

**Date:** September 5, 2007  
**To:** File  
**From:** Chet Morton, Malcolm Pirnie,  
**Re:** Draft - Owls head WPCP Hydrogen Sulfide Emissions  
**Project No.:** 2175-326

### **Introduction**

The New York City Department of Environmental Protection (DEP) is evaluating the need for odor control at the Owls Head Water Pollution Control Plant (WPCP) in Brooklyn, NY. As a result of findings from odor surveys conducted during the summer of 2006, the effluent weirs of the primary settling tanks were covered earlier this year and exhausted to carbon adsorbers based in order to reduce hydrogen sulfide emissions. From the end of July to early August of this year hydrogen sulfide emissions were measured for seven days from the plant's unit processes to gain a more complete understanding of the plant's emissions. This memo describes the scope and methodologies used to conduct the emissions measurements and presents the emission results.

### **Sampling Scope**

#### *Location*

The sampling was conducted at the Owls Head WPCP located in Brooklyn, NY.

#### *Sample Dates and Times*

The goal of the sampling effort was to sample the plant during the daily time period of elevated odor emissions. There is generally a diurnal cycle of dissolved sulfide in the influent to wastewater treatment plants. The higher the dissolved sulfide concentration, the greater the hydrogen sulfide emission potential, and the greater the odor emission potential of the wastewater.

In order to determine the time of the day when peak odor conditions occur at the plant, a continuous hydrogen sulfide monitor (OdaLog™ unit) was placed in the plant's headworks from the July 4 to 17 (the meter was in operation for approximately 10 days). It was determined that elevated odor conditions generally occur during the time period 12:00 pm to 10:00 pm and sometimes later.

The sample locations and method of sample collection are listed in Table 1.

The sampling was scheduled so that the primary settling tanks (PSTs) were sampled between 2:00 pm and 5:00 pm. The aeration tanks were sampled between 6:00 pm and 8:00 pm. The one hour difference in between the sampling was used for the flux chamber setup and equilibration.

The sampling took place on the following dates.

- July 31<sup>st</sup> –August 4<sup>th</sup>
- August 7<sup>th</sup> and 9<sup>th</sup>

### *Sample Collection*

Samples from water surfaces and effluent channel/weirs were collected using flux chambers. The flux chambers were allowed to equilibrate for 30 minutes before samples were taken. Samples were extracted from the flux chamber and collected in Tedlar bags using the evacuated lung method; or, were extracted by a Jerome Meter using its internal sampling pump and analyzed directly.

### *Sample/Analysis Parameters*

All samples were analyzed for hydrogen sulfide by Jerome 631X meters, manufactured by Arizona Instruments, Inc (AZI). Jerome meters can measure hydrogen sulfide from concentrations ranging from 0.003 to 50-ppm<sub>v</sub>. The Jerome meters that were used were calibrated by AZI within a month of the sampling effort. Before use each day the Jerome meters were regenerated and re-zeroed. Each night after sampling the Jerome meters were recharged which allowed them to operate by battery power for the daily sampling. They are generally able to take continuous samples for 6 hour on a single charge. One Jerome Meter (SN 1411) required AC power supply due to a faulty battery.

PST samples were taken continuously from the flux chambers by using data loggers attached to the Jerome meters. The data loggers were programmed to take a sample every 2 minutes and were operated for an average of one hour. Grab samples were collected in Tedlar bags or measured directly by a Jerome meter from the following sample locations: PST distribution channel, PST effluent channel, aeration tanks, and final settling tanks (FSTs). Grab samples were also collected from carbon adsorbers at the following locations: PST weirs (inlet and exhaust), gravity thickeners carbon adsorbers (exhaust) and the screening building carbon adsorber (exhaust).

## Emission Rates

The emission flux from treatment processes; and, the emission rate to the PST effluent weir carbon adsorber, and from the gravity thickener and screening building carbon adsorbers were determined. The following paragraphs describe the calculation approach.

