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Combining space for recreation and flood accomodation

– a design proposal for Länghem.

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Preface

This project originated from an interest in the Quality Evaluation Tool for recreation in healthcare settings. The project takes the theory out of the healthcare setting and applies it in a real project for a public park, which also must fill the function of flood adaptation.

I would like to thank my supervisor, Linn Osvalder for great input and encouragement throughout the project. I also want to thank Thomas Tranefors at Tranemo municipality for his participation and collaboration. Finally, I want to direct thanks to Claudia and my family and for support.

Abstract

Recreation plays an important role in improving both physical and mental health in an urban society. The Quality Evaluation Tool (QET) was published in 2014 as a tool for creating inclusive recreational space in healthcare settings. Meanwhile, ongoing changes in the global climate lead to new challenges to society, one such challenge is the threat from intense precipitation and subsequent flooding. This project set out to investigate the combination of recreation and flood adaptation within the same space. To define recreational functions for a wide public, the project made use of the QET. By adjusting the design principles defined in the QET for use outside healthcare settings, generalised principles were described that are suitable for wider use. These principles, together with design principles on flood adaptation found in literature, were then applied to create a design proposal for a new park in Länghem, Sweden. Combining flood adaptation and recreation requires the designer to have an understanding of both subjects and the ability to find creative solutions. All functions described by the twelve design principles were fulfilled in the design proposal. Site-specific solutions that provide space for water should be implemented based on well-defined local objectives for flood adaptation. The QET proved to be a useful tool in reaching the end product however to evaluate the quality of the tool as a foundation for public green space, further research is required to compare it against literature on recreation or by evaluating a realised project built on the QET.

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1. Introduction

1.1 Background

Global warming is leading to drastic changes in weather, including higher temperatures, longer periods of droughts, and more intense rainfall events (NASA, 2019; O'Gorman, 2015; Trenberth, 2011). This poses new challenges to society, for example higher temperatures are a threat to our health (McMichael et al. 2006) , while increased frequency of floodings in Europe can also be attributed to climate change (Kundzewicz et al. 2014).

A large portion of the health issues among adults in western society is related to stress. Stress is also an attributing factor to issues among children, such as violent behaviour (Godbey, 2011). Spending time in built, artificial environments has shown to increase stress levels and causes mental fatigue, while contact with natural environments can reduce stress levels. Aside from reducing stress levels, there is also evidence that being in contact with nature or natural elements can help recovery from injuries and mental problems, improve physical health and reduce behaviour-related issues among children. Visiting an urban park often involves walking which has proven to have many health benefits, primarily due to its positive effects on stress and reduction of obesity for both adults and children (ibid.). Furthermore, children suffering from Attention Deficit Hyperactivity Disorder (ADHD) have shown reduced symptoms when spending time outside, particularly in natural environments, to the degree that medication could be reduced in some cases (Kuo & Taylor, 2004).

This project was taken on per request by the municipality of Tranemo to combine flood adaptation and recreational values on

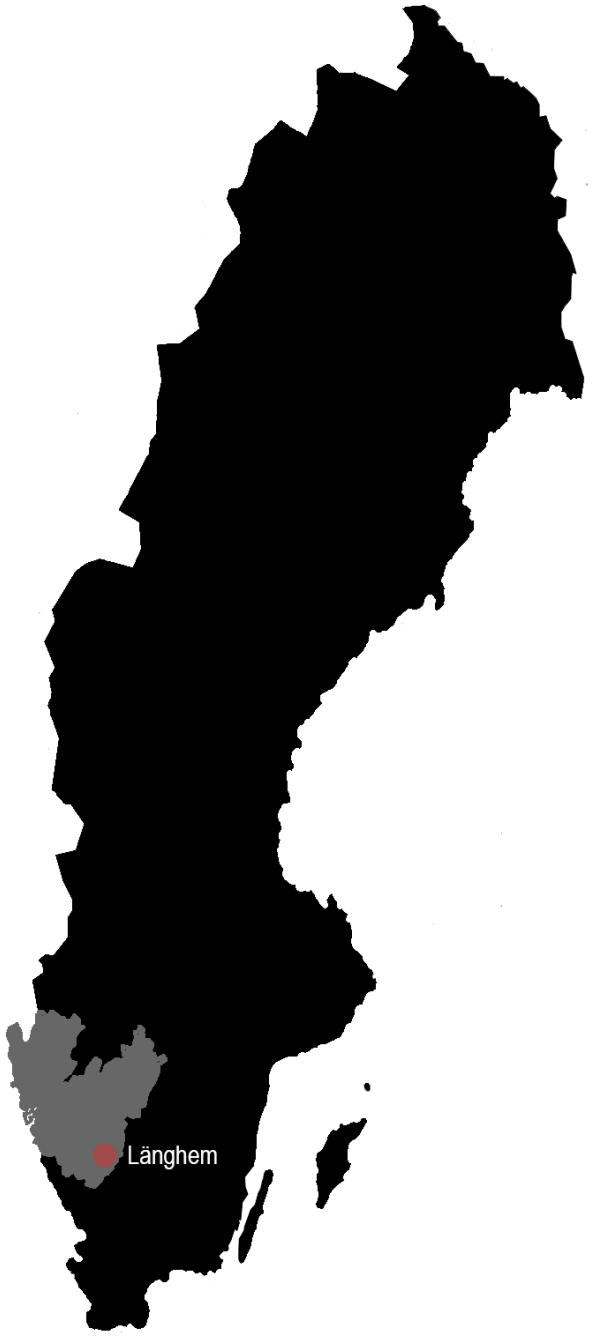

Figure 1. Location of Länghem within Västra Götaland county (gray). Illustration by Joel Forsman Semb

a site in the rural settlement of Länghem. Länghem is a town with 1119 inhabitants, in Tranemo municipality, Sweden (Statistiska Centralbyrån 2020). Open fields stretch from southwest to northeast at the fringes of the town. Beyond the fields are coniferous and mixed forests as well as several lakes within a 5 km radius from the

town Lantmäteriet (2015). This presents possibilities for recreation in natural areas close to the settlement. Within the settlement, there are however fewer options for recreation. The municipality is interested in creating recreational opportunities within the settlement. On the south edge of town, there is a green space of about 2.5 ha, which is the focal area of this thesis. This area is used for collecting runoff and the municipality has suggested using this area for recreation. Maintaining the function of the area as runoff retention is vital. To fulfill both these goals, the area could be converted to a multi-purpose urban space, which not only collects runoff but also provides recreational activities on a more local level. To create a sustainable green space in Länghem, the site should be adapted to local conditions as well as having resilience to the global trend in longer drought periods and more intense rainfalls.

The subject of this thesis arose from the planned development in Länghem as the author contacted the municipality to establish a collaboration. The development intends to retain the area's function of storing water and create space for recreation. It was decided that the thesis would investigate the area and deliver a design proposal that can be used for decision-making on the local development. The municipality requested a pond to be featured somewhere in the area and that the local preschool would get involved in the project.

1.2 Objective

The main objective was to investigate how an area that gathers runoff and acts as water storage can be used for recreation by the local users. The results were delivered through design principles and a design proposal built on those principles. The project also sets out to investigate the site in its current state and to involve a local preschool, which is a central user group.

1.3 Questions

Research question
- What challenges are there in developing a park that provides both recreation and flood adaptation?

Sub questions
- How can green space be used to reduce the impact of ongoing global changes in precipitation?
- How can QET be applied in urban design that is not a healthcare setting?

1.4 Delimitations

Climate change has many effects on society and urban spaces but in the context of this site, changes in precipitation may be the most impactful in the foreseeable future as the site is located in a region which already has high precipitation. Because of this, climate adaptation in this study is focused on meeting the anticipated changes in precipitation.

The project set out to define general design principles that can be applied in spaces that combine flood adaptation and recreation. These principles were then used to guide the design, leading to a design proposal which utilises site-specific solutions.These were the main results of the project.

Due to the many regulations surrounding playgrounds, the equipment-based

play area presented in the design is not described in detail, as this would go beyond the scope of this project.

1.5 Method

1.5.1 QET

This project aims to propose a design built upon evidence. Quality Evaluation Tool (QET) is a tool that evaluates the quality of outdoor environments from the aspect of improving well-being among people with different challenges and needs. The QET was developed for healthcare environments but because outdoor recreation is an important factor for the well-being of people, the objective of QET is just as relevant for recreation outside healthcare environments. QET already has defined design principles but they are described for healthcare settings. Therefore, new principles, for non-healthcare settings have been described, which builds on the principles from QET. QET was chosen because it considers the different needs people may have when it comes to recreation and is therefore useful for creating inclusive space, which was deemed crucial in reaching the whole population of Länghem as users of the site. Together with design principles on flood adaptation, QET defines functions for the design proposal.

1.5.2 Interviews

A qualitative interview was held with a group of children, aged 6, at Bikupan preschool, to investigate their usage of outdoor areas and what they would like to see implemented at the work area. The interview was held at Bikupan preschool with a group of around 15 children, accompanied by teachers. The participants were asked questions that were prepared in advance, complemented with any questions that may arise during the interview, and the children were encouraged to ask questions and come up with their suggestions.

Faux et al. (1988) argue that children need motivation to actively participate in the interviews. Furthermore, the motivation should be presented in a concrete way for the children to respond to it. The motivation that was presented to the children at Bikupan preschool was that they could get a new outdoor space to play in and that they could come with suggestions to what they would want to have in this space.

To avoid misunderstandings and to encourage the children to give answers, the language and questions had to be adapted by the interviewer. Kortesluoma et al. (2003) found that the language used by the interviewer had a large impact on what answers the children gave. The children did not respond as well to questions of abstract nature as they did to more tangible questions. Furthermore, using too advanced language may also limit the children's ability to correctly understand the given questions. Suggestive questions were avoided to not impact the answers given by the children, instead, the questions were formulated openly with a clear topic. For example: "What do you usually do when you are in the forest next to the football fields?"

Three preschool teachers were present at the interview. They were mostly passive during the interview but on a few occasions helped with clarifying questions that became too abstract. It should be mentioned that on one occasion a teacher asked if the children wouldn't want to have a sledding hill as a leading question, which could have impacted the response from the children.

Aside from the interview at the preschool, contact and information exchange have been active during the process of the project with representatives from the municipality, through emails, online meetings, and a meeting on the project site.

1.5.3 Literature

Literature has been gathered from the database Google Scholar, libraries, and web searches. Scientific literature and reports from institutions have been the primary sources of information gathering and in some cases websites have been used when no better sources were found. Theory on recreation is mostly based on "Outdoor environments in healthcare settings: A quality evaluation tool for use in designing healthcare gardens" (Bengtsson & Grahn, 2014), while other subjects have compiled literature found from searches.

1.5.4 Analyses

The site and its surroundings were analysed in GIS to understand the conditions of the site and its context.

Lynch (1960) analysed large American cities through interviews over a period of five years. The analysis in chapter 2.2 uses Lynch (1960) as basis for its content but with a different data collection. Instead of performing interviews, the analysis is based on a visit to the town, where the author was the sole observer. This was complemented with studies of map data in Geographic Information System (GIS). Instead of sorting the urban elements after frequency in interviewed observers, as Kevin Lynch did in The Image of the City, different elements have been assigned different "weights" based on the author's impressions. Due to the small scale of the town, it may become misleading to classify the urban elements on a scale of four, so instead, the different elements have been judged on a scale of one to three.

1.5.5 Design

Scientific findings have been the basis for forming design principles. Principles for flood adaptation-design were found and have been used to guide the design proposal. Because the QET was created for healthcare environments, its principles have been reworked to better fit outside a healthcare setting. Once the design principles and most of the analyses had been made, the design proposal was initiated. The proposal is based on the design principles and further guided by the interview, literature, and analyses of the site and its surroundings

1.5.6 Plant selection

The selection of all plants has followed a process that started with establishing site conditions for each location. This includes factors such as soil type, hardiness zone, shade/sun, water availability, and nutritional availability. Next, the desired function and/or aesthetics were defined. With these factors defined, the next step was to search for the plants that best fill the deciding factors. Browsing for trees and information-gathering was done in

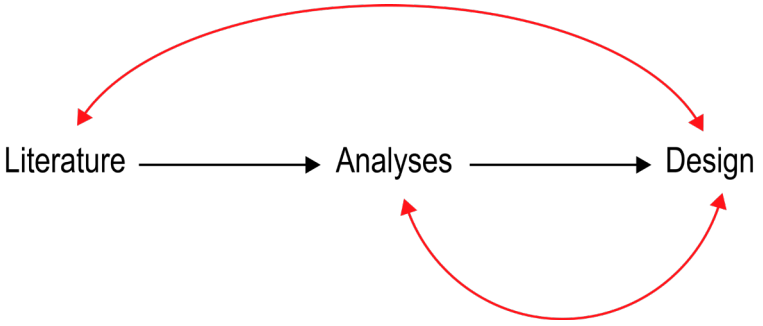

Figure 2. The work process was initially linear (black arrows) but became circular during the projects latter stage (red arrows). Illustration by Joel Forsman Semb

the book “Stadsträdslexikon” (Sjöman & Slagstedt, 2015). For shrubs and perennials, catalogues from the Swedish nurseries Essunga and Stångby were used. While literature was used, personal experiences and knowledge generated from university studies also played a major role in plant selection. To ensure hardy plants, many of the selected trees and shrubs have the quality certification “E-planta”, which is given to plants well-adapted to Swedish climates (E-gruppen, 2020). These plants have the letter “E” following their names in the plant lists.

1.5.7 Work process

Creating an evidence-based design meant that evidence had to be gathered before the design could take shape. This has not been a completely linear process however, a basis of literature was the first stage of the process, the second stage was to visit the site and conduct interviews, followed by analyses. The third stage initiated the design but once the design was taking place, new demand for evidence arose. While starting as a fairly linear process, the project became circular during its latter stage, as illustrated in figure 2, where the black lines illustrate the initial linear process and the red lines represent the more circular approach used in the latter stage of the project.

1.5.8 Information flow

During the project, the different methods have been connected in a flow of information. Information gathered and processed with the different methods are in some way linked to delivering the end product of a design proposal. In figure 3, the information flow is illustrated and it shows that the final destination for all information is in the design proposal.

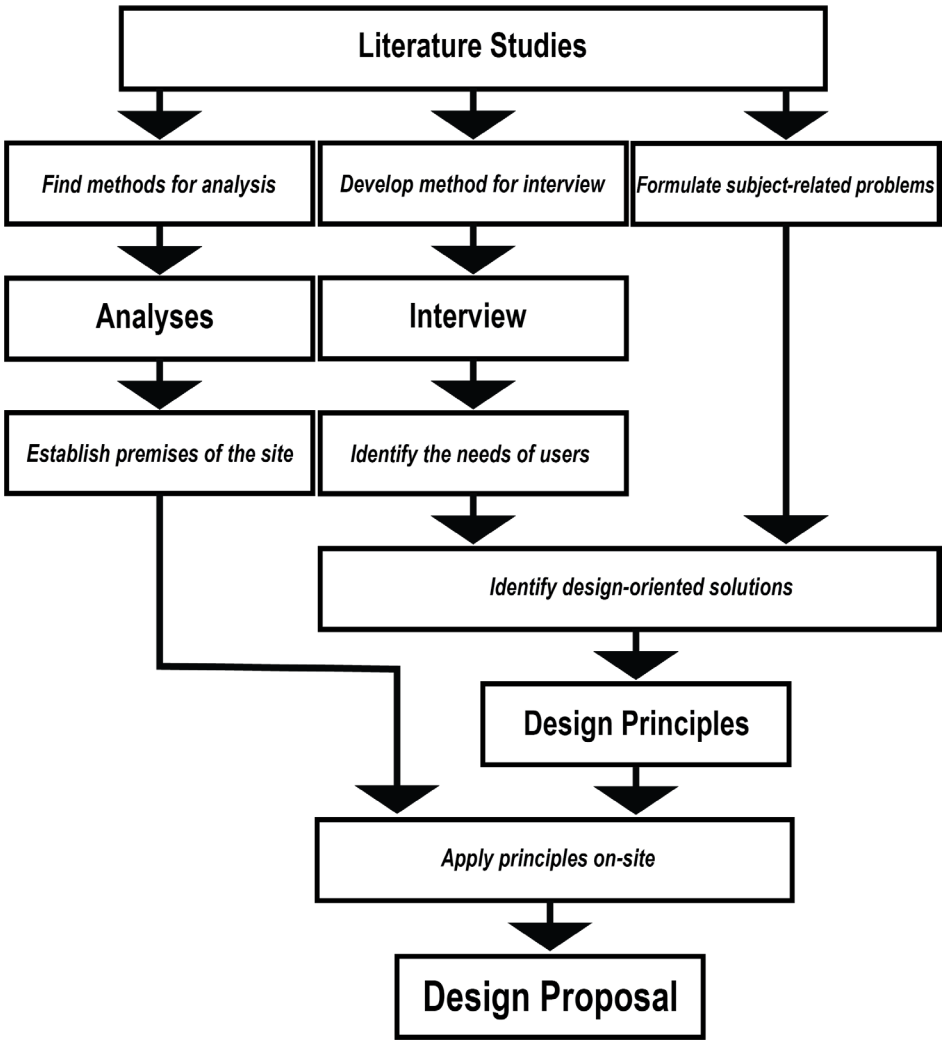

Figure 3. The flow of information all led towards the end product, the design proposal. Illustration by Joel Forsman Semb.

