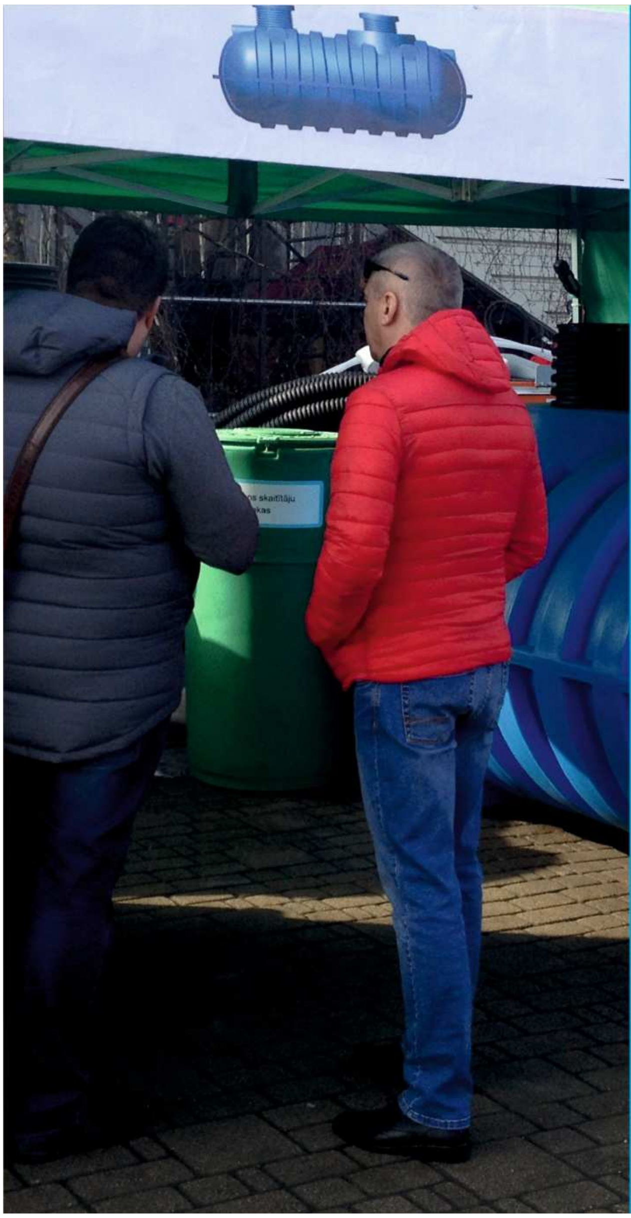
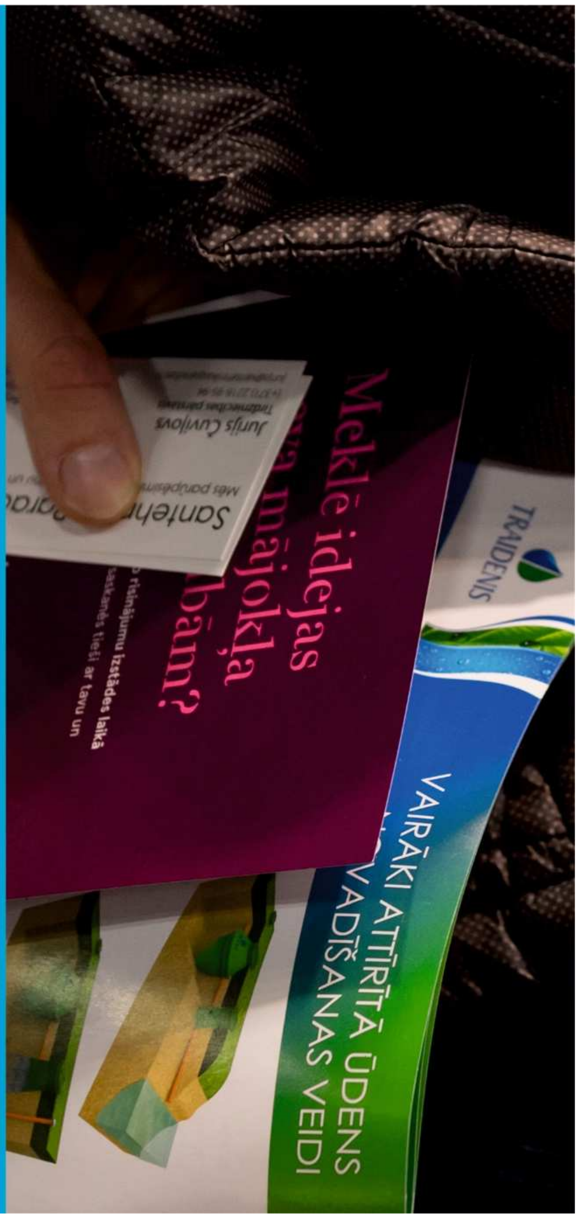




