



**Cwm Environmental
(Nantycaws)
Composting Facility**

Bioaerosols Monitoring

25th July 2022

**3rd Quarter Report 2022
'Open Windrow Composting'
(IVC Compost Processing has ceased)**

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Llanddarog Rd.
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**Site Detail:
Composting Facility (IVC & Pad)
Nantycaws Landfill Site
Llanddarog Rd.
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**Sampling date 25th July 2022
Report date 17th August 2022**

SUMMARY NANTYCAWS BIOAEROSOLS MONITORING

The In Vessel Composting (IVC) and External Windrow (Pad) Composting Operations

The Cwm Environmental composting facilities are located at the Nantycaws Landfill Site Llanddarog Road, Nantycaws, Carmarthenshire. There were two linked sites: the 'In-Vessel Composting Facility and the External Composting Pad. The sites are located in a rural area near to the Nantycaws landfill. The two sites were amalgamated under one bespoke Environmental Permit, (EPR/EP3698FL, November 2012); however, from 2020 the IVC has been idle.

Currently, the enclosed process IVC is idle and is not undertaking composting activities.

There are offices, a Civic Amenity site, **Materials Reclamation Facility** and the **Landfill** nearby. The **IVC facility** is just within 250m of a farmstead that is to the east of the overall facility.

The **Open Windrow Composting facility** is located to the north-west of the Offices and north-north-east of the landfill. To the north-west of the facility is a derelict farmstead 'Ty Hen'. Further to the north is the A48 highway with a petrol station and houses beyond.

Bioaerosols, composting and health effects

Bioaerosols are complex mixtures of airborne micro-organisms and their products, and are ubiquitous, particularly in rural environments. The most serious health problems appear to arise from *Aspergillus Fumigatus*, but there may be other fungal spores and bacteria that may present environmental effects at or near to composting facilities.

Environment Agency Requirements to Monitor Bioaerosols Emissions

Environment Agency Revised and Updated Policy in regard to Bioaerosols

Bioaerosols comes under the statutory control of the Natural Resources Wales, which has adopted the Environment Agency 'Policy' to provide the basis for monitoring bioaerosols. The Environment Agency (England) guidance is to use the M9 Methodology for the monitoring of bioaerosols.

This report utilises the M9 Method [Appx 2] with regard to upwind/downwind sampling.

In 2021 the NRW advised that the monitoring and sampling of bioaerosols could be reduced to twice per year. The site is waiting for the NRW letter of confirmation for this.

This Report

This report provides the **3rd Quarter 2022** bioaerosols monitoring results. With the IVC **NOT** undertaking composting; the focus was on sampling for the **External Windrow Composting Facilities**. On the day selected the activities of **Green Waste Compost WINDROW TURNING** on the pad were being undertaken. The wind direction was from the **SSE** i.e. was blowing **from** the MRF Site and was blowing across the site out **towards** the **NNW** i.e. to the North of Ty Hen and on to the A48 (i.e. to the west of the 'nearest sensitive receptor' – NSR). The following was concluded from the air quality results sampled **25/07/2022**:

Overall Conclusions

The **Maximum Median Upwind** Total Bacteria bioaerosols level was 30 cfu/m³; where-as the *Aspergillus Fumigatus* bioaerosols was 27 cfu/m³. The **MAXIMUM MEDIAN DOWNWIND** bioaerosols levels were increased: The **Total Bacteria was 200cfu/m³** (MEDIAN 157 cfu/m³); but the ***Aspergillus Fumigatus* was only 79 cfu/m³** (MEDIAN 43 cfu/m³). It was noted that the concentrations were consistent in the replications. Overall, the **Total Bacteria and *Aspergillus Fumigatus*** bioaerosols levels remained at less than 21% of the guidance threshold.

These levels are well within NRW thresholds and represent minimal risk to receptors.

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This Report provides the results of a specific one-day session of sampling of bioaerosols at the Composting Facility. The report follows guidelines provided within the M9 Guidance for monitoring bioaerosols.

Reference to The M9 Guidance and the AfOR Protocol

The M9 Guidance (refer APPENDIX 2) is referred to throughout; and was used as the basis for the methodology employed during these sampling sessions.

Recogen Ltd. Environmental Quality Reporting – An Independent Assessor

For the purposes of quality assurance in undertaking this risk assessment/monitoring work, Recogen Ltd. is a recognised organisation with appropriately trained, qualified and experienced personnel; *independent* to the composting site operator. This assessment/monitoring work was undertaken by D J Baldwin, BSc (Hons) CEnv. MCIWM, Technical Director with Recogen Ltd. who has 40 years waste and environmental management experience. David is FACTS (fertiliser advice certification) qualified and has the Environmental Permit Operators Certificate.

Recogen Ltd. is registered as a Quality Environmental Consultancy on the National Business Link Register and is a supplier of Technical Consultancy to DEFRA, The Waste and Resources Action Programme (WRAP) and to The Organic Recycling Group being part of the Renewable Energy Association

David has managed or contributed to many major projects on waste management for Government (**DEFRA, ETSU, DTI, WRAP, EA**) and The Waste Management Industry including Composting and Anaerobic Digestion processes, compost site design, product quality assurance (PAS100:2011 and 2018), The Compost Quality Protocol, ISO9001, ISO14001, COSHH and H&S Risk Assessments.

D and F Associates Laboratory (Widnes, Cheshire) was used for provision and enumeration of the Collection Plates. This laboratory operates to the UKAS accredited standards.

Notes:

1. Culture media supplied by D and F Associates Laboratory (Widnes, Cheshire) is in accordance with that specified in the AfOR Protocol. The mediums used are particularly useful for the identification of bacteria and the type used for the mould species and allows the Laboratory to accurately identify and quantify *Aspergillus Fumigatus* on plates that may contain many other mould species.

2. D and F Associates Laboratory (Widnes, Cheshire) operates to the UKAS accredited standards and also runs its own internal Quality Management System. All media preparation and storage is carried-out in accordance with UKAS approved Standard Operating Procedures and fully recorded to appropriate standards. D and F Associates Laboratory is an approved supplier of services to the Environment Agency.

BIOAEROSOLS MONITORING - DEFINITIONS

Bioaerosols, composting and health effects.

Bioaerosols are complex mixtures of airborne micro-organisms and their products, and are ubiquitous, particularly in rural environments. The more serious health problems appear to arise from *Aspergillus Fumigatus*, but there are other fungal spores and bacteria that may cause problems. International studies have shown that there is a wide variability in individual susceptibility to bioaerosol exposure.

Commercial scale composting activities tend to generate large amounts of bioaerosols; and these are likely to contain human allergens and pathogens. They have potential effects on respiratory health and may cause headaches, nausea and fatigue. There has been very little investigation into the effects of community exposure to bioaerosols from composting, but there is some limited data that suggest that living close to a composting facility may be associated with an increased risk of adverse health effects. The consensus from various studies is that bioaerosols from composting activities decline rapidly within the first 100 metres from a site and generally decline to background levels within 250m.

