patel tonra ltd
environmental solutions

For the Attention of
Waste Licensing (Applications) Unit
Environmental Protection Agency
PO Box 3000
Johnstown Castle Estate
Co. Wexford

Our Ref.: RG0204/WL Review
Direct Dial: 01 802 0521
Direct Fax: 01 802 0525
e-mail: vip.patel@pateltonra.com
Date: 6th March 2015

Dear EPA,

Re.: Waste Licence Review Application Ref. W0279-02; Rehab Glassco Ltd.
Unsolicited Additional Information: Air Emissions Monitoring/Air Dispersion Model

Patel Tonra Ltd., Environmental Solutions, is acting for our client, Rehab Glassco Ltd., under the instruction of Mr. Zeki Mustafa, Managing Director of Rehab Glassco Ltd.

Please find enclosed the following reports, in relation to the above Waste Licence Review Application:

(i) Air Scientific (Feb. 2015) *Air Emissions Compliance Monitoring Emissions Report*

(ii) Odour Monitoring Ireland (Feb. 2015) *Dispersion Modelling Assessment of Classical Air Pollutants from Named Emission Point Located in Rehab Glassco Ltd, Oberstown Industrial Park, Naas, Co. Kildare.*

We enclose 1 No. original and 1 No. copy in print, and 2 No. electronic copies, as per EPA *Instructions for Licence Applicants*. Please accept this letter as a declaration that the content of the electronic files on the accompanying CD-ROMs is a true copy of the original.

Yours sincerely,

pp.

Vip Patel
Director, Patel Tonra Ltd.

Report Title	Air Emissions Compliance Monitoring Emissions Report
Company address	Air Scientific Ltd., 40 Coolraine Heights, Old Cratloe Road, Limerick
Stack Emissions Testing Report Commissioned by	Rehab Glassco Limited
Facility Name	Rehab Glassco Limited
Contact Person	Paul Hodder / Zeki Mustafa
EPA Licence Number	W0279-01
Licence Holder	Rehab Glassco Ltd
Stack Reference Number	A1 / A2
Dates of the Monitoring Campaign	21-01-2015
Job Reference Number	REGLTL4210115
Report Written By	Mr. Gregory Dempsey
Report Approved by	Mr. Mark McGarry
Stack Testing Team	David Noonan and Daniel Mullins
Report Date	25-02-2015
Report Type	Test Report Compliance Monitoring
Version	1
Signature of Approver	**Operations Manager**

Opinions and interpretations expresses herein will be outside the scope of Air Scientific Limited INAB accreditation.
This test report shall not be reproduced, without the written approval of Air Scientific Limited.
All sampling and reporting is completed in accordance with Environmental Protection Agency Air Guidance Note 2 requirements.

ISO 17025
INAB
ACCREDITED
TESTING
DETAILED IN SCOPE REG NO.319T

Executive Summary

Monitoring Objectives

Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

Special Requirements

There were no special requirements.

Target Parameters

Total Gaseous Organic Carbon (TOC)
T A Luft Organics
Volumetric Flow Rates ($m^3.hr^{-1}$)

Emission Limit Values

A1	$mg.m^{-3}$
TOC	80
T A Luft Organics	Not applicable
Volume ($m^3.hr^{-1}$)	9,500

Reference Conditions

Reference Conditions	Value
Oxygen Reference %	-
Temperature K	273.15
Total Pressure kPa	101.3
Moisture %	-

Target Parameters

Total Gaseous Organic Carbon (TOC)
T A Luft Organics
Volumetric Flow Rates ($m^3.hr^{-1}$)

Emission Limit Values

A2	$mg.m^{-3}$
TOC	80
T A Luft Organics	Not applicable
Volume ($m^3.hr^{-1}$)	8,000

Reference Conditions

Reference Conditions	Value
Oxygen Reference %	-
Temperature K	273.15
Total Pressure kPa	101.3
Moisture %	-

Executive Summary

Overall Results

A1	Concentration				
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Compliant**
Total Gaseous Organic Carbon (TOC)	$mg.m^{-3}$	45.9	1.59	80	Yes
T A Luft Organics Class I/II/III Run 1 Run 2 Run 3	$mg.m^{-3}$	<0.41 <0.42 <0.72	0.02 0.02 0.02	-	-
Volumetric Flow Rate (Ref.)	$m^3.hr^{-1}$	5,600	-	9,500	-

A2	Concentration				
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Compliant**
Total Gaseous Organic Carbon (TOC)	$mg.m^{-3}$	59.6	1.98	80	Yes
T A Luft Organics Class I/II/III Run 1 Run 2 Run 3	$mg.m^{-3}$	<0.40 <0.46 <0.72	0.01 0.01 0.01	-	Yes
Volumetric Flow Rate (Ref.)	$m^3.hr^{-1}$	5,914	-	8,000	Yes

Accreditation details

Air Scientific Limited	INAB Number: 319T
External Analytical Laboratory	Accreditation number: UKAS 0605

Executive Summary

Process details

Stack Name	A1 – Old Drying Plant
Process status	Normal
Capacity (per/hour) (if applicable)	Variable
Continuous or Batch Process	Continuous
Feedstock	Glass
Abatement System	Bag Filters
Abatement Systems Running Status	Normal
Fuel	Natural Gas
Plume Appearance	Yes
Other information	None

Stack Name	A2 – New Drying Plant
Process status	Normal
Capacity (per/hour) (if applicable)	Variable
Continuous or Batch Process	Continuous
Feedstock	Glass
Abatement System	Bag Filters
Abatement Systems Running Status	Normal
Fuel	Gas
Plume Appearance	No
Other information	None

Executive Summary

Monitoring, Equipment & Analytical Methods

Parameter	Standard	Technical Procedure	Accredited Testing	Analytical Technique	Equipment / Media	Equipment ID Used on Site
Total Gaseous Organic Carbon (TOC)	EN12619:2013	2009	Yes	Flame Ionisation Detection	FID	ASLLK12EQ529 ASLLK12EQ500 ASLLK12EQ505 ASLLK12EQ507 ASLLK12EQ514 ASLLK12EQ542 ASLLK13EQ500 ASLLK14EQ506
T A Luft Organics	EN13649:2002	2019	Yes	Solvent Desorption/ GCMS	Activated Carbon	
Volumetric Flow Rate	EN 16911:2013	2005	Yes	Manometer / Pitot / Calculation	Manometer / Pitot / Calculation	

Sampling Deviations

Parameter	A1
EN12619:2013	None
EN13649:2002	None
EN 16911:2013	None
Flow Rates	EN 16911 - in accordance with MID 6911-1

Reference Documents

Risk Assessment (RA)	SOP 1011
Site Review (SR)	SOP 1015
Site Specific Protocol (SSP)	SOP 1015

Suitability of Sample Location

General Information	Value
Permanent/Temporary	Permanent
Inside/ Outside	Outside

Platform Details		
Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements	**Value**	**Comment**
Sufficient Working area to manipulate probe and measuring instruments	Yes	-
Platform has 2 handrails (approx. 0.5m & 1.0 m high)	Yes	-
Platform has vertical base boards (approx. 0.25 m high)	Yes	-
Platform has chains / self-closing gates at top of ladders	No	-
There are no obstructions present which hamper insertion of sampling equipment	Yes	-
Safe Access Available	Yes	-
Easy Access Available	Yes	-

Sampling Location / Platform Improvement Recommendations
None

BSEN 15259 Homogeneity Test Requirements
Not applicable
Select Option : **1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack** **2: Test results were obtained from previous Homogeneity test carried out by ASL** **3: Test results were obtained from previous Homogeneity test carried out by Alternative contractor**

Sampling Deviations

Parameter	A2
EN12619:2013	None
EN13649:2002	None
EN 16911:2013	None
Flow Rates	EN 16911 - in accordance with MID 6911-1

Reference Documents

Risk Assessment (RA)	SOP 1011
Site Review (SR)	SOP 1015
Site Specific Protocol (SSP)	SOP 1015

Suitability of Sample Location

General Information	Value
Permanent/Temporary	Permanent
Inside/ Outside	Inside

Platform Details		
Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements	**Value**	**Comment**
Sufficient Working area to manipulate probe and measuring instruments	Yes	-
Platform has 2 handrails (approx. 0.5m & 1.0 m high)	Yes	-
Platform has vertical base boards (approx. 0.25 m high)	Yes	-
Platform has chains / self-closing gates at top of ladders	No	-
There are no obstructions present which hamper insertion of sampling equipment	Yes	-
Safe Access Available	Yes	-
Easy Access Available	Yes	-

Sampling Location / Platform Improvement Recommendations
None

BSEN 15259 Homogeneity Test Requirements
Not applicable
Select Option : **1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack** **2: Test results were obtained from previous Homogeneity test carried out by ASL** **3: Test results were obtained from previous Homogeneity test carried out by Alternative contractor**

Stack Diagram

Figure 1: A1

Stack Diagram

Figure 2: A2

1. APPENDICES

Appendix I Monitoring Personnel & Equipment

Stack Emissions Monitoring Personnel

Team Leader	**Name**	David Noonan
	System approval	ASL Team Leader Approved
Technician	**Name**	Daniel Mullins
	System approval	ASL Technician Approved

Appendix II Stack Raw Data

Title:	Determination of Total Organic Compounds
Method:	EN 12619:2013
Client:	Rehab Glassco
Stack Reference:	A1

Licence Limits		
Emission Limit Value	80	$mg.m^{-3}$
Flow Rate Limit	9,500	$m^3.Hr^{-1}$
Results		
TOC Concentration	45.9	$mg.m^{-3}$
Flow Rate	5,637	$m^3.Hr^{-1}$
Uncertainty of Measurement	1.59	$mg.m^{-3}$
Reference Conditions		
Temperature (K)	273.13	^0K
Pressure (kPa)	101.3	kPa
Gas (Wet or Dry)	-	
Oxygen	-	%
Quality Data		**Units**
Sampling Time	21/01/2015 10:56	-
Instrument Range	100	ppm
Span Gas Value	78	ppm
Acceptable Gas Range	Yes	50 - 90% of Range
Oven Temperature	181	^0C
Average Temperature	180	^0C
Temperature Acceptable	Yes	Yes or No
Sample line temperature	181	C
Zero Drift		**Units**
Zero Down Sampling Line (Pre)	0	ppm
Zero Down Sampling Line (Post)	-0.2	ppm
Zero drift	-0.2	ppm
Allowable Zero Drift	1.56	ppm
Zero Drift Acceptable	Yes	Yes or No
Span Drift		**Units**
Span (Pre)	78	ppm
Span (Post)	77.9	ppm
Span Drift	-0.1	ppm
Allowable Span Drift	1.56	ppm
Span Drift Acceptable	Yes	Yes or No
Leak Check		
Span Gas Conc.	78	ppm
Recorded Conc. down Line (Pre)	78	ppm
Leak Result	0	ppm
Leak check acceptable (< 2%)	1.6	(Y/N)
Parameter		
Standard	EN 12619:2013	
Technical Procedure	2009	
Probe material	Stainless Steel	
Filtration Type	Ceramic Filter	
Heated Head Filter Used	Yes	
Heated Line Temperature	180	Deg C
Span Gas Reference Number	ASLLK14ING524	
Span Gas Expiry Date	Feb-17	
Span Gas Start Pressure (bar)	35	bar
Gas Cylinder Concentration (ppm)	78	ppm
Span Gas Uncertainty (%)	0.8	%
Zero Gas Type	Air	
Number of Sampling Lines Used	1	
Number of Sampling Points Used	1	
Sample Point I.D's	1	

Measured Quantities

Certified Range of Analyser	1000	ppm
Operational Range of Analyser	100	ppm
Measured Reading	29	ppm
Non linearity	0.4	ppm
Temperature Dependent Zero drift	0.15	ppm Per Degree
Temperature Dependent Span drift	0.1	% Per Degree
Cross-sensitivity	0.1	ppm
Leak	0	ppm
Calibration Gas uncertainty	0.8	ppm

Title:	**Determination of Stack Flow Rate**
Method:	EN 16911-1
Client:	Rehag Glassco
Stack Reference:	A1

Stack details	**Value**		**Units**
Date of survey	20/01/2015		
Time of survey	11:00		
Type	Circular		
Stack Diameter / Depth, D	0.48	**Length (m)**	m
Stack Width, W	-		m
Average Stack Gas Temp., Ta	112.5	385.65	C
Average Static Pressure, P static	0.4		kPa/mbar
Average Barometric Pressure, Pb	99.51		kPa
Type of Pitot	S		
Are Water Droplets Present ?	No		
Average Pitot Tube Calibration Coeff, Cp	0.82		
No local negative flow	No		
Highly homogeneous flow stream/gas velocity	Yes		
Sample Port Size	101.6		mm
Initial Pitot Leak Check	Pass		
Final Pitot Leak Check	Pass		
Orientation of Duct	Vertical		
Pitot Tube Cp	0.998		
Number of Lines Available	2		
Number of Lines Used	2		

Sampling Line A

Point	**Distance**	**Pa**	**Temp C**	**Velocity**	**Oxygen**	**Swirl**
1	0.07	104	112.5	12.4	17.5	<15
2	0.41	100	112.5	12.1	17.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		102	112.5	12.25	17.50	<15
Min		100	112.5	12.13	17.5	<15
Max		104	112.5	12.37	17.5	<15

Sampling Line B

Point	**Distance**	**Pa**	**Temp C**	**Velocity**	**Oxygen**	**Swirl**
1	0.07	109	112.5	12.7	17.5	<15
2	0.41	102	112.5	12.3	17.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		105.5	112.5	12.46	17.5	<15
Min		102	112.5	12.25	17.5	<15
Max		109	112.5	12.66	17.5	<15

Average stack Gas Velocity	12.35	m/s
Lowest Differential Pressure	100.00	Pa
Lowest Gas Velocity	12.13	m/s
Highest Gas Velocity	12.66	m/s
Average Differential Pressure	103.75	Pa
Velocity Ratio of High to Low (3:1)	1.04	
Average Angle of flow	<15	

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Molar Mass
Carbon Dioxide CO_2	-	3.4		44.01
Oxygen O_2	-	17.5		32
Nitrogen N_2	-	79.1		28.1
Moisture (H_2O)	-	-	0	18.02

Reference Conditions	Units	Numbers
Temperature	K	273.13
Total Pressure	kPa	101.3
Moisture	%	-
Oxygen (Dry)	%	-

