FINNISH INDUSTRIAL WASTEWATER GUIDE

Conveying non-domestic wastewater to sewers

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PREFACE

This publication is the international version of the Finnish Industrial Wastewater Guide. The guide was translated into English in the context of the BEST – Better Efficiency for Industrial Sewage Treatment project. The BEST project aims to improve industrial sewage treatment at municipal wastewater treatment plants by enhancing collaboration and best practices between municipalities, industries and water utilities in the Baltic Sea Region. The project is designated as a flagship project of the EU Strategy for the Baltic Sea Region and funded by the Interreg Baltic Sea Region Programme 2014–2020.

The Finnish Industrial Wastewater Guide describes Finnish practices for managing industrial wastewater. The translation of the guide was commissioned by the Helsinki Region Environmental Services Authority HSY. The translation of the guide aims to provide support for the project partners of the BEST project when drawing up industrial wastewater agreements, and promoting the collaboration between municipalities, industrial enterprises and water utilities.

The guide was first published in Finland in 2011. This translation is based on the fourth edition of the guide which was published in 2016. The working group of the original guide was comprised of Heli Lindberg, HSY, Eija Lehtinen, HSY, Kaisu Albeni, Kymi Water Ltd, Mirva Levomäki, Turun seudun puhdistamo Oy and Jarkko Laanti, Turun seudun puhdistamo Oy. Saijariina Toivikko from Finnish Water Utilities Association (FIWA) acted as the group secretary. The publisher of the international version of the guide is the Finnish Water Utilities Association.

We would like to sincerely thank all those people and institutions who have helped and taken part in the preparation of the Finnish Industrial Wastewater Guide over the years.

6 June, 2018 Finnish Water Utilities Association (FIWA)
Helsinki Region Environmental Services Authority (HSY)

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Abbreviations and terms

AVI	Regional Administrative State Agency
ELY	Centre for Economic Development, Transport and the Environment
ATU	Allylthiourea
AUR	Ammonium Uptake Rate
PE	Population equivalent
BAT	Best Available Technology
BCF	Bio-Concentration Factor, chemical concentration in a test organism in relation to the test environment
BOD_7	Biological Oxygen Demand (subscript 7 refers to the incubation time of 7 days)
BREF	BAT reference documents
CLP Regulation	Regulation on Classification, Labelling and Packaging of Chemicals
$COD_{Cr/Mn}$	Chemical Oxygen Demand (subscript Cr refers to oxidation by dichromate and Mn refers to oxidation by permanganate)
EC_{50}	Effective Concentration, 50 % / chemical concentration in which some effect occurs in half of the test organisms.
EPA	Environmental Protection Agency of the United States of America
E-PRTR	European Pollutant Release and Transfer Register
HELCOM	Baltic Marine Environment Protection Commission, Helsinki Commission
TLV	Threshold limit value of a chemical substance
IC_{50}	Inhibitory Concentration, 50 % / chemical concentration in which the activity in a biological process reduces by a half
K_{ow}	n-octanol / water partition coefficient, i.e. concentration in octanol/concentration in water; often expressed as logarithm $logK_{ow}$
LC_{50}	Lethal Concentration, 50 % / chemical concentration in which the half of test organisms dies
MMM	Ministry of Agriculture and Forestry
NOEC	No Observed Effect Concentration / chemical concentration in which no effects can be detected in test organisms as of yet
OUR	Oxygen Uptake Rate
ppm	Parts per million. A relative concentration measure which is equivalent to mg/l
REACH	Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
SSP	Sanitation Safety Plan / a wastewater management safety plan for reducing environmental and health risks caused by wastewater
STUK	Radiation and Nuclear Safety Authority
Tukes	Finnish Safety and Chemicals Agency
WHO	World Health Organisation
FIWA	Finnish Water Utilities Association
YM	Ministry of the Environment
EQS	Environmental Quality Standard. A concentration threshold in surface water, sediment or biota for a substance toxic and harmful to an aquatic environment.
YSL	Environmental Protection Act 524/2014
YsA	Environmental Protection Decree 713/2014

Chemical compounds

AOX	Adsorbable organic halogen compounds
BBP	Benzyl butyl phthalate
BDE	Brominated diphenol ethers
BFR	Brominated Flame Retardants
BTEX	Benzene, toluene, ethylbenzene and xylenes
CP	Chlorinated paraffins
DBP	Dibutyl phthalate
DCM	Dichloromethane
DDT	Dichloro-diphenyl-trichlorethane
DEHP	Di(2 ethylhexyl) phthalate / Bis(2-ethylhexyl)phthalate
EDC	1,2 dichloroethane
EDTA	Ethylenediamitetraacetic acid
ETBE	Ethyl tert-butyl ether
HBCD(D)	Hexabromocyclododecane
HCB	Hexachlorobenzene
MBeT	2-Mercatpobenzothiazole / Benzothiazole-2-thione
MTBE	Methyl tert-butyl ether
NP	Nonylphenol
NPE	Nonylphenol ethoxylates
OBT	Dibutyl phthalate
OP	Octylphenol
OPE	Octylphenol ethoxylates
PAH	Polycyclic aromatic hydrocarbons
PCA	Polychlorinated alkane compounds
PCB	Polychlorinated biphenyls
PCP	Pentachlorophenol
PER	Tetrachloroethylene
PFAS	Perflourinated alkylated compounds
PFOS	Perfluorinated octylsulfonates
PMY	Colony forming unit CFU
POP	Persistent Organic Pollutants
PVC	Polyvinyl chloride
SCCP	Short-chain chlorinated paraffins
TAEE	tert-Amyl-ethyl ether
TAME	tert-Amyl methyl ether
TBT	Tributyltin
TCM	Tetrachloromethane
VOC	Volatile Organic Compounds

1 INTRODUCTION

This guide describes Finnish practices for managing industrial wastewater and provides instructions for drawing up an industrial wastewater agreement. The purpose of this guide is to provide support for all those who are involved in decision-making concerning the conveying of industrial wastewater to sewers and the safe treatment of it at municipal wastewater treatment plants. The guide describes the industrial wastewater related legislation currently valid in Finland, information on different types of industrial waters, instructions for preparing an industrial wastewater agreement, formula of increased fee, monitoring of industrial wastewater and practical examples of functional solutions.

The guide describes the various stages in drawing up an industrial wastewater agreement and matters that have to be taken into account in preparing such an agreement. The aim of this guide is to provide as many concrete examples and instructions as possible. However, when preparing an industrial wastewater agreement, it is always recommended to use case-specific discretion and take the local circumstances in account.

The specific properties of industrial wastewater must be taken into account in the industrial wastewater agreement. The quality of wastewater conveyed to the sewers has impacts on the occupational safety of the employees of the water utility, the condition of the sewerage network and equipment of the treatment plant, the operation of the treatment process, the sludge quality and the state of the recipient water body. All these aspects must be taken into account in the agreement.

In practical operations we want to emphasise the importance of cooperation between different players. Conveying of industrial wastewater to sewers is technically, administratively and legislatively a many-sided matter. The best final solution is reached through an open and sufficient exchange of information between the various parties.

Terms

Industrial wastewater

In this guide, industrial wastewater is defined as wastewater that is conveyed to sewers and differs from normal domestic wastewater in its quality. Typically, such wastewater is created within industrial processes, such as operations by the food industry, surface treatment industry, paint industry, textile industry, chemical industry and graphics industry. Other kinds of industrial and commercial operations can also create wastewater that diverges from domestic wastewater, such as wastewater resulting from car washing and servicing operations, landfill leachate, wastewater ensuing from treatment of contaminated soils, wastewater from the operations of laboratories, laundries, dental care and hospitals.

Operator

In this guide, the term 'operator' refers to water utility’s customer which generates non-household wastewater destinated for the sewers of the water utility. The operator is the contracting party with which the wastewater agreement is drawn up if necessary.

Domestic wastewater

In this guide, domestic wastewater refers mainly to wastewater generated by human metabolism and household operations.

2 REGULATIONS AND AGREEMENTS ON INDUSTRIAL WASTEWATER IN FINLAND

2.1 Regulations and delivery terms and conditions concerning water services

2.1.1 Water Services Act 119/2001

Water Services Act 119/2001 has been in force since 2001 and it has been amended by the changes made to Water Services Act 681/2014. The Water Services Act concerns such industrial plants whose water supply and sewerage is paralleled by the residential water services. The Water Services Act does not refer to industrial plants whose wastewater diverges from the normal household wastewater in its amount and quality. According to Water Services Act 199/2001, Section 10, a water utility can decline to connect a property to the water supply or sewer networks of the water utility, if the quality and amount of wastewater conveyed to the sewer would interfere negatively with the operations of the water utility or would affect its ability to satisfactorily manage other properties' water services.

The general criteria for the fees of a water utility are defined in Water Services Act 119/2001, Section 18. The fees shall cover the investments and costs of a water utility, they shall be reasonable and equitable, and they shall take into account the exceptional amount or quality of wastewater. The fees shall prevent the conveying of harmful substances to the sewer and reduce the amount of wastewater.

2.1.2 General delivery terms and conditions of water services

Provisions according to the model set by the Finnish Water Utilities Association (FIWA) and The Association of Finnish Local and Regional Authorities are in general use.[1] These delivery terms and conditions, which primarily refer to common residential use, can also to some extent be applied to the agreements of industrial plants. Chapters 2.2 and 4.2 of the model describe how to make good use of the general delivery terms and conditions of a water utility when drawing up an industrial wastewater agreement.

The general delivery terms and conditions of water utilities set restrictions on the amount and quality of water conveyed to the sewers. The restrictions on the amount and quality of wastewater conveyed to a general sewer are described in the example form of the general delivery terms and conditions of a water utility provided by the Finnish Water Utilities Association (FIWA).

The customer cannot convey such water to the sewer, owned by the water utility, which may contain harmful substance concentrations, for which there is a law or regulatory provision set by Government Decisions or authorities, or which can cause harm to the operations and functions of sewers, pumping stations or treatment plants, or to the treatment of wastewater sludge or recipient water body.

It is forbidden to cool down wastewater so much that it causes a danger of freezing in the sewers or interferes with the operations of the treatment plant.

No petrol is allowed to be conveyed to the sewer, neither solvents, substances causing danger of fire or explosion, nor other hazardous waste.

Wastewater conveyed to the sewer of a water utility should not cause any harm or damage; and should not contain:

- objects, textiles, metals, grit, soil, glass, rubber, plastic, grease, oil or other such domestic or industrial waste which may cause blockage in the sewer or interfere with the treatment of wastewater; no substances which may react to sewage and cause blockage, toxicity, corrosion or a significant increase of the heat of sewage
- toxic substances or other substances causing toxic gases, acids or substances corrosive to the structures of the sewerage system
- sewage with a pH value (acidity value) lower than 6.0 or higher than 11 at the connection point of the sewer
- large temporary discharge amounts of water or a large amount of water with a temperature higher than +40 °C
- other substances which are harmful or toxic from the point of view of the sewer system or recipient watercourse; substances which disturb the function of the sewer network or operations of the wastewater treatment plant or endanger the health of the employees

Conveying stormwater and/or drainage water from buildings' foundations to the wastewater sewer is forbidden as is also conveying wastewater to the stormwater sewer unless explicitly stated otherwise in a separate agreement.

2.2 Regulations on environmental protection

2.2.1 Environmental Protection Act 527/2014 and Environmental Protection Decree 713/2014

Environmental Protection Act 527/2014 includes, among others, regulations on the general principles, obligations and prohibitions of environmental protection, authorisation regulations for lower-grade standard setting, regulations on environmental permits, notification procedure, compensations, supervision and administrative compulsion, as well as regulations on the right to appeal. Annex 1 of Environmental Protection Act 527/2014 includes a list of activities requiring an environmental permit. Annex 2 presents a list of activities that have to be registered.

Environmental Protection Decree 713/2014 regulates the jurisdiction of authorising bodies, permit application procedures and permit decisions, notification procedures, supervision and monitoring, among others. Both the Environmental Protection Act and the Environmental Protection Decree stipulate requirements for wastewater that is conveyed to sewers. The environmental permit decision takes also into account effluents discharged into the sewer network.

Section 15 of the Environmental Protection Act sets provisions on contingency planning and requires that the operator, whose environmental permit is granted by a governmental authorising body, has to prepare a contingency plan based on the risk assessment.

General requirements concerning effluents conveyed to the sewers

Section 41 of the Environmental Protection Decree comprises the general requirements which have to be fulfilled so that wastewater can be conveyed to the sewers and the right to refuse to receive such wastewater that fails to meet the requirements.

According to the Section 41 General requirements concerning releases conveyed to the sewers, industrial wastewater conveyed to the sewers of a water utility and other wastewater containing contaminating substances have to be pretreated in a due manner:

1. to prevent environmental hazards caused by pollutant releases from the water utility and to fulfil other requirements set by the stipulations concerning the recipient water bodies
2. to ensure the safe, environmentally acceptable utilisation and final treatment of sludge
3. to protect the sewer network and the health of the employees of wastewater treatment plants
4. to prevent harm to the operation of the treatment processes for wastewater and sludge
5. to prevent sewer network, treatment plants and their related equipment from getting damaged

The water utility can refuse to connect a property to the sewer of the water utility and to receive wastewater, referred in subsection 1 if the requirements, set in subsection 1, are not met.

Key contaminants for setting the limit values for pollutant releases

The environmental permit must state the necessary limit values for pollutant releases and other regulations on industrial wastewater to be conveyed to the sewer of the water utility or on other type of water that contains substances defined in Annex 1 of Environmental Protection Decree 713/2014. The authorising body of the environmental permit has to hear the water utility during the permit procedure.

Key contaminants for setting the limit values for pollutant releases (Annex 1, Environmental Protection Decree 713/2014):

1. organic halogen compounds and substances that may form such compounds in aquatic environments
2. organophosphorus compounds
3. organic tin compounds
4. substances and preparations that are proven to be carcinogenic or mutagenic, or to have properties that affect reproduction
5. persistent hydrocarbons and persistent and bioaccumulative toxic organic substances
6. cyanides and fluorides

7. metals and their compounds
8. arsenic and its compounds
9. biocides and plant protectants
10. suspended substances
11. substances that cause eutrophication, especially nitrates and phosphates
12. substances that affect the oxygen balance negatively.

To be taken into account in an industrial wastewater agreement

Special attention must be paid to the reception of substances, mentioned in Environmental Protection Decree 713/2014, and their conveyance to the sewer network. The possibility of environmental hazards in the aquatic environment and their prevention must be taken into account when preparing an industrial wastewater agreement. The general requirements on effluents conveyed to the sewer must be met.

2.2.2 Government Decree on Urban wastewater treatment 888/2006

Government Decree 888/2006 is applied to the treatment and conveying of urban, i.e. domestic wastewater that requires an environmental permit according to Environmental Protection Act 527/2014. The decree states the minimum requirements on treatment capacity, based on the urban wastewater directive, for wastewater treatment plants and requirements on monitoring frequency in treatment plants of various sizes. The treatment requirements for wastewater must be taken into account when planning, building or maintaining wastewater sewers. The best available techniques (BAT) must be used, and special attention must be paid to the amount of urban wastewater and its properties.

2.2.3 Government Decree on Substances dangerous and hazardous to the aquatic environment 1022/2006, Decree Amendments 868/2010 and 1308/2015

The purpose of Government Decree 1022/2006 is to protect surface water and improve its quality by preventing degradation caused by dangerous and hazardous substances. This decree has been amended by Decree 868/2010 and by Decree 1308/2015. The aim of the decree is to stop the releases and washout of substances dangerous to the aquatic environment, either at once or stage by stage. An additional aim is that no harm will be caused to the operations of the water utility by releases dangerous to the aquatic environment. The publication 15/2012 of the Ministry of the Environment, *Applying of stipulated regulations on substances dangerous and hazardous to the aquatic environment, a description of good practices*, presents good practices for implementing the decree in industry and wastewater treatment plants.[2]

Table A included in Annex 1 of the decree shows a list of substances which shall neither be discharged into surface waters nor sewers. This ban does not apply to effluents, which the operator can prove to have such an insignificant amount of the substance that there will be neither danger of contamination of surface water when allowing its release, nor any harm to the operations of the water utility.

Below is the substance list of Annex 1A:

- 1,2 dichloroethane
- aldrin
- dieldrin
- endrin
- isodrin
- DDT
- hexachlorobenzene
- hexachlorobutadiene
- hexachlorocyclohexane
- carbon tetrachloride
- pentachlorophenol
- tetrachloroethene (tetrachloroethylene)
- trichlorobenzene (1,2,4 trichlorobenzene)
- trichloroethene (trichloroethylene)
- trichloromethane (chloroform)

Items C and D of Annex 1 of Decree 1022/2006 include lists of the environmental quality standards for substances dangerous or harmful to the aquatic environment. The environmental quality standard (EQS) refers to such a substance concentration in surface water, sediment or biota that shall not be exceeded for the sake of human health or protection of the environment. The environmental quality standards can be defined either as annual average values or as temporary maximum allowed concentrations. The inland surface water and other surface water have norms that differ from each other on certain points.

Those environmental quality standards, which are presented in Item C2 of Annex 1, come into force on 22 December, 2018. In order to achieve a good chemical state for surface water, ELY centres (see Chapter 3.1.5) have to prepare a complementary monitoring programme concerning these substances and an action plan covering the substances in question by 22 December, 2018. Tables from Items C2 and D of Annex 1 of Decree 1022/2006 concerning substances dangerous and harmful to the aquatic environment are presented in Appendix 17 of this guide.

Section 6 b of the decree presents regulations on deviating from the environmental quality standards in a mixing zone. A mixing zone may be defined, for example, around the discharge area of the treatment plant if the requirements for the circumstances, presented in the decree, are all met. The decree also sets the monitoring frequency in case substances have been released into the water body. Annex 3 of the decree presents the analysis methods and requirements concerning the interpretations of the results.

The decree presents the maximum allowed limit values for releases containing mercury and mercury compounds, and for releases containing cadmium and cadmium compounds, both as concentration limits and as specific load limits. For the chlor-alkali industry, the limit value for mercury and mercury compounds is set at 50 µg/l and for other industries the limit value is 5 µg/l. The limit value for cadmium and its compounds is 10 µg/l.

Information on the measured quantities of a variety of harmful substances can be found in the report *Hazardous Substances at Wastewater Plants* (2014), which presents the results of studies conducted at 64 Finnish wastewater treatment plants.[3]

To be taken into account in an industrial wastewater agreement
The occurrence and concentration of substances, presented in Decree 1022/2006, in wastewater to be received should be defined when preparing an industrial wastewater agreement. Appendix 13 of this guide includes a questionnaire form that can be useful for making the definition. When setting the limit values, it is important to estimate how much and in which concentrations the substance in question may end up in the water body and whether there is a risk that the substance may exceed the environmental quality standard or affect the definition of a mixing zone when released into the water body.

2.2.4 BAT reference documents (BREFs)

The BAT reference documents or; in other words, the BREFs, provide information on state-of-the-art techniques: on best available methods and technical solutions, and consumption and release levels which can be achieved by them. The preparation of BREF documents is based on the Industrial Emissions Directive (IED). BAT documents are applied when permit regulations are set for industrial operations. The Commission has published BAT documents, which are also available in Finnish as summaries. Additionally, BAT publications have also been drawn up nationally.

To be taken into account in an industrial wastewater agreement
When preparing an industrial wastewater agreement, the BAT reference documents can be applied for those industries for which they are available.

2.2.5 Sanitation Safety Plan

Sanitation Safety Plan (SSP) is a management system for environmental and health risks focused on processes and different sections of wastewater management. Section 15 of Environmental Protection Act 527/2014 requires that the operator, to which the governmental authority grants the environmental permit, has to prepare a contingency plan based on risk assessment. By using SSP, the organisation responsible for the treatment and/or sewerage of wastewater can fulfil the obligation required by the law and ensure that its operations do not cause environmental degradation, health risks or deteriorate recreational values.

SSP's sub-section *Effluents* covers all different kinds of effluents conveyed to the sewer, including also industrial wastewater, the amount of effluents and the effects on wastewater management, as well as the management and coverage of the agreements of various joining parties. The risk management process steers towards controlled reception of industrial wastewater and implementation of suitable measures, such as exchange of information and industrial wastewater agreements.

2.3 Regulations and agreements on chemicals

2.3.1 Chemicals Act 599/2013/ and Chemicals Decree 675/1993

The Chemicals Act 599/2013 came into force in 2013 striving to clarify and standardise the national chemicals legislation according to EU legislation, especially from the point of view of REACH and CLP regulations. According to the Chemicals Act, the responsible party which is bringing a hazardous chemical to the market has to label the chemical as hazardous. If the product is hazardous according to the Chemicals Act, it is also hazardous as waste. Therefore, labels and warnings on the substance on the original package say that the substance is to be disposed of as hazardous waste.

The Chemicals Act also includes regulations on supervisory authorities concerning the legal provisions and their tasks. According to the Chemicals Act, an operator has to choose the chemical or the method that will cause the least danger to the environment and health, from the options available.

Chemicals Decree 675/1993 provides more detailed regulations on the obligations laid down in the Chemicals Act, which concern classifications, labelling and packaging.

2.3.2 REACH and CLP

The REACH regulation (EC) No 1907/2006 places responsibility on industry to manage the risks from chemicals and to provide safety information on the substances. Under REACH, the European Chemicals Agency ECHA collects information on substances for its database, which are produced or imported to the EU area yearly more than 1 tonne per one operator. Registration requires that the manufacturers and importers of these substances acquire all necessary information on the hazardous properties of substances, their methods of use, health and environmental impacts and safe usage. Downstream users of chemicals do not have to register, but they are obliged to use chemicals safely.

The Classification, Labelling and Packaging (CLP) Regulation (EC) No. 1272/2008 requires manufacturers, importers or downstream users of substances or mixtures to classify, label and package their hazardous chemicals appropriately before placing them on the market. When relevant information (e.g. toxicological data) on a substance or mixture meets the classification criteria in CLP, the hazards of a substance or mixture are identified by assigning a certain hazard class and category. The hazard classes in CLP cover physical, health, environmental and additional hazards. CLP sets detailed criteria for the labelling elements: pictograms, signal words and standard statements for hazard, prevention, response, storage and disposal, for every hazard class and category.

To be taken into account in an industrial wastewater agreement

Special attention must be paid when releasing substances harmful and dangerous to the aquatic environment in the sewer network. The hazard and precautionary statements in the labelling of a chemical communicate the identified hazards. The possibility of hazards caused to the aquatic environment and their prevention must be taken into consideration when drawing up an industrial wastewater agreement.

2.3.3 E-PRTR Regulation 166/2006

Regulation (EC) No. 166/2006 of the European Parliament and of the Council concerning the establishment of the European Pollutant Release and Transfer Register and amending Council 91/689/EEC and 96/61/EC (E-PRTR Regulation), obliges the major wastewater treatment plants (PE >100 000) to report releases of certain harmful substances into the air, water or ground. The regulation includes a list of substances that should be reported if the threshold value of the substances (kg/year) is exceeded. The E-PRTR Regulation comprises also large landfills and many industrial plants. The reporting obligation also concerns wastewater loading generated by an industrial plant and conveyed to the sewer network.

The implementation instruction of the E-PRTR Regulation includes a list presenting all relevant substances that have been estimated as relevant at the domestic wastewater treatment plants.[18] The list of these substances is presented here below. However, the regulation does not set any restrictions for the releases. All listed substances were not observed according to the paper *Occurrences of harmful substances in Finnish municipal wastewater, results from the E-PRTR report* published in 2008.

- Heavy metals
    - Arsenic and arsenic compounds, cadmium, chromium, copper, mercury, nickel, lead, zinc
- Volatile chlorinated hydrocarbons
    - 1,2 dichloroethane (EDC, dichloromethane (DCM), tetrachloroethylene (PER), tetrachloromethane (TCM), trichloroethylene, trichloromethane i.e. chloroform
- BTEX compounds
    - benzene, toluene, xylenes
- PAH compounds
    - naphthalene, fluoranthene, benzo(ghi)perylene
- Biocides
    - atrazine, diuron, simazine, isoproturon
- Organic lead compounds
    - Tributyltins (TBT), triphenyltins
- POP compounds
    - Hexachlorobenzene (HCB), lindane, pentachlorophenol (PCP), polychlorinated biphenyls (PCB)
- Phenols and alkylphenols
    - Nonylphenol and nonylphenol ethoxylates (NP/NPE compounds), phenols, octylphenols (OP) and octylphenol ethoxylates (OPE)
- Other compounds
    - Halogenated organic compounds (AOX), di(2-ethylhexyl)phthalate (DEHP), cyanides

To be taken into account in an industrial wastewater agreement

When preparing industrial wastewater agreements, special attention has to be paid to the substances listed above. The E-PRTR Regulation requires reporting but does not set restrictions for occurrences of the substances. If an industrial plant falls under the E-PRTR Regulation, the information on pollutant releases required for reporting is available.

2.3.4 The 2001 Stockholm Convention on POPs

A world-wide agreement concerning restrictions on POP compounds (persistent organic pollutants) came into force in May 2004. Finland ratified the agreement in 2002. The convention stops or heavily restricts the production, trade, use and releases of those POP compounds which fall under the agreement. The following compounds are included in the agreement: aldrin, dieldrin, endrin, DDT, heptachlor, chlordane, mirex, toxaphene, hexachlorobenzene, PCB, dioxins and furans, as well as the following added later: lindane (HCH) and its isomers (alpha- and beta-HCH), perfluorinated octylsulfonates (PFOS), brominated fire retardants (PBDE), penta- and octabromide phenylether, fire retardant hexabromide biphenyl (HBB), chlordecone used as biocide, pentachlorobenzene (PeCB) used as fire retardant in the production of biocides and hexabromide cyclododecane that was added to the prohibition Annex of the Stockholm Convention in May, 2013.

To be taken into account in an industrial wastewater agreement

When preparing an industrial wastewater agreement, it should be considered that the aim is to prevent occurrences of substances mentioned above. The acceptance of these substances being conveyed to the sewer leads to a situation where these substances will end up in the water bodies or treatment plant sludges.

2.3.5 HELCOM list of substances of special concern

The action plan drawn up in the context of implementing the Helsinki Convention on the marine environmental protection of the Baltic Sea area recognizes eleven substances or substance groups which are of special concern. The substances are dioxins, polychlorinated biphenyl compounds similar to dioxin (PCBs similar to dioxin), mercury, cadmium, tributyltin TBT), triphenyltin (TPhT), PBDE, HBCD, PFOS and perfluorooctanoic acid (PFOA), endosulfan, nonylphenols and nonylphenol ethoxylates, octylphenols and octylphenol ethoxylates, and chlorinated paraffins (SCCP, MCCP).

2.3.6 Government Decree on the Monitoring of the handling and storage of dangerous chemicals 685/2015

Government Decree 685/2015 regulates the safety of handling dangerous chemicals and explosives laid down in Chemicals Safety Act 390/2005 on the handling and storage of dangerous chemicals, and their related permit, notification, administrative procedures and monitoring.

According to the decree, a safety report is required which stipulates that the operator has recognised the risks of a major accident and that the necessary measures have been taken to prevent them and to restrict the consequences of such major accidents for the population, environment, properties and possessions. The safety report has to include a description of how the water is collected for fire extinction. The permit application for a large-scale industrial treatment and storage must also include an account of how the collection and treatment of water needed for fire extinction and cooling are arranged.

2.4 Regulations on treatment plant sludge, waste and health protection

2.4.1 Fertiliser Product Act 539/2006

Fertiliser Product Act 539/2006 regulates the production of fertiliser products, their placement on the market and import and export of these products. The act requires e.g. that all operators have to organise self-supervision and that all plants manufacturing organic fertiliser products have to be registered as an approved establishment. Soil produced from treatment plant sludge or other soil enrichment product falls under the scope of the Fertiliser Product Act.

2.4.2 Decree of the Ministry of Agriculture and Forestry on Fertiliser products 24/11

Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 24/11 lays down provisions on the classification and on the requirements for each type of fertiliser products, as well as on the quality, marking, packaging, transport, storage, use and other requirements for fertiliser products and for their raw materials.

Decree on Fertiliser Products 24/11 provides the maximum allowed concentrations of harmful metals and the maximum allowed concentrations of pathogens (Salmonella and *Escherichia coli*) in fertiliser products. The decree defines the limit values for heavy metals in fertiliser products presented below in Table 1.

To be taken into account in an industrial wastewater agreement

The concentration of harmful metals in sludge and their effect on the quality of fertiliser products manufactured from sludges should be taken into account when defining limit values for industrial wastewater.

Table 1: The maximum allowed concentrations of harmful metals in fertiliser products

Element	**Maximum allowed concentration** (mg/kg of dry substances)
Arsenic (As)	25
Mercury (Hg) 1)	1.0
Cadmium (Cd)	1.5
Chromium (Cr)	300
Copper (Cu)	600 2)
Lead (Pb)	100

Nickel (Ni)	100
Zinc (Zn)	1 500 [2)]

1) Definition of mercury by EPA 743 method

2) Exceeding of the maximum allowed concentrations in fertiliser products may be allowed if, according to a soil analysis, there is lack of copper or zinc

2.4.3 Decree of the Ministry of Agriculture and Forestry on the Exercise and supervision of activities regarding fertiliser products 11/12

Decree of the Ministry of Agriculture and Forestry on exercise and supervision of activities regarding fertiliser products 11/12 lays down provisions on the obligation to notify, to keep a file, to practise self-supervision, to notify in advance, as well as provisions on a laboratory approval, on an approval of an establishment manufacturing or technically processing organic fertiliser products or their raw materials, and on organising the control concerning fertiliser products.

Government Decree on waste 179/2012 also provides requirements concerning sludge producers, see Chapter 2.4.4.

2.4.4 Waste Act 646/2011 and Waste Decree 179/2012

The Waste Act stipulates the responsibilities of various parties concerning the organisation of waste management. The responsibility of municipal waste management comprises the organisation of transport, recycling, utilisation and final treatment services of domestic waste, including sludges from septic tanks and cesspits.

The Waste Act regulates the obligation of those who produce waste to obtain and provide information. A producer, manufacturer or importer of products has an obligation to obtain information on the production or product that generates waste, on its environmental or health effects, waste management and on the possibilities to reduce the amount and hazardousness of the produced waste. The waste holder must also be aware of the origin, amount, type, quality and other relevant information when organising waste management, like properties of waste, environmental and health effects of waste management and, if necessary, the holder must provide this information also for other parties of waste management.

A transfer document is needed when transporting waste, including the transport of sludges from septic tanks and cesspits, sludges from oil separation wells and grit chambers, construction and demolition waste, as well as contaminated soil extracts.

Hazardous waste is defined in the Waste Act as waste that is inflammable, explosive or infectious or is otherwise hazardous to human health or to the environment. The Waste Act prohibits mixing of hazardous waste with other waste types.

Government Decree on Waste 179/2012, Annex 4, provides a list of the most common waste and hazardous waste. Waste classification as hazardous waste is described in the publication *Categorisation of waste as hazardous waste* (2016).[4]

The requirements concerning the producer of wastewater sludge are included in the Government Decree on Waste. The requirements on producer records (Section 20) concern sludge producers. Additionally, the Government Decree on Waste comprises separate requirements to keep records on domestic wastewater sludges and on information provided to the supervisory authorities (Section 21). Section 18 and Annex 5 set requirements for monitoring the quality of sludge.

2.4.5 Regulation on by-products 1069/2009 and its implementing regulation 142/2011

The regulation on by-products (Regulation of the European Parliament and of the Commission (EC) No. 1069/2009) and its implementing regulation (Commission Regulation (EC) No. 142/2011) lay down the rules regarding collection, transport, storage, pretreatment, treatment, transformation, processing, use, disposal, placing on the market, import, export and transit transport of animal by-products.

Animal by-products refer to other products than those derived from animals for human consumption. They include, for example, animal carcasses, former foodstuffs of animal origin, food waste intended for composting facilities and by-products of animal origin from slaughterhouses and other foodstuff industries. The aim of the by-product regulation is to protect human and animal health by providing a regulative framework which ensures that various pathogens do not end up in the food chain.

By-products are classified in three categories according to the risk related to them. The classification serves for utilising and disposing of by-products. The highest risks are related to the by-products from the Category 1. Category 1 includes e.g. animals that are suspected of being infected with TSE (transmissible spongiform encephalopathies) and international catering waste. Category 2 includes by-products such as manure and carcasses of dead livestock. By-products of Category 3 are classed as low risk, and they include e.g. food waste from households, restaurants, catering services and institutional kitchens, including used cooking oil and foodstuffs of animal origin (processed animal by-products) from retail and wholesale businesses and from the food industry.

Processing plants treating animal-derived by-products of Category 1 and 2 and slaughterhouses must have a pretreatment process for the retention and collection of animal material from wastewater. Equipment used in the pretreatment process shall consist of drain traps or screens/sieves equipped with filter pore or mesh size of no more than 6 mm in the downstream end of the process. Floor drains must be equipped with sieves throughout the slaughter line and storages where risk material can end up in the sewers. Wastewater that has gone through the pretreatment process and is then conveyed to the sewer, does not fall under the scope of the by-product regulation after going through a 6 mm sieve, and the regulation concerning its treatment is laid down in the conditions of the environmental permit.

According to Implementing Regulation 142/2011, the disposal of animal by-products, including blood and milk, or products derived from by-products in the wastewater stream is prohibited. They must be collected and used or disposed of according to the by-product regulation. The only exception in Finland is the liquid milk products in retail stores which can be treated at wastewater treatment plants. That matter should be agreed upon with the water utility in question.

Act on Animal By-Products 517/2015 and based on it, Decree of the Ministry of Agriculture and Forestry 783/2015 on animal-derived products comprise the national reliefs related to the national implementation of the EU's animal by-product regulation in Finland. These reliefs concern the use and disposal of animal by-products and products that are derived from them.

The treatment of by-products of Category 3, including raw foodstuffs formerly of animal origin (unprocessed animal-based products), and of processed by-products from Category 2 in composting or biogas plants has to follow the procedure defined in the animal by-product decrees. Food waste of Category 3, former processed foodstuff of Category 3 (i.e. processed animal-derived products) and manure of Category 2 can also be treated by other nationally approved methods, which are regulated in Fertiliser Product Act 539/2006 and in the Ministry of Agriculture and Forestry Decrees based on the Fertiliser Product Act.

2.4.6 Health Protection Act 763/1994

According to the Health Protection Act, the storage, collection, transport, treatment and utilisation of waste and the conveying and treatment of wastewater must be executed so that no health hazard is caused. Additionally, sewers and related structures must be planned and designed, located, built and maintained so that no health hazard is caused.

2.5 Regulations and standards regarding certain industries

2.5.1 Government Decision on Amalgam-containing wastewater and waste resulting from dental care 112/1997

Wastewater generated by the activities in the treatment units of dental care clinics must be conveyed to the sewer through an amalgam-separator. The efficiency of such separators must be at least 95%.

2.5.2 Government Decree on the Environmental protection requirements of energy production units with a rated thermal input below 50 megawatts 750/2013

This decree is applied to such energy production units using solid, liquid or gaseous fuel and with a rated thermal input of at least 5 megawatts but below 50 megawatts. The decree is also applied if all energy production units of the entire plant area exceed 5 megawatts with their rated thermal input. The decree gives requirements on the treatment of condensation water, water from sweeping, oily water and water from the pickling process.

The operator must provide information on the amount and quality of wastewater from the energy production plant. If the operations generate or use materials which contain substances that are hazardous and harmful to the aquatic environment and which are listed in the Annex I of Government Decree 1022/2006, it has to be ensured that these substances do not reach the groundwater, aquatic environment or sewers.

Chimney sweeping water that is generated non-recurring must be pretreated by neutralisation and sedimentation before it can be conveyed to the sewer, or it must be collected and transferred further to an establishment equipped with an adequate treatment permit.

Water from pickling processes must be processed by neutralising before it is conveyed to the sewer or it must be collected and transferred further for suitable treatment. According to the decree the rinsing water from a pickling process can be led directly into the ground. The reception of pickling water at the wastewater treatment plant is discussed in Chapter 8.9.

When water from oil separators is led to the sewer, it must be treated in an oil separator of Class II according to Standard SFS-EN-858-1. The hydrocarbon concentration in water discharged from the oil separator has to be below 100 mg/l.

Water from oil separators that is led to rainwater drains or into a water body must be treated in an oil separator of Class I according to Standard SFS-EN-858-1. The hydrocarbon concentration in water discharged from the oil separator is below 5 mg/l.

The decree requires that the sewer must be equipped with a sampling and shutoff valve manhole right after the oil separator in order to prevent wastewater from the energy production plant from getting released into the sewers of the water utility. The sampling and shutoff valve manhole must be located, marked and protected so that there is an unobstructed entry to the manhole. It must be possible to close the valve without any delay. The oil separators must be kept operational and they must be emptied at least once a year.

2.5.3 Government Decree on Limiting emissions from large combustion plants 936/2014

Decree 939/2014 is applied to large-scale incineration plants which use solid, liquid or gaseous fuel and which have a thermal rate of at least 50 megawatts. The decree lays down the restrictions of emissions released into the air by large incineration plants in Section 97 of Environmental Protection Act 527/2014. The decree does not include requirements concerning wastewater.

2.5.4 Government Decree on Environmental protection regulations of liquid fuel distribution stations 444/2010

This decree is applied to the distribution stations of liquid fuels with a total volume of fuel tanks of at least of 10 m^3. The decree comprises regulations concerning the treatment of oily wastewater and conveying such wastewater to the sewer. When water from oil separators is led into the wastewater sewer or into a closed tank, it must be treated in an oil separator of Class II according to Standard SFS-EN-858-1. The hydrocarbon concentration in water discharged from the oil separator has to be below 100 mg/l. When water from oil separators is not led into the wastewater sewer, it must be treated in an oil separator of Class I according to Standard SFS-EN-858-1. The hydrocarbon concentration in water discharged from an oil separator has to be below 5 mg/l. After this, it can be led to the rainwater drain or into the water body based on the permit granted by environmental authorities.

2.5.5 Government Decree on Waste incineration 151/2013

The decree is applied to a waste incineration plant and waste co-incineration plant burning solid or liquid waste. The decree requires that there must a large enough basin or a tank for storing impure stormwater from the plant area or for leaks and other impure water from fire extinction actions at the plant premises. Impure water must be stored so that it can be investigated and treated if necessary.

Annex 4 of the decree includes the following limit values for pollutant releases defined for impurities in wastewater generated by the treatment of combustion gases.

1. Total solids	30 mg/l (95%) 45 mg/l (100%)
2. Mercury and its compounds as mercury (Hg)	0.03 mg/l
3. Cadmium and its compounds as cadmium (Cd)	0.05 mg/l
4. Thallium and its compounds as thallium (Tl)	0.05 mg/l
5. Arsenic and its compounds as arsenic (As)	0.15 mg/l
6. Lead and its compounds as lead (Pb)	0.2 mg/l
7. Chromium and its compounds as chromium (Cr)	0.5 mg/l
8. Copper and its compounds as copper (Cu)	0.5 mg/l
9. Nickel and its compounds as nickel (Ni)	0.5 mg/l
10. Zinc and its compounds as zinc (Zn)	1.5 mg/l
11. Dioxins and furans	0.3 ng/l

Wastewater shall not be diluted for complying with the limit values for pollutant releases.

The decree also stipulates the measurement of wastewater and the measuring frequency. If wastewater is treated together with other wastewater, it is required that mass balance calculations are provided for complying with the set limit values.

2.5.6 Decree of the Ministry of the Environment on Water supply and sewer systems of properties 1047/2017

The decree comprises guidelines and regulations concerning properties' water supply and sewer systems. The decree states that if sand, sludge, grease, petroleum, oil or other harmful substances can enter the property's wastewater system, the sewer or the aquatic environment, the property's wastewater system must be equipped with a separator or a treatment device. The decree replaces the former National Building Code of Finland D1 2007.

2.5.7 The Finnish Standard SFS 3352 for distribution stations of combustible liquids

According to the standard, wastewater generated in car wash activities must be conveyed to the sewer through adequate grit chambers and oil separators. Only tested and approved detergent mixtures should be used for car washes (see Chapter 8.11.3). The sewer after the oil separators must be equipped with a shutoff valve and monitoring manhole. The identifying colour of the lids of oil separators and shutoff valve manholes is yellow (Item 14). The purpose of the sewerage at the filling site of the tanks is to convey the accrued surface water and, in case of an accident, any leaked liquid fuel away from the filling site. The standard requires that the treated water from the oil separator of the tanks at the filling site must be conveyed to the wastewater sewer of the water utility (Item 14.3).

3 PARTIES INVOLVED WITH, AND DOCUMENTS RELATED TO INDUSTRIAL WASTEWATER

3.1 Parties involved in industrial wastewater issues

Parties involved in industrial wastewater issues include the municipality, water utility, operator, the authorities granting the environmental permit and supervising the operator (the Regional State Administrative Agency (AVI), the Centre for Economic Development, Transport and the Environment (ELY), the municipal environmental protection authority), and the supervisory authorities for chemicals use and storage.

3.1.1 Municipality

The municipality approves the operational area for the water utility operating in its territory. The operational area has to be such that the water utility is able to take care of the water services economically and pertinently. The operational area covers all areas where properties' connection to the water utility's sewers is necessary due to the amount and quality of housing. The municipalities are themselves responsible for granting the environmental permits for smaller-scale plants and for making the decisions on certain sewerage issues and other minor issues related to the Water Act. The responsibilities of a municipal environmental protection authority are described in Chapter 3.1.7.

3.1.2 Water utility

According to the Water Services Act, the task of a water utility is to provide household water for its customers and to organise sewerage and treatment of wastewater, stormwater and drainage water from foundations. A property that is located in the operational area of the water utility must be connected to the sewer of the water utility. A water utility can decline to connect a property to the sewer of the water utility, if the quality and amount of waste conveyed to the sewer would interfere negatively with the operations of the water utility or would affect its ability to satisfactorily manage other properties' water services. A water utility can also decline to connect a property to the water supply network of the water utility if the water consumption of that property would negatively affect the operations of the water utility. The Water Services Act does not oblige a water utility to connect an operator to the water utility's water supply and sewerage networks if the operator produces industrial water which diverges significantly from the household wastewater in its amount and quality or both. The connection can be implemented, however, by a separate agreement based on civil law.

