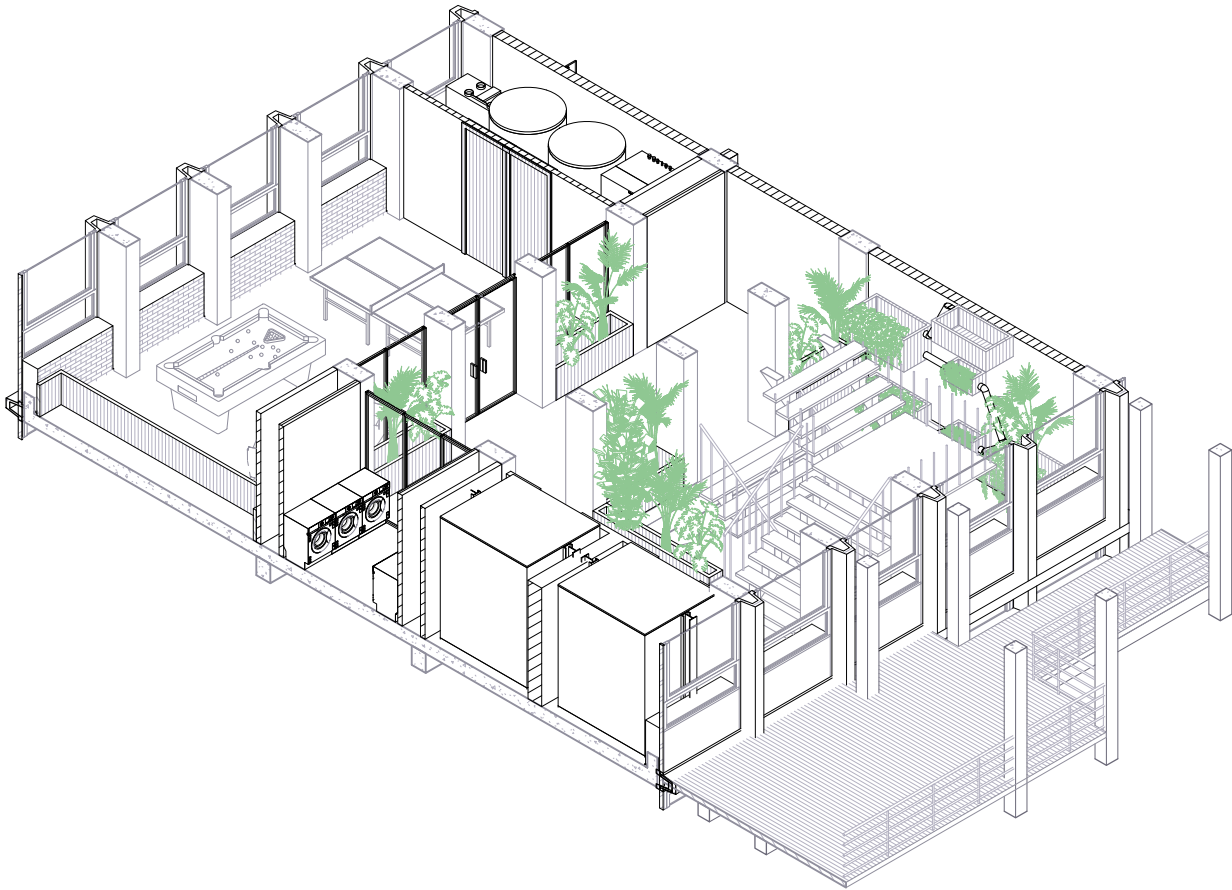


Transition space concept



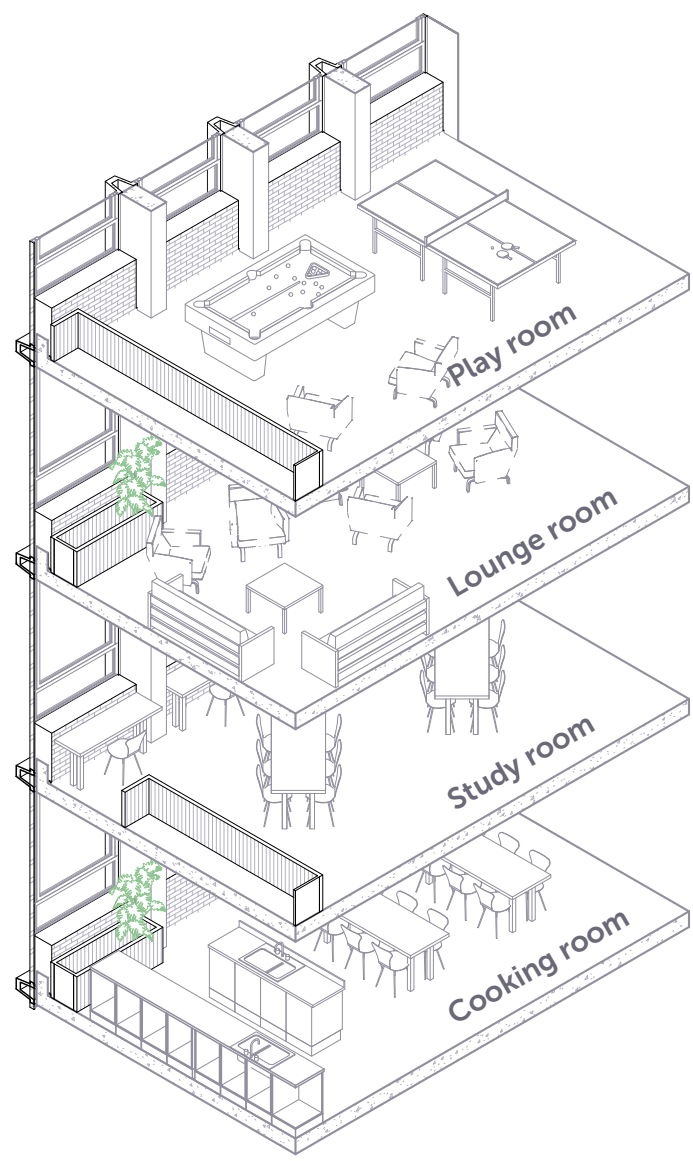


Transition space interieur



Typical floor

Transition space interieur



Collective spaces

Stair core impression



Gallery impression

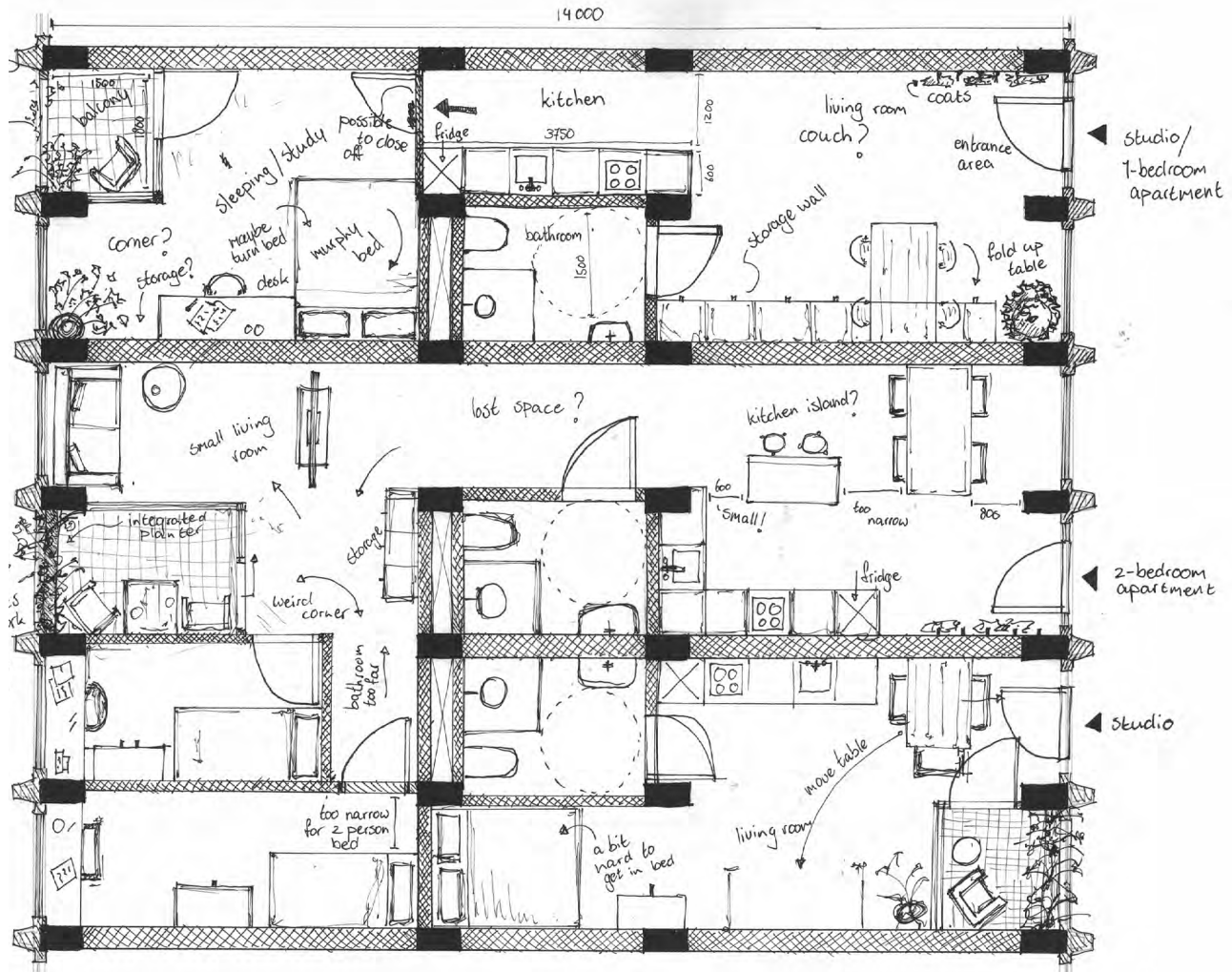


20

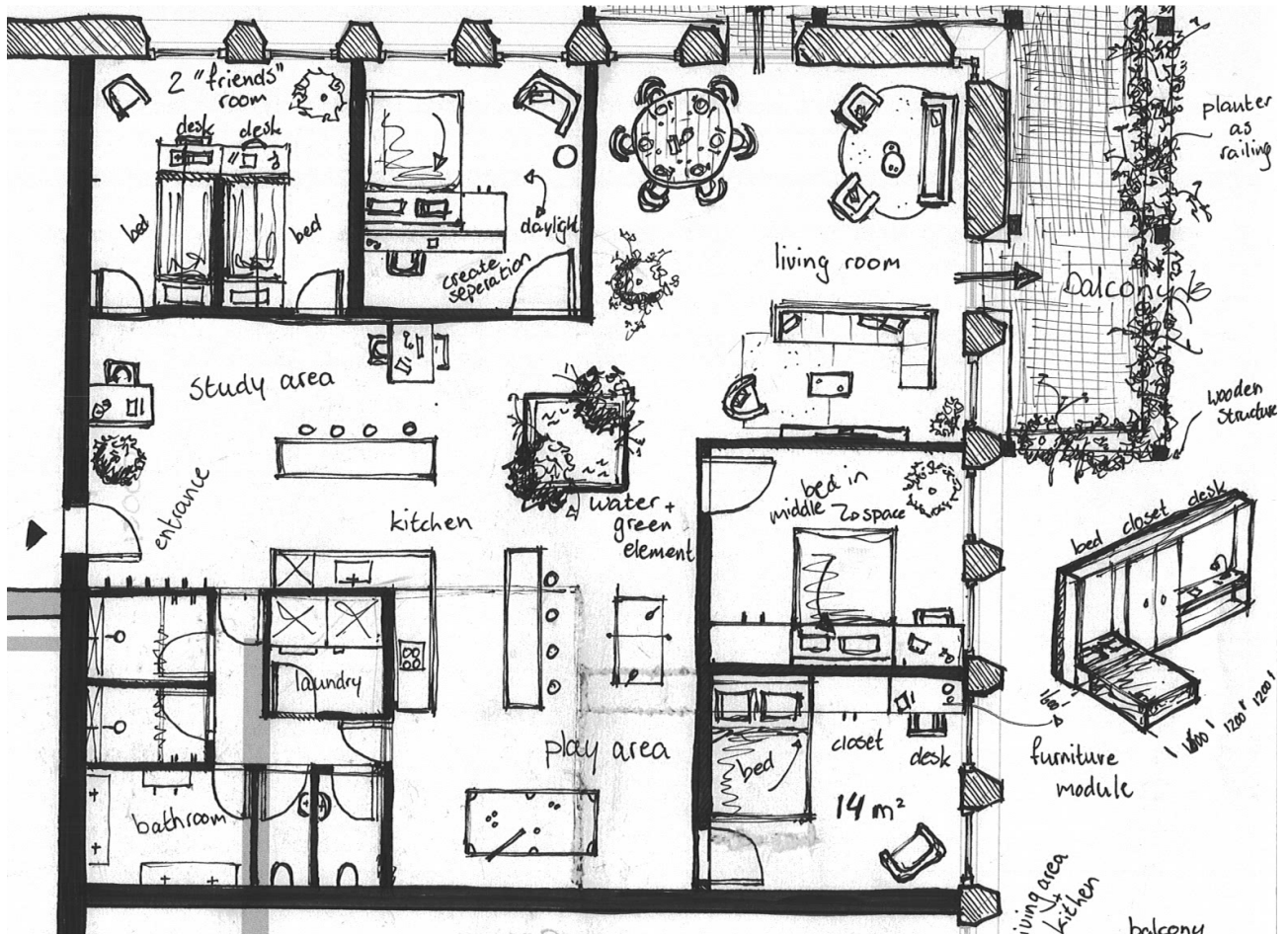
Homes

29.08.2022 - 08.12.2022

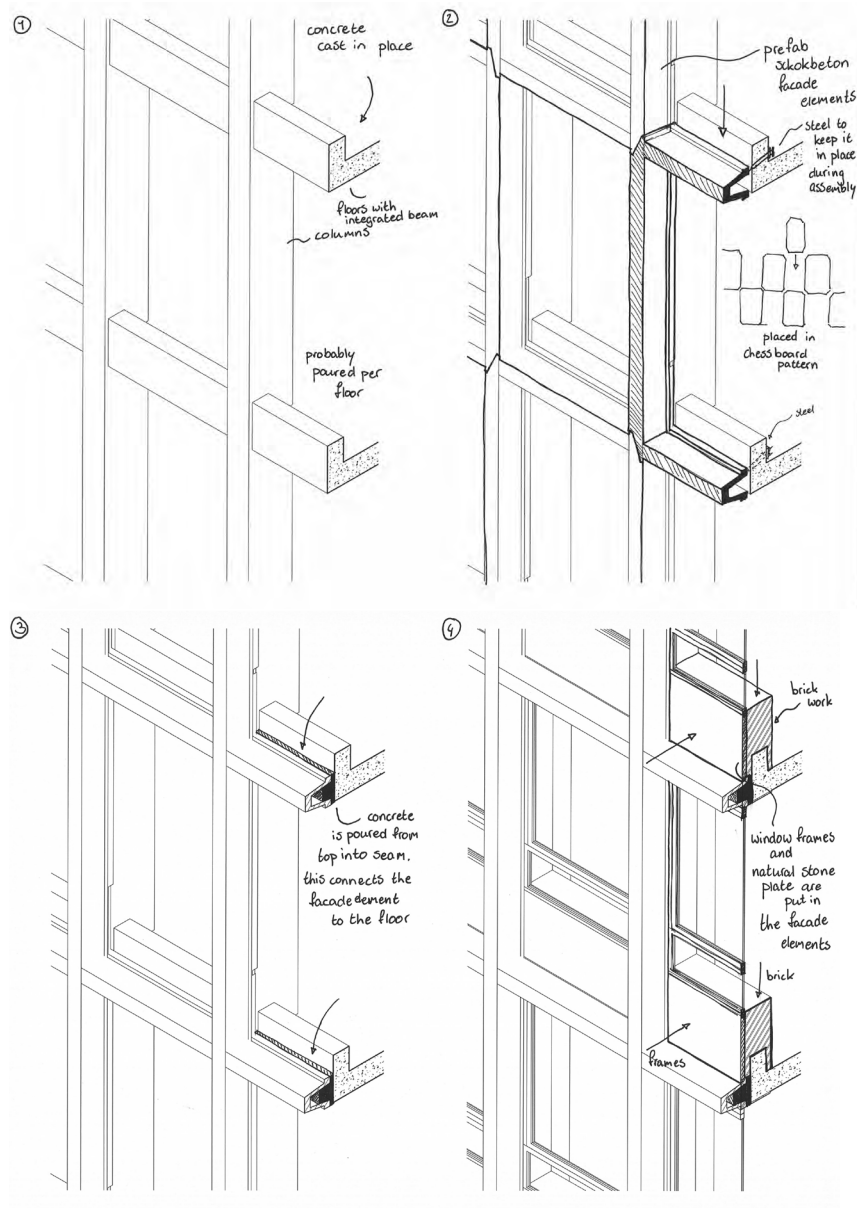
Initial sketches bedroom apartments



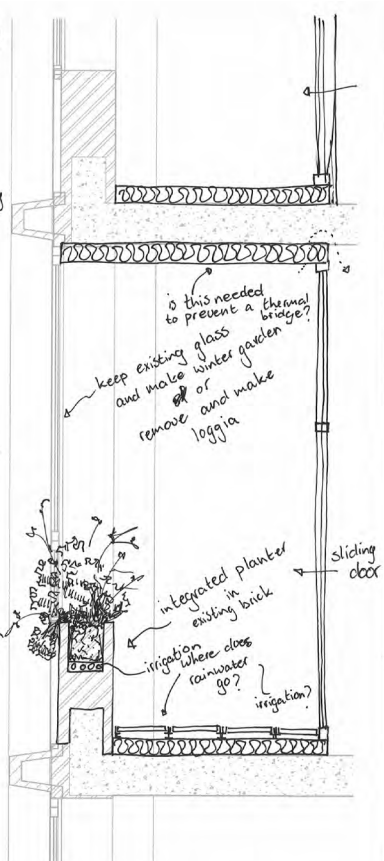
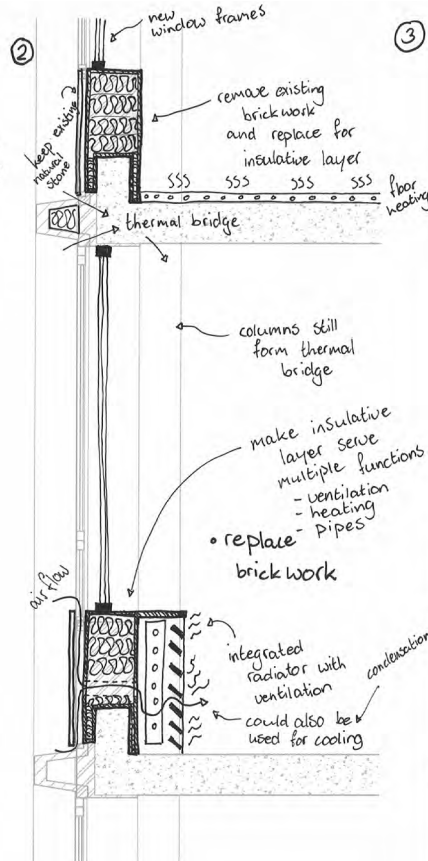
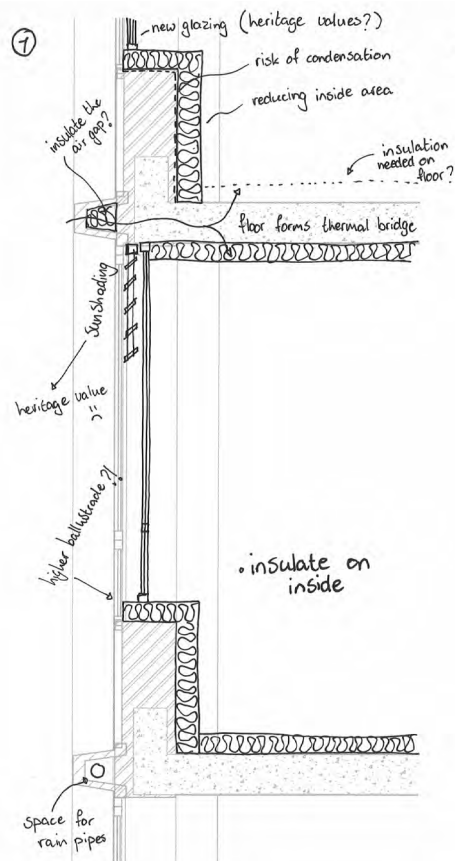
Initial sketches co-housing