General Stack Details

Stack details	Units	Value		
Stack Diameter / Depth, D	m	0.48		
Stack Width, W	m			
Stack Area, A	m^2	0.18		
Average Stack Gas Temp., Ta	C	112.5	385.65	K
Average Static Pressure, P static	kPa	0.4		
Average Barometric Pressure, Pb	kPa	99.51		
Average Pitot Tube Calibration Coeff, Kpt		0.82		

Calc box Area

Circular Duct		Rectangular Duct	
R =	0.24	Length (m)	0
R2 =	0.0576	Width (m)	-
Area = Pie*R2	0.18	Area	-

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density Kg/m3 p	Conc Dry % v/v	Dry Volume Fraction r
Carbon Dioxide CO_2	44.01	1.96	3.4	0.034
Oxygen O_2	32	1.43	17.5	0.175
Nitrogen N_2	28.1	1.25	79.1	0.791
Moisture (H_2O)	18.02	0.80		

where p=M/22.41
pi = r x p

	Dry Conc kg/m3 pi	Conc wet % v/v	Wet Volume Fraction r	Wet Conc kg/m3 pi
Carbon Dioxide CO_2	0.07	3.40	0.03	0.07
Oxygen O_2	0.25	17.50	0.18	0.25
Nitrogen N_2	0.99	79.10	0.79	0.99
Moisture (H_2O)	-	0	0.00	0.00

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P STD	kg/m^3	1.308
Wet Density (STP), P STW	kg/m^3	1.308
Dry Density (Actual), P Actual	kg/m^3	0.910
Average wet Density (Actual), P ActualW	kg/m^3	0.910

Where

P STD = sum of component concentrations, kg/m3 (excluding water vapour)
P STW = (P STD + pi of H2O) / (1 + (pi of H2O / 0.8036))
P actual = P STD x (T STP / (P STP)) x (Pa / Ta)
P actual W (at each sampling point) = P STW x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF
Temperature	K	385.65	273.13
Total Pressure	kPa	99.51	101.3
Moisture	%	0	-
Oxygen (Dry)	%	17.5	-

Gas Volumetric Flowrate	Units	Result
Gas Volumetric Flow Rate (Actual)	m^3/hr	8049
Gas Volumetric Flow Rate (STP, Wet)	m^3/hr	5600
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	5600
Gas Volumetric Flowrate REF to Oxygen	m^3/hr	

Where

Actual = Va * A * 3600
STP Wet =Actual x (Ts / Ta) x (Pa / Ps) x 3600
STP , Dry = STP Wet / (100 - (100 / Water Vapour %))
REF = STP Dry x (100 - Water Vapour %) / (100- Water Vapour Ref)) x (20.9 - O_2m)/ (20.9 -O_2 Ref)

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	100.00	Pa	>5 Pa	Pass	EN16911
Lowest Gas Velocity	12.13	m/s	-	-	-
Highest Gas Velocity	12.66	m/s	-	-	-
Ratio of Above	1.04	:1	<3:1	Pass	EN16911
Mean Velocity	12.35	m/s	-	-	-
Angle of flow	<15	degrees	< 15	Pass	EN16911
No local negative flow	No	-	-	-	-
Homogeneous flow	Yes	-	-	-	-

Calculation of stack Gas Velocity, V

Velocity at Traverse Point, V = Kcp * Sqroot ((2 * DP) / Density) 227.93535

Where

Kpt = Pitot tube calibration coefficient 0.82
Compressibility correction factor, assumed at a constant 0.998 0.998

Title:	***Determination of Speciated Organic Compounds***			
Method:	EN 13649			
Client:	Rehab Glassco			
Test Date:	21/01/2015			
Test Time:	10:44	11:17	11:47	
Laboratory Used:	RPS			
Certificate Numbers:	WK15- 0450			
Stack Reference:	A1			
Leak Check Results				
Prior to test:	0	0	0	l/min
Post Test:	0	0	0	l/min
Sample Volume Flow Rate:	0.422	0.419	0.411	l/min
Standard Requirement:	<5	<5	<5	%
Test Result:	0	0	0	%
Test Status	Pass	Pass	Pass	
Calibration Details				
Pump Number:	ASLLK12EQ500	ASLLK12EQ542	ASLLK12EQ500	
Calibration Unit:	ASLLK12EQ529	ASLLK12EQ529	ASLLK12EQ529	
Calibration Unit Uncertainty:	<2	<2	<2	%
Calibration Rate Before Test:	0.42	0.42	0.41	litres per minute
Calibration Rate After Test:	0.423	0.419	0.412	litres per minute
Maximum allowed flow	0.5	0.5	0.5	litres per minute
Average sample Volume:	0.4215	0.4195	0.411	litres per minute
Sample Test Time:	30	30	30	minutes
Pump Gas Temperature:	9.6	9.6	9.6	^{o}C
Pump Sample Pressure:	100.2	100.2	100.2	kPa
Actual Sample Volume:	0.01265	0.01259	0.01233	m^3
Normalised Gas Volume:	0.01208	0.01203	0.01178	Nm^3
Tube Details				
Tube Type:	226-09	226-09	226-09	
Tube Identification Number:	5542909535	5105206597	5105206594	
Blank Identification Number:	5105206601	5105206601	5105206601	
Main Adsorbent Layer	400	400	400	mg
Backup Adsorbent Layer	200	200	200	mg
Containment Material	Glass	Glass	Glass	
Breakthrough Occurred	No	No	No	
Tubes in Lab in <7 days	Yes	Yes	Yes	
Tubes >7 days were stored	<4	<4	<4	Deg C
Tubes >7 days were stored	Dark	Dark	Dark	-
Transport Container Airtight	Yes	Yes	Yes	
Exposed to Sunlight	No	No	No	
Transport Temp <20 Deg C	Yes	Yes	Yes	
Field Blank <10% Analyte Value	Yes	Yes	Yes	
Field Blank <10% ELV	Yes	Yes	Yes	
Test Details				
Adsorption Tube Temperature:	9.6	9.6	9.6	^{o}C
Stack Flow Rates				
Normalised Flow Rate:	5,600	$m^3.hr^{-1}$		

Speciated Organic Results

Class I	***ug/tube***	***mg.m^{-3}***
VOC Run 1	5	0.41
VOC Run 2	5	0.42
VOC Run 3	5	0.42

	Concentration	**Uncertainty**	**ELV**
	mg.m^{-3}	***mg.m^{-3}***	***mg.m^{-3}***
VOC Run 1	0.41	0.02	-
VOC Run 2	0.42	0.02	-
VOC Run 3	0.42	0.02	-

Title:	Determination of Total Organic Compounds
Method:	EN 12619:2013
Client:	Rehab Glassco
Stack Reference:	A2

Licence Limits		
Emission Limit Value	80	$mg.m^{-3}$
Flow Rate Limit	8,000	$m^3.Hr^{-1}$
Results		
TOC Concentration	59.6	$mg.m^{-3}$
Flow Rate	5,931	$m^3.Hr^{-1}$
Uncertainty of Measurement	1.98	$mg.m^{-3}$
Reference Conditions		
Temperature (K)	273.13	^0K
Pressure (kPa)	101.3	kPa
Gas (Wet or Dry)	-	
Oxygen	-	%
Quality Data		**Units**
Sampling Time	21/01/2015 13:06	-
Instrument Range	100	ppm
Span Gas Value	78	ppm
Acceptable Gas Range	Yes	50 - 90% of Range
Oven Temperature	180	^0C
Average Temperature	180	^0C
Temperature Acceptable	Yes	Yes or No
Sample line temperature	181	C
Zero Drift		**Units**
Zero Down Sampling Line (Pre)	0	ppm
Zero Down Sampling Line (Post)	-0.2	ppm
Zero drift	-0.2	ppm
Allowable Zero Drift	1.56	ppm
Zero Drift Acceptable	Yes	Yes or No
Span Drift		**Units**
Span (Pre)	78	ppm
Span (Post)	77.8	ppm
Span Drift	-0.2	ppm
Allowable Span Drift	1.56	ppm
Span Drift Acceptable	Yes	Yes or No
Leak Check		
Span Gas Conc.	78	ppm
Recorded Conc. down Line (Pre)	78	ppm
Leak Result	0	ppm
Leak check acceptable (< 2%)	1.6	(Y/N)
Parameter		
Standard	EN 12619:2013	
Technical Procedure	2009	
Probe material	Stainless Steel	
Filtration Type	Ceramic Filter	
Heated Head Filter Used	Yes	
Heated Line Temperature	180	Deg C
Span Gas Reference Number	ASLLK14ING524	
Span Gas Expiry Date	Feb-17	
Span Gas Start Pressure (bar)	30	bar
Gas Cylinder Concentration (ppm)	78	ppm
Span Gas Uncertainty (%)	0.8	%
Zero Gas Type	Air	
Number of Sampling Lines Used	1	
Number of Sampling Points Used	1	
Sample Point I.D's	1	

Measured Quantities

Certified Range of Analyser	1000	ppm
Operational Range of Analyser	100	ppm
Measured Reading	37	ppm
Non linearity	0.4	ppm
Temperature Dependent Zero drift	0.15	ppm Per Degree
Temperature Dependent Span drift	0.1	% Per Degree
Cross-sensitivity	0.1	ppm
Leak	0	ppm
Calibration Gas uncertainty	0.8	ppm

Title:	**Determination of Stack Flow Rate**
Method:	EN 16911-1
Client:	Rehab Glassco
Stack Reference:	A2

Stack details	**Value**		**Units**
Date of survey	20/01/2015		
Time of survey	13:00		
Type	Circular		
Stack Diameter / Depth, D	0.45	**Length (m)**	m
Stack Width, W	-		m
Average Stack Gas Temp., Ta	65.8	338.95	C
Average Static Pressure, P static	0.2		mbar
Average Barometric Pressure, Pb	100.1		kPa
Type of Pitot	S		
Are Water Droplets Present ?	No		
Average Pitot Tube Calibration Coeff, Cp	0.82		
No local negative flow	No		
Highly homogeneous flow stream/gas velocity	Yes		
Sample Port Size	101.6		mm
Initial Pitot Leak Check	Pass		
Final Pitot Leak Check	Pass		
Orientation of Duct	Vertical		
Pitot Tube Cp	0.998		
Number of Lines Available	2		
Number of Lines Used	2		

Sampling Line A

Point	**Distance**	**Pa**	**Temp C**	**Velocity**	**Oxygen**	**Swirl**
1	0.07	145	65.8	13.7	19.5	<15
2	0.38	124	65.8	12.7	19.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		134.5	65.8	13.19	19.50	<15
Min		124	65.8	12.67	19.5	<15
Max		145	65.8	13.71	19.5	<15

Sampling Line B

Point	**Distance**	**Pa**	**Temp C**	**Velocity**	**Oxygen**	**Swirl**
1	0.07	126	65.8	12.8	19.5	<15
2	0.38	125	65.8	12.7	19.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		125.5	65.8	12.75	19.5	<15
Min		125	65.8	12.73	19.5	<15
Max		126	65.8	12.78	19.5	<15

Average stack Gas Velocity	12.97	m/s
Lowest Differential Pressure	124.00	Pa
Lowest Gas Velocity	12.67	m/s
Highest Gas Velocity	13.71	m/s
Average Differential Pressure	130.00	Pa
Velocity Ratio of High to Low (3:1)	1.17	
Average Angle of flow	<15	

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Molar Mass
Carbon Dioxide CO_2	-	1.5		44.01
Oxygen O_2	-	19.5		32
Nitrogen N_2	-	79		28.1
Moisture (H_2O)	-	-	0	18.02

Reference Conditions	Units	Numbers
Temperature	K	273.13
Total Pressure	kPa	101.3
Moisture	%	-
Oxygen (Dry)	%	-

General Stack Details

Stack details	Units	Value		
Stack Diameter / Depth, D	m	0.45		
Stack Width, W	m	-		
Stack Area, A	m^2	0.16		
Average Stack Gas Temp., Ta	C	65.8	338.95	K
Average Static Pressure, P static	kPa	0.2		
Average Barometric Pressure, Pb	kPa	100.1		
Average Pitot Tube Calibration Coeff, Kpt		0.82		

Calc box Area

Circular Duct		Rectangular Duct	
R =	0.225	Length (m)	0
R2 =	0.050625	Width (m)	-
Area = Pie*R2	0.16	Area	-

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density Kg/m3 p	Conc Dry % v/v	Dry Volume Fraction r
Carbon Dioxide CO_2	44.01	1.96	1.5	0.015
Oxygen O_2	32	1.43	19.5	0.195
Nitrogen N_2	28.1	1.25	79	0.79
Moisture (H_2O)	18.02	0.80		

where p=M/22.41
pi = r x p

	Dry Conc kg/m3 pi	Conc wet % v/v	Wet Volume Fraction r	Wet Conc kg/m3 pi
Carbon Dioxide CO_2	0.03	1.50	0.02	0.03
Oxygen O_2	0.28	19.50	0.20	0.28
Nitrogen N_2	0.99	79.00	0.79	0.99
Moisture (H_2O)	-	0	0.00	0.00

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P STD	kg/m^3	1.298
Wet Density (STP), P STW	kg/m^3	1.298
Dry Density (Actual), P Actual	kg/m^3	1.034
Average wet Density (Actual), P ActualW	kg/m^3	1.034

Where

P STD = sum of component concentrations, kg/m3 (excluding water vapour)
P STW = (P STD + pi of H2O) / (1 + (pi of H2O / 0.8036))
P actual = P STD x (T STP / (P STP)) x (Pa / Ta)
P actual W (at each sampling point) = P STW x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF
Temperature	K	338.95	273.13
Total Pressure	kPa	100.1	101.3
Moisture	%	0	-
Oxygen (Dry)	%	19.5	-

Gas Volumetric Flowrate	Units	Result
Gas Volumetric Flow Rate (Actual)	m^3/hr	7427
Gas Volumetric Flow Rate (STP, Wet)	m^3/hr	5914
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	5914
Gas Volumetric Flowrate REF to Oxygen	m^3/hr	

Where

Actual = Va * A * 3600
STP Wet =Actual x (Ts / Ta) x (Pa / Ps) x 3600
STP , Dry = STP Wet / (100 - (100 / Water Vapour %))
REF = STP Dry x (100 - Water Vapour %) / (100- Water Vapour Ref)) x (20.9 - O_2m)/ (20.9 -O_2 Ref)

