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Eastern Metropolitan Regional Council  
Red Hill Waste Management Facility:  
Field-Based Ambient Odour Assessments

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Report  
August 2013

**THE ODOUR UNIT (WA) PTY LTD**

**Trading Name:** The Odour Unit (WA) Pty Limited  
**ABN:** 70 126 439 076  
**ACN:** 126 439 076  
**Address:** Showroom 1/16 Hulme Court, Myaree WA 6154  
**Office:** +61 8 9330 9476  
**Fax:** +61 8 9330 1868  
**Manager:** John Hurley  
**Mobile:** 0433 352 173  
**Email:** [jhurley@odourunit.com.au](mailto:jhurley@odourunit.com.au)

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**Disclaimer:** *This document presents the results of one or more Field-Based Ambient Odour Intensity Assessments (FAOA's); undertaken for the assessment of off-site ground level odour intensities downwind of the EMRC Waste Management Facility according to the German Standard VDI 3940. The results presented herein are representative of the observations made during each FAOA; and do not represent conditions outside of those FAOA observation times.*

Report Revision			
Report ID Number	Issue Date	Description	
<b>FAOA_Draft Report 2013</b>	14.08.2013	Draft Report of 8 x FAOA's from April – August 2013.	
<b>FAOA_Final Report 2014</b>	22.05.2014	Final Report of 8 x FAOA's from April – August 2013.	
<b>Prepared for:</b> Eastern Metropolitan Regional Council Red Hill Waste Management Facility (WMF)			
<b>Prepared By:</b> J. Hurley		<b>Approved By:</b> T. Schulz	



## **TERMS & DEFINITIONS**

“**ADC**” means Alternative Daily Cover;

“**Assessment Area**” refers to the defined area for the specific task in hand. The size and shape depend on the task and on the number and type of odour sources whose impact range is being assessed;

“**EMRC**” refers to The Eastern Metropolitan Regional Council;

“**FAOA**” means Field-Based Ambient Odour Intensity Assessment;

“**Grab Measurement**” refers to the panel member taking a single sniff of the ambient air at each ten second interval within the measurement cycle and ranking the odour intensity experienced at that grab measurement – the result is a single **Odour Sample**;

“**GWF**” refers to the EMRC WMF Green Waste Processing Facility;

“**Impact Range**” refers to the area in which an odour impact is caused by the emitter(s) under investigation;

“**Measurement Cycle**” refers to the time required for a single measurement at a measurement point (10 minutes);

“**Measurement Day**” refers to the day on which a survey or surveys was undertaken;

“**Measurement Point**” refers to the panel members’ position at which a single measurement is carried out. For a grid measurement the measurement point is usually situated at a point of intersection of grid lines;

“**Method**” refers to the methodology to be undertaken;

“**Methodology**” means the system of all individual tasks, techniques, tools and measurements undertaken to collect the desired dataset of information or solve the problem;

“**MSW**” refers to putrescible Municipal Solid Waste;



**“Odour Impact”** means the impact of odours on humans expressed by the frequency, duration, quality, intensity and hedonic tone of odorant concentrations above the recognition threshold in the field;

**“Odour Intensity”** refers to the strength of odour sensation caused by the olfactory stimulus;

**“Odour Quality”** means the comparative description of an odour with olfactory experience, e.g. “there is a smell of...”, “it smells burnt, rotten...” etc;

**“Panel”** refers to the group of panel members that carry out the survey;

**“Panel Members”** refer to person/s making up the panel;

**“Percentage Odour Time”** refers to the total times/intervals which the odour is recognizable during a measurement cycle at a single measurement point.

**“Recognition Threshold”** as it relates to the German Standard VDI 3940 means the odorant concentration at which a detectable odour within a facility’s impact range can be clearly assigned to a facility for the first time;

**“Red Hill”** refers to the EMRC WMF Red Hill Landfill;

**“Single Measurement”** refers to the measurement of odour impact at a measurement point over a defined measurement cycle;

**“Survey”** refers to a single FAOA;

**“Survey Period”** refers to the period in which all single measurements are carried out, e.g. from December to April, July to December;

**“TOU”** refers to The Odour Unit (WA) Pty Limited who are the commissioned consultant undertaking the Method for the EMRC;

**“WMF”** refers to the EMRC Red Hill Waste Management Facility.



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## 1 BACKGROUND FOR ASSESSMENT

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The EMRC commissioned TOU to undertake an odour assessment of the Red Hill WMF in response to recent complaints from offsite sensitive receptors related to observed odours from the WMF. Odours are typically observed in the early – mid morning and also in the evening periods and have been linked to three key processes at the WMF, namely: Power Plant Gasification, Active Tip Face and the GWF.

Previous assessments of the Red Hill WMF have been undertaken for the purposes of defining the baseline odour footprint from the site and that of the projected odour footprint of an upgraded site. The EMRC proposes to alter its onsite processes by way of incorporating other best-practice technologies to divert the wastes from landfill and process the wastes to generate either biogas for power generation, compost from digestion of wastes or a combination of both. The specific details of the proposed upgrades form part of the EMRC's Public Environmental Review (PER) document (July, 2012) are not discussed herein. When undertaking the PER the EMRC commissioned specific odour sampling and testing to be undertaken, as well as field-based odour intensity assessments. These works were undertaken by SLR Consulting and ETC respectively. The field work undertaken in 2012 observed very little, if any, offsite ground level odours and as such provided little insight into the 'culprit' source of odour/s from the WMF.

The continued incidence of offsite odours deemed to be emanating from the Red Hill WMF has prompted the EMRC to undertake further offsite assessments to pinpoint the source of odour/s that are the cause of the consistent complaints raised by sensitive receptors. Given the works done in the PER included site specific odour sampling, testing and subsequent derivation of a quantitative odour inventory, the reassessment of the odour sources was not needed, however, the reassessment of the odour impacts offsite in particular in relation to the locations of the sensitive receptors was required. This reassessment was done utilising field-based odour intensity assessments.

TOU utilise a method for assessing/observing the ground level impacts of odour emissions based on the German Standard VDI 3940 "*Measurement of Odour Impact by*



*Field Inspection*". This standard prescribes the methods by which field technicians (panel members) determine, define and document observed ground level odours and the manner in which the determination of these odours is defined in relation to odour character, frequency of odours observed and the odour intensity of those individual observations as a quantitative scale of measure. The system by which those observed odours are ranked according to the strength of the odour sensation experienced is based on the German Standard VDI 3882 Part 1.

The Measurement of Odour Impact by Field Inspection, otherwise referred to as a Field-Based Ambient Odour Intensity Assessment (hereinafter referred to [as FAOA](#)) utilises field data observations by 'ground-truthing' detectable odours from a pre-defined odour source to assess both the odour intensity of an observed odour, and its frequency of observation. These odours are detected by a panel of field technicians (*panel members*) that have been calibrated for their olfactory sensitivity according to the Australian/New Zealand Standard AS/NZS4323.3:2001.

The use of a FAOA provides a robust understanding of actual off-site odour impacts from a pre-defined odour source allowing the observations to be interpreted as (among others) problematic at a given location due to high intensity and frequency, or acceptable when observing a low intensity and frequency of those observations.

## 1.1 Purpose of FAOA

- To 'construct' an Ambient Odour Assessment Plan that accounts for conducive weather and process conditions that best suit the likelihood of observing offsite odours from the WMF;
  - The Ambient Odour Assessment Plan shall include, but not be limited to, the following detail:
    - (i) the number of locations at which the surveys will be undertaken with a one kilometre radius of the premises;
    - (ii) the manner by which the field surveys will be undertaken using recommendations within German VDI method 3940, including, but



- not limited, the selection of the panellists and the number of panellists per survey;
- (iii) identify meteorological and operational conditions conducive to possible odour impacts within the selected measurement area;
  - (iv) shall be undertaken during periods that are conducive to odour emissions;
  - (vi) the criteria to be used to compare odour field survey results and assess the level of odour impact and any changes to odour emissions from the premises.
- To determine the odour character, odour frequency and odour intensity of ground level observed odours from the EMRC Red Hill WMF;
  - To liaise with complainants at sensitive receptor locations and determine the odour impacts at those locations and other surrounding areas;
  - To carry out FAOA's with key complainants (where practicable) to observe their understanding of detectable odours and compare to TOU's observations;
  - To derive the odour impacts at those key sensitive receptor locations (and other areas) and compare the frequency and intensity of observations to a pre-determined odour criterion;
  - From the derived observations determine the culprit odour source/s at the WMF; and
  - Report to the EMRC the findings and incorporate these findings into an Odour Management Plan to be implemented by the EMRC to control the incidence of offsite malodours where practicable.

## 1.2 The Odour Source

The Red Hill WMF is located on Toodyay Road approximately 30 kilometres north-east of the Perth Metropolitan Area and covers an approximate total area of 305 hectares (**refer Figure 1.2.1**).

The WMF accepts in excess of 300,000 tonnes of waste per annum with Member Council waste contributing in excess of 100,000 tonnes. Other waste streams include wastes from public deliveries, commercial wastes, and greenwastes.