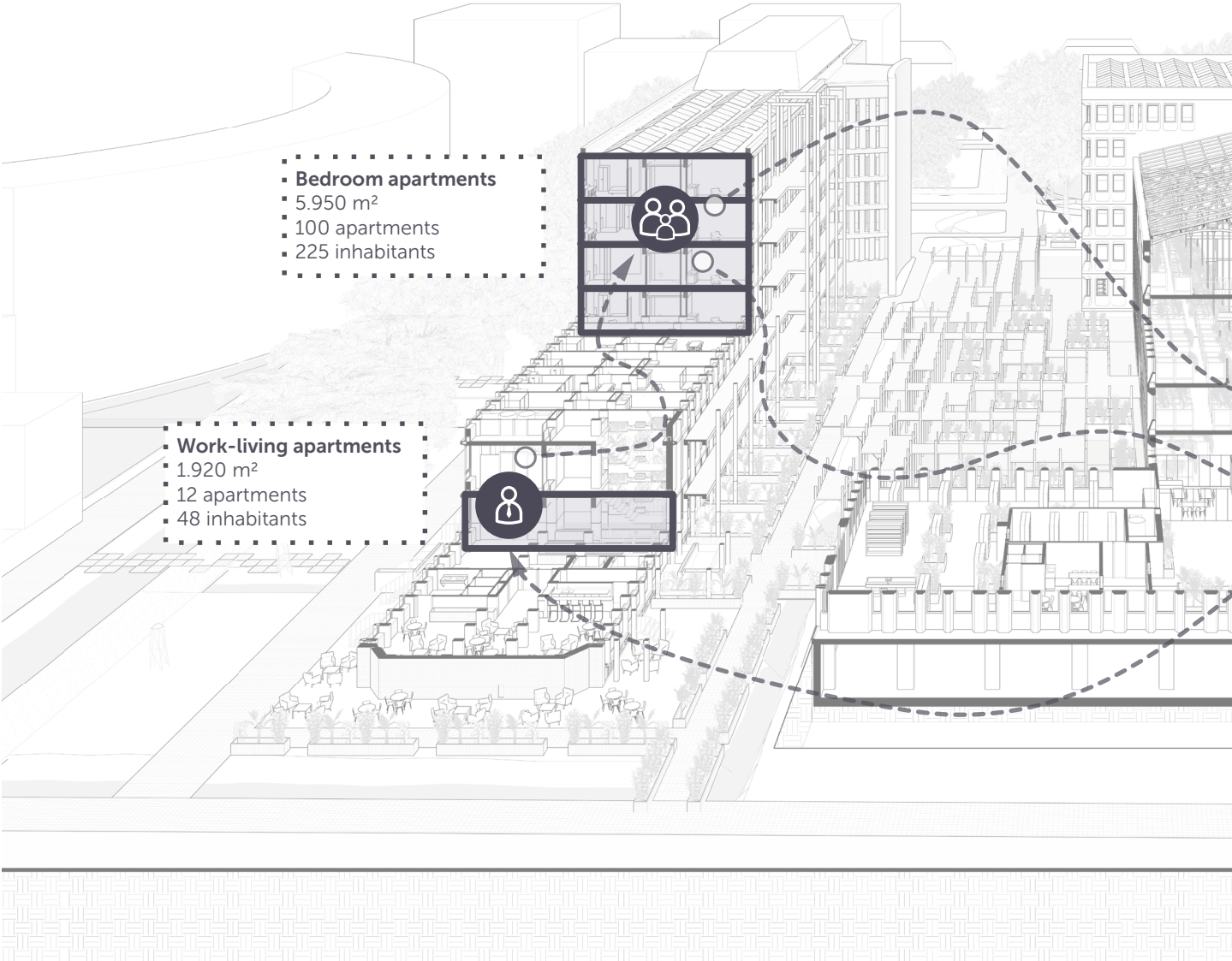
Facade construction existing building



Renovation options

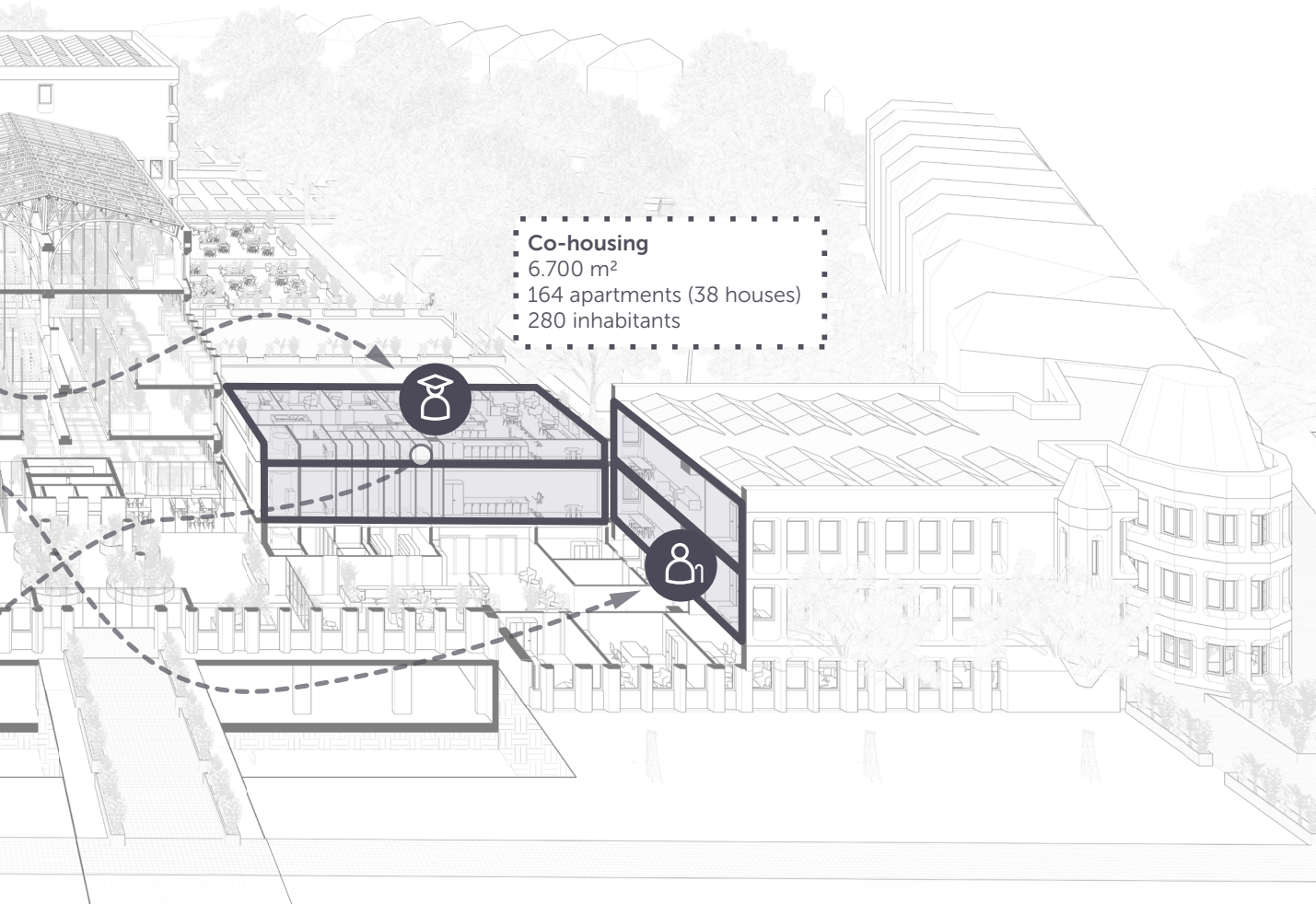


Growing within the building

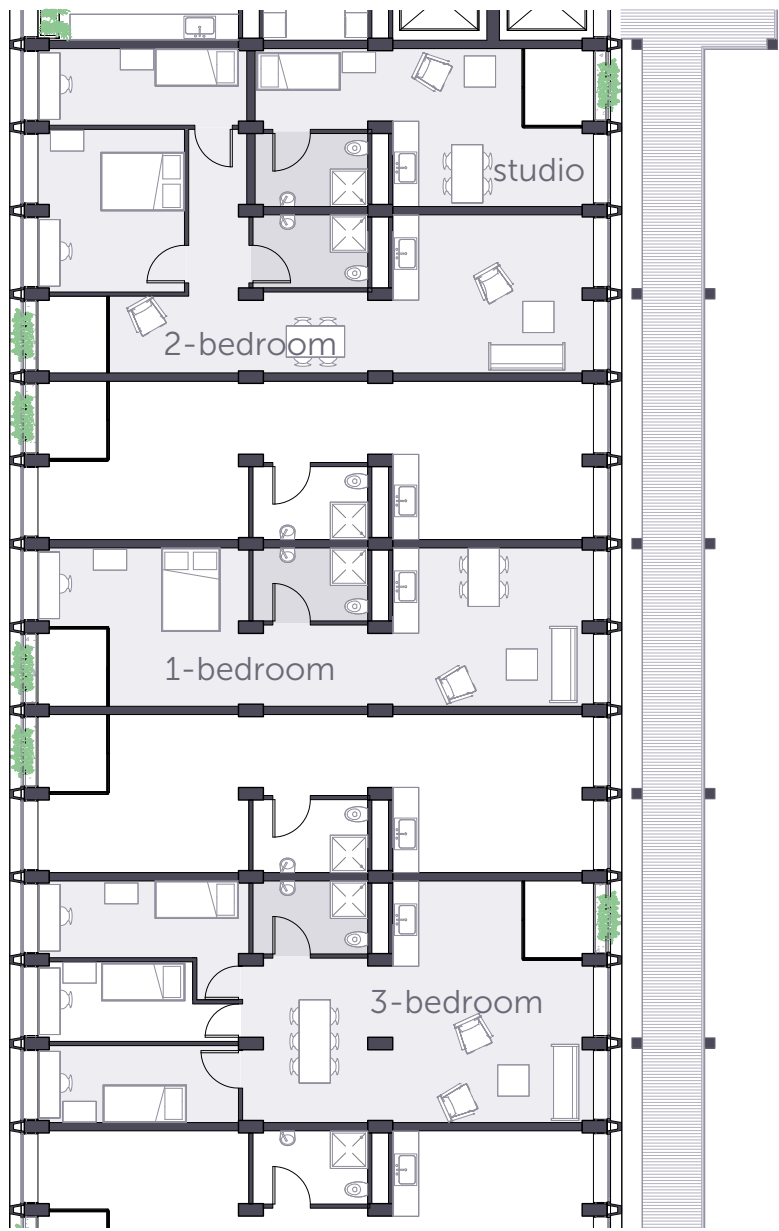


- **Bedroom apartments**
- 5.950 m²
- 100 apartments
- 225 inhabitants

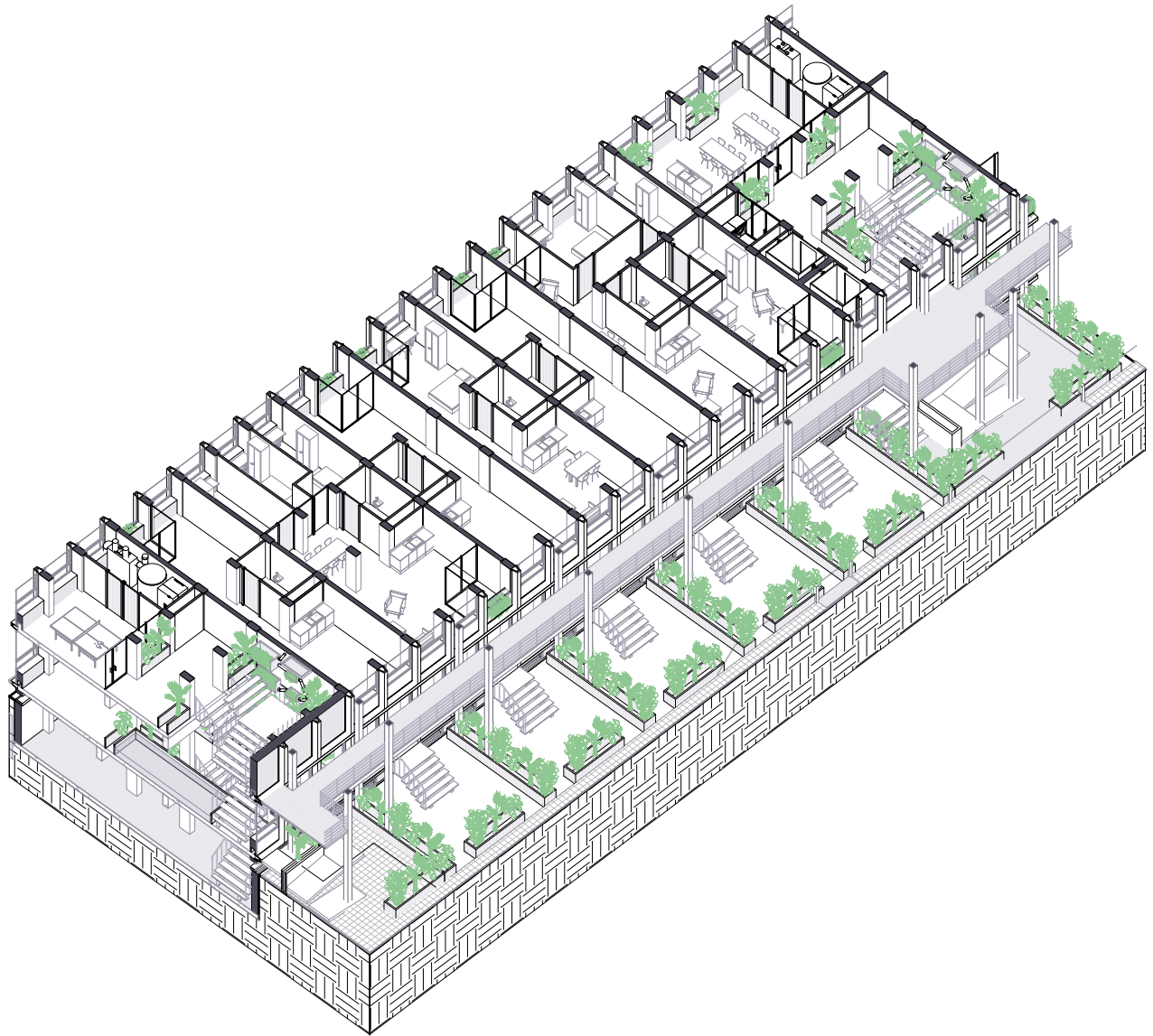
- **Work-living apartments**
- 1.920 m²
- 12 apartments
- 48 inhabitants



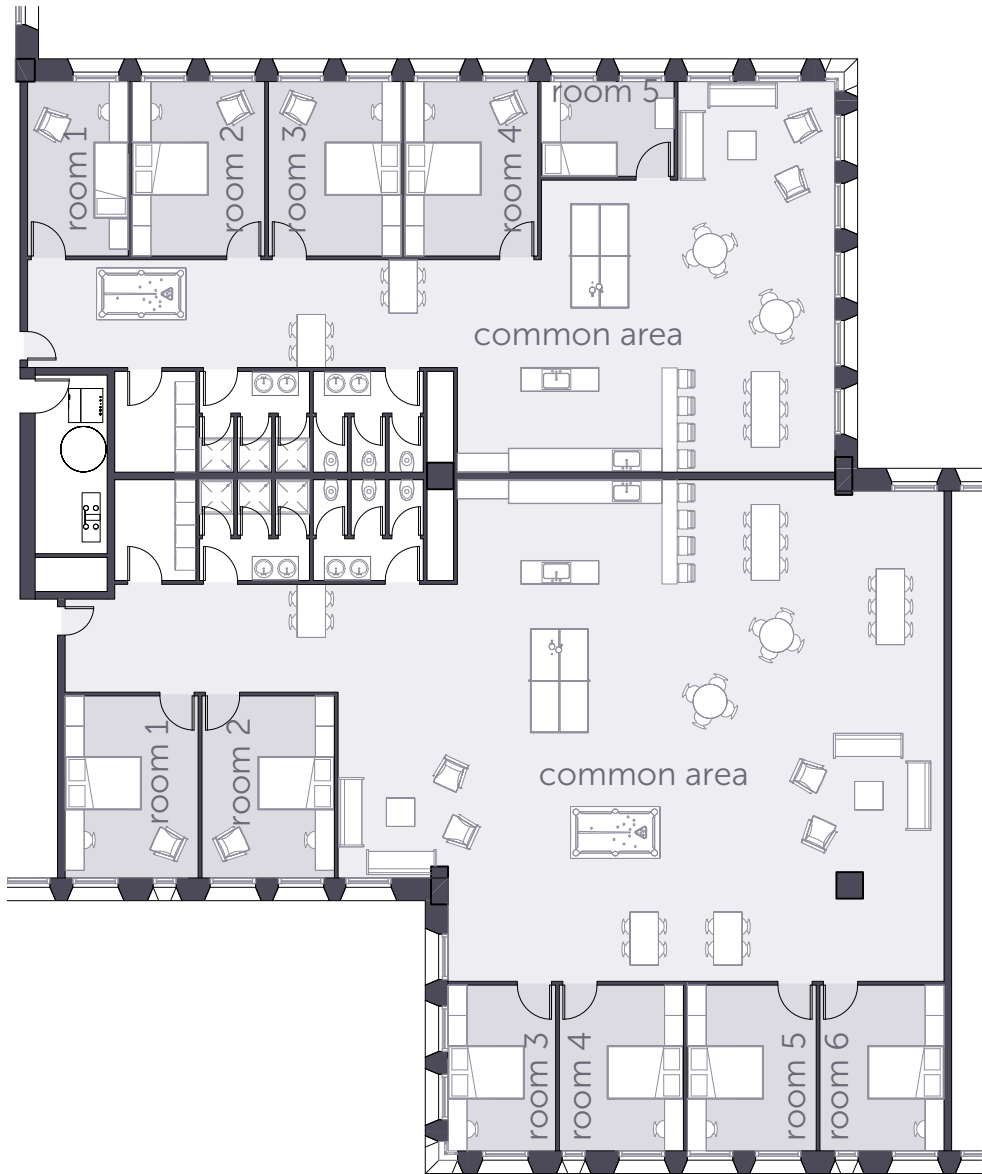
Flexible bedroom apartments



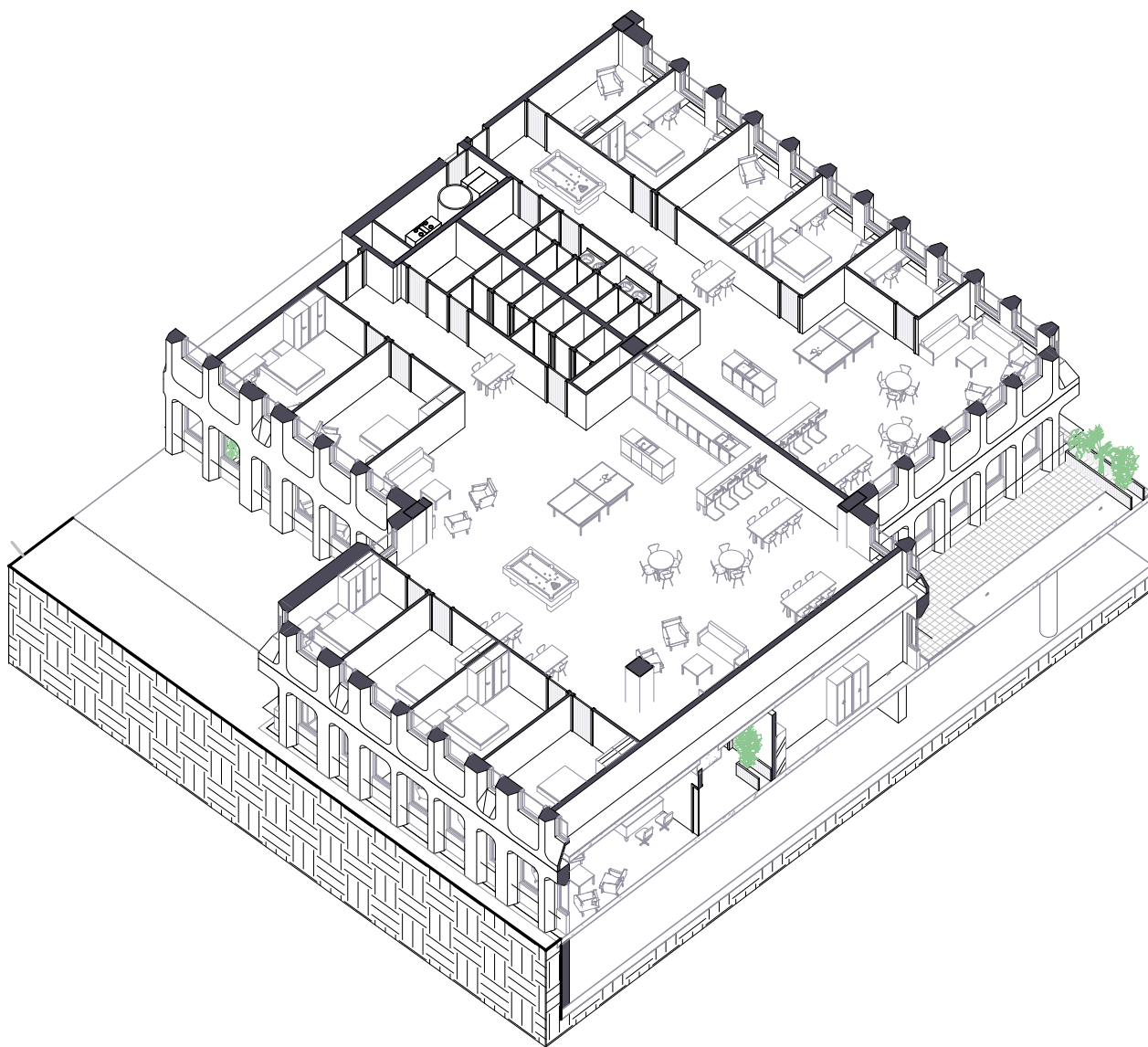
Flexible bedroom apartments



Co-housing apartments



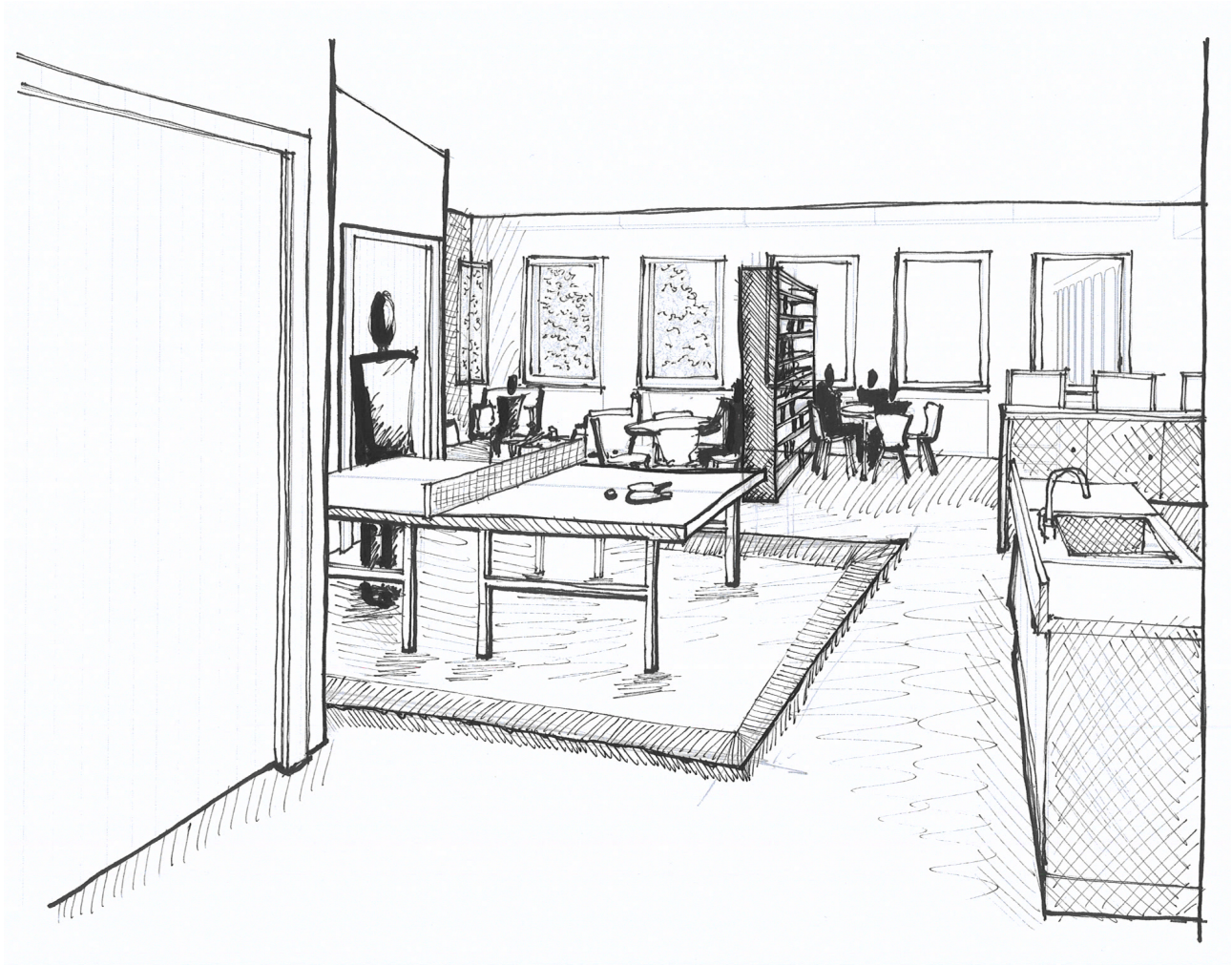
Co-housing apartments



Bedroom apartment impression



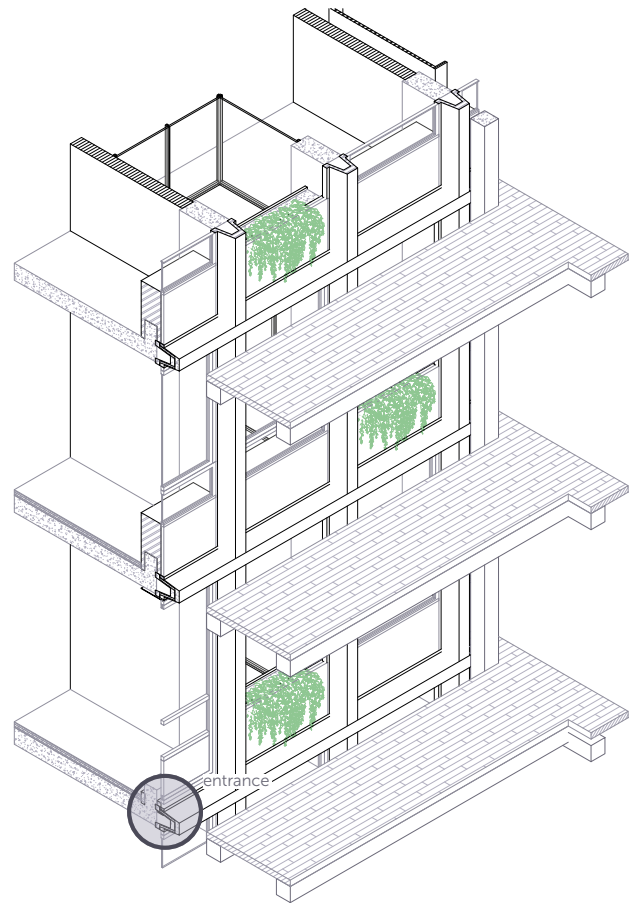
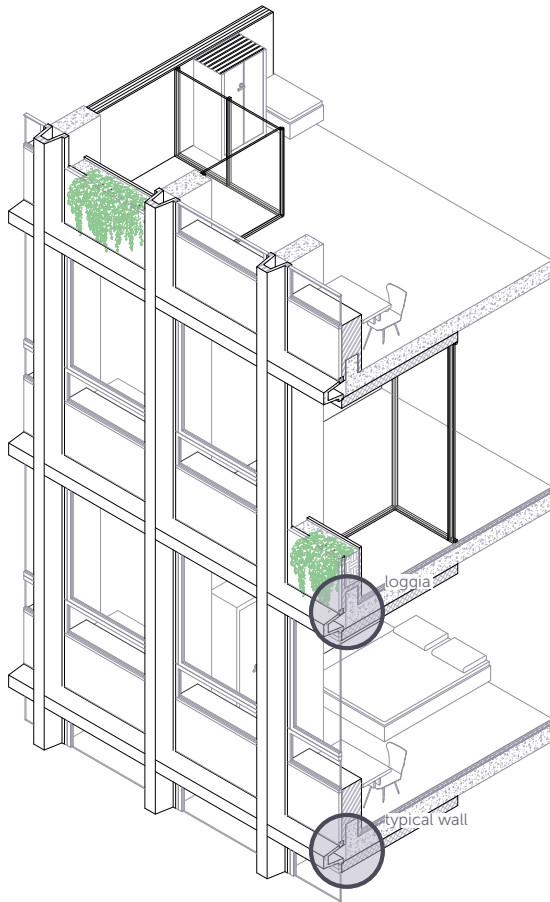
Co-housing apartment impression