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	124.00	Pa	>5 Pa	Pass	EN16911
Lowest Gas Velocity	12.67	m/s	-	-	-
Highest Gas Velocity	13.71	m/s	-	-	-
Ratio of Above	1.08	:1	<3:1	Pass	EN16911
Mean Velocity	12.97	m/s	-	-	-
Angle of flow	<15	degrees	< 15	Pass	EN16911
No local negative flow	No	-	-	-	-
Homogeneous flow	Yes	-	-	-	-

Calculation of stack Gas Velocity, V

Velocity at Traverse Point, V = Kcp * Sqroot ((2 * DP) / Density) 251.4644

Where

Kpt = Pitot tube calibration coefficient	0.82
Compressibility correction factor, assumed at a constant 0.998	0.998

Title:	***Determination of Speciated Organic Compounds***			
Method:	EN 13649			
Client:	Rehab Glassco			
Test Date:	21/01/2005			
Test Time:	12:57	13:44	14:30	
Laboratory Used:	RPS			
Certificate Numbers:	WK15-0450			
Stack Reference:	A2			
Leak Check Results				
Prior to test:	0	0	0	l/min
Post Test:	0	0	0	l/min
Sample Volume Flow Rate:	0.447	0.382	0.248	l/min
Standard Requirement:	<5			%
Test Result:	0			%
Test Status	Pass			
Calibration Details				
Pump Number:	ALSKLK12EQ500	ASLLK12EQ500	ASLLK12EQ540	
Calibration Unit:	ASLLK12EQ529	ASLLK12EQ529	ASLLK12EQ529	
Calibration Unit Uncertainty:	<2			%
Calibration Rate Before Test:	0.446	0.383	0.25	litres per minute
Calibration Rate After Test:	0.448	0.381	0.245	litres per minute
Maximum allowed flow	0.5	0.5	0.5	litres per minute
Average sample Volume:	0.447	0.382	0.2475	litres per minute
Sample Test Time:	30	30	30	minutes
Pump Gas Temperature:	14.5	14.5	14.5	^{o}C
Pump Sample Pressure:	100.1	100.1	100.1	kPa
Actual Sample Volume:	0.01341	0.01146	0.00743	m^3
Normalised Gas Volume:	0.01258	0.01075	0.00697	Nm^3
Tube Details				
Tube Type:	226-09	226-09	226-09	
Tube Identification Number:	5105206598	5105206595	5105206593	
Blank Identification Number:	4879621572	4879621572	4879621572	
Main Adsorbent Layer	400	400	400	mg
Backup Adsorbent Layer	200	200	200	mg
Containment Material	Glass	Glass	Glass	
Breakthrough Occurred				
Tubes in Lab in <7 days	Yes	Yes	Yes	
Tubes >7 days were stored	<4	<4	<4	Deg C
Tubes >7 days were stored	Dark	Dark	Dark	-
Transport Container Airtight	Yes	Yes	Yes	
Exposed to Sunlight	No	No	No	
Transport Temp <20 Deg C	Yes	Yes	Yes	
Field Blank <10% Analyte Value	Yes	Yes	Yes	
Field Blank <10% ELV	Yes	Yes	Yes	
Test Details				
Adsorption Tube Temperature:	14.5			^{o}C
Stack Flow Rates				
Normalised Flow Rate:	5914	$m^3.hr^{-1}$		

Speciated Organic Results

Class	***ug/tube***	***$mg.m^{-3}$***	***$kg.hr^{-1}$***
VOC Run 1	5	0.40	0.0024
VOC Run 2	5	0.46	0.0027
VOC Run 3	5	0.72	0.0042

	Concentration ***$mg.m^{-3}$***	**Uncertainty** ***$mg.m^{-3}$***	**ELV** ***$mg.m^{-3}$***
VOC Run 1	0.40	0.01	-
VOC Run 2	0.46	0.01	-
VOC Run 3	0.72	0.01	-

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DISPERSION MODELLING ASSESSMENT OF CLASSICAL AIR POLLUTANTS FROM NAMED EMISSION POINT LOCATED IN REHAB GLASSCO LTD, OBERSTOWN INDUSTRIAL PARK, NAAS, CO. KILDARE.

PERFORMED BY ODOUR MONITORING IRELAND ON THE BEHALF OF AXIS ENVIRONMENTAL LTD.

REPORT PREPARED BY:	Dr. Brian Sheridan
REPORT VERSION:	Document Ver.1
ATTENTION:	Mr. Mark McGarry
DATE:	27/02/2015
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ODOUR monitoring IRELAND

EXECUTIVE SUMMARY

Odour Monitoring Ireland was commissioned by Axis Environmental Ltd to perform a classical air pollutants air quality dispersion modelling assessment of the existing and proposed dryer process operations to be located in Rehab Glassco Ltd, Oberstown Industrial Park, Naas, Co. Kildare. The proposed emission limit values based on actual measurements for Volume flow, Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total organic carbon on emission point glass dryer emission point was utilised in conjunction with source characteristics within the dispersion modelling assessment. This was used to assess compliance with SI180 of 2011 and Directive 2008/50/EC, where applicable.

Dispersion modelling assessment was performed utilising AERMOD Prime (12060) dispersion model. Five years of hourly sequential meteorological data from Casement (2004 to 2008 inclusive) was used within the dispersion model (Worst case year 2004). The total mass limit emission rate of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total Organic Carbon was inputted with source characteristics for the existing and proposed operations into the dispersion model in order to assess compliance with SI180 of 2011 and 2008/50/EC CAFÉ directive on air quality.

The following conclusions are drawn from the study:

1. The assessment was carried out to provide information in line with relevant information for investigation of downwind impact from a facility.
2. Specific dispersion modelling was performed for Carbon monoxide, Oxides of nitrogen, Sulphur dioxide Particulate matter (Pm_{10} and $PM_{2.5}$) and Total organic carbon.
3. With regard to Carbon monoxide, the maximum GLC+Baseline predicted at the worst case sensitive receptor for Carbon monoxide is 440 $\mu g/m^3$ for the maximum 8-hour mean concentration at the 100th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 4.40% of the impact criterion for emissions from the combined existing and proposed operations.
4. With regard to Oxides of nitrogen, the maximum GLC+Baseline at the worst case sensitive receptor for Oxides of nitrogen is 31.80 $\mu g/m^3$ for the maximum 1-hour mean concentration at the 99.79th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 15.90% of the impact criterion for emissions from the combined existing and proposed operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Oxides of nitrogen. The maximum predicted annual average + baseline ground level concentration at the worst case sensitive receptor for NO_2 is 14 $\mu g/m^3$. When compared, the annual average NO_2 air quality impact is less than or equal to 35% of the impact criterion for emissions from the combined existing and proposed operations.
5. With regards to Sulphur dioxide, the maximum GLC+Baseline at the worst case sensitive receptor for Sulphur dioxide is 34 and 18 $\mu g/m^3$ for the maximum 1 hr and 24-hour mean concentration at the 99.73th and 99.18th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is 9.70 and 14.40% of the impact criterion for emissions from the combined existing and proposed operations. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor for SO_2 is 8.0 $\mu g/m^3$. When compared, the annual average SO_2 air quality impact is less than or equal to 40% of the impact criterion for emissions from the combined existing and proposed operations.
6. With regard to Total particulates as $PM_{10/2.5}$, the maximum GLC+Baseline at the worst case sensitive receptors for Total particulates as PM_{10} is 24 $\mu g/m^3$ for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 48% of the impact criterion for emissions from the combined existing and proposed operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as $PM1_{10}$ and $PM_{2.5}$. The maximum predicted annual average + baseline ground level

concentration at the nearest worst case sensitive receptor for Total particulates as PM_{10} and $PM_{2.5}$ is 20 and 13 $\mu g/m^3$. When compared, the annual average Total particulates as PM_{10} and $PM_{2.5}$ air quality impact is less than or equal to 50 and 52% of the impact criterion for emissions from the combined existing and proposed operations.

7. With regard to Total Organic Carbon, the maximum GLC at worst case sensitive receptors for TOC is 7.0 $\mu g/m^3$ for the maximum annual average concentration.

1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland was commissioned by Axis Environmental Ltd to perform a dispersion modelling assessment of existing and proposed air emissions from the glass drying processes located in Rehab Glassco for Carbon monoxide, Oxides of nitrogen, Sulphur dioxide Total particulates and Total organic carbon which could potentially be emitted from the onsite glass dryers located in Oberstown Industrial Park, Naas, Co. Kildare.

The assessment allowed for the examination of proposed short and long term ground level concentrations (GLC's) of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total organic carbon as a result of existing and proposed operations located at the facility.

Predicted dispersion modelling GLC's were compared to regulatory / guideline ground level limit values for Carbon monoxide, Oxides of nitrogen, Sulphur dioxide Total particulates and Total organic carbon contained in SI180 of 2011 and Directive 2008/50/EC.

The materials and methods, results, discussion of results and conclusions are presented within this document.

1.2 Scope of the work

The main aims of the study included:

- Calculation of total mass emission rate of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, total particulates and Total organic carbon from the existing and proposed emission point A1-1 and A1-2 for use within a dispersion modelling assessment.
- Dispersion modelling assessment of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total organic carbon emission limit values in accordance with EPA guidance AG4.
- Assessment of whether the predicted ground level concentrations of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total organic carbon from the two emission points (A1-1 and A1-2) is in compliance with ground level concentration limit values at receptors in the vicinity of the facility (as taken from SI 180 of 2011 and Directive 2008/50/EC).

1.3 Model assumptions

The approach adopted in this assessment is considered a worst-case investigation in respect of Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and Total organic carbon emissions to the atmosphere from the existing and proposed operations of the emission points. These predictions are therefore most likely to over estimate the GLC that may actually occur for each modelled scenario. These assumptions are summarised and include:

- Emissions to the atmosphere from the existing operations were assumed to occur 24 hours each day / 7 days per week, 365 days per year, 100% output for all sources.

- Five years of hourly sequential meteorological data from Casement 2004 to 2008 inclusive was used in the modelling screen which will provide statistical significant results in terms of the short and long term assessment. The worst case year 2004 was used for data analysis. This is in keeping with current national and international recommendations (EPA Guidance AG4). In addition, AERMOD incorporates a meteorological pre-processor AERMET PRO. The AERMET PRO meteorological pre-processor requires the input of surface characteristics, including surface roughness (z0), Bowen Ratio and Albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of Albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc.) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and Albedo and to a distance of 1km for surface roughness in line with USEPA recommendations.

- Maximum GLC's at receptors beyond the facility boundary + Background were compared with relevant air quality limits values.
- All emissions were assumed to occur at maximum potential emission concentration and mass emission rates for each scenario and were assumed to occur for 24 hours per day, 365 days per year.
- AERMOD Prime (12060) dispersion modelling was utilised throughout the assessment in order to provide the most conservative dispersion estimates.
- All building wake affects that could occur within the site were assessed within the dispersion model using the Prime algorithm and appropriate site maps.
- 10 m spaced topographical data was inputted into the model in order to take account of the rolling terrain in the vicinity of the site and to ensure receptor heights were appropriate.

2. Materials and methods

This section describes the materials and methods used throughout the dispersion modelling assessment.

2.1 Dispersion modelling assessment

2.1.1 Atmospheric dispersion modelling of air quality: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of emissions for many years, originally using Gaussian form ISCST 3. Once the compound emission rate from the source is known, ($g\ s^{-1}$), the impact on the vicinity can be estimated. These models can effectively be used in three different ways:

- Firstly, to assess the dispersion of compounds;
- Secondly, in a "reverse" mode, to estimate the maximum compound emissions which can be permitted from a site in order to prevent air quality impact occurring;
- And thirdly, to determine which process is contributing greatest to the compound impact and estimate the amount of required abatement to reduce this impact to within acceptable levels (McIntyre et al. 2000).

In this latter mode, models have been employed for imposing emission limits on industrial processes, control systems and existing facilities and processes (Sheridan et al., 2002).

Any dispersion modelling approach will exhibit variability between the predicted values and the measured or observed values due to the natural randomness of the atmospheric environment. A model prediction can, at best, represent only the most likely outcome given the apparent environmental conditions at the time. Uncertainty depends on the completeness of the information used as input to the model as well as the knowledge of the atmospheric environment and the ability to represent that process mathematically. Good input information (emission rates, source parameters, meteorological data and land use characteristics) entered into a dispersion model that treats the atmospheric environment simplistically will produce equally uncertain results as poor information entered into a dispersion model that seeks to simulate the atmospheric environment in a robust manner. It is assumed in this discussion that pollutant emission rates are representative of maximum emission events, source parameters accurately define the point of release and surrounding structures, meteorological conditions define the local atmospheric environment and land use characteristics describe the surrounding natural environment. These conditions are employed within the dispersion modelling assessment therefore providing good confidence in the generated predicted exposure concentration values.

2.1.2 Atmospheric dispersion modelling of air quality: dispersion model selection

The AERMOD model was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling, and concepts; treatment of both surface and elevated sources; and simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modeling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence theories are not based on sampling data or a specific averaging period. AERMOD was especially designed to support the U.S. EPA's regulatory modeling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, yet without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002).

Input data from stack emissions, and source characteristics were used to construct the basis of the modelling scenarios.

2.2 Air quality impact assessment criteria

The predicted air quality impact from the operation of the existing emission points for each scenario is compared to relevant air quality objectives and limits. Air quality standards and guidelines referenced in this report include:

- SI 180 of 2011 – Air Quality Standards Regulations 2011.
- EU limit values laid out in the Directive on Air Quality 2008/50/EC.

Air quality is judged relative to the relevant Air Quality Standards, which are concentrations of pollutants in the atmosphere, which achieve a certain standard of environmental quality. Air quality Standards are formulated on the basis of an assessment of the effects of the pollutant on public health and ecosystems.

In general terms, air quality standards have been framed in two categories, limit values and guideline values. Limit values are concentrations that cannot be exceeded and are based on WHO guidelines for the protection of human health. Guideline values have been established for long-term precautionary measures for the protection of human health and the environment. European legislation has also considered standard for the protection of vegetation and ecosystems.

