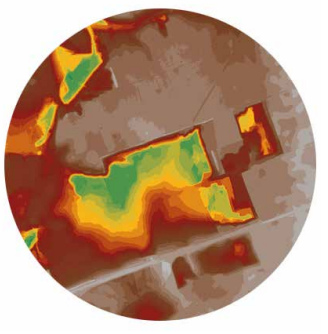
Abhinaya Gnana

MACHINE MADE LANDSCAPES

Choreographing a dynamic excavation landscape

Flowscapes Graduation Studio | Mentors : Steffen Nijhuis, Willemijn Wilms Floets



MSc Landscape architecture
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July 2018

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Choreographing a dynamic excavation landscape

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Choreographing a dynamic excavation landscape

A thesis presented
by
ABHINAYA GNANA

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This thesis has been approved by the

mentors : Dr. ir. Steffen Nijhuis and Dr. ir. Willemijn Wilms Floets
examiner: Ir. Paul Kuitenbrouwer

For my parents, S Gnanasekaran and Suguna Gnana

For my dearest brother, Nahilan Gnana

For my loving fiancé, Hridhay Rajkumar

ACKNOWLEDGMENTS.

No duty is more urgent than that of returning thanks" - James Allen

I am extremely grateful to my teachers, family, friends and colleagues who gave me the support I needed through all stages of the thesis project. I would first and foremost like to thank my mentors, Steffen Nijhuis and Willemijn Floets. They have been the best team any student could ask for, pushing me to develop my skills in all realms - to be structured and to be poetic. They were open to listening to all my ideas and always had very prompt, useful responses to any doubts I had. I am also thankful to the Chair of the Landscape Architecture department, Inge Bobbink, and other professors in the department, Saskia de Wit, Denise Picinnini, and Frits van Loon, with whom I have had very helpful conversations throughout the process. I would also have to extend a special thanks to Michiel Pouderoijen who helped me obtain all the base maps using his exceptional GIS knowledge.

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I would finally like to thank my family for all their loving support. My fiance Hridhay has always cheered me up when I have been low and knowing that he is there has kept me going. Nahilan, my little brother has been a bundle of mischief and joy, and has reminded me to be a child in my heart. I would like to thank my dad for being constantly interested in the project even though he is not in the field of design and providing me with motivation in all ways possible. And last, but not the least, my mom for being a role model because I cannot think of another person who is able to accomplish so many things in her life with so much enthusiasm.

ABSTRACT.

The exploitation of resources and minerals from the earth's surface for the benefits of mankind is a common practice all over the world for many decades. Usually, the excavation of mines and quarries is regarded as a purely economic process. There is no consideration about the way in which the excavations are changing the landscape spatially and the anticipation to an afterlife is not taken into account. Several countries are slowly realizing that such processes are detrimental to the landscape and have started thinking about rehabilitating the destroyed areas.

This landscape architecture design project is an attempt to explore excavation principles that adapt to the characteristics of the site and to "choreograph" a sand, clay and gravel quarry with the intention of facilitating ecological and recreational development. The park proposes routes and activities in which the experience of the unique spatial typologies formed by the excavators is at the center. The design is inspired by the spatial-visual experiences one gathers when one is at the top, in and around the vast space and its sections. In the tradition of European park architecture, loose organic and formal axial structures are combined to build up the scenic quarry choreography. Various minimal interventions capture the essence of a sand and clay quarry, creating curiosity and awareness about the landscape development of the site. This approach also helps to propose future possibilities for the part of the quarry which is yet to be excavated.

The design is a result of applying multiple excavation specific principles which can be tweaked to be applied to other quarrying sites as well. But because local geography and context heavily influence the application of these principles, they should be examined, questioned and translated into custom-made design. Once the land is exploited for its resources, it is very easy for a developer or any organization to further subject the land to economic exploitation without any consideration about the challenges and potentials the space possesses from a landscape perspective. However, the function(s) being employed on the land for economic viability must be carefully evaluated and a sensitive reading of the landscape can ensure an appropriate future usage. It should therefore be imperative for excavation companies to involve a landscape architect before the exploitation.

1 INTRODUCTION

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1. Sand excavation site
Image source: https://commons.wikimedia.org/wiki/File:Aerial view of a sand and gravel quarry in East Wagga

2. Gravel and sand sorting
Image source: https://ok.ru/noangel1/topic/66351470687580

3. Nature taking over iron ore mining site
Image source: https://www.lipov.com/Theme/Mining/i-sPMWfkC/A

4. Marble quarry
Image source: https://imgur.com/gallery/yRz8U

1.1. FASCINATION. People have progressively become experts at exploiting the earth for meeting their own ends for many decades. For instance, in the Netherlands, he dug peat from the lands for fuel, extracted salt for consumption, excavated stone, sand, gravel or clay for construction or other economic needs.

These exploitation landscapes which are like voids in the landscape have truly fascinated me for their characteristics. They are stand-out landscapes which in the minds of people are purely born out of economic needs and are not perceived for their landscape qualities.

1 **Stone quarrying site**
Retrieved from: *https://www.polycor.com/quarries-plants/*
2 **Peat dug land in the Netherlands**
Retrieved from: http://www.lowtechmagazine.com/2011/09/peat-and-coal-fossil-fuels-in-pre-industrial-times.html

1.2. *VIEWS ON EXPLOITED LANDSCAPES.* *Heavy machinery and industrial scales dominate these landscapes. There are a huge number of such areas being exploited and the public is not made aware of the exploitation activities or their impacts. They are almost always isolated and hidden scenes due to their unsafe and destructive environments.*

From the moment the ground is prepared for excavation, the machines are set to heavily alter the surroundings – clear the forests, clear the ground cover and tear apart the layers of the earth, slowly creating a space which is only fit for them – the man sitting propped up like a God inside the machine. These pieces of jewelry in the landscape continue to alter the terrain, unaware of the fact that they are constructing new landscapes the moment they set foot there.

The current trend is to identify these excavation sites after the entire process of exploitation is complete, and then to employ remediation techniques in a mitigated way, either by trying to return it to a natural state as close to its original one (renaturalisation), or to put it to some sort of recreational use (recultivation). There is more often than not no thought into the ecological or landscape implications of these remediation processes, within the site or at a larger scale.

These landscapes are purely looked at for their commercial benefits and heavily exploited for the material the earth has to offer. They fail to acknowledge the spatial characteristics of the sites and its aesthetic implications.

1.3. PROBLEM STATEMENT. *Therefore the graduation project aims to tackle the problem of current exploitation processes which are taking place in such a way that does not provide any awareness to the public. The processes during excavation and the remediation methods are carried out without being fully aware of the potentials and challenges of the area from an ecological or spatial point of view. The entire process lacks planning from the beginning of the exploitation to cover all the above issues.*

| Collage by author

1.4. RESEARCH OBJECTIVE.

*to identify and explore **excavation** approaches and principles for landscape construction with the intention of facilitating **ecological** and **recreational** development in excavation sites across multiple **scales** while creating **awareness** about them.*

1.4.1. RESEARCH QUESTIONS. To achieve the research objective the following questions must be addressed:

- What are the machines which transform such sites and what are the spaces they create in the **process** of excavation?
- What are the **spatial characteristics** of the site which make it unique and how are they constructed?
- How does **nature act** upon these sites to transform them constantly?

- What are the **principles** that one can work with while working with these sites?

- How can a **designer approach** and explore the way the site develops during excavation and after its completion?

- What are the **learnings** from the project and the way in which the principles can be applied on a site?
- How is the project related to the studio of **'flowscapes'**?
- Are the principles derived for this site also applicable to **other such sites** and if so, how?

1.5. RELEVANCE AND SCOPE OF PROJECT.

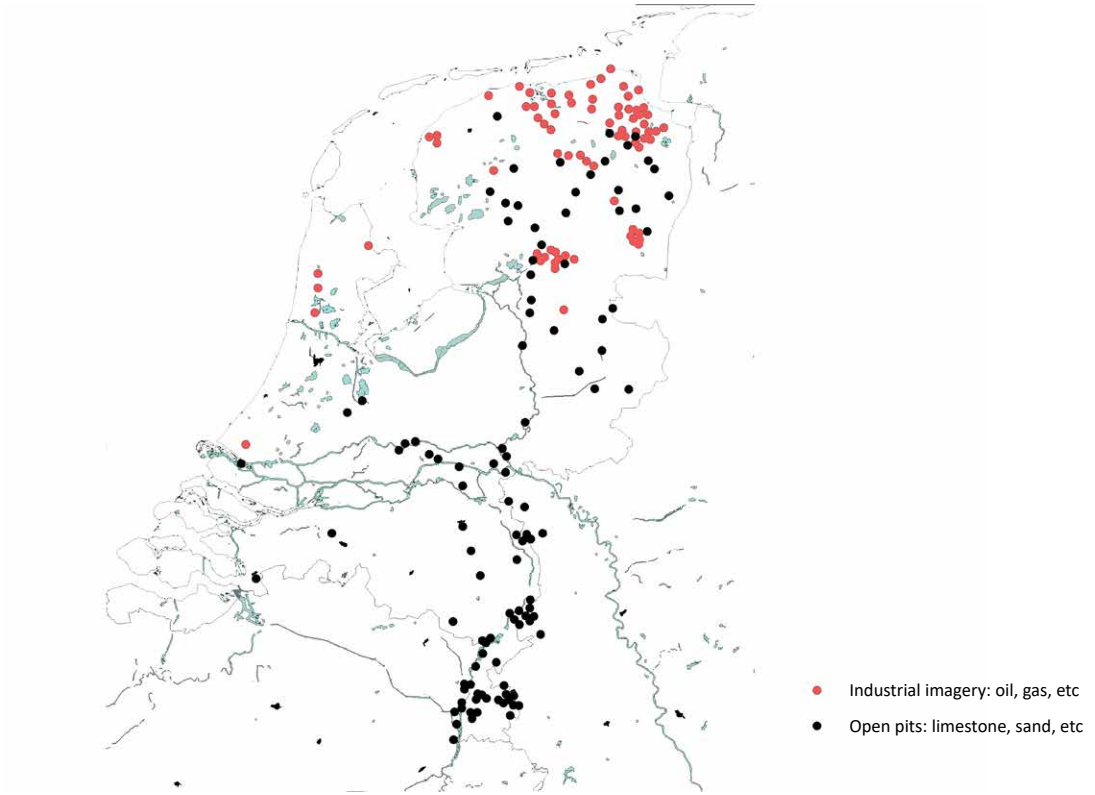
"An ounce of prevention is worth a pound of cure."

Man has found the earth's surface to be a treasure cove of resources and the layers of the earth have been constantly exploited for economic and survival needs. Such processes will continue to go on till there are alternative options for resources. There are numerous cities all over the world which are built around an excavation industry. They are places where either the digging is still going on, or such landscapes are found in their dilapidated states, stripped of all resources. Therefore, such a topic based on exploitation landscapes is highly relevant because such sites need attention all over the world.

Most such sites are found in their dilapidated states and a remediation process is sometimes set in place in a controlled manner after the entire process of exploitation is complete. Academically, this project is of relevance because it highlights the need for reading these landscapes for all the processes involved with them. The method of reading the landscape through the layers along with understanding it from the spatial-visual angle is beneficial to grasp the processes as well as the experience in such a landscape. The project not only thinks about the recovery of them by covering them up, or by employing new program at the end stage, but also tries to find solutions spatially during the excavation itself. The exploitation takes place to serve human needs and man is the one who is benefited at the end. Such a project will help to make the public aware of processes by making the space and the processes transparent. However, not every quarry will be part of a recreational program or become transparent. This project also derives ways in which such spaces can contribute to the ecological flow in a larger scale. This in turn benefits socially since such ecologically qualitative areas surrounding the urban environments will only add value to man.

The project aims to understand the processes that control the excavation landscape, and those processes which take place as a consequence of the excavation processes. The project will aim to address the relationship between the different processes which take place on a smaller quarry scale, but also on a larger regional scale through design interventions which meet the different parts of the research objective.

It aims to address the effects of time since the excavation landscape is not only one where humans act on for long periods of time, but also where the very materials the humans seek takes much longer to replenish.

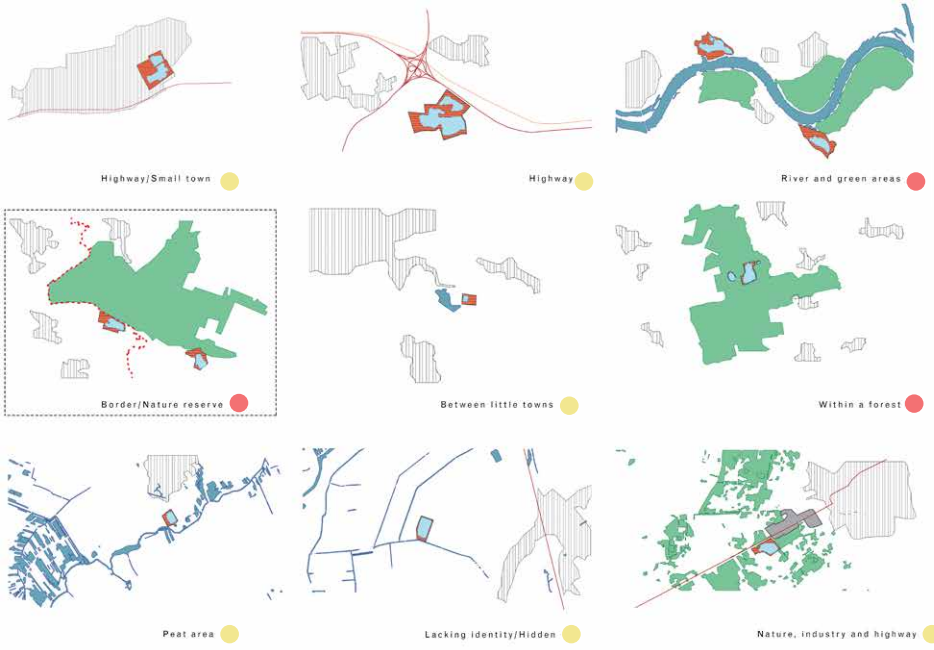


Drawing by author

1.6. SITE CHOICE. To address the research objective I decided to choose a site in and around the Netherlands as a testing ground. To narrow down to a possible exploited site, it was first necessary to look into current exploited areas.

Google earth and Edugis (category: *delfstofwinning or substance recovery*) are used as tools to identify sites, and they are classified them based on the imagery. Open pits as well as industrial sites are located.

1.6.1. CLASSIFICATION OF EXPLOITED SITES. *All the different materials of exploitation are mapped and classified into two broad categories of excavation and extraction. Excavation is selected as the category to explore since it has an evident impact on the earth's surface, and the sculpted nature of the surface can be explored.*

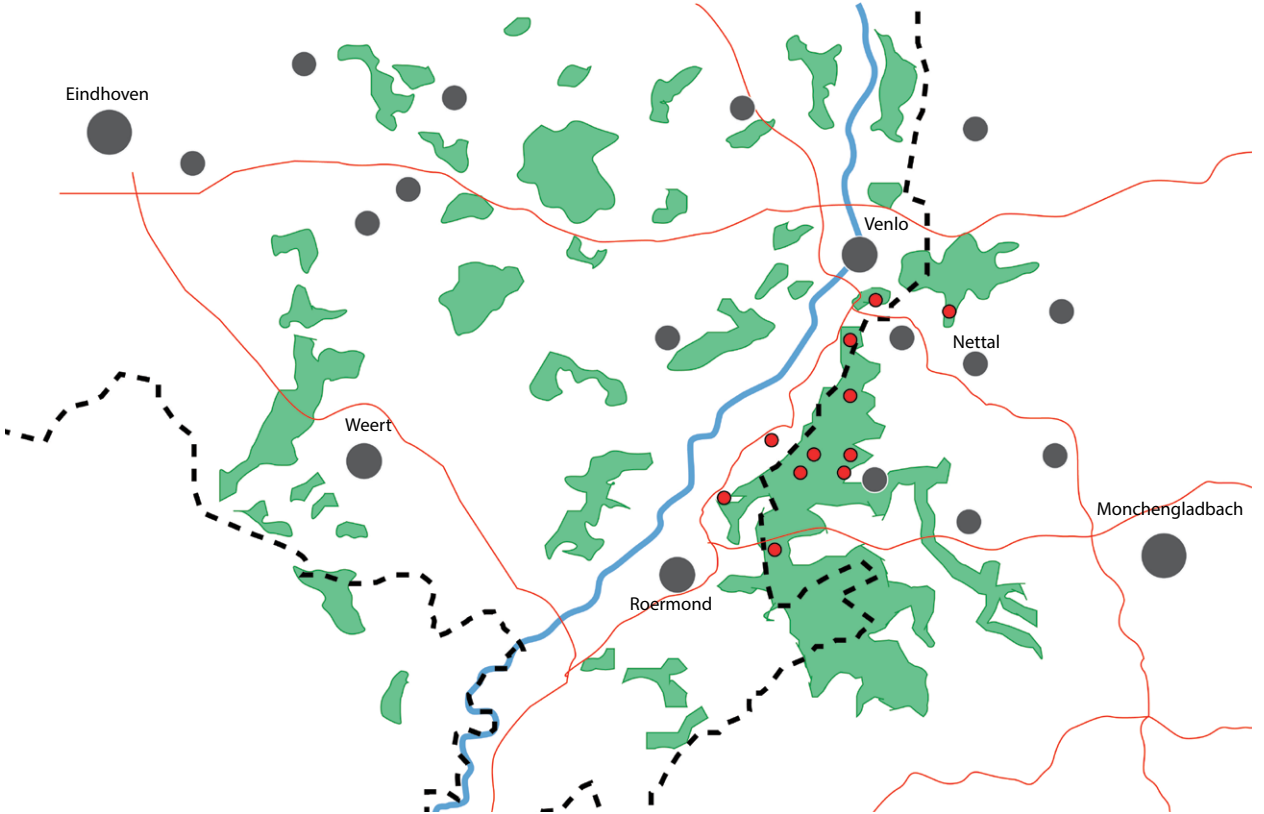


System of quarries which is to supply materials for a wider industry. The sand, clay and gravel found in the area is supplied to ceramic, building construction, road construction, and many more such industries which use the base materials.

Due to a specific purpose for excavation, the area is no longer active when the purpose is complete – construction of a specific highway, a housing complex in a nearby town, or excavation for water. Once the necessary activity is complete, the area is allowed to become a water body or is filled with material again, to later restore to original state.

It is a larger area where the material can be found and is thus exploited for larger industry gains meeting many purposes.

1.6.2. CLASSIFICATION OF EXCAVATION SITES. Further classification of excavation sites based on the purpose of excavation and the context of excavation helped to narrow down to a particular area of focus. It was decided to choose a region with multiple excavation sites which was for larger supply.

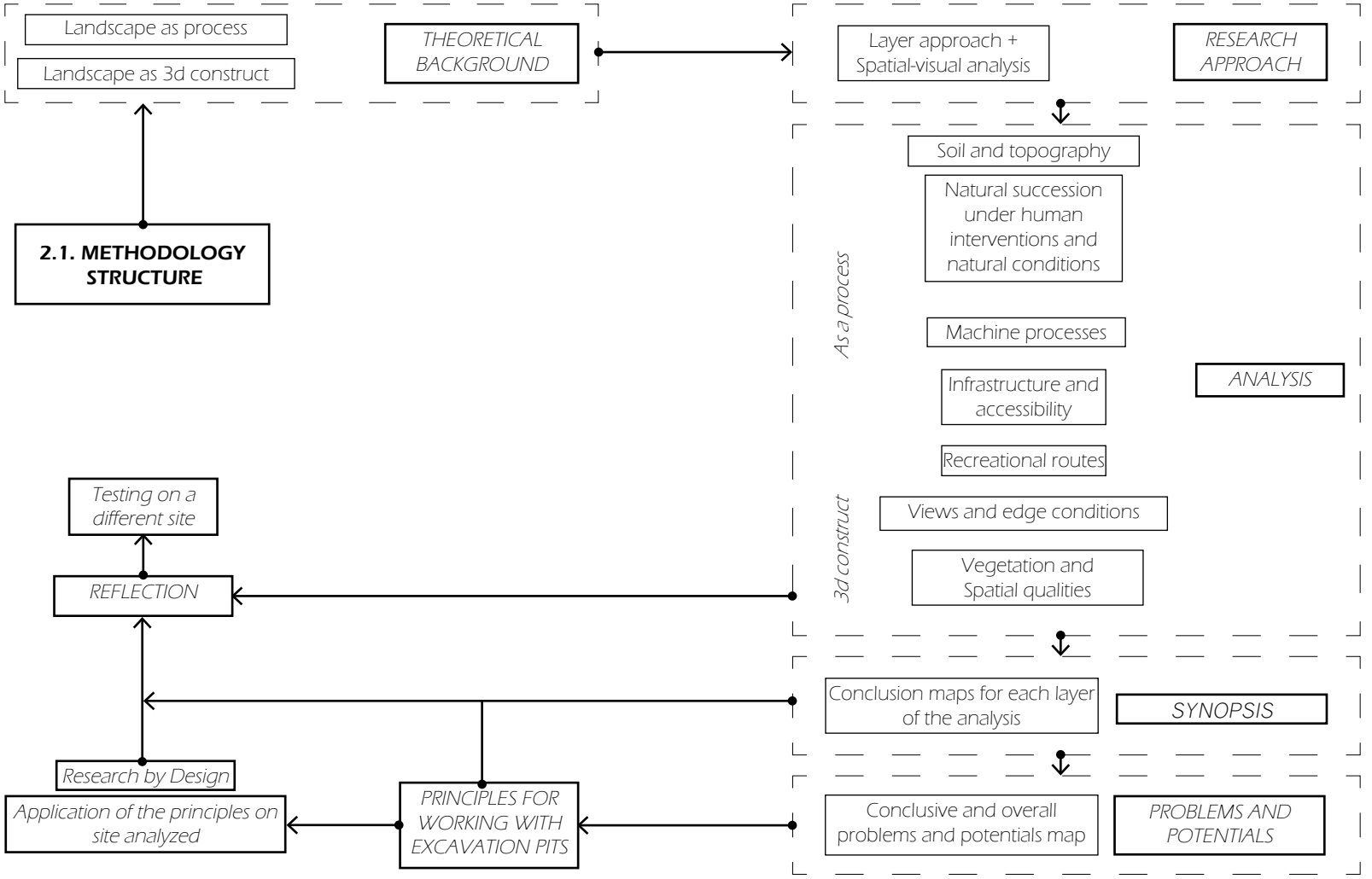


1.6.3. SITE - LARGE SCALE. *The region of Venlo-Roermond-Nettal (around the Netherlands and German border) is chosen as the site area where the research questions can be addressed. The area consists of multiple sand, clay and gravel quarries, which are either in ongoing or completed stages. The variety of quarries situated within a national nature reserve area provides a unique setting to address the general issues while being an interesting context to explore.*


Tegelen
Kaldenkirchen
Belfeld
Reuver
Bracht
Beesel
Brüggen
Swalmen
Elmpt
Roermond

Methodology structure
Theoretical framework
Research approach
Research design

2 METHODOLOGY


Landscape as process
Landscape as 3d construct
THEORETICAL BACKGROUND
Layer approach + Spatial-visual analysis
RESEARCH APPROACH
2.1. METHODOLOGY STRUCTURE
Soil and topography
Natural succession under human interventions and natural conditions
As a process
Machine processes
Infrastructure and accessibility
ANALYSIS
Recreational routes
Testing on a different site
Views and edge conditions
3d construct
REFLECTION
Vegetation and Spatial qualities
Conclusion maps for each layer of the analysis
SYNOPSIS
Research by Design
Application of the principles on site analyzed
PRINCIPLES FOR WORKING WITH EXCAVATION PITS
Conclusive and overall problems and potentials map
PROBLEMS AND POTENTIALS

1 **Designing a river garden**
Retrieved from: *http://www.gsd.harvard.edu/event/georges-descombes-designing-a-river-garden/*
2 **The spiral jetty**
Retrieved from: *https://www.diaart.org/media/w1050h700/object/smi-spiraljetty-steinmetz.jpg*

2.2. THEORETICAL BACKGROUND. The project uses two lenses as its backbone - Landscape as a process and Landscape as a 3d visual construct.

2.2.1. LANDSCAPE AS PROCESS. This lens deals with the "construction of landscape as a process rather than a product. Projects play a role as a open-ended strategy, as in staging or setting up future conditions. The landscape is a expression of the dynamic interaction between biotic, abiotic en anthropogenic factors." (Nijhuis,2006; Prominski, 2005; Marot, 1999). Since the 1960s, thought process evolved from thinking about nature as a static image to thinking about the natural world as dynamic, interrelated ecosystems that include humans, who have the ability to alter those ecosystems. The excavation ecosystem is in-fact however the opposite. The idea of humans altering the natural ecosystem here is more dominant than the other two systems and the fact that the former closely influences the latter is not very evident in such landscapes.

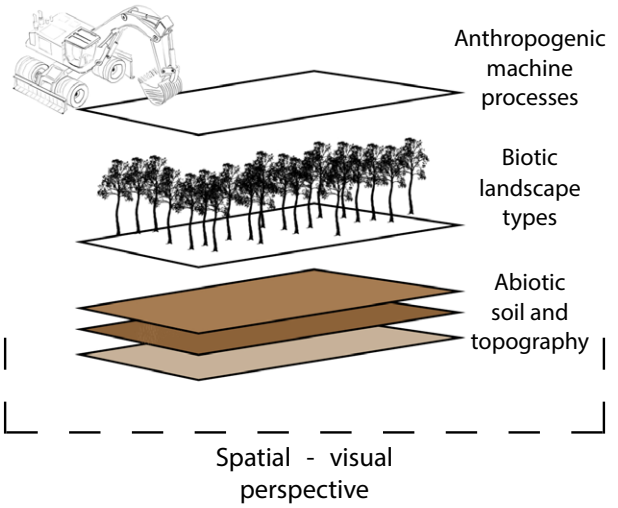
Seeing landscape as a temporal medium is a prime quality of this lens. The landscape cannot be represented as a single final image, but constantly changes due to various factors. Lawrence Halprin, Georges Decombes are landscape architects well knows to work with landforms created by natural processes, and site artists such as Robert Smithson, Michael Heizer, Mary Miss, and Robert Irwin also created works which resonated with the same ideas. The interventions aimed to not only create aesthetically pleasing spaces, but also aimed to show the temporal qualities of landscapes, by allowing nature to act upon their work freely. They envisioned their project by thinking about multiple images which changed through time. The excavation landscape is also one that is highly temporal in nature and thus, understanding it as a process rather than viewing it as a dilapidated image is important in this graduation project.

2.2.2. LANDSCAPE AS A THREE DIMENSIONAL CONSTRUCTION. *This lens states that the "visual form of the landscape is based on the sensorial experience that emerge only by movement and is affected by the position and intensity of light sources. The act of perceiving is linked with the sequential unfolding of information as our bodies pass through space"*[1] *(Nijhuis,2006; Prominski, 2005; Marot, 1999).*

The excavated landscape can fall under this lens because the land is literally sculpted as a three dimensional object to reveal dramatic topographies. By understanding the spaces as a sequence of being experienced through visual means will help capture this three-dimensional quality of the landscape. Though humans experience space through multiple senses, the sense of vision is one that is dominant and one that is given most importance to. Therefore, this lens is one that must be paid attention to. Also, while exposing the spatial qualities of this landscape, the processes that take place in this landscape can also be made evident by understanding the space through this lens.

