VillageWaters

Guidelines for the best technical solutions and practices for the wastewater treatment in scattered dwelling areas

Summary of best practices and solutions.
VillageWaters report – Version 2.0

Loreta Urtāne (Ed.)

FINDING THE BEST FITTING SOLUTIONS FOR WASTEWATER MANAGEMENT IN VILLAGES

VillageWaters Project
Research about Wastewater
Treatment Systems

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VillageWaters Project Research about Wastewater Treatment Systems

This report titled as 'Guidelines for the best technical solutions and practices for the wastewater treatment in scattered dwelling areas' as a part of the activity 4.5 'Dissemination of best practices in target group trainings' in VillageWaters –project (1st of March 2016 - 28th of February 2019), was published on 28th of February 2018 (period 4 of the project) only for project usage. Data was updated at the end of February 2019 as version 2.0 and the report was published at VillageWaters webpage.

The main challenge of this VillageWaters -project ('Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots') is to find out the most sustainable technological wastewater treatment solutions to decrease wastewater emissions of sparsely populated areas locally but also into the Baltic Sea to the level set by the EU water legislation. The main objective is to support the needs of households to avoid unnecessary investments and operating costs when shifting to improved waste water treatment and thus encourage them to implement new treatment systems. The work is conducted in 13 activities under four work packages in this project by 13 partners from Estonia, Finland, Latvia, Lithuania and Poland. The project's schedule is 1st of March 2016 until 28th of February 2019, including 6 periods. The budget is about 3 million euros that is mainly funded by the Interreg Baltic Sea Region (BSR) Programme.

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VillageWaters Project Research about Wastewater Treatment Systems

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Abstract

This report titled 'Guidelines for the best technical solutions and practices for the waste water treatment in scattered dwelling areas' summarizes the best practices and solutions found by the project pilots into guidelines. The guidelines will consider the key issues of procurement of a waste treatment system, such as how to buy new technology, how to evaluate its inputs and costs compared to other systems, how to operate with the maintenance, how to co-operate within village water cooperatives and how to communicate on the intentions, options and results. The guidelines also give basic information of the wastewater treatment systems and describe why they are used and how they impact local waters and the Baltic Sea, as well as the global environment. The guidelines give also tips on how to decrease wastewater emissions and climate impacts at the same time.

As a result of this report, training materials have been published on the project website (https://www.villagewaters.eu/Guides_for_Wastewater_Treatment_996):

Training Material Part 1: Considering the future of the Baltic Sea explains the status of the Baltic Sea and consequences of eutrophication.

Training Material Part 2: Consider before flush explains the origination of domestic wastewater and types of wastewater treatment systems.

Training Material Part 3: Consider and act summarizes historical development of wastewater treatment solutions and explains the origination of wastewater treatment system costs.

These materials are made simply and easy to use.

Keywords: wastewater treatment, purification technologies, holding tank, septic tank, package plant, soil filter, infiltration field, constructed wetland, legislation, Estonia, Finland, Latvia, Lithuania, Poland, Sweden.

Abbreviations and clarifications of terms

BOD	Biochemical oxygen demand is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water or wastewater sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a surrogate of the degree of organic pollution of water.
CTW	Constructed treatment wetlands
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, known as the Helsinki Convention. The Contracting Parties are Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.
Information Tool	Information Tool (IT) is a web-based service, which helps homeowners and small municipalities to find best available wastewater treatment system to their needs. The Information Tool is available at VillageWatres webpage: https://www.villagewaters.eu
PE	People equivalent
SBR	Sequencing batch reactor
SDWWTS	Small domestic wastewater treatment systems
WWHT	Wastewater holding tank
WWTP	Wastewater treatment plant
WWTPP	Wastewater treatment package plant

1. The Eutrophication Status of the Baltic Sea and Impacts of Waste Water Emissions

This chapter will focus on:

- **The peculiarities of the Baltic Sea**
  - Is the only inland sea in Europe;
  - Is one of the largest brackish-water basins in the world;
- **What is eutrophication and why the Baltic Sea is so vulnerable to eutrophication**
  - Because of the combination of a large catchment area (1,700,000 km^2) with associated human activities (85 million inhabitants) and a small body of water (surface area of 415,200 km^2) with limited exchange of water is very sensitive to nutrient enrichment and eutrophication.
  - Since the 1900s, the Baltic Sea has changed from an oligotrophic (nutrients less) clear-water sea into a eutrophic (nutrients rich) marine environment.
- **What is main pollution sources**

Covering a surface area of 415 000 km^2 the Baltic Sea is the largest brackish water ecosystems in the world. It is composed of seven sub-basins with varying surface areas, volume, depth and salinity. Combination of a large catchment area (1,700,000 km^2) with asso-ciated human activities (85 million inhabitants) and a small water surface area of 415,200 km^2 with limited exchange of water makes the Baltic Sea very sensitive to nutrient enrichment and eutrophication.

Eutrophication is a major problem in the Baltic Sea. Since the 1900s, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment. Excessive nitrogen and phosphorus loads coming from land-based sources, within and outside the catchment area of accounts for about 75% of the nitrogen load and at least 95% of the phosphorus load entering the Baltic Sea via rivers or as direct waterborne discharges[1].

[1] Helsinki Commission Fifth Baltic Sea Pollution Load Compilation PLC-5, 2011

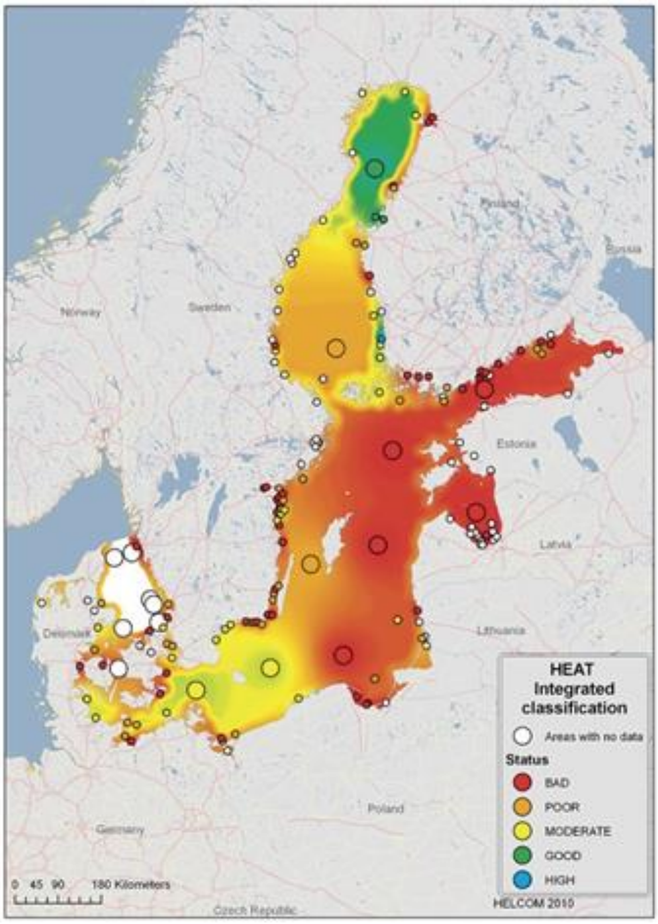

Figure 1. Heat-integrated classification describing the status of eutrophication in locations around the Baltic Sea. (Source: HELCOM 2010).

The use of the Baltic Sea for nutrient disposal has implied ecological damage manifestated as rocketing eutrophication (Figure 1). Eutrophication generates production of algae, which consequently consume oxygen when decomposed, implying that the supply of oxygen has been drastically overused, hampering the survival of other species and creating areas of sea bottom without any biological life. Such areas of oxygen depletion have increased drastically from approximately 5,000 km2 in around 1900 to the extension of 60,000 km^2 in present day (Figure 2).

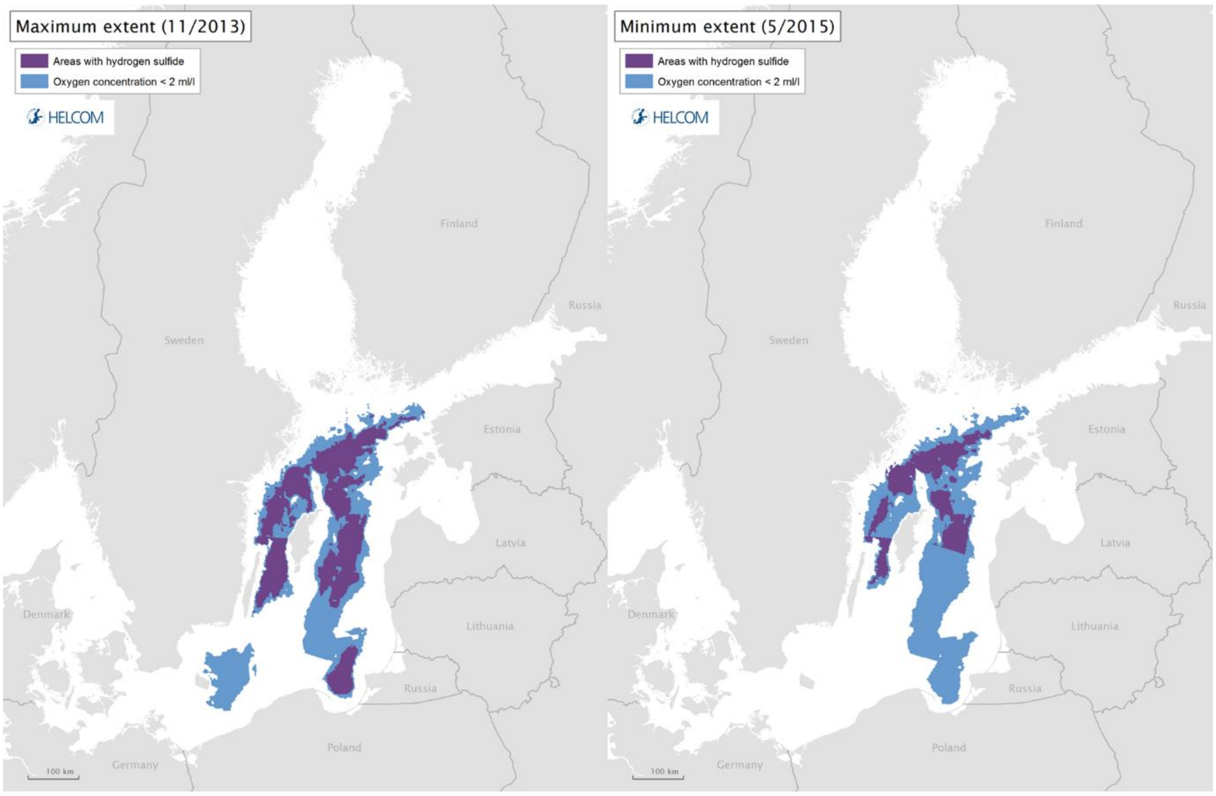

Figure 2. Minimum and maximum distribution of anoxic areas in the deep-water (where hydrogen sulphide is present) and areas with less than 2 ml/l oxygen during 2011–2015 (Source: http://stateofthebalticsea.helcom.fi/in-brief/our-baltic-sea/)

Based on the Helsinki Commission Fifth Baltic Sea Pollution Load Compilation (PLC-5) data, it is estimated that waterborne inputs to the Baltic Sea in 2006 amounted to 638,000 tonnes of nitrogen and 28,400 tonnes of phosphorus. About 5 % of the nitrogen load originated from point sources discharging directly into the Baltic Sea, while the rest entered via rivers. For phosphorus the contribution from point sources was higher, about 8 %. Atmospheric deposition additionally supplied the Baltic Sea with 196,000 tonnes of nitrogen in 2006 (Bartnicki et al. 2008), while the atmospheric deposition of phosphorus directly to the Baltic Sea is considered as low.

Due to active transnational cooperation under HELCOM Convention implementing Baltic Sea Action Plan (BSAP) the total inputs of nutrients to the Baltic Sea have decreased since the late 1980s and currently inputs levels equal those in the early 1960s. Despite the reduced inputs, the concentrations of nutrients in the sea have not declined accordingly due to the long residence time of water in the open Baltic Sea as well as feedback mechanisms such as release of phosphorus from anoxic sediments, and the prevalence of nitrogen-fixing cyanobacteria blooms in the subbasins of the Baltic Sea, whic foster processes that slow down the recovery from the eutrophied state (HELCOM 2014a).

Figure 3. Algae blooms in the Baltic proper, July 2005 (image courtesy Jeff Scmaltz, NASA) https://news.nationalgeographic.com/news/2010/02/100305-baltic-sea-algae-dead-zones-water/ .

During the period of 1994-2010 the total waterborne phosphorus inputs to the Baltic Sea was reduced by 20 %. Reduction of phosphorus inputs to the sea was observed in all Helsinki Convention Contracting Parties, except for Latvia where these inputs were significantly increasing (69 %). The highest reductions of total waterborne phosphorus inputs between 1994 and 2010 were reported for Denmark (34 %), Lithuania (38 %) and Poland (25 %). Riverine phosphorus inputs have decreased by approximately 5,700 tonnes (16 %) since 1994, accounting for more than 70 % of the total reduction in phosphorus inputs to the Baltic Sea. Phosphorus inputs from direct point sources have decreased by 68 %, or about 2,000 tonnes (Figure 4). For total waterborne phosphorus inputs, significant decreases were calculated for the Bothnian Sea (28 %), the Baltic Proper (26 %), the Danish Straits (40 %), and the Kattegat (22 %). For the Bothnian Bay the decrease was similar (21 %), but with a lower statistical confidence level. On the other hand, waterborne phosphorus inputs increased with nearly 50 % to the Gulf of Riga (data for Latvia are uncertain, especially for 2008-2010) and no significant trends were observed for the Gulf of Finland (shortcomings and uncertainties in the Russian data). Data revealing nitrogen loads are represented in Figure 5.

