# Policy of Onsite and Small-Scale Wastewater Treatment Options in Finland

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## ABSTRACT

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This thesis was done to explain the current Finnish policy on onsite and small-scale sanitation in depth. The most relevant legislation on national and European level was included as well as financing options for upgrades and new installments. In 2011 the latest legislation concerning rural wastewater treatment in Finland came into force. Private households are required to clean their wastewater from organic matter, phosphorus and nitrogen, before releasing it to nature.

The most used onsite wastewater treatment options were presented and explained and estimates for their initial and annual costs given. These options included infiltration systems, sand filters and small wastewater treatment plants as well as closed and septic tanks. Furthermore, alternative solutions such as dry toilets and constructed wetlands were taken into consideration.

The feasibility of the treatment options for Finnish circumstances was examined. In studies conducted around the country phosphorus and nitrogen removal has had varying results. None of the solutions was found to be universally usable. Improvement solutions for the implementation of the legislation were suggested and also legislation examples from other EU countries were taken into consideration.

Parts of the thesis were used in a policy document on rural wastewater treatment in central and eastern European countries drawn up by the non-governmental organization WEFC (Women in Europe for a Common Future).

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Key words: wastewater, policy, legislation, onsite treatment, Finland

**CONTENTS**

# ABBREVIATIONS AND TERMS

| | |
|---|---|
| TAMK | Tampere University of Applied Sciences |
| cr | credit |
| p.e. | population equivalent, also often abbreviated as PE |
| EU | European Union |
| WWTP | Wastewater treatment plants |
| WWTS | Wastewater treatment systems |
| HELCOM | Helsinki Commission |
| $BOD_5$ | Biochemical oxygen demand in 5 days |
| $BOD_7$ | Biochemical oxygen demand in 7 days |
| COD | Chemical oxygen demand |
| TSS | Total suspended solids |
| EEC | European Economic Community |

# 1 INTRODUCTION

In 1991 the European Economic Community, the precursor of the European Union, put a directive into force that obliged all member states to establish wastewater collection networks and treatment systems for all settlements with a population equivalent over 2000. The changes needed to be done by then end of 2005 (91/271/EEC). Finland became a member of the European Union in 1995 and thus had to comply with its legislation.

In 2013 about 10% of the Finnish population was living in municipalities with less than 2000 inhabitants (Population Register Centre 2013), which were not be considered by the directive. But many municipalities have a collective sewage network for less than 2000 p.e. (Kallio 2013). At the beginning of 2000s about one million people were not connected to communal sewage systems (Kujala-Räty et al. 2008, 9). In Finland settlements are dispersed and widely spread making extension of existing networks very costly. Thus onsite or small-scale sanitation options are absolutely essential in order to protect human health and the environment.

About 350 000 permanent residences are unconnected to sewage systems in Finland (Bäck et al. 2010, 230). Additionally, there are about 500 000 holiday homes (Statistics Finland 2013), which are often also using onsite wastewater treatment systems. Traditionally, private wastewater which was not lead into a sewage system was treated only in a septic tank for solid-liquid separation before being released into nature (Hyttinen 2007, 7). Due to recent changes in the national legislation all onsite wastewater treatment systems have to meet cleaning standards similar to highly efficient communal treatment plants. This requires upgrading and renewing of the majority of the Finnish onsite treatment systems.

Home owners are granted a transition time until 2016 to upgrade systems if necessary (209/2011). The Finnish Ministry of Environment expects that until then 200 000 - 250 000 currently unconnected properties will improve their system to dispose household wastewater in accordance with the legislation. It is the target to equip all onsite wastewater treatment systems with the best available technique by 2018. (Environmental Administration 2011)

# 2 TERMINOLOGY & EXPLANATIONS

Some of the most important terms are explained further to prevent confusion and to ease understanding of the context.

## 2.1 Wastewater

Wastewater in the widest sense is water whose quality has been affected by human activities. It may be discharged, for instance, from households, industries, agricultural areas, road and highways (WHO 2006, 182).

Domestic wastewater is the combined effluent from flush toilets, sinks, showers, bathtubs and home appliances. Therefore, it includes mainly human feces, urine, cooking residues, cleaning detergents and personal care products. When talking about wastewater in this thesis it is referring to the discharge from households.

## 2.2 Greywater

Greywater originates from domestic wash basins, showers, kitchens etc - thus it does not contain human feces or urine, but contamination from any other source is possible. (WHO 2006, 178) It is easier to treat separately, since the exclusion of toilet waste lowers the nutrient and pathogen levels considerably.

## 2.3 Blackwater

Blackwater is the other part of wastewater, only containing human wastes. Its only sources are flush and low-flush toilets. (WHO 2006, 177) Toilet waste is the most problematic part of wastewater to treat due to its high concentrations in nutrients (table 1), pathogens and viruses.

## 2.4 Sludge

Sludge is the accumulated solid matter from wastewater which is removed during the treatment process (Tchobanoglous et al. 2003, 4) by sedimentation processes. It is usually semi-solid, as it contains liquid matter as well (WHO 2006, 181). Sludge needs to be treated in order to reuse it safely. Sludge stabilization is done to reduce pathogen levels, odors and volume (van Haandel & van der Lubbe 2007). The end product can, for instance, be used as a fertilizer on fields.

## 2.5 Nutrients

Nutrients are chemical elements and compounds that plants and other organisms need to live and grow. In wastewater concentrations of phosphorus and nitrogen are especially important. Phosphorus and nitrogen are essential for plant growth (University of Hawai'i 2013), however, in high concentrations they can have negative effects on aquatic life as well as surface and groundwater quality.

TABLE 1 Average composition of wastewater produced by one person per day in Finland. (209/2011)

| Origin of load | $BOD_7$ | | Phosphorus | | Nitrogen | |
|---|---|---|---|---|---|---|
| | g/d | % | g/d | % | g/d | % |
| Excrement | 15 | 30 | 0,6 | 30 | 1,5 | 10 |
| Urine | 5 | 10 | 1,2 | 50 | 11,5 | 80 |
| Other | 30 | 60 | 0,4 | 20 | 1,0 | 10 |
| Total loading | 50 | 100 | 2,2 | 100 | 14 | 100 |

In Finland a daily average of 2,2 g of phosphorus is released in wastewater per person (table 1). Phosphorus is used by microorganisms to grow and multiply. This can become a problem when too much phosphorus is available in the water causing increased algal blooms and leading to eutrophication. Generally, in Finnish water bodies the availability of phosphorus is limiting the microbiological growth (Bäck et al. 2009, 94).

Nitrogen in wastewater in Finland is produced at an amount of 14 g per day per person (table 1). It is necessary for microorganisms but can also like phosphorus lead to fortified algal growth. In some Finnish lakes nitrogen is the limiting nutrient (Bäck et al. 2009, 94) and also in parts of the Baltic Sea (Helsinki Commission 2009, 11). Higher release of nitrogen into water bodies where it is not the limiting factor will not lead to additional algal growth. Most of the nitrogen in the wastewater comes from urine and fecal matter. During the wastewater treatment organic nitrogen from toilet waste is converted to ammonium ions and ammonia (Russell 2006, 174). Since both are highly toxic to aquatic life (Russell 2006, 175), it is essential that they are converted to other, less toxic forms of nitrogen with the help of bacteria before release.

### 2.6 Wastewater treatment process steps

Wastewater is cleaned in several steps to separate solid matter and liquid, reduce nutrient levels and eliminate pathogens, bacteria and impurities. Normal wastewater treatment plants in Finland and other industrialized countries use mechanical, chemical and biological processes (European Environmental Agency 2013), which can be divided into initial, primary, secondary, tertiary and sludge treatment.

