INFORMATION REGARDING ENVIRONMENTAL AUDIT REPORTS

August 2007

VICTORIA'S AUDIT SYSTEM

An environmental audit system has operated in Victoria since 1989. The *Environment Protection Act 1970* (the Act) provides for the appointment by the Environment Protection Authority (EPA Victoria) of environmental auditors and the conduct of independent, high quality and rigorous environmental audits.

An environmental audit is an assessment of the condition of the environment, or the nature and extent of harm (or risk of harm) posed by an industrial process or activity, waste, substance or noise. Environmental audit reports are prepared by EPA-appointed environmental auditors who are highly qualified and skilled individuals.

Under the Act, the function of an environmental auditor is to conduct environmental audits and prepare environmental audit reports. Where an environmental audit is conducted to determine the condition of a site or its suitability for certain uses, an environmental auditor may issue either a certificate or statement of environmental audit.

A certificate indicates that the auditor is of the opinion that the site is suitable for any beneficial use defined in the Act, whilst a statement indicates that there is some restriction on the use of the site.

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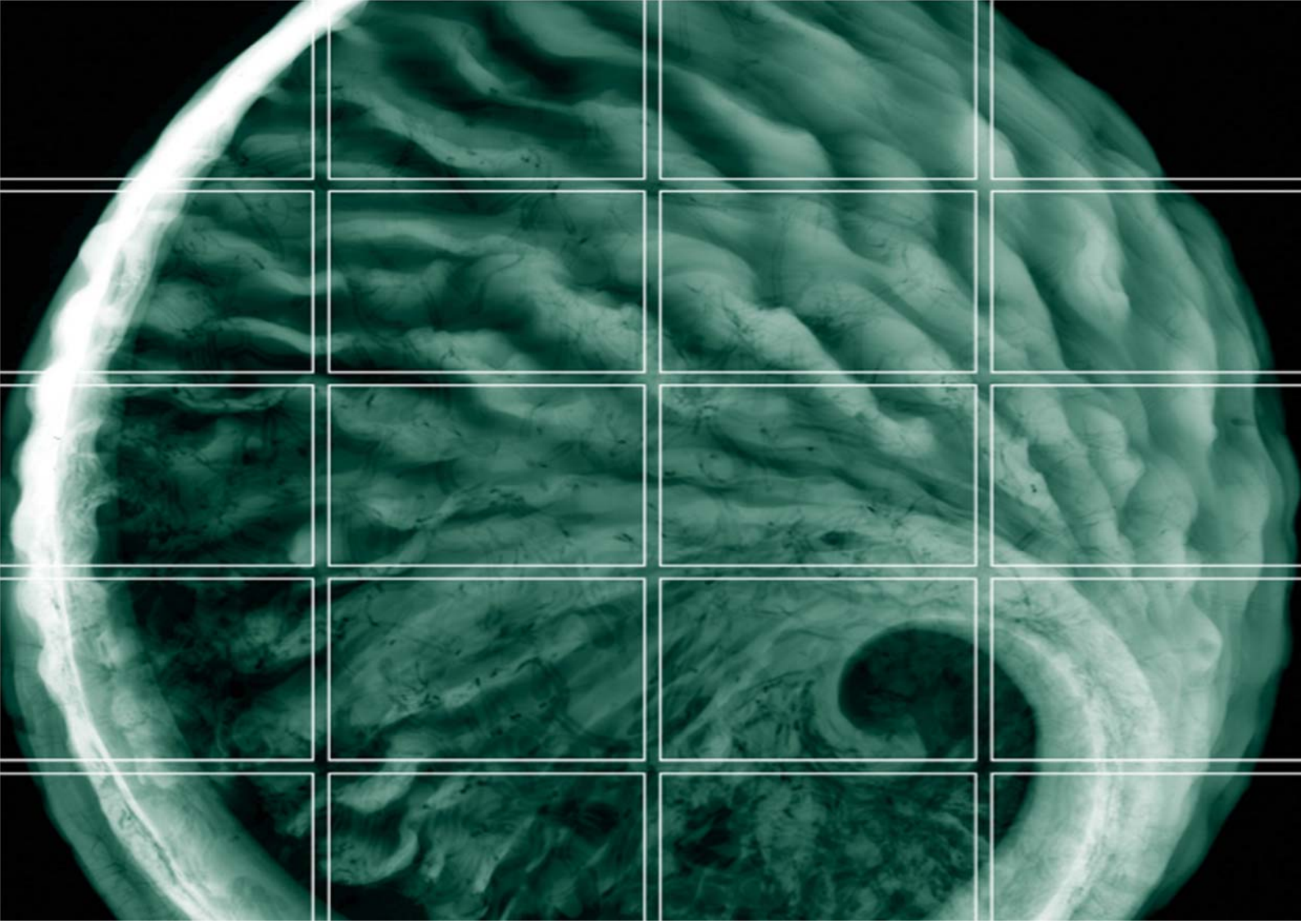

City of Greater Bendigo

Section 53V Audit of Risk of Harm - Landfill Buffer Eaglehawk Landfill 191 – 193 Upper California Gully Road, Eaglehawk Victoria

Service Order: 8005693

CARMS Reference: 60409-9
Service Order Number: 8005693

16 December 2019

Project No.: 0448421

The business of sustainability

ERM

Signature Page

Section 53V Audit of Risk of Harm - Landfill Buffer
Eaglehawk Landfill
191 – 193 Upper California Gully Road, Eaglehawk Victoria

Paul Fridell
Environmental Auditor
(Appointed pursuant to the
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EXECUTIVE SUMMARY

Paul Fridell (the Auditor) of Environmental Resources Management Australia Pty Ltd (ERM) was engaged in his capacity as an Environmental Auditor (a person appointed as an Environmental Auditor, pursuant to the Environment Protection Act 1970) to conduct a voluntary environmental audit of risk of possible harm or detriment to the land, noise and air environment within 500 metres of the Eaglehawk landfill (the site) located at 191-193 Upper California Gully Road, Eaglehawk. The audit was conducted in accordance with Section 53V of the Environment Protection Act 1970.

The purpose of the audit is to satisfy the requirements of EPA, Best Practice Environmental Management: Siting, Design, Operation and Rehabilitation of Landfills (the Landfill BPEM) (EPA Publication 788.3, August 2015) and Assessing planning proposals within the buffer of a landfill (EPA Publication 1642, October 2017).

The overall audit objective is limited to an assessment of the risk of possible harm or detriment to the land, noise and air environment within 500 metres of the landfill posed by potential subsurface migration of uncontrolled landfill gas in the subsurface and amenity impacts, including offensive odour, noise, dust and litter emissions. Specifically:

- *Review the landfill gas risk assessment and amenity risks (in particular odour, dust and noise) to determine the likely risks posed to any existing or proposed developments within the standard 500 metre buffer distance established in the Landfill BPEM guidelines for putrescible waste landfills;*
- *Assess the likely direction and extent of any landfill gas subsurface migration and amenity impacts that may be generated in the event of a reasonable worst case scenario, such as an abnormal weather event or failure of a landfill operations risk mitigation measure;*
- *Determine any appropriate on-site landfill operations risk mitigation measures or measures to be adopted by any future developments within the standard 500 metre buffer distance considering the likely direction and extent of any subsurface landfill gas migration or amenity impacts; and*
- *Determine, and recommend (if necessary), appropriate landfill management measures required if a change in the buffer distance is made as a result of this audit.*

It is intended that the risk mitigation measures identified within this audit will inform changes, if any, to the Greater Bendigo Planning Scheme.

The environmental auditor is of the opinion that the assessment methodologies of the reports prepared by the assessors was adequate for the purpose of this audit and confirm that the assessments were undertaken in accordance with applicable EPA Victorian guidelines, in particular the Landfill BPEM, as well as EPA Publication 1642 Assessing planning proposals within the buffer of a landfill. The table below summarises the auditor's findings:

Table E.1 Audit Findings

Audit Objectives	*Summary of Audit Findings*
Review landfill gas risk assessments and amenity risks (in particular odour, dust and noise) to determine the likely risks posed to any existing or proposed developments within the standard 500 metre buffer distance established in the Landfill BPEM guidelines for putrescible waste landfills	***Subsurface Landfill Gas*** *The risk assessment considered analysis of existing monitoring data and desk top analysis of various potential preferential pathways, and determined that the risk to receptors within the nominal landfill buffer of 500 metres due to landfill gas migration under existing and proposed developments is considered to be low within 250 m of the landfill and very low between 250 – 500 m. Commensurate with the current risk profile and in anticipation of any potential changes in the future risk, three levels of control (control areas) have been recommended within*

Audit Objectives	Summary of Audit Findings
	the existing buffer distance for new developments and to protect existing developments. ***Odour*** *Odour emission sampling of the existing operations identified the main sources of odour emissions are from the landfill tipping face (40%), green/food waste transfer facility (organics shed) (20%) and green waste mulch area (15%). Modelling indicates that sensitive receptors to the north and east of the site, as well as farming zoned land to the west, within the 500 metre buffer are likely to experience elevated odour levels from these current sources. Odour modelling indicated that areas to the south and south west were unlikely to be affected.* *Validation of the modelling results was not undertaken according to European Standard 'EN16841-2-2016: determination of odour in ambient air by using field inspection – Part 2: Plume method', or a suitable equivalent by the air quality consultant. This standard requires field validation to be undertaken by a person with a calibrated nose at various field meteorological conditions and at various potential positional patterns in the predicted plume footprint. To strictly comply with this standard it would require rapid deployment of appropriately trained persons in odour detection with permission to enter private property and buildings within the plume footprint. Without right of access and trained persons immediately available, it was deemed that strict compliance would not be practicable for a rural small landfill where the surrounding area is largely developed thus limiting movement of trained odour detectors. However the odour consultant did undertake an informal survey of residents in the predicted plume footprint and presented this anecdotal field evidence of validation of the plume. While this is not a categorical survey it does suggest some odour impact has historically occurred off-site as a result of current on-site activities. Without this validation work, it is assumed the modelling results are conservative and potentially overestimate the extent of impact.* *The odour from the future aftercare onsite activities (i.e. no operational landfill), is expected to be sourced from the continued operation of the food and organics transfer station and green waste storage and mulching area. In addition it has been advised by Council that the food and green transfer operation will now occur outside the shed on the concrete slab west of the building and shed will be used to transfer putrescible waste. These future sources have only been recent advised and therefore have not been considered in the odour modelling or in isolation from the landfill source (post closure). Considering the contribution of these activities to the overall odour emission source, it is likely that odour from these activities will continue to generate potential odour impacts.* ***Noise*** *The risk from noise emissions have been predicted to comply with the respective daytime and evening noise limits for the site based on existing conditions. Proposed activities in the future were not assessed,*

Audit Objectives	Summary of Audit Findings
	however they were not predicted to intensify and therefore are unlikely to significantly alter the current noise impact findings. ***Dust and Particulates*** *The risk from dust and particulate matter impacts at the nearest sensitive receptors is negligible under existing and proposed activities.*
Assess the likely direction and extent of any landfill gas subsurface migration and amenity impacts that may be generated in the event of a reasonable worst case scenario, such as an abnormal weather event or failure of a landfill operations risk mitigation measure	*For landfill gas, under assumed upset conditions, the assessment of risk scores for current normal operations and proposed site activities remains the same. Figure 8A of the AECOM report provides the risk scores within the Landfill BPEM buffer. The risk scores are higher closer to the landfill boundary, i.e. closer to the source, with the level of risk reducing as the distance to the landfill boundary increases.* *For odour, under a number of upset conditions, the 4 OU contour of likely odour impacts, generally extends beyond the Landfill BPEM buffer to the north and west of the site. The modelling extends beyond the Transfer Station buffer of 250 m in all directions, although the modelling has not been field validated.* *For dust, the assessment of upset conditions for both existing and proposed operations predicts compliance at sensitive receptors.* *For noise, no upset conditions were assessed as part of the assessment.*
Recommended Buffer	*The default amenity buffers applied to these land uses include:* ■ *500 metre buffer from the edges of the current cell (Cell 5);* ■ *250 metres buffer from the green/food waste transfer station building and the observed green waste processing area; and,* ■ *100 metres from general refuse transfer station.* *The landfill will close in the near future leaving the food/green waste facility and the green waste mulching as ongoing activities in the medium term future. The public general waste transfer station will move to a hard stand area to immediately adjacent and south west of the off-site Eaglehawk Eco-Centre near the entrance.* *The odour assessment modelling results identify potential elevated odour concentrations are likely to be experienced by sensitive receptors within the buffer areas to the north east of the site (south of Violet Street) during the operation of the landfill, green waste mulching and food/green waste transfer station operation, both under normal and upset conditions.* *After the closure of the landfill, the green waste mulching and food/green waste transfer station will continue to be a significant odour sources during the landfill aftercare period. In addition the future use scenario will see the food/green move outdoors and putrescible be stored in the shed prior to transfer.* *Considering the results of the odour assessment and the limited survey of the surrounding receptors, the auditor cannot justify any reduction of the existing default buffers during current or future operations. It is noted*

Audit Objectives	Summary of Audit Findings
	the current existing green/food waste transfer buffer extends over the majority of properties south of Violet Street. *The Auditor therefore recommends that appropriate planning controls be implemented within the default amenity buffer distance for a transfer station (i.e. 250 metres) to reduce intensification of sensitive uses until such time as the odour impacts are removed due to closure of the transfer station (food and green and putrescible), or a reassessment of odour impacts post closure of the landfill, demonstrates that odour impacts are reduced such that the amenity buffer can be reduced (refer to recommendation 1912-R2). The reassessment is to include revised modelling and a field validation program using a method based on 'European Standard EN16841-2-2016: Determination of odour in ambient air by using field inspection – Part 2: Plume method', adapted for Australian conditions, and subject to endorsement by an EPA appointed Environmental Auditor (refer to recommendation 1912-R1).* *No change is proposed to the 500 metre landfill amenity buffer (measured from the edge of the active cell). The only properties likely to be impacted based on odour modelling results and within the 500 metre buffer are south of Violet Street, which are also within the 250 metre food and green transfer station buffer. Given the imminent closure of the landfill active cell (approximately 2 years) and continued operation of the food and green facility, to avoid the administrative burden of implementing planning controls based on two overlapping buffers, it is deemed appropriate that the food/green transfer station buffer is adequate to address both sources now and into the future and thus no further action is recommended for the properties within the 500 metre landfill amenity buffer.* *Notwithstanding the recommendations above related to non-landfill activities, considering the subsurface landfill gas risk assessment, it is the auditor's opinion that the 500 metre Landfill BPEM buffer related to subsurface landfill gas migration remain with the implementation of the specified mitigation measures for future developments and additional off-site monitoring as recommended (1912-R3 and 1912-R4)).*
Determine any appropriate on-site landfill operations risk mitigation measures or measures to be adopted by any future developments within the standard 500 metre buffer distance considering the likely direction and extent of any subsurface landfill gas migration or amenity impacts	*As discussed above, it is recommended that the green waste mulching area and/or the food/green/putrescible waste transfer area be relocated by Council on-site to be more than 250 metres (nominal transfer station buffer distance) from any sensitive receptors where practicable. Where relocation is not practicable, then additional odour mitigation measures (e.g. ventilated structures, automated closing doors) are to be considered by Council and modelled to demonstrate reduced odour impacts to sensitive receptors within the 250 metre transfer station buffer distance (refer to recommendation 1912-R1).* *There has been no change made to the standard 500 metre landfill buffer distance, however, considering the presence of existing developments within the buffer and the potential for new developments, the recommendations are made within the standard 500 metre landfill gas buffer (1912-R3 and 1912-R4).*

Audit Objectives	*Summary of Audit Findings*
Determine, and recommend (if necessary), appropriate landfill management measures required if a change in the buffer distance is made as a result of this audit	*No change in the buffer distance has been proposed therefore no additional recommendations have been made against this objective.*

All audit recommendations are included in the table below which includes:

- *a unique reference identification number consisting of year, month and the recommendation number to allow tracking of the recommendation through subsequent audits;*
- *the priority ranking as per the table above; and*
- *a description of the recommendation.*

Table E.2 Auditor Recommendations

ID	Recommendations
1912-R1	*The City of Greater Bendigo is to relocate on-site (where practicable) the greenwaste mulching area and the food/green transfer facility to maintain 250 metre separation to existing sensitive receptors and areas zoned for residential development. Where this is not practicable, Council are to investigate the installation of odour mitigation measures.* *In both instances (relocation or additional mitigation measures) the Council is required to undertake odour, noise and dust modelling to demonstrate the ongoing operation of the onsite organic waste operations will not pose an unacceptable risk to sensitive receptors in the aftercare period.* *The reassessment of odour is to include revised modelling and a field validation program using a method based on 'European Standard EN16841-2-2016: Determination of odour in ambient air by using field inspection – Part 2: Plume method', adapted for Australian conditions, and subject to endorsement by an EPA appointed Environmental Auditor.*
1912–R2	*Planning controls are recommended for land within the 250 metre default amenity buffer for transfer station to limit intensification of sensitive uses within the buffer.*
1912-R3	*For land within 500 metres of waste placement on the site (effectively the boundary of the site), it is recommended that a Design and Development Overlay (DDO) be developed to ensure the following controls are implemented for new developments:* ■ *For new developments within Control Area 1 (residential) and Control Area 3 (industrial) (typically within approximately 250m of landfill) the developer will require LFG mitigation measures (membrane barriers and/or slab venting) to be incorporated into the design of the new structures as per British Standard 8485:2015.* ■ *Risk in Control Area 2 (existing and new residential developments) (typically 250-500m from landfill) will be addressed by increased monitoring by the landfill operator (Council). The Council planning department is obligated to obtain advice from the landfill operator*

ID	Recommendations
	(Council) on current LFG risk when considering new developments in this area.
1912-R4	*Specifically for control area 2, it is recommended that underground services and a number of new LFG monitoring bores be installed and monitored by the City of Greater Bendigo, as per Figure F9 of the AECOM report, to provide an early warning of the migration of LFG off-site. These additional bores and monitoring requirements are to be incorporated into the next revision of the current Environmental Monitoring Program for the site and verified by an EPA appointed Environmental Auditor as required by the current licence condition LI_L1. The EMP is to include contingency actions should LFG be encountered at levels that present a greater level of risk (as determined using British Standard 8485 (as amended)) as previously assessed in control area 2.*

The summary information related to this audit is presented in the table below in accordance with EPA Publication 1147, Environmental Auditor Guidelines – Provision of Environmental Audit Reports, Certificates and Statements.

Table E.3 Summary of Audit Information

Auditor	Paul Fridell
Auditor account number	*75638*
Auditor appointment end date	*23 May 2011 to 19 November 2023*
Audit type	*S53V Audit of Risk of Harm within proposed landfill buffer zone*
Date EPA Notified of Audit	*15/02/2018*
Audit service order number	*8005693 (CARMs 60409-9*
Name of person requesting the Audit	*Kylie Douglas*
Relationship to premises/ location	*Senior Landfill Engineer*
Name of premises owner	*City of Greater Bendigo*
Date of auditor engagement	*10/02/2018*
Completion date of the audit	*13 December 2019*
Reasons for audit	*Determine an appropriate buffer distance in consideration of* EPA, *Best Practice Environmental Management: Siting, Design, Operation and Rehabilitation of Landfills* (the Landfill BPEM) (EPA Publication 788.3, August 2015) and *Assessing planning proposals within the buffer of a landfill* (EPA Publication 1642, October 2017).
Audit Categorisation	*Risk of any possible harm or detriment to a segment to the land, noise and air environment within 500 m of the landfill posed by the landfill.*
Environmental Segments	*The Landfill BPEM buffer area (500 metres) surrounding the site – land defined by the premises boundary of the site on 191-193 Upper California Gully Road Eaglehawk as detailed in EPA licence 46490 – which the facility may pose a risk..*
If the audit was required by an EPA notice, licence or other, please provide EPA reference number	*Not applicable*

Current land use zoning	*Public Use Zone – Local Government (PUZ6)*
EPA Region	*North West*
Municipality	
Dominant – Lot on plan	*Lot 2 / PS326959*
Additional – Lot on Plan (s)	
Site/ Premises Name	*Eaglehawk Landfill*
Building/complex sub-unit No.	
Street/Lot – Lower No.	*191*
Street/ Lot – Upper No.	*193*
Street Name	*Upper California Gully*
Street Type (Road, Court, etc.)	*Road*
Street Suffix (north, south, etc.)	
Suburb	*Bendigo*
Postcode	*3556*
GIS coordinate of site centroid	
Longitude/ Northing	*144.241992*
Latitude / Easting	*-36.729838*
Member and Categories of Support Team Utilised	*Iain Cowan (odour and dust)* *Nathan Lynch (noise)*
Further work or requirements	*Refer to the audit findings in Table E.2*
Nature and extent of continuing risk	*Refer to the audit findings in Table E.1*
Outcomes of the Audit	*Refer to the audit findings in Table E.1*

Table E.4 Physical site information

Historical land use	*Disposal of mine tailings waste and used by local residents as a waste dump prior to landfilling.*
Current land use	*Landfill*
Surrounding land use - north	*Residential, native bushland*
Surrounding land use - south	*Native bushland, industrial zoned land*
Surrounding land use - east	*Industrial zoned land, residential*
Surrounding land use - west	*Native bushland, agricultural land use*
Proposed land use zoning	*-*
Nearest surface water receptor – name	*Devonshire Gully*
Nearest surface water receptor – direction	*Onsite, south*
Groundwater Segment	*Segment C (as per previous operational audit ERM, 2017)*

1. INTRODUCTION

Paul Fridell of Environmental Resources Management Australia Pty Ltd (ERM) was engaged in his capacity as an Environmental Auditor *(a person appointed as an Environmental Auditor, pursuant to the Environment Protection Act 1970)* to conduct a voluntary environmental audit of risk of possible harm or detriment to the land, noise and air environment within 500 metres of the Eaglehawk landfill (the site) located at 191-193 Upper California Gully Road, Eaglehawk (refer to *Figure 1, Appendix A* for a site locality plan). The audit was conducted in accordance with Section 53V of the *Environment Protection Act 1970*.

The objective of the audit is to determine an appropriate buffer distance by assessing the likely extent of potentially uncontrolled subsurface landfill gas and amenity impacts in upset or abnormal conditions (e.g. a failure of landfill design or management or abnormal weather conditions) migrating from the site.

1.1 Audit Purpose

The audit is required to satisfy the requirements of EPA, *Best Practice Environmental Management: Siting, Design, Operation and Rehabilitation of Landfills* (the Landfill BPEM) (EPA Publication 788.3, August 2015) and *Assessing planning proposals within the buffer of a landfill* (EPA Publication 1642, October 2017).

1.2 Audit Objective

The overall audit objective is limited to an assessment of the risk of possible harm or detriment to the land, noise and air environment within 500 metres of the landfill posed by potential subsurface migration of uncontrolled landfill gas in the subsurface and amenity impacts, including offensive odour, noise, dust and litter emissions during operation and aftercare periods.

The objectives of the audit are to:

- Review landfill gas risk assessments and amenity risks (in particular odour, dust and noise) to determine the likely risks posed to any existing or proposed developments within the standard 500 metre buffer distance established in the Landfill BPEM guidelines for putrescible waste landfills;
- Assess the likely direction and extent of any landfill gas subsurface migration and amenity impacts that may be generated in the event of a reasonable worst case scenario, such as an abnormal weather event or failure of a landfill operations risk mitigation measure;
- Determine any appropriate on-site landfill operations risk mitigation measures or measures to be adopted by any future developments within the standard 500 metre buffer distance considering the likely direction and extent of any subsurface landfill gas migration or amenity impacts; and
- Determine, and recommend (if necessary), appropriate landfill management measures required if a change in the buffer distance is made as a result of this audit.

The proposed risk mitigation measures will inform changes, if any, to the Greater Bendigo Planning Scheme.

The audit considered the adequacy of the assessment methodologies prepared by the assessor and confirm that the assessments were undertaken in accordance with applicable EPA Victorian guidelines, in particular the Landfill BPEM, as well as EPA Publication 1642 *Assessing planning proposals within the buffer of a landfill.*

1.3 Audit Scope

The scope was detailed in a report titled "*City of Greater Bendigo Eaglehawk Landfill Voluntary s53V Audit Scope"*, dated 17 May 2018. EPA Victoria provided feedback on the audit scope in email dated 27 June 2018. Refer to *Appendix B* for a copy of the scope document and EPA feedback. EPA feedback has been incorporated into the audit, where applicable.

This audit report has also been prepared in compliance with EPA Publication 952 (as amended) *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment.*

1.3.1 Audited Activity & Activity Components

The activities undertaken on-site that are relevant to this audit primarily include the operation of the landfill (waste placement) and green waste mulching, as well as leachate and landfill gas management. The audit has also considered activities undertaken in the onsite Recovery Centre, including municipal waste transfer station and food and organics waste transfer station.

The audit has considered the current licensed premises and the footprint of any future approved landfill operations (works approval or planning approval) that is not yet licensed.

1.3.2 Segments of the Environment Considered

The segments of the environment audited was the standard Landfill BPEM buffer area (500 m) surrounding the site to which the activities detailed above may pose a risk. The segments of the environment audited include an approximately 500 m buffer around the site - land defined by the premises boundary of the site on 191-193 Upper California Gully Rd, Eaglehawk, as detailed in EPA Licence 46490 - which the facility may pose a risk.

1.3.3 Elements of the Environment Considered

The elements of the environment considered relevant to this audit are listed in the table below.

Table 1.1 Elements of the Environment

Segment	Element		On-Site	Off-Site
Land	Soil	Excluded		
	Sediment	Excluded		
	Landfill Gas	Included		✓
	Human Health	Included		✓
	Ecosystems	Excluded		
	Aesthetics	Included		✓
Groundwater	All elements	Excluded		
Surface Water	All elements	Excluded		
Air	Odour	Included		✓
	Dust	Included		✓
	Climate	Excluded		
Noise	Sound	Included		✓

The onsite elements of the environment are audited separately under S53V Operations Landfill audit, last audit completed by ERM in 2019. They are not considered in this audit.

1.3.4 Beneficial Uses Considered

Beneficial uses considered during the audit were those specified in the relevant State Environmental Protection Policies ("SEPPs") including:

- *State Environment Protection Policy (Air Quality Management),* Victorian Government Gazette, No. S240, December 2001;
- *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade),* Victorian Government Gazette No. S31, June 1989, as varied by Variation to the State environment protection policy (*Control of Noise from Commerce, Industry and Trade*) No. S183, Gazette 31 October 2001; and
- *State Environment Protection Policy (Prevention and Management of Contaminated Land)*, Victorian Government Gazette, No. S95, June 2002, as varied by Variation to the State environment protection policy (Prevention and Management of Contamination of Land) No. G39, Gazette 26 September 2013.

1.3.5 Audit Criteria

In undertaking the audit, audit criteria were drawn from the above SEPPs, any site specific criteria and the following relevant EPA publications:

- EPA Victoria, *Licence 46490* (last amended 22/11/2017);
- EPA Publication 788.3, *Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills*, August 2015;
- EPA Publication 1642, *Assessing planning proposals within the buffer of a landfill*, October 2017;
- EPA Publication 1411, *Noise from Industry in Regional Victoria;*
- EPA Publication 1518, *Recommended separation distances for industrial residual air emissions* March 2013*;*
- EPA Publication 1684, *Landfill gas fugitive emissions monitoring guideline* February 2018;
- EPA Publication, 1191*, Protocol for Environmental Management – Mining and Extractive Industries,* December 2007;
- Sustainability Victoria, 2009, *Best Practice as Resource Recovery Centres*;
- CIRIA C665, 2007, *Assessing Risks Posed by Hazardous ground gases to buildings;*
- UK EA, LFTGNO3, 2004, *Guidance on the management of landfill gas; and*
- British Standard, 8485:2015, *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.*

The above State Environment Protection Policies identify indicators to be employed in measuring environmental quality, set out the environmental quality objectives for sustaining designated beneficial uses, and nominate criteria that may be used when assessing risk.

1.3.6 Audit Period

The audit considered all information made available by the licence holder and within the applicable assessment reports.

The audit was undertaken from 15 February 2018 until date October 2019.

1.3.7 Risk Assessment

The Environmental Auditor has reviewed the assessment of significant risks associated with the pertinent aspects of the landfill and transfer station as an integral part of the audit.

1.3.8 Exclusions

This audit focuses on any possible harm or detriment to the land, noise and air segments of the environment caused by the operation, and aftercare, of the landfill. The audit does not include:

- The onsite elements of the environment as these are audited separately under S53V Operations Landfill audit, last audit completed by ERM in 2019;
- The assessment of risks, except for amenity impacts, posed by other activities on the site unrelated to the landfill including the general operation of any on-site waste and resource recovery facility;
- The assessment of risks of any general earthworks activities or any extractive industry activities occurring on the site;
- The assessment of other segments of the environment that have not been identified in the scope of works, such as surface water;
- The potential amenity impacts of the landfill gas extraction system such as, noise, dust, odour, are not considered likely to be warrant separate consideration when compared to the impacts from the landfill and transfer station impacts. The system has been considered in this report in the context as a risk mitigation measure only;
- The impact of greenhouse gas emissions to atmosphere due to the presence of methane and carbon dioxide in landfill gas; and
- A total assessment of the site to determine suitability for future use of the site or surrounding areas.