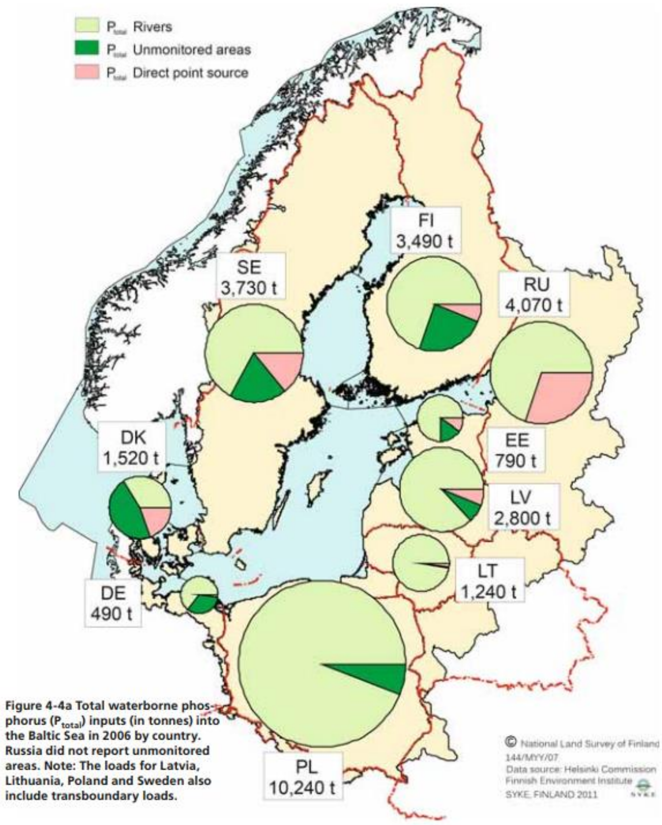

Figure 4. Total waterborne phosphorus (Ptotal) inputs (in tonnes) into the Baltic Sea by sub-region in 2006. Note: The loads for Latvia, Lithuania, Poland and Sweden also include transboundary loads.

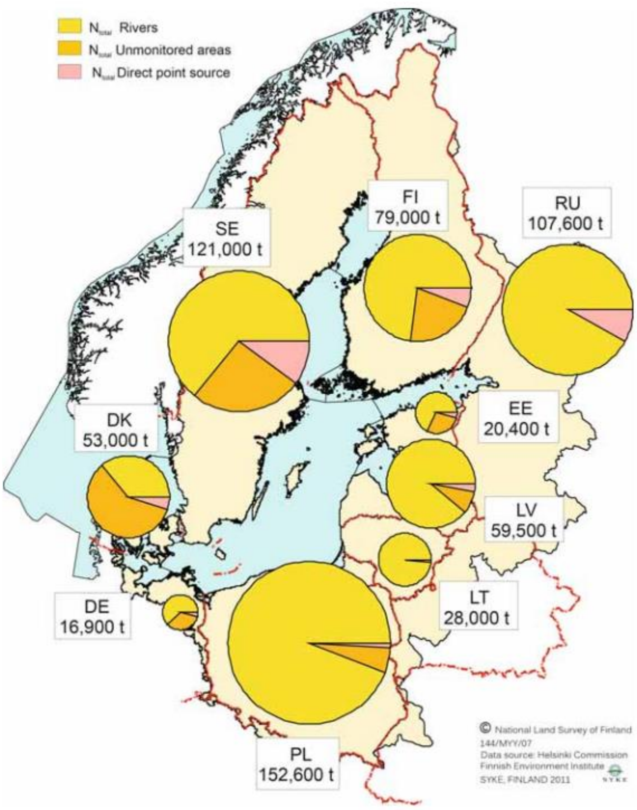

Figure 5. Total waterborne nitrogen (Ntotal) inputs (in tonnes) into the Baltic Sea by country in 2006. Note: The loads for Latvia, Lithuania, Poland and Swe-den also include transboundary loads

This indicates that the measures taken before and after 1994 to improve wastewater treatment, to reduce air emissions from combustion processes and losses from diffuse sources (agriculture and forestry) have led to a significant decrease in nutrient inputs to the Baltic Sea (Figure 6). Nevertheless phosphorus and nitrogen pools in the Baltic sea still exceeds natural sea ability for ecosystem self stabilisation.

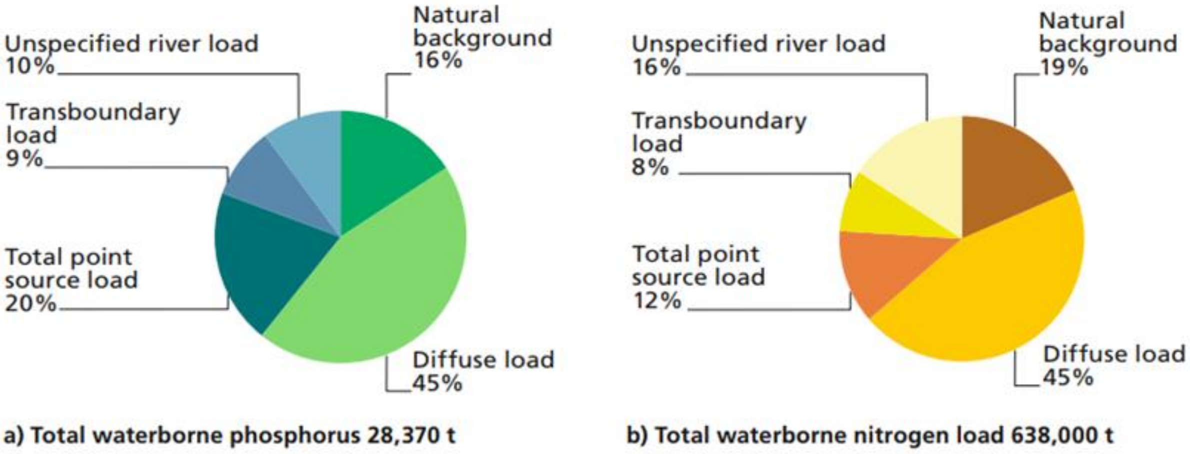

Figure 6. Proportion of different sources (in %) contributing to the a) total waterborne phosphorus and b) total waterborne nitrogen inputs into the Baltic Sea in 2006. (PLC-5, 2011).

As noted in PLC-5, only a few countries have reported nutrient loss data for scattered dwellings and storm water treatment, and thus only very general conclusions on these sources and reduction can be drawn . It is noted that in some countries (e.g., Denmark), phosphorus losses from scattered dwellings and storm water constructions constitute more than one third of the anthropogenic diffuse sources and in some catchment areas they are the main sources of input to inland surface waters. Around one million Finns live in rural areas in homes that are not connected to sewerage systems. Additionally, almost half a million holiday homes around Finland treat their own wastewater in local systems. The phosphorus loads entering waterbodies from unconnected households in rural areas and from holiday homes were estimated to amount to about 350 tonnes per year during the early 2000s (compared with the total phosphorus load of 175 tonnes annually from 4 million people connected to MWWTPs) (Figure 7).Total amount of phosphorus and nitrogen load from scattered dwelling in Poland, Estonia, Lithuania and Latvia is not available yet, but it can be assumed that in some catchment areas they are the main sources of input to inland surface waters.

In Sweden, the introduction of P-free detergents reduced the phosphorus load to inland waters by about 50 tonnes per year. Recently enacted Finnish legislation on the treatment of household wastewater outside sewerage systems facilitates improvements that will reduce the local loads burdening waterbodies. The same kind of legislation regarding scattered dwellings is in force in, e.g., Denmark and Sweden.

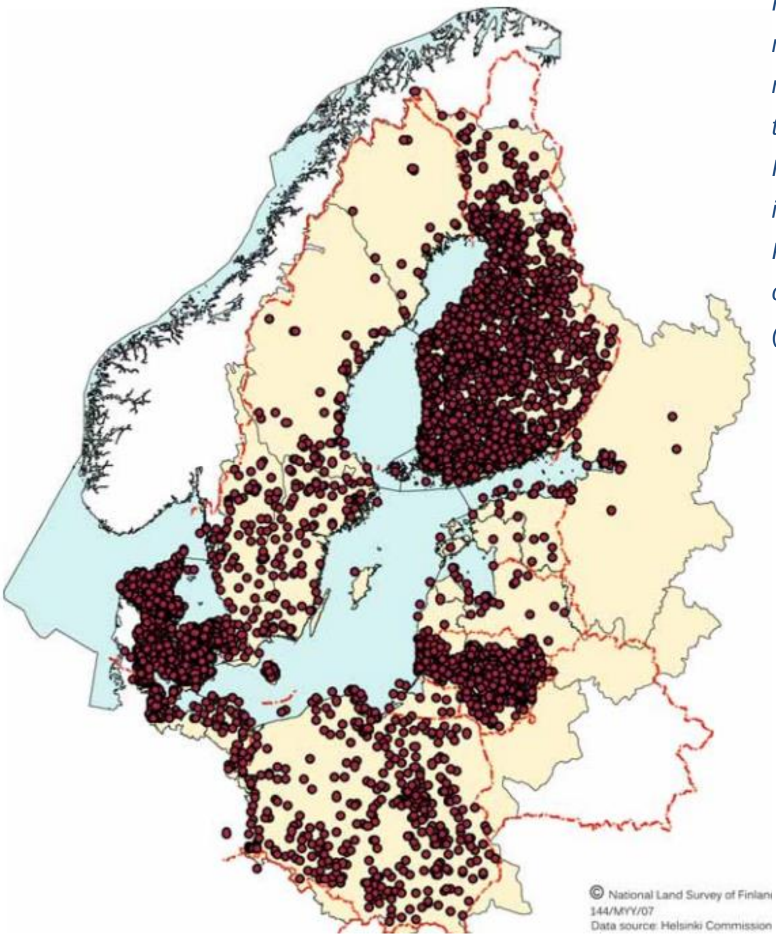

Figure 7. Municipal wastewater treatment plants for which data have been reported individually (MWWTPs larger than 10,000 PE) in 2006. Denmark, Finland and Lithuania also reported individual MWWTPs smaller than 10,000 PE, while information for some other countries was not reported in full (Source: PLC-5. HELCOM 2011).

The given fact is in accordance with PLC-5 data stressing the percentage of population not connected to urban wastewater collection and treatment systems in project countries as 13 % (1 million inhabitants) for Sweden, 19 % (252 000 inhabitants) for Estonia, 19 % (900 000 inhabitants) for Finland, 29 % (645 000 inhabitants) for Latvia, 38 % (975 000 inhabitants) for Lithuania and 38 % (14.7 million inhabitants) for Poland.

Even though in general agriculture leads as the largest diffuse contaminator of the Baltic Sea, the efficient treatment of community wastewaters is the fastest method to improve the status of the Baltic Sea. Eutrophicating nitrogen and phosphorus can be removed from wastewaters more cheaply and quickly compared to the individual protection measures that are applied at thousands of farms, with uncertain impact.

2. Main Principles of Wastewater Treatment and Basic Information on the Wastewater Treatment Systems

Concept
This chapter will summarise findings of project output A2.1 *'User's manual'* and focus particularly on following:

- The WWT facility basically repeat natural processes
- there are only 3 different WWT technologies available
- Why so many models (for example 96 – in Latvia) are available in the market

2.1. Main Principles of Wastewater Treatment

2.1.1.1. What is wastewater

Wastewater in its very common definition is any water that has been affected by human use. That means, in fact, any water discharge, resulting from domestic, industrial, commercial, or agricultural activities. Generally, wastewater can be classified by the producers as follows:

- Residential (domestic) wastewater – comes from human and household wastes from kitchen sinks, baths, toilets, showers, laundry etc;
- Industrial (commercial) wastewater – contains toxic chemicals, highly concentrated pollutants and other wastes from industries, factories, mills etc;
- Stormwater – flows from areas such as roofs, parks, gardens, roads, and gutters into drains.

Domestic wastewater treatment is studied within the frameworks of our project.

2.1.1.2. Domestic wastewater

Domestic wastewater usually contains comparatively small amounts of contaminants, but even small amount of pollutants makes a significant impact on environment.

Traditionally domestic wastewater is categorised into blackwater and greywater. As fig. 1 shows, blackwater sources are usually do not discharge big volumes of water, but black water is heavy polluted. Greywater is substantially bigger in volume, but contamination of pollutants in greywater is not so high.

Unfortunately, this is not a tradition in partner countries to split sewage systems for greywater and blackwater, so usually the total mix of domestic wastewater is the subject of treatment.

Generally, untreated wastewater contains high levels of organic material, numerous pathogenic microorganisms, as well as nutrients and toxic compounds that can be harmful to human health, environment and waterways, hence effective treatment of wastewater is very much essential.

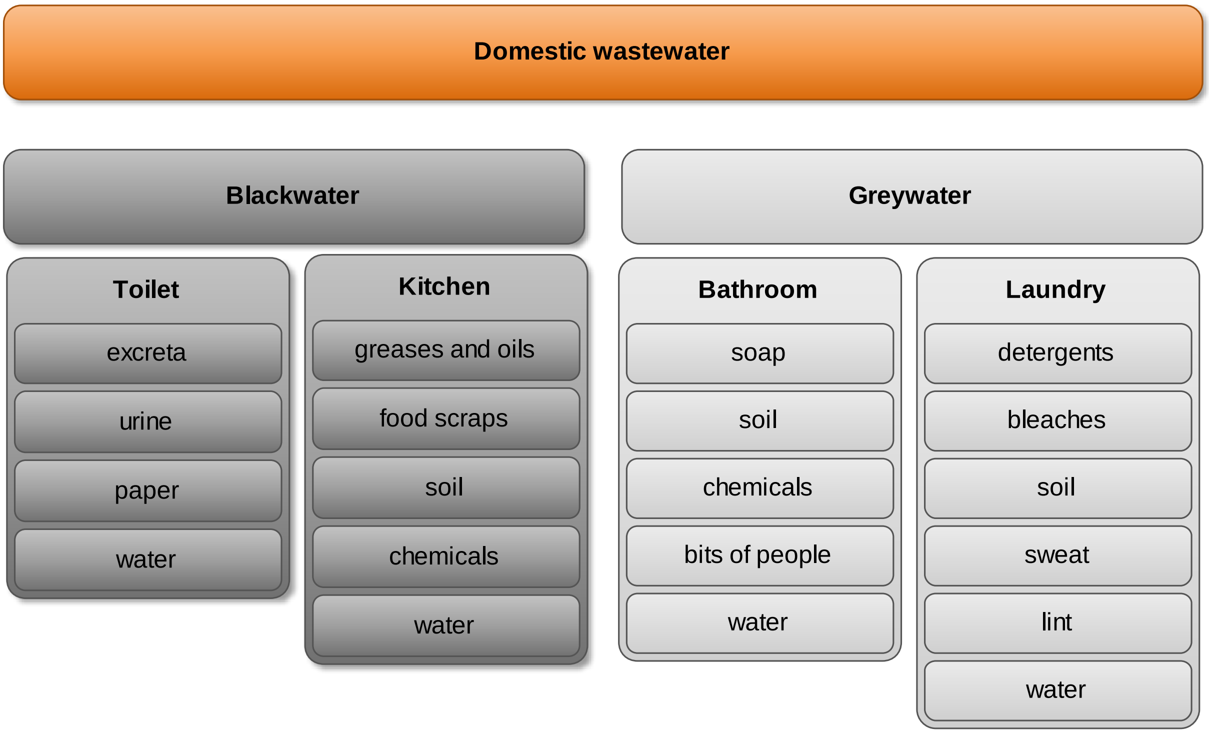

Figure 8. Categories of domestic wastewater

2.1.1.3. Domestic wastewater treatment

Domestic wastewater treatment is a process to improve the quality of household utilised water, removing some or all of the contaminants, making it suitable for reuse or discharge back to the environment. The major goal of wastewater treatment plants (henceforth referred as WWTP) is to eventually produce water that can be reused for various purposes or disposed of in a more ecological and healthy way. Wastewater treatment is a major element of water pollution control.

