Decision Document

Environmental Protection Act 1986, Part V

Proponent: SITA Australia Pty Ltd

Works Approval: W5830/2015/1

Registered office: 3 Rider Boulevard
RHODES NSW 2138

ACN: 002 902 650

Premises address: Allawuna Farm Landfill
2556 Great Southern Highway
ST RONANS WA 6302
Being Part of Lot 4869 on Plan 224502 as depicted in Appendix C and defined between the following Global Positioning System positions:

Position No.	Latitude	Longitude
1	116° 36' 46.9" E	31° 54' 13.87" S
2	116° 35' 35.19" E	31° 54' 42.02" S
3	116° 36' 11.2" E	31° 55' 13.47" S
4	116° 37' 20.34" E	31° 55' 9.64" S

Issue date: Thursday, 17 March 2016

Commencement date: Monday, 21 March 2016

Expiry date: Monday, 20 March 2023

Decision

Based on the assessment detailed in this document the Department of Environment Regulation (DER) has decided to grant a works approval. DER considers that in reaching this decision, it has taken into account all relevant considerations.

Decision Document prepared by: Lauren Fox
Licensing Officer

Decision Document reviewed by: Alan Kietzmann
Manager Licensing (Waste Industries)

3 Executive summary of proposal and assessment

Works approval W5830/2015/1 has been granted for the construction of Cells 1 and 2 of a Class II putrescible landfill located at Lot 4869 Great Southern Highway in Saint Ronans. The landfill meets the description and design capacity of a Category 64 landfill as defined in Schedule 1 of the *Environmental Protection Regulations 1987*. The Premises is located on a portion of the Allawuna Farm, an area of approximately 1,500 hectares, which consists of approximately 75% of cleared land for sheep grazing and broad acre crop production with the remaining 25% consisting of remnant vegetation. The landfill footprint area is approximately 36 hectares with the remainder of the property proposed to remain under the current land use arrangements, which is incorporated into the specified prescribed premises boundary within Lot 4869.

Development approval (DA) for the landfill was granted by the State Administrative Tribunal (SAT) on 8 March 2016 subject to conditions.

Cells 1 and 2 will each be constructed in two parts (a and b) with approximately 1.75 million m^3 of airspace available. Based on a proposed input of between 150,000 and 250,000 tonnes of waste per year, Cells 1 and 2 would have a combined operational life expectancy of approximately 6 to 7 years. This application is for the proposed construction of Cells 1 and 2 only however the application addresses the design and investigations undertaken for the whole landfill area encompassing the construction and filling of 6 cells over a period of approximately 20 years with an estimated 5.6 million m^3 of waste being landfilled.

An assessment of the works approval application is presented in Section 4 (Decision Table and supporting Appendix A). This includes but is not limited to an assessment of the suitability of containment provided by the proposed engineered cell design in the context of the proposed waste types and the sensitivity of the environmental setting.

Potential emissions associated with landfilling of Class II waste include leachate, landfill gas, odour, dust and noise. All of these emissions have been considered in the assessment of the landfill siting and design and associated potential risk to sensitive receptors undertaken by the Chief Executive Officer's (CEO's) delegate.

Identified receptors include, but are not be limited to, residences in the surrounding area, groundwater and surface watercourse including the Thirteen Mile Brook located approximately 150m west of the retention pond.

The CEO's delegate considers that the landfill does not represent an unacceptable risk to human receptors. An assessment of odour, landfill gas, dust and noise emissions together with potential impacts associated with surface water management, litter and vermin are provided in Section A7 and A10 – A21 of Appendix A.

The CEO's delegate considers that the landfill does not represent an unacceptable risk to the environment based on the data and conceptual site model presented. An assessment of the environmental setting, liner design, landform stability, surface water management, cover availability and risk of leachate emissions to groundwater is presented in Sections A2 to A9 of Appendix A.

There is considerable community interest in the proposal. 69 individual submissions were received from the community following the application being advertised in *The West Australian* and *Hills Gazette* newspapers, with some of these submissions submitted by community groups or signed by multiple people. All representations have been considered by the CEO's delegate in her determination of the application. Further information relating to these representations and how they have been considered is included in Appendix B.

A3 Landfill Liner and Leachate Management System Design

A3.1 Liner Design Components and Separation to Groundwater

An assessment of the proposed liner design provided in the Golder Report has been undertaken and the CEO's delegate considers it appropriate. The following summarises the main components as depicted in Figure A3.1:

- 0.3m of leachate drainage aggregate;
- Cushion geotextile;
- 2.0mm High Density Polyethylene (HDPE) geomembrane;
- 0.01m Geosynthetic Clay Liner (GCL) with a hydraulic conductivity of at least 1 x10^{-11} m/s;
- 0.5m of engineered clayey material, increased to a 1.5 m layer where sandy areas are identified.

Geotechnical testing of in-situ soils demonstrated that the clayey material was not suitable however, if used in conjunction with a geosynthetic clay liner (GCL), the existing material can still be used to form a compacted clay liner system which is detailed in the section A3 for liner design. The CEO's delegate agrees that the clayey material used together with a GCL is suitable for use in the liner system.

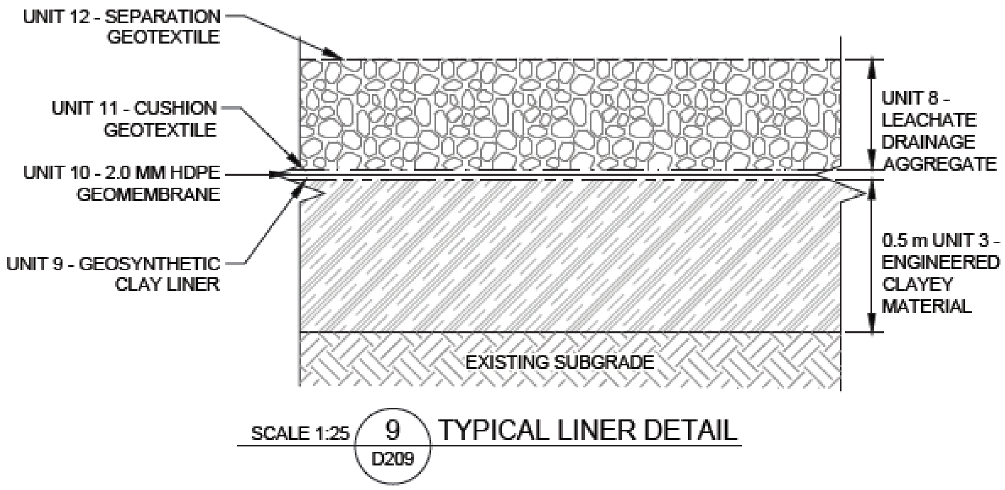
Prior to installing the liner, any geotechnically unsuitable or sandy regolith identified during the excavation for cell construction is to be removed and replaced with compacted clayey soil material sourced from the locally cut material during cell construction. The estimated extent of the deeper sandy material is depicted in Appendix H and is expected to be localised.

