Category		Title
NFR:	**5.D** **5.D.1** **5.D.2** **5.D.3**	**Wastewater handling** **Domestic wastewater handling** **Industrial wastewater handling** **Other wastewater handling**
SNAP:	**091001** **091002** **091007**	**Waste water treatment in industry** **Waste water treatment in residential/commercial sectors** **Latrines**
ISIC:		
Version	**Guidebook 2016**	

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Contents

1 Overview

This chapter covers emissions from waste water handling. In most cases, this will be an insignificant source for air pollutants. However, in urban areas, non-methane volatile organic compounds (NMVOC) emissions from waste water treatment plants will be of local importance.

Activities considered within this sector are biological treatment plants and latrines (storage tanks of human excreta, located under naturally ventilated wooden shelters).

Biological treatment plants are only of minor importance for emissions into air, and the most important of these emissions are greenhouse gases (CO_2, CH_4 and N_2O). Air pollutants include NMVOC and NH_3; however the contribution to the total emissions is only minor and only of local importance.

Latrines are generally only a minor source of emissions (mainly NH_3); however, in Poland, the contribution of this activity to the total ammonia emissions is reported to be about 3 %.

2 Description of sources

2.1 Process description

This section describes the processes and emissions from biological treatment plants and latrines.

2.1.1 Biological treatment plants

The main type of wastewater treatment plants in the Netherlands are low-load biological treatment plants with aeration by point aerators. For dephosphatizing, the simultaneous process is mostly used. Denitrification generally occurs using anaerobic zones in the wastewater treatment basin.

2.1.2 Latrines

A latrine is a simple ‘dry’ toilet built outside the house, usually in a backyard. A storage tank under the latrine can be a hole dug in the ground, or a concrete reservoir. Capacity of the tank can vary between 1 m^3 and 2 m^3, depending on the family size. The time of storage can vary between a few months and ‘forever’. Tanks are emptied by cesspool emptiers or contents are deposited on an animal manure heap. From time to time chlorinated lime is used for latrines disinfection.

Nitrogen content in human excreta depends on the diet, health and physical activity of an individual. A moderately active person with a daily intake of about 300 g of carbohydrates, 100 g of fat and 100 g of proteins excretes about 16 g of nitrogen. Kidneys void 95 % of nitrogen and the residual 5 % is excreted mostly as N in faeces. A person on European diet voids 80 to 90 % of nitrogen as urea (Harper et al, 1983).

Ammonia emissions derive mainly from the decomposition of urea and uric acid. Excreted urea is hydrolysed to NH_3 through the action of microbial urea. The rate of this hydrolysis depends on temperature, pH, amount of urea present and water content. The hydrolysis increases pH of collected urine and faeces to about 9. The decomposition of protein in faeces is a slow process, but during storage, 40 to 70 % of total N is converted to the NH_4^+ form (European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), 1994).

Table 2-1 Daily excretion of nitrogen in normal urine (pH 6.0) (source: Harper et al., 1983)

Compound	Quantity [g]	N equivalent [g]
Nitrogen compounds (total)	25–35	10–14
Urea (50 % of solid compounds depends on diet)	25–30	10–12
Creatinine	1.4 (1–1.8)	0.5
Ammonia	0.7 (0.3–1)	0.4
Uric acid	0.7 (0.5–0.8)	0.2
N in other compounds (e.g. amino acids)		0.5

Nitrogen is emitted from latrines as NH_3 in a free evaporation process. Ammonia emission from latrines depends on quantity and form of nitrogen compounds in human excreta, as well as on weather conditions.

