CIRCULAR ECONOMY IN EUROPE

Soil Management as an example in Germany and Finland

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ABSTRACT

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ABSTRACT

The purpose of this thesis was to show in what way the term Circular Economy is introduced and implemented in the European economy and legislation pointing out the meaning and influence on member states. As an example the situation in Germany and Finland are examined by studying the legislation and developing aims and trends.

To specify the term of Circular Economy the thesis will focus on waste management due to the significant effects waste can have on the environment. Legislation and belonging structures will be presented. To come to a more detailed level soil as an occurring waste is chosen as an concrete example out of the mineral waste sector of construction and demolition waste. The methods of reusing or recycling and legislation in terms of circular economy will be described. To show practical examples the Phoenix project from Dortmund, Germany and the Jätkäsaari project from Helsinki, Finland were studied, pointing out their strategies and actions aiming towards a circular economy.

As a result implemented legislative structures were compared in the two mentioned countries and beneficial effects of a realized circular economy on the economic, environmental and social sectors were concluded.

Keywords Circular Economy, waste management, soil managing methods, reuse

Pages 33 pages including appendices 2 pages

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1 INTRODUCTION

1.1 Background

The topic of this thesis is ´ Circular Economy in Europe – Soil Management as an example in Germany and Finland´. It was written at HAMK University of Applied Sciences in the study field of environmental engineering.

The topic of sustainability in general is becoming more and more important to all operating sectors in the world. The conviction of reusing and recycling any kind of product and material is influencing almost every process of production of goods. Recognizing the limited availability of the needed materials for a growing consumption throughout the world, attention finally was paid to how primary resources can be saved and which methods can be used to ensure the reuse of materials to avoid creating waste and more dump sites. The former treatment or none existing treatment affected the surrounding environment drastically. These arising issues should be taken care of. On purpose to keep materials in a circular flow of use, the topic of circular economy was implemented in the European Union.

1.2 Objectives and Methods

The main objective of the thesis is to point out what the term circular economy means for Europe and how it affects legislation and processes in member states of the European Union. The different developments and implementation progresses of Finland and Germany will be presented.

Research questions which will be studied and answered are the following:

- How is circular economy adapted in the legislation of Germany and Finland?
- How is circular economy implemented in waste management methods focusing on the material soil?
- How is the term of circular economy realized in real projects in the end?
- What are the advantages of implementing such a circular economy?

Based on these questions the thesis will be structured, beginning on a general level and ending with specific cases. So, it will go from defining an overview of the term of circular economy to a more detailed look at waste management and soil management. After introducing a definition of circular economy in the EU, it will specify on the view of a country level in Germany and Finland. To focus on one aspect of the wide topic of circular economy waste management will be presented as an example.

Showing the actual legislation of both countries and how laws are structured and combined, the implementation of the European directives on circular economy will be explained. To define mineral waste in the construction sector of the wide range of different types of waste, soil is picked as one of waste materials. How the circular economy is managing in working with soil, will be described in two specific projects. The Phoenix project in Dortmund as an example for Germany and the Jätkäsaari project in Helsinki for Finland.

As a literature based thesis the provided information is adapted from official and public documents of the concerned countries from internet sources and published reports.

2 CIRCULAR ECONOMY IN EUROPE

A circular economy is the opposite of linear economy which only contains the steps of production, consumption and disposal. The term of circular economy means that the product with its resources and materials is kept in the economical circle for as long as possible. For this the optimization of the product and the minimization of waste are important factors to guarantee a life cycle from cradle to cradle which is the main idea of circular economy (European commission,DG Environment, Pierre Henry).

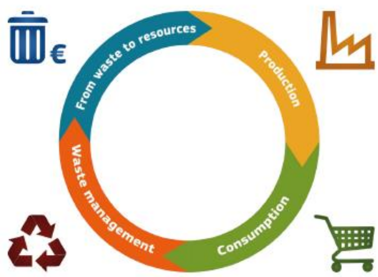

Figure 1. Scheme of Circular Economy (European commission,DG Environment, Pierre Henry)

Consisting of the stages of designing, production, consumption including repairing and reusing and waste management, the product should be designed with a long-term view to be capable of going through all of these phases. The typical life cycle is show in Figure 1.

In the European Union, an action plan to implement the circular economy was published on the 2nd of December in 2015 with the aim “to develop a sustainable, low carbon, resource efficient and competitive economy” (European Comission, 2015). Concerning the topic of circular economy every single produced item is included in this term. The EU action plan pays special attention to plastics, food waste, critical raw materials in electronical devices, construction and demolition products and biomass and bio-based products. The stated actions of the plan to implement the idea of circular economy are to improve existing funding and financing programs, like Horizon 2020 for supporting innovative ideas and projects like LIFE or COSME for supporting environmental protection and economy, and to implement new labels to provide more information for the consumer. The EU expects benefits for the economy by creating a high number of new jobs and reducing emissions significantly. Also, some detailed targets were set like, for example, to reduce landfilling to a maximum of 10% of total waste by 2030. Around the topic of waste and its management this thesis will focus on the following as one part of the wide range covered by circular economy(European Comission, 2015).

The situation of occurring waste will be described in general in Europe, as the United Nations Environment Programme generally points out that waste is "a global issue".(United Nations Environment Programme, 2015) Especially the construction and demolition (C&D) waste takes a huge part of the worldwide produced amount of waste. According to estimations based on data of the OECD countries C&D waste comes to 36% of the total waste. However, data has to be interpreted carefully because of incompleteness, varying definitions and different collecting methods.
Also, estimations for C&D waste in Europe varies heavily from 310 to 700 million tons per year. The newest data from EUROSTAT 2010 indicates the total amount of arising waste to 970 million tons in 2006. These numbers enhance the importance of sustainability in handling every type of waste arising in the construction sector. Even if most countries are developing their regulations and standards concerning recycling of demolition waste, there are dramatically diverging situations between the countries. The percentage of recycled and reused waste material can differ from 5% (China), 40% (USA) to 10%-90% (EU Member States).
In the past illegal dumping became popular after implementing controls and first directives. Land filling was the first controlled waste management until recycling, reuse and prevention became the most sustainable and important methods to manage waste. For the EU the Waste Framework Directive from 2008 sets a general target for 2020 that a minimum of 70% of non-hazardous C&D waste should be in a way recycled including reuse and backfilling and 50% of the municipal solid waste should be prepared for reuse, recycling and recovery (Bio Intelligence Service S.A.S., 2011).
To go further into detail the focus is set on the situation in the European member states Germany and Finland.

3 CIRCULAR ECONOMY IN GERMANY

The circular economy in Germany mostly focuses on the waste management aspect. On this topic, Germany had an international pioneering role in the past and still is one of the best equipped countries with sifting of refuse disposal plants and waste treating plants. Even when the statistics of recycling monitoring reports are satisfying the real percentage of usage for new products can vary from the given figures because the treatment method from waste to energy can be included in the term of recycling. The aspect of eco-design for supplying a circular economy and circular material flow is currently added by implementing the program for resource efficiency (Ressourceneffizienzprogramm II). Possible improvements for the German circular economy are to rearrange the current focus on the waste managing methods and establish new business concepts, researches for more innovation on the circular material flow and increase the responsibility of the individual producer for his product.

3.1 General Legislation

In Germany, the waste legislation is mainly determined by the Kreislaufwirtschaftsgesetz (KrWG) which could be translated as the circular economy law. The first law for managing waste was nacted in 1994 and replaced in 1996 by the Kreislaufwirtschafts- und Abfallgesetz (circular economy and waste law). Because of adapting the terminology and the restrictions of the European directive, the law was amended and renamed in 2012 to the Kreislaufwirtschaftsgesetz(Bio Intelligence Service S.A.S., 2011). Its purpose is to take care of natural resources, to protect human beings and the environment producing and managing waste and to develop recycling and sustainable handling of waste in general. With the determination of the order of priority of the actions to handle waste, the law is aiming at a significant reduction of the occurring amount of waste. The hierarchy is avoidance, preparation for reuse, recycling, other uses including energy recover and backfilling and at last disposal. These five steps are adopted from the European Waste Framework Directive (2008/98/EC) which has highly influenced the German regulations. The KrWG also contains when a material is defined as waste, who is in charge of the waste and how it should be handled.(Kreislaufwirtschaftsgesetz, 2012)

3.2 Facts and Data

Monitoring the amount of waste and its different types and quantities was started in Germany in 1995. For a period of 10 years the working-group Kreislaufwirtschaftsträger Bau (ARGE KWTB) published reports in two year intervals. The latest report of 2014, based on the data of the German federal bureau of statistics is pointing out a total demolition and construction waste of 202,0 mio tons, with only a small difference to previous numbers (2012: 192,0; 2010: 186,5 mio t; 2004: 200,7 mio t). (Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

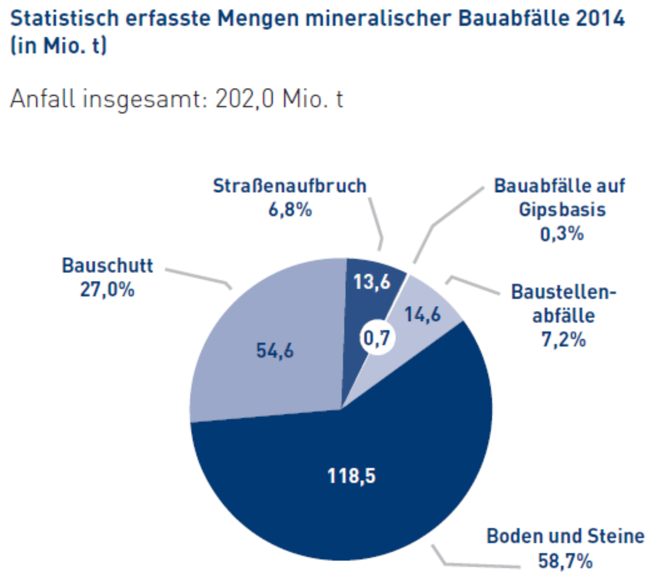

Figure 2. Amount of mineral construction waste in 2014(Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

Showing in the Figure 2 above 118,5 mio tons consist of excavated soil and stones (Boden und Steine), which comes to an percentage of 58,7%. This makes it obvious that the material soil is taking an important part in the total amount of waste.