The Golder Report indicates that the material is likely to achieve compaction to a permeability of 1 x 10^{-8} m/s. The CEO's delegate notes that the permeability of this material has not been considered in the assessment of risk to groundwater. The liner, as designed provides adequate containment.

The sub base geology beneath the compacted geotechnically approved fill layer typically comprises sandy clay and clayey sand regolith overlying granite bedrock (also refer to the geological description in section A2.3.3).

Condition 1.2.2 in the Works Approval requires that there is at least 2m separation to groundwater below waste at the base of the landfill. (The designed base of the landfill, as illustrated in Figures D7 and D8 of Appendix D (Figures D207 and D208 of the Golder Report), includes a minimum 2.5m separation from the base of waste to the highest predicted groundwater level (including groundwater levels which are indicative of an unconfined water table and those indicative of a semi-confined potentiometric head).

Figure A3.1: Proposed Landfill Liner Design *(Source: Golder Report, Appendix B)*



A3.2 Assessed Liner Performance

The Golder Report indicates that the designed liner system for both the landfill and leachate pond have been designed to *"contain the leachate for a period of up to 100 years"* with any breach of the liner systems not anticipated to occur within that period.

Golder discussed the risk of liner failure in the document *Allawuna - Response to DER Queries dated 20 July 2015 - Leachate Management,* dated 14 September 2015. Golder used Darcy's law constitutive equation using the following inputs to calculate the estimated time it would take for any leachate as the result of liner failure to reach Thirteen Mile Brook:

- Distance to nearest receptor (Thirteen Mile Brook is located 310m from landfill cells);
- Distance to groundwater of 2.5 m (with the top 0.5m being compacted clayey material);
- Permeability of compacted clayey material of 1×10^{-8} m/s when saturated with leachate;
- In-situ clay permeability of between 2.3×10^{-7} and 6.9×10^{-6} m/s; and
- Effective porosity of compacted clayey materials and in-situ clay of 0.25.

The influence of the HDPE and GCL layers has not been considered for the purposes of Golder's assessment. Golder has estimated that it would take an average of 350 years for any leachate to reach the Thirteen Mile Brook in the event of liner fail. DER has assessed the travel time for groundwater from the toe of the landfill to Thirteen Mile Brook would be about 125 years, and from the rear of the landfill footprint the same journey would take about 350 years.

The CEO's delegate considers that the assessed liner performance is considered to be reasonable for this site, given the environmental risk setting (refer to Sections A2.3.3 and 2.4).

A4 Leachate Collection Systems Design

A4.1 Leachate Production Rates

A water balance assessment has been provided in the Golder Report. Golder used the United States of America Environmental Protection Agency (USEPA) Hydrogeological Evaluation of Landfill Performance (HELP) computer program to simulate the water balance for the landfill under a range of scenarios. The HELP model is considered as a suitable model for this site. It is noted that the HELP model may underestimate the volume of leachate generated and this uncertainty has been addressed by using 90^{th} percentile monthly rainfall data as an input of the HELP model.

A level of conservatism was factored into the model by assuming that leachate production takes place after two successive wet years (over years 4 and 5). This was determined to be approximately 1,630 m^3 and was considered to be the maximum rate of leachate production that was likely to take place in the landfill. A review of this modelling by DER officers has identified a high level of conservatism considered in the leachate management system with a high level of confidence. The application states that site-specific climatic data will be used as an input during the operational phase of the landfill to allow for ongoing management of leachate being generated.

A4.2 Leachate Pond Storage Capacity

The leachate production rate calculated through the HELP model was used as an input to an additional water balance modelling exercise to determine the required capacity of the leachate storage pond using the GoldSim water balance model (version 11).

Simulated rainfall events were run using the model for a predicted operational period for the two consecutive wet years using HELP modelled data for years 4 and 5. Simulations considered the requirement to maintain a freeboard of at least 0.5 meters and the capacity to contain leachate during a 1 in 20 year storm event of 72 hours duration. The HELP model considered the input of contaminated stormwater being pumped into the leachate pond in the event of an emergency. Recirculation of leachate has not been considered the modelling data and will only occur in emergency situations. The modelling indicated that for this time period, one leachate pond would be sufficient to contain leachate at the premises.

The leachate pond is designed to have a surface area of 2,000 m^2 (40m x 50m) and a storage volume of 2,700 m^3, while maintaining a 0.5 m freeboard. The total storage capacity of the designed leachate pond is 3,600 m^3.

On the basis of the information provided and climatic information for the site, the CEO's delegate considers that the designed capacity of the leachate pond will be adequate to manage leachate from landfilling operations at the site at the predicted rate of growth of the landfill footprint for Cells 1 and 2.

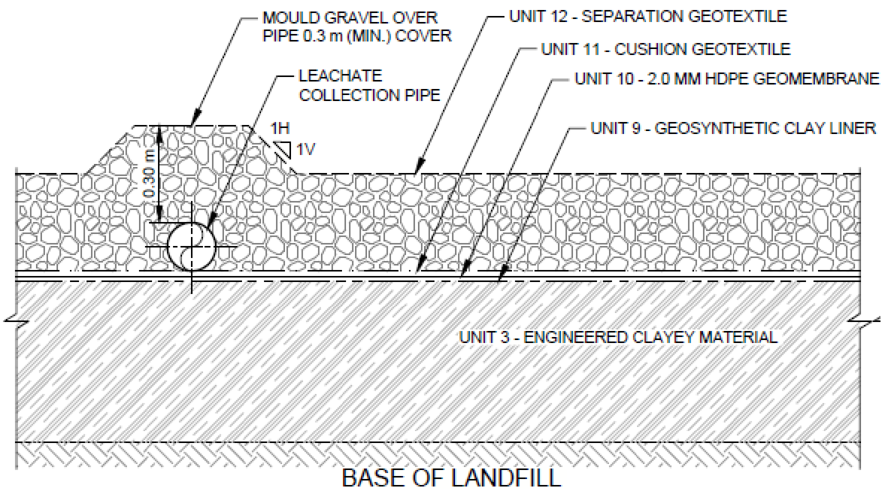
A4.3 Leachate Collection System Components and Operation

A leachate collection system will be installed as part of the landfill development and includes the following design and operational components as detailed in the Golder Report and additional information on leachate management provided by Golder on 14 September 2015:,

- The collection system is comprised of collection pipes, a collection sump and 300 mm drainage layer comprised of aggregate.
- The cells and aggregate drainage layers are designed in a manner that allows an approximate 3% slope towards the leachate collection sump to control the build-up of leachate head on the liner to a maximum 0.3m.
- The leachate collection system is incorporated into the liner system within the leachate drainage aggregate layer. Perforated pipes are installed within this drainage layer to capture leachate generated within the cell (as depicted in Figure A4.3).
- The collection pipes are proposed to be installed on a gradient of approximately 2.5 - 3% and header pipes installed on a gradient of 1%, which allow for leachate to gravity feed towards the leachate collection sump.
- The collection pipes will have a diameter of 150 mm with perforated holes every 300 mm along the pipe and header pipes to be designed with a diameter of 250 mm with perforated holes every 300 mm along the pipe. These pipes are to be installed within the 300 mm leachate drainage layer and will be covered with the drainage aggregate once installed. The drainage layer is overlain by a separation geotextile to assist in the prevention of clogging.
- The collection sump is proposed to be constructed over the liner system and will be include 0.2m of reinforced concrete at the base of the sump, and an additional 2.0mm HDPE geomembrane.
- The collection sump is designed with an extraction sump outlet which allows leachate to be pumped out of the sump. A pressure transducer will continuously monitor levels of leachate and an automatic pump system will be installed in the sump to allow for continuous pumping towards the leachate pond.

