



CLIENTS | PEOPLE | PERFORMANCE

Cargill Beef Australia

Proposed Upgrade to Cargill Bomen Abattoir's Wastewater Treatment Ponds

Statement of Environmental Effects

January 2009





Contents

1.	Introduction	1
2.	Background and Context	2
2.1	Site location and Description	2
2.2	Site History	3
3.	Statutory Planning Requirements	4
3.1	Definition of the Proposed Project	4
3.2	Environmental Planning and Assessment Act 1979	4
3.3	State Environmental Planning Policies	5
3.4	Regional Environmental Plans	6
3.5	Existing Zoning	6
3.6	Consultation	7
4.	Existing Ponds and Operations	8
5.	The Proposed Development	9
5.1	Purpose of the proposed upgrade	9
5.2	Proposed upgrade	9
5.3	Capacity of the treatment ponds	10
5.4	Captured gas	11
6.	Statement of Environmental Effects	12
6.1	Permissibility and Objectives	12
6.2	Business Operation	12
6.3	Character of the Locality	12
6.4	Hazardous and Offensive Development	13
6.5	Natural Hazards	14
6.6	Odour Assessment	14
6.7	Waste Assessment	15
6.8	Soil and Water Assessment	17
6.9	Greenhouse Gas Emissions Assessment	19
6.10	Access and Egress	22
6.11	Fire and Safety	22
6.12	Heritage	23
6.13	Visual Assessment	23



6.14	Services and Infrastructure	24
6.15	Summary	25
7.	Justifications for the Modification	26

Table Index

Table 1	Design Water and Wastewater Flows	16
Table 2	Summary – Recent Influent Characteristics into Pond treatment train	16
Table 3	Meeting of Design requirements	18
Table 4	Biogas utilization by cogeneration	19
Table 5	Energy Efficiency of a Typical Engine	22
Table 6	Recoverable Energy Sources for 1.4 MW option	22
Table 7	Utilities and services	24

Figure Index

Figure 1	Location plan	2
Figure 2	Simplify Model of the Existing Wastewater System	8
Figure 3	Proposed upgrades	9
Figure 4	Simplify Model of the Proposed Wastewater System	10
Figure 5	Bushfire prone land	14
Figure 6	Proposed locations of the flare and Pond 2b on a 10 metres contour map	24

Appendices

- A Preliminary Hazard Assessment
- B Agenda for CBA Wastewater Treatment Ponds PFM



1. Introduction

This application is to request the Department of Planning (DoP) to consider and approve the proposed modification of the Development Application (DA No. 220-07-2002-i) for the proposed renovation of the existing wastewater treatment ponds on Lot 2 DP 700113. The proposed works include:

- » A new covered anaerobic pond (Pond 2b) will be created to replace Ponds 1 and 2. As a result:
 - Existing Pond 1 (anaerobic) will be decommissioned and remediated as necessary, and
 - Existing Pond 2 (anaerobic) will be maintained for standby;
- » The new Pond 2b will be created to replace Ponds 1 and 2;
- » A Flare will be erected nearby to burn off gas captured by Pond 2b;
- » Existing Ponds 3 (anaerobic) and 4 (aerobic) will remain the same; and
- » No changes to the source of the wastewater are proposed.

The existing ponds are located in the Bomen Abattoir, which is owned by Cargill Beef Australia (CBA). A Development Application (DA No. 220-07-2002-i) was lodged with the DoP in 2002 for the expansion of the facility and was approved by the Minister on 27 February 2003. Two subsequent modifications were lodged with the DoP in 2003 and 2004. Both modifications were approved by the Minister.

The current proposal will be the third modification and is considered to have the following merits:

- » Increased efficiency of the wastewater treatment system;
- » Significantly reduced odour emissions from the anaerobic ponds, and
- » Control emissions of greenhouse gases via capturing and flaring off gas in the proposed Pond 2b.

2. Background and Context

2.1 Site location and Description

Figure 1 Location plan



The Cargill Abattoir (the Abattoir) is part of Bomen Business Park in an industrial precinct. The precinct is home to general industries and potentially hazardous and offensive industries, such as a waste oil refinery, Caltex Fuel depot, livestock saleyards and the existing Abattoir.

The Abattoir's site is irregular in shape. It is primarily accessed via Dampier Street. The site consists of two allotments which are:

- » Lot 1 DP 840624 – the eastern part of the site, which houses the abattoir plant building; and
- » Lot 2 DP 700113 – the western part of the site, which includes the wastewater treatment ponds.

The wastewater treatment ponds are also located in Lot 2 DP 700113 and are situated between Cooramin Street (to the north) and the railway line (to the south). A Wagga Wagga City Council water reservoir is located on the top of a hill to the west of the ponds.

Lot 2 DP 700113 is an "8" shaped allotment, which the northern and southern parts are joined by a narrow neck along the railway line. The allotment has an area of approximately 64 hectares and accessed primarily via the Lot 1 DP 840624.



2.2 Site History

The existing ponds are located in Lot 2 DP 700113 Bomen. CBA purchased the Abattoir, which was originally established in the late 1940s, in 1991. CBA retained and maintained the existing ponds when they purchased the Abattoir.

Development Application (DA No. 220-07-2002-i) was lodged with the then Department of Urban Affairs and Planning (now DoP) in 2002 for the expansion of the facility. The proposal was classified as State Significant, Designated and Integrated Development under the Environmental Planning and Assessment Act 1979 (EPA Act) and was approved by the Minister on 27 February 2003.

An Environmental Impact Statement, prepared by HLA Enviroscience Pty Ltd (HLA) accompanied the Application. In the EIS, CFA proposed to “intensify existing production at the Bomen Abattoir to 14,000 of cattle per week, or 2,000 head per day over a seven day working week.”¹ The proposed \$30 million expansion to support the intensification included:

- » an increase in load out facility;
- » an increase in chiller capacity;
- » an increase in freezer capacity;
- » an increase in wastewater treatment capacity;
- » improvements in odour controls at the plans; and
- » an increase in product cold storage.

Two subsequent modifications were lodged with the DoP and approved by the Minister.

- » MOD-61-1-2003-i sought to alter the proposed layout of the Abattoir expansion and to amend Conditions 1.2 and 1.3 of the Consent relating to the scope of development. The modification was approved on 3 November 2003.²
- » MOD-4-1-2004-i sought to modify Condition 5.23 of the Consent relating to soil contamination and remediation. The modification was approved on 31 March 2004.³

¹ HLA-Enviroscience (2002) EIS for Bomen Abattoir Expansion Proposal, Executive Summary, p 1.

² HLA-Enviroscience (2003) SEE for Modification to the Bomen Abattoir Expansion Proposal.

³ HLA-Enviroscience (2004) SEE for Modification to the Bomen Abattoir Expansion Proposal.



3. Statutory Planning Requirements

3.1 Definition of the Proposed Project

The existing Abattoir is defined as a 'rural industry' under the provisions of Clause 4 of the Environmental Planning and Assessment Model Provisions 1980 (Model Provisions) being a development which involves the *"handling, treating, processing or packing of primary products and includes the servicing in a workshop of plant or equipment used for rural purposes in the locality."*

The proposed alterations and additions of the existing wastewater treatment plant is an ancillary component to the operation of the Abattoir.

3.2 Environmental Planning and Assessment Act 1979

3.2.1 Development with or without consent under the EPA Act

Planning and development in NSW is carried out under the legislative structure of the *Environmental Planning and Assessment Act 1979* (EPA Act). The EPA Act provides two separate and distinct methods of assessment under Parts 4 and 5 of the EPA Act.

- » Part 4 is concerned with development assessment, according to the Act and the environmental planning instruments and Regulations made under the Act;
- » Part 5 is concerned with assessing the environmental impacts of an "activity". Activities typically comprise public infrastructure, such as railways, utilities and roads. The Development consent requirements of environmental planning instruments do not usually apply to 'activities'. However, each activity does require an assessment of the impacts of that activity upon the environment.

The original development proposal was assessed under Part 4 of the EPA Act. Therefore this modification will also be assessed under Part 4 of the EPA Act.

3.2.2 Designated Development

The original DA is classified as a 'designated development' pursuant to Category 22 under Schedule 3 of the *Environmental Planning and Assessment Regulation 2000* (EPA Regulation). Therefore this modification is subject to the provisions of Part 2 of Schedule 3 (Are alteration or addition designated development?) of the EPA Regulation.

The Director General's Requirements (DGRs) issued on 19 November 2008 requires a Statement of Environmental Effects (SEE) to accompany the application. Thus an Environmental Impact Statement (EIS) is not required for this modification.

3.2.3 Section 91 – Integrated development

Integrated development is a development that requires development consent and one or more approvals or licences under other statutes as detailed in Section 91 of EPA Act. The original development proposal and its subsequent modification were deemed as integrated developments under the EPA Act.

Amendments to the existing Environmental Protection Licence will be lodged with the EPA once the development proposal has been approved by the consent authority.



3.3 State Environmental Planning Policies

3.3.1 State Environmental Planning Policy 33 – Hazardous and Offensive Development

State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33) defines 'hazardous industry', 'hazardous storage establishment', 'offensive industry' and 'offensive storage establishment' for all NSW planning instruments, existing and future. The definitions enable decisions to approve or refuse a development to be based on the merit of proposal.

SEPP 33 also requires specified matters to be considered for proposals that are 'potentially hazardous' or 'potentially offensive' as defined in the policy pursuant to Clause 12 of the SEPP. For example, any application to carry out a potentially hazardous or potentially offensive development is to be advertised for public comment, and applications to carry out potentially hazardous development must be supported by a preliminary hazard analysis (PHA).

SEPP 33 does not change the role of councils as consent authorities, land zoning, or the designated development provisions of the EPA Act.

A PHA for the proposed additions has been completed by GHD. It is summarised in Section 6.4 and the PHA report has been provided at Appendix A.

3.3.2 State Environmental Planning Policy (Major Projects) 2005

State Environmental Planning Policy (Major Projects) 2005 (Major Projects SEPP), which replaces State Environmental Planning Policy (State Significant Development) 2005 (SSD SEPP), defines certain developments that are classed as 'major projects' under Part 3A of the EPA Act and determined by the Minister for Planning. The Major Projects SEPP also lists State significant sites.

The proposed alterations and additions to the wastewater treatment ponds do not satisfy any description listed under the schedules in the Major Project SEPP. However, the original development application was classified as a 'State Significant Development' under the SSD SEPP. The DoP is therefore the consent authority for this development proposal.

This development proposal is the third modification of the approved State Significant Development.

3.3.3 State Environmental Planning Policy (Infrastructure) 2007

Clause 104 of State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP), which replaces State Environmental Planning Policy 11 – Traffic Generating Development, ensures that the traffic management authority is given the opportunity to make a representation on certain 'traffic generating' development before a consent authority can make a determination on the proposal. The Infrastructure SEPP establishes the RTA as the sole traffic management authority to be consulted when a development is listed in Schedule 3.

The modification proposal does not involve alteration to the floor area of the Abattoir processing plant or number of employees and visitor approved by the original DA and subsequent modification. The proposed alterations and additions to the Abattoir does not satisfy the criteria listed within the Infrastructure SEPP, thus the provisions of the SEPP do not apply to the proposed development.

3.4 Regional Environmental Plans

There are no Regional Environmental Plans applicable to the site.

3.5 Existing Zoning

3.5.1 Wagga Wagga Local Environmental Plan 1985



The site is situated on land that is subject to the provisions of the Wagga Wagga Local Environmental Plan 1985 (the Wagga LEP). The Wagga LEP has adopted the Environmental Planning and Assessment Model Provisions 1980 (Model Provisions) with the exceptions of the definition of map in clause 4 (1), and clauses 15 and 36.

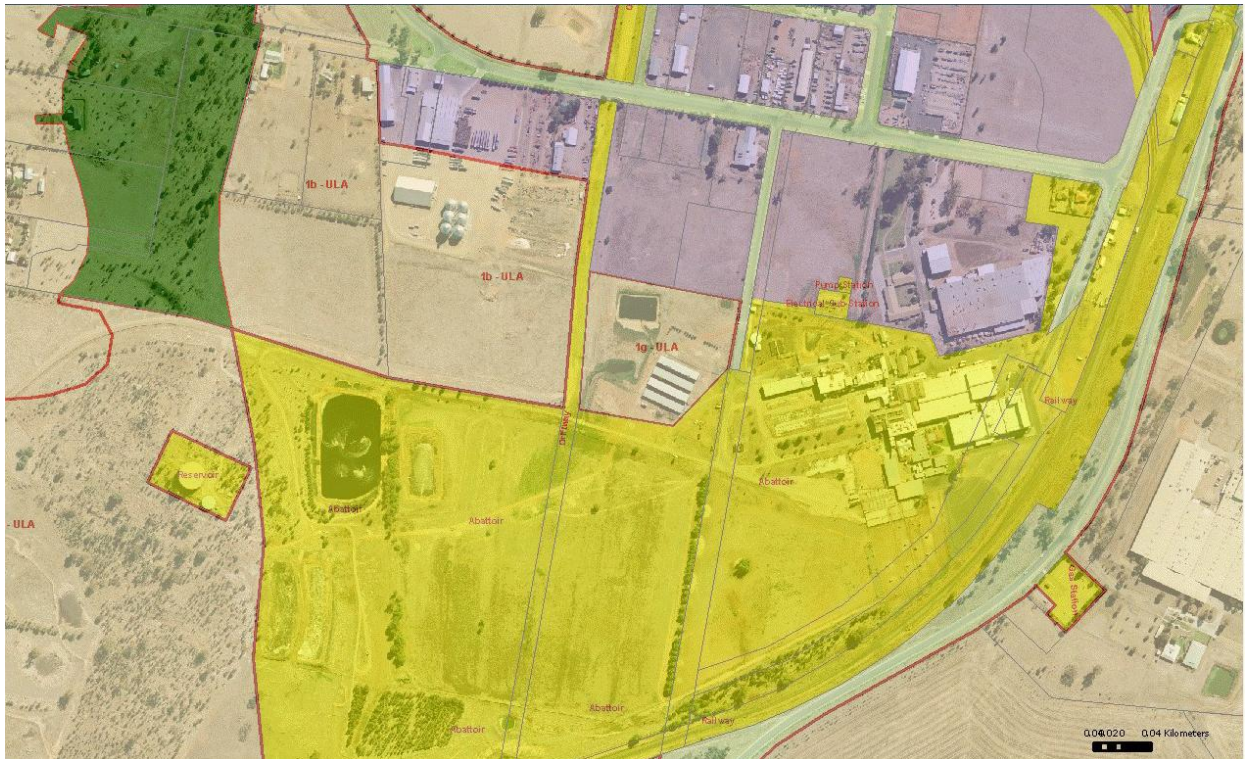
Wagga Wagga City Council (WWCC) is the consent authority to administer the Wagga LEP. However, since the development proposal is a modification of a Major Project, development under the Major Project SEPP the DoP is the consent authority.

WWCC has been consulted in the preparation of this development proposal.