The relevant air quality standards for the existing emission sources are presented in *Table 2.1.*

2.2.1 Air Quality Guidelines value for Classical air pollutants

Table 2.1 illustrates the guideline and limit values for classical air quality pollutants in Ireland.

Table 2.1. EU and Irish Limit values laid out in the SI 180 of 2011 and 2008/50/EC.

POLLUTANT	Objective			
	Concentration	**Maximum No. Of exceedences allowed**	**Exceedence expressed as percentile**	**Measured as**
Carbon monoxide (CO)	10 mg m^{-3}	None	100th percentile	Running 8 hour mean
Oxides of nitrogen (2008/50/EC and SI180 of 2011)	300 µg m^{-3} NO_2 200 µg m^{-3} NO_2 40 µg m^{-3} NO_2	18 times in a year 18 times in a year --	99.79th percentile 99.79th percentile --	1 hour mean 1 hour mean Annual mean
Sulphur dioxide	350 µg m^{-3} 125 µg m^{-3} 20 µg m^{-3}	24 times in a year 3 times in a year --	99.73th percentile 99.18th percentile --	1 hour mean 24 hour mean Annual mean and winter mean
Particulates (PM10) (2008/50/EC and SI180 of 2011)	50 µg m^{-3} 40 µg m^{-3} 20 µg m^{-3}	35 times in a year None None	90.40th percentile -- --	24 hour mean Annual mean Annual mean
Particulates (PM2.5) (2008/50/EC and SI180 of 2011)	25 µg m^{-3} – Stage 1 20 µg m^{-3} – Stage 2	None None	-- --	Annual mean Annual mean
TOC	-- µg m^{-3} -- µg m^{-3}	None None	-- --	Annual mean 1hr max

2.3 Existing Baseline Air Quality

The EPA has been monitoring national Air quality from a number of sites around the country. This information is available from the EPA's website. The values presented for Carbon monoxide, Oxides of Nitrogen Sulphur dioxide and Total particulates as $PM_{10,\ 2.5}$ give an indication of expected imissions of these pollutants are listed in *Table 2.1*. *Table 2.2* illustrates the baseline data expected to be obtained from a zone D area for these classical air pollutants. The existing facility would be considered to be located in a Zone D area according to the EPA's classification of zones for air quality (www.epa.ie). Traffic and industrial related emissions would be low to low / medium.

Table 2.2. Baseline air quality data used to assess air quality impact criterion in a number of Zone D region.

Reference air quality data – Source identity	Annual average Carbon monoxide conc. (µg m^{-3})	Annual average Oxides of nitrogen conc. (µg m^{-3})	Annual average Sulphur dioxide Conc. (µg m^{-3})	Annual average Total particulates conc (µg m^{-3})	Details
Castlebar	-	11	-	15	Measured 2013
Kilkitt	-	4	3	11	Measured 2013
Shannon Estuary	-	-	2	-	Measured 2013
Emo	-	4	-	-	Measured 2013
Claremorris	-	-	-	13 (8)	Measured 2013
Mullingar (zone C)	300	-	-	-	Measured 2013

Notes: [1] denotes taken from Air quality in Ireland 2013 – Key indicators of ambient air quality, www.epa.ie.

2.4 Meteorological data

Five years of hourly sequential meteorological data was chosen for the modelling exercise (i.e. Casement 2004 to 2008 inclusive). A schematic wind rose and tabular cumulative wind speed and directions of all five years are presented in *Section 7*. All five years of met data was screened to provide more statistical significant result output from the dispersion model. The worst case year 2004 was used for data presentation. This is in keeping with national and international recommendations on quality assurance in operating dispersion models and will provide a worst case assessment of predicted ground level concentrations based on the input emission rate data. Surface roughness, Albedo and Bowen ratio were assessed and characterised around Casement met station for AERMET Pro processing.

2.5 Terrain data

Topography effects were not accounted for within the dispersion modelling assessment as terrain was considered simple in the vicinity of the site with no significant deviations in the topography relative to the overall stack height. In addition, maximum ground level concentrations were predicted within the site boundary thereby eliminating any effects that deviations in terrain could have on predicted ground level concentrations.

2.6 Building wake effects

Building wake effects are accounted for in modelling scenarios through the use of the Prime algorithm (i.e. **<u>all</u>** building features located within the facility were assessed and the effects of same on plume grounding and dispersion) as this can have a significant effect on the compound plume dispersion at short distances from the source and can significantly increase GLC's in close proximity to the facility. All building structures and stack heights and orientations were inputted into the dispersion model in order to allow for wake effects to be taken in to account in the calculations.

3. Results

This section describes the results obtained from the dispersion modelling assessment of emissions from the existing and proposed operation located in Rehab Glassco Limited facility. All input data and source characteristics were developed in conjunction with engineering drawings and source characteristics for the emission point supplied by Axis Environmental Ltd.

3.1. Dispersion model input data – Source characteristics and input data

Table 3.1 illustrates the source characteristics utilised within the dispersion model for the named emission point. Grid reference location, stack height (A.G.L), maximum volume flow and temperature of the emission point(s) are presented within this table for reference purposes.

Table 3.1. Source characteristics for existing emission point – A1-1 and proposed emission point A1-2 – Glass drier stacks

Emission point identity	A1-1 – Existing glass drier emission point	A1-2 – Proposed glass drier emission point
X cord(m)	286765.9	286811
Y cord (m)	220378.9	220296
Finish floor level (m)	78	78
Stack height (m)	7.50	13
Temp (K)	423.15	343.15
Efflux velocity (m)	22.07	17.55
Stack tip dia. dimensions (m)	0.50	0.45
Worst case building height (m)	8.34 (Drier building), there are other buildings higher but not next to the stack	12 (Drier building)
Stack orientation (m)	Vertical	Vertical
Volumetric airflow rate (Nm^3/hr dry ref)	9,000	8,000
Volumetric airflow rate (Am^3/hr wet)	15,593	10,048
Carbon monoxide flue gas conc. (mg/Nm^3)	300	300
Oxides of nitrogen flue gas conc. (mg/Nm^3)	50	50
Sulphur dioxide flue gas conc. (mg/Nm^3)	50	50
Total particulates flue gas conc. (mg/Nm^3)	50	50
Total organic carbon flue gas conc. (mg/Nm^3)	80	80
Carbon monoxide mass emission rate (g/s)	0.75	0.67
Oxides of nitrogen mass emission rate (g/s)	0.125	0.11
Sulphur dioxide mass emission rate (g/s)	0.125	0.11
Total particulates mass emission rate (g/s)	0.125	0.11
Total organic carbon mass emission rate (g/s)	0.20	0.18

3.2 Dispersion modelling assessment

AERMOD Prime (12060) was used to determine the overall ground level impact of the existing emissions from the named emission point operating 24/7/365 days per year. These computations give the relevant GLC's at each 25 and 150-meter X Y Cartesian grid receptor location that is predicted to be exceeded for the specific air quality impact criteria. Receptor elevations were established at 1.80 m height above ground (normal breathing zone). A total Cartesian receptors gird of 2,357 points was established within the dispersion model giving a fine and course grid coverage of 1.0 km sq and 14.10 km sq centred on the exhaust stack.

Five years of hourly sequential meteorological data from Casement (Casement 2004 to 2008 inclusive) was screened with the worst case year 2004 been used for results presentation. Source characteristics as detailed in *Table 3.1* including emission data contained in *Table 3.1*) was inputted into the dispersion model.

Various averaging intervals were chosen to allow direct comparison of predicted GLC's with the relevant pollutant air quality assessment criteria as outlined in *Table 2.1*. In particular, 1 hr, 8 hr, 24-hour, percentile and annual average GLC's of the pollutants were calculated at distances from the site. Relevant percentiles of these GLC's were also computed for comparison with the relevant Air Quality Standards.

For modelling classical air pollutants and in order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak 1 hr concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK Environment Agency advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum short-term concentration due to emissions from the source to twice the annual mean background concentration.

In modelling air dispersion of NOx from combustion sources, the source term should be expressed as NO_2, e.g., NOx mass (expressed as NO_2). Some of the exhaust air is made up of NO while some is made up of NO_2. NO will be converted in the atmosphere to NO_2 but this will depend on a number of factors to include Ozone and VOC concentrations. In order to take account of this conversion the following screening can be performed.

Worse case scenario treatment

35% for short-term and 70% for long-term average concentration should be considered to assess compliance with the relevant air quality objective.

This is in accordance with recommendations from the Environmental Agency UK for the dispersion modelling of NO_2 emissions from combustion processes, www.environmentagency.gov.uk

3.3 Dispersion modelling scenarios

Ten distinct scenarios were assessed within the dispersion model. The output data was analysed to calculate the following:

Ref Scenario 1: Predicted Carbon monoxide emission contribution of all exhaust emission points to plume dispersal at the 100^{th} percentile of an 8 hour average for an Carbon monoxide concentration of less than or equal to 200 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.2*).

Ref Scenario 2: Predicted Oxides of nitrogen emission contribution of all exhaust emission points to plume dispersal at the 99.79^{th} percentile of an 1 hour average for an Oxides of nitrogen concentration of less than or equal to 14 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.3*).

Ref Scenario 3: Predicted Oxides of nitrogen emission contribution of all exhaust emission points to Oxides of nitrogen plume dispersal for the Annual average for an Oxides of nitrogen concentration of less than or equal to 2.8 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.4*).

Ref Scenario 4: Predicted Sulphur dioxide emission contribution of all exhaust emission points to plume dispersal at the 99.73^{th} percentile of an 1 hour average for an Sulphur dioxide concentration of less than or equal to 30 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.5*).

Ref Scenario 5: Predicted Sulphur dioxide emission contribution of exhaust stack of all exhaust emission points to plume dispersal at the 99.18^{th} percentile of an 24 hour average for an Sulphur dioxide concentration of less than or equal to 20 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.6*).

Ref Scenario 6: Predicted Sulphur dioxide emission contribution of all exhaust emission points to Sulphur dioxide plume dispersal for the Annual average for an Sulphur dioxide concentration of less than or equal to 4.0 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.7*).

Ref Scenario 7: Predicted Total particulates as PM_{10} emission contribution of all exhaust stack of exhaust emission points to plume dispersal at the 90.4^{th} percentile of an 24 hour average for an Total particulates as PM_{10} concentration of less than or equal to 8.0 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.8*).

Ref Scenario 8: Predicted Total particulates as PM_{10} emission contribution of all exhaust emission points to plume dispersal for the Annual average for an Total particulates as PM_{10} concentration of less than or equal to 4.0 $\mu g/m^3$ for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.9*).

Ref Scenario 9: Predicted Total particulates as $PM_{2.5}$ emission contribution of all exhaust emission points to plume dispersal for the Annual average for an Total particulates as $PM_{2.5}$ concentration of less than or equal to

4.0 µg/m^3 for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.10*).

Ref Scenario 10: Predicted TOC emission contribution of all exhaust emission points to plume dispersal for the Annual average for a TOC concentration of less than or equal to 6 µg/m^3 for 5 years of screened hourly sequential meteorological data (worst case year Casement 2004) (*see Figure 6.11*).

4. Results and Discussion of results

This section will describe the results obtained throughout the study.

AERMOD GIS Pro Prime (Ver. 12060) was used to determine the overall air quality impact of existing operations at Rehab Glassco Ltd, Oberstown Industrial Park, Naas, Co. Kildare. *Table 4.1* illustrates the tabular concentration results at each of the sensitive receptors in the vicinity of the facility.

Predicted GLC's presented within these tables will allow for comparison with SI 180 of 2011 and Directive 2008/50/EC guideline and limit values.

4.1 Assessment of air quality impacts for pollutants from named emission points.

Table 4.1 presents the comparison between model predictions at each sensitive receptor for air quality impacts for Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and TOC and the maximum percentage value of the air quality impact criterion.

Table 4.1. Predicated combined baseline and ground level concentration of named pollutant at each sensitive receptor and at or beyond the facility boundary.

Receptor identity	X coordinate (m)	Y coordinate (m)	Scen 1 (µg/m^3)	Scen 2 (µg/m^3)	Scen 3 (µg/m^3)	Scen 4 (µg/m^3)	Scen 5 (µg/m^3)	Scen 6 (µg/m^3)	Scen 7 (µg/m^3)	Scen 8 (µg/m^3)	Scen 9 (µg/m^3)	Scen 10 (µg/m^3)
R1	286532	220570	25.10	2.74	0.15	7.28	1.81	0.22	0.64	0.22	0.22	0.35
R2	286616	220551	35.83	3.91	0.23	10.65	2.35	0.33	1.02	0.33	0.33	0.53
R3	286620	220505	47.57	4.63	0.30	12.78	3.40	0.43	1.31	0.43	0.43	0.69
R4	286727	220568	45.82	4.06	0.34	11.15	3.13	0.49	1.22	0.49	0.49	0.79
R5	286777	220578	40.05	4.46	0.45	11.97	2.96	0.65	1.76	0.65	0.65	1.04
R6	286821	220579	42.08	4.65	0.63	13.03	3.68	0.91	2.18	0.91	0.91	1.46
R7	286638	220334	72.60	5.46	0.78	15.38	7.74	1.11	3.67	1.11	1.11	1.79
R8	286651	220238	54.04	4.03	0.52	11.31	5.31	0.74	2.23	0.74	0.74	1.20
R9	286887	220363	61.19	4.17	2.73	11.72	8.12	3.90	6.65	3.90	3.90	6.34
R10	286692	220177	54.41	5.10	0.38	12.44	4.89	0.54	1.43	0.54	0.54	0.88
R11	286826	220212	104.76	6.77	0.57	18.84	7.47	0.82	1.99	0.82	0.82	1.33
R12	286831	220180	82.67	6.14	0.47	16.66	5.86	0.67	1.58	0.67	0.67	1.09
R13	286825	220153	67.10	5.53	0.38	15.35	4.73	0.55	1.06	0.55	0.55	0.89
Max predicted value (µg/m^3)	-	-	104.76	6.77	2.73	18.84	8.12	3.90	6.65	3.90	3.90	6.34
Baseline value (µg/m^3)	-	-	300	22	11	6	3	3	15	15	8	-
Max predicted value at or beyond the facility boundary (µg/m^3)	-	-	140.00	10	3	28.00	15.00	5.00	9.00	5.00	5.00	7.00
Limit value (µg/m^3)	-	-	10,000	200	40	350	125	20	50	40	25	-
% value of impact criterion at or beyond the facility boundary	-	-	**4.40**	**15.90**	**35.0**	**9.70**	**14.40**	**40.0**	**48.0**	**50.0**	**52.0**	-
% value of impact criterion at receptor location	-	-	**4.0**	**14.40**	**34.30**	**7.10**	**8.90**	**34.50**	**43.30**	**47.30**	**47.60**	-

As can be observed in *Table 4.1*, the predicted maximum averaging ground level concentration and baseline concentration at each receptor location and at or beyond the facility boundary are well within the guideline / limit value for each pollutant.