According to the Water Services Act, so-called 'bulk plants' or, in other words, separate wastewater treatment plants are not water utilities. Customers of these plants are the water utilities, not the properties. To a certain extent, however, the regulations laid down in the Water Services Act refer also to such plants which only treat wastewater from water utilities.

3.1.3 Operator

The operator generating wastewater which diverges from domestic wastewater is a customer of the water utility. Wastewater generated by the operator is conveyed to the sewers owned by the water utility. The operator shall be aware of the quality of wastewater that is conveyed to the sewer, substance releases and effects of its operations. A plant conveying non-household wastewater to the sewers usually falls under the environmental permit obligation (see Chapter 3.2.3), but not always.

3.1.4 Regional State Administrative Agencies (AVI)

There are six Regional State Administrative Agencies in Finland; their scope of responsibility covers basic services, legal protection and permits, occupational safety and health, environmental permits, rescue services and contingency planning and the police. Four AVI Agencies (Southern Finland, Eastern Finland, Western and Central Finland and Northern Finland) hold responsibility areas for environmental permits. The AVI Agencies grant environmental permits. The responsibility area of AVI Agencies for the occupational safety is to guide and supervise the activities of the municipal authorities supervising chemicals in compliance with the regulations laid down in the Chemicals Act in issues of preventing chemicals-induced health hazards and risks of fire and explosion.

3.1.5 Centres for Economic Development, Transport and the Environment (ELY)

The Centres for Economic Development, Transport and the Environment, in short ELY centres, can be divided into 15 centres with responsibility areas such as economic development, labour force, competence and culture, transport and infrastructure, and the environment and natural resources. Their task field covers monitoring of the state of the environment, environmental protection, nature conservation, steering of land use and construction, protection of cultural landscapes and use and management of water resources. The ELY centres supervise adherence to the legal regulations on preventing and combating environmental hazards caused by chemicals at plants using chemicals. The task of ELY centres is to monitor the adherence to the permit regulations of environmental permits granted by officials from the AVI Agency. The ELY centres also issue a report on environment permit applications. Not all ELY centres hold a responsibility area for the environment.

3.1.6 Other supervisory authorities

The environmental authorities cooperate in chemicals-related supervisory issues with other authorities responsible e.g. for health, occupational safety and health, rural and rescue and safety technique issues. On the local level, the rescue authorities supervise the adherence of regulations pertaining to the Chemicals Safety Act (Act on the Safe Handling and Storage of Dangerous Chemicals and Explosives 390/2005). All national issues related to the supervision of chemicals have been centralised to the Finnish Safety and Chemicals Agency (TUKES).

The municipal supervisory authority responsible for chemicals supervises adherence to the Chemicals Act when it concerns bringing chemicals on the market and their retail sale. The occupational safety agencies of the Occupational Safety and Health Administration supervise the prevention and combating of health hazards and risk of fire and explosion caused by the use of chemicals at work.

3.1.7 Municipal environmental protection authorities

A municipal environmental protection authority acts as the supervisor of public interest in issues related to environmental protection. Act 64/1984 on municipal environmental protection administration sets the regulations concerning the municipal environmental authority and its tasks. The task of the municipal environmental protection authorities is to take care of planning, development and information concerning environmental protection. The most crucial tasks are, among others, processing of environmental permits, expert tasks related to town planning reports, preparing of statements related to environmental permits, tasks related to the Water Act, supervisory tasks related to water services and wastewater issues in sparsely populated areas, tasks related to waste management and supervision of waste management and also permit issues related to extracting of soil resources.[5]

3.2 Industrial wastewater agreements and other documents

Documents related to industrial wastewater include the industrial wastewater agreement, the service and connection agreements, the delivery terms and conditions of the water utility, and the environmental permit. A temporary agreement can be drawn up for occasional batches of wastewater and short-term operations with a wastewater quality diverging from normal household-generated wastewater. In addition to an industrial wastewater agreement, a water utility can also prepare separate letters of intent with the industry, for example agreements on the principles of the division of investment costs.

3.2.1 Normal connection and service contract

Agreements of water services include the connection and service agreement. The connection agreement concerns connecting a property to the sewer of a water utility and the service agreement refers to the delivery and use of services provided by a water utility. The parties of a connection agreement are the public utility and the owner of the property or the holder (the connecting party) equal to the owner. The service agreement can also be concluded with someone other than the connecting party when the contracting party of the public utility is the holder of the property, such as the tenant. The Water Services Act, Section 21, requires that an agreement concerning the connection and related conditions has to be prepared either in writing or electronically with each property that is to be connected to the sewer. The connection agreement is not to be made with an operator if the operator is different than the owner of the property.

The industrial wastewater agreement should be drawn up in parallel with the connection agreement if the property of the industrial plant has not yet been connected to the sewer of the water utility.

3.2.2 Delivery terms and conditions

General terms and conditions concerning connecting a property to the water utility's sewerage network and provision and usage of the services provided by the water utility are called general delivery terms and conditions. General delivery terms and conditions complement the connection agreement. The connection agreement between the water utility and operator can state that the contractual relation complies with the general delivery terms and conditions. These delivery terms and conditions, which primarily refer to common residential use, can also be applied to the agreements of industrial plants to some extent.

If the industrial wastewater agreement and the general delivery terms and conditions include conflicting conditions, the agreement shall determine. A separate agreement on the application of the delivery terms and conditions can also be drawn up with the operator. If necessary, delivery terms and conditions that differ from the general delivery terms and conditions of normal connecting parties can be prepared for the operator.

3.2.3 Industrial wastewater agreement

An industrial wastewater agreement shall be prepared if non-household wastewater is conveyed to the sewer of a water utility and if the amount and quality of industrial wastewater is such that it may have effects on the occupational safety of the water utility's employees, on the state of the sewer network, on the wastewater treatment process, or on the sludge quality. The agreement must also be drawn up if industrial wastewater includes such substances that may have an impact on the state of the recipient water body. An industrial wastewater agreement is necessary if for the aforementioned reasons, there is a need to set requirements, restrictions or monitoring obligations for wastewater, or to collect increased fees for non-household wastewater.

An industrial wastewater agreement is usually drawn up with such an operator which falls under the environmental permit obligation. However, it might be useful to conclude an industrial wastewater agreement with an operator which does not hold an environmental permit. The necessity of an industrial wastewater agreement is case-specifically decided upon by the water utility.

An industrial wastewater agreement can also be concluded retrospectively. The industrial wastewater agreement should be renewed if there are changes to the operations of the industrial plant, amount or quality of wastewater.

There is no need for an industrial wastewater agreement if the quality of wastewater ensuing from operations can be compared to household-generated wastewater and does not interfere negatively with the operations of the treatment plant (e.g. laboratories, dental clinics). If a water utility concludes a connection agreement with such a property owner, the property owner shall comply with the general delivery terms and conditions of the water utility. The water utility must also inform the operator about the decision that an industrial wastewater agreement is not necessary. The situation will change if problems with the quality of wastewater arise later on. In that case, the water utility may require an industrial wastewater agreement.

3.2.4 Provisional sewerage permit for occasional effluents

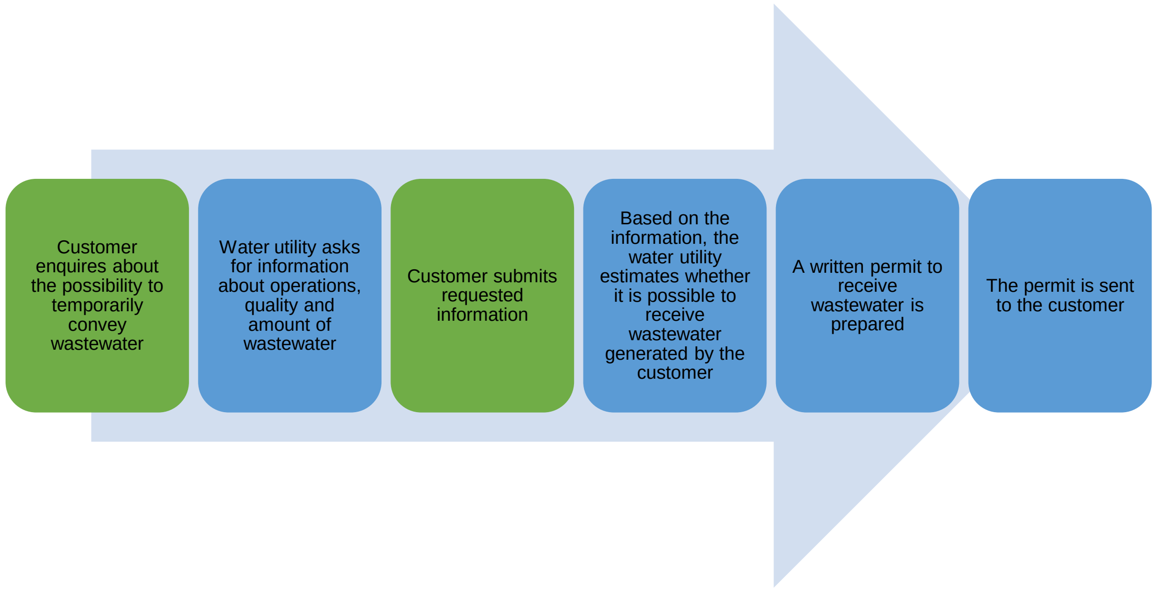
An agreement with the water utility or sewerage permit from it is needed for conveying occasional effluents to the sewer although wastewater in question would diverge only a little from normal domestic wastewater, or the amount of wastewater is minor, or conveyance of wastewater is non-recurring. In this case, a free-form application is sufficient or there is a fill-in application form available. The water utility provides a written decision on conveying wastewater to the sewer.

For a temporary permit, the water utility needs the following information:

- where and how wastewater is generated
- hazardous substances and their concentrations in wastewater
- the amount of wastewater
- wastewater test results
- operational safety information on the substance in wastewater
- contact information
- sewerage address
- information on sewerage date
- environmental permit decision

Additionally, the water utility may ask for a sample so that the consistency of a substance or composition of wastewater can be more easily estimated. Substances which should be analysed can be determined with the help of Appendix 16.

The process of a provisional sewerage permit is presented in Picture 1.



Picture 1: Preparation process of a provisional sewerage permit

When preparing these kinds of agreements, it should be considered that separately collected hazardous waste shall not be disposed of through a sewer (e.g. expired detergents). Provisional agreements are prepared, for instance, for the sewerage of wastewater generated by treating contaminated soils (Appendix 12).

Within the frame of provisional agreements, the fee for conveying wastewater to the sewer follows the same charging principles as for other types of wastewater.

3.2.5 Environmental permit

The Environmental Protection Act, the Environmental Protection Decree and the Water Act define those situations which require an environmental permit. In Annex 1 of Environmental Protection Act 527/2014, the operations subject to an environmental permit are listed in a catalogue which divides the operations subject to a permit into directive plants and other establishments. The environmental permit includes regulations on conveying wastewater to the sewer of a water utility. If there is an industrial wastewater agreement, the agreement is usually an appendix to the environmental permit application of the operator.

According to Environmental Protection Decree 713/2014, Section 42, the environmental authority shall hear the water utility during the permit process if substances mentioned in Annex 1 are conveyed to the sewer. Within the hearing, the water utility can bring forward the need to conclude an industrial wastewater agreement or other aspects which should be taken into account in the permit.

The implementation of an environmental permit is monitored according to the monitoring programme determined in the environmental permit which is usually supervised by the ELY centre. It is expedient that the monitoring, which is a requirement determined in the environmental permit and industrial wastewater agreement, must be conducted as consistently as possible.

In the processing stage of environmental permitting, a good proven practice has been that rescue services, environmental inspectors and water utilities perform collaborative monitoring at industrial plants.

The contents of the operator’s environmental permit and of the industrial wastewater agreement can differ from each other. The operator must follow the regulations presented in both documents.

3.2.6 Wastewater agreement between water utilities

Water utilities can conclude an agreement with each other, in which one water utility commits itself to receiving wastewater from the area of the other water utility. It is recommended that the agreement between water utilities is prepared according to the instructions presented in the Finnish Water Utilities Association FIWA’s publication *Model agreements between water utilities with explanations* (2008). Requirements on the amount and quality of wastewater shall be included in the agreement. In addition to the measuring obligation of the wastewater amount, also a monitoring programme of the wastewater quality could be added to the agreement. The agreement between water utilities must include a clause that the industrial wastewater agreement complies with the requirements set by the recipient water utility. The agreement must reserve a possibility at least to provide a report on the conditions of the agreement between the connecting party and the industrial plant in the negotiation phase, or the water utilities can draw up the agreement in cooperation. The contracting parties must ensure in advance that the recipient wastewater treatment plant is able to process industrial wastewater within the scope of its environmental permit. It can also be agreed that the recipient wastewater treatment plant is responsible for the inspections and supervision of the concerned industrial plants and providing them with instructions.

The operator concludes an industrial wastewater agreement with that water utility to whose sewerage network the operator will connect. Wastewater can run through the networks of several different water utilities and end up for treatment again at that treatment plant for which its own organisation is responsible. It would be advisable that all those parties whose operations may be influenced by wastewater are taken into account when preparing these agreements. In certain cases, an industrial wastewater agreement has been also concluded between three organisations, i.e. between the owner of the network, the wastewater treatment plant and the operator. For example in Turku this has been the case.

In the environmental permit process, the environmental authority granting the permit hears that water utility which owns the sewerage network to which the operator connects. In this context, the water utility receiving wastewater must have the right to present a proposal for the measures required from the industrial plant to ensure the quality of wastewater and to bring forward monitoring and pretreatment requirements. It is recommended to ensure in advance that the recipient treatment plant is able to process industrial wastewater according to its permit conditions. The aforementioned aspects must be included in the agreement between the water utilities.

4 PREPARATION AND CONTENTS OF AN INDUSTRIAL WASTEWATER AGREEMENT

4.1 Preparation process of an industrial wastewater agreement

When an agreement is drawn up, it is recommended to first visit the operation plant, discuss about the operations and negotiate the agreement contents with the operator.

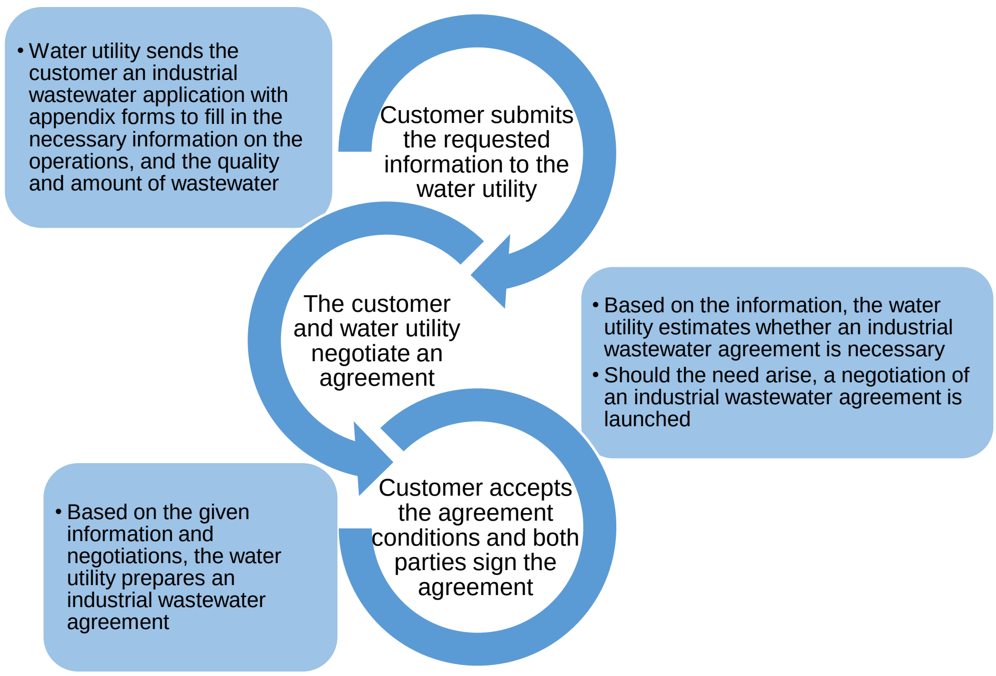
In most cases, the preparation of an industrial wastewater agreement is started by sending the operator an industrial wastewater application form drawn up by the water utility. The operator fills in the application form all information concerning the operator and property. The water utility can provide the necessary forms. Model forms are provided in Appendices 8, 12 and 13.

The application shall include following information:

- the operational time of the plant per day (24h)
- operations at the plant generating wastewater
- raw materials used in the processes
- substances defined in Decree 1022/2006, in the amendments 868/2010 and in Decree 1308/2015
- substances defined in Annex 1 of Environmental Protection Decree 713/2014 (Key substances which cause contamination and degradation when setting limit values for pollutant releases)
- the amount and quality of wastewater
- flow charts of wastewater pretreatment system
- measurements and operation method of the pretreatment system
- the measurement site for the discharge and the measurement method for the discharge
- a map drawing (e.g. town plan drawing) which shows the connection point
- the sampling point
- the amount of chemicals to be stored and used, manuals and operational safety information

Based on the collected information, the water utility draws up an estimation concerning the possibility of receiving wastewater and the need to set conditions and restrictions to be included in the agreement. If necessary, the background information shall be complemented and detailed. Based on this information, the water utility prepares an industrial wastewater agreement which includes the conditions set for conveying wastewater to the sewer. The agreement draft is then delivered to the operator to be checked. After approval, both parties will sign the contract. Appendices 1-8 present examples of industrial wastewater applications and agreements, as well as the limit values included in the appendices of agreement.

Picture 2 presents the preparation process of an industrial wastewater agreement.



Picture 2: Preparation process of an industrial wastewater agreement

For solving more complex agreement situations, it may be necessary to have several agreement negotiations and to modify the agreement draft in order to find a solution that satisfies both parties.

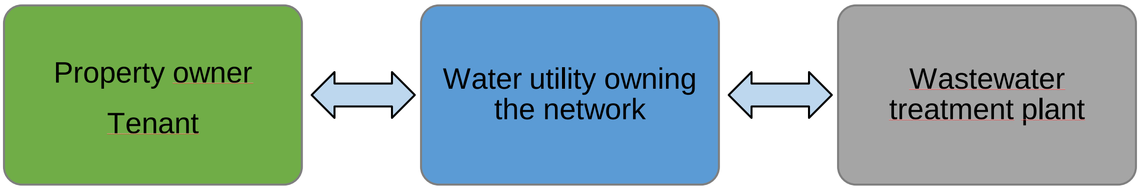
The water utility should be in contact with the municipal environmental office, Regional State Administrative Agency (AVI) or with the ELY centre before drawing up the industrial wastewater agreement. In this way, the situation concerning the operator's environmental permit will be checked and it can be clarified whether the authority supervising the activities of the operator has something to say concerning the wastewater agreement.

4.2 Contents of an industrial wastewater agreement

4.2.1 Contracting parties

The industrial wastewater agreement can be concluded either with the owner of the property or with the holder of the property, for example with the operator that generates wastewater. The contracting party is considered case-specifically. When concluding an agreement with a tenant, it is recommended to be also in contact with the owner of the property during the preparation phase of an industrial wastewater agreement. If the agreement is concluded with the operator which is a tenant of the property, the agreement must be delivered to the property owner for information. In this context, it is recommended that the responsibilities of different parties are clear in all possible future problem situations. Written consent from the property owner may be required from a tenant operator.

The water utility receiving wastewater into its sewer network may be a different organisation than the water utility that is responsible for treating wastewater. In this case, the agreements must state that the requirements concerning the capacity of the water utility treating wastewater, wastewater quality, monitoring, information acquisition etc. are taken into account in the mutual agreements between the two water utilities and in the industrial wastewater agreements. In certain cases, an industrial wastewater agreement has also been concluded between all three organisations, i.e. between the owner of the network, the wastewater treatment plant and the operator. This so-called tripartite contract is used by Turun seudun puhdistamo Oy (Picture 3).



Picture 3: Parties to be taken into account when preparing an agreement

The industrial wastewater agreement must include the following information about the water utility: name of the water utility, business ID, postal address, treatment plant that receives wastewater and visiting address of that plant. If the agreement is concluded with the owner of the sewer network which is a different organisation than the recipient wastewater treatment plant, it is also recommended to write the contact information of the wastewater treatment plant in the aforementioned manner into the agreement. Information about the operator: name, sector of industry, visiting address, business ID. Information on the property includes the district of the city, block and number of the plot. Additionally, the agreement must include property owner's information: name, postal address and number of the connection agreement. In case the operator is a tenant of the property, the agreement should include both the contact information of the property owner and the tenant. If the operator has a company operating in several localities, apart from the official contact information of the company, also the name and address of the operation site that is to be connected must be included in the agreement.

4.2.2 General terms and conditions

If the purpose is that the contractual relationship also follows the general delivery terms and conditions of the water utility, they must be given or sent to the operator when concluding the agreement and they must be referred to in the agreement. Matters included in the agreement are given first priority in respect of other document appendices. Alternatively, the agreement can also detail those items which are to be applied to or are not to be applied to the general delivery terms and conditions of the water utility. It is recommended to keep in mind that those parts where the general terms and conditions refer to the consumer or residential water services, they shall not be applied to the industrial plants or other enterprises.

The agreement must include agreed measures and transit periods, in case the general terms and conditions change. The special conditions must always be written into the industrial wastewater agreement because its contents have the highest priority in respect of the general delivery terms and conditions.

4.2.3 Conditions on changing the agreement

It is recommended to agree upon changing the conditions of the agreement. The water utility may have the need to change the conditions of an industrial wastewater agreement if it turns out to be necessary for ensuring the operations of the wastewater treatment plant, legislative changes or protection of the water body. It must be agreed upon when the new agreement conditions will enter into force (e.g. six months after the operator has been informed about them). It can also be agreed upon that the contracting parties will commit themselves to negotiate, on request of the other party, changes to the agreement in the event of changing circumstances.

It must be agreed upon that the operator shall submit a new application to the water utility concerning the conveyance of industrial wastewater if the operations of the company, amount or quality of wastewater change or the operator moves to another operating location. It should also be agreed upon when the application must be submitted to the water utility, for example, at least two months before the intended operational changes.

4.2.4 Amount and quality of wastewater

It may be necessary to limit the operator's wastewater discharge. The operator may be obliged to even out substantial discharges using balancing basins, or it might be possible to agree upon cost division with the company if the water utility is willing to balance the discharge peaks.

The operator may be obliged to monitor the amount of wastewater discharge using a method which is approved by the water utility if the amount is not the same as the purchased amount of water.

These kinds of situations will take place if, for example:

- a substantial part of purchased water binds to the products to be produced
- only a part of company's wastewater is industrial wastewater and the rest is normal sanitary wastewater, in which case it is recommended to sewer this wastewater fraction separately
- the operator removes water generated by raw materials, in which case the wastewater amount is larger than the sold water amount
- the operator uses a water source that is partly or entirely owned by the operator

If the wastewater invoicing is based on the purchased amount of water, the share which is absorbed into the product can be compensated in the wastewater invoicing. Some water utilities presume that 10−30% of water binds to the product so that invoicing based on the wastewater amount is acceptable. The share which is absorbed into the product can also be measured using a separate water meter.

Company's estimated daily (24h) or annual amount of wastewater shall be entered in the agreement.

Case-specifically, it is possible to set limit values for different substances concerning the quality and amount of wastewater which is conveyed to the sewer. Limit values may be set for concentrations and/or for loading. Setting limit values is covered in Chapter 6.

In special occasions, requirements have been set for reducing odour emissions or the agreement includes a clause on sharing the costs caused by removing odour.

4.2.5 Conditions related to structural solutions

The agreement can include more detailed requirements on the pretreatment of wastewater (for instance, separation of solids, separation of grease or neutralisation). The agreement may include the general requirement compliant with Decree 713/2014, Section 41 on pretreatment of wastewater and the requirement compliant with Environmental Protection Act 527/2014 on the use of best available technique (BAT) before conveying wastewater to the sewer network.

4.2.6 Monitoring

The agreement includes clauses on the monitoring of the amount and quality of wastewater, location of sampling and methods of sampling. The monitoring programme of wastewater should be drawn up as a separate protocol so that it is easier to make changes to it if necessary. The agreement may state that the operator monitors the amount and quality of wastewater which is conveyed to the sewer network in a manner approved by the water utility. If the operator holds an environmental permit, it is often reasonable to combine the monitoring activities required both in the wastewater agreement and environmental permit. In this way, it is ensured that the monitoring takes place in a manner which is approved both by the water utility and environmental authority which has granted the permit.

Additionally, the agreement may state that, besides the agreed monitoring programme, possible additional monitoring can also be implemented by a separate agreement if the situation so requires.

The agreement should also include a clause on the cost liability for wastewater monitoring samples and distribution of test results. Particularly, if the loading generated by the operator is very high in comparison to the total loading to the wastewater treatment plant, the operator’s own monitoring should be combined with the monitoring sampling performed by the wastewater treatment plant and thus create a total picture of industry-induced effects on the operation of the treatment plant.

In certain cases, the agreement should include an obligation to monitor the conditions of the sewers, manholes and wells at regular intervals and to repair any possible damage to the wells and sewers. (See Appendix 1)

The monitoring results shall be delivered to all parties whose operations could have an impact on wastewater. Appendices 9−11 include examples of different types of monitoring programmes.

4.2.7 Wastewater fees

According to Water Services Act 119/2001, Section 18 and 19, an increased wastewater fee can be collected for wastewater based on its amount and quality. There is more information available on wastewater fees in Chapter 5. If an agreement is concluded with an operator that does not fall under the application scope of the Water Services Act, the exceptional quality and amount of wastewater as well as the principle of cost coverage must be taken into consideration when agreeing upon fees.

4.2.8 Liability distribution among the parties

The agreement may specify the liabilities of both parties. The industrial wastewater agreement can confirm that the obligations laid down in the environmental permits of the parties are not to be transferred to the other party. However, this does not prevent the parties from changing the agreement when the needs for change as described in Chapter 4.4 arise.

It can also be agreed upon that, according to the matching principle, both parties are liable for compensating possible damages or hazards to the owner or holder of a shore or water area (i.e. area covered by water) or to other parties suffering from effluents.

4.2.9 Notification obligation

It is recommended to write the operational instructions in case of exceptional and emergency situations into the industrial wastewater agreement. The operator must immediately inform the water utility on exceptional and emergency situations and on disruptions affecting the quality or amount of wastewater (pollutant releases into the sewer network). Planned changes to the operations must be reported in advance. Respectively, the water utility informs the operator on disruptions and changes that have an effect on the operator's activities as early as possible. It is recommended to write the procedure to maintain up-to-date contact information in the agreement.

When agreeing upon the notification procedure, all parties on whose operations wastewater may have an impact must be taken into account. In case the wastewater treatment plant does not own the sewer network and the agreement has been concluded between the network owner and the operator, the notification obligation refers to all three parties, i.e. the operator must also inform the wastewater treatment plant receiving wastewater immediately on exceptional and emergency situations as well as on disruptions affecting the amount and quality of wastewater.

4.2.10 Environmental risk assessment

A large operator or one that is significant from the point of view of the water utility is expected to prepare an environmental risk assessment and a plan for managing wastewater resulting from fire extinction. A risk management plan for wastewater, conveyed to the sewer, must be delivered to all relevant parties if necessary.

4.2.11 Liability for damage and financial sanctions

It may be entered into the industrial wastewater agreement that the operator is liable for compensating the water utility, other customers or third parties for all those damages caused by conveying the operator's wastewater against the agreement conditions.

The agreement can oblige the operator to pay a contractual penalty if the quality of wastewater conveyed to the sewer diverges from the limit values set in the agreement and causes harm to the operations of the water utility. The sanctions cannot be an alternative to organising necessary pretreatment solutions. In some water utilities, it is a practice to enter such kinds of sanctions in their agreements (Appendix 5).

If desired, an agreement may include a statement that the parties are not liable for compensating each other for such damages which are caused by a force majeure. A force majeure refers to an impediment which is beyond the other agreement party's possibilities to influence and which cannot be expected to be taken into account at the time of the conclusion of the agreement and whose consequences could not have been avoided within reason. A force majeure can be a strike or an exceptional natural phenomenon, for example. Generally, a force majeure exception is not included in the industrial wastewater agreements.

4.2.12 Transfer of agreement

The agreement can include a statement concerning a possible transfer of agreement to a new water utility organisation to be constituted in the future. Furthermore, it can be agreed upon that the water utility may assign the industrial wastewater agreement to a new company that takes on the business operations of the original operator. The new operator shall accept the agreement conditions. Alternatively, the clause on agreement assignment can state that both parties shall accept the agreement assignment to a new organisation.

4.2.13 Entry into force of the agreement

The agreement may include a starting date from which the agreement comes into force. This is a normal practice if the operator is new and it is known that the operation starts on a certain date. The agreement can also include a statement that the agreement comes into force when both parties have signed it.

4.2.14 Period of validity and disagreements

The industrial wastewater agreement can be effective for the time being, or a set period of time can be entered in the agreement until which it is in effect. Experience has shown that it is recommendable to check the agreements at least at 3 to 5-year intervals or earlier if necessary. It is recommended to include a period of notice for both parties in the agreement.

The agreement names the court in which disagreements are handled. Usually the chosen court is the district court nearest to the location of the plant property or the nearest court of the water utility's municipality. Disagreements can also be settled by arbitration. In this case, the proceedings are not public but the ensuing costs are higher than for a hearing in a district court. Arbitration can mainly be applied to a joint-stock organisation which does not fall under the Act of Openness of Government Activities. It is recommendable to ensure that the place of jurisdiction is in Finland if the operator is foreign.

As a rule, the agreements do not include an extra item about settling disagreements because they are already mentioned in the general delivery terms and conditions of the water services.

4.2.15 Termination of the agreement

The agreement should include the possibility for termination. Termination is such an essential condition that its criteria and the parties' rights and liabilities must be entered in the agreement. Additionally, the agreement should include the possibility to discontinue the water supply under certain circumstances.

If the agreed limit values are exceeded and thus cause an immediate danger or harm to the plant's operations, health or the environment, the sewer plant has the right to stop receiving wastewater. The agreement may also include a clause on shutting off the water supply. Continuous exceeding of the limit values and other agreement violations can be written into the agreement as grounds to discontinue the reception of wastewater.

An industrial wastewater agreement is also cancelled as unnecessary when the operations end or the quality of the operation changes so that the agreement is no longer expedient.

4.2.16 Appendices

General delivery terms and conditions of water services or specifically tailored delivery terms and conditions are added to the agreement as appendices.[1] Additionally, the monitoring programme for wastewater, contact information of all parties and limit values set for wastewater to be conveyed to the sewer must be provided as appendices.

5 INDUSTRIAL WASTEWATER FEES

5.1 Criteria for industrial wastewater fees

Possible harm caused to the operations of a water utility shall be prevented through sufficient pretreatment before conveying wastewater to the sewer. However, even wastewater whose quality diverges significantly from the quality of domestic wastewater can be treated at the wastewater treatment plant. The costs ensuing from industrial wastewater can be collected by using the formula of increased fees, so that the costs caused by the water can be allocated properly. The beginning of this chapter provides instructions on how to use the formula of increased fees. If the industrial share of loading is very significant, sometimes the industrial plant can take part in the treatment plant investment costs. In this case, the operational costs can be collected in relation to the loading. Chapter 5.3 describes on a general level these kinds of agreements and the principles they comply with.

The collection of increased wastewater fees was started in Finland in the 1970s when the law on general water supply and sewer utilities, and the law on wastewater fees came into force. In those days the rate schedule model recommended by the former central organisation of the municipalities (today The Association of Finnish Local and Regional Authorities) was approved as the schedule of the increased fee for wastewater. The Finnish Water Utilities Association FIWA recommended in its guidelines *Wastewater conveyed to the sewer − the industrial wastewater agreement, limit values, monitoring and fee rates*, published in 2002, continuing to use the model of the formula of increased fees. This guide presents the renewed formula of the increased fee, which was prepared in 2011 together with water utilities and stakeholders (participants listed in Appendix 20).

The general criteria for the fees of a water utility are defined in the Water Services Act, Section 18. They generally refer to the operations of the water utility so that they cannot be implemented if they are not followed in all customer relationships of the utility. Therefore, they shall also be followed when the water utility agrees upon the industrial wastewater fees, even though the Water Services Act does not concern all industrial plants. It means, for example, that the fees need to be reasonable and equitable, and should cover the costs caused by the industrial wastewater (see Chapter 2.1.1).

Cost effects and grounds for payment can be considered case-specifically for large amounts of wastewater conveyed in a manageable manner to the sewer.

5.2 Formula of increased fees

The formula of increased fees can be applied to such wastewater that diverges from wastewater generated in a residential area.

The increase coefficient *k*, with which the normal fee for use is multiplied, is defined here in the formula:

$k = 1 + a \cdot T \cdot (L - 1)$,

where

k is the increase coefficient of the fee for use

a is the share of wastewater treatment costs in the combined costs of the sewer network and wastewater treatment

T is the rate structure coefficient, i.e. proceeds from the fees for wastewater use and basic fees combined, divided by the proceeds from the fees for wastewater use

L is the quality coefficient, i.e. the corrective coefficient with which the impact of higher concentrations in industrial wastewater on the costs compared to domestic wastewater is taken into account.

5.2.1 Calculation instructions for the coefficient *a*

The coefficient *a* represents the share of the wastewater treatment costs in the costs of the water utility.

The calculation of the coefficient *a* can be presented as follows:

$a = \frac{P_k + P_p}{(P_k + P_p) + (V_k + V_p)}$, where

P_k is operational costs of wastewater treatment

V_k is operational costs of sewerage

P_p is capital costs allocated for wastewater treatment

V_p is capital costs allocated for sewerage.

The calculation period of the costs should be long enough; for example three years back and three years forward. Accounting data is used for the calculation of actual costs. Estimations of future years can be made based on the investment plans and budgets. The calculation uses the write-off periods from the water utility's accounting and investment planning.

Often the share of wastewater treatment costs is some 40−60% from all costs of the sewerage utility so that typically the *a* coefficient varies between 0.4−0.6.

Operational costs of wastewater treatment

The operational costs of a wastewater treatment plant include costs related to the operations of a wastewater treatment plant, such as wages, purchased services, energy, chemicals, spare parts, equipment and materials, operating costs of odour removal, operating costs of sludge treatment and the administration of the treatment plant.

Operational costs of sewerage

The operational costs of sewers include the costs related to the operations of the sewer network and pumping stations, such as wages, purchased services, energy, spare parts, equipment and materials. Acute repairs of the sewer network fall under operational costs.

Capital costs of wastewater treatment

When calculating the capital costs of a wastewater treatment plant, the write-offs of investments and other capital costs, such as loan interests or entered incomes from the water utility to the owner, must be taken into account. All investment costs of the treatment plant, sludge treatment and effluent discharge systems must be taken into account in the cost calculation. These kinds of costs include, among others, planning costs, costs related to excavation, construction, machinery as well as property development-, electricity- and automation-related costs.

Capital costs of sewerage

When calculating the capital costs of sewers, the write-offs of investments and other capital costs, such as loan interests or entered incomes from the water utility to the owner, must be taken into account. All investments in a sewer network and pumping stations must be taken into account when calculating the capital costs of a sewer network. These kinds of costs include, among others, planning costs related to construction, renovation and rerouting of sewers and costs related to excavation, construction, and machinery, as well as property development-, electricity- and automation-related costs.

5.2.2 Calculation instructions for the rate structure coefficient *T*

The water utility collects a fixed basic fee and a fee for use, based on water consumption or the amount of wastewater, from its customers. The fee increase should be allocated for both fees. In practice, it is easier to allocate the increase just for the fee for use. Because of this, the increase effect of the basic fee is added to the fee for use by the rate structure coefficient *T*, which is calculated by dividing the annual total proceeds of wastewater usage and basic fees by the proceeds from the wastewater fees for use.

$T = (t_k + t_p)/t_k$, where

t_k is proceeds from wastewater fees for use
t_p is proceeds from wastewater basic fees.

In case the *T* coefficient is very near to the number 1, the water utility can consider whether the *T* coefficient should be applied at all.

5.2.3 Calculation instructions for the quality coefficient *L*

The quality of industrial wastewater compared to domestic wastewater is taken into account using the quality coefficient. The calculation formula for the quality coefficient *L* is presented below:

$L = b_1 \cdot (s/S) + b_2 \cdot (n/N) + b_3 \cdot (bod_7/BOD_7) + b_4 \cdot (p/P)$, where

b_1 is the weighting coefficient of the cost factor calculated for suspended solids
s is the concentration of suspended solids in wastewater conveyed to the sewer network from the operator’s property (mg/l)

S is the reference concentration of suspended solids (mg/l)
b_2 is the weighting coefficient of the cost factor calculated for nitrogen
n is the concentration of total nitrogen in wastewater conveyed to the sewer network from the operator's property (mg/l)
N is the reference concentration of total nitrogen (mg/l)
b_3 is the weighting coefficient of the cost factor calculated for biological oxygen demand (BOD)
bod_7 is the biological oxygen consumption of wastewater conveyed to the sewer network from the operator's property BOD_{ATU} (mg O_2/l)
BOD_7 is the reference concentration of biological oxygen consumption BOD_{ATU} (mgO_2/l)
b_4 is the weighting coefficient of the cost factor calculated for phosphorus
p is the concentration of total phosphorus in wastewater conveyed to the sewer network from the operator's property (mg/l)
P is the reference concentration of total phosphorus (mg/l).

Reference concentrations

The increase in the fee, which is collected for industrial wastewater, is founded on the industrial wastewater concentrations which are higher than the concentrations in normal domestic wastewater. The formula presents the concentrations in domestic wastewater as reference concentrations and the fee is increased in relation to the concentrations. The concentrations of wastewater received at the wastewater treatment plant have been diluted by stormwater and increased by industrial wastewater, so the average concentrations in wastewater received at the wastewater treatment plant do not usually reflect the quality of domestic wastewater.

The reference concentrations can be calculated using the treatment plant's discharge information on a dry period and the plant's average influent load. If loading generated by industrial plants increases significantly the concentrations in wastewater received at the treatment plant, the industrial impact can be eliminated by taking the industrial discharges and loads off the treatment plant's total loading. The dry-period discharge can be calculated by preparing a duration curve of the treatment plant's influent and by using a discharge rate defined at 20% (percentile) as dry-period discharge. A calculation example can be found in Appendix 19.

The applicability of this method should be considered case-specifically. When calculating the dry-period discharge, it is recommended to use a representative year in respect of the discharge and loading, or to use combined data of three different years, for example.

If there is no sufficient source material available, the median concentrations from Table 2 can be used as the reference concentration. The values in Table 2 are based on dry-period concentrations in wastewater received at Finnish wastewater treatment plants. Discharge or loading of industrial wastewater was not taken into account for this calculation because of insufficient data.

Table 2: Calculated concentrations in wastewater received at Finnish wastewater treatment plants using dry-period discharge

Parameter	Unit	Fluctuation range	Median	n
SS	mg/l	190–438	349	13
N_{tot}	mg/l	48–74	65	13
$BOD_{7(ATU)}$	mg/l	199–333	272	13
P_{tot}	mg/l	8.1–13	10	13
COD_{Cr}	mg/l	483–805	596	10

Weighting coefficients for cost factors

The relative cost share of substances, which are to be removed within wastewater treatment processes (solids, nitrogen, BOD_7, phosphorus), in the total costs of the treatment plant must be taken into account when calculating the *b* coefficients. Both the capital costs and operational costs must be taken into consideration in the calculation. The process type influences the calculation of *b* coefficients. The investments distribution of different unit processes (e.g. primary sedimentation, aeration, secondary sedimentation, post-filtration, sludge treatment) and operational costs (e.g. chemicals, energy, maintenance spare parts, human resources, maintenance, monitoring services) into different substance components are analysed in the calculation of *b* coefficients.

Appendix 18 presents different calculation models of *b* coefficients for various process types at a normal Finnish activated sludge plant. Example values are calculated for following processes:

1) removal of BOD and phosphorus
2) nitrification
3) removal efficiency of 70% for total nitrogen in activated sludge
4) removal efficiency of 70% for total nitrogen by post-filtration (methanol input)

Table 3 shows concisely the typical defined values for the *b* coefficients based on the calculation. Quite reliable results are achieved using the values of Table 3 when it comes to typical Finnish wastewater treatment plants. It should be noted that an exact definition of weighting coefficients of cost factors requires very detailed information on the division of operational and capital costs. Appendix 18 describes in more detail the background defaults used in the calculation. If the share of the plant's process phase in the investments, share of the cost type in the operational costs, or the share of the loading parameter in the costs differs essentially from the examples in Appendix 18, the *b* coefficients must be calculated case-specifically.

Table 3: Example values for different types of processes in the formula of wastewater fees (PE ca. 50 000)

Parameter	Coefficient	BOD and P removal	Nitrifying plant	Nitrogen removal plant	Nitrogen removal plant (methane input)
SS	b_1	0.46	0.43	0.44	0.38
N	b_2	0.00	0.25	0.26	0.35
BOD_7	b_3	0.39	0.23	0.22	0.19
P	b_4	0.15	0.09	0.08	0.08

Transforming the COD concentration

In certain cases, the COD value of industrial wastewater should be taken into consideration in the formula. One method is to transform the COD concentration into BOD concentration using a defined coefficient (for example 0.3−0.5).

5.2.4 Reviewing the formula coefficients

All formula coefficients are recommended to be reviewed whenever necessary or on a regular basis at 3- to 6-year intervals.

The operator-specific coefficient must be checked annually for industrial wastewater concentrations. The coefficient which is based on the concentrations of the previous year becomes effective at the beginning of April and is valid till the end of March the next year. In this way, the previous year’s research results on wastewater are available and there will be no need for separate balance calculations.

5.3 Cost distribution between partners

If the share of the industrial loading has been very significant, it has sometimes been agreed that the operator takes part in the investments of the wastewater treatment plant, when expanding the old treatment plant or building a new one. These kinds of agreements are always negotiated case-specifically, so this chapter presents only general principles that should be taken into account when negotiating an agreement.

Capital costs

In general, industry takes part in capital costs in relation to the agreed capacity provision. Therefore, the plant investment costs are specified for separated loading parameters (BOD, nitrogen, phosphorus, solids, inflow) in order to allocate the costs correctly. The agreement must include a specification as to which costs fall under capital costs, such as planning, basic improvement and construction costs. Industry may pay its share of the capital costs immediately or over a longer timeframe. It is recommended to take into account the risks concerning changing or termination of the industrial operations when planning the timing for the funding share payment. It might be beneficial for industry to exploit its own funding options for the investments. If industry pays capital costs for the water utility over several years, an agreement must be concluded on the applied interest, marginal, write-offs and payment time.

