Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Atmospheric Dispersion Modelling Report Commissioned by
BAE Systems

Installation Name & Address
BAE Systems
Bridge Road
Barrow-in-Furness
LA14 1AF

Release Point Reference(s)
Spray Booth Coating Exhaust, Oven & Adhesive Coating Stacks

Job Reference Number
CAT-3933

Report Written by
Matthew Pendlebury, MCERTS Level 2

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Report Approved by
James Eldridge, MCERTS Level 2

Signature of Report Approver


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1.0 INTRODUCTION

Exova Catalyst were commissioned by BAE Systems to undertake an atmospheric dispersion modelling exercise, to characterise the expected dispersion of emissions from the Spray Booth Coating Exhaust, Oven & Adhesive Coating Stacks at BAE Systems, Barrow-in-Furness.

Three scenarios have been modelled. Scenario 1 is the modelling of the emission points currently in operation. Scenario 2 is the modelling of the emission points currently in operation along with the new emission points in construction. Scenario 3 is the modelling of old and new emission points following the relocation of several of the older emission points.

This report describes the data used in the modelling, the methodology adopted, assumptions made and the results generated by the model. All emissions and site / building data used in the modelling exercise were based upon information supplied by BAE Systems.

The pollutants specifically of interest in the modelling exercise are Total Particulate Matter (TPM) and Volatile Organic Compounds (VOCs). As no environmental quality standards exist for these pollutants the results from this modelling will be compared to the Environmental Quality Standards for PM10 and Xylene respectively.

Modelling results have been assessed against applicable Environmental Quality Standards for the protection of human health at identified sensitive receptors and using 5 years of local meteorological data.

Consideration has also been given to significance criteria in the Environment Agency's Environmental Risk Assessment Framework which gives advice on assessing the impact of releases to air.

To identify sensitive receptors, careful consideration has been given to the concept of relevant exposure. Areas of relevant exposure are defined as outdoor locations (which can be above or below ground) where members of the public are regularly present, and are likely to be exposed for a period of time appropriate to the Environmental Quality Standard averaging period. Modelling results should not be compared to Environmental Quality Standards used in this modelling exercise if provisions concerning health and safety at work would apply or where members of the public would not have regular access.

2.0 SUMMARY OF THE MODELLING REPORT

2.1 Maximum Values - Scenario 1

Maximum predicted ground level concentrations for the assessment of annual mean and hourly concentrations against the relevant Environmental Quality Standards within the study area are presented in the table below. Both absolute maximum values and off site maximum values are included. Concentrations at all other locations will be less than those presented. It is important to note that maximum values may not represent areas of relevant exposure. Further details of the Environmental Quality Standards used can be found in section 6.7 of this report.

Pollutants and Environmental Quality Standards relevant to the protection of human health- maximum values:

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC	X-Grid Position (m)	Y-Grid Position (m)
Total Particulate Matter (TPM) – Absolute Maximum Values	24-Hour Mean (90.41st %ile)	50	30.5	124	124	155	248	309	2015	319295	468827
	Annual Mean	40	15.2	45.5	45.5	60.7	114	152	2016	319260	468862
Total Particulate Matter (TPM) – Maximum Off Site Values	24-Hour Mean (90.41st %ile)	50	30.5	65.9	65.9	96.4	132	193	2015	319356	468859
	Annual Mean	40	15.2	29.0	29.0	44.2	72.5	111	2016	319356	468859
Volatile Organic Compounds (VOCs) – Absolute Maximum Values	1-Hour Mean	66200	78.2	17486	17486	17564	26.4	26.5	2014	319050	469002
	Annual Mean	4410	39.1	1594	1594	1633	36.1	37.0	2014	319190	468932
Volatile Organic Compounds (VOCs) – Maximum Off Site Values	1-Hour Mean	66200	78.2	17116	17116	17194	25.9	26.0	2014	319356	468859
	Annual Mean	4410	39.1	664	664	703	15.1	15.9	2014	319356	468859

2.2 Maximum Values - Scenario 2

Maximum predicted ground level concentrations for the assessment of annual mean and hourly concentrations against the relevant Environmental Quality Standards within the study area are presented in the table below. Both absolute maximum values and off site maximum values are included. Concentrations at all other locations will be less than those presented. It is important to note that maximum values may not represent areas of relevant exposure. Further details of the Environmental Quality Standards used can be found in section 6.7 of this report.

Pollutants and Environmental Quality Standards relevant to the protection of human health- maximum values:

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC	X-Grid Position (m)	Y-Grid Position (m)
Total Particulate Matter (TPM) – Absolute Maximum Values	24-Hour Mean (90.41st %ile)	50	30.5	124	124	155	248	309	2015	319295	468827
	Annual Mean	40	15.2	45.8	45.8	61.0	115	153	2016	319260	468862
Total Particulate Matter (TPM) – Maximum Off Site Values	24-Hour Mean (90.41st %ile)	50	30.5	66.0	66.0	96.5	132	193	2015	319356	468859
	Annual Mean	40	15.2	29.3	29.3	44.5	73.2	111.3	2016	319356	468859
Volatile Organic Compounds (VOCs) – Absolute Maximum Values	1-Hour Mean	66200	78.2	17490	17490	17568	26.4	26.5	2014	319295	468827
	Annual Mean	4410	39.1	1604	1604	1643	36.4	37.3	2014	319190	468932
Volatile Organic Compounds (VOCs) – Maximum Off Site Values	1-Hour Mean	66200	78.2	17116	17116	17194	25.9	26.0	2014	319356	468859
	Annual Mean	4410	39.1	676	676	715	15.3	16.2	2014	319356	468859

2.3 Maximum Values - Scenario 3

Maximum predicted ground level concentrations for the assessment of annual mean and hourly concentrations against the relevant Environmental Quality Standards within the study area are presented in the table below. Both absolute maximum values and off site maximum values are included. Concentrations at all other locations will be less than those presented. It is important to note that maximum values may not represent areas of relevant exposure. Further details of the Environmental Quality Standards used can be found in section 6.7 of this report.

Pollutants and Environmental Quality Standards relevant to the protection of human health- maximum values:

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC	X-Grid Position (m)	Y-Grid Position (m)
Total Particulate Matter (TPM) – Absolute Maximum Values	24-Hour Mean (90.41st %ile)	50	30.5	37.1	13.0	43.5	26.0	86.9	2012	319575	468617
	Annual Mean	40	15.2	26.2	18.3	33.6	45.9	83.9	2016	319435	468582
Total Particulate Matter (TPM) – Maximum Off Site Values	24-Hour Mean (90.41st %ile)	50	30.5	18.4	6.42	36.90	12.8	73.8	2012	319641.8	468721
	Annual Mean	40	15.2	7.02	4.91	20.15	12.3	50.4	2016	319641.8	468721
Volatile Organic Compounds (VOCs) – Absolute Maximum Values	1-Hour Mean	66200	78.2	17485	6120	6198	9.24	9.36	2014	319050	469002
	Annual Mean	4410	39.1	1565	1096	1135	24.8	25.7	2016	319435	468582
Volatile Organic Compounds (VOCs) – Maximum Off Site Values	1-Hour Mean	66200	78.2	17101	5985	6064	9.04	9.2	2014	319356	468859
	Annual Mean	4410	39.1	603	422	461	9.57	10.45	2016	319356	468859

2.4 Pollutant Concentrations at Sensitive Receptors [Total Particulate Matter - Scenario 1]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	38.5	38.5	69.0	77.1	138	2013
	Annual Mean	40	15.2	8.98	8.98	24.2	22.5	60.5	2013
R2: Recreational Dock Area									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	14.3	14.3	44.7	28.5	89.5	2013
	Annual Mean	40	15.2	4.15	4.15	19.4	10.4	48.5	2014
R3: Basketball Court off Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	32.1	32.1	62.6	64.3	125	2013
	Annual Mean	40	15.2	8.76	8.76	24.0	21.9	60.0	2013
R4: Residential Property on Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	53.0	53.0	83.5	106	167	2013
	Annual Mean	40	15.2	12.4	12.4	27.6	31.0	69.0	2014
R5: Residential Property on Island Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	6.45	6.45	27.8	12.9	55.7	2013
	Annual Mean	40	10.7	1.60	1.60	12.3	4.00	30.7	2013
R6: Residential Property on St Vincent St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	45.8	9.28	9.28	55.0	18.6	110	2016
	Annual Mean	40	22.9	2.95	2.95	25.8	7.38	64.6	2016
R7: Barrow Rugby League Football Club									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	4.55	4.55	35.0	9.10	70.0	2016
	Annual Mean	40	15.2	1.21	1.21	16.4	3.03	41.1	2016
R8: Primary School on Trinity St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	5.97	5.97	27.4	11.9	54.7	2013
	Annual Mean	40	10.7	1.62	1.62	12.3	4.05	30.8	2013
R9: Crown Green Bowling Club on King Alfred St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	20.6	4.18	4.18	24.8	8.36	49.6	2016
	Annual Mean	40	10.3	0.90	0.90	11.2	2.25	28.0	2016
R10: Recreation Area off Promenade									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	5.68	5.68	36.2	11.4	72.3	2013
	Annual Mean	40	15.2	1.38	1.38	16.6	3.45	41.5	2016

2.5 Pollutant Concentrations at Sensitive Receptors [Total Particulate Matter - Scenario 2]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	38.1	38.1	68.6	76.2	137	2013
	Annual Mean	40	15.2	9.20	9.20	24.4	23.0	61.1	2014
R2: Recreational Dock Area									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	14.1	14.1	44.6	28.2	89.1	2013
	Annual Mean	40	15.2	4.30	4.30	19.5	10.8	48.8	2014
R3: Basketball Court off Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	31.7	31.7	62.1	63.3	124	2013
	Annual Mean	40	15.2	9.11	9.11	24.3	22.8	60.9	2013
R4: Residential Property on Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	53.0	53.0	83.4	106	167	2013
	Annual Mean	40	15.2	12.6	12.6	27.9	31.6	69.7	2013
R5: Residential Property on Island Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	5.75	5.75	27.1	11.5	54.3	2013
	Annual Mean	40	10.7	1.79	1.79	12.5	4.48	31.2	2013
R6: Residential Property on St Vincent St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	45.8	9.00	9.00	54.8	18.0	110	2016
	Annual Mean	40	22.9	3.11	3.11	26.0	7.78	65.0	2016
R7: Barrow Rugby League Football Club									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	4.36	4.36	34.8	8.72	69.7	2016
	Annual Mean	40	15.2	1.27	1.27	16.5	3.18	41.3	2016
R8: Primary School on Trinity St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	5.15	5.15	26.5	10.3	53.1	2015
	Annual Mean	40	10.7	1.84	1.84	12.5	4.60	31.3	2013
R9: Crown Green Bowling Club on King Alfred St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	20.6	3.69	3.69	24.3	7.38	48.6	2016
	Annual Mean	40	10.3	1.00	1.00	11.3	2.50	28.3	2016
R10: Recreation Area off Promenade									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	5.34	5.34	35.8	10.7	71.6	2014
	Annual Mean	40	15.2	1.47	1.47	16.7	3.68	41.8	2013

