FERNVIEW LANDFILL – DECOMMISSIONING AND POST CLOSURE MANAGEMENT PLAN

DRAFT DOCUMENT

The content contained herewith has been compiled by Fernview Environmental Pty Ltd and is based on:

- the document prepared in draft form by Bowman & Associates Pty Ltd titled "*Fernview Landfill - Decommissioning and Post Closure Management Plan"*, Version 1, dated 16 September 2015, submitted on 16 March 2020 to the Department of Water and Environmental Regulation (**DWER**) for review under condition 8-1 of Ministerial Statement 796; and
- Amendments, prepared by Ian Watkins of IW Projects Pty Ltd, requested by DWER following the review under condition 8-1 of Ministerial Statement 796.

This document remains in draft form, and it may be subject to change at any time and without notice.

DOCUMENT CONTROL

VERSION	DATE RELEASED	PREPARED BY	AMENDED BY	APPROVED BY
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ACRONYMS

AHD	Australian Height Datum
AS/NZS	Australian/New Zealand Standard
DWER	Department of Water and Environmental Regulation
EPA	Environment Protection Authority
GPS	Global Positioning System
HELP	Hydraulic Evaluation of Landfill Performance Model
MSW	Municipal Solid Waste
Shire	Shire of Gingin

UNITS OF MEASURE

g/m^2	Gram per Metre Square
ha	Hectare
km	Kilometre
km/hr	Kilometre per Hour
m	Metre
mbgl	Meters Below Ground Level
mm	Millimetre
mg/l	Milligram per Litre
m/s	Metre per Second
°C	Degree Celsius

1 INTRODUCTION

Site closure is an essential final activity in meeting the primary environmental goal of land management and conservation. Proper operation of a landfill should result in efficient remediation, enabling land to be used for other purposes following closure.

Many of the chronic impacts of landfilling occur long after the landfill has closed, and while these can be mitigated against by good design and operation of the landfill, best practice rehabilitation and long-term aftercare of the site will further minimise the potential of any detrimental impacts from the landfill. Best practice for rehabilitation and aftercare is considered very early in the design and operation phase of the landfill and should be in accordance with *Best Practice Guidelines for Siting, Design, Operation and Rehabilitation of Landfills* (Victorian EPA, August 2016).

This Landfill Decommissioning and Post Closure Management Plan sets out the proposed process by which operational landfill areas will be progressively shut down and managed beyond the active life of the landfill.

The term ‘closure’ refers to the process of shutting down the landfill and capping the waste mass. The ‘post-closure’ period refers to the activities after closure in which the site is managed and monitored.

2 ELEMENT/ISSUE

2.1 ASPECT OF THE ENVIRONMENT TO BE PROTECTED

The development of the landfill will require the clearing of 42.5 hectares of vegetation and the excavation of 29 hectares over the life of the landfill. The site closure and rehabilitation of landfills presents specific problems, particularly when the operation of the landfill has a projected lifespan of more than 30 years and landfill emissions continue to be produced after site closure.

The closure of a landfill is intended to protect the environment from the potentially negative impacts of a completed landfill. Conversely, the capping system employed during landfill closure is intended to isolate the waste mass from the environment to ensure controlled stabilisation of waste. The post closure period is the period of site monitoring to gauge the effectiveness of the closure systems employed and to determine when the site no longer has the potential to cause environmental damage.

Landfill gas collection systems are progressively installed into the waste mass as the landfill develops. This is primarily to control odour around the landfill site and reduce greenhouse gas emissions.

Vegetation on the final cap is initially selected to promote rapid root growth and stabilise the newly formed slopes. Once the slopes have been stabilised by the initial vegetation growth, native plants species will be grown to allow the landfill capped surface to blend in to the surrounding landscape.

Ongoing site monitoring and maintenance will be carried out to determine the effectiveness of the capping and gas extraction systems. The ongoing post closure period will continue until the site is deemed to be benign.

The key aspects of the environment that will continue to be protected and monitored after the site closure of the landfill will be groundwater and surface water, air quality, and flora and fauna.

2.2 LEGAL FRAMEWORK

The proposal for the development of a landfill was assessed under Part IV of the *Environmental Protection Act 1986* (see below). In addition to Ministerial Conditions (Statement 796), the Proponent will need to comply with a range of statutory and policy requirements as outlined in Table 1 below.

Table 1: Statutory, policy and other guideline requirements

Agency	Statute/Guideline	Applicability
Department of Water and Environmental Regulation	Environmental Protection Act 1986	Ministerial Statement 796 was issued under Part IV of the Act. Condition 796:7-1 provides the boundaries for clearing operations
Department of Water and Environmental Regulation	Environmental Protection Regulations 1987	Ministerial Statement 796 was issued under Part IV of the Act. Condition 796:7-1 provides the boundaries for clearing operations
Department of Water and Environmental Regulation	Preparing Environmental Management Plans 1996	Draft guidelines for the preparation of Environmental Management Plans submitted in compliance with Ministerial Conditions.
Department of Water and Environmental Regulation	Conservation and Land Management Act 1984	Protect the land situated in the proximity of the landfill and surrounding area
Department of Water and Environmental Regulation	Conservation and Land Management Regulations 2002	Protect the land situated in the proximity of the landfill and surrounding area
Department of Water and Environmental Regulation	Contaminated Sites Act 2003	Identification, recording, management and remediation of contaminated sites
Department of Water and Environmental Regulation	Environmental Protection (Unauthorised Discharges) Regulations 2004	Identification, recording and management of Unauthorised Discharges at a site
Department of Health	Health Act 1911	Laws relating to public health to ensure landfills do not cause an impact to public health
Department of Water and Environmental Regulation	Litter Act 1979	To establish and incorporate management practices in which litter does not affect the environment
Department of Water and Environmental Regulation	Waste Avoidance and Resource Recovery Act 2007	To provide a framework for efficient waste avoidance and resource recovery
EPA Victoria	Siting, Design, Operation & Rehabilitation of Landfills August 2016	Best Practice Environmental Management for closure and rehabilitation of landfills

3 CURRENT STATUS

3.1 THE PROJECT

Fernview Environmental Pty Ltd (Fernview) is proposing to build a regional landfill in the Shire of Gingin. Wannamal Road South is the proposed location for the landfill facility. This location was selected due to its topography, distance from sensitive premises and waterways, geological suitability and depth to groundwater.

3.2 RECEIVING ENVIRONMENT

3.2.1 Landforms and Soils

The proposed area is undulating with a rounded hill present along the centre of the northern boundary. The remainder of the area generally decreases in elevation from the western and northern boundaries with a low point in the southeast. Elevation ranges from approximately 165m Australian Height Datum (AHD) in the south-eastern portion of the area to approximately 220m AHD along the northern and western boundaries. The proposed landfill site will be cut into a hill where the topography shields it from view from most aspects in the surrounding landscape. The surrounding area is sparsely to heavily vegetated with remnant bush and regrowth.

Drilling approximately 1km south of the site shows the stratigraphic succession through to the Leederville Formation and underlying Parmelia Formation. A summary log for bore RG2A is provided in **Table 2**.

Table 2: Summary log for Bore RG2A

<table>
<tr><th>DEPTH (mbgl)*</th><th colspan="3">STRATIGRAPHIC UNITS</th></tr>
<tr><td>0-6</td><td colspan="3">Quaternary (Surficial Deposits)</td></tr>
<tr><td>6-25</td><td colspan="2">Poison Hill Greensand</td><td rowspan="5">Coolyena Group</td></tr>
<tr><td>25-34</td><td colspan="2">Gingin Chalk</td></tr>
<tr><td>34-63</td><td colspan="2">Molecap Greensand</td></tr>
<tr><td>63-148</td><td>Kardinya Shale</td><td rowspan="2">Osborne Formation</td></tr>
<tr><td>148-196</td><td>Henley Sandstone</td></tr>
<tr><td>196-254</td><td>Pinjar Shale</td><td rowspan="3">Leederville Formation</td><td rowspan="3">Warnboro Group</td></tr>
<tr><td>254-450</td><td>Wanneroo Member</td></tr>
<tr><td>450-472</td><td>Marginiup Member</td></tr>
<tr><td>472-490</td><td colspan="3">Parmelia (Sandstone) Formation</td></tr>
</table>

*mbgl = metres below ground level

Some detail of the shallow Quaternary and Upper Cretaceous sediments has been provided by recent air-core drilling at the proposed site to depths of 29m below ground level. Detailed logs of the six boreholes indicate mainly medium to coarse sands, mostly ferruginised with lateritised horizons at shallow depth (2m-5m below ground level) within the Surficial Deposits as described in Moncrieff (1989) and Kay and Diamond (2001).

The Upper Cretaceous sediments (Poison Hill Greensand) are clearly weathered to the drilled depth in each hole, as described by Kay and Diamond (2001), and it is unclear from the bore logs where the boundary is between the Surficial Deposits and the weathered Greensand. Indeed, as the Surficial Deposits are themselves weathered and reworked Upper Cretaceous (Moncrieff, 1989), it seems likely that the boundary between the two is gradational and not easily determined. Certainly, there is no obvious change in lithology or geophysical logs which define a stratigraphic boundary. The absence of any boundary indicates that the Surficial Deposits and upper weathered Poison Hill Greensand form a single vadose zone for the unconfined aquifer beneath the proposed landfill site.

3.2.2 Surface Hydrology

There are no surface water bodies present on the site; the nearest surface water body is Gingin Brook which has its headwaters located 4-5km to the southwest of the site. Boonanarring Brook which extends into the Boonanarring Nature Reserve is located approximately 5km to the west of the site. Red Gully Creek is some 15km to the northwest, and the Moore River 25km directly to the north. Lake Beermullah and White Lake are approximately 15km to the east, with Wannamal Lake lying approximately 15km to the northeast.

3.2.3 Groundwater Hydrology

Groundwater at the site is located within the unconfined Poison Hill aquifer, comprised of Poison Hill Greensand, Gingin Chalk and Molecap Greensand stratigraphic units. Groundwater with the Poison Hill aquifer beneath the study area is generally at 143mAHD which is between 20-70m below ground level (Crisalis International, 2006). Regional groundwater flow within the Poison Hill aquifer is generally to the southwest and there is no direct connection between the Poison Hill aquifer sediments and Leederville aquifer within the region (Crisalis International, 2006).

3.2.4 Vegetation and Flora

Heddle *et al* (1980) identified the vegetation within the survey area as part of the Cullalla Complex. This vegetation complex occurs on the Dandaragan Plateau and consists predominantly of a mixture of Low Open Forest of *Eucalyptus todtiana* and Open Woodland of *Corymbia calophylla* with a second storey of *E. todtiana, Banksia attenuate, B. menziesii and B. illicifolia.*

Approximately 40% of the estimated pre-European extent of the Cullulla vegetation complex is remaining and 3% is currently protected within secure reserves. This is below the minimum 10% target established in *Bush Forever* (Government of Western Australian, 2000).

A total of 151 species were recorded within the study area from the May and November 2006 and September 2007 surveys. This included 127 native species and 24 introduced species.

The dominant families were the Myrtaceae (*Eucalypt* family – 14 species), Proteaceae (*Banksia* family – 21 native species) and Papilionaceae (Pea family – 12 species, 1 introduced species).

The majority of species recorded within the study area were also recorded within the nearby Boonanarring Nature Reserve (Burbidge *et al*., 1996). No Declared Weeds were identified during the 2006 or 2007 surveys.

No species of Declared Rare or Priority Flora were recorded at the site during these surveys.

3.2.5 Fauna

A search of Department of Biodiversity, Conservation and Attractions (DBCA) Threatened Species and Communities database for threatened and priority native animals was undertaken to identify Scheduled and Priority species previously recorded in the region. A search of the Commonwealth *Environment Protection and Biodiversity Conservation* (*EPBC*) *Act 1999* online database was also undertaken.