2. Premises

2.1 Physical conditions

The primary soil in and around Länghem is moraine, but a patch of peat is just covering the site (Figure 4). Peat is made from organic matter that arises in wet areas, such as overgrown lakes or areas that remain wet due to heavy precipitation (SGU, n.d.).

When looking at the height differences around Länghem in figure 5, it becomes apparent that the site is located at the end of a valley. The high retention characteristics of peat soil together with the terrain suggest that the site is likely very wet, which also was observed during a visit to the site.

From visiting the site and speaking to stakeholders, no current use for the site could be found but according to Tranefors[1] the site held two treatment ponds in the southwest part once, which also can be seen in figure 6. At some point, the treatment ponds were removed or abandoned and since then the south part has become overgrown with trees and shrubs.

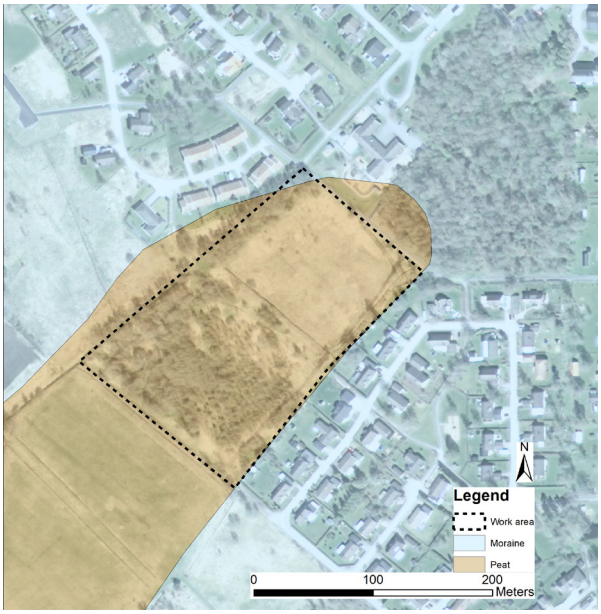

Figure 4. Soil map illustrating peat as brown and moraine as blue. Created from: Jordarter 1:25 000 - 1:100 000 © Sveriges geologiska undersökning (2014). Background map: Ortofoto 0,25 © Lantmäteriet (2019).

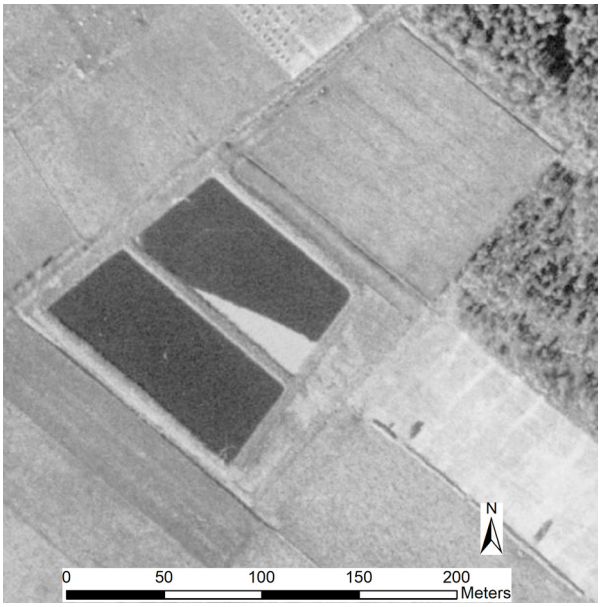

Figure 6. Air photograph from 1960, two treatment ponds are visible. Historic orthophotos © Lantmäteriet (2019).

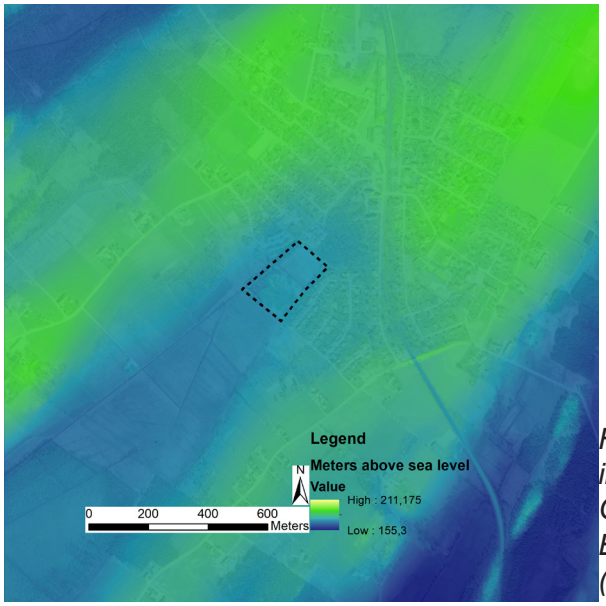

Figure 5. Elevation map over Länghem, Green illustrates higher elevations. Created from: GSD-Höjddata grid 50+ © Lantmäteriet (2015). Background map: Ortofoto 0,25 © Lantmäteriet (2019).

1. Thomas Tranefors, environmental strategist, Tranemo municipality, interview 2020-02-10

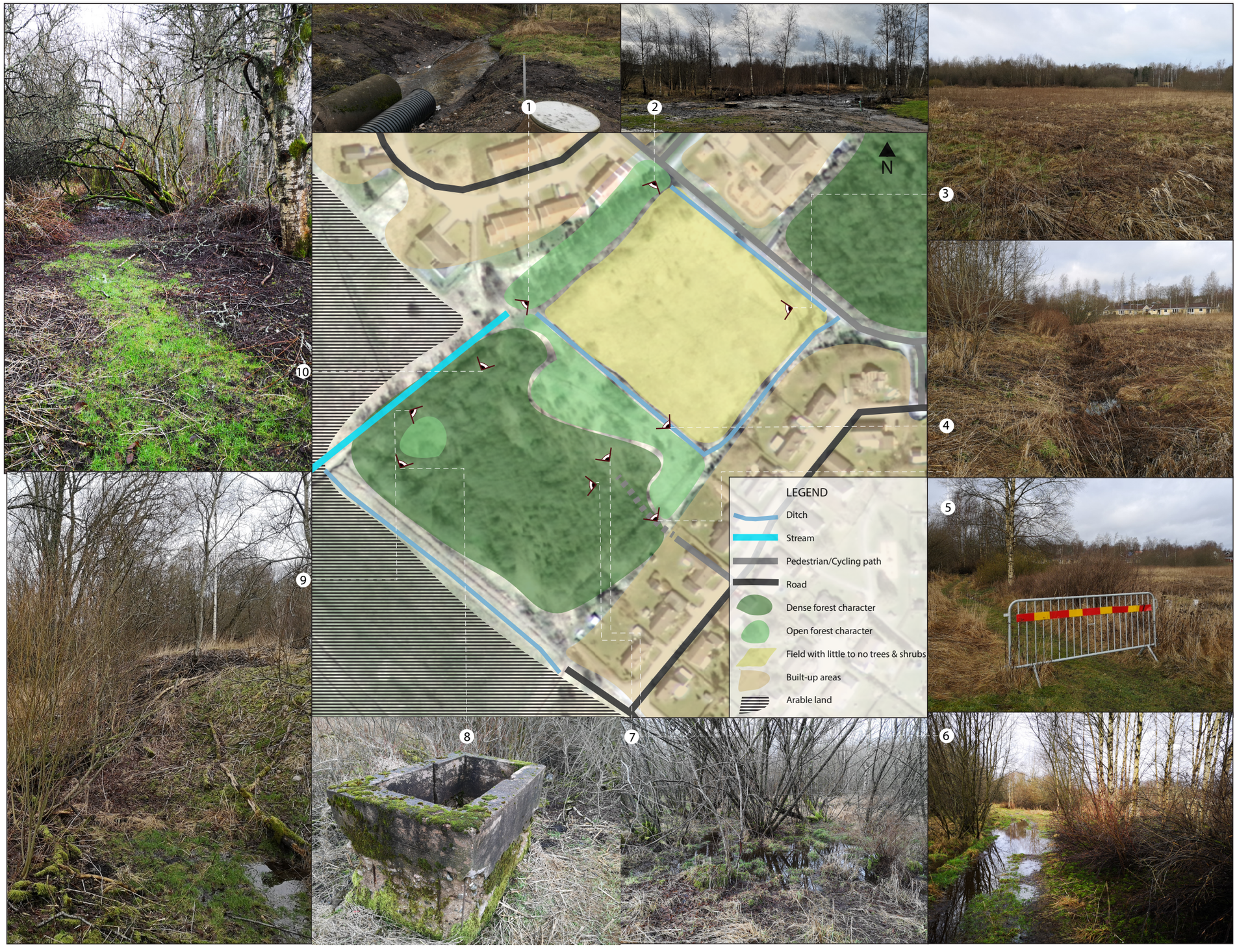

Figure. 7. A descriptive map over the focal area in its existing condition, accompanied with photographs from a site visit in February 2020. Illustrations and photographs by Joel Forsman Semb

Based on a site visit in February 2020 and from studying maps, a descriptive plan (Fig. 7.) has been made to describe the different characters of the site in its current condition. The area can be divided into two large parts, an open area in the north and an overgrown area in the south. A large open field with a few trees and shrubs scattered along its edges (Fig.7 (3)), together with a smaller area of sparse woodland (Fig.7 (2)) create the open area. The two character-areas have a natural border in the form of a ditch (Fig.7 (4)). The dense forest character is overgrown with trees and shrubs, making it very difficult to navigate through (Fig.7 (7)). While the open area is relatively flat, the dense forest is more undulating (Fig.7 (9 & 10)) and appears to be wetter, as pools of water could be found in multiple places. There is a closed-off path that enters the dense forest from the east (Fig.7 (5)). The path stretches 40m before it disappears into a puddle (Fig.7 (6)). There were not many signs of human activity on the site apart from an old campfire and a small ruin of some concrete structure (Fig.7 (8)). At the northwest edge, there is another entrance to the site, which likely is meant to connect to the eastern entrance. Next to the entry point is an outlet for a stream that flows from NE to SW along the edge of the site (Fig.7(1)).

Although the entire site can be considered wet, the dense forest appears to be

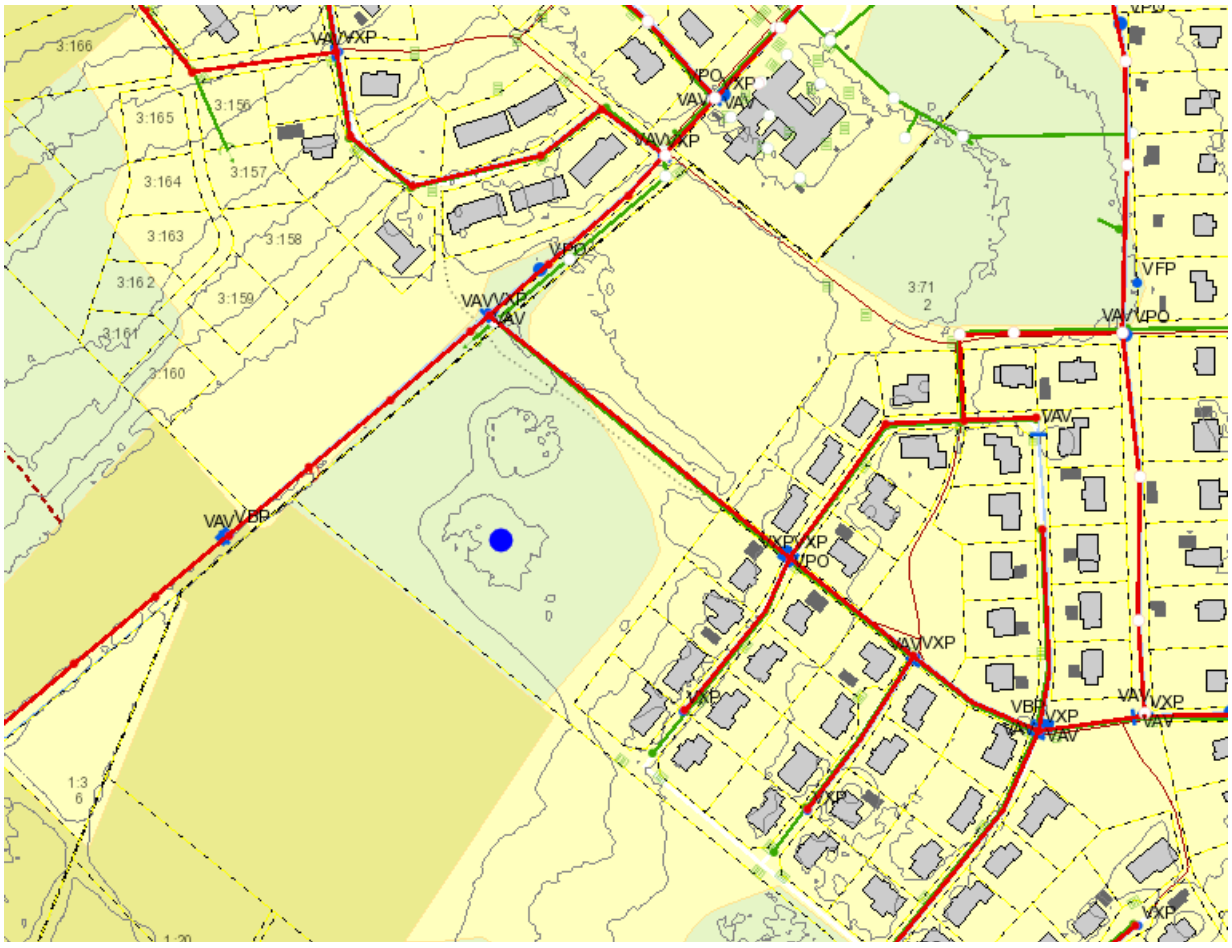

Figure 8. Height lines. Länsstyrelserna Geodatakatalog.n.d.

considerably wetter. This area is also at a lower altitude than the north (Fig. 8). This also becomes evident when observing the height differences around Länghem (Fig.5) as the terrain slopes from northeast to southwest.

The highest precipitation in Sweden can be found in the mountains along the border to Norway. Aside from these mountainous regions, the highest precipitation can be found close to Länghem. Between 1961 and 1990 the average yearly precipitation was >1000mm (Fig. 6) and approximately 30 days with >10 mm precipitation annually (Fig. 7).