The subject site is zoned 5 *Special Uses* for the purposes of an abattoir under the provisions of the Wagga LEP. The objectives for the Special Uses Zone are:

- » in the case of land shown unhatched on the map, are now owned or used for public or community purposes, and
- » in the case of land shown hatched on the map, will be acquired by a public authority for the particular public or community purpose shown on the map.

3.5.2 Wagga Wagga Development Control Plan (Urban Living Area) 2005



The site is sub-zoned 5(a) Special Uses (Urban Living Area) under the provisions of the Wagga Wagga Development Control Plan 2005 (the Wagga DCP). The specific objectives for the Special Uses Zone are:

- » To define areas used for purposes of education, public buildings, public utility undertakings, depots, church activities, cemeteries, private and public institutions and railways.
- » To encourage Government agencies and institutions to embody and reflect the aims of the plan in all their development and redevelopment projects.
- » To encourage the coordination of Government agencies and institutions to take into consideration the impact their activity will have on the environment.

The purpose of Special Uses Zone is to reserve or maintain land for the specific purposes shown on the Plan. The specified purpose of the land shown on the Plan is for 'abattoir'.

3.6 Consultation

A Planning Focus Meeting (PFM) was held at the GHD (Wagga Wagga) Office on 8th December 2008 with the representatives from GHD, CBA, DECC and WWCC. A number of key issues including: odour, waste, soil and water, greenhouse gas emissions, hazard and risk, visual impacts and the future co-gen facility has been discussed in the PFM. A copy of the agenda is provided for in Appendix B.

Relevant service providers have been consulted during the design process of the wastewater treatment ponds.

4. Existing Ponds and Operations

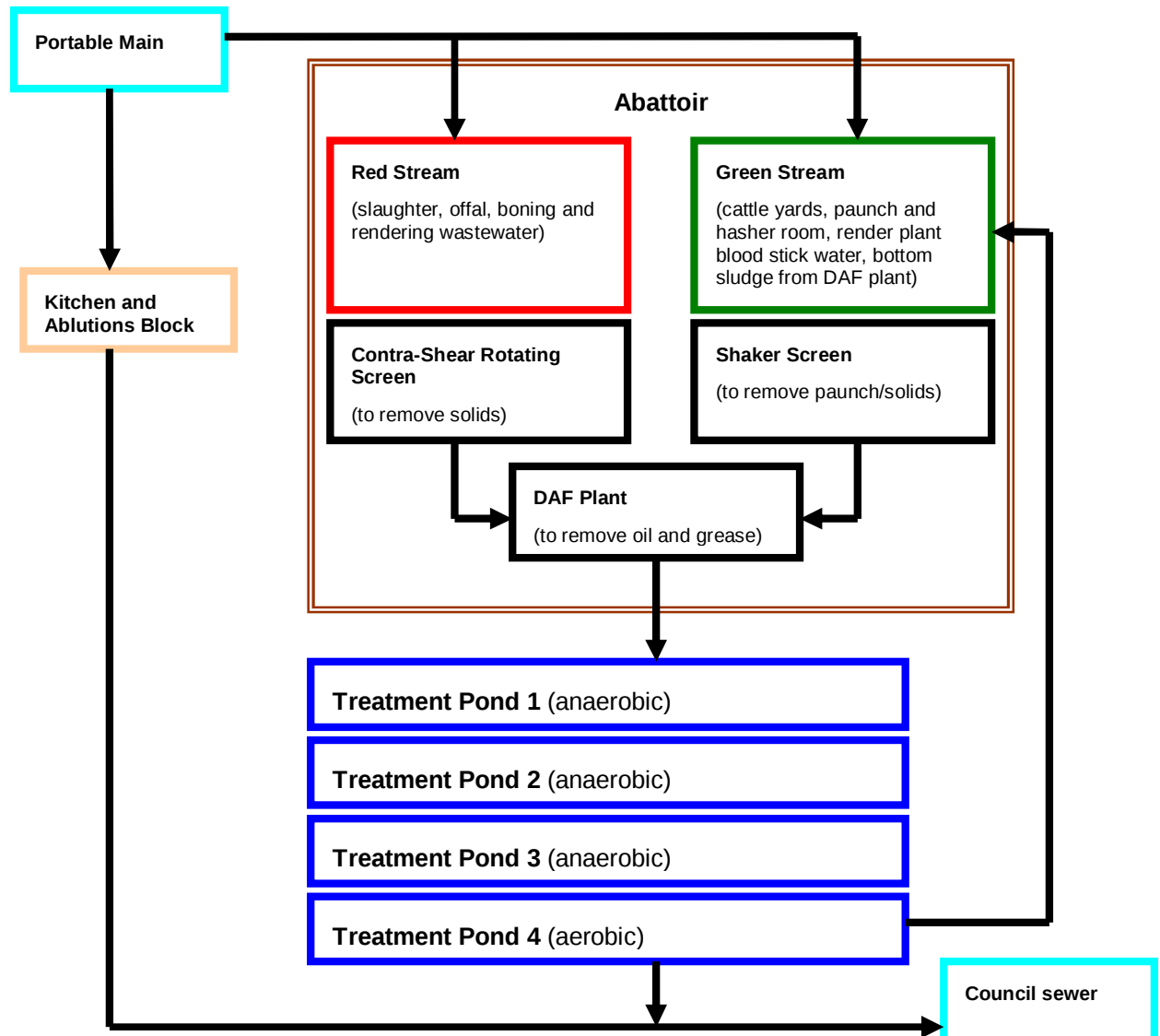
Under the current operation, approved wastewater from the plant, comprising organic oil, grease, paunch and solids is removed prior to the treatment process and treated separately in the four existing ponds.

Ponds 1, 2 and 3 are anaerobic and Pond 4 is aerobic (see Figure 2).

The generated gas (predominantly methane) is vapourised into the atmosphere. The abattoir has received complaints regarding odour emission from the anaerobic ponds, primarily due to the presence of sulphurous gases. One of the objectives of the proposed upgrades (the flare) is to address this issue.

Some of the treated water is recycled while the majority of the treated wastewater is disposed via trade waste as per the original development proposal and environmental license.

Figure 2 Simplify Model of the Existing Wastewater System



5. The Proposed Development

5.1 Purpose of the proposed upgrade

The current proposal is to replace two of the four aging treatment ponds with a new covered anaerobic pond. The work to upgrade the ponds is required by the NSW EPA, to reduce odour emissions caused by sulphurous compounds. These gaseous compounds, along with the substantive product (methane gas) will be captured by the covered pond and flared off on site. Burning the methane through the flare will significantly reduce greenhouse gas emissions from the site. Sulphurous compounds and other gases will be neutralized by the flaring process.

5.2 Proposed upgrade

The proposed upgrades aim at increasing the efficiency of the treatment system and to control gas emissions from the anaerobic ponds. CBA are proposing the following alterations and additions:

- » A new covered anaerobic pond (Pond 2b) will be created to replace Ponds 1 and 2. As a result Pond 1 will be discontinued and Pond 2 be maintained at a standby status for use once pond 2b is fully commissioned and microbiologically seeded from ponds 1 and 2.
- » Pond 2b will be situated to the east of Pond 2.
- » A Flare will be erected nearby to burn off gas captured by Pond 2b.
- » Ponds 3 (anaerobic) and 4 (aerobic) will remain the same.
- » No changes to the source of the wastewater are proposed.

Figure 3 Proposed upgrades

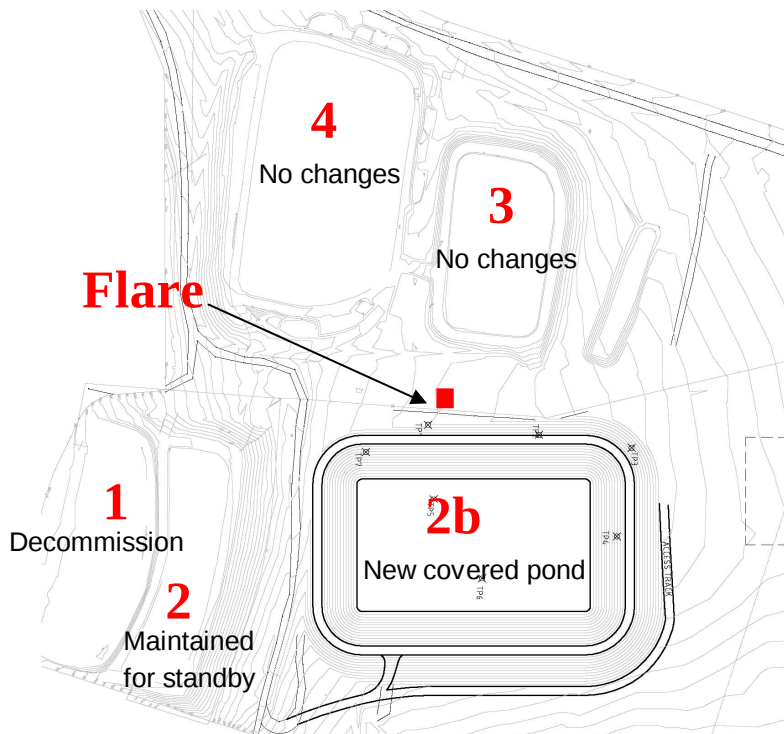
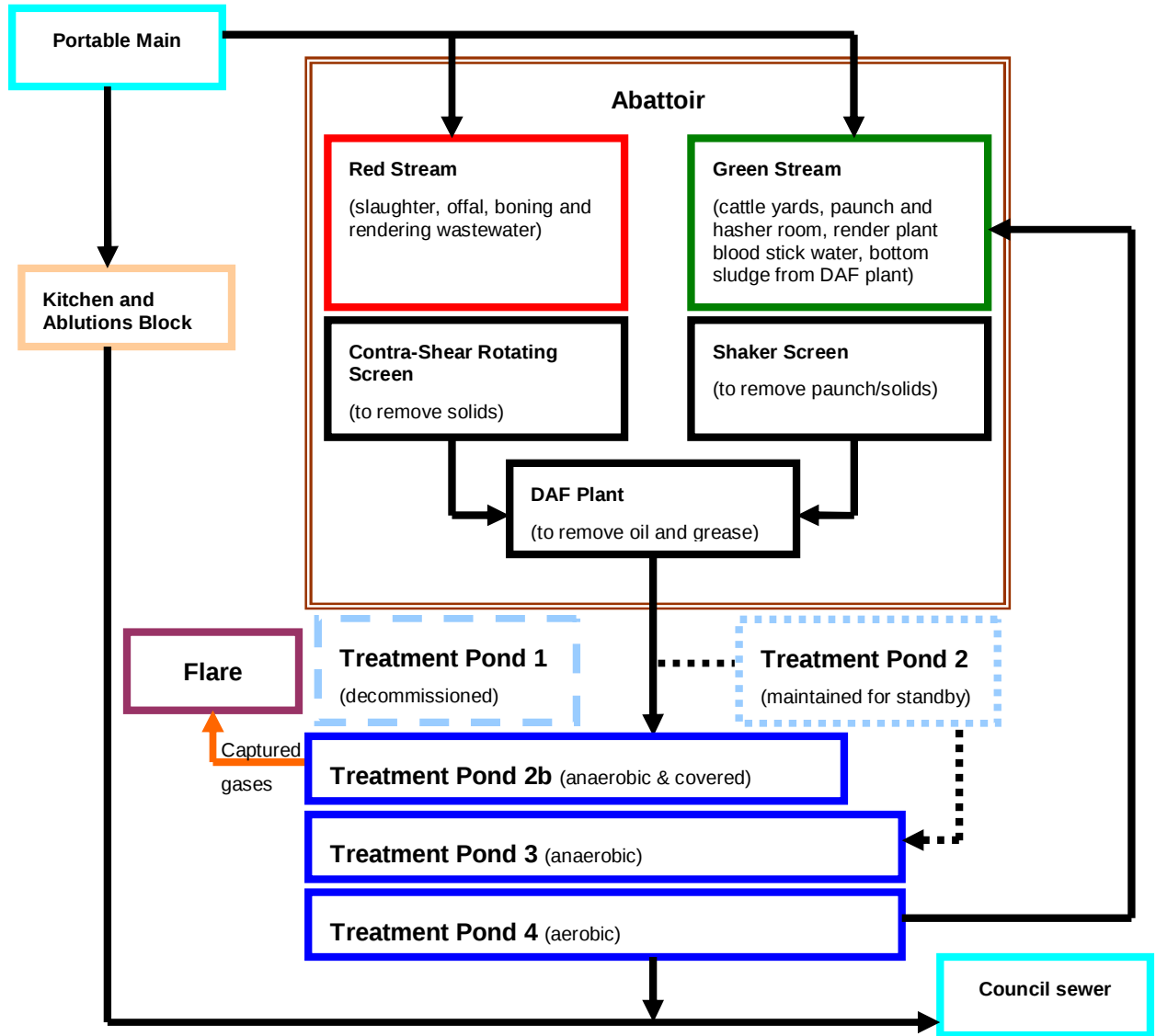


Figure 4 Simplify Model of the Proposed Wastewater System



5.3 Capacity of the treatment ponds

The abattoir has approval for processing up to 2,000 head of cattle per day, 6 or 7 working days per week (@ two 8-hour shifts), which would constitute about 5,446 tons of effluent loading per day. The current kill-rate is at 1500 head per day for 5 days per week, constituting 3268 tons per day of effluent loading (Tonnage includes water discharged and recycled).

The new Pond 2b will treat 70% of the organic waste (around 3,812 tons) while the remaining 30% (1,634 tons) will be treated by the existing Ponds 3 and 4.



5.4 Captured gas

There will be no change to the maximum approved kill-rate of 2000 head per day proposed by the original EIS and approved by the Minister.

The covered pond is designed to contain approximately 8000 to 10,000 cubic metres of gas. The captured gas is quickly sucked through a pipe to the flare via a fan to be burnt off, thus the captured gas is not required to be pressurised or stored in the process.

The auto-ignition temperature for methane is 580°C. The pressure of the gas built up within the covered ponds will not exceed 30 kilopascals (a safety valve is designed to be released when the internal pressure reaches 30 kilopascals), however the pressure under the cover is expected to be minimal or even in the negatives.

Gas from an external source may be used to maintain the heat of the flame. This is to ensure that all the contaminants (such as sulfate) are properly burnt off, thus controlling any emission or odour.



6. Statement of Environmental Effects

6.1 Permissibility and Objectives

6.1.1 Wagga Wagga Local Environmental Plan 1985

The subject site is zoned as Zone 5A (Special Uses) under the provisions of the Wagga LEP. Under this zone, developments that are described by "particular purpose indicated by black lettering on the map" are permissible without development consent. "Abattoir" is indicated as the particular purpose on the Wagga LEP Map.

The proposed upgrade of the wastewater treatment ponds is part of the abattoir operation, therefore the proposed upgrade is considered part of the "particular purpose" identified on the LEP map and therefore permissible.

6.1.2 Wagga Wagga Development Control Plan 2005

The subject site is sub-zoned 5A (Special Uses) under the provisions of the Wagga DCP. The site is defined by the DCP for the purpose of an "Abattoir". The proposed upgrade of the wastewater treatment ponds is a permissible development because the ponds are an ancillary to the abattoir, which is the particular land use shown on the Wagga DCP Map.

