ODOUR STUDY REPORT

WOOLWICH BIO-EN
ANAEROBIC DIGESTION FACILITY
ELMIRA, ONTARIO

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1.0 INTRODUCTION

This report summarizes the operations and odour abatement measures planned for the proposed Woolwich Bio-En Inc. (Bio-En) biogas facility (Facility) to be located in Elmira, Ontario.

Bio-En is a renewable energy company committed to developing leading edge anaerobic digestion (AD) facilities with environmentally sustainable energy producing technology. Bio-En is working with an Austrian design firm that specializes in biogas facilities to design the Facility.

The Facility will process up to 70,000 tonnes of organics annually to generate biogas and an agricultural soil amendment[1] or fertilizer. The biogas will be combusted in a combined heat and power (CHP) cogeneration system to produce 2,852 kilowatts (kW) of electricity and 3,020 kW of heat. Long-term, sustainable renewable energy generation and diversion of organic materials from landfills will be ensured through the responsible and profitable operation of the Facility.

The Facility is committed to controlling odour from its operations to mitigate any negative environmental impacts that may result from odour discharge at the Facility.

Air dispersion modelling has been performed for the significant sources of odour at the Facility and the resulting odour concentration is below the Ontario Ministry of the Environment (MOE) odour concentration guideline. A memorandum outlining the odour modelling performed is provided in the Emission Summary and Air Dispersion Modelling (ESDM) report and in Appendix B.

Odour emissions from the Facility are an indication of a loss in biogas production potential. Less biogas translates directly to less renewable energy generation and is therefore a loss of revenue for Bio-En. The Facility will be designed and operated to prevent generation of odour as much as possible in order to maximize biogas production. Where odour generation is unavoidable, odorous air will be collected directly from the source and treated using state-of-the-art technology.

Sections 2.0 to 5.0 outline potential sources of odour and key features of the design and operation of the abatement measures for the potential odours.

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[1] An agricultural soil amendment is a material applied to agricultural fields that is beneficial for crop production or soil health and does not degrade the natural environment.

2.0 BACKGROUND

The Facility will be located at 40 Martin's Lane in Elmira, Ontario. The general layout of the Facility will include two buildings, four smaller concrete tanks, three larger concrete tanks, and a storm water management (SWM) pond.

The Facility will receive a maximum 70,000 tonnes per year (on average, 1,346 tonnes per week to a maximum of 750 tonnes per day) of feedstocks from a variety of sources. The average weekly requirement of materials will vary depending on the dry matter content (DM) and calorie density of the feed stock.

Organics to be processed at the Facility include, but are not limited to:

Organics from food processing facilities, grocery stores, food distribution companies, bakeries, confectionary processing facilities, dairies and facilities that process dairy products, fruit and vegetable processing facilities, cereal and grain processing facilities, oil seed processing facilities, snack food processing facilities, snack food manufacturing facilities, breweries and distillers grain, wineries, alcoholic and non-alcoholic beverage manufacturing facilities, fruit and vegetable packing facilities, milling facilities, kitchen waste, livestock, aquaculture, and paunch manure, glycerol and by-products from ethanol, biodiesel, breweries, and distillery plants, fats, oil, and grease (FOG), of plant and animal origin, and accompanying food residuals collected from grease interceptors and / or grease traps at food production, food processing and/or food wholesale and retail facilities, renewable energy crops (i.e., corn silage), herbaceous plant waste from greenhouse, nurseries, garden centers & flower shops, and aquatic plants, organic solids skimmed from a dissolved air flotation (DAF) tank from wastewater for the production of animal or plant-based materials or from the production of any other food for human or animal consumption, spent grain soluble (SGS) from ethanol, breweries and distillers plant and source separated organics (SSO). These feedstocks may be received as a liquid or a solid.

The recipe will consist of any combination of the above organic feedstocks depending on availability to optimize gas production and anaerobic digester performance and will change from time to time.

The AD process to be employed at the Facility can be summarized as follows:

a) Incoming renewable energy crops and other solid wastes are unloaded into a covered receiving pit in the Solids Receiving area in the Process Building.

b) Liquid or slurry manure is unloaded from tankers into the first pretreatment tank or into one of the liquid storage tanks.

c) Incoming liquid feedstock materials are unloaded into 175 m^3 storage tanks located inside the Process Building. Trucks carrying liquid feedstock materials will enter the Liquids Receiving Area in the Process Building and will pump materials from the trucks directly into the storage tanks. The Liquids Receiving Area will have an area of approximately 123.2 m^2. The liquid materials are pumped from the storage tanks to a Liquid Organics Mixing Unit in the Process Building. The Liquid Organics Mixing Unit will be located in an area with a footprint of approximately 21.5 m^2. The incoming feedstock storage tanks are fully enclosed by a housing and equipped with a concrete barrier wall to create a containment area capable of holding 100% of the volume of the largest tank and 10% of the aggregate volume of the remaining tanks.

d) Incoming glycerine is unloaded into a 20 m^3 storage container and fed into the Liquid Organics Mixing Unit to be combined with the other feedstock materials.

e) Incoming solid organic materials will be unloaded in the Solids Receiving Area into a covered 130 m^3 receiving pit with a footprint of 43.9 m^2. The Solids Receiving Area is located in the Process Building and has a footprint of approximately 263.1 m^2 (including the receiving pit). The solid feedstocks are processed in the Solid Organics Pre-processing and Mixing Unit and are mixed with the other organic materials and recycled process water so they can be pumped to a storage tank or pretreatment tank. The Solid Organics Pre-processing and Mixing Unit is located in the Process Building in an area that has a foot print of approximately 24.2 m^2. Materials are pumped from the storage tank and/or the Solid Organics Pre-processing and Mixing Unit to the Pretreatment Tanks.

f) Residual material that is not suitable for AD is sorted from incoming SSO, kitchen and food processing waste, stored in the Process Building in a dedicated area with a footprint of approximately 51.3 m^2 and is transported off Site when the 40 m^3 bin has reached capacity. The residual waste will be removed from the Site in dedicated containers. Once the storage capacity of a container is reached, the container will be removed from the Site and a new container will moved into the contrary bin storage area. The proposed storage area meets the needs of the facility to manage the residuals. Two containers are on-site at all times, with a volume of 40 m^3 per container for a total capacity of 80 m^3. When a full container is taken off-site, it is returned empty within a few hours, ensuring that there is always available space for residual waste disposal.

g) Fresh municipal water, off-Site water, or water from the SWM pond is used to supplement the recycled process water as required to balance water losses in the AD process.

h) The organic materials are pumped from the Mixing Units to a Pretreatment Tank with a footprint of 74.6 m^2, equipped with two mixers to further homogenize the materials and increase the temperature of the organics to approximately 50 to 60°C. Pretreatment tanks are equipped with level sensors to prevent overflowing of liquids.

i) The mixed organic materials are then pumped to one of the two other Pretreatment Tanks with a foot print of 74.6 m^2 each, equipped with only one mixer each, for a hydraulic retention time (HRT) of approximately 20 hours. The Pretreatment Tanks are operated in batches. While the material in one of the tanks is undergoing pretreatment, the other tank is being emptied and filled with new material.

j) After pretreatment, the organic material is periodically pumped to one of two Main Digestion Tanks, each with a footprint of 483.6m^2, to complete the AD process and generate the desired biogas. Unlike the Pretreatment Tanks, the Main Digestion Tanks are operated under continuous mix conditions and the material from the Pretreatment Tanks is intermittently dosed in to the Main Digestion Tanks. The digesters are insulated and heated to maintain a temperature of approximately 35 to 45°C and have a HRT of approximately 15 to 25 days. During the AD process, the digester conditions and the resulting biogas is continuously monitored as part of an overall control process to optimize biogas yields and energy production.

k) The biogas from the Main Digestion Tanks and the Secondary Digestion and Repository Tank is collected in biogas storage membranes and is piped to a Combined Heat and Power (CHP) cogeneration unit, or to a flare if the CHP unit is not operational and the biogas storage is full.

l) Electrical and thermal energy are generated by the CHP units, which are specifically designed for the combustion of biogas. Thermal energy is recovered from the CHP unit using a heat exchanger.

m) The digestate is pumped from the Main Digestion Tanks through a solids separator to remove the solids (approximately 4 percent dry matter) for recycle water or directly to the Secondary Digester and Repository Tank with an approximate footprint of 647.3 m^2 to await off-Site transport and eventual land application on agricultural fields. The liquid portion of the digestate is either recirculated back to the Mixing Unit as an inoculant for the AD process or pumped to the Secondary Digester and Repository Tank. The Secondary

Digester and Repository Tank will have approximately 30 days storage capacity. The capacity of the solid/liquid separator equipment is 800 m^3/day. The intention is that all digestate material from the main digester tanks will pass through the solid/liquid separator equipment if it is appropriate. There may be instances where the material does not need to be passed through the solid/liquid separator. The solids/liquid separator is a non-essential part of the process. The intention will be to use the separator unless it is broken. It should be noted that it does not need to be used at all. It is used to decrease the percent solids before the material being put into the repository. The solids will be sold separately. The solids/liquids separator is used to increase profits.

n) The solid portion of the digestate (approximately 27 percent dry matter) is stored in a bin in the Process Building and transported off-Site when the bin reaches capacity. The digestate solids are land-applied as a nutrient source and soil conditioning agent (fertilizer), similar to the digestate liquids.