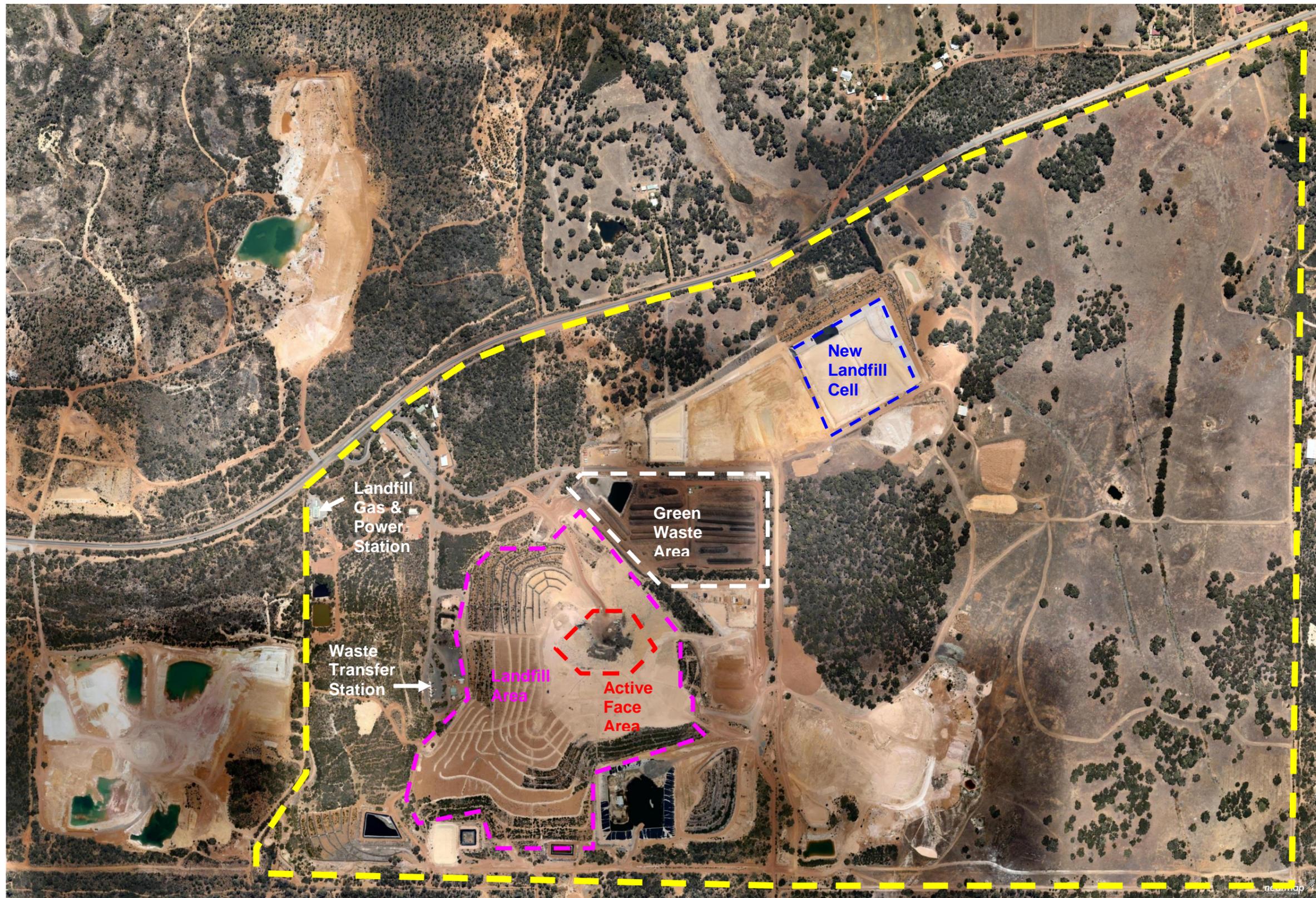
The existing landfill has four (4) landfill cells with approvals for construction of a new cell to be constructed near the north boundary of the site. The approval for this new landfill cell is valid until 19 October 2016. Currently, a recently capped landfill cell on the western side of the existing landfill is being drilled for methane gas extraction to the LGP. The LGP is in general a closed source of odour, however some odour has been observed in and around the LGP as well as some characteristic odour offsite that would suggest the LGP may potentially be inefficient in its process.

The active face comprises a large surface area of the existing landfill. The tipping area of the active face comprises a maximum length of 50 lineal metres. At the cessation of each working day the active face is clay capped to contain the MSW and minimise fugitive odours escaping.

The waste transfer station (WTS) receives daily waste streams from council trucks (kerbside collections) and the community. The WTS is a volume source building with an opening on one side. MSW is delivered to this building and transferred to landfill.

The green waste processing area involves three steps. Firstly the raw materials are delivered to site, secondly the raw materials are shredded to a compost fraction, and finally the shredded material is arranged into windrows for composting. The composting of the green waste at the WMF involves only the application of water for composting i.e. no composting of industrial liquors or wastes.

Leachate ponds onsite are considered to be a small contributor to the potential for site and offsite odours and in effect represent only a near field odour source.



**Figure 1.2.1:** EMRC Red Hill Waste Management Facility Site Layout.



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## 2 FAOA METHODOLOGY

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The undertaking of a FAOA survey is based herein on the German Standard VDI 3940 “*Measurement of Odour Impact by Field Inspection*”. This standard prescribes the methods by which field technicians (panel members) determine, define and document observed ground level odours and the manner in which the determination of these odours is defined in relation to odour character, frequency of odours observed and the odour intensity of those individual observations as a quantitative scale of measure.

TOU utilise a method for assessing the ground level impacts of odour emissions based on the German Standard VDI 3940 “*Measurement of Odour Impact by Field Inspection*”.

The TOU method as it relates to the EMRC Red Hill WMF encompasses (but is not limited to):

- Preferential worst-case meteorological conditions:
  - Time-of-day;
    - Early morning (6AM - 10AM); and
    - Early-late evening (4PM - 7PM).
  - Calm, cool conditions;
- **Roland Road** as the extent of the eastern sector field inspection *gridded* pattern;
- **Toodyay Road** as the extent of the northern sector field inspection *gridded* pattern;
- **Hidden Valley Road** as the extent of the southern sector field inspection *gridded* pattern;
- **No western sector;**
- Panelists (field technician) selection; and
- Number of panelists.

With this method, a panel of calibrated and experienced panel members conduct a single measurement(s) at discrete measurement points (a grid defined within the surveyed odour plume) within a pre-determined assessment area downwind of the site.



Each measurement cycle comprises 60 grab measurements every 10 seconds for a single measurement cycle of 10 minutes. Each grab measurement results in a single Odour Sample. Each assessment area is representative of a preferential wind condition as it relates to the odour source being assessed.

An FAOA survey comprises the total individual discrete measurement points, and the total single measurement(s) undertaken within the assessment area representative of the preferential wind condition on the measurement day. *For example: Under an easterly wind condition one survey on the measurement day was conducted by undertaking two single measurements at ten discrete measurement points within the assessment area. The outcome of the survey provided a dataset of twenty single measurements over the assessment area on that measurement day. The survey utilised a panel of five, with each panel member undertaking four single measurements over the assessment area.*

The survey period is often reflective of worst-case meteorological conditions. A survey may be undertaken at any interval during the survey period (i.e. daily, weekly etc).

The result of each FAOA survey derives the impact range within that assessment area for each survey. Assessment areas may vary over the survey period to cover multiple wind conditions.

For every single measurement the panel assesses the presence, character and intensity of any observed odours. Each survey is designed to collect a multitude of single measurements per measurement day, since one survey may typically take up to three hours to completely assess each measurement point within the assessment area when accounting for panel member mobility and the size of the panel itself.

In general, the objective of a survey is to determine the 'decay' of odours observed downwind of the odour source/s thus defining the odour impact and impact range.

Within the impact range the magnitude of the odour impact can be defined by determining the maximum distance to which the clearly recognizable odour is considered problematic. This is done by firstly assigning a level of odour intensity (the quantitative



scale) considered problematic for a given odour source, which would be considered equal to or greater than a nuisance odour intensity. For example, an assigned intensity of 3 (*distinct*) may be considered the upper limit to which an observed odour is acceptable in the community and therefore not an odour impact. Once a 3 is observed, or greater, the odour is clearly recognizable at that measurement point and hence the observed odour can be assigned to the facility being assessed (the recognition threshold). That measurement point can be considered wholly affected, or impacted, by a nuisance odour. Multiple measurement points within the assessment area impacted by an observed odour intensity of 3 or greater would then make up the impact range. However, the frequency of the odour observations must also be considered.

## 2.1 FAOA Objectives

The objectives of these FAOA surveys as they relate to the site are as follows:

- Define the Odour Key as it relates to the odour sources at the site;
- Define the problematic odour intensity and frequency criterion for the site;
- Under multiple preferential wind conditions and times of day:
  - Define the plume assessment area downwind of the site within the sector boundaries from the edge of the nearest odour source;
  - Determine the measurement points (locations within the surveyed odour plume), and their corresponding point identifications, within the assessment area;
  - Observe & record the odour intensities at each measurement point;
  - Derive the odour intensity frequencies at each measurement point;
  - Derive the odour impact at each measurement point as it relates to a pre-defined problematic odour intensity and frequency criterion; and
  - Determine the impact range (if any) off-site.
- Compile FAOA maps that detail the collected datasets over each survey period;
- Determine if the impact range is wholly affecting sensitive receptors; and
- Determine those odour emission sources at the site that are causing the off-site odour impact within those assessment areas.



## 2.2 The FAOA Odour Key Descriptors (Odour Quality)

The odour sources at the EMRC Red Hill WMF have their origins from the Incoming Wastes/Landfill, WTS, GWF, LGP and the liquor/evaporation ponds.

The incoming wastes via the weighbridge typically exhibit 'fresh' MSW/garbage characters, and Greenwaste characters. Other transient odours may also be experienced such as those from incomplete combustion of extracted landfill gases via the LGP and also from the delivery and handling of Biosolids.

The Liquor/Evaporation ponds are a near-field, minor odour source that have not been attributed to offsite odour complaints and therefore not considered further herein.

- The primary MSW odour sources are related to the Landfill;
- The primary Greenwaste odours are related to the GWF to include the MGB's;
- Odour characterised as boggy, foul and gassy are typically related to the LGP; and
- Odour characterised as foul, faecal, rubbery and shellfish are related to the Biosolids.

