TECHNICAL MEMORANDUM

DATE 29 May 2020 **Reference No.** 1777197-048-M-Rev1

TO State Resource Development Manager, Alkina Holdings Pty Ltd

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FROM Ed Clerk **EMAIL** eclerk@golder.com.au

PROPOSED GREAT SOUTHERN LANDFILL (GSL) – LANDFILL CLOSURE OBJECTIVES AND MEASURES

1.0 INTRODUCTION

Alkina Holdings Pty Ltd (Alkina) proposes to construct a Class II lined landfill, designed to accept putrescible wastes, which will be called the Great Southern Landfill (GSL or the site). The Site is located on Allawuna Farm lots 4869, 5931, 9926, and 26934 Great Southern Highway, St Ronans, in the Shire of York.

The proposed landfill would receive 150 000 to 250 000 tonnes per annum of Class II or III waste, with a lifetime capacity of approximately 5.6 million cubic metres. The cells for the landfill would be developed in stages, with the construction of up to seven cells.

The proposed GSL is being assessed by the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act). As part of this assessment process, an Environmental Scoping Document (ESD) has been developed by the EPA which identifies the preliminary key environmental factors to be considered and defines the form and content required of the Environmental Review Document (ERD) currently being developed by Alkina.

The purpose of this memorandum is to provide information for Alkina to incorporate into their ERD related to work items 14, 25 and 34 of the ESD which require Alkina to provide/discuss the "…*closure and rehabilitation measures to be implemented, and outcomes/objectives to be achieved"* as they relate to the preliminary key environmental factors of:

- Terrestrial fauna
- Terrestrial environmental quality
- Inland waters.

2.0 CLOSURE REQUIREMENTS

Given the project is currently undergoing assessment by the EPA, operating licence and/or Shire conditions relating to landfill closure are yet to be imposed. Should such conditions be written into GSL licencing or approval documents, then they will be captured in future revisions of the Landfill Management Plan, and included in the final GSL Closure Plan.

As no specific guideline is provided by the Department of Water and Environmental Regulation (DWER) in relation to the construction of a landfill and associated design, the EPA Victoria Publication 788.3, Best Practice Environmental Management; Siting, Design, Operation and Rehabilitation of Landfills (Vic BPEM) guidelines (August 2015) is considered to present the most applicable best practice guideline to manage the potential risks at the Site and has, therefore, been adopted for general guidance at GSL. DWER has previously demonstrated its support of the use of Vic BPEM rehabilitation and aftercare principles being adopted for the closure of landfills in Western Australia.

According to these Guidelines, best practice rehabilitation of landfills should include consideration of post-closure land use, settlement and final surface profile and landfill cap. The required outcomes of best practice landfill rehabilitation are to:

- Consider after use options for the Site
- Ensure that seepage through the landfill cap is no more than 75% of the anticipated seepage rate through the landfill liner
- Design and construct the best cap practicable to prevent pollution of groundwater and degradation of air quality through the escape of landfill gas
- Design and construct the most robust cap to ensure that the system will continue to achieve the objective in the event of several components of the system failing
- Progressively rehabilitate the landfill.

3.0 CLOSURE OBJECTIVES

3.1 Post Closure Land Use

A post closure land use has yet to be identified and agreed upon for the GSL. Ongoing stakeholder engagement throughout development and operation will include discussion on potential future land uses for the site. It is likely that a return to the pre-development land use i.e. farming activity, would be favoured. Other land use options would be considered should it be identified that farming activity presents a risk to achieving closure objectives. Other land use options will need to be agreed with landowners, suitable for current local government zoning requirements and present a lower level of risk towards achieving closure objectives.

The proposed closure objectives and measures outlined in the following sections are conceptual only and will need to be reviewed and revised based on the preferred post closure land use/s to be agreed with stakeholders.

3.2 Preliminary Closure Objectives

The overarching objective for site closure is to a deliver safe, stable, and non-polluting landform that is compatible with the surrounding pre-development terrestrial environmental quality and is suitable for the agreed post closure land use.

