# WASTEWATER AND SLUDGE, COLLECTION, TREATMENT AND PROCESSING

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## INTRODUCTION

Wastewater is a water that has been recently used in homes, businesses, or in industrial processing. Once it has passed down the drain, wastewater is sent to a treatment facility for processing before being discharged into either a receiving body of water or a municipal treatment plant for further treatment.[1,2]

Wastewater treatment facilities play a key role in protecting the environment, being involved in reception, storage, treatment, and disposal of an often-variegated stream of sewage from municipalities and different types of industries. Industrial wastewater may originate from petrochemicals, science-based industries (i.e., semiconductors, photo-electronics and electronic products), food industries (livestock, slaughterhouses, sugar factories etc.) as well as multiple manufacturing processes (i.e., pharmaceuticals, biological technology and paint manufacturing). Thus, emissions of malodorous gaseous compounds and of airborne pollutants from wastewater collection and treatment facilities, including volatile organic compounds (VOCs) and toxic air contaminants (TACs), represent a key ecological concern.[3] Wastewater treatment plants (WWTP's), within the San Diego Air Pollution Control District (District) jurisdiction collect and treat wastewater from the municipal and metropolitan sewer systems[4], storm water is not treated by WWTP's. The treatment of wastewater can be split into two main categories, the process accepting and treating the wastewater is called wastewater treatment, and the treatment of the sludge produced from the wastewater treatment is called sludge processing.

## WASTEWATER TREATMENT

### PROCESS DESCRIPTION:

Wastewater reaches the WWTP's through pump stations, where raw wastewater enters the wet well of the pump station and then pumped to the WWTP. The pump stations are located at various collection points to ultimately transport the wastewater to the WWTP's. Emissions can occur at multiple stages of the WWTP process including pump stations, headworks, outfall structures, sedimentation basins, activated sludge aeration, and digesters. Additional emissions can also occur from control equipment associated

[1] https://www.sdcoastkeeper.org/water-101/where-does-our-water-go
[2] https://www3.epa.gov/ttnchie1/ap42/ch04/final/c4s03.pdf
[3] https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/230/36760 (Download For full text)
[4] https://www.sandiego.gov/sites/default/files/legacy/publicutilities/pdf/publicutilfactsheet.pdf

with WWTP processes such as wet scrubbers, bio-filters, carbon adsorbers, thermal oxidizers, cogeneration units and/or flares. In general emissions from wastewater processes are quantified as follows:

$$E_a = U_a * EF * (1 - e)$$

$$E_h = U_h * EF * (1 - e)$$

Where:

| | | |
|---|---|---|
| $E_a$ | = | Annual emissions of each listed substance, (lbs/year) |
| $E_h$ | = | Maximum hourly emissions of each listed substance, (lbs/hour) |
| $U_a$ | = | Annual wastewater through-put flowrate, (million gallons/year) |
| $U_h$ | = | Maximum hourly wastewater through-put flowrate, (million gallons/hour) |
| **EF** | = | Emission factor, (lbs/million gallons through-put) |
| **e** | = | Control equipment collection and removal efficiency, (%) |

Wastewater entering a WWTP is called influent and the make-up of the influent is highly dependent on the tributaries involved. The District has completed air emissions testing at two of the largest WWTP in San Diego County, Point Loma Wastewater Treatment Plant and Encina Wastewater Treatment Plant, in order to estimate emissions associated with treating wastewater in San Diego County. In order to accurately apply the testing completed, it is important to understand the different processes at the two treatment plants and how they may affect emissions. District default emission factors were created based on an average of all source test data (Encina and Point Loma). Site Specific water sampling, along with throughputs and verifiable, control efficiency data, may be used to determine a weight percent of pollutant in the wastewater (lbs. pollutant emitted/lbs. pollutant in wastewater), which shall be used to calculate emissions factors as (lbs Pollutant emitted/million gal thru put).

