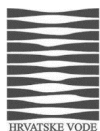


Zajednica izvršitelja



Naručitelj



Krajnji korisnik



STUDIJA OCJENE I PRAĆENJA UČINKOVITOSTI PROVEDBE PROJEKTA
IZGRADNJE KANALIZACIJSKE MREŽE I ANALIZA UČINKOVITOSTI RADA UREĐAJA
ZA PROČIŠĆAVANJE OTPADNIH VODA U GRADU POREČU – STUDIJA POREČ

IZVJEŠĆE 8a Modeliranje UPOV-a: validiranje modela – Poreč Jug
ožujak 2022



Evaluation and efficiency monitoring of the new implemented sewage network and wastewater treatment construction in the larger city of Poreč.

Report 8.1 – Wastewater treatment model calibration and validation.

WWTP Poreč-South

2022 02 28

Definitive Concept



Lagen-Aarleseweg 13
 NL – 5425 PD De Mortel (NB)
 The Netherlands

Phone: + 31 (0) 6 24842234

Mail: meijer@asmdesign.nl

Web: www.asmdesign.nl

IBAN: NL66 RABO 0113 1888 46

SWIFT: RABONL2U

VAT: NL-175272530B01

Business registration: 30206848

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Responsible Author(s)	: Sebastiaan. C.F. Meijer Ph.D. MSc., ASM Design B.V.
e-mail address	: meijer@asmdesign.nl
To	: Hrvatske Vode, Ulica grada Vukovara 220, 10000 Zagreb, Croatia
e-mail	:



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1 Management summary

1.1 General project introduction

The infrastructural investment “Sewerage and Wastewater Treatment Plants of City of Poreč”– Project Poreč, co-funded by European Union, is one of the largest investments in the public sector in Republic of Croatia. It involves rehabilitation and extension of the existing sewerage system and construction of four new wastewater treatment plants (WWTPs). The goal is to better protect the environment in and around the Poreč coastal area. Complementary a project is developed titled “Integrated Modelling of Wastewater Infrastructure System of City of Poreč” – Modelling Project. This project is an integrated environmental assessment to obtain a better understanding of the environmental impact of the system performance which is evaluated under range of operational conditions. A scenario study is developed using state-of-the-art (modelling) tools and methods which allows a holistic assessment of the wastewater system. The results of this study are in assistance of future operations and wastewater management in the region and used to elevate knowledge and professional skills of local water sector professionals.

The Modelling Project consists of 4 main components, namely:

- Part 1: Modelling the sewage collecting and transport system of City of Poreč,
- Part 2: Modelling of operation and performance of 4 WWTPs of City of Poreč,
- Part 3: Model assessment impact offshore outlets on aquatic water quality,
- Part 4: Establishment of the experimental laboratory setup for monitoring and optimization of wastewater management and operation.

Including a training is organized to extend the capacity of water professionals in the use of wastewater modelling for future assessments.

The Modelling project has a holistic system approach covering collection, processing, and aquatic discharge of wastewater, the interrelation between the different wastewater systems and impact on the environment, public health, and coastal seawater quality.

Several scenarios are calculated to explore the impact of Project Poreč on the previous mentioned factors and to and establish the best methods for management of the wastewater systems from an integrated perspective.

Modelling is used to demonstrate how upgrade of the Poreč wastewater system improves the environment. Further insight is developed in the overall interaction of the sub-systems on seawater quality. Knowledge is developed on how to operate and optimize the different wastewater systems, with the best overall results.



1.2 Project goals

The overall objective of the Poreč modelling project is to demonstrate how upgrading the total wastewater system improves the sea water quality in the Poreč coastal region. Therefore, the total wastewater system is modelled consisting of several sub-systems. By modelling the WWTP under different (extreme) conditions it is investigated how effluent discharge load and quality will affect the sea water quality. For each studied scenario, effluent concentration and flow profiles are calculated. These data are subsequently used as input for sea water quality modelling from which the environmental impact is calculated.

1.3 Context of this report

This report belongs to the reports in the series “modelling project part 2: Modelling of operation and performance of 4 WWTPs of City of Poreč”. Each WWTP is modelled and reported in a series of 4 documents of which this is the final. For accessibility the reports are set up using identical format and methods. Modelling project Part 2 is developed in four steps:

- Step 1: Static WWTP modeling using detailed design data. In the total project this is report number 5 consisting of 4 sub-reports, one for each WWTP (report number 5.1 to 5.4).
- Step 2: Dynamic WWTP modeling based on dynamic winter and summer influent measurements (data 2019). In the total project this is report number 6, consisting of 4 sub-reports, one for each WWTP (report number 6.1 to 6.4).
- Step 3: Analysis of operational WWTP scenarios up to the year 2045. In this step a series of operational scenarios are developed, and the potential coastal discharge loads and concentrations are quantified based on extrapolation simulations. In the total project this is report number 7, consisting of 4 sub-reports, one for each WWTP (report number 7.1 to 7.4).
- Step 4 (this report series): Model calibration and validation based on new operational measurements done in 2022. The model validity is tested by reproducing a new influent and effluent data set without the need of significant model adjustments. In the total project this is report number 8, consisting of 4 sub-reports one for each WWTP (report number 8.1 to 8.4).

1.4 Background and previous investigations

This research is part of an integrated environmental assessment of the wastewater transport, collecting and treatment system including the coastal recipient. The goal of this research is to obtain a better understanding of the environmental impact of modernization of the City of Poreč wastewater system and its performance. This report is part of a series studying the operation of 4 wastewater treatment plants of the larger City of Poreč. Models of the wastewater treatment are developed from detailed design information and influent flow and concentration data are measured in the summer and winter of 2019 and winter of 2022. In previous reports (numbered report 5, 6 and 7) model evaluations have been performed simulating a range of operational conditions and future scenarios. In report number 5 the average performance is evaluated using a static model. In report number 6



models are further developed to test and evaluate operation under realistic dynamic conditions. In report number 7 models are projected towards winter and summer conditions in 2045 including a dynamic scenario with peak loading and rain event. Based on the simulations results, the impact of the upgraded wastewater facilities on the coastal seawater quality is assessed. In this report the validity of the previously developed models is further investigated by calibrating the model using a new dataset measured in 2022, including operational performance data. It is tested if the previously developed dynamic model can reproduce measured effluent quality without having to alter critical model parameters. The study adds to the overall validity of the previously performed model calculations and scenario projections.

1.5 Reader

This report presents the validation of the previously developed model. Therefore, a static calibration is performed using a new 2022 operational dataset with influent and effluent measurements. The calibration methodology is according to published literature and explained in report 5 of this series. The setup and calibration of the dynamic model is explained in report 6. It was concluded that the model required little parameter adjustments, all not critical and well within the advised settings (default BioWin). In report 7 the model is used for scenario calculations towards the year 2045. This report tests the assumptions for the parameter settings and validates its application. The model settings are validated by calibrating the model using a new operational dataset with influent and effluent data measured in the winter of 2022. In chapter 3 the 2022 measured flow data is evaluated and presented for model application. In chapter 4 the influent quality sampling (concentrations) is discussed, and measurement results are presented and prepared for model application (appendix 1). Chapter 5 presents the influent (mass) loading profiles (appendix 2). Chapter 6 discusses the influent characterization results (appendix 3). Chapter 7 presents the model calibration and validation (appendix 4 and 5). Measured 2022 effluent results are compared with results of the calibrated model. The model is determined to be valid when effluent values are reproduced without significant adjustment of (stoichiometric) parameters. For all model studies some finetuning is necessary to reproduce specific operational conditions. For example, mixing conditions or aeration controller settings. Therefore, some kinetic parameters are adjusted within a typical range.

1.6 General conclusions

- The model is tested successfully on an independent data set and reproduced all data without significant adjustments.
- The model is tested reliable and validated for use for operational and scenario evaluation.
- The above conclusions apply to all presented results, under which previous WWTP modelling reports published in this series, which have used the validated model.

1.7 Recommendations

It is recommended to proceed with final development of the scenario analysis and sea water modelling taking in account the presented conclusions.



2 Introduction

2.1 Context of this report

This report belongs to the reports in the series “modelling project part 2: Modelling of operation and performance of 4 WWTPs of City of Poreč”. Each WWTP is modelled and reported in a series of 4 documents of which this is the final. For accessibility the reports are set up using identical format and methods. Modelling project Part 2 is developed in four steps:

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This research is part of an integrated environmental assessment of the wastewater transport, collecting and treatment system including the coastal recipient. The goal of this research is to obtain a better understanding of the environmental impact of modernization of the City of Poreč wastewater system and its performance. This report is part of a series studying the operation of 4 wastewater treatment plants of the larger City of Poreč. Models of the wastewater treatment are developed from detailed design information and influent flow and concentration data are measured in the summer and winter of 2019 and winter of 2022. In previous reports (numbered report 5, 6 and 7) model evaluations have been performed simulating a range of operational conditions and future scenarios. In report number 5 the average performance is evaluated using a static model. In report number 6 models are further developed to test and evaluate operation under realistic dynamic conditions. In report number 7 models are projected towards winter and summer conditions



in 2045 including a dynamic scenario with peak loading and rain event. Based on the simulations results, the impact of the upgraded wastewater facilities on the coastal seawater quality is assessed. In this report the validity of the previously developed models is further investigated by calibrating the model using a new dataset measured in 2022, including operational performance data. It is tested if the previously developed dynamic model can reproduce measured effluent quality without having to alter critical model parameters. The study adds to the overall validity of the previously performed model calculations and scenario projections.

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3 Influent flow measurements

3.1 Introduction and methods

The influent flow is measured for 24-hours (1 day) with measurement points produced every 2 hours based on a collected flow sample for all 4 treatment locations. The measurement period for WWTP Poreč-South and WWRP Vrsar starts Monday 17-01-2022 at 9:00 and for WWTP Poreč-North and WWRP Lanterna starts Tuesday 18-01-2022 at 9:00. The measurement day was with dry weather. There are no missing datapoints and the measured did not require data to be reconstructed. From the measured flow profile an hourly average flow is calculated for each hour of the day. The profile is used as an input for dynamic modeling.

3.2 Winter influent flow measurement results

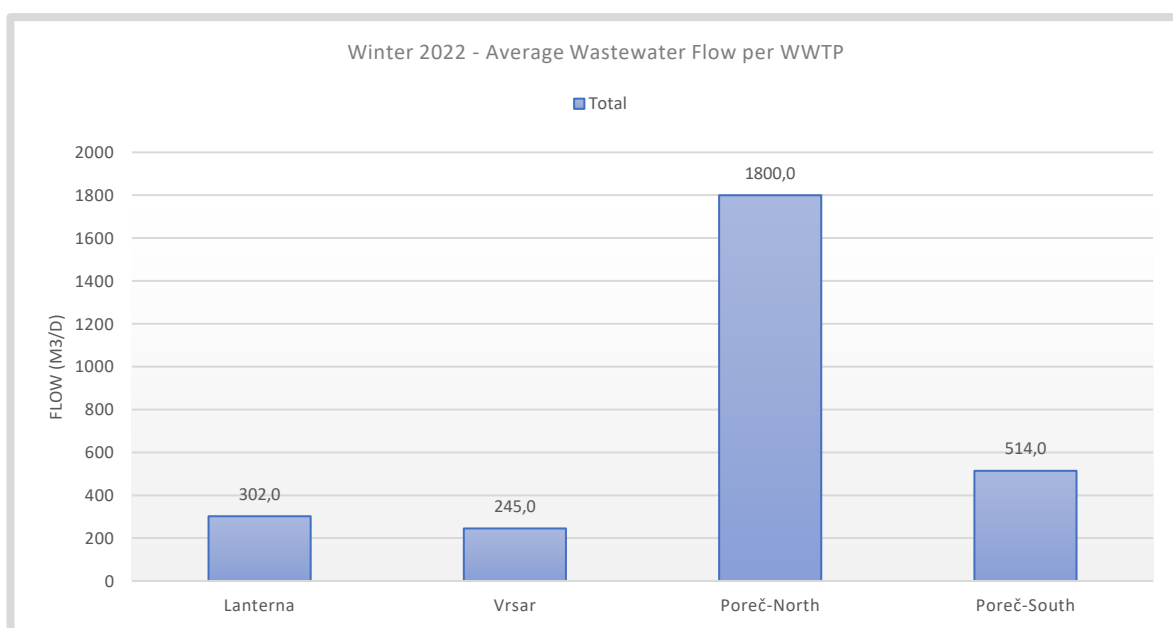


Figure 1. Winter 2022 - Average Dry Weather Wastewater Flow per WWTP.



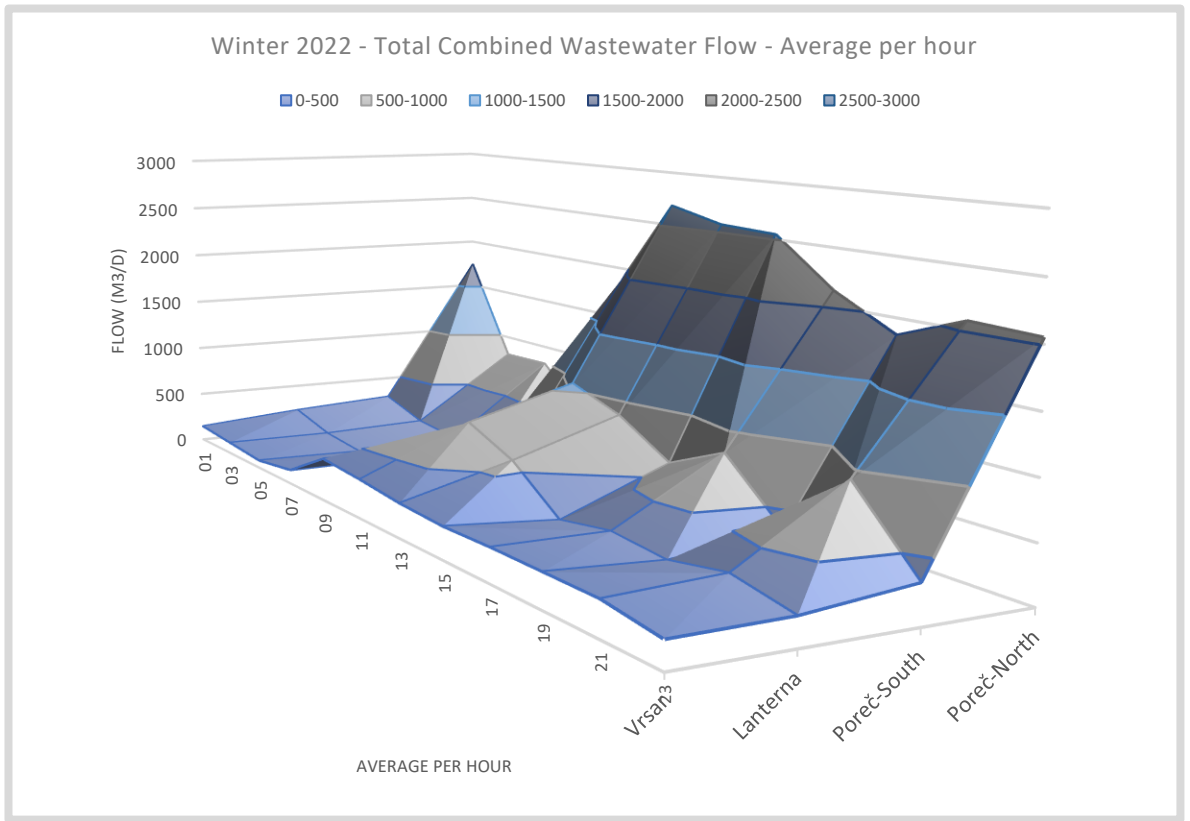


Figure 2. Winter 2022 - Surface plot of the total combined wastewater flow. The order of WWTP's is from lowest to highest wastewater producing community.

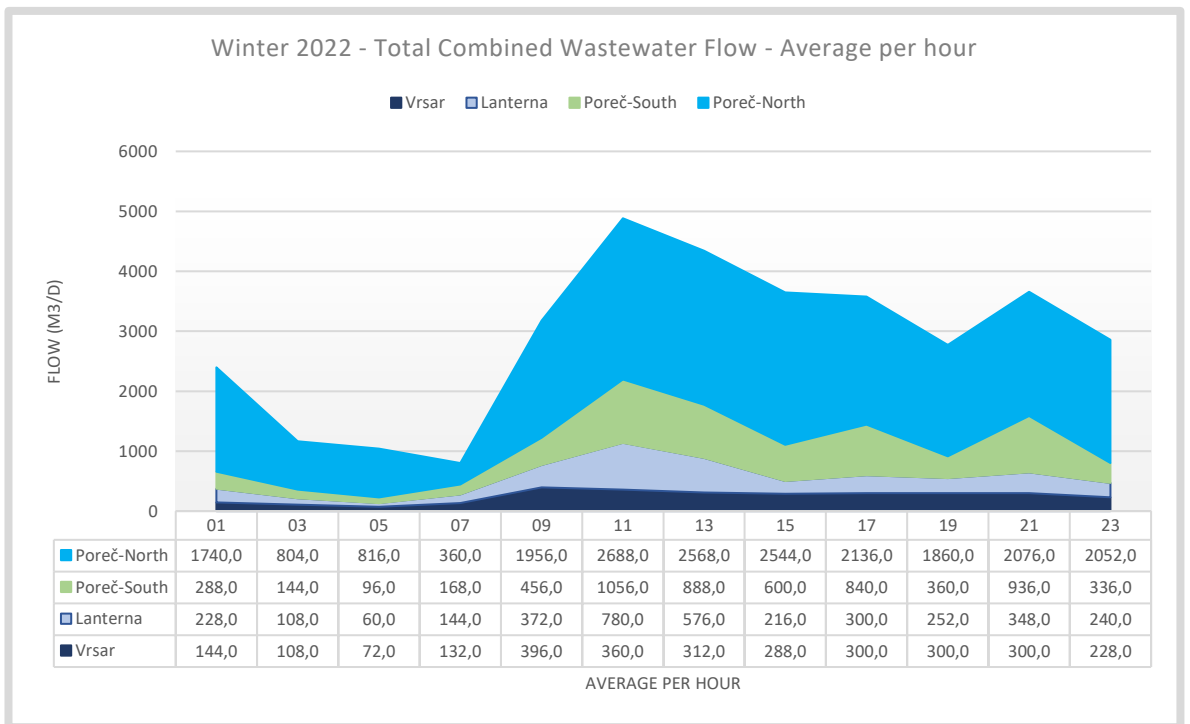


Figure 3. Winter 2022 -Total (sum of WWTP's) of the wastewater flow per hour.



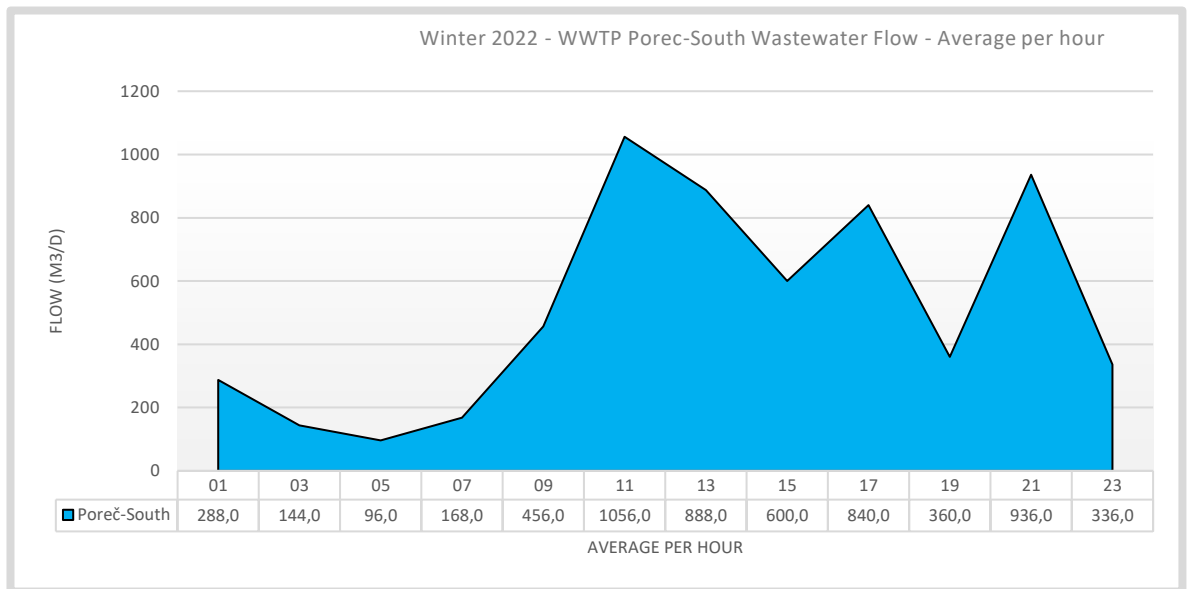


Figure 4. Winter 2022 - WWTP Poreč-South Dry Weather Wastewater Flow 24-hour average hourly measurements.

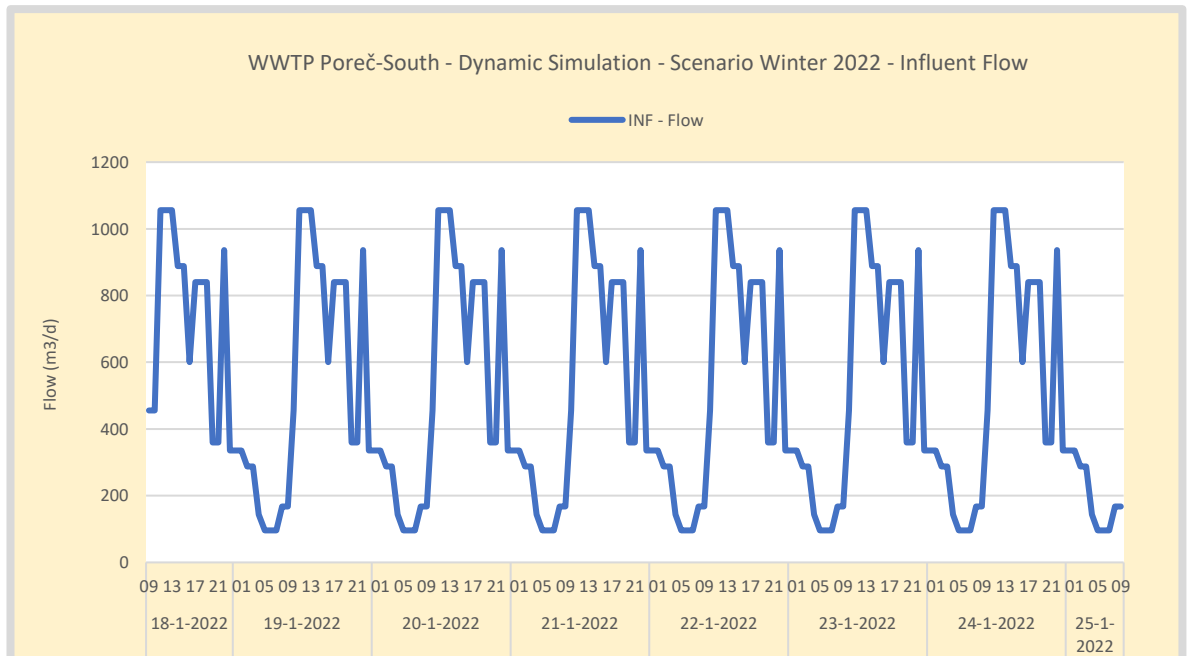


Figure 5. Winter 2022 - BioWin modelling WWTP Poreč-South: Wastewater Flow measured 24-hours and repeated for 7-days used for dynamic model input. The data is interpolated in the model on an hourly basis.

3.3 Conclusions flow measurements

Influent dry weather flow data measured in the winter of 2019 and 2022 are comparable. There is similarity in the minimum and maximum flow data as well as the flow distribution pattern over the day on an hourly basis. The profile is used in the calibration study to validate the model performance.



4 Influent quality sampling

4.1 Sampling method

Raw sewage wastewater is sampled at 4 WWTP locations; WWTP Poreč-North, WWTP Poreč-South, WWRP Vrsar and WWTP Lanterna. Continuous 24-hour automated samplers are used for a continued period of 24 hours. Per WWTP approximately 180 samples are collected and analyzed. Some by on-line measurement. The measurement period for WWTP Poreč-South and WWRP Vrsar starts Monday 17-01-2022 at 9:00 and for WWTP Poreč-North and WWTP Lanterna starts Tuesday 18-01-2022 at 9:00. During the measurement period there was absence of rain.

The type of wastewater sampler used is Hach AS950 Portable Sampler and WaterSam Ports. Samples are taken every 9-30 minutes (flow proportional) in bottles of volume 550–800 mL which are rotated automatically every 2 hours, for 24 h (total of 12 vessels collected per 24 hours for each sampling location). After a day of operation, samples are taken to the laboratory for analysis (Zagreb Laboratory for Water Technology at the Faculty of Food Technology and Biotechnology). Samplers are thermally insulated and refrigerated to preserve the samples and reduce occurring reactions.

Table 1. Parameters measured in wastewater.

Parameters determined in the wastewater of the city of Poreč.				
Code	Parameter	2h/24h composite	Filtered / Total	Chemical analysis method
TCOD	Total Chemical Oxygen Demand	2 hour composite	Total sample	ISO 6060-1989
CODMF	Chemical Oxygen Demand in filtrate (1.2 µm)	2 hour composite	Micro filtered	ISO 6060-1989
TN	Total nitrogen	2 hour composite	Total sample	EN ISO 11905-1 decomposition s peroxodisulfate
PO4	Orthophosphate	2 hour composite		DIN EN ISO 6878
NH4	Ammonia	2 hour composite		ISO 7150-1
TSS	Total suspended solids	2 hour composite	Total sample	Filtered, dried, weight
VSS	Volatile suspended solids (organic)	2 hour composite		Total solids minus inorganic fraction
ISS	Inorganic suspended solids	2 hour composite		Filtered, dried, weight, incinerated at 500 C, weight
pH	pH	2 hour composite		
EC	Electrical conductivity	2 hour composite		
BOD	Biological Oxygen demand over 5 days	24 hour composite	Total sample	Test run over 5 days
BODMF	Biological Oxygen demand over 5 days in filtrate (1.2 µm)	24 hour composite	Micro filtered	Test run over 5 days
TP	Total phosphorus	24 hour composite	Total sample	EN ISO 6878
NO3	Nitrate	24 hour composite		ISO 7890-1-2-1986
NO2	Nitrite	24 hour composite		EN ISO 26777

4.2 Measurement adjustments in the raw data

For the influent data some datapoints are corrected. All measured influent TSS measurements are too high in relation to the measurements of BOD and COD in the same samples. Measurement errors in TSS typically are the result of non-homogeneous samples. Especially the larger heavier TSS fraction will settle if the mixing conditions in a sewage sampling point are not ideal. COD is less affected because COD is related to the smaller



and lighter particulate (colloidal) fraction that will settle less rapidly and therefore less susceptible for poor mixing conditions. To compensate for the overestimation of measured solids all TSS measurements are reduced by 29% bringing the measurements within more typical concentration range and ratio's relative to BOD and COD. VSS is calculated from TSS and ISS measurements and therefore adjusted simultaneously.

4.3 Calculation method for the average influent concentration

For each 2-hour composite sample the flow volume is measured and concentration measured of all parameters in table 1. From these data every 2 hours the influent loads are calculated for each parameter. From the load profile the flow proportional (weighed) influent concentrations are calculated. Only weighed concentration are used in the model calculations. The results are presented in the following graphs.

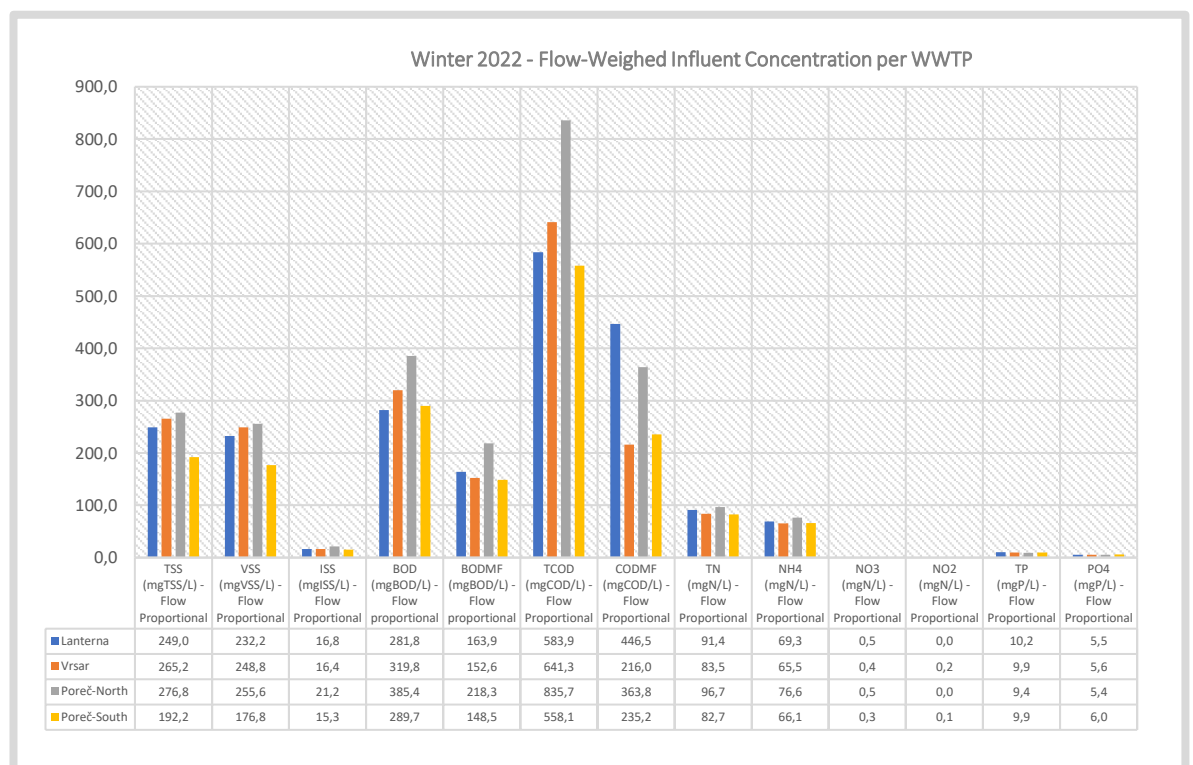


Figure 6. Winter 2022 - Flow-weighted average influent concentrations per WWTP.

4.4 Influent concentration profiles

The concentration of wastewater varies over time due to all kind of disturbances but most important population behavior. Human regular activity results in a distinctive measurement profile. For each measured parameter daily profiles are calculated and presented in the figures below. Measured concentration peaks are related to the sewage flow. High flow results in short sewer residence time and high concentration peaks early in the day while low flow results in lower peaks occurring later in the day. Transport of particulate material is very much dependent on the flow velocity in the sewer system. During the winter low flow season, it takes longer before particulate material arrives at the WWTP. This material settles overnight in the sewer and is collected in the morning when the flow increases.



Ammonia and orthophosphate peaks in the morning as the result of human source urine. The time on which peaks are measured at the WWTP starting from 6 hours in the morning, indicates the residence time in the sewer system. This effect is observed from the data in the figures below.

4.5 COD Influent concentration - Winter 2022

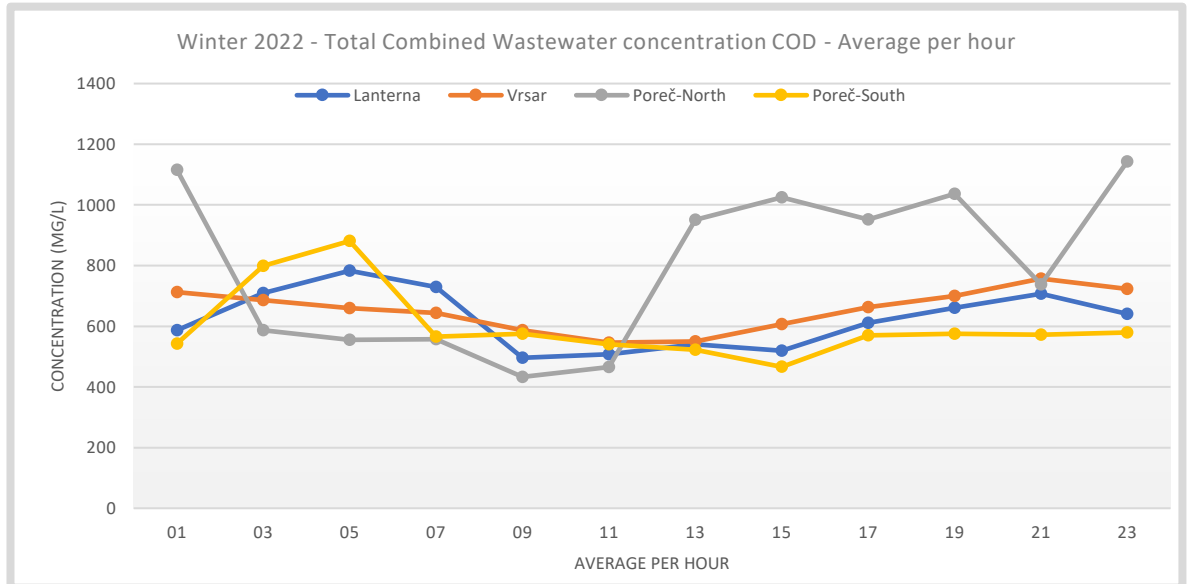


Figure 7. Winter 2022 - 24-hour COD Influent Concentration profile per WWTP.

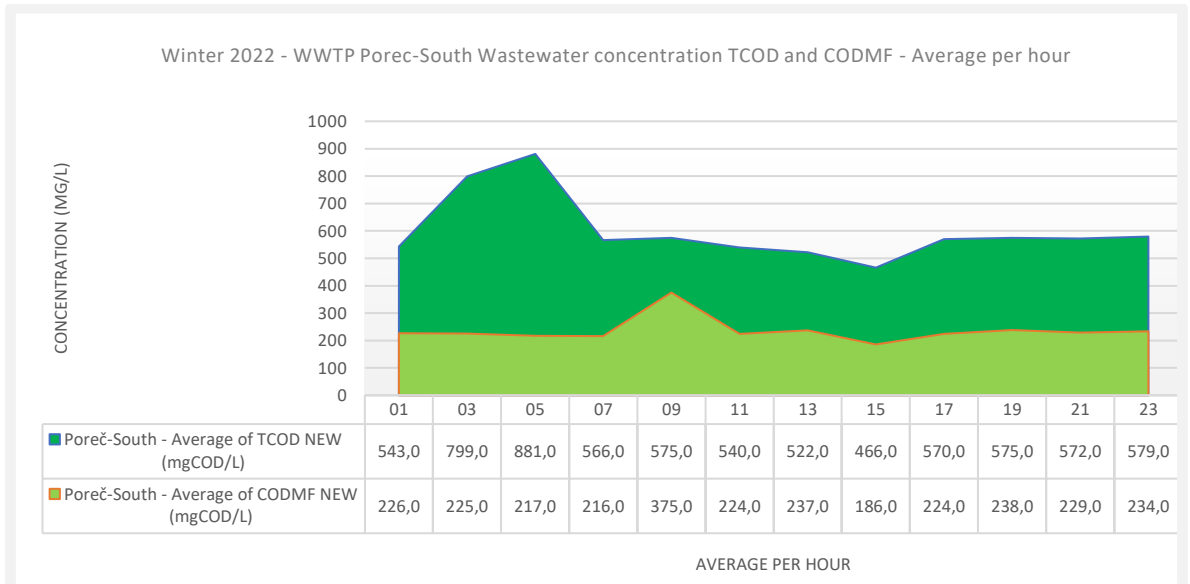


Figure 8. Winter 2022 - WWTP Poreč-South 24-hour average COD and COD micro-filtered influent Concentration.



