Table 4-5: Dust fallout components as total mass (milligrams per site) and concentration (milligrams of component per gram of dust fallout)

CATEGORY	ANALYTE	DFO1		DFO2		DFO4		DFO5		DFO8	
		mg	mg/kg	mg	mg/kg	mg	mg/kg	mg	mg/kg	mg	mg/kg
Heavy Metal	Arsenic	2.45E-03	2.58E-02	5.78E-03	1.99E-01	1.46E-02	3.10E-01	3.87E-03	2.89E-02	2.45E-03	1.36E-01
Heavy Metal	Barium	9.06E-01	9.54E+00	1.01E+00	3.47E+01	1.10E+00	2.35E+01	7.19E-01	5.36E+00	8.54E-01	4.74E+01
Heavy Metal	Chromium	1.16E-02	1.22E-01	4.24E-01	1.46E+01	4.20E-01	8.93E+00	3.75E-01	2.80E+00	2.81E-01	1.56E+01
Heavy Metal	Cobalt	7.00E-04	7.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heavy Metal	Copper	2.57E-02	2.70E-01	1.16E-03	3.98E-02	2.91E-02	6.19E-01	6.87E-03	5.13E-02	2.10E-03	1.17E-01
Heavy Metal	Iron	9.55E-02	1.01E+00	3.90E-02	1.34E+00	1.40E-01	2.98E+00	4.40E-02	3.28E-01	1.40E-01	7.78E+00
Heavy Metal	Lead	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-04	9.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heavy Metal	Manganese	1.64E-02	1.72E-01	6.24E-03	2.15E-01	1.26E-02	2.67E-01	3.00E-03	2.24E-02	1.28E-02	7.08E-01
Heavy Metal	Molybdenum	3.50E-04	3.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.60E-04	6.42E-03	0.00E+00	0.00E+00
Heavy Metal	Nickel	2.10E-03	2.21E-02	3.85E-04	1.33E-02	2.28E-03	4.84E-02	8.60E-04	6.42E-03	3.50E-04	1.94E-02
Heavy Metal	Strontium	2.39E-02	2.51E-01	2.05E-02	7.06E-01	2.72E-02	5.79E-01	6.43E-02	4.80E-01	1.48E-02	8.19E-01
Heavy Metal	Tin	7.35E-03	7.74E-02	0.00E+00	0.00E+00	1.37E-03	2.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heavy Metal	Titanium	6.65E-03	7.00E-02	7.26E-03	2.50E-01	1.53E-02	3.25E-01	1.18E-02	8.77E-02	7.55E-03	4.19E-01
Heavy Metal	Tungsten	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-03	2.57E-02	0.00E+00	0.00E+00
Heavy Metal	Vanadium	2.10E-03	2.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heavy Metal	Zinc	7.80E-01	8.21E+00	8.97E-01	3.09E+01	8.90E-01	1.89E+01	6.20E-01	4.63E+00	6.49E-01	3.60E+01
Heavy Metal	SUBTOTAL	1.88E+00	1.98E+01	2.41E+00	8.30E+01	2.66E+00	5.65E+01	1.85E+00	1.38E+01	1.96E+00	1.09E+02
Other Metal	Aluminium	3.56E-01	3.75E+00	2.45E-01	8.46E+00	3.15E-01	6.70E+00	2.20E-01	1.64E+00	2.32E-01	1.29E+01
Other Metal	Boron	5.67E-01	5.97E+00	6.65E-01	2.29E+01	7.11E-01	1.51E+01	4.99E-01	3.73E+00	5.41E-01	3.00E+01
Other Metal	Calcium	4.19E+00	4.41E+01	2.04E+00	7.03E+01	3.26E+00	6.93E+01	6.20E+00	4.63E+01	9.50E-01	5.28E+01
Other Metal	Magnesium	4.79E-01	5.04E+00	1.60E-01	5.52E+00	3.59E-01	7.65E+00	2.72E+00	2.03E+01	1.42E-01	7.89E+00
Other Metal	Potassium	4.01E+00	4.22E+01	1.20E+00	4.13E+01	2.59E+00	5.52E+01	4.56E+00	3.40E+01	8.70E-01	4.83E+01
Other Metal	Silicon	2.14E+00	2.25E+01	1.39E+00	4.78E+01	1.91E+00	4.07E+01	4.73E+00	3.53E+01	5.95E-01	3.31E+01
Other Metal	Sodium	5.45E+00	5.74E+01	5.50E+00	1.90E+02	4.41E+00	9.39E+01	2.18E+01	1.63E+02	2.44E+00	1.36E+02
Other Metal	SUBTOTAL	1.72E+01	1.81E+02	1.12E+01	3.86E+02	1.36E+01	2.88E+02	4.07E+01	3.04E+02	5.77E+00	3.21E+02
Non-metal	Phosphorus	1.36E+00	1.43E+01	1.04E-01	3.58E+00	1.57E+00	3.33E+01	1.46E-01	1.09E+00	1.23E-01	6.81E+00
Non-metal	Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.60E-04	6.42E-03	0.00E+00	0.00E+00
Non-metal	Sulphur	2.25E+00	2.37E+01	8.48E+00	2.92E+02	1.37E+01	2.91E+02	1.77E+01	1.32E+02	1.23E+01	6.81E+02
Non-metal	SUBTOTAL	3.61E+00	3.80E+01	8.58E+00	2.96E+02	1.53E+01	3.25E+02	1.78E+01	1.33E+02	1.24E+01	6.88E+02
ALL	TOTAL	2.27E+01	2.39E+02	2.22E+01	7.65E+02	3.15E+01	6.69E+02	6.04E+01	4.51E+02	2.01E+01	1.12E+03

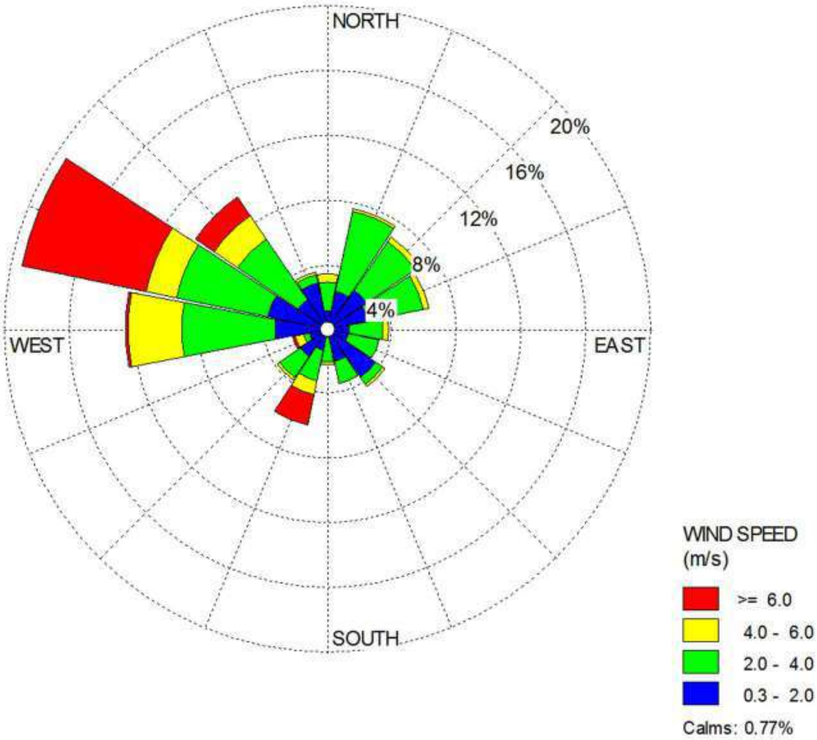


Figure 4-4: Wind rose for DFO monitoring period (08 May – 31 May 2017 at the UHA Plantations station)

5 ATMOSPHERIC DISPERSION MODEL

Atmospheric dispersion models provide a means to predict ambient air quality concentrations as a function of source configurations, emission levels, meteorological characteristics, topography and land use. They are a useful tool to ascertain the spatial and temporal patterns of ground level concentrations arising from the emissions of various point, line, area and volume sources. These outputs are used primarily in environmental and health impact assessments, risk assessments and emission control. There currently exists a wide range of modelling software available on the market. CALPUFF View 8.4 was utilized in this study. This is a new generation air dispersion model designed for long-range dispersion of airborne pollutants in puff plumes. CALPUFF is the recommended Level 3 model in South Africa's Regulations Regarding Air Dispersion Modelling, Government Notice 533 of 2014 (Government Gazette 37804). The CALPUFF model is applied to regional assessments (usually a domain larger than 50 x 50 km), where the facility is located within complex terrain, where land sea interactions are an important influence on the wind regime, and / or where a high proportion of hourly average wind speeds are below 1 m/s (calm conditions). The model domain in this study was 30 x 30 km with complex terrain.

5.1 MODEL INPUTS

5.1.1 *MODEL DOMAIN, TERRAIN AND LAND USE*

A 30 km x 30 km modelling domain was defined for this assessment. A nested grid was utilised with a resolution of 100 m x 100 m within 4500 m of the site, 500 m x 500 m from 4500 m to 7500 m of the site, and a 1000 m x 1000 m from 7500 m to 15000 m of the site. The NASA Shuttle Radar Topographic Mission (STRM) digital elevation model (DEM) (resolution 90 m x 90 m over a domain of 50 km x 50 km) was extracted and inputted to the model to account for terrain influences on dispersion. For the land use categorization, an AERSURFACE output was created from the Global Land Cover Characterization Global Coverage – Version 2 (1 km x 1 km resolution over a domain of 50 km x 50 km).

5.1.2 *METEOROLOGY*

Prevailing meteorology of the boundary layer is a dominant influence on atmospheric dispersion. Important parameters for the characterisation of dispersion potential include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth. To accurately represent meteorological conditions in the Upper Highway region, a 1 km resolution CALMET-ready WRF dataset for the period 17 May 2016 to 16 May 2017 centred at 29.82755° S and 30.74849° E and covering a domain of 50 km x 50 km was purchased from Lakes Environmental. The CALMET meteorological model contains a diagnostic wind field module that includes parameterized treatments of terrain effects.

5.1.3 *EMISSIONS INVENTORY*

In the absence of emissions information for the Shongweni Landfill, a unity model was run with an emission rate of 1 $g/m^2/s$ for the area of Valley 2. As such, ambient concentrations calculated are relative concentrations showing the dispersion pattern within the landscape and areas of potential impact. These relative concentrations can be calibrated using measured ambient concentrations.

5.1.4 *SENSITIVE RECEPTORS*

Sensitive receptors are sites where there is a potential health impact of emissions from the activity being investigated. Examples of sensitive receptors include, but are not limited to, densely populated areas, schools, hospitals, shopping centres and retirement homes. In this study, sensitive receptors were selected on the basis of population exposure, levels of complaints and to assess impacts at locations at various distances from the source along prevailing winds. Selected sensitive receptors include residences, schools, hospitals, a clinic, a veterinary hospital and other commercial enterprises. Details and locality of sensitive receptors selected for this dispersion assessment are shown in Table 5-1 and Figure 5-1.

Table 5-1: Sensitive receptors selected for the dispersion assessment

ID	RECEPTOR NAME	CLASSIFICATION	LATITUDE (ºS)	LONGITUDE (ºE)
1	Denny Mushrooms Farm	Commercial	-29.8161	30.7534
2	House 1 (Shongweni)	Residential	-29.8196	30.76168
3	House 2 (Shongweni)	Residential	-29.8444	30.75904
4	Waterberry Close	Residential	-29.8058	30.756
5	St. Helier Greenhouses	Commercial	-29.808	30.76566
6	Kwamanzini Primary School	School	-29.842	30.77144
7	House 3 (Shongweni)	Residential	-29.802	30.74711
8	Ntee High School	School	-29.8468	30.76765
9	Polo Pony Retirement Village	Residential	-29.7973	30.74361
10	Ndengetho High School	School	-29.8469	30.77319
11	Kwandengezi Clinic	Clinic	-29.8511	30.76829
12	Thokozamnganga High School	School	-29.8556	30.73811
13	Bhongo Primary School	School	-29.8481	30.77571
14	Botate Primary School	School	-29.8561	30.77073
15	Summerveld Equine Hospital	Veterinary Hospital	-29.809	30.71304
16	Hillcrest Private Hospital	Hospital	-29.7896	30.74242
17	Hillcrest Hospital	Hospital	-29.7896	30.7618
18	Chief Lokothwayo Primary School	School	-29.8475	30.78597
19	Dassenhoek High School	School	-29.8433	30.78855
20	Umthala Primary School	School	-29.8647	30.76238
21	Hillcrest Primary School	School	-29.7868	30.7596
22	Ndengezi Intermediate School	School	-29.8662	30.76218
23	Winston Park Primary School	School	-29.7968	30.78168
24	House 4 (Stockville)	Residential	-29.8084	30.79154
25	Ingane Yami Children's Village	Residential	-29.8297	30.77693
26	Mountbatten Drive	Residential	-29.815	30.77621
27	Highbury Preparatory School	School	-29.7805	30.75872
28	101 on Acutts Estate	Residential	-29.759	30.80314
29	Curro Hillcrest Christian Academy	School	-29.7616	30.77911
30	Baildon Drive, Waterfall	Residential	-29.741	30.83367
31	Sienna Road, Plantations Estate	Residential	-29.7949	30.76306
32	Kearsney College (High School)	School	-29.7584	30.7524
33	Play Park, Plantations Estate	Residential	-29.7981	30.76524

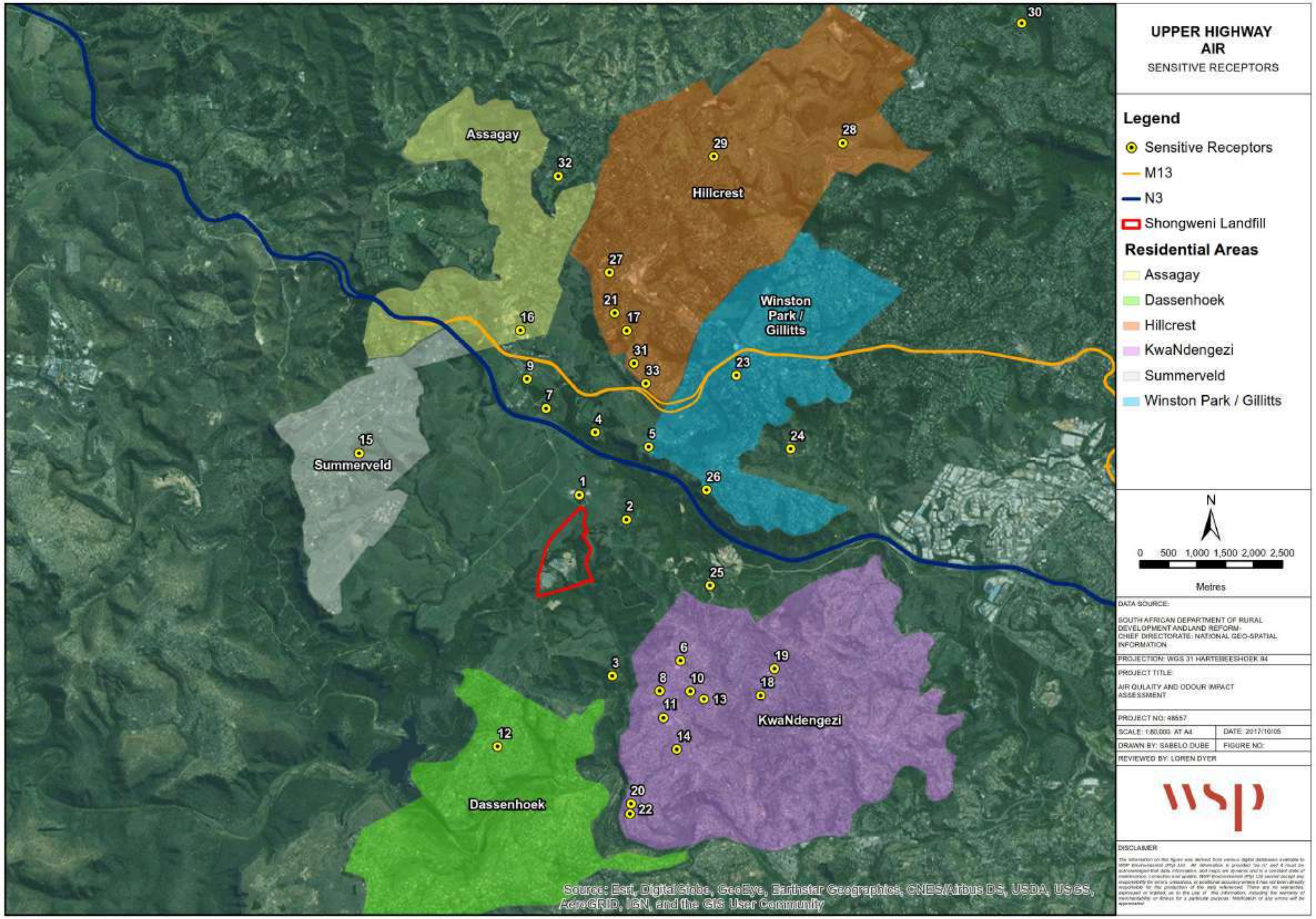


Figure 5-1: Sensitive receptors selected for dispersion assessment

5.2 MODEL OUTPUTS

5.2.1 STATISTICAL OUTPUTS AND ISOPLETH MAPS

The model output maps and tables that follow show concentrations that would be experienced at ground level. The following statistical outputs were calculated:

- Annual average is calculated by averaging all hourly concentrations over one calendar year. The calculation is conducted for each grid point within the modelling domain and at each sensitive receptor for every line of meteorological data (hourly) and then averaged for the number of hours.
- Rank 1 hourly and Rank 1 24-hour concentrations are the highest hourly and 24-hour average concentrations calculated for each grid point within the modelling domain and for each sensitive receptor for the entire meteorological period (one year in this case). Although the Rank 1 results are graphically presented in the maps that follow as concentration isopleths, in reality these values do not occur simultaneously across the model domain. Hence the rank isopleth maps do not depict a continuous average plume but rather a statistical distribution of the highest hourly and 24-hour averages over the modelling period.