- The proponent has committed to managing a maximum level of 300mm for the hydraulic head of leachate above the liner. This will be achieved by pumping the leachate from the collection sump into the leachate storage pond for evaporation. Based on calculations of the leachate volumes, the leachate pond is required to have a capacity of 2,700 m^3 whilst maintaining a freeboard of 0.5m.
- The leachate storage pond includes the following design components:
  - 0.5m clayey engineered material;
  - 0.01m Geosynthetic Clay Liner (GCL) with a hydraulic conductivity of at least 1 $x10^{-11}$ m/s;
  - 2.0 mm smooth HDPE liner; and
  - Minimum separation distance of 9.55 m between the base of leachate pond and highest estimated groundwater level at that location.
- In the event that leachate production exceeds the volume of the leachate pond, the proponent proposes to have leachate transferred offsite to an appropriate disposal facility or for diversion to the retention pond for short term storage (up to 14 days).
- The retention pond includes the following design components:
  - 0.5 m clayey engineered material;
  - 2.0 mm smooth HDPE liner; and
  - Minimum separation distance of 2.58 m between base of retention pond and highest estimated groundwater level at that location.
- Golder has provided a risk assessment (in addition to supporting documentation for the retention pond provided to DER on 14 September 2015) for leachate being stored in the retention pond. The CEO's delegate considers that the containment infrastructure of the retention pond is sufficient to contain any leachate on an interim basis in the event that the leachate pond exceeds capacity.
- Leachate is proposed to be recirculated through the landfill in the event of an emergency, however the Leachate Management Plan states that the option of leachate irrigation will be undertaken prior to offsite disposal. The assessments undertaken in the HELP and GoldSim models have been based on the assumption that *"no leachate is recirculated onto the landfill"*. DER's assessment has only considered recirculation in an emergency event where evaporation and offsite disposal are not available.

Figure A4.3: Leachate collection system within liner drainage layer *(Source: Golder Report, Appendix B)*



A4.5 Leachate Level Monitoring

A pressure transducer and continuous depth monitor will continuously monitor levels of leachate within the sump to assist in maintaining a maximum head of leachate of 0.3 m on the liner.
A leakage detection system has not been proposed, however the sub-surface drainage system discussed below in section A7.1 is designed to capture any leachate in the event of liner failure and divert it to the retention pond where the water quality will be tested for consideration of disposal options.

A5 Construction Quality Control

The works approval application includes specifications for Quality Assurance and Quality Control (QAQC) within the document *Allawuna Farm Landfill Technical Specification for the Construction of Cell 1, Cell 2 and Ancillary Works,* prepared by Golder Associates Pty Ltd, March 2015. For this purpose, an independent third party Quality Assurance Inspector (QAI) with experience in landfill construction and geosynthetic lining systems will be appointed to verify that the works have been carried out to the agreed standards. The duties of the third-party QAI will include:

- Inspections;
- Testing;
- Verification;
- Audits and evaluation of materials and workmanship;
- Provision of advice on installation, testing, repair and covering of the critical aspects of construction; and,
- Issuing a final QAQC report documenting the quality of the constructed facility.

The QAQC document will verify that:

- Materials used comply with Specifications; and,
- Method of construction/installation is appropriate and, as a result the design requirements have been met.

The QAQC document will contain the material/construction specifications, testing methods, testing frequency, corrective action and provides for appropriate documentation procedures.

Condition 1.2.5 of the Works Approval requires that independent construction quality assurance (CQA) of the key aspects of the construction works is performed and recorded in accordance with the Australian Standard AS 3798–2007 Guidelines on earthworks for commercial and residential developments (Standards Australia Limited, 2007). Condition 3.1.2 requires the submission of a Construction Quality Assurance Validation Report, demonstrating each cell has been constructed to the approved standard.

A6 Landfill Liner Integrity and Stability Assessments

A6.1 Seismicity

The Golder Report sourced information on the seismicity of the site location based on the Leonard et al (2013) Atlas of Seismic Hazard Maps of Australia. The Atlas indicates that the peak ground acceleration for the 1 in 500 year return period is approximately 0.075g.

The proposed landfill location is situated within an area of notable seismicity according to *The 2012 Australia Earthquake Hazard Map (Geoscience Australia, 2012).*

The site is considered to be approximately 11 km south west of Dumbleyung fault line. The nearest earthquake is reported to have been a 2.5 magnitude earthquake approximately 4 km from the premises boundary. The seismicity risk in the area was incorporated into the Golder stability assessment (refer to section A6.2 below). The seismicity at the site was simulated using a pseudo-static slope stability analysis to consider the impacts of seismicity on the landfill stability. The stability assessment considered the following seismic events:

- Operating basis earthquake;
- Maximum design earthquake; and
- Maximum credible earthquake.

The results of the assessment are discussed in the section below.

A6.2 Stability Assessment

The application contained a stability assessment undertaken by Golder (March, 2015) titled *Allawuna Farm Landfill, Stability Analysis and Liner System Integrity Assessment for Landfill Development.* The stability assessment included assessment of the following:

- Veneer stability assessment;
- Analyses of the basal liner system interface stability;
- Basal liner system integrity assessment;
- Waste stability; and
- Embankment and foundation stability.

DER engaged GHD Pty Ltd (GHD) to critically review the stability assessment received for this application. GHD's review in May 2015 identified the following:

- Geotechnical models used for the stability analysis did not seem to consider the variability of soil and rock depth at the site;
- Calculated minimum factors of safety were above the required minimum in all situations except for maximum credible earthquake conditions; and
- The proposed capping system is considered stable.

Additional information was sought from the proponent to address GHD's above findings. This additional information was provided in July 2015 and was assessed by GHD in August 2015. The supplementary information included:

- Reassessment of the stratigraphic models for global stability to identify and consider the varying soil and rock depths at the site;
- Re-analysis of the critical stability analyses with reduced effective cohesion to consider granular soils; and
- Sensitivity analysis of the strength parameters assigned to waste under credible earthquake conditions.

GHD's assessment of the supplementary information identified the following:

- The reassessment of critical stability analysis considered the impact of granular soils which were calculated to have reduced factors of safety (when compared to the results of the initial stability report) however these were still above the required minimum values; and
- The reassessment on strength parameters of waste material, including increased cohesion, was considered to be acceptable.