1.4 Auditor Independence

The audit has been completed by Paul Fridell. The auditor, who currently conducts the site operational audit, does not consider that there is any conflict of interest in undertaking this audit and that their current engagement is appropriate.

The auditor considers that they have, while undertaking this audit, acted diligently, impartially and conscientiously and exercised professional judgement. In forming their opinions and determinations, the auditor has maintained independence from the licence holder, City of Greater Bendigo, and the various assessors and identified other stakeholders.

1.5 Parties Involved

The following table lists relevant parties involved in this audit.

Table 1.2 Name and roles of parties involved during the Audit.

Name	Role
City of Greater Bendigo- waste management team	EPA Licence Holder and landfill operator, member of project Steering Committee
City of Greater Bendigo – statutory planning team	Planning requirements and project and Steering Committee co-ordinator
Centrum Town Planning – consultant town planner	Planning requirements
AECOM Australia Pty Ltd	Site Assessor – landfill gas
SLR Consulting Australia Pty Ltd	Site Assessor – noise and dust
Consulting Environmental Engineers	Site Assessor – odour
Paul Fridell	Environmental Auditor
EPA Victoria (EPA Vic)	Regulatory Body and member of project Steering Committee
Metropolitan Waste and Resource Recovery Group	Member of project Steering Committee
Loddon Mallee Waste and Resource Recovery Group	Member of project Steering Committee
Department of Environment, Land, Water and Planning	Member of project Steering Committee

2. AUDIT METHODOLOGY

2.1 Notification of Audit

It is a statutory requirement to notify EPA of the request to complete an audit and prepare an audit report. This takes the form of preparing a notification and forwarding it to the EPA's Manager of Environmental Audit. This was carried out on 15 February 2018 by Paul Fridell.

2.2 Site Inspection

The auditor, Paul Fridell, of ERM visited the site with Kylie Douglas of City of Greater Bendigo on the 29 November 2018 to assess the current environmental condition of the site and surrounds.

The site inspection allowed for a review of waste disposal and management activities at the site to assist in identifying risks posed by these activities, a review of pollution controls and site management practices to assist in identifying risks posed by waste disposal and management at the site and identification of any specific issues or risks that may require addressing.

2.3 Documents Reviewed and Considered

2.3.1 EPA Reports

The relevant EPA licence applicable during the audit included:

- Greater Bendigo City Council, Licence 46490, issued 9/5/1975 last amended 22 November 2017.

2.3.2 Site Specific Documents

A review of documents provided below has been undertaken as part of this audit and have been relied upon:

- SLR Consulting Australia Pty Ltd (SLR),2019, *Eaglehawk Landfill Dust Impact Assessment*, prepared for City of Greater Bendigo, 31 May 2019, report reference number 640.11831-RO1, version v3.0;
- Consulting Environmental Engineers (CEE), 2019, *Odour Assessment for Eaglehawk Landfill*, 30 March 2019, version 2-Final;
- SLR, 2017, *Eaglehawk Landfill Environmental Noise Assessment*, 23 October 2017, report reference number 640.11501-RO1, version v1.0;
- AECOM, 2019, *Buffer Zone Landfill Gas Risk Assessment Eaglehawk Landfill*, document reference 60579200, revision 2, 19 September 2019;
- AECOM Pty Ltd, 2017a, *Eaglehawk Landfill Hydrogeological Assessment, Revision 2016-2017*, Revision 3, 20 June 2017,
- Infrastructure Solutions Pty Ltd, 2018, *Eaglehawk Landfill Rehabilitation Conceptual Top of Landfill Cap Pre-settlement Contour Plan at Upper California Gully Road, Eaglehawk* -Drawings, 12 June 2018;
- ERM, 2019, *Section 53V Audit of Landfill Operations, Eaglehawk Landfill, 191-193 Upper California Gully Road Eaglehawk*, dated 30 September 2019.

2.3.3 External Reference Documents

In undertaking this audit, the auditor has considered the following external reference documents:

- Planning scheme information – sourced online from the State of Victoria, Department of Environment, Land, Water and Planning at http://planning-schemes.delwp.vic.gov.au/
- Google Earth, accessed March 2019
- Bureau of Meteorology – sourced online from http://bom.gov.au/;

2.3.4 EPA Publications

In undertaking this audit, the Environmental Auditor had regard to the following EPA guidelines, in addition to those detailed in *section 1.3.5:*

- EPA Victoria Publication 952, *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment;*
- EPA Victoria Publication 1147, *Environmental Auditor Guidelines – Provisions of Environmental Audit Reports, Certificates and Statements;*
- EPA Victoria Publication 1321, *Licence Assessment Guidelines – Guidelines for using a Risk Management Approach to Assess Compliance with Licence Conditions; and*
- EPA Victoria Publication 1323, *Landfill Licensing Guidelines*.

2.4 Stakeholder Engagement

As part of the audit, the stakeholder(s) consulted during the audit, generally as part of regular project steering committee meetings were:

- City of Greater Bendigo;
- EPA Victoria;
- Metropolitan Waste and Resource Recovery Group; and
- Department of Environment, Land, Water and Planning.

Steering committee meetings were conducted on 7 June 2018 (Auditor not invited), 31 July 2018, 1, 29 November 2018, 26 March 2019 and 31 July 2019.

In addition, the auditor was involved in a number of additional meetings/ teleconferences specifically regarding the assessment of landfill gas migration. These were:

- Meeting on 2 April 2019 attended by AECOM and Auditor;
- Meeting on 21 August 2018 attended by Council and Auditor;
- Telephone discussion on 21 May 2019 attended by EPA and Auditor;
- Meeting on 1 March 2019 attended by AECOM, Council and Auditor
- Teleconference on 12 June 2019 attended by AECOM, Council and Auditor; and
- Call on 11 July 2019 attended by AECOM and Auditor.

2.5 Auditor Support Personnel

The Environmental Auditor has principally relied upon his own expertise in contaminated land and landfills to assess the risks of landfill operations in undertaking this audit. ERM personnel utilised by the Environmental Auditor to assist in completing the audit are presented below:

- Nicole Bradley, report completion.

2.6 Auditor Expert Support

During this audit, the Environmental Auditor has called upon the expertise of two members of his expert support team.

2.6.1 Air Quality

In undertaking the review of the *Eaglehawk Landfill Dust Impact Assessment* (SLR, 2019) the auditor was assisted by his specialist support person (Dr Iain Cowan) for the following areas outside of the auditor's area of expertise:

- Air quality

Dr Cowan is employed by ERM and is a Certified Air Quality Professional by the Clean Air Society of Australia and New Zealand. He holds a Bachelor of Science (Honours), degree in Environmental Geology and phD in Environmental Engineering and has over 17 years-experience in the estimation of emissions, dispersion modelling and monitoring of ambient air quality, greenhouse gas species and odour.

Dr Cowan reviewed the draft and final documents of the reports and provided his comments in the auditor's master comments register for the report. The comments in the register were progressively closed out to the satisfaction of Dr Cowan and the auditor.

In addition, in undertaking the review of the *Odour Assessment for Eaglehawk Landfill* (CEE, 2019) the auditor was assisted by his specialist support person (Dr Iain Cowan) for the areas detailed above outside of the auditor's area of expertise. Dr Cowan reviewed the draft and final document and provided his comments in the auditor's master comments register for the report. Through updates in the assessor's document, the comments made by the auditor and Dr Cowan were progressively closed out to the satisfaction of Dr Cowan and the auditor.

2.6.2 Acoustics

In undertaking the review of the *Eaglehawk Landfill Environmental Noise Assessment* (SLR, 2017) the auditor was assisted by his specialist support person (Mr Nathan Lynch) for the areas outside of the auditor's area of expertise:

- Acoustics assessment

Mr Lynch is employed by ERM and is an associate member of the Australian Acoustical Society. He holds a Masters of Design Science (Audio & Acoustics) and has over 12 years-experience as an acoustic engineer.

Mr Lynch reviewed the document, which was finalised in 2017, and provided his comments in the auditor's master comments register for the report.

3. SITE DETAILS

3.1 Site Description

The site is located at the Eaglehawk Eco Centre, 191 – 193 Upper California Gully Road, Eaglehawk, Victoria and operates as a landfill under EPA Licence 46490 by the City of Greater Bendigo. The site occupies a total area of approximately 28 hectares (ha), with the current landfilling area comprising 3.2 ha (Cell 5 area) of the total site area. Cell 5 was constructed in December 2014 and began accepting waste in March 2015.

AECOM (2019) detail that the landfill "*has been developed as a valley-fill landfill in a gully that extended from the north-eastern side of Upper Californian Gully Road to the western boundary of the site although the precise extent of the original gully is unknown. The gully where filling took place extended to depths up to 15m below ground level currently observed at the sides of the landfill. Licensed landfill operations commenced in 1975. Prior to licensed landfilling, areas of the current landfill site and in its immediate vicinity were used for the disposal of mine waste (tailings) and by locals as a waste dump since the 1860s; the extent of off-site fill to the north-east of the current landfill is unknown*"

Although AECOM (2019) detail that Council undertook a study in 2018 of historical aerial photography and intrusive investigation and confirmed that putrescible waste is confined to within the landfill boundary, the report states that "*Historical tipping areas are known to extend further up the gully north and north east of the licensed landfill area at Eaglehawk landfill. The nature and amount of deposited waste is unknown, however it is anticipated that putrescible, organic (plant and animal) and potentially hazardous (agricultural and domestic origin) fill materials have been deposited. Historical tipping is expected to contribute to generation of LFG outside the licensed premises boundary*".

The site is bound by native bushland to the north-west, west, south-west and south of the site; residents/industrial buildings to the north-east of the site; industrial to the south-east of the site; and a recovery centre to the east of the site.

The site currently accepts waste from the City of Greater Bendigo.

The site currently accepts approximately 126,200 tonnes of waste per annum and of which approximately 17,000 tonnes is diverted to Patho Landfill. Approximately 29% is municipal solid wastes, 69% industrial waste (construction & demolition and commercial & industrial waste) and 2% prescribed industrial waste (category C soil and category C asbestos)[1].

Refer to *Appendix A, Figure 1* for a site location plan and *Figure 2* for a site features plan.

3.2 Site Layout

Prior to landfilling, the gully where the site is located was used for the disposal of mine waste (tailings) and by local residents as a waste dump. The gully has been partially backfilled with old mine tailings prior to landfilling.

The landfill has been developed as a valley-fill landfill. The landfill has five cells (Cell 1, Cell 2, Cell 3a, Cell 3b and Cell 5). Cells 1, 2 and 3 have been completed with Cell 5 currently being filled (refer to *Appendix A, Figure 2* for a site features plan). Cell 4 is noted on the figure however this cell has not received any waste historically and there is no intention of accepting waste into this designated cell area in the future.

[1] Eaglehawk Landfill EPA Levy waste data July 2017 – June 2018 provided by City of Greater Bendigo

The site currently consists of:

- weighbridge and gatehouse;
- green waste collection and mulching area;
- site office and shed;
- wheel wash facility;
- leachate pond and stormwater pond;
- landfill gas extraction system across the closed cells 1, 2, 3A and 3B to Electricity Generation Plant located in the south of the site. The plant has a flare which is only required when the generator is down;
- Transfer Station/Recycling centre including shed for the receipt and transfer of food and other organics, domestic car face area for disposal of waste for the landfill and area for the receipt and transfer of municipal waste to the Patho Landfill. As the majority of this facility is included in the licensed boundary, the full extent of the Transfer Station has been considered in this audit; and
- Eco Centre facility is mainly located adjacent to the site with a portion onsite but precluded from the site licensed boundary and so is not considered within this audit.

The access road to the site from Upper California Gully Road is bitumen through the weighbridge and the wheel wash. Internal roads are unsealed, however, crushed rock has been placed on the roads to minimise potential dust and mud issues.

The original landfilled area, namely Cell 1, is located across the majority of the eastern section of the site, with the remainder of the landfill covering the western portion of the site. The cell construction and rehabilitation details are included in *Table 6.1, Section 6.1.7*.

Leachate is extracted from the cells via gravity drainage to the leachate pond located south of operational Cell 5.

Refer to *Figure 2, Appendix A* for the site features plan which provides details of the layout of the site, including the areas detailed above.

3.3 Planning Scheme Zones and Potential Receptors

The surrounding land within the 500 m buffer includes the following zones and associated potential receptors. The zones have been used as the primary source for potential land use in areas within the current and proposed buffer area:

Table 3.1 Greater Bendigo Planning Scheme – Zones and Potential Receptors

Zone	Receptors	Direction relevant to the site
Public Conservation and Resource Zone (PCRZ)	■ Environment	North, south, east and west
Public Use Zone – Other Public Use (PUZ7)	■ Environment; ■ Humans and assets (buildings, structures, property & materials- non sensitive uses and activities); ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	North

Zone	Receptors	Direction relevant to the site
Industrial 1 Zone (IN1Z)	■ Humans and assets (buildings, structures, property & materials); ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	North, south, east
General Residential Zone (GRZ)	■ Humans and assets at the neighbouring residential properties; ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	North east, east and south east
Farming Zone	■ Environment; ■ Humans and assets at the neighbouring residential properties; ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	West
Public Park and Recreation PPRZ	■ Environment; ■ Humans and assets (buildings, structures, property & materials- non sensitive uses and activities); ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	North-east
Industrial 3 Zone (IN3Z)	■ Humans and assets (buildings, structures, property & materials); ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	East
Public Use 2 (Education) PUZ2	■ Humans and assets at the neighbouring Residential properties; ■ Humans and assets (subsurface infrastructure) in the vicinity of the site; ■ Other temporal sensitive receptors during construction/ excavation works.	South east

Source:
Planning information sourced at http://planning-schemes.delwp.vic.gov.au/ accessed March 2019
Receptors sourced from Table 8 of AECOM (2019) report

Planning scheme overlays applicable to these areas adjacent to the site are Environmental Significance Overlay, Heritage Overlay, Bushfire Management Overlay and Vegetation Protection Overlay.

The planning scheme zoning and overlay map for the site and within the Landfill BPEM buffer is presented in *Figure 3 Appendix A*.

3.4 Climate

Error! Reference source not found. summarises the area climate data. This data was sourced from the Bureau of Meteorology (BOM) (2018) website. Bendigo Airport, weather station number 081123 was used for current meteorological data as this is the closest operational weather station to the site, located approximately 8 km west of the site.

Table 3.2 Local Climate Data – Bendigo Airport, Victoria

Parameter	Summer (Jan)	Winter (July)	Annual
Mean Rainfall (mm)	33.2	55.1	510.2
Pan Evaporation (mm)	200 - 250	40 – 50	1400-1600
Mean Min. Temperature (ºC)	14.4	2.6	8.0
Mean Max. Temperature (ºC)	30.2	12.6	21.2

Source
http://www.bom.gov.au/climate/averages
Evaporation data obtained from the Bureau of Meteorology National PAN Evaporation Contour Maps
Rainfall and temperature data collected from all years of record for Bendigo Airport Weather Station (Rainfall, 1991 - 2019)

The annual PAN evaporation of approximately 1,400 - 1600 mm per year is considerably more than the average annual rainfall of approximately 510.2 mm reducing the potential for infiltration.

Wind roses sourced from the Bendigo Airport weather station indicate the dominant wind direction in the region (based on annual data) are in a northern and north westerly direction in the morning (9 am).

3.5 Topography

The site covers an area of approximately 28 Ha and is located in a shallow gully at a relatively elevated position in the landscape. The site is located at the upper western side of the local topographical ridge defining the surface water divide which runs approximately along the Upper California Gully Road. The general topography is one of moderate relief with rounded hills sloping to the Myers Creek floodplain to the south. The site is sloping south-west from about 250mAHD to 220 mAHD (AECOM, 2017a.)

3.6 Underground Services

AECOM (2019) report that there are limited underground services/structures in the vicinity of the landfill. A summary of the Dial-Before-You-Dg (DBYD) referrals dated June 2018 is presented in Table 5 of AECOM report (2019).

These revealed:

- Telstra communications along Bracewell road which do not intersect the site. The onsite Telstra service pits do not appear on the DBYD referral;
- Mains water stormwater sewer were shown immediately adjacent/intersecting the site at the tip entrance
- No other onsite services.

The location of offsite underground services are detailed in Figure 7C of the AECOM (2019) report.

4. GEOLOGY AND HYDROGEOLOGY

4.1 Regional and Site Specific Geology

The bedrock of the area is comprised of a Lower Ordovician metamorphised turbidite sequence folded into a set of NNW-SSE trending tight chevron folds on a bearing of 340◦ (AECOM, 2017a).

According to the Geological Survey of Victoria Geological Map Series, Raywood 7724-4 Zone 55, 1:50 000 (2001), the site is predominantly underlain by the Ordovician-aged Chewtonian unit. A minor section to the north-east consists of the similarly aged Bendigonian unit, both of the Castlemaine Group. These units consist of deep marine turbidites and hemipelagic sediments, sandstone, mudstone and black shale, which are richly fossiliferous. The Bendigonian unit outcrop in the north-eastern corner of the site has historically been targeted by mining operations (AECOM, 2017a).

The geological map shows the presence of Shepparton Formation sediments to the south of the site, however William and Wilkinson (1992) in AECOM (2017a) notes these were removed prior to landfilling in search of gold (AECOM, 2017a). AECOM (2019) detail that neither tertiary and quaternary sediments are present across the site.

The general lithological profile based on the bore logs of on-site bores comprises topsoil and fill (clay, sand, loose rubble_ to 0.5 – 3m below ground surface (mbgs)) overlying Ordovician mudstone (comprising various lithologies, from shale/ slate, sandstone and siltstone) (AECOM, 2017a). Subsurface geology encountered in recently drilled and installed landfill gas monitoring bores to a maximum depth of 15.2 mbgs were generally consistent with previous drilling results and historical bore logs (AECOM, 2019). Weathered sedimentary bedrock was encountered from surface, except for bores BH29, BH30 and BH31 where a layer of fill was observed above the natural geology, which was predominantly a fine grained, laminated siltstone with traces of fine to medium grained quartz sand within the silty matrix. Shale was observed from surface at location BH32 and occasional thin shale bands were apparent throughout the siltstone in many locations (AECOM, 2019).

AECOM (2019) notes that the 1:10,000 geological map indicates coarse and medium to fine sandstone beds around the landfill although drilling of the monitoring bores indicted multiple interceptions of coarse grained sediments of various thickness within the mudstone-siltstone sequence, with multiple instances of gravel/coarse sand within a fine grained matrix encountered during drilling of the monitoring bores.

The Bendigo 1:100,000 sheet area indicated that in the vicinity of the Eaglehawk landfill highly and moderately weathered metasediments predominate. A weathered zone of oxidised and leachate material was described in Douglas et al, 1976. Bore logs refer to highly variable thickness and degree of weathering of bedrock underneath and the vicinity of the site. Bore logs within 1 – 3 km surrounding the site describe variable weathered sediments encountered to depths of 4 – 20 m below ground while onsite investigated indicated that highly weathered siltstone up to 7 m to the north of the landfill, along the tip entrance road, half-way towards Upper California Gully Road while less weathered siltstone appeared closer to and underlying the landfill. Bedrock sediments are characterised by low permeability, probably best developed in the upper 20 m of oxidised and leachate material (Douglas et al,, 1976) but likely to extend to up to 200 m below ground surface. (AECOM, 2019)

AECOM (2019) detail that the Lower Ordovician sedimentary sequence is folded into a set of NNW-SSE trending tight folds with extensive local reverse faulting. The 1:10,000 Bendigo Gold Field – Eaglehawk geological map shows several anticlinal structures underlying the site (5 folds) and extending through the 500 m buffer, there are also folds intercepting the buffer zone outside of the landfill footprint. Folds are truncated by numerous faults with no major regional faults in the vicinity of the landfill – the Lancashire Fault inferred through the 500 m buffer and bordering the south-western portion of the landfill appear to be a break fault between Lancashire and Napoleon-Maiden Gully anticlinal structures. It is not unlikely that various types of faults exist in the vicinity of the landfill. Given the extensive network of mine shafts in the area (AECOM, 2019).

Fracturing is most common along the fold axes. Logs for bores within 1-3 km area surrounding the landfill describe deep structures such as faults and/or fractured zones at depths over 20 – 80 m below ground. In site specific bores, fracture/ fracture zones identification has been limited; fractures were noted in some bores logs at depths ranging from 8 mbgl to 14 mbgl (AECOM, 2019).

Prior to landfilling, the valley was partially filled with mine tailings of various thicknesses. These underlie the landfill, as detailed in Figure 7B of the AECOM (2019) report. Further detail of mine tailings are provided in section 6.7.2 of the AECOM report (2019). These deposits are considered permeable when unsaturated and generally continuous (AECOM, 2019)

The geological map of the site is provided in Figure F3 Appendix A of the AECOM (2019) report along with geological cross sections area presented in Figures F5A-C Appendix A of the AECOM (2019) report.

In addition, the landfill is located in an area that is likely to be underlain by extensive mine workings (shafts, drives and galleries) of uncertain depth and connectivity which have been buried or covered and are likely to extend throughout the 500 m buffer. Refer to Figure 7A *Appendix A* of the AECOM (2019) report for details of known mine workings. Mineshafts are clustered along anticlinal structures underlying the site with the Bendigonian unit bordering the north-east of the site most heavily mined. Shaft voids have been encountered during drilling at the site with the last mine shaft collapse ported in 2011. The depths and spatial extent of the shafts and associated workings are uncertain with main shafts potentially being hundreds of metres deep and have multiple lateral branches at various depths (AECOM, 2019).

4.2 Regional Hydrogeology

According to the Victorian Groundwater Beneficial Use Map Series, *North Western Victoria Water Table Aquifers* (1995), the regional groundwater aquifer for the Eaglehawk region is that of the Bedrock Aquifer, comprising Pre-Cainozoic Bedrock, of siltstone, mudstone, sandstone and granite.
The *Hydrogeological Map of Bendigo and Part of Deniliquin* (Geological Survey of Victoria, 1985) provided the following regional information of the area:

- depth to most useful aquifers 30 – 60 m;
- average aquifer thickness – 30 m;
- typical horizontal hydraulic conductivity – 0.1 m/day;
- maximum transmissivity – 10 m^2/day;
- typical storage coefficient 1x 10^{-2} to 2 x 10^{-1}; and
- groundwater salinities of up to 20,000 mg/L have been recorded from areas adjacent to the Riverine Plain, especially north of Bendigo. Fresh groundwater has been obtained from Bedrock aquifers near Longwood.

The Groundwater Resource Report indicates the salinity of the groundwater in the vicinity of the site to be in the range 1,001 – 3,500 mg/L.
Regionally, the upper aquifer occurs within fractures in the unweathered Ordovician-aged bedrock sediments and is best developed in the upper 20 m of oxidised and leached material, although groundwater flow is also likely to occur along bedding and fault planes at deeper depths (AECOM, 2017a).

4.3 Site Hydrogeology

As discussed in *Section 4.1* above, there are two geological units present in the bedrock on the site. The Bendigonian geological unit is limited in surface extent near the site entrance and has been extensively worked and dewatered in the pursuit of gold. The Chewtonian geological unit underlies the remainder of the site and the landfill itself. This unit has not been extensively worked or dewatered. Hydrogeological investigations have been undertaken at the site since 1993, with the groundwater monitoring network installed in the underlying Chewtonian unit.

The groundwater within the Ordovician bedrock sediments are characterised by low permeability (AECOM, 2019). AECOM (2019) detail that over the last 10 years, the reported depths to groundwater varied from about 5 – 10 m in bores located west and south of the landfill to about 20 m along the boundary with the closest potential receptors to the north of the landfill to a depth of 35m to the east of the landfill. Thus, the unsaturated profile varies in thickness, with at least 5 m available for gas transport during periods of high water table and more than 10-15 m available at other times to the north of the landfill, and to the east of the landfill there is at least 30 m of unsaturated profile available for gas transport.

The inferred groundwater flow direction across the site in both the shallower and deeper chewtonian aquifer systems is generally towards the west/south-west, consistent with site topography.

5. BENEFICIAL USES AND BUFFERS

5.1 Beneficial Uses

Beneficial uses requiring protection are based on the State Environmental Protections Policies (SEPPs) and the applicable land uses on and offsite that may be impacted by the site's operations. The applicable SEPPs, or guideline in the case of noise, and their beneficial uses requiring protection are detailed in the sections below.

5.1.1 SEPP – Prevention and Management of Contamination of Land

The objective of this policy is to maintain, and where appropriate and practicable, improve the condition of the land environment sufficient to protect current and future beneficial uses of land from the detrimental effects of contamination (Land SEPP, 2002).

The beneficial uses of land to be protected are defined under the Land SEPP by the current and zone land use. The landfill site is classified under the *'Industrial'* land use and surrounding areas as *'Parks and Reserves', 'Agricultural' and 'Sensitive-Other''*. *Table 5.1* below highlights the beneficial uses to be protected as outlined in the Land SEPP.

Table 5.1 Protected Beneficial Uses of Land

Beneficial Use	Land Use						
	'arks & Reserves	Agricultural	Sensitive use		Recreation/Op	Commercial	Industrial
			High density	Other			
Maintenance of ecosystems:							
Natural ecosystems	X						
Modified ecosystems	X	X		X	X		
Highly Modified ecosystems		X	X	X	X	X	X
Human Health	X	X	X	X	X	X	X
Buildings and structures	X	X	X	X	X	X	X
Aesthetics	X		X	X	X	X	
Production of food and fauna and fibre	X	X		X			

1. Highlighted segment(s) represent the site and the land immediately adjacent to the site.
2. The Beneficial uses of Maintenance of ecosystems and production of food and fauna and fibre have been excluded from the elements considered in the scope of this audit, see Table 4.1

5.1.2 SEPP – Air Quality Management

The aims of the Air SEPP are to:

- ensure that the environmental quality objectives of the State Environmental Protection Policy (Ambient Air Quality) are met;
- drive continuous improvement in air quality and achieve the cleanest air possible having regard to the social and economic development of Victoria; and
- support Victorian and national measures to address the enhanced greenhouse effect and depletion of the ozone layer (Air SEPP, 2001).

The beneficial uses to be protected under the Air SEPP include:

a. life, health and well-being of humans;

b. life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity;

c. local amenity and aesthetic enjoyment;

d. visibility;

e. the useful life and aesthetic appearance of buildings, structures, property and materials; and

f. climate systems that are consistent with human development, the life, health and well-being of humans, and the protection of ecosystem and biodiversity.

It is noted that the following beneficial uses have been excluded from the scope of the audit, as per Table 4.1:

- life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity; and
- climate systems that are consistent with human development, the life, health and well-being of humans, and the protection of ecosystem and biodiversity

5.1.3 Noise from Industry in Regional Victoria (EPA Publication 1411)

The objective of this guideline is to provide the methods to set noise levels for industry in Regional Victoria to promote normal domestic use of the home and sleep at night. The guidelines set out recommended maximum noise levels which can be applied to manage the impacts of noise on the community. These guidelines have been applied as the site does not fall within the SEPP N-1 (State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 ('SEPP N-1')) area. Reference is made to the SEPP N-1 in the assessment report as it provides the assessment methodology. The SEPP details the beneficial use as "normal domestic and recreational activities including, in particular, sleep in the night period".

5.2 Buffers

5.2.1 Landfill Buffer

The Landfill BPEM details that "*appropriate buffer distance must be maintained between the landfill and sensitive land uses (receptors) to protect those receptors from any impacts resulting from a failure of landfill design or management or abnormal weather conditions. These failures might constitute discharge from the site of potentially explosive landfill gas, offensive odours, noise, litter and dust. Features that could be adversely affected by landfilling operations include surface waters, buildings and structures and airports. Buffer areas are not an alternative to providing appropriate management practices, but provide for contingencies that may arise with typical management practices*.'

The Landfill BPEM (Table 5.2) details the buffer distances required for landfill gas migration, safety and amenity impacts for a Type 2 landfill (landfill accepting municipal (putrescible) waste – Eaglehawk landfill). With regard to landfill gas and amenity impacts, 500 metres from building or structures is the pertinent buffer distance.

The Landfill BPEM details that buffer distances for an operational landfill are set to reflect the potential impacts from landfilling activities. Generally, the buffers are set to manage:

- odour, which is of most concern during landfill operation; and
- landfill gas impacts, including the risk of explosion and/or asphyxiation. Landfill gas potential risk remain post closure and for at least 30 years post-closure.

While other potential impacts such as fire, litter, surface water and safety risks exist, protection from these impacts are covered within the buffers required for odour and landfill gas.

