



LANDFILL GAS MANAGEMENT PLAN

ALLAWUNA FARM LANDFILL

MARCH 2015



THE LEADER IN RESOURCE RECOVERY



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1. Introduction

The following categories of information will be addressed in the Allawuna Farm Landfill Gas Management Plan.

- a description of the bore monitoring network and the frequency of the monitoring;
- detail of the landfill gas extraction system and measures to regularly check that it is functioning at an optimal level, including management, maintenance and the provision for future installation and upgrade;
- an outline of the responsible SITA personnel for the implementation of the gas management plan.
- predictions of landfill gas generation rates.

2. Objective

To provide a basis for management and monitoring of landfill gas at the site to minimise migration and emissions of landfill gas and ensure that there is no risk of harm to human health or the surrounding environment.

3. Scope

Landfill Gas (LFG) is a combination of gases, which are formed during the degradation of putrescible wastes. The major constituents consist of methane (CH₄) and carbon dioxide (CO₂), with trace amounts of other volatile organic compounds (VOCs). The Plan focuses on the monitoring and reporting of CH₄ and CO₂ emissions associated with landfill gas.

4. Site Description and Engineering

SITA Australia is the leading producer of renewable energy from landfill gas in Australia. SITA operates a series of landfills throughout Australia. All SITA Landfills are equipped with landfill gas extraction and treatment systems. The majority of landfills also utilise landfill gas as a fuel source in engines to produce much needed renewable energy. SITA's Landfill Lucas Heights in Sydney is the largest such facility in Australia with approximately 15 modular landfill gas engines currently installed. SITA's expertise in landfill gas management will also be employed at the proposed Allawuna Farm Landfill facility.

The proposed landfill is located towards the western edge of the Shire of York, approximately 20km west of the town of York. The site is located on the southern side of the Great Southern Highway approximately 80km by road from Perth.

Allawuna Farm has a total area of approximately 1,500ha of which 75% has been cleared for farming. It is currently leased out for broad acre cropping. The proposed landfill footprint is located centrally to the site in an area currently under crop. The total landfill footprint comprises approximately 36 ha or 2.4 % of the total site area.

Department of Regulation (DER) Guidelines recommend a buffer to sensitive uses varying from 150 m in rural areas to 500 m in urbanised areas. The siting of the footprint achieves a 600m buffer to the common boundary with the property to the east. This 600m buffer is contained wholly within the Allawuna Farm property.

The nearest residence is located 1.9 km north-east of the landfill and is fully screened from the landfill by the landform and intervening remnant bush land. The next closest residence is located 2.4 km from the proposed landfill footprint. These very substantial buffer distances mean that subsurface landfill gas migration will not present a risk to local residencies. A location plan of these residences (receptors) is attached as **Appendix 8**.

The landfill will be constructed in a series of cells in phases over several years.

The landfill cells will be composite lined consisting of a compacted clayey base and sidewalls, a geosynthetic clay liner (GCL), 2.0 mm HDPE geomembrane layer and a geotextile cushion. The leachate collection layer will sit on top of the geotextile cushion. The leachate collection layer consists of a 300 mm layer of drainage aggregate which surrounds a network of perforated HDPE pipe work. The base of each cell is graded to direct leachate captured within the leachate drainage layer to a leachate extraction sump for extraction. Leachate levels will be maintained within the landfill in accordance with the facilities permit. The lining system will be constructed using a detailed quality assurance program supervised by an independent third party consultant.

When waste disposal operations cease in any cell (filled to capacity), a final landfill cap will be placed over the waste. The final cap will be designed to meet the EPA Victoria Best Practice Environmental Management (BPEM) guidelines.

These combined engineering measures are designed to significantly impede the migration of gas into the surrounding environment and minimize the potential for subsurface landfill gas migration or uncontrolled emissions of landfill gas from the facility.