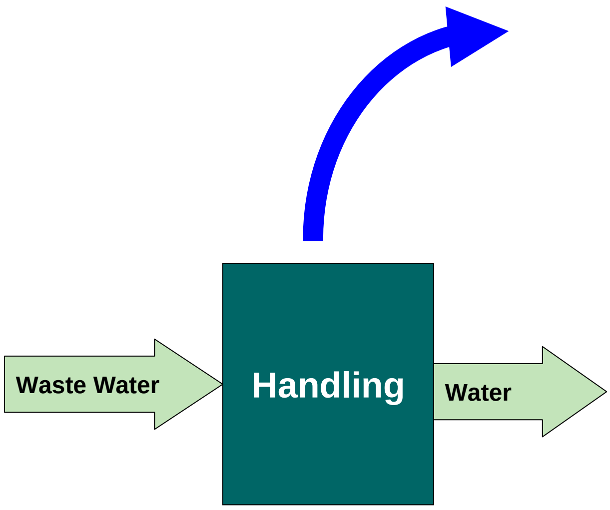

Figure 2-1 Process scheme for source category 5.D Waste water handling

2.2 Techniques

An overview is given in the process description. There are no specific techniques that are applicable here.

2.3 Emissions

In general, air emissions of persistent organic pollutants (POPs) as well as NMVOC, CO and NH_3 occur from waste water treatment plants, but are mostly insignificant for national total emissions. However, NMVOC emissions from waste water treatment plants to air may in some cases be significant in urban areas and may even contribute significantly at a national level. More information about these is provided in Sree et al. (2000), Oskouie et al. (2008), Atasoy et al. (2004) and Escalasa et al. (2003).

Emissions from biological treatment plants are mainly greenhouse gases: carbon dioxide, methane and nitrous oxide. These emissions are not treated in this chapter; guidance on reporting greenhouse gas emissions is provided by the Intergovernmental Panel on Climate Change (IPCC) Guidelines. Small quantities of NH_3 and NMVOC are emitted as well.

Emissions from latrines are mainly NH_3 and also small quantities of CH_4.

2.4 Controls

Reduction of ammonia emissions from latrines is possible by the installation of water supply and sewage systems, which is particularly possible in towns.

3 Methods

This source is expected to be only of minor importance for emissions of air pollutants and little information is available on estimating emissions from waste water handling.

3.1 Choice of method

Figure 3-1 presents the procedure to select the methods for estimating emissions from waste water handling. The basic ideas behind this procedure are:

- if detailed information is available, use it;
- if the source category is a key category, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it is more easy to obtain the necessary input data for this approach than to collect facility-level data needed for a Tier 3 estimate;
- the alternative of applying a Tier 3 method, using detailed process modelling, is not explicitly included in this decision tree. However, detailed modelling will always be done at facility level and results of such modelling could be seen as ‘facility data’ in the decision tree.

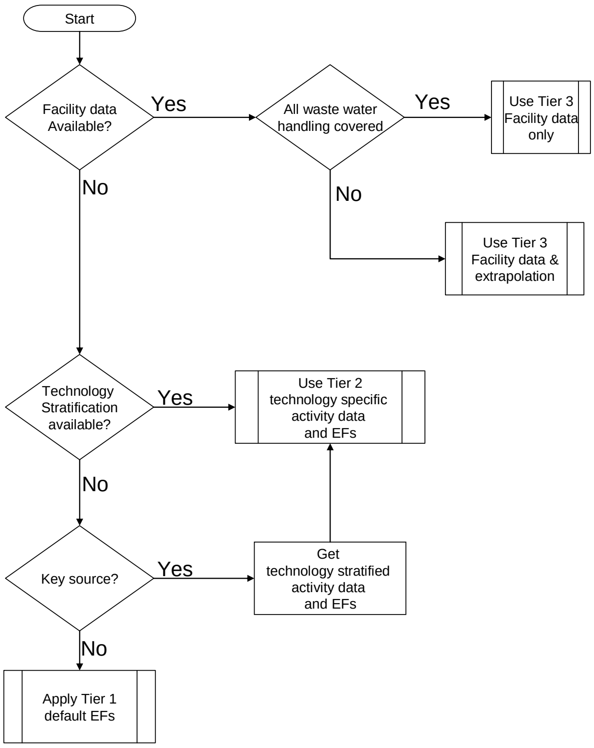

Figure 3-1 Decision tree for source category 5.D Waste water handling

3.2 Tier 1 default approach

3.2.1 Algorithm

The Tier 1 approach for emissions from waste water handling uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \quad (1)$$

This equation is applied at the national level. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different sub-processes in the handling of waste water.

