Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Department of Urban and Rural Delvelopment

BIODIVERCITY

URBAN ECOLOGICAL DESIGN

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MASTER'S THESIS 30 HEC
LANDSCAPE ARCHITECTURE PROGRAMME
ULTUNA, UPPSALA
2016

Swedish University of Agricultural Sciences
Faculty of Natural Resources and Agricultural Sciences
Department of Urban and Rural Development, Division of Landscape Architecture, Uppsala
Master's thesis for the Landscape Architecture programme

EX0504 Independent project in Landscape Architecture, 30 HEC
Level: Advanced A2E

Titel på svenska: Biologisk mångfald i staden: urban ekologisk gestaltning
Title in English: BiodiverCity: Urban Ecological Design

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Cover Photo: Tobias Pravitz

Original format: A4

Keywords: Urban Biodiversity, Alternative Lawns, Green Roofs, Green Walls, Ecological Design, Green Infrastructure, Urban Development

Online publication of this work: http://stud.epsilon.slu.se

ABSTRACT

The world as we know it is changing. The balance between rural and urban land is in many places on earth facing a dramatic shift. More and more people move from contryside to city. Today about 50% of the world's population live in urban environments. In about 30 years 12% more people than today will live in citylike constellations. In Sweden, Stockholm will grow by about 40% by 2030. This rapid development stresses the subject of building more and better. Today, in Stockholm, new buildings are raised mostly in-between other older buildings, densification being the concept. This way of planning cities often lead to a decrease of greenspace within the city borders.

In urban areas we are depending on green infrastructure to clean our air, filtrate our water, handle stormwater, provide recreational spaces and provide pollinators with nectar so that they can survive to pollinate our crops. These are all examples of ecosystem services and in order for these to be carried out, a high degree of biodiversity is crucial. People who live in cities with high biodiversity are both healthier and lead more meaningful lives than people in cities with a low degree of biodiversity. Thus, design of urban greenspace areas that doesn't provide ecological systems with anything else but coincidental benefits, can no longer be acceptable. Use of alternative approaches to landscape architecture should instead be implemented. Designing with and for ecosystems will thereby provide more sustainable urban structures that are better equipped for unforeseen changes in the environment and better suited for people to live in.

This master thesis focuses on the "*biodiversity trio*": Alternative lawns, Green roofs and Green walls. The thesis also includes remnant vegetation but does not focus on other green infrastructure elements such as shrubberies, marchlands or ponds which also can be valuable in ecological design.

The aim with this work has been to investigate the *biodiversity trio* and implement its elements into a concrete ecological design programme for a new housing area in Gröndal, Stockholm.

The thesis begins with a literature study, which includes a historic review on housing areas in Stockholm, a discription of Ecological design and the *biodiversity trio*, mostly from the perspective of ecosystem services. Interviews with relevant people from the branch follows the literature study and were conducted in order to get a broader perspective on the different subjects with information from people working mainly in a Swedish context.

The design programme implements and explains design solutions for alternative lawns, green roofs and green walls on a neighbourhood scale and provide both rich aesthetical as well as the more obvious high ecological values.

SAMMANFATTNING

FORSKNINGSFRÅGA

Hur kan ett ekologiskt gestaltningsprogram för ett nytt svenskt urbant flerfamiljshusområde utformas, med fokus på den "Biologiska mångfalstrion" bestående av: alternativa gräsytor, gröna tak och gröna väggar?

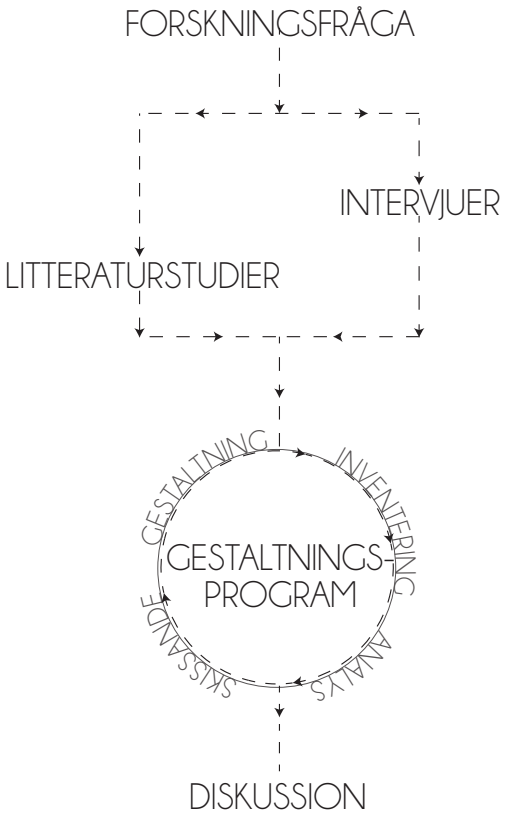
SYFTE

Syftet med detta masterarbete har varit att undersöka elementen **alternativa gräsytor, gröna tak och gröna väggar** ur ett landskaps-arkitekoniskt perspektiv samt implementera dessa i ett gestaltningsprogram för ett nytt bostadsområde i Stockholm.

DEL ETT: Undersöka byggstenarna i *trion för biologisk mångfald:* **Alternativa Gräsytor, Gröna Tak och Gröna Väggar**
Litteraturstudie, Intervjuer

DEL TVÅ: Använda trion för biologisk mångfald för att göra ett **gestaltningsprogram** för Bryggvägen, Gröndal
Gestaltningsprogram

ARBETETS STRUKTUR



Figur över metoderna som använts samt över hur arbetet har fortlöpt.

Figuren intill visar hur arbetet har förlupit. För att ta reda på svaret till forskningsfrågan använde jag mig av litteraturstudier och intervjuer med relevanta källor. Kunskaperna härifrån tog jag med mig när jag gick vidare till arbetet med inventeringar, analyser, skisser och gestaltning.

LITTERATURSTUDIER

HISTORISK BAKGRUND BOSTADSGÅRDAR

Den historiska bakgrunden visar hur bostadsgårdar i Stockholm har utvecklats under de senaste 150 åren. Från att ha varit en tät stad med trånga, osanitära gårdar till att bli en stad där planerarna allt mer bejakade luftinströmning, sol, ljus och natur under framförallt funktionalismen och sen på åttiotalet började förtäta befintlig mark inom staden och skapa mer slutna gårdar som idag ibland har fått en ekologisk prägel med exempelvis dagvattenhantering och gröna tak.

De tidsperioder som beskrivs är: **Stenstaden** (1850-1930), **Offentliga Parker** (1866-1900), **Trädgårdsstaden** 1900-1920, **Funktionalismen** (1930-

SAMMANFATTNING

1980), **Folkhemsbygget** (1940-1960), **Miljonprogrammet** (1965-1974), **Postmodernism och Förtätning** (1980- pågående) samt **Modern Ekologisk Planering** (2000- pågående).

ALTERNATIVA GRÄSYTOR

De koncept som tas upp här är **Örtmattor, Normaläng, Målerisk äng, Torräng, Skuggäng** och **Fuktäng**. Dessa växtsamhällen utgör alternativ till och innehar liknande funktioner som gräsmattor. De går att gå på (dock i något mindre utsträckning jämfört med gräsmattor) är vackra att se på men bidrar i mycket högre grad till biologisk mångfald än en gräsmatta på grund av deras respektive artrikedom samt förmåga att blomma och därmed förse insekter med nektar. De är också mer intressanta att se på för människor i och med deras ymniga blomning.

GRÖNA TAK

Gröna tak kan delas in i två kategorier – extensiva tak och intensiva tak. Extensiva tak har låg skötsel, ingen tilläggsbevattning och ingen näringstillförsel; ett substrat vars tjocklek är 20 cm djupt eller mindre och kan hålla örtartade växter och gräs. Intensiva tak har hög skötsel, regelbunden bevattning och näringstillförsel och kan hålla alla växtslag, från örter till träd. Dessa utgörs av substrat med ett djup över 20 cm.

GRÖNA VÄGGAR

Gröna väggar kan delas in i kategorierna Gröna fasader och Living Wall Systems. Gröna fasader är klättrande växter som oftast är rotade i marken och antingen växer direkt på fasaden eller på ett system av vajrar, eller liknande. Living Wall Systems är system där växterna är rotade i substrat i planteringslådor monterade i väggen eller i substrat som hålls uppe av en vertikal duk. De tillgängliga systemen kräver i dagsläget bevattnings- och näringstillförsel.

ANDRA GESTALTNINGSELEMENT

I detta arbete använder jag mig i huvudsak av tre gestaltningselement: Alternativa gräsytor, gröna tak och gröna väggar. Givetvis finns många andra landskapsarkitektoniska element att använda sig av varav många med framgång kan användas i ekologiska gestaltningssyften. Exempel på detta är dagvattendammar, våtmarker, faunadepåer, brynzoner och buskvegetation.

Anledningen till fokuset på de tre valda elementen är att dessa är relativt obeprövade i urban landskapsarkitektur. De finns på många platser, men ofta i en slentrianmässig utformning som inte alltid är till fördel för biologisk mångfald. Därför är tanken med detta arbete att utforska dessa tre element i syfte att öka den biologiska mångfalden och artrikedomen.

INTERVJUER

I arbetet intervjuade jag fyra landskapsarkitekter, en landskapsingenjör, en parkingenjör och en ekolog. Ämnena var ekologisk gestaltning, gräsmattor, alternativ till gräsmattor samt gröna väggar och tak.

Kunskaperna om ämnena varierade. Vissa var väl insatta i frågor rörande ekologisk gestaltning och gröna väggar och tak medan andra knappt hade rört vid frågorna mer än att de hade hört talas om begreppen på ett övergripande plan.

SAMMANFATTNING

Det som var intressant var att flera lyfte problematiken med att få ekologiskt värdefulla miljöer att se välskötta ut.

Det som var lite överraskande var att det fanns väldigt lite kunskap om gröna väggar och tak, men det speglar ändå den utveckling som skett de senaste åren med nya metoder för detta som ännu inte riktigt hunnit användas och få fäste i större skala i Sverige.

Många var dock överens om både problematiken och möjligheterna med ängsmark, vad det kräver, samt fördelarna med det. Det verkar som att värdefulla kunskaper om användningen av ängsmark har satt sig brett i branschen.

GESTALTNINGSPROGRAM

Gestaltningsprogrammet gjordes för bostadsområdet Bryggvägen i Gröndal i Stockholm. Platsen valdes utifrån detaljplanens storlek och skede. Programmet syftade till att bidra till den biologiska mångfalden och därför användes i huvudsak de tre elementen som ingår i den biologiska mångfaldstrion för uppsatsen: **alternativa gräsytor, gröna tak och gröna väggar**. Alla alternativa gräsytor som tas upp i litteraturstudien används i området. Av Gröna tak och gröna väggar används extensiva gröna tak och gröna fasader. Allt för att ge området en utformning med hög artrikedom som kan bidra till biologisk mångfald, samt en skötselintensitet som ligger på en låg nivå för att hushålla med resurser och främja växtsamhällen som gynnas av låg skötsel, däribland ängsvegetation.

Ett perspektiv ur gestaltningen står att finna på nästa sida.

DISKUSSION

I diskussionen adresseras problematiken med att hitta relevanta källor och exempel på ekologisk gestaltning i Sverige. Den allra mesta litteraturen och de flesta bra exempel kommer från Storbritannien, USA och Tyskland. Detta gör det svårt att förespråka specifika ekologiska lösningar som inte testats i det svenska klimatet. I detta hänseende blev intervjuerna mycket värdefulla eftersom att de alla gav information om erfarenheter ur ett svenskt perspektiv.

Vidare diskuteras problematiken kring inventering och analys. I och med att byggprojektet redan satt igång vid skedet för inventering och analys i detta arbete var tillgängligheten til alla delar av området mycket begränsat. Detta gjorde att det var svårt att få en helhetsbild av att uppleva platsen på det sätt som den sett ut tidigare. Det var också svårt att bilda sig en uppfattning om hur folk skulle ha rört sig utan att ha varit hindrade av avspärrningar.

Mitt fokus på den biologiska mångfaldstrion bestående av **alternativa gräsytor, gröna väggar och gröna tak** gjorde att den ekologiska gestaltning jag utförde begränsades till en skala som fungerade för de valda elementen. Ett annat sätt att arbeta med ekologisk gestaltning skulle ha kunnat vara att se på landskapet i ett större perspektiv och jobba med planering ur ett stadsdelsperspektiv med spridningsvägar till exempel.

Idén till det här masterarbetet var från början att fokusera på aspekter av biologisk mångfald och gestaltning av dessa. Därför var de mer lämpliga att applicera arbetet på en kvartersskala.

SAMMANFATTNING

Bilder över element som används i gestaltningsprogrammet (Alternativa gräsytor, gröna väggar och gröna tak), samt ett perspektv från gestaltningsprogrammet.

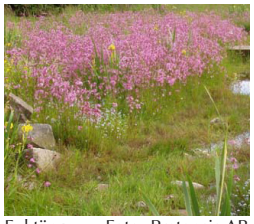
Örtmatta Foto: M.Ignatieva

Normaläng Foto: Pratensis AB

Målerisk äng Foto: Pratensis AB

Torräng Foto: Pratensis AB

Skuggäng Foto: Pratensis AB



Fuktäng Foto: Pratensis AB

Ett extensivt grönt tak Foto: M. Ignatieva

En grön vägg. Living Wall System Foto: M. Ignatieva

Perspektiv över den offentliga parken i Gestaltningsprogrammet.

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INTRODUCTION

AIM

OBJECTIVE

The objective of this thesis was to investigate the elements **alternative lawns, green roofs and green walls** from a landscape architectural perspective and implement them into a design programme of a new housing area in Stockholm.

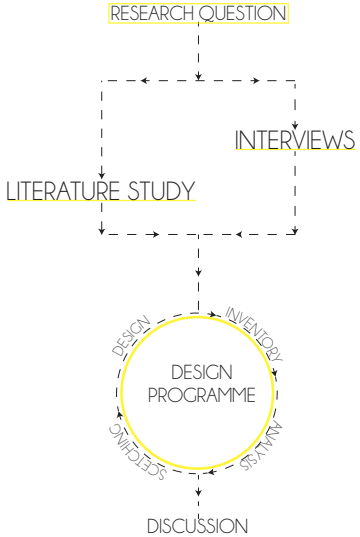
PART ONE: Investigate the elements of *the biodiversity trio:* **Alternative Lawns, Green Roofs & Green Walls** from a landscape arcitectural perspective, in the context of courtyards in Stockholm. *Literature Study and Interviews*

PART TWO: Use the **biodiversity trio** to create a **design programme** for Bryggvägen, Gröndal. *Design Programme*

RESEARCH QUESTION

How can an ecological design programme for a new Swedish urban multifamily housing area be developed, with emphasis on the "biodiversity trio": alternative lawns, green roofs and green walls?

THESIS STRUCTURE



DELIMITATION

This thesis focuses on ecological design and especially the elements: **green roofs, green walls and alternative lawns**. These are investigated to conclude their use as landscape architecture elements in urban context.

There are also other elements in urban landscapes such as ponds, shrubs and trees. These were partially included as for instance, remnant vegetation, but not focused on.

A case study area for the design programme was chosen in Gröndal, Stockholm due to the urban location and size of the construction area (lager than many others), as well as its status being developed in 2016-2017. It was a challenge to find an appropriate site suited for both analysis and realization of my design intent.

The season when I conducted the project was also a limiting factor. I visited the site in early spring. It limited my option for analysis of existing vegetation as well as other kinds of analyses and site observations. A large part of the site had already been excavated which limited the physical access to it.

Another delimitation were the limited publications for Swedish contexts on the theme of this thesis. The majority of sources and practices used were Anglo-American.

TARGET GROUPS

This thesis set out to create an example to inspire particularly landscape architects, working with city planning as well as on a smaller scale, but also for municipalities, landscape architecture students and other people working with urban greenspace.

BACKGROUND

THE SUBJECT

The urbanized environments in the world are growing. 54% of the all humans and 73% of the European people today live in citylike constellations (UN 2014). By 2050 66% of people in the world will be living in urban environments (UN 2014). This is true for Sweden as well. Stockholm, its capital, will see a population increase of ca 40% by 2030 (Stockholms stad 2016). And the new construction projects today are taking place on land in between existing housing projects, leaving less greenspace within the borders of the urban cityscape (Stockholm 2013). Densification can lead to decrease of vegetation structures that in particularly a city core is valuable as well as vulnerable (Berg, Granvik & Hedfors 2012).

Even though most people in Europe and Sweden lead urban lifestyles and may not think about it, they are still very much depending on ecosystem services for food production, air and water filtration, storm water management, temperature levelling and the providing of recreational areas nearby their homes (Bolund & Hunhammar, 1999). The increasing human activity in urban environments globe wide may threaten all these (Millennium Ecosystem Assessment, 2005). Changes in land use, urbanization and agriculture are the main factors that cause the decline in biodiversity and changes in vegetation (Müller, N.; Werner, P. 2010).

The positive link between ecosystem services and high biodiversity is clearly defined (UNEP 2008). A city with rich biological diversity contributes to its people becoming healthier and having more meaningful lives than otherwise (Ignatieva & Ahrne 2013).

Knowledge about the deterioration of both local and global environmental systems is widely spread (Rottle & Yucom 2010). The design of urban greenspace that doesn't provide anything for ecological systems and merely fill leftover space is therefore no longer satisfactory (Ignatieva & Ahrne 2013). To reach better sustainable solutions for urban landscape design, the use of alternative architectural approaches to the predominant exotic plantings and globally spread far-reaching lawns, should instead be exercised (Ignatieva & Ahrne 2013). Planning with and creating new ecological systems based on the environment, the design will in many ways provide more solid and sustainable cities that are also better prepared for rapid climate fluctuations (Beck 2013).

THE BIODIVERSITY TRIO

The focus of this thesis is **Alternative lawns, Green roofs and Green walls**. Ignatieva & Ahrne (2013) desctibe these elements as the sceleton of modern sustainable green infrastructure. They are given emphasis as important because of their ability to impact urban environments in terms of biodiversity, social values, economy as well as contributing significantly to ecosystem services. The elements also provide an alternative landscape architecture approach to the picturesque-gardenesque style that dominate much of the global urban greenspace today (Ignatieva & Ahrne 2013).

THE SITE

The case study area for the design programme is located in the city district Gröndal in the south-western parts of Stockholm, Sweden. The housing project began in the fall of 2015 and will be completed with 320 new apartments by 2017 (Stockholm 2016).

METHODS

Below follows in chronological order a description of the methods used in this thesis.

LITERATURE STUDY

The literature study can be divided into **five different sections**: historic review, ecological design, alternative lawns, green roofs and green walls.

The literature study intends to give an overarching perception of the concepts chosen and give good preconditions for further work. The categories were looked at through mainly the aspect of ecosystem services and among those mainly biodiversity. The concluding aim is to single out relevant solutions from the chosen categories to use for a design programme proposal.

The three categories within what I, in this thesis, call **the biodiversity trio** (alternative lawns, green roofs and green walls) were used because of their current status in the field of landscape architecture as being novel elements of **ecological design**, far from being used to their full potential. Also, as I found during the pre-studies and talks with relevant people, that the knowledge about the three concepts is very fragmented and there are many misconceptions.

The historic review presents an overview of historic greenspace design in Stockholm from 1850 to present day with a main focus on multifamily residential courtyards.

In my search for information I was handed appropriate literature and articles from my supervisor Maria Ignatieva who works on the research project ”LAWN” at SLU, developing alternatives to conventional lawn.

Search was also conducted on the internet. Epsilon, Libris and Ecosia was mainly used. Search key words were for example: Ecological design, ecology, ecosystem services, green roofs, green walls, vertical gardens, green façades, meadows, grass-free lawns.

INTERVIEWS

Standardised interviews with open questions and answers on a semi-structured level were conducted (Bjørndal 2007). The questions being open means that they can be answered in a way the person being interviewed choose. The interviews were also open for additional questions or comments when applicable.This method was chosen in order to get as much as possible information during the interview.

The questions were written down in a particular order and given in the same order as prepared and for the first time during the interviews. The questions were given in the structure of four categories: **background** on the interviewed person, **ecology, lawn & alternative lawn and green roofs & green walls**. This to make sure that the interviewed people would present answers that could be correlated to the information retrieved from the literature studies.

The interviewed people were chosen partly by recommendation from the Landscape Architecure division at SLU but also from my own investigation and experience. The selection was conducted in a way to interview three landscape architects with different perspectives on design, planning, management and maintenance and then to complete with people in the same field but with different focus.

The people interviewed were: landscape architects Hildegun Varhelyi-Nilsson, Sofia Eskilsdotter, Lars Johansson, landscape

METHODS

engineer Ann-Louise Dyer, park engineer Mats Berglund and ecologist Göran Thor.