5. Landfill Gas Collection System

5.1. Landfill Gas Collection Network

The collection system will be a network of vertical wells (and horizontal wells if required) drawing gas from capped and active landfill cells. The system will be designed to allow a negative pressure to be maintained in order to provide a balanced active gas extraction rate across all wells. Typically the extraction wells at the perimeter are under low vacuum. This not only prevents air ingress into the system, but also encourages an inward flow of LFG from the perimeter towards the center of the landfill. The vertical wells have approximately 40-50 m spacing (approximately 25 m radius of influence) as per **Appendix 4**, and will be drilled to approximately 75% of the depth of the in-filled waste. The wells are nominally 600 mm in diameter and fitted with 160 mm slotted HDPE pipes. If horizontal wells are used active cells are spaced at approximately 40 m apart on every second lift.

The landfill gas collection pipe work will be installed to allow condensate to be collected within either pumped condensate collection vessels or barometric condensate drop out traps. Pipe work falls will be designed to accommodate condensate management. The fall of the pipe work will also be designed in order to accommodate the potential for long term settlement. Collected condensate will be treated and disposed of in the same way as leachate.

The landfill gas collection network will be installed as soon as practicable but no later than six months following the completion of waste filling in any given area. New extraction wells or replacement wells will also be installed based on the evaluation of methane and extraction performance. Leachate sumps will also be connected to the system to control potential fugitive emissions from this source.

Initially landfill gas will be collected and combusted/treated through flaring. Given the proposed waste inputs and nature of waste being disposed of at Allawuna it is envisaged that the initial phase of the landfill gas extraction system and flare will be installed sometime during the first 5 years of operation. Flaring will be undertaken using a modular flaring unit which will be sized in accordance with the predicted landfill gas generation rates. It is envisaged that initially a flare capable of treating approximately 100-500m³/hr will be installed. As landfill quantities increase this will be upgraded to a 1,000-2,000m³/hr flare and so on until peak landfill gas generation rates are achieved. Once it becomes economically feasible and subject to approval the flare will be replaced by a landfill gas engine which will produce power for either use on site or export to the local/national power grid.

The main purpose of the flaring unit will be to convert methane into carbon dioxide and manage odours. The flares will be fitted with flame fail detection units, flash back arrestors and SMS texting, so that in the event of break down site staff are notified immediately. The flare will be designed and constructed in accordance with relevant Australian Standards and codes associated with landfill gas. Combustion emissions monitoring will be carried out in accordance with the facilities permit and best practice guidelines. Typical emissions limits values for the flares and engines which may be utilised at the facility are shown in **Appendix 6**.

The landfill gas extraction wells, collection system and flare will be designed and installed by third party expert contractors. These requirements are derived from SITA's Standard Operation Procedure: *SOP038 Landfill Gas Management, Gas Control Plan* (**Appendix 7**).

5.2. Monitoring Regime

5.2.1. Landfill Gas Monitoring

Each landfill gas extraction well will be monitored on a fortnightly basis in order to determine the quality of the gas which the well is producing. The gas will be analysed with a hand held sampler in order to determine the quantity of methane, carbon dioxide and oxygen which the well is producing. Depending on the results of the monitoring suction to the well will be adjusted in order to ensure that the landfill gas is being extracted at the optimum rate. Over extraction of landfill gas from the well could result in oxygen being drawn in to the waste mass resulting in rapid heating of the waste and a potential sub-surface fire. Under extraction of landfill gas from the well could potentially result in fugitive landfill gas emissions and potential odours. Each landfill gas extraction point will be numbered in order that data collected can be logged for future reference.

All landfill gas balancing will be carried out by a suitably qualified landfill gas technician.

The landfill gas extraction system will be visually inspected on a daily basis as part of the sites routine daily inspection checklist. The daily inspection will ensure that the system is working at full capacity with no pipe blockages, damaged pipe work, any localized landfill gas odours and that condensate collection systems are functioning.

A hand held portable specialized landfill gas analyser incorporating non-dispersive infrared absorption for methane and carbon dioxide, with an electrochemical cell for oxygen will be used. A series of in line filters on the portal will prevent ingress of contaminants into the analyser ensuring accurate readings. The analyser will be calibrated at intervals in accordance with the manufacturer's recommendations.