The following closure objectives have been developed for the proposed GSL.

Safe

- Materials harmful to human health will be buried, encapsulated, and/or remediated
- Potential attractants to disease vectors and vermin will be buried, encapsulated, or removed

- Final landforms will not pose unacceptable risks to people or fauna
- Infrastructure will be removed unless agreed to by regulators and transferred to post-closure landowners/managers.

Stable

- Final landforms will be geotechnically and erosionally stable.

Non-Polluting

- No deterioration of groundwater quality caused by seepage of recycled leachate from the landfill cells and recycled leachate pond
- No deterioration of downstream surface water resulting from seepage or run off from the landform (including sediment)
- Contaminated soils and groundwater will be remediated as required for the agreed post closure land use.

4.0 CLOSURE MEASURES

The following sections set out the conceptual closure measures to be implemented to achieve the objectives as stated in Section 3.2.

4.1 Final Landform Concept

For areas disturbed by landfill activities (i.e. the landfill footprint), the objective of the final landform will be to rehabilitate the landform to enable future reuse of the site in accordance with the agreed post-closure land use.

The final landform will be above the natural ground level but designed to tie-in with the existing topography of the surrounding area. It will be free draining and undulating (dome shaped) with inclines of 1V:5H, or 20%, whilst the highest point will be approximately 35 m above the pre-development ground surface.

Surface water and sediment management measures will be included in the final landform design, as described in Section 4.3.

The conceptual final waste landform for the GSL is shown in Figure 1.

