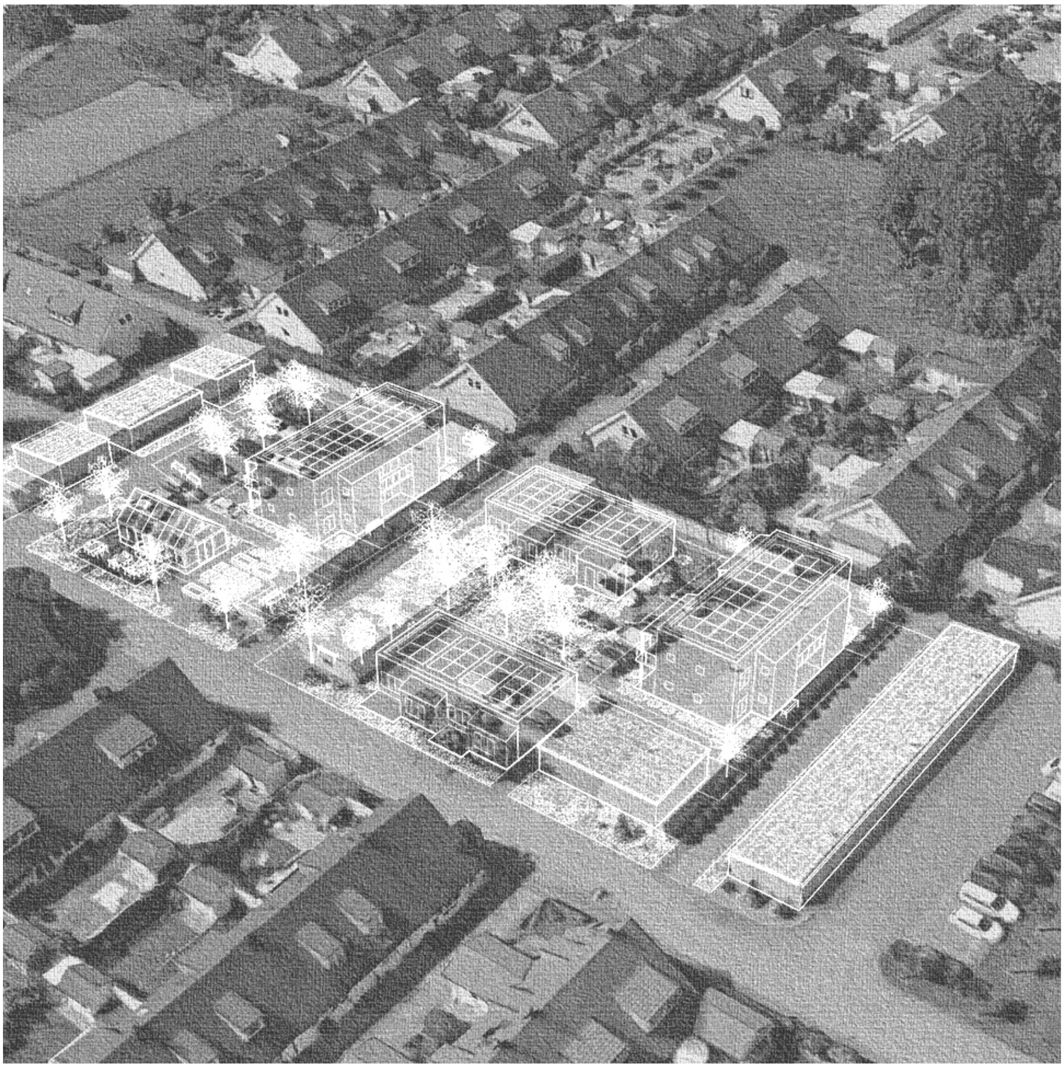
Parking: expired

Transformation of a 50-year-old Rowhouse Parking Lot Into Complementary Housing and Climate Resilient Green Space



Matilda Brännström

Master Thesis 2025
Chalmers School of Architecture
Department of Architecture & Civil Engineering
Examiner: Paula Femenias | Supervisor: Walter Unterrainer

Cover page illustration:

Fig. 0. Collage combining the old rowhouses in Persikogatan with the new design porposal, based on aerial photo from Google Earth Pro (2022).

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UNIVERSITY OF TECHNOLOGY

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Programme: Architecture and Planning Beyond Sustainability
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Thank you,

Walter - for both encouraging and challenging me in my work, and for contributing with your knowledge and calm.

Paula - for taking the time to give valuable feedback.

AT2019 - for being like a family during the bachelor years, making even the most stressful periods into dear memories.

Group 6 (and beyond) - for filling the master years with laughter and joy.

Family & Friends - for always believing in me and my creativity.

Simon - for all your love and support, for your patience and for reminding me to take breaks – you are my rock.

ABSTRACT

Sweden is estimated to have between three to five parking slots per car, which adds up to a total parking area that exceeds the total residential area in the country. At the same time, housing shortage is a fact in many cities, and so are the increasingly prevalent problems related to climate change, such as floodings and heat waves. This thesis aims to investigate if and how urban parking space could be transformed to help mitigate both of these issues. Focus is put on the shared parking lots in rowhouse neighbourhoods, through the example of Persikogatan in Gothenburg.

Literature reviews and contextual research concludes that the role of private cars in urban environments has changed significantly since the neighbourhood was built 50 years ago. The expansion of public transport along with introduction of carsharing and other mobility solutions provides opportunity for re-evaluation of these types of older residential parking spaces. Moreover, new multi-family housing is designed with less than half of the parking space provided in Persikogatan. The research also provides key strategies for housing shortage mitigation and climate resilience improvement. These include dedicating the new housing to specific age groups and improving the diversity of housing sizes, as well as increasing the ratio of green to paved area in the neighbourhood.

Through an iterative design process, involving site visits, reference studies and model explorations, all this research was translated into an architectural design proposal taking half of Persikogatan's parking space into consideration. The previously paved area is replaced by green and permeable landscaping, new common spaces and 12 additional apartments catered specifically to elderly.

The thesis results in a site-specific proposal, designed to complement the existing housing and functions in Persikogatan neighbourhood. However, the discourse and many of the design features are also applicable to other similar projects and shows how a previously unquestioned urban typology can be better utilised with consideration to current day needs. The thesis also gives explicit examples of how building material from redundant structures can be revitalised in a new context, and how characteristic design features could be interpreted in new ways.

Keywords: Housing shortage, climate resilience, depaving, sustainable densification, urban transformation

STUDENT BACKGROUND

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GLOSSARY

Carsharing
a service for short-term car rental, designed to be a convenient and affordable option to owning a private car. One or several vehicles are shared by either a closed community or by all who sign up for the service. Some common types of carsharing include fleets of cars provided by companies, or private car owners who rent out their car to others.

Condominium
translation of the Swedish term *Bostadsrätt* - a form of tenure common for housing that is part of a larger building or community. The residents hold exclusive rights to their individual units by owning a share in the Homeowners association, which owns the whole building. Thereby, all residents together own the building and its common spaces.

Densification
to make room for more people or functions within an area that is already exploited. A common tool in urban planning to make better use of available space and avoid urban sprawl.

Depaving
removing pavement or other impermeable surfaces and replacing it with permeable coverings, such as greenery or gravel, and thereby restoring the land to a more natural state.

Heat Island effect
a phenomenon where urban areas are significantly hotter than surrounding rural areas, due to factors such as expansive heat-absorbing dark surfaces (e.g. pavement and buildings), heat generating activities and lack of vegetation and water that can keep the temperature down.

Impervious surface
a surface with very little or no capacity to absorb storm water, most often in the form of human made structures made of asphalt, stone paving or plastic materials.

Rowhouse
individual housing units lined up in a row, sharing one or two exterior walls with the neighbouring units. A common type of residential building in Sweden, often arranged in coherent neighbourhoods with pedestrian internal streets and shared parking lots in central locations.

Single-family home
in this thesis used as a translation of the Swedish term *Småhus*, referring to smaller residential buildings intended for only one household. This includes both freestanding houses, semi-detached houses and rowhouses.

Sprawl
when cities grow outwards, often on behalf of valuable nature areas and agricultural land.

Sustainable Development Goals (SDG's)
17 societal, technical and environmental goals formulated by the United Nations (2015), serving as a common global agreement on what sustainable development explicitly means.

READING INSTRUCTIONS

This thesis is organised in five main chapters; introduction, background, context, design proposal and lastly conclusion & reflection.

Introduction - the first chapter briefly introduces the discourse in which the thesis is placed and outlines the goals and focus of the work as well as its relevance in relation to sustainable development.

Background - the second chapter gives a deeper understanding of the discourse, including societal and environmental preconditions as well as architectural and conceptual references. The different fields of research in this chapter are all related to the project in different ways and supporting its relevance and design choices from different perspectives.

Context - the third chapter investigates the project's practical preconditions, such as spatial and socioeconomic conditions. It also includes an analysis of what strengths and opportunities the project could make use of and what weaknesses and threats it should try to mitigate.

Design Proposal - the fourth chapter presents the architectural implementation of the thesis as a design proposal, placed in the chosen site and with considerations to the findings from the research presented in previous chapters.

Discussion - the fifth and last chapter summarises the theoretical findings and the design proposal in relation to the thesis's aim and research questions. It also involves a critical discussion of the project and the process, as well as ideas for further development.

Some Recurring Swedish References

A lot of the literature included in the thesis research is published by organisations with Swedish names. Some of these organisations, that are recurringly referred to, are explained briefly below.

Boverket is the Swedish National Board of Housing, Building and Planning. Responsible for guiding, analysing and regulating urban planning and housing development.

Fastighets-, Stadsbyggnads- and **Stadslednings-kontoret** are all municipal administrations, responsible for different aspects of planning and developing the city. Two of them recently changed names; Fastighetskontoret is now called Exploateringsförvaltningen and Stadsbyggnadskontoret is now Stadsbyggnadsförvaltningen.

Fastighetsägarna et. al, includes three organisations: **Fastighetsägarna** - The Swedish Property Federation, **Hyresgästföreningen** - The Swedish Union of Tenants and **Naturskyddsföreningen** - The Swedish Society for Nature Conservation. They respectively represent the Swedish real estate industry, the Swedish tenants and the environment.

1. INTRODUCTION

PROBLEM DESCRIPTION

According to the latest official survey about housing demand in Sweden, conducted by Boverket (2023), there is an average national need of 67 300 new dwellings per year from 2023-2030 to meet the demands. A massive need which can be explained both by a growing population and a housing shortage accumulated over many years. Gothenburg, Sweden's second largest city, is no exception to the national observations and in 2023 it was estimated that the city will need to provide 4,000-5,000 new dwellings per year up until 2040 (Stadsledningskontoret, 2023) to meet the demands.

Historically, many cities have developed through outward expansion, which has brought on consequences such as increased car dependency and loss of valuable green- and agricultural land (Boverket, 2017). As an alternative to this urban sprawl, densification is brought forward as a more sustainable method for combatting housing shortage, however, not if it happens on behalf of urban green space or by transformation of peripheral industrial sites without connection to the urban fabric (Boverket, 2017). One of the big challenges for successful densification is therefore to find suitable sites within the cities, where additional housing can be added without disrupting existing qualities or important eco-systems.

At the same time, there is about three to five parking slots per car in Sweden (Fastighetsägarna et al., 2020), distributed across more or less central locations. Much of this parking has been enforced by municipal regulations, which for a long time encouraged more parking than necessary due to high expectations on future car use (Fastighetsägarna et al., 2020). Nowadays the attitude towards cars is very different and parking regulations have changed. However, many older neighbourhoods still hold very large areas reserved only for cars. As public transport develops and carsharing becomes increasingly popular, one could argue that some of the parking space in such neighbourhoods could be used for something better.

Additionally, as pointed out by Teerlick et.al (2024), paved areas, such as parking lots, have a very negative impact in the light of the ongoing climate change, by lacking ability to absorb carbon and rainwater and by contributing significantly to the Urban Heat Island effect. Replacing even small patches of impervious surfaces with green options would lead to more climate resilient cities and entail positive effects for both human health and biodiversity (Teerlinck et al., 2024).

AIM AND OBJECTIVES

This master thesis aims to expore if, and subsequently how, residential parking space could be reevaluated and transformed to better respond to current day societal and environmental challenges, with a main emphasis on housing shortage and climate resilience but also involving issues such as urban sprawl, car dependency and biodiversity loss. The thesis focuses on the shared parking lots in rowhouse neighbourhoods – an urban typology that has not previously been considered for transformation, through the example of Persikogatan in Gothenburg.

RESEARCH QUESTIONS

How could the paved parking lots and garages in a rowhouse neighbourhood be transformed to counteract housing shortage and support a more climate resilient urban environment?

- *What kind of housing typologies and features would complement the existing supply in the project area?*
- *How could the existing garages on the site be repurposed in the transformation, either as intact volumes or as material resources?*

METHOD

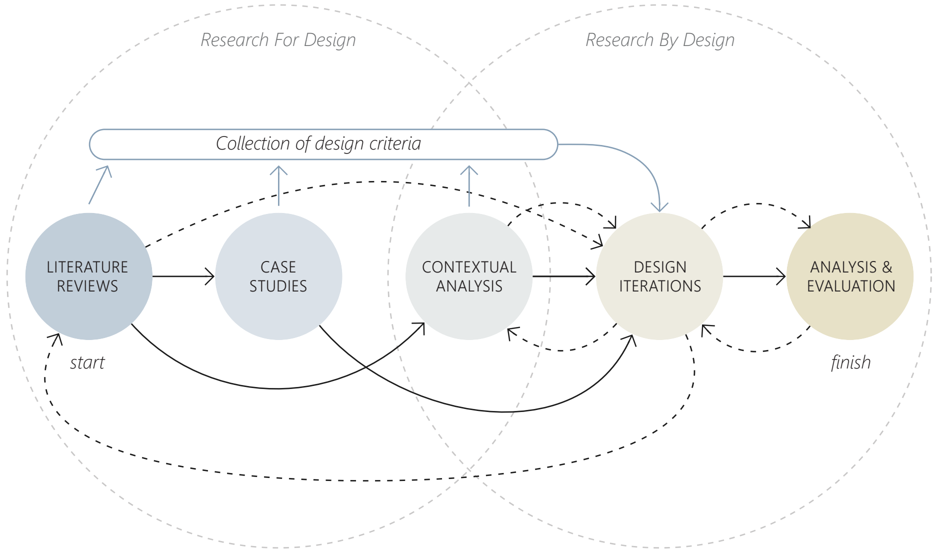


Fig. 1. Process diagram.

The thesis work can be roughly divided in a *Research for Design*-phase and a *Research by Design*-phase, with some overlap in the middle. Within these phases, five main project stages can be identified and arranged in an overall linear order, but the actual workflow was moving back and forth between the stages and looping them in an iterative process - as indicated by the arrows in the diagram above.

The initial phase, *Research for Design*, largely consisted of literature reviews including status reports about the housing situation and municipal development plans, as well as reports on mobility trends and sustainable densification strategies. This research helped specify the scope and preconditions of the thesis project and identify suitable sites for project implementation. Case studies were also conducted, providing conceptual and architectural inspiration for the project. Lastly, the contextual analysis in this phase involved geographical, socioeconomic and demographic analyses of the project area. Important findings from all these stages were compiled into an implicit set of criteria to consider in the upcoming design project.

In the second phase, *Research by Design*, the contextual analysis continued through mapping of existing and lacking qualities of the site, testing of spatial limitations and inventory of potentially reusable material. This process involved both analysis of documents and plans, as well as site visits during which spontaneous interviews were conducted with residents. In parallel, the architectural design developd through physical model explorations, hand sketches and digital drawing. This phase also included an ongoing critical evaluation of the emerging design project, leading to new iterations and further research. Ultimately, the qualities and consequences of the final design proposal were summarised in a concluding discussion.

DELIMITATIONS

Even though there are many types of urban parking spaces whose size and relevance also could be due for re-evaluation, this thesis focuses on transformation of shared parking lots in rowhouse neighbourhoods. This decision comes from a personal interest in the rowhouse typology and a curiosity to explore the possibilities of a kind of site that has not previously been considered for densification or transformation. Additionally, densification at a modest scale in this kind of site will not disrupt daylight conditions or other qualities of the existing housing, which might be a problem when densifying in other types of parking areas.

The thesis does not suggest that all parking space in the chosen neighbourhood should be transformed into housing and green areas, but a reasonable share based on studies and investigations of modern-day preconditions regarding mobility, parking regulations and urban transport. This research is accounted for in the background- and context chapters of the thesis.

When removing pavement, considerations need to be taken to potential contamination of the material - this is especially important for asphalt laid before the mid 1970's (Miljöförvaltningen, n.d.), since the asphalt up until then often contained coal tar which is harmful for both human and environmental health. Before removal, the asphalt therefore needs to be carefully analysed and then taken care of in a proper way if contaminated – a process which is not further investigated in the thesis.

The depaved soil will most likely also need to be sanitised before it can be safely repurposed in a residential garden. An alternative to chemical sanitation or shipping the soil away, is phytoremediation - a method where plants are used to naturally clean the soil. Different plant species can be used, what is important (Antoniadis et al., 2021) is that they have a high potential to absorb toxic elements, short life cycle, high biomass and that they are native in the area where they will be used. Due to time limitations, the thesis does not further elaborate on this method or how it could be implemented in the specific project. However, if the thesis project, or any similar depaving project, was to be realised, phytoremediation could be a highly relevant method to consider.

Lastly, the housing shortage situation is not simply solved by adding more housing. It's a much more complex problem which has to do with socio-economic conditions, queueing-systems, a balanced mix of different forms of tenure and housing sizes, and necessary rotation on the market. The thesis does not engage with all these aspects but puts focus on the latter two.

RELEVANCE FOR SUSTAINABLE DEVELOPMENT

It is widely known that the construction industry generally is not very sustainable and is currently contributing to a large share of global greenhouse gas emissions, as much as 37 % according to the UN Environment Programme (2023). These emissions must be reduced if we are to stay below the 1.5 °C temperature rise set in the 2015 Paris Agreement. However, as reflected in the 17 Sustainable Development Goals, the *SDG's* (United Nations, 2015), reducing carbon emissions is not enough. Other important actions include assuring social well-being for a growing population, supporting biodiversity and ecosystem services, striving for a more circular economy and being more careful with the earth's resources.

Sustainability Evaluation

The master thesis project has been critically evaluated in the light of the 17 Sustainable Development Goals, *the SDG's*, with the help of the *SDG Impact Assessment Tool* (Wexsus, 2019). According to the result of the assessment, presented in Figure 2, the project shows no indirect- or direct negative impact on the SDG's. Instead, it shows neutral or indirect positive impact regarding most of the goals, and for three of them; *No. 11. Sustainable Cities and Communities*, *No. 12. Responsible Consumption and Production* and *No. 15. Life on Land* - the project showed direct positive impact. Listed to the right is a summary of how the project has a positive impact in relation to these three goals.

Conclusions from the SDG Assesment:

- The project is placed in a location where it can make use of already existing public functions and infrastructure, thus not leading to extensive new construction or urban re-development.
- The project is densifying already exploit land, which prevents urban sprawl and won't interrupt natural ecosystems.
- The project reuses material from the old garages on the site and finds new use for some of them in their original shape. This lessens the need for new building material and thereby reduces the environmental impact compared to new construction.
- The project supports biodiversity and human health by bringing more greenery, flora and fauna into an area that is currently covered with pavement.
- The project supports natural water management through the reduction of impervious surface, decreasing the risk of flooding and reducing the stress on drainage systems.
- The project seeks to showcase an inspiring and new way of sustainable densification of cities, that could be implemented in more places and cities in the future.
- The project is promoting a less car dependent future.

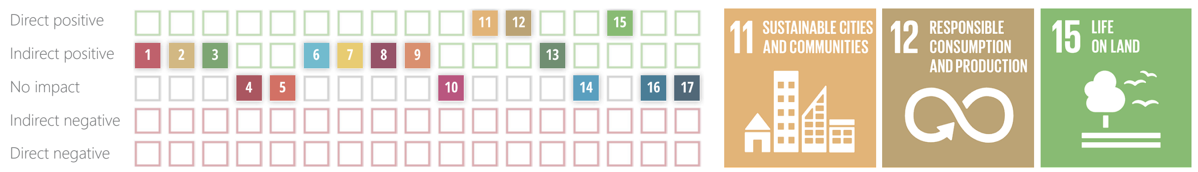


Fig. 2. The result from the SDG Impact Assessment and the three SDG's on which the project shows a direct positive impact. (Wexsus, 2025).

INTRODUCTION / RELEVANCE FOR SUSTAINABLE DEVELOPMENT

About circularity

As mentioned on the previous page, transitioning towards a more circular economy is one important strategy for sustainable development. The main idea behind a circular economic system is to minimise waste and resource extraction, by keeping products and materials circulating instead of being turned into waste. According to the Ellen MacArthur Foundation (n.d.), the system builds upon three key principles, which are all driven by design: waste- and pollution elimination, material- and product circulation and lastly nature regeneration.

Ideally, products and materials are circulated at their highest value, meaning that they should first and foremost be reused as intact products and if that is not possible – as components or lastly raw materials (Ellen MacArthur Foundation, n.d.). This is further explained by the so-called *Zero Waste Hierarchy*, interpreted in Figure 3, where circularity strategies are arranged according to environmental gain and resource efficiency (Hanemaaijer et al., 2017).