Composting

Composting is the biological decomposition of biodegradable waste under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat. It may include associated waste storage and treatment operations carried out at the composting facility.

Operations...likely to result in the uncontrolled release of high levels of bioaerosols; include the shredding of waste and the turning of waste in the sanitisation, stabilisation, and maturation stages of composting where these operations are not contained or are not subjected to exhaust ventilation and scrubbing/filtering.

sensitive receptors

'Sensitive receptors' refers to people likely to be within 250 metres of the composting operation for prolonged or frequent periods. This term would therefore apply to dwellings (including any associated gardens) and to workplaces where workers would frequently be present. It does not apply to the operators of composting facilities or their staff while carrying out the composting operation as their health is covered by Health and Safety legislation.

acceptable levels at the sensitive receptors

Refers to the concentrations of bioaerosols (as predicted or as derived from direct measurements) at the sensitive receptors that are attributable to the composting operations.

The acceptable (appropriate) levels (given as colony forming units per cubic metre of air) are:

Bioaerosol type	Threshold value	units
Total Bacteria	1000	cfu m ⁻³
Aspergillus Fumigatus	500	cfu m ⁻³

1.0 SITE LOCATION (IVC and External Composting Facility)

The Composting Facility
Cwm Environmental
Nantycaws Landfill Site
Llanddarog Rd.
Nant y Caws
Carmarthen
SA 32 8BG

Figure 1: Nantycaws Composting Site Location Map

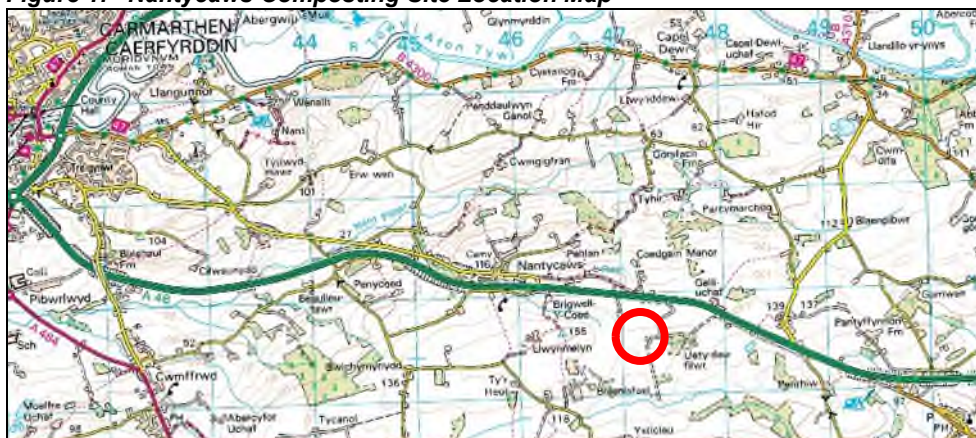
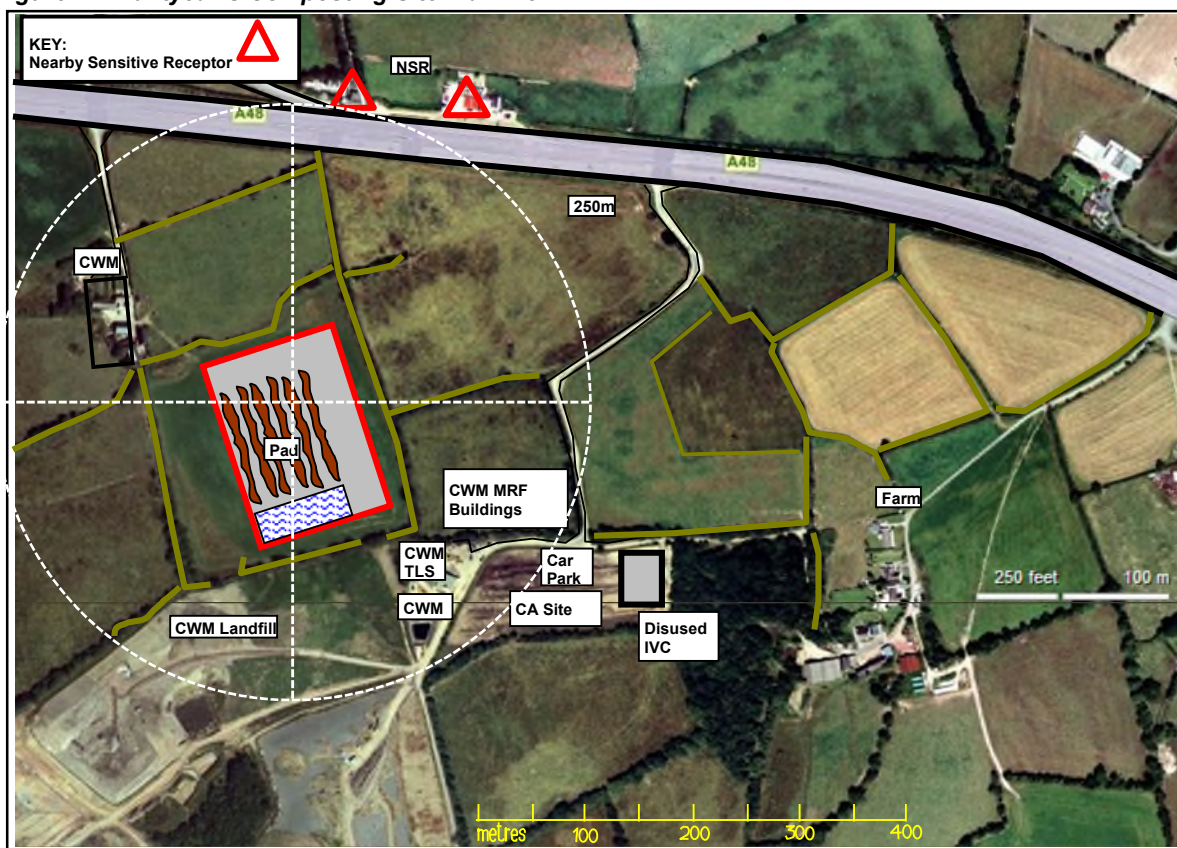


Figure 2: Nantycaws Composting Site Plan View



2.0 INTERPRETATION OF THE NRW / EA's BIOAEROSOL POLICY

2.1 Composting and Bioaerosols

Composting processes rely on biological activity, notably the utilisation of bacteria and fungi in order to bio-degrade the volatile material and convert it to more stable forms of humic substance. The process relies on mechanical treatment in the preparation and handling of the material, as well as specialist facilities for controlling the processes involved.

It is recognised that when any agitation of organic material occurs, especially turning, screening or shredding, or when leachate is recirculated, elevated numbers of micro-organisms may be released into the air. Once released into the air they can remain airborne for long periods and form a 'bioaerosol' – an aerosol of biological particles.

2.2 Bioaerosols Risk

Bioaerosols are small particles of biologically active material that may be carried independently in the air or otherwise may become attached to other particles of dust or moisture. Consequently, the minute particles may be inhalable and also respirable (deposited in the air sacs of the lungs where gases are exchanged). Some of the small particles (<3-5microns) in bioaerosols have the potential to be harmful to human health and can cause pathogenic or allergenic reactions. Human physiology and therefore susceptibility is receptor-dependent and so the EA have advised nominal values as reference levels for risk.