3.0 POTENTIAL SOURCES OF ODOUR

The following sources at the Facility have been identified as potential odour sources:

- Generation of Biogas - Pre-treatment, Main Digestion, and Secondary Digester and Repository (Digestate Storage) Tanks – Biogas is generated in Digestion Tanks when organic materials at the Facility undergo anaerobic digestion.
- Unloading of Organic Material – Solid and liquid organic material is transported on site and is unloaded in the process building as described in Section 2.0 steps a to d.
- Organic Separation, Preprocessing, and Storage - Once the organics are unloaded at the Facility, they undergo some separation and pre-processing in the operations building as described in Section 2.0 steps e to f.
- Fugitive building emissions- Fugitive odour emissions resulting from unloading and preprocessing could be released from the operations building if there is not adequate negative pressure in the building.
- Digestate loading to be shipped off site - The liquid digestate will be collected by a hauling company. The digestate will be pumped into trucks that will park beside the Secondary Digester and Repository Tank for loading. The solid digestate will be loaded on trucks in the building.
- Biofilter – The biofilter is used to treat the air that is used for the building ventilation in the unloading and processing areas.
- Flare – the back-up flare is used to combust excess biogas during times when the engines are not operational or biogas production exceeds the demands of the engine.

3.1 VARIABLES THAT MAY AFFECT RATES OF ODOUR GENERATION

Odour varies greatly based on the feedstocks received at an AD facility. There may be some variability associated with the quantity of odour generated from the organic materials at the Facility. The odour emissions from this Facility have been conservatively estimated. Variables that can affect the generation of odour from the Facility: include the level of decomposition of the organic materials, types of materials at the facility, the flowrate to the biofilter, the operation of the biofilter and the length of time the doors are open. The Facility will be operating to minimize odour and will consider these variables in its operations.

4.0 PLANNED ODOUR ABATEMENT MEASURES

4.1 GENERATION OF BIOGAS –PRE-TREATMENT, DIGESTION AND DIGESTATE STORAGE TANKS

The Pre-treatment tanks are sealed and the Main Digestion and Secondary Digester and Repository Tanks are sealed with double membrane covers. All of the biogas from these AD process tanks is combusted in two cogeneration units. If either or both of the cogeneration units are incapacitated for any reason or more biogas is generated than can be consumed by the cogeneration units the automated backup flare will combust the biogas. Combustion of the biogas eliminates odour in the biogas. This reduces the potential for odours being emitted from the Facility during the actual AD process.

4.2 UNLOADING OF ORGANIC MATERIAL

Odours are potentially generated from the incoming organic material, depending on the type of material, as it is unloaded and stored before it is pumped into the sealed AD process tanks. Odours from the unloading will be reduced by minimizing the amount of time that feedstock material is stored prior to addition to the AD process. Fresher material has less potential for odour and greater biogas potential.

The material will also be transported on site using covered trailers or tanker trucks. The doors at the Facility will close quickly once the truck is inside the Facility to minimize the potential release of odours from overhead doors. Unloading of all trucks will be done indoors in negative pressure unloading areas. All air that is vented from the building will be treated with a Biofilter as described in Section 4.6. The building ventilation calculation is also provided in Section 4.6.2.

Solid material will be unloaded into a covered receiving pit. The cover will be in place when unloading is not in process, which will serve to reduce odour.

4.3 ORGANIC SEPARATION, PRE-PROCESSING AND STORAGE

Odours are potentially generated from the organic materials as it is separated, pre-processed, and stored before it is pumped into the sealed AD process tanks. The Facility will be designed and operated to manage all potential odours generated as part of the pre and post-processing steps of the AD process. The Facility will have sealed storage tanks for liquid organic DAF and FOG materials. These tanks will be vented to the biofilter system. The operations occurring in the building may be regarded as fugitive sources of emissions; however, the building will be under adequate negative pressure to ensure that all air from the processing activities is vented through the biofilter. Preprocessing and storage of incoming organics and digestate solids separation and storage will be done indoors directly under exhaust hoods that create localized negative pressure zones with three to five air exchanges per hour. All air that is vented from these exhausts will be treated with a Biofilter, as described in Section 4.6.

4.4 FUGITIVE EMISSIONS

The building will be kept under negative pressure when the doors are closed so that there will be no fugitive emissions from the building. This negative pressure will be maintained from the draw of air through the building by the biofilter. Air will be drawn into the building using controlled air intake louvers. Although the negative pressure may be lost during the opening and closing of doors, it is expected that the biofilter fan will provide adequate ventilation. No fugitive emissions are expected to be emitted to the environment as the louvers will close when the doors are open and the intake ventilation air will be drawn through the open doors. When the doors are closed, the louvers will open once more permitting air to enter the building to create the negative pressure once again. The building will be designed to allow retrofitting double doors in the event that the planned odour mitigation measures are insufficiently effective.

There will be no outdoor storage piles at the Facility. All organic material will be transferred and stored indoors. The storage tanks at the Facility will be sealed. During storage tank filling, the headspace of air displaced will be treated by the biofilter.

It is not expected that the storm water management pond will be a significant source of odour, as it will only collect runoff (i.e., rainwater) from the site.

4.5 DIGESTATE LOADING ACTIVITIES

A third party hauler will collect the digestate at the Facility and will ship it off site to be used as a soil amendment or fertilizer. The truck will arrive on site and will be filled with digestate by pumping it directly from the Secondary Digester and Repository Tank into a tanker. During the filling, the air in the empty truck will be displaced and directed to the biofilter for treatment. The solid digestate will be loaded onto the trucks indoors. The solid digestate loading area will be ventilated and the air will be treated by the biofilter.

4.6 BIOFILTER

The only significant source of odour at the Facility is the biofilter that will be used to treat the air that is exhausted from the processing building, from activities including: truck loading and unloading, organics processing, and displacement of headspace from the storage tanks. There will be insignificant fugitive emissions from the building because the building will be under negative pressure when the doors are closed. There will be no outdoor storage piles at the Facility. All organic material will be transferred and stored indoors.

The inorganic media biofilters planned for the Facility will have the following key features:

- Eighty-five percent odour removal efficiency (manufacturer guaranteed performance rating)
- Sized and configured to provide redundancy to allow maintenance and servicing on one module while still providing treatment capacity on remaining modules by maintaining an inventory of parts, altering the flow rate to the biofilter, or by using the air as combustion intake air for the engines
- Inorganic filter media depth of 1.83 m
- The biofilter will have an empty bed residence time of approximately 34s
- Temperature and humidity of incoming air controlled for optimum biofilter performance
- Permanent inorganic filter material with ten year warranty to reduce media replacement downtime
- Operator friendly automated controls compatible with Facility control system

4.6.1 INORGANIC MEDIA BIOFILTER

Inorganic biofilters have been used in waste processing applications and are being utilized more often as regulations impose more rigid standards on odour emissions. In general, inorganic systems:

- Have a higher capital cost than organic systems
- Require less maintenance
- Have lower operating costs

A prime advantage of inorganic biofilters compared against organic media biofilters, is the lower total pressure drop and the deeper allowable media depth as a result. Typically, an inorganic system employs a media depth of up to 2 m, which can decrease the footprint requirements by half as compared to an organic system. Additionally, the empty bed retention time for these systems are also generally lower (typically 30 to 35 seconds).

Inorganic media systems offer less frequent media refreshment cycles; some vendors offer warranties to support a 10-year life cycle for the media. Much less frequent removal schedules imply less overall maintenance, system shutdowns for media removal, and greater consistency in odour abatement performance. Additionally, odour removal efficiencies are generally higher and more consistent for inorganic systems. Of note, inorganic systems have low background odour profile and thus, the theoretical maximum removal efficiency.

Bio-En recognizes that inorganic systems require attention to inlet air. Hydrogen sulphide and ammonia concentrations must be below critical operating levels, or must be removed if they are above prior to exposure of process air to the media. Humidification is critical, and while inorganic systems generally allow for pre-humidification without surface irrigation, the level of humidity must be ensured at near-saturation conditions for the media to be effective. A 28-meter stack is included in the biofilter design in order to achieve good dispersion of potential emissions.

4.6.2 AIR VENTILATION /ODOUR MAGNITUDE CALCULATION

The following calculation has been performed to demonstrate the ventilation/air exchanges that will take place in the building based on the various processing equipment that will be operated. This air volume will be treated by the biofilter prior to discharge to the atmosphere. The potential odour emission from the Facility's biofilter has been estimated based on a biofilter intake odour loading, the removal efficiency of the biofilter, and the flow rate of air being exhausted through the biofilter.