4.1.1 Carbon monoxide

The results for the potential air quality impact for dispersion modelling of Carbon monoxide based on the emission rates in *Table 3.1* are presented in *Table 4.1.* Results are presented for the maximum predicted percentile emission regime at each sensitive receptor and facility boundary. As can be observed in *Table 4.1,* the maximum GLC+Baseline predicted at the worst case sensitive receptor for Carbon monoxide is 440 $\mu g/m^3$ for the maximum 8-hour mean concentration at the 100th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 4.40% of the impact criterion for emissions from the combined existing and proposed operations.

4.1.2 Oxides of nitrogen

The results for the potential air quality impact for dispersion modelling of Oxides of nitrogen based on the emission rates in *Table 3.1* are presented in *Table 4.1.* Results are presented for the maximum predicted percentile emission regime at each sensitive receptor. As can be observed in *Table 4.1,* the maximum GLC+Baseline at the worst case sensitive receptor for Oxides of nitrogen is 31.80 $\mu g/m^3$ for the maximum 1-hour mean concentration at the 99.79th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 15.90% of the impact criterion for emissions from the combined existing and proposed operations.

An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Oxides of nitrogen. The maximum predicted annual average + baseline ground level concentration at the worst case sensitive receptor for NO_2 is 14 $\mu g/m^3$. When compared, the annual average NO_2 air quality impact is less than or equal to 35% of the impact criterion for emissions from the combined existing and proposed operations.

4.1.3 Sulphur dioxide

The results for the potential air quality impact for dispersion modelling of Sulphur dioxide based on the emission rates in *Table 3.1* are presented in *Table 4.1.* Results are presented for the maximum predicted percentile emission regime. As can be observed in *Table 4.1,* the maximum GLC+Baseline at the worst case sensitive receptor for Sulphur dioxide is 34 and 18 $\mu g/m^3$ for the maximum 1 hr and 24-hour mean concentration at the 99.73th and 99.18th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is 9.70 and 14.40% of the impact criterion for emissions from the combined existing and proposed operations.

An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Sulphur dioxide. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor for SO_2 is 8.0 $\mu g/m^3$. When compared, the annual average SO_2 air quality impact is less than or equal to 40% of the impact criterion for emissions from the combined existing and proposed operations.

4.1.4 Total particulates as PM10 and PM2.5

The results for the potential air quality impact for dispersion modelling of Total particulates based on the emission rates in *Table 3.1* are presented in *Table 4.1.* Results are presented for the maximum predicted percentile emission regime. As can be observed in *Table 4.1,* the maximum GLC+Baseline at the worst case sensitive receptors for Total particulates as PM_{10} is 24 $\mu g/m^3$ for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 48% of the impact criterion for emissions from the combined existing and proposed operations.

An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as PM_{10} and $PM_{2.5}$. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor for Total particulates as PM_{10} and $PM_{2.5}$ is 20 and 13 $\mu g/m^3$. When compared, the annual average Total particulates as PM_{10} and $PM_{2.5}$ air quality impact is less than or equal to 50 and 52% of the impact criterion for emissions from the combined existing and proposed operations.

4.1.5 TOC

The results for the potential air quality impact for dispersion modelling of Total organic carbon based on the emission rates in *Table 3.1* are presented in *Table 4.1.* Results are presented for the maximum predicted percentile emission regime. As can be observed in *Table 4.1,* the maximum GLC at the worst case sensitive receptors for TOC is 7.0 $\mu g/m^3$ for the maximum annual average concentration.

5. Conclusions

Odour Monitoring Ireland was commissioned by Axis Environmental Ltd to perform a desktop dispersion modelling study in order to assess the potential Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total particulates and TOC air quality impact associated with existing and proposed operations at Rehab Glassco Limited facility located in Oberstown Industrial Park, Naas, Co. Kildare. Following a detailed desktop review and dispersion modelling assessment, it was demonstrated that no significant Carbon monoxide, Oxides of nitrogen, Sulphur dioxide, Total Particulates or TOC impact will occur as a result of operation of existing and proposed facility.

The following conclusions are drawn from the study:

1. The assessment was carried out to provide information in line with relevant information for investigation of downwind impact from a facility.
2. Specific dispersion modelling was performed for Carbon monoxide, Oxides of nitrogen, Sulphur dioxide Particulate matter (Pm_{10} and $PM_{2.5}$) and Total organic carbon.
3. With regard to Carbon monoxide, the maximum GLC+Baseline predicted at the worst case sensitive receptor for Carbon monoxide is 440 $\mu g/m^3$ for the maximum 8-hour mean concentration at the 100th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 4.40% of the impact criterion for emissions from the combined existing and proposed operations.
4. With regard to Oxides of nitrogen, the maximum GLC+Baseline at the worst case sensitive receptor for Oxides of nitrogen is 31.80 $\mu g/m^3$ for the maximum 1-hour mean concentration at the 99.79th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 15.90% of the impact criterion for emissions from the combined existing and proposed operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Oxides of nitrogen. The maximum predicted annual average + baseline ground level concentration at the worst case sensitive receptor for NO_2 is 14 $\mu g/m^3$. When compared, the annual average NO_2 air quality impact is less than or equal to 35% of the impact criterion for emissions from the combined existing and proposed operations.
5. With regards to Sulphur dioxide, the maximum GLC+Baseline at the worst case sensitive receptor for Sulphur dioxide is 34 and 18 $\mu g/m^3$ for the maximum 1 hr and 24-hour mean concentration at the 99.73th and 99.18th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is 9.70 and 14.40% of the impact criterion for emissions from the combined existing and proposed operations. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor for SO_2 is 8.0 $\mu g/m^3$. When compared, the annual average SO_2 air quality impact is less than or equal to 40% of the impact criterion for emissions from the combined existing and proposed operations.
6. With regard to Total particulates as $PM_{10/2.5}$, the maximum GLC+Baseline at the worst case sensitive receptors for Total particulates as PM_{10} is 24 $\mu g/m^3$ for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 48% of the impact criterion for emissions from the combined existing and proposed operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as $PM1_{10}$ and $PM_{2.5}$. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor for Total particulates as PM_{10} and $PM_{2.5}$ is 20 and 13 $\mu g/m^3$. When compared, the annual average Total particulates as PM_{10} and $PM_{2.5}$ air quality impact is less than or equal to 50 and 52% of the impact criterion for emissions from the combined existing and proposed operations.
7. With regard to Total Organic Carbon, the maximum GLC at worst case sensitive receptors for TOC is 7.0 $\mu g/m^3$ for the maximum annual average concentration.

6. *Appendix I* - Air dispersion modelling contour plots (Process contribution only).

These contour plots are for illustrative purposes only. The pollutant contour values were selected for illustrative purposes only to allow for graphical representation of dispersion from the identified source.

6.1 Site layout drawing and location of existing and proposed emission points.

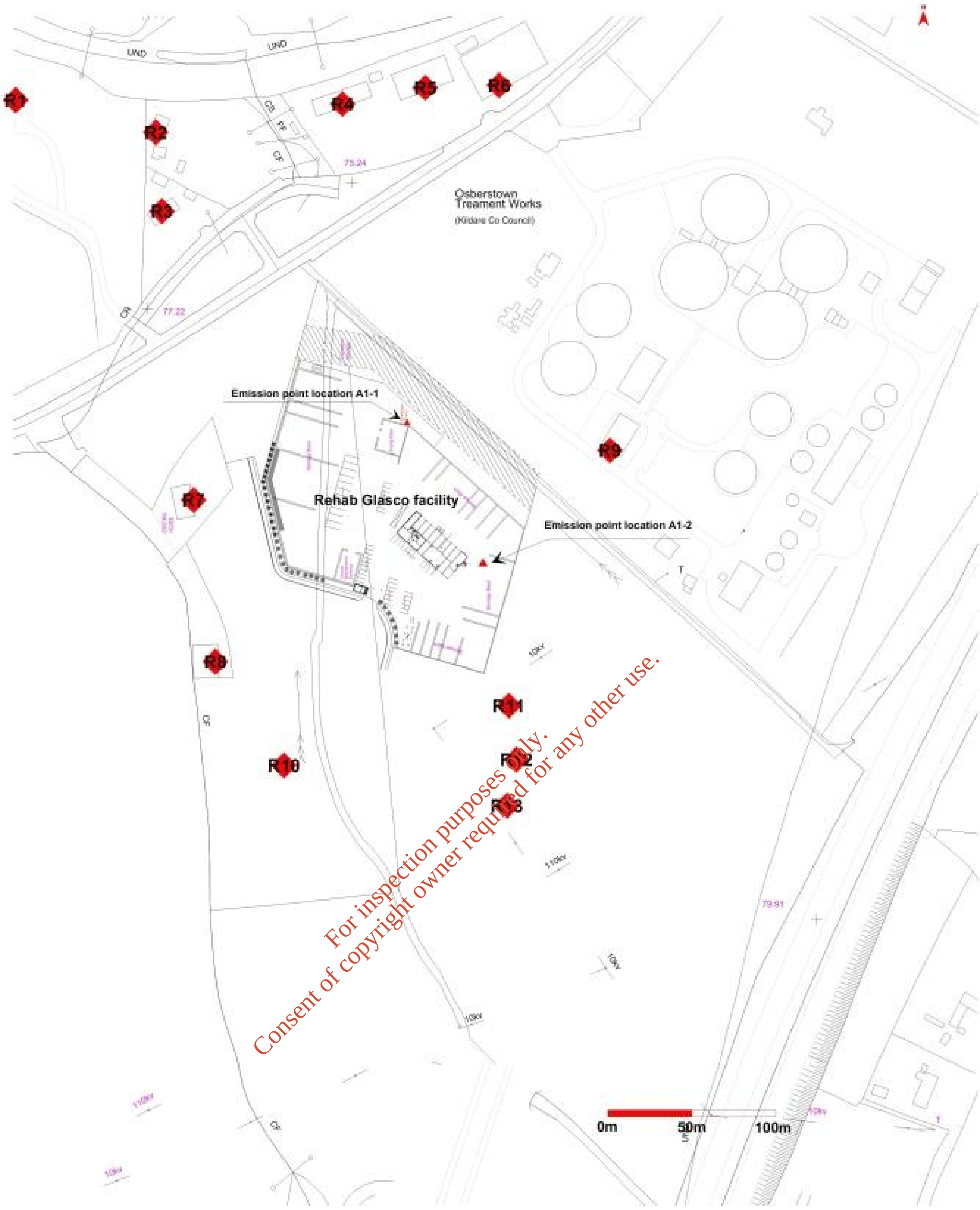

Figure 6.1. Plan view facility layout drawings for existing emission point (A1-1) and proposed emission point (A1-2) and nearest receptor locations.

6.2 Carbon monoxide contour.

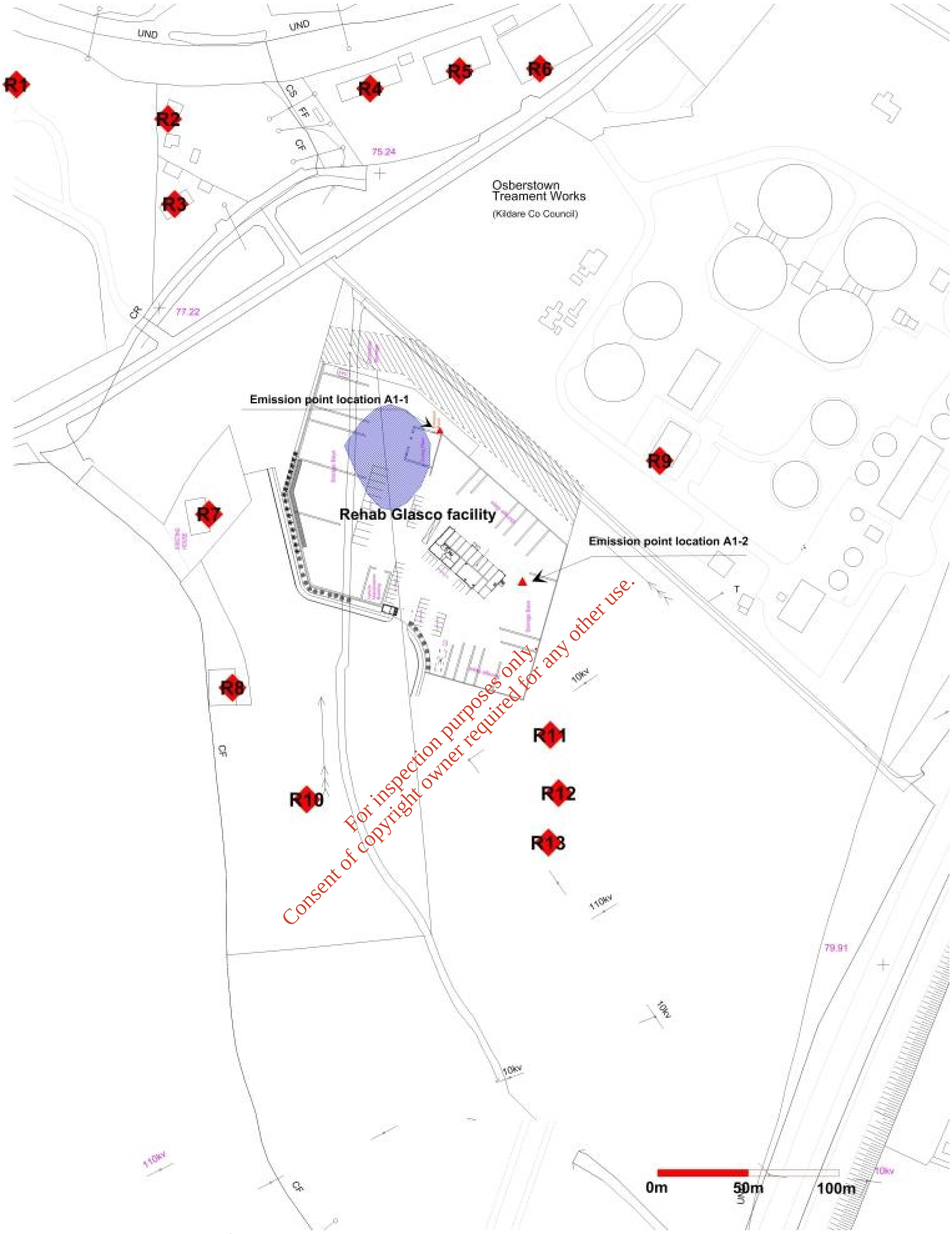

Figure 6.2. Predicted Carbon monoxide ground level concentration impact contribution of cumulative emissions from all named emission points for the 8 hr 100th %ile ground level concentration of ≤ 200 µg/m^3 ( ) for worst case meteorological year Casement 2004.

