

STRESS-RELIEVING EFFECT OF NATURE

In the renovation project of the Amsterdam Quay Walls



BSC Thesis Landscape Architecture (LAR81812)
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Abstract

This thesis report discusses the positive effect of nature on the relieve of stress, and more specifically on how this effect can optimally be applied in the renovation of the quay walls of Amsterdam. These quay walls are in need of renovation and the municipality of Amsterdam wants to find innovate solutions for this problem, giving the opportunity to implement this stress-relieving effect.

This research covers two theories on this stress-relieving effect, the Stress Recovery Theory (Ulrich, 1983) and the Attention Restoration Theory (Kaplan, 1995). Out of these theories, design criteria are developed. To implement green space on the quay walls of Amsterdam, design principles are created. A detailed design location is chosen, in which these design principles and the overall design are assessed based on the design criteria formed in the theoretical framework.

The final assessed design principles provide as tools for further implementation in the city centre of Amsterdam. More importantly, this research shows that the overall method by which these principles are placed in relation to each other has a very large effect on the degree to which the stress-relieving effect of nature can be achieved.

Table of contents

Abstract.....	1
Table of contents	2
Thesis introduction	3
Problem statement.....	3
Thesis statement and research goal.....	3
Target group	4
Stress	4
Concepts, methods and materials	5
Theoretical framework.....	6
Stress relieving effect of nature	6
Theories	6
Situation Quay walls of Amsterdam.....	9
Overall background info of the problem.....	9
Limitations and requirements when designing	9
Design principles	10
Analysis.....	11
The city of Amsterdam	11
Topic 1: State of the quay walls	12
Topic 2: Green network of Amsterdam.....	13
Topic 3: Stressors.....	15
Topic 4: Target group	17
Concluding.....	18
Potential locations.....	19
Detailed Area.....	21
Location	21
Map and data analysis.....	21
Design procedure.....	24
2 scenarios.....	24
The Designs.....	25
Concept	25
Attention Restoration Theory	26
Applied design principles.....	28
Design 1 (scenario 1).....	29

The cross-section	31
Multi-criteria evaluation	32
Final product	35
Design 2 (scenario 2)	37
The cross-section	38
Multi criteria evaluation	39
Final product	42
Discussion	44
Conclusion.....	45
Reflection.....	46
References.....	47

Thesis introduction

Problem statement

A growing body of research addresses the beneficial effects of nature exposure to mental health and psychological development. There are multiple theories describing this effect from different viewpoints. However, they all agree on the point that stress recovery happens faster through nature stimuli (Davis, 2004). In the urban environment, green space is becoming more sparse because of an increase in the population. This growth in population also contributes to an increasing number of stressors, making the city a more stressful environment (Ulrich, 1991). The topic of green design influencing perception and psychological states is very new and developing. The motive of this research is expanding the practical application of the thus far found research results to improve the conditions of the urban environment.

This report focusses on the city of Amsterdam, more precisely on the quay walls throughout the city centre. These walls face an urgent need for renovation. The municipality of Amsterdam wants to strengthen the position of the walls in the urban green-blue infrastructure, giving an opportunity to implement the stress-relieving effect of nature in the densely populated city centre of Amsterdam. Research will be done on this stress-relieving effect and the situation of the quay walls of Amsterdam. This will result in detailed designs of a specific location, together with a general conclusion of the implementation in the broader scale of the city.

Thesis statement and research goal

The aim of this project is to make use of the opportunity of redesigning the Quay walls in Amsterdam to make this into a better working environment. By means of this report a starting point will be set on taking the more societal aspect of green space into the

renovation program of the quay walls, which can be used as an example for further execution throughout other city structures.

Research question:

How can the stress relieving effects of urban green space be optimally achieved in the renovation design of the Quay walls for the workers of Amsterdam?

In order to give an answer to this research question, knowledge on the different elements of the question is necessary. This leads to the following specific research questions:

Specific research questions:

- 1. How can green space contribute to the relieve of stress?**
- 2. What are the limitations and requirements when designing for the renovation of the quay walls?**
- 3. How can green space be implemented on the quay walls of Amsterdam?**
- 4. Which site can best be used as a testing location for the implementation of the design principles of green space?**

In order to apply the stress-relieving effect of nature in the context of the Amsterdam quay walls, one needs to understand what spatial elements lead to this desired result. Clear **design criteria** for achieving the stress-relieving effects of nature in design will be formulated by means of a theoretical framework.

Then, it is important to understand what the renovation program of the quay walls entails. By analysing the situation of the quay walls of Amsterdam the **requirements and limitations** for this specific location will be sought.

To implement green in the location of the quay walls of Amsterdam, a clear understanding of the possibilities is necessary. This will be achieved through a list of **design guidelines** that fit the context, usage and dimensions of the quay walls. These will form the basis for the design process.

Finally, to research what is the optimal approach for the implementation of green space to achieve this stress-relieving effect, a **test site** must be sought. This will be found by means of an analysis.

Target group

In order to give a specification within the research, it has been chosen to make use of a target group. The target group of research is the workers in the city of Amsterdam. This group is chosen based on the element of stress, as work is a large factor that can cause a feeling of stress. This not only influences the mental health of many individuals, but it also has a negative impact on the company's performances (Stranks, 2005). This target audience will be important in the designing process, as it determines the usage and needs of the location. The workers mainly make use of the public space during their free times, as they will be in the company building during the day. Those free times are usually the short or lunch breaks, so this must be considered when designing.

However, the research looks at the general stress-relieving effect of green space, so the elements that are considered will apply for everyone. This means that the eventual (design) results can also be used as an example for further application throughout the whole of Amsterdam, but the placed elements might not be optimal in every location because of the different users of the street.

Stress

Stress can be described as: *"Stress is the unspecific physiological and psychological reaction to perceived threats to our physical, psychological or social integrity."* (Adli, 2011, pg. 1). This reaction is stimulated when the individual does not have the needed resources for the specific situation, or the anticipation of an undesirable situation. This stress reaction can be drawn back to an evolutionary standpoint, as this will activate the 'fight-or-flight' reaction, which is a survival instinct.

The element causing the stress reaction is called the **stressor**, a term that more often will be used in this report. The precise definition of this term according to the APA Dictionary of Psychology is: *'Any event, force, or condition that results in physical or emotional stress. Stressors may be internal or external forces that require adjustment or coping strategies on the part of the affected individual.'* ("Stressor", n.d.)

Two types of stress

What is important to indicate, is that this research identifies two different stress-sources. The first type is the stress formed by **personal driving forces**. In the context of this research, these are the stressors of the worker that are formed by their daily work. This is described in further detail in the earlier chapter of the target group.

The second element that evokes stress, are the **environmental stressors**. Research has shown that in the urban context, social stress has the most effect on mental health. This outweighs other elements, even though these also contribute to stress reactions, such as noise or pollution. The cities are becoming more crowded and the population density increases, which strengthens this social stress reaction (Adli, 2011). This has to do with the controllability of the environment, the clearer division between the different social classes and the larger distortion of chronobiological rhythms.

Figure 1 shows the spatial stressors of the city in a more concrete way.

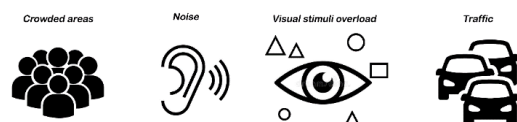


Figure 1: Environmental stressors of the urban context

These spatial stressors cause the feeling of a loss in control and lead to an impulse overload, causing the stress reaction. As stated above, the social stress has the biggest impact on the mental health of city dwellers. The element of 'crowded areas' therefore is

the most important aspect to consider when attempting to create a stress-relieving environment.

These two types of stressors will both have an influence on the amount of stress the workers experience. This research aims to create a restorative outdoors environment, which tackles both types of stress.

Concepts, methods and materials

The four specific research questions lead to four different products, which will be used in the application in a detailed design.

A detailed design will be sought and this location will be analysed. This will be done with literature research, map studies and a site visit.

By means of research through design, an answer to the research question will be sought. First, different design options will be created. These will be critically evaluated based on the theoretical framework, followed by the adapted final designs with attached visualisations.

Based on this critical assessment, conclusions can be drawn on the effectiveness of the used design guidelines and the way these are combined in the designs. This result can then be used to give an answer to the general research question, as the testing on a specific site by means of the detailed designs will give an answer to the implementation on the larger scale of Amsterdam.

Figure 2 shows these steps in a flowchart.

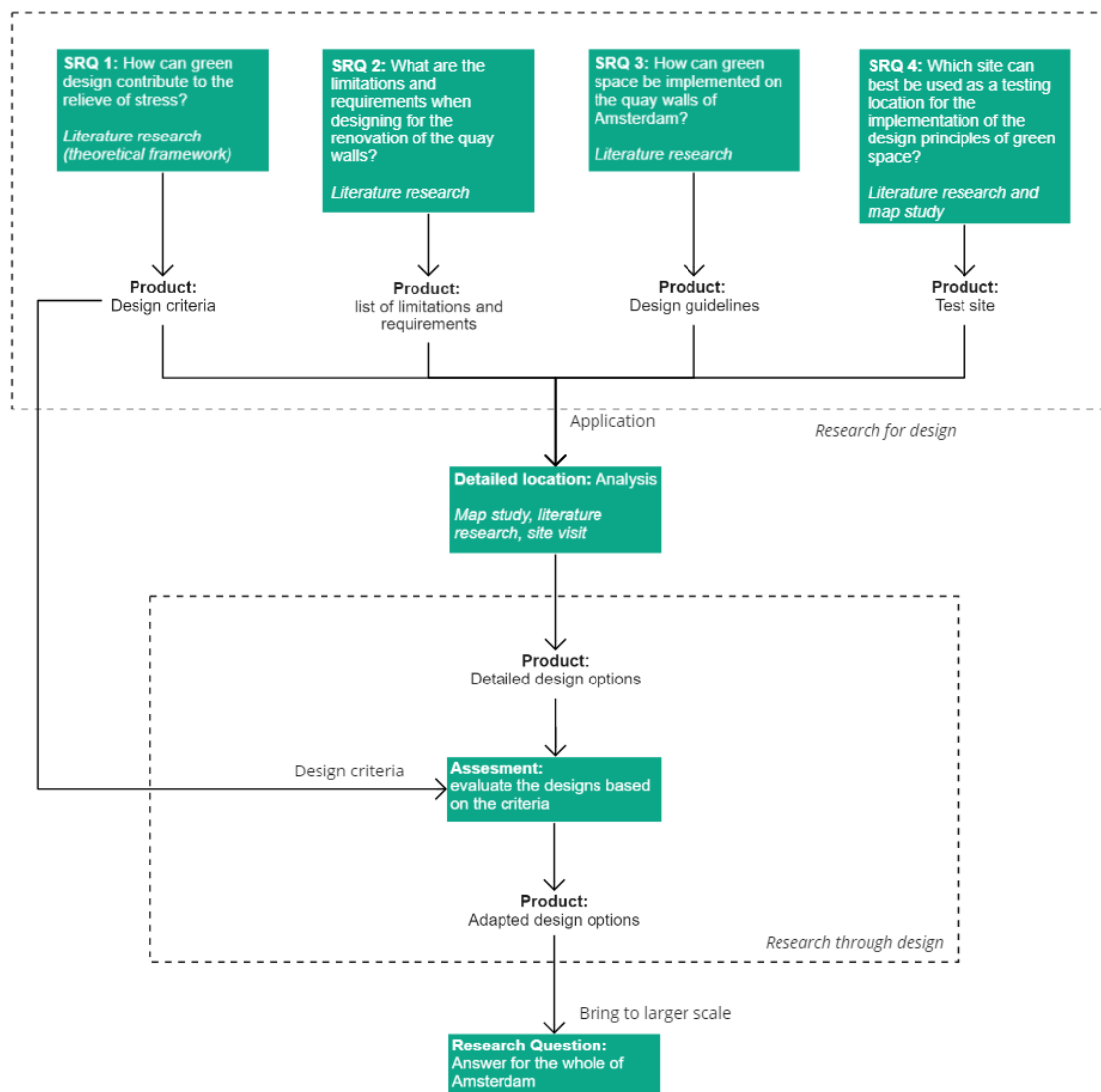


Figure 2: Flowchart of research and design steps of this research

Theoretical framework

Stress relieving effect of nature

The green infrastructure of cities plays a large part in the mental health of city dwellers, by means of different specific qualities that have a positive effect on humans. These qualities can be divided into three different categories: mitigation, instoration and restoration (Beute et al. (2020).

The former can be characterised by the elements of nature that reduce harm.

Examples are the reduction of air pollutants, cooling down the city and the reduction of noise. These are all elements that effect both the physical and mental health of people.

Then instoration is characterised by the elements that help in the building of capacities. There are many different elements that fall under this category, like the increase in social cohesion, the stimulation of physical activity and improving immune function. Finally, the element of restoration, which will be the main focus of this thesis. This element covers the more evolutionary effects of nature on mental health. It addresses the visual and intrinsic quality of nature effecting the mental health of citizens, and more specifically the reduction of stress.

Theories

In this research, two main theories are used as a foundation. These are the Stress Recovery Theory (Ulrich, 1983) and the Attention Restoration Theory (Kaplan, 1995).

The SRT and the ART both describe different elements that determine the degree to which a green space can be a so called 'restorative environment': the places that allow for renewal of personal adaptive resources to meet the demands of everyday life (Berto, 2014). These elements will be discussed below, portrait using a principle drawing with an additional detailed description.

Stress recovery theory

The principles that will be described below are based on the 'Preferenda' of Zanjonc (1980).

These are elements that cause affect, initial changes in the mood of the individual. These are configural and gross aspects, which are not applicable for more cognitive judgements but are based on the idea of direct effect on emotions. When looking at these aspects, it becomes clear that they are mainly based on structure and material aspects. The specific usage and general atmosphere of the design are not part of these criteria, as it focusses more on the overall correlation between the different elements and how they result in specific visual results. The criteria points resulting from this theory will be used in the design process when the overall goal and elements to be applied at the site are already chosen.

1. Complexity

Complexity describes the number of separated elements perceived in a space. The more elements that are dissimilar and put together in an unstructured way, the more complex a scene is. Numerous studies show that there is an inverted-U-shaped relation between complexity and preference (Berlyne, 1971). This means that on the extreme ends, highly complex or very low complex scenes, the preference of the location is the lowest. With the highly complex and unstructured scene, the viewer is not able to grasp the scene on the first sight. On the other end of very low complexity, the viewer is not provoked in further exploration because of the quick processing of what is there. This results in neither a strong emotion of exploration nor avoidance, making the area uninteresting.

2. Structural Properties

Strong orientation and structured information are considered as an element eliciting approach and liking. The complete picture, in other words the visual array, is usually more defining for affective responses than individual elements. By grouping and making structure in the complete visual array, more environmental elements can be grasped

quickly. Ulrich indicates in his theory, that the combination of high complexity, which is thoroughly structured, results in strong interest and liking. This is because the view is high in information, but put in such a way that this is quickly graspable.

- Focality

This element is a structural property which Ulrich sees as an important individual aspect. It describes the presence of a specific element that grabs the attention of the viewer. The eye is quickly guided to this element, a structural element which can be applied in a more chaotic context. Different patterns and textures can help the eye to be directed to this point of dominance. This element can serve as a landmark, helping in guiding the individual in the environment. This can both be applied in a situation of low and high complexity to achieve preference.

3. Depth

The perception of depth provides the possibility of knowing what lies behind, which is related with the attractiveness of a location. Distances between elements and relation between these in three dimensions can then be perceived. In case this depth cannot be experienced if the view is obstructed, then knowing if what lies behind can be dangerous is unknown. So, it is of importance that there is a feeling of spaciousness so the depth of the scene can be perceived.

4. Ground surface texture

The texture of the underground is one of the main factors determining the depth-perception. Even and smooth surfaces are necessary to perceive distance accurately, in contrast to rough and uneven textures. Next to that, the surface texture has an impact on the complexity of the scene. Scruffy surfaces give an unordered and more complex appearance that works against preference.