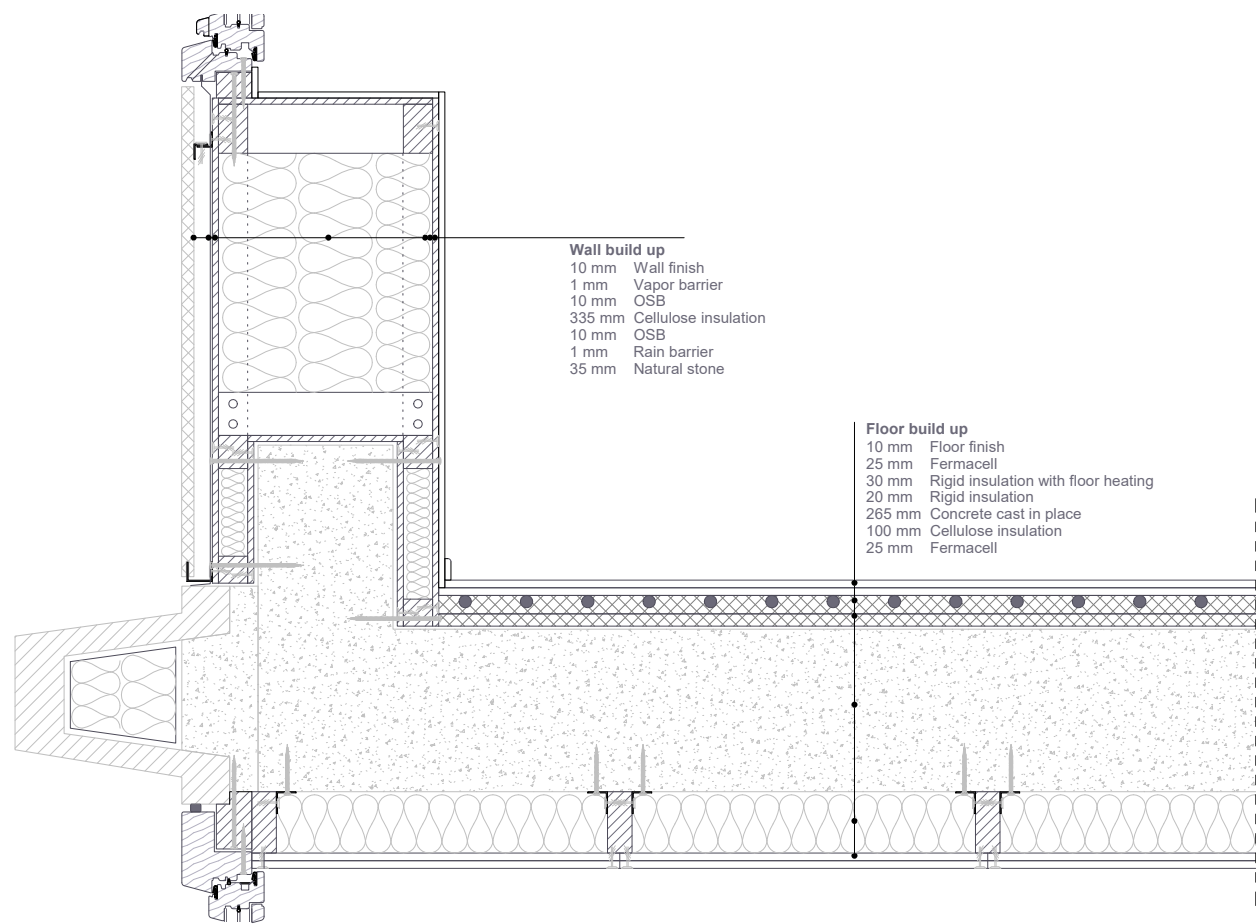
Facade fragment



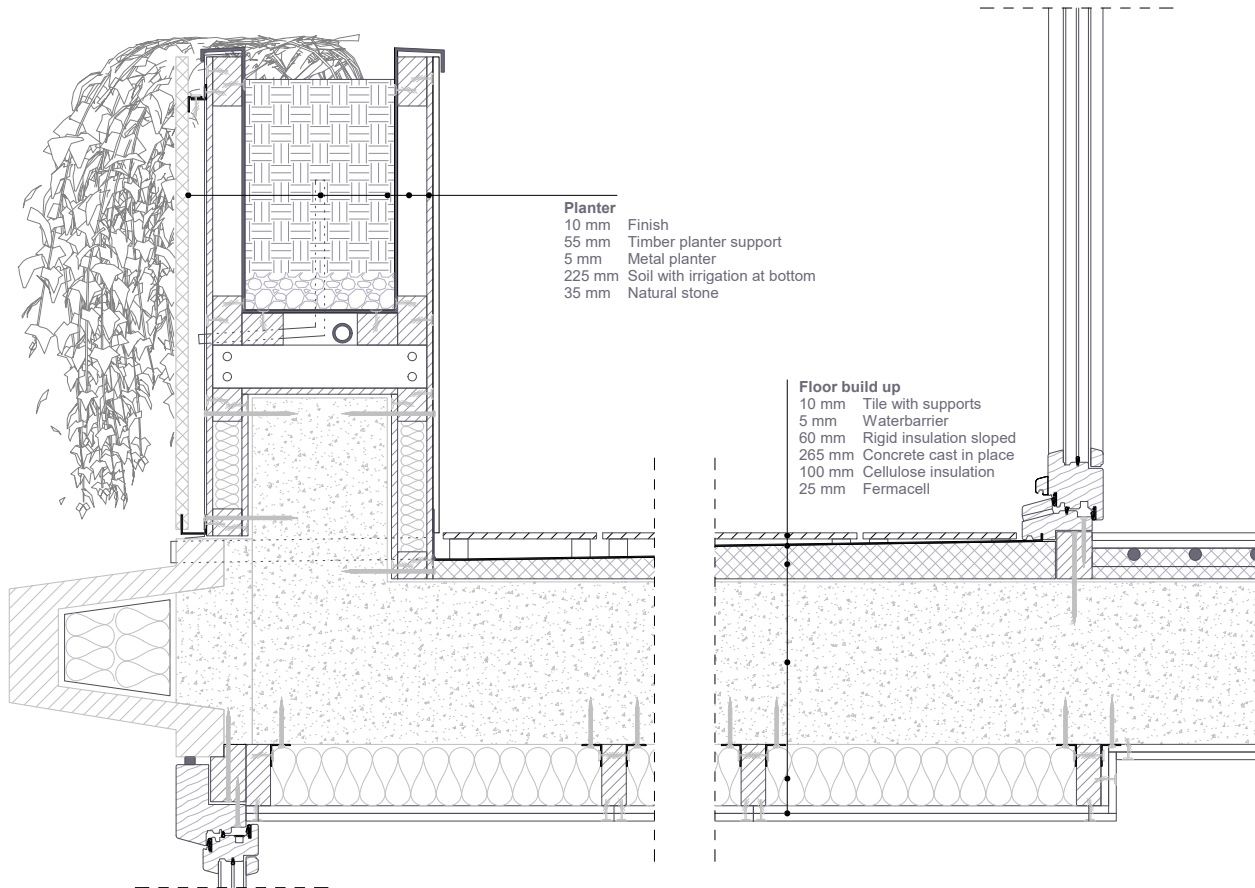
Facade fragments



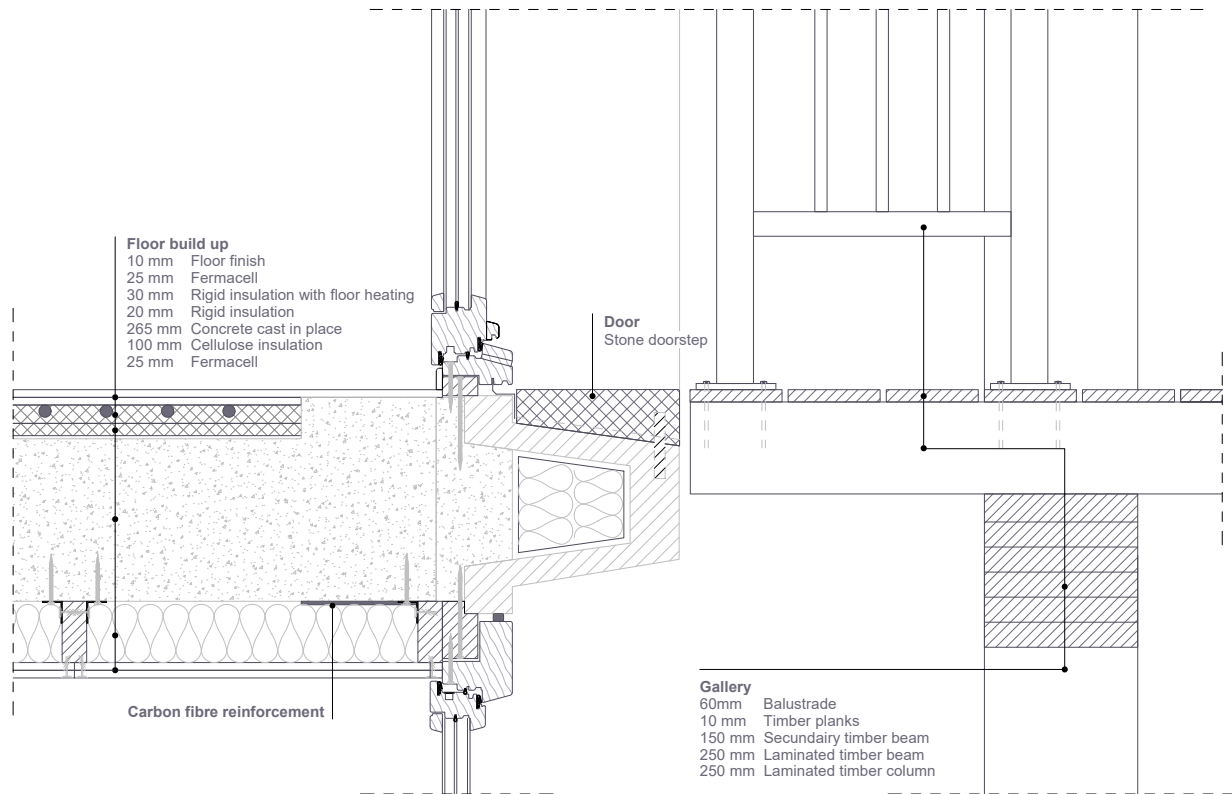
Typical wall detail



Loggia detail



Door detail



Facade elevation

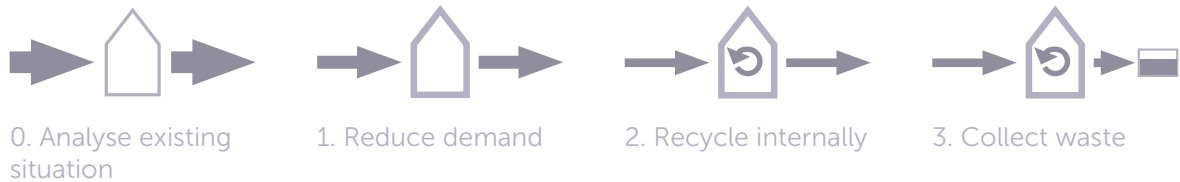


21

Systems

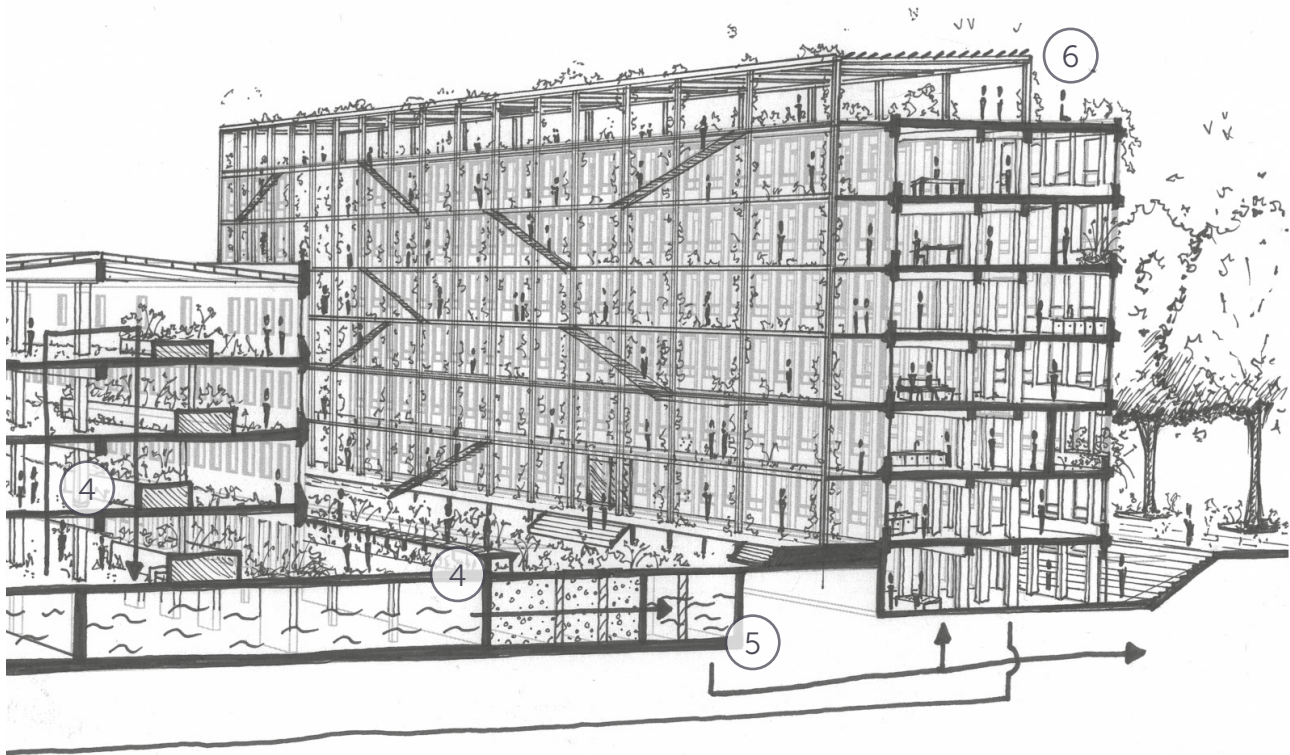
29.08.2022 - 08.12.2022

- 1a. insulation, sunshading, green roof
- 1b. storage of water, heat/cold, electricity
2. heat cascade from cooling, heat from living machine



- 3. collection of waste water, waste chutes in cores,
- 4. treatment of water with living machine
- 5. water & energy reused in building & neighborhood

- 6. pvt panels on roof & CHP
- 7. organic waste into fertilizer



4. Process waste



5. Re-use the effluent

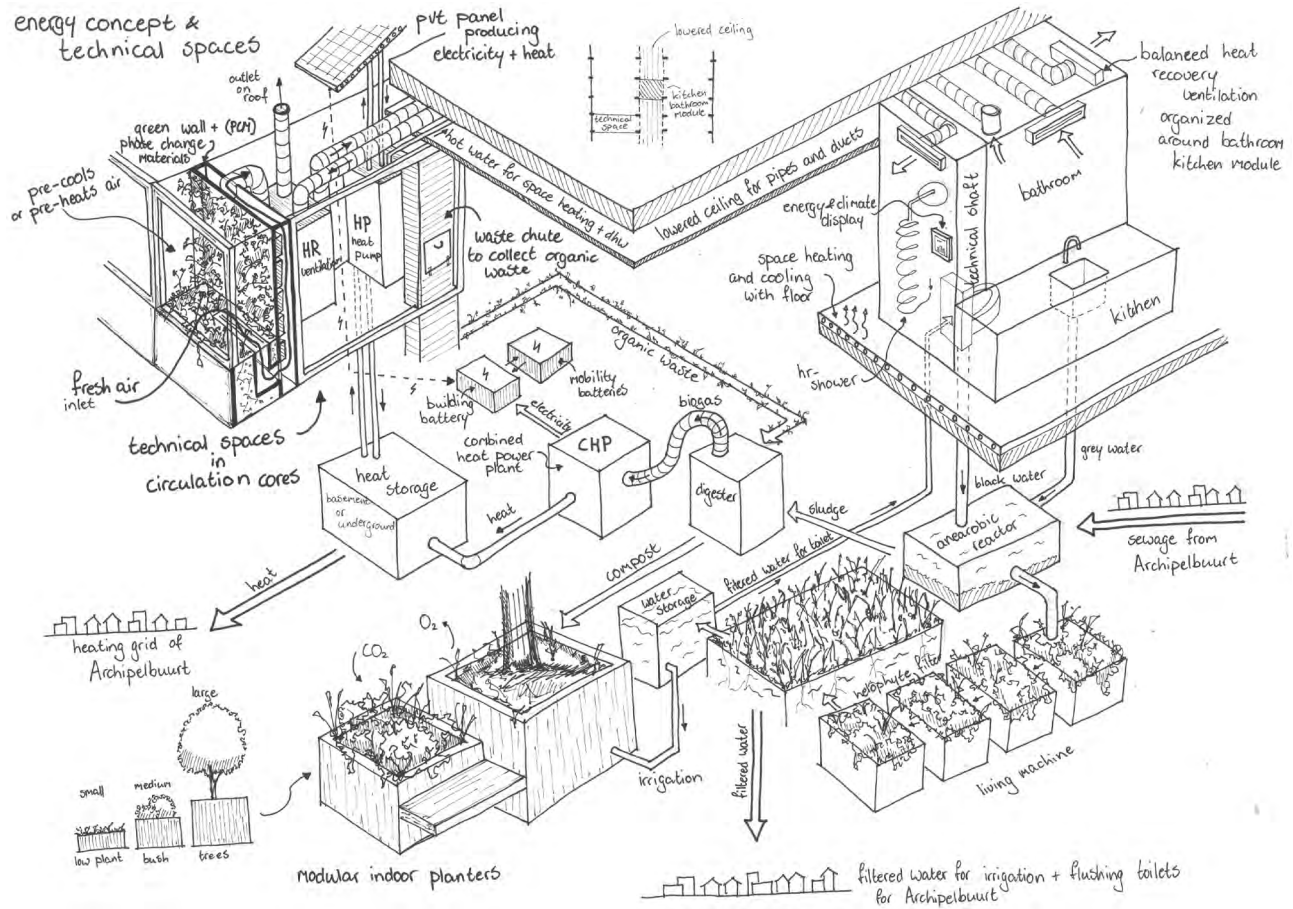


6. Supply demand sustainably

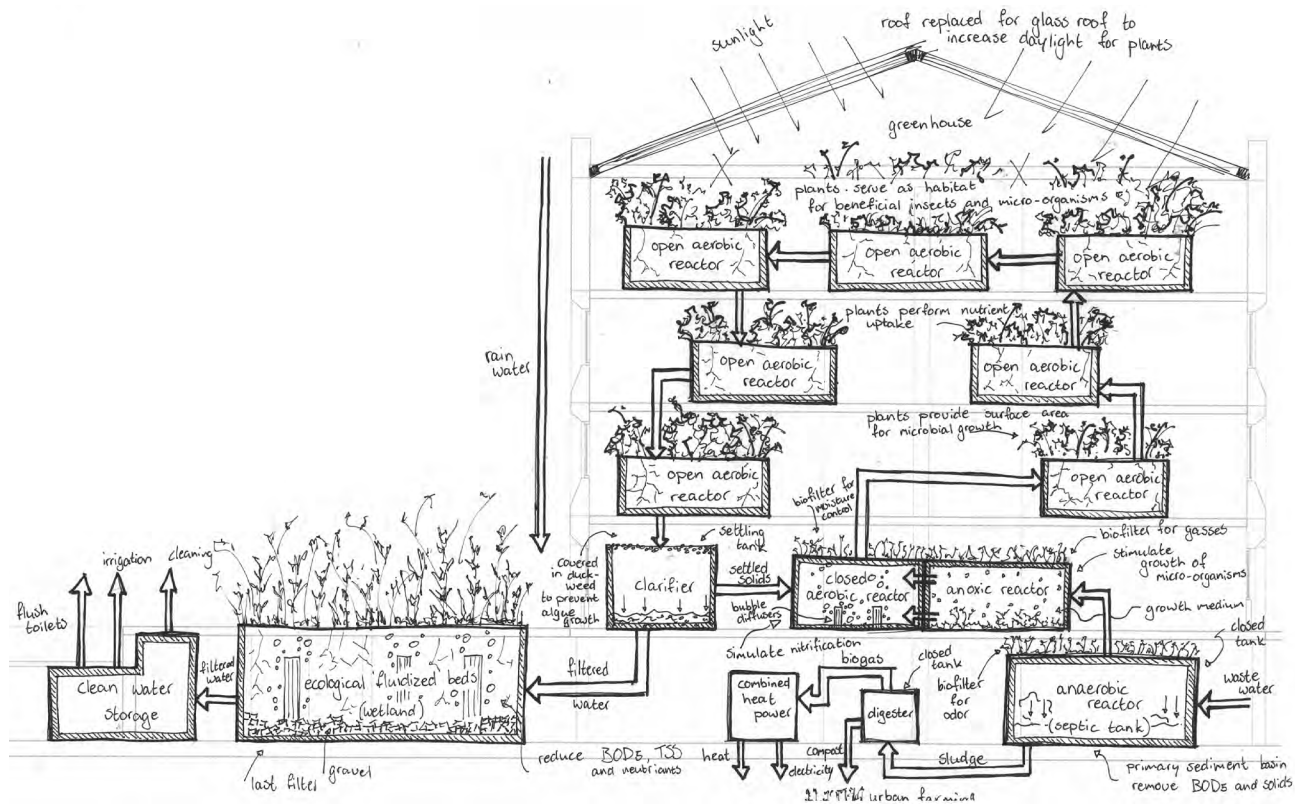


7. Waste equals food

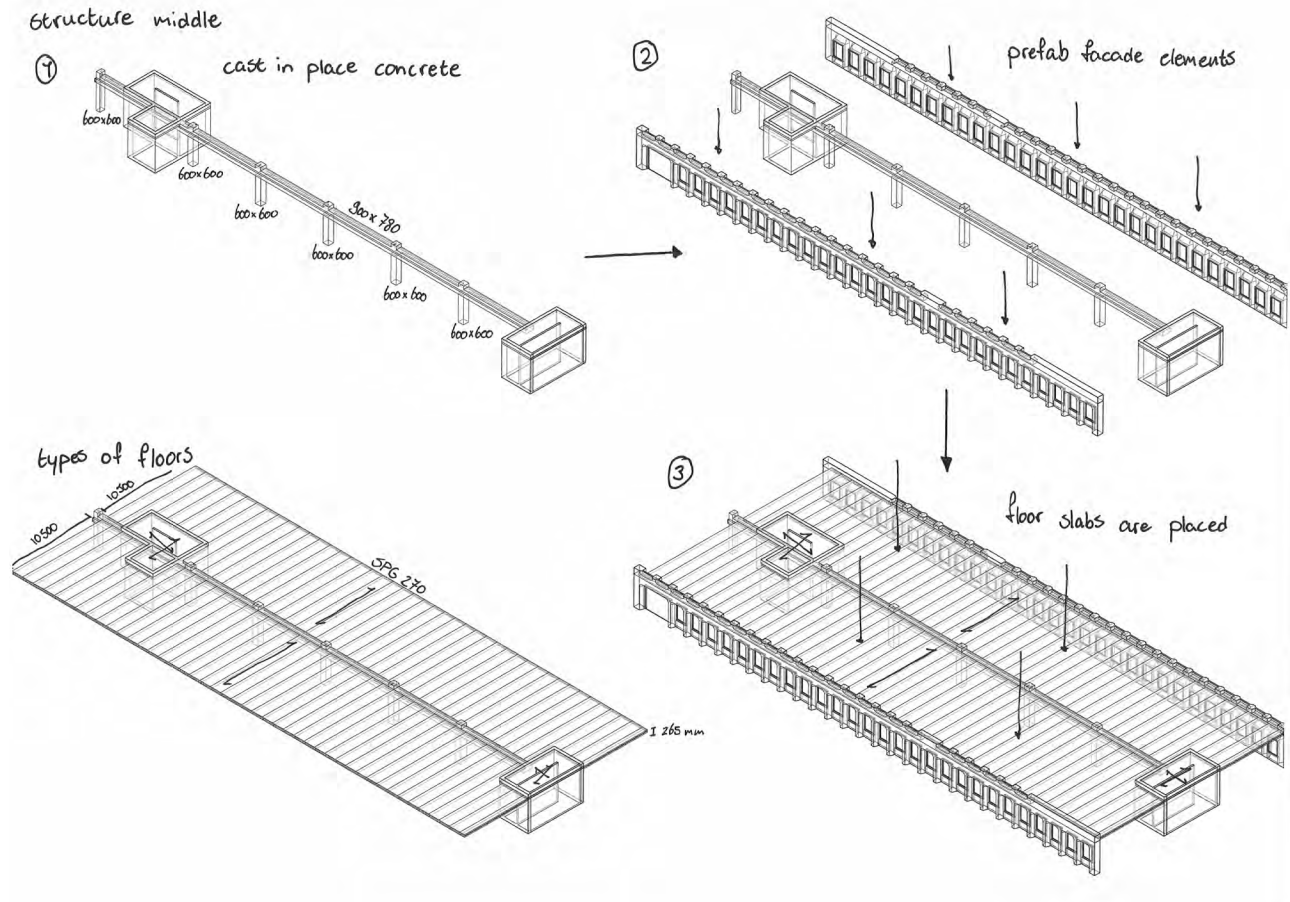
Detailed energy concept



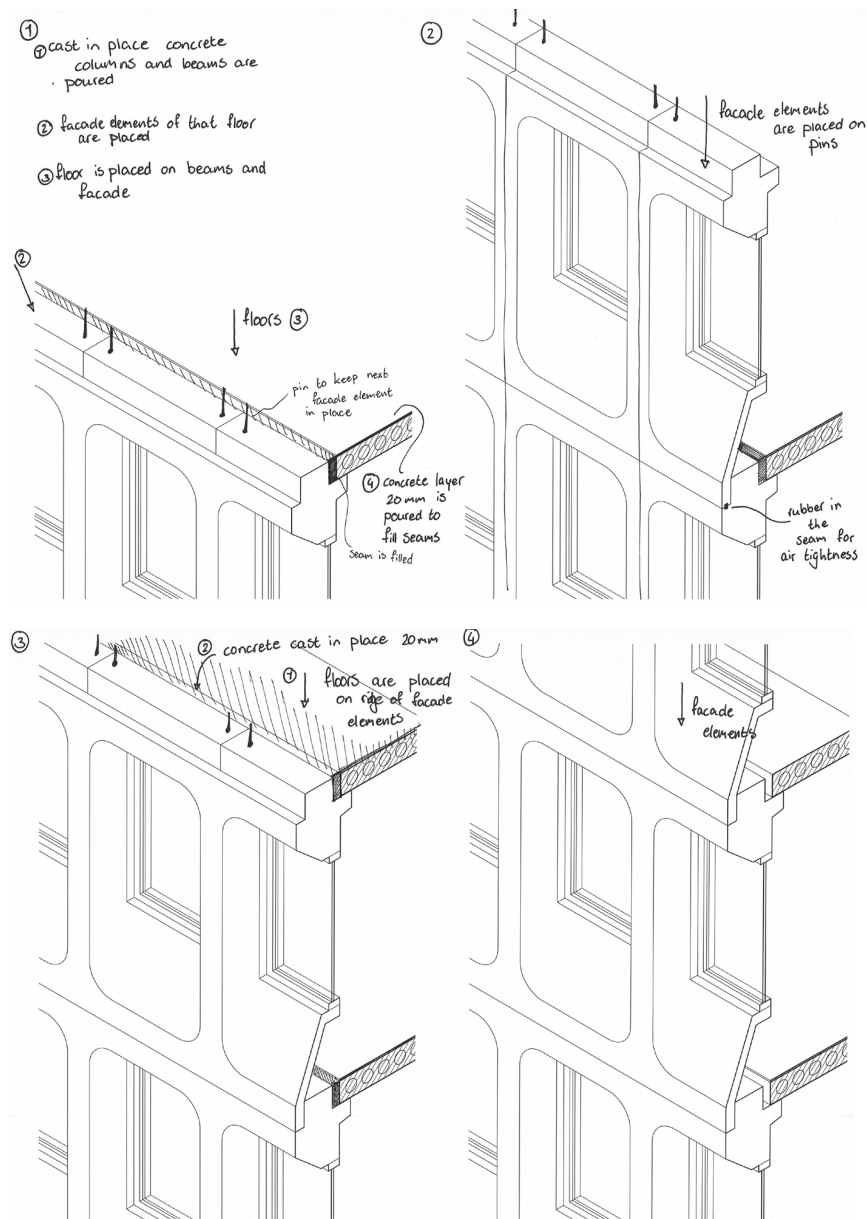
Living machine concept



Existing building structure



Facade construction



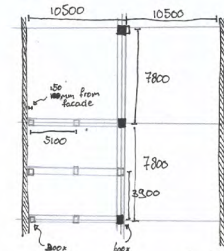
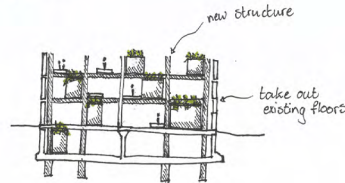
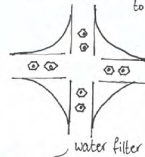
Living machine design sketches

living machine

living machine → evolve overtime in flexible framework

- 200 m³ anaerobic reactor (8/13)
- 150 m³ anoxic reactor (6/10)
- 150 m³ closed aerobic reactor (6/10)
- 400 m³ open aerobic reactor (16/26)
- 250 m³ open aerobic reactor (10/16)
- 150 m³ clarifier (6/10)
- ... m³ helophyte filter

rounded corners as reference
to building facade



- $4800 \times 3600 = 17,28 \text{ m}^2$
- 1.65 m high → 25 m³ per tank
- 1 m high → 15 m³ per tank