Part 3: Consider and act!

Contents

1 Historical development of wastewater treatment solutions

Development of wastewater treatment (WWT) technologies were initiated by industrial development and have been in line with urbanization process (Cooper P.F., 2001). The Great Britain was one of the first industrialised countries. Therefore the problems, which resulted from very fast development of densely populated cities and growing production of sewerage, there were identified before in many other countries. The need to reduce the impact to environment has led to the development of WWT technologies. The oldest WWT technologies had less treatment efficiency.

The oldest WWT solution is cesspool, which have rather high impact to environment. The development of improved WWT solutions historically were bind with the development of sewage networks and introduction of flash toilets. The first flash toilet was introduced by Sir John Harington in 1596. He designed two water closets (called the Necessary) for Queen Elizabeth I. In the beginning, this improvement did not achieve popularity and were adopted by Londoners only in the 1700s (Cooper P.F., 2001).

The development of sewage network and introduction of flash toilets improved the living conditions in homes, but directed pollution to the River Thames. According to historical data the amount of wastewater during the six years from 1850 to 1856 was doubled because of increased use of water closets (Halliday, 1999). At that time River Thames was highly polluted and in practice was transformed into a large cesspool (Cooper P.F., 2001). In order to improve wastewater treatment the septic tanks and chemical treatment plants were developed. Similarly the need to reduce amount of sludge, which originated during treatment process, the chemical treatment of sewage was replaced with biological treatment. The different treatment technologies like soil filters and constructed wetlands was also introduced to improve treatment efficiency.

The figure below summarise the first known facts on sewage treatment technologies. Development of towns and introduction of different industries was common picture around the most part of XIX–XX century Europe. New industrial centres arise as well as in VillageWaters Project area. Possibilities and gains from wastewater treatment were identified and wastewater treatment technologies were sonly transferred and introduced in our developing towns.

2 Historical development of wastewater treatment policy

The growth of towns and cities created sanitation problems that led development of wastewater treatment policy. The beginning of the wastewater treatment policy can be considered as initiated by the first Mayor of London, Henry Fitzalwyn, who take this responsibilities from about 1189 until his death in 1212. According to historical records, Henry Fitzalwyn ruled that cesspools be located no less than 75 cm (2.5 feet) from neighbouring buildings if made of stone or 105 cm (3.5 feet) if constructed of other materials (Wolfe P., 1999).