GHD concluded that the operational landfill design is considered to be stable and that no additional stability monitoring is required, provided that the landfill is constructed in accordance with the landfill design specifications. (GHD assessments are included in Appendix K).

Based on the GHD review, Golder's findings and recommendations regarding stability appear to be appropriate. Condition 1.2.1 requires the Works Approval Holder to construct the works in accordance with the application supporting documentation.

A6.3 Liner Integrity

Golder has undertaken an assessment of potential stresses in the lining system to inform the selection of appropriate geosynthetic materials to be used in the liner. This included both pre-waste placement and operational landfilling scenarios. Golder's liner integrity assessment determined the following:

- *The integrity of the lining system during waste placement is satisfactory;*
- *The settlement of the subgrade and embankment fill due to the loading imposed by the waste will not detrimentally impact the integrity of the lining system; and*
- *The post-waste deposition settlement will not affect the integrity of the lining system.*

A7 Surface Water Management

The proposed landfill design includes plans for the establishment of diversion bunds (0.5m high) and drains (0.5m deep by 3m wide) to divert any surface water and stormwater away from waste storage and landfill areas. The stormwater drain is proposed to be installed on the eastern side of the proposed landfill, with the diversion bunds constructed around the perimeter of the landfill. All surface water and stormwater will be diverted to a stormwater dam located on the creek line to the south-east of the landfill cells. An overview of the surface water diversion design is provided in Appendix L.

Stormwater management for the site was considered using predicted long-term rainfall events incorporating Bureau of Meteorology (BoM) and SILO data for York region. BoM data was used in the rainfall intensity-frequency-duration studies to calculate the rainfall intensity over varying storm events (i.e. 1 in 100 year Annual Recurrence Intervals (ARI) events over 24 hours). The SILO climatic data has been used by Golder for long-term daily evaporation estimates.

A water balance model was developed using GoldSim to calculate the capacity of the proposed stormwater dam and incorporated the estimated evaporation rates and rainfall data from the BoM and SILO data sets. The Golder Report has determined that the proposal will require a stormwater dam with a storage capacity of 36,000 m^3. This dam will be used to address the water requirements during construction and operations, including dust suppression and fire water supply. The dam embankment is proposed be constructed of compacted engineered clayey material.

Golder's simulation was undertaken for a 25 year period, with only one of these years failing to provide sufficient operational water. Golder has undertaken an Options Study to assess the availability of water during construction activities. The Options Study determined that an average rainfall year should provide sufficient water for use at the site and that the existing groundwater bores are able to be used as a source for additional water supply. A licence to take water is required to be obtained from DoW.

The application includes the *Allawuna Farm Landfill Surface Water and Sediment Management Plan,* August 2015, prepared by Golder Associates Pty Ltd (SWMP). The SWMP includes consideration of the environmental risks, mitigation and management options for surface water and stormwater. The CEO's delegate considers the assessment and risks to be acceptable. Section A15 includes a risk assessment for this component.

Flood events have also been considered by Golder as part of the application. Golder provided data on the simulation of a 1 in 100 year ARI event using the hydraulic modelling software, XPSWMM (XP Solutions, 2014). As a contingency for flooding, a dam spillway is proposed to be constructed as part of the stormwater dam which assists in directing stormwater towards Thirteen Mile Brook and away from the landfill cells. Based on 100 year ARI rainfall event, the peak design flood discharge has been modelled at 6.2 m^3/s from the dam spillway. In the event that flooding occurs, the modelling has demonstrated that the stormwater will not come into contact with the landfill cells.

A7.1 Sub-surface drainage

The application includes a subsoil drainage system under the landfill footprint which is designed as a short-term management system to assist in diverting groundwater seepage during construction of the embankment within the groundwater seepage area close to the creek.

The pipework is designed such that all groundwater seepage is diverted away from the embankment construction area towards the retention pond. The retention pond is designed with a capacity of 2,690m^3 and a freeboard of 0.5m. The total capacity of the pond is 3,900 m^3. The retention pond is to be constructed from 500 mm compacted engineered clayey fill material with a 2 mm HDPE liner. The design of the pond allows a separation distance of 2.58m from the base of the pond to the highest estimated groundwater level at that location.

Water collected in the subsurface drainage system will be stored within the retention pond and tested within 7 days of entering the pond. If the water tests determine that the water is not contaminated, it will be discharged to the stormwater dam for use around the premises or release through the sediment management structure.

The subsoil drainage system is not intended as a leachate detection or collection system, however if there are any liner failures, leachate will be captured within this system and diverted to the retention pond where water quality will be tested for consideration of disposal options. Although this system is intended as a temporary measure, it has been identified by the CEO's delegate that water and leachate may continue to be collected within this system during operations and post closure. Licence conditions will be included to require a minimum freeboard of 0.5m to be maintained on the retention pond at all times which will assist in containing any leachate collected in the system during operations and post closure. Licence conditions for discharge criteria from the retention pond may also be included.

A7.2 Sediment management

A Sediment Management Structure (SMS) is to be implemented on the creek line down-gradient from the stormwater dam. The SMS is proposed to be constructed of aggregate (between 250 – 500mm in size) to allow for the passage of water while reducing the passage of suspended solid particles. Sediment that has been contained behind the SMS or within the stormwater dam will be removed using excavating machinery and transported for disposal in the landfill.

In the event of heavy rainfall or localised flooding, the proponent has committed to additional temporary sediment controls such as sand bags or silt fences, which can installed further down the creek line to assist in the prevention of sediment migration towards Thirteen Mile Brook.

SITA has committed to meeting with members of the Rivercare project for the establishment and implementation of a rehabilitation and revegetation plan for Thirteen Mile Brook. This plan is required under the conditions of the planning approval.

The SWMP includes consideration of the environmental risks, mitigation and management options for sediment. The CEO's delegate considers the assessment and risks to be acceptable. Section A15 includes a risk assessment for this component.

A8 Landfill Cover

The application identified that 1,418,000 m^3 of material will be required during the lifetime of the landfill (all 6 cells operating over approximately 20 years). Of this required material, 561,000 m^3 is available within the landfill footprint as excavated material during construction and will be retained on-site.

An additional 857,000m^3 of material is required for the construction of the landfill, capping, and daily cover throughout the life of the landfill. The proponent has identified three borrow areas where additional material will be sourced for use. The borrow areas cover a total area of 20 hectares (depicted in Appendix F).

The borrow areas will be cut at a maximum depth of approximately 5m, progressively removing less material as the excavation progresses down gradient. Topsoil (200mm) will be retained for use in rehabilitation of land suitable for farming. It is anticipated that material will not be sourced from the borrow areas until year 10 onwards. Borrow material is not required for the construction or operations of Cells 1 and 2. Any potential emissions and discharges from these areas and any clearing of vegetation required have not been assessed under this application and will be assessed under any subsequent applications.