The post-closure buffers detailed in the Landfill BPEM are set to manage landfill gas impacts only, including the risk of explosion and/or asphyxiation. Table 8.2 of the Landfill BPEM details the buffer required for a Type 2 closed landfill, which remains at 500 metres from the location of waste to an off-site building or structure. This buffer distance applies until the site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Measurement and encroachment requirements are also consistent with the operational landfill requirements, see below.

It is noted that the 500 m buffer has already been encroached by residential and industrial developments with planning provisions that permit further development within this buffer. Refer to *Figure 3 Appendix A* for the planning zones located within the buffer.

The Landfill BPEM notes that '*the buildings and structures buffer distance applies to any building or structure (including subsurface structures such as stormwater drains or service trenches) located near a landfill and is there to provide a protection zone around a landfill for subsurface landfill gas migration.'*

The Landfill BPEM also notes that '*a lesser buffer distance may be applied subject to a risk assessment that considers design and operational measures. As part of a risk management approach, additional design or operational measures will be required to ameliorate the risks associated with a reduction of the buffer distances'*.

The Landfill BPEM requires that where the proposed development or planning scheme amendment would have the effect of allowing development that encroaches into the recommended landfill buffer area or increases the extent of development within the already encroached buffer area, EPA recommends that the planning or responsible authority require an environmental audit be conducted under Section 53V of the EP Act. The audit must assess the risk of harm to the proposed development posed by the potential offsite migration of landfill gas and amenity impacts resulting from the landfill.

The Landfill BPEM stipulates that proposed developments and any works within the recommended landfill buffer can pose a safety risk by potentially providing preferential pathways for landfill gas migration, or providing an environment where landfill gases can accumulate to dangerous levels. All buildings and structures should be considered, including:

- buildings and structures used for sensitive or non sensitive uses;
- change of use;
- infrastructure installation; and
- installation of pipelines.

5.2.2 Buffer measurement

The Landfill BPEM details that '*Buffers are measured from the sensitive land use to the edge of the closest cell. All cells, including closed cells, need to be considered in calculating buffers. For sites where there is uncertainty in the location of landfill cells, the boundary of the landfill premises is the point of measurement. Buffer measurement also needs to consider other activities capable of causing a nuisance, such as the leachate ponds, to the nearest sensitive land use.*'

Buffer measurement for post closure is similarly measured.

With regard to amenity impacts from landfilling, the EPA have advised (email dated 27 May 2019 copy provided in *Appendix B*) *the amenity buffer is measured from the nearest active cell, though taking into account any other activity on the landfill with potential impact. The rationale being that closed cells and unused areas of the landfill don't generate amenity impact.*

For buffer impacts from other onsite activities, that is those associated with a Transfer Station (including green waste collection and mulching), refer to *Section 5.2.4.*

5.2.3 Cell Status – Eaglehawk Landfill

As detailed above, it is assumed that there will be no potential amenity impacts from closed cells. For this site, although Cell 5 is the only currently operating cell, with all other cells (Cells 1, 2, 3a, 3b) no longer accepting waste, there are no cells that have final capping in place. As it is possible for any of these cells, including Cell 4, to be opened up for active filling in the future with a licence amendment, they cannot be considered closed cells.

The Auditor understands that the site is to be rehabilitated in accordance with EPA approved Rehabilitation Plan (Infrastructure Solutions, 2018) with final capping to be undertaken across Cells 1, 2, 3a, 3b.and 5. As such, the Auditor considers the probability of the cells being re-opened as highly unlikely.

In addition, the extent of waste cell boundaries in the old valley fill area near the site entrance (closest) to the residents is not well defined. As these areas are not accepting waste, these can be assumed as 'closed' cells, and considered with regard to LFG subsurface migration.

5.2.4 Transfer Station Threshold/ Separation Distances

The planning scheme (clause 53.10-1) details threshold distances required from certain types of site activities to detailed zones/land uses. Pertinent to this site is the stated threshold distances related to *Recycling and Resource Recovery*.

The states threshold distance for a 'Refuse and used material storage, sorting and recovery in a transfer station (excluding organic wastes) is stated as 100 metres. For other transfer station facilities accepting organic wastes it is noted that the *threshold distance is variable, dependent on the processes to be used and the materials to be processed or stored.*

The planning scheme refers to the *Best Practice at Resource Recovery Centres*, Sustainability Victoria, 2009, which in turn refers to the EPA Publication 1518 (March 2013)*, Recommended separation distances for industrial air emissions*. This guideline seeks to protect sensitive land uses from odour and dust by taking into account the potential impacts of industry encroaching on sensitive uses *and* the potential impacts of sensitive uses encroaching on industry. This guidelines states that the recommended separation distance for a Transfer Station (collecting, consolidating, temporarily storing, sorting or recovering refuse or used materials before transfer for disposal or use elsewhere) as 250 metres.

It details that separation distances should be determined by measuring from the 'activity boundary' of the activity to the nearest sensitive land use – this is then either to the property boundary of the nearest sensitive land use (Method 1) if the nearest sensitive land use is within an urban area or township or on a site less than 0.4 hectares or in a zone allowing subdivision to be less than 0.4 hectares, which will be to the residential areas; or to the activity boundary of the sensitive land use, such as for farming or commercial/industrial zones.

5.2.5 Auditor opinion on separation distances measurement

The auditor considers that the landfill buffer for current operations should be measured from all active and closed cells, as well as the leachate ponds, across the site.

For future operations, the auditor considers that the landfill buffer for future operations (aftercare) should be measured from all closed cells across the site.

Due to the uncertainty of the extent of cell boundaries, the buffer should be measured from the site boundary for current operations. For future operations, the buffer should be measured from the site boundary except in the south west portion of the site where it should be measured from the extent of the closed cells. However, due to the limited reduced and for ease of understanding, the auditor considers that the measurement of the Landfill BPEM buffer in future operations remain the same as for current operations.

For the transfer station threshold separation distance, this should be measured as detailed in *Section 5.2.4* for both current and future operations of the green/food transfer activities and putrescible waste storage and transfer operations. It is considered acceptable to apply the planning threshold distance of 100 metres for the public drop off area.

Refer to *Figures 4a and 4b Appendix A* which provide the separation distance for landfilling activities, Landfill BPEM buffer, and for green/food and putrescible transfer station activities (250 metres) and the public drop off area (100 metres) for current and proposed site operations. The Transfer station activities separation distance has been shown as 250 m from the current and proposed activities for understanding purposes. The measures distances (as detailed in *Section 5.2)* are based upon nominated operations areas current and future provided by City of Greater Bendigo, for both current and future operations (when known).

5.2.6 Assessing Planning Proposals

The '*Assessing planning proposals within the buffer of a landfill*', EPA Publication 1642, October 2017, restates the Landfill BPEM requirements regarding buffer requirements, their measurement and management of buffer encroachment, however also provides more information to assist planning and responsible authorities in the implementation of this advice when making decisions about development within landfill buffers and encourages a risk-based and cost-effective approach.

Specifically, it follows the following approach:

- Does the planning proposal fall within a landfill buffer? – default or site-specific
- Is the landfill operating or closed? If closed, assessment limited to risk of landfill gas impacts only. It notes that although there are potential odour impacts from a closed landfill, these are significantly less than an operating landfill. If operating, both risk of landfill gas and amenity impacts should be assessed. If the proposed use is sensitive to amenity impacts (ie from an operating landfill) it is recommended to seek EPA site specific advice prior to continuing the assessment. If not, or the landfill is closed, continue landfill gas risk assessment as follows.
- The level of assessment required is based on a number of site specific details, which will be applied to this site as follows:
  - What type of development would the permit or planning scheme amendment allow? It is assumed the most conservative and so new building or structure
  - Step 1 Assign a proposal score – Score of 2 assigned as assumed that below ground structures such as basements or lift shafts are excluded
  - Step 2 Assign a landfill score (AECOM, 2019)
    - Size score 3 (500,001 – 2,000,000 m3) (note that the site is at the upper end of this size

- Landfill type score 5 (putrescible)
- Landfill age score 5 (operating landfill)

- Step 3 Use the proposal score and landfill score to calculate an overall score – 2 x 13 = 26
- Step 4 Determine the level of assessment required – based on a score of 25, a section 53V audit is required, which includes an assessment of risk

It is also noted that landfills accepting Category C Prescribed Industrial Waste (PIW) are not within the scope of this guideline.

Although proposed uses within the current Landfill BPEM buffer may be sensitive to amenity impacts from the landfill operations, and the landfill accepts Category C waste, the EPA has been included as a stakeholder in this audit and has approved the scope of works, reference to the EPA is covered.

6. SITE OPERATIONS & ENVIRONMENTAL MANAGEMENT

6.1 Current

Activities currently occurring at the site are as detailed in the following sections. Refer to *Figure 2a Appendix A* for current site features and the main onsite activities considered in the landfill gas and amenity risk assessments.

6.1.1 Waste Acceptance

As detailed in Schedule 2 of the EPA Licence, the landfill is licensed to accept:

- General wastes - putrescible waste, solid inert waste, tyres shredded into pieces less than 250 mm in all directions and asbestos waste of domestic origin; and
- Prescribed Waste – Contaminated soil (Category C) and Asbestos (all forms).

The site is open 7 days a week, from 8 am to 4 pm weekdays, and 8 am to 4.30 pm weekends.

6.1.2 Materials Recycling Facility

Eaglehawk Eco-Centre is located at the site entrance, where recyclable waste, such as waste oil, electronic waste and batteries, are accepted. The Eco-Centre is located offsite and not included in the audit.

The on-site Transfer Station/Recovery Centre includes a portion precluded from the licence boundary, however for the purpose of this audit, all activities are considered included. This facility includes the management of municipal waste to be transferred to the Patho Landfill as well as food and organics waste which is collected and transferred to an offsite composting facility. In the future the putrescible waste transfer will occur in the shed and the processing of the food/green waste facility will move outside to the west of the current shed/structure.

The facility also includes a public waste (non-recyclable) drop off area where the material is collected and deposited to the landfill. In the future the public general waste transfer station will move to a hard stand area immediately adjacent and south west of the off-site Eaglehawk Eco-Centre near the entrance.

6.1.3 Green and food waste facility

The facility accepts green and food waste generated within the Council area. The waste is stockpiled within an on-site shed (on a concrete slab) in the onsite Recovery Centre prior to daily collection. All food waste and the majority of green waste is transferred offsite to Stanhope Composting facility. The remaining green waste received is mulched and stockpiled on-site for use on capping (see green waste mulching area below).

6.1.4 Green waste Mulching

Mulching is understood (SLR, 2019) to occur approximately 3-5 days every 3 months at the green waste storage and mulching area. The mulching is undertaken by a contractor with mulching equipment fitted with inbuilt watering system to suppress dust. In addition, one watering truck is used to continuously spray the green waste before it enters the mulcher.

6.1.5 Asbestos

Asbestos waste is accepted at the landfill and is disposed in Cell 5. The asbestos is deposited at different points of the cell depending on where the daily tipping face is located.

6.1.6 Prescribed Waste

The site is licensed to accept prescribed waste contaminated soil (Category C) for disposal to Cell 5.

6.1.7 Site Equipment

Onsite plant/equipment includes:

- weighbridge;
- wheel wash;
- compactor (38 tonne);
- excavator;
- front end loader;
- 2 utes;
- 2 fire fighting trucks;
- fire hydrant at site entrance and in shed and four water on-site tanks (15,000 L & 12,000 L); and
- diesel UST and associated bowser.

6.1.8 Landfill Cells and Construction

Five landfill cells have been constructed at the site with Cell 5 currently being filled. The remaining cells (Cell 1, Cell 2, Cell 3A and Cell 3B) have been filled, with all cells completed with intermediate capping. Cell 1 was not constructed with a landfill liner. Cell 2 was constructed with an EPA approved clay liner and Cells 3A, 3B and 5 were constructed with an EPA approved composite liner (GCL & HDPE). All of the cells have been constructed with gravity leachate drainage.

Cell construction and capping details are summarised below in *Table 6.1.* Final capping designs were detailed in conceptual rehabilitation plan (Infrastructure Solutions, 2018) approved as part of the notice of revocation of a PAN. Further to the approval of the final capping, a rehabilitation design report (Infrastructure Solutions, 2019) for Stage 1 works was prepared. It is understood that these plans have been approved by the Construction Auditor, however yet to be approved by the EPA.

Table 6.1 Cell Construction Details – Eaglehawk Landfill

Cell	Year Open	Landfill Liner	Landfill Capping
Cell 1	1975	No liner and no drainage layer, although understood from anecdotal evidence that building waste used for the base of the cell. Although cut off wall was constructed along the boundary of the unlined cell and the lined cells. Leachate drainage via gravity via cut off wall to two leachate sumps to the west of the site then fed to the leachate pond.	Intermediate capping, with final capping approved of 500 mm compacted soil plus 100 mm top soil. Reshaping to occur to minimise steepness of slopes.
Cell 2	1998	Compacted clay base liner but no side liner. EPA approved but not subjected to CQA. Leachate drainage via gravity to two leachate sumps then fed to the leachate pond.	Intermediate capping, with final capping approved of 500 mm compacted clay (permeability <1x10-9 m/s) plus 100 mm top soil. Reshaping to occur to minimise steepness of slopes.

Cell	Year Open	Landfill Liner	Landfill Capping
Cell 3A	2008	Engineered composite liner – GCL and HDPE, EPA approved and constructed under CQA. Leachate gravel drainage layer with leachate directed to two leachate sumps and then directed to the leachate pond.	Intermediate capping, with final capping approved of 500 mm compacted clay (permeability <1x10-9 m/s) plus 100 mm top soil
Cell 3B	2008	Engineered composite liner – GCL and HDPE, EPA approved and constructed under CQA. Leachate gravel drainage layer with leachate directed to two leachate sumps and then directed to the leachate pond.	Intermediate capping, with final capping approved of 500 mm compacted clay (permeability <1x10-9 m/s) plus 100 mm top soil
Cell 5	2015	Engineered composite liner – GCL and HDPE, EPA approved and constructed under CQA with auditor oversight (CARMs 60409-4). Leachate gravel drainage layer with leachate directed to one leachate sump and then directed to the leachate pond. Soil protection layer being placed on the landfill liner during waste placement.	Currently filling. The final capping will be 600mm of low permeability clay, with 600mm soil subbase and 100mm of top soil.

Sources:

- AECOM 2017a, Eaglehawk Landfill Hydrogeological Assessment
- AECOM, 2019, Buffer Zone Landfill Gas Risk Assessment Eaglehawk Landfill, September 2019 (AECOM, 2019)
- Infrastructure Solutions Pty Ltd (2018), Eaglehawk Landfill Rehabilitation Conceptual Top of Landfill Cap Pre-settlement Contour Plan at Upper California Gully Road, Eaglehawk -Drawings, 12 June 2018. A copy is provided in Appendix C

6.1.9 Waste Placement and Compaction

Waste is currently being placed on-site within an active tipping face of Cell 5. Materials deposited are compacted. During the site visit undertaken by the Auditor in November 2018, the tipping face appeared to be contained to within 900 m2 with areas around covered with daily cover. It is noted that a tip face this large is not operationally possible due to site constraints (Council comments dated 14 October 2019).

6.1.10 Waste Daily Cover

At the end of each day, waste is covered with 300 mm of daily cover such that no waste is visible. All clean fill received at the site is used as daily cover. Clean fill that is delivered to site is stockpiled near the tipping face and used as required for cover material at the end of each day. Waste cover at the time of the site visit by the auditor in November 2018 appeared to have been adequately applied.

It is understood that post the Auditor site visit, approved alternative cover commenced being applied, commencing May 2019, on a12 month trial basis.

6.1.11 Litter Management

Litter management is addressed by a contractor undertaking grounds maintenance and litter collection both within the landfill boundary and outside of the landfill on a fortnightly basis. The landfill is also closed during periods of high wind to reduce windblown litter.

6.1.12 Leachate Management

Leachate management from Cells 1, 2, 3A and 3B is via gravity to two sumps (LS_1 and LS_2) located in the west of the site and then to a clay lined leachate pond located in the south west corner of the site. A cut out wall has been installed to collect leachate from Cell 1 and direct it to the two sumps. Leachate management from Cell 5 is via a gravity drainage system comprising a leachate discharge pipe through the permanent bund wall which discharges into the down gradient leachate pond.

The leachate pond is understood (site inspection November 2018) to have a capacity of 4 ML. Leachate is then managed via evaporation in the pond.

6.1.13 Landfill Gas Management

A landfill gas extraction system, initially installed in 2003, is operated by LMS and consists of a series of extraction bores feeding to a ring main on the cap of the landfill. The system is currently installed across completed Cell 1 and Cell 2, and recently installed across Cells 3A and 3B. It is understood that further expansion of the system across further areas of Cell 1 was undertaken in January 2019 with eventual expansion eventually into Cell 5. Refer to *Figure 2a Appendix A* which includes the current and proposed gas field layout.

The gas is fed to a cogeneration unit located in the south of the site. A flare is available if the generator is not operating.

6.1.14 Site Access and Traffic Management

Traffic enters and exits the site on bitumen two way roads from Upper California Gully Road. Internal one way roads are unsealed, however, crushed rock has been placed on the roads to minimise potential dust and mud issues.

6.1.15 Fire Management

On-site firefighting water is supplied via a fire hydrant located at the entrance for the site. Three fire trucks are available for firefighting, two with firefighting hoses. The heavily vegetated areas to the north and west of the site, and fire access, are managed by Parks Victoria. Daily cover and regular fire monitoring are also used to mitigate the risk of fire.

A number of fires were reported in the previous audit period,

A site fire management plan is to be included in the EMS, however the plan has yet to be finalised.

6.1.16 Perimeter Fencing

As observed during the Auditor's site visit in November 2018 the perimeter fencing appears to be generally secure.

6.1.17 Site Risk Management Records

Site-specific procedures and protocols are currently included in Council's internal IMS.

Records have been maintained with copies of onsite Landfill Operator's Checklists, including daily and weekly checks, provided and reviewed during the Auditor site visit.

These are used to assess and monitor the implementation of on-site risk management measures. The Auditor observed that the Weekly and Monthly Inspection forms were completed with regularity.

6.1.18 Progressive Rehabilitation

Rehabilitation completed to date has included the construction of intermediate capping on all Cells, except for the current operational Cell 5, as detailed in *Table 6.1*.

Final capping designs were detailed in conceptual rehabilitation plan (Infrastructure Solutions, 2018) as part of a PAN (Notice ID: 90008474) requirement. The EPA approved (as per notice of revocation) capping profiles were:

- Cell 1 – 500mm plus 100mm of top soil
- Cell 2, 3A, 3B – 500mm with 100mm of top soil; and
- Cell 5 – 600mm of low permeability clay, with 600mm subbase and 100mm of top soil.

A contour amendment for the site licence was recently submitted to the EPA (the contours on the licence still include Cell 4 being constructed). As part of the contour amendment, a substantial part of the first stage of rehabilitation works has been assessed and approved by the construction auditor, with the construction auditor and contractor currently working through other parts of the design (Council comments in email dated 11 September 2019). A copy of the detailed cap design for Stage 1 prepared by Infrastructure Solutions Pty Ltd, titled *Eaglehawk Landfill Rehabilitation Plan – Stage 1* drawings dated 23 July 2019.

Refer to *Appendix C* for a copy of the conceptual rehabilitation plan (Infrastructure Solutions, 2018) and the rehabilitation design drawings for Stage 1 (Infrastructure Solutions, 2019).

6.1.19 Environmental monitoring

Monitoring is currently undertaken across the site in consideration of the verified Environmental Monitoring Program (EMP). This current verified EMP was completed in 2017 and re-verified by the Auditor in 2019, reflecting the identified risks at that time with a number of recommendations for the document to be updated to reflect the current monitoring network, current SEPP (Waters) and other guideline changes. Monitoring is undertaken to assess the performance of the measures taken to protect the environment from any potential environmental impacts and to identify and address any arising environmental issues.

6.2 Future

Once Cell 5 has been filled and capped, the site will no longer be licensed to accept waste for disposal, including general and prescribed wastes. A Transfer Station will remain on site, however it is proposed to develop a new facility on site, the location of which is undecided at this time.

It is understood that at current tipping rates there is about 4-6 years of airspace available (AECOM, 2019) in Cell 5 at the landfill, after which the cell will be capped. Future operations should then apply from approximately 2023 – 2025.

The following activities are proposed to occur in the future.

6.2.1 Materials Recycling Facility

Eaglehawk Eco-Centre will remain located offsite prior to entry to the site, where recyclable waste, such as waste oil, electronic waste and batteries, are accepted.

An onsite Transfer Station (Recovery Centre) will remain including the management of municipal waste to be transferred to the Patho Landfill (to be moved into the onsite shed) as well as food and organics waste which is collected and transferred to an offsite composting facility (see below). The small domestic drop off area will be moved to adjacent the Eco Centre, which is not a licensed area.

6.2.2 Green and food waste facility

The facility will continue to accept green and food waste. The waste will be located adjacent to the current shed prior to daily collection. All food waste and the majority of green waste will continue to be transferred offsite to Stanhope Composting facility. The remaining green waste received will be mulched and stockpiled on-site for use on capping, the location of which will be moved to the southwest of the site, south of the Cell 5, away from the majority of the sensitive receptors. Mulching is to continue to be undertaken as currently.

6.2.3 Landfill Cells and Construction

All five landfill cells will now have final capping installed, as detailed in *Table 6.1* above.

6.2.4 Leachate Management

Leachate management from all Cells will remain via a gravity drainage system to the clay lined leachate pond located in the south west corner of the site. The leachate pond will continue to manage leachate and will remain in the same location in the aftercare period

6.2.5 Landfill Gas Management

The landfill gas extraction system will be installed over all landfill cells, now to include recently closed Cell 5. Gas extraction will occur and fed to a cogeneration unit until such time as it is not economically feasible to do so (i.e. methane concentration reduces) and flared until such time as there is insufficient gas to operate it, so at the point in the future where the volumes of landfill gas decline. After this time, no collection will occur, however the volume and concentrations of landfill gas being generated will be reduced minimising the risk of landfill gas migration.

6.2.6 Site Access and Traffic Management

Traffic will continue to enter and exit the site on bitumen two way roads from Upper California Gully Road. Internal one way roads will remain unsealed with crushed rock remaining on the roads to minimise potential dust and mud issues

6.2.7 Site Risk Management Records

Site-specific procedures and protocols for the aftercare period of the landfill and for the current activities will be included in Council's internal IMS with records maintained. These will continue to be used to assess and monitor the implementation of on-site risk management measures.

6.2.8 Environmental monitoring

Aftercare monitoring will continue to be undertaken across the site in consideration of the verified Environmental Monitoring program (EMP) at that time.

The figure below, provided by Council as the best guess at this time, provides the proposed location of onsite activities in the future. Please note that Council advised, email dated 24 April 2019, that the shed will eventually no longer be utilised to transport material to the Patho Landfill.

For the purposes of this audit, consideration of the Landfill BPEM required buffer need only consider risks associated with the migration of landfill gas in the future. However, the amenity risks associated with the onsite Transfer Station will need to be considered in the context of the Planning Scheme buffer of 250 m.

Figure 6.1 Proposed Future Site Layout

7. ENVIRONMENTAL CONDITION OF THE SITE

The condition of the site, in particular in relation to landfill gas and amenity impacts that may affect land use in the buffer is outlined below.

7.1 Landfill Gas

Monitoring of landfill gas bores at and surrounding the site, in addition to on site surface emissions, subsurface services and buildings and structures, is undertaken on a biannual basis to assess current compliance with the licence conditions and to assess the risk of migration to sensitive receptors. The LFG monitoring locations are shown on Figures F3, F4A and F4B in Appendix A in AECOM report (2019). Monitoring allows an assessment of the current management measures in place and if additional measures are required.

Thirty three (33) subsurface landfill gas monitoring bores were monitored (BH01- BH09, BH15, BH17 – BH40), in addition to groundwater monitoring bores MB02, MB06 and MB08 in February 2017 only, along with surface emissions, subsurface services and buildings and structures. Note: Bores BH29 – BH40 were installed in June 2018, and so only included in the August 2018 monitoring event.

The audit (ERM, 2019) detailed that EPA Victoria issued a PAN on 1 December 2015 due to carbon dioxide and methane concentrations exceeding the Landfill BPEM action levels reported on the northern site boundary. A Landfill Gas Remediation Action Plan was developed in response to the PAN, requiring the installation of additional bores and consideration of additional gas control infrastructure depending on the outcome from delineation works. The PAN was revoked in October 2017.

Background carbon dioxide concentrations were assumed by AECOM/ URS over the 2019 audit monitoring reports of 3.5% v/v based on the average concentration reported in bores relatively remote to the filled area and so not considered impacted by LFG.

The majority of monitoring events were undertaken in falling barometric pressure.

Methane concentrations were not observed in the subsurface across the audit period, with the exception of BH18, BH26 and BH28, with bores BH18 and BH26 located within 20 m of the landfill.

Carbon dioxide concentrations were consistently reported above background levels over the audit period at a number of locations. In addition depleted oxygen levels were generally reported in these locations.

In order to assess the risk posed by subsurface landfill gas migration at the site, the Assessor (AECOM, 2018a in ERM 2019) calculated the gas screening value (GSV) for all locations over the audit period on an event basis, that is, peak flow rate multiplied by peak concentration per monitoring event. Due to the low flow rates, calculated GSVs, except for bore BH29 which equated to al low risk, equated to a very low risk in accordance with British Standard 8485 (2015). The BS 8485 (2015) also suggests consideration of increasing the hazard potential from landfill gas from very low to low if carbon dioxide concentrations are greater than 5% v/v. Therefore based on the GSV, the site is considered low hazard.

Concentrations of methane above the intermediate cap action level (200 ppm) were reported on six occasions at six locations. The exceedances occurred in areas of preferential LFG emission pathways, where landfill cover on the edges and slopes of the filled cells is least effective (AECOM, 2018a in ERM 2019).

Exceedances of the Landfill BPEM action level for subsurface services on and adjacent to the landfill site (10,000 ppm) and for buildings/structures on and adjacent to the landfill site (5,000ppm) were noted in one location - on-site Telstra pit located near the workshop (location Se6).

7.2 Air

7.2.1 Odour

The last audit (ERM, 2019) detailed that odour was monitored during daily site inspections. No odours were observed at the boundary of the site during the site visit. However, eight odour complaints were received by Council during the audit period, five of which were verified odour complaints sourced from the storage of collected organics prior to transportation for treatment.

7.2.2 Dust

Detailed in the last audit, dust levels are routinely monitored via daily site inspections. One dust complaint was received by Council over the audit period, with source concluded by Council to be the adjacent quarry site.

7.3 Noise

It is understood that noise levels are routinely monitored via a regular site inspection. Three verified noise complaints were received over the audit period. The source was a worn bucket on the loader used for the organics in addition to the green organics mulching operation on a weekend.

7.4 Conclusions

The scope of this audit has been restricted to the potential impacts from landfill gas, odour, dust and noise. As detailed in the Landfill BPEM, other potential impacts, such as fire, litter, surface water and safety risks, although exist, the buffers required for potential impacts from these fall within the buffer required for odour and landfill gas. Due to the complaints received for dust and noise and the onsite Transfer Station, specific assessments of these amenity impacts has been undertaken and specifically addressed in this audit.

8. LANDFILL GAS AND AMENITY RISK ASSESSMENTS

Council engaged a number of consultants to assess the risk from landfill gas migration and amenity risks (odour, dust and noise) to determine the likely risks posed to any existing or proposed development within the Landfill BPEM 500 m buffer distance under current operating conditions and potential future conditions once landfilling ceases, that is, in the aftercare period. The assessments also considered upset or abnormal conditions that may arise. These have been undertaken to assist with determining an appropriate buffer distance.

The auditor has reviewed these assessments and generally found that the methodology for the assessment of risk and their conclusions are considered adequate for the purpose of this audit.

The following sections provide a summary of the works undertaken and the conclusions from the assessments.

8.1 Landfill Gas

A landfill gas risk assessment, titled "*Buffer Zone Landfill Gas Risk Assessment Eaglehawk Landfill,* has been prepared by AECOM Australia Pty Ltd in September 2019 (AECOM, 2019) to provide a basis for consideration of development proposals and to provide recommendations in relation to minimum safe buffer distances. The report provided an assessment of potential landfill gas migration associated with the current and historical landfill currently and into the future in the facility aftercare period, considering normal and upset conditions.