Operational costs

The operational costs of a wastewater treatment plant are distributed for different loading parameters according to the costs ensuing from them. The principles of cost sharing are similar to the ones presented above in the formula of increased wastewater fees. Costs can be distributed in relation to the loading shares, or the formula of increased wastewater fees can be applied to the operational costs when collecting the fees. If the costs are divided in relation to the loading, it is recommended to pay special attention on the costs ensuing from the further treatment of sludge because the treatment costs for sludge treatment are divided differently in relation to different parameters as they are when treating wastewater.

Other costs

Also other costs of a water utility, such as the administration expenses of the sewer network and water utility have to be charged from the industrial customers. One possibility is to tie other costs with different parameters of influent loading and divide them in the same way as the operational costs; in other words, in relation to loading. Sometimes other costs have been charged as a certain percentual share of the valid wastewater rate.

Cooperation and information exchange

It is recommended to describe in the cost distribution agreement the practices concerning regular meetings and other information exchange. It can be necessary to organise an annual meeting between the water utility and the operator, and to go through the actual invoicing, and the loading information, loading development, future measures and investments which form the grounds for invoicing.

Changes in the capacity need

The cost distribution agreement may contain a clause on practices should the capacity need of one of the parties exceed the original reserved capacity. The agreement should at least include a clause concerning negotiation practices that must be followed in these kinds of situations.

6 SETTING RESTRICTIONS ON DIFFERENT PARAMETERS

6.1 General

When setting restrictions on the amount and quality of industrial wastewater, special attention must be paid to: the treatment capacity of the wastewater treatment plant, structure and material of the sewer network, raw materials and chemicals used by the treatment plant, time span that industrial wastewater remains in the network, substances included in industrial wastewater, changes in discharge, pH values and temperature. When setting restrictions, it must also be considered that substances end up through the treatment plant in the water body, or in treatment plant sludges. Harmful effects must be prevented by setting limit values. Ordering of a risk assessment of the impacts of industrial wastewater on the sewer network and operations of the wastewater treatment plant helps to determine the restrictions.

6.2 Properties of domestic wastewater

Domestic wastewater includes, among others, fats, solids, sulphur compounds, organic material, nutrients and pathogenic organisms. Wastewater loading refers to a certain amount of substances (BOD, phosphorus, nitrogen and solids) that comes to the treatment plant in a time unit. It is calculated as a total either in relation to a day (24 h) or per resident. When talking about the quality, it is the concentration what is referred to (mg/l).

Table 4 presents the discharge over a dry period using calculated concentrations in wastewater received at Finnish wastewater treatment plants. Government Decree on Treating Domestic Wastewater in Areas outside Sewer Networks 209/2011 (Table 4) includes the average loading of untreated wastewater generated by one resident as grams per day (g/d).[6]

Table 4: Loading values according to Government Decree 209/2011.

Substance	**g/resident/day**
BOD	50 (70*)
phosphorus	2.2
nitrogen	14

*) 70g BOD/res/d is the value presented in Government Decree on Urban Wastewater Treatment 888/2006.

Loading caused by industrial wastewater can often be estimated by comparing it to the human-generated loading. The calculation resolves how many persons equate to the water body loading caused by the industrial production. The gained number is called population equivalent (PE). Government Decree on Urban Wastewater Treatment 888/2006 defines the calculation method for PE.

Chemicals problematic to the environment are often used in households. As a consequence of using consumer chemicals, harmful substances may also end up in domestic wastewater. These kinds of substances include, among others:

- phosphate and chlorine compounds (detergents and cleansers)
- substances in cosmetics and cleansing agents
- pharmaceuticals
- finishing substances of textiles (e.g. nonylphenol ethoxylates)
- flame retardants (furniture, clothes)
- turpentine, paints, varnish and stain removers (furniture restoration, renovations, arts and crafts activities).

6.3 Current limit values for concentrations

Table 5 presents limit values applied by the Finnish wastewater treatment plants, HELCOM's recommendations for concentration limit values for wastewater conveyed to the sewers and limits values set for domestic wastewater. Some of HELCOM's recommendations are dependent on the sector of industry.

Table 5: Used and recommended limit values for wastewater conveyed to the sewer. Unit mg/l.

Substance Property	**HELCOM°**	**HSY 1)**	**Lahti°**	**Turku 2)**	**Vaasa 3)**	**Kymi4)**	**Min**	**Max**	**Drinking water 5)**
Arsenic (As)	0.3**	0.1	0.1	0.1		0.1	0.1	0.3	0.01
Mercury (Hg)	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.001
Silver, (Ag)		0.2	0.1	0.1	0.1	0.1	0.1	0.2	
Cadmium (Cd)	0.2	0.01	0.01	0.01	0.01	0.01	0.01	0.2	0.005
Total chromium (Cr)	0.5 [0.7*]	1.0	0.5	1.0	1.0	0.5	0.5	1.0	
Chromium VI (Cr^{6+})	0.1 [0.2*]	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.05
Copper (Cu)	0.5	2.0	2.0	2.0	1.5	0.5	0.5	2.0	2.0
Lead (Pb)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.01
Nickel (Ni)	1.0	0.5	0.5	0.5	1.0	0.5	0.5	1.0	0.02
Zinc (Zn)	2.0	3.0	2.0	2.0	2.0	2.0	2.0	3.0	
pH		6-11	6-11	6-11	6-11	6-9	6	11	6.5–9.5
Temperature (°C)		40	40	40	40	30	30	40	
Solids		300–500							
Total cyanide	0.2*	0.5	0.5	0.5	0.5	0.5	0.2	0.5	0.05
Fats			150	150		100	100	150	
Mineral oils / total hydrocarbon concentration		100	200	100	200	100	100	200	

1) Helsinki Region Environmental Services Authority HSY

2) Turun seudun puhdistamo Oy
3) Vaasan Vesi
4) Kymi Water Ltd
5) Decree of the Ministry of Social Affairs and Health 461/2000

6.3.1 Discharge

The wastewater discharge should be restricted if the sewer network or wastewater treatment plant functions on the upper limits of its capacity. High discharge peaks might negatively interfere with the operations of the plant. If large amounts of wastewater are in question, the capacity sufficiency must be computationally ensured. The operator can be obliged to balance large-scale discharges at balancing basins or it might be possible to agree upon cost division with the company, in case the water utility is willing to balance the discharge peaks. For example, the food industry can have difficulties locating the necessary balancing basin capacity on its premises for hygienic reasons. Generally, an industrial wastewater agreement includes a clause on maximum daily discharge or maximum hourly discharge.

6.3.2 Organic substance

Biological oxygen consumption (BOD_7) illustrates the amount of oxygen-consuming organic substances in wastewater. The high BOD in the sewer network can cause an explosive formation of methane, odour emissions and indirectly corrosion along with the formation of an anaerobic state.

The aeration basins of the wastewater treatment plants are sized to degrade a certain amount of organic substances. Oxygen consuming substances included in wastewater generated by an industrial plant can create problems in the wastewater treatment process if the influent load exceeds the aeration efficiency of the aeration equipment. An oxygen level decrease in the aeration basins can cause breakdown of the biosludge and problems with sludge settlement. Severe fluctuations of BOD loading may cause overgrowth of filamentous bacteria and therefore create problems, such as sludge that settles poorly.

The amount of organic loading in industrial wastewater must be restricted but attention should also be paid to the capacity values of the plant and to the operations of other loaders of the plant. The restrictions are executed by entering the limit values for solids and BOD loading in the agreement. On the other hand, organic substances that easily degrade in the nitrogen-removal process are needed so that especially carbon-containing wastewater from the foodstuff industry can be utilised in the nitrogen removal process. However, the utilisation of industrial wastewater in the nitrogen removal process may require special technical arrangements from the treatment plant.

Industrial wastewater may also include large amounts of organic substance that degrades only with difficulty. This is seen as high COD concentrations and especially as a high COD/BOD relation.

6.3.3 Nutrients, nitrogen and phosphorus

Nitrogen and phosphorus included in domestic wastewater are needed for the formation of activated sludge mass. In other words, the nutrients are not necessarily harmful to the treatment process. However, there are nutrients in domestic wastewater more than needed so that industrial wastewater which contains an abundance of nutrients burdens both the treatment plant and the recipient water body.

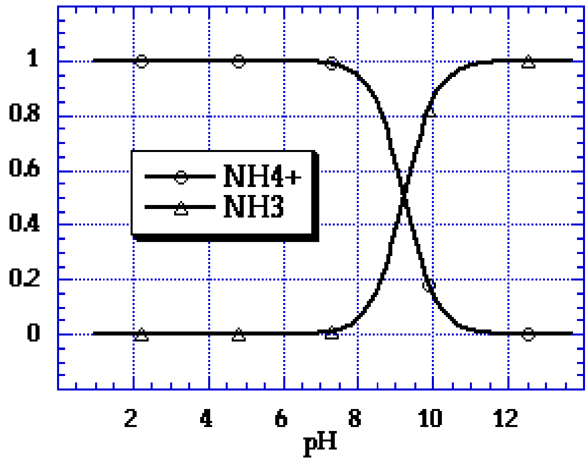
If the phosphorus loading of incoming wastewater varies a lot, the maintenance of a good phosphorus value can be difficult. These kinds of phosphorus loads can be for example detergent and phosphoric acid releases. Nutrient loading can especially be increased by meat processing, fish farming and fertiliser industries, landfills and composting facilities as well as by reject water from biogas plants.

Conveying large amounts of nutrients to the sewers can be the reason for an increased wastewater fee. The treatment plant's capacity is not always sufficient for high loads of nutrients so that it may come to restricting the burdening and demanding the pretreatment and balancing of wastewater. Conveying of nutrient-rich wastewater to the sewer must always be separately agreed upon with the water utility.

As a rule, phosphorus is removed chemically hence a phosphorus load increases especially the costs for chemicals. Nitrogen-removal is usually carried out in a biological process. A heavy nitrogen load increases the need for basins capacity and sometimes requires additional carbon input and alkalisation.

6.3.4 Ammonium

Ammonium compounds come in with domestic wastewater and ammonium concentrations received at the wastewater treatment plant are ca. 40 mg/l. The most important compounds containing ammonium are protein and urea from urine. Total nitrogen concentrations in the incoming water are ca. 50 mg/l. Oxidation of ammonium to nitrate in the recipient water body causes oxygen consumption and, in worst case, oxygen depletion. The toxicity level is influenced by the ammonium concentration, pH level, duration of discharge and species of fish. Ammonium in high concentrations inhibits nitrification. Ammonium in high concentrations causes damage to concrete. All ammonium salts, except carbonates, oxalates and fluorides are harmful to concrete. When the pH level increases sufficiently, the ammonium ion (NH_4^+) converts to volatile ammonia (NH_3) causing odour and corrosion problems.[7] Picture 4 presents the balance in the relative amounts of ammonium and ammonia in different pH.



Picture 4: The relative concentrations of ammonium (NH_4^+) and ammonia (NH_3) in relation to pH[8]

6.3.5 Solids

Conveying of solids to the sewers is restricted if necessary. Solids accumulate in the sewer pipes and dry wells of the wastewater pumping stations and disrupt the wastewater discharge.

The properties of solids determine their impact on the process. The composition of solids must also be monitored from the point of view of biological degradation rate. If solids do not degrade biologically, they may influence the settling properties of activated sludge, sludge drying and utilisation options for sludge. Solids increase the amount of resulting sludge. Special attention must be paid to the amount of solids in industrial wastewater because the treatment costs for the treatment plant's sludges have risen quite significantly during the past years. Generally, the limit value for solids in wastewater conveyed to the sewer is 300−500 mg/l. Definition of the limit value is influenced by the properties and composition of solids. High solids concentrations have impact on the wastewater fee.

6.3.6 Temperature

A high wastewater temperature (>40 °C) in the sewer network speeds up oxygen consuming reactions and causes corrosion and odour emissions. A high temperature in wastewater can also interfere negatively with the function of a grease separator, in which case fats conveyed into the sewer pipes cause blockages. Cold water slows down the microbial activities and interferes with the operation of the treatment plant. Especially the bacteria from nitrogen-removal are sensitive to low temperature. Big temperature changes harm both concrete and plastic pipes.[7]

6.3.7 pH

The pH value of wastewater received at the treatment plant has a significant impact on the operation of the biological process. Sudden changes in the pH value within the activated sludge process disturb the activities of the microorganisms. The biological process functions best when the pH level is 7−8. Chapter 6.4 discusses corrosion caused by pH.

6.3.8 Electrical conductivity

Electrical conductivity measures the ability of a solution to conduct electricity. Conductivity increases when the number of ions rises in wastewater because ions conduct an electric charge in solutions. Therefore, conductivity indirectly describes the amount of substances dissolved in wastewater.

In case the electrical conductivity increases, it should be clarified what is the reason for this. For example, the access of seawater to the sewer network can be noticed as increased electrical conductivity. The measurement unit is mS/m (millisiemens per one metre) or µS/cm (microsiemens per one centimetre), mS/m = 10 µS/cm. The values of electrical conductivity are in inland waters 5–10 mS/m, in groundwater 20 mS/m, in municipal wastewater 80–120 mS/m and in the bays of the Baltic Sea 200mS/m. The values are the highest in sea water − 1000–1200 mS/m.[9]

6.3.9 Colour

Some industrial plants convey coloured water to the sewer network. For example, the colour of wastewater generated by the textile industry can be very persistent. When preparing an agreement, it is recommended to ensure that the colourant is harmless. Above all, colour is an aesthetic harm. It is not very often that colour can be removed from wastewater.

6.4 Substances causing corrosion in concrete sewers

Corrosion is caused in concrete sewers by, among others, sulphate, sulphide, chloride, magnesium and ammonium concentrations in wastewater, or by acid wastewater and a high temperature.

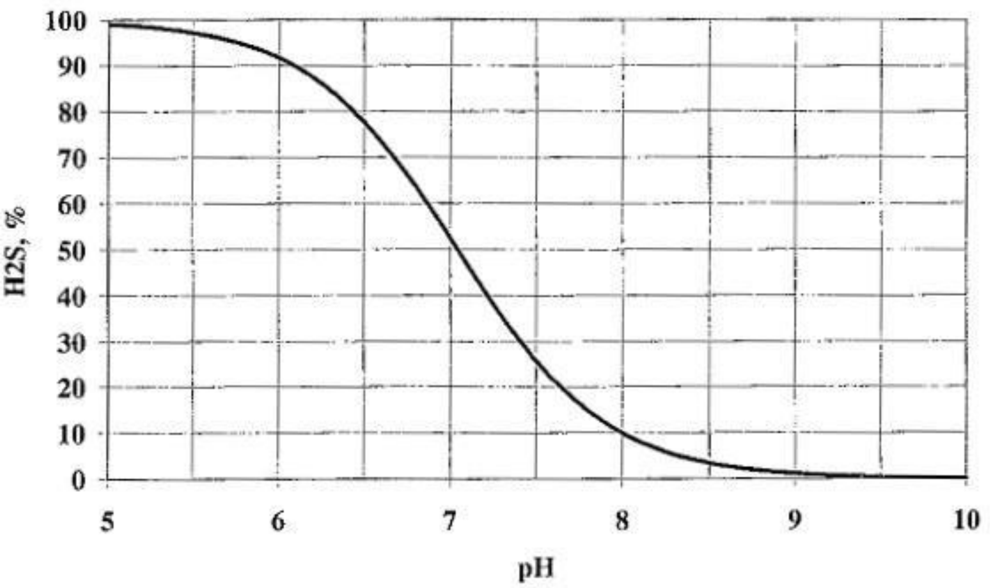
In a concrete sewer, a low pH level (pH<6) in wastewater causes corrosion to the sewer network and concrete pumping stations. Acids and carbonic acid, which belongs to the weak acids, dissolve concrete limestone causing degradation of concrete. Acids corrode cement stone compounds because cement stone is alkaline. Acids change the calcium compounds of cement stone to calcium salts of the acids in question, in which case the internal structure of cement stone is damaged. The rate of concrete degradation depends on the strength of acid and on the amount of acid in contact with the concrete in a certain time period. The chemical durability of a concrete sewer depends on the type and amount cement used in the concrete production.[10] However, differences between the durability of various cement qualities against acids are small. The pH limits of wastewater conveyed to the sewer vary in general between 6−11.[10]

6.4.1 Hydrogen sulphide

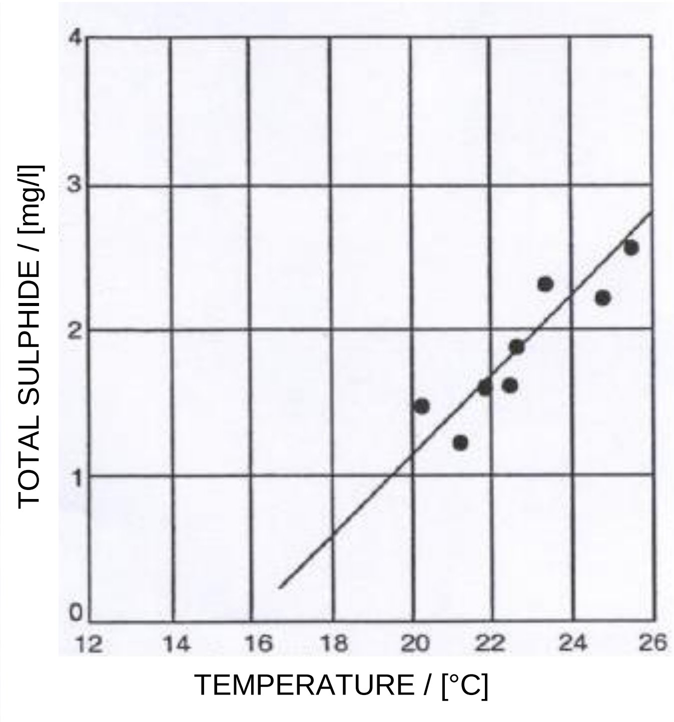
Under oxygen-depleted conditions, municipal and industrial wastewaters contain bacteria that decompose sulphur compounds, included in wastewater, into hydrogen sulphide gas. Hydrogen sulphide dissolves in water and it is released into the airspace of sewer pipes. Hydrogen sulphide is absorbed into the humid wall of a concrete pipe, in which case bacteria thriving under aerobic conditions change hydrogen sulphides into sulphuric acids. Hydrogen sulphide corrosion often forms in gravity sewers after long pressure sewers in the manner described above. A high temperature in wastewater increases bacterial activities and promotes the formation of corrosion.[10] Chapter 6.5.1 also examines hydrogen sulphide.

6.4.2 Sulphide

Sulphides are harmful to concrete structures. In case there are soluble sulphides in wastewater, the pH value of wastewater should always be over 7. Picture 5 presents the impact of the pH value on the amount of hydrogen sulphides released from sulphides. Sulphide as a bound, barely soluble salt is not as harmful. The typical limit value for a soluble sulphide is usually 5 mg/l [7]. An increase in temperature accelerates the formation of sulphides (Picture 6).



Picture 5: Percentile of released hydrogen sulphide in total sulphide in changing pH values [11]



Picture 6: The effect of temperature on microbiological sulphide production[12]

6.4.3 Sulphate, thiosulphate, sulphite

High concentrations of sulphate and sulphites in wastewater cause concrete corrosion under certain conditions. The corrosive effect of sulphate causes swelling of concrete while sulphate intrudes into concrete, hence creating corrosion. Sulphate ions (SO_4^{2-}) intrude into concrete and react with certain compounds of the cement stone. The volume of reaction products is larger than the volume of source substances and this causes swelling and irregular cracking in concrete. The amount of sulphates in the environment and intrusion of humidity into concrete have an impact on sulphate-induced damage to concrete. Concrete's resistance to chemical stress can be improved by choosing suitable cement, i.e. sulphate-resistant cement or by increasing the density of the concrete. The limit value for sulphate (composite value sulphate, thiosulphate, and sulphite) in wastewater conveyed to the sewers is usually 400 mg/l. The limit values are given as sulphates because a reliable analysis of sulphite and thiosulphate is difficult. Some industrial wastewater agreements oblige to monitor possible harms caused by high sulphate concentrations through video recording the sewers. The operator is responsible for the costs ensuing from possible harms.[7]

6.4.4 Chloride

High concentrations of chloride corrode the structures of sewers and pumping stations. Chloride is extremely harmful to the concrete rebar of pumping stations or other concrete structures if they are visible or near the concrete's surface so that chloride included in water can affect them and thus cause corrosion to the steel. Consequently, this causes damage to concrete which again increases corrosion even more.

Usually, chloride intrusion into concrete is caused by water containing road salts or by sea water. The limit value of the chloride concentration in wastewater conveyed to the sewers is usually 2 500 mg/l[13].

6.4.5 Magnesium salts

Magnesium salts cause damage to concrete. The overall effect of magnesium and ammonium is based on leaching of concrete; in other words, they dissolve calcium from concrete by replacing it with magnesium or ammonium. The limit value used for magnesium by Stockholm Water has been 300 mg/l.

6.4.6 Other corrosive substances

All acidic substances corrode concrete sewers and pumping stations. Table 6 presents the impact of different substances on concrete corrosion in different concentrations. Alkaline substances have not been proven to damage concrete sewers.[10] Appendix 15 presents the effects of a variety of chemical substances on concrete.

Table 6: Concrete corrosion caused by the effects of substances in wastewater [14]

Active substance	**Corrosion intensity low**	**Corrosion intensity high**	**Corrosion intensity very high**
acids (pH)	6.5-5.6	5.5-4.5	4.5
"free" carbonic acid (mg/CO_2/l)	15-30	30-60	60
ammonium (mg/NH_4/l)	15-30	30-60	60
magnesium	100-300	300-1 500	1500
sulphates (mg/SO_4 /l)	200-600	600-3 000	3 000

6.5 Odour causing substances

Odours are created under oxygen-depleted conditions especially caused by microbiological activity. Odour problems are caused by high concentrations of organic substances and a high wastewater temperature, which accelerates microbial activity.

6.5.1 Hydrogen sulphide

Usually, the gas causing odour is hydrogen sulphide. It is formed under oxygen-depleted conditions when microorganisms reduce sulphates and sulphur compounds such as proteins to hydrogen sulphide. In biological reactions, first the oxygen dissolved in wastewater is consumed, then the oxygen which is chemically bound to nitrate, and finally, the oxygen which is chemically bound to sulphate.

The formation of hydrogen sulphide is affected by the amount of organic substances and nutrients, oxygen content, pH value, temperature, discharge rate of wastewater, area of the pipe, time span how long wastewater remains in the pipe and sulphate content.[10] The Ministry of Social Affairs and Health has confirmed the catalogue of 2009 which concerns the reference values for concentrations known to be harmful to the air in workplaces. Table 7 presents reference values for hydrogen sulphide in the Finnish working conditions. Humans can smell hydrogen sulphide already in very low concentrations, i.e. much earlier than the concentration reaches the limit value determined for the occupational safety. Table 8 presents symptoms caused by hydrogen sulphide at different concentration levels in the air.

The amount of hydrogen sulphide can be reduced, among others, by increasing the pH level or by adding an oxidising substance. Obligations related to the removal of odour problems shall be agreed upon in an industrial wastewater agreement.

Table 7: Reference values for hydrogen sulphide in the Finnish working conditions, threshold limit value for concentrations (TLV)[15]

Time	**ppm**	**mg/m^3**
15 min	10	14
8 h	5	7

Table 8: Symptoms caused by different hydrogen sulphide concentrations[16]

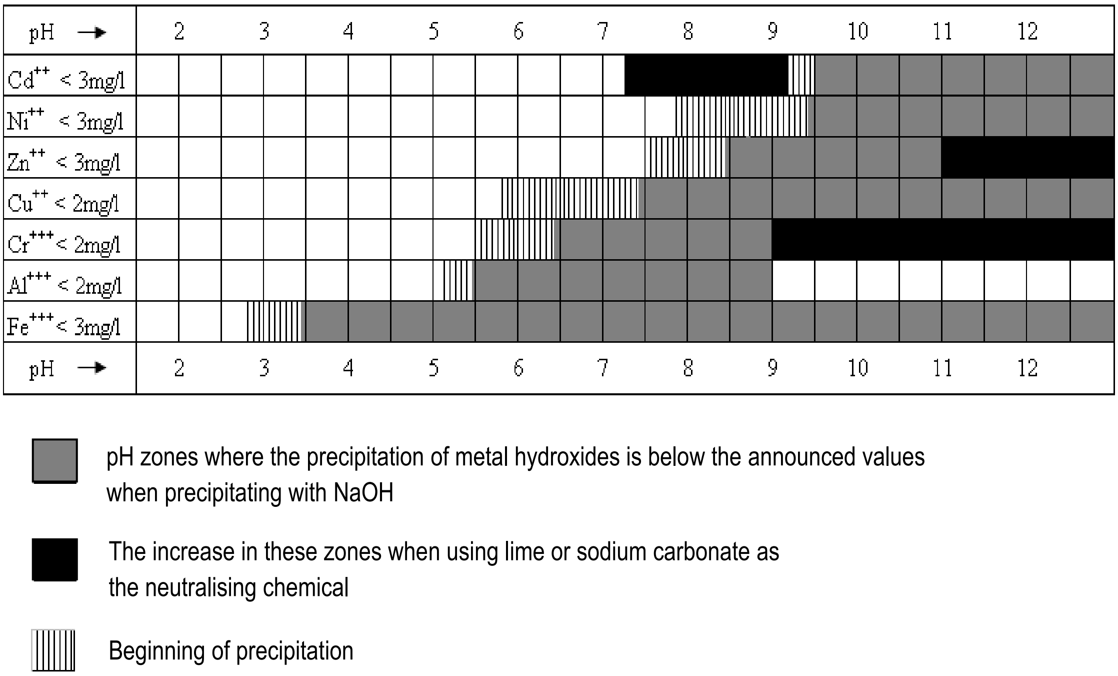
Symptom	**Concentration (ppm)**
Odour threshold, odour of a rotten egg	0.0005
Unpleasant smell	1.0
Headache, nausea, irritation in throat and eyes	10
Eye injury	50
Infection of the eye, irritation in respiratory tract, loss of the sense of smell, risk of death	100
Pulmonary oedema, risk of death	300
Convulsion, respiratory arrest	500
Blackout, cessation of breathing	1 000
Death	2 000

6.5.2 Other substances causing odour

Other substances causing odour in the sewers are methanethiol, nitrogen compounds and volatile chemicals.[10]

6.6 Heavy metals and metalloids

The biological treatment and mechanical treatment at the wastewater treatment plant together remove typically ca 20−90% of heavy metals included in wastewater. The removal efficiency of nickel is below 50% because it occurs as a complex compound and does not bind very easily to the sludge. Heavy metals bind mostly to the microorganisms in activated sludge. Some heavy metals, such as mercury, chromium, iron, copper and nickel in high concentrations inhibit nitrification. Appendix 14 lists substances that cause nitrification inhibition. Because of their toxicity, cadmium, mercury and lead are the most difficult heavy metals for sludge utilisation. Heavy metals are often toxic to aquatic organisms even in low concentrations.[13] Picture 7 presents the pH zones of precipitation of metal hydroxides.



Picture 7: pH zones of precipitation of the most important metal hydroxides[17]

6.6.1 Arsenic, As

Arsenic is a metalloid which is biologically non-degradable in the environment and which accumulates in the human body. Arsenic is very toxic to aquatic organisms. Arsenic may end up in wastewater along with biocides, fertilisers or waste from the metal industry. Other pollutant sources are metal smelting plants, wood impregnation plants and different kinds of incineration processes. Ca. 50−80% of arsenic binds to sludge in wastewater treatment. Generally, the limit value for arsenic in wastewater conveyed to the sewer is 0.1−0.5 mg/l.[18]

6.6.2 Mercury, Hg

Mercury is very toxic and as a consequence of microbial activities, it changes to methylmercury which is a far more dangerous form for organisms. The most significant migration pathway of mercury into the environment is transboundary. Mercury ends up at wastewater treatment plants for instance through leachate from landfills.[3] Mercury in wastewater also originates from food products and dental practices (amalgam waste). Mercury has been found in high concentrations in water locks and sewers, in places where mercury has been handled (for example, in laboratories, places where thermometers are treated, dental care practices, at schools in chemistry and physics classes, in the production of neon tubes and electronic components). Mercury is fractionally released by the chlorine gas production from sodium chloride as this type of production uses mercuric chloride. Mercury sources are also the mining and paper industries, copper and zinc production, as well as iron and steel production. However, the load from these industries does not generally end up at municipal wastewater treatment plants.

The biological treatment method does not play any significant role in the removal process of mercury. The mercury removal at the treatment plants is mainly 80−90%. Ca. 20−90% of mercury binds to sludge in wastewater treatment.[18,19,20,21] The limit value for mercury concentrations is usually 0.01–0.05 mg/l in wastewater conveyed to the sewer. The limit values for mercury are set in National Decree 868/2010 for the chlor-alkali industry at 50 µg/l and for other industries at 5 µg/l.[18,13] In the environmental quality standard EQS for mercury, the maximum allowed concentration is 0.07 µg/l and 20 µg /kg per fresh weight of a perch (fish). The environmental quality standard for inland surface waters refers to the soluble share.

6.6.3 Silver, Ag

Silver is lethal to bacteria already in low concentrations. Silver ions and many silver compounds are extremely toxic to freshwater fish and aquatic organisms and also to mammals. Silver is included in many daily items, such as in cutlery, jewellery and mirrors. It has been used in large quantities in graphics and picture production, as well as in dental care clinics (amalgam fillings and x-rays). Along with the digitalisation of radiography equipment, silver concentrations in sludge have decreased. Silver halides, i.e. silver salts, are used as antibacterial substances in some consumer goods, such as socks and sports shoes. Electronic devices also contain silver. The limit value for silver in wastewater conveyed to the sewer is usually 0.1−0.2 mg/l.[13]

6.6.4 Cadmium, Cd

Cadmium is hazardous both to the environment and human health. Cadmium compounds are toxic or extremely toxic to aquatic organisms. In the wastewater treatment process, it also inhibits nitrification. Cadmium is generated in the production of red glass and in recycling of glass (e.g. crushing). Wood ash contains also large amounts of cadmium. An object containing zinc can also include cadmium. Cadmium is also included in stabilisers of PVC plastics, alloys, surface treatment agents, paint pigments and nickel and cadmium batteries. Cadmium can end up at wastewater treatment plants, among others, through runoff from industrial operations, car washing stations, leachate from landfills, paint colourants, stormwater and households (from e.g. food). The chemical industry, lead, zinc, tin and copper production, paper industry or treatment of metals and ferrous metals within the aforementioned industries can also be the source of cadmium. However, wastewater generated by these industrial branches does not always end up at the municipal wastewater treatment plants.[3]

Ca. 30−80% of cadmium binds to sludge in wastewater treatment.[18,19,20,21] Cadmium removal at treatment plants is mainly 80-90%. The limit value for cadmium included in wastewater conveyed to the sewer has been set at 0.01–0.2 mg/l. According to National Decree 868/2010, the limit value for cadmium is set at 10 µg/l, the environmental quality standard for the annual average is 0.08–0.25 µg/l and the maximum allowed concentration is set at 0.45–1.5 µg/l.[18,13]

6.6.5 Cobalt, Co

In addition to nickel and iron, cobalt belongs to the so-called ferrous metals. Cobalt is extremely toxic to aquatic organisms. It is possible that cobalt might accumulate in the body. Animal tests have shown that cobalt is carcinogenic. Cobalt is used in metal mixtures and cobalt compounds are included in catalytic converters and pigments.[13]

6.6.6 Chromium (total chromium), Cr

Chromium is very toxic to aquatic organisms but it is not bioaccumulative. Hexavalent chromium is carcinogenic and mutagenic. Chromium is carried into wastewater from the surface treatment and leather industry, metal treatment and paint, varnish and colour production. Ca. 20−80% of chromium binds to sludge in wastewater treatment.[18,19,20,21] The limit value for total chromium concentrations in wastewater conveyed to the sewer is set at 0.5–1.0 mg/l.[18,13]

6.6.7 Copper, Cu

Copper compounds are toxic to most aquatic organisms. For this reason, copper sulphate has been used earlier for algae prevention in water bodies, if it has been necessary because of the intake of raw water, for instance.

For example, printing companies, dye-works and other quarters using colours can be the release source for copper. Copper is carried into wastewater through copper pipes and boilers from the surface treatment industry, circuit board production, treatment of metals and paint, varnish and colour production. The colour blue contains copper. Ca. 40−90% of copper binds to sludge in wastewater treatment[18,19,20,21] The limit value for total copper concentrations in wastewater conveyed to the sewer is set at 0.5–2.0 mg/l.[18,13]

6.6.8 Lead, Pb

Lead is a heavy metal and extremely toxic to aquatic organisms. In the wastewater treatment process, it is also a substance that inhibits nitrification. Lead is exported into wastewater from the paint and electronic industry (soldering materials) and through glaze colours. Lead is also used in metal mixtures, such as in zinc ingots. Lead can end up in wastewater also through stormwater and airborne fallouts. Ca. 50–90% of lead binds to sludge in wastewater treatment[18,19,20,21] and its removal rate at the wastewater treatment plant is usually 80–90%[3]. The limit value for lead concentrations in wastewater conveyed to the sewer is generally 0.5 mg/l. The annual average of 1.2 µg/l is set for lead as the environmental quality standard and the maximum allowed concentration is 14 µg/l[13]. The annual average of inland surface waters refers to the bioavailable and soluble share, the maximum allowed concentration means soluble share.

6.6.9 Nickel, Ni

Some nickel compounds are extremely toxic to aquatic organisms. In wastewater treatment, nickel can inhibit nitrification. Nickel is used, among others, in the production of stainless steel and metal mixtures, as well as in the surface treatment of metals. Coal combustion can cause nickel-containing emissions as airborne fallout. Food products and metal products are the most important nickel sources in wastewater. Nickel ends up in wastewater also from surface treatment plants, traffic emissions, precipitation chemicals and car servicing. Ca. 20–80% of nickel binds to sludge in wastewater treatment.[18,19,20,21] Nickel is not removed by the treatment processes. For nickel, the post-treatment improved the removal rate compared to the situation where no post-treatment was done.[3] The limit value for nickel concentrations in wastewater conveyed to the sewer is set at 0.5–2.0 mg/l. The annual average of 4–8.6 µg/l for nickel is set as the environmental quality standard and the maximum allowed concentration is 34 µg/l. The annual average of inland surface waters refers to the bioavailable and soluble share, the maximum allowed concentration means soluble share.

6.6.10 Zinc, Zn

Some zinc compounds are extremely toxic to aquatic organisms. Zinc is included in abundance in galvanised products such as car panels, building roofs, facades, pipe connections. Rust-proof colours and pigments also contain zinc. Zinc has replaced lead as a stabilising medium in PVC floor carpets. Zinc pyrithione is an active substance for example in boats' base coats that inhibits the growth of microorganisms. Zinc is carried into wastewater by the treatment processes of metals, surface treatments, paint and varnish production, traffic (brakes, wheels, asphalt) and galvanised surfaces. In households, zinc sources are mostly found in foodstuffs and hygiene products. Shampoos contain zinc pyrithione and sunscreens include other zinc compounds. Ca. 30−80% of zinc binds to sludge in wastewater treatment.[18,19,20,21] The limit value for zinc concentrations in wastewater conveyed to the sewer is set at 3.0 mg/l.[13]

6.6.11 Tin, Sn

Organic tin compounds, such as tributyltin (TBT), accumulate in the body and are extremely toxic to aquatic organisms and mammals − even in low concentrations. Today, organic tin compounds are not allowed to be used as agricultural biocides and anti-rot agents. Inorganic compounds of tin are relatively harmless. Tin is used especially for corrosion protection, soldering metal and as component for certain chemicals. Amalgam used in dental fillings includes tin to some extent. Organic tin compounds (dibutyltin, DBT) are used as stabilisers for PVC plastics and they can end up in the sewer network from floor and wall materials produced from PVC. Also glues, colours, chipping fluids and car accessories, agricultural biocides, protection impregnants and ships' algae resistant paint include organic tin compounds. Ship base coats contain tributyltin (TBT) and triphenyltin (TPHT). Inorganic tin compounds end up in small amounts in the sewer network from food products. The limit value for tin in wastewater conveyed to the sewer is set at 2 mg/l.[13,22] TBT's environmental quality standard is 0.0002 µg/l as an annual average and 0.0015 µg/l as the maximum allowed concentration.

6.7 Hydrocarbons (solvents, oils and fats)

This chapter divides substance compounds into groups according to practical operations as clearly and as practically as possible. Different laboratories can analyse different kinds of substance packages and therefore, the division of substances into groups does not necessarily follow the arrangement below.

6.7.1 Solvents

In this context, solvents refer to volatile hydrocarbons which cause occupational safety related problems in the sewer network, danger of explosion, odour problems, and corrosion to sewer equipment or malfunctions in the treatment process. For instance, the hydrocarbon chain of a hydrocarbon mixture in a typical car wash solvent is C_8-C_{13}.

6.7.2 VOC compounds <C_{10}

Volatile organic compounds (VOC compounds) include, among others, halogenated hydrocarbons (e.g. chlorinated hydrocarbons), aromatic hydrocarbons (e.g. BTEX compounds) and alcohols. Some water utilities use the limit value of 3 mg/l for chlorine-free VOC compounds conveyed to the sewer. It is not allowed to release chlorinated hydrocarbons into the sewer. In certain cases and only with a specific permission, the limit values for chlorinated hydrocarbons can be set at 0.01-0.05 mg/l. The environmental quality standards for chlorinated hydrocarbons are in the range of 0.01-12 µg/l. Limit values have been set case-specifically for wastewater containing alcohols. Alcohols do not necessarily belong to a VOC analysis package of a laboratory. In case the analysis should also include alcohols, it is recommended to check the analysis package or separately agree upon the matter.

6.7.3 Petrol hydrocarbons, i.e. BTEX compounds

BTEX compounds belong to petroleum hydrocarbons (benzene, toluene, ethylbenzene and xylenes). These are aromatic hydrocarbons that are components of a fuel and which are seen as the main harmful substances in general. BTEX compounds are also used as solvents, raw materials for pharmaceutical products, agrochemicals and in the production of polymers and explosive agents. They can be found in leachate from landfills, in wastewater generated by car service stations and in water generated by construction sites for remediating contaminated soils. BTEX compounds belong to the group of volatile organic compounds. The limit value for BTEX compounds is 3 mg/l in wastewater conveyed to the sewer. The environmental quality standard for benzene from BTEX compounds has been set at 8−50 µg/l. Special attention should be paid to the amount of benzene.

As additives of benzene, MTBE (Methyl tert-butyl ether) and TAME (tert-Amyl methyl ether) are fast moving ethers which have been used to raise the octane number and boost the combustion rate. Since the end of the first decade of the 21st century, there has been a vast development in petroleum's composition along with the distribution obligations concerning traffic's biofuels. MTBE or TAME is not in production anymore and today they are not added to the engine petroleum produced in Finland. At present, these components have been replaced by less-harmful oxygen-containing components, such as ethanol and ethanol-based ETBE (ethyl tert-butyl ether). Tertiary amyl ethyl ether (TAEE) is not produced in Finland and, at least at the moment, it is forbidden to add it to petroleum. The used limit values for MTBE and TAME are both set at 50 mg/l.

6.7.4 Halogenated compounds (AOX compounds)

Pollutant sources for halogenated organic compounds (such as dichloromethanes, chloroform, carbon tetrachloride) are, among others, organic solvents, plastic production, biocides, antibiotics and refrigeration devices and use of chlorine compounds. AOX compounds, i.e. absorbing organohalogen compounds, are organic chlorine, bromine and iodine compounds which are determined by the AOX (adsorbable organic halides) method. Some of the compounds are degradable and some are persistent.[23] The limit value for industrial wastewater set by HELCOM for AOX concentration is 1 mg/l.[24]

6.7.5 Mineral oils, hydrocarbons C_{10}-C_{40}

Compounds are classified as mineral oils if they include hydrocarbon fractions in the range of C_{10}-C_{40}. C_{10}-C_{21} mineral oils are semi-heavy, i.e. fuel oil and diesel. Hydrocarbon fractions C_{21}-C_{40} refer to heavy fuel oils and lubricants. Mineral oils can cause blockages in the sewer network, inhibit the functionality of activated sludge by preventing oxygen entry into sludge particles and create higher treatment costs for the water utility. The limit value for the total concentration of oil hydrocarbons in wastewater conveyed to the sewer is set at 50-200 mg/l.[7]

6.7.6 Fats

Fats are generated, among others, by slaughterhouses, dairies, plants treating animal-origin by-products, restaurants and dairies of dairy farms. Fats block sewer pipes and blockages in pipes can cause water damage in a property. Additionally, fats both of animal-origin and plant-origin consume a lot of oxygen during the treatment process. In other words, they can negatively interfere with the oxygen supply of a biological process and thus cause the growth of filamentous bacteria. Fat-containing wastewater generated by industry nearly always requires a pretreatment of wastewater. The National Building Code of Finland provides regulations on fat and grease separation. As a rule, the used limit value for wastewater conveyed to the sewer is set at 100−200 mg/l.[13,34]

6.8 Organic hazardous substances

The table that is included in Appendix 5 of the Finnish Environment Institute's publication *Monitoring of hazardous substances* presents the applications of 11 hazardous substances which have been recognised in the HELCOM's action plan for the Baltic Sea, as well as their use and restrictions for releases.[25] The substance descriptions presented below reveal the industrial pollutant sources of those substances. For many organic hazardous substances, households are a prominent pollutant source because substances are released into wastewater through products used in households.

