

Milestone package 2

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Regeneration of the HZ student garden

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Abstract

The HZ student run garden faces the issue of lead contamination and the need to become future proof. Lead being toxic to humans generates a sense of urgency which sparked the need for this research. Research shows that both problems can be solved by changing the approach for the garden. The need for a solution that caters to these issues brought the research question to life: How can the HZ garden become regenerative? This was not the only concern however, follow up questions about the garden also rose to inquire: how can the quality of the garden soil be renewed using regenerative practices and materials? how can the renewed health of the garden ecosystem be maintained after the solution is implemented? And how can stakeholders be involved with implementing the plan to make the HZ garden regenerative?

To collect the data needed to inform the answers to these questions, interviews, literature reviews and observations were conducted and utilized for their ability to provide extensive qualitative research. Within the results came very applicable options such as using biochar to absorb the heavy metal from the soil while also stabilizing soil conditions. This is the keystone solution. To bolster this solution, supporting methods of regenerative gardening were chosen to be implemented alongside the biochar remediation. Some of these included organic composting, biodiversity of plant species, and the prohibition of harmful chemicals within the garden. There is an emphasis on getting the garden to a point where it can be self-sufficient in as many ways as possible with the guidance and stewardship of green office members. These sub solutions will provide soil fertility, ideal soil conditions as well as health and abundance of the garden and its components above ground.

Key concepts and definitions

Heavy metals

These are metals which have high atomic weights and densities, these aspects make them durable and non-biodegradable. This results in them being persistent in the environment, they accumulate in spaces and even different organisms over time being transferred from one to another through various methods.

Lead contamination

Lead is a heavy metal (Pb). This makes it persistent and allows for it to accumulate in the soil. The presence of it in the soil is a form of contamination as it is not naturally occurring there and makes the soil toxic since it is harmful for humans to ingest. This is especially the case for children and women who are or plan to be pregnant as it creates development issues for them as they grow up. (Sharma et al., 2019)

Soil regeneration/restoration

This refers to the process of using the chosen remedies – whatever they may be, to restore the health of the soil to where it may have been before it was contaminated. For regeneration to truly have been attained, the soil needs to be fully rid of its harmful toxin levels.

Bioavailability

The ability for a substance to be absorbed by the body or by other biological destinations and have an effect. A key point for soil remediation is that there is no need to remove all the lead that exists within the soil. Only the soil that is bioavailable to humans and the produce which is the only state in which it presents a threat to our health (Ogawa et al., 2018).

Regenerative practices

Implementing the solutions with the intentional use of regenerative soil practices means there will be only beneficial effects to the other aspects of the environment. Rather than the processes only improving the state of one level but also helping on various levels. This can be for instance, removal of other harmful substances besides just lead, minimising emissions during implementation, supporting biodiversity and adding nutrients for plant health (EPA, 2020).

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)

This instrument is an analytical technique and is used to determine the quantity of a certain element existing within a sample. This works by running an extremely hot plasma through the sample, this heat excites the atoms and ions of the sample element which causes them to emit light. Based on the frequency of the light emitted from the electron of each element, the instrument is able to determine which element it is (Paul & Saikia, 2021).

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Introduction

The project for this minor involves working with the green office of HZ University of Applied sciences. The green office's mission is to help the HZ become greener and more sustainable minded in as many ways as possible. One of those methods includes having a garden that provides some fresh food and ingredients for the school. During the past year, it was discovered that the HZ Garden is contaminated with a lead amount that is over the threshold and for human consumption. The contamination exists below the first 10 cm of the soil. This means, any food crop that has a root system which reaches past this depth will be susceptible to lead absorption. The initial drive of this project is to conceive feasible solutions which will be used to decontaminate the soil from which the garden grows to ensure only safe produce comes from it. Alongside the need to remediate the soil, the entire garden should be approached with the idea of regeneration at the forefront to maintain the high standard of quality once achieved. Everyone in collaboration with the developments of this research for the garden includes HZ experts such as lab technicians, research experts, Eva van Gameren a gardening coach from Instituut voor Natuureducatie (IVN), the green office coordinator, Ingrid de Vries, as well as fellow minor/ internship students and other garden experts. All of whom are eager to find solutions and make progress so that the garden can provide safe food regeneratively.

Lead is a naturally occurring metal from the Earth's crust and due to the rise of industrialisation, it has been spread more through neighbourhoods and cities like Vlissingen (Thompson, 2000). What makes lead contamination an urgent issue is the fact that it does not break down when in soil because it is a heavy metal so this buildup can come from the era where lead was still used in automobile fuel and house paint in the early 1900's. The multipurposed ability of lead enabled an overuse of the metal for decades and gave it time to cycle through our environment. Today, much of the world knows of the harm lead causes and its use is currently banned in many countries. However, its durable nature prevents its decomposition and allows for it to still be present in our soils, water, air and bodies where it can accumulate over time.

With the presence of broken-down lead in the garden soil, it can be absorbed by the roots of the produce and enter the bodies of those who consume it. Lead harms the human body in multiple ways. These include damage of the nervous system, increased risk of high blood pressure, cardiovascular illnesses, reduced cognitive function, kidney damage, fertility issues and can even cause birth defects for women who are or have yet to be pregnant (Koula, 2024). Throughout this report, the urgency of the state of the garden soil will be explicitly explained as well as what can be done to regenerate its ecosystem.

It would be ideal to achieve this outcome by using environmentally conscious and regenerative methods. Not having to use chemical-based treatments or replacing the soil completely with new soil for instance. It is imperative that the problem be solved using natural methods that benefit the environment in more ways than one.

During the research phase, it was determined that a much different approach than what was intended needed to be explored. The research had to evolve from only solving the issue of lead contamination in the soil to becoming a wider ranging solution that will provide a future where the garden in all aspects can thrive.

Considering the change in this research approach, the purpose became geared more towards creating a framework for regenerative gardening that can be built around the main solution used to decontaminate the soil. According to Newton et al. (2020), “Regenerative agriculture is an alternative means of producing food that, its advocates claim, may have lower—or even net positive—environmental and/or social impacts”. The purpose of using this approach is to bolster the effectiveness of the chosen solution by ensuring all other aspects of the garden are considered and catered to using regenerative methods. This future for the garden is not achievable alone, the solutions provided by this report will require a team effort from the green office students of future years to be implemented. Regeneration within the HZ garden will allow the garden as an ecosystem to thrive and produce quality food in high yield once done efficiently. The report explores how this can be achieved in a way that aspiring green office gardeners can take initiative to dive even deeper into research or spark movements in the garden to bring the results to life.

The main question that will guide the research is: How can the HZ garden be regenerative?

To support the answer to this question and provide a wholesome result, other sub questions must be posed and considered, which are:

- How can the quality of the garden soil be renewed using regenerative practices and materials?
- How can the renewed health of the garden ecosystem be maintained after the solution is implemented?
- How can stakeholders be involved with implementing the plan to make the HZ garden regenerative?

Much consideration will go into determining how the HZ garden can become regenerative and have its soil health restored. The chosen solution is ultimately expected to fulfil this goal while taking all components of the garden into account, aiming for the most impactful results in a relatively short timeframe and developing an understanding of what it will take to maintain this regenerative nature in the garden. The feasibility and applicability of the final solution will be determined through extensive data analysis.

Theoretical framework

In this section, technical background on the research topics will be explored. This gives context on how the potential solutions work and why having them implemented is an urgent matter. This will allow for the entire report to be more relatable to readers. There will also be an explanation of the report layout, this is to provide an understanding of how the research process developed and evolved overtime.

Wide scale research has already been conducted and implemented in the field of soil decontamination so there are multiple possibilities to be explored. Some of these include mixing fish bones into the soil to draw out the bio available lead from the soil. Fish bones contain high amounts of apatite - $\text{Ca}_5(\text{PO}_4)_3$. This is a phosphate mineral which readily fuses with lead to form the crystalline mineral pyromorphite - $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$. This and other phosphate-rich compounds are being utilised in the recovery of lead from soil because once chemically bonded, the lead is then no longer bioavailable for humans (Freeman, 2012).

Secondly, applying a layer of activated charcoal has been shown to absorb lead content within the soil. Like the fish bones method, they bond chemically with the lead and make it less bioavailable and harder for plants and produce to absorb due to it being less prevalent (Thakur et al., 2014).

To form a concrete decision, a multi criteria analysis was conducted to break these ideas down based on their ability to satisfy every criterion that should be met. This allowed for a detailed analysis which highlights the strengths of both solutions based on how well they can deliver effective solutions. The MCA allows each solution to be graded using a point system. Points are rewarded based on the ability for the solutions to meet each criterion. The solution which tallies the most points will become the keystone solution.

Current regenerative efforts:

Removing the topsoil (first 10 cm) and covering the contaminated soil with a thick layer of clean soil and organic matter like manure and mulch is also useful. This allows for the contaminated soil to now be out of reach of the plants' roots preventing lead absorption completely (EPA, 2020). It provides a barrier from contamination but also could be quite a costly and labour-intensive solution. This method is recommended by experts to be the quickest and most guaranteed fix. It has been used in the garden for roughly three years; this secures the topsoil layer from being polluted. The efforts being made now will be to remediate the soil on deeper levels. This will prevent the cross contamination from lower soil to upper soil and ensure the health of plants with deeper root systems.

Why is lead in the soil?

Lead can become present in soil content by paedogenic and anthropogenic processes. Paedogenic refers to processes taking place within the soil, anthropogenic means any effects that are originating from human activities (Hao-wang et al., 2021). Due to the industrial nature of the city (Vlissingen), it is expected that the source of the soil contamination is almost entirely

anthropogenic. The contamination could be coming from the nearby factories where plume and exhaust can travel far distances, nearby waters of the harbour where boat parts, grease, ballast water and exhaust which also can contain traces of lead. These particles can travel on the wind far from their source and get trapped in soil in various ways.

Lead (Pb) can end up being retained in the soil by processes like adsorption, ion exchange and precipitation. Adsorption, meaning the Pb ions adhere themselves to the surfaces of soil particles, which results in reduced mobility of the lead. Once attached to soil particles in this way, the lead can remain in the soil for as much as 1000+ years (Brzozowski, 2022). Ion exchange refers to Pb replacing the positively charged ions of the soil particles. This reaction binds them together and creates the same immobilising effect and keeps them within the soil layers in forms that are insoluble. Thirdly, precipitation involves Pb reacting with components in the soil content to form insoluble compounds such as lead carbonate or lead phosphate. They also help to prevent lead from entering groundwater by leeching. The effectiveness of these processes is dependent on soil properties like pH levels, organic matter content and mineral content.

Nontoxic soil is ideal for the health of the garden because it is when the lead compounds are least toxic and bioavailable. It is when the Pb is unbound (not having been molecularly combined with another element to create an insoluble compound), free flowing and soluble which is undesirable for safe crop cultivation and safe for contact. This is the state where the lead is dissolvable and can be transmitted to humans, negatively affecting our health. (Zeng et al., 2017)

Equations:

$3\text{Pb}^{2+} + 2\text{PO}_4^{3-} \rightarrow \text{Pb}_3(\text{PO}_4)_2$ - this equation depicts the reaction that combines lead with phosphate to form lead phosphate. This can happen in the soil when phosphate is added and make the lead become no longer dissolvable.

$\text{Pb} + \text{CaCO}_3 \rightarrow \text{PbCO}_3 + \text{Ca}$ - this is the equation showing what happens when calcium carbonate (lime/limestone) is added to lead contaminated soil. It influences the soil making it less acidic as well as combining with Pb to form lead carbonate and calcium. Calcium is a byproduct of this reaction which strengthens cell walls of roots, promotes shoot development and enhances pest and disease resistance (Gary et al., 1999). So, this is a multi-purposed method of reducing lead.

These reactions are just a few of many that can prove beneficial for the reduction of lead levels in soil. They will give context to the remediation strategies that were in consideration.

How do we contract lead contamination?

The ability for lead to enter the body differs between that of children and adults. Lead can enter the body from the soil through ingestion, inhalation and dermally. When ingested by adults, 3 – 10% of the lead is absorbed into the body while the rest is released through the body via defecation. For young children and infants, the absorption of lead is much higher, reaching 40-50% (WHO, 2021). They absorb lead more efficiently in the gastrointestinal tract because of multiple biological vulnerabilities such as deficiencies in iron and calcium which occur in most children, immature liver detoxification and underdeveloped biological protective barriers from the nervous system (Adelsohn et al., 2010). This lead can be made available for injection by being on the produce, which is why washing your produce is an important step to safely ingesting it.

The second likely way for lead to enter our system in through inhalation, this mainly impacts those who work in and with the soil like the University grounds keepers and green office

members who participate in garden sessions (UK gov, 2024). Lead particles that are inhaled are absorbed in the respiratory system, with smaller particles finding their way to the lower respiratory tract and the bigger particles settling in the upper tract. The small particles in the lower tract are 100% absorbed and the larger particles are transferred by peristalsis and mucus into the gastrointestinal tract where it is then ingested.

Based on the tests ran by MCG Zuidwest, the lead levels from six samples came back with varying results. Three of these tests returned positive (marked green and labelled <LN). This means they are under or at the limit of concern. Two other test samples returned labelled as living (marked yellow). Here it's referring to the lead levels being at amounts expected in moderately developed areas, which is the level of development Vlissingen currently is. The resulting values of these tests are 84 mg/kg ds and 110 mg/kg ds. In the final test sample, the measured lead level was found to be 227.53 mg/kg ds, this value (marked amber) was labelled as industrial which explains that this is a level of lead expected in an industrial region. The upper limits of lead presence in soil for the EU is 50-300 mg/kg ds (Nag & Cummins, 2021).

It is clear that some areas of the garden are not stricken by high level of lead while some are of concern. These concerns are not dire in regard to governmental standards. However, the green office wants to take these results seriously and try to reduce the concerning values to be under or at the limit of concern (marked green and labelled <LN). These test results can all be found in appendix 6.

The ability to absorb lead from soil differs in different plant species. Fruits trees, for instance, are less likely to absorb lead from the soil. This is not the case for leafy or root vegetables. They are quite susceptible to lead absorption and have greater chance of transferring this absorbed lead to those who consume it. Because of this range, the idea is to ensure efforts are taken to make the soil generally healthier (Jia et al., 2022)

Effects of over exposure to lead contamination on the body

There are some significantly harmful effects of lead contamination on the renal system, this includes impairing the ability for the kidneys to reabsorb essential nutrients like phosphate or glucose. This limits the body from producing energy and creating new cells. After prolonged exposure and contamination, the body may be put at risk of hypertension and gradual loss of kidney function (Elinder & Evans, 2015).

Additionally, the reproductive system is also put at very concerning risk. Lead exposure has been linked to reduced male and female fertility. More specifically, reducing sperm mobility, count and disrupting their morphology. For women, prolonged exposure may disrupt menstrual cycles, increase the risk of miscarriage and hinder proper foetal development. (Santana et al., 2023)

Moreover, the impact of lead on the cardiovascular system is quite glaring and includes a number of issues. These include hypertension (high blood pressure), which has a major impact on the ability to get heart disease or stroke. It also negatively affects circulation by disrupting calcium regulation by mimicking calcium ions due to their similar chemical structure. This allows them to be able to enter the cells and displace much needed calcium in the process. It also interferes with the function of nitric oxide in the blood which is a molecule that allows blood vessels to relax. For these and other reasons, the presence of lead in the circulatory system affects vascular health in general and poses a serious threat to those who are exposed to it for prolonged periods (Liu et al., 2023).