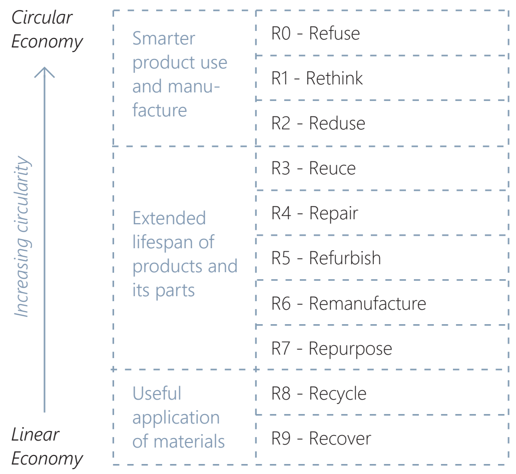


Fig. 3. Interpretation of the Zero Waste Hierarchy, adapted from the Netherlands Environmental Assessment Agency (PBL, 2017).

By being the largest consumer of raw materials (Pomponi & Moncaster, 2017), the construction industry has the potential of contributing significantly to reduced resource- and energy use, as well as reduced emissions and waste production, by applying more circular strategies. This thesis shows some examples of how this could be done, by implementing circularity strategies on different scales.

Application of Circularity Strategies

The fundamental idea of this thesis - to reevaluate and transform an urban typology that could be considered inefficiently utilised in its current context, is in itself an act of circularity which could be categorised as the top hierarchical strategies, refuse and rethink, by making sure that valuable urban space is not occupied by redundant purposes but instead redeveloped with consideration to modern-day needs and challenges.

Another way of applying the rethink-strategy, is to make product use more intense for instance through sharing – which is applied in the thesis project both through sharing of residential functions and through a suggested carsharing service. The project applies further circularity strategies, such as reduce and re-use, by using the old garage roofs in the new building facades – which both reduces the need for new resources as well as the need for shipping away discarded material. Other components from the old garages, such as the garage doors, may be reused in other projects, and the removed asphalt could be recycled into new pavement.

2. BACKGROUND

HOUSING SITUATION IN GOTHENBURG

According to a report by Stadsledningskontoret (2023), Gothenburg will have to provide 4,000-5,000 new dwellings per year up until 2040 to support the growing population and cover up for the accumulated housing shortage. In an extensive status report about the city's housing situation (Fastighetskontoret, 2022), it appears that all age groups are affected by the housing shortage, but it is most noticeable amongst young adults and the increasing number of elderly. Besides the need for more housing targeting these groups, there is also a need for increased rotation on the market to support a more efficient use of the existing housing stock where apartments with lower rents can be available to those who need them the most and where the larger housing options are not occupied by only one or two people.

... [the housing shortage] is most noticeable amongst young adults and elderly.

Struggles for Young Adults

The so-called young adults, aged 20-27, constitute a majority of those applying for apartments through the municipal housing agency (Fastighetskontoret, 2022), but high rents and queuing systems requiring years of foresight makes it difficult for them to get a rental apartment. According to the report (Fastighetskontoret, 2022), buying an apartment could also be an option to parts of this target group, if only there was a sufficient supply of suitable apartments. The struggles apply both to young people moving to Gothenburg for work or studies, and young locals who want to move away from home. There is therefore an urgent need for more dwellings with a suitable size and cost for this age group, both rentals and condominiums

Struggles for Elderly

The share of elderly, aged 65 and older, is predicted to increase with more than 44% (Stadsledningskontoret, 2023) by 2040, according to Gothenburg's municipal housing programme. This group is the least willing to move from their homes, but as they get older their need for care will increase and their ability to stay in a regular home decrease. The programme therefore states a large need for attractive and accessible housing options for this target group. As suggested in the housing status report (Fastighetskontoret, 2022), this could be normal apartments where the residents can live an independent life but with the possibility to have home care when needed and with facilities for socialisation with others.

Municipal Guidelines for Development

To accumulate the growing population, Gothenburg municipality suggests that urban development should mainly take place within the inner and intermediate parts of the city (Stadsbyggnadskontoret, 2022), through transformation of industrial sites and densification within already built areas. Additionally, to grow into a resilient multi-core city, the development of the intermediate city should be focused around local district centres, so-called nodes. This strategy will allow for a more local city life and encourage transportation by foot or bicycling to nearby essential services. Examples of such nodes are Angereds Centrum, Gamlestads Torg and Frölunda Torg, which are already serving as smaller city centres to many people and are well connected to the rest of Gothenburg through the public transport network.

BACKGROUND / HOUSING SITUATION IN GOTHENBURG

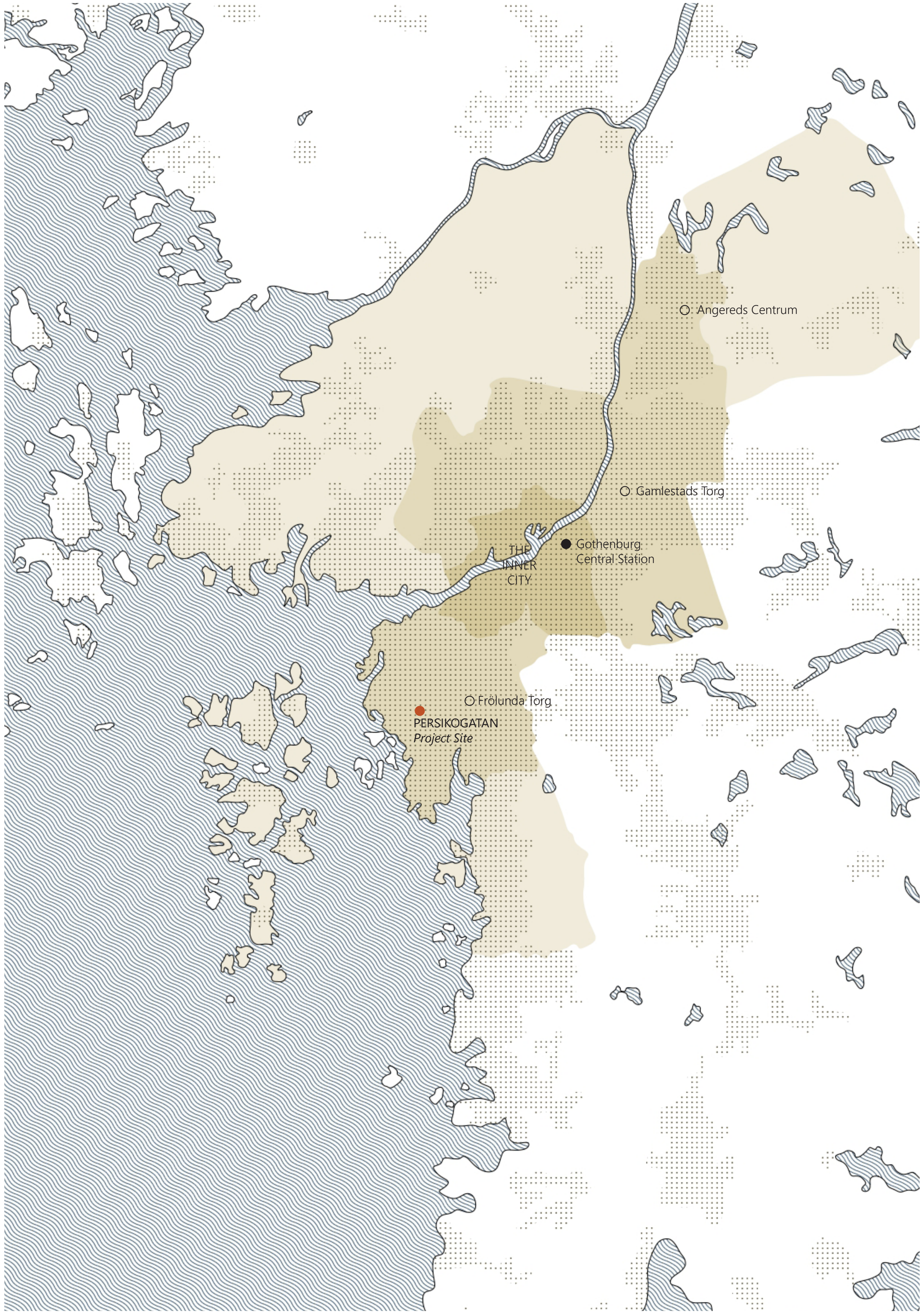


Fig. 4. Map of Gothenburg / Scale 1:200 000   N   *Urban Areas*   *The Intermediate City*   *The Outer City*   *Development Nodes*

SUSTAINABLE DENSIFICATION

As pointed out in the publication *Urban Density Done Right* (Boverket, 2017), densification is often associated with large-scale projects where the number of dwellings and economic profitability are maximised, while daylight conditions, urban green space and much needed free space are minimized. However, the publication also emphasizes that this is not representative for all densification projects and there are different strategies to assure more human- and environmentally friendly results.

Key Strategies

Some key strategies for sustainable densification, listed by Boverket (Boverket, 2017), are to protect resources such as water, green space, cultural environments and urban silhouettes and instead densify inefficiently used spaces such as over dimensioned parking areas. Additional recommendations include focusing the development along certain traffic routes, making sure to create mixed use areas where essential services can be reached by walking or bicycling and adding building types and forms of tenure that are lacking in an area with respect to what is already built and to those already living there. One of several contributors to the publication is Peder Hallkvist, city architect in Örebro, who concludes the densification concept as follows:

> *"The actual essence of densification is to create a more varied and rich environment, one that offers more for everyone at close proximity" – Peder Hallkvist (Boverket, 2017, p. 11)*

Another crucial factor in sustainable densification, pointed out in Boverket's publication (Boverket, 2017) is to maintain a sufficient amount and diversity of green spaces, either through preservation or addition. Carola Wingren, professor of Landscape Architecture, explains in the publication that parks are often already highly valued and respected whereas smaller green areas are being treated more carelessly, even though for example a ditch can be just as important as the park. A sustainable city needs a mix of well-maintained lawns and tidy flower beds together with more wild patches of greenery supporting biodiversity and natural processes such as pollination and photosynthesis. Green space also plays an important role in regards of rainwater management and climate adaption, for instance by allowing water to infiltrate into the ground. Wingren emphasizes that it does not have to be large-scale projects to be beneficial, even small patches of greenery can entail great benefits for biodiversity and climate resilience. With the same logics, small, impervious areas such as stone paving in gardens, can be a threat.

... even small patches of greenery can entail great benefits for biodiversity and climate resilience.

Expectations on Green Space

Wingren (Boverket, 2017) also brings up the fact that our use and expectations of urban green space is changing, with for example an increased interest in allotments and urban vegetable farming. The urban development must follow such societal changes and provide the kind of spaces that people seek. Many urban farming initiatives take place in public garden beds and in the form of shared gardens amongst neighbours. In these cases, Wingren points out that the social aspect is the primary one as the extent of city vegetable gardening cannot currently be carried out at a large extent. She also emphasizes the importance of assuring a good soil quality when establishing urban farms, to avoid potential health issues caused by contaminated soil.

Municipal Goals for Sustainable Densification

Gothenburg's comprehensive plan (Stadsbyggnadskontoret, 2022) emphasizes that available social services and green space should be the dimensioning factor in in all densification projects, to ensure a good quality of life for the current and future residents. In areas where new schools and preschools are hard to fit, themed housing could be a good option, for example catered to students or elderly who will not need such services. Moreover, existing green and blue areas should be respected, preserved and even expanded as they contribute with important ecological and social values. In new construction, ecosystem services and biodiversity should be integrated, to strengthen the presence of nature and greenery in the city.

Some explicit goals for the development of the intermediate city, listed in the comprehensive plan (Stadsbyggnadskontoret, 2022), are to strive for a mix of housing types, strive for efficient use of space and to shrink over-dimensioned traffic areas to make room for buildings and social areas. The development should be respectful of nature and when possible, lost green areas should be restored. Cultural values and local character should also be respected, by making sure new construction is gentle and responsive to the already built. Moreover, public transport, walking- and bicycling routes should be prioritized and strengthened (Stadsbyggnadskontoret, 2022).

PARKING REGULATIONS

According to calculations presented in a report by Fastighetsägarna et al.* (2020), there is about three to five parking slots per car in Sweden. With roughly five million cars, this adds up to a total parking area of around 500 km^2. Divided by the whole Swedish population, this means around 50 m^2 of parking per person, whereas the average residential area per person is only 42 m^2 per person (Fastighetsägarna et al., 2020). Ultimately, there is more parking area than residential area in Sweden. One could think that this relationship should be reversed and question whether all this parking space really is necessary.

... there is more parking area than residential area in Sweden.

In Sweden, minimum requirements for residential parking space are regulated by the municipalities through *parking norms* and *parking mandates.* The former applies generally to the whole municipality and the latter is specific for different projects (Fastighetsägarna et al., 2020). The framework for these regulations can be traced back to the latter half of last century - a time when the number of cars, car owners and car travelling was anticipated to continuously increase. For example, the City of Stockholm estimated in 1967 that 60-75% of the city's population would own a car in the future, however in 2020 only 37% owned a car (Fastighetsägarna et al., 2020). Current expectations on the future role of the car largely differs from the 60's and 70's, and the parking regulations have started to change. Nevertheless, many neighbourhoods developed during the most car enthusiastic era still hold an abundance of space reserved only for parked private vehicles.

Flexible Parking Regulations

In the past decade, some municipalities have implemented flexible parking regulations for new development. In Gothenburg for example, the parking norm now ranges between 0,2-1 car per housing unit (Stadsbyggnadskontoret, 2018), with consideration to centrality, available public transport, housing sizes and bicycling possibilities. In addition to this, Gothenburg municipality gives developers an opportunity to reduce the parking mandate even further by providing so-called mobility measures for the residents (Stadsbyggnadskontoret, 2018). These measures should encourage sustainable transport and reduce the need for a privately owned car, and could for examples be to introduce carsharing, increase public transport opportunities, give a discount on public transport or provide free bicycle service on occasions.

Car-free Housing

Reducing the parking mandate to zero is not suggested as a general solution, but there are some successful examples of car-free housing in central areas. One such example is *BrF Viva* in Gothenburg, with no space for private cars but instead a fleet of shared cars and bicycles. Some residents still own a private car and parks it elsewhere, but several of them consider selling after getting used to the shared vehicle system (Fastighetsägarna et al., 2020). This proves that shared mobility solutions can encourage less private car ownership. Generally, the more available parking space in a residential area, the more private cars and car travels, whereas less parking space and more public transport encourages development in the opposite direction (Fastighetsägarna et al., 2020).

**Fastighetsägarna et. al include three organisations; Fastighetsägarna, Hyresgästföreningen and Naturskyddsföreningen; The Swedish Property Federation, the Swedish Union of Tenants and The Swedish Society for Nature Conservation.*

MOTIVATION FOR THE ROWHOUSE CONTEXT

Rowhouse neighbourhoods do not account for the largest paved areas in cities, but they could nevertheless be a strategic place for sustainable densification. A lot of them are designed with central, shared parking lots that are large enough to fit some additional housing, but small enough to motivate keeping the additions at a modest scale where natural and circular material is a feasible option. There are many rowhouse neighbourhoods that were designed and built during the 1970's (Boverket, 2020b), a time when the expectations on private transport and car use was very different from today (Fastighetsägarna et al., 2020). Through empirical observations, rowhouse neighbourhoods with as many as 2.25 parking slots per household have been found in South-west Gothenburg - an area where the City Planning Office (Stadsbyggnadskontoret, 2018) suggests maximum 0.4-0.8 slots per household for new multi-family housing projects.

There is evidently a large discrepancy between how much parking space is considered needed and how much is available in some older rowhouse neighbourhoods, and it is therefore feasible to elaborate on the idea of reducing the number of parking slots to make better use of the space. Moreover, many of these rowhouse neighbourhoods are nowadays well integrated in the urban fabric and small-scale densification in such locations does not require much additional development of technical infrastructure, which according to Boverket (2017) is an important factor for the sustainability of a densification project.

The Site Selection Process

The specific project site was chosen through an iterative selection process, with the initial criteria of finding a rowhouse neighbourhood somewhere in Gothenburg with one or several common parking lots and garages, and with good accessibility to public transport. Through studies of the municipal comprehensive plan (Stadsbyggnadskontoret, 2022), the location criterion was specified to the intermediate parts of Gothenburg since this is where the municipality sees the most densification potential.

The southwest intermediate city showed to have an abundance of suitable project sites, many of them within walking distance from Frölunda Torg – which is one of the nodes where the municipality encourages development (Stadsbyggnadskontoret, 2022). Persikogatan has a central location amongst all these potential sites, and is also located right between two traffic routes, Stora Fiskebäcksvägen and Skattegårdsvägen, that are explicitly pointed out as potential development zones (Stadsbyggnadskontoret, 2022). This, along with some further research and calculations showed that Persikogatan could be the perfect site for the project.

Moreover, the fact that Persikogatan is surrounded by other neighbourhoods with similar layouts and conditions makes a supporting argument for the thesis and inspires an interesting discussion of how the thesis project could be potentially expanded in a future scenario.

BACKGROUND / SUSTAINABLE MOBILITY ON THE RISE

SUSTAINABLE MOBILITY ON THE RISE

Carsharing

Many private cars remain parked for as much as 97% of their lifetime (Fastighetsägarna et al., 2020). Through carsharing, the potential of each car could be better utilised and plenty of resources and space could be saved in the process. Over the past decade, carsharing has expanded significantly on both a global and n tional level. Between 2011-2018, the number of shared cars in Sweden more than tripled (Andersson et al., 2020) and the number of users increased even more. In 2018; 1.5% (Andersson et al., 2020) of Swedes with a driver's license were active carsharing users, and according to surveys conducted the same year, 30-80% (Fastighetsägarna et al., 2020) of people living in apartments were willing to join a carsharing service.

Different studies show different space-saving potential of carsharing; some suggest that a shared car can replace between 5-20 (Andersson et al., 2020) private cars, others suggest 5-10 (Fastighetsägarna et al., 2020). Assuming that at least the lowest range of these estimations is feasible, introducing carsharing could in theory decrease the need for parking space by 80%.

... carsharing could in theory decrease the need for parking space by 80%

In reality, the space-saving potential of carsharing is complex and dependant on factors such as the users and the location. As the situation is today, several different car sharing services are needed to cover the functions of a private car; free-floating carsharing for spontaneous trips, station-based car pools near people's homes for planned trips and traditional car rental for longer trips (Andersson et al., 2020). Package solutions including all these functions would be beneficial for increased use.

The environmental impacts of carsharing are also hard to measure; while a carsharing service may prevent some people from buying a private car, it may encourage others to use a car in a situation where they otherwise would have biked. However, the station-based carsharing model has proven (Andersson et al., 2020) to reduce household transport emissions, reduced car traffic and to prevent purchases of private cars. Some important driving forces for further development of carsharing, listed by Andersson et. al (2020) is continued development of smart technique, more parking slots reserved for shared vehicles and policy updates that make for instance peer-to-peer carsharing easier and more beneficial.

Fig. 5. Visualisation of the theoretical 80% space-saving potential of carsharing, applied to the project site. Green areas represent previous parking space that could instead be used for other functions. Aerial photo from 2022 (Google Earth Pro, 2022).

Other Sustainable Alternatives

Another mode of transport with potential of replacing private cars in short- to medium long travels is electric bicycles, e-bikes, which have steadily increased in sales over the past ten years (2030-sekretariatet, 2023). In 2018, the Swedish Government introduced a subsidy programme for e-bikes, reducing the cost by 25% (Anderson, 2022). The programme only ran for a year, but figures show (Anderson, 2022) that it led to a doubling of e-bike sales that year and a significand reduction of the new e-bike owners' car use. According to calculations by Tozluoğlu et al. (2024), e-bikes have the potential of reducing Gothenburg's car emissions by almost 45%. However, the transition towards more bicycle-based mobility is a dynamic process highly dependent on the development of desiccated infrastructure, equipment availability and social trends (Tozluoğlu et al., 2024).

A positive trend can also be seen in the development of public transport, both nationally (Westling, Emmy, 2024) and locally in Gothenburg where the share of travels by public transport, bike and foot increased from 20% (Cullberg et al., 2014) in 2014 to 41% (Koncernkontoret, 2024) in 2023. Västra Götalandsregionen, responsible for the region's public transport, aim at shortening travel times by 20-25% (Västra Götalandsregionen, 2024) and expanding the capacity with 70% up until 2035. Some explicit measures, listed on the public transport company's website (Västtrafik, n.d.), are to expand the network with new tram lines and new electric city busses, and to increase bicycle parking opportunities next to important traffic nodes for convenient switching between different sustainable modes of transport.

BACKGROUND / DESIGNING FOR CLIMATE RESILIENCE

DESIGNING FOR CLIMATE RESILIENCE

Urban areas are facing increasingly prevalent problems related to climate change, such as heatwaves, air pollution, flooding and droughts (Teerlinck et al., 2024). As discussed in the section about sustainable densification, green space can help mitigate the negative effects of these changes. As Wingren (Boverket, 2017) explained, a mix of different kinds of green space is favourable and as a network, even small patches of greenery can entail great benefits. Through a systematic review, Teerlinck et al. (2024) investigate more in detail how small green areas, such as domestic gardens, should be designed to maximise their positive climate impact.