5.2.2 MODEL CALIBRATION

As an alternative to the input of an emissions inventory to CALPUFF, a tentative calibration of the unity model was conducted using the peak measurement measurements downwind for VOCs (Campaign 4, 09 June 2017) and H_2S (30 August 2017). The Rank 1 hourly concentrations predicted by the unity model for the measurement locations were equated with the peak measurement concentration for each pollutant. Relative concentrations calculated by the dispersion model at all other discrete and grid point receptors are then calibrated against this value.

It is unlikely that WSP's measurement took place during the model Rank 1 period. Thus, the calibrated model is expected to offer lower estimates for concentrations across the study domain than would be experienced in reality. Further monitoring for these pollutants in the vicinity of the landfill site may produce higher measurements. These could then be used to refine the model calibration over time.

5.3 RESULTS

5.3.1 UNITY MODEL

The relative concentrations for sensitive receptors calculated using the unity model are presented in Table 5-2.

These outputs also are presented as the number of times larger than the lowest receptor concentration for each averaging period (Baildon Drive for Rank 1 hourly and annual average, and 101 Acutts for Rank 1 24-hour). Isopleth maps are presented in Figure 5-2 (annual), Figure 5-3 (Rank 1 24-hour) and Figure 5-4 (Rank 1 1-hour) that follow.

Key findings are as follows:

- The Denny Mushrooms farm and an isolated house (Clifton Canyon Guesthouse) to the north-east of the landfill site showed the highest levels of exposure across averaging periods;
- Waterberry Close showed the third highest Rank 1 hourly average concentration.
- Ingane Yami Children's Home showed the fourth highest Rank1 hourly average concentration;
- The schools with the highest levels of exposure are Kwamanzini Primary School (Rank 1 hourly) and Ntee High School (Rank 1 24-hour and annual average).

5.3.2 MODEL CALIBRATION

Results from the tentative model calibration (Table 5-3 and Figure 5-5 to Figure 5-8) indicate:

- Rank 1 hourly benzene concentrations above 5 µg/m^3 occurred at Denny Mushrooms Farm (11.10 µg/m^3) and at House 1 (7.03µg/m^3). This falls below the short-term TCEQ ESL;
- Annual average benzene concentrations fell below the NAAQS (5 µg/m^3 on an annual averaging period) at all selected receptors;
- Rank 1 hourly H_2S concentrations were significantly higher than the WHO annoyance guideline (7 µg/m^3 on a 30-minute averaging period) at a number of receptors. The Rank 1 24-hour concentration does not reach the WHO health guideline (150 µg/m^3 on a 24-hour averaging period) at any of the selected receptors.

Table 5-2: Relative concentrations and scale of impact calculated using the unity model for sensitive receptors

ID	RECEPTOR NAME	RELATIVE CONCENTRATIONS			EXPOSURE RELATIVE TO RECEPTOR WITH LOWEST EXPOSURE		
		ANNUAL	24-HOUR (RANK 1)	HOURLY (RANK 1)	ANNUAL	24-HOUR	HOURLY
1	Denny Mushrooms Farm	6.59E+06	3.74E+05	5.18E+04	160x	104x	210x
2	House 1 (Shongweni)	4.18E+06	3.04E+05	4.20E+04	130x	84x	133x
3	House 2 (Shongweni)	1.80E+06	2.55E+05	3.36E+04	104x	71x	57x
4	Waterberry Close	2.04E+06	1.21E+05	1.29E+04	40x	33x	65x
5	St. Helier Greenhouses	1.44E+06	1.78E+05	1.21E+04	37x	49x	46x
6	Kwamanzini Primary School	1.71E+06	1.67E+05	2.26E+04	70x	46x	54x
7	House 3 (Shongweni)	9.60E+05	1.05E+05	7.79E+03	24x	29x	31x
8	Ntee High School	1.46E+06	1.91E+05	2.44E+04	75x	53x	46x
9	Polo Pony Retirement Village	5.91E+05	4.44E+04	4.86E+03	15x	12x	19x
10	Ndengetho High School	1.51E+06	1.29E+05	2.11E+04	65x	36x	48x
11	Kwandengezi Clinic	1.29E+06	1.74E+05	2.15E+04	67x	48x	41x
12	Thokozamnganga High School	9.46E+05	7.81E+04	8.41E+03	26x	22x	30x
13	Bhongo Primary School	1.56E+06	1.29E+05	1.94E+04	60x	36x	50x
14	Botate Primary School	1.03E+06	1.20E+05	1.55E+04	48x	33x	33x
15	Summerveld Equine Hospital	5.00E+05	4.30E+04	3.04E+03	9x	12x	16x
16	Hillcrest Private Hospital	4.74E+05	3.28E+04	3.23E+03	10x	9x	15x
17	Hillcrest Hospital	6.37E+05	3.85E+04	3.05E+03	9x	11x	20x
18	Chief Lokothwayo Primary School	8.14E+05	6.90E+04	9.65E+03	30x	19x	26x
19	Dassenhoek High School	9.62E+05	7.34E+04	1.05E+04	32x	20x	31x
20	Umthala Primary School	7.42E+05	6.33E+04	4.93E+03	15x	18x	24x
21	Hillcrest Primary School	6.36E+05	4.20E+04	3.31E+03	10x	12x	20x
22	Ndengezi Intermediate School	8.67E+05	7.42E+04	4.28E+03	13x	21x	28x
23	Winston Park Primary School	3.13E+05	2.54E+04	2.58E+03	8x	7x	10x

ID	RECEPTOR NAME	RELATIVE CONCENTRATIONS			EXPOSURE RELATIVE TO RECEPTOR WITH LOWEST EXPOSURE		
		ANNUAL	24-HOUR (RANK 1)	HOURLY (RANK 1)	ANNUAL	24-HOUR	HOURLY
24	House 4 (Stockville)	4.47E+05	3.93E+04	2.70E+03	8x	11x	14x
25	Ingane Yami Children's Village	1.82E+06	1.24E+05	1.37E+04	42x	34x	58x
26	Mountbatten Drive	1.32E+06	1.26E+05	1.05E+04	32x	35x	42x
27	Highbury Preparatory School	6.28E+05	3.00E+04	2.54E+03	8x	8x	20x
28	101 on Acutts Estate	5.07E+04	3.62E+03	4.38E+02	1x	1x	2x
29	Curro Hillcrest Christian Academy	5.91E+04	5.29E+03	5.05E+02	2x	1x	2x
30	Baildon Drive, Waterfall	3.14E+04	4.66E+03	3.24E+02	1x	1x	1x
31	Sienna Road, Plantations Estate	8.16E+05	3.77E+04	3.75E+03	12x	10x	26x
32	Kearsney College (High School)	2.94E+05	1.39E+04	7.52E+02	2x	4x	9x
33	Play Park, Plantations Estate	8.81E+05	5.21E+04	4.80E+03	15x	14x	28x
Grid Maximum Across Domain		1.29E+07	3.34E+07	1.35E+08	39867x	9250x	4291x

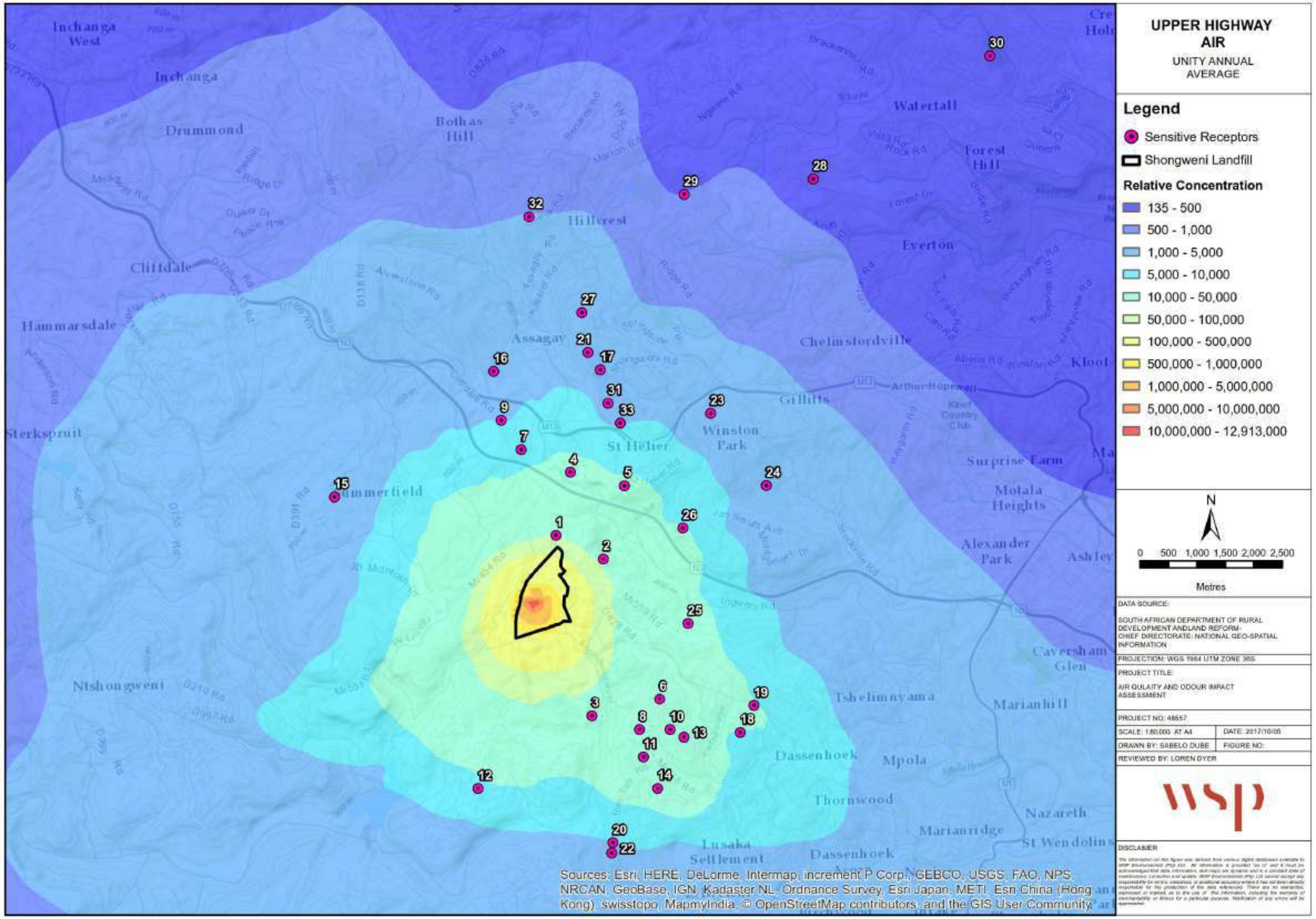


Figure 5-2: Annual average relative concentrations

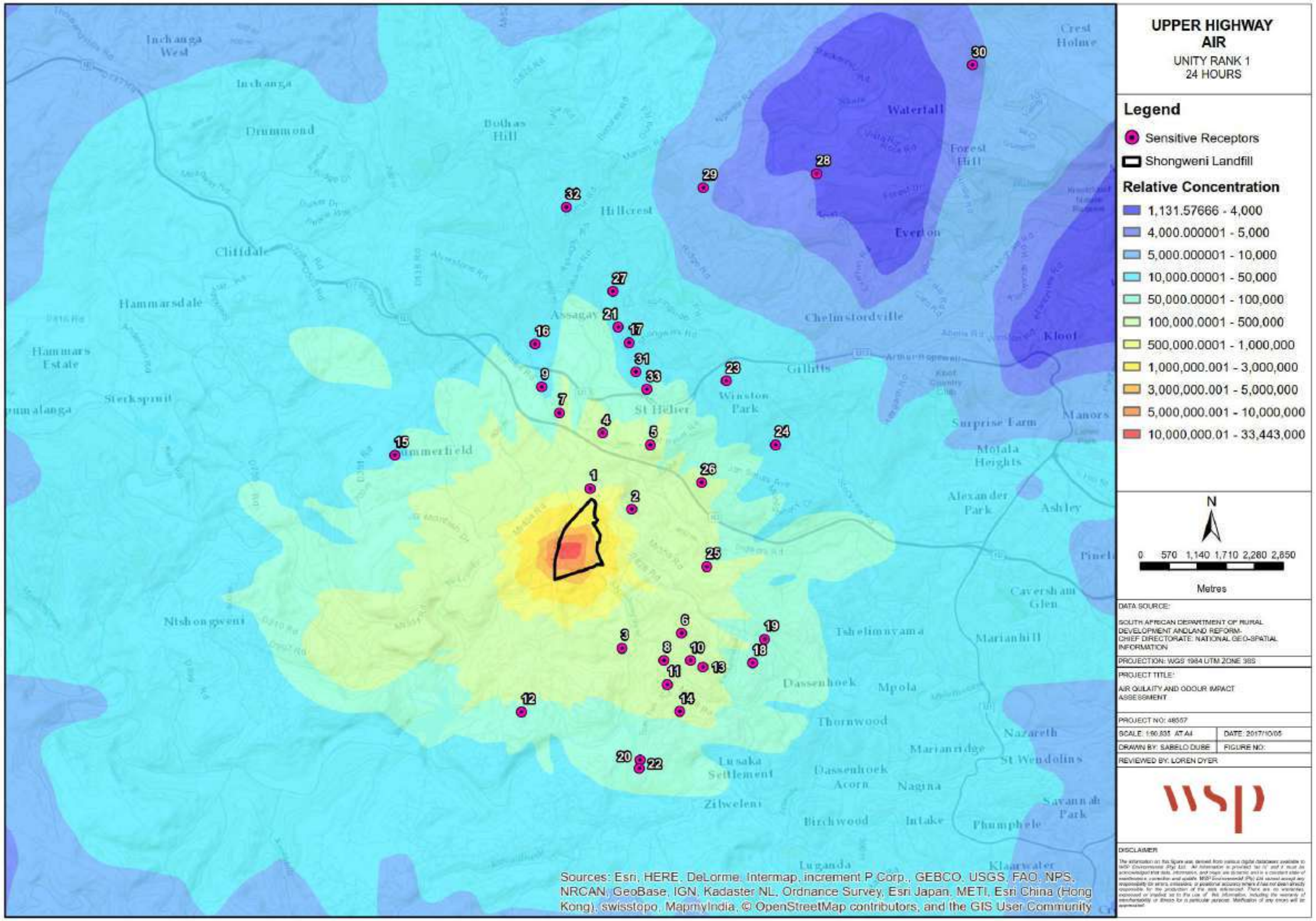
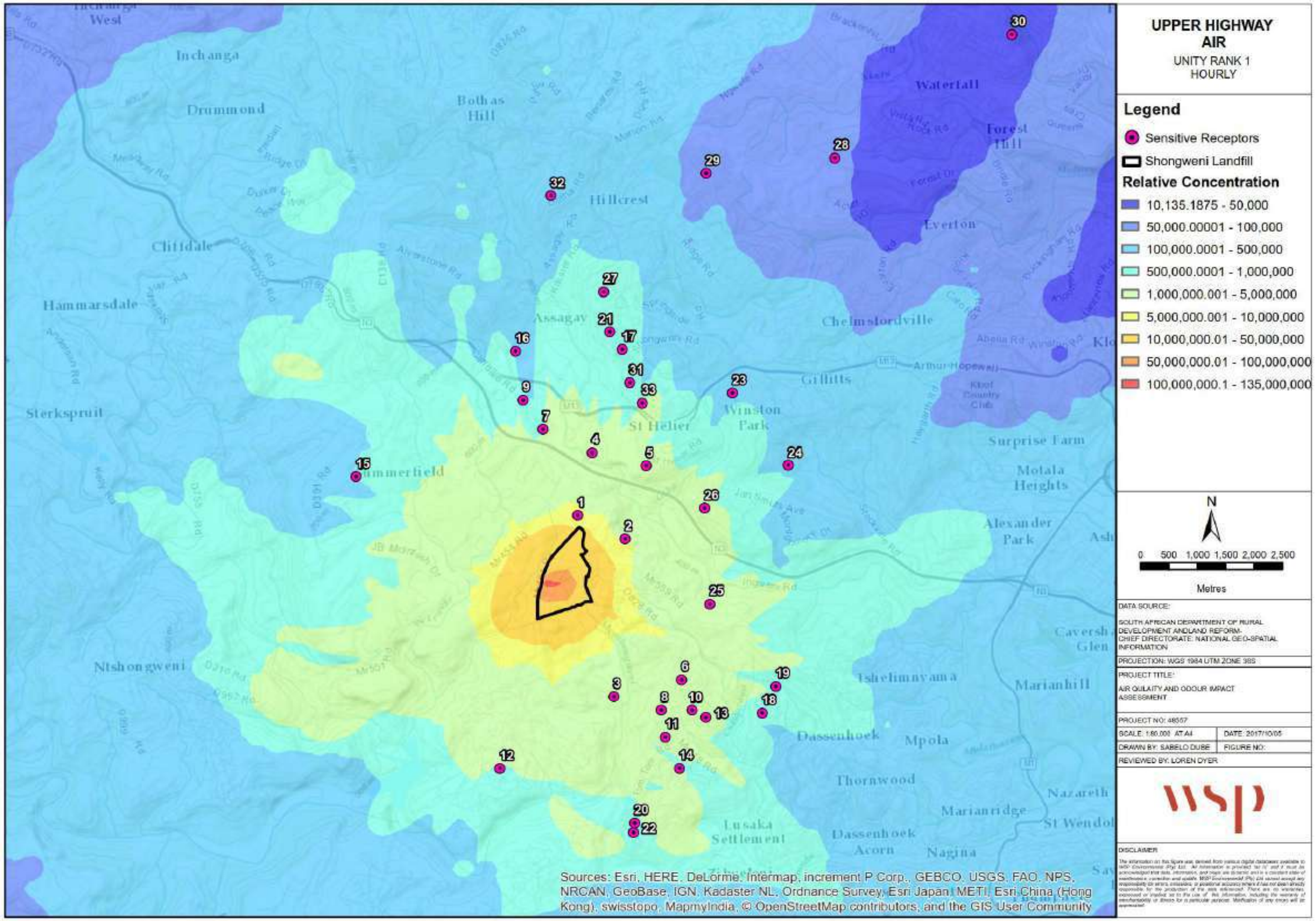