In the initial step, big items that would clog and hinder the following treatment steps are removed. Sticks, branches, rags, floatable objects, stones and plastics are taken out with screens. Primary treatment is where settable suspended solids and organic matter is separated through gravitational sedimentation (The World Bank 2013). The sludge is taken away for additional treatment, while the wastewater is cleaned further in the secondary treatment. More suspended solids are removed using chemicals or biological methods. Reduction of nutrient levels and disinfection, usually using chlorine or UV-light, is included in the secondary process step or it is part of tertiary treatment. The tertiary step is not done in all treatment plants. It removes residual suspended solids. After that the water is lead into the outfall, which can be a river, lake or sea. The suspended solids that are separated in the different process steps are directed to the sludge treatment. The treatment prepares the sludge for reuse. (Tchobanoglous et al. 2003, 11)

This is a general process which is used in communal wastewater treatment plants. The actual process varies from treatment plant to treatment plant and may include additional steps to clean wastewater. This depends on legislative requirements, local environment and specific contaminants.

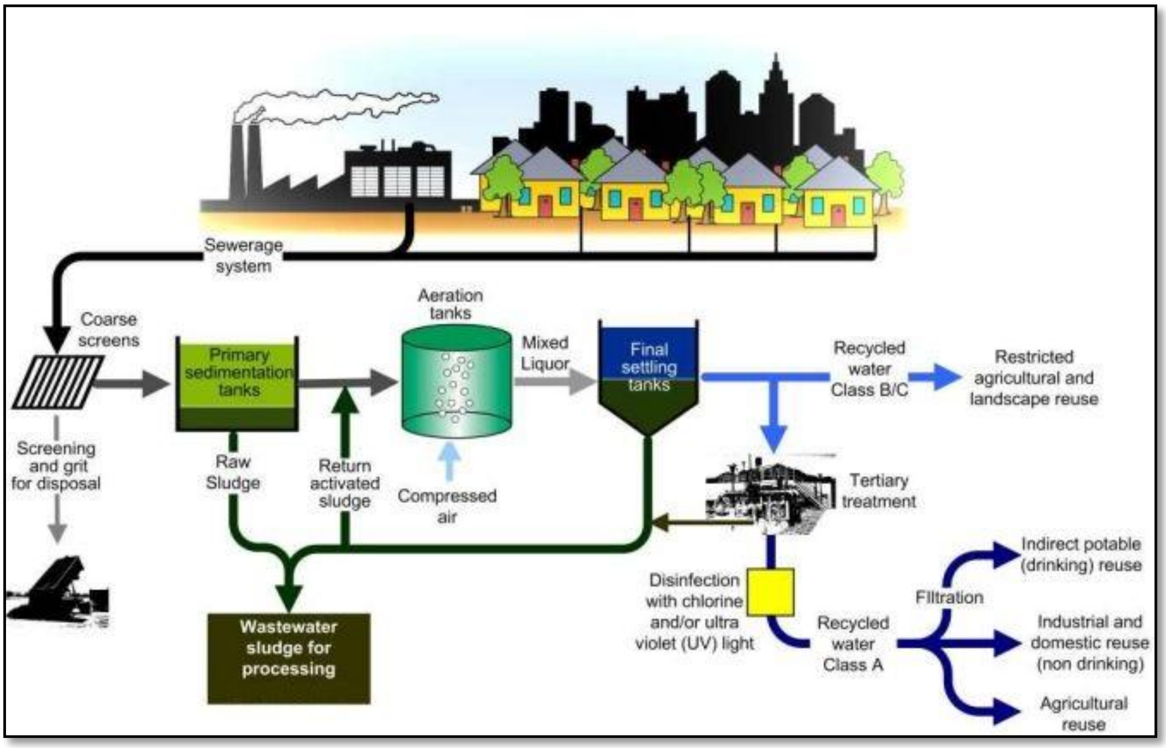


FIGURE 1 Schematic illustration of the wastewater treatment process (http://www.digitexsolution.com/water/wastewater-treatment-plants.html, modified)

## 2.7 Population equivalent

Population equivalent is a measurement for the amount of wastewater produced by a household, business or other building. It is measured in the amount of oxygen-demanding substances in the wastewater (OECD 2001). In the European Union, 1 p.e. means that the wastewater contains organic matter which has a $BOD_5$-value of 60 g of oxygen per day (European Environmental Agency). Through this, the wastewater discharges from industries, businesses and public institutions can be quantified depending on the biodegradable load they are releasing.

## 2.8 Finnish climate

Finland's climate has been classified under the widely used Köppen climate system as part of the temperate coniferous-mixed forest zone with cold, wet winters (Finnish Meteorological Institute). A similar climate can be found in Northern Sweden and Norway as well as in Siberia and Northern Canada and Alaska. During the warmest month average temperatures are over 10°C all over the country and during the coldest month below -3°C (Finnish Meteorological Institute).

Length and strength of the winter varies across the country. While during the period of 1981 to 2010 the permanent snow cover lasted on average up to 225 days in Lapland, snow only covered the most south-western tips and the Åland Island for less than 85 days a year. During March the snow cover usually reaches its maximum depth. In Lapland more than 80 cm of snow may cover the landscape, while in the south-western parts and on the Åland Island it is only 10-20cm at that time of the year. (Finnish Meteorological Institute)

# 3 NATIONAL & EUROPEAN LEGISLATION

Wastewater treatment in Finland is regulated by the European Union's Urban Wastewater Treatment Directive and national legislation. Rural areas with dispersed settlements are regulated through national decrees.

## 3.1 EU legislation - Urban Wastewater Treatment Directive (91/271/EEC)

In 1991 the European Economic Community agreed on a directive that would regulate the wastewater treatment in urban areas throughout all member states. The reason for implementing this legislation were the negative effects of releasing untreated household wastewater into the environment. With the establishment of the European Union based on the Maastricht Treaty from 1992 the directive was adopted into the EU legislation.

By the beginning of 2006 agglomerations with more than 2000 p.e. in terms of wastewater generation needed to have a centralized collection or multiply small-scale sanitation systems in place. Agglomerations in sensitive areas with more than 10000 p.e. already needed to have a collection system already by the beginning of 1999. The sanitation systems need to lower the levels of $BOD_5$, COD, TSS, phosphorus and nitrogen in the wastewater.

TABLE 2 Reduction levels for wastewater treatment plants in urban areas in the EU (91/271/EEC)

| Segment | Reduction level |
|---|---|
| $BOD_5$ | 70-90% |
| COD | 75% |
| Total suspended solids (TSS) | 90% (for > 10000 p.e.)<br>70% (2000 - 10000 p.e.) |
| Phosphorus | 80% |
| Nitrogen | 70-80% |

Wastewater treatment systems for urban areas were to be equipped with treatment solutions by the end of 2005 which complies with the reduction level targets. This was compulsory for all urban areas with more than 10000 p.e. and for urban areas with more than 2000 p.e. if the discharge of the treatment plant was conducted to fresh water or estuaries. These treatment systems need to use secondary treatment.

The directive also demands that industrial wastewaters that are also collected in communal treatment systems have to be suitable to be cleaned in the treatment plant and not affect the environment after being released. If necessary industrial wastewaters need to be pre-treated to meet the requirements.

The directive does not give any more specifics for the wastewater treatment in agglomerations from 2000 to 10000 p.e. which are not located in sensitive areas or discharge into fresh-water and estuaries. Neither takes it into consideration settlements with less than 2000 p.e. and dispersed settlements.

The directive is still today setting reduction levels for wastewaters from agglomerations over 2000 p.e. through the European Union. Later added member states had to adjust their wastewater treatment systems with different deadlines. However, Finland joined the European Union in 1995 and followed the deadlines given in the directive (Europe Direct 2013).

### 3.2 Finnish Environmental Protection Act (86/2000)

The Environmental Protection Act forbids all environmental pollution and aims to mend damage which has been caused by human activity. Any kind of polluting activity must be allowed by permission from the Finnish state.