The investigation of domestic WWTP market in partner countries discloses two approaches to waste water treatment at household:

- wastewater treatment on site – wastewater is treated directly after it is discharged from the household;
- postponed wastewater treatment – wastewater is collected at household, sometimes is partially treated, and later is evacuated to municipal WWTP.

According to EN 12566, small domestic wastewater treatment systems (henceforth referred as SDWWTS) are WWTP for up to 50 people equivalents (henceforth referred as PE).
Principle process flow diagram for typical large-scale WWTP may be referred with an asterisk to SD WWTP as well.

The next table resumes the correlation between stage of wastewater treatment, process, and process usage in SDWWTS.

Table 1. Stage and process of domestic wastewater treatment

Stage of Treatment	Process	Usage in SDWWTS
Preliminary	Screening of large solids	Usually is not needed
	Grit removal by flow attenuation	
Primary	Settlement of suspended solids	In first chamber of septic tank In first chamber of package plants
	Skimming of grease and oil	
Secondary	Biological treatment – activated sludge	Is used in all package plants or as a separate unit
Tertiary	Postclarification	Last chamber of package plants
	Phosphorous removal	Coagulation and settlement can be used if needed Experimental constructed wetlands
	Nitrogen removal	Usually is not used, except experimental constructed wetlands
	Sand filters for excessive SS removal	Usually is not used
	UV disinfection	Usually is not used
[]	Processing of sewage sludge produced from various stages of domestic wastewater treatment process	Not used. Excessive sludge is periodically evacuated to close municipal WWTP for processing

Next table summarizes the most popular wastewater technologies and formfactors, used in the region in SDWWTP.

Table 2. Summary of the most popular wastewater technologies, used in the region in SDWWTP

Wastewater treatment on site	Postponed wastewater treatment
Septic tank	Wastewater holding tank
Package plant	
Constructed treatment wetland	
Soil filter	

2.2. Basic Information on the Wastewater Treatment Systems

2.2.1.1. Wastewater holding tank

Wastewater holding tank (henceforth referred as WWHT) is an enclosed receptacle designed to collect and temporarily store wastewater in places where the use of wastewater treatment systems is limited or impossible. Other wastewater discharge, then evacuation to close municipal WWTP, is not expected for WWHT.

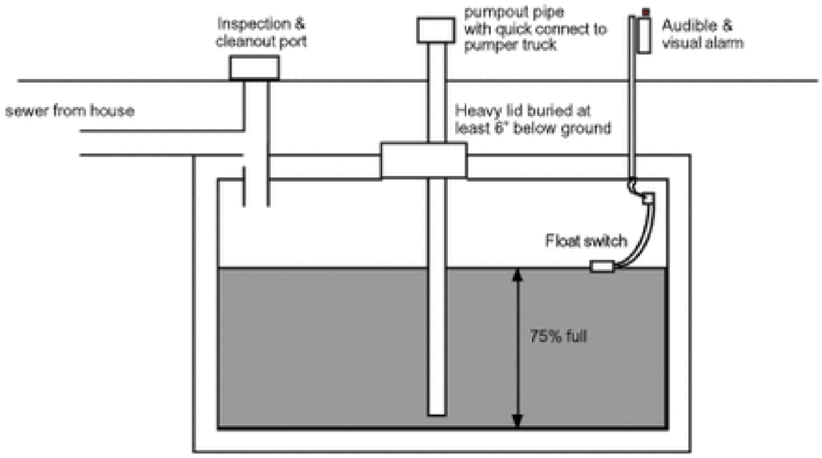

Figure 9. Wastewater holding tank with filling alarm

Wide variety of WWHT can be found on market. The sizes and shapes of WWHT depend on area of use, and can vary from small under-pod reservoir to multicubicmeter storages. Bigger tanks are usually equipped with filling alarm system.

Within the frameworks of our study chemical toilets (Portaloo, TOITOI, Honey Bucket etc) are considered as storage tanks too, since they do not have output to environment.

Cesspools could be considered as the older version of WWHT, but should not be used anymore, since classical cesspool is expected to have open non-watertight bottom.

WWHT in chemical toilet version are widely used in Latvian rural areas.

2.2.1.2. Septic tank

The septic tank is an enclosed receptacle designed to collect wastewater, segregate settleable and floatable solids (sludge and scum), accumulate, consolidate, and store solids, digest organic matter and discharge treated effluent. Septic tank provides primary wastewater treatment and may be the most important component used in all onsite treatment and collection alternatives, however, pollutants reduction coefficients of septic tanks do not allow to use it as the only step of wastewater treatment.

Besides its role in standard subsurface soil absorption systems, the pre-treatment provided by the septic tank is equally important in ensuring the success of other secondary treatment alternatives such as constructed wetlands and biological ponds. In addition, septic tank pre-treatment often precedes packaged aerobic treatment processes. Next table resumes treatment efficiency of septic tank

Table 3. Summary of Septic Tank Effluent Quality (Source: http://www.bfenvironmental.com)

Parameter	Effluent Concentration	Units	Percent Reduction
BOD_5	120 – 140	mg/l	40 – 50 %
COD	200 – 327	mg/l	60 – 70 %
Suspended Solids	39 – 155	mg/l	40 – 80 %
N_{total}	36 – 45	mg/l	0 – 50 %
P_{total}	20	mg/l	15%
Oil and Grease	20 – 25	mg/l	70 – 80 %

Septic tanks are passive low-rate anaerobic digesters, with their own ecosystem, in which facultative and anaerobic organisms perform complex biochemical processes. The tank operates as a plug-flow type of reactor (fluid and particles enter and exit the tank in progressive sequence), so there is usually no mixing or heating, particles ascend or descend, and stratification develops. Effluent quality suffers when this stratification doesn't develop. The environment within the tank's clear zone is generally anoxic, or inadequate in oxygen, while sites within the sludge and scum layers may be completely free of oxygen, or anaerobic.

Traditional septic tank contained only one compartment, however nowadays conventional septic tank consists of two compartments to avoid sludge flushing to output pipe.

The inflowing wastewater directed by the inlet fixture into the zone beneath the scum layer normally contains high levels of dissolved oxygen. The microbial population of septic tank rapidly depletes the dissolved oxygen as the flow moves towards the tank outlet.

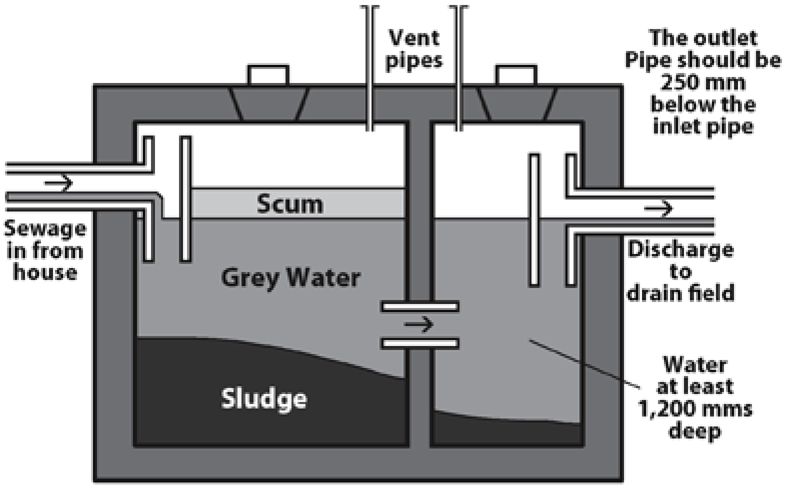

Figure 10. Typical septic tank design. (Source: https://www.mrfixitbali.com)

The microorganisms found in residential wastewater are primarily heterotrophic bacteria, which oxidize and solubilize organic matter. Facultative microbes (organisms that can function in either aerobic or anaerobic conditions) solubilize complex organic material to volatile organic acids, while strict anaerobes ferment the volatile organic acids to gases (methane, carbon dioxide, hydrogen sulphide, etc.). The microbes use the solubilized nutrients in the wastewater for cell growth and energy. These microbes are enteric, therefore, natural habitants of the wastewater, but it takes years to develop volatile organic acid and metabolite concentrations sufficient for colonization of methane formers and optimum digestion. Their population, growth and effectiveness are dependent on the characteristics of the wastewater (e.g., temperature, organic load, inorganic trash, toxic chemicals or cleaners, excessive fats, oils, grease, detergents, high hydraulic loads, etc.) as well as the sizing and design features of the tank. So, treatment efficiency is strongly dependent on permanence of influent wastewater, as well as on septic tank size – optimal retention time gives more viability to the process of treatment.

The digestion that takes place in the tank is performed predominately by bacteria. As the wastewater passes through the tank, its characteristics change, and different bacterial cultures predominate as the bacteria break down complex proteins, carbohydrates, and fats.

The sludge layer on the bottom of a septic tank includes various solids which are not dissolved in the septic effluent and which are dense enough to fall to the bottom of the tank. The septic tank bottom sludge is comprised of "settleable solids" and that portion of "suspended solids" which will, given enough time, also settle out. These accumulate at the bottom of the septic tank and should be periodically removed by sludge evacuation truck. Septic tanks can be both factory manufactured or assembled with concrete details.

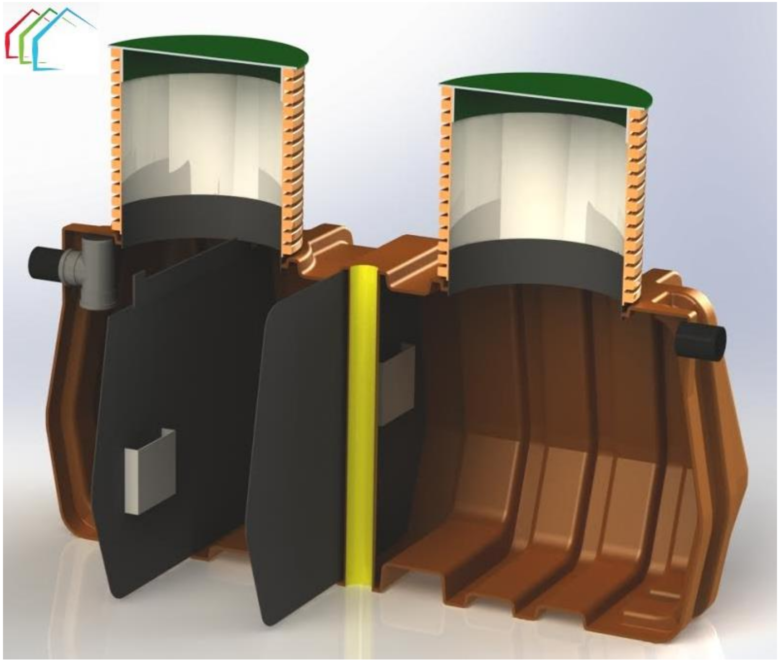

Figure 11. Factory manufactured septic tank, V=2500 l.

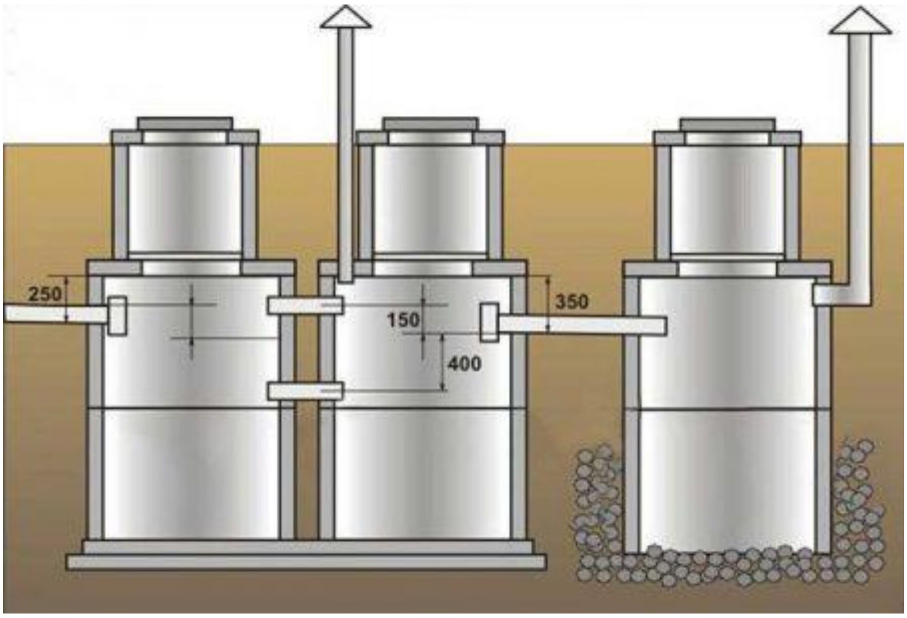

Figure 12. Septic tank and infiltration pit made of concrete rings

2.2.1.3. Package plant

Wastewater treatment package plant (henceforth referred as WWTPP) is an enclosed receptacle designed to collect wastewater, segregate settleable and floatable solids (sludge and scum), accumulate, consolidate, and store solids, digest organic matter on aerated sludge and discharge treated effluent. Package plant usually provides primary, secondary and tertiary stages of wastewater treatment and can be used as the only wastewater treatment system for a household. However, the variety of WWTPP, consisting of only primary and secondary, or even of only secondary wastewater treatment stages, are present on the market.

Table 4. Wastewater treatment stages in WWTPP

Stage of Treatment	Process	Compartment of WWTPP
Primary	Settlement of suspended solids	Primary clarifier
	Skimming of grease and oil	
Secondary	Biological treatment – activated sludge	Aerated sludge chamber
Tertiary	Postclarification	Secondary clarifier

As sewage enters a plant for treatment, it contains organic and inorganic matter along with other suspended solids. These solids can be removed from sewage in a Primary clarifier. Since the velocity of the flow through Primary clarifier is reduced, the suspended solids will gradually sink to the bottom, where they form a mass of solids called raw primary biosolids or sludge. Biosolids are usually removed from primary clarifier by sludge evacuation truck. Floating solids will float to the surface and for a scum. Primary treatment is unable to meet demands for higher discharged wastewater quality. To meet them, a secondary wastewater treatment stage is required and, in some cases, also the advanced treatment to remove nutrients and other contaminants is used.