3.2.2 Default emission factors

A default emission factor for NMVOC emissions from waste water handling has been derived from a Turkish study (Atasoy et al., 2004). This emission factor should be handled with care, since it may not be applicable to all waste water treatment plants. Furthermore, the emission factors reported in literature show a high variation. More specific information is available in the references indicated in subsection 2.3 of the present chapter. Emission factors for all other pollutants are not available and may be assumed negligible in most cases; therefore, this chapter does not report emission factors for these other pollutants.

For guidance on emissions from CH_4 and N_2O emissions from this source, refer to the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

Table 3-1 Tier 1 emission factors for source category 5.D Wastewater handling

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	5.D	Wastewater handling			
Fuel	NA				
Not applicable	NOx, CO, SOx, Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, PCP, SCCP				
Not estimated	NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	15	mg/m3 waste water handled	5	50	Atasoy et al. (2004)

3.2.3 Activity data

The relevant activity statistic for the Tier 1 approach is the total amount of waste water handled by all waste water treatment plants in the country.

3.3 Tier 2 technology-specific approach

3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach. To apply the Tier 2 approach, both the activity data and the emission factors need to be stratified according to the different techniques/processes that may occur in the country.

The approach followed to apply a Tier 2 approach is as follows:

Stratify the waste water handling in the country to model the different product and process types occurring in the national waste water handling ‘industry’ into the inventory by:

- defining the handling using each of the separate product and/or process types (together called ‘technologies’ in the formulae below) separately; and
- applying technology specific emission factors for each of these ‘technologies’:

$$E_{pollutant} = \sum_{technologies} AR_{handling,technology} \times EF_{technology,pollutant} \qquad (2)$$

where:

$AR_{handling,technology}$ = the waste water handling rate within the source category, using this specific ‘technology’,

$EF_{technology,pollutant}$ = the emission factor for this technology and this pollutant.

A country where only one technology is implemented will result in a penetration factor of 100 % and the algorithm reduces to:

$$E_{pollutant} = AR_{production} \times EF_{technology,pollutant} \quad (3)$$

where:

$E_{pollutant}$ = the emission of the specified pollutant,

$AR_{production}$ = the activity rate for the waste incineration,

$EF_{pollutant}$ = the emission factor for this pollutant.

The emission factors in this approach still will include all sub-processes within the waste incineration.

3.3.2 Technology-specific emission factors

This section presents emissions from waste water handling (the emission factor is identical to the emission factor used in the Tier 1 approach), but also considers separately NH_3 emissions from latrines.

3.3.2.1 Latrines

The emission factor for latrines has been determined from the similarity between latrines and open storage of animal manure in lagoons or ponds (Guidebook, 2006). Emission factors for CO_2, N_2O and CH_4 are not provided in this chapter. Information about these greenhouse gas emissions can be found in the 2006 IPCC Guidelines (IPCC, 2006).

Table 3-2 Tier 2 emission factors for source category 5.D Waste water handling, latrines

Tier 2 emission factors					
	Code	Name			
NFR Source Category	5.D.1	Domestic wastewater handling			
Fuel	NA				
SNAP (if applicable)	091007	Latrines			
Technologies/Practices					
Region or regional conditions					
Abatement technologies					
Not applicable	NOx, CO, SOx, Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, PCP, SCCP				
Not estimated	NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NH3	1.6	kg/person/year	0.8	3.2	Guidebook (2006)

3.3.2.2 Waste water handling

The default Tier 2 emission factor for NMVOC emissions from waste water handling is given in Table 3-3 below. The emission factor is equivalent to the emission factor used in the Tier 1 default approach.

