Swale
BOROUGH COUNCIL

Blue Town & Queenborough Inventory of Air Emissions

AGGX3790131/BV/AQ/BW/2686

March 2011

Environmental Services

SWALE BOROUGH COUNCIL

BLUE TOWN AND QUEENBOROUGH – INVENTORY OF AIR EMISSIONS

AGGX3790131/BV/AQ/BW/2686

Move Forward with Confidence

This page is left blank intentionally

Executive Summary

This report details an assessment into the levels of NO_x, PM_{10} and SO_2 emission from a variety of different sources in the Blue Town and Queenborough areas within the administrative area of Swale Borough Council.

As these areas have been identified as a cause for concern in terms of air pollution, the Council has considered it necessary to commission a local pollutant Emissions Inventory, to serve the following purposes:

- To get accurate estimates for pollutant emissions
- To inform policy in order to develop appropriate policies/strategies for emission reductions
- To feed into air quality dispersion modelling to assess air quality impacts

The methodology for each emission sector of the Emissions Inventory was chosen with consideration of the latest available guidance and emission factors. Emissions were calculated using local information obtained from a variety of sources combined with default parameters and/or recommended values found in literature, based on previous studies.

From the results, it can be concluded that shipping contributes the highest percentage of emissions for all three pollutants estimated within the study area. Over 93% of the SO_2 emissions are attributed to marine vessels. They also contribute over 66% of overall NO_x emissions, and 75% of PM_{10} emissions. Part A Processes were also found to contribute a large proportion of NO_x and PM_{10} emissions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This page is left blank intentionally

1 Introduction

1.1 Background

Bureau Veritas has been commissioned by Swale Borough Council (SBC) to develop an Emissions Inventory of air pollutants for the Blue Town (suburb of Sheerness) and Queenborough areas. As emission sources in this area are complex and varied, including the Port of Sheerness, and several industrial sites, SBC decided to prepare a detailed inventory of air emissions for the following purposes:

- To calculate accurate estimates for pollutant emissions;
- To inform policy in order to develop appropriate policies/strategies for emission reductions; and,
- To feed into air quality dispersion modelling to assess air quality impacts.

This study is based on the latest methodologies and guidance for emissions inventories and information collated for the study area. All main potential sources have been investigated including emissions from:

- Part A Industrial processes;
- Part B Industrial processes;
- Commercial shipping;
- Road traffic;
- Commercial, Institutional and Residential Combustion;
- Waste Treatment and Disposal;
- Agriculture; and
- Nature.

1.1.1 Description of the Local Authority Area

Situated in the northern maritime region of Kent, in the southeast of England, Swale is comprised of three main urban areas: Sittingbourne and Faversham town centres on the mainland, which are surrounded by countryside and numerous rural villages, and Sheerness town centre on the Isle of Sheppey. The island is accessed by road bridge and since the new Swale crossing was completed in July 2006 this has opened up the area for new residential development. Sheerness has a seaport for freight and significant industrial heritage, including the Sheerness Steel Works. The Swale area is part of the Thames Gateway with significant regeneration planned in the area. Swale has good road and rail networks to London and the coast. The ferry ports of Dover and Ramsgate and the Channel Tunnel terminus at Folkestone are approximately one hour away.

Emissions from road traffic have been the predominant air quality concern from a regulatory perspective in Swale. An Air Quality Management Area (AQMA) was declared in March 2009 along the A2 in Newington (west of Sittingborne) where exceedences of the annual mean objective for nitrogen dioxide (NO_2) were predicted. Other pollution sources, including industrial, commercial and domestic sources, also make a contribution to background pollution concentrations. Another AQMA is likely to be declared in Ospringe (near Faversham, east of Sittingborne) in 2011 following recorded exceedences of the NO_2 annual mean objective along the A2. Monitored levels of pollution in 2009 are available in the Swale Borough Council Local Air Quality Management Annual Progress Report 2010.

1.1.2 Description of the Study area

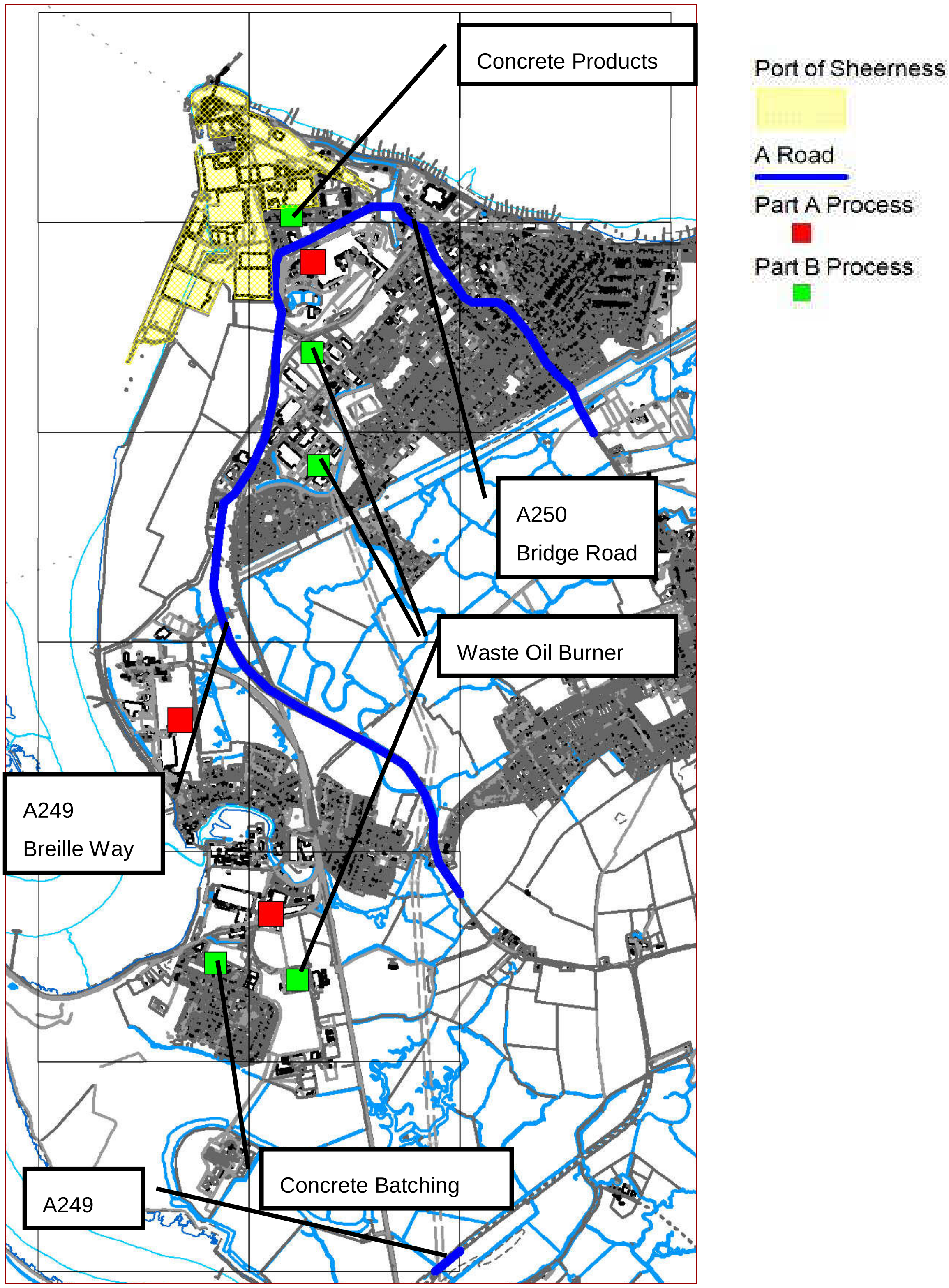
The area considered in this study is illustrated in Figure 1. Blue Town is a suburb of the main town of Isle of Sheppey, Sheerness. The emissions from the freight seaport and industrial processes including Sheerness

