# DRAFT PAPER

# Calculating emissions from urban waste water treatment plants to surface waters

# This activity is carried out by the European Topic Centre for Inland, Coastal and Marine Waters (ETC/ICM) for the European Environment Agency (EEA) and is part of the Action Plan 2020: 1.5.2.3: Improving the reporting of emissions to water, Task 3. Gap-analysis for UWWTPs for less frequently monitored pollutants. This document has no legal status. The goal of the document is only to help EU Member States to improve the quantification of emissions within the existing legislation.

1. **Background**

Under the Water Framework Directive (WFD), according to Article 5 of the Directive 2008/105/EC on Environmental Quality Standards (amended 2013/39/EU) Member States (MS) are required to report an inventory of annual emissions, discharges and losses of priority substances. The inventories should give information on the relevance of priority substances at the spatial scale of the River Basin District (RBD) or the national part of an international RBD, and on the loads discharged to the aquatic environment. This give information on the success of measures to reduce emissions and indicate whether further efforts may be needed to deliver good chemical status of surface waters.

Pursuant to Article 5(6) of EQS Directive a “Technical Guidance Document” was prepared. This guidance document aims to help MS establish the inventory and to reduce the burden by focusing on substances that are relevant at the RBD level. Ensuring EU wide comparability of the results was another objective of the guidance. The guidance recommends a two-step analysis to assess in the first step the current relevance (applying the described three imission and two emission criteria) of each substance (EQS Directive, Annex I, Part A) at the RBD level. The aim is to identify those substances which are of high relevance to concentrate the efforts to those substances. In the second step, for the substances of high relevance a more detailed analysis using a tiered approach should be performed (EU 2012). Different approaches are described. They vary in complexity in order to account for the wide range of data sources available across MS. The level (tier) with lowest complexity and informational value about true sources is based on ‘Point source information’. To quantify point source emissions data on point sources accordingly emissions factors should be used (EU 2012).

Results of the first reporting exercises (2nd River Basin Management Plan (RBMP) cycle) show main problems according to consistency, completeness and quality of reported emission data. The first inventory was incomparable between MS. For most substances, MS did not report point source emissions. Reasons might be that:

* substances were identified as not relevant or even only of minor relevance at RBD level. In that case, according to the recommendations of the guidance, only river loads at the RBD level are required,
* there is still a lack of reliable point source data emission factors.

Point sources such as urban wastewater treatment plants (UWWTPs) and industrial dischargers can be important sources for emissions to water. In particular, the urban waste water system collects a variety of pollutants coming from many different sources in urban areas (households (domestic chemicals, pharmaceuticals…), traffic (e.g. combustion processes), facade coatings (wall paint) etc.). For quantifying feasible input loads, reliable monitoring data are needed. Even if some pollutants are frequently monitored and well-reported for UWWTPs, there still is a lack of data and information for a lot of pollutants. Main reasons are:

* most pollutants are not included in national routine monitoring programs,
* often very low environmental concentrations and low concentrations in waste water (effluent),
* the need for sensitive analytical methods: low limits of detection (LoD) and quantification (LoQ).

1. **Aims and Objectives**

The main objective of this document is to provide recent information on substance emissions from UWWTPs. The aim is to support MS with monitoring information for quantifying at least UWWTP effluent emissions for selected relevant substances. Such information can be difficult to obtain. In earlier studies, gap-filling focused on more frequently monitored pollutants e.g. nutrients, metals and DEHP (Roovaart and Duijnhoven 2018). These calculations were based on information reported under E-PRTR - even so, these pollutants (metals and DEHP) seem to be underreported in E-PRTR. Most of less frequently monitored pollutants are nevertheless important as they can cause water quality problems (like PAHs, PFCs or different pesticides).

This document provides recent information on both frequently monitored and on less frequently monitored substances in UWWTP effluents. Based on a literature check, recommendations on mean UWWTP effluent concentrations and available emission factors are given. Using these mean concentrations or emission factors for selected substance loads from UWWTPs to surface waters can be quantified.

According to the availability of information for calculating UWWTP effluent loads two different approaches can be applied assuming that the applied mean pollutant concentration represents the mean situation in a MS or a River Basin District (RBD). Examples are given below:

1. If information about annual treated waste water flows are available mean (median) concentration values can be applied directly for each UWWTP using the following equation (Equation 1):

Equation 1

LUWWTP(X) = Cpollutant(Y) x Feffluent-UWWTP(X)

with:

LUWWTP(x) – annual load of individual UWWTP (kg/year)

Cpollutant(Y) – mean (median) pollutant concentration (µg/l)

Feffluent-UWWTP(X) – annual (mean) UWWTD effluent flow (m³/year)

**Example UWWTP(X):**

Feffluent-UWWTP(X) = 37,896,680 m3/year

Cpollutant(Y) = 0.0016 µg/l

LUWWTP(X),pollutant(Y) = 0.061 kg/year

Under UWWTD the mean annual volume of waste water treated should be reported at least for all UWWTPs with a design capacity more than 100,000 p.e. (potentially reportable in E-PRTR).

1. If information about amount (number) of treated p.e. is available e.g. mean national or mean EU emission factors (mg/p.e./year) can be used to calculate annual UWWTP effluent loads. Under the Urban Waste Water Directive[[1]](#footnote-1) Member States have a biennial obligation to report amongst others on UWWTPs. Information about all UWWTPs serving 'agglomerations[[2]](#footnote-2)' > 2,000 p.e.[[3]](#footnote-3) generated load needs to be reported. Required information is e.g. UWWTP capacity, treated nominal load in p.e. for each UWWTP and UWWTP location. Using this information loads can be calculated for all UWWTPs both on country level or RBD level (equation 2).

Equation 2

LUWWTP(X) = EFpollutant(Y) x TWUWWTP(X)

with:

LUWWTP(x) – annual load of individual UWWTP (kg/year)

EFpollutant(Y) – mean (national) emission factor (mg/p.e./year)

TWUWWTP(X) – annually treated amount of wastewater (p.e./year)

**Example UWWTP(X):**

TWUWWTP(X) = 100,000 p.e./year

EFpollutant(Y) = 1.6 mg/p.e./year

LUWWTP(X),pollutant(Y) = 0.16 kg/year

1. **Results of literature check**

Related to the EQS-Directive substances[[4]](#footnote-4), several monitoring campaigns for different countries with varying number of UWWTPs were found. Results of the literature check on monitoring information identified different groups of pollutants.

1. Several substances were measured in a number of monitoring programs/studies. Most studies found this group of substances in a large number of samples with varying mean/median concentrations (Table 1 and Annex 1).