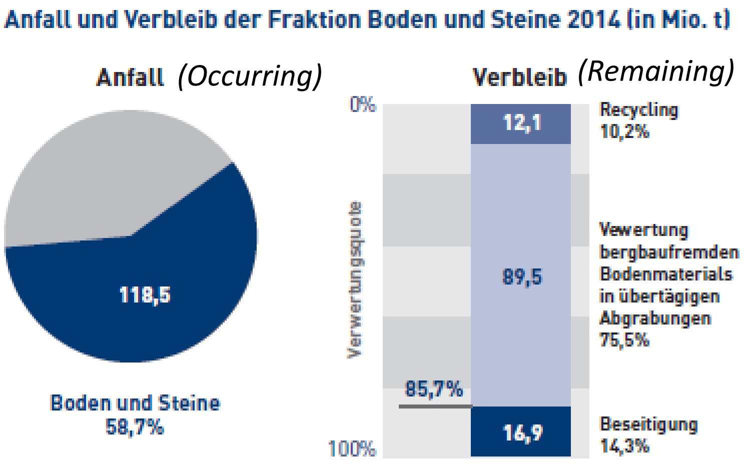

Figure 3. Rate in which treatment the material remained(Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

Showed in Figure 3, reported as reused excavated soil and stones is 75,5%, which means that it can be used in backfilling of for example quarries *(Verwertung bergbaufremden Bodenmaterials in übertägigen Abgrabungen*). The exact method of reusing or recycling the soil is not shown in the statistics and also not reported properly. Out of 10,2%

(Recycling) recycling materials were recovered and 14,3% *(Beseitigung)* of the total construction and demolition waste was disposed of. As a conclusion it can be said that 85,7% of the total 118,5 mio tons of excavated soil and stones were in a way reused.

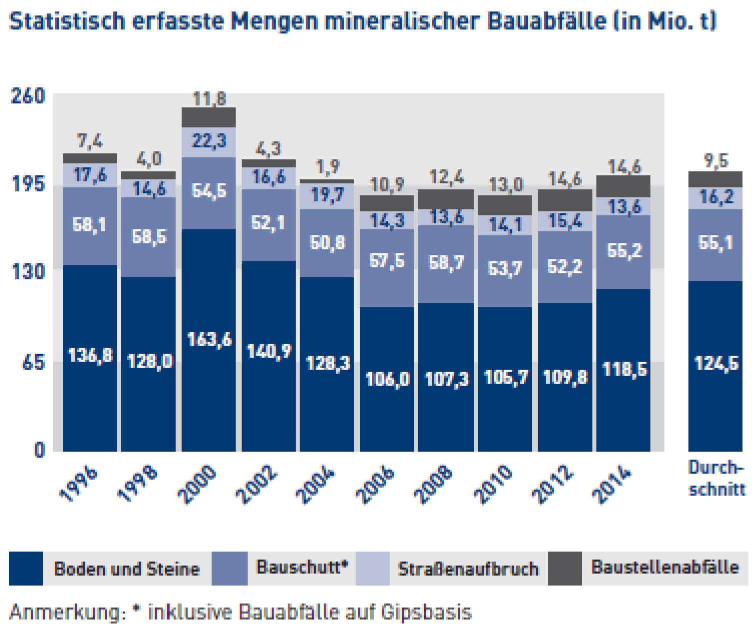

Figure 4. Statistical recorded mineral wastes in the construction sector of the last 20 years(Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

In the last 20 years, the distribution of the occurring waste sectors was extensively constant as shown in the graph above (Figure 4). Two-thirds of the arising amount was soil *(Boden und Steine)* and one third demolishing waste which includes building rubble *(Bauschutt)*, road surface material *(Straßenaufbruch)* and construction waste *(Baustellenabfälle).* On average 86% of the 124,5 mio tons of excavated soil and stones could be exploited.

3.3 Occurring Problems and Future Improvements

During the last few years the amount of the arising mineral waste of construction sites can be described as constant, although the amount of excavated soil rose in the last two monitoring reports. This trend could cause some problems on the path to a circular economy. Moreover, the image of recycled materials should be improved in society. Because in some regions where primary resources are easily available, for example in areas of quarry industries, these are preferred instead of reusing materials.

4 CIRCULAR ECONOMY IN FINLAND

Circular Economy became an important issue in Finland. A road map with the aim to become a leader country in circular economy by 2025 was published by Sitra, the Finnish Innovation Fund, in 2016. To reach the aim plans for five areas have been made which include the development of a sustainable food system, forest-based loops, technical loops, transport and logistics and common actions. Benefits of implementing a circular economy are expected for the economy, building up competitiveness for Finland, opportunities for export, a big number of new jobs and businesses. Regarding the environment, resource efficiency will grow and closed material circles will lead more and more to a waste-free society. Moreover, in the society people´s awareness for the topic will increase and new consumption methods will be discovered.

On the way to a leading position in circular economy the current situation of some aspects can be noticed positively. The technological standard is already quite high and will be developed further. Also, as a social aspect the society starts to share the economy trend with quality consciousness which will be extended in the future to sensitize the consumers for the topic. For the ecological change environment will be affected positively while reducing the usage of resources as well as greenhouse gas emissions. On other aspects, the country should work on to support the implementation of a working circular economy. For example, in politics the prime minister Juha Sipilä added circular economy targets to his government program but there are still many policy decisions, which should be made clearly to guarantee good starting conditions to aim at a leader position for circular economy. Going along with this, changes have to take place in the current legislation which often could slow down the needed processes and progresses. Despite the challenging economic situation in Europe, Finland could benefit from these plans with expected two to three billion of euros by the year 2030. (Sitra Studies 121, 2016)

4.1 General Legislation

For Finland in the 1970s waste was mainly dealt as a health issue. This changed in the 1980s when the focus was more and more put on the environmental protection, dealing nowadays with the main aim to reduce the waste amount. The most important law regarding the Finnish waste legislation is the Waste Act (646/2011) which adapts the Waste Framework Directive (2008/98/EC) as the KrWG does in Germany. The Waste Act gives a definition of waste, treatment options and describes responsibilities and transport guidelines. Also, it implements the five main steps of the waste management hierarchy the same as in the German legislation. They are shown in the graph below (Figure 5) in their graded order, starting with prevention and ending with disposal.

Figure 5. Waste management hierarchy (European Commission, 2016)

4.2 Facts and Data

The total amount of arising waste in Finland was 93,25 million tons including 1,9 million tons hazardous waste in 2014. The mostly used recovery method is the landfill disposal with a percentage of around 80% of the total. The second is the utilisation as a material with 13%, besides the alternatives of utilisation as energy, destruction by incineration and other disposal types such as reservoirs(Bio Intelligence Service S.A.S., 2011). Separating the arising amount of waste by sectors the mining and quarrying business takes the largest part with around 65% and the construction sector is the second biggest part in producing waste of 16,3 million tons (19,6%)(Official Statistics of Finland, 2016) (see Figure 6 below).

Comparing the different treatment methods while looking at the C&D waste the priorities are changing depending on the material. Concerning the ordinary mineral waste 1,4 million of 1,7 million tons are used as the same material for other purposes. It is diverging from hazardous mineral waste of which more than half is used as energy. The landfill disposal is the favored treatment method for hazardous and ordinary soil. More than 95% of the ordinary soil materials is disposed of in land fillings. These statistics are provided by the Official Statistics of Finland in several reports and tables.

Although every country tries to record the arising amounts of different types of waste, to make a comparison between these statistics is a difficult task because the methods and definition can vary in a wide range. For example, for Finnish statistics soil which is not used on-site or in road construction is reported as waste and in Germany soil used for road construction is reported as reused waste.

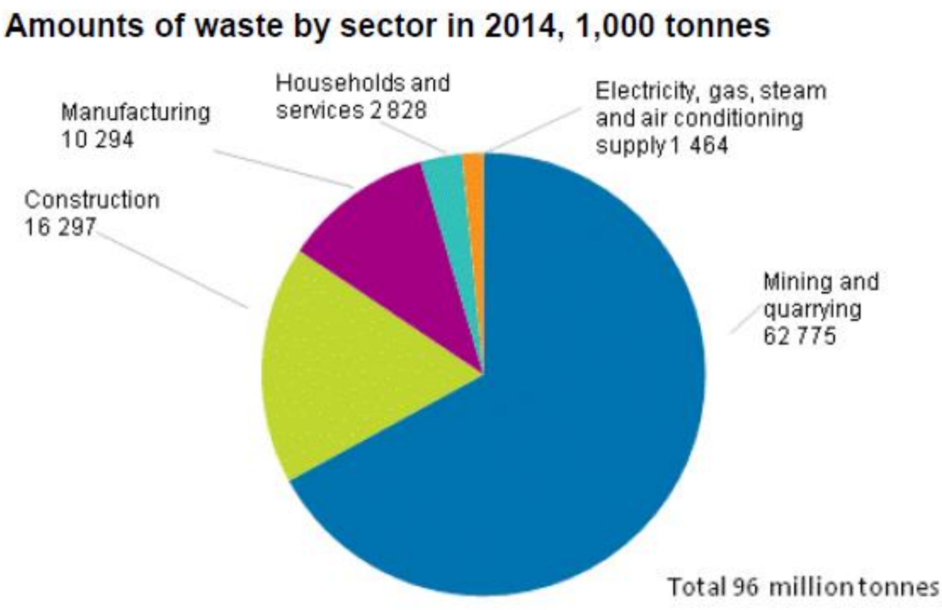

Figure 6. Statistical graph of arising waste amount (Official Statistics of Finland, 2016)

4.3 Occurring Problems and Future Improvements

One of the most challenging tasks for Finland is to make the transportation of waste efficient. Due to the low density of population and the wide land areas, the ways from one construction site to another or place of produced waste to the treatment plant can get really long and the costs of transportation very high. So, the locations of treatment plants must be picked carefully and the management of waste and soil must be organized before producing or excavating. In urban areas like the capital area around Helsinki/ Espoo/ Vantaa a proper management is much more worthwhile than in rural areas where this is not demanded.
Another challenge to handle concerning different construction materials is the recycling of wood. Because wood is an easily available material in Finland, it is a common material on the construction site. So, the logical consequence is that it is also a quite important part of the demolition waste materials with around 40% (regarding to statistics of 2012)(Bio Intelligence Service S.A.S., 2011). Except for using for energy purposes through burning, there are few opportunities to reuse wooden materials again, so currently research work is being conducted trying to find new options.