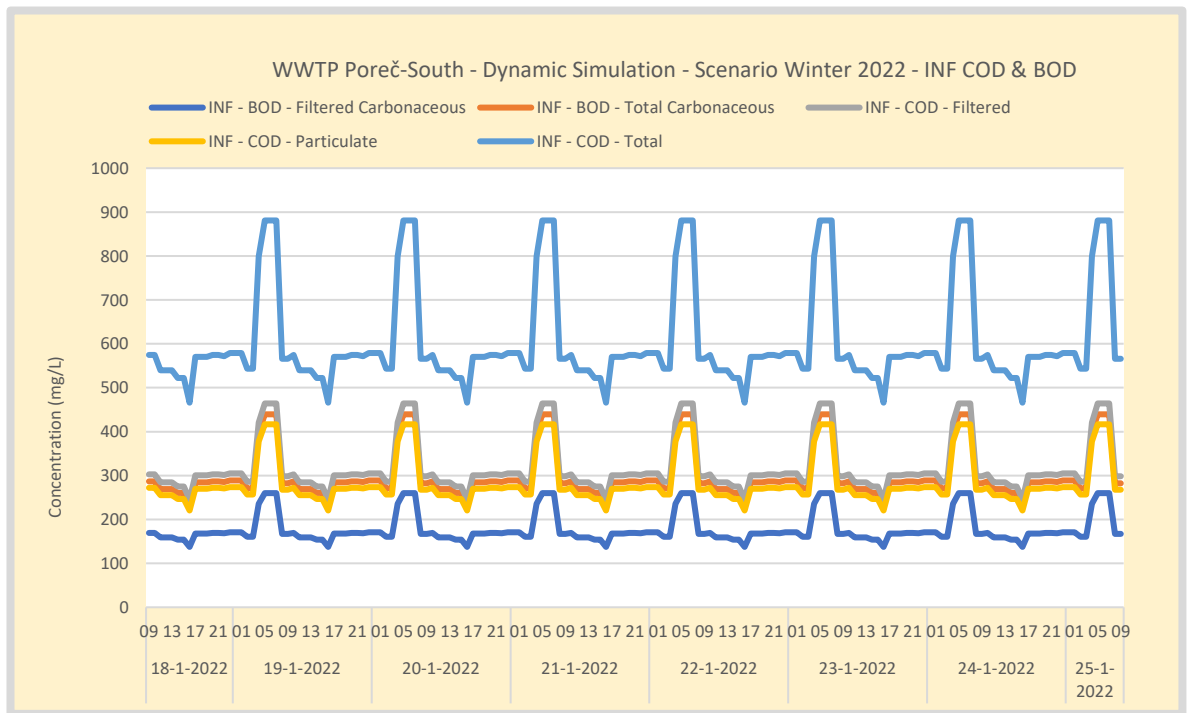


Figure 9. Dynamic Simulation – WWTP Poreč-South – Winter 24-hour average COD, COD micro-filtered, COD particulate, BOD and BOD filtered influent concentration. One day of measurement is repeated for 7 days in the dynamic simulation. The model input is the measured total COD concentration. Other fractions are calculated from the influent specification.

4.6 Nitrogen influent concentration – Winter 2022

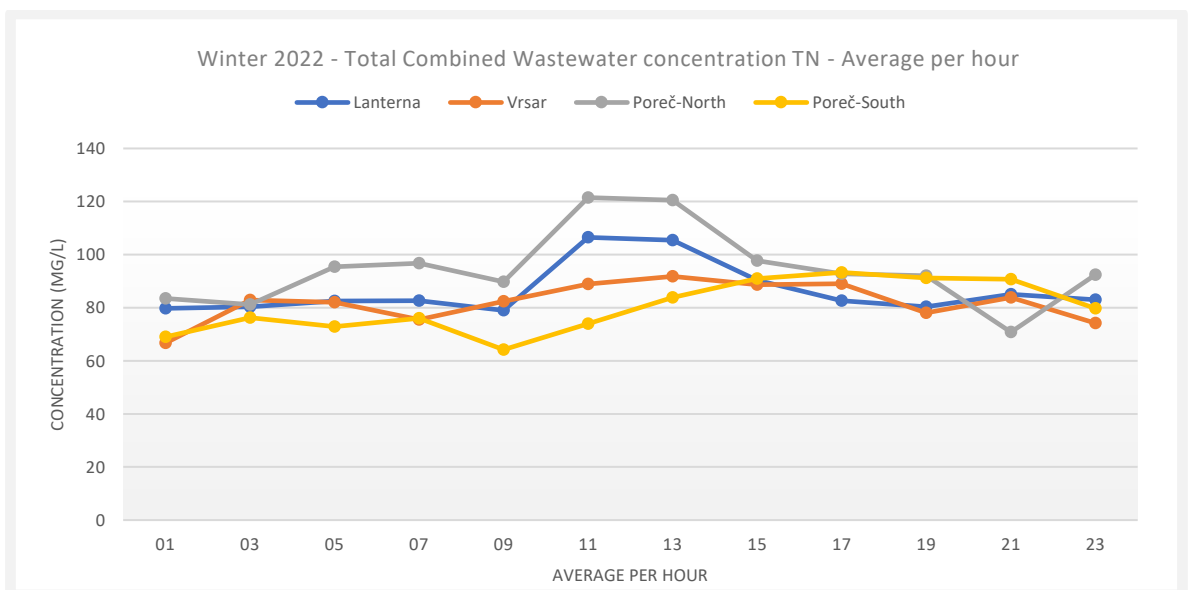


Figure 10. Winter 2022 - 24-hour TN Influent Concentration profile per WWTP.



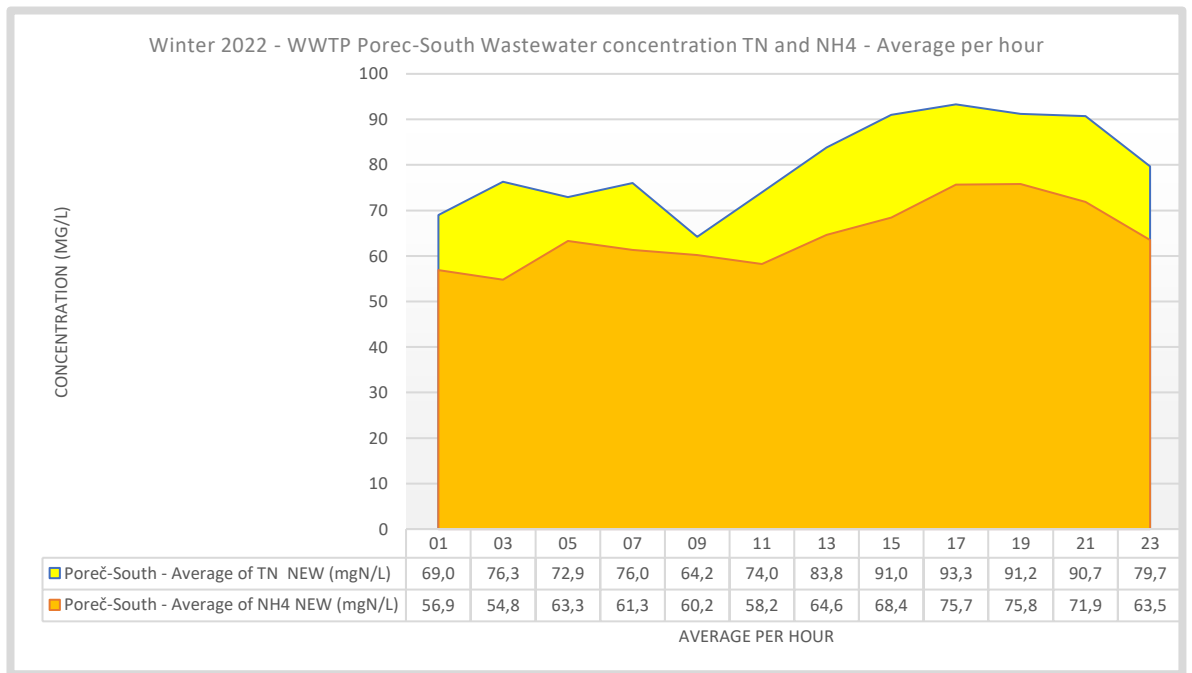


Figure 11. Winter 2022 - WWTP Poreč-South 24-hour average TN and NH4 influent Concentration.

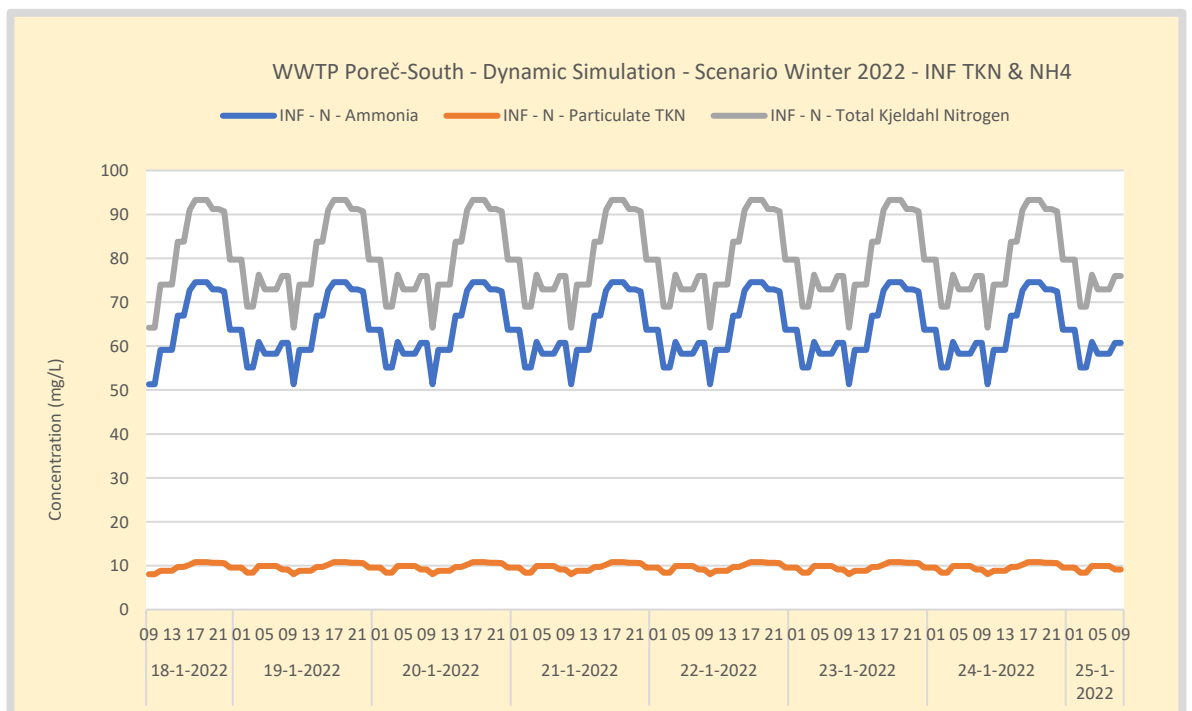


Figure 12. Dynamic Simulation – WWTP Poreč-South – Winter 24-hour average TKN, NH4 and particulate TKN influent concentration. One day of measurement is repeated for 7 days in the dynamic simulation. The model input is the measured TKN concentration. The other fractions are determined from the influent specification.



4.7 Phosphorus influent concentration – Winter 2022

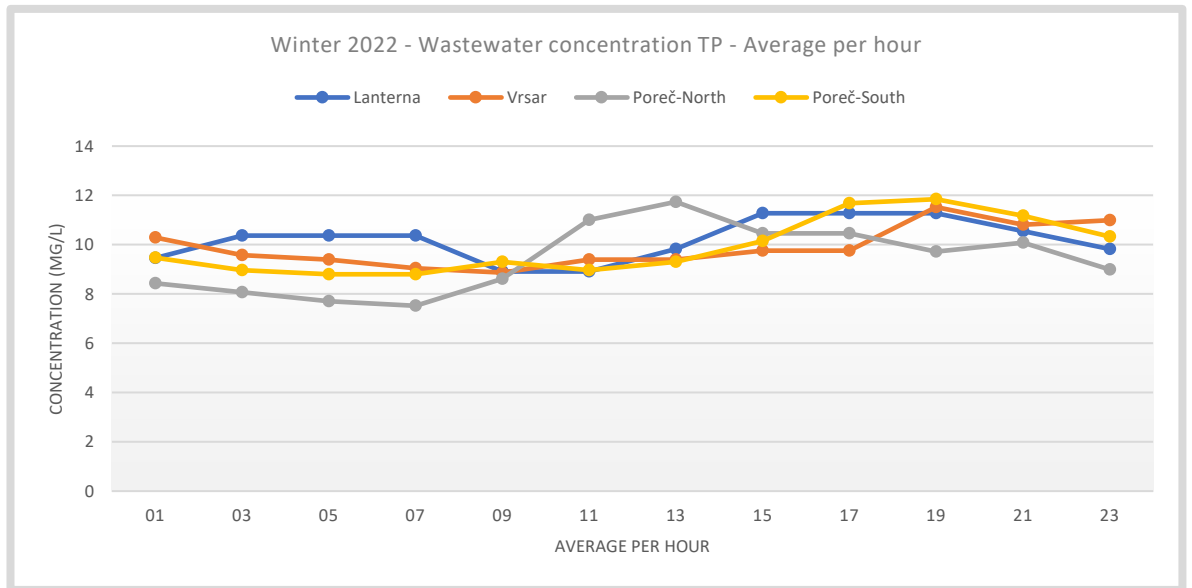


Figure 13. Winter 2022 - 24-hour TP influent concentration profile per WWTP.

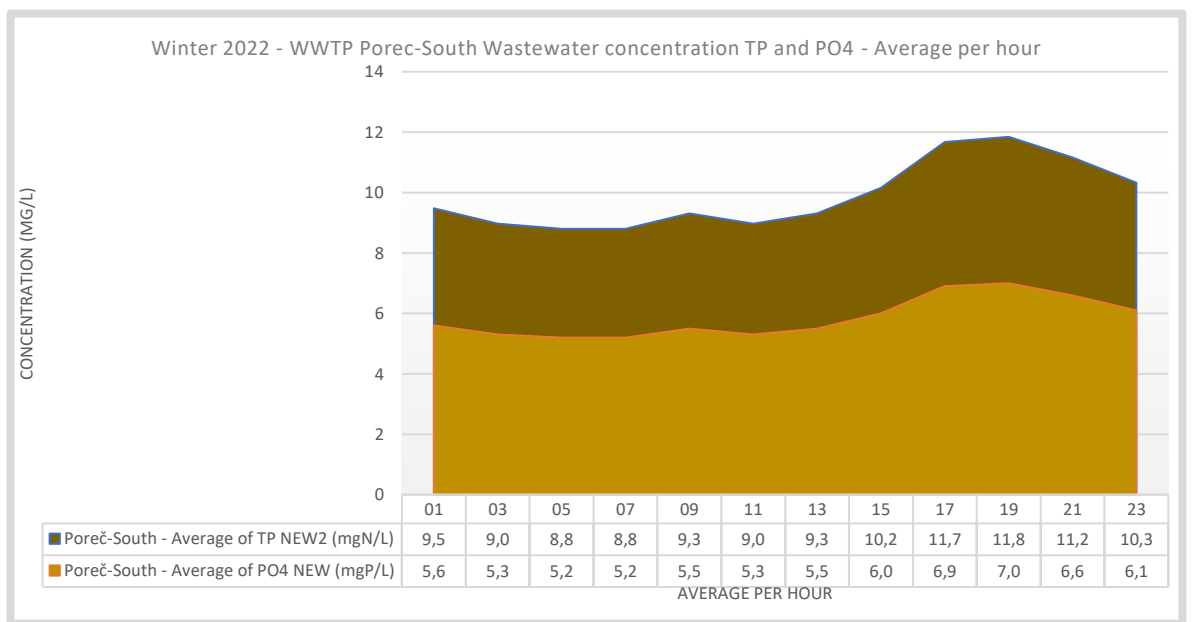


Figure 14. Winter 2022 - WWTP Poreč-South 24-hour average TP and PO4 influent concentration.



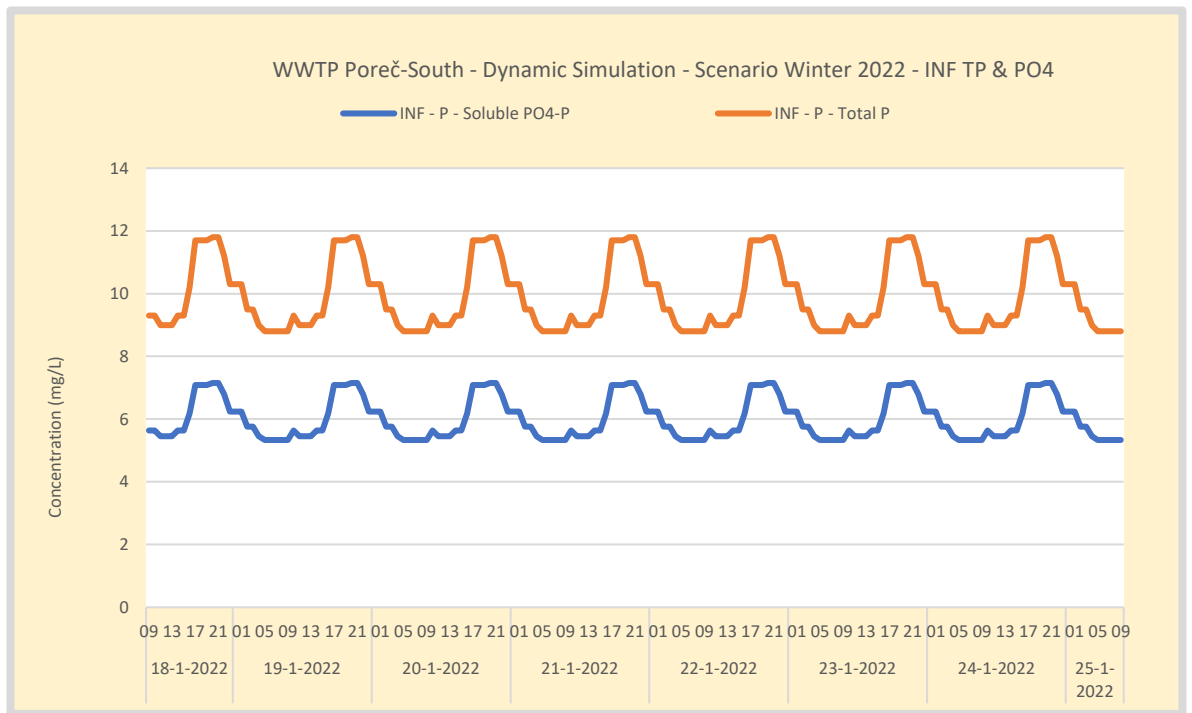


Figure 15. Dynamic Simulation – WWTP Poreč-South – Winter 24-hour average TP and PO4 influent Concentration. The model input is the measured TP concentration. One day of measurement is repeated for 7 days in the dynamic simulation. PO4 is determined from the influent specification.

4.8 Total Suspended Solids influent concentration – Winter 2022

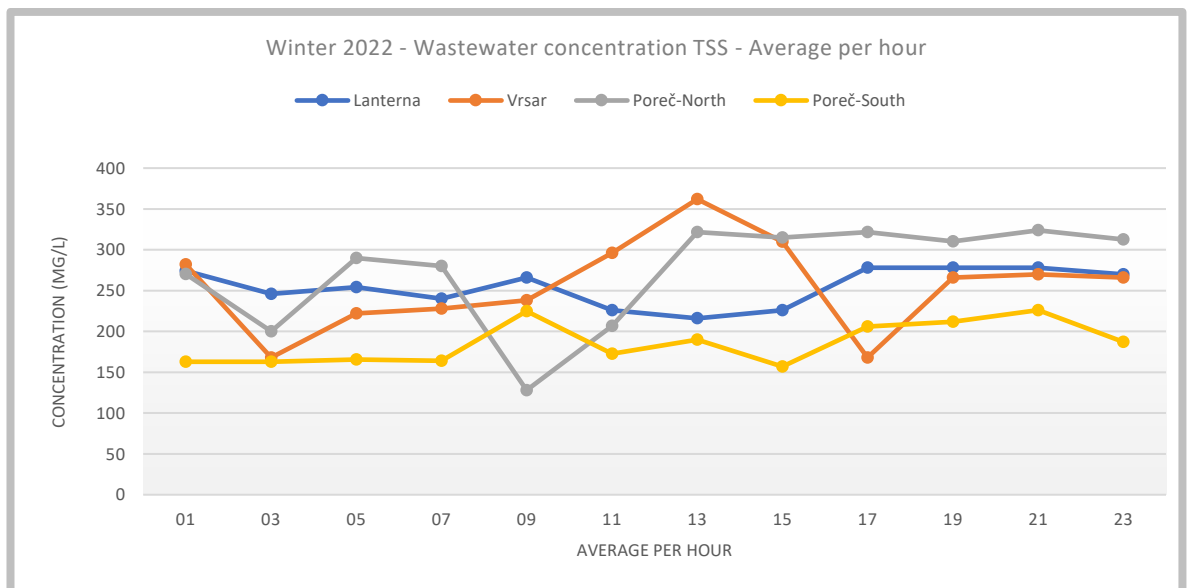


Figure 16. Winter 2022 - 24-hour TSS influent concentration profile per WWTP.



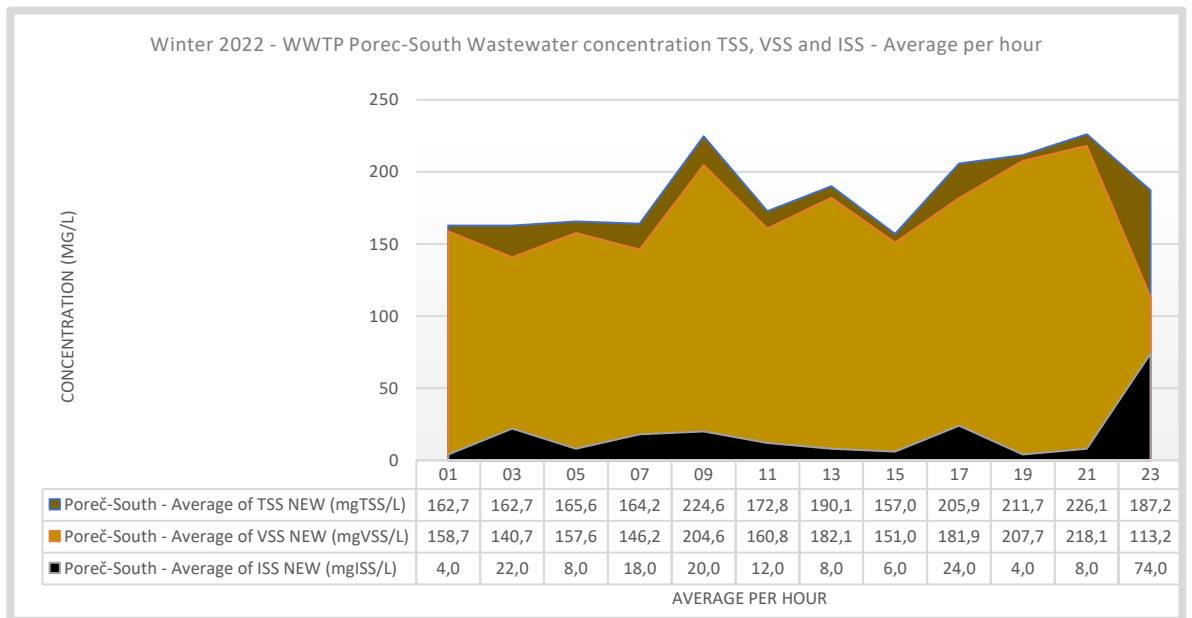


Figure 17. Winter 2022 - WWTP Poreč-South 24-hour average TSS, VSS and ISS influent concentration.

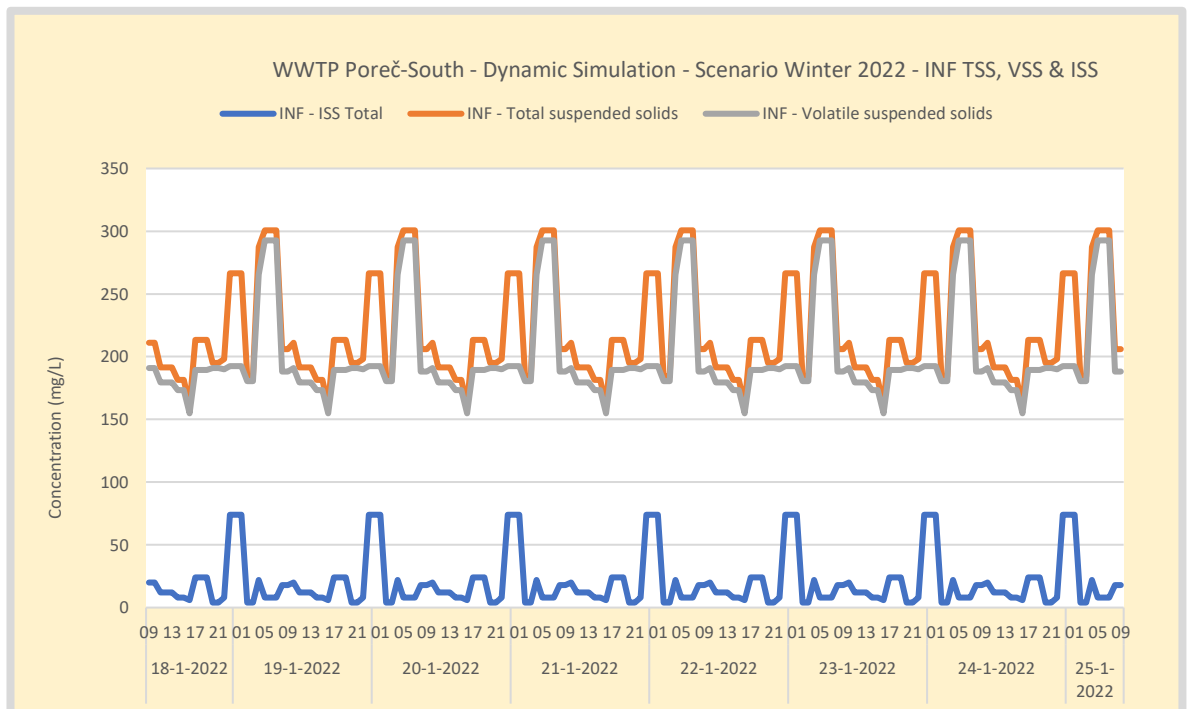


Figure 18. Dynamic Simulation – WWTP Poreč-South – Winter 24-hour average TSS, VSS (organic particulate) and ISS (inorganic particulate) influent concentration. One day of measurement is repeated for 7 days in the dynamic simulation. The model input is the measured ISS concentration. VSS is calculated based on (constant) fractions determined in the influent specification. TSS is modelled as the sum of ISS and VSS.



4.9 pH influent measurements - Winter 2022

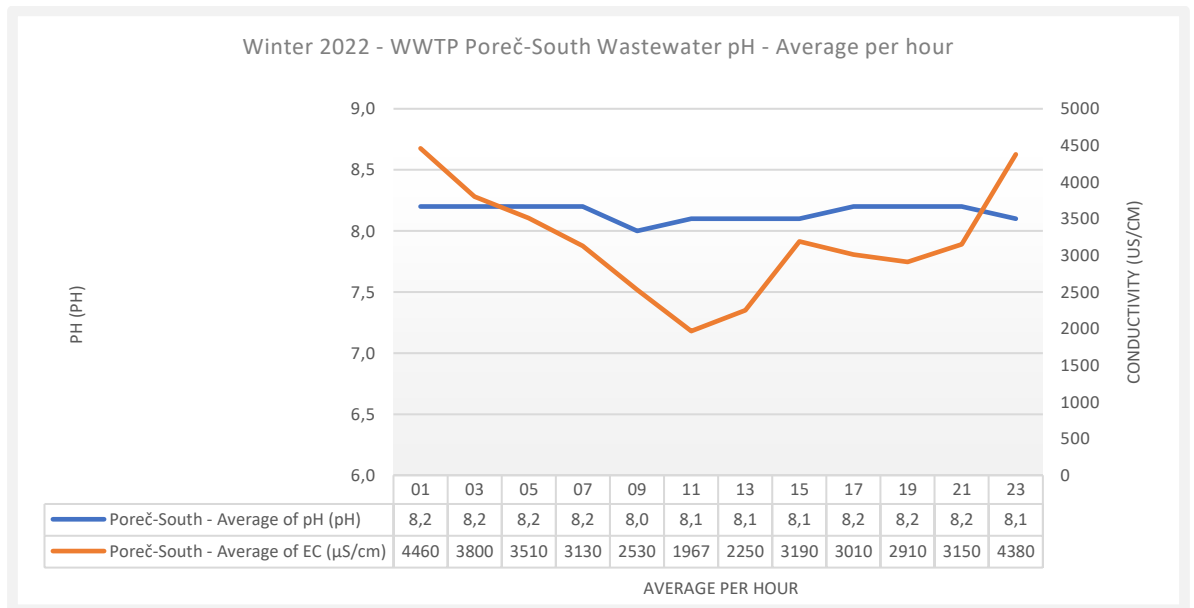


Figure 19. Winter 2022 - WWTP Poreč-South 24-hour average pH influent measurement.

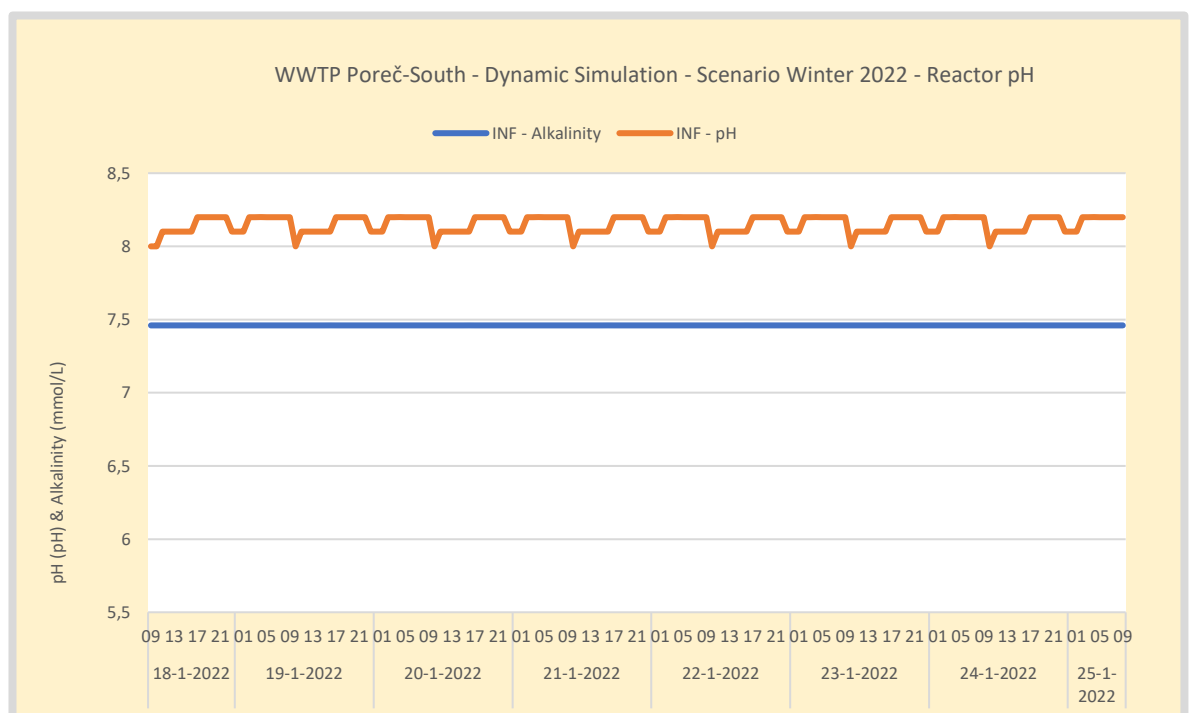


Figure 20. Dynamic Simulation – WWTP Poreč-South – Winter 24-hour average influent pH measurement. pH is a dynamic model input. The alkalinity of wastewater is estimated as a constant obtained from Poreč drinking water quality.



5 Influent loading profiles

5.1 Average influent loads

Daily average influent loads are presented in the graph below. The scale (0-100%) represents the total influent (total Poreč area) and the relative influent fractions treated by each WWTP.

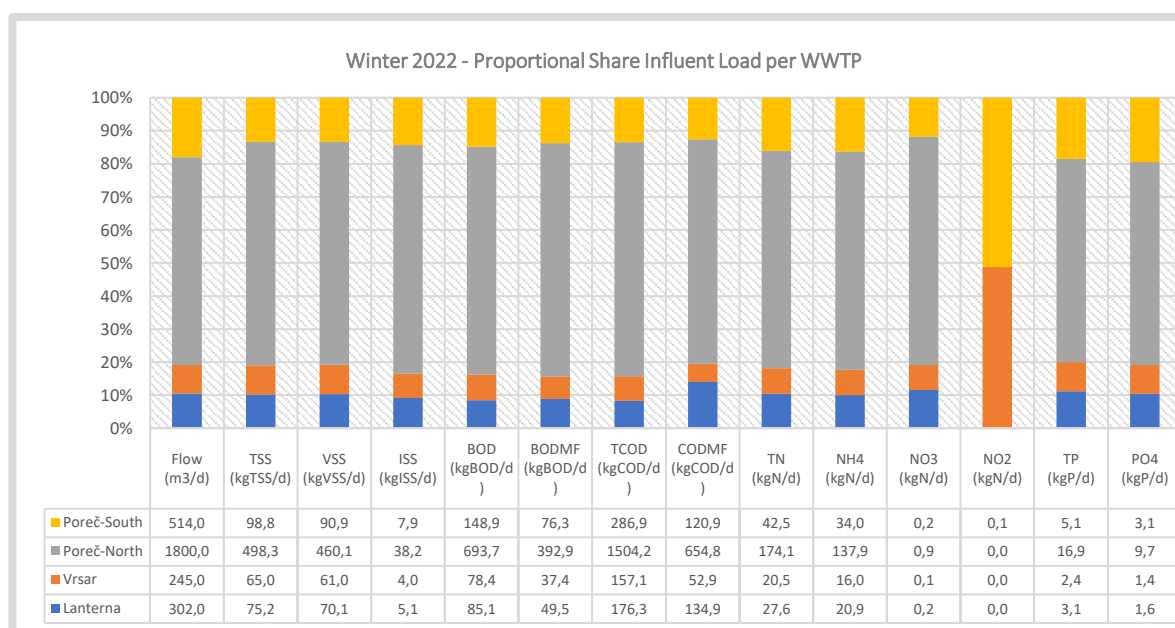


Figure 21. Winter 2022 - Proportional Share Influent Load per WWTP.

5.2 Influent COD 24-hour dynamic loading profile

The loading profile typically follows the flow profile with exception for periods where concentration peaks occur. The combined COD wastewater load for the Poreč area during the winter of 2022 is shown in the figures below. COD is partly particulate material and is transported more slowly through the sewer than soluble compounds. This effect is increased at low flow conditions. Compared to TN, the morning COD peak typically is lower and has a more gradual loading pattern over the day. The measured COD loading profile is typical for domestic source.



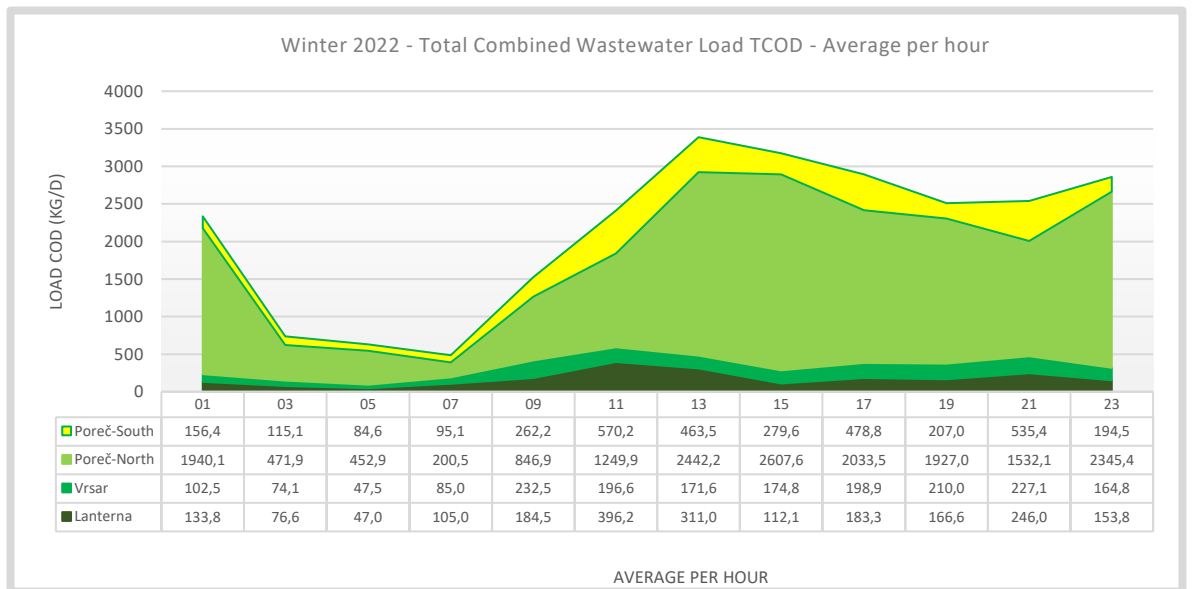


Figure 22. Winter 2022 - Sum of all WWTP's. Hourly average influent TCOD loads based on 1 measurement day, dry weather conditions.