Table 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number[[5]](#footnote-5) | CAS-number | Parameter | Number | CAS-number | Parameter |
| (20) | 7439-92-1 | Lead | (19) | 34123-59-6 | Isoproturon |
| (6) | 7440-43-9 | Cadmium | (45) | 886-50-0 | Terbutryn |
| (23) | 7440-02-0 | Nickel | (25) | 140-66-9 | 4-tert.-Octylphenol |
| (21) | 439-97-6 | Mercury | (28) | 50-32-8 | Benzo[a]pyrene |
| (24) | - | 4-iso Nonylphenols | 205-99-2 | Benzo[b]fluoranthene |
| (12) | 117-81-7 | DEHP | 191-24-2 | Benzo[g,h,i]perylene |
| (35) | 1763-23-1 | PFOS | 193-39-5 | Indeno[1,2,3-cd]-pyrene |
| (15) | 206-44-0 | Fluoranthene | (22) | 91-20-3 | Naphthalene |
| (13) | 330-54-1 | Diuron |  |  |  |

For some substances monitoring results vary significantly between different studies and Member States. In some studies, some substances can be found in UWWTP effluents quite often while in other studies they cannot be found with values > LoQ. Reasons might be:

* emissions are caused by regional or even local conditions/emission situations,
* special selection of UWWTPs,
* differing monitoring strategies (according to sampling procedures e.g. frequency, timeframe (short-term or long-term samples)) and preparation of samples) and
* differing analytical methods applied e.g. regarding sensitivity (LOD/LOQ) or analyzing of dissolved or total concentration.

Unfortunately, not all this information is available for all studies.

For these substances it will be tested to see if reliable mean concentrations can be derived.

Two MS (NL and DE) derived mean emission factors for several substances (see Annex 1). For German UWWTPs, emission factors were calculated only if more than 50 % of measured values were above LoQ. For the Netherlands, a method is used in which the number of observations lower than the LoQ is expressed as a percentage of the total number of observations. The larger this percentage, the lower the LoQ value is valued.

1. Some substances, especially some of the new substances of the EQS-Directive, were measured in different monitoring programs/studies but could not or at least only with a few values be found with concentrations > LoQ in UWWTP effluents in all studies (Table 2, and Annex 1). For these substances UWWTP effluent does not seem to be a relevant pathway for emissions to surface waters. Therefore, no mean concentrations or emission factors have been derived for these substances.

For some of these substances (shown in **bold** inTable 2), analytical methods might still not be sensitive enough to assess the relevance of UWWTP effluent as pathway for emissions to surface waters. Analytical LoQs are > than EQS values (Annex 1).

Table 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number[[6]](#footnote-6) | CAS-number | Parameter | Number | CAS-number | Parameter |
| (28) | 207-08-9 | Benzo[k]fluoranthene | (34) | 115-32-2 | **Dicofol** |
| (2) | 120-12-7 | Anthracene | (41) | 52315-07-8 | **Cypermethrin** |
| (3) | 1912-24-9 | Atrazine | (44) | 1024-57-3 | **cis-Heptachlorepoxide and trans-Heptachlorepoxide** |
| (43) | - | **HBCDD** | (38) | 74070-46-5 | Aclonifen |
| (40) | 28159-98-0 | **Cybutryne** | (39) | 42576-02-3 | Bifenox |
| (44) | 76-44-8 | **Heptachlor** | (36) | 124495-18-7 | Quinoxyfen |
| (42) | 62-73-7 | **Dichlorvos** |  |  |  |

1. For some substances only very few monitoring information were found (Table 3 and Annex 1). Reasons might be the following:

* In different MS some substances were identified as not relevant or even to be of minor relevance at RBD level. Reasons might be the ban on production and application. In that case according to the recommendations of the guidance detailed analyses are not required.
* For some substances UWWTP effluent is not a relevant pathway because of their specific use and application e.g. pesticides like DDT, which was mainly used in agricultural sector.

Table 3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number[[7]](#footnote-7) | CAS-number | Parameter | Number | CAS-number | Parameter |
| (1) | 15972-60-8 | Alachlor | (16) | 118-74-1 | Hexachlorobenzene |
| (4) | 71-43-2 | Benzene | (17) | 87-68-3 | Hexachlorobutadiene |
| (5) | 32534-81-9 | BDE | (18) | 608-73-1 | Hexachlorocyclohexane |
| (6a) | 56-23-5 | Carbo-tetrachloride | (26) | 608-93-5 | Pentachlorobenzene |
| (7) | 85535-84-8 | C10-C13 Chloralkanes | (27) | 87-86-5 | Pentachlorophenol |
| (8) | 470-90-6 | Chlorfenvinphos | (29) | 122-34-9 | Simazine |
| (9) | 2921-88-2 | Chlorpyrifos | (29a) | 127-18-4 | Tetrachloroethylene |
| (9a) | 309-00-2, 60-57-1, 72-20-8, 465-73-6 | Cyclodiene pesticides | (29b) | 79-01-6 | Trichloroethylene |
| (9b) | - | DDT total | (30) | 36643-28-4 | Tributyltin compounds |
| 50-29-3 | para-para-DDT | (31) | 12002-48-1 | Trichlorobenzenes |
| (10) | 107-06-2 | 1,2-Dichloroethane | (32) | 67-66-3 | Trichloromethane |
| (11) | 75-09-2 | Dichloromethane | (33) | 1582-09-8 | Trifluraline |
| (14) | | 115-29-7 | Endosulfan |  |  |  |

For these substances mean concentrations have not been derived.

**Question 1**

**Can you provide further information/data/results from monitoring campaigns?**

* **Measured mean and median effluent concentrations including information about**
  + **Number of UWWTPs**
  + **Analytical methods**
    - **LoQ/LoD**
    - **Total or dissolved concentration**
  + **Number of samples below LoQ/LoD**
  + **…**
* **Emission factors including information about methodology used**

1. **Recommendations for mean effluent concentrations and emission factors for load calculation**

**4.1) Mean effluent concentrations**

In some cases, mean concentrations differ quite a lot between different monitoring studies (see Annex 1). Reasons might be:

* a specific national or local emission situation;
* differences in applied sampling strategies;
* differences in applied analytical methods, especially concerning sensitivity (LoQ) etc.

First, it needs to be considered that statistical values of monitoring studies listed refer to the whole group of investigated UWWTPs in each study. Further information about UWWTPs (meta data like size or treatment type) were not available for all studies. Therefore, based on the available information further differentiation e.g. for treatment types was not possible.