The air ventilation calculation includes:

- The volume of air to be ventilated from the main building at an air exchange rate of approximately two exchanges per hour
- The volume of air exhausted from localized fume hoods in the processing areas at a rate of approximately five exchanges per hour

- The volume of air being displaced during tank filling at a rate of each tank being filled every hour

Estimated Flow Rate Requirements

Building Volumes (m^3)

Liquids Receiving	681
Solids Receiving	2,973
Solid Digestate Loading	488
Processing Area (pump room)	1,676
Contraries Storage	271
Total Volume	**6,089 m^3**

Air Exchanges (6,089 x 2 exchanges per hour) = 12,178 m^3/hr

Fume hoods (m^3)

Separator	45
Digestate storage	105
Kitchen Waste Hopper	150
Grinder	120
Contraries	90
Truck Loading Area	120
Total Volume	**630 m^3**

Air Exchanges (630 m^3 x 5 exchanges per hour) = 3,150 m^3/hr

Storage Tanks Filling (m^3)

Storage tank	175x4
Glycerine	20
Total	**720 m^3**

Assume filled once per hour = 720 m^3/hr

Digestate Hauling Truck Filling(m^3)

Assuming two trucks are filled each hour

Air Displaced - 35 m^3 x 2 =70 m^3

Total flow to biofilter = 16,119 m^3/hr

An additional, approximately 20 percent, airflow rate has been added to this ventilation rate as a safety factor to account for any additional airflow that may be required to ensure adequate negative pressure. This results in a flow rate to the biofilter of approximately 20,000 m^3/hr.

Odour Emission Estimation from the Biofilter

The odour emissions from the Biofilter have been estimated based on an odour inlet concentration to the biofilter of 10,000 odour unit (OU) and an odour removal efficiency of 80 percent, which is conservative, as the manufacturer states that a higher efficiency is guaranteed.

This odour inlet loading has been estimated based on discussions with BIOREM and CRA's experience with organic processing facilities. 10,000 OU/m^3 is a reasonable worst-case inlet concentration to the biofilter from an AD facility since most AD facilities look for fresh organic waste, which has not had the opportunity to decompose to high degree. Bio-En wishes to obtain as fresh organic material as possible, as this feedstock has the greatest biogas potential. The data presented in Appendix A shows a range of odour levels at the inlet of a biofilter from a rendering and municipal source separated organics facilities. Considering the material that Bio-En will receive is fresher and is not significantly processed in the Process Building, 10,000 OU/m^3 is a reasonable worst case. Information used to estimate the inlet odour loading of the air is provided in Appendix A.

Odour Emission Estimation from the Flare

CRA has assumed an inlet odour concentration of 10,000 OU as defined in the MOE Landfill Gas Interim Guideline (1992), and a conservative destruction efficiency of 80% for the flare. Through AERMOD modelling of odour emissions in accordance with the dispersion modelling guidance, CRA has determined that a revised design of the facility, including the 28 meter tall biofilter stack and an 8 meter tall candle-stick flare, will result in no odour exceedances at nearby sensitive receptors over a five-year period.

5.0 OPERATION OF ODOUR ABATEMENT MEASURES

Bio-En understands that proper operation and maintenance of the odour abatement measures is essential to the success of the Facility, not only to comply with regulatory obligations and to avoid conflicts with neighbours, but also to ensure the continued profitability of the Facility as outlined in Section 1.0. Where possible, Bio-En will source equipment from local suppliers to ensure that the supplier will be able to assist with the installation, start-up, maintenance, and repair of the equipment in a timely fashion. Where equipment cannot be purchased locally, the necessary training will be provided to Bio-En staff either on site or at the supplier's location.

Proper operation of the Facility, including the odour abatement measures, will result in a biogas facility that will not have a negative impact on the neighbourhood in which it is installed. Biogas facilities operate successfully in Europe with no negative feedback from neighbouring residents.

6.0 ONGOING SITE MONITORING

The site will be inspected on a daily basis to ensure that odours are not a problem. If odours are detected, the following steps will be put in place progressively until the odour is mitigated:

- Confirm all odour mitigation procedures and best practices are followed
- Ensure that the Process Building is maintained under negative pressure
- Inspect outdoor facilities for spills or standing water
- Inspect all piping, pumps, tanks, and other exposed equipment for cracks, leaks, etc.

As outlined in Section 8.1.2 of the D and O report, the biofilter has many redundancy features incorporated into its design. The Facility will maintain spare parts on site so that in the case of malfunction or maintenance, the repairs can be completed in a timely manner.

7.0 COMPLAINTS RESPONSE

Bio-En's design and operating procedures have been developed with the intention of minimizing negative impacts to the surrounding community. However, in the event that complaints regarding the operation of the site are received, Bio-En will handle the complaints as follows:

- Establish a complaint log which includes information such as the following:
  - Weather conditions (wind strength, wind direction, temperature, precipitation)
  - Contact information of the complaint
  - Details of the nature and severity of the complaint
  - Location, time, and date where the problem occurred and any other person to witness or be involved with the event
  - Time, date, and name of Bio-En/Township/Regional employee who received complaint
  - Any unusual events or activities that were occurring on site that may have attributed or caused the event which resulted in the complaint
  - Any other information pertinent to the specific complaint
- Coordinate complaint response with MOE staff where there is an exceedance of the MOE legislation limits or a term or condition of the Renewable Energy Approval.
- Cooperate with the MOE on voluntary or mandatory compliance instruments and record actions taken in this regard.
- Provide complainant with feedback about the problem and how it was rectified, within seven days of the complaint. If the issue cannot be rectified within seven days, Bio-En will continue to provide the complainant with weekly updates of mitigative actions being taken until the issue is resolved.

8.0 CONCLUSIONS

Odour modelling has been performed for the significant sources of odour at the Facility. Based on the modelling presented in Appendix B, the expected odour impacts at sensitive receptors are below the MOE Guideline of 1 OU.

MAP SYMBOL	CLASSIFICATION
A	AGRICULTURAL
R-1	RESIDENTIAL - SETTLEMENT
R-4	RESIDENTIAL - MIXED MEDIUM DENSITY
R-6	RESIDENTIAL - COMMERCIAL
C-1	CORE COMMERCIAL - URBAN
M-1	GENERAL INDUSTRIAL - DRY
O-1	OPEN SPACE
P	INSTITUTIONAL

LEGEND

POR1	POINT OF RECEPTION

NOTE: DISTANCES PRESENTED IN FIGURE ARE FROM SOURCE TO ESTIMATED PROPERTY LINE.

figure 1

ODOUR RECEPTORS
ODOUR STUDY REPORT
WOOLWICH BIO-EN FACILITY
Elmira, Ontario

46254-07(007)GN-WA001 DEC 9/2011

APPENDIX A

SUPPORTING INFORMATION FOR ODOUR INLET CONCENTRATION

Prepared May 08 2009

BIOREM

Potential Contaminants in inlet ducting before biofilter from organic waste facilities

Compound	Range
Ammonia	5 - 25 ppm
Trimethylamine	0.005 – 1.5 mg/m3
Triethylamine	0.02 – 1.0 mg/m3
Hydrogen Sulphide	ND – 10 ppm
Methyl Mercaptan	0.05 – 1.0 ppm
Ethyl Mercaptan	0.05 - 0.4 ppm
Dimethyl Sulphide	0.05 – 1.0 ppm
Dimethyl Disulphide	0.1 – 0.8 ppm
Butanol	0.002 – 10 mg/m3
Alpha-pinene	ND – 1ppm
Limonene	ND – 10.5 mg/m3
Acetic Acid	0.3 – 5.0 mg/m3
Oleic Acid	ND – 0.5 ppm
Butyric Acid	ND – 0.5 ppm

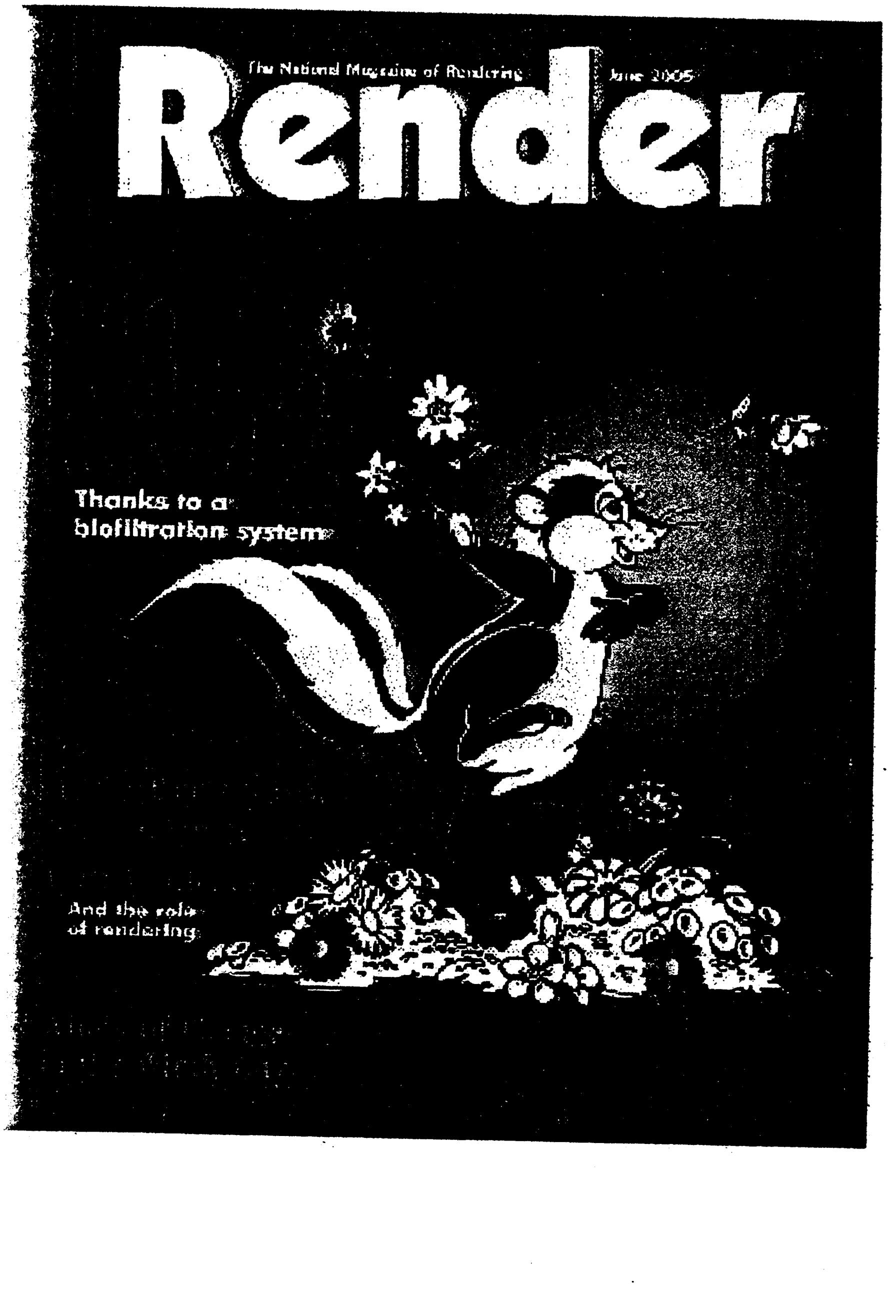
Cyclopentanol	ND – 8 mg/m3
Propylacetate	ND – 5 mg/m3
Propylbutyrat	ND – 8 mg/m3
Pentanone	0.05 – 2 mg/m3
Me-isobutylketone	0.003 – 10 mg/m3
Nonanal	ND – 5 mg/m3