Figure 5-3: Rank 1 24-hour relative concentrations



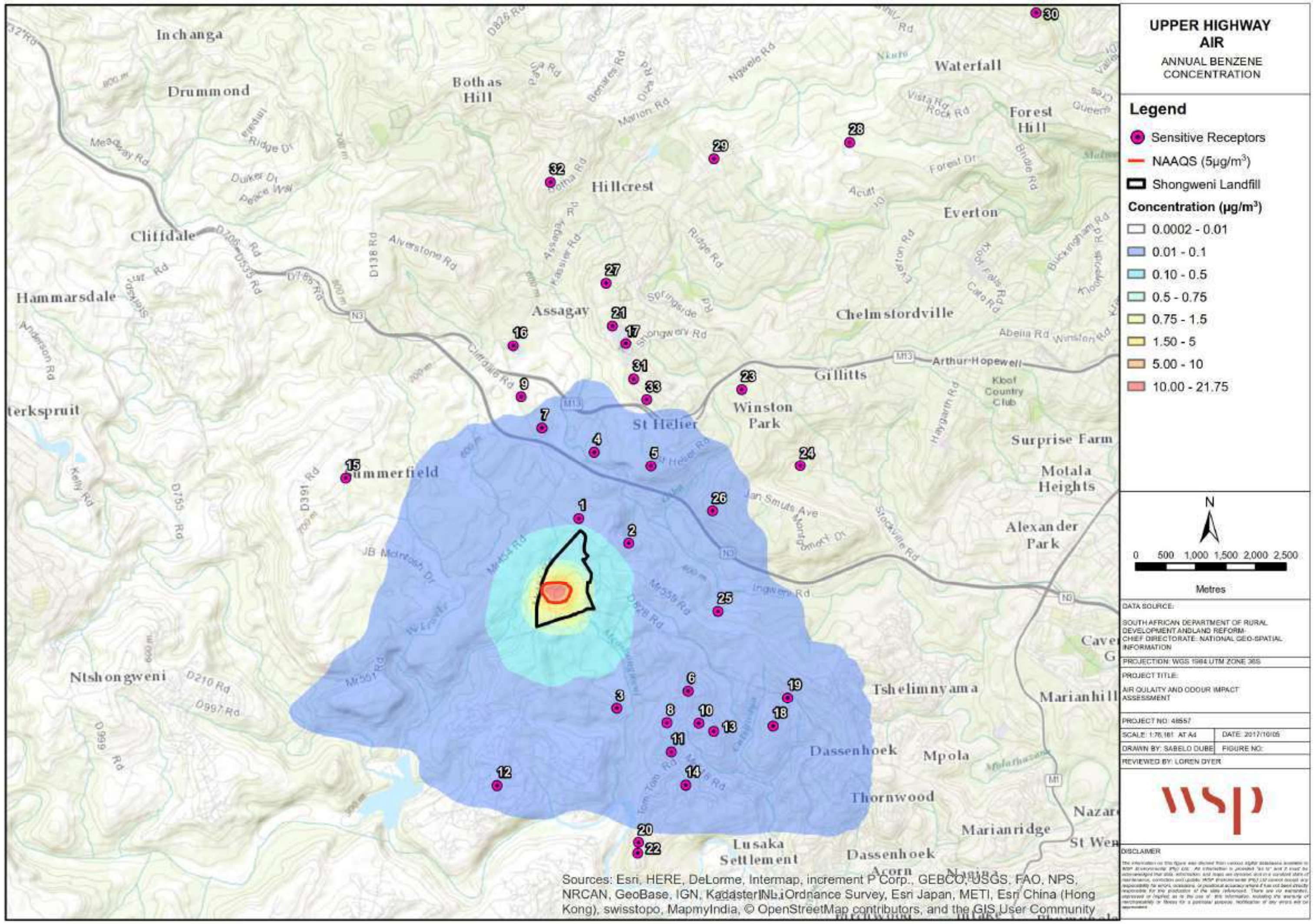
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 5-4: Rank 1 hourly relative concentrations

Table 5-3: Calibrated model concentration estimates for VOCs and H_2S

ID	BENZENE ($\mu g/m^3$)		ETHYLBENZENE ($\mu g/m^3$)		M/P-XYLENE ($\mu g/m^3$)		O-XYLENE ($\mu g/m^3$)		STYRENE ($\mu g/m^3$)		TOLUENE ($\mu g/m^3$)		TRICHLOROETHENE ($\mu g/m^3$)		HYDROGEN SULPHIDE ($\mu g/m^3$)	
	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	RANK 1 24HR	RANK 1 HOURLY
1	0.09	11.10	0.01	1.68	0.04	5.53	0.02	2.11	0.01	1.02	0.11	14.49	0.03	3.67	3.81	67.14
2	0.07	7.03	0.01	1.06	0.04	3.50	0.01	1.34	0.01	0.64	0.09	9.18	0.02	2.33	3.09	42.53
3	0.06	3.03	0.01	0.46	0.03	1.51	0.01	0.58	0.01	0.28	0.07	3.96	0.02	1.00	2.60	18.35
4	0.02	3.43	0.00	0.52	0.01	1.71	0.00	0.65	0.00	0.31	0.03	4.48	0.01	1.14	1.23	20.75
5	0.02	2.42	0.00	0.37	0.01	1.21	0.00	0.46	0.00	0.22	0.03	3.16	0.01	0.80	1.82	14.64
6	0.04	2.88	0.01	0.43	0.02	1.43	0.01	0.55	0.00	0.26	0.05	3.75	0.01	0.95	1.70	17.40
7	0.01	1.62	0.00	0.24	0.01	0.81	0.00	0.31	0.00	0.15	0.02	2.11	0.00	0.53	1.07	9.78
8	0.04	2.45	0.01	0.37	0.02	1.22	0.01	0.47	0.00	0.22	0.05	3.20	0.01	0.81	1.94	14.83
9	0.01	1.00	0.00	0.15	0.00	0.50	0.00	0.19	0.00	0.09	0.01	1.30	0.00	0.33	0.45	6.02
10	0.04	2.55	0.01	0.38	0.02	1.27	0.01	0.49	0.00	0.23	0.05	3.33	0.01	0.84	1.31	15.41
11	0.04	2.18	0.01	0.33	0.02	1.09	0.01	0.41	0.00	0.20	0.05	2.84	0.01	0.72	1.77	13.18
12	0.01	1.59	0.00	0.24	0.01	0.79	0.00	0.30	0.00	0.15	0.02	2.08	0.00	0.53	0.80	9.64
13	0.03	2.62	0.00	0.40	0.02	1.31	0.01	0.50	0.00	0.24	0.04	3.43	0.01	0.87	1.32	15.87
14	0.03	1.73	0.00	0.26	0.01	0.86	0.00	0.33	0.00	0.16	0.03	2.26	0.01	0.57	1.22	10.46
15	0.01	0.84	0.00	0.13	0.00	0.42	0.00	0.16	0.00	0.08	0.01	1.10	0.00	0.28	0.44	5.09
16	0.01	0.80	0.00	0.12	0.00	0.40	0.00	0.15	0.00	0.07	0.01	1.04	0.00	0.26	0.33	4.82
17	0.01	1.07	0.00	0.16	0.00	0.53	0.00	0.20	0.00	0.10	0.01	1.40	0.00	0.36	0.39	6.49
18	0.02	1.37	0.00	0.21	0.01	0.68	0.00	0.26	0.00	0.13	0.02	1.79	0.01	0.45	0.70	8.29
19	0.02	1.62	0.00	0.24	0.01	0.81	0.00	0.31	0.00	0.15	0.02	2.11	0.01	0.54	0.75	9.80
2	0.01	1.25	0.00	0.19	0.00	0.62	0.00	0.24	0.00	0.11	0.01	1.63	0.00	0.41	0.64	7.56
21	0.01	1.07	0.00	0.16	0.00	0.53	0.00	0.20	0.00	0.10	0.01	1.40	0.00	0.35	0.43	6.48
22	0.01	1.46	0.00	0.22	0.00	0.73	0.00	0.28	0.00	0.13	0.01	1.91	0.00	0.48	0.76	8.83
23	0.00	0.53	0.00	0.08	0.00	0.26	0.00	0.10	0.00	0.05	0.01	0.69	0.00	0.17	0.26	3.19
24	0.00	0.75	0.00	0.11	0.00	0.37	0.00	0.14	0.00	0.07	0.01	0.98	0.00	0.25	0.40	4.55
25	0.02	3.06	0.00	0.46	0.01	1.52	0.00	0.58	0.00	0.28	0.03	4.00	0.01	1.01	1.26	18.51

ID	BENZENE (µg/m^3)		ETHYLBENZENE (µg/m^3)		M/P-XYLENE (µg/m^3)		O-XYLENE (µg/m^3)		STYRENE (µg/m^3)		TOLUENE (µg/m^3)		TRICHLOROETHENE (µg/m^3)		HYDROGEN SULPHIDE (µg/m^3)	
	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	ANNUAL AVERAGE	RANK 1 HOURLY	RANK 1 24HR	RANK 1 HOURLY
2	0.02	2.23	0.00	0.34	0.01	1.11	0.00	0.42	0.00	0.20	0.02	2.91	0.01	0.74	1.29	13.49
27	0.00	1.06	0.00	0.16	0.00	0.53	0.00	0.20	0.00	0.10	0.01	1.38	0.00	0.35	0.31	6.40
2	0.00	0.09	0.00	0.01	0.00	0.04	0.00	0.02	0.00	0.01	0.00	0.11	0.00	0.03	0.04	0.52
2	0.00	0.10	0.00	0.02	0.00	0.05	0.00	0.02	0.00	0.01	0.00	0.13	0.00	0.03	0.05	0.60
3	0.00	0.05	0.00	0.01	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.07	0.00	0.02	0.05	0.32
31	0.01	1.37	0.00	0.21	0.00	0.68	0.00	0.26	0.00	0.13	0.01	1.79	0.00	0.45	0.38	8.31
32	0.00	0.49	0.00	0.07	0.00	0.25	0.00	0.09	0.00	0.05	0.00	0.65	0.00	0.16	0.14	2.99
33	0.01	1.48	0.00	0.22	0.00	0.74	0.00	0.28	0.00	0.14	0.01	1.94	0.00	0.49	0.53	8.97



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 5-5: Annual average benzene

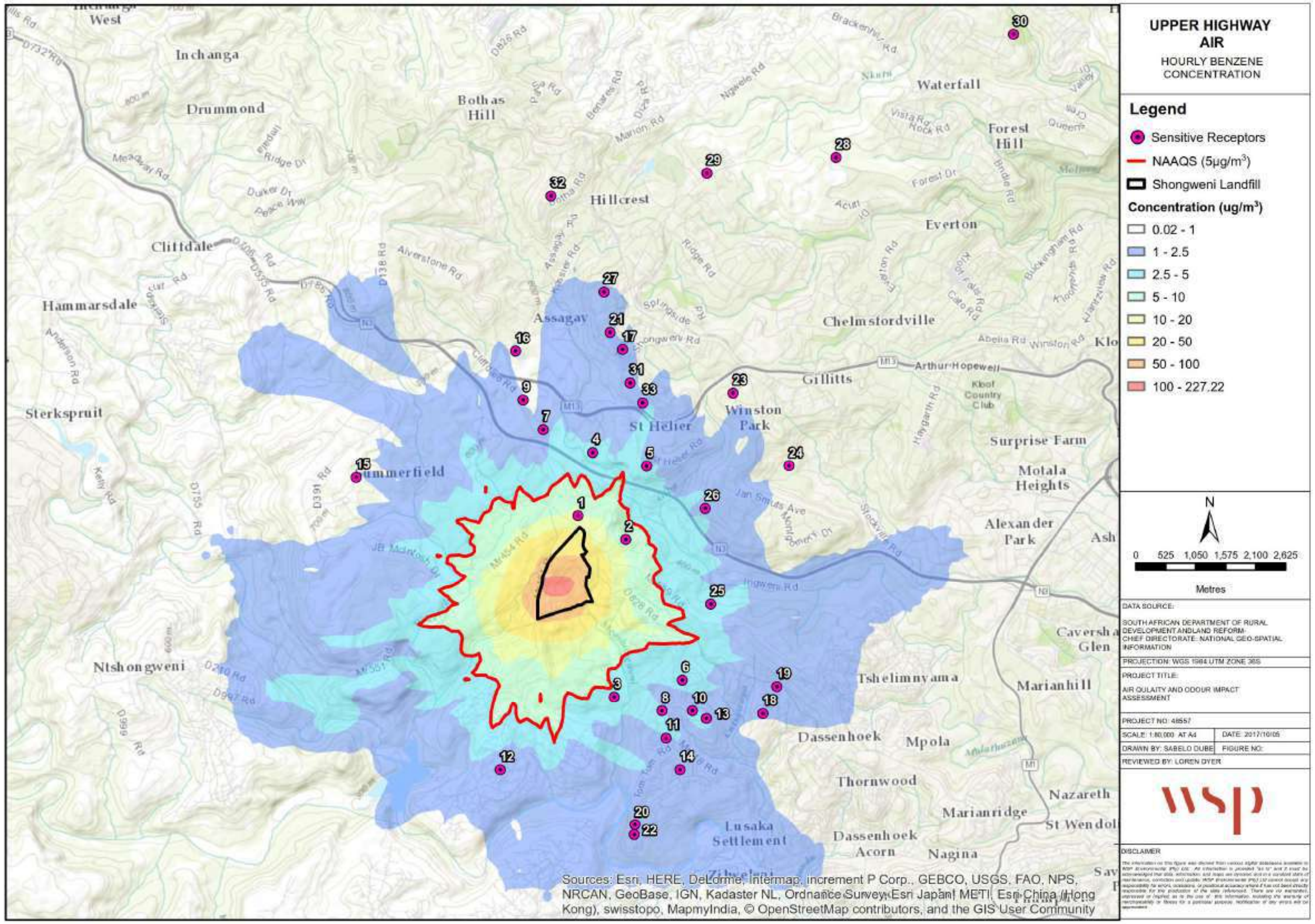
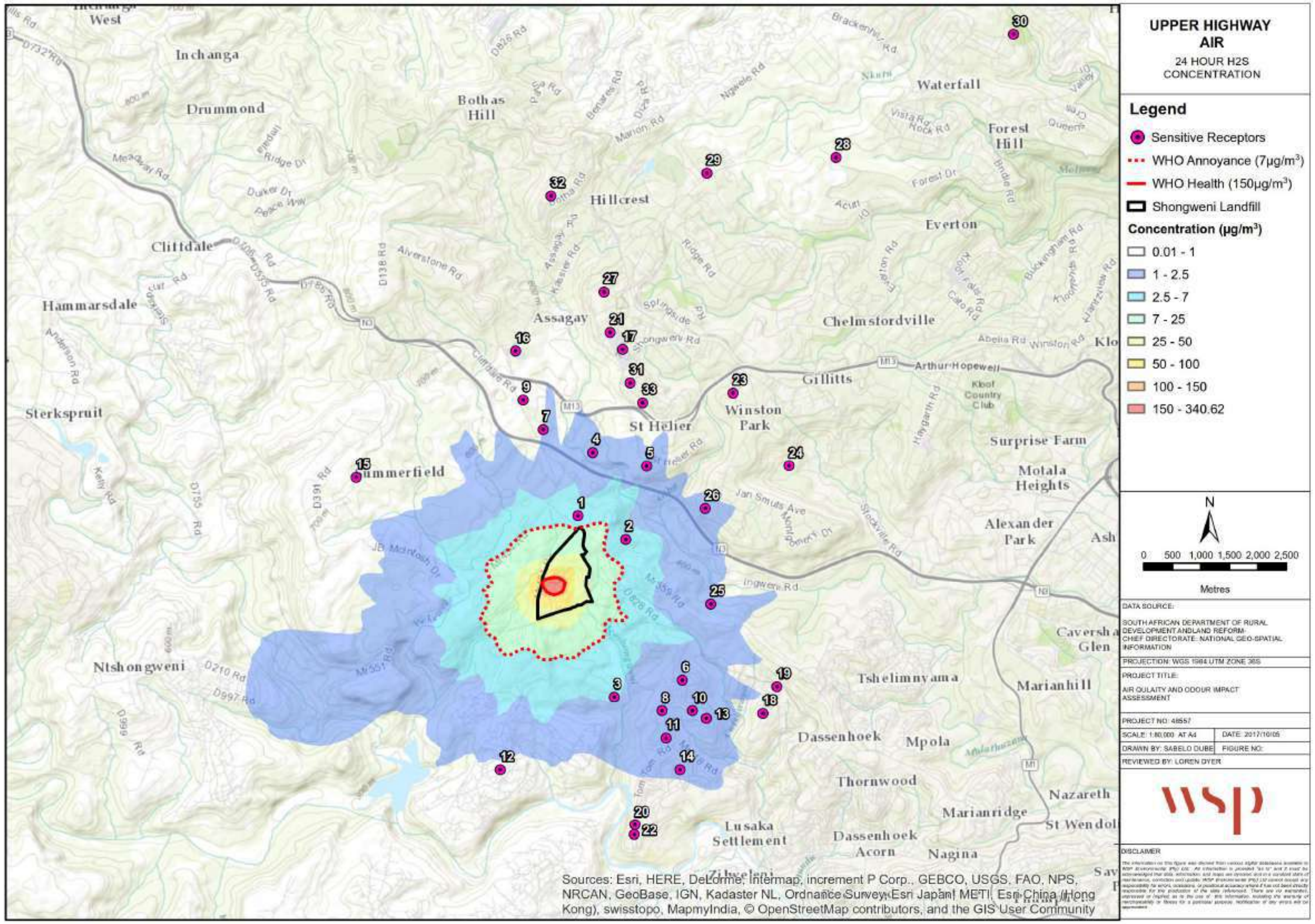