Waste that meets the definition of Clean fill in the *Landfill Waste Classification and Waste Definitions 1996* (As amended December 2009), published by the Department of Environment and Conservation, will also be used as cover material. Cover material will be subject to a payable levy, as prescribed under the provisions of the *Waste Avoidance and Resource Recovery Levy Act 2007*, unless an exemption is sought from and approved by DER.

Waste will be covered daily with 300mm of material. A condition will be included on the licence which addresses the cover requirements and frequency for each waste type accepted at the premises. The licence may include conditions which specify cover requirements for controlled wastes such as tyres and asbestos. The requirement for waste to be covered will assist in the reduction of odours, vermin and dust.

A9 Landfill Capping

Landfill capping is used to minimise infiltration into the waste mass and therefore leachate generation rates, prevent human and animal access to the waste, assist in controlling releases of landfill gas and to aid a beneficial after use of the site.

The application states that the Victorian document *Best Practice Environmental Management, Siting, design, operation and rehabilitation of landfills* (August 2015) (BPEM), will be used to set design objectives for the final landfill with the rate of infiltration not exceeding 75% of the seepage rate. The capping layer will contain appropriate gas collection piping, leachate recirculation piping and survey markers to monitor landfill settlement. The landform of the proposed final capping will be constructed at a minimum gradient of 1:50 and a maximum gradient of 1:5 to facilitate drainage of stormwater away from the surface.

The capping system will consist of the following components in order of bottom to top and as depicted below):

- 300 mm soil cover over final layer of waste;
- Geosynthetic Clay Liner (GCL);
- Linear Low Density Polyethylene (LLDPE) geomembrane liner;
- If required, cushion geotextile layer;
- Geocomposite drainage layer;
- 700 mm sub-soil layer; and
- 300 mm topsoil/mulch layer

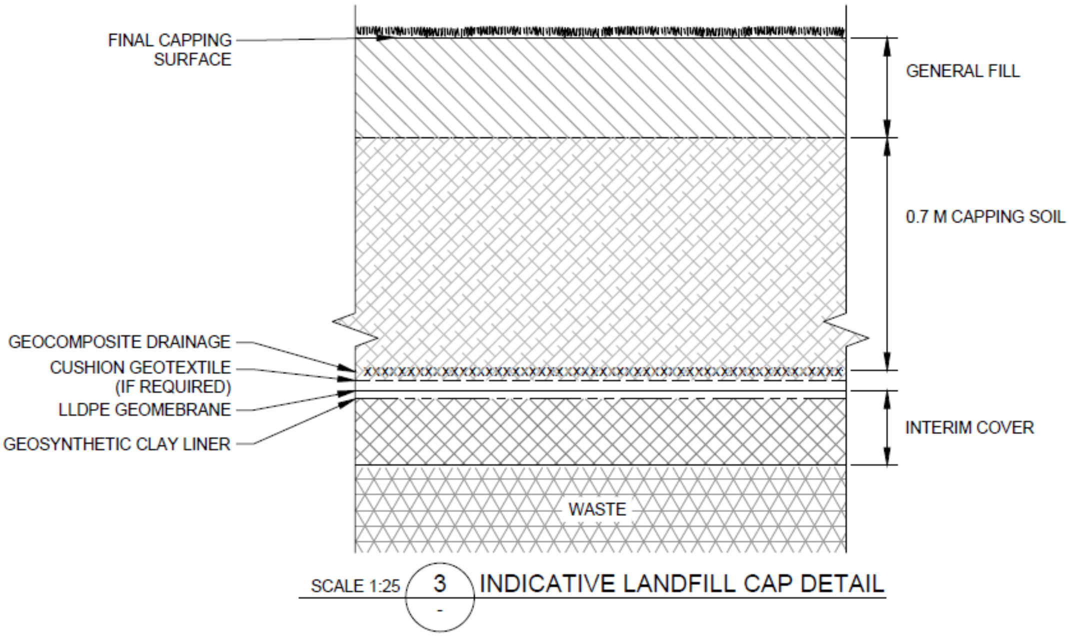


Figure A9: Capping components (Image provided by Golder Associates Pty Ltd)

The finished capped surface will be progressively rehabilitated for suitable post closure land use, and if planting is required, the plants will be selected from locally endemic species with shallow root structures to maintain the integrity of the capping system. Given that the capping system will be developed in accordance with the above specification and that the GHD stability review considers this capping to be stable, the CEO's delegate is satisfied that the proposed capping is acceptable.

Emissions and Monitoring

A10 Emissions of Landfill Gas (LFG)

Landfill Construction

The proposal has stated that two subsurface monitoring points will be installed to monitor background gas levels. The installation of these bores has been included on the Works Approval as condition 1.2.4 with certification of installation required under condition 3.1.3.

The background gas level monitoring has been included on the Works Approval as condition 2.1.5 which requires monthly monitoring commencing within 28 days of the bores being installed. These conditions have been included to reflect the commitments made in the occupier's application and will assist in the management of landfill gas during operations.

No emissions of landfill gas are expected at the construction stage.

Landfill Operation

A LFG assessment has been undertaken by Golder Associates Pty Ltd (Golder) using the GasSim model. Modelling has been based on an annual waste throughput of 250,000 tonnes per year with approximately 50% of waste being municipal solid waste and the other 50% being commercial and industrial waste, with a dry to average moisture content. Golder has advised that the waste degradation rates (k values) in Western Australia generally range from 0.02 to 0.06 which does not fit with the default rates of GasSim. The waste degradation rates used for the modelling are somewhat greater than the WA rates so Golder has considered the results as being conservative.

Rates were calculated using 50th and 90th percentiles (50% and 90%) which outline the probability that the LFG production rate will not be exceeded. Rates after 1 year of landfilling are estimated at 32 m^3/hr (50%) and 36 m^3/hr (90%) meaning that there is a 50% chance that the LFG production rate will be less than or equal to 32 m^3/hr and 90% chance that the rate will not exceed 36 m^3/hr. The peak LFG production rate is estimated at approximately 21 years of landfilling; associated predicted production rates are anticipated to be 1548 m^3/hr (50%) and 1661 m^3/hr (90%) respectively. The Proponent intends to update the GasSim model throughout the course of waste disposal at the premises.

A review of the LFG modelling and LFGMP provided in the application identified a need for further information to justify relevant conclusions and controls. For example, Golder has stated that lateral LFG migration is considered to be low risk (due to the presence of a liner and cap) however the risk assessment that has been undertaken to demonstrate how this risk rating was identified has not been provided. Additionally, a risk assessment has not been included to assess the impact on environmental receptors in the event of liner failure.

The potential for landfill fire to occur has not been considered in the LFGMP and LFG trigger levels for required actions have not been included. Proposed methods for detecting landfill fire and consideration of emergency management procedures under abnormal operating conditions and malfunction of the LFG management infrastructure will also need to be addressed in the LFGMP. The LFGMP will require updating at the licence application stage to address the above issues. A detailed risk assessment should also be provided as part of the LFGMP to identify all potential sources, pathways, receptors and controls relating to LFG.