2.6 Pollutant Concentrations at Sensitive Receptors [Total Particulate Matter - Scenario 3]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	5.54	5.54	36.0	11.08	72.0	2012
	Annual Mean	40	15.2	1.90	1.90	17.1	4.75	42.8	2016
R2: Recreational Dock Area									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	4.25	4.25	34.7	8.50	69.4	2016
	Annual Mean	40	15.2	1.34	1.34	16.6	3.35	41.4	2014
R3: Basketball Court off Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	7.95	7.95	38.4	15.90	76.8	2014
	Annual Mean	40	15.2	2.70	2.70	17.9	6.75	44.8	2014
R4: Residential Property on Stanley Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	5.59	5.59	36.1	11.18	72.1	2016
	Annual Mean	40	15.2	1.99	1.99	17.2	4.98	43.1	2014
R5: Residential Property on Island Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	5.49	5.49	26.9	10.98	53.8	2013
	Annual Mean	40	10.7	1.62	1.62	12.3	4.05	30.8	2013
R6: Residential Property on Island Rd									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	45.8	4.12	4.12	49.9	8.24	99.8	2016
	Annual Mean	40	22.9	1.37	1.37	24.2	3.43	60.6	2016
R7: Residential Property on St Vincent St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	2.14	2.14	32.6	4.28	65.2	2016
	Annual Mean	40	15.2	0.55	0.55	15.8	1.38	39.5	2016
R8: Barrow Rugby League Football Club									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	21.4	7.39	7.39	28.8	14.78	57.6	2015
	Annual Mean	40	10.7	2.06	2.06	12.8	5.15	31.9	2013
R9: Primary School on Trinity St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	20.6	2.70	2.70	23.3	5.40	46.7	2016
	Annual Mean	40	10.3	0.73	0.73	11.0	1.83	27.6	2016
R10: Crown Green Bowling Club on King Alfred St									
Total Particulate Matter (TPM)	24-Hour Mean (90.41st %ile)	50	30.5	2.73	2.73	33.2	5.46	66.4	2013
	Annual Mean	40	15.2	0.76	0.76	16.0	1.90	40.0	2012

2.7 Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 1]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6949	6949	7027	10.5	10.6	2015
	Annual Mean	4410	39.1	166	166	205	3.77	4.66	2016
R2: Recreational Dock Area									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2271	2271	2349	3.43	3.55	2015
	Annual Mean	4410	39.1	105	105	144	2.37	3.26	2013
R3: Basketball Court off Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	9036	9036	9115	13.7	13.8	2013
	Annual Mean	4410	39.1	84.3	84.3	123.4	1.91	2.80	2016
R4: Residential Property on Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6956	6956	7034	10.5	10.6	2015
	Annual Mean	4410	39.1	163	163	202	3.69	4.58	2016
R5: Residential Property on Island Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	3040	3040	3118	4.59	4.71	2016
	Annual Mean	4410	39.1	35.7	35.7	74.8	0.81	1.70	2013
R6: Residential Property on St Vincent St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2458	2458	2536	3.71	3.83	2013
	Annual Mean	4410	39.1	71.9	71.9	111.0	1.63	2.52	2016
R7: Barrow Rugby League Football Club									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	974	974	1053	1.47	1.59	2016
	Annual Mean	4410	39.1	28.7	28.7	67.8	0.65	1.54	2015
R8: Primary School on Trinity St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2493	2493	2572	3.77	3.88	2016
	Annual Mean	4410	39.1	34.3	34.3	73.4	0.78	1.66	2013
R9: Crown Green Bowling Club on King Alfred St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1476	1476	1554	2.23	2.35	2013
	Annual Mean	4410	39.1	17.0	17.0	56.1	0.38	1.27	2016
R10: Recreation Area off Promenade									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1994	1994	2073	3.01	3.13	2013
	Annual Mean	4410	39.1	31.1	31.1	70.2	0.71	1.59	2016

2.8 Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 2]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6949	6949	7027	10.5	10.6	2015
	Annual Mean	4410	39.1	174	174	213	3.95	4.83	2016
R2: Recreational Dock Area									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2281	2281	2359	3.45	3.56	2015
	Annual Mean	4410	39.1	110	110	149	2.48	3.37	2013
R3: Basketball Court off Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	9036	9036	9115	13.7	13.8	2013
	Annual Mean	4410	39.1	96.7	96.7	135.8	2.19	3.08	2016
R4: Residential Property on Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6956	6956	7034	10.5	10.6	2015
	Annual Mean	4410	39.1	171	171	210	3.88	4.76	2016
R5: Residential Property on Island Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	3042	3042	3120	4.59	4.71	2016
	Annual Mean	4410	39.1	43.2	43.2	82.3	0.98	1.87	2013
R6: Residential Property on St Vincent St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2458	2458	2536	3.71	3.83	2013
	Annual Mean	4410	39.1	78.3	78.3	117.4	1.78	2.66	2016
R7: Barrow Rugby League Football Club									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1054	1054	1133	1.59	1.71	2016
	Annual Mean	4410	39.1	30.5	30.5	69.6	0.69	1.58	2015
R8: Primary School on Trinity St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2493	2493	2572	3.77	3.88	2016
	Annual Mean	4410	39.1	44.1	44.1	83.2	1.00	1.89	2013
R9: Crown Green Bowling Club on King Alfred St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1483	1483	1561	2.24	2.36	2013
	Annual Mean	4410	39.1	21.1	21.1	60.2	0.48	1.36	2016
R10: Recreation Area off Promenade									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1995	1995	2074	3.01	3.13	2013
	Annual Mean	4410	39.1	34.3	34.3	73.4	0.78	1.66	2016

2.9 Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 3]

Maximum predicted ground level concentrations for assessment against Environmental Quality Standards within the study area are presented in the table below for the closest sensitive receptors identified. Full details of sensitive receptors can be found in section 6.6 of this report.

Pollutant	Averaging Period	Environmental Quality Standard (EQS) (µg/m³)	Background Concentration (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Maximum Process Contribution + Background Concentration (PEC) (µg/m³)	PC/EQS (%)	PEC/EQS (%)	Year of MET Data Resulting in Maximum PC
R1: Recreation Area off North Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6925	6925	7003	10.5	10.6	2015
	Annual Mean	4410	39.1	156	156	195	3.55	4.43	2016
R2: Recreational Dock Area									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2076	2076	2154	3.14	3.25	2015
	Annual Mean	4410	39.1	98.1	98.1	137.2	2.22	3.11	2013
R3: Basketball Court off Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	8958	8958	9036	13.5	13.6	2013
	Annual Mean	4410	39.1	89.1	89.1	128.2	2.02	2.91	2016
R4: Residential Property on Stanley Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	6925	6925	7003	10.5	10.6	2015
	Annual Mean	4410	39.1	160	160	199	3.63	4.51	2016
R5: Residential Property on Island Rd									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2980	2980	3058	4.50	4.62	2016
	Annual Mean	4410	39.1	43.6	43.6	82.7	0.99	1.88	2013
R6: Residential Property on St Vincent St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2238	2238	2317	3.38	3.50	2013
	Annual Mean	4410	39.1	76.1	76.1	115.2	1.73	2.61	2016
R7: Barrow Rugby League Football Club									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1033	1033	1111	1.56	1.68	2016
	Annual Mean	4410	39.1	28.9	28.9	68.0	0.65	1.54	2015
R8: Primary School on Trinity St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	2493	2493	2571	3.77	3.88	2016
	Annual Mean	4410	39.1	45.6	45.6	84.7	1.03	1.92	2013
R9: Crown Green Bowling Club on King Alfred St									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1387	1387	1465	2.10	2.21	2013
	Annual Mean	4410	39.1	20.6	20.6	59.7	0.47	1.35	2016
R10: Recreation Area off Promenade									
Volatile Organic Compounds (VOCs)	24-Hour Mean (90.41st %ile)	66200	78.2	1842	1842	1920	2.78	2.90	2012
	Annual Mean	4410	39.1	32.4	32.4	71.5	0.74	1.62	2016

2.10 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [TPM - Scenario 1]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
TPM	Annual Mean	40	8.98	8.98	22.5	60.5	75% or less of AQAL	>10% relative to AQAL	Moderate
R2: Recreational Dock Area									
TPM	Annual Mean	40	4.15	4.15	10.4	48.5	75% or less of AQAL	>10% relative to AQAL	Moderate
R3: Basketball Court off Stanley Rd									
TPM	Annual Mean	40	8.76	8.76	21.9	60.0	75% or less of AQAL	>10% relative to AQAL	Moderate
R4: Residential Property on Stanley Rd									
TPM	Annual Mean	40	12.4	12.4	31.0	69.0	75% or less of AQAL	>10% relative to AQAL	Moderate
R5: Residential Property on Island Rd									
TPM	Annual Mean	40	1.60	1.60	4.00	30.7	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
TPM	Annual Mean	40	2.95	2.95	7.38	64.6	75% or less of AQAL	6 - 10% relative to AQAL	Slight
R7: Barrow Rugby League Football Club									
TPM	Annual Mean	40	1.21	1.21	3.03	41.1	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R8 Primary School on Trinity St									
TPM	Annual Mean	40	1.62	1.62	4.05	30.8	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
TPM	Annual Mean	40	0.90	0.90	2.25	28.0	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R10 Recreation Area off Promenade									
TPM	Annual Mean	40	1.38	1.38	3.45	41.5	75% or less of AQAL	2 - 5% relative to AQAL	Negligible

2.11 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [TPM - Scenario 2]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
TPM	Annual Mean	40	9.20	9.20	23.0	61.1	75% or less of AQAL	>10% relative to AQAL	Moderate
R2: Recreational Dock Area									
TPM	Annual Mean	40	4.30	4.30	10.8	48.8	75% or less of AQAL	>10% relative to AQAL	Moderate
R3: Basketball Court off Stanley Rd									
TPM	Annual Mean	40	9.11	9.11	22.8	60.9	75% or less of AQAL	>10% relative to AQAL	Moderate
R4: Residential Property on Stanley Rd									
TPM	Annual Mean	40	12.6	12.6	31.6	69.7	75% or less of AQAL	>10% relative to AQAL	Moderate
R5: Residential Property on Island Rd									
TPM	Annual Mean	40	1.79	1.79	4.48	31.2	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
TPM	Annual Mean	40	3.11	3.11	7.78	65.0	75% or less of AQAL	6 - 10% relative to AQAL	Slight
R7: Barrow Rugby League Football Club									
TPM	Annual Mean	40	1.27	1.27	3.18	41.3	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R8 Primary School on Trinity St									
TPM	Annual Mean	40	1.84	1.84	4.60	31.3	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
TPM	Annual Mean	40	1.00	1.00	2.50	28.3	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R10 Recreation Area off Promenade									
TPM	Annual Mean	40	1.47	1.47	3.68	41.8	75% or less of AQAL	2 - 5% relative to AQAL	Negligible

2.12 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [TPM - Scenario 3]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
TPM	Annual Mean	40	1.90	1.90	4.75	42.8	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R2: Recreational Dock Area									
TPM	Annual Mean	40	1.34	1.34	3.35	41.4	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R3: Basketball Court off Stanley Rd									
TPM	Annual Mean	40	2.70	2.70	6.75	44.8	75% or less of AQAL	6 - 10% relative to AQAL	Slight
R4: Residential Property on Stanley Rd									
TPM	Annual Mean	40	1.99	1.99	4.98	43.1	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R5: Residential Property on Island Rd									
TPM	Annual Mean	40	1.62	1.62	4.05	30.8	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
TPM	Annual Mean	40	1.37	1.37	3.43	60.6	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R7: Barrow Rugby League Football Club									
TPM	Annual Mean	40	0.55	0.55	1.38	39.5	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R8 Primary School on Trinity St									
TPM	Annual Mean	40	2.06	2.06	5.15	31.9	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
TPM	Annual Mean	40	0.73	0.73	1.83	27.6	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R10 Recreation Area off Promenade									
TPM	Annual Mean	40	0.76	0.76	1.90	40.0	75% or less of AQAL	2 - 5% relative to AQAL	Negligible