TOOL BOX

Design solutions relevant to the project and the "biodiversity trio": Alternative Lawns, Green Roofs and Green Walls are presented after each section of the literature study and the interviews with the exception of the historic review part.

The chosen design solutions are then put together into design intentions to use in the design programme. The design intentions are presented in figures on page 42 and 43.

INVENTORY

Inventory on the site through field studies was made with inventory of vegetation, microclimate, soil conditions and terrain. Further inventory on what future microclimate and vegetation might be after construction was conducted through a desk study of the detaljplan. The inventory studies were carried out through photographing and scetching.

ANALYSIS

A **SWOT-analysis** was conducted. It is a method to use to find out the Strengths, Weaknesses, Opportunities and Threats of a place. Strenghths and weaknesses are regarded as internal aspects and opportunities and threats as external (Boverket 2006).

An unstructured **observation study** on movement was also conducted. It was conducted with open categories. Such an observation is a set of columns over what is in focus (Bjørndal 2007). I monitored people where they moved and in what manner. For instance: running, walking, driving.

A desk study on future movement after construction was also conducted. I assessed the amount of movement and activity based on the information on spaces in the detaljplan.

DESIGN PROGRAMME

The design programme was conducted based on analysis of the literature study and the interviews. Being a programme it is set at a level of detail that is somewhat general. The design is meant as solutions that could be applied to other places of construction as well, making the chosen site of Bryggvägen in Gröndal an illustrated example.

Studies of maps and plans were taken from Stockholms stad and illustrations and plans from various architectural firms.

The Design Programme was carried out through studies such as inventory, analysis, scetching and designing.

MAPS, PLANS AND ILLUSTRATIONS

Ortofoton from Lantmäteriet and photos and plans from Stockholms stad were studied.

Detaljplanen from Stockholms stad became the basis of the illustrations.

Scetching was mainly done digitally using programs such as Illustrator CS6 and Photoshop CS6.

Maps & Plans were created using Illustrator CS6 and Photoshop CS6 and Illustrations were created using Illustrator CS6 and Photoshop CS6.

CONCEPTS

CONCEPTS

Relevant concepts used throughout the thesis are presented below.

ECOLOGICAL DESIGN

Ecological design defines biotic processes and systems around the area of interest and includes the new design in those processes and systems to minimize the negative impact on surrounding environment. It also aims to improve ecological functions as well as maintain and generate resorces for human benefit (Rottle & Yucom 1996).

BIODIVERSITY

"The variability among living organisms from all sources (...) this includes diversity within species, between species and of ecosystems." (United Nations 1992)

URBAN BIODIVERSITY

"The variety and richness of living organisms... and habitat diversity found on the edge of human settlements" (Müller 2010 p. 3).

In this master's thesis I deal with Urban Biodiversity as a part of ecological design.

THE BIODIVERSITY TRIO

Alternative Lawns, Green Roofs and Green Walls make up a trio for biodiversity and modern green infrastructure. They provide for essential ecosystem services and contribute to biodiversity (Ignatieva & Ahrne 2013).

These are part of the work as fundamentals to design for biodiversity.

ALTERNATIVE LAWNS

- Grass-free lawn

A culture of mowing-tolerant forbs intended for walking on as well as viewing from an aesthetic point of view (Smith & Fellowes 2014).

- Meadow

Vegetation with high biodiversity compiled of forbs and straw plants (Hall, Granström & Sjörs, 2016).

- Pictoral Meadow

"Seed mixtures that create beautiful, impressionistic plantings [...] combining great public appeal with high wildlife value" (Dunnett, 2012)

GREEN ROOFS

"A green roof is a flat or sloped rooftop designed to support vegetation." (Dvorak & Volder 2010 p. 198)

GREEN WALLS

"The term green walls encompasses all forms of vegetated wall surfaces" (Green roofs for healthy cities, 2014)

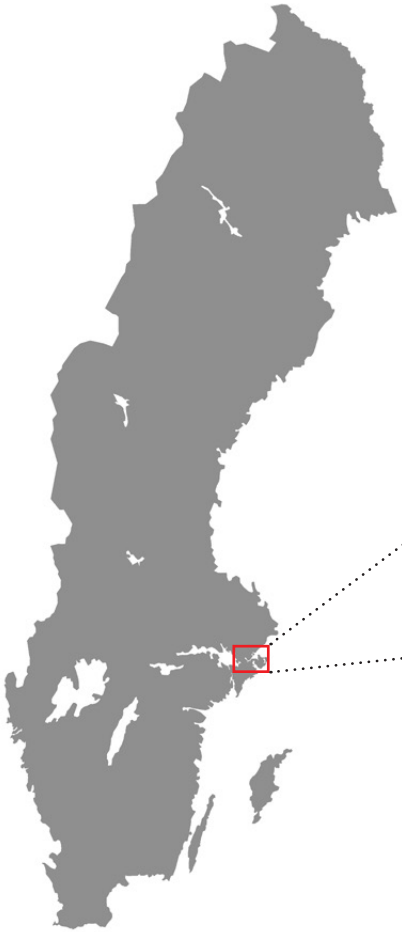
ECOSYSTEM SERVICES

The direct and indirect contributions of ecosystems for human wellbeing.

(Millennium Ecosystem Assessment, 2005)

THE SITE

SWEDEN



The placement of Stockholm in Sweden

STOCKHOLM

Inhabitants: 897 000
Size: 18 774 ha
Founded: 1250
(Stockholms stad u.å., Lundevall 2010)

Stockholm is the capital of Sweden and the largest city in the country. It's situated in the archipelago between lake Mälaren and the Baltic sea. Therefore most of the city is located on islands and water contact is significant for most of Stockholm (Lundevall 2010).

Gröndal in Stockholm

Gröndal. The development area marked in red
GSD-Ortofoto © Lantmäteriet 2016

GRÖNDAL

Gröndal is a city district within the larger district of Hägersten-Liljeholmen within Stockholms Stad. It is situated just south of the inner city. (Nationalencyklopedin 2016, Stockholms stad 2013)

Gröndal was developed after 1860 when a railway station in Liljeholmen was opened. It was developed into a worker's district because of the many factories in the area. (Nationalencyklopedien 2016)

Stjärnhusen is perhaps the most notable project in Gröndal, because of the successful design with abundant greenspace and light, well-planned apartments and neighborhoods in a small scale (Lander 2007).

BRYGGVÄGEN

Bryggvägen is the small street that runs through the development area and end on the shore of Mälaren. It's also the name of the new construction project and is situated just west of Essingeleden (motorway).

8 new housing complexes will be built with the start 2015 and finish 2017. 320 apartments are planned to be built and most are to become co-operative apartments (bostadsrätter) (Stockholms stad u.å.).

LITERATURE STUDY

PART ONE

HISTORIC REVIEW

This section aims to give an overview of the development of mainly courtyards in urban residential areas in Stockholm and to give context to the ecological courtyards in the design programme. Showing how the city has evolved through history the review strives to answer questions on how we've come to the point of urban design where we are today.

STONE CITY 1850-1930

With the new era of large amounts of people moving into the bigger cities to work followed a deficiency of housings and crowded living which in turn made sanitary problems critical (Rudberg u.å.). The ideas from Paris to establish large esplanades to let fresh air into the city and keep fires from spreading became a big inspiration for city planners (Selling 1970). In Stockholm this resulted in a plan for a stone city in a grid with long, broad avenues (Björk & Reppen 2000). They beacame part of the green infrastructure and an important addition to the parks (Selling 1970). The importance of this basic green infrastructure can hardly be overestimated. Had it not been done then it might not have been done at all.

The dense structure of stone houses in Stockholm

The dense blocks in Stockholm were created by the political agenda of economic liberalism in where people were given freedom to conduct business of their own interest (Åström 1993). This made exploitation of the city possible to a point were extremely crowded living conditions and the spreading of diseases were such a big issue that social movements such as hygienism were initiated and people like August Strindberg advocated for better living conditions (Andersson 2000). The lack of good apartments for the lower class was, at the time, nothing the city would do anything about. Instead they confided in entrepreneurs to solve the problems (Rudberg u.å.).

The inner city of Stockholm was fully exploited in the middle of the 1920's and the courtyards had slightly become more sanitary than the ones built on speculation at the turn of the 20th century (Åström, 1993).

HISTORIC REVIEW

PUBLIC PARKS 1866-1900

With Lindhagenplanen, the new city plan created by Albert Lindhagen 1866, public parks were for the first time in the history of Stockholm prioritized. The inner city hills that formerly had been avoided building on due to the difficult terrain were now seen as potential park areas. They were being added with soil and waste to become even higher (Lundevall 2006).

The idea was to create parks that were elevated to a point where people were lifted above the bad air in the city giving them a chance to breath fresh air and get a feel of groves and meadowland within the city. This would reduce the need for people to leave the city (on expensive trips) to reach nature and countryside. It was important that everyone, not just the wealthy, would be given access to the parks. They would be located close to people homes to increase their accessibility. In the spirit of the national romance era, with a deep appreciation for the local, the focus of the planting design was on native species (Lundevall 2006).

This approach has today been compromised as the city is densified in its in-between green spaces - partly in parks and predominantly in larger green areas.

Other novelty green infrastructure ideas in Lindhagenplanen included front yards with plantings and tree planted avenues for, mainly, the bourgeoisie to promenade through (Lundevall 2006).

A public park in Stockholm

The model city plan for Stockholm was around 1910 the medieval structure with less strict angles than before. Places with a difficult topography (for building) were now turned into sanctuaries and the block structure became more important than the single houses. The new ideal was to create a soft structure of uniform scale, character and colouring that would play well together (Lundevall 2006).

The courtyards were now being planted with trees and shrubs and in often the worker's wooden houses inside the grid system of the city were torn down, creating lush, airy spaces within the blocks. Fences that separated courtyards were also torn down to make larger common outdoor rooms (Åström 1993). Between the years 1910-1920, storgårdskvarter, (grand quarters) were made (Rudberg u.å.). These were spacious courtyards surrounded by houses which became the residents' common gardens.

GARDEN CITIES 1900-1920

Still, at the turn of the century, crowded living was a big problem resulting in tuberculosis and cholera epidemics (Rudberg u.å). The courtyards were mainly a place for latrines and many people lived in slum and destitution (Andersson 2000). To ease the low living standards that the poorest people endured, Stockholms Stad bought large land areas and gave loans for up to 80% of the cost to people who wanted to build their own

HISTORIC REVIEW

home (Lundevall 2006). Several other cities soon followed and planned land for workers who wanted to build their own home. The movement had been inspired by German and British ideas and the land that was sold was located a bit outside the city centres and planned along the railroad and the new electric tram, creating small-scale suburbs with community centres (Björk & Reppen 2000, Lundevall 2006). People often built their own houses themselves with the help of their family (Lönn, 1994).

Enskede, Stockholm. A city district with houses of uniform scale. The first of several garden cities in Sweden.

FUNCTIONALISM (MODERNISM) 1930-1980

- Folkhemmet
(People's homes era) 1940-1960
- Miljonprogrammet
(Million program) 1965-1974

FOLKHEMMET 1940-1960

The ideas of functionalism came in big in Swedish architecture with the 1930's Stockholm exhibition (Björk & Reppen 2000). Embraced by Socialdemokraterna (The largest socialist party) and included in the idea of folkhemmet, it was lauched as a political idea by future prime minister and Socialdemokrat Per Albin Hansson in 1928 (Rudberg u.å.). The construction of folkhemmet was first realized in the beginning of the 1940's with the socialist ideas that entailed cheaper rental houses in healthy environments for a broad middle class (Rudberg u.å.). The new society would focus on building its way into a better world (Rudberg u.å.). The modern functionalist city was forming into the shape of airy apartments exposed to sun and light located in a near proximity of parks and nature (Åström 1993). The new cityscape would become "a cultural park where houses and traffic were lifted on pillars and the ground with its trees and greenery would be freely disposed for play and recreation" (Åström 1993 p. 39).

Since economics was an important factor in the project of building the new society, mostly multi-family houses were built (Rudberg u.å.). These houses required less land than single-family houses, thus becoming cheaper to build and could then offer reasonable rents (ibid.). The courtyards around the multi-family houses as a result, were significantly smaller per person than many gardens of single-family houses. However, access to and views of green infrastructure from the own home was very important and often large trees and slabs of stone were kept when the houses were constructed and they were placed in existing, undulating terrain (Rudberg u.å.).

The skilled craftsmanship of building houses made it possible to conserve the existing green structures and with care insert houses in-between (Rudberg u.å.).

HISTORIC REVIEW

The result was often lean bodies of houses (lamellhus) that blended into the surrounding environment and still let light into the apartments facing north and south. The concept "House in Park" became widely used (Rudberg u.å.). The common areas of the houses were open and tied together the housing area, park and nature (Andersson 2000). This is what the landscape architecture of the small inner city island Reimersholme in Stockholm was planned after (Hallemar & Kling 2013). The area was built in the Stockholm School style of designed nature inspired by the surrounding landscape around Mälaren. The houses were placed as if organically evolved on an archipelagic island with nature flowing in between the them (Hallemar & Kling 2013).

Stjärnhusen, in Stockholm (Gröndal) and Örebro (Rosta), are two well renowned projects during folkhemsbygget. The houses were built as three-pointed stars with one apartment in every point with windows in three directions. The houses were then connected to other houses in the same shape forming circular enclosures of semi-private gardens for the residents that effectively sheltered from wind. In Rosta the smaller gardens connected to a large common park (Åström, 1993).

During the 1940's, punkthuset (a single high raised house body) became widely used, since it required very little land per built apartment. However, the houses were often placed in the landscape without any enclosed courtyard whatsoever, giving the residents little chance of finding a secluded place to go (Rudberg u.å.).

With the high economic growth that resulted in a rising number of car owners, the city planners had to deal with the increasingly dangerous street conditions (Rudberg u.å.; Åström 1993). The solution to this was to try and separate people from cars using the concept zoning (zonering). Åström (1993) describes the many new housing complexes being planned so that a circular street surrounded a neighborhood, which in turn would frame a common park. The large park area then became the resident's backyard, but while big and lush, however did not provide private spaces for the residents to withdraw to.

Stjärnhusen, Örebro. Small semi-private gardens are enclosed by house bodies and face a large common park.

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MILJONPROGRAMMET 1965-1974

Due to the Swedish parliamental decision to build one million homes between the years 1965-1974, the building era came to be called miljonprogrammet (Björk, Reppen 2000). In the middle of the 1960's, methods of more industrialized building character became widely used (Åström 1993). Not only prefabricated building materials were used but also the ability to completely flatten the foundation for housing areas was used, thus breaking the former landscape tradition of adapring to the surrounding landscape (Andersson 2000).

The aesthetics of the housing area weren't limited to the terrain anymore and could be placed anywhere. This resulted in a complete removal of existing plant material and soil. By the end of the project they would be replaced with new plantings with sparse plant diversity which often consisted only of berberis shrubberies, a few ornamental trees and a lawn (Andersson 2013; Björk, Reppen 2000). This was an effect of the ideal of having low maintenance that heavily influenced the aesthetics of the era (Andersson 2013).

The tax conditions for loans (when building more than 1000 apartments in one project) made it profitable to make long rows of housing complexes (Björk, Reppen 2000). The courtyards in turn became less personable than those before when being made to suit the very large amount of residents that would share and use the same outdoor space (Åström 1993).

However, the fascination of calculations and mathematical tables to provide answer to problems prompted architects to make spacious play areas for children as an important part of the new courtyards (Andersson 2000).

The housing areas of miljonprogrammet were often set close to large recreational areas, combining the open courtyards with nature and creating green corridors (Björk, Reppen 2000).

During the later years of the era a discontent of the anonymous and large scale neighbourhoods began to grow (Schönning 1997).

The discontent may have been connected to negative connotations people still bear in regards of the era in aspects of sustainability and care.

Bagarmossen, Stockholm. A car free courtyard with a spacious playground

Small front yards were made for the residents on the bottom floor.

HISTORIC REVIEW

POST MODERNISM AND DENSIFICATION 1980-

With the beginning of the 1980's a new era was born, post modernism, the ideal was a denser city with a mix of housing and commercial business in the same areas (Björk, Reppen, 2000). The post modern era opposed the modernist era and returned to the pre industrial tradition which entailed the closed block, creating sheltered yards, as opposed to the modernistic way of using houses that stood freely in the landscape with open yards (Kristensson 2008). However, the courtyard wasn't made quite as private as before; the houses often have three connected house bodies forming a square, leaving one side open that face the main street outside (Åström 1993). The courtyards, avenue and parks make up a connecting green infrastructure.

The densification of the cities reached the suburbs in the 1990s; land was expensive and to maximize profit, municipalities sold land planned for as many apartments possible on as little space possible by minimizing the space between the houses (Kling 2013). This resulted in smaller outdoor areas for residents. Kling (2013) describes the modern yards as vestibules to place bicycles and throw out garbage rather than an actual outdoor living space. The life that formerly took place in the yards next to the houses now take place on restaurants or in parks. For other activities people choose private seclusion within the walls of the home. Kristensson (2008) discusses the negative impact densification can have on ecology when overexploitation diminish the ecological effect a courtyard can have in the urban environment. The densification of the housing courtyards have further increased expectations on parks to inhabit functions that the smaller courtyards no longer can incorporate (Jansson, Persson & Östman 2013).

With the economic turn downwards in the 1990s and the political trend to deregulate markets, such as the housing market, the outdoor environment in housing areas started showing a greater variation than they had done before when outdoor space was more uniformly planned (Kristensson 2008).

Densification came as a solution to land becoming more expensive. But it left us with the problems of diminished greenspace and more ecosystem services having to take place in smaller areas.

Hammarby Sjöstad, Stockholm. A small courtyard enclosed by three houses creating a semi-open space.

HISTORIC REVIEW

MODERN ECOLOGICAL PLANNING 2000-

"Bo01" was the name of the European housing show held in Malmö in 2001 and had several show yards that would point to how Swedish courtyards might look in the future. With the show, the concept *Grönytefaktor* was presented in where the permeability in the ground material is measured and points are given depending on how much water an area can absorb (Kristensson 2008). Open water and flower beds on the ground are given the highest points. Measurements on how many trees and how many square meters plants there are, are also being used to set certain demands on building companies for greener courtyards (Kling 2013).

In 1993 the company Vegtech started producing green roofs for multi family buildings in urban environments mostly using prefabricated mats to be rolled out on the roofs (Vegtech 2015). Green roofs have mostly entailed Sedum species have been ideal for growing in shallow soil, harsh conditions with high solar radiation and draught plus their ability to utilize excess water (Dunnett & Nagase, 2011). However, the understanding that a green roof has other possibilities, totally different from that of a park or yard, because of different attitudes from clients, is a notion that has come later (Dunnett 2012).

In 1999 the district Augustenborg in Malmö, built during Folkhemseran, was altered towards an ecologically sustainable profile through state funding (MKB, Malmö Stad u.å.). The district was remodelled with a clear visible stormwater management, green roofs and green walls. Together with the city district Hammarby Sjöstad in Stockholm it is one of the early Swedish urban districts with an ecological profile (Kling 2013, Eklund & Juvander 2005). Hammarby Sjöstad was planned with much stormwater management, energy self sufficiency and waste disposal in ecological ways (Eklund & Juvander 2005).

Bo01, Augustenborg and Hammarby Sjöstad were all made more than 15 years ago. These areas were very modern at the time. But it may be so that he concept ecological design needs to move beyond these "turn of the millenia" places, however successful they might be we might need ecological design solutions more up to date to answer the pressing issues of reduced greenspace within our cities for instance.

Hammarby Sjöstad, Stockholm. A long canal that manages stormwater runs through parts of the city district

ECOLOGICAL DESIGN

DEFINING

There are several definitions on what ecological design can be. Kingsbury (2014) discusses the term ecological, in the context of design, and its **ambiguous** nature. While some people would call one design ecological, it might not at all be described as such by someone else. While ecology is a term that has a clear definition, the use of structures similar to nature's own in the design of new plant communities, can be defined in many different ways.

One definition of the term is: "the process of actively shaping the form and operations of complex environments in such a way that composition and processes help to maintain and, if possible, increase the integrity of a region's ecological relationships" (Rottle & Yocom, 2010 p. 14). Rottle & Yocom further advocate that ecological design should aim to protect and enhance processes that enable life forms to develop resilience and increase the biodiversity of the designed area.

Beck (2013), states that landscapes designed with an ecological approach are based on the precept of placing the right plant in the right place through lenses of biogeography. This principle is all about finding plants that fit the biome of the area at hand. They have been moulded to endure all the fluctuations of the local climate and thrive within that narrow ecological niche. Landscapes that are designed to match the chosen plants and their natural habitats should be easier to establish and also easier to maintain than landscapes that forcefully introduce exotic species to unfit milieus. This is the case with lawns established in dry, hot milieus. They consume large quantities of water while trying to mimic nature in a different biome than they are planted in (Beck 2013).