5 WASTE MANAGEMENT

To focus on one important field of the wide topic of circular economy waste management will be dealt with in the following chapter. As mentioned before the topic of waste management takes a large part of the circular economy in Germany where it is almost the only aspect focused on. In Finland, it also plays an important role in discussions about circular economy.

5.1 **Finland**

In Finland, the ´National Waste Plan for 2016´ was published in 2009 by the Ministry of the Environment. To reduce possible impact on the environment, health and society, several aims were worked out. First, the main objective is to prevent waste by promoting reusing and repairing methods to increase the efficiency of one product and its lifetime. Supporting aspects shall be implementing new ecolabels and waste taxation and using recycling materials with a priority in public to sensitize customers. Further actions will be to avoid hazardous materials by replacing them in production processes by less hazardous materials. To decrease the impacts of waste using waste as energy will be a more efficient way. Further improved will be safety and technology, communication between working parts like municipalities and companies as well as supporting funding for research.

Concrete targets for 2016 were to reuse and recycle about 50% of municipal waste and use 30% of the total waste amount as energy by incineration(Ministry of the Environment of Finland, 2009).

Currently the Finnish Ministry of Environment is working on a new waste plan aiming the year 2030. As a part of the Finnish circular economy it will also focus on waste management and will establish targets for construction and demolition waste as one aspect. The planned publishing and introducing date is set for autumn 2017 (Finnish Ministry of Environment, 2017).

5.1.1 Waste Legislation

The waste legislation consists of the main Waste Act (646/2011) (mentioned before) and the Waste Decree (179/2012). These are also completed by the Government Decision on Construction Waste (294/1997), the Environmental Protection Act (527/2014) and Decree (713/2014), the Government Decree on the recovery of certain wastes in earth construction (591/2006) and the Environmental Tax Act. The purpose of the additional legislation is to specify topics which are not sufficiently covered in the main laws.

5.2 **Germany**

In Germany, the waste management is also striving towards a closed loop economy. It is developing from the past habit of disposal to circular economy. A report of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of 2016 points out some main achievements and facts. In the last 25 years of political efforts towards a circular economy the citizens have been experiencing a sensitization for more sustainable waste management which should be continued in the future. From the economic point of view the implemented circular economy has turned out as a successfully new economic field with now around 200,000 employees, 6,000 companies and 40 billion euros of turnover per year. Regarding the environment, the conditions have improved a lot by reducing emissions but there are still unused potentials left. (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB), 2016).

In May of 2016 the same ministry has published in cooperation with other institutions another report ´Eine moderne Abfallwirtschaft – Wege und Ziele´ about the future fields of development on the way to a modern circular economy. One of the areas which should be improved is the strategic political control. This topic includes clear structures and responsibilities in the legislation frame, well-built road network, functioning controlling institutions and efficient disposal structures for local authorities. Another topic is the social development focusing on the environmental consciousness to create a better understanding in the society for the task of building up a circular economy. Also, more qualified employees have to be trained to guarantee a well working economy. The financial field must handle the problem that running costs and construction costs have to be borne by municipalities and suitable instruments for funding have to be found. These important points build up the pillars for implementing a modern circular economy successfully for all participants as shown in the Figure 7 below (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, 2016).

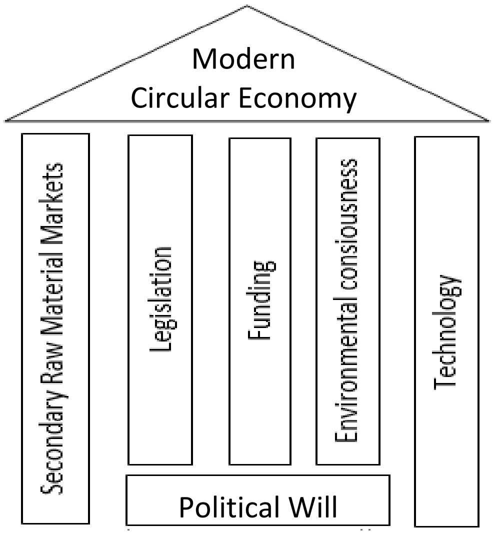

Figure 7. Pillars to a modern circular economy (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, 2016)

5.2.1 Additional Waste Legislation

In the Kreislaufwirtschaftsgesetz (mentioned above) the topic of waste management was dealt with on a deeper level. Furthermore, the law is completed by several other regulations and guidelines as, for example, the Abfallverzeichnisverordnung (AVV), Deponieverordnung (DepV) and the new drafted Ersatzbaustoff-verordnung.

Moreover, the German legislation is specified from each institutional level. The European law has an impact on the German federal law, which is adopted and extended slightly different from the sixteen different states (Bundesländer) of Germany for topics which are not sufficiently covered in the federal law. Furthermore, the municipalities of the states continue the regulations by giving recommendations and guidelines for companies and private households. At the end of the chain directives can slightly vary for the consumer.

To focus on one aspect of many different types of waste, included in the regulations of waste management, construction and demolition waste was chosen. This means the mineral wastes or inert waste (the term is used in the European directives) which are explained in the following.

6 SOIL AS A WASTE MATERIAL

6.1 Mineral Waste from Construction and Demolition waste in general

As shown in the Statistics of both countries of Finland and Germany construction and demolition waste constitute a huge part of the total amount of occurring waste. Due to this fact, this thesis concentrates on the produced waste during a construction or demolition process of a structure. Especially in demolition projects a high potential of recycling is available. The term of demolition and construction waste can cover a wide range of materials which usually consists of wood, plastic, steel, soil, stones, gravel, sand, rubble and concrete debris. A large part of these materials can be summed up under the term of mineral waste. In Germany the so called inert waste (Inertabfall) legislation is included in the topic of mineral waste. It means materials and substances which do not allow any physical, chemical or biological changes to its characteristics. They are not able to solve in other substances or burn or decompose. They also have the property not to cause harm to environment and human health. Examples of soil and rubble as a mineral waste are shown in Figures 8 and 9 below.(Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

Figure 8. Example of mineral wastes: soil (Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe- Steine und Erden e.V., 2017)

Figure 9. Example of mineral waste: rubble (Kreislaufwirtschaft Bau c/o Bundesverband Baustoffe-Steine und Erden e.V., 2017)

In the following the thesis will concentrate on soil as an occurring waste material and as a new possible recycled material for construction purposes and more.

6.2 **Specific Legislation for Soil**

6.2.1 Germany

As mentioned in 3.1 the KrWG is normally the main law for waste management, but this differs if we speak about soil as a material for reusing in construction. This law does not apply to uncontaminated soil or other natural materials excavated on a construction site meant to be used for construction purposes (§1 Abs. 2 S.11 KrWG). For uncontaminated soil Baugesetzbuch (BauGB), Bundesbodenschutz- u. Altlastenverordnung (BBodSchV) and Bundes-Bodenschutzgesetz (BBodSchG) and several other laws and guidelines are relevant.

Another important document concerning the reuse of soil are the technical rules established by the Länderarbeitsgemeinschaft Abfall (LAGA). The specific course of action how to proceed with excavated soil and in what way it can be reused is described. First, investigations of the available soil have to be made to check if further analyses are necessary. For this a close look was taken at the material and existing documents of the registered environmental liabilities. Under certain circumstances which are listed in the rules, like an earlier industry area, further going analyses are compulsory. The spectrum of investigation is defined by the LAGA, also the parameters, on which research must be done, are given. With this examination every soil is classified in a different installation category from Z 0 to Z 2. Depending on the planned use of the soil regulations can vary, as shown in Figure 10 below. Usually the "placing and inserting in a permeable layer for roots" is referring to topsoil for which the BBodSchV is valid. (LAGA Länderarbeitsgemeinschaft Abfall, 2003)