2.13 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 1]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
VOCs	Annual Mean	4410	166	166	3.77	4.66	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R2: Recreational Dock Area									
VOCs	Annual Mean	4410	105	105	2.37	3.26	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R3: Basketball Court off Stanley Rd									
VOCs	Annual Mean	4410	84.3	84.3	1.91	2.80	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R4: Residential Property on Stanley Rd									
VOCs	Annual Mean	4410	163	163	3.69	4.58	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R5: Residential Property on Island Rd									
VOCs	Annual Mean	4410	35.7	35.7	0.81	1.70	75% or less of AQAL	1% or less relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
VOCs	Annual Mean	4410	71.9	71.9	1.63	2.52	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R7: Barrow Rugby League Football Club									
VOCs	Annual Mean	4410	28.7	28.7	0.65	1.54	75% or less of AQAL	1% or less relative to AQAL	Negligible
R8 Primary School on Trinity St									
VOCs	Annual Mean	4410	34.3	34.3	0.78	1.66	75% or less of AQAL	1% or less relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
VOCs	Annual Mean	4410	17.0	17.0	0.38	1.27	75% or less of AQAL	1% or less relative to AQAL	Negligible
R10 Recreation Area off Promenade									
VOCs	Annual Mean	4410	31.1	31.1	0.71	1.59	75% or less of AQAL	1% or less relative to AQAL	Negligible

2.14 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 2]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
VOCs	Annual Mean	4410	174	174	3.95	4.83	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R2: Recreational Dock Area									
VOCs	Annual Mean	4410	110	110	2.48	3.37	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R3: Basketball Court off Stanley Rd									
VOCs	Annual Mean	4410	96.7	96.7	2.19	3.08	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R4: Residential Property on Stanley Rd									
VOCs	Annual Mean	4410	171	171	3.88	4.76	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R5: Residential Property on Island Rd									
VOCs	Annual Mean	4410	43.2	43.2	0.98	1.87	75% or less of AQAL	1% or less relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
VOCs	Annual Mean	4410	78.3	78.3	1.78	2.66	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R7: Barrow Rugby League Football Club									
VOCs	Annual Mean	4410	30.5	30.5	0.69	1.58	75% or less of AQAL	1% or less relative to AQAL	Negligible
R8 Primary School on Trinity St									
VOCs	Annual Mean	4410	44.1	44.1	1.00	1.89	75% or less of AQAL	1% or less relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
VOCs	Annual Mean	4410	21.1	21.1	0.48	1.36	75% or less of AQAL	1% or less relative to AQAL	Negligible
R10 Recreation Area off Promenade									
VOCs	Annual Mean	4410	34.3	34.3	0.78	1.66	75% or less of AQAL	1% or less relative to AQAL	Negligible

2.15 Impact Descriptors of Modelled Pollutant Concentrations at Sensitive Receptors [VOCs - Scenario 3]

In order to make an assessment of air quality impacts at receptor locations in a consistent way, the Institute of Air Quality Management (IAQM) and Environmental Protection UK have recommended an approach to defining the magnitude of changes and describing the air quality impacts at specific receptors in relation to annual mean pollutant concentrations.

The approach is based on the magnitude of change in pollutant concentration brought about by the scheme at the receptor location as a percentage of the assessment level (AQAL), in combination with the actual concentration at the receptor with the scheme in place, as shown in the following table:

Long term average concentration at receptor location (PEC) in assessment year	% Change in concentration relative to AQAL			
	1	2 - 5	6 - 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76% to 94% of AQAL	Negligible	Slight	Moderate	Moderate
95% to 102% of AQAL	Slight	Moderate	Moderate	Substantial
103% to 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The following table shows the magnitude of change in pollutant concentration due to emissions from the modelled emission points at each receptor location, and the associated impact descriptor.

Pollutant	Averaging Period	Air Quality Assessment Level (AQAL) (µg/m³)	Modelled Emission	Maximum Process Contribution (PC) (µg/m³)	Change in ambient pollutant concentration as % of the AQAL	PEC/AQAL (%)	PEC Descriptor	Magnitude of change	Impact Descriptor
R1: Recreation Area off North Rd									
VOCs	Annual Mean	4410	156	156	3.55	4.43	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R2: Recreational Dock Area									
VOCs	Annual Mean	4410	98.1	98.1	2.22	3.11	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R3: Basketball Court off Stanley Rd									
VOCs	Annual Mean	4410	89.1	89.1	2.02	2.91	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R4: Residential Property on Stanley Rd									
VOCs	Annual Mean	4410	160	160	3.63	4.51	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R5: Residential Property on Island Rd									
VOCs	Annual Mean	4410	43.6	43.6	0.99	1.88	75% or less of AQAL	1% or less relative to AQAL	Negligible
R6: Residential Property on St Vincent St									
VOCs	Annual Mean	4410	76.1	76.1	1.73	2.61	75% or less of AQAL	2 - 5% relative to AQAL	Negligible
R7: Barrow Rugby League Football Club									
VOCs	Annual Mean	4410	28.9	28.9	0.65	1.54	75% or less of AQAL	1% or less relative to AQAL	Negligible
R8 Primary School on Trinity St									
VOCs	Annual Mean	4410	45.6	45.6	1.03	1.92	75% or less of AQAL	1% or less relative to AQAL	Negligible
R9 Crown Green Bowling Club on King Alfred St									
VOCs	Annual Mean	4410	20.6	20.6	0.47	1.35	75% or less of AQAL	1% or less relative to AQAL	Negligible
R10 Recreation Area off Promenade									
VOCs	Annual Mean	4410	32.4	32.4	0.74	1.62	75% or less of AQAL	1% or less relative to AQAL	Negligible

2.16 Consideration of Cumulative Air Quality Impacts

The area surrounding the BAE Systems site is predominantly urban.

A check on the Cumbria County Council Planning website indicated that there have been no recent developments with planning permission in the vicinity of the site that would have a significant cumulative impact on pollutant concentrations at the receptors considered in this assessment.

There are no Environment Agency regulated industrial sites with emissions of Total Particulate Matter or Volatile Organic Compounds close to the site.

It is considered that the background PM10 and Xylene concentration data used in this assessment (see section 6.4 of this report) will be adequate to take account of background sources of pollution in the area and so no further assessment of cumulative effects is required.

Further information on assessing air quality impacts is available from the report 'Land-Use Planning & Development Control: Planning for Air Quality', published by the Institute of Air Quality Management in May 2015.

http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

3.0 DISCUSSION AND CONCLUSIONS

Maximum modelled results - Air quality concentrations for the protection of human health:

The tables in sections 2.1, 2.2 and 2.3 of this report show that the maximum VOC ground level concentrations are not predicted to exceed the relevant Environmental Quality Standards (EQS) as a result of emissions from the modelled emission points, for any of the modelled scenarios. The maximum TPM ground level concentrations are predicted to exceed the relevant Environmental Quality Standards for modelled scenarios 1 and 2.

The maximum off site ground level concentrations are not predicted to exceed the relevant EQS for VOCs or TPM as an annual mean. The maximum off site ground level concentrations for TPM as a 24 hour mean are predicted to exceed the relevant EQS for modelled scenarios 1 and 2. It should be noted that the the EQS is only exceeded at a small area close to the site boundary along the waterline.

The highest modelled off site process contribution + background concentration (PEC) is for TPM measured as a 24 hour mean (Scenario 2), which is predicted to be 132% of the EQS. The location where this occurs is close to the boundary, along the waterline, to the North of the site.

Following the re-location of several of the old emission points (Scenario 3) none of the predicted maximum ground level concentrations are predicted to exceed the relevant Environmental Quality Standards.

Modelling has been based on conservative assumptions, which can be found in section 7.0 of this report. Therefore modelled concentrations are likely to be precautionary.

Contour plots have been drawn for modelled TPM and VOC concentrations, to provide a visual representation of dispersion. As shown by the contour plots in section 8.0 of this report, the maximum ground level concentrations are consistent with the prevailing wind.

Maximum modelled results - Air quality concentrations for the protection of human health:

The tables in sections 2.2 to 2.9 of this report show that ground level concentrations may exceed the relevant EQS at some of the identified sensitive receptors as a result of emissions from the modelled emission points. This effects receptors 1, 3, 4 and 6. The ground level concentrations at these receptors os only exceeded for TPM as a 24 hour average and only under scenarios 2 and 3. Following the relocation of several of the old emission points (Scenario 3) no EQS are exceeded at any of the receptors.

The highest modelled PEC is for TPM measured as a 24 Hour mean (Scenario 2), which is predicted to be 167% of the EQS at Sensitive Receptor 4 (Residential Property on Stanley Rd).

The impact descriptors of modelled pollutant concentrations for sensitive receptors indicate that under Scenarios 1 and 2 there is a moderate impact from TPM emissions and negligible impact from VOC emissions. Under Scenario 3 the impact from emissions of both TPM and VOCs is considered negligible at all receptors with the exception of Receptor 3. The impact of TPM under scenario 3 is considered to be slight at receptor 3.

Significance criteria for modelled ground level concentrations are given in Environment Agency Horizontal Guidance Note H1, version 2.2, Annex F – Air Emissions, published in December 2011. This states that the process contribution (PC) can be considered insignificant if:

i) the long term (annual mean) process contribution is <1% of the long term EQS - It is unlikely that an emission at this level will make a significant contribution to air quality since process contributions will be small in comparison to background levels, even if a standard is exceeded. The 1% threshold is two orders of magnitude below the standard and provides a substantial safety margin to protect health and the environment; and