Steel works are understood to be the major sources of air pollutants in the Blue Town area. The Port of Sheerness is the UK's leading port for fresh produce and additionally handles over 450,000 tonnes per year of forest products and 400,000 cars per year[1].

Queenborough is the oldest town on the Isle of Sheppey which is undergoing a rapid change due to regeneration. Road traffic and fugitive PM_{10} emissions from ongoing construction are understood to be the major pollution sources.

[1] http://www.medwayports.com

Figure 1 – EI Study Area



1.2 Scope of Study

The scope of this study is described in terms of the pollutants taken into account, the sources of pollutants considered and both the spatial and temporal extents of the study.

1.2.1 Pollutants of Concern

The emissions inventory focuses on the following pollutants of concern identified:

- Nitrogen Dioxide (NO_2)
- Particulate matter of 10 microns or below (PM_{10})
- Sulphur Dioxide (SO_2)

These three pollutants are part of the key pollutants included in the national air quality standards and objectives, established by Government. The Air Quality Strategy (AQS)[2] for the UK (released in July 2007) provides the over-arching strategic framework for air quality in the UK and contains national air quality standards and objectives established by the UK Government and devolved administrations to protect human health. The air quality objectives incorporated in the AQS and the UK Legislation are derived from the Limit Values prescribed in the EU Directives transposed into national legislation by member states.

The Clean Air for Europe (CAFE) programme was initiated in the late 1990s to draw together previous directives into a single EU Directive on air quality. The Air Quality Standards (England) Regulations 2007[3] came into force on 15th February 2007 in order to align and bring together in one statutory instrument the Governments obligations to fulfil the requirements of the CAFE Directive.

The locations where the AQS objectives apply are defined in the AQS as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period of the AQS objective. Typically these include residential properties and schools/care homes for longer period (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives.

The objectives set out in the AQS for the three pollutants included in this emissions inventory are presented in Table 1.

[2] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland

[3] The Air Quality Standards Regulations 2007, Statutory Instrument No 64, The Stationary Office Limited

Table 1 – Air Quality Objectives for the Pollutants Included in the Emissions Inventory

Pollutant	Objective	Concentration Measured As	Date To Be Achieved By and Maintained Thereafter
Nitrogen Dioxide (NO_2) [a] All authorities	200 µg/m^3, not to be exceeded more than 18 times a year	hourly mean	31.12.2005
	40 µg/m^3	annual mean	31.12.2005
Particles (PM_{10}) (gravimetric) [b] All authorities	50 µg/m^3, not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 µg/m^3	annual mean	31.12.2004
Sulphur Dioxide (SO_2) All authorities	350 µg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31.12.2004
	125 µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31.12.2004
	266 µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31.12.2005

a EU Limit values in respect of nitrogen dioxide to be achieved by 1st January 2010.

b Measured using the European gravimetric transfer sampler or equivalent.

1.2.2 Emission Sources

Emissions sources can generally be divided into stationary emissions, such as industrial emissions from stack release, and mobile emissions, including road and shipping sources. However, there are other sources of emission which cannot be included in the categories above, either because it is difficult to locate the sources precisely (fugitive emissions due to cargo loading/unloading/handling from ships, lorries or trains for example) or because the emissions do not contribute significantly at the individual level, but may be significant if grouped together (sources such as oil, gas or coal commercial combustion). These sources are generally grouped as area sources, as opposed to point (or stationary) sources and mobile sources.

The sources (or potential sources) of NO_2, SO_2 and PM_{10} from the study area have been identified and divided into the following categories:

- Part A Industrial processes
- Part B Industrial processes
- Commercial shipping
- Road traffic
- Commercial, Institutional and Residential Combustion
- Waste Treatment and Disposal
- Agriculture
- Nature

1.2.3 Geographical and Temporal Extents

The geographical extent of the emissions inventory (EI) covers Blue Town and Queenborough. The EI will provide the estimates of total annual emissions at a spatial resolution of 1x1 km.

The EI covers the calendar year 2009. This will represents the "baseline" year, for which future inventories should be compared with. Therefore, the emission estimates are based on activities that occurred during 2009 as far as practicable. Where 2009 information was not available, data from previous years have been used to calculate reasonable estimates.

1.3 General Methodology

An emissions inventory can be developed following different approaches, which can vary significantly. The level of detail which can be achieved in preparing an inventory is mainly dictated by the time and resources available, as the data gathering process can be time consuming, and often the level of required information may not be available to calculate accurate emissions.

As port-related emissions inventories are still relatively new, only a few detailed inventories are available worldwide, let alone in Europe or indeed the UK. Therefore, a significant amount of research was carried out to identify available literature, guidance documents and best practice emissions inventories. Especially, the following key documents have been used for preparing this inventory:

- The most recent London Atmospheric Emissions Inventory (LAEI 2008)[4] from the Greater London Authority
- The Merseyside Atmospheric Emissions Inventory (MAEI) 2004 [5]
- The quantification of shipping emissions in the European Community report, compiled by Entec in 2002 [6]
- The UK Ship Emissions Inventory, compiled by Entec in 2010 [7]
- The UK National Atmospheric Emission Inventory Mapping Methodology[8]
- The latest methodology for Mobile Source Port Emissions Inventories from the US-Environmental Protection Agency (US-EPA) [9]
- The Emissions Inventories for the Port of Los Angeles[10] and Houston[11]

Based on these documents, a general common approach has been determined and adapted to the requirements of this study.

The methodology followed to determine the emissions for each source category is described below.