6.8.1 Chlorinated paraffins CP C_{10}-C_{13}

Chlorinated paraffins are also called chlor-alkalies or polychlorinated aliphatic compounds (PCA). They exist in various chain lengths and in different chlorination degrees. Chlorinated paraffins CP and PCA are carcinogenic and immediately toxic to aquatic organisms. Short-chain chlorinated paraffins (SCCP) are the most hazardous to the environment. Chlorinated paraffins are used as softeners, flame retardants and lubricants in coolants and metal working fluids. Chlorinated paraffins are classified as risk-reducing chemicals, which means that industrial plants using these substances have to prepare a risk assessment. The environmental quality standard for chlor-alkalies is as an annual average 0.4 µg/l and as the maximum allowed concentration 1.4 µg/l.[13]

6.8.2 Polychlorinated biphenyls PCB

PCB compounds are comprised of biphenyl molecules and different numbers of chlorine atoms. Biphenyl means two benzene rings together. PCB compounds can be found nearly everywhere in our environment. They are slowly degradable and fat-soluble and because of that they can bioaccumulate in organisms' fat tissue, and thus enrich in the food chain. PCB compounds are toxic to aquatic organisms and cause development and reproductive disorders for various species. The production, import and sale of products containing PCB compounds are not allowed in Finland. PCB compounds have been often used in the building industry, for example, as insulation material in cables and converters, as softeners in plastics, in capacitors of old fluorescent tubes and in seam compounds of certain facades built in 1957–1972. PCB can be detected in water in the context of the remediation of contaminated areas.[13]

6.8.3 Polycyclic aromatic hydrocarbons PAH

Polycyclic aromatic hydrocarbons or PAH compounds are hydrocarbons composed of joint multiple aromatic rings, such as, for example, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, phenanthrene, fluoranthene and naphthalene.[26] Naphthalene is very toxic to aquatic organisms. Naphthalene is used as an additive in liquid fuels and lubricants, and in the plastics and pharmaceutical industries. PAH compounds occur when an organic substance, for instance wood, burns imperfectly. PAH compounds in wastewater are generated by energy production (airborne fallout), metal smelting, various combustion processes and fires (water from fire extinction) and leachate from construction sites for remediating contaminated soils. The lightest PAH compounds are volatile and barely soluble. Their degradation under anaerobic conditions takes place very slowly. PAH compounds bind partly to sludge in wastewater treatment.[18,13] The environmental quality standard for PAH compounds refers to a benzo(a)pyrene concentration that can be seen as an indicator for PAH compounds. The environmental quality standard for benzo(a)pyrene is set as the maximum allowed concentration at 0.027-0.27 µg/l. Additionally, an environmental quality standard has been set for benzo(a)pyrene regarding the organisms.

Creosote oil is the oldest wood preservative which is industrially manufactured. It is produced by distilling coal tar. It is used for industrially impregnating crossties and poles, among others. The impregnant is composed of several hundred compounds which are even more hazardous than the carcinogenic PAH compounds.[27] The limit value for PAH compounds in wastewater conveyed to the sewer is set at 0.05 mg/l.

6.8.4 Dioxins and compounds similar to dioxins

Dioxins and similar types of compounds are generated as by-products of chlorinated chemicals, for example, in the production of wood impregnants. They are extremely wide spread and they can be found practically everywhere in our environment. According to research studies, dioxins and similar type of compounds end up at wastewater treatment plants especially though stormwater but also through domestic wastewater because dioxins and similar compounds can be found in foodstuffs in low concentrations.

According to research studies, the toxicity rate of dioxins and compounds similar to dioxins varies. They have been proven to cause liver damage and cancer in organisms. They are extremely hazardous to aquatic organisms. Dioxins are barely soluble and extremely persistent and bioaccumulative in the environment. The environmental quality standard for dioxins in organisms (perch) is set at 0.0065 $\mu g.kg^{-1}$ TEQ (sum of PCDD+PCDF+ PCB-DL).

6.8.5 Phthalates, e.g. DEHP

Phthalates are hazardous to the environment and wide spread compounds that are used, for example, in the plastics industry as plastics softeners. Phthalates degrade fast in the environment and therefore do not enrich in the food chain. Due to their wide spread use, the environment is continuously exposed to this compound. Some phthalates are immediately toxic to aquatic organisms and they can be carcinogenic and harmful to reproduction. Attempts have been made to reduce the use of many phthalates but they are still used in Finland to a significant extent.

Phthalates are used as softeners in plastics and they can be found in wallpapers, floors, in wet room floor coverings and other wall and interior materials. However, they can also be found in glues, colours, paints, varnish and cosmetics and personal care products. As much as half of PVC plastics' weight can be formed by phthalates which are loosely bound and slowly disintegrate from materials. For example, landfill water can contain phthalates. DEHP (di(2-ethylhexyl)phthatalate) is the most common phthalate and it has endocrine disrupting properties.[13] DEHP’s environmental quality standard is as an annual average 1.3 µg/l.

6.8.6 Brominated flame retardants

Flame retardants are used in plastics, rubber and textiles to prevent the material from catching fire, the spread of fire in these materials and to improve their heat resistance. Flame retardants can contain inorganic (e.g. antimony trioxide) or organic (e.g. chlorine, bromine or phosphorus) substances.[28] Flame retardants are slowly degradable, toxic and bioaccumulative.

Brominated flame retardants can be found, among others, in circuit boards, computer cases, TVs and in other electronics but also in fabrics, cars and construction materials. Polybrominated diphenyl ethers (PBDE) were also used earlier. Only a part of polybrominated diphenyl ethers were used in produced mixtures but in practice they are still found in the environment as a result of degradation.[13] The environmental quality standard for brominated diphenyl ethers is 0.14–0.014 µg/l as the maximum allowed concentration. Additionally, brominated diphenyl ethers hold an environmental quality standard which is set for organisms.

6.8.7 Hexabromocyclododecane HBCD(D)

Hexabromocyclododecane is a flame retardant that is used in Finland in the production of EPS insulation materials and in the insulation boards of buildings.[3] In wastewater treatment, HBCD accumulates in the sludge through which it is released into the soil. HBCD is persistent and along with the treated wastewater it ends up in water bodies. Higher concentrations of HBCD have been measured in wastewater at the treatment plants which receive wastewater from airports and electronic and insulation industries.[3]

The substance has proven to have effects on the reproduction of organisms and on their individual development. Additionally, it bioaccumulates and enriches in the food chain. HBCD was added to the prohibition Annex of the Stockholm Convention in 2013 and it was classified as a POP substance (persistent organic pollutant). The environmental quality standard for HBCDD is 0.05–0.5 µg/l as the maximum allowed concentration. Additionally, HBCDD holds an environmental quality standard which is set for organisms.

6.8.8 Perfluorinated alkylated substances, i.e. PFAS compounds

In perfluorinated alkylated compounds, hydrogen atoms in a hydrocarbon chain are replaced by fluorine. The most important of these substances are perfluorinated octylsulfonates (PFOS) and perfluorooctanoic acid (PFOA), which are most often found in the environment of the PFAS compounds. A common feature for these compounds is that they degrade extremely slowly in the environment and enrich in the food chain. Perflourinated octylsulfonates are classified as POP substances (persistent organic pollutants) and they are extremely toxic to aquatic organisms. The use of these substances is heavily restricted. Releases from these substances are assumed to continue throughout their lifecycle − in other words, during the production and use as well as after use. It also supposed that despite the restricted use, these substances will be found for a very long time in our environment. PFOS substances have been used or are still used in fire extinction foams, detergents, impregnants, metal coatings, additives in colours and varnishes, as well as in the production of semi-conductors and in hydraulic oils in the aviation industry.[13] The environmental quality standard for PFOS compounds is 7.2–36 µg/l as the maximum allowed concentration. Additionally, PFOS compounds hold an environmental quality standard which is set for organisms.

PFOSs can also be generated during the wastewater treatment process as a degradation product of almost 100 different compounds in which case the PFOS concentration in water leaving the treatment plant can be even higher than the PFOS concentration in influents.[3] PFOS is not biodegradable and it is released into the environment in the treated wastewater and sludge.

6.8.9 Phenols

Phenols are mainly used for producing phenolic resins but they can also be found in different solvents, detergents and disinfectants. Phenol dissolves well in water and hardly evaporates at all. Phenols are toxic to aquatic organisms but do not accumulate in the food chain. The limit value for phenol concentrations in wastewater conveyed to the sewer is 10 mg/l[18].

6.8.10 Chlorophenols

Chlorophenols are toxic to organisms and their degradation in nature is extremely slow. Chlorophenols accumulate in the bottom of water bodies and in the soil. Products containing chlorophenols are especially used in wood preservatives. The most common chlorophenol product is the Ky5 product which is meant to prevent the fresh timber from turning blue. The product contains natrium salts of tetra-, tri- and pentachlorophenols. Today, the use of products containing chlorophenols is forbidden. According to Government Decree 868/2010, chlorophenols shall not be released into the sewer.[29]

6.8.11 Nonylphenol and nonylphenol ethoxylates

Nonylphenols are extremely toxic to aquatic organisms and they can cause long-term adverse effects in the aquatic environment. Nonylphenols and nonylphenol ethoxylates are used, among others, in lubricants, stain removers, detergents, washing agents, anti-corrosive agents, metal working and grinding fluids, as well as in leather production. In the course of time, ethoxylates absorbed e.g. into the sludge change to phenols and their toxicity and solubility increases. Remains of nonylphenols can end up in wastewater also from textiles imported from outside the EU if nonylphenol ethoxylates have been used in their manufacture.[13,18] The environmental quality standard for the total toxicity of nonylphenols and nonylphenol ethoxylates is 0.3 µg/l as an annual average and 2.0 µg/l as the maximum allowed concentration.

6.8.12 Octylphenols and octylphenol ethoxylates

Octylphenol is classified as a substance harmful to the aquatic environment. Octylphenols and octylphenol ethoxylates are used, among others, in washing agents, detergents in servicing of motorised vehicles and in electronics industry, as well as in the production of glues and paints.[2] Octylphenol ethoxylates can also end up in wastewater from washing textiles.[3] They are soluble substances which reduce the surface tension of water.[18] The environmental quality standard for octylphenols is 0.01-0.1 µg/l as an annual average.

6.8.13 Bisphenol A

Bisphenol A is a monomer used in the plastics industry and its applications have been utilised especially for producing epoxy resins and polycarbonate plastics. Additionally, bisphenol A is a commonly used substance on the inner surfaces of tins and in soft drink bottles, as well as in the renovation linings of properties' sewer networks. Due to its extensive use, bisphenol A is released in large amounts into the environment where it nonetheless degrades fast and does not accumulate in the soil, water bodies or organisms.

In 2015, the Finnish Environment Institute (SYKE) proposed adding bisphenol A with an annual average of 0.15-1.5 µg/l to the national environmental quality standards. The national environmental quality standards, however, were not changed as proposed.

6.9 Other substances

6.9.1 Cyanide

Cyanide (CN) is used for tempering steel, in the colourant industry, for surface treatment of metals, in the mining industry, as a disinfectant, as an insecticide, for developing films and as a laboratory chemical. Cyanide can end up in wastewater from the surface treatment of metals (zinc coating, gilding, silvering) where the CN wastewater is oxidised to cyanates or minerals. Under acidic conditions, cyanide degrades into extremely toxic hydrogen cyanide, i.e. prussic acid. Potassium cyanide does bind to soil in the ground which means it is a substance with a tendency to migrate and thus can end up in groundwater. It requires an environmental permit to convey cyanide to the sewer. Cyanide is extremely toxic to aquatic organisms. The limit value for total cyanide in wastewater conveyed to the sewer is 0.5 mg/l.[30]

6.9.2 Musks

Synthetic musks are fragrances which are used in different cosmetics and personal care products, such as in soaps, detergents, air fresheners, laundry detergents, perfumes and aftershaves, moisturisers and other cosmetics. Musks end up in the environment carried by wastewater. Musks are relatively persistent compounds and some of them have been proven to accumulate through food chains in the environment. It has been proven that polycyclic musks accumulate in the wastewater treatment plant sludges. The toxicity rate of polycyclic musks is lower than it is for nitromusks. The use of nitromusks is restricted in the EU and Nordic Countries. The environmental impacts of musks are not yet sufficiently known.[31,32]

6.9.3 Siloxanes

Siloxanes are silicon compounds which are used as additives in fuels, car waxes, cleaning fluids, cosmetics, hygiene and biomedicinal products. According to research studies, siloxanes have a harmful effect on aquatic organisms. In the combustion reaction of biogas at a wastewater treatment plant, siloxanes are oxidised to silicon dioxides that accumulate in gas engines' spark plugs, pistons, piston rings and oil. Silicon dioxide may damage the pistons of a biogas engine and cause changes to the engine's running, maintenance and oil change frequencies. A water cleaner efficiently removes siloxanes but it has been proven to be an expensive solution.[33]

6.9.4 Pharmaceuticals

Pharmaceuticals end up in wastewater mainly through the use of medicine, as it is passed thought the digestive system, as well as through the incorrect disposal of surplus or old medicinal products to the sewer. Pharmaceuticals form a heterogenic group formed by biologically active substances whose chemical and physical properties and effects on organisms vary a lot depending on the drug. Therefore, also the removal of pharmaceuticals in wastewater treatment varies a lot between different processes and drug ingredients. Wastewater treatment plants cannot totally remove the pharmaceuticals included in wastewater coming in to the plant, which means that pharmaceuticals and their residues end up (constantly) in the water bodies and treatment plant sludge in low concentrations.

Examples of commonly used pharmaceuticals

Diclofenac is a commonly used anti-inflammatory drug. Diclofenac is a watch-list substance according to the priority substance directive but an EQS value is not set for it. The removal at the treatment plant is ca. 5%. According to research studies, the biological treatment method of a treatment plant has no significant effect on the removal of diclofenac.

Hormones E2 and EE2. 17α ethinylestradiol (EE2) is a synthetic hormone which is used e.g. in contraceptives. The substance has been proven to cause reproductive disorder in fish, among others. Both females and males naturally exude 17β estradiol (E2). Both ingredients are watch-list substances and fall under the priority substance directive but an EQS value is not set for them. E2 is highly biodegradable and EE2 is biodegradable. The removal rate of E2 was at 97% on average at the treatment plants. According to modelling, the EE2 removal rate is 66−80%.[3]

Ibuprofen is an anti-inflammatory drug and one of the most commonly used medicines in Finland. Ibuprofen is proposed to be classified as a watch-list substance. The removal rate of ibuprofen in wastewater treatment is high, >90%, independent of the size of the treatment plant, biological treatment used or possible post-treatment method.

Carbamazepine is an anti-epileptic drug and proposed to be classified as a watch-list substance. The average removal rate of carbamazepine at wastewater treatment plants is -5%. The removal rate is low, independent of the size of the treatment plant or biological method used. Carbamazepine's removal rate in the biological nitrogen-removal process was -30% on average and in the traditional active sludge process it was 10%.[3]

Antibiotics, i.e. antimicrobial drugs are used in the treatment of infections to destroy harmful bacteria. Macrolide antibiotics, i.e. erythromycin, clarithromycin and azithromycin are watch-list substances falling under the priority substance directive. The spread of antibiotics is related to the risk of creating antibiotic-resistant bacterial strains.

6.9.5 Foam-causing substances

Strong liquid detergents cause foaming problems in the sewer network or at the treatment plant. Foaming can also be caused by proteins and starch included in industrial wastewater. Wastewater that includes fats may cause the growth of filamentous bacteria at the treatment plant, in which case foaming can increase. If wastewater causes foaming, the use of an anti-foaming substance is required from the operators.[34]

6.9.6 Legionella

Legionella are Gram-negative, aerobic bacteria which are common in soil and in aquatic systems of properties and plants, for example. The growth of Legionella bacteria is robust in the temperature range of 20–45 ˚C. Legionella bacteria have been shown to exist e.g. in the aeration basins of the wastewater treatment plants, balancing basins of industry, cooling towers and in condensation water. Legionella bacteria have been detected in the aeration basins at municipal wastewater treatment plants in lower concentrations than at industrial wastewater treatment plants.[35]

Legionella bacteria have been proven to cause pneumonia and milder infections. People are exposed to Legionella bacteria through aerosols. If industrial wastewater is very warm and forms a major part of the treatment plant’s discharge, it is recommended to investigate the occurrence of Legionella.[36] Practice has shown that Legionella can be destroyed e.g. by increasing the pH level.

6.9.7 Microplastics

Microplastics are defined to be plastic particles below 5 mm in size. Many daily consumer products include microplastics as such − from clothing fibres, cosmetics and personal care products and drug ingredients to surface treatment materials. Additionally, microplastics are generated when larger plastic particles degrade.

Microplastics end up in water bodies through different channels − in wastewater and stormwater from municipalities, among others. According to research studies, microplastics exist nowadays practically everywhere in the aquatic environment, especially in oceans, and the amount of microplastics is assumed to increase.

The degradation time of (micro)plastics in the environment is not known in detail and it varies between different plastics. According to several studies, the degradation will take, however, at least several decades. Microplastics in an aquatic environment accumulate in aquatic organisms through nutriments and gills. Additionally, it is typical for microplastics that they adsorb different types of chemical compounds which as such are potentially harmful to the environment and organisms.

A properly functioning wastewater treatment plant has been shown to efficiently remove microplastics. Particles over ≥300 μm are removed in a normal wastewater treatment process by over 99%.[37] Minor particles are not removed as efficiently as the larger ones.[38] Microplastics are not currently taken into account in industrial wastewater agreements.

6.10 Substances inhibiting nitrification

The nitrogen-removal process is sensitive to different inhibition factors because the growth of nitrification bacteria is slowed down by several toxic substances and adverse growth conditions. Usually all such substances that are toxic inhibit nitrification. For example, free cyanide is extremely toxic to nitrification.

Autotrophic bacteria, which perform nitrification, are more sensitive to the effects of different substances than heterotrophic bacteria that perform denitrification. The autotrophic nitrifying bacteria are extremely sensitive to several heavy metals and synthetic organic chemicals. Appendix 14 presents a list of substances inhibiting nitrification.

Nitrifying plants should pay attention to the impact of received industrial wastewaters on nitrification when setting the limit values. Chapter 6.11.2 describes the performance of the nitrification inhibition test.

In addition to temperature, the nitrification process is also sensitive to changes in pH which can be caused by wastewater generated by different industries. The pH level of wastewater received at the treatment plant is regulated and monitored at the plant to ensure effective nitrification. An industrial establishment which conveys industrial wastewater to the treatment plant has to pay attention to the pH of its wastewater so that it does not burden the processes of the wastewater treatment plant.

Examples of substances inhibiting nitrification

(concentration (mg/l) inhibiting nitrification is given in brackets)

Formaldehyde (160) is a simple gas and a substance inhibiting nitrification. A saturated water solution is called **formalin**. Formaldehyde is released into the environment from certain paints, coating materials, textiles and furniture glues.

Thiourea (75% inhibition at 0.076 mg/l, 100% inhibition at 0.67 mg/l) is an organic compound, used in industry, which degrades when heated. Thiourea is toxic to organisms in an aquatic environment. It has also been proven to inhibit nitrification. Thiourea is used for removing copper remains and it can occur, among others, in water generated in pickling processes.

Lead (0.5-20) belongs to the heavy metals and is a substance inhibiting nitrification. Lead occurs in sulphide minerals of bedrock. Lead and its compounds are used for several purposes, such as in brass, bronze, different kinds of colourants, anti-corrosive agents as well as in electrical and telecom cables.

Cyanide (0.54-2.7) is the salt of hydrogen cyanide which inhibits nitrification. The most used cyanide, i.e. potassium cyanide, is used for tempering steel, separating gold and silver from ore, silvering, as a disinfectant, as a biocide, for developing films, producing colourants and as a laboratory chemical. Cyanide can end up in industrial wastewater at the wastewater treatment plant, or as washout water or along with stormwater.

Cadmium (0.5-20) is a heavy metal and a substance inhibiting nitrification. Cadmium ends up at wastewater treatment plants from mining and paper industries, chemicals industry, in the context of lead, zinc, tin and copper production, from metal and ferrous metal treatment and in leachate from landfills.[3]

Copper (75% inhibition at 4 mg/l of pure culture, 50% inhibition at 75 mg/l of activated sludge). Copper is a heavy metal and a substance inhibiting nitrification. Copper migrates to wastewater, among others, from surface treatment industry, circuit board manufacturing, metal treatment, as well as from the production of paint, varnish and colour and from their use.

Thioacetamide (0.52-7.5) is an organic sulphur compound which is used e.g. for sulphide precipitation. Thioacetamide is a substance inhibiting nitrification.

6.11 Toxicity in the treatment process

6.11.1 Oxygen uptake rate (OUR), i.e. respiration test

Toxic substances inhibit the biochemical activity so that the deceleration of oxygen uptake can be seen as the measure of toxicity. Measuring the oxygen uptake rate helps to detect possible hazards caused by toxic substances or toxic wastewater to the operation of a biological wastewater treatment plant.[39] The harmful effects of a certain substance or industrial wastewater upon the wastewater treatment plant can be less severe because the activated sludge process can be adapted to most wastewater types in the course of time. The performance of OUR measurement is described in Standard SFS EN ISO 8192 2007. The gained result is the inhibition percentage for different concentrations and the EC_{50} value.

6.11.2 Nitrification inhibition test

Inhibition refers to the prevention of the normal operation of the activated sludge process. Nitrification bacteria are sensitive to many hazardous substances. Many of these compounds, especially those originating from industry, can inhibit nitrification.

The nitrification inhibition effect of industrial wastewater or of a substance can be detected by laboratory tests according to Standard EN ISO 9509:2006 or Standard SFS –EN ISO 8192:2007. When the toxic amount of tested substance or industrial wastewater is added, the result is inhibition in nitrification. Appendix 14 includes a list of substances inhibiting nitrification.[13]

6.11.3 Biodegradation

With the help of the ratio between the BOD_7 and COD_{Cr} values, the quality of wastewater can be estimated. If the ratio is high (over 0.5), the organic substance in wastewater is highly degradable and wastewater is most probably not very toxic.[40] If the ratio is low, the organic substances in wastewater are only barely biodegradable or the toxic substances in wastewater inhibit the biochemical oxygen uptake. The toxic effect is reduced along with dilution. Toxicity is very likely if the BOD value in the results from the BOD definition performed by the dilution method increases along with the increasing dilution.

6.12 Biotests

The proportional toxicity of the sample to the test organisms can be estimated using acute toxicity tests. They describe the short-term effect on a test organism. The toxic effect of the acute toxicity tests is largely bound to the period of exposure, and it does not describe the long-term impacts of the chemical or its components on the test organism or its environment.

Chronic tests serve for predicting the probability whether a constant exposure causes harm to organisms. The response in chronic tests can be, for example, the birth rate or maturation of the organism during the test. It is possible to study toxicity of wastewater, impacts of harmful substances and environmental risks resulting from them by many different biotests under laboratory conditions (among others, toxicity, genotoxicity, degradability and accumulation tests) and by other methods based on the biological response.

6.12.1 Luminescent bacteria test

The luminescent bacteria test estimates the acute toxicity of a harmful substance or environmental sample using a luminescent bacterium (*Vibrio fischeri*). The luminescent bacteria produce light through the compounds forming as a by-product of their cell respiration. The inhibition (toxic effect) of the process related to the bacterium cell reduces cell respiration, in which case the light production of the bacterium also decreases. The luminous yield from luminescent bacteria, transferred to an aqueous extract, is measured by a luminometer. A Flash luminescent bacteria test (ISO 21338, 2009) using the luminescent bacterium (*Vibrio fischeri*) is meant for sludge and coloured or murky water. The test measures the change of the luminescent yield kinetically after a contact time of 30 s and 30 min with the test sample.

6.12.2 Water flea test

The water flea test helps to estimate the acute toxicity of a sample to invertebrates using the *Daphnia magna* water flea. The test follows how the movement of the water flea is prevented in different kinds of sample concentrations. Young daphnids are exposed to different sample concentrations for a 48-hour test period, after which the percentage of akinetic water fleas is calculated from each sample. The test performance is described in Standard SFS-EN ISO 6341.

6.12.3 Algae test

The acute toxicity of a chemical to aquatic plants can be analysed by the algae test according to Standard SFS-EN ISO 8692. This test studies the inhibition of algae growth of single-cell fresh-water green algae. The algae function as basic producers in several food chains within the aquatic ecosystem. Because the division rate of algae cells is high, the effects of compounds on the growth and multiplying of algae can be monitored in a short time. In the inhibition test of algae growth, single-cell green algae are cultivated in nutrient fluid and the algae's growth is monitored at least every 24 hours. The impact of different sample concentrations on the algae growth is studied for 72 hours. The result is a sample concentration causing a 50% inhibition.

6.13 Toxicity to aquatic organisms

The impact of substances on water bodies, as well as their toxicity, can be estimated by defining their toxicity to aquatic organisms. A crustacean and algae are substitute species which cover the level of several food chains. An acute or immediate toxicity to aquatic organisms is defined according to following values:

- Crustacean's 48-hour EC_{50} value (EU C.2, OECD 202)
- Algae's (EU C.3, OECD 201) or, for example, Lemna water plant's 72-hour / 96-hour EC_{50} value[41]

The LC_{50} (lethal concentration) value refers to a chemical concentration in which half of the test organisms die. The EC_{50} (effective concentration) value refers to a concentration in which half of the test organisms show some negative effect, such as immobility or inhibited growth. The IC_{50} (inhibitory concentration) value is a concentration in which, for example, the algae's growth is reduced by 50%.

A chronic toxicity to aquatic organisms is defined according to NOEC (no observed effect concentration) values of the aforementioned species. NOEC is a chemical concentration in which no effects of the substance on the organisms can be observed.42

The following tables present limit values and categories for interpreting properties of chemicals. Table 9 presents the category of acute toxicity and Table 10 shows the category of long-term toxicity to aquatic organisms. These limit values are used when preparing operational safety information bulletins.

Table 9: Acute toxicity to aquatic organisms[42]

$LC/EC/IC_{50}$ (mg/l)	**Category**
<1	extremely toxic
1-10	toxic
10–100	harmful
>100	very slightly toxic

Table 10: Long-term toxicity to aquatic organisms[43]

NOEC (mg/l)	**Category**
<0.01	extremely toxic
0.01–0.1	toxic
0.1–1.0	slightly toxic
>1.0	very slightly toxic

Bioaccumulation may cause chronic toxic effects on organisms even in low concentrations in the long-term range. The bioaccumulation of organic substances can be estimated using the octanol/water partition coefficient ($logK_{ow}$).[40] The substance has a tendency to bioaccumulate if $logK_{ow}$ ≥4. A better measure of bioaccumulation is however the BFC (bioconcentration factor) for fish, which is defined experimentally. The substance is bioaccumulative if the BCF for fish is ≥500.[40]

To be taken into account in an industrial wastewater agreement

Operational safety information bulletins concerning chemicals provide information on their toxicity to aquatic organisms. This information can be utilised when assessing the possible hazards caused to the water body when the substance in question is conveyed to the sewer, where it can after dilution and going through the treatment process migrate to the water body.

7 MONITORING OF INDUSTRIAL WASTEWATER

The quality of industrial wastewater is monitored using wastewater samples which are taken either by an external party, i.e. a consultant, or by the water utility in an agreed manner. The operator commits itself to following the industrial wastewater monitoring programme determined in the industrial wastewater agreement. When the monitoring programme is prepared, attention must be paid to the monitoring programme defined in the environmental permit decision. The party which is taking the samples must have sufficient training in respect of sampling. The certification of the sampler ensures the required competence. Instructions for monitoring harmful and hazardous substances are provided by the *Monitoring Guide for Harmful Waste* (Environmental Administration Guidelines 3/2010).[25]

7.1 Sampling point

The monitoring programme of the industrial wastewater agreement defines the sampling point. The wastewater samples can be taken from wastewater after the wastewater treatment process, from a separate sampling manhole or from such a wastewater manhole where all wastewater from the industrial plant runs into. The best sampling point is always in flowing water. Modern industrial plants often convey process wastewater and domestic wastewater separately in their own pipelines. When an industrial plant (for instance, a surface treatment plant) has its own treatment facility, the wastewater samples are taken after the treatment process. In a car servicing station, the wastewater sample is taken from such a manhole which is located directly after the grit chamber and oil separator. The wastewater sample must represent the kind of wastewater that is generated in normal production circumstances. The manhole used for sampling must be tagged because samples should always be taken from the same manhole.

7.2 Grab sample

A grab sample or a spot-check sample describes the momentary quality of wastewater at a certain time. It is especially suitable for monitoring facilities with lower environmental loading. A grab sample is also suitable for monitoring the concentration of a substance present in certain types of wastewater (e.g. wastewater monitoring of a car servicing station). A grab sample can also be used for continuous monitoring if it is difficult to get a composite sample and if the concentrations in wastewater vary only a little. It always pays off to take a grab sample when the treatment plant or pumping station receives water diverging from domestic wastewater. The fluctuation of the wastewater quality can be monitored by taking several grab samples over a 24-hour period. A grab sample is also suitable for examining volatile substances (for example, fats, oils, pH, chlorine, sulphide, cyanide, phenols, VOC compounds, phthalates and PAH compounds).[44]

7.3 Composite sample

Composite sampling consists of several grab samples. This sampling method is well suited for monitoring the average quality and the total load of the wastewater. A composite sample is gained by combining the grab samples, manually collected every hour, for instance, in a bottle, or by using an automatic sampling device to collect the samples.

The composite samples are usually taken as 24-hour composite samples using a continuous watch-controlled sampling device and combining the samples in one bottle. A sampling device with 24 bottles which collects samples every hour can also be useful. If the quality of wastewater varies a lot, the samples must be collected frequently so that the composite sample really represents the 24-hour quality of wastewater in the best possible manner. The weak point of this sampling method is that it does not pay attention to random changes in discharge; especially at irregular discharge peaks this can skew the results. The method is suitable for medium-large facilities with an even wastewater discharge.

For large-scale facilities, it is recommended that the wastewater samples are taken in relation to the discharge. In that case, it is required that the industrial plant acquires a permanently installed discharge meter approved by the water utility and a discharge-controlled sampling device which is used at times defined by the water utility or a consultant.

When planning the sampling, attention should be paid to the normal production rhythm in order to detect and define also the loading peaks. When using an automatic sampling device, the suction tube must be installed at a suitable height in the sampling manhole so that the sampler collects wastewater discharged into the sewer and not, for instance, any solids accumulated at the bottom of the manhole over time. It is recommended to clean the sampling manhole a couple days before sampling with e.g. a strong water-jet.

7.4 Frequency and analysis of wastewater monitoring

The quality of wastewater generated by the operator and its impact on the operations of the treatment plant determine the wastewater monitoring frequency. It is a normal procedure to take several composite samples from the operator's wastewater. The checking of increased wastewater fees requires from two to four wastewater samples. The monitoring programmes are individual according to what the process of the industrial plant is and what kinds of substances are possibly conveyed to the sewer.

When examining industrial plants, the focal point often is on the pH value and COD_{Cr}, BOD_7, phosphorus, nitrogen and solids concentrations in wastewater conveyed from the plant to the sewer, whereupon the result is the loading conveyed from the industrial plant to the sewer network. Wastewater containing metal conveyed from the industrial plants to the sewer network is examined for its heavy metal concentrations. Other harmful and hazardous substances are monitored if they appear in relevant concentrations. Wastewater generated by the food product industry can be monitored for its concentrations of fats and solids. Wastewater generated by car servicing stations, car repair shops and other such operators can be examined, among others, for solids and C_{10}-C_{40} mineral oils. Wastewater monitoring aims to detect those relevant harmful and hazardous substances that migrate in wastewater to the sewer.

The sampling tools should be clean. The sample shall not be heated during sampling and transport; i.e. the temperature should remain constant. The sample bottles are chosen according to what the sample is examined for (e.g. one bottle for fats/solvents). Sample bottles, used for normal analysing process, are made of food-quality plastic. When monitoring harmful substances in wastewater, attention should be paid to the materials of the sampling tools (e.g. plastics contain phthalates). Sampling for special analysis is executed according to the instructions provided by the laboratory. The research laboratory verifies the sampling methods, sample numbers, sampling tools and sample containers.

It is recommended to keep a sampling record which includes all information and observations related to sampling, such as the utilisation rate of the plant/operations, results from possible continuous meters, water temperature, daily discharge, discharge at the sampling time, sampling frequency, and time and amounts of incremental samples.

If the discharge at the sampling time is known, the results are presented as loads (g/d) in addition to the concentrations (mg/l). The results of the wastewater samples are sent to the operator, water utility and often also to the authorities supervising the operator's environmental permit.

The operator shall submit a report on the exceeding of defined limit values to the water utility.

8 CHARACTERISTICS OF INDUSTRIAL WASTEWATER

This chapter describes the formation of industrial wastewater, its characteristics, pretreatment, monitoring, and limit values. When preparing industrial wastewater agreements, it must be clarified case-specifically in regard to substances listed in Decree 868/2010 whether such substances occur in wastewater conveyed to the sewer. Appendix 16 presents examples of substances which are included in industrial wastewater generated by different sectors of industry and which should be examined in more detail.

8.1 Food industry

Wastewater generated by the food industry includes, among others, carbohydrates, proteins, fats, acids, alkalis, detergents, salts and preservatives. A high BOD value, solids, phosphorus and nitrogen concentrations and variations in the pH value are typical for food industry-generated wastewater.[51]

8.1.1 Dairy industry

The dairy industry can be roughly divided into two groups based on their products. Fresh product dairies produce milk and cream as well as different kinds of soured-milk products such as yoghurt and curdled milk. Cheese factories produce cheese, and often also process the whey generated as by-product in cheese production.

The wastewater loads generated by the dairy industry consist mainly of so-called “interface milk”; which is the watery milk that is generated in diluted water/product interfaces in the beginning and at the end of processes. Most dairies convey all “interface milk” to the sewer but separate the fractions with the highest milk concentrations and deliver them further to be used as fodder. Another significant loading is generated by the initial washing of tanks, pipelines and process equipment. Especially the initial washes of viscose and fatty products can create substantial loading. In the production of liquid products, the wastewater loading is usually at its lowest level but the production of viscose and fatty products can have very high loading. In Finland, the processing of whey is centralised in a few municipalities and the wastewater loading in these municipalities is quite notable. On average ca. 50−90% of water consumption in the dairy industry is generated through washing water.[45]

The organic loading in dairy wastewater consists of milk sugar, protein and fats. On average, the ratio of BOD/COD in dairy wastewater is 0.65. The BOD/COD ratio of cheese factories and whey processing plants is closer to 0.7 and for plants producing fatty products it is closer to 0.6. Milk fat is not easily biodegradable.[46] A high chemical and biological oxygen demand is typical for the milk processing industry. Typically, the COD concentration in dairy wastewater can vary between 2 000–4 500 mg/l.

Phosphorus loading in dairy wastewater is often low compared to the loading in domestic wastewater. Phosphorus in wastewater comes from milk and in some special cases also from detergents. Nitrogen in dairy wastewater is mainly in the nitrate form, originating from nitric acid used mainly in acid cleaning. Additionally, wastewater includes ammonia from protein.

The temperature of dairy industrial wastewater can be high and it can vary. A high temperature can result from high temperatures used the cleaning of equipment. A high temperature can cause odour emissions when conveying wastewater to the sewer and produce corrosive compounds under anaerobic conditions. If problems occur, wastewater should be cooled down before conveying it to the sewer network.[47]

The pH value of dairy wastewater can vary. The pH value of wastewater depends on the processes, used detergents and disinfectants. Dairy wastewater can also sour by itself as a result of its natural fermentation. Mainly sodium hydroxide (lye) and nitric acid are used as cleaning chemicals. Sodium hypochlorite, as well as hydrogen peroxide and peracetic acid mixtures are used for disinfection. Dairies' refrigeration facilities are ammonium systems. Ammonium leaks are extremely rare so that the risk ensuing from ammonium usage is rather low. The authorities supervising chemical safety require closed floor drains in those facilities where an ammonium leak risk exists.

Non-marketable product series (e.g. rancid milk products) can be treated in the digestion facility of the wastewater treatment plant, provided that the digestion facility has an approval from the Finnish Food Safety Authority EVIRA according to the EC Regulation on animal by-products concerning the disposal of animal-origin and derived food products. If the digestion facility has the necessary approval, the treatment must be agreed upon with the water utility concerned.

Dairy wastewater often requires pretreatment prior to conveying it to the sewer. The pretreatment usually includes discharge balancing, neutralising, grease separation and reduction of organic loading (biological processes). The dairy wastewater is monitored for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and fat concentration, among others. The successful neutralisation of acidic wastewater can be monitored by continuous pH measuring.

8.1.2 Slaughterhouses and meat processing plants

Wastewater generated by slaughterhouses and meat processing plants results from the cleaning of cattle sheds and transport vehicles, as well as from the different stages of slaughtering. Factors which affect the composition of wastewater include the species of the slaughtered animals, amounts of slaughtered animals, cleaning agents, disinfectants and water consumption. Water consumption at slaughterhouses is high because nearly all stages of meat processing produce wastewater. Water demand at slaughterhouses per slaughtered animal is around 2–18 l/kg.[48]

The problems caused by meat processing wastewater concern the high temperature of wastewater, lack of oxygen in wastewater, organic matter ending up in wastewater, high fat and protein contents in wastewater and odour problems. Fats, protein and blood contents in wastewater increase the BOD and COD values of wastewater. Especially fat loading can be seen in the COD values of meat processing wastewater.

Fats and sulphide included in the wastewater produce odour causing sulphur compounds and fatty acids. The high temperature of wastewater can be a partial reason for the poor oxygen solubility in wastewater. The generation of hydrogen sulphide increases when warm and oxygen-free wastewater flows into an anaerobic space. Sulphur compounds can still generate sulphuric acid which is corrosive to concrete sewers. Additional to hydrogen sulphide, wastewater generated by slaughterhouses and plants treating animal-origin by-products can also release ammonium which causes problems with odour and corrosion. Foaming of wastewater can also create problems.

Today all slaughterhouses and the majority of plants producing animal-origin by-products convey their wastewater after pretreatment to municipal wastewater treatment. A screen with a 6 mm mesh is used to prevent solids from entering the sewer (EC Regulation 1774/2002 on Animal By-Products). The aim should be to prevent blood and fat from ending up in wastewater as efficiently as possible. Chemicals, e.g. ferric nitrate or lye, which improve the oxygen level, can be used to combat odour emissions. The applied pretreatment can be, among others, fat separation, solids separation, chemical precipitation, pH adjustment and reducing of organic loading (biological processes). The treatment of slaughterhouse wastewater must comply with the instructions laid down in the by-product regulation. The slaughterhouse wastewater is monitored for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and fat concentration. If necessary, the temperature of wastewater is measured.[48] A BAT report on the slaughterhouse industry is available.

8.1.3 Breweries and the soft drink industry

Beer and soft drink production generates wastewater from the washing of bottles and from the rinsing and cleaning of production facilities. Small amounts of products manufactured in breweries can also be conveyed to the sewer, in which case the ethanol concentration in wastewater can be high from time to time. The wastewater generated in beverage production processes contains large amounts of organic substances (BOD, COD_{Cr}, solids).

The pH level of wastewater generated during beer production can vary a lot. Especially the cleaning of bottles and equipment produces either alkaline or acidic wastewater. Organic substances from breweries often are in liquid form. Neutralisation, separation of solids and reducing of organic loading are often used as pretreatment. Under suitable conditions, the wastewater treatment plant can utilise the liquid organic loading in biological nitrogen removal. The brewery wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids and pH value.[49]

The production of strong liquors generates wastewater that often includes high concentrations of ethanol. The solids-loading is lower than at breweries but the pH value of wastewater can be high. Besides the aforementioned substances, the electrical conductivity of wastewater should also be monitored.

8.1.4 Potato and root vegetable processing plants

The washing and peeling processes of potato and root vegetable peeling plants generate different kinds of wastewater, the quality and amount of which vary a lot depending on the peeling method. Washing of potatoes and root vegetables generates muddy water and soil sludge; peeling generates water containing cell sap, plant material and root vegetable rinsing water. Cleaning of the facilities and equipment produces different kinds of washing water. Wastewater amounts at farm peeling plants vary depending on the size of the operation and applied peeling methods − between 5–50 m^3 per day. The wastewater loading of a medium-sized potato or root vegetable peeling plant equates to an untreated wastewater loading generated in a suburban area of up to a thousand residents. Publication No. 57/2006 of the Finnish Environment Institute provides information on the pretreatment of wastewater generated by potato and root vegetable treatment.

Wastewater from peeling operations includes a lot of organic material which is mainly in liquid form. Biological oxygen demand is usually between 2 000–10 000 mg/l. The wastewater is also acidic, pH 4−5, and it includes a lot of nutrients, such as phosphorus and nitrogen. Typically, the wastewater contains starch which can cause foaming at the wastewater treatment plant.

The production of beet sugar generates wastewater which includes soil mainly from the washing phase. Processing of root vegetables generates calciferous waste and wastewater which includes easily degradable carbohydrates. Wastewater also contains a lot of nitrogen.

Wastewater generated by the vegetable and fruit industry includes soil rinsed off in the washing process, starch, sugar, plant parts and pressed fluids. A significant portion of wastewater is generated by the washing of process equipment and working facilities. Neutralisation, separation of solids and reducing of organic loading are often used as pretreatment. Water from potato and root vegetable treatment plants is examined for its BOD_7, COD_{Cr}, total nitrogen, total phosphorus and pH value.[50]

8.1.5 Bakeries

Wastewater generated by bakeries results mainly from washing the process equipment and dishes such as containers for sourdough starters, dough mixing containers, dough proofing boxes, ovens, deep-fat fryers and transport boxes. Bakery wastewater includes a lot of baking waste and solids consisting of fat residues and bread crumbs. The grain types used by Finnish bakeries consist mainly of carbohydrates with low fat concentrations.

The applied pretreatment for bakery wastewater is neutralisation and separation of fats and solids. Especially the sourdough bread starts to ferment in wastewater reducing its pH value which means increasing corrosion risks and odour emissions in the sewer lines. Bakery wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and fat concentration. The successful neutralisation of acidic wastewater can be monitored by continuous pH measuring.[51,52]

8.1.6 Fish processing plants

Fish processing plants generate wastewater resulting from rinsing off fish bleeding water and gutted fish remnants. Fish blood in bleeding water is the loading-causing substance. On the other hand, rinsing water contains a lot of fat which means that fat separation is necessary. Fish gutting plants are often located far away from sewerage systems so that plant-specific wastewater treatment plants have to be built just for their wastewater treatment. As a rule, fish is gutted manually but rinsed mechanically. Guts are recovered. In case wastewater from fish gutting is conveyed to the municipal sewer, it should be examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and fat concentration.[53] Wastewater ensuing from fish processing may cause odours in the sewer network, which should be taken into consideration when preparing an industrial wastewater agreement.

