

Municipal Wastewater Treatment Plants

There are approximately 351 facilities in Washington under SIC code 4952 Sewerage Systems.

Methods of Determining Emissions

In evaluating the emissions from municipal wastewater treatment plants one factor has become obvious, the quantity of emissions are not large enough to warrant being regulated as a VOC source. It is possible that the emission of a specific compound will exceed its Ambient Source Impact Level (ASIL) (Chapter 173-460 WAC) off of the plant site.

Conditions that may lead to emissions of a toxic air pollutant (TAP) that causes its ASIL to be exceeded are:

- ❖ A treatment plant with the secondary treatment unit (aeration basin, trickling filter, etc.) close to the facility property line.
- ❖ Any treatment plant receiving water from a chlorinated drinking water supply.
- ❖ A treatment plant receiving effluent from one or more industries that are discharging considerable quantities of volatile organic compounds.
- ❖ Any industrial wastewater treatment facility.
- ❖ Any solid waste disposal site leachate treatment facility.
- ❖ Any wastewater treatment plant that uses surface aeration processes.

Emission rates of air pollutants from the wastewater treatment process are not subject to a simple set of estimating factors unless those factors were developed specifically for that facility or a group of related facilities by means of source testing. Because of the variability of the design of the process components, drinking water quality, wastewater temperature and inorganic chemical content, and waste characteristics, a simple emission factor based on the influent flow rate or some such factor is not appropriate.

There have been several studies done recently on air emissions from sewage treatment plants. The largest study was required by the South Coast Air Quality Management District for all wastewater treatment facilities in their jurisdiction. This study looked only at total reactive organic gas emissions, not the individual compounds. This study was called Joint Emission Inventory Program and resulted in a set of unit process specific emission factors for ROG. This set of factors is called Pooled Emission Estimating Program. When applied to the plants for which these factors were developed, they are not very 'conservative' in that they are very close to the actual emission rate rather than being relatively conservative, higher than actual, as appropriate for a regulatory basis. The basic PEEP report does have emission factors for individual compounds by process unit.

Water Environment Research Foundation (WERF) has funded a multi-year research project that is looking at the emission rates for the 59 most common VOCs found in municipal wastewater treatment plant influents from process units and from various odor control devices in common use.

Table 1 lists some of the available models for estimating emissions from wastewater treatment facilities.

Based on the influent VOC testing by Ecology's Environmental Investigations and Laboratory Services Section, chloroform (CHCl_3) is the major pollutant of concern from the treatment process. Chloroform is generated during the chlorination of the water supply and during certain wastewater treatment plant chlorination activities. The chloroform coming in with the wastewater is more significant in terms of air emissions than the chloroform generated at the treatment plant during disinfection and prechlorination processes.

Emissions of volatile compounds from a wastewater treatment plant of any kind occur mostly at those locations where the water surface is turbulent. These areas are primarily aerated grit tanks, aerated channels, aeration basins, clarifier weirs, and other weirs or areas that have high levels of turbulence. Chlorination of the final effluent is not a significant source of chloroform emissions but is a significant source of effluent chloroform which will become air emissions when the chlorinated effluent is spray irrigated for disposal or falls over a water fall.

A typical emission profile from an air activated sludge treatment plant shows that most emissions from a treatment plant occur in the aeration basin of an activated sludge plant. Lower but potentially significant levels of emissions occur at clarifier weirs and aerated grit chambers.

A pure oxygen activated sludge facility has much lower emissions of volatile air contaminants due to the much lower air usage rates and increased ability for biodegradation to occur in the oxygen rich activated sludge tanks. The bulk of the air emissions from this kind of treatment plant come from the primary and secondary clarifiers, headworks and any aerated channels at the facility.

