Bindaree Beef Abattoir

SEPP 33: Hazard and Risk Assessment

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Section 1 Introduction

Bindaree Beef Pty Ltd, a meat processor based in Inverell NSW, is proposing to develop a new rendering and a bio-digester plant to generate biogas from meat processing production, waste product and effluent.

The produced biogas (predominately methane) will be stored in a single storage dome of 9,000 m^3 capacity and at a low 10 millibar gauge pressure. Methane is a potentially flammable chemical and is a Class 2.1 chemical under the *Storage and Handling of Dangerous Goods Code of Practice* (ADG Code). In addition, the new facility will store sulphuric acid and ferric chloride solution within a drying shed 25 m to the north-east of the biogas storage tank. These substances are classified as Class 8 corrosive substances under the ADG Code. Given the potential hazards associated with storing the abovementioned substances, there is the possibility that the proposed development would be within the definition of a "potentially hazardous industry" under *State Environmental Planning Policy 33 – Hazardous and Offensive Development* (SEPP 33). SEPP 33 requires the preparation of a Preliminary Hazard Analysis (PHA) for such establishments to accompany any application for development consent.

1.1 Background

In accordance with the NSW Department of Planning and Infrastructure (DP&I) Director-General's Requirements for the Development, a PHA has been prepared by CDM Smith Australia Pty Ltd (CDM Smith) for inclusion in the Environment Impact Statement. The results are summarised in this report.

This PHA has been prepared with reference to SEPP 33, and in accordance with the NSW DP&I's *Hazardous Industry Planning Advisory Papers* (HIPAPs) No 4 (*Risk Criteria*) and No 6 (*Hazard Analysis*).

1.2 Purpose and Scope

This document identifies and assesses offsite hazards and risks associated with the operational activities of the bio-digester storage facility at the Bindaree Beef Abattoir, Inverell for the purposes of planning approval

This document first provides a risk screening conducted as per procedures outlined in the NSW Government Hazardous and Offensive Development Application Guidelines - Applying SEPP 33 (Department of Planning 2011, hereafter referred to as the SEPP 33 Guidelines). A PHA is subsequently provided.

The aim of the report is to:

- Provide the preliminary risk screening results;
- Provide an PHA assessment of the hazards and risks associated with the proposed facility;
- Determine the incremental change (increase or decrease) in the risk levels associated with the proposed facility;
- Provide guidance and recommendations for mitigation of hazards;
- Evaluate the resulting risk levels against As Low As Reasonably Practicable (ALARP) criteria.

1.3 Methodology

The PHA was undertaken using industry best-practice methods as outlined in the Australian/New Zealand Standard AS/NZS 4360:2004 Risk Management through the following steps:

1. Review of the design, location and activities associated with the facility to identify potential (valid) risks and hazardous events as a result of the operations. The consequence and risk of each potential hazard was also identified;
2. The frequency (likelihood) of the potentially hazardous event was then estimated, if required by the consequence results;
3. The maximum reasonable significance of identified events were quantified by combining the frequency and consequence of each event to identify the total (cumulative) risk, as appropriate;
4. A qualitative assessment of risks to the environment, members of the public and their property as a result of abnormal and atypical events, with a comparison of these to applicable qualitative criteria;
5. Potential risk treatment measures (mitigation options) were then proposed to manage the potential hazardous events identified by the facility's operations and design (where applicable);
6. Opportunities to further reduce risks by elimination, minimisation, and/or incorporation of additional protective measures were then identified. This would demonstrate that the operation of the facility will not impose a level of risk that is intolerable with respect to its surroundings; and
7. Identification of residual risks assuming and considering the implementation of devised treatment and/or mitigation measures.

Section 2 Facility Description

2.1 Existing Facility

Bindaree Beef Abattoir is located within the Inverell Shire Council local government area, approximately 3 km west of the township of Inverell in northern NSW. The township of Inverell, with a population of 16,000, is located approximately 500 km north-west of Sydney.

The total area of the abattoir and surrounding holding pens is 143 ha, whilst the adjoining farm "Alsace" is 491 ha and is also owned by Bindaree Beef Pty Ltd. Figure 2-1 provides an aerial locality plan of the existing Bindaree Beef Abattoir site and the surrounding land uses.

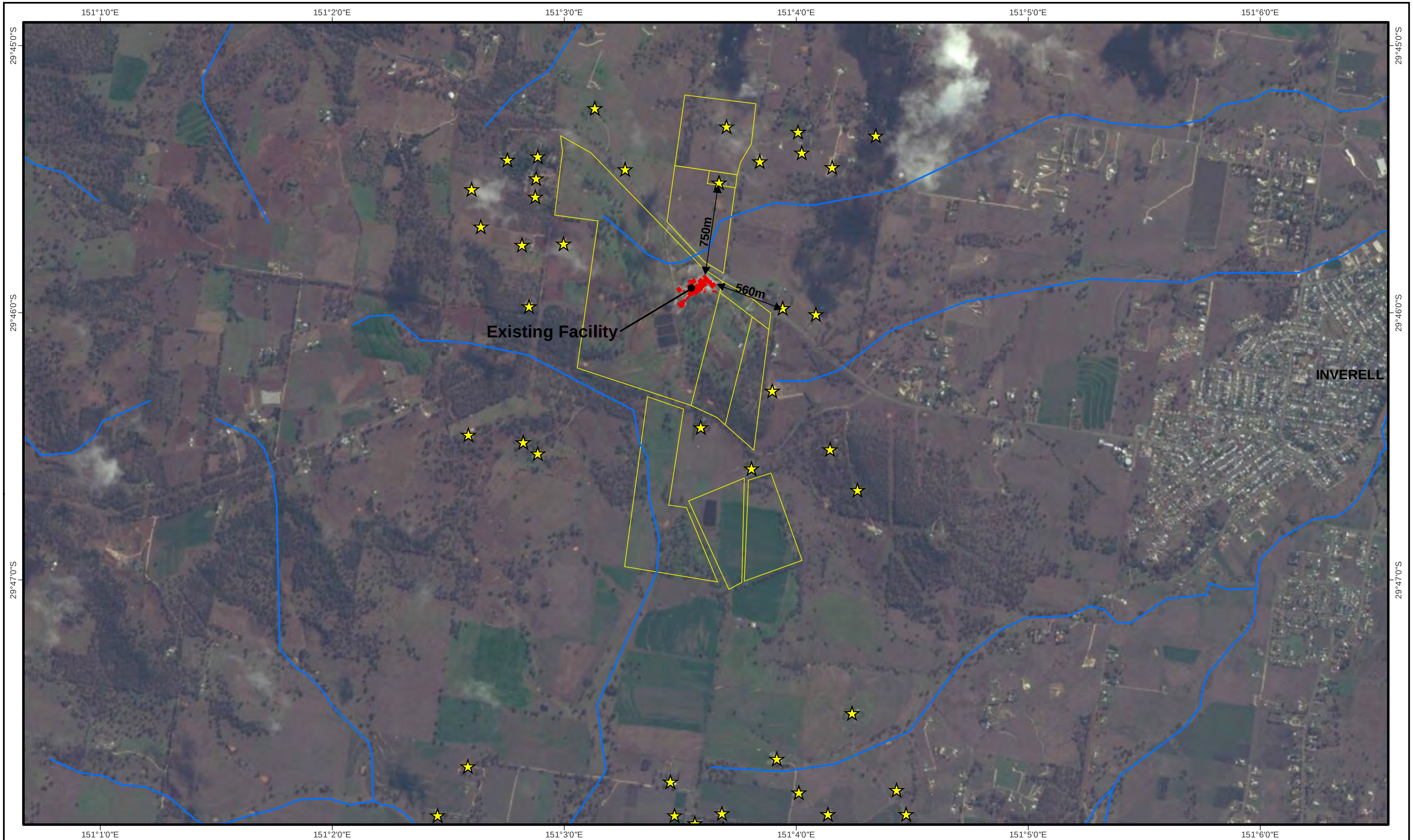
The Bindaree Beef facility is located immediately south of the Gwydir Highway at an elevation of between 720 m and 730 m Australian Height Datum (AHD). The facility is situated in an open gully flanked by topographic highs to the south-east (750 m AHD) and west (770 m AHD). The property contains sparse stands of vegetation along the inclines to the adjacent topographic highs, however the lower lying area of the property is almost completely devoid of vegetation.

The current facility includes:

- Unloading yards and holding pens;
- Boning rooms;
- A rendering plant for processing animal by-products into tallow and meat/blood/bone meal;
- Cold storage and freezer areas;
- Slaughter floor;
- Workshops;
- Boilers (coal fired);
- Car parking; and
- Administration buildings.

2.1.1 Surrounds

The facility is predominantly surrounded by rural land, with a number of smaller rural holdings to the west of the property. The closest residential property (not owned by Bindaree Beef Pty Ltd) is approximately 535 m east from the biogas facility site, on the Gwydir Highway. Additionally, the NSW Department of Environment and Climate Change (DECC) has a depot approximately 2.3 km to the east of the facility, also along the Gwydir Highway. Approximately 1.2 km north-north-east from the centre of the facility is the Mcilveen Park, located atop Tabletop Mountain. The Gwydir Highway runs parallel with the top and Copeton Dam Road runs parallel with the bottom of the facility's property boundary (Figure 2-1). The facility and the two roads are separated by open grass land and scattered vegetation. To the east and west, the property contains denser vegetation and some open grass land. The north western portion of the boundary runs parallel to McNeils Lane.



Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 2-1 Locality Plan

Key

- ★ Sensitive receptor
- Watercourse
- Property Boundary

0 500 1,000
Metres

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

Data Source:
Mitchel Halon Consulting, Vipac, GeoFab v2.0, ESRI Base Maps.

CDM Smith
cdmsmith.com

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Date (3/4/2014)

2.2 Proposed Facility

The site proposes to install a waste treatment system (bio-digester) and new render plant facility. The bio-digester generates biogas from waste product and effluent, utilising this gas for creating energy. This process has the potential to eliminate coal as a fuel source, therefore improving the facility's sustainability and reducing operational expenses. The net result is improved environmental outcomes and a significant reduction in carbon emissions.

The new Bindaree Beef facility will consist of:

- A waste treatment system that will produce biogas and a nutrient rich digestate liquid for organic fertiliser;
- A biogas utilisation system that will generate power and steam for onsite use; and
- A new energy efficient render plant that will use less electricity and steam.

There will be no modifications to how the cattle are processed, apart from the waste being redirected to the bio-digester. The waste generated from the current processing of cattle at the Bindaree Beef facility includes:

- Paunch and manure;
- Bone and skin; and
- Blood and wash down water.

2.2.1 Bio-digester Plant

All Bindaree Beef's organic waste matter will be diverted from anaerobic lagoons into an on-site anaerobic bio-digester. The bio-digester will be installed near the current processing plant. All waste effluent will be directed through the bio-digester process. All emissions (primarily methane) will be captured and stored in biogas storage tanks for use. This assessment assesses the whole bio-digester facility, but only the biogas storage tanks have been modelled for potential impact zones. The cumulative impacts of the biogas facility on the existing and proposed hazardous storages have been considered for the purpose of this offsite Hazard and Risk Assessment under SEPP 33.

2.2.2 Biogas Storage

Biogas is primarily a mixture of methane and carbon dioxide, generated when the biological material in organic waste is degraded by bacteria in a non-oxygen environment. This process is known as anaerobic digestion. Biogas will be collected onsite from the processes and will be stored to generate energy rendering plant and bio-digester. Since biogas is produced from the waste treatment process where methane is captured, it is considered as a source of renewable energy.

The biogas storage facility will consist of one dome shaped biogas storage tank, the biogas storage tank currently being considered is the SATTLER double membrane gas storage tank. An external membrane (27 m in diameter and 21 m high) encloses an internal membrane that holds biogas. The tanks are made of a PVC coated polyester fabric material. The space between the membranes contains air kept at 10 millibars positive pressure with a fan. The air pressure keeps the form of the outer membrane and the service gas pressure stable.

The outer membrane represents the building. It absorbs all external loads such as wind, hail and climatic conditions. The actual gas storage is located inside and is thus protected against atmospheric conditions. The basic components involved in the facility are identified in Figure 2-2 below.

At full capacity, the bladder will contain 9,000m^3 of biogas. The bladder is likely to be at full capacity at the beginning of the week and will decrease in volume towards the end of the week then return to full capacity over the weekend.

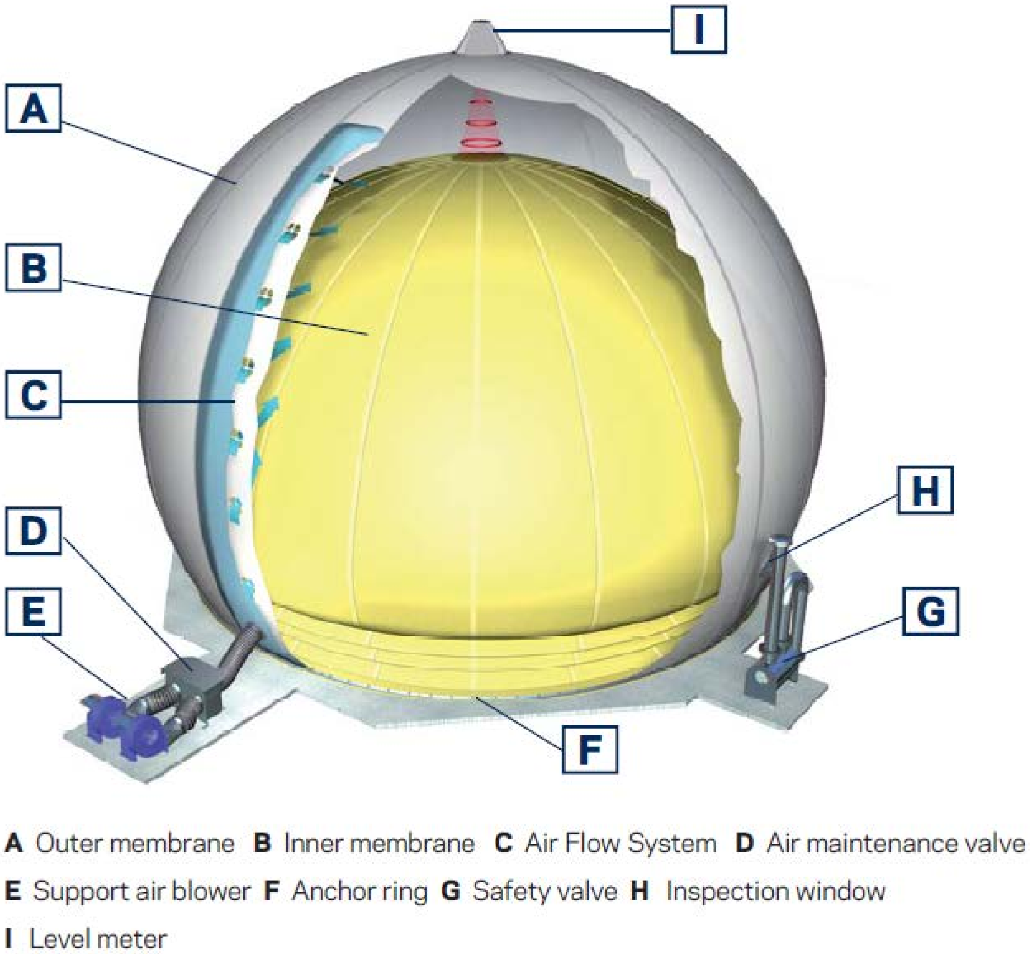


Figure 2-2 Proposed Double Membrane Biogas Storage Tank

2.2.3 Flare

An emergency release flare for the biogas will be fixed to the facility and will be either partially or fully enclosed. The flare will be approximately 5-6 m high and the flame height will be approximately 1.2m.

Section 3 Preliminary Risk Screen

3.1 Overview

This section provides a Preliminary Risk Screen to determine whether the proposed development is potentially hazardous and thus affected by SEPP 33. As part of the preliminary risk screen, the quantities of all classes of hazardous substances included in the proposed development and any adjacent existing inventory must be assessed. Quantity information, including distances of the hazardous substances to the site boundary, has been provided in Table 3-1.

The SEPP 33 Guidelines provide screening thresholds for hazardous substances. These thresholds identify the quantities below which it can be assumed there is unlikely to be a significant off-site risk. If any of the screening thresholds are exceeded the proposed development is to be considered 'potentially hazardous industry' and SEPP 33 applies.

3.2 Industry Assessment

The applicable local planning instrument is the *Inverell Local Environment Plan 2012.* Under this plan the site is zoned RU1 Primary Production and is defined as *Rural Industry – Livestock Processing Industry*. The proposed bio-digester plant and biogas storage facility is defined as *Electricity generation works and heat or co-generation* under the State and Regional Development SEPP. Although the gas storage tanks will be part of an integrated facility it is a separate use and for the purpose of SEPP 33 the proposed development is considered assessable.

3.3 Hazardous Substances

Table 3-1 details the existing and proposed hazardous substances onsite. The maximum quantity and storage locations for the hazardous substances are shown in Figure 3-3.