BIODIVERSITY

"Biodiversity refers to the complete variety of life on earth" (Rottle & Yocom 2010 p. 54). It regards the **diversity on all scales** such as variety in ecosystem types, species richness (amount of different species in a particular area) and genetic variations within species (Rottle & Yocom 2010).

"Ecological design, at its deepest level, is **design for biodiversity**" (Van der Ryn, & Cowan 1996 p. 156). Dunnet (2014) states that biodiversity is one of the great advantages of ecologically designed landscapes. Promoting biodiversity is one of the cornerstones in working with ecological design.

Urban biodiversity is affected by several factors, both anthropogenic and biologic. To cope with these factors it is important to consider climate changes, both global and local (global warming and urban heat island effect for example) and human activities (Nowak, D. 2010). Plant communities that reflect a large variety in species are widely considered to be more resilient to fluctuations in the environment than plant communities that have a lower diversity (Dunnett 2014). Dunnet (2014) continues to discuss the problems of not knowing the full extent to this due to a lack of research and that biodiversity for the sake of biodiversity isn't necessarily the best in terms of ecology. One should know why to strengthen biodiversity.

Ecosystems that are exposed to stress

ECOLOGICAL DESIGN

(draught, flooding for example), will loose plants. But if the plant community offers a high diversity, other plants are likely to fill the gap of the now vacant lot and the lost plant's functions, strengthening the ecosystem as a whole (Rottle & Yocom 2010). Biodiversity enhance resilience of plant communities and ecosystems to respond and adapt to changes in the local environment (Rottle & Yocom 2010). If offering a variety of shapes and forms of flowers for instance, a wider variety of pollinators will attract, thus making reproduction less vulnerable to change.

NATIVE SPECIES

The definition of what constitutes a native plant can be debated, if not referring to isolated islands and while having good knowledge of the flora (Kingsbury 2014).

Using exotic species may be problematic if the prerequisites of the new environment in which the plants are put are completely different to those the plants are genetically encoded for (Kingsbury 2014). There is an apparent risk in using large quantities of exotic species in public plantings that they won't survive the local climactic fluctuations. Native species are through scientific and practical experience safer to use in a long-term perspective, especially in stressed urban environments (Gustavsson 2014).

Native species can further be very valuable because of the cultural heritage they carry and the symbolism that express familiarity to people and strengthen people's relations to places (Gustavsson 2014).

NATURE AS MODEL

To achieve a successful design of plant communities, knowing their preferred condition is all. By selecting plants that nature itself might have selected, a strong ecological design can be established (Beck 2013).

The relationships between landscape architecture and ecology can be the aim to mimic natural patterns in the design of human environments (Rottle & Yocom 2010). Ecological landscapes are not replicas of the wilderness but merely systems inspired by and attempted to **imitate natural systems** (Beck 2013).

CUES TO CARE

A problem with landscapes designed to be rich in ecological qualities, can be people's perceptions of them. Many landscapes that are rich in biodiversity are often **perceived as messy** and mistaken as places lacking of maintenance. Landscapes that are ecologically successful should be presented in a way that people can accept, trimming nature into a package filled with ecological functions while **exhibiting neatness and care** (Nassauer 1995). Nassauer (1995) termed the indications of human intent in landscapes as **cues to care**.

Nature is a cultural product that often is perceived as a landscape with high ecological values. In many cases people aren't aware of the human intervention in landscapes and that maintenance in for example nature reserves is a prerequisite for thriving indigenous ecosystems. At the same time, people often don't notice ecological quality in other plant communities. In order for people to maintain and support ecological functions these have to be made visible (Nassauer 1995).

ECOLOGICAL DESIGN

Nassauer (2011) sets up a list of criterias that exhibits care to the public. A selection of the most relevant for this thesis are stated as below:

» *Neatness and order*
» *Structures and furnitures in good condition*
» *Clear, crisp edges between different types of vegetation and patches*
» *Mown lawn in the most visible and visited areas*
» *Colorful flowering*
» *Signs that inform about flora and fauna, the ecosystem services or habitat functions of the site (Nassauer 2011)*

Mown lawn and meadow plantings combined
Photo: Maria Ignatieva 2015

SUCCESSION

Landscape architect Hildegun Varhelyi-Nilsson states that being aware of the developments in plant communities is somewhat the essence of ecological thinking in design. Knowing what will happen and to plan for the change so that unexpected disturbances in the plantings won't change the expression of the design in an unintended way.

The feature of change over time in plant communities is one of the more distinctive characteristics of ecological design. This makes a design ecological because it is allowed to adapt to its surroundings and making way for natural processes rather than a forced list of plants (Dunnett 2014).

Succession is often halted by human or animal intervention. Shrubland that are on their way of changing into deep woods can be maintained in this semi-state for as long as it is managed or grazed (Robinson 2011).

To facilitate succession and thereby also resilience in the plant community a diversity of functional groups should be included (Dunnett 2014). Functional groups meaning different species that respond similarly to environmental change and/or share ecological niches. By doing so the risk of all different groups dying during a draught for example is significantly diminished (Dunnett 2014). If for instance plants with different germination requirements are used, one that germinates in sun and one that germinates in shade, the probability of one of them germinating is, from the perspective of sun and shade requirements, one hundred percent (Beck 2013).

NATURE PRESERVATION

Preservation of vegetation is used in many countries such as the Scandinavian, the UK, USA and the Netherlands. It involves the use of existing species native to the area involved in the project (Kingsbury 2014). Instead of introducing only new material one option for a design can be to use remnant vegetation.

The greatest advantage in using this kind of vegetation is that it is already mature with large trees and functioning plant

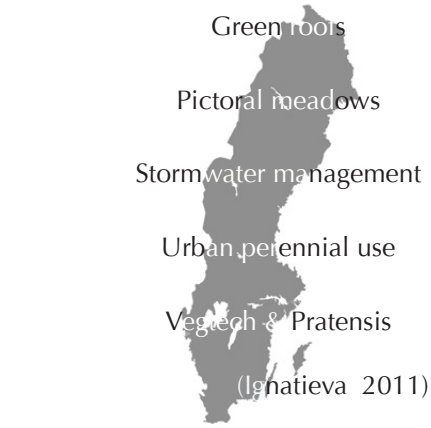
ECOLOGICAL DESIGN

communities. If the native vegetation is removed it won't merely do with planting replacement species in order to regain the former functions of for example biodiversity and aesthetics. If the same functions are to be re-established it may take decades or centuries, the cost may be significantly higher and sometimes it isn't at all possible to do (Florgård 2010).

The low cost in preserving vegetation and the maintenance of these areas is a great benefit. For a vegetation to be considered worth preserving an analysis must first be done to assess the quality of the plants to see whether or not they are useful from several points of views. In the stages of planning and designing a new area the vegetation to chose to be preserved should be of very resilient quality (Florgård 2010).

A key to a successful preservation of important vegetation is well-structured information of the project as a whole as well as the goals for it. Studies of preservation projects has shown that it otherwise is likely that something will go wrong and vegetation meant to be preserved is instead removed or damaged (Florgård 2010).

SWEDISH EXAMPLES OF ECOLOGICAL DESIGN



INTERNATIONAL EXAMPLES OF ECOLOGICAL DESIGN

The figures above illustrate the development of ecological design in Sweden and worldwide, realized as of today.

SOLUTIONS FOR DESIGN PROGRAMME

Combine high ecological values with **neatness and care**

Signs to inform of ecological qualities

Identify and save **remnant vegetation** of high quality

Use mainly **Native species** to ensure longevity and resilience as well as providing cultural carriers

A variety of plant species, plant structures and long flowering periods for pollinators as well as for people

Plan for **succession**

ALTERNATIVE LAWNS

Alternative lawns are referred to in this thesis as plant communities that inhabit qualities close to those of a conventional lawn such as openness, aesthetic values and the ability to walk on but with the difference of offering a high biodiversity. The alternative lawns presented here are Grass-free lawn and meadow

GRASS-FREE LAWN

Also known as **tapestry lawn**. Defined as a perennial culture of mowing-tolerant forbs intended for walking on as well as viewing from an aesthetic point of view (Smith & Fellowes 2014). Originally developed by **Lionel Smith** at the University of Reading. The forbs chosen for the lawn are all low growing, which means they avoid being cut too severely when mown and can regenerate quickly in the new lighter environment (Smith 2016).

Tapestry lawns with forbs instead of grasses can be used in a similar way as a grass lawn. However, a tapestry lawn can't manage the same heavy walking pressure as lawn. Therefore it cannot be laid out in large parks to play football on for example, even though it might work for some time (Smith 2016).

Native plant species in tapestry lawns carry a link to history and culture, perpetuating a genious loci as well as being better suited for the local climate and enhancing local biodiversity. (Ignatieva & Ahrne 2013).

BIODIVERSITY

Applying a grass free lawn instead of turf increases **species richness** instantly. A tapestry lawn can produce as much as 20 times more flowers than a turf and flower during most of the vegetation period, providing insects with nectar from a diversified flora for a long period. In studies, four times as many insects have visited tapestry lawns as turf. The heightened presence of insects in turn gives opportunity for insect predators such as birds and small mammals to feed (Smith 2016).

A tapestry lawn is an evolving plant community in where plants will die off, but having a high diversity helps mending blank patches creating a stable plant community (Smith 2016).

ECOSYSTEM SERVICES

Tapestry lawns can absorb storm-water up to 3 times as fast as a common grass lawn. Mowing is required, but only approximately a third of the times as common lawn is cut, which significantly reduces CO2 emissions from mowers. The rich flowering provides an aesthetic quality and an aid to pollinators (Smith 2016).

SOLUTIONS FOR DESIGN PROGRAMME

Use where people **activity is mediocre**

Use for **aesthetic** reasons in patches seen by many where grass may be superfluous and instead of other perennials.

Use to heighten species richness and heighten **Biodiversity**

Native species

ALTERNATIVE LAWNS

MEADOWS

Vegetation with high biodiversity compiled of forbs and straw plants (Hall, Granström & Sjörs).

BIODIVERSITY

"Meadows display considerable biodiversity" (Kingsbury 2014 p. 64). By establishing meadows in places where lawn is superflous a higher degree of species richness can be achieved (Hitchmough 2012). Meadows are compiled of many different species of forbs and straw plants, which makes for long flowering periods and a wide distribution of nectar to a variety of insecticides. Many meadow plants that used to exist in abundance are now rare and fight to survive which makes the use of these meadow species extra important for long-term biodiversity (Pratensis AB u.å.).

Native plant species are in meadows as in tapestry lawns better a link to history and culture, thus perpetuating a genius loci as well as being better suited for the local climate (Ignatieva & Ahrne 2013).

ECOSYSTEM SERVICES

Meadow plants are a steady supplier of nectar to pollinators due to their high biodiversity. (Malmaeus et al 2015).

They also supply habitats for pollinators, effective carbon sequestration, stormwater manangement and aesthetics in their flowering for people. (Malmaeus et al 2015).

MAINTENANCE SWEDISH MEADOWS

To maintain a Swedish meadow it is vital to reduce nutrients by cutting it once a year in late summer, after most of the flowering. The cuttings are thereafter removed from the location not to fertilize the ground further.

Nutrient rich soils can be cut once more in late spring to remove even more nutrients.

Cuttings should be left for week to let seeds drop down before cuttings are removed.

Blank spots (blottor) should be created in the ground, with a couple of years gap, during spring maintenance, for new seeds to germinate in order to ensure a healthy succession of plants. (Pratensis AB)

SOLUTIONS FOR DESIGN PROGRAMME

Use for **aesthetic** purposes where lawn may be superfluous

Use to heighten species richness and enforce **biodiversity** for meadow plants and insects

Use to create **interest** and connection to local flora and fauna and history

Use mainly **rolled turf** for instant effect. Seeds & plug plants to reduce costs

Native species

Common meadow Photo: Pratensis AB

ALTERNATIVE LAWNS

GRASS-FREE LAWN/ TAPESTRY LAWN (ÖRTMATTA)

A culture of mowing-tolerant forbs intended for walking on as well as viewing from an aesthetic point of view Smith & Fellowes 2014.)

The tapestry lawn developed by Lionel Smith is a compilation of native as well as exotic species (Smith 2016). In a Swedish context however, only native species have been selected by researchers at SLU (SLU u.å.).

Grass-free lawn/ Tapestry lawn Photo: Maria Ignatieva

COMMON MEADOW (VANLIG ÄNG)

Common meadows are plant communities that thrive on dry to medium moist soil. They can manage some clay. Common meadows contain a wide mix of forbs and straw plants (Pratensis AB u.å.).

Common meadow Photo: Pratensis AB

DRY MEADOW (TORRÄNG)

Meadows that thrive on infertile, dry soils or in places with low precipitation during spring and summer, often found on sloping grounds.

The species are thus often tough, small and slow growing (Hitchmough 2014).

Dry meadow Photo: Pratensis AB

ALTERNATIVE LAWNS

GROVE MEADOW (SKUGGÄNG)

Grove meadows are suited for less sunny microclimates such as below trees and on soil with medium moisture. They contain species that are high growing and delicate in leaf texture (Pratensis AB u.å.)

Grove meadow Photo: Pratensis AB

MESIC MEADOW (FUKTÄNG)

Meadows on infertile soil with a steady access of water and a gradual transference towards wet meadows (Kärr) (Pratensis 2016; Anderberg 1999). They can manage draught periods without having their roots drying too severely because of the water retaining ability of humus and clay in the soils where they grow (Kowarik & Von der Lippe 2014).

Vegetation is often rich in forbs and large leafed grasses (Anderberg 1999).

Mesic meadow Photo: Pratensis AB

PICTORAL MEADOW (MÅLERISK ÄNG)

Pictoral meadow is a concept initiated by Nigel Dunnett to create something in between neatness and untidiness and contain annual plant species that are visually appealing (Ignatieva et al 2008).

Pictoral meadows are compiled forbs that are traditionally found as weeds in crop fields. Often planted the first year to provide flowering as annuals establish to flower the following year (Pratensis 2015, SLU u.å.)

Pictoral meadow Photo: Pratensis AB

GREEN ROOFS

"A green roof is a flat or sloped rooftop designed to support vegetation."

(Dvorak & Volder 2010 p.198)

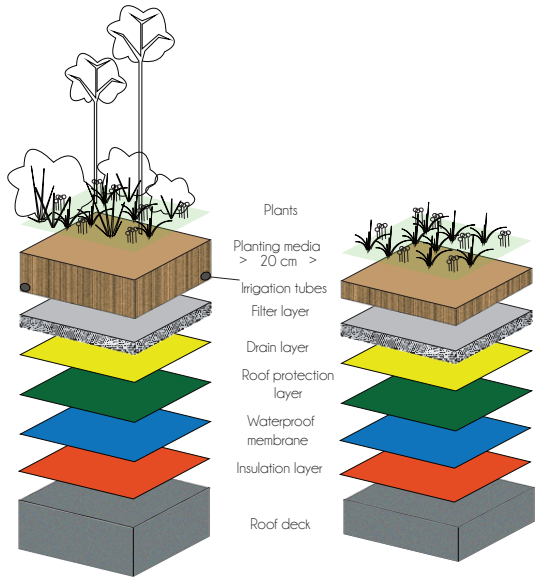
Green roofs have historically been used in Scandinavia to protect roof structures on buidings and increase their longevity. The most common function today is the regulation of water runoff (Ignatieva & Ahrne 2013).

There are several types of green roofs used. They can be divided into two categories: Intensive Green Roofs and Extensive Green Roofs (Peck 2008, Scholz-Barth & Weiler 2009). The type of green roof is determined by its structure and the maintenance it requires. The most common category used today is the extensive green roof planted with Sedum and Sempervivum species (Ignatieva & Bubnova 2014).

The green roof that supports vegetation in soil over 20 cm is called an intensive green roof. It requires fertilizing, weed sorting, irrigation and several cuttings per year is intensively maintained. They can support large shrubs or trees and are mostly used for ornamental purposes (Köhler 2006). Intensive green roofs are heavy because of the deep soil and can therefore not be used on every roof system without adding structural support (Wark & Wark 2003).

The other category, the extensive green roofs, has a planting media of maximum 20 cm, supports vegetation that is rarely or, in most cases, never cut (0-2 times a year), doesn't require fertilizer, irrigation (except maybe in an establishing phase and during periods of extreme draught), weed sorting or pesticides (Köhler 2007). In addition to this, the life expectancy of an Intensive Green Roof is estimated only to 25% of that of an Extensive Green Roof making them rather unsustainable (Kosareo & Ries 2006).

Intensive Green Roof Extensive Green Roof



Green roofs are, despite a higher initial cost, found to be less costly if examined during their entire life cycle than conventional roofs. Extensive green roofs have further an even higher cost-benefit ratio than an intensive green roof due to lower installation costs (Porsche & Köhler 2003).

BIODIVERSITY

Species richness is often lowest the closer to the centre of a city one gets (McKinney 2002). Since many large cities in the world are expanding and becoming denser with buildings, the need for developments of more green surfaces, that can increase biodiversity, is pressing (Ignatieva & Ahrne 2013). Especially extensive green roofs that aren't designed for social use can offer good undisturbed habitats for many plants and small animals such as birds and insects and play an important role on biodiversity in their area (Dunnett & Kingsbury 2004). The green roof can be ideal for different kinds of insects as well as other smaller

GREEN ROOFS

invertebrates and birds (Ignatieva & Bubnova 2014). Extensive green roofs can offer relatively diverse flora in urban environments, although not as diverse as intensive green roofs (Köhler 2006). Depending on choice of plant material, the green roof can increase biodiversity in the area and make good habitats for wildlife such as insects, invertebrates and birds (Ignatieva & Bubnova 2014). When designing a roof for the purpose of biodiversity and a vital succession with new plants and animals establishing, the roof should offer a variety of substrates and depths (Brenneisen 2006). For the roof to be able to inhabit a full range of dry meadow plants as well as many other drought-tolerant species, the thickness should be between 10-15 cm (Dunnett & Kingsbury 2004).

An important feature of green roofs aiding biodiversity is their function of acting stepping stones through a city. They can create important links between parks, gardens and other urban greenspace and let animals stop by and plants spread (Dunnett & Kingsbury 2004).

A varied microclimate on extensive green roofs has also shown to heighten biodiversity (Köhler 2006).

In order to get a maximised effect on biodiversity the focus must be on variety in: species of flowering plants, flowering period, plant form and structure and steadiness in structure over the seasons (Dunnett 2012). Using a variety in species can also increase the survival rate of forbs and grasses during dry periods (Dunnett & Nagase 2010). The survival rate of succulents is on the contrary in most cases independent of the diversity in plant species (Dunnett & Nagase 2010). The roof vegetation often has very different prerequisites than that of ground vegetation because the former will always be more exposed to solar radiation, wind, temperature fluctuation and draught (Dunnett 2012). Vegetation removed from a meadow and put on a tall building nearby will have a whole new climate to adapt to and many species will die. Therefore, the use of a specialized plant composition for the green roof by the use of rolled biodiversive turf from nurseries is encouraged (Ignatieva & Bubnova 2014).

Native plants are in most cases the best option to plant choice because of their adaption to the local climate (Obendorfer et. al 2007). Studies have shown that vegetation on green roofs tend to change over time with plants disappearing and others appearing (Köhler 2006).

ECOSYSTEM SERVICES BY GREEN ROOFS

The ecosystem services presented on the next page are: Stormwater management, life support of Pollinators, Temperature levelling and Energy conservation, Improving visual Aesthetics, Protection of roof membrane, Air cleaning and Noise reduction.

An extensive green roof with meadow, Sedum plants and bee hives Photo: Maria Ignatieva

GREEN ROOFS

STORMWATER MANAGEMENT

A roof that contains soil and vegetation has the ability to store water from precipitation and keeping it from creating large floods that carry and accumulate pollutants and toxins to other areas from where they eventually might reach the groundwater (Bolund & Hunhammar 1999). Instead these can be kept in smaller amounts and managed in place.

Handling storm water in place also reduces risk of sewages overflowing and along with the water carrying unfiltered waste such as heavy nutrients or polluters into lakes and rivers that otherwise might have been neutralized in lower concentration (Rowe 2010).
Extensive green roofs with sedum plantings are easy to establish and maintain. But they do not give the greatest effect on stormwater management or biodiversity, instead "by mixing succulents with grasses and forbs, stormwater retention and surface cooling were maximised." (Dvorak & Volder p. 205).

POLLINATORS

Because a green roof is elevated and not used or seen in the same way as vegetation on the ground it often has less strict demands from clients of expressing tidyness than design and vegetation on the ground (Dunnett 2012)

If using meadow plants on green roofs they will become a steady supplier of nectar to pollinators as well as good habitats . (Malmaeus et al 2015).