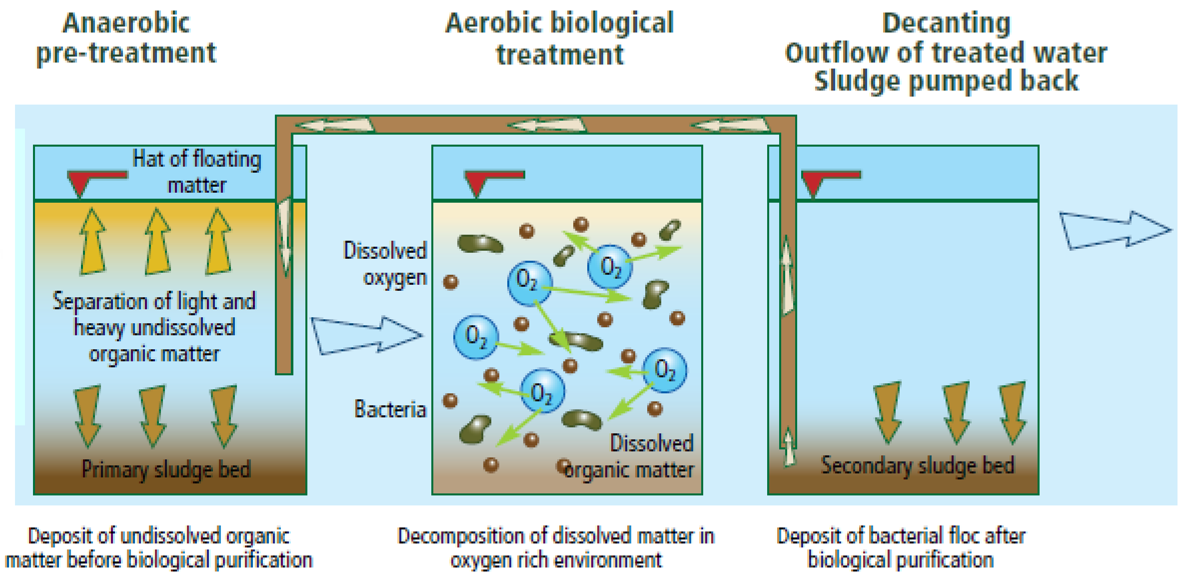

Figure 13. Conventional 3-compartment WWTPP. (Source: sotralenz.com)

The secondary stage of treatment removes about 85 percent of the organic matter in sewage by making use of the bacteria in it. The principal secondary treatment techniques used in secondary treatment are the trickling filter and the activated sludge process.

After effluent leaves the Primary clarifier it flows to a WWTPP compartment, using one or the other of these processes. A trickling filter is simply a bed of stones or other media from one to two meter deep through which sewage passes.

More recently, interlocking pieces of corrugated plastic or other synthetic media have also been used in trickling beds. Bacteria gather and multiply on these stones until they can consume most of the organic matter. The cleaner water trickles out through pipes for further treatment. From a trickling filter, the partially treated sewage flows to Secondary clarifier to settle sludge particles.

However, usage of trickling filter in today WWTPP is not popular towards the use of the activated sludge process. The activated sludge process speeds up the work of the bacteria by bringing air and sludge heavily laden with bacteria into close contact with sewage. After the sewage leaves the Primary clarifier in the primary stage, it flows into an aeration tank, where it is mixed with air and sludge loaded with bacteria and allowed to remain for several hours. During this time, the bacteria break down the organic matter into harmless by-products.

Partially treated wastewater after aeration tank or compartment of WWTPP flows to Secondary clarifier, where washed out particles of activated sludge are settled, and clarified water may be discharged to environment.

Settled in secondary clarifier sludge, now activated with additional billions of bacteria and other tiny organisms, can be used again by returning it to the aeration tank for mixing with air and new sewage.

WWTPP can be optionally equipped with additional Secondary clarifier and coagulant dosing plant to remove phosphorous. Optional UV disinfection is also available.

Conventional three-stage WWTPP is not only type for package plants.

Sequencing batch reactor (henceforth referred as SBR) is another type of WWTPP, using activated sludge process for domestic wastewater treatment. SBR process is well know in Europe and USA in the past two decades. The SBR process is an activated sludge process in which the sewage is inflows to Reaction Tank (SBR Tank), one batch at a time. Wastewater treatment is achieved by timed sequence of operations, which occur in the same SBR tank. Nest figure depicts sequence of SBR operating stages.

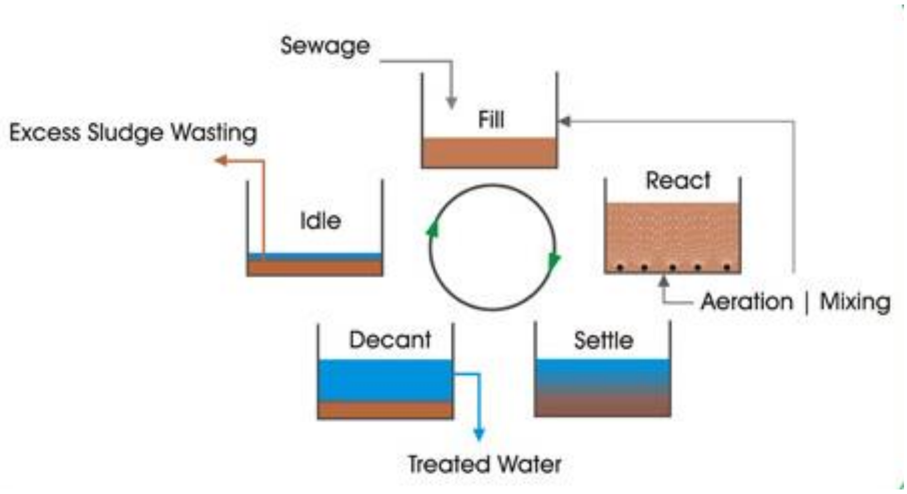

Figure 14. SBR stages of the treatment process (Source: http://camix.com)

- **Stage 1:** Filling. SBR Tank is filled with wastewater.
- **Stage 2:** Reaction. Reduction of biochemical oxygen demand (BOD) and ammonia nitrogen by bacteria in activated sludge. Aeration is ON.
- **Stage 3:** Settling. Aeration is OFF and sludge settles, leaving clear treated effluent above the sludge blanket.
- **Stage 4:** Decanting. Effluent is removed from the tank through decanter, without disturbing settled sludge.
- **Stage 5:** Idling. The SBR Tank waits until it is time to commence with new cycle of the filling stage.

Excessive sludge should be periodically evacuated to close municipal WWTP. During SBR process stages 1–5 SBR Tank acts as the equivalent of several compartments of conventional activated sludge process, described above:

- Aeration tank: the SBR Tank acts as aeration tank during reaction stage where activated sludge is mixed with influent wastewater under aeration conditions.
- Secondary Clarifier: the SBR Tank acts as secondary clarifier during settling and decanting stages where mixed liquor is allowed to settle under quiescent conditions, and the overflow id discharged.
- Sludge Return System: the activated sludge, following settling in the SBR Tank, is mixed with the influent similar to the sludge return system, except that feed is transferred to the sludge, rather then sludge returned to feed.

Figure 15. SBR type WWTPP (Source: Roth Umwelttecknik)

Manufacturers supply both twin SBR and single SBR WWTPP. Single SBR ignores idle stage, since it is working on one day cycle basis. Independent on type of activated sludge system, the aeration compressor is always a part of the process equipment.

2.2.1.4. Natural treatment systems

Natural technologies of wastewater treatment use modified natural self-treatment processes that take place in the ground soil, water and wetland environment. The next table contains natural treatment systems classified according to the treatment technology and general arrangement.

Table 5. Use of Natural technologies of Treatment (only suitable for Baltic climate are mentioned)

Type	Possibilities of the use in SDWWTP
Constructed treatment wetland	
Vertical flow downwards	Low flow sewage treatment; Polishing after septic tank discharge
Soil (ground) filters	
Vertical flow without vegetation	Polishing after septic tank discharge
Horizontal flow without vegetation	
Stabilization ponds	
Aerobic low-loaded	Polishing after conventional WWTP

Natural treatment methods are mainly used for wastewater treatment from decentralized houses, small settlements, dwelling, hotels, recreational facilities, restaurants and summer camps, smaller municipalities or their parts. Wastewater with high organic content and high load of fats, oils, oil derivatives, are without pre-treatment (treatment) inappropriate to unusable for natural technologies of treatment.

The advantages of natural treatment methods lie mainly in the natural character of the sewage facility, the possibility of its inclusion in a favourable environment, in relatively simple technological implementation, lower operating costs, investment costs comparable with conventional wastewater treatment plant, low energy consumption, possibilities of being overload by ballast water, the possibility of short-term and long-term shutdown, relatively rapid incorporation of the treatment process and achievement of the performance efficiency quality target in a short period of time after the start of operation, removal of the part of nutrients, especially nitrogen and phosphorus by biomass uptake, treatment of organically low-loaded wastewater that cannot be treated by conventional methods (treatment plants based on sludge activation processes)[2].

A certain disadvantage is the relatively high area, low efficiency in removing ammonia nitrogen in classic simple arrangement in the anaerobic filtration environment of constructed treatment wetland. Since most of the enumerated natural technologies are based on wastewater distribution though rather thin pipes, proper mechanical pre-treatment should be provided.

2.2.1.5. Vertical Flow Constructed Treatment Wetlands

Constructed treatment wetlands (henceforth referred as CTW) are natural wastewater technologies. They are constructed filtration systems planted with wetland vegetation (most often reed) with defined filter material and direction of wastewater flow. The basic principle of this method of cleaning is the flow of wastewater through the filtration system, which is planted with wetland vegetation. Filter material must be permeable enough to avoid clogging and subsequent surface flow.

When the wastewater passes through the material, the treatment occurs, carried out by the complex intertwining of chemical, physical, and biological processes. The water flows through the filter vertically at the constructed wetland wastewater treatment plant. Schematic cuts through individual variants of constructed wetlands show the Figure 9.

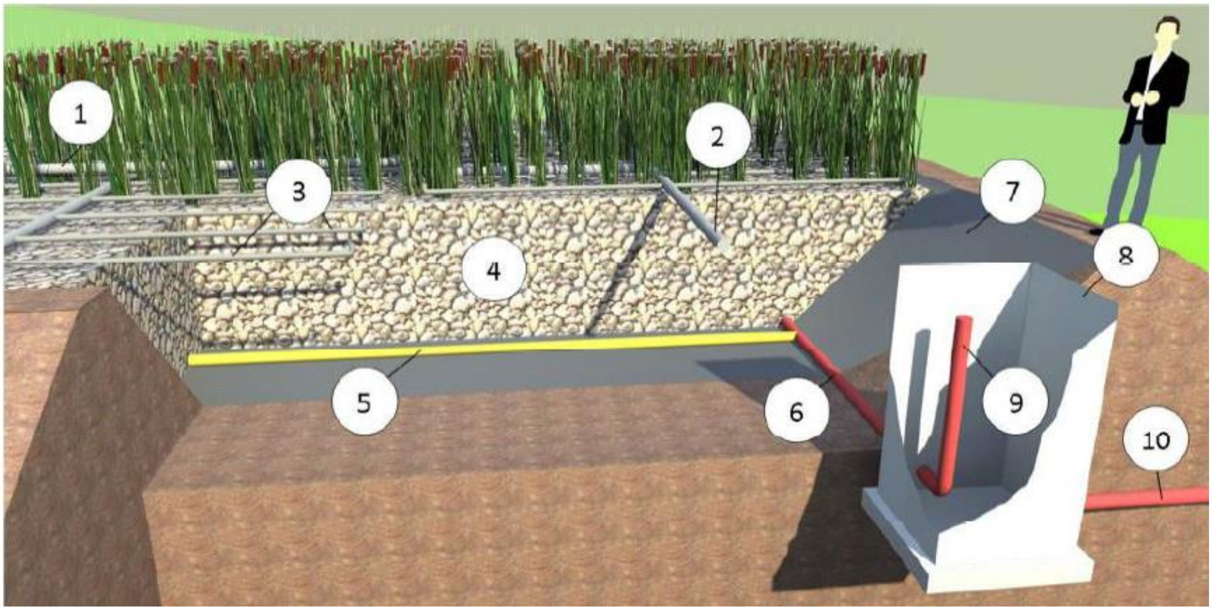

Figure 16. Side view of a Vertical Flow Filter with Wetland Vegetation. 1-inflow pipe, 2-distribution pipe, 3-more detailed distribution pipe system, 4-main filter material 5-collection pipe system, 6-collection main pipe, 7-lining, 8-inspection shaft, 9- Regulation pipe, 10-outflow pipe (Source: http://www.gwp.org)

Constructed treatment wetlands (also called „reed beds“) represent a biological treatment stage (secondary and/or tertiary) of wastewater treatment plants. It is based on slow filtration of pre-treated wastewater. It may also be used for tertiary treatment of effluent from WWTP with activated

[2] Miloš Rozkošný, Michal Kriška, Jan Šálek, Igor Bodík, Darja Istenič. Natural Technologies of Wastewater Treatment. Global Water Partnership Central and Eastern Europe, 2014. http://www.gwp.org/globalassets/global/gwp-cee_files/regional/natural-treatment.pdf

sludge process. Type of constructed wetland treating raw wastewater (without sedimentation pre-treatment) also exist (so called French system), however they operate in a different mode and are not popular in Baltics.

2.2.1.6. Soil filters

Soil filters are technological devices belonging, like as constructed wetland wastewater treatment plants and waste stabilization ponds, to the group of natural technologies of water treatment. Like the other devices, they can be divided into filters with vertical, horizontal and radial flow, but soil filters are without vegetation, often realized in underground. From terrain you can see only revision pipes that protrude from the grass or another terrain finish. The combination of these filters rarely occurs. It is necessary to ensure that the flow of treated wastewater is uniform throughout the whole filtration process. The advantages of soil filters include the organic character of the device, the possibilities of favourable integration into the environment, a simple technological design, relatively low investment and operating costs, minimal energy needs, possibilities of binge overload, relatively good treatment effect from the beginning of the operation, the ability to short-term and long-term shutdown, and treatment of organically low-loaded wastewater that cannot be cleaned with the usage of other intensive methods such as activation dry treatment. The disadvantages of soil filters include clogging, less effect on ammonia removal and relatively large surface intensity[3]. The Figure 10 depicts vertical flow unsaturated filtration of soil filter.