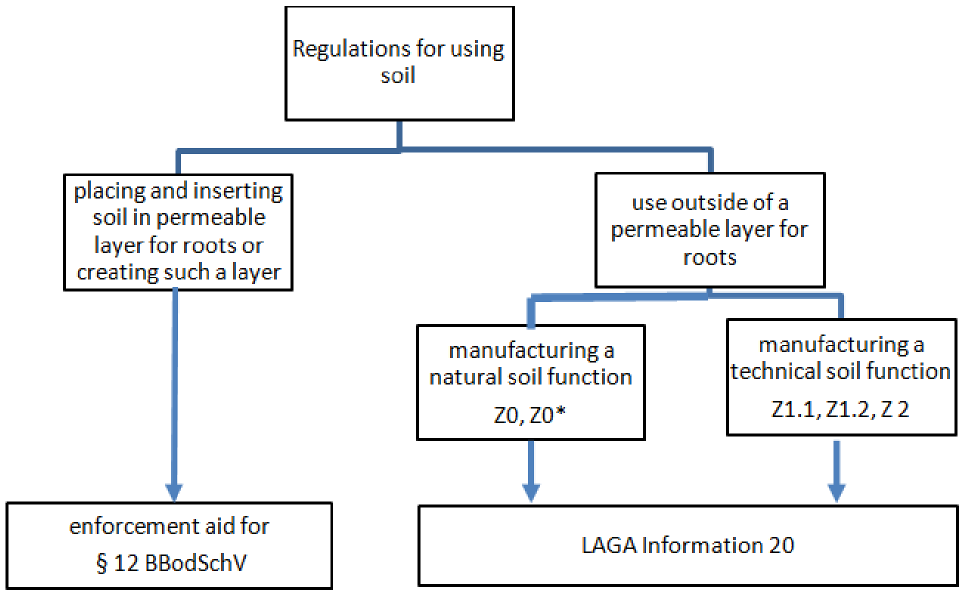

Figure 10. Different use of BBodSchV and LAGA (LAGA Länderarbeitsgemeinschaft Abfall, 2003)

The first installation class (Z 0) is meant for an unlimited installation for the exploitation of soil in reusing as a material similar to soil. While manufacturing the soil in a natural function, it should also meet the requirements of soil and groundwater protection. Furthermore, the soil must not exceed the given mapping values for solid contents (e.g. arsenic, lead, TOC) and eluate concentrations. The second class (Z 1), consisting of the mapping values Z 1.1 and Z1.2, is for soil used in open installations in technical structures. The last class (Z 2) is used for structures with defined technical safety measures to protect the groundwater of hazardous contents of the soil. Several additional guidelines for the construction are included in the installation class 2. (LAGA Länderarbeitsgemeinschaft Abfall, 2003)

6.2.2 Finland

Concerning Construction and Demolition waste including soil the Government Decree on Waste (179/2012) specifies the legislation. It includes a definition of C&D Waste and points out that there is no distinction between the waste of construction and demolition. Regarding section 15 the most important aim is to avoid the occurring of waste and to collect it separately for recovery options (section 16). Moreover, limiting values for backfilling operations are given specifically. Also, the

Land use and Building Act (132/1999) regulates permits for treating waste and ensures the ability to recycle. In addition, the land use and building decree (895/1999) says that the whole life cycle of a construction has to be taken into account in the design and planning phase and that especially the waste management has to be provided in the construction phase in a satisfactory way.
To evaluate soil conditions the ´Government Decree on the Assessment of Soil Contamination and Remediation Needs´ (214/2007) gives threshold values and guideline values to categorize soils in hazardous and non-hazardous soils.

6.3 Reusing possibilities defined by the European Directive

As given in the European Waste Framework Directive the hierarchy of possible options to reuse includes five steps adapted in Germany and Finland.

The first thing to follow the legislation is to prevent producing waste, meaning not to excavate unnecessary amounts of soil which could be avoided by a carefully and detailed plan in the beginning. Also, within such a soil and mass managing concept the direct reuse of soil at the excavated construction site would be part of preventing waste. Like every action to avoid turning a material into waste, belongs to the first aim of prevention. Additionally, actions of reducing the amount, enlarging the durability and decreasing the harmful effects of waste can be counted as an action of prevention.

If then waste is occurring after taking these actions the possibility of reusing should be checked. Defined as "preparing for reuse" is every method of examination, cleaning and repairing of the material to reuse for the same purpose as it was originally used. Important for the opportunity to reuse is the selective excavation and segregation of soil.
Recycling, as the third step, is defined as reusing the material in the same or other purposes, not including "recovery of waste as energy or the reprocessing of waste into fuel or material to be used for backfilling" (Waste Act).

If the soil material cannot be recycled or reused the waste should be utilized in a useful way in the economy or should replace other primary resources. An example could be to generate energy or benefit agriculture by used in land treatment.

The last and least wanted possibility to treat soil is to dispose of it on the provided sites. Disposal actions are, for example, landfilling, land treatment and incineration. In general, every method which is not recovery can be called disposal.

The separation between preparing for reuse, recycling and recovery methods can sometimes be difficult.

6.4 **Contaminated and not contaminated soil**

6.4.1 Definition of hazardous soil and non-hazardous soil

In which case a soil is hazardous or not may cause harm to human beings and the environment can be analyzed by the threshold values given. These can vary slightly from country to country and are given in therefore provided documents. Guidelining values are given to evaluate the researched results by several analyses. As mentioned in the legislation for soil given values for Finland can be found in the ´Government Decree on the Assessment of Soil Contamination and Remediation Needs´ and for Germany in the report given by the LAGA.

6.4.2 Reasons for contamination

Almost every contamination of soil is caused by industrial and human activities, so called anthropogenic reasons. Only a small fraction of soil in projects, in which polluted soil has to be handled, is naturally contaminated by coincidently accumulated hazardous compounds, produced by natural found metals or leaks from natural created sewer lines into the soil surface. For man-made causes there are multiple reasons. They especially occur more often in urban areas than in rural areas. Accidents like explosions or mistakes in factories and gas stations, industry activities, mining with the use of big machines directly in the soil like in many construction projects, transportation regarding pipe lines or also road salt usage, agriculture applying big amounts of chemicals on fields and not well maintained or badly planned waste disposals are all possible fields in which soil can get contaminated. The explained reasons are listed in Figure 11.

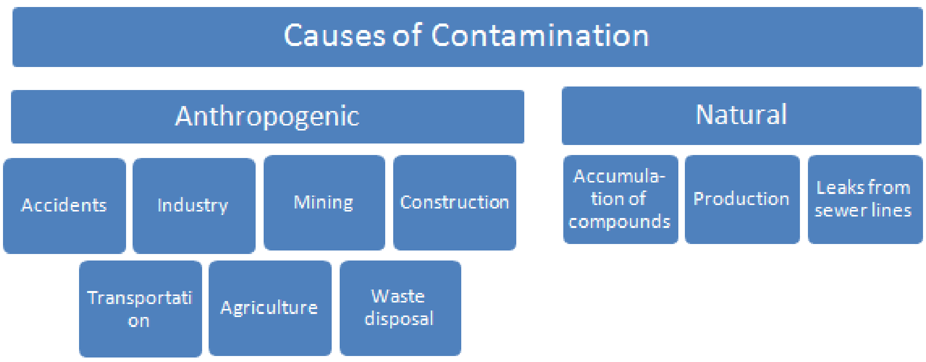

Figure 11. Causes of Contamination

Regarding an article of the ´Journal of Environmental and Public Health´ from 2013, three billion estimated tones of solid waste are disposed of including only a small fraction of hazardous waste(Panagos, van Liederkerke, Yigini, Montanarella, 2013).

Contamination of soil occurs caused by different substances. One possible contaminant is chlorinated hydrocarbons (CHCs). These chemical substances contain chlorine, carbon and hydrogen. Typical characteristics are their higher density than water and their persistence. Due to this it can get easily into the soil and last there for a long time because it doesn't easily solve in water. Several studies have pointed out that CHCs have an influence on human health. By drinking them in water or the contact with skin it can cause varying cancers, liver and kidney diseases and other consequences (ORICA, 2014).

Mineral oil is another compound often found in soil analysis. Usually, petroleum as a mineral oil contaminates soils due to accidents, leaks, gas stations or transport occasions. A clear statement about the effect of mineral oil compounds on human health cannot be made because studies are not certain if these are carcinogenic or harmless.

Polycyclic aromatic hydrocarbons (PAHs) are naturally occurring in materials like coal, crude oil and gasolines and can be set free to the air in burning processes of wood, coal etc. Breathing and skin contact are the possible ways to be get these compounds in the body. The real influence on health is unknown. Some abnormalities in blood and liver and cancer diseases can be suggested to be related to PAHs.

The most frequent pollutants found are heavy metals like arsenic, copper, lead, zinc and cadmium. They can appear naturally but often they are caused by industrial activities. The use is known as carcinogenic and can have toxic effects on several organs.
Benzene, toluene, ethylenzene and xylene, known as BTEX, belong to the unsaturated hydrocarbons and aromatic hydrocarbons. They mostly are set free to the air and can have cancer and liver and bone marrow diseases as consequences of inhaling or otherwise contact(Bennett, 1999).
All these compounds of pollutants and more can occur in soil due to human industry activities etc. Concerning estimations the largest share of the distributed pollutants in soil have the heavy metals with 34.8% and the mineral oil with 23.8% (shown in the Figure 12).

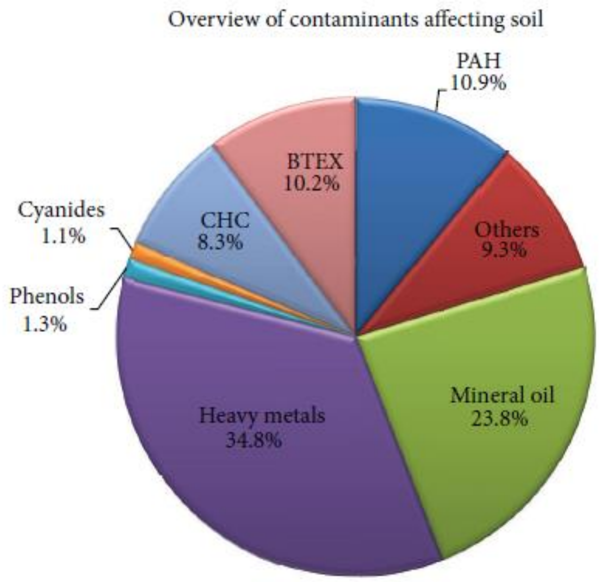

Figure 12. Distribution of soil contaminants(Panagos, van Liederkerke, Yigini, Montanarella, 2013)

6.5 Treatment methods for contaminated soil

Soils which are contaminated must be treated for reuse in a harmless condition. There are several methods available to achieve this goal. One of the frequently used methods is the bioremediation. It can be performed ex-situ or in-situ for removing contaminants like BTEX and PAHs but usually not suitable for heavy metals. The treatment works with organisms like bacteria, fungi or plants which are influencing the normal life functions of the contaminant. When the organisms are added to the contaminated soil, they react with the pollutant and have a less harmless substance as a result. For example, in an in-situ treatment nutrients and water are injected by spreading them evenly at the soil or by wells. The bioremediation should be prepared by laboratory analysis for identifying the chemical substances and can be affected by the pH-value, the temperature and the type of soil(Donlan & Bauder).