An extensive green roof with dry meadow plants in London Photo: Maria Ignatieva 2015

TEMPERATURE LEVELLING, ENERGY CONSERVATION

A green roof will provide both a cooling as well as a heating effect on the house it is applied on which will reduce costs of and the use of heating and cooling systems indoors (Rowe 2010). Green roofs could, if used more, be an important means to level temperatures in urban environments. The urban heat island effect (urban areas being warmer than their surrounding areas) could be reduced significantly (Nagase & Dunnett 2010).

AESTHETICS

A green roof can provide not only functional, but aesthetic factors as well. They can for instance connect private spaces of buildings with public spaces around, creating a unified look and a harmonious sense (Peck 2008).

To create a clear pattern and a mass effect that give spectators a rich experience, a few species that are visually dominant should be chosen in addition to the plant community to create a repetetive mass effect (Dunnett 2012).

GREEN ROOFS

PROTECTION OF ROOF MEMBRANE

The modern green roof was initiated in Germany around the year 1900 to reduce the negative impact of solar radiation effect on roof structures thus protecting it (Obendorfer et. al 2007). The protection of the roof of the private house was the main purpose of using green roofs also in Scandinavia during the 19th and 20th century (Ignatieva & Bubnova 2014). By applying a shielding green roof structure atop a roof, the membrane of a house recieves far better protection than without it (Wark & Wark 2003). The membrane being protected under the green carpet from UV-lighting, heat fluctuations, wind, precipitation, pollutants as well as damages and wear down due to other maintenance and construction on the roof (Wark & Wark 2003).

The life expectancy of an average roof system is approximately 25 years (Kosareo & Ries 2006). When applying a green roof on top of a conventional roof the estimated life expectancy increases with approximately 20-25 years (Kosareo & Ries 2006).

AIR CLEANING

Plants, but mostly the soil they grow in can absorb pollutants and by the effect of microorganisms, neutralize some of them. They also prevent the creation of pollutants such as ozone by reducing surface temperatures (Rowe 2010).

NOISE REDUCTION

”Vegetation in combination with the growing substrate will absorb sound waves to a greater degree than a hard surface.” (Rowe 2010 p. 2105). Maximum effect on noise reduction is given when using a 15-20 cm deep substrate (Rowe 2010).

MAINTENANCE

Extensive green roofs with mixes of meadow plants and stonecrops should be maintained as meadows with cuttings approximately once a year. If the roof isn’t used by people it might not need cutting at all.

If the roof is an intensive green roof it should be maintained in accordance to the requirements of the plantings (Rowe 2010).

SOLUTIONS FOR DESIGN PROGRAMME

Extensive green roofs

Variety in plant species, form, structure, flowering periods and microclimate

Meadow plants with a mix of Sedum and Sempervivum plants, other forbs and grasses

A few key species that are visually dominant

Mainly native plants

Rolled turf from nurseries

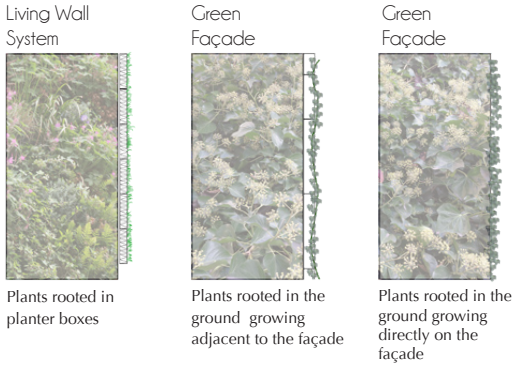
Varied substrate type and depth of 10-15 cm

GREEN WALLS

"All forms of vegetated wall surface" is a green wall (Ottelé 2011 p. 9).

Today green walls are used at a high degree to relieve building constructions from negative effect of ecological deficiency due to the removal of former existing natural milieu and restore ecological benefits (Perini et al 2012). Green walls have for 2000 years been used for fruit production, ornaments, to screen simpler façades and for shade. In the more recent history they were used to bring nature into cities (Köhler 2008).

Green walls are mainly divided into two categories. *Green façades* and *Living Wall Systems* (Ottelé et al 2011).



Green façades are systems of climbing plants rooted in the ground or in boxes on the ground growing directly on the façade or indirectly attached to wires, grids, meshes or other structures adjacent to the façade, or directly climbing on the façade (Green Roofs for Healthy Cities 2014; Ottelé et al 2011).

When using green façades implications may arise if plants climb directly on porous building material and not on structures adjacent to building (Ottelé et al 2011). The plants can grow up to 25 meters and maximal height will take several years to reach (Ottelé et al 2011). The system with meshes has the same expected lifespan as the other green façades but emits more greenhouse gases in a construction phase (Ottelé et al 2011).

Living wall systems (LWS) "involve planter boxes or other structures, such as layers of felt, to anchor plants that can be developed into modular systems attached to walls to facilitate plant growth without relying on rooting space at ground level." (Köhler 2008 p. 424).

Some Living Wall Systems are utilised with felt structures to hold the plants. Felt has a short lifespan and contribute to releasing high concentrations of greenhouse gases and toxins into water (Ottelé et al 2011). Planter boxes have a longer lifespan and release less toxins and greenhouse gases than felt layers, but still more than green façades (Ottelé et al 2011). LWS are furthermore often rather expensive, consume a great deal of energy and are difficult to maintain (Perini et al 2011).

BIODIVERSITY

Dunnett & Kingsbury (2004) and Köhler (2008) discuss green walls making a great difference on fauna biodiversity in urban areas. They provide habitats for insects, spiders, beetles and invertebrates that in turn are eaten by birds and bats who also frequent the shrubbery of the green walls.

The production of nectar and fruit is also an important quality that directly provides insects and birds with sources of food. Some birds that are sensitive to cold also use evergreen walls for winter roosting. In spring they are to some extent used for nesting (Chiquet, Dover & Mitchell 2012).

Some LWS that are designed with holes, such as those from Butong give good hibernation locales for many insects (Ignatieva & Ahrne 2013).

GREEN WALLS

ECOSYSTEM SERVICES BY GREEN WALLS

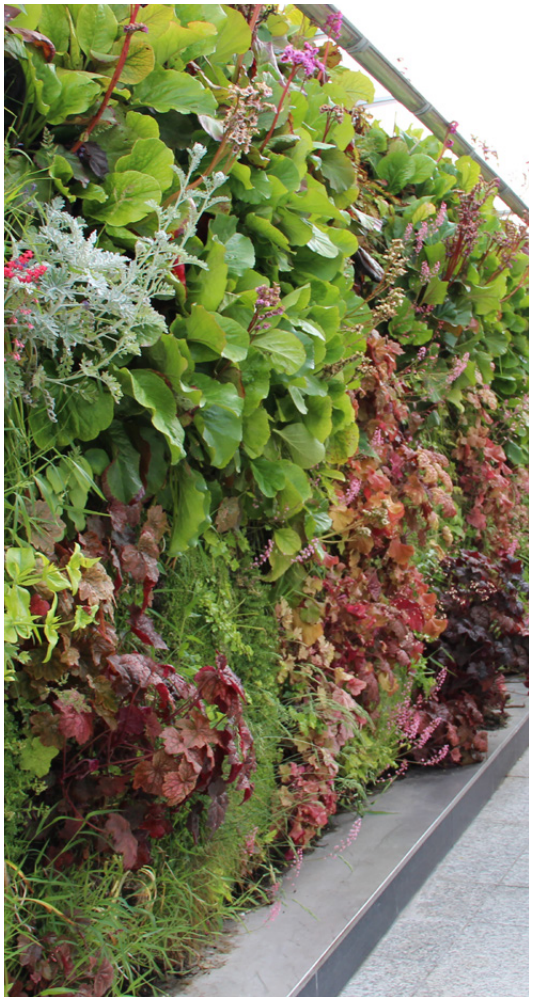
Below follows a series of ecosystem services provided by green walls. Stormwater management, temperature levelling, energy conservation, air cleaning, protection of walls and aesthetics.

STORMWATER MANAGEMENT

Green walls may play a role in the delay of stormwater, in the same way as stormwater is handled by green roofs (Dunnett & Kingsbury 2004).

TEMPERATURE LEVELLING

Green walls can stabilise temperatures close to the façades they are mounted on when shading them from solar radiation and keeping winds from cooling and heating in an extreme fluctuant way (Perini et al 2011). In summer the green walls will be cooler than bare walls and in winter they are warmer than bare walls (Perini et al 2011). By doing this the green wall structure also helps maintaining a better indoor climate than otherwise, thus keeping electric cost, for cooling and heating, down (Roehr & Laurenz 2008; Perini et al 2011).



A Living Wall System Photo: Maria Ignatieva

However, green façades are not as efficient as Living Wall Systems to insulate walls and keep heat and the energy save by cooling buildings is much higher in Mediterranean climates than in temperate ones (Ottelé et al 2011).

Furthermore, Living Wall Systems can be quite energy consuming in a production phase as well as for the use of irrigation (Perini et al 2011).

AIR CLEANERS

Climbers on walls are very effective in trapping dust and pollutant particles in their tissues that soon are to be discarded (Dunnett & Kingsbury 2004). They work as a sort of filter and particles follow dead foliage to the ground.

PROTECTION OF WALLS

The green wall can be protective of the wall from heavy rainfall and hail (Dunnett & Kingsbury 2004). Anneli Wallgren, landscape

GREEN WALLS

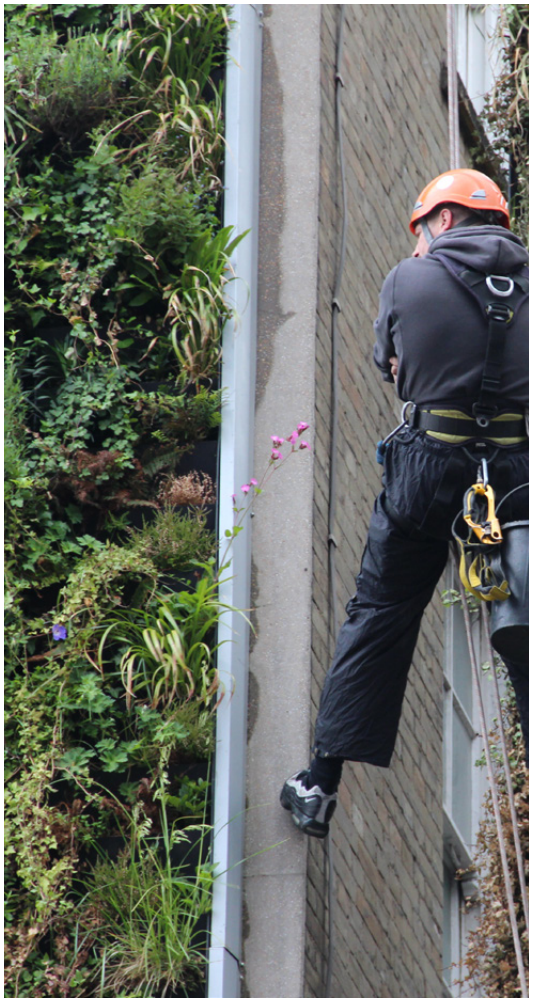
architect at the Swedish housing company Svenska bostäder, states that green walls can be effective in protecting the façade from graffiti. Buildings that are negatively affected by acidic rain can with the use of a green wall be protected from the damaging acids (Köhler 2008).

AESTHETICS

Green walls have long been used as an aesthetic addition in cities (Ottelé 2011). Sofia Eskilsdotter states that they can provide spaces with aesthetic stimulation where there formerly weren't any and that the most important service of a green wall is to provide people with green views.

MAINTENANCE

The maintenance of green façades and Living Wall Systems differ. Green façades can be as good as maintenance free, only with a yearly inspection and perhaps some pruning while LWS demand a higher degree of maintenance for trimming, irrigation and control of their complex systems (Dunnett & Kingsbury 2004, Perini et al 2011).



Living Wall System maintenance Photo: Maria Ignatieva

SOLUTIONS FOR DESIGN PROGRAMME

Green façades

Evergreen plant species where possible

Plants with aesthetic colour

A variety of plant species to offer long periods of flowering

Use for air cleaning in polluted areas

INTERVIEWS

PART ONE

DESIGN

HILDEGUN VARHELYI-NILSSON

Hildegun is a landscape architect at SLU and also works as a consultant at her own firm, in both Stockholm and Los Angeles.

ECOLOGY

I never use the term ecological design. It's more about sustainable design. That includes succession, water and everything around it. They're similar I guess.

In my work it's often tough to work with ecological issues. Instead, maintenance aspects play a larger role in my designs. It's always easier when there is an awareness with the people I work for, such as boroughs, but of course this is something I can put on the table as well and argue for. But it's often difficult with private parties.

In Los Angeles people have started to understand the drought problematics. I work a lot with drought resistant plants, but that doesn't necessarily mean high biodiversity. If most of the land is succulents and gravel it's basically the same degree of monoculture in the plant community as a lawn.

LAWN AND ALTERNATIVE LAWNS

The lawn in America somehow became a symbol of democracy. Everyone suddenly wanted one as the country rose in wealth. In Los Angeles today, that's very much out of fashion, in favour of the more natural looking steppe like character. Celebrities are often publicly shamed for having flourishing lawns in the dry L.A. climate.

I think pictoral meadows are brilliant because of the direct flowering. When planting a real meadow it often takes a year in planning and the effect sometimes comes within a few years.

GREEN ROOFS AND GREEN WALLS

The importance of green roofs increase with the rate our cities densify. There really are only benefits to green roofs: water retention, biodiversity and maximizing the use of urban space.

Green walls often demand quite complicate systems to support both irrigation and fertilization. I don't think they are very sustainable yet. But I don't think there is no limit to what the technology of green roofs in the future.

SOFIA ESKILSDOTTER –

Sofia is a landscape architect who works with the landscape architect programme at SLU. She also works as a consultant at her own firm.

ECOLOGY

Working with ecology and design is all about imitating nature. But there is a great resistance to ecological design in the field. People still listen to gardening programs that perpetuate an idea of English gardenesque design with lots of water and nutrients. Of course people see that as the ideal to strive for.

The relation between ecology and aesthetics is really important to think about when designing with ecology. It has to look neat to appeal to people. And it's always cheaper to design with ecological functions. Using native species for instance. Exotics and cultivars often demand higher maintenance. But it can also be important to work with colour to please people and therefore it can be justified letting cultivars into the design if one has good knowledge about their effects.

PLANNING

LAWN AND ALTERNATIVE LAWNS

I believe in using alternative lawns such as meadows in the right places. I think that working with clear edges is important, exposing the maintenance.

GREEN ROOFS AND GREEN WALLS

Meadow plantings on green roofs is very interesting. It has low demands on maintenance and provide grand visual effect.

Storm water is a great resource to use for green roofs and green walls. The green wall in Björns Trädgård (Stockholm) use storm water.

I think green walls in urban environments mainly have psychological effect. It's a great health benefit just seeing green structures in grey areas. And if there is a possibility to create a species rich environment as well then that's another benefit. Climbers can be great but can grow into vents. Therefore a built module is better. We're only at the beginning of this now, but the hope is to get them integrated into the house building process. That would reduce both cost and negative environmental effects.

LARS JOHANSSON

Lars is a landscape architect and works with the landscape architect programme at SLU. He has worked within several municipalities as city gardener and landscape architect, with design and planning but mostly planning.

ECOLOGY

There is a lot built up around concepts such as ecological design and biodiversity, but generally I believe that what people are doing out there in the field is basically the same as it was before.

Dutch heem parks always inspired me. Plant communities that are almost self sustainable. It doesn't look messy. At first they only used native plants, now they allow for some exotics too.

Something good today is all talk about handling of water. But there is so much hardened space in out cities and so much talk about creating places and spaces for people to meet etcetera which creates even more hard surfaces; still we keep talking about ecosystem services.

LAWN AND ALTERNATIVE LAWNS

I never understood the compulsive mowing of grass. People mow because the neighbours mow. I like a lawn when it's this thick carpet to play sports or have picnic on. But it's been used too much as filling for left over space.

Creating meadows can often be problematic in soils that are nutritious. They need meagre soil. For a while there were lots of ideas about creating meadowland just by reducing maintenance. That of course failed.

The contrast between high and low grass is interesting. Cut walkways in meadows for example. A good idea is to plant meadow in terrain so that the wear down isn't too high.

GREEN ROOFS AND GREEN WALLS

I am sceptical to green roofs and walls. They are often are used for greenwashing, for branding projects. Green roofs are good for delaying water, but I see risks of misuse as arguments to reduce greenspace elsewhere.

Green walls can be very technical and then they get very expensive. Why not deal with the greenspace we already have in our nature?

PLANNING AND MANAGEMENT

ANNELI WALLGREN

Anneli is head functioning landscape architect at Svenska Bostäder. It's owned by the borough of Stockholm and is one of the largest housing companies in Sweden.

ECOLOGY

We're working on rain gardens right now. It can be more efficient than using green roofs for handling rain.

Other ecological measures we work with is to release nutrients back into the ground when cutting all leaves on our grounds. We use chicken's manure as fertilizer and prescribe organic fertilizers for entrepreneurs to use.

In many areas we have birdhouses for birds to settle down within residential areas.

LAWN AND ALTERNATIVE LAWNS

Essentially we only manage ordinary lawns. A good lawn can provide a great gathering space for free activities. It is good to use in courtyards because of the relatively cheap maintenance compared to other surfaces.

The meadows we handle are transitions to nature or on nature land. We have tried to use meadows in courtyards but is hasn't worked due to wear down and complaints that it looked messy. We never made it in creating that perfect flowering meadow. Only in places where we could make little hills it's worked. Often we're having trouble just establishing regular lawn due to high wear down. However, I think sunken wet meadows area good alternative to lawns in the right place.

GREEN ROOFS AND GREEN WALLS

Both green walls and green roofs provide positive and lush impressions. We have worked with sedum roofs on complementary buildings and we use green façades with english ivy (Murgröna) on to prevent graffiti. It has worked well so far. But we keep them low not to cover any windows. On some buildings we use climbers that attach directly to the façade, but they are cut back every year to prevent damages to the façade. Other green walls i think could be problematic for us with a lot of maintenance high up on buildings.

ANN-LOUISE DYER

Ann-Louise is a landscape engineer at Uppsala municipality. She works with future investments and developments at the unit for operation and maintenance (Enheten för drift och underhåll)

ECOLOGY

We are currently developing guidelines for ecology as well as grass in the borough. Next year our annual plantings will be limited to edible plants and pollinators.

We try to invest more in initial establishing stages to get a lower maintenance costs further on. By doing so we hope to reduce ecological footprints as well.

LAWN AND ALTERNATIVE LAWNS

We have large areas with different kinds of grass in Uppsala. Lawn maintenance is a big part of our budget. We manage three types of grass: normal turf (bruksgräs), high grass cut twice a year and high grass cut once a year.

We are looking into how to change our machines to reduce the CO^2-emissions. If we also can reduce the spaces of lawn to meadows cut once or twice a year we will be

MANAGEMENT

able to lower CO^2-emissions even further. This will also help boosting other ecosystem services within Uppsala and hopefully biodiversity as well.

Last year we had an experiment with rich flowering meadow plants in planting boxes, which were very much appreciated.

We get lots of complaints if we don't cut lawns when people think we ought to. People have very strict views on lawns and get really upset if they think it looks messy.

When working with meadows and high grass it's important to make it seem well maintained. Working with contrasts between cut walkways and high grass is really interesting.

GREEN ROOFS AND GREEN WALLS

We only manage green roofs on public bathrooms with stonecrop. We are talking about developing it more in the future.

We're managing some green walls. Green façades with climbers such as Boston ivy (rådhusvin) and climbing hydrangea (klätterhortensia). I see the same qualities in green roofs and green walls as other green surfaces, which always is to improve ecosystem services.

MATS BERGLUND

Mats is a Park engineer at the Parks department of Skarpnäck's city district (Skarpnäcks stadsdelsförvaltning) in Stockholm stadsdelsförvaltning. He started off as being maintenance worker and has a basic gardening education. He is in charge of controlling the entrepreneurs doing the maintenance today. Most park engineers today are educated landscape engineers.

ECOLOGY

We try to leave as much as possible after each maintenance job like brushwood, logs, high stumps of trees etc. It used to be the other way around. We removed everything not to make untidy impressions. Often people call us and complain about brushwood lying around. I explain to them that it's for biodiversity reasons that we leave dead plant material, and they immediately soften.

Sometimes we of course have to take down trees, but our policy is and has been for many years now, that for every tree we remove, we plant two new ones close by to ensure the survival of at least one of them and to compensate the lost volume.