5. Threat/ tension

Natural settings that include elements that raise a feeling of danger will be more often disliked. A negative reaction will most often appear when this view of a threatful element is perceived. Elements that could be a threat for the human safety are for example rapid currents, the edge of a steep cliff or flooding.

6. Deflected vistas

A deflected vista means that the line of sight is deflected or curved, hiding what could be lying behind. It has been shown that this raises a feeling of interest and curiosity, as information could be gained by further exploration. However, this information must be gainable at a low risk, otherwise fear will be raised. There is a fine line between these two emotions.

These criteria points are illustrated in figure 3, showing the relations between the different elements.

Design criteria

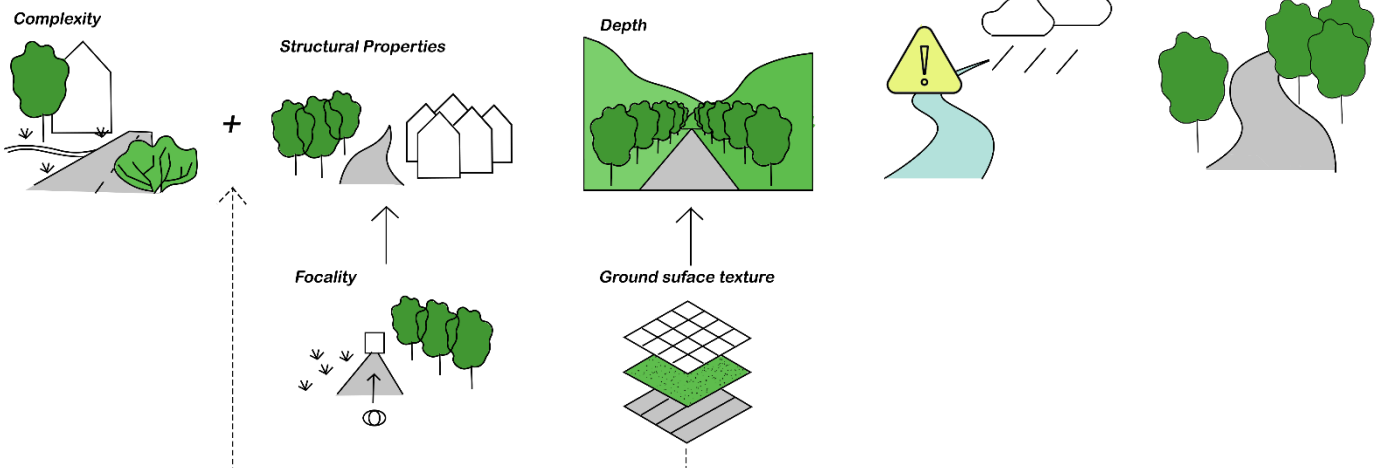


Figure 3: Stress Recovery Theory design criteria schematically depicted

Attention Restoration Theory

This theory covers with a slightly different aspect of the stress-experience. Whereas the former focusses on the characteristic of nature that provide a positive change in the emotions of viewers, without cognitive processor prior (Berto, 2014). The ART covers the positive effect of nature that needs more cognitive processing. The so called 'mental fatigue' that appears when direct attention is needed, causes the individual to have a higher change to get the stress response. The view of a natural scene costs 'involuntary' attention, meaning that this brings the executive system that regulates the direct attention to rest. Nature has 4 different restorative factors, which will be described below. These factors describe more the overall effect of the scene in total, so not the direct elements within this scene like in the previous theory.

1. Being away

As the name indicates, this factor covers the effect of restoration caused by a change in environment. This frees the mind from the element that needs direct attention, which can only be achieved by a conceptual rather than a physical change in environment. Nature can help in this change in view by providing a different atmosphere.

2. Fascination

This is the main element of this theory, describing the unique characteristic of nature that provides a so called 'soft fascination'. The attention needed for the view of nature does not require direct attention, but provides a form of fascination that can provide the mind

to rest. Besides, it gives opportunity for reflection that further enhances the recovering from direct attention fatigue .

3. Extent

For a view to be perceived as a location to completely constitute to a whole different world, it needs to have extent. In this way, there is enough to see and experience to totally take up the whole mind. The natural wilderness provides this extending effect, but it can also be achieved by providing enough depth and looking more at the detailed level.

4. Compatibility

The final element focusses more on the practicality of the location for the user. The purposes of the user and the demands of the environment must fit together so the activities in the location can go smoothly and without constraints. The natural setting already encompasses a unique compatibility to the human needs. However, one location cannot provide the needs for every single user. Nevertheless, the setting is still probable to be supportive because of the resting effect nature provides.

The provided factors are shown schematically in figure 4. These will provide a starting point for the design process, as they cover the goals of the overall design purposes and atmosphere to achieve the optimal stress-relieving design.

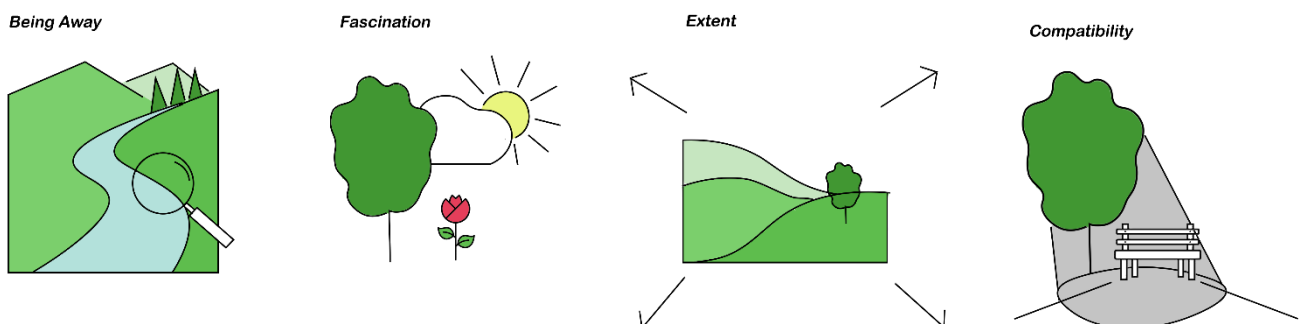


Figure 4: Attention Restoration Theory, the four aspects schematically depicted

Situation Quay walls of Amsterdam

When designing for a specific component of a site, in this case the quay walls of Amsterdam, it is important to get a general understanding of the needs and requirements associated to it. This chapter will serve as a source of background information on the state of the quay walls, as this will be the foundation element for the final given designs.

Overall background info of the problem

The canals of Amsterdam are very well known worldwide, and form one of the most important elements of attraction for the city. However, the quay walls of these canals are all in a very bad state. Around 205 kilometres of quay walls are in such a bad state that short-term solutions are highly necessary (Gemeente Amsterdam, 2019). The municipality of Amsterdam is working together with different parties, in order to search for innovative solutions for this problem. Their goal is not only to look for a constructive solution for the walls themselves, but also for ideas for a new form of usage of these quay walls (Gemeente Amsterdam, 2020). This is seen as a potential to introduce other elements in this renovation program. This research will make use of this opportunity to improve the working conditions of the urban city centre of Amsterdam.

Limitations and requirements when designing

By means of an analysis of different municipality report covering the quay walls and the future goals of Amsterdam, the following key-points have been identified:

1. Accessibility:
 - Inhabitants
 - Rescue services
 - Garbage trucks
 - Boats through the canal

2. Larger scale - Flow of the area: not a delaying element
3. Historical value (appearance, structures and elements, UNESCO)
4. Sustainability (climate change)
5. Biodiversity

The first point mainly covers the present usage of the canals. One of the most important elements, according to the municipality reports, is that the users of the street will not be restricted in accessing the buildings and elements that are present.

Secondly, looking at the larger scale of the city is of importance, as these streets are part of the overall flow of traffic and logistics. This means that the streets should not become something that can cause a delay or obstruction.

And like indicated before, the quay walls are of high importance to the historic characteristic of the city. The canals are part of the UNESCO zone, meaning that the present appearance is being protected. This must be considered when renovating.

Finally, the municipality of Amsterdam has some overall future goals for the city (Gemeente Amsterdam, 2011). Climate-adaption and biodiversity are important elements in these goals. The quay walls renovations serve as a great opportunity to implement more nature to reach these goals. The municipality has already experimented with some renewing ideas walls (Gemeente Amsterdam, 2020).

Concluding

To conclude this chapter, there are a few elements that are of importance to keep in mind when tackling the present quay wall situation. These different elements are not the main focus in this research, but will be kept in mind when starting the designing process, as indicated in the introductory chapter. These elements will not be used to assess the final designs.

Design principles

In order to implement green spaces on the quay wall, it is of importance to understand how this can be achieved. This research will make use of a list of different design principles, that will serve as tools for the application in the final designing stage. These design principles will eventually be assessed based on their contribution to the stress-relieve of the proposed designs, and consequently the larger scale of Amsterdam. Based on different reports on green implementation on quay walls and personal brainstorming, the following design principles have been identified (Koedood et al., 1996 & Gemeente Amsterdam, 2020 & msc MADE, 2020.)

This first group of principles determine the location on the street in which the green space will be implemented. The second group focusses more on the specific method this green space will be implemented. These design principles are illustrated in figure 5 and 6.

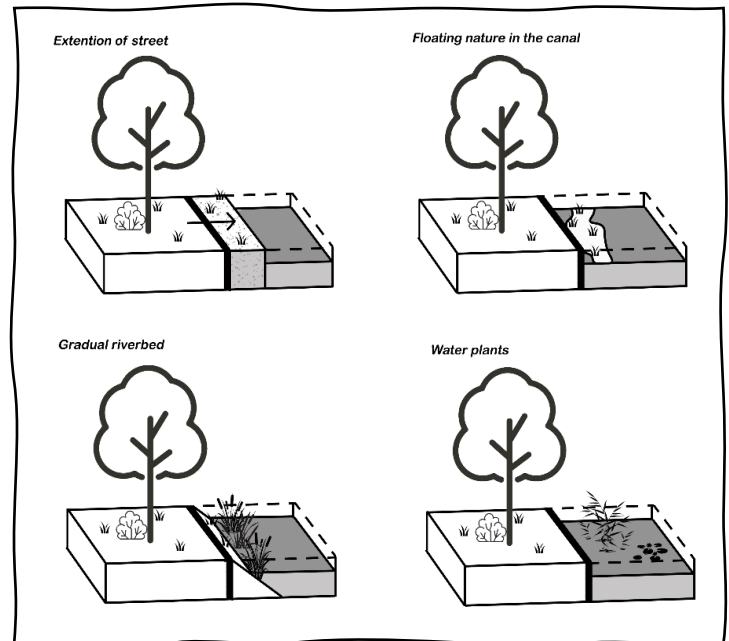


Figure 5: Design principles group 1: location of green space implementation

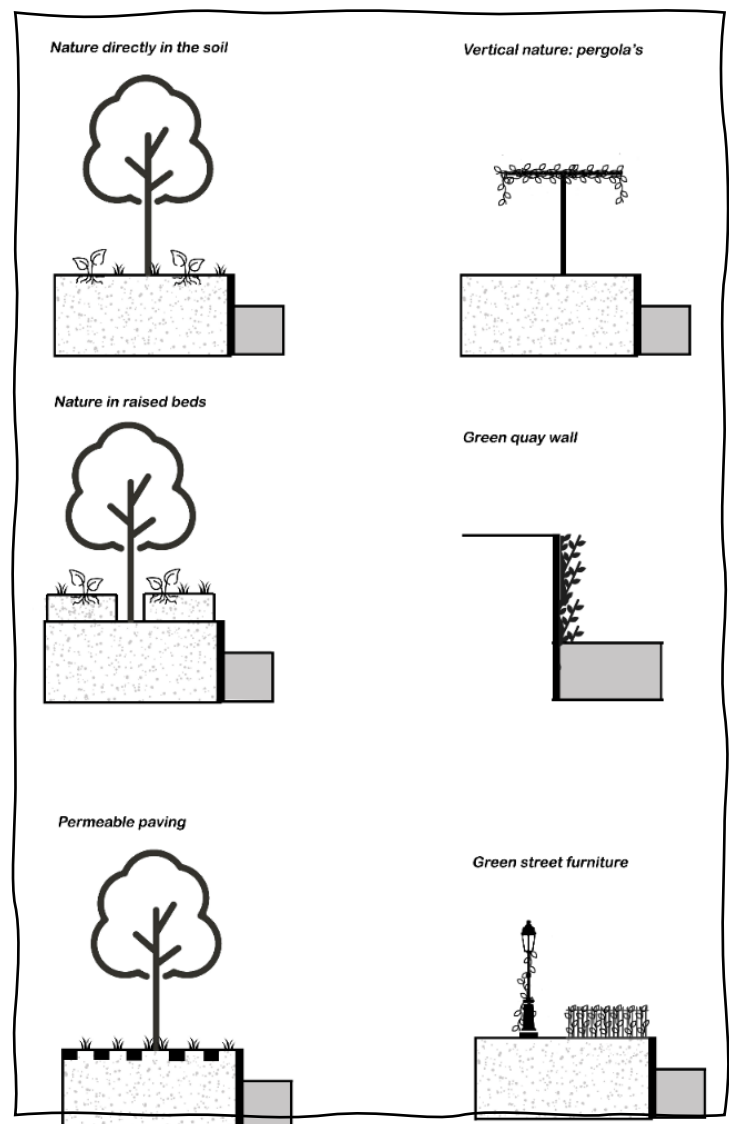


Figure 6: Design principles group 2: method of green space implementation

Analysis

Before starting a detailed design, an analysis of the area and surroundings is necessary. This will give a better understanding of the situation at the moment, and will give the opportunity to choose a fitting location. For the analysis of Amsterdam, the following topics will be extensively discussed below:

1. Green network of Amsterdam, space and types
2. Stressors, with a focus on traffic
3. Location of the target group (workers)
4. State of the quay walls, need for renovation

The analysis will start with a general introduction on the city of Amsterdam, to create a complete understanding of the site and context. Then the elements stated above will be further analysed, which will lead to a final conclusion and possible detailed design locations.

The city of Amsterdam

The city can be characterised as a diverse city, with a diverse set of services, economies, cultures, landscapes and people with different backgrounds (Gemeente Amsterdam, 2011). The city centre is a place where culture, economy and residential use comes together. Unique to the city centre is that the residential use and economic use are proportioned around one to one, whereas most cities have their economic hotspot at this city centre (Musterd & Salet, 2003). This combination already stems back to the Golden Age, the blooming moment for Amsterdam. At this time, the elite brought together living and shopping in the centre of the city.

Looking at the urban planning history of the city that has led to the present structure of the city, one must go back to the fourteenth century. This was the moment in which the first victory on the water was set, as the dikes were built. This gave the basis for the city to become a trading centre. The following step was the creation of the well-known canal

structure in the seventeenth century, which gave an enormous impulse for growth. These canals made use of the high water levels of the area, and made the city an optimal location for international trading system. From there on, the city expanded rapidly. The living environment was more pushed towards the outer edges of the city (mainly for the richer population), giving space for economic and especially cultural activities to locate in the centre.

The city is nowadays still expanding, at a very fast rate. The way the city is structured and maintained has a big impact on the position of the city as an international metropole. This puts a lot of pressure on the land use of the city, as there will be more groups of people influenced by the present elements, and these elements will be more intensively used.

Formation of the canal ring

In the sixteenth century, the city population had tripled within a generation. However, the size of the city had remained quite the same. This had to do with the land circumstances at that time. Amsterdam is located in a landscape of marsh. Large scale investments would be expensive and high in risks. However, at the beginning of the seventeenth century, new projects aroused. This was the moment in which the development of Amsterdam would be dominated by people, rather than the natural circumstances. The canals were the main part of the design created by Hendrik Jacobszoon Staets. These would cancel out the undesired outskirts of the city, and would create the opportunity for better transport in this city dominated by water.