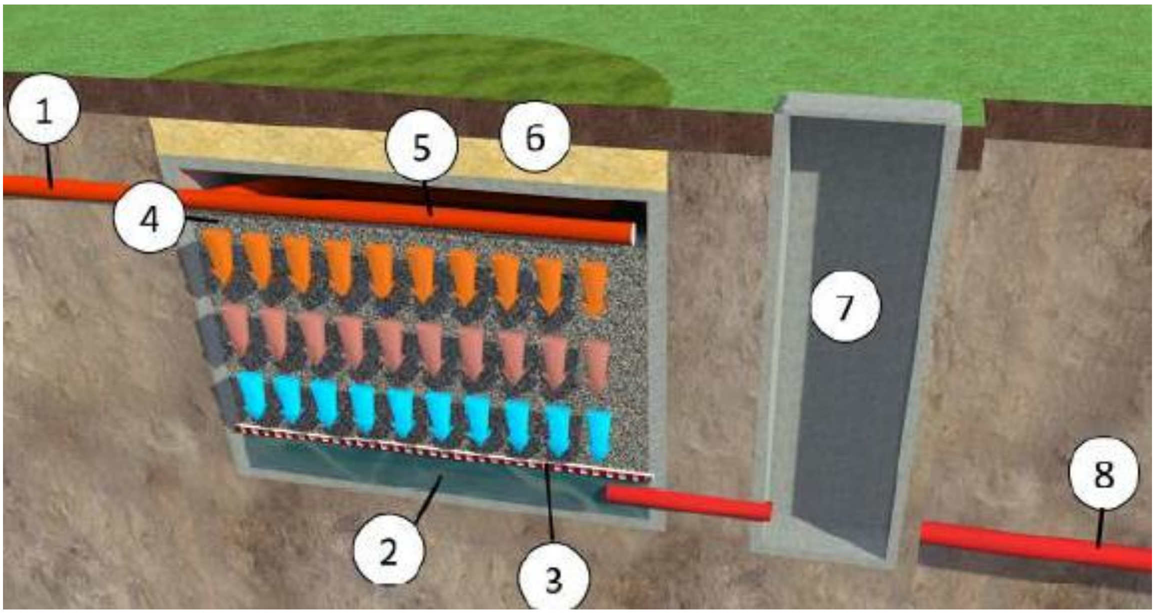

Figure 17. Vertical flow in unsaturated filtration environment downwards, even distribution of flow across the filter surface, sampling the filtered water from the bottom (1 – inlet, 2 – collecting space under the soil filter, 3 – fixed sieve of resistant material, 4 – filtration material, 5 – distribution pipe, 6 – initial backfill sand or clay, 7 – control shaft, 8 – drain) (Source: http://www.gwp.org)

In case of soil filter with vertical flow in saturated filtration environment, upwards soil frost zone should be taken in account (0.8–1.2 m).

2.2.1.7. Infiltration field

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[3] Miloš Rozkošný, Michal Kriška, Jan Šálek, Igor Bodík, Darja Istenič. Natural Technologies of Wastewater Treatment. Global Water Partnership Central and Eastern Europe, 2014. http://www.gwp.org/globalassets/global/gwp-cee_files/regional/natural-treatment.pdf

The traditional infiltration field, also known as leach field, is a system of perforated pipes, laid within a gravel layer under soil frost zone. Effluent trickles out of the pipes, through the gravel layer, and into the soil where further treatment occurs. The water trickles out of the pipes, through the gravel layer and then soaks into the ground.

Next figure depict the conventional design of infiltration field.

Figure 18. Traditional infiltration field under construction. (Source: www.koberlein.com)

Modern infiltration fields consist of infiltration tunnels in spite of perforated pipes, and such type of design substantially reduces installation and earth works.

Figure 19. Modern infiltration fields consisting of infiltration tunnels (Source: http://www.graf-water.com)

Infiltration field is not advised to use as a stage of wastewater treatment, since the result is not easy to control. It is mostly used for treated wastewater discharge after SDWWTP or septic tanks.

The suction velocity is strongly dependant on the type of soil, so the area of infiltration field should be designed individually. Not suitable for the regions with high level of groundwater.

3. How costs of Wastewater Treatment are incurred

Costs of wastewater treatment consist of the following parts:

- Investment costs;
- Operating costs;
- Maintenance costs.

Since SDWWTS it is not expected to gain any kind of income and profit, total costs should be calculated without discounting coefficients. The proposed way of calculation of total costs is valid in assumption that investments are made without any kind of loans, using own assets of customer.

3.1. Investment costs

The structure of SDWWTS investment costs is given in the next table.

Table 6. The structure of SDWWTS investment costs

No.	Costs description
1	Equipment cost
2	Construction costs
3	Start-up costs
4	Delivery costs

3.1.1.1. Equipment costs

Equipment costs usually includes all costs for SDWWTS set: reservoir, ventilation pipes, inspection manholes, aeration compressors, aeration system, internal pipework.

Multiple equipment units may be included for one system if necessary. Next table contains most possible equipment units to be added and use cases for them.

Table 7. most possible equipment units to be added to SDWWTS

Additional equipment	Use case
Septic tank	Pre-treatment stage for single activated sludge unit
Constructed wetland	Polishing after septic tank or SDWWTS
Dosing pump	Additional phosphorous removal
Retention and clarification unit	Additional phosphorous removal
Sewage pump or pumping station	The terrain of a land parcel does not allow to establish gravity sewage pipelines
Infiltration pipes or tunnels	Discharge to infiltration field is designed

Most commonly, the unit of measure is € per unit of equipment.

3.1.1.2. Construction costs

Construction costs include Design costs, Construction material costs, Construction work costs, Construction supervision costs

3.1.1.3. Design costs

This parameter is country specific, but for example it is not allowed in Latvia to perform any excavation works deeper then 30 cm without Building Permission and Construction Design. The amount is substantial comparing to equipment costs and can reach 1000 € - 2000 € per one set of design papers.

The unit of measure is € per set of design papers.

3.1.1.4. Construction material costs

All materials, except enumerated in subparagraph "Equipment costs", which are necessary to perform installation and start-up of SDWWTS, should be included in this parameter.

The list of most used materials for construction of SDWWTS is given in the next table.

Table 8. The list of most used materials for construction of SDWWTS

No.	Material	Units of measure	Comments and indications
1	Sewage pipes	€ / m	Multiply by the sum of distances from home to equipment, and from equipment to discharge point
2	Power supply cable	€ / m	Multiply by the distance from home to equipment or from power distribution board to equipment
3	Protective pipe for power supply cable	€ / m	Multiply by the distance from home to equipment or from power distribution board to equipment
4	Sewer manhole	€ / unit	Should be aggregated, if multiple units selected
5	Sand	€ / m^3	Estimation for sand bed volume see below in this subparagraph Not needed if concrete base plate is used
6	Concrete base	€ / unit	Estimation for concrete base dimensions see below in this subparagraph Not needed if no special indications from Manufacturer
7	Accessories for infiltration field	€ / set	Usually only one needed, consists of distribution manhole, ventilation pipe and some Tees depending on quantity of branches

No.	Material	Units of measure	Comments and indications
8	Gravel	€ / m^3	Estimation for gravel bed volume see below in this subparagraph For infiltration fields
9	Geotextile	€ / m^2	Estimation for geotextile area see below in this subparagraph For infiltration fields

The length and path of sewage pipe line from home to equipment and from equipment to discharge point is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by the pipe length. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

The length and path of cable line and cable protective pipe from home to equipment or from distribution board to equipment is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by the cable and protective pipe length. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

The quantity and placement of sewer manholes is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by quantity of sewer manholes. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

Sand volume in the sand bed for WWTP should be estimated as follows:

$V_{sand} = (L_{WWTP} + 1 \text{ meter}) \times (W_{WWTP} + 1 \text{ meter}) \times 0.2$ [m^3]

Sand volume in the sand backfilling for infiltration field, made of pipes, should be estimated as follows:

$V_{sand} = (L_{pipe}) \times 0.3$ [m^3]

Sand volume in the sand backfilling for infiltration field, made of tunnels, should be estimated as follows:

$V_{sand} = (L_{tunnel}) \times (W_{tunnel}) \times (H_{tunnel}) \times 1.2$ [m^3]

The height of concrete base should be taken 0.25 m

The area of concrete base can be calculated in the following way:

$S_{concretebase} = (L_{WWTP} + 0.4 \text{ meter}) \times (W_{WWTP} + 0.4 \text{ meter})$ [m^2]

Gravel volume in the gravel bed for infiltration field, made of pipes, should be estimated as follows:

$V_{gravel} = (L_{pipe}) \times 1.3$ [m^3]

Gravel volume in the gravel bed for infiltration field, made of tunnels, should be estimated as follows:

$V_{gravel} = (L_{tunnel}) \times (W_{tunnel}) \times 0.72$ [m^3]

Geotextile area in the sand backfilling for infiltration field, made of pipes, should be estimated as follows:

$S_{geotex} = (L_{pipe})$ [m²]

Geotextile area in the sand backfilling for infiltration field, made of tunnels, should be estimated as follows:

$S_{geotex} = (L_{tunnel}) \times (W_{tunnel}) \times 3.6$ [m²]

The total of all above position gives construction material component of Construction costs.

Many construction companies do not provide construction material costs as estimated, but offer total price for installation materials. The price offer should be stated as construction material component of Construction costs in this case.

Probably, some 10% should be added to final amount to compensate unmentioned auxiliary materials.

3.1.1.5. Construction work costs

The scope of works necessary to prepare SDWWTS for putting in operation are included in this parameter.

The list of the most necessary works for construction of SDWWTS is given in the next table.

Table 9. The list of the most necessary works for construction of SDWWTS

No.	Material	Units of measure	Comments and indications
1	Laying of Sewage pipes	€ / m	Multiply by the sum of distances from home to SDWWTS, and from SDWWTS to discharge point
2	Laying Power supply cable	€ / m	Multiply by the distance from home to SDWWTS or from power distribution board to SDWWTS
3	Installation of Sewer manhole	€ / unit	Should be aggregated, if multiple units selected
4	Excavation of construction pit	€ / m³	Estimation for volume of excavation pit see below in this subparagraph
5	Installation of concrete base	€ / unit	Not needed if no special indications from Manufacturer
6	Installation of equipment units	€ / unit	
7	Backfilling of construction pit	€ / m³	Estimation for volume of backfilling of construction pit see below in this subparagraph
8	Excavation of trenches or pit for infiltration field	€ / m³	Estimation for volume of excavation see below in this subparagraph
9	Laying of infiltration pipes	€ / m	Estimation for the length of infiltration pipes see below in this subparagraph For infiltration fields
10	Laying of gravel bed	€ / m²	Estimation for gravel bed area see below in this subparagraph

No.	Material	Units of measure	Comments and indications
			For infiltration fields
11	Laying of geotextile	€ / m²	Estimation for geotextile area see below in this subparagraph For infiltration fields
12	Backfilling of infiltration trenches or pit	€ / m³	Estimation for volume of excavation see below in this subparagraph

The length and path of sewage pipe line from home to equipment and from equipment to discharge point is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by the pipe length. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

The length and path of cable line and cable protective pipe from home to equipment or from distribution board to equipment is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by the cable and protective pipe length. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

The quantity and placement of sewer manholes is a subject of design works, this parameter is strongly customer specific. We exclude this parameter from cost evaluation model since specific SDWWTS equipment costs are not affected by quantity of sewer manholes. *However, for more precise estimation of initial investments additional Customer inputs of this parameter may be included in Information Tool.*

The volume of excavation pit for the equipment should be estimated as follows:

$V_{ex.pit} = (L_{WWTP} + 1 \text{ meter}) \times (W_{WWTP} + 1 \text{ meter}) \times (H_{WWTP} + \text{soil frost depth} + 0.2 \text{ meter})\ [m^3]$

Note: soil frost depth, or soil frost zone is specific to region and soil type, and can vary form 0.8 to 2.0 meters in Baltics. The less soil frost zone is for clay and clay loam, the deepest is for very coarse soil. Special checks are necessary for the northern regions of Finland.

The backfilling volume of excavation pit for the equipment can be estimated same way, as excavation volume, to simplify calculations. We keep in mind, sand bed forming or concrete base plate installation costs, same as equipment installation to the pit are included in this position.

Excavation pit volume for infiltration field, made of pipes, should be estimated as follows:

$V_{ex.pit} = (L_{pipe}) \times (\text{soil frost depth} + 1 \text{ meter})\ [m^3]$

Excavation pit volume for infiltration field, made of tunnels, should be estimated as follows:

$V_{ex.pit} = (L_{tunnel}) \times (W_{tunnel}) \times (H_{tunnel} + \text{soil frost depth} + 0.2 \text{ meter})\ [m^3]$

Area of the gravel bed for infiltration field, made of pipes, should be estimated as follows:

$S_{gravel\ bed} = (L_{pipe}) \times\ [m^2]$

Area of the gravel bed for infiltration field, made of tunnels, should be estimated as follows:

$S_{gravel\ bed} = (L_{tunnel}) \times (W_{tunnel}) \times 1.4\ [m^2]$

Geotextile area for infiltration field, made of pipes, should be estimated as follows:

$S_{geotex} = (L_{pipe})\ [m^2]$

Geotextile area for infiltration field, made of tunnels, should be estimated as follows:

$S_{geotex} = (L_{tunnel}) \times (W_{tunnel}) \times 3.6$ [m²]

The backfilling volume of infiltration trenches or pit can be estimated same way, as excavation volume, to simplify calculations. We keep in mind, sand bed forming and installation of drain pipes or tunnels are included in this position.

The total of all above position gives construction material component of Construction work costs.

Many construction companies do not provide construction work costs estimated, but offer total price for installation materials. The price offer should be stated as construction work component of Construction costs in this case.

3.1.1.6. Construction supervision costs

Most construction companies include costs of supervision of construction works by default. Third party supervisor is normally not needed.

3.1.1.7. Start-up costs

Start-up of SDWWTS is usually performed by vendor. The list of components of start-up costs is given in the next table.

Table 10. The list of components of start-up costs

No.	Component	Units of measure	Comments and indications
1	Transportation costs	€ / km	Dependant on vendor address. Distance between vendor and customer should be doubled for cost calculation. Usually price per kilometre is provided by start-up company.
2	Start-up engineer work	€ / unit	
3	Initial bacteria seeding material	€ / set	Not all models of equipment need it.
4	Initial set of chemicals for dosing	€ / set	Mostly for phosphorous additional removal.

3.1.1.8. Delivery costs

Delivery costs are affected by the geographical placement of vendor against customer. Delivery costs may take considerable share of investment costs and effect on choice of vendor.

The structure of delivery costs is given in the next table.

Table 11. Structure of delivery costs

No.	Component	Units of measure	Comments and indications
1	Equipment delivery	€ / km	Dependant on vendor address. Distance between vendor and customer should be doubled for cost calculation.
2	Delivery of materials	€ / km	Dependant on material seller address. Distance between seller and customer should be doubled for cost calculation.