1.1. The molar volume of air was adjusted for the measured temperature,

- $\rho V = nRT$
- $\frac{V}{n} \left( \frac{l}{mol} \right) = \frac{RT}{\rho}$
- $P = 1 \text{ atm}$
- $R = 8.206 \times 10^{-5} \text{ m}^3 \text{ atm/mol } ^\circ\text{K}$
- $V/n = \text{molar volume, i.e., liters/mol} = \text{m}^3/\text{mole}$  at the measured temperature

1.2. The hydrogen sulfide mass concentration from the emission sources was calculated as follows,

$$Y_{ppm, H_2S} * \left[ \frac{1 \text{ mol } H_2S}{10^6 \text{ mol } _{air}} \right] * \frac{1 \text{ mol } _{air}}{X \text{ m}^3 \text{ air}} * \frac{34.02 \text{ g } H_2S}{\text{mol } H_2S} * \frac{273.15^\circ \text{K}}{T_{measured}, ^\circ\text{K}} = \frac{\text{g } H_2S}{\text{m}^3 \text{ air}}$$

1.3. The hydrogen sulfide mass concentration was multiplied by the sweep air flow rate from the flux chamber and divided by the flux chamber area to yield an emission flux ( $\text{g}/\text{m}^2\text{sec}$ ); or for a point source, it was multiplied by the exhaust air flow rate to yield an emission rate ( $\text{g}/\text{sec}$ ).

1.4. Round flux chambers were used at most sample locations. At these locations the emission flux was based on the flux chamber surface area,  $0.13 \text{ m}^2$ . A rectangular flux chamber was used at the final settling tank effluent weir. At this location the emission flux was based on the flux chamber width,  $0.46 \text{ m}$ .

1.5. *Flux Air Flow Rate*

1.5.1. *Round flux chamber on non-aerated surfaces.* The flux air flow rate was the sweep air flow rate, 5 liters/minute ( $8.3 \times 10^{-5} \text{ m}^3/\text{sec}$ ).

1.5.2. *Round flux chamber on aerated surfaces i.e. aeration tanks.* The flux air flow rate was the aeration rate. The aeration rate used in units of  $\text{cfm}/\text{ft}^2$  is from the Tallman Island plant. (Receipt of the actual aeration tank air flow rates are pending.)

1.5.3. *Rectangular weir trough flux chamber.* The flux air flow rate was based on the measured exhaust air velocity from the flux chamber. This measurement

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accounted for supplied sweep air, plus the additional exhaust air due to water turbulence in the weir trough. The air flow rate was determined by multiplying the average velocity by the flux chamber exhaust port cross-sectional area.

#### 1.6. Point Sources

1.6.1. *PST Effluent Weir Carbon Adsorbers.* The exhaust air flow rate from each carbon adsorber was based on the air flow capacity of its fan, 450 cfm.

1.6.2. *Gravity Thickener Carbon Adsorbers.* The exhaust air flow rate was based on the air flow capacity of the carbon adsorber fan, 12,000 cfm. (This air flow rate was based on an assumed superficial velocity through these carbon adsorbers. An actual flow rate is pending from the plant.)

1.6.3. *Screening Building Carbon Adsorber.* The exhaust air flow rate was based on an assumed velocity of 20 fpm flow through the exhaust port of each adsorber. These units do not have fans but use natural flow from the screening building.

#### 1.7. Emission Rates

At the start of this project it was decided that the emission rates from the plant's unit processes would be compared to the emission rates from the PST weirs which are currently being controlled. A qualitative assessment would be made to determine the degree of emission control currently being achieved as compared to the uncontrolled emissions. The need for dispersion modeling would be considered after analysis of the controlled and uncontrolled emissions.

Maximum and average hydrogen sulfide emission fluxes and emission rates were calculated from the collected data for the plant's unit processes and carbon adsorbers and are given in Tables 2 and 3, respectively. Also shown in these tables is the relative percentage of emissions from the plant's sources which indicates that about 90% originate from the PST weirs.