NOTES:

1) This summary data is provided by Senior BIOREM Process Engineers based on some actual sampling (ex. hydrogen sulfide, TRS compounds), literature presented at conferences and professional estimates. Normally in applications where odour removal is the primary requirement very little data is collected on the individual chemicals compounds except perhaps for hydrogen sulfide or possibly some reduced sulfur compounds.
2) None of this data would include the impacts of manure as BIOREM has not yet installed any animal manure applications; however, BIOREM has many installations in municipal wastewater treatment plants.

Summary of Odour Levels Going into the Biofilter from Organics Management Facilities

Location / Source	**Odour Levels**	**Comments**
Rendering Plants Odours	10,200 OU/m3 (Max.) 6,275 OU/m3 (Avg.)	Article in Render Magazine June 2005 about Rothsay Dundas Pg 10, 11, 21. About 75% of the air volume at this facility is from plant air (tipping floor etc) and about 25% is from Process Air (cookers, dryers etc) so it probably overstates the odour levels vs an AD facility that does not include much processing or elevated temperatures.
Source Separated Organics (Region of Peel)	6,150 OU/m3	See Paper, *Advanced Odour Management Program for Municipal Composting*. Odours are from both the tipping floor and composting tunnels so odour levels are probably higher than what an AD process would experience.
Source Separated Organics & Biosolids (Cape Breton Regional Municipality)	13, 085 OU/m3	See Paper, *Advanced Odour Management Program for Municipal Composting*. Odours are from both the tipping floor and composting tunnels so odour levels are probably higher than what an AD process would experience.


The National Magazine of Rendering
June 2005
Render
Thanks to a biofiltration system
And the role of rendering

Odor Problem Solved

By Clifford Seth
Indumark

Engineering management at Rothsay, a rendering facility in Canada, reports it has all but eliminated odor complaints by installing a 250,000 cubic feet per minute (cfm) biofiltration system, replacing a scrubber system that could no longer provide sufficient removal efficiencies.

Tests conducted soon after startup in August 2003, with triplicate samples collected on three occasions over a two-week period, revealed an overall removal of greater than 94 percent. Preliminary results of Ontario's Ministry of the Environment (MOE) compliance testing that began in the spring of 2004 indicated average odor removal of 92 percent. Recent testing by a third-party consulting firm confirmed average removal efficiencies of 94 percent, with highs of 97 percent.

The new system was designed, manufactured, and installed by Biorem Technologies of Guelph, ON, Canada, who used their Biosorbens inorganic biofilter media. The company's technology was selected following extensive study and consideration of alternatives by Rothsay's corporate environmental engineering group and their consulting firm. The team established a 90 percent odor removal at all times as the primary design criterion.

"The scrubber system did its job for a long time, but increased residential development around the facility resulted in odor issues," recalled Amar Aulkh, Rothsay's chief engineer at their Dundas, ON, plant. "Performance testing on the scrubber system conducted in 2002 showed that odor removal efficiency was below our 90 percent target.

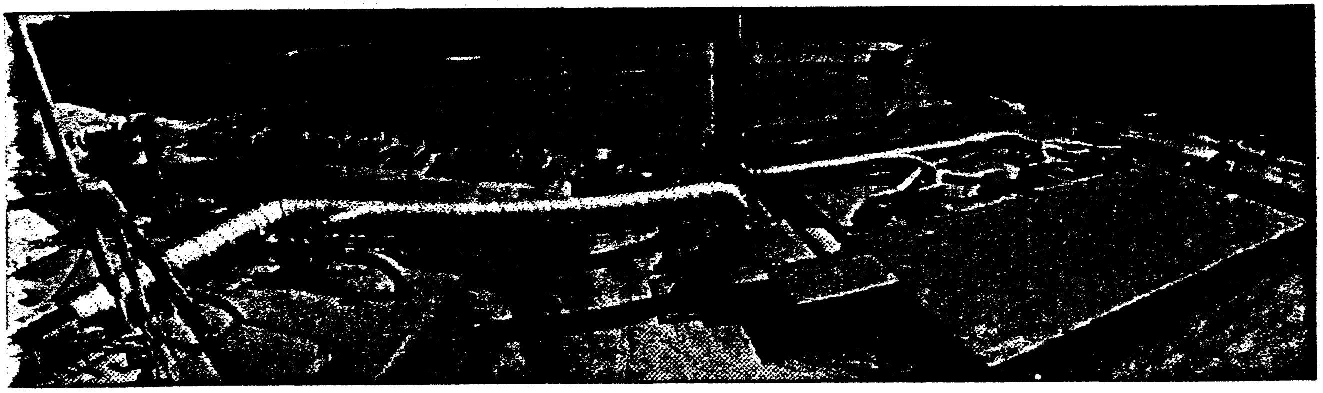
"We've seen a big difference since we installed the new system, with four or five tests since startup all showing 90 percent removal, and community concerns have significantly decreased," Aulkh commented. "This has helped us fulfill our environmental commitment, which includes assuring sound environmental management by requiring visible technology accountability at every level."

In addition to the technology accountability requirement, Rothsay's mission statement includes setting specific environmental performance goals as part of strategic planning and designing for the future. Environmental performance of the facility has been incorporated into the operation of the plant since its startup in the mid-1950s, and continues to be an integral aspect of operations.

The plant started with one scrubber, increasing to six by 2002 as the treated odorous gas stream increased from 50,000 cfm to 250,000 cfm. Its odor control system main collection duct receives input from multiple areas in two main buildings, with input from each area ranging from 60 cfm to 10,000 cfm. The scrubbers, two including primary with venturi, one with venturi only, and the other three air-through, had utilized sodium hypochlorite at 12 percent to remove odor, and potassium hydroxide to maintain pH.

"When we tested the scrubbers' performance in 2002, we found their performance no longer met our standard," Aulkh said. "To solve the problem, we tested alternative scrubbers that utilized chlorine dioxide, ozone, chlorine dioxide and ozone simultaneously, and a neutralizer, but could not get the 90 percent removal efficiency we needed.

"At the same time," he continued, "we had learned about biofiltration and incineration as part of a broad alternative methodology search that we also conducted. We determined that incineration was a cost-prohibitive alter-



A multiple-port duct collection network from the original scrubber system was incorporated into the replacement biofiltration system. Input from ports in two main buildings ranges from 60 cfm to 10,000 cfm for each port.

native for our operations at [one] point in time, and that this technology relies on long-term dependence on fuels.

"That moved the focus to biofiltration, and we spent a month testing odor removal efficiencies from airstreams from different areas of the plant, using media supplied by Biorem that they claimed had important differences compared to standard wood chip media," Aulkh stated. "The other biofiltration technology providers claimed to achieve similar effectiveness with their wood chip media, but their wood chips needed replacement every two or three years, which was a big job we wanted to avoid. Biorem claimed theirs would last 10 years.

"We evaluated all of the biofiltration technology providers, and chose Biorem because they had a combination of better warranty, closer proximity to our operations, and fair pricing. They also had a willingness to help us solve the problem as quickly as possible, which was important because MOE wanted quick action on the concerns we were receiving from the local community."

The odor control project decision was finalized in November 2002, following a one-month pilot-testing program with a proportional flow taken from each area of the plant.