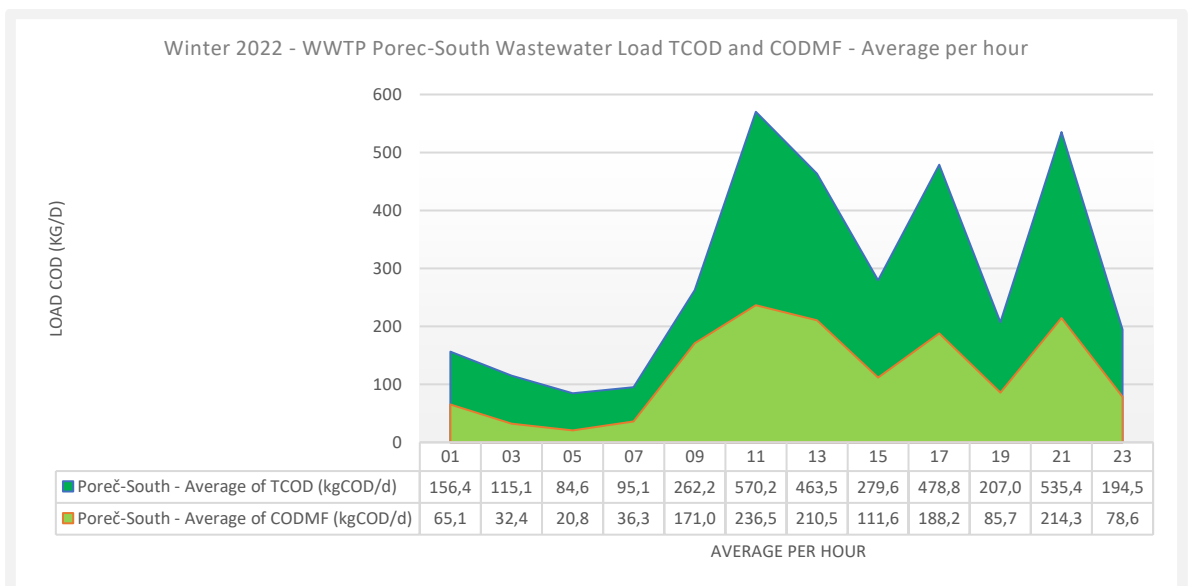


Figure 23. Winter 2022 - WWTP Poreč-South hourly average dry weather influent loads of total and filtered COD.

5.3 Influent Nitrogen 24-hour dynamic loading profile

The total nitrogen (TN) loading is presented in the graphs below. The data shows a typical domestical source. A large fraction of TN is soluble ammonium which is easily transported in the sewer. This typically results in a high peak of ammonium in the morning between 11:00 and 13:00, depending on the flow and sewer residence time. Ammonium peaks result in a high oxygen demand at the WWTP because of the nitrification process. Under peak conditions, especially when the wastewater is warm, aeration can be come limiting. Small presence of nitrate is measured in the sewage. Appearance of nitrate in closed sewers could be caused by nitrate rich groundwater infiltration.



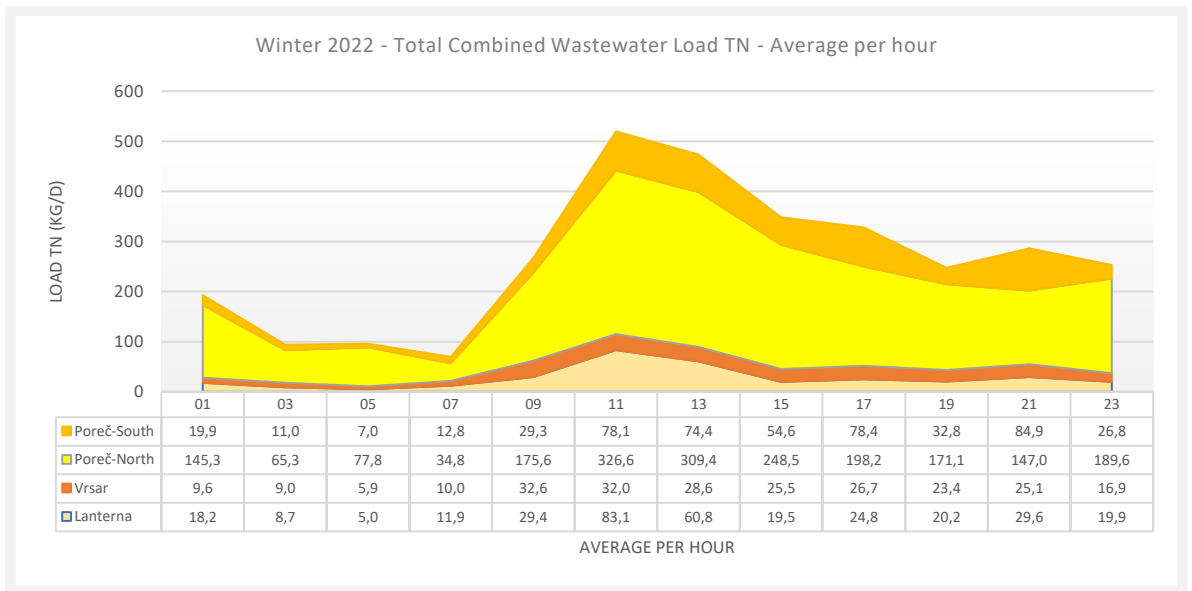


Figure 24. Winter 2022 - Sum of all WWTP's. Hourly average influent TN loads based on 1 measurement day under dry weather.

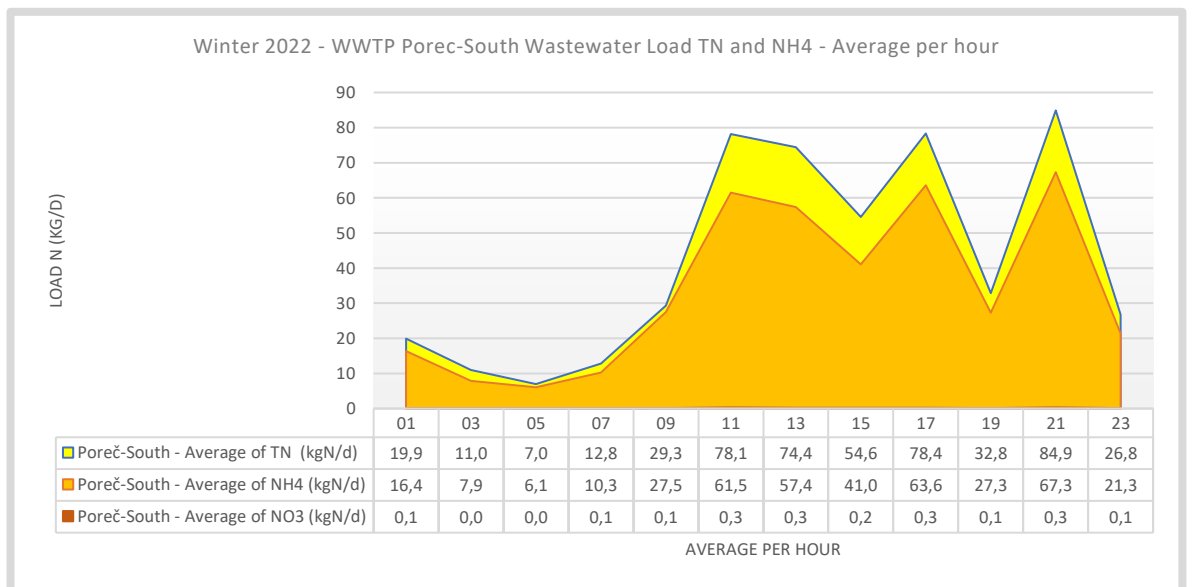


Figure 25. Winter 2022 - WWTP Poreč-South hourly average dry weather influent loads TN, NH4 and NO3, based on 1 measurement day under dry weather conditions.

5.4 Influent Phosphorus 24-hour dynamic loading profile

The phosphorus loading is presented in the graphs below. Phosphorus consists of a soluble ortho-phosphate fraction which is easily transported in the sewer system. Typically, a smaller fraction is related to particulate organic material (particulate COD).

Orthophosphate originates mostly from domestic source in the form of urine. Phosphate often resembles the ammonium profile, peaking between 11:00 and 13:00.



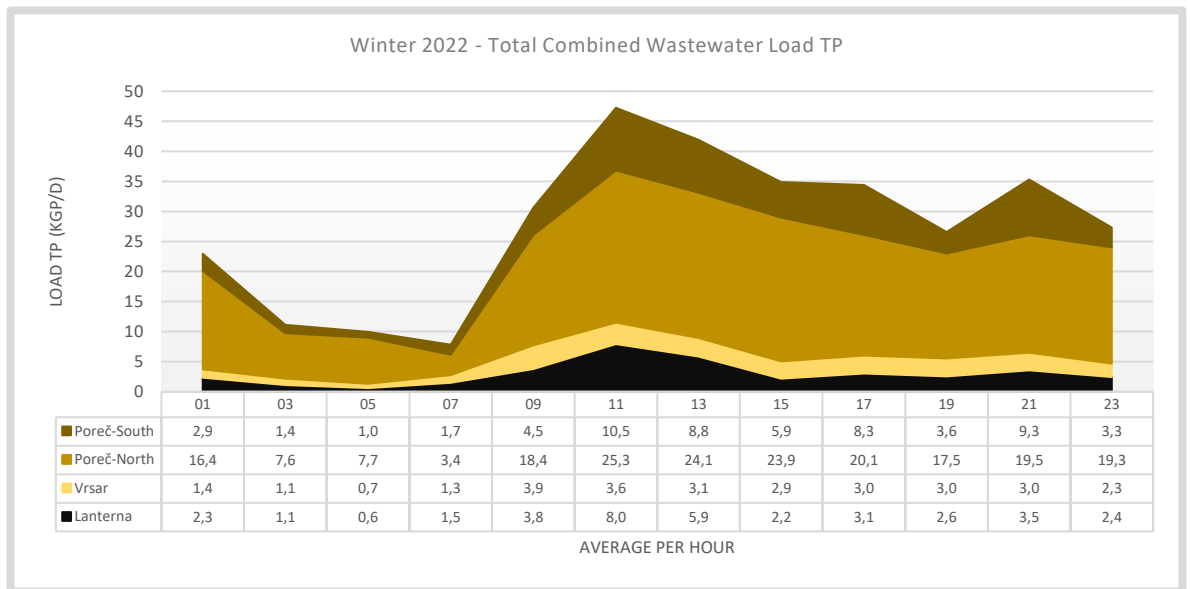


Figure 26. Winter 2022 - Sum of all WWTP's. Hourly average influent TP load based on 1 measurement day, dry weather conditions.

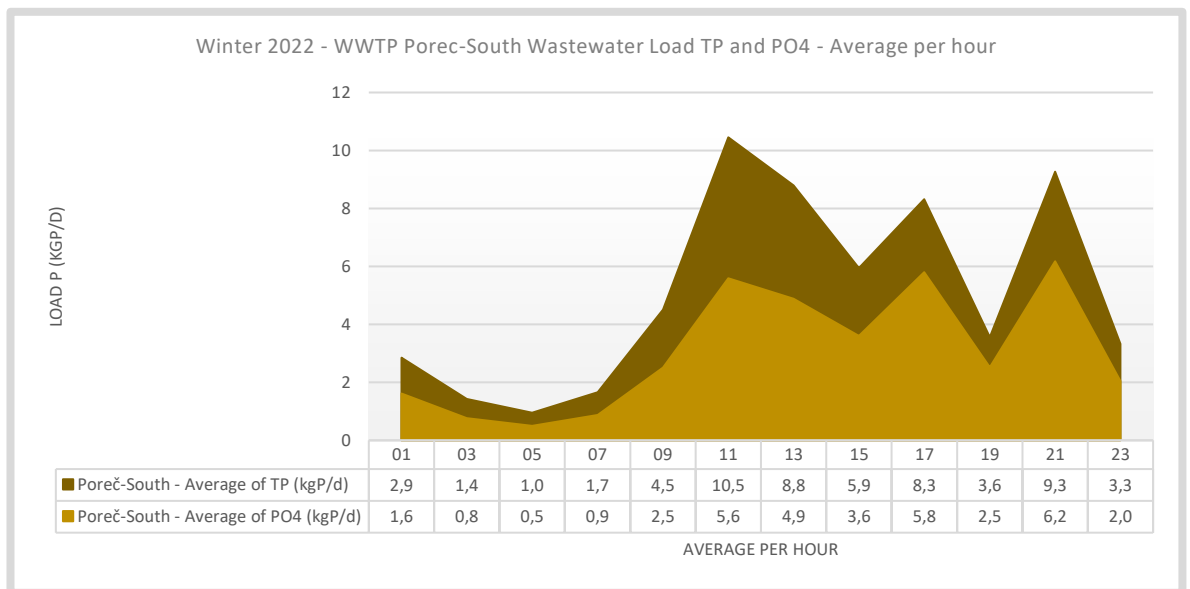


Figure 27. Winter 2022 - WWTP Poreč-South hourly average influent loads TP and PO4, based on 1 measurement day, dry weather conditions.

5.5 Influent Total Suspended Solids 24-hour dynamic loading profile

The loading of particulate material (total suspended solids) is presented in the graphs below. Particulate material typically has a longer transportation time in the sewer. Solid materials will settle in the sewer, especially during dry weather and low nightly flow. Therefore, at low flow conditions, TSS concentration measurements usually are underestimated by 15-25%. During peak flow or rain events, the settled TSS fraction is stirred up and transported to the WWTP. Under these conditions, concentration measurements are generally overestimated. As a result, during low season and low flow conditions, usually only one TSS peak is measured during the day, while during high



season two peaks are measured: One in the morning and one in the evening coinciding with the flow dynamics. TSS consists largely of organic material (volatile suspended solids or VSS). The inorganic fraction (ISS) is typically 6-9%. TSS is typically organic material from domestic source and solids collected from the pavement during rain events. Typically, half of the domestic TSS source is cellulose originating from toilet paper. Industrial and agricultural TSS usually are fibers with a low biodegradability.

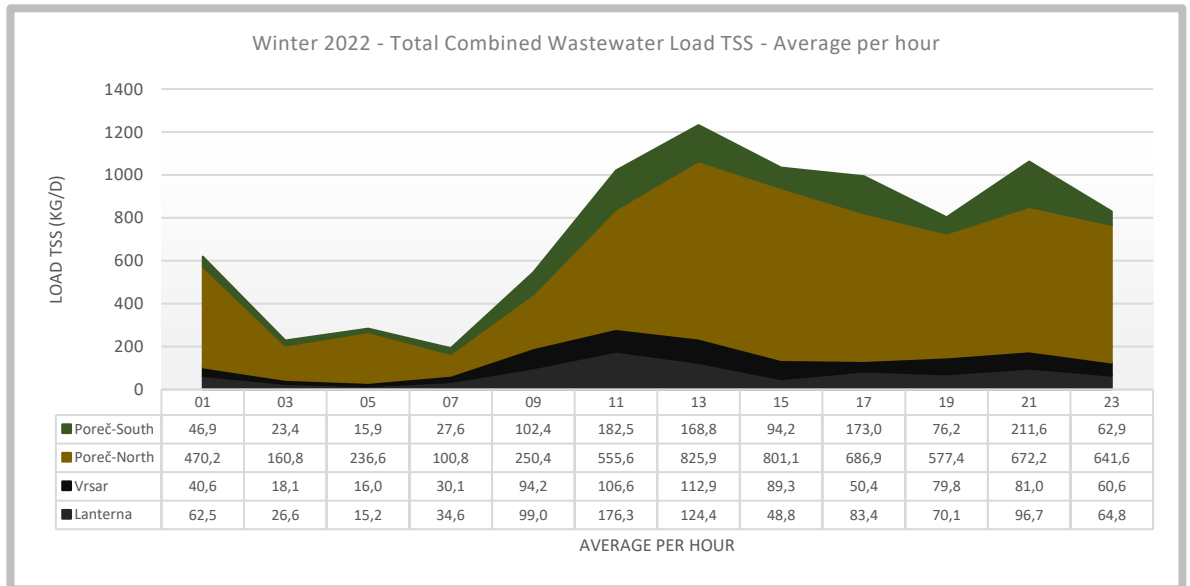


Figure 28. Winter 2022 - Sum of all WWTP's. Hourly average influent TSS load based on 1 measurement day, dry weather conditions.

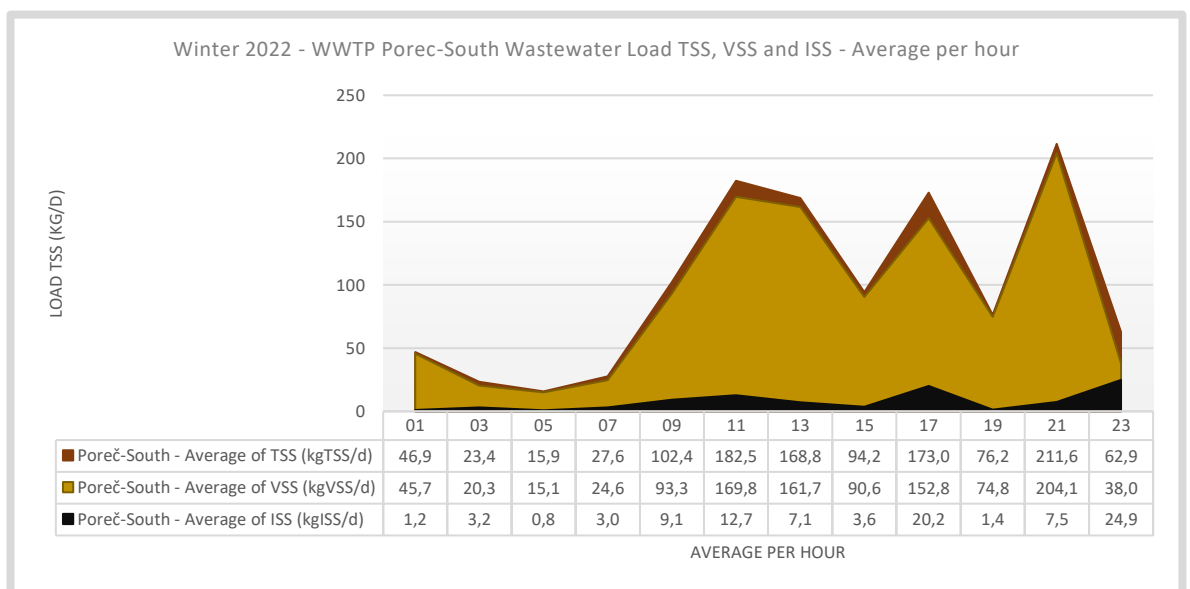


Figure 29. Winter 2022 - WWTP Poreč-South hourly average influent loads TSS, VSS and ISS, based on 1 measurement day, dry weather conditions.



6 Influent specification model

6.1 Determining fractions of influent concentrations

Influent is evaluated based on the BioWin influent specification model, also called influent characterization. This model makes separate calculations to be used as an input for the BioWin activated sludge model. The model is presented in appendix 3. The BioWin influent specification model requires average influent measurement values as input and calculates a set of wastewater parameters presented in the table below. From total COD, N and P the model determines the fractions. For example, the fractions soluble, particulate, and colloidal, biodegradable, and inert and the nitrogen and phosphorus fractions of the different COD fractions. Note that all fractions in the table are in terms of COD. BioWin calculates the influent strength in terms of COD. BOD is fitted to the measured COD using the specification model presented in appendix 3.

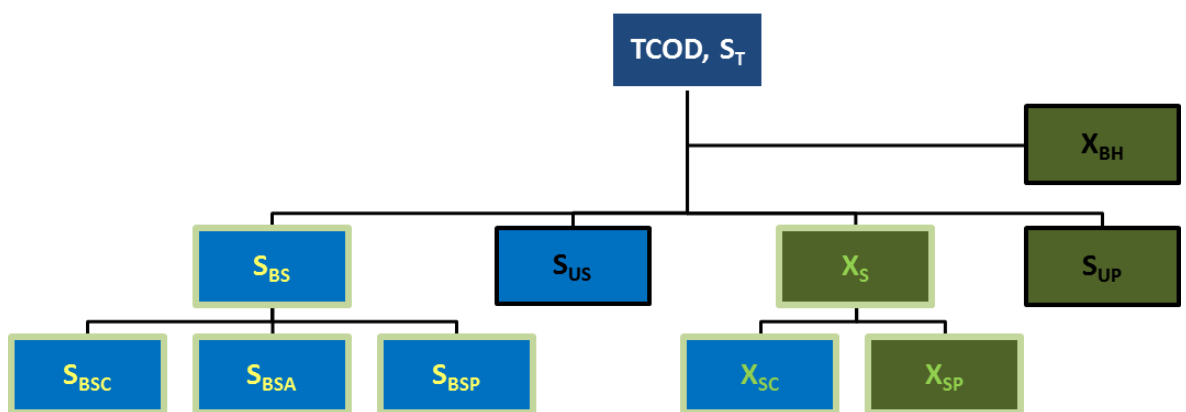


Figure 30. BioWin specification of COD fractions based on total COD in the influent. Blue is soluble (S) and (olive) green particulate or colloidal particulate (X). Green lined boxes are biodegradable and black lined boxes inert. Yellow text indicates readily biodegradable and green text slowly biodegradable.



Table 2. BioWin default influent fractions and calibrated values based on 2022 influent data. Technical note: Setting fractions to zero may result in simulation difficulties.

WWTP Poreč-South - Winter 2022 Result Influent Specifier - Initial Input COD Influent Fractions				
Name	Description	Unit	Raw Wastewater Defaults	Winter Calibrated Value
Fbs	Readily biodegradable (including Acetate)	[gCOD/g of total COD]	0,160	0,335
Fac	Acetate	[gCOD/g of readily biodegradable COD]	0,150	0,251
Fxsp	Non-colloidal slowly biodegradable	[gCOD/g of slowly degradable COD]	0,750	0,741
Fus	Unbiodegradable soluble	[gCOD/g of total COD]	0,050	0,086
Fup	Unbiodegradable particulate	[gCOD/g of total COD]	0,130	0,150
Fcel	Cellulose fraction of unbiodegradable particulate	[gCOD/gCOD]	0,500	0,500
Fna	Ammonia	[gNH ₃ -N/gTKN]	0,660	0,799
Fnox	Particulate ammonia organic nitrogen	[gN/g Organic N]	0,500	0,500
Fnus	Soluble unbiodegradable TKN	[gN/gTKN]	0,020	0,020
FupN	N:COD ratio for unbiodegradable part. COD	[gN/gCOD]	0,070	0,070
Fpo4	Phosphate	[gPO ₄ -P/gTP]	0,500	0,606
FupP	P:COD ratio for unbiodegradable part. COD	[gP/gCOD]	0,022	0,022
Fsr	Reduced sulfur [H ₂ S]	[gS/gS]	0,150	0,150
FZbh	Ordinary heterotrophic COD fraction	[gCOD/g of total COD]	0,020	0,020
FZbm	Methylotrophic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZao	Ammonia oxidizing COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZno	Nitrite oxidizing COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZaao	Anaerobic ammonia oxidizing COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZppa	Phosphorus accumulating COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZpa	Propionic acetogenic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZam	Acetoclastic methanogenic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZhm	Hydrogenotrophic methanogenic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZso	Sulfur oxidizing COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZsrp a	Sulfur reducing propionic acetogenic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZsra	Sulfur reducing acetotrophic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZsrh	Sulfur reducing hydrogenotrophic COD fraction	[gCOD/g of total COD]	1,00E-04	0,000
FZe	Endogenous products COD fraction	[gCOD/g of total COD]	0,0000	0,000

6.2 Results of the specification model

The table above presents the results of the influent specification model. The parameters are input values for BioWin. Input data for pH, Ca, Mg, and alkalinity are used to calculate pH and chemical precipitation reactions. Estimates of Ca, Mg, and alkalinity are made based on data from local drinking water quality measurements provided by the drinking water company. The unbiodegradable soluble COD and TKN in the influent is estimated based on measurement of effluent soluble COD and TKN. For systems with an SRT larger than 3 days typically 98% of effluent soluble COD is unbiodegradable (Fus, SI). Glass Filtered COD (COD_{GF}) is filtered over a glass fiber filter of 1,2 microns and typically is 40% of TCOD. Membrane Filtered COD (COD_{MF}) is flocculated, and membrane filtered over 0,45 microns and thereby the fraction COD_{MF} is always lower than COD_{GF} which contains some colloidal (particulate) material. BOD measurements are including the nitrification inhibitor ATU (therefore carbonaceous BOD). Volatile fatty acids are typically assumed to be 100% acetate. However also a smaller fraction of propionate may be present in raw sewage.



Table 3. Result of the BioWin influent specification model for all WWTP's.

Influent measurements for BioWin Influent Characterization - Winter 2022						
Main influent measurements	Notations	Unit	Lanterna	Vrsar	Poreč-North	Poreč-South
Flow	Q	m ³ /d	302	245	1800	514
Total COD	TCOD, ST	mgCOD/L	584	641	836	558
Total Kjeldahl Nitrogen	TKN	mgN/L	91,4	83,5	96,7	82,7
Total P	TP	mgP/L	10,2	9,9	9,4	9,9
Other influent measurements	Notations	Unit	Lanterna	Vrsar	Poreč-North	Poreč-South
Nitrate N	NO3-N, SNO3	mgN/L	0,5	0,6	0,5	0,4
pH	pH	-	8,0	8,1	7,9	8,2
Alkalinity (CaCO ₃ equivalent)	Alk	mgCaCO ₃ /L	373	373	373	373
Calcium	Ca, Sca	mg/l	80	80	80	80
Magnesium	Mg, SMg	mg/l	15	15	15	15
Dissolved oxygen	DO, (SO ₂)	mgO ₂ /l	0,1	0,1	0,1	0,1
Additional measurements for modeling	Notations	Unit	Lanterna	Vrsar	Poreč-North	Poreč-South
Effluent filtered COD	CODS_EFF	mgCOD/L	35	36	32	48
Influent filtered COD (including colloidal)	CODGF_INF, CODS_INF	mgCOD/L	279	270	455	294
Influent FF COD (excluding colloidal)	CODMF_INF	mgCOD/L	223	216	364	235
Influent acetate	HAc, VFA, SA	mgCOD/L	44,7	43,2	72,8	47,0
Influent ammonia	NH ₄ -N, SNH ₄	mgN/l	69,3	65,5	76,6	66,1
Influent ortho-phosphate	PO ₄ -P, SPO ₄	mgP/l	5,5	5,6	5,4	6,0
Influent carbonaceous BOD ₅	TCBOD, TBOD, BOD ₅	mgO ₂ /l	282	288	385	290
Influent filtered cBOD ₅	SCBOD, SBOD, BODS	mgO ₂ /l	164	153	273	149
Influent VSS	VSS	mgVSS/L	232	249	281	186
Influent TSS	TSS	mgTSS/L	249	265	305	202
Derived model fractions	Notations	Unit	Lanterna	Vrsar	Poreč-North	Poreč-South
Fraction unbiodegradable Soluble COD	Fus	-	#REF!	#REF!	#REF!	#REF!
Particulate COD non-colloidal	CODp, CODX	mgCOD/l	305	371	381	264
Readily biodegradable COD including VFA	Fbs	-	#REF!	#REF!	#REF!	#REF!
Acetate fraction of readily biodegradable COD (SBS)	Fac	-	#REF!	#REF!	#REF!	#REF!
fraction ammonia of TKN	Fna	-	0,76	0,78	0,79	0,80
fraction phosphate of TP	Fpo ₄	-	0,54	0,56	0,57	0,60
TCOD/BOD ₅ , total COD over BOD ₅ ratio	TCOD/BOD ₅	-	2,07	2,23	2,17	1,93
CODX/VSS, particulate (non-colloidal) COD/VSS ratio	Fcv	-	1,31	1,49	1,35	1,42
Inorganic suspended solids (ash fraction of TSS)	ISS	mg/l	17	16	23	16

6.3 Conclusions

The measured influent data results in a well fitted specification model within acceptable range of parameter settings. Influent data is tested reliable and validated as wastewater of mainly domestic source applicable for WWTP modelling. The result of the specification model is a set of BioWin model input parameters and is part of the model calibration procedure which is further discussed in the following chapter. The specification model and calculation method are presented in appendix 3.



7 Model calibration and validation

7.1 Static calibration

The model is calibrated based on average 24-hour dynamic winter 2022 influent and effluent measurements. Model parameters are adjusted to reproduce the measured average effluent performance of COD, N and P. The parameter adjustments for calibration are presented in the table below. No stoichiometric parameters are adjusted. This indicates the model is valid. Some kinetic parameters are adjusted to finetune the model performance on the specific dataset and correct for approximations used in the simulation of operational conditions. Finetuning of kinetic parameters is allowed within acceptable margin and typically required for each new simulated condition.

Table 4. BioWin model calibration parameter adjustments.

WWTP Poreč-South - 2022 - Calibrated parameters			
Parameter Name	BW Default	Calibrated	Affecting
Ordinary heterotrophic DO half sat. [mgO ₂ /L]	0,15	0,6	Simultaneous nitrification and denitrification
Ammonia oxidizing DO half sat. [mgO ₂ /L]	0,25	0,5	Reduces nitrification at low DO
Nitrite oxidizing DO half sat. [mgO ₂ /L]	0,5	0,25	Improves Nitrite oxidation at low DO
Anoxic growth factor OHO [-]	0,5	1,0	Adaptation to anoxic conditions
Anoxic growth factor PAO [-]	0,5	0,33	Adaptation to anoxic conditions
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1,6327	1,5	Solids accumulation from influent
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1,6	1,2	Solids accumulation from influent

7.2 Parameters PAO updated to TUDP-model

In BioWin the parameter for Anoxic P/PHA uptake and P/Ac release ratio are updated to the published TUDP-model. It is found that the anoxic performance of PAO's is less conservative than assumed in the default BioWin parameter settings. The PAO parameters are updated according to the latest research.

7.3 Anoxic growth factors for OHO and PAO

This parameter represents the fraction of heterotrophic organisms that can grow under both aerobic and anoxic conditions. The parameter proportionally reduces the growth rate under anoxic conditions. Substrate and nutrient limitations may further reduce the growth rate. Anoxic growth factors are adjusted to fit the model on the measured denitrification and effluent nitrogen concentration. The growth factors typically are increased for WWTP's designed with pre-denitrification where biomass is adapted to grow under full anoxic



conditions (this in contrary to simultaneous nitrification and denitrification often observed in carousel type processes). By increasing the growth factor, a larger fraction of heterotrophic biomass (PAO and OHO) will have denitrifying capacity. In systems without pre-denitrification these factors are usually set to the lower (default) value. The applied model adjustments are well within the acceptable range and do not affect the model reliability. These parameters also can change because of operation (e.g., applied anoxic recycle flow rate).

7.4 DO half saturation

The DO half saturation is a kinetic parameter determining the sensitivity for oxygen. It is adjusted to compensate for partial unaerated zones or unaerated periods which are the result of the oxygen control settings. By increasing the DO half saturation for denitrification, more simultaneous nitrification and denitrification (SND) will occur under low DO conditions. The parameter adjustment simulates the effect of partial aerated tanks. Under normal settings nitrite (NO₂) is formed in the model. Most likely as result of the simplified oxygen modeling because no nitrate is measured in the effluent. To compensate for this, the DO half saturation for nitrification is decreased to finetune the formation of nitrite. This has no significant effect on the model reliability and is mainly applied for fine tuning effluent results. The DO half saturation for nitrification is increased to reduce the nitrification rate at low DO concentration. This is done to reproduce the higher measured effluent ammonium concentration. Bacteria adjust to the operated DO conditions. This parameter therefore will change during operation and needs fine tuning for each simulated period. It is also possible the system is still adapting its kinetic sensitivity after its start-up and therefore not (yet) in steady state.

7.5 Particulate influent COD/VSS ratio

These parameters are the result of the influent specification calculation (appendix 3). The COD/VSS ratio determines how much solids accumulate in the WWTP and how much is biodegraded. The adjustments are directly derived from the applied influent measurements and well within the acceptable range and do not affect the model reliability.

Table 5. BioWin model calibration – Results model and measured effluent.

WWTP Poreč-South - Scenario Winter 2022 - Result static calibration			
Attribute	Unit	EFF Simulated	EFF-measurement
COD - Total	mg/L	59,2	58,6
BOD - Total Carbonaceous	mg/L	0,9	10,3
N - Total N	mgN/L	8,1	6,9
N - Ammonia	mgN/L	2,3	2,2
N - Nitrate	mgN/L	1,1	0,6
P - Total P	mgP/L	0,6	0,7
Total suspended solids	mg/L	0,0	0,0



7.6 Calibration results and discussion

In the table below, the results of the model and the effluent measurements are compared. The model predicts the effluent within a reasonable range. In the calibration procedure the model is fitted primarily to NH₄ by adjusting the aeration control, and it is attempted to find the most optimal overall dynamic fit with the least parameter adjustment required. There are however some small deviations between the measurements and model results which are here discussed. Typically, measurements have a margin of error and show a spread as the result of small errors. However, measured and modelled effluent BOD shows a consistent deviation and is not predicted accurately. In general BOD is not a very reliable measurement especially in the low concentration range. Moreover, high soluble BOD in the effluent is unlikely for systems with sufficient aerobic SRT, which is the case for this WWTP (table 9). Therefore, it is assumed the measured BOD is overestimated (and consequently also total COD). Or the sample may be contaminated. The concentration values of NH₄, NO₃ and NO₂ are reasonably predicted taking in account these concentrations vary depending on the operation and time of day. Effluent NH₄, NO₃ and NO₂ are strongly dependent on the applied aeration and recirculation controls. Operational data was not available, and these controls are estimated in the model. This may also explain the (slight) formation of NO₂ in the model which also is consistently overestimated compared to the measurements, which generally are zero. Most likely NO₂ is not measured accurately for it is complicated to preserve and store samples properly and NO₂ quickly can convert before being measured. Considering the relatively high measured NH₄ some NO₂ is expected to be formed. This is supported by TN which does not add up with other measured nitrogen components. This may indicate a measurement error. As the result of a model artifact TN in the model is underestimated; Filtered COD has no individual parameter to set the nitrogen fraction. In the MBR filtered COD is the only effluent COD fraction and this also partly can explain the (small) gap between measured and modeled TN.