[4] London Atmospheric Emissions Inventory (LAEI) 2008 – Emissions Estimation Methodology Manual – AEA for the GLA, August 2010

[5] Merseyside Atmospheric Emissions Inventory 2004 – Merseyside Air Quality Management Group, October 2006

[6] Quantification of Emissions from Ships Associated with Ship Movements Between Ports in the European Community - Entec UK for the EC, July 2002

[7] UK Ship Emissions Inventory – Entec for Defra, November 2010

[8] NAEI UK Emission Mapping Methodology 2006 – AEA for Defra, October 2008

[9] Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories – IFC for US-EPA, April 2009

[10] Port of Los Angeles – Inventory of Air Emissions 2008, December 2009

[11] 2007 Goods Movement Air Emissions Inventory at the Port of Houston, January 2009

1.3.1 Industrial Processes

Industrial processes operating in the study area are divided into two subcategories: Part A1 processes regulated by the Environment Agency, and Part A2/B processes, regulated by the local authorities.

Part A1 processes have been dealt with as stationary sources for which stack or vent emissions are generally monitored, with the data available from the Environment Agency.

Part A2 / B data were obtained from the Public Register files held within SBC. As annual throughput for these processes was not known, emissions have been calculated using average process sizes taken from the London Atmospheric Emissions Inventory (LAEI)[12] and emission factors taken from the US EPA AP 42, *Compilation of Emission Factors*[13].

1.3.2 Shipping

The methodology for the estimation of shipping emissions was based on the determination of activity-based emissions, i.e. considering emissions as the product of an activity by an emission factor.

Activity is typically expressed as the energy required for the operation over a year. This energy can be estimated based on the engine power, a load factor (i.e. the effective fraction of engine power used in real conditions of operation) and the number of hours of operation for a full year. These data have been estimated through the use of the most appropriate reports and guidance.

Emission factors are standard values that express the mass of emissions in terms of a unit of activity. For example, a typical emission factor, for a given pollutant, will be given as grams per kilowatt-hours (g/kW.h), representing the weight of pollutant divided by the energy of the engine to produce that emission.

Therefore, the following steps have been considered to determine the emissions for shipping:

- Description of the emission calculations
- Fleet characteristics (number, fuel and cargo type, engine power)
- Activity
- Load Factors
- Emission Factors
- Estimated emissions

1.3.3 Road Traffic

Emissions from road traffic on major roads have been determined using the latest Emissions Factor Toolkit (EFT), available on the UK Air Quality Archive website[14]. This tool, updated in 2010, is widely used in air quality assessments for LAQM and is based on the latest emission factors for road vehicles released by Department for Transport (DfT) in 2009.

Traffic flows for the major roads in the study area (A249 and A250) were taken from DfT Annual Average Daily Traffic Flow matrix website[15]. The emission contribution from minor roads in each grid

[12] London Atmospheric Emissions Inventory (LAEI) 2008 – Emissions Estimation Methodology Manual – AEA for the GLA, August 2010

[13] http://www.epa.gov/ttnchie1/ap42/ , accessed January 2011

[14] EFT V4.2.2 – November 2010 - laqm1.defra.gov.uk/review/tools/emissions.php

[15] http://www.dft.gov.uk/matrix/

square covering the area of assessment was calculated using the proportional influence of A-roads and minor roads in each grid square of the Defra background pollution maps[16].

1.3.4 Minor Sources

Emission estimates for minor sources not covered in the more detailed methodology (Commercial, Institutional and Residential Combustion, Waste Treatment and Disposal, Agriculture and Nature) have been taken from the National Atmospheric Emissions Inventory (NAEI)[17] for the year 2008 and have been assumed to be constant in the year of assessment.

.

[16] http://laqm1.defra.gov.uk/review/tools/background.php

[17] http://www.naei.org.uk/

2 Industrial Process Emissions

2.1 Source Description

Several industrial facilities operate within the study area. Part A1 processes are the larger, more polluting and complex industries, controlled by the Environment Agency (EA), such as power stations or refineries. Part B processes are small industrial processes subject to local authority air pollution control through the Local Authority Pollution Prevention and Control (LAPPC) regime.

Available process data were obtained from the Environment Agency.

2.2 Part A

Three Part A industrial processes operating within the study area have been identified:

- Invicta Merchant Bar Ltd, Rushenden Road, Queenborough
- Aesica Queenborough Ltd, Whiteway Road, Queenborough
- Thamesteel Ltd, Sheerness Steel Works, Breille Way, Sheerness

Emissions from these facilities were provided by the Environment Agency[18] using the information from the Performance Indicators annual submission data provided by the site operators based on periodic stack monitoring. The emissions from these sites are dependent upon throughput of the facility and are therefore subject to substantial variation between years. Any fugitive emissions from these facilities have not been included due to lack of information on materials handling and size and duration of any stockpiles. Other releases are likely to be an order of magnitude lower than those detailed.

As considerable variation between years was observed in the emissions from the Invicta site, and the site was not operational for most of 2009, the 2008 values which are the highest of those provided have been used (NOx emission for 2009 given as 1,111kg). Significant emissions from the Aesica facility were considered to be limited to NO_x for the purposes of this EI as the boiler plants are gas fired with no particulate or SO_2 monitoring requirement.

The emissions for the inventory are provided in Table 2.

[18] E-mails from PPC Officers Jolanta Diver and Martin Smith, February 2011

Table 2 – Part A Emissions

Name	Site Address	Process Type (EA Classification)	Emissions (tonnes/year)		
			NO_x as NO_2	SO_x as SO_2	PM_{10}
Invicta Merchant Bar Ltd	Rushenden Road, Queenborough, Sheerness, Kent, ME11 5HS	Ferrous Metals	31.75	-	0.49
Aesica Queenborough Ltd	Whiteway Road, Queenborough ME11 5EL	Pharmaceuticals	51.04	-	-
Thamesteel Ltd	Sheerness Steel Works, Breille Way, Sheerness, Kent, ME12 1TH	Ferrous Metals	62	20.4	10.7

2.3 Part B

There are 5 Part B industrial processes operating within study, which have been identified as part of the assessment and are likely to emit the pollutants of concern. Other Part B processes such as petrol stations, coating processes and dry cleaners are not considered to be significant emitters of the three pollutants under considerations. The full list is provided in Table 3, including details of the activity, potential emission and source type. These processes can be divided into 3 subcategories, based on the type of activity:

- 2 concrete related
- 3 waste oil burners

The NO_x, SO_x and PM_{10} emissions to air for year 2009 for these facilities were calculated using process size information from the LAEI and AP 42 emission factors[19]. The general equation for emissions estimation is E = A x EF x (1-ER/100), where:

- E = Emissions;
- A = Activity Rate;
- EF = Emission Factor, and
- ER = overall emission reduction efficiency, %.

[19] US EPA AP 42, *Compilation of Air Pollutant Emission Factors*. 11.12 Concrete Batching and 1.11 Waste Oil Combustion.