The landscape can be decomposed into various elements which are further discernible to the human eye. It would then be crucial to also understand the scale of these elements, and their characteristics. Catherine Dee, in her book Form and fabric in landscape architecture makes some classifications which can help to decompose and to read a landscape. Those classifications can be used to understand the quarry's innate qualities which make it unique.

The aim of this understanding would be to make the already existing qualities of a landscape evident by simply choosing the right points in the landscape from where they can be exposed. As Bernard Lassus says, a minimal intervention is enough to open up a new interpretation of the landscape, and this minimal intervention can be derived from the way the landscape is read.



2.3. RESEARCH APPROACH. The graduation project addresses two main theoretical ideas - landscape as a process, and landscape as a three dimensional construction. Therefore, the research approach is one that encompasses the relationships between the biotic, abiotic and the anthropogenic, and the spatial visual expression.

The project thus employs a layers approach which is used to not only understand processes but also the experiences in the quarry.

The layers which I have chosen to analyze are as follows:

- Anthropogenic
  Exploring the machines which are responsible for the excavation and the excavation process, thus.
- Biotic
  The vegetation which is prevalent in the quarry which results in a variety of landscape types and spatial qualities
- Abiotic
  The soil and topography of the quarry which is constantly shaped to excavate.

2.4. RESEARCH THROUGH DESIGN. This graduation project starts with a research objective and questions. The thesis follows a design by research and research-through-design via the layers approach described earlier (Nijhuis et al, 2012).

Analyzing the landscape through the lens of a dynamic process and as a space which has unique spatial characteristics which are experiencable, can form tools to understand what makes this landscape distinctive.

The methodology follows the stages mentioned below and will be elaborated in the chapters to follow:

Stage 1: Analysis

i. Larger scale analysis to understand processes and select site for further exploration
ii. Quarry scale analysis
    - Underground layers - soil, relief
    - Landscape types and species based on natural succession and human intervened succession
    - Machine processes
iii. Landscape spatial-visual characteristics analysis: The analysis of the edge conditions and context specific conditions which can give clues into the experiential qualities of the quarry.

Stage 2: Synopsis

i. Timeline analysis and factors influencing the formation of the natural layers

ii. The machine processes can be translated into spatial typologies based on the type of activity and a priority map can be prepared
    - The age of the quarrying can be related to the landscape type and a conclusion drawn about the differences between natural succession and human intervened succession. We can also get clues about the climax conditions of forests based on different succession, which can lead to a variety of landscape types within the given area
    - The analysis of the soil and topography can give clues about not just the excavation process, but how it affects the relief of the land.

One of the main synopsis would be not just about the individual layers, but also about the relationship between them.

Finally, structure maps or conclusion maps can be drawn which give insight into the next steps with respect to a "master-plan" for the quarry along with the potential interventions.

Therefore, the design principles can be found based on the analysis of the layers and the conclusions drawn.

Stage 3: Application

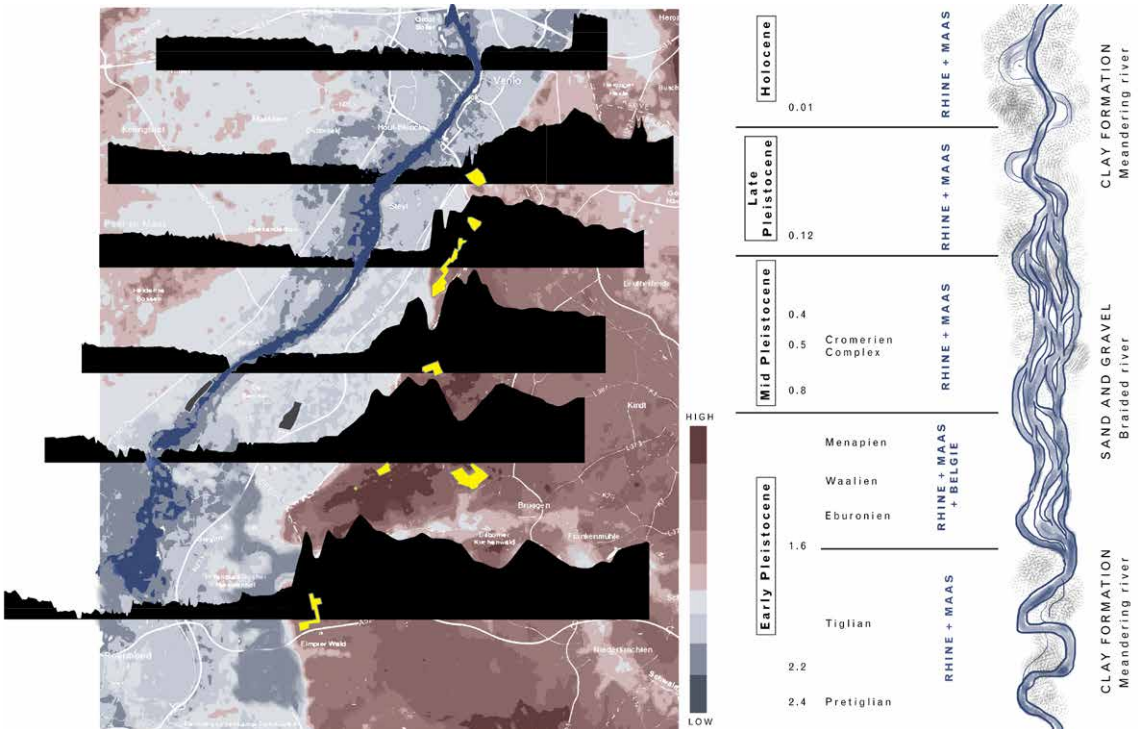
A set of design principles are arrived at based on the synopsis (conclusions) which can be tested to create design products.

Stage 5: Reflection

The learning outcomes are reflected upon, discussing whether the project results respond well to the research objective, the studio 'flowscapes', and the relationship between the research methodology and the design.

Underlying relationships
Selection of quarry
Quarry scale analysis
Potentials (Conclusions)

3 ANALYSIS



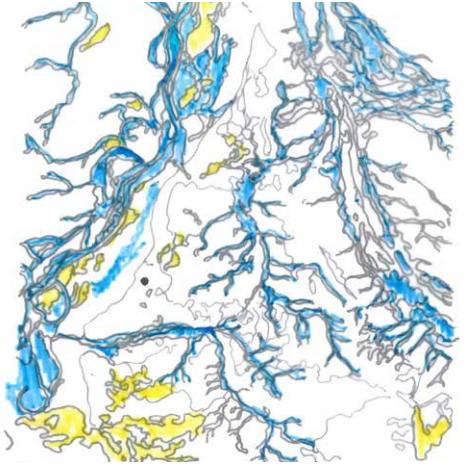
Sections overlayed on the height map in relationship to the river's changing course through time.
Height map source: *http://en-in.topographic-map.com/* - edited and drawn by author

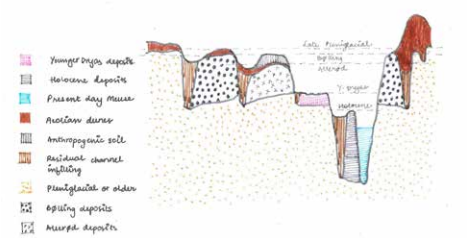
Sand, clay and gravel quarry at high terrace

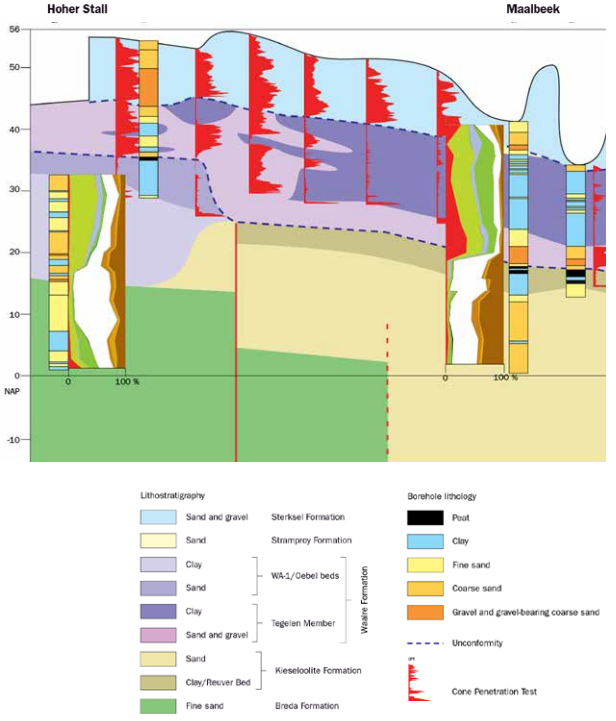
Sand, clay and gravel excavation close to the river

3.1. UNDERLYING RELATIONSHIPS. *The region selected is much higher (20-30m higher) than its adjacent river (Maas) valley. Sand, gravel and clay have been excavated from this higher region (quarries in yellow) even though in most other parts of the country, it is common to excavate close to the river where its rich sediments can be found (two dark blue excavation sites near the river).*

The answer to this is in delving into the geological formation of the high terrace and the layering of clay, sand and gravel by meandering and braiding patterns of the rivers Rhine and Maas whose courses have been changing drastically through the years. This change can be attributed to tectonic movements, human interventions and climate changes.







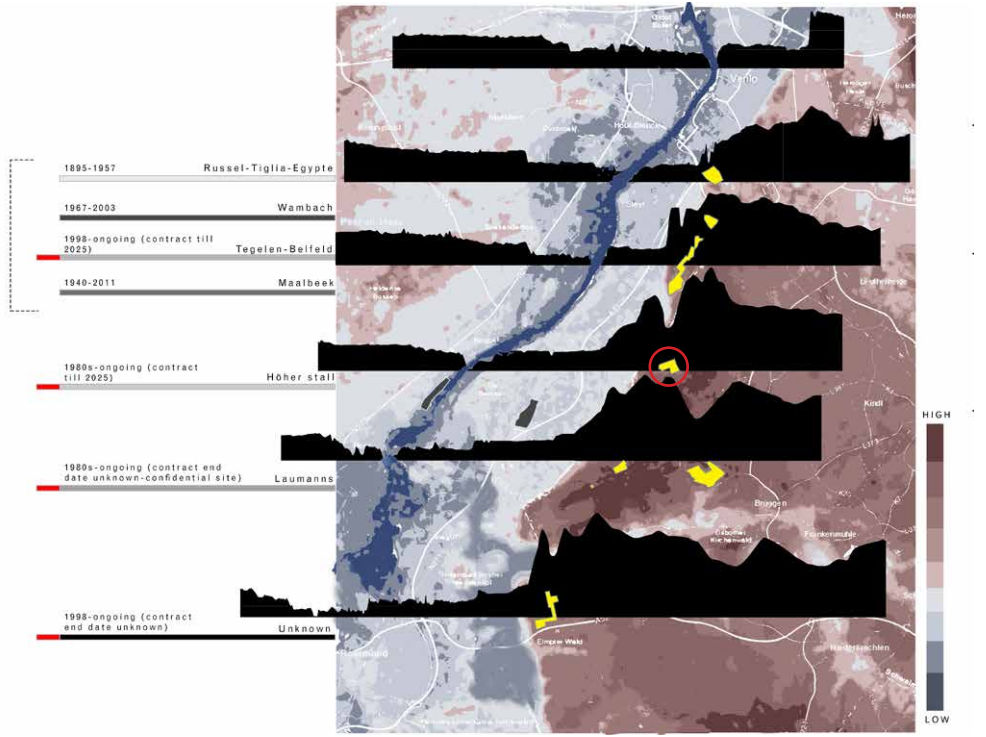
1 **Geological readings showing not only the current course of the river, but also the older arms - braiding and meandering can be seen.**
Drawing by the author using a geological map of the region

2 **River and aeolian deposits through the pleniglacial, bolling-allerod, younger-dryas and holocene periods.**
Retrieved from: *Tebbens, Leonardus. (1999). Late quaternary evolution of the meuse fluvial system and its sediment composition*

3 **Uncovering the cross-section and the longitudinal section through quarries of this region. This shows the various layers of the earth as one digs deeper - of clay, sand, gravel, or even peat.**
Retrieved from: *Westerhoff, Wim. (2009). Stratigraphy and sedimentary evolution. The lower Rhine-Meuse system during the late Pliocene and Early Pleistocene. pg.41*

3.1.1. GEOLOGICAL FORMATIONS. In general, quarry sites can be best understood through a geological reading of the site which makes the relationship between the horizontal and the vertical section clear.

In this case, the braiding and meandering river and its tributaries can be seen close to the high terrace. In conjunction with this, the section showing the river depositions during different climatic periods and the bore-hole readings at the quarry sites establishes the relationships. Hence, showing a case of geological reading forming a basis for landscape analysis for quarry sites.



Left: Age of quarries
Height map source: *http://en-in.topographic-map.com/* - edited and drawn by author

Sand, clay and gravel quarry at high terrace

Sand, clay and gravel excavation close to the river

Quarry chosen for research

Right: Aerial image of the quarry chosen, marking the boundaries of past, present and future excavation (till 2040)
Image source: *Google earth*

3.2. SELECTION OF QUARRY. The selection of the quarry to further explore for the research objective is based on the following:
- The age of the quarrying: *the quarry selected is one where the effects of previous excavation can be witnessed in phases, and one where excavation will continue till 2025.*
- The information obtained and level of access into the quarry for the sake of procuring initial information: *some of the areas were locked off and highly confidential, however the quarry chosen finally was possible to explore.*
- existence of functions close to the quarry which might have restricted free exploration for the sake of the thesis project: *one of the excavation sites, though older, has a holiday village and a cafe which forms the start point for a biking/hiking route in the region. The quarry selected however is free of such functions in its immediate vicinity.*

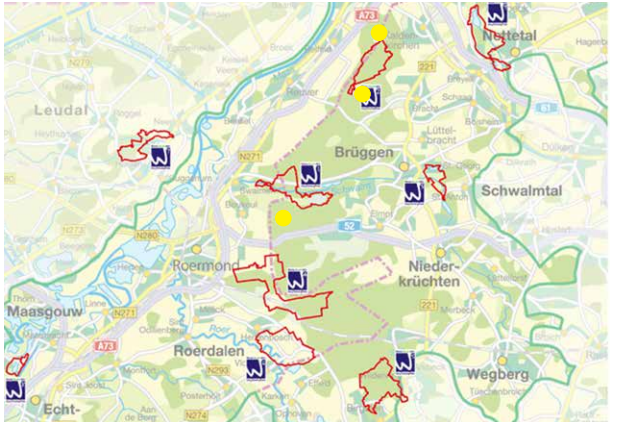

Future expansion
of excavation
boundaries
Current excavation
Past excavation area
which has now been
planted with pine trees
(monoculture for eco-
nomic purposes)
Höher stall quarry

3.3. SITE REGION BACKGROUND. The larger site carries the function of being a production landscape (agriculture and timber) since the 1800s (as far as the information is found through www.*topotijdreis.nl*). Today, the region is a nature preservation area, spotted with various hiking/nature trails which is mainly a mono-culture of pine varieties. The entire zone (Maas to Nette) consisting of brook landscapes, river landscapes, grasslands, and pine forests is maintained to give the visitor a wholesome experience.

Multiple *natuur* organizations (such as the vvmiddenlimburg, and the naturparkschwalm-nette) are in-charge of the preservation of the nature areas related to the rivers Maas, Schwalm and Nette, and also integrate walking/biking/hiking routes.

The area's location being close to the border between the Netherlands and Germany brings in visitors from both the countries. Residents of the towns and villages lining the area use it for exercising and leisure such as horse riding, or bird watching. Visitors from all over the countries visit the region for its vivid variety in ecology and beauty.

The area is also excavated for its rich availability of sand, gravel and clay. These quarries appear at the edge of some of the routes, but are fenced and lack information about the activities taking place. The area after reclamation is also mainly covered up, stripped of its qualities and returned to a mono-cultured site to be used for economic purposes.



Left: Some quarries marked along or near the hiking routes in the Maas-Schwalm-Nette region.
Image source: http://www.wa-wa-we.eu/nl/start.html

Active quarries along or near hiking trails.

1,2,3: Historical maps of the region indicating agricultural lands and forests for timber 1900, 1997 and 2017
Map source: *www.topotijdreis.nl*

4,5: Results of mono-culture in the region- pine varieties.
1. A walk through young pines
2. Rows of pines planted in a mass
Image source: *Author*


Bracht
Alst
Borholz
1


Kessel
Reuver
Bracht
Alst
Beesel
Meerlebroek
2


N273
N277
A73
B 221
Kessel
Reuver
Bracht
Alst
3


4

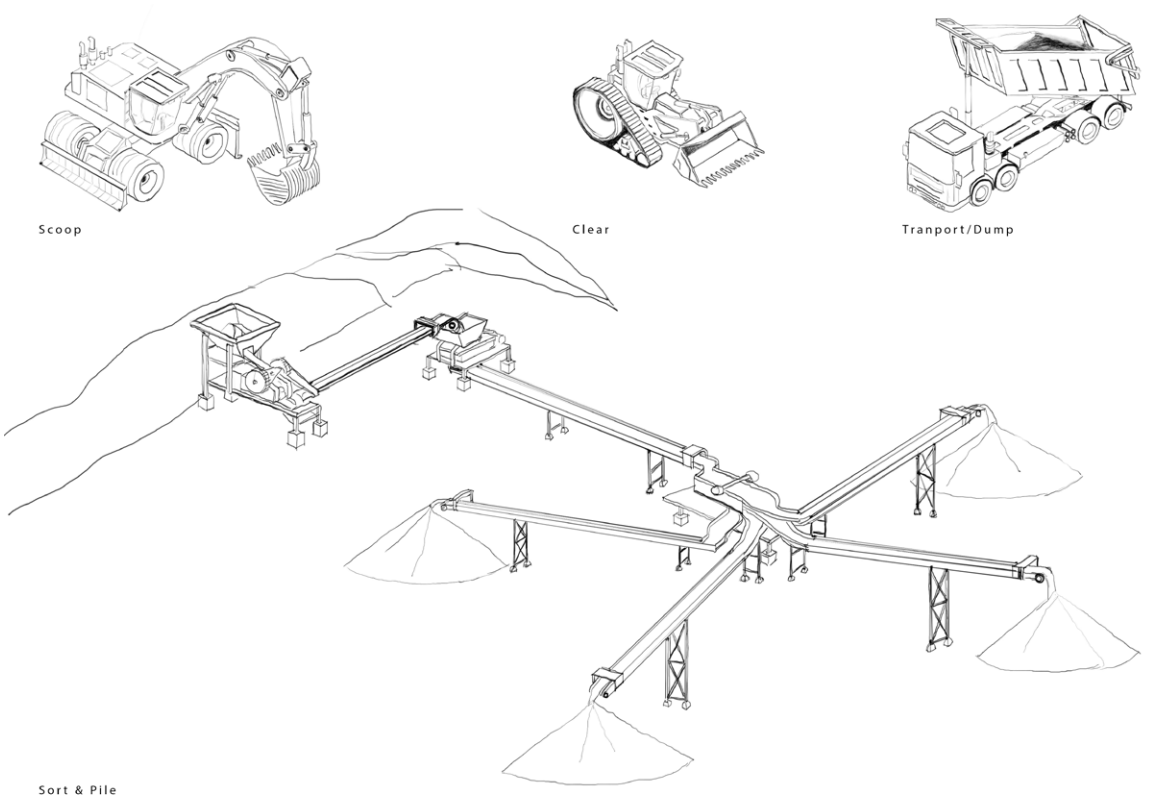

5

A sand/gravel sorting machine (surprisingly still in use though it looks like it is old)
Image source: Author

ANTHROPOGENIC BIOTIC ABIOTIC

SMALL SCALE ANALYSIS. *In the upcoming pages, the quarry will be analyzed based on its anthropogenic, biotic and abiotic characteristics. Most landscapes can be decomposed into their "underground" layer, "surface" layer and the "human-imposed" layers. Here, the three come together and hence the methodology is to analyze the quarry on the machine-based implications, the vegetative layer, and the soil/morphology layer.*

3.4. ANTHROPOGENIC. *The machines are the primary organizing devices, based on which the quarry and its spaces are formed. Therefore, the excavation process and the spaces formed thereof will be analyzed in the next few pages.*



Sand/clay excavation machinery widely classified into four categories based on their functions
Image source: Author

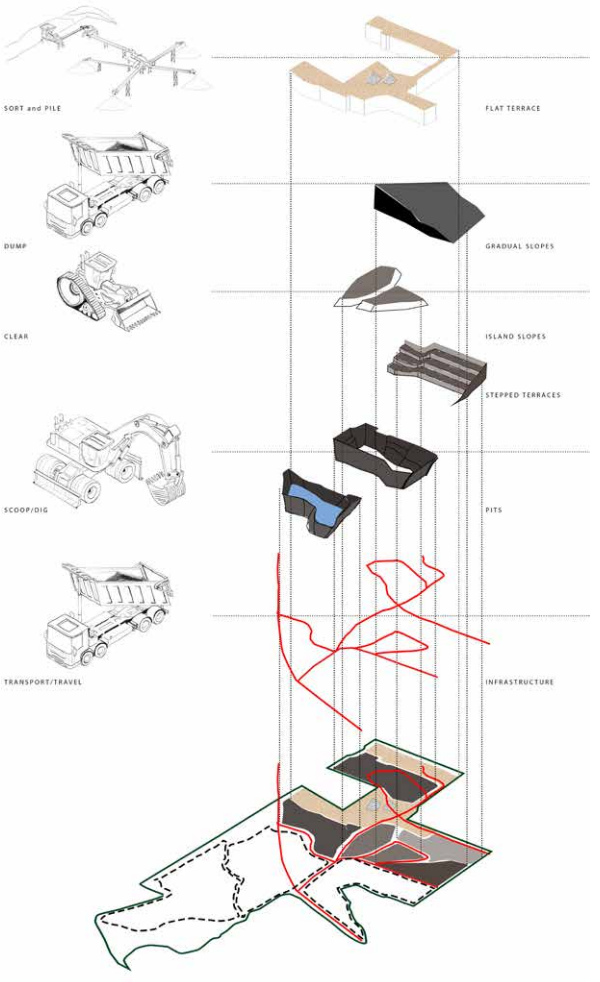
3.4.1. EXCAVATION MACHINERY. The overarching elements of the quarry are the above machines which can be found in varying size ranges, but essentially have the functions of *scooping/digging*, *clearing*, *transporting/dumping*, and *sorting/piling*.

To clearly understand the excavation process, from start to end, it is mandatory to uncover the functions of the machines that govern it. One can bear in mind that the above is specific to sand/clay excavation in an area where the ground is soft to dig. The machines involved would vary slightly to include blasters, or burrowing equipment.

3.4.2. DECOMPOSITION OF THE EXCAVATION PROCESS. *On visiting the quarry which still has on-going excavation, the spaces created by the machines can be witnessed. They can divided into the infrastructure layer (pathways of the machines while excavating), the stepped terraces, the island slopes or mounds, the gentle slopes on the edges of the quarry, the flat terrace used for sorting the material, and finally the deeper pits which are a result of extensive digging over a long period of time.*

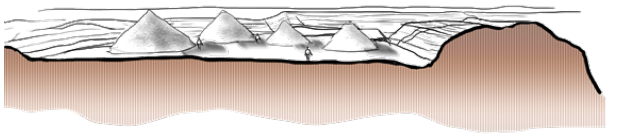
A problem initially stated in the beginning of the research is that quarries in general are only analyzed on completion of the excavation. The analysis of the quarries in the end yields results which help in the transformation of a reclaimed space. My study is focused on the transformation of the space through the "construction of the quarry".

This sort of decomposition helps to understand the true characteristic spaces in a quarry with such materials, and hence can guide the process of maintaining the spatial qualities of the space even on completion.

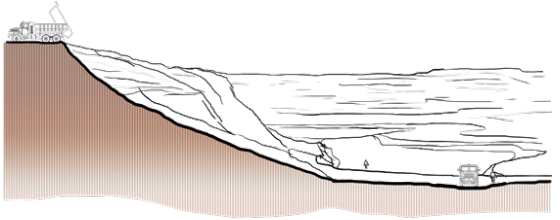


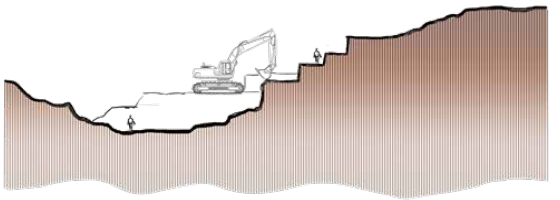
Spatial typologies of a sand/clay quarry during the process of excavation governed by the machines
Image source: Author

3.4.3. CHARACTERISTIC QUARRY SPACES. The following series of images are examples of the typical spaces created by machines during the excavation process. They are unique to excavation landscapes (especially sand, clay and gravel) and retaining some of them or all of them will distinguish an excavation landscape from others.