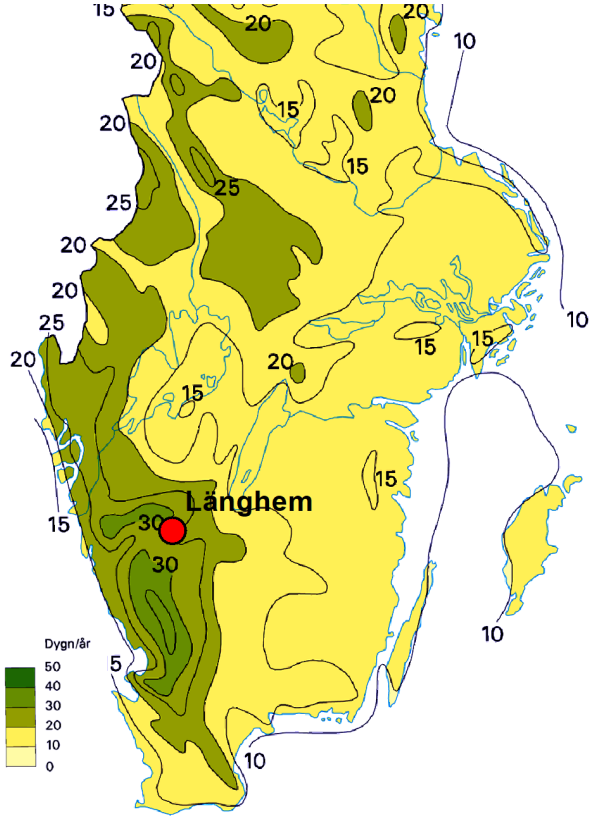

Figure 10. Average days of heavy precipitation per year. Normal dygnsnederbörd 10 mm medelvärde 1961-1990 © Sveriges meteorologiska och hydrologiska institut (2009).

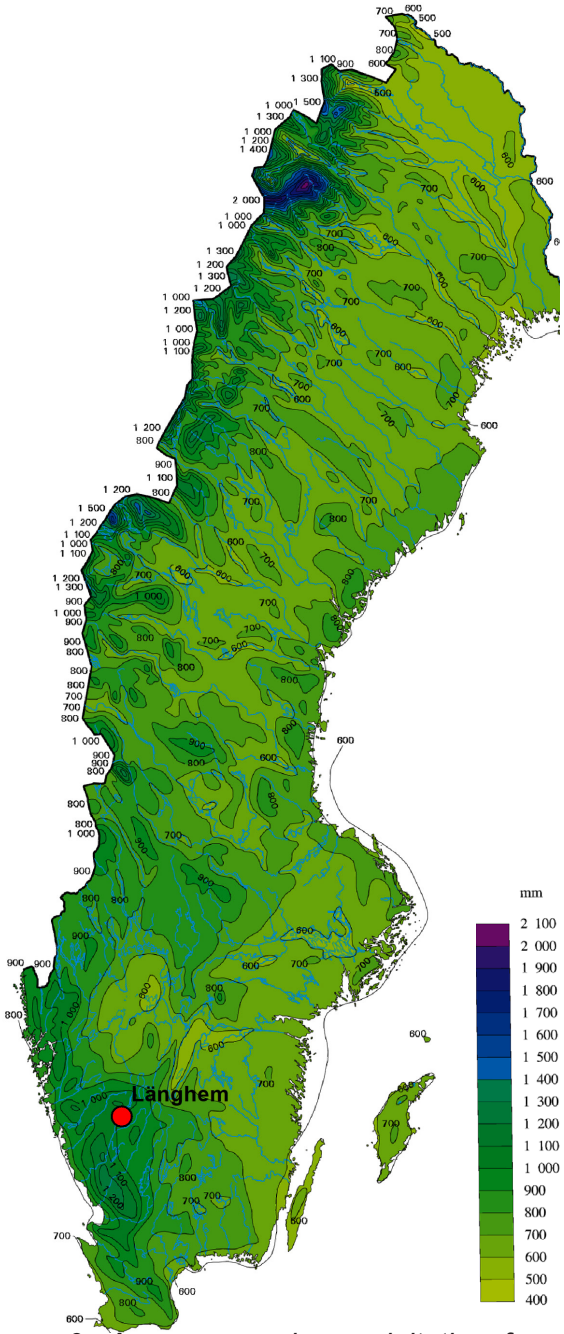

Figure 9. Average yearly precipitation from 1961-1990. Normal uppmätt årsnederbörd, medelvärde 1961-1990 (Edited) © Sveriges meteorologiska och hydrologiska institut (2009).

2.2. Areas, identity and movement

To get a foundation for the design, understanding the physical structure of Länghem can be helpful, as this may give an idea of place identity and movements within the town. Thus, an analysis of Länghem's physical space was made. The analysis aims to establish movement, identity and spatial division. In The Image of the City by Lynch (1960) a methodology is described based on interviews with users, often mentioned as a Lynch analysis. The analysis performed in this chapter is not based on interviews but investigates the same aspects as a Lynch analysis, using The Image of the City as basis for the content of the analysis. A further description of the used method can be found in chapter 1.5.4.

Lynch (1960) investigates how the physical environment in a city is perceived, which is materialised in an analysis that aims to communicate the visual perception of cities. The people in the city are the ones observing the city's physical environment and are therefore called 'observers' by Lynch. By examining and conducting interviews with observers in Los Angeles, Boston, and Jersey City, Lynch developed a methodology that divides the urban environment into five different elements: paths, edges, districts, nodes, and landmarks. Paths are linear elements that are used for movement by the observers. Furthermore, the observers observe the city while the move along the paths. Paths can be roads, bicycle roads, walkways, rivers, railroads, etc. Edges are another linear element that is not used for movement or at least not considered to be used for movement. Contrarily, edges can restrict movement and often acts as barriers, sometimes penetrable, other times not. Edges are often important in defining the limits of adjacent areas. Examples of edges are rivers, railroads, and shores. Districts are areas which the observer can enter into. In a district, there is a feeling of a specific character that unifies that area into one recognisable district. Nodes are spots in the city which the observer can enter and can be places where observers change mode of transport, convergences, crossings or they can be places that a lot of observers visits. Landmarks are points of reference such as buildings or a mountain. The urban elements - apart from districts - are classified on a scale of 1-4 based on how frequent the observers mentioned the elements.

The major paths in Länghem are mostly made up of roads that go through and into the town: Hagagatan, Boråsvägen, Ingestorpsvägen. These roads are fairly wide and see the most car traffic but also some pedestrians and cyclists move on them. Apart from the larger roads, Cypressvägen makes up the final major path. This is a shared-use path that connects the northwest and southwest districts. The path is used for recreational walks but is also the only passage through the two green lots in west Länghem, passing next to the focal area.

Lynch mentions railroads both as paths, because it is used to move along, and as edges, since railroads often act as linear boundaries. In the case of Länghem, the railroad cuts through the middle of the town with only two passages, making it the most dominating edge in the town. Because there are no train stations in Länghem, observers within the town can't move along the railroad, as such the railroad is not a path. Other edges are ditches in the focal area and the edge of a small forest in the middle of the town and lastly treelines

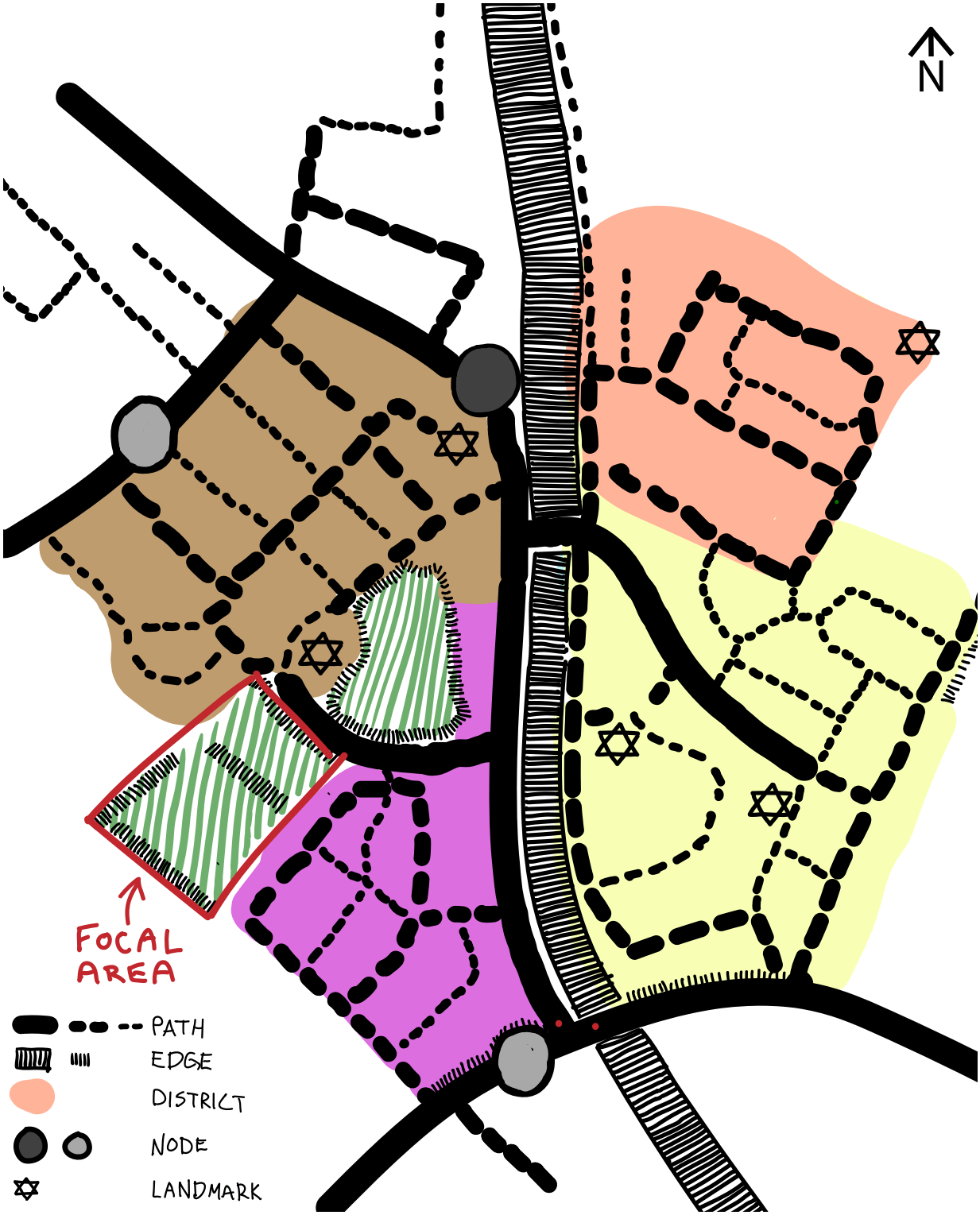

Figure 11. Lynch analysis over Länghem. Illustration by Joel Forsman Semb

next to the regional road that frames the south part of town and the regional road exiting Länghem in the northeast.

There are four districts and two green lots (focal area and adjacent lot) that do not belong to any district but are not quite districts of their own. There are no major distinctions between the different districts and the identities do not deviate as much as districts in larger cities typically do. Most of the housing consists of one or two-story villas in every district but there are some differences. The Northeast district (NE) is characterised by larger lots and larger buildings. NE has a more varied built-environment than the other districts. There are twin houses, larger villas, and apartment buildings and the local centre for primary healthcare within this district. Southeast district is characterised by narrow streets and smaller villas with smaller private gardens. The district holds the local church and school. Southwest district similarly consists mostly of smaller villas with intimate gardens but also has some larger lots. Northwest is where most of the commercial business within the town is located. Apart from businesses, the district consists mostly of single villas, the district is currently seeing some ongoing expansion to the west.

With the project site being considered separate from the surrounding districts and few people ever using the site, no strong place identity has been found.

Three nodes have been identified, all being bus stops. The main node is located in the centre of the town where the highest quantity of movement was observed.

There are five landmarks in Länghem, the most visually striking being the tower located on the northern edge of town. The other landmarks are a school, preschool, church, and the local grocery store.

3. Research

3.1 Interview at pre-school

The preschool 'Bikupan' is situated right next to the site, due to its proximity, the area could be suitable for the children at the preschool to use. To learn how to adapt the site to the local children, an interview took place at the preschool with a group of children at the age of 6, together with some teachers. The children had never used the site and did not have much thought of its current state, so instead they were interviewed on how they use other outdoor space, what they usually do and what they think is fun. The teachers also had some input on this and highlighted the fact that they combine outdoor play with education, which was a great way to engage the children while teaching them about nature. The conversation then led to what the children would like to have on the site in the future.

"I want more flowers and more summer"
-Anonymous child on what he/she would like to see on the site.

The interview was structured around questions or topics and depending on how the children answered, different sub-questions became relevant. The interview gave a lot of room for conversations to go outside this structure and if conversations started becoming irrelevant or dragged on for too long, the conversation was brought back to the structured topics. Figure 12 illustrates the structure that was used and the answers can be found in Table 1. A similar structure of topics was prepared for interviewing the teachers but was not used due to the limited time of the interview, instead, a short interview was held with a few teachers with a focus on outdoor education and suggestion for the project site. The interview took place in Swedish but the questions and answers have been translated to English. Questions regarding current usage of the project site were not asked (and have been crossed out) because none of the children use the site.

Although some of the suggestions (such as jacuzzis) are unlikely to be implemented on the site due to high costs, difficulty in maintenance, etc, many suggestions could potentially be implemented. Some of the more popular suggestions that could be investigated for implementation on-site were: water games, trees, and shrubs, flowers, boulders, "empty" open space, which can be used for games, open water, obstacle course, ropeway, bicycle track, and a hill.

"I like it when it is high (altitude), then I can see everything"
-Anonymous child on what the landscape should look like for the site.

When asked, the teacher suggested the following to be implemented on-site: An organised mixed-forest, a hill from sledding, a pond with fauna that the children could explore and be used for education. The preschool teaches sustainable development and are active in having classes in nature settings, therefore, the teachers were interested in a pond where the children could follow the development of animals.

The teachers did not think that a wetland-type environment goes well with children. They said the main reason they don't use the site currently is because of the wet environment which potentially could be dangerous to the children.

The teachers also told about the site's

history, mentioning that it had once been a lake and more recently it was used for ponds to purify water. According to the teachers, the field layer on the site is dominated by two species during spring and summer: fireweed (Chamaenerion angustifolium) and meadowsweet (Filipendula ulmaria).

When asked what the children like to do or what they remember doing when they play outdoors, almost all answers were activities in nature that don't require any built equipment or toys. When asked what they would like to see implemented in the design, around half of the answers were nature-related and the other half were focused on built equipment such as diving boards and jumping castles. Although the fact that the children only remembered nature-based activities could be attributed to a lack of built equipment in their vicinity it would otherwise suggest that the nature-based activities are the most memorable to them.

All answers given to questions on what activities the children do during winter were in some way related to snow. While snow-related activities may be popular during winter, the children probably also do other activities as well. The reason why all answers were related to snow could be partially due to snow being a common reference for winter in Scandinavia and the questions may have been somewhat biased, because there is the possibility that some activities overlap seasons but when asked about activities during a particular season, it is natural to think of activities that are unique to mentioned season.

To satisfy the users' need for recreation it is important to first ask who will be using the site for recreation. Apart from the children in the preschool, the user groups are rather wide. As seen in figure 11, there is a lack of available green space for recreation within the settlement and the site can be reached by the entire population of Länghem. Therefore, the design aims to satisfy the needs of the different users within Länghem with particular attention to the user group of young children. When designing for a wide group of users, there are many factors to consider. Some of the key factors are: availability, stimulation of different senses, different spatial qualities, stimulation of both calm activities and more active activities. These factors are reflected in the design principles (chapter 4.2).

3.2 Characteristics of peat

As the entire site stands on peat soil, it is important to understand the unique characteristics of the soil type. This chapter will describe peat and investigate some challenges that may arise in the design due to the soil.