6.3 Oxides of nitrogen contours.

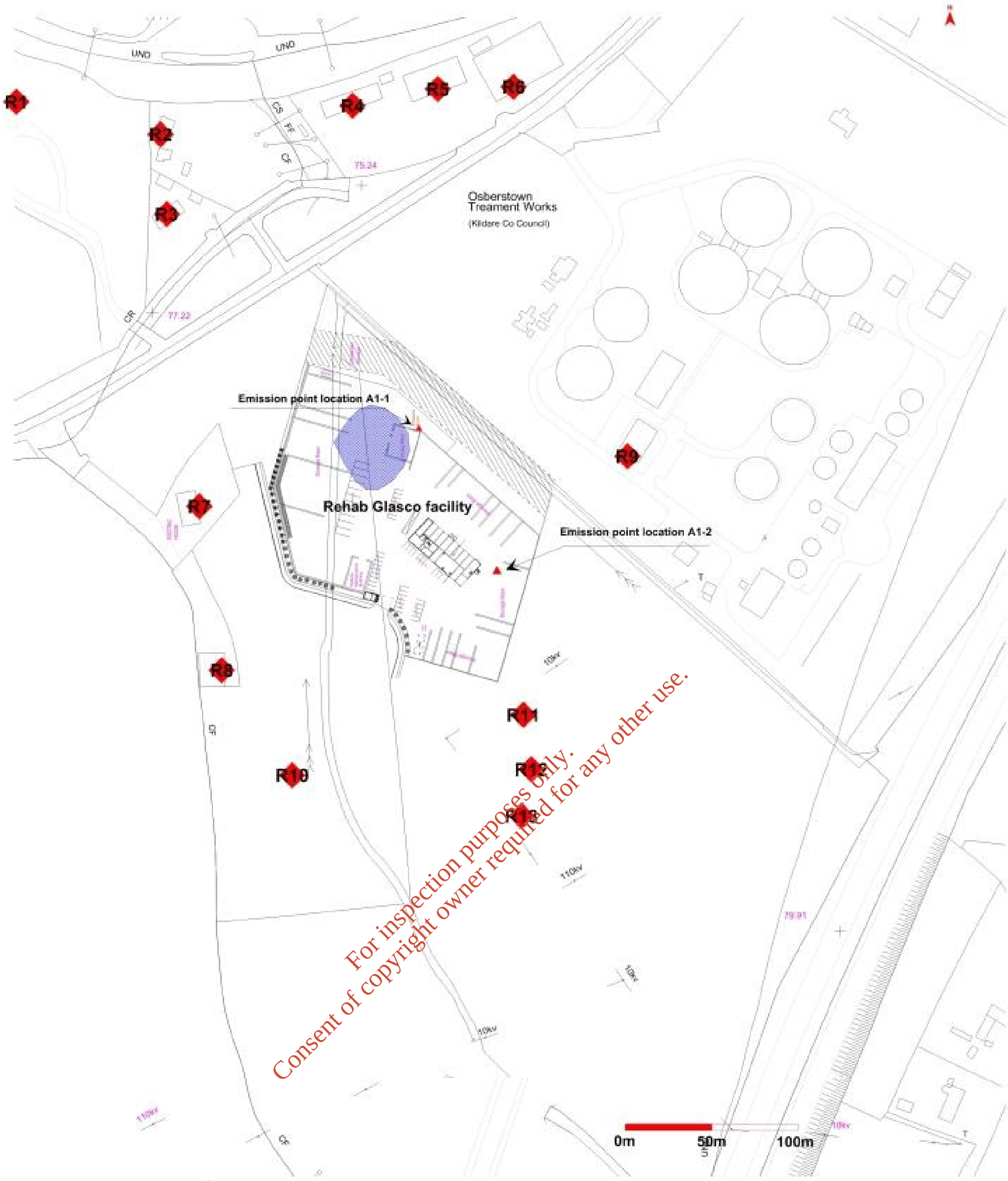

Figure 6.3. Predicted Oxides of nitrogen ground level concentration impact contribution of cumulative emissions from all named emission points for the 1 hr 99.79th %ile ground level concentration of ≤ 14 µg/m^3 (▬▬) for worst case meteorological year Casement 2004.

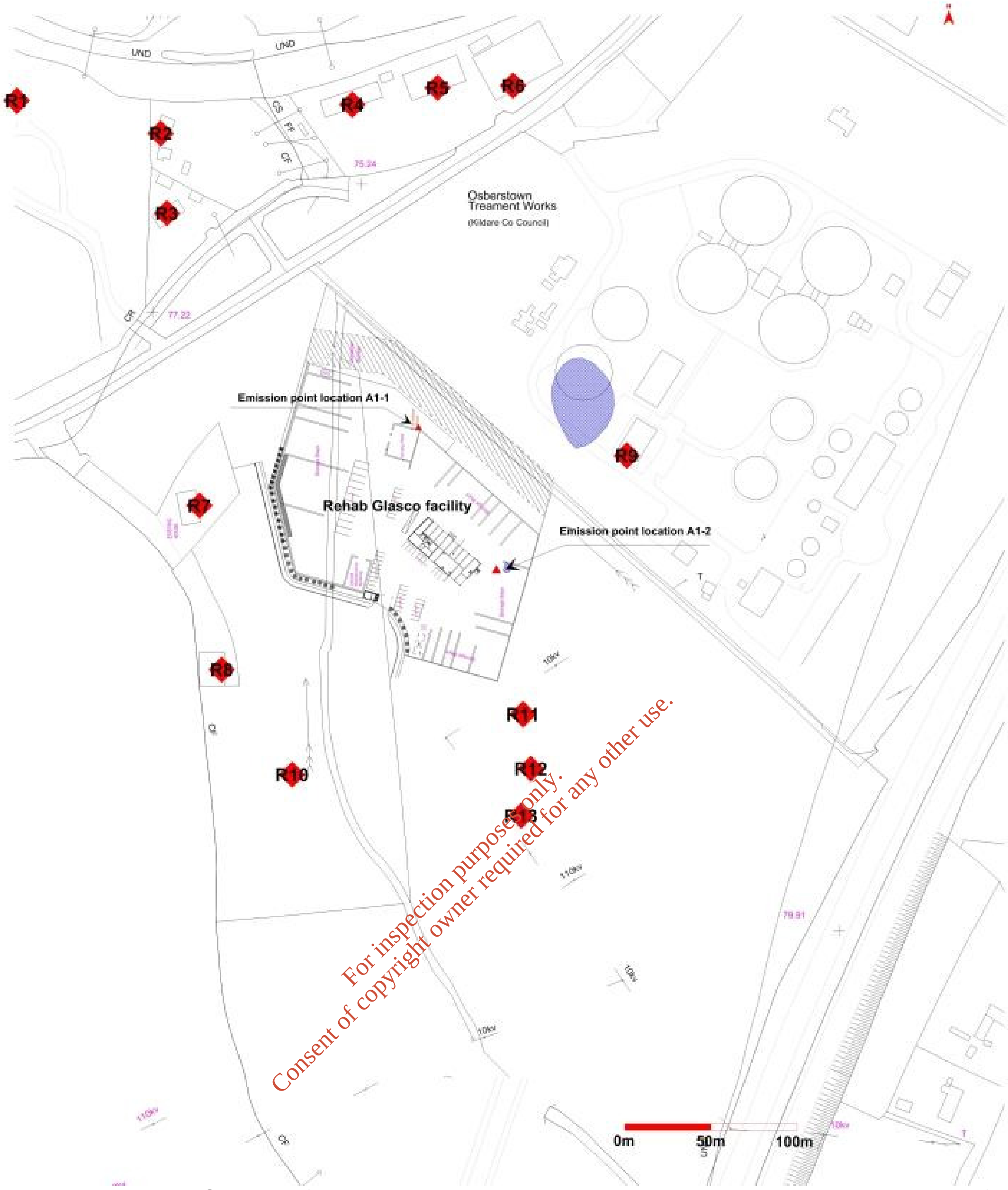

Figure 6.4. Predicted Oxides of nitrogen ground level concentration impact contribution of cumulative emissions from all named emission points for the Annual average ground level concentration of ≤ 2.8 µg/m^3 (▬▬) for worst case meteorological year Casement 2004.

6.4 Sulphur dioxide contours.

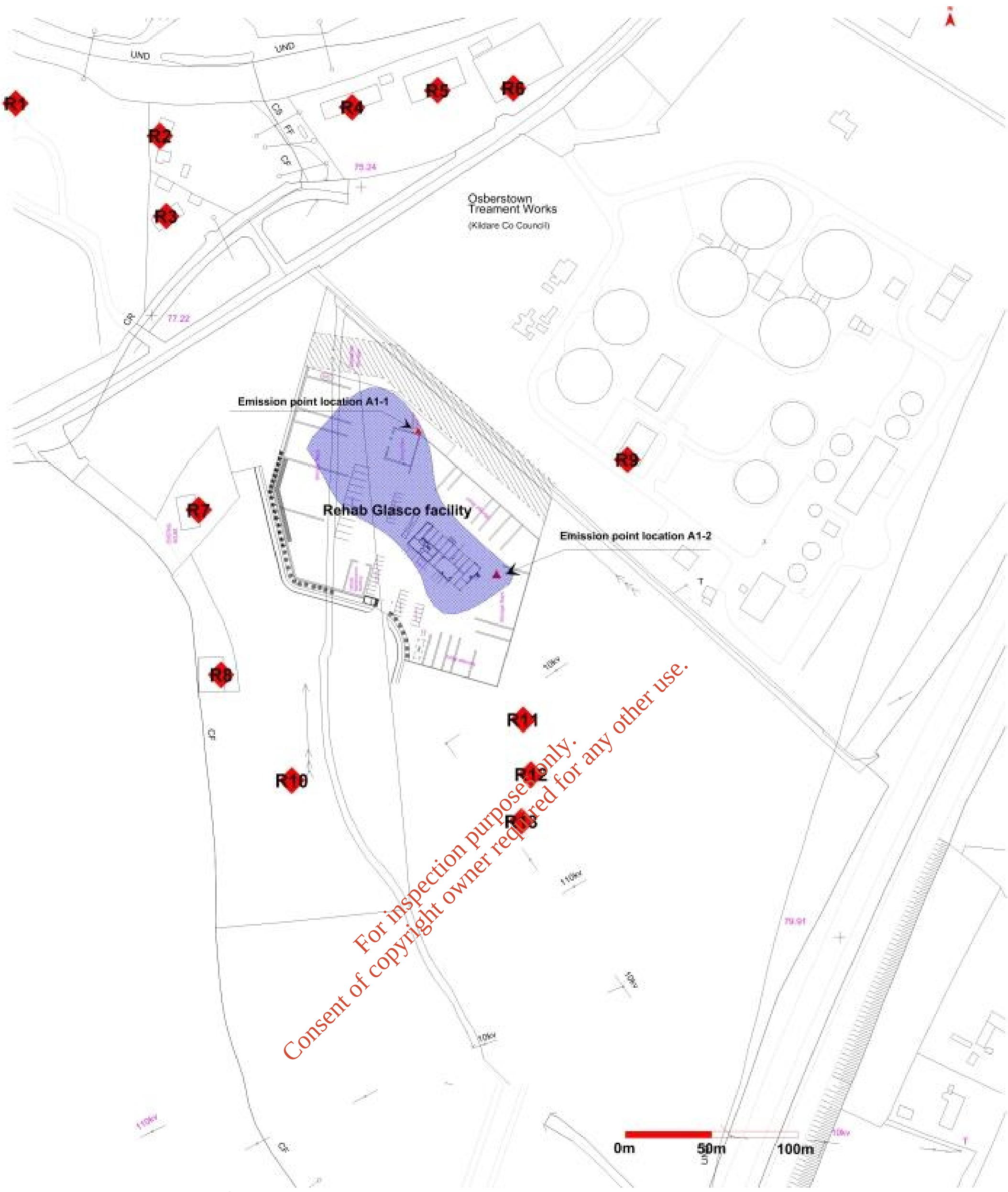

Figure 6.5. Predicted Sulphur dioxide ground level concentration impact contribution of cumulative emissions from all named emission points for the 1 hour 99.73th %ile ground level concentration of ≤ 30 µg/m^3 (——) for worst case meteorological year Casement 2004.