As a tool for adapting to climate changes and mitigating their negative consequences, the European Commission has defined a set of Nature-based Solutions, so-called NBS (2015). These are different actions inspired by natural processes, which can be used to tackle both societal, environmental and economic challenges in a resource efficient and resilient way. In their review, Teerlinck et al. (2024), identify four NBS particularly suitable for implementation on a smaller scale; greening sealed soil, reduced lawn management, increased presence of trees and introduction of green roofs - all of which supporting important eco system services and climate resilience.

Greening Sealed Soil

Sealed soil, or impervious surfaces, such as pavement and concrete, is an increasing issue in urban areas - largely connected to urban sprawl and an expansive network of roads but also due to excessive paving in domestic gardens (Teerlinck et al., 2024). Impervious ground coverings lack the ability to sequester carbon and prevents water from infiltrating into the ground, leading to lower ground water levels, increased flooding risk and increased stress on drainage systems. Additionally, paved areas entail locally increased temperatures and in turn further soil sealing through the Urban Heat Island effect (Teerlinck et al., 2024). Reducing the amount of paved area and replacing it with green or permeable options, is a fairly straightforward solution for mitigating negative climate change effects, and can for instance contribute to a local temperature reduction of between 0.5-4 °C (Teerlinck et al., 2024).

Reducing the amount of paved area and replacing it with green or permeable options, is a fairly straightforward solution for mitigating negative climate change effects

Reduced Lawn Management

Green and permeable is generally better than impermeable, but different types of greenery can have different impact in the light of sustainability. Teerlinck et al. (2024) describes that, due to societal norms and general aesthetic preferences, private lawns are subjected to intensive management practices. Mowing, fertilization and irrigation cause greenhouse gas emissions, elevated pH-levels and lessened ability to sequester carbon. Limiting these practices could entail both economic and environmental benefits (Teerlinck et al., 2024). An alternative to traditional lawns, that does not encourage destructive practices, is urban wildflower meadows. According to a study of a wildflower meadow in Cambridge (Marshall et al., 2023), the number of plant species, bug species and bug individuals was tripled in the meadow compared to a traditional lawn. Moreover, the lesser need for maintenance reduced of both emissions and expenses and, when evaluating the intangible values through a survey, the meadow was praised for being more aesthetic and providing more mental wellbeing than the lawn.

Increadsed Presence of Trees

Teerlinck et al. (2024) further describes the benefits of trees in urban environments, including locally reduced air temperature, reduced need for indoor cooling, sequestration and storing of carbon and breaking the wind. Moreover, by being able to absorb and temporarily hold large amounts of water, the trees help protect soil from rainfall impact and can ease the stress on drainage systems. Increasing the tree cover could be a good way of supporting both climate adaption and overall wellbeing, but Teerlinck et al. (2024) stresses the importance of choosing native species and carefully consider the local context, spatial limitations, planning regulations and practical details to assure a positive outcome. Some of the most common tree species in residential areas in Gothenburg are Swedish Whitebeam, birch and maple (Sveriges Allmännytta, 2020).

Boverket explains in an article on their website (2019) that the value of trees increases with their age, as older trees better support biodiversity by being homes for numerous other species. This makes it important to preserve existing trees, especially those who are 50 years or older and officially counts as *old trees* (Boverket, 2019). In case a tree turns out to be inconveniently located, it can rather easily be moved if the girth is less than 120 cm (Boverket, 2019). However, it can take up to a few years before the ecosystem services of a moved tree are restored to the same level as before.

Green Roofs

Nature-based Solutions are not limited to garden practices and landscaping design but can also be applied to buildings. The installation of green roofs and walls are such examples (Teerlinck et al., 2024, p. 10), which can entail benefits similar to those of increased tree cover, including reduced surface- and air temperatures and lowered energy consumption due to its natural cooling effect. According to the European Commission (2015), green roofs and walls also support improved biodiversity, act as carbon sinks, contribute to reduced risk of flooding thanks to their ability to hold water, and contribute to overall improvement of health and wellbeing.

PRACTICAL REFERENCES

1. DEPAVE

NON-PROFIT ORGANISATION FOUNDED IN 2008, BASED IN PORTLAND, OREGON

As a response to the problems related to impervious surfaces, a global depaving movement has emerged from local grassroots initiatives all over the world, with the common goal of bringing back nature and greenery into the cities.

One of the key players in the movement is a non-profit organisation called Depave, founded in Portland, Oregon, in 2008 (Depave, 2023). They focus on helping socially vulnerable communities overcome injustices and adapt to climate change by creating resilient urban greenspaces. Their concept is to replace underutilised impermeable surfaces with living, permeable alternatives, through participatory events involving volunteers and the local community. One such project is the Powell Butte Elementary School (Depave, 2019) where the 700 m^2 playground was depaved and transformed into a playful green oasis in 2019.

It is inspiring to see how an originally small local organisation can gain momentum as part of a global network and inspire similar actions and initiatives far and wide, from Belgium to Australia (Baraniuk, 2024). Thanks to Depave and similar organisations, the act of depaving is now gaining increased recognition from all sorts of organisations, including the UK government (UK Government, n.d.) who have a page on their website where they encourage citizens to remove parts of their garden pavement to help counteract flooding and heat islands and to support wildlife. Except for the benefits regarding climate resilience, air quality and biodiversity, Depave also points out the democratic aspects of depaving, and that regreened areas can enhance quality of life for all who live nearby (Depave, 2023).

BACKGROUND / PRACTICAL REFERENCES

Fig. 6. The playground of Powell Butte Elementary School, before transformation. Photo by Depave (2019).

Fig. 7. The playground of Powell Butte Elementary School after the transformation by Depave. Photo by Depave (2019).

Fig. 8. Aerial view of Frölunda Torg in 2014 (Google Earth Pro, 2014).

Fig. 9. Aerial view of Frölunda Torg in 2024 (Lantmäteriet, 2024a).

2. HOUSING DEVELOPMENT ON PARKING LOTS

EXAMPLES FROM FRÖLUNDA TORG DISTRICT IN SOUTHWEST GOTHENBURG, 2014-2024

As seen when comparing Figure 8 and 9, showing the same area in 2014 and 2024, several parking lots in the Frölunda Torg district have been transformed into housing over the past decade. Similar examples can be found all over Gothenburg and in many other cities. Many of these kind of projects are of a different scale than the intended thesis project but still provide arguments and inspiration for the concept of parking-to-housing transformation.

Between 2014-2021, the City of Gothenburg ran an ambitious housing programme called Bostad2021 (Göteborgs Stad, 2023) in collaboration with 27 building companies, with the goal of speeding up the development process and producing 7,000 new homes, in addition to the regular development, within seven years. As reported in an article by Larsson (2016), eleven out of the programme's 31 projects were planned in the place of former parking lots. Municipal stakeholders featured in the article argue that the considered parking lots were previously not fully utilised, didn't add much to the urban environment and could be perceived as unsafe environments - and that the new development makes the areas feel safer and more vibrant with more people present, more greenery and new services on the ground floors. The projects in Munspelsgatan and Mandolingatan, pointed out in Figure 9, are both a part of this programme, whereas Äppelträdgården (see practical reference no. 3) and Lergöksgatan were developed outside of the programme.

In the case of Mandolingatan, the former 522 (Larsson, 2016) ground parking slots are replaced by 966 slots gathered in parking decks, hidden underneath the new courtyards. This makes room for ca 550 (Framtiden, Göteborgs Stad, 2021) new rental apartments, and preserves the parking-to-housing ratio at ca 0.72 which is considered to be enough due to available public transport and the proximity to essential services. The new development also includes mobility bike- and carsharing to further reduce the need for private cars.

The different neighbourhoods in the Mandolingatan project, all designed by Liljewall Architects, form a coherent whole with brick facades, green roofs and solar panels (se Figure 11), yet with great variations in building heights and housing sizes. The goal is to attract a diversity of residents (Framtiden, Göteborgs Stad, 2021) by providing both small single apartments, larger options for families and some apartments especially catered to elderly. The latter are designed with extra safety features such as support handles in the bathrooms and stove guards, moreover, these apartments have their own access balconies to promote interaction between the elderly and to facilitate for home carers.

Fig. 10 & 11. Overview and rendered visualisation of the project in Mandolingatan (Göteborgs Stad, 2018; Tornstaden, 2019).

Fig. 12-14. Exterior photos from the award-winning first neighbourhood in Äppelträdgården. Photos by Kalle Sanner & Hans Wretling (2011) and Länsförsäkringar real estate agency (Länsförsäkringar, 2024)

3. ÄPPELTRÄDGÅRDEN

ROWHOUSE NEIGHBOURHOOD ON A FORMER PARKING LOT IN SOUTHWEST GOTHENBURG
BY WHITE ARCHITECTS, 2010-2019

Äppelträdgården, *The Apple Orchard*, is one of the parking transformations pointed out in Figure 9. In comparison to many other housing projects on parking lots, Äppelträdgården is kept at much smaller scale with buildings of maximum two floors and housing units in the form of both rowhouses, duplex houses and apartments. The scale, typology and conceptual ideas behind the project make it a highly relevant reference for the thesis project.

The project, designed by White Architects, was built in stages between 2011-2019 and includes 75 housing units of different sizes. The local authorities wanted the new development to contribute to a more diverse housing stock and promote a balanced population mix (White Arkitekter, n.d.), therefore family housing was requested as a complement to the many tower block apartment buildings already existing in the area. 40 of the homes are rentals and the remaining 35 are owned by their residents. The project consists of four smaller neighbourhoods arranged around internal streets, each neighbourhood with its own aesthetics yet with similar ideas regarding private and common spaces and with strong connections between each other through green areas and walkways. The first stage of the project, finished in 2011, was awarded the same year with the Housing Prize (White Arkitekter, n.d.) issued by Sveriges Arkitekter – the national association for Swedish Architects.

The two-storey scheme entails a human scale, connecting people to the gardens, streets and to each other. Kitchens and living rooms are located towards the internal, pedestrian-prioritising streets (White Arkitekter, n.d.) which act a shared elongation of the individual homes and encourage social interaction between neighbours. The contact with the outdoors is one of the main qualities of the project, with ground-floor gardens and common green space available to all residents and with an apple grove at the heart of the area (Sveahus, 2019) which is a place to meet and interact.

The building design and materiality of the different neighbourhoods is varied, with façade claddings ranging from coloured fibre cement sheet shingles to wood and corrugated steel. The vibrant yet natural colours (White Arkitekter, n.d.) were chosen to create a strong identity for the area and to provide a nice view for the residents in the nearby tower blocks. Some rowhouses are designed with atriums painted bright white and with big windows, to allow for a rich flow of daylight into the housing. All entrances are weather protected by either being pushed in to the façade or covered by small roofs (Sveahus, 2019). The residents have access to underground storage facilities and can choose to sign up for parking space if needed, however central Gothenburg is only 10-15 minutes away by public transport and both nature areas and popular bathing spots can be reached within a short walk or bike ride.

4. TINGBJERG

REVITALISATION AND DENSIFICATION OF 1950'S RESIDENTIAL NEIGHBOURHOOD IN COPENHAGEN, DENMARK. BY VANDKUNSTEN ARCHITECTS AND SLA DESIGN STUDIO, 2017-2027

Tingbjerg is originally a non-profit housing area from the 1950's, designed as a community, well-being- and nature-oriented housing project (SLA Design Studio, 2022). The area was meant to be a model of contemporary ideals, however, it only prospered for a short period of time before it started facing societal challenges and gain negative publicity. Because of this, a revitalisation programme was initiated in 2015, to diversify and revitalise the area. Actions include adding new connections to the area, introducing new housing and defining new spaces where both humans and non-humans can flourish.

The development evolves in phases and will result in a total of 1,000 (SLA Design Studio, 2022) new, privately owned, housing units, integrated amongst the existing 2,200 rental apartments. This high densification ratio results in a reduction of urban spaces; however their qualities, biodiversity and accessibility are improved, along with the perceived safety of the neighbourhood.

What is inspiring about this project is the spatially successful integration of a new building typology in a well-established neighbourhood, as well as the many thoughtful design elements contributing to the social and ecological sustainability of the neighbourhood.

The original structure and layout of the neighbourhood is preserved, as well as many of the grown trees along the internal alleys. All new buildings are located towards the perimeter of the common court yards, to make use of the existing streets and to preserve as much garden space as possible, and at the same time create more defined and intimate garden spaces to be shared by both new and old residents. Except for housing, the development entails a greater variety of plant species in the gardens - to both enhance biodiversity and strengthen the green character of the neighbourhood.

To complement the existing stock with a different form of housing, and to make sure that the original buildings still remain the dominant design element in the neighbourhood, the additional buildings are designed as two-storey wooden rowhouses with three to six units attached together. By breaking up the new buildings in smaller volumes with passages in between, the common courtyards are made more easily accessible, and the safety is enhanced by ensuring more sightlines towards the internal streets. The passages between courtyards and streets contain common functions for both new and old residents, such as recycling bins, bike parking and mailboxes – with the intention of encouraging spontaneous social interactions between neighbours.

Fig. 15 & 16. Exterior photos of the new rowhouses in Tingbjerg, surrounded by diverse greenery. Photos by Vandkunsten Architects (2022).

Fig. 17. Siteplan of old and new buildings in Tingbjerg. Illustration by SLA Design Studio (2022).

Fig. 18. Exterior photo showing one of the shared green courtyards in Tingbjerg. Photo by Vandkunsten Architects (2022).

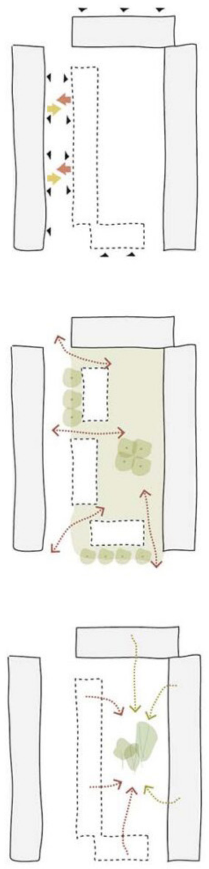


Fig. 19. Sketch showing design concepts for the additional buildings in the area. Vandkunsten Architects (2022).

5. B.R.O.T PRESSBAUM

CO-HOUSING PROJECT OUTSIDE OF VIENNA, AUSTRIA
BY NONCONFORM ARCHITECTS, 2014-2018

This Austrian co-housing project, located 20 km west of Vienna, is designed by Nonconform Architects together with the future residents - The B.R.O.T. Pressbaum Community Association. The name B.R.O.T is an acronym in German, standing for 'meet', 'talk', 'be open' and 'share' (B.R.O.T.-Pressbaum, 2025), which declares how the community strive to live their lives in a mindful way and in harmony with nature. Since it was completed in 2018, the project has won several wood design awards (Nonconform Architects, 2022).

The project, situated on a 14,000 m^2 plot (Nonconform Architects, 2022), developed through participatory workshops where the residents and architects together discussed and designed organisational, spatial, technical and aesthetical solutions. The ten houses are arranged in two rows, forming a small village with a central square and community building; including a common kitchen and launch area, office for co-working, play area, workshop and a music room etc. (B.R.O.T.-Pressbaum, n.d.). The total living area is area is just over 3,000 m^2 (B.R.O.T.-Pressbaum, n.d.), divided between 22 apartments of different sizes and forms of sharing – some are entirely private and some are connected for flexible sharing of spaces. This co-housing model makes room for 30% (Big See, 2020) more people compared to reg ular housing, and with 45% less sealed soil. In 2020, there lived 49 adults and 48 children in the village (B.R.O.T.-Pressbaum, n.d.)

This project is an inspiring reference both by its wholesome approach to a sustainable lifestyle, its architectural qualities and its technical solutions. The village is car-free with no parking space for private cars (Big See, 2020), instead, mobility needs are covered by shared e-cars, bikes and public transport. The outdoor space of the village is very green, with gravel paths connecting the buildings. There are both private and shared outdoor spaces, nicely integrated into the vegetation.

The houses are two to three storeys high and built with lightweight timber, cellulose insulation and a rear-ventilated larch wood facade. This construction, together with indoor temperature regulation through heat exchangers, result in a very low need for heating energy; only ca 27 kWh/m^2a (B.R.O.T.-Pressbaum, n.d.), which by far would qualify for the lowest energy standard in Sweden (Boverket, 2025). Through solar panels and their own biomass boiler, the village produces 75% (B.R.O.T.-Pressbaum, n.d.) of its total energy need. Additionally, thanks to the rainwater flushed toilets, thw village saves 500 – 1,000 m^3 of drinking water each year.

Fig. 20. Closeup photo of the larch wood cladding and a private patio, embedded by greenery. Photo by Kurt Hörbst (2018a).

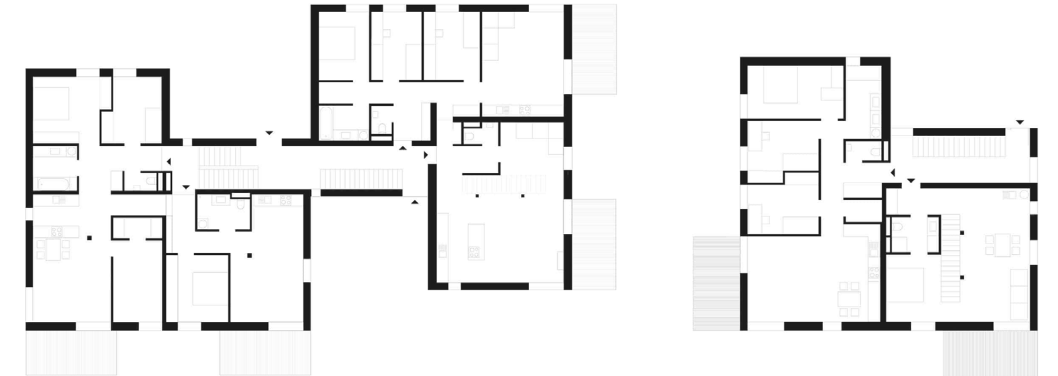


Fig. 21. Floorplans by Nonconform Architects (2018), showing six housing units - some connected two and two and some private.

Fig. 22 & 23. Siteplan by Nonconform Architects (2018) and exterior photo from the B.R.O.T Pressbaum Village, by Kurt Hörbst (2018b).

3. CONTEXT

SOUTHWEST GOTHENBURG

Southwest Gothenburg, part of *the Intermediate City*, includes a wide range of housing typologies and recreational values. The coastal areas are characterised by clusters of single-family housing, whereas the more central parts largely developed during the 1960's and 70's (Stadsbyggnadskontoret, 2022); which is reflected by the characteristic multi-family housing and by the many widespread parking lots that are commonly found close to Frölunda Torg.

Frölunda Torg - a Local City Centre

Frölunda Torg is both the name of an urban district and of a large shopping area at the heart of the district, serving as a local city centre with all sorts of essential services, along with a travel centre. It is one of the so-called nodes around which development is extra encouraged according to the municipal comprehensive plan (Stadsbyggnadskontoret, 2022).

A lot of large-scale housing development has taken place in and around Frölunda Torg over the past few years, through densification of school yards, green areas, parking lots and over dimensioned traffic areas. However, the municipality also sees great development potential in other parts of Southwest Gothenburg, for instance along the traffic routes *Stora Fiskebäcksvägen, Näsevägen* and *Skattegårdsvägen,* marked out in Figure 24. The comprehensive plan (Stadsbyggnadskontoret, 2022) suggests that these routes could be transformed to smaller streets and thereby enable development around them.

Urban Districts

The thesis project site, Persikogatan, belongs to the urban district Bratthammar, which borders to Fiskebäck to the north and west, Önnered to the south and Tynnered to the east (Stadsledningskontoret, 2021).

Mobility

From Frölunda Torg, busses and trams depart frequently towards different parts of Gothenburg. Destinations such as Gothenburg Central Station and Sahlgrenska University Hospital can be reached within 25 and 15 minutes respectively. Biking to these destinations is also a feasible option from Frölunda Torg, as some of Gothenburg's major bicycle commute routes pass by (Stadsbyggnadskontoret, 2022). By bike instead of bus, it would only take five minutes longer to reach these denstinations, with biking distances of 8.8 and 5.4 km respectively.

Car sharing services haven't yet been introduced in Bratthammar, but a few different options are available close to Frölunda Torg (KINTO, 2024; Volvo On Demand, 2024). Busses on the other hand are frequently passing through the district along Skattegårdsvägen and Stora Fiskebäcksvägen. From bus stops *Melongatan* and *Västes Gata*, which are closest to the project site, local busses depart every 20-30 minutes towards Frölunda Torg and *Järntorget* in Central Gothenburg. And from bus stop *Beryllgatan*, 1.2 kilometres walk from Persikogatan, direct busses towards *Brunnsparken* (right next to Gothenburg Central Station) depart every 5-10 minutes and takes only 13 minutes to reach the destination.