Table 3 – Part B Emissions 2009

Name	Site Address	Process Type (EA Classification)	Emissions (tonnes/year) - 2009		
			NO_x as NO_2	SO_x as SO_2	PM_{10}
Brett Concrete Ltd,	First Avenue, Off Rushenden Rd, Queenborough	Concrete Batching	-	-	0.004
B & A Whelan, Concrete Garden Ornaments	52 High Street, Bluetown, Sheerness, Kent. ME12 1RW	Concrete Products	-	-	0.004
David Croome Ltd, Croome Gold Start Logistics, Unit 5, Cullet Drive	Unit 5, Cullet Drive, Queenborough ME11 5JS	Waste Oil Burner	0.01	0.89	0.03
Kent Coach Travel T/A Travel Master	Dorset Road Industrial Estate, Dorset Road, Sheerness ME12 1LT	Waste Oil Burner	0.01	0.89	0.03
Matt Auto Repairs	Unit 9, Phase 2, New Road Industrial Estate, Sheerness, ME12 1DB	Waste Oil Burner	0.01	0.89	0.03

3 Shipping Emissions

This section presents the estimated emissions due to shipping related to the Port of Sheerness. The three pollutants considered in this inventory are emitted by marine vessel engines. SO_2 shipping emissions are generally higher than other land-based transport emissions as the shipping industry has been subject to little environmental regulation for a long time.

The International Marine Organisation (IMO) ship pollution rules are contained in the "International Convention on the Prevention of Pollution from Ships", known as MARPOL 73/78. However, limits on air pollutant emissions were not set in the Convention before its amendment in 1997, and the introduction of Annex VI - Air Pollution[20], which only came into force in 2005.

Annex VI regulations include limits in marine fuel sulphur content and set out SO_x Emission Control Areas (SECA, or SO_x ECA) for which special fuel requirements with tighter sulphur content are applicable. The Baltic Sea, North Sea and English Channel have all been designated as SECAs in 2007, for which a more stringent limit of 1.5% m/m fuel sulphur content applied [21].

Annex VI was amended in 2008, introducing even a tighter limit of 1% sulphur content for SECAs, which came into force in July 2010 [22]. The revised Annex VI will also allow for an Emission Control Area to be designated for particulate matter (PM), NO_x, or all three pollutants (NO_X SO_x and PM).

EU law also requires all ships at berth or anchorage in EU ports to use marine fuel < 0.1% sulphur content by mass. The law came into force in January 2010, but not all necessary adaptations by vessel operators have been completed yet.

3.1 Methodology

Shipping emissions are generally estimated separately for each of the following operating modes:

- Cruising (or "At Sea")
- Manoeuvring
- At Berth (or in port), which can further be divided into two distinct modes
  - Loading / Unloading
  - Hotelling

These modes are characterised by different energy consumption and engine load, and therefore lead to distinct emission patterns. They are also associated to a specific geographical area.

Cruising, also called *At Sea,* is the mode during which the ship operates at service speed (also called sea speed or normal cruising speed)

Manoeuvring mode is associated with arrival and departure from a port, i.e. the time within the port area during which a ship approaches or leaves the pier/wharf/dock (PWD) and generally operates at slower speed. Propulsion engines are generally still in operation even with tug assist.

At Berth mode covers the time during which the ship is stationary at PWD and either hotelling or loading/unloading. *Hotelling* is the time at berth when the vessel is operating auxiliary engines only or is cold ironing (i.e. using shore power to provide electricity to the ship instead of using the auxiliary engines). During this time, the ship is neither loading nor unloading cargo, and therefore consumes minimum power.

For each mode, the current practice is to combine the average energy consumption with energy-based emission factors to calculate emissions, using the equation:

[20] MARPOL Annex VI - Regulations for the Prevention of Air Pollution from Ships

[21] m/m means "by mass" and does not stand for any particular units

[22] ec.europa.eu/environment/air/transport/ships.htm

$$E = Energy \times EF$$

Where

$$Energy = T \times P \times LF$$

With E = Emissions (in grams [g])

Energy = Energy output of engine(s) over the period of time (in kilowatt-hour [kWh])

T = Time in mode considered (in hours [h])

P = Average rating power (in kilowatts [kW])

LF = Load Factor (fraction of rated power) for the operating mode considered (adim)

EF = Emission Factor (in grams per kilowatt-hour [g/kWh])

With regards to the rating power of marine vessels, it is important to consider both main and auxiliary engines. Main engines are used as the primary ship propulsion, while auxiliary engines are mainly used to generate on board electric power for lighting, ventilation, cranes, pumps, etc…

As the main and auxiliary engines will operate a different load depending on the operating mode considered (cruising, manoeuvring, hotelling), different load factors need to be considered for both engine types.

Therefore the total energy consumption for each mode can be further detailed as:

$$Energy = T \times (P_{prop} \times LF_{prop} + P_{aux} \times LF_{aux})$$

With P_{prop}, P_{aux} = respective average rating power of the main and auxiliary engines (in kW)

LF_{prop}, LF_{aux} = respective Load Factor for the main and auxiliary engines and the operating mode considered (adim)

The overall emissions for all ships entering/leaving the port for a year are then calculated as follows:

$$E_{Total} = Calls \times [E_{cruising} + E_{manoeuvring} + E_{at\ berth}] / 10^6$$

With E_{Total} = Overall shipping emissions per year (in tonnes/year [t/y])

$E_{cruising,\ manoeuvring,\ at\ berth}$ = Emission for each mode (in grams [g])

Calls = number of calls per year at the port, a call being one arrival and one departure to/from the port.

As emissions linked to the *Cruising* mode would only occur outside the study area,, only the *Manoeuvring* and *At Berth* modes have been considered in the emissions estimates.

3.2 Source Description

Ocean-going vessels calling at the Port of Sheerness have been categorised by the following main vessel types for the purpose of the inventory:

- Tanker (self-propelled liquid-cargo vessel including chemical tankers, petroleum product tankers, etc)

- Bulk Carrier (self-propelled dry-cargo ship that carries loose cargo)
- Roll-on/Roll-off (Ro-Ro) (self-propelled vessel that handles cargo that is rolled on and off the ship)
- Container Ship (self-propelled dry-cargo vessel that carries containerized cargo)

3.3 Data and Information Acquisition

3.3.1 Fleet Characteristics and Movements

Vessel movement data for 2009 and fleet characteristics were obtained from the DfT UK Maritime Statistics website[23]. The available data was for 'Medway Ports' which includes the Port of Chatham as well as the Port of Sheerness. The data were therefore split, in order to account for the Port of Sheerness alone using the ratio of throughput of the two ports contained in the River Medway Report[24]. 56% of the movements associated with Medway Ports were therefore assumed to relate to the Port of Sheerness.

The average power of propulsion and auxiliary engines were determined from literature for each vessel type. The LAEI 2008 includes estimates of shipping emissions from the Port of London. Although fleet characteristics are likely to vary between two ports, engine power data provided in the LAEI[25] were deemed a reasonable estimate for the Port of Sheerness fleet.