2.3 Environment Agency Policy and Approach to Bioaerosols.

The Environment Agency (The EA) has recently reviewed, updated and re-published ([Ref 3] 2010) its 'Policy' in regard to bioaerosols. This built upon the 2009 policy in regard to the use of 250metres as a distance from a composting activity, within which there was deemed greater risk. In summary, **the 2009 policy highlighted *the need to maintain bioaerosols at appropriate levels at any dwelling or workplace.***

In regard to this (see definitions in the Introduction on page 1) the M9 2018 follows the 2009 policy and provides the following: 'appropriate levels' may be....

- i) those before the start of the composting process or*
- ii) bioaerosols levels no greater than*
 - 1,000 colony forming units (cfu) m⁻³ total bacteria,*
 - 500 cfu m⁻³ Aspergillus Fumigatus and*

Reference to **appropriate levels** takes into account background levels specific to that locality. Background levels are highly variable and range from 1- 1,000 cfu/m³ or more.

2.4 Applying the Bioaerosols Policy to the Composting Site.

The open windrow Composting Facility at Nantycaws is situated within 250m of third-party workplaces and/or dwellings (see fig 2). These have been taken account of during monitoring.

3.0 COMPOSTING SITE - SENSITIVE RECEPTORS

3.1 IVC Site Situation with Regard to Sensitive Receptors

At this time the IVC facility is not in operation for composting. The IVC composting facility is located in the east of the site, in a rural setting and is separated from sensitive receptors by distances of >200 m. There is a farmstead and dwellings to the east that are 210m distant.

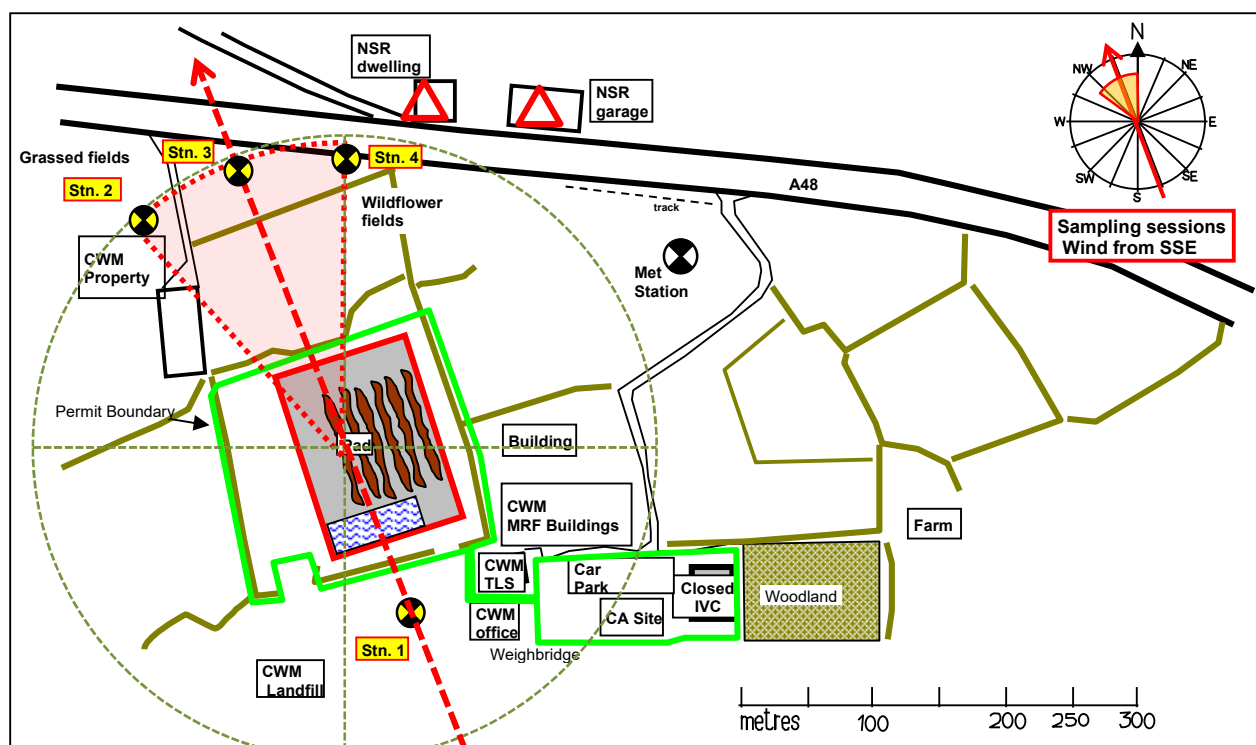
3.2 External Windrow Site Situation in Regard to Sensitive Receptors

The external windrow composting area is located within a rural area and is separated from sensitive receptors by distances of ~225 m. The Nearest Sensitive Receptors (NSR's) are the garage and dwellings on the northern side of the A48 carriageway and north of the facility.

4.0 BIOAEROSOL SAMPLING STATIONS

The following plan for sampling stations was utilised. The wind was generally towards the **North-North-Westerly direction** throughout the session and the sampling stations were located to provide data in accordance with the 'upwind' and 'downwind'; at locations as shown in Figure 3.

Figure 3: Sampling Station Locations – Open Windrow Composting Facility



Station 1.	SN 47224 17611	Located to the SSW , 50m from the site 100m UPWIND of the activity.
Station 2.	SN 46939 17892	Located 100m from the site to NW , 225m from centre of activity to provide the DOWNWIND sample to the LEFT of the centreline.
Station 3.	SN 47043 17952	Located 100m from the site to NNW , 225m from centre of activity to provide the DOWNWIND sample directly DOWNWIND of the Composting Pad .
Station 4.	SN 47136 17945	Located 100m from the site to N , 210m from centre of activity to provide the DOWNWIND sample to the RIGHT of the centreline.

The Materials Recovery Facility (MRF) treats municipal waste under a separate permit. Any emissions from this were not measured specifically but may have affected the downwind results.

5.0 BIOAEROSOL TYPES

The following types of bioaerosol were enumerated

Description	Total Bacteria	Aspergillus Fumigatus	Gram Negative bacteria
	cfu/m ³	cfu/m ³	<i>Not required</i>

These types relate to the EA guidance given earlier (Section 2.3 on page 3)

The gram-negative bacteria are NOT included because the IVC composting was deactivated.

6.0 BIOAEROSOL SAMPLING PROCEDURE

6.1 Standardised sampling Procedure

The procedure was based on the **M9 Methodology**. The Garage 'Sensitive Receptor' was **offset to the east** of the DOWNWIND of the site, but it's distance was used to determine locations from the site for the downwind stations. Each of the stations for the UPWIND and DOWNWIND samples were retained in their respective locations during all sessions as the variations in the wind directions were not so great as to entail significant variation within the downwind 'fan'.