Figure 5-6: Rank 1 hourly benzene



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 5-7: Rank 1 24-hour H_2S

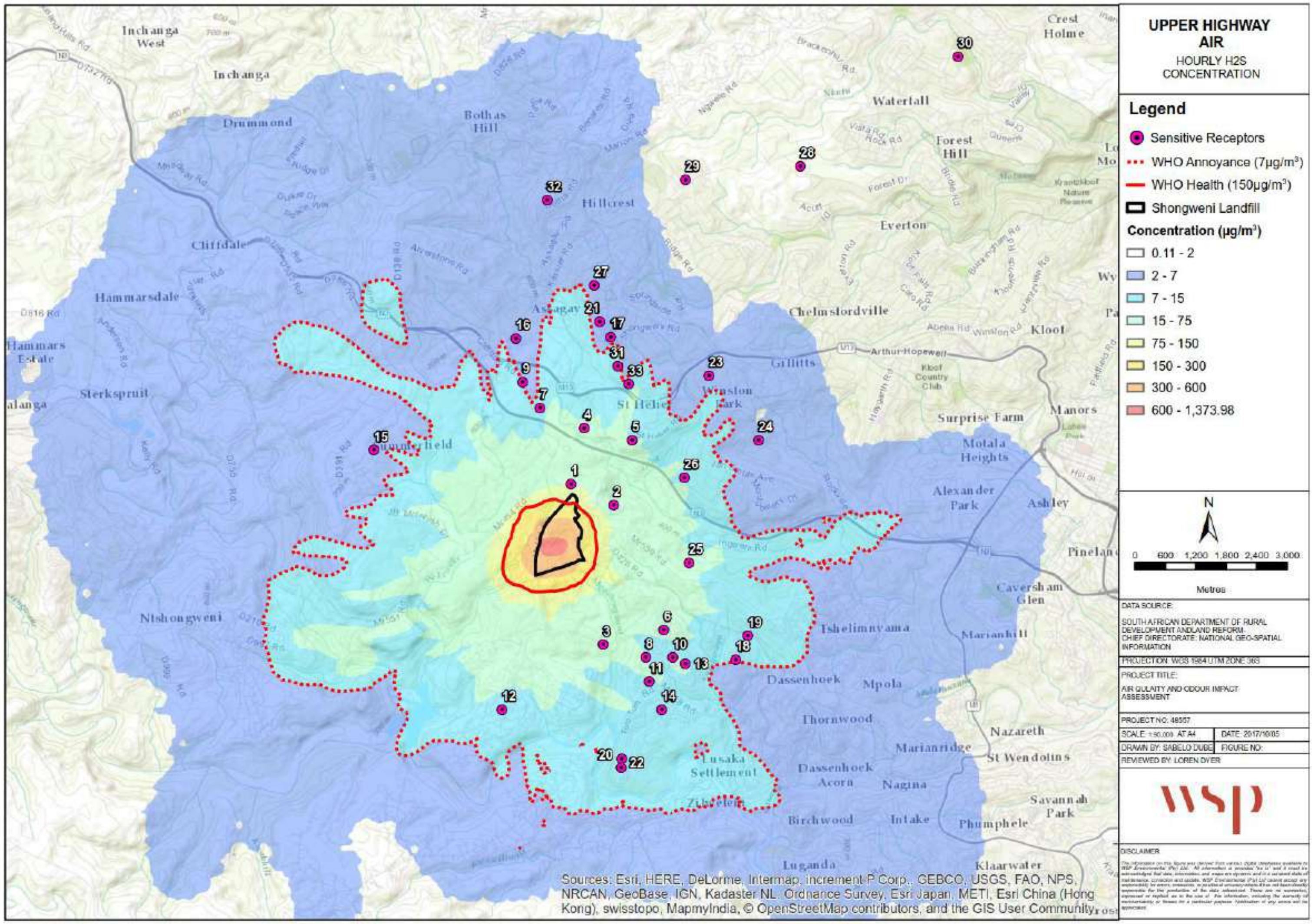


Figure 5-8: Rank 1 hourly H_2S

6 RESULTS AND DISCUSSION

6.1 WSP FOR UHA

WSP's H_2S results downwind of the site on the morning of 30 August 2017 showed:

- Concentrations (187 µg/m^3 and 180 µg/m^3) significantly higher than the WHO annoyance guideline (7 µg/m^3 on a 30-minute average) and health guideline (150 µg/m^3 on a 24-hour average).
  - The latter guideline, however, is on a 24-hour average whereas the smell event did not persist for 24-hours.

VOC Campaign 4 (09 June 2017) was blank corrected and samples were collected upwind and downwind of the EnviroServ landfill, including community samples (Plantations Estate):

- In the upwind sample, all volatiles were below detection level except ethylbenzene (0.10 µg/m^3 in one sample), m/p-xylene (0.03 µg/m^3 in one sample) and toluene (average 0.38 µg/m^3 for the two samples).
- The downwind concentrations of benzene, ethylbenzene, m/p-xylene, o-xylene, toluene and styrene show the highest values across the three sites. This suggests the landfill is the source of these pollutants.
- These pollutants remained detectable at the community receptor, Plantations Estate, but at concentrations below those of the samples collected immediately downwind of the landfill site (except for trichloroethene, which was found to be higher within the community than immediately downwind of the site).
- Of particular relevance are the benzene concentrations (downwind average of 23.74 µg/m^3 on an averaging period between 15 and 20 minutes, and Plantations average of 17.53 µg/m^3 on a 20-minute averaging period).

A unity model was run in model CALPUFF View 8.4 with an emission rate of 1 g/m^2/s for the area of Valley 2. Ambient concentrations calculated are relative concentrations showing the dispersion pattern within the landscape and areas of potential impact. As an alternative to the input of emissions data for the Shongweni Landfill, a tentative model calibration was conducted using measurement data. Results are lower than the expected reality. Results indicated:

- The Denny Mushrooms farm and an isolated house to the north-east of the landfill site showed the highest levels of exposure across averaging periods;
- Waterberry Close showed the third highest Rank 1 hourly average concentration;
- Ingane Yami Children's Home showed the fourth highest Rank 1 hourly average concentration;
- The schools with the highest levels of exposure are Kwamanzini Primary School (Rank 1 hourly) and Ntee High School (Rank 1 24-hour and annual average);
- Rank 1 hourly benzene concentrations above 5 µg/m^3 occurred at Denny Mushrooms Farm (11.10 µg/m^3) and at House 1 (7.03µg/m^3). This falls below the short-term UK EAL and TCEQ ESL;
- Annual average benzene concentrations fell below the NAAQS (5 µg/m^3 on an annual averaging period) at all selected receptors;
- Rank 1 hourly H_2S concentrations were significantly higher than the WHO annoyance guideline (7 µg/m^3 on a 30-minute averaging period) at a number of receptors. The Rank 1 24-hour concentration does not reach the WHO health guideline (150 µg/m^3 on a 24-hour averaging period) at any of the selected receptors.

6.2 GEOZONE FOR ENVIROSERV

The Radiello monitoring surveys by Geozone for EnviroServ covered a range of exposure periods, some of which were outside of the recommended ranges for this sampling technique. Long-term averages calculated from available data for offsite receptors suggested limited impact, except for exceedances of the WHO H_2S annoyance guideline (5 ppb on a 30-minute average) at Denny Mushrooms. A further monitoring campaign at six residential receptors (exposure periods of 11 to 16 days) indicated no health or annoyance impacts, albeit average H_2S exceeded the odour detection threshold at all monitoring points. A similar campaign was conducted at the six residential receptors with averaging periods of one hour to two hours and five minutes during an odour event. Concentrations of H_2S measured at five of the six residences exceeded the WHO annoyance guideline (5 ppb on a 30-minute averaging period). VOC concentrations fell below detection limits.

Average measurements taken over a 10-15 day period (and in some cases over 30 days) are inappropriate for determining odour nuisance, which is experienced as short-term (in the range of minutes) events. The recommended exposure times for Radiello sample media are specified and depend on the pollutant measured[54]:

- H_2S: Appropriate for 1 hour to 15 day range of exposure; and
- VOCs (chemically desorbed): 8 hour to 30 day range of exposure with recommended exposure set at 7 days for an ambient monitoring campaign.

Some monitoring periods exceeded the recommended maximum exposure limits of the sample media, with one particular measurement campaign extending over 40 days (September 2015). It is recommended that the exposure period is on the lower end of the range when humidity exceeds 90%. Moisture can interfere with sample analysis, increasing the probability of error, and ultimately decreasing confidence in the results.

Geozone also used the Radiello samplers for short-term measurements (averaging periods of one hour to two hours and five minutes) to assess shorter-term events. The results below detection limits for VOCs on the short-term residential measurements are likely due to Radiello tubes being inappropriate for such short averaging periods at ambient concentrations.

Insufficient QA/QC was undertaken in the Geozone study, further reducing confidence in the results. It was reported that blanks were periodically submitted for analysis however there is no mention of field blanks or duplicate samples and it is therefore assumed that these QA/QC measures recommended by international guidance were not implemented.

With the various concerns above, WSP ascertain that Geozone's conclusion that it was unlikely that persons would experience or develop adverse health effects as a consequence of inhalation exposure to ambient concentrations of measured pollutants was premature. Further sampling was required to establish long-term averages, and a suitable sampling medium needed to be identified to analyse short-term concentrations of key pollutants. These concerns were shared by Golder Associates, who reviewed the Geozone findings for UHA. We thus exclude these results from further consideration.

6.3 AIRSHED AND INFOTOX FOR ENVIROSERV

WSP's monitoring results from 09 June 2017 and modelled VOC outputs are significantly higher than those produced in the Airshed report. Since the odour event on the morning of 09 June 2017 extended for well over an hour, and was not an exceptional odour event (i.e. we do not expect these measurements to represent worst case odour concentrations) our results bring into question the dispersion modelling outputs in the Airshed assessment:

- The benzene concentrations measured at Plantations (the average of the two WSP samples was 17.53 $\mu g/m^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for four Plantations receptors (0.074 $\mu g/m^3$, 0.066 $\mu g/m^3$, 0.071 $\mu g/m^3$ and 0.056 $\mu g/m^3$);
- The toluene concentrations measured at Plantations (the average of the two WSP samples was 10.68 $\mu g/m^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors (2.022 $\mu g/m^3$, 1.909 $\mu g/m^3$, 2.340 $\mu g/m^3$, 1.611 $\mu g/m^3$);
- The styrene concentrations measure at Plantations (the average of two WSP samples was 0.42 $\mu g/m^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors (0.074 $\mu g/m^3$, 0.078 $\mu g/m^3$, 0.098 $\mu g/m^3$, 0.065 $\mu g/m^3$); and
- The trichloroethene concentration measured on one tube at Plantations (30.64 $\mu g/m^3$ on a 20-minute averaging period) is significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors[55] (0.117 $\mu g/m^3$, 0.105 $\mu g/m^3$, 0.136 $\mu g/m^3$, 0.089 $\mu g/m^3$).

A comparison between Airshed's model outputs and those of WSP's calibrated model reflected similar discrepancies. This is expected since calibration was based on the measurements used above. WSP's calibrated model's Rank 1 hourly

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[54] Radiello manual – www.sigma-aldrich.com/radiello

[55] Concentrations of *Trichloroethene* and *Trichloroethene (TCE)* in Table 4-7 of the Airshed report were summed for each receptor.

average concentrations of various VOCs and H_2S at the selected discrete receptors are compared with the hourly average (98th percentile) concentrations of proximate receptors as calculated in CALPUFF by Airshed as reported in the Airshed Report in Table 6-1 with receptor locations shown in Figure 6-1. Due to their short simulation duration, Airshed did not calculate annual average concentrations for the various receptors so a comparison of longer term averages was not possible. Since WSP's calibrated model is expected to offer lower estimates for concentrations across the study domain than would be experienced in reality, we expect the Airshed results to be higher than those of WSP's calibrated model. The main findings of the comparison are as follows:

- Hourly ethylbenzene, xylene and H_2S concentrations calculated by the WSP model are lower than those of the Airshed model at proximate receptors.
  - This is expected since the WSP model was calibrated against an odour event unlikely to represent the worst-case emission scenario.
- Hourly benzene and trichloroethene concentrations calculated by the WSP model are significantly higher than those of the Airshed model at proximate receptors.
  - The comparison between Rank 1 (WSP) with 98th percentile (Airshed) hourly concentrations would explain some of the discrepancy.
  - However, it appears that the benzene and trichloroethene emission rates inputted by Airshed to their model are a significant underestimate of real impact.

Our concern is that the underestimates of ambient concentrations by the Airshed simulations could be indicative of inaccurate emission inputs to Airshed's CALPUFF model. The source of this issue would be the concentration and flux data provided to Airshed by Infotox. A particular concern with the Infotox emissions dataset is the limited number of samples taken at each point. Emissions are expected to vary over space and time, and a larger database of measurements over time would ensure emission peaks are accounted for in the dispersion model assessment.

Another likely reason for the underestimate of ambient concentrations is that Airshed's modelling simulations cover only a short duration (two months, October – November 2016). In the Airshed report (page 13), the following is stated: "*Unless the health risk assessment clearly identifies acceptable health risk levels, it is recommended to extend the dispersion simulations to include the months from October 2016 up to end June 2017. This would provide the expected inversion conditions during the winter months. Nonetheless, extreme stable atmospheric conditions, such as those experienced during the winter months in the Mpumalanga Highveld may not be as prevalent in the study area, since there may be some coastal air buffering in the overlaying atmosphere.*"

We view this short simulation duration as a significant flaw in this assessment. Surface temperature inversions are a common feature of early winter mornings in the Shongweni/Hillcrest area, and of more relevance to this low-lying emission source than the upper air inversions mentioned in the quotation above. Furthermore, as documented in Diab and Preston-Whyte (1980)[56], low pressure systems approaching the region result in a lowering of the non-surface subsidence inversion and thus narrowing of the mixing layer. The mixing layer is shown to reach its narrowest depth just before the wind reversal associated with a squall front. From autumn into spring, the passing of cold fronts are a regular occurrence along the KwaZulu-Natal coast. The short simulation duration by Airshed likely fails to model peak pollution episodes in winter when pollutant accumulation on cool, calm nights is exacerbated by pre-frontal conditions.

The Regulations Regarding Air Dispersion Modelling, Government Notice 533 of 2014 (Government Gazette 37804) states the following: "*A minimum of 1-year on-site specific data or at least three years of appropriate off-site data must be used for Level 2 assessments. For Level 3 assessments, meteorological data from a minimum of three consecutive years is required. The meteorological data must be from a period no older than five years to the year of assessment. All data must be subjected to quality assurance procedures, and documented in the modelling study report*". The requirements above are to ensure that all seasonal scenarios are simulated in the model run, and to ensure that simulations are not based on a single anomalous year of meteorological data. We recommend that the Airshed simulations be repeated with at least one full year of meteorological data, although a multi-year dataset would be preferable in line with the Modelling Regulations.

The Modelling Regulations further provide a recommended modelling spatial resolution. The Regulations recommend a receptor spacing of 50 m in the general area of maximum impact and / or near the property boundary. A receptor spacing of 100 m is recommended for 5 km from the facility. Airshed applied a 200 m receptor resolution across their modelling domain (Airshed Report no.16EWM01 pg 44). As such peak concentrations may be a significant underestimate in the Airshed model.

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[56] Diab and Preston-Whyte. 1980. Local weather and air pollution potential: The case of Durban in Environmental Conservation, 7(3): 241-244.

Our final concerns with the Airshed assessment relate to the output percentile and averaging periods. The following statement is made in the Airshed report (page 48): "*The requirement for the Infotox health risk assessment was to provide the 98th percentile of the hourly average concentrations and the 75th percentile of the daily average concentration.*"

These percentiles are the only outputs tabulated for the VOCs and other odorous compounds. While this might be appropriate for a health assessment, in an odour assessment, particularly where there is a known odour nuisance, the 100th percentile (Rank 1) concentrations are relevant in the assessment of potential worst-case community exposures to odorous pollutants. Furthermore, hourly average concentrations are not sufficient for understanding odour events, which are likely to occur on shorter averaging periods. Mean hourly concentrations (the finest temporal resolution of most atmospheric dispersion models) can be converted to peak short-term concentrations (e.g. for 10-minutes averages) using well-documented statistical relationships (e.g. Hinds, 1969; Smith, 1973; Belgiorno et al., 2013)[57].