Equipment delivery may be performed generally in three ways:

- Equipment delivery by vendor – price per km is given by vendor;
- Delivery by forwarder – price per km can be found by surveying of local forwarders;
- Delivery by customer transport – average fuel price and consumption are available in statistical databases.

Installation materials are usually available in any building supplies store, so this position is excluded from delivery costs calculation.

3.2. Operating costs

The structure of SDWWTS operating costs is given in the next table.

Table 12. The structure of SDWWTS operating costs

No.	Costs description
1	Electrical power consumption
2	Consumption of chemicals
3	Bacteria seeds

Operating costs are important factor for SDWWTS technology and model selection.

Since customer usually gains an income monthly, total amount of operating costs should be reduced to monthly values to simplify understanding of cash flow for customer.

3.2.1.1. Electrical power consumption

Annual power consumption is available from equipment data sheet. Usually is not dependant on load, but only on compressor model used for aeration.

Given annual power consumption should be multiplied by average kWh price for each country from EUROSTAT database to result annual cost of electrical power for wastewater treatment.

3.2.1.2. Consumption of chemicals

Chemicals are mostly used to coagulate phosphates in SDWWTS. Chemicals dosing necessity and dose is indicated in equipment data sheet.

Wastewater flow and volume measurement is not obligatory for SDWWTS capacity up to 5 m^3/day, that is equal to 25 PE. So, SDWWTS up to 25 PE should calculate chemicals consumption on instant rate.

Sites, bigger then 25 PE should be equipped with flow and volume registration device, so chemical consumption should be calculated as gram of reagent per cubic meter.

3.2.1.3. Bacteria seeds

Regular bacteria seeding is usually advised only for septic tanks. Frequency of seeding and prices are available at vendor.

3.3. Maintenance costs

The structure of SDWWTS maintenance costs is given in the next table.

Table 13. The structure of SDWWTS maintenance costs

No.	Costs description
1	Service maintenance
2	Evacuation of excessive sludge

3.3.1.1. Service maintenance

Necessity of regular service maintenance is indicated in equipment data sheet. The list of components of service maintenance costs is given in the next table.

Table 14. The list of components of service maintenance costs

No.	Component	Units of measure	Comments and indications
1	Transportation costs	€ / km	Dependant on vendor address. Distance between vendor and customer should be doubled for cost calculation. Usually price per kilometre is provided by vendor.
2	Service technician work	€ / unit	

As we can see, service costs are also dependent on geographical placement of vendor against customer.

3.3.1.2. Evacuation of excessive sludge

Approximate annually produced volume of sludge and frequency of sludge evacuation is indicated in equipment data sheet. This procedure is usually performed once or twice per year.

The list of components of sludge evacuation costs is given in the next table.

Table 15. The list of components of sludge evacuation maintenance costs

No.	Component	Units of measure	Comments and indications
1	Transportation costs	€ / km	Dependant on customer and sludge recipient addresses
2	Sludge pumping	€ / m^3	Usually given by sludge evacuator company

Correct definition of transportation costs is an open issue.

REMARKS: Additional studying of addresses of sludge accepting companies is required.

4. How to select and buy appropriate technology

The following aspects at least are taken in account while selecting wastewater treatment technology:

- Technical aspect;
- Economy aspect;
- Environmental aspect.

4.1. Technical aspect

Technical aspect incorporates all inputs, which defines the operation of WWTP. The following most important inputs should be studied:

- hydraulic intake (hydraulic load);
- degree of contamination in the wastewater (biological load);
- treatment requirements;
- level of subterranean water
- available area under construction.

4.1.1.1. Hydraulic intake

Hydraulic intake is referred to two parameters:

- Daily discharge from customer – important to calculate bioreactor volume or CTW area;
- Maximum momentary discharge from customer – effects on clarifier sizing.

There are two ways to estimate daily discharge:

- Take potable water readings;
- Estimate 200 l/day/inhabitant/

Maximum momentary discharge depends on quantity of sanitary and other water using equipment, installed on site. This parameter can be calculated at any water supply designing company or using free online or downloadable calculators.

4.1.1.2. Degree of contamination in the wastewater

The most important contaminants of domestic wastewater are listed in the next table:

Table 16. Contaminants of domestic wastewater

#	Contaminant	Units of measure
1	BOD_5 – Biochemical Oxygen Demand Represents the concentration of biodegradable organic components	mg O_2/l
2	COD – Chemical Oxygen Demand Represents the total concentration of organic matter	mg O_2/l
3	SS – Suspended solids Represents the concentration of small solid particles which remain in suspension in water as a colloid or due to the motion of the water	mg/l
4	N_{total} – Total Nitrogen Measures the total concentration of organically bound nitrogen, ammonium nitrogen, and nitrate and nitrite nitrogen	mg/l
5	P_{total} – Total Phosphorous Measures the total concentration of all forms of phosphorous (orthophosphate, condensed phosphate and organic phosphate)	mg/l

There are two ways to estimate daily rate of contaminants:

- Make wastewater analyse, if available;
- Estimate specific loads per person.

Specific load of contaminants per person is defined by national legislation, example figures are listed in the next table.

Table 17. Specific load of contaminants per person in Latvia (Source: https://likumi.lv/ta/id/274990-noteikumi-par-latvijas-buvnormativu-lbn-223-15-kanalizacijas-buves-)

Contaminant	Specific load of contaminant per 1 person (kg/day)
BOD_5	0.07
COD	0.06
SS	0.11
N_{total}	0.01
P_{total}	0.002

REM: It is useful to have same data from other partner countries to include them to short prospect and use them in SelectionTool. It might be useful also to place on public pages of the project links to appropriate National Legislation page.

4.1.1.3. Treatment requirements

Treatment requirements are defined by national legislations and are issued by Regional Environmental Board or equivalent institution. Usually strictness of these requirement depend of population volume in the agglomeration, customer lives in.

The list of restricting parameters for wastewater discharge in Latvia is given in the next table.

Table 18. The list of restricting parameters for wastewater discharge in Latvia (Source: https://likumi.lv/doc.php?id=58276)

Parameter	PE in agglomeration	Maximum concentration limit	Percent of reduction referred to intake
BOD_5	< 200	Adequate treatment	–
	200 – 2000	Adequate treatment	50 – 70
	2000 – 10 000	25 mg/l	70 – 90
	> 10 000	25 mg/l	70 – 90
COD	< 200	Adequate treatment	–
	200 – 2000	Adequate treatment	50 – 70
	2000 – 10 000	125 mg/l	75
	> 10 000	125 mg/l	75
Suspended solids	< 10 000	< 35 mg/l	90
	≥ 10 000	< 35 mg/l	90
P_{total}	< 2000	Adequate treatment	–
	2000 – 10 000	Adequate treatment	10–15
	10 000 – 100 000	2 mg/l	80
	> 100 000	1 mg/l	80
N_{total}	< 2000	Adequate treatment	–
	2000 – 10 000	Adequate treatment	10–15
	10 000 – 100 000	15 mg/l	70–80
	> 100 000	10 mg/l	70–80

REMARKS: It is useful to have same data from other partner countries to include them to short prospect and use them in SelectionTool. It might be useful also to place on public pages of the project links to appropriate National Legislation page.

4.1.1.4. Level of subterranean water

Level of subterranean water affects equipment formfactor and usable technologies. Usually WWTP equipment should be installed above this level. Some manufacturers allow to install their WWTP partially below subterranean water level, but additionally fastened to concrete loads.

4.1.1.5. Available area under construction

Available area of construction and available haul road should be checked.

Area of construction effects on dimensions of equipment. Haul roads are necessary both for construction and later maintenance of WWTP, for example – for sludge evacuation truck access.

4.2. Economy aspect

As it is already stated in Clause 6, costs of wastewater treatment consist of the following parts:

- Investment costs;
- Operating costs;
- Maintenance costs.

Since private customer usually gains an income on monthly base, it is important to prepare for him cashflow list, based on costs of wastewater treatment and declared life term of the product. According to “Guide to Cost-Benefit Analysis of Investment Projects”, lifetime of wastewater transportation and treatment system is stated as 30 years.

REM: It might be useful to develop additional module to SelectionTool, which could produce cashflows for both immediate purchase and purchasing on bank loan. It could be something like provisional cashflow calculation as many internet shops provide to their customers.

4.3. Environmental aspect

Environmental aspect evaluates the effect of life cycle of WWTP on the following factors:

- Greenhouse effect factors;
- Eutrophication factors.

Environmental aspect undercovers the environmental impact of the following components of WWTP construction, operating and maintenance. WWTP life cycle components effects on environmental factors are listed in the next table.

Table 19. WWTP life cycle components effects on environmental factors

Life cycle component	Subcomponent	Factor effected
Construction	Excavation/backfilling	Greenhouse effect
	Materials	Greenhouse effect
Delivery	of WWTP equipment	Greenhouse effect
	of materials	Greenhouse effect
Operation	Power consumption	Greenhouse effect
	Residual contaminants	Eutrophication
Maintenance	Service works	Greenhouse effect
	Sludge evacuation	Greenhouse effect

Environmental aspect targets mostly Policy Makers and State Environmental Authorities rather then Water Services providers and Producers of wastewater.

SelectingTool should be powerful assistant to all target groups in fulfilling of their aims.

4.4. Weighting of the aspects

Obviously, weighting of WWTP selecting aspects is different for Producers and Water Services Provider or for Policy makers and State Environmental Authorities.

REMARKS: Weighting coefficients are under development. Latvian partner – LU – plans to perform an evaluation survey among Construction and Household Exhibotion MĀJA I 2018 in Riga.

5. Main target groups

5.1. Main target groups related to wastewater treatment in scattered dwelling areas

There are 4 main target groups related to wastewater treatment in scattered dwelling areas:

- Producer of Wastewater;
- Water Services Provider;
- Environmental Authorities; and
- Policy Makers (Fig. 20).

When planning for either communication on wastewater treatment solutions in general or particularly on the *Information Tool*, which is the main output of VillageWaters project, all beneficiaries and stakeholders of particular **target group** have to be approached according to each one specifism.

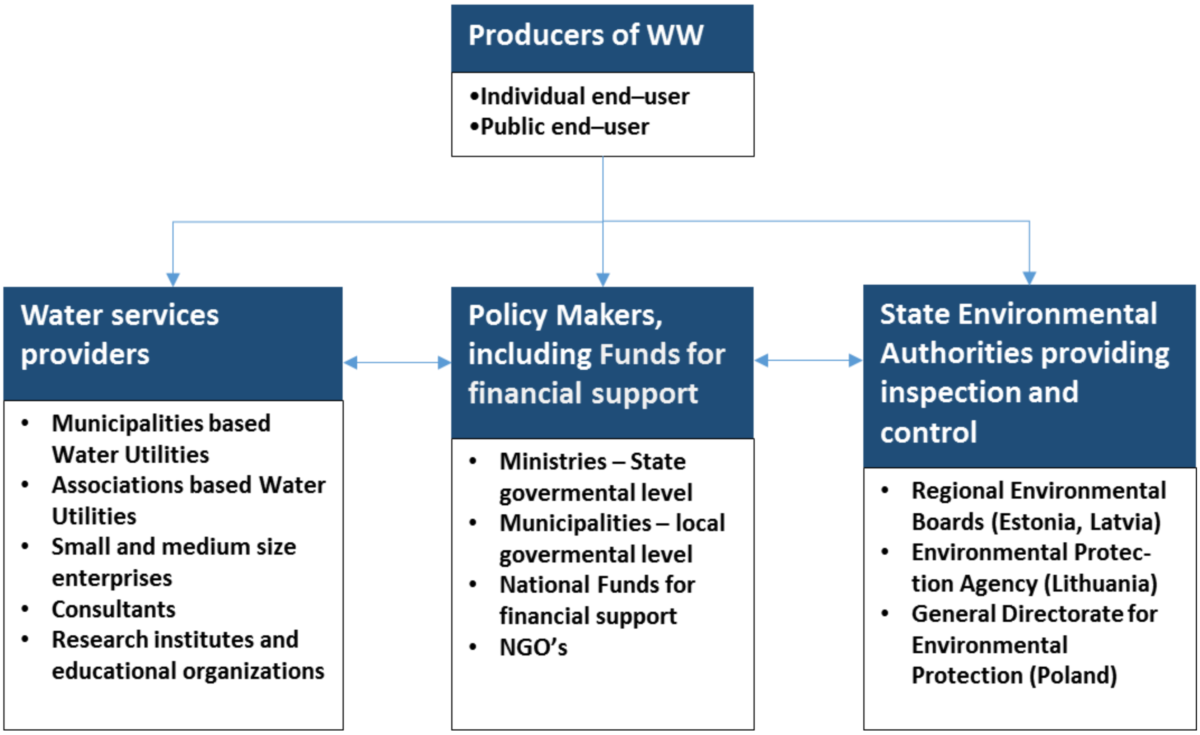

Figure 20. The main target groups related to wastewater treatment in scattered dwelling areas

5.1.1.1. Producer of Wastewater

The main target group and user of the *Information Tool* is wastewater producer, which in case of scattered dwelling areas is the **population** not connected to urban wastewater collection and treatment systems, which constitutes of individual (house owners and inhabitants) and public end-users, such as schools, kindergartens, hospitals etc.

According to PLC-5 (HELCOM, Fifth Baltic Sea Pollution Load Compilation) data the percentage of population not connected to urban wastewater collection and treatment systems in project counties are following: Finland – 19%, Estonia – 19%, Latvia – 29%, Lithuania – 38% and Poland – 38%.

From the EU policy point of view, the project target areas are:

- Scattered dwellings of big agglomerations (> 2000 PE), i.e. the last 10-5% of population not connected to the urban wastewater collection and treatment systems due to very high construction costs; and
- Small agglomerations (< 2000 PE) without centralized treatment systems or with limited urban wastewater collection systems.

The beneficiaries of the target group – Producers of WW, are summarized in Table 20. Table describes given main target group and the rationales of the *Information Tool* usage.

Table 20. The rationale of the Information Tool usage for the main target group - Producers of WW.

Beneficiary (Who?)	Rationale of use (For what?)
Producers of WW	**Individual** (households) and **public** (schools, kindergartens, hospitals etc.) **end-users** could use the *Information Tool* to identify environmental friendly and cost effective solutions for the wastewater treatment. For them the *Tool* will give a relevant information basis for the dialogues with Municipal and Environmental authorities. When the authorities also have access to the *Tool*, it makes the dialogue and the decision making process easier and ensures that best available solution for wastewater treatment is selected.

5.1.1.2. Water Services Provider

The *Information Tool* will be useful for **water services providers** which depending of existing institutional structure and responsibilities set by legislation of project country are the first advisory authority where to obtain information on wastewater treatment solutions.