The FAOA Odour Key (odour quality) for the EMRC WMF is:

- **Landfill Active Cell/Face (Landfill)**

- Handling, sorting and agitation, compaction and daily covering of MSW wastes
  - ❖ **Odour Key Descriptor(s) – Garbage, Off Domestic Bin, Slight Sickly Sweetness-Fruity/Fermented**

- **Greenwaste Facility (GWF)**

- Handling, shredding/chipping, composting/turning of clean greenwaste streams; and
- Handling, sorting, shredding/chipping and composting/turning of co-mingled greenwaste from MGB's with some contamination of other organic wastes
  - ❖ **Odour Key Descriptor(s) – Sharp Menthol/Pine, Forest Floor, Citric**



- **Landfill Gas and Power Plant (LGP)**

- Captured and extracted capped landfill gases processed through combustion engines to generate power with extremely high odour strengths; and
- If combustion of the extracted gas is incomplete, the partially treated landfill gas is emitted to atmosphere through the engine exhausts

- ❖ **Odour Key Descriptor(s) – Strong, Foul Boggy-Gassy**

- **WCWA Biosolids**

- Water Corporation of Western Australia Biosolids Treatment Project;
- Dewatered Biosolids from Metropolitan Sewerage Treatment Plant/s with a high strength, foul and faecal odour character sometimes resembling rotten shellfish and rubber

- ❖ **Odour Key Descriptor(s) – Faecal, Shellfish/Rubbery**

## 2.3 Odour Intensity Categories

The observed off-site odours are quantified according to the German Standard VDI 3882 Part 1. The category scale for judging odour intensity in the field is a quantitative reference scale where panel members award one of the attributes in the **Table 2.3.1** (below) to his or her odour impression.



<b>Table 2.3.1: – VDI 3882 (Part 1) Odour Intensity Categories</b>		
Odour Strength	Intensity Rank (code)	TOU Interpretation (meaning)
Not detectable	0	No odour detected
Very Weak	1	Odour recognised and assigned to the odour source
Weak	2	Odour is weak but not yet distinct
Distinct	3	Odour is clearly distinct
Strong	4	Strong odour detectable
Very Strong	5	If offensive, observer may consider moving from the area
Extremely Strong	6	Odour is sufficiently over-powering that assessor moves from area

An odour is clearly recognised (category of intensity 1) when the odour quality and hence an origin of the odour source can be clearly assigned.

## 2.4 Odour Intensity & Frequency Criterion

Referring to the Odour Intensity Categories listed and described in **Table 2.3.1** above, the odour intensity of **2 (Weak)** has been chosen to represent an odour impact from the EMRC Red Hill WMF.

An intensity level of 2 is more conservative in assessing a problematic odour impact when compared to the typically chosen intensity level of 3. The higher conservatism will demand a higher level of odour control and treatment.



The frequency of the observed odour intensity category of 2 will be considered problematic when the percentage odour time of the intensity category 2 is  $\geq 20\%$  of the single measurement cycle, i.e. 20% of a total of 60 odour samples (12 odour samples of an intensity of 2 or more).

This 20% does not include observed odour intensities less than 2, i.e. does not include an observed odour intensity of 1.

Should the single measurement cycle at a discrete measurement point result in a percentage of observed intensities of 2 equalling or exceeding 20%, then that single measurement point is considered to be odour impacted.

Where more than one panel member has assessed that measurement point within the FAOA survey, the results of the odour samples collected are averaged to derive the average frequency of each individually observed odour intensity, i.e. for 2 panel members assessing a single measurement point, the criterion is based on the percentage odour time from 120 odour samples.

## **2.5 Selection of Panel Members**

For the selection of Panel Members as it relates to the VDI 3940 standard, the most important selection criterion is currently odour sensitivity to *n*-butanol in nitrogen.

TOU specialises in, and stringently carries out Dynamic Olfactometry according to Australian Standard AS/NZS4323.3:2001. TOU performs panel member *n*-butanol calibrations before all olfactometry testing sessions in our laboratories, in addition to the required primary calibration where each panel member is calibrated against *n*-butanol from at least ten dilution series collected on three different, non-consecutive days.

TOU has considerable data history on each panellist for their individual sensitivity to the calibration reference gas *n*-butanol.

Each panel member is selected from TOU's pool of calibrated odour panelists.



VDI 3940 additionally recommends assessor calibration data history for the reference gas Hydrogen sulphide when assessing hedonic tone in concert with odour intensity. This methodology statement is only for odour intensity determination and, as such, this recommendation is not applicable.

Optional tests, from VDI 3940, are used to determine the panel members' ability to discriminate odours of different intensities. The first test involves ranking 7 flasks of different *n*-butanol concentrations (derived from VDI 3940). TOU has previously undertaken this optional test on more than one occasion for other FAOA surveys and found the results of this as poor, with only 2 of the panelists ranking them successfully. The assessors considered the solutions 'relatively weak' and 'too similar' to be compared to the VDI intensity scale. As such TOU does not rely on this optional test when selecting panel members.

The second optional test utilises the triangle method where each panel member must discern between three bags of odorants, 2 identical and 1 different, to identify the different sample by either intensity or quality. This test is routinely chosen to be performed before each survey when TOU considers that the panel members have been 'out of practice' for undertaking FAOA surveys.

As a general rule, TOU undertakes dynamic olfactometry assessments within the range of 500 – 900 odour tests annually. As a consequence TOU's panel members are highly skilled for olfactory analyses. As part of TOU's laboratory olfactometry analyses, TOU also undertakes laboratory derived intensity assessments on individual odour samples where the panel members are exposed to laboratory conditions of odour intensity determination. Additionally, TOU also undertakes a high volume of FAOA surveys annually which exposes panel members to a variety of odour sources in the field.

## **2.6 Size of Panel**

According to the German Standard VDI 3940 "the pool of assessors should consist of four times as many assessors as are needed for one measurement day, and of not less



than ten persons. The size of the panel should be chosen appropriate to the objective of the survey”.

As such a minimum of three FAOA panel members per measurement day is required. If for example the plume was considered wide reaching, the objective of the survey may be to observe the entire plume width and intensity and therefore more than three persons may be deployed.

TOU utilises three panel members as a minimum per FAOA survey, one of which acts as a coordinator for the group of assessors.

## **2.7 Frequency of FAOA Surveys**

The timing of each measurement day will coincide with the most preferential weather conditions representing those situations where odour emissions may be heightened from the site.

The timing for each FAOA under preferential weather conditions may be a combination of the early morning in the timeframe of 6AM – 8AM, midday timeframe of 12NOON – 2PM and the evening timeframes of 4PM – 6PM.

Preferentially, the timing of each FAOA will be under weather conditions exhibiting calm winds with cool ambient temperatures. Under these conditions the ground level odour emissions are ‘pooled’ above the odour source and meanders offsite under low wind speeds. In doing this the pooled odour plume can concentrate itself as a ‘package’ of odour. Because the ambient winds are sufficiently low, the plume meanders and undergoes very little dispersion due to mechanical and physical scrubbing thereby presenting as a worst-case scenario. An offsite observer would often experience a pooled plume of odour under these conditions and that plume does not readily disperse which means it can sit at a receptor location (or other) for extended periods of time.



Cool ambient temperatures also increase the density of the air and reduce the vertical mixing height in the atmosphere. This discourages dispersion and maintains the odour plume close to ground.

## **2.8 Preferential Ambient Wind Conditions, Assessment Areas & Measurement Points**

TOU tracks the weather daily and observes weather forecasts and immediate conditions prior to and on the morning or evening of each survey. TOU conducts each ambient survey preferentially when the winds are generally light to moderate (1m/s – 5m/s) and preferentially dusk and dawn to mirror those times where people inhabit their homes in the morning and evening.

According to the VDI 3940 (Part 1) standard, the assessment of a single measurement point should account for all times of the day where an odour source process is active, as a consequence the typical starting timeframes for each FAOA survey may be 6-8AM, 12NOON-2PM and 4-6PM.

The method adopted herein undertakes a **Plume Measurement** whereby the design of the FAOA's is to track the plume offsite. Assessors locate themselves downwind of the EMRC and undertake individual FAOA's designed to observe odour intensity and frequency whilst also determining the length and breadth of the observed odour plume, consequently the locations of each FAOA are not set and are often spontaneous when offsite to allow for sudden changes in process and weather conditions. The number of measurements points may be many or few, per survey day, depending on the observed plume measurement, weather conditions and topographical constraints.



### 3 EMRC ODOUR COMPLAINTS PRIOR & DURING FAOA'S

**Table 3.1:** Details of Odour Complaints received prior to, and during FAOA's.

Date of Complaint	Time of Complaint (24 hrs)	Complainant Location	Wind Direction (origin)	Wind Speed during Complaint Duration (m/s)	Weather Conditions	Complainant Downwind of Site?	Odour Character Descriptor Identified?	Odour Description	Complainant Likely Origin of Odour	Comments
22-02-2013	09:12	Karrak Court	W - SW	5.3	20 <sup>0</sup> C – 32 <sup>0</sup> C Daily min/max	Yes	No	Offensive	Not Identified	Nil
19-03-2013	16:43	Karrak Court	W - NW	2.5	Dry – 30 <sup>0</sup> C	Partially	No	Nil	Not Identified	Nil
20-03-2013	10:40	Toodyay Road	S - SW	0.8 – 5.0	13 <sup>0</sup> C – 25 <sup>0</sup> C Daily min/max	Yes	No	Foul at times	Not Identified	Odour observed during Capped Landfill Cell drilling for Gas Extraction
	18:30									Odours still observed once gas drilling had ceased
10-04-2013	17:00	Toodyay Road	SW	1.67	Sunny – 25 <sup>0</sup> C	Yes	No	Hideous	Not Readily Identified	Complaint was After Hours. Daily cover applied to Landfill Active Face after 4PM. Odour may be fugitives from Capped Cells and/or Green Waste
30-05-2013	10:00	Toodyay Road	SSW - S	3.5 – 8.6	Rain – 10 <sup>0</sup> C	Yes	No	Tip Smells	Landfill Active Face	Likely to be the Landfill Active Face
17-06-2013	15:20	Toodyay Road	SW	3.6	Showers – 16 <sup>0</sup> C	Yes	No	Nil	Not Identified	Odours reported as getting stronger over time
17-07-2013	10:00	Toodyay Road	S	7.8	Overcast – 12 <sup>0</sup> C	Yes	No	Mild, Intermittent, Tip Smells	Landfill Active Face	Residual Biosolid Wastes on pad plus Biosolids Leachate believed to be the main source
02-08-2013	18:00	Toodyay Road	SSW	3.1	Clear – 16 <sup>0</sup> C	Yes	No	Tip Smells	General Landfill	Complaint was After Hours



## 4 ODOUR SOURCE PROCESS DETAILS DURING FAOA'S

The daily covering of the Class III landfill typically starts at 3:00PM with clay and then the Alternative Daily Cover (ADC) material is sprayed on from 4:30 – 5:00PM.