Bearing this in mind calculated UWWTP effluent loads using the mean concentrations derived from all these different studies should only be seen as a first approximation. Regional peculiarities or even special situations for single UWWTPs (regarding e.g. treatment type, sewage composition) can not be considered. Nevertheless, in case no other data is available the loads calculated using the derived mean concentrations should provide an indication of the relevance of UWWTPs as emission pathway to surface waters.

To derive mean concentration supporting MS the following predefinitions are recommended:

* For statistical reasons the median concentration values from the studies instead of mean concentration values should be used.
* More than two median values need to be available.
* Only studies not older than 2010 should be considered because both substance application and (average) UWWTP treatment efficiency changes over time.
* If measured median concentration is < LoQ the value ½ LoQ should be used.

An example how to proceed deriving a mean concentration is given in the following Table 4.

Table 4: Example on deriving a mean UWWTP effluent concentration for lead

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Median (µg/l) concentration | Reference | Comment |
| **Lead, and its compounds** | 0.14 | Toshovski et al. (still unpublished); 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) |  |
| 0.2 | Engelmann et al. (2016); 91 UWWTP, 2001-2010, DE, Saxony |  |
| ~~1.1~~ | ~~Clara et al. (2009); LoQ 1.4 µg/l, LoD 0.7 µg/l~~ | deleted because study is older than 2010 |
| 1.2 | Clara et al. (2012); 9 UWWTP, 1 year, AT |  |
|  | ~~Clara et al. (2017); 8 UWWTP, AT (LoQ 0.5µg/l; 22 out of 32 values < LoQ)~~ | Deleted because no median value available – ask colleagues from AT to provide median values |
| 0.64 | Data base NL; 25 UWWTP, 2015-2018 |  |
| 0.62 | Gardner and Jones (2018); 600 UWWTP, 2015-2017, UK |  |
| 0.86 | Gardner et al. (2014); 162 UWWTP, 2010-2013, UK |  |
| **Result mean concentration lead (µg/l)** | **0.61** | | Range1): 0.14 – 1.2 µg/l; 6 different studies, 4 MS |

1) Range of median values of different single studies

Using the described criteria mean UWWTP effluent concentrations have been derived for the following substances:

* Lead, Cadmium, Nickel, Mercury, Nonylphenols, DEHP, PFOS, Fluoranthene, Diuron, Isoproturone and Terbutryne (Table 5).

Table 5. Derived mean (median) concentrations for UWWTP effluents

|  |  |  |
| --- | --- | --- |
| Parameter | Mean (median) concentration (µg/l) | Comment |
| Lead | 0.61 | Range1): 0.14 – 1.2 µg/l; 6 different studies, 4 MS |
| Cadmium | 0.0216 | Range1): 0.006 – 0.05 µg/l; 5 different studies, 4 MS |
| Nickel | 4.19 | Rang1)e: 3.8 – 4.8 µg/l; 5 different studies, 4 MS |
| Mercury | 0.00434 | Rang1)e: 0.0007 – 0.01 µg/l; 5 different studies, 4 MS |
| 4-iso-Nonylphenols | 0.113 | Range1): 0.01 – 0.2 µg/l; 6 different studies, 4 MS |
| DEHP | 0.66 | Range1): 0.24 – 1.7 µg/l; 6 different studies, 4 MS |
| PFOS | 0.00575 | Range1): 0.003 – 0.122 µg/l; 4 different studies (one European wide) |
| Fluoranthene, | 0.00478 | Range1): 0.0021 – 0.01 µg/l; 5 different studies, 3 MS |
| Diuron | 0.0191 | Range1): 0.004 – 0.059 µg/l; 6 different studies (one European wide) |
| Isoproturone | 0.0186 | Rang1)e: 0.0004 – 0.056 6 different studies (one European wide) |
| Terbutryne | 0.021 | Range1): 0.005 – 0.035 3 different studies, 2 MS |

1) Range of median values of different single studies

**4.2) Emission factors**

The available emission factors are listed in Table 6. These factors refer to UWWTPs with secondary and tertiary levels of treatment. Both UWWTPs equipped with primary level treatment only and those with more advanced levels of treatment (e.g. targeted micropollutant elimination such as activated-carbon filter or ozonisation) are not represented in the listed studies. In most EU countries, the number of UWWTPs with treatment levels beyond tertiary is limited. On the other hand, urban waste water treatment has improved in all parts of Europe over the last 30-40 years (EEA 2020). In 2017, most European countries collected and treated sewage to tertiary level from most of their population. In EU-27 countries, 69 % of the population were connected to tertiary level treatment and 13 % to secondary level treatment (EEA 2020, not yet published). Nevertheless, in Roovaart and Duijnhoven (2018) emission factors for UWWTPs with only primary level treatment had been derived even if it is based on a very limited number of plants. That is why the results are less reliable.

The available emission factors also may differ quite a lot (Table 6 and Annex 1). Reasons might be:

* differences in used data base,
* differences in used method to derive the emission factor etc.

As described for the mean concentrations, calculated loads using mean emission factors can only be seen as a first approximation. Regional peculiarities or even special situations of single UWWTPs can´t be considered.

Table 6. Emission factors for UWWTP effluents (results from a literature study)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | Emission factor (µg per capita per day) | Emission factor (g per p.e. per year) | | | | |
| Italy (TT, ST), Castiglioni et al. 2015 | Germany (TT, ST)[[8]](#footnote-8), Toshovski et al 2020 (still unpublished) | Netherlands (TT, ST); national data base | | PRTR (EU)[[9]](#footnote-9) (differentiated by treatment type) | |
| TT | ST |
| **Lead** | - | 0.0116 | 0.018 | | 0.29 | |
| **Cadmium** | - | 0.0005 | 0.000521 |  | 0.07 | |
| **Nickel** | - | 0.365 | 0.284 |  | 0.47 | |
| **Mercury** | - | 0.0002 | 0.000255 |  | 0.01 | |
| **4-iso-Nonylphenols** | - | 0.0036 | - |  | - | |
| **DEHP** | - | 0.141 | - |  | 0.04 | 0.36 |
| **PFOS** | 1 – 8 | 0.0002 | - |  | - | |
| **Fluoranthene,** | - | 0.0002 | - |  | - | |
| **Diuron** | - | 0.0013 | 0.0012 |  | - | |
| **Isoproturone** | - | 0.0016 | 0.0016 |  | - | |
| **Terbutryne** | - | 0.0029 | 0.000389 |  | - | |

TT – tertiary treatment; ST – secondary treatment

Depending on data availability and the specific situation the derived mean UWWTP effluent concentrations or the presented emission factors can be used to calculate UWWTP effluent pollutant loads emitted to surface waters as a first approximation on a national or a River Basin District level.

