Sampling Plan for Wastewater Treatment Plants

1 Introduction

Who is this document for?

The information in this document is likely relevant to all entities operating wastewater treatment plants (WWTPs). The content is specifically targeted to local council's that operate municipal treatment plants.

Objectives of this document

There are many comprehensive resources available about wastewater influent sampling. This document aims to provide a useful high-level resource to help entities operating WWTPs develop their own approach for influent wastewater sampling.

Sampling recommendations

This document provides recommendations for influent sampling for the following frequent purposes:

- Long-term influent monitoring, performance analysis, or design (sizing)
- Sampling for wastewater treatment software modelling
- Diurnal profile sampling

2 Sampling Methods and Location

Sampling Method

There are different ways to take wastewater samples. The simplest way is a "**grab sample**", where a sample is collected by filling a sample bottle once. The other common approach is a **24-hour composite sample**, where a small quantity of wastewater is collected based on set time intervals (time-weighted composite sample) or set flow intervals (flow-weighted composite sample). All individual samples are collected in a single bottle, which is then analysed. Another type of composite sampling is **aliquot sampling**, where the sample is collected as above, but a separate sample bottle is used for individual time periods (for example, a different bottle for every hour). Aliquot sampling is used to determine diurnal profiles.

Because wastewater influent concentrations show a diurnal pattern, taking a grab sample will not be representative of the average concentration (or pollutant load) going to the treatment plant. The diurnal pattern varies for each treatment plant, depending on factors such as population size, extent of collection network, and others. That is why 24-hour composite samples must be used.

Flowmeter Calibration

Treatment processes are typically sized based on pollutant loads (kg pollutant per day). Loads are calculated as the product from measured concentrations (gram pollutant per m^3) and influent volume (m^3 influent per day). It is thus important that any flowmeters are appropriately calibrated, correctly installed and operating correctly. A 10% flowmeter inaccuracy will directly impact the calculated loads by the same percentage.

Sampling Location

Generally influent samples are to be taken at a location upstream of any treatment plant internal recycle flows, such as waste activated sludge digester supernatant, sludge dewatering centrate return, or internal waste sump pump station returns. To take a representative sample, the sample is to be taken from a well-mixed, turbulent zone.

Samples can be taken upstream or downstream of influent screening, with the exact location being documented.

3 Sampling for Long-term Monitoring, Performance Analysis, and Design

Long-term influent monitoring sampling is recommended for all treatment plants. This data is used to monitor the treatment performance, understand the (remaining) treatment capacity of the plant, and long-term data is critical for accurately sizing future treatment plant upgrades. Only long-term data can show seasonal trends which could have a material impact on sizing of new treatment infrastructure. The recommended minimum long-term sampling parameters are shown in Table 1. Long-term sampling should be done at least every week.

There are activities for which more frequent sampling is beneficial. These include preliminary or detailed design and sizing of treatment upgrades, or a more detailed performance analysis of the existing biological treatment processes. The recommended parameters are the same as for long term sampling. It is recommended to increase the frequency to three times per week, to ensure any infrequent events that could have a material impact on process sizing such as septage or trade waste discharges are also captured in the data.

If the existing or proposed treatment process includes enhanced biological nutrient removal (such as enhanced biological phosphorus removal) then the modelling parameter set from section 4 should be considered.

Any trucked in waste such as **septage** or known **trade waste** discharges need to be documented during the sampling period.

- **Location**: Refer to section 2
- **Method**: 24-hour flow-weighted composite sampling
- **Frequency for long-term monitoring purposes**: At least weekly, on different weekdays, continuous
- **Frequency for performance analysis or design purposes:** Three days per week, on different days, for at least eight weeks[1]

Table 1 – Recommended sampling parameters for long-term monitoring, performance analysis, and design (sizing) purposes

No.	Parameter	Acronym	Filtration	Unit
1	Total Suspended Solids	TSS	Yes – 1.2 µm	g/m^3
2	Chemical Oxygen Demand	COD	No	g/m^3
3	Soluble COD	sCOD	Yes – 1.2 µm	g/m^3
4	Carbonaceous 5-day Biochemical Oxygen Demand	$CBOD_5$	No	g/m^3
5	Soluble $CBOD_5$	$sCBOD_5$	Yes – 1.2 µm	g/m^3
6	Total Kieldahl Nitrogen	TKN	No	g/m^3
7	Total Ammoniacal Nitrogen (NH_4^+-N and NH_3-N)	TAN	Optional – 1.2 µm	g/m^3
8	Nitrate-Nitrogen (NO_3^--N)	NO_3	Optional – 1.2 µm	g/m^3
9	Total Phosphorus	TP	No	g/m^3

[1] The duration can be varied. The objective is to ensure that any infrequent point discharges are captured. For design (sizing) purposes, it is important to provide sufficient data to enable a robust statistical analysis. At least 24 samples are recommended.