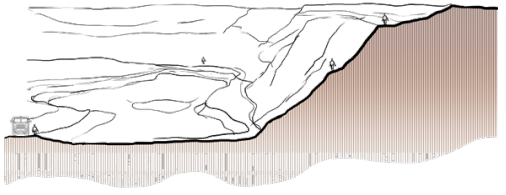
Flat terrace where the washing, sorting and temporary storage of sand and gravel takes place.
Image source: Author

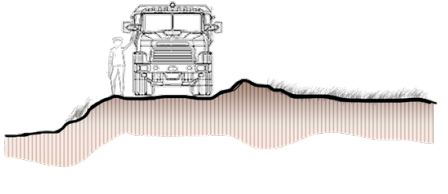




Left. Slopes formed due to dumping of unused material or due to clearing material to make way for machines

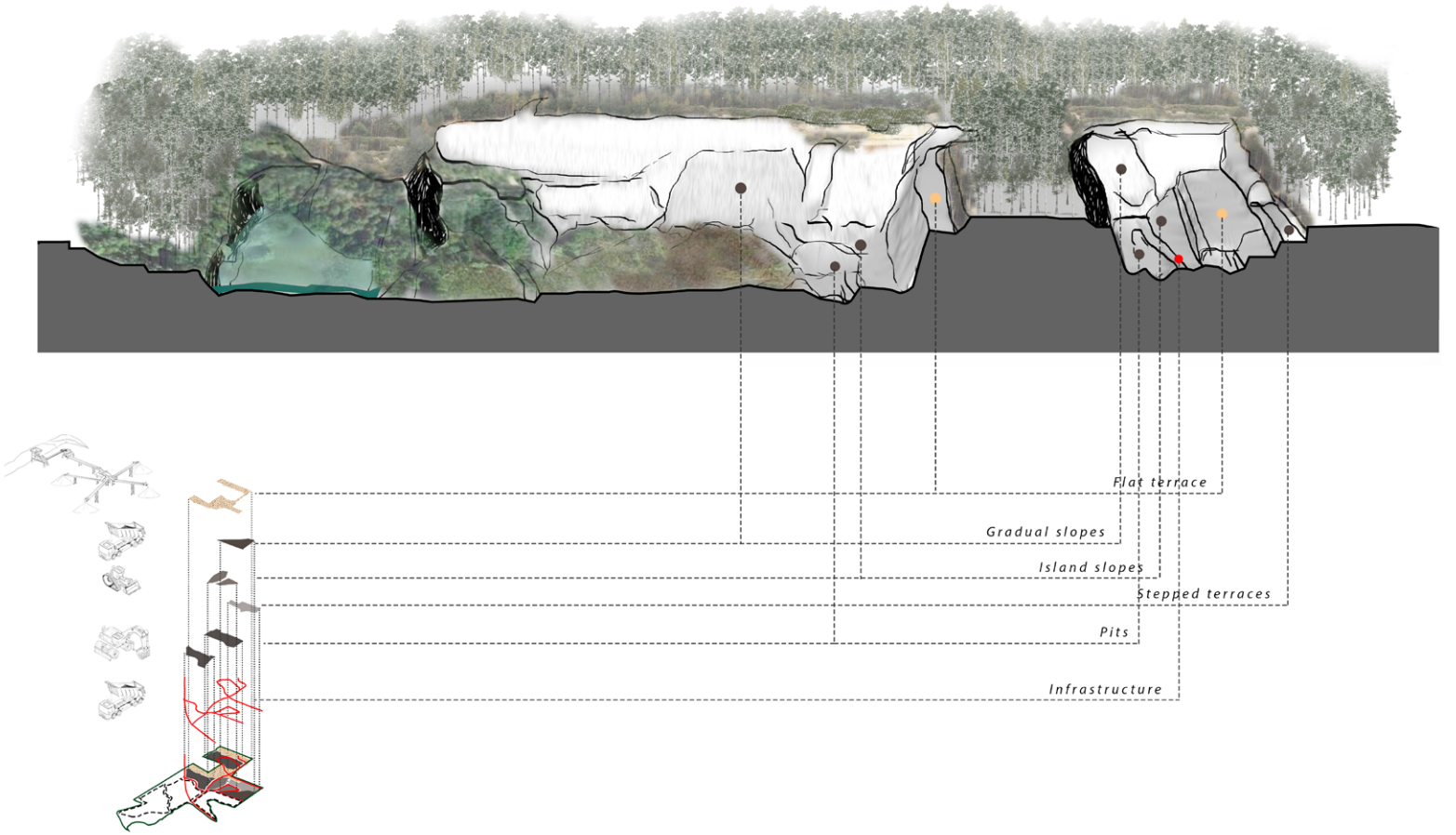
Right. Stepped terraces are the way to excavate to avoid sudden erosion of the edges and caving in of material.
Image source: Author

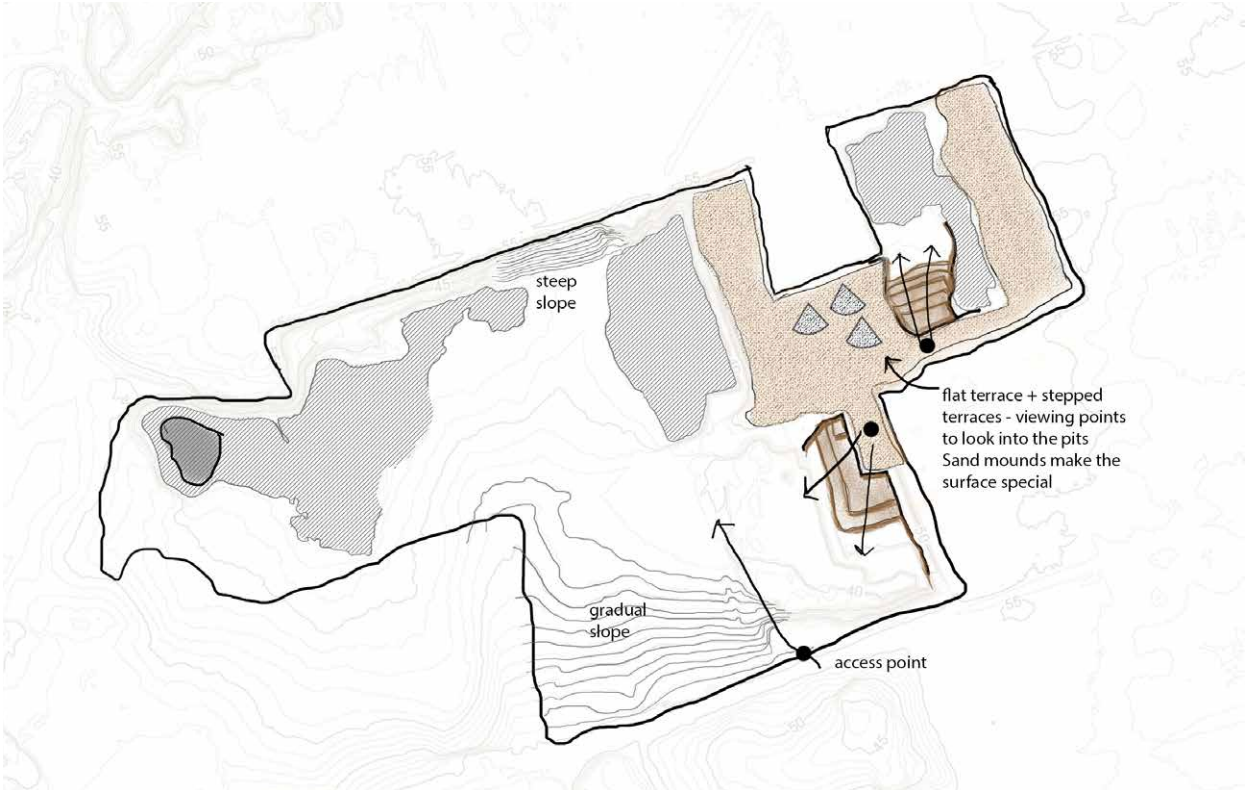




Left. Pits can be perceived from different points in the quarry at different scales. The entire quarry itself is also a large pit, but consisting of multiple smaller ones forming scalable spaces.

Right. The pathways which are created by machines are the link to all the spaces, and form the basic underlayer to the quarry spaces.
Image source: Author


Flat terrace
Gradual slopes
Island slopes
Stepped terraces
Pits
Infrastructure



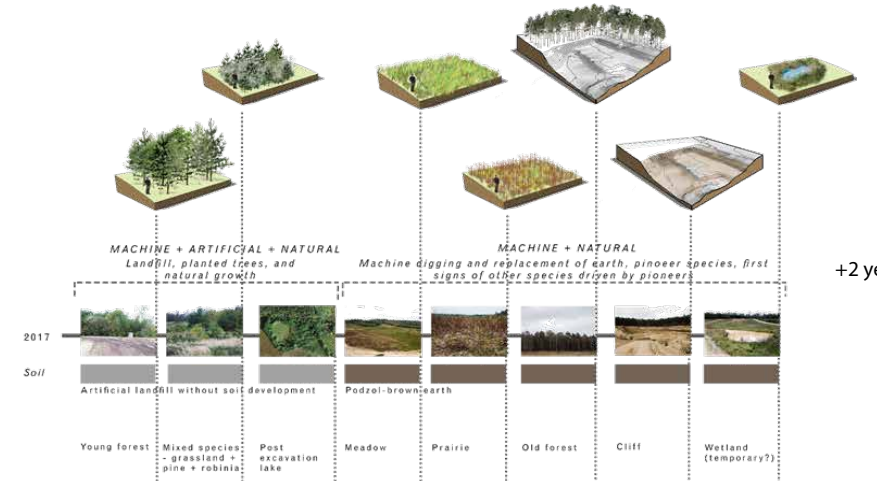
3.4.4. CONCLUSION. *All the different kinds of spatial qualities in a quarry make it a unique space. The part of the quarry where the excavation is complete lacks all these spatial variations that exist during the process of excavation, and make it seem more like any other space rather than a special excavation landscape.*

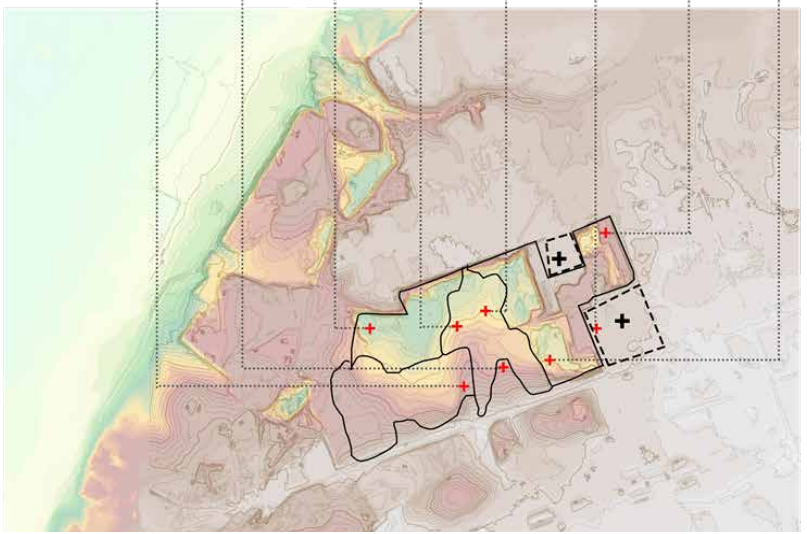
Left. The various landscape ecotones in the quarry during and post-excavation
Image source: Author

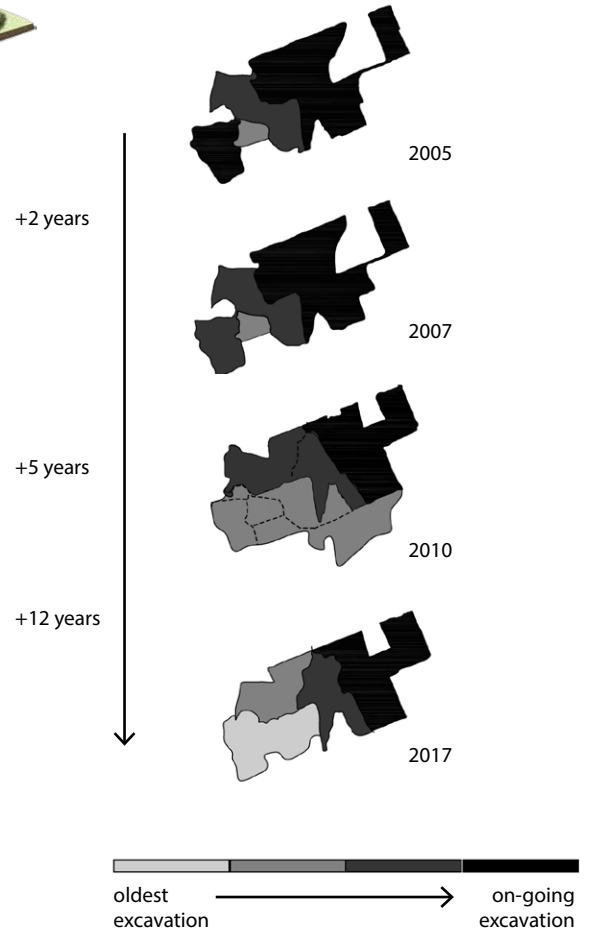
Right. The various landscape ecotones in the quarry and their relationship to the timeline of quarrying

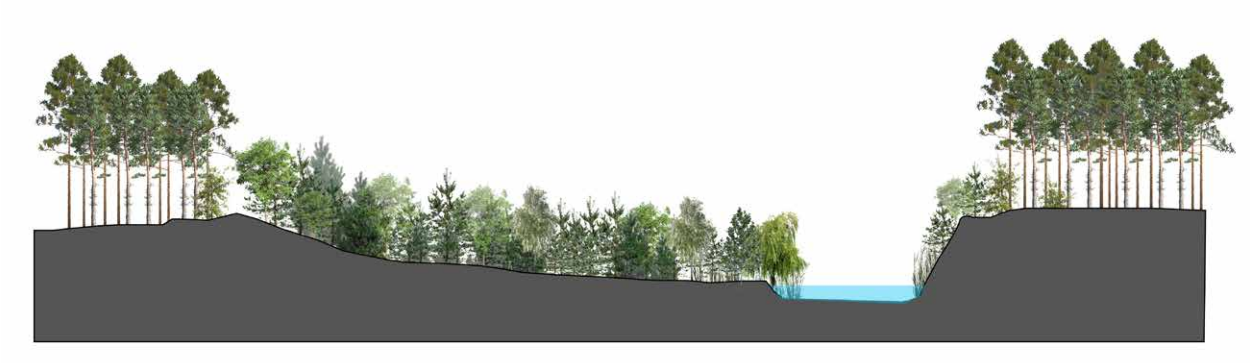
3.5. LANDSCAPE TYPES. *The quarry is home is many landscape types or eco-tones due to the excavation and different rates of completion of excavation. Starting from the bare soil with no vegetation to forest which is 50 years old, one can witness the contrast in the horizontal as well as the vertical direction.*

On superimposing the landscape types on the quarry site, one can witness that there is a correlation between the time of completion of quarrying and the age of the vegetation, which subsequently creates the contrasts. Therefore, a play can be created by regulating the duration of excavation in the areas yet to be dug up.


MACHINE + ARTIFICIAL + NATURAL
Landfill, planted trees, and natural growth
MACHINE + NATURAL
Machine digging and replacement of earth, pioneer species, first signs of other species driven by pioneers
2017
Soil
Artificial landfill without soil development
Podzol-brown earth
Young forest
Mixed species - grassland + pine + robinia
Post excavation lake
Meadow
Prairie
Old forest
Cliff
Wetland (temporary?)




+2 years
+5 years
+12 years
2005
2007
2010
2017
oldest excavation
on-going excavation



Left: An exaggerated section showing the existing condition of vegetation on the site.
Image source: Author

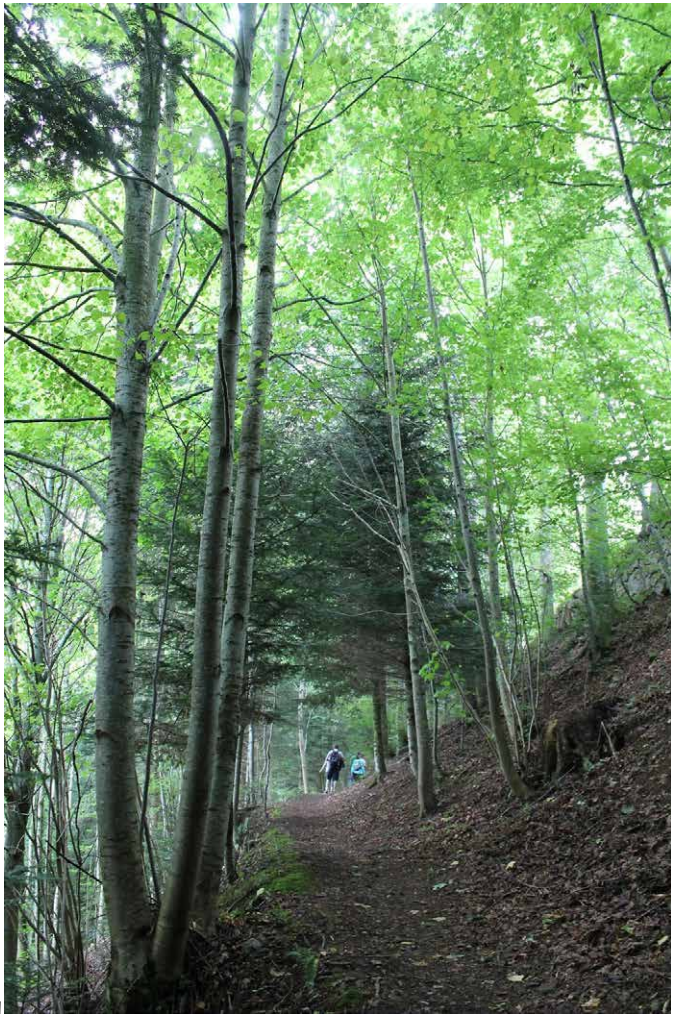
Right
1. The light atmosphere of a birch-pine forest.
Image source: Author
2,3. Beech-oak forest atmospheres with heavy shading.
Image source: http://www.bernardvanelegem.com/category/forests

[1,2] *http://www.psu.edu/dept/nkbiology/naturetrail/succession.htm*

3.5.1. EXISTING CONDITIONS. *The detailed vegetation map (on the right) of the region (Data found for the Netherlands region) gave the first indication of the fact that the natural vegetation found in this part of the country is primarily a Fagus-Quercetum forest or a beech-oak forest. On examining the site area, it is evident that the forest is actually dominated by pine varieties. This is not the naturally occurring phenomenon. What is seen as a natural forest, is actually heavily human influenced for his own needs.*

Closer examination of the vegetation (by collection of some leaf samples) shows that there are young oaks, beeches, birches, robinia among the pine species. However, the planting of the pine varieties disrupts the natural ecological succession. 'Ecological succession' is the observed process of change in the species structure of an ecological community over time.[1] If humans did not interfere by cutting down the trees for timber, or by removing the nutrients/moisture developed in the soil by excavation, then the low-lying oak-beech family which is shade resistant would eventually take over the pine family, resulting in a 'climax' forest after roughly 150 years. However, the constant disruption of the natural environment by man, along with planting of pine species which does not belong to the area does not allow for the natural succession to take place. "This energy input (by man) is directly proportional to the "energy" inherent in the force of ecological succession."[2]

A quarry is essentially a clean slate for the natural ecology to thrive, and this potential of the quarry landscape must be utilized instead of man "wasting" his energy in maintaining another piece of land for his own benefits. These spaces have the potential of fostering a unique ecological community (i.e., flora and fauna).



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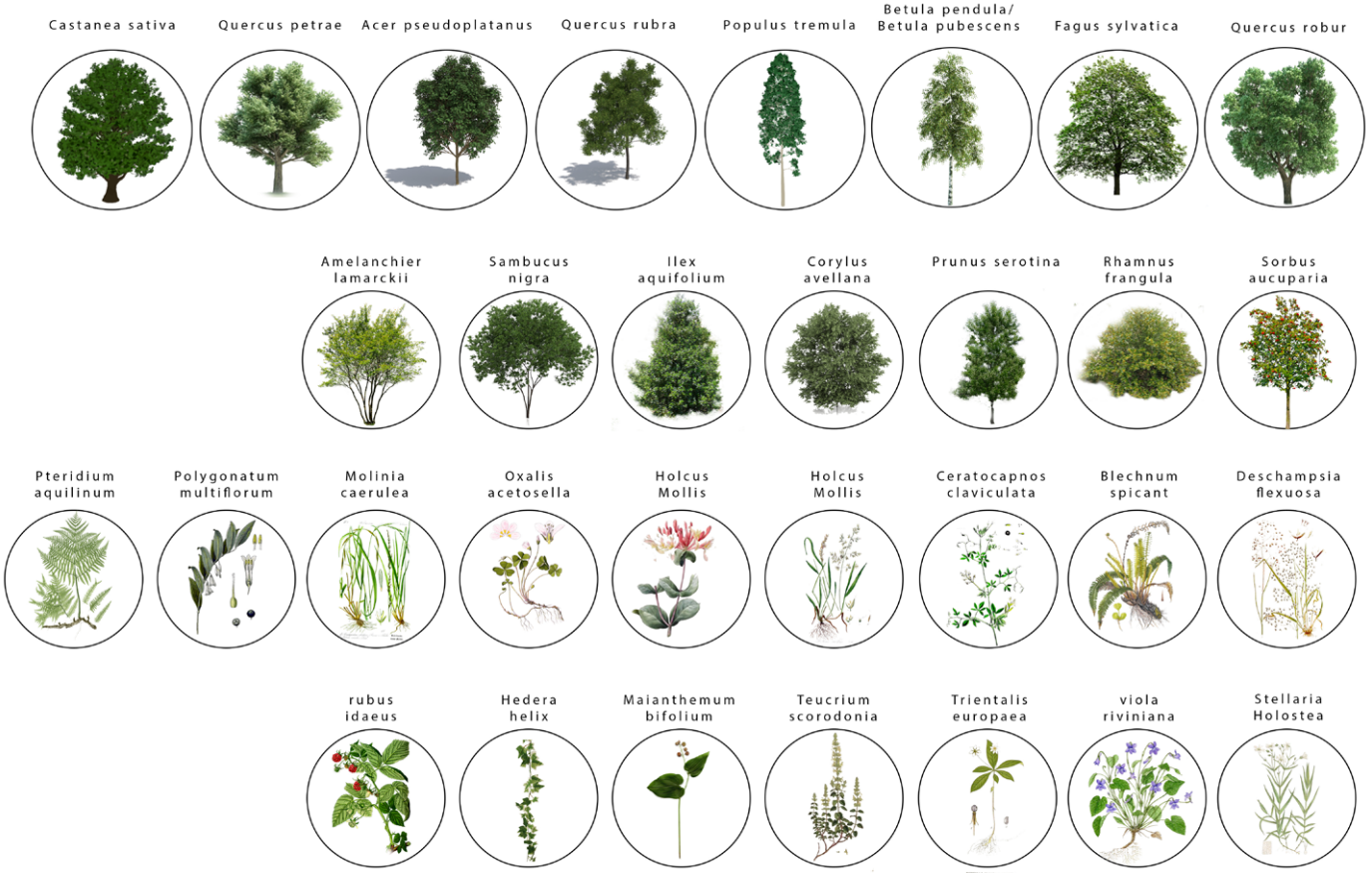
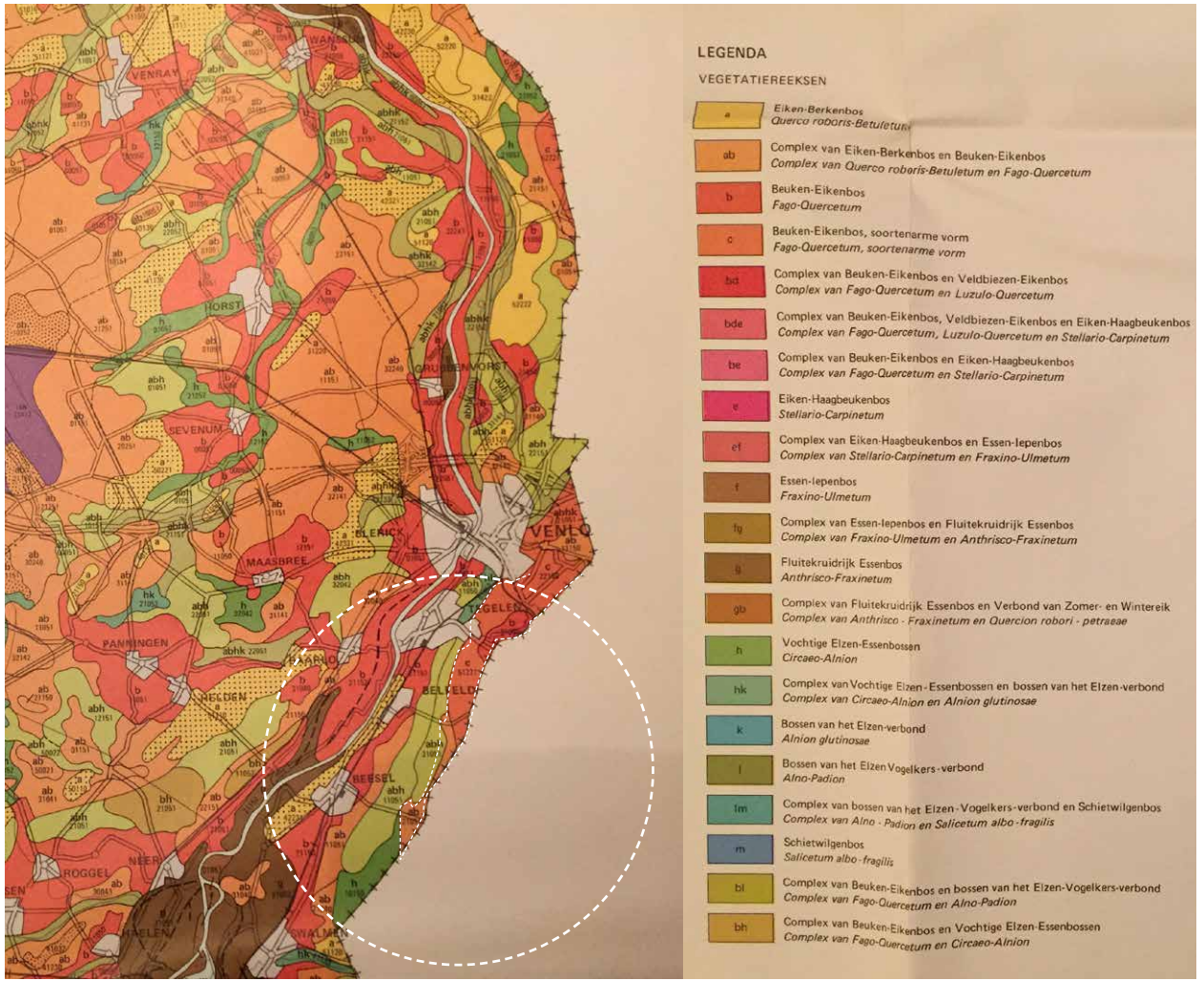
2

3



3.5.2. CLIMAX COMMUNITY. *A climax community is an ecological concept where a set of species best suited to the region (considering soil, water, climatic conditions) have reached a stable state. These species form a family with two main species being the dominant ones, in this case, Quercus-Fagus (Oak-beech). Though it is termed as a 'climax' state, natural or man-made disruptions (floods, forest fires, clearing for agriculture, etc)can cause the ecological succession to restart its cycle.*



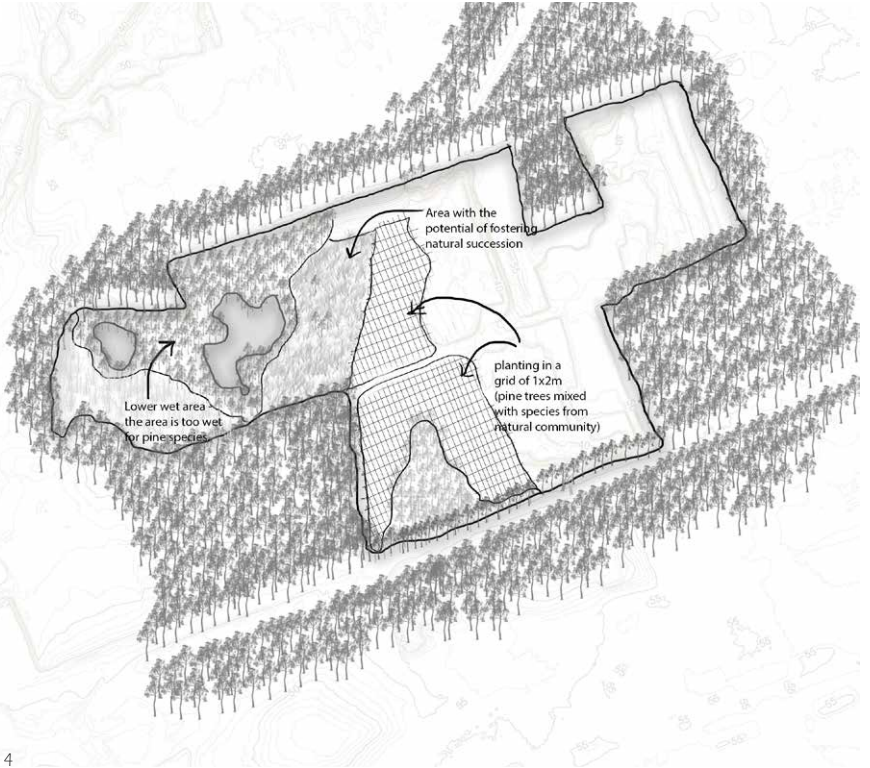
Left. Quercus-Fagus plant community

Right. The vegetation types map for eastern Netherlands.