Lastly, the most referenced and discussed implications of lead absorption on human health has to do with the nervous system, particularly the effects it has on children and their neurological

development. To be more descriptive, the presence of lead in the body hinders with the function of neurotransmitters. This results in a disruption of calcium dependent signalling which allows for the brain respond to cues and grow. This ends up creating cognitive deficits, behaviours and attention disorders as wells as reduced IQ. This not only can happen to children from their own experiences with absorption but also can be absorbed through their mothers during gestation period (Chen et al., 2012). Adults are also affected by lead absorption in the nervous system, which can increase the risk of memory issues and mood regulation disorders (Stewart & Shwartz, 2007).

It is not expected that students and staff spend an extremely long time working in the green office garden to contract chronic side effects and health issues. However, for anyone who will spend prolonged periods interacting with the garden soil and its produce as well as the students who do spend time there, the accumulation of lead in the body will only increase every time contact is made with contaminated soil and the objective is to completely eliminate this possibility as being a step in that process of accumulation for anyone involved.

Scientific Foundations of the Initial Two Remediation Methods

Solution A: Fish Bone Amendment (Phosphate Immobilization Theory)

The chemical make up of fish bones contain a specific type of calcium phosphate known as hydroxyapatite ($\text{Ca}_5(\text{PO}_4)_3\text{OH}$). When mixed into lead contaminated soil, a reaction between hydroxyapatite and the soluble lead creates the compound pyromorphite ($\text{Pb}_5(\text{PO}_4)_3\text{Cl}$) (Eliades, 2023). This is a very stable mineral which is also insoluble. This is a reaction known as phosphate-induced immobilization (Referred to in the equations above). This specific phosphate induced immobilization significantly reduces lead bioavailability without having it removed from the soil, instead, it draws the dissolvable lead to it and creates a compound of crystalline structure (Xu & Schwartz, 1994).

This method is a relatively passive means of remediation; there is no direct human action that can be done to remove the lead from the soil. Rather, the remedies must be implemented and from there patience is needed to measure the effectiveness. The soil conditions, however, also need to be managed to ensure effectiveness. This is because phosphate tends to bind more willingly to iron or aluminium when the soil is very acidic. Therefore, a pH that is slightly acidic to neutral is required for max efficiency as now the lead will be more willing to bind with the lead in the soil.

Implementation of this method would involve depositing the bones into holes made in the soil that reach beneath the top layer of soil. To make this an easier process, they can be ground into finer pieces as well, this however, is not necessary.

Solution B: Charcoal Amendment (Utilising Biochar/Sorption theory)

Charcoal in the form of biochar is a porous carbon-rich material produced by placing organic matter under pyrolysis with little to no presence of oxygen. Like a sponge there are many holes and pores in the biochar which means the surface is quite high. This excessive surface area allows for a lot of opportunities for absorption of heavy metals like lead. The surface of biochar has various chemical groups such as Carboxyl ($-\text{COOH}$), Hydroxyl ($-\text{OH}$) and Carbonyl ($-\text{C}=\text{O}$), these chemical groups bond with the lead in the soil via electrostatic attraction, exchange of ions and creating stable bonds (Guo et al., 2020).

Biochar is also used also to increase the pH of the soil (making it less acidic/more alkaline) due to its naturally neutral pH value. This aids in also making the lead less bioavailable. Biochar also replaces its own positive cations like Ca^{2+} and Mg^{2+} with those of lead Pb^{2+} and other toxic ones. Biochar also tends to contain silica, phosphates and carbonates

(similar to the fish bones) which are able to bind and react with the lead in the soil and make it immobile (Nguyen et al., 2023).

A recent study was done to compare the absorption efficiency between rice straw biochar and sewage sludge biochar. Results showed that a dosage of 12g/kg (12 grams of biochar for every 1 kilogram of soil) of rice straw biochar can reduce lead bioavailability by up to 38.7% and for sewage sludge biochar the reduction rate can be up to 34.5%. This shows clearly the ability for biochar to provide significant remediation of lead bioavailability. Different versions of biochar may produce varying absorption efficiencies; however, a significant reduction will always come from the application (Newton et al., 2020).

MCA Overview

An MCA was used to determine the ideal solution between the two. The criteria chosen were effectiveness, timeframe, sustainability, material cost, maintenance and workload. They were all weighted differently based on importance and influence on the final result. The criteria were chosen using aspects of a project that would guarantee success on multiple levels. These aspects include how well the problem becomes solved from the solution. Also, how possible it is to implement the solution within a specific timeframe and budget using the resources available to do the work. The winning solution of the MCA was Solution B: biochar amendment.

A full extent analysis of why Solution B won can be found in Appendix 1. To summarize, biochar is beneficial to the soil in many ways apart from absorbing lead. It sequesters carbon, balances pH, fertilizes the soil and promotes biodiversity. Fishbone amendments address less issues than this.

The method of implementing biochar in the soil is predicted to be an easier experience than that of fishbones. This is due to how they will both be retrieved and the ease with which they can be handled. The processes vary quite a bit where workload is concerned with biochar being dropped in holes in the soil and fishbones needing to be mixed into the soil.

There are more possible chemical reactions between biochar and lead than fishbones and lead. This makes the remediation process take less time for B than it would for A. Sustainability is higher for biochar because it absorbs carbon from the air in and around the soil whereas the decomposition of the fishbones releases carbon. Biochar is made through a process called pyrolysis. This process burns the organic material at such a high temperature that most of the atmospheric carbon that would come from the material is turned into solid form. This prevents the emissions and allows this carbon to be put into the ground where it will be sequestered for centuries, essentially removing it from the earth's carbon cycle (Afshar & Mofatteh, 2024). These are the results that propelled biochar as the winner of the two solutions.

Evolution of the solution

Further research proved that more would be needed to bolster the solution that was chosen. This is the best way to ensure that the chosen solution is layered and can address a most of the issues that can occur in the garden. The idea was no longer solely on soil health, now it had grown to address the overall health of the garden. An emphasis will be on choosing supporting regenerative solutions that will complement the biochar remediation. The end result should be an informative outline of methods that could be used to make the HZ garden regenerative. Regenerative gardening is the strategy of using natural processes to secure the general health of a garden (Khangura et al., 2023). The decision to take the research in an alternative direction was made concrete during an interview with the lab technician of HZ University of Applied Sciences. In this meeting, some aspects of the methodology were found to be impossible in achieving the desired outcome. Therefore, the logical next step was to broaden the scope of the research, enabling a more well-rounded solution as well as much more

followable concepts and plans for readers and garden keepers in the future. The interview can be found in Appendix 2 as it can provide more insight into how this current decision came to be. This framework can also build and be used as a foundation for further research which can optimize the solutions' strengths and help direct HZ green office gardeners in the future.

The solution evolved to become a framework to making the HZ garden regenerative using a hybrid method which focuses on three different points of emphasis. These are:

1. Regeneration using nutrients
2. Regeneration using biodiversity
3. Regeneration using proper practices

Regeneration using nutrients

Within this phase of regeneration, the biochar will be implemented into the garden soil. This will be the focal point and foundation of regenerating the garden. To be thorough in considering the different components of the garden ecosystem, various layers/systems within the garden will be addressed. This allows for deeper understanding of how the solutions affect the systems within the garden and makes it easier to pinpoint what is needed to secure the health of the entire garden. A description of these layers and how they'll all be influenced by the regeneration methods will be made clear in the methodology and results (Chen et al., 2023).

Mulching

Mulching and organic composting will also be used within this phase of using nutrients to regenerate the garden. They will be used to support each other by addressing the various requirements for garden health and come together to achieve a sense of total well-being. Mulching is the act of covering soil with organic material (Bogunović & Filipović, 2023). This organic material can be in the form of wood clippings, leaves, grass, twigs or straw. The presence of this organic cover provides a porous top layer for the soil, one which has pores of varying shapes and sizes. The pores allow for water to infiltrate less harshly; surface runoff is drastically reduced due to this and guarantees better soil structure (Thakur & Kumar, 2020). As the mulch decomposes, the organic matter within the soil increases and works as a kind of binder that holds the soil together. This is a very effective protective measure against soil erosion.

The decomposition of mulch (organic matter) creates nutrients for many soil organisms, these organisms in turn recycle these nutrients and increases soil fertility. Mulch provides a thick cover over the soil which creates a moist environment underneath and enhances temperature regulation. This is due to its ability to mitigate the harsh external effects like evaporation, which is reduced due to the presence of the mulch barrier making the exchange of water between air and soil much less frequent. Also, it prevents the weather and climate induced temperature change from having a direct effect on the temperature flux within the soil – also due to its role as a barrier against the harsh elements (TECA, 2020).

Organic composting

Composting is the process of collecting biodegradable food scraps and organic matter allowing them to decompose and get broken down. The broken-down organic matter that comes from this can then be used as fertiliser when mixed into soil. The byproducts of the chemical reactions that take place within composting are nutritious for the growth of plants and for the ecosystem of the soil. Soil organisms like earthworms, fungi and bacteria thrive off this decaying matter and return good health to the soil which in turn also feeds the plants (Ho et al., 2022).

Whether this compost is externally sourced or developed on site, it needs to be properly curated. This means it went through the four phases of the composting process and includes no impurities such as plastics which are not organic or biodegradable. The four phases as mentioned ensure the compost reaches its optimal ability to provide nutrients to the soil. These are mesophilic, thermophilic, cooling and maturation phases. Compost that is acquired from a company or another external source, must go through this sort of curative process. If not, it is also possible to collect food scraps for the garden and occasionally add them to the soil, this will also increase bioactivity in the soil, releasing nutrients, increase moisture content and providing good soil structure. Not only is this good for the soil health and fertility but it also improves the health and quality of the plants which grow in the garden (Ho et al., 2022).

Lastly, having a balanced C:N ratio allows organic matter to decompose efficiently in the soil. Including compost or food scraps in the garden soil ensures that this balance is kept. As the organic matter in compost is broken down carbon and nitrogen are both released at a controlled rates that will not overwhelm the plants. It acts as a slow, natural fertiliser because carbon acts as a crucial energy source for microorganisms living in the soil and nitrogen is needed to provide proteins necessary for plant growth (Brust, 2019). Phosphorous is equally important for the soil health as it is considered as deeply necessary for the germination of seeds and their early growth phases (Malhotra et al., 2018).

Regeneration using Biodiversity

Having a biodiverse garden has an array of positive benefits for production and health. There can be biodiversity in both flora and fauna around the garden.

Firstly, biodiversity in the garden's flora (plant species) is highly important to its overall health. According to HZ garden expert Eva van Gameren, including a variety of plant species provides resistance against plagues and diseases. Their ability to spread from one plant to another is limited because not all plants will be as susceptible to the disease as others. This method is polyculture, and it benefits more than just plant health. It improves soil health as well because of their different root types improving soil structure as well as the ability for plants to recycle nutrients in the soil in different ways. Polyculture also provides a diverse food source for a larger variety of pollinators, other insects and even microorganisms. Which leads into the next point.

The inclusion of varying fauna in the garden will bolster the health of soil and crop yield. Below ground there are many kinds of beneficial bacteria which feed on decaying plant matter and contribute heavily to nutrient cycling in the soil. Earthworms as well help in breaking down organic matter and converting it into the necessary nutrients needed for plant growth, they also help in soil aeration and bringing organic matter from the surface into subsoil

layers. This enhances the health of the soil in areas gardeners cannot reach, making their presence very necessary. Above ground, there are two categories for beneficial species: pollinators and predators. Pollinators such as bees, beetles and even small birds promote fertilization and cross pollination within the garden. Predators like ladybirds and spiders protect the garden from harmful insects that destroy produce and bring diseases to the crops (Sweetser, 2025).

Parasitoids have the same protective effect by laying eggs on other harmful insects which end up killing them. Enabling these insects to be live freely in the garden will increase overall crop yield during harvest time (Wood, 2023).

Regeneration using proper practices

One crucial point of attention for regenerating the garden's ecosystem is the use of no chemicals. Nonchemical use promotes soil health and supports biodiversity by removing harmful pollutants like synthetic fertilizers, pesticides and herbicides which disrupt the health of important soil organisms. These include earthworms and bacteria; their jobs, as mentioned before, result in the maintenance of soil fertility and structure. When these harmful chemicals are used, and these organisms reduce in numbers, the need for more artificial inputs increase even more (Beaumelle et al., 2023). This cycle causes the eventual degradation of the garden, pushing the soil closer to a state of barrenness and infertility. Chemical use in gardens also harms pollinators like bees, butterflies and other insects by weakening or even killing them in some cases. They can also alter or remove the scent of the flowers which changes how well they are able to be detected by pollinators (FWF, 2024). For these major reasons is why refraining entirely from the use of chemicals is necessary in maintaining the health of the HZ garden

Having standards that are upheld in the way the garden is cultivated and treated makes it less likely that harmful or degenerative practices and substances are not used in the garden. This secures its health.

Methodology

The type of research was shifted during the process out of necessity to accommodate for time and effectiveness. This led to the methodology being mostly geared to qualitative data and information that would inform the solutions.

Initially, the plan was to conduct lab tests to evaluate the reduction of lead and contaminant levels before and after the implementation of biochar. It turned out that it wasn't possible to retrieve the instruments needed to complete the test in mind. Based on this, the plan was changed to develop a much more wholesome solution for the garden. To achieve this, data was collected from researching the idea by reading multiple literature reviews, interviewing garden experts and a lab technician at the university.

The data collection for this project took place during an allocated research phase held between April and July. This data was collected and formulated to target students and staff in the green office specifically. This allows for the report to be used as a guide and teaching tool which informs the green office on the proper practices to carryout as a caretaker of the garden. It was also important that the methods are introduced and explained in a way that can act as a basis for new research to be done in the garden by future green office students. The intention was also to make this a welcoming study/learning tool to readers outside of the green office who may also be interested in gardening or farming. Students of the green office were chosen as the main target group because the garden is student lead with the guidance of garden experts. Green office students can use their ability to propose and initiate plans to implement these new regenerative practices into the garden. From personal experience as a research minor student at the green office, it was discovered how helpful it could be to have a foundation from which a deeper research report can be made.

To make the data collection phase be more seamless, it was important to determine what would be the data sources for this research. For instance, ideas of the various methods that could be used in the garden was found by interviewing garden experts. Through these interviews, new ideas were introduced based on their experience working in and caring for gardens. The literature reviews provided researched scientific insights into the regenerative solutions while suggesting new ones in the process. They were necessary in proving the effectiveness of these solutions and ensuring their ability to be implemented into the HZ garden. Interviews and observations were also carried out with experts within the school. They were able to further corroborate the feasibility of certain solutions and allowed for decisions to be made on whether they should be researched further. To structure the research properly, it was important to indicate layout of the general concept which was being written about. To do this, the general idea of regenerating the HZ garden on all levels was further segmented into the three different methods of achieving garden regeneration: via nutrients, biodiversity and proper practices. Within each of these there are gardening methods which were proposed during interviews and found in literature reviews which informed the topics and subtopics (regenerative solutions) that would be explored.

To analyse the range of literature sources which address regenerative gardening practices, Grounded Theory methodology was chosen. By using this approach, the data was examined inductively. This means theories were developed from the collected data as opposed to deductive examination which retrieves data from theories. This was chosen because theories and conclusions on what methods and practices would be used in the garden had to be made from data collected on those methods and practices. The reviewed literature provided a variation of strategies – these include organic composting, biochar application for the

remediation of the garden soil, mulching, fostering biodiversity of flora and fauna, and avoiding chemical use of any sort.