**Question 3**

**Do you agree with the recommendations (assumptions) made to derive mean UWWTP effluent concentrations:**

* **using median concentrations[[10]](#footnote-10) instead of mean concentrations (see Annex 1 and table 4),**
* **using studies not older than 2010 and**
* **using the value ½ LoQ if median concentration is < LoQ**

**or do you have any further suggestions to derive mean UWWTP effluent concentrations based on the results of literature study?**

1. **Summary**

Based on the results of a literature check for a small number of “priority substances”, recommendations for mean UWWTP effluent concentrations for calculating UWWTP effluent loads can be given.

For the remaining priority substances, mean concentrations have not been provided as for some there is insufficient information, while for others UWWTPs don´t seem to be a relevant pathway to surface waters.

To improve the work done, MS were kindly asked to provide further information/results of monitoring studies for UWWTPs. This updated version will be shared with the working group as a preparation of the **web-based meeting on September 9th**.

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**Annex 1**

Statistical values of EQS Directive substances frequently found in UWWTP effluents

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | Median (µg/l) | Mean (µg/l) | Min - Max (µg/l) | Emission factor (mg/p.e.) | Comment | Reference |
| **Category A substances (see chapter 3), page 5 in this document)** | | | | | | |
| **Lead, and its compounds**  (EQS: 1.2 µg/l (bioavailable fraction)) | 0.14 | 0.18 | 0.05 - 7 | 11.6 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
| 0.2 | 7.9 |  | - | 91 UWWTP, 2001-2010, DE, Saxony | Engelmann et al. (2016) |
| 1.1 | 1.2 | < LoQ – 3.7 | - | LoQ 1.4 µg/l, LoD 0.7 µg/l; total concentration | Clara et al. (2009) |
| 1.2 |  |  | - | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
|  | 0.069 – 0.38 | 0 – 0,5 | - | 8 UWWTP, AT (LoQ 0.5µg/l; 22 out of 32 values < LoQ); total concentration | Clara et al. (2017) |
| 0.64 | 1.118 | 0 - 27 | 18 | 25 UWWTP, 1990-2015, NL; total concentration | Data base NL) |
| 0.62 | 0.87 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.86 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Cadmium and its compounds**  (EQS: 0.08 – 0.25 µg/l) | 0.006 | 0.009 | < 0.001 (LoQ) - 1 | 0.5 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
| not found | | | | LoQ 0.1 – 0.5 µg/l; total concentration | Clara et al. (2009) |
|  | 0.00083 - 0.013 |  |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
| < 0.03 - 0.5 |  | n.n. - 24 |  | 91 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
| 0.010 | 0.094 |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
|  | 0.0056 – 0.028 | 0 – 0.05 |  | 8 UWWTP, AT (LoQ 0.05 µg/l; LoD 0.02 µg/l; all values <LoQ) ; total concentration | Clara et al. (2017) |
| < LoQ | 0.0297 | 0 – 0.56 | 0.521 | 25 UWWTP, 2015-2018, NL; LoQ 0.03 µg/l; total concentration | Data base NL |
| 0.027 | 0.044 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| < LoQ (0.1) |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Nickel and its compounds**  (EQS: 4 µg/l (bioavailable fraction)) | 4.4 | 4.786 | 0.5 - 18 | 365 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
| 4.5 | 8.1 | <LOD - 41 |  | LoQ 1 – 2.3 µg/l; total concentration | Clara et al. (2009) |
|  | 4.4 - 4,7 |  |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
| 4.3 |  | n.n. - 200 |  | 91 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
| 4.1 | 5.6 |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
|  | 7 – 8.2 | 0 - 30 |  | 8 UWWTP, AT (LoQ 4 µg/l; LoD 1 µg/l, 16 out of 36 values <LoQ); total concentration | Clara et al. (2017) |
| 3.8 | 6.304 | 0 – 57 | 284 | 25 UWWTP, 2015-2018, NL; total concentration | Data base NL |
| 3.85 | 4.9 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 4.8 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Mercury and its compounds**  (Biota EQS) | 0.002 | 0.006 | 0.0005 - 1.1 | 0.2 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
|  |  | n.n. - < LOD |  | LoQ 0.1 – 0.25 µg/l; total concentration | Clara et al. (2009) |
|  | 0.01 |  |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
|  | 0.019 | 0.0055 – 0.067 |  | 8 UWWTP, AT (LoQ 0.001 µg/l, LoD 0.0003 µg/l, all values (35) > LoQ); total concentration | Clara et al. (2017) |
| < 0.02 - 0.2 |  | n.n. - 0.5 |  | 91 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
| 0.01 |  |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
| < LoQ | 0.01075 | 0 – 0.12 | 0.255 | 32 UWWTP, 2015-2018, NL, LoQ 0.01 µg/l; total concentration | Data base NL |
| 0.004 | 0.0057 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.0007 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **4-iso-Nonylphenols**  (EQS: 0.3 µg/l) | 0.043 | 0.115 | 0.02 - 3.4 | 3.6 | 49 UWWTP, n=999, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
|  |  | < 0,03 - 7.8 |  | world wide Literature study | Luo et al. (2014) |
|  | 0.267 |  |  | 7 samples | Miropoll project (CH, in Loos et al. 2012) |
| 0.22 | 0.34 | n.n. – 1.8 |  | LoQ 0.09 µg/l; total concentration | Clara et al. (2009) |
| 0.18 | 0.25 |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
| 0.14 | 0.19 | 0.025 – 0.77 |  | 3 UWWTP, 2013, DE (Baden-Württemberg); total concentration | Lambert et al. 2014 |
| < LoQ | 0.0004651 | 0 – 0.02 |  | 11 UWWTP, 2015-2019, NL (found only in a few samples); LoQ 0.02 µg/l; total concentration | Data base NL |
|  | 0.364  0.37  0.285 |  |  | 3 UWWTP, AT; total concentration | Clara et al. (2005) |