1

2

3



4

1. View of the wet area which carries its own unique ecology

2. View of the grid plantation which will lead to mono-culture

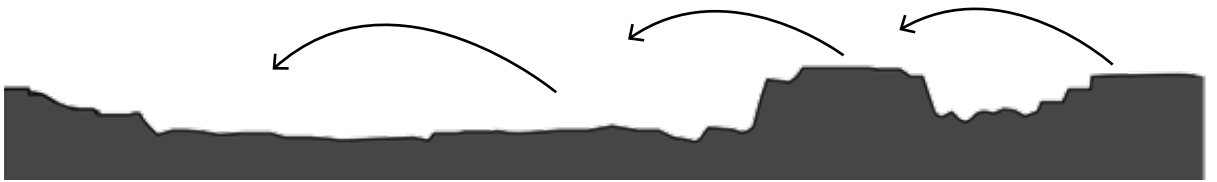
3. View of the young pine forest dotted with few other species fighting for their place in their natural conditions.

(In all the images, due to them being taken in the winter, one can witness the clear presence of evergreen communities, which are not natural to this part of the country.)

4. Conclusion map - biotic features of the site
Image sources: *Author*

3.5.3. CONCLUSION. *The quarry is a space where the natural underlayers of the soil gets exposed after the removal of many upper layers. The vegetation would depend on the soil below, but we witness that there is mono-culture in the part of the quarry where excavation is complete. The planting of pine in rows is a clear indication of this.*

This implies that man has a big role to play in the biotic characteristics of the quarry and that he is going against natural ecological succession. Even though the lower parts of the quarry tend to stay wet, the cutting of birch trees in the area has increased the elevation causing further growth of pine community in a space where wet ecology can be promoted..



1. Podsol soil earth profile.
Image source: *https://www.britannica.com/science/Podzol*

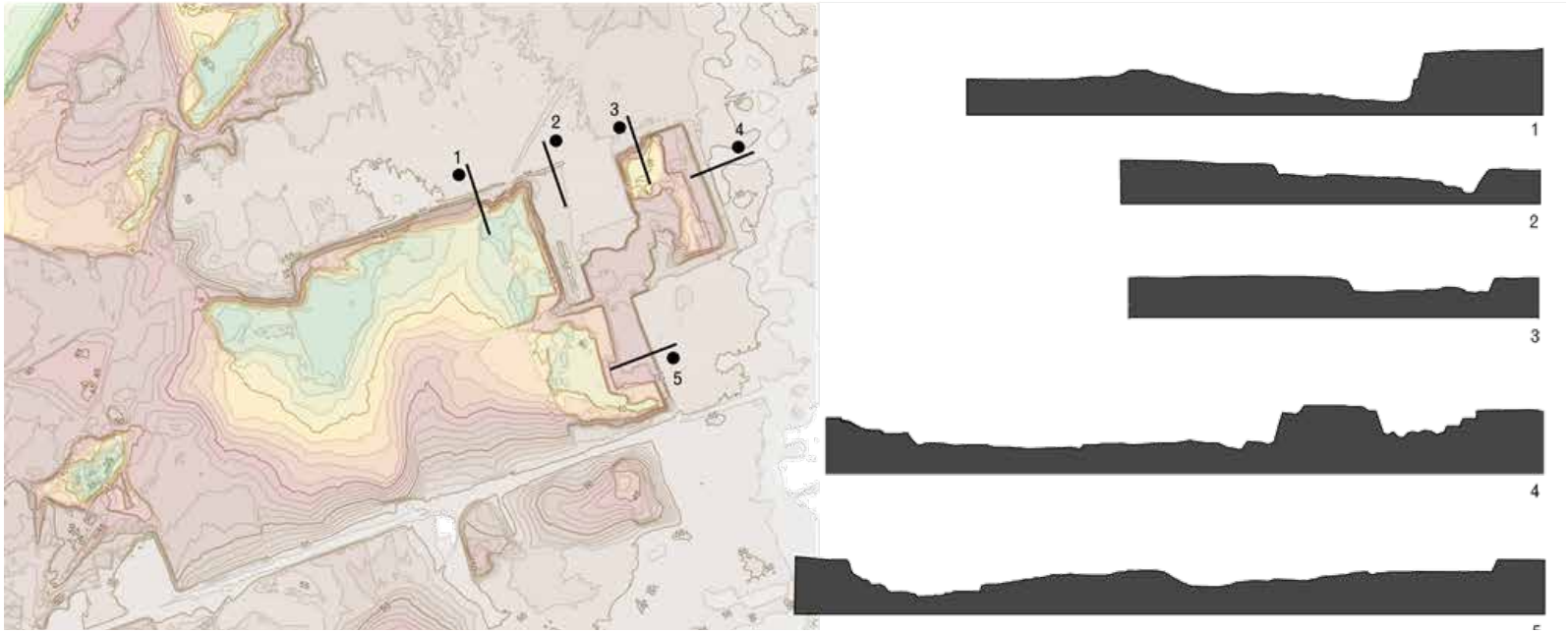
2. Initial condition of area before excavation began.

3. The area is excavated

4. The topsoil and unused material from previous excavated area is moved to create a gradual slope and terrain suitable for pine plantings

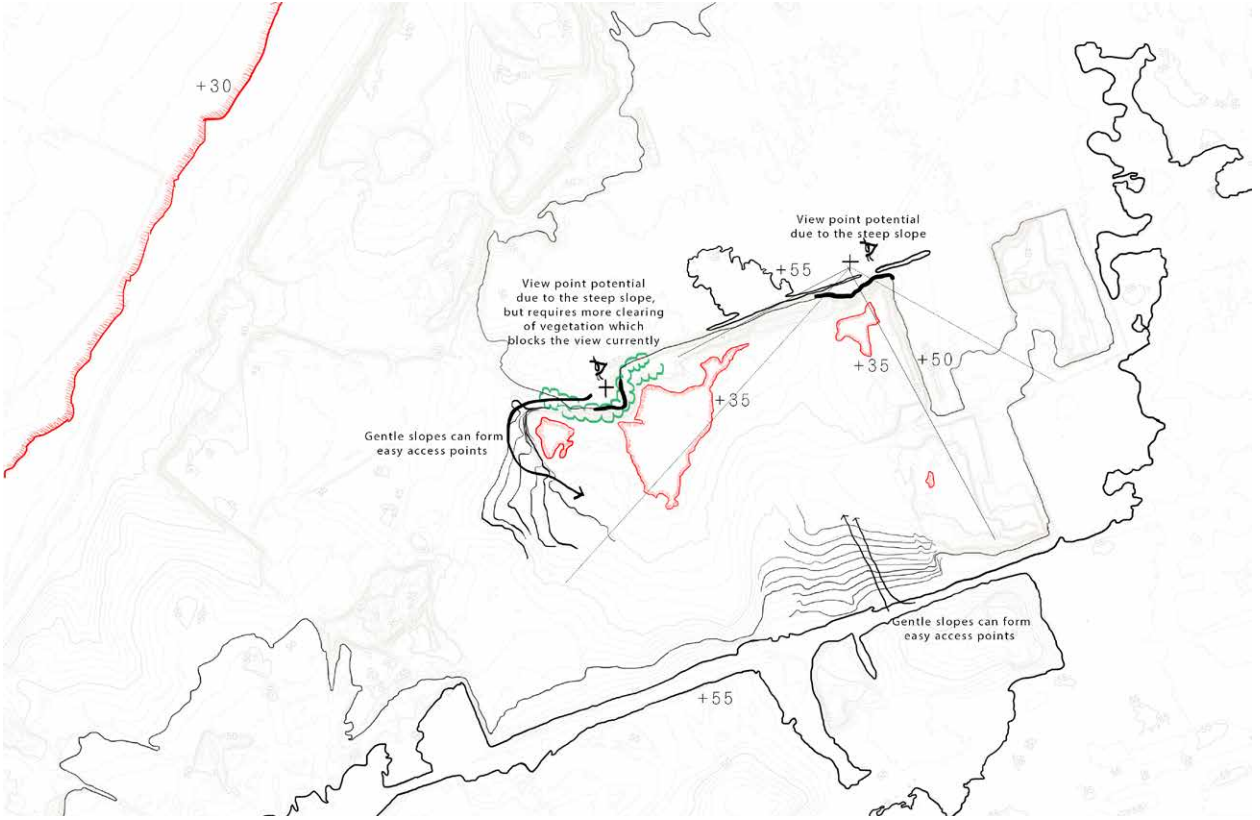
5,6. This moving of soil continues as the excavation moved forward continuously taking away the characteristics of the quarry.

3.6. MOVING OF SOIL. *Podzol soil is an infertile acidic soil type. It gets its striking layering because the mineral from the top layers are washed away by rainwater and the constant leeching of minerals gave the under-layer an ash-like colour. This podzol layer is constantly moved around to obtain the sand, clay and gravel from under it. Due to its infertile nature, alternative uses are employed such as forest planting, heathland or nature reserve. However, there is a possibility to use this moved soil for purposes other than just to return the area to its original use (forest planting for economic purposes in this case)*



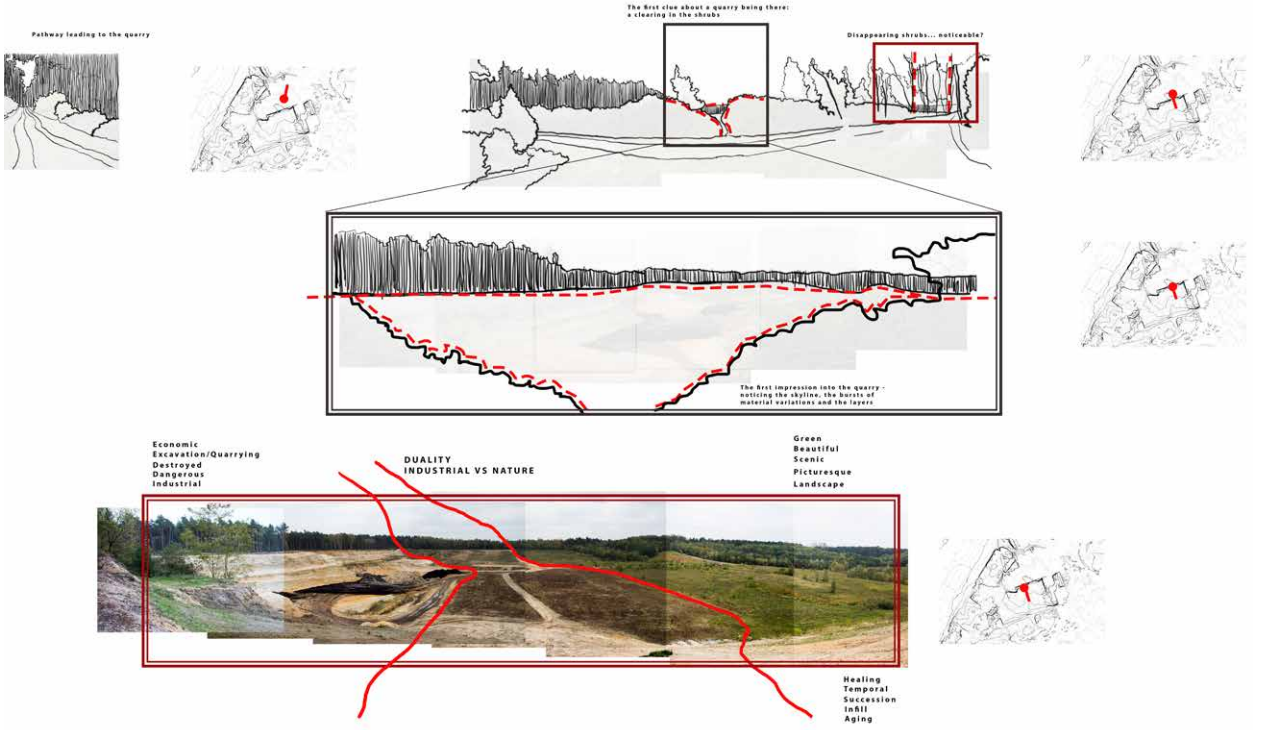
3.7. TOPOGRAPHY. *The quarry offers the range of height differences that most other spaces don't. Especially in a flat country like the Netherlands where the landscape doesn't offer much in the vertical direction, the excavation areas are a blessing.*

They are primarily inward oriented spaces which have unique spatial characteristics as described in the initial analysis. Therefore, working with them and not covering them up would be the best way to showcase and educate visitors about the processes of quarrying.



3.7.1. CONCLUSION. *The different parts of the quarry where the excavation is completed or very close to completion can be used for viewpoints, and to enter into the space. Typically, the highest points with steep slopes can be used for viewing considering that the vegetation is allowing for this.*

The lowest points (if low enough to reach a zone of saturation) will be capable of becoming water bodies and spaces from where the depth of the quarry can be experienced. Though the steep slopes can be used for dramatic entrance points, the gentle slopes provide disabled access.



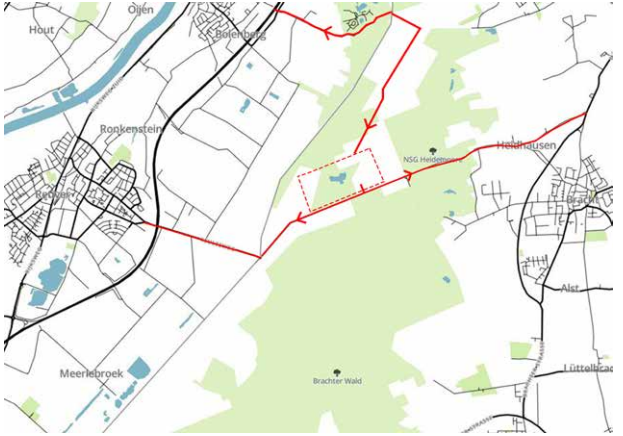
3.8. THE APPROACH. *The drama of the walk or bike ride leading up to the quarry is integrative in the experience of the quarry itself. One progresses from a relatively dark, narrow path to the edge of the quarry which forms the threshold between the closed and the vast open. The edge forms a brief window into the large space.*

The nature of the first view into the quarry is dependent on the phase of quarrying. It is to note that the view of the quarry while still on-going is impressive due to its dual qualities of industrial versus nature. One could argue that this is one of the most important features of the quarry and question to what extent must nature be allowed to take over.

3.9. QUARRY AS A THOROUGH ROUTE. *The quarry's location close to the border between the Netherlands and Germany creates opportunities for connections. The quarry is along the route between the two sides, and people passing by could take the opportunity to get a glimpse into the excavation landscape. The visitors biking or walking will especially get the experience of the viewpoint, even if they do not walk into the space.*

For the routing inside the quarry, the multiple access points are made use of. A feature of the quarry spaces is that once quarrying begins, more often than not, more than one entry/exit route is planned. These access and exit points keep changing as the excavation moves, so that the previous area can be transformed.

In the case of this quarry, the initial routes are almost disappearing, due to nature taking over the spaces, but on closer examination, one can still find these pathways. With this understanding of entry/exit points, the quarry can become a thorough fare - a shortcut for visitors through changing topographies and ecological conditions. Not only can the existing routes be used, but future ones can be planned to get integrated into the spaces as well.



1. Location of the quarry with respect to its larger context - Access from Dutch and German towns.

2. Various access points of the quarry - old and new.
Image source: Mapbox.com; edited by the author.

Agricultural structure of the historical area
Image source: Mapbox.com; edited by the author.

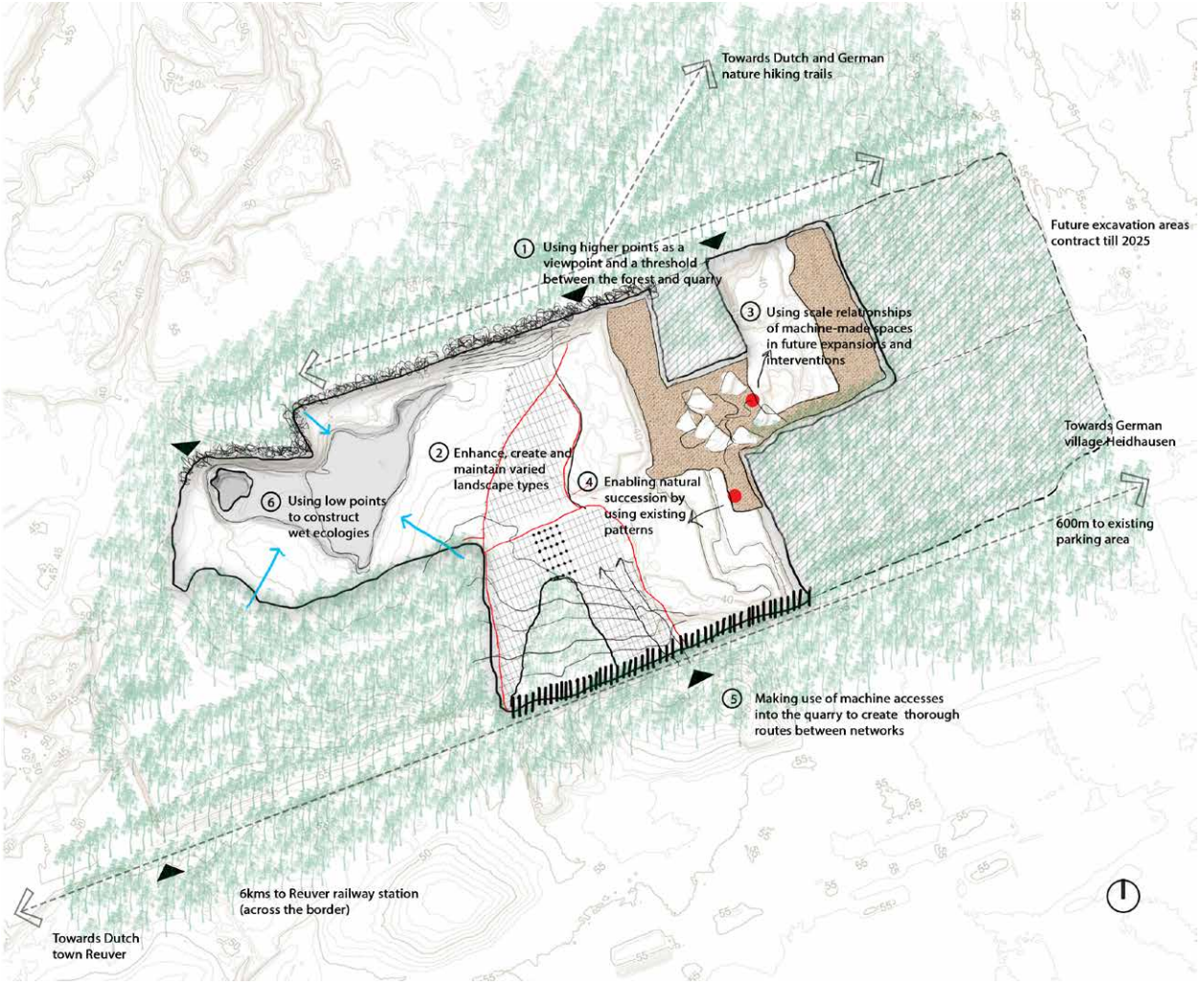
3.10. HISTORICAL RELATIONSHIPS. Looking at the historical map from the 1900s reveals the old agricultural patterns in the area, and the structure of these plots can be roughly noticed in the excavation pattern as well.

It perhaps has to do with the ownership, but it is interesting to note how the spaces of the quarry even after the completion of excavation can be related to the old structure. This structure can be used as a base for future excavation scale relationships. Though this structure forms the basis for organization in the horizontal direction, the vertical direction must also be addressed, and this is something that will be explored in a part of the upcoming research.

3.11. POTENTIALS AND CHALLENGES. Based on all the previous analysis, some final synopsis can be drawn, based on which the principles for the design can be arrived at.

The general conclusion is that the part where the excavation is complete lacks the characteristics of a typical quarry landscape. The vegetation on site helps to identify different sections of the quarry based on when the excavation was completed, and the variations this creates is unique since various scales can be experience in a small area. All the height differences within the quarry enable one to use the lower areas to create wet ecosystems and the higher ones as potential viewpoints to enjoy the sublime view of the pit.

These excavation takes place for economic purposes and after completion of the excavation, is once again returned to the forest plantation which is for economic purposes. Based on the analysis we can conclude that the site has characteristics which can be enhanced to be perceived as a scenic experientiable landscape while also reminding one about the economic activities that take place.


Towards Dutch and German nature hiking trails
Future excavation areas contract till 2025
1 Using higher points as a viewpoint and a threshold between the forest and quarry
3 Using scale relationships of machine-made spaces in future expansions and interventions
Towards German village Heidhausen
2 Enhance, create and maintain varied landscape types
4 Enabling natural succession by using existing patterns
6 Using low points to construct wet ecologies
600m to existing parking area
5 Making use of machine accesses into the quarry to create thorough routes between networks
6kms to Reuver railway station (across the border)
Towards Dutch town Reuver

4 DESIGN PRINCIPLES

DESIGN PRINCIPLES. *The purpose of the analysis of the machine dominated processes which influence the ecological conditions as well as the spatial conditions through experiential means is to ultimately derive design principles which could be used for excavation landscapes.*

The following principles are based on the understanding of interrelations between the various layers - The material to be quarried out is first and foremost instrumental in the processes that follow it. For example, a stone quarry's morphology and ecological condition varies widely compared to a sand or limestone one. Though an attempt is made to generalize the principles as much as possible, one must be aware that not all can apply to any type of excavation site. It is also important to note that the state in which the quarry is found widely drives the design process. In this case, a quarry where some parts are completely excavated and some are yet to be excavated created the opportunity to plan for the transformation of the area completed and also plan for the future. In the reflection part of the report, we can learn a bit more about which principles can be applied to which conditions. The design principles are as follows:

4.1. Creation of wet ecosystems through *Water Gravitas*
Use the understanding of topography and material in the quarry to create wet ecological conditions and spatial experiences around water as the focal point.

4.2. Using *Unused materials*
Make use of unused materials such as the top-soil and cut timber in or around the quarry to create spaces for enhanced kinesthetic experiences or to modulate thresholds.

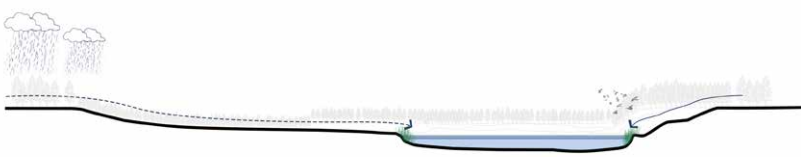
4.3. Ensure balance between *Machine scale & Human scale*
Ensure that the machine-made spaces in a quarry also fit the human scale by using the spatial typologies unique to (similar such) excavation spaces.

4.4. Employ *Natural succession*
Use the potential of the quarry being a "clean slate" to foster natural ecological systems. Using minimal interventions in the already planted areas, natural ecological succession can be employed.

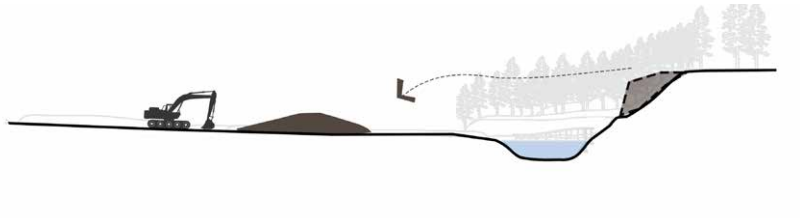
4.5. Recall the *Organizational backbones* and make use of *Past routes*
The history of the site could be recalled in many ways based on the significance of it. In this case, the characteristic organizational structure of the old agricultural pattern and the routes previously used for quarrying are used.

4.6. Employ *Program which is site-specific (to ensure economic viability)*
It often happens that such sites require a program overlay to ensure usage of the site. However, one must note that turning such a site into an area of ecological importance is also a program which can be considered. Not all quarries can be converted into spaces usable by man.