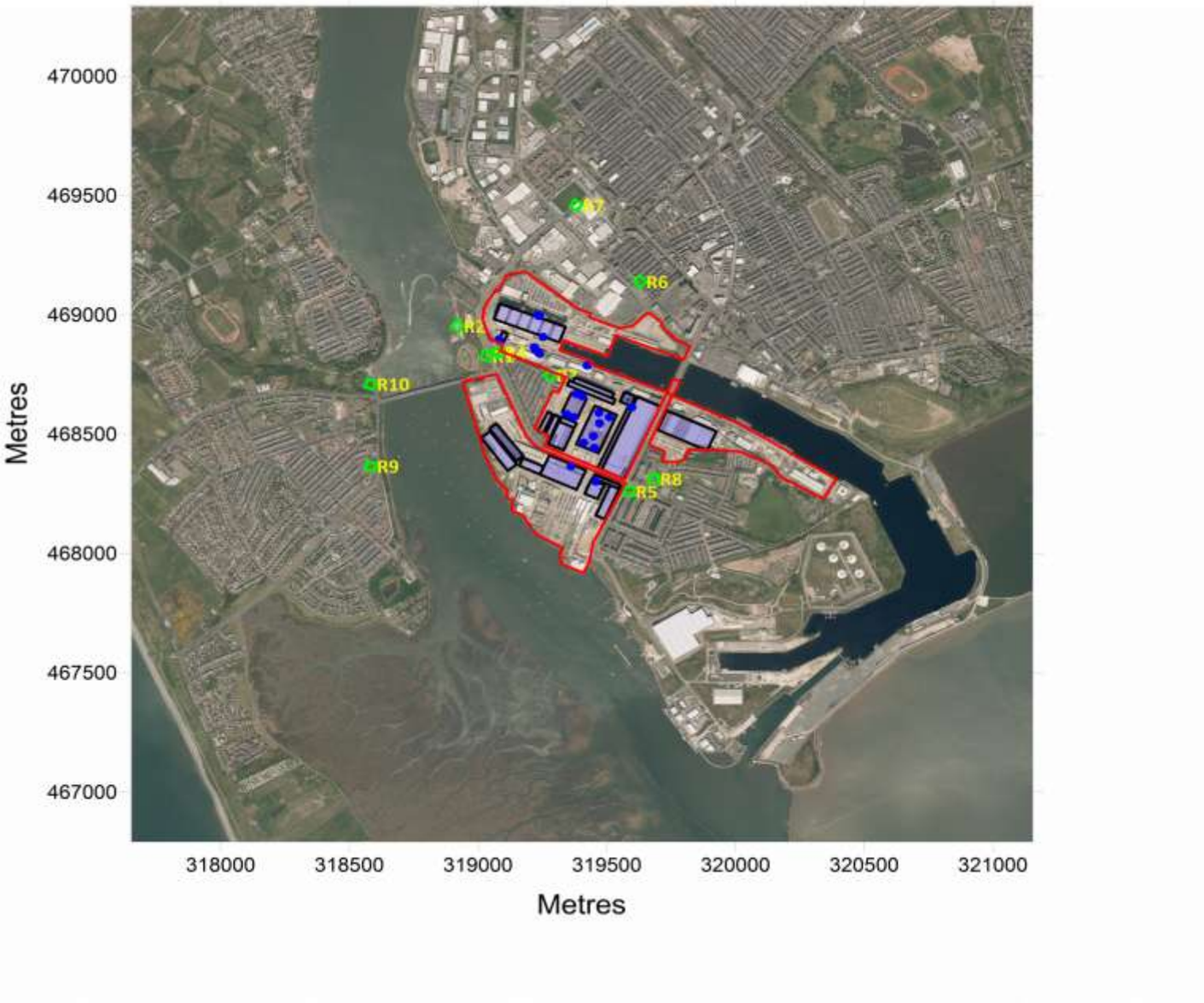
ii) the short term (1-hour mean) process contribution is <10% of the short term EQS – spatial and temporal conditions mean that process contributions are more likely to dominate ambient environmental concentrations. The 10% threshold is an order of magnitude below the standard and provides a substantial safety margin to protect health and the environment.

4.0 DESCRIPTION OF THE MODEL USED

The modelling exercise has been performed using ADMS 5 software. It is a “new generation” dispersion model which uses a skewed Gaussian concentration distribution to calculate dispersion under convective conditions. ADMS 5 was developed by Cambridge Environmental Research Consultants Ltd (CERC) and has been extensively validated against field data sets. The ADMS model is used by both regulatory bodies and industrial operators in the UK and satisfies the requirements of the Environment Agency on the choice of dispersion models, by complying with the Environment Agency policy EAS/2007/1/1.

5.0 SITE LOCATION

BAE Systems is located in Barrow-in-Furness along the North West coast of England. The aerial photography map below shows the location of the site (the site boundary is outlined in red) in relation to its local surroundings, as well as the location of the emission points and identified sensitive receptors (labelled R’X’). The area surrounding the site is predominantly urban with residential areas, schools and recreation areas all nearby.



6.0 DATA USED IN THE MODEL

The model was set-up with the following data:

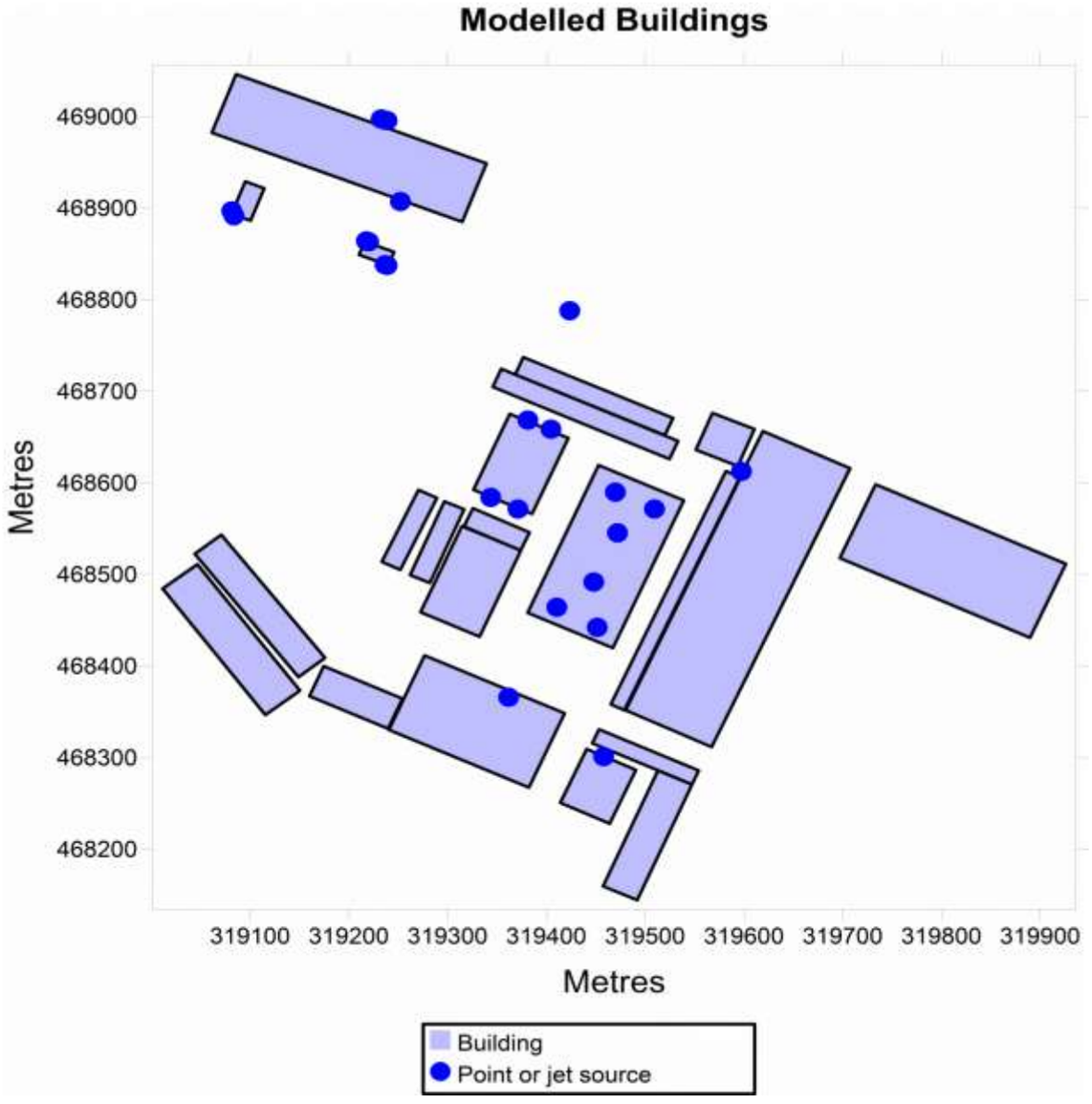
6.1 Buildings

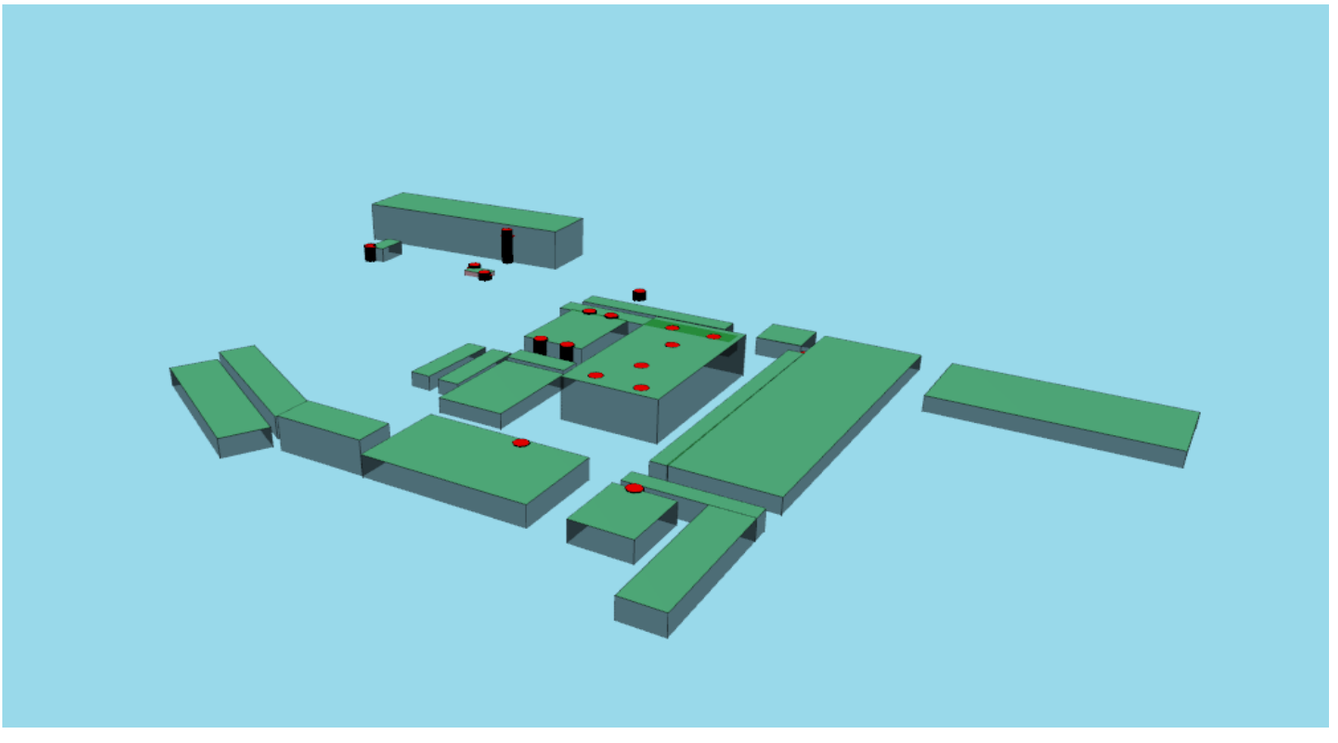
The effects of nearby buildings were considered in the modelling exercise to take account of building wake effects on dispersed pollutant concentrations. Buildings were considered that were close to the emission points and were greater than 3 metres high (> approximately 30% of the minimum modelled stack height). These buildings were chosen as they were deemed to be the most likely to have an effect on the dispersion characteristics of the release point gas plumes.