This canal system is now the most characterising element of Amsterdam. This has led to it becoming part of UNESCO world heritage, that makes sure that the buildings and overall look of the canals will be protected.

Topic 1: State of the quay walls

In order to make a stress-relieving design for the renovation of the quay walls, it is first important to know where these renovations are needed. The municipality of Amsterdam has identified different locations that are in need of renovation (Gemeente Amsterdam, 2019). The following map shows the states of the quay walls, broken down in three different categories.

The categorisation on the state of the quay walls is an ongoing process, which changes with more insight created. However, this map shows that almost every quay wall is ultimately in need of some kind of management. The quay walls accented in red are more prioritized for renewal, since these can form a dangerous situation. For the location choice of the detailed area, it does

not really matter if the need of renovation is acute or can be done in a later time frame. The goal of this research is showing how the quay wall design can be complimented with the positive effects of nature, and how this can be applied on the walls in need of renovation. It matters if the quay wall used is in need of renovation or not, so a location accented in green will not be considered.

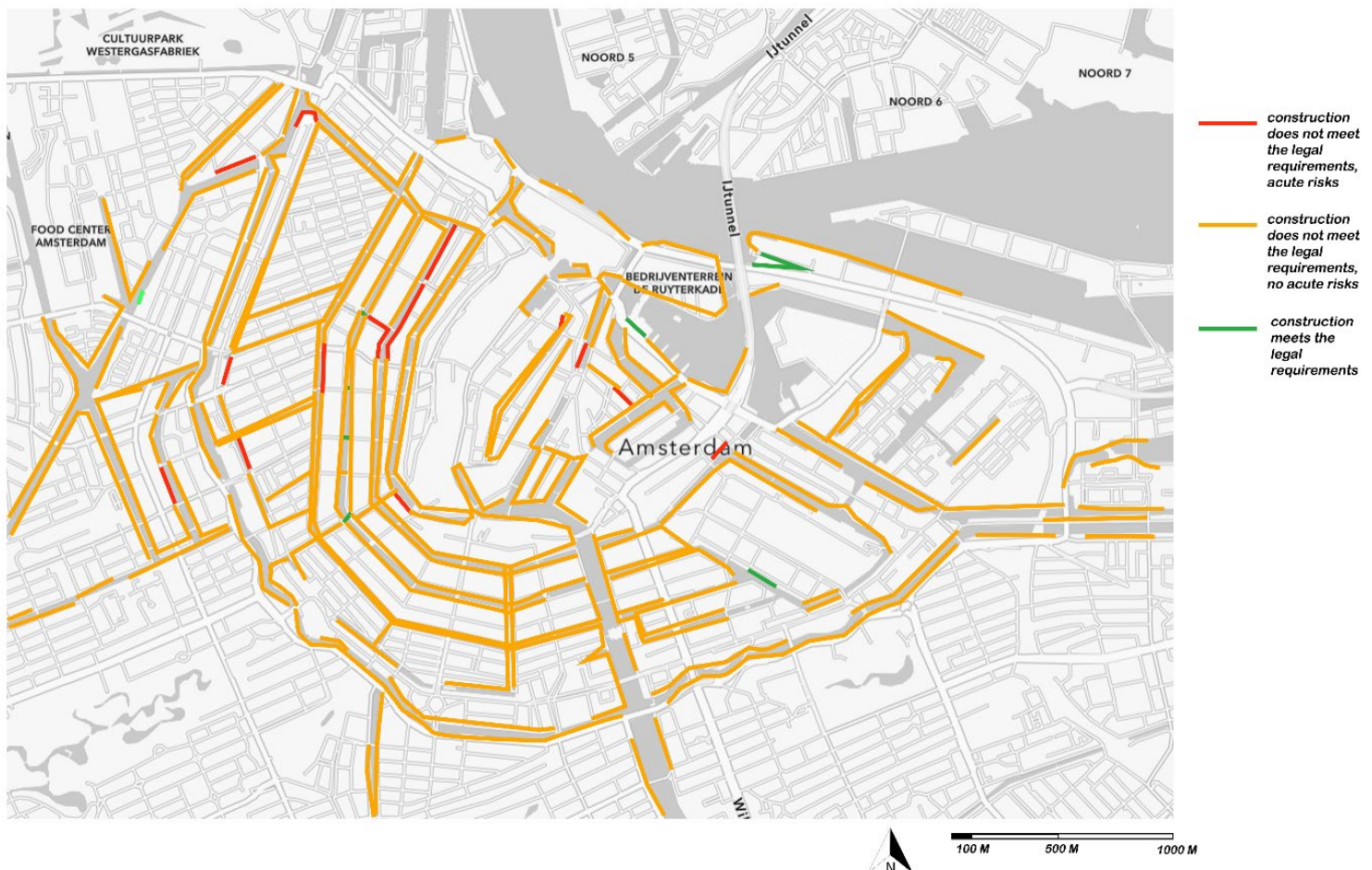


Figure 7: Analysis map of the state of the quay walls in the city centre of Amsterdam

Topic 2: Green network of Amsterdam

This element will be analysed in more detail, because of its relevance when designing new green spaces in the renovation of the quay walls. When looking at the present green spaces in Amsterdam, areas lacking in nature will become visible. These areas have more need in redesigning to meet the goal of the municipality in the strengthening of the green-blue networks. Besides, the implementation of more green space for the improvement of mental health will be more desired in areas where this green space lacks.

The following map (figure 8) shows the present public green spaces in the city centre of Amsterdam. This map is based on different sources available through the municipality of Amsterdam.

It becomes visible that nature in the area mainly comes in the form of tree rows. Most green patches are located at the southeast corner. Here lies the zoo Artis, the botanical garden, the Wertheimpark and the Oosterpark. In the south there are some more green patches, mainly around traffic junctions and larger buildings.

Remarkably is the fact that the inner city contains the least amount of vegetation. Mainly the outer areas and the canals contain the most public green.

The quay walls

When looking at the quay walls, it becomes clearly visible that green space is mainly achieved through tree rows along the streets. Besides from the trees, there is very little green space present. The tree rows follow the direction of the canals, and appear less on the roads crossing these canals. These tree rows



Figure 8: Analysis map of the green structure in the city centre of Amsterdam

are one of characteristic elements of the quay walls of Amsterdam, and one element the municipality wants to protect (Gemeente Amsterdam, 2020). Especially the Ulmus tree is a very often used tree species.

The quay walls include many monumental trees, which can result in problems when renovating. In the program plan of the municipality about the quay walls, it is stated that at the moment there is no technical method of keeping these trees. However, the presence of the characteristic trees along the quay walls is an element which must be protected according to the UNESCO guidelines. This means that the planting of new trees is desired when redesigning the walls.

Topic 3: Stressors

As indicated in the chapter on stress, this research identifies two different types of stress: caused by personal (work-related) driving forces, and environmental stressors. Since this outdoor environment will be visited by the worker during free times or (lunch) breaks, the stressors caused by work won't be present in the moment. To make the most optimal stress-relieving environment, the environmental stressors do have to be considered. However, this research focusses on how the green spaces can best be implemented to achieve the optimal stress-relieving effect caused by this green view, not on the method of decreasing these environmental stressors. To limit the negative influence of the environmental stressors, an analysis on the stressors of Amsterdam will be conducted, resulting in locations which already are under the influence of very little environmental stressors.

Besides, intensely used areas have high demands when it comes to design. To give an example: An area nearby a transport hub is intensively used for traffic that is making use of this hub. There will be many limitations for the implementation of green space. The users are very dependent on the presence of these roads, and the change in location and measurements can have a big impact on the functioning of these companies. However, it can be argued that these areas are more in need of the stress relieving effect of nature. Implementing nature can lessen the stress followed from the environmental stressors of the location. Even so, endeavouring to make a restorative green space on this intensively used location can be a misstep. There will be a smaller chance for a preference reaction in the individuals running into this location because of the presence of stressors. Since the research question of this report focusses on achieving the most optimal

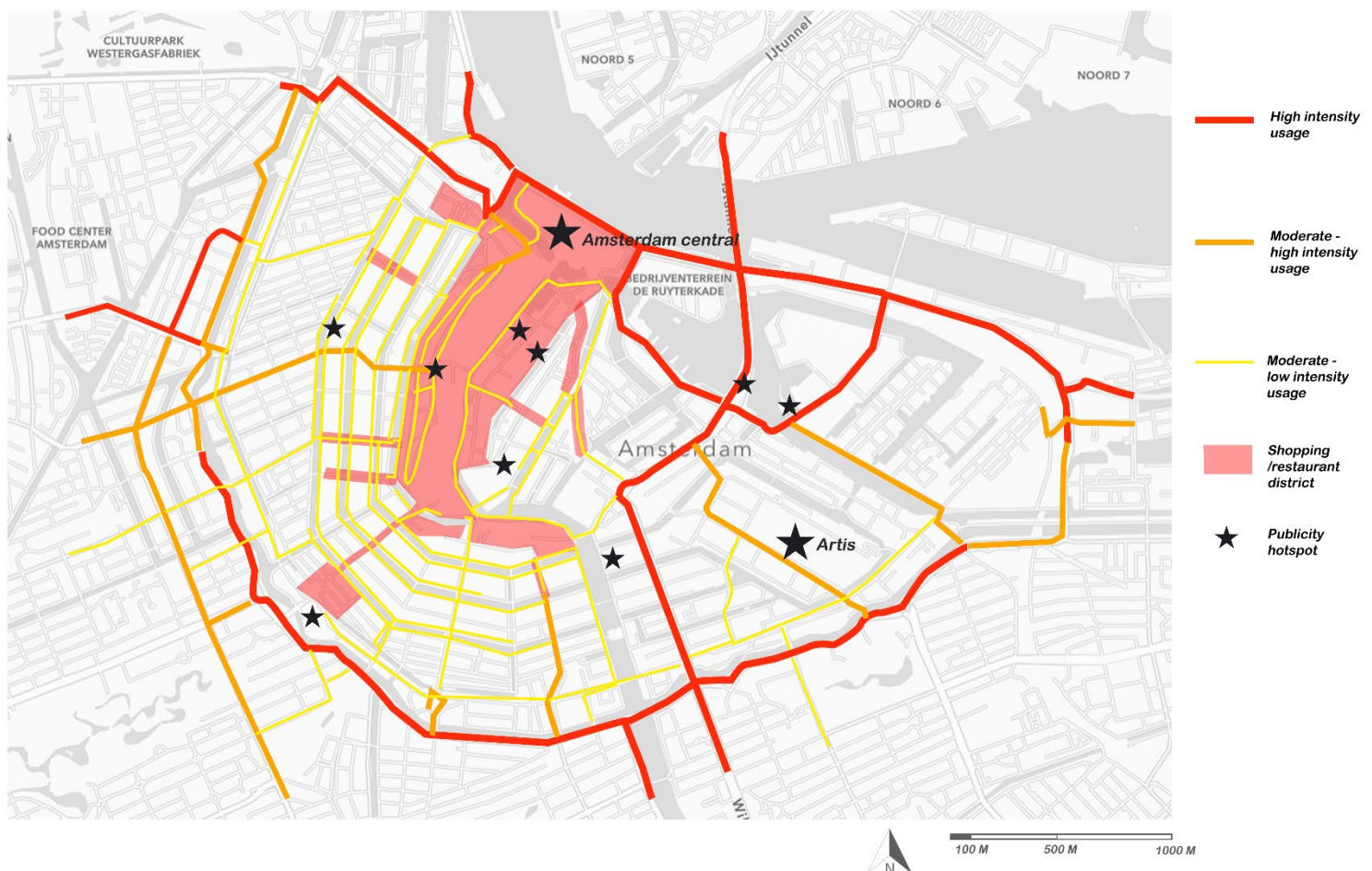
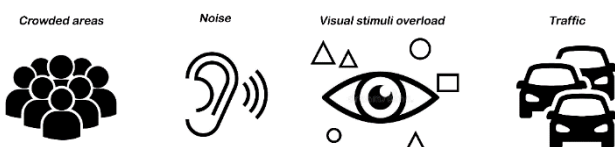


Figure 9: Analysis map of the urban stressors of the city centre of Amsterdam

location for the stress relieve of workers, the most optimal locations would then be the ones with the least number of stressors. In this way, the positives of nature can optimally be implemented.

The analysis map

As indicated in the introductory paragraph on stress, there are four main categories that determine the environmental stressors (as shown again in figure 10). Figure 9 shows the intensity in usage of the streets, together with the shopping districts and the publicity hotspots. The usage of the streets covers essentially all elements of stress, with a main focus on traffic and noise. By adding the shopping districts and hotspots, the clustering of pedestrians is included as well. The visual stimuli overload is mainly present in places that are used in high intensity, as these include many elements to attract people and exist out of more small elements. For example, the shopping streets include many smaller shops that all want to attract visitors with attractive signs, colours and products. Streets that are mainly used for living and working are more monotone, as this attraction factor is not necessary.



It is visible that mainly the roads around the

Figure 10: Environmental stressors of the urban context

city centre are being used intensively. Further, the roads leading towards the station are very busy, and the area around the station itself. The east side with the zoo Artis and the area around the harbour are intensively visited. Remarkable is that the smaller streets in the neighbourhood behind the canals are being used less intensively. The same goes for the neighbourhood on the west (Roeterseiland), which is then crossed by the main street the Weesperstraat.

Quay walls

As shown on the map (figure 9), the streets along the canals are being used moderate to low in intensity, especially the characteristic canal ring. The other quay walls along the canals throughout the city are being used very little. This is the case for the Voorburgwal (inner city), the quay walls along the canals of the Roeterseiland, the canals at the Marken (centre of Amsterdam) and the canals on the east. To conclude, mainly the quay walls of the canal ring are being used. However, this is still in a moderate to low intensity.

Topic 4: Target group

As this research specifies in the creation of a restorative environment for workers in the city, it is of importance to know where this audience is mainly located. By means of mapping the location of the target audience, the ideal locations for design can be identified. The chance that the design reaches the target audience optimally becomes larger when designing in the location where this group clusters. This has been achieved through identifying the location of offices in the city, the location where workers come together. The following map (figure 11) shows the presence of offices in three different densities.

As seen above, the offices are mainly located around the canal ring, and a bit in the inner city. The neighbourhoods behind the canal ring contain almost no offices, as this is more

a living environment. The inner city contains some offices on the edges, but this area is more characterised by shops.

Quay Walls

The buildings along the quay walls contain quite a lot of offices. For the canal ring applies: the further toward the inner city, the more offices present. This can be seen in the large number of offices along the Herengracht, especially on the east end of this canal.