Table 3-3 Tier 2 emission factors for source category 5.D Waste water handling, latrines

Tier 2 emission factors					
	Code	Name			
NFR Source Category	5.D.2	Industrial wastewater handling			
Fuel	NA				
SNAP (if applicable)	091001 091002	Waste water treatment in industry Waste water treatment in residential/commercial sectors			
Technologies/Practices	Waste water treatment plants				
Region or regional conditions					
Abatement technologies					
Not applicable	NOx, CO, SOx, Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, PCP, SCCP				
Not estimated	NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	15	mg/m3 waste water handled	5	50	Atasoy et al. (2004)

3.3.3 Abatement

Reduction efficiencies when abatement is in place are not available for this source category.

3.3.4 Activity data

It is assumed that tenants of urban flats and country houses with no water-flushed toilet have to use latrines outside the house. As it follows from Polish statistical data of 1992, 30 % of country houses and 4 % of urban flats had no water supply system, and 48 % of country houses and 14 % of urban flats had no water-flushed toilets. The number of people in an average family in town or countryside living together in the same home is needed for estimation of total number of latrine users. Based on that, it was estimated that about 10 million Polish inhabitants (approximately 25 % of the population) did not use water-flushed toilets. Changes of that total number during summer holidays are not accounted for.

For waste water handling, the relevant activity data is the total amount of waste water handled.

3.4 Tier 3 emission modelling and use of facility data

Not available for this source.

4 Data quality

4.1 Completeness

No specific issues.

4.2 Avoiding double counting with other sectors

No specific issues.

4.3 Verification

4.3.1 Best Available Technique emission factors

BAT emission factors are not available for this source. However, there is an extensive amount of information with regard to waste water treatment available in the Reference Document on Best Available Techniques in Common Waste Water and Waste Gas Treatment / Management Systems (European Commission, 2003).

4.4 Developing a consistent time series and recalculation

No specific issues.

4.5 Uncertainty assessment

No specific issues.

4.5.1 Emission factor uncertainties

No specific issues.

4.5.2 Activity data uncertainties

No specific issues.

4.6 Inventory quality assurance/quality control QA/QC

No specific issues.

4.7 Gridding

For latrines, it is good practice to disaggregate national totals on the basis of population, taking urban and rural differences in the number of latrines into account.

4.8 Reporting and documentation

No specific issues.

5 References

Atasoy et al. (2004). 'The estimation of NMVOC emissions from an urban-scale wastewater treatment plant', *Water Research*, Volume 38, pp. 3265–3274.

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European Commission (2003). Integrated Pollution Prevention and Control (IPPC). Reference Document on Best Available Technologies in Common Waste Water and Waste Gas Treatment / Management Systems, February 2003.

Guidebook (2006). European Monitoring and Evaluation Programme (EMEP)/Corinair Emission Inventory Guidebook, version 4 (2006 edition), published by the European Environmental Agency. Technical report No 11/2006. Available via http://reports.eea.europa.eu/EMEPCORINAIR4/en/page002.html.

Harper H.A., Rodwell V.W., Mayes P.A. (1983). Review of Physiological Chemistry, PZWL, Warszawa (Polish edition).

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Oskouie A.K., Lordi D.T., Granato T.C. and Kollia L. (2008). 'Plant-specific correlations to predict the total VOC emissions from wastewater treatment plants', *Atmospheric Environment*, in press, corrected proof. Available online 13.2.2008.

Sree U., Bauer H., Ellinger R., Schmidt H. and Puxbaum H. (2000). 'Hydrocarbon emissions from a municipal wastewater treatment pilot plant in Vienna', *Water, Air and Soil Pollution*, 124, pp. 177–186.

6 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's expert panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.