Each well station will also be fitted with an appropriately sized orifice plate so that the flow (m³/hr) of gas from each well can also be calculated. The suction pressure applied to each well will also be recorded.

5.2.2. Surface Emissions Monitoring

Surface emissions of landfill gas will be measured across the landfill surface at various locations including final capped areas, temporary capped areas, adjacent to penetrations in the cap and in the general working area. An Inspectra Laser Methane Gas analyser or equivalent will be used to identify surface emissions of gas. The analyser will be capable of identifying methane emissions as low as 1 part per million (0.01% Methane). Surface emissions monitoring will be carried out on a bi-annual basis. Any areas with unacceptably high levels of emissions will be remediated as soon as practicable. Remediation of such areas could involve applying additional suction to gas wells in the vicinity, placement of additional cover materials, repair of any damaged areas of final cap, or installation of additional landfill gas extraction infrastructure.

Surface emissions monitoring will be carried out by a trained landfill gas technician.

5.2.3. Subsurface Monitoring of Landfill Gas

Given the substantial buffer lands which the proposed Allawuna Landfill provides (2.4km to the nearest residence) there is no risk of subsurface gas migration causing any safety issues at local residencies. Location of these residences (receptors) is provided in **Appendix 8**.

It is proposed to install two monitoring points at an appropriate location in between the landfill footprint and site office area and additional monitoring points on either side of the landfill footprint in order to measure long term back ground levels of ground gases for future reference purposes. These points will be monitored on a monthly basis initially. Monitoring will commence prior to deposition of any waste within the landfill. Should any landfill gas be detected in these monitoring points additional monitoring points may be installed and monitoring frequencies increased in order to more accurately assess and remediate the issue.

5.2.4. Monitoring of Onsite Buildings

Monitoring of site buildings will be completed monthly. Should detectable methane and carbon dioxide levels exceed trigger levels then the offices will be evacuated in accordance with the facilities emergency response plan.

5.3. *Estimation of Landfill Gas Generation Rates*

GasSim modelling has been order to estimate landfill gas generation rates for the proposed Allawuna Landfill. This has been referenced in Golder document no. 147645033-010-L. The model shows gas generation rates peaking at around 2041 at approximately 1,661m³/hr. The GasSim report is included in **Appendix 5** of this report. Given SITA's experience and expertise at managing landfill gas we would expect at least 95% of this gas to be captured and treated by the facilities landfill gas management system during the operational life of the facility and close to 100% capture following final capping of the facility.

The GasSim model will be reviewed and updated on a periodic basis following the commencement of waste acceptance at the facility. By reviewing and updating the model regularly SITA will be able to carefully plan the installation of additional landfill gas collection infrastructure in order to maximise gas capture rates.

6. Review, Reporting and Actions

6.1. Review

This Plan will be reviewed on an annual basis.

A review of the landfill gas monitoring data will also be conducted annually in the Landfill's Annual Monitoring Review. This will form the basis of any non-conformance reporting to EPA in the Annual Performance Statement (APS). Any changes required by the Plan will be included in the monitoring regime and reported to the appropriate Environmental Auditor with the amended Plan.

6.2. Emergencies and Incident Reporting

Should an emergency arise, the procedures outlined in the site's Emergency Response Plan and SITA's SOP038 Landfill Gas Management, Gas Control Plan (**Appendix 7**) will be engaged.

All complaints or incidents relating to landfill gas management are to be reported in accordance with SITA's Incident Reporting and Corrective Action Procedure (PROC008). A Corrective Action Report (CAR) will be raised to investigate the complaints or incidents and to identify corrective actions.

6.3. Responsible Personnel

The following SITA personnel are responsible for the implementation of this LFG Management Plan:

6.3.1. SITA Personnel

SITA General Manager

- Liaison with executive management of SITA regarding external reporting requirements;
- Liaison with EPA, Third Party Consultants (including Landfill Gas Contractor).