Emissions from a sewage treatment plant are not constant but vary in relation to the flow received by the plant, the timing and content of industrial and commercial discharges to the plant, toxic material spills, the presence of any leaking underground gasoline or chemical storage tanks and, at very large facilities, by certain maintenance and odor control operations like prechlorination, chlorination of clarifier weirs to control algal growths, and by the adding and removing process units from service.

At this time there are no good models to account for the loss of volatile compounds from spray irrigated wastewater. A suggestion on how to model sprayfield emissions is to use

Table 1. Available Models for Estimating Emissions

PROCESS	AP-42	SIMS	TOXCHEM+	FATE	BASTE	Water8	CORAL
Aerated Grit removal	Ok	Ok	Yes	Ok	Yes	Yes	No
Primary clarifiers	Yes	No	Yes	No	Yes	Yes	No
Activated sludge basins	Ok	Ok	Yes	Yes	Yes	Yes	No
Trickling filters, RBC's, biotowers	No	No	Yes	No	Yes	Yes	No
Secondary clarifiers	Yes	No	Yes	No	Yes	Yes	No
Aerated lagoons	Yes	Yes	No*	No	Yes	Yes	No
Facultative lagoons	Yes	Yes	No*	No		Yes	No
Collection system components	Yes	Yes	Yes	No		Yes	Yes
Haz. waste lagoons	Yes	Yes	No	No			No
Spray irrigation	No	No	No	No			No
Evaporative lagoons	Yes	Yes	No	No			No

* The model can be made to mimic these processes

- ❖ AP-42 is the emissions estimating procedures given in Supplement D, Section 4.13. It has been superseded by SIMS and Water8.
- ❖ SIMS is the Surface Impoundment Modeling System, V2.0 developed by the OAQPS and CERL for CTC. It has been superseded by Water8.
- ❖ TOXCHEM+ is a wastewater treatment plant model produced by Enviromega with support from Environment Canada and EPA.
- ❖ FATE is the Fate and Treatability Estimator Model developed by EPA's Engineering and Analysis Div. of the Office of Science and Technology. It has been superseded by WATER8.
- ❖ BASTE is the Bay Area Sewage Treatment Emissions model developed by CH2M-Hill for East Bay MUD, with help from WEF.
- ❖ Water8 is EPA's current wastewater treatment systems emission model produced by OAQPS using the procedures from SIMS, FATE, AP-42, and other EPA sources.
- ❖ CORAL and CORAL+ are models for collection system emissions estimating. Developed by Richard Corsi of U. of Texas-Austin and distributed as public domain (CORAL) and commercial software (CORAL+). It is similar to the sewer portions of SIMS but more accurate.

the area source, surface release model in TSCREEN after developing a good guess at the emission rates.

Care must be taken in using water sample based analytical results. The sampling apparatus, sample containers, and the laboratory equipment are all cleaned with or utilize acetone and methylene chloride. This can cause false positives in the analysis process for these two chemicals. EILS recommends that influent water quality samples for these chemicals be acquired separately, in containers specifically cleaned without their use, and that the laboratory understands that these two chemicals are being looked for specifically, so the standard laboratory procedures that use these chemicals do not interfere with the analysis. However, if there is reason to suspect that there is a lot of acetone or methylene chloride in the treatment plant influent and it is certain that all of the acetone and methylene chloride is removed from the sampling apparatus and sample containers prior to their use, the acetone and methylene chloride results reported from the laboratory may be trustworthy.

In order for a large wastewater treatment plant to emit more than 10 TPY of a specific TAP, there must be a single or group of related industries that are discharging relatively large quantities of the specific chemical to the treatment plant. At the levels modeled to be needed in the municipal treatment plant influent, there must be an ineffective or nonexistent pretreatment program in place. It is more likely that an industrial wastewater treatment plant will have influent concentrations that may cause air emissions to reach the 10 TPY level or have cumulative emissions that reach the 25 TPY level.

Table 2 shows the influent concentrations needed to cause an emission to exceed ten tons per year of a listed TAP.