Maximum emissions were calculated as follows:

- **PST Continuous Measurements.** The maximum concentration was determined from each day's measurements at each sample location for seven days. Approximately 30 measurements were taken at each PST sampling location. The average of these daily maximum concentrations was used.
- **Grab Samples.** Each day three Jerome meter readings were taken from each grab sample collected in a Tedlar bag, or three readings were taken from air extracted from a flux chamber. The average of the three readings was determined. The maximum of the daily average reading at each location was determined.

Average emissions were calculated as follows:

- **PST Continuous Measurements.** The average concentration was determined from each day's measurements at each sample location for seven days. Approximately 30 measurements were taken at each PST sampling location. The average of these daily average concentrations was used.
- **Grab Samples.** Each day three Jerome meter readings are taken from each grab sample collected in a Tedlar bag, or three readings are taken from air extracted from a flux chamber. The average of the three readings was determined. The average of the daily average reading at each location was determined.

It is noted that while 90% of the plant's emissions originate from the PST weirs and is being directed through carbon adsorbers, the removal through the carbon adsorbers ranged from approximately 50% removal to the exhaust exceeding the inlet concentration. This indicates the carbon in the PST adsorbers is experiencing breakthrough and should be replaced to maintain effective emission control.

Tables 4 and 5 give the maximum and average concentrations, fluxes and emissions respectively for the individual sample locations.

**Table 1**  
**Owls Head WPCP**  
**Hydrogen Sulfide Emissions Sampling**  
**Sample Locations**

Sources	Sample Type	Sample Locations
PST Influent Chanel (Distribution Chanel)	Flux chamber Grab sample	At distribution for PST 2201 above Bay 4. At distribution for PST 2202 above Bay 1.
West Primary Tank (2201)	Flux chamber Continuous measurement	PST 2201, Bay 1, influent PST 2201, Bay 1, North Mid PST 2201, Bay 1, South Mid PST 2201, Bay 1, effluent PST 2201, Bay 2, influent PST 2201, Bay 2, North Mid PST 2201, Bay 2, South Mid PST 2201, Bay 2, effluent
East Primary Tank (2202)	Flux chamber Continuous measurement	PST 2202, Bay 2, influent PST 2202, Bay 2, mid PST 2202, Bay 2, effluent PST 2202, Bay 3, influent PST 2202, Bay 3, mid PST 2202, Bay 3, effluent
Primary Effluent Weir Carbon Adsorber	Grab sample	Inlet and exhaust of the vessel
Primary Effluent Chanel	Flux chamber Grab sample	Mid channel and end of channel.
Aeration Tanks	Flux chamber Grab sample	Pass A : RAS feed Mid-tank  Pass B: RAS Feed Mid-tank
Final Settling Tank	Flux chamber Grab sample	FST influent FST mid-tank FST effluent weir
Screening Carbon Adsorber	Grab sample	Vessel exhaust
GT Carbon Adsorber	Grab sample	Vessel exhaust

Attachment

Owls Head WPCP H2S Emissions

Table 2 Maximum Measured Hydrogen Sulfide Emissions				
Emission Source	Emission Area m <sup>2</sup>	Emission Flux g/m <sup>2</sup> -s	Emissions g/s	% of total
PST Distribution Channels	141	2.77E-05	3.90E-03	3.3%
PSTs	4,360	3.29E-07	1.44E-03	1.2%
PST Weirs	891	NA	1.08E-01	91%
PST Effluent Chanel	122	8.68E-06	1.06E-03	0.89%
Aeration Tanks	11,509	NA	1.12E-03	0.94%
FSTs	13,692	8.14E-09	1.11E-04	0.09%
FSTs Effluent Weir	805	5.63E-08	4.53E-05	0.04%
Screening Building Carbon Adsorbers	NA	NA	1.58E-07	<0.01%
Gravity Thickener Carbon Adsorbers	NA	NA	3.61E-03	3.04%
<b>Total</b>	-	-	1.19E-01	-