8.1.1 Objectives

The objective of the assessment was to "*provide a basis for consideration of development proposals within the vicinity of Eaglehawk Landfill and to provide recommendations in relation to management of landfill gas risk in consideration of existing best practice guidance".*

8.1.2 Scope of works/ methodology

The scope of work, as detailed by AECOM (2019) included:

- *Installation of soil gas monitoring bores*. An additional 12 LFG monitoring bores (BH29 – BH40) were installed in June 2018 to assist with the assessment and understanding of LFG migration within the current Landfill BPEM buffer. The location of these bores, installed to confirm LFG migration away from the waste footprint, considered methane concentrations at bores BH18 and BH26 at the northern boundary of the site (noted to be located within 20 m of the waste cell), potential preferential pathways of offsite LFG transport through more permeable subsurface geology, and gaps in perimeter monitoring bore network, detailed in Section 4.1 of the AECOM (2019) report. These bores are in addition to the existing bores that have been monitored for over 15 years, some bores since 2001, on a biannual basis. The location of the monitoring locations are detailed in Figure F3 in Appendix A of the AECOM report;
- *Undertaking three discrete monitoring events of the new and selected historical bores at the site and two methane emissions surveys of the subsurface services along the adjacent streets.* Monitoring, and installation, was undertaken in consideration of the EPA guidelines Landfill BPEM and Publication 1684;
- *Review of the conceptual site model, including LFG/ soil gas conditions at the site.* Assessment of background carbon dioxide concentrations was also undertaken in consideration of EPA Publication 1684 guidance. The background concentration was used to assist with understanding LFG migration*;*

- *Assessment of risk of LFG migration to land and potential receptors in the vicinity of the landfill under anticipated future site LFG conditions*. The risk assessment approach adopted by AECOM (2019) was based on EPA Publication 1642, which in turn referred to CIRIA (2007) and BS 8485 (2015), as well as UK EA (2004). The methodology adopted by AECOM, and assumptions and limitations, is detailed in Section 6.2 of the AECOM report. This included
  - updating the CSM (to consider current source characteristics and future source conditions and LFG migration pathways considering current migration controls, preferential pathways, background soil gas conditions, groundwater level fluctuations);
  - assessing the viability of connections between the various risk elements of source – pathway – receptor;
  - assessing the risk of LFG migration to the potential sensitive receptors (mapped according to land uses) under several possible viable LFG management scenarios and associated potential LFG fate & transport conditions; and then
  - evaluating the results for various scenarios (separation distances).
- *Review and selection of distances that would provide appropriate safeguards (buffers) to manage landfill gas risk.* Although the 500 m Landfill BPEM Buffer is adopted by AECOM as the default distance, as development has occurred within that buffer, development controls were mapped on the basis of risk rather than proximity;
- *Development of an approach to defining control (management) areas on the basis of LFG risk*; and
- *Propose building control measures within the adopted buffer*.

8.1.3 Summary of results

8.1.3.1 Background carbon dioxide

Assessment of background soil gas conditions found that concentrations of carbon dioxide in the subsurface geology is 3% v/v. It is therefore assumed that concentrations in excess of 3% v/v are indicative of the oxidation processes associated with LFG migration from the site.

8.1.3.2 Conceptual Site Model

A review of the conceptual site model considered the following facets:

- Landfill gas sources (Section 6.5 of AECOM report) – The primary source of LFG is the Eaglehawk landfill. AECOM note that it is uncertain whether subsurface mines underlying the investigations area contribute to the detected concentrations at and in the vicinity of the landfill. Potential secondary source of landfill gas dissolved into groundwater is considered unlikely;
- LFG generation (Section 6.6 of AECOM report) – LFG generation was simulated using empirical modelling (the LandGEM model from the US EPA) in order to compare empirical LFG generation and extraction data. The simulated data predicted peak methane generation rates between 5 and 7 Mm^3 per year which were considered by AECOM (2019) to overestimate gas generation as LMS extraction data (not including Cells 3A and 3B as only connected to the system in 2018 and not all of Cell 1 is covered by LFG extraction network) varied from 2013 to 2018 between < 3 Mm^3 to > 3.5 Mm^3. It is considered by AECOM (2019) that "*full site rehabilitation is estimated to happen within the next 10 years and waste degradation and LFG generation will continue for at least 30 years post closure";*

- Pathways (Section 6.7 of report) – AECOM considered a number of pathways and barriers that likely influence the vertical and lateral migration of LFG at the site. These include:
  - Natural geology –As detailed in *Section 4.1* of this audit, potential permeable pathways at the site are found in fractures in the Ordivician bedrock underlying the site; gravel/coarse sand encountered under the site while drilling; as well as fractures along fold axes of anticlinal structures underlying the site. Barriers include low permeable highly to moderately weathered bedrock, a zone of 20 m in upper bedrock. AECOM (2019) detail that " *At Eaglehawk landfill, the majority of the underlying sedimentary profile, while providing a low permeability barrier for potential lateral fugitive emissions, may also restrict potential for vertical gas migration to the surface and prolong travel distance subsurface through the zones of potentially higher permeability within the Ordovician sediments".* Refer to Figure F7B in Appendix A of the AECOM report)
  - Mine tailings (Section 6.7.2 of report) – The area of mine tailings at the site are detailed in Figure 7B in Appendix A of the AECOM report. AECOM detail that "*Unsaturated permeable mine tailings may provide a preferential gas migration pathway south-east and north-east of the site, particularly where the landfill is capped and the tailings are permeable.* It *is considered that due to the generally continuous nature of these relatively permeable deposits, tailings are likely to represent a continuous LFG migration pathway within the 500 m buffer. This pathway will only become significant when the landfill is capped and preferential vertical migration is constrained, and when the tailings are unsaturated and sufficiently permeable*". Refer to Figure F7B in Appendix A of the AECOM report;
  - Depth to groundwater and fluctuations in groundwater elevation (Section 6.7.3 of the report) the depth to groundwater influences the cross sectional area available for lateral gas migration. AECOM noted that "*for the closest receptors to the north of the landfill, the unsaturated profile varies in thickness, with at least 5 m available for gas transport during periods of high water table and more than 10-15 m available at other times., To the east of the landfill, there is at least 30 m of unsaturated profile available for gas transport within 250 m zone;*
  - Underground services (Section 6.7.4 of the report) – There are a limited number of underground services in the vicinity of the site and 2018 monitoring of sub-ground services remote form the landfill perimeter indicated negligible methane concentrations. Although methane has been detected onsite in the area of historical fill there is no offsite methane migration pathway. Refer to Figure F7C in Appendix A of the AECOM report;
  - Abandoned mine workings (Section 6.7.5) – There are likely to be multiple disused extensive mine workings in this area extending through the 500 m buffer of uncertain depth and connectivity, generally aligned with the gold bearing geological structures and may provide preferential LFG migration pathways. AT the same time they will facilitate LFG dissipation/ dissolution in the presence of air. Refer to Figure F7A in Appendix A of the AECOM report for the current known locations of the mine workings;
  - LFG Transport Barriers (Section 6.7.6 of the report). Barriers to LFG migration include:
    - Landfill interim cover and final cap - Final capping across the site has yet to be installed. The cap will be fully engineered and will provide a better containment for vertical LFG emissions, however, may facilitate lateral LFG migration and emissions;
    - Landfill side liner – A side liner will limit the potential for lateral migration. Both Cells 1 and 2 do not have side liners. In addition, issues with the side separation system between Cells 3A and 3B are considered to be the potential source of LFG migration to bores BH18 and BH26. The side liner in Cell 5 is expected to control fugitive emissions. Liner deterioration may provide release points in the future.

- Landfill gas recovery system – The system collects gas and reduces the potential for pressure build-up within the landfill cell, thus minimising potential for LFG migration. AECOM note that "*Over time, active LFG extraction is expected to cease at the site. This may result in relative pressure build up … and induce lateral advective transport*"
- LFG weathering – LFG can undergo changes in composition during transport including dilution (results suggest that this is not the primary attenuation mechanism), methane oxidation (attenuation) and water washing (not primary mechanism). Monitoring results indicate that methane oxidation is occurring, generally at rates exceeding that of migration, with significant capacity for further methane oxidation to occur.

- LFG Transport (Section 6.7.7 of the report)

- Vertical emissions – Monitoring of cap emissions, undertaken regularly since 2010, indicates that under current LFG management conditions, the intermediate capping is effectively controlling vertical methane emissions to atmosphere. AECOM (2019) consider that "*capping conditions during the remaining operational and future fully rehabilitated states of the landfill will provide an effective vertical LFG migration barrier."*
- Lateral emissions – Refer to Appendix C of the AECOM report for subsurface LFG monitoring data since 2001, including calculated GSV (Qhg).Monitoring results report methane concentrations generally below instrument detection limit (0.1% v/v), including the new bores, except for bores BH18 and BH26. AECOM detail that "*the reported concentrations of methane, carbon dioxide, oxygen and %balance….indicate that the degree of lateral LFG migration is very limited*". Table 7 of the report summarises the maximum concentrations of methane and carbon dioxide on the boundary, within 250 m of the site boundary and over 250 m from the site boundary confirming that the degree of migration is limited. AECOM further detail "*Qhg values … indicate that the risks associated with methane and carbon dioxide are very low within most of the 250 m band around the landfill. The density of data within the 250m band indicates a higher degree of confidence in the assessed level of landfill gas exposure and risk than in the band between 250m and the BPEM buffer of 500m. As distance from the landfill increases, attenuation will further reduce the concentration and flow rate of LFG, thus reducing the likelihood*". They also note "*Very low or insignificant gas flow rates at the bores close to the landfill and low concentrations of CO2 indicate that risk will not be any higher further away from the landfill, i.e. the worst case Qhg is a single value (0.8) corresponding to low risk (0.07 – 0.7).*
- Upon full rehabilitation, AECOM note that *"LFG build up in the landfill is likely to increase and promote lateral pressure-driven emissions through subsurface geology. It is anticipated that active LFG extraction at the site which will continue until the end of viable LFG recovery and be followed by further flaring, will provide sufficient control over pressure-driven lateral migration of LFG.*".

- Receptors (Section 6.8 of report) – AECOM based the potential receptors on the existing zoning in the proximity of the landfill. Refer to Table 8 of the AECOM report.
- Upset conditions - AECOM considered upset conditions to be the shutdown of the LFG extraction system during a period of high LFG generation. AECOM (2019) consider the following impacts of such a shutdown:
  - Cell 1 – lateral LFG migration will occur, however, given capping conditions and demonstrated natural attenuation of LFG in the vicinity of Cell 1, pressure driven migration is expected to be controlled by attenuation processes;
  - Cell 2 – as bound by other cells, lateral migration is expected to be limited;
  - Cells 3A/3B – as there are known preferential pathway in the side liners, this will likely be the release point.
  - Cell 5 – low permeable base, side liner and capping designed to contain build up of pressure.

8.1.3.3 Assessment of Risk

As discussed in *Section 8.1.2,* the risk assessment approach adopted by AECOM (2019) was based on EPA Publication 1642, which in turn referred to CIRIA (2007) and BS 8485 (2015), as well as UK EA (2004). AECOM risk assessment approach was based on the process and risk matrix as outlined in EPA Publication 1321 which is based on HB 203:2006, Environmental Risk Management – Principals and Process, which requires a qualitative assessment of likelihood and consequence to assess risk. The assessment and evaluation of risk adopted likelihood and severity tables as detailed in Section 7.2 of the AECOM report and an evaluation of risk score as a product of likelihood and severity/consequence. These tables are replicated below:

Table 8.1 Categories of Likelihood (AECOM, 2019)

#	Category	Description / Frequency
1	Extremely Unlikely	No recorded or known incidents Might occur in situation and time frame / Incident occurs less than once in a million years
2	Very Unlikely	No recorded incidents Might occur under atypical conditions / Incident occurs between once per million and once every 10,000 years
3	Unlikely	Few recorded incidents Might occur but not expected to / Incident occurs between once per 10,000 years and once every 100 years
4	Somewhat unlikely	Some recorded incidents Might occur occasionally / Incident occurs between once per 100 years and once every 10 years
5	Fairly probable	Several recorded incidents Expected to occur / Incident occurs between once per 10 years and once per year
6	Probable	Multiple recorded incidents Almost certain to occur / Incident occurs at least once per year

Table 8.2 Categories of Severity (AECOM, 2019)

Level	Category	Potential Impact		
		Human Health	Environment	Assets & Community
1	Minor	No injury or illness.	Nuisance on-site only.	No outside complaints; negligible financial loss
2	Noticeable	First aid required.	Noticeable off-site emissions. Maximum acceptable level of emission; no environmental harm.	Singular complaints; small financial loss.
3	Significant	Temporary impairment, able to resume normal duties immediately.	Material and sustained off-site emissions. Breach of permissible limits but no environmental harm.	Community complaints. Potential penalty infringement notice; written direction from regulatory agency. Small financial loss.
4	Severe	Temporary impairment / hospital treatment required; unable to resume normal duties immediately.	Off-site emissions warrant public warning & off-site emergency plan invocation. Significant compliance parameter breach.	Minor public outcry / community meetings or local media coverage. Penalty infringement notice. Major financial loss.
5	Major	Extensive human injuries/ illness. Permanent impairment and/or disability as a result of injury or illness.	Widespread but not persistent damage to land. Serious toxic effect on beneficial or protected species.	Short term public outcry / state media coverage. Evacuation of local populace. Major financial loss.
6	Catastrophic	Fatality (s) as a result of injury or illness.	Serious irreversible off-site impact.	Serious ongoing public outcry / national media coverage. Site shutdown; immense financial loss.

The risk score is evaluated as the product of likelihood and severity as detailed in *Table 8.3* below:

Table 8.3 Evaluation of Risk Score (Severity – Likelihood Matrix) (AECOM, 2019)

			Severity of Consequence					
			1	2	3	4	5	6
			Minor	Noticeable	Significant	Severe	Major	Catastrophic
Likelihood of Occurrence	1	Extremely Unlikely	1	2	3	4	5	6
	2	Very Unlikely	2	4	6	8	10	12
	3	Unlikely	3	6	9	12	15	18
	4	Somewhat Unlikely	4	8	12	16	20	24
	5	Fairly Probable	5	10	15	20	25	30
	6	Probable	6	12	18	24	30	36

The risk score is used to determine the site management actions and planning responses, as per Table 12 of the AECOM report, duplicated below:

Table 8.4 Risk Categorisation and Management (AECOM, 2019)

Risk Score	Risk Evaluation	Management Actions (from EPA Pub. 1321)	Recommended Measures	
			Landfill Management	Planning Department
6 or less	Acceptable without review	None required; continue routine management / monitoring practices.	Continue LFG management and monitoring as per landfill licence and aftercare management plan.	
>6 to 15	Acceptable with review	Review existing management practices and control measures for effectiveness; update if required and continue to implement as part of routine management and monitoring practices.	• Review LFG management. • If the ongoing monitoring as per EMP indicates elevated site risk profile, inform planning department to trigger planning controls.	Require specific LFG monitoring for construction, road / service maintenance works*.
16 or more	Tolerable with further action measures and review	Develop and implement additional measures to confirm and/or mitigate identified risks, such as additional monitoring or control measures.	• Implement additional on-site LFG management and monitoring as per landfill licence and aftercare management plan. • Inform planning department to trigger implementation of planning controls.	Planning proposal should require case specific LFGRA as per EPA Publication 1642 (2017).

The Auditor notes that the planning recommended measures for a risk score of >6 to 15 should also refer to potential building protection measures, which are further detailed in Tables 15 and 16 of the AECOM report.

Hazards were assessed using likelihood and consequences to determine the residual risk of the hazard assuming control measures are in place and are effective. In assessing risks of impacts, in most cases the consequence on a particular impact is constant and the likelihood can be reduced by implementation of control measures to reduce the overall likelihood.

The Auditor considers this approach acceptable.

The Auditor has reviewed the final risk scores, both within 250 m and 500m of the site in relation to adopted receptor groups (mapped according to land uses) and pathways from each Cell to those receptor groups based on the use of the matrices detailed above and agrees with the final residual risk scores, This is detailed in Table 13 of the AECOM report. This table is replicated below:

Table 8.5 Risk Assessment

Source			Existing Controls	Future Controls	Pathways	Receptor Group	Zones	Severity	Max Severity Score	250m			500m		
Cell	Year Open	Liner System								Likelihood & Score		Risk	Likelihood & Score		Risk
1	1975	No liner system	• Natural attenuation • Capping • LFG extraction • Structural discontinuities are tight and no methane emissions have been recorded • Low permeability and no methane emissions have been recorded	• LFG extraction • Aftercare management / monitoring • Natural attenuation • Capping and rehabilitation • Survey for mine workings prior to development • Ensure implementation of LFG Risk Management Plan	Mine workings Figure 7A	Residential / School	GRZ, PUZ2	Severe / major	5	Unlikely	3	15	Very unlikely	2	10
						Industrial	IN1Z, IN3Z	Minor / Significant	3	Unlikely	3	9	Very unlikely	2	6
						Limited development potential	PCRZ, PPRZ, PUZ7	Minor	1	Unlikely	3	3	Very unlikely	2	2
					Tailings Figure 7B	Industrial	IN1Z, IN3Z	Minor / Significant	3	Somewhat unlikely	4	12	Extremely unlikely	1	3
						Limited development potential	PPRZ	Minor	1	Somewhat unlikely	4	4	Extremely unlikely	1	1
					Underground services Figure 7C	Residential / School	GRZ	Severe / major	5	Unlikely	3	15	Very unlikely	2	10
						Industrial	IN1Z, IN3Z	Minor / Significant	3	Unlikely	3	9	Very unlikely	2	6
					Lithology / Geological structure Figure 7B	Residential / School	GRZ, PUZ2	Severe / major	5	Unlikely	3	15	Extremely unlikely	1	5
						Industrial	IN1Z, IN3Z	Minor / Significant	3	Unlikely	3	9	Extremely unlikely	1	3
						Limited development potential	PPRZ, PUZ7	Minor	1	Unlikely	3	3	Extremely unlikely	1	1
2	1998	Compacted clay liner (base)	• Clay basal liner • Natural attenuation												
3A and 3B	2008	Engineered composite base liner and side liner	• Engineered basal liner and side liner • Natural attenuation • LFG extraction • Structural discontinuities are tight and no methane emissions have been recorded • Low permeability and no methane emissions have been recorded	• LFG extraction • Aftercare management / monitoring • Natural attenuation • Capping and rehabilitation • Survey for mine workings prior to development • Ensure implementation of LFG management plan.	Mine workings Figure 7A	Residential / School	GRZ	Severe / major	5	No receptor within 250m			Extremely unlikely	1	5
						Limited development potential	PCRZ, PUZ7	Minor	1	Unlikely	3	3	Very unlikely	2	2
					Underground services Figure 7C	Residential / School	GRZ	Severe / major	5	No receptor within 250m			Very unlikely	2	10
						Industrial	IN1Z, IN3Z	Minor / Significant	3	No receptor within 250m			Very unlikely	2	6
					Lithology / Geological structure Figure 7B	Residential / School	GRZ	Severe / major	5	No receptor within 250m			Extremely unlikely	1	5
						Industrial	IN1Z, IN3Z	Minor / Significant	3	No receptor within 250m			Extremely unlikely	1	3
						Limited development potential	PCRZ, PUZ7	Minor	1	Unlikely	3	3	Extremely unlikely	1	1
5	2013	Engineered composite base and side liner	• Composite basal and side liner • Natural attenuation	• LFG extraction • Aftercare management / monitoring • Natural attenuation • Capping and rehabilitation	Liner failure (no pathway unless liner system fails)	Limited development potential	PCRZ	Minor	1	Extremely unlikely	1	1	Extremely unlikely	1	1
							FZ*	Severe / major	5	Extremely unlikely	1	5	Extremely unlikely	1	5

To classify sites for development, Gas Screening Values (GSV) were calculated using landfill gas monitoring results (the historical maxima of flow rate or concentration as per BS8485:2015 was applied) as per the following risk classifications table:

Table 8.6 Table 8.6 Risk Classification Based on GSV (AECOM, 2019)

CS	Hazard Potential	Site Characteristic GSV (L/hr)	Additional Factors
1	Very low	<0.07	Typical <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
2	Low	0.07 - <0.7	Typical measured flow rate <70 L/h (otherwise consider an increase to CS3)
3	Moderate	0.7 - <3.5	-
4	Moderate to high	3.5 - <15	-
5	High	15 - <70	-
6	Very high	>70	-

Monitoring of all bores indicated GSV values were generally 'very low' with a limited number of bores GSV values being 'low'. AECOM adopted a CS status of 2 for the areas within 250 m of the site and CS of 1 for the area between 250-250 m of the site.

The Auditor agrees with a CS2 applying adjacent to the landfill based on current monitoring results, they also agree that as the distance from the landfill increases the LFG concentrations and flow rates will reduce such that the risk reduces. The extent of the application of the CS2 area, that is, up to 250 metres from the site is considered arbitrary as well as conservative.

BS8485 proposes a number of gas protection measures that can be employed to mitigate landfill gas risk according to gas protection scores. These are detailed in Table 15 of the AECOM report.

As shown above, there were no risk scores above 16 and so all risk scores, based on *Table 8.5*, above were acceptable with or without review.

For a risk score of 6 or less, it is considered that no management actions are required, so continue routine management/monitoring practices and no planning responses are required.

For a risk score of greater than 6 but less than 15, management practices and control measures are to be reviewed with current routine management/monitoring to continue. Planning actions are to be based on the receptor group, risk score, characteristic site situation - whether within 250 m (CS2) or between 250 m – 500 m (CS1).

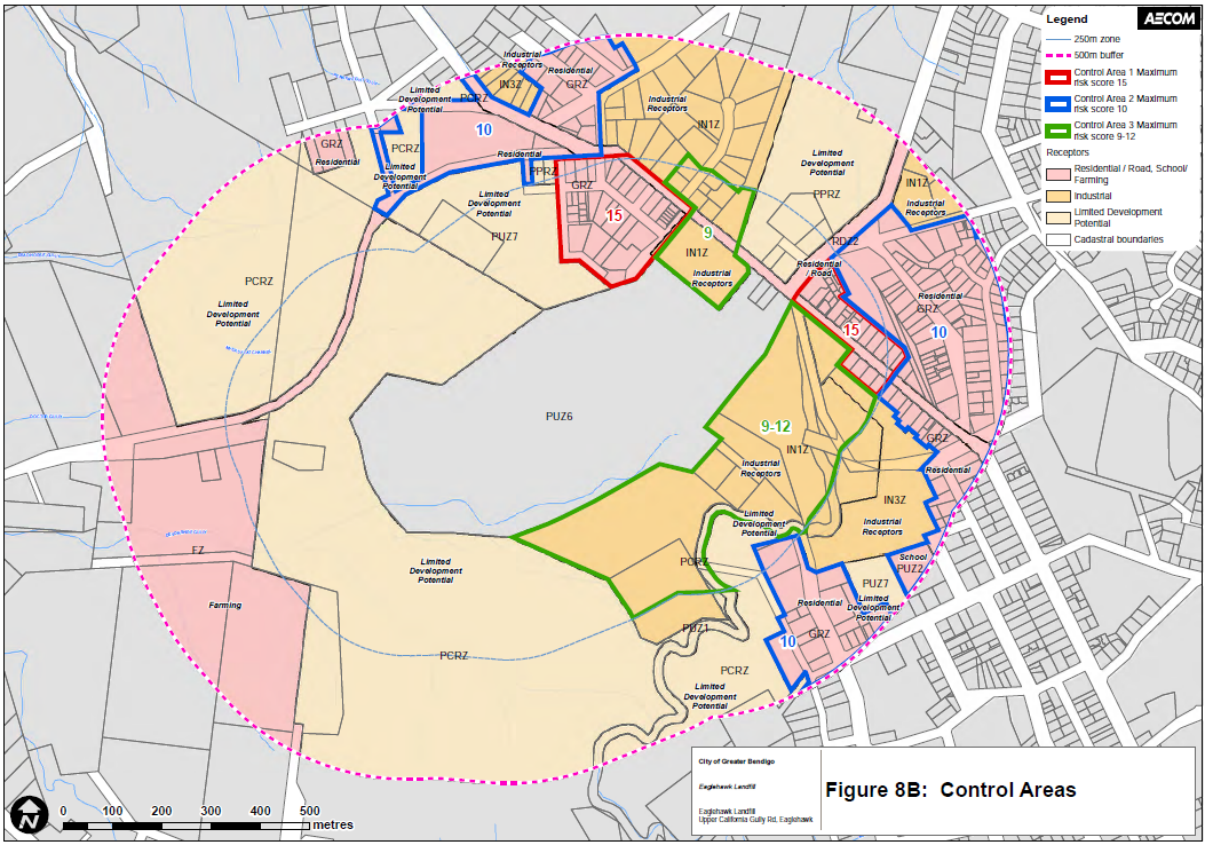
Control areas, which provide the basis for planning controls, have been designated where the risk scores are greater than 6 and according to the CS status, that is CS2 within 250 metre band and CS1 within 250-500 m band. These are presented in Table 16 of the AECOM report (duplicated below) and mapped in Figures F8A and F8B (Appendix A) of the AECOM report, Figure F8B also duplicated below.

Table 8.7 BS8485 Gas Protection Scores (AECOM 2019)

Description	Control Area (Figure F8A-F8B)	Planning Zone	Qualitative Risk Score	CS[1]	Building Type[2]	Minimum Gas Protection Score for new buildings[3]
Areas zoned residential	1	GRZ	15	2	A, B	3.5
Area zoned residential / school mainly between 250m and 500m from the landfill	2	GRZ	10	1	A, B	0 (i.e. no building protection measures).
Areas zoned industrial generally within 250m of landfill	3	IN1Z	9-12	2	C, D	1.5 – 2.5

[1] Refer BS 8485 Table 2 – CS2 corresponds to a GSV value between 0.07 and <0.7 L/hr
[2] Refer BS 8485 Table 3 – Type A, B corresponds to private or commercial/public buildings, Type C, D corresponds to commercial/public and commercial/industrial buildings
[3] Refer BS 8485 Table 4

Figure 8.1 Control Areas (AECOM, 2019)



8.1.4 Auditor's opinion on the adequacy, quality and completeness

The auditor has reviewed a number of versions of this report, each addressing many of the Auditor's and the EPA's comments and issues. There are some issues that have not been addressed by the assessor, and, as detailed in the comments register, will be addressed in this report.

In considering the adequacy of the LFG assessment report prepared by AECOM, the Auditor makes the following comments:

- The assessor, based on subsurface monitoring information (and calculated Qhg values), considers that the risks associated with methane and carbon dioxide are low risk (characteristic site situation 2 within (CS2)) within 250 metres of the landfill waste mass and the density of data within the 250m band indicates a high degree of confidence in the assessed gas risk under currently operating conditions. As a result of these results AECOM (2019) have designated a 0-250 m zone/band within the default 500 m buffer.
- It is reasonable and justifiable to assume that landfill gas risk will reduce inversely with distance from the waste source and thus the risk will reduce as distance from the landfill increases, to the maximum extent of 500 metres defined by the nominal BPEM buffer. In the absence of any data to the contrary, beyond 250 metres (250-500 metres from waste) the LFG risk was identified as very low risk (CS1) and it is on this basis that the development controls recommended for developments within 250m and between 250 m and 500 m were derived.
- Ultimately it was accepted by the auditor that the 250 metre distance from the landfill, as selected by AECOM, is an arbitrary distance and does not intend to specifically consider each of the risk profiles of the various preferential pathways identified, however this distance is understood to be selected for the purposes of defining a distance beyond which there can be a justifiable reduction in risk mitigation measures and controls. The Auditor agrees with this logic and is satisfied that although the 250 metre distance is arbitrary it is somewhat informed by the data close to the landfill and is considered conservative. It also provides a defined boundary for planning control purposes;
- Historical tipping area - It is noted that the report details that historical tipping areas are known to extend further up the gully north and north-east of the licensed landfill that may contribute to generation of LFG outside the licensed premises boundary (depending on age and type of waste). This audit report is limited to the licensed site and therefore does not specifically address the risks from areas outside of the premises boundary but the auditor acknowledges that the controls proposed should provide a high level of protection from methane and carbon dioxide gas generated by these wastes outside of the licensed boundary. Additional risk mitigation measures and controls may be required if the wastes deposited outside of the landfill are hazardous wastes or not putrescible waste;
- Upset conditions - In relation to upset conditions, an assessment of risk scores in relation to the possible event of the LFG extraction system not operating has not been undertaken. Although considered that the impact will be limited on most cells, for Cells 3A and 3B, AECOM note that as there are known preferential pathways in the side liners, this will likely be the release point. The Auditor considers that as there are no sensitive receptors in the vicinity of the boundary of these cells, the risk is likely to remain low if this event should occur. The auditor is in general agreement with this position;
- Buffer measurement – this has been based on the edge of the landfill site, rather than from the active and closed cells. The auditor considers that for the majority of the site, north, east, south, this is acceptable due to the cells generally considered to extend to the site boundary. Although, in the south west of the site, the buffer should be measured from the edge of Cell 5 and Cell 1/Cell 2, the Auditor considers that the buffer measurement from AECOM is conservative and does not materially change the control areas if the alternative measurement was undertaken.

8.1.5 Current risk

AECOM do not recommend any changes, that is reduction to the current buffer applying to the site, however based on an assessment of risk, has identified areas that will require management measures and planning controls with remaining areas not requiring any measures and/or controls.

The monitoring results, including calculated GSVs, indicated that the risks associated with LFG are generally very low within 250 m of the landfill with worst case corresponding to low risk. As such the area within 250 m of the landfill is considered low risk, with the area within 250 – 500 m of the landfill as very low risk.