Coffey Environments conducted a Level 1 Fauna Assessment including a site visit on 18 September 2007. Coffey Environments examined the site for available habitat types and searched for small reptiles and mammals. Any significant trees that contained hollows that may be suitable for breeding Black Cockatoos were recorded using a hand-held GPS. Signs of feeding such as chewing, scarring or scratch marks were noted. Carnaby's Black-Cockatoos have a short upper mandible and leave characteristic chewing marks on discarded Marri nuts and *Banksia* sp. cones. Searches for Southern Brown Bandicoot (Quenda) scats and scratchings were made across the site.

Several conservation significant fauna species have been identified by the DBCA as potentially occurring within the study area (**Table 3**).

Table 3: Potential Threatened and Priority Fauna

SPECIES	COMMON NAME	CONSERVATION STATUS		COMMENT
		DBCA* Threatened Native Animals	EPBC Act	
Dasyurus geoffroii	Chuditch, Western Quoll	Schedule 3 Vulnerable	Vulnerable	Species *unlikely* to be present as habitat is not suitable
Pseudocheirus occidentalis	Western Ringtail Possum	Schedule 1 Critically Endangered	Critically Endangered	Species *highly unlikely* to be present as habitat is not suitable and it is disjunct from the known current populations

SPECIES	COMMON NAME	CONSERVATION STATUS		COMMENT
		DBCA* Threatened Native Animals	EPBC Act	
Pseudomys shortridgei	Heath Mouse (Dayang)	Schedule 3 Vulnerable	Endangered	Species *unlikely* to be present as habitat is not suitable
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Schedule 2 Endangered	Endangered	Species *likely* to forage on-site but unlikely to rely on the area for survival
Pseudemydura umbrina	Western Swamp Tortoise	Schedule 1 Critically Endangered	Critically Endangered	Species *highly unlikely* to be present as there are no wetlands on-site
Macropus irma	Western Brush Wallaby	Priority 4		Species *unlikely t*o be present as there are no wetlands or lakes on-site
Galaxiella munda	Western Mud Minnow	Schedule 3 Vulnerable		Species *highly unlikely* to be present as there are no wetlands on-site

* Department of Biodiversity, Conservation and Attractions – Wildlife Conservation (Specially Protected Fauna) Notice 2018
Schedule 1= Fauna that is rare or is likely to become extinct as critically endangered fauna
Schedule 2 = Fauna that is rare or is likely to become extinct as endangered fauna
Schedule 3 = Fauna that is rare or is likely to become extinct as vulnerable fauna
Priority 4 = Rare, near threatened and other species in need of monitoring

Coffey Environments has used the data collected during the September 2007 site visit, vegetation association mapping, floristic data and photographs to provide an indication of the fauna habitats that are available within the site. Most of the area contains *Eucalyptus todtiana*, with a variety of shrubs providing undergrowth. The undergrowth includes *Adenanthos cygnorum*, *Nuytsia floribunda, Banksia menziesii, B. prionotes*, and *Xanthorrhoea preissii*. No surface water, streams or wetlands are present on the site.

Several conservation significant fauna species have been identified by the DWER as potentially occurring within the region. However, limited habitat types on-site, including the lack of any surface water, reduces the likelihood of several of these species occurring at the site.

Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), which are listed as Schedule 2 species ('*Fauna that is rare or is likely to become extinct as endangered fauna'*) under the Western Australian *Biodiversity Conservation Act 1916, Wildlife Conservation (Specially Protected Fauna) Notice 2018* is likely to frequent portions of the site that contain Banksias as these provide favourable foraging areas. No Black Cockatoos were sighted during the site visit, although potential feeding habitat are present in areas of Low Open Woodland of *Eucalyptus todtiana, Banksia menziesii* and *Banksia attenuata*, particularly to the south of the site.

However, Coffey Environments is of the opinion that the site has no particular conservation significance for this species of cockatoo given the extensive availability of similar woodland and heath habitat present within the region. This includes the Boonanarring Nature Reserve, which is located 1km from site and has 9,250ha of relatively undisturbed vegetation within the reserve. The study area's location is not considered strategic as there are extensive vested reserves with high quality feeding habitat both adjacent to and in close proximity to the site. Furthermore, the vegetation present at the site does not provide suitable breeding habitats for these species of cockatoo, and no suitable breeding hollows were recorded during the site visit.

During the site visit no scats, diggings or scratchings from mammal species listed as Schedule or Priority species were recorded. However, a number of scats and tracks from the Western Grey Kangaroo were recorded. The Western Grey Kangaroo is not protected under Commonwealth or State. Introduced European Rabbit scats and diggings were also present on tracks and in the vegetation.

Limited habitat types on-site, including the lack of any surface water reduces the likelihood of several of these species occurring at the site. Of the six Schedule 1 listed species, four are unlikely to occur at the site. The Western Swamp Tortoise requires wetland habitats which are not present; the Heath Mouse has a very limited distribution in the south-eastern wheatbelt through to the south coast and is unlikely to occur at the site. Western Ringtail Possums habituate peppermint (*Agonis flexuosa*) dominated woodlands and use tree hollows for nesting sites, preferring Tuarts (*E. gomphocephala*) and Marri (*Corymbia calophylla*) vegetation associations which are not present at the site.

The Chuditch (*Dasyurus geoffroii*) is a second species identified by the DWER as potentially occurring at the site which is listed as a Schedule 1 species. Chuditch generally prefer a site with dense understorey which provide adequate cover and den sites (usually hollow logs). The proposed landfill site is vegetated by low open woodlands, which has regrown from previously cleared vegetation. The site does not provide the dense understorey or den sites required by the Chuditch, and as such it is considered that the site is not one of significance for the species.

3.2.6 Social Environment

The property has been selectively cleared with farming and horticultural operations located in several areas of the property. A feedlot for Kimberly cattle was previously located near the Fernview Farm residence (approximately 2kms from site), which has subsequently been decommissioned. The majority of the remainder of the property is utilised for grazing. Areas of regrowth and scrub have been previously used for wildflower production, with evidence of Geraldton Wax (*Chamelaucium uncinatum*) plantations previously killed by frost.

Boonanarring Nature Reserve, a large flora and fauna reserve, is located 1.5km to the west of the property. To the immediate north is a privately owned former grazing property which is subject to substantial natural revegetation mainly comprised of scrubland. The property to the immediate east is privately owned, where limited grazing occurs on scrubland and to the south, the land is used for grazing on similar scarcely vegetated land.

The nearest residence is Fernview Farm, the property residence on Lot 99 and is located approximately 1.95km to the south of the proposed facility. Beyond Lot 98 (landfill site), the nearest residence to the facility is approximately 2.3km to the north east.

4 POTENTIAL IMPACTS

4.1 POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROJECT

Impacts of the proposal on groundwater, surface water, catchment issues and the biological environment are dealt with in other management plans prepared in compliance with Ministerial Statement 796. This Decommissioning and Post Closure Management Plan provides strategies for management of the landfill decommissioning and post closure activities for the progressive closure of the landfill and throughout the landfill post closure period.

The following sections are the potential environmental impacts/pollutants if the landfill is not properly managed.

4.1.1 Visual impacts

Visual impacts include:

- Risks presented by the landfill after abandonment, including unstable slopes and precipitous edges which are safety risks to stock, wildlife and humans;
- Monitoring bores and drill holes that are a risk to stock and native fauna if left open;
- Disturbed areas that are likely to result in wind and water erosion and are not conducive to natural regrowth unless satisfactorily rehabilitated; and
- Unsightly remains after abandonment of the landfill including abandoned landfill equipment, refuse and abandoned buildings and stockpiles, unless an acceptable abandonment strategy is employed.

4.1.2 Air Emissions

The air emissions associated with the processes of a landfill come, most commonly, in the form of landfill gas. Landfill gas is produced from the decomposition of putrescible wastes contained within the landfill. Landfill gas is comprised of two main gases; Methane and Carbon Dioxide. Methane is considerably more harmful to the environment than Carbon Dioxide, though both must be managed mutually as 'landfill gas' in order to establish a safe environmentally effective management strategy.

Landfill gas is primarily comprised of 45 - 60% methane (CH_4), 40 - 60% carbon dioxide (CO_2) and three groups of trace components. The trace compounds are Oxygen, Sulphur and Hydrocarbons. The sulphur compound is the primary cause of odours, while the hydrocarbons are considered the most hazardous due to their persistence.

4.1.3 Odour Emissions

Odour from a landfill facility occurs from the anaerobic breakdown of putrescible waste within the landfill. The most common odorous chemicals associated with landfill gas are Sulphur, Ammonia, volatile amines, Hydrogen Sulphide and volatile organic compounds. Emissions of these compounds have the potential to affect the amenity of nearby sensitive premises if management strategies are not appropriate.

Odour is directly linked to the landfill gas produced at a landfill facility and hence is managed as part of the landfill gas capture system. The odours from waste are typically associated with:

- Trace components in landfill gas,
- Handling of odorous wastes, and
- Inadequate emplacement and covering of biodegradable wastes.

4.1.4 Water Contaminants

The potential to discharge to the land through the groundwater due to landfilling activities occurs from the generation of leachate. Leachate is a liquid waste stemming from the decomposition of waste and excess rainfall/water percolating into the landfill. The combination of physical, chemical, and microbial processes in the landfill waste, transfer pollutants from the waste material to the percolating water.

The biodegradability of organic content in the waste and the compaction of the waste layers make the landfill an anaerobic environment, this gives many similarities to the composition of leachate among different landfills.

Leachate is comprised of a complex mixture of dissolved and colloidal organic matter, and inorganic compounds including heavy metals and ions.

Pollutants in Municipal Solid Waste (MSW) landfill leachate can be divided into four groups:

- Dissolved organic matter, quantified as chemical oxygen demand or total organic carbon, volatile fatty acids (that accumulate during the acid phase of the waste stabilisation, and more refractory compounds such as fulvic-like and humic-like compounds,
- Inorganic macrocomponents: Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}), Ammonium (NH^{4+}), Iron (Fe^{2+}), Manganese (Mn^{2+}), Chloride (Cl^{-}), Sulphate (SO_4^{2-}) and Hydrogen Carbonate (HCO^{3-}),
- Heavy metals: Cadmium (Cd^{2+}), Chromium (Cr^{3+}), Copper (Cu^{2+}), Lead (Pb^{2+}), Nickel (Ni^{2+}) and Zinc (Zn^{2+}), and
- Xenobiotic organic compounds originating from household or industrial chemicals and present in relatively low concentrations (usually less than 1 mg/l of individual compounds). These compounds include, among others, a variety of aromatic hydrocarbons, phenols, chlorinated aliphatics, pesticides, and plastisers.

Other compounds may be found in leachate from landfills: for example, Borate, Sulphide, Arsenate, Selenate, Barium, Lithium, Mercury, and Cobalt. However, in general, these compounds are found in very low concentrations and are only of secondary importance.

Although the composition of leachate contains many harmful components, the assurance that no leachate will ever come into contact with the groundwater, is that the leachate collection system will contain all landfill leachate at the facility even after closure of the landfill.

4.1.5 Noise Emissions

Noise may be generated at the landfill site during construction and during operation. Standard construction plant and earthmoving equipment will be the main source of noise emissions during construction. No blasting will be required as part of any site preparatory works.

- During operation, the main sources of noise from the facility will include:
- On-going stage construction activities (as detailed in the development and construction phase above),
- Operation activities including the placement (via compactors) and delivery of waste materials, and
- Vehicle movements (including reversing).

The remote nature of the site and large separation distances to sensitive land-uses means that there is little likelihood that noise or vibration emissions will result in off-site impacts.

5 ENVIRONMENTAL OBJECTIVES

5.1 PRINCIPAL ENVIRONMENTAL OBJECTIVES

The environmental objectives of the Decommissioning and Post Closure Management Plan are to provide a framework for closure planning for the proposed Fernview Landfill and to identify issues that need to be addressed as the closure planning progresses to narrow closure options over time.

