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METHODOLOGY FOR CALCULATING THE MAXIMUM AVERAGE WEEKLY LOAD (DRAFT)

CLIENT

Ministry of Agriculture of the Czech Republic

MINISTERSTVO ZEMĚDĚLSTVÍ

CONTRACTOR

Consortium

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VYSOKÁ ŠKOLA CHEMICKO-TECHNOLOGICKÁ V PRAZE

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UNICORN

National Implementation Programme for the Urban Waste Water Treatment Directive

Methodology for Calculating the Maximum Average Weekly Load

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Executive Summary

This methodology establishes a uniform procedure for calculating the maximum average weekly load at the inlet to an urban wastewater treatment plant in accordance with Article 6(5) of Directive (EU) 2024/3019 of the European Parliament and of the Council concerning urban wastewater treatment. The load is expressed in population equivalents, with one population equivalent corresponding to a load of 60 g BOD_5 per day.

The calculation is based on weekly volumes of wastewater passing through the treatment plant and BOD_5 concentrations determined in representative inlet samples. For each week for which valid data are available, the average daily BOD_5 load expressed in PE is calculated. The calculation is performed separately for each calendar year.

Weeks demonstrably affected by unusual weather conditions may be excluded from the annual dataset. The draft methodology further limits the effect of individual extreme values by using the 85th percentile. The highest value after this statistical trimming represents the annual maximum average weekly load. The result may not be lower than the average annual load of the UWWTP.

Use of the 85th percentile is a national methodological choice that is not directly prescribed by the Directive. Before final approval, the methodology must therefore be validated on a representative dataset from Czech UWWTPs, particularly with regard to different sampling frequencies, seasonal operation, the share of industrial wastewater and the occurrence of rainfall events.

For stable classification of a UWWTP into a size category within the National Implementation Programme, it is proposed to use the average of the annual values for the five preceding complete calendar years. This multi-year value is a separate stabilisation indicator and does not replace the annual maximum average weekly load determined in accordance with the Directive.

The methodology emphasises a uniform definition of weekly time windows, representative sampling, quality control of input data and a complete audit trail. The source data used, validation rules, the list of excluded weeks including the justification, the percentile calculation method and identification of the calculation tool used must be retained together with the resulting values.

The methodology also takes account of seasonal variations in load and the influence of significant industrial wastewater producers. A special procedure is established for UWWTPs dominated by separately conveyed industrial wastewater, in order to determine obligations on the basis of the actual urban wastewater load. The conditions are intended to prevent disproportionate obligations from being imposed on plants with a dominant industrial load, while also preventing artificial exclusion of load or circumvention of the rules for classifying a UWWTP.

1 Draft methodology for calculating the "maximum average weekly load" of a UWWTP (PE)

1.1 1. Purpose and scope

This methodology establishes a uniform procedure for calculating the "maximum average weekly load" of a wastewater treatment plant (UWWTP), expressed in population equivalents (PE), as required by Directive (EU) 2024/3019 concerning urban wastewater treatment.

The methodology is designed to be:

(i) data-based and auditable,

(ii) robust with respect to extreme values,

and (iii) practically applicable across operators and record-keeping systems.

The methodology is used to calculate the maximum weekly load of all UWWTPs that are required to measure wastewater flow.

1.2 2. Principle of the method – summary of the algorithm

The method uses weekly time windows of 7 × 24 hours. For each week in which at least one sample with a determined inlet BOD_5 concentration is collected, the following are established:

a) weekly volume of water passing through the plant, Q_week;
b) average weekly inlet BOD_5 concentration, C_BOD5,week (arithmetic mean of the samples collected during the week).

The weekly load expressed in PE (PE_week) is calculated from these values. The weekly load is calculated in this way for each week of the year in which an inlet sample was collected. For each calendar year, values above the 85th percentile of the resulting set of weekly-load values are removed. The highest value remaining after removal of values exceeding the 85th percentile is the maximum weekly load of the UWWTP for the calendar year concerned. If the resulting value is lower than the arithmetic mean annual load (the annual average inlet BOD_5 concentration multiplied by the annual volume passing through the plant and divided by the number of days in the year and by 60 g BOD_5), the average-load value is used instead of the maximum. For classification of the treatment plant by size, the maximum load is calculated as the five-year average of the maximum weekly loads for the individual years. Where five years of data are not available, for example for a new UWWTP, a shorter period is used, but not less than three years. Where even a three-year period is unavailable, the design capacity is used.