Building Reference	Shape	Height (m)	Length / Diameter (m)	Width (m)	Building Orientation Angle (°) (measured clockwise from north)	Centre X grid position (m)	Centre Y grid position (m)
1	Rectangular	6.5	15.5	31.9	201	319228	468851
2	Rectangular	18.5	20.7	37.9	111	319098	468908
3	Rectangular	51.0	68.4	271.5	201	319200	468966
4	Rectangular	17.0	21.5	195.5	204	319440	468675
5	Rectangular	21.0	165.4	20.6	294	319448	468695
6	Rectangular	20.0	45.9	43.6	113	319581	468647
7	Rectangular	16.8	97.1	335.0	115	319593	468484
8	Rectangular	16.8	280.1	16.4	205	319531	468482
9	Rectangular	22.0	64.3	54.8	25	319452	468269
10	Rectangular	21.0	16.6	110.5	204	319500	468301
11	Rectangular	21.0	138.0	37.8	204	319502	468215
12	Rectangular	20.0	21.6	63.1	205	319350	468549
13	Rectangular	16.0	103.0	65.5	204	319323	468493
14	Rectangular	16.0	21.8	87.7	113	319289	468535
15	Rectangular	16.0	20.6	86.8	115	319261	468549
16	Rectangular	35.0	35.7	87.2	204	319207	468366
17	Rectangular	22.0	88.9	155.3	204	319330	468340
18	Rectangular	20.0	44.0	172.6	53	319081	468429
19	Rectangular	23.0	34.0	170.5	232	319110	468466
20	Rectangular	27.0	90.7	64.9	204	319374	468621
21	Rectangular	45.0	94.5	176.4	114	319460	468520
22	Rectangular	16.8	211.3	88.3	114	319812	468515

Building dimensions and coordinates were obtained using ADMS Mapper, OS Mastermap and Google Earth maps.

The location and orientation of the modelled buildings are shown in the following diagrams.



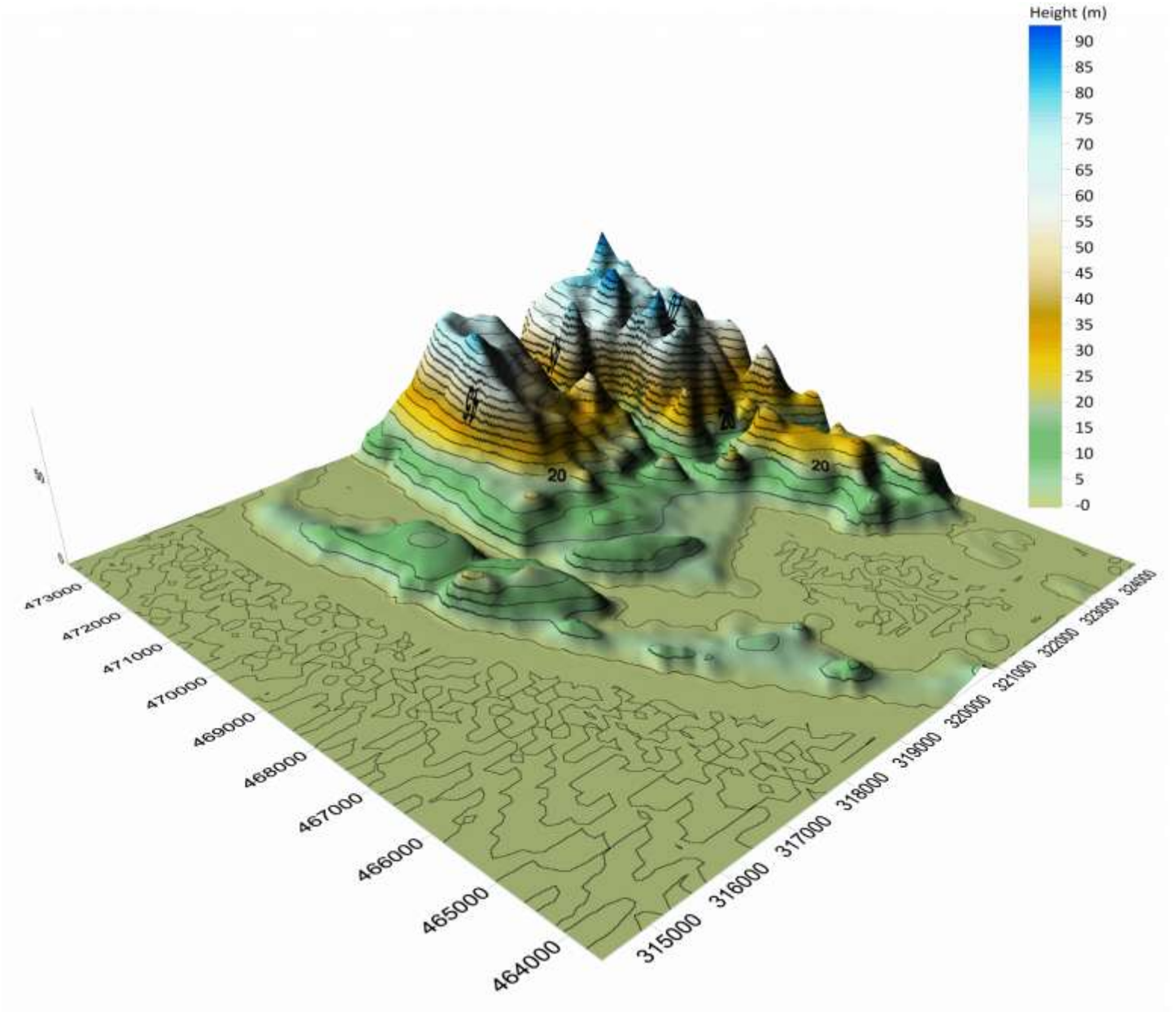


6.2 Terrain and Hills

Complex terrain can increase or decrease ground level concentrations at a given height. Terrain was therefore included in the modelling. Terrain data was sourced from Ordnance Survey:

https://www.ordnancesurvey.co.uk/opendatadownload/products.html

It was supplied in the form of an OS Landform Panorama Map (NTF). A 10km x 10km terrain map (below) was generated and used in the model, and was converted to a terrain file using ADMS 5.



6.3 Source Data

The following source data was entered into the model.

Parameter	DDH Spray Booth	DDH Shot Blast Facility	DDH Drying Facility	DDH Main Paint Shop	DDH DDH	DDH Paint Mixing Facility
Stack gas discharge height from ground level (m)[a]	9.1	5.3	5.3	10.0	45.0	8.0
Stack tip diameter (m)[ab]	0.84	0.52	0.19	0.35	1.53	0.56
Stack tip area (m^2)[c]	0.55	0.21	0.03	0.10	1.84	0.25
Stack gas discharge velocity (m/s)[a]	15.0	6.9	11.0	15.0	4.5	10.7
Stack gas discharge temperature (°C)[a]	25	25	245	25	25	25
Stack gas volumetric flow rate at actual stack conditions (m^3/s)[d]	8.31	1.47	0.31	1.44	8.27	2.64
Stack gas volumetric flow rate at reference conditions (m^3/s)[e]	7.62	1.34	0.16	1.32	7.58	2.41
X-grid position (m)[a] (Original Location)	319237	319238.7	319217.7	319220	319252.2	319232.7
Y-grid position (m)[a] (Original Location)	468838	468837.5	468864.3	468863.3	468907.3	468997.4
X-grid position (m)[a] (New Location)	319470	319509.5	319410.6	319451.6	-	-
Y-grid position (m)[a] (New Location)	468590	468571.6	468464.2	468442.4	-	-
TPM discharge emission concentration (mg/Nm^3)[ag]	9.40	0.67	0.75	1.10	1.80	0.70
TPM discharge emission rate (g/s)[h]	2.28	0.005	0.0003	0.008	0.45	0.02
VOC discharge emission concentration (mg/Nm^3)[ag]	3.80	-	10.0	13.5	332	38.2
VOC discharge emission rate (g/s)[h]	0.92	-	0.004	0.10	82.6	0.96
Parameter	**DDH Acoustic Tiling Facility**	**DDH Acoustic Tiling Facility (Mixing)**	**DDH Ex Reactor Facility (Spray Paint)**	**DDH Ex Reactor Facility (Hand Paint)**	**C10 Acoustic Tiling Facility**	**NAS Temp Enclosure**
Stack gas discharge height from ground level (m)[a]	8.0	8.0	19.5	19.5	13.3	23.0
Stack tip diameter (m)[b]	0.30	0.29	0.30	0.30	0.50	0.75
Stack tip area (m^2)[c]	0.07	0.07	0.07	0.07	0.20	0.44
Stack gas discharge velocity (m/s)[d]	18.5	18.5	10.2	15.0	15.0	15.0
Stack gas discharge temperature (°C)[e]	25	25	25	25	25	25
Stack gas volumetric flow rate at actual stack conditions (m^3/s)[f]	1.26	1.22	0.70	1.03	2.95	6.63
Stack gas volumetric flow rate at reference conditions (m^3/s)[g]	1.16	1.12	0.64	0.94	2.70	6.07
X-grid position (m)[hf] (Original Location)	319236	319236	319081.4	319083.7	319597.5	319361.8
Y-grid position (m)[hf] (Original Location)	468996.3	468996.3	468897.1	468891.7	468612.7	468366
X-grid position (m)[hf] (New Location)	-	-	319472	319448	-	-
Y-grid position (m)[hf] (New Location)	-	-	468545.5	468491.8	-	-
TPM discharge emission concentration (mg/Nm^3)[g]	0.80	0.80	5.00	1.10	0.60	1.30
TPM discharge emission rate (g/s)[j]	0.005	0.004	0.01	0.004	0.02	0.20
VOC discharge emission concentration (mg/Nm^3)[k]	-	18.8	1441	17.5	13.2	70.0
VOC discharge emission rate (g/s)[l]	-	0.10	2.52	0.07	0.41	10.9
Parameter	**NAS Annex Temp Enclosure**	**Other Wet Dock Temp Enclosure**	**CYF Paint Facility Shot Blast**	**CYF Paint Facility Spray Paint**	**CYF Paint Facility Tiling**	**CYF Paint Facility Insulation**
Stack gas discharge height from ground level (m)[a]	23.0	11.0	29.0	29.0	29.0	29.0
Stack tip diameter (m)[b]	0.45	0.30	0.50	0.50	0.50	0.50
Stack tip area (m^2)[c]	0.16	0.07	0.20	0.20	0.20	0.20
Stack gas discharge velocity (m/s)[d]	15.0	2.0	21.0	21.0	21.0	21.0
Stack gas discharge temperature (°C)[e]	25	25	25	25	25	25
Stack gas volumetric flow rate at actual stack conditions (m^3/s)[f]	2.39	0.14	4.12	4.12	4.12	4.12
Stack gas volumetric flow rate at reference conditions (m^3/s)[g]	2.19	0.13	3.78	3.78	3.78	3.78
X-grid position (m)[h] (Original Location)	319458	319423.7	319381.3	319404.7	319343.7	319371.3
Y-grid position (m)[h] (Original Location)	468301.2	468788.1	468668.6	468658.7	468584.1	468571.5
X-grid position (m)[h] (New Location)	-	-	-	-	-	-
Y-grid position (m)[h] (New Location)	-	-	-	-	-	-
TPM discharge emission concentration (mg/Nm^3)[i]	0.50	1.30	1.30	1.30	1.30	1.30
TPM discharge emission rate (g/s)[j]	0.010	0.00009	0.08	0.08	0.08	0.08
VOC discharge emission concentration (mg/Nm^3)[k]	176	70.0	-	70.0	70.0	70.0
VOC discharge emission rate (g/s)[l]	3.60	0.005	-	4.28	4.28	4.28

6.4 Notes on Source Data

Stack Reference conditions are 273K, 101.3kPa without correction for water vapour content.