Owls Head WPCP H2S Emissions

Table 3 Average Measured Hydrogen Sulfide Emissions				
Emission Source	Emission Area m <sup>2</sup>	Emission Flux g/m <sup>2</sup> -s	Emissions g/s	% of total
PST Distribution Channels	141	1.94E-05	2.74E-03	4.3%
PSTs	4,360	1.98E-07	8.61E-04	1.4%
PST Weirs	891	NA	5.74E-02	91%
PST Effluent Chanel	122	6.68E-06	8.13E-04	1.3%
Aeration Tanks	11,509	NA	8.68E-05	0.1%
FSTs	13,692	2.82E-10	3.86E-06	<0.1%
FSTs Effluent Weir	805	1.54E-08	1.24E-05	<0.1%
Screening Building Carbon Adsorbers	NA	NA	8.43E-08	<0.1%
Gravity Thickener Carbon Adsorbers	NA	NA	1.13E-03	1.8%
<b>Total</b>	-		6.30E-02	-

Owls Head WPCP H2S Emissions

Table 4 Individual Source Measured Maximum Hydrogen Sulfide Emissions					
Location	H2S (ppm)	H2S g/m <sup>3</sup>	Emission Flux g/m <sup>2</sup> -s	Emission Area m <sup>2</sup>	Emissions g/s
Influent Chanel (Distributon Chanel) 2201	28.0	3.90E-02	2.50E-05	35.7	8.92E-04
Influent Chanel (Distribution Chanel) 2202	34.0	4.73E-02	3.03E-05	35.2	1.07E-03
<i>West Primary Tank (2201)</i>					
PST 2201, Bay 1, influent	1.29	1.75E-03	1.12E-06	29.7	3.33E-05
PST 2201, Bay 1, North Mid	0.58	7.86E-04	5.04E-07	109	5.50E-05
PST 2201, Bay 1, South Mid	0.66	8.92E-04	5.72E-07	98.8	5.65E-05
PST 2201, Bay 1, effluent	0.56	7.55E-04	4.84E-07	26.0	1.26E-05
PST 2201, Bay 2, influent	0.69	9.34E-04	5.98E-07	29.3	1.75E-05
PST 2201, Bay 2, North Mid	0.33	4.45E-04	2.85E-07	108	3.06E-05
PST 2201, Bay 2, South Mid	0.27	3.61E-04	2.31E-07	108	2.49E-05
PST 2201, Bay 2, effluent	0.19	2.64E-04	1.69E-07	29.3	4.94E-06
<i>East Primary Tank (2202)</i>					
PST 2202, Bay 2, influent	0.09	1.27E-04	8.16E-08	29.3	2.39E-06
PST 2202, Bay 2, mid	0.08	1.11E-04	7.13E-08	215	1.53E-05
PST 2202, Bay 2, effluent	0.11	1.51E-04	9.66E-08	29.3	2.83E-06
PST 2202, Bay 3, influent	0.26	3.56E-04	2.28E-07	29.3	6.68E-06
PST 2202, Bay 3, mid	0.09	1.19E-04	7.62E-08	215	1.64E-05
PST 2202, Bay 3, effluent	0.11	1.45E-04	9.31E-08	29.3	2.73E-06
		0.00E+00			
Primary Effluent Weir Carbon Abs. In	46.3	6.33E-02	NA	NA	1.34E-02
Primary Effluent Weir Carbon Abs. Out	21.0	2.87E-02	-	-	-
Primary Effluent Chanel	9.78	1.35E-02	8.68E-06	121.7	1.06E-03
<i>Aeration Tanks</i>					
AT A influent	0.01	9.19E-06	2.66E-08	35.3	9.40E-07
AT A mid	0.01	1.24E-05	3.59E-08	659	2.37E-05
AT B	0.06	7.95E-05	2.30E-07	695	1.60E-04
<i>Final Settling Tank</i>					
FST influent	0.01	8.76E-06	5.61E-09	122	6.86E-07
FST mid	0.01	1.66E-05	1.07E-08	383	4.09E-06
FST effluent weir	0.03	4.80E-05	NA	16.8	9.43E-07
Screening Carbon Absorber	0.01	1.59E-05	NA	NA	1.58E-07
Gravity Thickener Carbon Absorber	0.12	1.59E-04	NA	NA	3.61E-03