LAWN AND ALTERNATIVE LAWN

We currently manage three types of grass areas: ornamental lawn (prydnadsgräsmatta) and normal lawn (bruksgräsmatta). Then there is the open grazed nature land. We used to have long grass in some places, but there were too many complaints that it looked messy and people were afraid of tics and stepping in dog poop. We changed it to conventional lawn.

We tried to make it work with meadows in several places. We sowed seeds from meadow plants and maintained the plantings in the right manner. We removed 20 cm soil and replaced it with soil made from sewage sludge (rötslam) from a local sewage plant (Henriksdals reningsverk). Unfortunately we never managed to get it to become real meadowland and we eventually went back to conventional lawn there as well.

Lawns are relatively cheap to maintain compared to many other surfaces such as flower bed plantings and many perennial plantings. That's good for us as we manage so much of it.

ECOLOGY

GÖRAN THOR

Göran is a professor of ecology at SLU. He works at Artdatabanken as well as teaching and research at the institution for ecology at SLU.

ECOLOGY

What's important when working with ecology, is knowing the place at hand. Knowing what's there and what's around. What plant qualities might be good to save, checking for unusual species in the area, create places that blend in with the landscape.

The most important measure to take if one wants to ensure high biodiversity is nutrient poor soil. The other thing is to work with variation. Varying the character of the vegetation and the species within them.

Planning for succession is also significant. Taking in the short as well as the long-term perspective. People love large, grand trees and sometimes remove all the small ones. But they forget that large trees eventually die.

When designing for biodiversity, a key aspect is to be aware of what groups are benefitted from what measure.

Ecology in urban environments has a lot to do with acceptance and involving people. If people accept a design then it's successful. The main focus should always be to create places that are well liked and with low maintenance.

LAWN AND ALTERNATIVE LAWNS

I'd like to push for the positive values in conventional lawns. It's easy to pick on them, but there is nothing better than a neatly cut lawn when you want to sit down and have picnic. However, lawns can be unpleasant if planted in too large quantities.

But I think meadows could be used much more than they are today. In sunny places beside activity areas for instance.

GREEN ROOFS AND GREEN WALLS

Green roofs are a great resource in cities. If one looks at photos from the air it becomes apparent how much space there is to redesign.

I wonder about the sustainability in green walls made of concrete. It's a material that leaves heavy ecological footprints. And how sustainable is concrete when filled with plants, soil, air and water?

INTERVIEWS

SUMMARY

+		−
	ECOLOGICAL DESIGN	Difficulty to change people's views
Ecosystem services Better establishment of plant communities Lower maitenance Heightened biodiversity		
	CONVENTIONAL LAWN	
Cheap compared to many other spaces CO2-sequestration Neat appearence Social activities/high use		High maintenance in comparison High CO2-emissions Low biodiversity Monotonous aesthetics
	ALTERNATIVE LAWNS	
Aesthetic appeal in flowering Enforce ecosystem services Hightened biodiversity Low maintenance		Can appear messy People's scare of tics Sensitive to intensive use
	GREEN ROOFS	
Maximising space use Enable ecosystem services May increase biodiversity		Greenwashing problem
	GREEN WALLS	
Enable ecosystem services Green views Heightened biodiversity		Greenwashing problem Difficult maintenance (LWS) Expensive (LWS) Fear of façade damage (GF*) Sustainability problems (LWS*)

*GF- Green façades
*LWS-Living Green Walls

SOLUTIONS FOR DESIGN PROGRAMME

ECOLOGY

Create **neat transitions** between surfaces
Plant communities that require **a minimum of added fertilizers, irrigation**
Plan for **succession**
Design with **low but continuous maintenance** in mind
Involve people

ALTERNATIVE LAWNS

Pictoral meadows for "direct" effect
Clear edges and **cut walkways**
Meadows in **Terrain**

GREEN ROOFS AND GREEN WALLS

Meadow on green roofs
Green façades

LAWN

Spaces for **tranquile** as well as **free activities**


DESIGN PROGRAMME
PART TWO

INVENTORY AND ANALYSIS

DETALJPLAN

Detaljplan* Bryggvägen (Stockholms stad 2014)

The detaljplan of Bryggvägen that was studied won legal force 2014 and was issued by Stockholms stad. It lay the foundation for the inventory and analysis and all the decisions on how to use the different spaces in the design programme for this work.

The site formerly inhabited an industrial facility and paking lots.

The future houses will be 5-6 storeys high.

The area is secluded and but is still located only ten minutes from the nearest tram (tvärbana).

*A "Detaljplan" is a plan/map issued by the municipality in Sweden to provide guidelines for how, what and where buildings are to be developed as well as a rough plan for the development of the outdoor space.

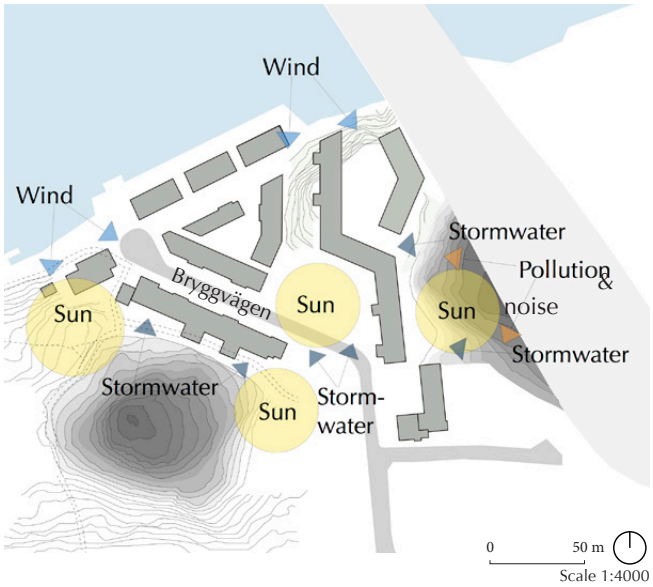
Gröndalsbron and Mälaren in the background

Gröndalsbron and a couple of large oaks

Large oaks in the middle of the development area

The pine hill west of the development area

CLIMACTIC FACTORS



The area is situated in between two steep hills and lake Mälaren north.

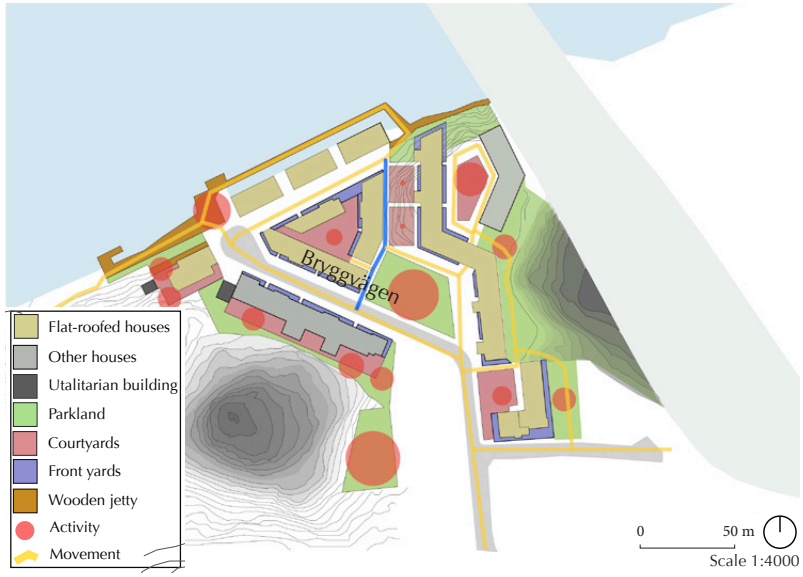
Several spots are exposed to full sunshine most of the day. The buildings shield the sun from reaching some parts and create shaded and wind shielded places.

The parts closest to Gröndalsbron are exposed to pollution as well as drought which demand tough plants. The remnant vegetation is therefore even more important here because the establishment of new trees here can be problematic.

In the western part, below the hill, there will be an abundance of water during rainfall.

INVENTORY AND ANALYSIS

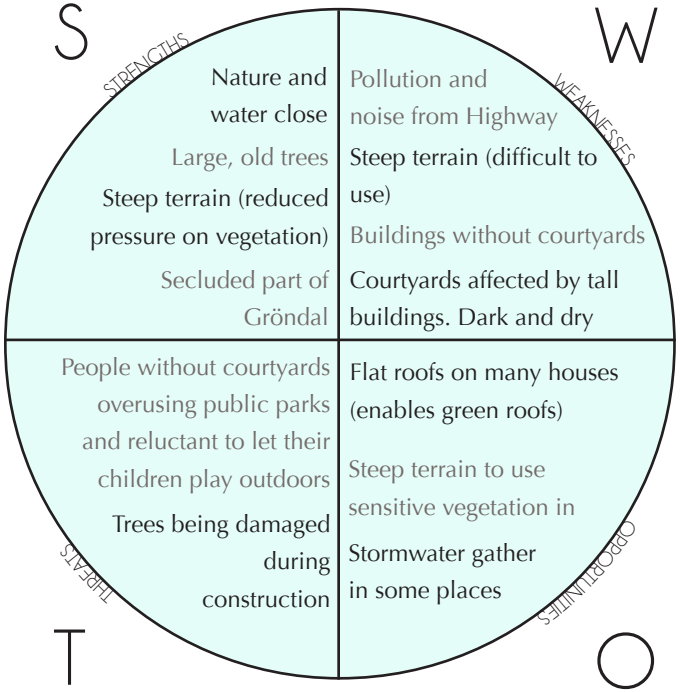
AREAS AND MOVEMENT



The areas presented above were assessed from an analysis of the detaljplan. Some areas such as streets, parkland and the wooden jettys were already set whereas the courtyards and front yards weren't. The three houses closest to Mälaren weren't given any courtyard space at all. Therefore the public park areas as well as the wooden jetties will become extra important to the residents of these houses.

The study of movement and activity was conducted partly by observations at the site and partly by a desk study where I assessed movement and activity of the future site based on information from the detaljplan and illustrations from architectural firms.

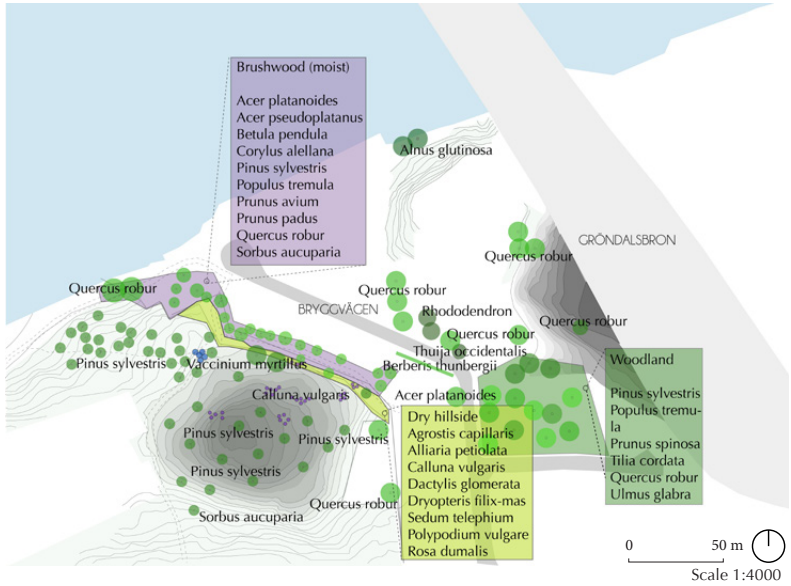
SWOT-ANALYSIS



The SWOT-analysis resulted in a series of bullet points to work with. These are the main issues that I find in the area. I used them to see what decisions to make during the scetching of solutions for the design programme.

INVENTORY AND ANALYSIS

VEGETATION



The vegetation in the area is a good reflection and indication of the overall conditions of the place. Heather shrubs and pine trees grow on dry hills. Brushwood of very mixed plants with different character on a sloping hillside with thicker soil. Oaks grow mainly where there is better soil conditions and the woodland with larger trees spread out in an environment also with thicker soil. Near the shore, a couple of alder trees grow and next to where there once was a building, rhododendrons and a thuija still stand.

The most important vegetation of the place today are the larger oaks and pine trees. But also the heather schrubberies as they make up strong and characteristic plant communities in the edges.

Quercus robur. Oak (Ek)

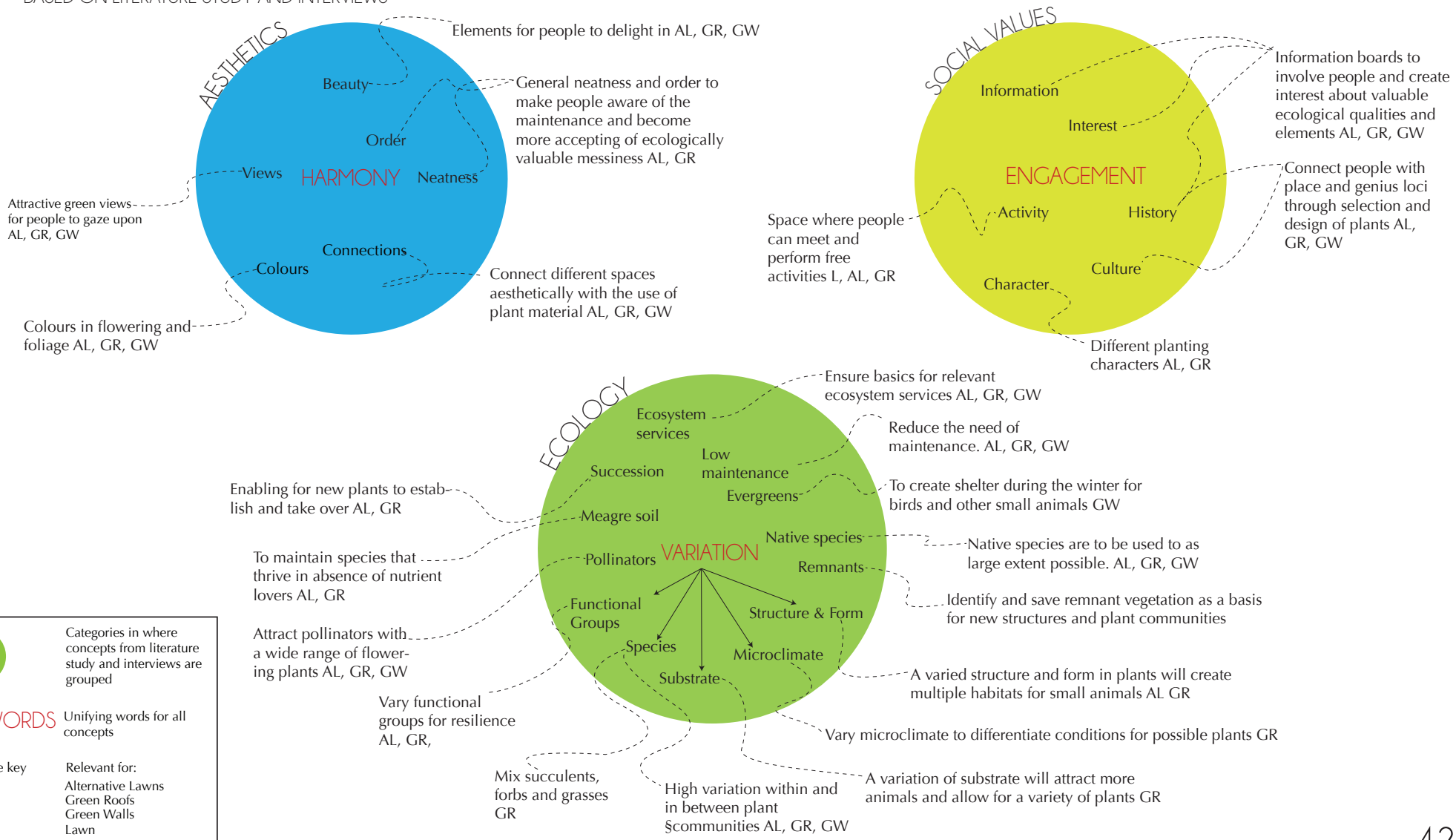
Pinus sylvestris. Pine tree (Tall)

Calluna vulgaris. Heather (Ljung)

GENERAL ECOLOGICAL DESIGN SOLUTIONS

- FOR MAINLY ALTERNATIVE LAWNS, GREEN ROOFS AND GREEN WALLS

BASED ON LITERATURE STUDY AND INTERVIEWS



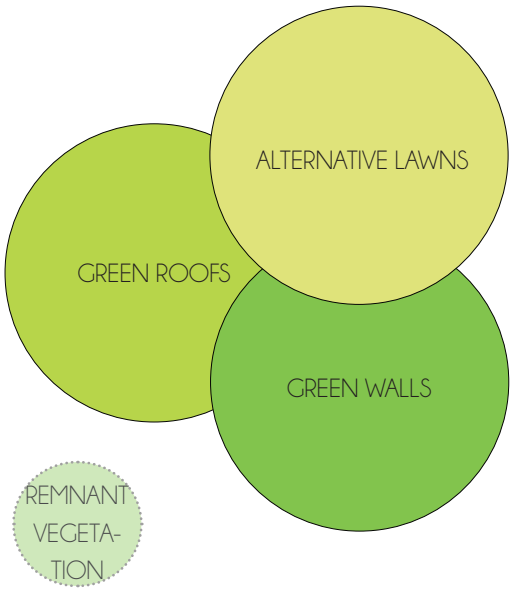
CATEGORY — Categories in where concepts from literature study and interviews are grouped

KEY WORDS — Unifying words for all concepts

Relevance key	Relevant for:
AL	Alternative Lawns
GR	Green Roofs
GW	Green Walls
L	Lawn

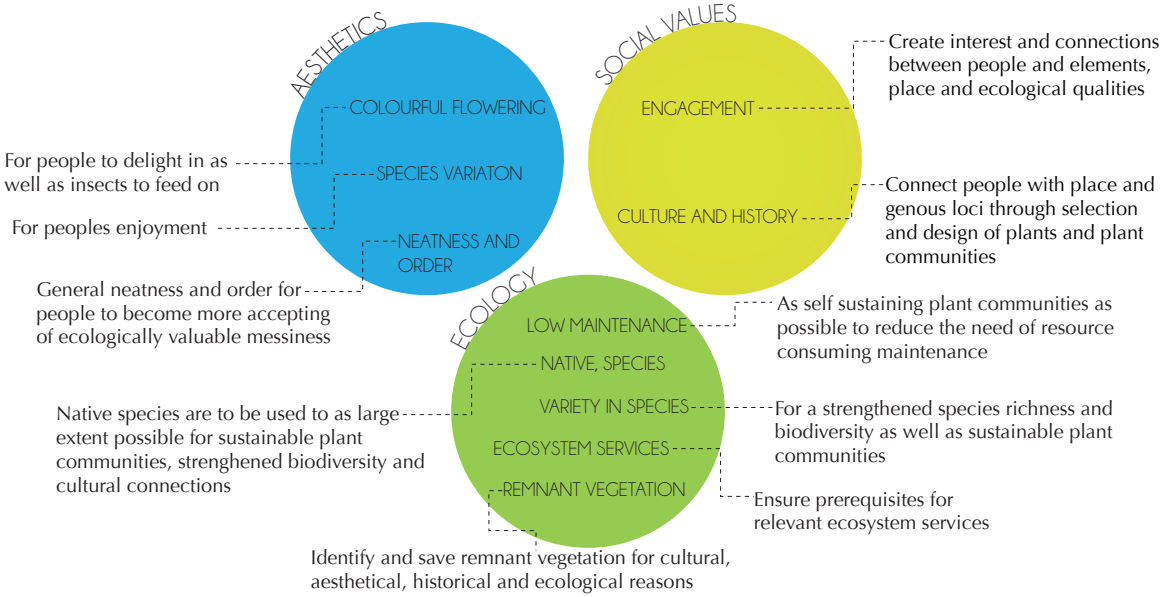
DESIGN

THE BIODIVERSITY TRIO



The biodiversity trio consists of **Alternative Lawn**, **Green Roofs** and **Green Walls** and make up the **main elements** of the design programme. **Remnant vegetation** will be an added element, too important for ecology, sense of place and structure not to include.

DESIGN SOLUTIONS FOR BRYGGVÄGEN

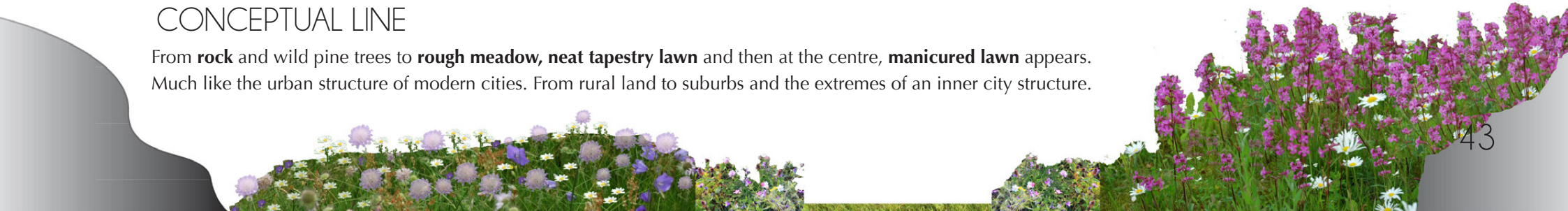


The figure above show the selected design solutions. Chosen concepts to work with are categorized under three headlines: **Aesthetics, Social values and Ecology**.