The decommissioning and post closure objectives of both the DWER and Fernview are to ensure that the post landfilling landform is safe, stable, non-erodible, and is, as far as is practicable, integrated into the surrounding landscape.

The Ministerial Statement and Environmental Commitments related to decommissioning and aftercare (**Table 4** below) are used as the basis for the Environmental Objectives.

5.1.1 Ministerial Statement

Condition 8 provides the following Landfill Decommissioning and Post-closure Management objectives:

8-1 Prior to the commencement of construction, the proponent shall prepare a draft Landfill Decommissioning and Post-closure Management Plan in accordance with the requirements of the CEO of the Department of Environment and Conservation.

8-2 At least two years prior to the anticipated date of closure, the proponent shall submit a final Landfill Decommissioning and Post-closure Management Plan designed to ensure that the site is left in an environmentally acceptable condition in accordance with the requirements of the CEO of the Department of Environment and Conservation.

The Landfill Decommissioning and Post-closure Management Plan shall address:

1. Progressive rehabilitation to pre-development condition or better through re-vegetation of capped landfill cells with selected local native species;

2. Choice of capping materials which are consistent with Best Practice Guidelines, which shall include a low permeability layer, followed by a sub-soil layer and a final layer of soil suitable for vegetation establishment;

3. Ongoing operational practice to ensure that the final landfill surface will be constructed to a predetermined crossfall to enhance surface water runoff while safeguarding against erosion and to ensure that final contours of the site will blend into the surrounding environment;

4. Monitoring and management of ground and surface water; and

5. Response, mitigation and contingency measures to be implemented if ground and surface water quality is affected to an unacceptable level as determined by the CEO of the Department of Environment and Conservation.

8-3 The proponent shall implement the final Landfill Decommissioning and Post-closure Management Plan required by conditions 8-2 until such time as the Minister for Environment determines, on advice of the CEO of the Department of Environment and Conservation, that the proponent's post-closure responsibilities are complete.

8-4 The proponent shall make the draft and final Landfill Decommissioning and Post-closure Management Plan required by conditions 8-1 and 8-2 publicly available in a manner approved by the CEO of the Department of Environment and Conservation.

The key objective is to ensure that closure planning and rehabilitation are carried out as an integral part of landfill planning, development and operation.

Table 4: Proponent Environmental Commitments Related to Landfill Closure

Topic	Objectives	Action Required	Timing	Advice
Decommissioning and Aftercare Management Plan	To provide the framework to ensure that the site is left in an environmentally acceptable condition at closure.	1. Prepare a Preliminary Decommissioning and Aftercare Management Plan prior to lodging a Works Approval Application, which will address but will not be limited to the following: Management procedures, Conceptual plans for the removal of site infrastructure, Conceptual plans for the final landform and landfill profile, A conceptual rehabilitation plan for all disturbed areas and a description of a process to agree on the end land use(s) with all stakeholders, A conceptual plan for post closure management of the leachate management and landfill gas systems, Long-term monitoring and maintenance schemes, and Preliminary plans for management of the landfill cap and landscape vegetation. 2. Preparation of a Final Decommissioning and Aftercare Management Plan at least 6 months prior to decommissioning, or at a time to be agreed with the EPA, which will address but will not be limited to the following: The management measures, Final plans for the removal of infrastructure, Final plans for the final landform, landfill profile and planting regime, A final rehabilitation plan for all disturbed areas and a description of a process to agree on the end land use(s) with all stakeholders, A final plan for post closure management of landfill leachate and landfill gas, and Final plans for management of the landfill cap and landscape vegetation. 3. Implementation of the approved Final Decommissioning and Aftercare Plan.	Prior to lodging a Works Approval application At least six months prior to the anticipated date of decommissioning or at a time to be agreed with the EPA	DWER

5.2 DECOMMISSIONING AND CLOSURE OBJECTIVES

The objective is to develop an environmentally friendly and usable farming space for the local stakeholders after the completion of the landfill operation. The aim is to remove all infrastructure on site and then shape the profile of the finished landfill to coincide with the surrounding landforms.

5.2.1 Removal of Site Infrastructure

It is an important process of the decommissioning and closure of the landfill site to remove all infrastructure that has been erected as part of the landfill operation. This will allow the land to be used again for farming once the landfill has been deemed environmentally safe.

The process of removal must be subject to relevant design schedules in order to determine which is removed first and which is removed last. It would be sensible to remove the office building once landfill operation closes as monitoring of the landfill can be done remotely. Ripping and removal of the roads would occur last as access to and from the landfill will be done periodically after closure.

The following infrastructure shall be removed in the order and method described:

- Fuel station – the fuel station will be emptied prior to moving of the tank. This will be done by a licenced remover and hauler of hydrocarbons. The fuel tank will then be disassembled and pumps, drip trays and hoses will be cleaned/washed for reuse. The fuel tank will be winched onto a large truck for transportation off site. The concrete pad/bund will be broken and removed using a rock hammer, excavator and truck,

- Water tanks – the water tanks will be emptied and dismantled from hoses and pumps. The tanks will be winched onto a truck and removed from the site,

- Underground grey water tanks – the tanks will be excavated carefully ensuring that treated or raw grey water is not released. The pumps and hoses will also be excavated and removed from the tanks. The tanks will be winched out and either placed directly onto a truck or emptied into a liquid waste carrier for removal off site. Grey water could be transported to the leachate ponds. The excavation shall be filled in with soil and compacted using the excavator,

- Office – the office and amenities building will be dismantled and removed in stages. The furniture and fittings will be removed prior to the roof, walls, floors and footings. The removal of fittings must be done when all power and water is switched off and disconnected. All materials from the building will be recycled where possible and shall be taken by truck off site. The footings will be removed using a rock hammer and excavator. The concrete will be recycled,

- Work shop – the workshop will be dismantled in a similar fashion to the office building. Remove all furniture, fittings and tools, disconnect all electricity and water, remove roof, walls and floors. Floors will be broken using a rock hammer and excavator. All materials are to be loaded for removal on trucks and reused or recycled where possible,

- Hard stand/carpark – the hardstand area will have its perimeter fence removed and will be ripped up and mixed with native soil. The carpark will be stripped of the sealer and ripped also. Soil improvers and seeds will be added to enhance regrowth and recovery. Removed asphalt will be disposed of at a licenced facility off site,

- Loading pad – the loading pad adjacent to the leachate pond will be removed using a rock hammer and excavator. The excavated concrete will be placed on a truck for removal and eventual recycling. The concrete must be clean of leachate or liquid waste before removal,

- Kerbing – kerbing along all roads will be removed with an excavator and broken into smaller sections, if required, by a rock hammer. The concrete will be recycled,

- Weighbridge – the weighbridge will be removed in stages as the important components must be maintained. The deck of the weighbridge will be disconnected from the weighing system and removed using a winch, placing it onto a truck. The fittings and weighing devices will be removed and stored for reuse. The concrete floor of the weighbridge will be broken and removed by an excavator and rock hammer. The concrete will be recycled,

- Stormwater and sedimentation dams – these dams will be filled in the same as the leachate pond, using soils native to the area. The soil will be compacted and mixed with soil improver and seeds to enhance regrowth and recovery,

- Stormwater drains – for all drains on site the method will be to fill them in with natural soils, compact and re-seed with grasses. Soil improver may be used if deemed necessary,

- Sediment fencing – the sediment retaining fencing will be removed using a dozer/excavator and taken off site in a truck. The captured sediment will be smoothed over and compacted,

- Power/water/data lines – all lines of power, water and data will be removed once there is no longer a need for these utilities on site. This will be done by excavating all underground lines once all power and water is switched off. The pipes and cables shall be reused and recycled once transferred off site,

- Lined ponds – The lined leachate pond will have all sludge removed with an excavator or pumped with a truck hose. This sludge will have to be disposed of to a licensed facility capable of accepting sludge waste. The liner of the pond will be removed by excavator and disposed to landfill. The leachate pond will be filled in using soils native to the area.

The soil will be compacted and mixed with soil improver and seeds to enhance regrowth and recovery,

- Leachate manholes – The leachate manholes cannot be removed as they will be buried up to 45m below ground. The manholes will have to be sealed with secure corrosive resistant lids. At the same time, leachate pipes below the landfill will be plugged or removed where possible,

- Access grid – the access shaker grid will be removed using an excavator, rock hammer and crane. The steel bars will be winched onto the back of a truck and the concrete footings broken by the rock hammer and removed by the excavator. Concrete will be carted off site for recycling,

- Culverts – all culverts on site will be filled in with compacted native soil mixed with soil improver for enhanced regrowth, and

- Access/dirt roads – all roads will be removed using excavators, dozers, strippers and trucks. The sealed sections of road will have the asphalt removed and taken to a licenced facility for disposal while all dirt roads will be ripped and tyned and mixed with soil improvers and seeds for regrowth.

5.2.2 Final Landfill Profile and Contours

The landfill is operated so that cells are completed and progressive rehabilitation can occur. The rehabilitation must follow the designed final contour layout in order to achieve the height requirements designated in the design of the landfill. While the waste placement and compaction occur in a new cell, an old cell can be rehabilitated in accordance with the designated design profile. **Drawing Fern-DA-008** shows the proposed final design of the landfill. The contours and capping are included in the Drawing.

The design of the final cap also caters for surface water runoff on top of the landfill and has a slope which falls to the north west as seen in **Drawing Fern-DA-009**.

6 IMPLEMENTATION STRATEGY

6.1 PRE-CLOSURE

6.1.1 Leachate Generation and Management

Leachate is formed from the infiltration of water (i.e. rain) into the landfill and also from the moisture content of the waste itself. Landfill leachate is highly variable in its chemical characteristics and can typically exhibit elevated levels of organics, nutrients and heavy metals.

Leachate composition is dependent upon a variety of factors which include but are not limited to:

- Heterogeneity and composition of the waste,
- Design of the landfill,
- Operational practices of the landfill,
- Age of the waste,
- Moisture content of the waste, and
- Stage of biodegradation achieved by the waste.

The two most traditional concepts of minimising leachate production are firstly, decreasing the ingress of the rainwater with the use of a landfill cap and secondly, allowing the percolation of rainwater into the waste mass and promoting biodegradation, hence speeding up the waste and shortening the post closure period.

At the Fernview Landfill, the leachate management system involves a combination of the above two scenarios. The cap is used to reduce the amount of water ingress into the landfill during the winter periods when rainfall frequency is much higher. During the summer months when rainfall is minimal, leachate recirculation is used to keep the landfill biodegradation occurring through ensuring the waste mass is constantly moist.

During severe winters, should there be excessive generation of leachate and the waste mass is not able to absorb all the liquid, the leachate will be stored in a leachate dam or disposed off-site.

The recirculation system will be designed to ensure sufficient capacity to store and treat all leachate generated over two consecutive wet years in accordance with *Siting, Design, Operation and Rehabilitation of Landfills* (EPA Victoria, August 2016).

The leachate recirculation system for the proposed facility will consist of the following elements:

- In areas of significant waste depth, slotted dispersion pipes may be installed in vertical bore holes 1m wide, backfilled with rubble,

- In areas close to the perimeter of the landfill, over bunds, slopes and shallow waste areas, horizontal leach drains will be constructed by excavating trenches within previously completed landfill lifts and burying horizontal slotted dispersion pipes in drainage aggregate and backfilling the trench with waste, and

- The leachate recirculation systems will be connected to the rising main from the leachate storage ponds via portable pipework.

The philosophy of leachate recirculation potentially offers the following benefits:

- The opportunity for the landfill operator to manage on-site the significant outputs from the landfill, e.g. landfill gas and leachate,

- A reduction or elimination of the requirement for landfill leachate treatment (through a treatment plant), thereby reducing treatment/off-site disposal costs and associated environmental impacts, and

- A relatively simple and inexpensive leachate management method.