6.2 Sampling Equipment

6.2.1 Samplers

Samplers comprised the 3 part 'Andersen' type sampler design, with base, sampling hole manifold and collection funnel. Hemi-cylindrical air stagnation baffles extending 150mm above the inlet to the cone were fitted during sampling. The samplers were mounted as a pair on a platform at the top of an adjustable tripod that enabled the inlet cone to be held at 1.5 - 1.8m above ground level.

6.2.2 Positive Displacement Suction Pumps

The air suction diaphragm pumps, were Charles Austen Pumps, twin headed parallel pumps operating off 12v DC Motors. The Pumps were pre-calibrated to provide a uniform air-flow rate with the target flow of 28.3 litres/minute (+/- 2%) (0.57 l/min). Measured flow-rates are shown in the results for each sampler.

6.3 Sample Collection media and Enumeration

The collection media and laboratory-based incubation and enumeration was undertaken by 'D&F Associates Labs' a laboratory working to UKAS accredited procedures.

6.4 Weather Monitoring Equipment

Weather during the sampling was monitored using a portable or on-site weather station, with temperature, humidity, wind direction and wind-speed monitoring. See section 7.

6.5 Sampler Locations

The sampling station locations are shown at figure 3.

6.6 Sample Management

The sample 'plates' were kept in a portable 12-volt refrigerator during the session and transport. The samples were delivered into the laboratory within 12 hours of the session completion.

7.0 MET DATA DURING SAMPLING

Weather data was recorded during the sessions of sampling. The Station was a Kestrel 4500, mounted on a tripod and mast at approx. 2.0m height above ground level. It was located on a clear open area of grass, approx. 25m west of the cattle grid near the main-road access. The station comprises a wind vane, anemometer, temperature and humidity sensors and programmable data-logger set at a logging interval of 1 minute. The data is shown at Table 1. The raw data is shown at Appendix 3.

Table 1: Meteorological Conditions Cwm Environmental, NantyCaws – 25th July 2022

Meteorological Conditions											
Site:		NantyCaws Landfill, Carmarthen				Site Operator:		Cwm Environmental			
Sampling Date:		25th July 2022				Monitoring Contractor:		Recogen Ltd.			
Sample Ref Nos.		Location	Bearing of Samplers from centre of Active Area ° to N	Mean Wind Direction wind blows TO during sampling period degrees ° to N	Difference in bearing of samplers and mean direction wind blows TO degrees ° to N	Wind Speed as sampling ms ⁻¹ @ 2m @10m		Mean Air Temp as sampling °C	Mean Air RH Mean RH%	Prevailing Weather Pressure mbar	Cloud Cover 1/8 ths (okta)
C	1A Dual Upwind	Upwind Stn. 1	165	346	-181	2.2	3.0	16.2	70.1	1015	5/8
C	1B Dual Left	Downwind Stn. 2	320		-25.7						
C	1C Dual Centre	Downwind Stn. 3	345		-1						
C	1D Dual Right	Downwind Stn. 4	370		24						
C	2A Dual U2wind	Upwind Stn. 1	165	339	-174	1.7	2.4	16.7	68.3	1015	5/8
C	2B Dual Left	Downwind Stn. 2	320		-18.8						
C	2C Dual Centre	Downwind Stn. 3	345		6						
C	2D Dual Right	Downwind Stn. 4	370		31						
C	3A Dual Upwind	Upwind Stn. 1	165	344	-179	2.1	2.9	17.0	66.0	1015	5/8
C	3B Dual Left	Downwind Stn. 2	320		-24.3						
C	3C Dual Centre	Downwind Stn. 3	345		1						
C	3D Dual Right	Downwind Stn. 4	370		26						
C	4A Dual Upwind	Upwind Stn. 1	165	341	-176	2.2	3.0	16.9	68.7	1015	5/8
C	4B Dual Left	Downwind Stn. 2	320		-21.3						
C	4C Dual Centre	Downwind Stn. 3	345		4						
C	4D Dual Right	Downwind Stn. 4	370		29						

In the early afternoon, during the monitoring, the weather was warm, bright and dry but with a fresh breeze from the South-South-East. The data recording was started 13:24PM and the temperature was steady at around 16.2 – 17.0° C. The sky remained bright with high cloud at 5/8. The wind from the **South-South-East** blowing out towards the **NNW**; as a fresh breeze at 1.7 to 2.2 m/sec at times. The air was dry with the relative humidity moderate at ~70% RH falling to 66% at times.

8.0 THE BIOAEROSOL SAMPLING RESULTS

The full raw results are shown in Appendix 1. These show the counts per plate and the calculation of the concentrations for each bioaerosol, based on the sampling time and airflow in the samplers.

The Data are presented in Tables 2 and 3 in accordance with the M9 Guidance. Table 2 shows the Results for **Total Viable Bacteria** and Table 3 shows the results for the **Aspergillus Fumigatus**.

The tables reveal the **MEAN** of the **UPWIND** results; and the **MEDIAN** of the **DOWNWIND** sampling results. The overall Median value is derived from all of the individual results.

Table 2: Sampling Results – TOTAL BACTERIA – Cwm Environmental – 25th July 2022

Site:		NantyCaws Landfill, Carmarthen		Type of materials on site		Composted Green Waste			
Sampling Date:		25th July 2022		Estimated material on site		4500 tonnes			
Site Operator:		Cwm Environmental		Type of Activity		Open Windrow Composting			
Monitoring Contractor:		Recogen Ltd of Shrewsbury.		Activities affecting bioaerosols release		Compost Turning . Other vehicle movements around the site.			
				Bioaerosol Type:		TOTAL BACTERIA			
Sample Ref Nos. Station Location ref.		Station Location bearing from centre of site ° from N	Distance from centre of activity metres	Difference in bearing between sampler location and mean direction that wind blows TO	Sampling Period		Concentration of bioaerosols Total Viable Bacteria cfu/m³	Median of UPWIND Samples Total Bacteria cfu/m³	Median of DOWNWIND Samples Total Bacteria cfu/m³
All Sample Refs: 'T' (Total Viable Bacteria)					Start Time	End Time			
C1 AT	UW Stn. 1	165	100	-181	13:27	13:47	30	30	200
C1 BT	DW Stn. 2	320	225	-26	13:33	13:38	200		
C1 CT	DW Stn. 3	345	225	-1	13:35	13:40	379		
C1 DT	DW Stn. 4	370	210	24	13:37	13:42	200		
C2 AT	UW Stn. 1	165	100	-174	14:08	14:28	13	13	71
C2 BT	DW Stn. 2	320	225	-19	14:14	14:19	50		
C2 CT	DW Stn. 3	345	225	6	14:16	14:21	243		
C2 DT	DW Stn. 4	370	210	31	14:18	14:23	71		
C3 AT	UW Stn. 1	165	100	-179	14:47	15:07	13	13	157
C3 BT	DW Stn. 2	320	225	-24	14:53	14:58	157		
C3 CT	DW Stn. 3	345	225	1	14:55	15:00	550		
C3 DT	DW Stn. 4	370	210	-24	14:57	15:02	136		
C4 AT	UW Stn. 1	165	100	-176	15:28	15:48	5	5	121
C4 BT	DW Stn. 2	320	225	-21	15:34	15:39	121		
C4 CT	DW Stn. 3	345	225	4	15:36	15:41	300		
C4 DT	DW Stn. 4	370	210	29	15:38	15:43	79		
				MEDIAN UP and DOWNWIND VALUE				13	157
				MAXIMUM MEDIAN UP & DOWNWIND VALUE				30	200