Table 3-1 Hazardous Substances

Hazardous Substance	Composition	Hazardous Properties	Maximum Quantity and Storage Type	Distance to Site Boundary (approx)	Distance to Biogas Storage facility	Location/ Storage ID
Existing Onsite Substances						
Chlorine	Assumed 100% pure	UN1017 Class/Division 2.3	2 x 70kg cylinders	15 m	382 m	1
Liquefied Petroleum Gases	Assumed 100% pure	UN 1075 Class/ Division 2.1	Above ground tank of 7500L	128 m	126 m	4
Carbon Dioxide Refrigerated Liquid	Assumed 100% pure	UN 2187 Class/ Division 2.2	Above ground tank of 45,000L	22 m	307 m	7
Ammonia Anhydrous (Liquid)	Assumed 100% pure	UN 1005 Class/ Division 2.3	2 x 1000kg cylinders and 2 x 230kg cylinders (Total 2460kg)	133 m	230 m	8
Oxygen, Refrigerated Liquid	Assumed 100% pure	UN 1073 Class/ Division 2.2	Above ground tank of 7000L	22 m	307 m	9

Hazardous Substance	Composition	Hazardous Properties	Maximum Quantity and Storage Type	Distance to Site Boundary (approx)	Distance to Biogas Storage facility	Location/ Storage ID
Proposed Additional Onsite Substances						
Sulphuric Acid (2)	Assumed 100% pure	UN 1830 Class/ Division 8	Above ground ICB of 1000L	270 m	25 m	10
Ferric Chloride Solution	Assumed 100% pure	UN 2582 Class/ Division 8	Above ground ICB of 1000L	270 m	25 m	11
Biogas	Average % (1)	UN 1971 Flammable gas (LEL 5% - 15% v/v)	9000m^3 at 10 millibar gauge pressure	317 m	-	12
- Methane	73.3					
- Carbon Dioxide	25.1					
- Oxygen	0.36					
- Hydrogen Sulfide	398.3 ppm					
- Balance (assumed to be Nitrogen)	1.13					

(1) Based on average of three test results taken on the 2/2/2013 by Air Labs Environmental

(2) For the purpose of classification under the ADG Code it is assumed that the sulphuric acid will consist of more than 51% acid.

Figure 3-1 shows the proposed site plan for the development, including the storage locations of hazardous substances.

3.4 Transportation Thresholds

Biogas produced and stored on-site will be used as fuel for the existing meat processing operations on-site. No transportation of methane off-site is intended. The vehicle movements required to deliver the additional sulphuric acid and ferric chloride solution are below the cumulative yearly and peak weekly movements as well as the 2 tonne load quantity maximum identified in Table 2 of the SEPP Guidelines. Therefore, no transportation screening thresholds as per the SEPP 33 Guidelines will be exceeded.

3.5 Hazardous Substances Storage Thresholds

The relevant hazardous substances onsite have been compared to SEPP 33 trigger thresholds in the table below. The locations of each of the storage locations for the dangerous goods onsite are shown in Figure 3-1 below.

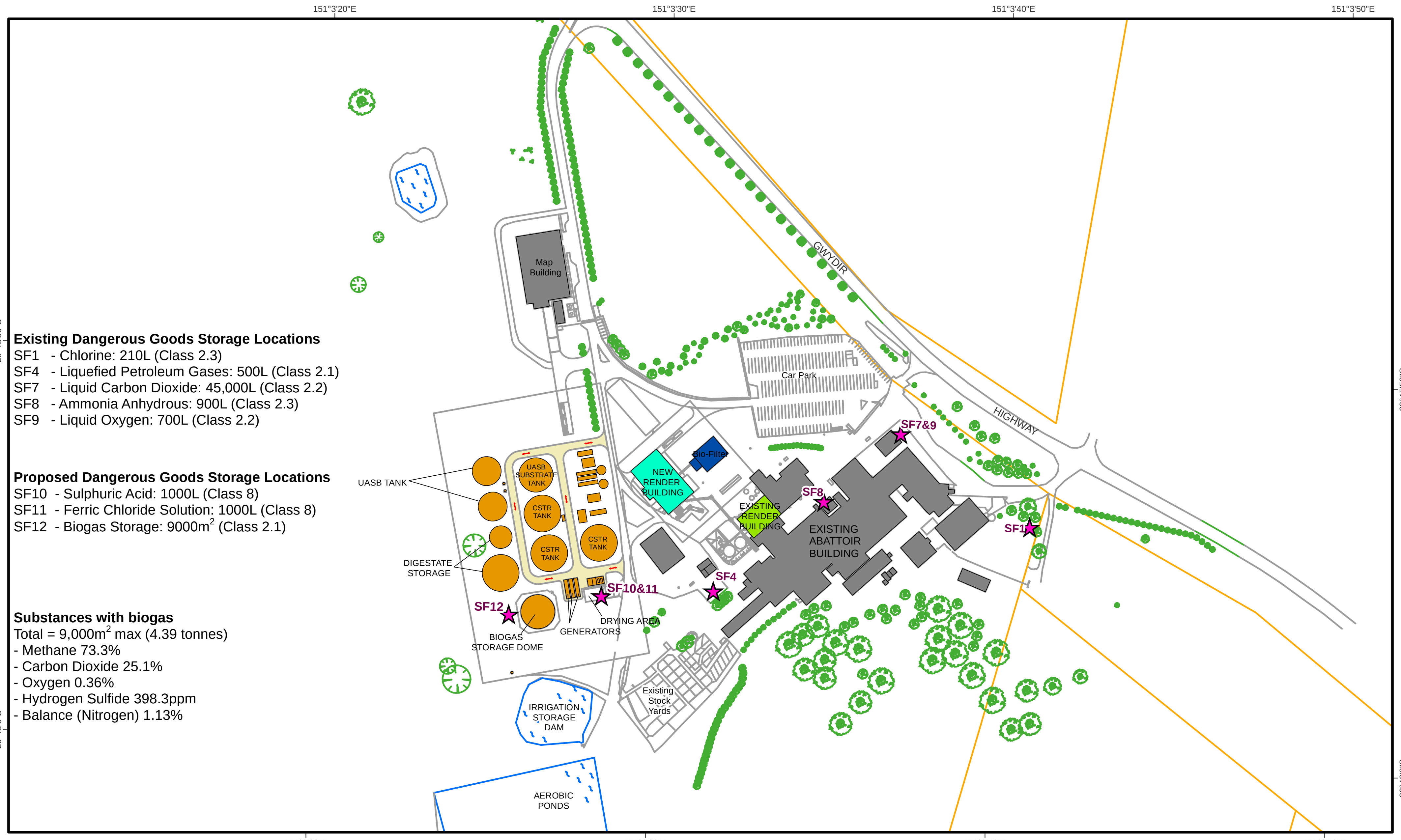
Table 3-2 SEPP 33 Screening Trigger Levels for Current Storages

Hazardous Substance	Current storage	Density	Actual storage	Trigger Volume	Trigger SEPP 33 Assessment (Y/N)
Existing Onsite Substances					
Chlorine (Gas)	2 x 70 kg cylinders (Total of 140 kg)	2.98 kg/m^3 @ 20ºC, 101.325 kPa	140 kg	1 tonne in containers <100 kg or 2.5 tonne in containers >100 kgs	No
LPG	Above ground tank of 7500 L	493.00 kg/ m^3	3697.5 kg	10 tonne (10,000 kg) or 16 m3 if in above ground tank	No
Ammonia Anhydrous (Liquid)	2 x 1000 kg cylinders and 2 x 230 kg cylinders (Total 2460 kg)	682.6 kg/ m^3 (Liquid)	1679.2 kg	5 tonne (5,000 kg)	No

Hazardous Substance	Current storage	Density	Actual storage	Trigger Volume	Trigger SEPP 33 Assessment (Y/N)
Proposed Additional Onsite Substances					
Sulphuric Acid (Packaging Group 2)	1 x 1000 L intermediate bulk container	1.84 kg / L	1840 kg	25 tonne (25,000 kg)	No
Ferric Chloride Solution (Packaging Group 2)	1 x 1000 L intermediate bulk container	1440 kg / m^3	1440 kg	50 tonne (50,000 kg)	No
Methane (Gas)	9000 m^3 at 10 millibar gauge pressure	0.668 kg/m^3 at 73% methane content	4,389 kg	100 kg	Yes

It is noted that only the biogas storage triggers the assessment under SEPP 33 for the volume of methane content to be stored onsite.

This result is slightly different to that provided in the Preliminary Environmental Assessment, as the original approach did not account for the composition of the biogas being only 73% methane and rather the calculations were made based on a pure methane composition.



Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 3-1 Site Plan and Hazardous Material Storage Locations

0 50 100
Metres

N S E W

Key

- Store Facility (SF) (Dangerous Goods Storage Location)
- Property Boundary
- Proposed Biodigester Facility
- Bio-Filter
- Existing Abattoir Building
- Existing Render Building
- New Render Building

Data Source:
Mitchel Halon Consulting, Vipac.

CDM Smith
cdmsmith.com

3.5.1 Methane Storage Thresholds

In accordance with the Australian Dangerous Goods (ADG) Code, the biogas (predominately methane) proposed to be produced at the Bindaree Beef facility is classified as a Class 2.1 substance.

Table 3-3 Methane Gas Properties

Gas	Formula	Molecular Weight	Density of pure methane
Methane	CH_4	16.043 kg/mol	0.668 kg/m^3 (1) at 73% methane content

(1) Normal Temperature and Pressure – is defined as air at 20°C and 1 Standard Atmospheric Pressure (atm)

The proposed facility will include one biogas storage tanks with a maximum capacity of 9,000m^3 each. Therefore, the calculated weight of methane, based on the maximum contained volume of one storage tank, and 73% methane content, has been determined as follows:

$$9{,}000m^3 \times 0.73 \times 0.668 = 4{,}389 \text{ kg (4.39 tonnes)}$$

According to Table 1 of the SEPP 33 Guidelines, the method to be used for risk screening of a Class 2.1 substance over 100 kg is through application of the graph provided within the SEPP 33 Guidelines, represented in Figure 3-2 below.

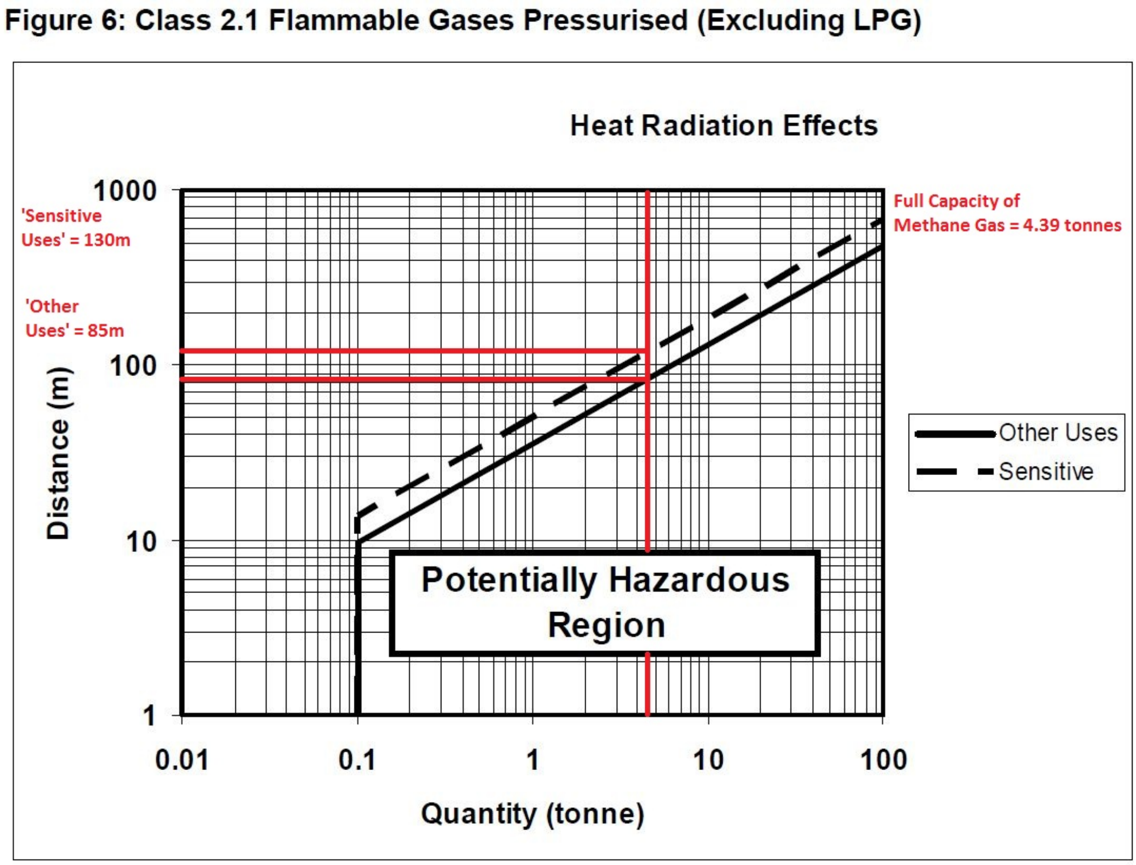


Figure 3-2 Screening Threshold Figure for Class 2.1 Flammable Gas Pressurised (Excluding LPG)

Figure 3-2 indicates that for the volume of methane proposed to be stored on-site, the potentially hazardous region would extend to approximately 85 m for 'other uses' and 130 m for 'sensitive uses'. The approximate distance between the proposed biogas tanks and the property boundary is

270 m, see Figure 3-3 below. As detailed in Table 3-4, the preliminary risk screen indicates that the thresholds for 'sensitive uses' and 'other uses' is not exceeded. NOTE: The above graph was developed for use on gas at pressures far higher than the 10 millibar in the gas spheres. The lower pressures provide a measure of safety not apparent on the nomograph required by the SEPP 33 Guideline.

Sensitive land uses refers to residential or other more sensitive land uses (SEPP 33 Guideline) with all uses that are not sensitive uses are considered to be other uses. The surrounding land is rural agricultural (other use) and the closest resident to the biogas tanks is 792 m to the north-east. There is no trigger to undertake a potential hazard assessment under the preliminary screening, however, a voluntary PHA has been prepared to ensure the community that there is no offsite risk posed by the proposed development.

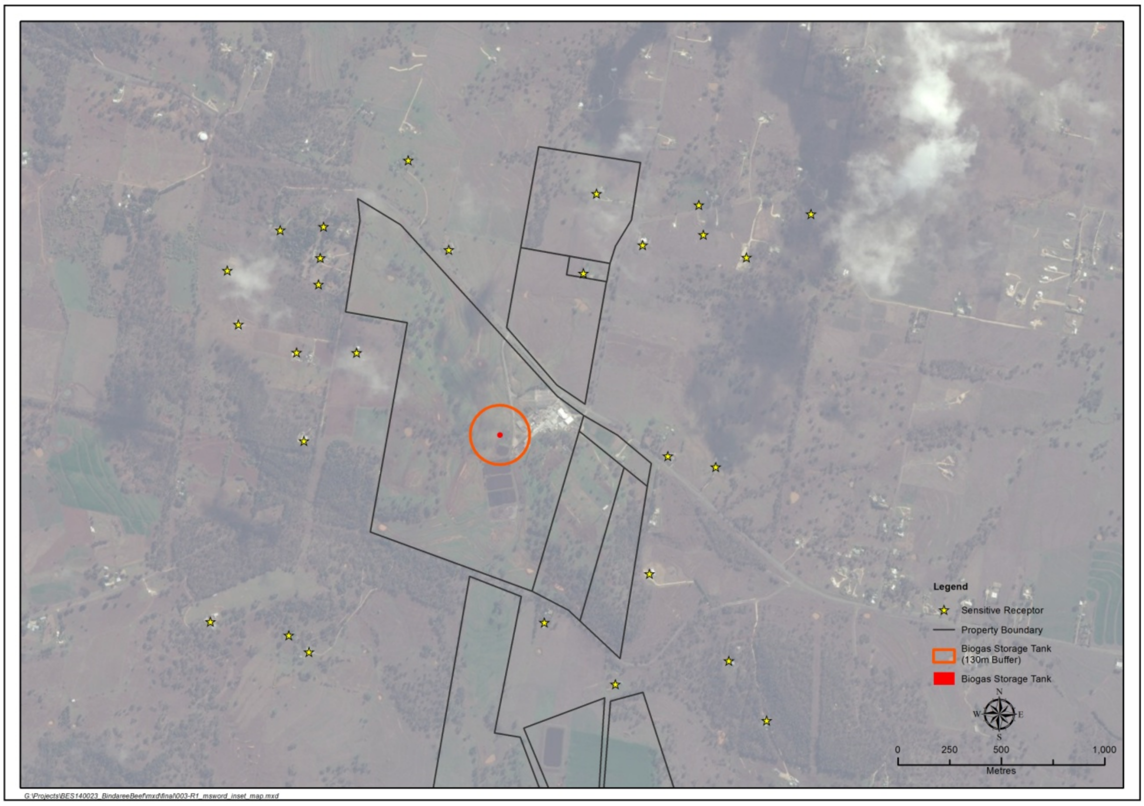


Figure 3-3 Bindaree Beef Abattoir Designated Buffer Area

The 130 m threshold for 'sensitive uses' does not exceed the property boundary and currently does not contain 'sensitive uses' as shown in Figure 3-3 above. Accordingly, the biogas storage tanks at the Bindaree Beef facility should not be considered as 'potentially hazardous'. Nevertheless, a voluntary PHA including detailed impact modelling has been provided in Section 4.

Table 3-4 Summary of Substance and Screening Thresholds

Threshold	Substance	DG Class (1)	Quantity	Screening Method (2)	Location	Result
Other Uses	Methane	2.1	4,389 kg	SEPP 33	Biogas Storage Tanks	Below Threshold (85m)
Sensitive Uses	Methane	2.1	4,389 kg	SEPP 33	Biogas Storage Tanks	Below Threshold (130m)

(1) ADG Code; (2) SEPP 33 Guidelines- Figure 6.

3.6 Summary

The preliminary risk screen has determined that of all the existing and proposed hazardous substances to be stored onsite only methane exceeds the storage threshold identified in SEPP 33. Accordingly, for the proposed storage quantity of methane, it has been determined that the threshold for 'other uses' is 85 m and 130 m for 'sensitive uses'. As the approximate distance between the biogas tanks and the boundary is 270 m, none of the SEPP 33 preliminary thresholds are triggered to require a PHA.