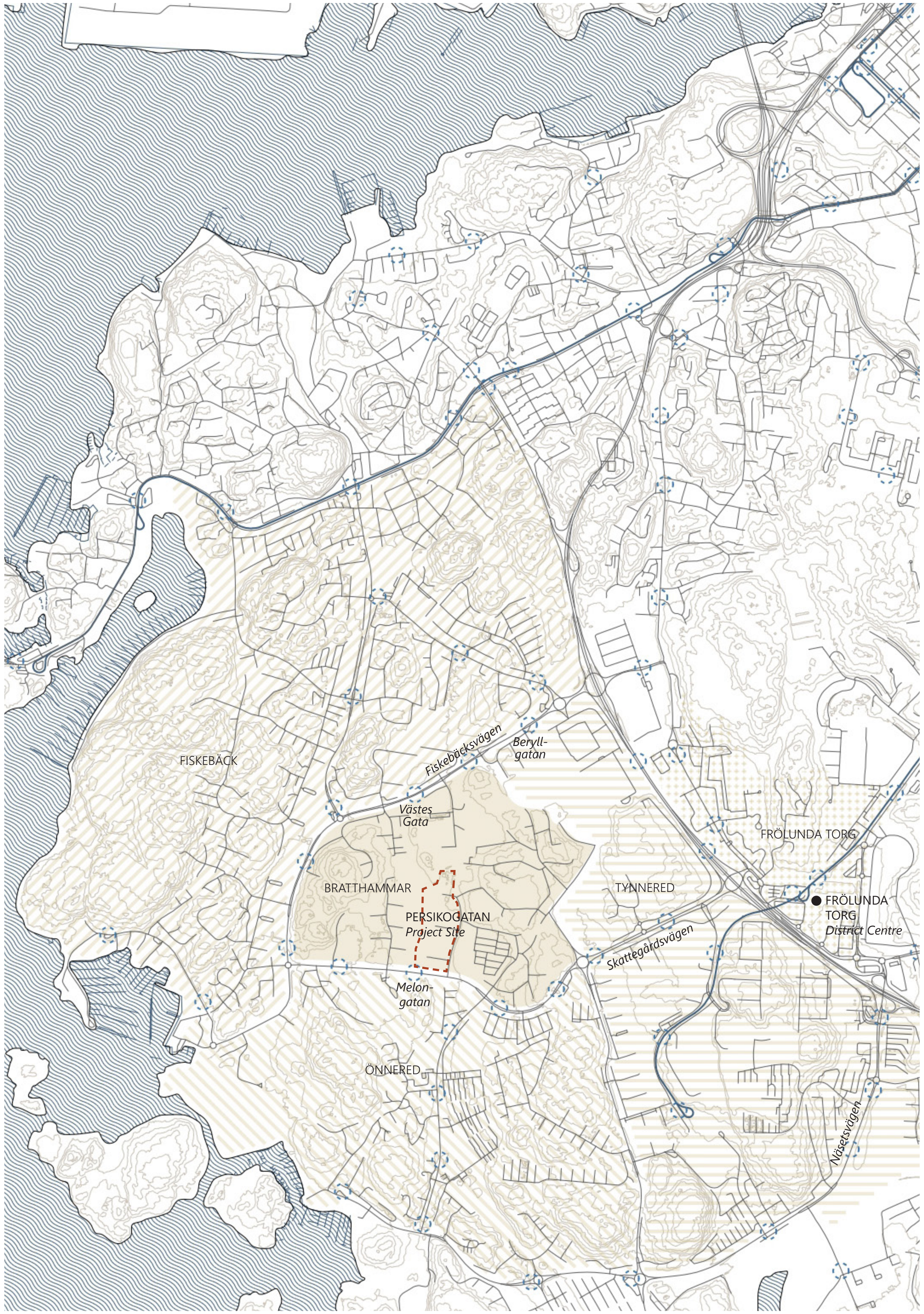


Fig. 24. Map of Southwest Gothenburg / Scale 1:25 000 N Bus/tram stops Urban Dsitricts

Greenery and Recreational Values

Southwest Gothenburg gives an overall green impression, thanks to its many small groves and prosperous residential gardens, as well as several larger nature areas with incorporated sports facilities and hiking trails – such as *Ruddalen's Nature Area* and *Påvelund Recreational Area*. Further down south, about one kilometre from Förlunda Torg, *Välen's Nature Reserve* expands along the Askim Bay. The nature reserve includes both leafy forests and vast open beach meadows which are kept open by grazing animals (Länsstyrelsen, n.d.). The reserve also offers hiking trails, a bird watching tower and a wetland museum.

A majority of the coastal area is connected by walking trails, leading through residential areas, swimming spots, harbours and coastal nature areas such as *Skärvallsberget* and *Sjöbacken*. Skärvallsberget, which is a small mountain, offers great views across the southern archipelago. Sjöbacken is a more flat and accessible area, which was once an ocean bay but then filled up with industrial waste and excavation mass from the construction of Frölunda Torg and other developing areas in the 1960's (Sjöbacken Association, n.d.). It is now a vast open grass field with only a few trees and bushes – a popular site for walks or runs.

Comments from the Locals

Through conversations with residents of Persikogatan, it turns out that the proximity to nature areas and nice walking trails, such as the route around Sjöbacken, is one of the best and most appreciated aspects of living in Bratthammar. Another quality brought up is the possibility to walk or bike to Frölunda Torg, and the convenient buss connections to central Gothenburg.

CONTEXT / SOUTHWEST GOTHENBURG

Fig. 25. Map of Southwest Gothenburg / Scale 1:25 000 N Nature Areas Pedestrian- / Bike Path

BRATTHAMMAR DISTRICT

Bratthammar is outlined by roads to the north, west, and south. But to the east, the border is instead defined by a change in building typology, with the villas belonging to Bratthammar and the apartment blocks belonging to Tynnered (Stadsledningskontoret, 2021). Bratthammar itself doesn't offer any services except for preschools, but the immediate area includes several schools, pre-schools, churches, a couple of grocery stores, pizza restaurants and a health centre. Less than two kilometres from the project site, Frölunda Torg offers all sorts of essential services, gyms and shopping.

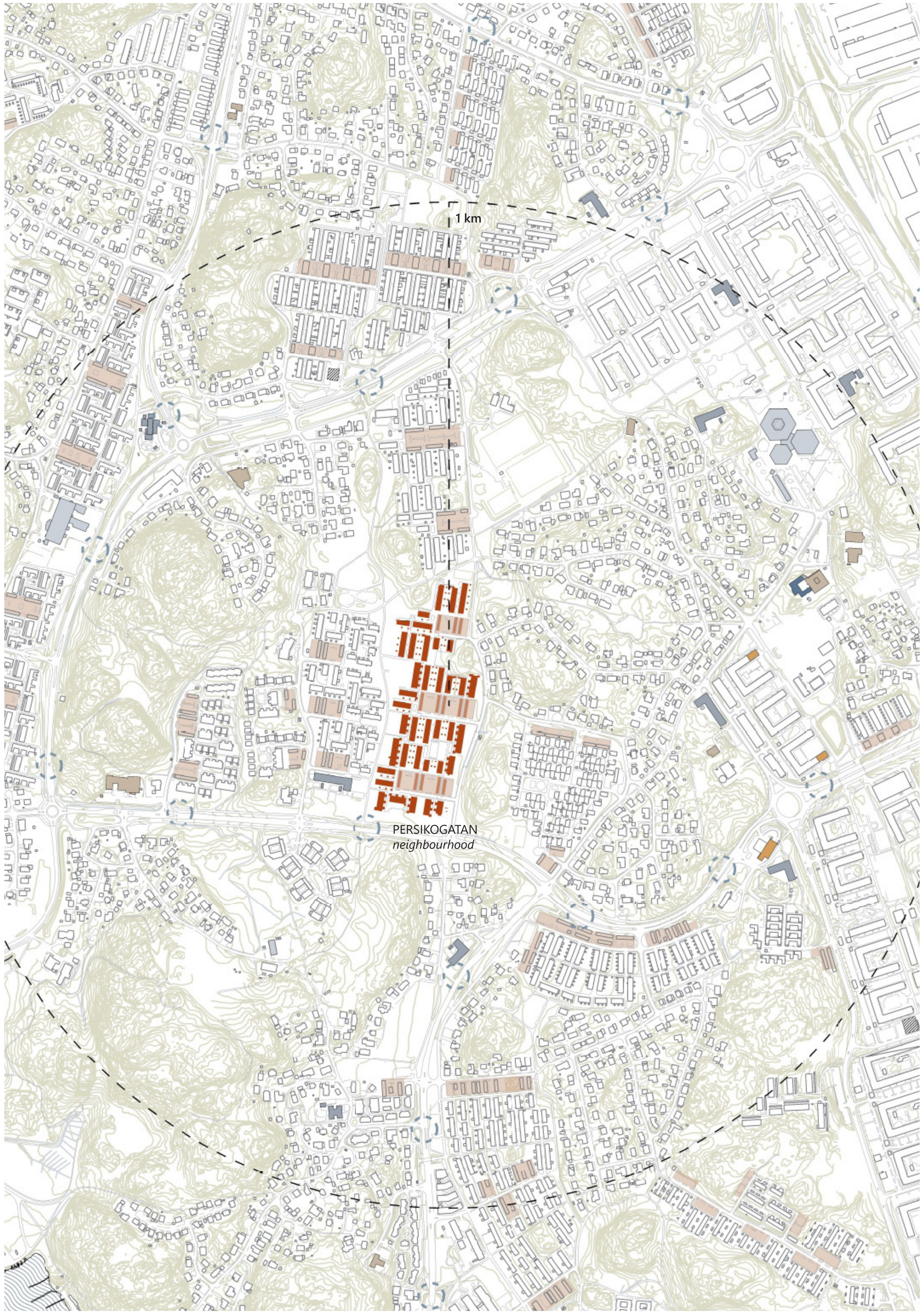
Development of the Area

The rowhouse neighbourhoods in and around Bratthammar were built during the 1960's and 1970's. They all have similar parking space deigns, with one or several paved parking areas in a central location on the plot, offering both open air parking and rows of garages. All these parking lots, highlighted in Figure 26, are examples of alternative sites for the thesis project. These sites could also be taken into consideration in a potential expansion of the thesis concept - a few additional housing units in each of these parking lots would add up to many new homes in an area well integrated into the urban fabric.

Housing Situation, Demographics and Socio-economic Preconditions

According to statistics compiled by the by the municipality (Stadsledningskontoret, 2024) 75% of the housing stock in Bratthammar was built during the 1970's and very little development has taken place since then. 97% of the housing is single-family homes and only 3% of the housing is rentals. The share of 65-84-year-olds is higher in Bratthammar than in Gothenburg in general, and the share of 19-29-year-olds is lower. Almost 50% of the households consist of 1-2 people, however 91% of the housing is 100 m^2 or larger. Similar conditions apply to neighbouring districts Fiskebäck and Önnered. Car ownership in these three districts is 38 cars per 100 inhabitants, which is 10 more than Gothenburg in general. Only ca 15% of the population in Bratthammar has foreign background, compared to 40% for Gothenburg as a whole.

To sum up these statistics, in Bratthammar and to some extent in neighbouring districts Fiskebäck and Önnered, the ratio between small households and smaller housing units seems unevenly distributed. There is also a lack of diversity regarding both housing types and forms of tenure. The lack of smaller housing units seem to make it difficult for young adults to move here, and the smaller households consisting of 1-2 people, probably in their middle ages, have nowhere to go if they want to downsize but still stay in the same area. Neighboring districts to the east have started undergoing development to make room for more residents, but Bratthammar has remained largely untouched since the 1970's.



School | Health Centre | Grocery Store | Shared Parking Lots
Pre-School | Church | Cafe/Restaurant | Bus Stop

Fig. 26. Map of Bratthammar / Scale 1:10 000

N

PERSIKOGATAN NEIGHBOURHOOD

Persikogatan rowhouse neighbourhood, designed by CFL Architect Group (acronym for Celander, Forser, Lindgren), was built in 1975 and includes 158 housing units attached together in rows. Most houses have a longitudinal orientation, with windows to the east and west, facing car free internal streets towards the front and small private gardens towards the back. The housing units come in three different layouts - type B, C and D, all of which consisting of 1.5 floors but with a variation of 2-5 bedrooms and average sizes of 110, 170 and 193 m^2 respectively. The neighbourhood is divided into individually owned properties for each house, however, the parking- and common areas are owned by the municipality (Lantmäteriet, 2024b).

Parking

The neighbourhood includes three common parking areas with a total of 313 slots, whereof 159 are in garages. This means two parking slots per household, which is a very high number compared to the general requirement of 0.4-0.8 slots per household for new multifamily housing in the same area (Stadsbyggnadskontoret, 2021). The parking areas in Persikogatan cover roughly 13,000 m^2, which corresponds to 17% of the ca 78,000 m^2 plot. There is no dedicated bicycle parking in the neighbourhood, instead many residents seem to keep their bikes parked in front of their houses.

The parking area's utilization rate is difficult to determine, but, if the average household sizes and car ownership of Persikogatan align with the statistics for Bratthammar in general (Stadsledningskontoret, 2024), there should be ca 175 cars in Persikogatan. This would mean that only 55% of the parking space is in use.

Common space and facilities

Except for housing and parking, the neighbourhood includes three playgrounds, a tennis court and a paved basketball court. The tennis court is exclusively accessible for members, who pay an annual fee and thereby contribute to the maintenance of the court. Just outside of the neighbourhood there is also a small soccer field made of gravel. According to one of the residents, who have lived in Persikogatan since it was new, there was originally plans for a community space in the neighbourhood, but they were never realised. However, since the 1970's, the neighbourhood has been equipped with common garbage bins – first for combustible waste and later for compost, which are placed in the common parking areas.

Gardens and Greenery

The private gardens vary in size between ca 70-130 m^2. Most of them are clearly separated from each other and from the common spaces by hedges, fences or planks. Many of the gardens are rich in greenery such as bushes and trees, while some gardens are entirely covered by wooden decks. Bushes, small trees and shrubs are also placed in front of the buildings, in dirt or gravel beds, separating the private homes from the public internal streets.

Towards the north and west, Persikogatan is surrounded by a grass covered zone with pedestrian walkways connecting to other similar neighbourhoods and connecting the north and south side of Bratthammar. The eastern side of the neighbourhood is mainly facing a small forest, and a few villas, both of which create a nice view from the neighbourhood.

Fig. 27. Map of Persikogatan / Scale 1:2 000 N Original site plan from 1974 (CFL Architect Group), aerial photo from 2022 (Google Earth Pro, 2022).

The southern entrance to Persikogatan's main street (east of the housing) is framed by greenery and gives a nice, welcoming impression.

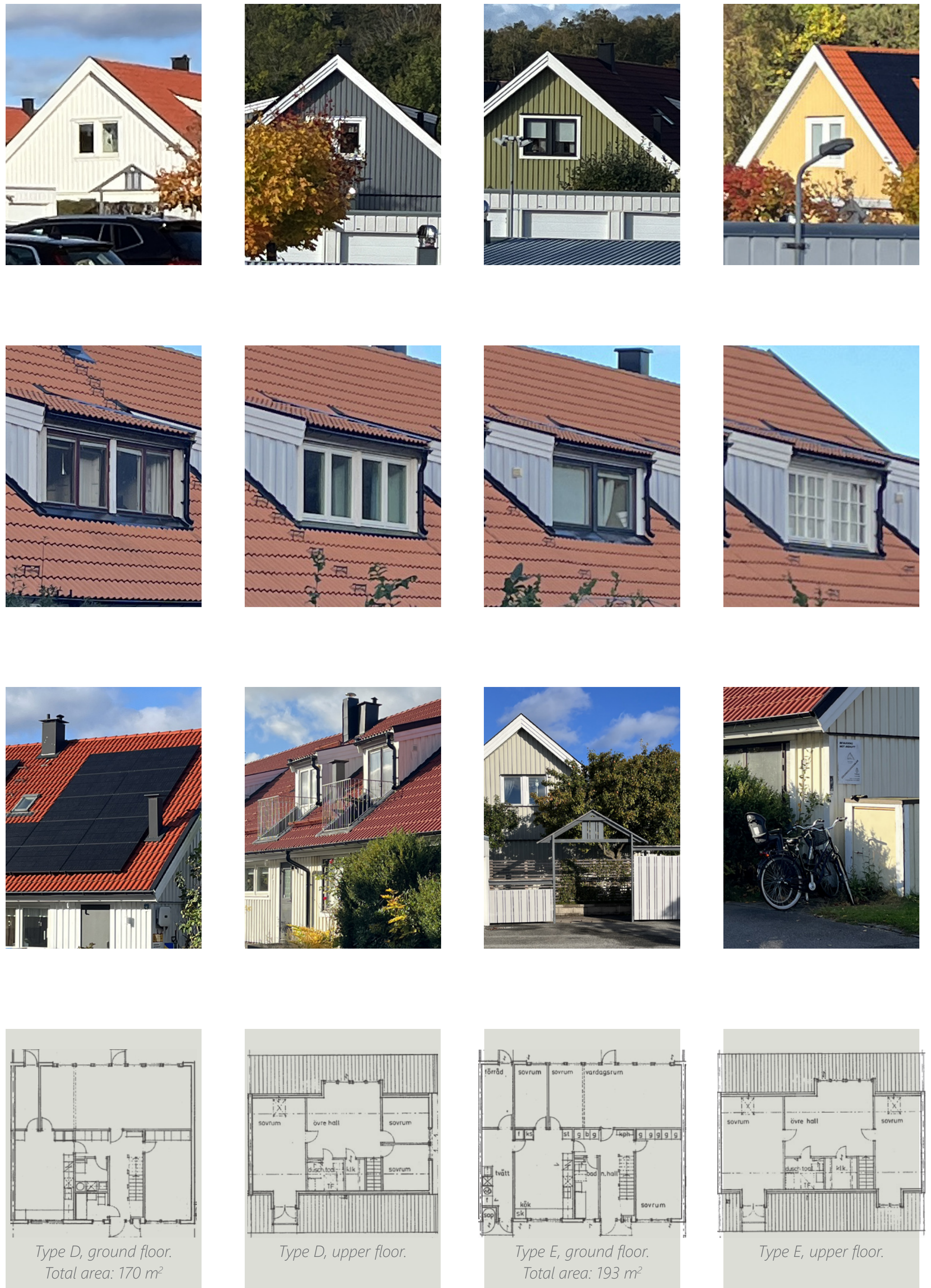
Example of one of the neighbourhood's internal streets, with rowhouses on both sides and pathces of stone paving and greenery.

Fig. 28. Exterior perspectives from Persikogatan neighbourhood. Photos by the author, October 2024

Persikogatan's central parking lot seen from its southeast corner, where both cars and pedestrians enter the neighbourhood.

The central parking lot seen from its southwest corner, with a glimpse of the small forest in the background.

Fig. 29. Exterior perspectives from Persikogatan's central parking lot. Photos by the author, October 2024



Examples of floorplans of existing housing in Persikogatan, showing two out of the three rowhouse types, Scale 1:400.

Fig. 30. Different details of Persikogatan. Photos by the author, October 2024, floorplans by FCL Architect group (1974).

CONTEXT / PERSIKOGATAN NEIGHBOURHOOD

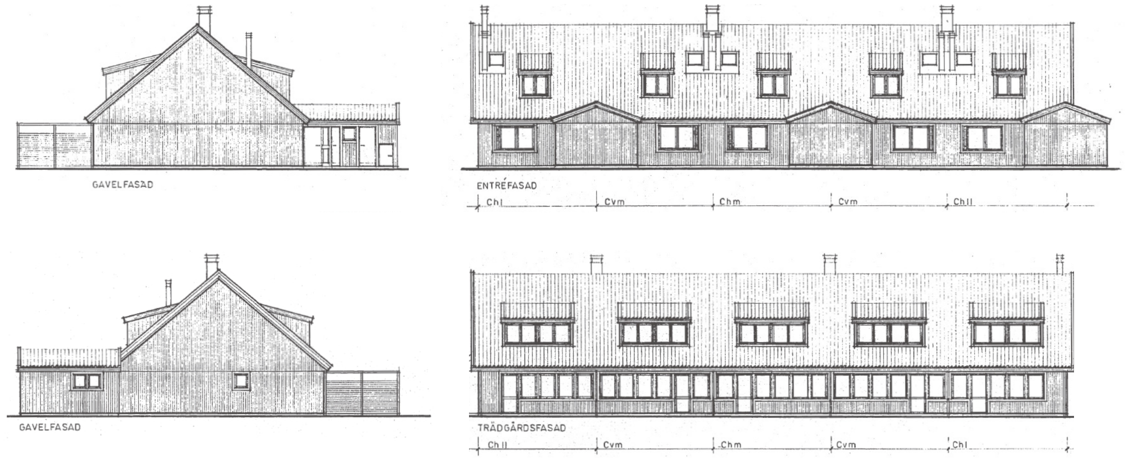


Fig. 31. Elevations of housing type C in Persikogatan, Scale 1:400 (CFL Architect Group, 1974).

Materiality and Details

The neighbourhood gives a coherent impression, largely due to the organised layout and the red tiled gable roofs which predominate the exterior expression. The houses have small individual details differentiating them from each other, such different styles and colours of widows, occasional solar panels and different façade colours. Originally, all the houses were painted in earthy colours typical for the 1970's – such as brown, green and yellow. But over the years, more and more houses have been re-painted in lighter white, beige and grey tones.