The leachate recirculation system will be designed and operated in accordance with best practice, in order to protect the environment. Specifically, the following will be considered:

- Operational practices such as the application of daily cover materials and compaction of emplaced waste materials will be undertaken in a manner which will optimise the even distribution of recirculated leachate and therefore the more rapid decomposition of waste,

- The addition of leachate to the landfill will be carefully controlled, avoiding complete saturation of the waste, which can potentially impact on the stability of cells and also inhibit decomposition of wastes,

- The final landfill design will ensure that leachate can be readily drained from each cell and the leachate head on the liner will not exceed design specifications, and

- A leachate storage pond will be incorporated into the leachate collection and recirculation system. The leachate pond will provide storage, if required, prior to recirculation into the landfill. This offers the opportunity to buffer the pH of the leachate and also provide some additional treatment e.g. aeration (for leachate produced during the acetogenic phase), subsequently also controlling the leachate head on the liner system. The design of the leachate collection system and leachate pond at the landfill will ensure the following requirements from *Siting, Design, Operation and Rehabilitation of Landfill* (EPA Victoria, August 2016):

    - It is appropriately sized to collect the estimated volume of leachate (predicted from a combination of worst-case scenario modeling and the Hydraulic Evaluation of Landfill Performance (HELP) Model),

    - It is resistant to chemical attack, and physical, chemical and biological clogging,

    - It is able to withstand the weight of waste and the compaction equipment without crushing, and

- It can be inspected and cleaned by readily available video inspection and pipe-cleaning equipment.

Leachate levels within the landfill will be controlled by regular monitoring of the leachate head on the landfill liner. Typically, the maximum head of leachate on the liner is limited to 300mm; however, the level of leachate at the sump will be higher in order to protect the pump in the sump.

6.1.2 Landfill Gas Extraction and Management

During operation, as the waste mass increases in volume, the gas extraction system is progressively installed. In areas that have been completed and reached final profile, vertical gas wells are drilled into the waste. Once the landfill has been completed and before final capping is installed, additional wells are constructed to complete the comprehensive extraction system.

The extraction system will operate by inducing a slight vacuum within the extraction wells and associated piping that will promote gas flow from the waste mass to the gas extraction wells. Condensate traps will be installed to allow for the capture and temporary storage of the condensate, which will be collected and used in the leachate recirculation system. An energy recovery facility will manage/utilise the landfill gas once it is extracted from the landfill. Where the recovered gas is of low quality (i.e. low methane content) it will be conveyed to a portable flare. The flare will remain in place throughout the life of the landfill to burn excess landfill gas that cannot be utilised to generate power.

The landfill lining and capping system aim to control gas migration from the landfill. The landfill gas collection system will be designed to:

- Prevent migration,
- Minimise emissions,
- Manage accelerated gas generation produced from leachate recirculation, and
- Optimise utilisation.

The primary components of the landfill gas control system will include the following in addition to the capping and lining system:

- Vertical and/or horizontal gas extraction wells will be installed in accordance with the placement of waste materials. The spacing of the wells will be determined following an operational assessment for the site. The gas wells and connecting joints will be designed to withstand anticipated settlement rates,
- Condensate traps, gas well heads and associated gas pipework will be connected to the gas extraction wells once the cell has been completed and landfill cap has been installed.

This will allow landfill gas to be captured and conveyed to the flare or the energy recovery facility according to the quality and quantity of the extracted landfill gas,

- An energy recovery facility will be used once a consistent quality and quantity of landfill gas is generated from the landfill. Generated electricity will supply power to the south-west interconnected grid, and

- Provisions for monitoring landfill gas quality and quantity produced from the facility. In addition, surface landfill gas monitoring will be conducted. Three of the most significant sources of landfill gas emissions are considered to be landfill gas flares, surface emissions from capped and temporary capped areas and landfill gas engines.

A landfill gas risk assessment has been undertaken to assess the potential for landfill gas migration beyond the lined and capped landfill facility. The outcome of this risk assessment has been used to determine the appropriate landfill gas management system during landfill operation and subsequent closure and post closure periods. The Landfill Gas Risk Assessment is included in Section 15 below.

The landfill gas management system is designed and operated through operational and monitoring procedures to prevent the escape of landfill gas beyond the containment system. The following management and mitigation measures minimise the impact of landfill gas emissions on the environment during the operation of the facility:

- A synthetic lined landfill base, which includes a leachate leak detection liner. This additional layer of synthetic liner associated with the leak detection system provides additional control of potential horizontal migration of landfill gas,

- The base liner leak detection system provides a potential for landfill gas monitoring and extraction from below the primary landfill base liner within each individual landfill cell,

- The active gas extraction system and utilisation plant (or enclosed flare) will be operational as soon as possible, depending on the quality and quantity of gas generated. This will minimise the release of uncontrolled landfill gas emissions through passive venting,

- Leachate infrastructure such as sumps, wells and side wall risers will be effectively sealed, only retaining any necessary access for monitoring and maintenance,

- During the operation of the facility, operational procedures will be implemented which will manage odour issues associated with the operation and maintenance of landfill gas collection and treatment systems,

- Surface landfill gas monitoring will be conducted on an annual basis. This monitoring will focus on areas within the landfill and immediately beyond the landfill perimeter. Monitoring will occur at the following locations:

    - On the active landfill area (uncovered),

- On the temporarily covered areas (intermediate cover),
- On the final capped areas,
- Around infrastructure penetrations into the landfill surface:
  - Leachate sumps,
  - Leak detection system sumps,
  - Landfill gas wells, manifolds and condensate pots,
  - Others as applicable,
- Around the external perimeter of the landfill,
- Perimeter landfill gas monitoring bores, if and when installed,

Monitoring is to occur at regular intervals across the surface of the landfill and adjacent land or at point sources where appropriate. The monitoring will be conducted in accordance with site operational procedures formed in compliance with the site environmental management plan. Testing for hydrogen sulphide will also be undertaken if landfill gas odours are of concern,

- All landfill gas monitoring results will be recorded and reported to DWER annually and a copy of the report will be forwarded to the Shire,
- Controlled leachate recirculation will be undertaken on-site which will influence landfill gas generation,
- Weather conditions will be monitored on-site. Cover materials placed for adverse weather conditions will avoid any opening and be able to reasonably withstand the anticipated conditions without significant damage and exposure of the underlying waste material,
- Smoking will only be allowed in certain areas of the site that are considered to be of low fire risk. Areas where smoking will not be allowed will include the active cell, in the vicinity of the leachate storage ponds and leachate and landfill gas infrastructure,
- Vegetation around the vicinity of the landfill will be monitored on a monthly basis, where particular attention will be given to any areas that indicate decline in health,
- Nearby land users will be advised of appropriate contacts that will record and subsequently address any valid complaints related to landfill gas (more likely to be received regarding odour). A Complaints Register will be established to record any complaints received, date, nature, and resolution action undertaken,

- The Site Manager will contact any complainants that have concerns related to landfill gas (odour) and determine the nature of the concern, and

- A comprehensive Aftercare Management Plan will be developed for the site and will include the long-term monitoring and management regime for the site.

The effectiveness of the landfill gas management system will be a function of the efficiency of the landfill gas collection and combustion systems. Hence, the landfill gas management infrastructure will be maintained for the full duration of landfill gas generation on site, including gas collection system, vacuum unit, gas scrubbing unit, generator(s), flare and electronic controls as applicable.

6.1.3 Landfill Capping

Landfill capping will occur progressively as soon as practically possible after portions of the final waste profile is reached. *Siting, Design, Operation and Rehabilitation of Landfill* (EPA Victoria, August 2016) states the following: A key element of the rehabilitation is the capping of the landfill. The design objectives for the final landfill surface or capping are:

- Minimising infiltration of water into the waste ensuring that the infiltration rate does not exceed the seepage rate through base of the landfill,

- Providing a long-term stable barrier between waste and the environment in order to protect human health and the environment,

- Preventing the uncontrolled escape of landfill gas, and

- Providing land suitable for its intended after use.

Due to the anticipated 30-year life of the active landfill and continuing best practice improvements in the landfill industry, the final capping system at the Fernview Landfill is not rigorously set in stone. Currently the traditional clay capping systems are being utilised with combinations of geomembranes and geotextiles, however, should a more suitable environmental outcome be achieved via a different capping system, subject to the DWER‘s approval, then that shall be utilised.

The landfill cap provides the long-term protection of the groundwater environment. The cap must be designed such that the infiltration through the cap does not exceed the calculated seepage rate through the landfill liner. This avoids the so-called ‘bathtub’ effect, in which leachate levels within the landfill build up and eventually break out through the surface of the landfill.

Figure 1 indicates the required performance standards of caps in both Class II and Class III landfills, as well as indicative cap designs, which are based on preventing infiltration by providing a very low permeability layer (clay or composite barrier).

Figure 1: Indicative landfill cap designs

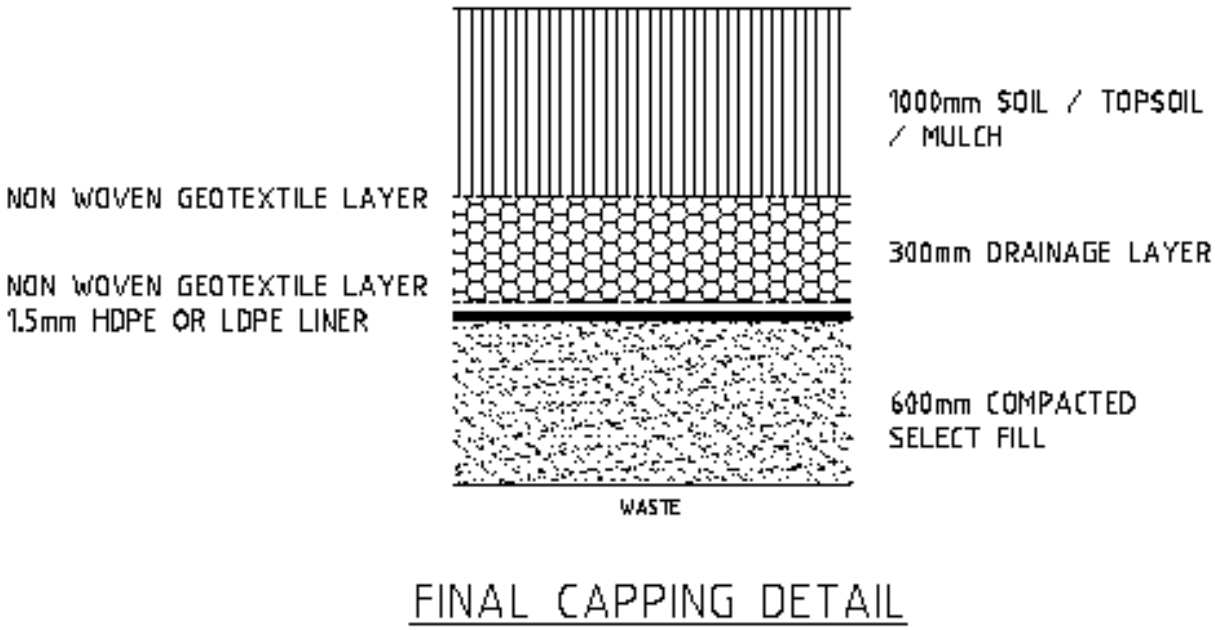
LANDFILL TYPE	CAP PERFORMANCE	INDICATIVE LANDFILL CAP	
Class III	75 per cent of the anticipated seepage rate through the liner	Topsoil / mulch Soil sub base Geomembrane Geotextiles	> 1 m
		Drainage layer	0.3 m
		Low permeability clay	> 0.6 m
		Gas collection layer	
		Earthen cover	0.3 m
		Waste	
Class II	75 per cent of the anticipated seepage rate through the liner	Topsoil / mulch	0.25 m
		Soil sub base	0.25 m
		Low permeability clay	0.5 m
		Earthen cover	0.3 m
		Waste	

Fernview propose to construct a final capping design as shown in **Figure 2** below. A layer of low-permeability flexible membrane liner will limit seepage through to the waste. Care will be taken in the selection of the particular geomembrane to be used, particularly with respect to the tensile strain that may be placed on the geomembrane as a result of settlement. To ensure the best results from the geomembrane the manufacturer will be consulted.