To appease community concerns, a voluntary PHA has been prepared for the methane stored in the biogas tank. In accordance with the SEPP33 Guideline, a PHA may be done qualitatively and/or quantitatively, depending on the circumstances of the proposal and its location (SEPP 33 Guideline). In accordance with the SEPP 33 Guideline (p. 16), a qualitative PHA may be sufficient in the following circumstances:

- Where the materials are relatively non-hazardous (for example, corrosive substances and some classes of flammables);
- Where there are no major worst-case consequences;
- Where the technical and management safeguards are self-evident and readily implemented; and
- Where the surrounding land uses are relatively non-sensitive.

From the initial risk screen and site assessment it has been determined that there are no major worst-case consequences, the technical safeguards can be readily implemented and the surrounding land uses are non-sensitive. Therefore, a qualitative PHA has been undertaken and supplemented with quantitative hazard scenario modelling.

Section 4 Preliminary Hazard Analysis

4.1 Hazard Analysis Process

HIPAP No 6 (*Hazard Analysis*) describes the nature of each step in the hazard analysis process. This can also be referred to as a risk assessment process. Proposed control measures are also included for significant potential risks and may be considered as part of risk management for the proposal.

The main elements of hazard analysis are:

- Identification of the nature and scale of all hazards at the facility, and the selection of representative incident scenarios;
- Analysis of the consequences of these incidents on people, property and the biophysical environment;
- Evaluation of the likelihood of such events occurring and the adequacy of safeguards;
- Calculation of the resulting risk levels of the facility; and
- Comparison of these risk levels with established risk criteria and identification of opportunities for risk reduction.

Figure 4-1 below provides a schematic of the hazard analysis process.

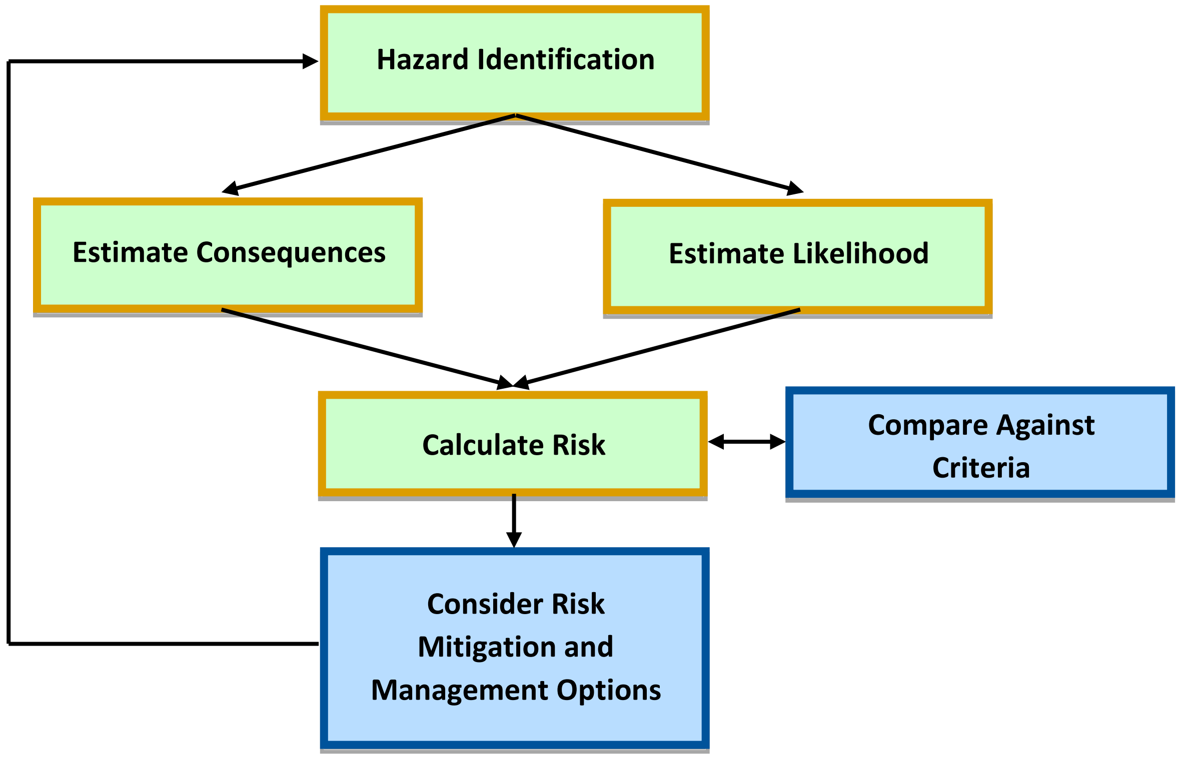


Figure 4-1 Methodology for Hazard Analysis

4.2 Hazard Analysis and Methodology

4.2.1 Hazard Identification

The hazard identification includes a review of potential hazards associated with the proposed biogas storage tank. The hazard identification includes a comprehensive identification of possible causes of potential incidents and their consequences to public safety and the biophysical environment, as well as an outline of the proposed operational and organisational safety controls required to mitigate the likelihood of the hazardous events from occurring.

A hazard identification analysis has been applied to the proposed biogas storage facility. This identification process considered the raw material, the proposed activities, the nature and quantity of material handled, storage requirements and plant layout. Possible impacts from off-site events on neighbouring sites were also considered.

4.2.2 Hazardous Scenarios

The primary major hazards event scenarios which had possible worst case impacts are:

1. Puncture of biogas tank causing vapour release and jet fire through ignition source (inclusive of heat hazard);
2. Puncture or failure of the biogas tank causing vapour cloud explosion through ignition source (inclusive of blast pressure and heat hazard); and
3. Puncture or failure of the biogas tank causing vapour cloud release and a localised anoxic environment.

4.2.3 Consequence Analysis

4.2.3.1 Modelling

Consequence analysis was used to quantify the potential for the hazardous incidents identified to cause injury or fatalities, damage property, or harm the biophysical environment. Quantitative modelling has been undertaken for the three scenarios outlined above.

Because the biogas storage tank pressure is relatively low (compared to similar storage vessels), CDM Smith first used a flow calculation for an ideal gas in the non-choked conditions. The equation used, from ***Health and Environmental Risk Analysis*** (Louvar and Louvar, 1998) is provided below.

Source Models for Vapors 95

$$Q_m = C_0 A P_0 \sqrt{\frac{2 g_c M}{R_g T_0}\left(\frac{\gamma}{\gamma - 1}\right)\left[\left(\frac{P_1}{P_0}\right)^{\frac{2}{\gamma}} - \left(\frac{P_1}{P_0}\right)^{\frac{\gamma+1}{\gamma}}\right]} \qquad \text{(Eq. 4.10)}$$

CDM Smith then analysed the risks using the Areal Locations of Hazardous Atmospheres (ALOHA) program which is the air modelling element of CAMEO, a program suite that assesses the health and safety impacts of emergency releases. It was produced as a joint effort of the US Environmental Protection Agency (US EPA) and the US National Oceanic and Atmospheric Administration (NOAA). It has been successfully used for decades and is currently in revision 5.4.4. The Australian Government has not produced any modelling or endorsed specific modelling packages. The CAMEO program is recognised and supported within industry and ALOHA is widely used for the purposes required in this assessment.

CDM Smith were sufficiently able to manipulate the ALOHA model by adjusting the volume output of gas volume to accommodate the restrictions on the model in dealing with low gas pressures. A conservative approach was taken and no offsite impacts were identified. Further details are provided on the modelling within the **Appendix A**.

For a 1 m hole in both membranes, the spreadsheet shows a flow of 1,262 kg of gas in the first minute and 978 kg per min (kg/min) following the initial minute. This reduction assumes that the gas pressure drops from 10 millibar in one minute and that the weight of the membrane pushes on the remaining gas with a pressure of 6 millibar. The gas contains 73% methane by volume, which is 50.3% by weight. The methane emission, therefore, is 634 kg/min for the first minute and 491 kg/min for the next 21 minutes, after which all gas would be expelled. The hazards were modelled using a 1 m hole as this produced the greatest hazard event. A highly unlikely scenario (a 1 m diameter hole in both internal and outer layers) was used to show the very worst case event along with a methane content of 73% which is higher than the expected maximum of 70%.

4.2.4 Study Assumptions

The modelling was based on the following assumptions:

- The biogas pressure is low enough for the gas to behave ideally;
- The biogas contains 73% methane and 25% carbon dioxide by volume (the remaining 2% is air);
- The biogas is stored at 10 millibars of pressure;
- While the gas sphere collapses, the weight of the membrane pushes on the remaining gas with a pressure of 6 millibar;
- The carbon dioxide depresses the flammability only through dilution, not thermodynamically; and
- The air between the outer membranes does not dilute the biogas significantly.

4.3 Risk Assessment Process

To quantify the potential for a given option to cause harm, a preliminary risk assessment process was undertaken with reference to the *AS/NZS ISO 31000* criteria.

The risk assessment was completed after due consideration of the following:

- The likely frequency of the potential hazard occurring as a result of a given management option;
- Indication of the cumulative impacts to surrounding land uses;
- The duration of any identified hazard;
- The affects and rate of usage of the hazardous substances to be used, stored, processed or produced by a management option;
- Public liability of the State for private infrastructure and visitors of public land; and
- Processes, types of machinery and equipment used within the Project that relate to the hazard and impact.

The risk assessment criteria in *AS/NZS ISO 31000* establishes a method for identifying risk profiles through combining the "likelihood" of a hazard or impact occurring with the "consequences" of a hazard or impact occurring, in terms of its effect on the health and safety of personnel and to the environment.

Definitions applicable to the risk assessment process as described in this document are outlined in Table 4-1.

Table 4-1 Definitions for Assessment of Hazard and Risk

Term	Definition
Hazard	Something with the potential to cause environmental harm. This can include hazardous substances, plant and equipment, work processes or other aspects of the surrounding environment.
Likelihood	The chance or probability of an event resulting in an impact occurring.
Consequence	How much harm the impact could have, how many people could be affected and the duration of the harm.
Unmitigated Risk	The likelihood that a harmful consequence might result when exposed to the hazard without implementation of the proposed mitigation measures.
Residual Risk	The likelihood that a harmful consequence might result when exposed to the hazard with the effective implementation of the proposed mitigation measures.

4.4 Likelihood Assessment

A qualitative assessment of the possible event frequency was undertaken to assess the likelihood of an impact occurring, based on the ratings included in Table 4-2.

Table 4-2 Ratings for Likelihood of Occurrence

Probability Rank	Description	Description
5	Almost certain	Will almost certainly occur. Has a 95% or greater chance of occurring within a 12-month period.
4	Likely	Probably will occur. Has a 70% to 95% chance of occurring within a 12-month period.
3	Possible	May possibly occur. Has a 30% to 70% chance of occurring within a 12-month period.
2	Unlikely	Could possibly occur. Has a 5% to 30% chance of occurring within a 12-month period.
1	Rare	Only likely to occur in exceptional circumstances. Has a 5% or less chance of occurring within a 12-month period.

4.5 Consequence Assessment

The potential level of consequence of a management and treatment option resulting in impacts to the predefined criteria was assessed in accordance with the definitions shown in Table 4-3. Each outcome has been individually assessed where a hazardous incident may have multiple impacts.

Table 4-3 Consequence Ratings

Score	Maximum Potential Consequence (Realistic)	
	Description	Safety and Health of People
5	Catastrophic	Multiple fatalities, significant irreversible effects to >5 people. Extensive long-term harm with widespread impacts that are non-reversible in <10 years. Significant non-compliances with legislative requirements that result in significant degradation to environmental values.
4	Major	Fatalities to 1-5 people, severe irreversible disability. Major long-term and widespread harm that is reversible in 2 - 10 years. Non-compliances with legislative requirements that result in major degradation to environmental values.
3	Moderate	Moderate irreversible disability or impairment (classified injury). Moderate environmental harm that is contained on-site or minor widespread harm that are reversible in <2 years. Non-compliances with the legislative requirements that result in minimal degradation to environmental values.
2	Minor	Reversible disability requiring hospitalisation (medical treatment case). Minor unplanned on-site harm that does not extend off-site. No non-compliances with legislative requirements.
1	Insignificant	No medical treatment (First Aid case). Insignificant impacts that are contained on-site. No habitat disturbance and nil non-compliances with legislative requirements.

4.6 Risk Matrix

The risk matrix adopted for the assessment is included in Table 4-4. The colour shading refers to the qualitative bands of risk (impact) level.

For the purposes of this impact assessment, risk levels are defined as follows:

- Extreme – Works must not proceed until suitable mitigation measures have been adopted to minimise the risk;
- High – Works should not proceed without consideration of alternative options or additional controls to minimise the risk. A documented action plan is required;
- Medium – Acceptable with formal review. A documented action plan is required; and
- Low – Acceptable with review.

Table 4-4 Risk assessment Matrix

Likelihood	Consequence				
	Catastrophic 5	Major 4	Moderate 3	Minor 2	Insignificant 1
Almost Certain 5	Extreme	Extreme	Extreme	High	Medium
Likely 4	Extreme	Extreme	High	Medium	Medium
Possible 3	Extreme	High	High	Medium	Low
Unlikely 2	High	High	Medium	Low	Low
Rare 1	Medium	Medium	Low	Low	Low

Table 4-5 summarizes the risks, impacts, and mitigation measures and the likelihood, consequence and risk both before and after mitigation measures.

Table 4-5 Hazard, Impact and Mitigation Table

Risk / Hazard	Activity / Cause	Impact	Unmitigated Risk			Mitigation Options	Mitigated Risk		
			L	C	R		L	C	R
Explosion	Start-up of tank and system. Initial mixing of biogas as it fills the system. Large leak with ignition by spark or flame	Damage to surrounding buildings, thermal burns to personnel within impact zone. Blast force of 3500 Pascals at 94 m for the first minute release then 3500 Pascals at 83 m for 30 mins after*. HIPAP No 4 shows that this pressure can shatter windows but is unlikely to cause any pressure impacts to the human body. This would constitute a survivable explosion.	4	3	High	- Commissioning tests undertaken - Removal of air from storage bladder prior to filling with biogas - Reduction or purging of air from the system using water or CO^2	2	3	Medium
	Ignition of gas explosion from flare within a hazard zone of storage tanks		2	2	Medium	Any biogas flaring systems, must comply with Australian Standard AS 1375 (Industrial Fuel Fired Appliances Code). Must be located outside the explosion hazard zones and away from any potential biogas release point.	1	2	Low
Explosion or Fire	Storage of biogas - Tank failure Main causes of failures: - Collision with equipment or vehicles; - Damage to pipeline or tanks; - Deviation from normal operating conditions (temperature or pressure); - Thermal stress (e.g. fire); - Poor quality control in fabrication or construction; and - Corrosion.	Fire (flash or Jet) (burns and thermal injuries) No jet fire likely given the low pressure of the storage, however thermal radiation to HIPAP No4 criterion to 44 m*.	1	3	Low	*Location* - Setback distances from other infrastructure established; - Assess explosive gas atmosphere zones in accordance with AS/NZS 60079.10; - An Impact Protection Zone around storage tanks; - Security fence and restricted access around biogas carrying parts of plant; and - Appropriate separation distances from boundary. *Design* - Installation of protective devices (e.g. emergency isolation valves, cut-off valves and one-way valves);	1	3	Low

Risk / Hazard	Activity / Cause	Impact	Unmitigated Risk			Mitigation Options	Mitigated Risk		
			L	C	R		L	C	R
Unconfined Vapour Cloud	Large leak without ignition. Tank Failure (as outlined above).	Flammable area of vapour cloud up to 88 m away. Concentrations up to 30,000 ppm (equal to 60% LEL) up to 114 m away*. Intoxication or poisoning from hydrogen sulphide or asphyxiation from oxygen displacement.	2	3	Medium	- Leak detection by automatic sensing devices; - Fitted with overpressure release valves; and - Gas Safety Regulations and Australian Standards to be met; - Implement where possible best practice including the Code of Practice for On-farm Biogas Production and Use (Piggeries) 1st Edition – Consultation Draft, March 2012. *Operation* - Fire Fighting Equipment nearby; - Emergency Response Plan; and - Employee training.	1	3	Low
Fire or Vapour Cloud	Pipeline leak (usually prolonged). Pipeline rupture (usually instantaneous). Pipeline blockage and corrosion from condensate.	Explosion. Gas Leak (Intoxication or poisoning from hydrogen sulphide or asphyxiation from oxygen displacement). Within 14 m of vapour plume too little oxygen to breath and within 20 m of the vapour plume enough hydrogen sulphide levels to cause dizziness and illness if a person remained in the area*.	2	3	Medium	- Gas pipelines to comply with AS 2885 (2008)- Pipelines; - Gas and Liquid Petroleum, AS4041 (2006)- Pressure piping and AS4131 (2009) – Polyethylene (PE) pipes for pressure applications; - Clearly marked biogas pipelines (yellow in colour); - Protective coatings to inhibit corrosion (also cathodic protection); - Physical protection of the pipe in any exposed location; - Be operated at pressures no more than 100 kPa (1bar) (AS/NZS 60079.10); and - Biogas conditioning to remove condensate.	1	3	Low

*Worst case impact modelled on a rare event of a 1 m puncture to both the inner and outer layers of the storage tanks

Section 5 Results and Discussions

5.1 Event Scenario 1 - Puncture of Biogas Tank Causing Vapour Release and Jet Fire through Ignition Source

The consequences of a large vapour release from a tank puncture of 1m in diameter with ignition would be a jet fire from the hole, the modelling results indicate that this would create a heat hazard as outlined below.