Auxiliary engine data is generally scarcer, and the LAEI does not include this information. However, it is possible to calculate auxiliary power from the propulsion power based on data from existing surveys. The average auxiliary to propulsion power ratio from the UK Ship Emissions Inventory[26] has been used for the purpose of this inventory. Based on this information, it was possible to estimate the average auxiliary power for each vessel category.

A summary of the characteristics for 2009 is provided in Table 4.

Table 4 - Fleet Characteristics and Movements for Year 2009

Vessel Type	Cargo Category	Number of Calls / Year	Average Vessel Power ME (Main Engine, kW)	Average Vessel Power AE (Auxiliary Engine, kW)
Tanker	Liquid Bulks	72	3,116	841
Ro-Ro	Unit Load	118	5,411	1,623
Container	Dry Bulks	298	6,226	1,370
Other Dry Bulk	Dry Bulks	781	6,226	1,307

23 http://www.dft.gov.uk/ukmaritimestatistics/

24 River Medway Report, Drewry Shipping Consultants Limited for Medway Council and Marine South East, 2007

25 LAEI 2008 – Table 9: Vessel Characteristics: Average Speed, Power and Tonnage

26 UK Ship Emissions Inventory – Entec for Defra, November 2010

3.3.2 Activity

Vessel movements for each call have been split into two operating modes; *Manoeuvring* and *At Berth*. To estimate the emission characteristics for each mode, the duration of activity in each mode, or time-in-mode, needs to be estimated. Ideally, this information would be available for each vessel calling at a port. However, available marine vessel movement data do not include the actual arrival and departure times to/from the port for each ship.

In the absence of reliable data, the average time per call (in hours) spent manoeuvring and at berth for each vessel type was derived from the survey reported in the 2002 Entec study[6]. The report contains assumptions of duration of in-port activities for each vessel category, which have been used for this inventory. Manoeuvring time was generally assumed to be 1 hour, while typical duration of a vessel at berth (loading/unloading and hotelling time) is estimated to be between 14 hours and 52 hours.

3.3.3 Emission Factors

Emission factors for each specific vessel type from the 2002 Entec study were used for this inventory.

Emission factors in grams/kilowatt-hour for NO_x, SO_2 and PM_{10} are provided for both the *Manoeuvring* and *In Port* activity (equivalent to the *At Berth* mode defined in this inventory). These have been assigned to each ship type, as shown in Table 5.

These emission factors were based on a complex study of emissions for different engine and fuel types, and were weighted based on the combination of emissions from both propulsion and auxiliary engines.

It is important to note that emission factors are associated with increased uncertainties, as they are derived from limited data. This is acknowledged in all port emissions inventory guidance and methodology reports used for the preparation of this inventory.

Table 5 – Emission Factors

Vessel Type	Emission Factor (g/kWh)					
	Manoeuvring			At Berth		
	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Tanker	11.50	12.60	2.23	11.55	12.58	2.18
Ro-Ro	12.50	12.30	2.30	13.00	12.30	1.40
Container	14.00	11.80	2.30	13.70	12.10	1.50
Other Dry Bulk	14.30	11.70	2.30	13.80	12.00	1.50

3.4 Emission Estimates

Based on all parameters described above, the emissions from the Port of Sheerness have been estimated using the equation defined in Section 3.1.

Table 6 summarises the overall emissions for each facility, including the contribution of *At Berth* and *Manoeuvring* modes.

The estimated total shipping emissions for the port for year 2009 are therefore 389 tonnes of NO_x, 346 tonnes of SO_2 and 46 tonnes of PM_{10}. These emissions have been equally divided between grid squares (590500, 175500) and (590500, 174500), in which mooring occurs, for emissions mapping purposes.

Table 6 – Total Shipping Emissions

Vessel Type	Emissions – (tonne/year) - 2009								
	Manoeuvring			At Berth			All Activities		
	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Tanker	0.5	0.6	0.1	29.6	32.2	5.6	30.1	32.8	5.7
Ro-Ro	1.5	1.4	0.3	15.3	14.4	1.6	16.7	15.9	1.9
Container	3.5	2.9	0.6	32.0	28.3	3.5	35.5	31.2	4.1
Other Dry Bulk	13.4	10.9	2.2	293.0	254.8	31.8	306.3	265.7	34.0
All Port							**389**	**346**	**46**

4 Road Vehicles

This section presents the estimated emissions within the study area due to road traffic

4.1 Methodology

Road traffic emissions are generally estimated separately for each vehicle category (cars, vans, HGVs…) as each vehicle type is associated to specific emission factors. The emission for a vehicle category can be estimated using the equation:

$$E = AADT \times D \times ER \times 365 / 10^6$$

With E = Emissions (in tonne/year [t/y])

AADT = Annual Average Daily Traffic flow (in vehicles per day [vehicle/d]) for the vehicle category

D = Average distance travelled on road in kilometres [km])

ER = Emission Rate (in grams per vehicle and per km [g/vehicle.km])

The contribution of all vehicle categories is then summed to obtain the overall road traffic emissions.

For the inventory, the distance D was assumed to be the length of all A-Roads in each grid square encompassing the study area.

4.2 Geographical Extent

There are two A-Roads (A249 and A250) within the study area, and a large number of smaller roads which have been considered.

4.3 Data and Information Acquisition

Traffic flows for the major road in the study area (A249 and A250) were taken from the DfT Annual Average Daily Traffic Flow matrix website[27]. The figures used are shown in Table 7.

Table 7 – A-Road Traffic Flow Data 2009

Road	AADT	%HDV	Average Speed (kph)
A250 (Bridge Road – also used for Millennium Way)	15,968	2.8	64
A249 (Breille Way)	8,011	8.6	64
A250 (High Street)	6,487	1.9	64
A249 (at Sheppey Crossing)	28,952	6.6	64

[27] http://www.dft.gov.uk/matrix/

To determine the emission rates for each A-Road, the latest Emission Factor Toolkit (EFT)[14] published by Defra has been used. The toolkit allows the user to calculate road traffic emissions based on vehicle fleet composition, traffic speeds and road type. The latest version of the EFT is based on the new vehicle emissions factors released by DfT in 2009, and includes brake and tyre wear emission contributions for PM_{10}.

4.4 Minor Roads

The emission contribution from minor roads in each grid square was calculated using the proportional influence of A-Roads and minor roads in each grid square of the Defra background pollution maps[28] covering the study area. Using this proportion, a factor was applied to the calculated A-Road emissions to gain an estimate of emissions from minor roads for which no traffic data were available.

4.5 Emission Estimates

Based on all parameters described above, the emissions for road vehicles in the study area have been estimated using the equation defined in Section 4.1. Table 8 shows the overall estimated road traffic emissions within the Port estate for year 2009. SO_2 emissions have been taken from the NAEI figures, as they are not available through the EFT.