Current industry best practise is to utilise a geosynthetic clay liner (GCL) and/or LLDPE liner as the synthetic barrier between the various soil layers in the cap structure. There are new, emerging solutions such as reinforced bituminous geomembrane liners that provide some improved engineering and environmental advantage over the traditional GCL/LLDPE lining systems. Prior to any capping being constructed on-site, detailed design will be carried out to confirm the suitability of the proposed capping system from an environmental, engineering, constructability and maintenance point of view, including obtaining the necessary environmental approval for the proposed construction works.

To avoid damage to geomembranes within a cap by vehicle traffic, the geomembrane will be placed at least 0.6 metres beneath the surface and protected by a geotextile cushion layer. **Figure 2** shows that the geomembrane will be placed at least 1.3m below the surface.

Figure 2: Landfill final capping detail



A 300mm drainage layer will be placed between the 1m surface layer of soil/mulch and the low permeability geomembrane layer. The purpose of the drainage layer is to remove excessive moisture that has permeated through the soil layer and will not be removed by evapotranspiration.

Where the proposed after-use of a landfill is to require revegetation of the site, the top-most layer must be able to support vegetation and be of sufficient depth to ensure that roots do not penetrate the cap, providing a conduit for water into the landfill and water out of the landfill. It is proposed that the 1m of soil/mulch will be sufficient to ensure no root damage occurs to the geomembrane liner.

The surface layer will reflect the type and depth of top soils found in the local area. It will be possible to duplicate the local topsoil conditions due to the storage of the initial stripped top-soil in the Spoil Dump Area of the site. The natural soil will also be adequate to support vegetation for erosion control due to the appropriate mix of soils and mulches to a 1m thickness. Any mulch used in the cap will be pasteurised to remove weed seeds, plant pathogens and pests.

Once the landfill cap has been constructed and the topsoil layer completed, it will be seeded with fast growing grass and shallow rooted plant species to rapidly establish a root structure to assist in the stabilisation of the newly placed cap and reduce erosion during winter. Over the following years, as the seeded grass species die off, the native grasses and other shallow rooted plant species will take over. Particular native species will be either seeded or tube stocks planted to achieve the desired visual effect on the capped surface.

It can be seen in the comparison between the indicative landfill cap shown in **Figure 1** and the proposed landfill cap in **Figure 2**, that the proposed landfill cap meets the criteria set by the *Siting, Design, Operation and Rehabilitation of Landfill* (EPA Victoria, August 2016) for a Class III landfill, even though Fernview Landfill is only classified as a Class II landfill.

6.1.4 Site Rehabilitation

Site rehabilitation refers to the rehabilitation of the overall property and not specifically to the landfill area. All those areas off the landfill that have been disturbed as part of the landfill operation and that are no longer needed during the post closure period will be rehabilitated. Rehabilitation will occur as soon as practically possible. This will include progressive rehabilitation before landfill operations have ceased.

The primary EPA objective for rehabilitation is to minimise environmental impacts resulting from permanent change to ecosystems. This requires the return of rehabilitated areas to self-sustaining and functional ecosystems comprised of local provenance species.

On closure of the landfill, including progressive closure during landfill operations, redundant roads and other improvements will be removed and the areas ripped and prepared for planting. Selected native species will be seeded or planted to initiate the re-growth of the vegetation. Once the initial growth has developed, the main method of further rehabilitation is to actively control weeds and feral animals and allow natural seeding to take over and maintain the vegetation growth.

Introduced plantings on the landfill should not include any noxious weed variety for that area, nor should the landfill provide a haven for weeds migrating from the surrounding area. Advice will be sought from the local DWER or the Department of Primary Industries and Regional Development (previously Department of Agriculture and Food) on species selected for planting to prevent them from becoming local pests. It is advised that planting be restricted to species indigenous to the area and of local provenance, to:

- Avoid inappropriate planting,
- Ensure the species are adapted to the local climate, and
- Enhance the local habitat.

Fernview intends that the site is rehabilitated and returned to pasture following site closure. This will be achieved by:

- The topography of the landfill cap will blend into the surrounding landscape, with a gradient of no steeper than 1V:5H to reflect surrounding landforms, and
- The surface of the cap will be vegetated with selected local native species based on the data obtained from baseline vegetation surveys as soon as possible following the placement of topsoil to provide erosion control.

6.2 POST-CLOSURE

The objective of post-closure monitoring and maintenance is to ensure that the landfill continues to be non-polluting and does not cause environmental harm after site closure, that is, it ensures the long-term integrity of the landfill.

As with many other activities, post closure monitoring and maintenance addresses multiple environmental objectives, water pollution, air pollution and protection of land use and local amenity. The monitoring and maintenance must be provided until the landfill does not pose a threat to the environment.

Fernview has a strong commitment to aftercare and envisages that the site will be managed by Fernview for an extended period following closure (typically 15-25 years). The site will only be transferred from Fernview control when monitoring confirms that the site is stable and non-polluting and with the written agreement of the DWER and the Shire of Gingin.

6.2.1 Leachate Generation and Management

Leachate volumes would be expected to stabilise once the completed cap has been installed. The monitoring of leachate volumes will determine the effectiveness of the capping and leachate management system and will continue for the period the landfill generates leachate.

Leachate collected in the landfill sumps shall be recirculated using an automated system. The leachate is reintroduced to the landfill through a series of perforated pipes buried during landfilling. Excess leachate shall be evaporated during dry summer months by transferring collected leachate to the engineered leachate ponds on site using the site leachate transfer management procedures. Accumulated sediment shall be periodically removed from the evaporation ponds and disposed of in a secure landfill or other form of secure disposal facility.

If required, leachate collected within the landfill sumps can be transferred to tanker trucks for off-site disposal.

The parameters to be analysed within the landfill leachate will specifically reflect the nature of the waste emplaced within the proposed facility. The following parameters will be analysed on a quarterly basis during landfill operation but may be reduced to half yearly or annually in consultation with the DWER once the landfill has ceased operation:

- pH
- Conductivity
- Alkalinity
- Total Suspended Solids (TSS)
- Total Organic Carbon (TOC)
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD5)
- Chloride

- Sulphate
- Total Nitrogen (TN)
- Zinc
- Manganese
- Total Phenol(s)
- Potassium
- Total Petroleum Hydrocarbons (TPH)
- Ammoniacal-N
- Nitrate
- Nitrite
- Total Phosphorus (TP)
- Sodium
- Calcium
- Iron
- Cadmium
- Chromium
- Copper
- Nickel
- Magnesium
- Lead
- Arsenic
- Mercury

Sampling will be performed in accordance with Australian Standards 5667.1 (1998).

Data collected from the monitoring of leachate within the landfill sumps and leachate pond will be compared against groundwater monitoring data to assess if there has been any negative impact from the landfill leachate on the local groundwater.

6.2.2 Landfill Gas Extraction and Management

Landfill gas generation is expected to peak approximately ten years after closure of the landfill. Beyond this time, gas generation quantities gradually reduce as the waste stabilises.

Landfill gas management will be carried out under contract to a specialist landfill gas management company and will continue for an anticipated term of 20 years beyond the operational life of the landfill or as long as is required to control landfill gas emissions from the closed landfill. The landfill gas management system and gas utilisation facility shall:

- Operate continually from the date of commissioning throughout the contracted term, subject to normal stoppages for maintenance,
- Comply with the requirements of the DWER to the management of landfill gas on the landfill gas field, and
- Control landfill gas odour generated or migrated from capped areas.

The gas management system encompasses all installed gas wells, pipelines, valves and other equipment used for or in connection with the odour control, production and delivery of landfill gas to the gas utilisation facility station. The gas utilisation station covers all equipment required to take delivery of landfill gas for treatment.

6.2.3 Monitoring Waste Settlement

Waste settlement is more rapid in the first few years of waste placement. By the time the landfill is closed, most of the settlement would have already occurred. Aerial surveys will be used to assess waste settlement, including differential settlement. Initially these surveys will take place annually; however, as the settlement rate decreases the surveys will be undertaken every two years.

6.2.4 Maintenance of the Landfill Cap and Vegetation

A twice-yearly site inspection will be carried out for a minimum of 15 years following closure to monitor and report on evidence of any indications that the integrity of the landfill synthetic capping liner has been compromised, leachate pop-outs, topsoil erosion and any areas showing poor vegetative growth.

The August – September inspection period of the landfill cap follows the dominant rainfall months of the year allowing any problems associated with rainfall to be identified and maintenance work scheduled for the following drier months.

Maintenance work to the landfill cap following closure may consist of, but is not limited to, mobilising earthmoving equipment to complete the following:

- Reinstatement of eroded areas of the cap to prevent landfill gas venting and infiltration of stormwater into the landfill, and
- Maintenance of stormwater drainage over the landfill cap to minimise the probability for cascading flow down landfill batters.

6.2.5 Maintenance of the Surface Water Drainage System

There is a system of engineered stormwater diversion drains constructed to divert stormwater around the landfill footprint. These drains control and manage surface water flow through the landfill site before rejoining existing drainage lines without affecting stormwater quality.

Twice yearly site inspections will be used to assess the condition of surface water drainage systems. All drains will be adequately maintained to ensure that they are free flowing and erosion managed. In time, once the site has been adequately revegetated and erosion is no longer occurring, the sediment ponds and other surface water features will be allowed to gradually fill up with sediment and return back to a more natural self-sustaining state.

6.2.6 Monitoring of Surface and Groundwater Quality

Surface water and groundwater will be monitored on a six-monthly basis (February to March, and August to September) to determine any impacts from the closed landfill. Groundwater will be monitored in the existing seven groundwater monitoring bores located around the landfill footprint and surface water will be monitored in the sediment pond and in stormwater drains where surface water is available, which will typically only occur immediately after rainfall events.

Details of the water monitoring programme will be set in consultation with the DWER, including monitoring locations, frequency and range of analysis. Standing water levels of the monitoring wells will also be taken to ensure groundwater flow direction.

Analysis of the following parameters every six months is currently proposed, with the intention of reducing the analysis period as potential environmental harm reduces:

- pH,
- Electrical conductivity,
- Arsenic,
- Chemical Oxygen Demand (COD)
- Ammonia – nitrogen,
- Chloride,
- Lead,
- Iron,
- Manganese, and
- Mercury.
- Nitrogen Oxide,
- Copper,
- Chromium,
- Sulphate
- Total nitrogen,
- Total Petroleum Hydrocarbons (TPH)
- Total Phosphorous (TP),
- Zinc
- Nickel, and
- Cadmium.

6.2.7 Perimeter Fence Inspection

Twice a year or more regularly if deemed necessary, the perimeter fence will be inspected. If there is any damage to the fence, it will be repaired immediately.

6.2.8 Weed Control

On an annual basis, (August to September) a weed inspection will be carried out and if there are declared weeds present on site, a weed eradication programme will be initiated. Weed control involves the participation of all neighboring properties and as such all neighboring landowners will be encouraged to control weeds on their respective properties.

6.2.9 Site Revegetation

The site will be cleared of all non-essential manmade improvements and all open areas revegetated with native species. As part of the annual weed inspection, the quality and quantity of species used for revegetation will be assessed. Should it be determined that the revegetation is not developing sufficiently, more revegetation will be carried out in these particular areas. The intent is that well before the end of the post closure period, the site will have been fully revegetated and returned to its natural state.