5.1.1 Heat Hazards

The thermal radiation heat hazards of such an explosion include:

In the first minute:

- Within 19 m the heat radiation would likely reach 12.6 kW/ (sq/m), this is potentially lethal within 60 seconds (HIPAP No 4, 2011) and is displayed as the red dotted line in Figure 5-1.
- Within 44 m the heat radiation would reach 4.7 kW/ (sq/m), this would cause pain in 15-20 seconds and injury after 30 seconds of exposure (at least second degree burns will occur) (HIPAP No 4, 2011) and is displayed as the yellow dotted line in Figure 5-1.
- Within 67 m the heat radiation would reach 2.1 kW/ (sq/m), this is the minimum to cause pain after 1 minute and is displayed as the green dotted line in Figure 5-1.

In subsequent minutes:

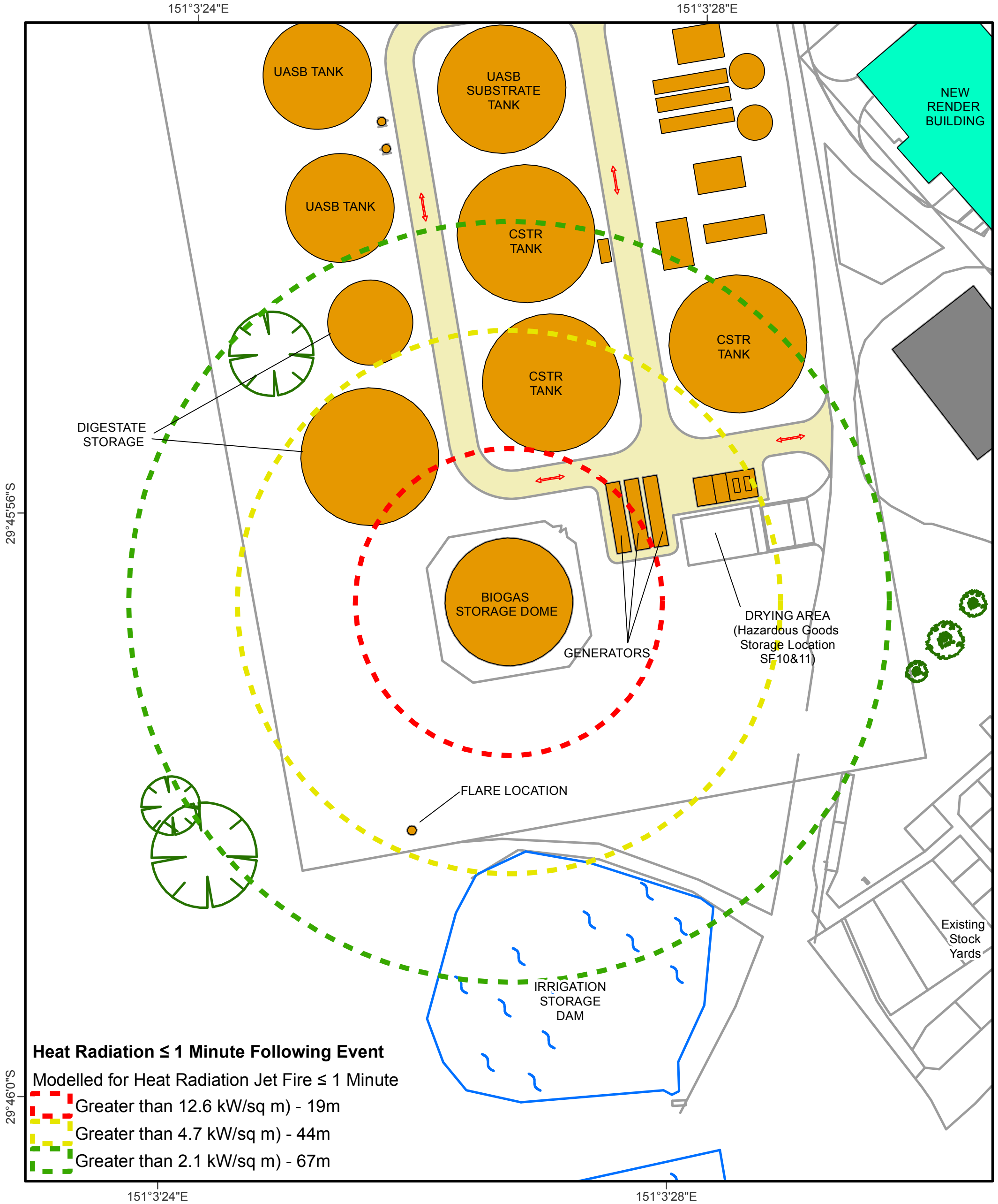
- Within 18 m the heat radiation would likely reach 12.6 kW/ (sq/m) this is potentially lethal within 60 seconds (HIPAP No 4, 2011) and is displayed as the red dotted line in Figure 5-1.
- Within 40 m the heat radiation would reach 4.7 kW/ (sq/m) this would cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns will occur) (HIPAP No 4, 2011) and is displayed as the yellow dotted line in Figure 5-1.
- Within 60 m the heat radiation would reach 2.1 kW/ (sq/m) this is the minimum to cause pain after 1 minute and is displayed as the green dotted line in Figure 5-1.

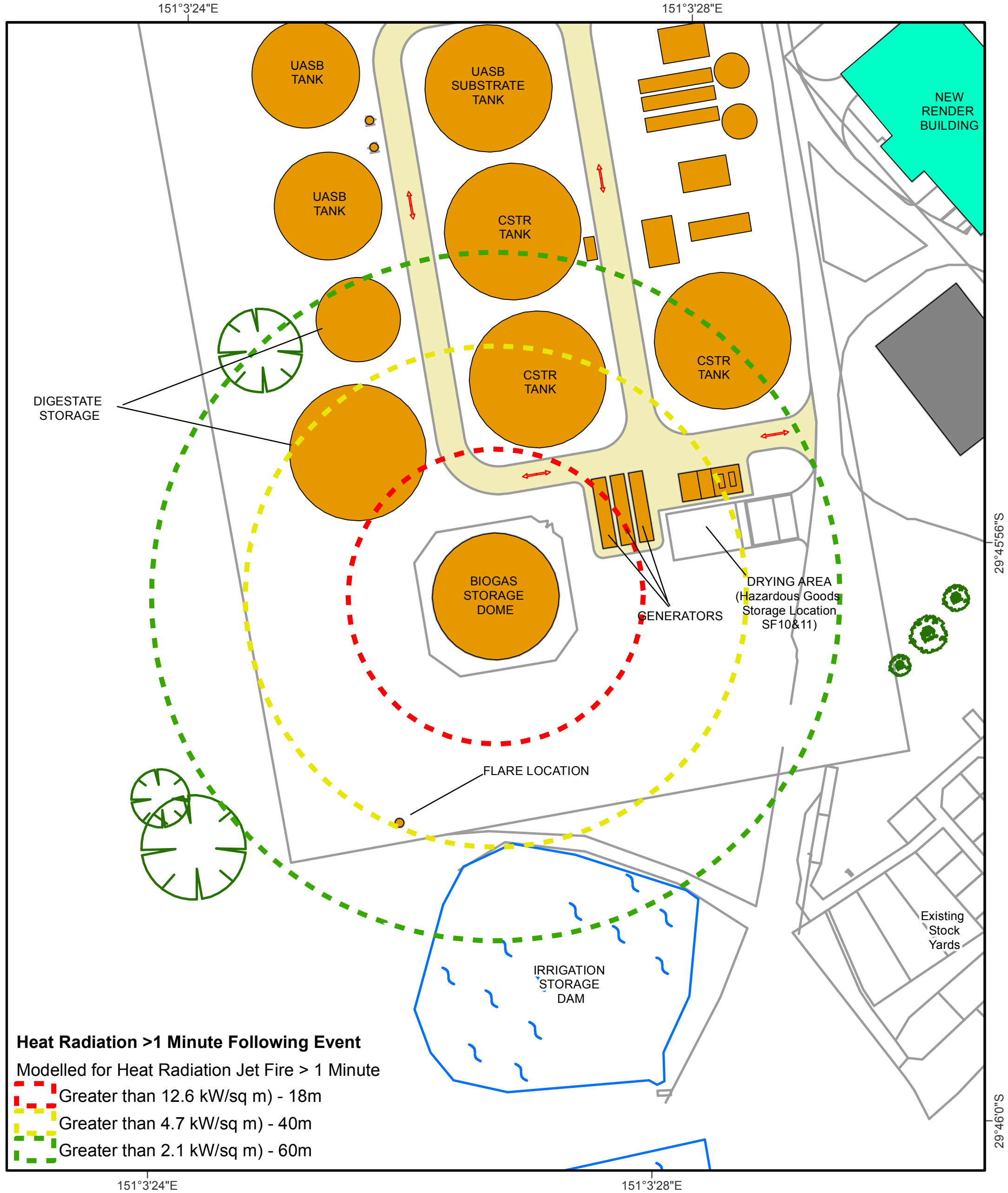
The model outputs have been provided in **Appendix B**.

5.1.2 Summary

The consequence of jet fire from a 1 m diameter puncture to the biogas membrane and outer layer would be to create a flame to 20 m which would be potentially lethal to anyone remaining in the area downwind in the flame plume and may cause second degree burns to people within 44 m of the flame plume upon explosion. The HIPAP No 4, 2011 suggested heat flux radiation at residential and sensitive use areas offsite should not exceed 4.7 kW/(sq/m) as the risk criterion for heat radiation, this impact zone would extend to 44m and is well within the site boundary.

The likelihood of this major event occurring is rare and may only occur in exceptional circumstances. As such the unmitigated risk is considered low and not of concern. The general health and safety measures, such as impact protection and separation of ignition sources suggested below in Section 4.7 would further reduce the likelihood of this impact onsite.





Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 5-1 Modelled for Heat Radiation Jet Fire Impact Zones

Key

- Proposed Biodigester Facility
- Existing Abattoir Building
- New Render Building

0 20 40
Metres

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Date (3/10/2014)

5.2 Event Scenario 2: Puncture or Failure of the Biogas Tank Causing Vapour Cloud Explosion through Ignition Source

The impacts modelled for a vapour cloud explosion include heat hazard and blast pressure. Using the flow rates discussed in Section 4.2.3.1 to calculate danger zones in ALOHA yields the following results were obtained for the maximum extent of a vapour cloud explosion, impacts of blast-pressure and heat.

5.2.1 Blast Pressure Hazards

A blast pressure of 7,000 pascals was never exceeded after any vapour cloud explosion we modelled. 7,000 pascals is the hazard criterion established by HIPAP No 4. HIPAP No 4 shows that at 7,000 pascals, most glass windows will shatter and about 10% of exposed persons will be injured. Figure 4.2 does not indicate a risk and the modelled pressure only achieved a 3,500 pascal output only half the trigger criteria.

5.2.2 Heat Hazards

The thermal radiation or heat hazards from such an explosion could include:

- Within 19 m the heat radiation would likely reach 10.0 kW/ (sq/m), this is potentially lethal within 60 seconds (HIPAP No 4, 2011) and is displayed as the red dotted line in Figure 5-2.
- Within 30 m the heat radiation would reach 5.0 kW/ (sq/m), this would cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns will occur) (HIPAP No 4, 2011) and is displayed as the yellow dotted line in Figure 5-2.
- Within 47 m the heat radiation would reach 2.0 kW/ (sq/m), this is the minimum to cause pain after 1 minute and is displayed as the green dotted line in Figure 5-2.

There are no offsite impacts of heat hazards in the rare occurrence of such a worst case vapour cloud explosion event.

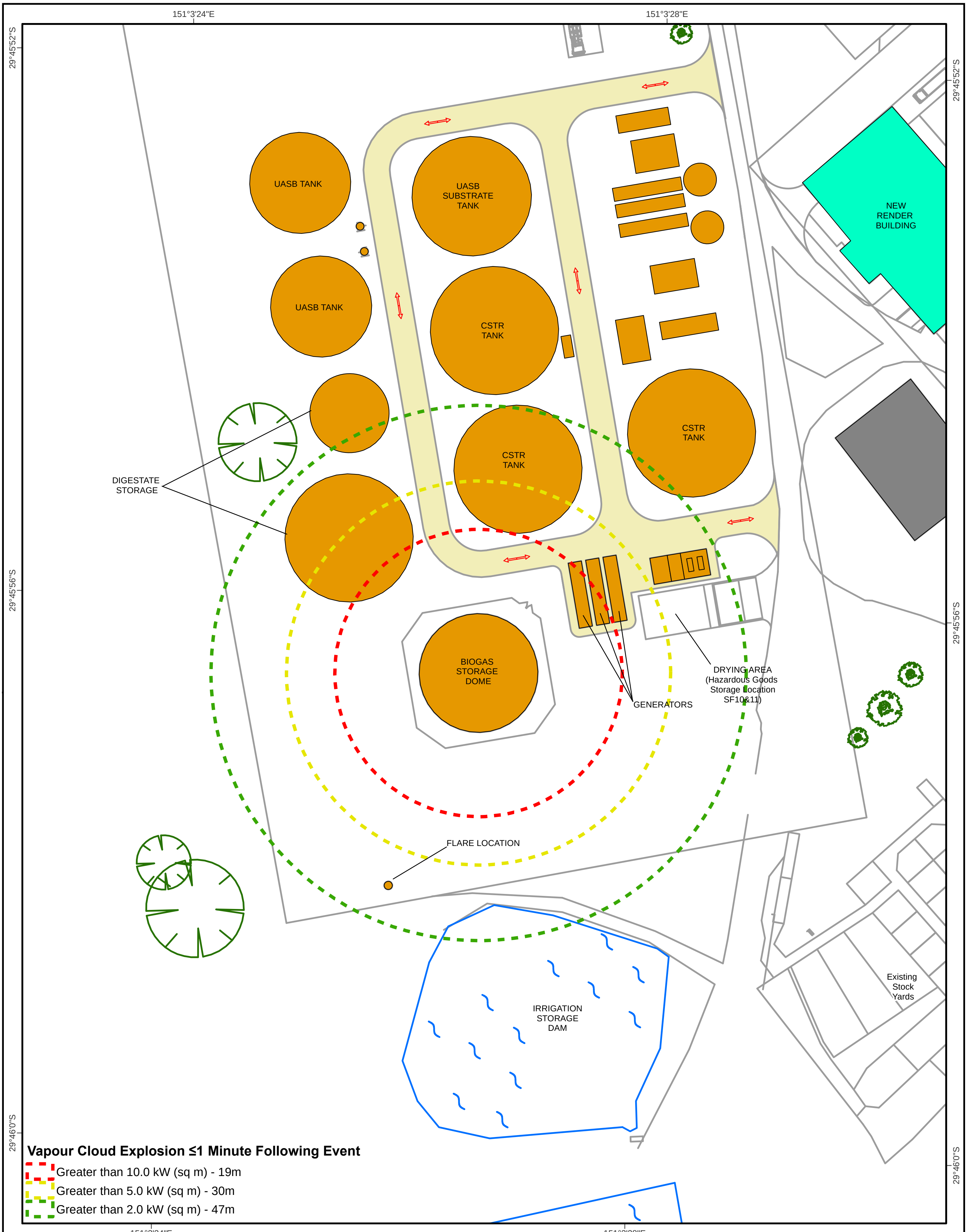
The model outputs are provided in **Appendix A**.

5.2.3 Summary

A vapour cloud explosion could occur from a puncture or rupture of both the biogas tank membrane and outer layer or it could occur during the start up on the plant through the mixing of biogas with air. The impact of such a worst case explosion would be minor and contained within the site boundary, due to the low pressure of biogas storage and the biogas composition.

The onsite impact could include damage to surrounding buildings (broken glass) and cause thermal burns to personnel within 30 m of the storage tank, this would constitute a survivable explosion. The blast force of 3,500 Pascals of any such explosion would be felt to 94 m from the storage tank, but is unlikely to cause any pressure impacts to the human body and this level does not trigger the hazard criterion within the HIPAP No 4.

The best protection against the effects of an accidental explosion is increased distance between the explosion site and the potential receptors. It is important to isolate potential explosive facilities from roads, public places and residents. The modelling indicates that sufficient distance to the site boundary and this hazard is not considered to impact beyond the boundary. Internally the facility can be managed to ensure the likelihood is reduced to as low as reasonably practicable through onsite safety design, operational controls and systems. The internal site layout complies with the German Agricultural Occupational Health and Safety Agency (2008) 'Safety Rules for Biogas Systems' guideline in the absence of a relevant Australian guideline for biogas safety.



Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 5-2 Vapour Cloud Explosion Through Ignition Source - Blast Pressure and Heat Hazard Impact Zones

0 15 30
Metres

Key

- Proposed Biodigester Facility
- Existing Abattoir Building
- New Render Building

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5.3 Event Scenario 3: Puncture or Failure of the Biogas Tank Causing Vapour Cloud Release and a Localised Anoxic Environment

The hazards caused by a puncture or failure of the biogas tank with a 1 m hole with a vapour cloud release is the flammable gas hazard zone and the asphyxia hazards.

5.3.1 Flammable Gas Hazard Area

Methane can form an explosive mixture in air at levels as low as 5 percent. The lower explosive limit (LEL) is 5% and the upper explosive limit (UEL) is 15%. However, methane rapidly dissipates into the atmosphere minimising the time frame for potential exposure in an emergency event. The LEL indicates the flammable area and at 60% of the LEL there are some localised pockets of gas that can attain a flammable concentration. Methane at 60% of the LEL is the hazard criterion established by HIPAP. Both the hazard areas of the LEL and the 60% hazard have been modelled and the results are provided below.