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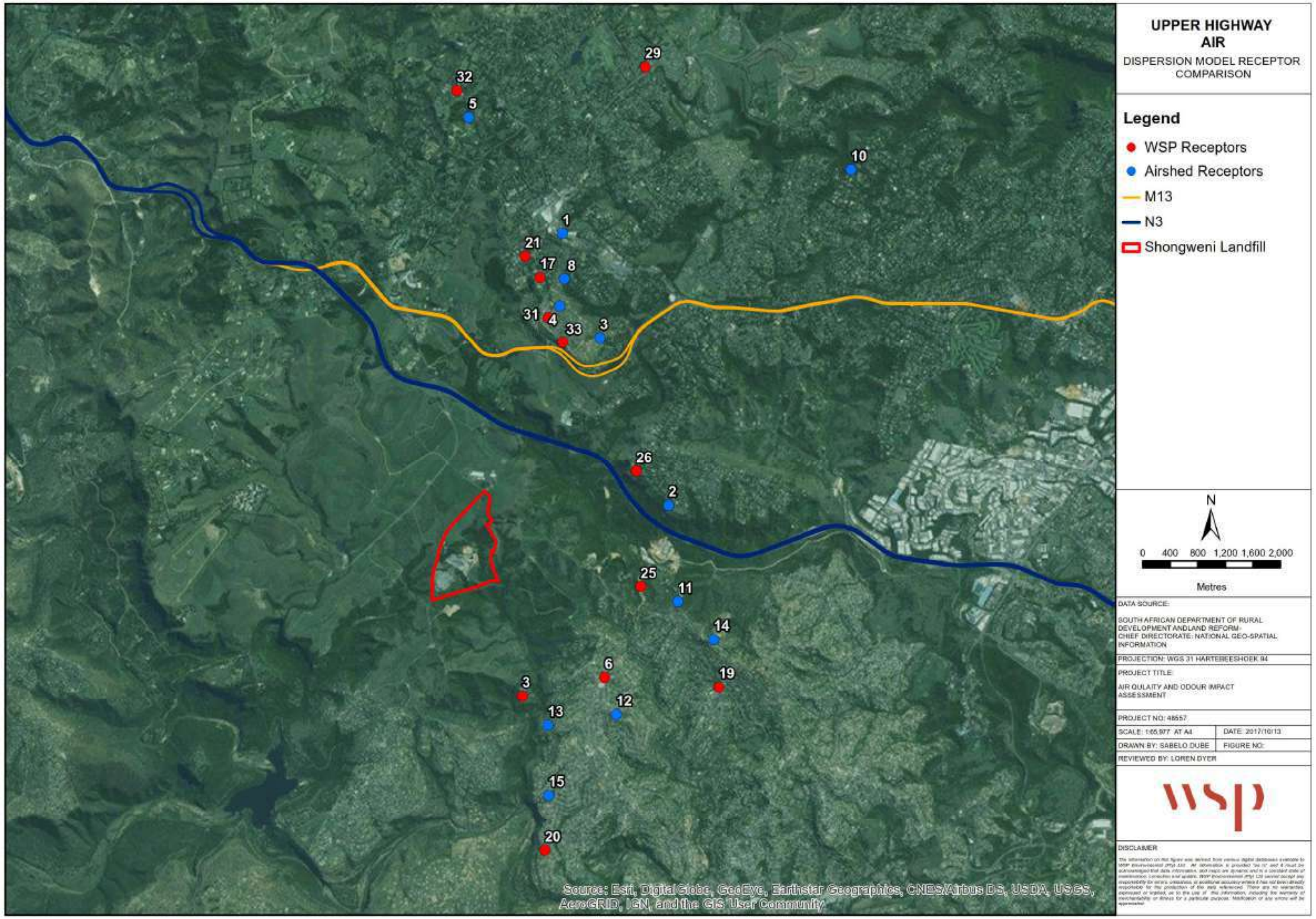
[57] Hinds, W.T. 1969. *Peak-to-mean concentration ratios from ground-level sources in building wakes* in Atmospheric Environment, 3: 145-156. Smith, M.E. 1973. Recommended Guide for the Prediction of the Dispersion of Airborne Effluents, ASME, New York. (Belgiorno. V.; Naddeo, V. and Zarra, T. (eds.). 2013. Odour Impact Assessment Handbook, John Wiley, Chapter 5, page 135.)

Table 6-1: WSP and Airshed model comparison

MODEL	RECEPTOR	HOURLY BENZENE (µg/m^3)	HOURLY ETHYLBENZENE (µg/m^3)	HOURLY M/P-XYLENE (µg/m^3)	HOURLY O-XYLENE (µg/m^3)	HOURLY STYRENE (µg/m^3)	HOURLY TOLUENE (µg/m^3)	HOURLY TRICHLOROETHENE (µg/m^3)	HOURLY HYDROGEN SULPHIDE (µg/m^3)	24-HOUR HYDROGEN SULPHIDE (µg/m^3)
WSP RANK 1	3	3.03	0.46	1.51	0.58	0.28	3.96	1.00	18.35	2.60
AIRSHED P98*	13	0.05	1.70	2.42	0.66	0.04	1.16	0.07	108.1	12.6
WSP RANK 1	6	2.88	0.43	1.43	0.55	0.26	3.75	0.95	17.40	1.70
AIRSHED P98*	12	0.09	2.90	4.11	1.14	0.08	2.05	0.11	192.2	19.0
WSP RANK 1	17	1.07	0.16	0.53	0.20	0.10	1.40	0.36	6.49	0.39
AIRSHED P98*	8	0.06	1.94	2.78	0.85	0.07	1.61	0.09	123.7	16.7
WSP RANK 1	19	1.62	0.24	0.81	0.31	0.15	2.11	0.54	9.80	0.75
AIRSHED P98*	14	0.05	1.80	2.71	0.76	0.07	1.58	0.10	166.8	12.1
WSP RANK 1	20	1.25	0.19	0.62	0.24	0.11	1.63	0.41	7.56	0.64
AIRSHED P98*	15	0.03	1.04	1.47	0.37	0.03	0.73	0.04	61.9	4.8
WSP RANK 1	21	1.07	0.16	0.53	0.20	0.10	1.40	0.35	6.48	0.43
AIRSHED P98*	1	0.04	1.40	2.05	0.65	0.05	1.31	0.07	151.1	13.1
WSP RANK 1	25	3.06	0.46	1.52	0.58	0.28	4.00	1.01	18.51	1.26
AIRSHED P98*	11	0.04	1.37	1.92	0.56	0.04	0.99	0.05	74.8	6.6
WSP RANK 1	26	2.23	0.34	1.11	0.42	0.20	2.91	0.74	13.49	1.29
AIRSHED P98*	2	0.06	2.11	3.14	0.91	0.07	1.74	0.11	157.4	12.1
WSP RANK 1	29	0.10	0.02	0.05	0.02	0.01	0.13	0.03	0.60	0.05
AIRSHED P98*	10	0.02	0.69	1.00	0.29	0.02	0.54	0.03	32.4	4.3
WSP RANK 1	31	1.37	0.21	0.68	0.26	0.13	1.79	0.45	8.31	0.38
AIRSHED P98*	4	0.07	2.29	3.30	1.05	0.08	1.91	0.11	127.6	18.0
WSP RANK 1	32	0.49	0.07	0.25	0.09	0.05	0.65	0.16	2.99	0.14
AIRSHED P98*	5	0.02	0.77	1.12	0.32	0.03	0.66	0.04	75.9	8.8
WSP RANK 1	33	1.48	0.22	0.74	0.28	0.14	1.94	0.49	8.97	0.53
AIRSHED P98*	3	0.07	2.54	3.69	1.10	0.07	2.02	0.12	153.1	20.3

* P98 for all pollutants except H_2S, which was P100.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 6-1: WSP and Airshed receptors used for comparison

7 CONCLUSION

It is WSP's conclusion that existing ambient monitoring data indicates a nuisance impact as a result of the emissions from the Shongweni Landfill. Further, the potential for health impacts on proximate communities is considered a legitimate community concern.

The uncertainty associated with any dispersion model depends on a combination of the uncertainties inherent in the adopted model and the uncertainties in the model input data. There are immediate concerns with the Infotox emission inputs as well as the meteorological data period inputted to the Airshed assessment. Reliance on these model outputs for any community health or odour assessment therefore is problematic. Emissions data (concentrations and flow) at various emission points on the EnviroServ site needs to be collected over time (e.g. quarterly to account for seasonal variations) using validated sampling methods to ensure that the inputs to a dispersion model are representative of the emission reality. Furthermore, modelling shortcomings (e.g. the input of a meteorological dataset that does not cover all seasons) needs to be addressed. Until then, any definitive statements on the health risk arising from community exposure to emissions from the EnviroServ Shongweni Landfill are premature.

7.1 RECOMMENDATIONS FOR FURTHER STUDY

- Further ambient gas monitoring with a high volume sampler for VOCs, aldehydes and mercaptans during odour events;
- Additional sampling campaigns for H_2S and VOCs will assist in identifying the P100 hourly and 24-hour concentrations of these pollutants;
  - This will allow for more refined atmospheric dispersion model calibration and a more representative assessment of long-term concentrations of these pollutants in the absence of continuous monitoring across the study domain.
- Dynamic olfactometry to assess odour nuisance;
  - There is the potential to calibrate e-nose results with dynamic olfactometry results and then use the e-nose for further testing.
- Both DFO samplers located to the west of the landfill (DFO6 and DFO7) were unrecoverable in this campaign. A repeat assessment with samplers to the west of the landfill site would assist with interpreting the influence of the site of heavy metal dust concentrations; and
- A background DFO site at significant distance from the Shongweni Landfill site (e.g. Waterfall) also would be useful to gauge whether the landfill is the source of the heavy metals detected in the dust fallout.

APPENDIX

A

E-NOSE INVESTIGATION NOTE PLC1-ES3

Investigation Note PLC1-ES3 (A)

Bashan Naidoo
(4 April 2017)

Source data:

Measurement set under analysis:

PLC1: Plantations concatenation 1 (13 Nov 2016 to 18 Nov 2016)

Reference signature:

ES3: EnviroServe signature (6 Dec 2016)

Aim:

General objective of the larger study:

To investigate the nature and extent of ES3 expression in the PLC1 measurement set.

Specific objective of this investigation note:

To determine the generalised ES3 expression within PLC1 over the full six day scope of PLC1.

Generalised methodology:

1. Identify the location of the reported offence (site at which the offence was perceived). In this broad study, several sites were noted. This investigation note pertains to one site within that broader study.
   Site of reported offence: Plantations Estate
2. Identify and locate the odour source (as alleged by the complainant).
   Alleged odour source: EnviroServe landfill site.
3. Capture signatures at the alleged odour source. If possible gain access to the site and capture at each odour source on site. Otherwise capture at the boundary outside the premises of the offender, downwind of the source and as close to the source as possible. A field technician must be in attendance at the instrument throughout data capture, and must log all conditions that may impact signature quality. Signatures are extracted from the data stream if and when prevailing conditions are acceptable.
   Signature file and location: ES3 was captured at the Landfill boundary.
4. Capture measurement sets at the site of reported offence. The measurement set should preferably span significant cyclic tendencies in the data (such as day/night cycles).
   Measurement file and location: PLC1 (Figure 1) captured at Plantations Estate (over 6 days)
5. Investigate the extent of signature (ES3) expression in the measurement set (PLC1).
   a. Perform a direct linear correlation to establish absolute levels of signature expression in the measurement set.
      Direct signature correlation: Figure 2
   b. Perform non-linear feature enhancement on the linear correlation trace. This effectively suppresses the baseline signal below the direct correlation values. Peaks are suppressed to a lesser degree and appear enhanced relative to the suppressed baseline. The effect of this technique is firstly to emulate the habituated odour perception of mammals (including humans) by drawing attention to away from

constant (baseline) odour signals and directing attention towards transient or changing signal peaks, and secondly to better estimate the olfactory perceptual dynamics as stimuli vary over time.

Habituated signature correlation: Figure 3

c. Signature loading is defined as the proportion of total odour at Plantations Estate that represents the signature under test (ES3). This estimates the total chemical load in the air (at Plantations Estate) that owes its origin to the identified odour source (at EnviroServe).

Total Signature Loading: Figure 4

Results:

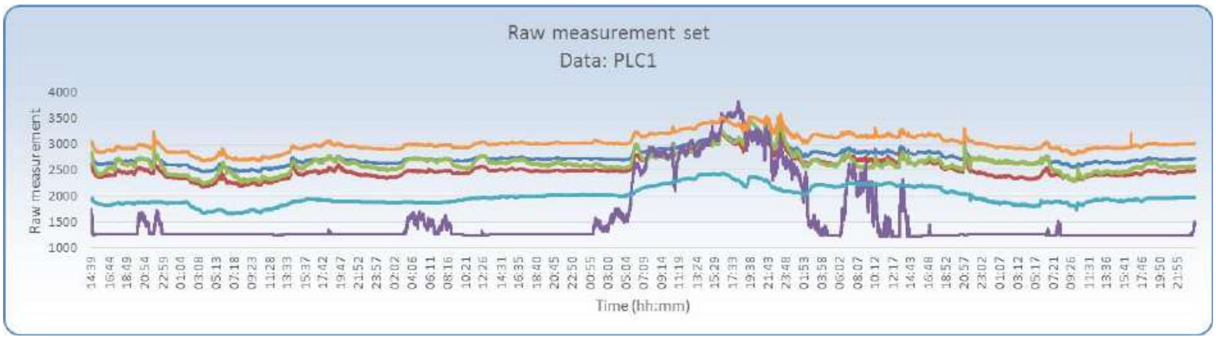


Figure 1: Raw Measurements taken at Plantations Estate (PLC1)

Understanding Figure 1:

The six traces indicate the raw sensory measurements across all six sensor channels during the monitoring period (PLC1) at the Plantations Estate. These signals may be ignored as they are further processed and interpreted in subsequent stages.

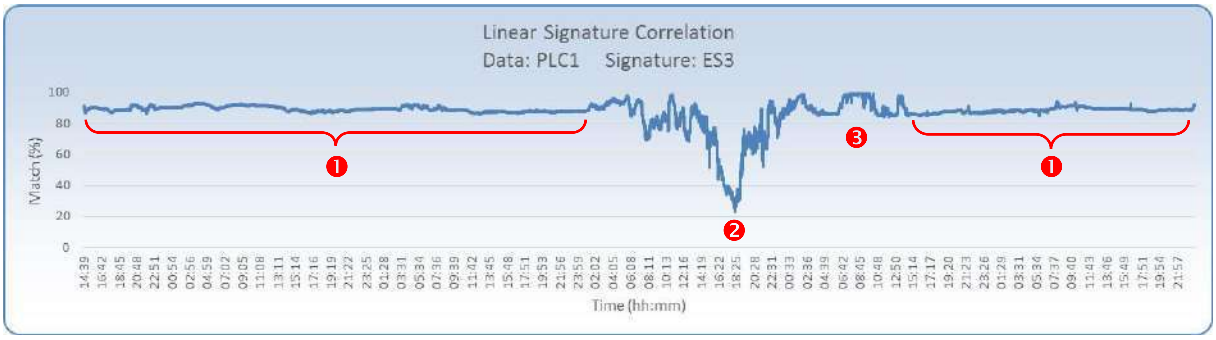


Figure 2: Linear correlation of EnviroServe Signature (ES3) with Plantations Estate measurements (PLC1), providing a similarity measure between the two data sets.

Understanding Figure 2:

The six channel measurement set (PLC1) from Figure 1 is correlated against the six channel odour signature (ES3) that was captured at the EnviroServe boundary. The result of the multidimensional linear correlation is indicated in figure two. This indicates the absolute linear similarity between the EnviroServe signature and the Plantations measurement set.

It should be noted that the mammalian (human) perception of the odour similarity is not absolute and will differ from the above linear correlation. Further processing of the above similarity measure allows us to better estimate the human perceptual experience of signature dynamics at the measurement site.

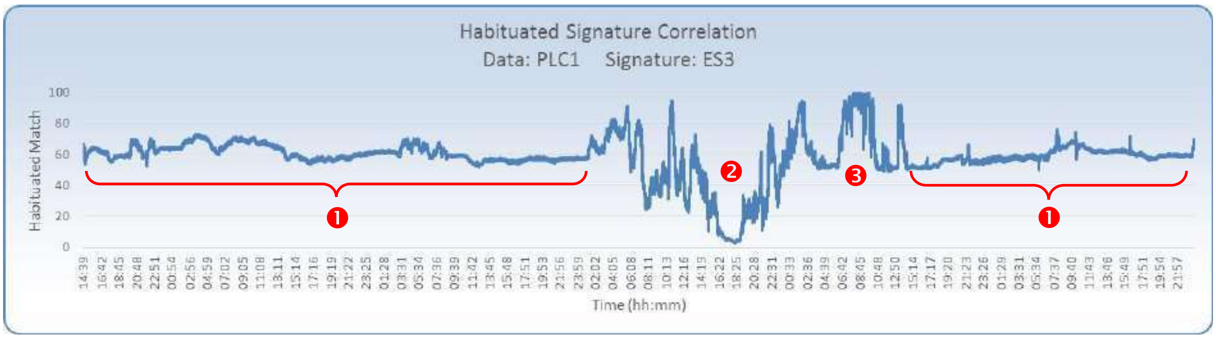


Figure 3: Habituated signature correlation at Plantations Estate. This estimates the human perceptual experience of ES3 dynamics at the Plantations Estate over the monitoring period.

Understanding Figure 3:

Human perception of stimulus (signature) dynamics is subject to habituation. Figure 3 is a processed version of the direct correlation graph (Figure 2) that suppresses baselines and enhances peaks. In this analysis, the baseline is suppressed below the direct correlation value; peaks are suppressed to a lesser extent and are therefore enhanced relative to the suppressed baseline. The purpose of this analysis is to draw attention to changes in the signature. It is a novelty filter that mimics aspects of the human odour perception and attentional system. The method was validated in the AVI study.