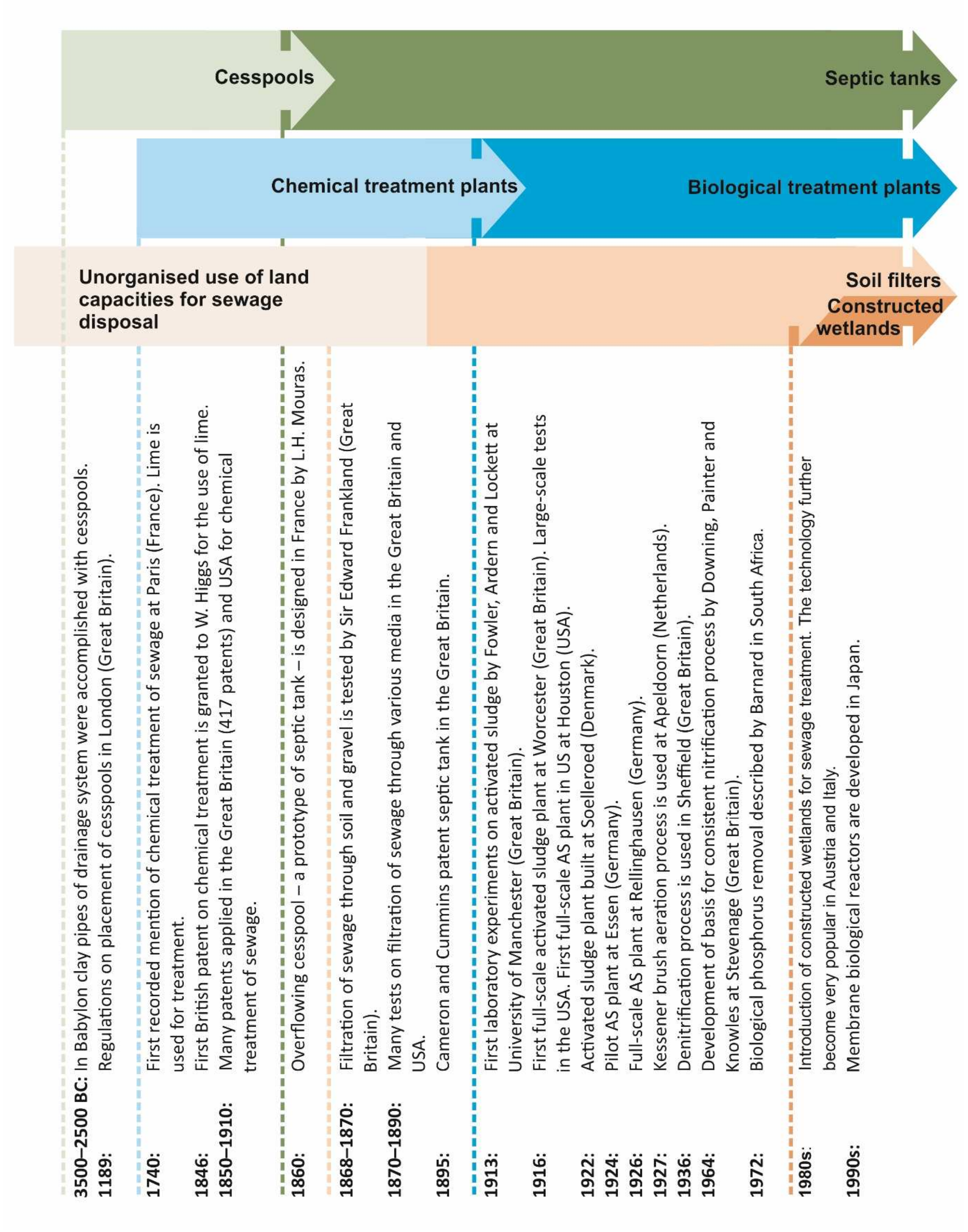


Figure 1. Historical development of wastewater treatment solutions. Figure: L.Urtāne.

Similarly as it was with the development of wastewater treatment technologies, also wastewater treatment policy was transferred from Great Britain and introduced in other countries. It is recorded that the King Francois I (was King of France from 1515 until his death in 1547) transferred experience obtained in the United Kingdom and started development of wastewater treatment policy in France from 1539. According to order issued by King Francois I, it was required for house owners to build cesspools (indoor pit toilets) for sewage collection in new houses. Cesspools were constructed so that they leaked and did not have to be emptied often. The cesspools of such construction had been used until the late 1700s (Cooper P.F., 2001).