Notes on source data:

a *Provided by Peter Winder, BAE Systems, via email.*

b *Where the stack is rectangular the diameter has been calculated assuming it is a circular of equivalent area.*

c *Stack tip area is calculated from the stack tip diameter using the standard π x radius squared formula.*
The DDH Main Hall (DDH DDH in listing) consists of 64 stacks across the buildings roof. It is expected no more than 6 would be emitting at any one time. For the purposes of the modelling this emission point has been modelled as a single combined duct equivalent to 10 single ducts.

d *Stack gas volumetric flow rate is calculated by multiplying the stack tip area by the stack gas discharge velocity.*

e *Stack gas volumetric flow rate, at reference conditions, is calculated from the stack gas volumetric flow rate, at actual conditions. The volumetric flow rate at actual conditions is multiplied by the formula 273/(273 + Stack temperature in Celsius).*

f *X and Y Grid Positions determined using ordnance survey aerial photography map and ADMS mapper software.*

g *Where the emission from the plant are not known (New Facilities) an average of emissions from the original stacks has been used. Results greater than two standard deviations from the mean have been removed from this average as they were considered to be outliers*

h *Discharge emission rates calculated by multiplication of the discharge emission concentrations by the volumetric flow rate.*

6.5 Background Data

The following background concentration data was used, in order to assess current air quality in the area of interest and to determine the Predicted Environmental Concentration (PEC - process contribution + background concentration) of pollutants.

Parameter	Site[a]	Human Health Receptor 1[b]	Human Health Receptor 2[c]	Human Health Receptor 3[d]	Human Health Receptor 4[e]	Human Health Receptor 5[f]
PM10 Annual Mean	15.24	15.24	15.24	15.24	15.24	10.70
PM10 24-Hour Mean	30.47	30.47	30.47	30.47	30.47	21.40
Xylene Annual Mean	39.11	39.11	39.11	39.11	39.11	39.11
Xylene 1-Hour Mean	78.21	78.21	78.21	78.21	78.21	78.21
Parameter		Human Health Receptor 6[g]	Human Health Receptor 7[h]	Human Health Receptor 8[i]	Human Health Receptor 9[j]	Human Health Receptor 10[k]
NOx Annual Mean		22.88	15.24	10.70	10.31	15.24
NOx 1-Hour Mean		45.76	30.47	21.40	20.63	30.47
Xylene Annual Mean		39.11	39.11	39.11	39.11	39.11
Xylene 1-Hour Mean		78.21	78.21	78.21	78.21	78.21

Background PM10 concentration data was obtained from background maps available from the Department for Environment, Food and Rural Affairs (Defra) UK Air website. Annual mean concentrations for 2017 were obtained from 2011 based 1km x 1km background maps for . Further information on Air Quality background maps is available from:

http://uk-air.defra.gov.uk/data/laqm-background-home

The closest available grid square to the location of interest was chosen. The X and Y coordinates for each grid square are for the South West corner:

[a] 1km x 1km grid square X = 318500 Y = 468500
[b] 1km x 1km grid square X = 318500 Y = 468500
[c] 1km x 1km grid square X = 318500 Y = 468500
[d] 1km x 1km grid square X = 318500 Y = 468500
[e] 1km x 1km grid square X = 318500 Y = 468500
[f] 1km x 1km grid square X = 319500 Y = 467500
[g] 1km x 1km grid square X = 319500 Y = 468500
[h] 1km x 1km grid square X = 318500 Y = 468500
[i] 1km x 1km grid square X = 319500 Y = 467500
[j] 1km x 1km grid square X = 318500 Y = 467500
[k] 1km x 1km grid square X = 318500 Y = 468500

For modelling purposes, the short term background concentration was taken to be twice the long term (annual) background concentration obtained from the Defra maps. This is a pragmatic approach for the assessment of short term air quality effects as suggested in the Environment Agency's guidance 'Air emissions risk assessment for your environmental permit', published in March 2016. Available from:

https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#calculate-pec

Background Xylene concentration data was obtained from the Department for Environment, Food and Rural Affairs (Defra) UK Air website. The result quoted is the maximum Xylene value measured in 2017 at the Chilbolton Observatory monitoring station.

https://uk-air.defra.gov.uk/data/data_selector

6.6 Modelled Domain / Output Grid

It is important that the grid of receptor points is not too widely spaced to ensure that the maximum process contribution values are not missed from the modelled results. Guidance for selecting the size of the modelled domain indicates that the model receptor grid should be spaced at around 1.5 times the stack height(s). The stacks providing the greatest contrinbution to the emission are above 25m, so the grid spacing should be a maximum of around 37.5m. A grid size of 3500m, with 101 grid points was chosen. This gives a grid spacing of approximately 34.7m, which is acceptable.

Gridded Output	Start	Finish
X (m)	317650	321150
Y (m)	466797	470297
Z (m)	0	

The height above ground (z value) was selected as zero. i.e. ground-level conditions.

Sensitive Receptors - Human Health

The following human health receptors were considered, that were closest to the emission points. Sensitive receptors relevant to human health were identified using aerial maps of the study area, giving consideration to the prevailing wind direction and the concept of relevant exposure. However, because the dispersion modelling uses an output grid, pollutant concentrations are considered across the whole modelled area using the contour plots.

The X and Y grid positions of the sensitive receptors were chosen to represent the facade of the building closest to the emission points where members of the public were considered most likely to be present.

Human Health Receptor	Description	X-grid position (m)	Y-grid position (m)
R1	Recreation Area off North Rd	319033	468829
R2	Recreational Dock Area	318920	468953
R3	Basketball Court off Stanley Rd	319280	468747
R4	Residential Property on Stanley Rd	319079	468843
R5	Residential Property on Island Rd	319588	468259
R6	Residential Property on St Vincent St	319629	469139
R7	Barrow Rugby League Football Club	319381	469459
R8	Primary School on Trinity St	319683	468313
R9	Crown Green Bowling Club on King Alfred St	318583	468365
R10	Recreation Area off Promenade	318583	468710

Sensitive Receptors - Ecological

No sensitive ecological receptors were included in the model.

6.7 Modelled Output Data / Environmental Quality Standards

The output data from the model was compared to the following Environmental Quality Standards.

Air quality concentrations for the protection of human health:

Pollutant	Measured as	Environmental Quality Standard Concentration	Exceedences as Percentile	Maximum Number of Exceedences Allowed
Particulates (PM10)[a]	24-Hour Mean	50 µg/m^3	90.41	Up to 35 times a year
	Annual Mean	40 µg/m^3	-	-
Xylene (o-, m-, p- or mixed isomers)[b]	1-Hour Mean	66200 µg/m^3	-	-
	Annual Mean	4410 µg/m^3	-	-

[a] Air Quality Objectives from The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, published in 2007 by Defra:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf

Air Quality Objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale. As such, there is no legal requirement to meet these objectives, except where they mirror equivalent legally binding limit values set at a European Union level, and implemented in England through The Air Quality Standards Regulations 2010:

http://www.legislation.gov.uk/uksi/2010/1001/introduction/made

However, under the Environment Act 1995, local authorities are required to work towards achieving the objectives prescribed in regulations. The Environment Agency is also required to have regard to the Air Quality Strategy in exercising their pollution control

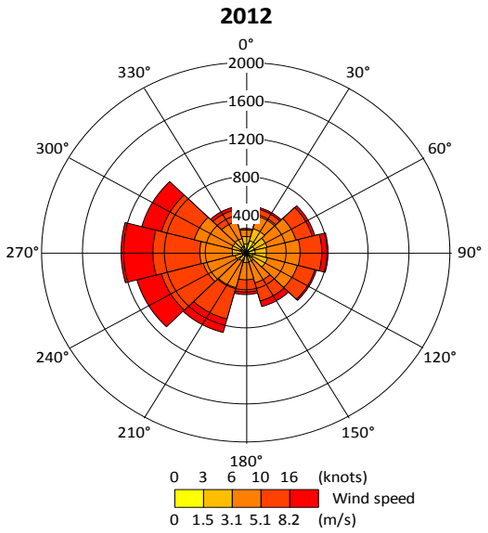
[b] Environmental Assessment Levels for Xylene. Xylene was chosen to be repesentative of the VOCs found within solvent based paint. It has the lowest assessment levels of all the compounds readily found within solvent based paint. This information is found within the, "Environmental Standards for Air Emissions," portion of the, "air emissions risk assessment for your environmental permit," section of the gov.uk website.

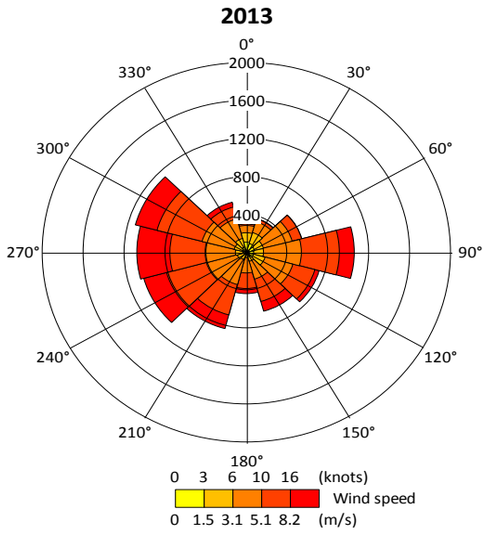
https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air-emissions

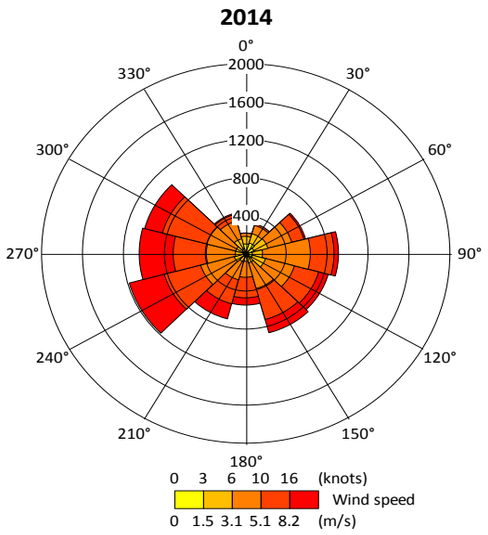
6.8 Meteorological Data / Wind Roses

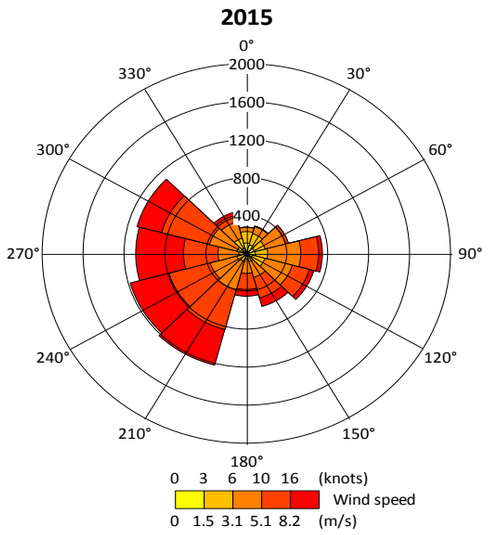
Meteorological data files were purchased directly from the Met Office covering the years 2012 to 2016. The meteorological monitoring station used for the data was Walney Island (54.12489, -3.25791). The data was supplied in an hourly-sequential format.