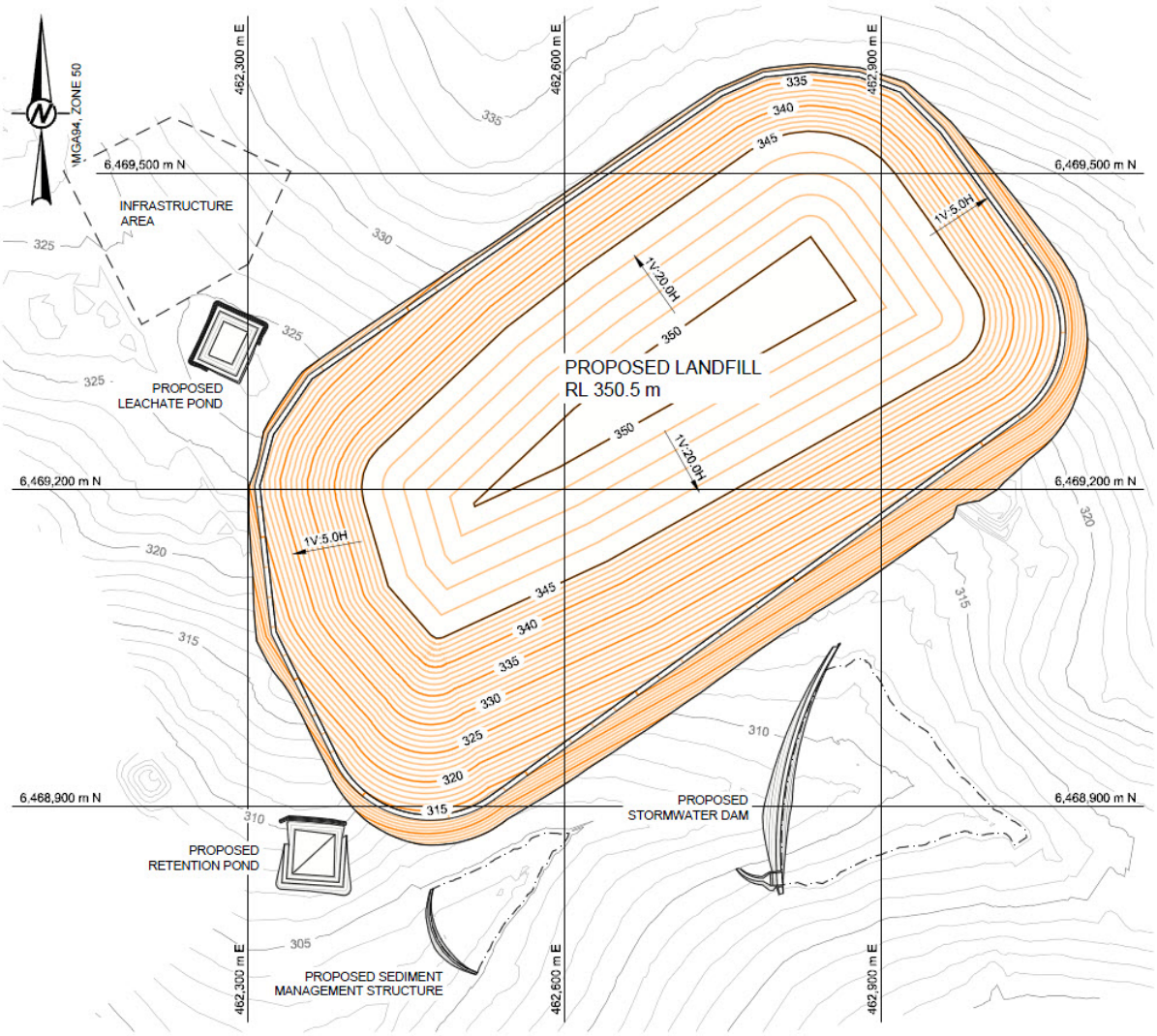

Figure 1: Conceptual final landform

4.2 Cell Capping

A capping system will be constructed over the final landform to:

- Minimise infiltration of water into the waste, reducing the infiltration rate does not exceed the seepage rate through base of the landfill
- Provide a long-term stable barrier between waste materials and the environment
- Prevent the uncontrolled escape of landfill gas
- Provide land suitable for its intended post closure use.

The capping system design will be developed prior to application, but a conceptual capping system has been developed for the Site, with the intent of achieving the identified closure objectives. The conceptual capping system is shown in Figure 2 and comprises a low permeability engineered liner and drainage layer, overlain by 1 m of soils.

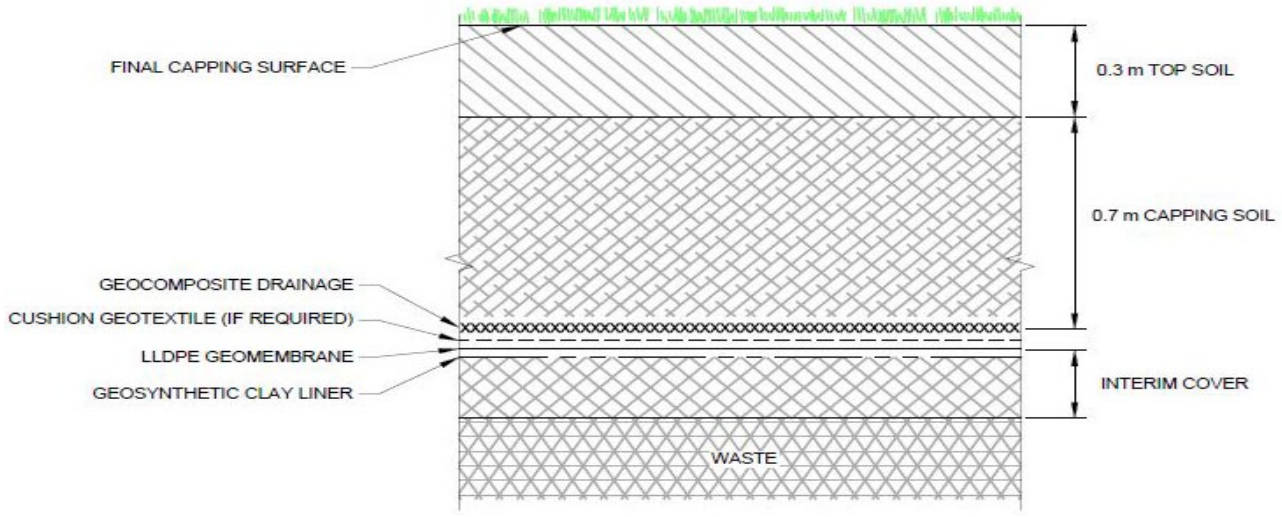

Figure 2: Conceptual capping design

Closure and rehabilitation of the landfill, which will include construction of capping layers and stormwater measures, should occur as a cell or cells reach final height (see Section 4.7).