In the first minute after a tank rupture or failure:

- The LEL extends 78 m from the tank in the down wind direction (flammable area), and is displayed as the red dotted line in Figure 5-3.
- The 60% LEL extends 114 m from the tank in the downwind direction (flammable pockets), and is displayed as the orange dotted line in Figure 5-3.

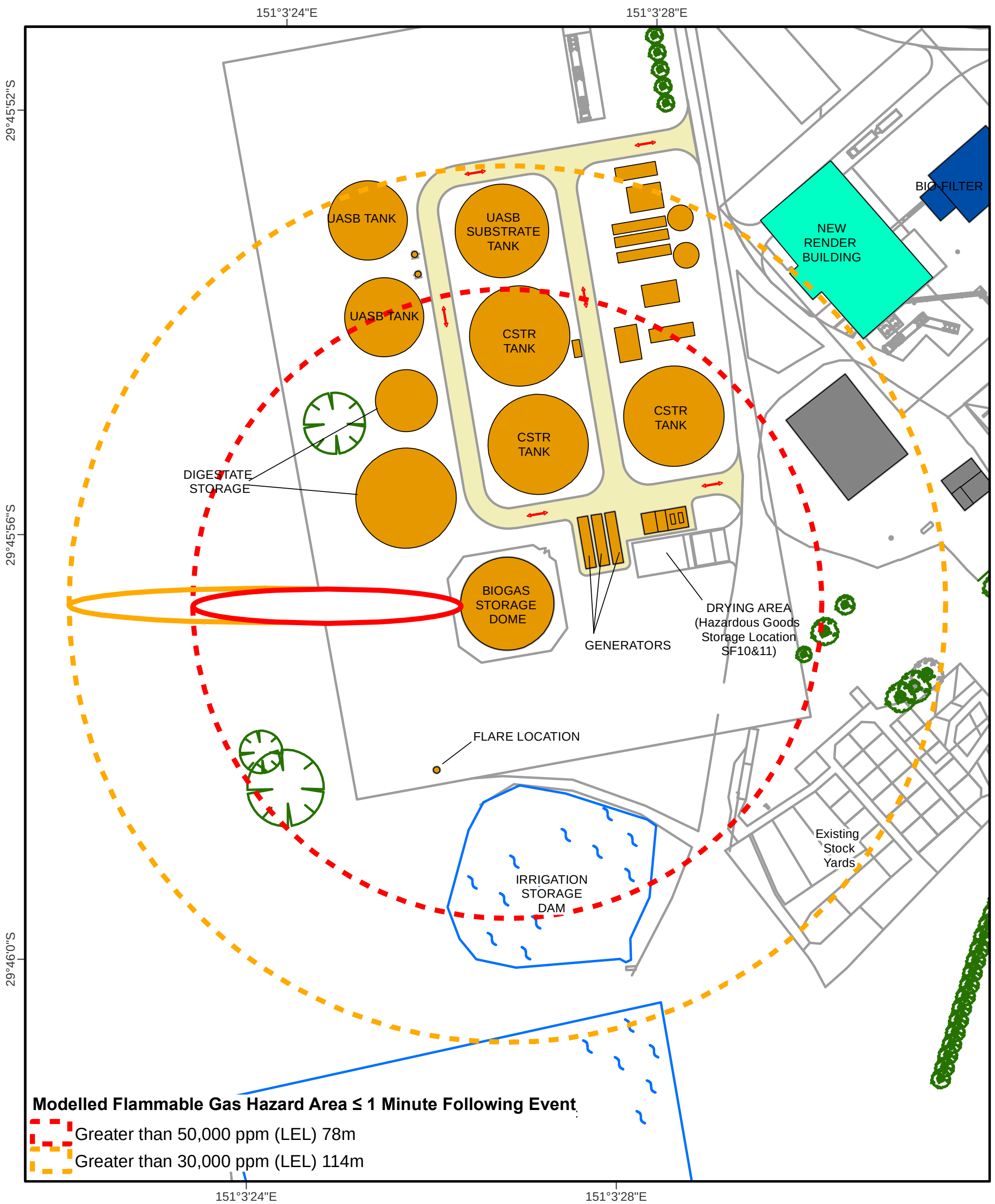
In subsequent minutes:

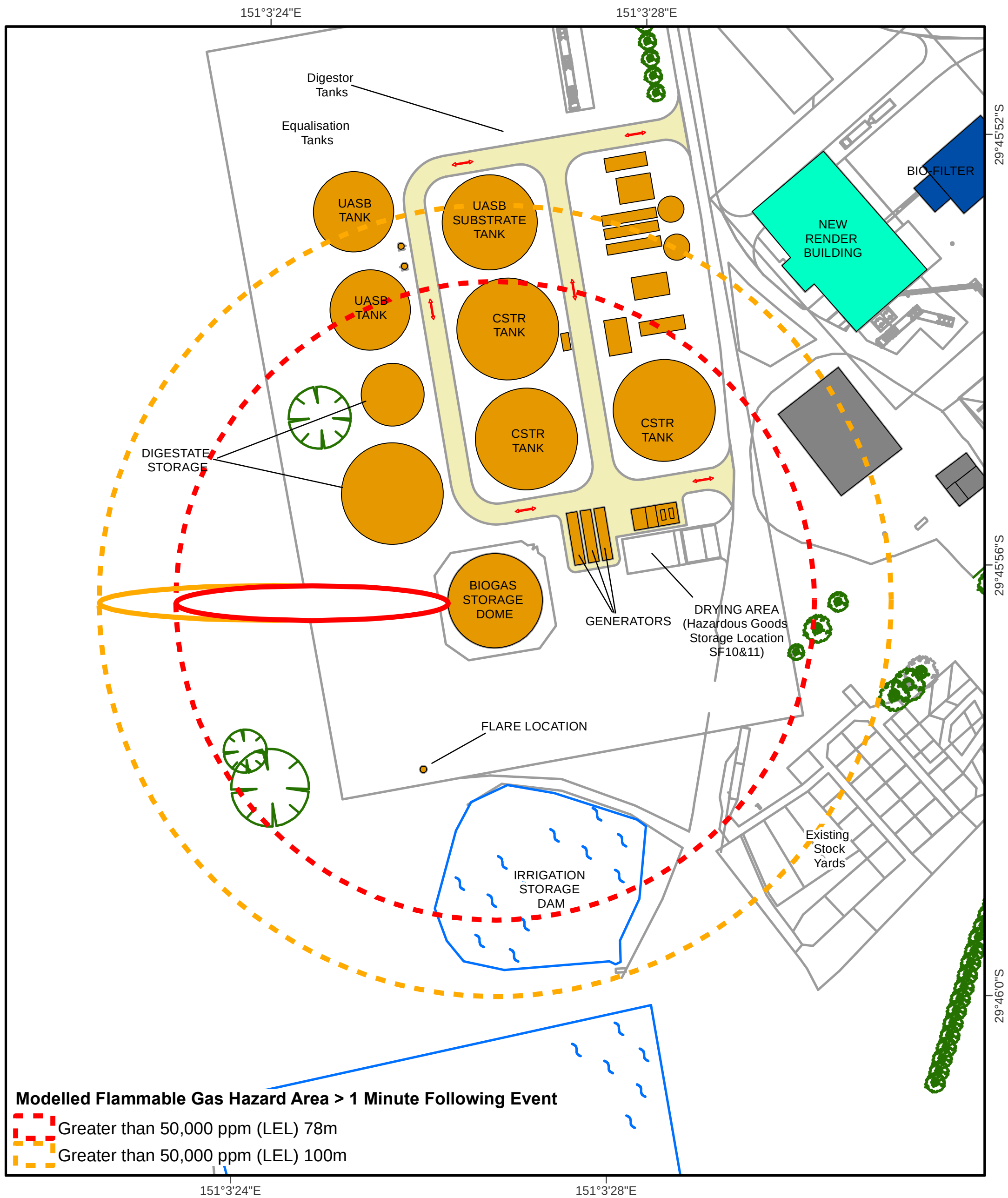
- The LEL also extends 78 m from the tank in the down wind direction, and is displayed as the red dotted line in Figure 5-3.
- Methane at 60% of the LEL occurs at 100 m from the tank in the downwind direction and is displayed as the orange dotted line in Figure 5-3.

The model outputs are provided in **Appendix B**.

A large 1 m diameter hole or leak in the tank would create a 78 m plume from the hole at the LEL and 114 m plume area at 60% of the LEL which creates some localised pockets of gas which could ignite. However, methane rapidly dissipates into the atmosphere minimising the timeframe for potential exposure in an emergency event.

This 114 m potential area of 60% LEL is the hazard criterion within the HIHAP which if exposed offsite would trigger a hazardous industry. This distance is within the boundary of the site and as such does not pose a risk to the surrounding community.





Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 5-3 Unignited Vapour Cloud Release - Flammable Gas Hazard Impact Zones

Key

- Proposed Biodigester Facility
- Existing Abattoir Building
- Bio-Filter
- New Render Building

0 25 50
Metres

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Date (3/10/2014)

5.3.2 Asphyxia Hazard Area

A methane vapour release can cause asphyxia through displacement of oxygen and presence of the hydrogen sulphide. The modelling indicates that there is a potential threat zone however it is noted that dispersion predictions are less reliable for such short distances. Nevertheless, CDM Smith have conservatively indicated the potential zones in Figure 5-4 to show the immediate areas where asphyxia could occur in the unlikely event of a 1m hole in both the membrane and tank.

- Within a 14 m vapour plume from the hole downwind there could be 870,000 ppm methane, creating a primarily oxygen deficient environment where breathing would not be possible. This is displayed as the red area in Figure 5-4.
- Within a 20 m vapour plume from the hole downwind there could be 435,000 ppm methane, this would contain enough hydrogen sulphide levels to cause illness if a person were to remain this area. This zone has been indicated by the orange area in Figure 5-4.

A vapour cloud release can occur where a significant volume of biogas is released immediately without igniting; such an event would create a flammable hazard area and an asphyxiation risk to personnel within the vicinity.

5.3.2.1 Asphyxiation and Intoxication (Poisoning) Risk

The exposure to methane itself is not a significant health risk as it is not suspected of causing cancer, no long term health effects are currently associated with exposure to methane and it is rapidly eliminated from the body.

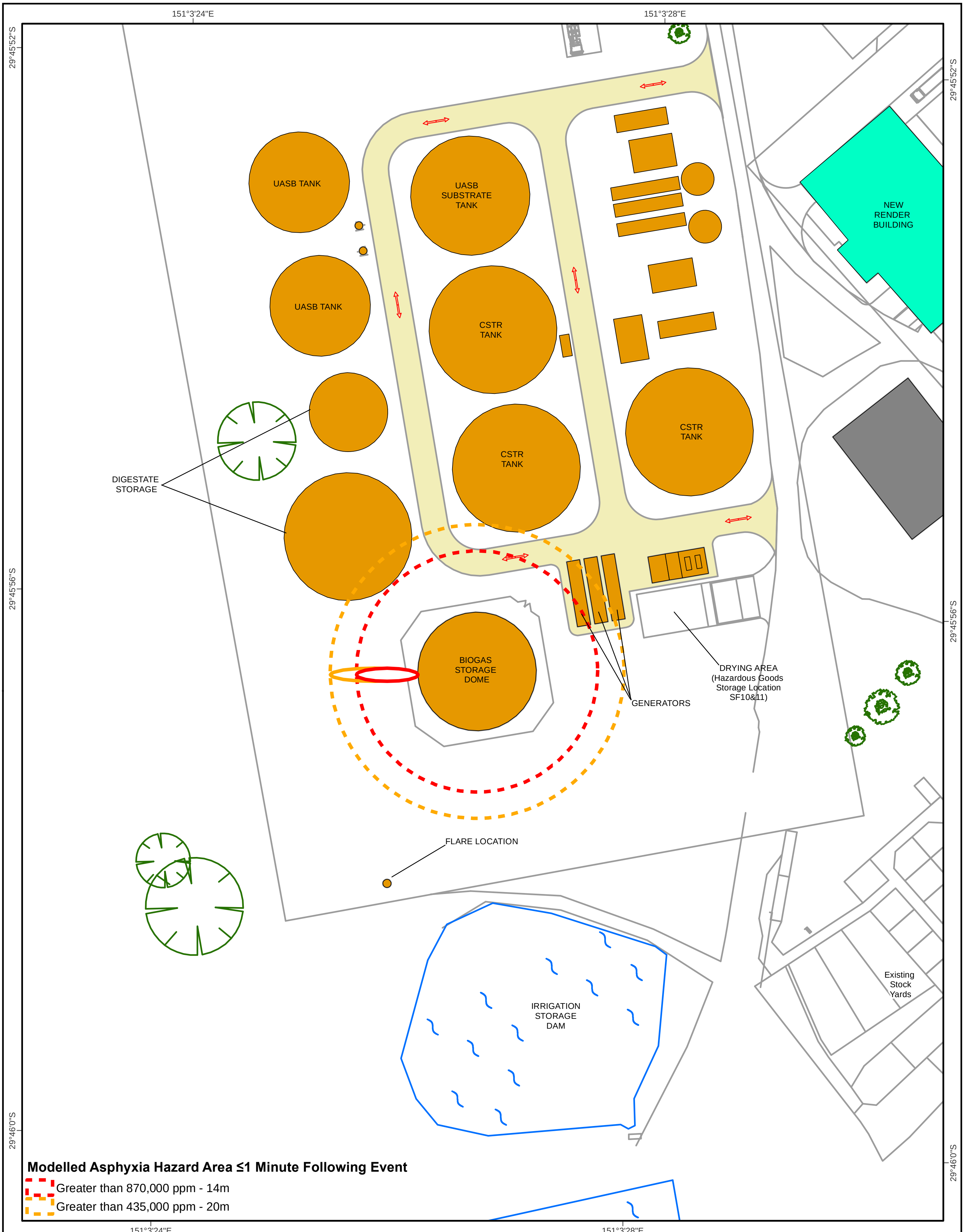
The only health effect of methane exposure is displacement of oxygen causing a risk of asphyxiation. Immediately or shortly after exposure to oxygen levels of less than 15% in air, a person may feel tired, dizzy, and have a headache. Asphyxiation can occur at 87% methane due to oxygen deficiency. This condition can occur within 14 m of the tank after a catastrophic release, this is well within the site boundary and poses no offsite risk of this hazard to the surrounding community or sensitive receptors.

In addition, biogas contains hydrogen sulphide which is a toxic gas that is heavier than air. At low levels, it has a characteristic odour similar to rotten eggs. It is produced during anaerobic decomposition of manure. Dangerous levels of the gas may be present during agitation and pumping of deep manure pits. Many deaths related to hydrogen sulphide exposure have occurred, one possible reason that fatalities occur so often is that olfactory senses are paralyzed at high concentrations and so victims cannot detect odours.

An offensive odour is detectable at 3 to 5 ppm with eye irritation at 10 ppm. Irritation to mucous membranes and lungs occurs at 20 ppm. Olfactory-nerve paralysis occurs at 150 ppm, followed by headaches, dizziness and nervous system depression at 200 ppm. Nausea, excitement, insomnia and death may occur after 30 minutes of exposure at 500 to 600 ppm. It is rapidly fatal at 700 to 2000 ppm (Agricultural and Bio systems Engineering College, Iowa State University).

The biogas composition contains 398.3 ppm which may result in concentrations of 200 ppm occurring for 20 minutes at a distance of 19 m from the tank. A live and capable person would, however, move. It is unlikely to cause death but could cause headaches, dizziness and nervous system depression.

The likelihood of such a significant puncture in both tanks to release such a volume of gas is rare and as such poses a low risk onsite and no risk to areas beyond the boundary.



Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 5-4 Unignited Vapour Cloud Release - Asphyxia Hazard Area

Key

- Proposed Biodigester Facility
- Existing Abattoir Building
- New Render Building

0 15 30
Metres

N E S W

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Date (3/10/2014)

5.4 Cumulative Impacts and Risks to other Hazardous Substances from Explosions or Release

CDM Smith analysed the blast pressure and thermal risk of an incident involving one gas sphere. In addition to the biogas tank, the site digester drying shed (25 m to the north-east of the biogas tank) will store organic polymers, sulphuric acid and ferric chloride solution. This drying shed is within the second and third hazard stages for jet fire and vapour cloud explosions (Refer to Figure 5-1 and Figure 5-2). At high temperatures ferric chloride solution can produce toxic hydrogen chloride and phosgene gases, while sulphuric acid can produce toxic sulphur dioxide. The primary cumulative hazard identified (through the placement of these substances in proximity to the biogas tank) was the heating of the substances to a point where the gases reached explosive concentrations inside the confined space (ICB).

In order to assess the potential cumulative impact CDM Smith undertook additional methane concentration modelling for the proposed storage location of the hazardous substances (refer to modelling data in the last two pages of **Appendix A**). CDM Smith calculated that the heat flux in the worst-case scenario would raise the temperature of a half-full ICB by 4.4 °C in eight minutes. This temperature increase would not significantly alter the degradation rate of the materials and therefore subsequent explosions through a pressure build-up in the ICB are extremely unlikely. Additionally, as identified in Section 5.2.1, a blast pressure of 7,000 pascals was never exceeded during the modelling. A blast pressures of less than 7,000 pascals (note: modelling only reached 3,500 pascals) are unlikely to damage a 1,000 litre ICB and therefore release of any gases produced is also unlikely. Furthermore, it is noted that the drying shed will be partially enclosed which would slightly delay the heating of the substances.