The design solutions are selected from the design solutions presented on page 42, which in turn are based on the literature study and the interviews.

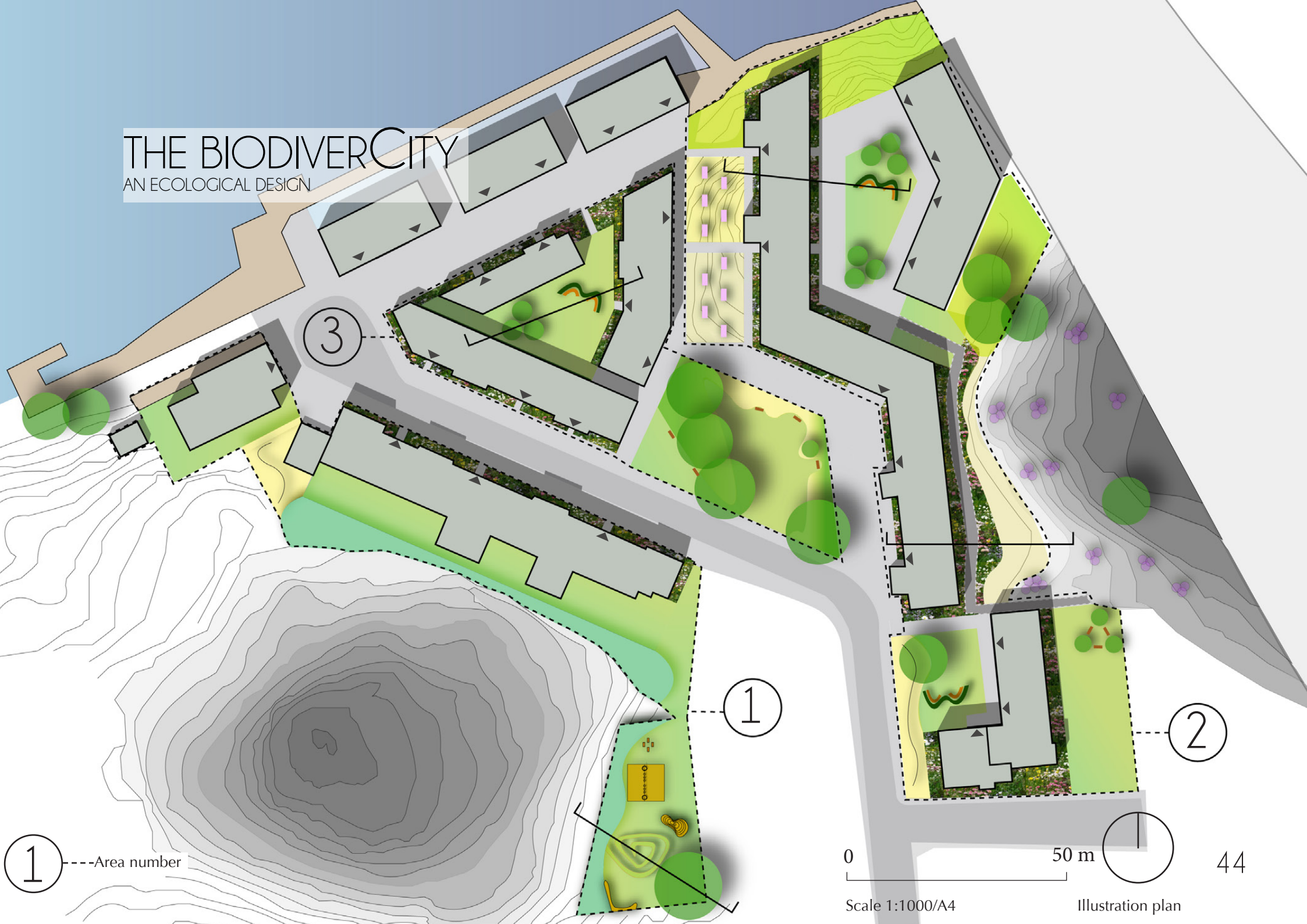
CONCEPTUAL LINE

From **rock** and wild pine trees to **rough meadow, neat tapestry lawn** and then at the centre, **manicured lawn** appears. Much like the urban structure of modern cities. From rural land to suburbs and the extremes of an inner city structure.



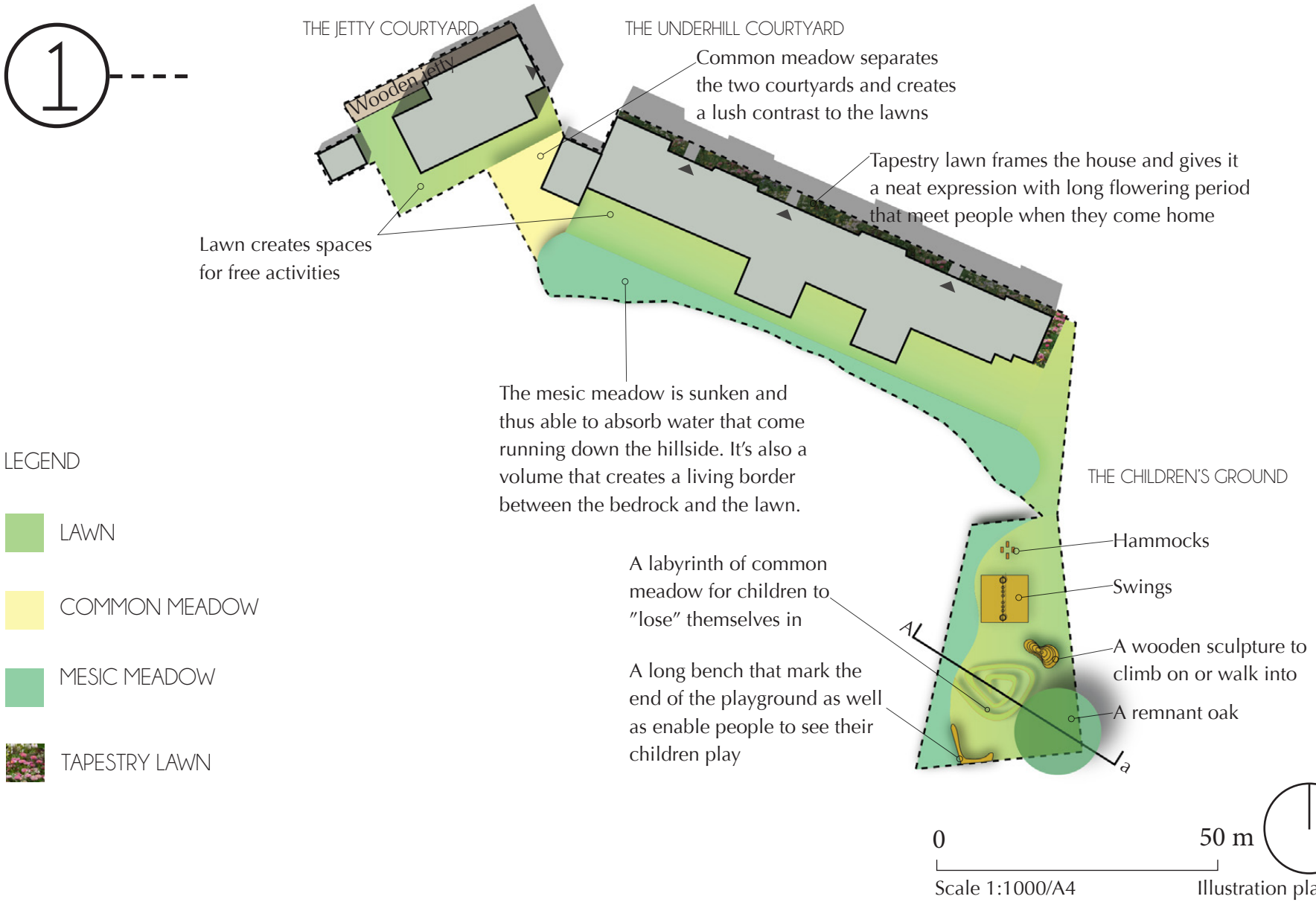
THE BIODIVERCITY

AN ECOLOGICAL DESIGN



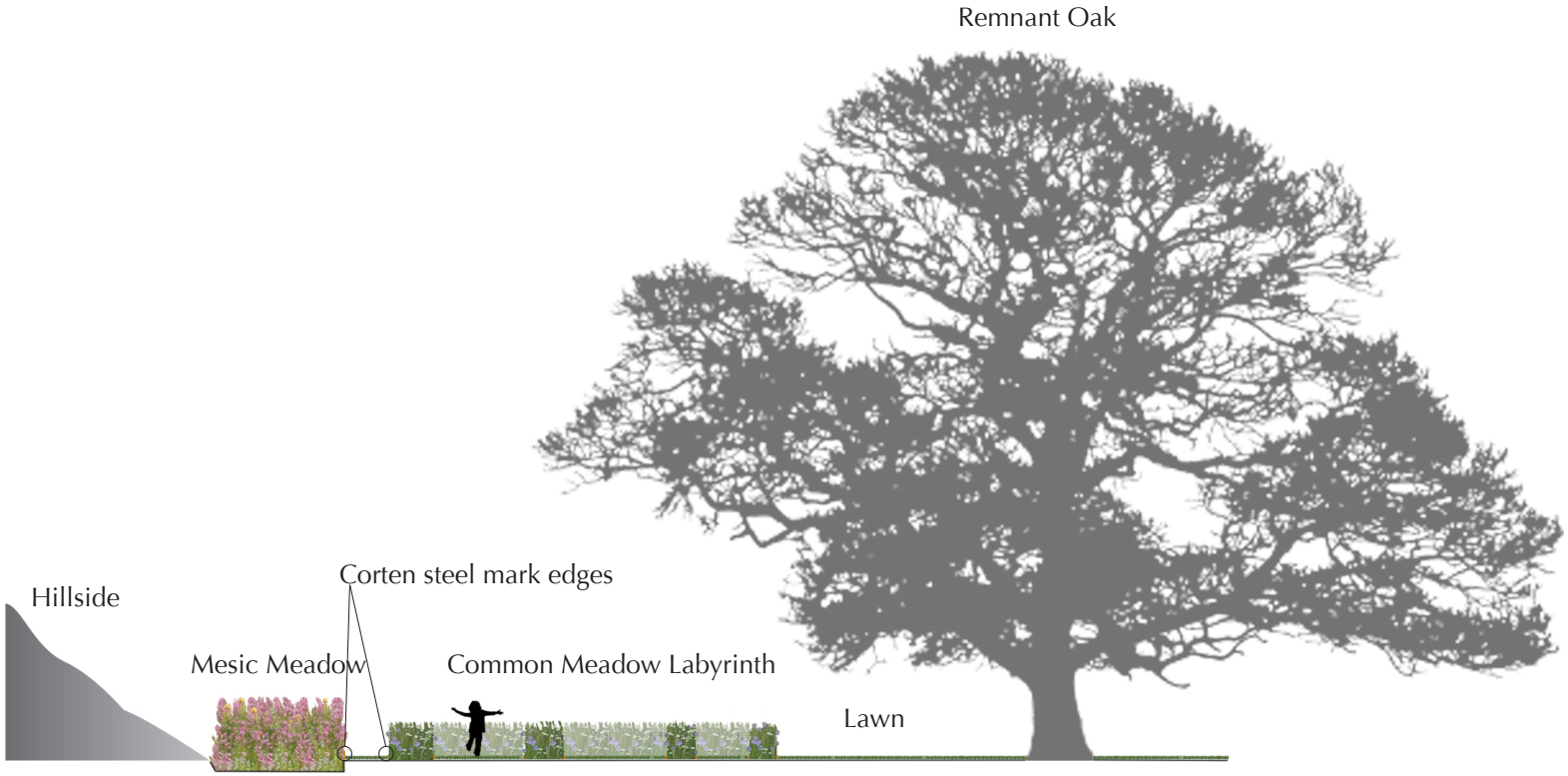
DESIGN PROGRAMME

1



DESIGN PROGRAMME

1 THE CHILDREN'S GROUND



A Selection of Section A–a Scale 1:150/A4

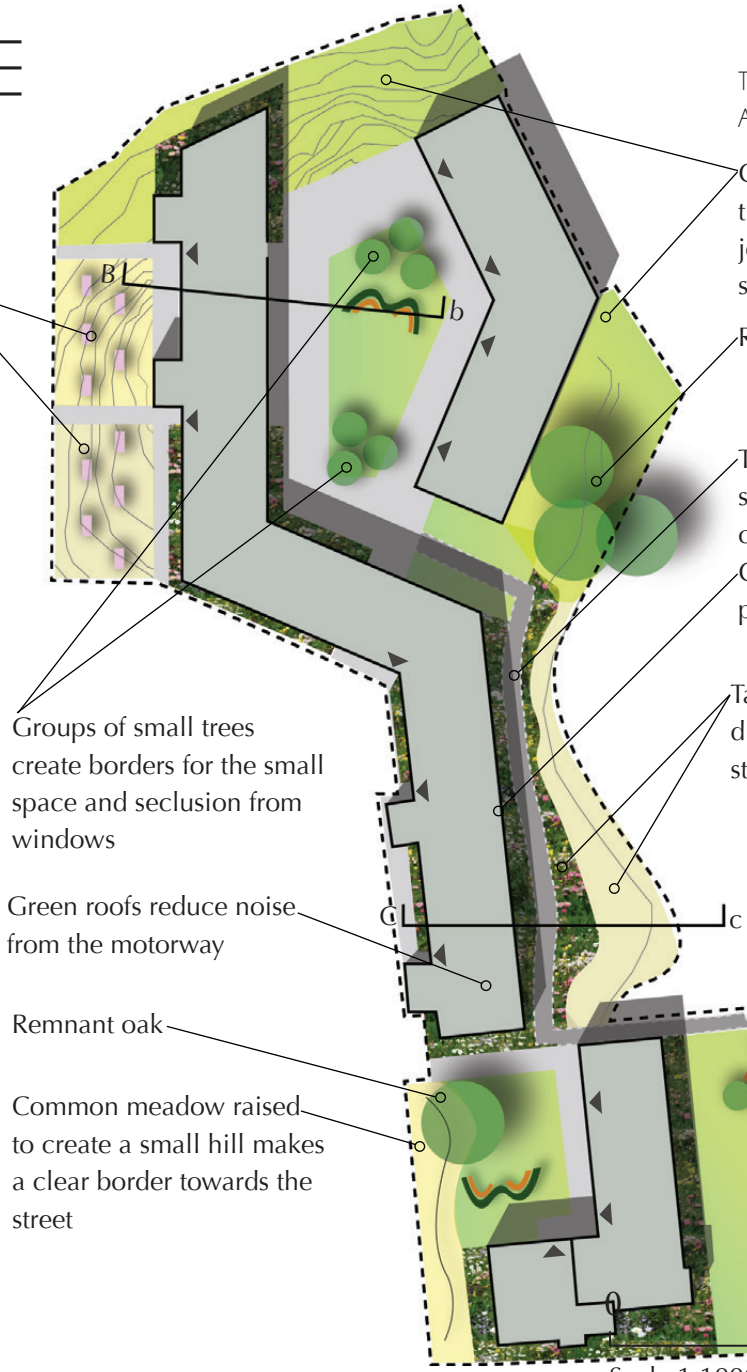
DESIGN PROGRAMME

2

The terrain is steep in front of the house and so the meadows are at low risk of being worn down by heavy use. Hammocks are placed on the hills for social use and walkways will be cut so that these easily can be accessed.

LEGEND

- LAWN
- GROVE MEADOW
- COMMON MEADOW
- DRY MEADOW
- TAPESTRY LAWN



THE GROVE COURTYARD AND THE LONG WALK

Grove meadow surrounds the house up to the wooden jetty and the water creates a soft barrier.

Remnant oaks

The path creates a short walk between the courtyards away from cars

Green façades diminish hazardous pollution from the motorway

Tapestry lawn frames the path and dry meadow is planted on the steeper hill.

Groups of small trees create borders for the small space and seclusion from windows

Green roofs reduce noise from the motorway

Remnant oak

Common meadow raised to create a small hill makes a clear border towards the street

THE PETITE COURTYARD

Three new oaks are planted to create a healthy succession of the oaks in the area. Together they form a canopy roof. Beneath them, benches are placed to create a space for tranquile activities. The rest of the lawn is left for free activities.