Commentary to assist interpretation

1. The wind during the sampling session was from the **SSE**; arriving from the grassed landfill/MRF site and exiting the Composting site towards the west of the A48 Garage and dwelling in the **NNW**.
2. The **UPWIND** values for Total Bacteria were **VERY LOW** i.e. median of 13 cfu/m³.
3. The **DOWNWIND MEDIAN** values for **Total Bacteria** showed a moderate increase compared to the samples in the Upwind; **BUT remained LOW**. The **DOWNWIND MEDIAN** value was 157 cfu/m³. There were some variations.
4. The **MAXIMUM MEDIAN VALUE** (derived from all values) was 200 cfu/m³.
5. The results show the benefit of retaining moisture within the windrows, and damping down dust.

Table 3: Sampling Results – ASPERGILLUS FUMIGATUS - Cwm Environmental - 25th July 2022

Site:		NantyCaws Landfill, Carmarthen		Type of materials on site		Composted Green Waste			
Sampling Date:		25 th July 2022		Estimated material on site		4500 tonnes			
Site Operator:		Cwm Environmental		Type of Activity		Open Windrow Composting			
Monitoring Contractor:		Recogen Ltd of Shrewsbury.		Activities affecting bioaerosols release		Compost Turning . Other vehicle movements around the site.			
				Bioaerosol Type:		ASPERGILLUS FUMIGATUS			
Sample Ref Nos. Station Location ref. All Sample Refs: 'F' (Asp. Fumigatus)		Station Location bearing from centre of site ° from N	Distance from centre of activity metres	Difference in bearing between sampler location and mean direction that wind blows TO	Sampling Period Start Time End Time		Concentration of bioaerosols Aspergillus Fumigatus cfu/m ³	Median of UPWIND Samples Aspergillus Fumigatus cfu/m ³	Median of DOWNWIND Samples Aspergillus Fumigatus cfu/m ³
C1 AF	UW Stn. 1	165	100	-181	13:27	13:47	13	36	
C1 BF	DW Stn. 2	320	225	-26	13:33	13:38	71		
C1 CF	DW Stn. 3	345	225	-1	13:35	13:40	14		
C1 DT	DW Stn. 4	370	210	24	13:37	13:42	36		
C2 AF	UW Stn. 1	165	100	-174	14:08	14:28	16	43	
C2 BF	DW Stn. 2	320	225	-19	14:14	14:19	43		
C2 CF	DW Stn. 3	345	225	6	14:16	14:21	43		
C2 DF	DW Stn. 4	370	210	31	14:18	14:23	57		
C3 AF	UW Stn. 1	165	100	-179	14:47	15:07	13	79	
C3 BF	DW Stn. 2	320	225	-24	14:53	14:58	14		
C3 CF	DW Stn. 3	345	225	1	14:55	15:00	107		
C3 DF	DW Stn. 4	370	210	-24	14:57	15:02	79		
C4 AF	UW Stn. 1	165	100	-176	15:28	15:48	27	64	
C4 BF	DW Stn. 2	320	225	-21	15:34	15:39	50		
C4 CF	DW Stn. 3	345	225	4	15:36	15:41	64		
C4 DF	DW Stn. 4	370	210	29	15:38	15:43	86		
				MEDIAN UP and DOWNWIND VALUE				13	43
				MAXIMUM MEDIAN UP & DOWNWIND VALUE				27	79

Commentary to assist interpretation

1. The wind during the sampling session was from the **SSE**; arriving from the grassed landfill and MRF; and exiting the Composting site towards the West of the A48 Garage and dwelling in the **NNW**.
2. The **UPWIND** values for Aspergillus Fumigatus were **VERY LOW** i.e. **median of 13 cfu/m³**.
3. The **DOWNWIND** values for **Aspergillus Fumigatus** showed a **SMALL** elevation compared to the samples in the Upwind. The **DOWNWIND MEDIAN** value was **43 cfu/m³**. The **MAXIMUM MEDIAN VALUE** (derived from all values) was **79 cfu/m³**.
4. The results show the benefit of retaining moisture within the windrows, and damping down dust. Aspergillus Fumigatus are also reduced by maintaining stabilisation temperatures at less than 55°C.

9.0 DISCUSSION OF RESULTS

9.1 Summary – Site Conditions and Activity During Sampling

This sampling occasion was undertaken in the late Summer time in dry conditions following hot dry weather. On site, there were movements of vehicles (loading shovels/equipment) moving materials on the main composting pad; and specifically undertaking the 'turning' of the compost. The Downwind sampling stations were located at approximately 210-225m from the centre of the turning activity on the compost pad. The rise in the **bioaerosols values** showed that the compost was having a moderate impact on emissions.

Table 4 provides a summary of results.

9.2 Summary - Bioaerosol levels

Table 4 – Summary of results Cwm Environmental Composting Facility 25th July 2022

	Activities	Total Bacteria		Asp. Fumigatus	
		Median UW	Median DW	Median UW	Median DW
		cfu/m ³	cfu/m ³	cfu/m ³	cfu/m ³
Session 1	Compost processing on the Pad	30	200	13	36
Session 2	Compost processing on the Pad	13	71	16	43
Session 3	Compost processing on the Pad	13	157	13	79
Session 4	Compost processing on the Pad	5	121	27	64
Overall	Median UW and Median Downwind	13	157	13	43
Maximum Median Upwind & Downwind		30	200	27	79

The **DOWNWIND** levels of **Total Bacteria** bioaerosols were found to be **LOW** and the **Aspergillus Fumigatus** bioaerosols concentrations were **VERY LOW**.

The results show that on average there was a moderate gain in the **Total Bacteria** bioaerosol levels due to the contribution from the 'turning' activities on the composting pad.

10.0 CONCLUSIONS-BIOAEROSOL SAMPLING

10.1 General Conclusions

The following may be concluded from the air quality results sampled **25th July 2022**.

The **MAXIMUM** of the median downwind **Total Bacteria** bioaerosols was **200 cfu/m³**.

The **MAXIMUM** of the median downwind **Aspergillus Fumigatus** bioaerosols was **79 cfu/m³**.

1. In general, the results in the samples taken **UPWIND** of the site show **VERY LOW** levels of Total Bacteria and **VERY LOW** levels of Aspergillus Fumigatus (AF).
2. In the **DOWNWIND**, the **MEDIAN Bacteria** type bioaerosol levels remained **LOW**. The **DOWNWIND MEDIAN** of the **Aspergillus Fumigatus** bioaerosols was **VERY LOW**.
3. On this occasion the results showed a moderate contribution of **Total Bacteria Bioaerosols resulting in the 200 cfu/m³ MAXIMUM MEDIAN** concentration in the air from the facility. Overall, the levels remained **below 21%** of the guideline level of 1000 cfu/m³.
4. These results reflect the use of dust suppression and moisture/temperature management.