4.3 Surface Water and Sediment Management

The Site is located in the upper reaches of the Thirteen Mile Brook, close to the catchment divide with the adjacent Six Mile Brook. Both watercourses ultimately drain to the Avon River. A small, ephemeral creek is located directly adjacent to the proposed development site and flows into the Thirteen Mile Brook approximately 250 m to the south-west of the site.

The overall surface water and sediment control strategy for closure comprises:

- Drainage control measures aimed at preventing or reducing soil erosion caused by concentrated flows over the final landform (i.e. landform reshaping).
- Erosion control measures aimed at preventing or reducing soil erosion caused by rain drop impact and sheet flow (i.e. landform reshaping, capping and revegetation of the final landform surface).
- Sediment control measures aimed at trapping and retaining sediment on site (i.e. a Sediment Management Structure).

Operational water bodies (e.g. stormwater dam, retention ponds) that are no longer required will be decommissioned, backfilled and rehabilitated during the closure works period.

4.4 Leachate Management

The operational leachate collection and treatment system, including subsurface drainage management measures, will need to be inspected and maintained for as long as the landfill is actively generating leachate. Following this period, the leachate collection and storage infrastructure will be decommissioned and removed. The disturbance footprints will be reshaped to align with surrounding contours and will be revegetated.

Leachate generation will be reduced through progressively reshaping to the final landform shape and capping waste as soon as possible after the final top of waste is achieved (see Section 4.5).

The final landform will be reshaped to shed surface water, and along with the low permeability capping system, infiltration into the landfill will be minimised to reduce ongoing leachate generation.

4.5 Remediation

Any soils or groundwater identified as potentially contaminated will be assessed and remediated (if required) in accordance with the Contaminated Sites Act (2003).

4.6 Revegetation

Disturbed areas will be revegetated using vegetation species suitable for the agreed post closure land use/s. Assuming the post-closure land use is a form of farming or grazing activity, typical regional pasture species would be sown.

On the landfill itself, direct seeding will be used to establish shallow-rooted native grasses, herbs, and shrubs. At this stage it is proposed that deep-rooted overstorey species are not established on the landfill cells as their roots may damage the underlying capping system. However, should alternative capping technology be developed in the future allowing for deep-rooted over-storey species, such flora may be considered. If landform erosion is a site risk, livestock would likely be excluded from the rehabilitated final landform area and non-palatable species would be used on its surface.

4.7 Progressive Closure

The landfill will be progressively closed as individual landfill cells or portions of the landfill reach the ultimate design profile, these areas will be reshaped to the final landform profile, capped, and revegetated.

The benefits of progressive closure include:

- Progressively closing off portions of the site
- Increased ability to shed surface water off the landfill and reduce the quantity of leachate being generated
- Reduced ongoing closure liability costs
- Reduced potential attractors to disease vectors, including reduced odour, vermin, and other feral animals
- Using the capping costs incurred, as a guide to assist in determining the closure reserves that will be required towards the end of the life of the landfill and during the post closure period
- Reduced litter generation
- Improved aesthetics.

5.0 POST-CLOSURE MONITORING AND MAINTENANCE

A post closure monitoring and maintenance plan will be developed in future versions of the GSL Closure Plan and will be aligned with closure objectives and completion criteria.