Peat is a soil type made up mostly or entirely of organic matter, these soils are formed from dead plants and animals (Vesterberg et al., 2016). The formation occurs in wet environments which are low in oxygen. The low oxygen content makes sure that the organic material doesn't decompose (Naturvårdsverket, 2019). The characteristics of a peat soil can vary depending on the grade of decomposition, but there are some general characteristics that differentiate all peat from mineral soils (Vesterberg et al., 2016). Peat has a low density and can be compressed to a high degree when pressure is applied. These

characteristics together with a low load-bearing capacity present a lot of challenges when it comes to construction of buildings and infrastructure and although innovation has made it possible to better conquer these challenges, it comes with higher costs (ibid.) and threats to the environment (ROADEX Network, n.d.).

Infiltration in peat soils is very low and comparable to clay soils (Cirkel, 1985). Peat soils also tend to have extremely high retention capacity when compared to other soil types (Savi et al., 2017). Whether peat is an effective tool to naturally reduce flooding is a topic that has been discussed largely with opposing opinions. Price (1992) & Evans et al. (1999) suggests that ombrotrophic peats may not have much impact on the intensity of streamflow. Shuttleworth et al. (2019) investigated three restoration projects of blanket peats in the UK and found reduced peak storm flows and an increased delay of the stream in measurements taken after the restorations, which would suggest that the capacity for peat to reduce flooding can vary depending on condition and

Figure 12. The script used during the interview at the preschool.

Category	Input from the interview
Free play activities the children specifically remember doing during summer	Collect moss, build treehouses, hide-and-seek, climbing, find hiding places, hide by themselves, search for wolves, go swimming.
Free play activities the children remember doing outdoor during winter	Build snowmen, build igloos, barbeque, have snowball fights, build snow-castles and use them for snowball fights, go sledding, make snow-angels, dig themselves as deep as they can, build a snow-horse.
What the children do when the weather is bad	Use a hood to protect the head, build a cover using moss as sealant, go back to the preschool.
Structural changes on the project site	A forest, fields, and some higher point. natural elements combined with a playground, a hill for sledding,
Requested features for the design	More flowers, more summer, Ice-cream, apple trees, space to build snow castles, more forest, more trees, more shrubs, more snow, a trampoline, boulders, space to sun-bath, an obstacle course, a jacuzzi, a swimming pool, a water-slide with a tunnel, a diving board, shrubs, lots of boulders which can be used to jump from one to another, flowers and trees, spruces, a playground ropeway, water games, a floating wooden house with a pier, a jumping castle, a field for water-fights, a bicycle track, a place to play football with goals and nets that catch stray balls, a hollowed-out tree, a castle with balls.

Table 1. Results of the interview compiled by category.

management of the site.

The majority of wetlands in south Sweden are affected by some sort of artificial drainage, often diking for agricultural or forestry purposes but factors such as off-road traffic can also lead to drainage. Diking leads to lower groundwater levels, which in turn drains the soil above the new groundwater level, exposing the soil to oxygen (Naturvårdsverket, 2019). Since peat is made up mostly or entirely of organic matter, it contains a high amount of carbon. When the carbon is exposed to oxygen it starts to oxidise, a process that produces carbon dioxide (ibid.) and greatly contributes to the emission of greenhouse gases. Emissions of carbon dioxide and

nitrous oxide from peatlands make up 6-8 percent of greenhouse gas emissions in Sweden according to Berglund & Berglund (2010) while Naturvårdsverket (2019) estimates that 20 percent of the total climate emissions of Sweden can be attributed to oxidising peat.

When oxidation occurs in a drained peat soil subsidence will occur, the amount of subsidence can depend on several factors. Berglund (1989) investigated a site with peat in Jönköping county, Sweden and found that the subsidence was more intense the initial four years after drainage was implemented and decreased over time. 1950-1954 subsidence was at 8.5 cm/year, 1964-1976 it was down to 0.9 cm/year. The site was used for agricultural purposes with varying intensity and the study attributes more than just oxidation as a factor to the subsidence and argues that 30-40 percent of the subsidence can be attributed to oxidation, which would equal to 3.0 cm yearly in the start and 0.3 cm yearly for the last twelve years. Areas with thicker peat layers and more intense cultivation had the most dramatic subsidence (ibid.). Due to the different factors involved, quantifying future subsidence as a result of the design suggestions in later chapters is a very complex task, some assumptions can however be made based on literature:

- No new diking has been made during the most recent years and there is no cultivation on the site, therefore the assumption is made that no dramatic subsidence should be currently ongoing.
- The new pond will drain the nearby areas, which will likely lead to increased subsidence, particularly during the first few years.
- The areas furthest away from the pond should be the least affected.
- By drying some of the peat soil, greenhouse gases will be released into the atmosphere

4. Design

The design will revolve around creating a park with two character areas. These areas overlap fairly well with the two existing parts that are illustrated in figure 4. The northern part will be an open area with cut grass and an open pond. This part will become drier to make it safe and suitable for young and old to use the grass for spontaneous purposes. The southern part will stay rich in trees and will resemble a wet forest with shrubs and a field layer on some parts. Here the site will remain very damp and feature a board-walk to keep the visitors dry.

4.1 Design process

Defining the design principles was the first part of the design process, it was essential to define the principles before continuing with the design as they describe the functions within the area. The design principles from Liao et al. (2016) were used in this project because they build on what seems to be the most widely accepted method to mitigate the threat of high water levels – flood adaptation . For principles on recreation, the Quality Evaluation Tool had already been chosen as the basis from the start of the project, however, the principles needed to be adapted to the context of an urban park. The principles from QET were rewritten, many of the principles described rather similar functions and could therefore be combined into fewer principles.

Once the principles were in place, movement through the focal area was investigated. While some users will seek to move within the area, others may

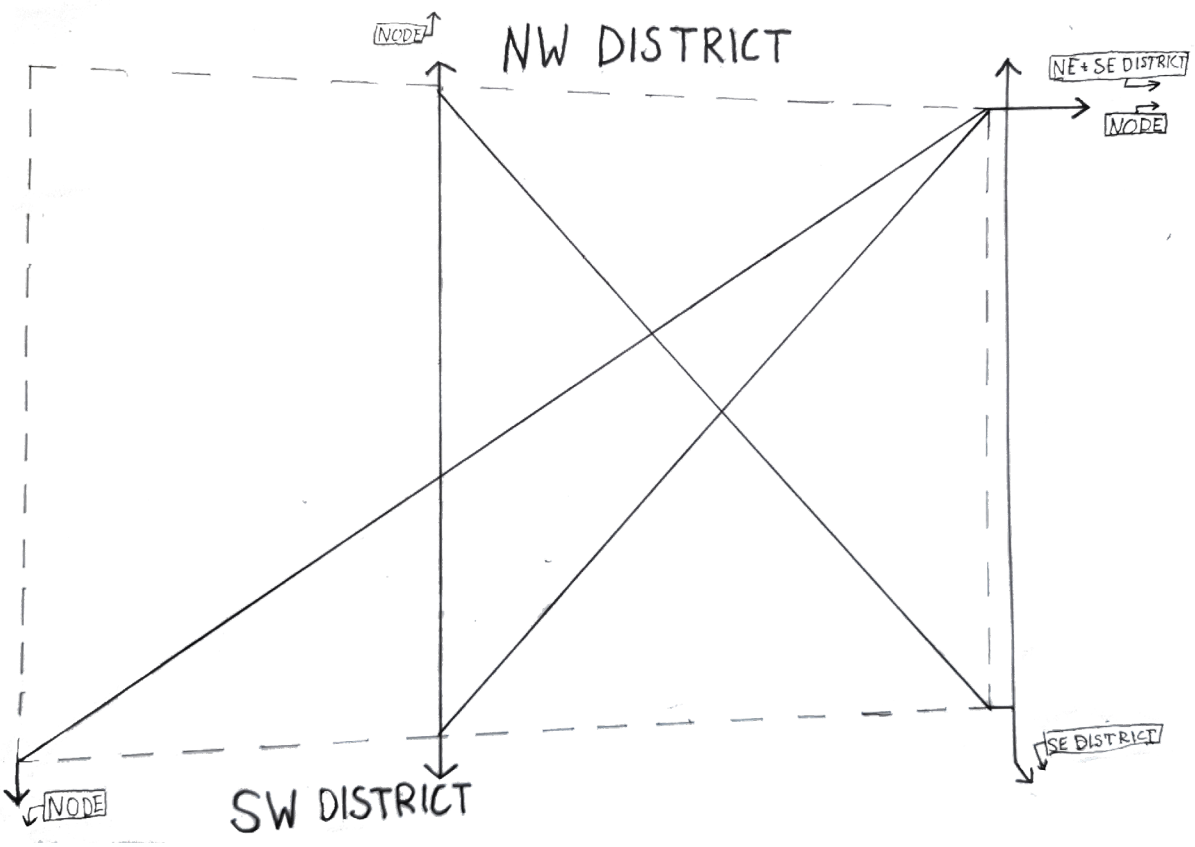

Figure 13. A sketch of desired movements based on the Lynch analysis. Illustration by Joel Forsman Semb

simply be interested in crossing the area as efficiently as possible and in the Lynch analysis, it was established that there are few connections between NW and SW district, divided by the focal area. With good connections, the focal area can instead become what connects NW and SW district. Therefore, it was important to decide on paths early in the process to avoid compromises.

Figure 13 illustrates a sketch on the estimation of desired movements based on the Lynch analysis. The most important connections are estimated to be between NW and SW district and connecting SW district to the central node. Connections to the eastern districts and the north and south nodes were also considered, however, these are believed to be secondary in importance. All of the connections are in direct contact with paths in adjacent areas.

As the design principles state that there should be different character areas with varying functions, the park was divided into two character areas, an open space focused on activity and social contacts in the north and a contemplative area with forest and nature theme in the south. This decision was also based on the fact that the south part already had a high amount of trees and the north part was close to the preschool and the soil is not quite as poorly drained as in the south, making it more suitable for activities on grass. The next step was to draw out existing elements on site that was intended to be kept in the new design. Identified features were checked for compatibility with user needs and functions defined by design principles and the preschool interview. The small ruin would be kept, as this can be considered a cultural connection, in line with design principle 10. The existing hill was to remain and be made more accessible as the children from the preschool requested hills that can be used for play and offer views. In the northernmost corner were a group of birches. It was decided to keep these, as they could offer a small forest-like setting for children to play in, as requested during the interview. During the site visit, it was observed that the southwestern edge of the area offered wide views over the open landscape. These views expose users to the cultural landscape just outside Länghem, according to design principle 10, and would therefore be incorporated into the design. As a pond had been requested by the municipality, height maps were investigated to find a suitable location, and placing the pond led to the idea of using the excavated masses from digging out the pond for a hill that would be more appropriate for sledding than the smaller hill in the south. Having an oblong hill would give space for larger groups of children to go sledding at the same time, so an oblong hill was placed in the higher part of the north area. All of these ideas were put on paper and with the basic features in place, paths could be drawn. The paths intend to create efficient passage through the area, with the desired movements in figure 13 in mind, while also offering longer walks within the park. This whole process was done while sketching on paper and in computer software. At this point, a concept was in place and an overview of the main structures was in place (Figure 14).

Moving forward the design process was quite organic, where one feature led to the next much alike how shaping the pond gave the idea of the sledding hill. The design principles and the preschool interview were used as a basis for decision-making during the design process. For example, using fences as a safety barrier was initially avoided in fear of creating an exclusive space, however, when the idea of using roundpole fencing came up due to its low profile and less exclusive

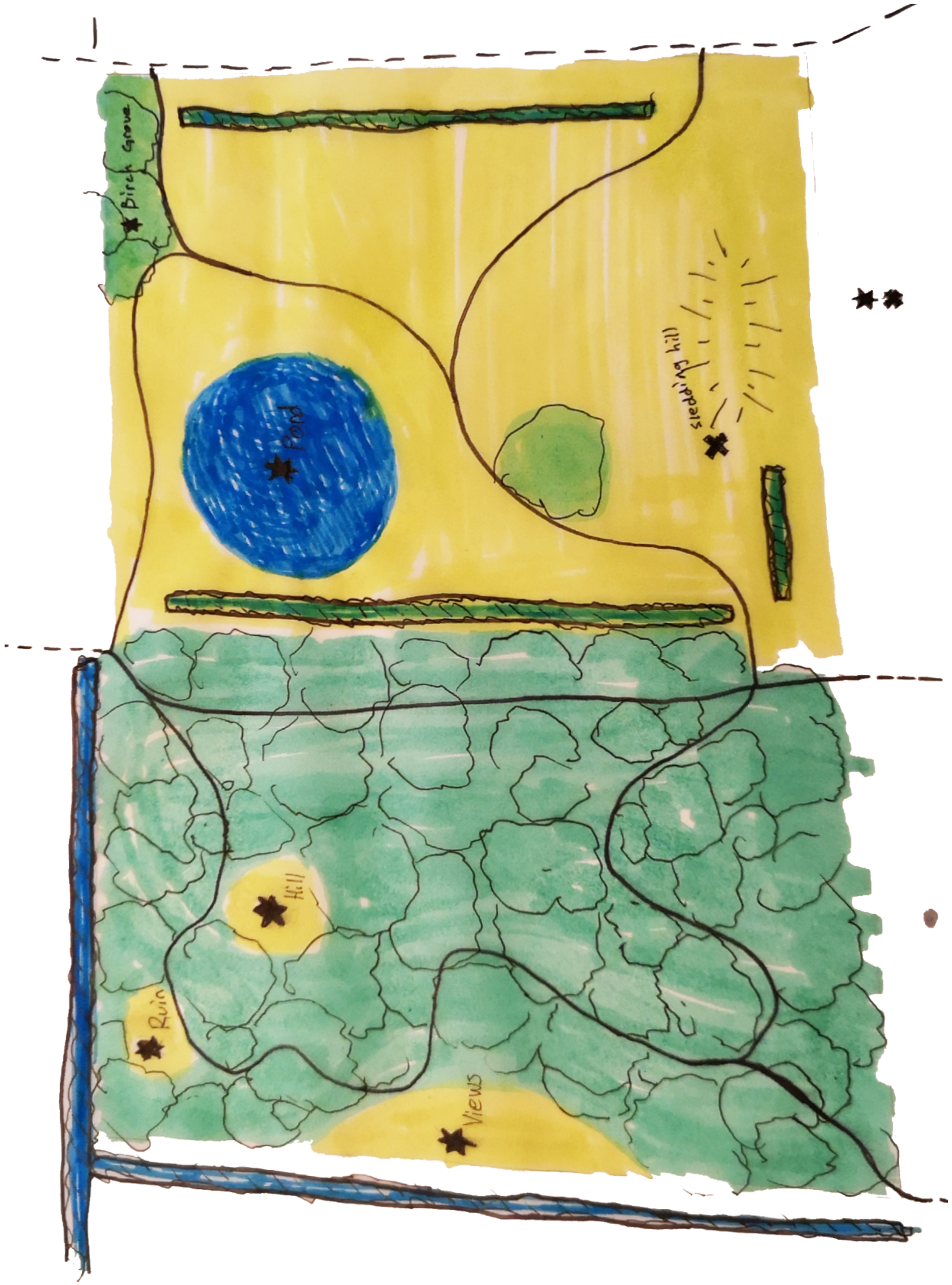

Figure 14. A sketch of the proposal from an early stage of the design process. Illustration by Joel Forsman Semb

expression, the suggestion had a stronger basis because it would relate to the local culture as defined in principle 10.

4.2 Design principles

To create an evidence-based design that incorporates both recreation and flood adaptation, the design principles are defined based on literature that have defined principles for recreation (Bengtsson & Grahn, 2014) and flood adaptation (Liao et al., 2016).

Principles on flood adaptation

Liao et al. (2016) critiques the conventional flood management which they argue is focused on preventing flooding through flood control infrastructure such as dams and dikes, which attempts to prevent the water from reaching urban areas. This type of management is bound to fail when the maximum capacity of the infrastructure is exceeded. Three design principles were formulated that aim to adapt to the forces of nature by allowing flooding to occur but limit its damage to society. Each principle has been elaborated on with the purpose to make it more tangible and clear as to how they can be incorporated in the design.

1. Urban design should anticipate and accommodate flooding.

o Anticipating and accommodating flooding can be incorporated in urban design by allowing open space to periodically flood during high water flows and thereby functioning both for recreation and flood protection. Bio-swales, rain gardens, and constructed wetlands can also be used to accommodate flooding. Other design methods that incorporate retention, storage, infiltration, and treatment are also considered to be accommodating flooding.