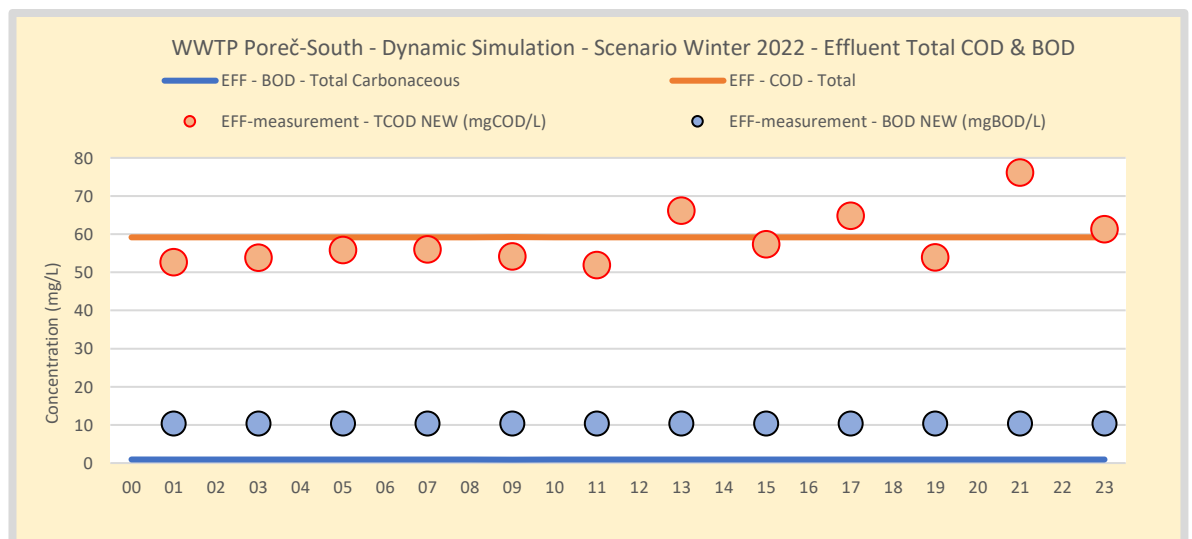


Figure 31. Winter 2022 – WWTP Poreč-South – Model validation based on 24-hour dynamic effluent COD and BOD data. For all measured effluent results the model underpredicts measured effluent BOD. Typical effluent BOD for systems operated at SRT > 3 days BOD is below 3 mg/L. The BOD measurements are likely unreliable.



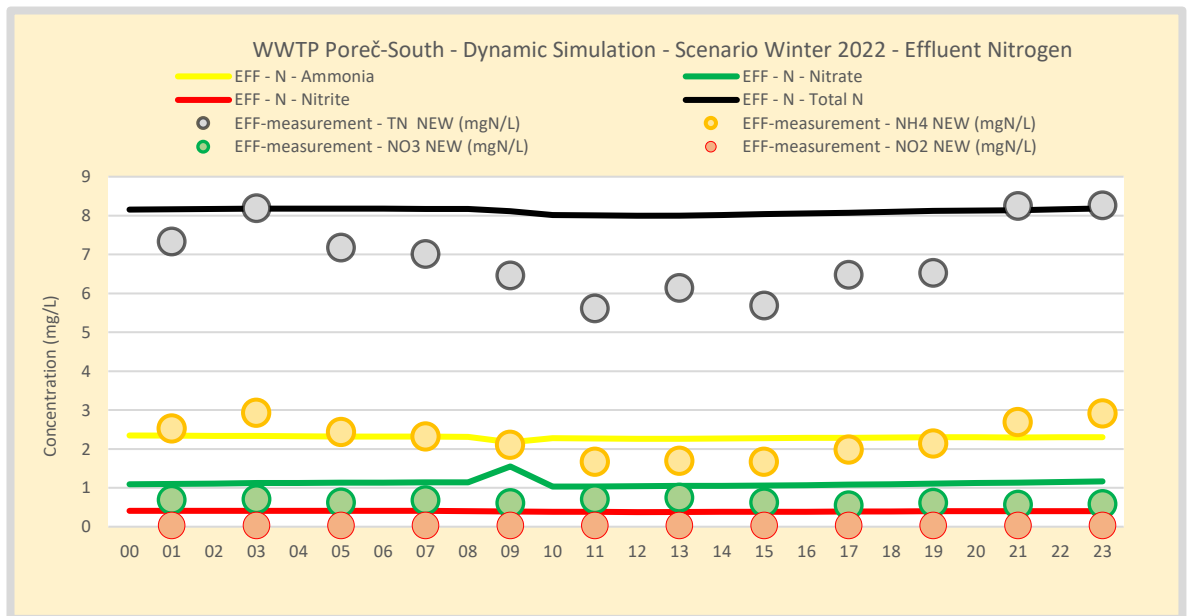


Figure 32. Winter 2022 – WWTP Poreč-South – Model validation based on 24-hour dynamic effluent TN, NH4 and NO3 data. The model is fitted to the effluent NH4 concentration. In the model 100% of effluent is buffered in the storage tank and measured variation in effluent TN cannot be simulated.

7.7 Model validation

The model is validated based on the presented calibration results; No stoichiometric or other critical parameters are adjusted to reproduce measured conditions. This indicates the model is valid and suited to simulate (dynamic) operational conditions and valid to be used for extrapolation to (future) load conditions (as is done in report 6 and 7). Validation is supported by dynamic model results. In the figures above the dynamic effluent performance is plotted against the measurements. The effluent is measured coming from the effluent buffer and is reasonably well reproduced by the model.

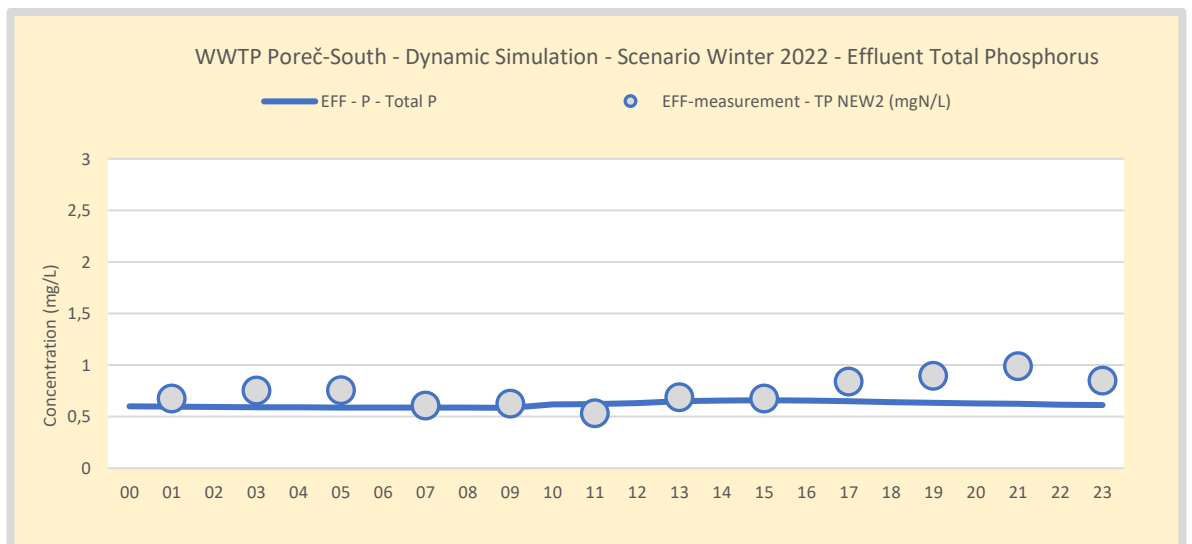


Figure 33. Winter 2022 – WWTP Poreč-South – Model validation based on 24-hour dynamic effluent TP.



7.8 Conclusion dynamic simulations

The WWTP result of the 2022 calibrated model (appendix 4) is largely identical to the results of the 2019 7-day dynamic winter simulation presented in report 7. The effluent concentration is simulated within the projected effluent limits. Due to operational differences of aeration, SRT, and internal recycles, operational hour to hour effluent results can differ considerably. However, the overall performance of COD, N and P-removal is largely identical for both the 2019 and 2022 models. This is explained by the minor parameter adjustments required to simulate both conditions. This indicates the model is well developed, has no gross shortcomings, and is tested valid for application in this research project.

7.9 Conclusions

- The model is calibrated based on the provided operational data.
- Parameters are all adjusted within the typical and acceptable range.
- No stoichiometric parameters are adjusted.
- All adjustments are used to fit the model to specific operational conditions and typically required for each performed simulation study.
- Based on the presented calibration results the model is validated for interpolation to study operational dynamics and extrapolation for scenario analysis.
- Additional validation is provided by the dynamic simulation.
- The 2019 and 2022 calibrated model results are in accordance.
- The model is tested valid for use in this research project.



8 Conclusions and recommendations

8.1 General conclusions

- The model is tested successfully on an independent data set and reproduced all data without significant adjustments.
- The model is tested reliable and validated for use for operational and scenario evaluation.
- The above conclusions apply to all presented results, under which previous WWTP modelling reports published in this series, which have used the here validated model.

8.2 Summary of technical conclusions

- Influent dry weather flow data measured in the winter of 2019 and 2022 are comparable.
- There is similarity in the minimum and maximum flow data as well as the flow distribution pattern over the day on an hourly basis.
- The measured profile is successfully used in the calibration study to validate the model performance.
- The measured influent data results in a well fitted model within acceptable range of parameter settings.
- Some measurements are inconsistent and corrected based on typical influent fractions.
- The total influent data set is tested reliable and validated as wastewater of mainly domestic source useful for WWTP modelling.
- The result of the specification model is used in the model calibration procedure.
- The model is calibrated based on the provided operational data.
- Parameters are all adjusted within the typical and acceptable range.
- No stoichiometric parameters needed to be adjusted.
- All adjustments are used to fit the model to specific operational conditions and typically required for each performed simulation study.
- Based on the calibration results the model is validated for interpolation, to study operational dynamics and for extrapolation and future scenario analysis.
- Additional model validation is provided by dynamic simulations.
- The 2019 and 2022 calibrated model results are in accordance.
- The model is tested valid for use in this research project.

8.3 Recommendations

It is recommended to proceed with final development of the scenario analysis and sea water modelling taking in account the presented conclusions.



Appendix 1. Influent Concentrations Winter 2022

Winter 2022 - Average Concentrations; Time Average and Flow Proportional				
	Lanterna	Vrsar	Poreč-North	Poreč-South
TSS				
(mgTSS/L) - Flow Proportional	249,0	265,2	276,8	192,2
VSS				
(mgVSS/L) - Flow Proportional	232,2	248,8	255,6	176,8
ISS				
(mgISS/L) - Flow Proportional	16,8	16,4	21,2	15,3
BOD				
(mgBOD/L) - Flow proportional	281,8	319,8	385,4	289,7
BODMF				
(mgBOD/L) - Flow proportional	163,9	152,6	218,3	148,5
TCOD				
(mgCOD/L) - Flow Proportional	583,9	641,3	835,7	558,1
CODMF				
(mgCOD/L) - Flow Proportional	446,5	216,0	363,8	235,2
TN				
(mgN/L) - Flow Proportional	91,4	83,5	96,7	82,7
NH4				
(mgN/L) - Flow Proportional	69,3	65,5	76,6	66,1
NO3				
(mgN/L) - Flow Proportional	0,5	0,4	0,5	0,3
NO2				
(mgN/L) - Flow Proportional	0,0	0,2	0,0	0,1
TP				
(mgP/L) - Flow Proportional	10,2	9,9	9,4	9,9
PO4				
(mgP/L) - Flow Proportional	5,5	5,6	5,4	6,0
pH (-) - Flow proportional	8,0	8,1	7,9	8,2
TSS				
(mgTSS/L) - Time Average	254,3	256,3	273,3	185,9
VSS				
(mgVSS/L) - Time Average	238,6	241,0	255,4	168,5
ISS				
(mgISS/L) - Time Average	15,8	15,3	18,0	17,3
BOD				
(mgBOD/L) - Time Average	281,8	319,8	385,4	289,7
BODMF				
(mgBOD/L) - Time Average	163,9	152,6	218,3	148,5
TCOD				
(mgCOD/L) - Time Average	624,3	652,9	796,4	599,0
CODMF				
(mgCOD/L) - Time Average	465,3	219,9	347,1	235,9
TN				
(mgN/L) - Time Average	86,5	82,0	94,5	80,2
NH4				
(mgN/L) - Time Average	68,3	64,1	73,6	64,6
NO3				
(mgN/L) - Time Average	0,5	0,4	0,5	0,3
NO2				
(mgN/L) - Time Average	0,0	0,2	0,0	0,1
TP				
(mgP/L) - Time Average	10,2	9,9	9,4	9,9
PO4				
(mgP/L) - Time Average	5,6	5,6	5,1	5,9
pH (-) - Time Average	8,0	8,1	7,9	8,2



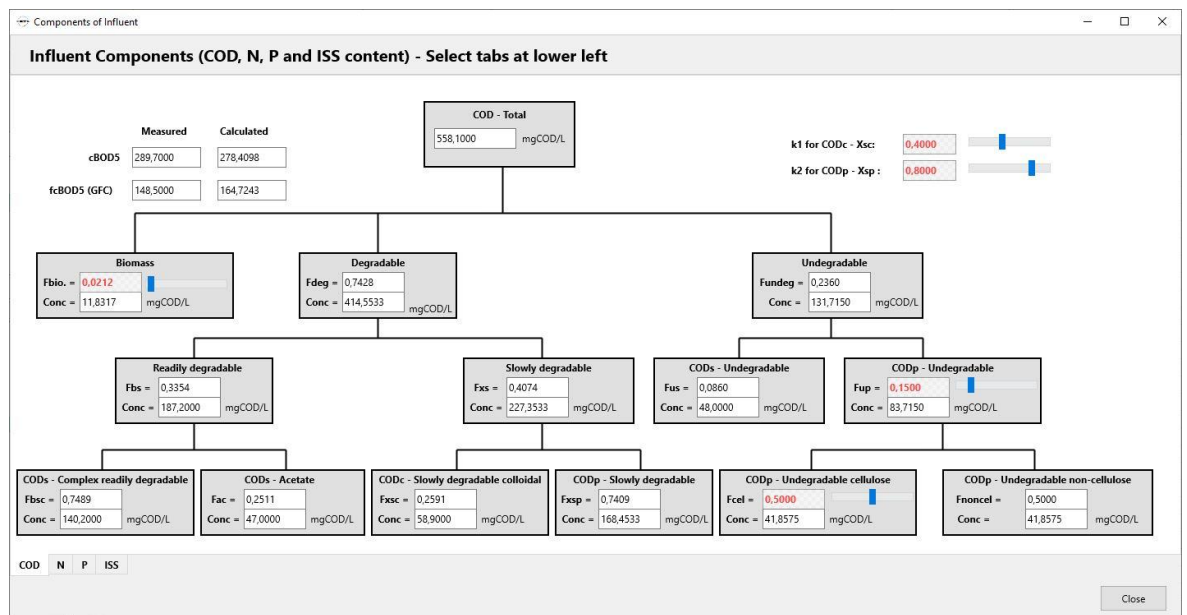
Appendix 2. Influent Load Winter 2022

Winter 2022 - Average Influent Loads per WWTP				
	Lanterna	Vrsar	Poreč-North	Poreč-South
Flow (m ³ /d)	302,0	245,0	1800,0	514,0
TSS (kgTSS/d)	75,2	65,0	498,3	98,8
VSS (kgVSS/d)	70,1	61,0	460,1	90,9
ISS (kgISS/d)	5,1	4,0	38,2	7,9
BOD (kgBOD/d)	85,1	78,4	693,7	148,9
BODMF (kgBOD/d)	49,5	37,4	392,9	76,3
TCOD (kgCOD/d)	176,3	157,1	1504,2	286,9
CODMF (kgCOD/d)	134,9	52,9	654,8	120,9
TN (kgN/d)	27,6	20,5	174,1	42,5
NH ₄ (kgN/d)	20,9	16,0	137,9	34,0
NO ₃ (kgN/d)	0,2	0,1	0,9	0,2
NO ₂ (kgN/d)	0,0	0,0	0,0	0,1
TP (kgP/d)	3,1	2,4	16,9	5,1
PO ₄ (kgP/d)	1,6	1,4	9,7	3,1



Appendix 3. BioWin Model Influent Specification

Results of the influent specification model



Influent Specifier - 2022 02 14 POSO Winter 2022 MYRrev001.ets

File Setting View Stoichiometry About

Input Measurements Adjust Fractions View Results Export to BioWin

Fraction / Parameter Estimates			Fraction Calculation Results			
Name	Default	Estimate	Influent Values	Measured	Calculated	Match Status
COD Fractions			COD - Total	558,1000	558,1000	-
Fbs	0,1600	0,3354	COD - Particulate	264,0000	264,0000	Excellent
Fac	0,1500	0,2511	COD - Filtered	294,1000	294,1000	Excellent
Fxs	0,6388	0,4074	COD - FF	235,2000	235,2000	Excellent
Fxsp	0,7500	0,7409	BOD - Total Carbonaceous	289,7000	278,4098	Excellent
Fbiomass	0,0212	0,0212	BOD - Filtered Carbonaceous	148,5000	164,7243	Excellent
Fus	0,0500	0,0860	VSS	185,7000	185,4138	Excellent
Fup	0,1300	0,1500	TSS	201,8000	201,5138	Excellent
Cellulose (Note...)	0,5000	0,5000				
Non-Cellulose	0,5000	0,5000				
COD : VSS			Influent CODp : VSS	1,4216	1,4238	Excellent
Particulate Biodegradable COD : VSS	1,6327	1,5000	Influent Total COD : cBOD	1,9265	2,0046	Excellent
Particulate Inert COD : VSS	1,6000	1,2000	VSS : TSS	0,9202	0,9201	Excellent
Cellulose COD : VSS	1,4000	1,4000				
BOD Model Parameters (Note...)						
k1 for CODc - Xsc	0,5000	0,4000				
k2 for CODp - Xsp	0,5000	0,8000				



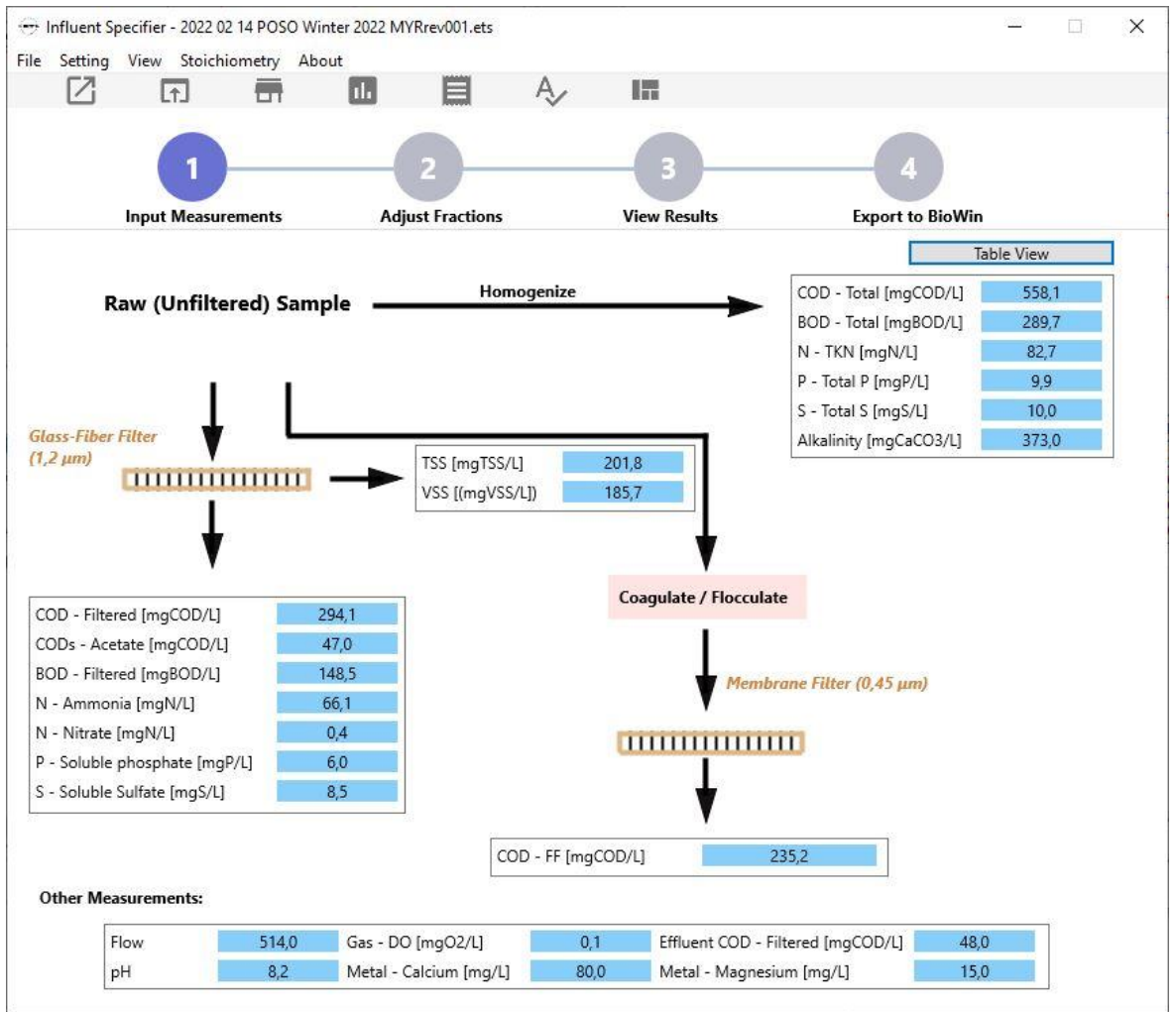
Influent Specifier - 2022 02 14 POSO Winter 2022 MYRrev001.ets

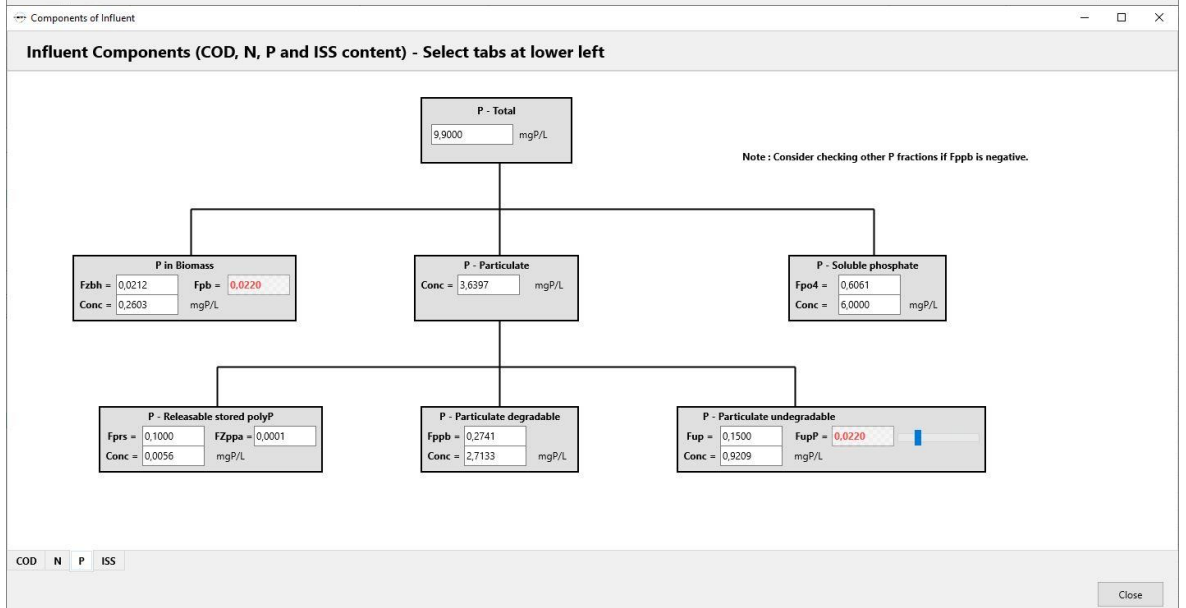
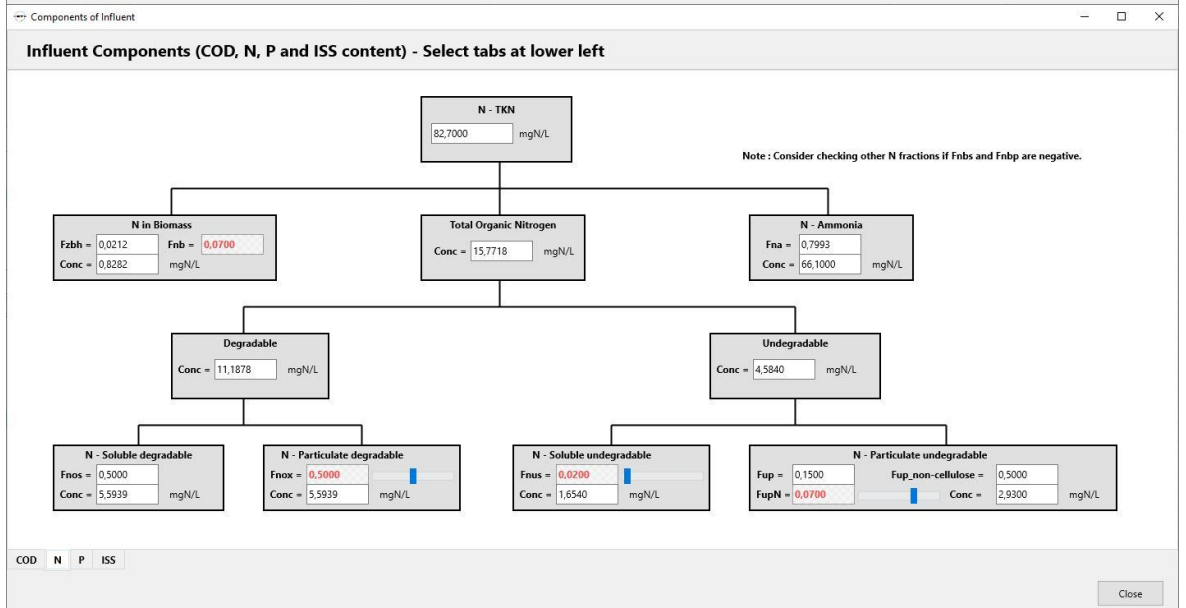
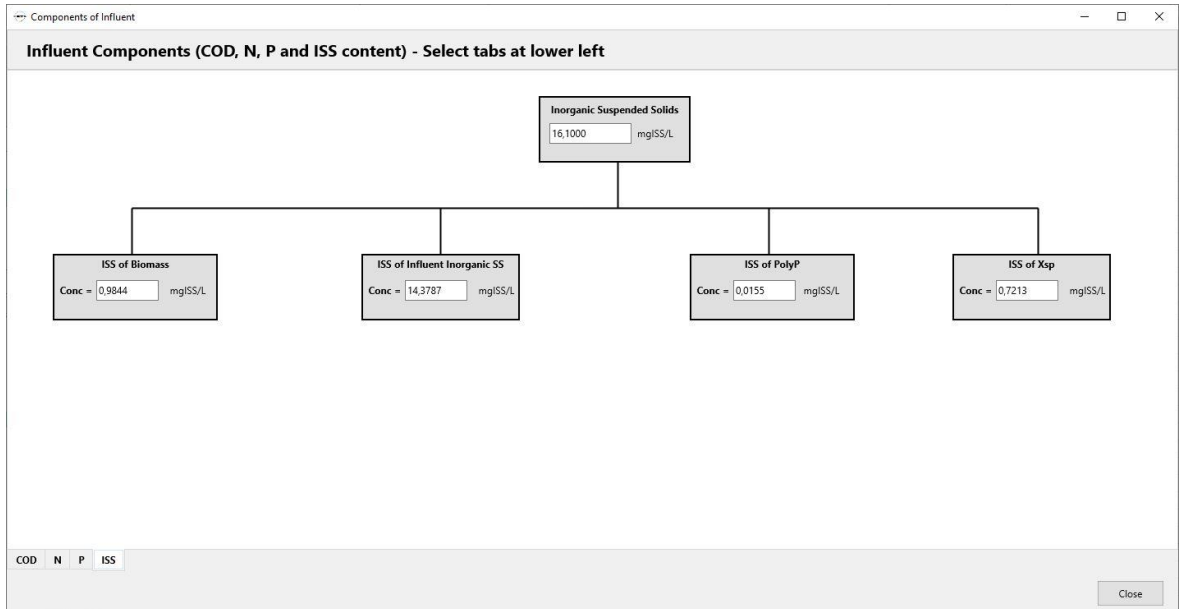
File Setting View Stoichiometry About

Input Measurements Adjust Fractions **3 View Results** 4 Export to BioWin

COD/BOD Calculation Results		P, N and ISS Calculation Results	
Name	Value	Name	Value
COD Calculation Results		P Calculation Results	
B - Z [mg/L]	11,8317	P in biomass [mgP/L]	0,2603
CODc - Xsc [mg/L]	58,9000	P - Particulate degradable [mgP/L]	2,7133
CODp - Xsp [mg/L]	168,4533	P - Particulate undegradable [mgP/L]	0,9209
CODp - (Xu + Xuc) [mg/L]	83,7150	P - Releasable stored polyP [mgP/L]	0,0056
CODs - Sa [mg/L]	47,0000	P - Soluble phosphate [mgP/L]	6,0000
CODs - Sc [mg/L]	140,2000	Measured Total P [mgP/L]	9,9000
CODs - Su [mg/L]	48,0000		
		N Calculation Results	
COD Total-check [mg/L]	558,1000	N in biomass [mgN/L]	0,8282
		N - Ammonia [mgN/L]	66,1000
COD - Particulate [mg/L]	264,0000	N - Particulate degradable organic [mgN/L]	5,5939
COD - Slowly Biodegradable [mg/L]	227,3533	N - Particulate undegradable organic [mgN/	2,9300
COD - Readily Biodegradable [mg/L]	187,2000	N - Soluble degradable organic [mgN/L]	5,5939
		N - Soluble undegradable organic [mgN/L]	1,6540
Sol. COD fraction	0,5270	Measured TKN [mgN/L]	82,7000
		ISS Calculation Results	
BOD Calculation Results		ISS of Biomass [mgISS/L]	0,9844
BODrbcod [mg/L]	133,5916	ISS of Influent Inorganic SS [mgISS/L]	14,3787
BODxsc [mg/L]	107,0711	ISS of PolyP [mgISS/L]	0,0155
BODxsp [mg/L]	31,1326	ISS of Xsp [mgISS/L]	0,7213
BODhet [mg/L]	6,6145	Measured ISS [mgISS/L]	16,1000
BODtotal [mg/L]	278,4098		







Presenting the BioWin influent specification model

The influent is divided in its fractions and used in the BioWin model calculations. Therefore, several influent fractions are introduced to facilitate the calculations in the model (Table 27, BW-influent tab). An overview of the fractions is presented below including relation to actual analytical measurements.

The influent unbiodegradable COD (S_{US}) for systems with a SRT > 3 days is based on the effluent measurement of soluble (glass filtered) COD according to:

$$S_{US} = COD_{S,EFF} = COD_{GF,EFF}$$

(Eq. 1)

The fraction unbiodegradable COD is calculated according to:

$$F_{US} = \frac{S_{US}}{TCOD} = \frac{COD_{GF,EFF}}{TCOD_{INF}}$$

(Eq. 2)

Soluble COD is including the colloidal and expressed as COD_S as the sum of all soluble model fractions. It can be measured from glass filtered COD according to:

$$COD_S = S_{BSA} + S_{BSP} + S_{BSC} + X_{SC} + S_{US} = COD_{GF,INF}$$

(Eq. 3)

Particulate (non-colloidal) COD (COD_p or COD_x) is the sum of particulate (non-colloidal) COD, particulate unbiodegradable COD and active biomass in the influent (X_{BH} is often assumed zero) given by:

$$COD_x = X_{SP} + S_{UP} + X_{BH} \approx X_{SP} + S_{UP}$$

(Eq. 4)

COD_x is calculated by subtracting the total COD and the soluble COD (COD_S) which is calculated based on the glass filtered COD according to:

$$COD_x = TCOD - COD_S = TCOD_{INF} - COD_{GF,INF}$$



(Eq. 5)

Soluble COD excluding the colloidal is expressed as COD_{MF} and measured from membrane filtering the COD according to:

$$COD_{MF} = S_{BSA} + S_{BSP} + S_{BSC} + S_{US} = COD_{MF,INF}$$

(Eq. 6)

The total soluble readily biodegradable COD (the total of acetate, propionate, and complex soluble COD but without slowly colloidal COD) is calculated from the measured micro filtered fraction COD_{MF} according to:

$$S_{BS} = S_{BSA} + S_{BSP} + S_{BSC} = COD_{MF} - S_{US} = COD_{MF,INF} - COD_{GF,EFF}$$

(Eq. 7)

The fraction of soluble readily biodegradable COD is given by:

$$F_{BS} = \frac{S_{BS}}{TCOD} = \frac{(S_{BSA} + S_{BSP} + S_{BSC})}{TCOD} = \frac{COD_{MF,INF} - COD_{GF,EFF}}{TCOD_{INF}}$$

(Eq. 8)

Influent acetate (+ propionate) is direct measured as VFA:

$$S_{BSA} + S_{BSP} = VFA_{INF}$$

(Eq. 9)

The fraction of readily biodegradable COD which is acetate is given by:

$$F_{AC} = \frac{S_{BSA}}{S_{BS}} = \frac{S_{BSA}}{(S_{BSA} + S_{BSP} + S_{BSC})} = \frac{VFA_{INF}}{COD_{MF,INF} - COD_{GF,EFF}}$$

(Eq. 10)



From the difference between the glass and membrane filtered COD, the colloidal fraction can be calculated according to:

$$X_{SC} = COD_S - COD_{MF} = COD_{GF,INF} - COD_{MF,INF}$$

(Eq. 11)

The last soluble parameter to be calculated is the complex soluble COD S_{BSC} calculated from the measurements according to:

$$S_{BSC} = COD_{MF} - S_{BSA} - S_{BSP} - S_{US} = COD_{MF,INF} - VFA_{INF} - COD_{GF,EFF}$$

(Eq. 12)

The total soluble (readily and slow colloidal) biodegradable COD (S_S) is the total of acetate, propionate, complex soluble COD and colloidal COD (influent methanol is assumed zero) given by:

$$S_S = S_{BSA} + S_{BSP} + S_{BSC} + X_{SC}$$

(Eq. 13)

And calculated according to:

$$S_S = COD_S - S_{US} = COD_{GF,INF} - COD_{GF,EFF}$$

(Eq. 14)

In the figure below biodegradable COD (S_S) is divided in fractions. BioWin notation of S_S should not be confused with IAWQ S_S which equals BioWin S_{BS} .



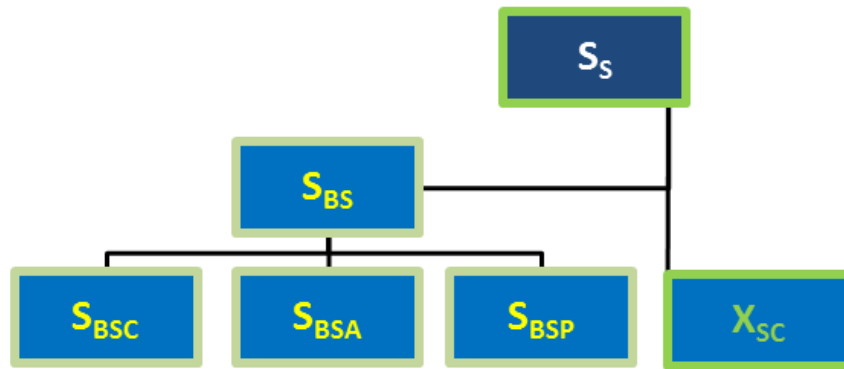


Figure 34. BioWin wastewater fractions of soluble biodegradable COD (S_s). The fraction is measured by glass filtering and includes all soluble and colloidal material. Blue fractions are soluble and (olive) green fractions (colloidal) particulate.

The last two influent fraction that need to be calculated are related to the solids: particulate biodegradable COD and unbiodegradable COD according to (Eq. 4):

$$COD_X = X_{SP} + S_{UP} + X_{BH} \approx X_{SP} + S_{UP}$$

These fractions are estimated from the BOD measurements in the influent as explained in the following sections of this chapter.