10.2 Overall Conclusion

The **Maximum Median Upwind** Total Bacteria bioaerosols level was 30 cfu/m³; where-as the Aspergillus Fumigatus bioaerosols was 27 cfu/m³. The **MAXIMUM MEDIAN DOWNWIND** bioaerosols levels were increased: The **Total Bacteria was 200cfu/m³** (MEDIAN 157 cfu/m³); but the **Aspergillus Fumigatus was only 79 cfu/m³** (MEDIAN 43 cfu/m³). It was noted that the concentrations were consistent in the replications. Overall, the **Total Bacteria and Aspergillus Fumigatus** bioaerosols levels remained at less than 21% of the guidance threshold.

These levels are well within NRW thresholds and represent minimal risk to receptors.

APPENDIX 1. Bioaerosols Sampling Record and Results

Results Table A1.1: Session 1: Bioaerosol levels UPWIND and DOWNWIND of the Compost Facility.

Run No.	Sample Type	Sampler position	Sampler station location	Sampler code	Pump Code	Pump Flowrate litres/min	Start time	End Time	Sample time. min.	PLATE COUNT cfu**	Total Bacteria cfu m ⁻³	Aspergillus Fumigatus cfu m ⁻³
C1 A	TVC	UPWIND A	1	YA	P1	28	13:27	13:47	20.00	17	30	
C1 B	TVC	DOWNWIND B	2	YB	P2	28	13:33	13:38	5.00	28	200	
C1 C	TVC	DOWNWIND C	3	RA	P3	28	13:35	13:40	5.00	53	379	
C1 D	TVC	DOWNWIND D	4	RB	P4	28	13:37	13:42	5.00	28	200	
C1 A	AF	UPWIND A	1	GA	Q1	28	13:27	13:47	20.00	7		13
C1 B	AF	DOWNWIND B	2	GB	Q2	28	13:33	13:38	5.00	10		71
C1 C	AF	DOWNWIND C	3	BA	Q3	28	13:35	13:40	5.00	2		14
C1 D	AF	DOWNWIND D	4	BB	Q4	28	13:37	13:42	5.00	5		36

*TVC=Total Viable (Bacteria) Count. AF=Aspergillus Fumigatus. **cfu = colony forming units

Results Table A1.2: Session 2: Bioaerosol levels UPWIND and DOWNWIND of the Compost Facility.

Run No.	Sample Type	Sampler position	Sampler station location	Sampler code	Pump Code	Pump Flowrate litres/min	Start time	End Time	Sample time. min.	PLATE COUNT cfu**	Total Bacteria cfu m ⁻³	Aspergillus Fumigatus cfu m ⁻³
C2 A	TVC	UPWIND A	1	YA	P1	28	14:08	14:28	20.00	7	13	
C2 B	TVC	DOWNWIND B	2	YB	P2	28	14:14	14:19	5.00	7	50	
C2 C	TVC	DOWNWIND C	3	RA	P3	28	14:16	14:21	5.00	34	243	
C2 D	TVC	DOWNWIND D	4	RB	P4	28	14:18	14:23	5.00	10	71	
C2 A	AF	UPWIND A	1	GA	Q1	28	14:08	14:28	20.00	9		16
C2 B	AF	DOWNWIND B	2	GB	Q2	28	14:14	14:19	5.00	6		43
C2 C	AF	DOWNWIND C	3	BA	Q3	28	14:16	14:21	5.00	6		43
C2 D	AF	DOWNWIND D	4	BB	Q4	28	14:18	14:23	5.00	8		57

*TVC=Total Viable (Bacteria) Count. AF=Aspergillus Fumigatus. **cfu = colony forming units

Results Table A1.3: Session 3: Bioaerosol levels UPWIND and DOWNWIND of the Compost Facility.

Run No.	Sample Type	Sampler position	Sampler station location	Sampler code	Pump Code	Pump Flowrate litres/min	Start time	End Time	Sample time. min.	PLATE COUNT cfu**	Total Bacteria cfu m ⁻³	Aspergillus Fumigatus cfu m ⁻³
C3 A	TVC	UPWIND A	1	YA	P1	28	14:47	15:07	20.00	7	13	
C3 B	TVC	DOWNWIND B	2	YB	P2	28	14:53	14:58	5.00	22	157	
C3 C	TVC	DOWNWIND C	3	RA	P3	28	14:55	15:00	5.00	77	550	
C3 D	TVC	DOWNWIND D	4	RB	P4	28	14:57	15:02	5.00	19	136	
C3 A	AF	UPWIND A	1	GA	Q1	28	14:47	15:07	20.00	7		13
C3 B	AF	DOWNWIND B	2	GB	Q2	28	14:53	14:58	5.00	2		14
C3 C	AF	DOWNWIND C	3	BA	Q3	28	14:55	15:00	5.00	15		107
C3 D	AF	DOWNWIND D	4	BB	Q4	28	14:57	15:02	5.00	11		79

*TVC=Total Viable (Bacteria) Count. AF=Aspergillus Fumigatus. **cfu = colony forming units

Results Table A1.4: Session 4: Bioaerosol levels UPWIND and DOWNWIND of the Compost Facility.

Run No.	Sample Type	Sampler position	Sampler station location	Sampler code	Pump Code	Pump Flowrate litres/min	Start time	End Time	Sample time. min.	PLATE COUNT cfu**	Total Bacteria cfu m ⁻³	Aspergillus Fumigatus cfu m ⁻³
C4 A	TVC	UPWIND A	1	YA	P1	28	15:28	15:48	20.00	3	5	
C4 B	TVC	DOWNWIND B	2	YB	P2	28	15:34	15:39	5.00	17	121	
C4 C	TVC	DOWNWIND C	3	RA	P3	28	15:36	15:41	5.00	42	300	
C4 D	TVC	DOWNWIND D	4	RB	P4	28	15:38	15:43	5.00	11	79	
C4 A	AF	UPWIND A	1	GA	Q1	28	15:28	15:48	20.00	15		27
C4 B	AF	DOWNWIND B	2	GB	Q2	28	15:34	15:39	5.00	7		50
C4 C	AF	DOWNWIND C	3	BA	Q3	28	15:36	15:41	5.00	9		64
C4 D	AF	DOWNWIND D	4	BB	Q4	28	15:38	15:43	5.00	12		86

*TVC=Total Viable (Bacteria) Count. AF=Aspergillus Fumigatus. **cfu = colony forming units

Results Table A1.5: CONTROL PLATES

Control Type	Total Bacteria CfU/Plate (T)	Aspergillus Fumigatus CfU/Plate (F)
Passive Un-exposed Control	CT1 =0, CT2 =0	CF1 =0, CF2 =0

APPENDIX 2. The M9v2 Technical Guidance Note (Monitoring)

Technical Guidance Note (Monitoring) M9



Environmental monitoring of bioaerosols at regulated facilities

Environment Agency January 2018 Version 2

Sampling bioaerosols

Bioaerosols can be measured using a number of different techniques. This technical note describes the following techniques for sampling bioaerosols:

Impaction

The impaction method uses a single stage Andersen sampler, loaded with a Petri dish of appropriate media. This method uses inertial forces to collect microorganisms in the air. Air is drawn through the perforated holes in the sampling head at a constant rate, using a vacuum pump. The velocity of the air is determined by the diameter of the holes in the sampling head. When the air hits the collection surface it is forced to change direction. The inertia of the microorganisms prevents them from changing direction, which causes them to become impacted onto the Petri dish media. When a sufficient volume of air has been collected, the Petri dish is removed and incubated, without further treatment.