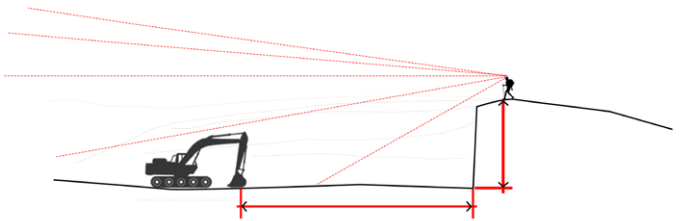
4.1. Water gravitas



4.2. Unused materials

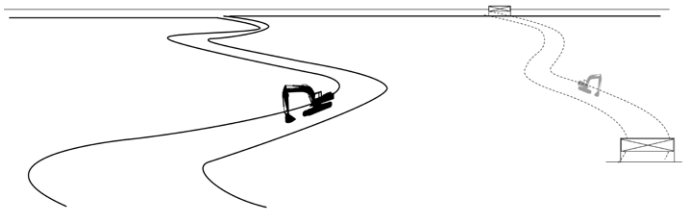


4.3. Machine-scale vs Human-scale

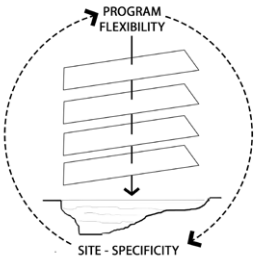


4.4. Natural ecological succession

4.5. Organizational backbones and Past routes



4.6. Quarry-specific program



Ecological ripple
Routing experiences
The lake and ramble
Scale relationships
Organization of the plan
Development Plan 2030

5 *DERIVING THE DEVELOPMENT PLAN*

5.1. DEVELOPMENT PLAN. *The development plan is the projected time-slice vision for the quarry in the year 2030 which will mark the end of excavation in the area. It is important to note that it is merely one possible way of applying the previously mentioned design principles. The principles help in designing the site based on various layers of interest which will be explained in the upcoming pages.*

The quarry can be divided (broadly) into two parts:

Completed: *The area where the quarrying is complete, the main characteristics of an excavation landscape are not visible due to the excessive human interventions. This part of the quarry is used to conduct research on the spatial-visual and kinesthetic experience of the quarry.*

To-be-quarried: *This area is currently all completely forested, and the plan is to continue quarrying untill roughly 2030. Although the area is also employed with the design principles for all purposes, it is left more open to the changes that could undergo as a ripple effect from the interventions in the area that is completed. The area is therefore designed based on the spatial principles which will leave it flexible and open to ecological, recreational and educational development.*

Find the fold-out plan in the end

5.2. ORGANIZATION OF THE PLAN. *The development plan is a product of the application of principles which can be decomposed into the following layers of interest:*

a. Scale relationships *- a balance of spatial scale between machine-made excavation landscape and human occupied post-excavation landscape.*

b. The ramble *- a composition around the quarry lake*

c. Paths of experience *- the network of kinesthetic connections which bind all the spaces together.*

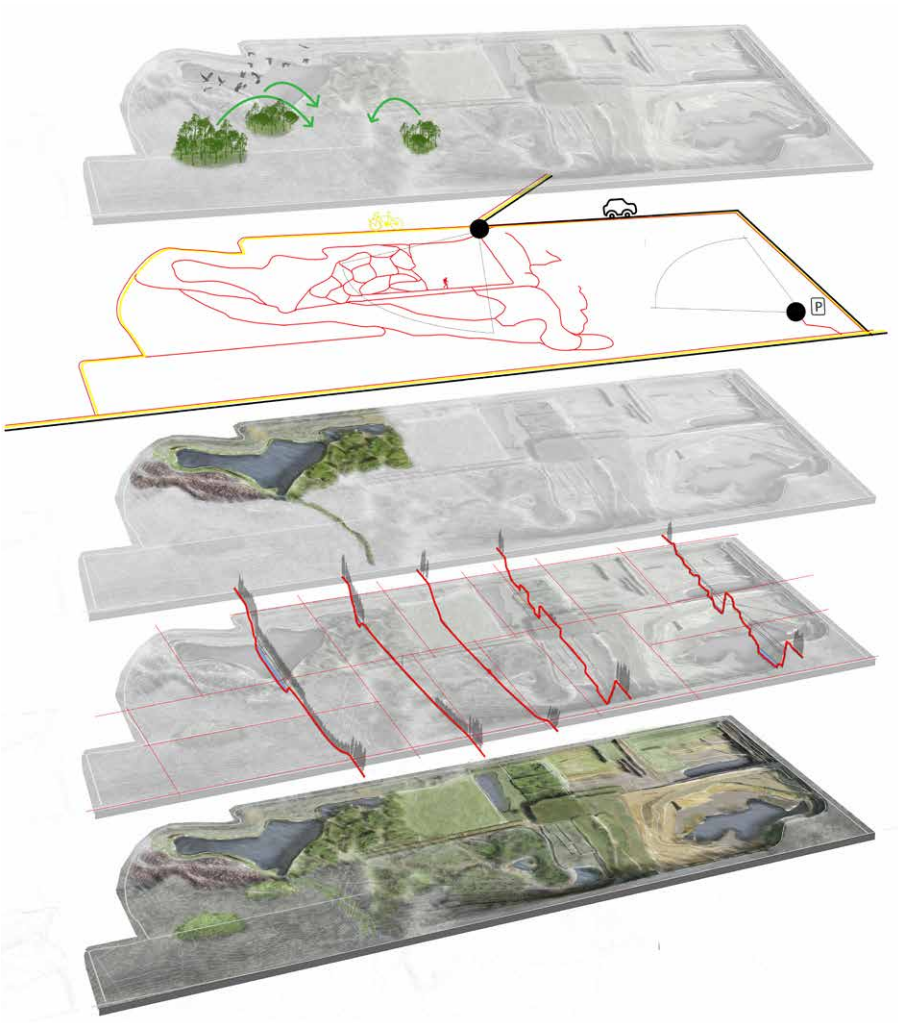
d. Ecological ripple *- the interventions which set natural ecological succession into motion.*

d. Ecological ripple

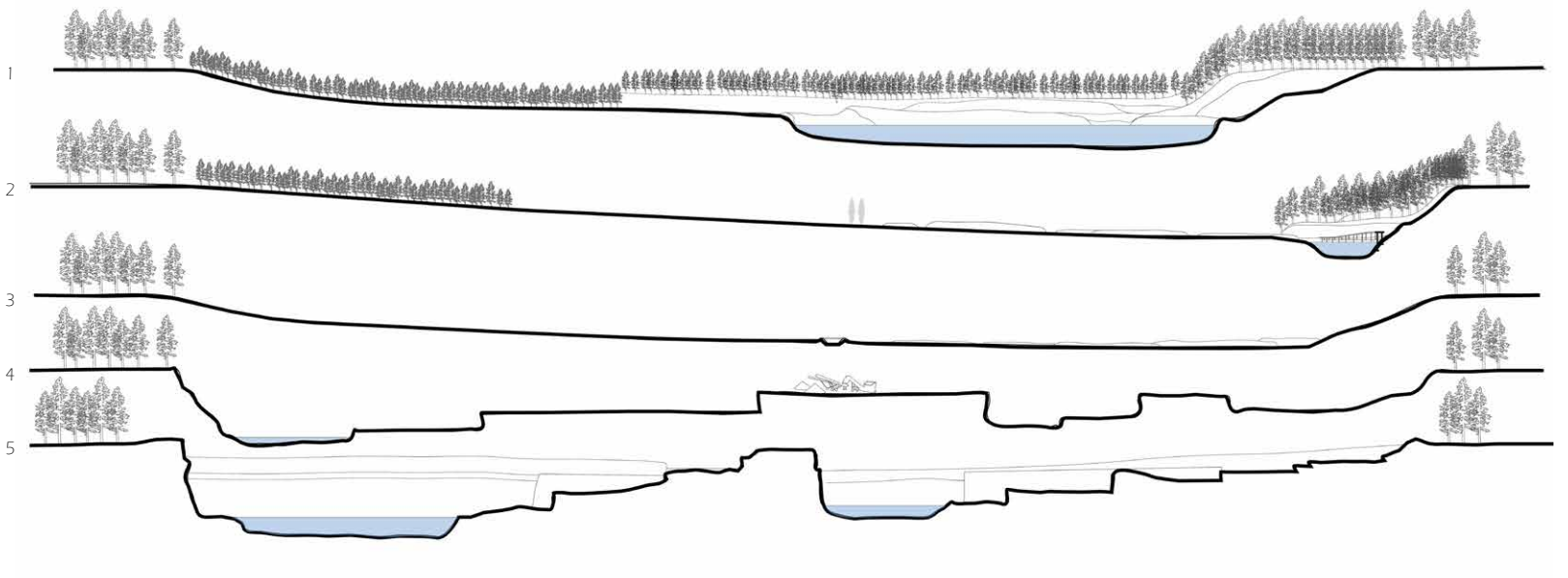
c. Paths of experience

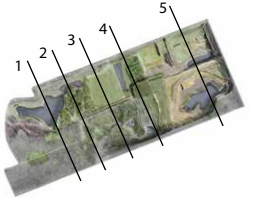
b. The ramble

a. Scale relationships



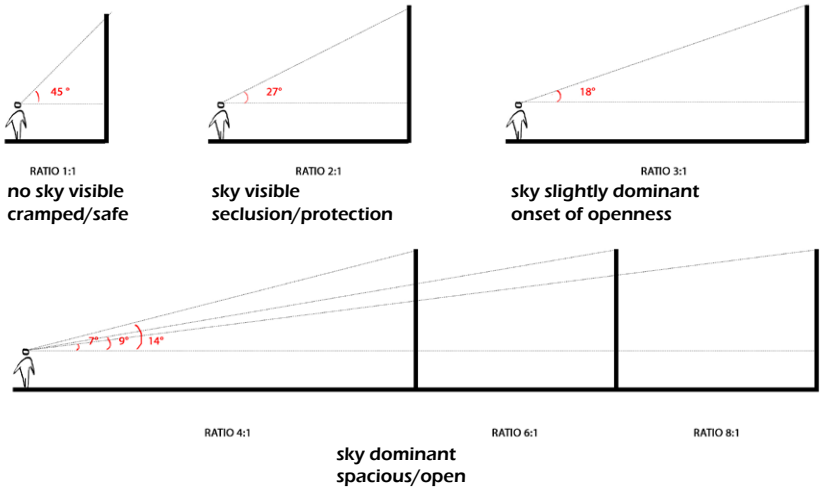
Development plan 2030





5.3. BALANCING MACHINE-SCALE AND HUMAN SCALE. Sections 1, 2 and 3 show the area of the quarry which has already been completed; sections 4, 5 show the area of the quarry which is yet to be excavated. It has been assumed that the final depth of the quarry will be roughly -28 metres from the highest point. The depth of the quarry in the current condition is 20-22 metres. Judging from the water retained in the lowest part of the quarry, and referring to the geological bore hole section, it can be judged that the lowest level could go upto -28 metres, instead of -22 metres since this is the depth where the clayey layer is reached. This ensures that the water body will be a more permanent one with minor fluctuations based on the rainfall. Since the overall depth of quarrying is increased by 6 metres compared to the current conditions, the rest of the areas can be varied in depth - a negotiation to ensure a balance between machine scale and human scale.

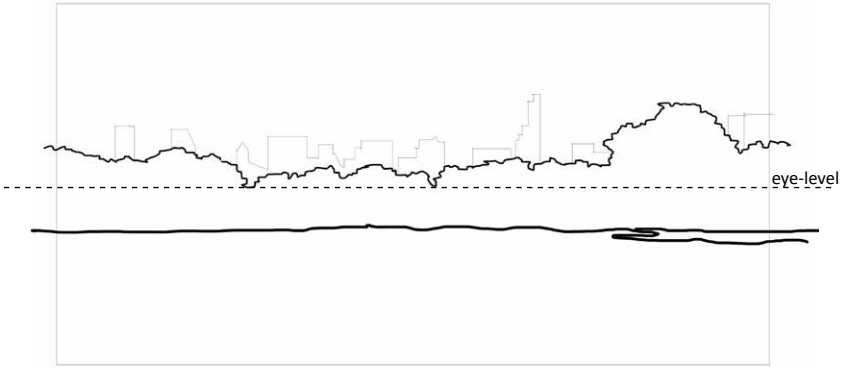
The possibility of digging all of the quarry to a depth of -22 or -28 was disregarded due to the fact that all the potentials offered by the topographical gradients and landscape types in such a quarry would vanish, creating one large temporary water body. Though this might be one of the visually appealing option and ensures maximum exploitation of materials,, it does not ensure the wholesome landscape development.



Space definition is based on proportions and the ratio of the observer's distance to the height of the spatial boundary/screen.
Image source: *Nijhuis, S. (2015). GIS-based landscape design research. p.248.*

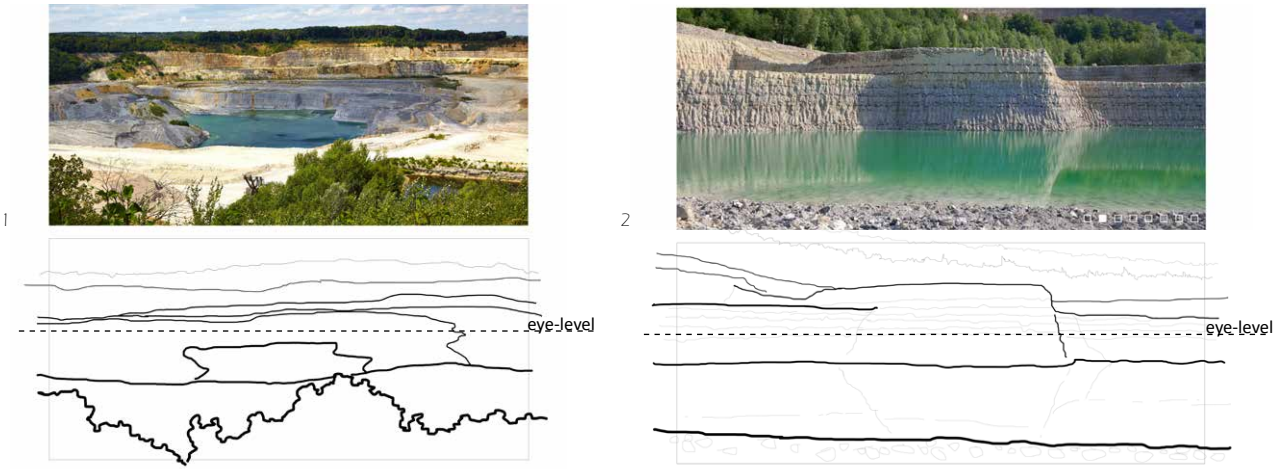
5.3.1. SPACE DEFINITIONS BASED ON GROUND-WORKS. During excavation or within 1 year of completion of excavation when the vegetation is not tall enough to create a sense of space, it is the earth's sculpted form which dominates and dictates the characteristic perception of the quarry. The form of the ground is the overarching layers which makes a machine-made landscape stand out in comparison to other landscapes. Over and above this, the vegetation adds more character to the excavation landscape which will make the space more experientiable over time. Space definitions are based on the ratios of horizontal distance from "object or screen of enclosure" to the height of the vertical screen. One may get feelings of safety and coziness in a relatively enclosed space or on the other extreme, feel lost, vulnerable or disoriented when it is too open. (Nijhuis, 2015) This said, there is also a lot more which determines the perception of space in the quarry, like the way light and shadows fall, the colour and scale of the texture of surfaces(materials) being viewed, the nature and degree of enclosure and many more factors.

The analysis of the ongoing excavation area reveals that the variations in space typologies (pg.29) created by the machines during the excavation process, exposing different colours and textures of materials in the horizontal and vertical direction is what makes the experience in such a landscape interesting. Following some organizational structures will ensure that there is a balance in the variety of spatial proportions. The next pages will describe the process of experimenting with the spatial compositions of the future excavation process. The advantage of this approach is that there are enough differences in the topography allowing for architectonic foci to be overlaid based on the program which fits the situation. (offering economic viability or offering a space for ecological developments)



The Great lawn at Central park
Image source: http://www.centralparknyc.org/things-to-see-and-do/attractions/great-lawn.html

5.3.2. PRECEDENTS FOR SCALE UNDERSTANDING. *To get a further understanding of degrees of openness, some studies on other existing landscapes was made. This helped to get a grasp on the feelings under different situations, with varying scales of foregrounds and backgrounds. The above drawing is of one view from one edge of the great lawn in Central park, New York, which is one of the most open spaces in the park. The tall buildings in the background, as well as the trees in the middle ground help one of locate oneself in the space. The elliptical, enclosed, inward oriented space automatically ensures that one would like to experience the "inside" without losing touch of the "outside".*



1. ENCI Quarry overall view
Image source: *https://www.natuurmonumenten.nl/natuurgebieden/sint-pietersberg/nieuws/enci-groeve-maastricht-vanaf-1-mei-weer-vanaf-beide-zijden*

2. ENCI Quarry waterbody view
Image source: *https://www.natuurmonumenten.nl/natuurgebieden/sint-pietersberg/nieuws/enci-groeve-maastricht-vanaf-1-mei-weer-vanaf-beide-zijden*

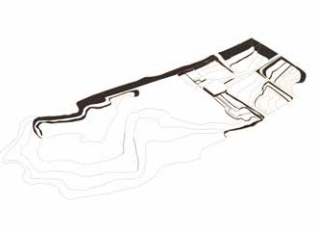
The example of the Great Lawn, though offers an insight into the feeling of openness, does not account for the changes in textures and layers similar to that in a quarry. Therefore, this example of the ENCI quarry, Netherlands, shows how one can first get an overview of the spaces, getting a sense of the openness while also noticing the layers or vertical drops, which helps to view the background in steps, instead of feeling a vast plain openness. The sculpting of the land itself offers this quality due to the geological characteristics, and in following certain sizes of terraces, this balance can be achieved. In the second view which is closer to the central water body, one can notice how there is a further break-up on scale. The gravel on the banks, along with the subtle striations on the vertical surfaces creating shadows creates a vivid foreground (also a space ratio of 1:1 or 2:1). This foreground ensures that the tall surrounding forest background does not create a sense of feeling lost in the space.

This study of two very different spaces allows a further experimentation in the design of the quarry.

2018

2021

2024



2028

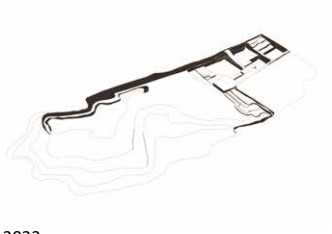
2019

2022

2025

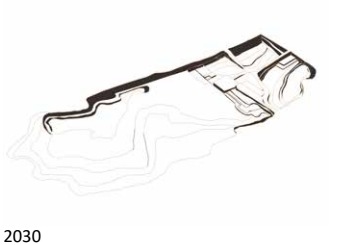
2029

2020



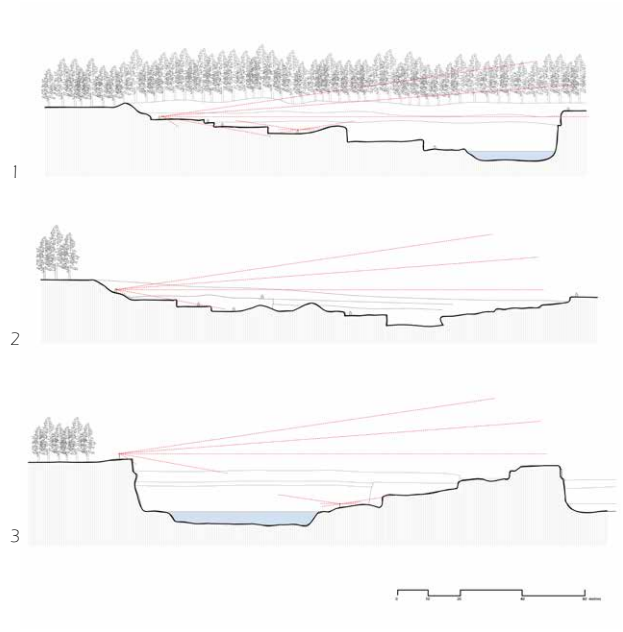
2023

2026



2030

5.3.3. ANIMATING THE EXCAVATION. *While keeping in mind the design principles and concepts for future excavation spaces, sketches are made which capture the excavation process from today up to 2030. Through this process of sketching the process, various insights were gathered, and it became the stepping stone in the process of the master plan. Instead of the solution of drawing up various possibilities of plans and sections, or spending time on a computer model which is time-consuming to change contours, the sketch process was faster, and also clarified some of the principles that were applied to arrive at the master plan. In the upcoming pages, these applications and the research will be decomposed.*



5.3.4. FOLLOWING A STRUCTURE. *As described earlier, the quarry is designed to accommodate a number of permutations and combinations of spaces based on the degree of openness that one wants to achieve. Some of the rules followed in this design are:*

- following the old agricultural pattern for (relatively) higher points (plots varying between 150-250 metres by 150-250 metres)

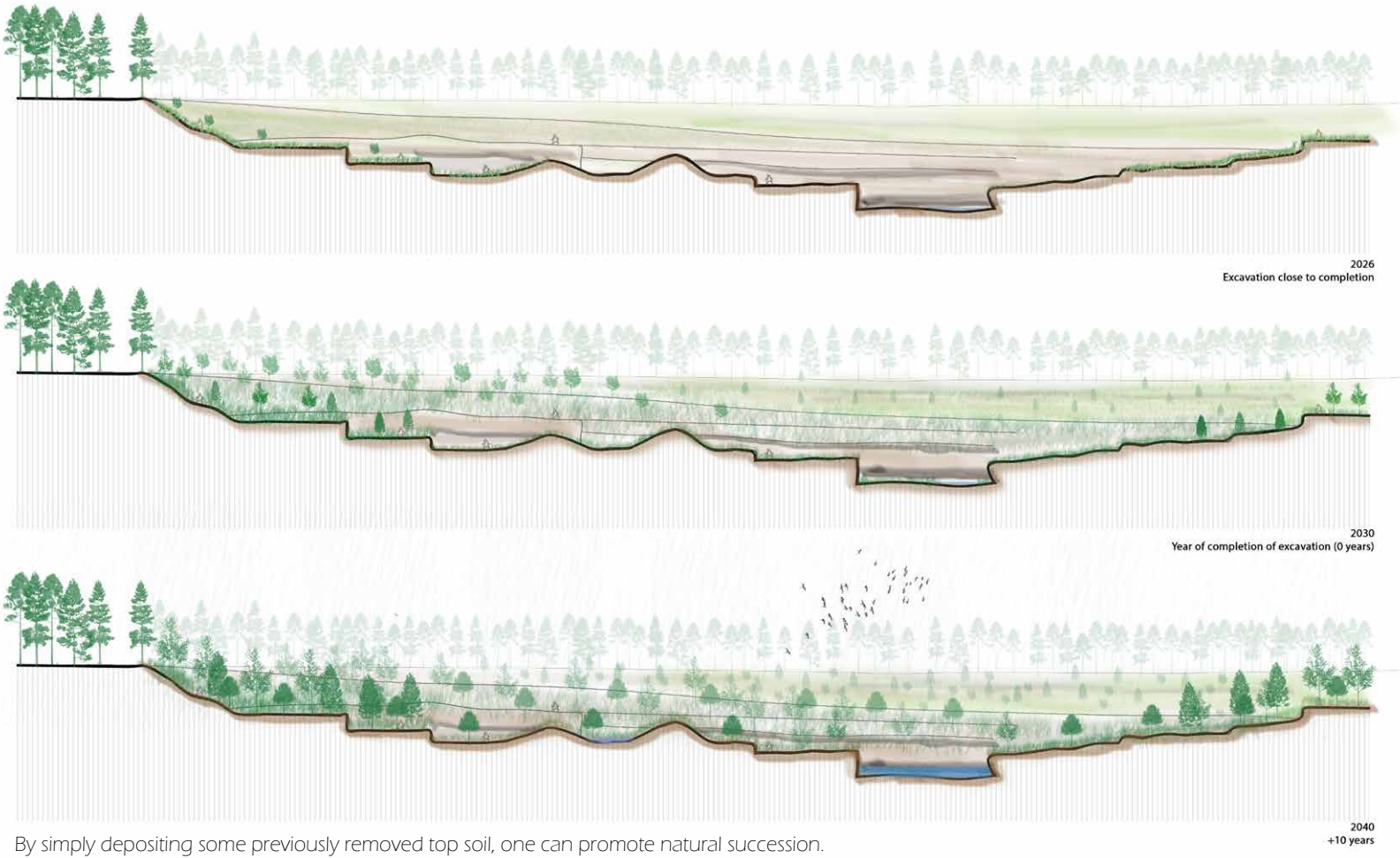
- achieving combinations of stepped terraces, slopes and flat terraces higher than the other areas which provide a platform for getting an overview of the enclosure one would be in when in a lower point. This would help to locate a focal point in the landscape and avoids the feeling of vulnerability.

- providing multiple degrees of enclosures at different levels.

- ensuring ratios of 1:1- 3:1at the lowest points and a clear orientation using different degrees of enclosures.

5.3.5. FUTURE POSSIBILITIES. *As the excavation continues in one part of the quarry, the other parts of the quarry are open for minimal interventions which can make it enjoyable for a wide audience. Above is a part of the quarry envisioned as a biker's paradise.*

Artists are provided with a vast blank canvas to create sculptures or installations - not to mention that the quarry's walls and surfaces itself are nature's artworks made visible by machines. As time goes by, nature takes over the land and visitors passing by regularly can see how the land changes.

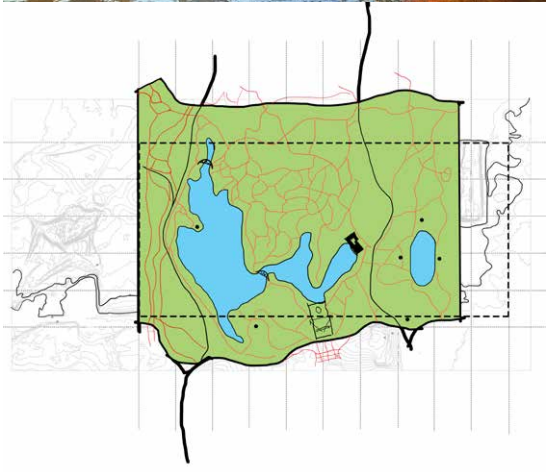


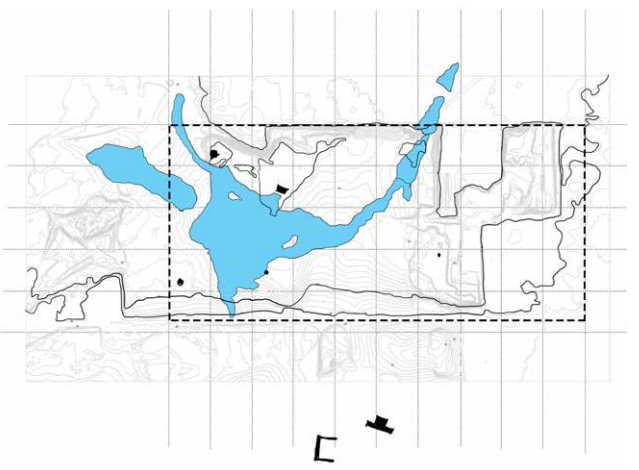
By simply depositing some previously removed top soil, one can promote natural succession. The series of sections shows yet another future possibility which is to leave the quarry untouched, without any interventions.

Slowly the area develops into a Fagus-Quercus (Beech-oak) forest being able to foster a wide range of species which could be unique to the location.

The lake
Image source: Photo by the author

5.4. THE HÖHER QUARRY LAKE. The lowest point at the quarry where now exists a serene water body has the potential to be expanded into a lake that can further be used for recreational purposes and to foster wet ecologies. The lake will also provide the necessary picturesque open foreground to ensure respite while being at the lowest point in a deep quarry (-22 to -25 metres).





1. The lake at Central Park
Image source: http://progressonline.it/autunno-a-new-york-uguale-foliage-a-central-park/

2. Stourhead lake
Image source: https://www.tripadvisor.co.uk/LocationPhotoDirectLink-g209964-d214676-i232624672-Stourhead_House_and_Garden-Warminster_Wiltshire_England.html

5.4.1. SCALE COMPARISONS. To get an idea of the scale of a qualitative picturesque lake, the lakes at Central Park, New York and Stourhead, Stourton are compared with the water body in the quarry. (The black dotted line marks the edges of the quarry as found in 2018). Based on these comparisons, conclusions on the size, and shape of the lake can be arrived at, which helps to experiment with the formation of the lake at the quarry.

After site visit in October 2017

After site visit in March 2018

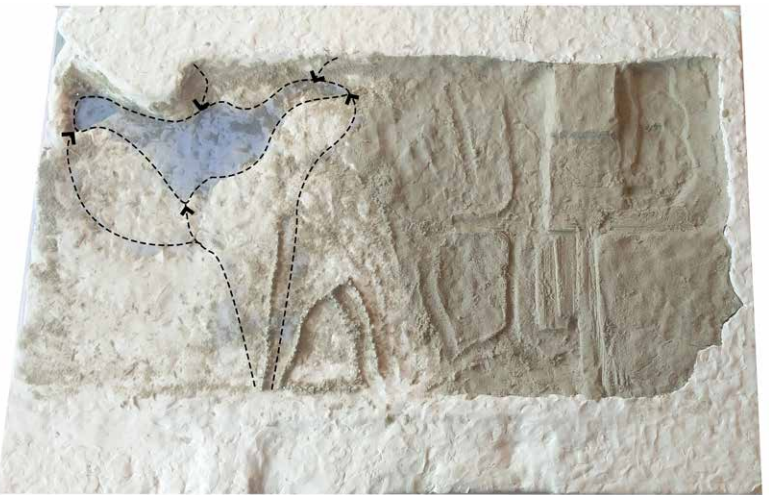
5.4.2. PHYSICAL MODEL EXPERIMENTS. *A physical model is molded using plasticine and "magic sand" so that the model is easily sculpted and is mainly used to visualize the current condition of the quarry as well as experiment with the water flow/ accumulation (to create a bigger water body).*

On the adjacent page are documented pictures of the four main steps in finding the ideal water body size and shape. Water is first dyed blue and poured along the edges of the quarry. The water body size slowly grows from 1.5m depth to -3m depth. The material at this depth is now clay/peat and the water can be held in the area for longer before it seeps down into the earth. Since the clay/peat under-layer is not as solid, there are mild fluctuations in the water levels (up to 50cms) based on the rainfall. This allows for a varying shoreline and thus, healthy vivid wet ecology.