The pollution of groundwater is prohibited. Therefore, it is forbidden to release substances, that pollute the groundwater in a way that is endangering health or degrade the quality of the water in any other way, into the ground. This is especially important in areas which are used for drinking water supply or are suitable for it. Furthermore, it is not allowed to release polluting substances into the ground if the groundwater on another's property can be affected by it.

In case a property has no connection the communal sewer system, wastewater originating from the area has to pose no risk of pollution before lead into the ground or any surface water body. Greywater may be lead straight into the ground - however, only when the amount is very small and the water does not contain other substances that can harm the environment.

Onsite wastewater treatment systems have be suitable for purpose, load and location of the property. Better systems may have to be installed by the property owner or occupant to meet reduction levels defined in the Government Decree on Domestic Wastewater Treatment in Areas Outside of the Sewage Network (209/2011).

Buildings in areas, which will be covered by communal sewer networks in the foreseeable future, can be excluded from the duty to upgrade wastewater systems. Also home owners and occupants being of old age, facing long-term unemployment or severe illness can apply for an exception. Exceptions can be valid for a maximum of five years at a time.

### 3.3 Finnish Water Services Act (119/2001)

The Water Services Act ensures that in settlements or structures similar to settlements used for business or leisure activities connected buildings are provided with high quality drinking water and suitable sewer connections. The construction of these networks is controlled by the regional centers of the Finnish Environment Institute.

However, the cleaning of domestic wastewater  is the responsibility of the property owner or occupant. The municipality is responsible for establishing a network or expanding an existing one only when the area lacking a proper sanitation network is large enough. Same applies if health considerations or environmental protection are an issue in the area.

## 3.4 Finnish Government Decree on Domestic Wastewater Treatment in Areas Outside of the Sewage Network (209/2011)

The Government Decree on Domestic Wastewater Treatment in Areas Outside of the Sewage Network came into force on March 15, 2011. The decree is concerning all buildings with a wastewater effluent in areas with no communal sewage network connection, which have not been excluded according to the Environmental Protection Act (86/2000). The decree is part of Finland's strategy for fulfilling the targets of the Baltic Sea Action Plan.

Wastewater has to be cleaned especially from organic matter ($BOD_7$), phosphorus and nitrogen, before it can be released back to nature. Table 1 shows the average amount of organic matter ($BOD_7$), phosphorus and nitrogen contained in excrement, urine and other wastewater produced by one person, living in a dispersed settlement, per day in grams per day and percentage.

The new legislation from 2011 replaced the former decree on domestic wastewater treatment in unconnected areas from 2004 (542/2003). In main changes in the legislation are the amount allowable BOD and nutrient load that can be released into nature. As it can be seen from table 3, the current legislation lowered the reduction limits for normal areas. According to this, 80% of organic matter, 70% of phosphorus and 30% of nitrogen content in the wastewater has to the eliminated before it can be released into nature. Sensitive areas are e.g. shore lines and important ground water areas, which are more susceptible to changes in the environment, thus stricter reduction targets are enacted.

TABLE 3 Load reduction for normal and sensitive areas. (209/2011)

| Segment | New legislation | | Old legislation |
|---|---|---|---|
| | Normal areas | Sensitive areas | Normal areas |
| Organic matter ($BOD_7$) | 80% | 90% | 90% |
| Phosphorus | 70% | 85% | 85% |
| Nitrogen | 30% | 40% | 40% |

The legislation obligates home owners and occupants to install or renew existing wastewater treatment systems that can fulfill the load reduction criteria under normal circumstances. Reduction levels may lessen if only specific fractions of the wastewater need to be cleaned.

TABLE 4 Reduction levels for different fractions of wastewater. (Ministry of the Environment 2011, 40)

| Type | Normal areas | Sensitive areas |
|---|---|---|
| Greywater | 67% organic matter<br>0% phosphorus<br>0% nitrogen | 83% organic matter<br>18% phosphorus<br>0% nitrogen |
| Greywater and feces (no urine) | 78% organic matter<br>34% phosphorus<br>0% nitrogen | 89% organic matter<br>67% phosphorus<br>0% nitrogen |
| Greywater and urine (no feces) | 71% organic matter<br>59% phosphorus<br>22% nitrogen | 86% organic matter<br>79% phosphorus<br>33% nitrogen |

Furthermore, records have to be kept about the wastewater treatment system to be able to evaluate the stress that it puts onto the environment. The usage and maintenance have to follow the manual instructions of the wastewater treatment system. The planning and construction of the wastewater systems are subject to the Land Use and Building Act (132/1999). Sludge and wastewater from closed tank systems need to be handled in accordance to the Waste Act (1072/1993).

Buildings that have been finished before 2004 are given a transitional time of five years, that means until 2016, to renew their wastewater treatment systems, if they do not meet the reduction levels.

### 3.5 HELCOM Baltic Sea Action Plan

The "Convention on the Protection of the Marine Environment of the Baltic Sea", also known as the Helsinki Convention, came into force in 2000. The Helsinki Convention is a political agreement between Finland, Sweden, Denmark, Germany, Poland, Lithuania, Latvia, Estonia and Russia aiming to reduce and prevent pollution of the Baltic Sea. The convention is governed by the Helsinki Commission which has supervisory and coordinative duties and acts as an environmental policy maker in the Baltic Sea region. The work of the Helsinki Commission is driven by the vision of a Baltic Sea environment that is healthy and sustainable for nature, national economies and people living in that region. (Helsinki Commission)

The Helsinki Commission has several priorities through which the problems concerning the state of the Baltic Sea area are tackled. Besides the release of hazardous substances and the effects of transport on sea and land also eutrophication in parts of the sea area is one of these main issues. Eutrophication in the Baltic Sea is mostly caused by the extensive release of nitrogen and phosphorus from anthropogenic sources, especially agricultural activity but also insufficiently cleaned wastewater. Due to the fact that water and pollutants travel in the sea area eutrophication does not always show in the region where it was caused but rather where the aquatic environment is most sensitive to it. The Archipelago Sea just off the Finnish coast is one of these areas.

The Helsinki Commission has drawn up the Baltic Sea Action Plan which is a strategy for the region to tackle the priority problems, fulfill agreements and put the environmental policy into action. The Baltic Sea Action Plan was adopted by all parties in 2007 and set the goals until 2021. In order to reduce eutrophication all parties are committing to reduce nitrogen and phosphorus emissions to water ways, which are in the catchment area of the Baltic Sea (Helsinki Commission 2007).

TABLE 5 HELCOM emission reduction targets until 2021 (Helsinki Commission 2007)

| **Country** | **Phosphorus (tonnes)** | **Nitrogen (tonnes)** |
|---|---|---|
| Denmark | 16 | 17,210 |
| Estonia | 220 | 900 |
| Finland | 150 | 1,200 |
| Germany | 240 | 5,620 |
| Latvia | 300 | 2,560 |
| Lithuania | 880 | 11,750 |
| Poland | 8,760 | 62,400 |
| Russia | 2,500 | 6,970 |
| Sweden | 290 | 20,780 |
| Transboundary Common pool | 1,660 | 3,780 |

As seen in table 5 Finland has to reduce annually 150 tonnes of phosphorus and 1200 tonnes of nitrogen from the average annual input from 1997-2003 to meet the goals set in the Baltic Sea Action Plan. Since Finnish surface and groundwater ways are within the catchment area of the Baltic Sea, reducing the nutrient load in these will also affect the amount of nutrients that find their way to the Baltic Sea. Reducing nitrogen and phosphorus from rural wastewater is one way to help reaching the HELCOM emission targets.

# 4 INSTITUTIONAL FRAMEWORK & FINANCING

In Finland, people living in dispersed settlements without a connection to communal sewage systems are forced to follow the legislation and update their wastewater treatment systems or join a communal sewer, when feasible. The costs for the changes have to be carried by house owners and occupants. However, there are some possibilities to get financial aid to reduce the costs for individual households. Financial aid can be given by the state or municipalities.