Open and axial coding was used to categorise the practices based on their ability to provide regeneration to the garden ecosystem. Open and axial coding were highly necessary steps in the analysis of this qualitative data. In open coding, the data was broken down into discrete parts, for example, literature on the effects of composting would be under regenerative garden practices. This was done to label them as methods that would contribute significantly to regeneration. To do this, the data was carefully read through without any expectations of what it's saying. Allowing the data to speak for itself in this way gives it a chance to be interpreted in its truest form. It also can be done by asking open questions in interviews that allow for the interviewees to think of their own solutions and suggest their own methods. This is opposed to asking leading questions that allow for answers to be only given on a specific idea or topic. Similarly, reading research on topics that address regenerative gardening methods can allow for fresh ideas to be introduced rather than starting off by researching specific topics. From this very raw and broad data, labels can be made when recognising patterns and common appearances. These recognised patterns lay out the steps that should be taken as further research is done. It became clear which topics are worth exploring further and which did not help the current research question to be answered.

In the axial coding phase, similarities in the different open codes were noted and then used to create subcategories within the context of the main idea. An example of this could be how biochar, organic composting and mulching were all allocated in the subcategory, regeneration using nutrients while, biodiversity in flora and fauna were given their own subcategory. This was done because they are different ways how the garden can be improved by using these practices and to keep them organised, those with similar approaches were grouped together (ContentSquare, 2024). Data saturation was reached as the interconnected aspects of each method were highlighted consistently throughout the data collection process.

Regenerative gardening was defined in the theoretical framework as a strategy which involves using only natural processes to improve the health of a garden according to Khagura et al., (2023). There are multiple approaches that can be taken to achieve garden regeneration such as increasing nutrient content in the soil, utilising only natural/regenerative garden practices, planting and accommodating the diversity of species in and around the garden.

To be sure that the research instrument would be robust theoretically, the concept of regenerative gardening was operationalised into observable sub concepts. These include, regeneration using nutrients, biodiversity and proper practices. Every sub concept was subsequently divided into indicators; these indicators were possible to find after conducting preliminary research and interviews.

The interviews were curated in a way that would allow the interviewee to speak freely on the ideas that come to them, they were able to express which methods meant the most to them in terms of garden regeneration. This was the ideal design due to the ability for raw information to be clearly express and later reflected in writing. If the interview questions were more closed and specific like 'define biochar remediation' or 'how to regenerate the garden using nutrients', it would be expected that the answers would be bottle necked in nature rather allowing a range of new topics and suggestions to be presented.

The three sub concepts, although robust, needed to be operationalized further to help in giving a direction to doing deeper research. Without that guidance, the developed plan would be unclear and less defined. The exact broken-down structure of each concept can be found in table form in Appendix 3.

Ethics

To be intentional with protecting the identity of respondents and interviewees, an effort was made to refrain from using the names of these individuals. It was deemed necessary only to mention the role of the respondents to give context to the reason why their opinion was identified as useful and relevant to the research topics. For instance, interviews and discussions took place with the HZ lab technician for their expertise on what tests can be ran to give supporting data to be researched. Similarly, a fellow student at HZ who studies Chemistry was also consulted about the feasibility of using experiments to retrieve useful data. The HZ Garden experts were involved in interviews and discussions because of their understanding of garden health and cultivation which provided much needed ideas for strategies to be used in the garden. This is the form of research used to give the research more form in the earlier stages. With the help of the above-mentioned individuals, the initial data was given the direction in which it should continue forward. This led to them being divided and operationalized in the way they were.

Validity

The validity of the research is determined by appropriateness of the research method used to find the data. It is a measure of how effective the means is at retrieving the data that will help in creating a relevant result (Taherdoost, 2016). The validity of the data was confirmed using the different types of research validity tests. The first of these is face validity. This is the weakest of the tests as it is a subjective method for proving how valid the data is. The test is conducted by reading the information and discerning on a personal level whether what is read matches tonally with the themes that are to be discussed throughout the report. It works to ensure data will appear relevant to the reader. Secondly, content validity was assessed to determine the usefulness of the data being gathered. This can be determined by allowing for individuals with expert backgrounds on the specific topic to read through and corroborate with what is being written. This is a form of proof reading which gives the research a stamp of approval from experts in the field who agree that the work is truthful and accurate. Without these approvals, the work may reduce in credibility as it can't yet pass as universally true or accurate research. This was not fully possible during this research, however, the data which informs this report comes mostly from accredited sources which were formerly peer reviewed. Being that this report exists as a regenerative gardening framework rather than a report which uses values which require an expert's approval, it is protected – to an extent from containing an oversaturation of incorrect data and misinformative research. This, however, does not mean this report is safe from uncertainties. To mitigate these uncertainties, the developments of the report were often made known to the experts and discerning figures who were present. Garden experts, green office coordinators and research coach were all external opinions which were considered in the writing of new material as well as correcting existing material. By utilising the expertise of others, the work outcome of the research became more seamless, robust and relevant to the garden itself along with those who will benefit from it. Unnecessary and unusable data was removed and replaced with solutions that would provide the most impactful results in the garden and that is due to the presence and involvement of the experts who were present.

Within content validity it is also important to ensure that your research methods (if including questionnaires or interviews) contain questions which sound like they are gathering the intended information. This will prevent the experience of receiving answers irrelevant to the topic. Based on the answers that were received during the interview process, it was concluded that these questions were indeed useful in inquiring the right information from the interviewees.

Persistent observation was also used to provide validity to the data. It is a validity test which works by having the researcher be present in the field of research for a prolonged period where they can become well acquainted with the subject of research. This is useful because rather than writing about an environment based 100% on external bias and information, the researcher is now able to write from the perspective of the subject and give voice to aspects that would not have been considered if work was totally done from the outside. Being involved with the HZ garden guided the point of view of this report to be from the perspective of what the garden needs. For instance, by working in the garden on a weekly basis observations were made on the quality of compost being used currently. It was clear that it was not fully organic, this is a sentiment shared with the entire garden group and experts as there were signs of plastic contamination within it (Scopetani et al., 2022). Noticing this gave further confirmation that implementing actual approved organic compost into the soil was a necessity, whether it be sourced or made on site as a project by future green office researchers. Another instance demonstrating the usefulness of persistent observation was witnessing the importance of mulching on soil health. The fluctuation in weather conditions can have a profound effect on the soil; by adding mulch, the garden was able to be resistant to the effects of a fluctuating weather system. Mulching kept the moisture content, temperature and structure of the soil steady even when faced with harsh dry/sunny weather, freezing temperatures or heavy rain. This was noticed when working in the garden and realising that the texture and feel of the soil that is always relatively the same, despite what the external conditions may be (Iqbal et al., 2020).

Reliability

(Loh, 2015) state that the demonstration of the validity of qualitative research is what confirms the reliability of said qualitative research. Due to this entire research containing only qualitative research, the reliability should have already been proven throughout the explanation of its validity. On the other hand, there are some theories which require the reliability of the research to be tested separately from validity. Considering these very mixed views on whether reliability of qualitative research should be tested, a dependability audit was chosen as the most effective and necessary method. This was developed also by Lincoln and Guba in 1985, it was their way of giving attention to the need for some level of reliability to be established for qualitative research, especially peers in the same field. In this case the dependability will be examined by assessing how the data was collected, how it was kept and the accuracy of said data.

The data was collected in several ways, these included interviews, literature review and persistent observation (see Appendix 7). The interview questions can be found in the Appendix 4. They were used to ask for suggestions of new ideas and methods from the garden experts, green office coordinator and lab technician. The interview with the garden expert took place on April 10th and lasted 10 minutes. The interview with the lab technician was held on May 19th, lasted 15 minutes and included myself, the lab tech, my research coach and a fellow student. Several research papers on the many involved topics were read and analysed, this method was used to do in-depth research of the ideas which came from conducting the interviews. It was then possible to provide accredited data which could support all the solutions that were planned for the regeneration of the HZ garden. Without this data, there would be no way to demonstrate why these solutions are applicable to the research area and if they are beneficial. Lastly, persistent observation was of major benefit to understand the research subject. Without building that connection with what you are researching, without seeing it in person and being active in the physical sense, it is hard to then know what to write about it that reflects commitment to solving the research question. Being present provided an

understanding of what to advocate for. In this case and as previously mentioned, working in the garden allowed for the nuances of this garden's ecosystem to be noted and included within any plan which was made. It allowed for the needs of this garden to be met with intention and not by default by implementing any random garden practices. This way the garden can have a solution curated specifically for its needs.

The data was carefully kept ensuring that the ideas and information remain how they were when initially discovered. Interview answers were written down along with additional notes for context. By doing this it's easier to remember exactly what was being said when interpreting. This helps to prevent the possibility of forgetting completely why and what was said when conducting the interviews. Notes and images were taken during weekly garden sessions to keep track of the state of the garden over the research period. Useful data and information found in literature were promptly archived for later use and interpretation for this report.

The intention has always been to retrieve most data from peer reviewed research papers, especially when it comes to sources which are meant to support the key points of the solution. Concepts can be retrieved from a wider variety of sources so long as they are from trusted organisational websites. There is no complete avoidance of uncertainties, however, retrieving data carefully from accredited sources was of most importance to uphold a standard of dependable data.

Methodological limitations

Retrieving this data did not go as smoothly as desired. There were multiple instances and circumstances that prevented the process from being seamless. First of these were the lack of external experts. Having the approval of experts who have done research on the topics within the research subject would have been an effective way to validate the work being done for this report. It would have been ideal for this data to be analysed and critiqued by fresh perspectives, however, no responses from any external experts were received. Up to 6 emails were sent out to experts who wrote the reports that were sourced in this report, there was hope any respondent would be able to give significant guidance and advice on the methods that this report implements. It would also have been beneficial to have another discerning eye for what is/is not necessary. The lack of responses could have been for multiple reasons: possible language barrier, position change of the authors (completion of dissertation, no longer with research company) or even inexperience with reaching out to researchers at different institutions. Some of these initial inquiries can be found in Appendix 5.

There was approximately 5 months given to complete this research report, in that time enough data was gathered to create a robust solution to the research question. If there was more time to undertake this research, more could have been done to find support for key points and to ensure the data was validated more than it currently is. Perhaps there would be more time to revisit requesting the expertise of more external researchers and experts.

Lastly, with the lack of access to equipment, it was not possible to run soil tests dedicated to this research. This could have provided the opportunity to include some level of quantitative research rather than containing only qualitative research. To overcome the lack of equipment that could be used to complete the methodology that was planned initially, it was decided to rely more on qualitative research. Also, the decision was made to create a framework for regenerative gardening in the HZ garden rather than providing a solution to a single issue in the garden. Not only did this encourage more dependence on the available experts and literature but it helped to transform this report into a learning tool that can be expanded on by future students.

Results

The research methods used in the methodology were effective in gathering a substantial amount of data which was used to inform the solutions. The topic of this report is regenerative gardening; this is the general strategy that will be implemented in the garden. To achieve it, it was divided into three concepts and each of those concepts were divided into sub concepts. The analysis of the collected data revealed the following topics, regeneration using nutrients, biodiversity and proper practices. These topics along with their corresponding subtopics provide an insight into a wholesome approach to garden regeneration and cultivation. These topics were retrieved from the raw collected data by using grounded theory, and open and axial coding as a method of analysis.

Topic 1: Regeneration using nutrients

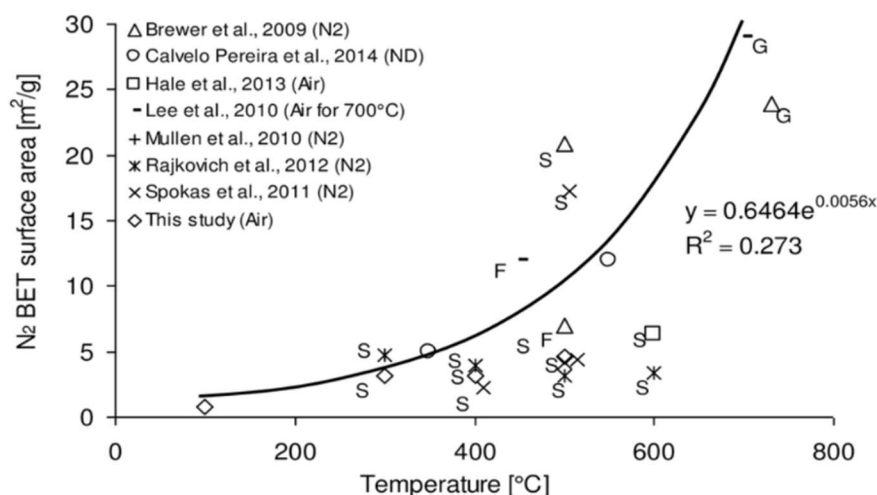
Regeneration using nutrients addresses the regeneration of a garden's ecosystem above and below ground by ensuring the soil has the right amount of nutrients. The ability for soil to provide all the nutrients a plant needs to grow and fruit is referred to as the soil's fertility (McGrath et al., 2014). The need to secure an ideal level of soil fertility was frequently suggested from literature research. It soon became evident that it is a requirement for healthy garden soil and without it, would leave the soil barren and incapable of accommodating crops. One instance of this being stressed as a requirement says

Soil nutrients are critical elements for plant growth and productivity. The bioavailability of nutrients in the soil solution may determine root growth, root proliferation and specific functional responses. Nitrogen (N), phosphorus (P), iron (Fe) and sulphur (S) are among the nutrients that have been reported to alter post-embryonic root developmental processes (López-Bucio et al., 2003 and p.285).

This makes it quite clear how important nutrients are for garden health and what specific nutrients are especially needed to be within the soil ecosystem.

Nutrition can come in various forms; this was also discovered through research of regenerative practices. These different approaches were then linked due to their similar effects and became subtopics under the decided main topic of regeneration using nutrients.

Subtopic 1.1: Biochar remediation is a regenerative method of providing making a garden fertile and providing nutrients. It is done by adding biochar into the soil, biochar is made by using pyrolysis of organic matter. This process is where organic matter is combusted at temperatures between 600 and 700 degrees without the presence of oxygen. Burning at these high temperatures allow for the material not to turn to ash. What is left behind is the non-combustible mineral content of the organic matter. This happens because the higher the pyrolysis temperature, the more surface area the byproduct will have (as can be seen in the graph below).



Graph showing the byproduct surface area based on the pyrolysis temperature (Rafiq et al., 2016)

The surface area becomes a defining aspect for the biochar due to its ability to remove impurities from its environment. The high porosity of the surface area acts as a sponge which helps to reduce the presence of heavy metals like lead and other micropollutants within the soil. This is the benefit of biochar which made it a compelling solution to use in the garden as the origin of this research was to find a feasible solution to reduce the lead levels within the soil. With the issue of soil pollution being solved by biochar remediation, a variety of supporting practices can be used alongside it to ensure other aspects of garden health are considered and taken care of.

In a research paper by Z. Hossain (2020), the importance of biochar on nutrient dynamics on soil and plants is described. He says, “biochar also increases soil pH and, thus, influences nutrient availability for plants. Biochar also alters soil biological properties by increasing microbial populations, enzyme activity, soil respiration, and microbial biomass”. The power to improve the chemical balance and physical structure of the soil is the reason why biochar remediation was chosen as the main gardening principle to spark the regeneration of the HZ garden. (Hossain et al., 2020)

Subtopic 1.2: Organic composting is another method that can be implemented to regenerate the HZ garden. “Composting is a traditional organic waste treatment technology that can convert organic waste into high-quality organic biofertilizers” (Yin et al., 2023). This method was chosen to act as the main fertilizer for the garden. By keeping regeneration as a core principle, all chosen methods and materials must comply with what it means to be regenerative. Composting fits this well because it allows for organic waste to be reused as fertiliser rather than being disposed of with other municipal waste. This reduces the amount of waste produced and finds a natural way for it to be ‘disposed’ of by allowing decomposition to turn it into plant and soil nutrients. Not only is it a natural source of nutrients but it fosters ideal soil conditions for the garden as well. Adding organic compost regulates soil temperature, reduces the potential of soil erosion, improves soil moisture content and provides aeration. Organic composting was chosen because it fits seamlessly within the framework of creating a regenerative garden.