7 PERFORMANCE INDICATORS

The DWER objective is that the post landfilling landform is safe, stable, non-erodible, non-polluting and is, as far as is practicable, integrated into the surrounding landscape. The performance indicators for stability, non-erodibility, pollutability and integration are fundamental for sustaining the landscape integrity after landfilling has occurred.

- Stability: The stability of the engineered select fill beneath the landfill liner is assured, as quality assurance is measured during construction. The underlying sandy soil will remain in a natural compactive state. The continual compaction of the waste, combined with constant removal of both landfill gas and leachate will instigate subsidence within the landfill which can be monitored and rectified. The capping system will provide stability on the surface of the landfill post operation through high compaction rates and the use of a 1m thick soil/mulch layer, a 300mm aggregate layer, a geomembrane layer protected by geotextile and 600mm of compacted select fill.

- Non-eroding: The capping system of the landfill will be non-eroding as it will consist of soils, materials and local vegetation to prevent erosion. Surface water monitoring will include ongoing measures and actions to prevent and monitor for any erosional influences near or on the site of the landfill.

- Non-polluting: Continual monitoring of leachate and landfill gas quantity and quality will ensure that any pollutants from the landfill are captured and remediated before environmental harm can occur. This includes groundwater monitoring outside the landfill area to ensure groundwater integrity.

- Integration into the landscape: The integration into the surrounding landscape will be done using shallow rooted native and local grass species. Gradients of no greater than 1V:5H will be enforced to minimise erosion.

- Safety is to be addressed in the ongoing development of the landfill where the landfill site will be securely fenced and access to the site will only be authorised with the approval of the Site Manager.

8 CONTINGENCIES

The continual environmental monitoring that will occur at the site will help indicate if any breaches occur concerning the amenity of the surrounding environment. These will be used in consultation with the management strategies outlined in this document and the Landfill Management Plan for the Fernview Landfill.

With the landfill being continually developed in a number of landfill cells and subsequently being progressively capped, any shortcomings or improvements in landfill design, operation or closure can be incorporated into future works to ensure that the best environmental outcome can be achieved on site.

9 CONTAMINATED SITE

The facility will be operated under the DWER issued licence. This licence will guide the environmental management of the site in order to adequately protect the environment and to provide the licensee with protection under the *Environmental Protection Act 1986*.

In the event that there is contamination identified on site as a result of the landfill activities, Fernview will consult closely with the DWER to determine the extent and impact of the contamination and future actions required.

The *Contaminated Sites Act 2003* and associated Guidelines will be used as the basis for the management of the contamination on site.

10 STAKEHOLDER CONSULTATION

10.1 STAKEHOLDERS

The objective of stakeholder consultation is to enable all stakeholders to have their interests considered during the Fernview Landfill closure process.

The following stakeholders have expressed an interest in viewing and commenting on this document.

Table 5: Stakeholders

STAKEHOLDER	STAKEHOLDER CONTACT
Shire of Gingin	(08) 9575 2211
Fernview Farm Land Owner	0428 877664
Western Power	1800 622 008
Department of Water	(08) 6364 7600
Environmental Protection Authority	(08) 6467 5600
Department of Environment Regulation	(08) 6467 5000

10.2 COMMUNITY AND STAKEHOLDER LIAISON

Ministerial Condition 8-4 has been set in regard to making publicly available the draft and final Landfill Decommissioning and Post-Closure Management Plan.

8-4 The proponent shall make the draft and final Landfill Decommissioning and Post-closure Management Plans required by conditions 8-1 and 8-2 publicly available in a manner approved by the CEO of the Department of Environment and Conservation.

The outcome of this requirement will be provided in annual communication to the DWER in the Environmental Compliance Report.

10.3 ONGOING LIAISON

Liaison with the DWER through the annual reporting will be completed as required. The landfill operator will continue to liaise with Local Government Authorities, particularly the Shire of Gingin, in regard to rehabilitation of disturbed areas outside the operational area.

Specific modes of communication to be used in relation to the closure of the Fernview Landfill include:

- Letters inviting personal briefings to be sent to State and Federal MPs who represent the local Shires, as well as neighbouring land owners and key interest groups,
- Informal and formal meetings,
- Telephone conversations,
- Distribution of information packages within the community containing,
    - Question and answer sheet,
    - List of project participants with contact details,
    - Possible after uses of the site,
    - Map of site, and
- E-mail correspondence.

Fernview will maintain an extended interaction with the community during the final proposals to cease operations at the site. This will include meetings and briefings with:

- The Shire of Gingin,
- DWER and EPA,
- Key stakeholders including:
    - Neighbouring property owners,
    - WA Farmers Federation, and
    - Concerned citizens.

Fernview is committed to open, proactive, timely and shared communication with all stakeholders to ensure the closure operations, activities and plans of the Fernview Landfill have been clearly communicated to stakeholders and concerns adequately addressed. Fernview is committed to open communication as the foundation of positive ongoing relationships and the company values stakeholder input and feedback.

11 ONGOING COMPLIANCE REQUIREMENTS

11.1 AUDITING

The Landfill Site Manager will be required to ensure that all management actions as per **Section 5.2** of this document are carried out. An audit of actions is to be conducted each year prior to reporting annually and submitted as part of the Annual Audit Compliance Report for the DWER.

It is recommended that there be adequate accountability to manage the closure planning including:

- The accountability for resourcing and implementing the closure plan should be clearly identified,
- Adequate resources must be provided to assure conformance with the closure plan,
- Adequate finance to implement the closure plan,
- The on-going management and monitoring requirements after closure should be assessed and adequately provided for, and
- The implementation of the closure plan should reflect the status of the operation.

The above requirements are to be updated and taken into account in forward landfill planning and included in the updated Decommissioning and Post Closure Management Plan two years prior to the end of landfill operation.

11.2 REVIEW AND REVISION

Operation at the Fernview Landfill is expected to be over 30 years with the development of 10 cells taking place over the lifetime of the facility.

Experience gained as the landfill expands into each new area will enable a final closure plan to be developed prior to operations extending into cells 9 and 10. All stakeholders are to be consulted prior to finalising the revised document.

It is also a duty of Fernview to ensure the cost of closure is adequately represented in company accounts and that the community is not left with a liability. Therefore:

- A cost estimate for closure should be developed from the closure plan,
- Closure costs should be reviewed regularly to reflect changing circumstances,
- The financial provision for closure should reflect the real cost,
- Accepted accounting standards should be the basis for the financial provision, and
- Adequate securities should protect the community from closure liabilities.

11.3 REPORTING

An annual Environmental Compliance Report will be submitted to the DWER along with the annual monitoring report required by the Landfill Licence. These two reports will provide the necessary details on the performance of the site during the closure period and would typically include a summary of the surface and groundwater monitoring results, subsidence monitoring, information on the performance of the leachate management systems and landfill gas extraction network.

12 KEY MANAGEMENT ACTIONS

Table 6: Key management actions for the decommissioning and post closure of the Landfill

ISSUE	MANAGEMENT ACTION	WHEN	RESPONSIBILITY
	PRE-CLOSURE		
Visual Impact	Ensure vegetation buffers are maintained through foreground plantings as required to screen landfill operations, particularly from the north west.	Ongoing	Landfill Site Manager
	Maintain a Complaints Register.	Ongoing	Landfill Site Manager
	Use topsoil and overburden for tree plantings on and around cells if these are visible outside of the landfill.		Landfill Site Manager
	Ongoing consultation with community to ensure minimal visual impacts.	Ongoing	Landfill Site Manager
	Provide tube stock trees to any local residents for screening direct line of site into the landfill.	Ongoing	Landfill Site Manager
Monitoring	Progress of rehabilitation of areas outside landfill operational area in consultation with the Shire of Gingin. Ensure dieback hygiene is maintained for any vehicles entering this or other conservation areas for fencing or firebreak maintenance. Take photographs each year from the same vantage point, as evidence of progress, until the Shire of Gingin is satisfied with the rehabilitation.	Ongoing	Landfill Site Manager

ISSUE	MANAGEMENT ACTION	WHEN	RESPONSIBILITY
	Leachate and landfill gas quantity and quality	Ongoing	Site Manager/Contractor
	Surface and groundwater quality	Ongoing	Environmental Manager
Review and Revision	The Closure and Rehabilitation Strategy to be periodically revised.		Landfill Site Manager
DWER Annual Report	Provide an update on re-growth and rehabilitation of disturbed areas outside operational area.	Each year in Annual Report.	Environmental Manager
	Provide an update on re-growth of vegetation on previously rehabilitated areas subject to rehabilitation.	Commencing in the year following first cell rehabilitation efforts.	Environmental Manager
	Provide DWER with a copy of the Complaints Register.	Each year in Annual Report.	Environmental Manager
	POST CLOSURE		
Monitoring	Progress of rehabilitation of areas outside of landfill operational area in consultation with the Shire of Gingin. Take photographs each year from the same vantage point, as evidence of progress, until the Shire of Gingin is satisfied with the rehabilitation.		Environmental Manager
	Leachate and landfill gas quantity and quality.	Twice yearly	Environmental Manager/Contractor

ISSUE	MANAGEMENT ACTION	WHEN	RESPONSIBILITY
	Subsidence/Settlement.	Twice yearly	Environmental Manager
	Surface and groundwater quality.	Twice yearly	Environmental Manager
Review and Revision	The Closure and Rehabilitation Strategy to be periodically revised.	Ongoing	Environmental Manager
Final Closure Strategy	A final Closure Strategy will be prepared and submitted for review by all relevant stakeholders.		Environmental Manager
DWER Annual Report	Provide an update on the status of landfill operations and intentions for next year including any rehabilitation undertaken.	Each year in Annual Report	Environmental Manager
	Provide an update on re-growth and rehabilitation of disturbed areas outside operational area.	Each year in Annual Report	Environmental Manager
	Provide an update on re-growth of vegetation on previously rehabilitated areas subject to rehabilitation.	Commencing in the year following first cell rehabilitation efforts	Environmental Manager
	Provide DWER with a copy of the Complaints Register.	Each year in Annual Report	Environmental Manager