- place for 40 tanks per floor
- in total 200 tanks
- including basement

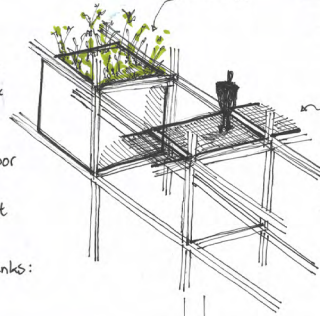
- total amount of needed tanks:
52/85

- total added max. weight: ~~13000~~ kg
- tanks:
1,300,000 kg

structure:

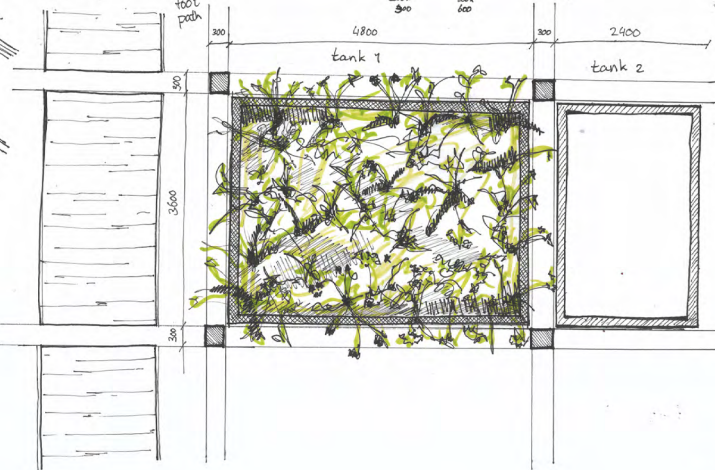
- removed weight:

- hollow-core = 380 kg/m²
- 1150 m²/floor = 437,000 kg
- 3 floor removed = 1,311,000 kg
- top-up =

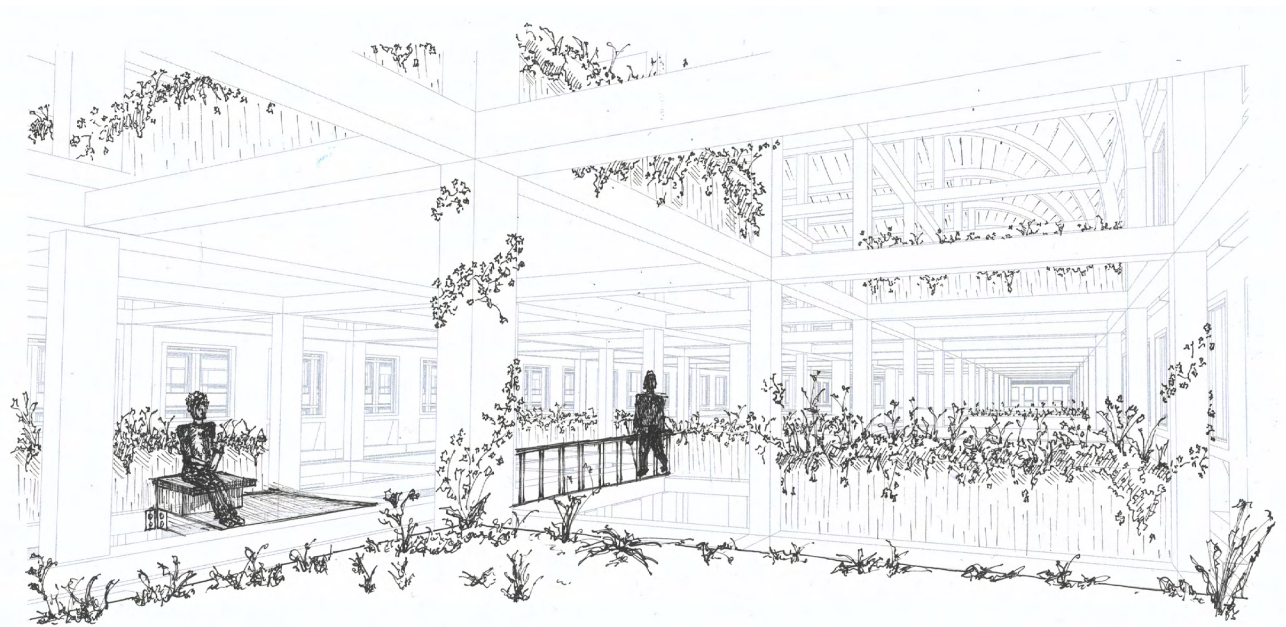


foot path

foot path



Living machine impression



Design & Research calculations

Design & Research

The continuation of the research comes from the design, specifically from the designed energy concept for the building. With this energy concept, initial calculations can be performed to investigate the impact of the design on the neighborhood. 150 apartments - 390 inhabitants

Water input

The waste water from the neighborhood together with the rainwater forms an input for the building.
Grey water: 183.000.000 L/year
Black water: 124.000.000 L/year
Rainwater: 670.400.000 L/year (neighborhood), estimated is that 30% can be captured and reused: 201.120.000 L/year.

Material input

The material input exists of the organic waste from the neighborhood and the sludge from the sewage, seperated in the living machine.
Organic waste: 34.3 kg/person/year x 6600 persons = 226.380 kg/year
Sludge: 21.3 kg/person/year x 6600 persons = 140.580 kg/year.

Energy input

The energy input comes from the utilization of the sun and organic waste as sources. This energy is converted using PVT panels and a biogas combined heat power plant (CHP).
PVT electr.: $190\text{kWh/m}^2 \times 4800\text{m}^2 = 912.000\text{ kWh}$
PVT heat: $510\text{kWh/m}^2 \times 4800\text{m}^2 = 2.448.000\text{ kWh}$
Biogas production from organic waste:
 $226.380\text{ kg/year organic waste} \times 573.000\text{ ml CH}_4/\text{kg} = 129.715.740.000\text{ ml CH}_4/\text{year}$
Biogas production from sludge:
 $140.580\text{ kg/year sludge} \times 334.000\text{ ml CH}_4/\text{kg} =$

$46.953.720.000\text{ ml CH}_4/\text{year}$

Total biogas production:

$46.953.720.000\text{ ml CH}_4 + 129.715.740.000\text{ ml CH}_4 = 176.669.460.000\text{ ml CH}_4 = 176.670\text{ m}^3\text{CH}_4/\text{year}$

CHP electr.: $176.670\text{ m}^3\text{CH}_4/\text{year} \times 9,9\text{ kWh} \times 45\% = 787.064\text{ kWh/year}$

CHP heat: $176.670\text{ m}^3\text{CH}_4/\text{year} \times 9,9\text{ kWh} \times 55\% = 961.968\text{ kWh/year}$

Total electr. production: 1.700.000 kWh/year

Total heat production: 3.410.000 kWh/year

Water usage of building

Fresh water usage: 375 persons x 120 L/day x 365 = 16.425.000 L/year

Grey water production: 10.704.000 L/year

Black water production: 5.721.000 L/year

Energy usage of building

Appartments electricity: 100 bedroom app. x 2000 kWh + 12 work living appartments x 2500 kWh + 38 co-housing x 3500 kWh = 382.000 kWh/year

Appartments DHW: 2.5 kWh/person/day x 365 x 390 persons = 355.875 kWh/year

Appartments heat: 80 kWh/m² x 14.000 m² = 1.120.000 kWh/year

Appartments cold: 114.000 kWh/year

Public electr: $80\text{kWh/m}^2 \times 2.530\text{m}^2 = 202.400\text{ kWh}$

Public DHW: 7.000 kWh/year

Public heat: 150.000 kWh/year

Public cold: 35.000 kWh/year

Total electricity: 584.400 kWh/year

Total DHW: 362.875 kWh/year

Total heat: 1.270.000 kWh/year

Total heating incl DHW: 1.632.875 kWh/year

Living machine capacity

From research multiple capacities for living machines can be found ranging from 73.000 L/m² to 102.607 L/m². Using this number for the area designated for the living machine (5000m²) gives a capacity between 365.000.000 L/year to 513.035.000 L/year (Findhorn - Schotland, 1995).

A more precise studies of the Waterfabriek in Emmen gives the capacity and sizes of the separate elements of the living machine (Waterfabriek Wildlife - Emmen (2016): <https://edepot.wur.nl/9682>). The living machine has the following dimensions:

- 140 m³ anoxic reactor
- 140 m³ closed aerobic reactor
- 370 m³ open aerobic reactor
- 235 m³ open aerobic reactor

The living machine is designed for 60 m³/h = 525.600.000 L/year, but operates on a lower capacity of 35 m³/h > 306.600.000 L/year. The sizes of the Emmen Waterfabriek have been leading for the design of the living machine in the renovation.

Water output

The output of the building is calculated taking the input, the usage, and the treatment in account. This gives a fresh water output of 307.000.000 L/year.

Energy output

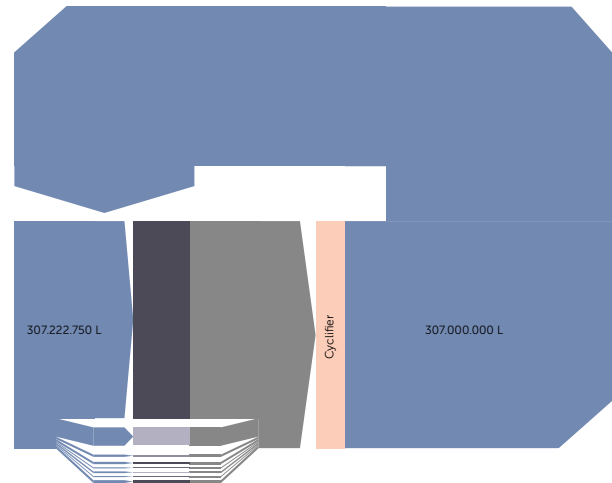
The output of the building is calculated taking the input and the usage in account.

Electricity output: 1.217.100 kWh/year

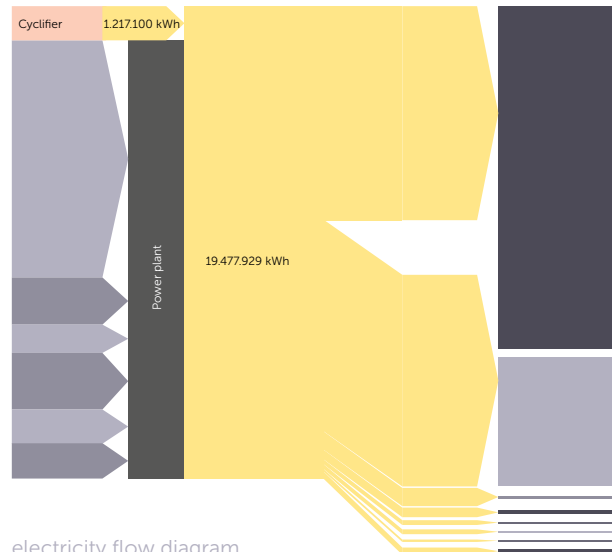
Heating output: 3.117.500 kWh/year

Impact on the neighborhood

The outputs are integrated in the flow diagrams acquired from the urban metabolism research.

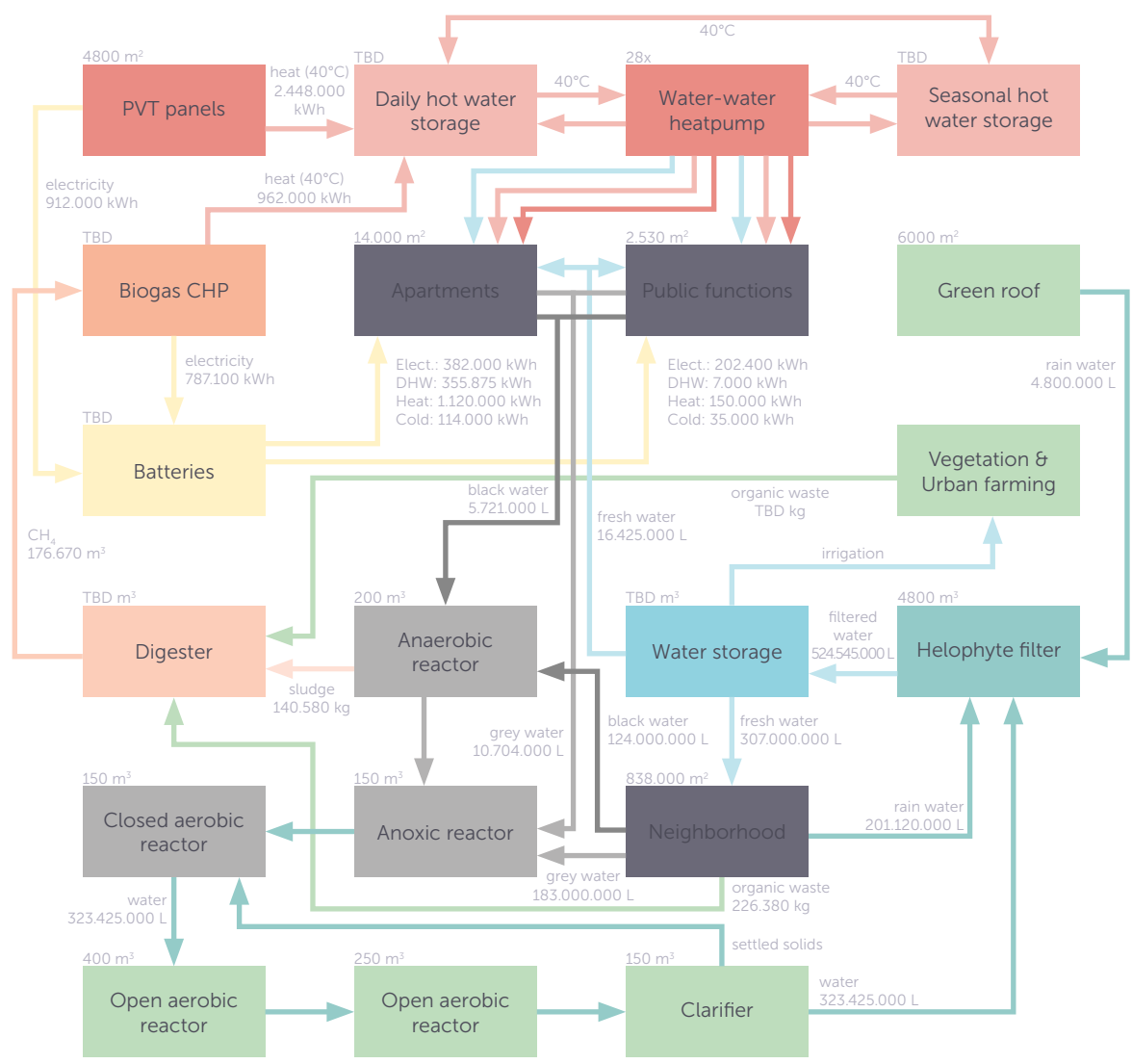


water flow diagram



electricity flow diagram

Energy concept - Cyclifier



Living machine - different elements

200 m³

Anaerobic reactor

200.000 kg

anaerobic reactor

- septic tank / primary sedimentation basin
- reduces the concentrations of BOD₅ and solids
- sludge is periodically removed
- biofilter for odor control
- no daylight required

150 m³

Anoxic reactor

150.000 kg

anoxic reactor

- promote growth of floc-forming microorganisms
- remove a significant portion of BOD₅
- biofilter for odor control
- no daylight required

150 m³

Closed aerobic reactor

150.000 kg

closed aerobic reactor

- reduce the dissolved wastewater BOD₅
- stimulate nitrification
- contains fine bubble diffusers
- biofilter for odor control
- no daylight required

400 m³

Open aerobic reactor

400.000 kg

open aerobic reactors

- contains fine bubble diffusers
- surfaces are covered with vegetation
- plants provide surface area for microbial growth, perform nutrient uptake, serve as a habitat for beneficial insects and microorganisms
- daylight required

150 m³

Clarifier

150.000 kg

clarifier

- settling tank
- settled solids pumped to closed aerobic reactor
- covered with duckweed

4800 m³

Helophyte filter

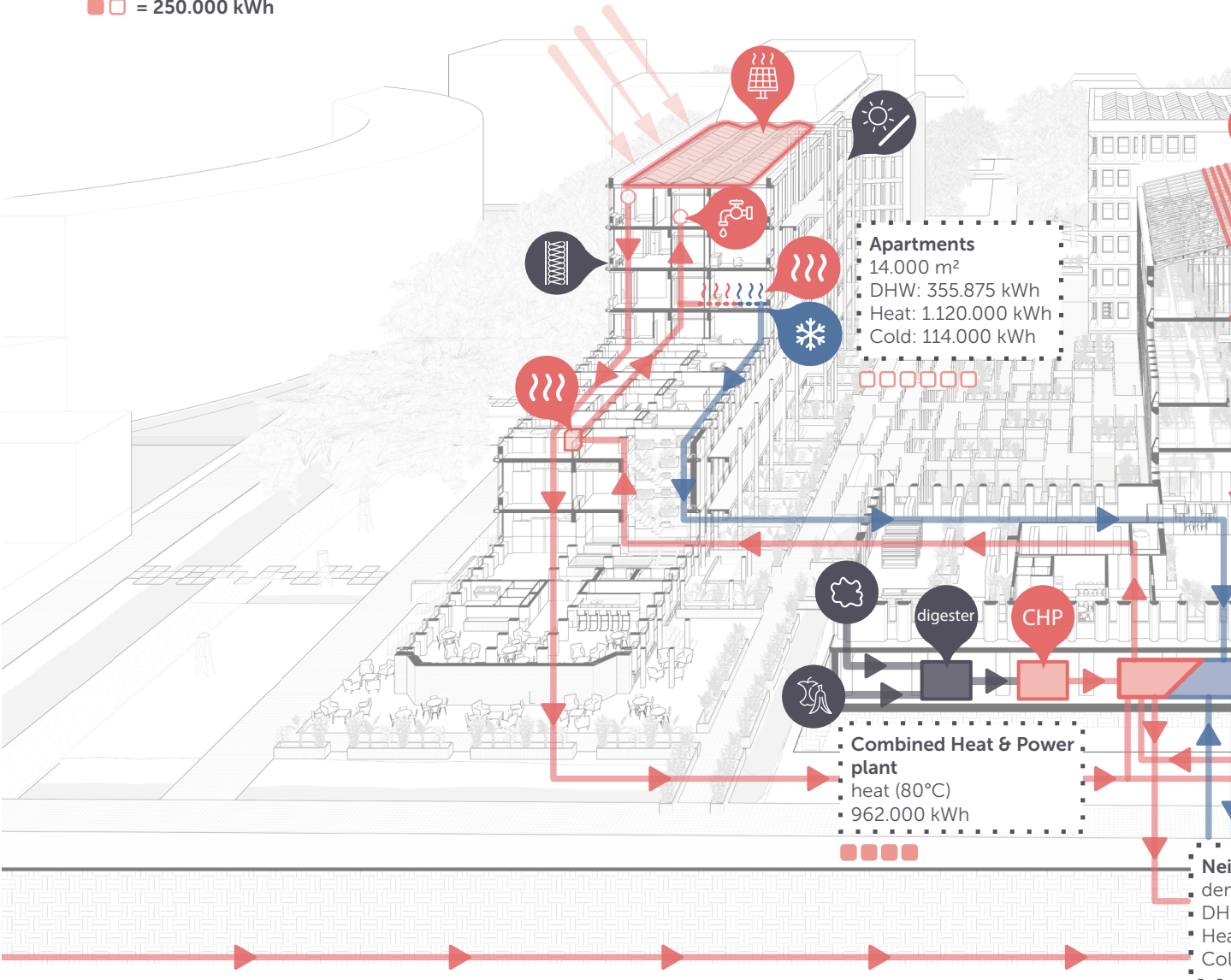
weight not relevant, as it is placed outside

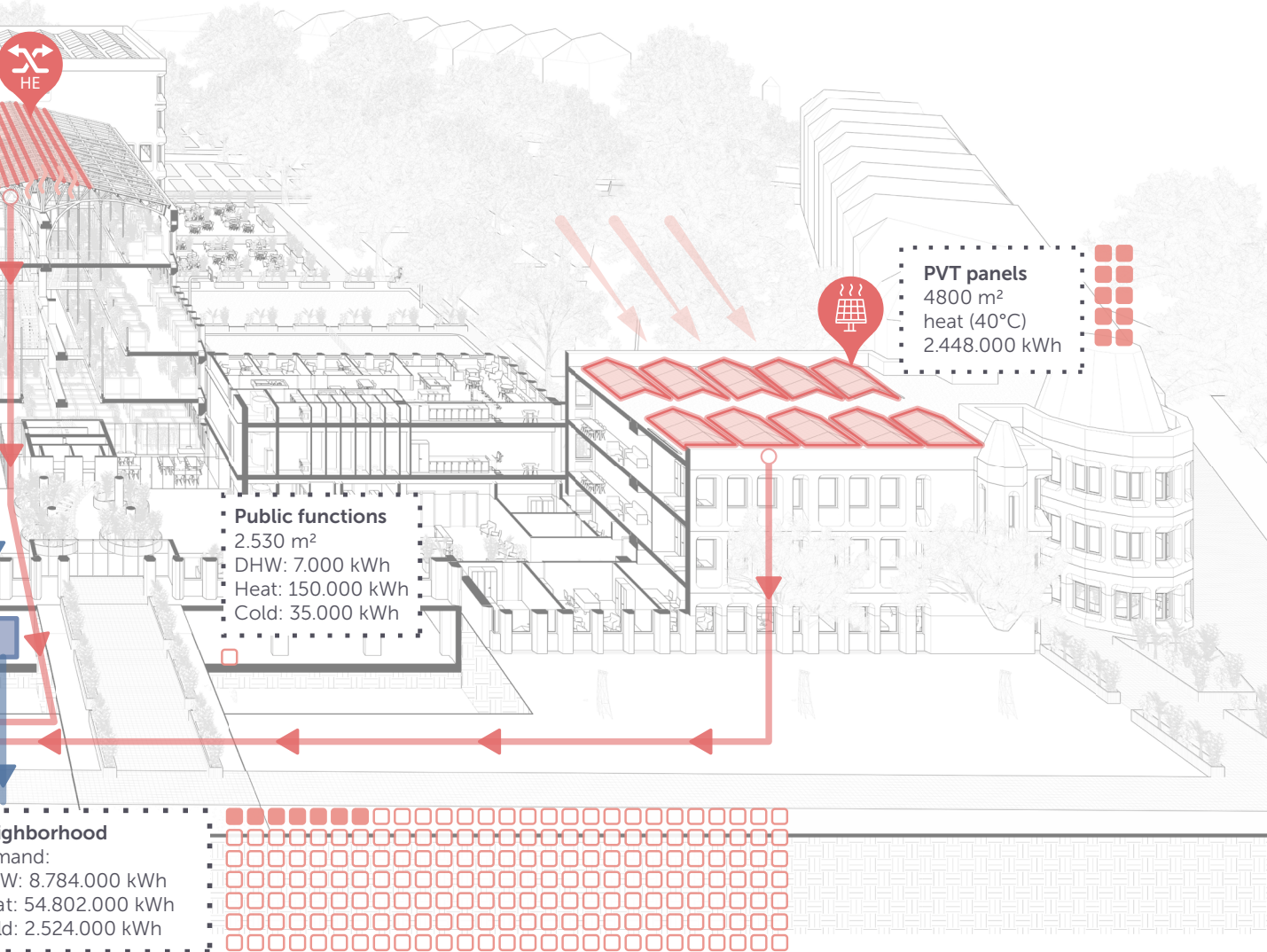
ecological fluidized beds (EFBs) / helophyte filter

- polishing filters that perform final treatment
- contains inner and outer tank
- inner tank contains an attached growth medium
- air lift pipes