Table 8 – Total Road Vehicle Emissions

Pollutant	Emission (tonne/year) – 2009
NO_x	21.1
PM_{10}	1.6
SO_2	0.2

[28] http://laqm1.defra.gov.uk/review/tools/background.php

5 Uncertainties and Potential for Future Development

As discussed in each of the above sections, this document is based on the latest guidance and best methodologies for emission inventories. Emissions have been calculated using local information combined with default parameters and/or recommended values found in literature, based on previous studies. There were also a number of constraints associated to this project due to limited resources, lack of available local data and information, and also, for shipping emissions, the fact that only a small number of port-related emissions inventories have been completed so far, all of which contribute to various gaps and simplifications in the calculation of emissions.

It is therefore important to note that there is high uncertainty involved in the estimation of emissions, especially shipping emissions, which are based on a series of complex calculations and a number of assumptions. The following provides a basis for potential developments in the inventory methodology and reduction of uncertainties in emission estimates.

5.1 Shipping

The estimation of shipping emissions relies on a number of parameters such as engine energy consumption and emission factors. As discussed in Section 3, regulation has changed recently with regards to fuel sulphur content following the latest amendments of the MARPOL Annex VI that came into force in July 2010. As the emission factors used for the inventory are based on previous surveys, these do not take into account the impact of the regulation changes. It is likely that emission factors for SO_x, but also for other pollutants, and therefore overall shipping emissions, will progressively be driven down by these changes.

Further data could also be obtained with regards to the exact destination / area of operation for each class of ship, such as the assignment of ship categories to specific berths. However, it is acknowledged that this task may not be easily achievable, as it would require significant time and resources.

5.2 Cargo Handling Equipment

Cargo Handling Equipment contribution have not been included. Emissions associated to CHE could be estimated, including cranes, wheeled / mobile shovels, ship loaders, conveyor systems, forklifts and yard tractors and other similar equipment. To achieve this would require detailed fleet composition, vehicle type, number, engine type, fuel / energy consumption and movement constraints to define the area of operation accurately.

5.3 Aggregate Storage

Fugitive emissions from aggregate storage could be estimated based on the potential for stockpile erosion. Although the methodology induces high uncertainties in calculated emissions due to the nature of fugitive emission, further work could be done to refine the location of potential emissions, based on a better understanding of weekly or monthly activity profiles for each storage site area, including loading/unloading patterns. This would also allow estimating the potential for fugitive emissions from loading and unloading raw material.

Resuspension of dust and particulates is also possible. The potential for these, especially on unpaved roads, could be estimated based on similar methodology used for aggregate storage fugitive emissions from the US-EPA. However, this would require a detailed inventory of all potential areas of concern.

6 Summary of 2009 Emissions and Conclusions

This section presents the emission results for the Blue Town and Queenborough air emissions inventory for year 2009. These findings have given a greater understanding of emission levels in Swale, will provide a baseline should any similar work be carried out be carried out in the future, and will help in any future modelling of atmospheric pollution levels in the borough. Table 9 summarises the 2009 total emissions by category across the study area. Results indicate overall emissions of 581 tonnes of NO_x, 371 tonnes of SO_2 and 62 tonnes of PM_{10} for 2009.

From these results it can be concluded that ships contribute the highest percentage of emissions for all 3 pollutants. Over 93% of the SO_2 emissions are attributed to marine vessels. They also contribute over 66% of overall NO_x emissions, and 75% of PM_{10} emissions. Part A Processes also contribute a large proportion of NO_x and PM_{10} emissions (respectively 25% and 19% of overall emissions). Despite NO_2 pollution from traffic emissions being the major concern from a local air quality management perspective in Swale, traffic is only estimated to emit 3.6% of the total NO_x emitted within the study area. This finding should not influence the consideration of this pollutant for management purposes as road traffic will be the major source of pollution at many individual sensitive receptors, which are not considered in this report.

Table 9 – Assessment Area Emissions by Category

Source	Emission (tonne/year - 2009)			Emission (% of Total)		
	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Traffic	21.1	0.2	1.6	3.6%	0.0%	2.7%
Shipping	388.7	345.6	45.7	66.9%	93.2%	75.9%
Part B Processes	0.0	2.7	0.1	0.0%	0.7%	0.2%
Part A Processes	144.8	20.4	11.2	24.9%	5.5%	18.6%
Commercial, Institutional and Residential Combustion	26.4	2.1	0.4	4.5%	0.6%	0.7%
Waste Treatment and Disposal	0.1	0.0	0.5	0.0%	0.0%	0.8%
Agriculture	0.0	0.0	0.0	0.0%	0.0%	0.0%
Nature	0.1	0.0	0.6	0.0%	0.0%	1.0%
TOTAL	**581.2**	**370.9**	**60.1**	100%	100%	100%

The emission results for each grid square are shown in the Appendix.

Appendix 1: Itemised Emissions per Grid Square

NO_x tonnes/year

x	y	Traffic	Shipping	Part B Processes	Part A Processes	Commercial, Institutional and Residential Combustion	Waste Treatment and Disposal	Nature	Total
590500	175500	0.118	194.353					0.000	194.5
591500	175500	1.685				1.830	0.000	0.001	3.5
592500	175500	0.118				0.004	0.001	0.001	0.1
590500	174500	0.118	194.353					0.001	194.5
591500	174500	5.647		0.011	62.003	3.970	0.010	0.011	71.7
592500	174500	3.126				12.200	0.013	0.033	15.4
590500	173500	2.024				0.001	0.003	0.001	2.0
591500	173500	1.500		0.011		2.710	0.007	0.006	4.2
590500	172500	1.575			51.040	0.823	0.002	0.002	53.4
591500	172500	3.322				2.170	0.004	0.006	5.5
590500	171500	0.118				1.270	0.006	0.004	1.4
591500	171500	0.599		0.011	0.037	1.410	0.004	0.002	33.8
590500	170500	0.118					0.002	0.001	0.1
591500	170500	0.988				0.044	0.001	0.001	1.0
Total		**21.1**	**388.7**	**0.0**	**144.8**	**26.4**	**0.1**	**0.1**	**581.2**