The next important milestone for development of wastewater treatment policy is 1898, when the Commission on Sewage Disposal was formed by the United Kingdom government. The most important output of this Commission is so-called “20:30 standard”. The standard issued by 8th Royal Commission on Sewage Disposal defines the “Royal Commission Standard” where 20 mg/litre for BOD and 30 mg/litre for suspended solids was required for effluent being discharged to rivers after sewage treatment. This “Royal Commission Standard” as “general standard” later on was introduced in many other countries (Cooper P.F., 2001).

In the 1970s the raise of wastewater treatment standards to improve an environment condition to some extent were driven by public opinion and greater public awareness (Cooper P.F., 2001). The Clean Water Act in 1972 was issued in the USA and several Directives were issued in the European Union – Surface Water Directive[1] in 1975, Bathing Water Directive[2] in 1976, the Fishing Waters Directive[3] in 1978, the Shellfish Water Directive[4] in 1979 and the Drinking Water Directive[5] in 1980 – to define water quality requirements for surface water potential recipients of wastewater.

The Urban Waste Water Treatment Directive[6] in 1991 was one of the most important legal acts, which has provided European-wide standards for wastewater treatment. These directive focuses at first to bigger agglomerations and with respect to small wastewater treatment facilities the particular reduction of nitrogen and phosphorus was not required. Therefore the reduction of third biggest source for eutrophication of the Baltic Sea was still future decisions issue.

HELCOM RECOMMENDATION 28E/6[7] adopted 15 November 2007 recommends to the Governments of the Contracting States that the following practices should be promoted in on-site wastewater treatment for single family homes, small businesses and settlements up to 300 PE – for a high standard household with warm water, showers, laundry and dishwashing machines and flush toilets this would mean approximately a basic reduction of 80% of BOD_5, 70% of total phosphorus and 29% of total nitrogen or BOD_5 of 20 mg/l, P_{tot} 5 mg/l and N_{tot} 25 mg/l in the effluent of the treatment plant.

[1] Council Directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (75/440/EEC);
[2] Council Directive of 8 December 1975 concerning the quality of bathing water (76/160/EEC);
[3] Council Directive of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life (78/659/EEC);
[4] Council Directive of 30 October 1979 on the quality required of shellfish waters (79/923/EEC);
[5] Council Directive of 15 July 1980 relating to the quality of water intended for human consumption (80/778/EEC);
[6] Council Directive of 21 May 1991 concerning urban waste-water treatment (91/271/EEC);
[7] HELCOM RECOMMENDATION 28E/6 “On-site wastewater treatment of single family homes, small businesses and settlements up to 300 person equivalents (P.E.)” having regard to Article 20, Paragraph 1 b) of the Helsinki Convention.

Figure 2. Historical development of wastewater treatment policy. Figure: L.Urtāne.

3 How requirements for additional sewage treatment are set?

3.1 Sensitive area

There are several political instruments used to reduce wastewater treatment effect to eutrophication process. Identification of sensitive area is one of them. The designation of **sensitive area** was required by the Urban Waste Water Treatment Directive (UWWTD) in order to identify areas, where more stringent wastewater treatment as secondary treatment should be put in place. In practice it means that removal of phosphorus and/or nitrogen in the treatment plants of large cities must be applied.

In total 16 EU Member States has designated whole territory as sensitive area and all VillageWaters project countries – Estonia, Finland, Latvia, Lithuania and Poland – are among them.

Sensitive area – an area, which is designated in accordance with requirements of WWTD and where more stringent wastewater treatment as secondary treatment should be applied.

3.2 Sensitive water

With respect to small domestic wastewater treatment plants the **sensitive waters** approach is used. Sensitive waters are specified according to their environmental importance or intended human use. They may require stringent protection measures to meet their special qualities. With respect to wastewater discharge it means that more strict requirements for small wastewater treatment plants may be set if treated sewage is discharged to sensitive surface water body or WWT plant is located in the area having specific conditions – protected nature area, area intended for the abstraction of drinking water, area where protection of groundwater is poor or bad etc. The identification of waters sensitive to wastewater discharge and setting requirements for advanced treatment of sewage is country specific.