"It did considerably better than the scrubbers right away, and we quickly got the removal efficiency over 90 percent," Aulkh noted. "The pilot was important, because while we had visited four or five biofiltration installations and were impressed with the performance of all of them – you could stand on the filtration bed and not smell anything offensive – we didn't know if they would work for our plant."

Construction of the final system began in January 2003, with both the plant's consulting firm and Biorem on site until completion in August. The multiple-port duct collection network from the original scrubber system was incorporated into the biofiltration system, but the main duct now leads into the Biorem system. This new system begins with its three-chamber preconditioning unit, where water from plant recycling and fresh water sources is sprayed into the gas stream at 500 gallons per minute in each chamber to achieve 98 percent relative humidity within the stream – above the 95 percent minimum Biorem recommends.

The gas stream then moves to a mist eliminator for water drop removal, followed by an inlet plenum common to the two banks of three biofiltration cells. Each of the six cells contains a five-and-a-half-foot bed of the Biosorbens media, and has a fan to draw the stream from the top of the bed and out the bottom to the outlet plenum. Individual cells can be isolated for work if needed, with the other five still in operation. As part of the contract, media samples are sent to Biorem every four months for checking on the effectiveness of the odor-removing microbes.

Each cell handles an equivalent amount of captured plant and process air, with each 150 horsepower fan working with a variable frequency drive (VFD) and controlled by a programmable logic controller (PLC). Rothsay has recently completed installation of a similar size biofiltration system at their Moorefield, ON, plant.

"The VFDs are good to have," Aulkh noted. "With the extremes of heat and cold we have, we can vary the horsepower accordingly, knocking it down to as low as 25 percent of capacity when there is no processing going on during a winter weekend.

"It is a good, environmentally-friendly system that works," he concluded. "There are no chemicals. It is easy

Continued on page 21

Test Day 1. Media Temp 18-20°C

	Inlet odor units/m³	Inlet odor units/m³	% Removal
Sample 1	2,856	364	
Sample 2	3,152	357	
Sample 3	2,664	282	
Average	2,901	328	89

Test Day 2. Media Temp 16°C

	Inlet odor units/m³	Inlet odor units/m³	% Removal
Sample 1	10,168	164	
Sample 2	10,212	173	
Sample 3	10,212	164	
Average	10,197	167	98

Test Day 3. Media Temp 14°C

	Inlet odor units/m³	Inlet odor units/m³	% Removal
Sample 1	4,218	237	
Sample 2	5,905	228	
Sample 3	7,060	182	
Average	5,728	215	95

m³- cubic meter

As shown above, the first few tests for the biofiltration system showed average odor removal greater than 94 percent, exceeding the 90 percent design criterion. Later testing by Ontario's regulatory agency indicated average odor removal of 92 percent, and recent tests by a third-party consulting firm showed 94 percent.

Biofilter *Continued from page 11*

to operate, all automatic, with our stationary engineers having PLC panels for routine monitoring of temperatures, pressures, and flows. There haven't been any problems with the process, we've just had to clean out the mist eliminator and the preconditioning chamber sump every couple of months."

Biorem describes its Biosorbens media as designed to handle a wide range of odor-causing compounds, and also suitable for removal of volatile organic compounds. Compound classes successfully treated include aldehydes, ketones, alcohols, volatile fatty acids, and aliphatic and aromatic hydrocarbons.

The media is said to maintain a balance between optimal growing conditions for the microbes, while offering ideal pressure drop through the media, high moisture retention, long operating life, and resistance to decomposition and compaction, while providing a surface on which the biomass film can flourish.

It is described as consisting of inert, uniformly shaped hydrophilic cores that are produced with nutrient-rich organic and inorganic adsorbents. These characteristics are said to decrease residence time, and increase serviceable life to more than 10 years. Its high surface area-to-volume ratio is said to result in requiring only one-third the space needed by organic medias.

Biorem, established in 1994, offers a comprehensive monitoring and support program for its biofilters and media. Its resources include experienced engineers, chemists, and industrial microbiologists, and state-of-the-art laboratory and research facilities. ◆

APPENDIX B

ODOUR MODELLING MEMO

CONESTOGA-ROVERS
& ASSOCIATES

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Telephone: (519) 884-0510 Fax: (519) 884-0525
www.CRAworld.com

MEMORANDUM

TO:	Sarah Tebbutt	REF. NO.:	046254
FROM:	Stephen Koo/ca/6	DATE:	December 9, 2011

RE: **AERMOD Odour Modelling Assessment**
Woolwich Bio-En Inc., Elmira, Ontario

1.0 INTRODUCTION

This memorandum has been prepared to summarize the methodology and results of the air dispersion modelling performed for the determination of odour compliance of the proposed Woolwich Bio-En Inc. (Bio-En) Anaerobic Digestion (AD) facility to be located at 40 Martin's Lane in Elmira, Ontario (Facility). The dispersion modelling considered all significant odour-related air emission sources that have the potential to release odour at the Facility. The results of the dispersion modelling will be used to evaluate the Facility's compliance with acceptable odour limits, as prescribed by the Ontario Ministry of the Environment (MOE).

Dispersion modelling for the concentration of odour was performed using the United States Environmental Protection Agency (USEPA) multi-source dispersion model AERMOD, as prescribed by Ontario Regulation 419/05 (O.Reg. 419). AERMOD is an advanced steady-state plume model that has the ability to incorporate building cavity downwash, actual source parameters, emission rates, terrain and historical meteorological information to predict ground level concentrations (GLCs) at specified locations.

Odour-based dispersion modelling was performed for both a tiered receptor grid and discrete sensitive receptors, as described by O.Reg. 419, and the MOE technical bulletin entitled, "Methodology for Modelling Assessments with 10-Minute Average Standards and Guidelines under O.Reg. 419/05" dated April 2008.

2.0 MODELLING METHODOLOGY

2.1 GENERAL MODELLING APPROACH

As per the April 2008 technical bulletin, a series of models were performed to determine odour compliance, as described below.

- Step 1: An air dispersion model, constructed as prescribed by O.Reg. 419/05, using a tiered receptor grid, is modelled for a 1-hour averaging period at ground level. All modelled results are then converted to a 10-minute averaging period. The removal of meteorological anomalies is allowed to determine the maximum compliance odour value. After this is done, if the odour-based guideline of 1 odour unit

(OU) is not exceeded at any modelled point, no further modelling is required. If the odour-based guideline is exceeded, further modelling is required.

- Step 2: An air dispersion model, with discrete receptors located at all locations where human activities may occur, is modelled for a 1-hour averaging period. All modelled results are then converted to a 10-minute averaging period. After this is done, if the odour-based guideline of 1 OU is not exceeded at any discrete receptor, no further modelling is required. If the odour-based guideline is exceeded, further modelling is required.
- Step 3: An air dispersion model, with a discrete receptor located where human activities may occur, is modelled for a 1-hour averaging period. All modelled results are then converted to a 10-minute averaging period. A frequency analysis by year, based on the 99.5th percentile, is then performed to determine the maximum compliance odour value. The 99.5th percentile is equivalent to removing the highest 44 modelled concentrations per year.

2.2 MODEL EXECUTABLES

The following USEPA executables were used in the assessment:

- AERMOD meteorological pre-processor (AERMET), version 06341
- AERMOD digital terrain pre-processor (AERMAP), version 09040
- AERMIC air dispersion model (AERMOD), version 09292
- Building Profile Input Program (BPIP), version 04274

2.3 METEOROLOGICAL DATA

Five years of local meteorological data was obtained from the MOE for use in the assessment. The meteorological data is from the Elora Research Climate Station, and was processed by MOE with land-use classifications for the Facility locale. The meteorology covers the dates from January 1, 2004 to December 31, 2008. The hourly data included many factors which affect the dispersion of air contaminants including wind speed, wind direction, temperature, ceiling height, and atmospheric stability.

2.4 AVERAGING PERIODS AND TIME-BASED CONCENTRATION CONVERSION

Odour levels are based on 10-minute peak concentrations of 1 odour unit (OU). An OU for a compound is defined as a threshold where 50 percent of the population would detect, but not identify, the odiferous compound. This definition is normally applied at sensitive receptors. Sensitive receptors may include residences, camping grounds, schools, community centres, day care centres, recreational centres and outdoor public recreational areas, or any other locations as specified by MOE.

All concentrations at the receptors were modelled. As AERMOD cannot model averaging periods less than 1 hour, the 1-hour averaging period was used with the resulting predicted concentrations converted to the shorter 10-minute averaging period using the MOE conversion factor of 1.65.

2.5 DIGITAL ELEVATION MODEL DATA

Digital elevation model (DEM) data was obtained from the MOE. The DEM data was used to include the effects of terrain in the modelling. The terrain used is from the DEM dataset tile085.

DEM data was preprocessed with AERMAP for use with AERMOD.

2.6 SOURCE INPUT PARAMETERS

Sources at the Facility were modelled as point sources based on their physical description. Point source parameters and locations were based on information provided by Facility personnel and site drawings. All sources were conservatively assumed to be operating simultaneously, continuously, and at maximum emission rates.

Based on Facility provided information, the biofilter and flare stacks were identified as the only significant sources at the Facility that would emit odour.

A summary of the AERMOD source input parameters and odour emission rates are provided in Table 1. The Facility property boundary and the locations of the modelled sources are shown on Figure 1.