The Vic BPEM Guidelines state that the typical period for aftercare for a putrescible landfill is approximately 30 years. The GSL will, in this early iteration of a landfill rehabilitation and closure plan, adopt the Vic BPEM guidance and assume a 30-year aftercare period for monitoring and maintenance activities. This period may be revised—extended or reduced, based on the outcomes of such monitoring and maintenance activities and will be captured in future iterations of the GSL Closure Plan. The following areas relevant to the GSL will be considered in the post closure monitoring and maintenance plan:

- Maintenance of landfill cap to address any areas of erosion, restore any depressions, and seal and monitor cracks caused by settlement
- Monitor and maintain revegetation (e.g. reseeding, weed management)

- Maintenance and operation of leachate collection and treatment system
- Maintenance and operation of landfill gas extraction system
- Monitoring of groundwater, surface water, landfill gas, leachate, and settlement.

5.1 Post-closure Monitoring Activities

Monitoring and maintenance activities will be undertaken post-closure, until such a time that the landfill does not pose a risk to the environment. Additionally, leachate collection, gas collection, stormwater sediment controls, monitoring and reporting practices will be maintained to a standard equivalent to that employed during the operational life of the landfill. Criteria set by the project approval and other relevant legislation and guidelines will be adhered to.

Infrastructure establishment and ongoing monitoring activities for relevant closure aspects are outlined in Table 1.

Table 1: Post-closure monitoring activities

Closure Aspect	Completion Criteria	Monitoring Activity	Frequency	Monitoring Equipment/Network
Surface Water Management	Diversions and watercourses erode at a rate consistent with surrounding surface water features.	■ Full walk-through of the diversions, as well as upstream and downstream reaches, by a suitably qualified person to assess: ▪ Bank condition, including any piping ▪ Bed condition ▪ In-stream structures. ■ This will include taking photographs at set photo points and determining changes over time.	Annually	Established photo points within each stream and or diversion, as well as in the upstream and downstream reaches of the landfill area.
		■ Water quality monitoring[1] of field pH, total dissolved solids (TDS), electrical conductivity (EC), temperature, oxygen demand (OD) and oxidation reduction potential (ORP).	Six-monthly during closure implementation, annually thereafter	Surface water sampling of Thirteen Mile Brook (nearby and downstream locations to be identified).

[1] Water quality sampling will be undertaken by suitably qualified personnel in alignment with Australian Standard AS/NZS 5667.1-1998 (Water Quality – Sampling – Guidance on the design of sampling programmes, sampling techniques and the preservation and handling of samples).

Closure Aspect	Completion Criteria	Monitoring Activity	Frequency	Monitoring Equipment/Network
	Quantity and quality of streamflow to downstream environmental receptors are not significantly affected. The concentrations of contaminants of concern < derived risk-based criteria (Tier 1, 2 or 3) for the relevant future land use.	■ Water quality sample collection for lab analysis[2] (pH, EC, TDS, Cations (Ca, Mg, Na, K), Anions (Cl, SO4, Alkalinity), N as NO3, NH4, nitrite, Total N, TSS, Total P, Total and Dissolved Metals 13 metal suite (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Zn), Acidity). ■ Hydrocarbons (suite dependent on site-specific analysis of on-site chemicals). ■ *Laboratory suites may be refined as necessary during operation.*		On-site features that remain, if applicable, the stormwater dam, sediment retention dam, retention pond.
Groundwater Management	Groundwater flow and level regimes are similar to pre-landfill conditions upon cessation of operations. The concentrations of contaminants of concern < derived risk-based criteria (Tier 1, 2 or 3) for the relevant future land use.	■ Water quality monitoring of field pH, TDS, EC, temperature, OD, ORP and water level. ■ Water quality sample collection for lab analysis (pH, EC, TDS, Cations (Ca, Mg, Na, K), Anions (Cl, SO4, Alkalinity), N as NO3, NH4, nitrite, Total N, TSS, Total P, Total and Dissolved Metals 13 metal suite (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Zn), Acidity). ■ Hydrocarbons (suite dependent on site-specific analysis of on-site chemicals).	Six-monthly during closure implementation, annually thereafter	Existing monitoring wells: MB04, MB05, MB06, MB10, MB11, MB12, GMB05, GMB03 MB13*, MB14* and GMB06*. *Bores may be destroyed during landfill construction thereby additional monitoring wells may be required.

[2] All water samples will be submitted to a laboratory with current National Association of Testing Authorities (NATA) accreditation for the analysis undertaken.