2. Urban design should incorporate the ecological process of flooding.

o Flooding with low to medium intensity can have ecological importance and when all flooding is mitigated, these values are lost. When flooding is accommodated, ecosystem services can be sustained.

3. Urban design should reveal the flood dynamic to the public.

o When flooding is hidden away, it takes away human interaction and understanding of flooding as a naturally occurring phenomenon. By revealing the water dynamics to people, it will educate and lead to a better understanding of it.

Principles on recreation

In Bengtsson & Grahn (2014) 19 environmental qualities are defined to be used with the Quality Evaluation Tool (QET). These qualities are structured under two separate sections – A. being comfortable in the outdoor environment and B. access to nature and surrounding life:

A. Being comfortable in the outdoor environment

- Closeness and easy access
- Enclosure and entrance
- Safety and security
- Familiarity
- Orientation and way finding
- Different options in different kinds of weather

B. Access to nature and surrounding life

- Joyful and meaningful activities
- Contact with surrounding life
- Social opportunities
- Culture and connection to the past
- Symbolism/reflection
- Prospect
- Space
- Rich in species

- Sensual pleasures of nature
- Seasons changing in nature
- Serene
- Wild nature
- Refuge

The tool was created for healthcare settings and instead of using them with their entire original definitions, they work as the basis for new principles that are adapted to the current case in this study with more tangible definitions. The purpose of these qualities is to set guidelines for a space that offers recreation to a wide range of different users.

4. The park should be visible from public areas and private properties within close proximity but should offer shelter from external views. (Closeness and easy access & Enclosure and entrance & Safety and Security)
5. The entrances to the park are inviting and clearly defined so they are easy to find and the park is accessible from all sides. The placement of entrances should be within as close proximity to users' indoor environments as is feasible. (Enclosure and entrance)
6. Paths are comfortable and safe to use at all times of the day, regardless of disability. (Safety and Security)
7. Although the park has two different character areas, the whole area is perceived as one park and not two separate parks. The paths guide the users to new areas. (Familiarity & Orientation and way finding)
   - The same furniture (lamps, waste bins benches, etc.) is used throughout the park.
   - Connectivity is good between the two character areas.
   - Paths always lead on to a new area, there are no dead ends.
8. The park can offer something to its users in different seasons and weather conditions. (Different options in different kinds of weather)
   - Some locations can shelter users from wind, rain, and sun.
   - Some locations have sunlight throughout most of the day.
   - Around benches, deciduous trees are favored to provide shade in summer but let in sun during winter.
9. There are opportunities for activities to people with different needs, it is possible to engage with the community as well as having alone time. The park has one part more suitable for dynamic activities and a separate part more adapted to contemplative uses. (Joyful and meaningful activities & Contact with surrounding life & Social opportunities)
   - The northern part of the park open and invites spontaneous social interactions. There is space for social gatherings where users can sit or prepare food.
   - The southern part of the park is more intimate and offers private locations, sheltered from views.
10. Some of the new elements in the park may relate to the local culture and existing elements that users may relate to culture or nature can be preserved and highlighted. (Culture and connection to the past & Symbolism/reflection & Sensual pleasures of nature)
    - The design of fences can take inspiration from roundpole fences that are widely used in rural Sweden.
    - The little ruin should be preserved.
    - Users can walk in enclosed forest character in the southern part of the park where they come close to the plants and can experience the greenery with all senses.
    - Open up for some views over the fields southwest.
11. The two parts of the park have different characters. (Prospect & Space & Serene & Refuge)

- The northern part should be a well maintained open area.
- The southern part should be enclosed by trees & shrubs and offer calm spaces.

12. There should be a variety of different plants in the park, some of which are of a wild character and there is something of interest every season. (Rich in species & Seasons changing in nature & Wild nature)
- Use a variety of plants that are interesting over different seasons.
- Use some plants that can be found in the local wilderness.

This sums up to twelve design principles, three focused on flood adaptation, and nine focused on recreation. These will set the basis for further design.

Incorporating suggestions from pre-school

This project set out to incorporate some ideas from the local preschool into the design product. The results of the interview was structured in five categories (table 1):

- Free play activities the children specifically remember doing during summer
- Free play activities the children specifically remember doing during winter
- What the children do when the weather is bad
- Structural changes on the project site
- Requested features for the design

Although some of the suggested features are difficult to implement on the project site or contradicts the concept of the park, many features and structural changes would work well. The preschool have play equipment similar to a playground but lacks green structure and nature-related features. Because the park is located just next to the preschool, where play equipment is available, equipment may not be of high importance in the park. Instead, the focal point will be on suggestions and experiences in nature and how these can be implemented in the design.
First off, structural changes have been kept central through the whole design process. The requested changes were:

- Forest
- Fields
- Higher point with views/sledding hill
- Natural elements combined with playground

The last bullet has not truly been incorporated in the design, for the reasons mentioned above. The others have been however. The north side, closest to the preschool will have an open field of cut grass and the south side will have a character more resembling a forest. While the field is more adapted to larger groups of children playing freely, the forest is not, because this area is still very wet and may require more supervision when the children go there. A hill will be made from the excavation of the new pond, with an oblong shape. This shape will give plenty of space for simultaneous sledding. These new structural changes should open up for most of the activities the children do in other outdoor environments.

4.3 Design proposal

The design will revolve around creating a park with two character areas. These areas overlap fairly well with the two existing parts that are illustrated in figure 7. The northern part will be an open area with cut grass and an open pond. This part will become dryer to make it safe and suitable for young and old to use the grass for spontaneous purposes. The southern part will stay rich in trees and will resemble a wet forest with shrubs and a field layer on some parts. Here, the site will remain very damp and feature a board-walk to keep the visitors dry.

4.3.1 The northern part

This part is centered around the pond, which will act as a storage basin for runoff. The pond will also reduce the water content in the topsoil in its vicinity, making the area less wet, hence safer and more comfortable to use. This creates opportunities to make an open area suitable for social gatherings and activities.

Cut grass covers this ground on this part of the ground, this creates a large area that will be sun-lit (8). The open grass-covered space leaves sufficient space for small spontaneous gatherings as well as larger community-organised gatherings (9). To make this space more comfortable and safe for use, it will be partially drained by sloping it down to the central piece of the northern half, an open pond. The soil under the grass may also need to be mixed with sand to achieve sufficient drainage. The pond will not have any water influx, apart from any runoff from the surrounding area. This means that the water level of the pond may vary depending on recent precipitation, creating a dynamic shoreline. Thus revealing flood dynamics to the users, which can be further highlighted by an information sign (3). The fluctuating water levels in the pond should also bring ecological values by creating a flooded habitat (2). The pond will function as storage for water, accommodating flooding (1). Along the eastern shore, a perennial planting is placed. This planting will not only bring aesthetical values but also functions as a fence towards the open field where children may be playing. A roundpole-style fence could also be used to complement the planting with a more rigid fence. Roundpole fences would relate to local culture, while also not restrict the views over the pond.

Any dugout from the site, mostly from the pond, is used to create an oblong hill along the eastern edge, which can be used for activities requested by children during the interviews.

Existing birches in the northern corner are kept to create a grove, which is located next to the equipment-based play area, creating an opportunity for children to mix equipment-based play with creative play in nature-setting. An eye-catching solitary tree (Cercidiphyllum japonicum) is placed centrally along the pathway where it can be observed from close and afar. A Betula pendula ‘Dalecarlica’ is placed along the northern ditch, together with a small thicket of Amelanchier alnifolia to create some framing structure in the otherwise open space. A. alnifolia is also used to create a small thicket on the eastern side of the sledding hill, to restrict access and fence off the eastern ditch. Solitary Taxus baccata ‘Columna Suecica’ frames the northeastern entrance. A. alnifolia is used as a hedge against the shared-use path to the north.

Table 2 describes how the design principles have been incorporated into the design of the north area

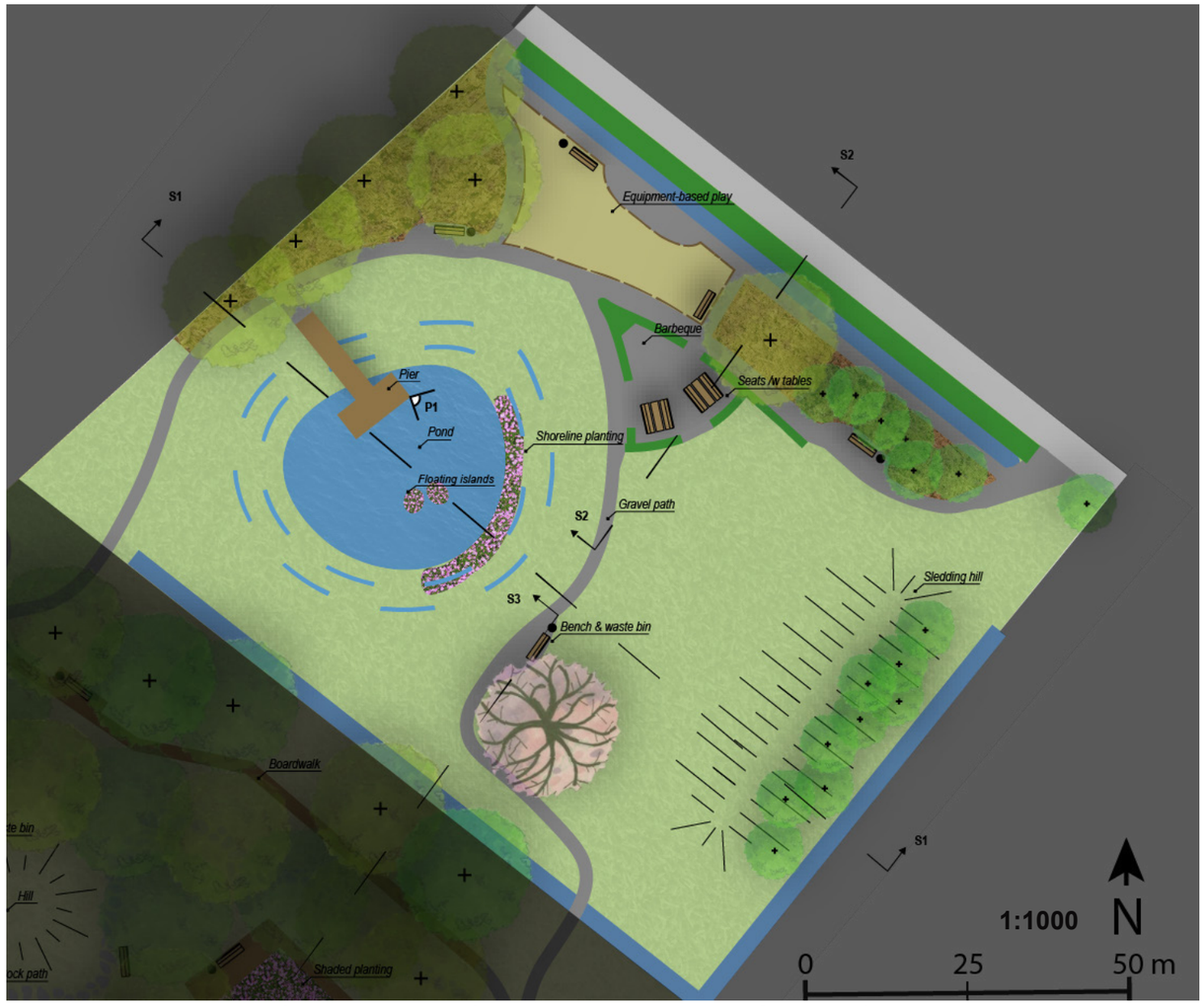

Figure 15. Illustrative plan for the north part of the park. Accompanied by Section 1 & 2. Illustrations by Joel Forsman Semb

Section 1,
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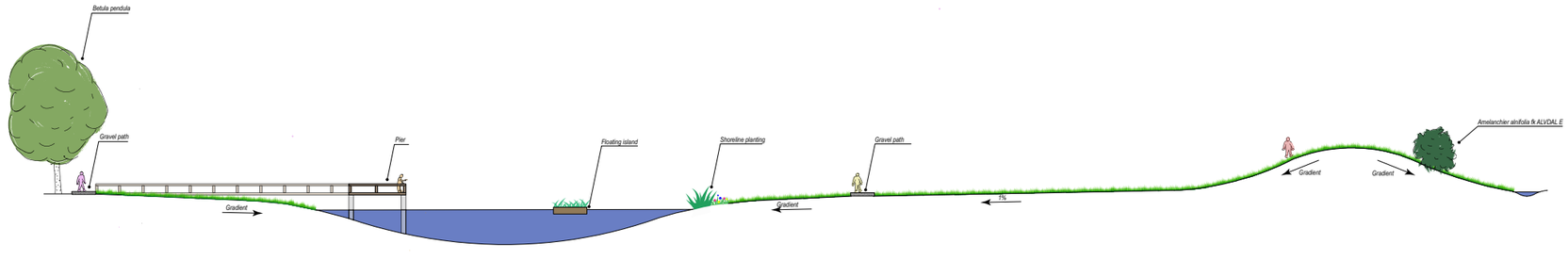


Section 2.
1:250

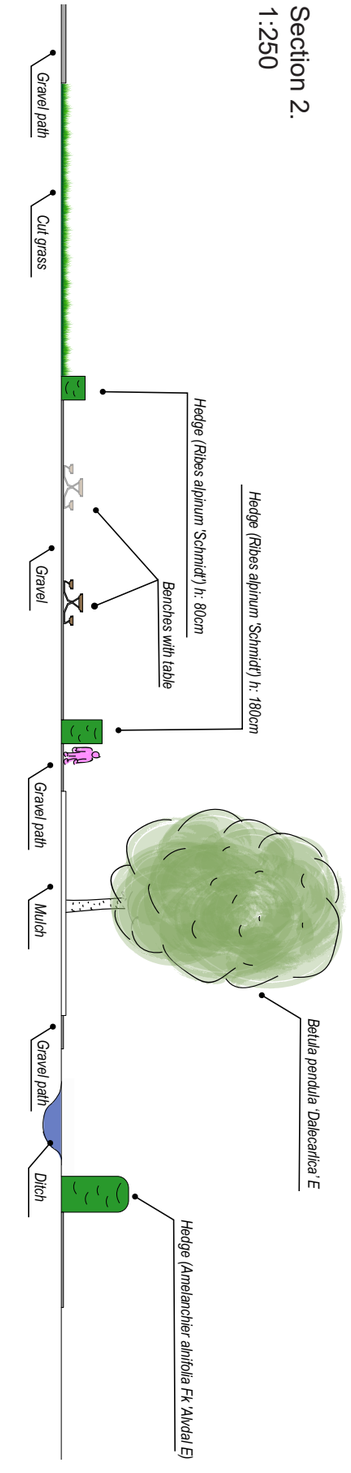


Figure 16. An illustrative view over the shoreline planting and the northeastern part of the park (Perspective 1). Illustration by Joel Forsman Semb.

1	The new pond will provide water storage, with space for runoff during heavy rainfall events. Transforming the ditches to rain gardens will improve retention and act as water treatment.
2	The dynamic shoreline of the pond may create unique habitats.
3	Fluctuating water levels in the pond will highlight flood dynamics to users, particularly to users who regularly visit the area and could be part of education for the local preschool.
4	A tall hedge limits views into the park from the northwest, the sledding hill restricts views from private properties to the west and the birch grove limits views from the northeast. While these barriers protect against external views, they are however not solid, making the park visible from adjacent areas.
5	The entrances are clearly defined and are framed to appear inviting. Entrances are placed based on an analysis of desired movements.
6	Paths and the pier are designed to be accessible by setting disabled users as the user standard (see chapter 4.3.4). Lights provide a sense of security during darker hours by illuminating areas around the paths. The paths are illuminated to a degree that users with impaired vision clearly can see the ground.
7	The same models of furniture are used in the whole park, including benches, trash bins, lamps, and any other furniture. Paths are connected across the whole park and guide the users from one area to another with no dead ends.
8	This part of the park creates a lot of space with exposure to the sun throughout all seasons. Shelter against wind can be found by the birch grove and at the barbeque area.
9	Open and inviting spaces create opportunities for social contacts and different activities. The equipment-based play area, barbeque area, shoreline planting, and pier provides activities for the users, while the sledding hill and open grass field offer a sandbox for creative activities.
10	Fencing around the equipment-based play area uses the traditional design of roundpole fences, which is a common symbol for cultural landscapes in rural Sweden.
11	This part of the park is a well-maintained and open character area with a focus on social contacts and activities.
12	The perennial shoreline planting uses contrasting plants with aesthetics that strongly differs from the perennial planting in the south area.