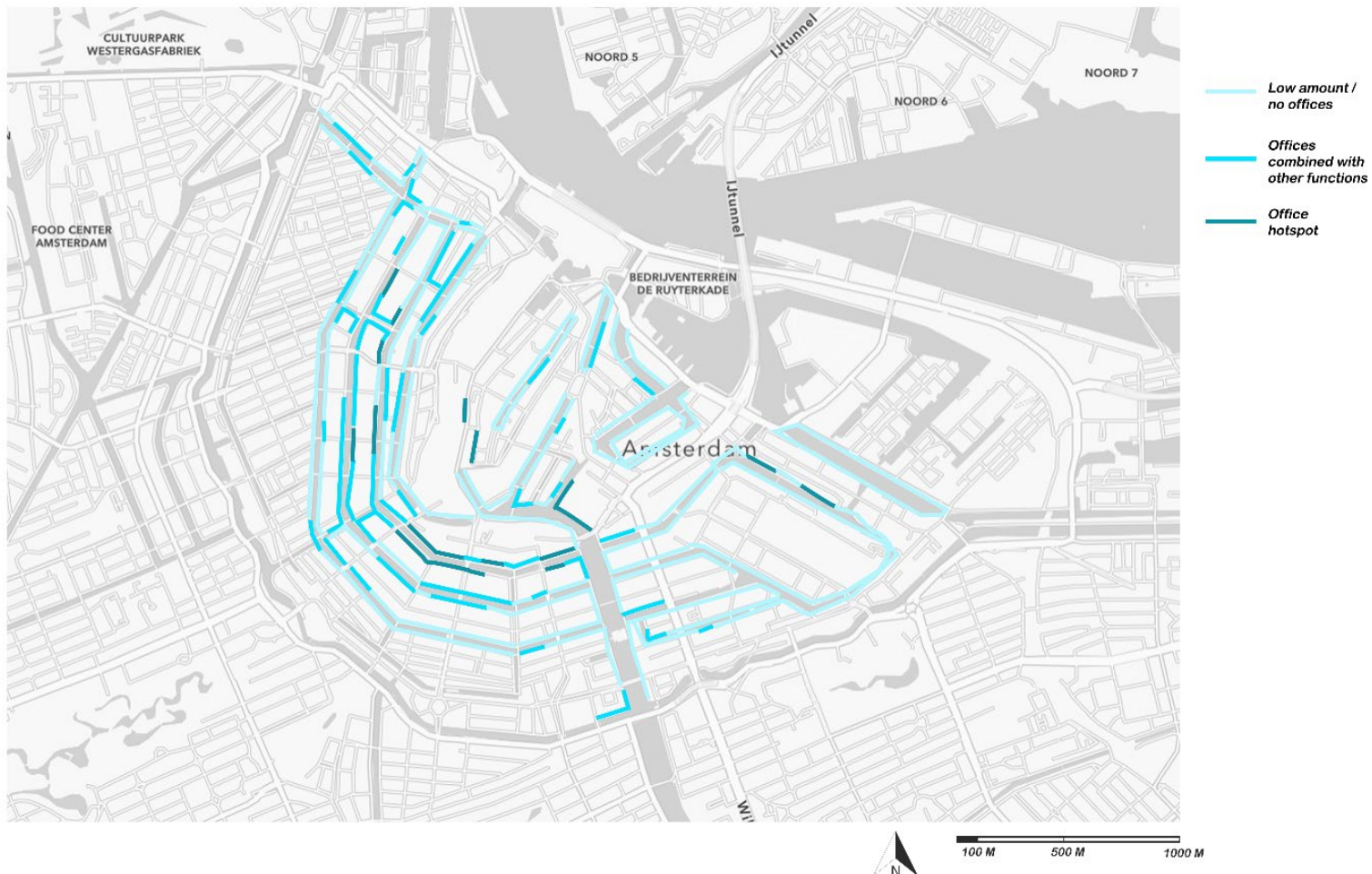


Figure 11: Analysis map of the location of the number of offices located in the city centre of Amsterdam

Concluding

The city of Amsterdam has a rich history, with elements that are present to this day and are being protected. The circumstances of the landscape resulted in a specific design in managing the water system, which led to the characteristic canals throughout the city centre. However, the city is expanding and the density is increasing. This puts a pressure on the available space, which could result in the loss of present elements if this development is not coordinated well.

Specific analysis

The quay walls are in a very bad state. Almost every wall needs eventual renovation, with some specific areas in need of short term improvements. This means that the municipality needs to find good solutions, as this will be a large scale and expensive intervention, influencing the city's appearance.

The green structure of the city centre is mainly dominated by tree rows. There is a small assortment of parks or other green patches, which are predominantly located at the east of the city centre. This small amount of green space means that the stress-relieving effect of nature is not taken advantage of in Amsterdam. The implementation of nature in the renovation design of the quay walls is a good opportunity to enlarge the green space in Amsterdam, so the positive effects of nature can be taken advantage of. The quay walls are virtually equal in the amount of nature present. They are characterised by a row of trees, with a few exceptions lacking these elements.

When looking at the optimal locations for creating a restorative environment for workers, the best locations would be the places with the least number of external stressors. The intensity of the road usage and clustering can identify the locations with a lot of external stressors. These are mainly located in the ring around the city centre. For the quay walls applies that these are used moderate to low in intensity. There are a few roads that cross the canals, which are being used more intensively, leading to more stressors.

The target audience, workers in the centre, is mainly located just outside the shopping core. The clustering is primarily at the first canals seen from the centre. This is primarily the Herengracht.

Potential locations

With using the offices map as a base, and eliminating streets based on the information from the target group map, the green networks map and the quay wall situation map, the potential detailed design locations have been identified (figure 12)

Space: most opportunities

As all these locations meet the analysis requirements, further selection must be done. Based on the list of requirements resulted from the theoretical framework, it becomes clear that with more space more of these requirements can be optimally achieved. This for example applies for the 'Depth' and 'reflected vistas' elements from the SRT, and the 'Extent' and 'being away' elements from the ART. These elements can be achieved through good design on a small scale. However, more opportunities are available

with more space.

The locations that are part of the canal ring (Herengracht and Keizersgracht) all have the same depth in street cross-section (around 10 meters). The Amstel Pier, however, has a larger public space along the quay wall. This has to do with the placement of the buildings further away from the canal.

This could prove to be a location with more opportunities in design. However, for this design it has been chosen not to go for this location. This has to do with the representativity of this location for the application in the rest of Amsterdam. As the quay walls usually are characterised by small streets along the water, a design on this limited amount of space will give more application possibilities in the rest of the city. There where more space is possible, the design can be extended.

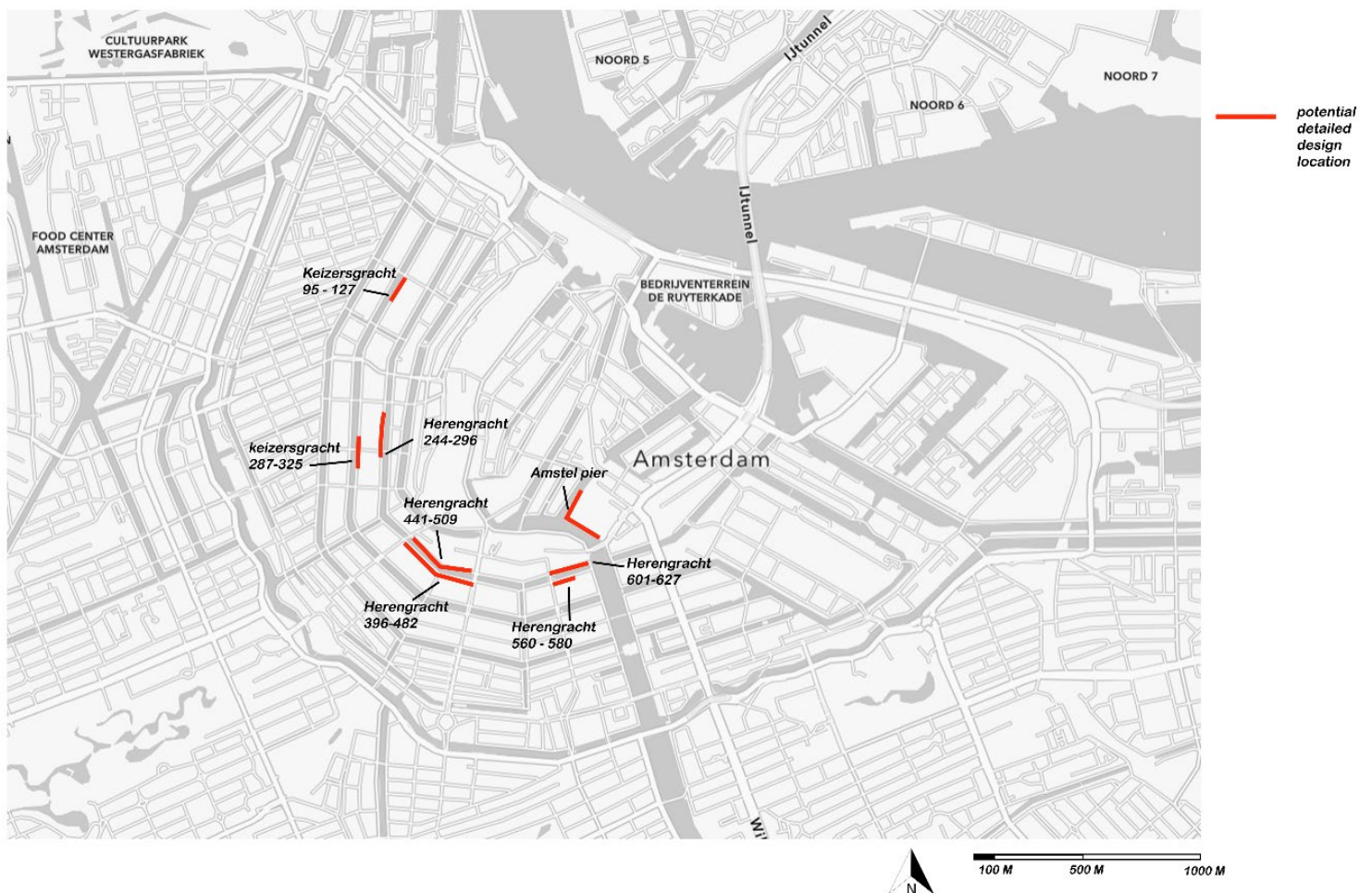


Figure 12: Potential detailed design locations based on the analysis

For the further selection of the possible detailed area locations, a more thorough look at the nature and stressor situation of the exact sites is needed, and the density of the offices is taken into consideration. By means of the maps provided by the municipality, the next location has been chosen as the optimal for this design.

Detailed area: Herengracht 466-482

This location has been chosen, as it contains the least amount of nature (trees and nearby green patches). The street usage is moderate-low, and there are no busy streets nearby that could influence the stressors of the location. Besides, the density of offices is one of the highest (function of working is 92%). The section of house 466-482 has been chosen instead of 396-482 in order to make the final design location comprehensive and compact.



Figure 13: Present situation of the Herengracht 466-482, shown from the east side of the street



Figure 14: Present situation of the Herengracht 466-482, shown from the west side of the street

Detailed Area

Location

The location chosen is the Herengracht 466 until 482. This part of the Herengracht is part of the so called 'Gouden Bocht', the location which was added in the fourth extension of the canal ring (Gemeente Amsterdam, 09-10-2019). In the design of the fourth extension, this part of the Herengracht was directed to the richest citizens of Amsterdam. This can nowadays be seen in the larger buildings (in comparison to the rest of the canal buildings) and the more decorative elements integrated in the architecture. This part of the Herengracht is therefore especially important to the heritage of the canal structure.



Figure 15: Buildings of the detailed design location, picture taken from the opposite street

Map and data analysis

Users

The figure below (16) shows the present structures of the detailed area, with according functions. The street contains 9 parking spaces for cars and 4 appointed parking spots for bikes. Besides, there is street furniture present in the form of streetlights, trash bins and one bench. There are two points of interest, that is the boarding point for boats and the loading and unloading location for trucks.

Starting off with the boarding point, which can be noticeable in the location by means of a small stair in the quay wall construction. Besides, an area is sectioned off with poles in the water right next to the quay wall. In this area, the parking of boats is not allowed. Further parking of boats along the canal is allowed.

The loading and unloading location for trucks is important for the traffic on the Vijzelstraat, and the building the Bazel. This location cannot be filled with other elements or used by other cars, which must be considered when designing.

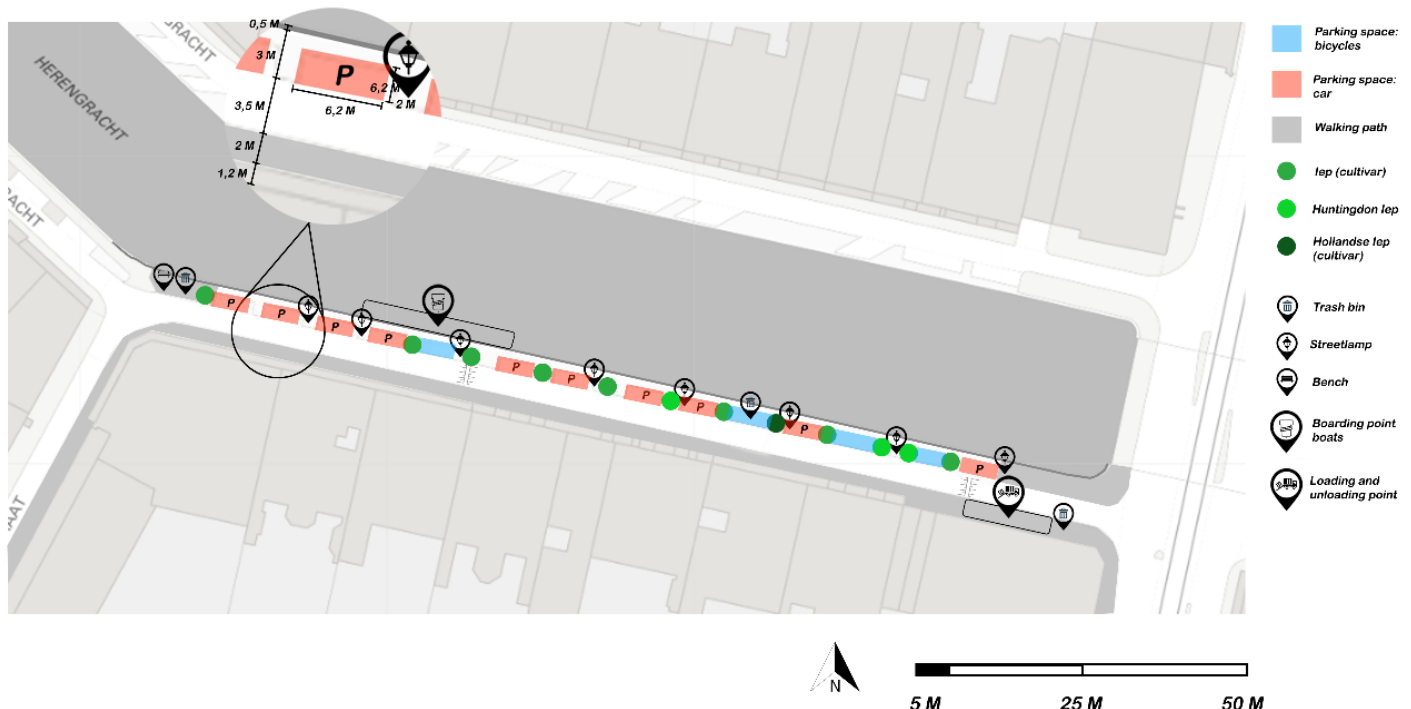


Figure 16: Analysis map of the present usage and dimensions of the detailed design location

There is one resting location for the cyclist and pedestrians using the street, which is on the west side of the detailed area location. The rest of the street doesn't contain any benches, which stimulates the continuity of the traffic and thereby withholds people in staying in the area to experience it more thoroughly. The parking spots (in total 10 spots, which one of them is disabled parking), are paid. There are a few allocated bicycle parking spots in which metal divisions are placed.

The cut out circle shows the measurements of the road. The total depth of the road (only taking in the public space) is 9 meters. The small strip of 1,2 meters along the buildings is property of those buildings, and is mostly sectioned off with posts. The length of the detailed area section (house number 466 until 482) is around 152,1 meters. The depth of the canal is 24,5 meters.

Traffic situation

Figure 17 shows the users of the street and the traffic structures associated to it.

The Herengracht 466-482 is a one-way street. The users of this street are mainly cyclists and

pedestrians, with a small amount of car traffic. The Vijzelstraat, which crosses the Herengracht on the east side of the map above, is used more intensively. On this street, there are trams, taxi's, trucks and there is more intensive car traffic. The metro follows this street, but it goes underground so this is not noticeable.

Historical elements

The Herengracht is part of the UNESCO world heritage area, meaning that the appearance and structure of the canal is protected. All buildings (482-466) are monumental buildings, build in the seventeenth century as part of the design of the canal structure. Only the 'Bazel' is more recently build, in 1919-1926, but it is still a national monument.

In addition, the bridge on the east side of the road (the Isa van Eeghenbrug) is a national monument. The bridge design stems from 1922, but there was already a bridge in this location in 1727 as part of the canal structure. There are no monumental trees in this part of the Herengracht, these have already been removed in the past.