1.3 Definitions, symbols and units

Symbol	Description	Unit	Note
Q_week	Weekly volume of water passing through the UWWTP (sum/integral of flow over the defined week)	m^3/week	From inlet or outlet flow/volume data
C_BOD5,week	Average weekly BOD_5 concentration at the inlet	mg/l	Arithmetic mean of samples collected during the week
PE_week	Weekly load expressed in PE (corresponding to the average daily BOD_5 load during the week)	PE	
P85	85th percentile of PE_week values within the calendar year	PE	A consistent percentile definition shall be used
PE_max,year	Annual maximum weekly load after trimming extreme values	PE	1 value per year
PE_max,average	Stabilised result – average of annual maxima over N years	PE	Target N = 5
Q_year	annual volume of water passing through the plant	m^3/year	
C_BOD5,year	annual average BOD_5 concentration at the inlet	mg/l	
D_year	number of days in the year	days	(365/366)
PE_avg,year	average annual load	PE	

Conversion constant for calculation in PE: 1 PE corresponds to 60 g BOD_5/day.

1.4 Input data and minimum requirements

1.4.1 Flow/volume of water passing through the treatment plant (Q)

The input is a time series that allows the weekly volume Q_week to be determined reliably. Acceptable sources include: (i) continuous flow measurement integrated to obtain volume; (ii) daily volumes (from daily flow-meter readings); and (iii) weekly flow-meter totaliser readings.

The data must include a time stamp (at least at daily resolution), and the units must be clearly defined.

1.4.2 BOD_5 at the inlet

The input consists of the results of laboratory analyses of inlet BOD_5, including the date/time of sampling. The inlet sample is a 24-hour composite sample, unless otherwise specified in the water management permit. For the purposes of this methodology, the 24-hour composite sample is assigned

to a week according to the sampling start time stated in the report (or, where this is not stated, according to the sampling end time).

1.4.3 Minimum sampling frequency

The minimum frequency of inlet BOD_5 sampling is the same as that prescribed for effluent monitoring for the relevant UWWTP category.

1.4.4 Temporal consistency

The temporal distribution of inlet samples is consistent with effluent sampling. Samples should be distributed evenly throughout the year. In justified cases (tourism or campaign-based industrial wastewater production), the frequency may be adapted to wastewater production, provided that the effluent sampling frequency is adapted in the same way.

1.5 Definition of a "week" (time window)

A "week" is defined as 24 × 7 consecutive hours. The beginning and end of the week are selected with regard to the available wastewater flow measurement and recording arrangements.

A week is assigned to the calendar year in which the greater part of its duration (in hours) falls. In the event of a tie, it is assigned to the year in which the week begins.

1.6 Calculation procedure

The calculation is performed by calendar year, followed by stabilisation using a multi-year average of the annual maxima.

1.6.1 Calculation of weekly BOD_5 concentration (C_BOD5,week)

For each week, C_BOD5,week is determined as the arithmetic mean of the concentrations in all BOD_5 samples collected during that week.

Where only one sample is collected in a week, its value is used. Weeks without a BOD_5 sample are not evaluated as PE_week.

1.6.2 Calculation of weekly volume (Q_week)

Q_week is determined as the sum of the daily volumes during the week or as the integral of continuously measured flow over the defined weekly time window.

1.6.3 Calculation of weekly load expressed in PE (PE_week)

For each evaluated week, the following is calculated:

$$PE\_week = (Q\_week \times C\_BOD5,week) / (7 \times 60)$$

where Q_week is expressed in m^3/week and C_BOD5,week in mg/l. The constants 7 × 60 convert the value to an average daily load on the basis of the definition 1 PE = 60 g BOD_5/day. The result is the number of PE.

1.6.4 Optional exclusion of an extraordinary ("rainfall-affected") week

Exclusion of extraordinary weeks is not a mandatory part of the calculation. The methodology allows a week to be excluded only in justified cases where the operator demonstrates the occurrence of extraordinary circumstances (e.g. an extreme rainfall event, an accident or a major operational intervention) and supports this with appropriate documentation.

1.6.5 Trimming extreme weeks using the 85th percentile (P85)

For each calendar year, the 85th percentile P85 is determined from the set of PE_week values after any optional exclusion of extraordinary weeks. All weeks for which PE_week > P85 are then excluded (values equal to P85 are retained).