The BioWin influent tab the fraction of slowly biodegradable influent COD which is particulate is given by:

$$F_{XPS} = \frac{X_{SP}}{X_{SC} + X_{SP}}$$

(Eq. 15)

VSS is often calculated from ISS (Ash) measurement according to:

$$VSS = TSS - ISS$$

(Eq. 16)

The influent ratio of particulate (non-colloidal) COD to VSS is given by:

$$F_{CV} = \frac{COD_X}{VSS} = \frac{TCOD - COD_S}{VSS} = \frac{TCOD_{INF} - COD_{GF,INF}}{TSS - ISS}$$



(Eq. 17)

Ammonia is given by:

$$NH_3 = F_{NA} \times TKN$$

(Eq. 18)

Soluble unbiodegradable organic nitrogen is given by:

$$N_{US} = F_{NUS} \times TKN$$

(Eq. 19)

Nitrogen from organisms present in the influent is calculated by the sum of the products of the various organism concentrations and their respective nitrogen fractions, i.e.:

$$Organisms, N = \sum Zb_x - f_{N,Zbx}$$

(Eq. 20)

Unbiodegradable particulate nitrogen is given by:

$$X_{IN} = F_{UP,N} \times F_{UP} \times TCOD$$

(Eq. 21)

The remaining organic nitrogen is broken into particulate and soluble components. Particulate biodegradable organic nitrogen is given by:

$$X_{ON} = (TKN - NH_3 - N_{US} - X_{IN} - Organisms, N) \times F_{NOX}$$

(Eq. 22)

Soluble biodegradable organic nitrogen is given by:

$$N_{OS} = (TKN - NH_3 - N_{US} - X_{IN} - Organisms, N) \times (1 - F_{NOX})$$

(Eq. 23)



Similarly, an explanation of the fractionation of influent phosphorus is as follows. Soluble orthophosphate is given by:

$$PO_4 = F_{PO_4} \times TP$$

(Eq. 24)

Phosphorus from organisms present in the influent is calculated by the sum of the products of the various organism concentrations and their respective phosphorus fractions, i.e.:

$$Organisms, P = \sum Zb_x - f_{P,zbx}$$

(Eq. 25)

Unbiodegradable particulate phosphorus is given by:

$$X_{IN} = F_{UP,P} \times F_{UP} \times TCOD$$

(Eq. 26)

The remaining particulate biodegradable organic phosphorus is given by:

$$X_{OP} = TP - PO_4 - X_{IP} - Organisms, P$$

(Eq. 27)



Appendix 4. Winter 2022 results dynamic model validation

Winter operation process flow diagram

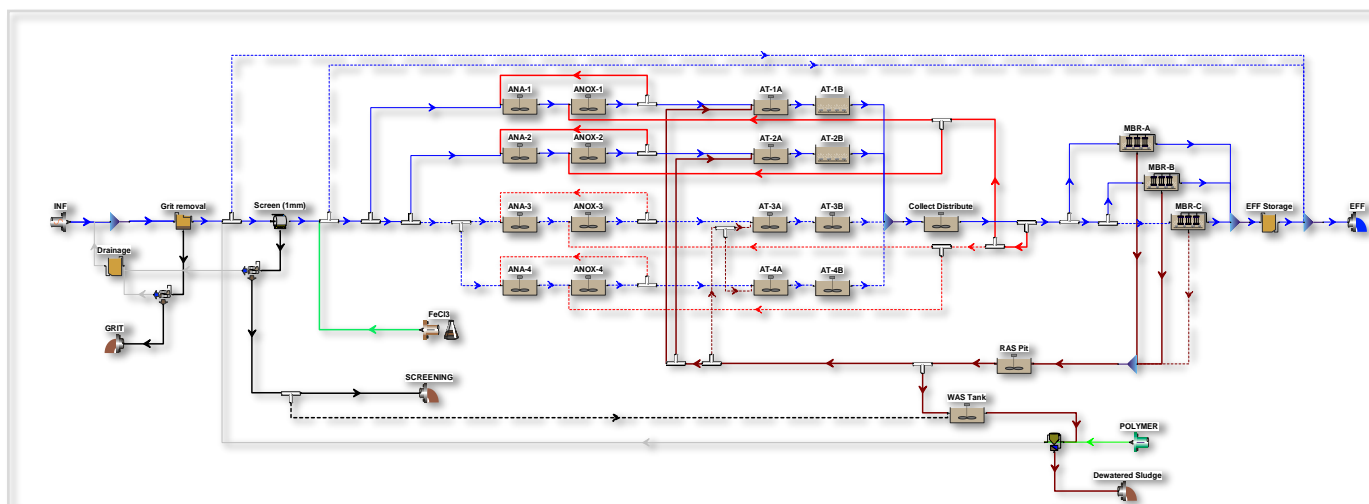


Figure 35. WWTP Poreč-South - BioWin model winter operation. Lines 1 and 2 and MBR's A and B are in operation (dashed lines not operated).

Average performance overview

Based on the total dataset the average WWTP performance is calculated and presented in the tables below. The effluent performance and aerobic SRT is well within the design criteria. There are no solids measured in the effluent because of the MBR technology. Total nitrogen is well below the effluent standard. Effluent COD is largely inert soluble material.

Table 6. WWTP Poreč-South - Winter 2019 - Dynamic average effluent concentration (mg/L)

WWTP Poreč-South - Scenario Winter 2022 - Dynamic average effluent concentration (mg/L)			
EFF	Temperature	Concentration	10,0
EFF	COD - Total	Concentration	59,2
EFF	N - Total N	Concentration	8,1
EFF	P - Total P	Concentration	0,6
EFF	Total suspended solids	Concentration	0,0

Table 7. WWTP Poreč-South - Winter 2019 - Dynamic average Air flow rate (m3/h)

WWTP Poreč-South - Scenario Winter 2022 - Dynamic average Air flow rate (m3/h)			
AT-1A	Air flow rate	Flow	0,0
AT-1B	Air flow rate	Flow	135,4
AT-2A	Air flow rate	Flow	0,0
AT-2B	Air flow rate	Flow	135,4
AT-3A	Air flow rate	Flow	0,0
AT-3B	Air flow rate	Flow	0,0
AT-4A	Air flow rate	Flow	0,0
AT-4B	Air flow rate	Flow	0,0
MBR-A	Air flow rate	Flow	158,3
MBR-B	Air flow rate	Flow	174,4
MBR-C	Air flow rate	Flow	0,0

Table 8. WWTP Poreč-South - Winter 2019 - Dynamic average Flows (m3/d)

WWTP Poreč-South - Scenario Winter 2022 - Dynamic average Flows (m3/d)			
ANA-R1	Flow (S)	Flow	782,4
ANA-R2	Flow (S)	Flow	782,4
ANA-R3	Flow (S)	Flow	0,0
ANA-R4	Flow (S)	Flow	0,0
ANOX-R1	Flow (U)	Flow	22.140,0
	Flow (S)	Flow	22.140,0
ANOX-R2	Flow (S)	Flow	22.140,0
ANOX-R3	Flow (S)	Flow	11.070,0
ANOX-R4	Flow (S)	Flow	0,0
AS Emergency Bypass	Flow (S)	Flow	0,0
Dewatering Centrifuge	Flow (U)	Flow	0,5
Grit removal	Flow (U)	Flow	0,1
MBR-A	Flow (U)	Flow	4.697,2
MBR-B	Flow (U)	Flow	4.172,9
MBR-C	Flow (U)	Flow	0,0
Screen (1mm)	Flow (U)	Flow	0,1
Screen Emergency Bypass	Flow (S)	Flow	0,0
WAS Splitter	Flow (S)	Flow	27,7

Table 9. WWTP Poreč-South - Winter 2019 - Dynamic average sludge production SRT and HRT

WWTP Poreč-South - Scenario Winter 2022 - Dynamic average SRT and HRT	
Temperature	10 °C
Average waste sludge production	79,6 kgTSS/d
SRT Total	62,9 d
SRT Aerobic	17,7 d
SRT AT+ANOX	37,5 d
WAS Tank HRT	0,9 hour
ANA HRT to influent	18,4 hour



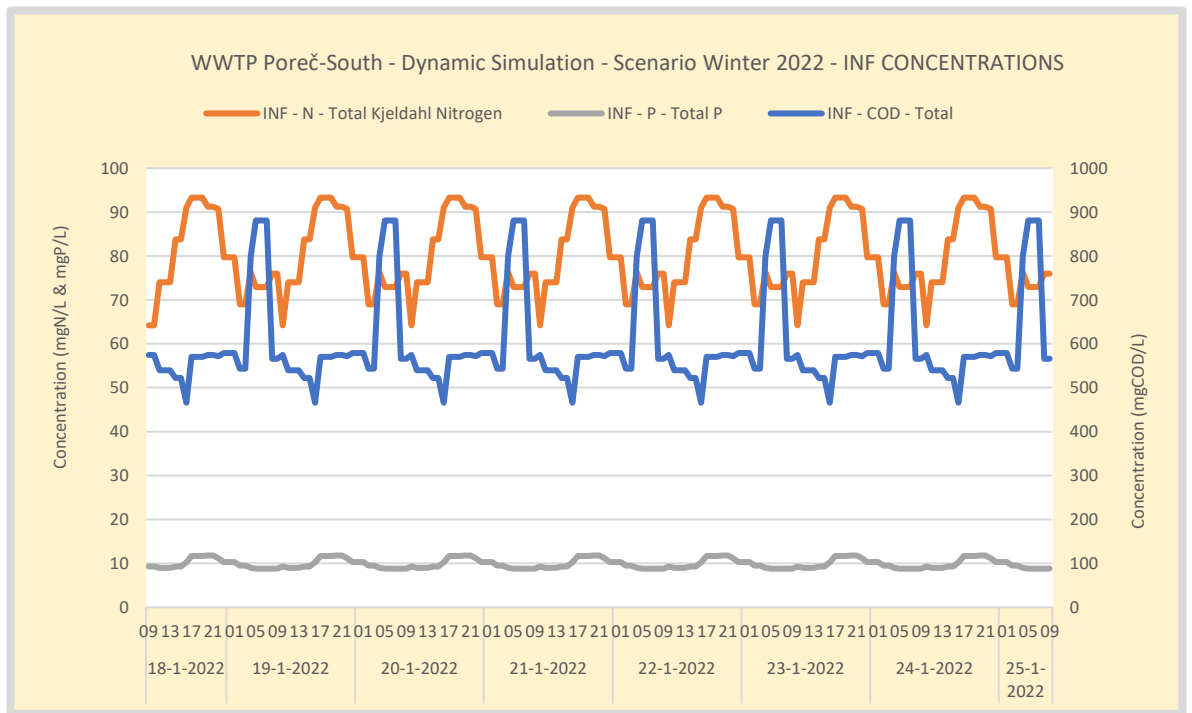


Figure 37. Winter 2022 - WWTP Poreč-South dynamic Influent load COD, TKN and TP.

Process and recycle flows modelling results

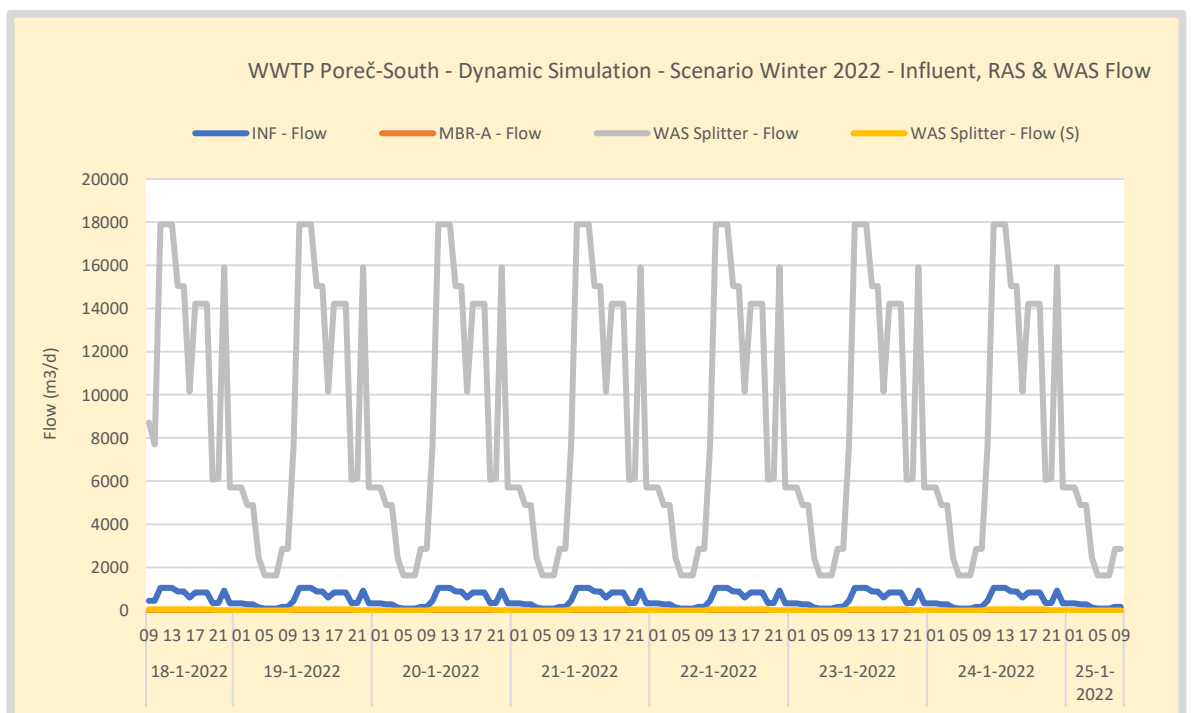


Figure 38. Winter 2022 - WWTP Poreč-South flow rate settings and control. The MLSS sludge return flow is proportional to the influent at 1800%. The maximum capacity is 13.670 m3/d per MBR. The WAS flow is operated 10 hours a day on a constant flow to the dewatering.



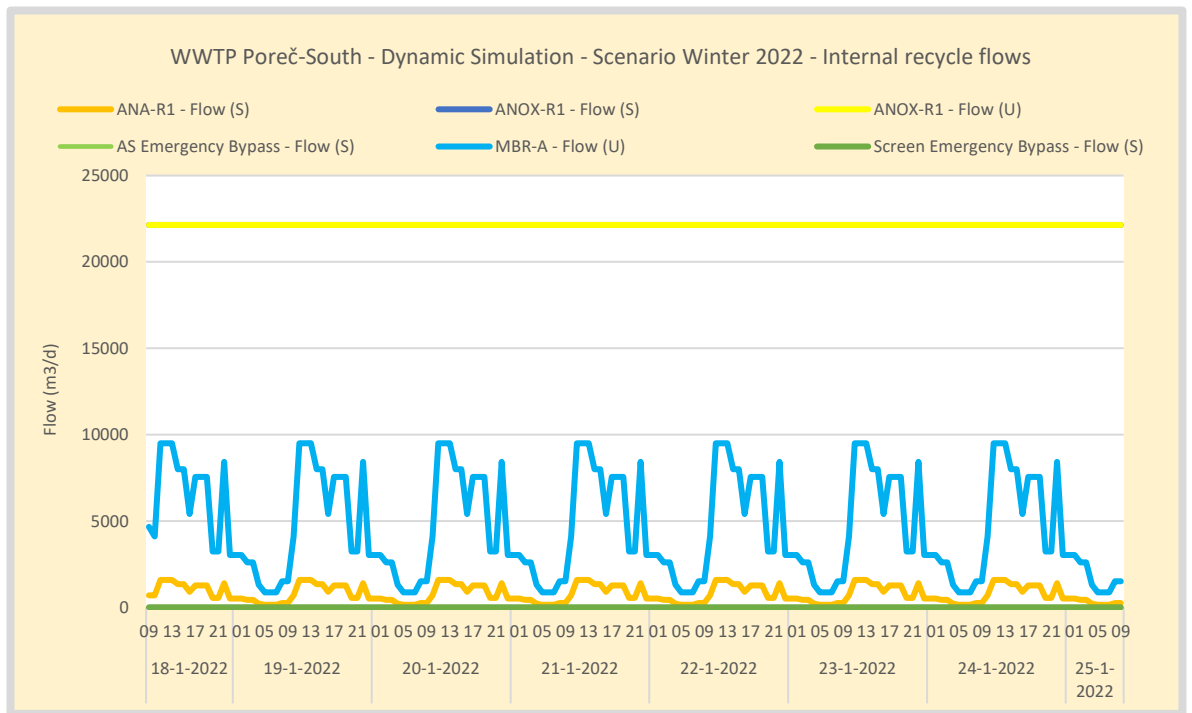


Figure 39. Winter 2022 - WWTP Poreč-South flow rate settings and control. The bypasses are not used. The upper bound of the anoxic recycle is according to the design. The anoxic recycle is controlled relative to the influent flow.

Waterline operation modelling results

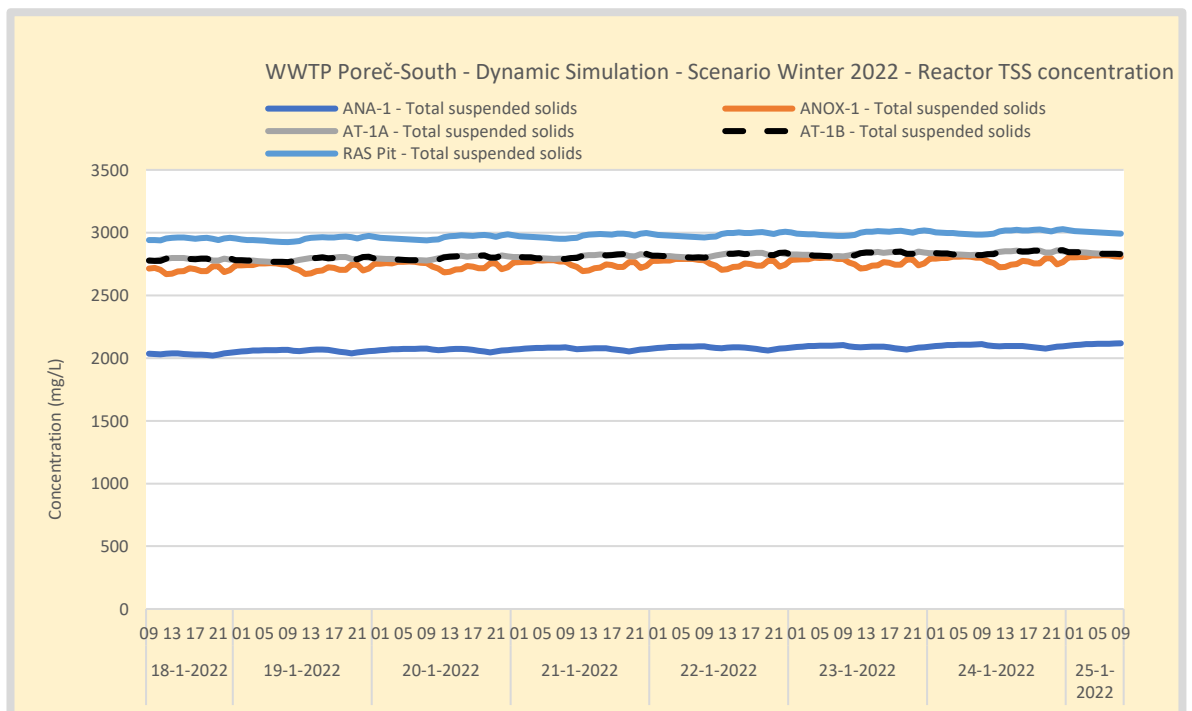


Figure 40. Winter 2022 - WWTP Poreč-South TSS profile in the waterline. TSS in the MBR is controlled on approximately 2,7 gTSS/L by adjusting the WAS flow and SRT. In the winter, the reactor volume relative to the influent loading is very high. This results in low sludge production and a long SRT. The process is therefore operated with a lower TSS concentration during the winter.



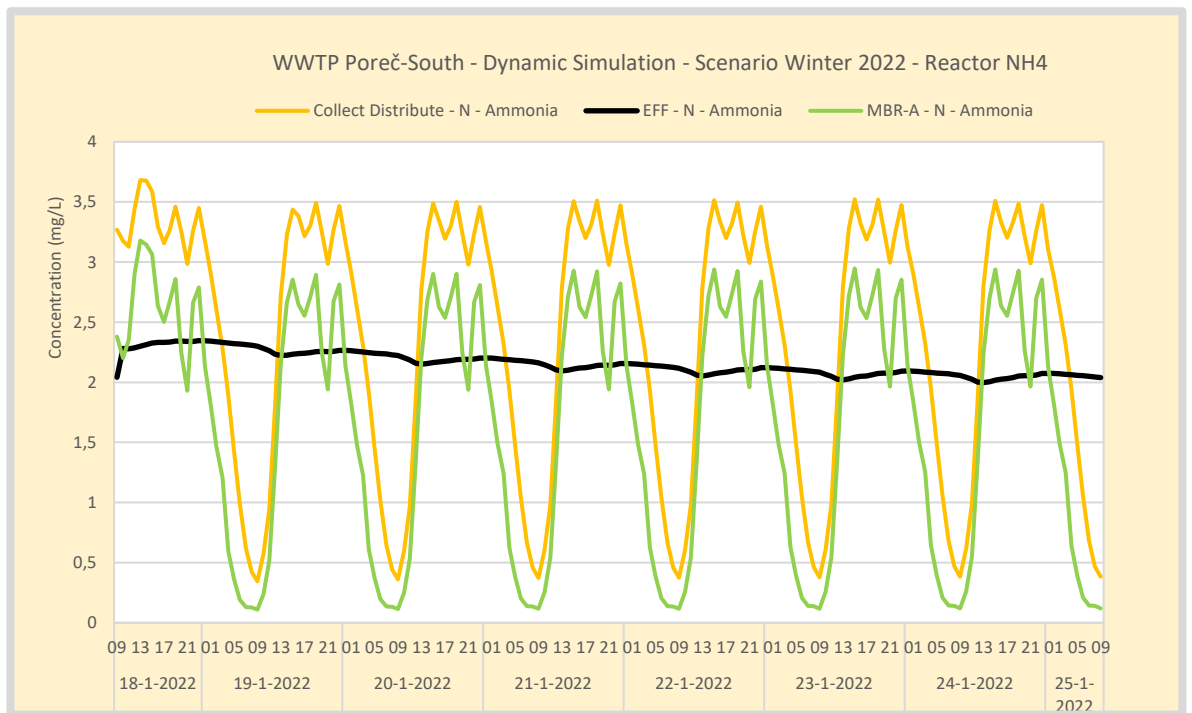


Figure 41. Winter 2022 - WWTP Poreč-South ammonium profile in the waterline. The air input of AT-B is controlled based on NH4 measurements. AT-A is unaerated.

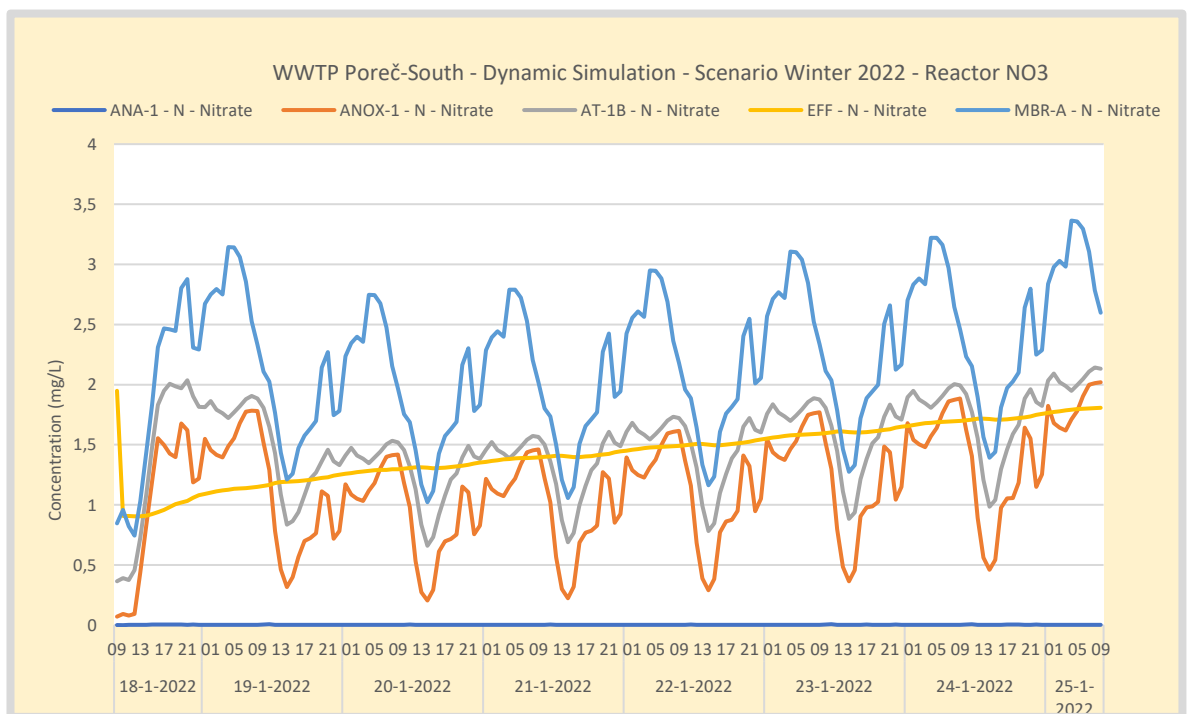


Figure 42. Winter 2022 - WWTP Poreč-South nitrate in the anoxic tank.



Waterline concentration profiles modelling results

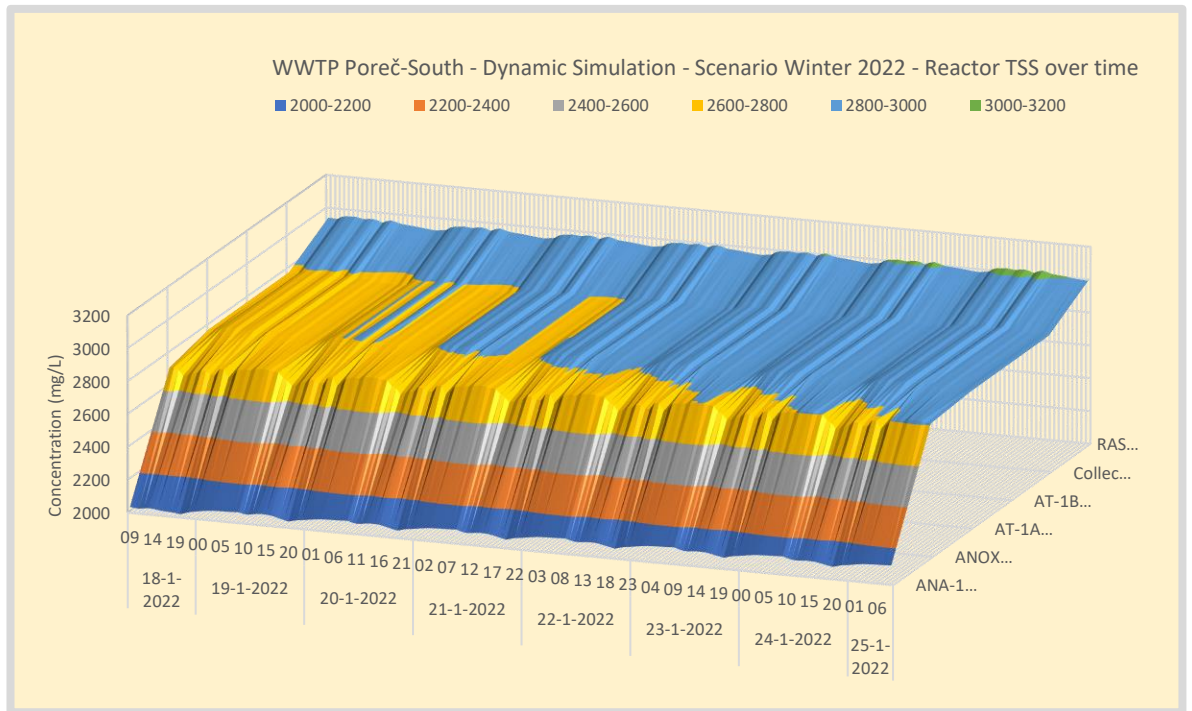


Figure 43. Winter 2022 - WWTP Poreč-South TSS concentration profile over the waterline.

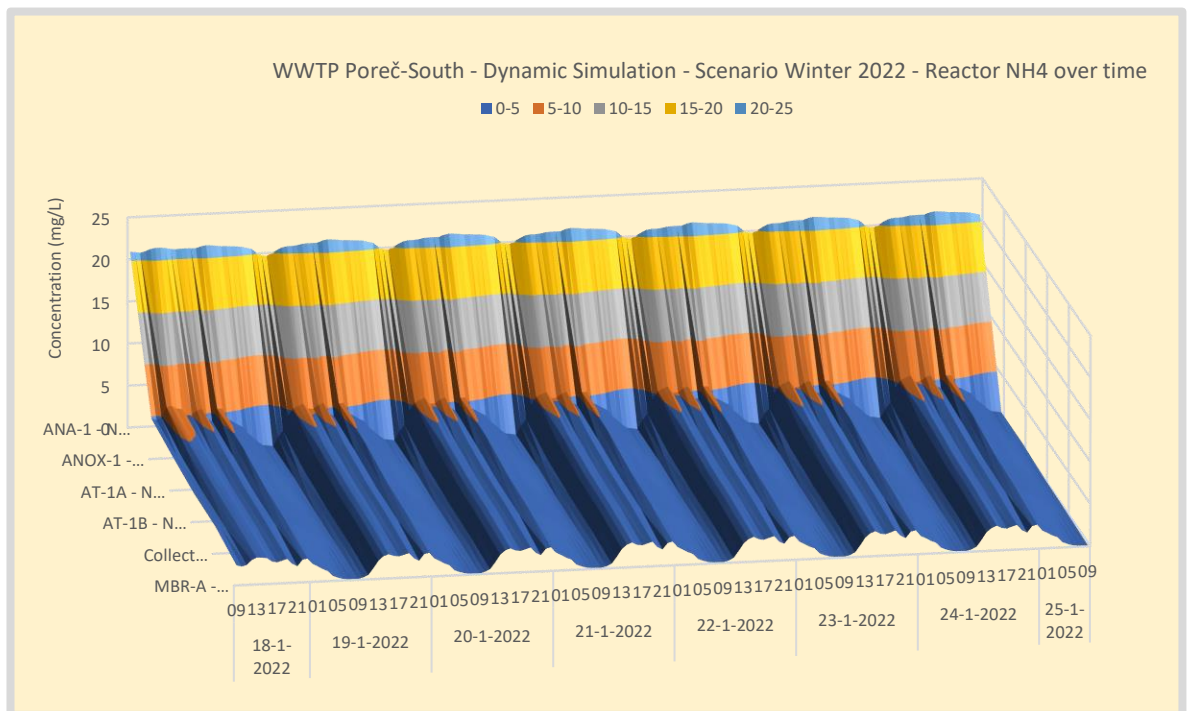


Figure 44. Winter 2022 - WWTP Poreč-South NH4 concentration profile over the waterline.



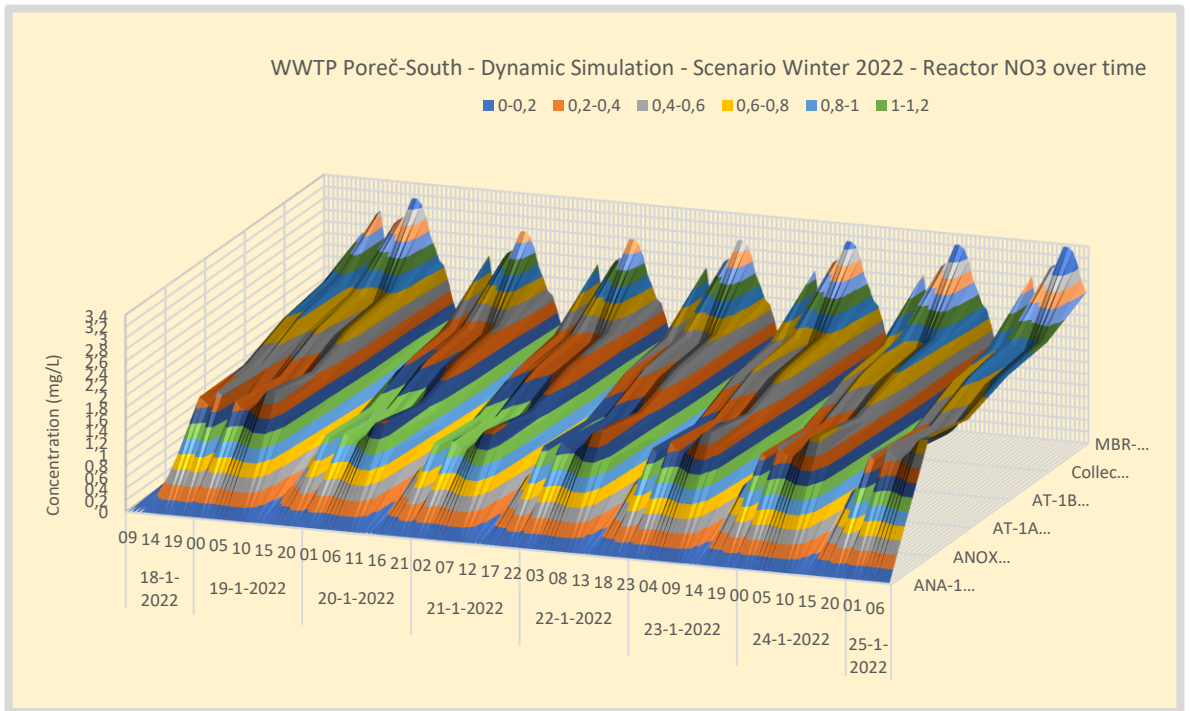


Figure 45. Winter 2022 - WWTP Poreč-South NO3 concentration profile over the waterline.

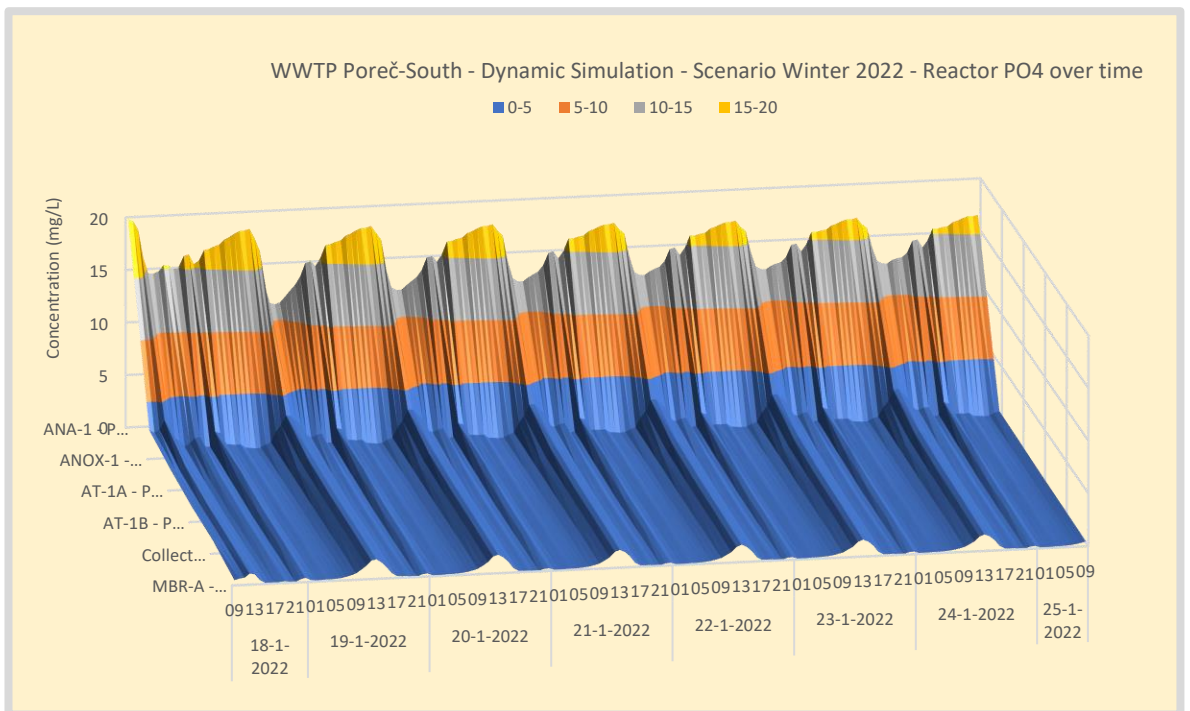


Figure 46. Winter 2022 - WWTP Poreč-South PO4 concentration profile over the waterline.