The structure of given target group is country specific. The responsibilities either for development of centralized or decentralized wastewater services depend on national legislation specifism. In certain project countries, for example in Latvia, Municipalities are responsible for providing water services for municipal inhabitants as it is their statutory duty. Therefore, water utilities could be either Municipalities or Associations based.

The stakeholders of given main target group are summarized in Table 21. Table describes main target group and the rationales of the *Information Tool* usage by giving a general view on the beneficiaries. An overview of the country specific stakeholders representing public or private sector is done in Table 22.

Table 21. The rationale of the Information Tool usage for the main target group – Water services providers and advisors.

Stakeholders (Who?)	Rationale of use (For what?)
Water ser-vices provid-ers and advi-sors	**Associations or Municipalities based Water Utilities,** which look for wastewater treatment system on several dwellings or village level use the *Information Tool* to identify environmental friendly and cost effective wastewater treatment solutions. They use the *Tool* as a support to their advisory work for better management of wastewaters in rural areas. They access versatile, many-sided and specific information on the options available for wastewater treatment solutions in varying circumstances of households and villages, and communicate and share that with the people of households.
	Small and Medium Size Enterprises (SMEs) could use the *Information Tool* to obtain information on environmental, social and economic issues of wastewater treatment, on availability and pricing of components, equipment and works for building, maintenance and decommissioning, for defining design parameters for wastewater works and specifications for systems, components and equipment in accordance with existing legislation, on work demands for earthworks, pipelining, electrifying and constructing, on project management and leadership of constructing wastewater plants, on services for running and maintaining wastewater treatment plants etc.
	Research institutes and **Educational Organizations** could use the *Information Tool* as material to train people, who work with wastewater treatment in sparsely populated areas, are members of water cooperatives or belong to other bodies (e.g. local authorities) responsible for wastewater treatment in sparsely populated areas.

Instructions to Project Partners:

Please, review table below according to definitied main target groups and put notes to describe country specific stakeholders if needed.

Table 22. Country specific stakeholders of the main target group – Water services providers and advisors.

Stakeholders	Estonia	Finland	Latvia	Lithuania	Poland	Sweden*
Water services providers and advisors						
Public sector						
Associations based Water Utilities	X	X (1)		X (8)	X	X
Municipalities based Water Utilities			X			
Regional associations of advisors	X	X (2, 3)		X	X (11)	
Educational organisations		X (4, 5)		X	X (12)	
Private sector						
SMEs	X	X	X	X	X	X
Waste water consultants and engineering companies		X (6, 7)	X	X (9, 10)		X
Manufacturers		X	X			X
Installation companies		X	x			X
Resellers		X	X			X

NOTES: * Overview covers also Sweden, which initially was project partner.

Finland: (1) The Finnish Union for Associations for Water and Environment, especially its eleven regional member associations enclosing almost the whole Finland within their advisory work for better management of waste waters in rural areas, done on the field in direct contact with households.

(2) The Martha Organization, a Finnish home economics organization organized in 1300 local clubs all over the Finland. **(3)** Rural Women's Advisory Organization, a nationwide organization for advice directed at households and small enterprises in rural areas, total membership 65 000 in over 2000 municipal and village level associations. **(4)** Vocational education institutes for adults, such as Sykli and Saimaan ammattiopisto, which train people who deal with wastewater treatment in sparsely populated areas. **(5)** Universities and institutes, which have water treatment or agricultural faculties or units such as HAMK, LAMK, Aalto, LUT, SYKE; **(6)** Association of ProAgria Centers, ProAgria, a Finnish expert organization offering services and know–how to develop competitiveness in rural businesses, emphasizes environmental values including clean waters. **(7)** The Finnish Union for Associations for Water and Environment, especially its eleven regional member associations enclosing almost the whole Finland within their advisory work for better management of waste waters in rural areas, done on the field in direct contact with households.

Lithuania: (8) Lithuanian Water Suppliers association and its more than 100 member organizations, which take care of the water supply and sewage disposal; . **(9)** The Clean Water Association and Environmental Protection Association, which give advice, realize and run implementation projects and manufacturing of waste water treatment components and equipment; **(10)** Association of Lithuanian Hydraulic and Land Management engineers and Lithuania Water Suppliers association and others), working with rural associations and communities, SMEs and farmers;

Poland: (11) The regional Agricultural Advisory Centers, which is an acknowledged information bridge between best practices and final user. **(12)** Institute of Technology and Life Sciences in Falenty, Institute of Life Sciences in Poznań and the Institute of Environmental Protection in Warsaw, which strive to improve exiting solutions and implement best-fit practices.

5.1.1.3. State Environmental Authorities

The *Information Tool* will be useful also for **State Environmental Authorities** (Regional Environmental Boards, State inspectorates etc.), responsible for requirements setting and control of wastewater treatment efficiency.

An overview of the country specific stakeholders is done in Table 23.

Instructions to Project Partners:

Please, review table below by putting name of state environmental authorities if operate in your country.

Table 23. Country specific beneficiaries of the main target group – State Environmental Authorities.

Stakeholders	Estonia	Finland	Latvia	Lithuania	Poland	Sweden*
State Environmental Authorities providing control and inspection						
Regional environmental boards	X		X			
Environmental Protection Agency and 10 Regional Environmental Protection departments				X		
General Directorate for Environmental Protection					X	

5.1.1.4. Policy makers

Policy makers on national level are ministries and/or environmental Agencies, which are responsible for design of policy, initial development of legislation and implementation of policy by application of all instruments for sustainable use of water resources in the country. On the local level the Municipalities act for the development of their mandatory development planning documents and, relatedly, internal legal acts and, complementary, also developing support mechanisms for improved wastewater treatment in the whole territory of municipality.

The important role also plays intermediary organizations as national and, particularly, local **NGO's,** which act for the public awareness rising to save water recourses and to motivate Local and State Governments for improved wastewater treatment. There could be various types of NGO's at the local level, which might be interested and involved, starting from local development issue- and village/community-based interest groups up to public consultative councils at the municipal decision maing boards as well as on water resources specialized NGO's, networks etc.

The stakeholders of the given target group are summarized in Table 24. Table describes the main target group and the rationales of the *Information Tool* usage by giving a general view on the stekeholders. An overview of the country specific stakeholders – users of the *Information Tool*, representing either state or non governmental level are summarized in Table 25.

Table 24. The rationales of the Information Tool usage for the main target group - Policy Makers.

Stakeholders (Who?)	Rationale of use (For what?)
Policy Makers, including Funds for financial support	On national level **ministries** responsible for development of legislation should use the *Information Tool* to get relevant background information on wastewater treatment technologies available in the market, while the LCA data should be used to introduce supporting mechanisms for environmental friendly and cost effective long term solutions.
	Municipalities use the *Information Tool* in dialogues with society to develop local legal acts and support mechanisms for improved wastewater treatment.
	NGO's could use the Information Tool for public awareness rising to save water recourses and to motivate Local and State Governments for improved wastewater treatment.

Instructions to Project Partners:

Please, review table below according to definitied main target groups and put notes to describe country specific stakeholders if needed.

Table 25. Country specific stakeholders of the main target group – Policy Makers.

Stakeholders	Estonia	Finland	Latvia	Lithuania	Poland	Sweden*
Policy Makers, including Funds for financial support						
Regional and Local municipal governments	X		X	X	X	
Municipalities based associations		X (1)	X (2)			
National governmental organisations (Ministries)	X		X (3)	X (4,5)	X (6,7)	
National Fund for financial support					X (8)	
NGO		X		X	X	X

NOTES: * Overview covers also Sweden, which initially was project partner.

Finland: (1) Village Action Association of Finland, and its more than 130 member organizations (for example, regional village action associations, village action associations and village action committees) are often bodies that have the authorization for planning and implementing the waste water system renewal in villages.

Latvia: (2) Latvian Association of Local and Regional Governments, which unites all Latvian municipalities and Association of Latvian Costal Municipalities, which unites 16 municipalities located along the coast of the Baltic Sea and the Gulf of Riga; **(3)** Ministry of Environment and Regional Development

Lithuania: (**4**) Ministry of Environment, **(5)** Ministry of Agriculture with their executive bodies, especially the National Paying Agency and the Fisheries Service;

Poland: (6) The Ministry of Agriculture and Rural Development with their executive bodies, especially the Agency for Restructuring and Modernization of Agriculture (ARMA), which implements instruments co-financed by the European Union and provides support from national funds, their main beneficiaries are farmers, rural residents, agricultural producer groups, SME and local authorities. **(7)** The Ministry of the Environment with executive bodies, especially the General Directorate for Environmental Protection, which with its regional branches supports and supervises the building of the household wastewater treatment plants. **(8)** The National Fund for Environmental Protection and Water Management, which provides financial support for different household wastewater treatment improvements.

5.2. Goals for communication with main target groups

The goals of the external communication according to the project proposal:

- **Increase knowledge** among people of scattered dwelling communities, related policymakers, authorities and environmental NGOs, technology, development, and advisory SMEs, research institutes and municipalities.
- **Change attitude** of people of scattered dwelling communities, municipalities and related policymakers concerning scattered dwelling after getting increased knowledge of small scaled wastewater treatment solutions.
- **Change behaviour** of people of scattered dwelling communities, municipalities and related policymakers so that the best available technical solutions for small scaled wastewater treatment are going to be taken into use.

Communication philosophy and approaches.

The aim of the communication is to:

1. bring people and communities in rural areas to **learn** about and **discuss** the topic of waste water treatment
2. help them **make informed decisions** regarding waste water management
3. make sure they **find and use the information tool** when it's published

- We will not only communicate at the end of the project and about the results of it (traditional "dissemination" approach) but **throughout the project**, to raise interest and activate potential users of the tool.
- We want to **adapt our communication to the different target groups and their needs.** To reach their attention, we cannot approach laymen identically as we do professionals.
- We want to make the project **interesting and approachable** to the target groups – local authorities, families, house owners and villagers, SME's and NGO's. The project is not some distant EU bureau and it's not all about technology – it's **villages and persons**. To achieve this, we involve people, share experiences and make the audiences familiar with us - the persons working in and for the project.

For **professional audiences** (authorities, researchers, experts, SMEs), we publish different types of information, such as articles, guidelines, and metadata of the information tool.

6. Environmental action-oriented communication model for wastewater communication and management development at the local municipal level

6.1. Needs for complementary set of communication instruments

The general objectivesfor A4.5 as communication and dissemination work package, according to the VillageWaters project proposal, are oriented towards following educational categories to be developed during project time span for stakeholders to be involved:

- **Raising awareness** among national and transnational authorities, financiers, designers of WWTPs and relevant organisations.
- **Increasing knowledge** among people of scattered dwelling communities, related policymakers, authorities and environmental NGOs, technology, development, and advisory SMEs, research institutes and municipalities.
- **Changing attitude** of people of scattered dwelling communities, municipalities and related policy-makers so that the best available technical solutions for small-scaled wastewater treatment are going to be taken into use.

In order to increase knowledge and, in particular, change attitude and to raise awareness, according to international and national activities and practice experiences there is not enough just to organize information campaigns etc and trainings. There is necessity to work more complex and more selective and also complementary applying various communication instruments so targeting different stakeholder qualities as knowledge, abilities and scills, value orientations and attitudes. For example, in Latvia, when working with coastal and/or municipal environmental management development issues, there is applied combination of following instruments - planning and implementing not only the best available information instruments combined with general/specific adult training, but using also stakeholders participation-cooperation activities as well as best practice cases, demo cases and best inhabitants behaviour practices. This approach is called action-oriented environmental communication.

In preparation of manual and also related further on stakeholders training materials, there is particularly important in the each partner country to collect and summarize the best available practices in coastal municipalities in general and, especially, in the project pilot case territories. Experineces gathred could serve as backbone for working with both, the Information Tool itself and related small-scale WWT plants dissemination to the target groups, especially to local village inhabitants.

The content of this project guideline is addressed mainly for local inhabitants and is including not only the considerations how to select new WWT technology but also how this selection will reduce impacts on environment and Baltic Sea in particular. The experience gained from PP6 participation in the internation exhibition “Māja I” (House) with VillageWaters stand demonstrated that part of public was attracted by poster “What is Baltic Sea algal blom and how it is binded by the household?”.

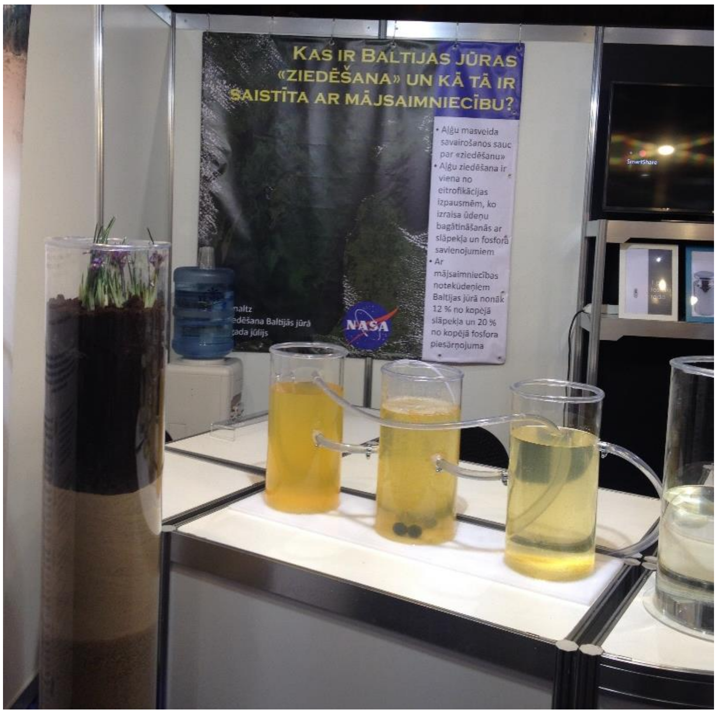

Figure 21. The VillageWaters stand in the international exibition "Māja I" (House) in Riga (08.03.-11.03) which is the largest building industry event in Latvia that offers an insight into the recent development tendencies of the building industry and is visited by 35 trousand visitors on average

Another important work direction is how to best effectively communicate on the intentions/options for WWT solutions" selection and how to cooperate with stakeholders and beneficieries represented main target groups.

In this relation there are to mentioned the main steps to start with to be prepared to develop and apply later on the local best effective communicatin approaches and instruments.

- Introduction to the local WW treatment traditions and circumstances, particularly paying attention to identification groups of stakeholders and beneficieries in villages;
- Identification of certain stakeholders and beneficieries, including indivual households, who will become participants in training seminars;
- Generation of wastewater communication/training development initiatives and planning for the further project development in the frame of A4.5.

