Appendix D:
Air Quality Modelling

TATHAM ENGINEERING

BAYSHORE VILLAGE EFFLUENT SPRAY IRRIGATION CLASS EA

AIR QUALITY IMPACT ASSESSMENT

Odour and Suspended Solids Emissions from Wind Drift and Evaporation

Introduction

The Bayshore Village facultative lagoon effluent may contain odorous components mainly hydrogen sulphide (H_2S), which is a toxic and odorous gas, and ammonia, which is a pungent gas. These are the main contaminants that can contribute to odour during spraying of the effluent.

In a study for different sources of H_2S (Draft Screening Assessment, Hydrogen Sulfide, Sodium Sulfide and Sodium Sulfide, by Environment and Climate Change Canada, Health Canada, September 2017), two large urban secondary treatment systems with facultative lagoons were reviewed and H_2S concentrations were found to be undetectable. It was concluded that a wastewater treatment system that is "secondary or equivalent", i.e., achieving reductions of BOD and TSS specified in the Wastewater Systems Effluent Regulations (Canada 2012b), will also remove hydrogen sulphide to non-detectable levels (detection limit of 2 µg/L) (ECCC 2015). Therefore, the H_2S detection limit was used for this assessment.

Odour is released into the atmosphere during wastewater spray application through wind drift, when fine effluent droplets evaporate, and/or when water is evaporated from the surface of the soil, releasing dissolved odorous gases into the atmosphere.

In addition to odour, the suspended solids release to the air and transfer to neighboring properties due to wind drift was also addressed.

Factors that affect drift and odour include discharge pressure of the spray irrigation equipment; nozzle size and type, which can affect droplet size; contact time between wastewater and air; and weather conditions (wind, humidity, temperature, stability level).

Methodology

Based on the South Field and North Field spray irrigation drawings and the available aerial imagery and Google street view, we understand that the existing spray irrigation system is a sprinkler solid set system with 1-1.5 m risers. These systems usually include a permanent sprinkler installation, consisting of above or below ground piping. They have impact sprinklers with nozzles operating at 40 to 60 psi. The efficiency of these systems is in the range of 70% to 75%. This means that only 70% to 75% of water remains in the soil and the rest is lost during the application process to evaporation, wind drift or runoff. To calculate

the worst-case emission rate for the components, it was assumed that the efficiency of the existing effluent irrigation system at Bayshore Village is 70%.

Emission rates were calculated using a mass balance methodology. It was assumed that the remaining 30% is transferred completely to the air by wind drift and evaporation and assumed that the amount being drifted is completely evaporated before hitting the ground at a further distance. This creates the worst-case emission rate for ammonia, H_2S and suspended solids from drift.

For the worst-case assessment, we also used the highest historical daily spray rate, which is approximately 80% higher than the average daily spray rate. The maximum annual average ammonia and TSS concentrations in the lagoon effluent for the past 10 years were used in this assessment.

To determine the effect of these contaminants on the surrounding sensitive receptors, air dispersion modelling using the most recent regulatory version of AERMOD air dispersion model was completed and the highest point of impingement (POI) concentrations were determined. Air dispersion modelling was completed in accordance with the Guideline A-11- Air Dispersion Modelling Guide for Ontario. The results were compared to the applicable MECP compliance limits.

Odour Emission from Soil Evaporation

Evaporation of water from an unsaturated soil surface is known as actual evaporation, AE. The amount of evaporation depends on the soil type and its water conductivity as well as the pore sizes. Weather conditions also affect the water content above the surface and evaporation amount. Denser soils, such as the silty clay in the South and North Fields, have lower water conductivity as well as lower evaporation rates due to less pores. Based on the published evaporation rates, the measured evaporation is in the range of 3.5 mm/day for a bare column of natural silt. Soil in the North and South Fields is covered with vegetation, which reduces the evaporation rate from the soil surface. To be conservative, we used the bare soil evaporation rate in the evaporation calculation and ammonia and H_2S emission rate assessment.

Results

Modelling was completed for three alternative solutions for the period of May to September, as follows:

- Do Nothing;
- Alt. 3: Establish one new spray irrigation field (West);
- Alt. 6: Build effluent disposal bed on West field, spray irrigate on South Field, and decommission North Field.

Spray irrigation options assume existing type of spray irrigation heads for the new spray irrigation field.

The findings are as follows:

- Under existing conditions (Do Nothing), the spray irrigation operation's modelled emissions for ammonia, hydrogen sulphide and suspended solids are all below the MECP criteria at the property limits.
- The emissions of all 3 parameters are lower for Alternatives 3 and 6.

Air Dispersion Modelling Results – Emissions Summary

Contaminant Name	Contaminant CAS #	Total Emission Rate (g/s)	Maximum POI[1] Concentration (µg/m³)	MECP Criteria (µg/m³)	Averaging Period	Limiting Effect	Percentage of Criteria (%)
Do Nothing							
Ammonia	7664-41-7	0.0664	4.46	100	24-hr	Health	4.46%
Total Suspended Solids	NA-PM	1.24	83.2	120	24-hr	Visibility	69.33%
Hydrogen Sulphide	7783-06-4	0.0000483	0.00324	7	24-hr	Health	0.05%
		0.000145	0.0584	13	10-min	Odour	0.45%

Contaminant Name	Contaminant CAS #	Total Emission Rate (g/s)	Maximum POI[1] Concentration (µg/m³)	MECP Criteria (µg/m³)	Averaging Period	Limiting Effect	Percentage of Criteria (%)
Alternative 3: Add Spray Irrigation on West Field							
Ammonia	7664-41-7	0.0842	3.50	100	24-hr	Health	3.50%
Total Suspended Solids	NA-PM	1.24	51.5	120	24-hr	Visibility	42.91%
Hydrogen Sulphide	7783-06-4	0.0000613	0.00255	7	24-hr	Health	0.04%
		0.000184	0.0472	13	10-min	Odour	0.36%

Contaminant Name	Contaminant CAS #	Total Emission Rate (g/s)	Maximum POI[1] Concentration (µg/m³)	MECP Criteria (µg/m³)	Averaging Period	Limiting Effect	Percentage of Criteria (%)
Alternative 6: Abandon North Field, Keep South Field, Effluent Bed on West Field							
Ammonia	7664-41-7	0.0223	4.16	100	24-hr	Health	4.16%
Total Suspended Solids	NA-PM	0.184	42.2	120	24-hr	Visibility	35.20%
Hydrogen Sulphide	7783-06-4	0.0000162	0.00910	7	24-hr	Health	0.13%
		0.0000487	0.0314	13	10-min	Odour	0.24%