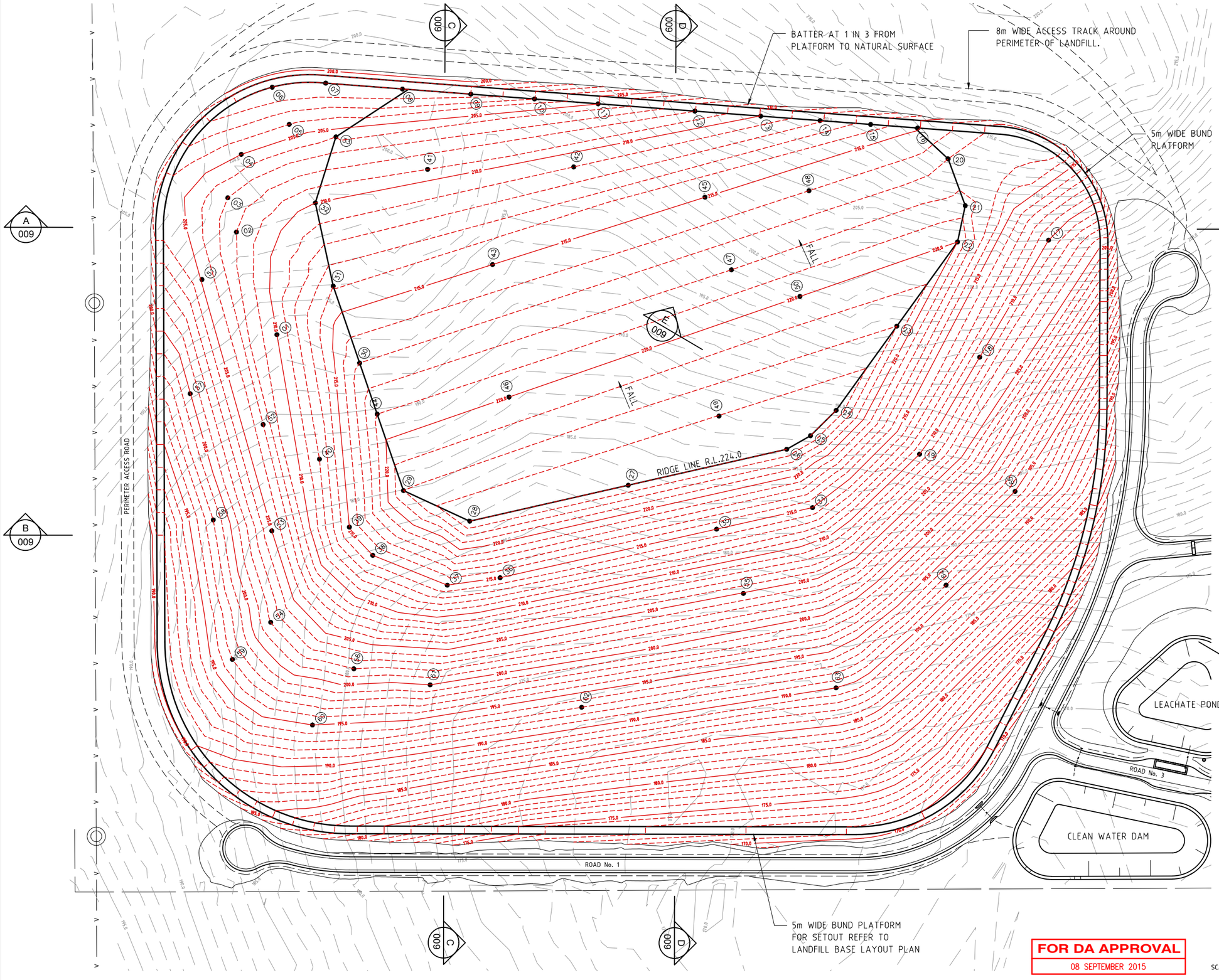
13 REFERENCES

EPA Victoria, Siting, Design, Operation and Rehabilitation of Landfill August 2016.

14 DRAWINGS

Drawing Fern-DA-008 Landfill Finished Waste Surface Layout Plan

Drawing Fern-DA-009 Landfill Finished Waste Surface Cross Sections



NOTE:
SURFACE SHOWN IS NOMINAL UNDERSIDE OF CAPPING LAYER.

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FINISHED SURFACE SETOUT TABLE

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24	402569.990	6545864.260	224.000
25	402553.342	6545847.802	224.000
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28	402331.971	6545792.258	224.000
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39	402253.783	6545788.440	215.000
40	402234.342	6545832.574	212.000
41	402304.572	6546020.802	209.000
42	402399.525	6546022.404	211.000
43	402346.769	6545958.973	215.000
44	402271.861	6545861.834	219.000
45	402484.807	6546002.703	215.000
46	402357.469	6545872.911	220.000
47	402501.977	6545955.572	218.000
48	402552.335	6546006.923	216.000
49	402493.873	6545860.548	223.021
50	402546.490	6545938.263	220.000
51	402158.010	6545949.260	205.000
52	402197.757	6545855.069	207.000
53	402203.384	6545785.975	205.000
54	402202.656	6545726.608	202.000
55	402509.750	6545745.360	205.000
56	402256.702	6545696.391	202.000
57	402150.370	6545875.087	200.000
58	402165.349	6545793.091	198.000
59	402177.750	6545702.469	197.000
60	402229.807	6545659.890	195.000
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FOR DA APPROVAL
08 SEPTEMBER 2015

SCALE 25 0 50 100m 1 : 1250

Bowman & Associates Pty Ltd
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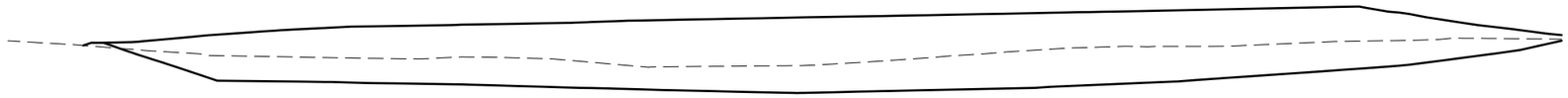
Client	Location	Drawing Title
Aurigen Group Limited	Fernview Farm, Lot 98 Wannamal Road South, Cullalla	Landfill Finished Waste Surface Layout Plan

Date	Scale	Design By	Drawn By	Project	Drawing Number	Revision	Drawing Size
08/09/15	1:1250	B.W.B.	S.B.Y.	Proposed Landfill - Development Application	Fern - DA - 008	A	A1



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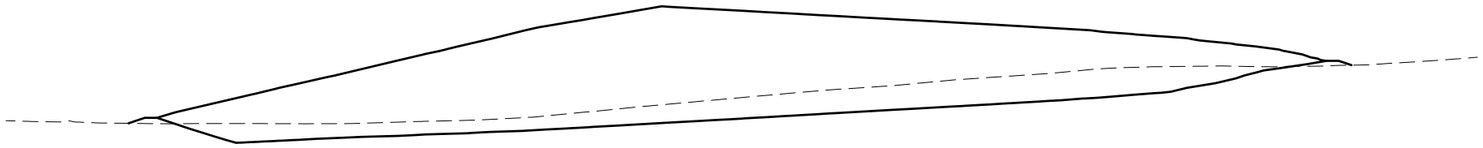

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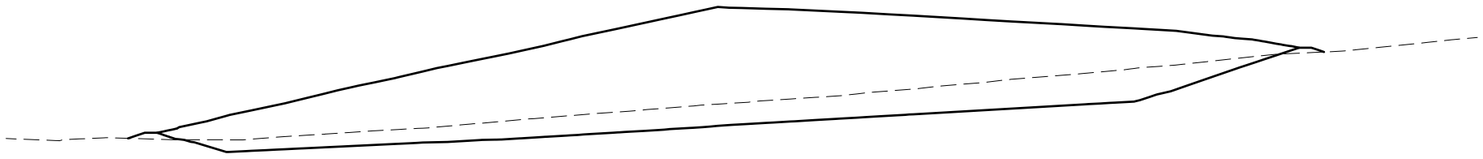

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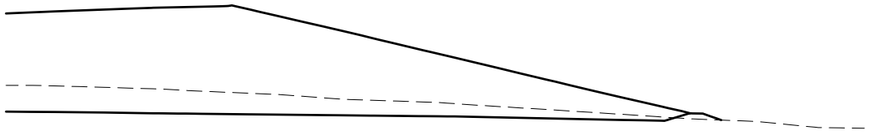

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FOR DA APPROVAL
08 SEPTEMBER 2015

SCALE 25 0 50 100m 1 : 1250

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Client	Location	Drawing Title
Aurigen Group Limited	Fernview Farm, Lot 98 Wannamal Road South, Cullalla	Landfill Finished Waste Surface Cross Sections

Date	Scale	Design By	Drawn By	Project	Drawing Number	Revision	Drawing Size
08/09/15	1:1250	B.W.B.	S.B.Y.	Proposed Landfill - Development Application	Fern - DA - 009	A	A1

15 LANDFILL GAS RISK ASSESSMENT

Landfill Gas Risk Assessment

A risk assessment of all identified potential environmental risks associated with the management of landfill gas on site has been undertaken. The primary consideration being the potential impact to on-site personnel and infrastructure and neighbouring residential properties (if any).

The landfill gas risk has been assessed based on the DWER *Risk Assessment Guidance Statement February 2017*. This document rates risks based on the likelihood and consequence of landfill gas impacting on the environment and public health.

Risk Criteria - For environmental and public health impacts there are the following Consequences:

- Environmental:
    - Slight:
        - On-site impact: minimal, and
        - Specific Consequence Criteria (for environment) met.
    - Minor:
        - On-site impacts: low level,
        - Off-site impacts local scale: minimal,
        - Off-site impacts wider scale: not detectable, and
        - Specific Consequence Criteria (for environment) likely to be met.
    - Moderate:
        - On-site impacts: mid-level,
        - Off-site impacts local scale: low level,
        - Off-site impacts wider scale: minimal, and
        - Specific Consequence Criteria (for environment) are at risk of not being met.
    - Major:
        - On-site impacts: high level,
        - Off-site impacts local scale: mid-level,
        - Off-site impacts wider scale: low level,
        - Short term impact to an area of high conservation value or special significance, and
        - Specific Consequence Criteria (for environment) are exceeded.
    - Severe:
        - On-site impacts: catastrophic,
        - Off-site impacts local scale: high level or above,
        - Off-site impacts wider scale: mid-level or above,
        - Mid to long term or permanent impact to an area of high conservation value or special significance, and

        - Specific Consequence Criteria (for environment) are significantly exceeded.

- Public Health and Amenity:
    - Slight
        - Local Scale Impacts: minor impacts to amenity, and
        - Specific Consequence Criteria (for Public Health) criteria met.
    - Minor:
        - Specific Consequence Criteria (for public health) are likely to be met, and,
        - Local Scale Impacts: Low-level impact to amenity.
    - Moderate:
        - Adverse health effects: low level or occasional medical treatment,
        - Specific Consequence Criteria (for public health) are at risk of not being met, and
        - Local Scale Impacts: Mid-level impact to amenity.
    - Major:
        - Adverse health effects: mid-level or frequent medical treatment,
        - Specific Consequence Criteria (for public health) are exceeded, and
        - Local Scale Impacts: High-level impact to amenity.
    - Severe:
        - Loss of life,
        - Adverse health effects: high level or ongoing medical treatment,
        - Specific Consequence Criteria (for public health) are significantly exceeded, and
        - Local Scale Impacts: Permanent loss of amenity.

Likelihood:

- Rare – The risk event may only occur in exceptional circumstances.
- Unlikely – The risk will probably not occur in most circumstances.
- Possible – The risk event could occur at some time.
- Likely – The risk event will probably occur in most circumstances.
- Almost Certain – The risk event is expected to occur in most circumstances.

Table 1 – Risk Rating Matrix provides the risk rating based on the relevant risk likelihood and consequence.

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

The outcome of the risk assessment is that there is a low risk of landfill gas impact on any receptors, including the nearest residential property as a result of the site activities.

Table 2 – Landfill Gas Management Risk Assessment provides the detail of the risk assessment.