One option, for which all households can apply, is a tax deduction given by the Finnish Tax Administration for work done at homes and holiday residences. The household tax deduction is entitled to all persons that pay someone else to do basic renovation and maintenance work at their home or holiday residence. This also includes the upgrading and renewing of wastewater treatment systems. Equipment and material costs are not covered by this tax incentive only work hours. Private persons are entitled to a tax support up to 2000€. Spouses can get up to 4000€ together from the household tax deduction. (Finnish Tax Administration)

Furthermore, there is the possibility to get financial help on social grounds. The Act on Grants for Renovations, Energy and Health Hazards in Residences (1184/2005) states that low-income households are entitled to receive grant money for upgrading onsite household wastewater treatment systems in areas which are not covered by sewage networks. Grant money is given by the municipalities based on a national annual budget. A maximum of 35% of the total costs for wastewater system improvements can be covered by the grant. The grant is given to house owners, who have to use the house as a permanent residence for the following five years. Financial help on social grounds is not given for the improvement of wastewater treatment systems in holiday homes. (Ministry of the Environment 2011, 82)

The last possibility for financial support is given by the Finnish Ministry of Environment through the regional Centres for Economic Development, Transport and the Environment. Based on the Act on Water Supply Support (686/2004) up to 30%, in special cases up to 50%, of the total costs of the wastewater treatment system improvement can be covered. The financial aid is intended for co-operatives and projects that benefit more than one single household. It can be used, for instance, when some households join together to built a small-scale sanitation system or for small private businesses or buildings housing spaces for leisure activities like sports centers. (Ministry of the Environment 2011, 83)

# 5 PLANNING & EDUCATION

In order to plan and design onsite and small-scale wastewater treatment systems in Finland suitable education is necessary. Guidelines on necessary qualifications and decrees are given by FISE Qualification of Professionals in Building, HVAC and Real Estate Sector in Finland. The necessary degree of education for the design plan depends on the type of building for which the wastewater system is planned and the location.

Wastewater systems for single family homes, detached houses, holiday homes with flush toilets, apartment buildings with less than 20 p.e. and row houses with less than 20 p.e. are considered to be less demanding to design. Therefore, it is not necessary to have a degree in higher education to be allowed to plan such systems. However, it is mandatory to have at least one of the following qualifications:

- construction or HVAC/building services technician
- rural water management or environmental (with focus on water supply) specialist
- completed vocational training in environmental management (with focus on wastewater management in dispersed settlements)
- educational training in nature and environment (with focus on wastewater service management)

The education has to include studies in water supply engineering or HVAC/building services engineering or earth-construction. If they are not included, they have to be taken additionally, as well as studies in property-specific wastewater management in dispersed settlements. (FISE Ltd.)

The wastewater system for more complicated buildings, such as bigger apartment buildings and row houses with more than 20 p.e., business and industrial buildings and any building which is located in important ground water areas in Finland need a degree in higher education to design. Accepted degrees are

- Master of Engineering in construction engineering, environmental engineering or HVAC/building services engineering
- Bachelor of Science from a University of Applied Sciences in construction engineering, environmental engineering or HVAC/building services engineering

Included in the studies needs to be courses on water supply engineering, HVAC/building services engineering and earth-construction as well as geology, hydrology, limnology and chemistry. If any of these topics has not been covered in the degree, then additional courses have to be taken, for instance, through open studies at Universities of Applied Sciences. (FISE Ltd.)

The actual building and installing of the wastewater treatment system can be done by a professional construction company with specialization in the field. Workers who construct the system do not need special training to be entitled to do the work.

# 6 AWARENESS RAISING

Since the issue of wastewater treatment in rural areas has already been integrated into legislation, awareness raising in itself is not done anymore in Finland. However, the Ministry of the Environment is supporting guidance projects all over the country. Regional projects give unbiased information to home owners and occupants about wastewater treatment systems and help to evaluating if there is a need to upgrade existing systems. Many of the guidance projects were implemented in 2012, the year after the release of the new legislation. Some projects are also going on in 2013. Advice through the guidance projects is usually given by internet, phone and personal meetings and is free of charge. The guidance projects are financed by the Centres for Economic Development, Transportation and the Environment through the European Agricultural Fund for Rural Development. General advice is also given by municipal environmental offices and the Centres for Economic Development, Transportation and the Environment themselves.

One new project which started this year is a guidance project on the usability of dry toilets as a solution for onsite wastewater treatment. The project is focusing on the Pirkanmaa region in south-central Finland. It is implemented by the Global Dry Toilet Association of Finland. The project should raise the awareness among rural population that dry toilets are a suitable option for permanent homes for all-year-around, indoor use. It included a survey among private households about their willingness to use dry toilets and offered personal guidance on choosing and planning systems suitable for specific needs. The project was funded by the Pirkanmaa Regional Centre for Economic Development, Transport and the Environment, the City of Tampere and the Finnish Ministry of the Environment. (Pakula 2013)

# 7 TREATMENT OPTIONS

There are several options for the onsite treatment of household wastewater. Which option should be chosen, if a new system has to be used, depends on the circumstances on the individual property. Factors such as the size of the property, amount of people living permanently in the household and currently used system for removal of wastewater influence the available choices. But also location of the property, soil structure and the budget of the property owner are crucial points to consider.

Prices mentioned in the following sections refer to solutions suitable for one household with up to five persons.

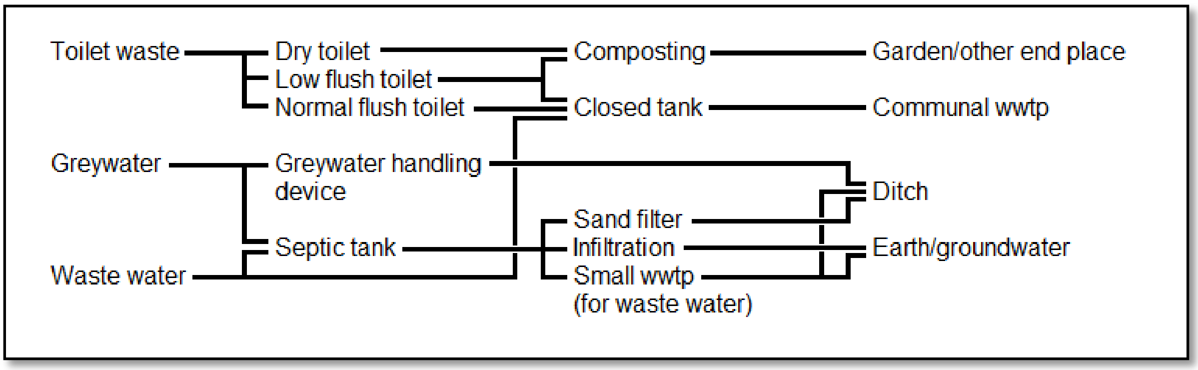


FIGURE 2 Diagram of onsite treatment options

## 7.1 Closed tanks

Closed tanks contain wastewater without processing it any further. They are water-tight, temporary storage units made of polyethylene, fiberglass or concrete. However, they need to be emptied frequently to avoid over-flowing and possible damage of the tank. Wastewater from closed tanks has to be taken to a treatment facility. Closed tanks are relatively cheap to acquire and install. (Ministry of the Environment 2011, 55) Closed tanks are not a treatment option per se but an intermediate storage solution to keep wastewater contained for a certain time.