Another method of soil treatment is thermal desorption. Here the soil is heated until the contaminants solve to the air. This process always follows an off-gas treatment to remove the hazardous substances from the air. The method can be used for petroleum contaminated soils. Generally the soil can be heated up to 1,000°F.(United States Environmental Protection Agency, 2012)
Incineration as a treatment should not be mixed up with thermal desorption. After the burning process only materials which are incombustible are left.

Other common treatments can be land filling which is tried to be avoided in a circular economy and solidification of contaminated soils which will be explained in the specific project of the Jätkäsaari in Helsinki.

6.6 Management methods

6.6.1 Germany

In Germany the structure for soil management has stepped from a general level to more details. It starts on the federal level with its main legislation consisting of the KrWG, BBodSch and the explanatory leaflet of the LAGA which was adapted by the federal states. The Mantelverordnung which is part of the Ersatzbaustoffverordnung will try to combine and renew the BBodSch and Altlastenverordnung, ordinance for contaminated sites, to structure the legislation more clearly. But it is still not enacted and has not come into force yet.

So, on the regional state level the terms for managing soil are extended. For example, in the state of North Rhine Westphalia (NRW) the LBodSch, several explanatory leaflets and technical aids like the *´Abfall- und boden-schutzrechtliche Anforderungen zum Umgang mit belastetem Bodenmaterial´* in which demands and exceptions are added and explained. As a state NRW also provides information about hazardous waste from the past and harmful changes in soil in a subject information called *´Fachinformationssystem "Altlasten und schädliche Boden-veränderungen" ´* shortened (FIS AlBo). With this system the remaining hazardous substances in soils are reported and can help contractors in setting up their specified design for a project. To manage occurring and demanded soil masses an internet platform for soil, rubble and building components named ALOIS was implemented(ALOIS - Abfall Online Informationssystem). It works on a voluntary basis only and is more used so far in densely populated areas like the Ruhr Area. Concrete user information is not provided. A strategy for implementing sustainability in NRW was published in 2016 by the LANUV (The North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection) but soil management is not a topic on which the report concentrates.

The next step of the structure is the municipal level and city level. As a city Dortmund refers in many recommendations to state guidelines. For topics like reporting the use of recycling materials and recommendations of guiding installation values (Dortmunder Einbauwerte) the city gives its own documents.

The final step for the actual management taking place is left to the contracting companies. They are responsible for the excavation of soils and the final reusing or disposing method which usually is determined in the designing and planning process. Thanks to communication between companies soils can be sometimes needed in other projects in which they are currently demanded and have not been disposed of. This only happens on a voluntary basis and in some cases in which no demand or reusing possibility is found soil can be stored without any usage.

As a conclusion it can be said that the management topic is takes place on a more voluntary stage and is regulated and restricted by different organizational levels.

6.6.2 Finland

Because of Finland's different landscape areas, methods of soil management vary due to population. For example, in the sparsely populated region of Lapland attempts of managing soil sustainably, between different projects are almost impossible. To conclude the most important aspect in this area is to reuse occurring soil on sites to avoid land filling or restoring in another place. In more southern regions with more population and more possible projects transports of soils from one site to another site where it is needed may work out to be used in a sustainable way, if the costs and emissions of the transport distances are not higher than disposal or landfilling costs. Still problems of a lack of projects and matching demand and needs can appear and sustainable soil management can become difficult to perform. The most developed management methods of soil can be studied in the capital area of Helsinki where a special program system was implemented to manage occurring soil masses in the most sustainable way as possible. The strategy for the Helsinki area will be explained in more detail in chapter 9.2.

In the following a closer look will be taken at actual projects of Germany and Finland, pointing out how land masses were managed in polluted or not polluted conditions.

7 SOIL MANAGEMENT AT THE PHOENIX GELÄNDE, DORTMUND, GERMANY

7.1 Description of the location

The city of Dortmund is part of the Ruhr district in North Rhine Westphalia which is one of the biggest conurbations due to the former coal and steel industry. In the focused area in Dortmund the industrial development began in 1841 with the construction and founding of the iron and steel works by Hermann Diedrich Piepenstock. It was expanded and modernized until it was on its highest point of production in the 1960s with about 10.000 workers and known as the most modern basic oxygen steelmaking shop in Europe. After the Second World War steel was less demanded and after a few changes in the company ownership the western part of the area was closed in 1998 and the eastern part in 2001. Because of the huge area and the location next to the city center (shown in the Figure 13) as well as the good transport link and the favorable natural setting due to the nearby river Emscher, a concept was worked out how to transform the former steel industry area into one of the biggest locations for innovation in Germany. The decision of the municipal council for recreating the area was made in the year 2000.

City

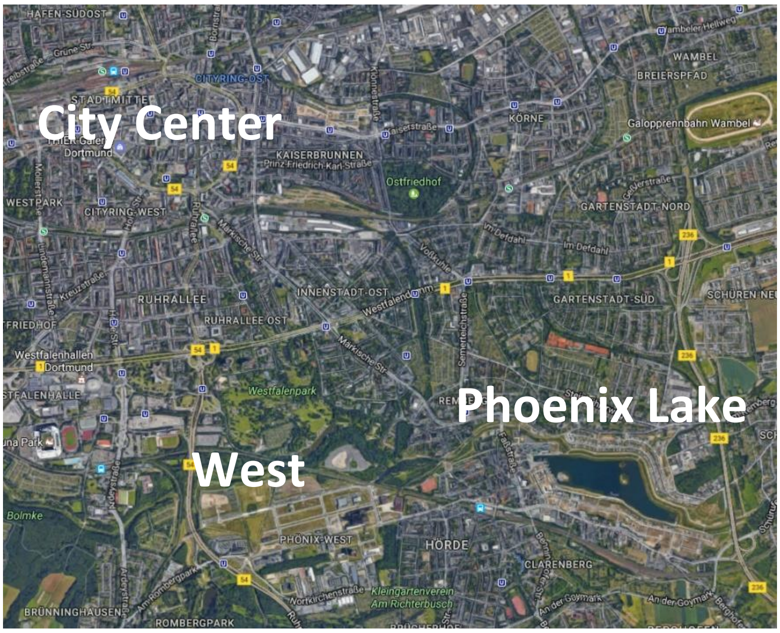

Figure 13. Actual aerial picture location of the Phoenix area in Dortmund (Google Maps, 2017)

7.2 Strategy for soil management around the Ruhr Area

Due to the former industrial economy in the Ruhr Area soil contaminations appear individually and remediation programs can get quite expensive. A strategy especially for soil management in the area was not developed but a trend can be identified. Between the choice of decontaminating or securing techniques security measures are preferred because of the more cost-effective and on-site realization. By choosing this method expensive remediation and transports can be avoided but permanent supervision of the secured contaminated soil must be ensured.

7.3 Project Description

With the aim to create a suitable environment for living, working and leisure activities and to increase the value of the district Hörde the project of the Phoenix area was implemented. Moreover, 10 000 new work places should have been set up by the project. The area consists of the west part of the former blast furnace plant and the east part of the former oxygen steelmaking shop. For the west part ´Phoenix West´ an industrial estate with possibilities for leisure and culture activities was planned. On the other hand in the eastern part ´Phoenix See´ a residential area with an artificial lake has been realized to provide leisure time activities, possibilities of a countryside life and a good location for service companies. The river Emscher which was earlier led underground through the city was restored to its natural state along the Phoenix Lake but for ecological reasons holds separate from the lake. The original overview plan for the project is shown below (Figure 14).
Both areas together comprise around 200 ha of a former industrial area for the new project. The whole planning process of the project started in 2000 and the realized constructed area was finished in 2011. During planning different aspects had to be considered. A solution for the structural and countryside ecological aspects as for the water and soil management had to be found. The following text will focus on the topic of the soil management.

Figure 14. Planned areas of Phoenix West and Lake (Stadt Dortmund, 2006)

7.4 Soil Management in the project

The general management for the land masses is recorded in the ´Planfeststellungsunterlagen´. In this report every aspect of the project is specified and how and in which way it will be handled and performed. This report is also the most important document for the permission procedure with the local authorities to get the permit for starting the construction. After the decision to rebuild the Phoenix area was made in 2000, preparing research and analysis work was done, the ´Planfeststellungsunterlagen´ has been worked out and was handed in at the competent authority in 2003. The documents were studied and the public was involved, the permit was given in 2005. The public works planning procedure (Planfestellungsverfahren) for the documents are in accordance with the current legislation for water (WHG) and soil (BBodSchG).

For setting up the soil management the condition of the soil which is supposed to be excavated has to be known. For this purpose a number of analyses were done and an expert´s report was presented. Access to this report was not permitted on request for this thesis. The provided public information about the soil quality in the two different areas will be explained in the following. The information published by the city of Dortmund is taken from two documents: (Stadt Dortmund, 2003)and (Stadt Dortmund, 2006)

7.4.1 PHOENIX See Project

In the planned lake area the condition of the soil and groundwater was unremarkable in comparison with the area of Phoenix West. In the past ground level of the area was raised around 10m with embankments of soil and building rubble to keep the ground dry for the industrial use and to avoid flooding of the river Emscher.