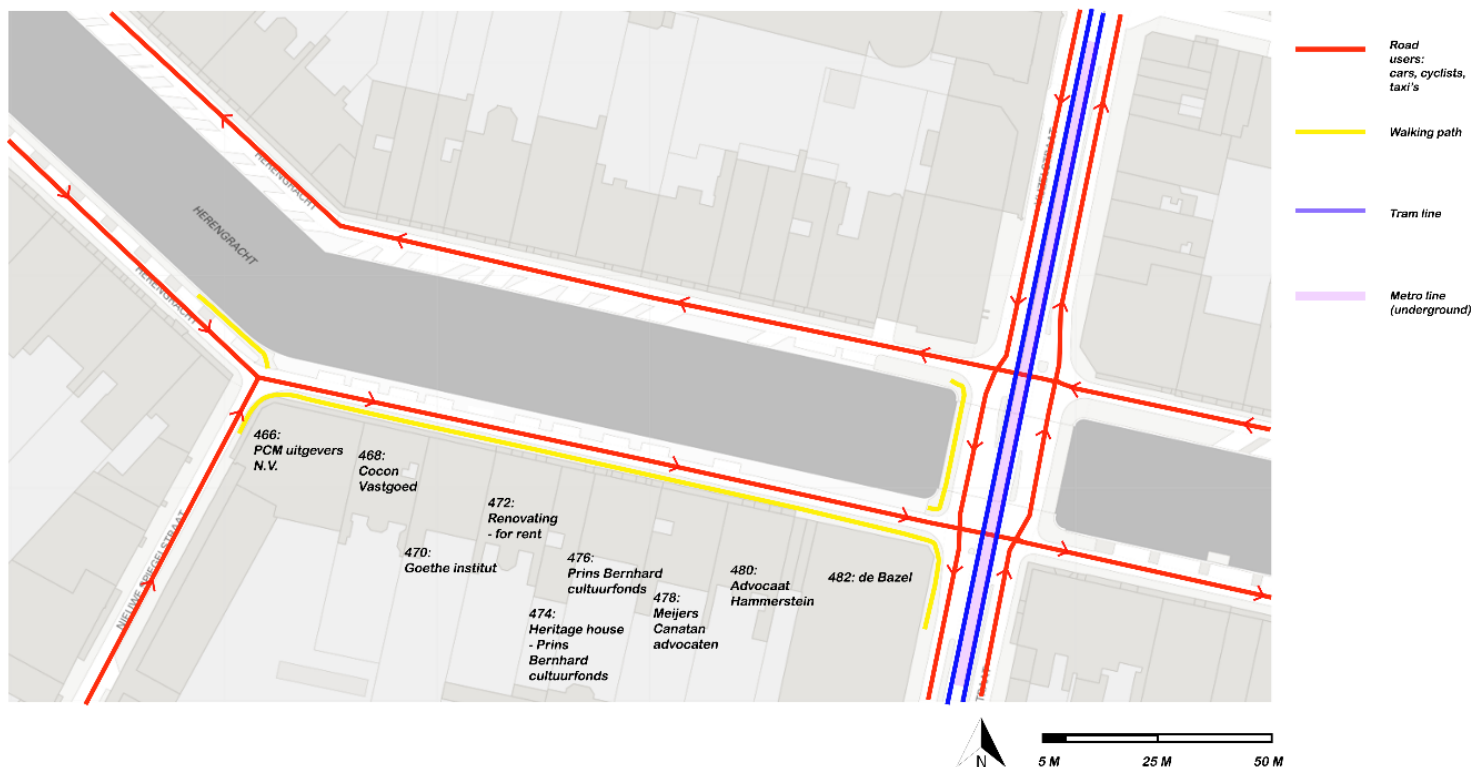


Figure 17: Analysis map of the street usage of the detailed design location

Site visit and observation (stressors)

On the morning of the second of June, the site was visited. During this visit pictures were taken, traffic was analysed and the users of the street were observed during a time span of one and a half hour.

During this visit there was construction work on the Vijzelstraat (east road crossing the Herengracht). This had a lot of impact on the movements of traffic, the people present and the stressors of the study location. This must be considered when drawing conclusions from this visit, as this is a temporary situation and doesn't show the area at its normal state.

For traffic, the site was drastically influenced by the construction work. The one-way road was changed in the direction of traffic. Besides, the road was blocked at the east side because of the construction of the Vijzelstraat. The car traffic that was observed during the visit consisted out of cars entering on the west side and having to drive back. The parking places were all in use.



Figure 18: Photo of the parking spots of the detailed design location

Cyclist, pedestrians and scooters were still able to make use of both directions of the road. Cyclists were the main users of the road, followed by the pedestrians. These pedestrians mainly consisted of groups using this street to move themselves through the city. Especially groups of youth were witnessed. There were almost no users that stayed in the street, it was used more as a connection between different locations. Only on the east side of the road there is a bench present, which was used by different people.

This to me shows that there is a will to stay in the road, but there are no opportunities given.



Figure 20: Photo of the resting location (bench) on the west side of the street

The sounds observed were mainly overruled by the construction work. However, when not taking this into account, the sounds of the traffic around were noticeable. This was mainly the cars and scooters using the road itself, and subtle sounds of the traffic in the nearby streets. This to me shows that the area itself can be described as a quite silent area, especially if there would be no cars and scooters allowed in the street section.

For the workers practically the same observations apply. The people coming from the buildings during the lunch break time (around 12.30) all left this street to go to a different location. Only for a small (smoking) break, 2 workers were observed who stayed in the street. Remarkable was that these people went to the east corner, where there is a bench present and there is more space to stand.

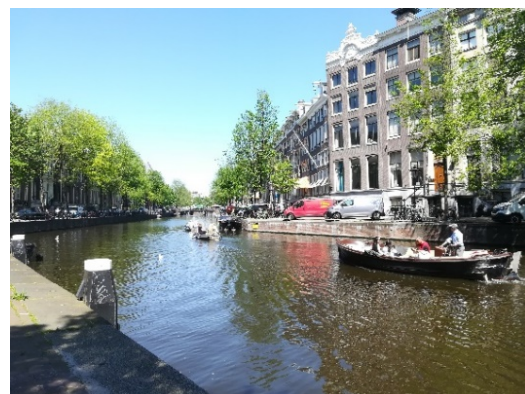


Figure 19: Photo of the canal, private boat using the water

The water traffic was very extensive. A few small boats used the water, and these made little to no sound. One small boat was parked along the quay wall, but mainly the part of the canal on the west of this street was used for parking.

Design procedure

As concluded in the theoretical framework section, the two theories can be applied in different moments in the design process, as they focus on different aspects of the design. The SRT focusses on the element that need little to no cognitive processing. These then revolve around structural and material aspects of the design. On the other hand, the ART focusses on elements that need more cognitive processing, which then cover elements that are part of the overall atmosphere and usage of the design.

The design process will start with describing the concept of the design, which will be described and evaluated by means of the criteria points of the ART. Then the specific design principles for the implementation of green in design will be chosen that fit the best within the two scenarios (these will be described in the following section). Per scenario a design will then be created, keeping

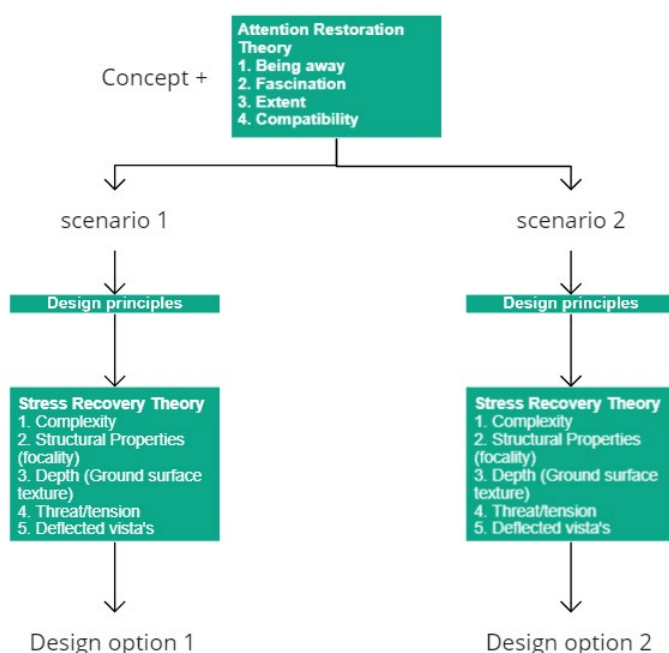


Figure 22: Flowchart of the designing procedure

the concept and criteria points of the SRT in mind. The following figure (22) show the steps described above in a more concrete manner.

2 scenarios

Through the analysis of the city of Amsterdam, the most fitting location with least amount of environmental stressors has been chosen. However, this is still a street which is being used by different users. As stated above, the stressors of the urban environment are mainly determined by social stressors. Figure 21 shows these stressors again by means of principle drawings.

The stressors of the detailed design location are heavily influenced by the traffic using the street, which also puts spatial limitations on the area. The most ideal solution would then be to close the street off for motorised vehicles and scooters. Many policy documents of the municipality of Amsterdam already discuss this topic (Gemeente Amsterdam, 2018). The traffic using the streets and bridges have a bad influence on the state of these structures. The inhabitants of the city, the amount of visitors and the urban logistics are increasing. The municipality of Amsterdam wants to decrease the amount of car traffic in the city to make sure the future city will still be a pleasant living environment.

However, this requires quite drastic spatial changes in the city structure. This is not a process that can happen in the short-term. For that reason, this report works with two scenario's: completely car-free, and car traffic still implemented in the final designs. This will provide a design option that can be applied in the short term to still blend in to the present traffic situation, and a more optimal design that could provide inspiration for possible future implementation.

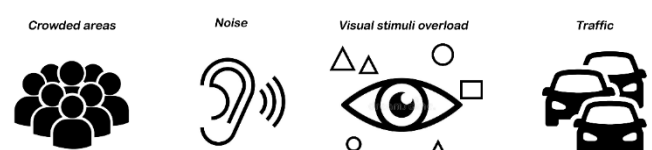


Figure 21: Environmental stressors of the urban context

The Designs

The Attention Restoration theory indicated that the creation of a suiting natural landscape has a positive effect on stress-relieve. This chapter will cover the method in which this theory will be covered in the designs.

Concept

The goal of the design is to create a place for the workers to escape to and feel like they are in the calming and controllable nature. As water is the focal point of the canals, this will be embraced and used as a base for the type of nature that will be recreated. The concept of the designs is 'the riverbank'. The river geomorphology of the typical Dutch river has a certain structure. For this design we will use the meandering river as an example. Figure 24 gives a simplistic illustration of the characteristic shape of this meandering river.

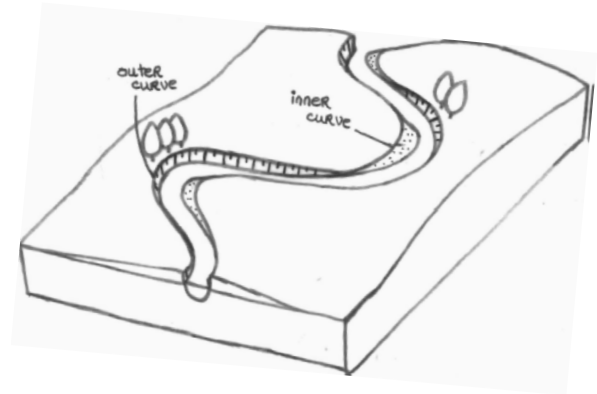


Figure 24: Schematic picture of the Riverbank concept

The meandering river owes its structure to the river current, which guides its riverbed in different curves. There is an inner and an outer curve. The outer curve is under the influence of erosion, as the river current is the strongest here. The riverbank is steep and high. The inner curve is the location of sedimentation. Over here, the river deposits its materials because of the slow current. This riverbank increases very gradual. This part is the location which is more suited for entering the water.

Atmospheric collage

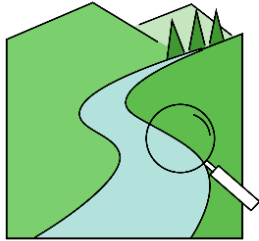
Figure 23 shows a collage of the design concepts, giving an impression of the desired atmosphere, materials and plant types to be used in the design.



Figure 23: Atmospheric collage of the Riverbank concept

Attention Restoration Theory

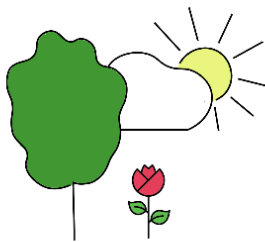
Being Away



Being away

As described above, the goal of this design is to create an environment that takes the workers away from their working environment. The design must bring the individual away from their previous context in order to have a real 'break'. This will be achieved by creating a deviating environment compared to the space around, so that this space can really be experienced as 'a place to escape'. This can be achieved within this concept through the implementation of a lot of (different) water plants, different shapes inspired by meandering river and textures and materials that **refer to the river shore**.

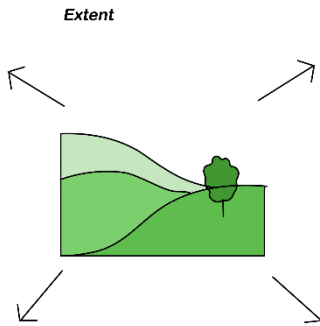
Fascination



Fascination

This element covers the more subtle elements of the environment, that determine the stress-relieving effect of a green space. For the riverbank, the elements that effect this fascination are for example the flow of the water, the colder breeze flowing over the water, the rustling of the leaves of nearby trees etc. By considering these possible positive elements of the design and capitalising on these, this element can be strengthened. Because nature encompasses this positive effect already by itself, and the goal of this design is to implement more nature, this criteria point will automatically be achieved. However, in order to completely make use of this effect it is important to implement spaces where the users can experience this effect to the fullest. This can be achieved by placing **resting locations** like benches and viewpoints.

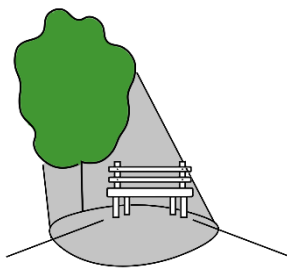
Figure 25: Schematic picture of the first two aspects of the Attention Restoration Theory



Extent

The area must give the feeling of being in a completely different environment, which can be achieved by making it feel large and coherent. In the context of a river, extent is reached through the length of the river itself and the width of the river shore. This element can be achieved through clever design, in which the feeling of **depth** can create the illusion that a place is larger than reality. Besides, by adding enough **differences on a small scale**, the river can be miniaturised. For example, meandering can be recreated on a small area even though in the realistic situation this would require a vast amount of space.

Compatibility



Compatibility

For this element, the target audience plays a more important role. As this research focusses on the stress-relieve of workers, and the detailed design location encompasses offices directly connected to the design location, an optimal design will be formed in this context. As described in the paragraph on the target audience, workers make use of the public space during their (short) breaks. The design location functions as a location to escape the office, and for example to eat their lunch or smoke a cigarette. As the office worker uses their direct attention during work, it is of importance that the design provides an environment that doesn't need much mental processing. This can be achieved by giving the individual enough **guidance** in the form of walking paths, and providing the **necessary elements** of the location that are wanted when taking this break from work. Street furniture, like benches, lamp posts and trash bins play an important role in this criterion. The way these elements are placed and spatially guided are then important in the overall design structure.

Figure 26: Schematic picture of the last two aspects of the Attention Restoration Theory

Applied design principles

Scenario 1

This design follows the scenario in which motored traffic is not allowed in the street. This gives many opportunities in designing, since there is no space taken by parking spots for cars.

Figure 27 shows the design principles that have been applied in this design.

It has been chosen to implement design principles that require a larger amount of space, since the absence of car parking provides this space.

Scenario 2

In this scenario traffic is allowed in the street. This means that there is a more limited space for implementing greenery. Figure 27 shows the design principles applied in this design.

The design principles that are deviating from the previous design are: pergola's and nature in raised beds. These elements are very fitting for implementing in a more limited space to still create a green environment.