Table 2. Wastewater Influent Concentrations in Grams/Liter at a 30 MGD Municipal Wastewater Treatment Plant to Cause an Emission of 10 TPY of the Listed TAP

TAP	Surface Aeration Influent Conc. (g/L)	Diffused Aeration Influent Conc. (g/L)
Acetone	14,996	32,135
Chloroform	287	1,103
Styrene	249	705
Toluene	1,583	4,370
Methylene Chloride	322	1,626

TAPs listed above were the most common ones reported of the volatile organic compounds analyzed by the VOA test (part of a water priority pollutant scan). These

compounds are also among the list of 59 chemicals found to be most common nationwide in the wastewater influent and in the air emissions from wastewater treatment plants.

Modeling work has shown that any treatment plant expansion for a community with chlorinated drinking water needs to be looked at for compliance with ambient chloroform criteria. Aeration basin expansions of as small as 0.5 mgd with surface or diffused aeration can result in ambient concentrations of chloroform that exceed the ASIL at a reasonable fence line distance (10 meters at a small plant and 20 meters at a large facility)[†].

Currently only WATER8, TOXCHEM+ and BASTE are capable of modeling the emissions from a trickling filter. The gaseous kinetics of a trickling filter are quite similar to a stripping tower. The major difference that is obvious, is that the trickling filter has a much lower surface area and turbulence in the filter bed than occurs in a packed bed stripping tower.

The best routine sampling for determining compliance with a TAP emission limitation from a treatment plant is regular influent and effluent sampling and analysis for the chemical(s) of concern combined with use of the emission estimating model used during permitting. The influent sample collection and analysis is a relatively standard test procedure that is established in Standard Methods for the Examination of Water and Wastewater and the EPA Test Methods for water quality analysis. These tests are grab samples, analogous to a source test. The frequency of these tests should be once per month, but on a different day and time each month. If the source wants to do a series of grab samples to determine when the most typical or highest influent concentrations exist, They should take samples hourly over a 7 day period. Composite samplers capable of taking 24 hourly samples that meet the zero headspace requirements of the test procedure are now becoming available.

In order to sample the air emissions from the various treatment units at a wastewater treatment plant, is necessary to enclose the entire treatment unit and measure the off gas concentrations of the various air pollutants, or to use a flux chamber. Except for facilities that have been required to be enclosed for odor control or climate reasons, most actual source testing of the emissions from wastewater treatment processes has been through the use of flux chambers.

Various control devices may be beneficial for reducing emissions from wastewater treatment processes. VOC emissions may be reduced by means of compost beds, aerating with odorous air (2-way movement of gases from bubbles to water based on chemical equilibrium conditions), odor control scrubbers operated to maximize VOC pollution control, activated carbon following conventional odor control scrubbers and various scrubbing liquors, steel wool or iron filings for H₂S control. Other than anaerobic digester off gases, pollutant concentrations are too low and air volumes are too high to allow for

[†] Influent Chloroform content of 6.5 ug/l

the use of flares or thermal oxidation units for emission control. Changing the method of aeration to an activated sludge process or changing the ventilation rate of a trickling filter can result in decreased emissions from those process units. Wastewater treatment plant managers and maintenance staff do not like to use activated carbon for odor (and VOC) control because of concerns about spontaneous combustion in the carbon, dangerous and hazardous waste disposal issues, on-site regeneration of the spent carbon, and loading the carbon with chemicals other than the target chemicals.

References

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emissions Factors Volume 1: Stationary Point and Area Sources*, Fifth Edition with Supplements, January 1995, Document No. AP-42. (Section 4.3 Wastewater Collection, Treatment and Storage, September 1991)

(available by section on Internet at <http://www.epa.gov/ttn/chief/ap42.html>)

Washington State Department of Ecology, *Facility/Site on the Web*, accessed 1/20/98. (<http://www.wa.gov/ecology/iss/fsweb/fshome.html>)