| 0.105 | 0.15 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.2 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Di(2-ethylhexyl)-phthalate (DEHP)**  (EQS: 1.3 µg/l) | 1.7 | 3.12 | 0.05-12 | 141 | 49 UWWTP, n=999, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) ; total concentration | Toshovski et al. (still unpublished) |
|  | < 2 |  |  |  | Schütte et al. (2017) |
|  |  | 0.0001 - 54 |  | world wide, literature study | Luo et al. (2014) |
| < LoQ | 0.1474 | 0 – 3.2 |  | 17 UWWTP, 2015-2018, NL (found in only a few samples (10 out of 94)); LoQ 0.5 µg/l; total concentration | Data base NL |
| 0.24 | 0.32 | 0.05 – 2.3 |  | 3 UWWTP, 2013, DE (Baden-Württemberg) ; total concentration | Lambert et al. 2014 |
| 0.5 | 1.6 | <LOD – 6.6 |  | LoQ 0.12 -0.26 µg/l; total concentration | Clara et al. (2009) |
| 0.52 |  |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
| 0.45 | 0.76 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.78 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **PFOS**  (EQS: 00001.3 µg/l) | 0.003 | 0.008 | 0.0005 - 0.82 | 0.2 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) ; total concentration | Toshovski et al. (still unpublished) |
|  |  | 0.005 - 0.04 |  | 40 UWWTP, 2015-2016, DE (Baden-Württemberg) | Rau und Metzger (2017) |
|  | 0.007 |  |  |  | Maus et al. (2016) |
|  | 0.013 |  |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
|  | 0.015 | 0.0005 – 0.12 |  | 8 UWWTP, AT (LoQ 0.001 µg/l; LoD 0.0005 µg/l, 1 value out of 34 < LoQ); total concentration | Clara et al. (2017) |
|  |  |  | 1-8 µg per capita per day | 6 UWWTP, 2010-2013, IT | Castiglioni et al. (2015) |
|  |  | 0.016 – 0.303 |  | 7 UWWTD, CH | Huset et al. (2008) |
| 0.0122 | 0.0625 | 2.101 (max) |  | Summary of analytical results for chemicals in EU UWWTP effluents (91 UWWTP) | Loos et al. 2013 |
| < LoQ | 0.01926 | 0 – 0.43 |  | 40 UWWTP, 2015-2018, NL (found in 74 samples out of 220)), LoQ 0.005 µg/l; total concentration | Data base NL |
|  | 0.114 |  |  | 7 samples | Miropoll project (CH, in Loos et al. 2012) |
| 0.0053 | 0.062 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
|  |  | 0.0073 - 0.017  0.096 - 0.462 |  | 2 UWWTP, 2006 - 2007, Singapore | Yu et al. (2009) |
| **Fluoranthene**  (EQS: 0.0063 µg/l) | 0.0021 | 0.0037 | 0.0005 - 0.11 | 0.2 | 49 UWWTP, n=999, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) ; total concentration | Toshovski et al. (still unpublished) |
| not found | | | | LoQ 0.2 µg/l; total concentration | Clara et al. (2009) |
|  | 0.000071-0.0023 | 0 – 0.005 |  | 8 UWWTP, AT (LoQ 0.005 µg/l, LoD 0.0022 µg/l, all values < LoQ); total concentration | Clara et al. (2017) |
| < LoQ | 0.0005195 | 0 – 0.02 |  | 22 UWWTP, 2015 - 2018, NL (found in only a few samples (2 out of 77)), LoQ 0.005 µg/l; total concentration | Data base NL |
| 0.003 | 0.003 | 0.002 – 0.005 |  | 3 UWWTP, 2013, DE (Baden-Württemberg); total concentration | Lambert et al. 2014 |
| 0.01 | 0.013 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.0063 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Diuron**  (EQS: 0.2 µg/l) | 0.016 | 0.023 | 0.005 - 0.59 | 1.3 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) ; total concentration | Toshovski et al. (still unpublished) |
| 0.041 | 0.06 | n.n. – 0.21 |  | LoQ 0.0063 – 0.015 µg/l; total concentration | Clara et al. (2009) |
|  | 0.094 |  |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
|  | 0.32. |  |  | 30 UWWTP, 2011, Andalusia | Barco-Bonilla et al. (2013) |
|  |  | 0.002 - 2.53 |  | world wide, Literature study | Luo et al. (2014) |
| 0.014 |  | n.n. – 6.6 |  | 92 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
| 0.059 | 0.073 | 0.03 – 0.3 |  | 3 UWWTP, 2013, DE (Baden-Württemberg); total concentration | Lambert et al. 2014 |
|  | 0.127 |  |  | 3 UWWTP, 2007-2009, Catalonia | Köck-Schulmeyer et al. (2013) |
|  | 0.07±0.041 |  |  | 1 UWWTP, 2009 - 2010, CH | Margot et al. (2013) |
| 0.040 | 0.073 |  |  | 9 UWWTP, 1 Jahr, AT; total concentration | Clara et al. (2012) |
|  | 0.19±0.23 |  |  | 1 UWWTP, 2009, CH | Morasch et al. (2010) |
| 0.0116 | 0.0617 | 1.426 (max) |  | Summary of analytical results for chemicals in EU UWWTP effluents (91 UWWTP) | Loos et al. 2013 |
| < LoQ | 0.01687 | 0 – 0.32 | 1.2 | 32 UWWTP, 2015-2018, NL, LoQ 0.02 µg/l; total concentration | Data base NL |
|  | 1.379 |  |  | 7 samples | Miropoll project (CH, in Loos et al. 2012) |
|  | 0.025±0.004  0.182±0.015 |  |  | 2 UWWTP, 2009, DE (Koblenz) | Wick et al. (2010) |
| **Isoproturon**  (EQS: 0.3 µg/l) | 0.019 | 0.047 | 0.005 - 5.2 | 1.6 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples) ; total concentration | Toshovski et al. (still unpublished) |
|  | 0.084 |  |  | 88 UWWTP, 2001-2010, DE (Saxony) | Engelmann (2016) |
|  | 0.012 | n.n. – 0.05 |  | LoQ 0.0092 – 0.026 µg/l; total concentration | Clara et al. (2009) |
|  |  | 0.0063 - 0.031 |  | 2 UWWTP, AT; total concentration | Clara et al. (2014) |
|  | 0.050 |  |  | 30 UWWTP, 2011, Andalusia | Barco-Bonilla et al. (2013) |
| 0.056 | 0.059 | 0.005 – 0.16 |  | 3 UWWTP, 2013, DE (Baden-Württemberg); total concentration | Lambert et al. 2014 |
| 0.009 |  | n.n. - 15 |  | 92 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
|  | 0.039±0.032 |  |  | 1 UWWTP, 2009 - 2010, CH | Margot et al. (2013) |
|  | 0.013 |  |  | 3 UWWTP, 2007-2009, Catalonia | Köck-Schulmeyer et al. (2013) |
| 0.022 |  |  |  | 9 UWWTP, 1 year, AT; total concentration | Clara et al. (2012) |
|  | 0.34±0.47 |  |  | 1 UWWTP, 2009, CH | Morasch et al. (2010) |
| < LoQ | 0.003576 | 0 – 0.16 | 1.6 | 33 UWWTP, 2015-2018, NL, LoQ 0.01 µg/l; total concentration | Data base NL |