In the worst-case scenario (extremely unlikely), if an ICB containing one of the abovementioned substances was to explode, any gaseous releases would be subsequent, not simultaneous, because the substances in the ICBs need time to heat before a risk emerges. A person or structure near the drying shed may experience blast pressure to a lesser extent than experienced by the initial jet fire or vapour cloud explosion from the biogas tank. No additional heat would be experienced as these are non-flammable substances. Subsequent skin, eye and mucous membrane irritation and breathing difficulty may occur through direct contact or inhalation of any hydrogen chloride, phosgene or sulphur dioxide gases however this would be localised around the drying shed and would not produce impacts offsite.

In addition to the above, it is unlikely that any of the events addressed within this document would impact on other dangerous goods storages onsite, as these storages are of a significant distance away from the biogas facility and drying shed that no cumulative impact in the event of an emergency is likely. The chlorine is located 398 m away at the far eastern side of the site and the ammonia is located 238 m away. Both of these locations are outside the potential impact zone for any of the scenarios modelled within this assessment which had a maximum impact area of 114 m where any such impact may be possible in a worst case event.

Figure 5-5 below shows a summary of the impacts in the worst case scenarios for the storage of Biogas. The modelling as illustrated clearly shows that there will be no offsite impacts or hazards imposed upon the surrounding community from this development.

Bindaree Beef Abattoir - Hazard and Risk Assessment Locations

Figure 5-5 Overview of Worst Case Scenario Impacts and Distance to Boundary of Site

Key

- Sensitive Receptor
- Designated Buffer Area
- Property Boundary
- Proposed Biodigester Facility
- Bio-Filter
- Existing Abattoir Building
- Existing Render Building
- New Render Building
- High hazard zone (20m)
- Possible injury zone (78m)
- Injury unlikely (114m)

0 100 200
Metres

N W E S

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Date (3/10/2014)

5.5 Key Preventive Measures

CDM Smith's scope of works was limited to assessment and modelling of impacts in accordance with SEPP 33 to determine if hazards related to the proposed facility could impact offsite areas. CDM Smith has determined that potential events arising from the facility will not impact offsite areas. Nevertheless, the following are recommended preventative measures to reduce the likelihood of an event occurring and the consequence of the associated impacts onsite:

- **Impact Free Area** – An exclusion zone is to apply around the tank to protect the tank against dangerous impacts, this can be developed from impact bollards or secure fencing. This area should be clear of anything which could give rise to fire, explosion, and damage to the tank by mechanical impact (collapsing, wind throw, objects carried off in case of storm etc).
- **Ignition Source Prohibition** – The New South Wales *Work Health and Safety Act 2011* requires a person conducting a business to ensure, so far as is reasonably practicable, the health and safety of their workers while at work in the business or undertaking. It is therefore recommended that the biogas tank be isolated from spark-producing equipment. Onsite safety setback zones should be identified by the infrastructure provider. However, without specific details of the safety measures and controls built into the system, CDM Smith recommends that reliable ignition sources (e.g. open flames, smoking etc) should be kept 40 m (measured at the nearest point on the perimeter, not the centre) from the tank. It is advisable that work crews within this zone use combustible gas detectors. Furthermore, while not recommending complete prohibition of secondary ignition sources (e.g. generators, tank pump motors, controls, car engines etc) within the 40 m zone, the ignition risk posed by these sources should be assessed by the proponent with complete consideration of the safety measures and controls built into these sources by the manufacturers.
- **Emergency Flare** – Emergency flares could exist within the ignition source prohibition area as they are only used intermittently and provided appropriate safety is built into the design. The risk associated with the emergency flare needs to be considered including the use of electric ignition systems, the use of a flare without pilot fuel and use of an enclosed flare if practical (Australian Pork Limited 2012). The design of the flare burner management system should meet Australia Standard 3814: Industrial and Commercial Gas-fired Appliances. The best practice principles outlined in the Code of Practice for On-farm Biogas Production and Use (Piggeries) (Australian Pork Limited 2012) should be followed, these include:
    - The location of the flare shall be such that in the event of unburnt gas being vented, it will not cause a hazard;
    - To minimise fire risk, a biogas flare needs to be installed outside hazardous zones established by other parts of the biogas plant, and shall be installed with a setback of at least 6 metres from any building or potentially flammable structure (i.e. grain silo) (GAOHSA 2008) as well as any gas carrying part of the biogas plant (other than the biogas transfer pipeline);
    - The materials selection for all valves and components shall be compatible with biogas and the associated leachate or condensates;
    - The provision of a flame arrester at the flare inlet or the provision of a temperature sensor to initiate a shutdown if there is the presence of heat at the flare inlet. The use of a fusible link can also be used for this function and is the preferred option;
    - The provision of a safety shut-off system for the gas;

- The electrical installation to be compliant with AS 3000 Electrical installations;
- The flare ignition system shall work continuously during operation. Alternatively, the flare can be fitted with a flame monitoring system that automates gas shut off, self-check and re-ignition;
- Where a blower is required, it is to be compliant with the hazardous zone rating, earthing requirements of the gas blower and the flare system to be assessed;
- Specifically for flares associated with CAPs operating under negative pressure, the extraction system shall have some form of pressure and/or oxygen control to ensure that no excessive amounts of oxygen are induced into the gathering system; and
- To prevent access to the flare by unauthorised persons and animals, the installation of a security fence is recommended. However, shut off valves and other safety features need to remain easily accessible. (Australian Pork Limited 2012)

- **Restricted Access** – A lockable hatch cover can prevent entry, but would probably be more cost-effective to use a fence with lockable gate which would encompass the tank, digester, and gas reception pit; plus a fence around the base of the flare.
- **Fire Fighting Equipment** – Sufficient fire fighting equipment to be located within the vicinity of the tanks.
- **Boundary Separation Distances** – Maintain at least 130 m from the boundary of the property to avoid the potential modelled impacts from the worst case major event hazard with the biogas tanks.
- **Leak Detection –** Design of the tank to have leak detection system in addition to training of staff that hydrogen sulphide causes a "rotten egg" smell and if they can smell it, the level may be too high to be safe.
- **Compliance with Health and Safety Requirements** – The containment, extraction and treatment of any biogas generated must comply with *Australian Standard AS 2865-1986 Safe Working in a Confined Space*, the *NSW Occupational Health and Safety (Confined Spaces) Regulation 1990* and the *NSW Occupational Health and Safety Act 2000.*
- **Procedures and Maintenance** – Occupiers of such facilities must implement and maintain emergency and response procedures and plans in accordance with the requirements of the occupational health and safety standards specified in the design requirement above.
- **Site Procedures and Training** – Establishment of procedures and training of staff to meet the requirements of the occupational health and safety standards specified in the design requirement above.

Section 6 Conclusion

In conclusion the three major risk consequences from the storage of biogas at the Bindaree Beef Abattoir are the release of a jet fire from tank puncture, a vapour cloud explosion from a tank rupture or start-up and the unignited release of a significant amount of biogas onsite. The modelled events will not have offsite impacts and this development is classified as a potentially hazardous development for sensitive receptors if developed within the limited area identified around the site in accordance with the SEPP 33 process, however, it is unlikely to pose any hazards to the surrounding community.

The potential for incidents is well understood and the design of the proposed biogas storage facility and equipment will minimise the probability of an incident occurring and mitigating an incident if it did occur. The consequence of these worst case scenarios are only considered to have a major impact with no catastrophic impacts predicted. In addition, the likelihood of these events are all low to rare and as such are not considered to be significant onsite risks provided that internal health and safety measures are implemented to mitigate and manage the risks.

The preliminary hazard and risk assessment meets the requirements of the SEPP 33 process and assessment of the proposed works has found that the levels of risks to the biophysical environment and to the safety of the public, staff and contractors from the project can be reduced to ALARP levels through design, operational controls and ongoing monitoring of the storage facility.

The present risk assessment has shown that the overall risk associated with the proposed project is very low and does not introduce an excessive additional risk to the surrounding community.

References

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NSW Government (2011), Hazardous Industry Planning Advisory Paper No 6: Hazard Analysis published in January 2011, ISBN 978-0-73475-862-0.

Ruihong Zhang, and Hongwei Xin, (1994) *Agricultural and Biosystems Engineering Department*, Iowa State University, Ames, Presented at the 1994 National Poultry Waste Management Symposium, Athens, Georgia, October 31.

Salvi. O., Chaubet. C., Evanno. S. (2012), *Improving the safety of Biogas Production in Europe*, Revista de Ingenieria 37(pp57-65).

Workcover NSW (2005), *Storage and Handling of Dangerous Goods*, Code of Practice, NSW Government.

Glossary

Term / Abbreviation	Meaning
Ignition Source	A source of energy sufficient to ignite combustible dusts, combustible fibres, flammable vapours, flammable gases or flammable or combustible fumes, and includes the following: ▪ A naked flame; ▪ Exposed incandescent material; ▪ Hot surfaces; ▪ Radiant heat; ▪ A spark from mechanical friction; ▪ A spark from static electricity; and ▪ An electrical arc.
Protected Work	Mean any: ▪ Dwelling house; ▪ Government or public building, church, chapel, college, school, hospital, theatre or public hall; ▪ Shop, factory, warehouse, store or other building or any timber yard, in which any person is employed or engaged in a trade, business or profession; ▪ Building or structure in or about which persons are usually present or from time to time assemble; or ▪ Reservoir used for the supply of reticulated water to the public.
Separation	In relation to the separation of dangerous goods from a person, property or thing, means the physical separation of the dangerous goods from the person, property or thing, by either distance or a physical barrier.

Appendix A - Modelling Results

Consistent with CDM Smith practice in the past, we determined the impact zones using ***Areal Locations of Hazardous Atmospheres*** (ALOHA) program which is the air modelling element of ***CAMEO***, a program suite that assesses the health and safety impacts of emergency releases. It was produced as a joint effort of the US Environmental Protection Agency (US EPA) and the US National Oceanic and Atmospheric Administration (NOAA). It has been successfully used for decades and is currently in revision 5.4.4. CAMEO is recognised and supported within industry and ALOHA is widely used for the purposes required in this assessment.

ALOHA has some limitations when it comes to modeling the dispersion of gas mixtures at stable meteorological conditions and low wind speeds. These shortcomings are more important for modeling toxic exposures and less important for modeling the effects of fire. Indeed, the conditions where the model starts to fail are precisely those in which the distance to hazardous endpoint is smallest and the off-site community is apparently safest.

In addition, ALOHA's internal emissions algorithm would have required us to assume that the gas was pure methane and that we store it at a pressure of 100 millibars, gauge. This gas contains 28% carbon dioxide by volume and is stored at 10 millibars, gauge. That algorithm was not useful for our purpose.

We used an ideal gas emissions formula to calculate the emission rate of the gas mixture, and then use ALOHA to calculate the blast pressure, thermal, and concentration effects of the releases and subsequent fires. This approach sufficiently addressed ALOHA's problems in dealing with low gas pressures. We have been conservative in doing this and it clearly demonstrates that there are no offsite impacts.

Emissions from Digester Gas Tanks at Bindaree Beef

Constants	first minute, P = 10 millibar			subsequent, P = 6 millibar	
Co	0.61			0.61	
A	0.785	1 m circle		0.785	1 m circle
Po	102,338	Pascals		101,933	Pascals
P1	101,325	Pascals		101,325	Pascals
gc	1	N/N		1	N/N
Mole weight	23.29	Daltons		23.29	Daltons
%Ch4 by mass	50.28%	w/w		50.28%	w/w
Rg	8314.3	PA M3/Kmole °K		8314.3	PA M3/Kmole °K
To	298.15	°K		298.15	°K
	1.32	Heat cap ratio		1.32	Heat cap ratio

Calculations	first minute, P = 10 millibar			subsequent, P = 6 millibar	
coefficient	49029.53	CoAPo		48835.35	CoAPo
pressure factor	0.0024			0.0014	
gamma factor	4.13			4.13	
gas factor	7.751E-05			7.751E-05	
Root base	1.839E-07			1.113E-07	
Square root	0.000429			0.000334	
Mass flow	21.03	kg of gas/second		16.29	kg of gas/second
flow / minute	1262	kg of gas / min		978	kg of gas / min
flow / minute	634	kg of CH_4 / min		491	kg of CH_4 / min

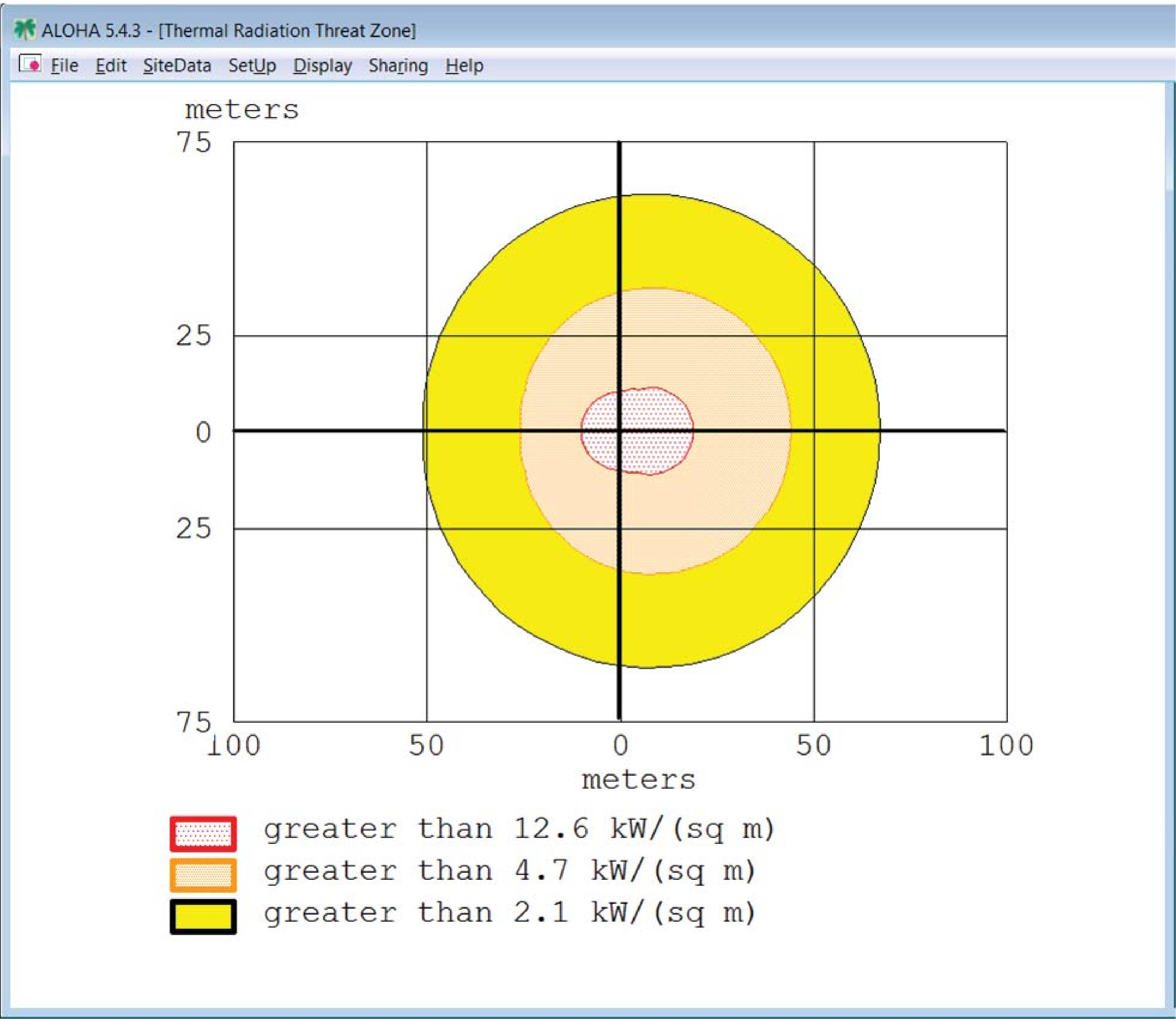
Event Scenario 1 - Vapour release from tank - Heat 1m hole at 1min

Text Summary ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                    Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm      PAC-2: 2900 ppm      PAC-3: 17000 ppm
  LEL: 50000 ppm       UEL: 150000 ppm
  Ambient Boiling Point: -162.1° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country             Cloud Cover: 5 tenths
  Air Temperature: 25° C                     Stability Class: C
  No Inversion Height                        Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in spherical tank
  Flammable chemical is burning as it escapes from tank
  Tank Diameter: 25.5 meters                 Tank Volume: 8,682 cubic meters
  Tank contains gas only                     Internal Temperature: 25° C
  Amount of Chemical in Tank: 8,746 cubic meters
  Internal Press: 1.1001 atmospheres
  Circular Opening Diameter: 40 centimeters
  Max Flame Length: 33 meters                Burn Duration: 2 minutes
  Max Burn Rate: 621 kilograms/min
  Total Amount Burned: 711 kilograms