2.7 TIERED RECEPTORS AND DISCRETE SENSITIVE RECEPTORS

Two sets of receptors were used in the assessment:

- A tiered receptor grid, located at ground level, for use with the Step 1 model
- A series of discrete sensitive receptors for use with the Step 2 and Step 3 models

The tiered receptor grid was defined based on a bounding box that encapsulates all the modelled sources. The grid was then tiered starting from the edge of the bounding box with a fine resolution, and progressing to coarser resolutions at further distances. All tiered distances were defined relative to the bounding box. The receptor grid used is described as follows:

- Bounding box origin (SW corner)(X,Y): 536,372.5, 4,828,001.5 (m)
- Size (width, height): 50.4, 38.1 (m)
- 20 m spacing within 200 m of the edge of the bounding box
- 50 m spacing from 200 m to 500 m
- 100 m spacing from 500 to 1,000 m
- 200 m spacing from 1,000 to 2,000 m
- 500 m spacing from 2,000 to 5,000 m

A property line ground level receptor grid with 10 m spacing was used to evaluate the maximum property boundary concentration. No receptors were placed inside the Facility's property line. A total of 1,976 receptors were used in the receptor grid and along the property line.

For the discrete sensitive receptors, a series of receptors were sited at locations of human activities. The locations for each receptor was selected based on the MOE's definition of a sensitive receptor, as follows:

> "*…any location where routine or normal activities occurring at reasonably expected times would experience adverse effect(s) from odour discharges from the Facility, including one or a combination of:*
>
> *(a) private residences or public facilities where people sleep…*
>
> *(b) institutional facilities …*
>
> *(c) outdoor public recreational areas …*
>
> *(d) commercial areas where there are continuous public activities..*"

A total of four sensitive receptors were identified that may be adversely affected by odour from the Facility. All receptors are residential. The locations of these receptors are presented in Figure 2.

2.8 ON-SITE BUILDING DATA

All on-site Facility buildings were modelled in AERMOD to account for building cavity downwash. Cavity downwash can result in air contaminants being forced to ground level prematurely under certain meteorological conditions, which can result in higher than expected near-field odour levels.

The USEPA Building Profile Input Program (BPIP) was used to calculate downwash effects for use with the AERMOD. All modelled buildings are presented in Figure 1.

2.9 FREQUENCY ANALYSIS

Step 3 models were not required to assess frequency impacts. However, they were still conducted in order to provide a complete overview. The frequency analysis was performed using the POSTFILE output option in AERMOD to calculate the 1-hour concentrations at the sensitive receptors for each single hour across the entire five year meteorological period. The concentrations calculated were then converted to a 10-minute averaging period and aggregated for each year to determine the frequency distribution and compliance odour concentration at each receptor.

3.0 DISPERSION MODELLING RESULTS

All odour models were developed and executed following the methodology described above.

The five years of meteorological data included over 43,800 hours of data. The AERMOD model was run to calculate the maximum 1-hour ground level concentration (GLC) for odour. The meteorological conditions, which would result in the maximum odour concentrations, would typically be stable atmospheric conditions such as an inversion with low wind speed. The maximum hour out of 43,800 hours of data would not occur at each grid point simultaneously since the wind can only blow in one direction during one hour.

3.1 STEP 1 ANALYSIS

As per Step 1 of the technical bulletin, a tiered receptor grid was used to calculate the maximum 1-hour odour concentrations at each receptor location. The 1-hour concentrations were converted to 10-minute concentrations using the MOE time-based conversion factor of 1.65. As per MOE guidelines, for each modelled year the eight meteorological 1-hour periods that resulted in the highest eight GLCs were identified and removed. This resulted in the removal of a total of 40 hours from evaluation. After the removal of meteorological anomalies, the maximum odour GLC was calculated to be 0.91 OU.

The Step 1 maximum 10-minute odour concentration isopleths are presented in Figure 3. A summary of the hours removed from the analysis is provided in Table 2. A Step 2 analysis was still performed in order to show the Facility's compliance with the 1 OU guideline.

3.2 STEP 2 ANALYSIS

As per Step 2 of the technical bulletin, elevated receptors were used to calculate the maximum 1-hour odour concentration at each sensitive receptor location. The 1-hour concentrations were converted to 10-minute concentrations using the MOE time-based conversion factor of 1.65. The maximum odour concentration at any sensitive receptor was calculated to be 0.93 OU. As this odour concentration meets the 1 OU odour guideline at all sensitive receptors, a Step 3 analysis is not required for any of the sensitive receptors.

Based on the Step 2 analysis, the maximum odour concentrations for each of the discrete receptors are as follows:

- Township Road 14 Residence, 0.91 OU
- Arthur Street N. Residence, 0.93 OU
- High Street East Residence, 0.80 OU
- High Street West Residence, 0.84 OU

A Step 3 analysis was still performed in order to show the Facility's compliance with the 1 OU guideline.

3.3 STEP 3 ANALYSIS

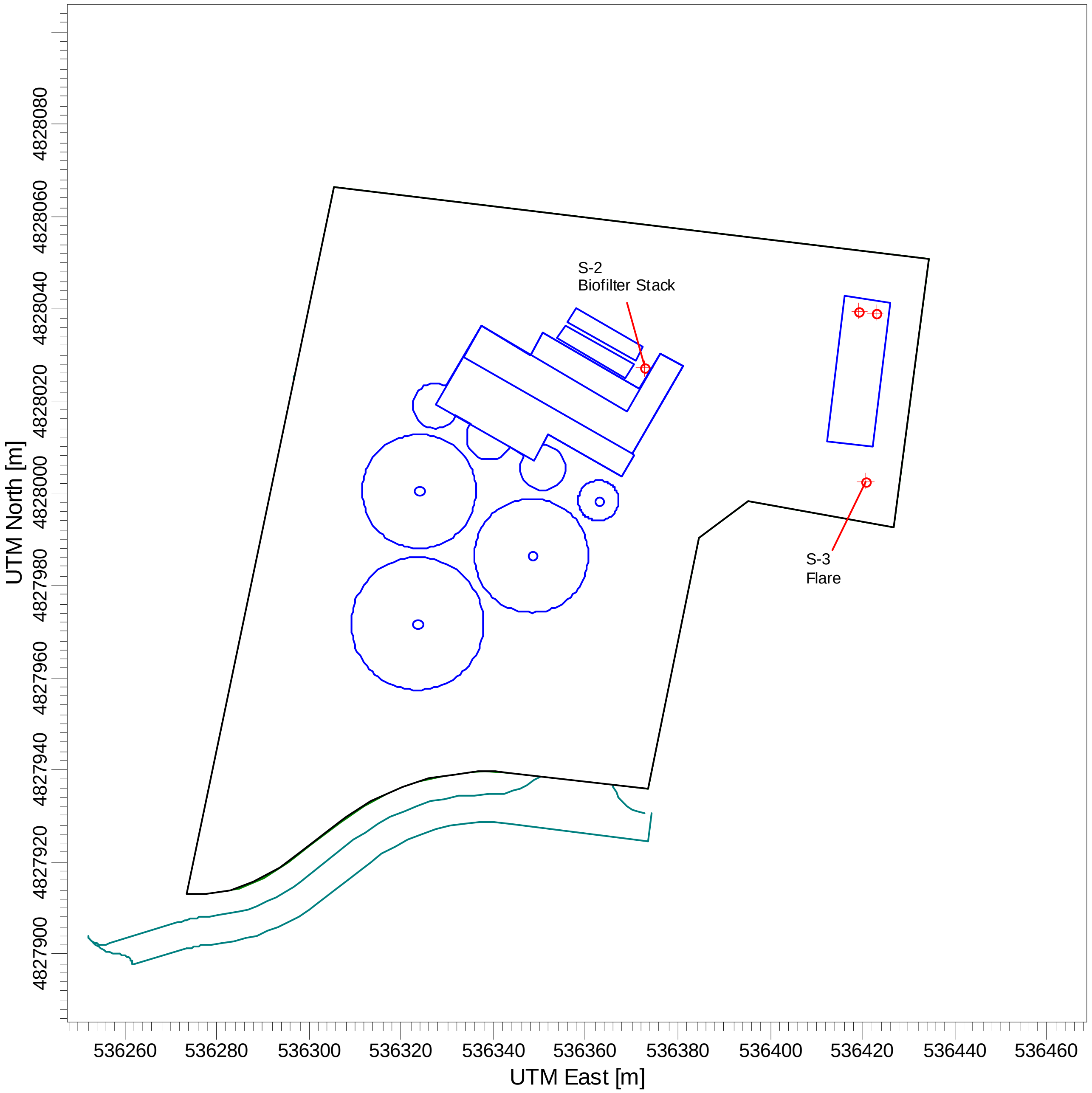
As per Step 3 of the technical bulletin, the maximum 1-hour odour concentrations for all hours in the meteorological dataset for each sensitive receptor were modelled for frequency. The 1-hour concentrations were recorded using the POSTFILE option in AERMOD. The resulting 1-hour concentrations were converted to 10-minute concentrations using the MOE time-based conversion factor of 1.65. The 10-minute concentrations were then sorted into odour bins of 0.1 OU increments to evaluate for frequency. In addition, the compliance odour value was determined for each discrete receptor by removing the highest 44 concentrations per year (equivalent to the 99.5th percentile), as per the guidance presented in the technical bulletin.