| 0.0004 | 0.0101 | 0.27 (max) |  | Summary of analytical results for chemicals in EU UWWTP effluents | Loos et al. 2013 |
|  | 0.058±0.005  0.05±0.002 |  |  | 2 UWWTP, 2009, DE (Koblenz) | Wick et al. (2010) |
| **Terbutryn**  (EQS: 0.0065 µg/l) | 0.035 | 0.044 | 0.005 - 0.29 | 2.9 | 49 UWWTP, n=1,000, 2017-2019, DE (emission factor is based on median effluent concentrations of 49 UWWTPs (found in more than 50% of samples); total concentration | Toshovski et al. (still unpublished) |
|  | 0.190 |  |  |  | Schütte et al. (2017) |
|  |  | 0.029 - 0.095 |  | 40 UWWTP, 2015-2016, DE (Baden-Württemberg) | Rau und Metzger (2017) |
|  | 0.041 |  |  | 94 UWWTP, 2001-2010, DE (Saxony) | Engelmann (2016) |
|  | 0.0078 – 0.033 | 0 - 0.05 |  | 8 UWWTP, AT (LoQ 0.05 µg/l, LoD 0.025 µg/l, all values < LoQ); total concentration | Clara et al. (2017) |
|  | 0.054 |  |  |  | Maus et al. (2016) |
| 0.024 |  | n.n. - 0.64 |  | 94 UWWTP, 2001-2010, DE (Saxony) | Engelmann et al. (2016) |
|  | 0.019±0.016 |  |  | 1 UWWTP, 2009 - 2010, CH | Margot et al. (2013) |
| < LoQ | 0.00307 | 0 – 0.07 | 0.389 | 32 UWWTP, 2015-2018, NL, LoQ 0.01 µg/l; total concentration | Data base NL |
|  | 0.39±0.53 |  |  | 1 UWWTP, 2009, CH | Morasch et al. (2010) |
|  | 0.028±0.004  0.0123±0.007 |  |  | 2 UWWTP, 2009, DE (Koblenz) | Wick et al. (2010) |
| **4-tert.-Octylphenol**  (EQS: 0.1 µg/l) | not found | | | | LoQ: 0.005 – 2 µg /l; total concentration | Data base NL |
| not found | | | | LoQ 0.08 µg/l; total concentration | Clara et al. (2009) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (4 out of 23); (LoQ: 0.025 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | < LoQ | < LoQ - 0.2 |  | 49 UWWTP, n=1000, 2017-2019, DE, found in 27% of 1,000 values > LoQ); (LoQ: 0.02 µg/l); total concentration | Toshovski et al. (still unpublished) |
| 0.05 | 0.042 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| **Benzo[a]pyrene**  (EQS: 0.0017 µg/l) | not found | | | | LoQ: 0.00001 - 0.2 µg /l; total concentration | Data base NL |
| not found | | | | LoQ: 0.05 µg/l; total concentration | Clara et al. (2009) |
|  | 0.00011 – 0.0005 | 0 – 0.0029 |  | 8 UWWTP, AT, found in only a few samples; (LoQ: 0.001 µg/l, LoD 0.0004 µg/l, all values < LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (1 out of 17); (LoQ: 0.005 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | 0.0007 | < LoQ - 0.057 |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 33% of 1,000 values > LoQ; (LoQ: 0.0005 µg/l); total concentration | Toshovski et al. (still unpublished) |
| 0.0035 | 0.0049 |  |  | 600 UWWTP, 2015-2017, UK; total concentration | Gardner and Jones (2018) |
| 0.0011 |  |  |  | 162 UWWTP, 2010-2013, UK; total concentration | Gardner et al. (2014) |
| **Benzo[b]fluoranthene**  (PNECwasser: 0.017 µg/l) | not found | | | | LoQ: 0.00002 - 0.1 µg /l; total concentration | Data base NL |
| not found | | | | LoQ: 0.03 µg/l; total concentration | Clara et al. (2009) |
|  | 0.00013 – 0.00094 | 0 – 0.0032 |  | 8 UWWTP, AT, found in only a few samples; (LoQ: 0.001 µg/l, LoD: 0.00086, 1 value out of 31 > LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (4 out of 17); (LoQ: 0.005 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | 0.001 | < LoQ – 0.083 |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 15% of values > LoQ; (LoQ: 0.001 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Benzo[g,h,i]perylene**  (PNECwasser: 0.0082 µg/l) | not found | | | | LoQ: 0.00002 - 0.2 µg /l; total concentration | Data base NL |
|  |  |  |  | found only in 1 sample out of 15; (LoQ: 0.002 µg/l); total concentration | Clara et al. (2009) |
|  | 0.00049 – 0.001 | 0 – 0.013 |  | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.00059 µg/l, found in 30 out of 31 samples > LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples; (5 out of 17); (LoQ: 0.0005 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | 0.0006 | < LoQ – 0.05 |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 27% of 1,000 values > LoQ; (LoQ: 0.0005 µg/l); total concentration | Toshovski et al. (still unpublished) |
|  | 0.001 |  |  |  | Gardner et al. (2014) |
| **Indeno[1,2,3-cd]-pyrene**  (PNECwasser: 0.0027 µg/l) | not found | | | | LoQ: 0.00002 - 0.2 µg /l; total concentration | Data base NL |
| not found | | | | LoQ: 0.002 µg/l; total concentration | Clara et al. (2009) |
|  | 0.00017 – 0.00069 | 0 – 0.0022 |  | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.00057, found in only a few samples (2 out of 31) > LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (8 out of 17); (LoD: 0.0005 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | 0.0006 | < LoQ – 0.053 |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 23% of 1,000 values > LoQ (LoQ: 0.0005 µg/l); total concentration | Toshovski et al. (still unpublished) |
|  | 0.0014 |  |  |  | Gardner et al. (2014) |
| **Naphthalene**  (EQS: 2 µg/l) |  |  |  |  | found in only a few samples (2 out of 85); (LoQ: 0.001 - 10 µg /l); total concentration | Data base NL |
| not found | | | | LoQ: 0.05 µg/l; total concentration | Clara et al. (2009) |
|  | 0.01 – 0.012 | 0 – 0.054 |  | 8 UWWTP, AT, (LoQ: 0.0074 µg/l, LoD 0.002, found in 17 out of 31 samples > LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in 11 of 17 samples (LoQ: 0.01 µg/l); total concentration | Lambert et al. 2014 |
| < LoQ | 0.01 | < LoQ - 0.065) |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 43% of 1,000 values > LoQ (LoQ: 0,001 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Category B substances (see chapter 3), page 6 in this document)** | | | | | | |
| **Benzo[k]fluoranthene**  (PNECwasser: 0.017 µg/l) | not found | | | | LoQ: 0.00001 - 0.2 µg /l; total concentration | Data base NL |