Subtopic 1.3: Mulching is the third and final subtopic under regeneration using nutrients. It was chosen for its many benefits, including those which create a positive balance of water content for the soil, these are: minimising water runoff, enhancing soil infiltration capacity and regulating evapotranspiration by acting as a barrier. A flat surface provides a perfect runway for water to flow in what-ever direction the floor may follow; by flowing away, water is not able to infiltrate the soil. However, when mulch is present, there is no longer a smooth path for water to travel on, instead, it acts as a funnel which controls the amount of water reaching the soil surface and reduces flow to point where the water is hitting the surface as slow as it needs to infiltrate the soil in that position. This allows for water able to infiltrate the soil to increase. The same also takes place in the opposite direction, with the mulch acting as a protective barrier, much less moisture leaves the soil through evapotranspiration. Lastly, mulching protects the soil from the harsh elements above; by blanketing the soil, the ground is less susceptible to extreme temperature change during extreme weather conditions. Using mulching was discovered during the gardening sessions at HZ University which were led by the garden expert. When asked about the use of mulching, the response given was “mulching is used to secure ideal soil health on multiple levels. It creates a subsoil environment that allows plants to thrive and doubles as a fertiliser if you use organic materials.”

Topic 2: Regeneration using biodiversity

“Biodiversity is an attribute of an area and specifically refers to the variety within and among living organisms, assemblages of living organisms, biotic communities, and biotic processes, whether naturally occurring or modified by humans” (Swingland, 2013).

The garden must be treated like the complex ecosystem it is. Biodiversity ensures the health of an ecosystem by making sure resources, nutrients and structure all stay balanced and at the levels needed for the collective to thrive in the environment. Every organism has something unique to offer an ecosystem, the more variation there is of unique benefits, needs will be met and taken care of. This is why it is important to include a level of diversity within the garden. The following subtopics will be addressing how this can be achieved in HZ’s garden.

Subtopic 2.1: Biodiversity of flora, this refers to having a variety of plant species in the area. Having more plant species within the garden supports more species of taxa like birds, butterflies and other pollinators, allows for different species to perform their own niche functions which increase soil health like nitrogen fixing or providing nutrient rich mulch (Limareva, 2014). Including plants of different structure within the garden like trees, shrubs and low-lying plants allow for a number of benefits as well, these include cooling (heat protection), improved habitat quality, promotes seed dispersal and increased pest control (Nighswander et al., 2021). During an interview with a garden expert, the following recommendation was made and stressed, “Try to avoid any sort of monoculture, having only one plant or too many of one plant attracts plagues to your garden. Therefore, it is important that different species are planted to help prevent plant diseases from spreading”. This was proven through research about the link between biodiversity and plague prevention. When plants of the same species are planted together in large amounts, they compete for nutrients, light, space and water. This reduces the yield at harvest as they had less ability to thrive in their space, it also depletes the soil of its nutrients as they all require the same type of nutrition from the soil. When planting a higher number of species, you minimise competition and promote cooperation between the plants as they all provide their own niche benefits to the soil health (Limareva, 2014).

Subtopic 2.2: Biodiversity of fauna is the inclusion of a variety of animal species within a specified area. There are different types of fauna that can be present in a garden ecosystem. There's subsoil fauna, these include earthworms, larvae and mites, also worth mentioning are beneficial bacteria and fungi. Their jobs are to aerate the soil as well as break down organic material and convert it to nutrients. They aerate the soil by moving around throughout the soil in search of food, mates and to form habitats. This activity creates pockets of air inside the soil; this is a preventative measure against compacted soil which hinders root growth and mobility. As the subsoil organisms assist in decomposition by eating decaying plant and organic matter, allowing for them to be transferred into nutrients like carbon, nitrogen, phosphorus and other minerals. Plants thrive off these nutrients by using them to build cell matter, to produce chlorophyll and for the process of photosynthesis. With the presence of more nutrients in the soil, greater yield can be expected at harvest and plant health will increase as well.

Above ground are insects, small mammals and birds. They help maintain soil health by aerating, providing natural fertiliser and they assist plants by dispersing seeds, pollinating and controlling pest populations (WWF, 2023). They disperse seeds when consuming plants, fruits and seeds and releasing it as waste around the garden, birds can also carry seeds in their feathers unintentionally and place them in other spots of the garden. Similarly, pollination occurs when these animals interact with flowers like bees and birds, they carry pollen from flower to flower within the garden and fertilise other flowers by adding external pollen to their flowers (Cronk & Ojeda, 2008). Pest control is also a necessary job of these surface-dwelling animals as those who are predators tend to keep pest populations in check by eating them (Dinesh et al., 2022). It's clear to see how biodiversity is a key determining factor of how healthy an ecosystem will be. The healthiest ecosystems tend to have many systems and connections in play. This is closest to how natural ecosystems are and is the reason why they are successful and highly resilient.

Topic 3: Regeneration using proper practices

Subtopic 3.1: Anti-chemical organic gardening is the final method of gardening to be used. This is intended to be the practice of gardening without using any harmful chemical fertilisers, pesticides, fungicides etc. The importance of utilising this method is to prevent the many negative (short and long term) effects that chemical gardening has on the area of use, the land around it and the health of plant and animal populations within the garden. In a recent study by Zhou et al. (2025), a clear overview was given about the negative impacts of chemical use in gardens:

Pesticides significantly accumulate in soil, disrupting its physicochemical and biological characteristics, which in turn, harms flora and fauna and undermines soil health crucial for crop quality and ecosystem services. The contamination extends to water bodies, with agricultural, runoff and industrial effluent introducing these chemicals into rivers and groundwater, thus impairing water quality and posing risks to human health through exposure and the food chain. (p.3)

Apart from these effects, the presence of these chemicals in the environment also disrupts the quality of aquatic life when leeching takes these harmful chemicals from

agricultural lands to the sea. Fishes and microorganisms both suffer in the presence of these chemicals as it reduces water quality by affecting oxygen levels and contributing to algae blooms which, in themselves, have several negative impacts to the environment. By adding harmful chemicals to the garden, crucial soil processes like nitrogen fixation, nutrient decomposition and nutrient cycling are significantly impaired. This is due to microorganisms and microbes that perform these tasks experiencing complications like decrease in quantity, biomass and enzyme activity (Zhou et al., 2025).

It is also highly important that the effects of pesticides, organophosphorus and insecticides on human health are well understood. Pesticide poisoning accounts for around 11000 – 150000 fatalities per year. This comes in the form of ingestion, inhalation or topical exposure. As this accumulates in the body, diseases and illnesses can become present over time; some of these include cancers, diabetes, neurological disorders, issues in foetal development, respiratory disorders, fertility issues and organ failure (Eddleston, 2024).

Results: Summary of findings

By analysing the data, three main themes were discovered and given their own respective subthemes. These include:

- Regeneration using nutrients (Biochar remediation, Organic Composting, Mulching)
- Regeneration using biodiversity (biodiversity of flora, biodiversity of fauna)
- Regeneration using proper practices (Anti-chemical organic gardening)

The keystone method for the regeneration of the garden was chosen to be biochar remediation. This was selected for its ability to address the initial problem that generated cause for research which is the presence of a toxic level of lead in the soil. Biochar would also be implemented as a natural solution to secure good soil fertility by acting as a fertilizer as well as encouraging enzyme activity, increasing soil pH, providing a rich environment for microbial health etc.

By adding other solutions which can be implemented alongside the biochar remediation, the garden can be one of high yield and good health because of the different efforts made to secure the wellbeing of the various aspects it involves. Organic composting and mulching address the need for ideal soil conditions (temperature regulation, water retention, nutrient availability) and resilience in the face of extreme weather conditions. The ideal soil conditions can also be achieved through having a diverse set of fauna included in the garden's ecosystem. They do work gardeners can't do like decomposing and frequent cross pollination, underground they also make the air more breathable and less compacted and provide waste which adds as a fertilizer. Biodiversity of flora provides much needed resistance to plagues, provides nutrients and balance to the soil and accommodates the much-needed fauna species.

Lastly, by not using harmful chemicals in the garden, contact pollution to adjacent lands will be prevented. The multifaceted nature of this solution as well as the others are what made them ideal choices to achieve regeneration. They succeed in achieving this because they are beneficial to more than just the issue they're serving. They are not serving one aspect of the environment as well as negatively impacting another. Instead, their use and implementation in the garden generate no concerning effects on the climate and environment.

Discussion

With the results having been collected, the questions that directed this research can begin to be answered. These answers will come through the creation of solid solutions based on each proposed method. The solutions will act as clear plans for implementation in the garden and transform the once abstract data into tangible instructions that can be applied.

This discussion will address the theories of the solutions and their applicability to the garden in real life. Understanding this will allow for a very practical opportunity for the ideas and principles of regeneration to blossom on the campus.

The results indicate that it is indeed possible to achieve regeneration within the HZ Garden. This can be done by implementing methods that not only cater to the issues they were meant to solve but are also beneficial and provide no harm to the environment in the short or long term. By thinking of the garden as a system with many parts, much more concerns within the garden can be taken care of or even prevented. It was deduced that no aspect of the garden's ecosystem is completely isolated. Every component within the garden is connected to or will directly affect another. When any of the methods are implemented, a chain reaction of benefits take place in other areas. This further proves the essence of the regeneration, leaving no action to be able to negatively effect others. It is important to provide solutions that can only be beneficial in multiple ways and not negative, striving for only the most impactful, cohesive actions to be taken.

Every solution addresses regeneration as well as their respective issues. For instance, biochar remediation is meant to mitigate the issue of concerning lead levels. To provide this treatment, locally sourced biochar needs to be used. There is also the possibility of creating the biochar using the laboratory equipment at HZ. Once the biochar is brought to the garden, the application of it within the soil can begin. This process entails digging holes in the soil that reach below the non-contaminated topsoil (first 10cm). In those holes, biochar pieces or powder can be deposited thoroughly mixed in with the soil allowing biochar to span the length of the hole up to the bottom of the topsoil layer. Not only will the lead then be absorbed making there be much less bioavailable lead in the soil, but it also helps the atmosphere by sequestering carbon. It also provides much needed fertiliser for the plants as well.

Organic composting delivers rich nutrients and minerals into soil, without it, plants would not have enough nutrition to build themselves and conduct their processes. Outside of this, compost is made from waste materials, this means the use of it aids in reducing municipal waste. It also provides the ideal conditions for soil fertility. The benefits of composting also extend to the other solutions, this being 'biodiversity of fauna', subsoil organisms thrive off compost. They are key contributors to the cycle of nutrients in the soil and rely heavily on the success and inclusion of one another. This compost can be locally sourced or created at HZ in the garden by students. Currently there are compost piles located in the garden. The compost piles provide an opportunity for further research to be done by green office students on how to efficiently curate organic compost that can be used in the garden soil. Mulching is very necessary for the garden as it protects the soil from the harsh weather and temperature while maintaining ideal soil conditions. Mulch is also easily sourced from the HZ garden in the form of dried weeds. The unwanted weeds that are removed from the beds of the garden can be dried and recycled as an organic mulch material for the garden. This recycling keeps the garden self sufficient, and the gardeners involved conducting this process.

The absence of harmful chemicals in the soil allows for a healthy environment on many levels. Below soil, natural chemical processes are not disrupted and allowed to take their natural course. The ecosystem can be guided by green office gardeners to balance itself; this can be done by allowing biodiversity of flora (plant species) within the garden. The garden already contains a diverse set of flowering species. Herb like mint and basil can be found there

alongside fruits such as strawberries and tomatoes, leafy greens including kale and multiple lettuce species as well as tubers like potatoes, carrots and radishes. Rather than depleting the soil's nutrients in competition with one another, they work in unison to provide a balanced ecosystem. These different plant species also accommodate for more fauna species who can find much more of their food and shelter preferences in a bigger selection of plant species. The garden has a multitude of insects, some of which are ladybugs, beetles, worms, bees and butterflies. Since they are already present in strong numbers, the focus should be more on accommodating them, allowing them to stay near and feel attracted to the garden. Efforts like building insect hotels and maintaining the other practices guarantee this. Regenerative gardening is achieved here because the garden is guided to a point where it can take care of a lot of its own processes naturally and with much less need for human intervention. By not using chemicals, the garden's environmental footprint can remain low and no harm.

The data has been clear in describing what the garden needs to be successfully regenerative. The HZ Garden should be approached as one organism, one that is in many ways self sufficient. This self sufficiency must be stewarded by green office garden session member with much care and consideration for the interconnectedness within the garden's ecosystem. No plant, animal, process, material or method used within the garden is isolated. Once implemented within the ecosystem, it will react positively or negatively with many other components. It is the responsibility of the gardeners to determine what are the best and most beneficial applications for the HZ garden as it is ushered into its regenerative and more resilient future. The solutions provided (based on research) were all found to be regarded as beneficial for the garden and the environment. Existing theories tend to be in support of these solutions which is why they were ultimately chosen.

There were limitations present in the collection of this data. As mentioned before, the report being written as a framework was not the initial intention. There was a notable shift in the research approach which reduced the available time to realise this report as it is now. Perhaps more time would allow for the report to be supported with more compatible research methods and sources. Some methods like biochar remediation and the effect of unnatural garden chemicals on the environment are still being researched by experts and have results which are still evolving rapidly.

The sources used to collect the data were literature reviews, interviews and observation. To analyse this data grounded theory and open and axial coding were used. They were chosen due to their compatibility with qualitative data. Since there was no quantitative data, analysis methods that would truly challenge the data to get as much impact from it as possible was a necessary choice. They were also relevant methods of analysis based on the type of data collecting methods. This allowed for as much to be interpreted from the data as possible and assisted in the way the report was laid out. It was expected initially that an extensive single solution to solve the issue of lead contamination in the soil would be found. Instead, it became a broader, informative framework on the ways the entire garden can become healthy and regenerative rather than just the soil. This outcome was quite unexpected and different from what the initial plan was, however, it still carries a very impactful and usable message.

The data results were successfully used to provide answers to the sub questions as well. The soil quality's renewal comes from the application of biochar remediation along side supporting solutions like organic composting and biodiversity of fauna. Although these solutions are of clear significant impact, most of the proposed solutions contribute to the soil's overall health. This renewed quality of the soil and health of the garden can come from the students taking the responsibility to provide garden maintenance at least weekly at the garden sessions. Upholding the methods and practices over time in the garden guarantees the ecosystem's longevity. By implementing the methods from this research green office members and guests to the garden sessions can provide a more regenerative future for the garden. The

report was written to invite readers to understand the methods and their backgrounds. Understanding why they were chosen, what effects will become present and how they can be implemented will allow for the garden session members to bring these solutions to life out of their own interests or to provide deeper research on any of the topics addressed.