6.2 Business Operation

The development approval for the abattoir expansion in 2002, approved the abattoir to process up to 2,000 head of cattle per day, 6 or 7 working days per week, which would constitute about 5,446 tons of effluent loading per day. The proposed upgrade of the wastewater treatment pond is to increase efficiency of the aging system and it is also the first stage of a future onsite co-generation facility. Therefore the modification will not result in:

- » Any increase of the approved kill rate, and
- » Any changes to the existing abattoir operation

6.3 Character of the Locality

The Abattoir is located within the Bomen Business Park. The business park is a major regional industrial estate that is home to some major industries, such as Heniz, Southern Oil Refinery and Caltex. Therefore the character is its surrounding is generally industrial developments with some heavy and offensive industries.

The proposed upgrade of the existing wastewater treatment ponds will have minimal impacts on the character of the locality.



6.4 Hazardous and Offensive Development

The effluent generated from the processing plant is primary treated at the abattoir, then diverted to the secondary treatment consisting of anaerobic Ponds 1, 2, and 3 and tertiary treatment in aerobic pond no. 4 located approximately 700m from the processing plant. The biogas generated from the effluent in the treatment ponds contain a significant quantity of methane gas, which is released into the atmosphere. The biogas often has an offensive odour that can be a nuisance to the nearby residential and industrial neighbours.

GHD was commissioned by CBA to complete a Preliminary Hazard Assessment (PHA) for the proposed biogas recovery system. The PHA was completed in accordance to the guidelines given in DoP Hazardous Industry Planning Advisory Paper (HIPAP) No 6 'Hazard Analysis' and HIPAP No 4 'Risk Criteria for Land Use Planning'.

It was considered not to include the processing facility in this PHA based on the separation distance between the processing facility and the proposed anaerobic pond location.

The hazard identification was completed and the hazardous events with potential to cause off site impact were selected. The main hazards with potential for off site impact identified were fire and explosion involving the biogas. No toxic gases were identified with the potential to cause injury or fatality at the residential or industrial areas.

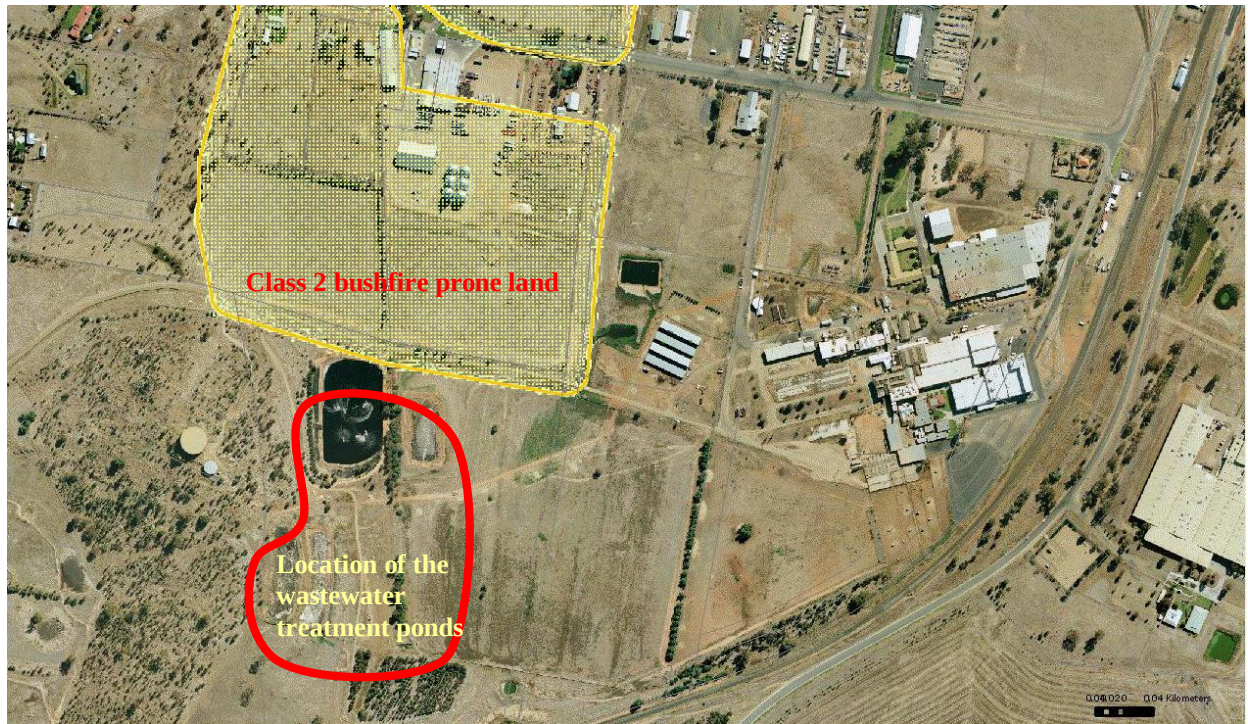
Consequence modelling was completed and the impact to the residential and industrial areas was assessed using the guidelines given in the DoP Hazardous Industry Planning Advisory Paper. The consequent analysis showed that the residential and industrial areas are not impacted from a hazardous event at the proposed location of the biogas recovery system with respect to fatality, injury or property damage. This is used to demonstrate that the risk criteria of DoP are satisfied.

A number of recommendations are made with respect to the implementation of prevention and mitigation controls to reduce the off site as well as on site risks to people, properties and environment to As Low As Reasonably Practical (ALARP).

6.5 Natural Hazards

6.5.1 Bushfire Prone Land

Figure 5 Bushfire prone land



The wastewater treatment ponds are outside of the designated bushfire prone land (see Figure 5). However the facility is close to the bushfire prone land and the fact that it captures and burns off combustible gases should be considered. Refer to Section 6.11 for details regarding fire and safety management.

6.5.2 Flooding

According to Wagga Wagga City Council's information, the subject site is not flood affected.

6.6 Odour Assessment

The management action plan for commissioning the new covered anaerobic pond 2b and the future decommissioning of Pond 1 and continued maintenance of Pond 2 is:

1. Construction of new Pond 2b complete with cover, flare and controls;
2. Connect pipes at various valve pits;
3. Divert the current flow from Pond 1, 2 through 3 and 4 as follows: 2b, 3, 4;
4. After the Pond 2b is commissioned:
 - Pond 1 is discontinued
 - Pond 2 is maintained for emergency
 - Ponds 3 and 4 are maintained for normal use



A preliminary odour modelling prior to stage 6 above will set a calculated upper limit for odour release. Cargill management will then use a field olfactometer such as the Nasal Ranger or equivalent to quantitatively detect down wind odour levels and log results. Should the set upper limit be reached at any stage, refurbishment operations will be discontinued allowing any released odours to become dispersed and remaining solid organic matter to become further stabilized.

It should be noted that there is no urgency from Cargill's management to discontinue the use of Pond 1 and maintained Pond 2 on standby. They will be utilised to seed Pond 2b once the latter comes operational whereafter Ponds 1 will be disconnected to stabilise and Pond 2 is maintained for emergency purposes. It is expected that, once feed into Ponds 1 and 2 is discontinued, their odour levels will reduce. Odour and gas from Pond 2b will be captured under the cover and flared off above a minimum temperature ensuring proper combustion to stable oxidized compounds.

6.7 Waste Assessment

Waste to be accepted into the treatment system consists of the "RED" and "GREEN" waste streams generated from normal abattoir operation.

Currently, there are three anaerobic Ponds (numbers 1, 2 and 3) in series followed by an aerobic Pond (number 4), with effluent from the last pond typically discharged to sewer (trade waste) or recycle for cattle wash. CBA have a licence to irrigate under EPA guidelines but don't currently do so. Wastewater from the meat processing operations are categorised and initially treated separately as:

- » one stream from the abattoir kill floor and boning room made up of a RED stream; and
- » a GREEN stream from the paunch removal and cattle yards.

The RED and GREEN streams are as follows:

The RED stream carries material from the raw material bin, kill floor, boning room and wash down to a Contrashear separator. The liquid flow is then passed to the RED DAF from where third grade tallow is recovered. The underflow is combined with waste material from the hide plant, tallow and blood stick water and pumped to the DAF 2 (Syskill).

The GREEN stream is the combined flow from: the yard, hasher room and paunch removal. It is pumped to a 0.9 mm shaker screen. The screened GREEN stream is pumped to the DAF 2 (Syskill).

DAF 2 (Syskill) top flow is filtered and solids combined with the shaker screen solids for composting. DAF 2 underflow and filtrate drainage is pumped for treatment in the existing Ponds (1, 2, 3 and 4). Approximately 1 – 2 ML/day of the treated water is recycled to the yard tank. The remainder is directed to sewer (under a Trade Waste Agreement) and thence to the Wagga Wagga STP. Some sludge is recovered from the aerobic pond, which goes to a drying bed on-site before being disposed offsite as composted material. The anaerobic Pond 2b design considerations are summarised in Table 1 and Table 2.

It must be noted that organic matter designated as "oil & grease" discharged for secondary treatment is free from aromatic compounds.



Table 1 Design Water and Wastewater Flows

Input	Units	Current 1200 hd/day @ 2000L/head	Future (2000 hd/day) @2000 L/head	Future (2000 hd/day) @ 1800L/head
Average potable Water Flow	ML/day	2.4	4	3.6
Wastewater (over a 10 hr day) 90% of potable water flow	ML/day	2.16	3.6	3.24
Recycle Flow	ML/day	2	2	2
Total wastewater flow (weekday)	ML/day	4.16	5.6	5.24
Weekend wastewater flows	ML/d	0.5 -2	0.5-2	0.5-2
Peak daily flow	ML/d	4.7	6.5	6
Discharge flow rate (to be constant for 7 day period)	ML/day	3.6	4.6	4.3
Average flow COD load @ 8,500 mg/L	t/day	31	40	37
Peak flow COD load @ 8,500 mg/L	t/day	40	55	51
Peak COD load	t/day	70	95	90

Table 2 Summary – Recent Influent Characteristics into Pond treatment train

Parameter	Average	Maximum	Minimum
BOD ₅ (mg/L)	3 890	5 480	2 930
COD (mg/L)	9 870	17 900	2 590
TSS (mg/L)	3 790	6 100	1 980
Oil & grease (mg/L)	2 780	6 840	318
Ammonia (mg/L)	142.4	206	90
TKN (mg/L)	350	406	273
TP (mg/L)	59.2	82.1	47.1
pH	7.15	7.40	6.90
Conductivity (µS/cm)	2 011	2 560	1 520
Sulphate (mg/L)	21.5	31.1	16.6



The adopted basis of design for the anaerobic pond includes the following criteria:

- » 8,500 mg/L COD;
- » 3.2 ML/d average flow, 4.2 ML/d peak day (current); and
- » 4.6 ML/d average flow, 6 - 6.5 ML/d peak day (future).

This represents a loading of 27,000 and 39,000 kg COD/day for current and future scenarios. Based on:

- » 0.55 kg m³/kg COD destroyed; and
- » 70 % COD destruction.

Then gas expected to be produced = 9,000 – 14000 m³/d. (current).

For the future load, this is equivalent to some 15,000- 20,000 m³/d.

- » Pond 2 is to be operated in series with the new Pond 2b for a few weeks allowing seeding of 2b, whereafter Ponds 1 and 2 will cease to be used as part of the secondary treatment system.

Cargill is in the process of replacing an effluent pipe that has reached its limit of serviceable life. The replacement pipe route is to the south of the new Pond 2b. This pipe route will have an earth bund wall down-slope to divert possible spills towards an on-site catchment pond. This infrastructure will serve to contain possible spills or wash down from the pond rehabilitation works, preventing any possible off-site contamination.

6.8 Soil and Water Assessment

Cargill monitors soil moisture continuously to detect possible leaks from the secondary treatment ponds. Decommissioning of Pond 1 will leave it empty and intact, no damage to the inner sealing layer. The discharge pipe will remain connected such that rain water can be directed to Pond 2. Pond 2 will be maintained for standby use in future, hence the inner sealing layer should be kept intact during construction.

The tender specifications clearly determine construction contractor's responsibilities during construction and rehabilitation of the site. Provision will be made for storm water catchment and erosion prevention.

The pond 2b cover will be equipped with pumps and pipes to remove rainwater from its surface and discharge to a suitable downstream catchment area.

Waste water discharge: the Pond 2b design provides for water level fluctuation such that the inflow, for example 5 days per week, is discharged equally over 7 days to trade waste. The treatment design is to meet the trade waste requirements. As part of Cargill's environmental management system, effluent samples are analyzed on a regular basis and data kept on record. Deviations outside of allowable limits prompt management action to rectify faulty plant and equipment.

It is worth noting that the new effluent transfer pipe is to be equipped with flow meters such that the plant SCADA system will stop pumps automatically if a leak occurs, thus minimizing spillage to the on-site catchment ponds.



Table 3 Meeting of Design requirements

General requirement	Proposed design
Safe design, construction, operation and materials of construction	Constructed earthen embankments
Meet Wagga Wagga City Council trade waste requirements	With Ponds 3 and 4 downstream
No pollution of surface or groundwater	Compacted lining
Ponds 3 and 4 must be able to be taken off line simultaneously for desludging	Ability to feed either pond
Final treated water to be suitable for recycle to wash (soak) cattle and wash yards (nominally C class quality)	With Pond 4, disinfection likely to be required.
Odour minimisation to be achieved by gas scrubbing, good combustion of biogas and sludge management.	Gas to be collected and used
Pond depth to allow for surge, and provision of balanced flow to sewer (even out over 7 days) by freeboard in CAL, automatic valving and storage in ponds 3 and 4	Pond has high freeboard to allow for storage of wastewater and gas
Automated for 24/7 control	PLC control of system Manual valves for feeding alternative ponds
Maximise biogas production by having a mixed pond, sludge recycle and relatively long HRT.	Recycle introduced
Robust and reliable treatment, and improved fat removal	Scum breaker recycle points introduced
Good quality flare with H ₂ S scrubber before or after the flare	Proposed for electricity generation, not flare
Measures to be put in place to prevent uncontrolled discharges.	High freeboard
Minimum of 3 m road around pond for access	In design
Gas to be stored under cover, which means that a flexible cover and O ₂ and CH ₄ monitoring will be required.	Cover flexible to store gas

The proposed orientation of the new pond 2B is adjacent to Pond 2 and near Pond 3, orientated with its long axis along the general contour lines in the area.

The proposed feed arrangement / flow path is as follows:

- » Initially Pond 1 and/or 2 then Pond 2b, then (for approximately 4 months whereafter Pond 1 will be disconnected and Pond 2 will be put on stand by)
- » Pond 3
- » Pond 4.