Water depth -1.5m

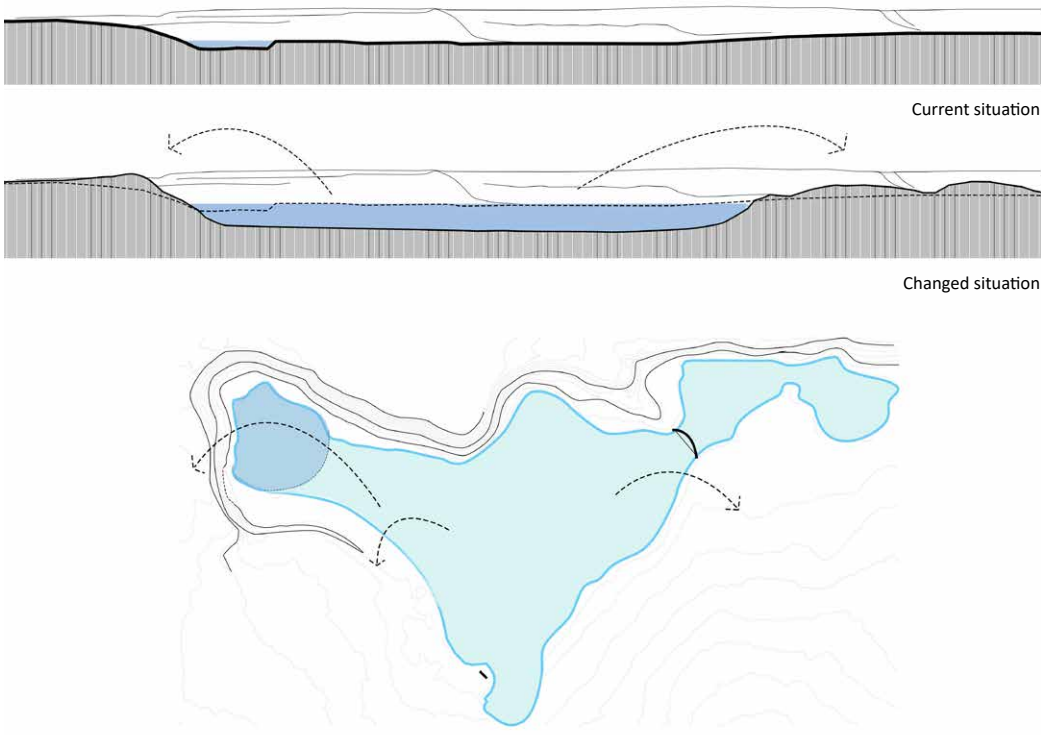
Water depth -2.5m

Water depth -1.75m



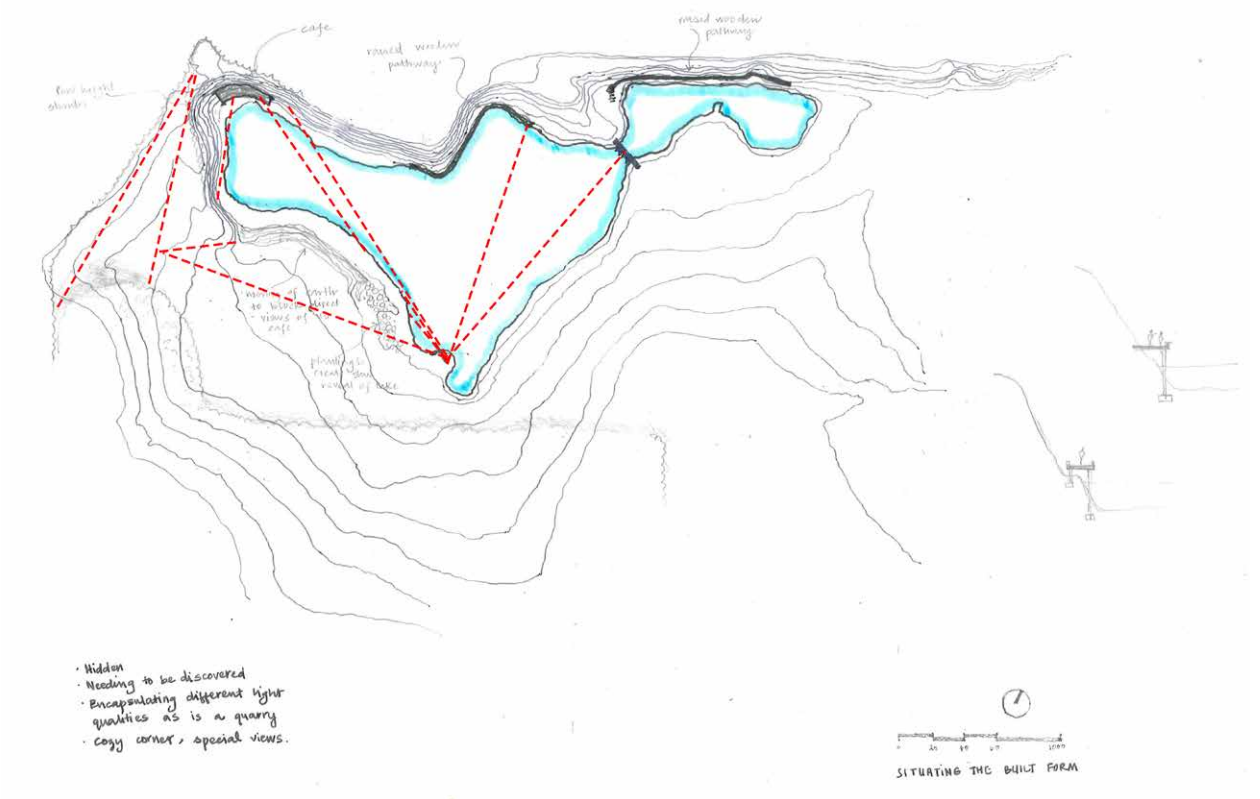
Water depth -3m

Principle for the formation of the lake ensemble



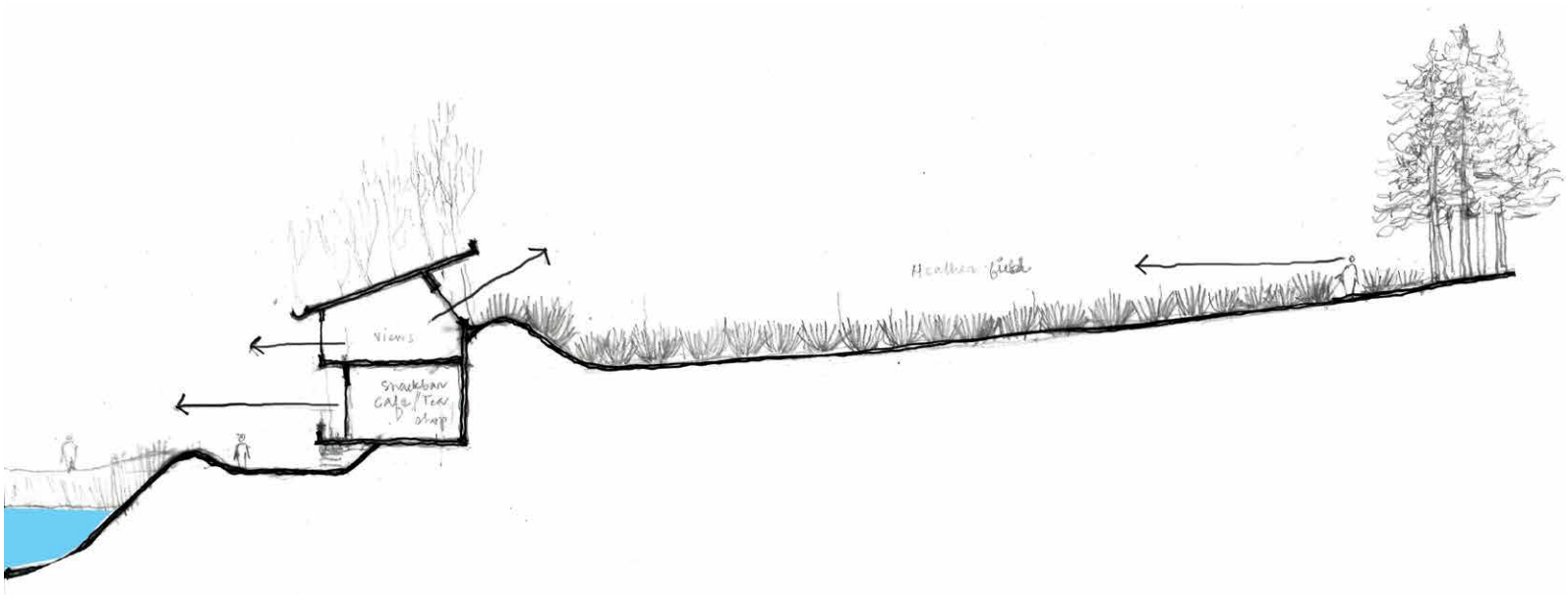
5.4.3. CUT AND FILL. *The formation of the lake and its surroundings are based mainly on the principle of cut and fill. The material is dug out based on the previous experiments conducted using the model creating the choreographed series of images around the lake.*

Find the fold-out plan in the end



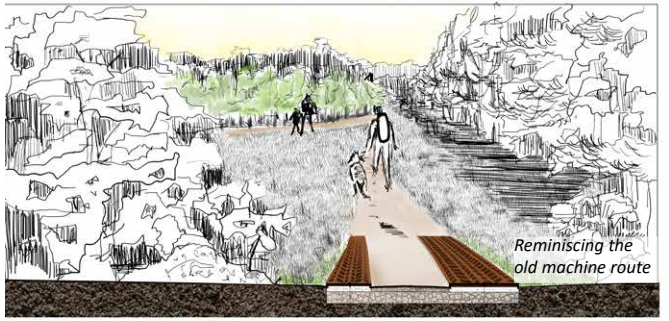
Sight lines based on which the lake ensemble has been designed.

5.4.4. THE LAKE COMPOSITION. *The construction of the lake goes hand-in-hand with the construction of the braided walk and choreography of the views thereof around it. The material dug out along with the unused material for the ongoing excavation facilitates the building of mounds and raised edges around the lake. The morphology of the lake is adjusted slightly to include some architectonic elements at strategic locations as well as appropriate locations from where these elements can be best viewed. A walk around the lake encompasses many spatial experiences which are characteristic to excavation landscapes.*



Experiments on the Höher cafe design

5.4.5. THE LAKE EXPERIENCE. *The lake and its elements are composed such that the views from each point entice one to move towards the next point. On entering the quarry, the walk through the heather field directs the view towards the stand-alone bench. The pathway slowly moves from stabilized earth to wood combined with corten steel, and transitions back to earth as the walk moves closer to water. This change of material signifies the change from natural to man-made to natural again. The architectonic elements are adorned with a combination of wood and corten steel, both of which also age gracefully as the landscape around it ages.*



1

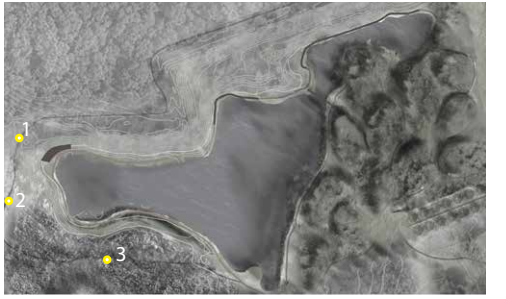
On of the entries into the quarry is through a route which was previously used to enter the quarry. Corten steel etched with tire marks reminds one of this old machine route. The casual passerby may park his bike and stop to admire the picturesque quarry before continuing on his journey to his town.

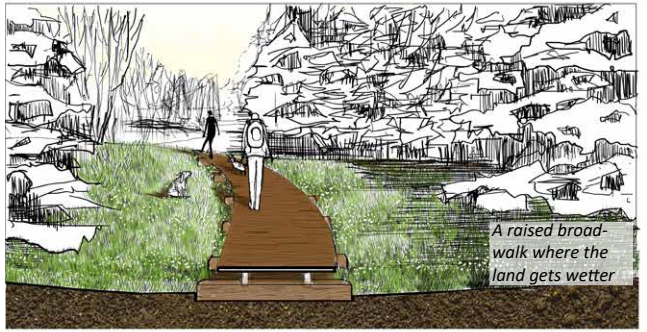
2

Moving ahead, the path forks, one leading out of the quarry to the other side, and the other going towards to the lake. The heather fields lining the pathway blooms a beautiful lavender and requires maintenance to create this image. Lacking any kind of maintenance, one can be aware of the fact that slowly a forest will take over the land.

3

As the path curves slowly towards the lake, the ground sinks slightly. To facilitate movement during the wet seasons, the ground is stabilized with the help of a hidden mesh holding gravel on top of which, a more natural layer of earth is used. A raised wooden pathway is added in the parts that are lower.



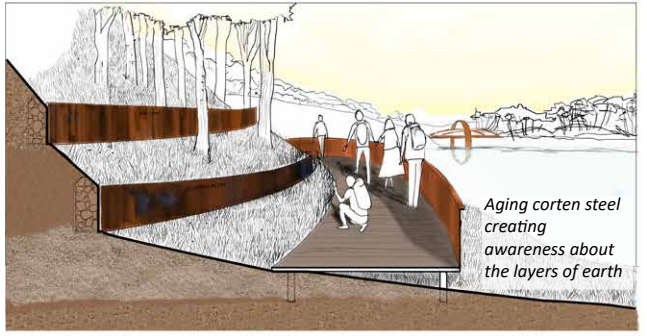


4

The raised wooden pathway leads one through the darker denser tree cover and slowly the weeping willow tree is revealed in the distance.

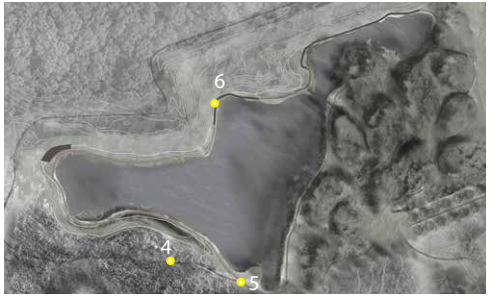
5

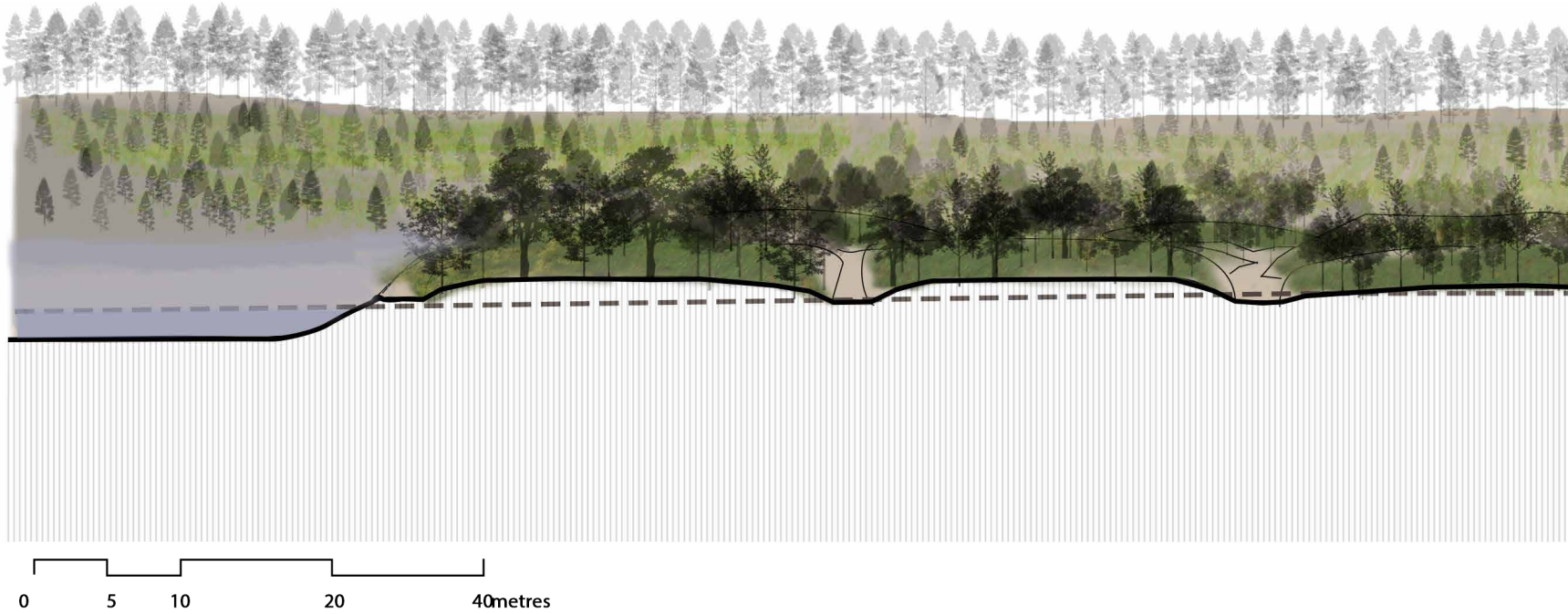
The end of this winding pathway finally reveals the picturesque view of the lake with the rising walls of the quarry all around. The bench under the willow tree beckons the tired hiker to pause and enjoy the scenery around him.



6

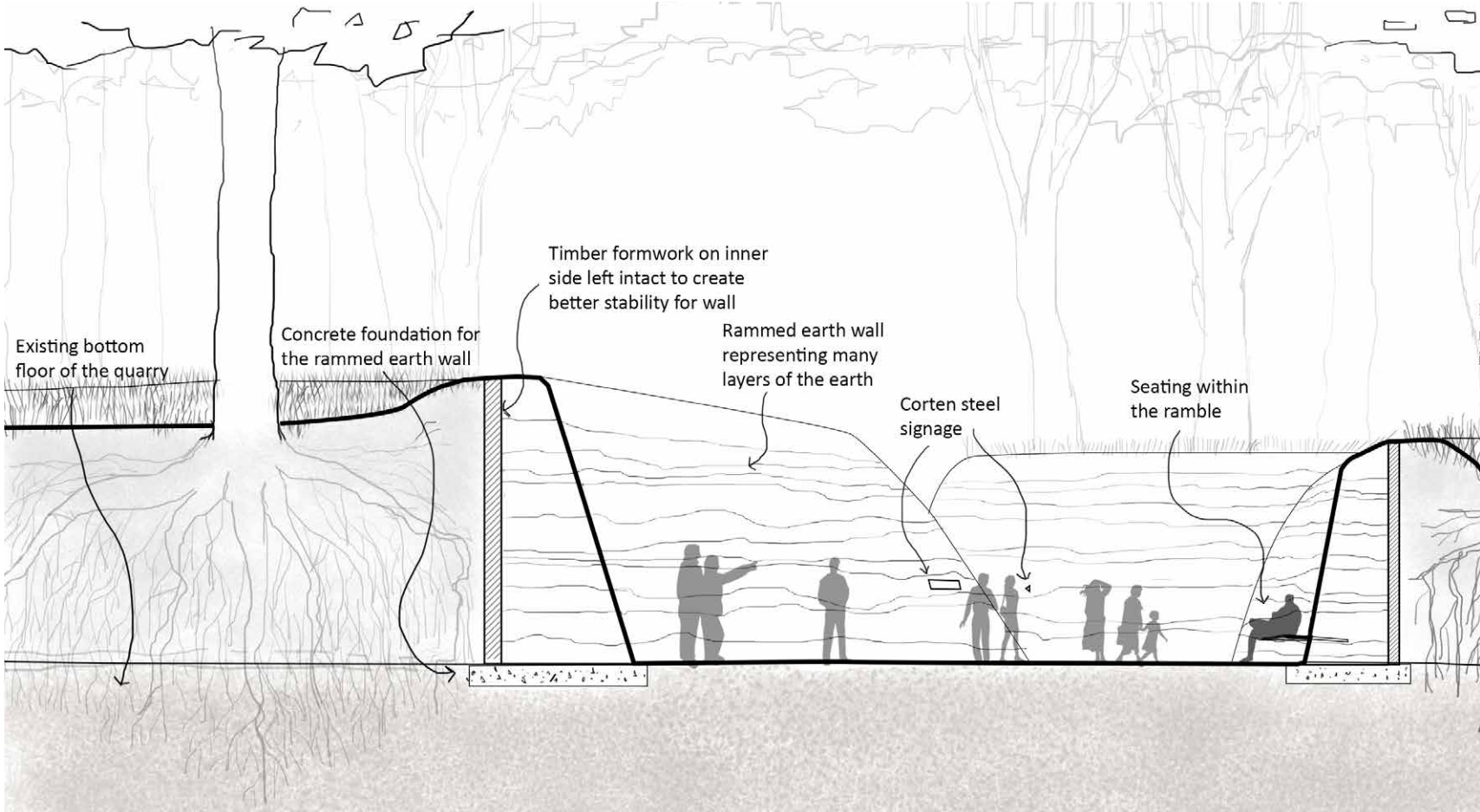
The pathway lining the lake changes in elevation and corten steel aging at different rates at each level represent the layers of the earth formed at various geological time periods. These also help to reinforce the slopes at a point where the pathway climbs up the crumbling slopes of the quarry.



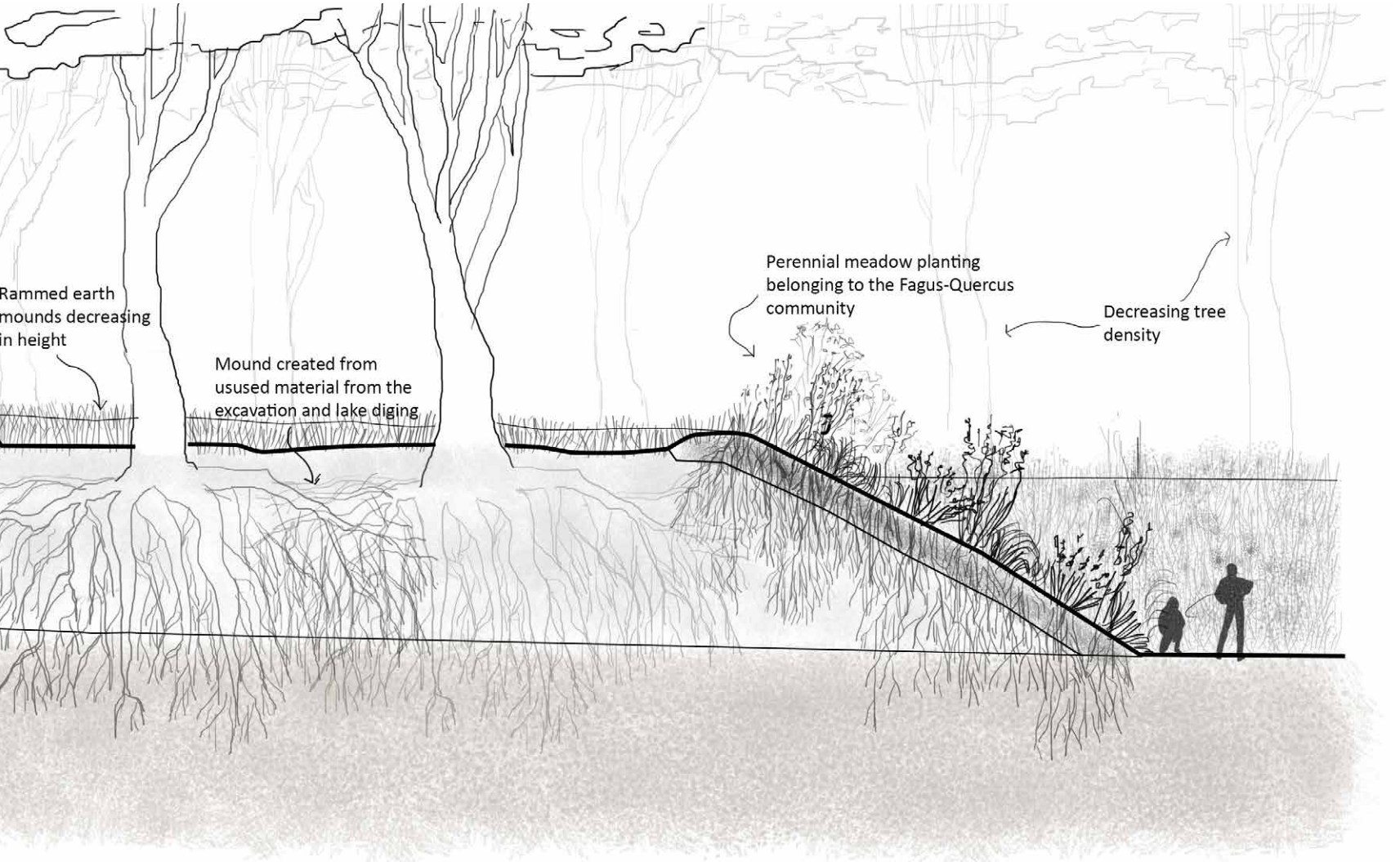


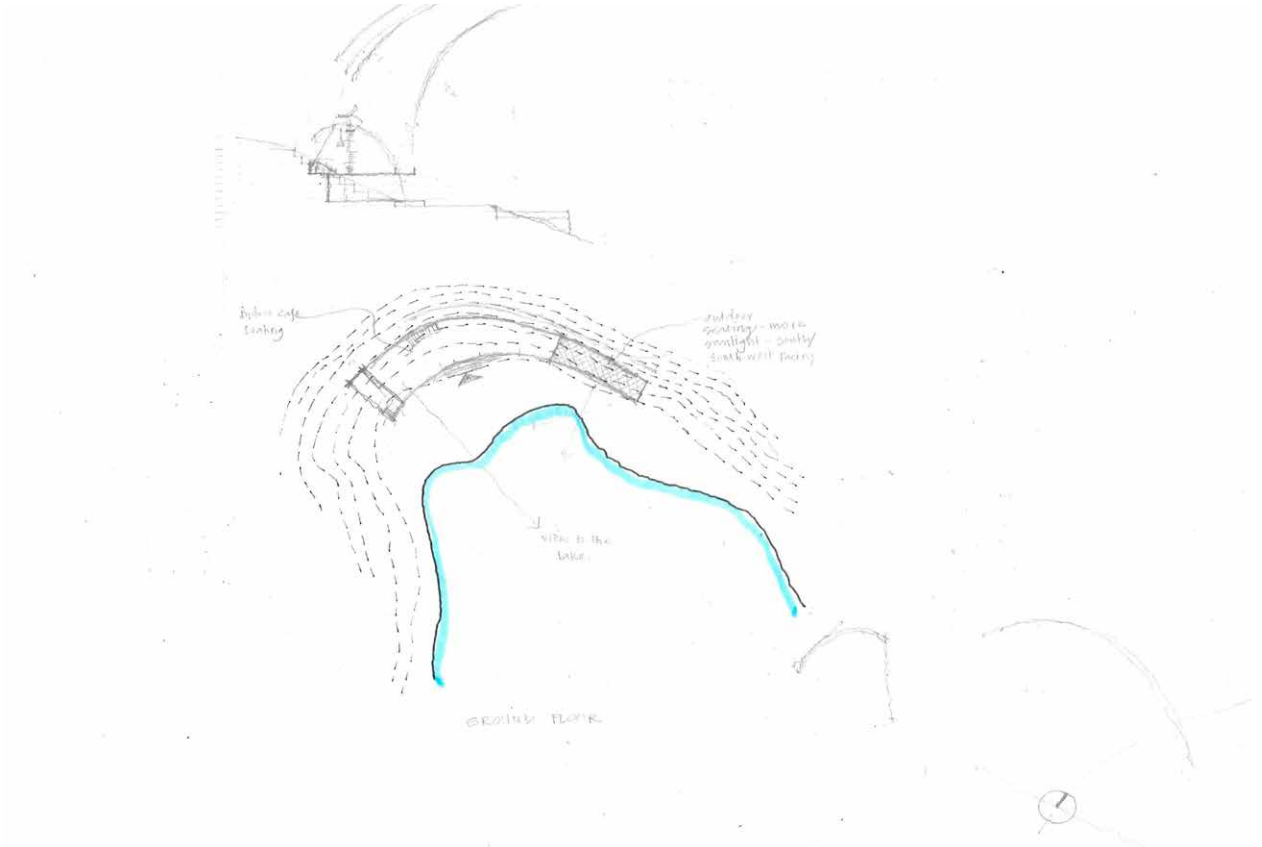
Concept for the braided walk - mounds decreasing in height and tree density