The testing of the soil showed a local pollution in the area of a former gasworks with PAH and higher concentration of chrome. Also, in the center pollution with CHCs was discovered. Based on the soil analysis the expert drew the conclusion that a reuse and installation of the excavated soil excluding the pollution of the former gasworks is supportable. Because of the low concentration of eluate concentration no hazardous potential for ground water is expected. But a permanent control by experts of the excavation and installation works with chemical analysis is required. The material of the former gasworks should be disposed of and will approximately comprise of less than 10%. The frequency of the control analysis for disposal material is every 5000m³ for natural soil, every 2500m³ for soil material for installation like building rubble and recycling material and for planned disposal material every 1000m³. The testing samples will be taken at stored amassing of soil.

As an example the analysis of the polluted gasworks soil which will be send to disposal is documented Table 1 below.

Table 1 ((Stadt Dortmund, 2006)

Time	September 2005- September 2006
Excavation volume	Ca. 125.000 m³
Number of testing samples	Ca. 120
Frequency of sampling	1 sample every 1.041m³

Extra analysis	Ca. 450 (10x10m grid)

As a reference for interpreting the testing findings the area specific recommended installation values (´Dortmunder Einbauwerte´- appendix 1) are used. These correspond to the given general LAGA values mentioned before.

The main aim of the management of the occurring land masses was to reuse and restore all material inside the construction area. To build the artificial lake with its 24 ha surface around 2.5 million m³ of soil had to be moved and excavated. Around four-fifths of the excavated soil has been used to model the shoreline area and residential area and around 500,000 m³ of soil were transported to the west area for reinstallation. For the transport the “Eliasbahn” was used which is an old industrial railway line between the west and eastern part of the Phoenix area, originally used for transporting pig iron from the production to the processing plant.

The first step to construct the lake was to excavate a ditch for a drainage purpose with a deepness around 10m which is on the future lake bottom. After the total amount of soil had been rearranged it was covered by natural and clean soil with a varying thickness from one to three meters to avoid direct contact with human beings. The whole process was finished with the flooding of the lake in October of 2010 with 600,000m³ of drinking water.

Concerning the emissions and impacts of the project it can be said that constant research work of air and noise disruption was done. Especially for the odor annoyance by the releasing Naphthalene of the soil air measurements were done and classified as harmless. To assess the aspects of how water and the environment will be influenced two environmental impact studies were conducted which could not find any hazardous impact on these topics. Moreover, the lake functions as a protection against flooding because of the implemented overflow structure at the river Emscher. In case of flooding it leads water from the river into the lake which has capacity to take the flooding amount.

The past situation and the current is reported in the aerial pictures in the Figures 15 and 16 below.

Figure 15. Aerial picture of Phoenix before construction ((Mader, 2015)

Figure 16. Aerial picture of constructed lake (Mader, 2015)

7.4.2 PHOENIX West Project

Due to the almost a 150-year period of use the soil surface condition in the Phoenix West area has changed substantially. The level of the ground has risen about 20m and two disposal sites were built close to the terrain. This and former coking plants and their additional plants caused local contamination of soil and groundwater. A large part of soil mass which is supposed to be excavated is harmless and can be used for the planned purposes for the industrial estate. But the discovered polluted soil of the coking plant and the belonging parts had to be separately remediated under the supervision of an expert and further testing samples. The specific values of the soil contamination were not provided in the public documents.

Focusing on the methods of soil managing the polluted soil was installed on a disposal site which was created next to the construction area and the later industrial estate. To keep the transport costs low and make the planning economical and sustainable the polluted soil was restored in two securing structures (Volume: 88.000m³ and 140.000m³) inside the planned terrain which were later on provided with a qualified base and surface sealing. One of the securing structures is the Kaiserberg, shown in Figure 17. The polluted soil was restored in a controlled way and securely covered to create a structure which now functions as an element of the landscape and view point over the area.

Figure 17. Kaiserberg (Phoenix-See, Wikipedia-Die freie Enzyklopädie, 2017)

7.4.3 Project Criticism and Future maintenance

In the future the whole structure has to be maintained especially the lake. One aspect is the water quality which has to be controlled and regulated. Because the lake is a closed stretch of water the value of phosphate has to be monitored and also regulated by a constructed special plant which eliminates phosphorus. Currently the water quality is good and no effects of any pollution of soil or others impacts can be recognized. Moreover, the water level is also monitored and regulated with possible drains.

Concerning constructions the area is included in some soil restrictions for land owner. The house owners are obliged to dispose of excavated soil caused by constructions of foundations or bigger gardening activities like planting trees. Also, the costs of applying 0,5m clean soil on the constructed surface are imposed on the purchaser of the plot of land.
A few years after the project was closed an evaluation and effects could be pointed out. Having a view on the social development it can be said that this project had gentrification as a consequence. It was criticized that an increase of the gap between poor and rich people could be noticed in the district. Long-established people of the ´Hörde` district who usually belong to the working class were driven out by the rising rents. The revaluing of the whole area attracted people from the higher income classes who could afford the prices. On the other hand the prices for rents for the already existing apartments and houses rose.

8 SOIL MANAGEMENT AT JÄTKÄSAARI, HELSINKI, FINLAND

8.1 Description of the location

Jätkäsaari is a district of the capital city Helsinki located in the south-west of the close city centre (Figure 18). The area was a former coastal industrial and port district. The island Jätkäsaari, Hietasaari and Saukko transformed in a connected peninsula for harbour facilities in the beginning of the 19th century. Until 2008 it was used as a container and passenger harbour. Due to the expanding business since the 1960s the traffic capacity reached its limit and the container harbour was moved to another area, Vuosaari. The passenger harbour is still located in Jätkäsaari.

Figure 18. Aerial view of Jätkäsaari location (Google Maps, 2017)

8.2 Soil management strategy for the Helsinki area

A strategy for soil management in the capital area of Helsinki was implemented on 27 June 2014 with the ´Excavation material development program´(*Kaivumaiden kehittämisohjelma).* The goal of this program is to halve the costs reported in 2010 and transport distances by the year of 2017.

Because of the disposal sites around the area which were running out of capacity the need was identified to start avoiding land filling. This aim shall be achieved by focusing on three key points. These consist of reducing the amount of excavated soil during the planning phase of a project, promoting the reuse of the material in the economic sector and ensuring the security of the final installed soil on site. By means of these measures significant savings of 5-10 million euros in construction per year could be reached. In 2015 the savings could be determined as follows: 10 million Euros, 2,100,000 liters of fuel and 5,300 tons of CO_2-emissions.

The implemented program also designated creating new work departments. A special working group on soil was implemented with a city mass coordinator as a chairman starting in 2014. The main task of the current soil mass coordinator Mikko Suominen is to ensure that the drawn up aims of the strategy will be achieved. A tool for this purpose is the new worked out Excel form which can be find in Appendix 2. For every planned project there is an obligation to fill out the form to ensure that occurring needs meet the current demands and the other way round by giving information about the type and amount of soil, date and site to the soil mass coordinator. With this process the flow of soil masses can be followed, supervised and coordinated.(The City of Helsinki, 2014)

8.3 **Project Description**

The ongoing project in Jätkäsaari is part of "one of the largest construction projects in the Helsinki area" subsume under the project West Harbour. The area of the former industry area shall become a residential and business district. The planning process started in 2006 and in 2009 applications for permits, which were given in 2009 and 2014, and remediation as well as the first housing construction were started. The first phase of soil reuse was done from 2009 until 2011 and the second started in 2015. The aim of the project is to create housing for 17,000 residents and 6,000 jobs on the 100ha wide area. In the future, the area shall provide services like schools, shops and business possibilities as well as parks for leisure time activities, a swimming pool and a boat harbour. Different options of housing should bring all kind of people together. Suitable housings for students, seniors, disabled, families and singles in different price categories are planned to be at hand. A special vacuum waste collection system will be implemented and the passenger ship terminal will be kept up. (K. Järvinen, J. Jalonen, 2016)
A comparison of the past and planned situation is shown in the Figure 19 below.

Figure 19. Planned development for Jätkäsaari area (Niiranen, 2016)

8.4 **Methods and Problems**

To analyse the soil in the area thousands of soil samples have been taken and examined for contamination (a rough map is shown in Figure 20). Pollution by heavy metals like copper, lead, zinc and arsenic, as well as PAH compounds could be found. The contamination was mainly spread in two bigger areas of the site caused by harbour and shipping activities in the past.

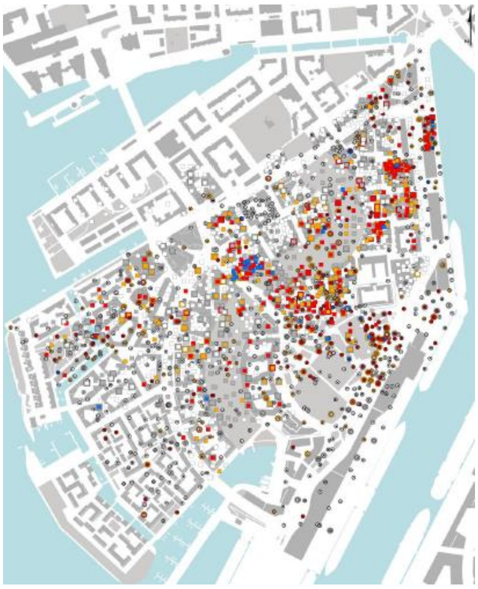

Figure 20. Soil samples in the area (Niiranen, 2016)

As the main risk assessment points out, contaminated soils do not have to be excavated necessarily. The contamination found has no impact on the environment due to a natural layer functioning as a protection. But contaminated parts over the sea level must be excavated for construction purposes. They were reused in park structures of the area if they were suitable or have been made suitable.