The internal streets, as well as the parking lots, mainly consist of impermeable materials such as stone paving and asphalt. Though, the parking lots have small zones of permeable stones and some greenery in the form of bushes and small maple trees. The garages, mainly cladded with similar wood panelling as the houses, are painted in a light grey colour, have white plastic covered garage doors and galvanised corrugated roofing.

Comments From the Residents

Through conversations with residents, it appears that the pedestrian walkway to the west of the neighbourhood is frequently used by people of all ages, which contributes to a lively feeling and gives opportunities for social interactions. It also appears that Persikogatan is a neighbourhood where people tend to stay as long as they can; single 80- and 90-year-olds still live in some of the houses and several couples in their 70's, and some houses have been taken over by the children of former residents.

Several residents praise the room organisation of their houses; with all essential functions and at least one bedroom on the ground floor (this applies to housing type D and E), which makes it possible to stay in their homes even when they can no longer walk the stairs. Another aspect appreciated by several residents is the small-scale design of the neighbourhood, and the that the cars are gathered away from the internal streets. According to the residents, the parking areas are never entirely full, and one person expresses appreciation that there are always parking slots available for their visitors.

INVENTORY OF REUSABLE MATERIAL

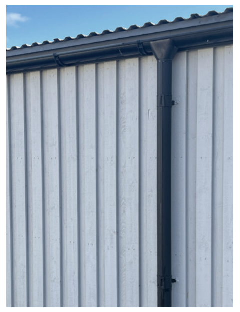
Through site visits and neighbourhood analysis, an inventory of potentially reusable materials has been put together. The objects and materials displayed here are currently part of the parking areas in Persikogatan, and some of them will have to removed or relocated in the transformation process. Reusing or repurposing them on site is a way of avoiding resource waste and transportation emissions, as well as reducing the need for new material.

Timber cladding
On the sides and back of the garages

Corrugated metal roofing sheets
Total area: ca 2770 m^2

Permeable paving
Ca 40-80 m^2 per parking lot

Garage doors
Could be sold or donated for reuse elsewhere



Gutters & downpipes
On the back of garages

Wooden portals
Between parking lots and walkways

Concrete planters, gravel & bushes

Maple trees, 6-8 m tall
6-12 trees/parking area, girth ca 60-80 cm

Fig. 32. Potentially reusable material in Persikogatan's parking lots. Photos by the author, October 2024.

SWOT-ANALYSIS

The thesis project, along with its local context and societal preconditions, has been assessed through a so-called *SWOT-analysis* to identify strengths and opportunities that should be taken care of as well as weaknesses and threats that need to be dealt with:

Strengths

- Good access to public transport
- Low noise levels on the site
- The site is less than two kilometres from Frölunda Torg, with all essential services
- A small local grocery store is located only one kilometre from the site
- Plenty of similar sites nearby, to consider in a potential expansion of the project
- Proximity to the ocean and nature, with many recreational values
- Some of the material from the parking garages could be considered for reuse
- District heating is available in the area
- The area is appreciated as a residential area amongst elderly and families with children

Weaknesses

- No car-sharing in the immediate area
- Lack of smaller housing in the neighbourhood and surrounding area
- Persikogatan does not offer any social space for adults, except for a few picknick benches, nor any indoor common space

Opportunities

- The parking slots are gathered in large parking areas with good sun conditions, that could be suitable for transformation
- Electric bikes, carsharing and public transport is on the rise
- Many one- or two people households in the area, who might be interested in downsizing. This could initiate necessary rotation on the housing market and make the larger homes available for bigger households
- Adding smaller housing in Persikogatan would allow for a more diverse mix of residents of different ages and background
- Re-greening paved areas would improve tolerance for heavy rainfall
- The green space and social functions that the transformation aims to include could benefit both new and current residents.

Threats

- Residents might be upset about a reduction of parking space
- Contaminated soil might make the depaved areas inappropriate for gardening

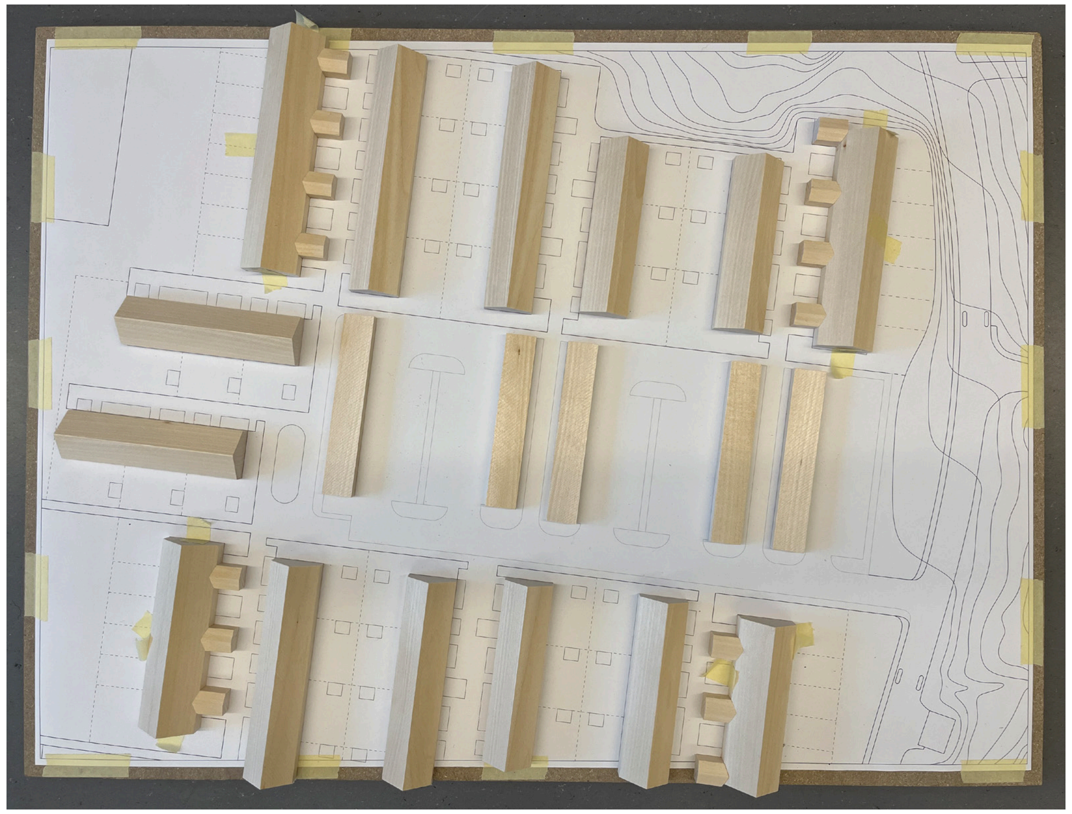
4. DESIGN PROPOSAL

DEVELOPING THE DESIGN

The spatial organisation of the central parking lot could be seen the thesis' main design challenge, with the goal of finding a configuration that would fit all the desired functions within the limited space and without disrupting existing qualities such as daylight preconditions and pedestrian connections, and without disrupting the overall scale of the neighbourhood.

A physical model in scale 1:250 was made early in the process and used for initial design explorations, some of which can be seen in Figure 34. This process allowed for playful iterations and helped clarify design decisions, such as which garages to keep and which to remove and what kind of shape the new buildings could take.

The model was later completed with refined versions of the new buildings, as well as vegetation and new terrain, and displayed as part of the project exhibition. Some photos of the finalised model can be seen in the Appendix.



The draft version of the site model of the central parking lot, measuring 60 x 80 cm, in scale 1:250. Used for initial design explorations. A refined version of this model was used as a means of presentation for the finished design project, see photos in the Appendix.

Fig. 33. Photo of physical site model under construction.

DESIGN PROPOSAL / DEVELOPING THE DESIGN

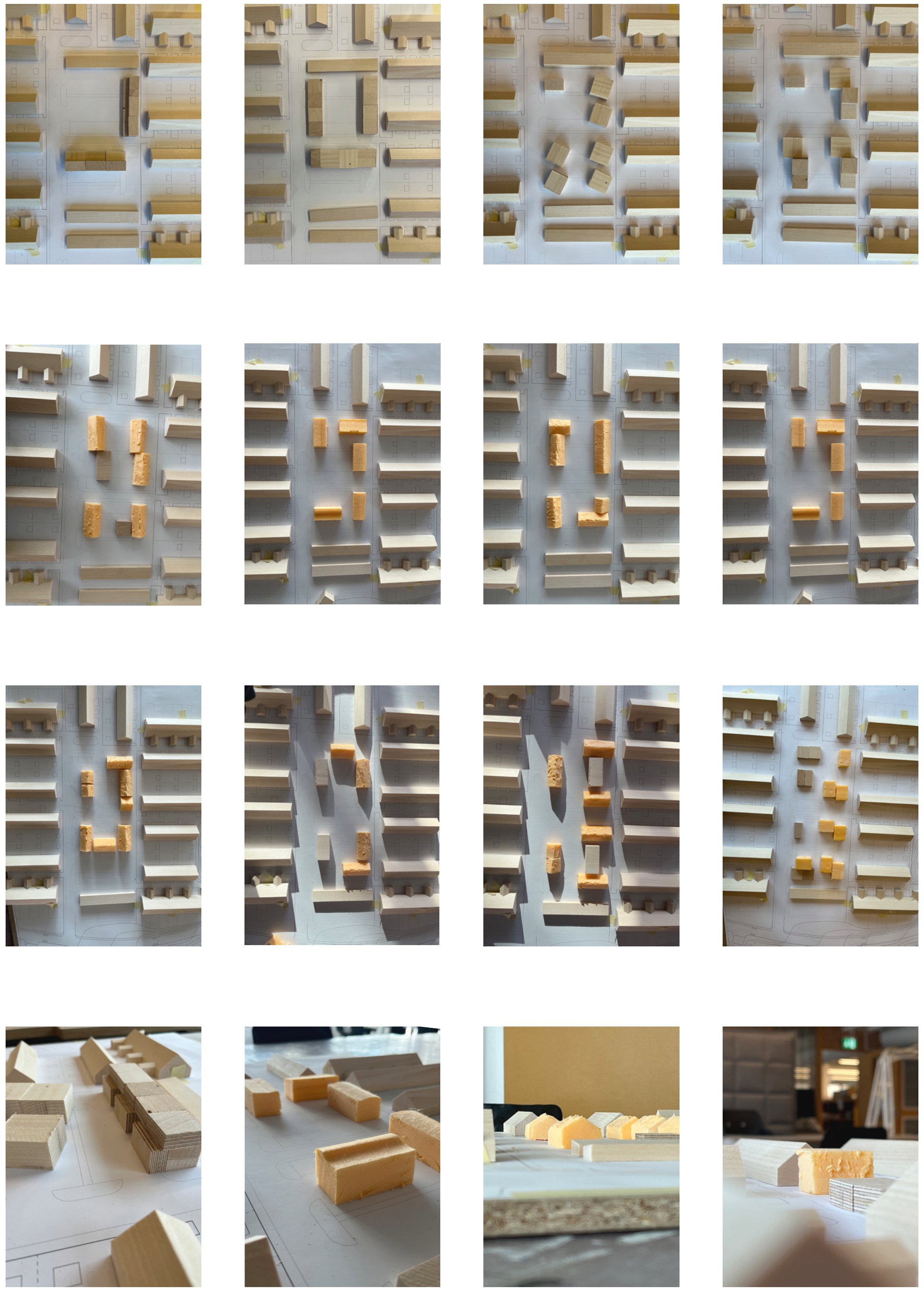
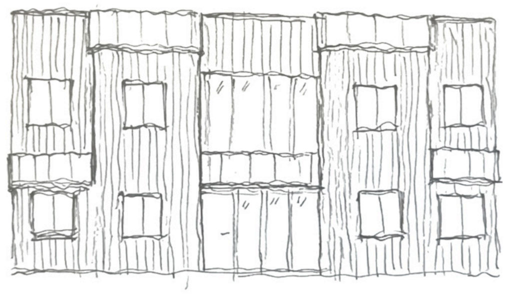


Fig. 34. Spatial layout explorations through phsycial modelling.

Except for working with the spatial organisation, a lot of the design process was dedicated to the exterior design of the new residential buildings, to make sure they fit together with the existing rowhouses and don't take over the visual impression of the neighbourhood. The goal was to establish a dialogue between the old and new, with similarities in proportions and expression, and yet allow them to have their own aesthetical expression.

In the physical modelling phase, this dialogue started out a bit hesitantly. However, it took off through hand sketching, when interpreting the rowhouse facades with pen and paper and carefully studying their proportions and measurements. These sketches then inspired and guided the initial design ideas for the new facades, which were then further developed through iterative digital modelling - some examples can be seen in Figure 36.

Front façade of existing rowhouse.



Sketch proposal for front façade of new two-storey building.

Back façade of existing rowhouse.

Sketch proposal for back façade of new two-storey building.

Fig. 35. Facade sketches of the existing rowhouses and the new buildings.

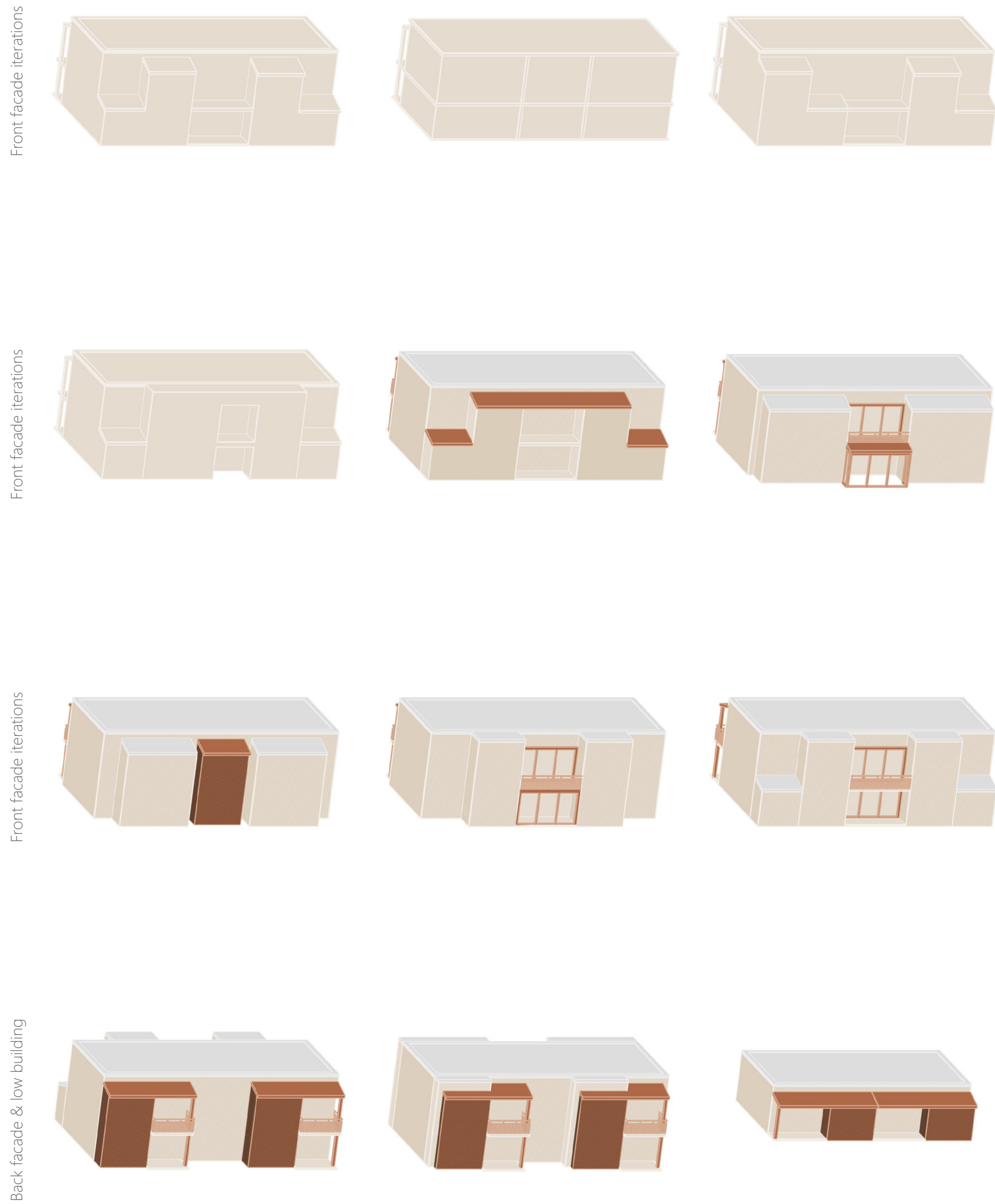


Fig. 36. Exterior design iterations, through digital modelling.

PROGRAMME

Based on the research presented in previous chapters, half of Persikogatan's parking space is taken into consideration for the transformation project to make room for new functions. This leaves the neighbourhood with one parking slot per household instead of two, which is still more than the recommendation for new multifamily housing in the area. Most of the transformation takes place on the central parking lot, which makes the remaining parking space evenly distributed across the site and allows for a new neighbourhood centre in the middle of the plot.

Housing

Four new residential buildings, with a total of 12 apartments, are added to the central parking lot. With this addition, the neighbourhood includes a total of 170 housing units. The new buildings come in three different types: A, B1 and B2, with slight variations in design. All new apartments consist of two rooms and dedicated to elderly singles or couples. This typology and target group are chosen to complement the existing stock in the area and to promote increased rotation on the housing market.

Guest Apartment

A guest apartment of 30 m² is also added to the central parking lot, to be utilised by friends and family of both new and old residents. If needed, it could also be used by a home health aide tending to the elderly in the neighbourhood.

Parking and Carsharing

The former 313 parking slots, including both garages and open-air parking, are reduced to 158 private slots, 12 guest slots and two accessible slots near the new housing. Additionally, four slots are reserved for carsharing, which could in theory replace between 20-80 private cars (Andersson et al., 2020; Fastighetsägarna et al., 2020). These shared vehicles can be used by all residents in the neighbourhood, and potentially by external people too.

Bicycle Storage

With consideration to Persikogatan's location, biking is a feasible replacement to many daily car rides. An important precondition for increased bike use is the availability of safe and convenient storage, therefore the project includes parking space for 88 regular bikes or e-bikes and 30 cargo bikes, in lockable storage rooms distributed across the central and southern parking lot. Since many residents already have their bikes parked outside their houses, new storage space is not needed for all households but it could be nice for those who get a cargo bike or e-bike that needs more safe storage.

Greenhouse (and community building)

A common greenhouse / conservatory á 40 m², to be used for dinners and get-togethers by both new and old residents, is added in the centre of the neighbourhood along with a set of shared garden beds and an outdoor seating area. This becomes a new social node in the neighbourhood, encouraging social interactions. As a future addition, a community building is suggested in the southern parking lot.

Energy Production

The new residential buildings are equipped with solar panels on the roofs, providing energy for the new housing and potentially for charging e-bikes.

Recycling

Three garage slots in each of the northern and southern parking areas are suggested to be transformed into recycling rooms for e.g. cardboard, glass and plastic waste – a function previously lacking in the neighbourhood. The total area of these rooms, 100 m², should be enough to cover the need for both the new and old residents, according to average waste volumes (Göteborgs Stad, 2024).