| not found | | | | LoQ: 0.03 µg/l; total concentration | Clara et al. (2009) |
|  | 0.00014 – 0.00055 | 0 – 0.003 |  | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.00044 µg/l, found in only a few samples (2 out of 31) > LoQ); total concentration | Clara et al. (2017) |
| not found | | | | 3 UWWTP, 2013, DE (Baden-Württemberg), LoQ: 0.005 µg/l; total concentration | Lambert et al. 2014 |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (46 out of 1,000); (LoQ: 0.001 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Anthracene**  (EQS: 0.1 µg/l) | not found | | | | LoQ: 0.00001 - 0.1 µg /l; total concentration | Data base NL |
| not found | | | | LoQ: 0.05 µg/l; total concentration | Clara et al. (2009) |
|  | 0.000032 – 0.0016 | 0 – 0.018 |  | 8 UWWTP, AT, (LoQ: 0.018 µg/l, LoD 0.00049, found in 13 out of 31 samples > LoQ); total concentration | Clara et al. (2017) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (1 out of 17); (LoQ: 0.005 µg/l); total concentration | Lambert et al. 2014 |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (38 out of 999); (LoQ: 0.001 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Atrazine**  (EQS: 0.6 µg/l) |  |  |  |  | found in only a few samples (9 out of 158); (LoQ: 0.001 – 2 µg /l); total concentration | Data base NL |
|  |  |  |  | found in only a few samples (4 out of 33 samples > LoQ); (LoQ: 0.0084 – 0.24 µg/l); total concentration | Clara et al. (2009) |
|  |  |  |  | 3 UWWTP, 2013, DE (Baden-Württemberg), found in only a few samples (3 out of 23); (LoQ: 0.01 µg/l); total concentration | Lambert et al. 2014 |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (41 out of 1,000); (LoQ: 0.01 µg/l); total concentration | Toshovski et al. (still unpublished) |
| 0.0022 | 0.0042 |  |  | Summary of analytical results for chemicals in EU UWWTP effluents; varying LoQs | Loos et al. 2013 |
|  |  |  |  | 12 UWWTPs, found in 11 UWWTPs (LoQ: 0.0084-0.24 µg/l) | Danube Countries; unpublished study |
| **Hexabromocyclododecanes (HBCDD)**  (EQS: 0.0016 µg/l) | not found | | | | total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.05 µg/l, LoD 0.025 µg/l); total concentration | Clara et al. (2017) |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (8 out of 1,000); (LoQ: 0.005 µg/l); total concentration | Toshovski et al. (still unpublished) |
| 0.0074 | 0.011 |  |  | 600 UWWTP, 2015-2017, UK, LoQ: 0.0016 µg/l; total concentration | Gardner and Jones (2018) |
| **Cybutryne**  (EQS: 0.0025 µg/l) | not found | | | | total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.05 µg/l, LoD 0.025 µg/l); total concentration | Clara et al. (2017) |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (35 out of 1,000); (LoQ: 0.005 µg/l) ; total concentration | Toshovski et al. (still unpublished) |
| **Heptachlor**  (EQS: 0.0000002 µg/l) | not found | | | | LoD: 0.0001 – 0.05 µg /l; total concentration | Data base NL |
| not found | | | | AT, LoD: 0.004 µg/l; total concentration | Clara et al. (2009) |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, LoQ: 0.004 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Dichlorvos**  (EQS: 0.0006 µg/l) | not found | | | | LoQ: 0.0001 – 0.05 µg /l; total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.05 µg/l, 0.025 µg/l); total concentration | Clara et al. (2017) |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only a few samples (4 out of 1,000); (LoQ: 0.01 µg/l); total concentration | Toshovski et al. (still unpublished) |
| not found | | | | 12 UWWTPs, (LoQ: 0.02 µg/l) | Danube Countries; unpublished study |
| **Dicofol**  (EQS: 0.0013 µg/l) | not found | | | | LoQ: 0.001 – 0.1 µg /l; total concentration | Data base NL |
|  | 0.000097 – 0.00058 | 0 – 0.0031 |  | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.0005 µg/l, found in only 1 sample (1 out of 32) > LoQ); total concentration | Clara et al. (2017) |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, (LoQ: 0.02 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Cypermethrin**  (EQS: 0.00008 µg/l) | not found | | | | LoQ: 0.003 – 0.06 µg /l; total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.0005 µg/l); total concentration | Clara et al. (2017) |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, (LoQ: 0.005 µg/l); total concentration | Toshovski et al. (still unpublished) |
| 0.00014 | 0.00034 |  |  | 600 UWWTP, 2015-2017, UK, LoQ: 0.00008 µg/l; total concentration | Gardner and Jones (2018) |
| **cis-Heptachlorepoxide and trans-Heptachlorepoxide**2  (EQS: 0.0000002 µg/l) | not found | | | | LoQ:0.0001 – 0.05 µg /l; total concentration | Data base NL |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, (LoQ: 0.004 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Aclonifen**  (EQS: 0.12 µg/l) |  |  |  |  | found in only 1 sample (1 out of 123); (LoQ: 0.002 – 1 µg /l); total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.05 µg/l, LoD 0.025); total concentration | Clara et al. (2017) |
|  |  |  |  | 49 UWWTP, n=1,000, 2017-2019, DE, found in only 1 sample (1 out of 1,000); (LoQ: 0.01 µg/l); total concentration | Toshovski et al. (still unpublished) |
| **Bifenox**  (EQS: 0.012 µg/l) |  |  |  |  | found in only a few samples (2 out of 110); (LoQ: 0.002 – 0.2 µg /l); total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.001 µg/l, LoD 0.0005); total concentration | Clara et al. (2017) |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, (LoQ: 0.004 µg/l); total concentration | Toshovski et al. (still unpublished) |
| not found | | | | 12 UWWTPs, (LoQ: 0.001 µg/l) | Danube Countries; unpublished study |