6.9 Greenhouse Gas Emissions Assessment

Cargill is indeed planning to utilise the biogas in the near future. Budget constraints prompted that the development be divided into Phase 1 (the covered pond) cover and flare which is planned to be followed by Phase 2 (gas conditioning, conveyance and cogeneration system). Phase 2 was not yet designed in detail at the time of this application, therefore has to be covered in a separate application to follow in 2009. It is worth noting that in November 2008 DECC announced \$2.9m funding to Cargill for the biogas cogeneration project. Installation is scheduled to commence approximately in the first quarter of 2010, subject to DA approval.

The existing secondary treatment system utilises anaerobic digestion which continuously releases methane rich gas into the atmosphere. In Phase 1 of the development (this application) the methane content of the biogas will be reduced to carbon dioxide by the flare equipment. This development (Phase 1) constitutes a significant improvement in terms of greenhouse gas emissions as the current greenhouse gas effect will be reduced by 20:1 when released as CO₂.

In Phase 2 (future application) the same conversion of methane to carbon dioxide will be effected using a combustion engine. This engine will drive a generator set delivering electricity for use on-site, thereby off-setting Cargill's grid demand. Exhaust gas from the engine will be used for steam generation thereby reducing Cargill's current natural gas usage for the same purpose. The cogeneration system analysis and CO₂ – reduction calculation is outlined in Table 4:

Table 4 Biogas utilization by cogeneration

Biogas For Cogeneration		1,4 MW generator
Generator Output (net)	MW	1.21
Annual Operating Hours	hr/yr	8000
Annual Electricity Produced	MWh/yr	9719
Steam Produced (67% of electricity)	MW	0.81
Steam Production Hours	hr/yr	6024
Annual Steam Production	MWh/yr	4903
	tonnes/yr	6538
Avoided Gas Consumption (80% boiler efficiency)	GJ/yr	22064
Capital Cost		
Generators		\$ 1,822,266.25
Scrubber		\$ 400,000.00
Steam Generator		\$ 300,000.00
Total		\$ 2,472,266.25
Annual Costs		
Capital Charge (@10% for 10 years)		\$0.00



Biogas For Cogeneration		1,4 MW generator	
O&M Engine	\$25/MWe	-\$	242,968.83
O&M Steam	\$5/tonne	-\$	32,688.05
			-\$275,656.89
Annual Income			
Avoided Electricity Cost	12cent/KWh	\$	874,687.80
RECs	\$30/MWh	\$	291,562.60
NGACs (3.8 for each REC)	\$12/MW	\$	443,175.15
Avoided gas cost	\$6/GJ	\$	132,386.62
NGACs (for avoided gas)	\$12/MW	\$	13,503.44
		\$	1,755,315.61
Annual Cost Benefit		\$	1,479,658.72
Simple Payback Period excl covered pond	yrs	1.67	
Tonne CO2 reduced	tonnes/yr	44948	

Pond 2b design capacity allows up to a nominal kill rate of 2000 head/day and will generate an average of 11,300 STD m³/day biogas at the current kill rate of 1250 head/day, containing 65 – 70% methane. The recommended options for energy conversion systems are based on 1200 head/day and can be expanded at any later stage. Based on the predicted gas generation, theoretical energy production is over 395,000 MJ/d (which is equivalent to some 4.5 MW). After taking into account, general losses and engine efficiencies for using and / or converting the biogas to electrical energy, there are considered to be two options for cogeneration (which looks feasible for the plant) – 1.05 MW engine or 1.4 MW engine.

Gas generation from the ponds is estimated to be of the order of 10,000 – 16,000 m³/day. Peak would be up to 32,000 – 35,000. The flexible pond cover will provide some storage allowing buffer build-up during peak production. The flare system will provide safe disposal of the excess methane rich gas, and incorporate necessary safety equipment, including flame trap and explosion damper.

The purpose of flaring the gas is to achieve combustion of the gaseous products of anaerobic digestion (which mainly consist of methane and carbon dioxide) to prevent odours and minimise greenhouse gas discharge to the atmosphere. The biogas concentration would be expected to be about 60 – 80% methane, 20 – 40 % carbon dioxide, with low concentrations of nitrogen, hydrogen, and possibly sulphur compounds. The expected S content may be up to 1000 ppm volumetric (based on 20 mg/L SO₄ in 6 ML/d in 20,000m³/d gas, and assuming some 50% has entered the gas phase), and scrubbing to remove this would be warranted for any gas use engines. This gas mixture should not be explosive. However, caution must be taken because mixtures of gas and air with a methane concentration of 5.3% to 14% by volume are explosive.

The system arrangement of the gas off-take and flare involves several components, with the main components being the collection system, the pipework / ducting / transfer component, and the gas flaring system.



The biogas will be collected under a slight vacuum via a collection header system on the cover. The vacuum is achieved and controlled by a duty/standby system of variable speed blowers. Pipework may be cast or ductile iron or stainless steel or possibly pressure rated PVC (nominally 250 mm pipe to accommodate future peak flow).

Prior to the entry to the gas blowers, the biogas passes to a condensate trap (knockout pot), along with a stainless steel filter to remove moisture and suspended solids present in the biogas.

A variable gas flow rate is allowed for via control of a variable speed drive (VSD) and/or flow-regulating valve. At low pressure readings the blower and flare shut down.

The system will be provided with an analyser prior to the blowers to detect the presence of high levels of oxygen. Detection of oxygen above the set level shuts the valves on the blower discharge, in order to preclude the creation of an explosive mixture (biogas is explosive at relatively low concentrations, as low as 7% in air).

6.9.1 Power generator options

The current kill rate is 1200 head per day, which is expected to produce 10,200 – 12,400 SCM/day of biogas (nominal value 11,300 SCM/day) with a methane content of 65 – 70%. Based on these values, the expected electricity available (or engine rating) would be 1.05 – 1.37 MW.

The future kill is planned to increase to 2000 head per day, which is expected to produce 16,900 to 20,700 SCM/day of biogas (nominal value 18,800 SCM/day) with a methane content of 65 – 70%. Based on these future values, the expected electricity available (or engine rating) would be 1.74 – 2.29 MW.

Cargill adopted the approach that the power generation equipment is chosen to suit the current biogas production range, while allowing room for possible expansion to an additional generation unit in the future.

Biogas engines vary in size and characteristics. For example Deutz and Jenbacher both have viable engines rated within the expected electricity range of 1.05 – 1.37 MW. These engine models are:

- » Deutz TCG 2020 V12, rating 1.021 MW
- » Jenbacher J320 GS, rating 1.064 MW
- » Deutz TCG 2020 V16 K, rating 1.260 MW
- » Deutz TCG 2020 V16, rating 1.364 MW
- » Jenbacher J420 GS, rating 1.416 MW.

At this stage only engines from Deutz and Jenbacher have been investigated, however other manufacturers (eg. Caterpillar and Cummins) may also have suitably sized engines available. If an another generating set is added in the future to capitalise on the additional biogas produced, it may be selected as a similar model to those listed above so that spare parts and alternate maintenance procedures can be minimised. (Engines are designed in groups that use the pistons and cylinders, but the number each varies to produce different sized engines.)

Calculations have shown that it better to risk over-capitalising and buying a larger engine, than it is to risk losing the potential income from the biogas produced, as any gas that can not be put through the generator must be flared and will therefore not earn any revenue. Although the simple pay-off period for



a larger engine (1.4 MW) would be approximately 2 months longer than a small engine (1.05 MW), the revenue would be increased by \$125,000 per annum.

6.9.2 Cogeneration options

In any engine, only a proportion of the energy that enters a system is converted to electrical energy. The table below shows the approximate distribution of energy through the system. (The calculations and values below are indicative for a 1050 kW generator set and will vary for different size engines.)

Table 5 Energy Efficiency of a Typical Engine

Output Energy	% of input
Electrical	41%
Exhaust heat	22%
Jacket water heat	22%
Intercooler heat	5%
Other (Engine heat, etc)	10%
Total	100%

Of the energy that is converted to heat (exhaust, jacket water, intercooler, etc), only two sources are recoverable:

Table 6 Recoverable Energy Sources for 1.4 MW option

Output Energy	Temperature (°C)	Energy (kW)	Recoverable energy (kW)
Exhaust heat	470	721	700
Jacket water heat	81 to 92	712	700

The exhaust heat will be used to produce 700 kW of steam at 10 barg and 184 °C to serve the rendering plant at Cargill. The jacket water heat could be used to produce 700 kW of hot water up to 75 °C. Utilisation of the jacket water heat will be finalised during the detailed design to follow in 2009. Currently the condensate from the rendering operation serves as hot water for wash down requirements.

6.10 Access and Egress

The proposal additions and alterations to the wastewater treatment ponds will not result in any increase in the amount of traffic accessing the Abattoir plant and there are no proposed changes to existing access and vehicular movements on the site.

6.11 Fire and Safety

The NSW Rural Fire Services (RFS) conducted a site visit on 14 November 2008. Drawings detailing the design and site lay-out were presented to the RFS. The proposed plans were forwarded by the RFS to the Team Leader Specials of the Sydney Fire Services (SFS), whom will comment on fire protection measures applicable in this instance. Preliminary discussion with the SFS indicated that the standard



requirements will be provided after the assessment which is due within weeks. The SFS mentioned no absolute restriction applicable in this instance.

CBA is willing and able to install fire protection equipment and measures as may be directed by the SFS. Budgetary provision is made in this regard.

The WWCC has a large reservoir (>1 ML) next to the proposed site from which four pipe lines serve the Cargill Beef site. (Please refer to Figure 6) The reservoir is constructed on the ground level which is 12 to 15m elevated above the proposed new pond location. The reservoir top water level is elevated by more than 20 metres above the proposed pond location, allowing for gravity water supply if for example fire hydrants are to be installed. The pipe route is within 200m from the proposed new pond location. If so required, a new trench route can be placed within open space between existing ponds and around the proposed new pond.

6.12 Heritage

The subject site is not listed as an Item of Environmental Heritage and there are no known significant heritage values associated with the site. The site is not located in a Conversation Area designated by the Wagga DCP.

6.13 Visual Assessment

The site is part of the Bomen Business Park which is an industrial estate that houses the stockyard, refineries and manufacturing plants. Therefore the upgrade of the wastewater treatment ponds will have minimal visual impacts to its surroundings.

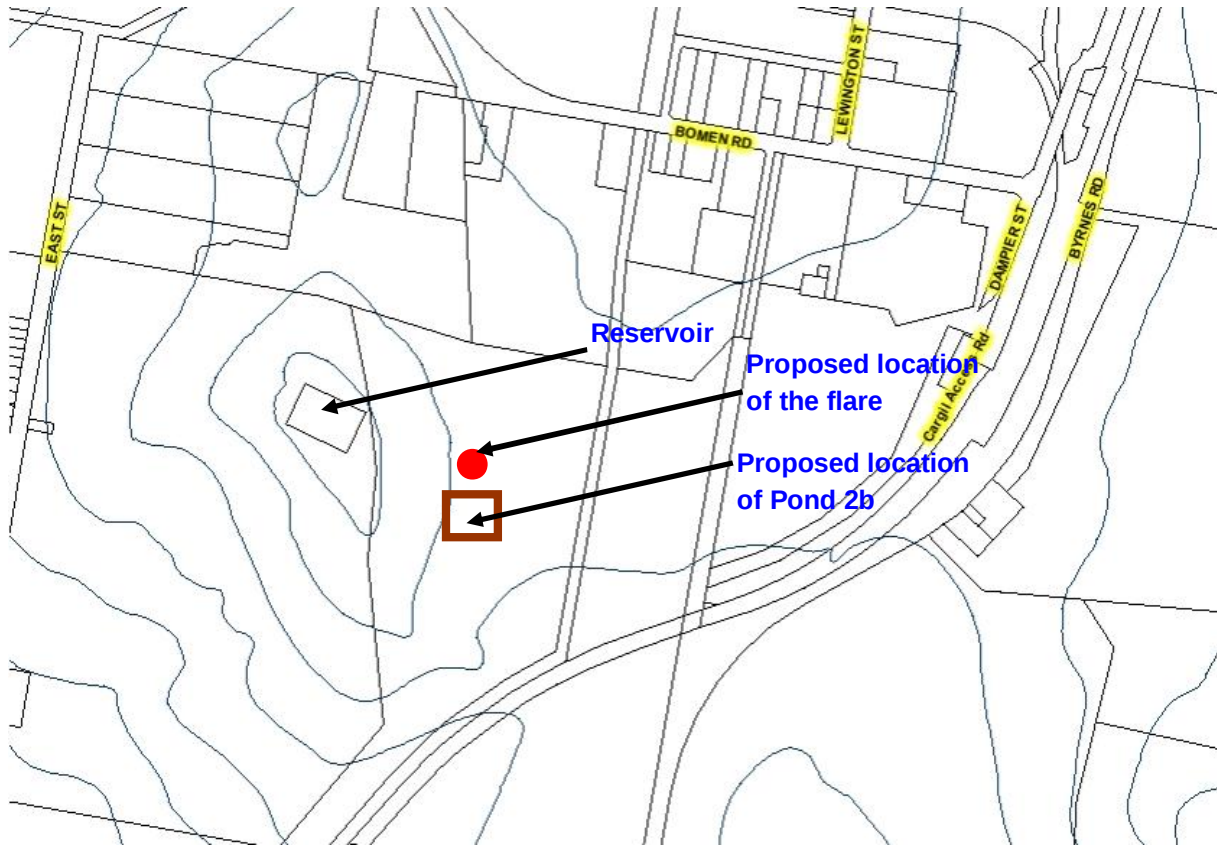
6.13.1 Ponds

The cover of the proposed anaerobic pond (Pond 2b) is expected to be a metre above the embankment of the pond. The proposed cover pond is not highly visible and it is expected to have similar impacts as a large rural dam.

6.13.2 Flare

The proposed Flare will be 8 metres in height. Figure 6 shows that the flare should not be intruded over the ridgeline. Given the angle of incidence and vegetation over the hill, the visual impacts on the residence of Carwrights Hills and people travelling on the Olympic Highway are expected to be minimal.

Figure 6 Proposed locations of the flare and Pond 2b on a 10 metres contour map



6.14 Services and Infrastructure

The proposed upgrades (Pond 2b and flare) will require the following to operate:

Table 7 Utilities and services

Utilities	Demand	Delivery
Electricity	194 Ampere / phase; 3-phase	Available from existing transformer
LPG Gas	14 day (minimum) storage	Specified as part of new works
Water	For pump priming and fire fighting	Available from Council reservoir via existing metered pipe line and connection point close to pond 2b location.
Sewerage	Not required	
Compressed air		Specified to be part of contractor's responsibility to supply as part of new plant and equipment.
Plant control system		The new control system is specified to wireless transfer data and alarm conditions to the main SCADA-system on the site.



6.15 Summary

Overall, it is considered that the proposed upgrades of CBA's wastewater treatment system are expected to have minimal environmental impacts on both the natural and built environments, and negligible social and economic impacts to the surrounding areas.

The development proposal is to upgrade the existing wastewater treatment system and it is permissible under the provisions of both Wagga LEP and Wagga DCP, therefore it is considered that site is suitable for the proposed development.