Green Roofs

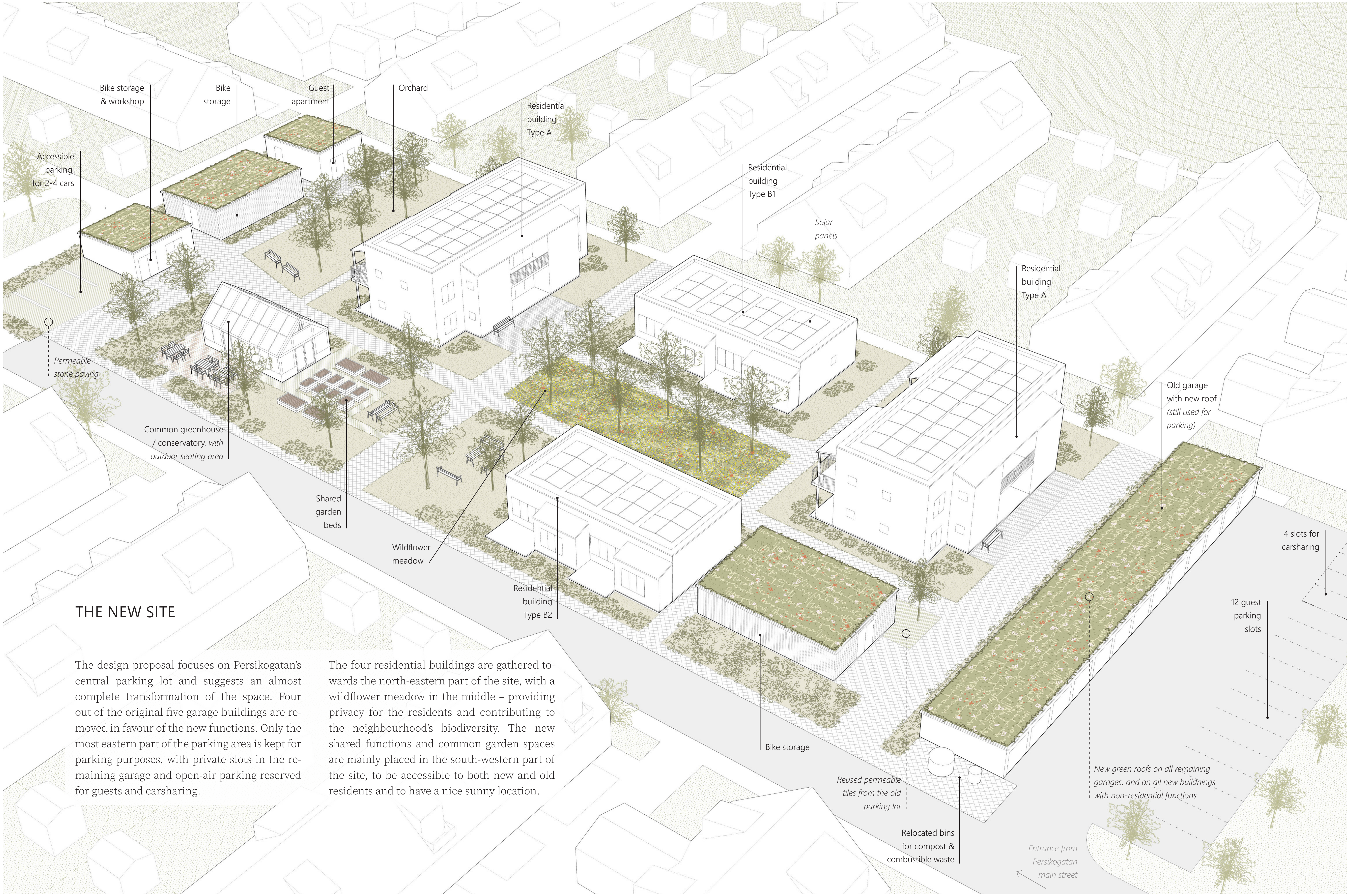
Most of the garages on the site will remain intact and keep their original function but will be equipped with new green roofs to support biodiversity and rainwater management as well as contribute to an overall greener feeling in the neighbourhood. The old, corrugated roofing sheets from all the garages can thereby be repurposed and will be used as façade cladding on the new buildings.

Climate Resilience

The exterior space in the transformation areas, e.g. the landscape in between and around the around the new buildings, is depaved and redesigned in a more climate resilient way, with more trees and vegetation, permeable materials and a wildflower meadow.

Fig. 37. Schematic overview of the transformation project / Scale 1:2 000 N *Original site plan from 1974 (CFL Architect Group).*

DESIGN PROPOSAL / THE NEW SITE



THE NEW SITE

The design proposal focuses on Persikogatan's central parking lot and suggests an almost complete transformation of the space. Four out of the original five garage buildings are removed in favour of the new functions. Only the most eastern part of the parking area is kept for parking purposes, with private slots in the remaining garage and open-air parking reserved for guests and carsharing.

The four residential buildings are gathered towards the north-eastern part of the site, with a wildflower meadow in the middle – providing privacy for the residents and contributing to the neighbourhood's biodiversity. The new shared functions and common garden spaces are mainly placed in the south-western part of the site, to be accessible to both new and old residents and to have a nice sunny location.

Fig. 38. Aerial perspective from southeast, showing the transformation proposal for the central parking lot.

N

DESIGN PROPOSAL / THE NEW SITE

Fig. 39. The proposed new site plan for the central parking lot / Scale 1:250

A. Residential building Type A
B1. Residential building Type B1
B2. Residential building Type B2

1. Bike storage
2. Workshop 30 m^2
3. Guest apartment 30 m^2

4. Orchard
5. Greenhouse
6. Garden beds

7. Social seating area
8. Wildflower meadow
9. Relocated bins

Fig. 40. The southern, main entrance to the new residential area, which is also a pedestrian passage leading to the rowhouses further north.

Fig. 41. One of the western entrances to the new residential area, between the bike storage shed and the bike workshop.

Exterior perspectives from the transformed central parking lot.

Fig. 42. View from the southwest corner of the wildflower meadow, with buildings B1 and B2 on either side and building type A in the background.

Fig. 43. View from the southeast corner of the wildflower meadow, where the entrances to building B1 and B2 can be seen more clearly.

THE NEW RESIDENTIAL BUILDINGS

The new residential buildings have been designed with consideration to both interior and exterior qualities, to make a good complement to the existing rowhouses from both functional and aesthetical aspects. The design proposal involves three different types of residential buildings – type A, B1 and B2, with variations in size, number of floors and entrance locations. These variations derive from careful considerations to daylight conditions for both the new and old houses, as well as from a desire to create a vibrant and social courtyard where entrances are located towards the centre.

All new apartments consist of two rooms (bedroom and living room) and a separate kitchen, and range between 55-61 m^2. This size falls within the range of a typical newly constructed two-room apartment in the Gothenburg area (Fastighetskontoret, 2022) and is intended to suit the target group of the project – elderly singles or couples who are looking to downsize from a larger single-family home.

The new two-storey residential buildings, both type A, were designed first and have the most in common with the older rowhouses. Their size and exterior design takes inspiration from the proportions and geometries of the existing rowhouses, as can be seen in Figures 40 and 44, with similar window placement and same roof slope on protruding elements. The sloping tile roof is perceived as the dominating element of the rowhouses, which except for the dormers gives a rather homogenous expression, whereas the new buildings are given flat roofs but still obtain a homogeneity thanks to the tall vertical facades. The one-storey buildings, type B1 and B2, are smaller versions of type A.

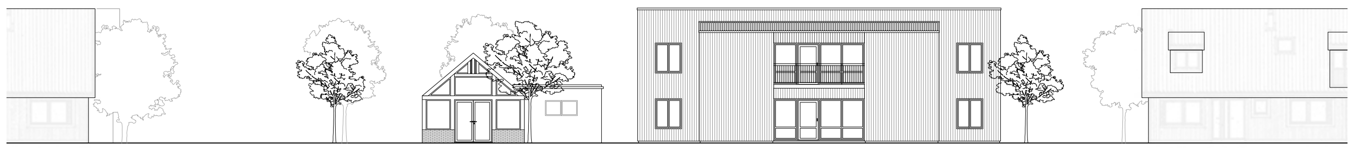


Fig. 44. Section A / Cross section through the site, showing residential building Type A alongside the greenhouse and the old rowhouses.

Scale 1:400

0 5 10 15 [m]

DESIGN PROPOSAL / THE NEW RESIDENTIAL BUILDINGS

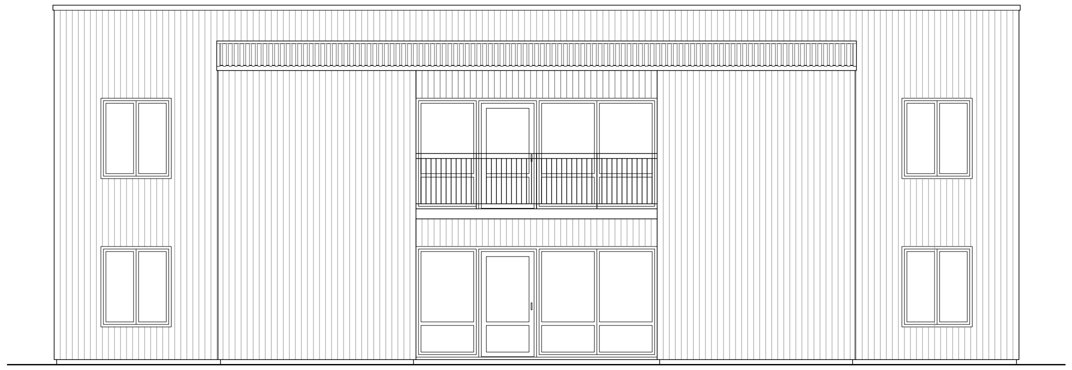


Fig. 45. Residential building Type A / East Elevation

Fig. 46. Residential building Type A / West Elevation

Scale 1:150

0 1 2 3 4 5 [m]

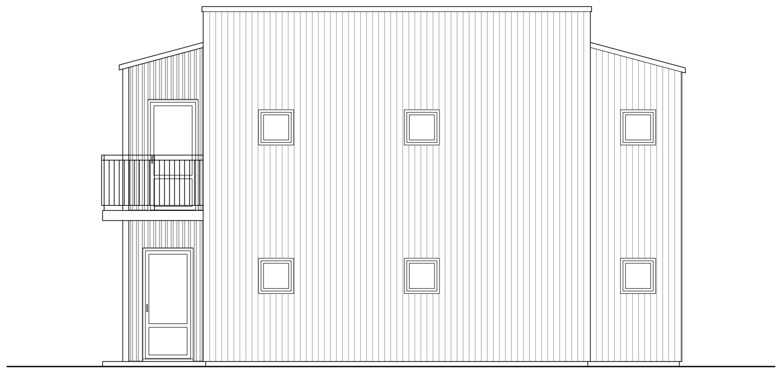


Fig. 47. Residential building Type A / South Elevation / Scale 1:150

0 1 2 3 4 5 [m]

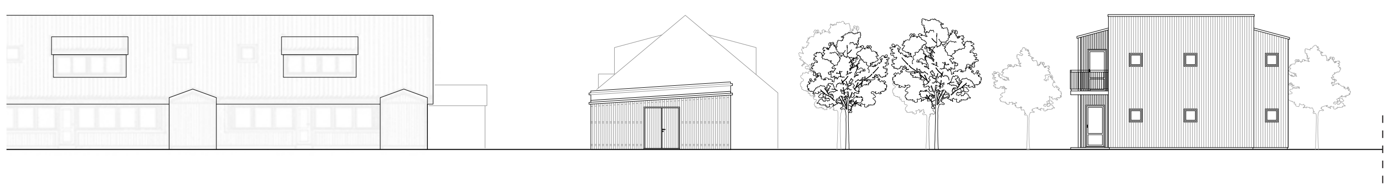


Fig. 48. Section B / Long section through the site, showing bike storage, residential buildings Type A and B1 and original garage.

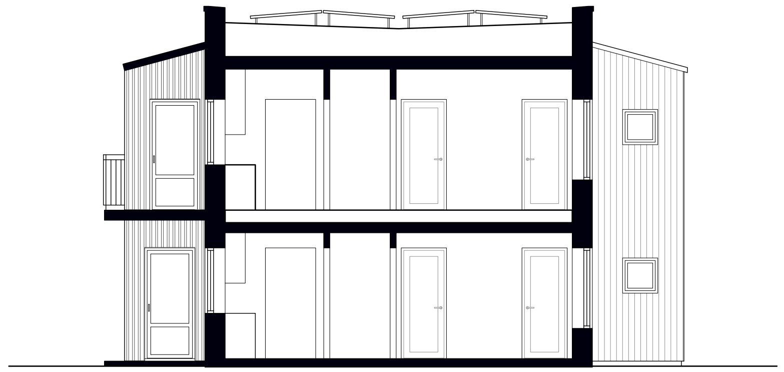
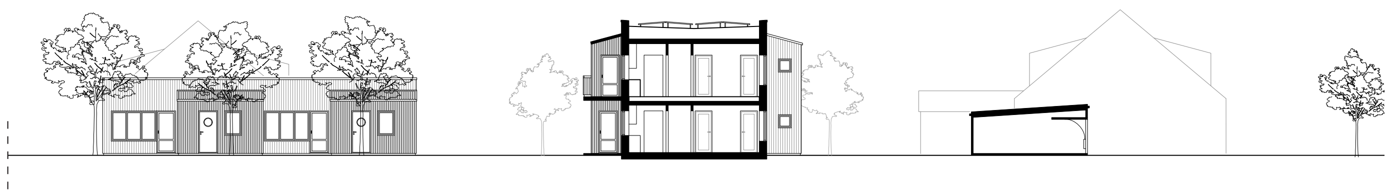


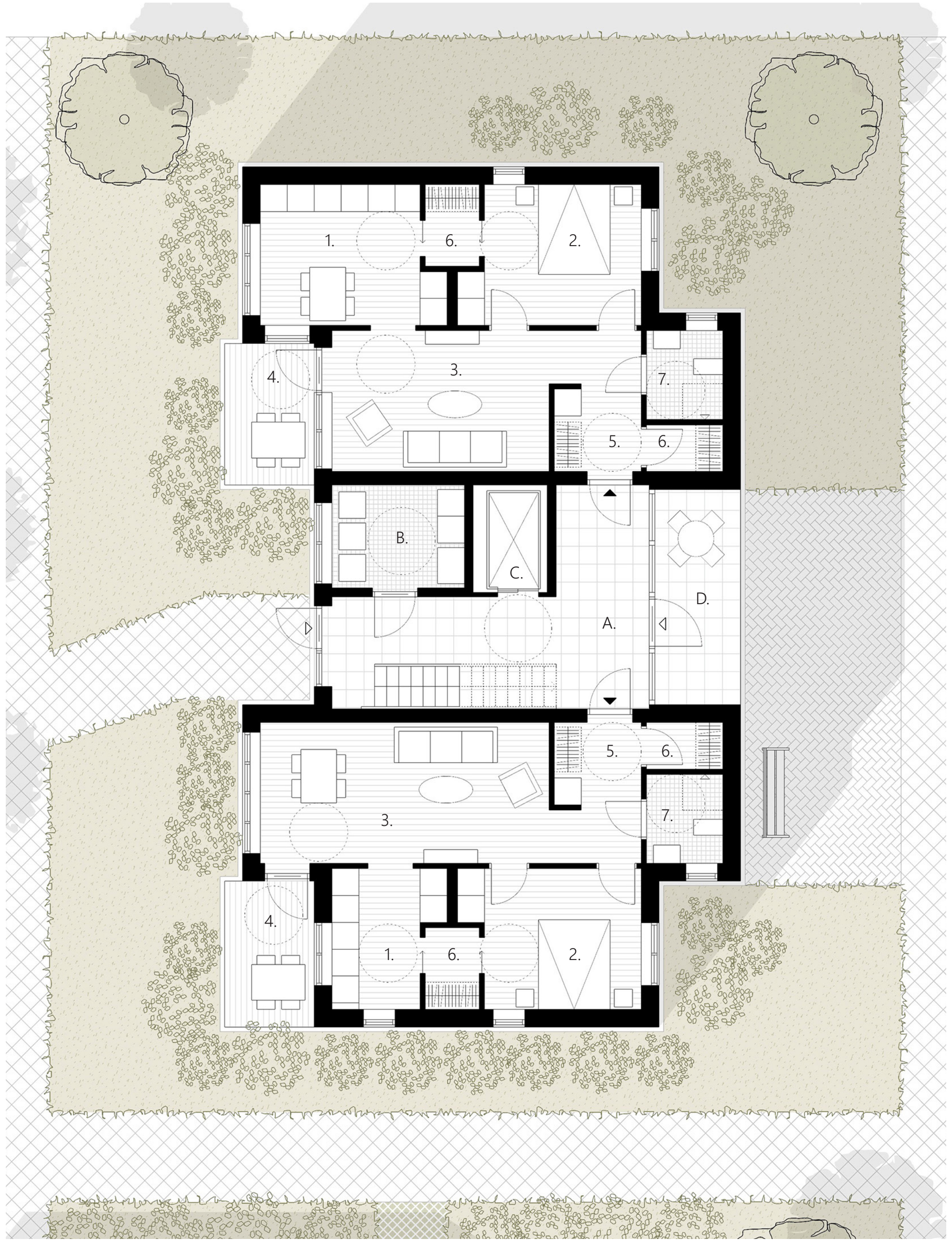
Fig. 49. Residential building Type A / Cross Section / Scale 1:150

0 1 2 3 4 5 [m]



Scale 1:400

0 5 10 15 [m]



Private:
1. Kitchen
2. Bedroom
3. Living Room
4. Patio / Balcony
5. Hallway
6. Closet / Storage
7. Bathroom

Shared:
A. Entrance Hall
B. Laundry
C. Elevator
D. Patio / Balcony
E. Lounge (see Figure 47)

Fig. 50. Ground floor of residential building Type A / Scale 1:150

0 1 2 3 4 5 [m]   N

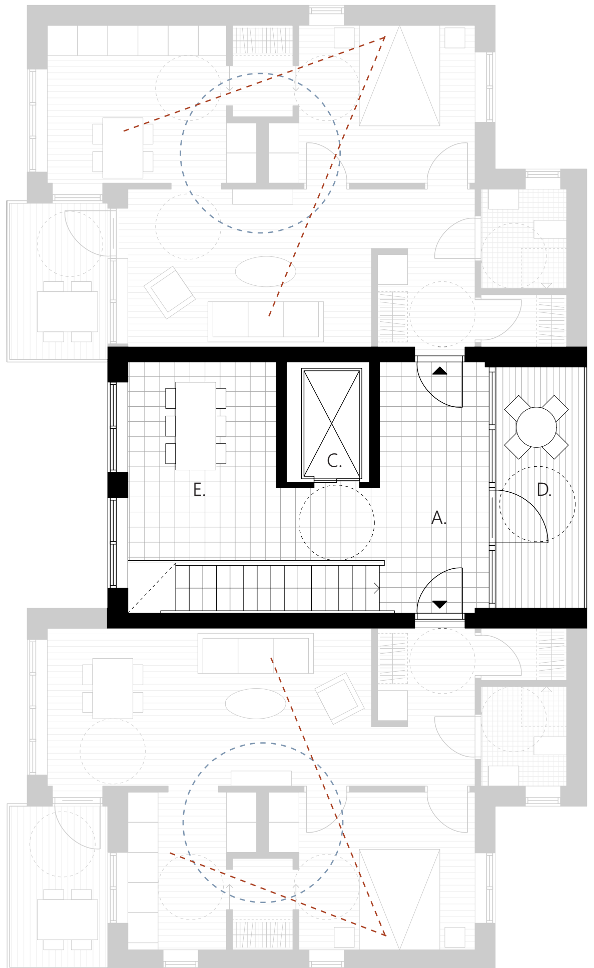
Residential Building Type A

The new two-storey residential buildings, both Type A and identical, are oriented in a longitudinal direction, with most of their windows towards east and west. The buildings include two apartments on each floor, one to the north and one to the south, and a common indoor space in the middle from where the apartments are entered. The main entrance to the building is from the east, but a smaller door also allows entrance from the west. The shared space includes a roofed patio and balcony towards east, a laundry room on the ground floor and an indoor dining area on the upper floor – to be used for neighbour get-togethers or when residents want to host larger groups of friends or family.

All apartments in this building are 55 m^2 and have a roofed balcony or patio of 6 m^2. The apartment layout is identical between the ground- and upper floor but differs slightly between the northern and southern apartments to make sure that all dwellings get the pleasant south-west orientation of their private balconies or patios. All apartments have two small walk-in closets, one adjacent to the hallway and one in between the kitchen and bedroom – the latter acting as a passage with sliding doors on each side. Thanks to this passage, a circular flow of movement is made possible – improving the spatial connection and flexible use of the apartment.

Since the apartments are catered to elderly, they are 100% accessible and designed to facilitate for potentially declining physical abilities. For instance, the bedroom is connected through site lines both kitchen and living room - allow for contact between someone who needs to spend time awake in bed and another person who might want to spend time in other rooms as well. This is illustrated in the plan below and further emphasized in the interior perspectives on the next page.

The apartments are big enough for two people but not too big for someone to live in alone, and with the shared indoor and outdoor spaces there is a chance to a rich social life even for those living alone.



Floorplan of the second floor in a residential building Type A, with illustrations indicating the circular flow and important sight lines between the bedroom and kitchen/living room.

Fig. 51. Second floor of residential building Type A / Scale 1:150

0 1 2 3 4 5 [m]   N

Fig. 52. The living room in one of the the ground floor apartments in houisng type A, with a view towards the orchard outside.

Fig. 53. Interior perspective from an apartment in houisng type A, showing the visual connection between the bedroom and other rooms.

Interior perspectives from one of the new apartments.

Fig. 54. View of the wildflower meadow and buildings B1 and B2, from the upper floor balcony in the eastern two-storey building.

Fig. 55. The western facade of one of the two-storey residential buildings, facing the new orchard.

Exterior perspectives showing examples of the patios and balconies of the new residential buildings.