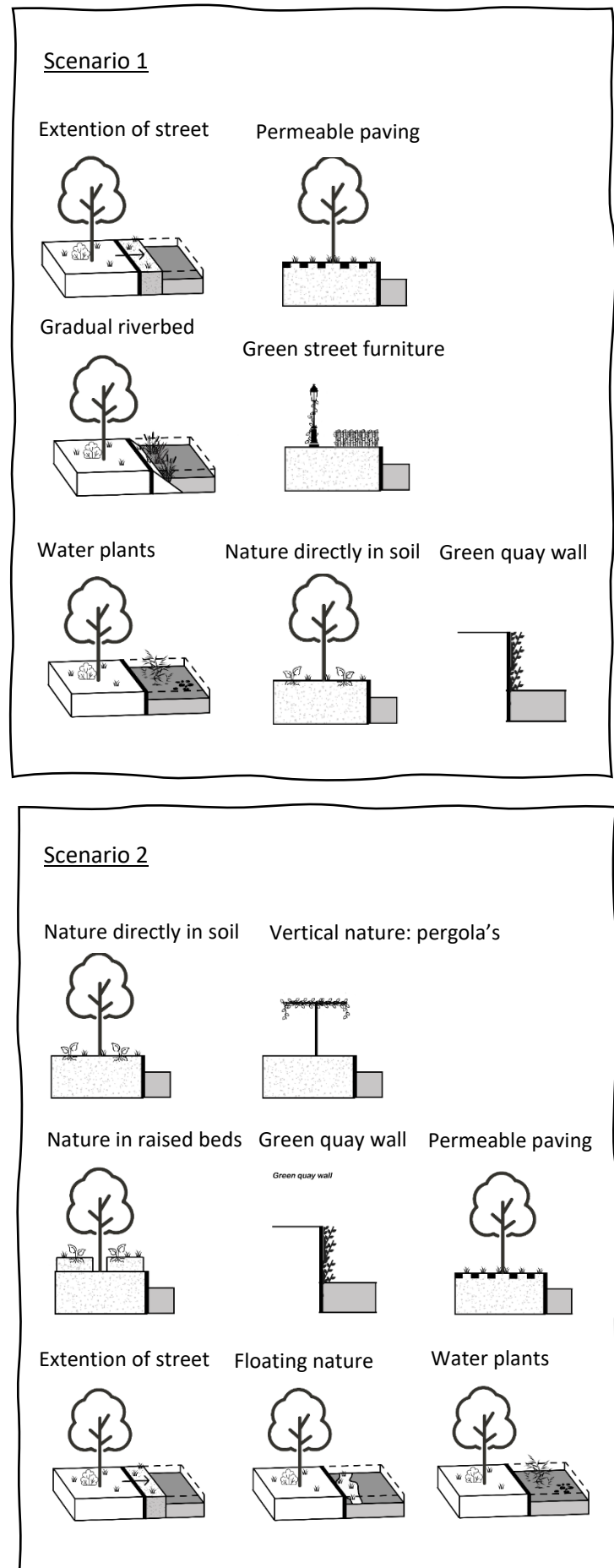


Figure 27: Design criteria chosen for the two different scenarios

Design 1 (scenario 1)

This design is heavily inspired by the flows of the meandering river. On a small scale, the curves formed by the current of the water are recreated. These form the extending parts of the road along the quay wall. The non-extended parts of the wall represent the outside curve of a river, where erosion takes place. Over here, the quay wall drops down vertical. This interchange of extension and reduction can be placed on its own at one side of the canal, but can also be repeated at the opposite side. The curvature then must follow the opposite flow. In this way the curves can combine so the curvature of the meandering river can be recreated.

To strengthen this feeling of the outer (eroding) side of the river, the plant border together with the quay wall is raised. The user is hindered to have a complete view of the water when walking along these sections. This is used to raise a feeling of exploration.

The water can be overseen in the extended areas, to which the visitor is directed by means of walking paths. This visual effect is illustrated in figure 29.

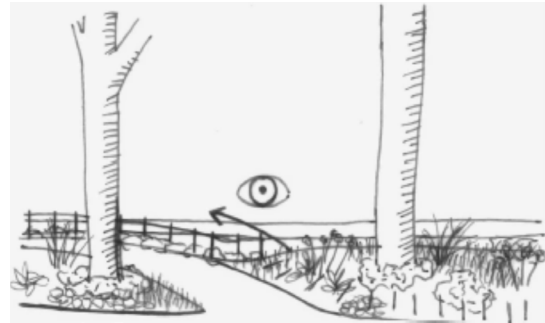


Figure 29: Illustration of the raised plant beds along the vertical quay walls

The extended area represents the inner curve of the river, in which sedimentation takes place. Over here, the user has a view on the water and the greenery of the vegetated canal bank. Because the user is brought more away from the street and is surrounded with greenery, this place provides for a strong feeling of escape.

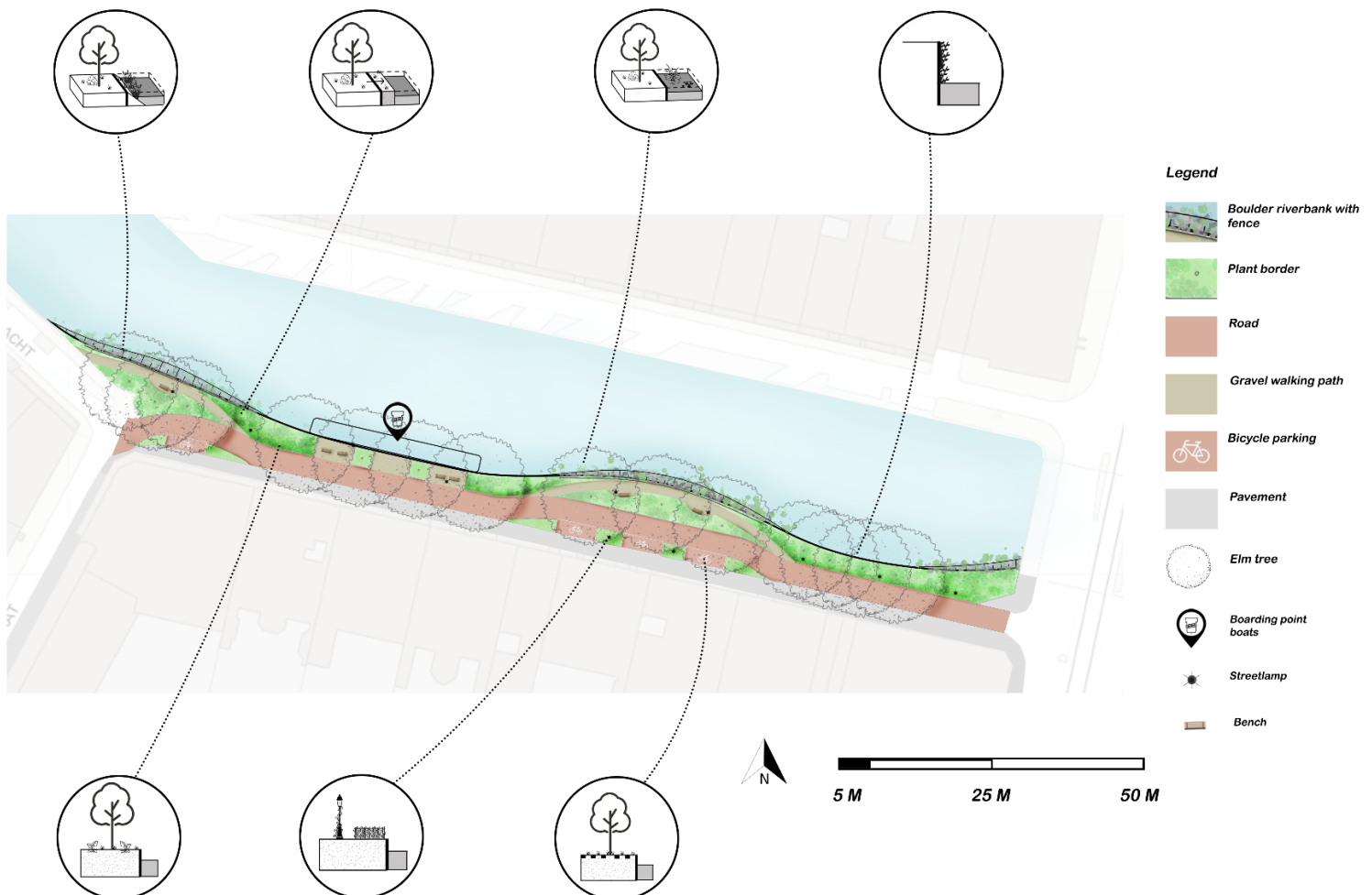
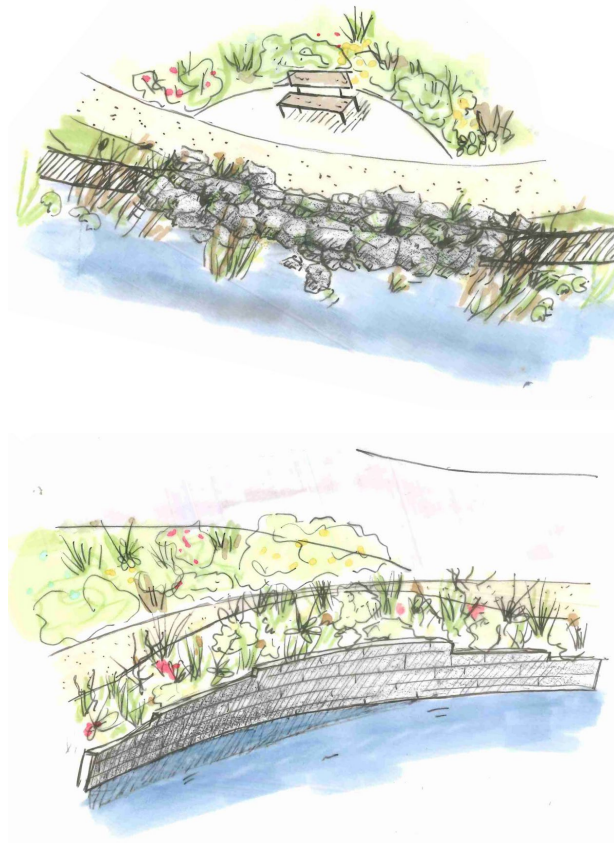


Figure 28: Map of the initial design for scenario 1

The water can be experienced the best as there are no visual obstructions. Besides, because of the gradual riverbed there is more opportunity for water plants to grow.

The following figure (figure 30) shows the two different shapes of the quay wall. The top one shows the elevated wall with the plant bed behind. The lower figure shows the gradual riverbed, with vegetation on top of it.



*Figure 30: Illustration of the two different quay walls.
Top picture: gradual quay wall, bottom picture: vertical
elevated quay wall*

In this design only cyclists and pedestrians are users of the street. Bicycle parking spaces are implemented, so the workers of the offices are able to park their bicycle nearby. The boarding point for boats is still accessible.

Next to it are benches that give the users a location for overseeing the water more in the position of a spectator. This is in contrast with the earlier described extended areas, where the user brought more towards the water.

The surfaces in the design have been optimally used for the addition of greenery. This can be seen in the vertical parts of the quay wall, which is overgrown with wall plants (green quay wall design principle). Next to that, the bicycle paths are made with grass concrete pavers, which allow there to be more grass implemented in the design (permeable paving design principle). Finally, the street furniture is used for implementing more greenery. This is in the form of green lantern poles and vegetated fences.

The cross-section

Figure 32 shows the cross-section, taken at the part of extension and with a view of the west. This location can be seen in figure 31.

In this cross-section, the different usages of the street are visible. The pedestrian walking along the canal is separated from the traffic of the street, and is surrounded by greenery to strengthen the feeling of escape. The nature of the gradual riverbed gives more interest to the view and gives an opportunity for more nature implementation. The users of the road have a view of the nature along the canal, with little obstructions by the trees. These create more dynamic, offer shade to all users of the street and belong to the historic appearance of the canals.



Figure 31: Location of the cross-section



Figure 32: Cross-section of the initial design of scenario 1

Multi-criteria evaluation

Stress Recovery Theory

Structural elements

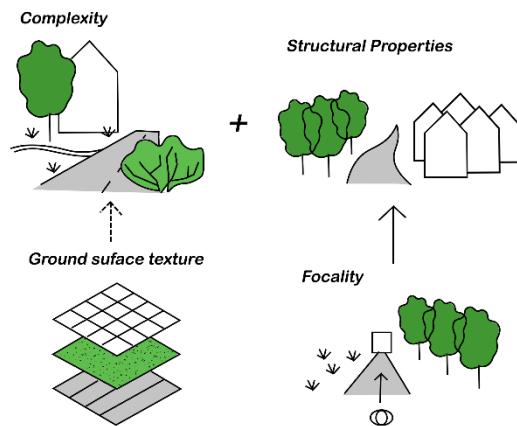


Figure 33: Structural elements of the Stress Recovery Theory

As discovered in the theoretical framework chapter, the design criteria shown in the figure above are strongly connected and dependent on each other. For that reason, these elements will be discussed together in this part of the critical assesment.

The complexity of the design can be described as the amount of separate elements percieved in a space. When looking at this design, the complexity can be described as being quite moderate. Not many various element are present, but there is enough variety for it to be interesting to the eye. However, because of the urban context with many different houses, people (social stressors), traffic stimuli around the location (being able to hear the trams etc.) and other elements, this can be experienced as fairly complex. The structure of the curving canal and the trees along the water result in more order in this context. By applying the design principles in such a way that this creates a steady structure, high amounts of complexity can be avoided.

The ground surface contains quite some smooth even textures, helping in making the design not too complex. However, the **permeable paving** can cause for a more scruffy texture, which is describes as causing more complexity. The way the grass grows

inbetween the tiles will always differ. But these grass concrete pavers have a repeating structure, which could bring in more order to limit this complex appearance.

This design has high focality by means of the walking paths towards the **extended areas**. The visitor is guided by means of the shape and the elevation in the **plant beds**, resulting in the visual blockage of the water. This gives structure in the whole visual array of the street, as it guides the visitor to the resting points of these extended areas. This is further enhanced by the **gradual riverbed**. This attracts the visitor towards the water as the main focal point and brings them more towards the experience of the water.

Things that might weaken the structure in the design, is the green **street furniture**. As the way the plants grow around the fence and light poles can result in less equility. However, this is on the more smaller scale. As Ulrich describes in his theory, this structure adressess mainly the visual array of elements. In case this street furniture is placed in a structured manner, this complexity can be avoided.

Besides, the way the **plant beds** are filled in can influence the complexity of the scene. In case the planting is very chaotic and wild, more structural elements of the shape of the bed and the framing of the bed in its context might be desired. In case the planting contains a more visible structure, this will not be needed. In this case, a good inbetween has to be sought to find the optimal attractive appearance.

Depth

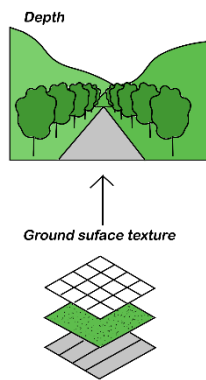


Figure 34: Illustrated design criterium of the Stress Recovery Theory

When looking at the depth properties of the location, it is interesting to notice that there is ample feeling of depth even though the street section is very narrow. This has to do with the view over the water, which is quite wide and open, making it possible to look in the distance at the opposite street. The available surface for designing is very limited. This means that depth creation should be applied on the smaller scale.

This design makes use of the **extention of the street** to create more space for designing. This part has an open view, except from some trees. This makes it possible to see the view behind, making the observer able to percieve depth.

With the implementation of the **gradual riverbed**, more depth can be created in the transition of the surface to the water. The way the different plant species follow each other makes the viewer able to experience the lowering of the riverbed by sight. By combining the different design principles sequentially, this effect can also be strengtened. This can be achieved with the extension of the street, followed by the gradual riverbed and ending in the placement of (floating) **water plants**. In this way, on a small scale a layered effect can be achieved.