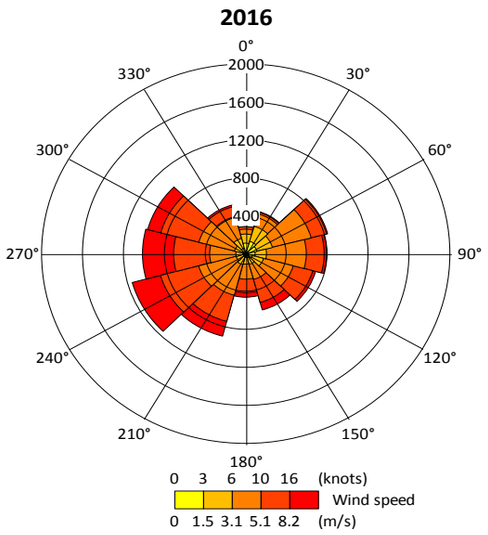
The wind roses for the 5 years of meteorological data are shown below.











The surface roughness of the meteorological monitoring station site was selected as being 0.3, which reflects the fact that the monitoring station lies in an agricultural area (Agricultural areas (max) designation in ADMS 5).

The surface roughness of the dispersion site was selected as being 1.0, which reflects the fact that the site lies in a Urban area (Cities, Woodlands designation in ADMS 5).

The dispersion site latitude was entered as 54.12489°.

7.0 MODELLING ASSUMPTIONS

Pollutant information and all assumptions made regarding the emissions data can be found within section 6.3 and 6.4 of this report.

Pollutant mass emission rates were taken from information provided by BAE Systems. Emission rates for the new facilities were estimated based on emissions from current operations.

Concentration values were converted to mass emission rates using the normalised volumetric flow rate of the stack gas.

The effects of buildings close to the emission points and terrain on dispersion of pollutants were taken into account by the model.

Dispersion of pollutants was undertaken assuming that the plant will be operating seven days a week with two shifts encompassing the period 06:00 to 00:00. It is assumed that emissions are continuous throughout this time.

All Total Particulate Matter assumed to have an aerodynamic diameter less than 10 microns to allow comparison to the PM10 Environmental Assessment Levels.

All Total Volatile Organic Compounds considered to be Xylene as it is the compound with the lowest assessment levels that is readily found within solvent based paint.

8.0 CONTOUR PLOT RESULTS FROM THE MODELLING EXERCISE

Contour plots of process contribution dispersion have been drawn for each of the modelled pollutant emissions, for the year of meteorological data resulting in the highest absolute maximum ground level concentration.

Base map with no contour plots superimposed

The base map (below) is identical to the maps used in the contour plots, and can be used to identify the areas / buildings the contour plots may be overlapping. The emission points and receptor locations are also shown.

8.1 TPM measured as a 24-hour mean (90.41 percentile, process contribution) [Scenario 1]

Year of meteorological data resulting in maximum process contributions	2015
Environmental Quality Standard	50 µg/m^3

8.2 TPM measured as a 24-hour mean (90.41 percentile, process contribution) [Scenario 2]

Year of meteorological data resulting in maximum process contributions	2015
Environmental Quality Standard	50 µg/m^3

8.3 TPM measured as a 24-hour mean (90.41 percentile, process contribution) [Scenario 3]

Year of meteorological data resulting in maximum process contributions	2012
Environmental Quality Standard	50 µg/m^3

8.4 TPM measured as a Annual mean (process contribution) [Scenario 1]

Year of meteorological data resulting in maximum process contributions	2016
Environmental Quality Standard	40 µg/m^3

8.5 TPM measured as a Annual mean (process contribution) [Scenario 2]

Year of meteorological data resulting in maximum process contributions	2016
Environmental Quality Standard	40 µg/m^3

8.6 TPM measured as a Annual mean (process contribution) [Scenario 3]

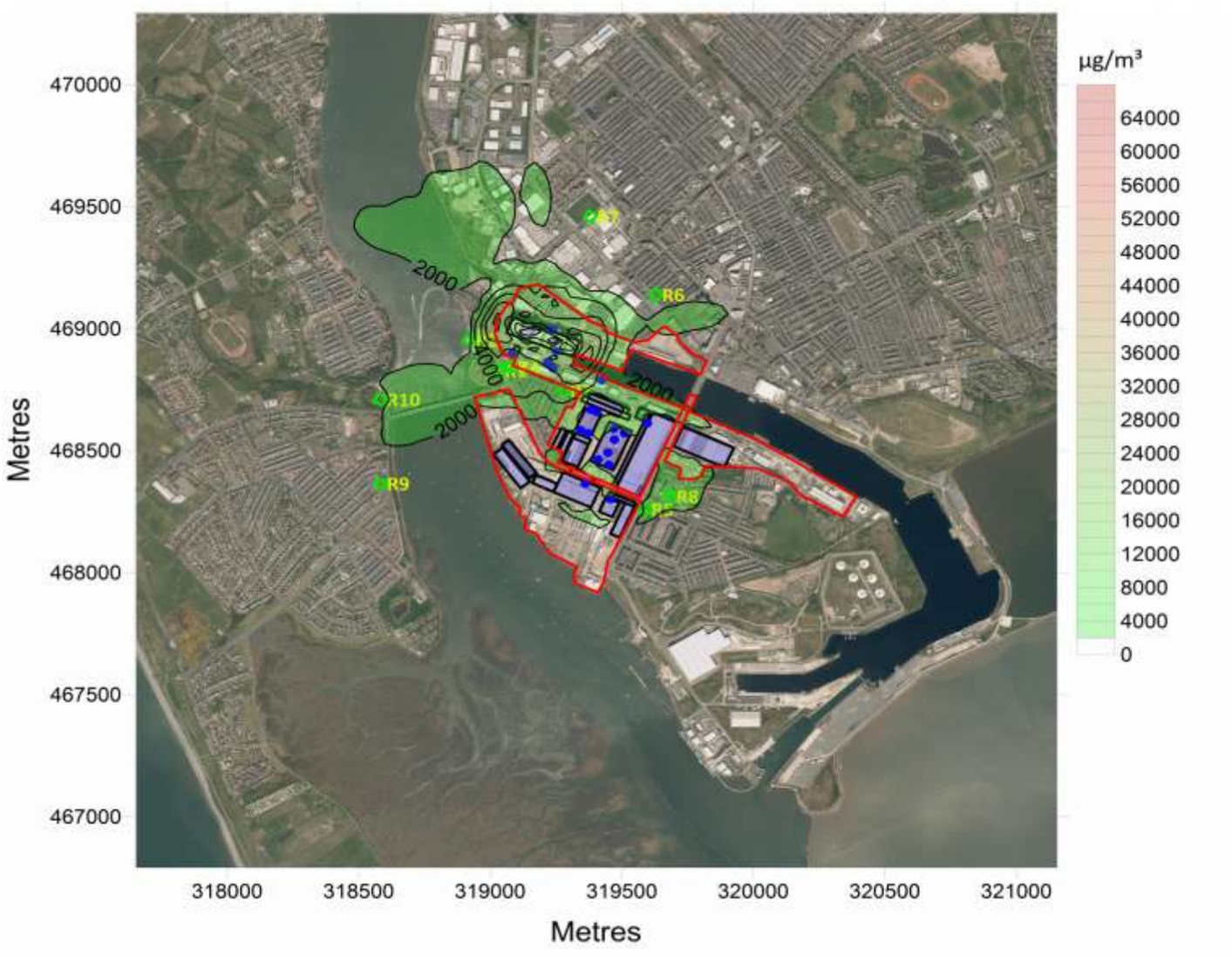
Year of meteorological data resulting in maximum process contributions	2016
Environmental Quality Standard	40 µg/m^3

8.7 VOCs measured as a 1-Hour mean (process contribution) [Scenario 1]

Year of meteorological data resulting in maximum process contributions	2014
Environmental Quality Standard	66200 µg/m^3

8.8 VOCs measured as a 1-Hour mean (process contribution) [Scenario 2]

Year of meteorological data resulting in maximum process contributions	2014
Environmental Quality Standard	66200 µg/m^3



8.9 VOCs measured as a 1-Hour mean (process contribution) [Scenario 3]

Year of meteorological data resulting in maximum process contributions	2014
Environmental Quality Standard	66200 µg/m^3

8.10 VOCs measured as an annual mean (process contribution) [Scenario 1]

Year of meteorological data resulting in maximum process contributions	2014
Environmental Quality Standard	4410 µg/m^3

8.11 VOCs measured as an annual mean (process contribution) [Scenario 2]

Year of meteorological data resulting in maximum process contributions	2014
Environmental Quality Standard	4410 µg/m^3

8.12 VOCs measured as an annual mean (process contribution) [Scenario 3]

Year of meteorological data resulting in maximum process contributions	2016
Environmental Quality Standard	4410 µg/m^3

APPENDIX 1 - Results from the Modelling Exercise

Predicted Absolute Maximum Modelled Process Contributions - Mean measured values

These results are based on Scenario 1

Pollutant and Averaging Period	Year of Meteorological Data					EQS
	2012	2013	2014	2015	2016	
TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	118.8	103.9	105.8	124.1	109.6	50
TPM Annual Mean (µg/m^3)	43.0	38.3	39.8	41.0	45.5	40
VOC 1-Hour Mean (µg/m^3)	16646	16845	16966	16888	16833	66200
VOC Annual Mean (µg/m^3)	1487	1554	1594	1576	1393	4410

These results are based on Scenario 2

Pollutant and Averaging Period	Year of Meteorological Data					EQS
	2012	2013	2014	2015	2016	
TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	118.8	104.3	105.8	124.1	109.6	50
TPM Annual Mean (µg/m^3)	43.3	38.6	40.1	41.2	45.8	40
VOC 1-Hour Mean (µg/m^3)	16646	16845	16973	16888	16840	66200
VOC Annual Mean (µg/m^3)	1494	1562	1604	1583	1401	4410

These results are based on Scenario 3

Pollutant and Averaging Period	Year of Meteorological Data					EQS
	2012	2013	2014	2015	2016	
TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	37.1	36.3	35.7	34.3	36.7	50
TPM Annual Mean (µg/m^3)	25.6	25.6	25.7	25.4	26.2	40
VOC 1-Hour Mean (µg/m^3)	16622	16821	16964	16888	16833	66200
VOC Annual Mean (µg/m^3)	1459	1523	1565	1550	1363	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 1