In Finland, the emptying of closed tanks has to be done by a professional company, since special pumping and storing equipment is needed to transfer the wastewater to a communal treatment plant. There has to be enough space on the property to access the closed tank with a vacuum truck. Reducing the amount of wastewater entering the closed tank is advisable, since the emptying has to be paid by the property owner. (Ministry of the Environment 2011, 55)

FIGURE 3 Closed tanks store wastewater from households (http://www.ecolator.fi/tuotteet/umpisailio)

A source separation of grey and black water, where all toilet waste is conducted into a closed tank, can significantly lengthen emptying intervals. Greywater then has to be treated with a different system, in order to fulfill reduction levels. (Ministry of the Environment 2011, 55) A closed tank system might be the only option when the property is located in an area of water supply from surface or groundwater sources. It can also be used as a temporary solution during renovation works or when the property is planned to be connected to the communal sewage system in the foreseeable future (Jyväskylä University of Applied Sciences).

In 2013 the price for closed tanks with volumes from 3m³ to 6m³ from Finnish manufacturers range between 1500€ to 2000€ (talotarvike.com). Closed tanks from foreign companies might be cheaper, however the suitability for Finnish climate conditions is not ensured. The annual running costs for emptying depends on the amount of wastewater led into the tank. For a family of 5 the yearly costs can go up to 3000€ to hold all wastewater (Saralehto 2004, 6).

### 7.2 Septic tanks

As a primary treatment step, septic tanks can be used for household wastewater. They have been used traditionally as the only treatment step in Finland.

Septic tanks are water-tight containers made from polyethylene, fiberglass or concrete, which are buried into the earth. The main purpose is to separate solids and liquids in a septic tank. Solids are settling on the bottom of the tank, while oil and grease form scum on the surface. Neither scum nor solids can exit the tank via the outlet pipe, as they will clog the pipe of the secondary treatment which cleans the wastewater further. This can be done with the help of compartments and/or screens (United States Environmental Protection Agency, 2).

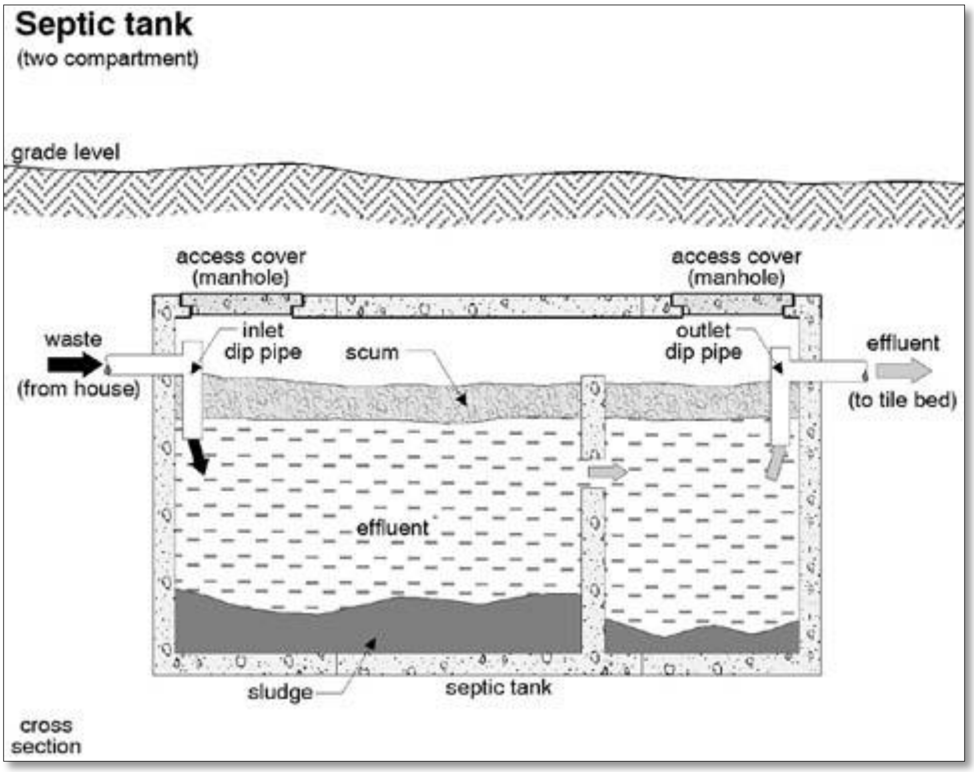


FIGURE 4 Schematic cross section of a 2-chambered septic tank (http://www.521flow.com/info/Septic%20Tank%20Pumping%20Info.html)

In regular intervals scum and solids have to be removed with a vacuum truck to ensure that the septic tank is functioning properly and sedimentation is not building up too much. As for closed tanks, this has to be done by professionals.

Septic tanks reduce the settable solid parts in wastewater. However, they perform poorly in bacteria and virus removal (WHO 2006, 95). They remove about 15% of the organic matter and about 10% of the phosphorus in the wastewater (Ministry of the Environment 2011, 11). Therefore, the discharge from the septic tank has to be treated further. Septic tanks can be used to pre-treat wastewater containing black water, and also for grey water only. A three chambered septic tank is required by law if toilet waste is contained in the wastewater. Greywater can be treated in a 2-chamber septic tank.

Septic tanks for wastewater are usually sold in combination with an infiltration or sand filter system. The prices for the combined systems are listened under 7.3 and 7.4. A new septic tank for greywater treatment costs about 1000€ (rakentaja.fi).

### 7.3 Infiltration

Infiltration is one option to handle wastewater from a septic tank. It is also possible to use for treating source-separated grey water. The wastewater is distributed over a drainage field via pipes. In the drainage field, the wastewater is cleaned by running through layers of soil towards the groundwater. The usage of this treatment is restricted by the property size as the drainage field requires space.

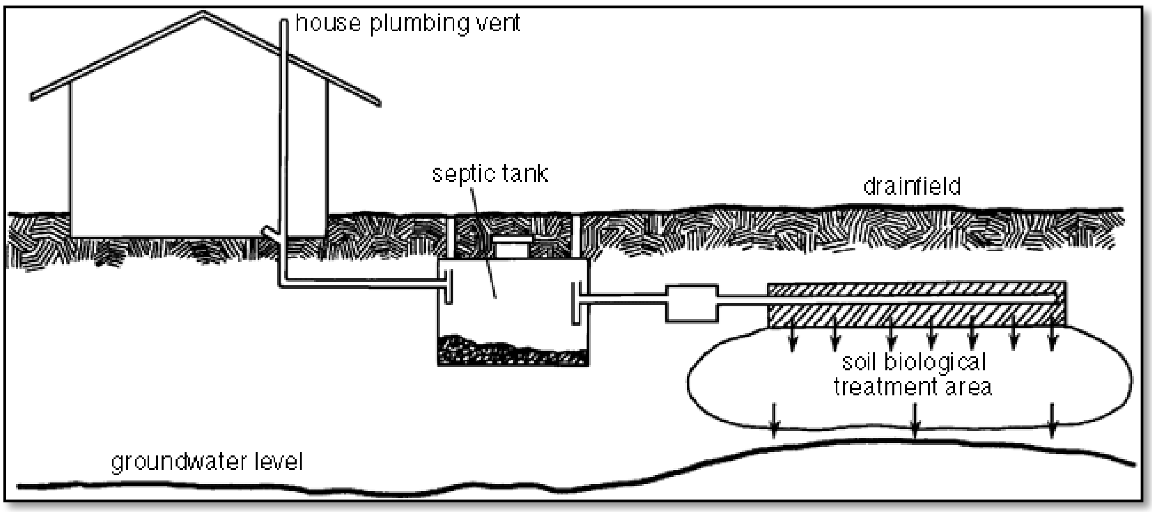


FIGURE 5 Schematic infiltration system (http://www.ag.ndsu.edu/news/newsreleases/2011/july-11-2011/don2019t-overwork-flooded-septic-systems)

The suitability of a property for this kind of treatment depends on the soil conditions. In too coarse soil types the wastewater runs through too quickly and does not get cleaned enough. Too compact soil is a problem because the wastewater is sinking in very slowly and might dam in the top soil. (Ministry of the Environment 2011, 56) Additionally, the soil layer has be at least 1 m thick measuring from the inlet pipe to the groundwater level. Therefore, the soil has to be evaluated prior to building an infiltration drainage field.