Landfill Site Manager

- Any ancillary site-specific or supplementary liaison with EPA, Independent EPA approved Environmental Auditor, Consultants and Third Party Contractor.

Operations Supervisor

- Coordination of landfill operations.
- Coordination of landfill gas infrastructure works with contractors
- Liaison with Third Party Contractors.

7. Appendices

7.1. Appendix 1 - Typical Proposed Well Head Arrangements



Combined Leachate and Gas Extraction Well Head



Basic Well Head Arrangement

7.2. Appendix 2 - Typical Proposed Flaring Unit Arrangements



Large 2,000m³/hr fully enclosed flaring unit



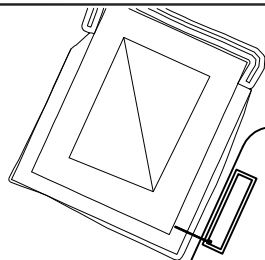
Smaller 500 m³/hr flaring unit

7.3. Appendix 3 - Typical Proposed Well Station Arrangement



7.4. Appendix 4 – Proposed Landfill Gas Extraction Well Locations

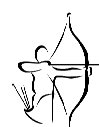
Drawing showing approximate location of landfill gas extraction wells and radii of influence of each well in Cell 1 and 2 (spacing of wells 40m).



PROPOSED LANDFILL
CELL 2

STORMWATER
DAM

12 MARCH 2015



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7.5. Appendix 5 – Gas Sim Model

(source Golder document no. 147645033-010-L).

Table 3: GasSim Model Results

	Year	Model Gas Generated (50 th %ile) (m ³ /hr)	Model Gas Generated (90 th %ile) (m ³ /hr)
Total Bulk Landfill Gas Produced	2020 (Completion of Year 1)	32	36
	2041 (maximum gas production)	1548	1661