Table 2. Description of how each design principle has been incorporated into the north area

4.3.2 The southern part

The concept here was to create a wet forest that can offer a peaceful space for contemplation. Flood adaptation is built on the idea that society should adapt after nature, instead of the other way around. Based on these ideals, maintaining a wet environment in this part made the most sense. Because there are existing trees of different species growing in this part, the soil thickness and quality are considered sufficient for trees, assuming they are adapted to the site conditions. Adding together these factors led to the decision of creating a forest-like character that can complement the functions of the northern part.

With trees enclosing the area, this part of the park is more intimate and aims to create a space for contemplation. Here users can escape the stress from daily life and interact with elements of nature. Meandering paths guide the users through the park with different options depending on the users' preference. If the intent is to cross the park as quickly as possible, there is a path connecting north to south and a circular path that provides relaxing walks within the park. Boardwalks provide a dry and even surface for convenient walks. There is also a stone path, which allows the users to get closer to the ground, allowing more interaction with any natural elements that may be inaccessible from the boardwalk at the expense of less convenient surfacing.

The existing hill has been made accessible by removing the thicket, currently covering it, and can be accessed from the stone path. Here users can find a drier spot with altitude to rest and enjoy an overview. There is also a viewpoint connected to the boardwalk that offers views over the open fields to the south.

By adapting the site to wet conditions, it will be resilient to periods of intense precipitation. The boardwalks are elevated 30 cm from the ground and the plants are adapted to the site conditions, which means the area can retain water and accommodate flooding without losing its recreational uses (1).

Trees with an x illustrate new trees, which are concentrated along the edges of the area. The new trees are a mix of Betula pendula 'Dalecarlica', Picea omorika, Salix alba var. sericea, and Taxus baccata. New shrubs are placed under the trees where needed. The new shrubs are a mix of Cornus sericea 'Farba', Philadelphus coronaries 'Finn', Rhododendron catawbiense 'Grandiflorum', Rhododendron 'Persil' and Salix caprea 'Kilmarnock'.

Table 3 describes how the design principles have been incorporated into the design of the south area.

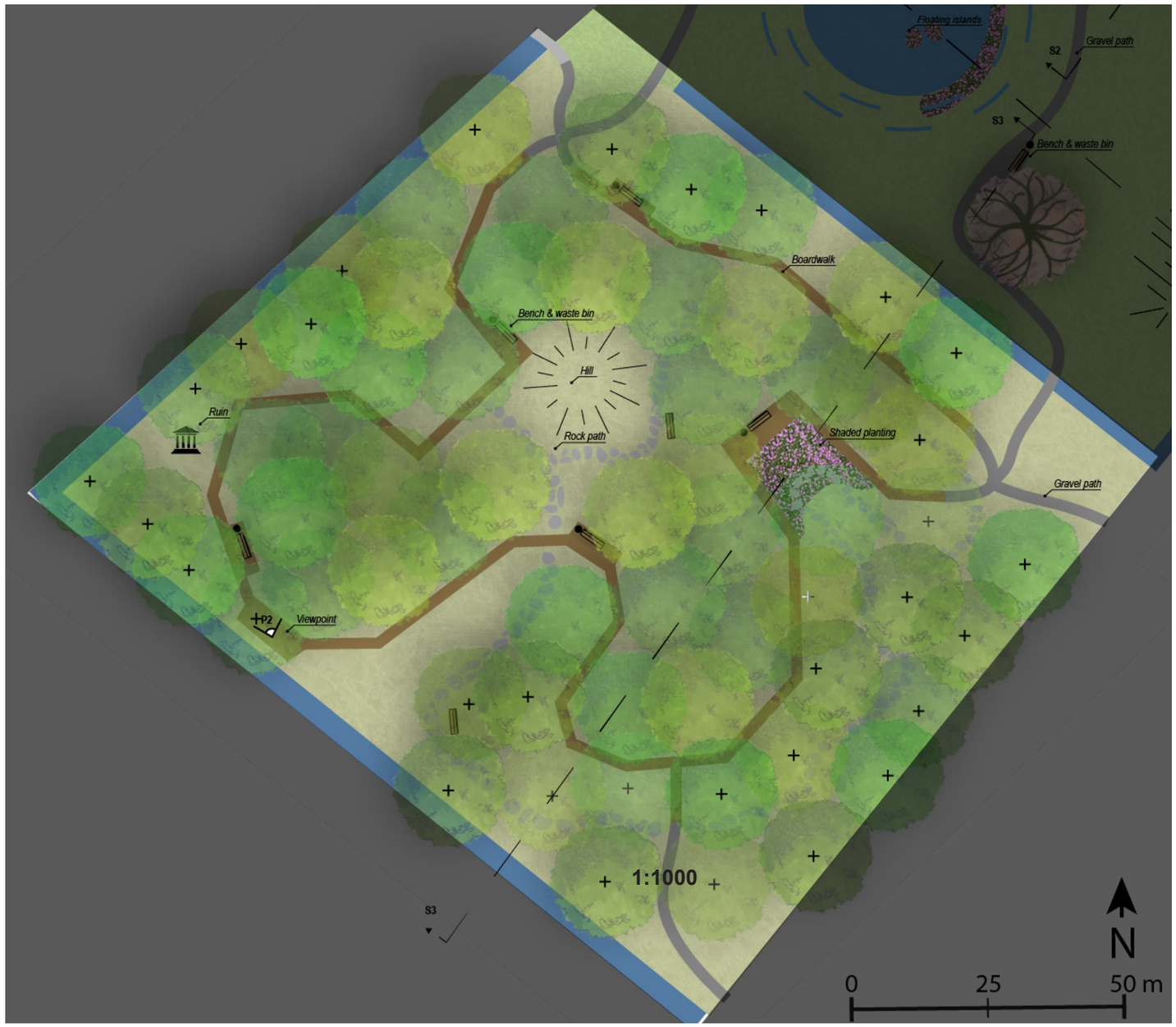


Figure 17. An illustrative plan for the south part of the park accompanied by section 1. Illustrations by Joel Forsman Semb

Section 3.
1:500

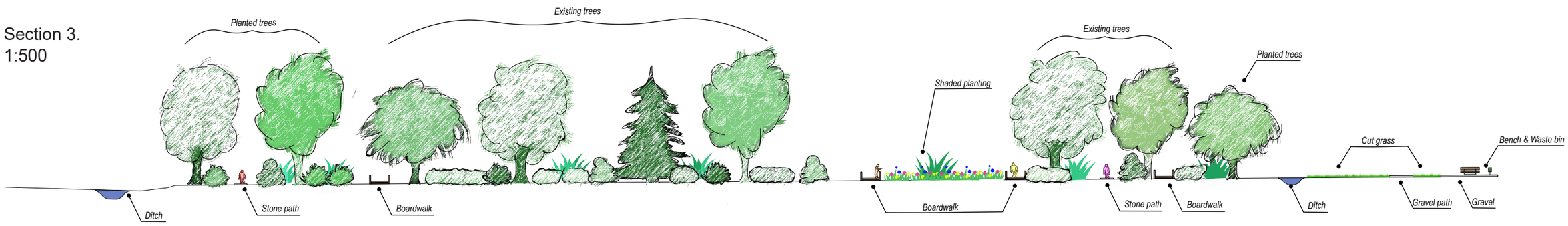


Figure 18. An illustrative image showing the boardwalk with the surrounding forest-like character in the south part of the park. Illustration by Joel Forsman Semb

1	By maintaining the wet character in the area, a lot of water can be retained in the soil. Furthermore, the functions in the area are protected from high water levels through elevated boardwalk and plant selection.
2	By retaining water, the area should create unique habitats.
3	Water retention is visible to the users by leaving much of the field layer open. In case of high water levels, the stone path may be inaccessible to users, which may initiate thought-processes connected to water.
4	The dense forest-character shelters the area from external views. The treeline may act as a local landmark, clearly visible to surrounding neighbourhoods.
5	The forest opens up around the entrances to spatially define entrances and appear inviting. Entrances were placed based on movement analysis, anticipating desired movements.
6	Boardwalks are designed to be accessible by setting disabled users as the user standard (see chapter 4.3.4). In the close vicinity of the boardwalk, shrubs are sparsely used and lights provide a sense of security during darker hours by illuminating areas around the boardwalk. The boardwalk is illuminated to a degree that users with impaired vision clearly can see the surfacing and outlines.
7	The same models of furniture are used in the whole park, including benches, trash bins, lamps, and any other furniture. Paths are connected across the whole park and guide the users from one area to another with no dead ends.
8	The trees provide shelter from wind and to some degree against rain. Deciduous trees are predominately used as they provide shade during summer and let in some sunshine during winter. Some scattered coniferous trees together with the evergreen Rhododendron catawbiense ‘Grandiflorum’ will ensure sufficient wind protection during winter.
9	This part of the park offers a contemplative environment for users and provides intimate locations.
10	The small ruin is kept as it can inspire thoughts on society and its interactions with nature. The southern edge has opened up for views over the agricultural fields, which brings the rural cultural landscape into the park. Daily interactions with natural elements through different senses are facilitated by creating a forest-like area close to the users’ homes.
11	This part of the park provides a calm forest character, enclosed by trees.
12	Naturally seeded plants are used together with some new species to create a somewhat wild forest-like character. The proposal creates a more diverse area by introducing new species while maintaining some existing trees and shrubs. The more diverse plant selection will provide more features over different seasons. The shaded perennial planting provides a long season of bloom with something of interest over every season.

Table 3. Desciption of how the design principles were incorporated into the southern part of the park.

4.3.3 Benches and furniture

There should be benches that are placed along the paths every 50-100 meters, there should be benches both in sunny and shaded locations and preferably on locations that are interesting for a break. Benches should have a 1 m wide area next to the bench where a wheelchair can fit, this space should have a smooth surface for easy turning in a wheelchair (Lundell 2005).

4.3.4 Pathing

Paths can vary somewhat in width but should be no less than 1.6m wide and feature some wider parts that are at least 2m wide to allow the turning of electrical wheelchairs. Slopes that stretch for long distances should not exceed 1:40, however for short slopes up to 1:20 is acceptable. Paths have enough light for users with reduced eyesight to navigate safely during dark hours and areas outside the path are lit to make the users feel secure. Lamps, waste bins, and benches must not be placed in a manner that makes them obstacles to persons travelling along paths.

In the drier parts, gravel is used for surfacing on the paths (dark-grey lines in figure 15 & 17). The surface must be even and smooth, which can be achieved with a top cover of stone powder according to Lundell (2005). For the wetter parts, the paths use board-walks (brown lines in figure 15 & 17). The planks should be placed perpendicular to the direction of travel to avoid the wheels from wheelchairs and strollers to get locked between planks. The gap between the planks is a maximum of 5 mm to make the surfacing as smooth as possible. Railings are placed on both sides. To avoid becoming a slippery surface, planks may require treatment or coating.

Although having the same surfacing throughout the entire park would contribute to a coherent expression, making the park feel more as one, according to design principle 7, neither of the two surface materials is appropriate for the entire park because a gravel path would not be

Figure 19. Roundpole fence (gärdsgård), a traditional element commonly found in cultural landscapes of rural Sweden. Illustration by Joel Forsman Semb

sufficiently dry in the wetter grounds and the board-walks would limit access to the drier grass field due to handrails along the board-walks.

4.3.5 Children's play

While the entire park can be used for creative play, much of the focus for the northern part was to create opportunities for children's activities, as this better fits the social and active character designated to the area. As mentioned in earlier chapters, the northern part will become less wet and with the addition of cut grass as ground cover, there is plenty of space for creative activities. Creative activities can also take place on the sledding hill, which can be used for snow-related activities during winter and games during warmer seasons. The equipment-based play area could be a conventional playground, or something different, such as a water-themed playground that incorporates educational aspects to teach about water dynamics. The area is fenced with a traditional roundpole fence (Figure 19), which is quite transparent and provides a cultural connection. Next to the equipment-based play area is the birch grove, where the children can interact with the trees. Although the north area has been designed with the intent of providing activities for children, the south part also offers relevant experiences to children. Here, they can experience forest character and the stone path was designed with the request of rocks that the children could jump between in mind. There are soft barriers in place within the park to reduce the risk of water-accidents. These barriers were designed with the notion of young children being supervised when playing in the park.

4.3.6 Perennial Plantings

Two perennial plantings are presented in this chapter, one that is fitted to the conditions next to the pond (1), and one that is fitted to the plantings in the south part of the park (2). The park is located in zone 4 according to the Swedish hardiness zones by Riksförbundet Svensk Trädgård (Riksförbundet Svensk Trädgård n.d.). Plants must work on peat soil and since peat tends to have a low pH, plants that grow on calcareous soils have been avoided. Lastly, plant choice has been limited to species that can be acquired from Swedish suppliers.

The shoreline planting is found at the shoreline of the pond and will be partially covered in water but due to fluctuating water levels, the water availability could prove quite dynamic, which means that some of the plants must be resilient to changes in water availability. Furthermore, the planting will see a lot of sun throughout most of the day, which also is an essential qualification for plant choice. The concept of this border is contrasts, which is expressed in the colours and structure of the plants. To achieve a strong colour contrasts, plants which flower simultaneously were chosen. This will create a powerful expression in colour, creating an attraction for visitors during summer, albeit for a limited time. It is not a coincidence that this border is located in the north part of the park, as this attraction aims to bring users to a specific point and create opportunities for social encounters. Caltha palustris provides yellow flowers and deep green foliage that is relative to the plant large and heart-shaped. The low-growing plant is best placed on the lower side where it can stick out of the water. Glyceria fluitans is a medium tall grass with a soft expression from its somewhat hanging growth. The grass creates dense clumps