5.4.6. THE BRAIDED WALK. *The geological understandings are translated into the braided walk, which in combination with the lake, makes for the 'ramble'. It is the alternating movement of the river between meandering and braiding which causes the accumulation of clay, peat, sand and gravel. The walk through the mounds lets one immerse themselves in the quarry experience. The mounds gradually decrease in height from the lake to the open grassland preparing for the open scale to come. The density of the trees and ground cover also gradually decrease to allow for this change in scale.*

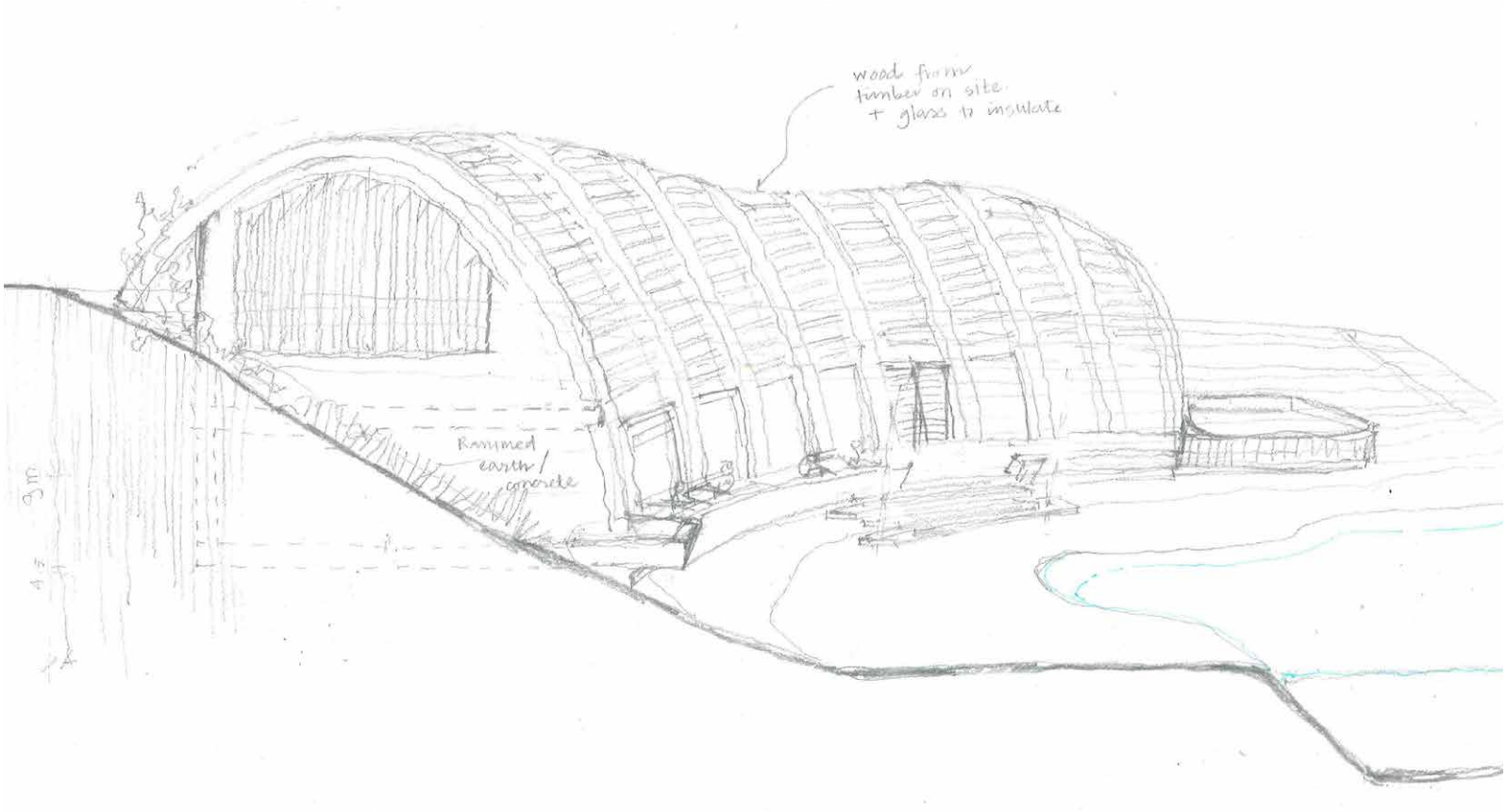


Detail section of the mounds showing the rammed earth walls which remind one about the quarry

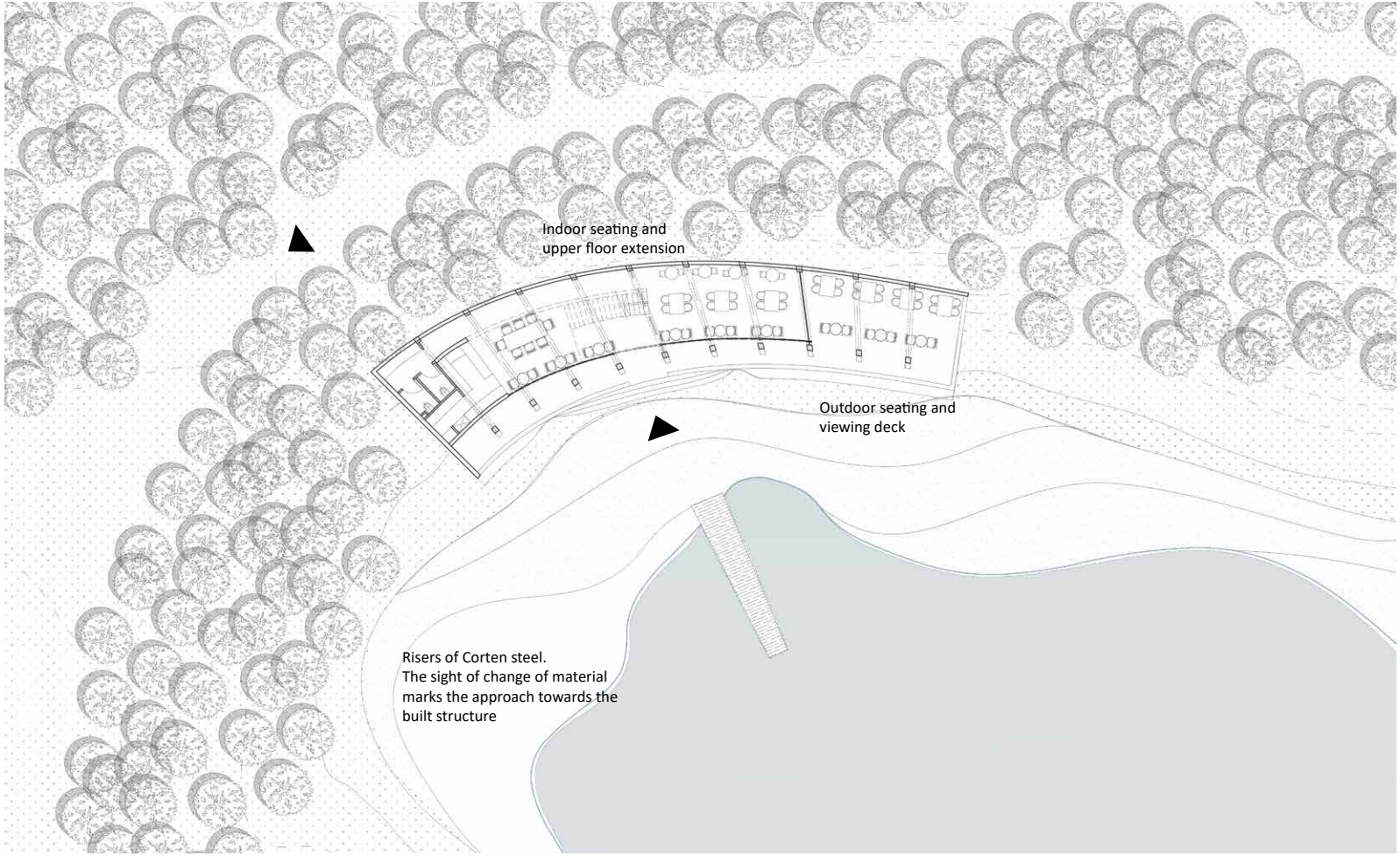

Rammed earth mounds decreasing in height
Mound created from ususued material from the excavation and lake diging
Perennial meadow planting belonging to the Fagus-Quercus community
Decreasing tree density



5.4.7. CAFE HÖHER. *The cafe by the quarry lake contains the quarry experience by itself. The placement of the cafe structure in the corner creates its own exclusive views and quiet space. One cannot view the building till one walks till the bench corner of the lake, and once within the building, one cannot view the bench unless on the outdoor deck. It is a structure which is partly within the earth, and partly exposed. The contrasts presented in the built structure represent the thresholds that the quarry has to offer. During the peak seasons (Spring and summer), the cafe expands to serving on the upper level as well, and during the other seasons, presents a sheltered raised platform from where bird-watching can take place.*

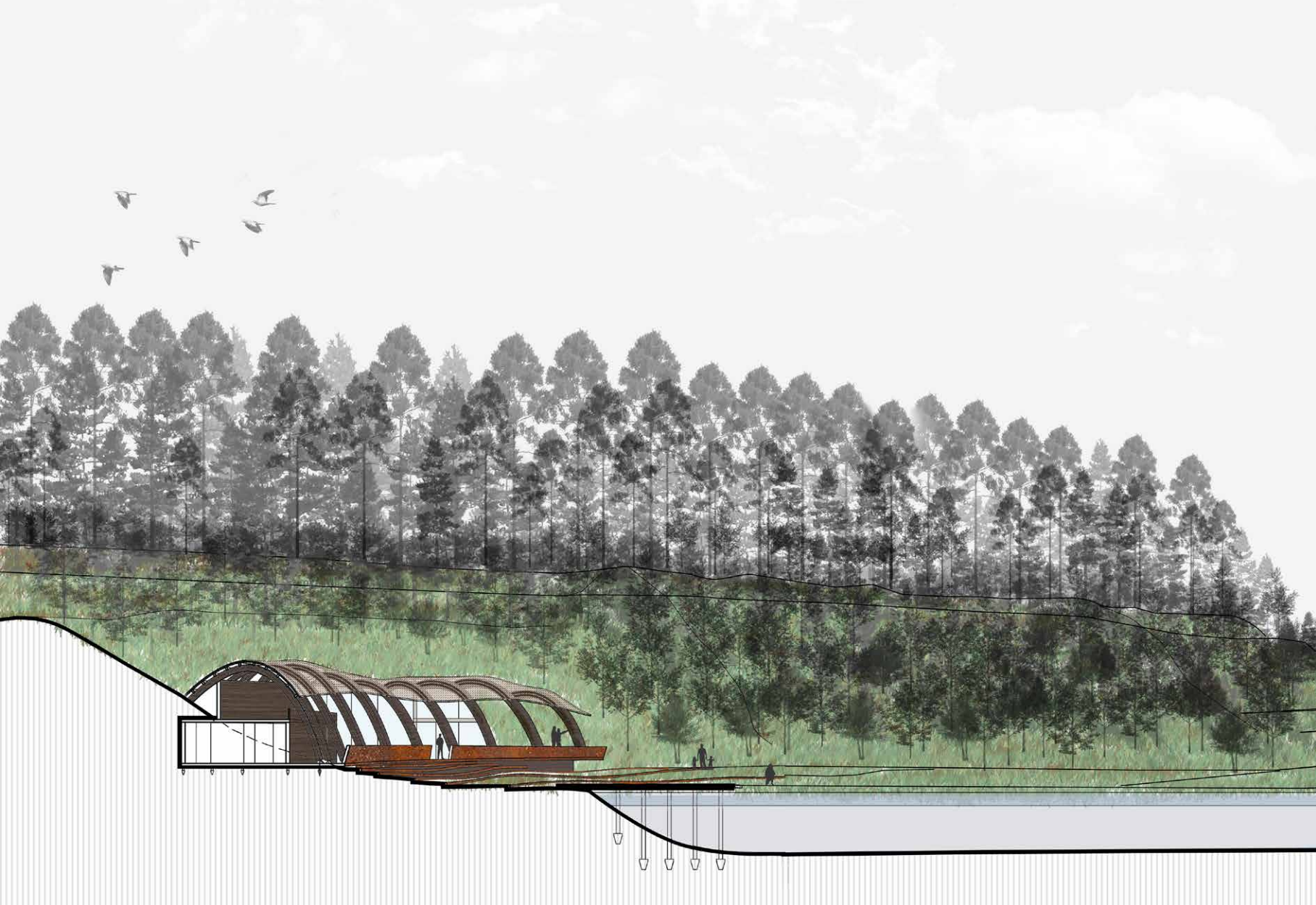


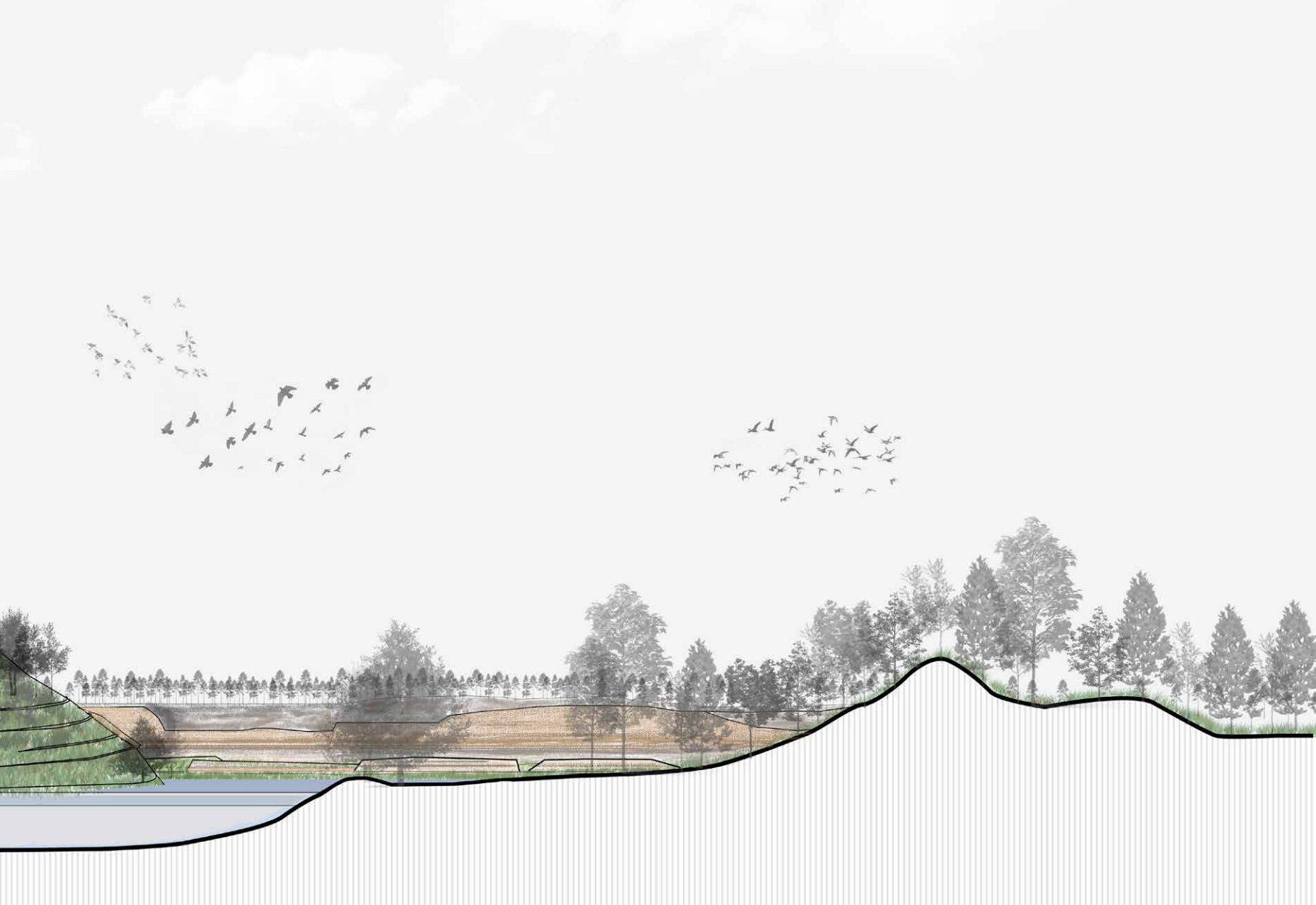
Experiments on the Höher cafe design



Höher cafe plan

Höher cafe sectional view





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5.5. PATHS OF EXPERIENCE. The Höher quarry is situated within a dense forest consisting of multiple routes of varying hierarchy. Many local dog walkers or joggers, hikers, bikers, as well as cars and motorcycles frequent the surroundings of this quarry. Therefore, the edges of the quarry are carefully modulated in order to ensure safety as well as choreograph the extent of views into the space. A minimal intervention of digging a small trench around the edges along with planting thick woody plants ensures that the casual passer-by does not step too close to the edge where it isn't designed.

The quarry is also capable of acting as a picturesque thorough access from one side to the other. Therefore, viewpoints are situated on either sides to allow for visitors to park their bikes or cars to enjoy a quick view into the vast expanse of the machine made space.

1. Avenue des Champs-Élysées, Paris
Image source: http://onebigphoto.com/paris-champs-elysees/

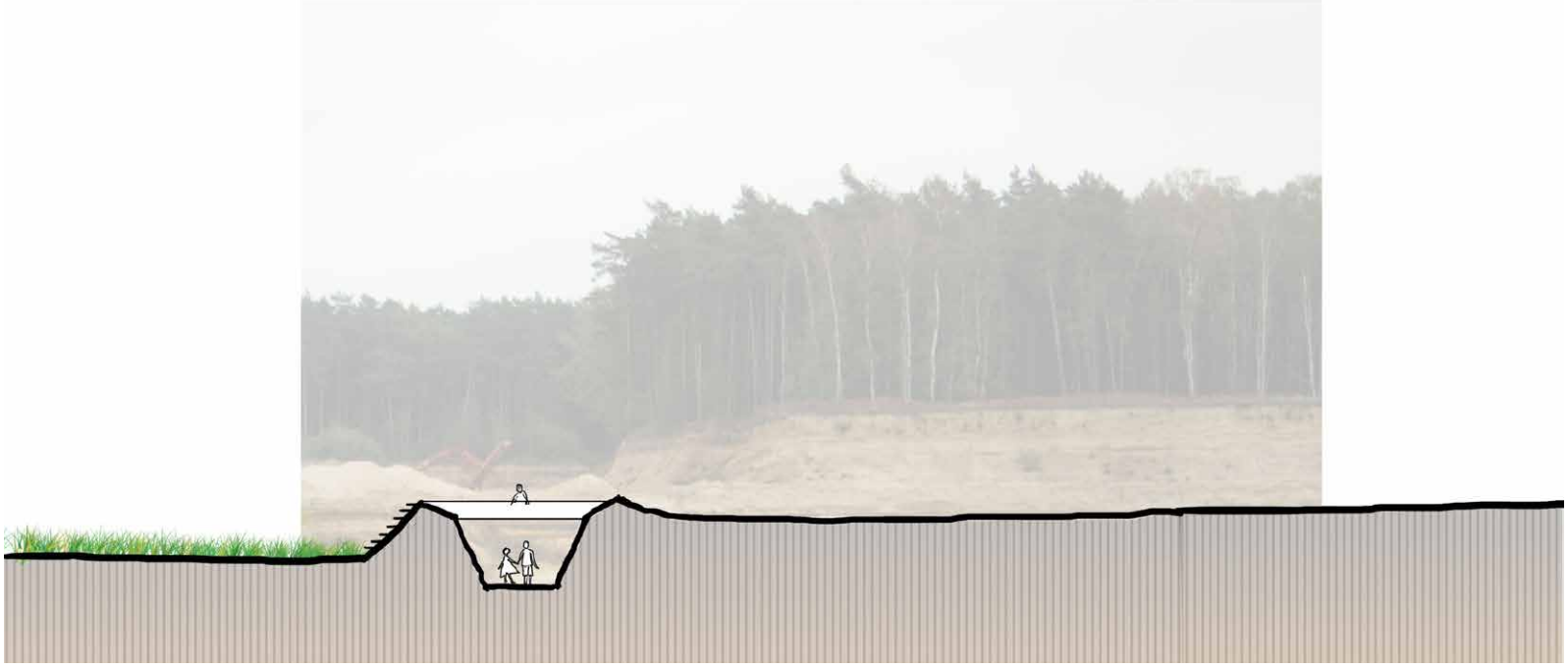
2. The mall, Central Park, New York
Image source: http://emcfht.ca/wp-content/uploads/2018/02/RETREAT.jpg

5.5.1. AXIS. *An axis is an imaginary line in the landscape around which various elements are organized (sometimes symmetrically)whose edges when reinforced by defining elements can direct one's movement towards a point of interest at the end of it. (Learndesignprinciples.com, n.d.)*

The flat terrace where the sorting of sand and gravel takes place is chosen to be the point of interest in the quarry towards which movement is directed. The old rusted machine at a higher flat terrace is left there after the end of the excavation as an element which recalls the old purpose of the site years after the excavation, once nature takes over the site. A line of poplars guides the walk as the ground gently dips moving towards the machine. As the elevation declines, the edges raise on the sides slowly blocking the views and directing towards the machine. The vertical surface in view adorned with textures and striations balances the scale when one reaches closer to the surface.

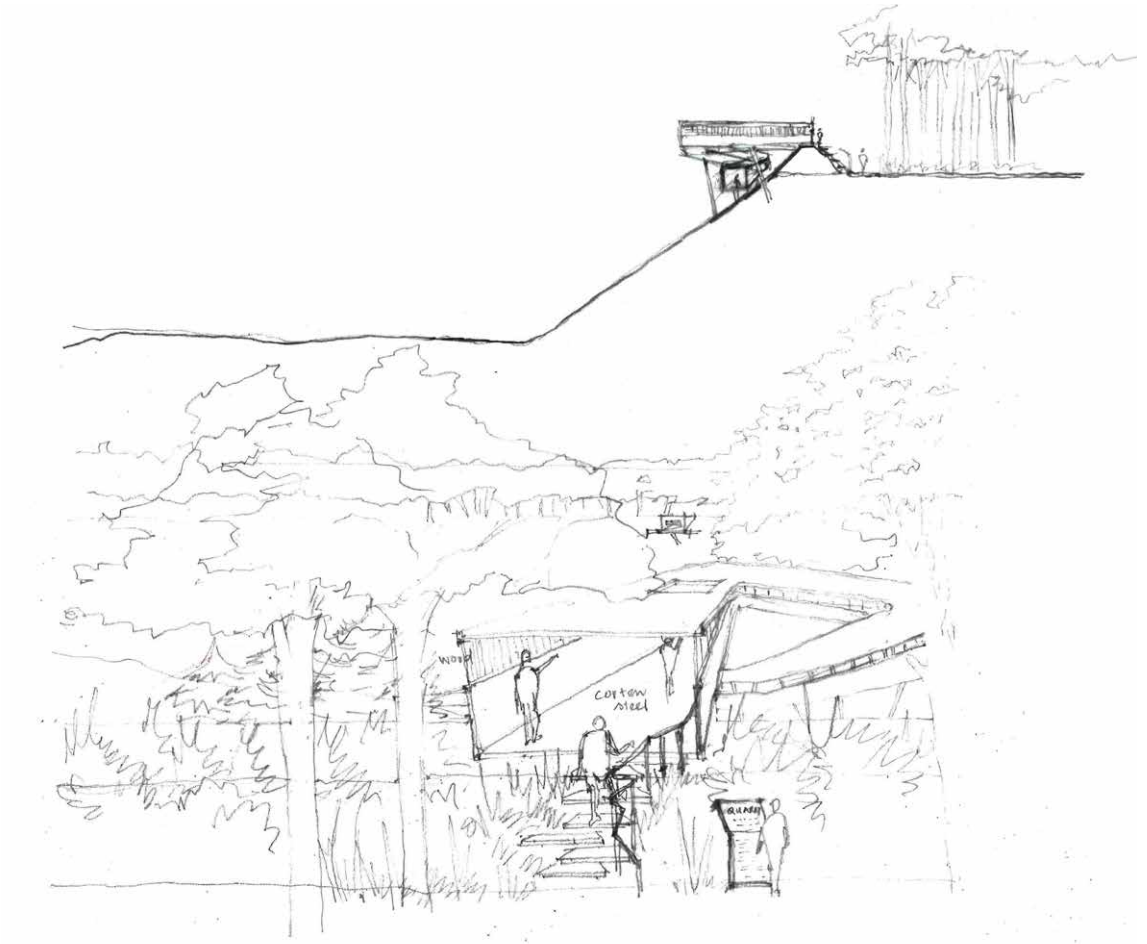
Existing condition of the walk towards the terrace - Establising an axis

The axis lined by poplars leading towards the machine -
The path down memory lane reminds of the function
that once was - a quarry of sand, clay and gravel



Section along the sunken pathway leading to the machine view

Viewpoint and walk to the quarry



5.5.2. VIEWS. *The walk inside the quarry leads to the pathway once again changing slowly to corten steel close to the steep edge. The climb through the dimly lit tunnel leads one back to the starting point from where looking back, one gets an overview of all that they experienced.*


höher grünne
lake view

View of the quarry in October 2017

View of the quarry in March 2018

5.6. ECOLOGICAL SUCCESSION. Natural ecological succession and ecological regeneration of mined sites can be a very complicated topic. It comes as no surprise that there is immense research in the direction of oak (beech) regeneration in forests. A study conducted in the Garwolin forest District of Poland showed that the main species in the forest were Pinus sylvestris (Scots Pine), Quercus robur and Quercus petraea (pedunculate and sessile oaks), Fraxinus excelsior.L (European ash) and Alnus glutinosa Gaertn (Black alder). It has been noted that the Pinus species (which are planted) dominate the area, even though it should be that after 150 years or so, the Quercus species should be dominating, moving towards a stable climax environment. The Fraxinus and Alnus only grow in rich and moist soil conditions, and the area having poor quality soils are not hosts to these species for a majority. Young Quercus occupy 30% of the area and 10% is occupied by Betula verrucosa (birch) and Carpinus Betulus (hornbeam).