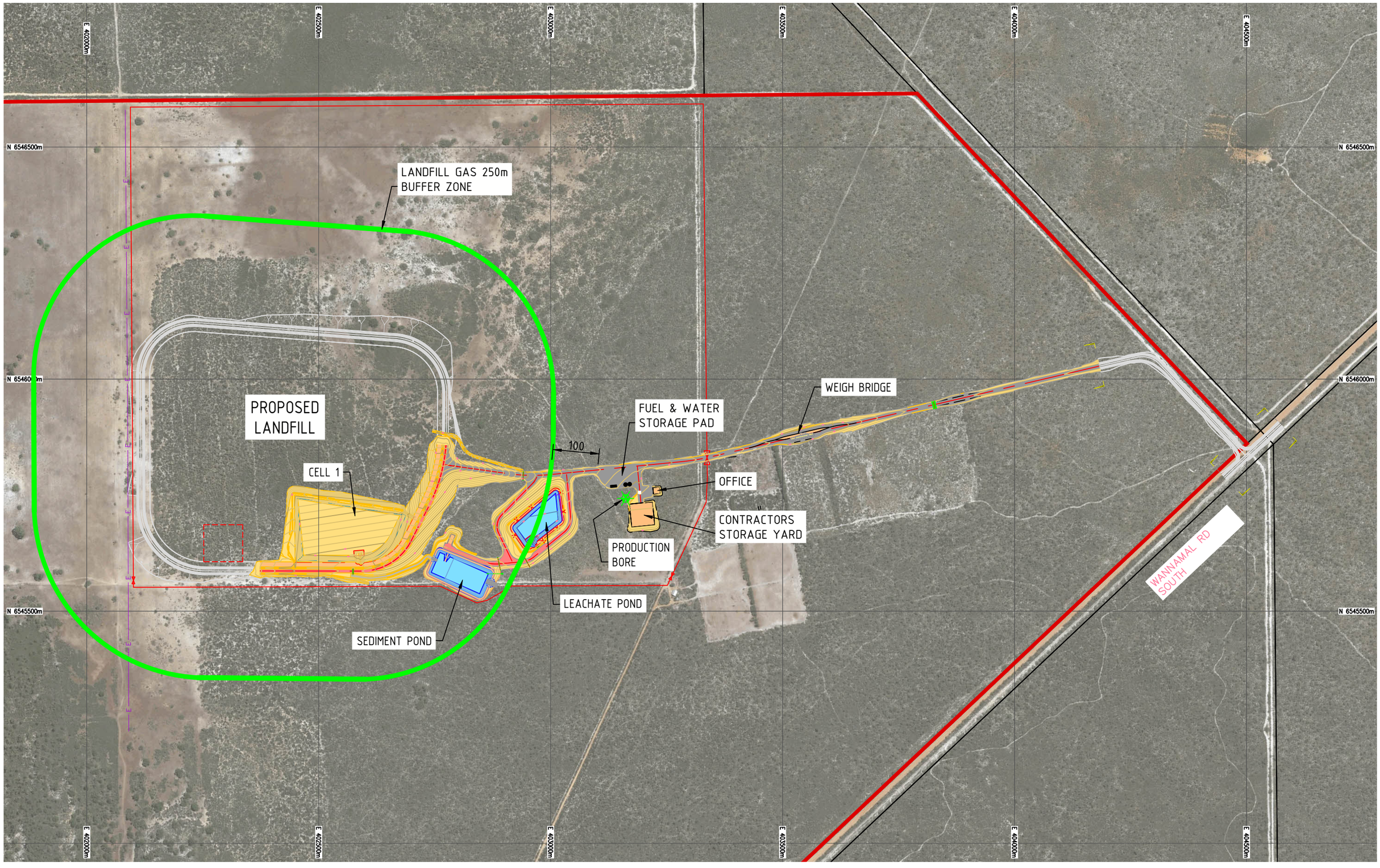
Table 2 – Landfill Gas Management Risk Assessment

Emission Source Description	Environmental Impact Risk	Management Tools and Mitigation Options/Factors	Activation Trigger and Corrective Action	Monitoring of Corrective Action Efficiency	Contingency Action if Corrective Action is Ineffective	Likelihood & Consequence	Risk Level
Subterranean landfill gas migration.	Subterranean landfill gas migration impacting on adjacent landfill infrastructure. Refer to the attached Site Layout Plan.	Best practise landfill lining system, including a leak detection system, landfill operations gas extraction will ensure absolute minimum landfill gas emissions through the liner and into the surrounding soil. Naturally occurring sandy soil has low resistant to gas migration; however, enables rapid dispersion of any gas emissions and hence reduces the distance of the migration. No belowground services except landfill gas pipes; hence, no preferential gas flow pathway. Nearest on-site infrastructure (fuel and water storage pad) is in excess of 350 m from the edge of the landfill and this infrastructure has no below ground services trenches. No landfill gas monitoring bores are proposed due to the total absence of preferential flow paths for any gas migration and the fact that the above mitigating factors make it highly unlikely that there would be any negative impact from landfill gas.	Activation Trigger: • Landfill gas odour detected. • Landfill gas surface monitoring indicates the presence of landfill gas. • Dead vegetation surrounding the landfill. Corrective Action: • Identify the location of where the gas is emitting. • Identify the gas flow pathway (possible trench excavation). • If possible, cut off the flow pathway. • Allow the accumulated gas to dissipate. • May be necessary to install a gas venting system. • May be necessary to install gas monitoring bores.	Undertake landfill gas monitoring of the area immediately around the original emission point to confirm that the gas flow has ceased. Repeat monitoring a week later to again confirm that the gas flow has ceased.	Further investigation and remedial action to detect and cut off the gas flow.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Low
	Subterranean landfill gas migration impacting on the nearest neighbouring infrastructure – farm shed 1.3km and farmhouse 2km south of the landfill. Note: The *Best Practice Guidelines for Siting, Design,*	Neighbouring infrastructure substantially beyond (+5 times) the influence zone considered in the Victorian landfill development guidelines. Minimum 1.3km separation distance. Best practise landfill lining system, including a leak detection system, landfill operations gas extraction will ensure absolute minimum landfill gas emissions through the liner and into the surrounding soil.	Activation Trigger: • Landfill gas odour detected. • Landfill gas surface monitoring indicates the presence of landfill gas. • Dead vegetation surrounding the landfill. Corrective Action: • Identify the location of where the gas is emitting.	Undertake landfill gas monitoring of the area immediately around the original emission point to confirm that the gas flow has ceased. Repeat monitoring a week later to again confirm that the gas flow has ceased.	Further investigation and remedial action to detect and cut off the gas flow.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Low

Emission Source Description	Environmental Impact Risk	Management Tools and Mitigation Options/Factors	Activation Trigger and Corrective Action	Monitoring of Corrective Action Efficiency	Contingency Action if Corrective Action is Ineffective	Likelihood & Consequence	Risk Level
	Operation and Rehabilitation of Landfills (Victorian EPA, August 2016), Table B.2 only deals with developments within 250 m of the landfill.	Naturally occurring sandy soil has low resistant to gas migration; however, enables rapid dispersion of any gas emissions and hence reduces the distance of the migration. No belowground services between the neighbouring infrastructure and the landfill; hence, no preferential gas flow pathway. No landfill gas monitoring bores are proposed due to the substantial distance to the neighbouring infrastructure and the absence of preferential flow paths for any gas migration and the fact that the above mitigating factors make it highly unlikely that there would be any negative impact from landfill gas.	• Identify the gas flow pathway (possible trench excavation). • If possible, cut off the flow pathway. • Allow the accumulated gas to dissipate. • May be necessary to install a gas venting system. • May be necessary to install gas monitoring bores.				
Fugitive landfill gas emissions.	Consistent odour emissions (amenity impact), gas concentrations (explosive risk) and toxins (health impact) beyond the landfill perimeter and impacting on the site users. Refer to the attached Site Layout Plan.	Buffer distance and topography between odour source and site office and weighbridge provides significant opportunity for any odour emissions, gas concentrations and toxins to dissipate. External work activities in close proximity to the landfill will potentially be impacted by landfill gas related odour; however, during this will be minimal and variable.	Physical nature of the site. Nil corrective actions possible.	Physical nature of the site. Nil corrective actions possible.	Physical nature of the site. Nil contingency actions possible.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Fugitive landfill gas emissions.
		Compliance with the DWER landfill development requirements ensures the appropriate design and construction of the landfill infrastructure. In particular the landfill liner, landfill gas extraction system and landfill capping to be able to adequately manager the level of fugitive gas emissions from the landfill.	Activation Trigger: • Inability to obtain a Works Approval (due to substandard infrastructure design). Corrective Action: • Amend design to comply with the appropriate guidelines.	Able to obtain a Works Approval.	Further amendments to the design to comply with the appropriate guidelines.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Low

Emission Source Description	Environmental Impact Risk	Management Tools and Mitigation Options/Factors	Activation Trigger and Corrective Action	Monitoring of Corrective Action Efficiency	Contingency Action if Corrective Action is Ineffective	Likelihood & Consequence	Risk Level
		Appropriate construction quality control to ensure that the construction works are carried out to the required standards.	Activation Trigger: • Substandard construction works identified. Corrective Action: • Increase construction quality control.	Confirm construction works carried out according to specifications.	Rigorous enforcement of contract conditions and technical specification. Withhold payment for works. Dispute resolution process.	Environmental Rare & Slight Public Health Rare & Slight	Low
		Appropriate training and monitoring of landfill operator performance to ensure that the landfill is operated to best practise standards.	Activation Trigger: • Operator performance is identified as being substandard. • On-site odour monitoring identifies unreasonable levels of odour. • An odour complaint is received. Corrective Action: • Improve staff training and monitoring of performance in order to achieve the necessary standard of performance on site.	Confirm landfill operator performance is operated to best practise standards. Consult with complainant to see if the odour concerns have been solved.	Replace operations staff.	Environmental Rare & Slight Public Health Rare & Slight	Low
		Utilisation of specialist landfill gas contractor to design, install and manage the gas extraction infrastructure. This ensures best practise landfill gas management and hence, optimisation of gas capture and destruction, resulting in minimal fugitive gas emissions from site. Contract conditions to transfer the appropriate level of control to the contractor to ensure that the landfill gas system is installed, operated	Activation Trigger: • Contractor performance is identified as being substandard. • On-site odour monitoring identifies unreasonable levels of odour. • An odour complaint is received. Corrective Action: • Rigorous enforcement of contractual conditions.	More regular odour monitoring of contractor performance. Consult with complainant to see if the odour concerns have been solved.	Amend contract to capture operational shortcomings. In an extreme case, replace contractor.	Environmental Rare & Slight Public Health Rare & Slight	Low

Emission Source Description	Environmental Impact Risk	Management Tools and Mitigation Options/Factors	Activation Trigger and Corrective Action	Monitoring of Corrective Action Efficiency	Contingency Action if Corrective Action is Ineffective	Likelihood & Consequence	Risk Level
		and monitored in accordance with licence conditions and best practise. Progressive installation of landfill gas extraction system to maximise landfill gas extraction. Progressive installation of landfill capping system to minimise landfill gas fugitive emissions. Monitoring and maintenance of gas extraction system to ensure optimum operation of the system.					
		Regular monitoring of the performance of the gas extraction network and making adjustment and or repairs as required. The Victorian landfill development guidelines set rigorous fugitive gas emission limits and action levels. Compliance with these maximum emission levels will substantially reduce fugitive gas emissions from site.	Activation Trigger: • On-site odour monitoring identifies unreasonable levels of odour. • An odour complaint is received. Corrective Action: • Rigorous enforcement of contractual conditions.	More regular odour monitoring of contractor performance. Consult with complainant to see if the odour concerns have been solved.	Amend contract to capture operational shortcomings. In an extreme case, replace contractor.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Low
Fugitive landfill gas emissions.	Consistent odour emissions (amenity impact), gas concentrations (explosive risk) and toxins (health impact) beyond the site boundary and impacting on the nearest neighbouring residential property - farmhouse 2km south of the landfill. Note: The *Best Practice Guidelines for Siting, Design, Operation and*	Buffer distance (8 times) and topography between odour source and nearest residential receptor provides significant opportunity for any odour emissions, gas concentrations and toxins to dissipate.	Physical nature of the site. Nil corrective actions possible.	Physical nature of the site. Nil corrective actions possible.	Physical nature of the site. Nil contingency actions possible.	<u>Environmental</u> Rare & Slight <u>Public Health</u> Rare & Slight	Fugitive landfill gas emissions.
		Compliance with the DWER landfill development guidelines ensures the appropriate design and construction of the landfill infrastructure. In particular the landfill liner, landfill gas extraction system and landfill capping to be able to adequately	Activation Trigger: • Inability to obtain a Works Approval (due to substandard infrastructure design). Corrective Action:	Able to obtain a Works Approval.	Further amendments to the design to comply with the appropriate guidelines.	<u>Environmental</u> Rare & Slight <u>Public Health</u>	Low



FERNVIEW ENVIRONMENTAL

FERNVIEW LANDFILL FACILITY

LANDFIL GAS BUFFER ZONE

0 10 20 30

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DRAWN:	MR	24/08/20
CHECKED:	RR	24/08/20
APPROVED:		

DRAWING NUMBER: MSE1221-SK-04

REVISION: A

UNO SCALE: 1:7500

SHEET: 1 OF 1

SIZE A3