The way the **plant beds** is filled in has an impact on the depth perception. If the front plants directly block the view of what lies

behind, the viewer will be restrained in experiencing the full depth of the area.

The **ground surface textures** contain, like stated above, ample smooth textures. This has much to do with the presence of the main road and the walking paths in the extended parts. Again, the permeable paving is quite rough, which is indicated to have a more negative effect on the depth perception of a view. However, the continuous texture of the tiles results in a fairly smooth overall appereance.

Threat/ tension

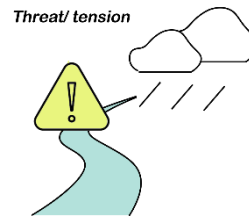


Figure 35: Illustrated design criterium of the Stress Recovery Theory

When looking at the elements on sight that could cause for feelings of threat or tension, the steepness of the canal and the traffic of the road can be identified as possible sources. This design deals with the transition of the street towards the water in two ways.

The 'outer edges' have a vertical quay wall. This could cause in a feeling of danger, since this is very steep. However, this part of the wall is not reachable, because of the **plant beds**. In this way, the feeling of danger will be restricted.

However, this is not the case for the section along the boarding point of the boats. Over here, the benches are directly pointed towards the water and the steep quay wall. Adding a section inbetween, or a fence, could reduce this negative feeling.

The **gradual riverbed** along the extended areas gives a smoother transition towards the water. This helps in the reduction of the danger reaction, as escaping the water is possible. Besides, the placement of **street**

furniture in the form of a fence will give more security that falling in the water is not possible.

When looking at the traffic situation that could lead to dangerous situations or feelings of danger, some points of interest can be indicated. The traffic of the road comes across very little obstacles that could make for a feeling of danger. However, when looking at the most important target group which is the pedestrian workers, the traffic could result in a negative experience. There is a continuous pavement along the buildings, and there are some paths leading to the extended areas on the side of the canal. In case the pedestrian wants to reach this extended part, then they have to cross the road. To ensure that this is perceived as a safe environment, the placement of a pedestrian crossing might be wished.

Deflected Vista's

Deflected vistas

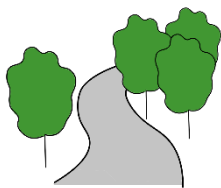


Figure 37: Illustrated design criterium of the Stress Recovery Theory

Because of the openness of the design, not a lot of deflected vistas are present. The whole area is quite transparent, as there are not many high vertical elements present. The trees do provide a visual obstruction, but these are fairly narrow. This does not cover a large area to provide for this element of curiosity.

However, this design implements the element of deflected vista's in the elevation of the **plant beds**. This makes the visitor curious in exploring further, to get a complete view of the water. Even though these raised elements are not very high to completely block the view, a feeling of exploration is still stimulated.

The curvature of the walking paths of the **extended areas** could provide in a location for a deflected vista, as this curve could be complimented with a view-blocking element, in the form of **street furniture** or a specific plant choice. However, the way this effects the depth perception must be considered when this is implemented.

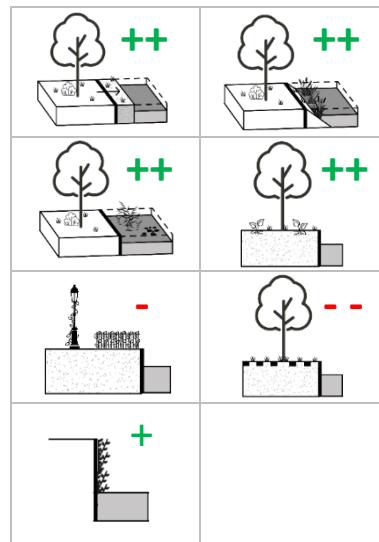


Figure 36: Summarised assessment of the design principles applied in scenario 1

Final product

Adjustments

Based on the multi-criteria evaluation, certain elements were adapted to create the final design. Figure 38 shows the final product map with the adapted elements. These will be described in more detail below. Then, a visualisation is given. This shows the used materials, planting and atmosphere.

6 Deflected vista

A deflected vista has been added in the extension area. This follows the curve of the walking path, hiding what lies behind. This is used to arouse curiosity to discover the information that lies behind. This strengthens the attractiveness of the extended part even more, to create a place of discovery and being away. This element has not been extended too far, in order to not block the view on this extended part too much. In this way, the feeling of depth will not be obstructed too much.

8 Feeling of safety

This element has been strengthened in two different ways. The problem of the dangerous crossings for pedestrians has been solved by adding crosswalks. Studies have shown that the placement of zebra crosswalks give a stronger feeling of safety and improve the road-crossing experience of pedestrians (Havard & Willis, 2012).

Next to that, the feeling of danger has been reduced by the placement of green strips and fences in front of the benches along the boarding point. The addition of the green gives a feeling that the steep slope of the quay wall is less reachable, and the addition of the fences block the possibility of falling in the water.

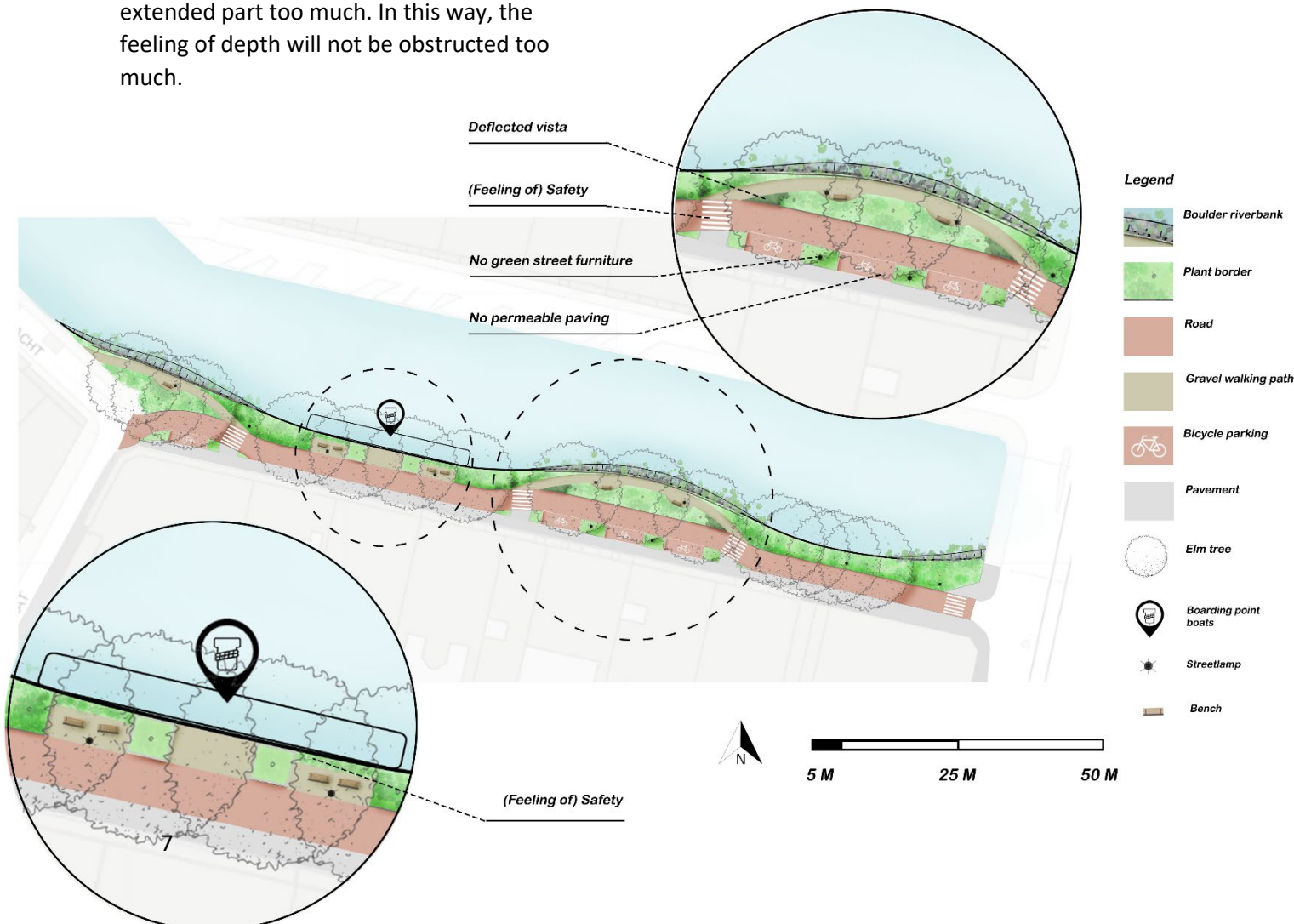


Figure 38: Adapted design map of scenario 1

9 Street furniture

The critical evaluation has shown that the design principle of green street furniture does not have a direct positive effect on the stress-relieving effects of the design. This makes it not a helping element, and therefore it has been chosen to be eliminated from the design. This decision has also been made because of the possibility that the added greenery on the street furniture could lead to a more chaotic and complex appearance.

10 Permeable paving

This element has been eliminated based on the same reasoning as the former. The permeable paving does not have a positive effect on the stress-relieve. The uneven surface has a more negative effect on the complexity and feeling of depth of the design.

Visualisation

Figure 39 shows the visualisation of the design. For this visualisation, the optimal application on both sides of the canal is shown.

An impression of the vegetation is shown. There has been chosen to implement a 'wilder' vegetation combination, in line with the concept idea of the natural riverbed. Because of the smooth surfaces of the walking path and the road, together with the discernible borders of the plant beds, this more chaotic vegetation does introduce too much complexity. This is also supported by the usage of plants that are not so high to block the view, in order to keep it transparent.

At the opposite side of the water, the elevated vertical quay wall is visible. The green quay wall gives it a more natural appearance which supports the concept. This quay wall is only visible when standing at a different street, so this element has a positive influence in case the design is carried through at the opposite side of the street as well.



Figure 39: Visualisation of the adapted design for scenario 1

Design 2 (scenario 2)

For this design, the present structure of the road has been fairly retained. In order to keep to the present intensity of the traffic and needs in parking, this structure is effective.

The curves of the meandering river have been achieved by using floatlands. The water traffic is considered, as the floatlands don't extend very far into the canal. The report about the available space of future Amsterdam (Gemeente Amsterdam, 2020) describes that water traffic is probable to become more intensive. Floatlands are movable elements and can be removed or replaced in case these cause problems for the more intensive water traffic.

Along these floatlands are locations where the worker can rest and fully experience the nature on the site. There is a possibility to sit down under the shade of the pergola. The pergola is implemented to give a stronger feeling of enclosure and escape from the street behind.

Behind the car parking spots raised plant beds are placed. This makes sure cars won't crush the plants in the border. Besides, this hinders the user to have a complete view over the water behind, stimulating the feeling of exploration. These plant beds will have the height of around 1 meter. The only place where there water can be totally overseen is the locations along the floatlands. The users of the street are in this way guided to these locations.

A small extension of the street has been implemented to create more space for greenery. This amount is limited, to make sure the water traffic is not blocked.



Figure 40: Initial design map of scenario 2

The cross-section

Figure 42 shows the cross-section of the design. In figure 41 the location of this cross-section is shown.

This cross-section shows the division between the different users. Besides, the gradient of the nature towards the water is visible. The visitor can escape the street as they enter the seating area covered by the pergola to provide a feeling of enclosure. Over here, the user has a view on the nature in the water, extending the nature that is located on the street itself. The users of the road are also able to experience the nature on the street, by getting a sight on the elevated plant beds, the trees and the exterior of the pergola's (which are covered with climbing plants).

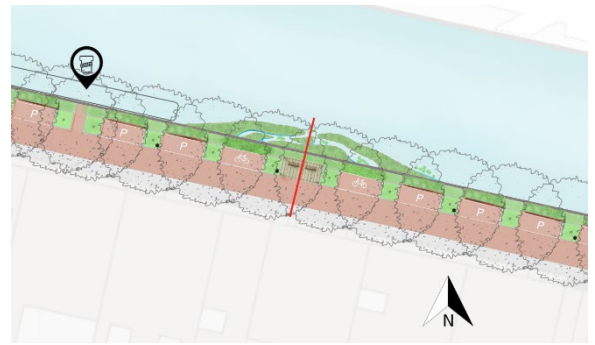


Figure 41: location of the cross-section for scenario 2



Figure 42: Cross-section of the initial design of scenario 2

Multi criteria evaluation

Structural elements

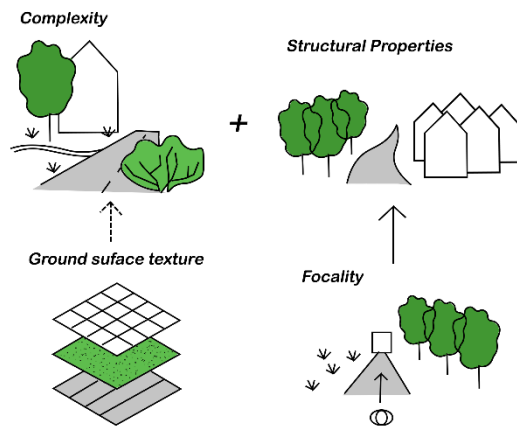


Figure 43: Structural elements of the Stress Recovery Theory

This design can be described as quite structured. The way the street is organised follows a recognisable pattern. The trees are placed in rows, the parking spots for cars and bicycles are located at structured locations and the floatlands follow a visible flow. However, because this scenario includes traffic, the overall situation of the street is quite complex. The different traffic users result in a more complex situation. Because of the more structural design of this street, a middle ground has been found to make the area attractive.

As in the previous design, this design implements the **permeable paving** design principle. This is a less smooth surface, which could result in a more complex appearance. The tiles have an overall repeated structure, but the way the grass grows can cause for a wilder and more complex appearance.

The design makes use of the element of focality, by guiding the visitor to the resting locations. This is mainly achieved through the implementation of the **elevated plant beds**, as they hide the view on the water. The plant beds along the resting locations are not elevated, giving the viewer the opportunity to oversee the water. This 'hiding' aspect of the elevated plant beds is used in such a way to

give guidance to the focal point of the street. By placing the **floatlands** at this resting point, the importance of these locations is emphasised. As there is more information to be discovered at these locations, the attractiveness of these focal points is strengthened.

Elements that must be considered concerning this design criterium, is the filling in of the green spaces, especially the **floatlands**. As the forms of these floatlands are already quite unstructured, a more structural filling in of these areas might be desirable. The placement of the **water plants** can take away of the shapes of the floatlands, giving it a more complex appearance. An in between must be sought, giving it still an interesting look but making sure there is a structure perceptible.

Depth

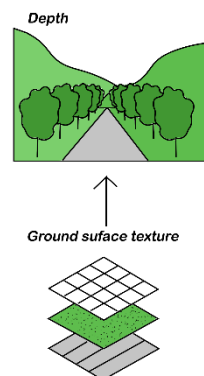


Figure 44: Illustrated design criterium of the Stress Recovery Theory

As this scenario has a big influence on the available space, this design is quite limited in achieving a large surface, which then has a negative impact on the depth perception. However, the addition of a small **street extension** already gives more opportunities.

The design does not include many vertical elements that create a large block in the view, which could have a negative impact on the depth perception. The only elements giving some visual obstructions are the tree trunks and the elevated plant beds. These tree trunks are not very wide, so they won't have a large negative effect on the visibility. However, the

elevated plant beds can have a more negative effect on the depth perception. As there are quite a lot of these structures, the overall depth perception could be negatively influenced. What is important to be considered, is the height of these beds. This design makes use of 1 meter high beds, which result in quite a lot of restricted depths.

The element of the **floatlands** has a highly positive effect on the depth of the design. This is an element that extends the street, showing more information continuing from what can be seen on the street level. Besides, the fact that this information is placed in a lower level makes use of the depth that can be experienced from the lower water level.

With the addition of the **water plants**, this element is even further extended, making use of one further surface level (directly on the water level).