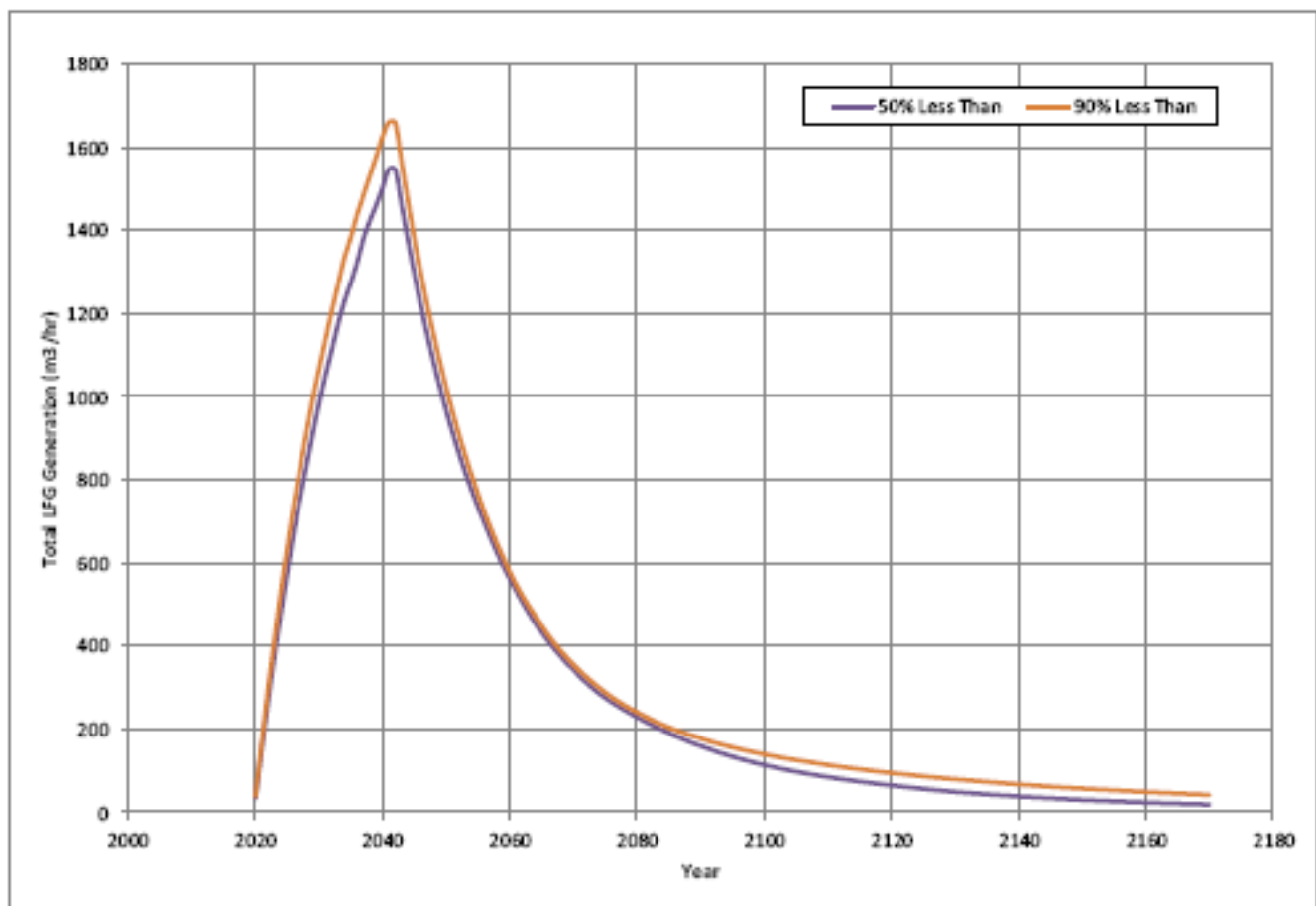


Figure 1: Total Bulk Landfill Gas Generation

7.6. Appendix 6 – Typical Flare and Landfill Gas Utilisation Emission Rates

Location: Landfill Gas Utilisation Plant and/or flare

Volume to be emitted: Approximately 1,500 – 2,500m³/hr at peak landfill gas production

Minimum Discharge Height – 8m

Parameter	Flare Emission Limit Value ^{Note 1,3}	Utilisation Plant Emission Limit Value ^{Note 1,3}
Nitrogen Oxides (NO _x)	150 mg/m ³	500 mg/m ³
CO	50 mg/m ³	650 mg/m ³
Particulates	Not applicable	130 mg/m ³
Total Organic Carbon (TOC)	10 mg/m ³	Not applicable
TA Luft Organics Class I ^(Note 2)	Not applicable	20 mg/m ³ (at mass flows > 0.1 kg/hr)
TA Luft Organics Class II ^(Note 2)	Not applicable	100 mg/m ³ (at mass flows > 2 kg/hr)
TA Luft Organics Class III ^(Note 2)	Not applicable	150 mg/m ³ (at mass flows > 3kg/hr)
Hydrogen Chloride	50 mg/m ³ (at mass flows > 0.3 kg/h)	50 mg/m ³ (at mass flows > 0.3 kg/h)
Hydrogen Fluoride	5 mg/m ³ (at mass flows > 0.05 kg/h)	5 mg/m ³ (at mass flows > 0.05 kg/h)

Note 1: Dry gas referenced to 5% oxygen by volume for utilisation plants and 3% oxygen by volume for flares.

Note 2: In addition to the above individual limits, the sum of the concentrations of Class I, II and III shall not exceed the Class III limits.

Note 3: These emission limit values may be revised with the agreement of the Environment Agency on the basis of the technology employed.

7.7. Appendix 7 - Landfill Gas Control Plan



LANDFILL GAS MANAGEMENT, GAS CONTROL PLAN Standard Operating Procedure - SOP038 (4)

System	Date of Issue:	Document Author	Reviewed	Authorised
EMS	16 Sep 2009	Compliance Officer	Post Collection Manager Date: 01 Sep 2009	System Administrator Date: 15 Sep 2009
Company			Location	Department
SITA Australia West Australian Landfill Services		VIC WA	Hallam Road Landfill Taylors Road Landfill Shale Road Landfill Allawuna Landfill	Infrastructure

1. Purpose

To outline the procedure to be adopted in relation to the installation, operation, maintenance and management of a gas extraction system and gas plant. The gas control plan shall serve as a tool for landfill staff to achieve the objectives with regard to statutory environmental requirements.