7. Justifications for the Modification

The proposed upgrades have a number of attributes which support the case for the proposed covered anaerobic pond with biogas capture and conditioning equipment and gas flare at Cargill's Abattoir. The following merits are considered to be resulted from the proposed upgrades to the existing wastewater treatment ponds:

- » Increased efficiency of the Abattoir's wastewater treatment system;
- » Control emissions of greenhouse gases via capturing and flaring off gas in the proposed Pond 2b,
- » Significantly reduced odour emissions from the existing anaerobic ponds
- » Improve the productivity and viability of the Abattoir, and
- » Establish the infrastructure for a future on-site co-gen facility.

On behalf of the land owner please direct any enquiries to:

Chrisjan Joubert

GHD Pty Ltd

Suite 3, Level 1

161 –169 Baylis Street

WAGGA WAGGA NSW 2650

Phone: (02) 6923 7426

Email: chrisjan.joubert@ghd.com.au



Appendix A

Preliminary Hazard Assessment

GHD Pty Ltd



CLIENTS | PEOPLE | PERFORMANCE

Cargill Beef Abattoir

Report for Biogas Recovery and Flare Preliminary Hazard Assessment (PHA)

December 2008

Contents

1.	Executive Summary	2
2.	Introduction	3
2.1	Background	3
2.2	Aims and Objectives	3
3.	Process Description	4
3.1	Site Location	4
3.2	Project Description	5
3.3	Statutory Requirement	6
4.	Methodology	7
4.1	Hazard Assessment	8
4.2	Consequence Analysis	9
4.3	Frequency Analysis	10
4.4	Risk Analysis	11
4.5	Risk Criteria	11
5.	Hazard Identification	13
5.1	Hazardous Materials	13
5.2	Hazardous Scenarios	13
5.3	Study Assumptions	19
6.	Results and Discussion	20
6.1	Event S1: Explosion inside the Pond Cover	20
6.2	Event S4: Explosion inside the Combustion Chamber	21
6.3	Events S2 & S3: Thermal Radiation	22
6.4	Risk Analysis	24
6.5	Effects on the Biophysical Environment	24
7.	Recommendations	25
8.	Conclusions	26

9. References	27
---------------	----

Table Index

Table 4-1 Explosion Overpressure Effect	9
Table 4-2 Thermal Radiation Effect	10
Table 4-3 Individual Fatality Risk Criteria	11
Table 5-1 Properties of Methane Gas	13
Table 5-2 Hazard Identification	14
Table 6-1 Hazardous Events – Consequence Assessment	20

Figure Index

Figure 3-1 Cargill Beef Processing Facility	4
Figure 4-1 Risk Assessment Methodology	8
Figure 6-1 Explosion Overpressure – Covered Pond	21
Figure 6-2 Explosion Overpressure – Combustion Chamber	22
Figure 6-3 Thermal Radiation from a Fireball – 12.6kW/m ²	23
Figure 6-4 Thermal Radiation from a Fireball – 4.7kW/m ²	23

Appendices

- A Consequence Models
- B Consequence Results
- C Process Flow Diagram

Glossary

PHA	Preliminary Hazard Assessment
QRA	Quantitative Risk Assessment
HIPAP	Hazardous Industry Planning Advisory Paper
DoP	NSW Department of Planning
SEPP	State Environmental Planning Policy
CBA	Cargill Beef Australia
HDPE	High Density Poly Ethylene
ALARP	As Low As Reasonably Practical
P&ID	Process & Instrumentation Diagram
PFD	Process Flow Diagram
LOC	Loss of Containment

1. Executive Summary

Cargill Beef Australia (CBA) owns and operates a cattle processing plant in Bomen, Wagga Wagga, NSW. The effluent generated from the processing plant is primary treated then diverted to the secondary treatment consisting of anaerobic- and aerobic ponds located approximately 500m from the processing plant. The biogas generated from the effluent in the treatment ponds contain a significant quantity of methane gas, which is released into the atmosphere. The biogas often has an offensive odour that can be a nuisance to the nearby residential and industrial neighbours.

CBA is investigating the option of recovering the biogas by building a covered anaerobic pond with extraction fans and flare system to combust the biogas and destroy the odour.

There are two benefits from the project:

- » Destruction of odorous component in the biogas; and
- » Reduction in the release of methane gas into the atmosphere, hence reduction in greenhouse gas.

In future, the plan is to utilise the biogas in a cogeneration plant.

GHD was commissioned by CBA to complete a Preliminary Hazard Assessment (PHA) for the proposed biogas recovery system. The PHA was completed in accordance to the guidelines given in NSW DoP Hazardous Industry Planning Advisory Paper (HIPAP) No 6 'Hazard Analysis' and HIPAP No 4 'Risk Criteria for Land Use Planning'.

It was considered not to include the processing facility in this PHA based on the separation distance between the processing facility and the proposed anaerobic pond location.

The hazard identification was completed and the hazardous events with potential to cause off site impact were selected. The main hazards with potential for off site impact identified were fire and explosion involving the biogas. No toxic gases were identified with the potential to cause injury or fatality at the residential or industrial areas.

Consequence modelling was completed and the impact to the residential and industrial areas was assessed using the guidelines given in the NSW DoP Hazardous Industry Planning Advisory Paper. The consequence analysis showed that the residential and industrial areas are not impacted from a hazardous event at the proposed location of the biogas recovery system with respect to fatality, injury or property damage. This is used to demonstrate that the risk criteria of NSW DoP is satisfied.

A number of recommendations are made with respect to the implementation of prevention and mitigation controls to reduce the off site as well as on site risk to people, properties and environment to As Low As Reasonably Practical (ALARP).

2. Introduction

2.1 Background

Cargill Beef Australia (CBA) operates a cattle processing plant at Bomen, Wagga Wagga, NSW. The effluent generated from the abattoir process is subject to primary and secondary treatments in order to discharge to trade waste standards. Primary treatment includes filtration and dissolved air filtration (DAF), secondary treatment includes anaerobic- and aerobic treatment in a series of open ponds. CBA is implementing a number of treatment process changes, which includes investigating the option to upgrade the secondary treatment system. This involves the design and construction of a new covered anaerobic pond and biogas utilisation facility. The primary driver for CBA to undertake this project is to minimise odour nuisance to the surrounding community. In addition, there is an opportunity to recover the biogas and utilise the gas through a cogeneration plant to generate energy and reduce greenhouse gas emission.

The first stage of the proposed biogas recovery project will include construction of a 75 ML covered pond and recovery of the biogas, which will be incinerated in a combustions chamber. The subsequent stage will include installation of a cogeneration facility, which will consume the biogas to generate electricity and steam.

CBA have engaged GHD to complete the Preliminary Hazard Assessment (PHA) for the first stage of the proposal, that is, bio gas recovery and incineration system.

2.2 Aims and Objectives

The aim of this PHA is to determine off site and on site impact from the proposed project and ensure that the criteria of the NSW DoP Land Use Planning (LUP) is complied with.

The primary objectives of the PHA are:

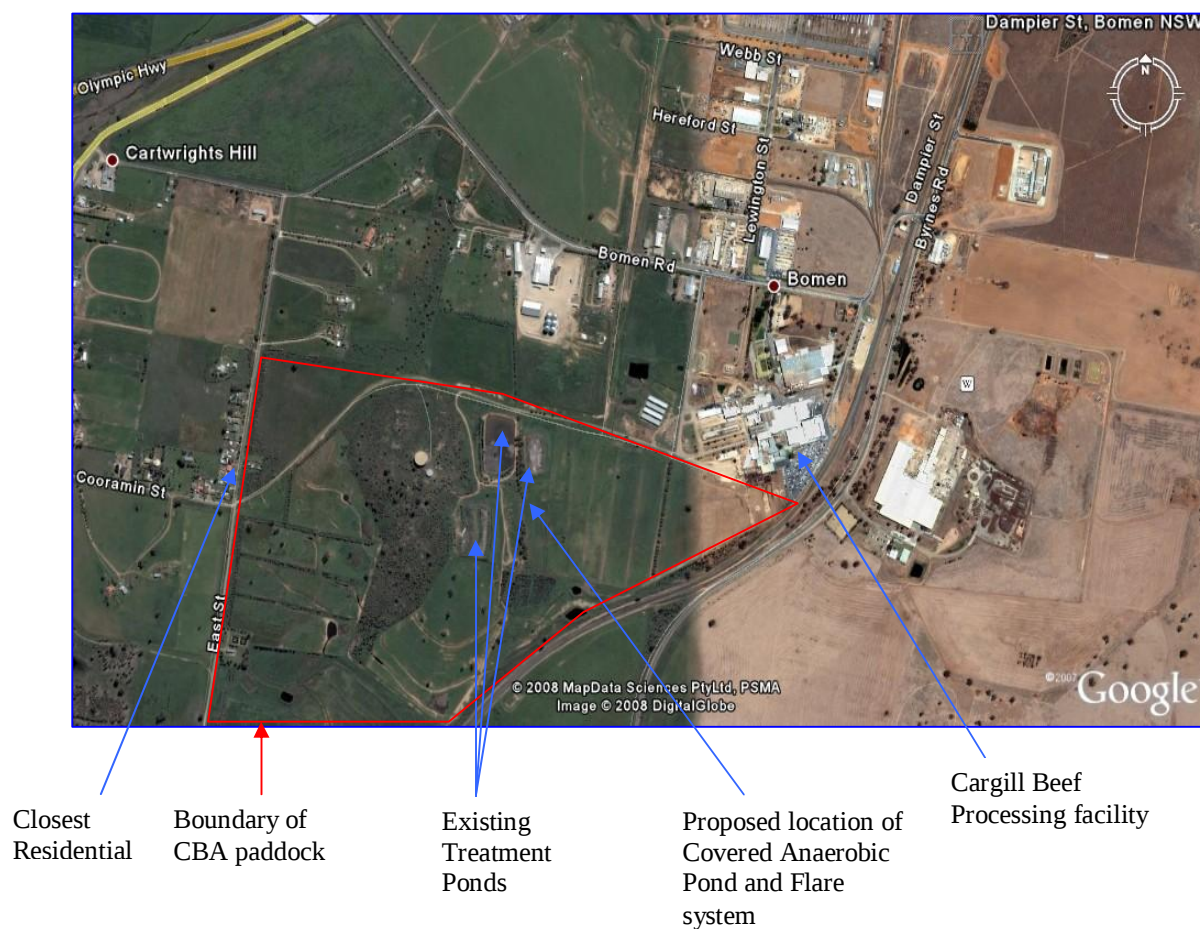
- » Identify all credible hazardous scenarios associated with the proposed project;
- » Determine the consequence of an hazardous event;
- » Assess the impact to the people, property and the environment in the surrounding vicinity;
- » Identify risk reduction and mitigation measures to ensure risk is as low as reasonably practical (ALARP); and
- » Produce a Report, which clearly documents the findings and recommendations of this PHA.

3. Process Description

3.1 Site Location

The Cargill Beef Abattoir facility is located at Bomen in Wagga Wagga at the corner of Bomen road and Dampier Street as shown in Figure 3-1. The new anaerobic pond is to be located southwest direction approximately 500m from the processing facility. Some light industries are located in the vicinity of the processing plant but none are close to the proposed location of the pond and flare.

Figure 3-1 Cargill Beef Processing Facility



The proposed anaerobic pond will be located adjacent to the current treatment pond as shown in Figure 3-1. The flare system will be located a minimum of 15m but approximately 50m from the pond water line.

3.2 Project Description

Cargill Beef is proposing to construct a new pond and divert the effluent from the abattoir into the new pond. The proposed anaerobic pond will be located adjacent to the current treatment ponds (No 3 and No 4). The Process Flow Diagram (PFD) is given in Appendix C.

The proposed anaerobic pond will be fully covered to enable the capture of biogas that will be released as a result of the biological action involving the sludge in the pond. The cover is proposed to be constructed from a 2 mm thick high density polyethylene (HDPE) material.

The proposed size of the pond will be approximately 75,000 m³ with the following dimensions:

Length: 130 m

Width: 75 m

Depth: 6.5 m

The nominal gas production rate from the pond will be approximately 11,400 m³/day with a maximum of 16,000m³/day.

The biogas composition is expected to comprise of:

Methane: 60 to 80 w/w%;

Carbon Dioxide: 20 to 40 w/w%

Low concentrations of nitrogen and hydrogen in the biogas are expected with low concentrations of sulphur compounds.

A low (<30 Pa) to slightly negative pressure will be maintained inside the pond cover by a variable speed drive fan. A 250 mm duct will connect the pond cover to the suction of the fan, which will blow the gas into the flare combustion chamber.

3.2.1 Flare System:

The flare system will be specifically designed for the combustion of biogas. The combustion package will comprise of a vertical combustion chamber with a continuous pilot flame. The pilot flame will be supplied by natural gas either from a gas bottle or a gas pipeline.

The biogas will enter from the bottom of the chamber and mix with air, which will enter the chamber through air dampers provided at the bottom the chamber.

The temperature inside the combustion chamber will be maintained above 800° C to ensure the odour components in the biogas are destroyed.

The flare will be approximately 7 m high.

3.3 Statutory Requirement

The Director-General's Requirements for the EA require a PHA as per *State Environmental Planning Policy No.33 – Hazardous and Offensive Development* (SEPP 33). A PHA broadly examines the likely potential hazards that may occur as a result of a hazardous or offensive development.

SEPP 33 requires developments that are potentially hazardous to be the subject of a PHA to determine the risk to people, property and the environment at the proposed location and in the presence of controls. Should such risk exceed the criteria of acceptability, the development is classified as 'hazardous industry' and may not be permissible within most industrial zones in NSW.

This PHA was completed in accordance to the guideline provided in NSW DoP Hazardous Industry Planning Advisory Paper (HIPAP) No 6 'Hazard Analysis' and HIPAP No 4 'Risk Criteria for land Use Safety Planning'.