Thermal cycle

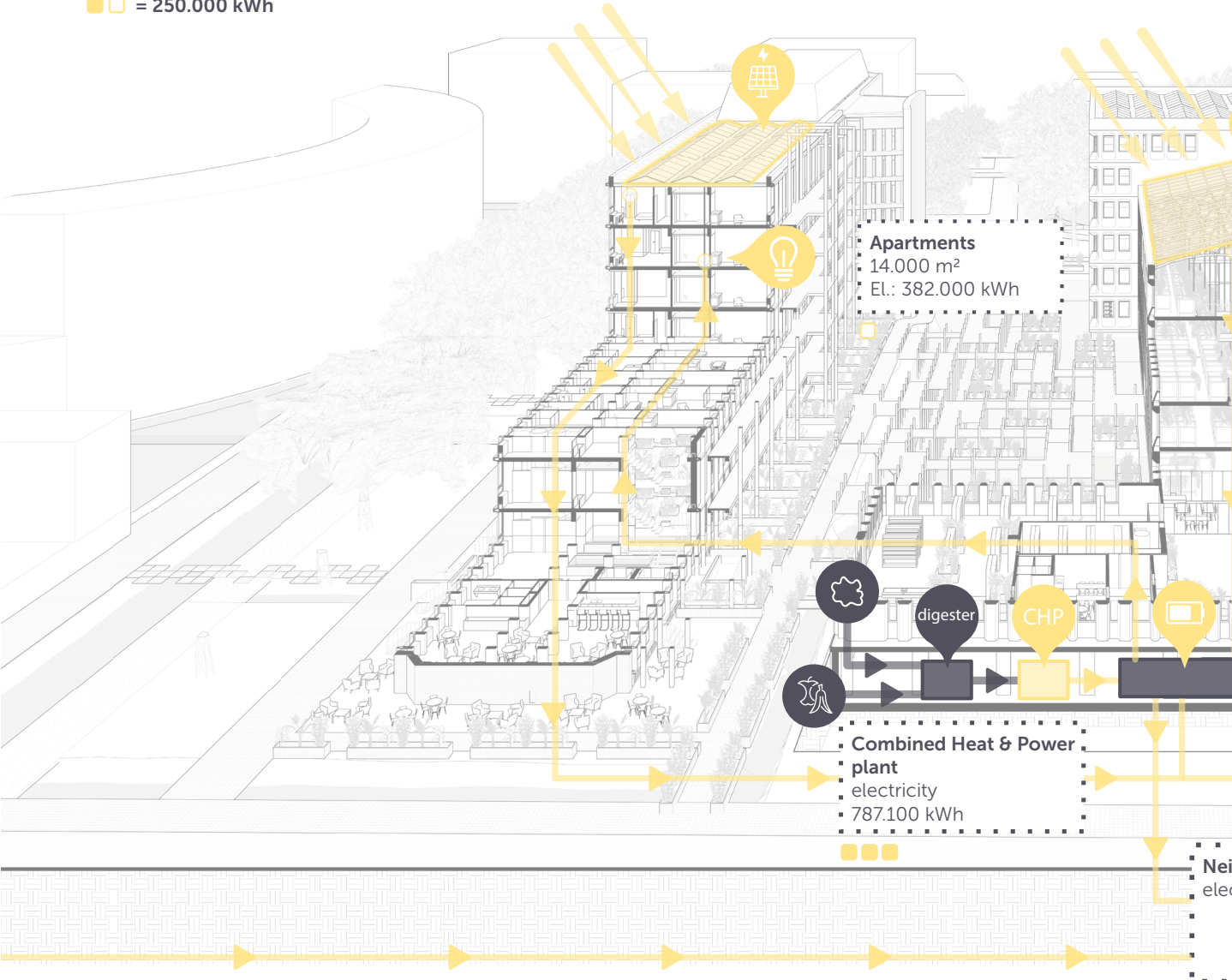
■ produced □ used
■ □ = 250.000 kWh

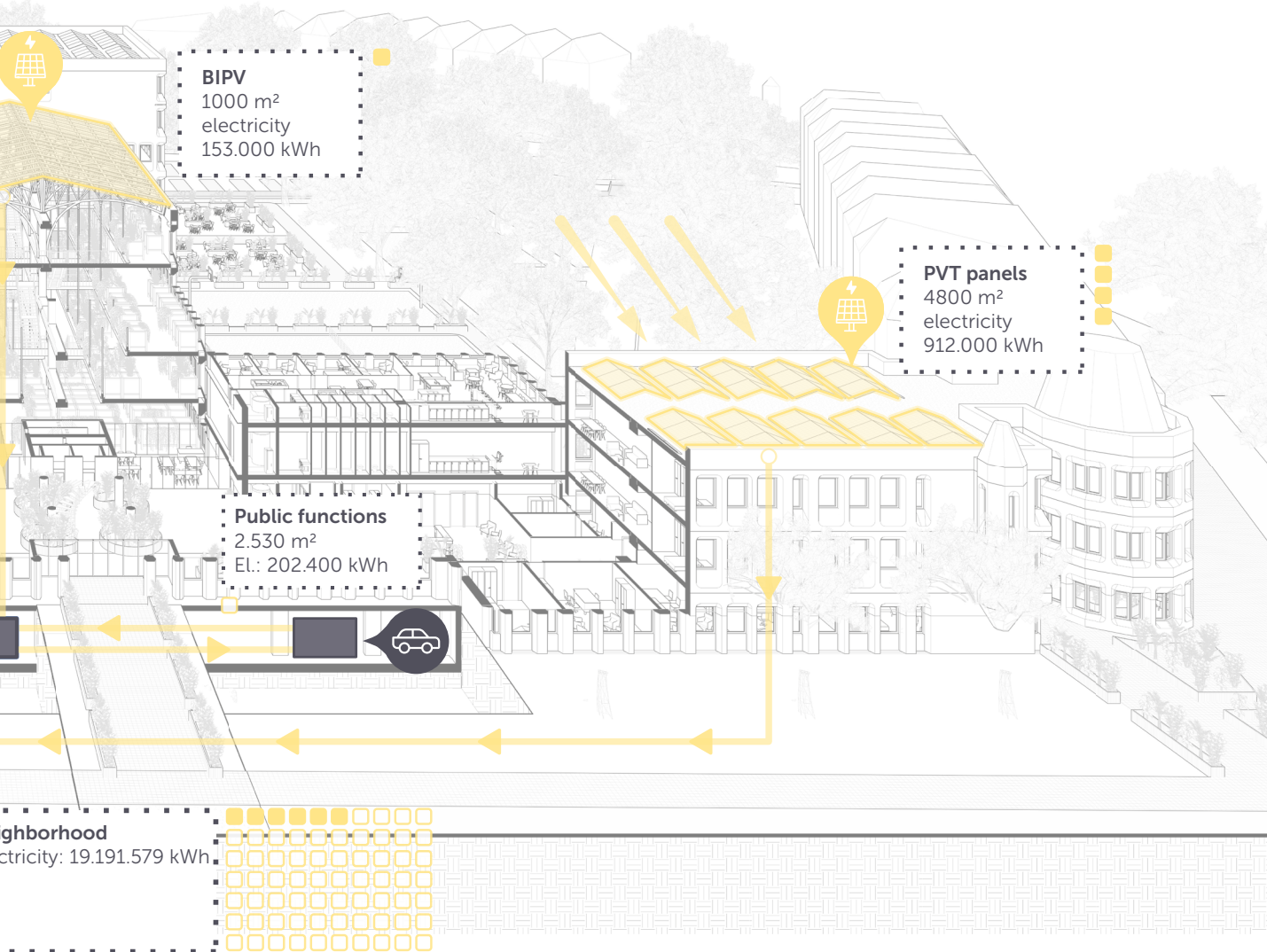




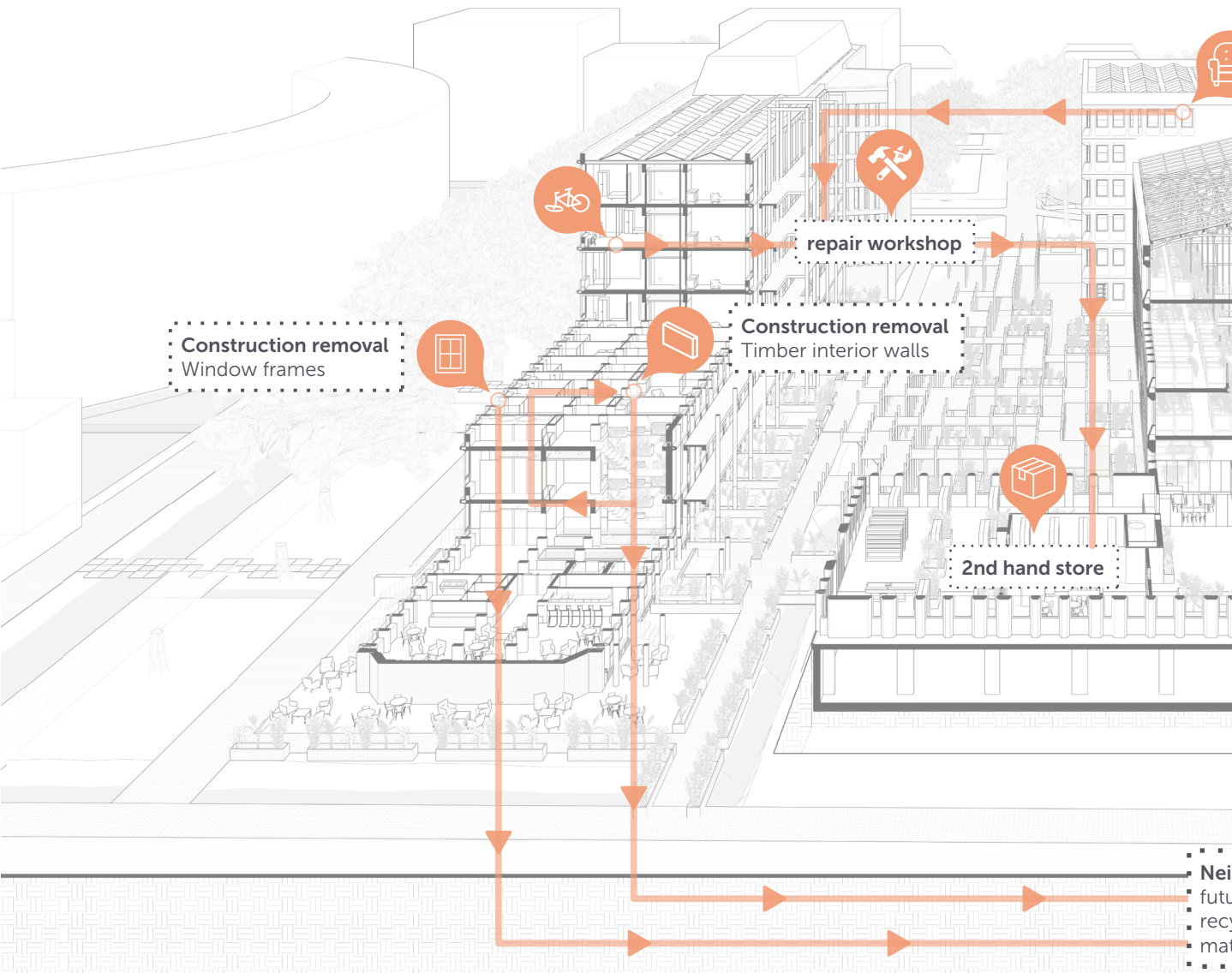
Electrical cycle

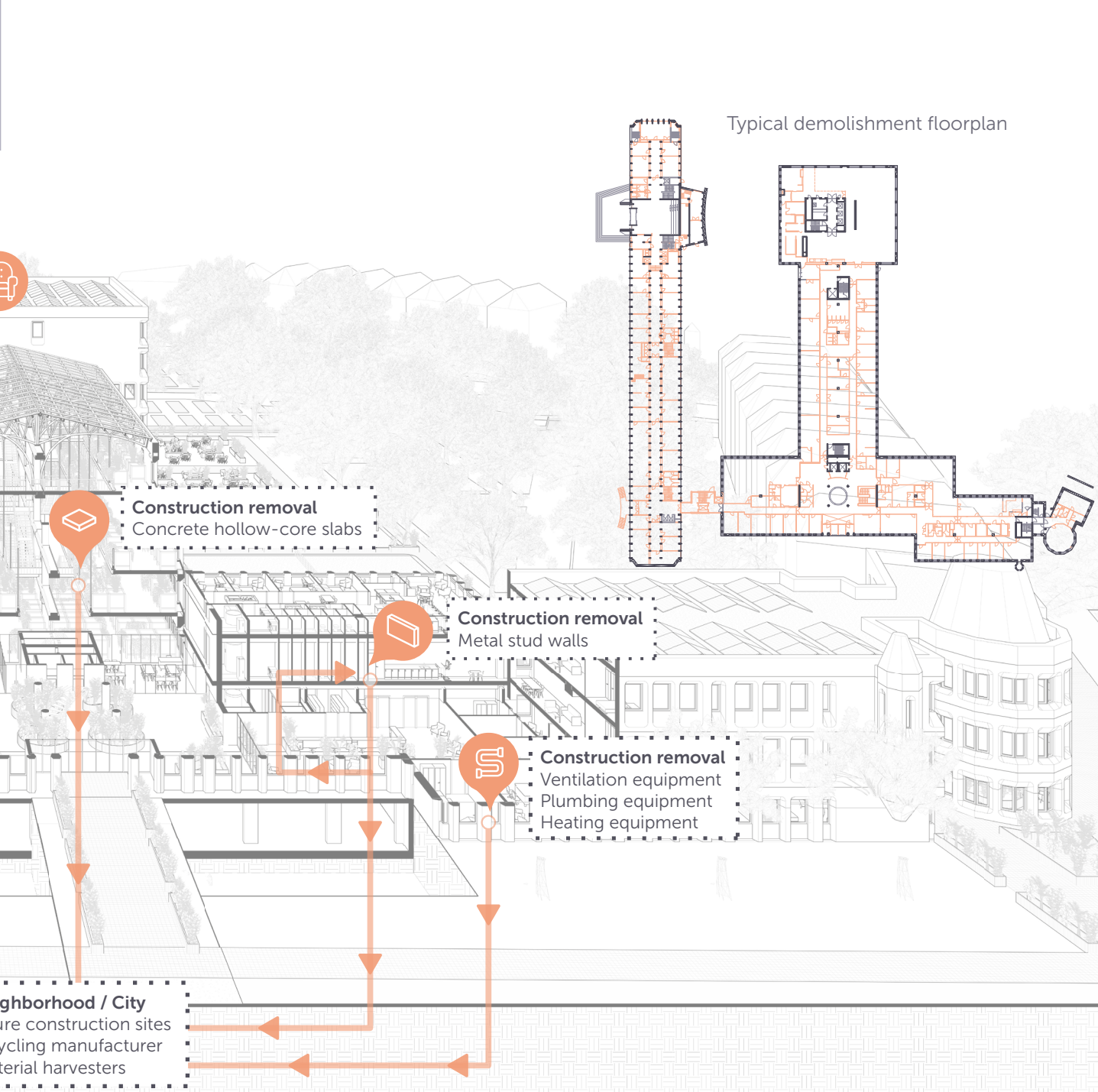
■ produced □ used
■ □ = 250.000 kWh



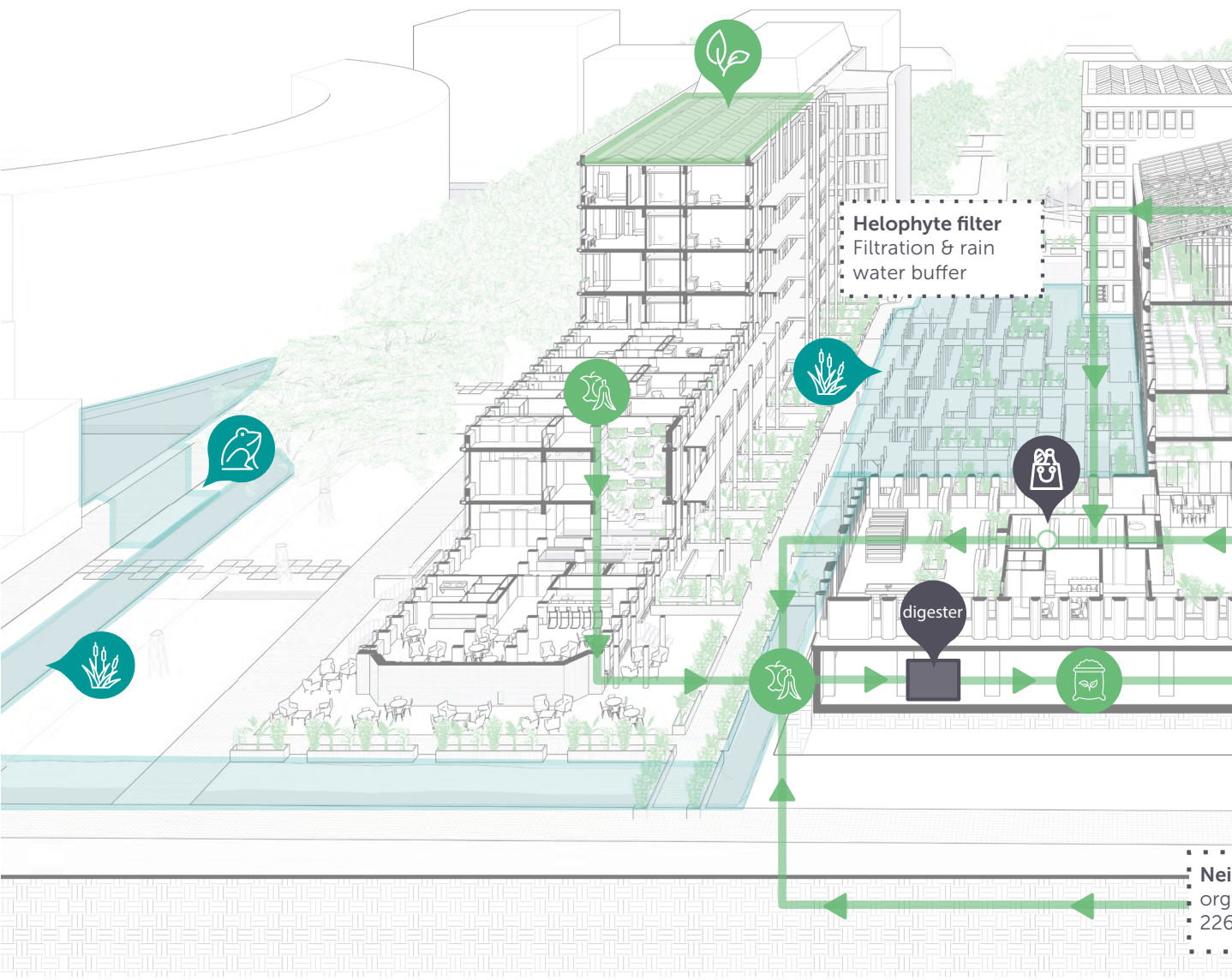


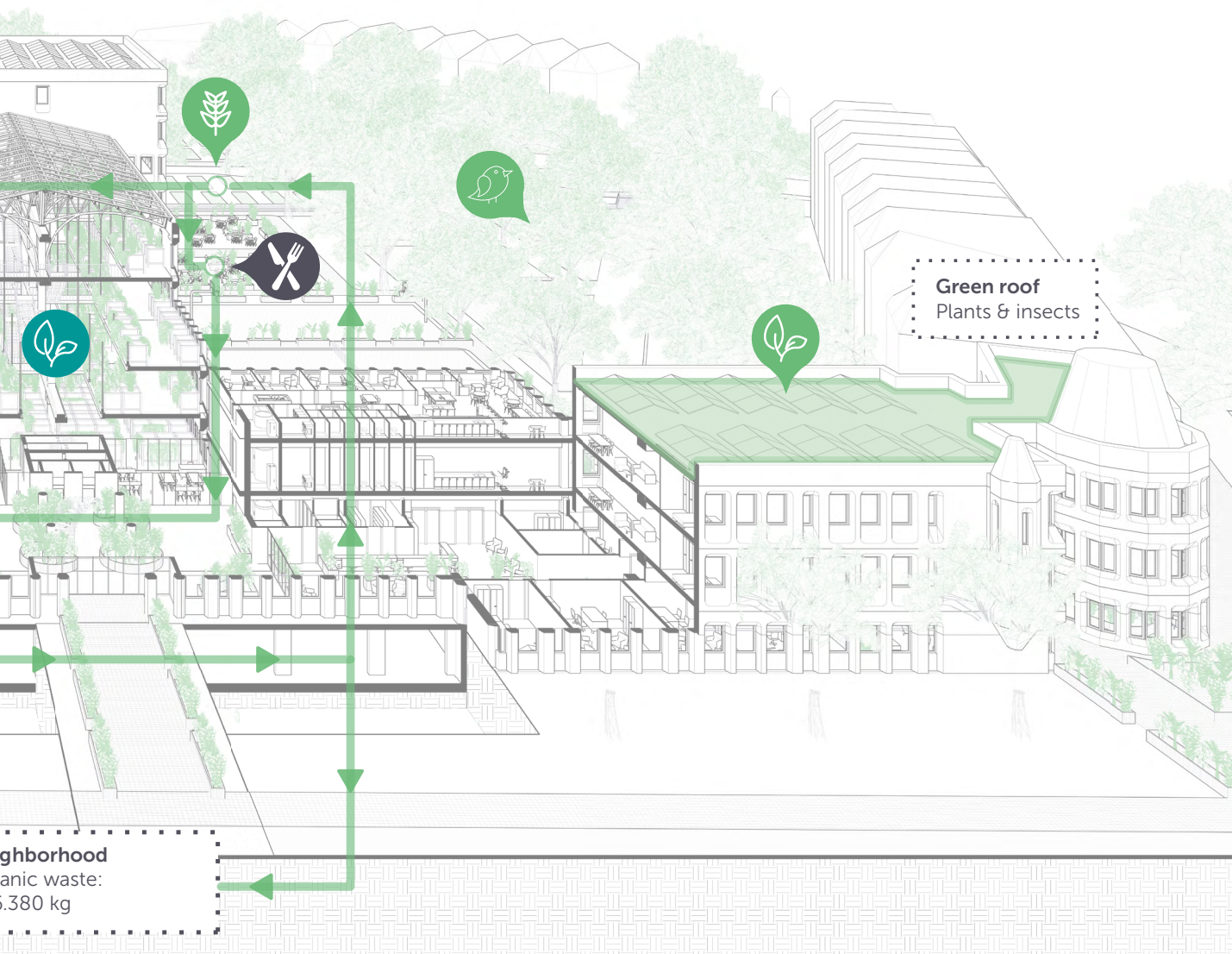
Material cycle



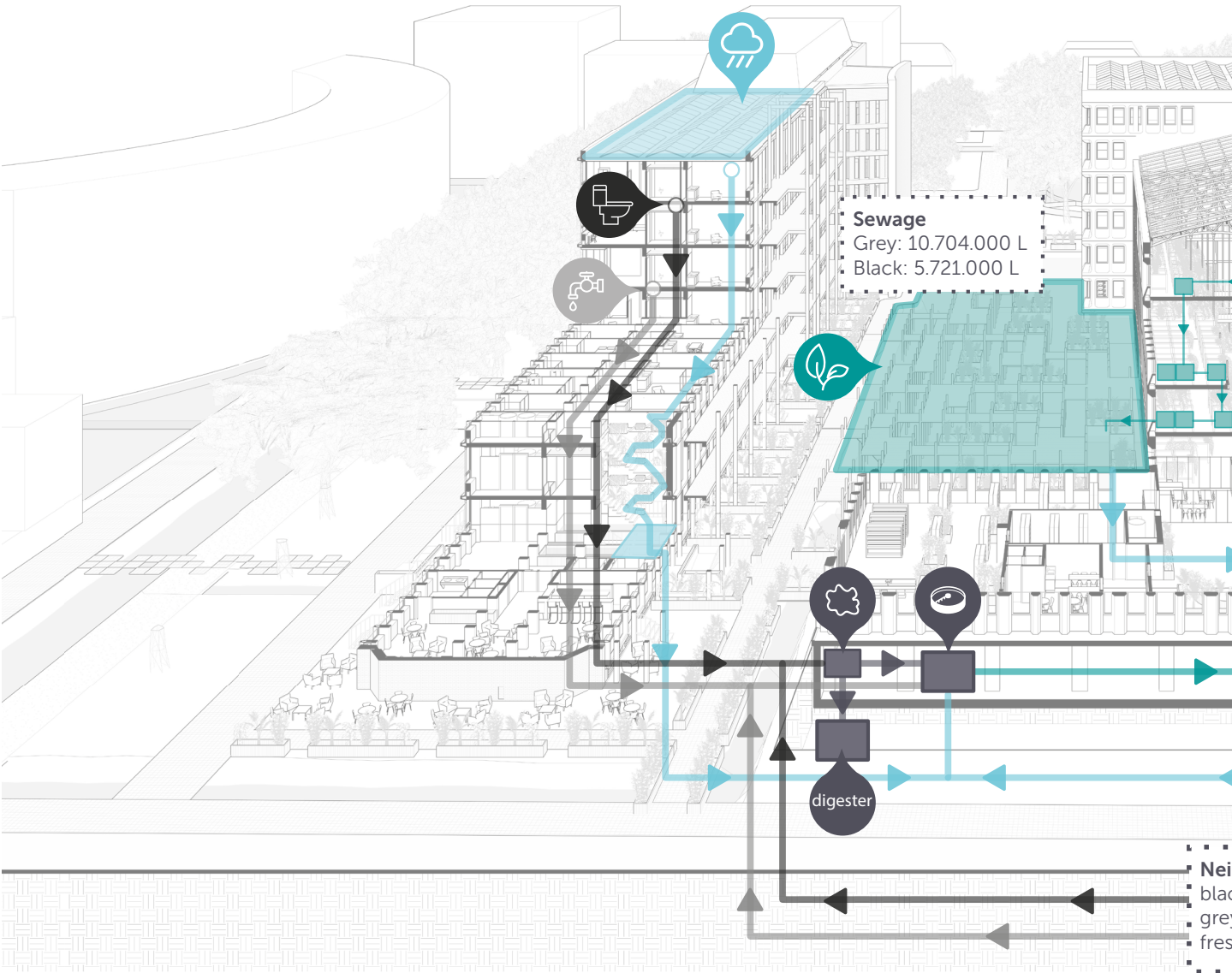


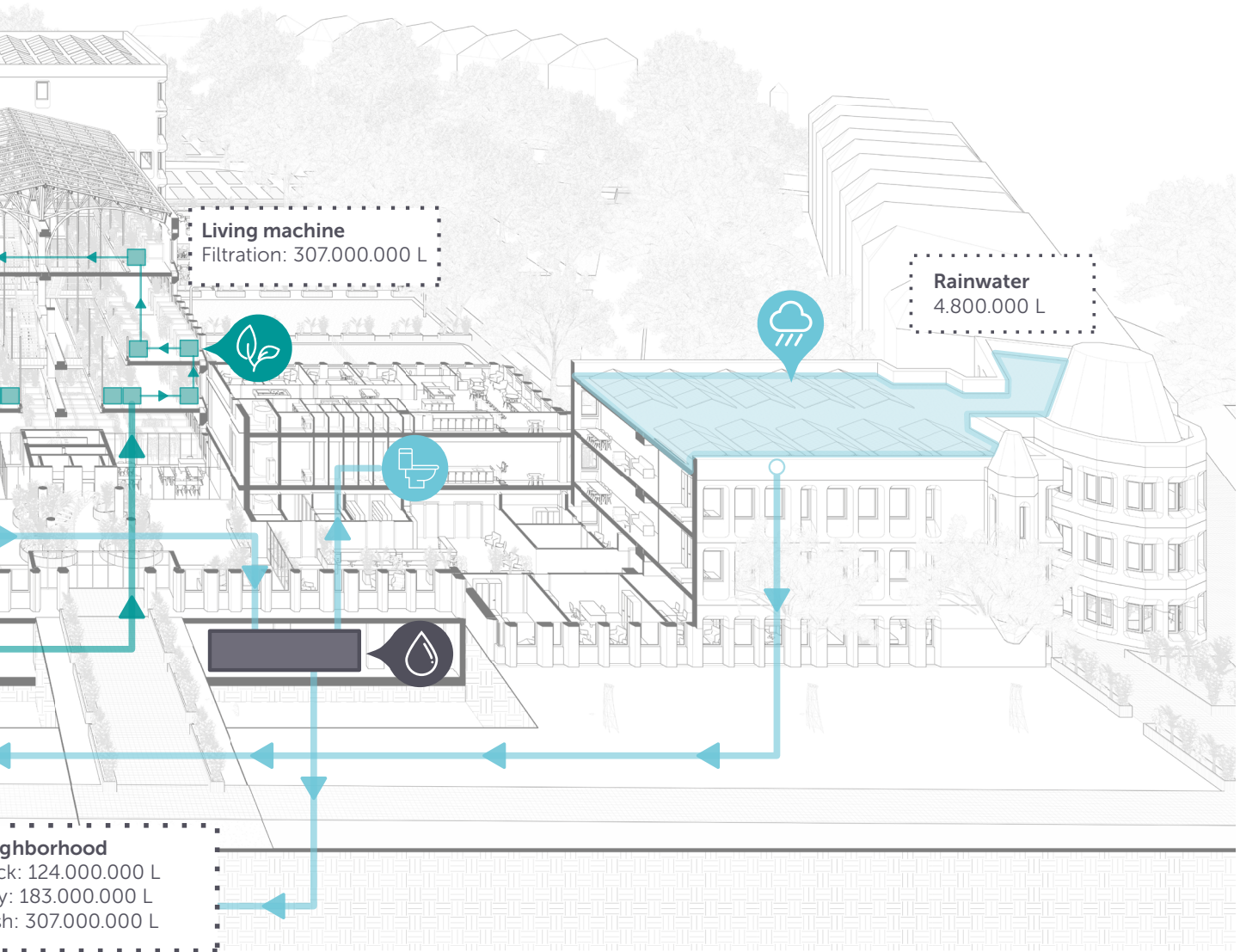
Biotic cycle



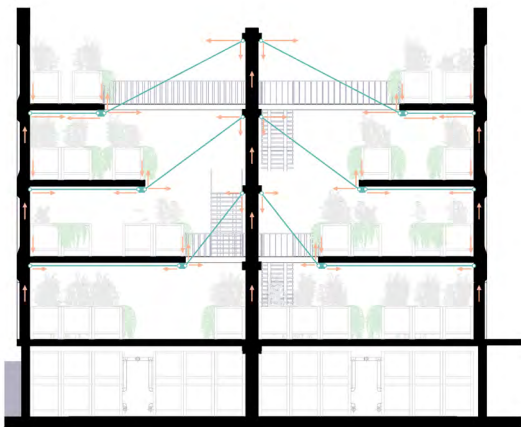


Water cycle