As a part of the ABSOILS project co-financed by the EU LIFE+ Environmental Policy & Governance program carried by Ramboll Finland Oy as one of the three participants, the sustainable method of stabilization of 120,000m³ soil was used. The stabilization of the dredged sediments was carried out with cement as a binder material which changes the soil mass properties (the process is shown in Figure 21). For the use of fly ash and sulphur removal products needed for further procedures an extra permit is needed.

Figure 21. Stabilization progress with cement (ABSOILS)

The transport costs have decreased with reusing soil inside one project and only transporting soil not suitable for reuse to the closest land fillings. Otherwise every ton of soil transported to a disposal site would have been carried by a truck through the whole city center to sites located outside the city area. Not used for reinstallation is soil with hazardous compounds or organic waste which was less than 10% of the total amount of excavated soil. With this method resources can be used efficiently. The total amount of excavated soil was 109,100 tons from which 8,100 tons were disposed.(ABSOILS)

To implement this method for a bigger project beforehand planning of reusing excavated soil with a long-term view is needed. Especially for permits time should be calculated because for now every recycling of contaminated soil needs to have an extra permission in Finland. In this project to make sure that the reinstalled contaminated soil has no effect on the nearby environment a rain water drainage system with an impermeable bentonite mat with a slope subsurface was installed (shown in Figure 22)

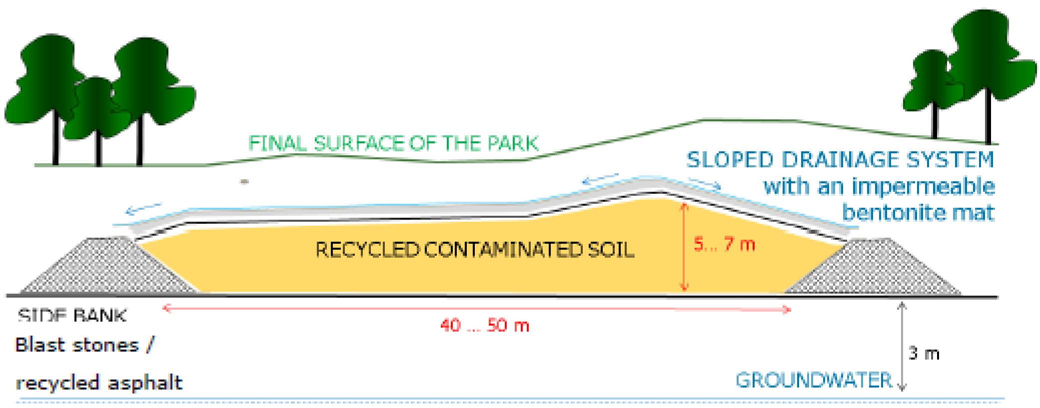

Figure 22. Structure of reinstalled soil (Niiranen, 2016)

Economic advantages were the financial savings of two million euros due to recycling. Also, environmental advantages of saving 740,000kg carbon dioxide and 300,000 l fuel can be mentioned. Concerning both topics savings around 60% could be achieved by not disposing of the total amount of excavated and contaminated soil. In the below graph (Figure 23) the needed energy and CO_2- equivalent with the reusing soil method is compared to the conventual dig and dump method. Around two- third of the conventional needed energy and emissions could be saved with the soil reusing method.(Niiranen, 2016)

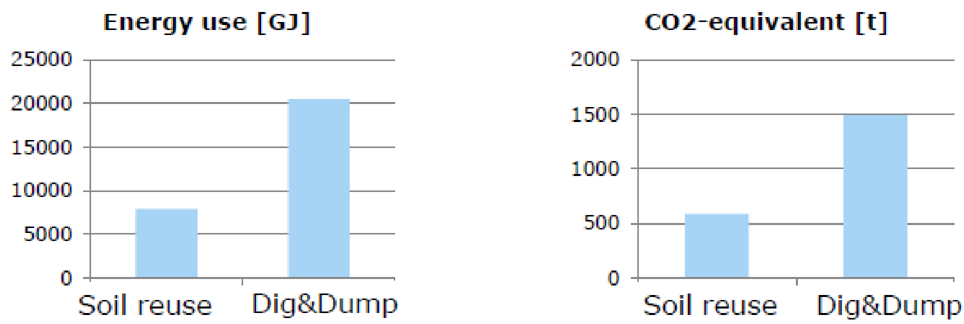

Figure 23. Consumption comparison of reuse and disposal (Niiranen, 2016)

9 CONCLUSION

To answer the drawn-up research questions about adapting legislations about circular economy and how to implement these in waste management methods in general and in specific projects, the following conclusions and advantages of circular economy can be pointed out.

After examining the different structures of legislation in Germany and Finland it can be said that both comply with the European directives and adapting the waste hierarchy with its five steps. Referring to the term of circular economy the German legislation is adapting it in its main law of waste management (KrWG) in opposition to the Finnish two main laws about waste (Waste Act and Waste Decree) which does not use the same term but also does not differ widely relating to the content. In both countries the main legislation is completed with several decrees, guidelines or recommendations. For the German legislation it is going further into detail with every step of organizational level. But for both countries in the end the planner, designer and performing contractor are responsible for the correct realization and production of the best possible sustainable solutions. For the future both legislative situations have to be improved by clarifying and combining the spread legislation. The structure and responsibilities are similar in the presented countries. Attention is always paid to big challenging projects in which a big amount of soil must be relocated. Besides to this attention should also be paid to smaller projects in less important areas because in sum they have the same effects on the environment.

Concentrating on the environment after studying two concrete examples of different countries many advantages of implementing a circular economy and a sustainable soil management can be revealed.

For the financial aspect, high savings of construction costs can be pointed out as shown in the Jätkasaari project. Even if a longer planning phase is needed the savings of a well-planned project are bigger. The development of the circular economy sector creates jobs and increases the international competitiveness while boosting the economy.

Regarding the environmental topic following a circular economy decreases the ecological footprint by reducing the CO_2-emissions, transportation length and need of fuel. Due to the less movement of soil, less contamination caused by construction processes and changes in soils can happen. So, virgin soil is protected and minimally used. Thanks to reusing excavated soil less landfilling will appear, the less natural area will be interrupted and less space will be needed.

Other advantages for the society in general will be the sensitization of consumer´s responsibility and less disturbance caused by noise due to the reduced transportation.

All in all, it can be said that implementing a circular economy on a European basis is one very important step out of a wide working field towards a sustainable future to protect the planet we are living on. It is worth to serve as an example for other countries to join the path towards a sustainable functioning world.

Regarding the study itself a sufficient overview could be given about the legislative regulations in the European Union, Germany and Finland. To get deeper into the material specific laws can be studied more closely. Breaking the general term of circular economy down to management methods in specific projects is a quite difficult task because attention can be paid to many aspects and the most important should emphasized. Concerning the projects detailed planning progresses would have been interesting to study but this detailed information was not provided to the public.

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Dortmunder Einbauwerte

Fortsetzung der Vorlage:

Fachbereich:	Datum:	Seite
StA 60 - Umweltamt -	26.09.2006	12

Anlage

Dortmunder Einbauwerte
in Anlehnung an
die LAGA-Richtlinie
"Techn. Regeln für die Verwertung mineralischer Reststoffe/Abfälle"

Zuordnungswerte Feststoff für Recyclingbaustoffe/nicht aufbereiteten Bauschutt/(Boden)

Parameter	Dimension		Zuordnungswert		
		Z 0	Z 1.1	Z 1.2	Z 2
Arsen2	mg/kg	20,00	30,00	50,00	150,00
Blei (2)	mg/kg	100,00	200,00	300,00	1000,00
Cadmium (2)	mg/kg	0,60	2 (3)	5 (3)	20 (3)
Chrom (gesamt) (2)	mg/kg	50,00	100,00	200,00	600,00
Kupfer (2)	mg/kg	40,00	100,00	200,00	600,00
Nickel (2)	mg/kg	40,00	100,00	200,00	600,00
Quecksilber	mg/kg	0,30	1,00	3,00	10,00
Zink (2)	mg/kg	120,00	300,00	1000,00	1500,00
Kohlenwasserstoffe	mg/kg	100,00	300 (1)	500 (1)	1000 (1)
PAK nach EPA	mg/kg	1	10 (3)	20 (3)	75,00
EOX	mg/kg	1,00	3,00	5,00	10,00
PCB	mg/kg	0,02	0,10	0,50	1,00

(1) Überschreitungen, die auf Asphaltanteile zurückzuführen sind, stellen kein Ausschlußkriterium dar.
(2) Sollen Recyclingbaustoffe, z.B. Vorabsiebmaterial, und nicht aufbereiteter Bauschutt als Bodenmaterial für Rekultivierungszwecke und Geländeauffüllungen in der Einbauklasse 1 verwendet werden, ist die Untersuchung von Arsen und Schwermetallen erforderlich. Es gelten dann die Kriterien und Zuordnungswerte Z 1 (Z 1.1 und Z 1.2) der Technischen Regeln Boden.
(3) Die Werte wurden aufgrund ortsüblicher Hintergrundbelastungen angehoben.