<u>Emission Description</u>

Emission: Significant generation of LFG resulting from the decomposition of putrescible waste within the landfill which will be extracted through a LFG extraction system for treatment via

    - LFG balancing to be conducted by an appropriate professional.
- LFG extraction system will be inspected visually each day;
    - Checking system is working at capacity;
    - Checking for pipe blockages;
    - Checking for any damage to pipes;
    - Checking that condensate collection systems are in working order; and
    - Checking for detection of any odours
- Surface monitoring of LFG across the landfill including final capped and working areas
    - Conducted bi-annually using an Inspectra Laser Methane Gas analyser (or equivalent); and
    - Identification of surface LFG will involve remedial action such as the addition of suction to extraction wells in the area, applying additional cover material, repairs if there is any damage in the area (including the cap), installation of additional LFG extraction wells and infrastructure.
- Subsurface monitoring
    - Two monitoring points will be installed under the Works Approval between the site office and landfill footprint area to monitor for background gas levels.
    - Additional monitoring points will later be installed on either side of the landfill footprint area;
    - Monitoring points will initially be tested on a monthly basis;
    - Monitoring will commence prior to any waste being placed in the landfill; and
    - If LFG is detected, additional monitoring stations will be installed and monitoring frequency increased to be able to more accurately assess the situation and determine what remediation action is required.

Risk Assessment
Consequence: Major
Likelihood: Unlikely
Risk Rating: Moderate

Regulatory Controls
Conditions for LFG monitoring will be considered for inclusion on the licence as well as the inclusion of a licence condition to maintain a 0.3 metre maximum head of leachate on the liner to assist in the prevention of LFG extraction wells becoming blocked with leachate.

It is recommended that a new (updated) LFGMP and associated risk assessment be submitted as part of the licence application which addresses the gaps identified in DER's review as detailed at the start of this section. DER may consider that a condition be included on the licence to require compliance with the LFGMP. Conditions for the installation and monitoring of background gas levels have been included on the Works Approval as discussed in the 'Construction' section above.

Residual Risk
Consequence: Major
Likelihood: Unlikely
Risk Rating: Moderate

A11 Fugitive Emissions to Groundwater

Landfill Construction and Operation
Emission Description
Although this emission is generated during site operations (during and following waste placement), the risks are considered as part of landfill design and prior to construction. The main emission from landfills that poses a risk to groundwater is leachate. Leachate seepage to groundwater from landfilling operations may arise if liner defects occur during placement and/or over time in the liner or leachate management system, including leachate storage pond.

Landfill liner systems cannot be made completely impermeable and all liners will therefore experience a certain level of leachate seepage. Landfill leachate from a putrescible landfill mainly consists of dissolved organic matter and inorganic compounds such as sulphates, chlorides and ammonium salts. Leachate may also contain some metals including lead, nickel and copper, hydrocarbons and synthetic organic compounds.

Impact
Potential contamination of groundwater and surface water receptors. This includes Thirteen Mile Brook located 350 m west of the site as discussed under sections A2.2 and A2.3.

Controls
The liner and leachate management design are detailed in Sections A3 and A4. The landfill has been designed to limit leachate movement through the liner and is appropriately designed for the environmental setting.

The existing groundwater monitoring network installed at the site is appropriately located and installed to monitor both background groundwater quality and potential movement of leachate though any liner defects.

Risk Assessment
Consequence: Moderate
Likelihood: Unlikely
Risk Rating: Moderate

Regulatory Controls
The primary controls limiting leachate emissions to groundwater (and indirectly to surface water) are the correct design and construction of the landfill cells. This is required through conditions 1.2.1, 1.2.3 to 1.2.5 and 3.1.1 to 3.1.3 of the Works Approval.

Operational conditions will be considered as part of the licence assessment however it is likely that conditions will be included on the leachate to require a limit of 300mm of leachate head within the leachate sump and ensuring a freeboard of 0.5 m of the leachate dam. The licence may also include specific management conditions to be undertaken in the event that leachate head in the sump is exceeded or when freeboard in the leachate dam is exceeded. Management actions will likely include the requirement to remove leachate offsite, or undertake maintenance if blockages in the system are identified. Monitoring conditions may be included on the licence to verify the leachate head in the sump and to monitor the leachate extracted from the sump.

Residual Risk
Consequence: Moderate
Likelihood: Unlikely
Risk Rating: Moderate

A12 Fugitive Dust Emissions

Landfill construction

Emission Description
Dust can be generated during the construction of the landfill cells by vehicle movements, and earthworks.

Impact
Fugitive dust emissions can impact on local air quality and cause nuisance to residents although these are located some distance from the premises (1.9 km). Fugitive dust emissions can also adversely impact on adjacent vegetation including any agricultural crops grown on land adjacent to the premises, including crops grown within the existing farming areas of the Allawuna Farm.

Appendix B

Summary of Issues Raised in Public Submissions

The submitter numbers listed below correspond to interested parties who provided comment and submissions regarding the works approval application. These numbers may relate to individuals, families or community groups. The 'Summary of Submission Points' provides a representation of the main points raised in the community submissions.

Number	Submitter	Summary of Submission Points	Response
1	**Seismic Issues** 4, 5, 9, 10, 11, 12, 13, 15, 16, 18, 19, 20, 21, 22, 23, 28, 29, 30, 31, 32, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 56, 58, 59, 62, 68, 69	• Comments that York is located within the South West Seismic Zone. • There is concern that in the event of an earthquake there is potential for the pit to collapse, liquefaction to occur and a risk of damaging the liner integrity resulting in contamination to surface water, groundwater and land as well as the release of landfill gas.	The risk associated with earthquakes has been considered in the stability assessment. Further information is detailed in Section A6 in Appendix A.
2	**Composite Liner** 13, 15, 18, 23, 28, 5, 14, 16, 18, 34, 36, 41, 42, 44, 46, 48, 51, 59	• Community has concerns that HDPE liners degrade and break down over time. • Concerns that any failure of the liner will results in contamination and impacts to the drinking water catchments. • There are concerns that the manufacturers of HDPE liners are unable to guarantee 100 per cent, the integrity of the liner system. • Concerns that the 2m separation distance between groundwater will not be maintained.	It is recognised that HDPE liners deteriorate over time. The potential for liner defects and degradation to occur has been incorporated into the assessment of liner performance and calculations of liner leakage rates. An assessment of the liner design and leachate management systems is included in Section A3 in Appendix A. The landfill design in the application includes a minimum 2m separation to the maximum recorded potentiometric surface of the confined aquifer. Conditions 1.2.2 and 1.2.3 have been included in the Works Approval, which requires at least 2m separation to any seasonal shallow or perched groundwater. Licence conditions will be included for monitoring of groundwater which will include the ongoing verification that the minimum 2m separation distance is maintained throughout the landfill operations.