8.2 Metal industry

Wastewater generated by the metal industry may contain, for example, grinding swarf, oils, fats, varnishes, solvents, acids, alkalis, heavy metals, cyanides and other hazardous substances. The composition of wastewater depends on the production processes and working methods. Liquid waste produced by the metal industry is collected separately as hazardous waste, e.g. liquids from industrial parts washers. A BAT report is available for the metal industry. The metal industry can be a release source especially for tributyltin, mercury, cadmium and nickel. The occurrence of these substances in wastewater should be examined. Determination of hazardous organic substances shall be considered based on the substances and their amounts used in the processes. Possible release sources of hazardous organic substances can be, among others, the use of octylphenols and ethoxylates as industrial cleaning agents, HBCD as flame retardant, PFOS for metal surfaces and semiconductor industry, and the use of DEHP and DBP in paints.[3,2]

8.2.1 Surface finishing plants

The most important wastewater types in a surface finishing plant consist of rinsing waters, used bath solvents and floor rinsing water. Rinsing water usually contains all kinds of metals and chemical compounds which are included in the baths. Rinsing waters can refer to acidic or alkaline, cyanide-, chromic acid- or chromate-containing wastewater, wastewater containing other metals, or to wastewater containing phosphate or oil. Sulphate concentrations in wastewater can be high.

Wastewater generated by surface finishing plants is pretreated at the surface treatment plant before it is conveyed to the sewer. The applied pretreatment method can be, for example, removal of fats and mineral oils, pH adjustment, cyanide disintegration, chromate reduction, precipitation of heavy metals, grit and active carbon filtration. Baths removed from use shall not be conveyed to the wastewater treatment plant of the surface finishing plant because strong solvents easily mix up the entire treatment process. Bath solvents are classified as hazardous waste. Treatment of bath solvents falls under the environmental permit.[54] Wastewater is examined, among others, for solids, pH and heavy metals. If necessary, the examination may also cover mineral oils and concentrations of volatile organic compounds (VOC). Appendix 1 provides a model for an industrial wastewater agreement of a surface finishing plant.[55]

8.2.2 Steel pickling plants

Acid pickling is a process in which steel is treated to remove the oxide layer and other impurities on welded joints. As a rule, a mixture of nitric acid or hydrofluoric acid is used for acid pickling (acid concentrations usually 10−20%). Wastewater including e.g. chromium, nickel, iron and fluoride is generated by rinsing with water after the pickling process. Pickling wastewater is pretreated before conveying it to the sewer. Metals are often removed through hydroxide precipitation. Wastewater is examined, among others, for solids, pH, electrical conductivity and heavy metals.[56,57]

8.2.3 Phosphating process plants

Phosphating refers to a chemical treatment of metal surfaces in which a thin metal phosphate surface is formed when the metal surface reacts with the bath solvent. The surface coating improves the adhesion and permanence of paint layers to the metal surface.

There are several different types of phosphate surface coatings available. The most suitable one is chosen according to the conditions of use. The most-used phosphates are zinc, iron and manganese phosphates and their compounds. Wastewater from phosphating plants includes fats, oils and heavy metals, e.g. nickel, zinc and manganese. Phosphorus concentrations are very high. Wastewater generated by a phosphating plant is pretreated before conveying it to the sewer. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, electrical conductivity and heavy metals. If necessary, the examination may also cover mineral oils and volatile organic compounds (VOC).[58]

8.2.4 Anodising plants

Anodisation is an electrolytic oxidation process in which the surface layer of metal (e.g. aluminium, magnesium or zinc) is turned into a protective oxide layer.[59] Wastewater is generated through rinsing water from the anodising process. Additionally, in the context of anodising, sometimes dyeing is carried out using metal salt or some other chemical. Wastewater from the anodising process is alkaline, acidic or may contain metals. Alkaline wastewater refers to post-pickling rinsing water and acidic wastewater refers to post-anodising rinsing water. Rinsing water contains low concentrations of all those metals which the treated profiles include. An aluminium profile can contain besides aluminium, also iron, copper, silicon, manganese, magnesium, chromium and zinc. Rinsing water generated through cold sealing includes small amounts of cobalt and nickel. Sulphate concentrations can be high. Wastewater generated by anodising plants is pretreated before conveying it to the sewer. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, electrical conductivity, sulphate and heavy metals.[60]

8.2.5 Shipyards

At shipyards, old vessels are repaired or new ships are built. Chemicals used in shipyards are mainly paints. Wastewater generated by a shipyard must be treated to remove solids containing paint. The applied pretreatment method is solids and oil separation. If necessary, wastewater from shipyards is examined for heavy metals, oil hydrocarbons C_{10}-C_{40} and VOC compounds.[61] If primer removal is practiced at the shipyard, wastewater must also be examined for tributyltin (TBT) and triphenylitin (TPHT).

8.3 Chemical industry

The chemical industry refers to an industry where the production is based on chemical reactions. The largerst sectors of the Finnish chemical industry are the manufacturing of basic chemicals and production of oil and coal products. Other sectors of the chemical industry are the production of plastics, pharmaceuticals, paints, colours and rubber products.[62] Wastewater includes chemicals used in the chemical engineering industry. Wastewater also contains residues of inert raw materials in processes, of cleaning and washing water, as well as of leaks and floor cleaning water. Pollutant releases can be reduced e.g. by recycling flushing water. A BAT report is available for the chemical industry.

Chemical industry generates wastewater containing hazardous organic substances and their determination shall be considered based on the substances and their amounts used in the processes. Possible release sources of organic hazardous substances can be, among others, the use of DEPH as a softener in plastics and rubber products, in carpet surface treatment or in cosmetics production, the use of HBCD as flame retardant in polystyrene production and in paints, the use of octylphenols, ethoxylates, nonylphenols and nonylphenol ethoxylates in industrial detergents, as well as in production of paints and varnishes.[2,3]

8.3.1 Paint and coatings industry

Wastewater generated by the paint and coatings industry consists of washing water from the cleaning of production facilities, pipelines and production containers. Wastewater includes colour pigments, latex (natural rubber), solvents, heavy metals and solids. Colourants included in wastewater contain different kinds of compounds (surfactants, biocides, stabilisers, softeners etc.) that can be toxic and inhibit nitrification. The applied pretreatment method of wastewater is solvent removal and solids separation. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, heavy metals and VOC compounds.[63] Additionally, wastewater is examined for nonylphenols, nonylphenol ethoxylates, octylphenols and octylphenol ethoxylates, provided these substances occur in the wastewater. The paint industry can also be the release source of DEHP, DBP and BBP; therefore, the occurrence of these substances in wastewater should be examined.[2,3]

8.3.2 Rubber industry

Wastewater generated by the rubber industry results from rinsing products after grinding, cleaning of moulds, condensation water of vulcanisation equipment, washing solvents for pretreating textiles (cloths) and from cooling water. Wastewater generated by a rubber plant is pretreated if necessary. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, heavy metals, VOC compounds and mineral oils.[64] The possible occurrence of organic hazardous substances in wastewater, such as DEHP, DBP, MBeT, octylphenols and ethylene thiourea, must be clarified.

8.3.3 Explosives factory and blasting sites

Wastewater generated at explosives factories and blasting sites has high nitrogen concentrations (contains nitrate NO_3-N). The wastewater can also include sulphuric acid and sulphur dioxide. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and heavy metals.[65]

8.3.4 Pharmaceutical production plants

Wastewaters from pharmaceutical industry consist of process water and cooling water. Raw materials at pharmaceutical plants include auxiliary substances, acids, alkalies and organic solvents. Active substances in drugs are e.g. PAH compounds (polyaromatic hydrocarbons) and zinc oxides. Ethanol is the organic solvent that is most often used. PAH compounds and zinc oxides may occur in wastewater in very small amounts. Wastewater is examined for BOD_7, $COD_{Cr,}$ total nitrogen, total phosphorus, solids, pH value, electrical conductivity and VOC compounds. If necessary, the examination may also cover AOX compounds. Additionally, it should be considered whether concentrations of pharmaceuticals should be examined.[66]

8.3.5 Enzyme production plants

The main raw materials of enzyme production include various kinds of carbohydrates and proteins functioning as sources of energy and nitrogen, as well as inorganic salts. Auxiliary substances are pH regulators, anti-foaming agents, flocculants, filtration auxiliary substances, stabilisers, preservatives, washing agents and disinfectants. Lye and acid are used for washing. If necessary, the applied pretreatment method is solids separation and neutralisation. Wastewater is examined for BOD_7, $COD_{Cr,}$ total nitrogen, total phosphorus, solids and pH.[67]

8.3.6 Sulphuric acid production plants

Sulphuric acid production generates wastewater from washing the gases. Washing water for gas contains sulphuric acid, mercury, arsenic and other metals occurring as impurities in sulphur dioxide gas. The applied pretreatment method is removal of heavy metals and neutralisation. Wastewater is examined for pH, electrical conductivity and for sulphate and heavy metal concentrations.[68]

8.3.7 Printing ink factories

Wastewater generated by printing ink factories results from washing and rinsing water of production containers, such as the binder and emulsion containers. Wastewater contains paste and print ink, which include binders, pigments, alcohols and glycols. Wastewater includes the solids mentioned above and heavy metals, such as copper and zinc. Wastewater shall be pretreated before conveying it to the sewer. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, electrical conductivity, heavy metals and VOC compounds.[69]

8.4 Printing industry

Graphic production causes loading which results from organic solvents and other organic substances that have toxic properties. The quality of a substance conveyed to the sewer depends on the applied printing techniques. Fixers and developers are sorted into hazardous waste. The printing industry can be an emission source especially for DBP, cadmium, lead and zinc; therefore, it is recommended to find out whether these substances occur in the wastewater.[3]

8.4.1 Offset printing plants

The offset technique can be divided into two different types: heatset and coldset techniques. The heatset technique is used for printing magazines and the coldset technique is applied to the printing of newspapers.

Heatset printing uses ca. 4−15% of isopropanol as an additive in dampening water. Printing colours include, among others, mineral oils, pigments and hydrocarbon resin. Some of the water used for humidifying air in the press rooms and cooling printing machines vaporises into air. Another part is absorbed into the printed products. Developers used for producing the plate and washing water for the developer container are sorted into hazardous waste treatment. Wastewater conveyed to the sewer includes small amounts of chemicals used in print plate production, for example in print inks, washing liquids and glue.

Coldset printing does not use isopropanol in dampening water. Substances used for the developer are phosphoric acid, sodium hydroxide and sodium salts. Developers used for producing the plate and washing water for the developer container are sorted into hazardous waste treatment. Wastewater is generated by humidifying air and washing the machines used for plate production, as well as through air conditioners, non-recurring washing (pipes) and dampening water. Washing of the surfaces and other machine parts also produces wastewater. Water used for cooling printing machines circulates in a closed cycle and does not end up in the sewer, whereas water used for humidifying air in the press rooms totally evaporates into the air.

Wastewater generated in the processes includes dampening water, rinsing water, paper dust and printing ink residues. Only a small part of the used water ends up in the sewer because most of it is absorbed into the printed products as dampening water.

Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and heavy metals.

8.4.2 Silk-screen printing plants

Silk-screen printing, i.e. serigraphy or serigraph printing, is a method whereby ink is printed through a mesh stretched over a frame onto the printing surface. Impurities in wastewater result from the production of printing substrates and mesh screen cleaning. Samples taken from the process water of the aforementioned processes show a tendency for nitrification inhibition. When the pattern is manufactured, the non-hardened light-sensitive emulsion is washed off from the mesh screen. The emulsion contains acrylates, diazo compounds and mycotoxins. If the manufacturing is mechanised, the emulsion residues at the bottom of the machine must be collected and they must be properly disposed of. Water is conveyed to the sewer after filtration or sludge separation. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, pH value, electrical conductivity and heavy metals.[13]

8.5 Forest industry

The operations of the forest industry include peeling plants, sawmills, plywood, pulp, paper and carton plants as well as de-inking plants. Wastewater generated by the forest industry usually includes fibres, lignosulphonates, lignin, chlorophenols and several other toxic compounds. Wastewater generated by the forest industry is often low in nutrients but BOD and COD_{Cr} concentrations and loads are high. Depending on the production, the biodegradability rate of wastewater measured with the COD_{Cr}/BOD ratio varies, whereby it is in the range of 2−2.5:1 at a plant producing mechanical pulp and paper, and in the range of 2.7−3.2:1 at a plant producing chemical pulp.[70] A BAT report is available for the forest industry.

8.5.1 Pulp and paper industry

Debarking and peeling of timber causes moderate loading but the biggest source of organic loading at pulp and paper plants is the process after debarking and peeling – the production of mechanical, chemical-mechanical or chemical pulp. Organic loading caused by a paper machine is relatively lower, whereas the wastewater discharge and solids-containing releases from it are high.

Wastewater generated in the processes of pulp and paper industry include nutrients, fibres and oxygen-consuming substances, and in smaller amounts e.g. resin acids, fatty acids and other compounds that can be toxic to aquatic organisms. Wastewater includes elements of wood, both in its original and changed form (for instance, lignin, starch and alcohols). Additionally, wastewater includes different kinds of auxiliary substances and process chemicals in their original or changed form.

Wood also extracts small amounts of metals. A part of the dissolved metals is bound with complex formers (EDTA, DTPA) in pulp bleaching. The biodegradability of complex formers in wastewater treatment is low or moderate.

If chloro compounds (typically chlorine dioxide) are used as pulp bleaching chemicals, wastewater from bleaching also includes organochloride compounds (AOX). Solids consist mainly of wood-based material, such as fibres and also coating pigments and fillers in the context of recycled fibres and paper production.

A significant phosphorus source in wastewater generation is wood bark and the mechanical production of pulp. Additionally, chemicals containing phosphorus are used in pulp and paper production and in the production of vapour necessary for the process. In chemical pulp production, a part of phosphorus included in the wood material accumulates in the resulting ash within the chemical recovery and thus does not load wastewater unless the ash is removed from the process together with wastewater.

Nitrogen originates from wood elements and some chemicals used. Among others, complex formers, retention substances and optical brightening agents can increase nitrogen loading.

Wastewater generated by the forest industry is warm or even hot. The temperature of wastewater generated by mechanical pulp and paper production is typically at 45–50 °C but non-precooled wastewater resulting from pulp production can be over 60 °C (some special fractions even more than 80 °C). Such high temperature wastewater must be cooled down before it can be treated.

Wastewater generated by the forest industry can include Legionella bacteria. The forest industry's wastewater is pretreated if it is conveyed to a joint treatment at a municipal wastewater treatment plant. Necessary pretreatments are at least screening, primary sedimentation, adjustment of the pH value and, if necessary, also cooling. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and electrical conductivity. If necessary, the examination may also cover heavy metals and AOX compounds.[70] Determination of hazardous organic substances shall be considered based on the substances and their amounts used in the processes.

8.6 Textile and leather industry

The textile and leather industry is the user of a wide range of chemicals, of which some are harmful, irritating, corrosive, flammable or hazardous to the environment. A BAT report is available for the textile and leather industry.

8.6.1 Textile printing

A significant amount of various kinds of chemicals is used for textile printing. Applied chemicals, of which some end up totally or partly in wastewater, include glycerine-based dispersants (colours), reactive substances, different thickeners (thickening alginate, pigment binders, urea, sodium hydroxide methanesulphonate and 4-chlorine-m-creosol), printing chemicals (acetone and sodium chloroacetate) and finishing chemicals (sodium silicate, lye, hydrogen peroxide and acetic acid). Additionally, sodium hydroxide- and 2-Methyl-2,4-pentanediol-based detergents and potassium carbonate-containing fatty alcohol-glycol ether are used.

Wastewater generated by dye houses includes lye, soap and small amounts of colourants and acetic acid. Some of the colourants contain small amounts of complexly bound chromium or copper.

Impurities and auxiliary substances, such as lubricants and paste, added to the textiles in the manufacturing process come out of the textiles during washing processes.

Hydrogen peroxide, lye, detergents and optical brighteners are used for bleaching textiles. Depending on the textile material, reactive colours or dispersion colours are used for dyeing. The applied pretreatment method of wastewater is solvents and solids separation, if necessary. Wastewater is examined for BOD_7, COD_{Cr}, total phosphorus, total nitrogen, solids, pH, electrical conductivity, heavy metals and VOC compounds.[71,72] Determination of hazardous organic substances shall be considered based on the substances and their amounts used in the processes. DEHP can show up in wastewater when PVC textiles are manufactured.

8.6.2 Tanneries

Wastewater ensuing from treating leather includes surfactants, alkalies, fats, chromium compounds and various colourants. In some processes nonylphenol ethoxylates are used for removing fat from leather. Wastewater generated by tanneries has to be pretreated before conveying it to the sewer. The applied pretreatment is removal of solids and chromium and neutralisation. Tanneries' wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, electrical conductivity, sulphate concentration, hexavalent chromium and total chromium.[73] Determination of hazardous organic substances shall be considered based on the substances and their amounts used in the processes.

8.6.3 Laundries

Wastewater generated by laundries is often alkaline (pH 9.5–11) and has a high temperature. Wastewater includes apart from emulsified dirt and grease components, also material loosened from textiles (lint), chemicals (detergent agents) and treatment agents dissolved from textiles (e.g. colourants and finishing chemicals). It is forbidden to convey wastewater from dry-cleaning, distillation waste and contact water to the sewer. Wastewater from laundry cleaning is often similar to domestic wastewater but it may contain a lot of phosphorus. If necessary, wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH and electrical conductivity.[74] Laundries can be a release source especially for alkylphenols (NP, NPE, OP, OPE) and DEHP. The occurrence of these substances in wastewater is not recommendable.[3]

8.7 Manufacturing of mineral products

8.7.1 Glassworks and fibreglass plants

The primary raw materials of glass are sand, sodium carbonate, potassium carbonate and calcium oxide. For example, sodium, barium and potassium carbonates, feldspars, zinc oxides, cadmium sulphides, zinc selenide, selenium, potassium dichromate and sodium selenide are used for producing glass. Additionally, crystal production uses lead compounds to make glass soft enough for grinding. The colourants used are metal oxides. Glass grinding generates process water. The applied pretreatment method is solids separation. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and heavy metals.[75]

A fibreglass production plant manufactures fibreglass wool and yarn. The products are used e.g. in floor materials and filters. Wastewater generated by glass melting is pretreated before conveying it to the sewer. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and heavy metals.[76]

8.7.2 Concrete plants

Concrete's raw materials are natural stone material, binders, water and additives that improve concrete's properties. Concrete's washing water is generated by cleaning the concrete mixers, treatment containers, machine tools and transport equipment. Washing water is alkaline (pH ca. 12), saline, hard and has high sulphate concentrations. Additionally, it contains a lot of solids, to small extent chromium originating from cement and often also some mineral oils.

Washing water is often conveyed through a concrete washer to the production to be further utilised. If washing water is not recycled, such washing water which includes concrete must be conveyed to the sewer via sedimentation basins. Sludge accrued in the sedimentation basins must be removed often enough from the bottom of the basins so that concrete sludge is not conveyed to the sewer. Wastewater, conveyed to the sewer, is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity, sulphate concentration and mineral oils.[77]

8.8 Transport

8.8.1 Ports

Wastewater from passenger ships at ports consists of so-called grey water from washing and black water from toilets. Wastewater is usually conveyed by pumping from the ships to the sewer in the berth area. Wastewater from ship toilets is heavily loaded; for example, the BOD_7 and solids concentrations are around tenfold compared to normal domestic wastewater. Organic substances in wastewater generated in ships consume a lot of oxygen during the degradation process. When the conditions become oxygen-free, foul-smelling hydrogen sulphide is created. Wastewater generated in ships is proven to cause corrosion problems in the sewer lines and at the wastewater pumping stations, in addition to causing odour emissions.

The EU and the International Maritime Organisation IMO have proposed tightening regulations to reduce ships' sulphur dioxide releases. Sulphur oxides are neutralised in the exhaust treatment which generates wastewater with very high sulphate concentrations containing also heavy metals.

The conditions on conveying ships' wastewater to the sewer may require the removal of odour and corrosion causing substances. An industrial wastewater agreement may include an obligation to monitor the condition of the sewer so that possible corrosion damages can be discovered. Odour emissions caused by ship-generated wastewater can be removed through chemical treatment or oxidation equipment. Corrosion and odour risks ensuing from sulphur scrubber effluents must be clarified before conveying wastewater to the sewer. Additionally, the removal of heavy metal concentrations included in scrubber effluents may require pretreatment before they are mixed with other wastewater types of the ship.

8.8.2 Wastewater from airports

In Finland, propylene glycol solvents are used for anti-icing aircraft, i.e. to remove ice from aircraft or to prevent aircraft from icing. Glycol solutions include 50–80% of propylene glycol, colorants, corrosion inhibitors and thickeners.

Propylene glycol ($C_3H_6(OH)_2$) is highly soluble, rapidly biodegradable and non-toxic. The major hazardous effects caused by propylene glycol are oxygen consumption in the water body through the decomposition of the substance and an unpleasant, sweet odour.[78]

It has been shown that some glycol solutions include small amounts of nonylphenols and nonylphenol ethoxylates which are hazardous to the aquatic environment. Propylene glycol may generate hazardous decomposition substances, such as acetaldehyde, ethanol, acetate and methane under oxygen-depleted conditions.[79]

De-icing fluids used at the airport include e.g. acetate and formates which are soluble organic, biodegradable compounds that consume oxygen in the degrading process.[78] Anti-icing and de-icing fluids usually contain only few nutrients.

Today, glycol is collected at airports with glycol-suction sweepers. Glycol recycling and reuse is becoming more frequent. Glycol is received at the wastewater treatment plant if it can be treated within the nitrogen removal process or in a digestion facility in a controlled manner. Glycol reception at a wastewater treatment plant must comply with the conditions defined in the environmental permit. Wastewater is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value and electrical conductivity. If necessary, the examination may also cover heavy metals. It is recommended to examine wastewater generated at airports for its nonylphenols and their ethoxylates, HBCD and PFOS because there are signs of their presence in airport wastewater.[3]

8.9 Energy production

Wastewater generated in flue gas scrubbing and flue gas condensing (condensation water) must be neutralised, sedimented and filtered before conveying it to the sewer. Chimney sweeping water that is generated non-recurring must be pretreated by neutralisation and sedimentation before it can be conveyed to the sewer, or it must be collected and transferred further to an establishment equipped with an adequate treatment permit. Pickling water is generated when a boiler is cleaned using alkali to clean grease and acid to remove iron flakes. Pickling water must always be treated by neutralisation. Additionally, in other respects, the treatment need must be clarified case-specifically before conveying pickling water to the sewer. Practice has shown that some pickling waters are toxic to the nitrification process, especially if thiourea is used for treating old boilers. In this case pickling wastewater cannot be conveyed to the sewer. Wastewater is examined for pH, solids, mineral oils, PAH compounds and heavy metals.

Chapter 2.5.5 of this guide describes Government Decree 151/2013 on Waste incineration. Chapter 2.5.2 concentrates on Government Decree 750/2013 on the Environmental protection requirements of energy production units with a rated thermal input below 50 megawatts. Chapter 2.5.3 focuses on Government Decree 936/2014 on Limiting releases from large combustion plants.

8.10 Waste management

Large waste treatment plants are so-called directive plants. The operational frame of directive plants is aligned in BAT reference documents (BREFs).

8.10.1 Waste treatment plants and landfills

Landfill water is mainly generated through infiltrating rainwater, water from landfill-disposed waste and other leachate in the area.

The amount and quality of landfill water vary depending on climate conditions, composition of waste, pretreatment and degrading processes and conditions, as well as on the size, structure, management methods and age of the landfill.

The amount of water discharged from a landfill in operation is on average 7–12 m^3/ha per day, and ca. 3–5 m^3/ha of water per day infiltrates through a decommissioned, surface-sealed landfill. Landfill water includes high concentrations of degradable organic substances. Phosphorus concentrations are usually low but instead landfill water includes a lot of nitrogen. Nitrogen occurs mainly as ammonium. High chloride concentrations and electrical conductivity are characteristic of landfill water. These parameters are typical indicators for landfill water. Landfill water usually includes a lot of iron and manganese.[80]

Heavy metals and other hazardous metals (copper, arsenic, cadmium, chromium, lead, mercury, zinc, tin, nickel), as well as organic harmful compounds are found especially at such landfills where industrial waste or hazardous waste has been disposed of. Landfill water may also contain uranium. Landfill water can influence the quality of wastewater treatment plant sludge and harm the possibilities to utilise the sludge. Landfill water is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity, heavy metals and VOC compounds. If necessary, the examination may also cover chloride and AOX compounds. It is recommended to investigate at least once the organic hazardous substances in the wastewater of a waste treatment plant. The following compounds have been detected in landfill leachate: organotins, PFOS, PBDE, alkylphenols and their ethoxylates and phthalates.[81] In related literature, leachate is mentioned as a possible source of e.g. endosulfan and benzo(a)pyrene.[3]

Models for industrial wastewater agreements and related monitoring programmes for waste management plants are included in Appendices 2 and 11 of this guide. Good practices in the monitoring of waste treatment plants are described in the report by The Finnish Solid Waste Association (KIVO).[82]

8.10.2 Composting plants and facilities

Composting plants treat e.g. biowaste, sludge from wastewater treatment or oily soils. The quality of compost influences the quality of water generated. The generated wastewater is also affected by the composting methods. These can be an open composting stack or a closed composting reactor. Rainwater falling in the stack composting area can dilute thus generated wastewater and there can be considerable differences in water quality.

Wastewater generated at composting plants mainly consists of the process water from the composting process and runoff from the post-ripening field. If the composting plant is located at a waste treatment plant, it is possible that runoff from landfill might be infiltrating there. Wastewater from a composting plant is highly concentrated, especially concerning nitrogen compounds and organic substances. The pretreatment of water aims to remove nitrogen in order to reduce the loading to the wastewater treatment plant.[83] Composting leachate is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and heavy metals. If necessary, the examination may also cover chloride and AOX compounds. It is recommended to investigate at least once the organic hazardous substances included in the composting plants' wastewater. Table 11 presents the quality of runoff resulting from stack composting at Metsäpirtti in Sipoo in 2010. Table 12 presents the quality of wastewater generated at the Ämmässuo landfill and biowaste composting facility (results are averages from 2005−2010).

Table 11: Quality of runoff from stack composting at Metsäpirtti in Sipoo in mg/l (in 2010)

Parameter	Average	Min	Max	Standard deviation
pH value	7.1	6.5	8.0	0.6
Electrical conductivity mS/m	225	97	526	160
Solids mg/l	305	6,2	1000	380
BOD_7 mg/l	77	19	320	100
COD_{Mn} mg/l	139	130	140	7.6
Total nitrogen	300	49	620	218
Total phosphorus	7.6	0.9	21	6.6
Copper	0.11	0.03	0.3	0.1
Zinc	0.23	0.070	0.7	0.2

Cadmium	0.0006	<0.0005	0.0015	0.0005
Total chromium	0.013	<0.002	0.050	0.015
Lead	0.007	0.002	0.022	0.008
Nickel	0.050	0.012	0.193	0.059
Mercury	<0.0002	<0.0002	<0.0002	0.0001

Table 12: Quality of wastewater at the Ämmässuo landfill and biowaste composting facility in mg/l (in 2005−2010)

Parameter	**Average**	**Min**	**Max**	**Standard deviation**
pH value	7.5	3.9	8.0	0.4
Electrical conductivity mS/m	732	89	2 100	372
Solids mg/l	161	15	5 800	635
BOD_7 mg/l	1 140	14	54 000	5 891
COD_{Cr} mg/l	2 630	250	78 000	8 404
Total nitrogen	547	47	1 100	277
Total phosphorus	13.4	1	610	66
Copper	0.25	0.01	2.2	0.48
Zinc	0.37	0.03	3.4	0.62
Cadmium	0.008	<0.01	0.011	0.003
Total chromium	0.14	0.02	0.26	0.05
Lead	0.16	<0.1	0.5	0.13
Nickel	0.11	0.02	0.21	0.05
Arsenic	0.02	0.01	0.04	0.02

8.10.3 Biogas plants

Biogas plants are typically located at wastewater treatment plants or as separate co-treatment plants or at farms. Separately collected biowaste, cattle manure, wastewater sludge, septic tank sludge, plant-based waste, industrial wastewater and sludges, and other organic materials, among others, are treated in bioreactors. The reception capacity of the wastewater treatment plant must first be examined if reject water from the biogas plant is planned to be conveyed to municipal wastewater treatment.

Reject water is heavily loaded compared to municipal wastewater. Especially nitrogen included in reject water can cause problems at the treatment plant. Most of the nitrogen is in ammonium form. Pretreatment of reject water aims to remove nitrogen, phosphorus and solids.[84] Substances that should be examined in reject water are defined according to what kinds of waste types are treated at the biogas plant. Wastewater generated by a biogas plant is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH, electrical conductivity, heavy metals and VOC compounds. If necessary, the examination may also cover chloride, AOX compounds and alkalinity. It is recommended to investigate at least once the organic hazardous substances included in the biogas plant's wastewater. The following compounds, among others, have been detected in reject water of biogas plants: PBDE, PAH, dioxins, perfluorinated compounds, alkylphenols and their ethoxylates and phthalates.[85]

Table 13 shows the properties of reject water from co-treatment plants and the biogas plants of municipal wastewater treatment plants. Table 14 presents the properties of reject water from different biogas plants.

Table 13: Quality of reject water from biogas plants without pretreatment[33]

Parameter	**Co-treatment plant (mg/l)**		**Biogas plant of a wastewater treatment plant (mg/l)**	
	average	standard deviation	average	standard deviation
Solids	3 860	2 460	6 190	4 480
BOD_7	1 790	890	1 120	750
COD_{Cr}	6 550	2 970		
total P	82	48	142	105
total N	1 003	381	993	171
NH_4-N	642	282	734	105
Alkalinity	59	19	77	14

Table 14: Properties of reject water from six biogas plants[84]

Parameter	**A**	**B**	**C**	**D**	**E**	**F**
Solids (%)	0.2	0.8	0.4	0.6	0.45	
total N (mg/l)	2 450	2 200	3 000	2 600	1 025	1 400
total P (mg/l)	111	5	75	50	77	40
BOD_7 (mg/l)	2 835	3 600	2 000	3 000	1 852	1 270
COD (mg/l)	11 500		6 000		5 252	3 770

8.10.4 Sludges from septic tanks and cesspits

Domestic waste includes all kinds of waste generated by households, including sludges from septic tanks and cesspits. Sludges from septic tanks and cesspits belong to the scope of organised waste transport and they must be conveyed to the reception places according to the local waste management regulations. Septic tank and cesspit sludges are transported to a wastewater treatment plant or to a purpose-built reception station. Transfer documents concerning the loads must be delivered to the water utility. Transport operators conveying septic tank and cesspit sludges must be listed in the waste management register.

Concentrations of organic substances and nutrients in septic tank and cesspit sludges can be 10−30 fold compared to normal domestic wastewater and therefore it is important to take the capacity of the treatment plant into account. Table 15 presents values used in planning of the reception of septic tank and cesspit sludges. Rough solids such as sand and grit must be removed from septic tank sludges via a grit chamber and other debris by screening in order to prevent wastewater pumps and treatment lines from getting blocked. Table 16 presents annual averages of concentrations in septic tank and cesspit sludges.

Table 15: Experimental or calculatory quality data used in planning of the reception of sludges from sedimentation basins and cesspits (unit mg/l)[86]

Substance	Planning value	Cesspit sludge	Sedimentation basin sludge	Combination
BOD_7	5 000	670	3 300	2 000
total P	150	60	120	80
total N	750	430	440	410

Table 16: Range of annual average concentrations of sedimentation and cesspit sludges brought to Biovakka Suomi Ltd's reception station for sedimentation basin and cesspit sludges at Topinoja in 2009−2010[87]

Substance	range mg/l
BOD_{7atu}	1 600-3 100
COD_{Cr}	700-12 000
total P	66-99
total N	380-480
Solids	2 500-6 200

8.11 Services

8.11.1 Hospitals

Hospital-generated wastewater includes washing fluids, disinfectants, pharmaceutical and chemical residues, bacteria and viruses. Wastewater generated in radiology departments may contain silver and mercury. Wastewater is usually examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity and heavy metals. If necessary, the examination may cover AOX compounds, VOC compounds and pharmaceutical substances.[13]

8.11.2 Dental clinics

A major source for mercury released into the public sewer is amalgam used by dental care as filling material. Amalgam is a metal alloy of which 45% is mercury. Mercury ends up in the sewer when making new fillings and removing old ones. When conveyed to the sewer, mercury ends up in wastewater sludge and harms the utilisation of sludge. Amalgam is still used in certain situations as dental restorative material because it is a very durable material.

Dental care clinics aim to prevent conveying mercury into wastewater with the help of an amalgam separator. According to Government Decree 112/1997, an amalgam separator must be installed in the sewer of a high-power suction unit or dental care unit (see Chapter 2.5.1).

When renovating dental clinics' sewer pipes, all amalgam-containing sludge accrued in the pipelines should be collected and sorted into hazardous waste. Fixers and developers resulting from radiography must also be sorted into hazardous waste.[88] [89]

8.11.3 Service stations and garages

Wastewater of service stations consists of surface runoff generated on the yard, car washing water and sanitary water. Water from car washing is conveyed to the sewer through a grit chamber and an oil separator which must be adequately sized. If the residence time in the separator and chamber is too short, solvents dissolve somewhere in the sewer or eventually at the wastewater pumping station. Solvents make the seals of wastewater pumps brittle.

Surface runoff of the meter field, i.e. the area in immediate vicinity of fuel distribution meters, must be conveyed to the sewer through an oil separator. Government Decree 444/2010 presents the environmental protection regulations on liquid fuel distribution stations. According to the aforementioned decree, the requirement for separation is that the total concentration of hydrocarbons in wastewater is at a maximum of 100 mg/l when conveyed to the sewer.

Grease traps of the service stations' restaurants are sized in the same way as grease traps in other restaurants (see next chapter).

Different types of washing chemicals are used for car washing. The detergent combination refers to a washing chemical combination which is used in different stages of the washing process; such as solvents, shampoo, rinsing fluids and waxes. The detergent combination should not include chemicals classified as hazardous to the environment such as chlorinated hydrocarbons or nonylphenol ethoxylates.

Solvents can be used as such or they can be included in the shampoo. Based on the Finnish Standard SFS 3352, the services stations can only use such hydrocarbonic solution-containing detergent combinations that have been approved for the washing purposes of the operator. Incompatible combinations of detergents and solvents emulsify in the oil separators, in which case the separator does not work. The use of hydrocarbonic solvents in detergent combinations has significantly reduced in Finland.

The detergent combination is tested and its composition is examined in the approval proceedings. The approved detergent combinations are listed, based on the applications, in the approved washing agent combination register and they are marked with an approval number. Approved combinations of car wash detergents are listed in the catalogue which is kept by the Finnish Petroleum and Biofuels Association (http://www.oil.fi).

Waste oils, solvents and cooling fluids resulting from the repair shops of car service stations are sorted into hazardous waste collection. Service stations and car repair shops must keep a record of emptying grit chambers and oil separators and of other transports of hazardous waste. In 2011, the Finnish Petroleum Federation (today called the Finnish Petroleum and Biofuels Association) published a guide for vehicle washing operations providing information on the selection of detergent agents and on the proper treatment of ensuing wastewater.[90]

Wastewater generated by car service stations is examined for BOD_7, COD_{Cr}, total nitrogen, total phosphorus, solids, pH value, electrical conductivity, heavy metals and mineral oils. Additionally, the examination of alkylphenols and alkylphenol ethoxylates included in service stations' wastewater should also be taken into consideration.

8.11.4 Restaurants

The grease traps of restaurants must be sized according to Standard EN-1825-2. A grease trap is installed in restaurants which prepare over 50 servings of food per day. The restaurants are obliged to collect cooking fats separately and sort them into biowaste. Grease traps must have overflow alarms, and regular maintenance must be organised.

8.11.5 Waste grinders

The general delivery terms and conditions of water services state that a waste grinder can only be installed with a permit granted by the water utility. Today, nearly no permits are granted because the implementation of waste grinders can have impacts on the odour emissions and maintenance demand of the sewers. Many municipalities organise a separate collection for biowaste.

8.11.6 Water of public indoor swimming pools

The water of public indoor swimming pools is conveyed either to the stormwater or wastewater sewer. When conveying it to the stormwater sewer network, the regulations of the municipal environmental protection authority must be complied with. When conveying water from public indoor swimming pools to the sewer network, attention must be paid to the capacity of the sewer network and wastewater treatment plant. If the treatment plant is small, the hydraulic capacity must be clarified separately.

8.12 Construction

8.12.1 Construction sites

A plan concerning the treatment of stormwater during construction must be presented at the same time when the building permits are handled. Drainage water and stormwater from construction sites are usually conveyed directly or through a solids separation into the water body. In case water is conveyed to the sewer network of the water utility, solids separation must be organised. It is typical for stormwater from blasting sites to show a very high nitrogen concentration. The water amounts can also be significantly large.

Asbestos and iron sedimentation from renovation sites must be collected separately and transferred for suitable treatment.

8.12.2 Remediation of contaminated soils

Water generated by remediation of contaminated soils may include a lot of different kinds of hazardous substances (e.g. heavy metals, solvents, PAH compounds). Water conveyed to the sewer should be examined for concentrations of the same substances which have been detected in the contaminated soils. Water from contaminated soils must always be conveyed to the sewer through a solids separation to prevent sewer blockages. If the water includes harmful substances, water treatment must be complemented by oil separation or grit and active coal filtration. The representative of the remediation site must be in contact with the water utility in good time before water is planned to be pumped into the sewer network. As a rule, a wastewater fee is charged for pumped water according to a measured or an estimated water amount. An increased fee can be collected for pumped water if the water includes e.g. nitrogen or solids more than the normal domestic wastewater. A pumping permit can be applied for with the application form provided in Appendix 12.

8.13 Other

8.13.1 Laboratories

Laboratories operate in many different kinds sectors of industry and within many different types of production plants. Laboratory operations include, among others, laboratories for chemical monitoring and analyses, school laboratories, photographic laboratories and laboratories in health care. Various kinds of chemicals in small amounts are generated by laboratories where different kinds of tests and analyses are applied.

Chemicals which are expired or removed from use cannot be conveyed to the sewer. If the solution includes, for instance, mercury, lead, cadmium, nickel or other heavy metal clearly toxic to the biological activities, it must be separately sorted into the hazardous waste collection. All liquids and reaction products classified as hazardous waste must be collected separately. The environmental authorities require for laboratories to keep a record of hazardous waste. The records must be presented upon request.

Mild water solutions can be conveyed to the sewer if the solution does not contain flammable, insoluble substances or substances hazardous to the environment.[13] If the solution contains substances which are harmful to the biological treatment in high concentrations but as a mild water solution (<20%) such as alcohols (methanol, ethanol, propanol and glycol) biodegradable, the mild watery solution can be conveyed in small amounts to the sewer. A permit and instructions must be requested from the relevant water utility. A water utility can require an annual report on the amounts of chemicals conveyed to the sewer and set a daily limit value in respect of the amounts to be conveyed to the sewer.

Neither chlorinated solutions of organic solvents can be conveyed to the sewer, nor extremely volatile solvents, nor highly flammable fluids (e.g. ethers and hexanes). Chlorine-free VOC compounds (e.g. benzene, ethylbenzene, toluene or xylene) can be conveyed to the sewer if the total concentration of the original solution does not exceed 3 mg/l (Appendix 7). The concentration limit value cannot be achieved by diluting the solution before conveying it to the sewer. Special attention must be paid to solvents which do not dissolve in water because they clearly constitute a fire risk in the sewer network.

If a compound is classified by its concentration as hazardous waste, it cannot be conveyed to the sewer. Today, more attention than ever must be paid to such substances which do not degrade biologically and which are accumulative or persistent compounds.

General instructions for laboratories

Do not convey to the sewer:

- chemicals which are old or removed from use
- substances toxic to the aquatic environment
- highly flammable substances
- substances classified as hazardous waste
- solids causing blockages

Substances which can be conveyed to the sewer:

- Mild chemicals-containing water solutions which are not classified as hazardous waste
- acids and alkalis neutralised to pH level 6-11

Laboratories must pay attention to the limit values and instructions provided by the water utility. An example of sorting instructions for chemical waste is provided by Aalto University's occupational safety guidelines.[91]

8.13.2 Art workshops and hobby clubs

Art workshops and hobby clubs generate waste that must be disposed of. This kind of waste includes, among others, colour pastes, artists' paints and pigments, water from washing paintbrushes and water generated by plasterwork. Artists' paints, pigments and pastes can include heavy metals, and gypsum sludges block the sewers. Solvent-containing washing agents for painting tools must be sorted into a hazardous waste collection. Water containing gypsum is conveyed to the sewer through a solids separator. The first rinsing water of graphical printing plates includes heavy metals in soluble form. They must be collected separately and sorted into a hazard waste container.

8.13.3 Wastewater from animal shelters

Washing of animal shelters and animals generates wastewater. As a rule, wastewater is conveyed to a sludge or urine tank. If wastewater is conveyed to the sewer network of a water utility, it must be led through a solids separator so that no manure, litter or other sewer blocking solids end up in the sewer.[92]

8.13.4 Stormwater

Stormwater, or runoff, refers to rainwater or melting water that must be conveyed off the ground, a building roof or other similar surfaces. In large paved areas, the amount of stormwater can increase significantly and this requires retaining runoff before conducting them to the drainage, so that the capacity of the stormwater drain network is not exceeded.

Primarily, stormwater must be conveyed to a stormwater drain network, and only to the sewer network if it is necessary. The Government Decree 444/2010 and Standard SFS-EN 858-1 stipulate provisions on oil separators before conveying runoff to the stormwater drain network. It is forbidden to convey stormwater to the sewer unless this has been agreed upon by a separate contract. According to the Water Services Act, Section 17 d, runoff shall not be conveyed to the wastewater sewer except under certain conditions to a combined sewer constructed before 2015.

Provisions on conveyance and treatment of stormwater for operators subject to an environmental permit are stipulated in the granted environmental permit. The municipal environmental protection authority may set regulations on the quality of stormwater if it is conveyed directly into the water body. The water utility for its part can set restrictions which aim to ensure the functionality of the network (e.g. discharge balancing, removal of solids). The water utility must also take the effects on the wastewater treatment process and the recipient water body into account in the stormwater provisions when conveying stormwater to a wastewater treatment plant.

8.13.5 Sludge generated by other water utilities

Sediments containing aluminium and iron generated by water utilities significantly increase the amount of sludge at the wastewater treatment plant. Aluminium sulphate is still used as precipitation chemical at some water utilities although most utilities have switched over to use ferrous sulphate. In 2007, approximately 90 tonnes of aluminium sulphate was used for precipitation in Finland. The aluminium-containing sludge is usually conveyed untreated to the wastewater treatment plant.