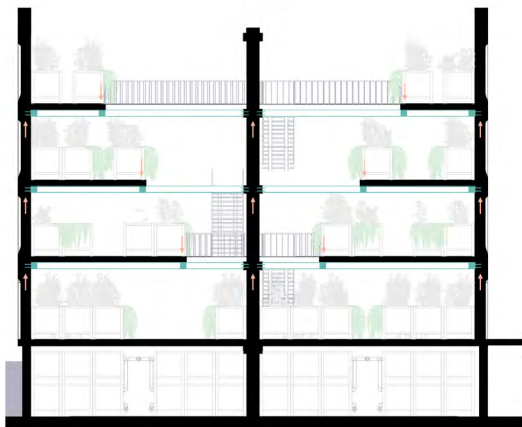




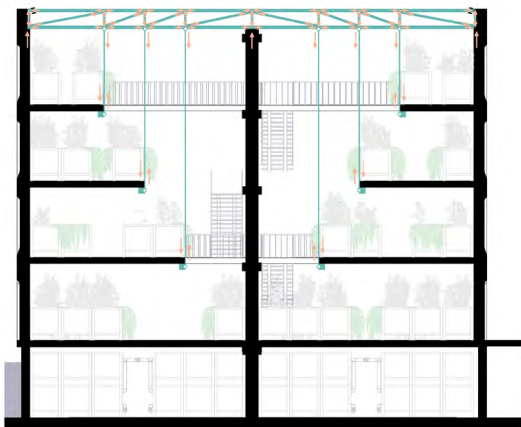
Additional load bearing structure



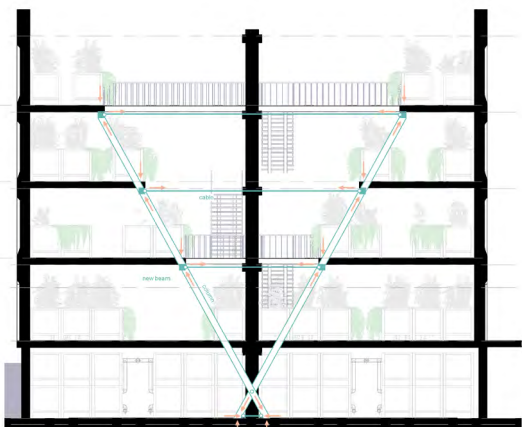
Cables connected to middle beams



Additional beams

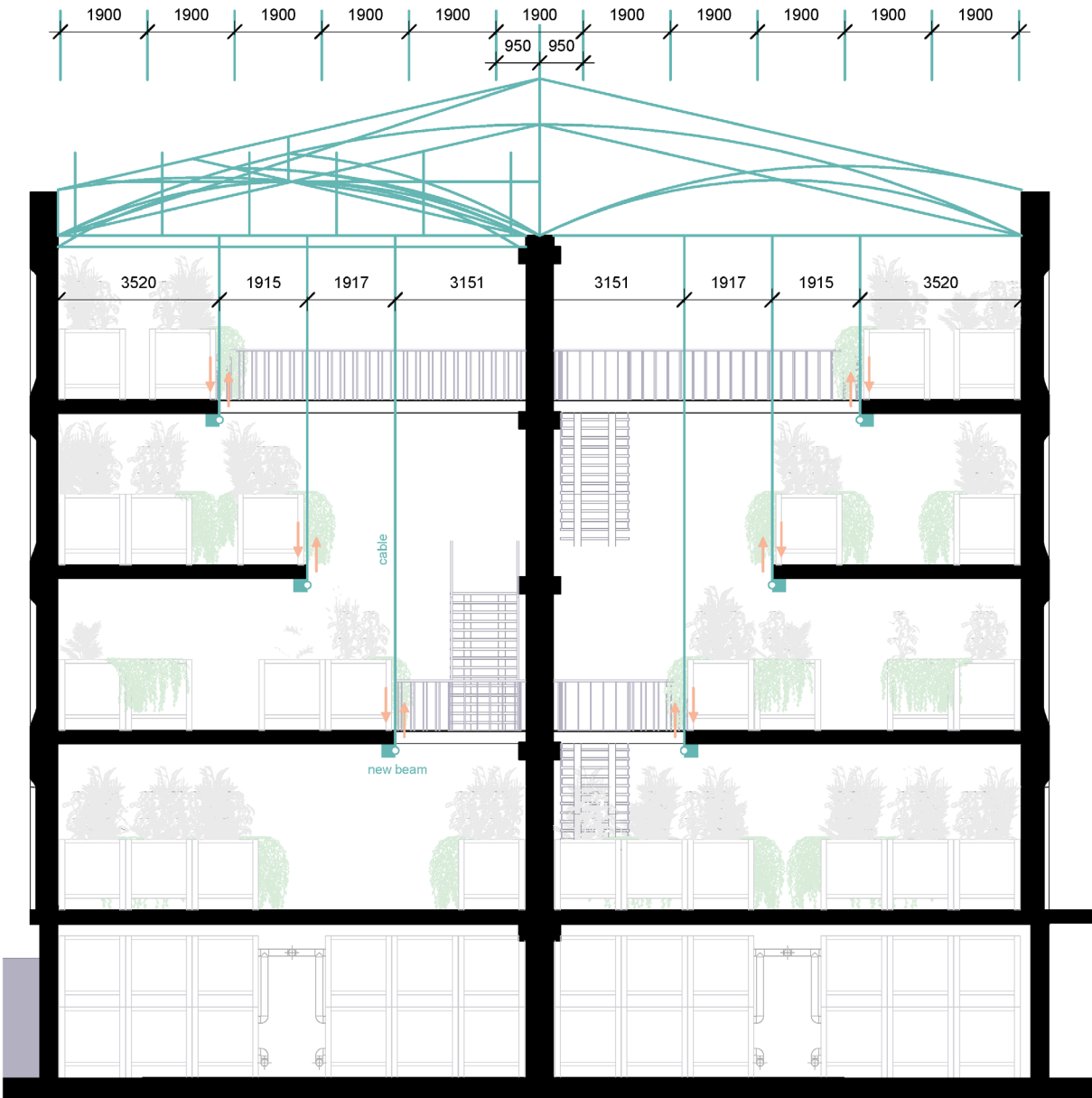


Cables connected to trusses

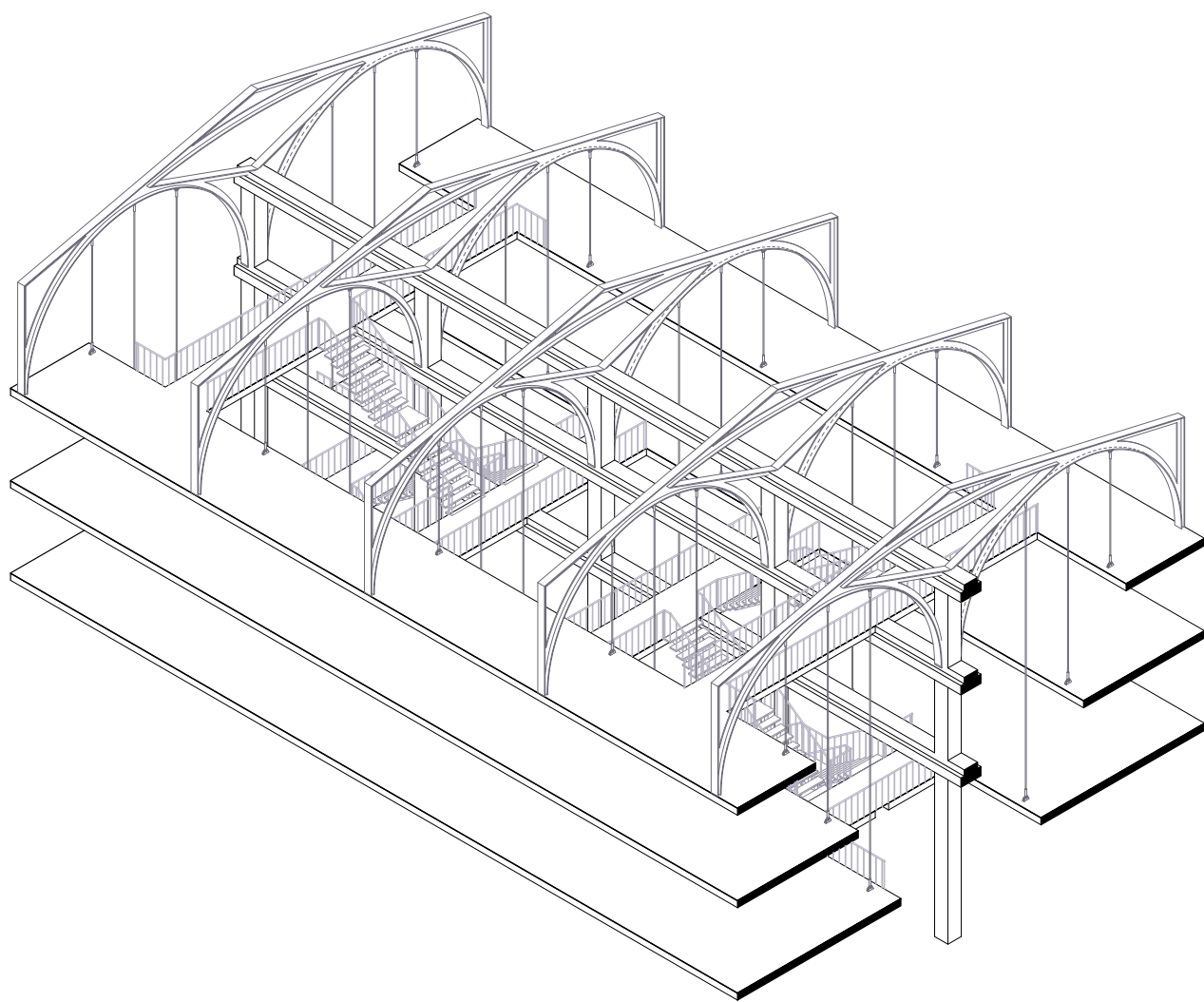


Diagonal trusses

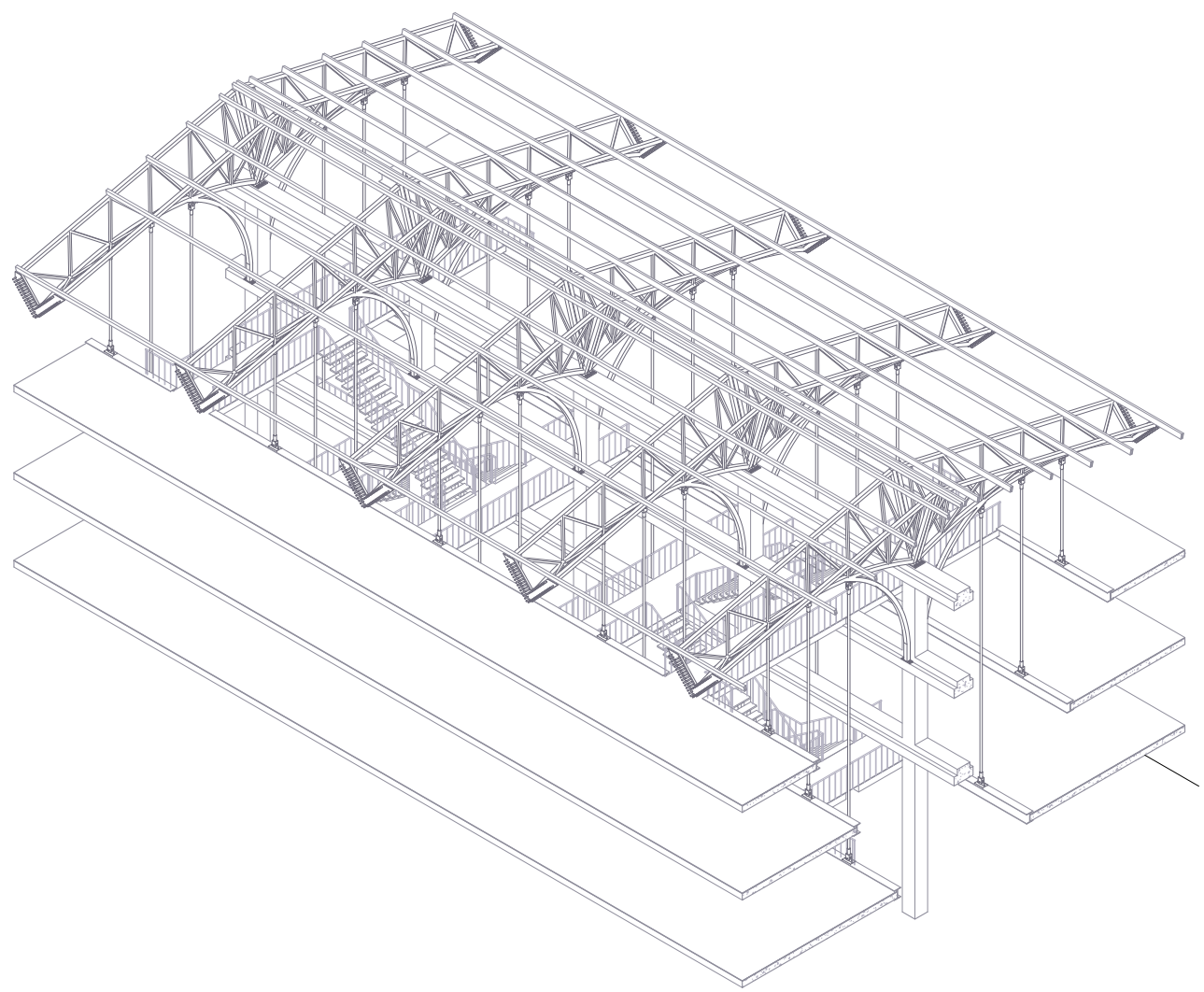
Roof construction options



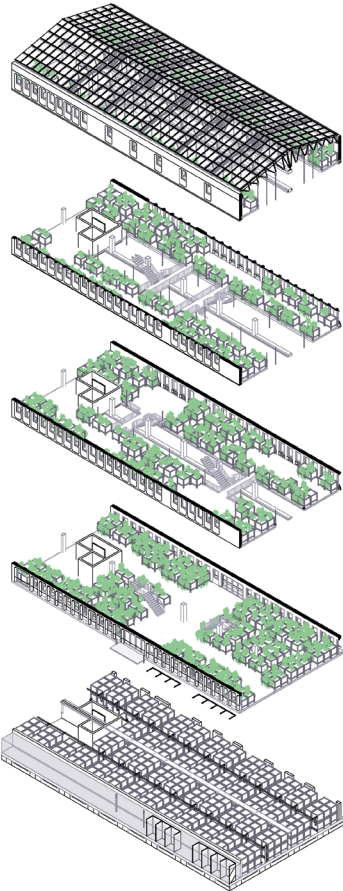
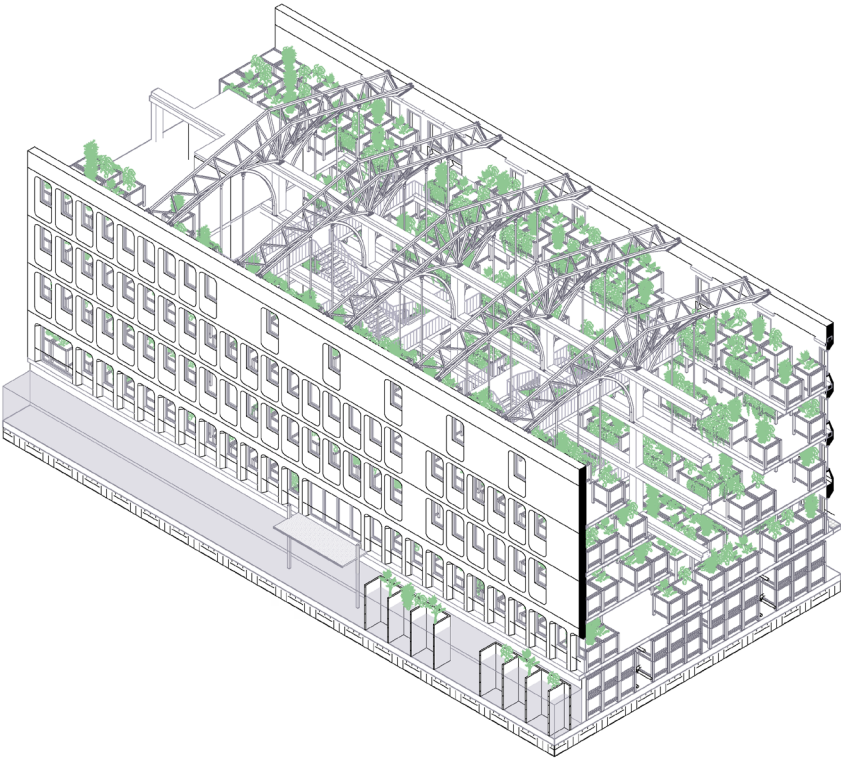
Initial roof truss design