4. Methodology

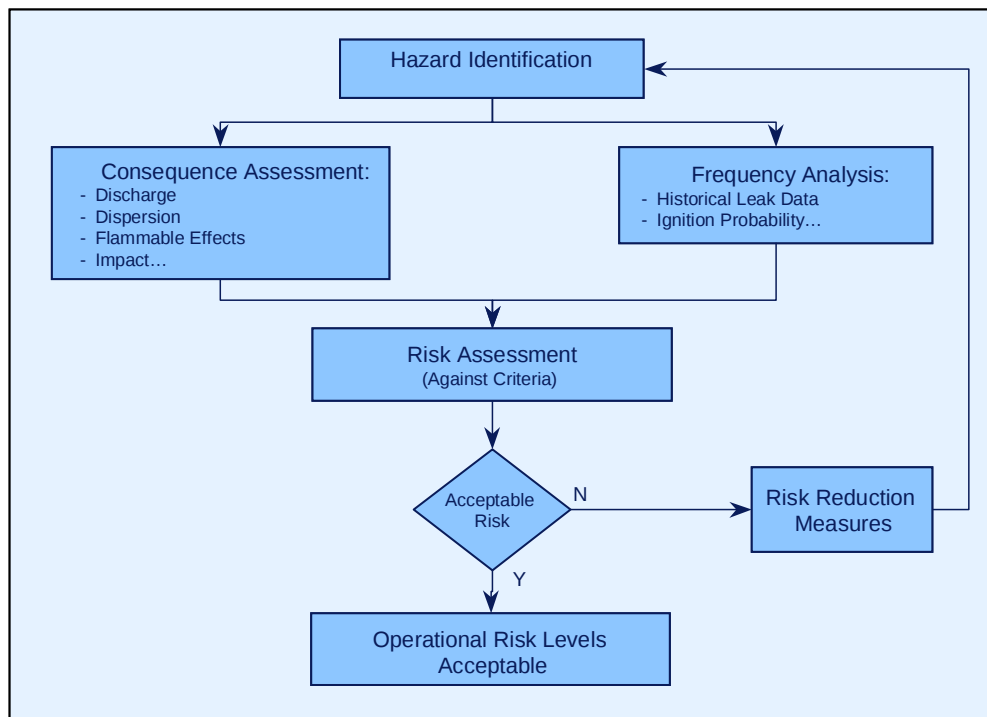
A PHA is to provide sufficient information and assessment of risks associated with the proposed development to show that it satisfies the risk management requirements of the proponent company and the relevant public authorities. Within this brief, the main objective of the PHA is to show that the residual risk levels are acceptable in relation to the surrounding land use, and that risk will be appropriately managed. This is done by systematically:

- » Identifying intrinsic hazards and abnormal operating conditions that could give rise to hazards;
- » Identifying the range of safeguards;
- » Assessing the risks by determining the probability (likelihood) and consequence (effects) of hazardous events for people, the surrounding land uses and environment; and
- » Identifying approaches to reduce the risks by elimination, minimisation and/or incorporation of additional protective measures.

The PHA needs to be carefully and clearly documented with the assumptions and uncertainties of final design and operation defined.

The flow chart shown in Figure 4-1 shows the overall PHA methodology. This methodology is in line with that set out in HIPAP 6. Each step is described in detail in the sections, which follow.

Figure 4-1 Risk Assessment Methodology



4.1 Hazard Assessment

The objective of hazard assessment is to develop a comprehensive understanding of the hazards and risks associated with the proposed facility and its operations, the adequacy of the safeguards.

A hazard has the potential to cause harm to people, damage to property and harm the biophysical environment.

The key elements to hazard analysis is:

- » Identification of hazards and development of credible 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 the safeguards; and
- » Calculation of the resulting risk levels of the facility; and
- » Comparison of these risk levels with established risk criteria and identification of risk reduction measures.

4.2 Consequence Analysis

The objectives of the consequence analysis are to:

- » Determine relevant toxic and flammable inventories;
- » Analyse a representative set of spill or loss of containment cases;
- » Determine the consequences of each release with regards to the potential of fire and explosion and offsite impact to people, environment and properties.

The processes used to complete the analysis are;

- » Discharge rate modelling;
- » Dispersion Modelling; and
- » Fire and Explosion Impact Modelling.

The dispersion and subsequent fire and explosion effects calculations are performed using the PHAST (Process Hazard Assessment Software Tool). PHAST is a commercial software developed by (Det Norske Veritas) DNV.

The consequence of explosion overpressure and thermal radiation as given in HIPAP No 4 are presented in Table 4-1 and Table 4-2.

Table 4-1 Explosion Overpressure Effect

Explosion Overpressure (kPa)	Effect
3.5	• 90% glass breakage • No fatality and very low probability of injury
7	• Damage to internal partitions and joinery but can be repaired • Probability of injury is 10%. No fatality
14	• House uninhabitable and badly cracked
21	• Reinforced structure distort • Storage tanks fail • 20% chance of fatality to a person in a building
35	• House uninhabitable • Wagons and plant items overturned • Threshold of eardrum damage • 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open

Explosion Overpressure (kPa)	Effect
70	• Threshold of lung damage • 100% chance of fatality for a person in a building or in the open • Complete demolition of houses

Table 4-2 Thermal Radiation Effect

Heat Radiation (kW/m ²)	Effect
1.2	Received from sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burn will occur)
12.6	• Significant chance of fatality for extended exposure. • Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure • Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23	• Likely fatality for extended exposure and chance of fatality for instantaneous exposure • Spontaneous ignition of wood after long exposure • Unprotected steel will reach thermal stress temperatures which can cause failure • Pressure vessel needs to be relieved or failure would occur
35	• Cellulosic material will pilot ignite within one minute exposure • Significant chance of fatality for people exposed instantaneously

4.3 Frequency Analysis

The objective of the frequency analysis is to determine the frequency of each of the hazardous events. The process followed is:

- » Selection of appropriate generic base leak frequencies from available industry data sources;

- » Completion of a parts count of the plant to determine the number of components able to initiate the identified hazardous events;
- » Selection of ignition probabilities for flammable releases from available published data; and
- » Combination of release frequencies with immediate and delayed ignition probabilities (and applicable mitigation measures) enabling determination of a range of gas release and fire event frequencies.

4.4 Risk Analysis

Risk is the likelihood of the defined adverse outcome. Risk of a facility can be calculated by combining the results of frequency analysis with the consequence assessment of all the hazardous events.

Risk is usually expressed as individual risk or as societal risk with respect to public health and safety. Individual risk is the measure of risk of fatality to an individual located at a specific location within the effect zone of the hazardous incident. Societal risk takes into account the risk of fatality to a group of people and is specified as the likelihood of specified number of fatalities normally represented by a F-N curve.

4.5 Risk Criteria

The risk criteria of NSW DoP Hazardous Industry Planning Advisory Paper (HIPAP) No 4 is given below.

4.5.1 Individual Fatality Risk Criteria

The risk criteria for individual fatality from hazardous events at a facility is given in Table 4-3.

Table 4-3 Individual Fatality Risk Criteria

Exposure Type	Risk Levels
Hospitals, schools, child-care facilities and old age housing developments	Half in a million per year (0.5×10^{-6} per year)
Residential developments and places of continuous occupancy (hotels/resorts)	One in a million per year (1×10^{-6} per year)
Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres	Five in a million per year (5×10^{-6} per year)
Sporting complexes and active open space areas	Ten in a million per year (10×10^{-6} per year)
Industrial sites	Fifty in a million per year (50×10^{-6} per year)

4.5.2 Injury Risk

- » Incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year.
- » Incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year.

4.5.3 Societal Risk

The societal risk analysis combines the consequences and likelihood information with population information. The result is presented in the form of 'F-N curve', which is a graph showing the cumulative frequency (F) of killing 'n' or more people (N).

4.5.4 Property Damage

- » Incident heat flux radiation at neighbouring potentially hazardous installations or at land zoned to accommodate such installations should not exceed a risk of 50 in a million per year for 23 kW/m^2 heat flux,
- » Incident explosion overpressure at neighbouring potentially hazardous installations, at land zoned to accommodate such installations or at nearest public buildings should not exceed risk of 50 in a million per year for the 14 kPa explosion overpressure level

5. Hazard Identification

5.1 Hazardous Materials

Methane Gas

The biogas released from the oxidation pond can contain between 60 to 80% of methane gas and carbon dioxide between 20 to 40%. A small quantity of nitrogen, hydrogen and sulphur compound can also be present. Methane in pure form is a colourless and odourless gas. It is lighter than air, therefore, will disperse in the air. It has a relatively high ignition point.

The physical properties of pure methane gas is given Table 5-1 below:

Table 5-1 Properties of Methane Gas

Appearance	Colourless & Odourless
Fire/Explosion	Flammable Gas
Specific Gravity	0.6
Flammability Range	5 to 15%
Auto ignition temperature	595 °C
UN Number	1971

5.2 Hazardous Scenarios

The main hazardous event involving the proposed covered pond and the combustion system is the release of biogas from the covered area or from the ducts and potential ignition that will lead to a fire or explosion.

There are no toxic gases present in the biogas that can cause off site impact with respect to fatality or injury. However, the odour present in the biogas can be offensive to the off site people as per the current situation.

The hazardous events identified for the proposed biogas recovery project is presented in Table 5-2.

Table 5-2 Hazard Identification

HAZARD IDENTIFICATION					
Project	Biogas Recovery & Combustion				
Site	Bomen				
No	Hazard Scenario	Causes	Consequence	Safeguards	Actions
S1	Explosion – methane explosion inside the covered pond area. This is possible during the start up when sufficient oxygen will be present	1. Ignition source (electrical equipment) and correct methane-air mixture inside the cover; 2. Hot work in the vicinity of covered area; 3. Static buildup; 4. Lightning strike near the covered pond;	Explosion overpressure from the explosion of methane gas. Potential for personnel in the area to be injured from overpressure.	1. Hot work control procedure to control hot work; 2. There is sufficient separation distance between the covered pond and the abattoir, other industrial facilities and residential area.	1. Electrical equipment inside and near the covered pond area to be suitably rated for hazardous area; 2. Provide explosion vent on the covered section; 3. Fence off the covered pond to prevent unauthorised access to people mainly the public and vehicles; 4. Install oxygen analyser inside the covered pond to alarm if an explosive mixture is formed; 5. Provide earthing to prevent static buildup

HAZARD IDENTIFICATION					
Project	Biogas Recovery & Combustion				
Site	Bomen				
No	Hazard Scenario	Causes	Consequence	Safeguards	Actions
S2	Jet Fire – discharge side of fan. Biogas leak from fan or discharge duct/pipe.	1. Seal or gasket failure on the fan 2. Flange failure on the duct/pipe 3. ignition source	Thermal radiation from a jet fire. Personnel in the area exposed to thermal radiation.	1. Hot work control procedure to control hot work; 2. There is sufficient separation distance between the covered pond and the abattoir, other industrial facilities and residential area.	As in 1. Provide remote fan shut down.
S3	Fireball – delayed ignition	1. Seal or gasket failure on the fan 2. Flange failure on the duct/pipe 3. ignition source	Thermal radiation from a fireball. Personnel in the area exposed to thermal radiation.	There is sufficient separation distance between the covered pond and the abattoir, other industrial facilities and residential area.	As in 1. Provide remote fan shut down.

HAZARD IDENTIFICATION					
Project	Biogas Recovery & Combustion				
Site	Bomen				
No	Hazard Scenario	Causes	Consequence	Safeguards	Actions
S4	Explosion inside the combustion chamber	1. Loss of pilot flame and formation of explosive mixture 2. Introduction of biogas into hot combustion chamber (above auto ignition temperature of methane)	Explosion overpressure and projectiles from the combustion chamber. Potential for personnel in the area to be impacted.	Safety management system on the flare system will isolate the biogas.	6. Provide explosion vent on the combustion unit.
The following events are not included in the consequence assessment as they are mainly on site impact.					
4	Offensive biogas – loss of combustion	1. Fan failure 2. Loss of pilot flame and loss of combustion.	Biogas released into the environment and affects the residential area and nearby industrial sites. Potential for complaints and breach of licence.	1. Duty and stand-by fan. 2. Loss of auto pilot alarm	

HAZARD IDENTIFICATION					
Project		Biogas Recovery & Combustion			
Site		Bomen			
No	Hazard Scenario	Causes	Consequence	Safeguards	Actions
5	Bush or grass Fire	1. Large grass around the covered pond and hot weather.	Potential fire or explosion involving the covered pond. Damage to pond and flare system.	1. Fire hydrants around the 2. Housekeeping to maintain the grass and bush in the vicinity of the covered pond.	7 Consider fire break between the paddock and the covered pond.
6	Natural events	1. Storm water on pond cover due to failure of removal pumps. 2. Flood	Overflow of pond onto the ground and potential contamination.	No catchment and stormwater inflow into covered pond possible.	
7	Lack of oxygen inside the pond cover, potential for asphyxiation.	1. Uncontrolled entry into the pond cover. 2. Pockets of low oxygen zones inside the pond cover during maintenance activity.	Single or multiple fatalities from asphyxiation.	1. Confined Space Entry procedure 2. Access doors kept locked and Danger sign posted.	

HAZARD IDENTIFICATION					
Project		Biogas Recovery & Combustion			
Site		Bomen			
No	Hazard Scenario	Causes	Consequence	Safeguards	Actions
8	Falling into the pond resulting in drowning or health implications.	1. Uncontrolled entry into the pond cover 2. Not wearing appropriate PPE	Fatality or serious injury from drowning or consuming the contaminated effluent.	1. PPE 2. JSA 3. Pond is fenced with gate 4. Authorised access only.	
9	Loss of containment (LOC) of effluent from the covered pond.	1. Pond full (excessive effluent generation)	Effluent overflows onto the paddock and contaminates the ground.	1. High level measurement and high level alarm. 2. Pond inventory management.	

5.3 Study Assumptions

The assumptions made in the risk assessment of the hazardous scenarios associated with the proposed project.

- » The biogas is assumed to be 100% methane gas for the purpose of fire and explosion consequence assessment;
- » Jet fire is considered at downstream of the blower as upstream the pressure will generally be below atmospheric pressure;
- » Release of bio gas around the flare system or the fan will not result in an explosion due to lack of confinement but will be more likely a fireball;
- » No other combustible or flammable material will be stored around the covered pond or the flare system except the gas bottle for the pilot flame;
- » Access to vehicle will be restricted around the covered pond and the flare system, only authorised vehicle can access the pond;
- » Overpressure relief vent will be provided on the covered pond;
- » The vacant land surrounding the covered pond and flare is not planned for residential or industrial development;
- » There will be a communications link between the covered pond and flare system to the control room in the main facility to allow remote monitoring;
- » There are no toxic gases associated with the biogas with the ability to cause fatality or injury off site.

6. Results and Discussion

This section presents the results of the consequence analysis completed using the PHAST package. The consequence modelling of the hazardous scenarios listed below in Table 6-1 were completed.

The average biogas flow rate generation from the pond is expected to be 11,400m³/day (314 kg/hr assuming methane gas density of 0.66 kg/m³).