Aluminium sludge may cause harm to the activated sludge process at the wastewater treatment plant. It is suspected that aluminium sludge causes problems for sludge settlement in primary sedimentation and oxygen-depletion in aeration. It also interferes negatively with effluent quality. Aluminium clearly affects the short-term ability of microbes in activated sludge to consume oxygen. The impact of aluminium on microbial activities can be toxic or it prevents oxygen from dissolving in water. Therefore, aluminium sludge should be conveyed in small amounts to a wastewater treatment plant.[93]

9 ILLICIT RELEASES

It is often a difficult and slow process to deal with sudden illicit releases of industrial wastewater. If pollutant releases are detected in the sewer network or at the wastewater treatment plant, a sample must be taken from the diverging water or substance (e.g. oily water). Observations concerning unexpected releases must be recorded (date, time, place, odour, colour of wastewater, other observations). In these situations, it is recommended to draw up a short report on the releases in question, and, if needed, the report can be submitted to the authorities. If there is any doubt that a pollutant release can cause a risk of fire (for example, there is a notable layer of oil or solvent in the basins of the treatment plant or at the wastewater pumping station), rescue services, environmental centre and police should be requested to evaluate the situation. If there is any doubt that the release could be classified as an environmental offence, the police is responsible for taking the samples. The supervisors, managers and other staff at the water utility must be informed about pollutant releases so that occupational safety is properly taken into account.

9.1 Criminal liability

Operations which are in contradiction with the industrial wastewater agreement's provisions may sometimes fulfil the criteria for an offence as determined in the Criminal Code of Finland (39/1889). This kind of an offence can be, for example, an environmental offence as referred to in Chapter 48 of the code.

An act which violates the conditions of an industrial wastewater agreement is not as such a penal offence but the act must also fulfil the criteria of a criminal offence. Most of the criminal offences are so-called indictable offences, i.e. the police can investigate and the prosecutor can decide to press charges for these offences even though the plaintiff does not present a penalty demand. A preliminary investigation and a possible pressing of charges require, however, that the aforementioned authorities are properly informed about the action.

9.2 Tracing of pollutant releases

The localisation of the source of pollutant releases should be prepared for by compiling maps on which the locations of any industrial plants and car service stations are tagged in the runoff area of each pumping station. Respectively, it is recommended to prepare a list which includes all the industrial operators, service stations, hospitals or other special targets located in the runoff area of each pumping station. The list must also include the address of each operation.

When a pollutant release is detected, it is important to determine its characteristics. First, the aim is to find out whether the release is continuous (e.g. a tank leak) or non-recurring. If it is a continuous release and there are undeniable traces from a substance in the sewer, the property causing the pollutant release should be localised by taking samples from different spots in the sewer network so that the direction of the release can be determined. If the release is non-recurring or occurs infrequently, the target (e.g. a pumping station) must be visited at regular intervals to monitor the situation. If it is a question of an oil- or solvent-containing release, the oil separators or solvent and waste oil collection methods must be checked in the discharge area. Good cooperation with the environmental authorities and the primary industrial customers often makes it easier to settle the situation concerning pollutant releases.

In a problem situation, monitoring must be continued through sampling until the situation is over.

9.3 Continuous measuring systems installed in the sewer network

Continuous measuring of the pH value, installed in the network, quickly detects all pH peaks that occur in the network. It is recommended to integrate an alarm in the pH measuring system at the influent pumping station of the wastewater treatment plant. The detection of the pollutant source is facilitated by knowing which pumping station area is the pollutant coming from, and therefore which list of operators should be investigated.

9.4 Smoke testing

Smoke tests are used to detect problems in properties' service sewers, in the wastewater sewer and stormwater sewer network and to localise odour problems. In smoke testing, smoke is blown into the sewer through a smoke generator. Smoke forces its way out through the open sewer ends and other openings, providing an opportunity to clarify the following probable problem points, for example:

- functionality of sewer vents on the properties' roofs
- properties' drainage water connections to the wastewater sewer
- leakage points in the sewer network
- locations of sewer manholes
- uncharted sewer lines
- uncharted manholes
- locations of inoperable oil separators

Residents living on the properties where the smoke tests are to be executed, as well as the local authorities must be informed about the intended smoke test by sending a notification in advance. The residents are also requested to ensure that there is enough water in the sewer's water locks to prevent smoke from intruding into their dwellings. The used smoke is not toxic but it may cause irritation in eyes and respiratory tracks.[94,95]

9.5 Tracer tests

Trace tests are applied in industrial processes and in investigations of water bodies and wastewater. The tracers used are radioactive compounds or colourants, such as fluorescent rhodamine WT. Fluorescent tracer compounds have the advantages of being non-toxic and environmentally friendly, they are affordable and have a good perceptiveness in water samples and at the measuring spot. Rhodamine WT is a tracer compound approved by the US Environmental Protection Agency EPA for measurements to be performed near water intake plants. The availability of rhodamine can be a problem in Finland.

Pyranine is used as the colouring agent for district heating water. Also the so-called “chlorophyll”, i.e. a fluorescent sodium salt, is used in sewer investigations. Good results have also been gained from the beetroot colour which is used as a foodstuff additive.

When using colourants, it must be ensured that the applied colourant does not include harmful or hazardous chemicals.

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INSTRUCTIONS ON HOW TO USE THE APPENDICES OF THIS GUIDE

- The appendices include examples of agreements between a water utility and industry that are in use.
- Agreements included in this guide as appendices are not meant to be copied as such but, for applicable parts, they can be of assistance when preparing an agreement. Where used, it is recommended to bear in mind that practical situations and circumstances change. Additionally, different water utilities have different methods to prepare an agreement, which reflects on the example agreements provided in the appendices of this guide. Therefore, each agreement provision should be carefully considered.
- When using the appendices of this guide for preparing an agreement, it should be checked that the other conditions of your agreement are congruent with the ones provided in this guide. Not all examples provided in this guide include all conditions.
- In the course of time, the decrees and regulations mentioned in the appendices of this guide or the numerical order of the general delivery terms and conditions may change; therefore, it is recommended to check them.
- When necessary, it is also recommended to seek for advice of a competent professional consultant when preparing an industrial wastewater agreement.

APPENDIX 1: Example of an industrial wastewater agreement for three different sectors

The water utility and operator mentioned in Item 2 have concluded the following agreement on conveying wastewater to the sewer of the water utility.

1 INFORMATION ON THE WATER UTILITY

Name	Model Water Utility Ltd
Business ID	1123-56
Postal address	P.O. Box 20, 00987
Treatment plant	Model Wastewater Treatment Plant
Street address	Example Street 6

2 INFORMATION ON THE OPERATOR

Name	Meat Ltd/ Colour Ltd/ Model surface Ltd
Sector	Meat processing / Colour production / Surface treatment
Street address	
Business ID	

3 INFORMATION ON THE PROPERTY

Sector of the city
Block
Plot no.
Connection agreement no. or location of the operations

4 OWNER OF THE PROPERTY

Name
Postal address

5 GENERAL CONDITIONS

The parties of this agreement shall comply with the general delivery terms and conditions of the water utility (Annex 3) valid at the time, with the rate formula set by the water utility and with the service price list, both valid at the time, for those parts which are not in conflict with this agreement.

If the documents are in conflict with each other, the priority order is as follows:
1. text of the agreement document, 2. annexes of the agreement document in their numerical order.

5.1 Previous agreements

This agreement serves to ensure the compliance of the wastewater agreement and the monitoring of wastewater with current legislation and present circumstances. This agreement replaces for all parts the previous agreement, concluded on 5 May, 2005, and all rate annexes, prepared after the conclusion of the previous agreement.

5.2 Renewal of the application

The operator must submit a new application to the water utility concerning the conveyance of industrial wastewater if the business activities of the operator, amount or quality of wastewater change, or the operator moves to another operating location in the catchment area of the water utility. The application must be submitted to the water utility at least two (2) months prior to the intended operational change.

5.3 Changing of the agreement conditions

The conditions and terms of this agreement can be changed if it proves to be necessary for the operations of the sewerage plant or for ensuring the water protection, or in case the circumstances, regulations or obligations set by the authorities change fundamentally. The water utility shall notify the operator of the need to change the agreement conditions, and the parties shall negotiate the amendments. The new agreement conditions, here referred to, will come into force when both parties have signed the agreement.

5.4 Limit values for wastewater and related decrees and regulations

The operator shall comply with the limit values, set by the water utility, for wastewater to be conveyed to the sewer, and with other conditions (Annex 1), Government Decree 1022/2006 on Substances Harmful and Dangerous to the Aquatic Environment, as well as other regulations set by the environmental authorities.

5.5 Notification obligation

The operator shall immediately inform the wastewater treatment department of the water utility about any exceptional or emergency situations, and about such disturbances which have an impact on the quality or amount of wastewater.

5.6 Pretreatment of wastewater

Wastewater shall be pretreated before conveying it to the sewer network.

5.7 Monitoring of wastewater

The operator shall build or organise a facility which serves for taking samples from wastewater. The operator shall monitor the amount and quality of wastewater conveyed to the sewer network by a method approved by the water utility (Annex 2). The water utility has the right to change the monitoring programme for industrial wastewater during the agreement period if necessary. The operator is responsible for the costs ensuing from the monitoring of wastewater. The representative of the water utility has the right to check the wastewater pretreatment equipment and take samples from wastewater on the premises of the operator.

5.8 Wastewater fee

The water utility collects a wastewater fee according to the amount of wastewater. The fee can be collected as an increased fee according to the quality of wastewater. The amount of an increased wastewater fee is based on the BOD (organic substance), solids, nitrogen and phosphorus concentrations in company's wastewater.

6 SPECIAL CONDITIONS

Wastewater conveyed to the sewer network shall not include substances, listed below, more than the following concentrations:

Below are examples of conditions in different industrial sectors:

Substance	highest allowed concentration mg/l	load kg/a *or* g/d
Meat processing		
solids	500	
fat	150	
Colour production		
solids	300	600 (kg/a)
copper	2	6 (kg/a)
Surface treatment		
nickel	0.5	30 (g/d)
total chromium	1.0	50 (g/d)
copper	2.0	100 (g/d)
zinc	3.0	150 (g/d)
hexavalent chromium	0.1	
total cyanide	0.5	
cadmium	0.01	

6.1 Other special conditions

examples of special conditions in different industrial sectors

Meat processing / Colour production

Amount of wastewater 600 m³ per year at most.

Surface treatment

The industrial plant has the obligation to video record the sewers because of the high sulphate concentrations. The measurement of the wastewater amount shall be organised.

Special condition on odour emissions

If the wastewater despite pretreatment causes odour emissions (e.g. hydrogen sulphide) in the sewer network, at the wastewater treatment plant or in the surroundings, the pretreatment of wastewater shall be intensified to remove odourous gases before pumping wastewater into the sewer network.

Risk management

The operator must prepare an environmental risk assessment and a management plan for fire extinction wastewater by x.x.201x.

7 RESPONSIBILITIES OF THE WATER UTILITY AND OPERATOR

Based on its environmental permit, the water utility is responsible for all examinations and clarifications related to the state of wastewater, treatment plant and water body receiving wastewater. The water utility’s obligations defined in its environmental permit cannot be assigned to the operator by this agreement. Respectively, the operator’s obligations defined its environmental permit cannot be assigned to the water utility. However, this does not prevent the parties from changing the agreement when the needs for change, as described in Item 5.3, materialise.

Nevertheless, according to the matching principle both parties are responsible for compensating possible damages or hazards to the owner of a shore or water area (i.e. area covered by water) or to other parties suffering from discharging wastewater.

8 LIABILITIES FOR DAMAGES

The operator is liable for compensating all such harm and damages, caused to the water utility, its other customers and third parties, which ensue from non-compliance with the conditions of this agreement, from exceeding the maximum allowed concentrations laid down by the government decrees or decisions, or from not adhering to the restrictions mentioned in the general terms and conditions [7.8].

9 PERIOD OF VALIDITY AND PREMATURE TERMINATION OF THE AGREEMENT

This agreement becomes effective after both parties have signed it. The agreement is in force until further notice. The operator can discontinue the agreement with one (1) month's notice. The notice period starts from the date on which the written notice of termination is submitted to the water utility.

However, the agreement ends at the latest when the operator terminates its operations according to the industrial wastewater application on its premises. The water utility can cancel the agreement if the operator does not comply with the special conditions set in this agreement in its operations or otherwise does not follow the conditions set in this agreement. However, before the agreement is cancelled, the operator should be reprimanded in writing and thus given a possibility to rectify its operations according to the conditions. If the operator does not rectify its operations according to the agreement conditions despite the written complaint, the agreement can be cancelled by sending a written notice of termination to the operator. The agreement shall cease to be in force six (6) months after the notice of termination. Nonetheless, the reception of water can be discontinued already before the notice period ends according to the water utility's general delivery terms and conditions (Annex 3, Item 3.13).

If the operator causes an essential breach of the agreement conditions or neglects its obligations ensuing from authority regulations laid down by the legislation, and its operations are apt to cause immediate danger or substantial harm to the operations of the plant or to human health or to the environment, the reception of water can be immediately discontinued and the agreement can be cancelled without notice.

10 AGREEMENT TRANSFER

The water utility can transfer the agreement to a water services organisation, to be founded later, to which the operations of the present water utility are transferred.

The operator has the right to assign this agreement to a third party whether this results from incorporation or selling the business operations. The third party shall approve the conditions of this agreement. Additionally, the operator has the right to assign the agreement inside its group if the group company approves the conditions of this agreement.

11 DISAGREEMENTS

Disagreements concerning this agreement shall be settled by the district court nearest to the property's location. This agreement has been made in two (2) copies with the same content, one for each agreement party.

For the water utility signed by	For the operator signed by
Date	Date
(Signature)	(Signature)

ANNEXES

This agreement includes the following annexes:

Annex 1	Wastewater limit values and other conditions
Annex 2	Wastewater monitoring programme
Annex 3	General delivery terms and conditions of the water utility

APPENDIX 2: Example of an industrial wastewater agreement for waste management

Model Water Utility and the operator below have concluded the following agreement. The operator is allowed to convey wastewater from the property mentioned in Item 2 to the sewer of the water utility on the conditions included in this agreement.

1 INFORMATION ON THE OPERATOR

Waste Management Company Ltd	
Address	*PL 123, 12345 City*
Sector of industry	*Waste management*

2 PROPERTY

Owner of the property	*Waste management company Ltd*
Address of the property	*Address street 5, 12345 Model city*
District of the city:	*xxx*
Block/ plot	*123*

3 WASTEWATER TO BE CONVEYED TO THE SEWER

The operations on the property comprise landfill activities. At the landfill, leachate seeping through the old waste fill area (310–1650 m³/d), water (150–270 m³/d) under the liner of the old waste fill area and leachate from the new waste fill area (100 m³/d) are conveyed to the sewer through a wastewater balancing basin (16 000 m³). Wastewater from the new composting facility and wastewater from the old composting plant (10 m³/d), burdened water from the utilisation area (200–865 m³/d) and sanitary water (0-10 m³/d) are conveyed directly to the sewer. Altogether 1000–4400 m³/d of water is conveyed to the sewer whereas the annual amount of water is 509 000 m³.

4 GENERAL CONDITIONS

The operator shall comply with the property-specific connection agreement mentioned in Item 2, conditions included in this agreement and the currently valid general delivery terms and conditions of Model Water Utility. If the documents are in conflict with each other, the validity order is as follows:
1. text of the agreement document, 2. annexes of the agreement document in their numerical order.

Model Water Utility has the right to follow the conditions of the agreement, in case it proves to be necessary to ensure the operations of the sewerage utility or for water protection.

The operator shall submit a new application for conveying industrial wastewater to Model Water Utility if its operations or the quality of its wastewater have essentially changed. The application must be submitted to Model Water Utility at least two (2) months prior to the intended operational change.

5 SPECIAL CONDITIONS

Wastewater generated on the property must fulfil the conditions listed in Item 1 when conveying it to the sewer.

Other special conditions:

- 5 000 m^3 of water at most can be temporarily conveyed to the sewer in a day
- Water of the balancing basin shall be pumped on a 24-hour basis according to the water level of the basin
- An anti-foaming agent must be added to the water to be pumped into the sewer if it is necessary
- The operator shall build or organise a facility which serves for taking samples from wastewater; Model Water Utility must give its approval to the facility
- The operator shall monitor the amount and quality of wastewater conveyed to the sewer network by a method approved by Model Water Utility according to the manner presented in Annex 2
- The operator shall immediately inform the wastewater treatment plant of Model Water Utility about disturbances affecting the quality and amount of wastewater
- The operator monitors the quality of wastewater conveyed to the sewer by measuring the conductivity using a continuous meter; the results of measurements must be available to Model Water Utility

An annual meeting shall be organised between Model Water Utility and Waste Management Company for negotiating landfill matters.

6 WASTEWATER FEES

Model Water Utility collects a fee for wastewater according to the currently valid rate formula based on the amount of wastewater. The fee can be collected as an increased fee according to the quality of wastewater. The amount of an increased wastewater fee is based on the BOD (organic substance), solids, nitrogen, and phosphorus concentrations in company's wastewater. The increased fee shall be calculated using the Model Water Utility's calculation formula for an increased fee, valid at the time. The quality of wastewater is defined as agreed upon the wastewater monitoring in Annex 2.

7 LIABILITIES FOR DAMAGES

The operator is liable for compensating all such harm and damage, caused for the water utility, other customers and third parties, which ensue from non-compliance with the conditions of this agreement, from exceeding the maximum allowed concentrations laid down in the government decrees or decisions, or from not adhering to the restrictions mentioned in the general terms and conditions of the water utility mentioned in Item 7.8.

8 PERIOD OF VALIDITY AND PREMATURE TERMINATION OF THE AGREEMENT

This agreement becomes effective after both parties have signed it. The agreement is in force for four (4) years. After two (2) years from the conclusion of this agreement, Waste Management Company Ltd shall submit a report on how to essentially reduce the nitrogen loading of the landfill. The operator can discontinue the agreement on one (1) month's notice. The notice period starts from the date on which the written notice of termination is submitted to the water utility.

The water utility can discontinue the agreement if the operator does not comply with permit conditions in its operations, or otherwise does not abide by the conditions of this agreement. However, before the agreement is cancelled, the operator should be reprimanded in writing and thus given a possibility to rectify its operations according to the conditions. If the operator does not rectify its operations according to the agreement conditions despite the written complaint, the agreement can be cancelled by sending a written notice of termination to the operator. The agreement shall cease to be in force six (6) months after the notice of termination. Nonetheless, the reception of water can be discontinued already before the notice period ends by complying with the water utility's general delivery terms and conditions (Annex 3, Item 3.13).

If the operator causes an essential breach of the agreement conditions or neglects its obligations ensuing from authority regulations laid down by the legislation, and its operations are apt to cause immediate danger or substantial harm to the operations of the plant or to human health or to the environment, the reception of water can be immediately discontinued and the agreement can be cancelled without notice.

9 DISAGREEMENTS

Disagreements concerning this agreement shall be settled by the district court nearest to the property's location.

This agreement has been made in two (2) copies with the same content, one for each agreement party.

For the water utility signed by	For the operator signed by
Date	Date
(Signature)	(Signature)

ANNEXES

Annex 1 Maximum allowed limit values for wastewater to be conveyed to the sewer
Annex 2 Wastewater monitoring performed by the operator
Annex 3 General delivery terms and conditions of the water utility

APPENDIX 3: Example of an industrial wastewater agreement with a surface finishing plant

Model Water Utility and the operator, mentioned in Item 1 of this agreement, have concluded the following agreement. The property, mentioned in Item 2, is allowed to convey industrial wastewater to the sewer network of the water utility on the conditions included in this agreement.

1 OPERATOR

Company Ltd
Address Street 2
12345 Model City

2 PROPERTY

District of the city	xxx
Block	123
Plot no.	4
Owner of the property	Company 2

3 OPERATIONS

The company cleans new machined parts manufactured from stainless and acid-proof steel in an industrial parts washer. The company uses alkali-based washing agents. Ca. 3 m^3 of industrial wastewater is generated per month.

4 GENERAL CONDITIONS

The connecting party shall comply the general delivery terms and conditions of Model Water Utility. The company must submit a new application for conveying industrial wastewater to Model Water Utility if the operations of the company, the amount or quality of wastewater changes, or if the company transfers to another business location within the region of the city. The application must be submitted to Model Water Utility at least two (2) months prior to the intended operational change.

Model Water Utility has the right to change the conditions of the agreement on conveying industrial wastewater if it is proven to be necessary to ensure the operations of the sewerage utility or for water protection. New agreement conditions, here referred to, become valid six (6) months after they have been given for the applicant’s information.

5 SPECIAL CONDITIONS

Wastewater conveyed to the sewer network shall not include substances, listed below, more than the following concentrations:

Substance	maximum allowed concentration (mg/l)
cadmium	0.01
nickel	0.5
zinc	3.0
chromium	1.0
copper	2.0
lead	0.5

Other special conditions:

In respect of wastewater conveyed to the sewer, the company shall abide by Government Decree on Substances Dangerous and Hazardous to the Aquatic Environment 1022/2006 with the respective amendments, by Environmental Protection Act 527/2014 and by Environmental Protection Decree 713/2014.

If necessary, industrial wastewater shall be treated using the best available technology, i.e. the BAT technique before conveying it to the sewer.

Diluting of metal-containing wastewater for achieving the set concentration limit values is forbidden.

The connecting party shall immediately inform Model Water Utility about exceptional and dangerous situations, as well as about disturbances affecting the quality and amount of wastewater.

The connecting party shall build or organise a facility which serves for taking samples from wastewater.

The connecting party shall monitor the amount and quality of wastewater conveyed to the sewer network by a method approved by Model Water Utility. Model Water Utility has the right to change the monitoring programme for industrial wastewater during the agreement period if necessary.

6 TERMINATION OF THE AGREEMENT

The operator can discontinue the agreement on one (1) month’s notice. The notice period starts from the date on which the written notice of termination is submitted to the water utility.

However, the agreement ends at the latest when the operator terminates its operations according to the industrial wastewater application on its premises.

The water utility can discontinue the agreement if the operator does not comply with permit conditions in its operations, or otherwise does not abide by the conditions of this agreement. However, before the agreement is cancelled, the operator should be reprimanded in writing and thus given a possibility to rectify its operations according to the conditions.

If the operator does not rectify its operations according to the agreement conditions despite the written complaint, the agreement can be cancelled by sending a written notice of termination to the operator. The agreement ends six (6) months after the notice of termination. Nonetheless, the reception of water can be discontinued already before the notice period ends by complying with the water utility’s general delivery terms and conditions (Annex 1, Item 3.13).

If the operator causes an essential breach of the agreement conditions or neglects its obligations ensuing from authority regulations laid down by the legislation, and its operations are apt to cause immediate danger or substantial harm to the operations of the plant or to human health or to the environment, the reception of water can be immediately discontinued and the agreement can be cancelled without notice.

7 VALIDITY PERIOD OF THE AGREEMENT

This agreement has been made in two (2) copies with the same content, one for each agreement party. The connecting party has received the currently valid Water Utility's general delivery terms and conditions when preparing this agreement. This agreement becomes effective after both parties have signed it.

The agreement is in force until further notice.

For Model Water Utility signed by	For the connecting party signed by
Date	Date
Head of the unit	Head of the unit

ANNEXES

Annex 1. General delivery terms and conditions of the water utility
Annex 2. Monitoring programme for industrial wastewater

APPENDIX 4: Example of an industrial wastewater agreement which includes the sanction practice

Model Water Utility and the property owner/holder (hereinafter the connecting party) have together made the following agreement. The property, mentioned in Item 1, is allowed to be connected to the sewer on the conditions included in this agreement, and from there is allowed to convey industrial wastewater to the sewer network of the water utility.

1 PROPERTY

Name	
Address	
District of the city	
Block	
Sector of industry	

2 PROPERTY OWNER / HOLDER, I.E. THE CONNECTING PARTY

Name	
Address	
Contact person	
Telephone	

3 GENERAL CONDITIONS

Non-household wastewater conveyed to the sewer shall not cause harm to the sewer network, its operations or to the wastewater treatment plant. For ensuring the utilisation of treatment plant sludge, wastewater shall not be conveyed to the sewer if it includes substances that complicate sludge utilisation.

The connecting party shall comply with the currently valid general delivery terms and conditions and fees of the water utility for those parts upon which not otherwise agreed.

The connecting party shall submit a new application for conveying wastewater to the water utility if the operations of the company or the quality or amount of wastewater change, or if the company moves to another business location in the catchment area of the water utility. The application must be submitted to the water utility at least two (2) months prior to the intended operational change. If the company is transferred to the possession of a third party, the connecting party is responsible for transferring this agreement and its obligations to the third party, and for informing the water utility about the transferral.

The water utility has the right to change the conditions of the wastewater conveyance agreement if
1. it turns out to be necessary for ensuring the operations of the water utility or for water protection
2. circumstances, decrees or obligations set by the authorities change significantly

New agreement conditions, here referred to, become valid six (6) months after the third party has been informed about them.

4 SPECIAL CONDITIONS

4.1 Quality and amount of wastewater

When conveyed to the sewer, wastewater shall fulfil the limit values concerning concentrations and quality mentioned in Annex 1. If necessary, Annex 2 presents the additional conditions.

The connecting party is liable to immediately prevent wastewater from entering into the sewer if the properties of wastewater do not fulfil the requirements set for wastewater to be conveyed to the sewer.

4.2 Measuring of the amount of wastewater

The amount of wastewater conveyed to the sewer shall be measured and monitored using a method approved by the water utility. The water utility has the right to inspect the condition and measurement accuracy of the water meter.

The connecting party is responsible for organising free und unimpeded access for the representative of the water utility to the measuring point for the aforementioned inspection purpose.

4.3 Sampling and monitoring

The mutual agreement between the connecting party and water utility requires taking wastewater samples from the sewer of the connecting party at a certain place that is seen as appropriate for defining the wastewater quality.

The connecting party monitors, at its own expense, the quality and amount of wastewater conveyed to the sewer network. The connecting party prepares a monitoring programme on the monitoring activities which the water utility approves. The connecting party submits the monitoring results to the water utility in a manner agreed separately.

4.4 Pretreatment

If the wastewater as such does not fulfil the requirements set for wastewater conveyed to the sewer of the water utility or it contains hazardous substances from the point of view of the water utility, it must be pretreated before conveying it to the sewer in a manner approved by the water utility and considering that:

1. the aforementioned conditions set for wastewater in this agreement and its annexes are fulfilled
2. the water utility's employees' health is not put in danger
3. the sewer network, treatment plant and the related equipment are not getting damaged
4. the operations of the treatment processes for wastewater and sludge are not negatively interfered with
5. the final disposal of sludge is not negatively interfered with
6. hazards which ensue from the water utility's pollutant releases into the environment are prevented and the regulations concerning the recipient water body are fulfilled.

5 LIABILITIES OF THE WATER UTILITY AND CONNECTING PARTY

Based on its environmental permit, the water utility is responsible for all examinations and clarifications related to the state of wastewater, treatment plant and water body receiving wastewater. The connecting party is responsible for its own wastewater according to its own permits and this agreement. Nevertheless, according to the matching principle, both parties are responsible for compensating for possible damages or hazards to the owner or holder of a shore or water area (i.e. area covered by water) or to other parties suffering from the damages or hazards caused by discharging wastewater.

The connecting party is liable for compensating all those direct or indirect damages to the water utility or third parties caused by conveying wastewater of the connecting party in contradiction with this agreement to the sewer network.

6 NOTIFICATION OBLIGATION

The connecting party shall inform without delay about any possible exceptions or dangerous situations and planned measures which may cause harm to the operations of the water utility. If, despite precautions, a substance is released into the sewer and possibly causes harm or danger to the operations of the wastewater treatment plant, the matter must be immediately reported to the supervisor of the treatment plant.

The connecting party shall name a responsible person and a deputy for conveying wastewater and their contact information shall be given to the water utility.

The water utility can discontinue receiving sewage water due to a force majeure, temporary maintenance work or an unforeseeable reason without an obligation to compensate possible damage, harm or other kind of loss caused by the interruption. The water utility shall inform the connecting party about the interruption without delay considering the circumstances.

7 SANCTIONS

The agreement can oblige the connecting party to pay a contractual penalty to the water utility if the quality of wastewater conveyed to the sewer diverges from the limit values set in the agreement and thus causes harm to the operations of the water utility. The amount of the contractual penalty is per exceeding incident 1000 $m^3 \times$ wastewater fee valid at the time.

The connecting party is liable for compensating all those damages which it has caused to the water utility by conveying its wastewater in contradiction with the agreement conditions.

8 WASTEWATER FEES

If the exceptional amount or quality of wastewater so requires, the water utility has the possibility to collect a wastewater fee which differs from the usual rate. If the quality of wastewater (BOD value, phosphorus, nitrogen and solids concentration or some other value) requires collecting an increased fee, the fee is defined by applying a calculation formula, verified for the use of the water utility and derived from the principles of the increased wastewater fee calculation generally used in Finland.

(The formula of the increased wastewater fee is explained in more detail in Chapter 5.2 of the Finnish Industrial Wastewater Guide.)

9 DISAGREEMENTS

Any disagreements concerning this agreement shall be heard by Model city's district court as the first instance.

10 TERMINATION OF THE AGREEMENT

The connecting party can discontinue the agreement with one (1) month's notice. The notice period starts from the date on which the written notice of termination is submitted to the water utility.

The water utility can discontinue the agreement if the connecting party does not comply with the special conditions of this agreement in its operations, or otherwise does not abide by the conditions of this agreement.

However, before the agreement is cancelled, the connecting party should be reprimanded in writing and thus given a possibility to rectify its operations according to the conditions.

If the connecting party does not rectify its operations according to the agreement conditions despite the written complaint, the agreement can be cancelled by sending a written notice of termination to the connecting party. The agreement ends six (6) months after the notice of termination. Nonetheless, the reception of water can be discontinued already before the notice period ends by complying with the general delivery terms and conditions of the water utility (Annex 3, Item 3.13).

11 VALIDITY PERIOD OF THE AGREEMENT

This agreement has been made in two (2) copies with the same content, one for each agreement party. The connecting party has received the currently valid general delivery terms and conditions, rate formula and price list of the water utility when preparing this agreement. This agreement becomes effective after both parties have signed it.

The agreement is in force until further notice. However, the agreement ends at the latest when the operator terminates its operations according to the industrial wastewater application on its premises.

Place and time Model Water Utility	Place and time Name of the company
(Signature)	(Signature)

ANNEXES

ANNEX 1. Quality of wastewater conveyed to the sewer
ANNEX 2. Special conditions on the quality and amount of wastewater conveyed to the sewer (if necessary)
ANNEX 3. Determination of the increased fee for wastewater (if necessary)

APPENDIX 5: Example of a waste management utility's industrial wastewater agreement with sections on limit values and increased fee

This agreement (hereinafter the Agreement) signed by Model City Water Utility (hereinafter Water Utility) and by NN (hereinafter Company) replaces the previous agreement of x.x.20XX concerning the conveyance of wastewater.

According to this Agreement, the target (hereinafter Company) defined in Item 1 is allowed to convey pretreated wastewater on certain conditions mentioned in this Agreement to the sewer network of Model City Water Utility (hereinafter Water Utility).

1. Company

Company below has the right to convey its wastewater to the sewer network of Water Utility.

NN
Address
xx
Property registration ID
Sector of industry: Treatment plant for industrial waste and treatment of hazardous waste (sector of industry ID 90020)

2. General delivery terms and conditions

Company shall comply with the currently valid connection and use agreement (Annex 1) and the general delivery terms and conditions (Annex 2) of Water Utility for those parts upon which not otherwise agreed.

Company shall submit a new application to Water Utility for conveying wastewater if Company's operations or the quality or amount of its wastewater change. The application must be submitted to Water Utility at least two (2) months prior to the intended operational change.

If the circumstances or obligations, set by the authorities, change after this Agreement has been signed, the contractual parties oblige themselves to negotiate, on request of the other party, for changing the Agreement to such that corresponds to the changed circumstances.

3. Special conditions

3.1. Quality, loading and conveying of wastewater

Company pretreats its wastewater so that it fulfils the quality criteria specified later.

Company is allowed to convey wastewater of xxx m^3/d at maximum, by an even discharge to the sewer of Water Utility.

Wastewater conveyed to the sewer network shall not include substances, listed below, more than the following concentrations:

APPENDIX 5

Limit values for metals

Metal	***Requirement***
Arsenic (As)	0.1 mg/l
Mercury (Hg)	0.01 mg/l
Silver (Ag)	0.1 mg/l
Cadmium (Cd)	0.01 mg/l
Total chromium (Cr)	0.5 mg/l
Chromium VI (Cr6+)	0.1 mg/l
Copper	0.5 mg/l
Lead (Pb)	0.5 mg/l
Nickel (Ni)	0.5 mg/l
Zinc (Zn)	3.0 mg/l
Tin (Sn)	2.0 mg/l
Magnesium (Mg)	300 mg/l

Other substance-specific limit values

Parameter	***Requirement***
pH	6.0–10.0
Temperature	35 °C
Sulphate, thiosulphate, sulphite (sum value)	1 000 mg/l
Total cyanide	0.5 mg/l
Ammonium	40 mg/l
Formaldehyde	1.0 mg/l
Phosphorus	8 mg/l
Phenol and cresol	10 mg/l
Nitrogen	40 mg/l
BOD_{7ATU}	400 mg/l
Solids	350 mg/l
Chloride	5000 mg/l

Instructions for solvents

Substances which the requirement concerns	***Requirement***
Extremely flammable solvents, highly flammable solvents, and solvents insoluble in waster (e.g. diethyl ether, petroleum ether, cyclohexane)	Forbidden to convey to the sewer
Chlorinated solvents (e.g. trichloroethylene, tetrachloroethylene, methylene chloride, chloroform and carbon tetrachloride)	Forbidden to convey to the sewer
Highly flammable, flammable, toxic solvents insoluble in water or petroleum hydrocarbons (monocyclic aromatic hydrocarbons, e.g. benzene, ethylbenzene, toluene and xylene)	Wastewater conveyed to the sewer can include the aforementioned compounds altogether 3 mg/l at maximum
Total hydrocarbon concentration	100 mg/l

Additionally, wastewater shall fulfil the conditions set in Government Decree 1022/2006 currently valid. This decree concerning substances dangerous and hazardous to the aquatic environment includes a list of substances that shall neither be released into surface water nor to the sewer network of a water utility.

It is forbidden to dilute wastewater with other type of water in order to achieve the set concentration values.

The water treatment plant must install an alarm which disrupts pumping of water into the sewer if the pH value sinks too low.

The aforementioned concentrations have been defined so that wastewater does not contain substances or properties which can cause damage to the sewer or to the structures of the pumping stations or to treatment plants. The aim was to define the concentration so that wastewater does not include any substances or properties which cause unreasonable harm to the operations of the treatment plant or clearly reduce the disposal possibilities of sludge.

If Company's wastewater exceeds the concentration limits values and causes the aforementioned problems for the network, treatment plant or health risks to the employees of the treatment plant, Company must remove this harm at its own expense.

3.2. Sampling

Company shall measure the amount and quality of wastewater, conveyed to the sewer network, and shall take a 24-hour composite sample from it at its own expense. Company shall send the discharge data of the previous month to Water Utility by the 5th day of next month.

Water Utility has the right to have access to all information on the sampling procedure if it so wishes. Company monitors the quality of its wastewater conveyed to the sewer network according to the monitoring programme approved by both contracting parties. The monitoring programme valid at the time of the signing of the agreement shall comply with Annex 3 (hereinafter Monitoring Programme). Monitoring Programme regulates the number of the definitions of wastewater, extent and frequency of sampling. If necessary, Monitoring Programme can be changed by a mutual agreement between both contractual parties.

3.3. Pretreatment

Wastewater shall be pretreated by the best available technology, i.e. by the BAT technique, before conveying it to the sewer network of Water Utility.

Wastewater must be pretreated in a due manner: 1) in order to protect the health of employees of Water Utility, 2) to prevent damage to the sewer network, treatment plant and their equipment, 3) to prevent any negative interference in the operations of wastewater and sludge treatment processes, 4) to prevent hazards caused by releases from the treatment plant and sewer network into the environment and to fulfil the obligations ensuing from the regulations set for the recipient water body, 5) to ensure a safe sludge disposal acceptable from the point of view of the environment.

Company shall plan its wastewater process, pretreatment and application measures so that they fulfil the rules defined in this agreement.

4. Liabilities of Water Utility and Company

Based on its environmental permit, Water Utility is responsible for all examinations and clarifications related to the state of wastewater, treatment plant and water body receiving wastewater. This Agreement does not serve for transferring obligations included in Water Utility's environmental permit to Company. However, this does not prevent the parties from changing the Agreement when the needs for change, as described in Item 2, materialise. Respectively, Company's obligations defined in its environmental permit cannot be assigned to Water Utility.

Nevertheless, according to the matching principle both parties are responsible for compensating possible damages or hazards to the owner of a shore or water area (i.e. area covered by water) or to other parties suffering from discharging of wastewater.

5. Notification obligation

Company shall inform without delay about possible exception and danger situations and planned measures which may cause harm to the operations of Water Utility.

Water Utility shall inform without delay about possible exception and danger situations and planned measures which may cause harm to the operations of Water Utility or interrupt them.

6. Sanctions

If the quality of Company's wastewater, conveyed to the sewer network of Water Utility, diverges from the limit values defined in Item 3.1, or from the general delivery terms and conditions mentioned in Item 2, or otherwise causes essential harm to the operations of Water Utility, Company may be obliged to pay Water Utility an Agreement penalty, mentioned hereinafter.

The amount of the Agreement penalty, mentioned in Item 3.1 on diverging from set limit values, is set for each exceeding time at 1000 m^3 x the currently valid wastewater fee.

If the exceeding causes immediate danger or significant harm to the operations of the treatment plant, its employees or to the environment, Water Utility has the right to discontinue the water supply and shut off immediately Company's sewer. Otherwise the contracting parties negotiate how to solve the problem in a different way.

Continuing or frequent exceeding of limit values or non-compliance with other Agreement conditions, despite written reminders from Water Utility, entitles Water Utility to discontinue receiving industrial wastewater. Before the reception of wastewater is interrupted, the contractual parties shall negotiate another solution for the problem.

7. Wastewater rate

Water Utility collects a wastewater fee for wastewater, conveyed to the public sewer, based on measurements and quality. Water Utility invoices Company at 2-month intervals.

In addition to the fees, mentioned in the connection and service agreement, based on Water Utility's rate and service price list, Company pays an increased wastewater fee for its wastewater if the quality of its wastewater diverges from the normal domestic wastewater quality.

The wastewater fee is determined according to the increased wastewater rate if the quality of wastewater diverges from the normal domestic wastewater quality. The wastewater coefficient is calculated by nationally approved calculation principles of increased wastewater rate based on the wastewater quality and currently valid rate of Water Utility. The quality of wastewater is defined as agreed in Monitoring Programme described in Item 3. The wastewater fee is calculated according to the actual concentrations.

The increased wastewater rate is calculated according to following formula:

$$k = 1 + a \cdot T \cdot (L - 1)$$

$$L = L_1 \cdot (s/S) + L_2 \cdot (n/N) + L_3 \cdot (bod/BOD) + L_4 \cdot (p/P)$$

where

k	is	increased coefficient of wastewater fee	
a	is	coefficient	0.49
T	is	rate coefficient	1.3
L1	is	solids (S)	0.44
L2	is	total nitrogen (N)	0.26
L3	is	BOD_7	0.22
L4	is	total phosphorus (P)	0.08

Lower case letters refer to the concentrations in Company's wastewater and upper case letters refer to the average concentrations used as reference values.

Average concentrations in wastewater as reference values:

Solids (S)	350 mg/l
Total nitrogen (N)	50 mg/l
BOD_7	250 mg/l
Total phosphorus (P)	8 mg/l

8. Other conditions

The contracting parties have the right to assign this agreement to a third party if this is caused by incorporation or selling of the business operations. The third party shall approve the conditions of this agreement. Additionally, Company has the right to assign the agreement within its group if the group company approves the conditions of this Agreement.

Company repairs damages in the range of Company - Model Water Utility at its own expenses if any corrosion to the pumps caused by Company's wastewater or concrete corrosion or sewer damage is detected. The condition of the sewer between Model's pumping station and Model's treatment plant shall be charted by Company before signing the Agreement. The inspection report on the condition of the sewer and Model's pumping station is presented in Annex 6.

9. Disagreements

Company and Water Utility agree upon that both parties are willing to negotiate and discuss a possible disagreement together and in mutual trust and cooperation in order to find a mutually satisfying solution to the problem in question.

In case no mutual understanding can be achieved, disagreements will be resolved by an arbitration procedure. The arbitrators are determined by the Arbitration Institute of the Finland Chamber of Commerce and the arbitration complies with the rules of the mentioned institutes.

10. Entry into force of the agreement

This Agreement has been made in two (2) copies with the same content, one for each Agreement party. The Agreement comes into force on x.x.xxxx.

11. Termination of the agreement

The Agreement is in force until further notice. The Agreement is updated to match the current circumstances every three year.

The termination period of the Agreement is one year for both parties.