- At Point Loma WWTP, there are eight odor control systems and site specific source test data obtained during 1996 will be used to estimate emissions. Each of the WWTP sections has an exclusive caustic scrubber/carbon adsorber odor control system: (1) headworks, (2) sedimentation basins 1 and 2, (3) sedimentation basins 3 and 4, (4) sedimentation basins 5 and 6, (5) sedimentation basins 7 and 8, (6) sedimentation basins 9 and 10, (7) sedimentation basins 11 and 12 and (8) outfall structure. . However, since the source test data in 1996 did not include hydrogen sulfide, methanol, and perchloroethylene, the 1989 source test data was used to determine these emission factors.
    - Data obtained from the January through March 1996 source test was used to determine compound specific emission factors for the odor control systems.
    - Several toxins were sampled during the 1996 source testing. For compounds that were non-detectable or below the level of quantification, half the detection level was used for emission factor determination.
    - The 1996 source test did not sample for hydrogen sulfide, ammonia, methanol and perchloroethylene. Therefore, emission factors for these compounds were developed based on source tests conducted for the Toxic Emissions Inventory 1989.
- For Encina's wastewater processing, there were two odor removal systems and site-specific source test data obtained during 1993 will be used to estimate emissions. Each of the WWTP sections had an exclusive caustic scrubber odor control system. The headworks controls, collects, and controls emissions from: headworks, influent junction structure, weirs, and primary sedimentation basins.

The activated sludge aeration controls collect and control emissions from: aeration tanks and its' associated channels. . The source test data in 1993 did not include methane, the 1991 source test was used to determine methane emission factor.

- Data obtained from the September 1993 source test was used to determine compound specific emission factors for the three odor control systems. The September 1991 test data was not used since this does not represent the most current configuration of the facility.

- The September 1993 test reported ammonium hydroxide emissions which are believed to be ammonia emissions reacting with moisture. Since ammonia composes a fraction of the ammonium hydroxide, an ammonia emission factor was determined based on the fraction ammonia in ammonium hydroxide.

## 2.3 ASSUMPTIONS / LIMITATIONS:

- Assume 100% capture for facilities that have collection vents.

- Default emission factors were determined after controls.

- Assume that other possible toxic emissions that were not sampled during the source tests are negligible.

- Emissions from pump stations are assumed to be similar to the emissions from the headworks of WWTP's. A set of emission factors based on headworks source test results may be used to determine emissions from the pump stations.

- Test data from Encina and Point Loma WWTP's may not be applicable to some WWTP's that mainly process residential discharges. Encina and Point Loma WWTP's are believed to have a higher percentage of industrial discharge.

- Outlet test data was used to generate emission factors. However, it was observed that VOC emissions may not be controlled as consistently as expected. The control devices were reported to have negative control efficiencies for several VOC's. It is possible that VOC emissions are temporarily accumulated in the control device and is later emitted.

- It is unknown what the exact wastewater flowrate was through the WWTP during the source test. Assume typical wastewater flowrate (80 million gallons/hour) into the WWTP is representative and adequate for emission factor determination.

**Assumptions for Encina WWTP.**

- The exact wastewater flowrate was unknown through the WWTP during the source test of the control devices. Assume typical wastewater flowrate into the WWTP is representative and adequate for emission factor determination.

- Assume the toxic emissions obtained from the headworks source test is representative of untested toxic emissions from the activated sludge aeration. This assumption is not applied to the sludge dewatering because sludge, not wastewater, is processed at the sludge dewatering operation.

- Assume emissions from the uncontrolled secondary sedimentation basins are negligible.

- Assume all other fugitive emissions are negligible.

**Assumptions for Point Loma WWTP.**

- The headworks controls were not source tested during the 1996 test. Assume that the source test data obtained from the sedimentation basins source tests are applicable to the headworks.

- Each odor removal system is composed of four stacks. However, only two stacks were tested. Assume that the emissions from the two untested stacks are similar to the tested stacks. Therefore, the test results were doubled to account for the two untested stacks.

- The emissions are based on WWTP through-put in million gallons per day. For the sedimentation basins, assume that each sedimentation basin processes an equal amount of the total plant through-put. Therefore, for emission calculations, only a fraction of the total through-put should be reported as being processed through each sedimentation basin.