Conclusion

To conclude, this research report aimed to determine how the HZ garden could become regenerative. Based on extensive qualitative data research and analysis, it can be deduced that regeneration can be achieved by using a hybrid solution where soil regenerative methods can be executed in the garden sessions. Hybrid solution will be consisting of multiple courses of action all varying in nature, focus and results. This is opposed to having a singular course of action which would provide more a more limited overall result. The significance of the solution being a hybrid is to ensure that as many aspects of the garden as possible are considered and catered to through the implementation of these methods. The results show that gardening can be done regeneratively in various ways. There is no one way to be regenerative because regeneration can be applied in all actions we take. The chosen approaches were as follows:

- Regeneration using nutrients
- Regeneration using biodiversity
- Regeneration using proper practices

The main takeaway from the research results is that no component of the garden is singular in nature, to truly understand how to take good care of the garden, it must be thought of as one whole. Everything which resides in the garden is linked within the intricate web that is the entire garden's ecosystem. Treating the entire garden's ecosystem as one organism means that the effects of any solution that is implemented needs to be of benefit to or at least neutral toward every link it has within the ecosystem. With this understanding every decision for the garden needs to be made with consideration for the overall health of its ecosystem.

This research report explains in depth what can be done to make the garden regenerative but also raises the question of how they can be done. Much data was found and used to form the report into an informative framework. The next step would expectedly be to bring those ideas to life. This may not have been the purpose of this research, but it gives a wide range of opportunities to not only conduct research on how to make these changes tangible and implemented in the real world. Any further action on this report can be toward developing plans of action and maintenance plans. The creation of these plans will allow for the HZ gardeners follow the progress of the solutions and intervene when necessary.

Creating a framework for regeneration required an understanding of where the world currently is and is currently ready for. Sustainability is now behind us and it is imperative that we look to the future to understand what comes next. Regeneration in our daily lives means to look to the future rather than the present. Preparing resources like gardens as fuel sources that are resilient and self reliant which is a regeneration of the natural world and its capability to provide food and fertile soil for our use. What follows this research should be an initiative to start implementing tangible change using the solutions proposed. It will not be a quick process, but the healing of nature will always happen in its own time.

References

- Afshar, M., & Mofatteh, S. (2024). Biochar for a sustainable future: Environmentally friendly production and diverse applications. *Results in Engineering*, 23, 102433. <https://doi.org/10.1016/j.rineng.2024.102433>
- Beaumelle, L., Tison, L., Eisenhauer, N., Hines, J., Malladi, S., Pelosi, C., Thouvenot, L., & Phillips, H. R. P. (2023). Pesticide effects on soil fauna communities—A meta-analysis. *Journal of Applied Ecology*, 60(7), 1239–1253. <https://doi.org/10.1111/1365-2664.14437>
- Bogunović, I., & Filipović, V. (2023). Mulch as a nature-based solution to halt and reverse land degradation in agricultural areas. *Current Opinion in Environmental Science & Health*, 34, 100488. <https://doi.org/10.1016/j.coesh.2023.100488>
- Brzozowski, R. (2022, December 2). *Bulletin #2281, Know Your Soil: Lead in the Soil*. Cooperative Extension Publications. Retrieved May 30, 2025, from <https://extension.umaine.edu/publications/2281e/>
- Brust, G. E. (2019). Management Strategies for Organic Vegetable Fertility. In *Elsevier eBooks* (pp. 193–212). <https://doi.org/10.1016/b978-0-12-812060-6.00009-x>
- Chen, H., Gao, Y., Dong, H., Sarkar, B., Song, H., Li, J., Bolan, N., Quin, B. F., Yang, X., Li, F., Wu, F., Meng, J., Wang, H., & Chen, W. (2023). Chitin and crawfish shell biochar composite decreased heavy metal bioavailability and shifted rhizosphere bacterial community in an arsenic/lead co-contaminated soil. *Environment International*, 176, 107989. <https://doi.org/10.1016/j.envint.2023.107989>
- Cronk, Q., & Ojeda, I. (2008). Bird-pollinated flowers in an evolutionary and molecular context. *Journal of Experimental Botany*, 59(4), 715–727. <https://doi.org/10.1093/jxb/ern009>
- Dinesh, G. K., Priyanka, B., Anokhe, A., Ramesh, P. T., Venkitachalam, R., Sri, K. S. K., Abinaya, S., Anithaa, V., & Soni, R. (2022). Chapter 18 Ecosystem services and ecological role of birds in insect and pest control. In *Plant protection* (pp. 463–504). <https://doi.org/10.1515/9783110771558-018>
- Eddleston, M. (2024). Poisoning by pesticides. *Medicine*, 52(6), 390–393. <https://doi.org/10.1016/j.mpmed.2024.03.011>
- Ho, T. T. K., Tra, V. T., Le, T. H., Nguyen, N., Tran, C., Nguyen, P., Vo, T., Thai, V., & Bui, X. (2022). Compost to improve sustainable soil cultivation and crop productivity. *Case Studies in Chemical and Environmental Engineering*, 6, 100211. <https://doi.org/10.1016/j.cscee.2022.100211>
- Hossain, M. Z., Bahar, M. M., Sarkar, B., Donne, S. W., Ok, Y. S., Palansooriya, K. N., Kirkham, M. B., Chowdhury, S., & Bolan, N. (2020). Biochar and its importance on nutrient dynamics in soil and plant. *Biochar*, 2(4), 379–420. <https://doi.org/10.1007/s42773-020-00065-z>
- Iqbal, R., Raza, M. a. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., Toleikiene, M., Haider, I., Aslam, M. U., & Nazar, M. A. (2020). Potential agricultural and environmental

benefits of mulches—a review. *Bulletin of the National Research Centre/Bulletin of the National Research Center*, 44(1). <https://doi.org/10.1186/s42269-020-00290-3>

Jia, L., Ma, H., Guan, Y., Zou, L., Jiang, L., Hang, Y., Feng, X., Ren, X., Tian, Y., Pan, H., & Rong, S. (2022b). Lead absorption capacity in different parts of plants and its influencing factors: a systematic review and meta-analysis. *Research Square (Research Square)*. <https://doi.org/10.21203/rs.3.rs-1852447/v1>

Khangura, R., Ferris, D., Wagg, C., & Bowyer, J. (2023). Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health. *Sustainability*, 15(3), 2338. <https://doi.org/10.3390/su15032338>

Limareva, A. (2012). *Ecological Principles in Natural Temperate Forest Ecosystems Relevant for Productive Food Forests* [Bachelor' thesis, Van Hall Larenstein University of Applied Sciences]. <https://netwerkvoedselbosbouw.nl/wp-content/uploads/2020/12/Limareva-A.-2014.-Ecological-Principles.pdf>

Loh, J. (2015). Inquiry into Issues of Trustworthiness and Quality in Narrative Studies: A Perspective. *The Qualitative Report*. <https://doi.org/10.46743/2160-3715/2013.1477>

López-Bucio, J., Cruz-Ramírez, A., & Herrera-Estrella, L. (2003). The role of nutrient availability in regulating root architecture. *Current Opinion in Plant Biology*, 6(3), 280–287. [https://doi.org/10.1016/s1369-5266\(03\)00035-9](https://doi.org/10.1016/s1369-5266(03)00035-9)

Malhotra, H., Vandana, N., Sharma, S., & Pandey, R. (2018). Phosphorus nutrition: plant growth in response to deficiency and excess. In *Springer eBooks* (pp. 171–190). https://doi.org/10.1007/978-981-10-9044-8_7

McGrath, J., Spargo, J., & Penn, C. (2014). Soil fertility and plant nutrition. In Elsevier eBooks (pp. 166–184). <https://doi.org/10.1016/b978-0-444-52512-3.00249-7>

(PDF) *Mulching: An Efficient Technology for Sustainable Agriculture Production*. Available from: https://www.researchgate.net/publication/374464014_Mulching_An_Efficient_Technology_for_Sustainable_Agriculture_Production [accessed Jun 13 2025].

Nag, R., & Cummins, E. (2021). Human health risk assessment of lead (Pb) through the environmental-food pathway. *The Science of the Total Environment*, 810, 151168. <https://doi.org/10.1016/j.scitotenv.2021.151168>

Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., & Johns, C. (2020). What is regenerative agriculture? A review of scholar and practitioner definitions based on processes and outcomes. *Frontiers in Sustainable Food Systems*, 4. <https://doi.org/10.3389/fsufs.2020.577723>

Nighswander, G. P., Sinclair, J. S., Dale, A. G., Qiu, J., & Iannone, B. V. (2021). Importance of plant diversity and structure for urban garden pest resistance. *Landscape and Urban Planning*, 215, 104211. <https://doi.org/10.1016/j.landurbplan.2021.104211>

Rafiq, M. K., Bachmann, R. T., Rafiq, M. T., Shang, Z., Joseph, S., & Long, R. (2016). Influence of Pyrolysis Temperature on Physico-Chemical Properties of Corn Stover (*Zea mays* L.) Biochar and Feasibility for Carbon Capture and Energy Balance. *PLoS ONE*, *11*(6), e0156894. <https://doi.org/10.1371/journal.pone.0156894>

Scopetani, C., Chelazzi, D., Cincinelli, A., Martellini, T., Leiniö, V., & Pellinen, J. (2022). Hazardous contaminants in plastics contained in compost and agricultural soil. *Chemosphere*, *293*, 133645. <https://doi.org/10.1016/j.chemosphere.2022.133645>

Sweetser, R. (2025, May 7). *Attract the Bugs That Are Good for Your Plants!* Almanac. Retrieved June 9, 2025, from <https://www.almanac.com/beneficial-insects-garden>

Swingland, I. R. (2013). Biodiversity, Definition of. In *Elsevier eBooks* (pp. 399–410). <https://doi.org/10.1016/b978-0-12-384719-5.00009-5>

Taherdoost, H. (2016). Validity and reliability of the research instrument; How to test the validation of a Questionnaire/Survey in a research. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3205040>

Technologies and Practices for Small Agricultural Producers. (2020, December). *Mulching in organic agriculture*. Food and Agriculture Organization of the United Nations. Retrieved June 28, 2025, from <https://teca.apps.fao.org/en/technologies/8365/>

Thakur, M., & Kumar, R. (2020). Mulching: Boosting crop productivity and improving soil environment in herbal plants. *Journal of Applied Research on Medicinal and Aromatic Plants*, *20*, 100287. <https://doi.org/10.1016/j.jarmap.2020.100287>

Wood, N. (2023, December 13). *Bugs With Benefits: Beneficial Insects for Pest Control*. Gardening Express: For Everyone's Garden. Retrieved June 27, 2025, from <https://www.almanac.com/beneficial-insects-garden>

WWF. (2023, season-01). *Here's how insects help keep ecosystems in balance*. Retrieved May 30, 2025, from <https://www.worldwildlife.org/magazine/issues/spring-2023/articles/here-s-how-insects-help-keep-ecosystems-in-balance#:~:text=Whether%20they%20crawl%2C%20fly%2C%20squirm,and%20crops%2C%20and%20control%20pests.>

Yin, J., Xie, M., Yu, X., Feng, H., Wang, M., Zhang, Y., & Chen, T. (2023). A review of the definition, influencing factors, and mechanisms of rapid composting of organic waste. *Environmental Pollution*, *342*, 123125. <https://doi.org/10.1016/j.envpol.2023.123125>

Zhou, W., Li, M., & Achal, V. (2024). A comprehensive review on environmental and human health impacts of chemical pesticide usage. *Emerging Contaminants*, *11*(1), 100410. <https://doi.org/10.1016/j.emcon.2024.100410>

(2024, November 7). *5 qualitative data analysis methods*. Content Square. Retrieved June 5, 2025, from <https://contentsquare.com/guides/qualitative-data-analysis/methods/>

Appendix

Appendix 1: MCA Analysis

To determine what solution is more ideal based on their specific attributes an multi criteria analysis will be carried out. This will allow for both solutions' key elements to be highlighted and compared to determine which one works best. Based on each criterion, both solutions will compete for the best score out of 5, with each criterion being of a different weight due to importance, the scores will have varying effect on the overall result. Nevertheless, the solution with the higher overall score at the end will ultimately be chosen for implementation.

Criteria: 100%	Solution A: Fish bones	Solution B: Biochar
Effectiveness 20%	3	4
Timeframe 20%	2	4
Sustainability 20%	5	5
Material cost 5%	4	3
Maintenance 15%	4	4
Workload 20%	2	4
Total score:	3.2	4.15

Solution B ended up becoming the winning solution due to resiliently scoring high for the criteria. To give more context, B has the potential and is expected to be more effective than A due to it's multipurpose nature. As seen in the description above, biochar is a solution that benefits soil health in multiple ways and combat the issue of lead contamination in different manners. Not only is the issue of lead contamination being addressed but studies have also revealed the capability for biochar to do much more such as increasing biodiversity, reducing pH levels of the soil and even carbon sequestering. This is opposed to solution A which provided 1 sure method of remediating the soil was the reason why solution B is thought to be more effective in helping to solve the issue.

In terms of timeframe and workload, solution B was shows the capability of being easier and less time consuming. The insertion of biochar into the contaminated soil layers will be done by making holes in various locations throughout the garden to drop them in. This of course will be preceded by controlled sample testing which can help to determine whether the solution is working well. What makes this process different from that of solution A is the need to mix the fish bones more throughout the soil layers, not only this but ensuring there is not much flesh being buried under the garden, this can cause an unpleasant smell in the environment and welcome pests to the garden in search of the possible food producing that stench. The multiple ways with which biochar is able to immobilise lead in the soil means that it will be much more readily able to bond, enhancing the overall productivity and reducing the time it takes.

Solution B is considered to be more sustainable than A because of there being no releasing of carbon as any of the organic matter connected to the fish bones decomposes. Instead, the biochar will work in reverse and sequester carbon from the environment and atmosphere around it. Not only this but instead of burning it (which creates emissions), it is being used as a fertilising agent for the garden soil.

The cost of fish bones are expected to be low to basically negligible, while there will be a cost for biochar to be attained. This is what makes solution A score more that B. At the end of the implementation process, an MCA will be redone to highlight stakeholder perspectives. It will

include scores chosen by the garden expert, garden/green office coordinator and a fellow student in the green office minor. They will have all seen how the process took place over time in the garden and will be able to give varying perspectives on what they thought about it.

Appendix 2: Lab technician interview script excerpt

Researcher - Is there the possibility to use the ICPOES machine from the lab?

Lab tech – It can be used to test samples, these samples will have to be treated with a special solution to be prepared for testing. What are you testing the samples to find?

Researcher – the intention is to test the difference in soil sample after biochar has been implemented over a period of time, is this possible?

Lab tech – if the purpose of testing for lead levels is to determine how much lead will be present in the soil after biochar implementation, the ICPOES will not show this result. In the eyes of this machine, the same amount of lead will be found as there is not difference to the machine what state it is in. So, although it may become less bioavailable, the same amount of lead will be detected.

Appendix 3

Regenerative gardening b...		
Overarching concept	Main decision groups	Subconcepts (actual solutions)
Regeneration		
	Using nutrients	
		Biochar remediation
		Organic composting
		Mulching
	Using biodiversity	
		Diversity in flora
		Diversity in fauna
	Using proper practices	
		Non-chemical use

Image depicting the operationalisation table

Appendix 4

Researcher – How would you like to see the HZ garden become regenerative?

Garden expert – by using herbs and other plants that enrich the soil. Making sure not to unnecessarily disturb the soil. This can cause damage the root systems underneath the soil

What practices would you suggest to me as a researcher, based on your background knowledge?

Mulching, organic composting where you ensure the compost comes from a reliable source, attracting worms and beneficial insects to make the garden and its soil more fertile.