Owls Head WPCP H2S Emissions

Table 6 Individual Source Measured Average Hydrogen Sulfide Emissions					
Location	H2S' (ppm)	H2S' g/m <sup>3</sup>	Emission Flux' g/m <sup>2</sup> -s	Emission Area m <sup>2</sup>	Emissions' g/s
Influent Chanel (Distribution Chanel) 2201	23	3.18E-02	2.04E-05	35.7	7.26E-04
Influent Chanel (Distribution Chanel) 2202	21	2.89E-02	1.85E-05	35.2	6.52E-04
<i>West Primary Tank (2201)</i>					
PST 2201, Bay 1, influent	0.83	1.14E-03	7.28E-07	29.7	2.17E-05
PST 2201, Bay 1, North Mid	0.35	4.74E-04	3.04E-07	109	3.32E-05
PST 2201, Bay 1, South Mid	0.37	5.04E-04	3.23E-07	98.8	3.19E-05
PST 2201, Bay 1, effluent	0.28	3.81E-04	2.44E-07	26.0	6.35E-06
PST 2201, Bay 2, influent	0.47	6.41E-04	4.11E-07	29.3	1.20E-05
PST 2201, Bay 2, North Mid	0.24	3.33E-04	2.13E-07	108	2.29E-05
PST 2201, Bay 2, South Mid	0.15	2.03E-04	1.30E-07	108	1.40E-05
PST 2201, Bay 2, effluent	0.11	1.51E-04	9.70E-08	29.3	2.84E-06
<i>East Primary Tank (2202)</i>					
PST 2202, Bay 2, influent	0.03	4.40E-05	2.82E-08	29.3	8.25E-07
PST 2202, Bay 2, mid	0.03	3.91E-05	2.51E-08	215	5.39E-06
PST 2202, Bay 2, effluent	0.06	8.45E-05	5.41E-08	29.3	1.59E-06
PST 2202, Bay 3, influent	0.15	1.96E-04	1.26E-07	29.3	3.68E-06
PST 2202, Bay 3, mid	0.04	5.16E-05	3.31E-08	215	7.11E-06
PST 2202, Bay 3, effluent	0.06	7.61E-05	4.88E-08	29.3	1.43E-06
		0.00E+00			
Primary Effluent Weir Carbon Abs. In	25	3.38E-02	NA	NA	7.17E-03
Primary Effluent Weir Carbon Abs. Out	14	1.96E-02	-	-	-
Primary Effluent Chanel	7.5	1.04E-02	6.68E-06	121.7	8.13E-04
<i>Aeration Tanks</i>					
AT A influent	0.005	6.62E-06	4.68E-10	35.3	1.65E-08
AT A mid	0.005	6.44E-06	6.14E-10	659	4.05E-07
AT B	0.03	3.52E-05	2.15E-08	695	1.50E-05
<i>Final Settling Tank</i>					
FST influent	0.002	3.30E-06	2.22E-10	122	2.71E-08
FST mid	0.002	2.67E-06	3.42E-10	383	1.31E-07
FST effluent weir	0.01	1.31E-05	NA	16.8	2.58E-07
Screening Carbon Absorber	0.01	8.52E-06	NA	NA	8.43E-08
Gravity Thickener Carbon Absorber	0.03	4.97E-05	NA	NA	1.13E-03