2. Scope

This procedure applies to the Taylors Road, Hallam Road, South Cardup and Allawuna Landfills.

3. Procedure

3.1 Gas Extraction System Design

3.1.1 When designing either a new landfill gas system or stage extension, the current and future gas production from the site and the hierarchy below shall be considered. The system implemented shall be chosen by considering factors including the quantity of gas utilised, cost to the site operator and environmental benefit.

	Waste reduction Re-use, recycling or energy recovery Landfill gas energy recovery Landfill gas flaring Landfill gas monitoring
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Extract from 'Decision Making Flow Chart for Managing Greenhouse Gas Emissions from Solid Waste'. Source: EPA Publication 722.

3.1.2 Alternative operating methods which may assist with the control of landfill gas, and the reduction of greenhouse gas, should be considered. Such methods include, but are not limited to, venting gas through compost piles, and mechanical-biological pre-treatment of waste.

3.1.3 The gas contractor will ensure the design of the Gas Extraction System complies with applicable standards.

3.1.4 Subject to accessibility, the gas contractor will ensure optimum coverage of (or distribution of extraction vacuum over) each cell area.

NOTE: The area covered by the extraction system should include the leachate collection sumps and consider the proposed capping design.

3.1.5 The gas contractor will consult the Site Manager with all structures to be developed. A combination of vertical and horizontal gas wells may be used where appropriate.

3.1.6 Where possible, mulched material is to be utilised as a cover layer over intermediate and capped areas to assist with gas oxidation.

3.2 Staging of Gas Extraction System Installation

3.2.1 A landfill gas extraction system, consisting of perimeter wells installed at approximately 50m intervals, must be established and operated at all times in the landfill.

3.2.2 Within 6 months of the completion of each cell, a series of perimeter landfill gas extraction wells must be installed. Each well must be fitted with a valve to regulate gas flow.

3.2.3 The Site Manager will give the gas contractor notice in writing that the gas contractor is required to install Gas Extraction System stage works. Information to be provided to the gas contractor shall include as built closure contours of the cell and top of liner survey.

3.2.4 Design drawing shall be issued by the gas contractor for approval by SITA.

3.3 Gas Extraction System and Gas Plant Construction

3.3.1 Representatives of the gas contractor will be inducted before commencing work on site in accordance with the Contractor and Visitor Control Procedure.

3.3.2 The gas contractor will construct each stage of the Gas Extraction System in accordance with its in-house construction procedure, (eg. EDL-CD-006 for construction by Energy Developments Limited at Taylors Road Landfill).

3.3.3 The gas contractor will construct each stage of the Gas Plant in accordance with relevant laws, in-house construction procedure and good engineering practice.

3.4 Gas Extraction System Operation and Maintenance

3.4.1 The gas contractor will operate and maintain the Gas Extraction System to ensure optimum performance with regard to maximising commercial recovery of landfill gas and minimising off-site landfill gas emissions, including sealing sumps upon connection to the Gas Collection System to prevent odorous emissions while facilitating any further leachate sump monitoring requirements.

3.4.2 The gas contractor shall develop a maintenance and monitoring plan to record the operation of the Gas Extraction System such as gasfield readings, a Gas Plant Maintenance Log and Gas Extraction System Repair Log. Records shall be available for inspection by SITA upon request.

3.4.3 The gas contractor will operate and maintain the Gas Plant in accordance with regulatory compliance.

Regulations specific to Taylors Road:

Treatment and disposal facilities for the landfill gas extraction must, where necessary, be acoustically shielded and must consist of:

- I. blowers located within an enclosed structure
- II. condensate knockout equipment

- III. a conventional candlestick type flare or ground effects flare
- IV. a suitable pipeline allowing for pumping of landfill gas off-site to an EPA approved electricity generation facility.