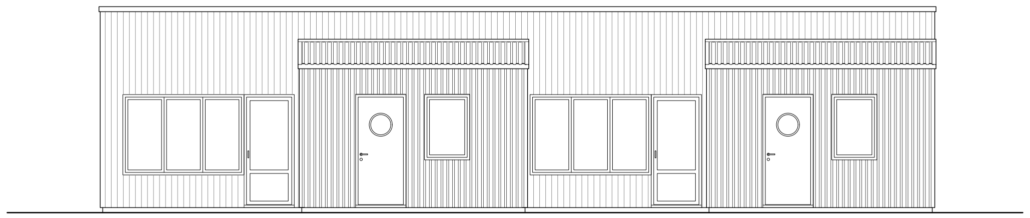


Fig. 56. Residential building Type B1 / South Elevation

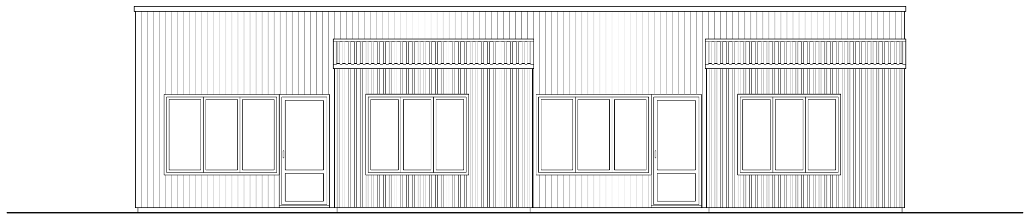


Fig. 57. Residential building Type B2 / South Elevation

Residential Buildings Type B1 & B2

The two one-storey buildings have individual names, Type B1 and B2, due to slight variations in floorplans and entrance situations, but they are generally quite like each other and include many features copied from residential building Type A. These buildings are kept at only one floor because of their longitudinal directions, to avoid blocking the sun from the rowhouse garden to the north or from the wildflower meadow in the middle of the new houses. This one-floor typology leaves way for more individualistic apartment layouts, with private ground floor entrances and private laundry equippment.

Both these buildings hold two apartments each, measuring 61 m^2 in building B1 and 55 m^2 in building B2. All apartments have generous private patios of ca 9 m^2 oriented towards the south. The B1-building also has its entrance towards the south, whereas B2 has northern-facing entrances, a design choice which gathers all the entrances towards the centre of the new houses which gives the neighbours a better chance see and talk to each other.

Alike the A-buildings, the apartments in B1 and B2 both have visual connections between the bedroom and kitchen, and a circular floor plan. The extra space in the B1-apartments also allows for a separate laundry room, while B2 has its laundry machine in the bathroom. Unlike all other apartments, tjose in B2 have no walk-in closet near the hallway, but they do have a nice sight line from the hallway out through the living room door.

Scale 1:150 0 1 2 3 4 5 [m]

DESIGN PROPOSAL / THE NEW RESIDENTIAL BUILDINGS

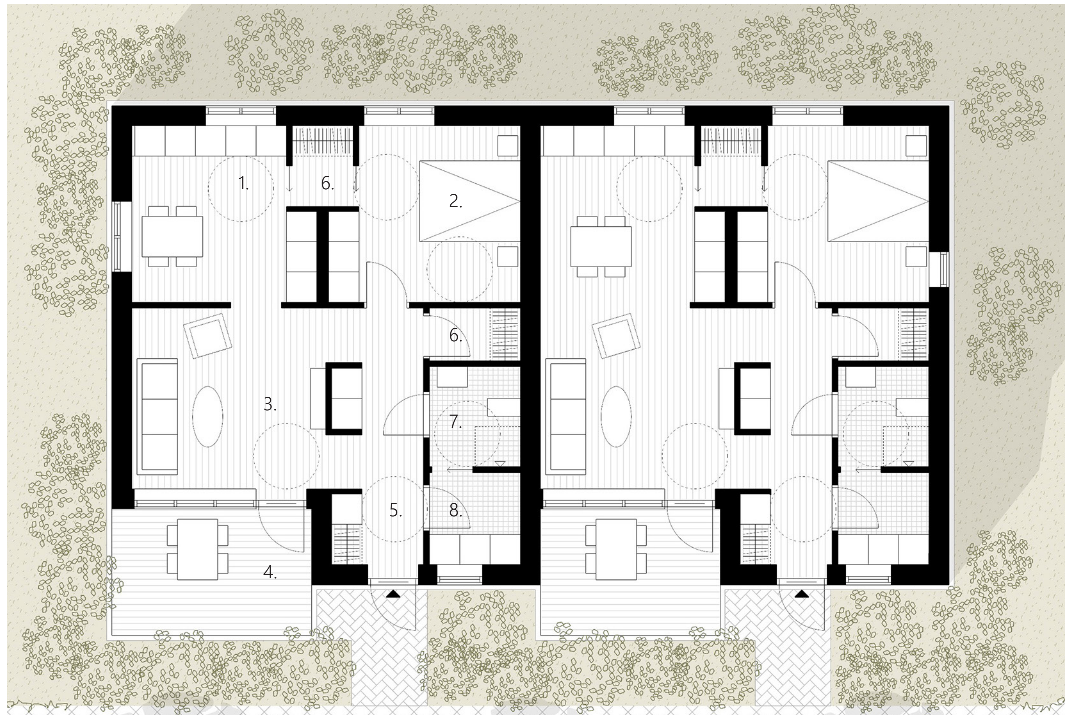


Fig. 58. Floor plan of residential building Type B1.

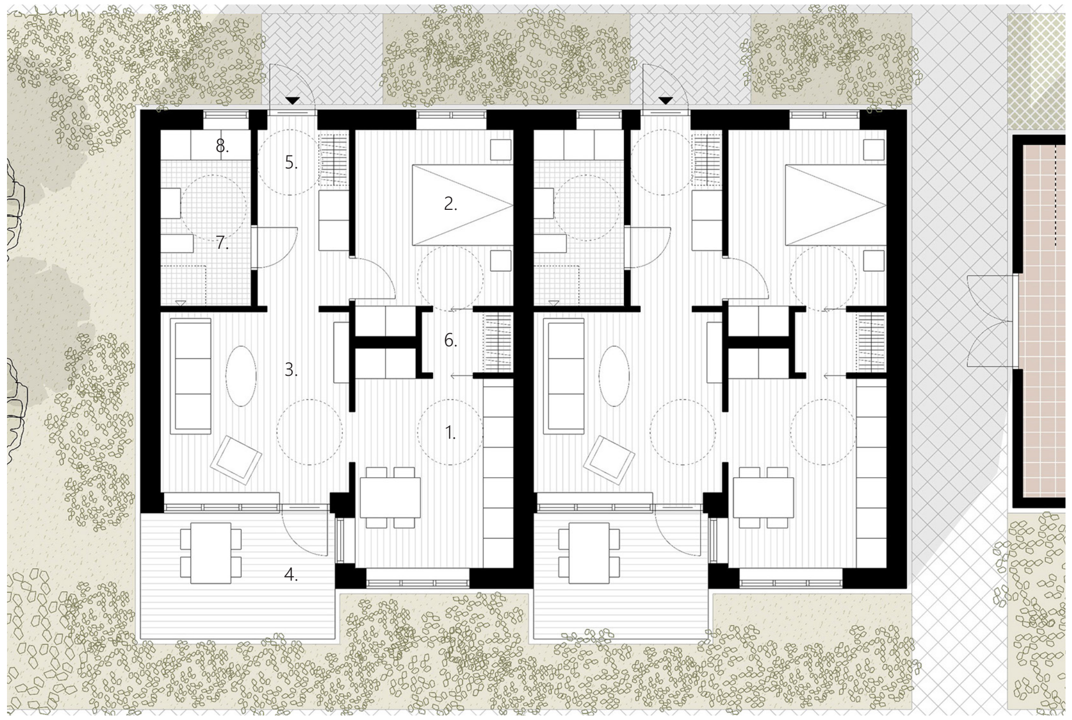


Fig. 59. Floor plan of residential building Type B2, with a glimpse of a bicycle storage to the right.

1. Kitchen
2. Bedroom
3. Living Room
4. Patio
5. Hallway
6. Closet / Storage
7. Bathroom
8. Laundry

Scale 1:150 0 1 2 3 4 5 [m] N

REUSED MATERIALS

Since some garages will have to be demolished in the transformation process, to leave way for new buildings and functions, their construction materials are made available for reuse. By including some of this material in the new buildings, the project can save in on new resources and some transportation, and at the same time incorporate a memory of what the site once was. One such material is the garage's corrugated roofing sheets, which are repurposed as façade cladding and roofing in some parts of the new buildings. The metal sheets are given a new red colour, inspired by the red tiled roofs which are characteristic for the neighbourhood.

The project further incorporates circular design through reusing the permeable tiles (pointed out in Figure 38) which were previously used in between the parking rows, as well as a relocation of the small maple trees which were already growing in the transformed parking area.

Fig. 60. All new residential buildings have bay windows cladded with corrugated metal sheets from the old garage roofs, here exemplified by the western facade of one of the two-storey residential buildings.

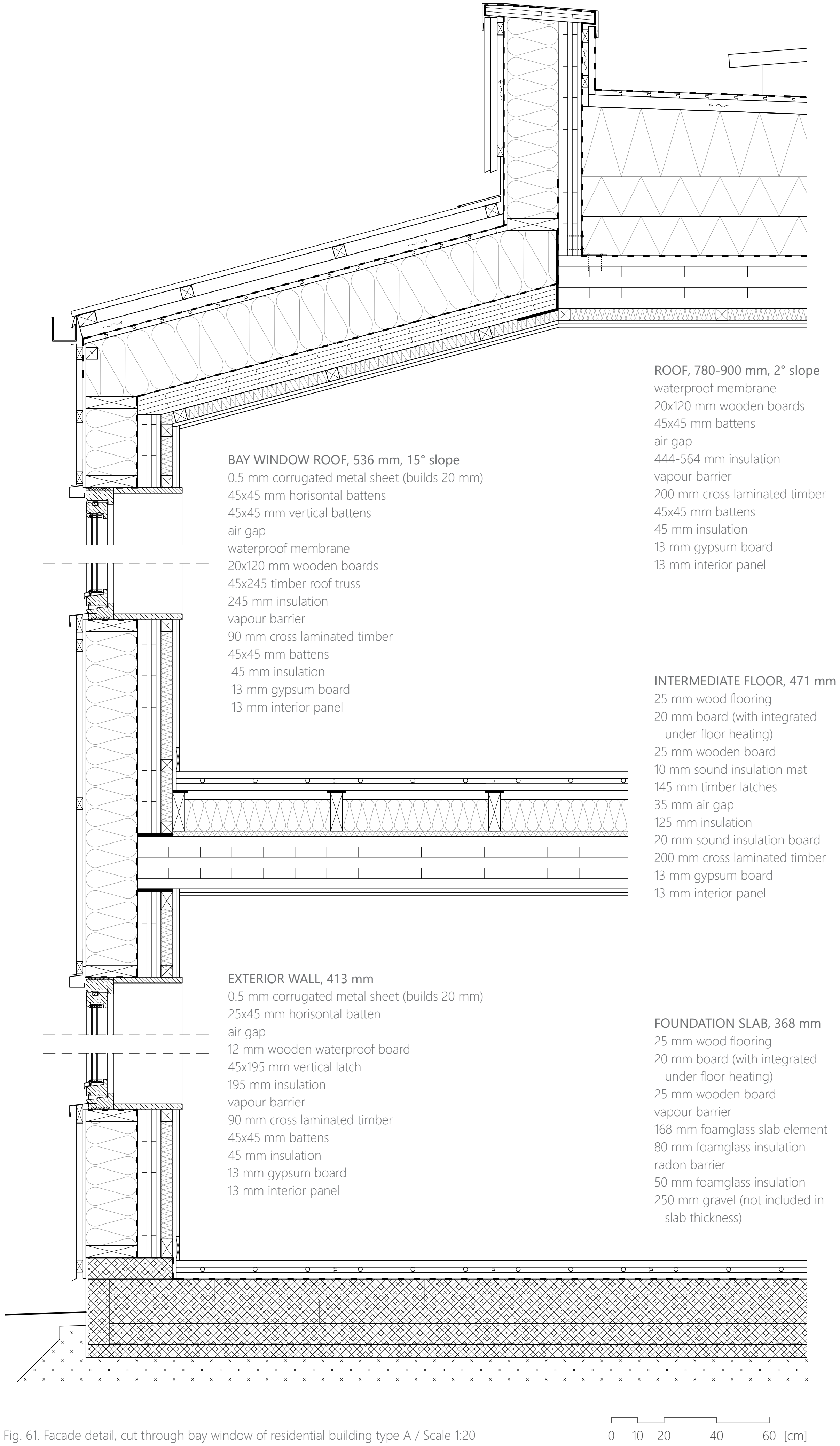


Fig. 61. Facade detail, cut through bay window of residential building type A / Scale 1:20


Fig. 62. The proposed new greenhouse, with design details inspired by the portals and planks from the old parking lot.

Besides the tangible reuse of old materials, the project also preserves and translates one of the small but significant design features of the original parking area – the wooden portals and fences between the parking lot and the pedestrian aisle. The specific pattern of the planks and the decorative detail by the ridge of the portal is copied to the new greenhouse, as a strategy to anchor the new buildings to the site and unite the old and new.


Fig. 63. Existing portal and plank between the parking lot and a pedestrian path.

A NEW SOCIAL NODE

The greenhouse becomes the centrepiece of a new social node at the heart of the neighbourhood, intended to provide value for both old and new residents and to cover up for the lack of defined common space in the neighbourhood. Together with adjacent functions such as different seating areas, shared garden beds, a shared bike workshop and an orchard, this becomes a vibrant addition to the neighbourhood - encouraging both spontaneous social interactions as well as more planned events and get-togethers. It could be a natural gathering point for the many elderly residents already living in the rowhouses and the new elderly residents, where weekly events could take place. It could also be a place for intergenerational exchanges, where seniors could teach gardening to the younger residents of the neighbourhood or the younger residents could help seniors fixing their bikes or rollator walkers in the workshop.

The greenhouse also provide opportunity for the new elderly residents to host larger parties of family and friends, without being restricted by the limited space in their private homes – which might otherwise be a big concern when downsizing from a single-family home to a small apartment.


Fig. 64. Interior perspective from the new greenhouse, currently used for a get-together by some of the neighbourhood's younger residents.

DESIGN PROPOSAL / A NEW SOCIAL NODE

Fig. 65. Exterior perspective of the greenhouse and shared garden beds in front - a new social node at the heart of the neighbourhood.

5. DISCUSSION

DISCUSSION / CONCLUSION

CONCLUSION

The aim of this thesis has been to explore if, and subsequently how, shared parking space in rowhouse neighbourhoods could be reevaluated and transformed to better respond to current day societal and environmental challenges, with a main emphasis on housing shortage and climate resilience but also involving issues such as urban sprawl, car dependency and biodiversity loss. The foundation of the work builds upon extensive literature reviews and contextual analysis, providing arguments for the feasibility of such a transformation and guidance regarding how it could be done. Following two pages conclude how the thesis responds to its aim and research questions.

Reduction of parking space

Thorough analysis of societal, contextual and geographical preconditions of the project site, together with research on parking regulations, mobility trends and urban transport development, provides arguments for taking 50% of Persikogatans parking space into consideration for the transformation project. This reduces Persikogatan's parking-to-housing ratio from two slots per household to one, which is still more than the general recommendation for new multi-family housing in this part of Gothenburg. The parking space reduction allows for an addition of 12 new housing units in the form of apartments, new bicycle storage and a bicycle workshop, a guest apartment and a shared greenhouse, as well as 1,800 m^2 additional green space and 2,100 m^2 of green roofs.

Target group

Out of the two target groups most affected by the housing shortage in Gothenburg, elderly seem to be the most suitable group for this specific site. Demographic research shows that the area already is home to many elderly, and it appears that many of them want to stay in the area for as long as they can. However, there is currently a lack of smaller housing options in the area and many elderly singles or couples therefore occupy larger homes than they might need. The new housing in Persikogatan can hopefully make an attractive alternative to some of them, and thus a moving chain could be induced – making the larger homes available to larger families and thereby allowing for a more efficient use of the existing housing stock.

Housing typology

To suit elderly singles or couples, and to make a complementing addition to the large single-family homes in the neighbourhood, two-room apartments felt like a suitable typology for the new housing. The apartments range between 55-61 m2, which is significantly smaller than the rest of the housing in the Brattahammar area, but still 100% accessible and with architectural qualities such as sightlines and circular flow in all apartments. Some of the apartments share functions such as laundry rooms and social spaces, while others are more individualistic with their own laundry equipment and private. These variations in design are meant to make the new housing appeal to a wider audience, with different preferences.

While aiming for the size and typology to be complementary to the existing, the aim of the aesthetical design was to create a dialogue between old and new. By picking up on features such as building height, proportions and characteristic angles, the new buildings adapt to the old rowhouses while still having their own identity. Instead of the 1.5-floor typology, characteristic for the 1970's, the new residential buildings consist of either one or two floors, depending on their placement – with careful consideration to the sun conditions of both new and existing dwellings and gardens.

Complementary functions

Except for the additional housing, the transformation project complements the neighbourhood with currently lacking functions such as safe bike storage, a guest apartment, carsharing and recycling rooms – all of which to be used by both new and old residents. Moreover, a common greenhouse and a shared garden area are proposed at the heart of the neighbourhood, forming a new social node which could provide opportunities for social interactions and spontaneous meetings between neighbours. Additional intangible values, such as the feeling of safety and well-being, could also be improved by the increased presence of elderly adults and by the increased amount of greenery.

To the neighbourhood's current residents, the reduction of parking space might at first seem upsetting and unfair. However, the new practical functions and intangible values brought by the transformation could hopefully make up for the reduction - at least in the long run after the presumed initial protests have faded.

Climate resilience

As for the climate resilience, findings from the research point to the many negative effects of paved and impermeable surfaces. However, they also point to the relatively straightforward solution of improving climate resilience by replacing pavement with green and permeable options. Going more in depth in the matter, low maintenance greenery such as wildflower meadows is more beneficial than traditional lawns, and trees and green roofs can also be very beneficial. These findings motivate the landscaping of the transformation proposal, where as much as possible of the previously paved area is replaced by green or permeable elements, such as grass, flowerbeds and a wildflower meadow. The transformation also includes a relocation of existing trees from the parking lots and the addition of anew orchard. Moreover, all garages that are not removed in the process are suggested to be equipped with new green roofs.

Reuse of garages

Four of the neighbourhood's garage buildings will be demolished in the transformation project, to make room for new buildings, however, their corrugated metal roofs provide great opportunity for circular design and have been used as a significant design element in the new residential buildings – both as roofs and as façade cladding. By simple measures such as repainting and cutting, the corrugated metal sheets can be reused as intact products – a strategy at the top of the zero-waste hierarchy. Most of the remaining garages keep their original function as parking space, but three slots each in the northern and southern parking areas are transformed into recycling rooms. This change of use is intended to require minimum adjustments to the garages, with the perimeter of the building kept intact and the only addition being a dividing wall between the remaining garages and the new recycling room.

REFLECTION

I started out this thesis project with a desire to explore the possibilities of reusing a kind of urban space that haven't previously been exposed to transformation nor questioned in its relevance. By providing extensive background research supporting this kind of transformation, and by providing an architectural example of how this could be done, the thesis contributes with new insights to the field of sustainable densification. The thesis also engage in the larger discussion on how urban space could be re-evaluated and better utilised with consideration to modern-day, and possibly future, societal and ecological preconditions. Moreover, it provides practical examples of circular design, as well as ideas of how traditional 1970's architecture could be complemented with new additions.

Even though the thesis results in a site-specific design proposal, many of its features and arguments are equally relevant and applicable in other situations as well. There is plenty of rowhouse neighbourhoods with similar preconditions as Persikogatan, and many other under-utilised paved areas, that could be subject to similar transformations.

The idea behind the relatively small scale of this densification project derives both from a desire to adapt to the scale of the already existing buildings and to the available space, but also from economic and logistical reasons. Smaller buildings normally require less investment and material and can be done a few units at a time, to not disturb the area too much and to let the development happen at a more human and organic pace than a larger scale project. This would allow for continuous evaluation of how much new housing that should be introduced, what qualities might need to be added and how well the concept works.

Another argument for gradual implementation is to allow for the neighbourhood to get used to the idea of the project. Although the research clearly motivates a reduction in parking space in the given context, the neighbourhood's current residents might not yet be ready for such a transformation and the implementation might be met with resistance. A gradual transition towards less and less parking space, simultaneous to a process of implementing and encouraging more sustainable mobility options and having an open dialogue with the residents about how the project could be beneficial to them, would probably be the most feasible strategy.

The process

While the theoretical research and gathering of arguments for the project progressed smoothly, the architectural implementation turned out to be more complex. When going into the design phase and more thorough spatial investigations, the project site proved to be smaller than I first expected and the visualisation of a "small village" within the neighbourhood wasn't applicable. Thus, finding a spatial layout fitting both a reasonable amount of new housing units, as well as the desired common functions and green space, became the most challenging phase of the project. At this point, the initial two target groups were cut back to one, some of the intended common functions were discarded and the number of expected housing units was reduced. These decisions, together with dozens of layout iterations through model explorations and sketches, eventually led up to the spatial disposition of the final design proposal. After having settled on this rough site plan, the rest of the design project continued in a more confident manner and even though many new design challenges came up along the way, the overall feeling was that the project was developing in a feasible direction.

Another big challenge turned out to be the exterior design of the new residential buildings – to find a shape and design that could accommodate the apartment typology without disrupting the overall scale of the neighbourhood. As with all densification projects, the new buildings should be respectful to what is already there and get into a dialogue with the existing buildings, while still having their own identity and being a clear addition of their time. Many different volumes, building heights and designs were tested before the final breakthrough came with a hand drawn interpretation of the rowhouse facades. By analysing the components and proportions in this sketch, and interpreting them in a new composition, a tentative new façade was sketched out, which was then iterated into the final proposal. Interpretations through hand sketches would probably have been a good tool to apply even earlier in the process, since the sketching becomes yet another means of understanding the already built and thereby being able to figure out what a good complement could look like.