No.	Parameter	Acronym	Filtration	Unit
10	Dissolved Reactive Phosphorus	DRP	Yes – 1.2 µm	g/m^3
11	Oils and Grease*	FOG	No	g/m^3
12	Alkalinity	ALK	No	g/m^3 as $CaCO_3$
13	Temperature (field measurement)	-	No	°C
14	pH (field measurement)	-	No	-

(*) Oil and grease is usually done as a grab sample in a glass sample bottle because they can adhere to plastic tubing and sample bottles and impacting the accuracy of the measured concentration.

4 Modelling Sampling

When modelling biological wastewater treatment processes including biological nutrient removal, it is important to know the detailed composition of influent wastewater, such as for example total and soluble chemical oxygen demand *[s]COD*, readily biodegradable chemical oxygen demand *rbCOD*, total and dissolved reactive phosphorus, and more. The full list of samples is outlined in Table 2. This parameter list is based on the BioWin influent specifier. It may need to be slightly adjusted if a different modelling software is used.

The sampling results need to be analysed together with the long-term sampling results from section 3.

Any trucked in waste such as **septage** or known **trade waste** discharges need to be documented during the sampling period. Sampling during wet weather should be avoided.

- **Location**: refer to section 2
- **Method**: 24-hour flow-weighted composite sampling
- **Frequency**: daily, for at least two weeks

Table 2 – Recommended sampling parameters for modelling purposes

No.	Parameter	Acronym	Filtration	Unit
1	Total Suspended Solids	TSS	Yes – 1.2 µm	g/m^3
2	Volatile Suspended Solids	VSS	Yes – 1.2 µm	g/m^3
3	Chemical Oxygen Demand	COD	No	g/m^3
4	Soluble COD	sCOD	Yes – 1.2 µm	g/m^3
5	Filtered Flocculated COD	ffCOD	Yes – 0.45 µm	g/m^3
6	COD as Acetate	-	Yes – 1.2 µm	g/m^3
7	Carbonaceous 5-day Biochemical Oxygen Demand	$CBOD_5$	No	g/m^3
8	Soluble $CBOD_5$	$sCBOD_5$	Yes – 1.2 µm	g/m^3
9	Total Kieldahl Nitrogen	TKN	No	g/m^3
10	Total Ammoniacal Nitrogen (NH_4^+-N and NH_3-N)	TAN	Optional – 1.2 µm	g/m^3
11	Nitrate-Nitrogen (NO_3^--N)	NO_3	Optional – 1.2 µm	g/m^3

No.	Parameter	Acronym	Filtration	Unit
12	Dissolved Reactive Phosphorus	DRP	Yes – 1.2 µm	g/m^3
13	Total Phosphorus	TP	No	g/m^3
14	Oil and Grease*	FOG	No	g/m^3
15	Alkalinity	ALK	No	g/m^3 as $CaCO_3$
16	Temperature (field measurement)	-	No	°C
17	pH (field measurement)	-	No	-

(*) Oil and grease is usually done as a grab sample in a glass sample bottle because they can adhere to plastic tubing and sample bottles and impacting the accuracy of the measured concentration. This is not required for modelling, but it is a useful parameter to analyse for during intensive sampling.

5 Diurnal Profile Sampling

In certain cases, it is useful to develop an understanding of the incoming influent concentrations on an hourly or two-hourly basis. A typical use case is to investigate if there are point discharges such as dumping of trucked septage or trade waste discharges into the collection network, and this is reflected in the recommended samples in Table 3. There are other use cases which may need a different set of sampling parameters.

This type of sampling requires an aliquot sampler, as described in section 2.

To analyse this data sufficiently, the measured treatment plant inflow volume should be recorded for each sampled time-period (i.e. every one or two hours).

- **Location**: refer to section 2
- **Method**: One or two-hour time-weighted or flow-weighted composite sampling, for a total of 24 hours
- **Frequency**: two to three times per week, for at least two weeks (or longer, as needed)

Table 3 – Recommended sampling parameters for diurnal profile sampling purposes

No.	Parameter	Acronym	Filtration	Unit
1	Total Suspended Solids	TSS	Yes – 1.2 µm	g/m^3
2	Chemical Oxygen Demand	COD	No	g/m^3
3	Total Nitrogen	TN	No	g/m^3
4	Total Ammoniacal Nitrogen (NH_4^+-N and NH_3-N)	TAN	Optional – 1.2 µm	g/m^3
5	Total Phosphorus	TP	No	g/m^3