6.2. Action-oriented communication instruments in practice

Environmental communication is an essential environmental management instrument along with the legal, economic, planning, administrative and infrastructural instruments in preventing environmental degradation, in ensuring sustainability and in achieving a **change in understanding, attitude and behaviour,** when applying it at any governance level, but community and local governance level, in particular. It is an efficient instrument in search for sustainable solutions and in environmental and coastal policy planning and implementation, and it has an enormous potential for targeting key general environmental objectives, but, definitely, being also straight forwarded and oriented towards wastewater communication sector as well: **building WWT awareness, sustainable lifestyles and environmental co-operation among all parties involved.** Simultaneous and complimentary development of all instruments (refer Fig.22) and their application to the implementation of local municipal wastewater (multi-instrumentality) and, particularly, communication instruments development is to be recognized as very important and therefore especially necessary to be promoted in coastal case study municipalities of the project.

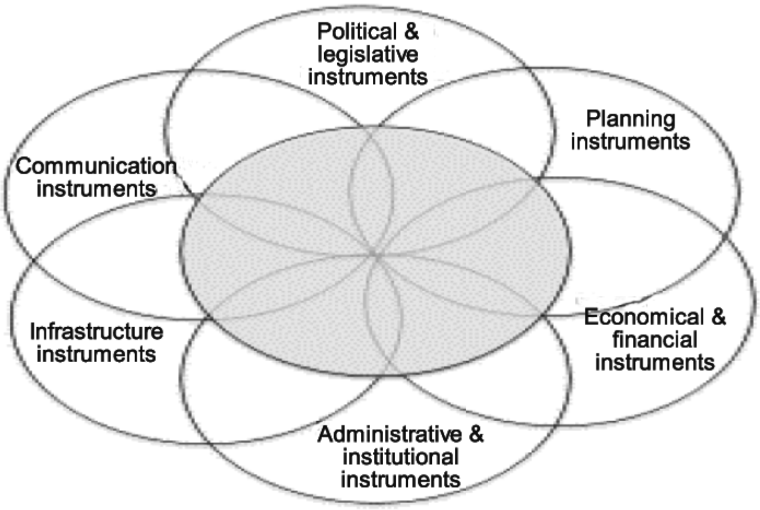

Figure 22. Mutual integration imperative for all main groups of governance instruments to be applied either to general coastal governanc or any particular sector, including WWT communication (Source: Ernsteins 2011)

At the glance describing the main statements for environtmental communication activities related development status still to be found in the many coastal municipalities could be generalized as follows:

- insufficiently coordinated circulation and availability of **environmental information**, its inconsistency with the needs of different local target groups and particular key issues, e.g. wastewater management in coastal areas,
- not sufficiently developed general pu**blic and local inhabitant's education and understanding** about the importance of environmental protection and environmental problem-solving possibilities in coastal territories,
- insufficient **non-governmental capacity** and activity of community and other target groups, as well as not fully engaged all eventual **mechanisms for participation** in decision-making,
- insufficient preconditions and stimuli for an **environmentally friendly lifestyle** (pro-environmental behaviour) and action of local coastal community and different target groups.

This could be, at least partially, attributed also to the WWT management situation in the municipalities and in such general conditions there are necessity to look at the environmental communication as **multi-stakeholder understanding and co-operation enhancement process,** e.g. by complementarily involving all four components mentioned, but all in all - by considering and applying **values, intentions and opinions of all key target groups**, i.e. local inhabitants, municipal and state institutions, NGOs and the media, businesses, etc. This could be called collaboration and **action-oriented communication (AOC) model** – the model of incremental environmental communication cycle – subsequently demonstrating the linkage between environmental communication components or the cyclic basic steps of the communication process and the pedagogical/practical results that within the particular cycle ensure applied and concrete practical case-oriented environmental awareness development, but within the multi–cycle integration - the process of repeated and supplementary self-experience development, which facilitates general environmental awareness enhancement (refer Fig. 23).

Environmental communication is to be seen here as complementary set of environmental information and education/training, environmental participation (all target groups) and pro-environmentally behaviour (PEB). Model application in practice cases at the municipalities has yielded positive results as to the model's practical applicability in environmental communication process initiation and facilitation, stimulation of target group/stakeholder self-activation for co-operation, dialogue and increased participation in building a sustainable local community.

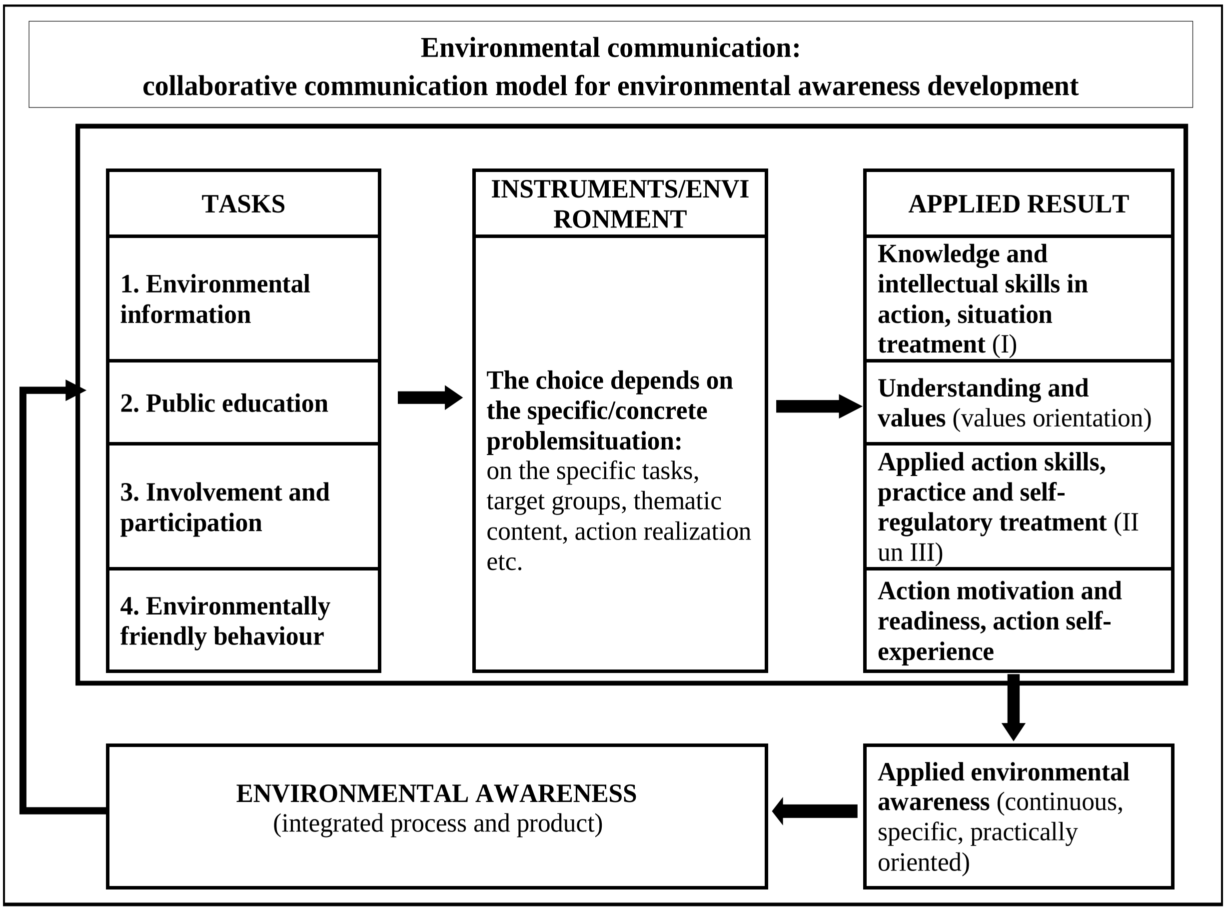

Figure 23. Environmental communication process cycle – action-oriented communication model: four instruments as complementary tasks for communication process of multi-cycle application (Source: Ernsteins 1999)

The developed AOC model can be considered as comprehensive systemic approach towards environmental communication as it **pools into a coherent system** (refer Fig.24) all of the key elements (or dimensions) that form a joint communicative environment - environmental information, environmental education, public participation and environmentally friendly behaviour. Thus, it aims at illuminating the interaction of the four notions (often disengaged both in theory and municipal practice) and discarding the traditional communication approach – **information flow-focussed approach.** The model also insists that the potential of the combined force of these four communication dimensions can only be utilised to the full extent through ensuring co-operation and partnership among all target (stakeholder) groups involved.

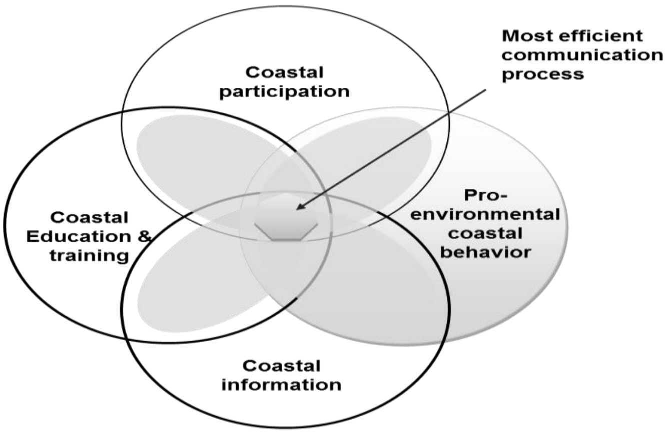

Figure 24. Application of environmental communication model for coastal governance: four instruments as complementary communication ones for most efficient communication process (adapted, Source: Ernsteins 1999)

All main four communication instruments in the relation to water resources and WWT could be desribed in short as follows:

- **Environmental information:** information is easily accessible but it is excessive: WWTT consumer faces difficulty in assessing number and objectivity of information etc.
- **Environmental education:** consumers may be educated through various personal and community concerns, e.g. environemnt, Baltic Sea, health etc. Formal education on water resources is often poorly developed. Non-formal education lacks a clear-cut communication platform: mediators pursue differing non-formal educational activities and consumers are confused by different educational contents.
- **Public participation:** participation is irregular and unsystematic; everyday collaboration among target groups should be promoted; NGOs should be popularised; active involvement of residents needs to be achieved; collaboration with foreign countries, dissemination of best practice and adaptation for local needs, development of reciprocal links among all target groups needs to be promoted.
- **Pro-environmentally action:** consumers are positively affected by best cases and demonstration installations; this testifies to importance of environmental marketing activities etc. in attracting consumers to environmental friendly approaches and technologies.

6.3. Local WWT communication practice and further development

Action oriented communication model is based on the **imperative of two complementarities**:

- the complementarity of the four environmental communication dimensions, and
- the complementarity of all target groups working in partnership.

Purposefully promoted collaborative communication development, i.e. also implementing collaborative governance models into practice, might provide more sufficient professional activity of municipality specialists/employees and self-experience activity of target groups (Fig.25) for development and use of communication instruments.

Generally speaking of all main stakeholders we shall keep in mind the folowing groups:

- Households/Residents;
- Municipality - elective, executive, subordinated, municipal companies;
- Business sector;
- State as National/Regional public administration, both general/environmental;
- Mediators.

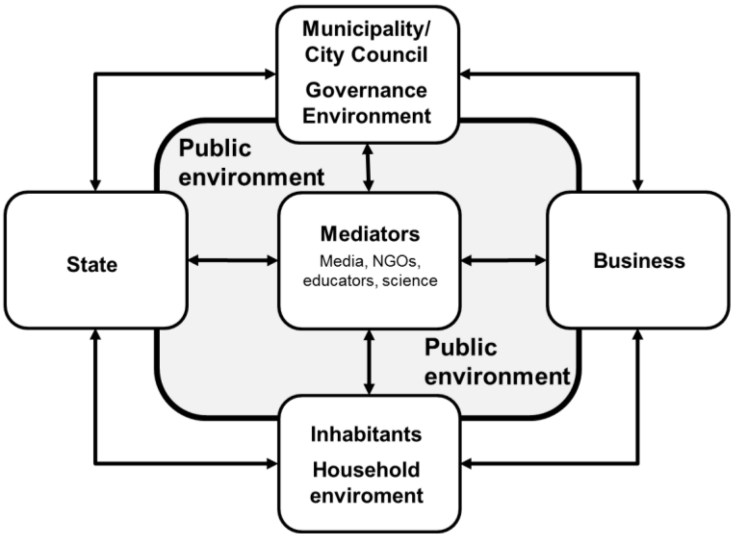

Figure 25. General target groups constallation and their interaction facilitation in the open public environment, as well as for governance environment and household environment greening (adapted, Source: Ernsteins 1999)

Even for WWT case in the project we are going to concentrate in particular towards to 4 main target groups:

- Producer of Wastewater = Households/Residents;
- Water Services Provider = Business sector, including Municipality based water utilities;
- Environmental Authorities = State;
- Policy Makers = State as National public administration, Municipality as local public administration, NGO's as those who motivate both Local and State Governments for improved wastewater treatment improvement;
- Mediators = VillageWaters project.

Pro-environmental behaviour (PEB) in households in general and particularly in the field of wastewater management are our direct Villagewaters project aim. Important role for the development of PEB in the household level are playing exactly communication and it`s governance. In the frame of the project, PEB in the municipal and household wastewater sector is to be addressed within the mentioned above AOC model of environmental communication collaboration four-stage cycle, where PEB is one of the four successive procedural dimensions (also the instrument) of environmental communication, together with environmental information, environmental education and public participation, which are equally necessary for successful coastal environmental and sustainable development on the stages of their problem identification, assessment, decision making and problem solving. Model provides that through these dimensions is realized communication process as a result of which gradually could be obtained individual/group's **knowledge, experience, awareness, skills, motivation and readiness** for the certain action – environmental awareness and PEB in wastewater management.

Initial communication studies' results in different partner countries and pilot cases provide the opportunity to summaries the proposals voiced by the target groups concerning prospects for **pro-environmental WWTT communication development**. These proposals shall be integrated into the communication activities planned as part of the Villagewater project.

Subsequently, the aim of the Villagewaters communication development at the local cases studies municipalities would be:

- to produce a real applicable end-product in the form of a locally tailored wastewater communication and collaboration planning and/or **action programme proposal**, including particularly, stakeholders **training seminars on coastal wastewater management**, and
- to give an initial boost to the further local wastewater **communication process** development, broaden the outlook of the target groups so as to reveal the unacknowledged potential of environmental communication in building local environmental awareness, facilitating participation, expanding the usual confined frameworks of co-operation, breaking the traditional perceptions and stimulating new innovative approaches.

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VillageWaters