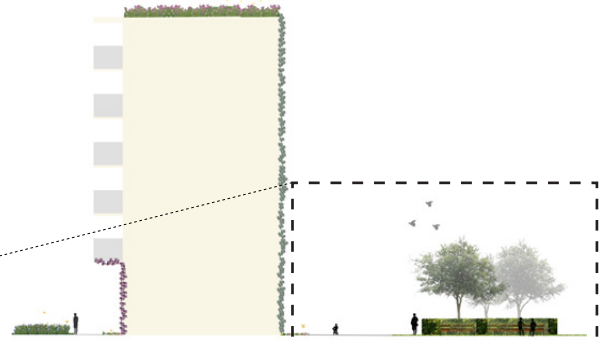
0 50 m

Scale 1:1000/A4

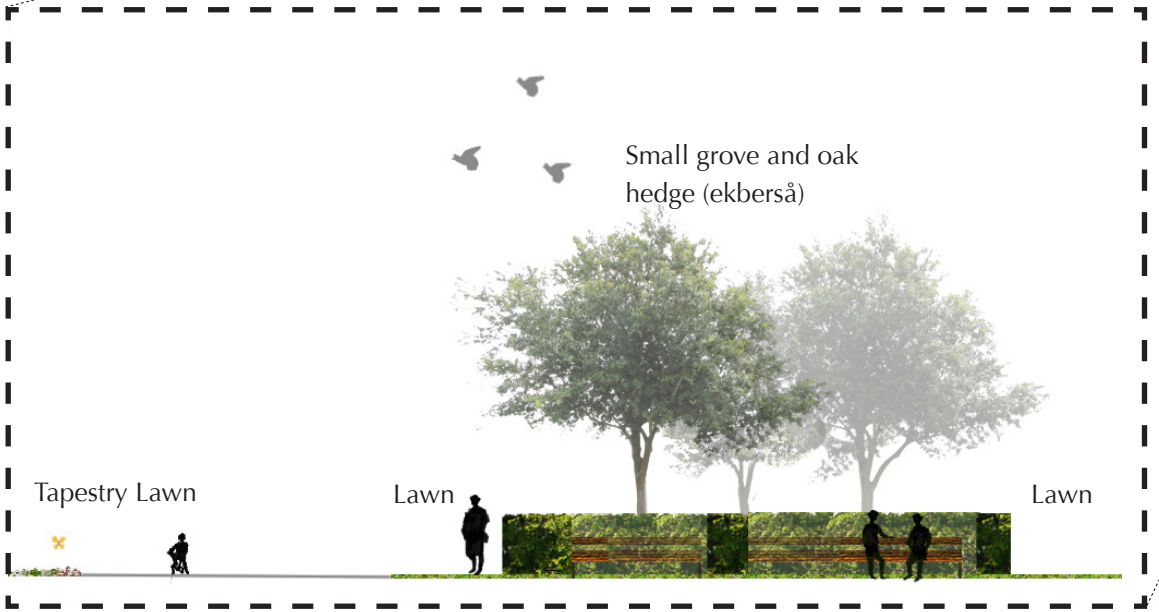
Illustration plan

DESIGN PROGRAMME

2 THE GROVE COURTYARD



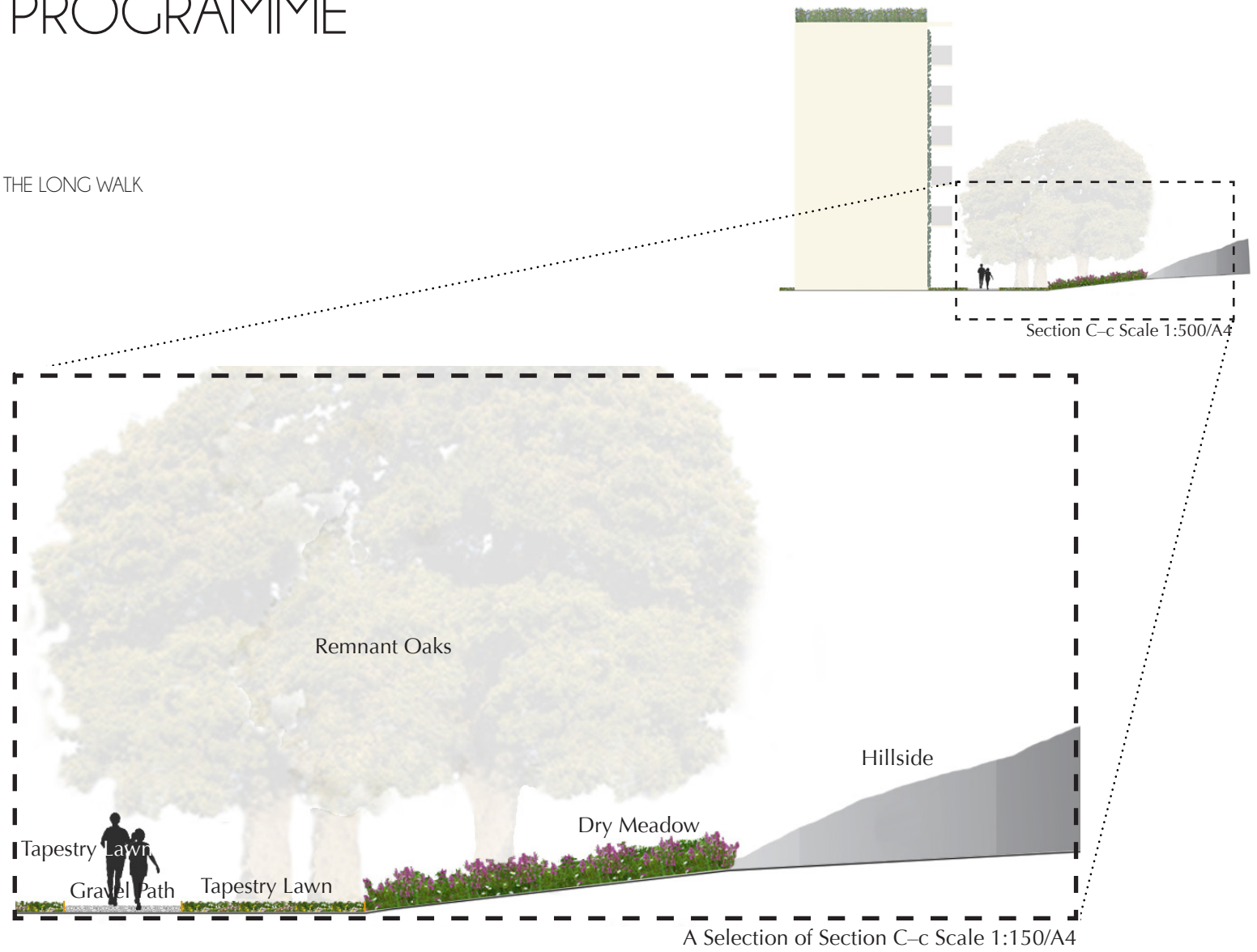
Section B–b Scale 1:500/A4



A Selection of Section B–b Scale 1:150/A4

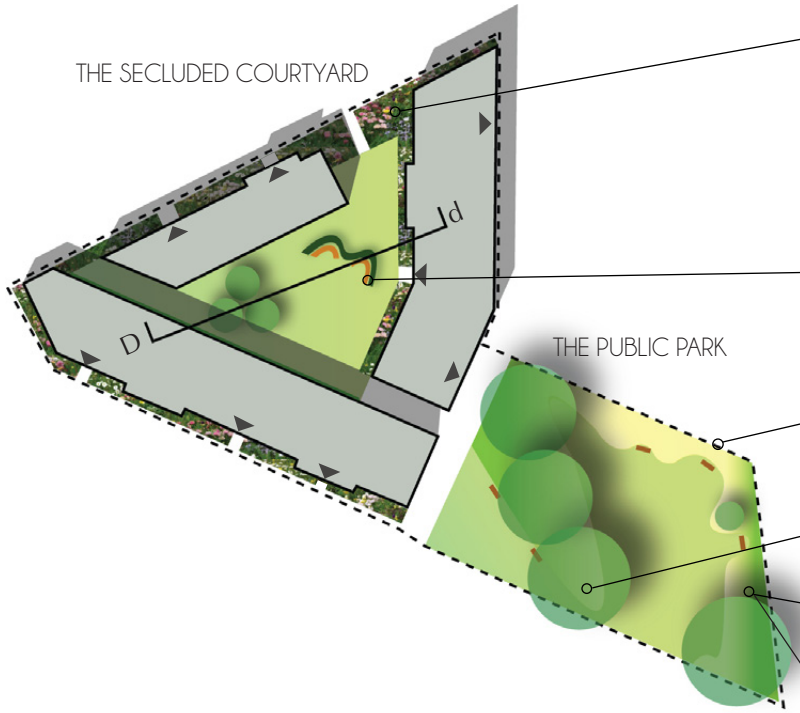
DESIGN PROGRAMME

2 THE LONG WALK



DESIGN PROGRAMME

3



The houses and **the courtyard** are framed by **tapestry lawn**. This gives the residents a lush, colourful flowering just outside their door during a long period of the season. It also creates a clear border to the semi-private area within the courtyard.

An **oak hedge** creates a space within the courtyard. The trees provide volume to the open lawn.

The public park will provide people with open as well as semi-open spaces for different kinds of activities

Four remnant **oaks** are preserved as a historical and cultural link to the past. A new one is planted

Common and Grove meadow are planted to grow into each other. Grove meadow mainly under the oaks and common meadow in sunnier spots. In the edge zones they will meet and compete and in time create a nanatural boundaries.

Pictoral meadow will be sown into the meadow space the first year while the perennial meadow plants establish themself. This will give the new residents a lush, blossoming effect straight away.

Perspective A

LEGEND

LAWN

COMMON AND GROVE MEADOW

TAPESTRY LAWN

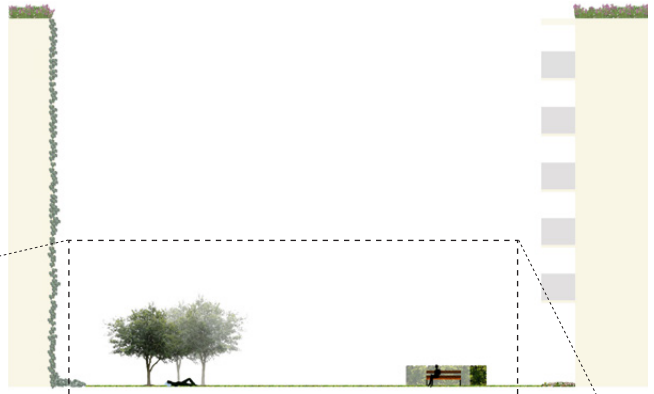
0 50 m

Scale 1:1000/A4

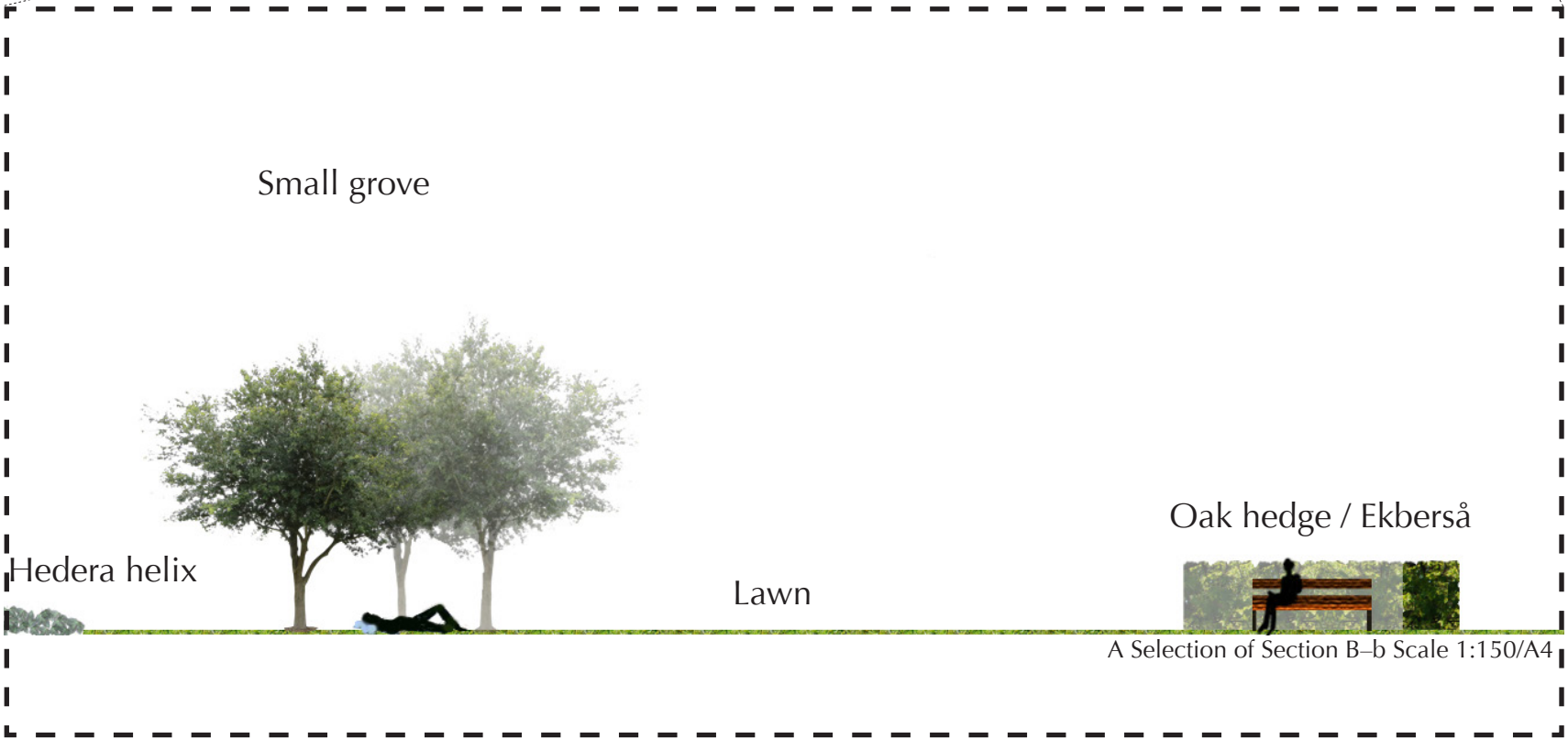
Illustration plan

DESIGN PROGRAMME

3 THE SECLUDED COURTYARD



Section B–b Scale 1:500/A4



A Selection of Section B–b Scale 1:150/A4

DESIGN PROGRAMME

3 ---- THE PUBLIC PARK

REMNANT OAKS
make up large volumes instantly, providing the new area with a historical link as well as ecological processes already in function

SHARP EDGES
are created by short cut turf next to the taller, free-growing meadow plants making a neat contrast

COMMON AND GROVE MEADOW
contrast the lawn in an undulating shape and enclose the large oak trunks.

BOARDS
provide information and details about flora and fauna that exist in the area as well as basic ecosystem services taking place

THE LAWN
creates spaces for free and social activities as well as tranquile and secluded parts for stillness.

Perspective A

DESIGN PROGRAMME

1 SOCIAL GREEN ROOFS

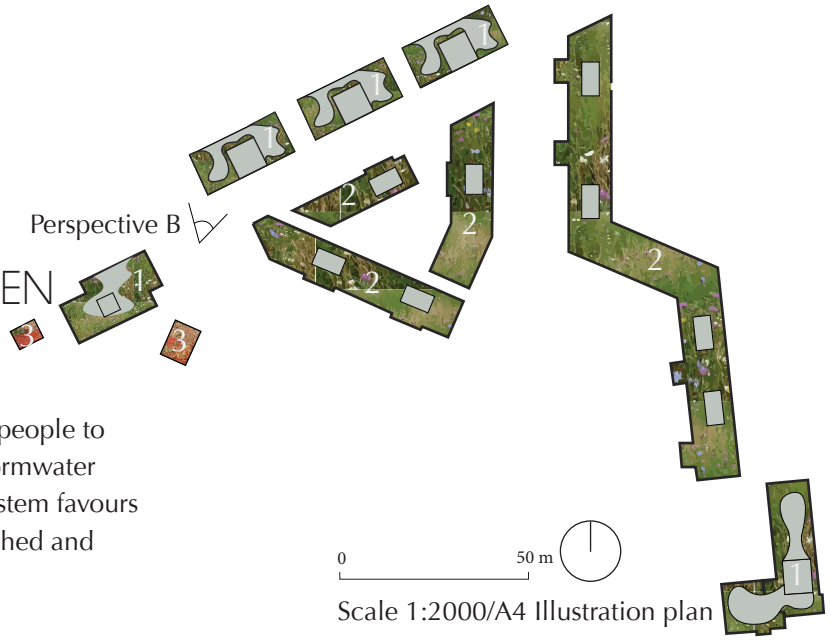
Extensive green roofs with possibility for people to use for leisure activities.

Elements: Plants, ground material, furniture

The plant material on these roofs are to be planned with high regard to aesthetics since people will come out here and interact with the plants.

Every roof will be planned with a varied plant material and every roof will have one or two species that inhabit strong aesthetic values and are unique to that one roof. This will further increase interest when people see that the other roof gardens display other colours and create a stronger feeling of character for the buildings. It will attract different kinds of insects as well as give space for a wide range of plants.

The plants will be a low maintained mix of sedum, and forbs and grasses that are typical to dry meadows. A few plants will also be planned to withstand draught as well as shade such as Dryopteris filix-mas, Sedum acre and Alchemilla mollis.



Scale 1:2000/A4 Illustration plan

2 BIODIVERSE GREEN ROOFS

Extensive green roofs, not for people to use actively but for a good stormwater management and other ecosystem favours that result from a well established and developed diverse flora.

Elements: Plants

The plant material on these roofs are chosen mostly for their biological qualities since these roofs only will be seen from windows. The mass effect of a well functioning meadow will be attractive enough for its purpose. Species for a dry meadow plant community with spots of sedum are used.

The smll animals visiting here can find a haven of nectars and locales to hibernate and breed in.

The maintenance here is the same as on any dry meadow, cut in july august and remove lant material.

3 THE SMALL GREEN ROOFS

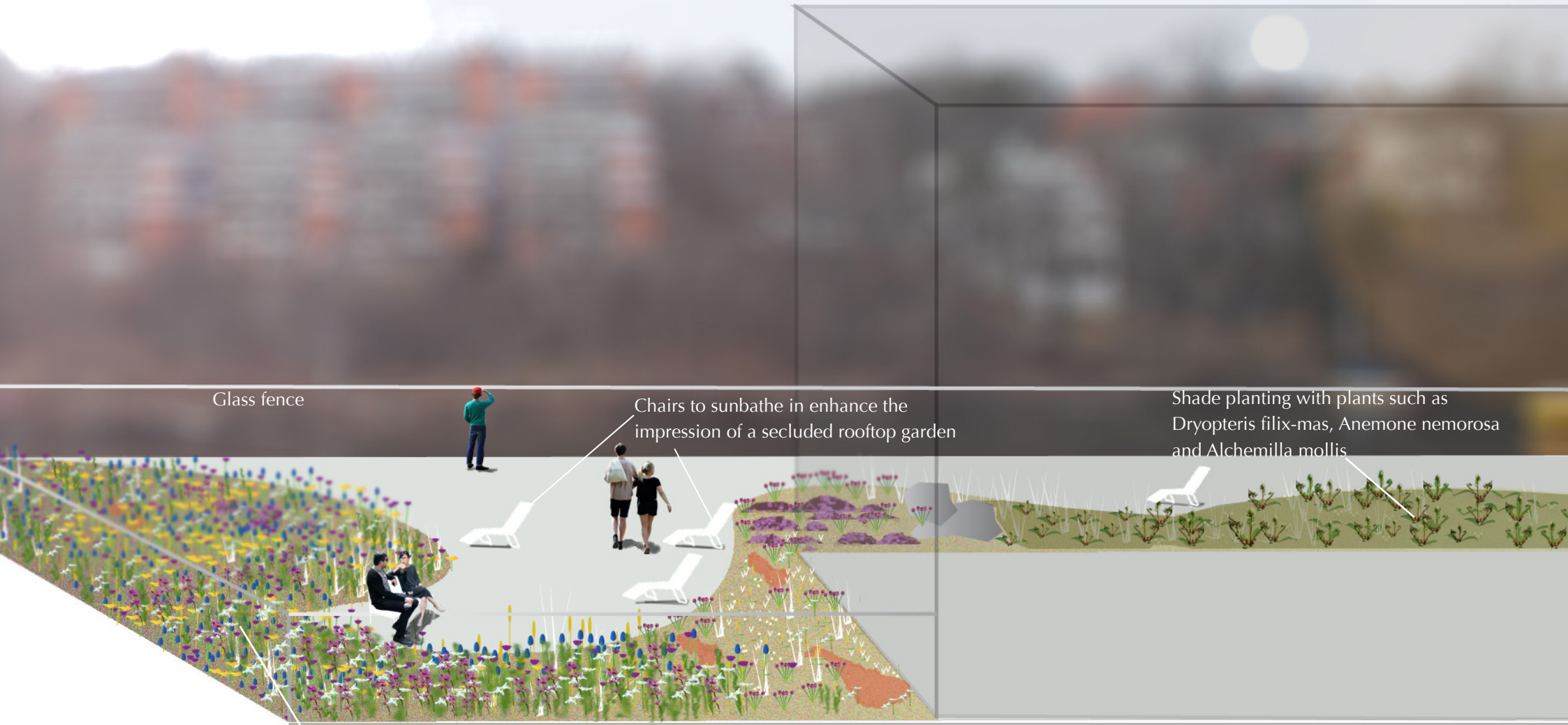
Extensive green roofs. These roofs will never be walked on and mostly used for stormwater management.

Elements: Plants

The plant community on these roofs is made up mostly by Sedum species, but also some forbs and straw plants.

Almost no maintenance will be performed on these roofs. Only if the plant community is collapsing.

DESIGN PROGRAMME
-THE ROOFTOP GARDEN



Perspective B


DISCUSSION

DISCUSSION

LITERATURE

The intention of this thesis was to explore conceptual backgrounds, ideas and theories about alternative lawns, green walls, green roofs and general ecological design solutions with emphasis on biodiversity and implement them in a landscape architecture design programme. I have tried to realize these innovative ecological ideas into a design for an urban multifamily housing area in Stockholm.

The literature I studied was based on analysis of books and research papers which were retrieved mainly from Primo. There are quite a few sources related to the Ecological Design theme, but there are limited references on Swedish implementation of green roofs, walls and alternative lawns since these particular topics are relatively new and unexplored for Swedish conditions.

Books on the chosen eras in Swedish architectural history were available in abundance. However, the work on sorting the material and trying to read the history of courtyards within the architectural history took more effort since most literature mainly focused on buildings or infrastructure. This is a clear example of the invisibility of landscape architecture in literature, and in extension, in people's general awareness of the subject.

The information on ecological design was mostly found in British, but also in literature from Germany and the United States. The term is a wide concept that was more difficult to find in Swedish literature.

ALTERNATIVE LAWNS

The sources of information of alternative lawns, grass-free lawns and meadows that I used came mainly from a Pratensis AB, but also from the SLU Lawn project (www.slu.se) and recommendations from British researcher Lionel Smith. Since the use of alternative lawns aiming to enhance biodiversity, is a quite novel concept, the literature is very scarce here as well.

GREEN ROOFS

The most thurough literature on green roofs came mainly from Great Britain and Germany. In those research papers I found detailed evaluation reports based on green roof observations over longer periods of time. Swedish sources partly came from green roof companies, but there were a few comprehensive articles about green roofs for Swedish conditions as well, which gave my work a broader base in the research of the subject.

GREEN WALLS

While doing the literature study I found some difficulties in obtaining sufficient amount of information. Most research has been done by a small number of people in Europe of which almost nothing has been done in Sweden. Green walls as a phenomenon are seen as important and for having a high ecological potential. But the reality of green walls implemented today, apart from green façades is that they are quite expensive and resource consuming.

The relevant literature I found on green walls was generally scarce and not related to Swedish conditions or principles of sustainability. I believe that the work on

DISCUSSION

green walls would have benefitted from deeper evaluations on green walls over longer periods of time. However I did find many papers that evaluate green walls effect on microclimate and energy consumption of buildings. As this wasn't my focus I only enclosed parts of these studies.

Green walls, as a phenomenon is not new. It's been used in gardening for thousands of years. But in the new modern context of which they are being used today, it is a relatively new concept. This I believe is because of the rapid development of new techniques such as wire structures and different forms of Living Green Walls. These kinds of walls haven't yet been subjected to deeper analyses. So it's difficult to say much about the long-term sustainability on green walls. In my opinion, we don't have products that are thuroughly tested for use in a variety of climate zones or for different purposes (for example biodiversity and specific ecosystem services).