Closure Aspect	Completion Criteria	Monitoring Activity	Frequency	Monitoring Equipment/Network
		■ *Laboratory suites may be refined as necessary during operation.*		
Ground Gas	No exceedances of the relevant Landfill Gas Action Levels, as per Vic BPEM, Table 6.4.	■ Monitoring of the performance of the gas extraction and destruction system[3]. As a minimum, the following monitoring is anticipated on the landfill areas: ▪ Flare operation ▪ Gas flow rate ▪ Oxygen content ▪ Methane content ▪ Moisture content ▪ Temperature. ■ *The monitoring locations and frequency will be determined by the landfill gas contractor.*	Six-monthly during closure implementation, annually thereafter	The gas management and control systems installed during the operation of the site will continue to operate during the post-closure period until the active gas generation phase is completed. The landfill gas monitoring program established during the operation of the site will serve as the basis for routine monitoring in the post-closure period.
		■ The following minimum locations will be monitored for fugitive emissions: ▪ Landfill surface final cap – around the capped surface and around penetrations through the capped surface		

[3] Gas monitoring will be undertaken by suitably qualified personnel in alignment with relevant Australian Standards.

Closure Aspect	Completion Criteria	Monitoring Activity	Frequency	Monitoring Equipment/Network
		▪ Landfill surface intermediate cover area – around the covered surface and around penetrations through the covered surface ▪ At the landfill gas flare. ■ *The monitoring locations and frequency will be determined by the landfill gas contractor.*		
Stability	Capping integrity remains intact. Waste slopes are not steeper than 1V:5H for the final landform. Embankment slopes are not steeper than 1V:3H for long term conditions (embankments that may be present for > 20 years).	■ Comparative LiDAR assessment and or survey and aerial photograph analysis to assess landform settlement.	Annually for years 1 – 10, biennially thereafter if trend towards stability demonstrated by year 10	Annual LiDAR pickup, survey and aerial photography of all closure landforms including the waste area and critical surface water diversions.
Erosion	Erosion rate at any point on a slope does not exceed the target threshold average rate by more than 100%.	■ Drone survey of all rehabilitated slopes to assess changes in elevation from CQA survey and therefore estimate soil loss rates over time.	Annually for years 1 – 10, biennially thereafter if trend towards stability demonstrated by year 10	

Closure Aspect	Completion Criteria	Monitoring Activity	Frequency	Monitoring Equipment/Network
		■ Visual assessment of high-risk slopes to ground truth soil loss estimates from survey data.		
		■ Visual inspection of areas of sheet, rill or gully erosion and estimate peak erosion rates by: ▪ Recording rill and gully abundance, width and depth ▪ Recording any areas (and extent) of sediment wash-off at the toe or immediately downstream of rehabilitated slopes.	Annually for years 1 – 10, biennially thereafter if trend towards stability demonstrated by year 10	Established photo points at areas of observed erosion to document changes over time.
Revegetation	Vegetation cover over time to be within tolerance range for key parameters (species diversity, species richness, species composition, ratio of native to introduced species) as compared to selected reference site/s.	■ Vegetation assessment of rehabilitation monitoring plots and analogue sites of: ▪ Species richness ▪ Species composition ▪ Ratio of native to introduced species.	Annually for years 1 – 5, biennially for years 6 – 10, triennially thereafter	Monitoring plots and photo points will be established in both off-site reference areas and rehabilitated areas of the landfill footprint

6.0 REFERENCES

Environmental Protection Authority (EPA) (1986). Environmental Protection Act (EP Act).

Environmental Protection Authority (EPA) Victoria (2015). Publication 788.3, Best Practice Environmental Management; Siting, Design, Operation and Rehabilitation of Landfills (Vic BPEM) guidelines (August 2015).

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https://golderassociates.sharepoint.com/sites/101511/shared documents/06 deliverables/correspondence out/055 - erd comments addendum/attachment c - revised rehabiliation memo/attachment c 1777197-048-m-rev1.docx