Further development of the thesis

As mentioned in previous chapters, a possible extension of the thesis project could be to include more neighbourhoods in the transformation. Even though depaving is beneficial already on this small scale, the practice could entail huge environmental benefits if even more parking lots were to be transformed – which would allow the new patches of greenery could collaborate as a network of climate resilient green space. Similar logics apply to the project's impact on housing shortage mitigation; adding a few additional housing units in Persikogatan will not make a significant contribution but if all rowhouse neighbourhoods with similar preconditions and parking-to-housing ratio were to be transformed through similar projects, the result would entail plenty of new housing units in areas already well integrated into the urban fabric.

Another development of the project could be to incorporate more of the reusable materials surveyed on site, and make sure that the design of the new buildings would be adapted to the dimensions of the available material. For instance, the wooden façade cladding from the demolished garages comes in rather short lengths and a limited quantity. By iterating the design of new buildings and giving them a more patchwork-like façade, allowing different expressions in different patches, it would be easier to make use of circular material from either the site or elsewhere.

REFERENCES

LITERATURE

2030-sekretariatet. (2023, October 31). *Antal sålda cyklar och elcyklar*. 2030 Miljöbarometern. https://2030.miljobarometern.se/nationella-indikatorer/bilen/antal-salda-cyklar-och-elcyklar-b1l/

Anderson, A. (2022). *E-Bikes subsidies reduce reliance on cars and cut emissions, but at what cost?* Swedish House of Finance, Stockholm School of Economics. https://www.hhs.se/en/houseoffinance/research/featured-topics/2022/e-bikes-subsidies-reduce-reliance-on-cars-and-cut-emissions-but-at-what-cost/

Andersson, K., Boyer, R., & Schnurr, M. (2020). *Carsharing. Overview and Perspectives of Market, Customers, and Policies*. [Deliverable for SESMA (WP 4)]. RISE Research Institutes of Sweden.

Antoniadis, V., Shaheen, S. M., Stärk, H.-J., Wennrich, R., Levizou, E., Merbach, I., & Rinklebe, J. (2021). *Phytoremediation potential of twelve wild plant species for toxic elements in a contaminated soil.* Environment International, 146, 106233. https://doi.org/10.1016/j.envint.2020.106233

Baraniuk, C. (2024, February 23). *The cities stripping out concrete for earth and plants*. BBC. https://www.bbc.com/future/article/20240222-depaving-the-cities-replacing-concrete-with-earth-and-plants

Big See. (2020). Baugruppe B.R.O.T., Pressbaum. *BIG SEE*. https://bigsee.eu/baugruppe-b-r-o-t/

Boverket. (2017). *Urban density done right: Ideas on Densification of Cities and Other Communities*. The Swedish National Board of Housing, Building and Planning.

Boverket. (2019, May 27). *Urbana träd och ekosystemtjänster.* Boverket. https://www.boverket.se/sv/PBL-kunskapsbanken/teman/ekosystemtjanster/praktiken/mangfald/urbana_trad/

Boverket. (2020, June 3). *Under miljonprogrammet byggdes en miljon bostäder*. Boverket. https://www.boverket.se/sv/samhallsplanering/stadsutveckling/miljonprogrammet/

Boverket. (2023, August 21). *Behov av bostadsbyggande 2023-2030*. Boverket. https://www.boverket.se/sv/samhallsplanering/bostadsmarknad/bostadsmarknaden/behov-av-bostadsbyggande/behov-2023/

B.R.O.T.-Pressbaum. (n.d.). *Gemeinschaft B.R.O.T.-Pressbaum*. Gemeinsam Wohnen B.R.O.T. Pressbaum. Retrieved 26 February 2025, from https://www.brot-pressbaum.at/info-english/

B.R.O.T.-Pressbaum. (2025). *BROT-Pressbaum community*. Gemeinsam Wohnen B.R.O.T. Pressbaum. https://www.brot-pressbaum.at/

Cullberg, M., Montin, S., & Tahvlizadeh, N. (2014). *Urban Challenges, Policy and Action in Gothenburg: GAPS project baseline study* (No. 5). Mistra Urban Futures.

Depave. (2019). *Powell Butte Elementary.* Depave. https://www.depave.org/projects/powell-butte-elementary

Ellen MacArthur Foundation. (n.d.). *What is a circular economy?* Ellen MacArthur Foundation. Retrieved 28 April 2025, from https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

European Commission: Directorate-General for Research and Innovation. (2015). *Towards an EU research and innovation policy agenda for nature-based solutions and re-naturing cities :final report of the Horizon 2020 expert group on 'Nature based solutions and re naturing cities': (Full version).* Publications Office. https://data.europa.eu/doi/10.2777/479582

REFERENCES

Fastighetsägarna, Hyresgästföreningen, & Naturskyddsföreningen. (2020). *Framtiden för parkering och nya bostäder: Analyser av bostadsmarknad, markanvändning och miljökonsekvenser.* https://www.fastighetsagarna.se/aktuellt/rapporter/stockholms-rapporter/framtiden-for-parkering-och-nya-bostader/

Fastighetskontoret. (2022). *Lägesrapport 2022: Bostadsförsörjning*. https://goteborg.se/wps/portal/start/bygga-bo-och-leva-hallbart/bostader-och-lokaler/bostadsforsorjning

Framtiden, Göteborgs Stad. (2021, February 25). *Bostad2021: Start för uthyrning i Poseidons nya ekologiska kvarter på Mandolingatan. Framtiden*. https://framtiden.se/blog/2021/02/25/bostad2021-start-for-uthyrning-i-poseidons-nya-ekologiska-kvarter-pa-mandolingatan/

Göteborgs Stad. (2023). BoStad2021. Göteborg 2023. https://goteborg2023.com/en/jubileumsprojekt/bostad2021/

Hanemaaijer, A., Hekkert, M., Potting, J., & Worrell, E. (2017, January 27). *Circular Economy: Measuring innovation in product chains. PBL Netherlands Environmental Assessment Agency.* https://www.pbl.nl/en/publications/circular-economy-measuring-innovation-in-product-chains

KINTO. (2024). *KINTO Share—Boka bil*. https://www.kinto-mobility.se/kinto-share/boka-bil/

Koncernkontoret. (2024). *Uppföljning 2023: Regionalt trafikförsörjningsprogram i Västra Götaland* (VGR Analys No. 4). Västra Götalandsregionen. https://mellanarkiv-offentlig.vgregion.se/alfresco/s/archive/stream/public/v1/source/available/sofia/ikn12269-861277490-28/surrogate/Uppf%C3%B6ljning%20TFP%202023_klar.pdf

Länsstyrelsen. (n.d.). *Välen*. Länsstyrelsen Västra Götaland. Retrieved 1 April 2025, from https://www.lansstyrelsen.se/vastra-gotaland/besoksmal/naturreservat/valen.html

Lantmäteriet. (n.d.). *Vem Äger Fastigheten?* [Computer software]. https://www.lantmateriet.se/sv/fastighet-och-mark/information-om-fastigheter/vem-ager-fastigheten/

Larsson, A. (2016, December 29). *Trenden: Bostäder på p-platser* [Newspaper]. Göteborgs-Posten. https://www.gp.se/nyheter/goteborg/trenden-bostader-pa-p-platser.d9f8b34c-d1c3-4246-84fa-44b27de368bf

Marshall, C. A. M., Wilkinson, M. T., Hadfield, P. M., Rogers, S. M., Shanklin, J. D., Eversham, B. C., Healey, R., Kranse, O. P., Preston, C. D., Coghill, S. J., McGonigle, K. L., Moggridge, G. D., Pilbeam, P. G., Marza, A. C., Szigecsan, D., Mitchell, J., Hicks, M. A., Wallis, S. M., Xu, Z., … Eves-van den Akker, S. (2023). *Urban wildflower meadow planting for biodiversity, climate and society: An evaluation at King's College, Cambridge*. Ecological Solutions and Evidence, 2023(4), 18. https://doi.org/10.1002/2688-8319.12243

Miljöförvaltningen. (n.d.). *Asfalt och tjärasfalt*. Göteborgs stad. Retrieved 3 March 2025, from https://goteborg.se/wps/portal?uri=gbglnk%3a201992582914200

Nonconform Architects. (2018). *Gemeinschaftliches Wohnen B.R.O.T Pressbaum*. Nonconform. https://www.nonconform.at/architektur/baugruppenprojekt-b-r-o-t-pressbaum/

Pomponi, F., & Moncaster, A. (2017). *Circular economy for the built environment: A research framework*. Journal of Cleaner Production, 143, 710–718. https://doi.org/10.1016/j.jclepro.2016.12.055

Poseidon. (2024). *Mandolingatan, kvarter G*. Poseidon - Nya Bostäder. https://poseidon.goteborg.se/nya-bostader/mandolingatan-kvarter-g/

Sjöbacken Association. (n.d.). *Sjöbacken.* Sjöbacken i Ur Och Skur. Retrieved 1 April 2025, from https://sjobacken-nu.webnode.se/

SLA Design Studio. (2022, November 28). *Tingbjerg*. SLA. https://www.sla.dk/cases/tingbjerg/

Stadsbyggnadskontoret. (2018). *Riktlinjer för mobilitet och parkering i Göteborgs Stad: Hantering av mobilitets- och parkeringsfrågor i detaljplan och bygglov* (Nos. 16–0469). Göteborgs Stad. https://goteborg.se/wps/portal/start/goteborg-vaxer/sa-arbetar-staden-med-stadsutveckling/sa-utvecklas-resande-och-infrastruktur/parkeringspolicy-och-parkeringstal

Stadsbyggnadskontoret. (2021). *Anvisningar till 'Riktlinjer för mobilitet och parkering i Göteborgs Stad'* (Nos. 16–0469). Göteborgs Stad. https://goteborg.se/wps/wcm/connect/fbf6ef6f-fc85-4b65-a6a2-832e72232afb/Anvisningar+till+riktlinjer+f%C3%B6r+-mobilitet+och+parkering+i+G%C3%B6teborgs+Stad+version+1.2.pdf?MOD=AJPERES

Stadsbyggnadskontoret. (2022, May 19). *Översiktsplan för Göteborg*. Göteborgs Stad - Översiktsplan. https://oversiktsplan.goteborg.se/

Stadsledningskontoret. (2021). *Områdesindelning*. Göteborgs Stad. https://goteborg.se/wps/portal?uri=gbglnk%3a201883111038743

Stadsledningskontoret. (2023, January 26). *Göteborgs Stads program för bostadsförsörjning 2021–2026*. Göteborgs Stad. https://goteborg.se/wps/portal/start/bygga-bo-och-leva-hallbart/bostader-och-lokaler/bostadsforsorjning

Stadsledningskontoret. (2024). *Göteborgsbladet—Sydväst.* Göteborgs Stad - Statistik och Analys. https://goteborg.se/wps/portal?uri=gbglnk%3a20188311275396

Sveahus. (2019). *Äppelträdgården*. Sveahus. https://www.sveahus.se/sv/referenser/appeltradgarden

Sveriges Allmännytta. (2020, March 10). *5 600 träd kartlagda i Göteborg*. Sveriges Allmännytta. https://www.sverigesallmannytta.se/5-600-trad-kartlagda-i-goteborg/

Teerlinck, J., Wittemans, K., Beele, E., Dewaelheyns, V., Steen, T., & Somers, B. (2024). *What can Nature-based Solutions in domestic gardens contribute to climate change adaption in Western-Europe? A systematic review*. Frontiers in Environmental Science, 12, 1430739. https://doi.org/10.3389/fenvs.2024.1430739

Tozluoğlu, Ç., Liao, Y., & Sprei, F. (2024). *Potential of e-bikes to replace passenger car trips and reduce greenhouse gas emissions.* Journal of Cycling and Micromobility Research, 2, 100043. https://doi.org/10.1016/j.jcmr.2024.100043

UK Government. (n.d.). *De-pave your garden*. Mayor of London. https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/parks-green-spaces-and-biodiversity/make-our-city-greener-healthier-and-wilder/de-pave-your-garden

United Nations. (2015). *The 17 Goals*. United Nations. https://sdgs.un.org/goals

United Nations Environment Programme, Yale Center for Ecosystems + Architecture. (2023). *Building Materials and the Climate: Constructing a New Future*. United Nations Environment Programme. https://wedocs.unep.org/xmlui/handle/20.500.11822/43293

Västra Götalandsregionen. (2024, March 28). *Målbild Koll2035 för storstadstrafiken i Göteborg. Västra Götalandsregionen*. https://www.vgregion.se/kollektivtrafik/sa-styrs-kollektivtrafiken/trafikforsorjningsprogrammet/kollektivtrafikplaner-for-stadstrafiken/goteborg-molndal-partille-stadstrafik/

Västtrafik. (n.d.). *Nästa: Framtiden*. Västtrafik. Retrieved 5 March 2025, from https://www.vasttrafik.se/info/nasta-framtiden/

Volvo On Demand. (2024). *On Demand—Stationer*. Volvo On Demand. https://www.volvocars.com/se/on-demand/stationer

Wexsus. (2019). *SDG Impact Assessment Tool*. SDG Impact Assesment Tool. https://sdgimpactassessmenttool.org/en-gb

White Arkitekter. (n.d.). *Äppelträdgården Estate—Diverse family housing*. White Arkitekter. Retrieved 28 March 2025, from https://whitearkitekter.com/project/appeltradgarden-estate/

GRAPHIC MATERIAL

All figures and drawings not included in the list below are works of the author.

The visualisations of the design proposal are based on a Rhino model, rendered in Twinmotion and post-processed in Photoshop. Furniture, vegetation and people have been added from Twinmotion's asset library, no AI was used in the production.

Figure 2: Wexsus. (2025). *SDG Impact Assessment* [Diagram]. https://sdgimpactassessmenttool.org/en-gb

Figure 3: Interpretation of a diagram by PBL - the Netherlands Environmental Assessment Agency: PBL. (2017). *Circularity strategies within the production chain, in order of priority* [Diagram]. https://www.pbl.nl/en/publications/circular-economy-measuring-innovation-in-product-chains

Figure 0, 5, 27: Google Earth Pro. (2022). A*erial view of Persikogatan*, Gothenburg, Sweden [Photograph].

Figure 6, 7: Depave. (2019). *Powell Butte Elementary*. Depave. https://www.depave.org/projects/powell-butte-elementary

Figure 8: Google Earth Pro. (2014). *Aerial View of Frölunda Torg* [Photograph].

Figure 9: Lantmäteriet. (2024a). *Aerial View of Frölunda Torg* [Photograph]. https://minkarta.lantmateriet.se/

Figure 10: Göteborgs Stad. (2018). *Järnbrott—Bostäder vid Mandolingatan (BoStad2021)*. Göteborgs Stad - Plan- och byggprojekt. https://goteborg.se/wps/portal?uri=gbglnk%3agbg.page.bb-7386fd-1152-47cb-9da4-d06bd7780a77&projektid=BN0441/14

Figure 11: Tornstaden. (2019). *Mandolingatan—V Frölunda, Göteborg*. Tornstaden. https://tornstaden.se/projekt/mandolingatan-v-frolunda-goteborg/

Figure 12, 14: Sanner, K., & Wretling, H. (2011). *Äppelträdgården*, [Photograph]. https://whitearkitekter.com/se/projekt/appeltradgarden/

Figure 13: Länsförsäkringar. (2024). *Tvärflöjtsgatan 4*. Länsförsäkringar Fastighetsförmedling. https://www.lansfast.se/till-salu/villa/vastra-gotaland/goteborg/vastra-frolunda/tvarflojtsgatan-4/cmvilla5gobsqb00e4sl5jc/

Figure 15, 16, 18, 19: Vandkunsten Architects. (2022). *Interpreting and consolidating architectural heritage*. Vandkunsten Architects. https://vandkunsten.com/en/projects/interpreting-and-consolidating-architectural-heritage

Figure 17: SLA Design Studio. (2022, November 28). *Tingbjerg*. SLA. https://www.sla.dk/cases/tingbjerg/

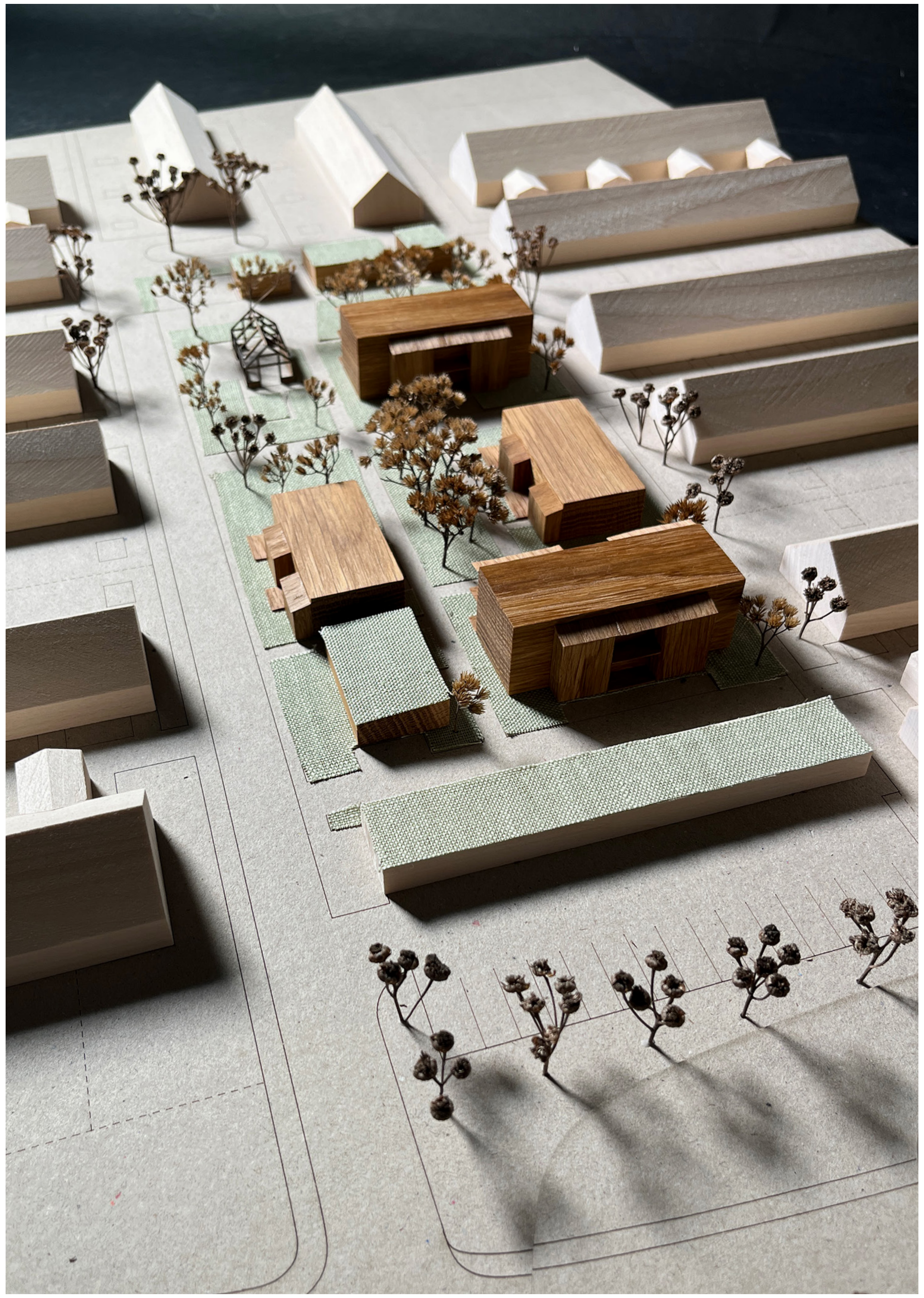
Figure 20: Hörbst, K. (2018a). *Gemeinschaftliches Wohnen B.R.O.T Pressbaum* [Photograph]. https://www.nonconform.at/architektur/baugruppenprojekt-b-r-o-t-pressbaum/

Figure 21, 22: Nonconform Architects. (2018a). *Community Living BROT Pressbaum* [Architectural Plans]. https://www.nonconform.at/architektur/baugruppenprojekt-b-r-o-t-pressbaum/

Figure 23: Hörbst, K. (2018b). *Wohnprojekt B.R.O.T.* [Photograph]. https://architektur.hoerbst.com/projekt/wohnprojekt-b-r-o-t/

Figure 27, 30, 31, 37: CFL Architect Group, acronym for Celander, Forser & Lindgren. (1974). *Bratthammar Radhusområde Etapp II* [Architectural drawings]. Accessed via Stadsbyggnadsförvaltningen Göteborgs Stad, Beställ allmänna handlingar från stadsbyggnadsförvaltningen. Retrieved 1 April 2025, from https://goteborg.se/wps/portal?uri=gbglnk%3a20130304-131250

APPENDIX



Model of the central parking lot, showing the new buildings and new greenery surrounded by the older rowhouses. Built in scale 1:250.

Main model materials: linden (representing old buildings), oak (representing new buildings), linen fabric (representing new greenery).

Parking: expired

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