What kind of gardening practices would you suggest me staying away from using?
Refrain from monoculture, here only one crop is planted in an area which strips the land bare of its nutrients.

What materials would you like to have implemented in the garden?
Firstly, refrain from the use of chemicals in the garden as their long and short term benefits no small garden owners in anyway.

Appendix 5

Hello,

My name is Sidney Williams and I'm a research minor student from HZ University of Applied Sciences. I recently read your website which explains how your company addresses soil health for agriculture. I'm currently doing a research report on soil remediation using biochar at my university. I would love to get to know more about soil treatment from your perspective as I feel like your expertise can be very valuable to helping me regenerate the soil on my campus to be free of pollutants and functional for small-scale agriculture. Would you be willing to have a discussion where I ask you some questions about this topic. This can be done in whichever way you prefer; via email where I send you the questions or via call where I ask you the questions in real time.

Please do inform me if you'd be willing to help, I'd greatly appreciate it.

Kind regards,
Sidney Williams

Appendix 6



Table 3: Composition values and testing for T101

Analysis sample	MM4			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	50-100 0.7			
Humus (% ds)	4.2 29-11-			
Lutum (% ds)	2024			
Date of assessment	Measure			
Soil-class sample				Class industry
	GSSD			T101
OTHER				
Organic matter (humus)	<0.7			% % % m/m
Lutum	4.2			% (m/m) ds
Dry matter	93.1	93.1		
Glow residue	99			
METAL				
Barium	< 20	<43	mg/kg ds	---(6)
Cadmium	< 0.20	<0.23	mg/kg ds	<LN
Cobalt	< 3.0	<6.0	mg/kg ds	<LN
Copper	< 5.0	<6.7	mg/kg ds	<LN
Mercury	< 0.050	<0.049	mg/kg ds	<LN
Molybdenum	< 1.5	<1.1	mg/kg ds	<LN
Nickel	< 4.0	<6.9	mg/kg ds	<LN
Lead	150	227 53	mg/kg ds	IND
Zinc	25		mg/kg ds	<LN
OTHER (ORGANIC) COMPOUNDS				
Mineral oil C10 - C40	< 35	<123	mg/kg ds	<LN
Mineral oil C10 - C12	< 3.0	10.5	mg/kg ds	---(6)
Mineral oil C12 - C16	< 5.0	17.5	mg/kg ds	---(6)
Mineral oil C16 - C21	< 5.0	17.5	mg/kg ds	---(6)
Mineral oil C21 - C30	< 10	35	mg/kg ds	---(6)
Mineral oil C30 - C35	< 5.0	17.5	mg/kg ds	---(6)
Mineral oil C35 - C40	< 7.0	24.5	mg/kg ds	---(6)
CHLORINATED HYDROCARBONS PCB28				
PCB52 PCB101	< 0.0010	<0.0035	mg/kg ds	
PCB118 PCB138	< 0.0010	<0.0035	mg/kg ds	
PCB153 PCB180	< 0.0010	<0.0035	mg/kg ds	
PCB(sum 7)	< 0.0010	<0.0035	mg/kg ds	
PAK	< 0.0010	<0.0035	mg/kg ds	
Naphthalene Phenanthrene	< 0.0010	<0.0035	mg/kg ds	
Anthracene Fluoranthene	< 0.0010	<0.0035	mg/kg ds	
Benzo(a)anthracene		<0.025	mg/kg ds	<LN
Chrysene				
Benzo(k)fluoranthene				
Benzo(a)pyrene	<0.050	<0.035	mg/kg ds	
Benzo(g,h,i)perylene	<0.050	<0.035	mg/kg ds	
Indeno-(1,2,3-c,d)pyrene	<0.050	<0.035	mg/kg ds	
PAK 10 VROM	0.11	0.11	mg/kg ds	
	0.058	0.058	mg/kg ds	
	0.057	0.057	mg/kg ds	
	< 0.050	<0.035	mg/kg ds	
	0.055	0.055	mg/kg ds	
	< 0.050	<0.035	mg/kg ds	
	< 0.050	<0.035	mg/kg ds	
		0.49	mg/kg ds	<LN

< :less than the detection
 <LN limit :Agriculture/nature
 WO :Living
 IND :Industry
 MV Moderately polluted
 SV Heavily contaminated
 6 :Has no standard value
 # :increased reporting limit :Standardized
 GSSD measurement value

Table 1: Composition and assessment of the soil quality intervention value (land soil) (T.130)

Analysis sample	MM1			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	10-60 2.8 5.8			
Humus (% ds)	29-11-2024			
Lutum (% ds)				
Date of assessment				
Soil class sample				Complies with Intervention value
				T130
	Measure	GSSD		
OTHER				
Organic matter (humus)	2.8		% % m/m	
Lutum	5.8		% (m/m) ds	
Dry matter	87.3	87.3		
Glow residue	97			
METAL				
Barium	28	74	mg/kg ds	--- (5)
Cadmium	0.32	0.50	mg/kg ds	<=IW
Cobalt	4.5	11.2	mg/kg ds	<=IW
Copper	20	36	mg/kg ds	<=IW
Mercury	0.11	0.15	mg/kg ds	<=IW
Molybdenum	< 1.5	<1.1	mg/kg ds	<=IW
Nickel	13-76	29	mg/kg ds	<=IW
Lead	78	110	mg/kg ds	<=IW
Zinc		153	mg/kg ds	<=IW
OTHER (ORGANIC) COMPOUNDS				
Mineral oil C10 - C40	< 35	<88	mg/kg ds	<=IW
Mineral oil C10 - C12	< 3.0	7.5	mg/kg ds	--- (5)
Mineral oil C12 - C16	< 5.0	12.5	mg/kg ds	--- (5)
Mineral oil C16 - C21	< 5.0	12.5	mg/kg ds	--- (5)
Mineral oil C21 - C30	11	39	mg/kg ds	--- (5)
Mineral oil C30 - C35	6.9 <	24.6	mg/kg ds	--- (5)
Mineral oil C35 - C40	7.0	17.5	mg/kg ds	--- (5)
CHLORINATED HYDROCARBONS PCB28				
PCB52 PCB101	<0.0010	<0.0025	mg/kg ds	
PCB118 PCB138	<0.0010	<0.0025	mg/kg ds	
PCB153 PCB180	<0.0010	<0.0025	mg/kg ds	
PCB(sum 7)	<0.0010	<0.0025	mg/kg ds	
PAK	0.0034	0.0121	mg/kg ds	
Naphthalene Phenanthrene	0.0036	0.0129	mg/kg ds	
Anthracene Fluoranthene	0.0024	0.0086	mg/kg ds	
Benzo(a)anthracene		0.044	mg/kg ds	<=IW
Chrysene				
Benzo(k)fluoranthene				
Benzo(a)pyrene	<0.050	<0.035	mg/kg ds	
Benzo(g,h,i)perylene	0.14	0.14	mg/kg ds	
Indeno-(1,2,3-c,d)pyrene	0.10	0.10	mg/kg ds	
PAK 10 VROM	0.31	0.31	mg/kg ds	
	0.19	0.19	mg/kg ds	
	0.18	0.18	mg/kg ds	
	0.099	0.099	mg/kg ds	
	0.18	0.18	mg/kg ds	
	0.13	0.13	mg/kg ds	
	0.13	0.13	mg/kg ds	
		1.49	mg/kg ds	<=IW

Table 1: Composition values and testing for T101

Analysis sample	MM1			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	10-60	2.8		
Humus (% ds)	5.8	29-11-		
Lutum (% ds)	2024			
Date of assessment				
Soil class sample				Class industry
	Measure	GSSD		T101
OTHER				
Organic matter (humus)	2.8		% % % m/m	
Lutum	5.8		% (m/m) ds	
Dry matter	87.3	87.3		
Glow residue	97			
METAL				
Barium	28	74	mg/kg ds	---(6)
Cadmium	0.32	0.50	mg/kg ds	<LN
Cobalt	4.5	11.2	mg/kg ds	<LN
Copper	20	36	mg/kg ds	<LN
Mercury	0.11	0.15	mg/kg ds	<LN
Molybdenum	<1.5	<1.1	mg/kg ds	<LN
Nickel	13.76	29	mg/kg ds	<LN
Lead	78	110	mg/kg ds	WO
Zinc		153	mg/kg ds	WO
OTHER (ORGANIC) COMPOUNDS				
				<LN
				---(6)
Mineral oil C10 - C40	< 35	<88	mg/kg ds	---(6)
Mineral oil C10 - C12	<3.0	7.5	mg/kg ds	---(6)
Mineral oil C12 - C16	<5.0	12.5	mg/kg ds	---(6)
Mineral oil C16 - C21	<5.0	12.5	mg/kg ds	---(6)
Mineral oil C21 - C30	11	39	mg/kg ds	---(6)
Mineral oil C30 - C35	6.9<	24.6	mg/kg ds	
Mineral oil C35 - C40	7.0	17.5	mg/kg ds	
CHLORINATED HYDROCARBONS PCB28				
PCB52	PCB101	<0.0010	<0.0025	mg/kg ds
PCB118	PCB138	<0.0010	<0.0025	mg/kg ds
PCB153	PCB180	<0.0010	<0.0025	mg/kg ds
PCB(sum 7)		<0.0010	<0.0025	mg/kg ds
PAK				
Naphthalene	Phenanthrene	0.0034	0.0121	mg/kg ds
Anthracene	Fluoranthene	0.0036	0.0129	mg/kg ds
Benzo(a)anthracene		0.0024	0.0086	mg/kg ds
Chrysene			0.044	mg/kg ds
Benzo(k)fluoranthene				
Benzo(a)pyrene				
Benzo(g,h,i)perylene		<0.050	<0.035	mg/kg ds
Indeno-(1,2,3-c,d)pyrene		0.14	0.14	mg/kg ds
PAK 10.VROM		0.10	0.10	mg/kg ds
		0.31	0.31	mg/kg ds
		0.19	0.19	mg/kg ds
		0.18	0.18	mg/kg ds
		0.099	0.099	mg/kg ds
		0.18	0.18	mg/kg ds
		0.13	0.13	mg/kg ds
		0.13	0.13	mg/kg ds
			1.49	mg/kg ds
				<LN

Table 3: Composition and assessment of the soil quality intervention value (land soil) (T.130)

Analysis sample	MM4			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	50-100 0.7			
Humus (% ds)	4.2 29-11-			
Lutum (% ds)	2024			
Date of assessment				
Soil class sample				Complies with Intervention value
	Measure	GSSD		T130
OTHER				
Organic matter (humus)	<0.7		% % % m/m	
Lutum	4.2		% (m/m) ds	
Dry matter	93.1	93.1		
Glow residue	99			
METAL				
Barium	< 20	<43	mg/kg ds	--- (5)
Cadmium	< 0.20	<0.23	mg/kg ds	<=IW
Cobalt	< 3.0	<6.0	mg/kg ds	<=IW
Copper	< 5.0	<6.7	mg/kg ds	<=IW
Mercury	< 0.050	<0.049	mg/kg ds	<=IW
Molybdenum	< 1.5	<1.1	mg/kg ds	<=IW
Nickel	< 4.0	<6.9	mg/kg ds	<=IW
Lead	150	227 53	mg/kg ds	<=IW
Zinc	25		mg/kg ds	<=IW
OTHER (ORGANIC) COMPOUNDS				
Mineral oil C10 - C40	< 35	<123	mg/kg ds	<=IW
Mineral oil C10 - C12	< 3.0	10.5	mg/kg ds	--- (5)
Mineral oil C12 - C16	< 5.0	17.5	mg/kg ds	--- (5)
Mineral oil C16 - C21	< 5.0	17.5	mg/kg ds	--- (5)
Mineral oil C21 - C30	< 10	35	mg/kg ds	--- (5)
Mineral oil C30 - C35	< 5.0	17.5	mg/kg ds	--- (5)
Mineral oil C35 - C40	< 7.0	24.5	mg/kg ds	--- (5)
CHLORINATED HYDROCARBONS PCB28				
PCB52 PCB101	< 0.0010	<0.0035	mg/kg ds	
PCB118 PCB138	< 0.0010	<0.0035	mg/kg ds	
PCB153 PCB180	< 0.0010	<0.0035	mg/kg ds	
PCB(sum 7)	< 0.0010	<0.0035	mg/kg ds	
PAK	< 0.0010	<0.0035	mg/kg ds	
Naphthalene Phenanthrene	< 0.0010	<0.0035	mg/kg ds	
Anthracene Fluoranthene	< 0.0010	<0.0035	mg/kg ds	
Benzo(a)anthracene		<0.025	mg/kg ds	<=IW
Chrysene				
Benzo(k)fluoranthene				
Benzo(a)pyrene	<0.050	<0.035	mg/kg ds	
Benzo(g,h,i)perylene	<0.050	<0.035	mg/kg ds	
Indeno(1,2,3-c,d)pyrene	<0.050	<0.035	mg/kg ds	
PAK 10 VROM	0.11	0.11	mg/kg ds	
	0.058	0.058	mg/kg ds	
	0.057 <	0.057	mg/kg ds	
	0.050	<0.035	mg/kg ds	
	0.055 <	0.055	mg/kg ds	
	0.050 <	<0.035	mg/kg ds	
	0.050	<0.035	mg/kg ds	
		0.49	mg/kg ds	<=IW

< :less than detection limit :less than or equal to intervention value :greater than intervention value
 <=IW
 > IW 5
 # :IW missing: duty of care
 GSSD applies :increased reporting limit Standardized measurement value

Table 2: Composition values and testing for T101

Analysis sample	M2			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	10-50	3.9		
Humus (% ds)	6.1	29-11-		
Lutum (% ds)	2024			
Date of assessment				
Soil class sample				Class industry
	Measure	GSSD		T101
OTHER				
Organic matter (humus)	3.9			%% % m/m
Lutum	6.1			% (m/m) ds
Dry matter	86.2	86.2		
Glow residue	96			
METAL				
Barium	35	90	mg/kg ds	--- (6)
Cadmium	0.43	0.64	mg/kg ds	
Cobalt	6.0	14.6	mg/kg ds	WO
Copper	27	46	mg/kg ds	
Mercury	0.35	0.46	mg/kg ds	<LN
Molybdenum	< 1.5	< 1.1	mg/kg ds	
Nickel	17.59	37	mg/kg ds	WO
Lead	89	84	mg/kg ds	WO
Zinc		168	mg/kg ds	<LN
OTHER (ORGANIC) COMPOUNDS				
				WO
				WO
Mineral oil C10 - C40	36 <	92	mg/kg ds	WO
Mineral oil C10 - C12	3.0 <	5.4	mg/kg ds	
Mineral oil C12 - C16	5.0 <	9.0	mg/kg ds	<LN
Mineral oil C16 - C21	5.0	9.0	mg/kg ds	--- (6)
Mineral oil C21 - C30	16.12	41	mg/kg ds	--- (6)
Mineral oil C30 - C35	< 7.0	31	mg/kg ds	--- (6)
Mineral oil C35 - C40		12.6	mg/kg ds	--- (6)
				--- (6)
CHLORINATED HYDROCARBONS PCB28				
PCB52 PCB101	0.0052	0.0133	mg/kg ds	
PCB118 PCB138	0.0050	0.0128	mg/kg ds	
PCB153 PCB180	0.012	0.031	mg/kg ds	
PCB(sum 7)	0.0035	0.0090	mg/kg ds	
PAK	0.014	0.036	mg/kg ds	
Naphthalene Phenanthrene	0.017	0.044	mg/kg ds	
Anthracene Fluoranthene	0.0085	0.0218	mg/kg ds	
Benzo(a)anthracene		0.17	mg/kg ds	IND
Chrysene				
Benzo(k)fluoranthene				
Benzo(a)pyrene				
Benzo(g,h,i)perylene	<0.050	<0.035	mg/kg ds	
Indeno-(1,2,3-c,d)pyrene	0.089	0.089	mg/kg ds	
PAK 10 VROM	0.082	0.082	mg/kg ds	
	0.23	0.23	mg/kg ds	
	0.20	0.20	mg/kg ds	
	0.18	0.18	mg/kg ds	
	0.12	0.12	mg/kg ds	
	0.20	0.20	mg/kg ds	
	0.15	0.15	mg/kg ds	
	0.15	0.15	mg/kg ds	
		1.44	mg/kg ds	
				<LN