Sensitive waters – a surface water of environmental importance, which are eutrophic or which may become eutrophic if protective actions are not taken, poor protected groundwater, or have to be protected in order to meet standards for intended human uses.

Table 1. Use of political instruments to reduce wastewater treatment effect to eutrophication – sensitive area and sensitive water

SENSITIVE AREA	SENSITIVE WATER
Removal of nitrogen and phosphorus as advanced treatment is required for agglomerations > 10 000 PE.	Advanced treatment is required for small domestic WWT plants if: 1. Treated wastewater is discharged in surface water having status of: • Priority fish water, • Bathing water, • Surface water intended for drinking water consumption, • Waterbody at risk; 2. Treatment plant is located in: • Nature protection area, • Area with poor or bad protected groundwater resources, • Area for drinking water consumption, • Coastal area.
Is required in all VillageWaters Project countries	Identification of waters sensitive for wastewater discharge and setting requirements for advanced wastewater treatment is country specific.

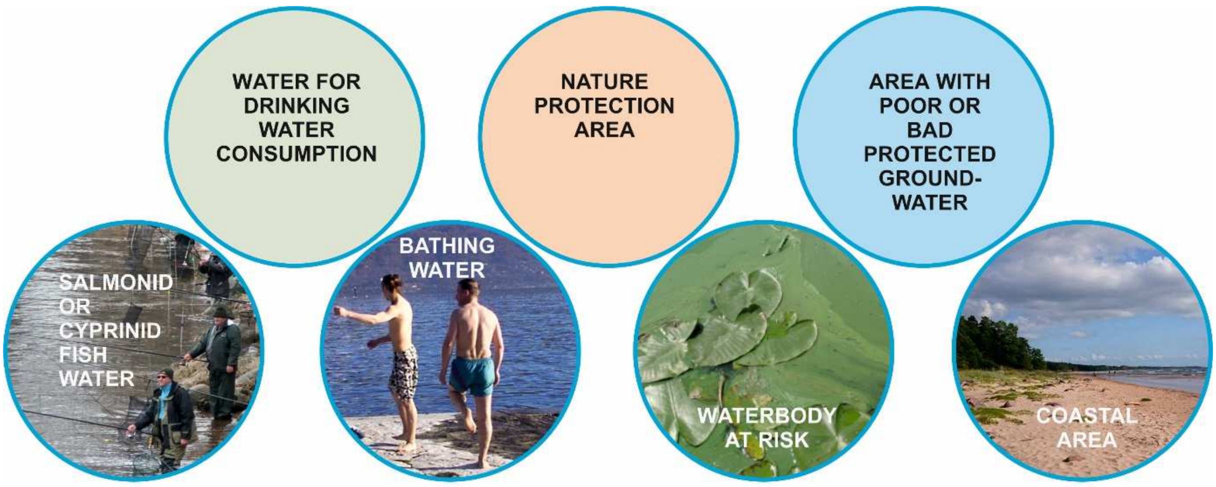


Figure 3. Types of sensitive water. Photo: L. Urtāne, A.V. Urtans

4 How costs of wastewater treatment are incurred?

The selection of wastewater treatment solution is very important decision and cost estimation is a very important consideration. The first step of cost estimation is decision on priorities – what is most important for you – either cost of wastewater treatment solution or quality? The quality, what means not only sewage treatment quality, but also quality of your living condition, is discussed in next Chapter. This Chapter summarise considerations on domestic sewage treatment plant installation cost.

If the sewage treatment plant cost is the main factor due to budget limitations, you need to make sure if every component forming final costs of wastewater treatment is considered. The initial purchase cost of sewage treatment plant (investment cost) is so called visible part of costs, but also the delivery, installation, emptying, consumption of electricity etc. will be needed during installation and operation of plant, and this is so called "hidden" expenses.

The total cost of wastewater treatment solution is formed from:

- Investment costs;
- Operational costs;
- Maintenance costs.