SO_2 tonnes/year

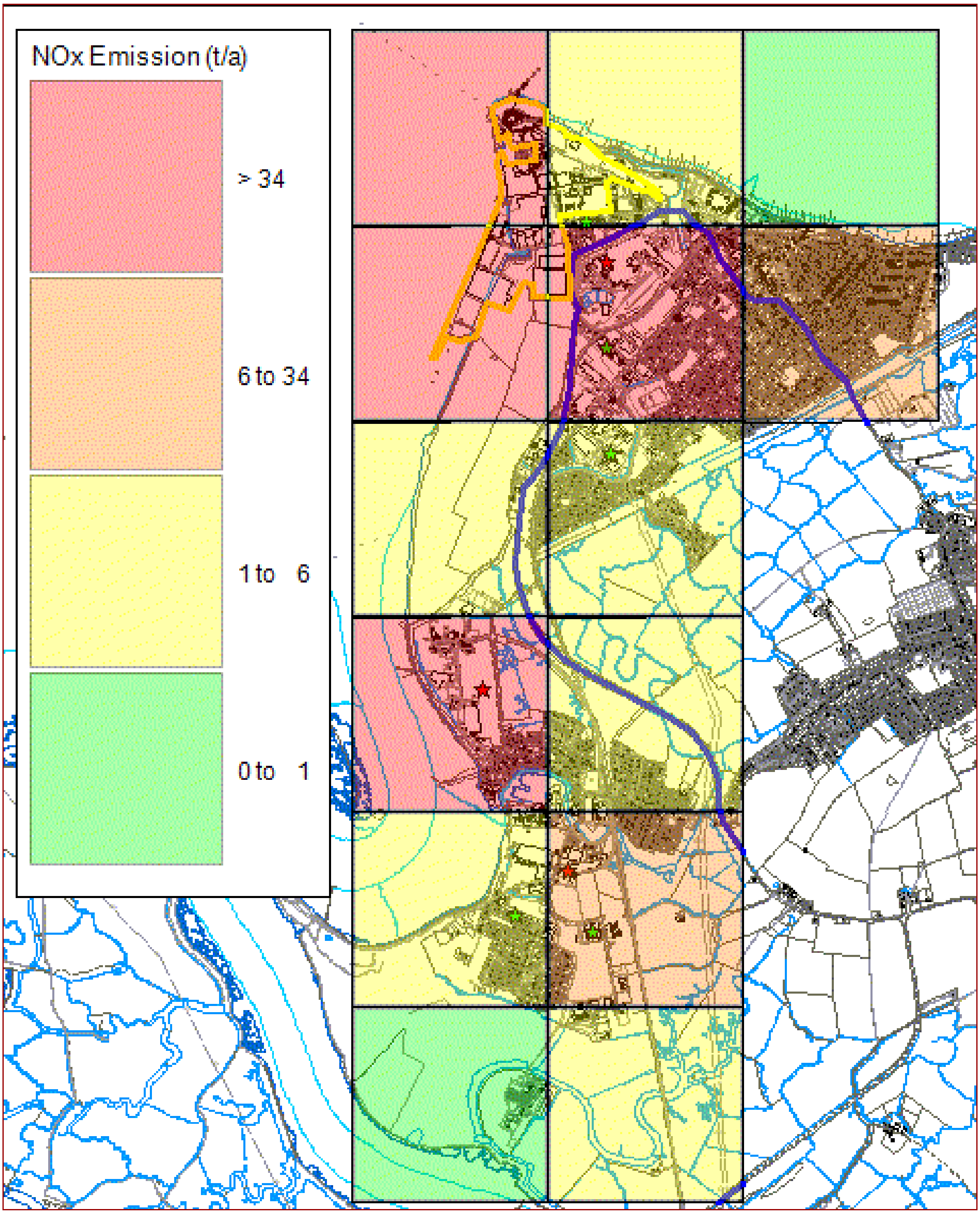
x	y	Traffic	Shipping	Part B Processes	Part A Processes	Commercial, Institutional and Residential Combustion	Waste Treatment and Disposal	Total
590500	175500		172.800					172.8
591500	175500	0.007				0.567		0.6
592500	175500	0.000				0.013		0.0
590500	174500		172.800					172.8
591500	174500	0.030		0.885	20.350	0.307		21.6
592500	174500	0.037				0.824	0.004	0.9
590500	173500	0.011				0.008		0.0
591500	173500	0.010		0.885		0.101		1.0
590500	172500	0.009				0.050	0.000	0.1
591500	172500	0.023				0.103	0.000	0.1
590500	171500	0.005				0.029		0.0
591500	171500	0.019		0.885		0.112	0.000	1.0
590500	170500						0.000	0.0
591500	170500	0.005				0.005	0.000	0.0
Total		**0.2**	**345.6**	**2.7**	**20.4**	**2.1**	**0.0**	**370.9**

PM_{10} tonnes/year

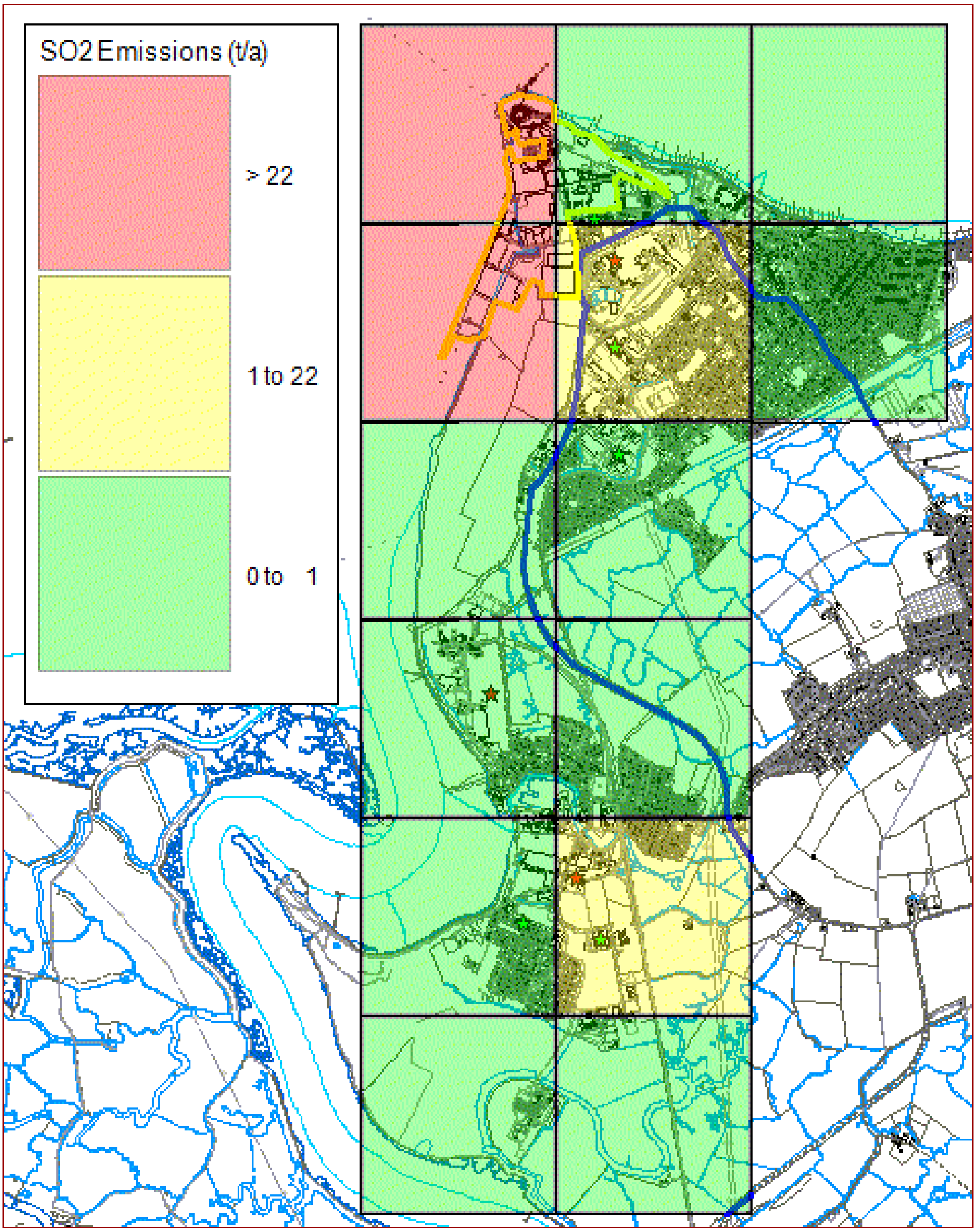
x	y	Traffic	Shipping	Part B Processes	Part A Processes	Commercial, Institutional and Residential Combustion	Waste Treatment and Disposal	Agriculture	Nature	Total
590500	175500	0.009	22.831						0.003	22.8
591500	175500	0.144		0.004		0.060	0.002		0.010	0.2
592500	175500	0.009				0.002	0.008		0.007	0.0
590500	174500	0.009	22.831						0.005	22.8
591500	174500	0.433		0.031	10.718	0.061	0.106		0.100	11.4
592500	174500	0.320				0.191	0.077	0.001	0.296	0.9
590500	173500	0.140				0.000	0.033		0.005	0.2
591500	173500	0.103		0.031		0.031	0.081		0.051	0.3
590500	172500	0.109				0.011	0.013	0.007	0.014	0.2
591500	172500	0.229				0.028	0.048	0.002	0.055	0.4
590500	171500	0.009		0.004		0.015	0.067	0.001	0.032	0.1
591500	171500	0.041		0.031	0.493	0.016	0.040	0.006	0.017	0.6
590500	170500	0.009					0.014	0.007	0.009	0.0
591500	170500	0.074				0.001	0.001	0.006	0.008	0.1
Total		**1.6**	**45.7**	**0.1**	**11.2**	**0.4**	**0.5**	**0.0**	**0.6**	**60.2**