5.2 Sample location strategy

The principle of this specification is to compare the concentrations in air unaffected by the activities of the facility (that is the background air sampled upwind of the plant) with the concentration of bioaerosols in air downwind of the plant. This comparison enables an assessment of the plant related contribution over a specified area to be made. The difference between the upwind and downwind concentration caused by bioaerosol emissions from the site is known as the process contribution. It uses sampling locations that form a fan like shape, which helps to ensure that variable wind directions are taken account of during the sampling period.

5.2.2 Sample locations upwind of the site

Sampling should be carried out upwind of the site. Upwind data should provide information on the concentration of specified bioaerosols that are present in the air blowing onto the operational area of the site. This should reflect either the background concentration at that time, or the effects of neighbouring operations, such as agricultural activities.

Upwind data indicates the concentration of bioaerosols that would be present, irrespective of whether the facility was there or not. The sample location of the upwind concentration measurement should be measured at a distance of 50m from the centre of the active operational area.

5.2.3 Sample locations downwind of the site

Sampling should be carried out downwind of the site, using a fan like shape arrangement to detect the position of the plume. The orientation of the measurement area is determined by the prevailing mean wind direction.

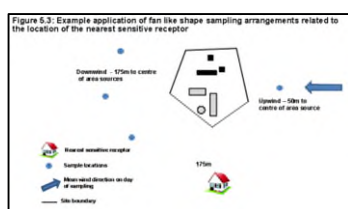
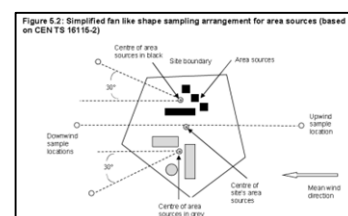
This approach is used to ensure that measurements are made in the emission plume, during the sampling campaign. If there are any buildings, installations or structures between the downwind location(s) and the centre of the active operational area, then sampling should be carried out upwind of that structure or installation, at a distance greater than twice its height.

Figure 5.1 shows this approach applied to a facility with a single point source. Topography or vegetation may restrict the line of sight required to locate sample traverses. This may make it difficult to determine the angle for locating the sample points. The restriction should be noted in the sample strategy and final monitoring report. For area sources, the orientation of the fan like shape sampling arrangement is selected by determining the centre point of the sources in the site.

Each impaction sampler should be mounted onto a tripod, or other suitable structure, so that the top of the inlet cone is held between 1.5 and 1.8m above the ground. Each single stage impaction sampler fitted with a cone should be fitted with a hemi-cylindrical baffle extending in height at least 15 centimetres (cm) above the top of the inlet of the cone, to ensure stagnation point sampling.

5.6.2 Sampling procedure

A single Petri dish (with the lid removed) should be loaded into each sampler immediately prior to use, in accordance with the manufacturer's instructions. Once loaded, the sampler should be kept upright, to prevent the Petri dish from dislodging. A single sample of *Aspergillus fumigatus* (1 Petri dish containing selective medium) should be collected at each of the specified locations using a single stage impaction sampler. The same procedure should be repeated for mesophilic bacteria using Petri dishes containing selective medium specific for the culturing of mesophilic bacteria.



Photograph 5.1: Single stage impaction sampler (Andersen) set up in the field



APPENDIX 3: METEOROLOGICAL DATA Recorded by the Met Station.