All of them have to be considered before decision on particular wastewater treatment solution is taken. The results of interviews done during implementation of VillageWaters Project clearly demonstrate, that also operational and maintenance costs have to be an important consideration. The respondents, whose decision on wastewater treatment solution was taken some time ago and who had already operated chosen wastewater treatment plant, always mark the operational and maintenance cost as more important than those respondents, which were in the decision making process. The next figure summarise all components forming total cost of wastewater treatment solution, which have to be considered during decision making process.

INVESTMENT COST

EQUIPMENT COST

Equipment costs usually includes all costs of wastewater treatment plant.

CONSTRUCTION COST

- Technical documentation cost,
- Construction material cost,
- Construction work cost,
- Construction supervision cost.

START-UP COST

Is performed by vendor and consists from:

- Transportation cost,
- Start-up engineer work cost,
- Initial bacteria seeding material cost, if needed,
- Initial set of chemicals for dosing, if needed.

DELIVERY COST

Delivery costs are affected by the geographical placement of vendor against customer. It consists from:

- Equipment delivery,
- Delivery of materials.

OPERATIONAL COST

ELECTRICITY CONSUMPTION

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

CONSUMPTION OF CHEMICALS

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

BACTERIA SEEDS

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

MAINTENANCE COST

SERVICE MAINTENANCE

Necessity of regular service maintenance is indicated in equipment data sheet. It consists from:

- Transportation cost, which is dependant on distance between vendor and customer,
- Service technician work.

EVACUATION OF EXCESSIVE

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. Cost consists from:

- Transportation cost,
- Sludge pumping cost.

Figure 4. Components forming total cost of wastewater treatment solution.

5 How to select and buy appropriate technology?

There is a large variety of wastewater treatment (WWT) systems suitable for sewage treatment available on the market with a range of prices. The selection of cost effective and environmental friendly WWT solution therefore become more and more difficult decision for households. In addition to cost related considerations also quality related considerations have to be done. The last ones relates either to technical aspect, which can be characterised as our living quality or environmental aspect, which is treatment efficiency and can be characterised as our impact to water environment.

The next figure summarise main factors and preconditions, which have to be considered during decision making process.

TECHNICAL ASPECTS

AMOUNT OF SEWAGE PRODUCED

This is hydraulic load characterised by 2 parameters:

- Daily discharge, which is used to calculate bioreactor volume or area of constructed wetland;
- Max momentary discharge, which effects the clarifier sizing.

CONCENTRATION OF POLLUTING SUBSTANCES IN THE WASTEWATER

There are 2 ways to estimate daily rate of pollutants:

- Make wastewater analyse,
- Calculate specific loads per person according to standards.

Analyses based estimation always is more precise.

LEVEL OF SHALLOW GROUNDWATER

Usually WWT plant should be installed above the level of shallow groundwater. Some manufacturers allow to install their WWT plants partially below to this level, but additionally fastened with concrete construction.

AREA AVAILABLE FOR CONSTRUCTION

Available area for construction affects the dimensions of equipment. Haul roads are necessary both for construction and later maintenance of WWT plant, for example, for sludge evacuation truck access

ENVIRONMENTAL ASPECTS

TREATMENT REQUIREMENTS SET BY RESPONSIBLE AUTHORITY

Treatment requirements are defined by national legislation and are issued by responsible authority. There are 2 types of requirements used in practice – the general requirements, which is based on requirements set by Urban WWT Directive and therefore are similar to all project countries and specific requirements, which are country specific and depends on sensitivity of water used for treated sewage discharge.

GREENHOUSE EFFECT FACTORS

Each of our activity affects the environment. This factor can be characterised as global one and describes our ecological foot print.

EUTROPHICATION FACTORS

This factor relates to eutrophication of the Baltic Sea. With reduction of nutrients in sewage, also total loads to the Baltic Sea is reduced.

Figure 5. Main factors and preconditions to be considered during decision making to select cost effective and environment friendly wastewater treatment solution.