Aeration and DO concentration modelling results

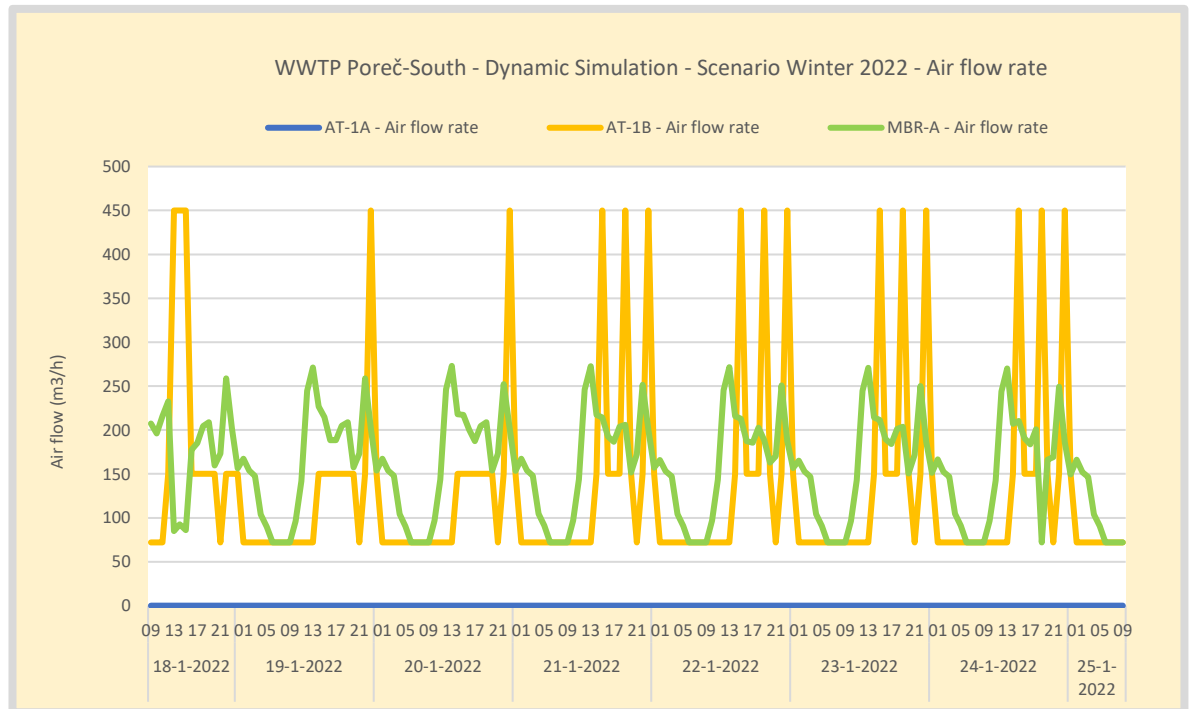


Figure 47. Winter 2022 - WWTP Poreč-South air input in the different aerated reactors. AT-A is non aerated. AT-B is step controlled on NH₄ measurement. Both MBR's are setpoint controlled on DO.

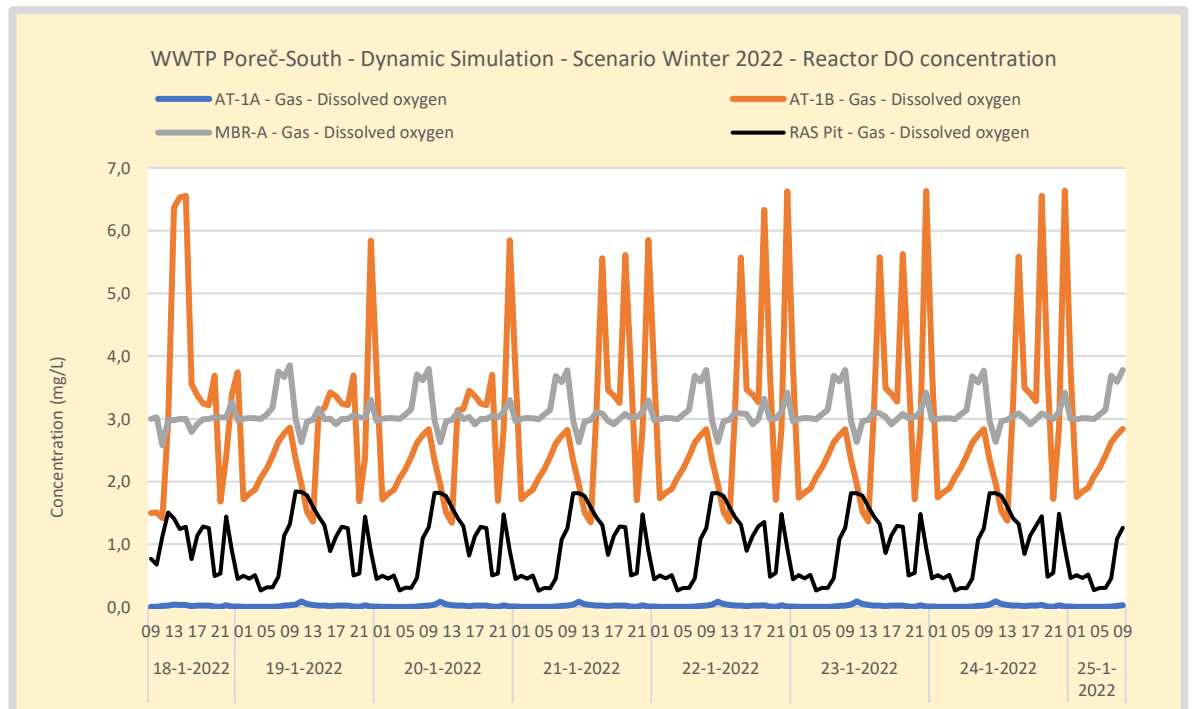


Figure 48. Winter 2022 - WWTP Poreč-South DO concentration gradients. Aeration is controlled in AT-B and both MBR's. DO is the result of the designed air input.



pH and alkalinity profiles modelling results

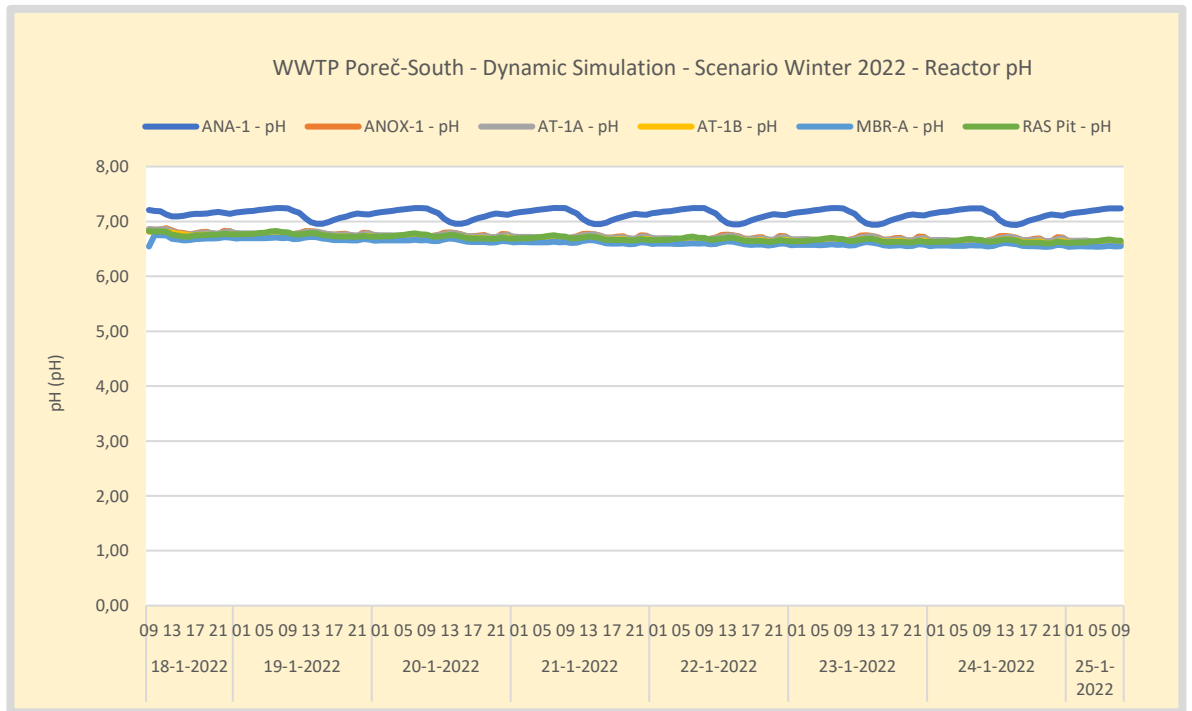


Figure 49. Winter 2022 - WWTP Poreč-South pH profile over the activated sludge reactors. Influent pH is measured continuously and is not limiting.

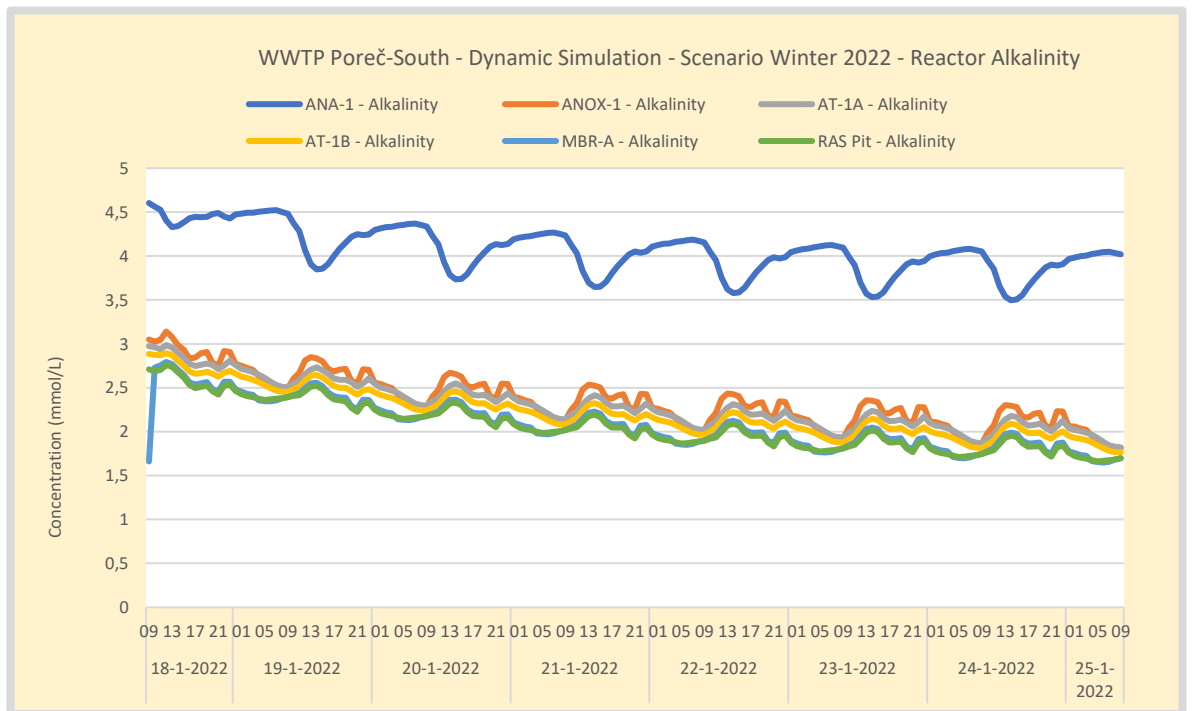


Figure 50. Winter 2022 - WWTP Poreč-South alkalinity profile over the activated sludge reactors. Influent alkalinity is estimated from local drinking water quality measurements at 7,46 mmol/L. Alkalinity is not limiting.



Chemical load and flow modelling results

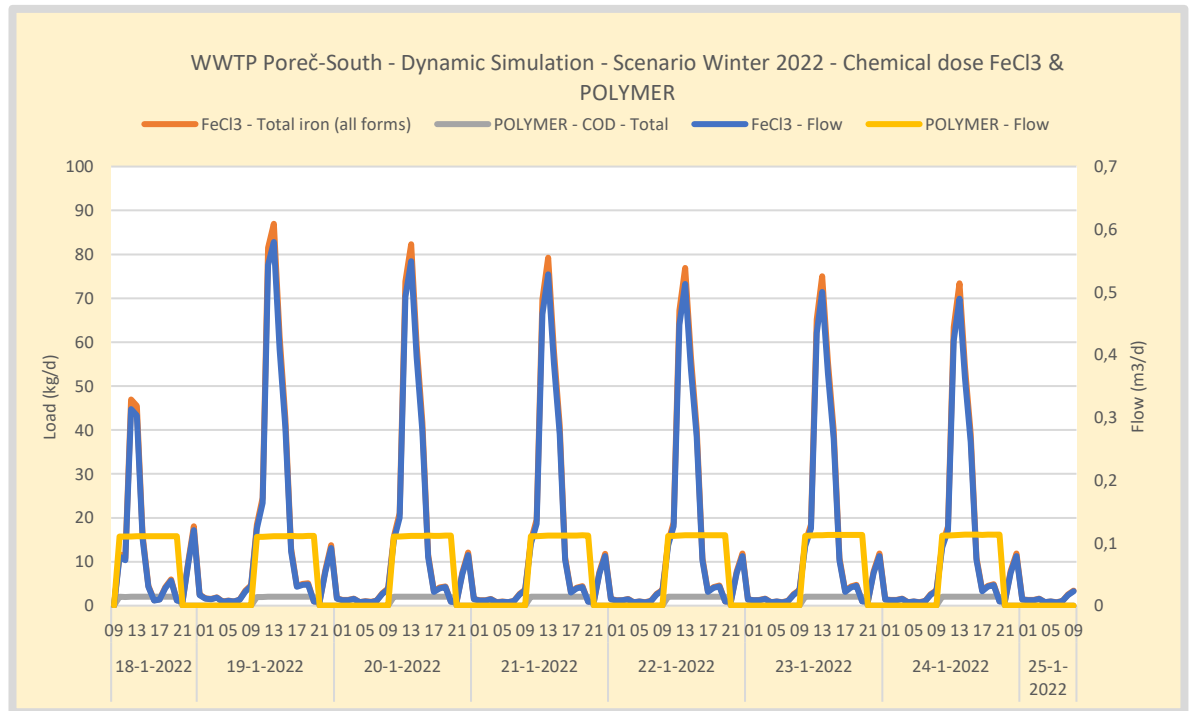


Figure 51. Winter 2022 - WWTP Poreč-South load and flow of Iron and PE. Effluent load proportional iron dosage is required for P-removal with a factor 0,3 m³/kgP. PE is assumed particulate biodegradable COD with a COD/VSS ratio of 1,42 gCOD/gTSS and dosed proportional to the WAS load based on 8 kg PE (dry weight) dosed per 1000 kg WAS (dry weight) flowing in the dewatering.

Sludge line operation modelling results

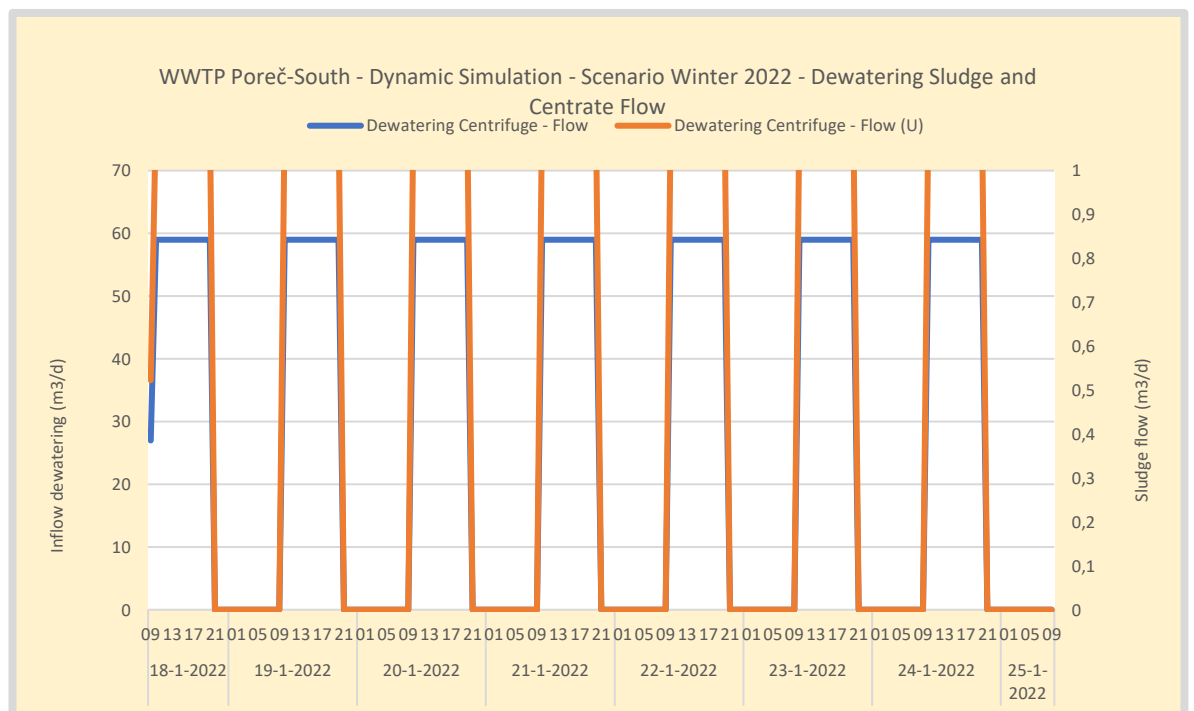


Figure 52. Winter 2022 - WWTP Poreč-South dewatered sludge and centrate flow.

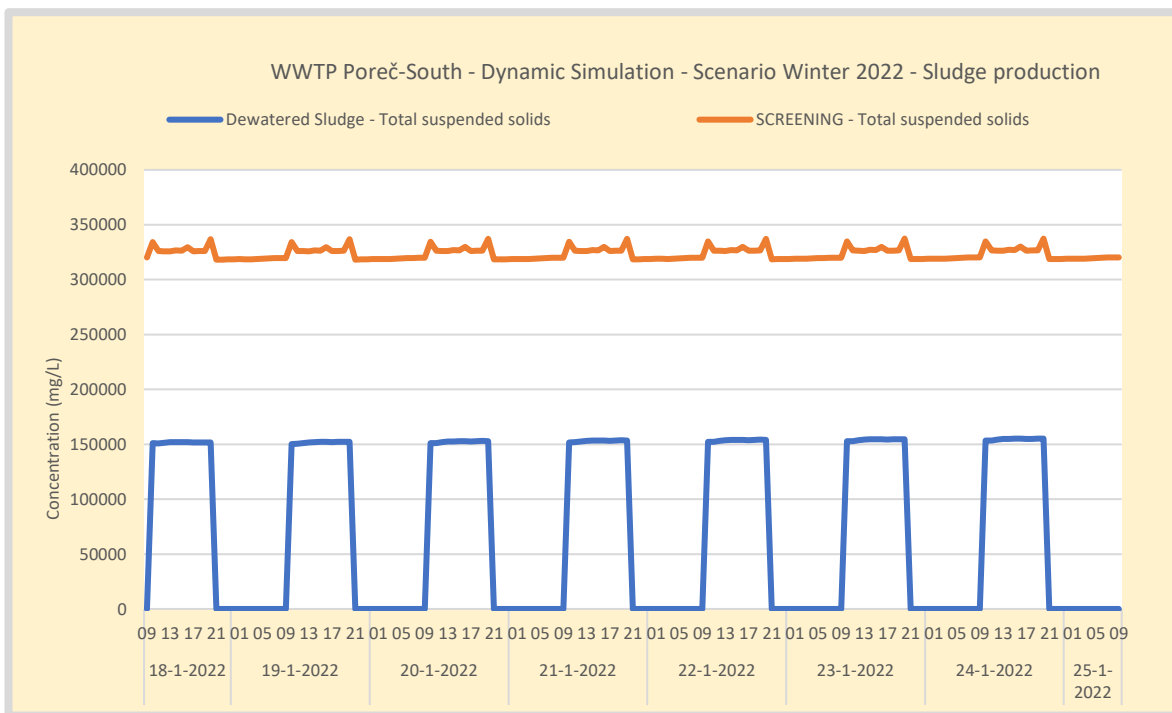


Figure 53. Winter 2022 - WWTP Poreč-South dewatered sludge and screening sludge concentration. The design assumes dewatered sludge at 23% dry matter. Simulation is done with a lower percentage. This does not affect the simulation result. Screening is an estimated concentration as the result of the press operation.

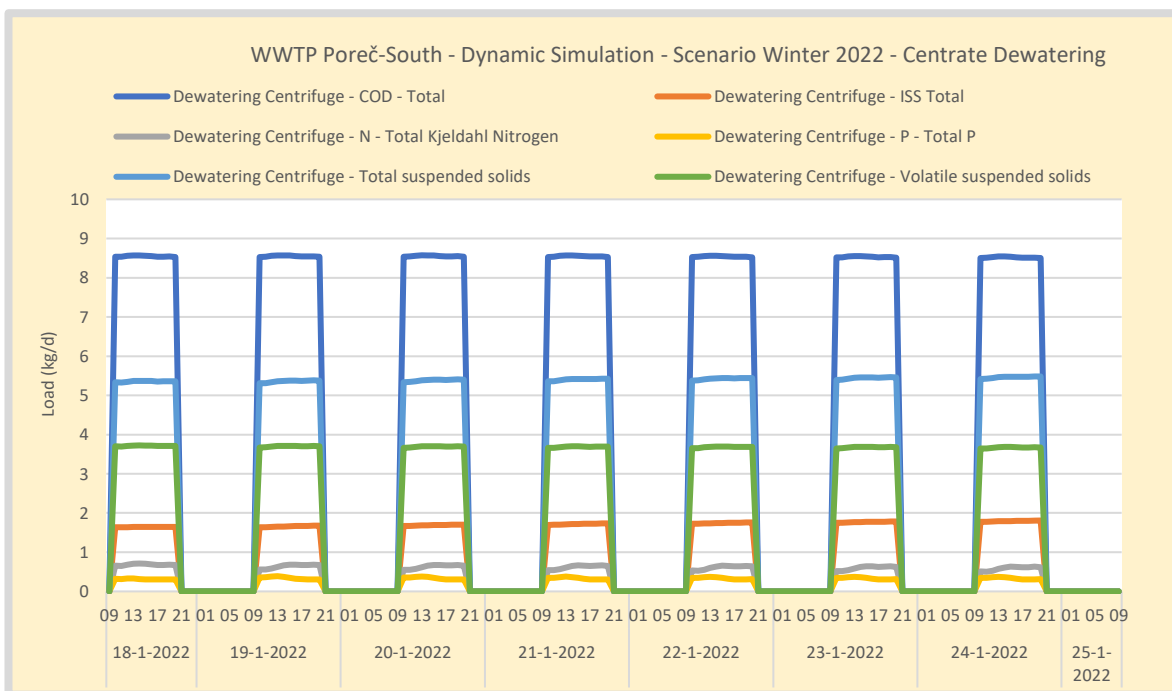


Figure 54. Winter 2022 - WWTP Poreč-South Centrate load dewatering.



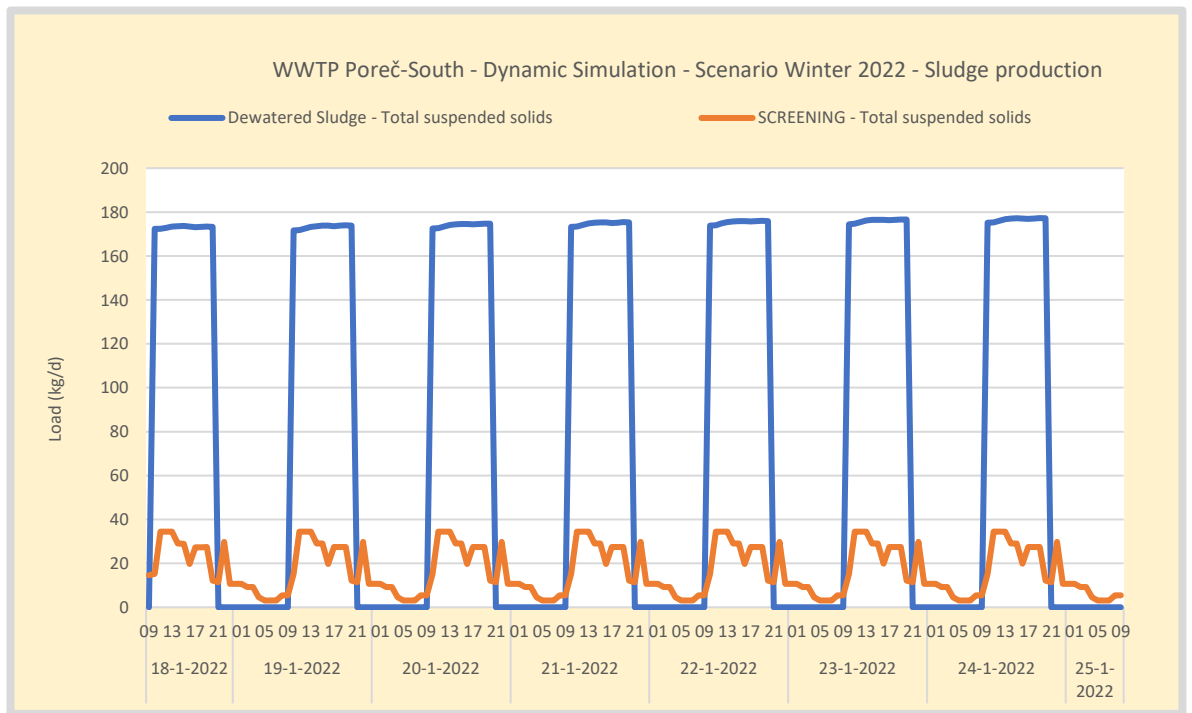


Figure 55. Winter 2022 - WWTP Poreč-South dewatered sludge load and compacted screening load. Dewatered sludge is operated 10 hours a day. Screening is produces continuously as a factor of the influent.

Effluent modelling results

In the figures below the dynamic effluent quality of the plant is presented under winter conditions. The last day included a major rain event. The measurement is coming from the effluent buffer and has a reduced dynamic profile.

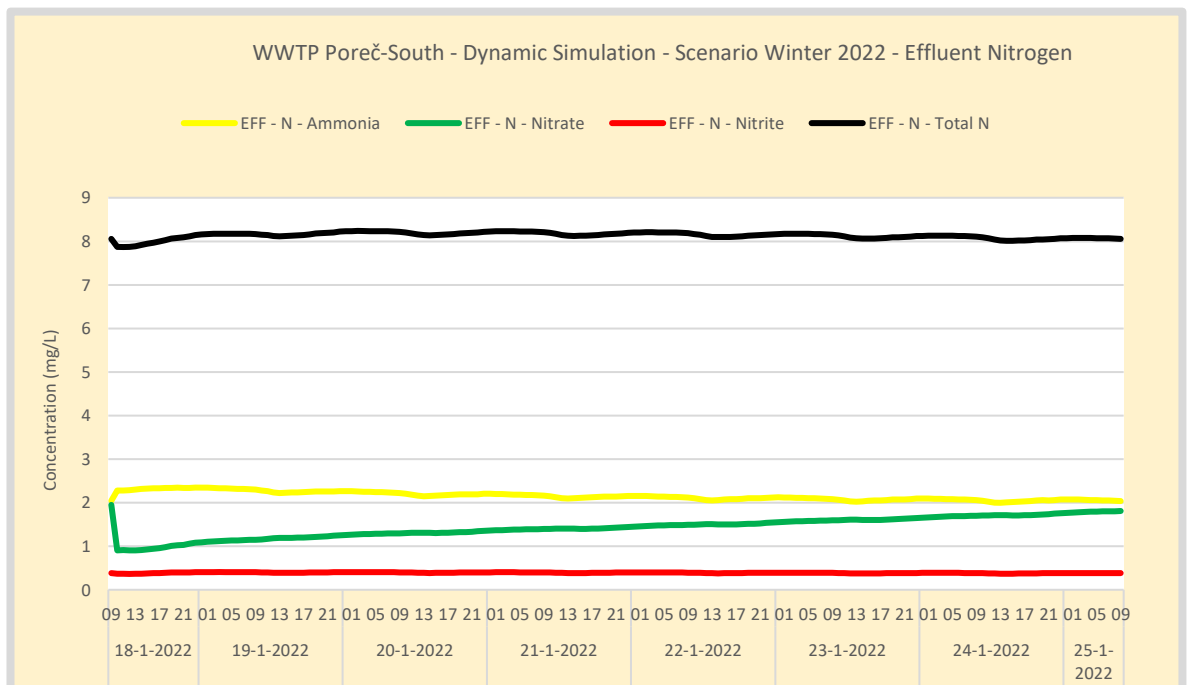


Figure 56. Winter 2022 - WWTP Poreč-South Effluent nitrogen concentration. Effluent is measured in the outflow of the large effluent buffer.



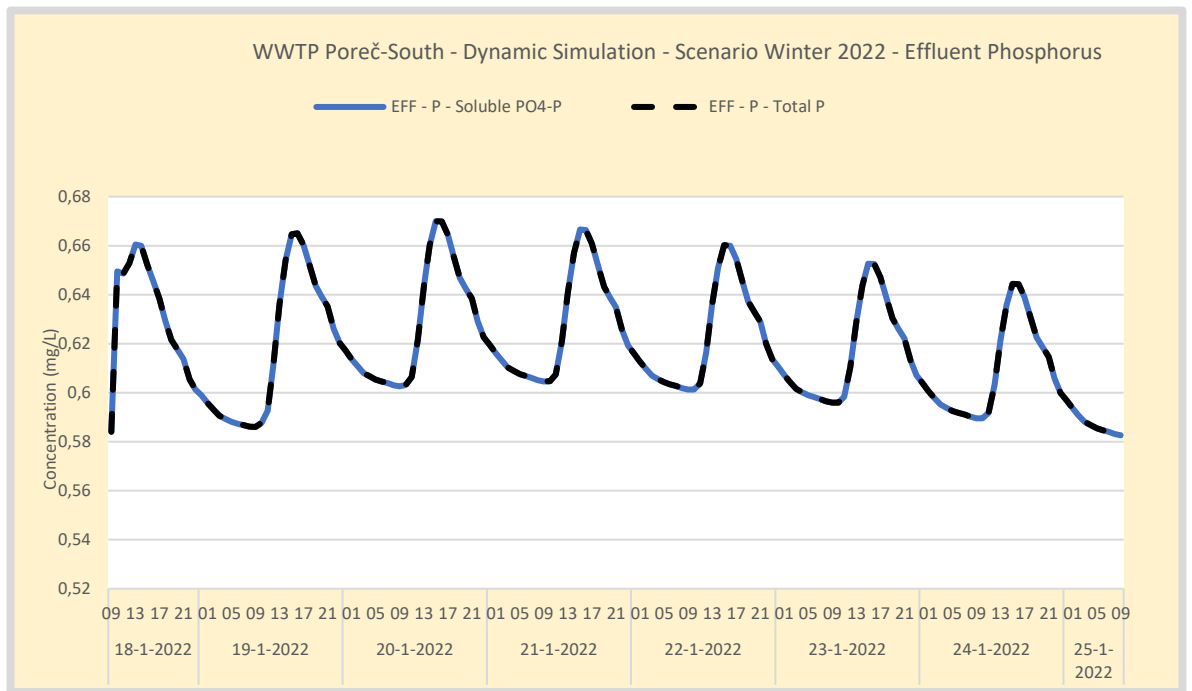


Figure 57. Winter 2022 - WWTP Poreč-South Effluent phosphorus concentration. Effluent is measured in the outflow of the large effluent buffer.

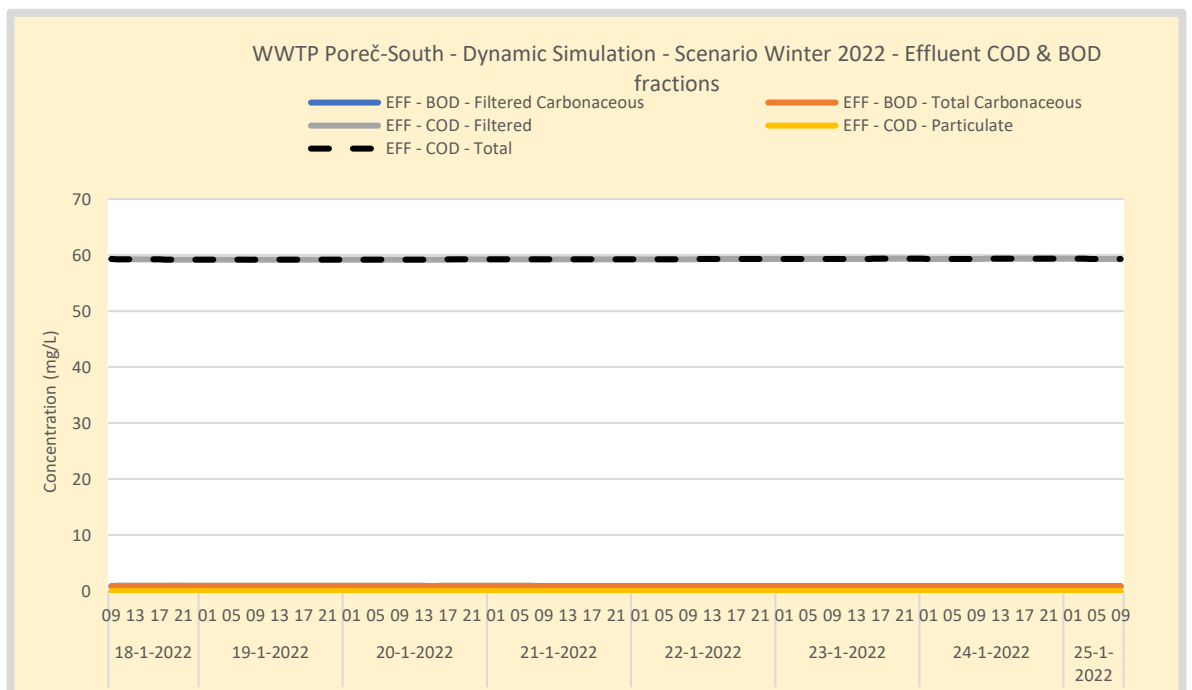


Figure 58. Winter 2022 - WWTP Poreč-South Effluent COD and BOD concentration. Effluent is measured in the outflow of the large effluent buffer.