The lack of literature on green walls made it difficult to get a generally good understanding on how to use green sustainable walls in Sweden today. Most of the literature was not Swedish and therefore was not written with Swedish premises in mind. Therefore this is visible in my design programme, that in the near future of vertical greening, I believe mostly in the use of green façades.

EXAMPLES

When trying to find good examples of urban housing areas designed with ecological intentions in Sweden I was surprised to find that there are so few places that can actually be considered using ecological principles in their planning and design. The best examples are Hammarby Sjöstad in Stockholm and Augustenborg in Malmö. Hammarby Sjöstad has a clear sustainability perspective on the design but focus mostly on ecology on an infrastructural level, dealing with waste and stormwater management, energy and transport. Those issues are of course important though difficult to apply on my case, having chosen a narrower focus of ecological design. Augustenborg was a better example, but again dealing with mostly stormwater management ecology on a different level through green roofs and stormwater management for example.

"CUES TO CARE"

One of the things that became more apparent than others in implementation of ecological design was the notion about value of expressing human presence. It was an issue stressed by both literature and interviewed people. Most of them agreed on that in order to succeed with ecological design in urban landscapes it is extremely important to address people's inclination to neatness. As Göran Thor expressed it: "If people accept a design, then it's successful" (p. 36).

INTERVIEWS

The interviews were conducted with an aim to get an understanding of the experiences of Swedish landscape architects (and professionals closely related to the field of landscape architecture) on using ecological principles in their work and particularly in

DISCUSSION

relation to alternative lawns, green roofs and green walls. I saw this part of my work as a complement to the literature study. This turned out to be successful since the background literature research for the main part was focused on foreign conditions. Through the interviews I was able to get a broad Swedish perspective on these issues.

The interviews contributed to the work as to what is successful and unsuccessful in ecological design in a Swedish context. The interviewed people gave experience-based information, which provided another dimension to the background and another perspective to the literature study, which had a more scientific viewpoint.

The interviewed people were landscape architects. I think they represent a fairly wide range within the profession, and stressed different angles on working with design, planning and management. Those who weren't landscape architects got to fill the gaps of what knowledge couldn't be retrieved within the landscape architects. This was especially true to the interview with Göran Thor since his perspective on ecology was fairly unique.

INVENTORY AND ANALYSIS

The issues with the inventory were the time of year and the construction process.

I wasn't able to visit the area during different seasons and the season being early spring gave me a limited amount of information of the site. Especially concerning vegetation structure and conditions of specific plants. For instance, the quality of the trees was difficult to assess due to the lack of leaves during March and beginning of April when I did the inventories.

Since most of the site was already demolished it was difficult to see what had been there before. This was also something that made it impossible to see what more vegetation could have been preserved had I come in sooner in the process.

It was also difficult to assess to what extent people had been using the area. Much of the development site was enclosed by fences, which made it difficult to get around to see and understand the place as well as monitor other people. My observational study of movement was probably impaired by this fact.

DESIGN

In my design I focused specifically on alternative lawns, green roofs and green walls in the urban context of Gröndal and Bryggvägen. Another focus would of course have given the neighborhood another expression. But the idea from the beginning was to do an ecological design that included these elements.

Another way of conducting an ecological design programme could have been to look at it in the broader sense. It could in that case have included other elements and principles (larger scale planning of the site, patch configuration etc.). But the idea of this thesis from the beginning was to concentrate on the biodiversity aspects and the opportunities for a few novel elements to work in an urban environment. Therefore the scale was more appropriate to apply on neighbourhood level. The exclusion of an investigation of trees and shrubs to work in an ecological design was done to get more focus on the biodiversity trio.

Had I included other elements in the literature study, as well as for the design

DISCUSSION

soultions and the interviews, the investigation and case of trying the biodiversity trio might have been diminished and the focus would incidentally have shifted. However, I did use the remnant vegetation in the final design programme as a complement to the biodiversity trio. Mostly because I saw it as such a great asset for existing ecological systems as well as reasons for aesthetics, culture and economy.

RESULTS

The research question was:
How can an ecological design programme for a new Swedish urban multifamily housing area be developed, with emphasis on the "biodiversity trio": alternative lawns, green roofs and green walls?

The research question was answered through the design programme and the included illustrations. The design decisions were based on the literature study, the interviews and the detailed site analysis. It covers design solutions of how to integrate ecologically valuable biotopes into urban environments.

The thesis contributes to the field of landscape architecture by exemplifying how to work with ecological principles in an urban housing area. The design programme can be used to get a better understanding on how to implement ecological processes in other urban environments as well.

The design solutions aimed to increase biodiversity through mainly the use of alternative lawns, green roofs and green walls.

LAWN VS. ALTERNATIVE LAWN

Even though I set out to do a design using mainly alternative lawns instead of conventional lawn it soon became apparent that it wouldn't work not using lawn in most spaces where people move around. The result was that lawn took up almost as much space as alternative lawns. I didn't see this when going into the project. It's very important to use lawn to get people's approval and liking. If one gives people space to use lawns, then they will be less sceptical about messy edges with meadow plantings. Lawn is in this sense a prerequisite for urban ecological design.

MAINTENANCE

The ecological solutions used in the thesis and the successful implementation of the them are depending on future maintenance.

Even though one of the reasons of using alternative lawns for example, is to decrease the amount of maintenance it is important to think about management procedures. If for example meadows are fertilized or cut as often as the lawn areas, they will seize to be meadows and become something that might resemble a lawn again. Or if they aren't cut at all their species richness will decrease and they will appear very untidy, especially during the winter season.

INFORMATION

The importance of working with information and spreading of new knowledge is apparent when working with ecological design. It's a difficult task. It's not something I focused on in my thesis, but it's an important part of the design programme. Using signs can

DISCUSSION

be very significant to explain why people should be ware of an ecologically valuable environment. Putting signs in large public parks can be an obvious measure, but putting signs into a neighbourhood, I found when trying it out, was much more complex. I think that a sign in someone's courtyard that only is meant for residents to read could appear very strange. It may give the impression of being in a public park instead of one's home.

I think that other types of information would be better suited for a courtyard than signs. Rental apartments and cooperatives often have their own homepage. This, I think would be a better suitable arena for the spreading of information on ecology in these types of spaces.

I could have worked more with information and different kinds of boards and signs and how to communicate with people about ecologically valuable environments. Researching community dialogue etc. A design programme for information would definitely have been useful but time consuming and shifting focus from the biodiversity trio.

DIFFICULT SPACES

A few places showed to be difficult to design. This was the case with the steep front courtyards in Area 2. I wanted them to have a social function as well as the more obvious ecological functions. Their location, outside one of the larger houses and in the middle of the residential area, is ideal for social use. Meadow on a hill will work very well since that space will be dry as well as low in nutrients. But a steep hill is not ideal for any social activities. However, the addition of hammocks may give people a reason to use the space in a way they wouldn't have done otherwise.

The space in Area 2 between the eastern hillside and the long house is a space that didn't seem as a place that many would choose to go to because of the noise from the bridge and the character of being a narrow backside to a house. I think if planted with conventional lawn people would have felt like they were on the wrong side of the house. Therefore I suggested a path so that it won't feel like one goes there to be there, but instead to move through the area. At the same time it's a lush and neat place with lots of flowers.

The enclosed courtyards in Area 1 and 3 were also difficult to incorporate with the biodiversity concept. They are both so much on display and the centre of attention that I didn't see any other way than to suggest conventional lawn for recreational activities. I framed the lawn in area 3 with tapestry lawn and English ivy. Since these areas are so much on display, anything not looking neat would have singled itself out too much and I think that could have given people reason to become upset over other messiness in the area.

ECOLOGICAL CHOICES

The chosen ecological solutions are of course only a few of many that I retrieved from the interviews and literature study. I presented them all on page 42 and the ones that I chose to work with on page 43.

What I found most important was not surprisingly to ensure basic ecosystem services. This was done by the use of the biodiversity trio; strenghthening biodiversity

DISCUSSION

and thereby ensuring basic ecosystem services. But also by planning ecosystem services such as carbon sequestration and stormwater management.

What I chose not to focus on was for example the intricate parts of plant composition and different kinds of microclimate. I could have chosen to work with the structure of the plants to maximize the effect of a differentiated textures, height and so on within the plant communities. I could also have created several different microclimates to ensure many different plant species to germinate. But I chose to look above that and focus on the bigger picture because even though that might have had effect, I had to make way for other choices to fit into the design programme. I couldn't focus on all design solutions that I found, but had to extract a few from the large masse that I gathered.

I don't think the ecological aspect of the design would have been improved had I worked with a greater number of ecological solutions. The question then would have been if the solutions would have been as visible as they are now, ensuring the publics liking and understanding and thereby also their protection of them. People's liking and understanding is vital for urban ecological design to be successful. Therefore it might be more clever to always focus on a few solutions that are easier to grasp for the general population.

Different kinds of ecological design solutions could also possibly work against one another. For instance, if ensuring multiple microclimates, the possibility of providing large areas of one biotope isn't possible. Having larger areas to work with ensures longeviety for some plants but excludes others. Having many different small locales might create spots for many species to germinate once, but make spreading difficult thus making every plant community vulnerable to environmental change.

FUTURE RESEARCH

- Ecological solutions that aim to reshape urban structures on a larger scale. For instance, investigating how to work with ecological functions, patches, stepping stones and corridors to enhance biodiversity within an urban city district.

- Further investigations on green walls and their sustainability for use in urban environments. There is much left to find out about on this subject.

- Research could also be done on wheather or not modern residential areas are actually large enough for people to lead good lives in and for ecological functions to work within. Recently courtyards have become smaller than before and therefore this could be an interesting topic.

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APPENDIX

APPENDIX A

QUESTIONAIRRE LANDSCAPE ARCHITECT

1. What is your training?

2. Describe your work.

ECOLOGY

3. How do you consider ecology and biodiversity in your work?

4. What is your idea of ecological design?

5. Have you used ecological design in any project? If yes, how? If no, why not?

6. How do building companies/municipalities, value ecology in relation to economic aspects?

7. Where do you think the branch is turning, if absolute ecological design is on the one side and exotic spectacular design is on the other?
8. How often is does a project have grand intentions on ecology that are severely diminished due to economy or other reasons?

9. What do you think of the relation between ecological design and maintenance?

GRASS

10. Do you see any problematic issues in the use of conventional lawns? What are they?

11. How do you perceive the public's opinion on traditional lawns?

12. How could a landscape architect work with lawns in a different way?

ALTERNATIVE LAWNS

13. Have you used alternative lawns (for example meadows or tapestry lawns) I any project?

14. Have you seen any examples of designed meadows or tapestry lawns in anywhere? What was your impression of it?

GREEN WALLS AND GREEN ROOFS

15. Have you used green walls and/ or green roofs in your work? If yes, how? If no, why not?

16. What qualities do you see in the use of green walls and green roofs?
17. Do you have ideas of how to use green walls and green roofs in new ways?

18. Is there anything you would like to add?

APPENDIX B

QUESTIONAIRRE PLANNING AND MANAGEMENT, HOUSING COMPANY/ MUNICIPALITY

1. What is your training?

2. Describe your work.

3. How long have you been in the position you are in right now?

4. How long have you been working with the management and planning of green areas?

5. What qualities do you see in green areas where people live?

6. What qualities do you want to achieve in your work with green areas?

ECOLOGY

7. How do you consider ecology when planning and managing green areas?

8. How do you consider the relation between different kinds of green areas (for instance two housing yards' connections or the relation between a yard and the surrounding landscape)?

9. How do you regard ecology in relation to economy? How do you prioritize in your short-term and long-term planning?

10. How do you work with long-term sustainability and resilience (disease, climatic, competition) in plant communities?

11. How do you consider the wildlife fauna in the management of housing areas?

GRASS

12. What different kinds of grass areas do you work with?

13. What qualities does a lawn have in a (semi) public environment?

14. Describe how you plan and organize the work around lawns?

15. Do you have guidelines for the work with lawns?

16. What kind of problematic issues can you see in the planning and maintenance of lawns?

17. What is your opinion on smaller wildlife in lawns such as bees and butterflies?

18. What cost calculations per space unit do you have on different kinds of lawns?

19. How many times are your different lawn types cut every year and how many hours are put into the work?

20. How much fertilization, irrigation, pesticides are used in your lawns?

21. Are there examples on cost reductions when it comes to lawns in the areas you work with? What are they?

22. How could you work with lawns and grass in a different way from today?

APPENDIX B

23. Have you seen any examples of lawns and grass areas that are different from the ones you work with?

ALTERNATIVE LAWNS

24. Have you thought of using any alternatives to lawns, for example meadows or tapestry lawn (low perennial mats that are cut)?

25. Have you seen any examples of meadows or tapestry lawns in housing areas? What was your experience of it?

GREEN WALLS AND ROOFS

26. Do you plan and maintain any green walls and roofs? If yes, how?

27. Have you thought of using (more) green walls and roofs? If not why?

28. What positive and negative qualities can you see in the use of green walls and roofs?

29. Is there anything you would like to add?

APPENDIX C

QUESTIONAIRRE LOCAL MANAGER, MUNICIPALITY

1. What is your training?

2. Describe your work.

3. How long have you been in the position you are in right now?

4. How long have you been working with the planning and maintenance of green areas?

5. What qualities do you see in green areas in urban environments?

ECOLOGY

6. How do you consider ecology and biological diversity when planning your work?

7. How do you consider the connections between the areas where you work and the surrounding landscape (parks, yards, gardens, nature)? (What effect do you have on surrounding areas and how good is the ecological exchange?)

8. What kind of problematic issues can you see in the green areas you work with?

9. How do you regard the wildlife fauna in the maintenance?

GRASS

10. What kind of different grass areas/lawns do you work with?

11. What kind of problematic issues can you see when it comes to planning for and maintaining lawns?

12. Do you have guidelines for the work with lawns?

13. What cost calculations per space unit do you have on different kinds of lawns?

14. How many times are your different lawn types cut each year and how many hours are put into the work?

15. How do you think you could work with lawns/grass in a different way?

ALTERNATIVE LAWNS

16. Have you thought of using alternatives to lawns, for example meadows or tapestry lawn (low perennial mats that are cut)?

17. Have you seen any examples of meadows or tapestry lawns in housing areas? What was your impression of it?

GREEN WALLS AND GREEN ROOFS

18. Do you work with green walls and/or green roofs? How?

19. Have you thought about using (more) green walls and/or green roofs?

20. Is there anything you would like to add?

APPENDIX D

QUESTIONNAIRE ECOLOGIST

1. What is your training?
2. Describe your work.

ECOLOGY

3. What problematic issues can you see in the design, planning and maintenance of green areas in housing areas from an ecological point of view?

4. How do you think they could work in a different way?

5. Do you have any good examples of housing areas that work well ecologically?

GRASS

6. What problematic issues can you see in traditional lawns?

7. How could landscape architects, planners and maintenance personnel work with other types of vegetation instead of lawns?

8. How do you perceive the public opinion on traditional lawns?

ALTERNATIVE LAWNS

9. What qualities do you think of the use of meadows and tapestry lawns bring to urban environments?

10. What problematic issues can you see in the use of meadows and tapestry lawns?

GREEN WALLS AND GREEN ROOFS

11. What qualities do you see in the use of green walls and green roofs?

12. What problematic issues can you see in the use of green walls and green roofs?

13. Do you have any ideas on how to use green walls and green roofs in new ways?

14. Is there anything you would like to add?

APPENDIX E

PLANT LIST FOR SWEDISH ALTERNATIVE LAWNS

GRASS-FREE LAWN/ TAPESTRY LAWN (ÖRTMATTA)

Forbs
Achillea millefolium Rölleka
Armeria maritima Strandtrift
Bellis perennis Tusensköna
Campanula rotundifolia Liten blåklocka
Dianthus deltoides Backnejlika
Galium verum Gulmåra
Hieracium pilosella Gråfibbla
Hypochoeris radicata Rotfibbla
Leucanthemum vulgare
Lotus corniculatus Käringtand
Plantago media Rödkämpar
Potentilla argentea Femfingerört
Potentilla erecta Blodrot
Primula veris Gullviva
Prunella vulgaris Brunört
Silene vulgaris Smällglim
Thymus serpyllum Backtimjan
Veronica spicata Axveronica
Viola tricolor Styvmorsviol

COMMON MEADOW (NORMALÄNG)

Forbs
Rölleka Achillea millefolium
Stor blåklocka Campanula persicifolia
Rödklint Centaurea jacea
Väddklint Centaurea scabiosa
Brudbröd Filipendula vulgaris
Gulmåra Galium verum
Humleblomster Geum rivale
Flockfibbla Hieracium umbellatum
Fyrkantig johannesört Hypericum maculatum
Äkta johannesört Hypericum perforatum
Slåtterfibbla Hypochoeris maculata
Åkervädd Knautia arvensis
Sommarfibbla Leontodon hispidus
Prästkrage Leucanthemum vulgare
Svartkämpar Plantago lanceolata
Rödkämpar Plantago media
Gullviva Primula veris
Brunört Prunella vulgaris
Smörblomma Ranunculus acris
Höskallra Rhinanthus serotinus
Ängssyra Rumex acetosa
Rödblära Silene dioica
Smällglim Silene vulgaris
Ängsvädd Succisa pratensis

Straw plants
Vårbrodd Anthoxanthum odoratum
Ängshavre Helictotrichon pratensis
Luddhavre Helictotrichon pubescens
Kamäxing Cynosurus cristatus
Fårsvingel Festuca ovina
Rödsvingel Festuca rubra

DRY MEADOW (TORRÄNG)

Achillea millefolium Rölleka
Campanula rotundifolia Liten blåklocka
Dianthus deltoides Backnejlika
Galium verum Gumåra
Hieracium aurantiacum Rödfibbla
Hieracium pilosella Gråfibbla
Hieracium umbellatum Flockfibbla
Hypericum maculatum Fyrkantig johannesört
Hypochoeris radicata Rotfibbla
Jasione montana Blåmunkar
Knautia arvensis Åkervädd
Leucanthemum vulgare Prästkrage
Linaria vulgaris Gulsporre
Lotus corniculatus Käringtand
Viscaria vulgaris Tjärblomster
Pimpinella saxifraga Bockrot
Rumex acetosella Bergssyra
Saxifraga granulata Mandelblom

APPENDIX E

Solidago virgaurea Gullris
Viola tricolor Styvmorsviol

Straw plants
Agrostis capillaris Rödven
Anthoxanthum odoratum Vårbrodd
Briza media Darrgräs
Bromus hordeaceus Luddlosta
Deschampsia flexuosa Kruståtel
Festuca ovina Fårsvingel
Festuca rubra Rödsvingel
Helictotrichon pratensis Ängshavre
Luzula campestris Knippfryle
Phleum phleoides Flentimotej
Phleum pratense ssp bertoloni Vildtimotej

GROVE MEADOW (SKUGGÄNG)

Hässleklocka Campanula latifolia
Nässelklocka Campanula trachelium
Midsommarblomster Geranium sylvaticum
Skogsförgätmigej Myosotis sylvatica
Blodrot Potentilla erecta
Rödblära Silene dioica
Buskstjärnblomma Stellaria holostea
Ärenpris Veronica officinalis

Straw plant
Rödven Agrostis capillaris
Kruståtel Deschampsia flexuosa
Rödsvingel Festuca rubra
Bergslok Melica nutans
Hässlebrodd Milium effuse
Lundgröe Poa nemoralis

MESIC MEADOW (FUKTÄNG)

Forbs
Achillea ptarmica Nysört
Angelica sylvestris Strätta
Caltha palustris Kabbleka
Eupatorium cannabinum Hampflockel
Filipendula ulmaria Älgört
Geranium sylvaticum Midsommarblomster
Geum rivale Humleblomster
Hypericum maculatum Fyrkantig johannesört
Lychnis flos-cuculi Gökblomster
Lysimachia vulgaris Videört
Lythrum salicaria Fackelblomster
Myosotis scorpioides Äkta förgätmigej
Prunella vulgaris Brunört
Ranunculus acris Smörblomma
Serratula tinctoria Ängsskära
Silene dioica Rödblära
Succisa pratensis Ängsvädd
Trollius europaeus Smörboll
Valeriana officinalis Läkevänderot

Straw plants
Ängskavle Alopecurus pratensis
Darrgräs Briza media
Bunkestarr Carex elata
Kamäxing Cynosurus cristatus
Tuvtåtel Deschampsia caespitosa
Ängssvingel Festuca pratensis
Rödsvingel Festuca rubra

PICTORAL MEADOW (MÅLERISK ÄNG)

Agrostemma githago Klätt
Anthemis arvensis Åkerkulla
Centaurea cyanea Blåklint
Papaver rhoeas Kornvallmo
Papaver dubium Rågvallmo