Table 6-1 Hazardous Events – Consequence Assessment

Hazard ID	Description	Max inventory of methane gas (kg)	Process Condition	Scenario
S1	Explosive mixture of methane and air inside the covered pond leading to an explosion.	Maximum of 6600 kg of gas inside the pond cover. Confined Volume: 10,000 m ³	Ambient conditions	Explosion Overpressure
S2	Release of biogas from a leak in the duct or the fan on the discharge side – immediate ignition	50 mm hole size Release rate of 0.51 kg/s	100 kPa (fan discharge pressure), ambient temperature.	Jet Fire
S3	Release of biogas from a leak in the duct or the fan on the discharge side – delayed ignition	314 kg of gas cloud formed (3600 release duration)	Ambient conditions	Fire Ball
S4	Explosive gas mixture inside the combustion chamber ignites.	14.5 kg of gas inside the combustion chamber	Ambient conditions	Explosion Overpressure

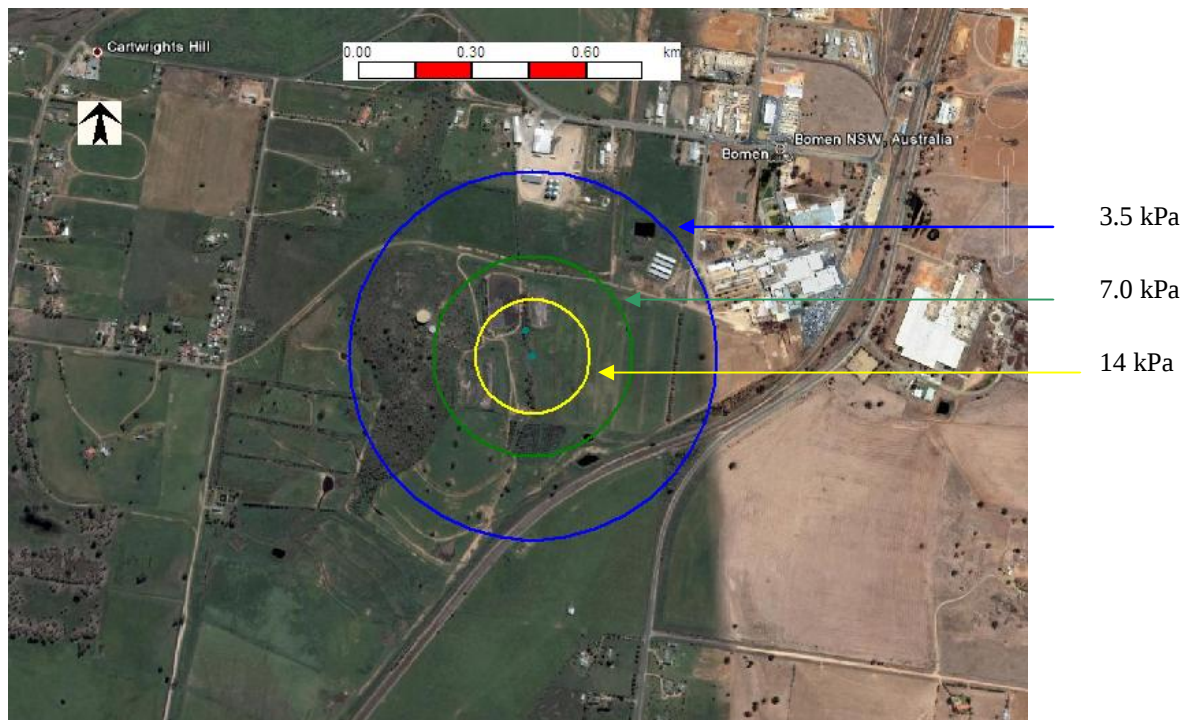
6.1 Event S1: Explosion inside the Pond Cover

The explosion of the biogas inside the pond cover is considered to be one of the most significant hazards due to the potential for a large inventory of gas in a confinement of the covered pond.

The overpressure generated from the explosion is presented Figure 6-1 below. The results are extremely conservative as it is assumed that the biogas is 100% methane whereas it is actually much lower in

concentration. In calculating the overpressure, a confined strength of 8 has been used that is equivalent to a congested area typical of a process plant. The inventory of biogas included in the consequence calculation is maximum possible but in actual operation the volume of gas inside the cover will be much smaller.

Figure 6-1 Explosion Overpressure – Covered Pond



The 7 kPa and 14 kPa overpressure from an explosion inside the pond cover are not impacting the residential or industrial areas as shown in Figure 6-1. Exposure to these overpressures is not expected to cause fatality, however, there is potential for injury if someone is present inside the overpressure contour.

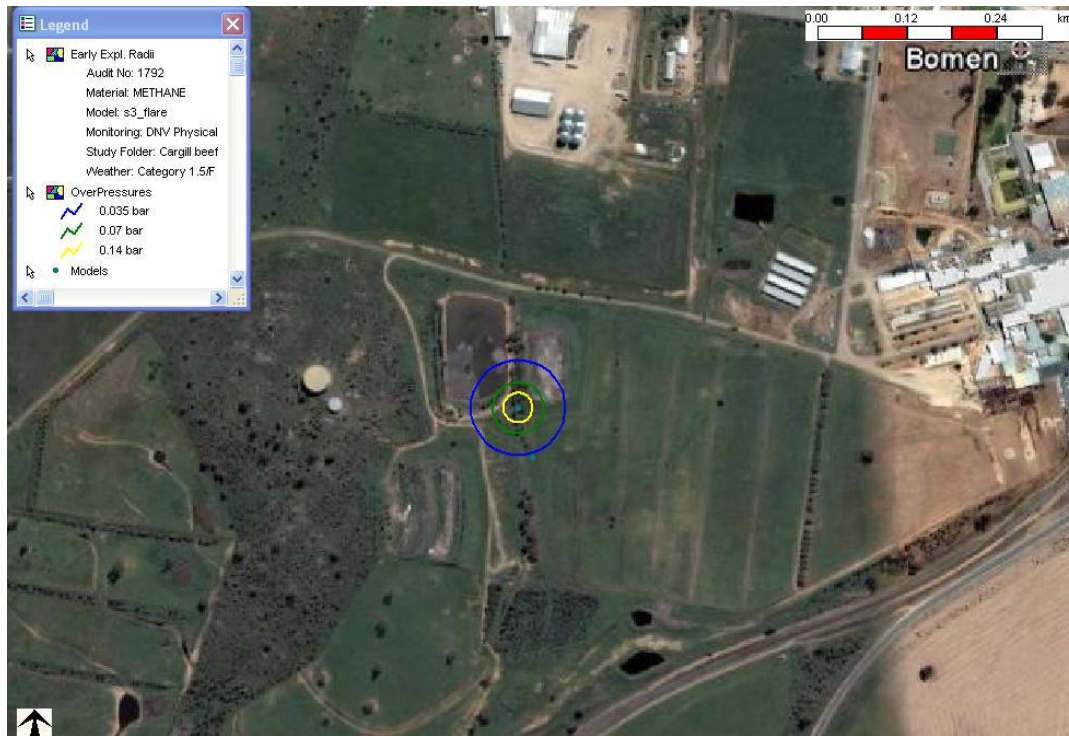
6.2 Event S4: Explosion inside the Combustion Chamber

Loss of flame inside the combustion chamber and loss of pilot flame can cause the formation of an explosive mixture inside the combustion chamber resulting in an explosion under the correct conditions.

The overpressures generated from an explosion of biogas inside the combustion chamber are presented in Figure 6-2.

The overpressures of interest are not impacting on residential or industrial areas.

Figure 6-2 Explosion Overpressure – Combustion Chamber



6.3 Events S2 & S3: Thermal Radiation

The effect of thermal radiation for 12.6 kW/m^2 and 4.7 kW/m^2 from a delayed ignition of biogas cloud is presented in Figure 6-3 and Figure 6-4. Thermal radiation at 12.6 kW/m^2 can cause fatality and at 4.7 kW/m^2 can cause injury. None of the contours are impacting the residential or the industrial areas. The 4.7 kW/m^2 thermal radiation can impede the fire fighters from accessing the fire hydrants that fall within the band. However, the thermal radiation represented here are for a fireball, which lasts a short duration.

The effects of jet fire from a 50 mm or 100 mm hole is insignificant and the contours are not presented here but the consequence results can be found in Appendix B.

Figure 6-3 Thermal Radiation from a Fireball – 12.6kW/m²



Figure 6-4 Thermal Radiation from a Fireball – 4.7kW/m²



6.4 Risk Analysis

Based on the results of consequence assessment, the risk of fatality off site from exposure to thermal radiation or explosion involving the covered pond or the flare system was considered extremely unlikely to warrant a detail frequency analysis and risk calculation.

6.5 Effects on the Biophysical Environment

The land surrounding the pond is owned by CBA and there are no future plans for development of this surrounding land for other uses.

The location of the pond is on an elevated ground and is unlikely to be affected by flash flooding caused by a storm. A failure of the pond wall can lead to a partial loss of containment (LOC) of the effluent, which will flow down the slope on the eastern side and potentially onto the railway line.

There is potential for the pond lining to leak and contaminate the ground water. CBA have a program to continuously monitor the ground water at designated locations to detect leakage from the ponds and subsequent contamination.

There are no sensitive ecosystem, waterways or marine system close to the location of the pond to be affected by a loss of containment of abattoir liquid effluent or biogas. The biogas is not toxic, therefore, is considered unlikely to harm the flora and fauna in the area. The proposed biogas recovery project will actually minimise the quantity of biogas released into the environment and will provide the following benefits:

- » A reduction in the emission of methane gas, which is a major greenhouse gas; and
- » A reduction in offensive odour from the ponds.

7. Recommendations

A number of recommendations made to improve the design and ensure a safe biogas recovery system.

1. Complete the hazard and operability (HAZOP) study when detail information including the P&ID are available.
2. Investigate the practicality of installing gas detection meters with alarm at strategic locations around the covered pond and the incineration system to enable detection of leaks with potential for explosion. Oxygen analysers are planned to be provided inside the cover to detect oxygen ingress into the covered volume and sending an alarm to the control room of the development of an explosive gas mixture.
3. Provide fire break around the perimeter of the covered pond to prevent explosion involving biogas in the covered pond. Note: the construction plans provide for an access road around the pond.
4. Investigate if explosion vents are required on the pond cover. Provide pressure relief points on the pond cover to allow venting during failure or non operation of the fan and flare.
5. Fence the covered pond area to prevent unauthorised access to general public.
6. Display signage of Fire and Explosion Danger at strategic locations around the covered pond to warn people of the hazard.
7. Maintain the grass and shrub surrounding the covered pond area to prevent grass fire.
8. Include grass fire in the emergency response plan for the Bomen site.
9. Review and implement the control of hot work around the covered pond and the flare system.
10. Explosion proof rated instrumentation, electrical components and motors to be used around the covered pond and the flare system.
11. Control the access of vehicles and other equipment, that can be potential ignition source, into the covered pond area and flare system,
12. Include the oxygen monitors, gas monitors and the flare system critical components including the flame scanner into the maintenance program to ensure a high level of reliability and safety integrity of the biogas system.
13. Fail safe design: in the event of a power failure a) the pond can continue to overflow as usual into the trade waste system and b) gas build-up to a low maximum pressure for release to atmosphere (as happens currently with uncovered ponds).

Other opportunities to improve the safety of the system should be identified and incorporated into the design to aim for a risk reduction of As Low As Reasonably Practical (ALARP).

8. Conclusions

The preliminary hazard assessment (PHA) of the proposed biogas recovery project at Bomen Abattoir was completed. The purpose of the project is to improve the environmental performance of the facility by reducing the emission of greenhouse gas into the atmosphere. In addition the offensive odour from the pond will be eliminated. These will be achieved by collecting the biogas from the covered pond and incinerating it in a purpose built flare system.

The main hazards from the proposed biogas recovery project are fire and explosion involving the biogas, which can be between 60 to 80 % w/w methane. Consequence modelling of the hazardous scenarios was completed using PHAST, thermal radiation and overpressure contours were developed and overlayed on the map of the proposed site of the covered pond and flare system.

There is potential for explosion of the biogas present inside the covered pond leading to the development of overpressure wave. There is potential for explosion inside the combustion chamber of the flare system. The explosion overpressures generated from these explosions were assessed to be unable to cause fatality or injury at the residential or industrial areas and unable to damage any properties.

The thermal radiation from a fire involving biogas was assessed not to impact the residential or industrial areas.

The proposed biogas recovery project has been assessed to be unable to cause off site impact with respect to injury, fatality or property damage. However, a number of recommendations have been made to improve the design and safety performance of the proposed biogas recovery system.

9. References

1. Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning, Department of Planning (DoP), NSW.
2. Hazardous Industry Planning Advisory Paper No 6 – Hazard Analysis, Department of Planning (DoP), NSW.
3. Guidelines for Quantitative Risk Assessment – Purple Book - CPR 18E.
4. Risk Analysis in the Process Industries, IChemE, publication 45, 1990.
5. Meidl J.H., Flammable Hazardous Materials, 2nd Edition, 1978.
6. PHAST – Process Hazard Assessment Software Tool, guidelines, DNV.
7. Gulan K., Unconfined Vapour Cloud Explosions, IChemE, 1979.
8. Chamberlain, G. A., 1987, Developments in design methods for predicting thermal radiation from flares, Chem. Eng. Res. Des. v65 (1987).

Appendix A

Consequence Models

A 1 Consequence Modelling

One part of the risk assessment process involves generating consequences for the release events identified. The steps involved in determining consequences are:

- » Determine release conditions based upon materials involved, process conditions and available inventory etc;
- » Based on release conditions, determine the types of events which will occur (eg jet fire, toxic cloud, evaporating pool or explosion etc);
- » Calculate the extent of the consequences; and
- » Establish the impact of the consequence (e.g. proportion of people killed when exposed to a toxic dose)

The consequences are calculated using empirically derived models, which can then be used to determine which release cases generate offsite effects and should be included in the risk model. The level at which fatal consequences are considered to occur will directly influence the risks.

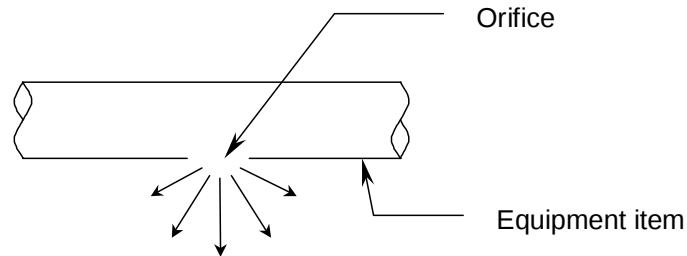
This Appendix discusses basic concepts and theory behind the various consequence models used in the analysis. The models discussed are:

- » Discharge Modelling
- » Dispersion
- » Flammable Effects - Jet Fire
- » Explosion – Multi Energy Explosion Model

A 1.1 Discharge Modelling

If there is a hole in a pipeline, vessel, flange or other piece of process equipment, the fluid inside will be released through the opening, provided the process pressure or static head is higher than ambient pressure. The properties of the fluid upon exiting the hole play a large role in determining consequences, eg, vapour or liquid, velocity of release etc. Figure A 1 illustrates an example scenario.

Figure A 1 Typical Discharge



The discharge can be considered to occur in two stages, the first is expansion from initial storage conditions to orifice conditions, the second from orifice conditions to ambient conditions.

The conditions at the orifice are calculated by assuming isentropic expansion, i.e., entropy before release equals entropy at orifice. This allows enthalpy and specific volume at the orifice to be calculated.

The equations for mass flow rate ($\dot{m}$) and discharge velocity (u_0) are then given by:

$$\dot{m} = C_d A_o \rho_o \sqrt{-2(H_o - H_i)}$$

AND

$$u_0 = C_d \sqrt{-2(H_o - H_i)}$$

Where

- C_d = Discharge coefficients
- A_o = Area of the orifice
- ρ_o = density of the material in the orifice
- H_o = Enthalpy at the orifice
- H_i = Enthalpy at initial storage conditions

The discharge parameters passed forward to the dispersion model are as follows:

- » Release height (m) and orientation;
- » Thermodynamic data: release temperature (single phase) or liquid mass fraction (two-phase), initial drop size;
- » Other data:
 - for instantaneous release: mass of released pollutant (kg), expansion energy (J)

- for continuous release: release angle (degrees), rate of release (kg/s), release velocity (m/s), release duration (s).