The AECOM (2019) assessment evaluated the risk of LFG migration from each landfill cell (source) to adopted receptor groups via designated pathways within the Landfill BPEM buffer. The assessed risk scores designate the management practices and control measures required (refer to *Table 8.4*) and the control areas designate the planning controls required (refer to *Table 8.7*).Three control areas were identified based on risk scores (greater than 6 and less than 15), see Figure F8A in Appendix A of the AECOM report.

In relation to upset conditions, the assessment of risk scores remains the same.

8.1.5.1 Mitigation measures

As detailed in *Table 8.4,* the recommended measures are both landfill management and planning development controls:

Landfill Management

- The main measure to continue at the site is the LFG extraction system to extract LFG and minimise potential pressure building up minimising the risk of LFG lateral migration. This is anticipated to continue at the site until LFG concentrations are reduced to levels that would pose no risk of offsite migration at harmful levels.
- In addition, to install and maintain the final capping at the site such that vertical migration is limited and the LFG extraction system is as efficient as possible. In the event of LFG extraction failure, consider additional measures, such as passive vent/trench for Cells 3A and 3B and Cell 5.

Development controls

- Building control measures – These are gas protection measures used to mitigate landfill gas risk according to gas protection scores. Table 15 of the AECOM report details the building control measures proposed for buildings (by building type) within the buffer in control areas classified as CS2. There are no building control measures for a control area classified as CS1, so, currently for any development greater than 250m from the site. Due to ongoing monitoring, the characteristic site situation may change based on the results of the monitoring.
- Requirement for specific LFG monitoring during construction, road/service maintenance works to protect onsite workers from potential LFG risks.

8.1.5.2 Monitoring

- Ongoing monitoring of LFG monitoring locations that are currently being monitored;
- Specifically for control area 2, it is recommended that a number of new LFG monitoring bores be installed to provide an early warning of the migration of LFG to allow for landfill operations to review existing management practices and control measures for effectiveness and for planners to respond with appropriate development controls, if any;
- Update the site Environmental Management Plan to include additional LFG monitoring bores required to be monitored, in addition to contingency events should LFG be encountered at levels that present a greater risk than previously assessed.

8.1.6 Future risk

The assessment does not provide an updated assessment of the risks associated with the landfill into the future from LFG migration. In the future, the landfill will no longer be operational with final capping and the landfill gas extraction system extended across the recently closed Cell 5. AECOM (2019) note that capping presents a higher risk of lateral LFG migration.

AECOM consider that capping of all cells, currently and in the future will provide an effective vertical LFG migration barrier. However, upon full site rehabilitation, LFG build up in the landfill is likely to increase and promote lateral pressure-driven emissions through subsurface geology. AECOM propose that the ongoing LFG extraction system will provide sufficient control over pressure-driven lateral migration of LFG. The auditor concurs with this view and as such it was assumed that the current risk would over-estimate the future as the LFG extraction would remain constant while the LFG generation rate would rapidly decrease once organic waste placement ceases.

8.2 Dust

A Dust Impact Assessment, considering particulate matter and nuisance dust emissions, has been prepared by SLR Consulting (Australia) Pty Ltd (SLR) to provide an assessment of potential dust impacts associated with the facility from current and proposed future onsite activities, under normal and upset conditions.
A copy of the report, and auditor comments register, is located in *Appendix D.*

8.2.1 Objectives

The objective of the assessment, consistent with the audit, was to assess the potential dust impacts associated with the facility from current and proposed future onsite activities, under normal and upset conditions.

8.2.2 Scope or works/ methodology

The scope of works and methodology have been reviewed and considered appropriate, with the current and future and upset conditions assessed and were also considered appropriate.

Dust emissions included in the assessment were as follows:

- Suspended particulate matter – airborne contaminants that can be inhaled directly into the lungs. Emissions of particular matter less than 10 um and 2.5 um in diameter (referred to as PM10 and PM2.5, respectively) are considered important pollutants due to their ability to penetrate into the respiratory system and cause health impacts; and
- Deposited particulate – Deposited dust, measure din grams per square meter per month (g/m2/month) and cause nuisance impacts.

The works undertaken included:

- Assessment of background air quality;
- Complaints review received from January 2017 to November 2018 – Three complaints were made, one of which SLR noted as highlighting the importance of dust management procedures in particular in upset conditions (such as extremely busy days, staff constraints, only one truck available);
- Detailed atmospheric modelling (AERMOD) of current and future operational scenarios to assess potential for suspended particulate concentrations and dust deposition rates due to fugitive particulate emissions from the facility to result in off-site air quality impacts.
    - Estimate fugitive emissions of total suspended particulate PM10 and PM2.5 using published emissions factors from the National Pollutant Inventory (NPI) Emission Estimation Technique Manual “NPI Emission Estimation Technique Manual for mining” V 3.1, January 2012 (DSEWPC, 2012), as appropriate.
    - Modelled results for the facility operating under normal conditions for both existing and proposed operations to be assessed based on compliance with the PEM Criteria. Criteria tabulated below:

Table 8.8 PEM Assessment Criteria for Particular Matter Mining and Extractive Industries

Pollutant	Averaging Period	Air Quality Standard	
PM_{10}	24-hour	60 µg/m^3	
$PM_{2.5}$	24-hour	36 µg/m^3	
Pollutant	**Averaging Period**	**Maximum Increase in Deposited Dust Level**	**Maximum Total Deposited Dust Level**
Dust deposition	Annual	2 g/m^2/month	4 g/m^2/month

- Considered incoming and outgoing waste from the site including vehicle movements
- Dust emission sources modelled for existing and proposed operations are detailed in the following figure. Existing and proposed activities considered are those detailed in Section X of this report.
- Activities considered to lead to upset conditions were the infrequent mulching of green waste - these activities in addition to normal operations are considered in relation to appropriate separate distance for development from the facility.

Figure 8.2 Location of existing operations modelled emission sources (SLR, 2019)

Figure 8.3 Location of proposed operations modelled emission sources (SLR, 2019)

It is noted that the figures provided by Council do not make any reference to domestic concrete/rubble in proposed future operations.

The nearest sensitive receptors considered are detailed in the figure provided below:

Figure 8.4 Sensitive Receptors (SLR, 2019)

Table 8.9 Nearest Sensitive Receptors (SLR, 2019)

ID	Name	UTM Coordinates Zone 55s (mE, mS)	Distance/Location from Facility
R1	69 Bonazza Road, Maiden Gully	253,101, 5,930,995	420 m southwest
R2	44 Bonazza Road, Maiden Gully	253,157, 5,930,661	700 m southwest
R3	64 Bracewell Street, Maiden Gully	252,720, 5,931,424	560 m west
R4	12 James Street, Eaglehawk	253,318, 5,932,147	510 m northwest
R5	16 Walker Crescent, Eaglehawk	253,709, 5,931,894	115 m north
R6	Walker Crescent, Eaglehawk	253,817, 5,931,876	65 m north
R7	196 Upper California Gully Road, Eaglehawk	254,187, 5,931,784	200 m northeast
R8	California Gully Primary School	254,434, 5,931,199	560 m southeast
R9	32 Butler Street, Eaglehawk	254,176, 5,931,124	435 m south-southeast

It is noted that receptors have been measured from the facility boundary rather than from the activity boundary, that is the activities as noted in *Figures 8.2* and *8.3* detailed above. This would only impact on those receptors to the north, say receptor R5 and R6 or those receptors to the east, receptor R7.

8.2.3 Summary of results

SLR (2019) detailed that modelling of normal conditions allowed assessment of compliance with the relevant air quality criteria (PEM) and any potential impact to air quality experienced at the nearest sensitive receptors, while the modelling of existing and proposed scenarios when the facility is operating under upset conditions can be used to assess against separation distance requirements of the facility in relation to particulate matter and nuisance dust.

Model results are expressed as the maximum predicted concentration for each averaging period at the selected assessment locations over the 2013 – 2017 modelling periods. The facility operating under normal conditions for both the existing and proposed operations was assessed based on compliance with the PEM Criteria.

For the assessment of upset conditions for both existing and proposed operations, reference is made to compliance at sensitive receptors.

8.2.3.1 Deposited Dust

The maximum monthly dust deposition rates predicted at all sensitive receptor locations are detailed in the SLR (2019) report (Table 19) for 2013 to 2017. 2017 data only duplicated below, and are below the relevant assessment criteria. SLR conclude that no nuisance dust impacts would therefore be expected as a result of dust emissions from the facility.

Table 8.10 Predicted Dust Deposition Rates (SLR, 2019)

Receptor ID	Maximum Monthly Incremental Dust Deposition Rates (g/m²/month)			
	Current – Normal	Current – Upset	Proposed – Normal	Proposed – Upset
2017				
R1	0.09	0.1	0.1	0.2
R2	0.04	0.06	0.05	0.09
R3	0.08	0.1	0.1	0.1
R4	0.07	0.1	0.08	0.1
R5	0.4	0.6	0.4	0.5
R6	0.5	0.8	0.5	0.7
R7	0.6	0.8	0.7	0.7
R8	0.1	0.2	0.2	0.3
R9	0.2	0.2	0.2	0.4
PEM Criterion	2.0		2.0	

SLR (2019) detail that compliance with the PEM criterion for dust deposition at all the sensitive receptors when modelling upset conditions, implies the 500 m separation distance requirement adequately protects the amenity of residents from nuisance dust. SLR concluded that given compliance with location R6, located approximately 65 m from the site boundary, suggests the separation distance requirement may be reduced in relation to nuisance dust.

8.2.3.2 PM10

The incremental and cumulative annual average and 24-hour average PM10 concentrations predicted at surrounding sensitive receptors were calculated and presented in the SLR (2019) report (Tables 20 and 21), 2013 to 2017. 2017 data only duplicated below for maximum average 24-hour PM10. Contour plots are also presented in Appendix B (although noted in report as Appendix C) of the report. SLR modelling found that the maximum 24-hour average cumulative PM10 concentrations predicted at the nearest sensitive receptors are below the relevant ambient air quality criterion of 60 ug/m3 at all receptors for both existing and proposed operations under normal or upset conditions.

Table 8.11 Predicted Maximum 24-Hour Average PM10 Concentrations (SLR 2019)

Receptor ID	Background Concentration Assumed[1] (µg/m³)	Maximum 24-Hour Average PM_{10} Concentrations (µg/m³)							
		Incremental				Cumulative[1]			
		Current – Normal	Current – Upset	Proposed – Normal	Proposed – Upset	Current – Normal	Current – Upset	Proposed – Normal	Proposed – Upset
2017									
R1	20.0	4.5	6.2	6.1	10.0	24.5	26.2	26.1	30.0
R2	20.0	3.5	4.9	4.4	6.6	23.5	24.9	24.4	26.6
R3	20.0	4.0	5.6	5.1	7.9	24.0	25.6	25.1	27.9
R4	20.0	3.4	6.1	3.3	5.0	23.4	26.1	23.3	25.0
R5	20.0	12.6	15.2	12.4	13.8	32.6	35.2	32.4	33.8
R6	20.0	14.7	20.9	13.1	18.7	34.7	40.9	33.1	38.7
R7	20.0	28.0	33.8	32.9	39.3	48.0	53.8	52.9	59.3
R8	20.0	7.2	11.0	9.1	14.3	27.2	31.0	29.1	34.3
R9	20.0	10.0	13.2	9.9	12.3	30.0	33.2	29.9	32.3
PEM Criterion	-	-				60.0			

1 Includes yearly varying 70th percentile background PM_{10} concentrations based on data from Geelong South (see Section 5.1.2)

Modelling predicts compliance with the PEM criterion of the maximum 24-hour average PM10 concentrations at all the sensitive receptors, when modelling upset conditions. The highest reported concentrations under upset conditions, under both current and proposed activities, was at location R7, which is located 200 m from the site boundary. This implies the applicable separation distance requirement may be reduced in relation to the impacts of PM10 to at least 200 m. It is noted that compliance was also predicted at the closest receptor (R6) some 65 m from the site boundary suggesting that the separation distance to the north may be considered to be reduced to this distance.

8.2.3.3 PM2.5

The incremental and cumulative annual average and 24-hour average PM2.5 concentrations predicted at surrounding sensitive receptors were calculated and presented in the SLR (2019) report (Tables 22 and 23) 2013 to 2017. 2017 data only duplicated below for maximum average 24-hour PM10. Contour plots are also presented in Appendix B (although noted in report as Appendix C) of the report. SLR modelling found that the maximum 24-hour average cumulative PM2.5 concentrations predicted at the nearest sensitive receptors are below the relevant ambient air quality criterion of 36 ug/m3 at all receptors for both existing and proposed operations under normal or upset conditions.

Table 8.12 Predicted Maximum 24-Hour Average PM10 Concentrations (SLR 2019)

Receptor ID	Background Concentration Assumed (µg/m³)	Maximum 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)							
		Incremental				Cumulative[1]			
		Existing– Normal	Existing – Upset	Proposed – Normal	Proposed – Upset	Existing – Normal	Existing – Upset	Proposed – Normal	Proposed – Upset
2017									
R1	8.0	0.4	0.6	0.6	0.7	8.4	8.6	8.6	8.7
R2	8.0	0.3	0.5	0.4	0.5	8.3	8.5	8.4	8.5
R3	8.0	0.3	0.4	0.4	0.5	8.3	8.4	8.4	8.5
R4	8.0	0.3	0.6	0.3	0.4	8.3	8.6	8.3	8.4
R5	8.0	1.0	1.3	1.0	1.1	9.0	9.3	9.0	9.1
R6	8.0	1.5	2.1	1.2	1.4	9.5	10.1	9.2	9.4
R7	8.0	2.6	3.2	3.1	3.6	10.6	11.2	11.1	11.6
R8	8.0	0.7	1.1	0.9	1.1	8.7	9.1	8.9	9.1
R9	8.0	0.9	1.3	0.9	1.1	8.9	9.3	8.9	9.1
PEM Criterion	-	-				36.0			

1 Includes background 24-hour average $PM_{2.5}$ concentrations from Geelong South (see Section 5.1.2).

Modelling also predicts compliance with the PEM criterion of the maximum 24-hour average PM2.5 concentrations at all the sensitive receptors, when modelling upset conditions. The highest reported concentrations under upset conditions, both current and proposed was at location R7, which is located 200 m from the site boundary. This implies the applicable separation distance requirement may be reduced in relation to the impacts of PM2.5.

SLR 2019 conclude that "*Compliance with PEM criteria at all the sensitive receptors, when modelling upset conditions, implies the 500 m separation distance requirement adequately protects the human health and amenity of local residents. In addition, given compliance with the PEM criterion at locations approximately 65 m from the site boundary, the 500 m separation distance requirement may be reduced in relation to the impacts of nuisance dust, PM10 and PM2.5*"

8.2.4 Auditor's opinion on the adequacy, quality and completeness

The auditor notes the following issue was noted during the review of the report

- Buffer measurement - The separation distance for the sensitive receptors were considered the same under current and proposed conditions, however, once the landfill is closed, the buffer distance under the Landfill BPEM of 500 m only applies to landfill gas. The separation distance for a transfer station of 250m would then kick in based on EPA Publication 1578 *Recommended separation distances for industrial air emissions*;
- Upset conditions – athough only considered the mulching operations, which occur infrequently, the modelling considered the weather conditions, however, not consider other upset conditions that were noted in the report (Section 5.2) which was considered the source of one of the dust complaints including staff shortage, only one water truck available and the site was busy. This does not appear to have been considered?
- Separation distance measurement – As noted in *Section 8.2.2*, this has been measured from the site boundary rather than from the activity boundary, as required in EPA Publication 1578. This means that for receptors, such as those to the north, they are further away than currently detailed. Based on the assessment undertaken, this does not impact on the results, however may impact on the recommended separation distance going forward if this is proposed to be reduced.

The auditor considers that the dust assessment undertaken was adequate, of sufficient quality and completeness for the purpose of this audit, that is, to meet the objectives of the audit.

The auditor considers that the assessor report followed the guidelines applicable at the time of the investigations.

8.2.5 Current risk

SLR (2019) conclude that "*the results of the modelling indicate that the potential for dust and particulate matter impacts at the nearest sensitive receptors is negligible*".

With regard to the current Landfill BPEM buffer, there is the potential for the buffer distance to be reduced, potentially to 200 m, that is the location of the highest concentrations reported close to the maximum for PM10.

8.2.5.1 Mitigation measures

SLR (2019) has suggested a number management practices to minimise dust emissions, refer to Section 9.1 of the report. The previous audit (ERM, 2017) detailed a number of mitigation measures undertaken to minimise dust, including spraying unsealed road surfaces, dusty loads, stockpiles with water if required, revegetation of unvegetated areas, and relocating of mulching of green waste. City of Greater Bendigo should consider those management practices recommended by the Assessor and includes these in their site procedures if considered appropriate.

8.2.5.2 Monitoring

With regard to ongoing monitoring, SLR(2019) have stated that due to the very small number of complaints, and the negligible off-site impacts being predicted at the nearest sensitive receptors, no instrument-based air quality monitoring programs are recommended. Rather regular site inspections for visible dust emissions should be undertaken with complaints appropriately addressed. These are already in place at the site in the site verified EMP (AECOM, 2017).

8.2.6 Future risk

The results of the modelling indicate that all off-site cumulative annual average and maximum PM10 and PM2.5 concentrations, and monthly dust deposition rates comply with the relevant guidelines at the nearest receptors for proposed normal and upset conditions

With regard to the separation distance to apply post landfill closure, that is the distance applicable under the EPA Publication 1578 of 250 m, the predictions suggest that compliance with the relevant guidelines should be attained within that separation distance under upset conditions.

Ongoing management and monitoring are as per current risk, see *Section 8.2.5* above.

8.3 Odour

An assessment of odour risk has been undertaken by Consulting Environmental Engineers (CEE), titled *Odour Assessment for Eaglehawk Landfill.* A copy of the report, and auditor comments register, is located in *Appendix D.*
The assessment was generally conducted prior to the engagement of the auditor, finalised post provision of auditor comments.

8.3.1 Objectives

The objectives of the assessment, pertinent to this audit, were detailed as:

- The risk to the residential area associated with airborne odour releases;
- If the 500 m landfill buffer distance could be reduced to 250 m or other lesser distance from the landfill boundary based on appropriate modelling methods;
- Upset conditions were also addressed, post Project Review Meeting 31 July 2018.

The report has considered the site's compliance with the site licence, that is odours at the site boundary as well as likely odours if waste was excavated from the east side of the industrial, both of which do not form part of the objective of this project and so the works and conclusions associated with these considerations have been ignored.

8.3.2 Scope of works/ methodology

The scope of works and methodology, were initially defined by Council in July 2017, prior to the appointment of the auditor with updates in July 2018, post appointment. These have been reviewed and considered appropriate, with the current and future operations and upset conditions assessment considered appropriate. This included:

- Development of an appropriate odour criterion for the site;
- Undertaking odour monitoring at selected onsite locations – current cell, leachate pond, green waste mulching area, Transfer Area and Organics shed. This included the selection of appropriate monitoring techniques for each location;
- Undertaking odour dispersion modelling to reflect normal operating conditions and in upset conditions.

- Activities included in upset conditions were: 50% increase in emissions from the active cell (for example during wet weather or when an unusually large volume of waste arrives); doubling in emissions from the FOGO shed (for example when there is no cartage to the composting facility); doubling in emissions from the recent fill area (for example in prolonged wet weather or there is a significant reduction in barometric pressure at a time of light winds); and

- Surveying the community to understand their perceptions of odour and to verify model predictions.

Validation of the modelling results was not undertaken according to European Standard 'EN16841-2-2016: determination of odour in ambient air by using field inspection – Part 2: Plume method', or a suitable equivalent by the air quality consultant. This standard requires field validation to be undertaken by a trained nose at various field meteorological conditions and at various potential positional patterns in the predicted plume footprint. To strictly comply this would require rapid deployment of appropriately trained persons in odour detection with permission to enter private property and buildings within the plume footprint. Without right of access and trained persons immediately available, it was deemed that strict compliance would not be practicable for a rural small landfill where the surrounding area is largely developed limiting movement of the trained odour detectors. However the odour consultant did undertake an informal survey of residents in the predicted plume footprint and presented this anecdotal field evidence of validation of the plume. While this is not a categorical survey it does suggest some odour impact has historically occurred off-site as a result of current on-site activities. Without this validation work, it is assumed the modelling results are conservative and potentially over estimate the extent of impact.

8.3.3 Summary of results

An odour criterion of 4 OU level was considered appropriate to protect residential amenity in the region of the landfill at 99.9 percentile frequency. This means that the predicted odour level must be within the odour criterion for 99.9 % of the hours in a year, as set out in the SEPP (AQM).This is considered the practical odour limit at which no odour complaints occur. The Auditor agrees with this criterion.

A summary of odour emissions estimate for normal operations was developed post monitoring replicated below:

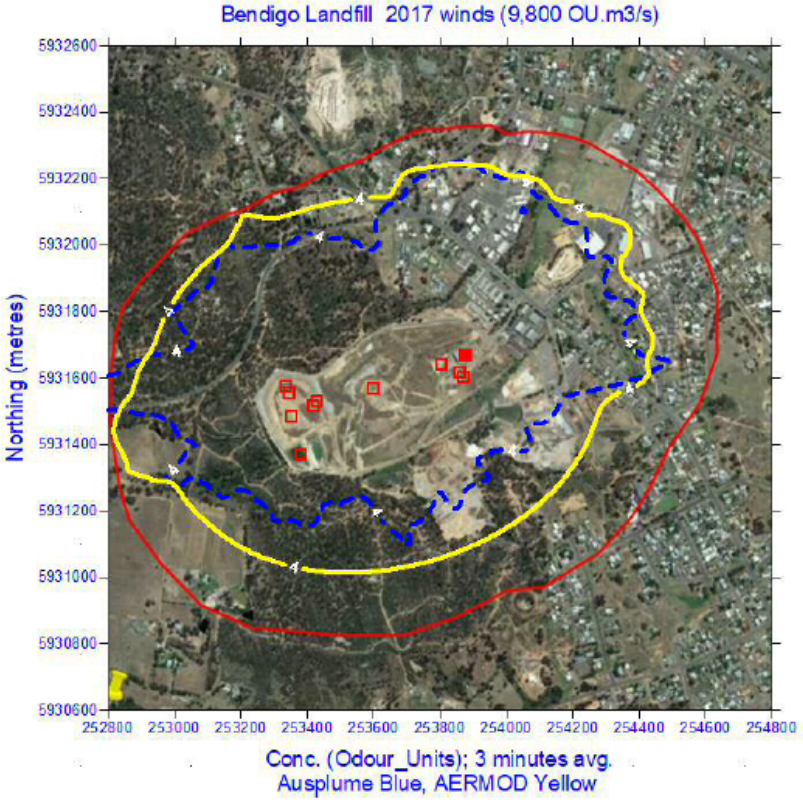
Table 8.13 Summary of Odour Emissions Estimate for Normal Operations (CEE, 2019)

	Bendigo Landfill Odour Inventory							
Type	**Source**	**East**	**North**	**Length**	**Area**	**SOER**	**OU/s**	**Basis for Estimate**
Area	Active North	253,334	5,931,577	10	100	16	**1,600**	ETC sampling result
Area	Active East	253,430	5,931,530	10	100	23	**2,300**	from Tim Pollock paper
Area	Recent Fill North	253,345	5,931,554	30	900	0.03	**27**	from ESA paper
Area	Recent Fill West	253,417	5,931,517	30	900	0.1	**90**	from ESA paper
Area	Recent Fill East	253,353	5,931,484	30	900	0.2	**180**	from ESA paper
Area	Leachate Pond	253,380	5,931,370	41	1681	0.05	**84**	ETC sampling result
Area	Mulch	253,600	5,931,570	15	225	6.6	**1,485**	ETC sampling result
Area	Transfer Truck	253,860	5,931,619	9	81	10	**810**	estimated
Area	Transfer Pile	253,870	5,931,602	12	144	6	**864**	estimated
Area	Trailer Unloading	253,804	5,931,640	9	81	4	**324**	estimated
Volume	Organics Shed	253,877	5,931,670	Sig Y = 9	Sig Z=2	Ht = 1	**2,000**	ETC sampling result
						Total	**9,764**	

As can be seen, the main sources of OU/s are the active landfill, mulching area and the organics shed.

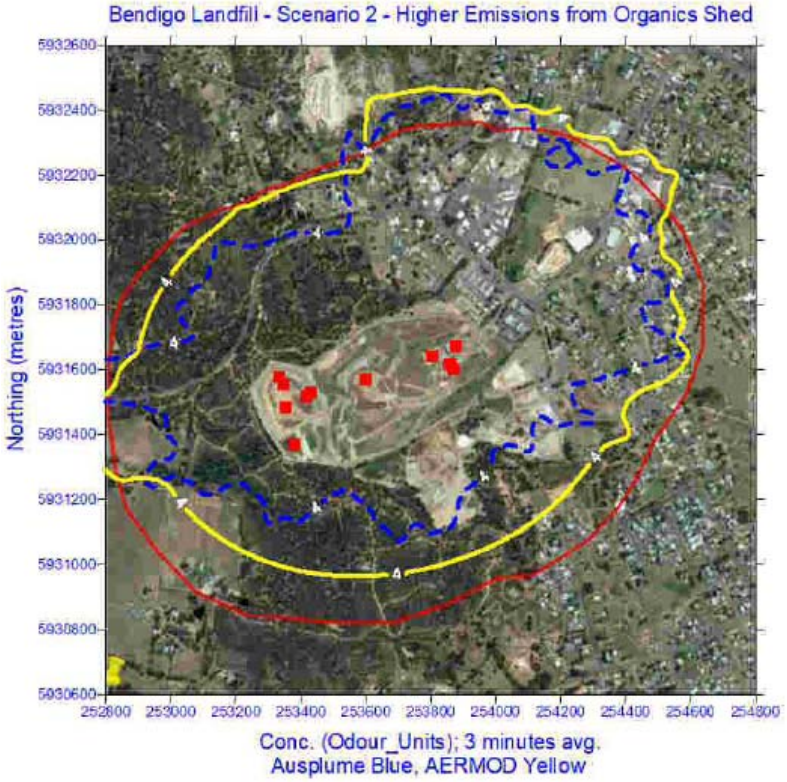
Odour dispersion modelling under normal conditions with the 4 OU contour contained within the 500 m buffer. The figure below, using 2017 wind data, shows the predicted odour contours – the 4 OU contour shown as a solid yellow line for AERMOD (and dashed blue line for Ausplume for comparison purposes) and red line the 500 m buffer. However, the purpose of the buffer is to protect receptors from any impact resulting from upset conditions or abnormal weather conditions.

Figure 8.5 Odour Dispersion Model Predictions using 2017 Wind File – Normal Conditions (CEE, 2019)



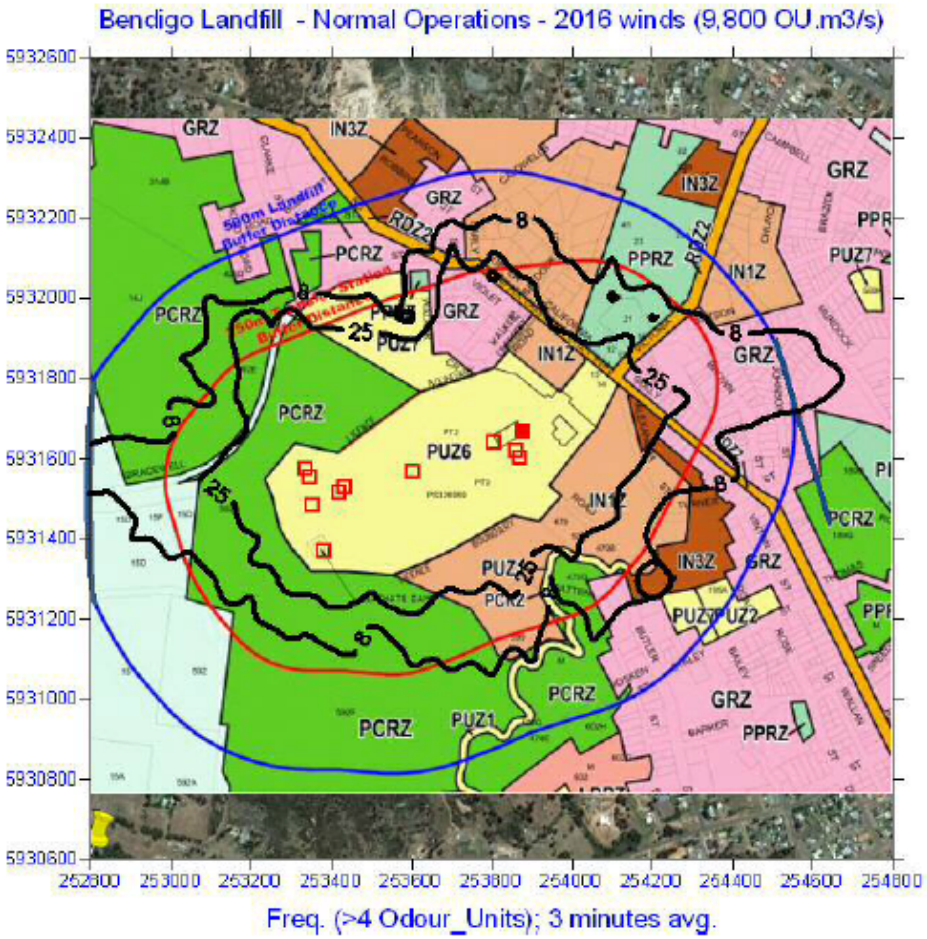
Under a number of upset conditions, the 4 OU generally extends beyond the buffer zone to the north and west. Refer to Figures 9-3 to 9-5 in the report for all upset condition contours. The following figure shows the 4 OU contour for upset conditions for increased odour from the organics shed:

Figure 8.6 Odour Dispersion Model Predictions – Upset Conditions - Increased Odour from Organics Shed (CEE, 2019)



Under normal operations, the assessment predicted the frequency (in hours per year) of odour levels exceeding 4 OU 8 hours per year (corresponding to 99.9% frequency) and 25 hours per year (corresponding to a noticeable degree of annoyance) which is detailed in the figure below. This reveals that the 4OU contours extend beyond the 250 m buffer in addition to the 500 m buffer for 8 hours per year, and generally remain within the 250 m buffer with minor extension beyond the 250 m buffer to the north for 25 hours per year. This means that the residents to the north, east and west are subject to odour at 4 OU 25 hours per year.