It must be ensured that the flare:

- I. Is brought into operation as soon as practicable after the rate of extraction of landfill gas from the site is insufficient to prevent gas migration and associated odours resulting from excessive accumulation of gas in the landfill;
- II. The rate of gas flaring is sufficient to minimise migration of landfill gas and associated odour beyond the boundaries of the premises;
- III. Use of the flare ceases immediately after sufficient extraction of landfill gas from the site is available to prevent gas migration and associated odours resulting from the excessive accumulation of gas in the landfill;
- IV. The valve isolating the flare from the landfill gas supply must be kept closed when the flare is not in use; and
- V. The flare is operated smokelessly at all times.

3.4.4 Gas monitoring shall occur in accordance with the site specific environmental monitoring manual.

3.4.5 The requirement for additional gas monitoring bores shall be assessed, and installed where appropriate.

3.4.6 Formal inspection of cap shall occur in accordance with Site Maintenance - Landfills and Compost Facilities.

3.5 Environmental/Occupational Health and Safety and Emergency Response

3.5.1 The gas contractor shall be considered an extended duration gas contractor and must therefore develop and submit to SITA evidence of their management system documentation.

3.5.2 The gas contractor will design the Gas Plant so as to include control systems and a pager system that will:

- allow unattended operation
- alert a duty operator in the event of a plant outage

The gas contractor shall have detailed emergency and outage response Procedures, and have personnel available for emergency assistance at all times.

3.5.3 The gas contractor will investigate any uncontrolled release of gas from the Gas Extraction System, use of the flare, or other uncontrolled events and report as soon as practicable to the Site Manager on the cause, impact and remedial action taken, plus actions to be taken to prevent recurrence.

3.6 Reporting

- 3.6.1 On a monthly basis the gas contractor will prepare and submit to the Site Manager a written report detailing quality of gas, flow rates, vacuum applied to gasfield and number of wells onsite and in operation. If wells are not operating the reasons shall be stated.
- 3.6.2 If necessary, the gas contractor will meet with the Site Manager to discuss Gas Extraction System performance issues and to establish remedial action plans if required.

3.7 Training

The gas contractor will ensure that all construction and operations staff receive adequate training and are suitably qualified to enable them to fulfil their duties. All training shall be documented in accordance with the gas contractor's own management system.

4. Responsibility

SITA Site Manager
The Construction Manager of the Gas Contractor
The Operations Manager of the Gas Contractor