Government of **Western Australia**
Department of **Environment Regulation**

Appendix D
Construction Overview

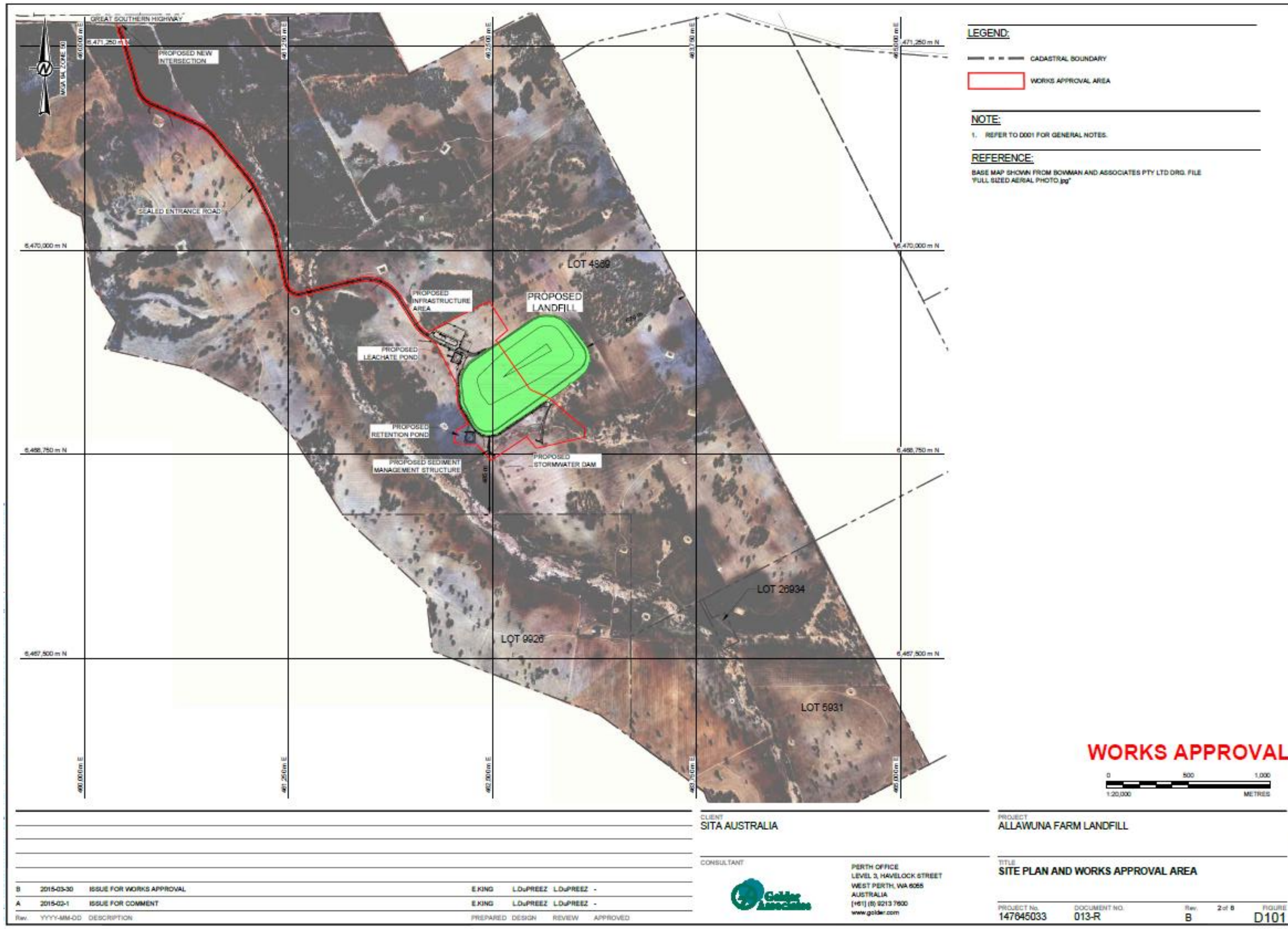


Figure D1

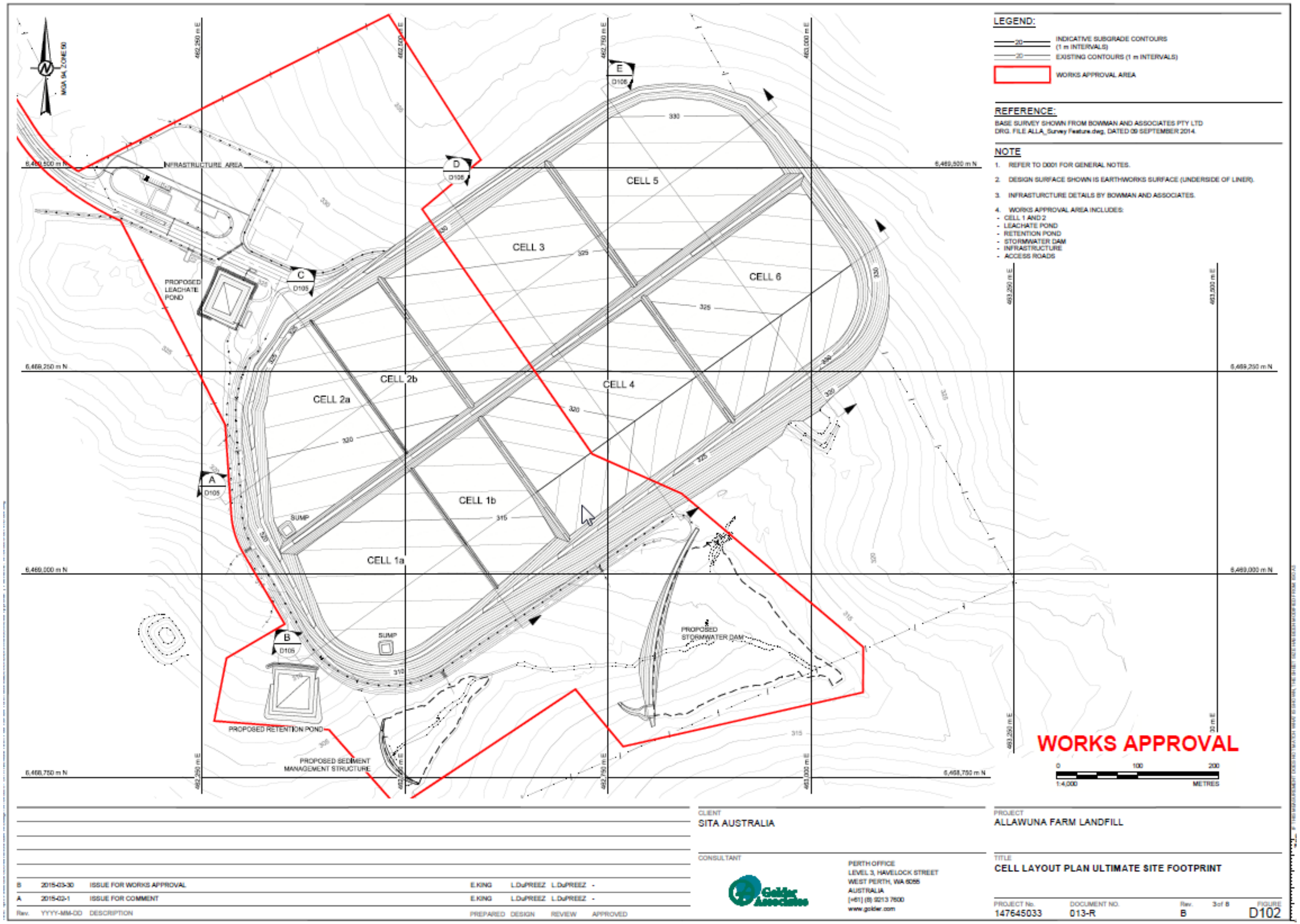

LEGEND:
INDICATIVE SUBGRADE CONTOURS (1 m INTERVALS)
EXISTING CONTOURS (1 m INTERVALS)
WORKS APPROVAL AREA
REFERENCE:
BASE SURVEY SHOWN FROM BOWMAN AND ASSOCIATES PTY LTD
DRG. FILE ALLA_Survey Feature.dwg, DATED 09 SEPTEMBER 2014.
NOTE
1. REFER TO D001 FOR GENERAL NOTES.
2. DESIGN SURFACE SHOWN IS EARTHWORKS SURFACE (UNDERSIDE OF LINER).
3. INFRASTRUCTURE DETAILS BY BOWMAN AND ASSOCIATES.
4. WORKS APPROVAL AREA INCLUDES:
- CELL 1 AND 2
- LEACHATE POND
- RETENTION POND
- STORMWATER DAM
- INFRASTRUCTURE
- ACCESS ROADS
CELL 1a
CELL 1b
CELL 2a
CELL 2b
CELL 3
CELL 4