A 1.2 Dispersion

When a leak occurs, the material will be released into the atmosphere. Upon being released, it will start to disperse and dilute into the surrounding atmosphere. The limiting (lowest) concentration of interest is related to flammable and toxic limits for flammable and toxic substances respectively. The model used to determine extent of release is described below, along with some of the key input parameters.

PHAST is a consequence-modelling package that utilises the Unified Dispersion Model (Witlox *et al*, 1999). This models the dispersion following a ground level or elevated two-phase unpressurised or pressurised release. It allows for continuous, instantaneous, constant finite duration and general time varying releases. It includes a unified model for jet, heavy and passive two phase dispersion including possible droplet rain out, pool spreading and re-evaporation.

A 1.3 Flammable Effects

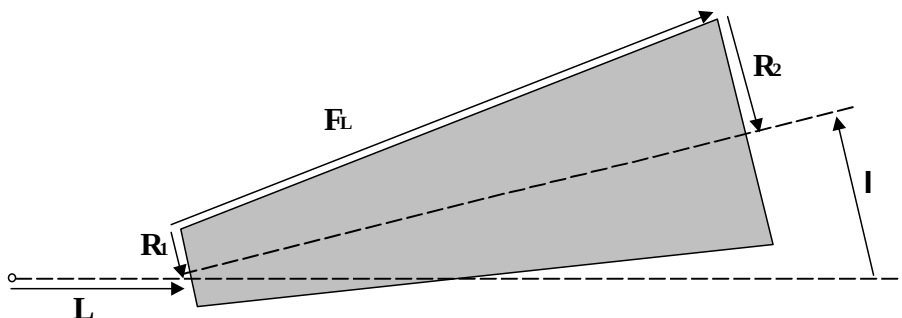
If the release is of a flammable material, it is possible for the release to be ignited. The resulting type of fire (eg. jet, pool, explosion etc) depends on the physical properties of the release and whether the ignition is immediate or delayed.

A 1.3.1 Jet Fire

Jet fires are a result of high momentum releases. If a flammable release is ignited instantaneously, a jet fire will result. The flame will have a degree of 'lift off' as the flammable mixture has to dilute to be within the flammable limits. This section briefly discusses the model used for jet fires as well as key parameters in the calculation.

The jet fire calculation utilises the Chamberlain model (Chamberlain 1987). In this model, jet fires are modelled as a conical flame, with the ignited portion lift off, inclination and shape being determined by the material being released, the pressure at which it is being released and the hole size that it is being released through. These release parameters are the main inputs to the jet fire radiation calculations. Figure A 2 below shows a graphical representation of the jet fire model.

Figure A 2: Truncated Cone Jet Fire Model



Where;

L = Lift off

I = Flame Inclination

R₁ = Flame Base Radius

R₂ = Flame End Radius

F_L = Flame Length

The jet fire calculations model radiation from the entire surface of the ignited portion of the jet. This includes radiation from the cone forming the body of the flame, as well as from the ends of the cone. The amount of radiation that a nearby receiver is exposed to is determined by its distance from the flame surface, as well as by the orientation of the flame relative to the receiver. The key parameters in the calculation of the radiation exposure of a receiver are therefore the flame lift off, the flame inclination, and the dimensions of the ignited portion of the jet (i.e. flame length and end radii).

A 1.3 Multi Energy Explosion Model

The Multi Energy Model gives overpressure of an explosion as a function of distance from the explosion. The explosion is modelled as a sphere and overpressure is calculated based on scaled distance from the centre. This section explains the key parameters involved in the multi energy model.

The energy released by the explosion, E, is calculated as the product of the mass of fuel in the cloud and the heat of combustion. This assumes a stoichiometric mixture of fuel and air.

The distance scaling factor, S, is related to the energy released by the explosion and the atmospheric pressure by

$$S = \left[\frac{E}{P_a} \right]^{1/3}$$

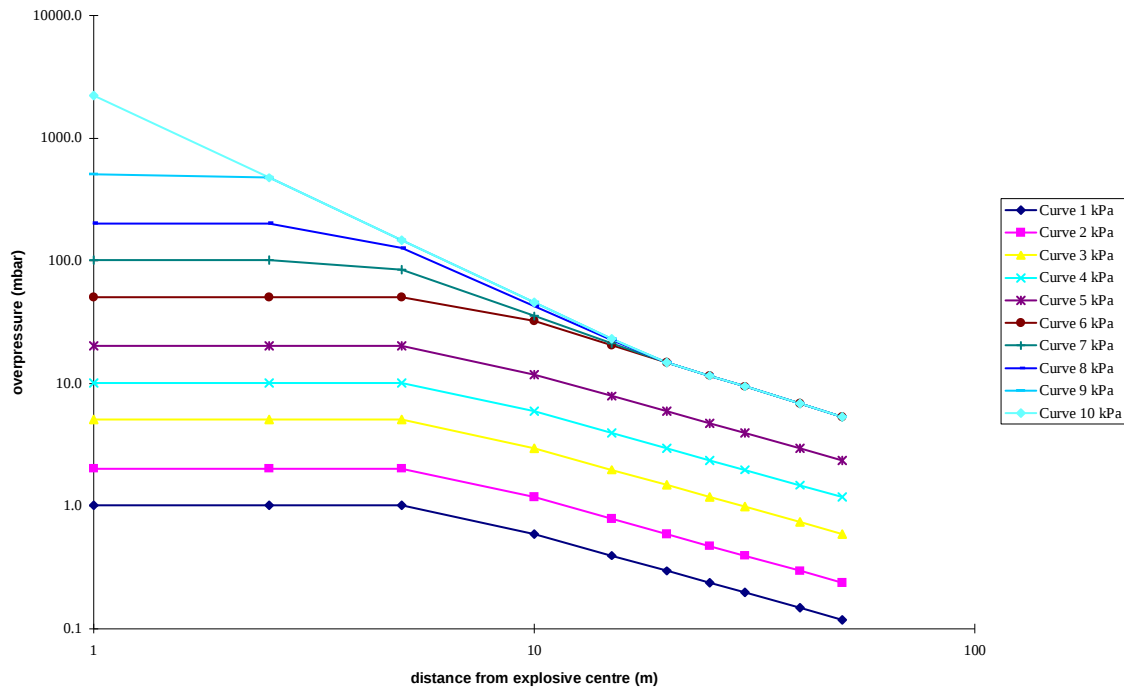
The scaled distance r is then given by

$$r = \frac{d}{S}$$

where d is the actual distance of the receiver from the cloud centre.

To calculate overpressure a set of 10 curves is used. The actual curve used depends on the degree of confinement, with a confinement of 1 being least confined and 10 most confined. Process plants generally have a confinement factor of 7, though it needs to be assessed for each individual process. The graph showing the 10 curves is included in Figure A 3.

Figure A 3 Multi Energy Curves



References

Chamberlain, G. A., 1987, Developments in design methods for predicting thermal radiation from flares, Chem. Eng. Res. Des. v65 (1987).

Lees, F.P., "Loss Prevention in the Process Industries", Vol 2, Butterworth Heinemann, Oxford, United Kingdom, 1996.

SAFETI (Software for the Assessment of Fire Explosion and Toxic Impact) v6.4.2 help file.

TNO Yellow book, 2nd edition, TNO, The Netherlands (1992).

Wilton, H.W.M. and Holt, A., "A unified model for jet, heavy and passive dispersion including droplet rainout and re-evaporation", CCPS 1999 ADM paper.

Appendix B

Consequence Results

Table B 1 Consequence Results – Thermal Radiation

Event	Section Description	Hole Size (mm)	Process Conditions		Thermal Radiation Distances (m)			Release
			P (kPag)	T (°C)	4.7 kW/m ²	12.6 kW/m ²	23 kW/m ²	
s2_50mm	Jet fire from 50mm leak from pipeline – fan discharge	50	100	25	12	9	7	0.51 kg/s
s2_100mm	Jet fire from 100mm leak from pipeline – fan discharge	100	100	25	25	20	17	2.06 kg/s
s2_fireball	Fireball from gas leak - delayed ignition	-	atm	25	140	83	56	318 kg

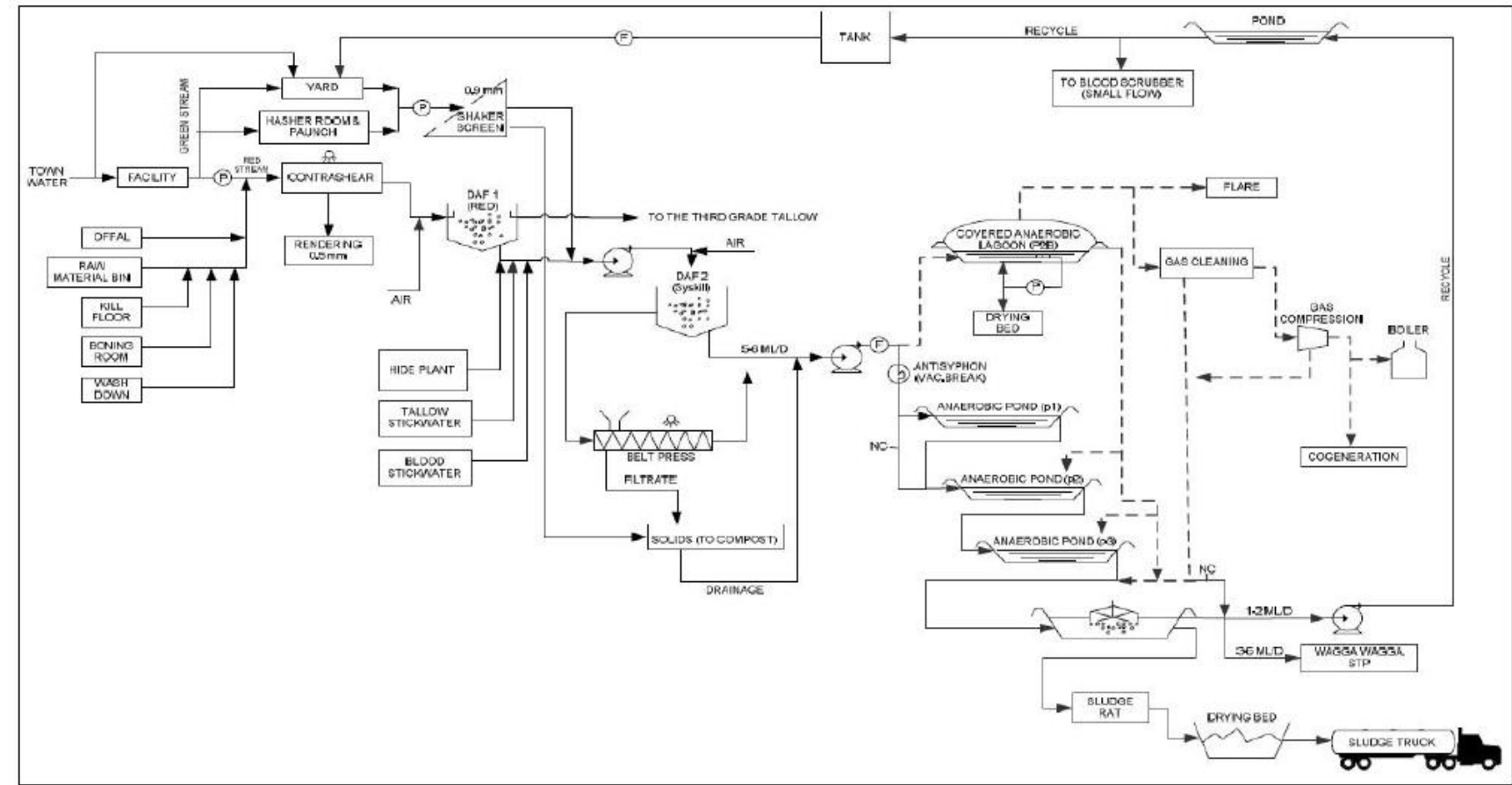
Table B 2 Consequence Results – Explosion Overpressure

Event	Section Description	Hole Size (mm)	Process Conditions		Overpressure Distances (m)			Inventory (kg)
			P (kPag)	T (°C)	3.5 kPa	7 kPa	14 kPa	
s1_expl	Explosion from inside covered pond	-	Atm	25	485	262	152	6600
s3_flare	Explosion inside the combustion chamber	-	atm	25	63	34	20	6600

Appendix C

Process Flow Diagram

Process Flow Diagram



GHD

180 Lonsdale Street
Melbourne, Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com.au

© GHD 2008

This document is and shall remain the property of GHD. The document may only be used for the purpose of for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	Raj Chatiar	Chrisjan Joubert				18/12/08





Appendix B

Agenda for CBA Wastewater Treatment Ponds PFM

2 December 2008



Cargill Beef Abattoir – Wastewater Treatment Ponds

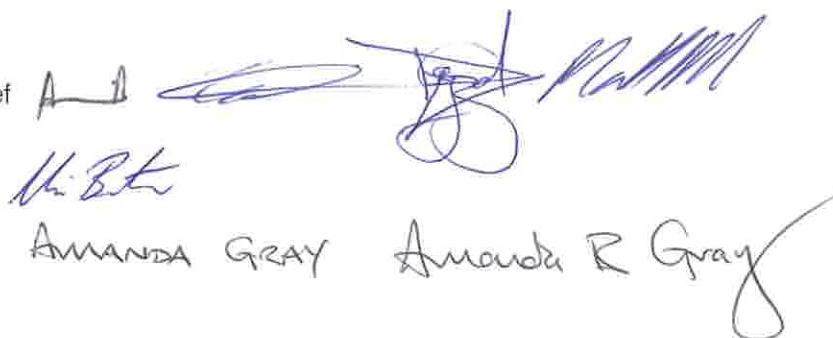
Modification Application No: 220-07-2002 MOD 3

Planning Focus Meeting Agenda

8 December 2008
GHD Wagga Office

Attendance

- Cargill Beef
- GHD
- DECC
- WWCC


AMANDA GRAY Amanda R Gray

Summary of the Proposal

Cargill Beef Australia proposes to upgrade its abattoir treatment ponds by replacing two existing anaerobic ponds with a new covered anaerobic pond. The captured gas from the covered pond will be burnt off by a new flare nearby. The covered pond methane gas collection has the capacity to be upgraded to a cogeneration (co-gen) facility in the future, however it is not as part of the current proposal.

Agenda

- Background of the Project
- Discussing Key Issues identified by the DGRs
 - Odour
 - Waste
 - Soil and Water
 - Greenhouse Gas Emissions
 - Hazard and Risk
 - Visual
 - Other issues



GHD Pty Ltd ABN 39 008 488 373

Suite 3, Level 1, 161-169 Baylis Street

Wagga Wagga NSW 2650

T: 61 2 6923 7400 F: 61 2 6971 9565 E: wgamail@ghd.com.au

© **GHD Pty Ltd 2009**

This document is and shall remain the property of GHD Pty Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Consultancy Agreement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	Gary Cheung	Tracy Bentick		David Gribble		15/01/2009