6 How to use VillageWaters Project Information Tool to select best available wastewater treatment solution?

HOW TO START

Go to www.villagewaters.eu page and select Information Tool.

Then select appropriate language on the right part of the page.

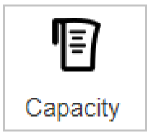
Next steps are shown for English version of the website; please look for localized description in local manuals.

SELECTION OF THE MAIN PARAMETERS

There are five main parameters possible to choose:

Click on “Country” button to select country-specific WWTP data base.

Selection available between:
Estonia, Finland, Latvia, Lithuania, Poland, Sweden



Click on “Capacity” to input quantity of persons in your house or agglomeration.

Minimum: 1 person. Maximum: country-specific. Input by slider.

Click “Technology” to filter technologies, selected for capacity entered. Select checkboxes near appropriate technologies.

Quantity and description of technologies are country-specific

Click “Dimensions” to input dimensional restrictions for selected equipment.

Maximum length and maximum width in meters are able to input via sliders.

Click “Costs” to input upper and lower borders for annualized costs for WWTP operation, maintenance and annualized investments.

Input by two-limits slider.

DISPLAY MODES FOR FILTERED LIST OF EQUIPMENT

You can choose display mode for suitable filtered equipment list in the following two ways:

Display mode Essential data	The following data are displayed for each unit in the filtered list: Model of equipment; Manufacturer and country of origin; Type of technology; BOD removal efficiency; Dimensions of construction pit for equipment; Lifetime in years, according to manufacturer data; Investment costs in EUR with VAT; Frequency of sludge evacuations per year.
Display mode Advanced scientific	The following data are displayed for each unit in the filtered list: Model of equipment; Manufacturer and country of origin; Type of technology; BOD removal efficiency; Dimensions of construction pit for equipment; Lifetime in years, according to manufacturer data; Investment costs in EUR with VAT; Frequency of sludge evacuations per year. Power consumption as kWH/month; Daily lifecicle cost as EUR per person; Carbon dioxide emission; Phosporous emission; Efficiency of Nitrogen removal; Efficiency of phosphorous removal

EQUIPMENT DATASHEET

After looking on advanced or essential data displayed in the filtered list of equipment, you can click on any listed equipment model name to see datasheet of it.

ASD PCK ASD PCKI 1,5 - 4

Biological plant, EkoStandarts Tehnoloģijas, Latvia

Primary clarifier, Microbio.degrad Clarification

Expected lifespan of this wastewater treatment system is **10 years**

Efficiency

BOD removal:	93.7%
COD removal:	0%
Suspended solids:	90%
Nitrogen removal:	80%
Phosphorus removal:	95%

Daily capacity ranges

Inflow range:	0.3 - 1.2 m^3
BOD inflow in day:	120 - 360 g
Nitrogen inflow per day:	26 - 78 g
Phosphorus inflow per day:	5 - 15 g

Outflow

BOD concentration:	28 mg/l
COD concentration:	733.3 mg/l
Suspended solids:	46.7 mg/l
Nitrogen concentration:	13.3 mg/l

Further information

EkoStandarts Tehnoloģijas
www.ekostandarts.lv
Riga, Daugavgrīvas street 93
Ekostandarts Technologies

The datasheet contains information about equipment manufacturer and link to manufacturer’s or vendor’s website.

Removal efficiency for at least BOD, Nitrogen and Phosphorous are displayed. There available to see COD and Suspended Solids removal efficiency for some countries.

Daily inflow BOD, Nitrogen and Phosphorus load are displayed.

The concentration of contaminants in the outlet water are calculated and displayed as well.

Another useful data like investment costs, construction dimensions, power consumption per year, sludge evacuation per year and annual usage costs are displayed.

Environmental impact is calculated and displayed as well for this equipment.

References

COOPER P. F. 2001. Historical aspects of wastewater treatment. In: Decentralised Sanitation and Reuse: Concepts, Systems and Implementation, IWA Publishing.

WOLFE P. 1999. History of wastewater. In World of Water 2000. pp. 24–36.