Table 2: Composition and assessment of the soil quality intervention value (land soil) (T.130)

Analysis sample	M2			
Certificate code	2024133279			
Date	22-11-2024			
Trajectory (cm-mv)	10-50 3.9 6.1			
Humus (% ds)	29-11-2024			
Lutum (% ds)				
Date of assessment				
Soil class sample				Complies with Intervention value
	Measure	GSSD		T130
OTHER				
Organic matter (humus)	3.9		% % m/m	
Lutum	6.1		% (m/m) ds	
Dry matter	86.2	86.2		
Glow residue	96			
METAL				
Barium	35	90	mg/kg ds	--- (5)
Cadmium	0.43	0.64	mg/kg ds	<=IW
Cobalt	6.0	14.6	mg/kg ds	<=IW
Copper	27	46	mg/kg ds	<=IW
Mercury	0.35	0.46	mg/kg ds	<=IW
Molybdenum	< 1.5	<1.1	mg/kg ds	<=IW
Nickel	17.59	37	mg/kg ds	<=IW
Lead	89	84	mg/kg ds	<=IW
Zinc		168	mg/kg ds	<=IW
OTHER (ORGANIC) COMPOUNDS				
Mineral oil C10 - C40	36 <	92	mg/kg ds	<=IW
Mineral oil C10 - C12	3.0 <	5.4	mg/kg ds	--- (5)
Mineral oil C12 - C16	5.0 <	9.0	mg/kg ds	--- (5)
Mineral oil C16 - C21	5.0	9.0	mg/kg ds	--- (5)
Mineral oil C21 - C30	16.12	41	mg/kg ds	--- (5)
Mineral oil C30 - C35	< 7.0	31	mg/kg ds	--- (5)
Mineral oil C35 - C40		12.6	mg/kg ds	--- (5)
CHLORINATED HYDROCARBONS PCB28				
PCB52 PCB101	0.0052	0.0133	mg/kg ds	
PCB118 PCB138	0.0050	0.0128	mg/kg ds	
PCB153 PCB180	0.012	0.031	mg/kg ds	
PCB(sum 7)	0.0035	0.0090	mg/kg ds	
PAK	0.014	0.036	mg/kg ds	
Naphthalene Phenanthrene	0.017	0.044	mg/kg ds	
Anthracene Fluoranthene	0.0085	0.0218	mg/kg ds	
Benzo(a)anthracene		0.17	mg/kg ds	<=IW
Chrysene				
Benzo(k)fluoranthene				
Benzo(a)pyrene	<0.050	<0.035	mg/kg ds	
Benzo(g,h,i)perylene	0.089	0.089	mg/kg ds	
Indeno-(1,2,3-c,d)pyrene	0.082	0.082	mg/kg ds	
PAK 10 VROM	0.23	0.23	mg/kg ds	
	0.20	0.20	mg/kg ds	
	0.18	0.18	mg/kg ds	
	0.12	0.12	mg/kg ds	
	0.20	0.20	mg/kg ds	
	0.15	0.15	mg/kg ds	
	0.15	0.15	mg/kg ds	
		1.44	mg/kg ds	<=IW

Appendix 7



Image showing beetle larvae, earthworm and flatworm species living in the on the garden soil aiding in fauna biodiversity



Image showing efficiency of wool mulch in maintaining soil moisture despite external conditions (this is less than a minute after removing mulch from the garden bed)



Image showing example of flora biodiversity within the garden

Reflection from intervention update 2

What I did well – Did deep research which provided useful information. Found results that are very applicable to the HZ garden and explained them in a way that green office students and member can relate to and use. Adapting the research approach after a necessary change, allowing for a wider ranging result.

What could've been done better – Writing with less grammatical errors could have been achieved by using a spell checker, this would've allowed for an easier reading experience. The discussion could have been less repetitive, using that space to compare the theory from the data with the practicality of implementing it in the garden. Adding more evidence in the appendix is needed to give stronger support to claims made in the report.

Give more background into how the MCA was developed. How were these criteria decided on and why. Justify the urgency for biochar remediation more accurately by explaining how dangerous it is based on regulations and be clear on how much was found. This is important to help the reader understand how dangerous it truly is and what are the real-life risks posed by the HZ garden.

Give more evidence on how I collected research, pictures and observational notes as well as interview times and location.

What improvements I made in response – fixed all the suggested grammatical errors and ran the report through a spell checker. I gave more context to the amount of lead found in the garden to ensure the report is does not allow the reader to think it is more dangerous than the results show. I agreed with the importance of adding more evidence of my observations as I hadn't included it before.

Logbook

Logbook			Logbook			Total hours done:
individual hours:	397			257.5		654.5
Date	Time (hrs)	Garage Activities	Date	Time (hr)	Green Office/Research Activities	
2/4/2025	8	Introduction to Applied research assignments	5/2/2025		First call with green office, making initial plan for the minor	
6/2/2025	7	Working on getting to know assignment and Mapstell	6/2/2025	4	Gardening session	
7/2/2025	8	Working on getting to know assignment	11/2/2025	8	Meeting with research coach, initial work on research report topic	
10/2/2025	6	Getting to know assignment, coach meeting	12/2/2025	2	Green office call	
12/2/2025	8	Working on getting to know assignment	13/2/2025	8	Gardening session	
13/2/2025	2	Working on getting to know assignment and Mapstell	19/2/2025	1.5	Green office call	
14/2/2025	9	Mapstell workshop, individual update	20/2/2025	8	Garden session	
24/2/2025	6	Working on individual update	21/2/2025	7	Researching project topic at green office	
27/2/2025	5	Working on research report and proposal	28/2/2025	6	Gardening session	
28/2/2025	2	Carnaval Party	11/3/2025	0.5	Nature 3 days intake session	
11/3/2025	5	Working on research proposal	12/3/2025	2	Update meeting - Waste ambassadors	
12/3/2025	8	Update meeting, typing of research proposal	13/3/2025	7	Gardening session	
13/3/2025	5	Working on research proposal	17/3/2025	9	Biobased battle	
25/3/2025	8	Working on Essay	18/3/2025	9	Biobased battle	
28/3/2025	8	Working Essay	19/3/2025	9	Biobased battle	
29/3/2025	0.5	Update meeting	20/3/2025	9	Biobased battle	
7/4/2025	9	Working on research proposal	21/3/2025	10	Nature 3 days	
8/4/2025	7	Working on research proposal	22/3/2025	24	Nature 3 days	
9/4/2025	6	Working on research proposal	23/3/2025	16	Nature 3 days	
10/4/2025	5	Working on research proposal	28/3/2025	6	Gardening session	
11/4/2025	1	Update meeting, Working on updating proposal and plan for the minor based on coach's advice	3/4/2025	6	Gardening session	
11/4/2025	8	Working on Contribution to collaboration resit	8/4/2025	4	Garden maintenance	
17/4/2025	8	Working on Milestone Package	9/4/2025	3	Art presentation: yin yang disordered	
22/4/2025	8	Working on Milestone Package	10/4/2025	5	Garden session	
23/4/2025	1	Update meeting	11/4/2025	1.5	MCG Zuidwest meeting	
					Discussing potential lab testing with	

24/4/2025	4 Working on Milestone Package		11/4/2025	Discussing potential lab testing with 1 chemistry colleague
25/4/2025	6 Working on Milestone Package		17/4/2025	6 Garden Session
29/4/2025	6 Working on Milestone Package		23/4/2025	Contacting chemistry colleague and MCG 4 Zuidwest about project progress
1/5/2025	6 Working on Milestone Package		23/4/2025	1 Green office meeting
6/5/2025	6 Working on Milestone Package		24/4/2025	4 Waste ambassador meeting with gemeente
8/5/2025	2 Working on research report and proposal		24/4/2025	6 Garden Session
9/5/2025	6 Working on research report and data collection		25/4/2025	Working
12/5/2025	4 Working on research report and data collection		7/5/2025	1 Green office meeting
13/5/2025	4 Working on research report and data collection		8/5/2025	6 Garden Session
14/5/2025	1 update meeting		14/5/2025	1 Green office meeting
14/5/2025	Time management course on linkedin learning for 4 personal development		15/5/2025	5 Garden session
16/5/2025	4 Working on research report and data collection		16/5/2025	Meeting with lab tech to discuss feasibility 2 of methodology
20/5/2025	1 update meeting		19/5/2025	Waste ambassador meeting with gemeente and UCR- discussing plans for waste 2 management event
21/5/2025	4 Working on research report and data collection		19/5/2025	Working on advertisement poster for the 4 waste management event
23/5/2025	Time management course on linkedin learning for 4 personal development		22/5/2025	6 Garden session
27/5/2025	6 Working on research report and data collection		23/5/2025	Finalizing and reviewing poster for waste 3 management event
28/5/2025	5 Working on research report and data collection		28/5/2025	1 Green office meeting
29/5/2025	6 Working on research report and data collection		28/5/2025	Sticking up posters for the waste 1 management event
30/5/2025	6 Working on research report and data collection		3/6/2025	Literature research for report at green 8 office
2/6/2025	Time management course on linkedin learning for 4 personal development		4/6/2025	1 Green office meeting
2/6/2025	6 Literature research for report		5/6/2025	4 Garden Session
4/6/2025	7 Literature research for report		5/6/2025	1 Progress discussion with coach
5/6/2025	4 Literature research for report		12/6/2025	2 Garden session
6/6/2025	Writing research for project report (due to approaching 12 deadline)		12/6/2025	6 Writing for project report at green office
9/6/2025	Writing research for project report (due to approaching 12 deadline)		20/6/2025	8 Writing for project report at green office
10/6/2025	Writing research for project report (due to approaching 12 deadline)			
11/6/2025	Writing research for project report (due to approaching 12 deadline)			
13/6/2025	Writing research for project report (due to approaching 12 deadline)			
16/6/2025	12 Writing collaboration portfolio			
17/6/2025	12 Writing Individual showcase			
18/6/2025	12 Writing collaboration portfolio & individual showcase			
19/6/2025	5 Finalizing poster presentation			
19/6/2025	0.5 Progress update meeting			
19/6/2025	5 Poster presentation and project market			
23/6/2025	Writing collaboration portfolio 2 (due to approaching 12 deadline)			
24/6/2025	Writing collaboration portfolio 2 (due to approaching 12 deadline)			
25/4/2025	Writing collaboration portfolio 2 (due to approaching 12 deadline)			

Research Coach feedback

180 and 360 degree feedback form – Minor HZ Studio The Garage



180 and 360 degree feedback for the Garage “Minor Students”

Feedback for – Sidney Williams

Feedback given by- Ingrid de Vries on 25 June 2025

Communication

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Actively collects feedbacks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>
Actively listen to others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>
Provides positive feedbacks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>

How can they improve in this area?

Sidney is silent, but still engages in a good way. With a lot of attention, Sidney listens to advice and incorporates it. Whenever he is needed, he also makes sure to be there.

I was able to grow as an individual in knowing when to speak up. It's important that I remember my quietness may not always be beneficial, especially when there is something that I need to know or to be communicative with my peers and my coaches.



Motivation

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Consistently puts in effort and strives to improve	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>
Handle setbacks and obstacles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>
Enthusiastic to their work and committed to achieving their goals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>

How can they improve in this area?

Sidney was still dealing this semester with other courses and had to juggle between classes and minor work. He still managed to do that in a good way. Sidney had to change his research approach and actually did that in such a way that it turned out even better than his original research approach.

It has indeed been a difficult experience juggling my responsibilities, I'm thankful for the opportunity I had because I learn a lot about myself. One of my biggest weaknesses is time management and I plan to work on this to have it become a strength of mine.



Team-building

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Demonstrate a willingness to listen to and consider the perspectives and ideas of others on the team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>
Contribute to building a positive and supportive team culture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>
Resolve conflicts and address issues within the team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>

How can they improve in this area?

Sidney is lovely to have on board. Not only is he enthusiastic about the minor, he also likes to contribute to the green office in general and contributing to a better world.

I've been able to see the importance of being present and being a part of a team this semester. I hope to join many more teams like the green office where I am allowed room to grow and be involved with activities that are linked with helping the world become more regenerative.



Strategic mindset

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Develop well defined plans to attain objective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>
Developing and executing strategic plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>
Effectively plan and organize meetings and appointments	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How can they improve in this area?

Sidney is thoughtful and really thinks well before he acts. Very good. What he needs to improve is his time management.

I noticed where I can be more vocal as a leader and that can be my next developmental step in becoming an even better team member. By thinking of and coming up with activities on my own I can become more or a person who leads change making activities and initiatives.



Personal Leadership

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Rather convince than directs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>
Treats colleagues with respect, even in tense situations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>
Creates an environment where everyone can succeed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	<input type="radio"/>	<input type="radio"/>

How can they improve in this area?

Sidney is very polite and respectful towards others, students, experts and teachers. And leaves room for others to thrive. With his work, he also likes to contribute and create value for others. Whenever he brings in an idea he also clarifies his argumentation.

I've grown to understand through experiences like waste ambassadors the need for everyone to feel heard and involved in a team/group setting. This creates a stronger bond between members as everyone can freely be themselves. I find it important to make sure I can provide that environment to help everyone I work have enough space to be.




Result and Orientation

	Never	Rarely	Occasionally	Often	Always	No Opportunity to observe
Takes swift decision	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Proactively seek out opportunities to improve processes or system that contribute	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Focus on achieving results that are aligned	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

How can they improve in this area?

See also my previous comments. Sidney wants to achieve and contribute.

Research coach signature: 

Poster

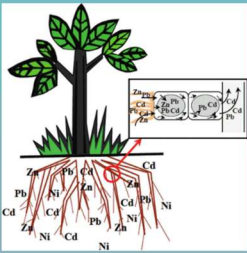
Regenerating the HZ Garden

By: Sidney Williams

Current Situation:
Unsafe levels of Lead and Pfas in the soil

Causes for this pollution:

- Industrial era overuse
- Heavy metal durability
- Ongoing pollution



How does this affect us?

- Inhalation
- Ingestion
- Surface absorption

Negative effects:

- Birth defects
- High blood pressure
- Cognitive deficits
- hormonal imbalances
- Fertility issues

Solutions:

Regeneration using nutrients

- Biochar remediation
- Organic composting
- Mulching

Regeneration using biodiversity

- Variation in Flora species
- Variation in Fauna species

Regeneration using good practices

- No use of chemicals
- No use of polluting practices

Research Question :
How can the HZ garden's soil biome be remediated?