The compliance OU for each of the sensitive receptors is summarized in Table 3 and presented in Figure 4. The frequency distribution for each receptor is also summarized in Table 3.

Should you have any questions on the above, please do not hesitate to contact us.

PROJECT TITLE:

FIGURE 1
FACILITY PROPERTY BOUNDARY, BUILDINGS, AND ODOUR SOURCES



COMMENTS:

SOURCES:

4

COMPANY NAME:

WOOLWICH BIO-EN INC., ELMIRA, ONTARIO

RECEPTORS:

2000

MODELER:

CRA

SCALE: 1:1,388

0 0.05 km

CONESTOGA-ROVERS & ASSOCIATES

DATE:

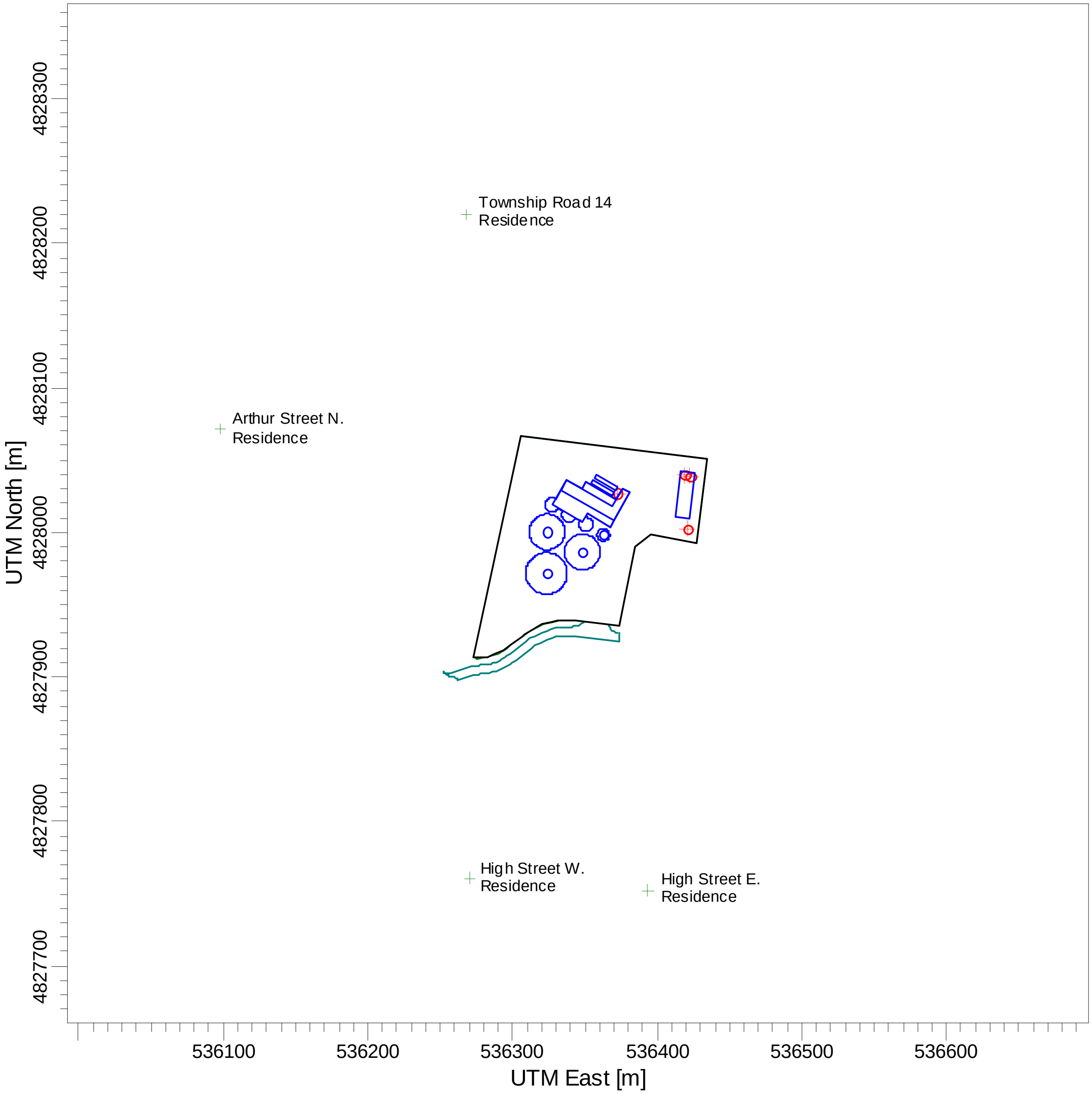
11/11/2011

PROJECT NO.:

046254

PROJECT TITLE:

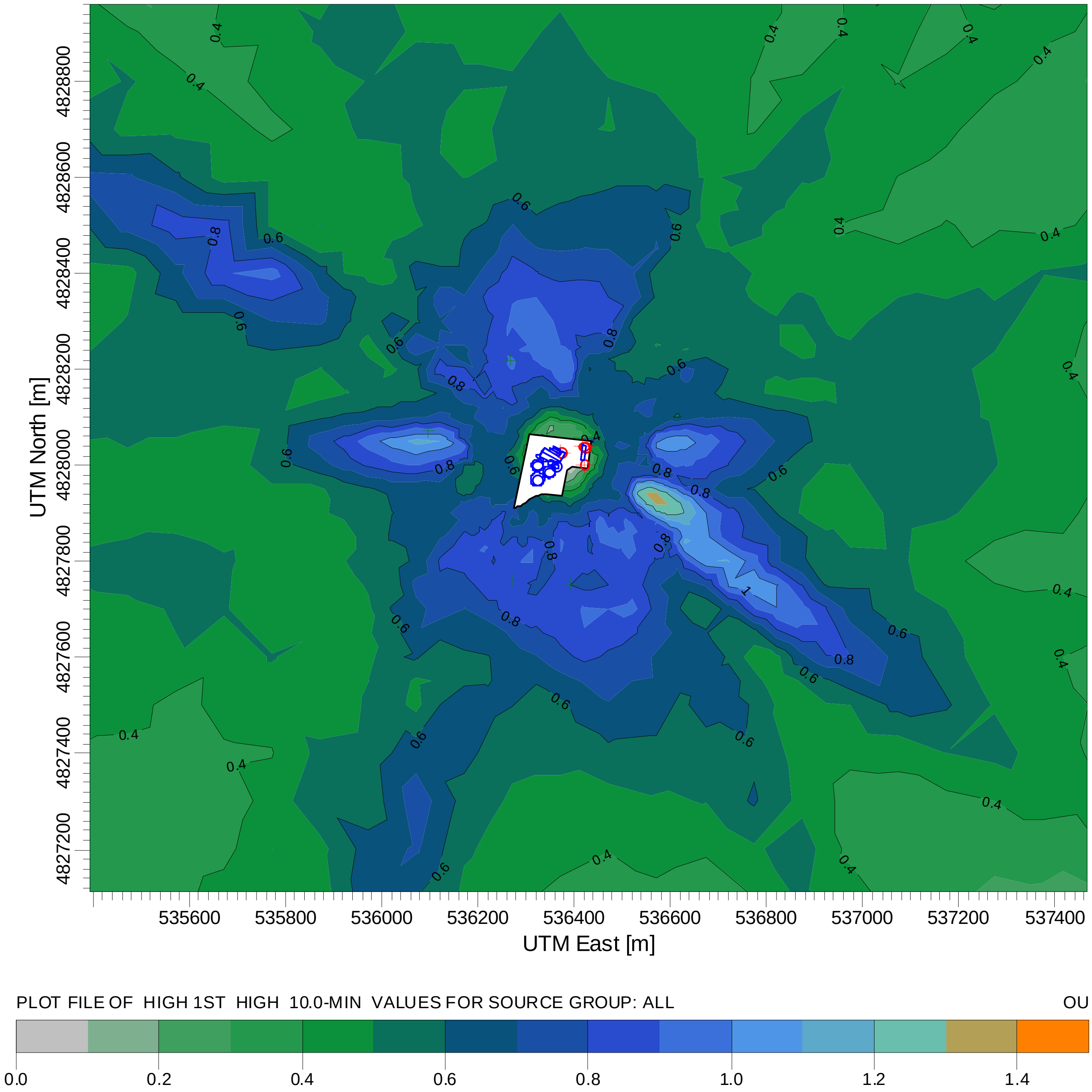
FIGURE 2
DISCRETE SENSITIVE RECEPTOR LOCATIONS



COMMENTS:	SOURCES: **4**	COMPANY NAME: **WOOLWICH BIO-EN INC., ELMIRA, ONTARIO**	
	RECEPTORS: **2000**	MODELER: **CRA**	CONESTOGA-ROVERS & ASSOCIATES
		SCALE: 1:4,434 0 0.1 km	
		DATE: **11/11/2011**	PROJECT NO.: **046254**

PROJECT TITLE:

FIGURE 3
STEP 1 MAXIMUM 10-MINUTE GROUND LEVEL ODOUR CONCENTRATIONS



COMMENTS:

Maximum predicted odour concentrations after removal of meteorological outliers is 0.91 OU.