In Finland, an infiltration system is prohibited to be built in areas where groundwater is taken as a drinking water source by private households or by public purification plants. This also concerns properties which are located in the catchment area of groundwater drinking water sources and other important groundwater areas (Ministry of the Environment 2011, 56). Infiltration systems reduce efficiently organic matter, phosphorus and possibly nitrogen from the let in wastewater (WHO 2006, 96). The soil eliminates most bacteria but viruses may travel into the groundwater (Ministry of the Environment 2011, 56).

A new infiltration system with a 3-chambered septic tank and appropriate pipes costs about 1500-2000€ (Taloon Yhtiöt Ltd.). Foreign manufacturer might offer cheaper solutions. The infiltration pipes cost in Finland about 600€ (Taloon Yhtiöt Ltd.), which can be used if a functioning septic tank is already in place.

### 7.4 Sand filters

Another possible alternative that can clean septic tank discharge are sand filters. Like infiltration systems, sand filters are also suitable for cleaning only grey water. Sand filters are constructed filtration systems, where the wastewater is treated by flowing through an area of filter sand or industrial filter material. They are also called vertical-flow wetlands.

The distribution of the wastewater is done through buried pipes. At the bottom of the filter layer the cleaned water is collected with a drain and then lead into small surface waters e.g. ditches (Ministry of the Environment 2011, 57). Organic matter, bacteria and phosphorus load are reduced in sand filters. BOD removal can be over 80% if fine- and medium-grain soils are used as filter material (WHO 2006, 98). However, phosphorus reduction depends heavily on the regular phosphorus content of the wastewater, the properties of the filter material and the usage time of the filter. It might be necessary to utilize an additional phosphorus filter or other reduction method to meet the Finnish standards (Ministry of the Environment 2011, 57). Iron and aluminium oxide-rich sands can achieve higher phosphorus, bacteria and virus reduction levels than other filter materials (WHO 2006, 98).

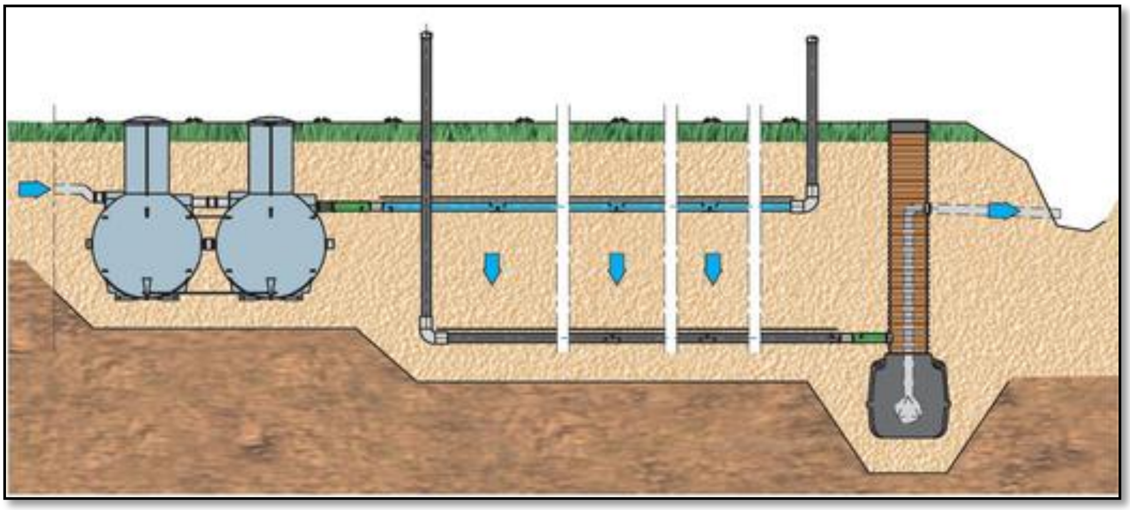

FIGURE 6 Schematic sand filter system with two septic tanks, a collection tank and a pump (http://www.wavin-labko.fi/tuotteet/jatevesijarjestelmat/maaperakasittely/labko_mp_pumppukaivo/)

Sand filters require a certain area and thus only applicable on properties with sufficient space. This treatment can be used for properties where soil or groundwater conditions do not allow infiltration systems. If it is crucial to protect groundwater under the property, the area under the sand filter has to be made water-tight before construction (Ministry of the Environment 2011, 57).

Sand filters use a distribution system like infiltration. The costs for the septic tank and distribution pipes are thus the same as for infiltration systems. Also a collection pipe system is necessary, costing about 500-600€ (Taloon Yhtiöt Ltd.).

## 7.5 Small treatment plant

In Finland various manufacturers are producing small ready-to-install treatment plants. These small wastewater treatment plants are using biological and chemical treatment processes to reduce BOD levels, phosphorus and nitrogen (Ministry of the Environment 2011, 58). Activated sludge processes are implemented and phosphorus is usually removed with chemicals.

Small treatment plants do not require as much space as solutions with sand filters or infiltration systems as they are rather compact. They also work on their own without a septic tank as pre-treatment. However, small treatment plants need careful maintenance to ensure high reduction levels. Also access to the opening of the system for vacuum trucks is necessary as sludge has to be removed in regular intervals.

Small treatment plants are meant for permanent residences where wastewater is produced all year around. Without enough and regular input wastewater small treatment plants do not work properly, because biological treatment cannot develop sufficiently (Ministry of the Environment 2011, 59). It is therefore not an option for holiday homes.

Prices for small wastewater treatment plants range between 5200€ to 8500€ for one household with up to 5 persons (Taloon Yhtiö Ltd.).

### 7.6 Price overview

TABLE 6 Expenses for different treatment systems in Finland in 2008 (Jätevesitieto toiminnaksi -hanke, modified)

| **Treatment system** | **Initial investment/€** | **Annual expenses/€** | **Expenses over 15 years (without VAT)/€** |
|---|---|---|---|
| Closed tank ca. $5m^3$ | 2300 | 3000 | 47300 |
| Closed tank ca $11m^3$ | 4000 | 1500 | 26500 |
| Infiltration | 3000-3500 | 150 | 5250-5750 |
| Sand filter | 4500-6250 | 150 | 6750-8500 |
| Sand filter with additional phosphorus removal | 6000-8000 | 225-275 | 9375-11375 |
| Small treatment plant | 8500 | 350 | 13750 |
| Small treatment plant with servicing agreement | 8500 | 580 | 17200 |
| Closed tank (5-$10m^3$) and infiltration (for greywater) | 4800-6500 | 500-800 | 14000-16800 |
| Closed tank (5-$10m^3$) and sand filter (for greywater) | 6500-8200 | 500-800 | 15700-18500 |

The prices in table 6 are representative for Finnish pricing in 2008. The treatment options are all suitable for a five-person-household. They include the costs for building permit, the planning of the system by a professional, the construction and installation. Furthermore, plastic and other equipment and necessary soil and sand masses are also part of the investment costs. Annual expenses depend on the system and can be costs for emptying by vacuum trucks and disposal of wastewater and sludge, maintenance of equipment, replacing and disposal of filter material and dephosphorisation agent.

## 7.7 Alternative systems

### 7.7.1 Dry toilets

Dry or composting toilets are an alternative to flush toilets which are dominating the bath rooms in the industrialized nations. Dry toilets are suitable especially in environmentally sensitive areas or regions that are arid or face frequent water shortages (Del Porto & Steinfeld 1999). However, they can also be a good option for houses in regions that do not have these challenges. In Finland dry toilets are used in summer cottages (Global Dry Toilet Association of Finland 2011, 2) which often are not connected to drinking water and sewage networks.