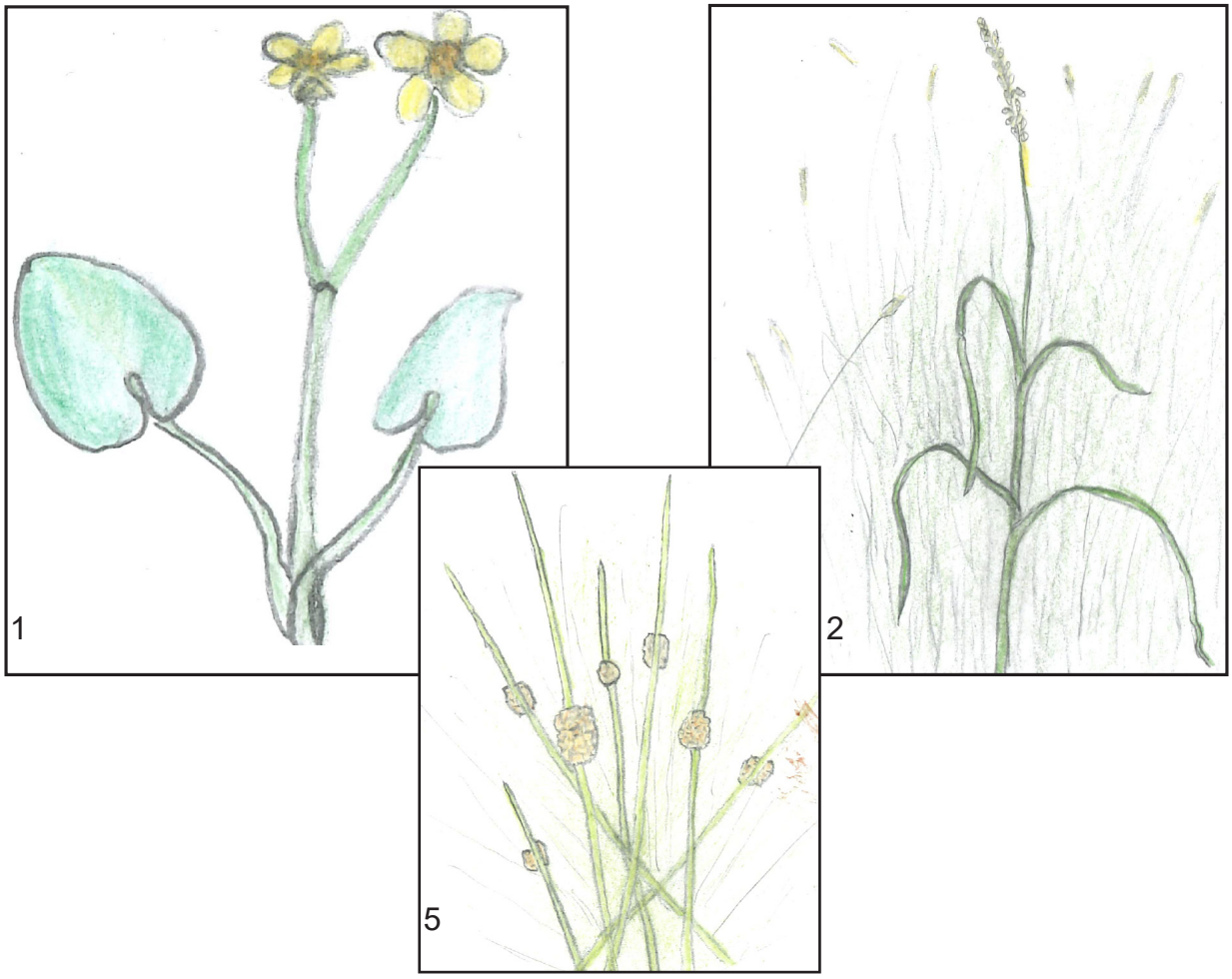
that provide a clear green background for contrast against the purple colours. Iris pseudacourus and I. spuria have stiletto-like foliage and large yellow and purple flowers. Juncus effuses is another medium-tall grass but its straight growth and spiky foliage create a spiky clump, thus, bringing a very different character than G. fluitans. Lythrum salicaria 'Robert' has large, torch-like inflorescence that brings a lot of purples in oblong shapes. Mentha aquatica is in this context a modest plant but it brings aroma and the small leaves and round flowers contrast its accompanied plants. Menyanthes trifoliata adds some white to the mix and together with its unusual foliage, it grows straight up from the water, preferably placed in the lower part. Ranunculus flammula has lots of small yellow flowers that almost shines, the loose manner it grows contrasts with some of the more strict shapes of the other plants.

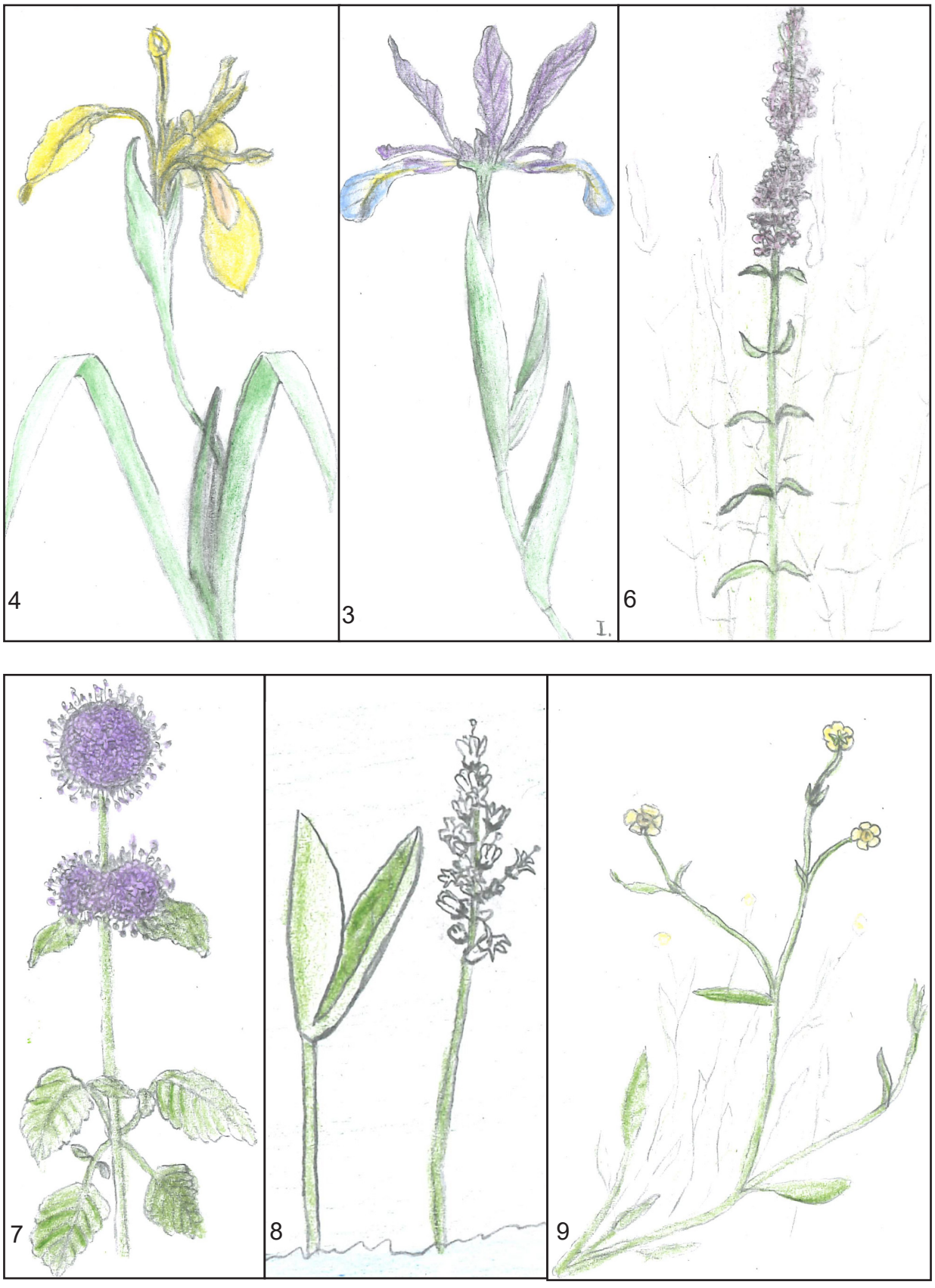
The shaded planting has moist to wet conditions and is expected to maintain a fairly even water availability. The flower-bed will be shaded as its name suggests. Thus, plants should be adapted to wet woodland conditions. Contemplation is the main theme in this part of the park, which led to the decision to find a calm composition of plants where strong contrasts in colour are avoided. Instead of using colours to give contrasts, brightness and the structure in foliage are the tools for creating contrasts in the border. Dark red and green colours make up the foundation, and elements of white and pink will bring in some brightness in contrast to the darker tones. Red as the dominating colour was chosen due to it being a warm colour, which seems appropriate for a place of contemplation. Many of the plants here have bronze or rust-coloured foliage to avoid too much cold green colour. Having a long season for the plants was also crucial in this border, as this will complement the limited flower season of border 1 and because of the few colours used, it is less important to have several species flower at the same time. The season starts in February with bulbs bringing some white colours until May when the perennials will take over, flowering continuously until September, and thereafter, colourful foliage and remaining structures will extend the season until winter comes.

The two bulbs, Galanthus magnet, and Leucojum aestivum have similar character and when the bloom from G. magnet ends, Leucojum picks up, thus a long period of white flowers are upheld from February. Three different ferns are used, which make up the structural foundation in the planting. Dryopteris erythrosora var. prolifica, Matteuccia struthiopteris, and Athyrium filix-femina 'Lady in Red'. The first has foliage that shifts from dark green to copper with nuances of red in the stem. M. struthiopteris is deciduous and creates tall upright clumps. It is semi-evergreen, providing structure and some colour during winter. The last one was selected for its elegant red stems. The latter two are both deciduous. Sedge is used to create a grass-like character in a location to dark for grass, Carex nigra was specifically chosen for its dark tones. Epimedium x rubrum and Primula japonica 'Millers Crimson' add crimson tones to the mix and provides a colourful yet calm expression. The two Astilbes adds colour from its fireworks of bloom. A. x arendsii 'Brautschleier, together with Convallaria majalis and Polygonatum multiflorum 'Variegatum' adds brighter tones to the mix.

	SHORELINE PLANTING			
	Name	**Height (cm)**	**Color**	**Flower period**
1	*Caltha palustris*	30	Yellow flower	May-June
2	*Glyceria fluitans*	60-100	Green flower	June-July
3	*Iris pseudacorus*	80	Yellow flower	June-July
4	*Iris spuria*	70	Blue flower	June
5	*Juncus effuses*	70-150	Green flower	June-August
6	*Lythrum salicaria* 'Robert'	70	Pink flower	June-August
7	*Mentha aquatica*	45	Purple flower	July-August
8	*Menyanthes trifoliata*	20-40	White flower	May-June
9	*Ranunculus flammula*	100	Yellow flower	July-August

Table 4. List of plants for the shorline planting.

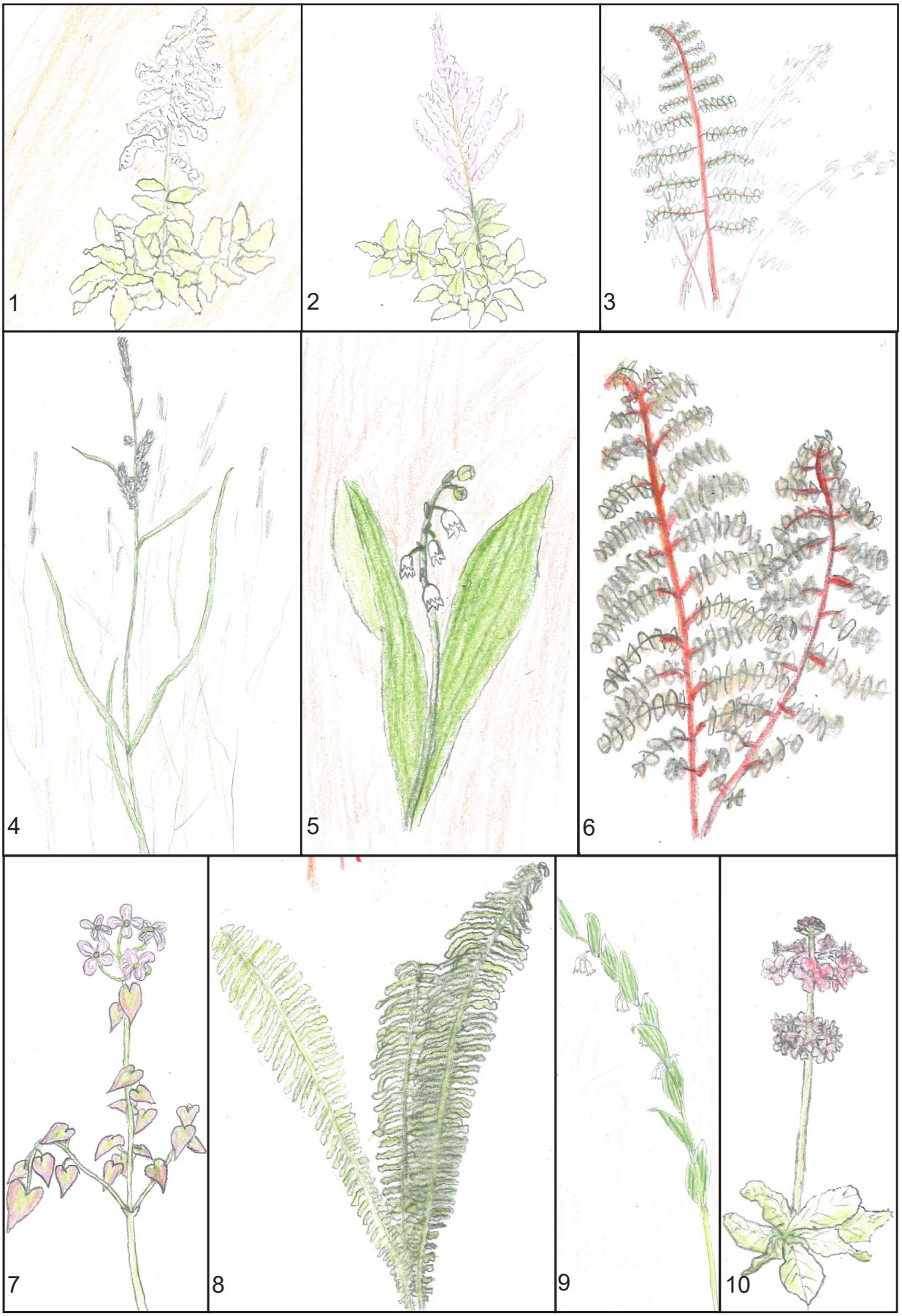




Illustrations by Joel Forsman Semb

	SHADED PLANTING			
	Name	**Height (cm)**	**Color**	**Flower period**
1	*Astilbe x arendsii 'Brautschleier'*	80	White flower	July-August
2	*Astilbe simplicifolia 'Sprite'*	30	Pink flower	August-September
3	*Athyrium filix-femina 'Lady in Red'*	70	Green foliage with red stems	-
4	*Carex nigra*	50	Black flower	June-July
5	*Convallaria majalis*	20	White flower	May
6	*Dryopteris erythrosora var. prolifica*	40	Red & green foliage	-
7	*Epimedium x rubrum*	30	Red flower	May.June
8	*Matteuccia struthiopteris*	100	Green foliage	-
9	*Polygonatum multiflorum 'Variegatum'*	60	White flower, green/white foliage	May-June
10	*Primula japonica 'Millers Crimson'*	50	Crimson red flowers	June
11	*Rodgersia aesculifolia 'Bronze Peacock'*	80	Red flower, bronze foliage	July-August
	Bulbs			
12	*Galanthus magnet*	20	White flower	February-March
13	*Leucojum aestivum*	35	White flower	April-May

Table 5. List of plants for the shaded planting.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4.3.7 Trees & Shrubs

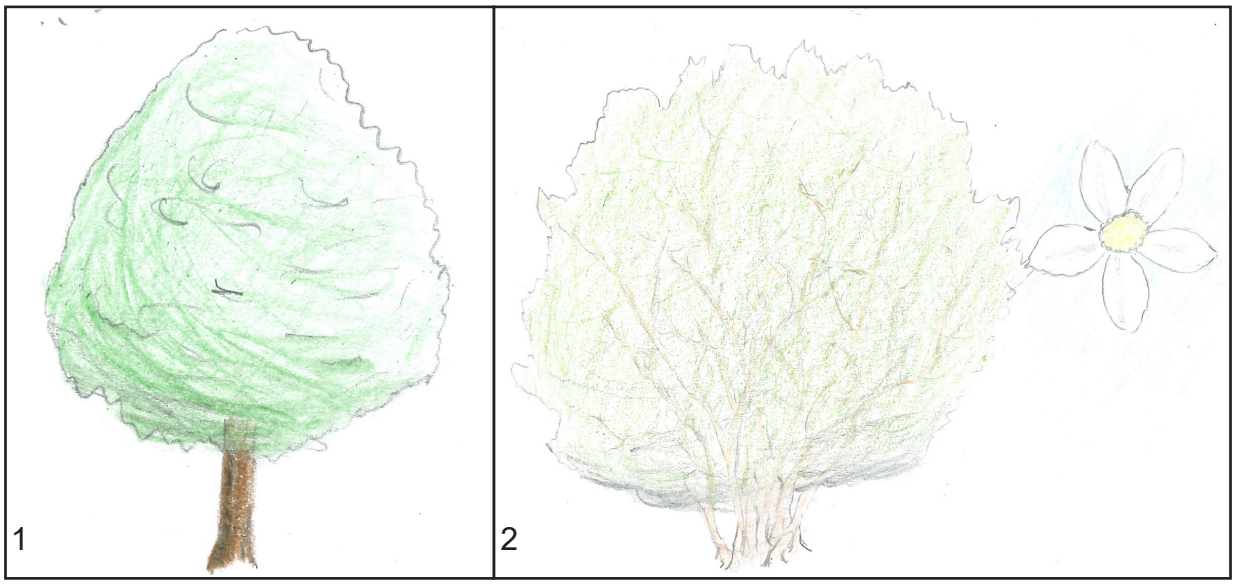
As mentioned previously, this proposal makes use of existing trees on site. During the site visit, observations were made to support this idea as many sizable trees were seen, which at-glance appeared to generally be in good health. Birches (Betula pendula & B. pubescens) are by far the most common trees in the area. Other species include Alnus glutinosa, Prunus padus, Picea abies, Pinus sylvestris. By keeping some existing trees, the park will immediately have some larger trees in place which is particularly important in the south park to achieve a forest-like character. The trees found generally seemed to have seeded naturally on the site and all the species mentioned above can commonly be found in the local wilderness (Sjöman & Slagstedt, 2015). Having wild trees that haven't been subjected to pruning may not always be suitable for a park environment, however, it makes sense when studying the design principles. Principle 12 describes that the park should have spaces with wild character and by including species that are commonly found in local wilderness, a connection to nature can be achieved, as described in principle 10.