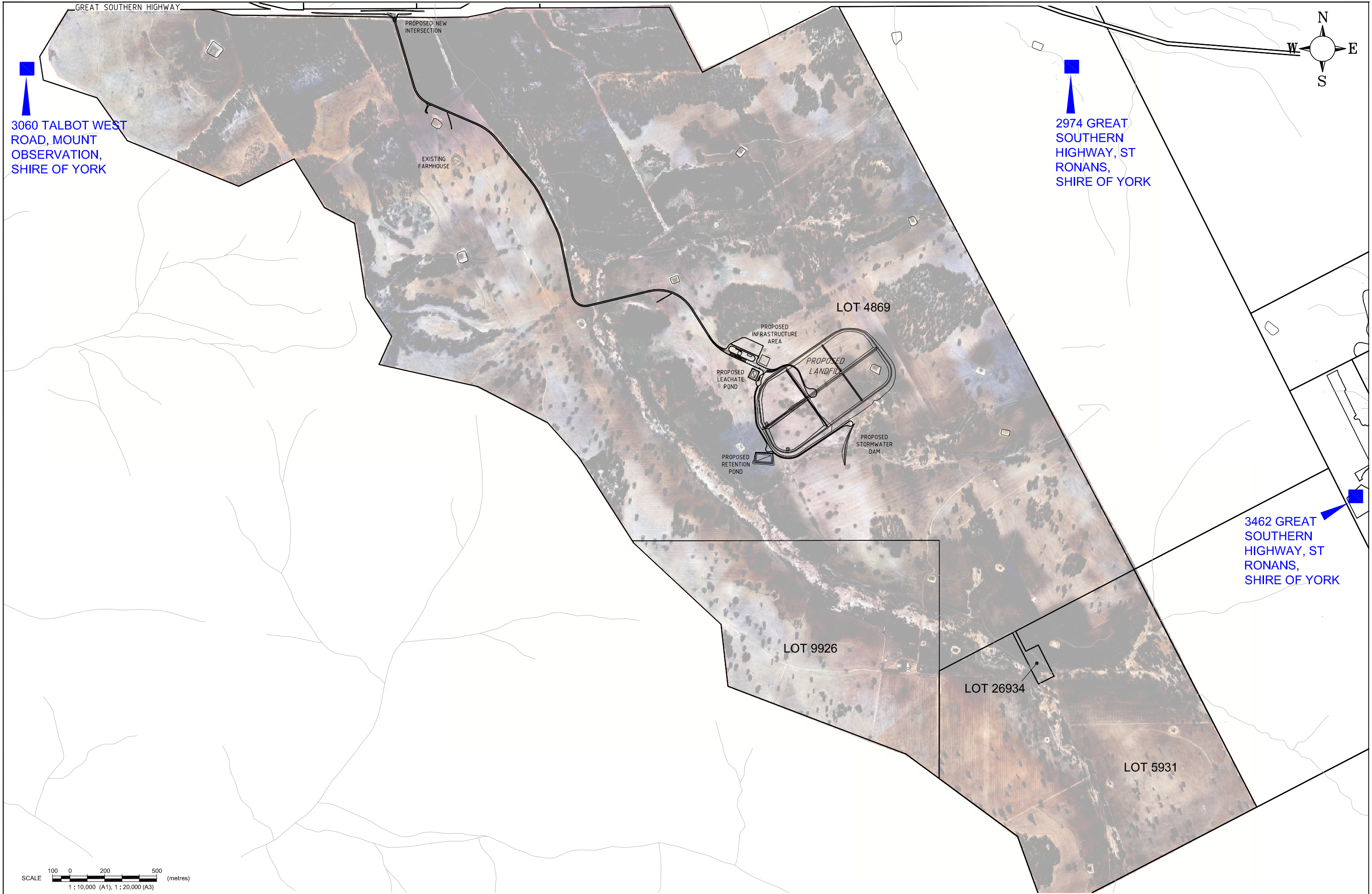
5. References and Associated Documents


- Contractor and Visitor Control Procedure PROC013
- Contractor Agreement FORM034
- Contractor Induction Register REG012
- Construction and Operation Procedures (site specific)
- Design drawings (site specific) The Contractors Management System Documentation (site specific)
- Monthly reports submitted by the Contractor (site specific)
- Preferred Contractors Register REG015
- Site Maintenance - Landfills and Compost Facilities SOP041
- Training Records completed by the contractor (site specific)

6. Key Monitoring Criteria

Type of Monitoring	How Often	Responsibility
Written notice to the gas contractor to commence installation of gas extraction stage works	As occurs	Site Manager
Development and submission of design drawings	As occurs	The Construction Manager of the Gas Contractor
Preparation and submission of a monthly report to SITA	Monthly	The Operations Manager of the Gas Contractor

7.8. Appendix 8 - Location of Residences (Receptors) - Allawuna Farm Landfill



<div><div><div>Bowman and Associates Pty Ltd</div><div>ABN: 22 112 399 514</div><div>Mail: PO Box 2059, Rossmoynne WA 6148 Office: 8/640 Beeliar Drive, Success WA 6164</div><div>Phone: (08) 9414 9670 Web: www.bowmanassociates.com.au</div></div></div>		Client				Location				Drawing Title		
		SITA Australia				Lots 4869, 5931, 9926 & 26934 Great Southern Hwy, Saint Ronans				Site Plan and Receptors		
		Date	Scale	Design By	Drawn By	Project				Drawing Number	Revision	Drawing Size
		04/03/15	1:10,000	B.W.B.	S.B.Y.	Allawuna Farm Landfill				Figure 2	A	A1