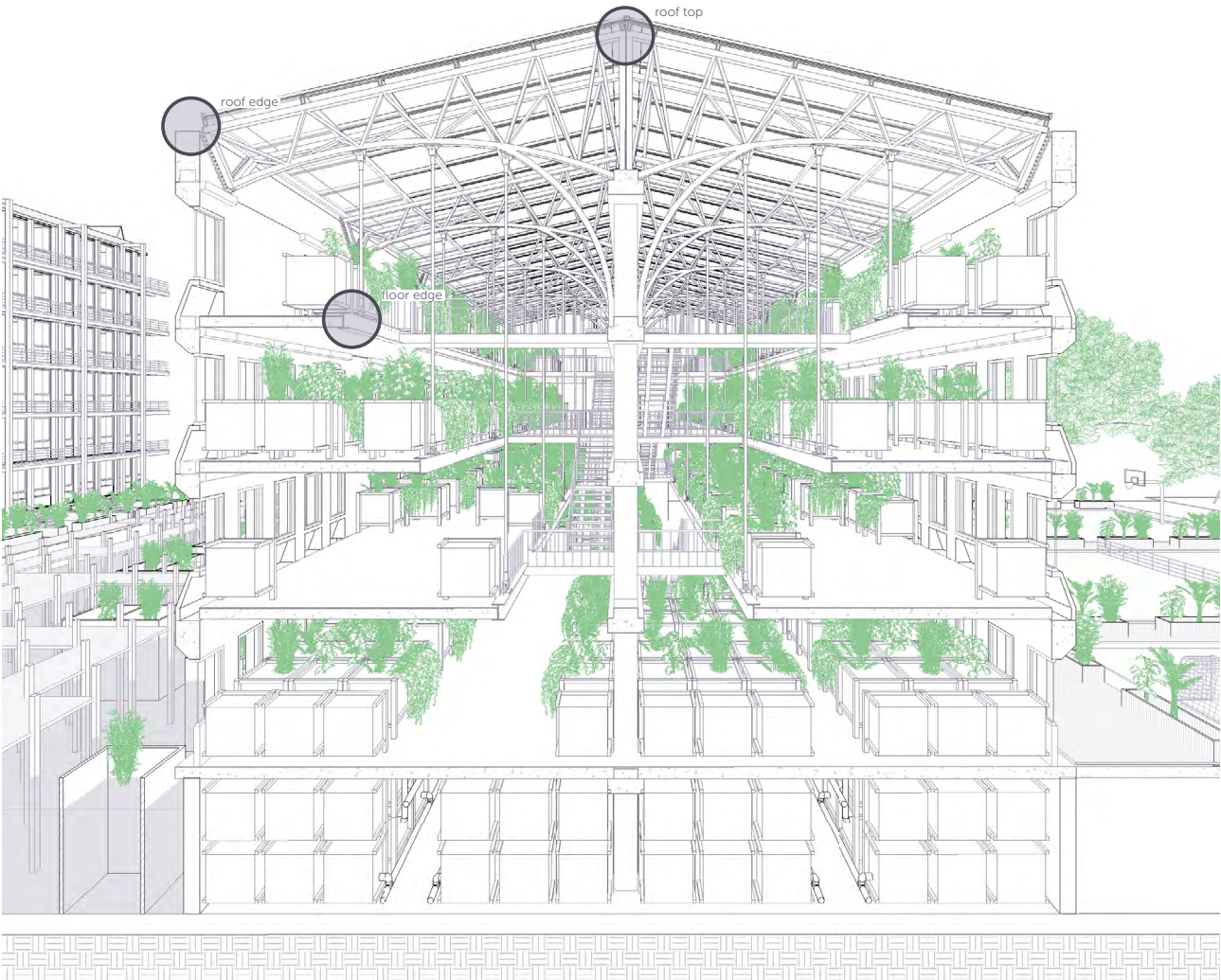
Final roof truss design



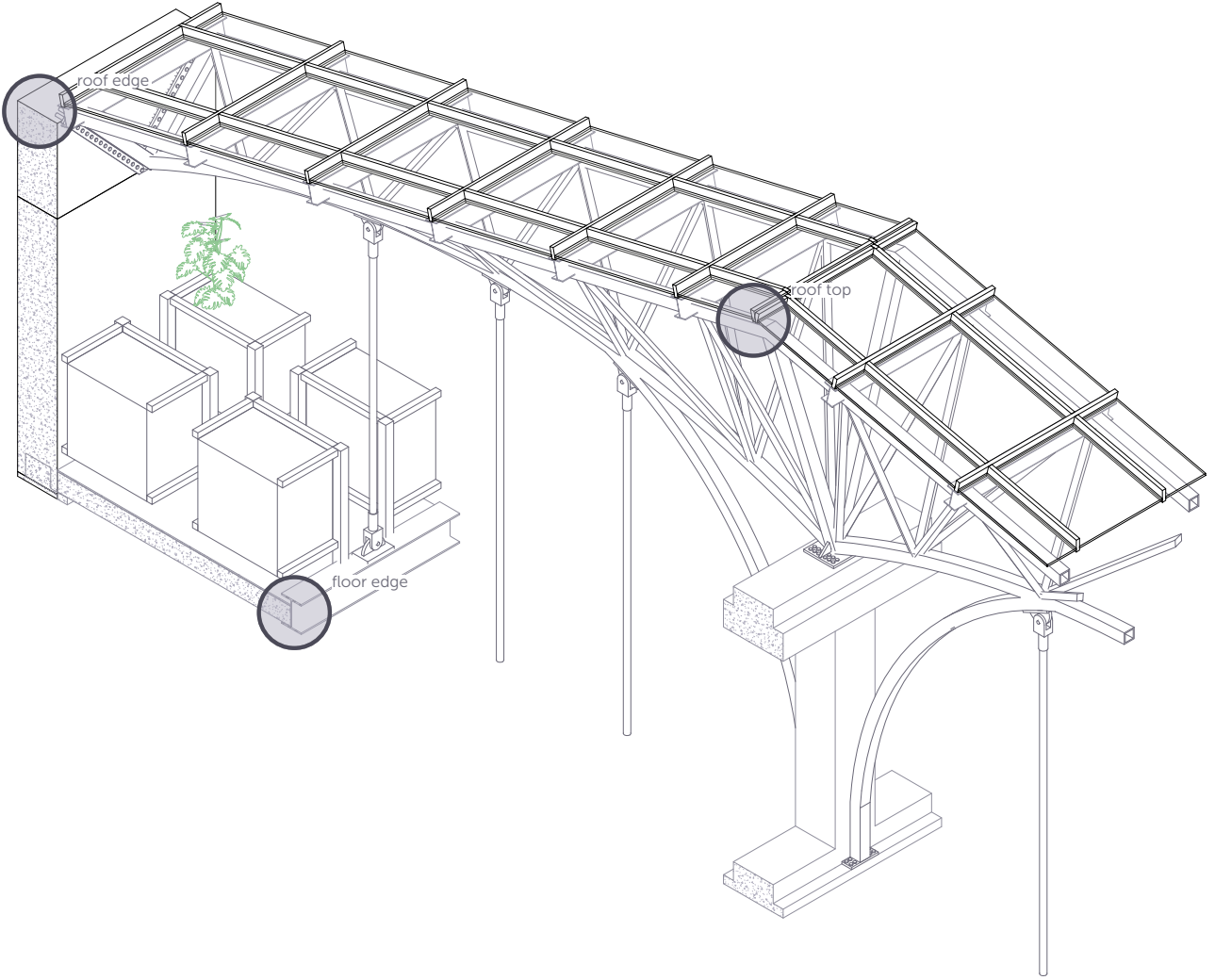
Living machine design



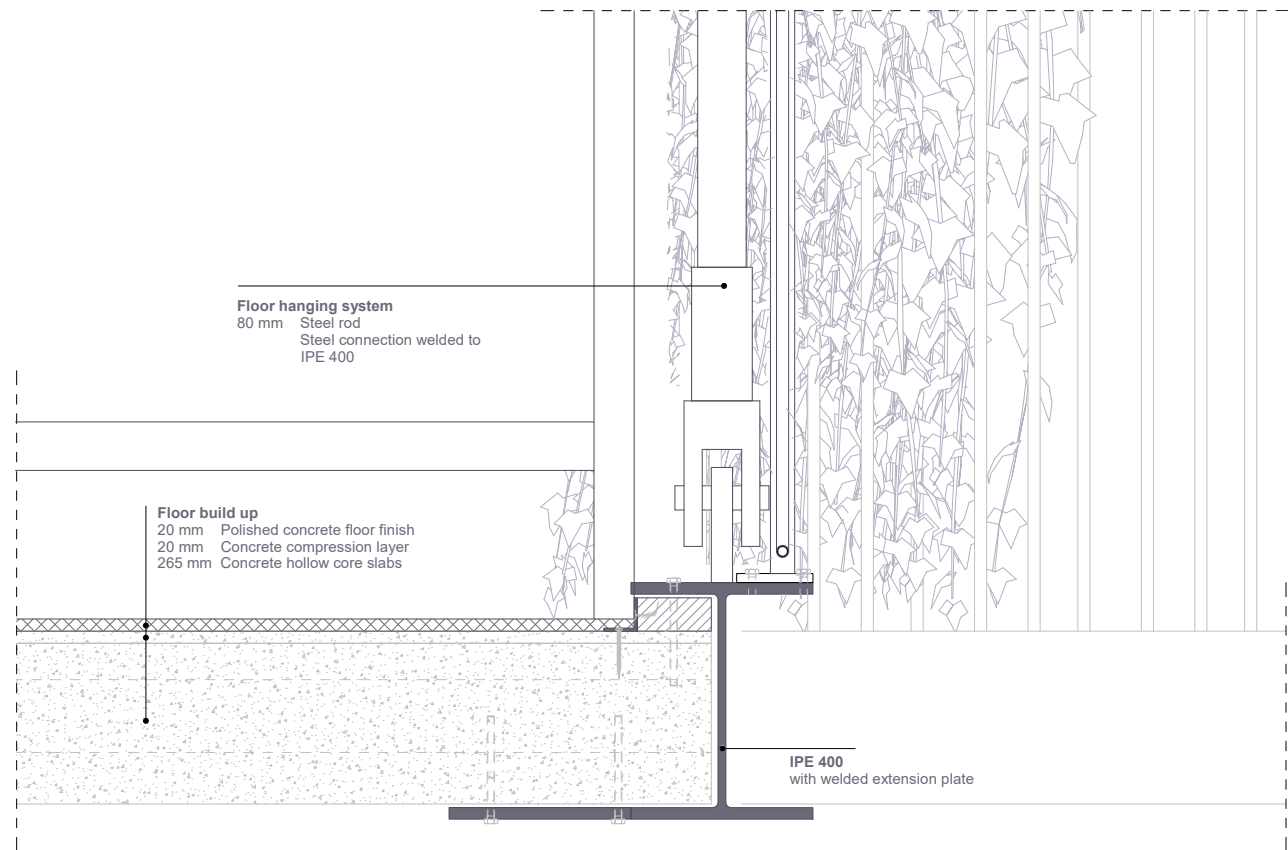
Living machine section



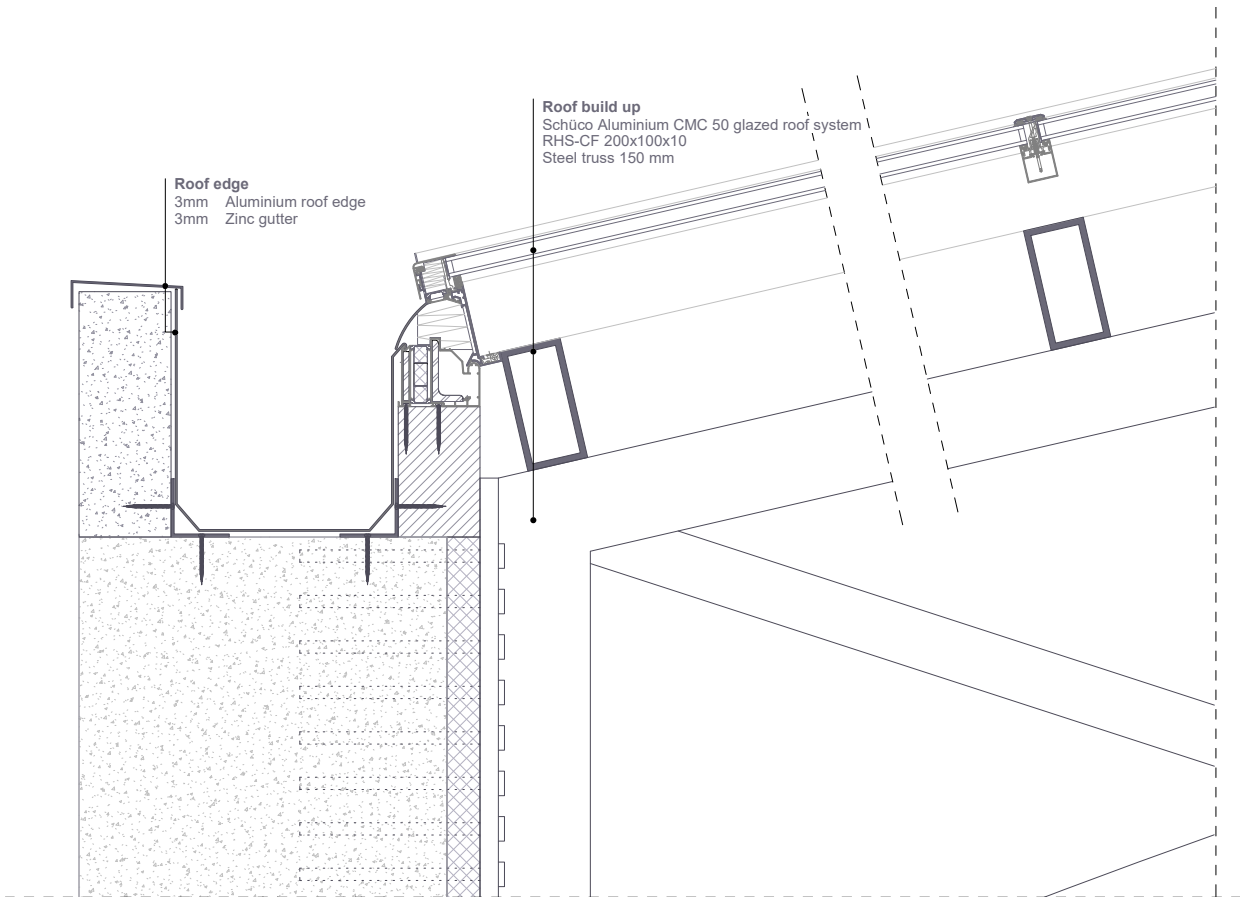
Living machine details



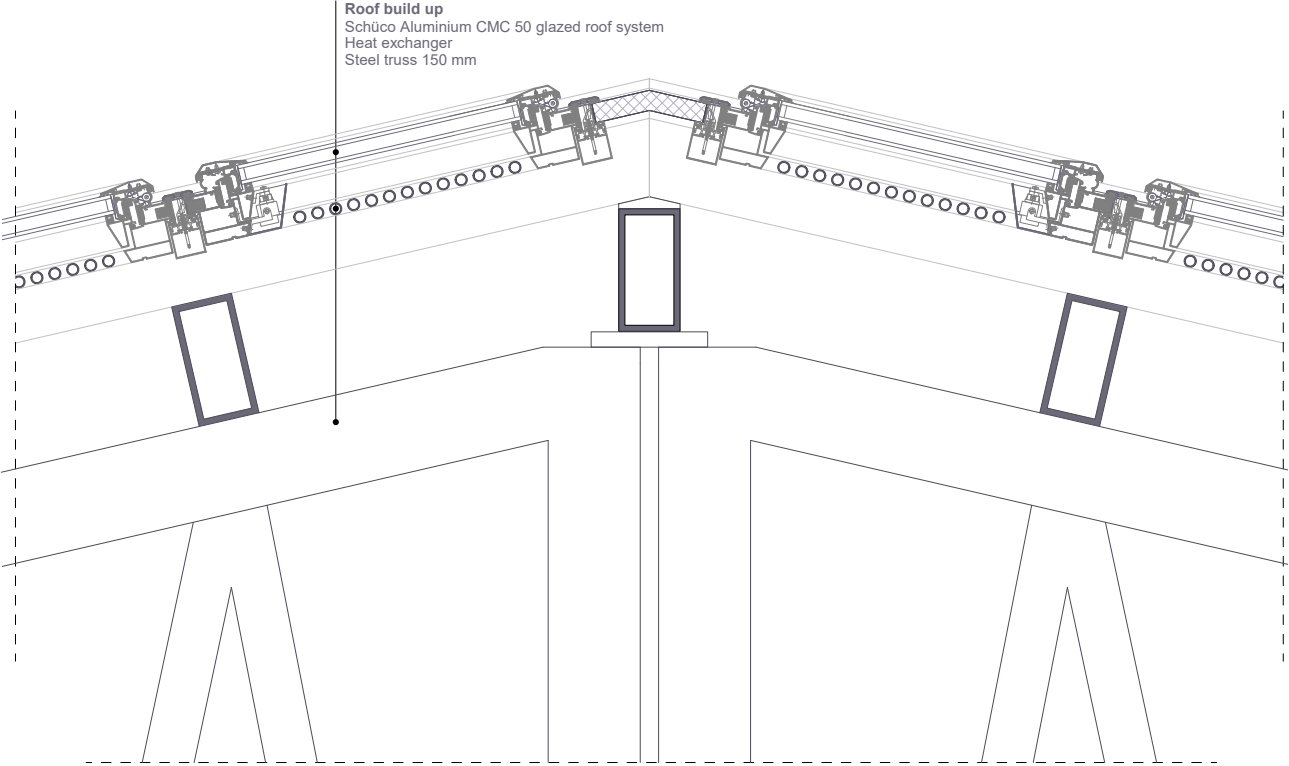
Floor edge detail



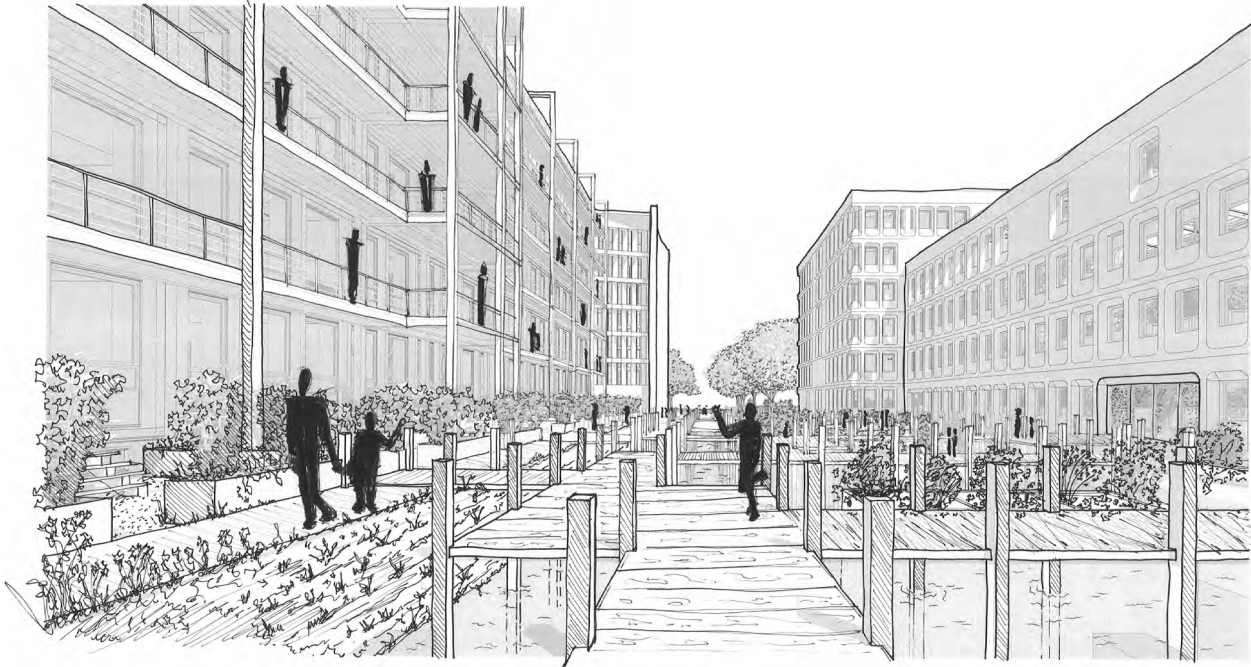
Roof edge detail



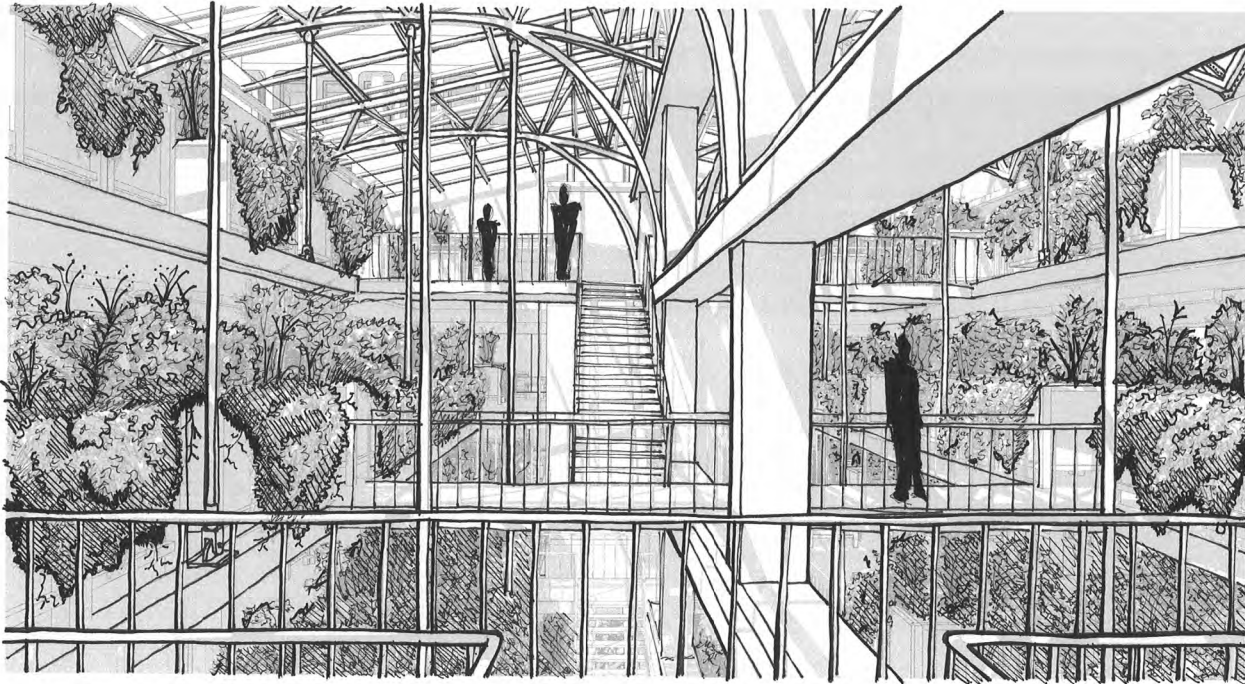
Roof top detail



Water square impression



Living machine impression



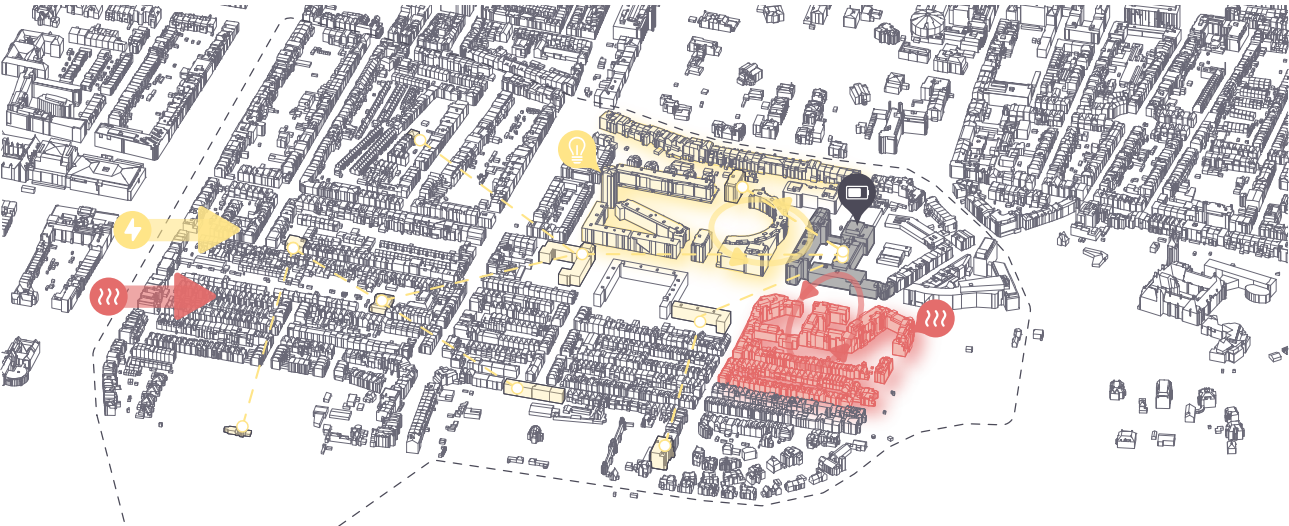
22

Conclusions

29.08.2022 - 08.12.2022

Conclusion of cycles

energy cycle



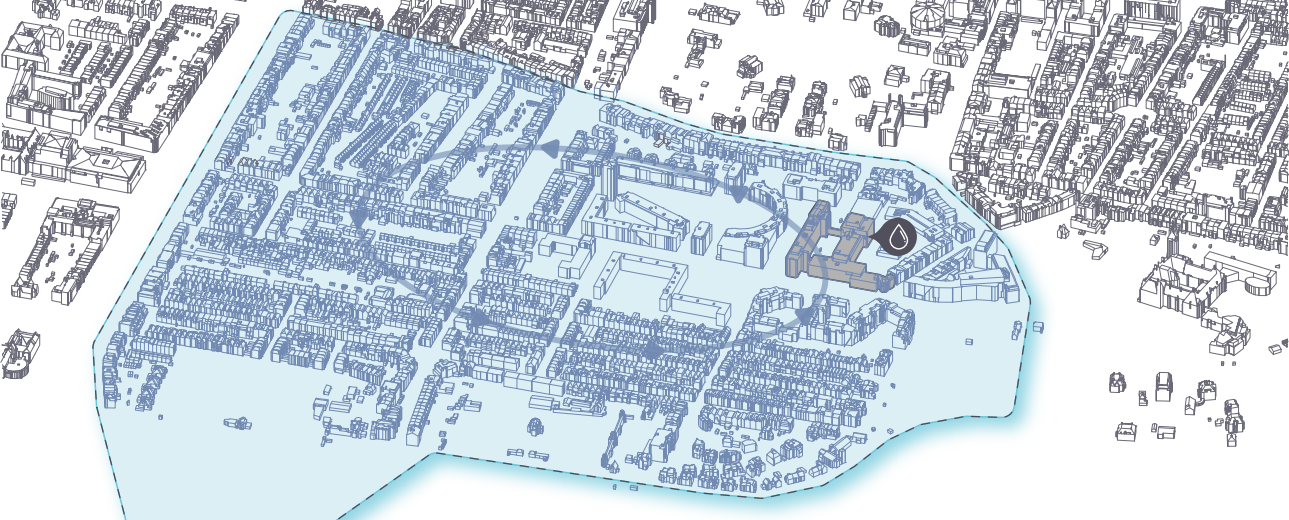
material cycle



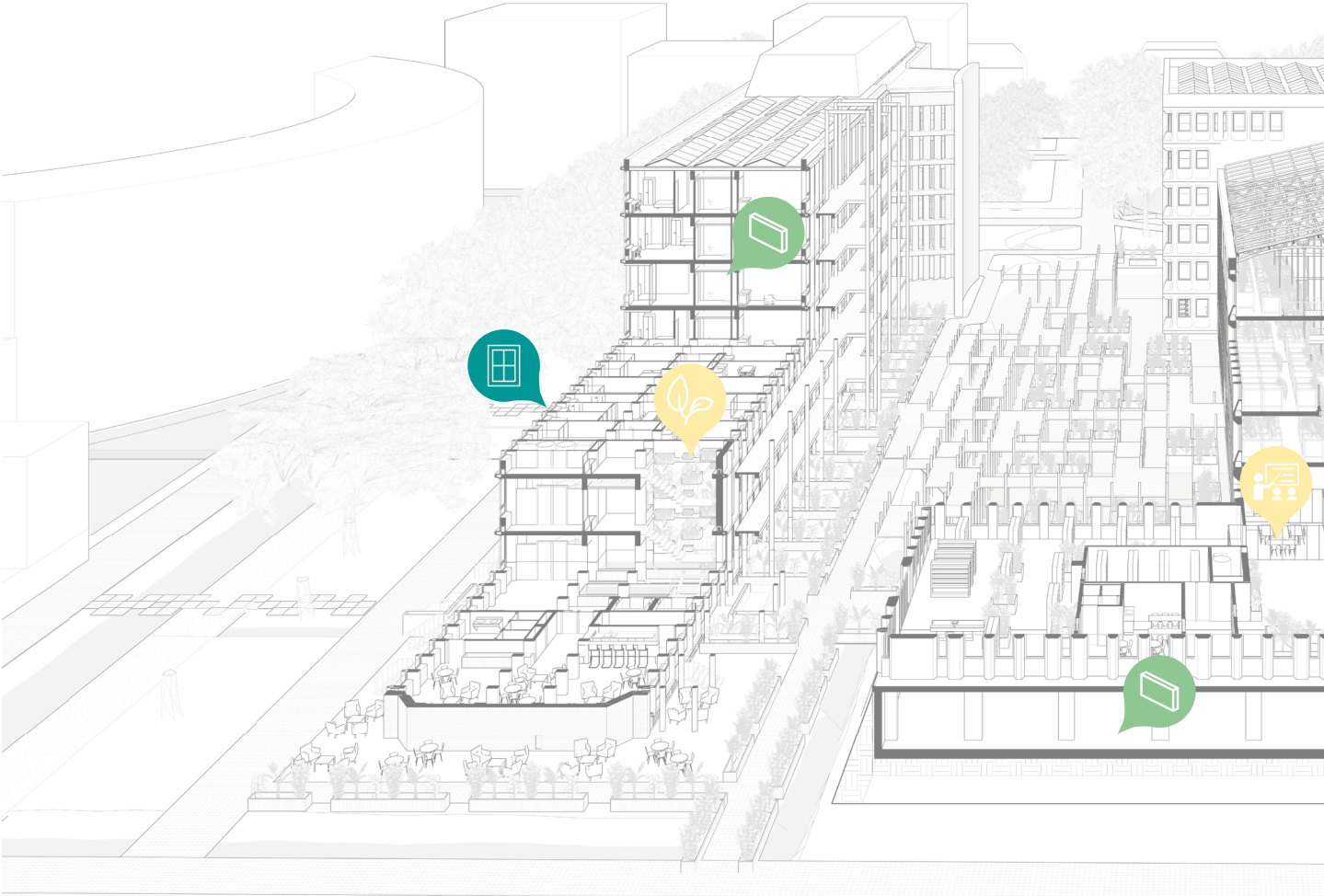
biotic cycle



water cycle



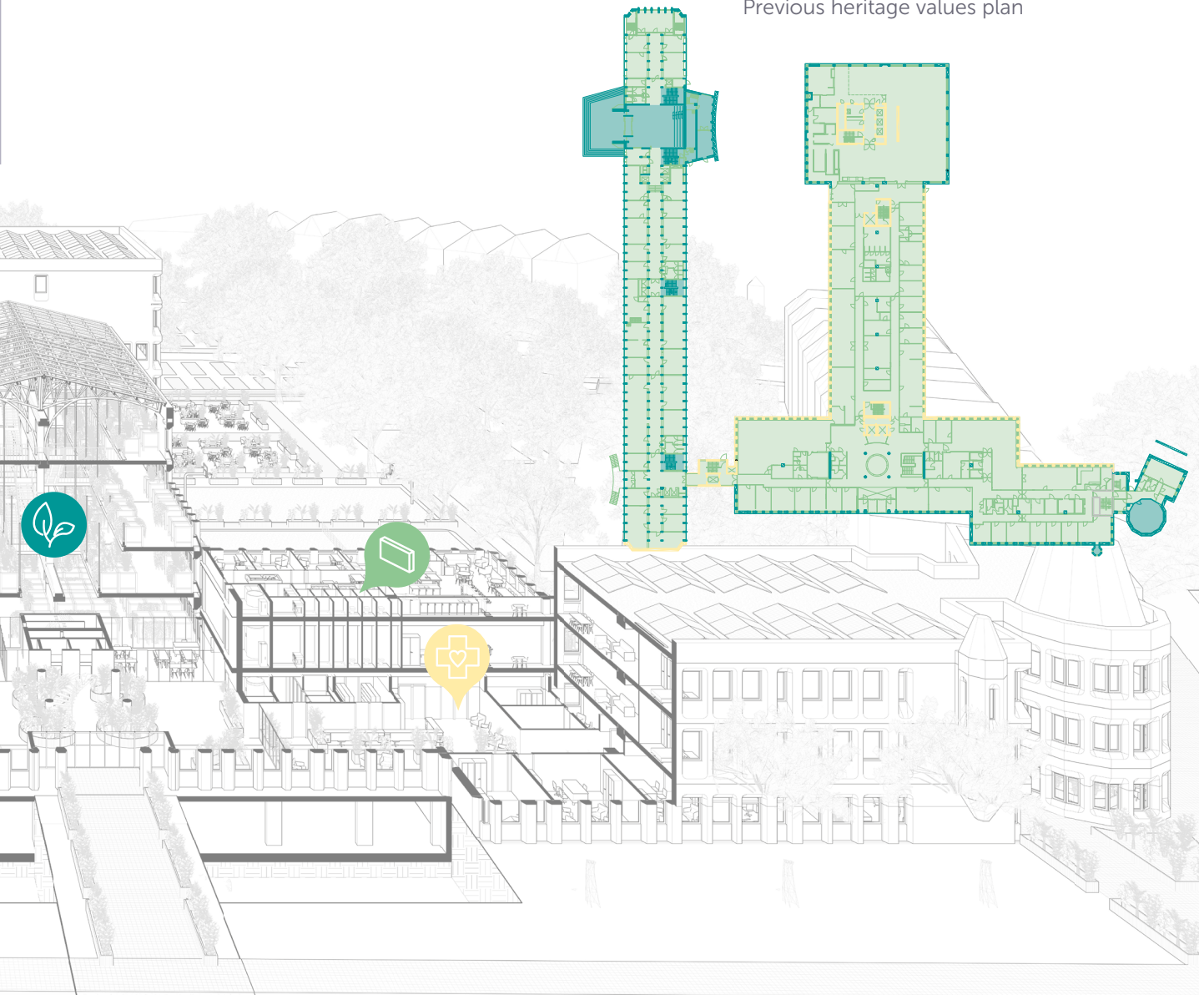
Conclusion of improved values



high value - should be preserved as much as possible

medium value - changes are possible

Previous heritage values plan



careful consideration

low value - opportunities for change

Cyclifier

01 Humans + Nature

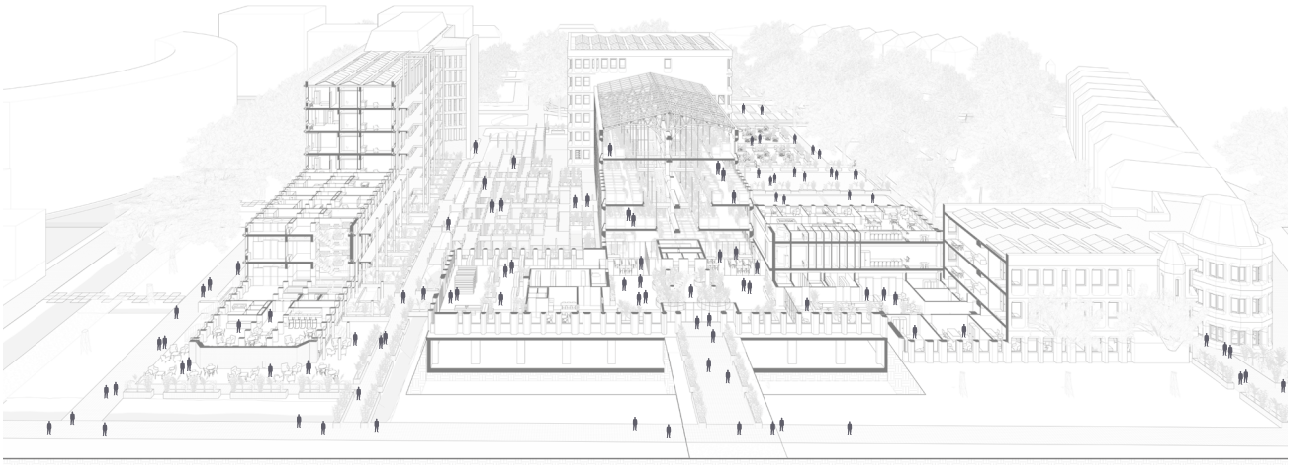
closing cycles
connect to green blue structure
creating awareness