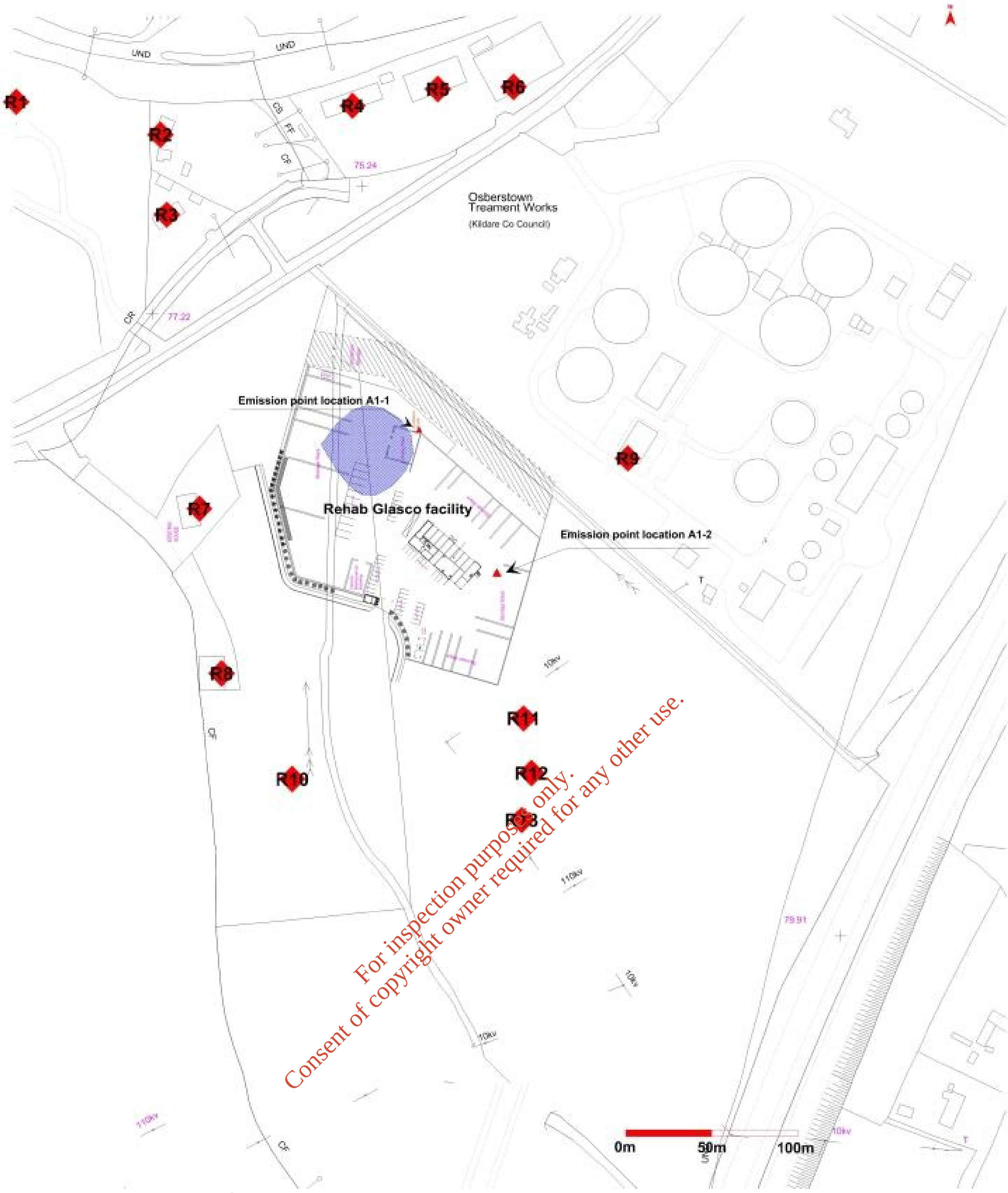

Figure 6.6. Predicted Sulphur dioxide ground level concentration impact contribution of cumulative emissions from all named emission points for the 24 hour 99.18th %ile ground level concentration of ≤ 20 µg/m^3 (▬▬) for worst case meteorological year Casement 2004.

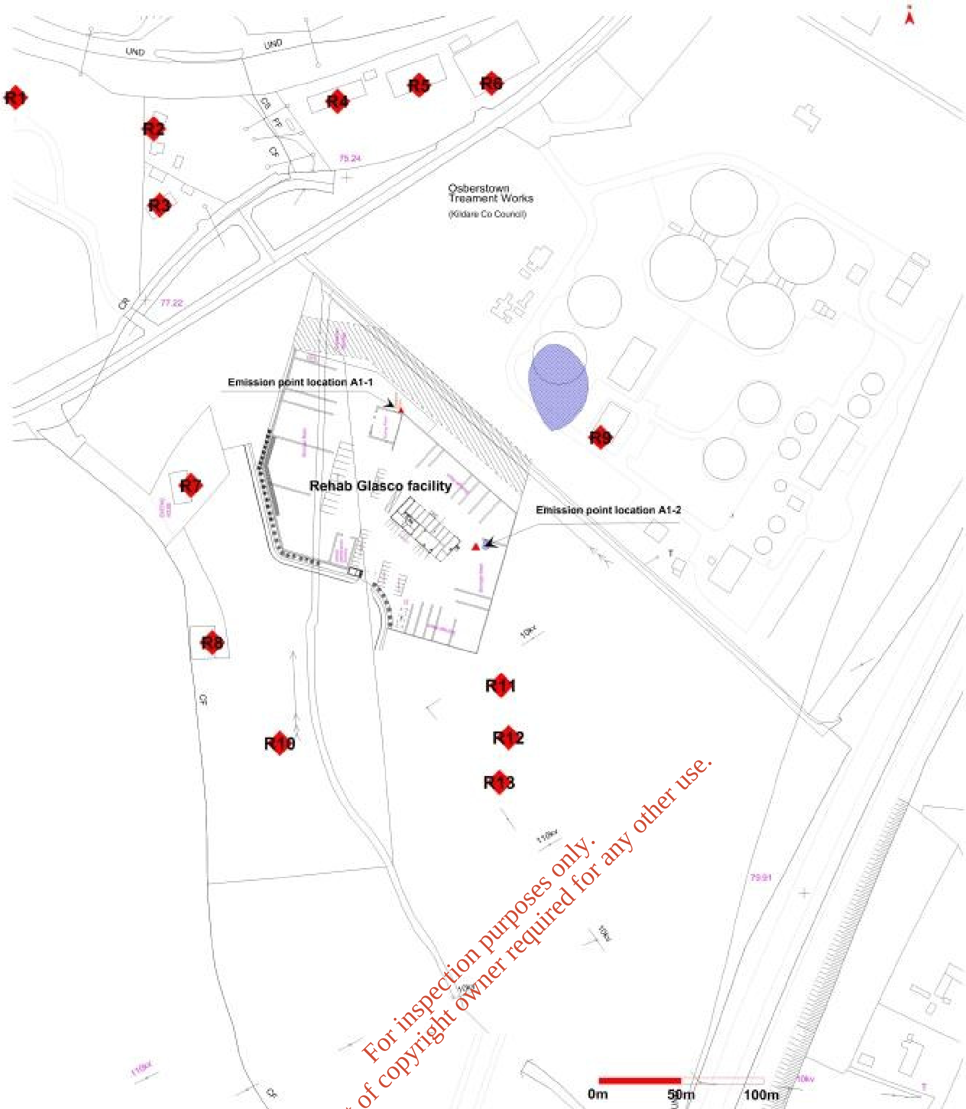

Figure 6.7. Predicted Sulphur dioxide ground level concentration impact contribution of cumulative emissions from all named emission points for the Annual average ground level concentration of ≤ 4.0 µg/m^3 (blue line) for worst case meteorological year Casement 2004.

6.5 Total particulates contours.

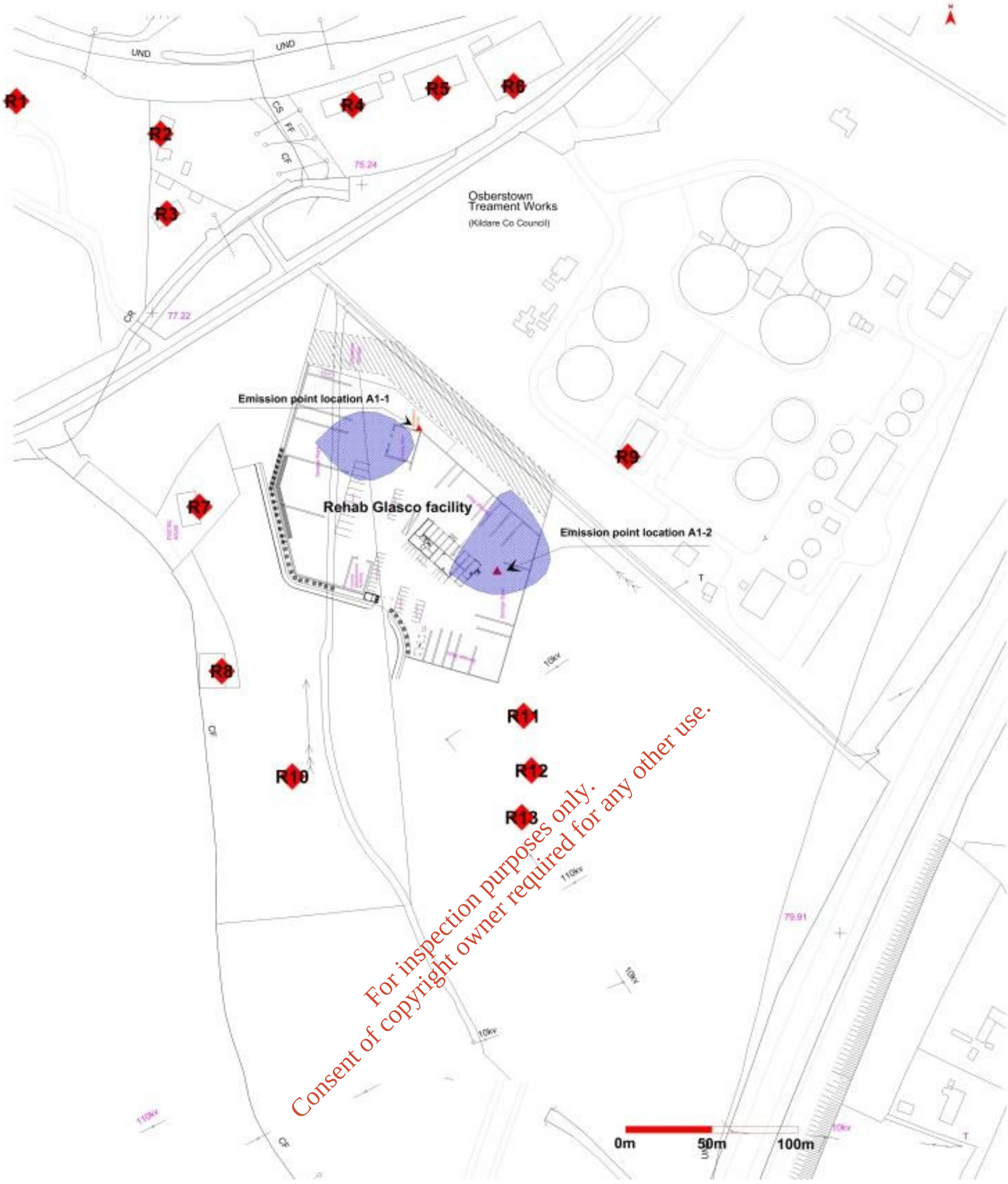

Figure 6.8. Predicted Total particulates as PM_{10} ground level concentration impact contribution of cumulative emissions from all named emission points for the 24 hour 90.40th %ile ground level concentration of ≤ 8.0 µg/m^3 (▬) for worst case meteorological year Casement 2004.

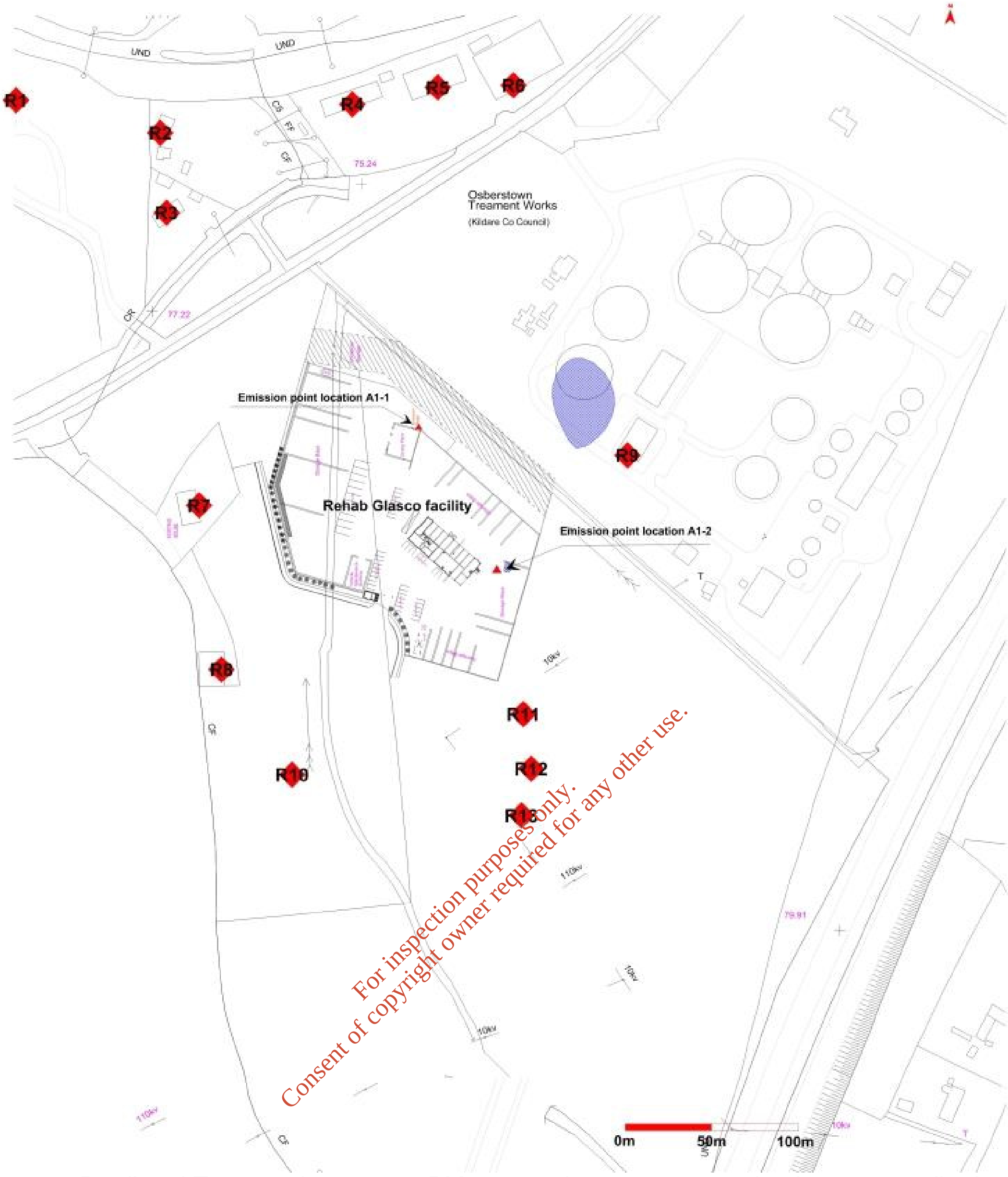

Figure 6.9. Predicted Total particulates as PM_{10} ground level concentration impact contribution of cumulative emissions from all named emission points for the Annual average ground level concentration of ≤ 4.0 µg/m^3 (▬▬) for worst case meteorological year Casement 2004.