Green Highlighted cells refer to 'active' odour activities.

Orange Highlighted cells refer to 'inactive' odour activities.

Table 4.1: EMRC Red Hill WMF Odour Source Details during each FAOA.									
FAOA Date	Time Range of FAOA (24hrs)	Wind Direction (origin)	Wind Speed (m/s)	Daily Class III Wastes to General Landfill @ Time of FAOA	Burial of Quarantine Wastes to Class III General Landfill	Burial of Class IV Wastes to Landfill Cell	Greenwaste & MGB Turning; Shredding; Trommeling; Bulk Cartage	LGP Drilling; Extracting	WCWA Biosolids Delivery & Processing
Tuesday, 30 <sup>th</sup> April 2013	12:00 – 16:00	NNE - WSW	3.6 – 6.6	Yes	YES (12:11hrs)	YES Contaminated Soils	Trommeling	YES	NO
Monday, 6 <sup>th</sup> May 2013	14:00 – 17:00	WSW - SSW	1.9 – 4.7	Yes	YES (12:00hrs)	YES (14:27hrs)	Trommeling & Shredding	NO	NO
Friday, 17 <sup>th</sup> May 2013	14:00 – 17:00	WSW	3.6 – 6.6	Yes	NO	YES Contaminated Soils	Turning	NO	NO
Wednesday, 29 <sup>th</sup> May 2013	15:00 – 19:00	W - WNW	2.5 – 6.1	Yes	YES (12:45hrs)	YES (14:39hrs)	Trommeling	NO	Received on Previous Day
Tuesday, 18 <sup>th</sup> June 2013	14:00 – 17:00	W	3.1 – 4.7	Yes	YES (14:00hrs)	YES Meat Authority (14:27hrs)	Turning	NO	YES
Monday, 15 <sup>th</sup> July 2013	14:00 – 17:00	NW	6.6 – 8.3 (gusting)	Yes	NO	NO	Turning & Screening	NO	NO
Tuesday, 16 <sup>th</sup> July 2013	08:00 – 10:30	N	1.7 – 5.5	Yes	NO	NO	Turning & Carting to Stockpile	NO	Residue of Biosolids & Leachate still evident
Friday, 9 <sup>th</sup> August 2013	09:00 – 11:30	N	2.5 – 3.1 (fluky)	Yes	Yes (10:51hrs)	NO	- Turning Mulch Windrows - Turning MGB Windrows - Screening & Grinding	NO	NO



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## 5 FAOA SURVEY RESULTS SUMMARY & SURVEY MAPS

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- 8 individual FAOA surveys were undertaken from April 2013 onward;
  - Surveys were spread over a few months to gather as much variability in process and seasonal effects on odour impacts as possible;
- Each survey attempted to observe downwind odour intensity and frequency in and around discrete receptor locations;
- The primary odour characters observed from the 8 completed surveys were;
  - Boggy-Gassy
  - Fruity-Fermented
  - Garbage/MSW
- On at least one occasion the odour characters of Boggy-Gassy were deemed to be emanating from the LGP Plant under a west, south-west wind origin;
- Where Fruity-Fermented/Garbage/MSW characters were observed, the timeframe of the FAOA/s was in general in the late afternoon/early evening (4-6PM);
- Where only MSW odours were observed the timeframe of the FAOA/s was in general in the morning (9AM);
- Odour plumes were narrow and highly transient with plumes mainly observed when there were breezes/winds following calm periods;
- Narrow plumes meant that repeatable observations at discrete observation locations were difficult to achieve when winds were in flux;
- Meetings/Discussions with residents at discrete receptor locations of Persoonia Close, Karrak Court and Toodyay Road suggested that the main odorant observed was of a Fruity-Fermented/Garbage/MSW character;
  - Residents also expressed that the incidence of odour impacts had decreased in recent months/years, however; when impacted the odour was sufficiently strong in its intensity to be considered a malodour that negatively affected their amenity
- No Biosolids odour was observed during the FAOA program attributed most likely to its small exposed surface area and transient occupancy at the WMF, however;