02 Humans + Humans

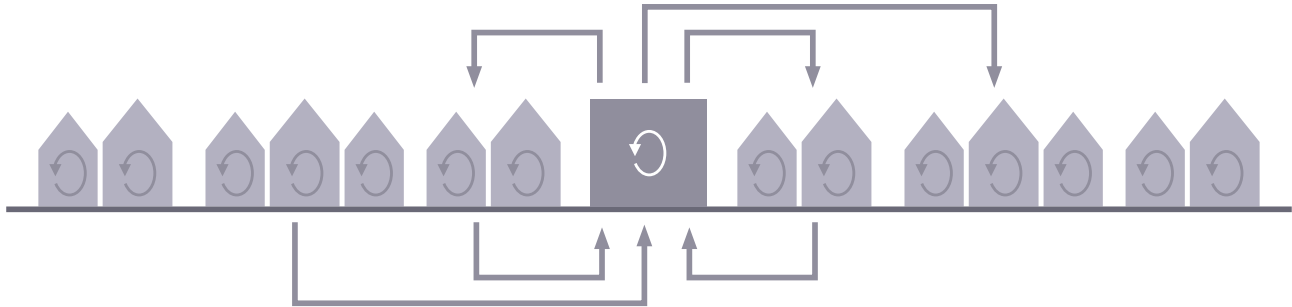
social interaction
healthy living
growing within building

03 Humans + Building

improving the values of building
positive impact on surroundings



renovation strategy to make **entire neighborhoods** sustainable and **future proof**



conditions

scale/size of building
shape of building
context
financial means
stakeholder cooperation

23

Reflection

29.08.2022 - 08.12.2022

Disconnection from Nature

The topic for this graduation project arrived from a personal interest and fascination with nature, especially about the integration of nature and architecture. This topic is now more relevant than ever as we are facing urgent societal challenges caused by the current relationship between nature and humans. These challenges arose as humans currently harm the environment, taking away resources and giving back unusable waste in return. This results in problems like climate change, a decrease of biodiversity, shortage of resources, and abundance of waste; all ultimately leading to an inhabitable planet for humans and many other species.

Minimize negative environmental impact

Humans are already trying to tackle these challenges, but in current articles, policy documents, and academic debates about sustainability strategies, the main focus lies on the reduction and minimization of the negative environmental impact (Van Dijk, Tenpierik & Van den Dobbelsteen, 2014). This graduation project aims to shift the focus from minimizing the negative environmental impact towards creating a positive impact on the environment (Figure 1).

How will we live together?

Something that formed a great part of the inspiration for this positive impact and the rest of the project was the Architecture Biennale in Venice 2021. This exhibition helped to broaden the topic of the research from its main focus on nature to the theme of "how will we live together?" This shifted my personal view towards sustainability and together with feedback from the design tutor introduced the term "wellbeing" into the project.

Wellbeing

This term of wellbeing became the main theme for the project. This wellbeing was about living in balance and community with each other. The social community reacts to current societal problems, like loneliness and polarization. The ecological community reacts to climate change, loss of biodiversity, and abundance of waste.

Relevant feedback that was given by the tutors was about how to define and measure wellbeing. For ecological wellbeing, a framework was created with the urban metabolism analysis. Social wellbeing was harder to define as clearly and objectively as the ecological aspects.

The week after this feedback coincidentally a presentation was given by PhD candidate Daniël van Staveren from MBE, who was developing a method to make values measurable. Parts of this concept have been used to rate the social values of this design.

National relevant challenges

The graduation project also reacts to some of the national dutch challenges formulated by the government. These are the aim to be Energy neutral by 2050 as a reaction to the climate crisis and the goal to built 1.000.000 new homes in 2030 to solve the current housing crisis.

The program chosen for the design is closely related to these challenges as both housing as well as ecological functions will be added to create a building that will not just be energy neutral, but energy positive to support the surrounding neighborhood with becoming energy neutral.

Reflection

The graduation project reacts in multiple ways to a diverse range of societal challenges. A critical question that can be asked is; how much influence can an architect have on these challenges? As architects, we sometimes tend to overestimate the reach and influence we have with our projects. This does however not mean that a project should ignore these challenges or that it is a bad thing to be optimistic with the design. But I have found that a critical and realistic view of the project from time to time will only improve the concept, at least that was the case with my project.

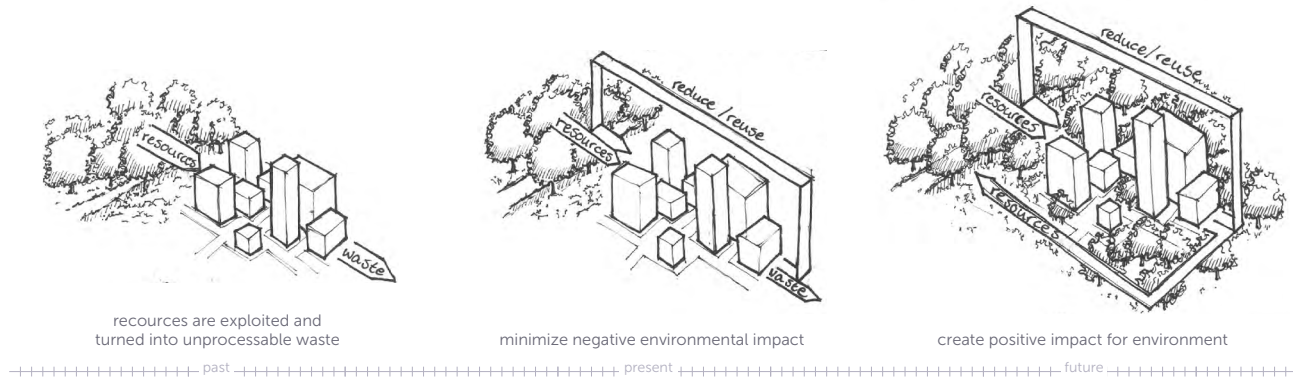


Figure 1 Sketch of urban metabolism - based on Kennedy, C., Pincetl, S. & Bunje, P. (2011)

Technical University of Delft *aspect 2*

Master program

This graduation project takes place inside of the master program Architecture, Urbanism and Building Sciences at the Technical University of Delft. This master program relates closely to the chosen graduation topic as most of the previously discussed environmental and societal challenges arose in the built environment. My belief is however that it is also there where most possibilities for change and improvement are. The open-ended technological cycles are taking place in an existing built environment and to control and alter these cycles, transformation of existing buildings and infrastructures is needed.

Master track

The graduation project is part of the Architecture master track, meaning the research and design are focussed on a building design as the final product. This graduation does however have a lot of common ground between two other master tracks Urbanism and Building Technology.

Inside of the master track Urbanism, the term Urban Metabolism is already used to analyze the flows and cycles of cities (Figure 2). In my graduation project, this concept is however used to guide the transformation of a building, researching if adjustments on the smaller architectural scale can influence the cycles and flows on a larger level of the neighborhood. Next to this the social aspects of community making inside of Urbanism are used to create a community between humans themselves, but also between humans and nature. The delegate of the board of examiners from Urbanism, also gave insightful feedback and research for the project, providing a different viewpoint.

Another master track that has close relation with this graduation project is Building Technology. To alter and evolve these urban cycles, a strong focus on building systems and installations is developed, with the main focus on systems and concepts inspired by nature. Fully integrating these new technologies inside of an architectural design.

The architecture track, in which this graduation project takes place, forms the perfect middle ground between the larger urban scale and the smaller building technology scale. The graduation project is related to this master track as the main goal of the project is to design a transformation on a building level, designing from the larger 1:500 scale down to the 1:5 detail scale. This graduation project showcases the importance of designing through the scales and including input from other fields, like Urbanism and Building Technology to come to a complete and integrated design.

Studio topic

Inside of the Architecture master track the Heritage Graduation Studio is chosen. There was some doubt between the Heritage studio and the Architectural Engineering studio as this graduation topic would fit in both studios, but the added knowledge of transforming existing buildings was valued higher than the additional knowledge of the technical aspects. The graduation project relates to the topic of vacant heritage, as the focus is on the transformation of vacant heritage buildings into ecological and social positive buildings by altering the cycles in the neighborhood. The project tries to expand the scope of the current heritage field by not only looking at the cultural values but also including the ecological values during the design process.

Reflection

During the process, these two scales from the other master tracks proved useful and offered a whole new field of knowledge and research. The risk with all these aspects and fields is that the graduation project becomes too broad and big to handle. This is something I have encountered quite some times during the process. But after good feedback from the tutors and reflection, I started creating boundaries and limits of the graduation

project, acknowledging that certain parts of the project would stay on a more conceptual level and in real life would be developed by other actors. This helped to create a specific scope of focus which was crucial for me to be able to have progress in the research and design. I have learned that architecture can be so much more if other scales and viewpoints are also taken into account, in this way creating a design that is more complete and stronger.

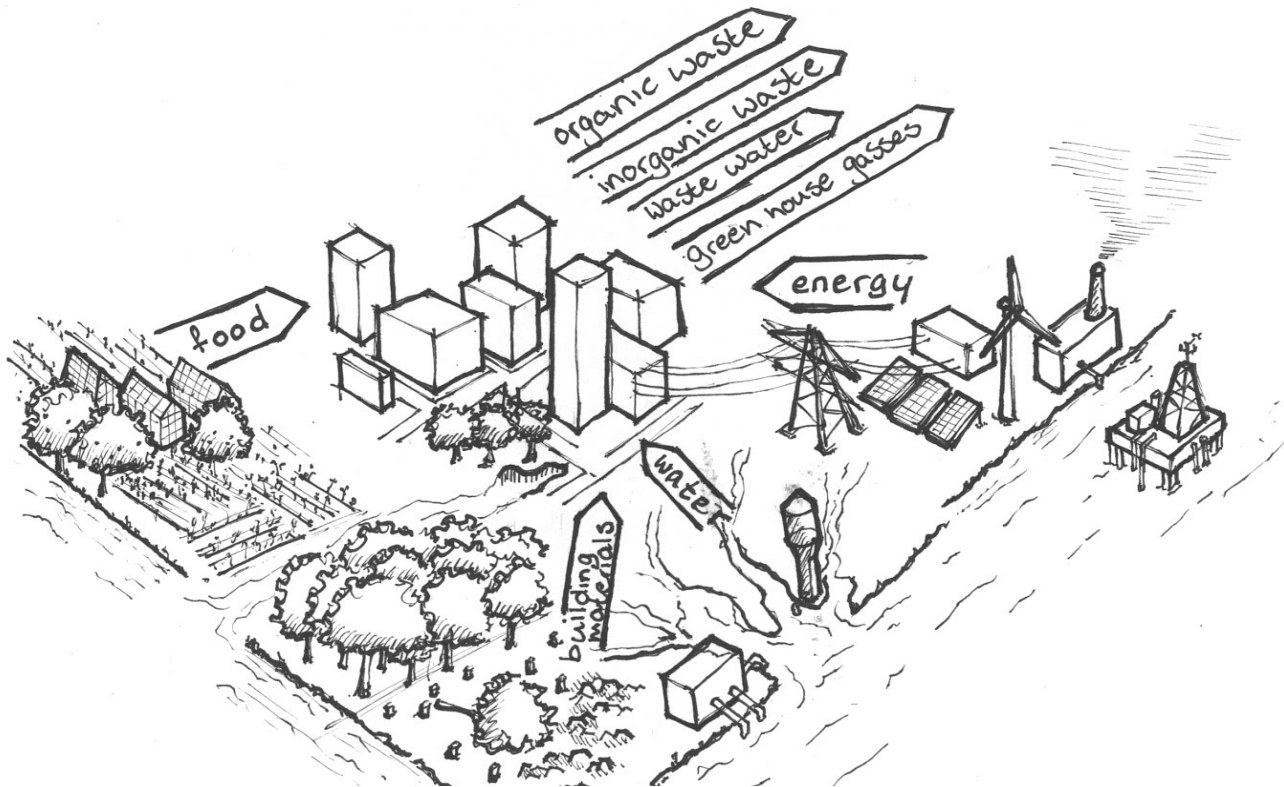


Figure 2 Sketch of urban metabolism

Adapting 20th Century Heritage *aspect 3*

Values

The Adapting 20th Century Heritage Graduation studio and the overall Heritage track inside Architecture are primarily focused on value-based transformation strategies, specifically the cultural values. There are currently different frameworks to analyze, define and signify these cultural values. The two most used ones at the TU Delft are the value assessment from Kuipers & De Jonge (2017), which combines the Brand layers with the values of Riegl and on the other hand the framework from Tarrafa Pereira da Silva & Pereira Roders (2012) with eight primary values. I found that these two frameworks complemented each other, where the eight primary values were more elaborate than the Riegl values, but the Brand layers created a better relationship with the actual built object. This is why I combined these two frameworks to assess the cultural values in my graduation project.

What I found is that these cultural values only gave one side of the story when redesigning and transforming a building. It ignored a whole other part that is so important in my graduation project; ecology. This is why I wanted to expand the current methodology of heritage redesigning with another aspect of values; the ecological values.

To assess this aspect, I used the concept of Urban Metabolism, which looks at a built environment as if it is an ecosystem, with its own flows and cycles to sustain it. From this method, I defined four categories, with subcategories that could be analyzed. In this way, creating a graduation project that could be relevant to the method of the Heritage track, but also to other architects, as a new way of guiding the design with both ecological and cultural values was developed.

Transformation frameworks

These two aspects, each have their own relationship with the built environment and have their own way of guiding the design, see Figure 3. The cultural values can be organized based on their significance, resulting in a transformation framework that defines which elements to preserve and which elements have opportunities for change to maintain the relationship. For the transformation framework of the ecological values, I conducted case study analysis and defined how to close cycles to improve the relationship.

Spatial Building Typology

Next to this a book of the Spatial Building Typology research is made, which is part of a new series of books. This year's volume will focus on the spatial building typology of police stations. This book series will add to the field of knowledge by carefully defining Spatial Building Typologies based on spatial aspects analyzed on four scales.

Reflection

Something that I still did not fully achieve with the graduation project is an integrated and combined framework with the two aspects. Currently, these are divided into two frameworks, each focusing on different aspects. Is such a combined framework actually possible as they currently guide the design in different ways? Another question would be if it actually is necessary to have these two frameworks combined into one? Would this make it easier to use or does this current division create clarity in the use and output? To fully dive into these questions further research and practice would be needed. This is definitely something I am interested in and will continue doing when I start working as an architect.

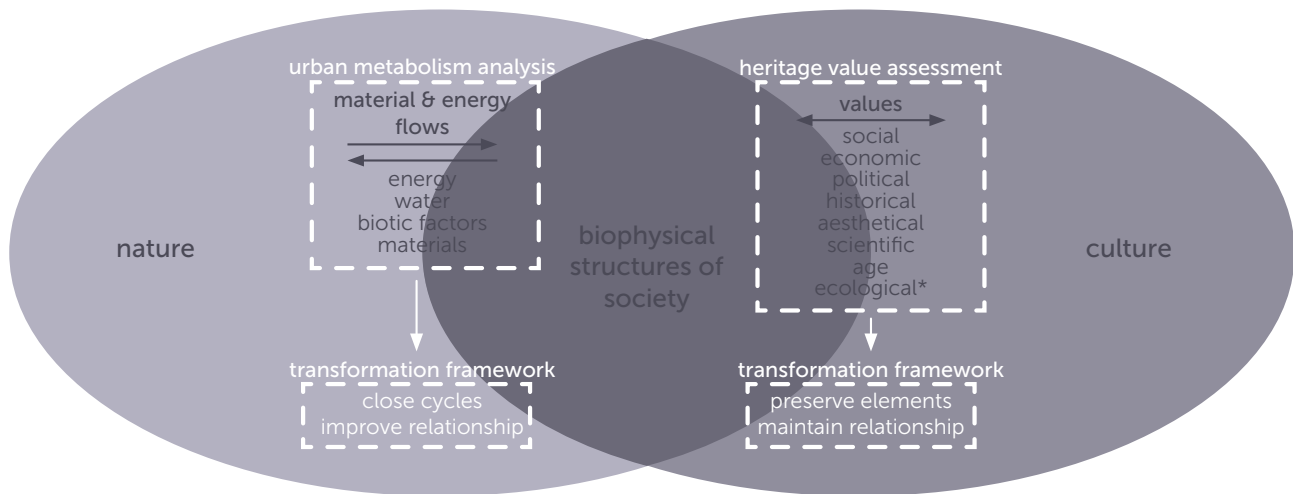


Figure 3 Relation between heritage value assessment and the urban metabolism analysis

Research and Design *aspect 1*

Design by Research

The relation between the research and the design has multiple aspects. The main outcome of the first part of the research is the two transformation frameworks, see Figure 4 and Figure 5. These transformation frameworks each guide the design in a different way; the cultural value framework sets the boundaries and opportunities for change, while the ecological value framework helped to define the program, the scope, and some of the design starting points.

The research will further in the design process be used for smaller specific research into design topics, like material choices, climate systems, and ecological elements.

The ecological framework was also used to create design criteria as can be seen in Figure 6. With these criteria, the design can be measured and evaluated objectively. It sets goals for the amount of energy and water the building should produce and store. These goals are not fixed for the entire process but evolve over time. This brings us to the next point; research by design.

Research by Design

The design is in this graduation project used to test if the goals and criteria defined with the research can actually be achieved. This is an interdependent circular process, with constantly evolving goals and a constantly evolving design. The ultimate goal of both the research and the design is to see how much influence the transformation of a building can have on the closing of urban cycles and the creation of communities, to create a future in which we can live together.

Reflection

What was personally difficult to do was setting the goals. They needed to be both optimistic and realistic. With which values would I be satisfied and was that then the maximum achievable or could it even be better? Especially for the elements that were not so easily objectified, like social values, I struggled a while during the project.

At one point a presentation was given about a method with which even these social values could be reduced into simple statements which could be scored. This method was a new view and a nice way of very carefully defining what makes a certain value. The downfall of this method is that it takes quite some time and sometimes the results are too oversimplified to be realistic and useful.

What I have learned during this graduation project, is that for some values or aspects it is fine that they are subjective, not everything can be reduced to something as simple that it can be measured in numbers. Sometimes intuition is just as useful as a whole criteria table with numbers.



Figure 6 Example of criteria to guide the design

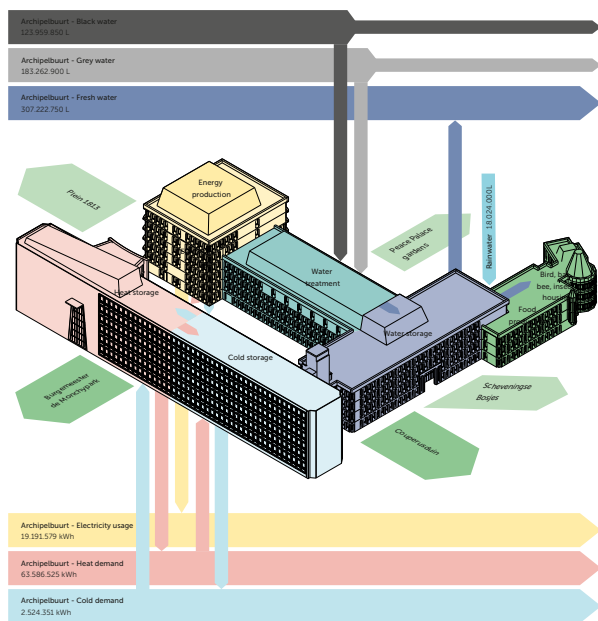


Figure 4 Ecological value based transformation framework

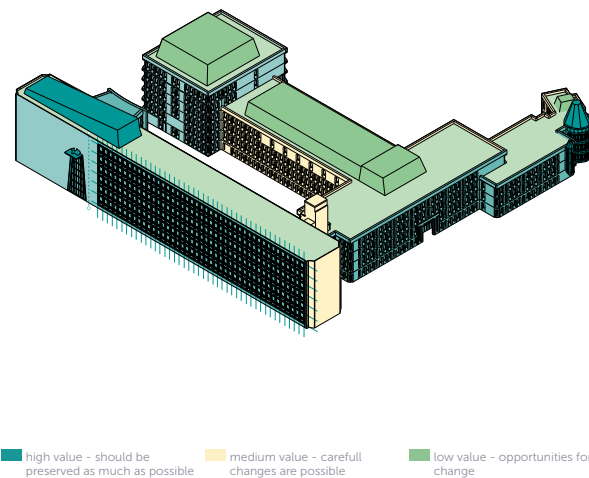


Figure 5 Cultural value based transformation framework

Ethical issues or dilemmas *aspect 5*

Research

Some ethical issues or dilemmas that occurred while doing the research were related to the used research methods. The urban metabolism analysis was a very large data-based analysis of the neighborhood (Figure 7). Unfortunately, not all needed data was given or available from the municipality. That is why I decided at one point that certain data should be calculated making assumptions.

For example, the water consumption of the buildings in the Archipelbuurt was not given, therefore I calculated the average water consumption per square meter for each of the different functions available in the Archipelbuurt. This number was then multiplied by the number of square meters present of each function in the neighborhood. The numbers of the urban metabolism analysis are therefore not the exact correct numbers, but they should be quite close to the actual data. As these numbers are used to guide a design it was deemed acceptable that this method was used.

Another research method of the case study analysis was used to define how cycles could be closed on in a community. For the case study research, three projects were chosen. The selection of case studies was done as objectively as possible, but sometimes the selection criteria are less usual. In my case, the projects were chosen as they all three formed good example projects that showed how cycles could be closed, but a lot of other projects have this as well. The reason why specifically these three were chosen, was because these three projects had the data and information about the cycles available.

Design

During the design, the ethical issues and dilemmas mainly arose from the matter of nature and humans. Specifically, with defining and placing the program the priority was questioned. Another dilemma was that if the project would need to be financially feasible, an unfair disadvantage of nature would arise as the rent of the building is paid by humans and not by plants. Of course, it is possible to use nature to increase the income of the building, but expressing the financial value in money will always lead to this dilemma.

Applying in practice

The last part of the reflection is about the possibilities, but also the issues of applying this research and design in practice. The first one is related to the research method used for urban metabolism. In my belief, this is a very useful and insightful analysis to conduct before you start designing, but it does require a substantial amount of data and time, which could not always be available for a project in practice.

Another challenge of this design is the matter of ownership, as this graduation project aims to influence an entire neighborhood, this also means that to have this project work successfully changes in larger infrastructure are needed. Other actors, like the municipality, the grid companies, and city planners should also be evolved in the execution. I do however still believe that this would be a very valuable experiment to be applied in practice to find a new way of living together.

Van Dijk, S. Tenpierik, M. & Van den Dobbelsteen, A. (2014). Continuing the building's cycles: A literature review and analysis of current systems theories in comparison with the theory of Cradle to Cradle. *Resources, Conservation and Recycling*, volume 82, 21-34. <https://doi.org/10.1016/j.resconrec.2013.10.007>