The **pergola's** add another layer to the design. This design principle is very suitable in situations of limited space, as it brings in another layer in the same amount of surface. What is important to consider, is the amount of visual blockage this element introduces when standing underneath of it. If the vegetation on the pergola hangs over too much, a lot of information of the surroundings will be hidden. An in between is important to be sought, to make sure there are no negative effects that overrule the positive.

The **permeable paving** used in this design can have a more negative effect on the depth perception, as described about the previous scenario design.

Threat/ tension

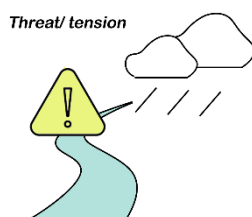


Figure 45: Illustrated design criterium of the Stress Recovery Theory

The implementation of traffic in this design introduces more (feeling of) danger. This is something to consider when designing in this context, to make sure the stress-relieving effects will be reached optimally.

This design implements three different resting locations along the waterside. The pavement is on the other side of the street, forcing people to cross the road. As in the previous scenario design, the addition of a safe crossing location relieves the threat feelings.

Next to that, the resting location at the east side of the street is closely located to the busier Vijzelstraat. The implementation of a divisional element that leads to a relieve in the feeling of threat is desirable.

The addition, the **pergola** gives a feeling of enclosure and protection. As the resting areas are closely located along the street, the addition of this design principle helps in creating a more safe-feeling location.

The other element that could cause for a feeling of danger/threat, is the presence of a very steep quay wall. This design makes use of a **plant border** in front of the resting area, which gives a protective division between these areas. However, the addition of **street furniture** in the form of a fence could even further reduce this feeling of danger.

Deflected Vista's

Deflected vistas

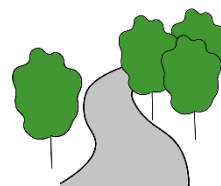


Figure 46: Illustrated design criterium of the Stress Recovery Theory

This design makes use of the deflected vistas in the implementation of the **elevated plant beds**. This element results in curiosity, stimulating people to explore what can be seen of the water. As this design is quite limited in space, the addition of a curved road or another element is very constrained. Implementing a visual blockage will quickly

lead to a restriction of depth, as the possibility to explore what lays behind is limited.

When looking along the water into the street, the resting locations are being blocked by the placement of the tree rows and the **plant borders**. With further exploration into the street, the present elements will become more visible.

This element can also be seen back in the floatlands. These elements are blocked from the view when standing on the road because of the quay wall. The floatlands will become more visible when approaching these at the resting areas.

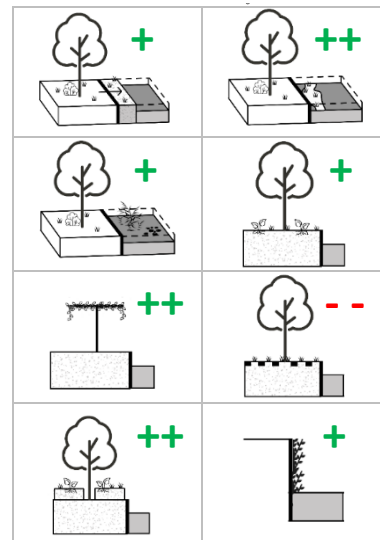


Figure 47: Summarised assessment of the design principles applied in scenario 2

Final product

Adjustments

Based on the multi-criteria evaluation, certain elements were adapted to create the final design. Figure 48 shows the final product map with the adapted elements. These will be described in more detail below. Then, a visualisation will be given. This shows the used materials, planting and atmosphere.

- Depth perception

The elevated plant beds are now all at the height of 1 meter. This causes quite a lot of visual blockages of the water, which restricts the depth perception of the location. The solution to this problem is differentiating the heights of the beds, but keeping the elevated element. In this way, the positive effects concerning the deflected vista aspect and the blockage of cars running over the plants will still be maintained.

The plant beds will have ascending heights, with the highest in the middle of the row being the 1 meter. The following figure (49) shows schematically what is meant by this ascension.

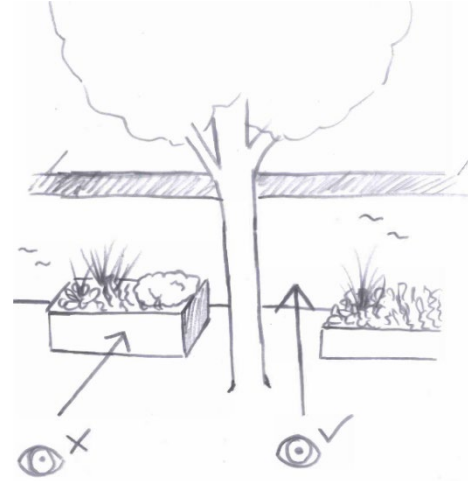


Figure 47: Illustration of the elevated ascending plant beds

- No permeable paving

There has been chosen to remove the design principle of the permeable paving.

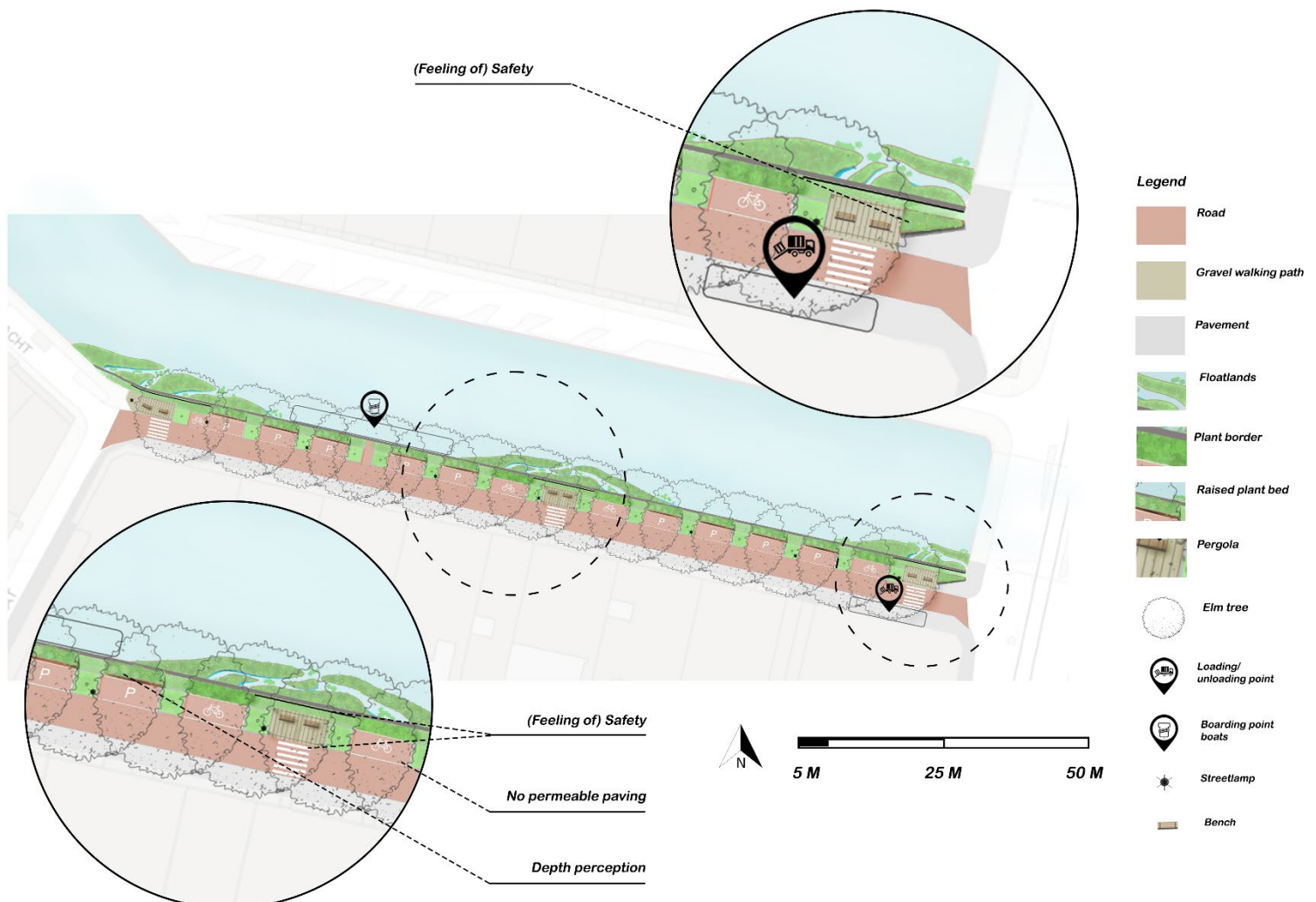


Figure 48: Adapted design map of scenario 2

As indicated, this can have a negative effect on the depth perception and the complexity of the design. This is caused by the way the grass grows through the tiles, which leads to a more cluttered visual. To make sure the overall surface of the road gives of a smooth appearance, the paving of the road is carried through in the parking spaces.

- (Feeling of) Safety

To strengthen the feeling of safety, in other words reduce the feeling of threat, two different elements have been introduced.

First off, the feeling of threat caused by traffic. As the crossing of the road causes a feeling of danger, three zebra crossings have been introduced. These will lead the users to the resting points at the opposite side of the road.

Next to that, an elevated plant bed has been placed at the outer east edge of the street. This will give a division between the resting area and the Vijzelstraat, to strengthen the feeling of being in a more enclosed space.

The second element is the feeling of threat followed by the steep quay wall. By implementing street furniture in the form of a fence, this feeling is lessened. These are added along the resting points, to give a stronger feeling of safety but not blocking the view.

Visualisation

Figure 50 shows a visualisation of the design. The overall atmosphere and planting are shown. Because of the very prominent structuring in the design, the implementation of a 'wild' planting has a positive effect on the attractiveness of the design.



Figure 48: Visualisation of the adapted design for scenario 2

Discussion

This chapter contains a critical view on this report. The information gained from the literature research, the designs created in this report and the critical assessment of these, will be discussed.

By means of a theoretical framework, the design criteria that determines the stress-relieving effect of the final design have been indicated. What must be noted, it that this limitation to two theories can influence the overall reliability. Human psychology is a very elaborate subject, as it must deal with much subjectivity and personal factors. The extent to which, and the amount of stress is experienced differs per person. However, ample research studies show the positive relation between the view on nature and stress-relieve. The used theories are well-known and often tested. Besides, the elements discussed in these theories are broad, giving ample room for personal differences.

However, these theories are limited to the view of nature. The usage of the green spaces is not considered, which can also have an impact on the stress-relieving effect of the design. This element was considered during the literature research phase. However, this element was eventually eliminated to specify and because of the limited time available for the writing of this thesis. An additional research on the stress-relieve of the design (and design principles) would be a good addition to this report to strengthen the reliability.

Next to this, these theories are more directed at (large) surfaces, instead of only looking at an element like a quay wall itself. This is also the reason why this research has a larger focus on the overall design of the street, with the specific walls of the canals being an element in it. In case only the quay wall itself will be tackled; more specified research will be necessary.

When assessing the design section of this report, one must deal with more subjectivity and artistic interpretations. The way the design principles are implemented has a big influence on the final assessment of these. If there would be more design options given, a more accurate assessment could be executed. Again, with an eye on the limited time of this research, a limitation had to be made. Next to that, the assessment of the designs when looking at the appearance (which is the leading factor in this research, determining the extent to which stress-relieve is achieved) is difficult to achieve when the design is not put into realisation. By means of the design map and visualisations, this assessment had to be conducted.

Finally, this report looks focusses on locations with little environmental stressors to create the optimal stress-relieving environment. In order to achieve a good stress-relieving environment also in the places that are under the influence of many environmental stressors, research on this topic is helpful. By finding methods on decreasing the environmental stressors throughout Amsterdam, the implementation of the research findings of this report will become more effective.

Conclusion

This chapter will combine the findings of this research in order to give an answer to the main research question:

How can the stress relieving effects of urban green space be optimally achieved in the renovation design of the Quay walls for the workers of Amsterdam?

By researching the different elements effecting the stress-relieving effect, and then relating this to the situation of the quay walls of Amsterdam, the best application method has been sought.

What can be concluded from this research, is that there is not one perfect solution or design to reach this stress-relieving goal. Mainly the combination of different elements and the way these elements relate to each other has the biggest impact on the degree to which the stress-relieving effect is achieved. As the needs of the streets per location and overall needs throughout time differ (as shown with the two different scenario's), the optimal design will also be different (also determined by the available space).

However, the usage and testing of design principles has provided us with tools for further application. The principles that stimulate the stress-relieving effect and that are suiting in the context of the quay walls have been indicated.

When discussing the overall atmosphere of the design, the Attention Restoration Theory taught us that the creation of a natural scenery is of high importance, which can be achieved by means of a concept. This design uses the concept of the riverbed, which is effective in the context of the Amsterdam quay walls because of the presence of the canals.

For the design elements itself, the implementation of the Stress Reduction Theory elements and the critical assessments based on the criteria created from this theory,

makes it possible to make the following overall conclusions:

1. The extension of the design towards the water has a very positive effect. This creates more opportunities in designing, and strengthens the stress-relieving effects in different aspects. Combining this with elements that work with depth-perception, like a gradual riverbed and water plants, strengthens this effect even further.
2. The addition of vegetation to existing structures has a negative effect on the stress-relieve; this will only introduce a cluttered appearance.
3. The addition of green spaces in the vertical direction has a positive effect (especially on the depth perception) This is very applicable in situations with limited amount of space.
4. The placement of more practical elements like fences and divisions, eliminates elements that can evoke the feeling of threat.
5. The manner in which the different elements (design principles) are placed in relation to each other is of very high importance. When well applied, this can introduce structure and the stimulation of exploration.

The stress-relieving designs given in this report can best be applied when the environmental stressors are not/in a very small amount present, to achieve the most stress-relieving environment.

Reflection

In the last 8 weeks I have been working very hard to create the report you have in front of you now. I must say, this was quite an intense period in which I have learned a lot. Both on the writing of a thesis report, and on my personal experience of such a new process and situation.

The procedure for this thesis was quite new for me. Until now, the courses I have followed focussed on the different elements apart that now have been combined in one product. Starting with the research part, which I would say to be one of my strongest points. However, this directly resulted in a small problem, as I was delving into this element too much. The topic I chose for this thesis is something that interests me very much, which made me very excited to research this into the very last detail. This caused a slight moment of panic, seeing that the time that was available for this component was very limited. This forced me to make a bold selection in the theories which are now the leading factor behind this research. Luckily, I have the feeling that the research conducted resulted in a wise choice in the theoretical framework, as the theories provide enough depth and compliment each other very well.

The transition to the creative process of designing was something very new to me. During my bachelor years I learned that I sometimes struggle during the creative process, as I want to take too many elements into account. This then blocks my ability to get into the creative flow, as I place too many restrictions on myself. However, I think that I have found a way to let this blockage go because of my studio experiences. As this thesis combines the research and the creative process in the same project, I had slight difficulties in making this switch. Nonetheless, I am proud of the designs I have created. This transition formed more of a problem timewise.

Speaking of time, the larger freedom in time-management was something new for me. Overall, I think I managed quite well. As there still were some deadlines a certain structure was still given, and I was able to reach these deadlines in time. However, I do think the last week was a moment of rush. Quite a lot of text still had to be written, as I left some elements open of the theoretical framework because I lost some time during the research process. This meant a lost weekend, but I think this is not very strange or problematic. Being able to manage my time well was one of my learning goals, which I think I achieved very well.

The other learning goal I created, was becoming more independent and more initiative-taking when there were obstacles. I think I definitely have become more independent, as I had to trust more on my own abilities because of the little amount of tutorials/question hours. I realised that the steps I took were good and that I can trust my own abilities more. This was a very difficult process for me, especially in the beginning. I was struggling a lot with being confident in my choice-making. It might have helped me out if I would have sent more emails to my supervisor to support me in this. However, by delving more into the deep, I think I came out much stronger.

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All pictures added in this report are self-made on the day of the site visit (second of June).