Dry toilets collect only toilet waste into a container which usually needs to be located directly under the toilet bowl. If managed properly, dry toilets are odorless, kill bacteria and pathogens and produce humus as end product. The containment of the toilet waste is crucial to prevent pathogens from spreading. The container needs to be inaccessible for flies, bugs, beetles and other arthropods, otherwise pathogens can be transported to foods and objects that humans use. (Del Porto & Steinfeld 1999) Odors, carbon dioxide and water-vapor are removed from the container with the help of a screened exhaust, which may be fan-forced (Global Dry Toilet Association of Finland 2011, 5). Excess liquid needs to be drained from the container bottom to prevent anaerobic digestion to take place because of saturation. A urine diverting dry toilet can help prevent this problem.

There are several options for dry toilets available in Finland and the suitability of them depend on the available space and other circumstances. Furthermore, the property needs to be big enough to spread stable urine and leachate e.g. on the lawn. About 500-600 $m^2$ are necessary for a four-person household (Pakula 2013).The feces are usually collected in a composting bin and then composted for about one year. The finished compost can only be used on the property or then an agreement has to be made with the local waste collection company. It cannot be put into the normal household waste. Dry toilets usually work not depending on if there are breaks in the waste creation e.g. due to holidays, or if they are used very extensively for some time. (Pakula 2013)

Greywater from the household appliances and sinks can be managed more easily. For instance, an infiltration system or sand filters can be used. Only a two-chambered septic tank is necessary for primary treatment.

The costs for a greywater treatment system are similar to regular infiltration and sand filters, as the same technology is necessary. Dry toilets from Finnish manufacturers are available from 200€ to 2000€ (Rweyendela 2012, 42). Additionally, accessories like an electric fan, composting bin, electric heater, ventilation pipe and a porcelain seat need to be purchased to make the dry toilet fit into indoor settings.

### 7.7.2 Constructed horizontal wetlands

Constructed wetlands are categorized into two types: horizontal-flow and vertical-flow. Vertical-flow wetlands are generally sand filters which have been discussed in section 7.4. Horizontal-flow wetlands, also called surface-flow wetlands, are planned to resemble natural wetlands. (Scholz 2006, 108)

Natural wetlands are areas where the soil is saturated with water. Fens, swamps and marshes are specific kinds of horizontal wetlands. Wetlands are known to clean and purify water working as ecological filters. They are a "half-way world between terrestrial and aquatic ecosystems" (Smith 1980, Scholz 2006, 92) providing a conservation area for wildlife and plants. Some wetland areas are also used by local communities for recreational purposes (Maltby & Barker 2009).

In order to use constructed horizontal wetlands as a treatment option for domestic wastewater sufficient land area is necessary. It needs a loamy or sandy topsoil to facilitate the growth of macrophytes. Constructed wetlands reduce bacteria and virus levels, suspended solids, organic matter, heavy metals, nitrogen and phosphorus from wastewater. (Scholz 2006, 108) However, it is not used only by itself. A septic tank is needed to separate a big amount of solids beforehand, so that the natural system will not clog.

# 8 DISSCUSSION

## 8.1 Legislation in other EU countries

Already since 2003, when the first decree (542/2003) concerning wastewater treatment systems in areas unconnected to communal sewage systems was put into force, the Finnish government tries to reduce the risk insufficiently cleaned household wastewater poses. Also other European countries have taken legislative steps to decrease the problematic situation.

### 8.1.1 Germany

Only 4% of the German population are living in areas unconnected to communal sewers (SPIN Project, 4). Even though Germany has very wide-spread sewage networks about 3,2 million citizens have to use onsite and small-scale wastewater treatment systems. The Wastewater Regulation (AbwV 1997) directs all wastewater discharges to water courses in Germany. The requirements set by the legislation are affecting wastewater treatment plants of all sizes. For all treatment plants up to 1000 p.e. only emission levels for COD and $BOD_5$ are relevant. The discharge which is after treatment led into water course can have a maximum COD of 150 mg/l and $BOD_5$ of 40 mg/l. Phosphorus and nitrogen emissions are not considered for small-scale options.

### 8.1.2 France

Also France has taken already legislative measures to control household wastewater from unconnected properties. The Decree from September 7, 2009 (Arrêté du 7 septembre 2009) sets the technical requirements for small-scale treatment systems and the TSS- and $BOD_5$-levels of the discharge. Treatment systems handling organic load with a $BOD_5$ up to 1,2 kg per day are considered in the decree. Considering that according to the European Union's standard one person produces about 60 g of $BOD_5$ per day, the decree applies to wastewater treatment systems serving up to 20 persons in total. All systems for which the decree is relevant need to ensure that the discharged water contains not more than 30 mg/l of TSS and 35 mg/l of $BOD_5$. As in the German legislation, phosphorus and nitrogen emissions are not subject of the technical requirements of on-site and small-scale wastewater treatment systems in France.

### 8.1.3 Sweden

Sweden's legislation concerning decentralized wastewater treatment systems also set limitations for organic matter, phosphorus and nitrogen. The circumstances are similar to Finland. About 1,25 million people are not connected to communal sewage systems in Sweden, which accounts for 13% of the whole population (SPIN Project, 4). As in Finland, these properties have to clean their wastewater onsite or in a small collective. - In 2006 Sweden's Environmental Protection Agency set up general guidelines for small-scale wastewater treatment systems (NFS 2006:7). The guidelines are enacting reduction levels for sanitation solutions serving up to 25 p.e.

TABLE 7 Reduction levels for onsite and small-scale WWTS in Sweden (NFS 2006:7)

| Segment | Normal level | High level |
|---|---|---|
| $BOD_7$ | 90% | 90% |
| Phosphorus | 70% | 90% |
| Nitrogen | - | 70% |

The higher reduction levels can be generally enacted in environmentally sensitive areas, such as on shore lines and close to water reservoirs. In other areas the normal reduction levels are valid. (SPIN Project)

### 8.1.4 Central and Eastern European Countries

In many other EU countries, especially the Central and Eastern European countries which joined during the last two enlargements in 2004 and 2007, rural wastewater treatment is rather poorly developed if at all. In most of these countries these are no legislative requirements for wastewater treatment in general other than what the European Union has set. In Central and Eastern Europe about 30% of the population lives in settlements with less than 2000 inhabitants.(Global Water Partnership 2012, 8)

### 8.2 Feasibility and usability of treatment options

Closed tanks, 3-chambered septic tanks with an infiltration field or sand filters and small wastewater treatment plants have all been approved by the Finnish government as suitable options for the Finnish climate. However, there have been doubts about the feasibility and usability of all systems.

Closed tanks are the only option where the property owner does not have to worry about the effectiveness of the system, because the wastewater is not treated onsite. Because the operation costs are so high, it is not an affordable solution for many households.

Wastewater treatment relies on microbiological activity to reduce bacteria, viruses and nutrients. Most microorganisms only work in a certain temperature range. Too high and too low temperatures can inactivate microorganisms. Due to the Finnish climate too low temperatures are more of a concern. Especially ammonia removal can become a problem in cold climate. Bacteria to convert ammonium ions and ammonia work only properly in warm surroundings (Goodfellow 2000, 28). At 5°C there is only one third of the amount of bacteria than at 15°C, because their reproduction is slowed down considerably (Sipilä, Paavola, Lehto & Jauhiainen 2011, 37). Problems may thus occur in infiltration systems, sand filters and small treatment plants during winter.

For sand filters and also infiltration systems that means that wastewater has to be distributed more slowly during the winter months to ensure adequate treatment (Purdue University). Septic tanks therefore need to be big enough to store a bigger amount of wastewater during cold months.

