INFOTOX (Pty) Ltd
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Retrieval and scientific interpretation of ecotoxicological information

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Community Health Risk Assessment for the EnviroServ Shongweni Waste Disposal Facility
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1 Methodology

INFOTOX follows the USEPA (1992)[1] methodology for air pathway assessment at waste disposal sites, which covers the following aspects:

- Characterisation of air emission sources
- Determination of the effects of atmospheric processes such as transport and dilution
- Evaluation of the exposure potential at receptors of interest

The second and third bullets collectively are addressed by mathematical dispersion modelling.

These steps are followed to provide the necessary information for conducting a human health risk assessment.

2 Characterisation of air emission sources

2.1 Project outline

Landfill gas may contain a variety of odorous and hazardous substances. Hydrogen sulphide is of prominent interest and the reason for complaints from neighbouring communities. The USEPA methodology for air pathway assessment requires that sources of gaseous releases at the landfill site be quantified. The releases can then be modelled for dispersion using mathematical air dispersion models, to determine ambient air concentrations of the substances at receptor locations. It is important to note that modelling is not based on measured air concentrations of substances at the disposal site, but on fluxes. A point source can be modelled using a release rate of the substance of interest, typically expressed in grams/second (g/sec). The concentration of a substance in the gas stream and the volumetric flow rate of the gas are required as source input data for modelling. Modelling of releases of substances from the disposal site work face and from liquid surfaces such as storm water dams is more complex because modelling must treat releases as area sources. INFOTOX uses surface isolation flux chambers (patented) for this purpose. A contaminant flux is reported in the unit mg/m^2-min.

[1] USEPA. 1992. Air/Superfund National Technical Guidance Study Series. Volume 1 – Overview of the Air Pathway Assessments for Superfund Sites (Revised). EPA-450/1-89-001a.

INFOTOX manufactured flux chambers based on some of the principles of a USEPA design (Schmidt et al. 1996)[2]. Conceptually, however, the INFOTOX flux chambers have unique features. The flux chamber consists of a cylindrical polypropylene enclosure with diameter 750 mm and height of 50 mm. For measurement, the chamber is positioned with its open section on a level area to enclose the emission surface, and pressed into position. A surface area of 0.4 m^2 is covered. Soil is compacted around the outside of the chamber to ensure an airtight position on the surface to be investigated. On the inside walls of the flux chamber, a nylon tube with 3-mm diameter holes spaced at distances of approximately 20 mm serves to extract air across the surface of the isolated area. Intake air is allowed through a 1.8-meter polypropylene pipe of 50-mm diameter, positioned in the centre of the flux chamber. The intake pipe has 10-mm diameter intake holes around the circumference inside the flux chamber, 5 mm above the soil surface. A large diameter pipe is used to prevent any pressure differential between the suction side and the sweep air inlet inside the chamber. A calibrated sampling station is used to pump the sweep air and sample air through the system. Sweep-air flow rates are controlled at approximately 900 millilitres per minute, which would simulate practically zero wind speed. At least two volume changes of the flux chamber with sweep air are allowed before sampling is started. The flux chamber assembly is illustrated in Figures 2.1 and 2.2 below.

Figure 2.1: View of the flux chamber box from underneath.

Figure 2.2: Flux chamber assembly in operation at the Shongweni site.

INFOTOX also developed flux chambers that can float on liquid surfaces. These were used to measure emissions from storm water dams, as illustrated in Figure 2.3 for the storm water dam at Valley 1. .

[2] Schmidt C E, et al., 1996. Assessment of Odor Emissions Using the US EPA Flux Chamber and Olfactory Odor Measurement. Lecture No 96-FA147.04, presented at the 89th Annual Meeting and Exhibition of the Air and Waste Management Association, Nashville, Tennessee.

Figure 2.3: Floating flux chamber in position for flux measurements.

Chemical analysis of the sweep air is conducted using 2 methods:

- Direct reading of H_2S (soil gas) concentration using a MultiRae Lite wireless portable gas monitor.

Figure 2.4: Flux chamber in position, showing the MultiRae Lite portable gas monitor.