Figure 8.7 Odour Dispersion Model Predictions – Hours per year over 4 OU – Normal Operations (CEE, 2019)



A community survey, asking for perceptions in relation to landfill odour, was undertaken in June 2018 to verify the odour dispersion model predictions. The survey was sent to 200 premises within the 500 m buffer zone with 29 responses provided. These responses are provided in the figure below:

Figure 8.8 Responses of Residents to Odour Survey (CEE, 2019)

Figure Legend

- Red location – odour is often high
- Orange location – odour is occasionally noticeable
- Green location – odour is not detected

Responses from the community show general agreement with the predictions of the odour model, showing highest odour and adverse effect on amenity occur to the north-east, north and west of the landfill.

8.3.4 Auditor's opinion on adequacy, quality and completeness

The auditor details the following issues noted during the review of the report:

- Guidelines – the assessment refers to the previous versions of the Landfill BPEM - EPA Publication 788.2 October 2014, *Siting, Design, Operation and Rehabilitation of Landfills*; and the *Assessment planning proposals within the buffer of a landfill*, referring instead to the previous version EPA Publication 1625-June 2016, *Assessing Planning Proposals near Landfills (however also referring to the correct guidelines elsewhere in the report).* The Auditor does not consider that this has impacted on the odour assessment undertaken and considers that the works were consistent with the current guidelines applicable at the time;
- Current site activities - The current and future site operations did not reflect the current site operations. These included the following activities that are not applicable:
  - Liquid wastes delivered to the site by tankers are deposited in shallow trenches dug into the active cell.
  - Leachate from the active cell is collected in the leachate pond in the south-west of the landfill, from where it is recycled over the top of the active cell.

The auditor considers that although these have been detailed, they do not appear to have been reflected in the onsite measurements undertaken and so not reflected in the results of the assessment.

- Future site activities - The future site conditions, that is, not including ongoing landfilling at Cell 5, were not modelled.
- Separation distance measurement – This has been measured from the site boundary rather than from the activity boundary, as required in EPA Publication 1578,and consider the distance of 250 m when considering Transfer Station activities, such as the FOGO transfer station. Based on the assessment undertaken, this does not impact on the results.

  The Auditor considers that once landfilling has ceased and the cells rehabilitated, an odour assessment should be undertaken based on current aftercare conditions with the applicable separation distance to re-assess the risks to sensitive receptors within that distance.

The auditor considers that the assessments undertaken were adequate, of sufficient quality and completeness for the purpose of this audit, that is, to meet the objectives of the audit.

8.3.5 Current risk

CEE (2019) found that:

- Risk to Residential areas - Residential land north and east of the landfill is within the 4 OU contour, and there is good evidence that farming dwelling sites west of the landfill also experience elevated odour levels. The extent of the risk of a reduction in amenity due to odour is illustrated by the community survey results (see *Figure 8.8*) and the extent of the 4 OU contour in the odour dispersion model plots, Figures B1 – B6, Appendix B of the report.
- Potential Buffer Zone reduction - Based on the findings of the community survey and the odour modelling results, it is considered that there can be no reduction in the buffer zone to the west, north and east of the facility. A minor reduction in the buffer zone (500 m buffer), by about 50 to 100 m, could be acceptable to the south of the facility. This is based on the wind patterns and topographic conditions resulting in less frequent transport of odour to the south of the landfill.

No mitigation measures or monitoring recommendations have been made by the assessor.

8.3.6 Future risk

With regard to future risk, that is when the active landfill operations cease:

- Long term risks of odour. Once the landfill ceases accepting waste, assumed around 2023 -2025, there will be a period of about 40 years when odour can continue to escape from the filled cells. The release of odour can be managed by capping all cells and installing a landfill gas extraction system. Long term, however, there is a risk that the gas extraction system can be discontinued as uneconomic. Then there may be a period of subsequent odour release, albeit at a low rate.

The ongoing risk of odour from the remaining assumed onsite activities, FOGO and mulching, has not been modelled to date. It is likely that odour from these activities, currently significant sources of OU/s, as per *Table 8.13*, will continue to generate similar OU contours as currently during the aftercare period, in particular to the north, east (FOGO) and to the west (mulching). However, the final Transfer Station location has not been determined and so difficult to model. Ideally these facilities should be relocated on-site to be more than 250 metres away from sensitive receptors. Where this is not practicable then additional odour mitigation measures are required to be identified and installed. Odour modelling should be undertaken considering any proposed new location on-site and the effect of any proposed mitigation measures.

The Auditor considers that an odour modelling exercise should be undertaken as part of the assessment of the final location of onsite operations in the aftercare period to assess the risks to sensitive receptors at proposed locations.

8.4 Noise

A Noise Assessment has been prepared by SLR Consulting (Australia) Pty Ltd (SLR) to assess noise emissions from the operation of the Eaglehawk landfill. A copy of the report, and auditor comments register, is located in *Appendix D.*

The assessment was undertaken in October 2017 prior to the engagement of the auditor.

8.4.1 Objectives

The objectives of the assessment was to assess the noise and vibration emissions from the operation of the landfill.

8.4.2 Scope of works/ methodology

The scope of works and methodology have been reviewed and considered appropriate, with the current conditions assessed and were also considered appropriate. The works undertaken included:

- Establish noise level design goals (criteria) for environmental noise emissions at potentially noise affected sensitive receivers. As the nearest residences are within the urban growth boundary, the recommended maximum noise levels from the landfill are therefore determined from SEPP N-1. Table 3 of the report provides the SEPP N-1 Noise limits, duplicated below:

Table 8.14 SEPP N-1 noise limits (NIRV recommended maximum noise levels) (SLR, 2017)

Total Influencing Factor	0.3659
Zoning Levels, dBA	
Day	57
Evening	50
Night	45
Measured background noise level at position, L_{90}, dBA	
Day	38 (Low)
Evening	31 (Low)
Saturday (1300h-2200h)	34 (Low)
Sunday (0700h-2200h) (used Sat.)	34 (Low)
Night	25 (Low)
Noise Limit, dBA	
Day	52
Evening	44
Saturday (1300h-2200h)	45
Sunday (0700h-2200h)	45
Night	38

Note: Due to multiple industries being present, the above limits are for the total noise emitted. For each industry's contribution the limit would be 3 dB less than the above.

- Carry out noise and vibration measurements near the closest residence to determine compliance with EPA and relevant standards. The closest residence was determine to the north of the site, 10 Bragg street (which had previously submitted a noise complaint regarding the landfill), as detailed in Figure 1 of the report, duplicated below:

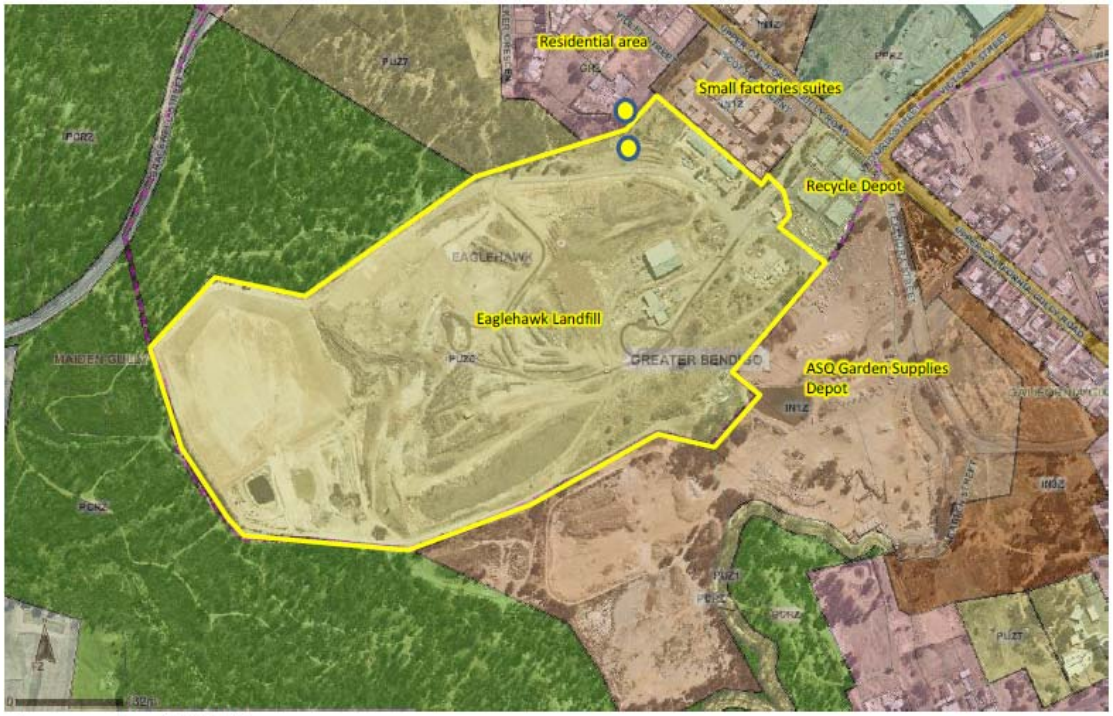


Figure 8.9 Noise and Vibration measurement locations (SLR, 2017)

Noise logging was undertaken at the nearest residence from 22 August to 6 September 2017. Staff at the facility recorded the date and time of any significant noise events over this period, including offsite events such as ASQ crushing.

Vibration logging, logger deployed on the site near the north-east corner opposite the nearest residences, was undertaken from 7 August 2017 – 22 August 2017

SLR note that the assessment did not include the operation of the gas generator and the green waste mulcher as these were not operating at the time. However, note that based on their calculations concluded that the gas generator will not significantly contribute to the noise level at the residences with a sound power level of 110 dBA due to the substantial shielding provided by the site and its greater distance away even and that the noise from the green waste mulcher must be less than 110 dBA sound power level to not exceed the RMNL at the residences..

- Develop a computer noise model (incorporating the surrounding topography and all acoustically significant plant and equipment) to enable the calculation of predicted noise levels at the nearest potentially affected noise sensitive receivers. This was undertaken using SoundPlan software for two operational scenarios under enhanced meteorological conditions. This included undertaking noise level measurements of the main plant items on site on 7 August 2017, such as Front End Loaders, street sweepers, excavator, compactor, dozer, kerbside and water truck and bin tipper. The two operational scenarios modelled were
  - Current operations; and
  - Kerbside and water truck movements along the north access road;
- From results of the computer modelling, assess noise levels from current and proposed future operations to the noise criteria at the nearest potentially affected receivers;
- Compare the predicted level of noise emissions from the facility with the design goals, and where required recommend appropriate noise mitigation measures that will result in compliance with the relevant criteria.

8.4.3 Summary of results

The results of the vibration logging revealed that there was no significant ground vibration measured over the period.

The dominant noise measured by the noise logger was birdsong and distant traffic. There was some industrial noise such as reversing beepers and truck movements but it is not known where these were located. SLR concluded that apart from a few days where the excess was small, one of which was a very windy day (Sunday 3 September), the measured Leq noise level typically did not exceed the recommended maximum noise level for the day, evening and night periods. And that during this period there was normal operation of the landfill and likely from other industries. A summary of Leq noise levels measured by the logger outside the residence is detailed in Table 5 of the report and duplicated below:

Table 8.15 Noise logging summary results, Leq (arithmetic average hourly Leq's) (SLR, 2017)

Period	Tue 22	Wed 23	Thu 24	Fri 25	Sat 26	Sun 27	Mon 28	Tue 29	Wed 30	Thu 31	Fri 1	Sat 2	Sun 3	Mon 4	Tue 5
Day		51	52	51	52	-	52	52	53	50	51	52	-	52	51
Evening	39	39	39	38	44	48	40	35	42	43	44	47	54	42	43
Night	33	37	36	33	38	36	34	33	38	39	39	42	41	40	35
NIRV recommended maximum noise level															
Day	52	52	52	52	52	-	52	52	52	52	52	52	-	52	52
Evening	44	44	44	44	45	45	44	44	44	44	44	45	45	44	44
Night	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38

... Level exceeds RMNL

Based on modelling conducted, the effective noise level at the closest residential receivers to the site have been predicted and shown in Table 7 of the report, duplicated below:

Table 8.16 Noise modelling results, predicted operational noise levels, dBA (SLR, 2017)

Scenario	Residential dwelling	
	10 Bragg Street	16 Walker Crescent
1. Current operations	39	41
2. Access road to the north	39	41
RMNL (-3 dB for multiple industries)		
Day	49	49
Evening	41	41
Saturday 1300h-12200h	42	42
Sunday 0700h-2200h	42	42
Night	35	35

Note: No adjustments for noise character have been applied.

This reveals that compliance is achieved for both operational scenarios for both day and evening operations at 10 Bragg Street in addition to 16 Walker Street, the residence immediately behind 10 Bragg Street).

The dominant source of noise to the residential locations was from the two front end loaders located near the green waste mulcher and recycled waste facility. The proposed bin truck movements on the north road were the next dominant source in this proposed scenario.
The reason for the dominance of the front end loaders is due mainly to their closer proximity to the residences and the reduced shielding.

When the landfill cell becomes filled and the mobile plant become more elevated, then noise from these sources will contribute more and the overall noise level from the site will increase however it is not predicted to extend beyond the existing 250m buffer for an operating waste transfer station.

Refer to Appendices C and D of the SLR report for noise contour plots for both scenarios modelled, replicated below.

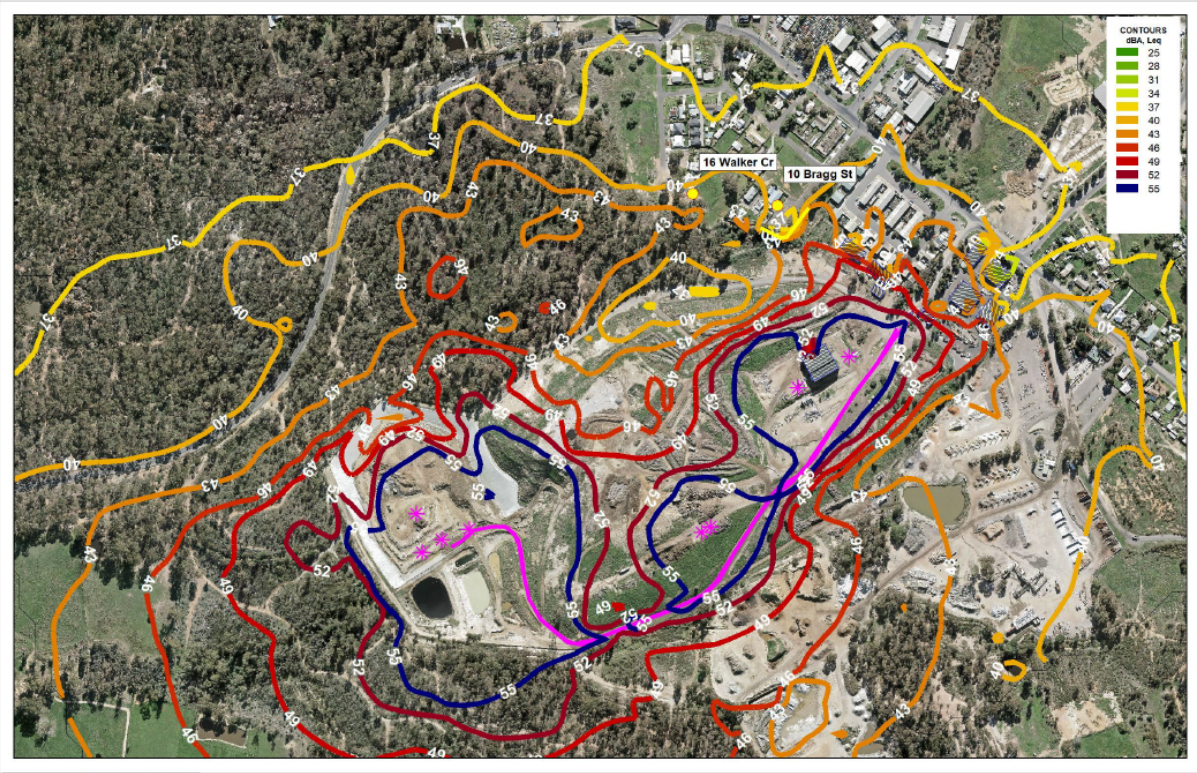


Figure 8.10 Current Landfill operation (SLR, 2017)

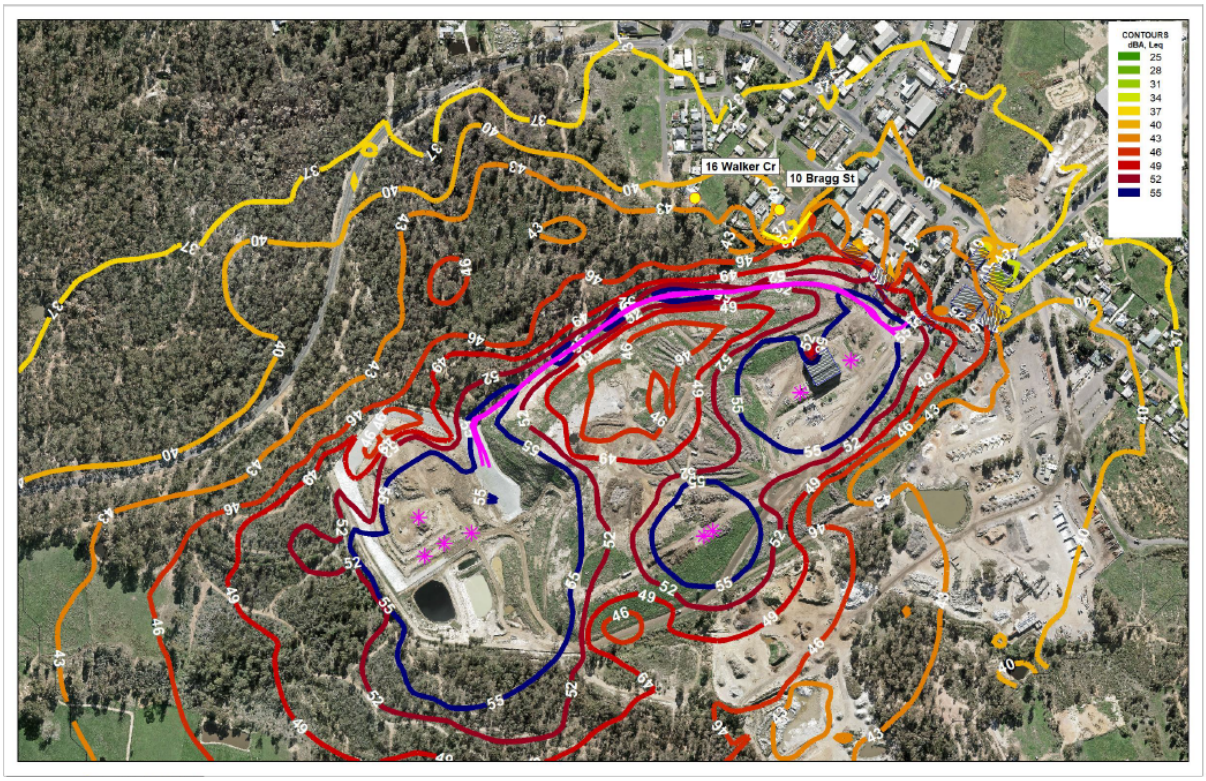


Figure 8.11 Current Landfill operation – Using Northern Road (SLR, 2017)

These reveal that the noise levels are within the maximum noise levels within the majority of the Landfill BPEM buffer, in particular at the nearest sensitive residential receptors to the north.

The predicted results indicate that there is no margin for tonal or impulsive adjustments of the noise from current operations. These adjustments would be either +2 or +5 dB depending on their loudness. These adjustments would typically apply to reversing beepers, tail gate bangs and crashes, empty bin trucks driving over speed humps, and the green waste mulcher.

8.4.4 Auditor's opinion on the adequacy, quality and completeness

The Auditor details the following issues identified during the review of the report:

- Buffer – the impact of the landfill operations were to the nearest sensitive receptor rather than to all potential receptors within the Landfill BPEM buffer. Reference to the modelled contour maps provides an assessment of the noise contours within the buffer.
- Future risk – the proposed future site activities have not been considered in the assessment, however it is acknowledged that the location of the future infrastructure is not currently known.
- Worst case scenario/upset conditions – the assessment did not specifically consider worst case scenario, such as elevation of onsite plant when the filling of the site, however it is not expected that this would significantly extend beyond the nominal buffer of 250m an operating transfer station.

8.4.5 Current risk

SLR (2017) conclude that noise emissions have been predicted to comply with the respective daytime and evening noise limits for the site.

8.4.5.1 Mitigation measures

- Green waste mulcher – As this piece of equipment was not included in the noise assessment it is recommended that either the noise from the green waste mulcher be less than 110 dBA sound power level, (or ~82 dBA sound pressure level at 10m away) to not exceed the RMNL at the residences, or the green waste mulcher must be either located further away from the residences, or enclosed or substantially shielded; and
- Broadband reversing alarms be used on the mobile plant on the site, and that speed humps not be used on the north road if this is used for access to the landfill cell

8.4.5.2 Monitoring

No recommendations regarding monitoring has been made by the assessor.

9. BUFFER ASSESSMENT

9.1 Risk findings – existing and proposed activities

Based on the assessments conducted, the following details the likely risks posed to any existing or proposed developments within the standard 500 metre buffer distance established in the Landfill BPEM guidelines for putrescible landfills. The Transfer station separation distance is also considered.

9.1.1 Landfill Gas

The risk of LFG migration, under existing and proposed developments within 250 m of the landfill is considered low while between 250 – 500 m as very low. AECOM (2019) evaluated the risk of LFG migration to the areas within the Landfill BPEM buffer in relation to adopted receptor groups and pathways from each Cell to those receptor groups and provided risk scores for designated areas across the Landfill BPEM buffer. Three control areas were identified based on risk scores (greater than 6 and less than 15), see Figure F8A in Appendix A of the AECOM report. The assessed risk scores designate the management practices and control measures required (refer to *Table 8.4*) and the control areas designate the planning controls required (refer to *Table 8.7*).

9.1.2 Dust

The assessment (SLR, 2019) concluded that the potential for dust and particulate matter impacts at the nearest sensitive receptors is negligible under existing and proposed activities. The Auditor considers that the risk of dust impacts to be low.

9.1.3 Odour

CEE (2019) found that the residential land (sensitive receptors) to the north and east as well as farming zoned land to the west under existing site activities are within the 4 OU, that is likely to experience elevated odour levels. This was confirmed by a community survey. The risk of odour impacts within the buffer area is therefore considered by the Auditor to be high.

The ongoing risk of odour from the proposed onsite activities, FOGO and mulching, has not been modelled. It is likely that odour from these activities, currently significant sources of OU/s, as per *Table 8.13*, will continue to generate similar OU contours as currently, in particular to the north, east (FOGO) and to the west (mulching). However, the final Transfer Station location has not been determined and so difficult to model.

The Auditor considers that an odour modelling exercise should be undertaken as part of the assessment of the final location of onsite operations in the aftercare period to assess the risks to sensitive receptors at proposed locations.

9.1.4 Noise

SLR (2017) conclude that noise emissions have been predicted to comply with the respective daytime and evening noise limits for the site based on existing conditions. The Auditor considers the risk to be low. Proposed activities in the future were not assessed.

9.2 Risk findings - reasonable worst case

The following provides an assessment of the likely direction and extent of any landfill gas subsurface migration and amenity impacts that may be generated in the event of a reasonable worst case scenario, such as an abnormal weather event or failure of a landfill operations risk mitigation measure.

9.2.1 Landfill gas

Under assumed upset conditions, the assessment of risk scores remains the same as normal operations for existing and proposed site activities. Figure 8A provides the risk scores within the Landfill BPEM buffer. The risk scores are higher closer to the landfill boundary, ie closer to the source, with the level of risk reducing as the distance to the landfill boundary increases.

9.2.2 Odour

Under a number of upset conditions, the 4 OU generally extends beyond the Landfill BPEM buffer to the north and west of the site. The risk of odour impacts within the buffer area is therefore considered by the Auditor to be high.

9.2.3 Dust

For the assessment of upset conditions for both existing and proposed operations, modelling predicts compliance at sensitive receptors. The Auditor considers that the risk of dust impacts to be low.

9.2.4 Noise

No upset conditions were assessed as part of the assessment.

9.3 Proposed Buffer

Based on the assessment reports, the following proposed buffer distances are detailed as follows:

9.3.1 Landfill gas

AECOM do not recommend any reduction to the current Landfill BPEM buffer applying to the site, however based on an assessment of risk, has identified areas that will require management measures and planning controls with remaining areas not requiring any measures and/or controls, in order to allow for new land use and development. Refer to Figure 8A Appendix A of the AECOM report.

9.3.2 Odour

CEE (2019) recommend that based on the findings of the community survey and the odour modelling results, it is considered that there can be no reduction in the Landfill BPEM buffer to the west, north and east of the facility. A minor reduction in the buffer zone (500 m buffer), by about 50 to 100 m, could be acceptable to the south of the facility. This is based on the wind patterns and topographic conditions resulting in less frequent transport of odour to the south of the landfill.

No change to the buffer around the Transfer Station (250 m) is recommended.

9.3.3 Dust

With regard to the current Landfill BPEM buffer, there is the potential for the buffer distance to be reduced, potentially to 200 m, that is the location of the highest concentrations reported close to the maximum for PM10 (sensitive receptor to the east).

9.3.4 Noise

The assessor did not assess the potential for a reduction in the separation distances. However, the modelled contours (Appendix C (Predicted noise from current operations) and Appendix D (Predicted noise from proposed operations using North Road) in the SLR Report) suggest that there is the potential to reduce the buffer distance.

9.3.5 Recommended buffer

The Auditor has considered the Landfill BPEM buffer and note that development within the landfill has already taken place. Ongoing development within the Landfill BPEM buffer and the planning controls associated with those is the purpose of this audit.

The odour assessment modelling results reveal elevated odour levels are likely to be experienced by sensitive receptors within the buffer, both under normal and upset conditions, however as the land is zoned to allow such development and that development has already taken place for many years, it is difficult to limit ongoing development.

Although the odour assessment suggests that a minor reduction in the buffer zone could be acceptable to the south of the site, based on the landfill gas assessment it is recommended that the Landfill BPEM buffer remain as 500 m, with the implementation of mitigation measures and monitoring as detailed in the following sections. The Transfer Station separation distance of 250m is also recommended to remain as is.

Measurement of the buffer distance for current conditions should be from the active and closed cells, for this site from the site boundary in current and future conditions.

The Auditor considers that an odour modelling exercise should be undertaken as part of the assessment of the final location of onsite operations in the aftercare period to assess the risks to sensitive receptors at proposed locations.

9.4 Risk management and monitoring

Based on the assessment reports, the following risk management measures and monitoring are recommended:

9.4.1 Mitigation measures

The following appropriate landfill operations risk mitigation measures are recommended to be adopted by any future developments within the standard 500 m buffer distance considering the likely direction and extent of any subsurface landfill gas migration or amenity impacts.

9.4.1.1 Landfill Gas

The Assessor has recommended the following landfill measures in addition to development controls be implemented:

Landfill Management

- The main measure to continue at the site is the LFG extraction system to extract LFG and minimise potential pressure building up minimising the risk of LFG lateral migration. This is anticipated to continue at the site until LFG concentrations are reduced to levels that would pose no risk of offsite migration at harmful levels.
- In addition to install and maintain the final capping at the site such that vertical migration is limited and the LFG extraction system is as efficient as possible. In the event of LFG extraction failure, consider additional measures such as passive vent/trench for Cells 3A and 3B and Cell 5.