12. Signing of the agreement

Model Water Utility Company

ANNEXES

ANNEX 1 General delivery terms and conditions
ANNEX 2 Agreement conditions of the connection and service agreement
ANNEX 3 Monitoring Programme
ANNEX 4 Map extract from a reception point for wastewater
ANNEX 5 Currently valid extract from Government Decree 1022/2006
ANNEX 6 Condition assessment of the pumping stations and sewer network

APPENDIX 6: Example of limit values and other conditions presented in Annex 1 of an industrial wastewater agreement

LIMIT VALUES FOR METALS

Metal		Maximum allowed concentration mg/l
Arsenic	(As)	0.1
Mercury	(Hg)	0.01
Silver	(Ag)	0.2
Cadmium	(Cd)	0.01
Total chromium	(Cr)	1.0
Chromium VI	(Cr^{6+})	0.1
Copper	(Cu)	2.0
Lead	(Pb)	0.5
Nickel	(Ni)	0.5
Zinc	(Zn)	3.0
Tin	(Sn)	2.0

OTHER SUBSTANCE-SPECIFIC LIMIT VALUES

pH value	6.0–11.0
Temperature	40 °C
Sulphate	400 mg/l
Total cyanide CN	0.5 mg/l

CASE-SPECIFIC LIMIT VALUES

Case-specific limit values and loading values can be defined if the sewer network or the operations of the treatment plants so requires; for example:

pH value
Solids
Metals
Fat (food industry)
BOD_7 (biological oxygen consumption)
Substances inhibiting nitrogen removal

INSTRUCTIONS FOR VOC COMPOUNDS (SOLVENTS)

1. Extremely flammable solvents, highly flammable solvents, and VOC compounds which are insoluble in water (e.g. diethyl ether, petroleum ether, cyclohexane)
    - Forbidden to convey to the sewer
2. Chlorinated VOC compounds (e.g. trichloroethylene, tetrachloroethylene, chloroform and carbon tetrachloride)
    - Forbidden to convey to the sewer
3. Chlorine-free VOC compounds (e.g. toluene and xylene)
    - Wastewater conveyed to the sewer network can include the aforementioned compounds altogether 3 mg/l at most
4. The total hydrocarbon concentration (C_{10}-C_{40}) in wastewater conveyed to the sewer network can be 100 mg/l at most (Government Decree on Environmental Protection Regulations of Liquid Fuel Distribution Stations 444/2010)

ADDITIONALLY TO BE CONSIDERED

1. If generated wastewater as such does not fulfil the aforementioned requirements, it is not allowed to dilute it in order to achieve the limit values. The limit values also concern specific non-recurring wastewater conveyed to the sewer. The application field of the aforementioned limit values shall be determined in the agreements to be concluded.
2. The Government Decrees must be taken into consideration when conveying wastewater diverging from normal domestic wastewater to the sewer.
    - Government Decree on Substances Dangerous and Hazardous to the Aquatic Environment 1022/2006 and 868/2010
    - Environmental Protection Decree 713/2014 (Section 41), Annex 1
3. Only washing chemicals belonging to the same approved detergent combination can be used at the service station at the same time. According to the instructions, the approval number must be marked on the detergent package. According to the instructions of the water utility, the detergent combinations, used in the washing activities of car service stations and car repair shops, shall comply with the approval of the Finnish Petroleum and Biofuels Association (SFS 3352/17.2.2014: Distribution stations of combustible liquids). Also car wash services, which operate in the sewerage area of the water utility, shall use these detergent combinations.

APPENDIX 7: Example of limit values and other conditions presented in Annex 2 of an industrial wastewater agreement

When conveyed to the sewer, wastewater shall not contain the following substances in concentrations exceeding the limit values given below.

METALS

Arsenic	As	0.1	mg/l
Mercury	Hg	0.01	mg/l
Silver	Ag	0.1	mg/l
Cadmium	Cd	0.01	mg/l
Total chromium	Cr	0.5*	mg/l
Chromium (VI)	Cr(6+)	0.1	mg/l
Copper	Cu	2.0*	mg/l
Lead	Pb	0.5	mg/l
Nickel	Ni	0.5	mg/l
Zinc	Zn	2.0*	mg/l
Tin	Sn	2.0	mg/l
Fluoride	F-	50	mg/l

*) HELCOM agreement

SOLVENTS

1. Extremely flammable solvents, highly flammable solvents, and solvents insoluble in waster (e.g. diethyl ether, petroleum ether) shall not be conveyed to the sewer.
2. Chlorinated hydrocarbon solvents (e.g. trichloroethylene, tetrachloroethylene, methylene chloride, chloroform and carbon tetrachloride) shall not be conveyed to the sewer.
3. Wastewater conveyed to the sewer can contain monocyclic aromatic hydrocarbons (e.g. benzene, ethylbenzene, toluene, xylene) 3 mg/l at most. (VOC)
4. The total carbonic concentration of wastewater conveyed to the sewer can be 200 mg/l at most.

OTHERS

pH	6.0-11.0	
Temperature	40°C	
Sulphate, thiosulphate		
Sulphite altogether	400	mg/l
Total cyanide CN	0.5	mg/l
Fat	150	mg/l
Oil	50	mg/l

Case-specific limit values can be determined if the sewer network or the operations of the treatment plant so requires.

Additionally, the connecting party cannot convey following substances/materials to the sewer:

- objects, textiles, grit or other similar materials or objects which may cause blockages in the sewer
- substances forming toxic gases

- wastewater that has temperature over +40°C
- large quantities of non-recurring wastewater
- substances harmful or damaging to the wastewater treatment plant or to the recipient water body.

Wastewater shall not be diluted in order to achieve the limit values. The limit values also concern specific non-recurring wastewater conveyed to the sewer (e.g. baths).

APPENDIX 8: Example of an industrial wastewater application

<table>
<tr><td rowspan="4">Information on the operator:</td><td colspan="6">Name</td></tr>
<tr><td colspan="6">Sector of industry</td></tr>
<tr><td colspan="6">Street address</td></tr>
<tr><td colspan="6">Postal address</td></tr>
<tr><td>Information on property's location</td><td colspan="2">Sector of the city</td><td colspan="2">Block</td><td colspan="2">Plot no</td></tr>
<tr><td rowspan="4">Owner of the property</td><td colspan="6">Name</td></tr>
<tr><td colspan="6">Address</td></tr>
<tr><td colspan="6">Contact person</td></tr>
<tr><td colspan="2">Phone</td><td colspan="2">Email address</td><td colspan="2">Connection agreement no.</td></tr>
<tr><td rowspan="3">Wastewater issues</td><td colspan="6">Contact person</td></tr>
<tr><td colspan="6">Postal address of the contact person</td></tr>
<tr><td colspan="2">Phone</td><td colspan="4">Email address</td></tr>
<tr><td rowspan="7">Operations</td><td colspan="2">New ☐</td><td colspan="2">Change in operations ☐</td><td colspan="2">Operations continue without changes ☐</td></tr>
<tr><td colspan="6">Start date of operations</td></tr>
<tr><td rowspan="2">Number of employees</td><td colspan="5">Operations</td></tr>
<tr><td>one-shift ☐</td><td colspan="2">two-shift ☐</td><td colspan="2">three-shift ☐</td></tr>
<tr><td colspan="6">General description of the operations</td></tr>
<tr><td colspan="6">Generation of industrial wastewater</td></tr>
<tr><td colspan="6">Quality of industrial wastewater</td></tr>
<tr><td rowspan="3">Amounts of wastewater</td><td colspan="6">Industrial wastewater
m³/24 hours m³/a</td></tr>
<tr><td colspan="6">Sanitary wastewater
m³/24 hours m³/a</td></tr>
<tr><td colspan="6">Cooling water
m³/24 hours m³/a</td></tr>
<tr><td>Pretreatment of industrial wastewater</td><td colspan="6">How industrial wastewater is pretreated</td></tr>
<tr><td>Application submitted</td><td colspan="6">date</td></tr>
</table>

APPENDIX 8

REQUIRED ANNEXES

ANNEX 1.	Site layout
ANNEX 2.	Used chemicals and raw materials
ANNEX 3.	Process flowchart of pretreatment of industrial wastewater
ANNEX 4.	Drawing of the location of sampling site
ANNEX 5.	Environmental permit decision

Application submission date and contact information

Paint and Colour Ltd
Address
PO Box

APPENDIX 9: Example 1 of a monitoring programme in an industrial wastewater agreement

The amount and quality of industrial wastewater are monitored by taking a 24-hour composite sample from wastewater conveyed to the sewer every other month. The samples are taken by an automatic sampling device from the sampling point located after the wastewater treatment equipment. The samples shall be taken by an external party or a person who has sufficient know-how in wastewater sampling. The person or party who takes the samples shall also note down the amount of industrial wastewater conveyed to the sewer network on the 24-hour basis when the samples are taken.

The samples are examined for the pH value, solids concentration, biological and chemical oxygen demand (BOD_7 and COD_{Cr}), total phosphorus and total nitrogen concentrations, heavy metals (cadmium, lead, total chromium, nickel, zinc, copper) and VOC compounds (volatile organic compounds).

The samples are examined in an external laboratory. As soon as the results from the analyses are available, the responsible laboratory shall send the data on industrial wastewater quantity, monitoring results and the wastewater loads calculated from them to the following email addresses for the information of all concerned parties at the water utility.

For more information, please contact:

(Signature)

Container cleaning Ltd
Address
PO Box

APPENDIX 10: Example 2 of a monitoring programme in an industrial wastewater agreement

The amount and quality of industrial wastewater are monitored by taking a 24-hour composite sample from wastewater conveyed to the sewer once every three months. The samples are taken from such a monitoring manhole where all wastewater from the property accrues. The sampling manhole shall be marked with the colour red. The samples shall be taken by an external party with sufficient know-how in taking samples from wastewater. The sampler shall establish the property's water consumption during the sampling.

The samples are examined for the pH value, electrical conductivity, solids, biological and chemical oxygen consumption (BOD_7 and COD_{Cr}), total phosphorus concentration, total nitrogen concentration and mineral oils (C_{10}-C_{40}). Additionally, once a year, the samples are analysed for VOC compounds (volatile organic compounds).

The samples are examined in an external laboratory. As soon as the results from the analyses are available, the responsible laboratory shall send the information about the amount of industrial wastewater, monitoring results and the wastewater loads calculated from them to the following email addresses for the information of all concerned parties at the water utility.

For more information, please contact at the water utility:

(Signature)

APPENDIX 11: Example of a monitoring programme for waste oil in an industrial wastewater agreement

Monitoring of the amount and quality of wastewater generated by Waste Oil Treatment Ltd will be performed four times a year: in March, June, September and November. The measurement of the pH value in wastewater conveyed to the sewer will be continuous.

The samples are taken as a 24-hour composite sample using an automatic sampling device. The discharge during the 24-hour sampling period will be recorded in the source information of the samples. Samples are taken from the wastewater manhole before connecting to the public sewer.

The sampling, fixation and delivery to the laboratory shall follow the instructions given by the laboratory.

The composite samples shall be **analysed for following parameters**. However, the definitions of mineral oils and solvents shall be made based on their grab samples.

Parameters to be analysed	**Continuous monitoring**	**Once every three months**
Temperature	X	
pH	X	X
Electrical conductivity		X
Heavy metals 1)		X
Cr^{6+}		X
As		X
Cyanide (CN^-)		X
Ag		X
Total nitrogen (N_{tot})		X
Total phosphorus (P_{tot})		X
BOD_7		X
COD_{Cr}		X
Solids		X
Sulphide		X
Sulphate		X
Carbon disulphide		X
Ammoniacal nitrogen (NH_4-N)		X
Chloride		X
(Surfactants)		4)
Mineral oils		X
Oils and fats		X
Solvents 2)		X
Halogenated solvents 3)		X

1) Heavy metals: Cu, Ni, Pb, Zn, Cr, Cd, Sn, Hg

2) and 3) The analysis shall include at least the following substances which should not be conveyed to the sewer:

1,2-dichloroethane, aldrin, dieldrin, endrin, isodrin, DDT, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclohexane, carbon tetrachloride, pentachlorophenols, tetrachloroethene (tetrachloroethylene), trichlorobenzene (1,2,4-trichlorobenzene), trichloroethene (trichloroethylene) and trichloromethane (chloroform).

Additionally, the analysis shall comprise the key oil hydrocarbons and other volatile solvents at least in that scope as mentioned in Model Water Utility's discharge permit conditions for wastewater diverging from domestic wastewater.

4) The analysis is performed once and after that whenever it is necessary

If changes in wastewater quality are detected and it shows a tendency towards deterioration, the analysis palette and/or the sampling frequency can be checked. The changes shall always be agreed upon in writing.

Sampling shall be performed by a person experienced in sampling or a certified expert on environmental sampling who is qualified especially for wastewater sampling. Analyses are performed in a laboratory which is either accredited or it holds a comprehensive quality system. Where possible, the laboratory shall be determined so that the compounds to be analysed belong to the sphere of accreditation of the laboratory.

The consultant who carried out the analyses shall deliver the monitoring results with the relevant data on wastewater amounts **without delay** directly to Model Water Utility to the address:

Model Water Utility
PO Box 1234

The annual total loading calculations and information about the annual discharge from the previous year shall be delivered to same address by the end of March every year.

For more information, please contact:

(Signature)

APPENDIX 12: Example of an application for conveying water from contaminated soil remediation sites to the sewer

Land owner / Operator	Name of the company	
	Address of the company	
	Contact information of the contact person	
Supervision of the remediation of soils and water areas	Name of the company	
	Address of the company	
	Contact information of the contact person	
Information on the contaminated area	Location/address of the site	
	Block/plot	
	Area (m²) of the contaminated site	
	Starting date of the excavation work	Duration (in months) of the excavation work
	Hazardous substances in the soil	
	Treatment method for water	
	Measurement method for water amounts	
	Authority granting the permit (contact information)	Permit no.
Water pumped into the sewer	Name of the payer	
	Invoicing address	
	Contact information of the contact person	
Application submitted	Date	

Required annexes:
Environmental permit decision

APPENDIX 13: Example of the operator's report on the hazardous and dangerous substances used

1) Government Decree on Environmental Protection 713/2014
2) Government Decree on Substances Dangerous and Hazardous to the Aquatic Environment 1022/2006 and the respective amendments 868/2010 and 1308/2015
3) Regulation (EC) No 166/2006 of the European Parliament and Council concerning the establishment of European Pollutant Release and Transfer Register amending Council 91/689/EEC and 96/61/EC (E-PRTR Regulation)

Substance	CAS number	Decree / Regulation	in use x = yes	use kg/a	to the sewer kg/a	Purpose of use
(benzothiazole-2-ylthio) Methyl thiocyanate (TCMTB)	21564-17-0	2				
1,1,1-tricholorethane	71-55-6	3				
1,1,2,2-tetrachloroethane	79-34-5	3				
1,2,3,4,5,6-hexachlorocyclohexane (HCH)	608-73-1	3				
1,2-dichlorobenzene	95-50-1	2				
1,2-dichloroethane (EDC)	107-06-2	2,3				
1,4-dichlorobenzene	106-46-7	2				
Aclonifen	74070-46-5	2				
Alachlor	15972-60-8	2,3				
Aldrin	309-00-2	2,3				
Ammonia (NH3)	7664-41-7	3				
Anthracene	120-12-7	2,3				
Arsenic and arsenic		1,3				
Asbestos	1332-21-4	3				
Atrazine	1912-24-9	2,3				
Benzene	71-43-2	2,3				
Benzo(a)pyrene	50-32-8	2				
Bentso(b)-fluoranthene	205-99-2	2				
Bentso(g,h,i)perylene	191-24-2	2,3				
Bentso(k)-fluoranthene	207-08-9	2				
Benzothiazole-2-thiol (di(benzothiatzol-2-yl)disulphide (CAS 120-78-5) degradation product)	149-30-4	2				
Benzyl butyl phthalate (BBP)	85-68-7	2				
Bifenox	42576-02-3	2				
Brominated diphenyl ethers (PBDE)	32534-81-9	2,3				
Bronopol (2-Bromo-2-nitropropane-1,3-diol)	52-51-7	2				
C10-13-chloroalkanes	85535-84-8	2				
Cadmium and cadmium compounds (depending on water hardness classes)	7440-43-9	2,3				
Carbon dioxide (CO2)	124-38-9	3				
Carbon monoxide (CO)	630-08-0	3				
Carbon tetrachloride	56-23-5	2				
Chlorine and inorganic compounds		3				

Substance	CAS number	Decree / Regulation	in use x = yes	use kg/a	to the sewer kg/a	Purpose of use
Chloroalkanes, C10–C13	85535-84-8	2,3				
Chlorobenzene	108-90-7	2				
Chlorofluorocarbons (CFC compounds)		3				
Chlordane	57-74-9	3				
Chlordecone / Kepone	143-50-0	3				
Chlorfenvinphos	470-90-6	2,3				
Chlorides		3				
Chlorpyriphos (chlorpyriphos-ethyl)	2921-88-2	2,3				
Copper and copper compounds		3				
Chromium and chromium compounds		3				
Cyanides	28159-98-0	2				
Cybutryne	309-00-2 60-	2				
Cyclodiene pesticides: aldrin dieldrin endrin isodrin	52315-07-8	2				
Cypermethrin	886-50-0	2				
DDT	50-29-3	2,3				
Di(2-ethylhexyl)phthalate (DEHP)	117-81-7	2,3				
Dibutyl phthalate (DBP)	84-74-2	2				
Dieldrin	60-57-1	2,3				
Dichloromethane (DCM)	75-09-2	2,3				
Dichlorvos	62-73-7	2				
Dicfol	115-32-2					
Dimethoate	60-51-5	2				
Dioxins and dioxin-like compounds	footnote 1	2				
Dinitrogen oxide (N_2O) /nitrous oxide	10024-97-2	3				
Diuron	330-54-1	2,3				
Endosulfan	115-29-7	2,3				
Endrin	72-20-8	2,3				
Ethylene oxide	75-21-8	3				
Ethylene thiourea (degradation products of mancozeb (CAS 8018-01-7))	96-45-7	2				
Ethylbenzene	100-41-4	3				
Fluoranthene	206-44-0	2,3				
Fluor and inorganic compounds		3				
Fluorides		3				
Fluorohydrocarbons (HFC compounds)		3				
Halogenated organic compounds (as AOX compounds)		3				
Halons		3				
Heptachlor	76-44-8	3				
Heptachlor and heptachlorepoxide	76-44-8/ 1024-	2				
Hexabromide cyclododecane (HBCDD)	footnote 2	2				
Hexabromide biphenyl	36355-1-8	3				

Substance	CAS number	Decree / Regulation	in use x = yes	use kg/a	to the sewer kg/a	Purpose of use
Hexachlorobenzene (HCB)	118-74-1	2,3				
Hexachlorobutadiene (HCBD)	87-68-3	2,3				
Hexachlorocyclohexane (gamma isomer, lindane)	608-73-1	2				
Hydrogen cyanide (HCN)		1,3				
Indeno (1,2,3-cd)pyrene	193-39-5	2				
Isodrin	465-73-6	2,3				
Isoproturon	34123-59-6	2,3				
Lead and lead compounds	7439-92-1	2,3				
Lindane	58-89-9	3				
MCPA (4-chloro-2-methyl-phenoxyacetic acid)	94-74-6	2				
Mercury and mercury compounds	7439-97-6	2,3				
Methane (CH_4)	74-82-8	3				
Metals and their compounds	footnote 3	1				
Metamitrons(4-amino-3-methyl-6-phenyl--1,2,4-triazin-5-one)	41394-05-2	2				
Mirex	2385-85-5	3				
Non-methane volatile organic compounds (NMVOC compounds)		3				
Naphthalene	91-20-3	2,3				
Nickel and nickel compounds	7440-02-0	2,3				
Nitrogen oxides (NO_x/NO_2)	75-01-4	3				
Nonylphenol (4-nonylphenol)	104-40-5	2				
Nonylphenols and nonylphenolxylates (NP/NPE compounds)		3				
Octylphenol ((4-(1,1,3,3-tetramethylbutyl)phenol))	140-66-9	2				
Octylphenols and octylphenol ethoxylates	1806-26-4	3				
Total organic carbon (TOC)		3				
Organic tin compounds		1,3				
Organophosphorus compounds		1				
Hydrochlorofluorocarbos (HCFC compounds)		3				
Para-para-DDT	50-29-3	2				
PCDD + PCDF (dioxins + furans) (TEQ)		3				
Pentachlorobenzene	608-93-5	2,3				
Pentachlorophenol (PCP)	87-86-5	2,3				
Perfluorocarbons (PFC compounds)		3				
Perfluorooctane sulphonic acid and derivates (PFOS)	1336-36-3	3				
Phenols	108-95-2	3				

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Substance	CAS number	Decree / Regulation	in use x = yes	use kg/a	to the sewer kg/a	Purpose of use
Polychlorinated biphenyls (PCB compounds)		2,3				
Polycyclic aromatic hydro-carbons (PAH compounds)	67747-09-5	2				
Prochloraz (N-Propyl-N-[2-(2,4,6-trichlorophenoxy)ethyl]-1H-imidazole-1-carboxamide)	108-46-3	2				
Quinoxyfen	124495-18-7	2				
Resorcinol (1,3-benzenediol)		3				
Sulphur oxides (SOx/SO_2)	2551-62-4	3				
Sulphurhexafluorid (SF_6)	122-34-9	2,3				
Simazine		1,3				
Zinc and zinc compounds	74-90-8	3				
Terbutryyni	127-18-4	2,3				
Tetrachloroethylene (PER)	56-23-5	3				
Tetrachloromethane (TCM)	8001-35-2	3				
Toxaphene	108-88-3	3				
Toluene	101200-48-0	2				
Total DDT	not applicable	2				
Total phosphorus		3				
Total nitrogen		3				
Tribenuron-methyl (Methyl-2-(3-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)3-methylureidosulponyl) benzoate)	36643-28-4	2,3				
Tributyltin compounds (Tributyltin-cation)		3				
Triphenyltin and triphenyltin compounds	1582-09-8	2,3				
Trifluralin	12002-48-1	2				
Trichlorobenzene (1,2,4-trichlorobenzene)	79-01-6	2,3				
Trichloroethylene	67-66-3	2,3				
Trichloromethane (chloroform)		3				
Vinyl chloride		1				
Xylenes	1330-20-7	3				
Biocides, pesticides and herbicides		1				
Organic halogenated compounds and substances that can constitute such compounds in the aquatic environment		1				
Particulate matters (PM10)		1				
Persistent and bio-accumulative toxic organic substances		1				
Persistent hydrocarbons		1				

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Substance	CAS number	Decree / Regulation	in use x = yes	use kg/a	to the sewer kg/a	Purpose of use
Reprotoxic compounds		1				
Substances and products which have carcinogenic, mutagenic or reprotoxic properties		1				
Substances that cause eutrophication, especially nitrates and phosphates		1				
Substances that have a negative influence on the oxygen balance		3				

APPENDIX 14: Substances inhibiting nitrification

Abbreviation	Explanation
IA	inhibiting ammonia oxidation (nitrification)
IN	inhibiting nitrate oxidation
LV	limit value
AS	activated sludge
BR	biorotor
PC	pure culture / axenic culture
VSS	volatile suspended solids

SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Acetamide	C2H5NO	IA=0	100	Hockenbury & Grady 1977
Acetone	C3H6O	IA=75	2 000	Tomlinson et al. 1966
		IA=50	8 100	Hooper 1973
		Nitrification inhibition	804	Oslislo et al.1985
Acetonitrile	C2H3N	IA=0	100	
Allyl alcohol	CH2:CH.CH2OH	IA=75	19.7	Barnes & Bliss 1983
		75	19.5	Stensel, McDowell & Ritter
Allyl isothiocyanate	CH2:CHCH2NCS	IA=75	1.9	Tomlinson et al. 1966
Allyl chloride (3-Chloroprene)	C3H5Cl	IA=75	180	Tomlinson et al. 1966
		IA=0	120	Wood et al.1981
Allylthiourea	C4H8N2S	IA=100	2	Abendt 1983, Young 1973
		IA=100	5	Raff 1981
		IA=100	3–5	Reimann 1973
		IA=38	1.16	Wood 1981
		IA=82	0.12	Hooper 1973
4'-Aminopropiophenone (para-aminopropio-phenone)		IA=75-100	100	Hockenbury 1977
Aniline	C6H5NH2	IA=75	7.7	Barnes & Bliss 1983
		IA=89	5	Hockenbury & Grady 1977
		IA=88	11.6	Hockenbury & Grady 1977
		IA=76	2.5	Hockenbury & Grady 1977
		IA=75	7.7	Tomlinson et al. 1966
		IA=54	2.3	Hockenbury & Grady 1977
		IA=50	<1	Hockenbury & Grady 1977
		75	7.7	Stensel, McDowell & Ritter
Arsenic	As^{3+}	IA=50	292	Beg 1980
		IA=10	32	Beg 1980

SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Benzaldehyde	C7H6O	Interferes with BOD analysis	400	Verschueren 1977
Benzene	C6H6	IA=0	500	Zhdanova 1962
		IA=LV	500	Zhdanova 1962
Benzidine dihydrochloride	C12H12Nx2HCl	IA=84	100	Hockenbury & Grady 1977
		IA=56	50	Hockenbury & Grady 1977
		IA=50	45	Hockenbury & Grady 1977
		IA=12	10	Hockenbury & Grady 1977
Benzocaine	C9H11O2	IA=50	>100	Hockenbury & Grady 1977
		IA=30	100	Hockenbury & Grady 1977
		IA=27	50	Hockenbury & Grady 1977
		IA=0	10	Hockenbury & Grady 1977
Benzylamine	C7H9N	IA=50	>100	Hockenbury & Grady 1977
		IA=26	100	Hockenbury & Grady 1977
		IA=10	50	Hockenbury & Grady 1977
		IA=0	10	Hockenbury & Grady 1977
2,2'-Bipyridine	C10H8N2	IA=91	100	Hockenbury & Grady 1977
		IA=81	50	Hockenbury & Grady 1977
		IA=50	23	Hockenbury & Grady 1977
		IA=23	10	Hockenbury & Grady 1977
Cadmium	Cd2+	IA=LV	0.5	Martin 1982
		IA=LV	20	Knoetze 1979
Chlorobenzene	C6H5Cl	IA=0	100	Hockenbury & Grady 1977
Chloroacetic acid	C2H3ClO2	IA=75	100	Arenshtein 1962
Chloroform	CHCl3	IA=75	18	Tomlinson et al. 1966
Copper	Cu	Toxic	4.2	Stensel, McDowell & Ritter
		Toxic	20	Stensel, McDowell & Ritter
		IA=76	17mg/g VSS	Tomlinson et al. 1966
		IA=75	4 PV	Tomlinson et al. 1966
		IA=50	0.8 PV	Tomlinson et al. 1966
		IA=50	75 AL	Tomlinson et al. 1966
		IA=10	0.3 PV	Tomlinson et al. 1966

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SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Chromium	Cr6+	IA=LV	1	Martin 1982
		IA=75	150	Beg et al. 1980
		IA=50	50	Beg et al. 1980
		IA=25	17	Beg et al. 1980
		IA=10	6	Knoetze 1979
		Toxic	0.25	Stensel, McDowell & Ritter
Cobalt	Co	Toxic	59	Stensel, McDowell & Ritter
m-Creosol	CH3C6H4OH	IA=75	11.4	Tomlinson et al. 1966
o-Creosol	CH3C6H4OH	IA=75	12.8	Tomlinson et al. 1966
p-Creosol	CH3C6H4OH	IA=75	16.5	Tomlinson et al. 1966
Cyanide	CN	IA=97	2.7	Tomlinson et al. 1966
		IA=75	0.65	Tomlinson et al. 1966
		IA=75	1.3	Barnes & Bliss 1983
		IA=42	0.54	Tomlinson et al. 1966
Cyclohexane	C6H12	IA=RA	40	
Diethanolamine	C4H11NO2	IA=LV	100	Hockenbury & Grady 1977
Diethylene glycol	C4H10O3	IA=LV	200	Zhdanova 1962
Diethylamine	C4H11N	IA=0	100	Hockenbury & Grady 1977
Diethyldithiocarbonate		IA=100	2.25	Hooper 1973
1,2-Dichloroiethane	C2H4C12	IA=LV	125	Blok 1981
Dimethylamine	C2H7N	IA=0	100	Hockenbury 1977
Dimethylhydrazine	C2H8N2	IA=50	19.2	Kane 1983
		IN=50	1160	Kane 1983
Dimethyl-p-nitrosoaniline	(CH3)2NC6H4NO	IA=75	19.5	Barnes & Bliss 1983
2,4-Dinitrophenol	C6H4(NO2)2	IA=75	460	Tomlinson et al. 1966
		IN=75	405	Tomlinson et al. 1966
Dithiooxamide	NH2CSCSNH2	IA=100	6	Tomlinson et al. 1966
		IA=75	42	Tomlinson et al. 1966
		IA=75	1.8	Tomlinson et al. 1966
		IA=75	1.1	Tomlinson et al. 1966
		IA=75	1.1	Barnes & Bliss 1983
		IA=35	1.2	Tomlinson et al. 1966
1,4-Dioxane	C4H8O2	IA=LV	825	Blok 1981
Dodecylamine	C12H27N	IA=96	100	Hockenbury & Grady 1977
		IA=95	50	Hockenbury & Grady 1977
		IA=66	1	Hockenbury & Grady 1977
Etyleenidiamiini	C2H8N2	IA=73	100	Hockenbury & Grady 1977
		IA=61	30	Hockenbury & Grady 1977
		IA=50	17	Hockenbury & Grady 1977
		IA=41	10	Hockenbury & Grady

SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Ethyl urethane / ethyl carbamate	NH2COOC2H5	IA=75	1782	Barnes & Bliss 1983
Formaldehyde	CH2O	IA=LV	160	Blok 1981
Guanidine	CH5N3	IA=75	4.7	Greenfield 1981
		IA=75	11.8	Barnes & Bliss 1983
Guanidine carbonate	((NH2)2CNH)H2CO3	75	16.5	Stensel, McDowell & Ritter
Hexamethylenediamine	C6H16N2	IA=52	100	Hockenbury & Grady 1977
		IA=50	85	Hockenbury & Grady 1977
		IA=45	50	Hockenbury & Grady 1977
		IA=27	10	Hockenbury & Grady 1977
Hydrazine	NH2NH2	IA=75	58	Tomlinson et al. 1966
Hydrazine sulfate	H2N2SO4	IA=75	252	Tomlinson et al. 1966
		IA=75	189	Tomlinson et al. 1966
Lead	Pb	IA=LV	0,5	Martin 1982
		IA=LV	20	Knoetze 1979
Magnesium	Mg	IA=LV	50	Vismara 1982
Mercaptobenzothiazole	C6H4SC(SH):N	IA=75	3	Tomlinson et al. 1966
		75	3	Stensel, McDowell & Ritter
Mercury	Mercury	IA=LV	1	Knoetze 1979
		Toxic	2	Stensel, McDowell & Ritter
Methanol	CH4O	IA=100	160,2	Hooper 1973
Methylene chloride	CH2C12	IA=LV	130	Blok 1981
Methylene blue	C16H18N3ClS	IA=100	35.59	Hooper 1973
Methylaminehydrochloride	CH3NH2HCl	IA=75	1550	Tomlinson et al. 1966
		IN=50	3400	Tomlinson et al. 1966
n-Methylaniline	C7H9N	IA=90	100	Hockenbury & Grady 1977
		IA=83	50	Hockenbury & Grady 1977
		IA=71	10	Hockenbury & Grady 1977
		IA=50	<1	Hockenbury & Grady 1977
n - Methylaniline	C7H9N	IN=58	100	Hockenbury 1977
Methyl isothiocyanate	CH3NCS	IA=75	0.8	Tomlinson et al. 1966
		75	0.8	Stensel, McDowell & Ritter
Methylthiourea	CH3NHCSNH2	IA=100	0.9	Wood 1981
Methylthiouronium sulfate	(NH2C(:NH)SCH)2H2 SO4	IA=75	6.4	Barnes & Bliss 1983

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SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Monoethanolamine	C2H7NO	IA=50	>200	Hockenbury & Grady 1977
		IA=20	200	Hockenbury & Grady 1977
		IA=16	100	Hockenbury & Grady 1977
l-Naphthylamine	C10H9N	IA=81	100	Hockenbury & Grady 1977
		IA=81	50	Hockenbury & Grady 1977
		IA=50	15	Hockenbury & Grady 1977
		IA=45	10	Hockenbury & Grady 1977
Nickel	Ni2+	IA=LV	1	Knoetze 1979
		IA=LV	0.1	Martin 1982
		IA=100	5	Sherrard 1981
		IA=100	3	Beckmann 1972
		IA=88	12	Martin 1982
		Toxic	11.7	Stensel, McDowell & Ritter
Nickel sulfate	NiSO4x6H2O	IA=75	105	Tomlinson et al. 1966
		IN=75	1315	Tomlinson et al. 1966
Ninhydrin	C9H6O4	IA=50	>100	Hockenbury & Grady 1977
		IA=31	10	Hockenbury & Grady 1977
		IA=30	100	Hockenbury & Grady 1977
		IA=26	50	Hockenbury & Grady 1977
p-Nitroaniline	C6H6N2O2	IA=67	100	Hockenbury & Grady 1977
		IA=52	50	Hockenbury & Grady 1977
		IA=50	31	Hockenbury & Grady 1977
		IA=46	10	Hockenbury & Grady 1977
		IA=37	100	Hockenbury 1977
p-nitrobenzaldehyde	C7H5NO3	IA=76	100	Hockenbury & Grady 1977
		IA=50	87	Hockenbury & Grady 1977
		IA=32	50	Hockenbury & Grady 1977
		IA=29	10	Hockenbury & Grady 1977
		IN=26	100	Hockenbury 1977
Phenanthroline	C12H8N2	IA=100	9.91	Hooper 1973

SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
Phenol	C6H5OH	IA=99	23.5	Tomlinson et al. 1966
		IA=75	5.6	Tomlinson et al. 1966
		IA=75	5.6	Barnes & Bliss 1983
		IA=40	4.7	Tomlinson et al. 1966
		75	5.6	Stensel, McDowell & Ritter
Piperidine cyclopentyl methyldithiocarbamate	C5H9NHCSSNH2C5 H10	IA=75	57	Tomlinson et al. 1966
Potassium chlorate	KClO3	IA=75	2400	Tomlinson et al. 1966
		IA=75	240	Tomlinson et al. 1966
Potassium chromate	K2CRO4	IA=75	680	Tomlinson et al. 1966
		IA=75	5400	Tomlinson et al. 1966
Potassium cyanate	KCN	IA=78	0,32	Hooper 1973
Potassium thiocyanate	KCNS	IA=75	>300	Tomlinson et al. 1966
Propylamine	C3H9N	IA=0	100	
Pyridine	C5H5N	IA=LV	15	Blok 1981 (agar test)
		IA=75	50	Blok 1981
		IA=50	100	Stafford 1974
		IA=38	10	Beccari 1980
Silver	Ag	Toxic	0.25	Stensel, McDowell & Ritter
Sodium azide	NaN3	IA=100	117.02	Bhandari 1979
		IA=75	23	Tomlinson et al. 1966
		IN=75	14	Tomlinson et al. 1966
Sodium methyldithiocarbamate (metam-sodium)	CH3NHCSSNa	IA=99,5	12,9	Tomlinson et al. 1966
		IA=91	2.6	Tomlinson et al. 1966
		IA=75	0.9	Tomlinson et al. 1966
		IA=75	0.9	Barnes & Bliss 1983
Sodium cyanate	NaCNO	IA=40	160	Tomlinson et al. 1966
Sodium cyanide	NaCN	75	0.65	Stensel, McDowell & Ritter
		IA=80	3.43	Tomlinson et al. 1966
		IA=75	1.18	Tomlinson et al. 1966
		IA=75	1.17	Tomlinson et al. 1966
		IN=75	2.79	Tomlinson et al. 1966
		IA=45	1.47	Tomlinson et al. 1966
		IA=20	0.49	Tomlinson et al. 1966
Strychine	C21H22O2N2	IA=75	267	Barnes & Bliss 1983
Sulfamic acid	H3NO3S	IA=0	100	Hockenbury 1977
Sulfide	S2-	IA=100	3.2	Hooper 1973
		IA=76	5	Beccari 1980
		IA=28	1	Beccari 1980
Tannins	C76H52O46	IA=50	>150	Hockenbury & Grady 1977
		IA=22	150	Hockenbury & Grady 1977
		IA=20	100	Hockenbury & Grady 1977
		IA=7	50	Hockenbury & Grady

SUBSTANCE	CHEMICAL FORMULA	INHIBITION (%)	C (mg/l)	SOURCE
TCMP		IA=100	50*	Raff 1985
* (TCMP from the manufacturer FA HACH Chemical Co.)		IA=100	10	Young 1973
		IA=100	2.31	Salvas 1984
		IA=100	1	Campbell 1965
		IA=100	0.2	Campbell 1965
		IA=86	11.55	Hooper 1973
Thioacetamide	CH3CSNH2	IA=100	7.5	Tomlinson et al. 1966
		IA=75	0.53	Tomlinson et al. 1966
		IA=75	0.52	Barnes & Bliss 1983
		75	0.53	Stensel, McDowell & Ritter
Thiosemicarbazide (amine-thiourea)	NH(NH2)CSNH2	IA=75	0.18	Tomlinson et al. 1966
		IA=79	0.91	Wood 1981
Thiocyanate	CNS	IA=27	500	
		IA=12	100	
Thiourea	(NH2)2CS	IA=100	0.67	Bhandari 1979
		IA=96	0.76	Tomlinson et al. 1966
		IA=77	0.152	Tomlinson et al. 1966
		IA=75	0.076	Tomlinson et al. 1966
		IA=75	0.076	Barnes & Bliss 1983
		75	0.076	Stensel, McDowell & Ritter
Toluene	C7H8 C6H15N	IA=RA	350	Blok 1981 (agar test)
		IA=63	150	Hockenbury & Grady
		IA=50	127	Hockenbury & Grady
		IA=35	100	Hockenbury & Grady
Trimethylamine	N(CH3)3	IA=75	118	Tomlinson et al. 1966
		IN=75	254	Tomlinson et al. 1966
Zinc	Zn	IA=100	3	Beckmann 1972
		Toxic	3	Stensel, McDowell & Ritter

Source: Svenskt Vatten, publikation P95 ”Råd vid mottagande av avloppsvatten från industri och annan verksamhet”. March 2009.