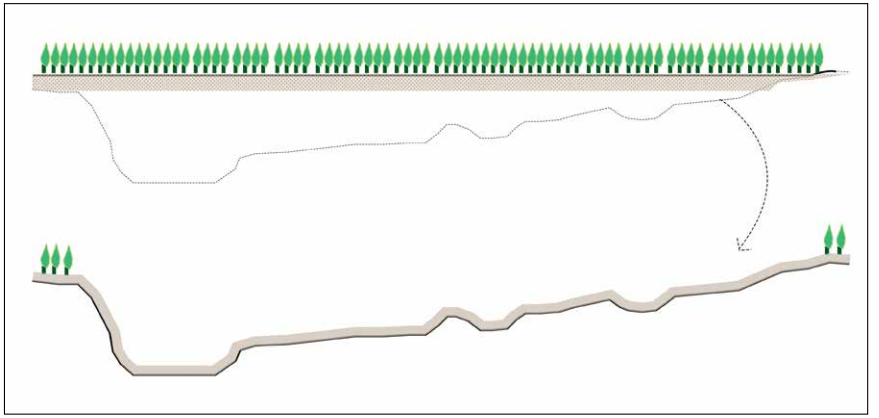
This study concluded that one of the main reasons for the lack of regeneration can be attributed to low light penetration (12%) due to higher densities of pine species. The data suggested that oak generation was best found in gaps of 100-150 m^2 and 151-300 m^2. Young oaks (up to 2 years) are shade tolerant, but as they mature, they require a lot of light to sustain themselves. (Dobrowolska, 2006) This study can be beneficial to understanding the development of an oak-beech forest in the Höher quarry site.

Primary ecological succession is that natural life begins to grow in a place where life has previously not existed. Examples of this would include an area destroyed by a volcano eruption, or like in this case, deep mining which removes all the nutrients in the soil. Secondary succession is the reformation of life where ecosystems have already been established. This would include an area which has been affected by forest fires or floods. The excavation site, if left to itself, will (probably) begin to slowly undergo primary succession over many years, and this process is highly unpredictable. It can result in a community which is not native to the region due to changed (or polluted) soil communities, and if it a region receiving heavy rainfall, is under threat of heavy erosion. Therefore, the wise and faster solution is to employ secondary succession. The easiest way to do this is to use the topsoil that was previously removed so that it forms a nutrient base for new life. Though the part of the quarry where excavation was completed has been covered with topsoil and been planted with pine varieties (a species that is further up the succession cycle, which helps to restore soil nitrogen levels and promote the climax species), positive results do not yield because they are mainly planted at very close distances for economic purposes.

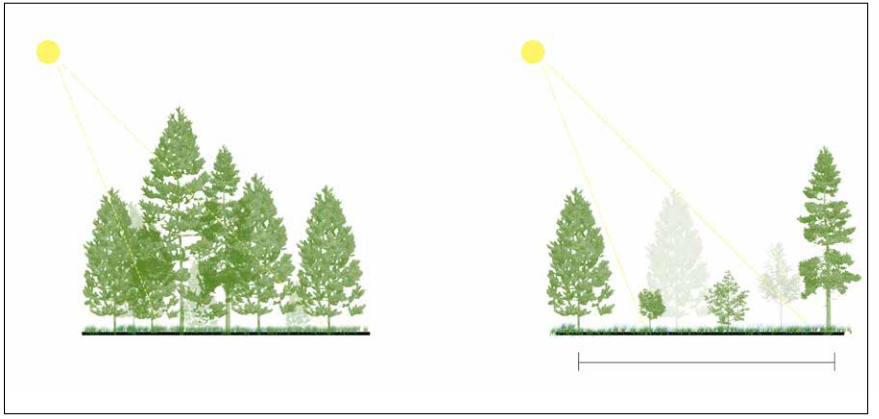
The site area is complex in nature also due to the formation of peat bogs in certain areas. There is a strong relationship between the growth of Betula pubescens and Betula pendula (birches) and the depletion of sphagnum mosses. (Theunissen, 2008) This is a difficult situation because the Betula community is part of the pioneer species leading to the Quercus-Fagus forest, but is a threat to Sphagnum development. The answer to this perhaps lies in more research from an ecologist, but the ideal situation would be to obtain a balance in environments. Based on the previous understanding about oak regeneration, we could conclude that the answer lies in experimenting with the densities of plantings of Pinus and managing the growth of the Betula species.

Study on gap size influencing oak regeneration in a forest in Poland.
Dobrowolska, D. (2006). Oak natural regeneration and conversion processes in mixed Scots pine stands. Forestry, 79(5), pp.503-513.

The excessive growth of Betula species can limit the growth of Sphagnum moss which is related to peat regeneration.
Theunissen, M. (2008). What makes birches grow? Relating environmental factors to the growth of birch in raised bogs. [online] Edepot.wur.nl. Available at: http://edepot.wur.nl/237939



Principle of transferring nutrients from top-soil



Principle of allowing enough sunlight to penetrate

Primary succession

Secondary succession

To get this experimentation started, a portion of the Pinus-Betula dominated forest is cut down and young Quercus species along with other species of the Quercus-Fagus community are encouraged to grow. Three "chunks" of forest of different areas (a, b and c) are chosen to experiment with the amount of light penetration. The new forest can be periodically visited and maintained to check for 'gap analysis', growth rates, and other invasive species which might take over. In the newly excavated area, top soil can be laid out along the terraces to maintain the quarry space characteristics and new pioneering species part of the Quercus-Fagus community can be planted to further test the growth conditions (in case of ecological focus on site).

A long forest walk,
Changing altitudes and carefully navigated pathways,
The sound of machines in the far distance intertwined with wind, birds and talk..
A unique mix of landscapes- open, closed, light and dark,
Nothing you have seen in any winding park.

Where once stood a destroyed land
Now stands nature, and no, not destroyed land, constructed land.
Can every other tainted piece of earth be seen as beautiful?
That is the question I have tried to answer in this tale, so unusual.

Clay, sand, gravel and stone,
there are but other relics exploited since the bygone.
We are the soothsayers, the designers,
Lets begin changing one, this majestic piece of earth we stand before,
slowly but surely, paving the way for two, three and many more.

Reflection
Learning through a test case

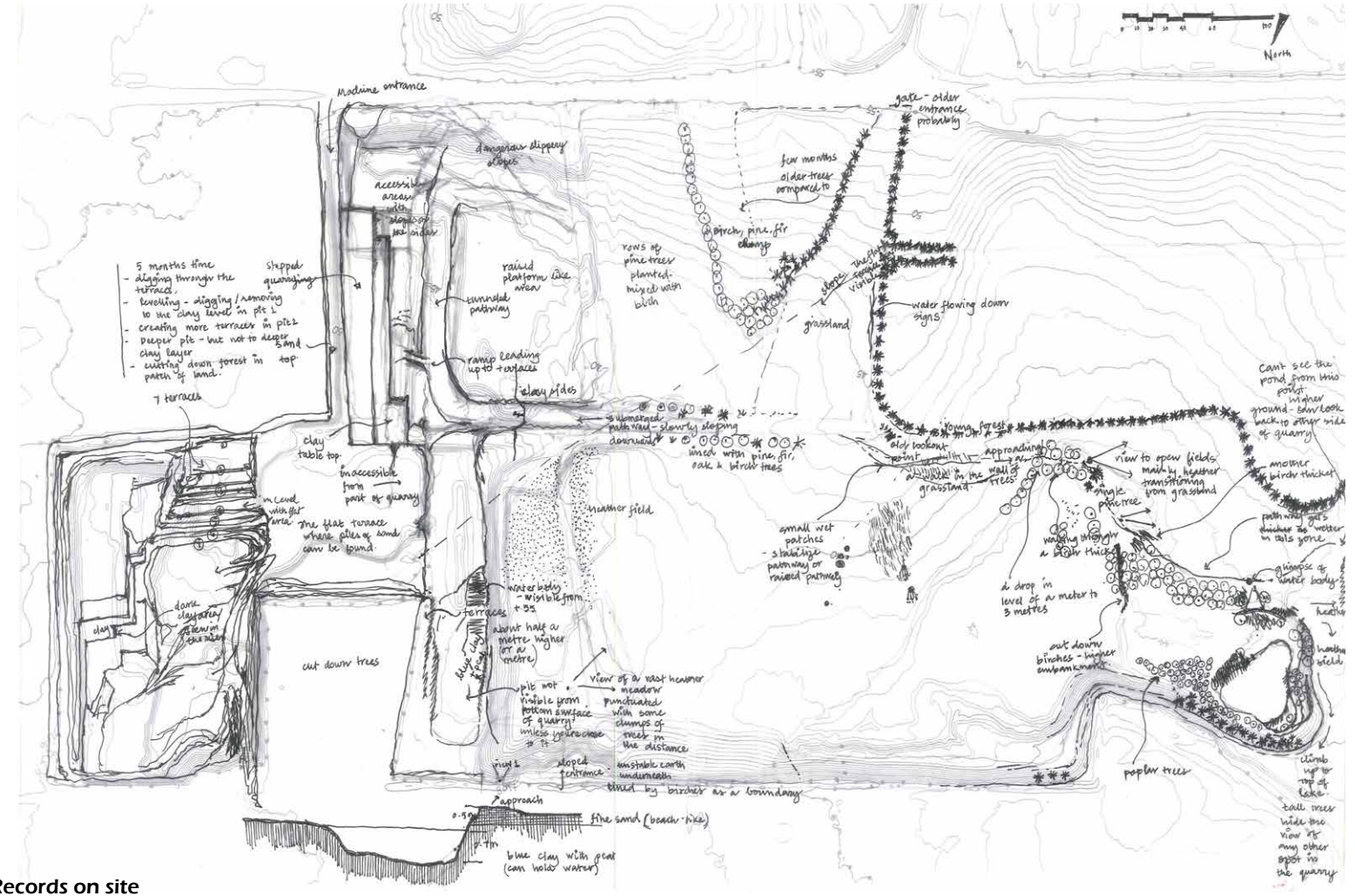
6 DISCUSSION AND REMARKS

6.1. REFLECTION. *The fascination in the beginning of the year for exploited landscapes led to a project based on which I have learnt a great deal. Looking at the end results, I can reflect upon the process which led me to them.*

The beginning stages of the project were inter-weaved with many questions about exploited l landscapes. Through the design process, I have come to realize that the lack of clarity in the beginning was only warranted because of the high variations in the characteristics of each type of exploited landscape. Like many students of landscape architecture, I had naively started off with the idea that I could solve a very major problem of exploitation of the earth's surface since it seemed like the mining industry will never come to an end. After two years of studying landscape architecture in the Netherlands, I am able to realize that my growing up in India had made me blind to the beauty in such landscapes. The levels of corruption and disruption mask the true identity of such landscapes. The initial stages of finalizing a site area however changed these beliefs. At the end of the project, I can conclude that the ways of looking at (reading) a landscape through different lens itself has an impact on the way interventions are employed on the area.

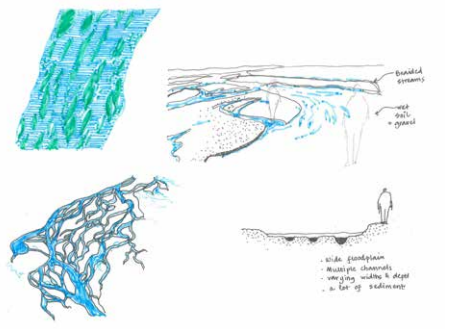
6.1.1. Relationship between the research and the design -the research method and application to other excavation sites

The thought about how man is not going to stop exploiting earth for its resources for at least the next century this led to the selection of a site where excavation will continue to take place for the next 15 years (or more). If I needed to design for the future excavations, it was important I understood how they did that in the first place. The lack of any straight-forward information about mining practices left me exploring by myself, finding new ways to understand this. My first instinct was to of course contact mining companies for this expert information, but soon I discovered that many of these companies have policies against disclosing information. Therefore, through many Youtube videos and Google search images (and common sense), I broadly concluded that there are certain machines which play the most important roles in the process, but I was still left questioning about the spatial qualities they create. Luckily, a site visit to the on-going excavation area early in the research process (October) helped me to get a grip on the spaces created during the process. The experience of feeling overwhelmed in the vast landscape drove a major part of the design. The site visit heavily guided the initial analysis steps. The experience of touching and walking on different materials in the quarry was very useful to the research process. **The combination of the technical understanding of the process along with the spatial experiences on site** *drove the research and thus the design in a similar fashion.*



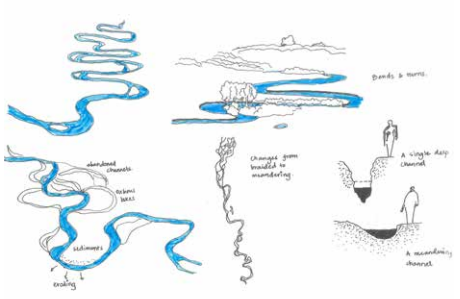
Records on site

The site visit further urged me to start thinking about the height differences, not only in the quarry, but also around the quarry. The bike ride up the hill near the border between the Netherlands and Germany had me questioning the sudden increase in elevation. This process turned out to be crucial to the research and the design since it led to the **geological reading of the site**. The curiosity about the extent of impact on digging made me to question how many years it would take for the earth to naturally compensate for this loss. This led to the understanding of many concepts which were translated later into design. At the end of the project, it has become more and more clear that the material of the excavation landscape is of primary concern which underpins the process of exploiting it. Therefore, the geological reading, along with the technical understanding of the processes involved, without losing sight that the site has experiential qualities can be employed on any excavation landscape.



6.1.2. The endless pit of variety in exploited landscapes

As discussed above, the research method is possible to employ on other exploited landscapes. The research conducted on this particular site mainly led to the need for a better balance of scale and proportion in the spaces in order to accentuate the machine-made spaces while still making it possible for human experience, the need for clarity about the (ecological and excavation) processes on site and to question the need for a program which drives the remediation of many "disturbed sites". The principles derived to tackle these needs respond to this particular site and are tailored to fit other excavation landscapes as well but one must be aware that there are a very many types of excavation landscapes, each differing greatly from one another. (On the right are some images to prove this) Therefore, the principles can be applied to other cases, but being mindful of the variations of context can help in tweaking the principles as per the changes. It can also be noted that the geological reading, the excavation process and the specific landscape can provide its own clues into the tweaking of the principles.



1. Stone Quarry
Image source: http://www.4x4explore.com/rds/s_rds/stone_qry.html

2. Iron-ore Mining
Image source: http://www.cet.edu.au/research-projects/iron-systems/projects/hypogene-mineralization-and-fluid-flow-in-selected-high-grade-bif-hosted-iron-ore-deposits

3. Slate mining belt
Image source: https://slateassociation.org/nature-characteristics-slate/

4. Diamond mine
Image source: http://www.mining.com/top-producing-diamond-mines-2016/

6.1.3. The design proposals as a response to the research objective

In the end, does the design respond to the initial objective or not? Does the design contribute sufficiently to the ecological, recreational and educational development of the excavation landscape and how does the research method enable this?

The development plan is proposed for the year of 2030 when the excavation is projected to stop, and the design focuses more on the experiences of the area where excavation is complete and where it is on-going currently. This is because future development of the quarry as a ripple effect to the interventions and guidelines proposed is at the crux of the project. The area where excavation is completed lacks the characteristics of a quarry landscape, and therefore, the interventions focus on this part, designing the routing which binds the design together. It is believed that not all parts of the landscape need to be designed in detail, but the spatial guidelines for future excavation will allow flexibility for various possibilities. A program is not necessarily required to be the only solution for remediation of such sites, whereas, they can also be allowed to be a part of an ecological network - a program for flora and fauna. However, if required and it suits the case, based on the context, different functions are possible for a given space. This can be clearly seen through the demonstration of visualizations.

The design and composition of the lake and its surroundings was one of the most important parts of the research-by-design process. It showed that **recreational development** *is possible by expanding the extents of the lake. The understanding of the layers of materials underneath helped in doing so. The search for the right placement of architectonic elements also helped to grasp the true spirit of the excavation landscape, i.e., the thresholds displaying various contrasts. The fluctuating water level and taking care of the water flow towards the lake ensures* **ecological development,** *along with steps taken to employ natural succession.* **Educational development** *is one that is implied since the design aims to make evident, the characteristics of the excavation landscape through subtle means. The walk along the axis towards the ruined rusted machine is intended to evoke the memory of the landscape and remind one about the activities on the site. On the other hand, the workability of such a project also involves literally educating the quarrying companies and workers about the impacts of quarrying in a certain way and ways of remediation. Therefore, the design facilitates the overall landscape development of the quarry.*

6.1.4. Relationship between the project and the studio theme, 'Flowscapes'

The project is part of the graduation studio, '*flowscapes*' under the MSc of Landscape Architecture. One of the main themes of the studio is to uncover infrastructures as landscapes and landscapes as infrastructures, and this project encompasses this theme. This demands that design be approached through a multi-layered understanding of the landscape, respecting the unique qualities of the infrastructure landscape. The excavation landscape is especially fitting to this due to the machines (infrastructure) that dominate it and the design being driven by this logic.

The "flow" of machines, materials, people, and ecology through the sculpting of the earth calls for design which pays attention to the landscape as a set of architectonic elements. There is a strong presence of green-blue elements in the site even though man carves away the land unaware of his fight against nature. The project creates this awareness and questions further developments based on these flows.

Research-by-design is part of the studio methodology which comes into play after the research stage to test the analysis and the effectiveness of the design principles. There was a constant tug between the formulation of the design principles, the overall development plan and the parts of the plan. The experiments and options during this process showed that there is always more than one way to apply the understanding on a site.

6.1.5. The role of the landscape architect

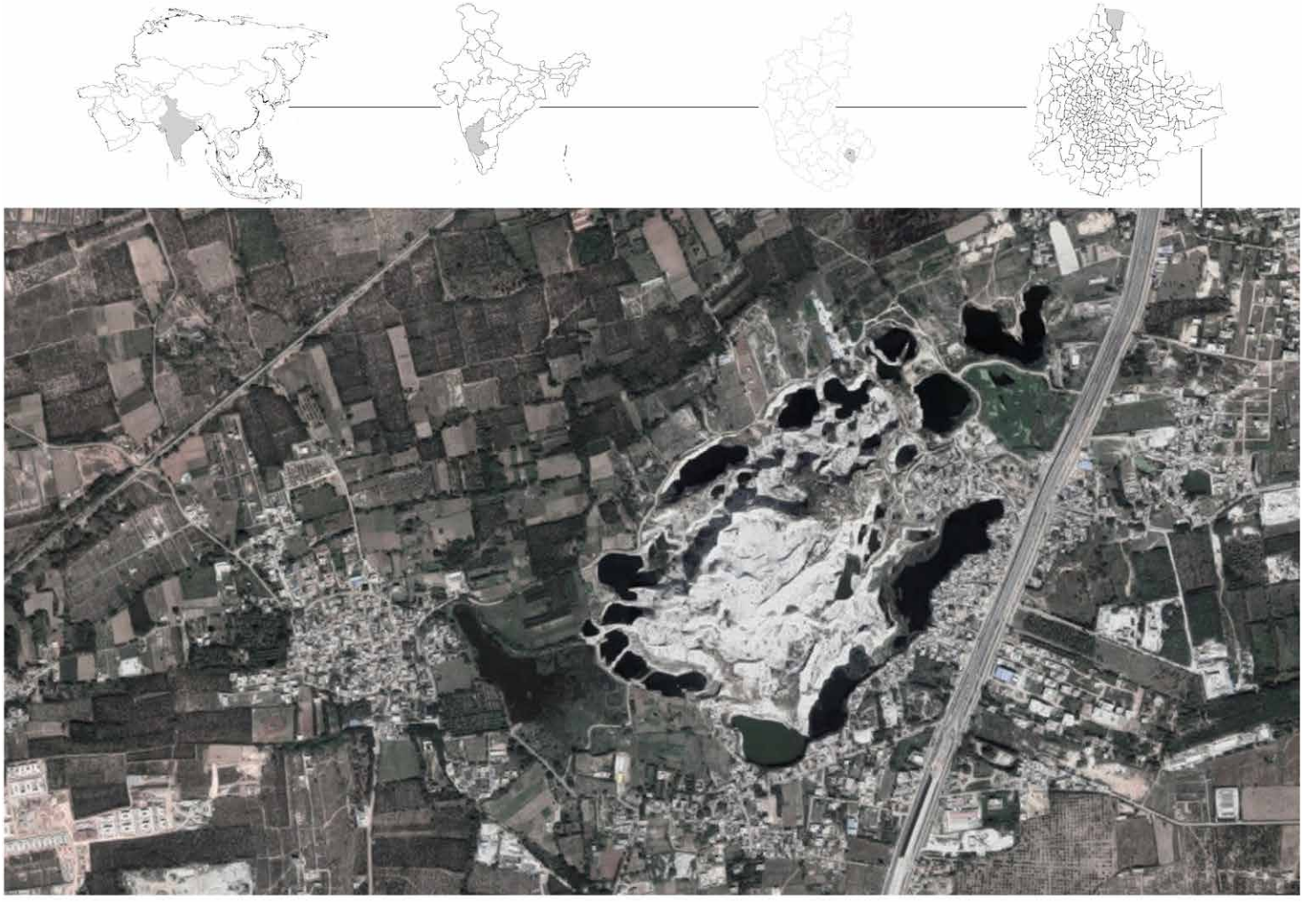
As mentioned earlier, the project aims to firstly create awareness and secondly, plan future excavations before they begin to ensure proper landscape construction. To achieve these goals, the excavation companies and land owners must involve a landscape architect in the planning processes. The landscape architect can in-turn also approach such companies to educate them about the challenges and potentials of such places from the landscape perspective. This will also help in a two-fold reading of the site - from the technical point of view and from the spatial-visual perspective. It is the role of the architect to then work with the technicalities and sensitively understand the economic needs of the exploitation while guiding to do the same to facilitate overall development during as well as after the processes are complete. The process of changing people's minds about such matters might be a tiresome one, but taking steps to educate them about the matter is a good starting point and it is the responsibility of the landscape architect to take these steps.

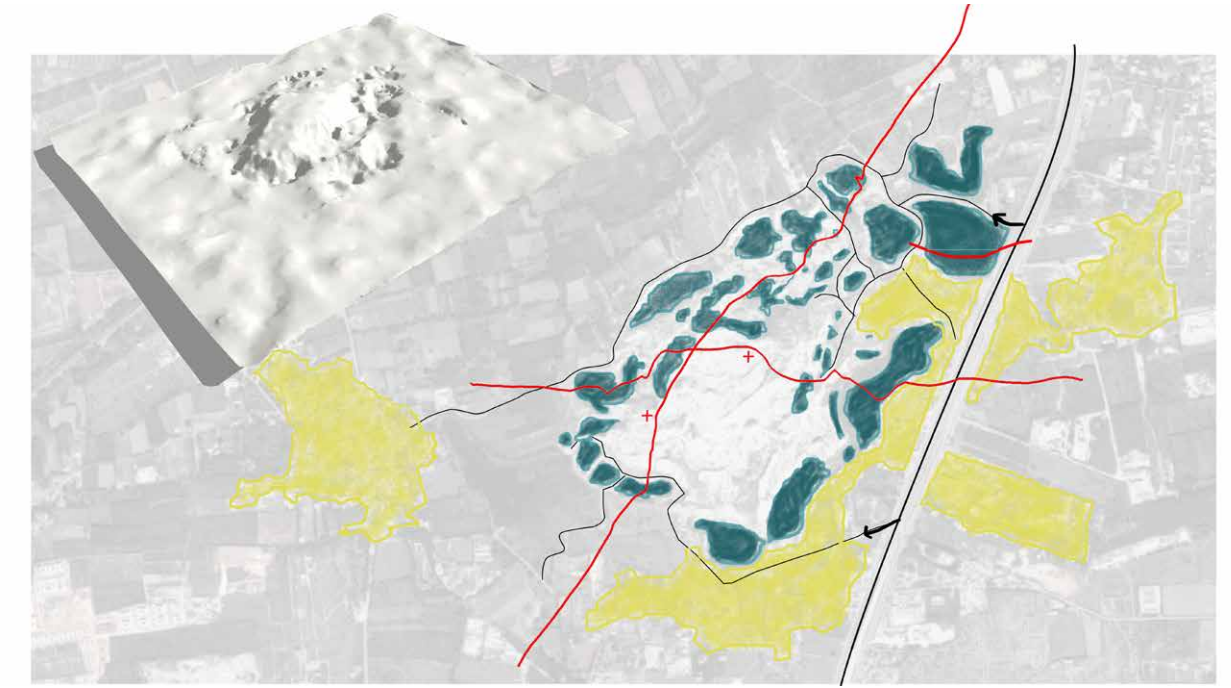
6.2. LEARNING THROUGH A TEST CASE. BETTAHALSOOR, BENGALURU, INDIA

6.2.1. Introduction. *To learn further from the thesis, another quarry of a different type is explored through the lens of some of the principles derived in the graduation project. The test case chosen is a stone quarry (stone extracted/blasted from a hill), Bettahalsoor located in the city of Bengaluru in India. For the sake of exploration and trying to check if the principles can also be applied to other kinds of excavation sites, a stone quarry is chosen.*

The chosen quarry in Bangalore was recently abandoned and requires attention due to many reasons. The main thing to note about the site is that the base material is stone and thus, there are numerous water bodies that form easily. The lower elevations of the villages and agricultural lands around the hill are constantly threatened by risk of floods from the water pools formed around the hill due to haphazard excavation. The micro climate of the region is in poor condition and the temperature is increased multi-fold because of the exposed rock surfaces that are not treated in any way. (Avg maximum temperature: 30°C and Avg minimum temperature: 23°C; Avg rainfall: 859mm) The water inflow (especially during the monsoons) exceeds the rates of evaporation and this poses a threat to the landscape. The site is also in threat of constant unplanned encroachments by the surrounding villages.

With this brief initial information about the site and its context, it is possible to quickly test some of the principles keeping in mind the Indian context.





Initial exploration of some principles.

Site model showing the terrain of the site which can be used for exploration.

6.2.2. Testing principles. *Water being the primary characteristic of this site, the principle of* **water gravitas** *can be tweaked to find some site-specific starting points. A site model revealing the terrain can be utilized to understand the water drainage in the larger context as well as for the smaller pools. The landscape types and ecotones are also governed by the slopes of the water bodies and their edges. Therefore, paying attention to them would be a good spatial starting point.*

But before addressing the water, one can understand a lot about the spatial qualities of the site by looking into the excavation process. Since blasting is one of the main methods used for such an excavation, the slopes formed in the smaller scale are more difficult to control during the excavation. Therefore, there must be careful consideration about the post excavation treatment of the uneven rough stone slopes.

6.2.3. Conclusions. The principles that are derived in the graduation project are specific for excavation sites and can be used as starting points for design solutions. One of the important conclusions of this exploration is that the principles are most quarry-specific when used in relation with each other. The application of two or three or more together will make the design stronger. The context plays a very strong role in the way in which these principles are applied. For example, the proximity of the villages and the agricultural fields calls for a proposal for the further expansion of the village without damaging the landscape, and the specific hill-like character to the site influences the other spatial choreographies.

That said, it is still possible to choreograph the experiences through excavation sites since there is no doubt that such sites have tremendous picturesque qualities to them. It has become evident that dealing with such sites is a complex matter due to possible ownership issues and bureaucracies that might be involved with them. Throughout the graduation project, one point that was repeatedly discussed was about the party that would execute any design that a landscape architect might propose. This is even more clear in the Indian context since the government bodies fear illegal activities (continuing exploitation of minerals) taking place once permission is granted to make changes to the site. Therefore, it is important to approach them with caution and to ensure that, at the least, some awareness is created in the process.

The project has been valuable in many ways to uncover the mysteries of excavation sites. Many of these sites still stand abandoned and in threat of contamination, many of which are yet to undergo unplanned changes. I hope that the graduation project can be a vehicle to drive addressing other such sites.

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Excavation processes construct landscapes with every move of the machine