Development controls

- Building control measures – These are gas protection measures used to mitigate landfill gas risk according to gas protection scores. Table 14 of the AECOM report details the building control measures proposed for buildings (by building type) within the buffer in control areas classified as CS2. There are no building control measures for a control area classified as CS1, so, currently for any development greater than 250m from the site. Due to ongoing monitoring, the characteristic site situation may change based on the results of the monitoring.
- Requirement for specific LFG monitoring during construction, road/service maintenance works to protect onsite workers from potential LFG risks.

9.4.1.2 Odour

Landfill Operational

No mitigation measure recommendations were made by the assessor. The Auditor recommends that current measures continue to be implemented at the site.

The Auditor considers that an odour modelling exercise should be undertaken as part of the assessment of the final location of onsite operations in the aftercare period to assess the risks to sensitive receptors at proposed locations.

Development controls

No recommendations are made.

9.4.1.3 Dust

SLR (2019) has suggested a number management practices to minimise dust emissions, refer to Section 9.1 of the report. The previous audit (ERM, 2017) detailed a number of mitigation measures undertaken to minimise dust, including spraying unsealed road surfaces, dusty loads, stockpiles with water if required, revegetation of unvegetated areas, and relocating of mulching of green waste. City of Greater Bendigo should consider those management practices recommended by the Assessor and includes these in their site procedures if considered appropriate.

9.4.1.4 Noise

The Assessor has recommended the following measures be implemented:

- Green waste mulcher – As this piece of equipment was not included in the noise assessment it is recommended that either the noise from the green waste mulcher be less than 110 dBA sound power level, (or ~82 dBA sound pressure level at 10m away) to not exceed the RMNL at the residences, or the green waste mulcher must be either located further away from the residences, or enclosed or substantially shielded; and
- Broadband reversing alarms be used on the mobile plant on the site, and that speed humps not be used on the north road if this is used for access to the landfill cell.

9.4.2 Monitoring

The following recommendations regarding ongoing monitoring are made based on the Assessor recommendations as well as the Auditor's. The Auditor has recommended that the current monitoring requirements for the site detailed in the current verified EMP remain and be re-assessed when the site EMP is being updated and/or the site Aftercare Management Plan is being prepared/updated. Additional monitoring requirements are detailed below:

9.4.2.1 LFG

The following recommendations are made:

- Specifically for control area 2, it is recommended that a number of new LFG monitoring bores be installed to provide an early warning of the migration of LFG to allow for landfill operations to review existing management practices and control measures for effectiveness and for City of Greater Bendigo to respond with appropriate development controls, if any;
- Update the site Environmental Management Plan to include additional LFG monitoring bores required to be monitored, in addition to contingency events should LFG be encountered at levels that present a greater risk than previously assessed.

9.4.2.2 Odour

No monitoring recommendations were made by the assessor. The Auditor recommends current odour monitoring continue to be implemented at the site.

9.4.2.3 Dust

With regard to ongoing monitoring, SLR(2019) have stated that due to the very small number of complaints, and the negligible off-site impacts being predicted at the nearest sensitive receptors, no instrument-based air quality monitoring programs are recommended. Rather regular site inspections for visible dust emissions should be undertaken with complaints appropriately addressed. These are already in place at the site in the site verified EMP (AECOM, 2017).

9.4.2.4 Noise

No monitoring recommendations were made by the assessor.

10. AUDIT FINDINGS

The auditor has reviewed a number of assessments undertaken to identify and assess the environmental risks associated with current and future proposed site operations. Based on the risk assessments undertaken by others, the auditor has determined an appropriate buffer distance by assessing the likely extent of potentially uncontrolled subsurface landfill gas and amenity impacts in upset or abnormal conditions (e.g. a failure of landfill design or management or abnormal weather conditions) migrating from the site during operational and aftercare scenarios.

The audit findings are summarised in the table below:

Table 10 Audit Findings

Audit Objectives	Summary of Audit Findings
Review landfill gas risk assessments and amenity risks (in particular odour, dust and noise) to determine the likely risks posed to any existing or proposed developments within the standard 500 metre buffer distance established in the Landfill BPEM guidelines for putrescible waste landfills	**Subsurface Landfill Gas** The risk assessment considered analysis of existing monitoring data and desk top analysis of various potential preferential pathways, and determined that the risk to receptors within the nominal landfill buffer of 500 metres due to landfill gas migration under existing and proposed developments is considered to be low within 250 m of the landfill and very low between 250 – 500 m. Commensurate with the current risk profile and in anticipation of any potential changes in the future risk, three levels of control (control areas) have been recommended within the existing buffer distance for new developments and to protect existing developments. **Odour** Odour emission sampling of the existing operations identified the main sources of odour emissions are from the landfill tipping face (40%), green/food waste transfer facility (organics shed) (20%) and green waste mulch area (15%). Modelling indicates that sensitive receptors to the north and east of the site, as well as farming zoned land to the west, within the 500 metre buffer are likely to experience elevated odour levels from these current sources. Odour modelling indicated that areas to the south and south west were unlikely to be affected. Validation of the modelling results was not undertaken according to European Standard 'EN16841-2-2016: determination of odour in ambient air by using field inspection – Part 2: Plume method', or a suitable equivalent by the air quality consultant. This standard requires field validation to be undertaken by a person with a calibrated nose at various field meteorological conditions and at various potential positional patterns in the predicted plume footprint. To strictly comply with this standard it would require rapid deployment of appropriately trained persons in odour detection with permission to enter private property and buildings within the plume footprint. Without right of access and trained persons immediately available, it was deemed that strict compliance would not be practicable for a rural small landfill where the surrounding area is largely developed thus limiting movement of trained odour detectors. However the odour consultant did undertake an informal survey of residents in the predicted plume footprint and presented this anecdotal field evidence of validation of the plume. While this is not a

Audit Objectives	Summary of Audit Findings
	categorical survey it does suggest some odour impact has historically occurred off-site as a result of current on-site activities. Without this validation work, it is assumed the modelling results are conservative and potentially overestimate the extent of impact. The odour from the future aftercare onsite activities (i.e. no operational landfill), is expected to be sourced from the continued operation of the food and organics transfer station and green waste storage and mulching area. In addition it has been advised by Council that the food and green transfer operation will now occur outside the shed on the concrete slab west of the building and shed will be used to transfer putrescible waste. These future sources have only been recent advised and therefore have not been considered in the odour modelling or in isolation from the landfill source (post closure). Considering the contribution of these activities to the overall odour emission source, it is likely that odour from these activities will continue to generate potential odour impacts. **Noise** The risk from noise emissions have been predicted to comply with the respective daytime and evening noise limits for the site based on existing conditions. Proposed activities in the future were not assessed, however they were not predicted to intensify and therefore are unlikely to significantly alter the current noise impact findings. **Dust and Particulates** The risk from dust and particulate matter impacts at the nearest sensitive receptors is negligible under existing and proposed activities.
Assess the likely direction and extent of any landfill gas subsurface migration and amenity impacts that may be generated in the event of a reasonable worst case scenario, such as an abnormal weather event or failure of a landfill operations risk mitigation measure	For landfill gas, under assumed upset conditions, the assessment of risk scores for current normal operations and proposed site activities remains the same. Figure 8A of the AECOM report provides the risk scores within the Landfill BPEM buffer. The risk scores are higher closer to the landfill boundary, i.e. closer to the source, with the level of risk reducing as the distance to the landfill boundary increases. For odour, under a number of upset conditions, the 4 OU contour of likely odour impacts, generally extends beyond the Landfill BPEM buffer to the north and west of the site. The modelling extends beyond the Transfer Station buffer of 250 m in all directions, although the modelling has not been field validated. For dust, the assessment of upset conditions for both existing and proposed operations predicts compliance at sensitive receptors. For noise, no upset conditions were assessed as part of the assessment.
Recommended Buffer	The default amenity buffers applied to these land uses include: ■ 500 metre buffer from the edges of the current cell (Cell 5); ■ 250 metres buffer from the green/food waste transfer station building and the observed green waste processing area; and, ■ 100 metres from general refuse transfer station.

Audit Objectives	Summary of Audit Findings
	The landfill will close in the near future leaving the food/green waste facility and the green waste mulching as ongoing activities in the medium term future. The public general waste transfer station will move to a hard stand area to immediately adjacent and south west of the off-site Eaglehawk Eco-Centre near the entrance. The odour assessment modelling results identify potential elevated odour concentrations are likely to be experienced by sensitive receptors within the buffer areas to the north east of the site (south of Violet Street) during the operation of the landfill, green waste mulching and food/green waste transfer station operation, both under normal and upset conditions. After the closure of the landfill, the green waste mulching and food/green waste transfer station will continue to be a significant odour sources during the landfill aftercare period. In addition the future use scenario will see the food/green move outdoors and putrescible be stored in the shed prior to transfer. Considering the results of the odour assessment and the limited survey of the surrounding receptors, the auditor cannot justify any reduction of the existing default buffers during current or future operations. It is noted the current existing green/food waste transfer buffer extends over the majority of properties south of Violet Street. The Auditor therefore recommends that appropriate planning controls be implemented within the default amenity buffer distance for a transfer station (i.e. 250 metres) to reduce intensification of sensitive uses until such time as the odour impacts are removed due to closure of the transfer station (food and green and putrescible), or a reassessment of odour impacts post closure of the landfill, demonstrates that odour impacts are reduced such that the amenity buffer can be reduced (refer to recommendation 1912-R2). The reassessment is to include revised modelling and a field validation program using a method based on ‘European Standard EN16841-2-2016: Determination of odour in ambient air by using field inspection – Part 2: Plume method’, adapted for Australian conditions, and subject to endorsement by an EPA appointed Environmental Auditor (refer to recommendation 1912-R1). No change is proposed to the 500 metre landfill amenity buffer (measured from the edge of the active cell). The only properties likely to be impacted based on odour modelling results and within the 500 metre buffer are south of Violet Street, which are also within the 250 metre food and green transfer station buffer. Given the imminent closure of the landfill active cell (approximately 2 years) and continued operation of the food and green facility, to avoid the administrative burden of implementing planning controls based on two overlapping buffers, it is deemed appropriate that the food/green transfer station buffer is adequate to address both sources now and into the future and thus no further action is recommended for the properties within the 500 metre landfill amenity buffer.

Audit Objectives	Summary of Audit Findings
	Notwithstanding the recommendations above related to non-landfill activities, considering the subsurface landfill gas risk assessment, it is the auditor's opinion that the 500 metre Landfill BPEM buffer related to subsurface landfill gas migration remain with the implementation of the specified mitigation measures for future developments and additional off-site monitoring as recommended (1912-R3 and 1912-R4)).
Determine any appropriate on-site landfill operations risk mitigation measures or measures to be adopted by any future developments within the standard 500 metre buffer distance considering the likely direction and extent of any subsurface landfill gas migration or amenity impacts.	As discussed above, it is recommended that the green waste mulching area and/or the food/green/putrescible waste transfer area be relocated by Council on-site to be more than 250 metres (nominal transfer station buffer distance) from any sensitive receptors where practicable. Where relocation is not practicable, then additional odour mitigation measures (e.g. ventilated structures, automated closing doors) are to be considered by Council and modelled to demonstrate reduced odour impacts to sensitive receptors within the 250 metre transfer station buffer distance (refer to recommendation 1912-R1). There has been no change made to the standard 500 metre landfill buffer distance, however, considering the presence of existing developments within the buffer and the potential for new developments, the recommendations are made within the standard 500 metre landfill gas buffer (1912-R3 and 1912-R4).
Determine, and recommend (if necessary), appropriate landfill management measures required if a change in the buffer distance is made as a result of this audit	No change in the buffer distance has been proposed therefore no additional recommendations have been made against this objective.

11. AUDITOR RECOMMENDATIONS

All audit recommendations are included in the table below which includes:

- a unique reference identification number consisting of year, month and the recommendation number to allow tracking of the recommendation through subsequent audits; and
- a description of the recommendation.

Table 11.1 Auditor Recommendations

ID	Recommendations
1912-R1	*The City of Greater Bendigo is to relocate on-site (where practicable) the greenwaste mulching area and the food/green transfer facility to maintain 250 metre separation to existing sensitive receptors and areas zoned for residential development. Where this is not practicable, Council are to investigate the installation of odour mitigation measures. In both instances (relocation or additional mitigation measures) the Council is required to undertake odour, noise and dust modelling to demonstrate the ongoing operation of the onsite organic waste operations will not pose an unacceptable risk to sensitive receptors in the aftercare period.*
1912–R2	*Planning controls are recommended for land within the 250 metre default amenity buffer for transfer station to limit intensification of sensitive uses within the buffer.*
1912-R3	*For land within 500 metres of waste placement on the site (effectively the boundary of the site), it is recommended that a Design and Development Overlay (DDO) be developed to ensure the following controls are implemented for new developments:* ■ *For new developments within Control Area 1 (residential) and Control Area 3 (industrial) (typically within approximately 250m of landfill) the developer will require LFG mitigation measures (membrane barriers and/or slab venting) to be incorporated into the design of the new structures as per British Standard 8485:2015.* ■ *Risk in Control Area 2 (existing and new residential developments) (typically 250-500m from landfill) will be addressed by increased monitoring by the landfill operator (Council). The Council planning department is obligated to obtain advice from the landfill operator (Council) on current LFG risk when considering new developments in this area.*
1912-R4	*Specifically for control area 2, it is recommended that underground services and a number of new LFG monitoring bores be installed and monitored by the City of Greater Bendigo, as per Figure F9 of the AECOM report, to provide an early warning of the migration of LFG off-site. These additional bores and monitoring requirements are to be incorporated into the next revision of the current Environmental Monitoring Program for the site and verified by an EPA appointed Environmental Auditor as required by the current licence condition LI_L1. The EMP is to include contingency actions should LFG be encountered at levels that present a greater level of risk (as determined using British Standard 8485 (as amended)) as previously assessed in control area 2.*

12. STATEMENT OF LIMITATIONS

This environmental audit report ("Report") has been prepared in accordance with Part IXD of the Environmental Protection Act 1970. The Report presents the Auditor's opinion on:

- potential risks posed by the Eaglehawk Landfill ("the site") to the relevant beneficial uses of the land, noise and air environment within 500 metres of the site;
- An appropriate buffer distance by assessing the likely extent of potentially uncontrolled subsurface landfill gas and amenity impacts in upset or abnormal conditions (e.g. a failure of landfill design or management or abnormal weather conditions) migrating from the site.

The scope of this audit is limited to the specific scope as defined in this Report and the Auditor makes no other statement, warranty, comment in respect of the environmental conditions, risks or otherwise in relation to the site beyond this defined scope in this Report.

This Report:

- has been prepared by Paul Fridell of Environmental Resources Management Australia Pty Ltd ("ERM") and his team as indicated in the appropriate sections of this Report for the City of Greater Bendigo (client);
- may be used and relied on by the City of Greater Bendigo (client);
- may be used by and provided to EPA for the purpose of meeting statutory obligations in accordance with the relevant sections of the *Environment Protection Act 1970;*
- may be provided to other third parties but such third parties' use of or reliance on the Report is at their sole risk because of, and subject to, the uncertainties associated with this audit as noted in the following paragraphs and in this Report; and
- may only be used for the purpose as stated in Section 1 of the Report (and must not be used for any other purpose).

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by ERM and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by the Auditor, his team and ERM in connection with preparing this Report were undertaken in accordance with current professional practice and by reference to relevant environmental regulatory authority and industry standards in accordance with section 53V of the *Environment Protection Act 1970*.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by the Auditor, his team and ERM when undertaking services and preparing the Report ("Assumptions"), as specified throughout this Report.

In preparing the audit, the Auditor and his team have considered the available information in reaching a conclusion regarding the level of risk to beneficial uses; and this has required consideration of information that in some cases was not capable of being verified within the time scale of the audit, is of a nature that does not allow it to be quantified, or had a high degree of uncertainty with respect to magnitude of effect and likelihood of effect. In some cases information was not available and was not able to be obtained within the time scale of the audit. Where information was not available or was uncertain, the Auditor has made a judgment regarding the situation that, in his opinion, is likely to apply. The assessment of risk requires a consideration of the magnitude of effect and the likelihood that an effect of that magnitude will occur; this is inherently uncertain and depends on the significance that persons place on the effect, and other persons may reach an alternative conclusion as to the level of risk that applies.

Because of these factors, caution is required in the use of the information in this Report, and persons referring to, relying on or using in any way the conclusions of this Report should make their own assessment and seek independent advice from persons with the relevant expertise in the field to satisfy themselves that they understand the underlying information and level of uncertainty, and the level of risk that they would assign, which may differ from the level of risk that the Auditor has assigned.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation of this Report and are relevant until such time as the site conditions or relevant legislations changes, at which time, ERM expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

The Auditor and ERM have prepared this Report on the basis of information provided by SLR Consulting Australia Pty Ltd, Consulting Environmental Engineers and AECOM Pty Ltd; the Auditor and his team have carried out checks of samples of this information in accordance with industry practice; this checking did not extend to all information; and the Auditor and ERM have not carried out field work to independently verify the information. Where the Auditor considered that the level of uncertainty or errors in the information could lead to a significantly different finding, the Auditor has made recommendations for further work to be carried out in the future to resolve the uncertainty. Because of this, there is uncertainty in the conclusions regarding the risk to beneficial uses and the Auditor and ERM expressly disclaim responsibility for errors that have arisen because of uncertainty in the information.

This Report should be read in full and no excerpts are taken to be representative of the findings of this Report.

APPENDIX A FIGURES

Figure 1: Site Locality Plan

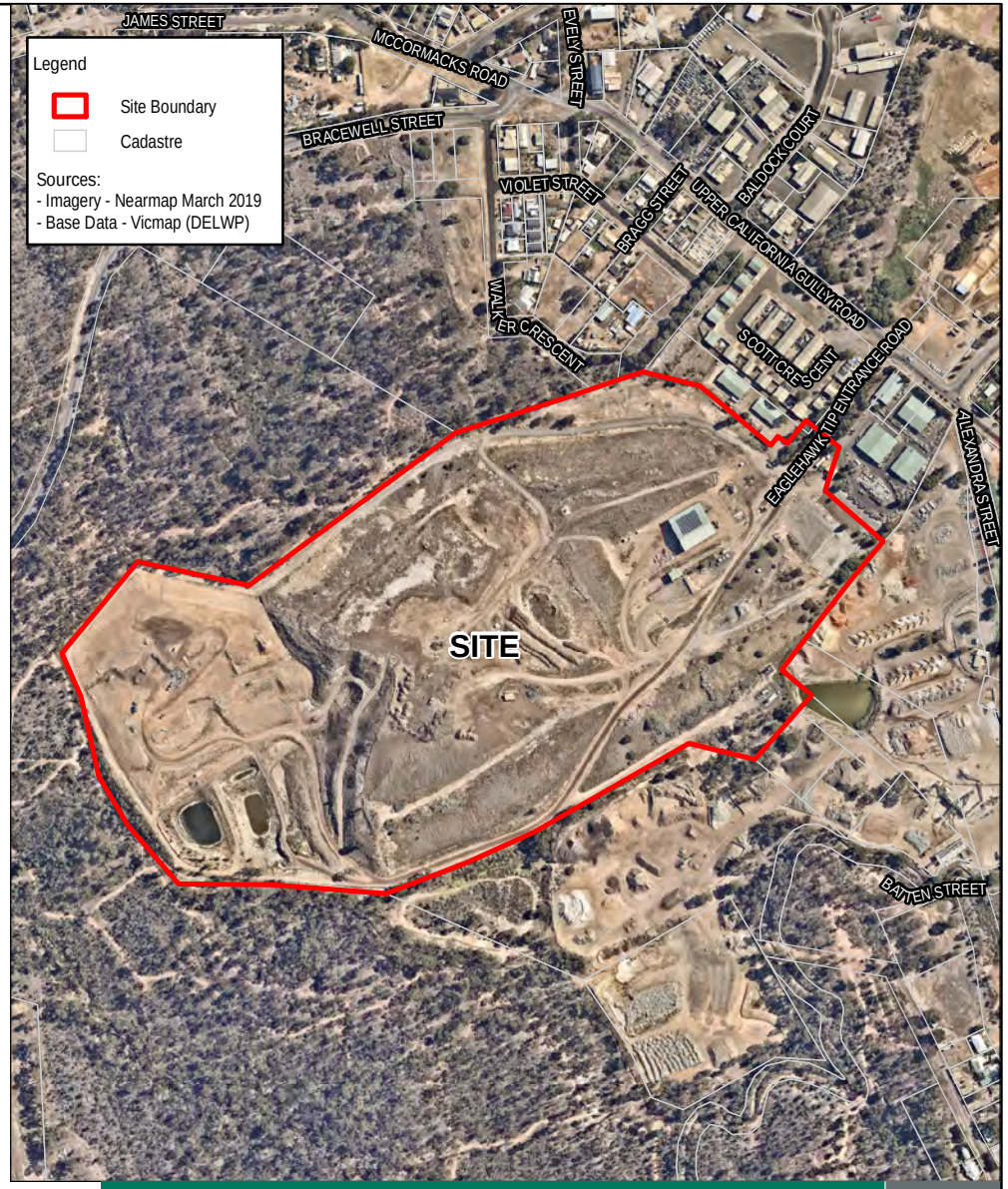
Figure 2a Site Features Plan – current Operations

Figure 2b Site Features Plan – Proposed Operations

Figure 3 Planning Scheme Zoning and Overlay Map

Figure 4a Separation Distances – Current Operations

Figure 4b Separation Distances – Proposed Operations



Site Location

F1

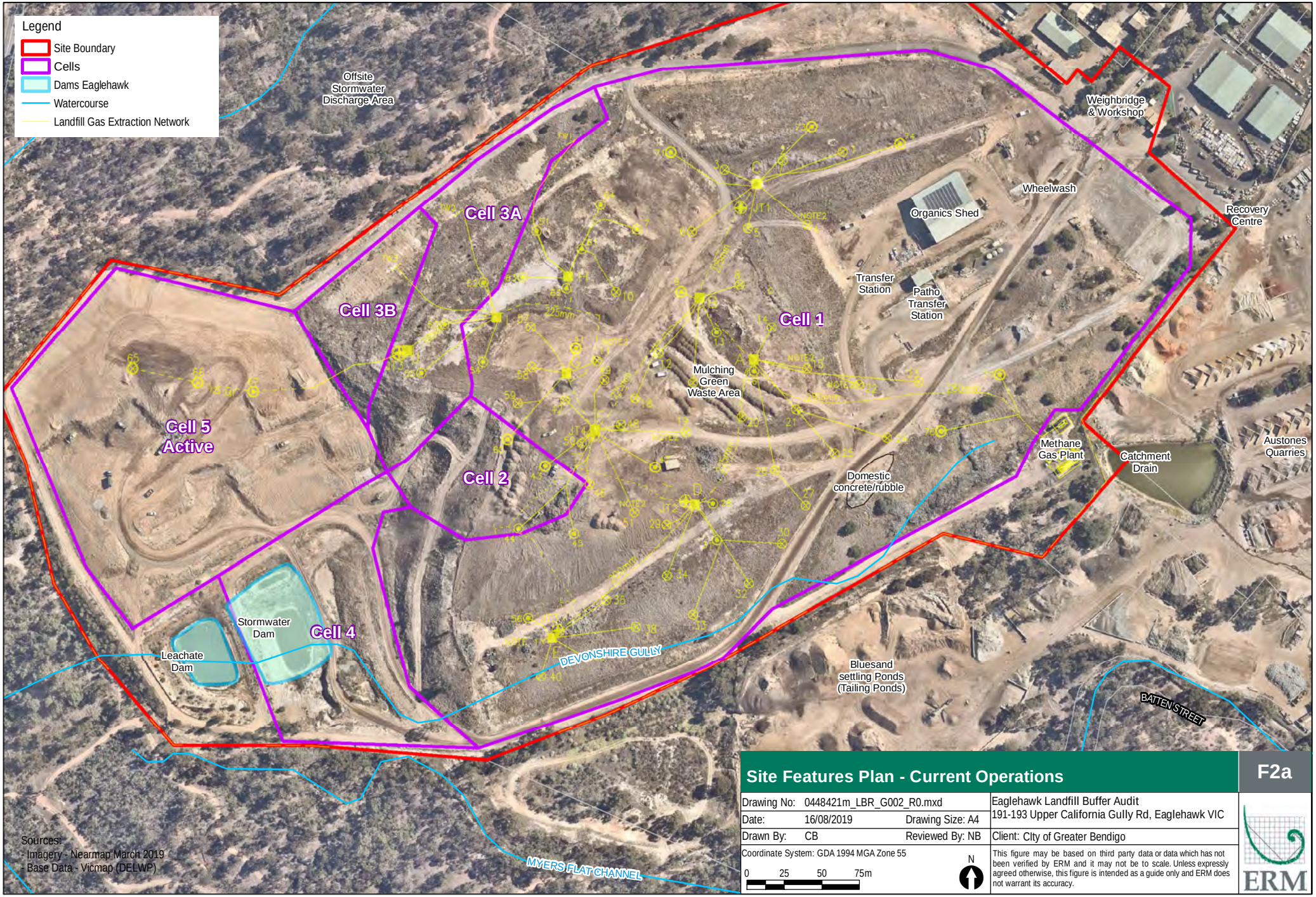
Drawing No:	0448421m_LBR_G001_R0.mxd		Eaglehawk Landfill Buffer Audit 191- 193 Upper California Gully Rd, Eaglehawk VIC
Date:	16/08/2019	Drawing Size: A4	
Drawn By:	CB	Reviewed By: NB	Client: City of Greater Bendigo

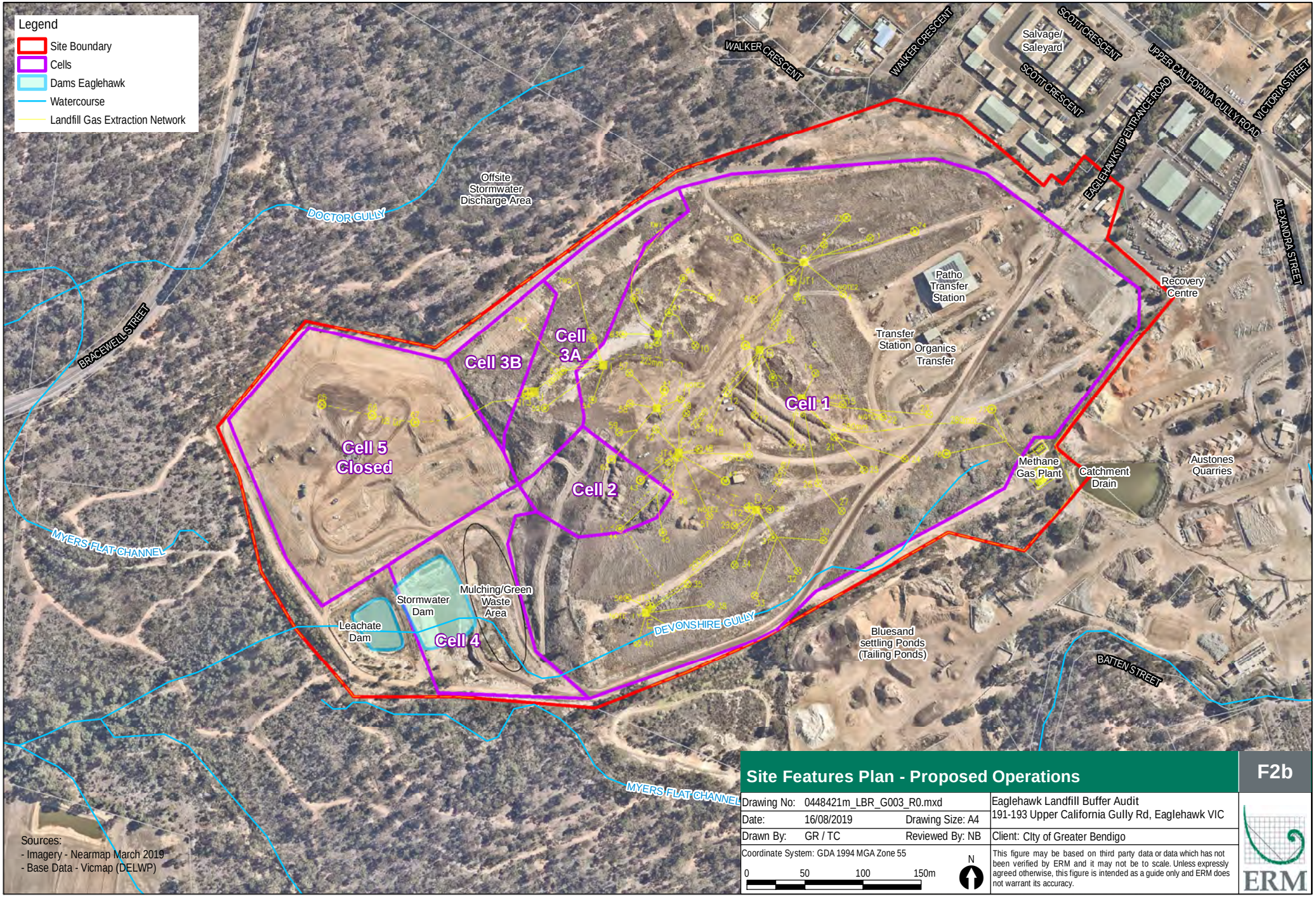
Coordinate System: GDA 1994 MGA Zone 55

0 100 200m

N

ERM


Legend
Site Boundary
Cells
Dams Eaglehawk
Watercourse
Landfill Gas Extraction Network
Offsite Stormwater Discharge Area
Weighbridge & Workshop
Wheelwash
Organics Shed
Recovery Centre
Transfer Station
Patho Transfer Station
Cell 3A
Cell 3B
Cell 1
Cell 5 Active
Cell 2
Cell 4
Mulching Green Waste Area
Methane Gas Plant
Catchment Drain
Austones Quarries
Domestic concrete/rubble
Stormwater Dam
Leachate Dam
DEVONSHIRE GULLY
Bluesand settling Ponds (Tailing Ponds)
BATTEN STREET
MYERS FLAT CHANNEL
Sources:
- Imagery - Nearmap March 2019
- Base Data - Vicmap (DELWP)
Site Features Plan - Current Operations
F2a
Drawing No: 0448421m_LBR_G002_R0.mxd
Date: 16/08/2019
Drawing Size: A4
Drawn By: CB
Reviewed By: NB
Coordinate System: GDA 1994 MGA Zone 55
0 25 50 75m
N
Eaglehawk Landfill Buffer Audit
191-193 Upper California Gully Rd, Eaglehawk VIC
Client: Clty of Greater Bendigo
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.
ERM