THREAT ZONE:
  Threat Modeled: Thermal radiation from jet fire
  Red   : 19 meters --- (12.6 kW/(sq m))
  Orange: 44 meters --- (4.7 kW/(sq m))
  Yellow: 67 meters --- (2.1 kW/(sq m))
```

CDM Smith software manipulation notes:

To achieve a 10 millibar pressure manual calculations of emissions of gas was first undertaken in a spreadsheet to determine that 40cm hole within the model would produce the equivalent amount of gas released as a 1m diameter hole at low pressure.


ALOHA 5.4.3 - [Thermal Radiation Threat Zone]
File Edit SiteData SetUp Display Sharing Help
meters
75
25
0
25
75
100
50
0
50
100
meters
greater than 12.6 kW/(sq m)
greater than 4.7 kW/(sq m)
greater than 2.1 kW/(sq m)

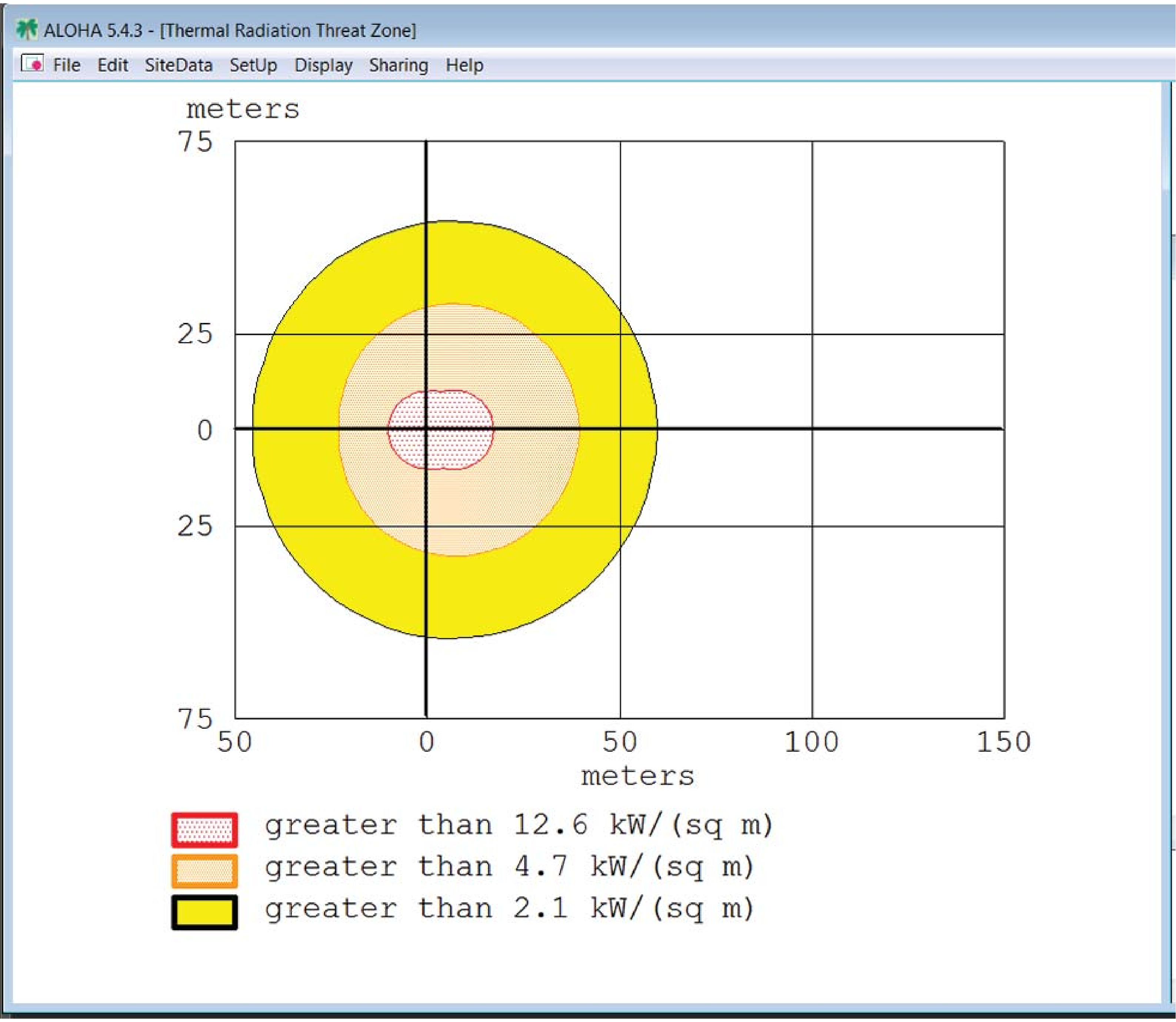
Event Scenario 1 - Vapour release from tank - Heat 1m hole later impacts

Text Summary

ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                   Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm    PAC-2: 2900 ppm      PAC-3: 17000 ppm
  LEL: 50000 ppm     UEL: 150000 ppm
  Ambient Boiling Point: -162.1° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 25° C                   Stability Class: C
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in spherical tank
  Flammable chemical is burning as it escapes from tank
  Tank Diameter: 25.5 meters               Tank Volume: 8,682 cubic meters
  Tank contains gas only                   Internal Temperature: 25° C
  Amount of Chemical in Tank: 8,746 cubic meters
  Internal Press: 1.1001 atmospheres
  Circular Opening Diameter: 35 centimeters
  Max Flame Length: 29 meters              Burn Duration: 3 minutes
  Max Burn Rate: 475 kilograms/min
  Total Amount Burned: 711 kilograms

THREAT ZONE:
  Threat Modeled: Thermal radiation from jet fire
  Red   : 18 meters --- (12.6 kW/(sq m))
  Orange: 40 meters --- (4.7 kW/(sq m))
  Yellow: 60 meters --- (2.1 kW/(sq m))
```

CDM Smith software manipulation notes:

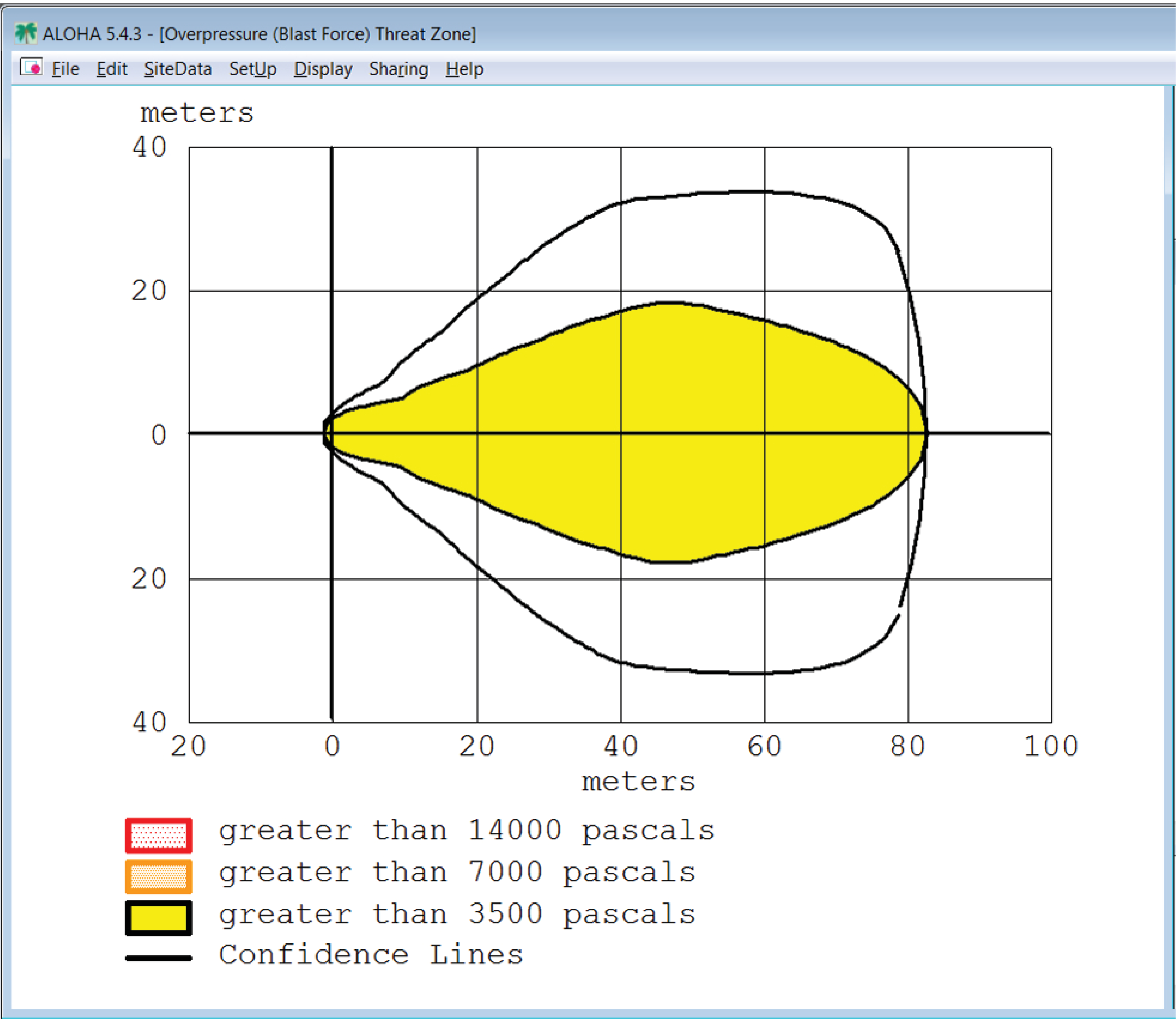

ALOHA 5.4.3 - [Thermal Radiation Threat Zone]
File Edit SiteData SetUp Display Sharing Help
meters
75
25
0
25
75
50
0
50
100
150
meters
greater than 12.6 kW/(sq m)
greater than 4.7 kW/(sq m)
greater than 2.1 kW/(sq m)

Event Scenario 2: Ignited gas explosion from tank - 1m hole Vapour Cloud Fire LEL

Text Summary ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                     Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm     PAC-2: 2900 ppm       PAC-3: 17000 ppm
  LEL: 50000 ppm      UEL: 150000 ppm
  Ambient Boiling Point: -162.1° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country             Cloud Cover: 5 tenths
  Air Temperature: 25° C                     Stability Class: C
  No Inversion Height                        Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 491 kilograms/min           Source Height: 0
  Release Duration: 25 minutes
  Release Rate: 491 kilograms/min
  Total Amount Released: 12,275 kilograms
  Note: This chemical may flash boil and/or result in two phase flow.
     Use both dispersion modules to investigate its potential behavior.

THREAT ZONE:
  Threat Modeled: Overpressure (blast force) from vapor cloud explosion
  Type of Ignition: ignited by spark or flame
  Level of Congestion: uncongested
  Model Run: Gaussian
  Red   : LOC was never exceeded --- (14000 pascals)
  Orange: LOC was never exceeded --- (7000 pascals)
  Yellow: 83 meters --- (3500 pascals)
```

CDM Smith software manipulation notes: The model only operates at 100millibar pressure and was thus adjusted to model at 27cm hole as this would achieve a 10millibar pressure release at 100cm diameter hole and thus model the same impacts.

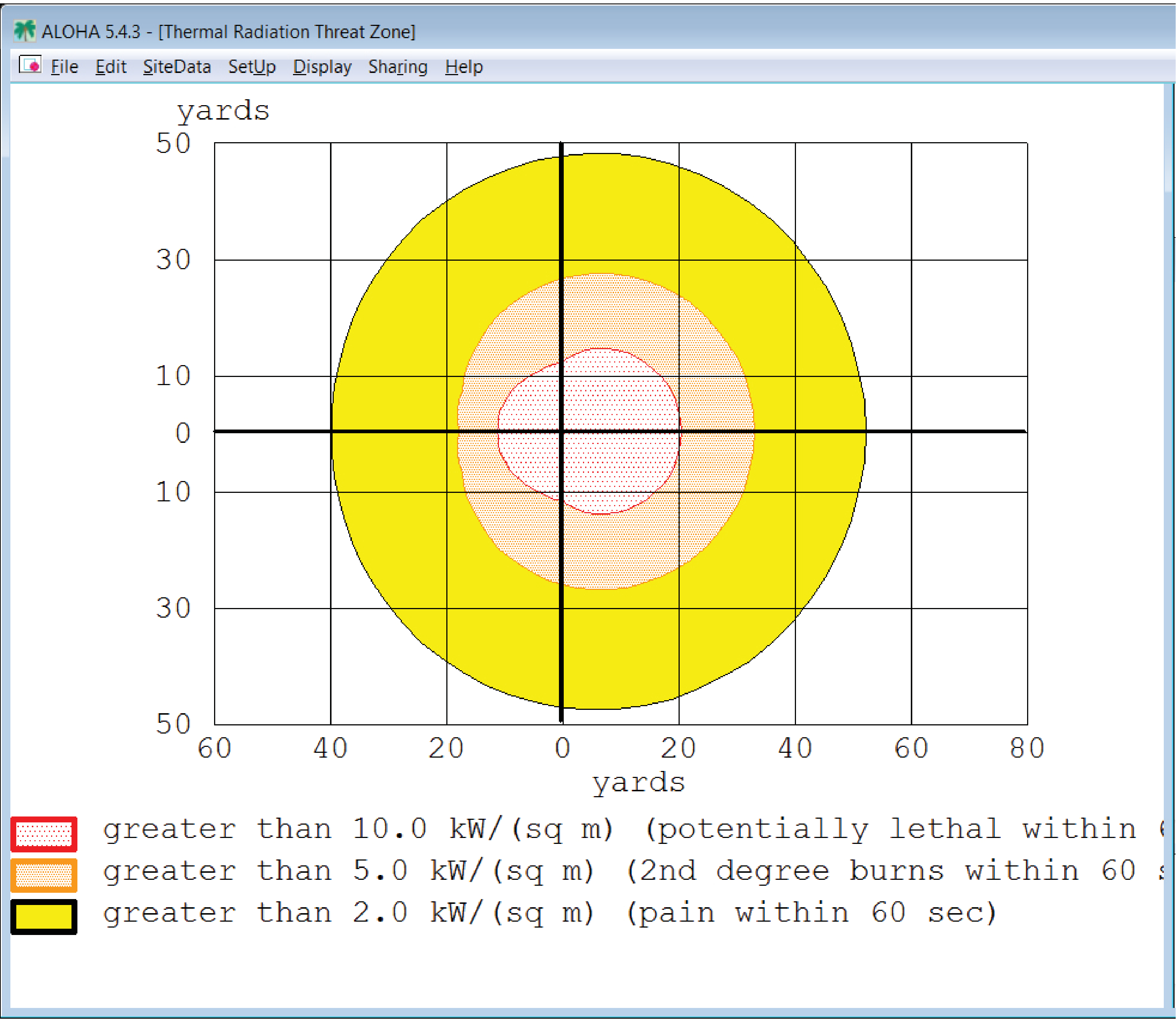

ALOHA 5.4.3 - [Overpressure (Blast Force) Threat Zone]
File Edit SiteData SetUp Display Sharing Help
meters
40
20
0
20
40
20
0
20
40
60
80
100
meters
greater than 14000 pascals
greater than 7000 pascals
greater than 3500 pascals
Confidence Lines

Event Scenario 2 - Ignited gas explosion from tank - Blast zone latter with 1m hole

Text Summary ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                  Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm    PAC-2: 2900 ppm     PAC-3: 17000 ppm
  LEL: 50000 ppm     UEL: 150000 ppm
  Ambient Boiling Point: -259.7° F
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country          Cloud Cover: 5 tenths
  Air Temperature: 25° C                  Stability Class: C
  No Inversion Height                     Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in spherical tank
  Flammable chemical is burning as it escapes from tank
  Tank Diameter: 25.5 meters              Tank Volume: 8,682 cubic meters
  Tank contains gas only                  Internal Temperature: 25° C
  Amount of Chemical in Tank: 8,746 cubic meters
  Internal Press: 1.1001 atmospheres
  Circular Opening Diameter: 27 centimeters
  Max Flame Length: 24 yards              Burn Duration: 5 minutes
  Max Burn Rate: 623 pounds/min
  Total Amount Burned: 1,568 pounds

THREAT ZONE:
  Threat Modeled: Thermal radiation from jet fire
  Red   : 21 yards --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
  Orange: 33 yards --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
  Yellow: 52 yards --- (2.0 kW/(sq m) = pain within 60 sec)
```

CDM Smith software manipulation notes:

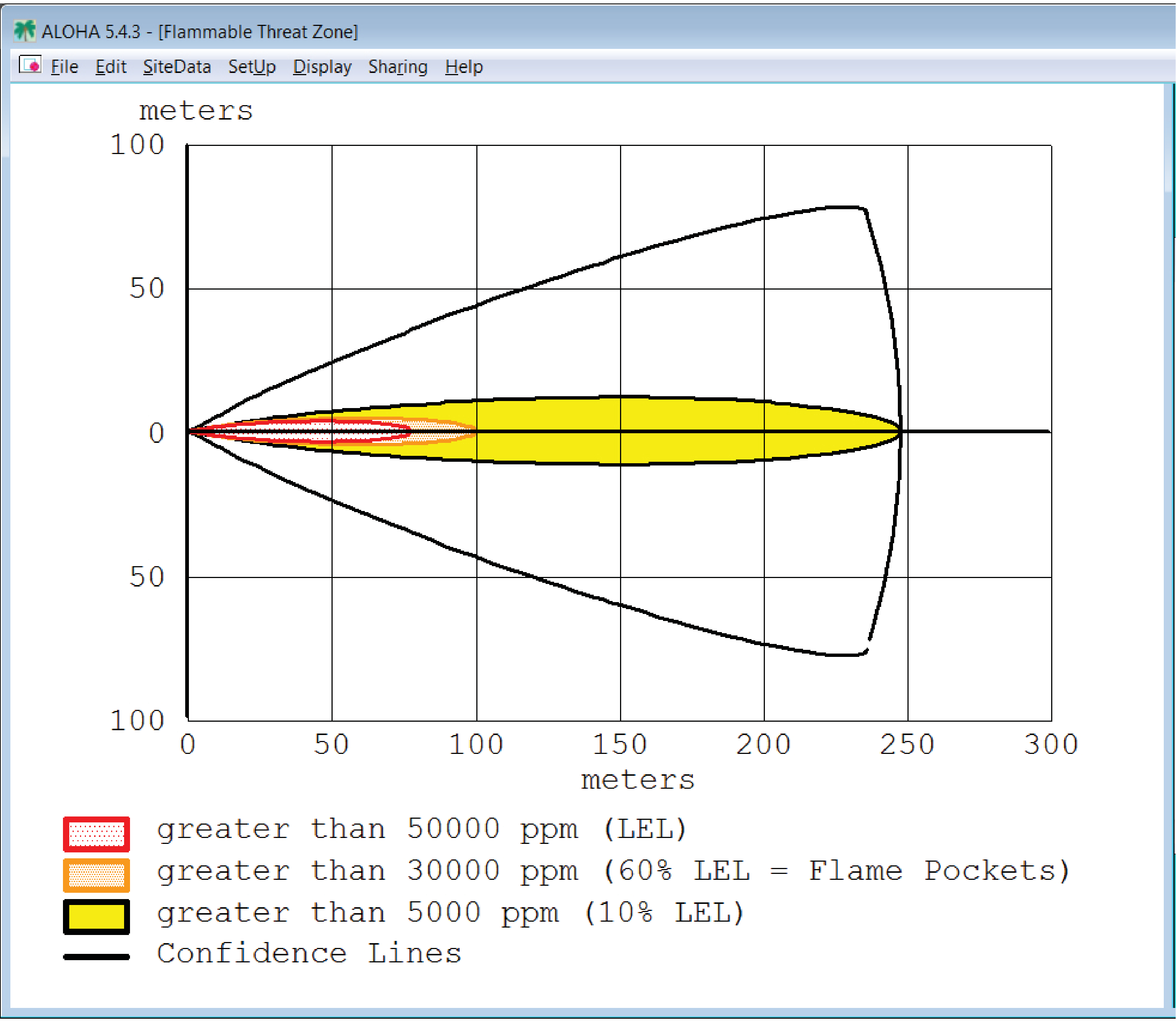

ALOHA 5.4.3 - [Thermal Radiation Threat Zone]
File Edit SiteData SetUp Display Sharing Help
yards
50
30
10
0
10
30
50
60 40 20 0 20 40 60 80
yards
greater than 10.0 kW/(sq m) (potentially lethal within
greater than 5.0 kW/(sq m) (2nd degree burns within 60
greater than 2.0 kW/(sq m) (pain within 60 sec)

Event Scenario 2 - Ignited gas explosion from tank - LEL Zone later 1m hole

Text Summary

ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                     Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm    PAC-2: 2900 ppm     PAC-3: 17000 ppm
  LEL: 50000 ppm     UEL: 150000 ppm
  Ambient Boiling Point: -162.1° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 25° C                   Stability Class: C
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 491 kilograms/min         Source Height: 0
  Release Duration: 25 minutes
  Release Rate: 491 kilograms/min
  Total Amount Released: 12,275 kilograms
  Note: This chemical may flash boil and/or result in two phase flow.
     Use both dispersion modules to investigate its potential behavior.