| **Quinoxyfen**  (EQS: 0.15 µg/l) | not found | | | | LoQ: 0.01 – 0.05 µg /l; total concentration | Data base NL |
| not found | | | | 8 UWWTP, AT, (LoQ: 0.05 µg/l, LoD 0.025); total concentration | Clara et al. (2017) |
| not found | | | | 49 UWWTP, n=1,000, 2017-2019, DE, (LoQ: 0.01 µg/l); total concentration | Toshovski et al. (still unpublished) |
| not found | | | | 12 UWWTPs, (LoQ: 0.001 µg/l) | Danube Countries; unpublished study |
| **Category C substances (see chapter 3), page 6 in this document)** | | | | | | |
| **Alachlor**  (EQS: 0.3 µg/l) | not found | | | | LoQ: 0.05 µg/l; total concentration | Clara et al. (2009) |
| **Benzens**  (EQS: 10 µg/l) | not found | | | | LoQ: 0.879 µg/l; total concentration | Clara et al. (2009) |
| **BDE** |  |  |  |  | LoQ: 0.24 – 1.4 µg/l, found in only a few samples; total concentration | Clara et al. (2009) |
|  |  |  |  | LoQ: 0.0001 µg/l, found in only a few samples; total concentration | Lambert et al. (2014) |
| **C10-C13 Chloralcanes**  (EQS: 0.4 µg/l) | not found | | | | LoQ: 0.1 µg/l; total concentration | Clara et al. (2009) |
| **Chlorfenvinphos**  (EQS: 0.1 µg/l) | not found | | | | LoQ: 0.011 – 0.022 µg/l; total concentration | Clara et al. (2009) |
| **Chlorpyrifos**  (EQS: 0.03 µg/l) |  |  |  |  | LoQ: 0.005 µg/l, found in only a few samples (2 out of 15 and 9 out of 18)) ; total concentration | Clara et al. (2009) |
| **Cyclodiene pesticides**  (EQS: Sum 0.01 µg/l) | not found | | | | LoQ: 0.005 – 0.01 µg/l; total concentration | Clara et al. (2009) |
| **DDT total**  (EQS: 0.025 µg/l) | not found | | | | LoQ: 0.015 µg/l; total concentration | Clara et al. (2009) |
| **para-para-DDT**  (EQS: 0.01 µg/l) | not found | | | | LoQ: 0.005 µg/l; total concentration | Clara et al. (2009) |
| **1,2-Dichloroethane**  (EQS: 10 µg/l) | not found | | | | LoQ: 1.252 µg/l; total concentration | Clara et al. (2009) |
| **Dichloromethane**  (EQS: 20 µg/l) |  |  |  |  | LoQ: 1.328 µg/l, found in only a few samples (2 out of 15); total concentration | Clara et al. (2009) |
| **Endosulfan**  (EQS: 0.005 µg/l) | not found | | | | LoQ: 0.01 µg/l; total concentration | Clara et al. (2009) |
| not found | | | | LoQ: 0.001 µg/l; total concentration | Lambert et al. (2014) |
| **Hexachlorobenzene** | not found | | | | LoQ: 0.005 µg/l; total concentration | Clara et al. (2009) |
| not found | | | | LoQ: 0.002 µg/l; total concentration | Lambert et al. (2014) |
| **Hexachlorobutadiene** | not found | | | | LoQ: 0.005 µg/l; total concentration | Clara et al. (2009) |
| not found | | | | LoQ: 0.005 µg/l; total concentration | Lambert et al. (2014) |
| **Hexachlorocyclohexane**  (EQS: 0.02 µg/l) | not found | | | | LoQ: 0.02 µg/l; total concentration | Clara et al. (2009) |
| 0.004 | 0.0043 | 0.0023 -0.01 |  | LoQ: 0.005/0.002 µg/l; only found ƴ-Hexachlorocyclohexane in all samples (3 UWWTD, 17 samples); total concentration | Lambert et al. (2014) |
| **Pentachlorobenzene**  (EQS: 0.007 µg/l) | not found | | | | LoQ: 0.01 µg/l; total concentration | Clara et al. (2009) |
| **Pentachlorophenol**  (EQS: 0.4 µg/l) | not found | | | | LoQ: 0.66 – 1.4 µg/l; total concentration | Clara et al. (2009) |
| not found | | | | LoQ: 0.1 µg/l; total concentration | Lambert et al. (2014) |
| **Simazine**  (EQS: 1 µg/l) |  |  | 0 – 0.22 |  | LoQ: 0.041 – 0.18 µg/l, found in only 1 sample (out of 15 and out of 18); total concentration | Clara et al. (2009) |
| **Tetrachloroethylene**  (EQS: 10 µg/l) | not found | | | | LoQ: 0.01 µg/l; total concentration | Clara et al. (2009) |
| **Trichloroethylene**  (EQS: 10 µg/l) | not found | | | | LoQ: 1.463 µg/l; total concentration | Clara et al. (2009) |
| **Tributyltin compounds**  (EQS: 0.0002 µg/l) |  | 0.0018 and 0.00022 | 0.0052 and 0.002 |  | LoQ: 0.0002 µg/l, found 6 out of 15 samples > LoQ and 15 out of 45 samples > LoQ; total concentration | Clara et al. (2009) |
| < LoQ | 0.00004 | < LoQ – 0.00014 |  | LoQ: 0.00005 µg/l, found in only 4 sample (out of 19); total concentration | Lambert et al. (2014) |
| **Trichlorobenzenes**  (EQS: 0.4 µg/l) | not found | | | | LoQ: 1.622 µg/l; total concentration | Clara et al. (2009) |
| **Trichloromethane**  (EQS: 2.5 µg/l) |  |  |  |  | LoQ: 1.483 µg/l, found in only 1 sample (out of 15); total concentration | Clara et al. (2009) |
| not found | | | | LoQ: 0.1 µg/l; total concentration | Lambert et al. (2014) |
| **Trifluraline**  (EQS: 0.03 µg/l) | not found | | | | LoQ: 0.005 µg/l; total concentration | Clara et al. (2009) |

1. [Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment as amended by Commission Directive 98/15/EC and Regulations 1882/2003/EC and 1137/2008/EC](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1991L0271:20081211:EN:PDF) (UWWTD) [↑](#footnote-ref-1)
2. Pursuant Article 2 (4) of UWWTD 'agglomeration' means an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point [↑](#footnote-ref-2)
3. Pursuant Article 2 (5) of UWWTD 'p.e. (population equivalent)' means the organic biodegradable load having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day [↑](#footnote-ref-3)
4. EQS-Directive, Annex I, Part A [↑](#footnote-ref-4)
5. Substance number – EQS-Directive (Annex I, Part A) [↑](#footnote-ref-5)
6. Substance number – EQS-Directive (Annex I, Part A) [↑](#footnote-ref-6)
7. Substance number – EQS-Directive (Annex I, Part A) [↑](#footnote-ref-7)
8. Based on monitored concentration of 49 UWWTPs of different size and number (mean value for three years) of treated p.e. in Germany [↑](#footnote-ref-8)
9. Based on PRTR data 2011-2015, differentiated by treatment type (Roovaart and Duijnhoven 2018) [↑](#footnote-ref-9)
10. Study specific [↑](#footnote-ref-10)