Zuordnungswerte Eluat für Recyclingbaustoffe/nicht aufbereiteten Bauschutt/(Boden)

Parameter	Dimension		Zuordnungswert		
		Z 0	Z 1.1	Z 1.2	Z 2
pH-Wert			7,0 - 12,5		
elektr. Leitfähigkeit	µS/cm	500,00	1500,00	2500,00	3000,00
Chlorid	mg/l	10,00	20,00	40,00	150,00
Sulfat	mg/l	50,00	150,00	300,00	600,00
Arsen	µg/l	10,00	10,00	40,00	50,00
Blei	µg/l	20,00	40,00	100,00	100,00
Cadmium	µg/l	2,00	2,00	5,00	5,00
Chrom (gesamt)	µg/l	15,00	30,00	75,00	100,00
Kupfer	µg/l	50,00	50,00	150,00	200,00
Nickel	µg/l	40,00	50,00	100,00	100,00
Quecksilber	µg/l	0,20	0,20	1,00	2,00
Zink	µg/l	100,00	100,00	300,00	400,00
Phenolindex	µg/l	< 10	10,00	50,00	100,00

Hanke:	
Hankkeen osoite:	
Projektinvetäjä:	
Suunnittelija ja yritys:	
Suunnitteluaikataulu:	
Toteutusaikataulu:	
Urakoitsija:	
Rakennuttaja:	
Taulukon palautus:	s10taulukko@sito.fi ja mikko.suominen@hel.fi
Massakoordinaattori:	mikko.suominen@hel.fi

Päivämäärä ja laatija			Päivämäärä ja laatija		

VERSIO 19.3.2015

Laatija merkitsee nimensä ja muutospäivämäärän

Nimeä s10-taulukot seuraavasti:
päivämäärä – s10 – kohde
Esim. 2013-04-15 S10 VIILARINTIE

Viite InfraRYL 2010.

littera	Nimi	Huomioita	yks.	määrä	€/yks.	€/tulo	Arviointitapa, A, B tai C*	yks.	määrä	€/yks.	€/tulo	kuljetus-matka (km)	kuljetus-kerrat	sijainti	Selite/ohje
			SUUNNITTELIJA TÄYTTÄÄ SUUNNITTELUVAIHE					**URAKOITSIJA TÄYTTÄÄ TOTEUTUNUT**							
			HANKKEESSA KAIVETTAVAT MASSAT												
1000	**Maa- pohja- ja kalliorakenteet**														Litteroiden 1000-1700 kohdalla lasketaan hankkeen aikana kaivettavien
	Poistettavat pintamaat		m3ktr					m3itd							massojen kokonaismäärät ja arvioidaan niiden laatua.
	Poistettavat rakennekerrokset ja penkereet		m3ktr					m3itd							Sisältää vanhat kerrosrakenteet.
	Poistettavat, purettavat betonirakenteet ja betonimurskekerrokset		m3ktr					m3itd							
	Poistettavat päällysterakenteet (asfaltti)		m3ktr					m3itd							
	Muut poistettavat maa- ja pengerrakenteet		m3ktr					m3itd							Sisältää vanhat täytöt.
1200	**Haitta-aineita sisältävät maat ja rakenteet**														
	Poistettavat maat, kohonneita haitta-ainepitoisuuksia		m3ktr					m3itd							Haitta-aineet yli kynnysarvon, alle alemman ohjearvon.
	Poistettavat pilaantuneet maat, ulkopuolinen vastaanotto		m3ktr					m3itd							Pilaantuneet massat, jotka kuljetetaan ulkopuoliseen vastaanottopaikkaan.
	Poistettavat mineraalisia purkujätteitä sisältävät maat (helsinki-moreeni)		m3ktr					m3itd							Tiiliä, betonia, puuta tms. mineraalisia purkujätteitä sisältävä maa-aines, yli 10 %:tia.
	Poistettavat maatuhkakerrokset, ulkopuolinen vastaanotto		m3ktr					m3itd							Maassa oleva tuhka.
	Poistettavat purkujätteitä (puu, muovi jne.) sisältävät maat		m3ktr					m3itd							
1600	**Maaleikkaukset ja -kaivannot**														
	Leikkaus, kelpoisuusluokka S1, S2, S3, S4		m3ktr					m3itd							Sora, karkea moreeni.
	Leikkaus, kelpoisuusluokka H1 , H2		m3ktr					m3itd							Hiekka, hiekkamoreeni.
	Leikkaus, kelpoisuusluokka H3, H4		m3ktr					m3itd							
	Leikkaus, kelpoisuusluokka U1 ja U2		m3ktr					m3itd							Siltti, SiMr, jäykkä savi.
	Leikkaus, kelpoisuusluokka U3 ja U4		m3ktr					m3itd							Pehmeä savi ja lieju.
	Leikkaus, kelpoisuusluokka Turve (Tv)		m3ktr					m3itd							Turve
	Leikkaus, kelpoisuusluokka tuntematon		m3ktr					m3itd							Maalajia tai materiaali ei ole tiedossa.
1640	**Vedenalaiset maaleikkaukset**														
	Vedenalainen maaleikkaus, kuljetus vesiläjitykseen		m3ktr					m3itd							Vesiläjitykseen kelpaava massa
	Vedenalainen maaleikkaus, maaläjitys, kelpoisuus maarakentamiseen?		m3ktr					m3itd							Maarakentamiseen kelpaava massa (merihiekka tms.).
	Vedenalainen maaleikkaus, maaläjitys, pilaantunut sedimentti		m3ktr					m3itd							Maalle nostettava, pilaantunut sedimentti.
	Muut vedenalaiset maaleikkaukset		m3ktr					m3itd							
1700	**Kallioleikkaukset, kaivannot ja tunnelit**														
	Kallioleikkaukset, tunnelilouhe		m3ktr					m3itd							Tunnelilouhe
	Kallioleikkaukset, kaivannot ja tunnelit		m3ktr					m3itd							Kaikki muut kalliolouhinnat.
	Vedenalaiset kallioleikkaukset		m3ktr					m3itd							Kaikki vedenalaiset kalliolouhinnat.
			HANKKEESSA TARVITTAVAT MASSAT												
1800	**Penkereet, maapadot ja täytöt**														Litterassa 1800 lasketaan tässä hankkeessa tarvittavat massamäärät.
	Louhepenkereet		m3rtr					m3rtd							
	Penkereet ja kantavat kerrokset, murske		m3rtr					m3rtd							
	Penkereet ja jakavat kerrokset, kelpoisuusluokka S		m3rtr					m3rtd							
	Penkereet ja suodatinkerrokset, kelpoisuusluokka H		m3rtr					m3rtd							
	Maastonmuotoilut, luiskaverhoilut, kelpoisuusluokka S, H, U1 ja U2		m3rtr					m3rtd							
	Maastonmuotoilut, luiskaverhoilut, kelpoisuusluokka U3 ja U4		m3rtr					m3rtd							
	Penkereet, maarakenteet, stabiloitu savi		m3rtr					m3rtd							rakentamiseen kelpoiseksi esim. sementillä stabiloitu pehmeä savi
	Penkereet, maarakenteet MARA-asetuksen mukaisesti		m3rtr					m3rtd							Maara-asetuksen mukaiset massamäärät (Valtioneuvoston asetus eräiden jätteiden hyödyntämisestä
	Penkereet, maarakenteet ympäristöluvan mukaisesti		m3rtr					m3rtd							esim. tuhka, stabiloitu pima-massat, tai litteran 1200 massatarve.
			HANKKEEN KAIVUMASSASUUNNITELMA												
5000	**Välivarasto ja läjitystarve, litterat 1000, 1600, 1640, 1700 ja 1800.**														Litterassa 5000 lasketaan tämän hankkeen osalta tarve välivarastoida massoja tässä kohteessa, toim
	Välivarastointi, S, H, U1, U2		m3rtr					m3itd							Paikka tulee osoittaa suunnitelmassa tässä kohteessa.
	Välivarastointi, louhe		m3rtr					m3itd							Paikka tulee osoittaa suunnitelmassa tässä kohteessa.
	Toimitus ulkopuoliseen kohteeseen, louhe		m3rtr					m3itd							Paikka tulee osoittaa suunnitelmassa.
	Toimitus ulkopuoliseen kohteeseen, S, H, U1, U2		m3rtr					m3itd							Paikka tulee osoittaa suunnitelmassa.
	Toimitus ulkopuoliseen kohteeseen, U3, U4		m3rtr					m3itd							Paikka tulee osoittaa suunnitelmassa.
	Muut ulkopuolelle toimitetut		m3rtr					m3itd							Massat, joille ei voida osoittaa välivarasto- tai toimituspaikkaa.

MUUTA HUOMIOITAVAA:

MASSALAATUJEN ARVIOINTITAPA*	**A**	Laatu varmistetaan kairauksilla, näytetutkimuksilla ja/tai maatutkalla ennen rakentamista ja rakenteet suunnitellaan ja toteutetaan tutkimustulosten mukaan.
	B	Laatua ei tutkita tarkasti (kairaus- ja näytemäärä on vähäinen) tai laatu on arvioitu.
	C	Laatu todetaan vasta rakentamisen aikana ja rakentamisaikataulu sovitetaan niin, että korjaaviin toimenpiteisiin on mahdollisuus.

LUOKITUS INRARYL LIITE T17 soveltaen

Luokka S (sisältää luokat S1-S4)
Maalaji: Sr, srHk, srHkMr, SrMr
mahdollinen käyttökohde: jakavan kerroksen materiaali ja pengermateriaali

Luokka H (sisältää luokat H1-H4)
Maalaji: Hk, HkMr, siHk
mahdollinen käyttökohde: suodatinhiekka, pengermateriaali - sopii penkereen yläosaan

Luokka H1, H2
Maalaji: Hk
Käyttökohde: suodatinhiekka

Luokka H3, H4
Maalaji: Hk, HkMr, siHk
Käyttökohde: pengermateriaali, sopii penkereen yläosaan

Luokka U1
Maalaji: Si, SiMr
Käyttökohde: maisemahoidollinentäyttö tai kuivana meluvalli

Luokka U2
Maalaji: jäykkä Sa
Käyttökohde: maastonmuotoilut, läjitys

Luokka U3
Maalaji: pehmeä Sa
Käyttökohde: maastonmuotoilut, läjitys

Luokka U4
Maalaji: lj
Käyttökohde: maastonmuotoilut, läjitys

Luokka Tv
Maalaji: Tv
Käyttökohde: Kasvukerrokset (tv)