Fluxes of H_2S are calculated using Equation 2.1.

$$F = C_{soil\ gas} \times S_{sweep\ air} \times CF/A \quad (2.1)$$

Where:

F	Flux of the contaminant from soil (mg/m^2-min)
$C_{soil\ gas}$	Contaminant concentration in soil gas as measured (mg/m^3)
$S_{sweep\ air}$	Flux chamber sweep air flow rate (ml/min)

CF	Conversion factor (1.0E-06 m^3/ml)
A	Flux chamber area (m^2)

A number of INFOTOX H_2S readings were compared to readings conducted by Envitech Solutions using an instrument that has a higher concentration range.

- Collection of Silonite canister samples for laboratory analysis. A canister in position for sampling is shown in Figure 2.4.

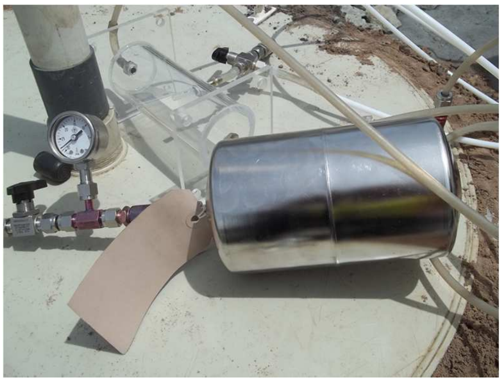

Figure 2.4: Flux chamber in position, showing the canister and sampling train.

The purpose of canister sampling is to quantify not only H_2S, but also bulk gases (including landfill gas primary constituents methane and carbon dioxide), odorous substances and a range of volatile organic compounds. Fluxes of these compounds can be determined using Equation 2.1.

A total of 33 flux chamber measurements were conducted on the active Valley 2 site. This number was determined using a standard USEPA (1986)[3] approach.

INFOTOX also measured H_2S concentrations in headspace gas in 5 tanks at the Leachate Treatment Plant. These were direct measurements without flux chambers. The Leachate Treatment Plant is shown in Figure 2.5.

[3] USEPA. 1986. Measurement of gaseous emission rates from land surfaces using an emission isolation flux chamber. User's guide. EPA 600/8-86-008 (NTIS PB-223161). US Environmental Protection Agency.

Figure 2.5: View of the Leachate Treatment Plant.

Measurements were also conducted in headspace volumes of leachate storage tanks, as well as post carbon filters at the whirlybird extraction systems at the tanks. These were also direct measurements without flux chambers. Figure 2.6 shows a tank with whirlybird extraction systems on top.

Figure 2.6: Leachate storage tank with whirlybird extraction systems on the top.

Measurements for H_2S were conducted pre- and post the carbon filters at 2 whirlybird systems on the active Valley 2 site. A whirlybird is shown in Figure 2.7.

Figure 2.7: View of a whirlybird extraction system at Valley 2.

Figure 2.8 demarcates sampling locations that were covered over the period 21 November up to 1 December 2016. Locations where canister samples were collected are indicated by red markers.