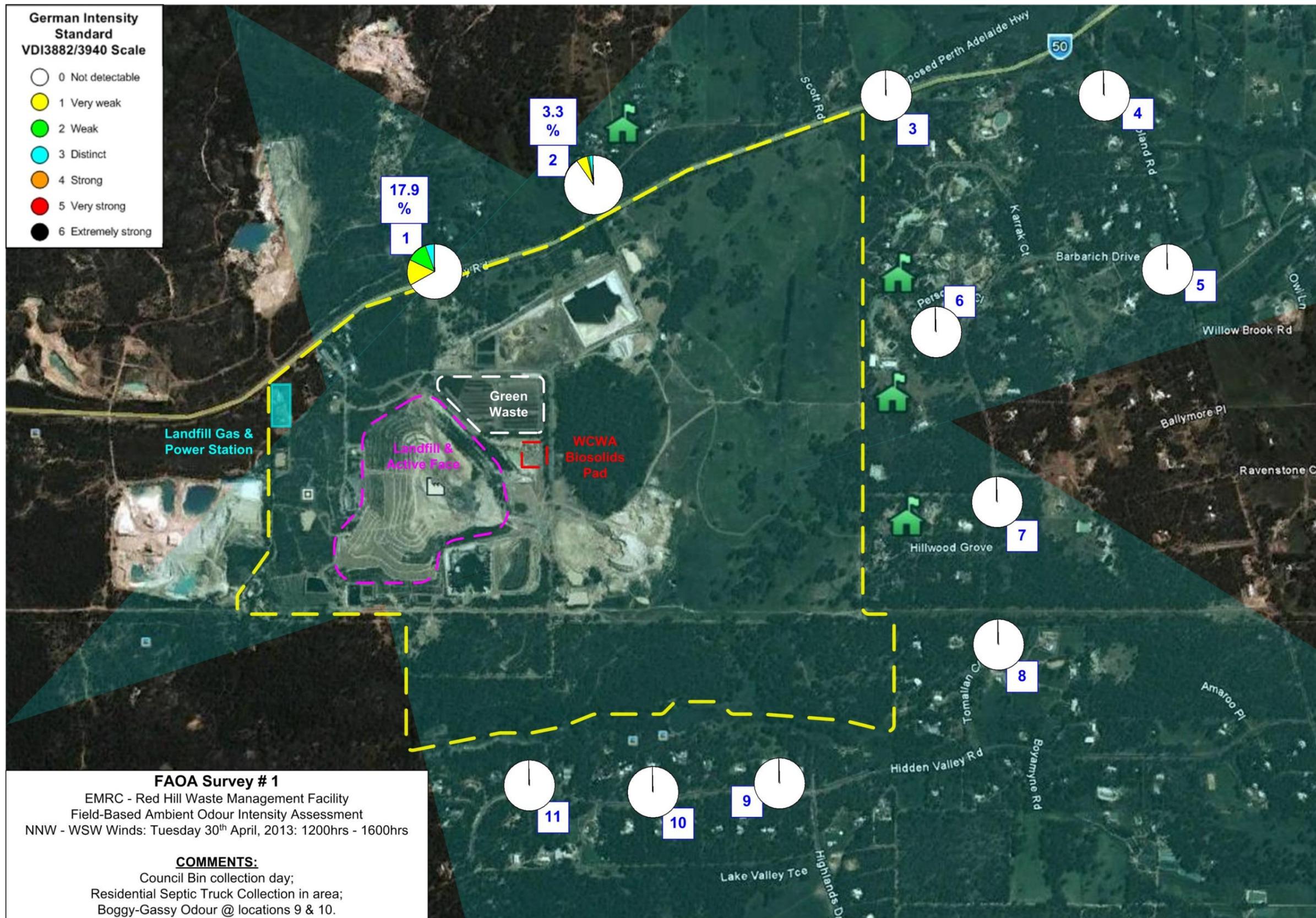


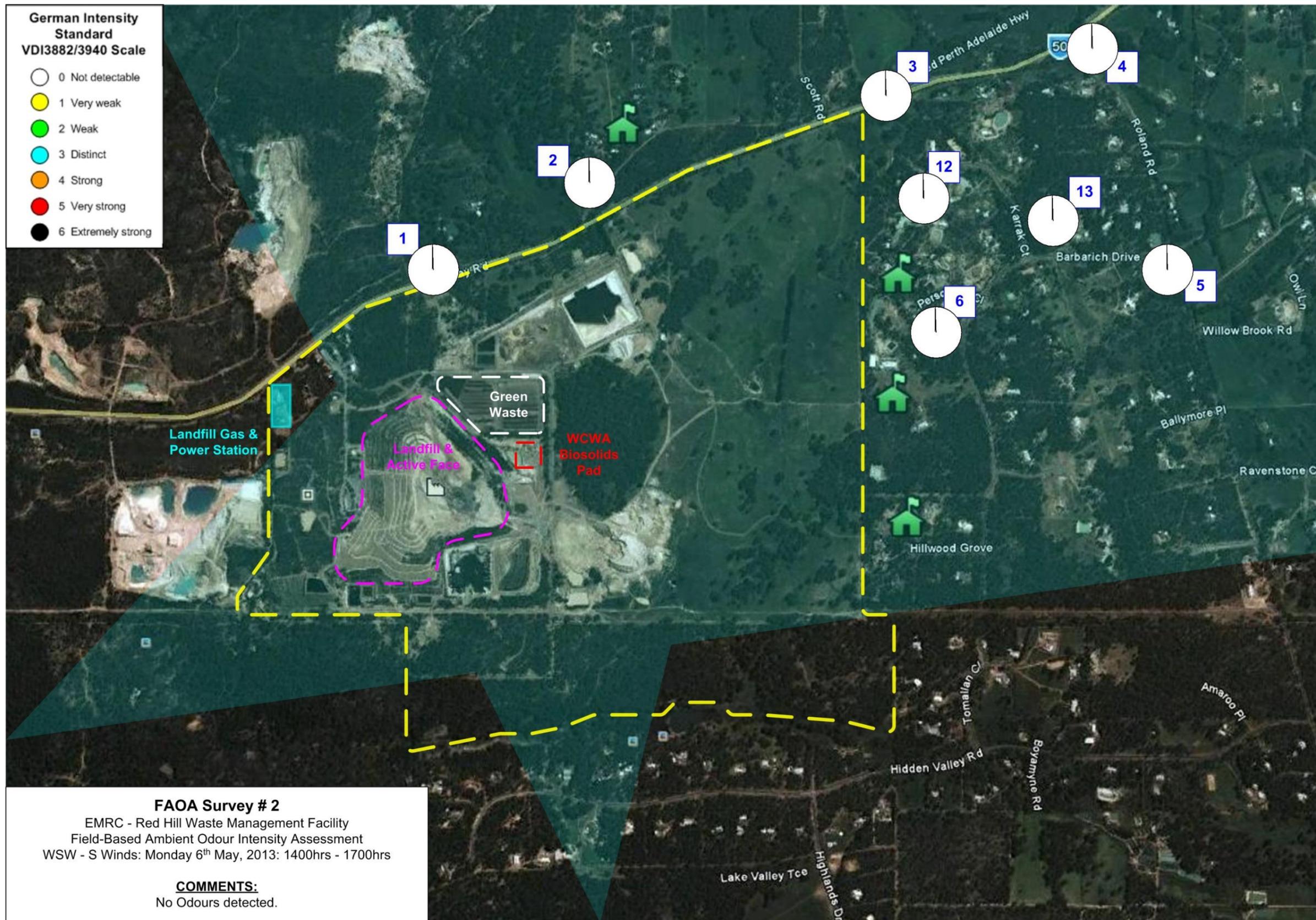
complaint/s did arise through the EMRC complaints hotline suggesting that Biosolids odour was in the community;

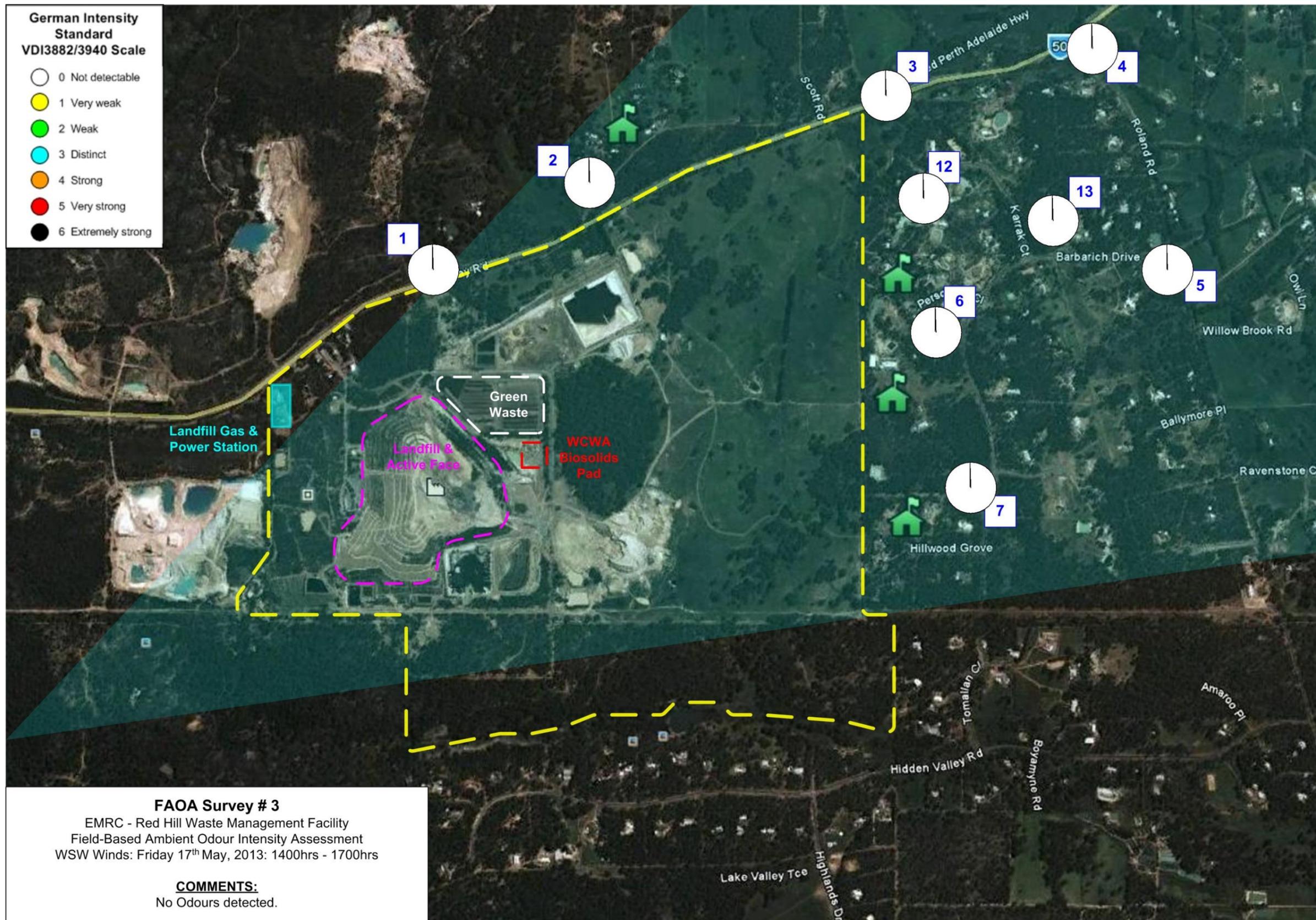
- On at least one occasion the EMRC did link a receptor complaint to works being undertaken at the Biosolids area within the WMF site
- Greenwaste odours were highly transient during the FAOA program. On one occasion the greenwaste odour was momentarily observed along Toodyay Road (southerly wind origin) prior to an actual survey. The team then setup to survey at that location however the timing of the survey and flux in wind conditions returned no result at that time;
- Results showed that the continued incidence of malodour often presented under cool and calm ambient conditions which precluded odours from effectively dispersing through thermal lift and/or mechanical stripping due to ground level turbulence, and where fluky/windy conditions prevailed (>calm) the malodour was observable although often quickly dispersed and/or dilute; and
- Conclusively, the Fruity-Fermented/Garbage/MSW odours from the Active Face activities, in particular during the end-of-day activities of Clay & ADC covering of the active face, were the most frequently observed offsite.

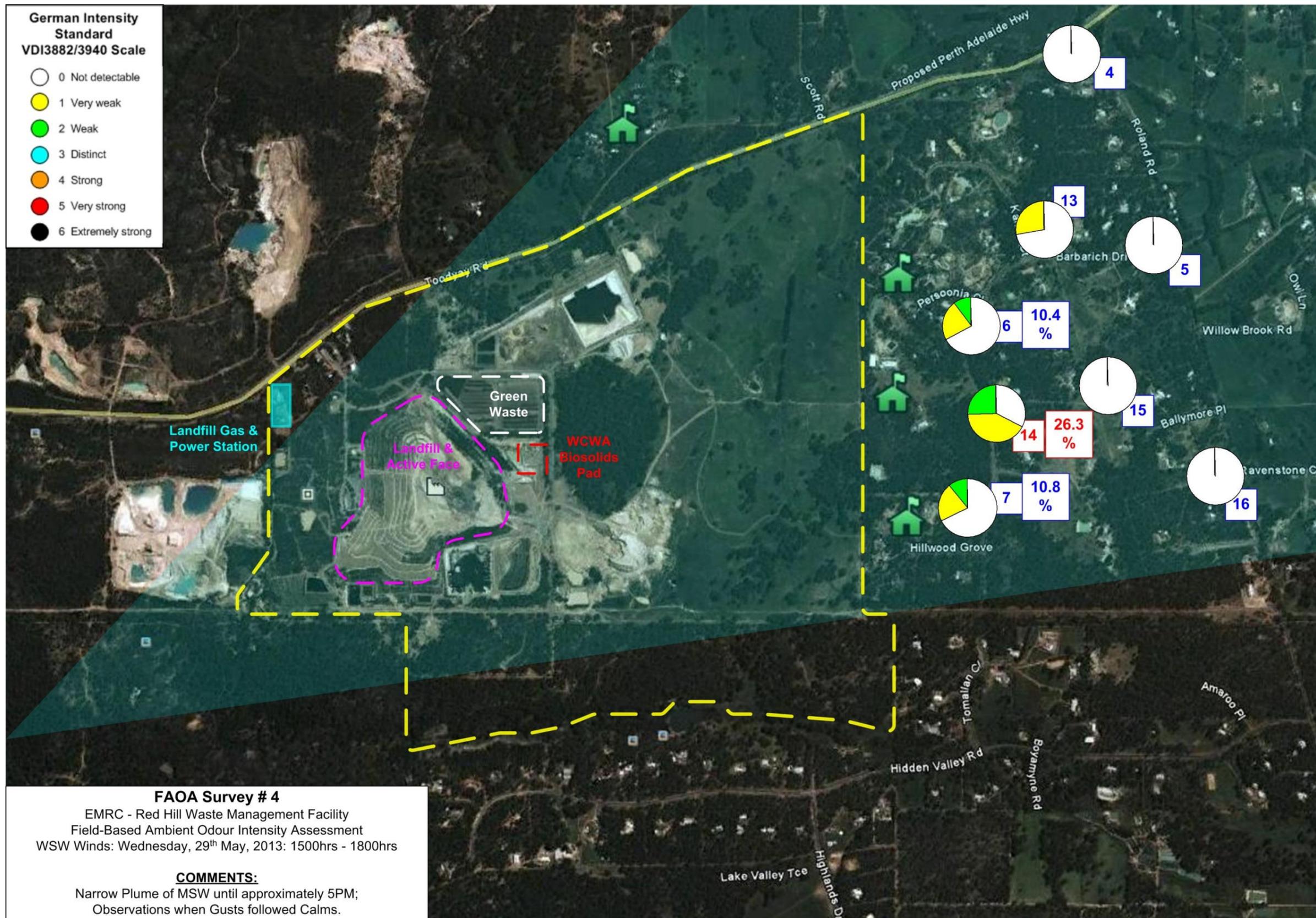
At the completion of each FAOA, the data is processed to derive frequency charts for observed odour intensities. At each measurement point, all assessors made their individual observations in concert with one another. In this way the data could be averaged for each measurement point. The data can be best “visualised” in FAOA maps which are presented below. The location numbers are used purely for identification and do not represent the order of each location surveyed.