Configuration information for all Bioreactor units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers
ANA-1	200,0000	36,3636	5,500	Un-aerated
ANOX-1	175,0000	31,8182	5,500	Un-aerated
AT-1A	180,0000	32,7273	5,500	Un-aerated
ANA-3	200,0000	36,3636	5,500	Un-aerated
ANOX-3	175,0000	31,8182	5,500	Un-aerated
AT-3A	180,0000	32,7273	5,500	Un-aerated
ANA-4	200,0000	36,3636	5,500	Un-aerated
ANOX-4	175,0000	31,8182	5,500	Un-aerated
AT-4A	180,0000	32,7273	5,500	Un-aerated
Collect Distribute	198,0000	36,0000	5,500	Un-aerated
RAS Pit	81,8230	40,9115	2,000	Un-aerated
WAS Tank	1,0000	0,0189	53,000	Un-aerated
ANA-2	200,0000	36,3636	5,500	Un-aerated
ANOX-2	175,0000	31,8182	5,500	Un-aerated
AT-2A	180,0000	32,7273	5,500	Un-aerated
AT-1B	180,0000	32,7273	5,500	163
AT-2B	180,0000	32,7273	5,500	163
AT-3B	180,0000	32,7273	5,500	Un-aerated
AT-4B	180,0000	32,7273	5,500	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
ANA-1	0



ANOX-1	0
AT-1A	0
ANA-3	0
ANOX-3	0
AT-3A	0
ANA-4	0
ANOX-4	0
AT-4A	0
Collect Distribute	0
RAS Pit	0
WAS Tank	0
ANA-2	0
ANOX-2	0
AT-2A	0
AT-3B	0
AT-4B	0

Element name	Average Air flow rate [m3/hr (20C, 1 atm)]
AT-1B	3600,0
AT-2B	3600,0

Aeration equipment parameters

Element name	k_1 in C = $k_1(PC)^{0.25 + k_2}$	k_2 in C = $k_1(PC)^{0.25 + k_2}$	Y in C = $U_{sg} \cdot Y$ [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser (20C, 1 atm)	Max. air flow rate per diffuser (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) +	'B' in diffuser pressure drop = A + B*(Qa/Diff) +	'C' in diffuser pressure drop = A + B*(Qa/Diff) +



								C*(Qa/Dif f)^2	C*(Qa/Dif f)^2	C*(Qa/Dif f)^2
ANA-1	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANOX-1	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-1A	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANA-3	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANOX-3	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-3A	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANA-4	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANOX-4	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-4A	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
Collect Distribute	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
RAS Pit	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
WAS Tank	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANA-2	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
ANOX-2	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-2A	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-1B	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-2B	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-3B	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0
AT-4B	1,2400	0,8960	0,8880	0,0380	0,2500	0,5000	10,0000	3,0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers	# of cassettes	Displaced volume / cassette	Membrane area / cassette	Total displaced	Membrane surface area [m2]
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						[m3/casset te]	[m2/casset te]	volume [m3]	
MBR-A	75,0000	13,6364	5,500	150	3,00	1,690	1650,00	5,07	4950,00
MBR-B	75,0000	13,6364	5,500	102	3,00	1,690	1100,00	5,07	3300,00
MBR-C	75,0000	13,6364	5,500	Un-aerated	3,00	1,690	1100,00	5,07	3300,00

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR-A	3,0
MBR-B	3,0
MBR-C	0

Element name	Split method	Average Split specification
MBR-A	Flow paced	1800,00 %
MBR-B	Flow paced	800,00 %
MBR-C	Ratio	1,00

Aeration equipment parameters

Element name	k_1 in C = $k_1(PC)^{0.25 + k_2}$	k_2 in C = $k_2(PC)^{0.25 + k_2}$	Y in $Kla = C Usg ^ Y$ [m3/(m2 d)]	Area of diffuser	Diffuser mounting height	Min. air flow rate per diffuser (20C, 1 atm)	Max. air flow rate per diffuser (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR-A	0,0500	0,3800	1,0000	0,0500	0,2500	2,0000	50,0000	1,0000	0	0



MBR-B	0,0500	0,3800	1,0000	0,0500	0,2500	2,0000	50,0000	1,0000	0	0
MBR-C	0,0500	0,3800	1,0000	0,0500	0,2500	2,0000	50,0000	1,0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR-A	101,3250	0,3000
MBR-B	101,3250	0,3000
MBR-C	101,3250	0,3000

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR-A	0,0400	20,9500	1,2000	19,9000	0	0	0	0	2,0000
MBR-B	0,0400	20,9500	1,2000	19,9000	0	0	0	0	2,0000
MBR-C	0,0400	20,9500	1,2000	19,9000	0	0	0	0	2,0000

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]
Grit removal	3200,4000	12,6000	254,000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
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Grit removal	Flow paced	0,01 %
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Element name	Percent removal	Blanket fraction
Grit removal	5,00	0,10

Configuration information for all Influent - COD units

Operating data Average (flow/time weighted as required)

Element name	INF
Flow	516,72
COD - Total mgCOD/L	558,67
N - Total Kjeldahl Nitrogen mgN/L	82,63
P - Total P mgP/L	10,13
S - Total S mgS/L	10,00
N - Nitrate mgN/L	0,30
pH	8,14
Alkalinity mmol/L	7,46
ISS Total mgISS/L	15,77
Metal soluble - Calcium mg/L	80,00
Metal soluble - Magnesium mg/L	15,00
Gas - Dissolved oxygen mg/L	0,10

Element name	INF
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0,3354
Fac - Acetate [gCOD/g of readily biodegradable COD]	0,2511
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0,7409



Fus - Unbiodegradable soluble [gCOD/g of total COD]	0,0860
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0,1500
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0,5000
Fna - Ammonia [gNH3-N/gTKN]	0,7993
Fnox - Particulate organic nitrogen [gN/g Organic N]	0,5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0,0100
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0,0700
Fpo4 - Phosphate [gPO4-P/gTP]	0,6061
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0,0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0,1500
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0,0200
FZbm - Methyloctrophic COD fraction [gCOD/g of total COD]	1,000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1,000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1,000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1,000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1,000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1,000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1,000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1,000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1,000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1,000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1,000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1,000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Input - Iron (as ferric chloride) units

Operating data Average (flow/time weighted as required)



Element name	FeCl3
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylophilic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0



N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	150000,00
Metal soluble - Ferrous [mg/L]	0



Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	5,00
Other Anions (strong acids) [meq/L]	8062,73
Gas - Dissolved total CO2 [mmol/L]	7,00
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	4,20012767098175E-8

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
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Compacter1	Flow paced	0,01 %
Compacter2	Flow paced	0,01 %

Element name	Percent removal
Compacter1	100,00
Compacter2	100,00

Configuration information for all Separator - Microscreen units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Screen (1mm)	Flow paced	0,02 %

Element name	Percent removal
Screen (1mm)	3,00

Configuration information for all Separator - Cyclone (dewatering) units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Dewatering Centrifuge	Fraction	0,02



Element name	Percent removal
Dewatering Centrifuge	97,00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
ANA-R1	Flow paced	150,00 %
ANA-R3	Flowrate [Side]	0
ANA-R4	Flowrate [Side]	0
MBR Distributer1	Ratio	1,00
AS Emergency Bypass	Bypass	15936
INF Distributer1	Ratio	1,00
INF Distributer3	Ratio	1,00
Screen Emergency Bypass	Bypass	14640
ANOX-R1	Flowrate [Side]	22140
ANOX-R2	Flowrate [Main]	0
ANOX-R4	Flowrate [Side]	0
RAS Splitter2	Ratio	1,00
WAS Splitter	Flowrate [Side]	27,499998
RAS Splitter1	Flowrate [Side]	0
SCREENING Splitter	Flowrate [Side]	0
MBR Distributer2	Flowrate [Main]	0
INF Distributer2	Flowrate [Main]	0
ANOX-R3	Fraction	0,50
ANA-R2	Flow paced	150,00 %
RAS Splitter3	Ratio	1,00



Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	POLYMER
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylothetic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	18180,00
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0



CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H ₂ PO ₄ - adsorbed [mg/L]	0
HFO - Low with H ₂ PO ₄ - adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H ⁺ adsorbed [mg/L]	0
HFO - High with H ⁺ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H ₂ PO ₄ - adsorbed [mg/L]	0
HAO - Low with H ₂ PO ₄ - adsorbed [mg/L]	0
HAO - Aged [mg/L]	0



P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	0
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	3,74528456863004E-12

Configuration information for all Equalization Tank units



Physical data

Element name	Volume[m3]	Area[m2]	Depth[m]
EFF Storage	2150,0000	390,9091	5,500
Drainage	27,0000	9,0000	3,000

BioWin Album

Album page - Loads Overview

Elements	Flow [m3/d]	Total suspended solids [kg /d]	Volatile suspended solids [kg /d]	ISS Total [kg /d]	BOD - Total Carbonaceo us [kg /d]	COD - Total [kg /d]	N - Total N [kg N/d]	P - Total P [kg P/d]
INF	456,00	96,23	87,11	9,12	130,80	262,20	29,41	4,24
Drainage	0,02	0	0	0	0,00	0,00	0,00	0,00
GRIT	0,02	0,12	0,00	0,12	0,00	0,01	0,00	0,00
SCREENIN G	0,05	14,60	14,39	0,21	1,57	18,95	0,67	0,22
Dewatering Centrifuge	0,00	0	0	0	0	0	0	0
Screen (1mm)	167,91	28,40	25,93	2,48	46,31	87,01	13,72	1,61
ANA-1	335,99	711,55	489,98	221,58	132,40	695,68	46,06	40,13
ANOX-1	11405,99	32036,90	21378,75	10658,15	5142,79	30080,73	1785,34	1805,49
AT-1A	12581,99	35603,98	23754,79	11849,19	5707,80	33416,04	1980,89	2006,57
AT-1B	12581,99	35599,56	23746,17	11853,38	5703,01	33409,26	1980,49	2006,54
Collect Distribute	25163,98	71196,87	47486,26	23710,60	11399,38	66809,85	3959,71	4013,06
MBR-A	0,00	0	0	0	0,00	0,00	0,00	0,00
EFF Storage	167,99	0	0	0	0,15	9,96	1,35	0,10



EFF	167,99	0,00	0,00	0,00	0,15	9,96	1,35	0,10
RAS Pit	2855,99	8547,09	5697,64	2849,45	1361,62	8005,77	474,40	482,03
WAS Tank	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dewatered Sludge	0	0	0	0	0	0	0	0
FeCl3	0,00	0	0	0	0	0	0	0
POLYMER	0,00	0,00	0,00	0,00	0,00	0,00	0	0

Album page - Loads

Elements	INF	GRIT	SCREENING	EFF	Dewatered Sludge	FeCl3	POLYMER
Flow [m3/d]	456,00	0,02	0,05	167,99	0	0,00	0,00
Total suspended solids [kg /d]	96,23	0,12	14,60	0,00	0	0	0,00
Volatile suspended solids [kg /d]	87,11	0,00	14,39	0,00	0	0	0,00
ISS Total [kg /d]	9,12	0,12	0,21	0,00	0	0	0,00
BOD - Total Carbonaceous [kg /d]	130,80	0,00	1,57	0,15	0	0	0,00
COD - Total [kg /d]	262,20	0,01	18,95	9,96	0	0	0,00
N - Total N [kg N/d]	29,41	0,00	0,67	1,35	0	0	0
P - Total P [kg P/d]	4,24	0,00	0,22	0,10	0	0	0
Total iron (all forms) [kg Me/d]	0	0,00	0,00	0,00	0	0,00	0

Album page - Concentration Overview

Elements	Flow [m3/d]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	ISS Total [mg/L]	BOD - Total Carbonaceous [mg/L]	COD - Total [mg/L]	N - Total N [mgN/L]	P - Total P [mgP/L]
INF	456,00	211,03	191,03	20,00	286,84	575,00	64,50	9,30
Drainage	0,02	0	0	0	156,72	282,68	71,40	5,72
GRIT	0,02	7211,32	185,59	7025,73	278,68	558,64	83,33	9,90



SCREENIN G	0,05	320178,44	315618,36	4560,08	34366,69	415508,01	14655,50	4891,36
Dewatering Centrifuge	0,00	0	0	0	0	0	0	0
Screen (1mm)	167,91	169,15	154,40	14,75	275,80	518,20	81,71	9,60
ANA-1	335,99	2117,76	1458,29	659,47	394,06	2070,50	137,09	119,43
ANOX-1	11405,99	2808,78	1874,34	934,43	450,88	2637,27	156,53	158,29
AT-1A	12581,99	2829,76	1888,00	941,76	453,65	2655,86	157,44	159,48
AT-1B	12581,99	2829,41	1887,31	942,09	453,27	2655,32	157,41	159,48
Collect Distribute	25163,98	2829,32	1887,07	942,24	453,00	2654,98	157,36	159,48
MBR-A	0,00	0	0	0	0,65	59,42	6,00	0,45
EFF Storage	167,99	0	0	0	0,86	59,32	8,06	0,58
EFF	167,99	0,00	0,00	0,00	0,86	59,32	8,06	0,58
RAS Pit	2855,99	2992,69	1994,98	997,71	476,76	2803,15	166,11	168,78
WAS Tank	0,00	3000,18	2009,83	990,36	482,79	2824,82	167,27	169,67
Dewatered Sludge	0	0	0	0	0	0	0	0
FeCl3	0,00	0	0	0	0	0	0	0
POLYMER	0,00	12197,85	12120,00	77,85	11555,44	18180,00	0	0

Album page - Concentration

Element	INF	GRIT	Dewatering Centrifuge	SCREENING	ANA-1	ANOX-1	AT-1B	Collect Distribute	EFF	RAS Pit	Dewatered Sludge
Flow [m3/d]	456,00	0,02	0,00	0,05	335,99	11405,99	12581,99	25163,98	167,99	2855,99	0
Total suspend	211,03	7211,32	0	320178,44	2117,76	2808,78	2829,41	2829,32	0,00	2992,69	0



ed solids												
[mg/L]												
Volatile	191,03	185,59	0	315618,	1458,29	1874,34	1887,31	1887,07	0,00	1994,98	0	
suspend				36								
ed solids												
[mg/L]												
ISS Total	20,00	7025,73	0	4560,08	659,47	934,43	942,09	942,24	0,00	997,71	0	
[mg/L]												
BOD -	286,84	278,68	0	34366,6	394,06	450,88	453,27	453,00	0,86	476,76	0	
Total				9								
Carbona												
ceous												
[mg/L]												
BOD -	169,71	164,89	0	165,19	1,10	0,36	0,57	0,58	0,86	0,52	0	
Filtered												
Carbona												
ceous												
[mg/L]												
COD -	575,00	558,64	0	415508,	2070,50	2637,27	2655,32	2654,98	59,32	2803,15	0	
Total				01								
[mg/L]												
COD -	272,00	264,25	0	415213,	2013,07	2578,37	2596,07	2595,70	0,00	2743,86	0	
Particula				07								
te [mg/L]												
COD -	303,00	294,39	0	294,94	57,43	58,90	59,25	59,28	59,32	59,30	0	
Filtered												
[mg/L]												
N - Total	64,50	83,33	0	14655,5	137,09	156,53	157,41	157,36	8,06	166,11	0	
N				0								
[mgN/L]												
N - Total	64,20	83,03	0	14655,2	137,09	154,46	155,18	155,06	5,87	163,53	0	
Kjeldahl				0								
Nitrogen												
[mgN/L]												
N -	8,06	8,55	0	14581,7	113,67	150,38	151,48	151,47	0,00	160,19	0	
Particula				7								
te TKN												
[mgN/L]												



N - Ammonia [mgN/L]	51,32	66,37	0	66,24	20,70	0,92	0,52	0,38	2,04	0,10	0
N - Nitrate [mgN/L]	0,30	0,30	0	0,30	0,00	2,02	2,13	2,22	1,81	2,55	0
N - Nitrite [mgN/L]	0	0,00	0	0,00	0,00	0,05	0,09	0,08	0,38	0,02	0
P - Total P [mgP/L]	9,30	9,90	0	4891,36	119,43	158,29	159,48	159,48	0,58	168,78	0
P - Soluble PO4-P [mgP/L]	5,64	6,00	0	6,11	16,56	0,85	0,63	0,57	0,58	0,46	0

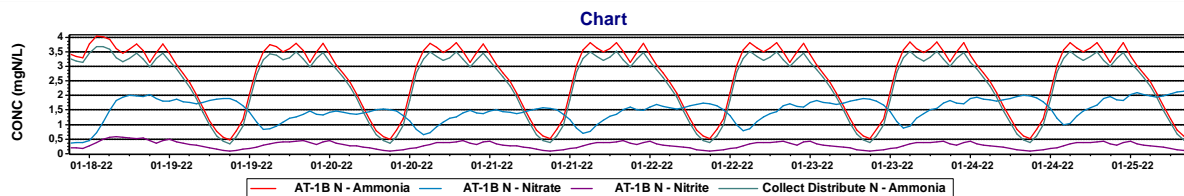
Album page - Conversions

Elements	Nit - Ammonia removal rate [kg/d]	Denit - Nitrate removal rate [kg/d]	OTR [kg/d]	OUR - Carbonaceous [kg/d]	OUR - Nitrification [kg/d]	OUR - Sulfur [kg/d]	OUR - Total [kg/d]	SOTR [kg/d]
ANA-1	0,00	0,53	0	0,01	0,00	0,05	0,05	0
ANA-2	0,00	0,53	0	0,01	0,00	0,05	0,05	0
ANA-3	0	0	0	0	0	0	0	0
ANA-4	0	0	0	0	0	0	0	0
ANOX-1	1,71	3,68	0	2,74	7,77	5,04	15,55	0
ANOX-2	1,71	3,68	0	2,74	7,77	5,04	15,55	0
ANOX-3	0	0	0	0	0	0	0	0
ANOX-4	0	0	0	0	0	0	0	0
AT-1A	0,31	3,31	0	0,65	1,62	1,16	3,43	0
AT-1B	5,29	1,36	70,88	10,91	21,99	2,15	35,06	230,17

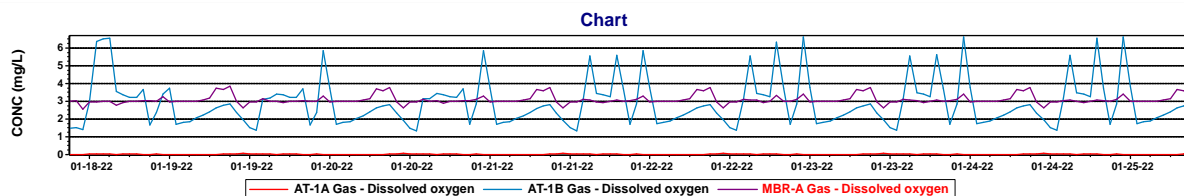


AT-2A	0,31	3,31	0	0,65	1,62	1,16	3,43	0
AT-2B	5,29	1,36	70,88	10,91	21,99	2,15	35,06	230,17
AT-3A	0	0	0	0	0	0	0	0
AT-3B	0	0	0	0	0	0	0	0
AT-4A	0	0	0	0	0	0	0	0
AT-4B	0	0	0	0	0	0	0	0
Collect	4,17	2,34	0	10,55	18,25	1,68	30,49	0
Distribute								
MBR-A	0,74	0,46	11,63	4,55	3,25	0,19	7,99	49,05
MBR-B	0,80	0,55	11,81	4,97	3,50	0,21	8,67	47,86
MBR-C	0,00	0,00	0	0,00	0,00	0,00	0,00	0
RAS Pit	0,60	1,07	0	3,60	2,68	0,14	6,42	0
WAS Tank	0	0	0	0	0	0	0	0
	----	----	----	----	----	----	----	----
Total	20,94	22,21	165,20	52,28	90,45	19,00	161,73	557,25

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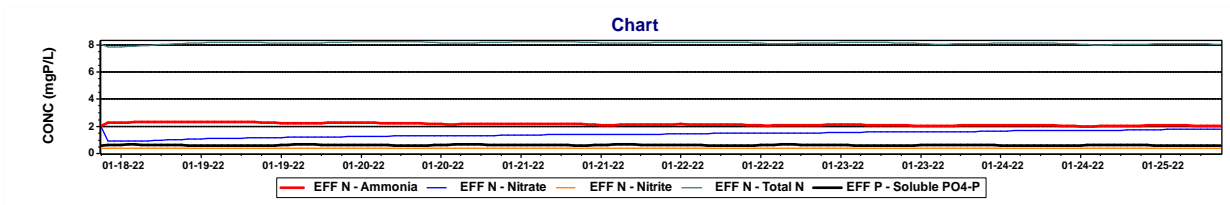


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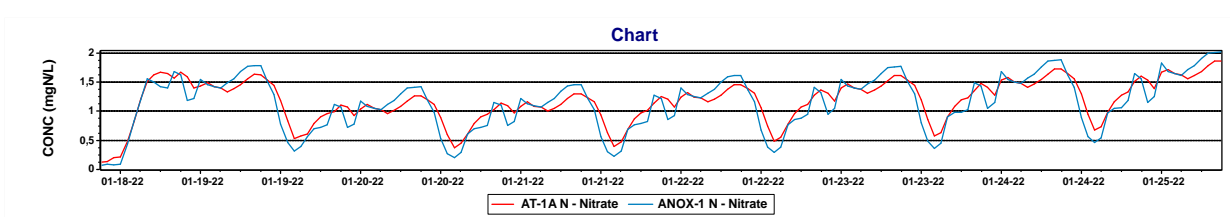


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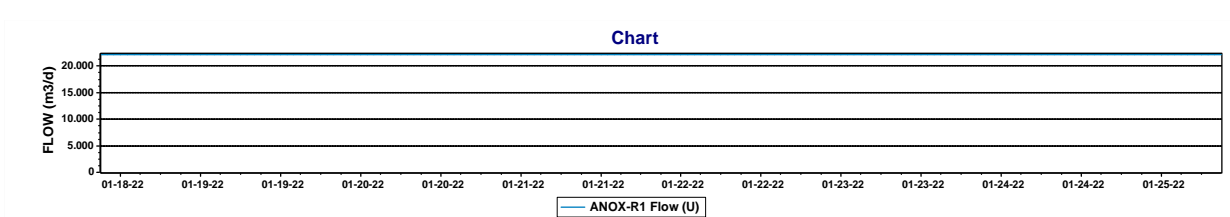




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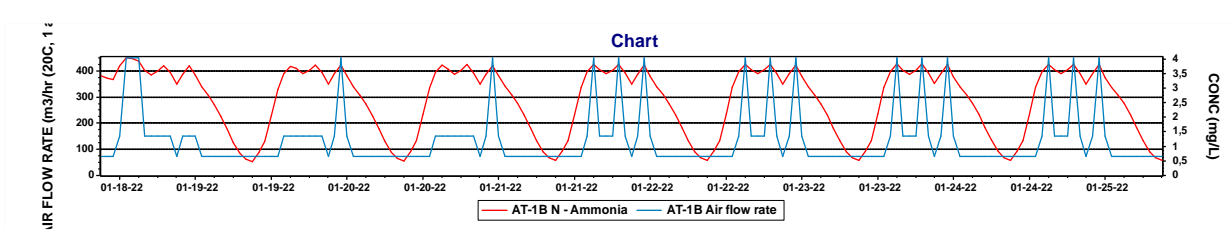


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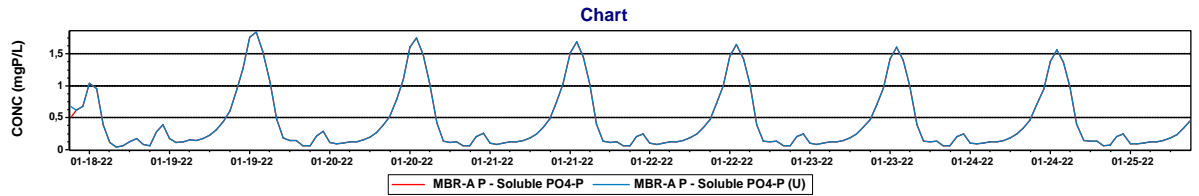
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Global Parameters

Common

Name	Default	Value
Hydrolysis rate [1/d]	2,1000	2,1000 1,0290
Hydrolysis half sat. [-]	0,0600	0,0600 1,0000
External organics hydrolysis rate [1/d]	2,1000	2,1000 1,0290
External organics hydrolysis half sat. [-]	0,0600	0,0600 1,0000
Anoxic hydrolysis factor [-]	0,2800	0,2800 1,0000
Anaerobic hydrolysis factor (AS) [-]	0,0400	0,0400 1,0000
Anaerobic hydrolysis factor (AD) [-]	0,5000	0,5000 1,0000
Adsorption rate of colloids [L/(mgCOD d)]	0,1500	0,1500 1,0290
Ammonification rate [L/(mgCOD d)]	0,0800	0,0800 1,0290
Assimilative nitrate/nitrite reduction rate [1/d]	0,5000	0,5000 1,0000
Endogenous products decay rate [1/d]	0	0 1,0000

Ammonia oxidizing

Name	Default	Value
Max. spec. growth rate [1/d]	0,9000	0,9000 1,0720
Substrate (NH4) half sat. [mgN/L]	0,7000	0,7000 1,0000
Byproduct NH4 logistic slope [-]	50,0000	50,0000 1,0000



Byproduct NH4 inflection point [mgN/L]	1,4000	1,4000	1,0000
Denite DO half sat. [mg/L]	0,1000	0,1000	1,0000
Denite HNO2 half sat. [mgN/L]	5,000E-6	5,000E-6	1,0000
Aerobic decay rate [1/d]	0,1700	0,1700	1,0290
Anoxic/anaerobic decay rate [1/d]	0,0800	0,0800	1,0290
KiHNO2 [mmol/L]	5,000E-3	5,000E-3	1,0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0,7000	0,7000	1,0600
Substrate (NO2) half sat. [mgN/L]	0,1000	0,1000	1,0000
Aerobic decay rate [1/d]	0,1700	0,1700	1,0290
Anoxic/anaerobic decay rate [1/d]	0,0800	0,0800	1,0290
KiNH3 [mmol/L]	0,0750	0,0750	1,0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0,2000	0,2000	1,1000
Substrate (NH4) half sat. [mgN/L]	2,0000	2,0000	1,0000
Substrate (NO2) half sat. [mgN/L]	1,0000	1,0000	1,0000
Aerobic decay rate [1/d]	0,0190	0,0190	1,0290
Anoxic/anaerobic decay rate [1/d]	9,500E-3	9,500E-3	1,0290
Ki Nitrite [mgN/L]	1000,0000	1000,0000	1,0000
Nitrite sensitivity constant [L / (d mgN)]	0,0160	0,0160	1,0000

Ordinary heterotrophic



Name	Default	Value	
Max. spec. growth rate [1/d]	3,2000	3,2000	1,0290
Substrate half sat. [mgCOD/L]	5,0000	5,0000	1,0000
Anoxic growth factor [-]	0,5000	1,0000	1,0000
Denite N2 producers (NO3 or NO2) [-]	0,5000	0,5000	1,0000
Aerobic decay rate [1/d]	0,6200	0,6200	1,0290
Anoxic decay rate [1/d]	0,2330	0,2330	1,0290
Anaerobic decay rate [1/d]	0,1310	0,1310	1,0290
Fermentation rate [1/d]	1,6000	1,6000	1,0290
Fermentation half sat. [mgCOD/L]	5,0000	5,0000	1,0000
Fermentation growth factor (AS) [-]	0,2500	0,2500	1,0000
Free nitrous acid inhibition [mol/L]	1,000E-7	1,000E-7	1,0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4,3000	4,3000	1,0290
Substrate (Ind #1) half sat. [mgCOD/L]	1,0000	1,0000	1,0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60,0000	60,0000	1,0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0,0500	0,0500	1,0000
Maximum specific growth rate on Ind #2 COD [1/d]	1,5000	1,5000	1,0290
Substrate (Ind #2) half sat. [mgCOD/L]	30,0000	30,0000	1,0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000,0000	3000,0000	1,0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0,0500	0,0500	1,0000
Maximum specific growth rate on Ind #3 COD [1/d]	4,3000	4,3000	1,0290
Substrate (Ind #3) half sat. [mgCOD/L]	1,0000	1,0000	1,0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60,0000	60,0000	1,0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0,0500	0,0500	1,0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2,0000	2,0000	1,0290



Substrate (adsorbed hydrocarbon) half sat. [-]	0,1500	0,1500	1,0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0,0100	0,0100	1,0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0,2000	0,2000	1,0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1,3000	1,3000	1,0720
Methanol half sat. [mgCOD/L]	0,5000	0,5000	1,0000
Denite N2 producers (NO3 or NO2) [-]	0,5000	0,5000	1,0000
Aerobic decay rate [1/d]	0,0400	0,0400	1,0290
Anoxic/anaerobic decay rate [1/d]	0,0300	0,0300	1,0290
Free nitrous acid inhibition [mmol/L]	1,000E-7	1,000E-7	1,0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0,9500	0,9500	1,0000
Max. spec. growth rate, P-limited [1/d]	0,4200	0,4200	1,0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0,1000	0,1000	1,0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0,0500	0,0500	1,0000
Magnesium half sat. [mgMg/L]	0,1000	0,1000	1,0000
Cation half sat. [mmol/L]	0,1000	0,1000	1,0000
Calcium half sat. [mgCa/L]	0,1000	0,1000	1,0000
Aerobic/anoxic decay rate [1/d]	0,1000	0,1000	1,0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1,0000
Anaerobic decay rate [1/d]	0,0400	0,0400	1,0000
Anaerobic maintenance rate [1/d]	0	0	1,0000
Sequestration rate [1/d]	4,5000	4,5000	1,0000



Anoxic growth factor [-]	0,3300	0,3300	1,0000
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Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0,2500	0,2500	1,0290
Substrate half sat. [mgCOD/L]	10,0000	10,0000	1,0000
Acetate inhibition [mgCOD/L]	10000,0000	10000,0000	1,0000
Anaerobic decay rate [1/d]	0,0500	0,0500	1,0290
Aerobic/anoxic decay rate [1/d]	0,5200	0,5200	1,0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0,3000	0,3000	1,0290
H ₂ -utilizing max. spec. growth rate [1/d]	1,4000	1,4000	1,0290
Acetoclastic substrate half sat. [mgCOD/L]	100,0000	100,0000	1,0000
Acetoclastic methanol half sat. [mgCOD/L]	0,5000	0,5000	1,0000
H ₂ -utilizing CO ₂ half sat. [mmol/L]	0,1000	0,1000	1,0000
H ₂ -utilizing substrate half sat. [mgCOD/L]	1,0000	1,0000	1,0000
H ₂ -utilizing methanol half sat. [mgCOD/L]	0,5000	0,5000	1,0000
Acetoclastic propionic inhibition [mgCOD/L]	10000,0000	10000,0000	1,0000
Acetoclastic anaerobic decay rate [1/d]	0,1300	0,1300	1,0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0,6000	0,6000	1,0290
H ₂ -utilizing anaerobic decay rate [1/d]	0,1300	0,1300	1,0290
H ₂ -utilizing aerobic/anoxic decay rate [1/d]	2,8000	2,8000	1,0290

Sulfur oxidizing



Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0,7500	0,7500	1,0290
Maximum specific growth rate (sulfur) [1/d]	0,1000	0,1000	1,0290
Substrate (H2S) half sat. [mgS/L]	1,0000	1,0000	1,0000
Substrate (sulfur) half sat. [mgS/L]	1,0000	1,0000	1,0000
Anoxic growth factor [-]	0,5000	0,5000	1,0000
Decay rate [1/d]	0,0400	0,0400	1,0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0,5830	0,5830	1,0350
Propionic acid half sat. [mgCOD/L]	295,0000	295,0000	1,0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185,0000	185,0000	1,0000
Sulfate (SO4=) half sat. [mgS/L]	2,4700	2,4700	1,0000
Decay rate [1/d]	0,0185	0,0185	1,0350
Acetotrophic max. spec. growth rate [1/d]	0,6120	0,6120	1,0350
Acetic acid half sat. [mgCOD/L]	24,0000	24,0000	1,0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164,0000	164,0000	1,0000
Sulfate (SO4=) half sat. [mgS/L]	6,4100	6,4100	1,0000
Decay rate [1/d]	0,0275	0,0275	1,0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2,8000	2,8000	1,0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0,1000	0,1000	1,0350
Hydrogen half sat. [mgCOD/L]	0,0700	0,0700	1,0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550,0000	550,0000	1,0000
Sulfate (SO4=) half sat. [mgS/L]	6,4100	6,4100	1,0000
Sulfur (S) half sat. [mgS/L]	50,0000	50,0000	1,0000
Decay rate [1/d]	0,0600	0,0600	1,0350



pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4,0000	4,0000
Ordinary heterotrophic high pH limit [-]	10,0000	10,0000
Methylotrophic low pH limit [-]	4,0000	4,0000
Methylotrophic high pH limit [-]	10,0000	10,0000
Autotrophic low pH limit [-]	5,5000	5,5000
Autotrophic high pH limit [-]	9,5000	9,5000
Phosphorus accumulating low pH limit [-]	4,0000	4,0000
Phosphorus accumulating high pH limit [-]	10,0000	10,0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5,5000	5,5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8,5000	8,5000
Propionic acetogenic low pH limit [-]	4,0000	4,0000
Propionic acetogenic high pH limit [-]	10,0000	10,0000
Acetoclastic methanogenic low pH limit [-]	5,0000	5,0000
Acetoclastic methanogenic high pH limit [-]	9,0000	9,0000
H2-utilizing methanogenic low pH limit [-]	5,0000	5,0000
H2-utilizing methanogenic high pH limit [-]	9,0000	9,0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0,1500	0,7000
Phosphorus accumulating DO half sat. [mgO2/L]	0,0500	0,0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0,1500	0,1500
Ammonia oxidizing DO half sat. [mgO2/L]	0,2500	0,7000
Nitrite oxidizing DO half sat. [mgO2/L]	0,5000	0,1000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0,0100	0,0100



Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0,2500	0,2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0,0500	0,0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0,1000	0,1000
Anoxic NO3(->N2) half sat. [mgN/L]	0,0500	0,0500
Anoxic NO2(->N2) half sat. (mgN/L)	0,0100	0,0100
NH3 nutrient half sat. [mgN/L]	5,000E-3	5,000E-3
PolyP half sat. [mgP/mgCOD]	0,0100	0,0100
VFA sequestration half sat. [mgCOD/L]	5,0000	5,0000
P uptake half sat. [mgP/L]	0,1500	0,1500
P nutrient half sat. [mgP/L]	1,000E-3	1,000E-3
Autotrophic CO2 half sat. [mmol/L]	0,1000	0,1000
H2 low/high half sat. [mgCOD/L]	1,0000	1,0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5,0000	5,0000
Synthesis anion/cation half sat. [meq/L]	0,0100	0,0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3,912E-3	3,912E-3
Biomass/Endog Mg content (gMg/gCOD)	3,912E-3	3,912E-3
Biomass/Endog other cations content (mol/gCOD)	5,115E-4	5,115E-4
Biomass/Endog other Anions content (mol/gCOD)	1,410E-4	1,410E-4
N in endogenous residue [mgN/mgCOD]	0,0700	0,0700
P in endogenous residue [mgP/mgCOD]	0,0220	0,0220
Ca content of slowly biodegradabe (gCa/gCOD)	3,912E-3	3,912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3,700E-4	3,700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1,6327	1,5000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1,6000	1,2000
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1,4000	1,4000



External organic COD:VSS ratio [mgCOD/mgVSS]	1,6000	1,6000
Molecular weight of other anions [mg/mmol]	35,5000	35,5000
Molecular weight of other cations [mg/mmol]	39,0983	39,0983

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0,1500	0,1500
Denite NO2 fraction as TEA [-]	0,5000	0,5000
Byproduct NH4 fraction to N2O [-]	2,500E-3	2,500E-3
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0,0900	0,0900
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0,1140	0,1140



Nitrate production [mgN/mgBiomassCOD]	2,2800	2,2800
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0,6660	0,6660
Yield (fermentation, low H2) [-]	0,1000	0,1000
Yield (fermentation, high H2) [-]	0,1000	0,1000
H2 yield (fermentation low H2) [-]	0,3500	0,3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0,7000	0,7000
CO2 yield (fermentation, low H2) [-]	0,7000	0,7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Endogenous fraction - aerobic [-]	0,0800	0,0800
Endogenous fraction - anoxic [-]	0,1030	0,1030
Endogenous fraction - anaerobic [-]	0,1840	0,1840
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200
Yield (anoxic) [-]	0,5400	0,5400
Yield propionic (aerobic) [-]	0,6400	0,6400
Yield propionic (anoxic) [-]	0,4600	0,4600
Yield acetic (aerobic) [-]	0,6000	0,6000
Yield acetic (anoxic) [-]	0,4300	0,4300
Yield methanol (aerobic) [-]	0,5000	0,5000



Adsorp. max. [-]	1,0000	1,0000
Max fraction to N2O at high FNA over nitrate [-]	0,0500	0,0500
Max fraction to N2O at high FNA over nitrite [-]	0,1000	0,1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0,5000	0,5000
Yield Ind #1 COD (Anoxic) [-]	0,4000	0,4000
Yield Ind #1 COD (Anaerobic) [-]	0,0400	0,0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224,0000	224,0000
Yield Ind #2 COD (Aerobic) [-]	0,5000	0,5000
Yield Ind #2 COD (Anoxic) [-]	0,4000	0,4000
Yield Ind #2 COD (Anaerobic) [-]	0,0500	0,0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240,0000	240,0000
Yield on Ind #3 COD (Aerobic) [-]	0,5000	0,5000
Yield on Ind #3 COD (Anoxic) [-]	0,4000	0,4000
Yield on Ind #3 COD (Anaerobic) [-]	0,0400	0,0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288,0000	288,0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0,5000	0,5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0,4000	0,4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0,0400	0,0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336,0000	336,0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3,2000	3,2000
Max. hydrocarbon adsorp. ratio [-]	1,0000	1,0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0



Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0,4000	0,4000
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200
Max fraction to N ₂ O at high FNA over nitrate [-]	0,1000	0,1000
Max fraction to N ₂ O at high FNA over nitrite [-]	0,1500	0,1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0,6390	0,6390
Yield (anoxic) [-]	0,5200	0,5200
Aerobic P/PHA uptake [mgP/mgCOD]	0,9300	0,9300
Anoxic P/PHA uptake [mgP/mgCOD]	0,3500	0,6350
Yield of PHA on Ac sequestration [-]	0,8890	0,8890
N in biomass [mgN/mgCOD]	0,0700	0,0700
N in sol. inert [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous part. [-]	0,2500	0,2500
Inert fraction of endogenous sol. [-]	0,2000	0,2000
P/Ac release ratio [mgP/mgCOD]	0,5100	0,5300
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200
Yield of low PP [-]	0,9400	0,9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0,3000	0,3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0,1500	0,1500



Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0,0500	0,0500
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Propionic acetogenic

Name	Default	Value
Yield [-]	0,1000	0,1000
H2 yield [-]	0,4000	0,4000
CO2 yield [-]	1,0000	1,0000
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0,1000	0,1000
Acetoclastic yield on methanol[-]	0,1000	0,1000
H2-utilizing yield [-]	0,1000	0,1000
H2-utilizing yield on methanol [-]	0,1000	0,1000
N in acetoclastic biomass [mgN/mgCOD]	0,0700	0,0700
N in H2-utilizing biomass [mgN/mgCOD]	0,0700	0,0700
P in acetoclastic biomass [mgP/mgCOD]	0,0220	0,0220
P in H2-utilizing biomass [mgP/mgCOD]	0,0220	0,0220
Acetoclastic fraction to endog. residue [-]	0,0800	0,0800
H2-utilizing fraction to endog. residue [-]	0,0800	0,0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200



Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0,5000	0,5000
Yield (Anoxic) [mgCOD/mgS]	0,3500	0,3500
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H ₂ COD]	0,0712	0,0712
Yield [mgCOD/mg Ac COD]	0,0470	0,0470
Yield [mgCOD/mg Pr COD]	0,0384	0,0384
N in biomass [mgN/mgCOD]	0,0700	0,0700
P in biomass [mgP/mgCOD]	0,0220	0,0220
Fraction to endogenous residue [-]	0,0800	0,0800
COD:VSS ratio [mgCOD/mgVSS]	1,4200	1,4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2,500E-3	2,500E-3
BOD calculation rate constant for X _{sc} degradation [1/d]	0,5000	0,4000
BOD calculation rate constant for X _{sp} (and hydrocarbon) degradation [1/d]	0,5000	0,8000
BOD calculation rate constant for X _{eo} degradation [1/d]	0,5000	0,5000



Heating fuel/Chemical Costs

Name	Default	Value
Methanol [€/L]	0,3884	0,3884
Ferric chloride [€/kg Fe]	1,0327	1,0327
Ferric sulfate [€/kg Fe]	0,6973	0,6973
Ferrous chloride [€/kg Fe]	0,5384	0,5384
Ferrous sulfate [€/kg Fe]	2,0919	2,0919
Aluminum sulfate [€/kg Al]	1,4917	1,4917
Aluminum chloride [€/kg Al]	1,7477	1,7477
Poly Aluminum Chloride (PAC) [€/kg Al]	1,0327	1,0327
Natural gas [€/GJ]	2,6480	2,6480
Heating oil [€/L]	0,4413	0,4413
Diesel [€/L]	0,6179	0,6179
Custom fuel [€/L]	0,8827	0,8827
Biogas sale price [€/GJ]	1,7653	1,7653

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23,9000	23,9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0,3500	0,3500
Anaerobic digester gas hold-up factor []	1,0000	1,0000

Combined Heat and Power (CHP) engine

Name	Default	Value
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Methane heat of combustion [kJ/mole]	800,0000	800,0000
Hydrogen heat of combustion [kJ/mole]	240,0000	240,0000
CHP engine heat price [€/kWh]	0	0
CHP engine power price [€/kWh]	0,1324	0,1324

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [kJ/kg]	48000	48000
Calorific value of heating fuel oil [kJ/kg]	42000	42000
Calorific value of diesel [kJ/kg]	46000	46000
Calorific value of custom fuel [kJ/kg]	32000	32000

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [kg/m3]	900	900
Density of diesel [kg/m3]	875	875
Density of custom fuel [kg/m3]	790	790

Mass transfer

Name	Default	Value
KI for H2 [m/d]	17,0000	17,0000 1,0240
KI for CO2 [m/d]	10,0000	10,0000 1,0240
KI for NH3 [m/d]	1,0000	1,0000 1,0240
KI for CH4 [m/d]	8,0000	8,0000 1,0240
KI for N2 [m/d]	15,0000	15,0000 1,0240



KI for N2O [m/d]	8,0000	8,0000	1,0240
KI for H2S [m/d]	1,0000	1,0000	1,0240
KI for Ind #1 COD [m/d]	0	0	1,0240
KI for Ind #2 COD [m/d]	0,5000	0,5000	1,0240
KI for Ind #3 COD [m/d]	0	0	1,0240
KI for O2 [m/d]	13,0000	13,0000	1,0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3,4000E-2	3,4000E-2	2400,0000
O2 [M/atm]	1,3000E-3	1,3000E-3	1500,0000
N2 [M/atm]	6,5000E-4	6,5000E-4	1300,0000
N2O [M/atm]	2,5000E-2	2,5000E-2	2600,0000
NH3 [M/atm]	5,8000E+1	5,8000E+1	4100,0000
CH4 [M/atm]	1,4000E-3	1,4000E-3	1600,0000
H2 [M/atm]	7,8000E-4	7,8000E-4	500,0000
H2S [M/Atm]	1,0000E-1	1,0000E-1	2200,0000
Ind 1 [M/Atm]	1,9000E+3	1,9000E+3	7300,0000
Ind 2 [M/Atm]	1,8000E-1	1,8000E-1	2200,0000
Ind 3 [M/Atm]	1,5000E-1	1,5000E-1	1900,0000

Properties constants

Name	Default	Value
K in Viscosity = $K e^{-(Ea/RT)}$ [Pa s]	6,849E-7	6,849E-7
Ea in Viscosity = $K e^{-(Ea/RT)}$ [j/mol]	1,780E+4	1,780E+4
Y in ML Viscosity = H2O viscosity * $(1+A*MLSS^Y)$ [-]	1,0000	1,0000
A in ML Viscosity = H2O viscosity * $(1+A*MLSS^Y)$ [m3/g]	1,000E-7	1,000E-7



A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3,248E-4	3,248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5,2000	5,2000
B in Antoine equn. [T in K, P in Bar {NIST}]	1734,0000	1734,0000
C in Antoine equn. [T in K, P in Bar {NIST}]	-39,5000	-39,5000

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820,0000	3820,0000
Ferric sulfate solution density [kg/m3]	4800,0000	4800,0000
Ferrous chloride solution density [kg/m3]	3160,0000	3160,0000
Ferrous sulfate solution density [kg/m3]	1150,0000	1150,0000
Aluminum sulfate solution density [kg/m3]	1950,0000	1950,0000
Aluminum chloride solution density [kg/m3]	2480,0000	2480,0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1,000E+5	1,000E+5	1,0240
Vivianite redissolution rate [L/(mol d)]	1,000E+5	1,000E+5	1,0240
Vivianite half sat. [mgTSS/L]	0,0100	0,0100	1,0000
FeS precipitation rate [L/(mol d)]	1000,0000	1000,0000	1,0240
FeS redissolution rate [L/(mol d)]	10,0000	10,0000	1,0240
FeS half sat. [mgTSS/L]	0,1000	0,1000	1,0000
Struvite precipitation rate [L ² /(mol ² d)]	3,000E+10	3,000E+10	1,0240
Struvite redissolution rate [L ² /(mol ² d)]	3,000E+11	3,000E+11	1,0240
Struvite half sat. [mgTSS/L]	1,0000	1,0000	1,0000
Brushite precipitation rate [L/(mol d)]	1,000E+6	1,000E+6	1,0000
Brushite redissolution rate [L/(mol d)]	10000,0000	10000,0000	1,0000



Brushite half sat. [mgTSS/L]	1,0000	1,0000	1,0000
HAP precipitation rate [g/d]	5,000E-4	5,000E-4	1,0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1,710E-36	1,710E-36
FeS solubility product [mol/L]^2	4,258E-4	4,258E-4
Struvite solubility product [mol/L]^3	6,918E-14	6,918E-14
Brushite solubility product [mol/L]^2	2,490E-7	2,490E-7

Fe rates

Name	Default	Value
A in aging rate = $A * \exp(-G/B)$ [1/d]	16,1550	16,1550 1,0000
B in aging rate = $A * \exp(-G/B)$ [1/s]	57,3000	57,3000 1,0000
HFO(L) aging rate factor	2,500E-4	2,500E-4 1,0000
HFO(H) with H ₂ PO ₄ ⁻ bound aging factor []	1,000E-5	1,000E-5 1,0000
HFO(L) with H ₂ PO ₄ ⁻ bound aging factor []	0,4000	0,4000 1,0000
H ₂ PO ₄ ⁻ coprecipitation rate [mol/(L d)]	1,500E-9	1,500E-9 1,0000
H ₂ PO ₄ ⁻ Adsorption rate [mol/(L d)]	2,000E-11	2,000E-11 1,0000
H ⁺ competition for HFO(H) protonation sites [L/(mmol . d)]	1000,0000	1000,0000 1,0000
H ⁺ competition for HFO(L) protonation sites [L/(mmol . d)]	100,0000	100,0000 1,0000

Fe constants

Name	Default	Value
Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4,0000	4,0000



Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2,4000	2,4000
H+ competition level for Fe(OH)3 [mol/L]	7,000E-7	7,000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4-}/({mol H2PO4-}{mf HFO(H)}^2)]	2,000E-9	2,000E-9
Colloidal COD removed with Ferric [gCOD/Fe active site]	80,0000	80,0000
Minimum residual P level with iron addition [mgP/L]	0,0150	0,0150
HFO(H) with H2PO4- P release factor	10000,0000	10000,0000
HFO(L) with H2PO4- P release factor	10000,0000	10000,0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1,000E-7	1,000E-7	1,0000
Half Sat. acetic acid	0,5000	0,5000	1,0000
Iron reduction using propionic acid	1,000E-7	1,000E-7	1,0000
Half Sat. propionic acid	0,5000	0,5000	1,0000
Iron reduction using dissolved hydrogen gas	1,000E-7	1,000E-7	1,0000
Half Sat. dissolved hydrogen gas	0,5000	0,5000	1,0000
Iron reduction using hydrogen sulfide	5,000E-5	5,000E-5	1,0000
Half Sat. hydrogen sulfide	0,5000	0,5000	1,0000
Iron oxidation rate (aerobic)	1,000E-3	1,000E-3	1,0000
Abiotic iron reduction using acetic acid	2,000E-5	2,000E-5	1,0000
Abiotic iron reduction using propionic acid	2,000E-5	2,000E-5	1,0000
Abiotic iron reduction using dissolved hydrogen gas	2,000E-5	2,000E-5	1,0000
Abiotic iron reduction using hydrogen sulfide	2,000E-5	2,000E-5	1,0000
Abiotic iron oxidation rate (aerobic)	1,0000	1,0000	1,0000

CEPT rates

Name	Default	Value
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HFO colloidal adsorption rate	1,0000	1,0000	1,0000
Residual Xsc for adsorption to HFO	5,0000	5,0000	1,0000
Slope for Xsc residual	1,0000	1,0000	1,0000
HAO colloidal adsorption rate	1,0000	1,0000	1,0000
Residual Xsc for adsorption to HAO	5,0000	5,0000	1,0000
Slope for Xsc residual	1,0000	1,0000	1,0000

Al rates

Name	Default	Value	
A in aging rate = $A * \exp(-G/B)$ [1/d]	16,1550	16,1550	1,0000
B in aging rate = $A * \exp(-G/B)$ [1/s]	57,3000	57,3000	1,0000
HAO(L) aging rate factor	2,500E-4	2,500E-4	1,0000
HAO(H) with H2PO4- bound aging factor []	1,000E-5	1,000E-5	1,0000
HAO(L) with H2PO4- bound aging factor []	0,4000	0,4000	1,0000
H2PO4- coprecipitation rate [mol/(L d)]	1,500E-9	1,500E-9	1,0000
H2PO4- Adsorption rate [mol / (L d)]	1,000E-9	1,000E-9	1,0000

Al constants

Name	Default	Value
Al active site factor(high) [{mol Sites}/{mol HAO(H)}]	3,0000	3,0000
Al active site factor(low) [{mol Sites}/{mol HAO(L)}]	1,5000	1,5000
Equilibrium constant for $\text{AlOH}_3\text{-H}_2\text{PO}_4^-$ [{mf HAO(H).H2PO4-}/({mol H2PO4-}{mf HAO(H)}^2)]	8,000E-10	8,000E-10
Colloidal COD removed with Al [gCOD/Al active site]	30,0000	30,0000
Minimum residual P level with Al addition [mgP/L]	0,0150	0,0150
HAO(H) with H2PO4- P release factor	10000,0000	10000,0000
HAO(L) with H2PO4- P release factor	10000,0000	10000,0000



Pipe and pump parameters

Name	Default	Value
Static head [m]	0,2500	0,2500
Pipe length (headloss calc.s) [m]	50,0000	50,0000
Pipe inside diameter [mm]	500,000	500,000
K(fittings) - Total minor losses K	5,0000	5,0000
Pipe roughness [mm]	0,200	0,200
'A' in overall pump efficiency = $A + B*Q + C*(Q^2)$ [-]	0,8500	0,8500
'B' in overall pump efficiency = $A + B*Q + C*(Q^2)$ [-]/(m ³ /d)]	0	0
'C' in overall pump efficiency = $A + B*Q + C*(Q^2)$ [-]/(m ³ /d) ²]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0,0500	1,0000
90° bend	0,7500	5,0000
45° bend	0,3000	2,0000
Butterfly valve (open)	0,3000	1,0000
Non-return valve	1,0000	0
Outlet (bellmouth)	0,2000	1,0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101,3250	101,3250
Fractional effective saturation depth (Fed) [-]	0,3250	0,3250
Supply gas CO ₂ content [vol. %]	0,0400	0,0400



Supply gas O2 [vol. %]	20,9500	20,9500
Off-gas CO2 [vol. %]	2,0000	2,0000
Off-gas O2 [vol. %]	18,8000	18,8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2,0000	2,0000
Set point controller gain []	1,0000	1,0000

MABR Membrane effective diffusivities

Name	Default	Value	
O2 [m2/s]	2,500E-9	2,500E-9	1,0000
N2 [m2/s]	1,900E-9	1,900E-9	1,0000
CO2 [m2/s]	1,960E-9	1,960E-9	1,0000
H2 [m2/s]	5,850E-9	5,850E-9	1,0000
CH4 [m2/s]	1,963E-9	1,963E-9	1,0000
NH3 [m2/s]	2,000E-9	2,000E-9	1,0000
N2O [m2/s]	1,607E-9	1,607E-9	1,0000
H2S [m2/s]	1,530E-9	1,530E-9	1,0000
Ind 1 [m2/s]	7,240E-10	7,240E-10	1,0000
Ind 2 [m2/s]	8,900E-10	8,900E-10	1,0000
Ind 3 [m2/s]	7,960E-10	7,960E-10	1,0000

MABR Membrane transfer factors

Name	Default	Value	
O2 []	1,0000	1,0000	1,0000



N2 []	1,0000	1,0000	1,0000
CO2 []	1,0000	1,0000	1,0000
H2 []	1,0000	1,0000	1,0000
CH4 []	1,0000	1,0000	1,0000
NH3 []	1,0000	1,0000	1,0000
N2O []	1,0000	1,0000	1,0000
H2S []	1,0000	1,0000	1,0000
Ind 1 []	1,0000	1,0000	1,0000
Ind 2 []	1,0000	1,0000	1,0000
Ind 3 []	1,0000	1,0000	1,0000

Blower

Name	Default	Value
Intake filter pressure drop [kPa]	3,5000	3,5000
Pressure drop through distribution system (piping/valves) [kPa]	3,0000	3,0000
Adiabatic/polytropic compression exponent (1.4 for adiabatic)	1,4000	1,4000
'A' in blower efficiency = $A + B \cdot Q_a + C \cdot (Q_a^2)$ [-]	0,7500	0,7500
'B' in blower efficiency = $A + B \cdot Q_a + C \cdot (Q_a^2)$ [-] / (m ³ /hr (20C, 1 atm))]	0	0
'C' in blower efficiency = $A + B \cdot Q_a + C \cdot (Q_a^2)$ [-] / (m ³ /hr (20C, 1 atm)) ²]	0	0

Diffuser

Name	Default	Value
k1 in $C = k1(PC)^{0.25} + k2$	1,2400	1,2400
k2 in $C = k1(PC)^{0.25} + k2$	0,8960	0,8960
Y in $Kla = C \cdot U_{sg}^Y - U_{sg}$ in [m ³ /(m ² d)]	0,8880	0,8880
Area of one diffuser [m ²]	0,0410	0,0380
Diffuser mounting height [m]	0,2500	0,2500



Min. air flow rate per diffuser m3/hr (20C, 1 atm)	0,5000	0,5000
Max. air flow rate per diffuser m3/hr (20C, 1 atm)	10,0000	10,0000
'A' in diffuser pressure drop = $A + B \cdot (Qa/Diff) + C \cdot (Qa/Diff)^2$ [kPa]	3,0000	3,0000
'B' in diffuser pressure drop = $A + B \cdot (Qa/Diff) + C \cdot (Qa/Diff)^2$ [kPa/(m3/hr (20C, 1 atm))]	0	0
'C' in diffuser pressure drop = $A + B \cdot (Qa/Diff) + C \cdot (Qa/Diff)^2$ [kPa/(m3/hr (20C, 1 atm))^2]	0	0

Surface aerators

Name	Default	Value
Surface aerator Std. oxygen transfer rate [kg O /(kW hr)]	1,50000	1,50000

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [m/d]	170,000	170,000
Vesilind hindered zone settling parameter (K) [L/g]	0,370	0,370
Clarification switching function [mg/L]	100,000	100,000
Specified TSS conc.for height calc. [mg/L]	2500,000	2500,000
Maximum compactability constant [mg/L]	15000,000	15000,000
Maximum compactability slope [L/mg]	0,010	0,010

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [m/d]	410,000	410,000
Maximum (practical) settling velocity (Vo') [m/d]	270,000	270,000
Hindered zone settling parameter (Kh) [L/g]	0,400	0,400
Flocculent zone settling parameter (Kf) [L/g]	2,500	2,500



Maximum non-settleable TSS [mg/L]	20,0000	20,0000
Non-settleable fraction [-]	1,000E-3	1,000E-3
Specified TSS conc. for height calc. [mg/L]	2500,0000	2500,0000

Emission factors

Name	Default	Value
Carbon dioxide equivalence of nitrous oxide	296,0000	296,0000
Carbon dioxide equivalence of methane	23,0000	23,0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	8,0000	8,0000	1,0000
Attachment TSS half sat. [mg/L]	100,0000	100,0000	1,0000
Detachment rate [g/(m3 d)]	8000,0000	8000,0000	1,0000
Solids movement factor []	10,0000	10,0000	1,0000
Diffusion neta []	0,8000	0,8000	1,0000
Thin film limit [mm]	0,5000	0,5000	1,0000
Thick film limit [mm]	3,0000	3,0000	1,0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	1,2500	1,2500	1,0000
Film surface area to media area ratio - Max.[]	1,0000	1,0000	1,0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4,0000	4,0000	1,0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5,000E+4	5,000E+4	1,0000



Biomass - Methylothetic	5,000E+4	5,000E+4	1,0000
Biomass - Ammonia oxidizing	1,000E+5	1,000E+5	1,0000
Biomass - Nitrite oxidizing	1,000E+5	1,000E+5	1,0000
Biomass - Anaerobic ammonia oxidizing	5,000E+4	5,000E+4	1,0000
Biomass - Phosphorus accumulating	5,000E+4	5,000E+4	1,0000
Biomass - Propionic acetogenic	5,000E+4	5,000E+4	1,0000
Biomass - Acetoclastic methanogenic	5,000E+4	5,000E+4	1,0000
Biomass - Hydrogenotrophic methanogenic	5,000E+4	5,000E+4	1,0000
Biomass - Endogenous products	3,000E+4	3,000E+4	1,0000
CODp - Slowly degradable particulate	5000,0000	5000,0000	1,0000
CODp - Slowly degradable colloidal	4000,0000	4000,0000	1,0000
CODp - Degradable external organics	5000,0000	5000,0000	1,0000
CODp - Undegradable non-cellulose	5000,0000	5000,0000	1,0000
CODp - Undegradable cellulose	5000,0000	5000,0000	1,0000
N - Particulate degradable organic	0	0	1,0000
P - Particulate degradable organic	0	0	1,0000
N - Particulate degradable external organics	0	0	1,0000
P - Particulate degradable external organics	0	0	1,0000
N - Particulate undegradable	0	0	1,0000
P - Particulate undegradable	0	0	1,0000
CODp - Stored PHA	5000,0000	5000,0000	1,0000
P - Releasable stored polyP	1,150E+6	1,150E+6	1,0000
P - Unreleasable stored polyP	1,150E+6	1,150E+6	1,0000
CODs - Complex readily degradable	0	0	1,0000
CODs - Acetate	0	0	1,0000
CODs - Propionate	0	0	1,0000
CODs - Methanol	0	0	1,0000
Gas - Dissolved hydrogen	0	0	1,0000
Gas - Dissolved methane	0	0	1,0000
N - Ammonia	0	0	1,0000
N - Soluble degradable organic	0	0	1,0000



Gas - Dissolved nitrous oxide	0	0	1,0000
N - Nitrite	0	0	1,0000
N - Nitrate	0	0	1,0000
Gas - Dissolved nitrogen	0	0	1,0000
P - Soluble phosphate	0	0	1,0000
CODs - Undegradable	0	0	1,0000
N - Soluble undegradable organic	0	0	1,0000
Influent inorganic suspended solids	1,300E+6	1,300E+6	1,0000
Precipitate - Struvite	8,500E+5	8,500E+5	1,0000
Precipitate - Brushite	1,165E+6	1,165E+6	1,0000
Precipitate - Hydroxy - apatite	1,600E+6	1,600E+6	1,0000
Precipitate - Vivianite	1,340E+6	1,340E+6	1,0000
HFO - High surface	5,000E+4	5,000E+4	1,0000
HFO - Low surface	5,000E+4	5,000E+4	1,0000
HFO - High with H ₂ PO ₄ - adsorbed	5,000E+4	5,000E+4	1,0000
HFO - Low with H ₂ PO ₄ - adsorbed	5,000E+4	5,000E+4	1,0000
HFO - Aged	5,000E+4	5,000E+4	1,0000
HFO - Low with H ⁺ adsorbed	5,000E+4	5,000E+4	1,0000
HFO - High with H ⁺ adsorbed	5,000E+4	5,000E+4	1,0000
HAO - High surface	5,000E+4	5,000E+4	1,0000
HAO - Low surface	5,000E+4	5,000E+4	1,0000
HAO - High with H ₂ PO ₄ - adsorbed	5,000E+4	5,000E+4	1,0000
HAO - Low with H ₂ PO ₄ - adsorbed	5,000E+4	5,000E+4	1,0000
HAO - Aged	5,000E+4	5,000E+4	1,0000
P - Bound on aged HMO	5,000E+4	5,000E+4	1,0000
Metal soluble - Magnesium	0	0	1,0000
Metal soluble - Calcium	0	0	1,0000
Metal soluble - Ferric	0	0	1,0000
Metal soluble - Ferrous	0	0	1,0000
Metal soluble - Aluminum	0	0	1,0000
Other Cations (strong bases)	0	0	1,0000



Other Anions (strong acids)	0	0	1,0000
Gas - Dissolved total CO2	0	0	1,0000
User defined - UD1	0	0	1,0000
User defined - UD2	0	0	1,0000
User defined - UD3	5,000E+4	5,000E+4	1,0000
User defined - UD4	5,000E+4	5,000E+4	1,0000
Biomass - Sulfur oxidizing	1,000E+5	1,000E+5	1,0000
Biomass - Sulfur reducing propionic acetogenic	5,000E+4	5,000E+4	1,0000
Biomass - Sulfur reducing acetotrophic	5,000E+4	5,000E+4	1,0000
Biomass - Sulfur reducing hydrogenotrophic	1,000E+5	1,000E+5	1,0000
Gas - Dissolved total sulfides	0	0	1,0000
S - Soluble sulfate	0	0	1,0000
S - Particulate elemental sulfur	5,000E+4	5,000E+4	1,0000
Precipitate - Ferrous sulfide	5,000E+4	5,000E+4	1,0000
CODp - Adsorbed hydrocarbon	5,000E+4	5,000E+4	1,0000
CODs - Degradable volatile ind. #1	0	0	1,0000
CODs - Degradable volatile ind. #2	0	0	1,0000
CODs - Degradable volatile ind. #3	0	0	1,0000
CODs - Soluble hydrocarbon	0	0	1,0000
Gas - Dissolved oxygen	0	0	1,0000

Effective diffusivities [m2/s]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5,000E-14	5,000E-14	1,0290
Biomass - Methyloctrophic	5,000E-14	5,000E-14	1,0290
Biomass - Ammonia oxidizing	5,000E-14	5,000E-14	1,0290
Biomass - Nitrite oxidizing	5,000E-14	5,000E-14	1,0290
Biomass - Anaerobic ammonia oxidizing	5,000E-14	5,000E-14	1,0290
Biomass - Phosphorus accumulating	5,000E-14	5,000E-14	1,0290



Biomass - Propionic acetogenic	5,000E-14	5,000E-14	1,0290
Biomass - Acetoclastic methanogenic	5,000E-14	5,000E-14	1,0290
Biomass - Hydrogenotrophic methanogenic	5,000E-14	5,000E-14	1,0290
Biomass - Endogenous products	5,000E-14	5,000E-14	1,0290
CODp - Slowly degradable particulate	5,000E-14	5,000E-14	1,0290
CODp - Slowly degradable colloidal	5,000E-10	5,000E-10	1,0290
CODp - Degradable external organics	5,000E-14	5,000E-14	1,0290
CODp - Undegradable non-cellulose	5,000E-14	5,000E-14	1,0290
CODp - Undegradable cellulose	5,000E-14	5,000E-14	1,0290
N - Particulate degradable organic	5,000E-14	5,000E-14	1,0290
P - Particulate degradable organic	5,000E-14	5,000E-14	1,0290
N - Particulate degradable external organics	5,000E-14	5,000E-14	1,0290
P - Particulate degradable external organics	5,000E-14	5,000E-14	1,0290
N - Particulate undegradable	5,000E-14	5,000E-14	1,0290
P - Particulate undegradable	5,000E-14	5,000E-14	1,0290
CODp - Stored PHA	5,000E-14	5,000E-14	1,0290
P - Releasable stored polyP	5,000E-14	5,000E-14	1,0290
P - Unreleasable stored polyP	5,000E-14	5,000E-14	1,0290
CODs - Complex readily degradable	6,900E-10	6,900E-10	1,0290
CODs - Acetate	1,240E-9	1,240E-9	1,0290
CODs - Propionate	8,300E-10	8,300E-10	1,0290
CODs - Methanol	1,600E-9	1,600E-9	1,0290
Gas - Dissolved hydrogen	5,850E-9	5,850E-9	1,0290
Gas - Dissolved methane	1,963E-9	1,963E-9	1,0290
N - Ammonia	2,000E-9	2,000E-9	1,0290
N - Soluble degradable organic	1,370E-9	1,370E-9	1,0290
Gas - Dissolved nitrous oxide	1,607E-9	1,607E-9	1,0290
N - Nitrite	2,980E-9	2,980E-9	1,0290
N - Nitrate	2,980E-9	2,980E-9	1,0290
Gas - Dissolved nitrogen	1,900E-9	1,900E-9	1,0290
P - Soluble phosphate	2,000E-9	2,000E-9	1,0290



CODs - Undegradable	6,900E-10	6,900E-10	1,0290
N - Soluble undegradable organic	6,850E-10	6,850E-10	1,0290
Influent inorganic suspended solids	5,000E-14	5,000E-14	1,0290
Precipitate - Struvite	5,000E-14	5,000E-14	1,0290
Precipitate - Brushite	5,000E-14	5,000E-14	1,0290
Precipitate - Hydroxy - apatite	5,000E-14	5,000E-14	1,0290
Precipitate - Vivianite	5,000E-14	5,000E-14	1,0290
HFO - High surface	5,000E-14	5,000E-14	1,0290
HFO - Low surface	5,000E-14	5,000E-14	1,0290
HFO - High with H ₂ PO ₄ - adsorbed	5,000E-14	5,000E-14	1,0290
HFO - Low with H ₂ PO ₄ - adsorbed	5,000E-14	5,000E-14	1,0290
HFO - Aged	5,000E-14	5,000E-14	1,0290
HFO - Low with H ⁺ adsorbed	5,000E-14	5,000E-14	1,0290
HFO - High with H ⁺ adsorbed	5,000E-14	5,000E-14	1,0290
HAO - High surface	5,000E-14	5,000E-14	1,0290
HAO - Low surface	5,000E-14	5,000E-14	1,0290
HAO - High with H ₂ PO ₄ - adsorbed	5,000E-14	5,000E-14	1,0290
HAO - Low with H ₂ PO ₄ - adsorbed	5,000E-14	5,000E-14	1,0290
HAO - Aged	5,000E-14	5,000E-14	1,0290
P - Bound on aged HMO	5,000E-14	5,000E-14	1,0290
Metal soluble - Magnesium	7,200E-10	7,200E-10	1,0290
Metal soluble - Calcium	7,200E-10	7,200E-10	1,0290
Metal soluble - Ferric	4,800E-10	4,800E-10	1,0290
Metal soluble - Ferrous	4,800E-10	4,800E-10	1,0290
Metal soluble - Aluminum	4,800E-10	4,800E-10	1,0290
Other Cations (strong bases)	1,440E-9	1,440E-9	1,0290
Other Anions (strong acids)	1,440E-9	1,440E-9	1,0290
Gas - Dissolved total CO ₂	1,960E-9	1,960E-9	1,0290
User defined - UD1	6,900E-10	6,900E-10	1,0290
User defined - UD2	6,900E-10	6,900E-10	1,0290
User defined - UD3	5,000E-14	5,000E-14	1,0290



User defined - UD4	5,000E-14	5,000E-14	1,0290
Biomass - Sulfur oxidizing	5,000E-14	5,000E-14	1,0290
Biomass - Sulfur reducing propionic acetogenic	5,000E-14	5,000E-14	1,0290
Biomass - Sulfur reducing acetotrophic	5,000E-14	5,000E-14	1,0290
Biomass - Sulfur reducing hydrogenotrophic	5,000E-14	5,000E-14	1,0290
Gas - Dissolved total sulfides	1,530E-9	1,530E-9	1,0290
S - Soluble sulfate	2,130E-10	2,130E-10	1,0290
S - Particulate elemental sulfur	5,000E-14	5,000E-14	1,0290
Precipitate - Ferrous sulfide	5,000E-14	5,000E-14	1,0290
CODp - Adsorbed hydrocarbon	5,000E-14	5,000E-14	1,0290
CODs - Degradable volatile ind. #1	7,240E-10	7,240E-10	1,0290
CODs - Degradable volatile ind. #2	8,900E-10	8,900E-10	1,0290
CODs - Degradable volatile ind. #3	7,960E-10	7,960E-10	1,0290
CODs - Soluble hydrocarbon	7,120E-10	7,120E-10	1,0290
Gas - Dissolved oxygen	2,500E-9	2,500E-9	1,0290

EPS Strength coefficients []

Name	Default	Value	
Biomass - Ordinary heterotrophic	1,0000	1,0000	1,0000
Biomass - Methylothetic	1,0000	1,0000	1,0000
Biomass - Ammonia oxidizing	5,0000	5,0000	1,0000
Biomass - Nitrite oxidizing	25,0000	25,0000	1,0000
Biomass - Anaerobic ammonia oxidizing	10,0000	10,0000	1,0000
Biomass - Phosphorus accumulating	1,0000	1,0000	1,0000
Biomass - Propionic acetogenic	1,0000	1,0000	1,0000
Biomass - Acetoclastic methanogenic	1,0000	1,0000	1,0000
Biomass - Hydrogenotrophic methanogenic	1,0000	1,0000	1,0000
Biomass - Endogenous products	1,0000	1,0000	1,0000
CODp - Slowly degradable particulate	1,0000	1,0000	1,0000



CODp - Slowly degradable colloidal	1,0000	1,0000	1,0000
CODp - Degradable external organics	1,0000	1,0000	1,0000
CODp - Undegradable non-cellulose	1,0000	1,0000	1,0000
CODp - Undegradable cellulose	1,0000	1,0000	1,0000
N - Particulate degradable organic	1,0000	1,0000	1,0000
P - Particulate degradable organic	1,0000	1,0000	1,0000
N - Particulate degradable external organics	1,0000	1,0000	1,0000
P - Particulate degradable external organics	1,0000	1,0000	1,0000
N - Particulate undegradable	1,0000	1,0000	1,0000
P - Particulate undegradable	1,0000	1,0000	1,0000
CODp - Stored PHA	1,0000	1,0000	1,0000
P - Releasable stored polyP	1,0000	1,0000	1,0000
P - Unreleasable stored polyP	1,0000	1,0000	1,0000
CODs - Complex readily degradable	0	0	1,0000
CODs - Acetate	0	0	1,0000
CODs - Propionate	0	0	1,0000
CODs - Methanol	0	0	1,0000
Gas - Dissolved hydrogen	0	0	1,0000
Gas - Dissolved methane	0	0	1,0000
N - Ammonia	0	0	1,0000
N - Soluble degradable organic	0	0	1,0000
Gas - Dissolved nitrous oxide	0	0	1,0000
N - Nitrite	0	0	1,0000
N - Nitrate	0	0	1,0000
Gas - Dissolved nitrogen	0	0	1,0000
P - Soluble phosphate	0	0	1,0000
CODs - Undegradable	0	0	1,0000
N - Soluble undegradable organic	0	0	1,0000
Influent inorganic suspended solids	0,3300	0,3300	1,0000
Precipitate - Struvite	1,0000	1,0000	1,0000
Precipitate - Brushite	1,0000	1,0000	1,0000



Precipitate - Hydroxy - apatite	1,0000	1,0000	1,0000
Precipitate - Vivianite	1,0000	1,0000	1,0000
HFO - High surface	1,0000	1,0000	1,0000
HFO - Low surface	1,0000	1,0000	1,0000
HFO - High with H2PO4- adsorbed	1,0000	1,0000	1,0000
HFO - Low with H2PO4- adsorbed	1,0000	1,0000	1,0000
HFO - Aged	1,0000	1,0000	1,0000
HFO - Low with H+ adsorbed	1,0000	1,0000	1,0000
HFO - High with H+ adsorbed	1,0000	1,0000	1,0000
HAO - High surface	1,0000	1,0000	1,0000
HAO - Low surface	1,0000	1,0000	1,0000
HAO - High with H2PO4- adsorbed	1,0000	1,0000	1,0000
HAO - Low with H2PO4- adsorbed	1,0000	1,0000	1,0000
HAO - Aged	1,0000	1,0000	1,0000
P - Bound on aged HMO	1,0000	1,0000	1,0000
Metal soluble - Magnesium	0	0	1,0000
Metal soluble - Calcium	0	0	1,0000
Metal soluble - Ferric	0	0	1,0000
Metal soluble - Ferrous	0	0	1,0000
Metal soluble - Aluminum	0	0	1,0000
Other Cations (strong bases)	0	0	1,0000
Other Anions (strong acids)	0	0	1,0000
Gas - Dissolved total CO2	0	0	1,0000
User defined - UD1	0	0	1,0000
User defined - UD2	0	0	1,0000
User defined - UD3	1,0000	1,0000	1,0000
User defined - UD4	1,0000	1,0000	1,0000
Biomass - Sulfur oxidizing	1,0000	1,0000	1,0000
Biomass - Sulfur reducing propionic acetogenic	1,0000	1,0000	1,0000
Biomass - Sulfur reducing acetotrophic	1,0000	1,0000	1,0000
Biomass - Sulfur reducing hydrogenotrophic	1,0000	1,0000	1,0000



Gas - Dissolved total sulfides	0	0	1,0000
S - Soluble sulfate	0	0	1,0000
S - Particulate elemental sulfur	1,0000	1,0000	1,0000
Precipitate - Ferrous sulfide	1,0000	1,0000	1,0000
CODp - Adsorbed hydrocarbon	1,0000	1,0000	1,0000
CODs - Degradable volatile ind. #1	0	0	1,0000
CODs - Degradable volatile ind. #2	0	0	1,0000
CODs - Degradable volatile ind. #3	0	0	1,0000
CODs - Soluble hydrocarbon	0	0	1,0000
Gas - Dissolved oxygen	0	0	1,0000