- Using only regenerative practices
- Does not have a lengthy research to implementation period

Key solutions :


Biochar

- Absorbs pollutants swiftly and efficiently using pores and chemical bonds
- Carbon rich and sequestrating
- Increases pH value of soil which immobilises Lead


Organic Composting

- Improves soil bioactivity
- Creates a rich insoil environment which mitigates negative effects


Key Solutions



Biochar



Organic composting



Biodiversity in fauna

Layout:




Image showing poster for individual showcase

Reflection of poster presentation feedback

Poster presentation criteria and assessment form - Minor H2 Studio The Garage: Applied Research Team

Format poster presentation assessment and criteria by coaches and peers

Student name(s)	Sidney
Student number(s)	
Research unit name	CE
Name project	Regenerating the HZ garden
Name of the research coach(es)	
Date	19.6.20
Signature (by research coach) (on the right)	<i>Carla</i>

Per aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?

Very good Sufficient Insufficient

- Very good:** Objective and research question relevant and underpinned; Methods valid and appropriate; Stakeholder engagement meaningful; Evaluation process relevant and well-motivated.
- Sufficient:** Objective and research question focused but general; Methods clear, match objective; Stakeholder engagement clearly described; Evaluation process clear and thorough.
- Insufficient:** Objective and research question unclear or irrelevant; Methods inadequate or not convincing; Stakeholder engagement invalid or a; Evaluation incidentally or not part of the process.

Motivation, feedback and feed forward:
Clear what let focus was.

Analysis, conclusions and recommendations: what are validated lessons learned from this project?

Very good Sufficient Insufficient

- Very good:** Results thoroughly analysed and validated; Conclusions adequate and coherent with objective; Lessons learned link between initial situation and impact of results strong, realistic and convincing.
- Sufficient:** Results satisfactory analysed; Conclusions appropriate but obvious; Lessons learned and recommendations convincing.
- Insufficient:** Results provide raw data only; Conclusions poorly drawn or lacks essential issues; Recommendations reaching too close or lacking.

Motivation, feedback and feed forward:
bit general but interesting the way you tell about the project

Poster presentation criteria and assessment form - Minor H2 Studio The Garage: Applied Research Team

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

Very good Sufficient Insufficient

- Very good:** Subject and claims up-to-date and well-underpinned; Attention captured with adequate and effective body language, enthusiasm, eye contact, pace, pronunciation, appropriate length of presentation (2-3 minutes); smooth transition between topics; Questions, suggestions and error handling in depth, adequately, with critical attitude.
- Sufficient:** Subject and claims trustworthy, nearly all underpinned, well synthesized and in logical order; Attention captured with appropriate eye contact, pace, gestures, compatible with audience; Questions and suggestions handling satisfying, shows self-reflection.
- Insufficient:** Subject and claims not convincingly conveyed or misinterpreted, major aspects and references missing; Attention poorly captured through limited eye contact or annoying body language, loses attention of audience, too long / short; Questions and suggestions handling not vigorous or inadequate, lacks self-reflection.

Motivation, feedback and feed forward:
Clear what you did and how in the poster. Do miss the theoretical background.

Structure and design: how does the poster spark interest to reading it?

Very good Sufficient Insufficient

- Very good:** Selection of key results convincing and illustrative; Presentation of information well-organized, visually appealing, consistent, professional, according to norms, creative and aesthetic; Tables, figures, images of added value and informative.
- Sufficient:** Selection of key results relevant and clear; Presentation of information structured, logical order, balanced, correct format, slight lack of organization; Tables, figures, images correct and supporting.
- Insufficient:** Selection of key results unclear or poor; Presentation of information visually not effective, absence of structure or logical order; Tables, figures, images inadequate, confusing, dominating or lacking.

Motivation, feedback and feed forward:
Structure - pictures - tables

Poster presentation criteria and assessment form - Minor H2 Studio The Garage: Applied Research Team

Format poster presentation assessment and criteria by coaches and peers

Student name(s)	
Student number(s)	
Research unit name	
Name project	
Name of the research coach(es)	
Date	
Signature (by research coach) (on the right)	

Per aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?

Very good Sufficient Insufficient

- Very good:** Objective and research question relevant and underpinned; Methods valid and appropriate; Stakeholder engagement meaningful; Evaluation process relevant and well-motivated.
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Motivation, feedback and feed forward:
No mention on poster of method or stakeholders

Analysis, conclusions and recommendations: what are validated lessons learned from this project?

Very good Sufficient Insufficient

- Very good:** Results thoroughly analysed and validated; Conclusions adequate and coherent with objective; Lessons learned link between initial situation and impact of results strong, realistic and convincing.
- Sufficient:** Results satisfactory analysed; Conclusions appropriate but obvious; Lessons learned and recommendations convincing.
- Insufficient:** Results provide raw data only; Conclusions poorly drawn or lacks essential issues; Recommendations reaching too close or lacking.

Motivation, feedback and feed forward:
key findings and reasoning clear

Poster presentation criteria and assessment form - Minor H2 Studio The Garage: Applied Research Team

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

Very good Sufficient Insufficient

- Very good:** Subject and claims up-to-date and well-underpinned; Attention captured with adequate and effective body language, enthusiasm, eye contact, pace, pronunciation, appropriate length of presentation (2-3 minutes); smooth transition between topics; Questions, suggestions and error handling in depth, adequately, with critical attitude.
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Motivation, feedback and feed forward:
very detailed

Structure and design: how does the poster spark interest to reading it?

Very good Sufficient Insufficient

- Very good:** Selection of key results convincing and illustrative; Presentation of information well-organized, visually appealing, consistent, professional, according to norms, creative and aesthetic; Tables, figures, images of added value and informative.
- Sufficient:** Selection of key results relevant and clear; Presentation of information structured, logical order, balanced, correct format, slight lack of organization; Tables, figures, images correct and supporting.
- Insufficient:** Selection of key results unclear or poor; Presentation of information visually not effective, absence of structure or logical order; Tables, figures, images inadequate, confusing, dominating or lacking.

Motivation, feedback and feed forward:
lots of information, very clear

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Subject and claims up-to-date and well-underpinned Attention captured with adequate and effective body language, enthusiasm, eye contact, pace, pronunciation, appropriate length of presentation (2-3 minutes), smooth transition between topics Questions, suggestions and error handling in depth, adequately, with critical attitude 	<ul style="list-style-type: none"> Subject and claims trustworthy, nearly all underpinned, well synthesized and in logical order Attention captured with appropriate eye contact, pace, gestures, compatible with audience Questions and suggestions handling satisfying, shows self-reflection 	<ul style="list-style-type: none"> Subject and claims not convincingly conveyed or misinterpreted, major aspects and references missing Attention poorly captured through limited eye contact or annoying body language, loses attention of audience, too long / short Questions and suggestions handling not vigorous or inadequate, lacks self-reflection

Motivation, feedback and feed forward:
There was a nice flow to the presentation

Structure and design: how does the poster spark interest to reading it?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Selection of key results convincing and illustrative Presentation of information well-organised, visually appealing, consistent, professional, according to norms, creative and authentic Tables, figures, images of added value and informative 	<ul style="list-style-type: none"> Selection of key results relevant and clear Presentation of information structured, logical order, balanced, correct format, slight lack of organization Tables, figures, images correct and supporting 	<ul style="list-style-type: none"> Selection of key results unclear or poor Presentation of information visually not effective, absence of structure or logical order Tables, figures, images inadequate, confusing, dominating or lacking

Motivation, feedback and feed forward:
The poster is structured, but aesthetics are a bit dated, a cleaner look is preferred

Format poster presentation assessment and criteria by coaches and peers

Student name(s)	Sidney Williams
Student number(s)	
Research unit name	
Name project	
Name of the research coach(es)	
Date	
Signature (by research coach) (not to sign)	

Per aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Objective and research question relevant and underpinned Methods valid and appropriate Stakeholder engagement meaningful Evaluation process relevant and well-motivated 	<ul style="list-style-type: none"> Objective and research question focused but general Methods clear, match objective Stakeholder engagement clearly described Evaluation process clear and thorough 	<ul style="list-style-type: none"> Objective and research question unclear or irrelevant Methods inadequate or not convincing Stakeholder engagement invalid or a Evaluation incidentally or not part of the process

Motivation, feedback and feed forward:
very clear the objectives and introduction of the project

Analysis, conclusions and recommendations: what are validated lessons learned from this project?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Results thoroughly analysed and validated Conclusions adequate and coherent with objective Lessons learned link between initial situation and impact of results strong, realistic and convincing 	<ul style="list-style-type: none"> Results satisfactory analysed Conclusions appropriate but obvious Lessons learned and recommendations convincing 	<ul style="list-style-type: none"> Results provide raw data only Conclusions poorly drawn or lack essential issues Recommendations reaching too close or lacking

Motivation, feedback and feed forward:
very good solutions and well explained when I had questions

Format poster presentation assessment and criteria by coaches and peers

Student name(s)	Sidney
Student number(s)	
Research unit name	
Name project	
Name of the research coach(es)	
Date	
Signature (by research coach) (not to sign)	

Per aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?

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Motivation, feedback and feed forward:
a lot of information -> not bad but more focus?

Analysis, conclusions and recommendations: what are validated lessons learned from this project?

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Motivation, feedback and feed forward:

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:

Structure and design: how does the poster spark interest to reading it?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Selection of key results convincing and illustrative Presentation of information well-organised, visually appealing, consistent, professional, according to norms, creative and authentic Tables, figures, images of added value and informative 	<ul style="list-style-type: none"> Selection of key results relevant and clear Presentation of information structured, logical order, balanced, correct format, slight lack of organization Tables, figures, images correct and supporting 	<ul style="list-style-type: none"> Selection of key results unclear or poor Presentation of information visually not effective, absence of structure or logical order Tables, figures, images inadequate, confusing, dominating or lacking

Motivation, feedback and feed forward:
Poster is nice but could've been more attractive to look at

Poster presentation criteria and assessment form - Minor H2 Studio The Garage - Applied Research Track

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:
Standard is good to understand, + good answers to questions, make the problem more clear & personal to the audience

Structure and design: how does the poster spark interest to reading it?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Selection of key results convincing and illustrative Presentation of information well-organized, visually appealing, consistent, professional, according to norms, creative and authentic Tables, figures, images of added value and informative 	<ul style="list-style-type: none"> Selection of key results relevant and clear Presentation of information structured, logical order, balanced, correct format, slight lack of organization Tables, figures, images correct and supporting 	<ul style="list-style-type: none"> Selection of key results unclear or poor Presentation of information visually not effective, absence of structure or logical order Tables, figures, images inadequate, confusing, dominating or lacking

Motivation, feedback and feed forward:
make the story more clear: problem -> solution & prof.

Poster presentation criteria and assessment form - Minor H2 Studio The Garage - Applied Research Track

Formal poster presentation assessment and criteria by coaches and peers

Student name(s): *for Andrew W.*

Student number(s):

Research unit name:

Name project: *Regenerating the H2X*

Name of the research coach(es):

Date:

Signature (by research coach) (pen or sign):

Per aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Objective and research question relevant and underpinned Methods valid and appropriate Stakeholder engagement meaningful Evaluation process relevant and well-motivated 	<ul style="list-style-type: none"> Objective and research question focused but general Methods clear, match objective Stakeholder engagement clearly described Evaluation process clear and thorough 	<ul style="list-style-type: none"> Objective and research question unclear or irrelevant Methods inadequate or not convincing Stakeholder engagement muted or a Evaluation inadequately or not part of the process

Motivation, feedback and feed forward:
Intro & solid, we understand the problem and the proposal

Analysis, conclusions and recommendations: what are validated lessons learned from this project?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Results thoroughly analysed and validated Conclusions adequate and coherent with objective Lessons learned (link between initial situation and impact of results) strong, realistic and convincing 	<ul style="list-style-type: none"> Conclusions appropriate but obvious Lessons learned and recommendations convincing 	<ul style="list-style-type: none"> Results provide raw data only Conclusions poorly drawn or lacks rhetorical appeal Recommendations reaching top close or lacking

Motivation, feedback and feed forward:
The project establishes a framework for others also follow, yet results are more abstract

Poster presentation criteria and assessment form - Minor H2 Studio The Garage - Applied Research Track

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

<input checked="" type="checkbox"/> Very good	<input type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Subject and claims up-to-date and well-understood Attention captured with adequate and effective body language, enthusiasm, eye contact, pace, pronunciation, appropriate length of presentation (2-3 minutes), smooth transition between topics Questions, suggestions and error handling in depth, adequately, with critical attitude 	<ul style="list-style-type: none"> Subject and claims trustworthy, nearly all understood, well synthesized and in logical order Attention captured with appropriate eye contact, pace, gestures, compatible with audience Questions and suggestions handling satisfying, shows self-reflection 	<ul style="list-style-type: none"> Subject and claims not convincingly conveyed or misinterpreted, major aspects and references missing Attention poorly captured through limited eye contact or among body language, loses attention of audience, too long / short Questions and suggestions handling not vigorous or inadequate, lacks self-reflection

Motivation, feedback and feed forward:
Spoke well about the whole project! Could speak a bit louder, but it was fine!

Structure and design: how does the poster spark interest to reading it?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
<ul style="list-style-type: none"> Selection of key results convincing and illustrative Presentation of information well-organized, visually appealing, consistent, professional, according to norms, creative and authentic Tables, figures, images of added value and informative 	<ul style="list-style-type: none"> Selection of key results relevant and clear Presentation of information structured, logical order, balanced, correct format, slight lack of organization Tables, figures, images correct and supporting 	<ul style="list-style-type: none"> Selection of key results unclear or poor Presentation of information visually not effective, absence of structure or logical order Tables, figures, images inadequate, confusing, dominating or lacking

Motivation, feedback and feed forward:
The order of topics could follow one pattern: either columns or lines. I got a bit confused with the second column if I should proceed to 'solutions' or 'research question'

Poster presentation criteria and assessment form - Minor H2 Studio The Garage - Applied Research Track

Presentation skills and professional attitude: how does the presenter tell the story and interact with the audience?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:
Clear speaking, maybe a little bit more volume

Structure and design: how does the poster spark interest to reading it?

<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:



Format poster presentation assessment and criteria by coaches and peers	
Student name(s)	WIDJEY
Student number(s)	
Research unit name	
Name project	
Name of the research coach(es)	
Date	
Signature (by research coach) (with date)	

For aspect of the Poster select a criterion that applies most, and motivate your selection.

Introduction, objective and approach: what is at stake, and how is impact planned to be made?		
<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:		

Analysis, conclusions and recommendations: what are validated lessons learned from this project?		
<input type="checkbox"/> Very good	<input checked="" type="checkbox"/> Sufficient	<input type="checkbox"/> Insufficient
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Motivation, feedback and feed forward:		

Version: 2018-01-15
 Created by: Meaurio Studio The Garage: Applied Research Track
 Last updated: 2018-01-15
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I made it very important to me to articulate my presentation as well as I could, I've learned this from my many poster presentations in my civil engineering course. Naturally I am soft spoken so I must ensure I am projecting my voice at a volume that my audience can listen to comfortably. In presentations knowing or not knowing the answers to the follow up questions can make or break your performance and the perspective on the audience of how much work you did. I'm glad I was able to show I put in a lot of work to obtain the results I had by answering the questions presented to me with confidence. During the presentation however, I could have made my thought process clearer to the audience. My reasoning for all the choices I made and presented were not fully communicated to some and left them rather confused on what the purpose was for choosing the presented solutions. This could have been better if I had completed my report earlier or had been further along in my research. With the report not being finished at that time, I had to explain what I planned to put in it rather than what had been done. Changes like those could have given my script much more support. My poster design and format drew some criticism as well; I will ensure to show my poster draft to my coaches before submission dates. This will give me time to ensure – from different perspectives – that the poster is aesthetically pleasing to more people than just myself.

Research coach signature: 