- Hydrogen sulfide from the odor control systems was not tested during the 1996 source test. The H2S source test data required from the Toxic Emissions Inventory 1989 was used to determine H2S emissions. Assume an H2S control efficiency of 95 - 99% for the odor control system.

- The 1989 source test data was used for compounds that were not tested during 1996. Specifically, these compounds were ammonia, hydrogen sulfide, methanol and perchloroethylene.

## SLUDGE PROCESSING

### PROCESS DESCRIPTION:

Sludge or biosolids are generated as a by-product of the wastewater treatment process. Grindings, screenings, sedimentation, chemical precipitation and biological growth are some of the components of sludge. Sludge is typically dewatered prior to disposal or composting to reduce its weight and volume. Polymers are added to the sludge to promote thickening prior to dewatering. Centrifuges and belt presses are common equipment used to separate liquid and raw and/or digested sludge. The liquid obtained from dewatering is typically returned to the beginning of the wastewater treatment process. Sludge processing is considered a separate process from wastewater treatment and has different emissions. Emissions may be collected from various operations (i.e., headworks, outfall structures, sedimentation basins, activated sludge aeration, digesters, etc.). These emissions may be controlled by wet scrubbers, bio-filters, carbon adsorbers and/or flares.

Similar to wastewater treatment, hydrogen sulfide (H2S) poses the main VOC concern in sludge processing operations. Smaller sludge processing operations and aerobically digested wastewater typically do not use odor collection/control systems. H2S odors are usually minimized by the addition of ferric chloride or hydrogen peroxide prior to sludge processing (at the pump station or at the final stages of anaerobic digestion). Similar to emission factors for WWTPs, district default emission factors are created based on an average of all source test data. Sludge processing default emission factors are created from the following sources:

- **At Encina WWTP**, there was a caustic scrubber odor removal system that controls sludge processing emissions. Emissions were controlled for the dewatering building, bin room, truck loading and dissolved air floatation equipment. Site specific source test data obtained during 1993 will be used to estimate emissions.

- **At Point Loma WWTP**, there is no sludge processing. Digested sludge was pumped from Point Loma WWTP to the Metro Biosolids Center for processing.

- **At the Metro Biosolids Center**, there was a caustic scrubber/acid scrubber/carbon adsorber odor removal system. The odor control system controlled emissions from the pre-digestion process (raw sludge from North City Water Reclamation) and the post-digestion process (digested sludge from Point Loma WWTP and digested sludge produced on-site). The pre-digestion process included receiving tanks, de-gritter vessels, thickening centrifuges, sludge screens and thickened sludge blending tanks. The post-digestion process included storage tanks, dewatering centrifuges, storage silos and the loading area. The equipment had never been source tested by the District. Note: the digestion process produces methane gas which fuels combustion equipment or are controlled by flares.

For sludge processing operations that have not been source tested, average emission factors based on source test data are used to determine emissions.

Emissions from sludge processing operations are quantified as follows:

$$\boldsymbol{E_a = U_a * EF * (1 - e)}$$

$$\boldsymbol{E_h = U_h * EF * (1 - e)}$$

Where:

**$E_a$** = Annual emissions of each listed substance, (lbs./year)
**$E_h$** = Maximum hourly emissions of each listed substance, (lbs./hour)
**$U_a$** = Annual sludge production, (lbs. sludge produced/year)
**$U_h$** = Maximum hourly sludge production, (lbs. sludge produced/hour)
**EF** = Emission factor, (lbs./lbs. sludge produced)
**e** = Control equipment collection and removal efficiency, (%)

**EMISSIONS INFORMATION:**

- Site specific source test were used to determine compound specific emission factors for the odor

control system.

- The source tests were conducted at Encina WWTP on September 1991 and September 1993. These source test data were combined to generate average emission factors.

**ASSUMPTIONS / LIMITATIONS:**

- Assume 100% capture for facilities that have collection vents.
- Emission factors were determined after controls.
- Assume that other possible toxic emissions that were not sampled during the source tests are negligible.
- It is unknown what the exact wastewater flowrate was through the WWTP during the source test. Assume typical wastewater flowrate (80 million gallons/hour) into the WWTP is representative and adequate for emission factor determination.