Appendix 2: Emission Maps

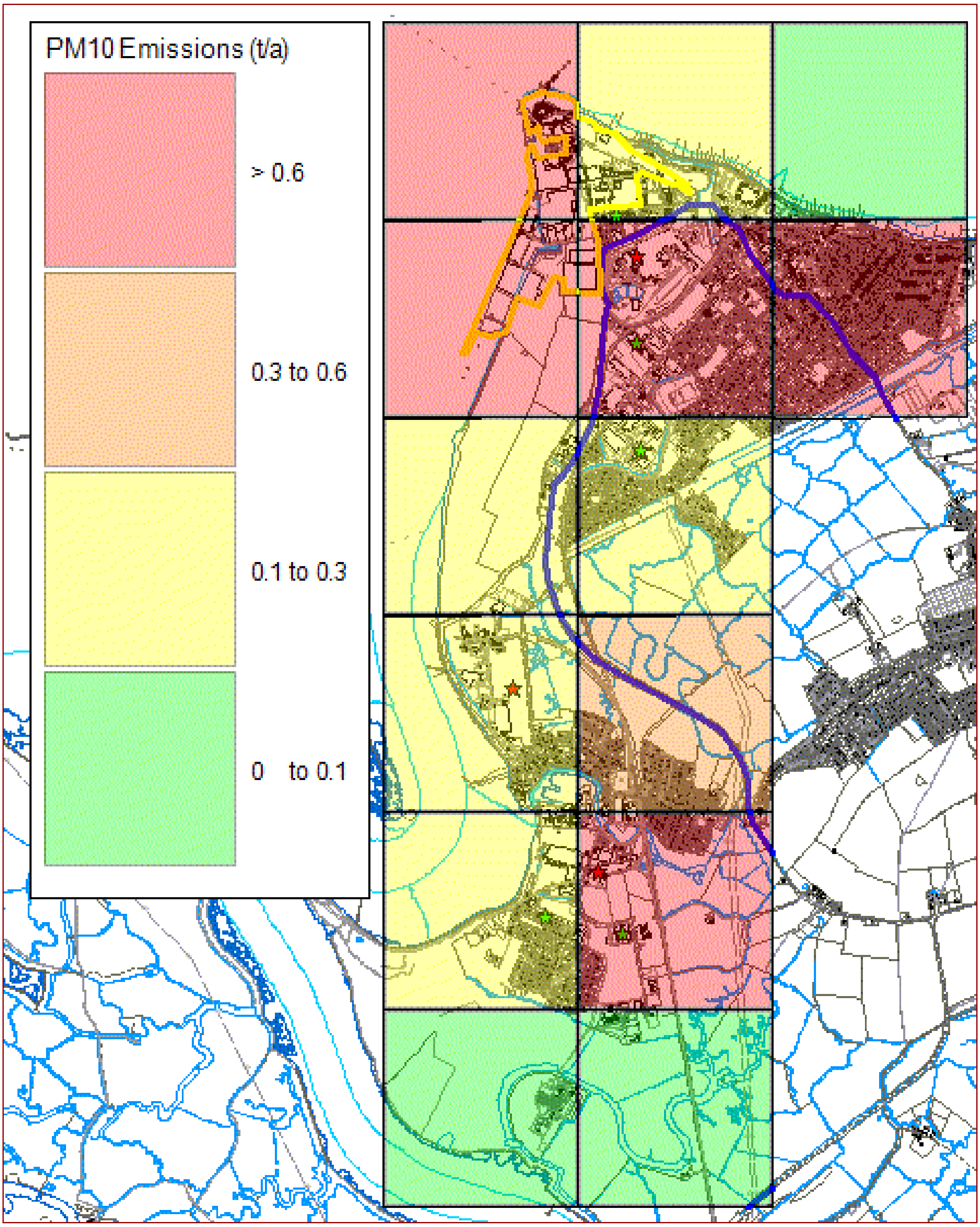
NO_x tonnes/year



SO_2 tonnes/year



PM_{10} tonnes/year



Copies of this document are available on the council website
www.swale.gov.uk.

If you would like further information, more copies or alternative versions (i.e. large print, audio, different language) we will do our best to accommodate your request please contact:

Customer Services,
Phone: 01795 417850
Email: csc@swale.gov.uk

Produced by the Communications and Marketing Team for Environmental Services © Swale Borough Council GD0162 March 2011