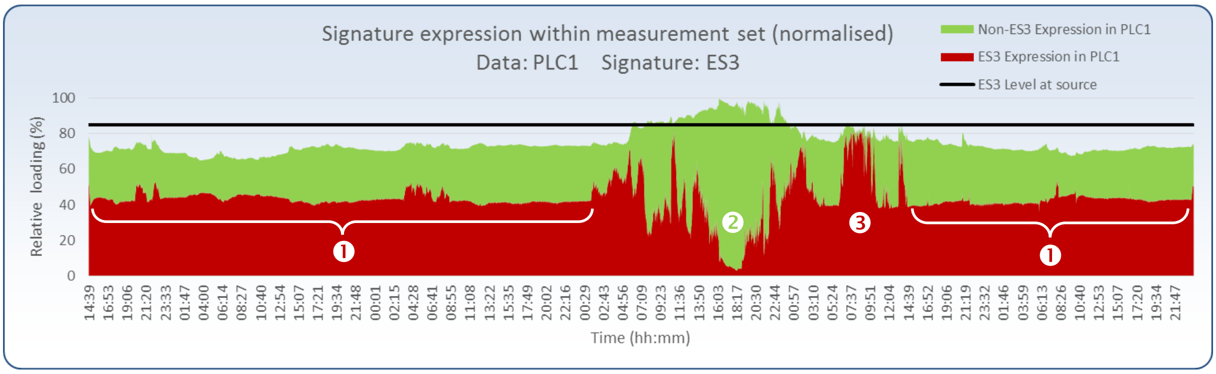


Figure 4: Levels of ES3 and non-ES3 expression at Plantations Estate.

Understanding Figure 4:

The upper envelope of the stacked green curve indicates the total odour loading at the Plantations Estate during the study period. This has been normalised so that the maximum load is 100%.

The dark lower band indicates the ES3 component of expression within the total odour load at the Plantations Estate.

The upper (green) band indicates the non-ES3 component of expression within the total odour load at the Plantations Estate.

Both bands combined (stacked) indicate the total odour loading (signature + non-signature).

A solid black line describes the level of the ES3 signature as measured at the EnviroServe boundary, also appropriately normalised for viewing over the normalised PLC1 odour load characteristic. This enables us to compare ES3 expression at Plantations Estate against the absolute level encountered at the landfill boundary. That is, it allows us to infer how strong the signature encountered at Plantations is, relative to the original signature at the EnviroServe boundary.

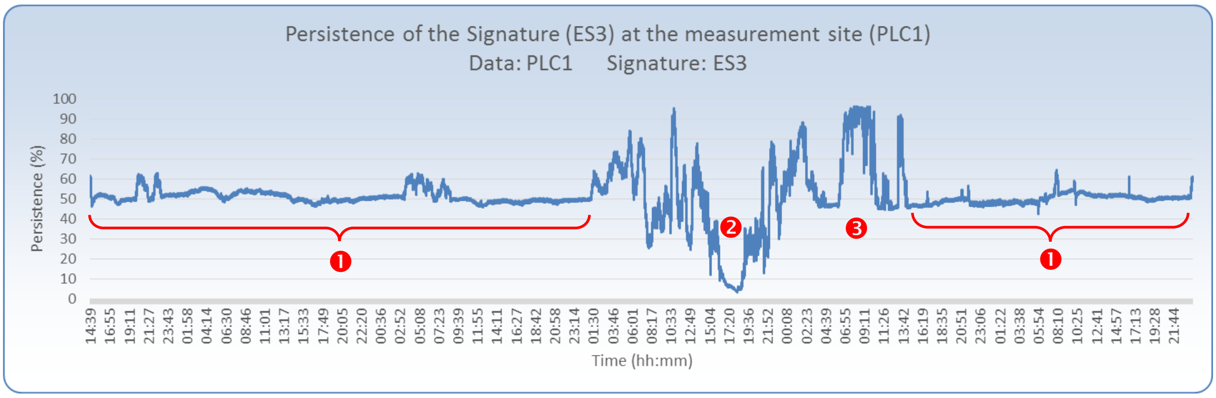


Figure 5: Signature (ES3) persistence (in PLC1) at the measurement site, over the study period.

Understanding Figure 5:

Figure 5 reformulates aspects of Figure 4. Data in the lower band of Figure 4, (ES3 expression), is now described as a percentage of the original signature level at the EnviroServe source (black line in Figure 4). This figure tells us the extent to which intensity observed at the source during signature capture on 6 Dec 2016, persists at the remote measurement location over the measurement period.

Analyses:

The result set exposes a large collection of findings. For clarity, the level of reporting detail is deliberately reduced. This investigation note therefore discusses a significant subset of the findings encoded in the result set. These findings pertain to the period of monitoring at the Plantations Estate, and to the ES3 signature collected at the EnviroServe boundary. The findings may be generalised beyond the monitoring period within reason.

The following are outcomes are addressed:

- Finding 1: The baseline experience of ES3 at Plantations Estate
- Finding 2: A significant non-ES3 event at Plantations Estate
- Finding 3: A significant ES3 event at Plantations Estate

Finding 1: The baseline experience of ES3 at Plantations Estate

The results show a stable baseline over the study period with major and minor events superimposed over it. The marker ❶ is used to indicate baseline zones in all Figures.

Baseline identity: (nature of smell)

From Figure 2 we observe that the Plantations Estate baseline correlates strongly with ES3. Linear correlation levels are approximately 90%. This indicates a strong similarity.

Perceived baseline dynamics: (estimated human perception of change)

Despite a relatively flat linear baseline correlation, human observers will be sensitive to minor changes due to natural habituation processes in olfactory perception. Figure 3 estimates the human experience over the baseline period. The human will experience a more eventful baseline dynamic.

Baseline intensity: (strength relative to ES3 at source)

Figure 4 indicates that ES3 constitutes more than half the baseline activation at Plantations. ES3 is therefore the dominant contributor to smell over the baseline periods. The ES3 signature was captured at the EnviroServe boundary. It was deliberately captured close to source and at high intensity. This ensures purity of the signature. Figure 5 indicates the level of ES3 encountered at Plantations Estate expressed as a percentage of the original high source intensity. During the baseline period, ES3 is expressed at 50% to 65% of ES3 source intensity. This indicates that the base ES3 odour at Plantations Estate is very intense, especially given the distance from source.

Summary and conclusion:

There is a high similarity between the ES3 and the baseline smell at Plantations Estate. The human observer will perceive baseline variation due to habituation. Even so, the absolute level of ES3 is consistent over the monitoring period and can therefore reasonable be presumed to extend significantly outside that period.

Finding 2: A significant non-ES3 event at Plantations Estate

Results show that external (non-ES3) events of significant magnitude do occur. The marker ❷ is used to indicate a non-ES3 event in Figures 2 to 5. Note that it is still possible that the non-ES3 event originated at EnviroServe, however, the data cannot prove this and it is presumed external.

Event identity: (nature of smell)

Figure 2 indicates a strong decorrelation at marker❷. This indicates that the event source was different from ES3. The ES3 stimulus is displaced at the monitoring site and is replaced by an unknown stimulus for the duration of the event. The data cannot furnish any description of the source identity.

Perceived dynamics: (estimated human perception of change)

Figures 3 and 5 estimate only ES3 perception dynamics. We can infer from these graphs that the perception of ES3 dropped off during the event. An alternate stimulus (or combination of stimuli) would have been perceived at this time. Without a signature, dynamics of the external signature cannot be further estimated.

Event intensity: (strength relative to source)

Figure 4 indicates that the total odour loading peaked during this event. The intensity is presumed strong. However, without a signature, we cannot furnish a clear estimate of intensity.

Summary and conclusion:

A significant external event displaced ES3 at the monitored site for the event duration. Perception of ES3 dropped-off to insignificant levels. In the absence of a signature for the external source, it is unwise to infer much more meaning from the results.

Finding 3: A significant ES3 event at Plantations Estate

Results show that ES3 events of significant magnitude occur in addition to the ES3 dominated baseline. The marker ❸ is used to indicate a significant ES3 event in Figures 2 to 5.

Event identity: (nature of smell)

Figure 2 indicates the linear correlation (similarity) between ES3 and the PLC1. During the period of the event, a correlation level of up to 100% is achieved. This indicates that the stimulus encountered at Plantations Estate was near identical to the ES3 signature observed at the EnviroServe boundary in both character and intensity.

Perceived dynamics: (estimated human perception of change)

The generalised human observer is expected to experience a very high intensity ES3 characteristic at Plantations Estate, and that intensity and identity is sustained at a high level throughout the event. This is very clear from Figure 3 with estimates a saturating peak even under simulated habituation.

Event intensity: (strength relative to source)

Figure 4 shows dramatic ES3 domination of the event. Figure 5 shows that the Plantations Estate intensity of ES3 approximates the ES3 intensity as observed directly at the EnviroServe boundary during signature capture. This is a surprisingly intense expression of ES3 at the Plantations Estate when one considers the distance from the ES3 source.

Summary and conclusion:

The ES3 event is extreme and sustained. During the event, levels of odour at the Plantations Estate are comparable to levels experienced at the EnviroServe boundary during signature capture; and that signature was captured at a peaking boundary level. The data shows that; during this event, Plantations Estate would experience what it would be like to be located directly next to EnviroServe (at the time of signature capture).

APPENDIX

B

MONITORING FIELDSHEETS

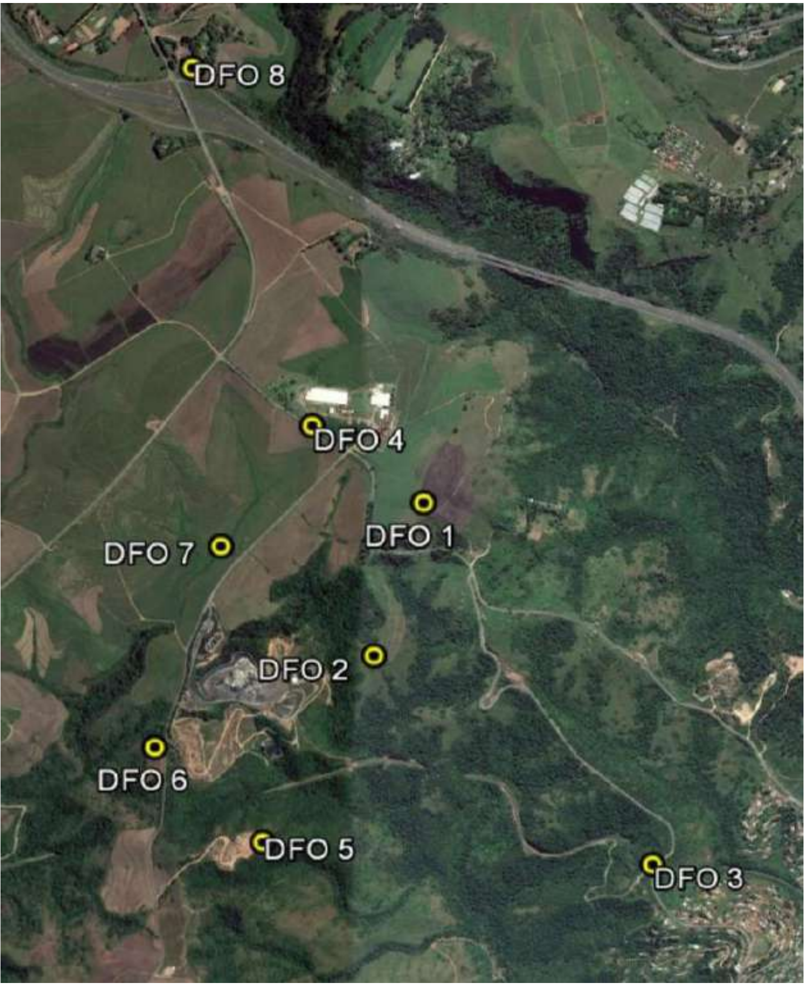
Project	48557: UHA AQIA
Monitoring	Gases

Run	Sample Location	Latitude	Longitude	Samples taken	Sample Vol (l)	Tube Codes	Date	Start Time	Notes
1	Cnr Mr559 Route and Mr 461 Rd	-29.817679°	30.753172°	1 x tedlar bag	2.00 (as analysed)		06/04/2017	07:15	moderate SW, cool, strong H2S smell
2	Entrance to Valley 1	-29.827342°	30.745971°	1 x tedlar bag	7.008 (as analysed)	G0129814	08/05/2017	13:00	NE, sunny, 20% cloud cover, rotten egg smell with petroleum-type hydrocarbons
				3 x markes tubes (@ 200ml/min for 15 min)	3.00	G0129826 - Field blank G0129825 G0129891			
3	Waterberry Close	-29.803549°	30.756330°	1 x markes tube (@ 200ml/min for 15 min)	3.00	F093184	15/05/2017	12:16	Gusty, intermittent rainfall, cold, overcast, samples collected during dry periods, rotten egg and hydrocarbon smell coming and going
	M13 below Plantations Estate	-29.799278°	30.765387°	1 x markes tube (@ 200ml/min for 10 min)	2.00	G0129861		12:58	
	Plantations Estate - Vecchio	-29.797530°	30.767984°	1 x markes tube (@ 200ml/min for 15 min)	3.00	G0129873		14:00	

	Date	09/06/2017								
Sample ID	Tube #	Pollutant parameter	Sample Location	Lat	Long	Start (hh:mm)	Flow rate (ml/min)	Sample Vol (l)	Wind Direction	Notes
4c	G0129891	VOCs	Community	-29.794872°	30.762902°	05:48	200	4.000	WSW / Gusty	
	G0129848	VOCs				05:50	180	3.600		
	G0129814	VOCs				06:14	200	4.000		
	G0129825	VOCs				06:15	180	3.600		
4b	G0129826	VOCs	Downwind	-29.821160°	30.754355°	05:09	180	3.599	WSW / Gusty	
	G0129832	VOCs					180	3.597		
	G0129819	VOCs				05:40	180	2.762		
	G0129897	VOCs					180	2.769		
4a	4772	VOCs	Upwind	-29.832691°	30.749378°	05:10	180	3.600	WSW / Gusty	
	4776	VOCs					180	3.600		
	4771	VOCs				05:35	180	4.140		
	4775	VOCs					180	8.640		
	4777	VOCs				-	-	-		Blank

Project	48557: UHA AQIA						
Monitoring	DFO Network						
ID	Site Description	Lat	Long	Installation		Collection	
DFO 1	TH Watch Tower	-29.8194	30.7566	08/05/2017	10:26	31/05/2017	09:15
DFO 2	Eskom hill	-29.8255	30.7545		10:58		09:28
DFO 3	Gate to Transnet control room	-29.8338	30.7666		11:23		-
DFO 4	Denny Mushrooms	-29.8164	30.7518		11:39		10:15
DFO 5	Quarry	-29.8328	30.7497		13:09		09:50
DFO 6	Sugarcane opposite Valley 1	-29.8290	30.7450		13:16		-
DFO 7	Sugarcane north of ES gate	-29.8211	30.7479		13:25		10:04
DFO 8	TH Site Office	-29.8026	30.7468		13:35		08:45

Notes	
DFO 1	High algae.
DFO 2	Bush fire.
DFO 3	Bucket and stand missing.
DFO 4	
DFO 5	
DFO 6	Bucket and stand missing.
DFO 7	Deployed dry. Found with a dead bird in bucket. Sample discarded.
DFO 8	Deployed dry without an extension.



Date	30/08/2017									
Sample ID / Tube #	Pollutant parameter	Sample Location	Lat	Long	Start (hh:mm)	Stop (hh:mm)	Duration (min)	Flow rate (ml/min)	Sample Vol (l)	Wind Direction
6853301136	H2S	Downwind	-29.821160°	30.754355°	05:02	05:12	10	1000	10.00	SW
6853301137	H2S				05:21	05:31	10	1000	10.00	
6853301134	H2S	Upwind	-29.832615°	30.747919°	04:42	04:52	10	1000	10.00	SW

APPENDIX

C

LABORATORY REPORTS

AMENDED REPORT

CLIENT DETAILS

Contact	Lisa Ramsay
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Facsimile	
Email	Lisa.Ramsay@WSPGroup.co.za
Project	WSP SHONGWENI
Order Number	WSP SHONGWENI
Samples	1
Sample matrix	

LABORATORY DETAILS

Laboratory	RBT
Address	259 Kent Avenue Ferndale, 2194
Telephone	+27 (0)11 590 3000
Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17- 0300 R1
Report Number	0000001295
Date Received	07/04/2017 14:44
Date Started	21/04/2017 12:53
Date Reported	05/07/2017 09:53

Whilst X- Lab Earth Science (Pty) Ltd conforms to ISO/IEC 17025 standards, results of analysis in this report fall outside of the current scope of accreditation.

This report cancels and supersedes the Report No, 0000000397, issued by X- Lab Earth Science on 24/04/2017. The reason for re- issue is that the incorrect units were expressed in the report.