Table A3.1: Meteorological Data 25th July 2022

Time	Wind	Wind	Wind	Air	RH	BP		Time	Wind	Wind	Wind	Air	RH	BP
	Bearing	Direction	ms ⁻¹	°C	%	mb			Bearing	Direction	ms ⁻¹	°C	%	mb
13:24:15	148	SSE	1.2	17.7	64.5	1015		14:38:15	169	S	2.3	17.1	66.9	1015
13:25:15	148	SSE	0.6	16.7	67.9	1015		14:39:15	168	SSE	1.9	17.8	64.6	1015
13:26:15	164	SSE	2.0	16.7	68.3	1016		14:40:15	159	SSE	2.0	16.5	68.0	1015
13:27:15	164	SSE	2.0	15.7	71.0	1016		14:41:15	159	SSE	1.8	17.6	65.0	1015
13:28:15	167	SSE	1.6	15.8	72.5	1016		14:42:15	169	S	2.5	16.8	67.2	1015
13:29:15	167	SSE	2.8	15.7	72.5	1017		14:43:15	169	S	2.7	17.6	65.2	1015
13:30:15	172	S	2.6	15.6	72.1	1016		14:44:15	172	S	2.0	16.4	68.5	1015
13:31:15	174	S	2.1	15.9	70.9	1015		14:45:15	171	S	2.1	17.4	65.4	1015
13:32:15	169	S	2.5	15.7	71.2	1015		14:46:15	162	SSE	2.4	17.3	65.5	1015
13:33:15	168	SSE	2.3	16.3	69.8	1015		14:47:15	163	SSE	1.7	16.9	66.8	1015
13:34:15	159	SSE	2.0	16.5	71.2	1015		14:48:15	167	SSE	2.1	17.1	65.7	1015
13:35:15	159	SSE	2.1	16.4	70.8	1015		14:49:15	165	SSE	2.1	16.9	66.5	1015
13:36:15	169	S	2.6	16.3	69.5	1015		14:50:15	165	SSE	2.6	16.5	67.7	1016
13:37:15	169	S	2.4	16.3	69.3	1015		14:51:15	164	SSE	2.0	16.8	66.8	1016
13:38:15	172	S	1.6	16.4	69.9	1015		14:52:15	154	SSE	1.8	16.5	67.8	1015
13:39:15	171	S	1.6	17.2	67.9	1015		14:53:15	154	SSE	2.4	16.8	66.7	1015
13:40:15	162	SSE	2.6	16.7	68.8	1015		14:54:15	163	SSE	2.9	16.8	67.1	1015
13:41:15	163	SSE	2.1	16.1	69.3	1015		14:55:15	165	SSE	2.4	16.5	67.9	1015
13:42:15	167	SSE	2.6	16.2	69.1	1016		14:56:15	169	S	3.1	17.6	65.1	1016
13:43:15	165	SSE	2.6	16.1	69.6	1016		14:57:15	168	SSE	1.8	17.9	63.5	1015
13:44:15	165	SSE	2.7	16.4	69.7	1016		14:58:15	171	S	1.5	17.7	63.9	1015
13:45:15	164	SSE	2.1	16.0	69.8	1015		14:59:15	171	S	2.5	17.0	65.7	1015
13:46:15	154	SSE	1.6	16.1	69.7	1016		15:00:15	165	SSE	2.7	16.6	66.9	1015
13:47:15	154	SSE	2.2	16.4	68.7	1016		15:01:15	165	SSE	2.4	16.6	66.9	1015
13:48:15	163	SSE	2.7	16.2	69.6	1015		15:02:15	161	SSE	1.6	16.5	67.6	1015
13:49:15	165	SSE	2.1	17.0	67.2	1016		15:03:15	161	SSE	2.5	16.9	66.7	1015
13:50:15	169	S	2.7	16.5	68.5	1015		15:04:15	163	SSE	1.3	17.8	63.2	1015
13:51:15	168	SSE	1.8	16.8	66.0	1016		15:05:15	163	SSE	1.4	17.8	64.1	1015
13:52:15	171	S	1.3	17.1	65.9	1016		15:06:15	164	SSE	1.6	17.2	65.7	1015
13:53:15	171	S	2.7	16.4	67.2	1016		15:07:15	164	SSE	2.3	17.7	64.2	1015
13:54:15	165	SSE	2.5	16.3	67.7	1015		15:08:15	156	SSE	1.4	17.1	66.1	1015
13:55:15	165	SSE	2.3	16.5	66.8	1016		15:09:15	156	SSE	1.6	17.0	66.4	1015
13:56:15	161	SSE	1.0	17.4	64.1	1016		15:10:15	166	SSE	2.1	16.9	66.8	1015
13:57:15	161	SSE	3.1	16.2	68.2	1016		15:11:15	166	SSE	2.0	16.7	67.3	1015
13:58:15	163	SSE	2.0	16.2	67.7	1015		15:12:15	166	SSE	3.0	17.2	66.7	1015
13:59:15	163	SSE	1.8	16.3	68.1	1016		15:13:15	166	SSE	2.5	17.8	65.0	1015
14:00:15	164	SSE	1.1	16.4	67.8	1015		15:14:15	148	SSE	1.3	17.2	66.5	1015
14:01:15	164	SSE	2.2	17.0	66.0	1016		15:15:15	148	SSE	2.3	17.9	64.5	1015
14:02:15	156	SSE	1.4	16.9	66.7	1016		15:16:15	165	SSE	2.1	17.8	64.6	1015
14:03:15	156	SSE	2.0	16.6	67.3	1016		15:17:15	165	SSE	2.2	17.0	67.4	1015
14:04:15	166	SSE	1.7	16.9	66.1	1016		15:18:15	144	SE	1.1	17.6	65.7	1015
14:05:15	166	SSE	1.4	16.6	67.5	1015		15:19:15	144	SE	1.4	17.0	67.3	1015
14:06:15	166	SSE	2.3	16.4	68.2	1016		15:20:15	180	S	0.9	17.1	66.8	1015
14:07:15	166	SSE	3.5	16.6	68.5	1015		15:21:15	153	SSE	1.7	17.1	66.7	1015
14:08:15	148	SSE	2.5	16.1	69.8	1015		15:22:15	169	S	1.2	16.5	68.0	1015
14:09:15	148	SSE	2.5	16.7	68.5	1016		15:23:15	169	S	2.5	17.3	66.2	1015
14:10:15	165	SSE	3.1	16.5	69.1	1015		15:24:15	148	SSE	1.5	17.9	64.3	1015
14:11:15	165	SSE	2.1	16.4	69.9	1016		15:25:15	148	SSE	1.8	17.1	66.5	1015
14:12:15	144	SE	1.0	17.2	67.4	1016		15:26:15	171	S	1.8	16.8	67.2	1015
14:13:15	144	SE	1.4	17.0	66.9	1015		15:27:15	170	S	2.1	16.6	67.6	1015
14:14:15	171	S	1.0	16.7	67.8	1016		15:28:15	163	SSE	2.1	16.4	68.4	1015
14:15:15	165	SSE	1.2	16.9	66.8	1016		15:29:15	164	SSE	1.1	16.9	66.6	1015
14:16:15	169	S	1.2	16.1	69.1	1016		15:30:15	168	SSE	1.5	17.5	65.6	1015
14:17:15	169	S	2.0	16.5	68.1	1015		15:31:15	168	SSE	2.8	16.0	70.6	1015
14:18:15	148	SSE	0.9	17.6	64.4	1015		15:32:15	180	S	1.3	16.7	68.1	1016
14:19:15	148	SSE	1.5	17.9	64.1	1015		15:33:15	180	S	2.3	16.7	67.5	1015
14:20:15	171	S	1.9	16.7	68.7	1015		15:34:15	153	SSE	2.8	17.7	66.8	1016
14:21:15	170	S	3.1	16.2	70.2	1015		15:35:15	157	SSE	1.8	17.2	68.0	1015
14:22:15	163	SSE	2.3	16.2	70.2	1015		15:36:15	171	S	2.9	17.0	70.1	1015
14:23:15	164	SSE	1.4	16.4	69.0	1015		15:37:15	170	S	2.2	17.4	68.7	1015
14:24:15	146	SE	1.3	17.0	67.9	1015		15:38:15	156	SSE	2.2	17.0	70.8	1015
14:25:15	146	SE	1.8	16.1	70.9	1016		15:39:15	156	SSE	2.1	15.9	73.5	1015
14:26:15	158	SSE	0.8	17.3	66.7	1015		15:40:15	159	SSE	3.5	16.4	72.5	1015
14:27:15	158	SSE	1.6	16.8	68.1	1015		15:41:15	157	SSE	2.8	16.7	71.4	1015
14:28:15	148	SSE	2.9	15.6	72.3	1015		15:42:15	157	SSE	2.0	17.3	68.7	1015
14:29:15	171	S	2.2	15.9	71.5	1015		15:43:15	157	SSE	2.0	16.8	70.1	1015
14:30:15	144	SE	0.6	19.1	63.3	1015		15:44:15	158	SSE	2.2	17.5	67.8	1015
14:31:15	180	S	0.9	20.0	62.7	1015		15:45:15	151	SSE	2.2	16.8	70.5	1016
14:32:15	153	SSE	0.3	20.7	61.1	1015		15:46:15	159	SSE	1.9	16.5	70.9	1015
14:33:15	144	SE	0.7	21.3	58.6	1015		15:47:15	152	SSE	2.6	16.5	71.9	1016
14:34:15	180	S	0.5	21.7	57.0	1015		15:48:15	164	SSE	2.2	17.1	70.5	1015
14:35:15	153	SSE	0.8	21.6	56.7	1015		15:49:15	159	SSE	3.4	17.4	69.7	1016
14:36:15	129	SE	0.0	21.5	55.6	1015		15:50:15	171	S	0.4	17.7	61.9	1,016
14:37:15	129	SE	0.0	22.1	53.0	1015		15:51:15	172	S	0.7	17.3	62.9	1,016