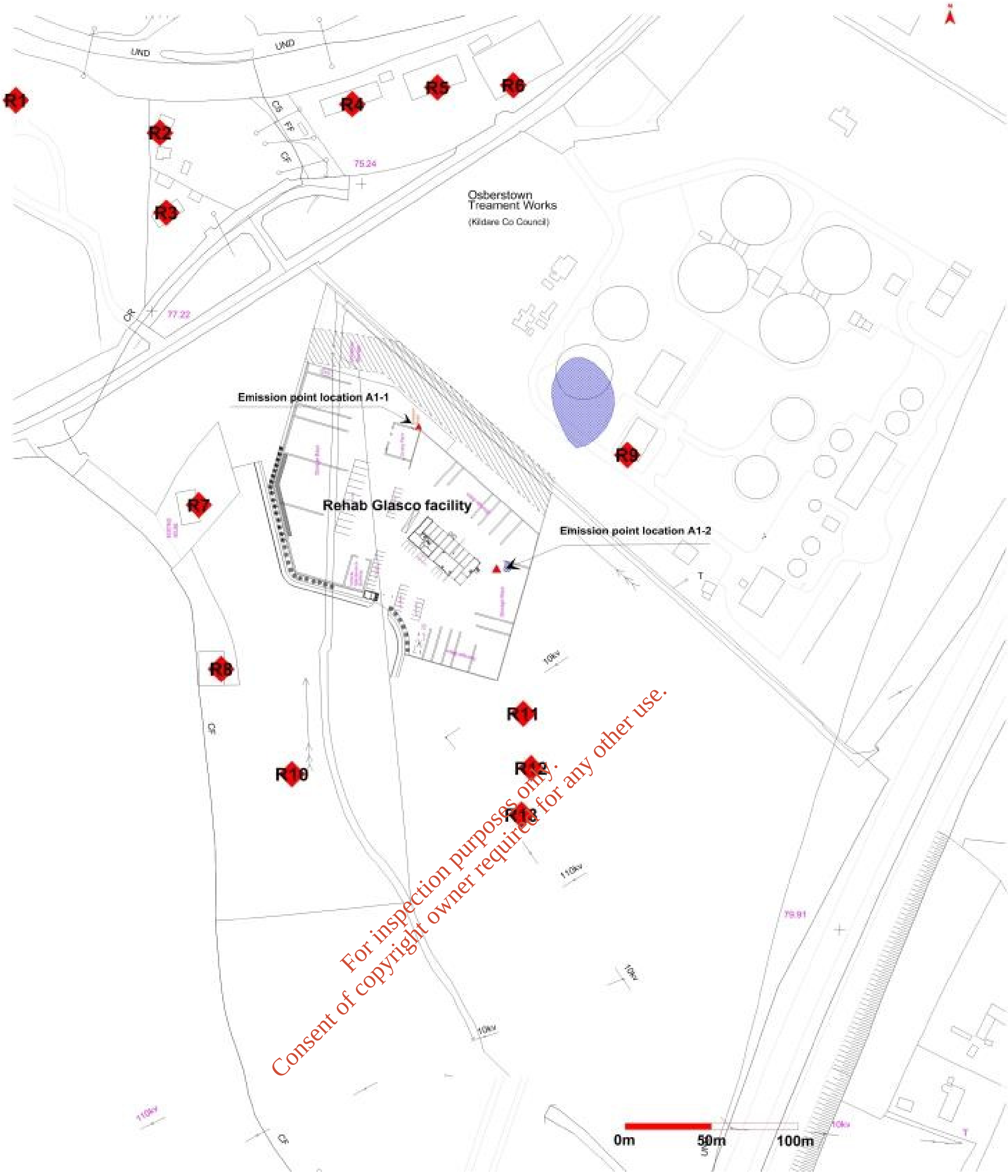

Figure 6.10. Predicted Total particulates as $PM_{2.5}$ ground level concentration impact contribution of cumulative emissions from all named emission points for the Annual average ground level concentration of ≤ 4.0 µg/m^3 (━━) for worst case meteorological year Casement 2004.

6.5 Total Organic Carbon contour.

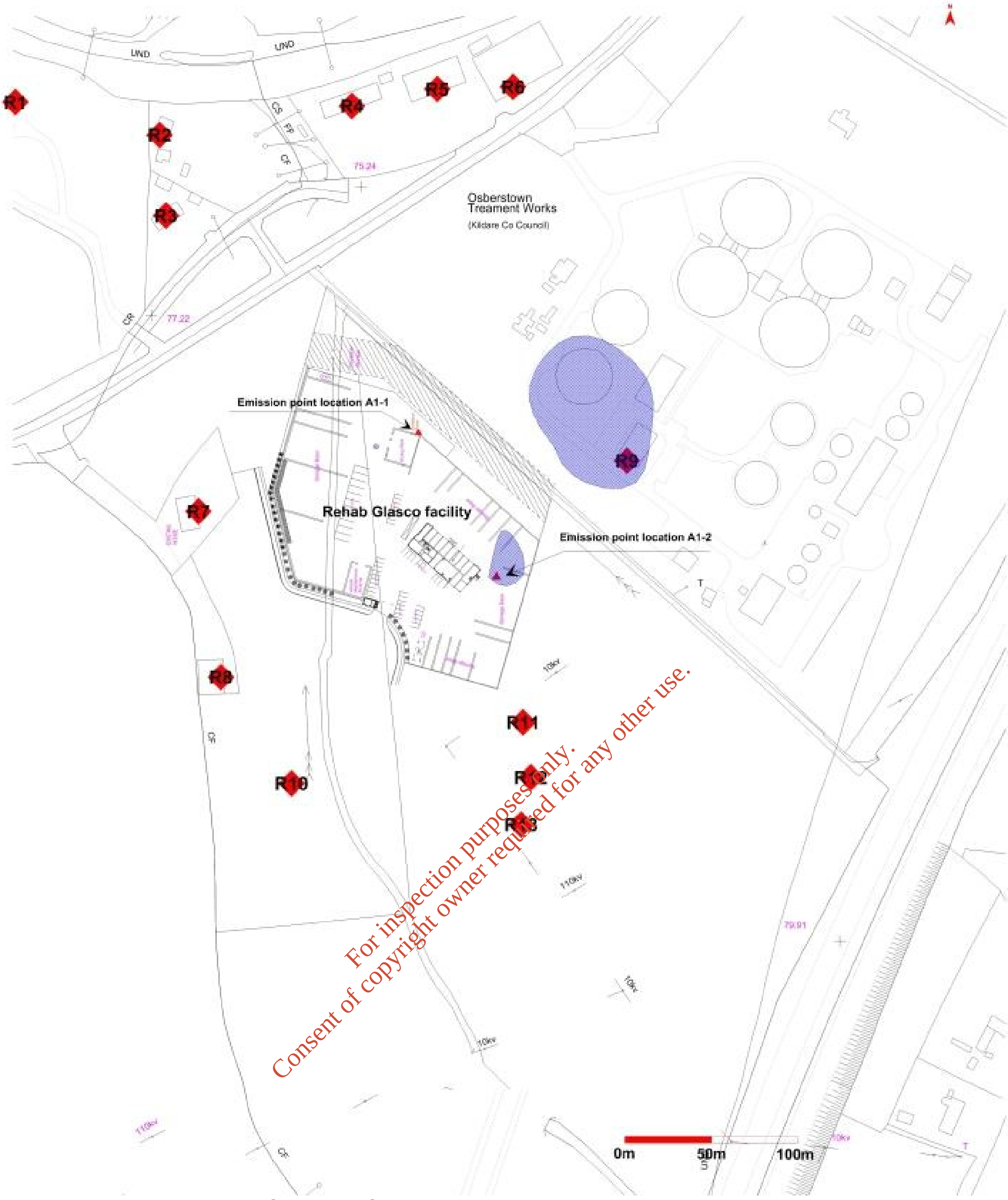

Figure 6.11. Predicted Total Organic Carbon ground level concentration impact contribution of cumulative emissions from all named emission points for the Annual average ground level concentration of ≤ 6.0 µg/m^3 (▬▬) for worst case meteorological year Casement 2004.

7. *Appendix II* - Meteorological data used within the Dispersion modelling study.

Meteorological file Casement 2004 to 2008 inclusive

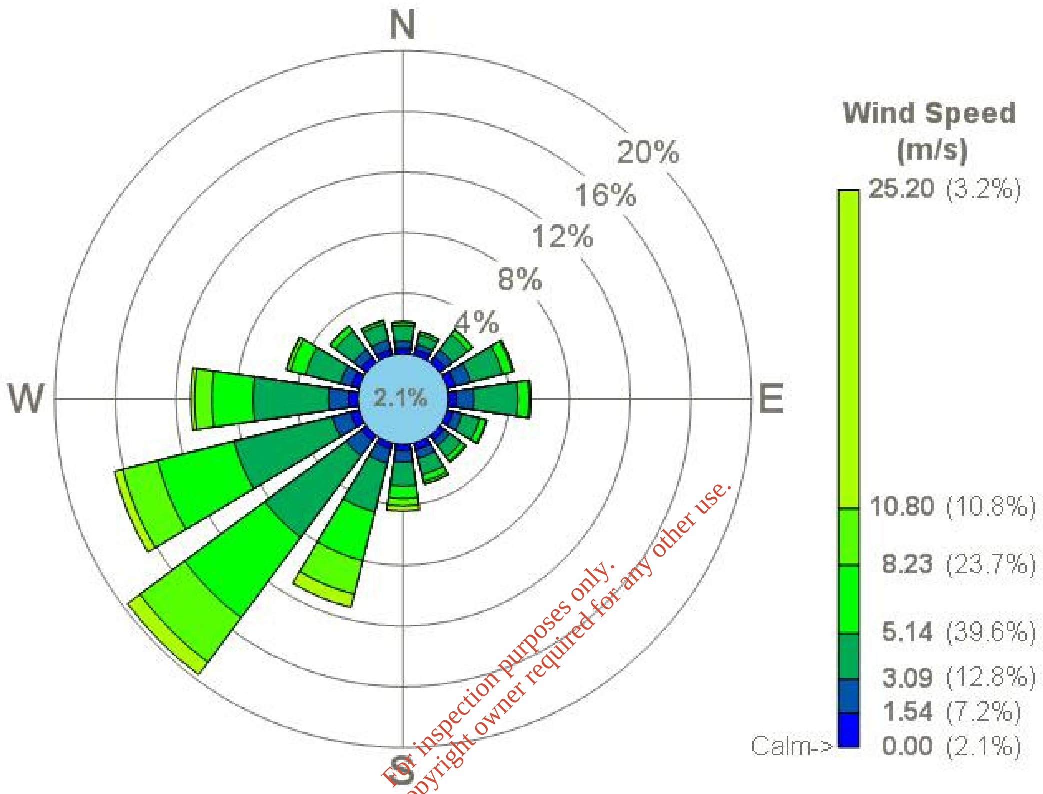

Figure 7.1. Schematic illustrating windrose for meteorological data used for atmospheric dispersion modelling – Casement 2004 to 2008 inclusive.

Table 7.1. Cumulative wind speed and direction for meteorological data used for atmospheric dispersion modelling Casement 2004 to 2008 inclusive.

Cumulative Wind Speed Categories							
Relative Direction	**> 1.54**	**>3.09**	**>5.14**	**>8.23**	**> 10.80**	**< 10.80**	**Total**
0	0.37	0.47	1.03	0.23	0.00	0.00	2.10
22.5	0.39	0.35	0.64	0.20	0.01	0.00	1.58
45	0.47	0.58	1.27	0.37	0.03	0.00	2.72
67.5	0.54	1.06	2.18	0.66	0.10	0.00	4.54
90	0.52	1.15	2.91	0.74	0.10	0.01	5.44
112.5	0.40	0.61	1.21	0.43	0.05	0.01	2.72
135	0.37	0.46	0.93	0.33	0.10	0.02	2.20
157.5	0.46	0.58	1.12	0.45	0.18	0.03	2.82
180	0.41	0.74	1.62	0.81	0.48	0.34	4.40
202.5	0.38	0.98	3.33	3.31	2.29	0.90	11.19
225	0.43	1.24	6.69	6.60	3.68	1.02	19.66
247.5	0.58	1.24	6.68	5.22	2.37	0.57	16.66
270	0.60	1.33	4.98	2.73	1.14	0.26	11.04
292.5	0.51	0.76	2.38	1.01	0.26	0.04	4.96
315	0.45	0.63	1.50	0.40	0.03	0.00	3.01
337.5	0.38	0.64	1.09	0.21	0.03	0.00	2.37
Total	**7.24**	**12.83**	**39.58**	**23.70**	**10.85**	**3.20**	**97.40**
Calms	**--**	**-**	**-**	**-**	**-**	**-**	**2.12**
Missing	**-**	**-**	**-**	**-**	**-**	**-**	**0.48**
Total	**-**	**-**	**-**	**-**	**-**	**-**	**100.00**

8. *Appendix III* - Checklist for EPA requirements for air dispersion modelling reporting

Table 8.1. EPA checklist as taken from their air dispersion modelling requirements report.

Item	Yes/No	Reason for omission/Notes
Location map	Section 6	-
Site plan	Section 6	-
List of pollutants modelled and relevant air quality guidelines	Yes	-
Details of modelled scenarios	Yes	-
Model description and justification	Yes	-
Special model treatments used	Yes	-
Table of emission parameters used	Yes	-
Details of modelled domain and receptors	Yes	-
Details of meteorological data used (including origin) and justification	Yes	-
Details of terrain treatment	Yes	-
Details of building treatment	Yes	-
Details of modelled wet/dry deposition	N/A	-
Sensitivity analysis	N/A	Five years of hourly sequential data used from nearest valid met station-Casement 2004 to 2008 inclusive. Worst case year was Year 2004.
Assessment of impacts	Yes	Pollutant emissions assessment from process identified.
Model input files	No	DVD can be sent upon request. Files are a total of 4.60 GB in size.