Small treatment plants need to keep operation temperature on a certain level. Too low temperatures can inhibit nitrogen reduction. It is essential to keep up the incoming wastewater flow throughout the cold months to ensure microbiological growth and avoid breaks in the treatment efficiency (Sipilä, Paavola, Lehto & Jauhiainen 2011, 36). Longer pauses due to holidays may affect treatment for many weeks after, because the microorganisms need time to reproduce. Also sufficient retention time for the biological process is important, therefore the capacity to store a bigger amount of wastewater during the winter has to be possible.

Several studies have been made on the effectiveness of sand filters and small treatment plants in general. The some of the most recognized studies done in Finland are the Hajasampo-project run by the Finnish Environmental Institute, the AHA 21-project conducted in the region of Varsinais-Suomi in south-west Finland and a study by the Finnish magazine TM Rakennusmaailma.

The Hajasampo- project was mostly done on sand filters. The sand filters showed good reduction for $BOD_7$ and nitrogen but results for phosphorus had great variance, however sufficient on the average. (MINWA Project)

In the AHA 21-study sand filters and small treatment plants were tested. Sand filters showed that an additional phosphorus removal might be necessary to meet reduction levels and also nitrogen removal was only partially successful. (MINWA Project)

The test on small treatment plants done by TM Rakennusmaailma followed the effectiveness of plants from eight different manufacturers for about 1,5 years. All test subjects reduced $BOD_7$ sufficiently and also phosphorus removal was mostly meeting reduction targets for normal areas. However, nitrogen removal had mixed results. (2011, 35-36)

Since infiltration systems work similar to sand filters, it is assumed that they can have similar problems. Septic tanks suitable for storing more wastewater during winter months, when release through the distribution pipes is slowed down, should be part of the system. Infiltration systems may also not remove phosphorus and nitrogen satisfactory. However, measuring the efficiency of these systems is difficult since the wastewater is not collected as an effluent stream after the treatment.

Dry toilets are in general very reliable. However, they need more surveillance and maintenance than flush toilets (Pakula 2013). If the system is not used properly, which might be difficult for small children or elderly people, problems can occur e.g. with the effectiveness of the composting or odors. Furthermore, people might not be comfortable with treating their toilet waste at home and having to generally handle it by themselves.

Additionally, the composting time in Finland is longer than in more southern regions, since the compost will be frozen during the winter months.

Horizontal wetlands are less known to people as a treatment option for wastewater. Due to the amount of space that is necessary, especially if an additional storage pond has to be installed, it would be a more suitable option for a few neighboring properties to use jointly.

What has to be considered in Finland when using constructed horizontal wetlands is the effectiveness during winter months. Freezing temperatures and high amounts of precipitation coming down as snow and ice are slowing down the biological processes in the wetland. One option to make it work in cold climates is to build an additional storage pool, where wastewater can be stored during winter time and then be released to the wetland in spring. (Maltby & Barker 2009)

## 8.3 Problems with policy & implementation

The current legislation for rural areas in Finland relies heavily on the financial input from private households. Especially the initial input can be very high, up to 8500€ (table 6) in 2008. Due to rising prices in all sectors the current investment costs may be higher. The Finnish legislation model is not applicable in countries with low income and high income inequality.

In sensitive areas such as shorelines and ground water areas, households may only have the option of using closed tanks to store wastewater, because nothing may be released to the ground. Closed tanks have very high annual costs, especially when it used by larger households. Additional annual costs of thousands of Euros seem unbalanced to annual costs of 400-500€ for a household connected to the communal sewage network (Saralehto 2004, 6).

Professional advice from municipalities and independent associations is available for the suitability of treatment options for properties. However, advice on alternative systems such as dry toilets is lacking, because profound knowledge and training is not readily available in Finland. Thus, the implementation of alternative systems is slowed down. (Pakula 2013)

The reception of the legislation on onsite sanitation has been rather negative among the people concerned by it, since the first version came out in 2003 (Weckström 2011, 29). The loosened reduction levels for $BOD_7$, phosphorus and nitrogen and the longer transition period that came with the new legislation in 2011 did not help much to change minds. In mid-2013 only about 1/3 of the properties that need upgrading of their wastewater treatment system had done so (Helsingin sanomat 2013).

Furthermore, the reason for putting the legislation into force brought up some disapproval. Insufficiently cleaned wastewater has negative effects on surface and groundwater. However, the impact it has on the Baltic Sea is rather small compared to the nutrients released by agriculture in Finland. About 8,5% of all phosphorus released to water ways and about 3,4% of all nitrogen has its source from dispersed settlements with private wastewater treatment (Bäck et al. 2010, 230). Most of the emissions are released by agricultural activities. They account for 67% of phosphorus load and 53,4% of nitrogen (Bäck et al. 2010, 224). Farmers and agricultural companies have been supported by the Finnish state to reduce nutrient releases.

## 8.4 Suggestions for improvement

The biggest problem is that the effectiveness of the different onsite systems has not yet been proven. As mentioned before, studies have given results with great variance. Therefore, it would be necessary to collect more information on the usability of the different systems. For this further studies especially about infiltration and sand filters would need to be conducted.

The annual financial input for properties that need to use closed tanks, because the location does not allow to conduct any wastewater to the ground, may put a significant strain on household's budgets. Additional financial support would lessen this problem.

Another idea for these areas would also be to source separate toilet waste and greywater, containing toilet waste and treating greywater efficiently, so the released organic matter and nutrients are of very low concentrations, not harming the environment. The use of natural, bio-degradable household products in these houses would further help in this matter.

Source separate is anyways a good way to reduce the contamination load. Since toilet waste holds most of the nutrient load, it would be an option to treat it separately from the greywater. Treating only greywater with infiltration, sand filters or a small treatment plant will lead to more stable and sufficient load reduction results. Toilet waste can either be contained by a closed tank or composted in a dry toilet. The promotion of source separation could thus lower the environmental stress from dispersed settlements significantly, making the wastewater treatment more successful.

Furthermore, the use of dry toilets in permanent dwellings is not yet very common. Even though, suitable technology is available and usually easy to use and maintain. Since people in Finland are very used to flush toilets, they might find it foreign to use a dry toilet on a regular basis. However, dry toilets can not only reduce the contamination load, but it can also significantly reduce water usage in households. More awareness campaigns would help people understand that dry toilets are an alternative system that is usable and reliable in treating toilet waste.

As mentioned above, the usage of natural, bio-degradable household cleaning agents and frequently used personal hygiene products can reduce the chemical load in the wastewater and thus make it easier to be treated. Bio-degradable products put less stress on the wastewater treatment system and surrounding environment after release. Making people aware of this situation could help lessen the strain wastewater puts on the surrounding environment.

## 9 CONCLUSIONS

Finland has one of the most thorough and strict rural wastewater treatment policy in the European Union. On the one hand, it is exemplary for other countries to show that rural wastewater treatment can be brought to a high standard. Once the transition time is over and the majority of the unconnected properties have upgraded their wastewater treatment systems to comply with the legislation, improvements will be seen especially in the surrounding environment close to properties. The state of surrounding surface waters will improve especially. On the other hand, there are also problems concerning the legislation and issues that can be improved to make rural wastewater treatment more successful and sustainable in the long run.

Various technologies are available to treat household wastewater. However, their effectiveness and suitability for the Finnish climate has shown varying results. Additional studies are necessary to bring clearance on the matter. Alternative technologies should be considered more thoroughly and appropriate training needs to be given to planners and builders.

Furthermore, there might be still a lack of awareness on the wastewater issue among rural population. The changes in the treatment systems have been made rather hesitantly in the last decade. The personal attitude towards the problem can have an impact on the quality and composition of the wastewater.

With more support from the Finnish state and municipalities through awareness raising, further studies, guidance and financial means property owner could become more agreeing to implementing the regulations. Thus, making the Finnish model on rural wastewater treatment more successful.

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