Site Features Plan - Proposed Operations

F2b

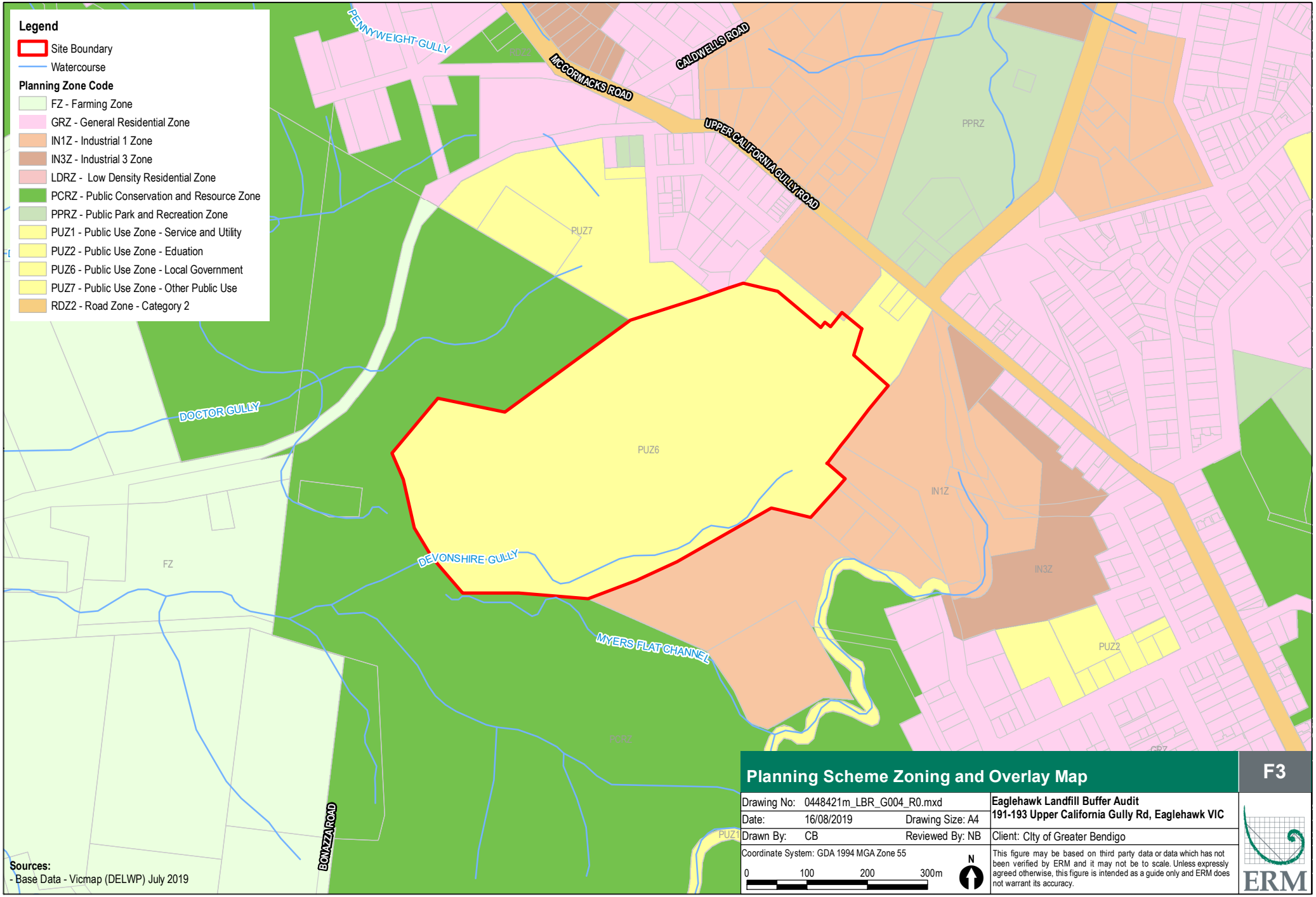
Drawing No:	0448421m_LBR_G003_R0.mxd		Eaglehawk Landfill Buffer Audit 191-193 Upper California Gully Rd, Eaglehawk VIC
Date:	16/08/2019	Drawing Size: A4	
Drawn By:	GR / TC	Reviewed By: NB	Client: Clty of Greater Bendigo

Coordinate System: GDA 1994 MGA Zone 55

0 50 100 150m

N

ERM


Legend
Site Boundary
Watercourse
Planning Zone Code
FZ - Farming Zone
GRZ - General Residential Zone
IN1Z - Industrial 1 Zone
IN3Z - Industrial 3 Zone
LDRZ - Low Density Residential Zone
PCRZ - Public Conservation and Resource Zone
PPRZ - Public Park and Recreation Zone
PUZ1 - Public Use Zone - Service and Utility
PUZ2 - Public Use Zone - Eduation
PUZ6 - Public Use Zone - Local Government
PUZ7 - Public Use Zone - Other Public Use
RDZ2 - Road Zone - Category 2
PENNYWEIGHT GULLY
RDZ2
MCCORMACKS ROAD
CALDWELLS ROAD
UPPER CALIFORNIA GULLY ROAD
PPRZ
PUZ7
DOCTOR GULLY
PUZ6
IN1Z
IN3Z
FZ
DEVONSHIRE GULLY
MYERS FLAT CHANNEL
PUZ2
PCRZ
GRZ
BONAZZA ROAD
PUZ1
Sources:
- Base Data - Vicmap (DELWP) July 2019
Planning Scheme Zoning and Overlay Map
F3
Drawing No: 0448421m_LBR_G004_R0.mxd
Date: 16/08/2019
Drawing Size: A4
Drawn By: CB
Reviewed By: NB
Coordinate System: GDA 1994 MGA Zone 55
0 100 200 300m
N
Eaglehawk Landfill Buffer Audit
191-193 Upper California Gully Rd, Eaglehawk VIC
Client: Clty of Greater Bendigo
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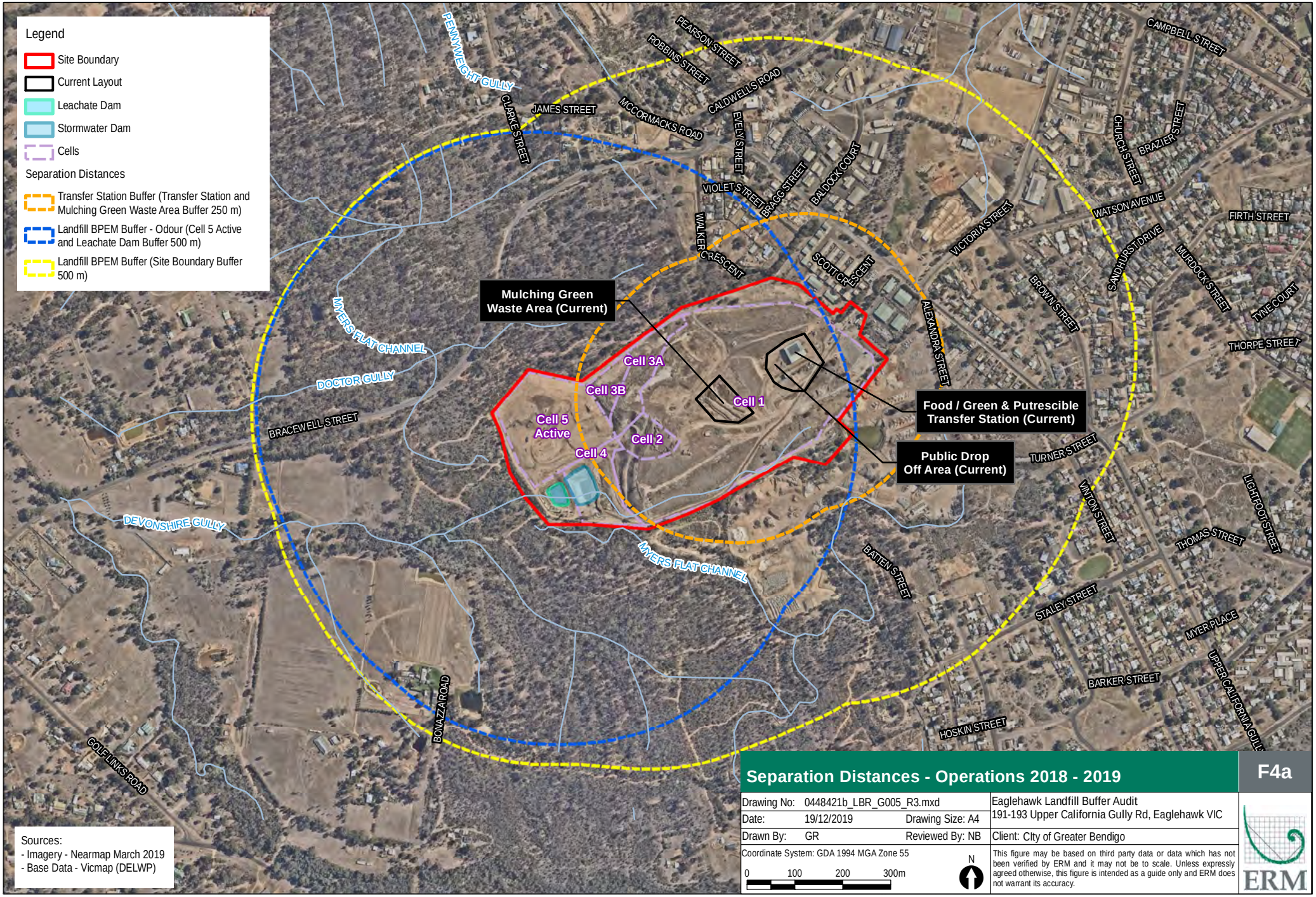
ERM


Legend
Site Boundary
Current Layout
Leachate Dam
Stormwater Dam
Cells
Separation Distances
Transfer Station Buffer (Transfer Station and Mulching Green Waste Area Buffer 250 m)
Landfill BPEM Buffer - Odour (Cell 5 Active and Leachate Dam Buffer 500 m)
Landfill BPEM Buffer (Site Boundary Buffer 500 m)
Mulching Green Waste Area (Current)
Food / Green & Putrescible Transfer Station (Current)
Public Drop Off Area (Current)
Cell 1
Cell 2
Cell 3A
Cell 3B
Cell 4
Cell 5 Active
PENNYWEIGHT GULLY
PEARSON STREET
ROBBINS STREET
CAMPBELL STREET
CALDWELLS ROAD
JAMES STREET
McCORMACKS ROAD
CLARKE STREET
EVELYN STREET
CHURCH STREET
BRAZIER STREET
VIOLET STREET
BRAGG STREET
BALDOCK COURT
WATSON AVENUE
FIRTH STREET
WALKER CRESCENT
SCOTT CRESCENT
VICTORIA STREET
SANDHURST DRIVE
MURDOCK STREET
TYNE COURT
BROWN STREET
ALEXANDRA STREET
THORPE STREET
MYERS FLAT CHANNEL
DOCTOR GULLY
BRACEWELL STREET
TURNER STREET
VINTON STREET
LIGHTFOOT STREET
THOMAS STREET
DEVONSHIRE GULLY
MYERS FLAT CHANNEL
BATTEN STREET
STALEY STREET
MYER PLACE
BARKER STREET
UPPER CALIFORNIA GULLY
BONAZZA ROAD
GOLF LINKS ROAD
HOSKIN STREET
Sources:
- Imagery - Nearmap March 2019
- Base Data - Vicmap (DELWP)
Separation Distances - Operations 2018 - 2019
F4a
Drawing No: 0448421b_LBR_G005_R3.mxd
Date: 19/12/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: NB
Coordinate System: GDA 1994 MGA Zone 55
0 100 200 300m
N
Eaglehawk Landfill Buffer Audit
191-193 Upper California Gully Rd, Eaglehawk VIC
Client: Clty of Greater Bendigo
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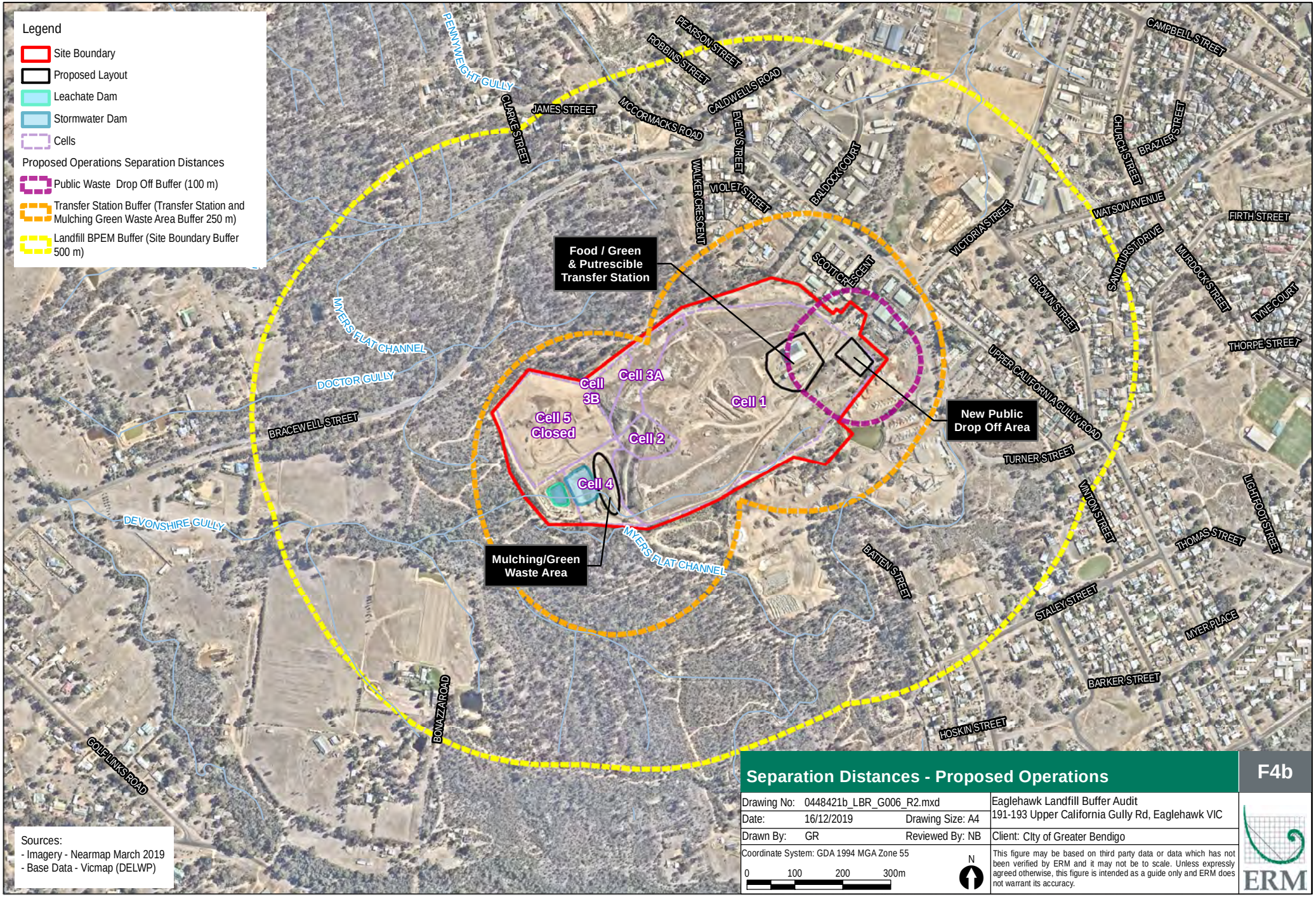
ERM


Legend
Site Boundary
Proposed Layout
Leachate Dam
Stormwater Dam
Cells
Proposed Operations Separation Distances
Public Waste Drop Off Buffer (100 m)
Transfer Station Buffer (Transfer Station and Mulching Green Waste Area Buffer 250 m)
Landfill BPEM Buffer (Site Boundary Buffer 500 m)
Food / Green & Putrescible Transfer Station
New Public Drop Off Area
Mulching/Green Waste Area
Cell 1
Cell 2
Cell 3A
Cell 3B
Cell 4
Cell 5 Closed
PENNYWEIGHT GULLY
CLARKE STREET
JAMES STREET
PEARSON STREET
ROBBINS STREET
CALDWELLS ROAD
McCORMACKS ROAD
EVELYN STREET
WALKER CRESCENT
VIOLET STREET
BALDOCK COURT
CAMPBELL STREET
CHURCH STREET
BRAZIER STREET
WATSON AVENUE
FIRTH STREET
VICTORIA STREET
SCOTT CRESCENT
SANDHURST DRIVE
MURDOCK STREET
TYNE COURT
BROWN STREET
THORPE STREET
UPPER CALIFORNIA GULLY ROAD
TURNER STREET
VINTON STREET
LIGHTFOOT STREET
THOMAS STREET
BATTEN STREET
STALEY STREET
MYER PLACE
BARKER STREET
HOSKIN STREET
MYERS FLAT CHANNEL
DOCTOR GULLY
BRACEWELL STREET
DEVONSHIRE GULLY
BONAZZA ROAD
GOLF LINKS ROAD
Sources:
- Imagery - Nearmap March 2019
- Base Data - Vicmap (DELWP)
Separation Distances - Proposed Operations
F4b
Drawing No: 0448421b_LBR_G006_R2.mxd
Date: 16/12/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: NB
Coordinate System: GDA 1994 MGA Zone 55
0 100 200 300m
N
Eaglehawk Landfill Buffer Audit
191-193 Upper California Gully Rd, Eaglehawk VIC
Client: Clty of Greater Bendigo
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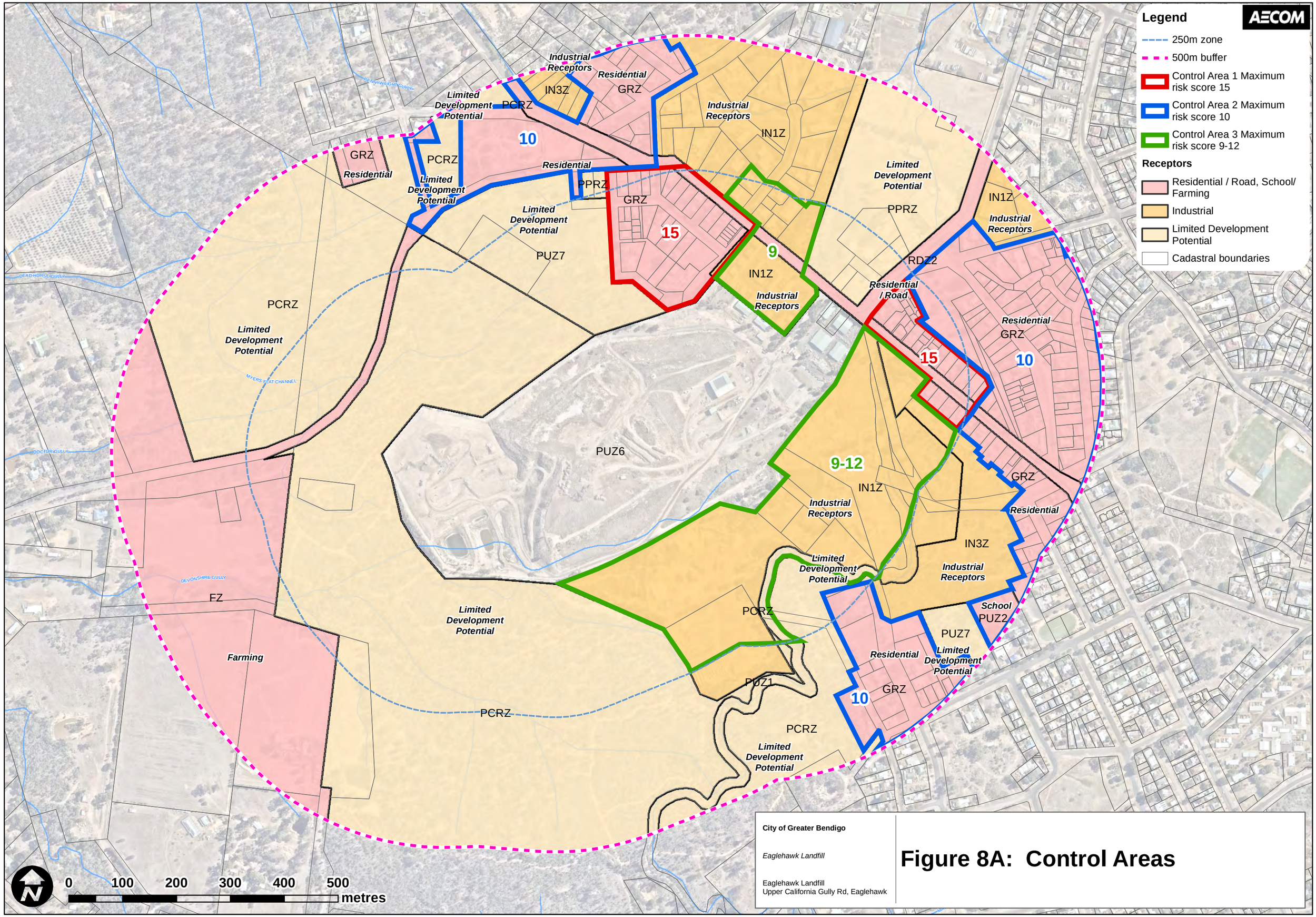
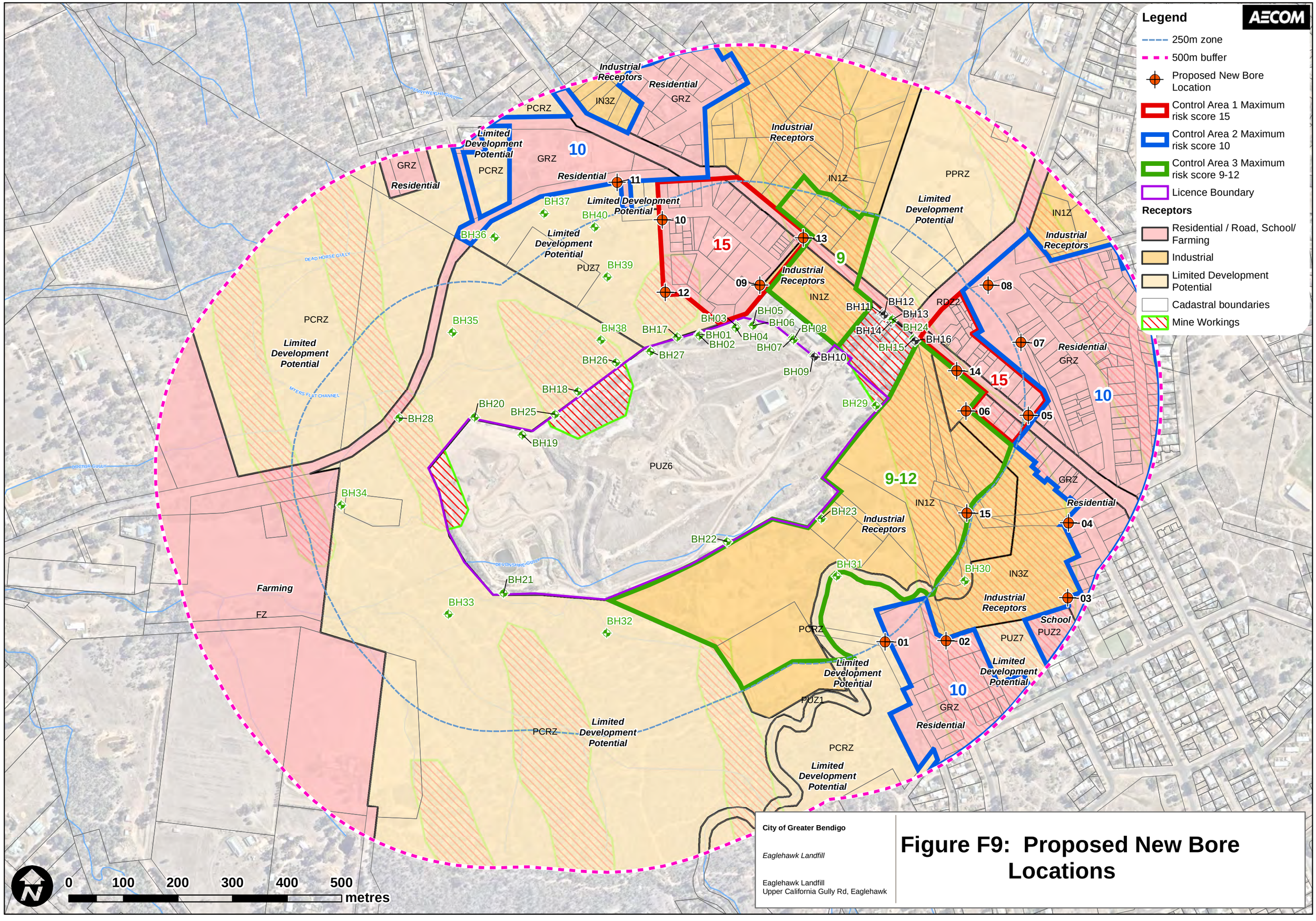
ERM


Legend
AECOM
250m zone
500m buffer
Control Area 1 Maximum risk score 15
Control Area 2 Maximum risk score 10
Control Area 3 Maximum risk score 9-12
Receptors
Residential / Road, School/ Farming
Industrial
Limited Development Potential
Cadastral boundaries
Industrial Receptors
Residential
IN3Z
GRZ
Limited Development Potential
PCRZ
10
IN1Z
PPRZ
15
9
PUZ7
RDZ2
Residential / Road
9-12
PUZ6
School
PUZ2
PUZ1
FZ
Farming
DEVONSHIRE GULLY
MYERS FLAT CHANNEL
DEAD HORSE GULLY
DOCTOR GULLY
0
100
200
300
400
500
metres
City of Greater Bendigo
Eaglehawk Landfill
Eaglehawk Landfill
Upper California Gully Rd, Eaglehawk
Figure 8A: Control Areas


Legend
AECOM
250m zone
500m buffer
Proposed New Bore Location
Control Area 1 Maximum risk score 15
Control Area 2 Maximum risk score 10
Control Area 3 Maximum risk score 9-12
Licence Boundary
Receptors
Residential / Road, School/ Farming
Industrial
Limited Development Potential
Cadastral boundaries
Mine Workings
Industrial Receptors
Residential
Limited Development Potential
PCRZ
GRZ
IN3Z
IN1Z
PPRZ
PUZ7
PUZ6
PUZ2
PUZ1
FZ
RDZ2
School
Farming
10
15
9
9-12
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
BH01
BH02
BH03
BH04
BH05
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BH17
BH18
BH19
BH20
BH21
BH22
BH23
BH24
BH25
BH26
BH27
BH28
BH29
BH30
BH31
BH32
BH33
BH34
BH35
BH36
BH37
BH38
BH39
BH40
DEAD HORSE GULLY
MYERS FLAT CHANNEL
DOCTOR GULLY
DEVONSHIRE GULLY
0
100
200
300
400
500
metres
City of Greater Bendigo
Eaglehawk Landfill
Eaglehawk Landfill
Upper California Gully Rd, Eaglehawk
Figure F9: Proposed New Bore Locations

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