APPENDIX 15: The effect of chemical substances on concrete

Compounds	**Effect on concrete**
Acetic acid 10%	degrades slowly
Acetic acid 30%	”
Acetone	removes water
Acidic water pH ≤ 6,5	degrades slowly, rebar might be at risk
Acidum salis	see Hydrochloric acid
Alizarin	not hazardous
Allyl isothiocyanate / Mustard oil	degrades, especially when in contact with the air
Almond oil	degrades slowly
Aluminium chloride	destroys rapidly; rebar at risk
Aluminium sulphate	degrades cracked concrete, rebar at risk
Alum	see potassium alum (potassium aluminium sulphate)
Ammonia gas	may degrade concrete slowly; in porous or cracked concrete rebar at risk
Ammonium fluoride	degrades slowly
Ammonium hydroxide	not hazardous
Ammonium carbonate	”
Ammonium chloride	degrades slowly; in porous or cracked concrete rebar at risk
Ammonium nitrate	degrades; rebar at risk
Ammonium oxalate	not hazardous
Ammonium sulphate	degrades; rebar at risk
Ammonium bisulphate	” “
Ammonium sulphide	”
Ammonium sulphite	”
Ammonium superphosphate	” in porous or cracked concrete rebar at risk
Ammonium thiosulphate	degrades
Ammonium cyanide	degrades slowly
Animal fats	solid fats degrade slowly, liquid fats degrade faster
Anthracene	not hazardous
Apple wine	degrades slowly, see acetic acid
Arsenic acid	not hazardous
Ash	not hazardous if sulphides and sulphates are washed away. If ash contains sulphides and sulphates, moist ash is hazardous. Hot ash causes thermal expansion.
Baking powder	see $NaHCO_3$
Barium hydroxide	not hazardous
Beer	may contain fermentation product acetic, carbonic, lactic or tannic acid
Benzene	removes water
Bleach	see Hypochlorite, Sulphuric acid, etc
Borax	not hazardous
Boric acid	effect insignificant
Bromine	degrades especially if contains bromic acid
Butanone / methyl ethyl ketone MEK	removes water
Buttermilk	degrades slowly
Butyl stearate	degrades slowly

Compounds	**Effect on concrete**
CaHSO3	degrades rapidly
CaCl2	rebar at risk
Ca(OH)2	not hazardous
Ca(NO3)2	not hazardous
CaSO4	degrades concrete if its sulphate-resistance sensitive
CoSO4	”
CuSO4	”
CuS	hazardous if contains sulphates
CuCl2	degrades slowly
Cu-rich surface treatment fluids	not hazardous
Calcium compounds	see Ca
Carbazole	not hazardous
Carbon	may contain water-soluble sulphides, sulphates, etc.
Carbon dioxide	as gas may cause persistent shrinking
Carbonic acid	degrades slowly, corrosive to steel
Carbon sulphide CS2	may corrode slowly
Carbon tetrachloride	removes water
Castor oil	degrades, especially when in contact with the air
Cellulose	not hazardous
Chile saltpetre	see NaNo3
Chlorine gas	degrades slowly moist concrete, corrosive to steel
Cleaning solutions	in cracked or porous concrete the rebar at risk
Coal tar oil	anthracene, benzene, carbazole, creosol, etc.
Cocoa bean oil	degrades, especially when in contact with the air
Coconut oil	degrades, especially when in contact with the air
Cod liver oil	degrades slowly
Coke (fuel)	may contain water-soluble sulphides and sulphates
Combustion gases	when hot causes thermal expansion, frozen condensed gases
Cottonseed oil	degrades, especially when in contact with the air
Corn syrup	degrades slowly
Chromic acid 5%	rebar at risk
Chromic acid 10%	”
Chromic acid 50%	”
Chromic acid 60%	”
Chrome plating solutions (surface treatment 1)	degrade slowly
Cobalt compounds	see Co
Concentrated acetic acid	degrades slowly
Copper compounds	see Cu
Creosote	degrades when in contact with phenol
Creosol	”
Cumol	removes water
Diethyl ether / Ethyl ether	removes water
Dinitrophenol	degrades slowly
Epsom salt	see MgSO4
Ethanol	removes water
Ethyl acetate	degrades moist concrete already in gaseous form

Compounds	**Effect on concrete**
Exhaust gases from motor vehicles	may degrade moist concrete if contain carbonic acid, sulphuric acid or nitric acid
Fermented fruits, grain, vegetables and their extracts	slow degradation
Fertilisers	see ammonium sulphate, phosphoric acid, etc.
Fish stock	degrades
Fish oil	degrades slowly
Fruit juices	acids and sugar included in them cause degradation
Formaldehyde 37%	corrodes slowly through formic acid
Formalin / Formol	”
Formic acid 10%	degrades slowly
Formic acid 30%	”
Formic acid 90%	”
Fuel (benzine, petrol)	removes water
German saltpetre / Leuna Saltpetre	see Potassium nitrate and sulphate
Glucose	degrades slowly
Glycol	”
Glycerol /Glycerine / Glycerin	”
Grease and fat	as solid degrade slowly, as liquid degrade faster
H_2SO_4 10 %	destroys rapidly
H_2SO_4 30 %	destroys rapidly
H_2SO_4 50 %	”
H_2SO_4 60 %	”
H_2SO_4 70 %	”
H_2SO_4 80 %	”
H_2SO_4 93 %	corrodes
H_2SO_4 concentrated	”
H_2SO_4 gas	”
H_2SO_3	corrodes rapidly
Honey	not hazardous
Humic acids	corrode and disintegrate slowly
Hydroflouric acid 10%	corrodes rapidly, also rebar
Hydroflouric acid 30%	”
Hydroflouric acid 40%	”
Hydroflouric acid 75%	”
Hypochlorous acid 10%	slowly corrosive
Hydrochloric acid 10%	corrodes rapidly, also rebar
Hydrochloric acid 30%	”
Hydrochloric acid 37	”
Hydrogen sulphide H_2S	not hazardous but in a humid and oxidised environment turns into sulphuric acid and corrodes slowly
Iodine	degrades slowly
Iron chloride / Ferric chloride	degrades slowly
Iron nitrate / Ferric nitrate	not hazardous
Iron sulphate / Ferrous sulphate	degrades a low-quality concrete
Iron sulphide / Ferric sulphide	hazardous if contains sulphates

Compounds	Effect on concrete
K_2CO_3	not hazardous
KCl	rebar at risk
KCN	degrades slowly
$K_2Cr_2O_7$	degrades
$KMnO_4$	not hazardous
KNO_3	degrades slowly
KOH 5 %	not hazardous
KOH 25 %	corrodes
KOH 95 %	corrodes
K_2SO_4	degrades concrete that has low sulphate-resistance
$KHSO_4$	”
K_2S	not hazardous
Kerosene	removes water
Lactic acid 5%	degrades slowly
Lactic acid 25%	degrades
Lead nitrate	degrades slowly
Liquid ammonia	harmful only with aluminium salts
Lignite oils	if contains liquid fats, degradation is slow
Linseed oil	the skin is not hazardous
Lubricants	if contain liquid fats, degrade slowly
Lye and caustic soda	see NaOH
$MgCl_2$	degrades slowly, in porous or cracked concrete rebar at risk
$Mg(NO_3)_2$	degrades slowly
$MgSO_4$	degrades concrete that has low sulphate-resistance
Manure	degrades slowly
Margarine	degrades slowly as solid, degrades faster as liquid
Mash (sour mash for spirits)	may contain organic acids, e.g. lactic acid
Methanol	removes water
Methyl isoamyl ketone	”
Methyl isobutyl ketone	”
Mercury chlorides	degrades slowly
Milk	through fermentation, see Lactic acid
Mineral oils	when liquid fats present, degrade slowly
Molasses	when warm degrade slowly
$NaHCO_3$	not hazardous
Na_2SO_4	degrades concrete that has low sulphate-resistance
Na_2SO_3	degrades concrete that has low sulphate-resistance
$Na_2S_2O_7$	degrades slowly concrete that has low sulphate-resistance
$NaHSO_4$	degrades
$NaHSO_3$	”
Na_2S	degrades slowly
NaBr	”
Na_2CO_3	not hazardous
NaCl	rebar at risk
$Na_2Cr_2O_7$	degrades slowly already as a mild solution
$NaNO_3$	degrades slowly

Compounds	Effect on concrete
$NaNo_2$	degrades slowly
$NaPO_3$	”
NaOH 1 %	not hazardous
NaOH 10 %	”
NaOH 30 %	corrodes
NaOH 25 %	”
NaOH 40 %	”
Nickel sulphate	degrades concrete that has low sulphate-resistance
Nickel plating solutions (surface	nickel ammonium sulphate degrades slowly
Nitric acid 2%	corrodes fast
Nitric acid 5%	corrodes fast
Nitric acid 10%	”
Nitric acid 20%	”
Nitric acid 30%	”
Nitric acid 40%	“
Offal / Slaughterhouse waste	organic acids disintegrate
Oleic acid 100%	not hazardous
Olive oil	degrades slowly
Oxalic acid	not hazardous, protects containers against mild acids and salt water, toxic
Paraffin ≤ 35 ^{o}Be	removes water; if contains liquid fats, then slow release
Paraffin > 35 ^{o}Be	”
Paraffin	not hazardous
Peanut oil /Groundnut oil	degrades slowly
Perchloroethylene	removes water
Perchloric acid 10%	corrodes
Phenanthrene	removes water
Phenol 5%	degrades slowly
Phenol 15 – 25%	”
Phosphoric acid 10%	degrades slowly
Phosphoric acid 85%	”
Pitch	not hazardous
Poppyseed oil	degrades slowly
Potassium aluminium sulphate	degrades concrete that has low sulphate-resistance
Pyrite / Iron pyrite	see Iron sulphide and CuS
Rape oil	degrades, especially when in contact with the air
Resin	not hazardous
Resin oils	”
Road salts	see $CaCl_2$, NaCl and $MgCl_2$
Rock salt	see NaCl
Saltpeter /Saltpetre	see Potassium nitrate = KNO_3
Salt water (e.g. a mine)	see NaCl and other salts
Sea water	depending on the sea sulphate-resistant concrete, rebar at risk
Silage	if contains acetic acid, butyric acid and lactic acid may degrade slowly
Sludge	see Wastewater and hydrogen sulphide

Compounds	Effect on concrete
Soda water	see Carbonic acid
Sodium hypochlorite	degrades slowly
Sour milk	see Lactic acid
Sauerkraut	may contain acids such as lactic acid
Soy bean oil	as liquid disintegrate slowly but the dried-up skin not hazardous
Sugar	degrades slowly
Strontium chloride	not hazardous
Sulphur oxide, SO_2	forms sulphurous acid
Sulphite solutions	degrade
Tannic acid	degrades slowly
Tanning solution	if acidic, corrosion of a different grade
Tartaric acid solution	not hazardous
Toluene	removes water
Train exhaust gases	may degrade moist concrete if gas contains
Trichloroethylene	removes water
Turpentine	”
Tobacco	if contains organic acids, then corrodes slowly
Urea	not hazardous
Urine	rebar at risk in porous concrete or in concrete of a weak quality
Whey	see lactic acid
Wine	not hazardous
	carbonic, nitric or sulphuric acid etc.
Wastewater (sanitary)	usually not hazardous, see, however, hydrogen sulphide
Wastewater (mining)	sulphides, sulphates or acids which often degrade (if included); also rebar at risk
Tung oil	disintegrates slowly as liquid, dry skin not hazardous
Xylene	removes water
Zinc chloride	degrades slowly
Zinc nitrate	not hazardous
Zinc sulphate	degrades slowly
Zinc plating solutions (surface treatment l)	if contain sulphuric acid or hydrochloric acid, they corrode

Source: Finnish Maintenance Society, Promaint, Korroosiokäsikirja *(Corrosion manual)* No.12, 2004

APPENDIX 16: Examples of substances to be investigated in industrial wastewater

NB! The need to investigate substances mentioned in Decree 1022/2006 shall be assessed case by case.

Sector/industry	BOD_7	COD_{Cr}	N	P	SS	T	pH	Conductivity	SO_4	Metals	VOC	Oils	Fats	Other
Food industry														Typically a high BOD_7, solids, phosphorus and nitrogen concentration, and changes in the pH value
Dairies	x	x	x	x	x		x						x	pH and T under continuous measurements if necessary
Slaughterhouses	x	x	x	x	x	x	x	x					x	pH and T under continuous measurements if necessary
Breweries	x	x	x	x	x		x							
Distilleries (spirits)	x	x	x	x	x		x	x						
Potato and vegetable processing plants	x	x	x	x	x		x							
Bakeries	x	x	x	x	x		x						x	pH and T under continuous measurements if necessary
Fish processing plants	x	x	x	x	x		x						x	pH and T under continuous measurements if necessary
Metal industry														Can be the release source especially for TBT, mercury, cadmium and nickel
Surface finishing plants					x		x			x	x	x		CN and zinc if necessary*
Steel pickling plants					x		x	x		x				
Phosphating process plants	x	x	x	x	x		x	x		x	x	x		
Anodising plants	x	x	x	x	x		x	x	x	x				
Shipyards										x	x	x		TBT and TPHT if necessary
Chemical industry														DEHP, HBCD, alkylphenols and their ethoxylates if necessary
Paint and coating industry	x	x	x	x	x		x			x	x			Alkylphenols and their ethoxylates, DEHP, DBP and BBP
Rubber industry	x	x	x	x	x		x			x	x	x		DEHP, DBP, MBeT, octyliphenols and ethylenthiourea if necessary
Explosives	x	x	x	x	x		x			x				
Pharmaceutical products	x	x	x	x	x		x	x			x			AOX and drug ingredient concentrations if necessary
Enzyme production	x	x	x	x	x		x							
Sulphuric acid production							x	x	x	x				
Printing inks	x	x	x	x	x		x	x		x	x			
Printing industry														Can be the release source especially for DBP, cadmium, lead and zinc
Offset	x	x	x	x			x	x		x				
Silk screen printing	x	x	x	x			x	x		x				

Sector/industry	**BOD_7**	**COD_{Cr}**	**N**	**P**	**SS**	**T**	**pH**	**Conductivity**	**SO_4**	**Metals**	**VOC**	**Oils**	**Fats**	**Other**
Forest industry														High BOD_7 and COD_{Cr} concentrations are typical
Paper and pulp industry	x	x	x	x	x		x	x		x				AOX if necessary
Textile and leather industry														
Textile (textile printing)	x	x	x	x	x		x	x		x	x			Organic substances and DEHP if necessary
Leather (tanneries)	x	x	x	x	x		x	x	x	x				Cr and hexavalent chromium from metals. Organic hazardous substances if necessary
Laundries	x	x	x	x	x		x	x						Alkylphenols and their ethoxylates, DEHP
Manufacturing of mineral products														
Glassworks and fibreglass plants	x	x	x	x	x		x	x		x				
Concrete plants	x	x	x	x	x		x	x	x			x		if necessary (coloured pavers)
Traffic														
Airports	x	x	x	x	x		x	x		x				Alkylphenols and their ethoxylates, HBCD, PFOS
Energy production					x		x			x		x		PAH compounds
Waste management														TBT, PFOS, PBDE, phthalates (DEHP), alkylphenols and their ethoxylates if necessary
Waste treatment plants/landfill	x	x	x	x	x		x	x		x	x			AOX and chloride concentrations if necessary
Composting/Leachate	x	x	x	x	x		x	x		x				AOX and chloride concentrations if necessary
Biogas plants	x	x	x	x	x		x	x		x	x			AOX and chloride concentrations, and alkalinity if necessary
Services														
Hospitals	x	x	x	x	x		x	x		x	x			AOX and drug ingredient concentrations if necessary
Car service stations	x	x	x	x	x		x	x		x	x	x		Alkylphenols and their ethoxylates if necessary

AOX	Halogenated organic compounds
Alkylphenols and their ethoxylates	Nonylphenols and their ethxylates, Octylphenols and their ethoxylates
CN	Cyanide
SS	Solids
T	Temperature
TBT	Tributyltin
Oils	Mineral oils C_4-C_{10}
*	Galvanising plant

APPENDIX 17 Harmful and hazardous substances to the aquatic environment. Government Decree 1022/2006 on Substances Dangerous and Hazardous to the Aquatic Environment, Annex 1, C2, D

NB! The environmental quality standards (EQS) of substances 34–45 included in Annex 1, Item C2 will come into force on 22 December, 2018.

C2) The environmental quality standards for substances specified as harmful and hazardous to the aquatic environment according to the water framework directive

AA: annual average
MAC: maximum allowed concentration
Unit: [μg/l] in columns (4)-(7), [μg/kg fresh weight] in column (8)

No.	Name of the substance	CAS-number (1)	AA-EQS (2) Inland surface water	AA-EQS (2) Sea water and other surface water	MAC-EQS (4) Inland surface water	MAC-EQS (4) Sea water and other surface water	EQS perch/ Baltic herring (12)
1	Alachlor	15972–60-8	0.3	0.3	0.7	0.7	
2	Anthracene	120–12-7	0.1	0.1	0.1	0.1	
3	Atrazine	1912–24-9	0.6	0.6	2	2	
4	Benzene	71–43-2	10	8	50	50	
5	Brominated diphenyl ethers (5)	32534–81-9			0.14	0.014	0.0085
6	Cadmium and cadmium compounds (depending on water hardness class) (6)	7440-43-9	≤0.08 (class 1) 0.08 (class 2) 0.09 (class 3) 0.15 (class 4) 0.25 (class 5) (3)	0.2	≤0.45 (class 1) 0.45 (class 2) 0.6(class 3) 0.9 (class 4) 1.5 (class 5) (3)	≤0.45 (class 1) 0.45 (class 2) 0.6 (class 3) 0.9 (class 4) 1.5 (class 5)	
(6a)	Carbontetrachloride(7)	56-23-5	12	12	not applicable	not applicable	
7	C10-13-chloroalkanes (8)	85535-84-8	0.4	0.4	1.4	1.4	
8	Chlorfenvinphos	470-90-6	0.1	0.1	0.3	0.3	
9	Chlorpyriphos (chlorpyriphos-ethyl)	2921-88-2	0.03	0.03	0.1	0.1	
(9a)	Cyclodiene pesticides: aldrin (7) dieldrin (7) endrin (7) isodrin (7)	309-00-2 60-57-1 72-20-8 465-73-6	Σ = 0.01	Σ = 0.005	not applicable	not applicable	
(9b)	Total DDT (7) (9)	not applicable	0.025	0.025	not applicable	not applicable	
	para-para DDT (7)	50-29-3	0.01	0.01	not applicable	not applicable	
10	1,2-Dichloroethane	107-06-2	10	10	not applicable	not applicable	
11	Dichloromethane	75-09-2	20	20	not applicable	not applicable	
12	Di(2-ethylhexyl) phthalate (DEHP)	117-81-7	1.3	1.3	not applicable	not applicable	
13	Diurone	330-54-1	0.2	0.2	1.8	1.8	
14	Endosulfan	115-29-7	0.005	0.0005	0.01	0.004	
15	Fluoranthene	206-44-0			0.12	0.12	30
16	Hexachloro-benzene	118-74-1			0.05	0.05	10
17	Hexachlorobutadiene	87-68-3			0.6	0.6	55
18	Hexachlorocyclohexane	608-73-1	0.02	0.002	0.04	0.02	
19	Isoproturon	34123-59-6	0.3	0.3	1	1	
20	Lead and lead compounds	7439-92-1	1.2 (13) (3)	1.3	14 (3)	14	

No.	Name of the substance	CAS-number (1)	AA-EQS (2) Inland surface water	AA-EQS (2) Sea water and other surface water	MAC-EQS (4) Inland surface water	MAC-EQS (4) Sea water and other surface water	EQS perch/ Baltic herring (12)
21	Mercury and mercury compounds	7439-97-6			0.07 (3)	0.07	20
22	Naphtalene	91-20-3	2	2	130	130	
23	Nickel and nickel compounds	7440-02-0	4 (13) (3)	8,6	34 (3)	34	
24	Nonylphenols (4-nonylphenol) (15)	84852-15-3	0.3	0.3	2	2	
25	Octylphenols ((4- (1,1′,3,3′-Tetramethylbutyl) phenol))	140-66-9	0.1	0.01	not applicable	not applicable	
26	Pentchlorobenzene	608-93-5	0.007	0.0007	not applicable	not applicable	
27	Pentachlorophenol	87-86-5	0.4	0.4	1	1	
28	Polycyclic aromatic hydrocarbons (PAH) (11)	not applicable	not applicable	not applicable	not applicable	not applicable	
	Benzo(a)pyrene	50-32-8			0.27	0.027	5
	Benzo(b)fluoranthene	205-99-2	See footnote 11.	See footnote 11.	0.017	0.017	See footnote 11.
	Benzo(k)fluoranthene	207-08-9	See footnote 11.	See footnote 11.	0.017	0.017	See footnote11.
	Benzo(ghi)pyrelene	191-24-2	See footnote 11.	See footnote 11.	8.2×10^{-3}	8.2×10^{-4}	See footnote 11
	Indeno(1,2,3-CD)pyrene	193-39-5	See footnote 11.	See footnote 11.	not applicable	not applicable	See footnote 11
29	Simazine	122-34-9	1	1	4	4	
(29a)	Tetrachloroethene (7)	127-18-4	10	10	not applicable	not applicable	
(29b)	Trichloroethene (7)	79-01-6	10	10	not applicable	V	
30	Tributyltin compounds (tributyltin cation)	36643-28-4	0.0002	0.0002	0.0015	0.0015	
31	Trichlorobenzenes	12002-48-1	0.4	0.4	not applicable	not applicable	
32	Trichloromethane	67-66-3	2.5	2.5	not applicable	not applicable	
33	Trifluralin	1582-09-8	0.03	0.03	not applicable	not applicable	
34	Dicofol	115-32-2			not applicable(10)	not applicable(10)	33
35	Perfluorooctanesulfon ate acid and its derivates (PFOS)	1763-23-1			36	7.2	9.1
36	Quinoxyfen	124495-18-7	0.15	0.015	2.7	0.54	
37	Dioxins and dioxin-like compounds	See footnote 9 in Annex 1, Item C1			not applicable	not applicable	Sum PCDD+PCDF + PCB-DL 0.0065 μg.kg^{-1} TEQ (14)
38	Aclonifen	74070-46-5	0.12	0.012	0.12	0.012	
39	Binfenox	42576-02-3	0.012	0.0012	0.04	0.004	
40	Cybutryne	28159-98-0	0.0025	0.0025	0.016	0.016	
41	Supermethrin	52315-07-8	8×10^{-5}	8×10^{-6}	6×10^{-4}	6×10^{-5}	
42	Dichlorvos	62-73-7	6×10^{-4}	6×10^{-5}	7×10^{-4}	7×10^{-5}	
43	Hexabromocyclo-decane (HBCDD)	See footnote in Annex 1, Item C1			0.5	0.05	167
44	Heptachlor and heptachlor epoxide	76-44-8/ 1024-57-3			3×10^{-4}	3×10^{-5}	6.7×10^{-3}
45	Terbutryn	886-50-0	0.065	0.0065	0.34	0.034	

(1) CAS: Chemical Abstracts Service.

(2) This parameter is an environmental quality standard, expressed as an arithmetic annual average (AA-EQS) It is applied to the total concentration of all isomers if not otherwise mentioned. The average is calculated as an arithmetic average of the results measured at each representative monitoring site during one year.

(3) Apart from cadmium, lead, mercury and nickel (hereinafter 'metals'), the environmental quality standards defined in this Annex are expressed as total concentrations in the whole water sample. The EQS of metals refers to dissolved concentrations, i.e. a dissolved phase of a water sample by filtration with a 0.45 µm filter or any equivalent pretreatment. When assessing the monitoring results against the EQS, the following aspects shall be taken into consideration:

a) metals and the natural background concentrations of metal compounds, by adding an estimate of a natural background concentration to EQS according to the table below,

b) water hardness, pH or other water quality parameters which influence the bioavailability of metals.

The sum of the natural background concentration and EQS. In target areas where the concentrations are high due to geological reasons, an expert assessment can derogate from the background concentration values.

	Cadmium	**Nickel**	**Lead**	**Mercury**
	µg/l (water) background + AA EQS	**µg/l (water) background +AA EQS**	**µg/l (water) background + AA EQS**	**µg/kg (perch/ Baltic herring) background + EQS**
Lakes				
with little humus (colour number Pt mg/l <30)	0.02 + 0.08 = 0.1 (class 1 and 2)	1 + 4 = 5 (13)	0.1 + 1.2 = 1.3 (13)	180 + 20 = 200
normal humus (colour number Pt mg/l 30–90)	0.02 + 0.08 = 0.1 (class 1 and 2)	1 + 4 = 5 (13)	0.2 + 1.2 = 1.4 (13)	200 + 20 = 220
abundant humus (colour number Pt mg/l >90)	0.02 + 0.08 = 0.1 (class 1 and 2)	1 + 4 = 5 (13)	0.7 + 1.2 = 1.9 (13)	230 + 20 = 250
Rivers				
Coniferous forest and loam (colour number Pt mg/l <90, in catchment area the bog percentage <25)	0.02 + 0.08 = 0.1 (class 1 and 2)	1 + 4 = 5 (13)	0.3 + 1.2 = 1.5 (13)	180 + 20 = 200
Peat land (colour number Pt mg/l >90, in catchment area the bog percentage >25)	0.02 + 0.08 = 0.1 (class 1 and 2)	1 + 4 = 5 (13)	0.5 + 1.2 = 1.7 (13)	230 + 20 = 250
Coastal waters / sea water	0.02 + 0.2 = 0.22	1 + 8.6 = 9.6	0.03 + 1.3 = 1.33	180 + 20 = 200

(4) This parameter is an environmental quality standard expressed as a maximum allowed concentration (MAC-EQS). When the parameter MAC-EQS is marked as "not applicable", the AA-EQS values are interpreted as providing protection from short-term contamination peaks in continuous pollutant releases because they are significantly lower than the derived values based on acute toxicity. The application of EQS's maximum allowed concentration means that the measured concentration does not exceed the norm at any of the monitoring points. However, such statistics methods can be applied to the estimation as percentiles so that an acceptable reliability and accuracy level can be determined for adhering to the MAC-EQS value.

(5) For substances belonging to the brominated diphenylethers (No. 5), the environmental quality standard refers to the concentration sum of compound numbers 28, 47, 99, 100, 153 and 154.

(6) For cadmium and cadmium compounds (No. 6), the environmental quality standards vary depending on water hardness divided into five classes: class 1 <40 mg $CaCO_3$/l, class 2: 40–50 mg $CaCO_3$/l, class 3: 50–100 mg $CaCO_3$/l, class 4: 100–200 mg $CaCO_3$/l and class 5: ≥200 mg $CaCO_3$/l.

(7) This substance is not a substance prioritised according to the water framework directive but another polluting substance; for these kinds of substances, the environmental quality standards refer to the norms applied to the legislation before 13 January, 2009.

(8) No reference parameters have been determined for this substance group. The reference parameters must be determined using an analytical method.

(9) Total DDT is the sum of isomers' 1,1,1-trichloro-2, 2-bis(p-chlorophenyl)ethane (CAS number 50-29-3), EU number 200-024-3), 1,1,1-Trichloro-2(o-chlorophenyl)-2-(p-chlorophenyl)ethane (CAS number 789-02-6), EU number 212-332-5), 1,1-dichloro-2,2 bis-(p-chlorophenyle)ethylene (CAS number 72-55-9, EU number 200-784-6), and 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane (CAS number 7254–8, EU

number 200-783-0).

(10) There is not enough information available to determine the MAC-EQS of these substances.

(11) For hazardous substances (No. 28) belonging to the polycyclic aromatic hydrocarbons (PAH), the EQS relative to organisms refers to the benzo(a)pyrene concentration; i.e. toxicity which they are based.on. Benzo(a)pyrene can be seen as the indicator of other polyaromatic hydrogen carbons. Therefore, it is only necessary to monitor benzo(a) pyerene as a comparison to the environmental quality standard related to organisms.

(12) The environmental quality standard (EQS) related to organisms refers to fish if not otherwise noted. The EQS is measured for perch in inland surface waters and on the open sea for Baltic herring. For numbers 15 (fluoranthene) and 28 (polycyclic aromatic hydrocarbons), the environmental quality standards for organisms refer to molluscs. For assessing the chemical conditions, it is not relevant to monitor fluoranthene and polycyclic aromatic hydrocarbons in fish. For number 37 (dioxins and dioxin-like compounds), the EQSs for organisms refer to fish in EU Regulation (EC) No. 1881/2006 on setting maximum levels for dioxins, dioxin-like PCB compounds and non-dioxin-like PCBs in foodstuffs amended by Commission Regulation (EU) No. 1259/2011 (OJ L 320, 3.12.2011, page 18) according to Chapter 5.3 of Annex on 2 December, 2011.

(13) These EQSs refer to the bioavailable concentrations of the substances in question.

(14) PCDD: polychlorinated dibenzo-p-dioxins; PCDF: polychlorinated dibenzofurans, PCB-DL: dioxin-like polychlorinated biphenyls;

TEQ: Toxic equivalency quotients as WHO-TEQ 2015 (World Health Organisation's scheme).

(15) Total toxicity of nonylphenols and nonylphenolethoxylates is not allowed to exceed the EQS. The total toxicity is calculated with the scheme: ∑ (Cxx TEF),

TEF = toxic equivalency factor
Cx = concentration of each nonylphenol compound

Substance	Toxic equivalency factor (TEF)
nonylphenols	1
nonylphenolmono and diethoxylates	0.5

D) Substances hazardous to the aquatic environment defined by the national method

	Name	CAS number [1]	Environmental quality standard AA-EQS [2] [3] inland surface waters, µg/l	Environmental quality standard AA-EQS [2] [3] other surface waters, µg/l	Environmental quality standard AA-EQS [2] [3] surface waters for household use, µg/l
1.	Chlorobenzene	108-90-7	9.3	3.2	3
2.	1,2-Dichlorobenzene	95-50-1	7.4	0.74	0.3
3.	1,4-Dichlorobenzene	106-46-7	20	2	0.1
4.	Benz-butyl phthalate (BBP)[2]	85-68-7	10	1.4	10
6.	Resorcinol (1,3-Benzenendiol)	108-46-3			
7.	(Benzothiazol-2-ylthio)methyl thiocyanate (TCMTB)	21564-17-0			
8.	Degradation product of bentzothiazol-2-thiol (di(benzothiazol-2- yl) disulphide (CAS 120-78-5)	149-30-4			
9.	Bronopol (2-bromo-2-nitropropane-1,3-diol)	52-51-7	4	0,4	4
10.	Dimethoate	60-51-5	0.7	0.07	
11.	MCPA (4-Cloro-2-methylphenoxy)acetic acid	94-74-6	1.6	0.16	

12.	Metamitron (4-Amino-3-methyl-6-phenyl-1,2,4-triarzin-5-one)	41394-05-2	32	3.2	
13.	Prochloratz (N-propyl-N-[2-(2,4,6-trichlorophenoxy)ethyl]-1H-imidazole-1-carboxamide)	67747-09-5	1	0.1	
14.	Ethylene thiourea (degradation product of mancozeb (CAS 8018-01-7)	96-45-7	200	20	
15.	Tribenuron methyl (Methyl-2-(3-(4-metoxy- 6-methyl-1,3,5-triazin-2-yl) 3-methylureidosulphonyl) benzoate)	101200-48-0	0.1	0.01	

[1] CAS: Chemical Abstracts Service.

[2] This parameter is an environmental quality standard, expressed as an arithmetic annual average (AA-EQS). It refers the sum of all isomers' concentrations if not otherwise regulated. The average is calculated as an arithmetic average of the results measured at each representative monitoring site during one year.

[3] The environmental quality standards (EQSs) are expressed as total concentrations in the whole water sample.

APPENDIX 18: Calculation models for coefficient *b* in different process types

Following factors were assumed and taken into consideration in the calculation of the coefficients:

- the coefficient of BOD and nitrogen in the phosphorus removal process is 0 for all factors
- the nitrogen coefficient of primary sedimentation is 0 in all cases
- the mutual dependency of organic substance and solids in sludge formation is taken into consideration
- calculated shares are estimated by the accuracy of 0.1
- nitrogen's presence reduces the phosphorus share to insignificance in some parameters (energy and maintenance spare parts)
- BOD has a small share in nitrification process due to the precipitation chemical, in other nitrogen removal processes this has not been taken into consideration

REMOVAL OF BOD AND PHOSPHORUS

INVESTMENTS (write-offs)

Unit process	Division of the investment costs in unit processes into different parameters					Share of the process phase in total investments	Division of the investment costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Primary sedimentation	0.3		0.2	0.5	1.0	0.10	0.031	0.000	0.021	0.052
Aeration	0.6		0.1	0.3	1.0	0.38	0.226	0.000	0.038	0.113
Secondary sedimentation	0.4		0.2	0.4	1.0	0.19	0.077	0.000	0.038	0.077
Post-filtration					0.0	0.00	0.000	0.000	0.000	0.000
Sludge treatment	0.3		0.1	0.6	1.0	0.33	0.098	0.000	0.033	0.196
							0.432	0.000	0.130	0.438

OPERATIONAL COSTS

	Division of the operational cost type into different parameters					Share of the cost type in operational costs	Division of the operational costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Chemicals	0.1		0.6	0.3	1.0	0.08	0.008	0.000	0.045	0.023
Energy	0.6		0.1	0.3	1.0	0.09	0.057	0.000	0.009	0.028
Maintenance spare parts	0.3		0.1	0.6	1.0	0.06	0.019	0.000	0.006	0.038
Human resources	0.4		0.2	0.4	1.0	0.19	0.075	0.000	0.038	0.075
Maintenance and monitoring services	0.3		0.2	0.5	1.0	0.13	0.038	0.000	0.025	0.063
Sludge upgrading services	0.3		0.1	0.6	1.0	0.45	0.136	0.000	0.045	0.272
							0.332	0.000	0.169	0.499

			Share in total costs
Write-offs	1134	€ t/a	0.59
Operational costs	795	€ t/a	0.41
Total	1929	€ t/a	

COEFFICIENTS	BOD	N	P	SS
Investment cost by components	0.432	0.000	0.130	0.438
Write-offs/total cost	0.59	0.59	0.59	0.59
Operational cost by components	0.332	0	0.169	0.499
Operational cost / total cost	0.41	0.41	0.41	0.41
COEFFICIENT	0.39	0.00	0.15	0.46

APPENDIX 18

NITRIFICATION PROCESS

INVESTMENTS (write-offs)

Unit process	Division of the investment costs in unit processes into different parameters					Share of the process phase in total investments	Division of the investment costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Primary sedimentation	0.3		0.2	0.5	1.0	0.09	0.026	0.000	0.018	0.044
Aeration	0.2	0.5		0.3	1.0	0.44	0.087	0.219	0.000	0.131
Secondary sedimentation	0.2	0.3	0.1	0.4	1.0	0.18	0.036	0.054	0.018	0.072
Post-filtration					0.0	0.00	0.000	0.000	0.000	0.000
Sludge treatment	0.2		0.1	0.7	1.0	0.29	0.059	0.000	0.029	0.206
							0.209	0.273	0.065	0.453

OPERATIONAL COSTS

	Division of the operational cost type into different parameters					Share of the cost type in operational costs	Division of the operational costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Chemicals	0.1	0.4	0.3	0.2	1.0	0.17	0.017	0.070	0.052	0.035
Energy	0.4	0.5		0.1	1.0	0.11	0.044	0.056	0.000	0.011
Maintenance spare parts	0.2	0.3		0.5	1.0	0.06	0.012	0.017	0.000	0.029
Human resources	0.3	0.3	0.1	0.3	1.0	0.14	0.043	0.043	0.014	0.043
Maintenance and monitoring services	0.2	0.3	0.1	0.4	1.0	0.10	0.019	0.029	0.010	0.039
Sludge upgrading services	0.3		0.1	0.6	1.0	0.42	0.125	0.000	0.042	0.249
							0.261	0.215	0.118	0.406

			Share in total costs
Write-offs	1321	€ t/a	0.56
Operational costs	1035	€ t/a	0.44
Total	2356	€ t/a	

COEFFICIENTS	BOD	N	P	SS
Investment cost by components	0.209	0.273	0.065	0.453
Write-offs/total cost	0.56	0.56	0.56	0.56
Operational cost by components	0.261	0.215	0.118	0.406
Operational cost / total cost	0.44	0.44	0.44	0.44
COEFFICIENT	0.23	0.25	0.09	0.43

APPENDIX 18

NITROGEN REMOVAL 70 %

INVESTMENTS (write-offs)

Unit process	Division of the investment costs in unit processes into different parameters					Share of the process phase in total investments	Division of the investment costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Primary sedimentation	0.3		0.2	0.5	1.0	0.09	0.026	0.000	0.018	0.044
Aeration	0.2	0.5		0.3	1.0	0.44	0.088	0.221	0.000	0.132
Secondary sedimentation	0.2	0.3	0.1	0.4	1.0	0.18	0.036	0.054	0.018	0.072
Post-filtration					0.0	0.00	0.000	0.000	0.000	0.000
Sludge treatment	0.2		0.1	0.7	1.0	0.29	0.058	0.000	0.029	0.204
							0.209	0.275	0.065	0.452

OPERATIONAL COSTS

	Division of the operational cost type into different parameters					Share of the cost type in operational costs	Division of the operational costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Chemicals		0.5	0.3	0.2	1.0	0.13	0.000	0.065	0.039	0.026
Energy	0.4	0.6		0.1	1.0	0.11	0.032	0.065	0.000	0.011
Maintenance spare parts	0.2	0.3		0.5	1.0	0.06	0.013	0.019	0.000	0.032
Human resources	0.3	0.3	0.1	0.3	1.0	0.16	0.048	0.048	0.016	0.048
Maintenance and monitoring services	0.2	0.3	0.1	0.4	1.0	0.11	0.022	0.032	0.011	0.043
Sludge upgrading services	0.3		0.1	0.6	1.0	0.43	0.129	0.000	0.043	0.258
							0.244	0.229	0.109	0.418

			Share in total costs
Write-offs	1412	€ t/a	0.60
Operational costs	930	€ t/a	0.40
Total	2342	€ t/a	

COEFFICIENTS	BOD	N	P	SS
Investment cost by components	0.209	0.275	0.065	0.452
Write-offs/total cost	0.60	0.60	0.60	0.60
Operational cost by components	0.244	0.229	0.109	0.418
Operational cost / total cost	0.40	0.40	0.40	0.40
COEFFICIENT	0.22	0.26	0.08	0.44

NITROGEN REMOVAL 70 % (METHANOL DOSAGE)

INVESTMENTS (write-offs)

Unit process	Division of the investment costs in unit processes into different parameters					Share of the process phase in total investments	Division of the investment costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Primary sedimentation	0.3		0.2	0.5	1.0	0.06	0.019	0.000	0.013	0.032
Aeration	0.2	0.5		0.3	1.0	0.34	0.068	0.170	0.000	0.102
Secondary sedimentation	0.2	0.3	0.1	0.4	1.0	0.13	0.026	0.039	0.013	0.053
Post-filtration		0.8	0.1	0.1	1.0	0.25	0.000	0.197	0.025	0.025
Sludge treatment	0.2		0.1	0.7	1.0	0.22	0.044	0.000	0.022	0.153
							0.157	0.407	0.072	0.364

OPERATIONAL COSTS

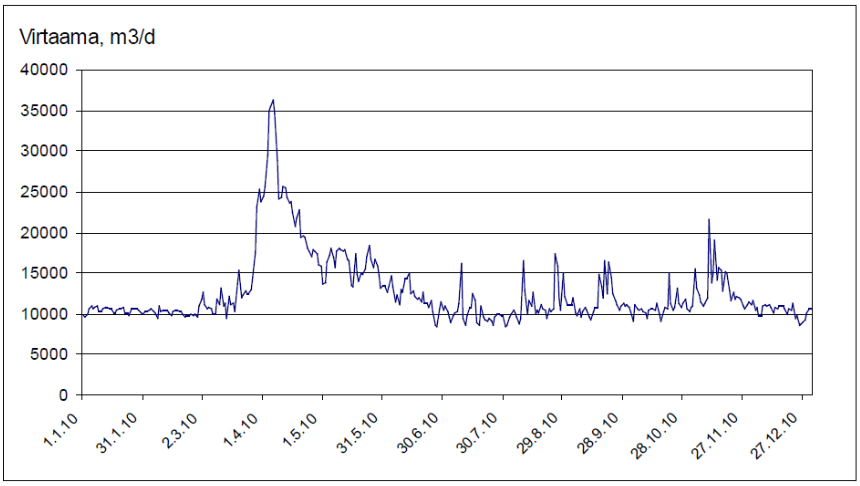
	Division of the operational cost type into different parameters					Share of the cost type in operational costs	Division of the operational costs into different parameters			
	BOD	N	P	SS	Sum		BOD	N	P	SS
Chemicals		0.6	0.2	0.2	1.0	0.15	0.000	0.090	0.030	0.030
Energy	0.4	0.6		0.1	1.0	0.11	0.033	0.066	0.000	0.011
Maintenance spare parts	0.2	0.3		0.5	1.0	0.07	0.014	0.021	0.000	0.035
Human resources	0.3	0.3	0.1	0.3	1.0	0.15	0.045	0.045	0.015	0.045
Maintenance and monitoring services	0.2	0.3	0.1	0.4	1.0	0.11	0.022	0.033	0.011	0.044
Sludge upgrading services	0.3		0.1	0.6	1.0	0.41	0.123	0.000	0.041	0.246
							0.237	0.255	0.097	0.411

			Share in total costs
Write-offs	1816	€ t/a	0.64
Operational costs	1000	€ t/a	0.36
Total	2816	€ t/a	

COEFFICIENTS	BOD	N	P	SS
Investment cost by components	0.157	0.407	0.072	0.364
Write-offs/total cost	0.64	0.64	0.64	0.64
Operational cost by components	0.237	0.255	0.097	0.411
Operational cost / total cost	0.36	0.36	0.36	0.36
COEFFICIENT	0.19	0.35	0.08	0.38

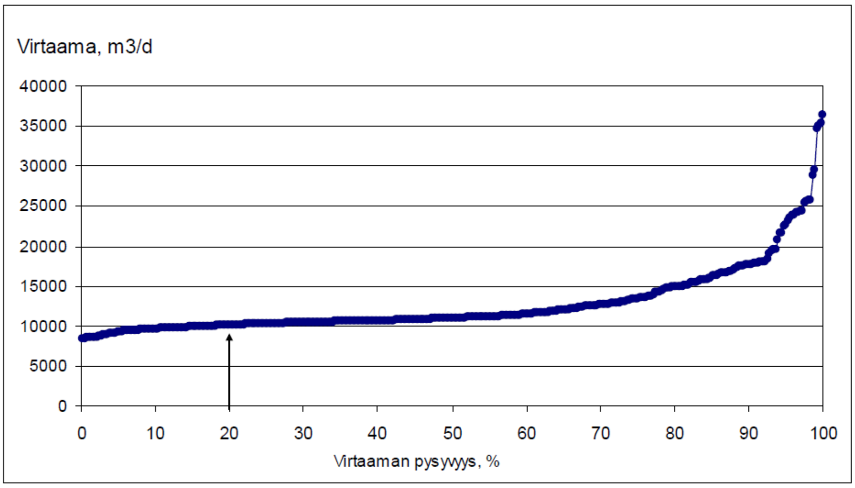
APPENDIX 19: Calculation of a reference concentration with the duration curve

A dry-period concentration defined computationally shall be used as a reference concentration, in which case the effect of runoff caused by rainfall can be eliminated. A dry-period concentration can be determined based on the influent load at the treatment plant, the industrial loading and the duration curve of the discharge. The annual discharge of the treatment plant is presented in Picture 1.



Picture 1. Influent flow rate (“Virtaama”, m^3/d) to the treatment plant

By arranging the daily discharges in ascending order, the dry-period discharge can be determined with a duration curve. Picture 2 presents the duration curve of the treatment plant’s discharge. According to the results, 20% of the time the discharge is smaller than 10 133 m^3/d. The minimum discharge of the treatment plant shall not be directly used as the starting point of the calculation because public holidays might show up as lower water consumption and therefore skew the calculation result.



Picture 2. Duration curve (“Virtaaman pysyvyys”, %) of the treatment plant’s influent flow rate (“Virtaama”, m^3/d)

The annual summary of the influent’s loading information (kg/d), which the treatment plant is obliged to draw up from its monitoring operations, is used as source data. The industry’s influence on the influent concentration can be significant. In this case, when calculating the reference concentration, attention should be paid to the industrial loading (kg/d) and the respective industrial wastewater discharge (m^3/d) determined by industrial wastewater monitoring.

Loading of domestic wastewater (kg/d)
= Influent at the treatment plant (kg/d) – Industrial loading (kg/d)

Domestic wastewater discharge (m^3/d)
= Dry-period discharge of the treatment plant (m^3/d) – Industrial discharge (m^3/d)

The reference concentration is calculated by dividing the loading of domestic wastewater with domestic wastewater discharge.

Concentration (mg/l)
= Loading of domestic wastewater (kg/d) / domestic wastewater discharge (m^3/d) x 1000

Table 1 presents the computational reference concentrations based on the calculation of the discharge duration curve presented above. According to the example, the industrial share in the loading has been small and therefore, its influence has not been specifically taken into consideration.

Table 1. Calculation of the reference concentration

From annual summary		Reference concentrations
BOD	2945 kg/d	291 mg/l
Solids	3534 kg/d	349 mg/l
Nitrogen	520 kg/d	51 mg/l
Phosphorus	98 kg/d	9.7 mg/l

Discharge 10133 m^3/d

APPENDIX 20: Parties and persons who commented on the original guide and participated in the workshop on the increased wastewater fee

Parties and persons who commented on the original guide:

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Annamari Enström	FCG
Tapani Eskola	Kymi Water Ltd
Eeva Heiska	City of Oulainen
Pekka Huttula	Finnish Petroleum Federation
Kari Kaasalainen	KUVES
Satu Kaivonen	Sanoma Oy
Ari Kangas	Regional State Administrative Agency (AVI) for Southern Finland
Airi Karvonen	Ministry of the Environment
Pertti Keskitalo	Ramboll Finland Oy
Riitta Kettunen	Ramboll Finland Oy
Marja Koljonen	BSAG
Reijo Kuivamäki	Pöyry Finland Oy
Inkeri Kuningas	MetropoliLab Oy
Juha Lahtela	Environmental Centre, City of Helsinki
Jukka Lammentausta	Water Protection Association of the River Kokemäenjoki (KVVY)
Jyrki Lammila	Centre for Economic Development, Transport and the Environment for Southwest Finland (ELY)
Eija Lehtinen	Helsinki Region Environmental Authority Services HSY
Seela Petra Lehtonen	The Graphic Arts Workshop IIKKA at WeeGee
Mirva Levomäki	Water Protection Association of Southwest Finland
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Johanna Ritari	SVSY
Kirsi Rontu	The Association of Finnish Local and Regional Authorities
Satu Räsänen	Confederation of Finnish Industries (EK)
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Heikki Sandelin	Tampere Water
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Olli Valo	Centre for Economic Development, Transport and the Environment for Häme (ELY)
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Anne Åkerberg	The Water and Environment Association of River Kymi

Persons who participated in the workshop on the increased wastewater fee:

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