Receptor		Pollutant and Averaging Period	Year of Meteorological Data					EQS
			2012	2013	2014	2015	2016	
R1	Recreation Area off North Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	27.3	38.1	32.7	29.8	31.5	50
		TPM Annual Mean (µg/m^3)	7.60	8.95	8.93	6.86	8.24	40
		VOC 1-Hour Mean (µg/m^3)	6940	6936	6892	6949	6889	66200
		VOC Annual Mean (µg/m^3)	149	132	137	106	166	4410
R2	Basketball Court off Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	13.6	14.1	12.8	12.5	13.0	50
		TPM Annual Mean (µg/m^3)	3.86	4.00	4.16	3.52	3.59	40
		VOC 1-Hour Mean (µg/m^3)	2106	2042	1984	2271	2062	66200
		VOC Annual Mean (µg/m^3)	88.9	105	102	82.5	85.9	4410
R3	Residential Property on Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	22.7	31.7	24.8	29.0	27.6	50
		TPM Annual Mean (µg/m^3)	8.14	8.85	7.39	8.25	8.34	40
		VOC 1-Hour Mean (µg/m^3)	6628	9036	7726	8768	8564	66200
		VOC Annual Mean (µg/m^3)	76.2	79.2	71.1	79.9	84.3	4410
R4	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	37.0	53.0	48.5	36.8	41.3	50
		TPM Annual Mean (µg/m^3)	10.4	12.3	12.3	9.4	10.8	40
		VOC 1-Hour Mean (µg/m^3)	6947	6943	6899	6956	6896	66200
		VOC Annual Mean (µg/m^3)	143	128	132	105	163	4410
R5	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.12	5.75	4.58	4.61	4.88	50
		TPM Annual Mean (µg/m^3)	1.44	1.65	1.43	1.51	1.49	40
		VOC 1-Hour Mean (µg/m^3)	2079	2084	2138	2031	3040	66200
		VOC Annual Mean (µg/m^3)	33.2	35.7	31.0	33.6	33.6	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 1

R6	Residential Property on St Vincent St						
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	8.17	7.92	7.48	7.71	9.00	50
		TPM Annual Mean (µg/m^3)	2.68	2.55	2.68	2.85	2.94	40
		VOC 1-Hour Mean (µg/m^3)	2003	2458	1905	2117	2262	66200
		VOC Annual Mean (µg/m^3)	69.0	65.2	71.2	69.1	71.9	4410
R7	Barrow Rugby League Football Club							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	3.95	3.49	3.60	4.02	4.36	50
		TPM Annual Mean (µg/m^3)	1.06	0.99	1.07	1.16	1.20	40
		VOC 1-Hour Mean (µg/m^3)	939	883	935	760	974	66200
		VOC Annual Mean (µg/m^3)	25.3	23.8	25.3	28.7	27.0	4410
R8	Primary School on Trinity St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.40	4.98	4.95	5.15	4.93	50
		TPM Annual Mean (µg/m^3)	1.43	1.66	1.47	1.56	1.52	40
		VOC 1-Hour Mean (µg/m^3)	2080	2067	2265	2358	2493	66200
		VOC Annual Mean (µg/m^3)	29.9	34.3	30.1	31.5	31.1	4410
R9	Crown Green Bowling Club on King Alfred St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	2.80	2.42	2.22	2.05	3.69	50
		TPM Annual Mean (µg/m^3)	0.80	0.66	0.69	0.57	0.92	40
		VOC 1-Hour Mean (µg/m^3)	1443	1476	1409	1270	1405	66200
		VOC Annual Mean (µg/m^3)	15.1	11.1	12.1	10.4	17.0	4410
R10	Recreation Area off Promenade							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.73	5.34	5.29	4.58	5.04	50
		TPM Annual Mean (µg/m^3)	1.25	1.39	1.33	1.10	1.40	40
		VOC 1-Hour Mean (µg/m^3)	1981	1994	1905	1882	1893	66200
		VOC Annual Mean (µg/m^3)	26.9	26.3	26.1	22.1	31.1	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 2

Receptor		Pollutant and Averaging Period	Year of Meteorological Data					EQS
			2012	2013	2014	2015	2016	
R1	Recreation Area off North Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	28.0	38.5	33.0	29.8	31.5	50
		TPM Annual Mean (µg/m^3)	7.81	9.16	9.15	7.05	8.44	40
		VOC 1-Hour Mean (µg/m^3)	6940	6937	6892	6949	6889	66200
		VOC Annual Mean (µg/m^3)	158	140	146	113	174	4410
R2	Basketball Court off Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	13.7	14.3	13.0	12.8	13.9	50
		TPM Annual Mean (µg/m^3)	3.99	4.12	4.30	3.65	3.72	40
		VOC 1-Hour Mean (µg/m^3)	2125	2048	1988	2281	2064	66200
		VOC Annual Mean (µg/m^3)	94.1	110	107	87.2	90.9	4410
R3	Residential Property on Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	22.7	32.1	24.8	29.0	28.0	50
		TPM Annual Mean (µg/m^3)	8.47	9.20	7.83	8.59	8.69	40
		VOC 1-Hour Mean (µg/m^3)	6628	9036	7726	8768	8564	66200
		VOC Annual Mean (µg/m^3)	88.0	92.1	87.1	91.9	96.7	4410
R4	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	38.8	53.0	49.5	37.8	41.3	50
		TPM Annual Mean (µg/m^3)	10.6	12.5	12.6	9.7	11.0	40
		VOC 1-Hour Mean (µg/m^3)	6947	6943	6899	6956	6896	66200
		VOC Annual Mean (µg/m^3)	152	137	142	113	171	4410
R5	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.47	6.45	5.13	5.02	5.37	50
		TPM Annual Mean (µg/m^3)	1.61	1.84	1.61	1.68	1.67	40
		VOC 1-Hour Mean (µg/m^3)	2080	2121	2138	2034	3042	66200
		VOC Annual Mean (µg/m^3)	39.8	43.2	37.9	40.4	40.7	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 2

R6	Residential Property on St Vincent St						
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	8.31	8.20	7.77	8.15	9.28	50
		TPM Annual Mean (µg/m^3)	2.83	2.69	2.81	3.02	3.10	40
		VOC 1-Hour Mean (µg/m^3)	2003	2458	1905	2117	2262	66200
		VOC Annual Mean (µg/m^3)	74.9	70.7	76.3	75.8	78.3	4410
R7	Barrow Rugby League Football Club							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.21	3.67	3.77	4.15	4.55	50
		TPM Annual Mean (µg/m^3)	1.12	1.04	1.13	1.21	1.26	40
		VOC 1-Hour Mean (µg/m^3)	1019	920	969	787	1054	66200
		VOC Annual Mean (µg/m^3)	27.4	25.6	27.5	30.5	29.3	4410
R8	Primary School on Trinity St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	5.17	5.97	5.79	5.74	5.72	50
		TPM Annual Mean (µg/m^3)	1.63	1.89	1.69	1.78	1.73	40
		VOC 1-Hour Mean (µg/m^3)	2082	2072	2270	2360	2493	66200
		VOC Annual Mean (µg/m^3)	38.4	44.1	39.7	40.7	40.1	4410
R9	Crown Green Bowling Club on King Alfred St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	3.21	2.71	2.63	2.19	4.18	50
		TPM Annual Mean (µg/m^3)	0.89	0.75	0.78	0.65	1.02	40
		VOC 1-Hour Mean (µg/m^3)	1448	1483	1424	1272	1429	66200
		VOC Annual Mean (µg/m^3)	18.6	14.9	15.7	13.4	21.1	4410
R10	Recreation Area off Promenade							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	5.02	5.68	5.54	4.82	5.20	50
		TPM Annual Mean (µg/m^3)	1.34	1.49	1.42	1.19	1.48	40
		VOC 1-Hour Mean (µg/m^3)	1994	1995	1922	1882	1893	66200
		VOC Annual Mean (µg/m^3)	30.7	30.1	29.7	25.5	34.3	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 3

Receptor		Pollutant and Averaging Period	Year of Meteorological Data					EQS
			2012	2013	2014	2015	2016	
R1	Recreation Area off North Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	5.54	5.43	5.43	5.34	5.51	50
		TPM Annual Mean (µg/m^3)	1.88	1.79	1.91	1.56	1.91	40
		VOC 1-Hour Mean (µg/m^3)	6916	6913	6867	6925	6865	66200
		VOC Annual Mean (µg/m^3)	141	126	133	101	156	4410
R2	Basketball Court off Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.18	4.09	3.99	3.69	4.25	50
		TPM Annual Mean (µg/m^3)	1.21	1.28	1.34	1.12	1.17	40
		VOC 1-Hour Mean (µg/m^3)	1956	1883	1788	2076	1910	66200
		VOC Annual Mean (µg/m^3)	83.0	98.1	95.6	77.1	80.7	4410
R3	Residential Property on Stanley Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	7.06	6.71	7.95	6.64	7.44	50
		TPM Annual Mean (µg/m^3)	2.27	2.37	2.71	2.24	2.39	40
		VOC 1-Hour Mean (µg/m^3)	6509	8958	7615	8664	8453	66200
		VOC Annual Mean (µg/m^3)	80.6	83.9	80.3	84.0	89.1	4410
R4	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	5.49	5.22	5.45	5.33	5.59	50
		TPM Annual Mean (µg/m^3)	1.88	1.83	1.99	1.60	1.96	40
		VOC 1-Hour Mean (µg/m^3)	6916	6912	6867	6925	6864	66200
		VOC Annual Mean (µg/m^3)	141	125	133	103	160	4410
R5	Residential Property on Island Rd							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	4.15	5.49	4.29	4.74	5.20	50
		TPM Annual Mean (µg/m^3)	1.55	1.65	1.46	1.63	1.64	40
		VOC 1-Hour Mean (µg/m^3)	2076	2065	2056	2045	2980	66200
		VOC Annual Mean (µg/m^3)	40.3	43.6	38.3	41.0	41.3	4410

APPENDIX 1 - Results from the Modelling Exercise

Predicted Modelled Process Contributions at Sensitive Receptors - Mean measured values

These results are based on Scenario 3

R6	Residential Property on St Vincent St						
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	3.58	3.31	3.42	3.59	4.12	50
		TPM Annual Mean (µg/m^3)	1.21	1.12	1.21	1.31	1.37	40
		VOC 1-Hour Mean (µg/m^3)	1810	2238	1722	1938	2078	66200
		VOC Annual Mean (µg/m^3)	72.6	68.6	74.0	73.6	76.1	4410
R7	Barrow Rugby League Football Club							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	1.58	1.54	1.87	1.47	2.14	50
		TPM Annual Mean (µg/m^3)	0.51	0.45	0.52	0.47	0.55	40
		VOC 1-Hour Mean (µg/m^3)	1007	899	935	761	1033	66200
		VOC Annual Mean (µg/m^3)	26.1	24.4	26.3	28.9	27.7	4410
R8	Primary School on Trinity St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	6.43	7.01	6.90	7.39	6.67	50
		TPM Annual Mean (µg/m^3)	1.91	2.11	1.96	2.08	2.02	40
		VOC 1-Hour Mean (µg/m^3)	1982	1977	2156	2276	2493	66200
		VOC Annual Mean (µg/m^3)	39.7	45.6	41.2	42.2	41.6	4410
R9	Crown Green Bowling Club on King Alfred St							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	2.48	2.47	2.50	2.42	2.70	50
		TPM Annual Mean (µg/m^3)	0.72	0.69	0.66	0.58	0.75	40
		VOC 1-Hour Mean (µg/m^3)	1351	1387	1325	1173	1352	66200
		VOC Annual Mean (µg/m^3)	18.3	14.7	15.5	13.2	20.6	4410
R10	Recreation Area off Promenade							
		TPM 24-Hour Mean (90.41 %ile) (µg/m^3)	2.66	2.73	2.50	2.44	2.53	50
		TPM Annual Mean (µg/m^3)	0.78	0.76	0.75	0.70	0.71	40
		VOC 1-Hour Mean (µg/m^3)	1842	1834	1773	1719	1730	66200
		VOC Annual Mean (µg/m^3)	29.3	28.6	28.3	24.5	32.4	4410