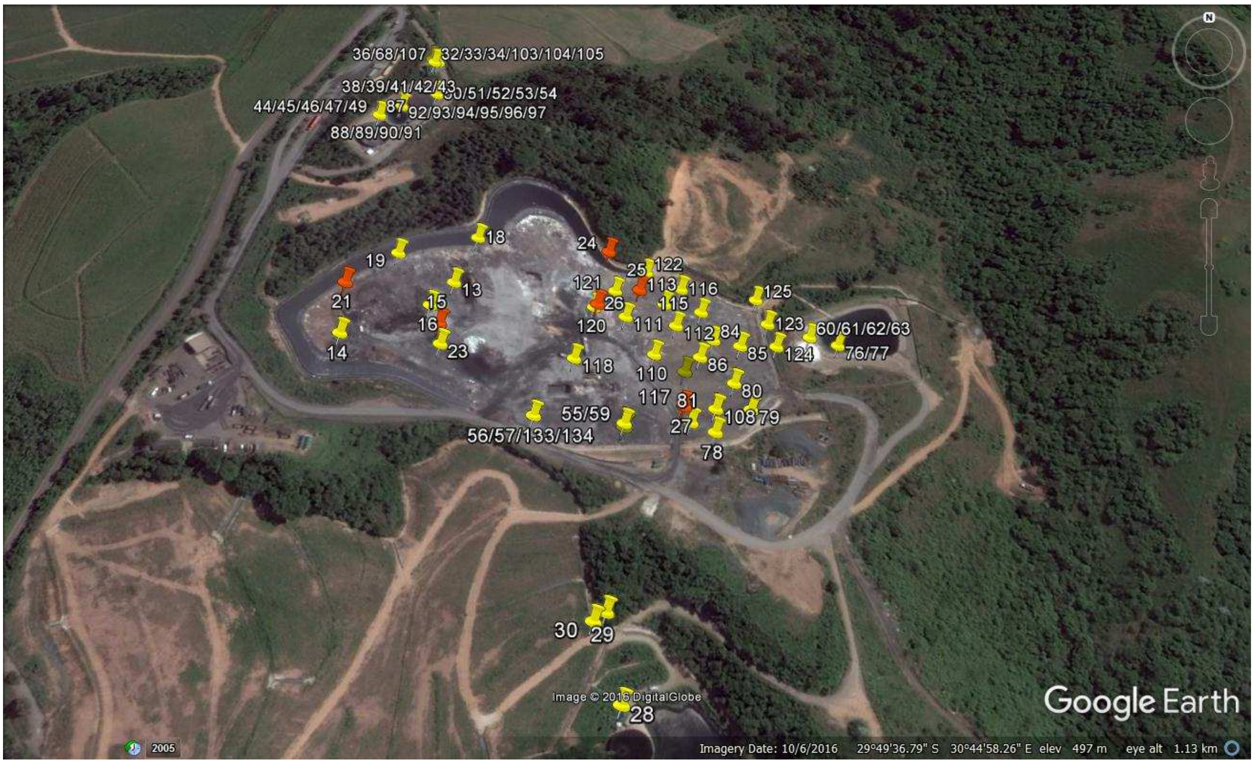

Figure 2.8: Map with sampling locations.

2.2 Status of work

The study has been planned in 2 phases. Phase 1 covered flux chamber measurements at Valley 2 and storm water dams at valley 1 and 2, measurement of H_2S in headspace in the tanks at the Leachate Treatment Plant, and at the tanks at the Tank Farm and the whirlybirds on top of the tanks. Two whirlybirds in Valley 2 were also sampled.

This work has been completed and data are being processed. Results of the canister samples have not been received and are expected during the course of the week of 19 December 2016. All of these data are required for dispersion modelling.

Phase 2 will focus primarily on measuring H_2S at whirlybird extraction systems at Valley 1 and verification measurements at tanks at Valley 2. Depending on the results of the canister samples, additional canister samples may be collected. This phase will start on 17 January 2017.

3 Mathematical dispersion modelling

3.1 Project outline

Airshed Planning Professionals (Pty) Ltd has been appointed to conduct mathematical dispersion modelling on contaminant source data provided by INFOTOX. The following mathematical dispersion models are available for application: CALPUFF; ADMS; SCIPUFF and AUSTAL. Using more than 1 model assists in verification of modelled ambient air concentrations through convergence across the entire modelling domain.

The Airshed modelling was initiated by developing a "straw dog" that included all potential sources of emission at the Shongweni Landfill Site, topography of the modelling domain and meteorology. Default contaminant flux values (unit releases) were used to test-run the various models. The default fluxes will be replaced by actual measured fluxes after completion of the INFOTOX field survey.

3.2 Status of work

Airshed has developed a conceptual mathematical dispersion profile for the modelling domain. This is based on unit release of substances form identified sources. Further development depends on source data provided to Airshed by INFOTOX. It is expected that development will be an iterative process, refining the concentrations of contaminants at receptor locations as more source data become available. A reasonably complete data set cannot be expected before end January 2017.

4 Community health risk assessment

Only preliminary work has been conducted on this part of the study.

The INFOTOX community health risk assessment for exposure to airborne contaminants will follow the paradigm for regulatory human health risk assessment that was developed by the USA National Research Council in the USA in 1983. This model has been adopted and refined by the US Environmental Protection Agency (USEPA) and other agencies in the world, and is widely used for quantitative health risk assessments. The health risk assessment for contaminants of potential concern will be conducted for averaging times that correspond with the observation of health effects, e.g., hourly, daily or annual averages. INFOTOX will consider which percentiles of the modelled data (99th, 90th or 75th) would be the most appropriate for interpretation.

Following receipt of results of the canister samples and consideration of the list of priority substances determined for landfill sites[4], INFOTOX will conduct toxicological reviews and prioritise hazardous substances for inclusion in the human health risk assessment.

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[4] UK Environment Agency. 2010. Guidance for monitoring trace components in landfill gas surface emissions. LFTGN04 v3.