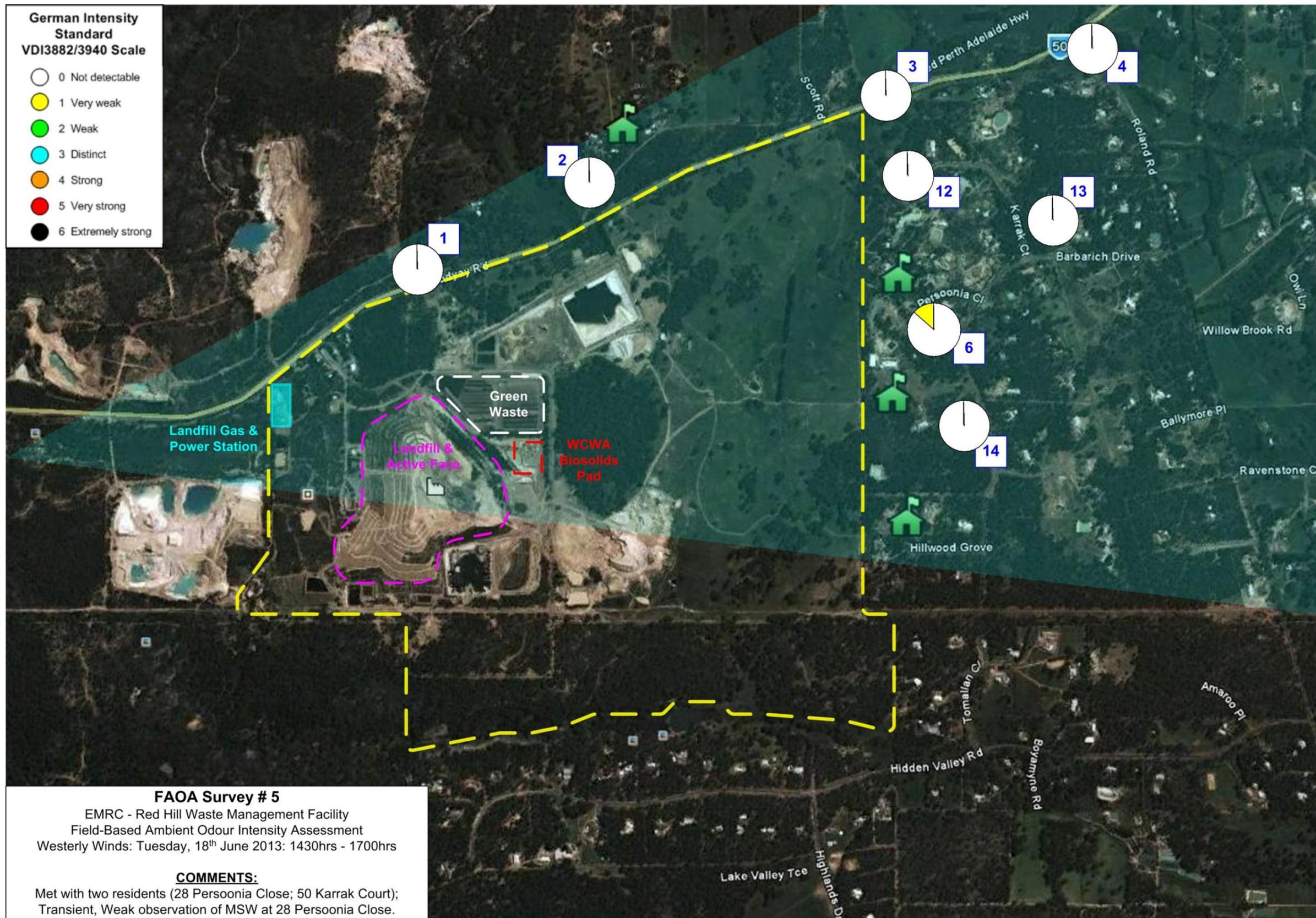
Following the FAOA maps is the statistical data tabulated for each FAOA comparing the frequency and intensity of odours observed at each survey location.