SIGNATORIES

Greg Ondrejkovic

Technical Supervisor/Technical Signatory

Martin Olivier

Operations Manager/Technical Signatory

TEST REPORT

Parameter	Units	LOR	Sample Number: JBX17- 0300.001 Sample Name: TENAX TUBE

Volatile Organic Compounds (VOC) in Air

Parameter	Units	LOR	JBX17- 0300.001 TENAX TUBE
Dichlorodifluoromethane *	ng/tube	0.8	<0.80
Chloromethane *	ng/tube	0.85	<0.85
Vinyl chloride (Chloroethene) *	ng/tube	0.8	<0.80
Bromomethane *	ng/tube	0.6	<0.60
Chloroethane (Ethyl Chloride) *	ng/tube	0.9	<0.90
Trichlorofluoromethane *	ng/tube	0.6	<0.60
Dichloromethane (Methylene	ng/tube	2	<2.00
trans- 1,2- dichloroethene *	ng/tube	0.95	<0.95
1,1- dichloroethene *	ng/tube	0.85	<0.85
MTBE *	ng/tube	0.95	<0.95
1,1- dichloroethane *	ng/tube	0.9	<0.90
cis- 1,2- dichloroethene *	ng/tube	0.65	<0.65
2,2- dichloropropane *	ng/tube	0.95	<0.95
Bromochloromethane *	ng/tube	0.75	<0.75
Trichloromethane (Chloroform) *	ng/tube	2	<2.00
1,1,1- trichloroethane *	ng/tube	0.95	<0.95
1,2- dichloroethane *	ng/tube	0.65	<0.65
1,1- dichloropropene *	ng/tube	0.75	<0.75
Benzene *	ng/tube	1	61.36
Tert Amyl Methyl Ether (tAME) *	ng/tube	0.55	<0.55
1,2- dichloropropane *	ng/tube	0.85	<0.85
Trichloroethene *	ng/tube	0.5	<0.50
Dibromomethane *	ng/tube	0.8	<0.80
cis- 1,3- dichloropropene *	ng/tube	0.8	<0.80
Toluene *	ng/tube	1	113.06
trans- 1,3- dichloropropene *	ng/tube	0.9	<0.90
1,1,2- trichloroethane *	ng/tube	0.9	<0.90
1,3- dichloropropane *	ng/tube	0.65	<0.65
Tetrachloroethene *	ng/tube	0.8	1933.59
Bromodichloromethane *	ng/tube	1	<1.00
Dibromochloromethane *	ng/tube	0.75	<0.75
1,2- dibromoethane *	ng/tube	0.95	<0.95
Chlorobenzene *	ng/tube	0.8	<0.80
1,1,1,2- tetrachloroethene *	ng/tube	0.75	<0.75
Carbon tetrachloride *	ng/tube	1	<1.00
Ethylbenzene *	ng/tube	0.75	20.08
m/p- xylene *	ng/tube	0.8	35.57
o- xylene *	ng/tube	0.75	17.37
Styrene *	ng/tube	0.85	153.35
Bromoform *	ng/tube	2	<2.00
Isopropylbenzene (Cumene) *	ng/tube	0.75	<0.75

TEST REPORT

Parameter	Units	LOR	Sample Number JBX17-0300.001 Sample Name TENAX TUBE

Volatile Organic Compounds (VOC) in Air

1,2,3-trichloropropane *	ng/tube	0.9	<0.90
n-propylbenzene *	ng/tube	2	<2.00
Bromobenzene *	ng/tube	0.8	<0.80
2-chlorotoluene *	ng/tube	0.85	<0.85
1,3,5-trimethylbenzene *	ng/tube	0.55	11.42
4-chlorotoluene *	ng/tube	0.7	<0.70
1,3-dichlorobenzene *	ng/tube	1	<1.00
tert-butylbenzene *	ng/tube	0.85	<0.85
1,2,4-trichlorobenzene *	ng/tube	0.8	<0.80
sec-butylbenzene *	ng/tube	0.8	<0.80
p-Isopropyltoluene (p-Cymene) *	ng/tube	0.8	<0.80
1,4-dichlorobenzene *	ng/tube	0.75	<0.75
n-butylbenzene *	ng/tube	2	<2.00
1,2-dichlorobenzene *	ng/tube	0.85	<0.85
1,2-dibromo-3-chloropropane *	ng/tube	0.85	<0.85
1,2,4-trimethylbenzene *	ng/tube	0.75	<0.75
Hexachlorobutadiene *	ng/tube	0.5	<0.50
Naphthalene *	ng/tube	0.5	<0.50
1,2,3-trichlorobenzene *	ng/tube	0.8	<0.80

METHOD SUMMARY

METHOD	METHOD SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*”.

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

AMENDED REPORT

CLIENT DETAILS

Contact	Lisa Ramsay
Client	WSP
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Telephone	+27 31 240-8843
Facsimile	
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Project	To Follow
Order Number	To Follow
Samples	4
Sample matrix	AIR

LABORATORY DETAILS

Laboratory	X-Lab Earth Science
Address	259 Kent Avenue Ferndale, 2194
Telephone	+27 (0)11 590 3000
Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17-0379 R1
Report Number	0000001221
Date Received	11/05/2017 08:14
Date Started	15/05/2017 10:55
Date Reported	30/06/2017 08:35

Whilst X-Lab Earth Science (Pty) Ltd conforms to ISO/IEC 17025 standards, results of analysis in this report fall outside of the current scope of accreditation.

This report cancels and supersedes the Report No, 0000000679, issued by X-Lab Earth Science on 15/05/2017. The reason for re-issue is that the incorrect reporting units were used in the report.

SIGNATORIES

Greg Ondrejkovic

Technical Supervisor/Technical Signatory

Martin Olivier

General Manager/Technical Signatory

AMENDED REPORT

Parameter	Units	LOR	Sample Number Sample Name	JBX17-0379.001 G0129814	JBX17-0379.002 G0129826	JBX17-0379.003 G0129825	JBX17-0379.004 G0129891

Volatile Organic Compounds (VOC) in Air

Dichlorodifluoromethane *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
Chloromethane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
Vinyl chloride (Chloroethene) *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
Bromomethane *	ng/tube	0.6	<0.60	<0.60	<0.60	<0.60
Chloroethane (Ethyl Chloride) *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
Trichlorofluoromethane *	ng/tube	0.6	<0.60	<0.60	<0.60	<0.60
Dichloromethane (Methylene	ng/tube	2	<2.00	<2.00	<2.00	<2.00
trans-1,2-dichloroethene *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95
1,1-dichloroethene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
MTBE *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95
1,1-dichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
cis-1,2-dichloroethene *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65
2,2-dichloropropane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95
Bromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
Trichloromethane (Chloroform) *	ng/tube	2	<2.00	<2.00	<2.00	<2.00
1,1,1-trichloroethane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95
1,2-dichloroethane *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65
1,1-dichloropropene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
Benzene *	ng/tube	1	31.27	10.62	7.65	22.21
Tert Amyl Methyl Ether (tAME) *	ng/tube	0.55	<0.55	<0.55	<0.55	<0.55
1,2-dichloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
Trichloroethene *	ng/tube	0.5	<0.50	19.06	6.01	8.15
Dibromomethane *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
cis-1,3-dichloropropene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
Toluene *	ng/tube	1	73.35	6.87	12.48	12.57
trans-1,3-dichloropropene *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
1,1,2-trichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
1,3-dichloropropane *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65
Tetrachloroethene *	ng/tube	0.8	9.48	<0.80	1.54	1.32
Bromodichloromethane *	ng/tube	1	<1.00	<1.00	<1.00	<1.00
Dibromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
1,2-dibromoethane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95
Chlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
1,1,1,2-tetrachloroethene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
Carbon tetrachloride *	ng/tube	1	<1.00	<1.00	<1.00	<1.00
Ethylbenzene *	ng/tube	0.75	28.04	<0.75	3.43	4.04
m/p-xylene *	ng/tube	0.8	97.22	0.99	13.37	14.80
o-xylene *	ng/tube	0.75	48.02	<0.75	5.49	6.93
Styrene *	ng/tube	0.85	16.21	1.77	4.54	4.38
Bromoform *	ng/tube	2	<2.00	<2.00	<2.00	<2.00
Isopropylbenzene (Cumene) *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75

AMENDED REPORT

Parameter	Units	LOR	Sample Number Sample Name	JBX17-0379.001 G0129814	JBX17-0379.002 G0129826	JBX17-0379.003 G0129825	JBX17-0379.004 G0129891

Volatile Organic Compounds (VOC) in Air

1,1,2,2-tetrachloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
1,2,3-trichloropropane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90
n-propylbenzene *	ng/tube	2	<2.00	<2.00	<2.00	<2.00
Bromobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
2-chlorotoluene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
1,3,5-trimethylbenzene *	ng/tube	0.55	<0.55	<0.55	<0.55	<0.55
4-chlorotoluene *	ng/tube	0.7	<0.70	<0.70	<0.70	<0.70
1,3-dichlorobenzene *	ng/tube	1	<1.00	<1.00	<1.00	<1.00
tert-butylbenzene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
1,2,4-trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
sec-butylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
p-Isopropyltoluene (p-Cymene) *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
1,4-dichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
n-butylbenzene *	ng/tube	2	<2.00	<2.00	<2.00	<2.00
1,2-dichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80
1,2-dibromo-3-chloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85
1,2,4-trimethylbenzene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75
Hexachlorobutadiene *	ng/tube	0.5	<0.50	<0.50	<0.50	<0.50
Naphthalene *	ng/tube	0.5	<0.50	<0.50	<0.50	<0.50
1,2,3-trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80

METHOD SUMMARY

METHOD	METHOD SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*".

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

X-LAB EARTH

AMENDED REPORT

CLIENT DETAILS

Contact	Lisa Ramsay
Client	WSP
Address	Block A Langford Road Westville Durban
Telephone	+27 31 240- 8843
Facsimile	
Email	Lisa.Ramsay@WSPGroup.co.za
Project	To Follow
Order Number	To Follow
Samples	3
Sample matrix	AIR

LABORATORY DETAILS

Laboratory	RBT
Address	259 Kent Avenue Ferndale, 2194
Telephone	+27 (0)11 590 3000
Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17- 0413 R1
Report Number	0000000932
Date Received	16/05/2017 08:16
Date Started	31/05/2017 15:58
Date Reported	05/06/2017 12:00

Whilst X- Lab Earth Science (Pty) Ltd conforms to ISO/IEC 17025 standards, results of analysis in this report fall outside of the current scope of accreditation.

This report cancels and supersedes the Report No, 0000000902, issued by X- Lab Earth Science on 01/06/2017. The reason for the re- issue is that the incorrect reporting units were used on the report.

SIGNATORIES

Greg Ondrejkovic

Technical Supervisor/Technical Signatory

Martin Olivier

Operations Manager/Technical Signatory

TEST REPORT

	Sample Number Sample Name		JBX17-0413.001 F093184 G	JBX17-0413.002 GO129873	JBX17-0413.003 G0129861
Parameter	Units	LOR			

Volatile Organic Compounds (VOC) in Air

Dichlorodifluoromethane *	ng/tube	0.8	<0.80	<0.80	<0.80
Chloromethane *	ng/tube	0.85	<0.85	<0.85	<0.85
Vinyl chloride (Chloroethene) *	ng/tube	0.8	<0.80	<0.80	<0.80
Bromomethane *	ng/tube	0.6	<0.60	<0.60	<0.60
Chloroethane (Ethyl Chloride) *	ng/tube	0.9	<0.90	<0.90	<0.90
Trichlorofluoromethane *	ng/tube	0.6	<0.60	<0.60	<0.60
Dichloromethane (Methylene	ng/tube	2	<2.00	<2.00	<2.00
trans-1,2-dichloroethene *	ng/tube	0.95	<0.95	<0.95	<0.95
1,1-dichloroethene *	ng/tube	0.85	<0.85	<0.85	<0.85
MTBE *	ng/tube	0.95	<0.95	<0.95	<0.95
1,1-dichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
cis-1,2-dichloroethene *	ng/tube	0.65	<0.65	<0.65	<0.65
2,2-dichloropropane *	ng/tube	0.95	<0.95	<0.95	<0.95
Bromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75
Trichloromethane (Chloroform) *	ng/tube	2	<2.00	<2.00	<2.00
1,1,1-trichloroethane *	ng/tube	0.95	<0.95	<0.95	<0.95
1,2-dichloroethane *	ng/tube	0.65	<0.65	<0.65	<0.65
1,1-dichloropropene *	ng/tube	0.75	<0.75	<0.75	<0.75
Benzene *	ng/tube	1	44.81	28.37	46.92
Tert Amyl Methyl Ether (tAME) *	ng/tube	0.55	<0.55	<0.55	<0.55
1,2-dichloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85
Trichloroethene *	ng/tube	0.5	44.80	31.43	36.21
Dibromomethane *	ng/tube	0.8	<0.80	<0.80	<0.80
cis-1,3-dichloropropene *	ng/tube	0.8	<0.80	<0.80	<0.80
Toluene *	ng/tube	1	96.88	95.07	102.46
trans-1,3-dichloropropene *	ng/tube	0.9	<0.90	<0.90	<0.90
1,1,2-trichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
1,3-dichloropropane *	ng/tube	0.65	<0.65	<0.65	<0.65
Tetrachloroethene *	ng/tube	0.8	<0.80	<0.80	<0.80
Bromodichloromethane *	ng/tube	1	<1.00	<1.00	<1.00
Dibromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75
1,2-dibromoethane *	ng/tube	0.95	<0.95	<0.95	<0.95
Chlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
1,1,1,2-tetrachloroethene *	ng/tube	0.75	<0.75	<0.75	<0.75
Carbon tetrachloride *	ng/tube	1	<1.00	<1.00	<1.00
Ethylbenzene *	ng/tube	0.75	20.88	11.89	12.67
m/p-xylene *	ng/tube	0.8	41.02	26.96	20.44
o-xylene *	ng/tube	0.75	16.15	12.35	8.76
Styrene *	ng/tube	0.85	28.88	10.52	32.32
Bromoform *	ng/tube	2	<2.00	<2.00	<2.00
Isopropylbenzene (Cumene) *	ng/tube	0.75	<0.75	<0.75	<0.75

TEST REPORT

Parameter	Units	LOR	Sample Number JBX17-0413.001 Sample Name F093184 G	JBX17-0413.002 GO129873	JBX17-0413.003 G0129861

Volatile Organic Compounds (VOC) in Air

1,1,2,2-tetrachloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
1,2,3-trichloropropane *	ng/tube	0.9	<0.90	<0.90	<0.90
n-propylbenzene *	ng/tube	2	<2.00	<2.00	<2.00
Bromobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
2-chlorotoluene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,3,5-trimethylbenzene *	ng/tube	0.55	<0.55	<0.55	<0.55
4-chlorotoluene *	ng/tube	0.7	<0.70	<0.70	<0.70
1,3-dichlorobenzene *	ng/tube	1	<1.00	<1.00	<1.00
tert-butylbenzene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2,4-trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
sec-butylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
p-Isopropyltoluene (p-Cymene) *	ng/tube	0.8	<0.80	<0.80	<0.80
1,4-dichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75
n-butylbenzene *	ng/tube	2	<2.00	<2.00	<2.00
1,2-dichlorobenzene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2-dibromo-3-chloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2,4-trimethylbenzene *	ng/tube	0.75	<0.75	<0.75	<0.75
Hexachlorobutadiene *	ng/tube	0.5	<0.50	<0.50	<0.50
Naphthalene *	ng/tube	0.5	<0.50	<0.50	<0.50
1,2,3-trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80

METHOD SUMMARY

METHOD	METHOD SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*”.

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

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X-LAB EARTH

TEST REPORT

CLIENT DETAILS

Contact	Loren Dyer
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Facsimile	
Email	loren.dyer@wspgroup.co.za
Project	WSP006
Order Number	WSP006
Samples	5
Sample matrix	WATER

LABORATORY DETAILS

Laboratory	X- Lab Earth Science
Address	259 Kent Avenue Ferndale, 2194
Telephone	+27 (0)11 590 3000
Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17- 0471A
Report Number	0000001130
Date Received	21/06/2017 14:51
Date Started	21/06/2017 15:03
Date Reported	26/06/2017 16:17

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Please note:
Dissolved Hg on waters by ICP- MS - Refers to the liquid filtrate/solube portion.
ICP- MS Metals on waters (Dissolved) - Refers to the liquid filtrate/solube portion.
ICP- OES Metals on waters (Dissolved) - Refers to the liquid filtrate/solube portior
Total Suspended Solids - Refers to the Insolube portion.
Metals on Filters - Refers to the metals results on the filter/insolube portion.