Meteorological dataset for Elora CRS processed for local land use by MOE Modelling Division.

SOURCES:

4

COMPANY NAME:

WOOLWICH BIO-EN INC., ELMIRA, ONTARIO

RECEPTORS:

2000

MODELER:

CRA

CONESTOGA-ROVERS & ASSOCIATES

OUTPUT TYPE:

Concentration

SCALE: 1:13,016

0 0.4 km

MAX:

1.3285 OU

DATE:

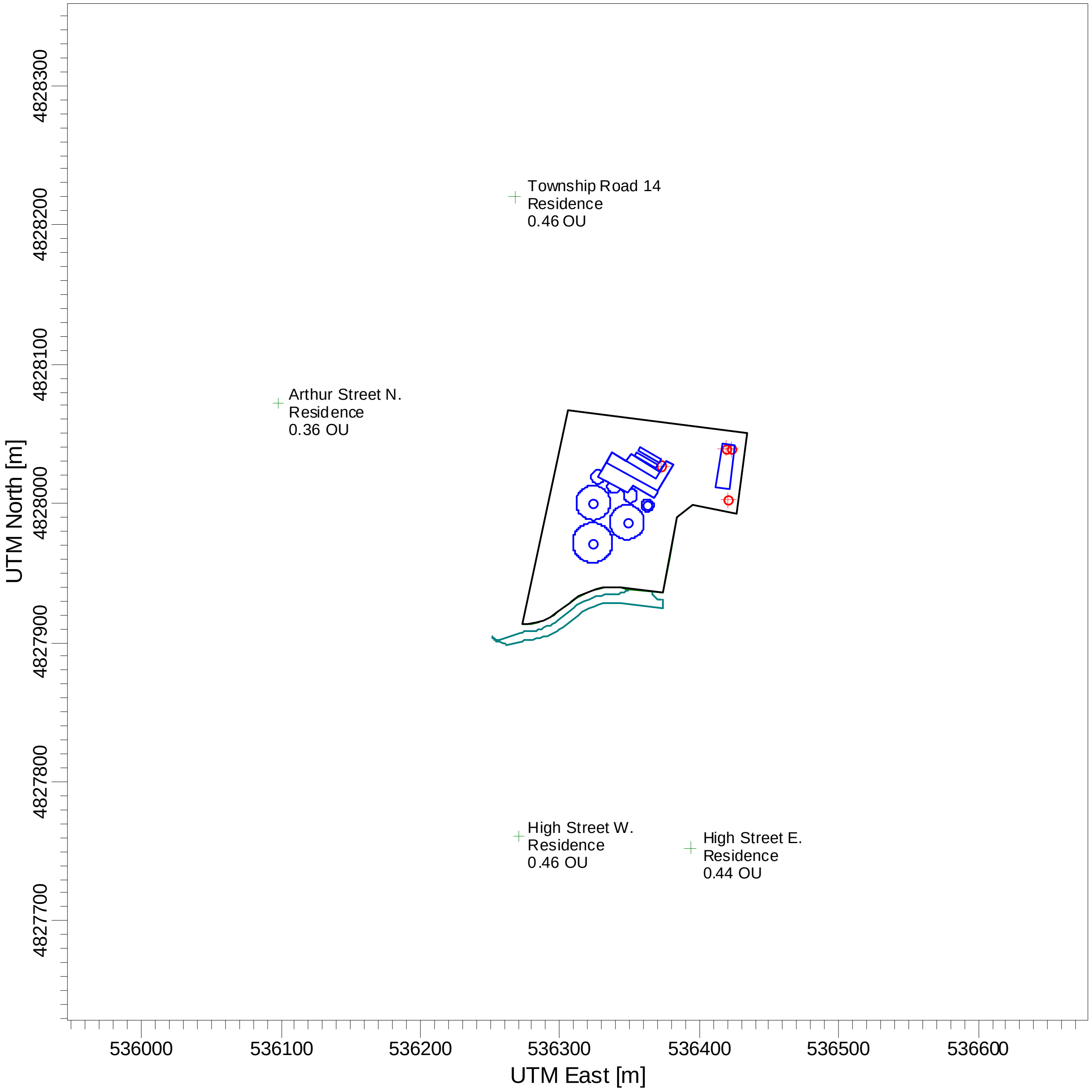
12/9/2011

PROJECT NO.:

046254

PROJECT TITLE:

FIGURE 4
STEP 3 COMPLIANCE 10-MINUTE ODOUR CONCENTRATIONS AT SENSITIVE RECEPTORS



COMMENTS:

Predicted odour concentrations at sensitive receptors after removal of the highest 44 odour hours per year.

SOURCES:

4

COMPANY NAME:

WOOLWICH BIO-EN INC., ELMIRA, ONTARIO

RECEPTORS:

2000

MODELER:

CRA

CONESTOGA-ROVERS & ASSOCIATES

SCALE: 1:4,596

0 ▭ 0.1 km

DATE:

12/9/2011

PROJECT NO.:

046254

TABLE 1

AERMOD ODOUR DISPERSION MODELLING SOURCE PARAMETERS
WOOLWICH BIO-EN INC.
ELMIRA, ONTARIO

Source Identifier	*Description*	*Source Type*	*UTM Coordinates X (m)*	*UTM Coordinates Y (m)*	*Exit Height (m)*	*Exit Diameter (m)*	*Exit Temperature (K)*	*Exit Velocity (m/s)*	*Maximum Modelled Emission Rate* $(ou/m^3/s)^{-6}$
S-2	Biofilter Stack	point	536,421.53	4,828,041.89	28.00	0.54	288.15	24.02	1.11E+04
S-3	Flare	point	536,420.67	4,828,002.55	8.00	0.50	1123.15	21.22	8.33E+03

TABLE 2

STEP 1 IDENTIFIED METEOROLOGICAL OUTLIER HOURS
WOOLWICH BIO-EN INCORPORATED
ELMIRA, ONTARIO

Summary of Hours by Model Year									
2004		***2005***		***2006***		***2007***		***2008***	
Rank	*Date (ymmddhh)*	*Rank*	*Date (ymmddhh)*	*Rank*	*Date (ymmddhh)*	*Rank*	*Date (ymmddhh)*	*Rank*	*Date (ymmddhh)*
1	4082512	2	5011903	8	6092710	5	7081417	3	8050712
6	4070416	7	5092812	10	6070918	20	7030214	4	8090508
12	4062405	9	5092813	24	6121307	21	7072614	11	8010901
15	4051415	13	5042611	50	6112920	45	7100113	14	8061401
18	4051713	16	5051016	53	6052815	52	7100114	22	8010815
19	4100822	17	5051017	58	6012407	63	7100308	28	8010820
23	4010302	25	5111213	60	6121309	65	7050715	29	8070810
27	4012119	26	5111212	72	6013010	68	7100117	32	8101514

TABLE 3

10-MINUTE COMPLIANCE ODOUR CONCENTRATION AND FREQUENCY DISTRIBUTION AT SENSITIVE RECEPTORS
WOOLWICH BIO-EN INCORPORATED
ELMIRA, ONTARIO

	Sensitive Receptors											
	Township Road 14 Residence			*Arthur Street N. Residence*			*High Street E. Residence*			*High Street W. Residence*		
	Odour Value (ou)	*Total Hours (hours)*	*Frequency (%)*	*Odour Value (ou)*	*Total Hours (hours)*	*Frequency (%)*	*Odour Value (ou)*	*Total Hours (hours)*	*Frequency (%)*	*Odour Value (ou)*	*Total Hours (hours)*	*Frequency (%)*
Maximum OU	0.91	--	--	0.93	--	--	0.80	--	--	0.84	--	--
Compliance OU	0.46 (1)	--	--	0.36 (1)	--	--	0.46 (1)	--	--	0.44 (1)	--	--
Odour Bins (ou)												
less than 0.1	--	41,913	95.59%	--	41,120	93.78%	--	41,656	95.00%	--	41,423	94.47%
0.1-0.2	--	663	1.51%	--	1469	3.35%	--	903	2.06%	--	942	2.15%
0.2-0.3	--	565	1.29%	--	892	2.03%	--	583	1.33%	--	712	1.62%
0.3-0.4	--	416	0.95%	--	286	0.65%	--	406	0.93%	--	468	1.07%
0.4-0.5	--	187	0.43%	--	67	0.15%	--	201	0.46%	--	198	0.45%
0.5-0.6	--	75	0.17%	--	10	0.02%	--	56	0.13%	--	71	0.16%
0.6-0.7	--	21	0.05%	--	3	0.01%	--	29	0.07%	--	27	0.06%
0.7-0.8	--	6	0.01%	--	0	0.00%	--	13	0.03%	--	5	0.01%
0.8-0.9	--	1	0.00%	--	0	0.00%	--	1	0.00%	--	2	0.00%
0.9-1.0	--	1	0.00%	--	1	0.00%	--	0	0.00%	--	0	0.00%
greater than 1.0	--	0	0.00%	--	0	0.00%	--	0	0.00%	--	0	0.00%

Notes:

(1) Compliance odour value is determined after removal of the highest 44 odour values per year.
The maximum of the remaining 45th values for each of the five modelled meteorological years represents the compliance odour value.