THREAT ZONE:
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Gaussian
  Red   : 78 meters --- (50000 ppm = LEL)
  Orange: 100 meters --- (30000 ppm = 60% LEL = Flame Pockets)
  Yellow: 248 meters --- (5000 ppm = 10% LEL)
```

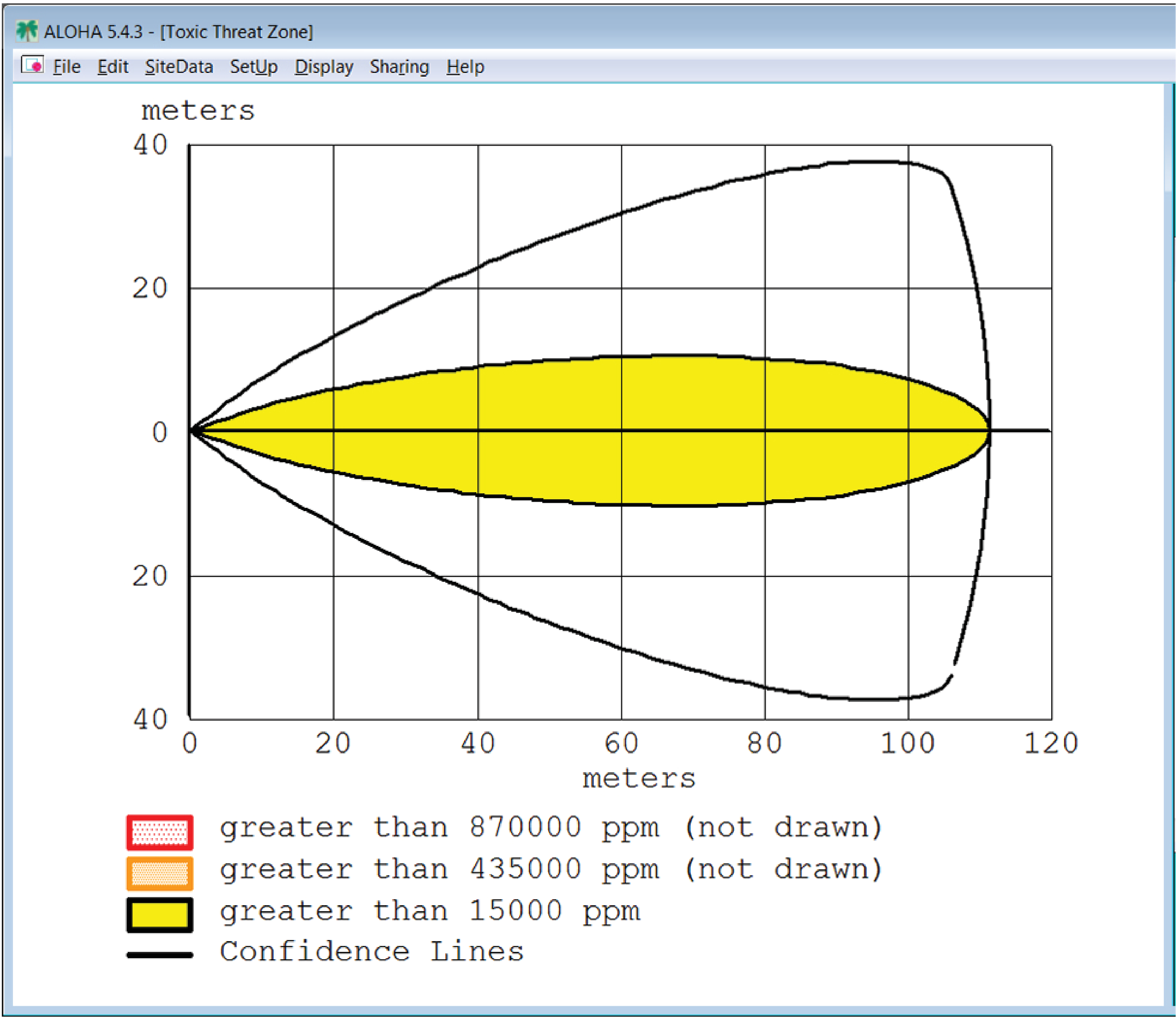

ALOHA 5.4.3 - [Flammable Threat Zone]
File Edit SiteData SetUp Display Sharing Help
meters
100
50
0
50
100
0
50
100
150
200
250
300
meters
greater than 50000 ppm (LEL)
greater than 30000 ppm (60% LEL = Flame Pockets)
greater than 5000 ppm (10% LEL)
Confidence Lines

Event Scenario 3 - Asphyxia with 100cm hole

Text Summary

ALOHA® 5.4.3

```
SITE DATA:
  Location: INVERELL, NEW SOUTH WALES, AU
  Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
  Time: October 22, 2013  1107 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: METHANE                   Molecular Weight: 16.04 g/mol
  PAC-1: 2900 ppm    PAC-2: 2900 ppm     PAC-3: 17000 ppm
  LEL: 50000 ppm     UEL: 150000 ppm
  Ambient Boiling Point: -162.1° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3 meters/second from NNW at 3 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 25° C                   Stability Class: C
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 600 kilograms/min         Source Height: 0
  Release Duration: 20 minutes
  Release Rate: 600 kilograms/min
  Total Amount Released: 12,000 kilograms
  Note: This chemical may flash boil and/or result in two phase flow.
     Use both dispersion modules to investigate its potential behavior.

THREAT ZONE:
  Model Run: Gaussian
  Red   : 14 meters --- (870000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Orange: 20 meters --- (435000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Yellow: 111 meters --- (15000 ppm)
```


ALOHA 5.4.3 - [Toxic Threat Zone]
File Edit SiteData SetUp Display Sharing Help
meters
40
20
0
20
40
0
20
40
60
80
100
120
meters
greater than 870000 ppm (not drawn)
greater than 435000 ppm (not drawn)
greater than 15000 ppm
Confidence Lines

Parameter	FeCl3	Polymer	Acid	Unit
distance	25			meters
gas flux	491			kg/min
heat flux	6.3			kW/m2
heat flux	6300			J/(sec*m2)
heat flux	378000			J / (min*m2)
duration	8.17			minutes
Surface	3	3	3	m2
Total Heat	9,264,780	9,264,780	9,264,780	joules
total mass	500	500	500	kilograms
Moles	27,778	27,778	27,778	moles
Specific Heat	75.31	75.31	75.31	J/(mol Deg)
Temp Increase	4.43	4.43	4.43	degrees C

Heat Effect of Jet Fire on the Hazardous Substance Storage Area (Drying Shed)

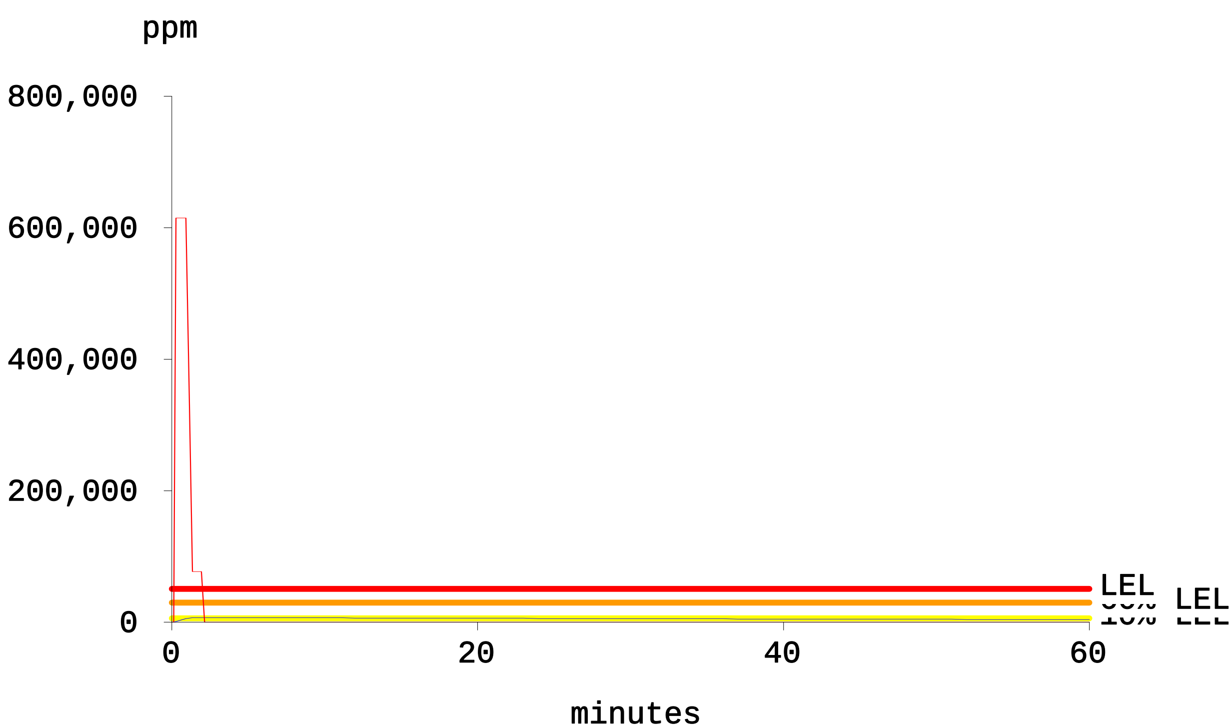
Containing:
1) Ferric Chloride Solution ($FeCl_3$)
2) Polymer ($CH_2CHCONH_2$)
3) Sulphuric Acid (H_2SO_4)

Methane Concentration Scenario at Hazardous Substance Storage Location (Drying Shed) - LEL Zone 1m hole.

Concentration at Point

ALOHA® 5.4.3

```
Time: October 22, 2013  1107 hours ST (user specified)

Chemical Name: METHANE

Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)

THREAT AT POINT:
  Model Run: Gaussian
  Concentration Estimates at the point:
  Downwind: 25 meters                    Off Centerline: 0 meters
  Max Concentration:
     Outdoor: 615,000 ppm
     Indoor:  7,010 ppm
```



Outdoor Concentration

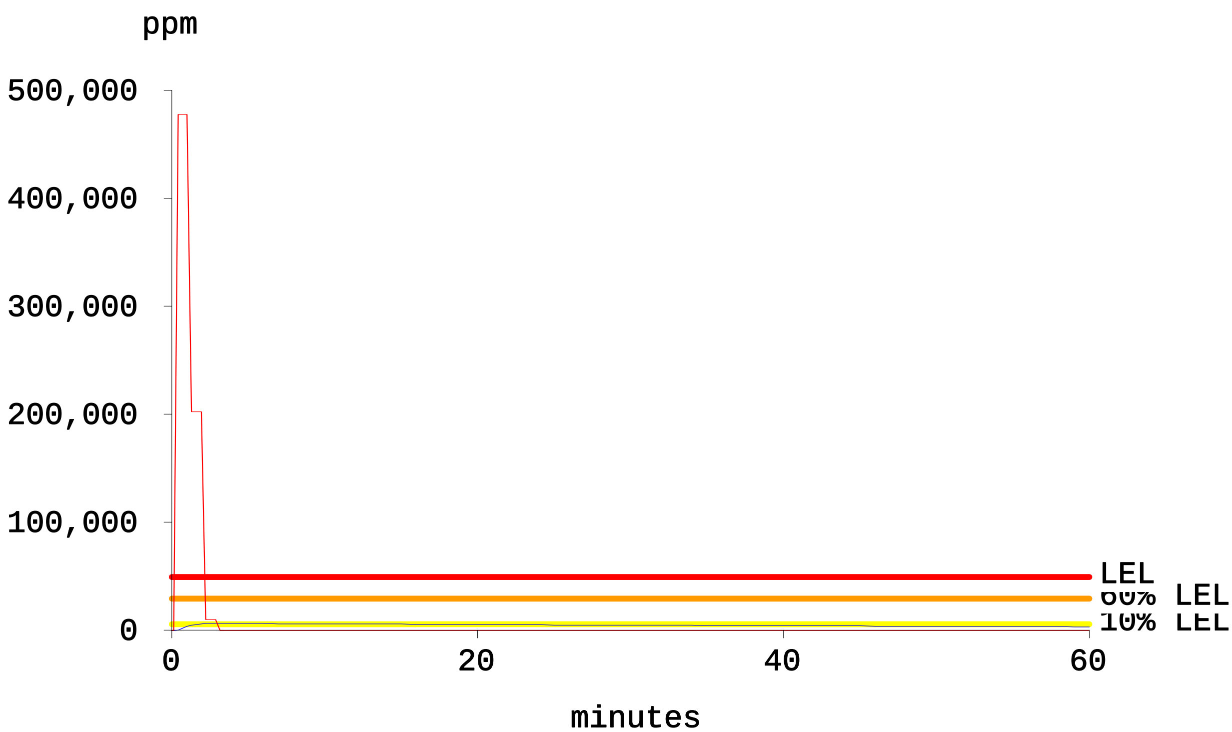
Indoor Concentration

At Point: Downwind: 25 meters Off Centerline: 0 meters

Methane Concentration Scenario at Hazardous Substance Storage Location (Drying Shed) - LEL Zone Later 1m hole.

Concentration at Point ALOHA® 5.4.3

```
Time: October 22, 2013  1107 hours ST (user specified)

Chemical Name: METHANE

Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)

THREAT AT POINT:
  Model Run: Gaussian
  Concentration Estimates at the point:
  Downwind: 25 meters                    Off Centerline: 0 meters
  Max Concentration:
     Outdoor: 478,000 ppm
     Indoor:  6,890 ppm
```



Outdoor Concentration

Indoor Concentration

At Point: Downwind: 25 meters Off Centerline: 0 meters

Appendix B - Disclaimer and Limitations

This report has been prepared by CDM Smith Australia Pty Ltd (CDM Smith) for the sole benefit of Mitchel Hanlon Consulting Pty Ltd for the sole purpose of addressing the hazards and risks associated with a biogas storage facility for Bindaree Beef as per SEPP 33.

The information on which this report is based has been provided by Mitchel Hanlon Consulting Pty Ltd and third parties. CDM Smith (including its officer and employee):

(a) Has relied upon and presumed the accuracy of this information;

(b) Has not verified the accuracy or reliability of this information (other than as expressly stated in this report);

(c) Has not made any independent investigations or enquiries in respect of those matters of which it has no actual knowledge at the time of giving this report to Mitchel Hanlon Consulting Pty Ltd; and

(d) Makes no warranty or guarantee, expressed or implied, as to the accuracy or reliability of this information.

In recognition of the limited use to be made by Mitchel Hanlon Consulting Pty Ltd of this report, Mitchel Hanlon Consulting Pty Ltd agrees that, to the maximum extent permitted by law, CDM Smith (including its officer and employee) shall not be liable for any losses, claims, costs, expenses, damages (whether in statute, in contract or tort for negligence or otherwise) suffered or incurred by Mitchel Hanlon Consulting Pty Ltd or any third party as a result of or in connection with the information, findings, opinions, estimates, recommendations and conclusions provided in the course of this report.

If further information becomes available, or additional assumptions need to be made, CDM Smith reserves its right to amend this report.