T0775

SIGNATORIES

Greg Ondrejkovic

Technical Supervisor/Technical Signatory

Martin Olivier

General Manager/Technical Signatory

TEST REPORT

Parameter	Units	LOR	Sample Number Sample Name	JBX17-0471A.001 DFO1	JBX17-0471A.002 DFO2	JBX17-0471A.003 DFO5	JBX17-0471A.004 DFO7	JBX17-0471A.005 DFO8

Dustfallout ASTM D1739

Nett Mass of Sample *	mg	-	95.0000	29.0000	134.0000	47.0000	18.0000

Hg on air samples by ICP-MS Method: ME-AN-026

Mercury *	µg/filter	1	<1.0	<1.0	<1.0	<1.0	<1.0

ICP-MS Metals on waters (Dissolved) Method: ME-AN-026

Aluminium	mg/l	0.003	0.16	0.014	<0.003	0.011	0.005
Arsenic	mg/l	0.0005	0.0070	0.015	0.0090	0.032	0.0070
Barium	mg/l	0.005	0.017	0.014	0.067	0.008	0.011
Beryllium	mg/l	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth *	mg/l	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Boron	mg/l	0.002	0.22	0.014	0.022	0.002	<0.002
Cadmium	mg/l	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/l	0.002	0.031	1.1	0.87	0.92	0.80
Cobalt	mg/l	0.0004	0.0020	<0.0004	<0.0004	<0.0004	<0.0004
Copper	mg/l	0.0009	0.059	0.0030	0.0090	0.042	0.0060
Iron	mg/l	0.05	0.11	<0.050	<0.050	<0.050	<0.050
Lead	mg/l	0.0005	<0.0005	<0.0005	<0.0005	0.0010	<0.0005
Lithium *	mg/l	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese	mg/l	0.002	0.041	0.011	<0.002	0.010	0.025
Molybdenum	mg/l	0.001	0.001	<0.001	0.002	<0.001	<0.001
Nickel	mg/l	0.001	0.006	0.001	0.002	0.005	0.001
Rubidium *	mg/l	0.004	NA	NA	NA	NA	NA
Selenium	mg/l	0.002	<0.002	<0.002	0.002	<0.002	<0.002
Silver	mg/l	0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Strontium	mg/l	0.0006	0.031	0.0090	0.11	0.018	0.0050
Thallium	mg/l	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Thorium *	mg/l	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Tin	mg/l	0.002	0.021	<0.002	<0.002	0.003	<0.002
Titanium	mg/l	0.0005	0.017	0.016	0.025	0.025	0.013
Tungsten	mg/l	0.006	<0.006	<0.006	0.008	<0.006	<0.006
Uranium	mg/l	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Vanadium	mg/l	0.0005	0.0060	<0.0005	<0.0005	<0.0005	<0.0005
Zinc	mg/l	0.05	0.20	0.07	<0.05	<0.05	0.11
Zirconium *	mg/l	0.007	<0.007	<0.007	<0.007	<0.007	<0.007

TEST REPORT

Parameter	Units	LOR	Sample Number Sample Name: JBX17-0471A.001 DFO1	JBX17-0471A.002 DFO2	JBX17-0471A.003 DFO5	JBX17-0471A.004 DFO7	JBX17-0471A.005 DFO8

ICP-MS Metals on waters (Dissolved) Method: ME-AN-026 (continued)

Parameter	Units	LOR	DFO1	DFO2	DFO5	DFO7	DFO8
Antimony	mg/l	0.008	<0.01	<0.01	<0.01	<0.01	<0.01

ICP-OES Metals on waters (Dissolved) Method: ME-AN-027

Parameter	Units	LOR	DFO1	DFO2	DFO5	DFO7	DFO8
Calcium	mg/l	0.5	9.8	4.0	10	4.3	1.6
Magnesium	mg/l	0.01	1.2	0.33	4.7	0.57	0.28
Phosphorus	mg/l	0.03	3.7	0.27	0.34	3.2	0.35
Potassium	mg/l	0.2	9.4	0.8	9.0	3.7	0.6
Silicon	mg/l	1	6.1	3.6	11	4.2	1.7
Sodium	mg/l	0.5	11	9.1	47	5.3	2.4
Sulphur	mg/l	0.07	6.2	22	41	30	35

Metals on Filters Method: ME-AN-027

Parameter	Units	LOR	DFO1	DFO2	DFO5	DFO7	DFO8
Silver	mg/filter	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Aluminium	mg/filter	0.002	0.30	0.24	0.22	0.31	0.23
Arsenic	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gold *	mg/filter	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Boron	mg/filter	0.0005	0.49	0.66	0.49	0.71	0.54
Barium	mg/filter	0.0002	0.90	1.0	0.69	1.1	0.85
Beryllium	mg/filter	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth *	mg/filter	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Calcium	mg/filter	0.05	0.76	0.50	1.9	1.3	0.39
Cadmium	mg/filter	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	mg/filter	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	mg/filter	0.0002	0.0007	0.0003	0.0005	0.0009	0.0006
Copper	mg/filter	0.002	0.005	<0.002	0.003	0.010	<0.002
Iron	mg/filter	0.005	0.057	0.039	0.044	0.14	0.14
Indium *	mg/filter	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iridium *	mg/filter	0.09	<0.09	<0.09	<0.09	<0.09	<0.09
Potassium	mg/filter	0.02	0.72	0.89	0.69	0.91	0.66
Lithium *	mg/filter	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Magnesium	mg/filter	0.001	0.059	0.033	0.70	0.10	0.044
Manganese	mg/filter	0.001	0.002	0.002	0.003	0.008	0.004
Molybdenum	mg/filter	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sodium	mg/filter	0.05	1.6	2.0	1.6	2.0	1.6
Niobium *	mg/filter	0.014	NA	NA	NA	NA	NA
Nickel	mg/filter	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phosphorus	mg/filter	0.003	0.066	<0.003	<0.003	0.11	<0.003
Lead	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Palladium *	mg/filter	0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Parameter	Units	LOR	Sample Number JBX17-0471A.001 Sample Name DFO1	JBX17-0471A.002 DFO2	JBX17-0471A.003 DFO5	JBX17-0471A.004 DFO7	JBX17-0471A.005 DFO8

Metals on Filters Method: ME-AN-027 (continued)

Parameter	Units	LOR	DFO1	DFO2	DFO5	DFO7	DFO8
Platinum *	mg/filter	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Rhenium *	mg/filter	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rhodium *	mg/filter	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ruthenium *	mg/filter	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sulphur	mg/filter	0.007	0.082	0.010	0.020	0.036	0.013
Antimony	mg/filter	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silicon	mg/filter	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	mg/filter	0.0001	0.013	0.017	0.017	0.019	0.013
Tantalum *	mg/filter	0.014	NA	NA	NA	NA	NA
Tellurium *	mg/filter	0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Thorium *	mg/filter	0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Titanium	mg/filter	0.0005	0.0007	0.0011	0.0010	0.0039	0.0030
Thallium	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium *	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/filter	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tungsten *	mg/filter	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/filter	0.001	0.71	0.87	0.62	0.89	0.61
Zirconium *	mg/filter	0.018	<0.018	<0.018	<0.018	<0.018	<0.018

Total Suspended Solids Method: ME-AN-009

Parameter	Units	LOR	DFO1	DFO2	DFO5	DFO7	DFO8
TSS (0.7µm) @ 105ºC	mg/l	21	96	<21	64	42	30

METHOD SUMMARY

METHOD	METHOD SUMMARY
ME-AN-011	Total dissolved solids (TDS) is determined gravimetrically on a filtered aliquot of aqueous sample by evaporating the sample to dryness in a pre-weighed container at 105 deg C. The method is based on APHA 2540 C.
ME-AN-026	Analytical fractions are generated from the sampling train as specified in USEPA Method 29. Fractions 1B, 2B, 3A, 3B and 3C are analysed for Hg by inductively coupled plasma mass spectrometry (ICP-MS). Based on USEPA Method 29. Note: only the following elements are covered by M29; Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Hg, Ni, P, Se, Ag, Tl & Zn.
ME-AN-027	Dissolved metals are determined on a filtered and acidified (to 1% HNO3) portion of aqueous sample by inductively coupled plasma optical emission spectrometry (ICP-OES). The method is based on EPA 200.7 and APHA 3120.
ME-AN-009	Total suspended solids (TSS) is determined gravimetrically by filtering an aliquot of well-shaken aqueous sample through a pre-weighed filter which is then dried at 105 deg C. The method is based on APHA 2540 D.
ME-AN-026	Dissolved metals are determined on a filtered and acidified (to 1% HNO3) portion of aqueous sample by inductively coupled plasma mass spectrometry (ICP-MS). The method is based on EPA 200.8 and APHA 3030 B.
ME-AN-026	
ME-AN-027	Filters are digested with a mixture of nitric and hydrochloric acids. The digest is then analysed for metals, excluding Hg, by inductively coupled plasma optical emission spectrometry (ICP-OES). Based on NIOSH methods 7300 and 7301.

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*".

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

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LAB-QLT-REP-001

TEST REPORT

CLIENT DETAILS

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Project	To Follow
Order Number	To Follow
Samples	8
Sample matrix	AIR

LABORATORY DETAILS

Laboratory	X- Lab Earth Science
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Telephone	+27 (0)11 590 3000
Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17- 0479
Report Number	0000001132
Date Received	13/06/2017 14:17
Date Started	26/06/2017 14:19
Date Reported	26/06/2017 16:20

Whilst X- Lab Earth Science (Pty) Ltd conforms to ISO/IEC 17025 standards, results of analysis in this report fall outside of the current scope of accreditation.

SIGNATORIES

Greg Ondrejkovic	Martin Olivier
Technical Supervisor/Technical Signatory	General Manager/Technical Signatory

TEST REPORT

Sample Number
Sample Name

Volatile Organic Compounds (VOC) in Air

Parameter	Units	LOR	JBX17-0479.001 GO129891	JBX17-0479.002 GO129814	JBX17-0479.003 GO129826	JBX17-0479.004 GO129819	JBX17-0479.005 364772
Dichlorodifluoromethane *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
Chloromethane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
Vinyl chloride (Chloroethene) *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
Bromomethane *	ng/tube	0.6	<0.60	<0.60	<0.60	<0.60	<0.60
Chloroethane (Ethyl Chloride) *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
Trichlorofluoromethane *	ng/tube	0.6	<0.60	<0.60	<0.60	<0.60	<0.60
Dichloromethane (Methylene	ng/tube	1	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1,2-dichloroethene *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95	<0.95
1,1-dichloroethene *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
MTBE *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95	<0.95
1,1-dichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
cis-1,2-dichloroethene *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65	<0.65
2,2-dichloropropane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95	<0.95
Bromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Trichloromethane (Chloroform) *	ng/tube	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1-trichloroethane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95	<0.95
1,2-dichloroethane *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65	<0.65
1,1-dichloropropene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Benzene *	ng/tube	1	87.90	69.85	46.49	91.08	5.30
Tert Amyl Methyl Ether (tAME) *	ng/tube	0.55	<0.55	<0.55	<0.55	<0.55	<0.55
1,2-dichloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
Trichloroethene *	ng/tube	0.5	122.82	<0.50	37.08	2.60	<0.50
Dibromomethane *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
cis-1,3-dichloropropene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
Toluene *	ng/tube	1	54.17	34.76	60.34	33.72	4.23
trans-1,3-dichloropropene *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
1,1,2-trichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
1,3-dichloropropane *	ng/tube	0.65	<0.65	<0.65	<0.65	<0.65	<0.65
Tetrachloroethene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
Bromodichloromethane *	ng/tube	1	<1.00	<1.00	<1.00	<1.00	<1.00
Dibromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
1,2-dibromoethane *	ng/tube	0.95	<0.95	<0.95	<0.95	<0.95	<0.95
Chlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
1,1,1,2-tetrachloroethene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Carbon tetrachloride *	ng/tube	1	<1.00	<1.00	<1.00	<1.00	<1.00
Ethylbenzene *	ng/tube	0.75	2.38	2.32	6.03	4.28	0.75
m/p-xylene *	ng/tube	0.8	6.33	6.42	18.11	9.24	1.16
o-xylene *	ng/tube	0.75	2.63	2.53	7.17	3.93	<0.75
Styrene *	ng/tube	0.85	3.51	3.32	7.85	9.55	1.69
Bromoform *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
Isopropylbenzene (Cumene) *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75

TEST REPORT

Parameter	Sample Number Sample Name Units	LOR	JBX17-0479.001 GO129891	JBX17-0479.002 GO129814	JBX17-0479.003 GO129826	JBX17-0479.004 GO129819	JBX17-0479.005 364772
Volatile Organic Compounds (VOC) in Air							
1,1,2,2-tetrachloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
1,2,3-trichloropropane *	ng/tube	0.9	<0.90	<0.90	<0.90	<0.90	<0.90
n-propylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
Bromobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
2-chlorotoluene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
1,3,5-trimethylbenzene *	ng/tube	0.55	<0.55	<0.55	<0.55	<0.55	<0.55
4-chlorotoluene *	ng/tube	0.7	<0.70	<0.70	<0.70	<0.70	<0.70
1,3-dichlorobenzene *	ng/tube	1	<1.00	<1.00	<1.00	<1.00	<1.00
tert-butylbenzene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
1,2,4-trichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
sec-butylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
p-Isopropyltoluene (p-Cymene) *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80
1,4-dichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
n-butylbenzene *	ng/tube	0.6	<0.60	<0.60	<0.60	<0.60	<0.60
1,2-dichlorobenzene *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
1,2-dibromo-3-chloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85	<0.85	<0.85
1,2,4-trimethylbenzene *	ng/tube	0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Hexachlorobutadiene *	ng/tube	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Naphthalene *	ng/tube	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,2,3-trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80	<0.80	<0.80

TEST REPORT

Sample Number
Sample Name

Parameter	Units	LOR	JBX17-0479.006 364771	JBX17-0479.007 364777	JBX17-0479.008 364773BG

Volatile Organic Compounds (VOC) in Air

Dichlorodifluoromethane *	ng/tube	0.8	<0.80	<0.80	<0.80
Chloromethane *	ng/tube	0.85	<0.85	<0.85	<0.85
Vinyl chloride (Chloroethene) *	ng/tube	0.8	<0.80	<0.80	<0.80
Bromomethane *	ng/tube	0.6	<0.60	<0.60	<0.60
Chloroethane (Ethyl Chloride) *	ng/tube	0.9	<0.90	<0.90	<0.90
Trichlorofluoromethane *	ng/tube	0.6	<0.60	<0.60	<0.60
Dichloromethane (Methylene	ng/tube	1	<1.00	<1.00	<1.00
trans-1,2-dichloroethene *	ng/tube	0.95	<0.95	<0.95	<0.95
1,1-dichloroethene *	ng/tube	0.9	<0.90	<0.90	<0.90
MTBE *	ng/tube	0.95	<0.95	<0.95	<0.95
1,1-dichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
cis-1,2-dichloroethene *	ng/tube	0.65	<0.65	<0.65	<0.65
2,2-dichloropropane *	ng/tube	0.95	<0.95	<0.95	<0.95
Bromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75
Trichloromethane (Chloroform) *	ng/tube	0.5	<0.50	<0.50	<0.50
1,1,1-trichloroethane *	ng/tube	0.95	<0.95	<0.95	<0.95
1,2-dichloroethane *	ng/tube	0.65	<0.65	<0.65	<0.65
1,1-dichloropropene *	ng/tube	0.75	<0.75	<0.75	<0.75
Benzene *	ng/tube	1	8.10	8.76	164.07
Tert Amyl Methyl Ether (tAME) *	ng/tube	0.55	<0.55	<0.55	<0.55
1,2-dichloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85
Trichloroethene *	ng/tube	0.5	<0.50	<0.50	<0.50
Dibromomethane *	ng/tube	0.8	<0.80	<0.80	<0.80
cis-1,3-dichloropropene *	ng/tube	0.8	<0.80	<0.80	<0.80
Toluene *	ng/tube	1	2.04	1.74	204.42
trans-1,3-dichloropropene *	ng/tube	0.9	<0.90	<0.90	<0.90
1,1,2-trichloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
1,3-dichloropropane *	ng/tube	0.65	<0.65	<0.65	<0.65
Tetrachloroethene *	ng/tube	0.8	<0.80	<0.80	<0.80
Bromodichloromethane *	ng/tube	1	<1.00	<1.00	<1.00
Dibromochloromethane *	ng/tube	0.75	<0.75	<0.75	<0.75
1,2-dibromoethane *	ng/tube	0.95	<0.95	<0.95	<0.95
Chlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
1,1,1,2-tetrachloroethene *	ng/tube	0.75	<0.75	<0.75	<0.75
Carbon tetrachloride *	ng/tube	1	<1.00	<1.00	<1.00
Ethylbenzene *	ng/tube	0.75	<0.75	<0.75	23.81
m/p-xylene *	ng/tube	0.8	0.88	1.05	78.41
o-xylene *	ng/tube	0.75	<0.75	<0.75	29.93
Styrene *	ng/tube	0.85	0.85	1.72	8.50
Bromoform *	ng/tube	0.9	<0.90	<0.90	<0.90
Isopropylbenzene (Cumene) *	ng/tube	0.75	<0.75	<0.75	<0.75

TEST REPORT

Parameter	Units	LOR	JBX17- 0479.006 364771	JBX17- 0479.007 364777	JBX17- 0479.008 364773BG
		Sample Number Sample Name			

Volatile Organic Compounds (VOC) in Air

1,1,2,2- tetrachloroethane *	ng/tube	0.9	<0.90	<0.90	<0.90
1,2,3- trichloropropane *	ng/tube	0.9	<0.90	<0.90	<0.90
n- propylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
Bromobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
2- chlorotoluene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,3,5- trimethylbenzene *	ng/tube	0.55	<0.55	<0.55	<0.55
4- chlorotoluene *	ng/tube	0.7	<0.70	<0.70	<0.70
1,3- dichlorobenzene *	ng/tube	1	<1.00	<1.00	<1.00
tert- butylbenzene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2,4- trichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75
sec- butylbenzene *	ng/tube	0.8	<0.80	<0.80	<0.80
p- Isopropyltoluene (p- Cymene) *	ng/tube	0.8	<0.80	<0.80	<0.80
1,4- dichlorobenzene *	ng/tube	0.75	<0.75	<0.75	<0.75
n- butylbenzene *	ng/tube	0.6	<0.60	<0.60	<0.60
1,2- dichlorobenzene *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2- dibromo- 3- chloropropane *	ng/tube	0.85	<0.85	<0.85	<0.85
1,2,4- trimethylbenzene *	ng/tube	0.75	<0.75	<0.75	<0.75
Hexachlorobutadiene *	ng/tube	0.5	<0.50	<0.50	<0.50
Naphthalene *	ng/tube	0.5	<0.50	<0.50	<0.50
1,2,3- trichlorobenzene *	ng/tube	0.8	<0.80	<0.80	<0.80

METHOD SUMMARY

METHOD	METHOD SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*".

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

X-LAB EARTH

TEST REPORT

CLIENT DETAILS

Contact	Bryan Grant
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Project	UHA01 (5)
Order Number	UHA01 (5)
Samples	3
Sample matrix	AIR

LABORATORY DETAILS

Laboratory	X- Lab Earth Science
Address	259 Kent Avenue Ferndale, 2194
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Laboratory Manager	Mr Martin Olivier
Lab Reference	JBX17- 0702
Report Number	0000002024
Date Received	05/09/2017 12:50
Date Started	11/09/2017 14:06
Date Reported	15/09/2017 13:04

Whilst X- Lab Earth Science (Pty) Ltd conforms to ISO/IEC 17025 standards, results of analysis in this report fall outside of the current scope of accreditation.

SIGNATORIES

Greg Ondrejkovic

Technical Supervisor/Technical Signatory

Martin Olivier

General Manager/Technical Signatory

TEST REPORT

Parameter	Units	LOR	Sample Number: JBX17- 0702.001 Sample Name: 6853301136	Sample Number: JBX17- 0702.003 Sample Name: 6853301137	Sample Number: JBX17- 0702.005 Sample Name: 6853301134
H2S calculation for charcoal tubes					
Sampling Volume *	l	1.2	10	10	10
Ambient Concentration H2S *	mg/m3	0.03	0.187	0.180	<0.030

METHOD SUMMARY

METHOD	METHOD SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	*Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body*”.

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

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