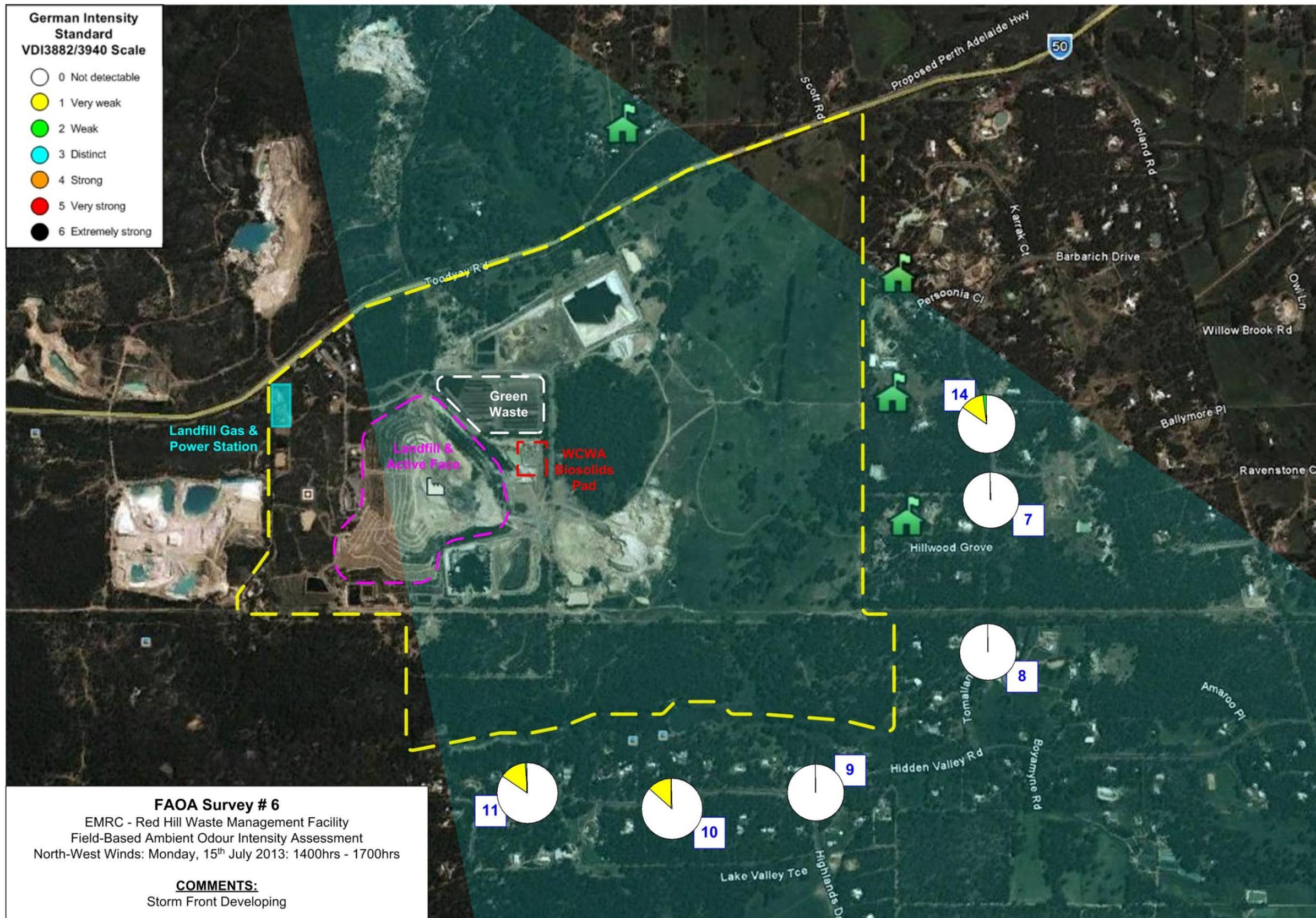


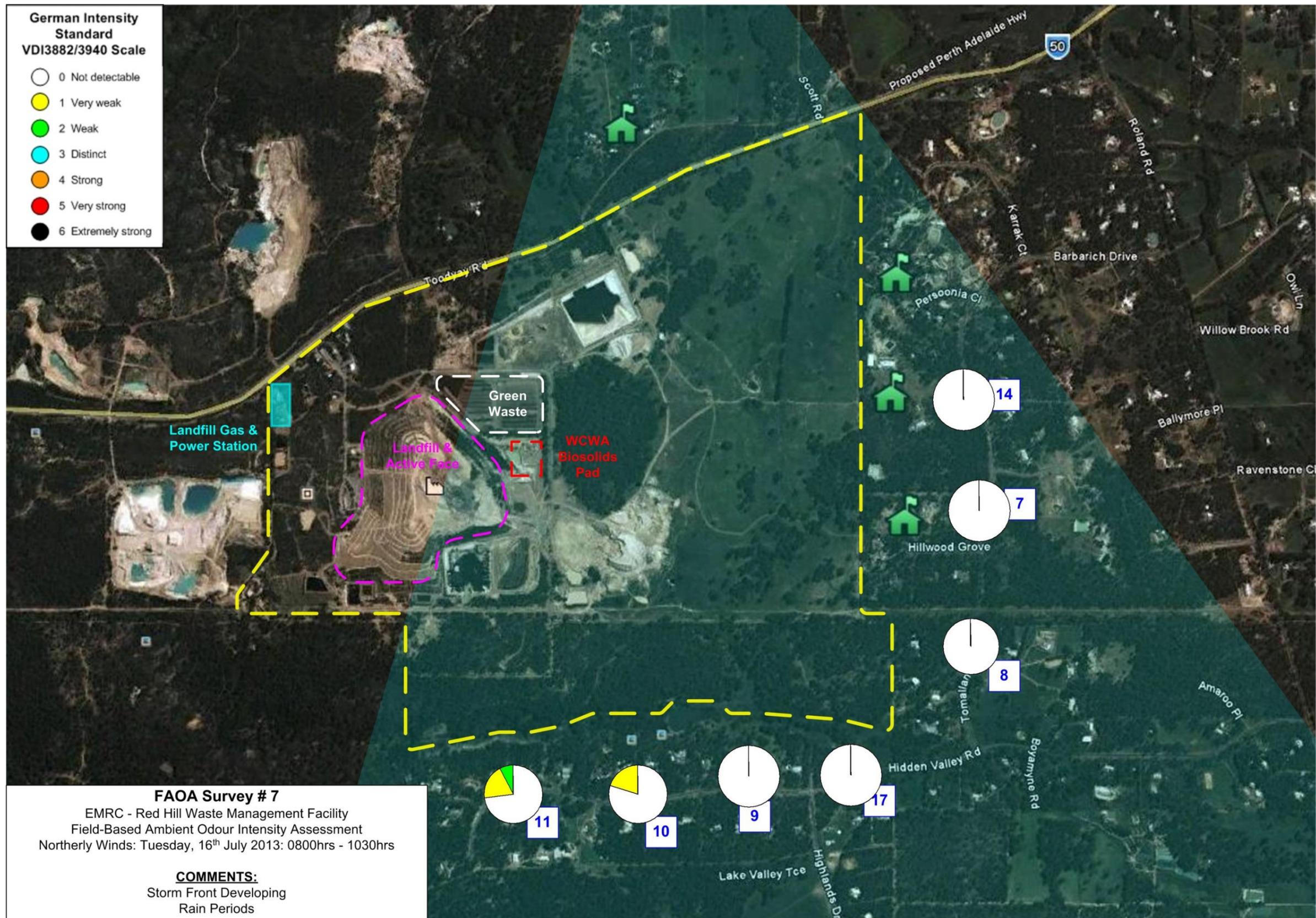


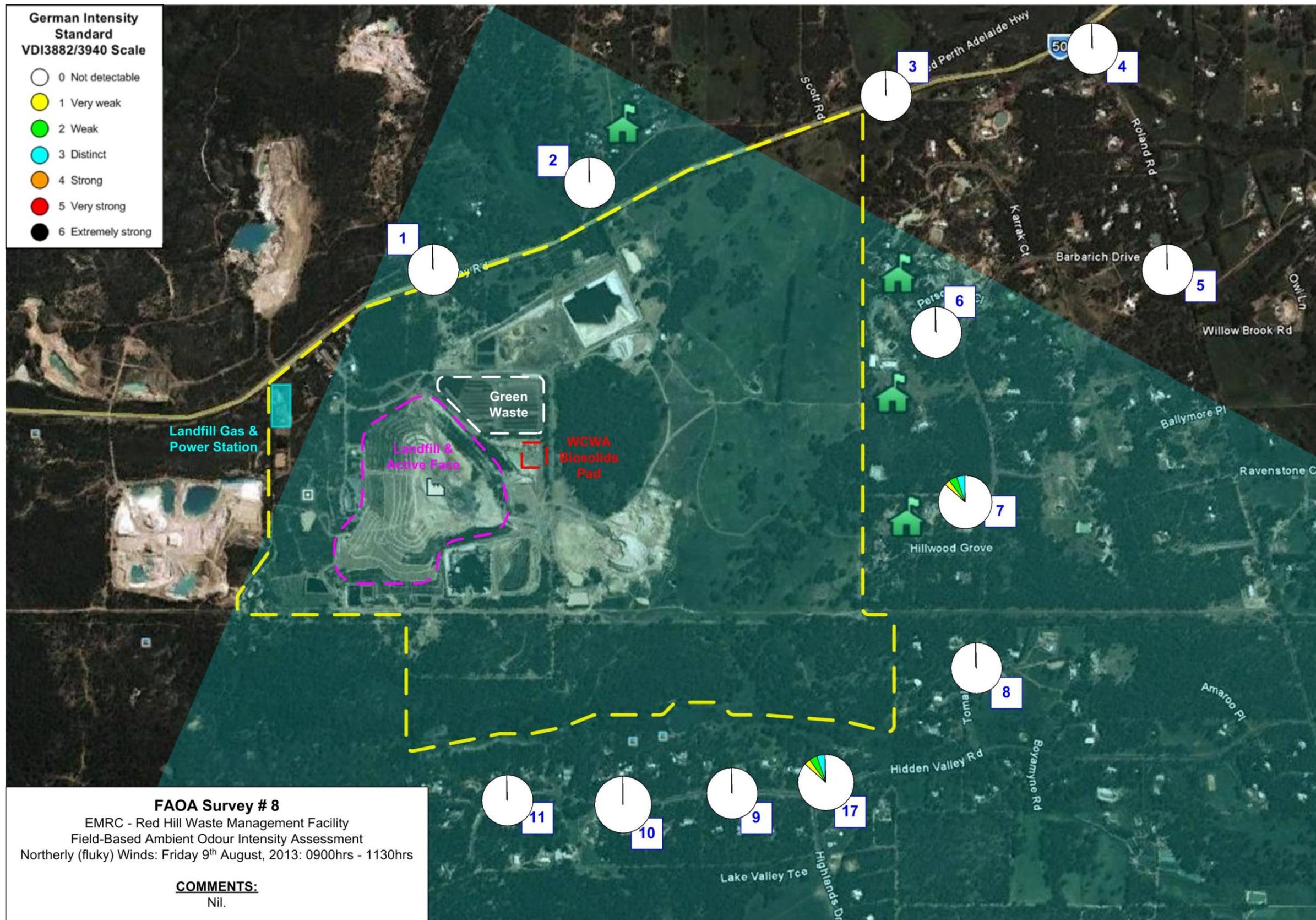














**Table 5.1:** FAOA Survey Number; FAOA Date; FAOA Day; FAOA Start Time; Survey Location & Frequency (%) of Odour Intensities Observed

FAOA Survey Number →	1	2	3	4	5	6	7	8	Averaged Odour Frequency (%) of Observed Odour Intensities	
Wind Direction →	NNE - WSW	SW	WSW	W - WNW	W	NW	N	N		
Date of FAOA →	30 <sup>th</sup> April	6 <sup>th</sup> May	17 <sup>th</sup> May	29 <sup>th</sup> May	18 <sup>th</sup> June	15 <sup>th</sup> July	16 <sup>th</sup> July	8 <sup>th</sup> August		
Day of FAOA →	Tuesday	Monday	Friday	Wednesday	Tuesday	Monday	Tuesday	Friday		
FAOA Start Time →	12PM	2PM	2PM	3PM	2:30PM	2PM	8AM	9AM		
Location 1 (Toodyay Road)	0	66.7	100	100	n/a	100	n/a	n/a	100	93.3
	1	15.4				3.1				
	2	12.5				2.5				
	3	5.4				1.1				
	4									
	5									
	6									
Location 2 (Toodyay Road)	0	90.4	100	100	n/a	100	n/a	n/a	100	98.1
	1	6.3				1.3				
	2	0.8				0.1				
	3	2.5				0.5				
	4									
	5									
	6									
Location 3 (Toodyay Road)	0	100	100	100	n/a	100	n/a	n/a	100	100
	1									
	2									
	3									
	4									
	5									
	6									
Location 4 (Cnr. Toodyay Road & Roland Road)	0	100	100	100	100	n/a	n/a	n/a	100	100
	1									
	2									
	3									
	4									
	5									
	6									
Location 5 (Roland Road)	0	100	100	100	n/a	n/a	n/a	n/a	100	100
	1									
	2									
	3									
	4									
	5									
	6									
Location 6 (Persoonia Close)	0	100	100	100	66.7	86.3	n/a	n/a	100	92.2
	1				22.9	13.8			6.1	
	2				10.4				1.7	
	3									
	4									
	5									
	6									
Location 7 (Barbarich Drive)	0	100	n/a	100	67.1	n/a	100	100	86.7	92.3
	1			22.1	4.2					
	2			10.8	2.6					
	3				0.8					
	4									
	5									
	6									
Location 8 (Tomallan Close)	0	100	n/a	n/a	n/a	n/a	100	100	100	100
	1									
	2									
	3									
	4									
	5									
	6									