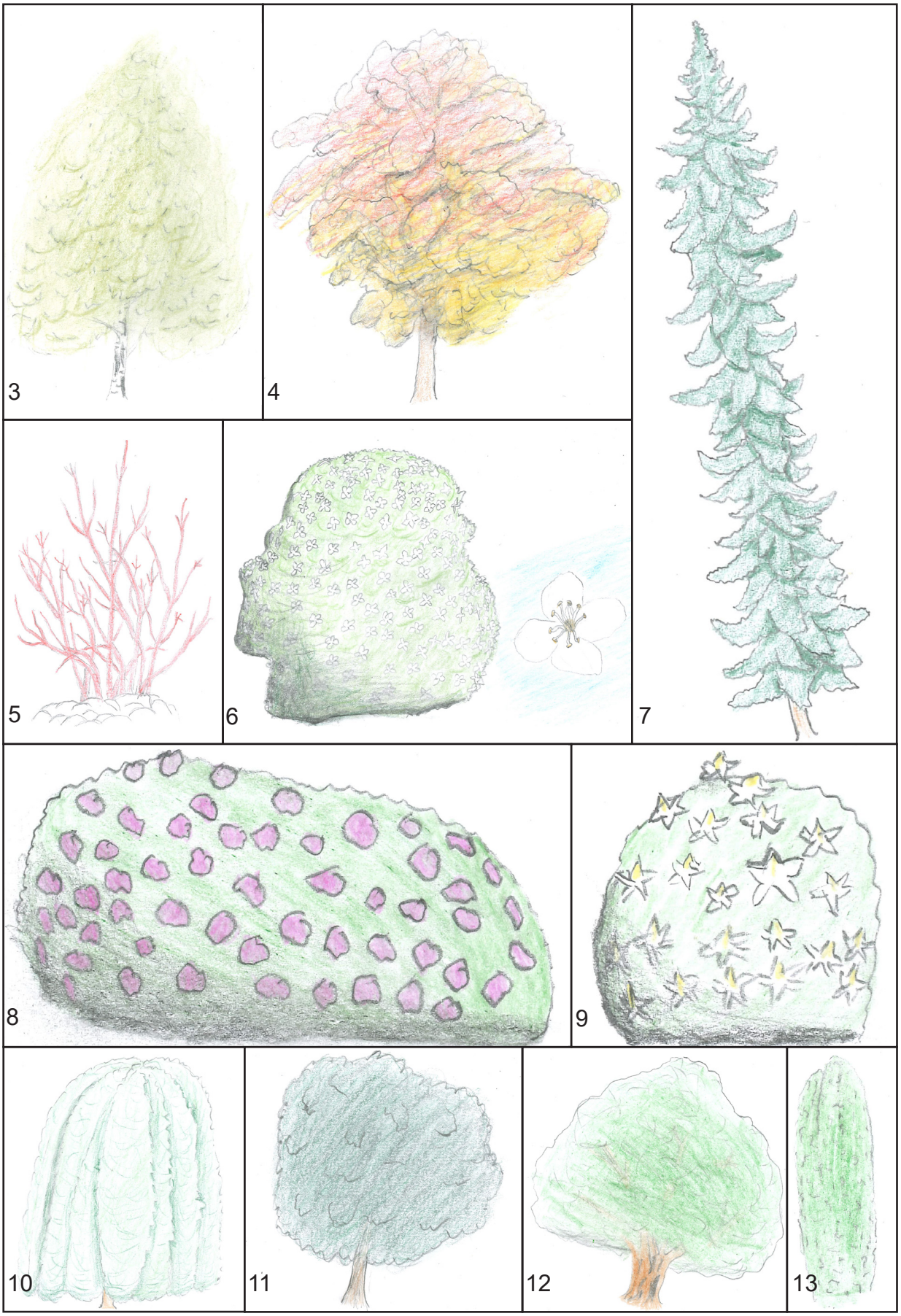
The existing shrubs in the southern part are generally rather overgrown to the point that traversing the area is nearly impossible. Some shrubs could be kept for the same argument as for the trees, however, a strict selection should be practiced close to paths (both boardwalk and stone path) to open up for views and maintain security.

While existing plants will give a strong foundation that will create structures from the start, additional trees and shrubs have been used to fill out where existing trees are missing or insufficient and to achieve functions left unfulfilled by existing plant material. For the south area, a central point has been to select plants that are fitting to a forest character, that wouldn't contrast too much to the existing plants. For the north area, fewer but more eye-catching species have been used, aligning with the more open and structured character.

TREES & SHRUBS				
	Name	**Height**	**Color**	**Flower period**
1	Alnus glutinosa fk FYRIS E	15 m		
2	*Amelanchier alnifolia fk ALVDAL E*	3 m	White flowers	May-June
3	*Betula pendula 'Dalecarlica' E*	20 m	White trunk	April-May
4	*Cercidiphyllum japonicum fk GÖTEBORG E*	10 m	Red flowers. Yellow, orange & red foliage in fall	April-May
5	*Cornus sericea 'Farba' E*	2 m	White flowers. Red branches	May-June
6	*Philadelphus coronarius 'Finn' E*	3 m	White flowers	June
7	*Picea omorika*	20 m		
8	*Rhododendron catawbiense 'Grandiflorum'*	5 m	Purple flowers	May-June
9	*Rhododendron 'Persil'*	1,5 m	White/yellow flowers	May-June
10	*Salix caprea 'Kilmarnock'*	2 m	Yellow flowers	March-April
11	*Salix alba var. sericea BODEN SILVER® E*	20 m	Silver-green foliage	April
12	*Taxus baccata*	7 m	Red fruits	
13	*Taxus baccata 'Columna Suecica' E*	4 m		

Table 6. List of new trees & shrubs for the project site.

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5. Outcome

5.1 Discussion

To improve the pond's function as water storage, it may be possible to connect it directly to an influx from the north. This influx is however dug underground and should therefore be dug up. Before proceeding with this idea, one must consider the impacts downstream, as directing the influx to the pond would reduce water downstream and could therefore have ecological effects and possibly cultural effects.

As there are ditches already on-site, these could be converted to rain gardens to provide a different expression and to purify water that may come from surrounding areas. Due to the soil retention coupled with the addition of storage from the pond, the construction of additional bioswales and similar solutions would be hard to argue for. These solutions may have a stronger purpose in denser urban environments or where there is limited space.

Rhododendron may, by many, be related to home gardens and parks and less to forests and during bloom, they may seem a bit misplaced in the south part. However, they also provide lush green foliage, particularly the evergreen and large-growing R. catawbiense 'Grandiflorum'. By avoiding strict pruning they can achieve a more wild character. Lastly, finding a suitable replacement with similar qualities proved difficult, particularly when considering the site conditions.

The decision to increase drainage on the site was based on a request from the municipality to include a pond in the design, but was also considered a necessity to make the park safe for use by the preschool. Draining the soil by constructing a pond is likely going to lead to subsidence within the area. Most of the subsidence should occur during the first years after construction. The direct impacts of subsidence on the community are not expected to be high, as there are no nearby buildings on peat soil. From a global perspective, the impact is perhaps more troublesome, as subsidence will release stored carbon as greenhouse gases and contribute to global warming and changes in the soil may have effects on its retention abilities. Before proceeding with a design, an impact assessment should be made and the municipality could also investigate alternative options for recreation within Länghem to find whether other solutions could provide the same values with less impact on the climate. One solution could be to make use of the concept for the southern half of the park for the entire area as one "wetlands park" while creating a space that is safer for young children somewhere else. There is another green space next to the preschool, north of the work area, with moraine and a higher altitude, which should make for less wet conditions. This space has been allocated as a site for future recreation by the municipality in their latest in-depth general plan and could be a valid option.

While the design in this project is adapted to the given site, the design principles may have some use in other urban design projects. The first three principles were defined for broad use in their source and did not need to be reworked, but were simply given some explanation to make it more tangible. The rest of the principles built on the principles from the Quality Evaluation Tool, which was created for a healthcare environment. These were all reworked to better fit outside a healthcare environment ,but still holding on to the same values. The principles have been defined with the project site in mind, so studying the original principles may be

useful before applying the new principles in this project.

Questions may arise regarding the safety of having a pond without fences in an area where small children will be playing. Though there are no real fences around the pond, there are soft barriers in place. Small children should be accompanied by supervising adults, so the main concern has been with large groups of children, such as with a preschool class where it may be difficult to give full attention to every child at any moment. While the whole area can be used by children, the places that are believed to be the main attraction for larger groups to play with less individual supervision are the hill, the open grass field, and the space for equipment-based play. From the grass field and hill towards the pond is the shoreline planting, with some quite tall and dense plants, which acts as a barrier. The equipment-based play area is fenced in with a rather open and admittedly, easy to climb-fence. These soft barriers are not meant to allow for unsupervised play by small children but rather to aid in supervision. The soft barriers will be a visual barrier while also being a physical barrier that should delay anyone trying to penetrate them. The alternative to these soft barriers would be using more solid structures would give a stronger sense of enclosure and in some cases may restrict views.

The Quality Evaluation Tool provides a method for creating a recreational space that is inclusive and is directed to a broad group of users. While the preschool was the focal group of users in this project, it was still important to create a space that is inclusive to the rest of the community. For any recreational project that may have a wide user group, QET gives the designer an evidence-based foundation for the designer to build on, making it a great tool for public spaces. In a project with a narrow group of users were the needs are well known and limited, the QET may be a less suitable method.

Keeping some of the trees that are already present on the site will require some work in selecting good individuals that can be kept. For a good development of the trees and to achieve a less overgrown character, some trees and shrubs will need to be cleared. The selection can be based on the tree's health, aesthetical values, distance to other trees, and in some cases ecological values. Mapping out the trees should be done by inspection during fieldwork and can be presented in a map that clarifies which trees should be kept. Keeping trees that are already on the site should reduce costs during construction and will provide large trees already at the opening of the park.

5.1.1 Method discussion

The plant selection could have been extended with more in-depth examination of how the different species interact with each other. This is particularly relevant for the perennials, as some species may be stronger and tend to spread more aggressively than others, which could lead to fewer species remaining after a few years. If this would have been included in the method, a more sustainable plant selection may have been achieved. However, this would have required a lot of time to research and when considering the limitations of peat, finding replacements for many of the perennials could prove difficult.

It is important to distinguish the methodology in chapter 2.2 from the methodology in The Image of the City by Lynch (1960) as the results like varies by the different method for data collection. Ideally, data would've been collected

through interviews, however, this was difficult to achieve due to time limitations and challenges in contacting a large enough user group to get reliable results. Analyses based on The Image of the City are often performed without interviews as interviewing requires a fair amount of work hours. In searching for alternative methods that do not incorporate interviews, it seemed to be a knowledge gap. Ideally, a method that investigates similar aspects as Lynch with a different route for data collection should be developed and described for more reliable results.

The Quality Evaluation Tool provided a framework for the project, which was helpful as the tool provides a fairly holistic answer to recreation in design. However, by focusing on QET, other literature has not been taken into account for recreation. If instead literature was summarized, the resulting design principles could have been rather different. While there is plenty of literature on inclusiveness in urban design, finding literature that investigates the subject within the context of recreation proved difficult. Thus, comparing any differences in said literature to the Quality Evaluation Tool could be beneficial.

The Quality Evaluation Tool was developed specifically for evaluation, taking it out of its intended purpose should therefore be done carefully. Designing urban areas requires the planner to consider more than measurable factors and something the tool does not account well for are the aesthetics and spatial qualities of a site. These factors can play a major role in how a site is perceived by its users but are difficult to measure or describe through evidence. This problem is not unique to the QET and is a struggle for any evidence-based design, as these values are critical to the quality of urban design but lack methods to be measured.

As mentioned in the method chapter, this project started with a fairly linear work process but later became very much circular once the design was initiated. It is difficult to imagine a design process that is not circular, as decisions made during the design process often creates a need to investigate subjects through literature or by analysis. Furthermore, when changes were made to the design proposal in this project, it often affected other elements of the design, prompting the need to make subsequent changes in the design. For example, if the placement of a path is changed, the placement of aligning elements such as plantings may need to be adjusted, or if the idea of the pond would be scrapped, constructing the sledding hill would be difficult as it relies on excavation from the pond.

5.2 Conclusions

Design principles were taken from two separate sources, one on recreation and flood adaptation and this study illustrated that the two can be combined. One realisation was that while the two purposes can be combined there can be certain challenges in doing so when the client has very specific requests. In the case of Länghem, including a pond was requested. This request may raise some concern in regards to sustainability due to its effect on the volatile peat and while the pond will acts as storage, its construction may impact retention in the surrounding soil. An environmental impact assessment is recommended to establish whether benefits of a pond outweighs subsequent disadvantages.

Using green space to reduce impacts

of changes in precipitation can be implemented on different levels. Investigating some of the leading Swedish municipalities within climate adaptation showed that it is good to develop structural objectives, which can be achieved through site specific solutions. The design proposal made use of the site's existing function of soil retention complemented with storage by implementing a pond and the by converting the ditches to raingardens, retention and purification is increased.

QET has been applied in the design of a park by adapting the design principles from QET to better fit outside a healthcare setting. These new principles were then implemented through site-specific solutions and presented in a design proposal. Using the QET or other evidence-based design methodology gives the planner a strong foundation to achieve certain uses or qualities in their projects. However, if the design relies too much on evidence, visual and spatial qualities that are crucial to how a site is perceived may be lost in the process. The best use of evidence-based methodology may be to consider it a tool in a more diverse toolbox.

Combining flood adaptation and recreation in the same space comes with some restrictions on what solutions can be implemented. However, every function described in the design principles could be achieved. In summary, recreation and flood adaptation can successfully be combined but puts a higher requirement of competence on the designer as there are more parameters that must align and an understanding for both subjects is required to deliver a sustainable product.

5.2.1 Further research

The Quality Evaluation Tool is a relatively new method for urban design and has mostly seen application in academic projects. In this project, the method was reworked for use outside healthcare settings, but the method was not analysed. The QET was developed for recreation in healthcare settings, in this project the design principles were modified to fit to a wider context of recreation. Further studies on the subject could compare the design principles presented in the project against literature on recreation to evaluate their quality and if applicable, modify and complement the principles to cover relevant functions that have not been covered.

In case this project is realised, an evaluation of the site, once built, could prove useful in establishing the accuracy of the modified QET principles. An appropriate method could be to interview and possibly observe different user groups on how they use the site. In such a case, it would be important to include a variety of users with unique needs to investigate if the method is effective in being inclusive for wide user-groups.

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