1.6.6 Determination of PE_max,year

The annual "maximum weekly load" PE_max,year is determined as the highest of the remaining PE_week values after trimming using the 85th percentile.

Recommendation for IT implementation: use a consistent percentile definition with linear interpolation, equivalent to the PERCENTILE.INC function in MS Excel.

If this value is lower than the average UWWTP load (PE_avg,year), calculated as follows:

C_BOD5,year, determined as the arithmetic mean of all inlet BOD_5 measurements in mg/l, is multiplied by the total annual volume Q_year passing through the UWWTP and divided by the number of days in the year and by 60 (definition: 1 PE = 60 g BOD_5/day). The average-load value is then used. In this case, PE_max,year = PE_avg,year.

PE_avg,year = (Q_year × C_BOD5,year) / (D_year × 60)

1.6.7 Stabilisation of the result over time (multi-year averaging) – classification of the UWWTP

The resulting "maximum average weekly load" PE_max,average is determined as the arithmetic mean of the PE_max,year values for the assessment period. This period consists of the five consecutive preceding years.

Where complete data for five years are not available (for example for new UWWTPs), a shorter period may temporarily be used, with a minimum of three years, and the five-year regime shall be adopted once the data become available. Where even three consecutive years of data are unavailable, the UWWTP category is determined on the basis of its design capacity.

1.7 Outputs

The methodology provides at least the following outputs:

- PE_max,year – annual maximum weekly load after trimming (1 value per calendar year).
- PE_max,average – average of the annual maxima over the last N years (target N = 5).

For auditability, it is recommended that the following be archived for each year: the list of evaluated weeks, the P85 value, the list of excluded weeks (percentile-based or optional exclusion) and the definition of the week used (time window).

1.8 Industrial wastewater

The load of an urban wastewater treatment plant shall be determined solely on the basis of the load of urban wastewater entering the treatment plant separately, provided that all of the following conditions are met:

a) urban wastewater and industrial wastewater are conveyed to the treatment plant separately;

b) industrial wastewater is conveyed separately to the treatment plant from one or more sources;

c) the BOD_5 load of the industrial wastewater represents at least 80% of the total BOD_5 load of wastewater treated at the plant.

Where the conditions in points (a) to (c) are not met, the load of the urban wastewater treatment plant shall include the entire BOD_5 load of all wastewater treated at that plant.

The proportion of the BOD_5 load referred to in point (c) shall be determined for the period defined in Section 6.7.

The Ministry of Agriculture shall maintain a list of UWWTPs meeting the conditions in points (a) to (c).

2 Conclusion

The methodology provides a uniform, transparent and auditable procedure for determining the maximum average weekly load of a UWWTP. Its purpose is to capture the actual load entering the UWWTP, including seasonal changes, variations in wastewater production and the influence of significant industrial producers, and thereby enable correct and stable classification of the UWWTP for the purposes of the National Implementation Programme.

The calculation is based on operating data on the volume passing through the plant and the inlet BOD_5 concentration, and limits the influence of individual extraordinary or non-representative values. Multi-year assessment is intended to ensure that classification of the UWWTP is not disproportionately affected by a short-term operational change or a single extraordinary year.

The special procedure for UWWTPs dominated by separately conveyed industrial wastewater enables their size to be assessed on the basis of the actual urban wastewater load. The conditions for its application are designed to ensure that such UWWTPs are not subject to disproportionate obligations caused by a dominant industrial load, while preventing artificial splitting or exclusion of load in order to circumvent obligations under the Directive.

3 Data sources, information and supporting materials for methodology validation

1. **Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment**, in particular the provisions governing determination of the population equivalent on the basis of the maximum average weekly load at the inlet to a wastewater treatment plant.

2. **Selected data from the Asset and Operating Records of Water Supply and Sewerage Systems (VÚME/VÚPE)**, maintained in accordance with the applicable legislation of the Czech Republic. The data were used primarily to verify the availability, scope and usability of the operating data needed to determine UWWTP load.

3. **Operating and laboratory data from wastewater treatment plants in the Czech Republic.** The proposed calculation procedure was tested on multi-year data series from dozens of UWWTPs of different size categories and with different characteristics of the incoming wastewater. The testing focused in particular on verifying the feasibility of the calculation, the influence of sampling frequency, seasonal variations in load, the presence of industrial wastewater and the stability of results between individual years.