Location 9 (Hidden Valley Road)	0	100					100	100	100	100
	1									
	2									
	3		n/a	n/a	n/a	n/a				
	4									
	5									
Location 10 (Hidden Valley Road)	0	100					86.3	79.6	100	91.5
	1						13.7	20.4		8.5
	2									
	3		n/a	n/a	n/a	n/a				
	4									
	5									
Location 11 (Hidden Valley Road)	0	100					84.2	71.2	100	88.9
	1						15.0	21.3		9.1
	2						0.8	7.5		2.0
	3									
	4									
	5									
Location 12 (Karrak Court)	0		100	100						100
	1									
	2	n/a								
	3						n/a	n/a	n/a	
	4									
	5									
Location 13 (Cnr. Barbarich Drive & Karrak Court)	0		100	100	71.7	100				92.9
	1				28.3					7.1
	2									
	3	n/a					n/a	n/a	n/a	
	4									
	5									
Location 14 (Barbarich Drive)	0				32.9	100	84.6	100		79.4
	1				40.8		13.8			13.6
	2				26.3		1.7			7.0
	3	n/a	n/a	n/a					n/a	
	4									
	5									
Location 15 (Bond Retreat)	0				100					100
	1									
	2									
	3	n/a	n/a	n/a			n/a	n/a	n/a	
	4									
	5									
Location 16 (Roland Road)	0				100					100
	1									
	2									
	3	n/a	n/a	n/a			n/a	n/a	n/a	
	4									
	5									
Location 17 (Hidden Valley Road)	0							100	83.3	91.7
	1								8.33	4.17
	2								8.33	4.17
	3	n/a	n/a	n/a			n/a			
	4									
	5									

*n/a = not assessed due to unfavourable wind direction (wind origin)*



The data tabled above shows the individual dates of each FAOA, the weather conditions, FAOA start time and the corresponding odour intensity and frequency observations for each measurement point. There were seventeen (17) measurement points.

The data can also be represented graphically by plotting the receptor distance from the odour source versus the ground level concentration of averaged observed odours.

These ground level odour concentrations were estimated by using the Weber-Fechner relationship which is described in the VDI (1992) standard and is as follows:

$$I = m \text{ Log}(C) + b \quad (\text{Equation 1})$$

Or

$$C = 10 [(I - b) / m] \quad (\text{Equation 2})$$

Where

I = Numerical rating of odour intensity (strength) defined in the German standard "Olfactometry – Determination of Odour Intensity" (VDI 1992), (Intensity units).

m = Odorant-specific slope sometimes referred to as Weber-Fechner constant (Intensity unit/ou).

C = Odour concentration (ou).

b = Odorant-specific intercept (Intensity unit/ou).

A previous study undertaken by SLR for the EMRC in 2012 reported the constant as 2.5. In this 2012 report, the value of m, otherwise known as the Weber-Fechner constant  $k_w$ , was taken from another study of municipal garbage in 2006 which estimated that at an odour intensity of '3', the corresponding odour concentration is 10 odour units (ou). The value of b was also taken from the 2006 study which was 0.5.

Utilizing an intensity of 3 and its corresponding odour strength of 10ou, together with the odorant-specific intercept (b) of 0.5, derivation of the Weber-Fechner constant ( $k_w$ ) is as follows:



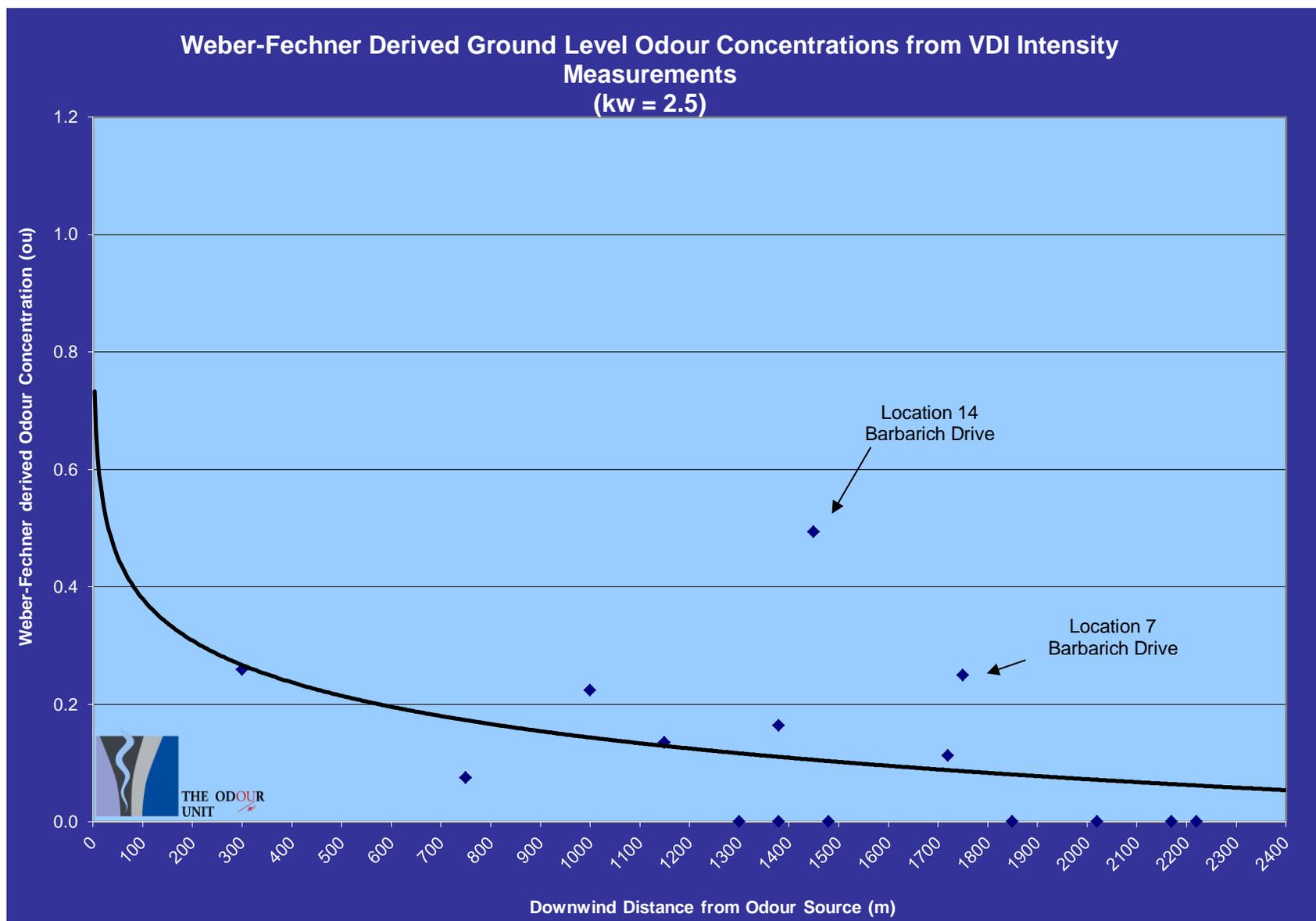
$$\begin{aligned}k_w &= [l - b] / [\log C] \\ &= [3 - 0.5] / [\log 10] \\ &= [2.5] / [1]\end{aligned}$$

$$k_w = 2.5$$

This constant of 2.5 was utilised in 2012 to estimate ground level odour concentrations from the odour intensity data collected between March – May 2012. The findings were determined by SLR to sufficiently correlate with SLR's odour emission modelling assessment, and therefore deemed the methods used to sample and assess those odour emissions to be valid.

Utilizing the constant value of 2.5, the graph below illustrates the plotted relationship of those averaged odour intensity observations, which have been converted to ground level concentrations, plotted against the distance from the nearest odour source at the EMRC Red Hill WMF. For measurement point 1, the nearest odour source is the edge of the Greenwaste Facility, whereas for measurement points 9, 10 and 11, the nearest WMF odour source is the active face of the landfill.

The graph shows the clear trend that odour is decaying the further distance away from the odour source an observer is. However, there are outliers on the graph below, in particular two measurement points (locations) on Barbarich Drive. These two observation measurement points were assessed under westerly conditions with, in general, a clear line of sight to the WMF. Therefore there is less ability for the odour to be scrubbed or dispersed by topographical features; hence a higher observed odour concentration than those measurement locations 'around' it. Key complainant locations require very specific wind conditions and times of day to replicate the odour impacts at those locations which cannot always be achieved when undertaking this type of field assessment; however, the graph shows low level odour intensity impacts are observable up to distances of typically 1,800m offsite of the EMRC Red Hill WMF.





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## 6 DISCUSSION OF FAOA SURVEY RESULTS

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A total of eight (8) individual field based ambient odour intensity assessments (FAOA's) were undertaken from the 30<sup>th</sup> April – 9<sup>th</sup> August 2013, for the EMRC Red Hill WMF. Seventeen (17) individual measurement points were assessed over the course of the 8 FAOA's.

The results have shown that odour is a factor in the community and that the primary odorant is emanating from the general landfill (Class III) at the WMF. Other WMF sources of odour are from the Greenwaste Facility, with transient odours emanating from the WCWA Biosolids, Landfill Gas & Power Plant (LGP) due to incomplete combustion and potentially fugitive odours from the capped landfill cells, specifically when the cells are being drilled for gas extraction.

When considering odour impacts at each surveyed measurement point, measurement point 14 (Barbarich Drive) was considered odour impacted during the FAOA undertaken on Wednesday 29<sup>th</sup> May from 3PM and under a westerly wind origin, since the odour criterion of 20% of observations for an intensity of 2 was exceeded.

Although only one measurement point was considered impacted during the FAOA program, the findings nonetheless verify the data already received from key complainants and demonstrate that the type of complaints (times of day, character of odours observed) are substantiated.

The frequency and intensity of the odours observed by TOU were not expected to be the same as those observed by complainants. This is because the FAOA's undertaken by TOU represent a small percentage of 'exposure' time to the WMF daily odours compared to that of the residing complainants. In general TOU spent 3 hours in the field per FAOA of which represents 20% of the daily time that residents may be exposed to WMF odours between 7AM – 9PM (based on working daily operational hours and times of complaints). However, the data collected verified the complaints and subsequently showed that the general landfill activity, to include the daily covering of the active face, is the primary source of malodour in the community.