CELL 5
CELL 6
INFRASTRUCTURE AREA
PROPOSED LEACHATE POND
PROPOSED RETENTION POND
PROPOSED SEDIMENT MANAGEMENT STRUCTURE
PROPOSED STORMWATER DAM
SUMP
WORKS APPROVAL
1:4,000
METRES
CLIENT
SITA AUSTRALIA
CONSULTANT
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
[+61] (8) 9213 7600
www.golder.com
PROJECT
ALLAWUNA FARM LANDFILL
TITLE
CELL LAYOUT PLAN ULTIMATE SITE FOOTPRINT
PROJECT No. 147645033
DOCUMENT No. 013-R
Rev. B
3 of 8
FIGURE D102
B 2015-03-30 ISSUE FOR WORKS APPROVAL E.KING L.DuPREEZ L.DuPREEZ
A 2015-02-1 ISSUE FOR COMMENT E.KING L.DuPREEZ L.DuPREEZ
Rev. YYYY-MM-DD DESCRIPTION PREPARED DESIGN REVIEW APPROVED

Figure D2

Government of **Western Australia**
Department of **Environment Regulation**

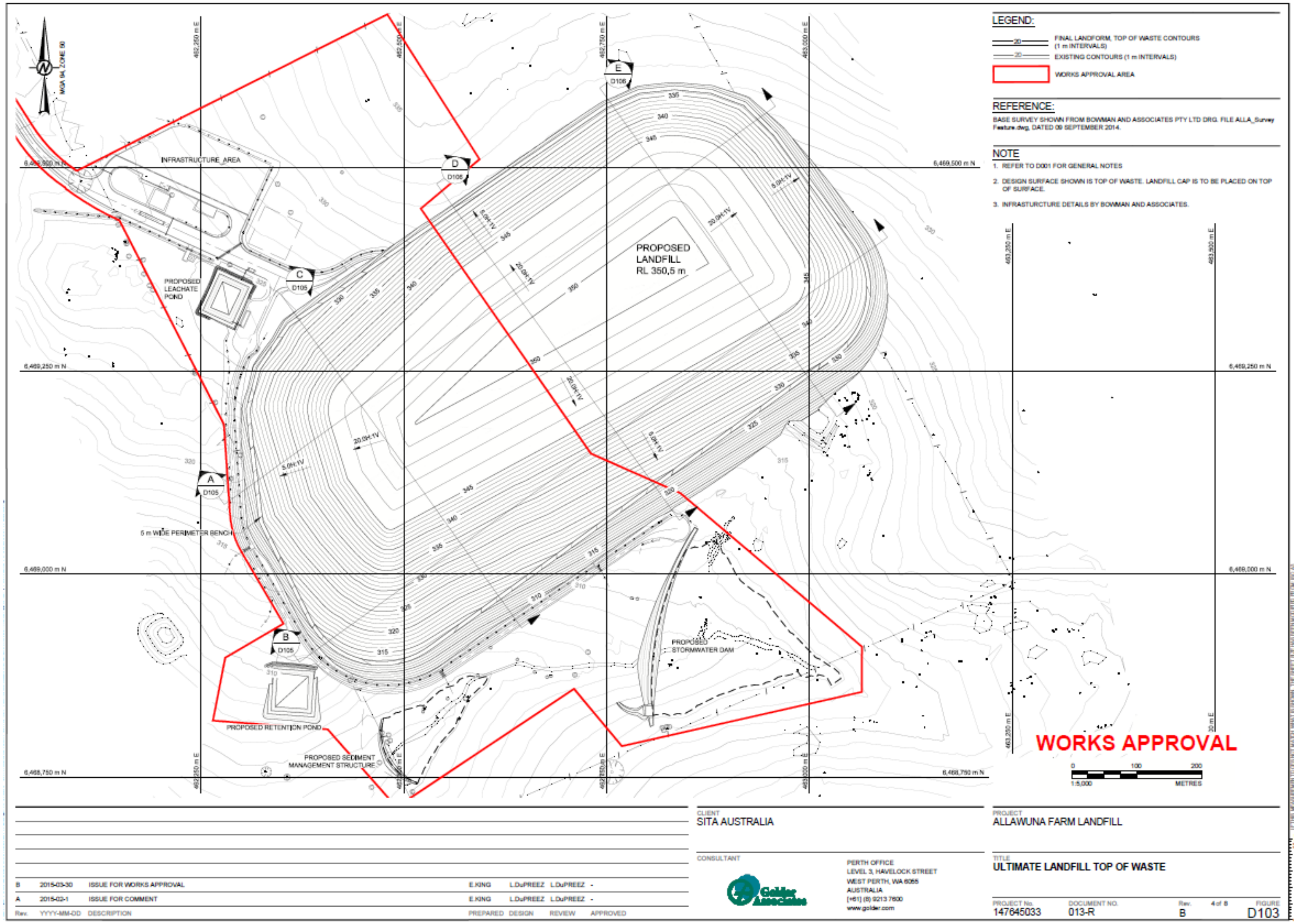


Figure D3

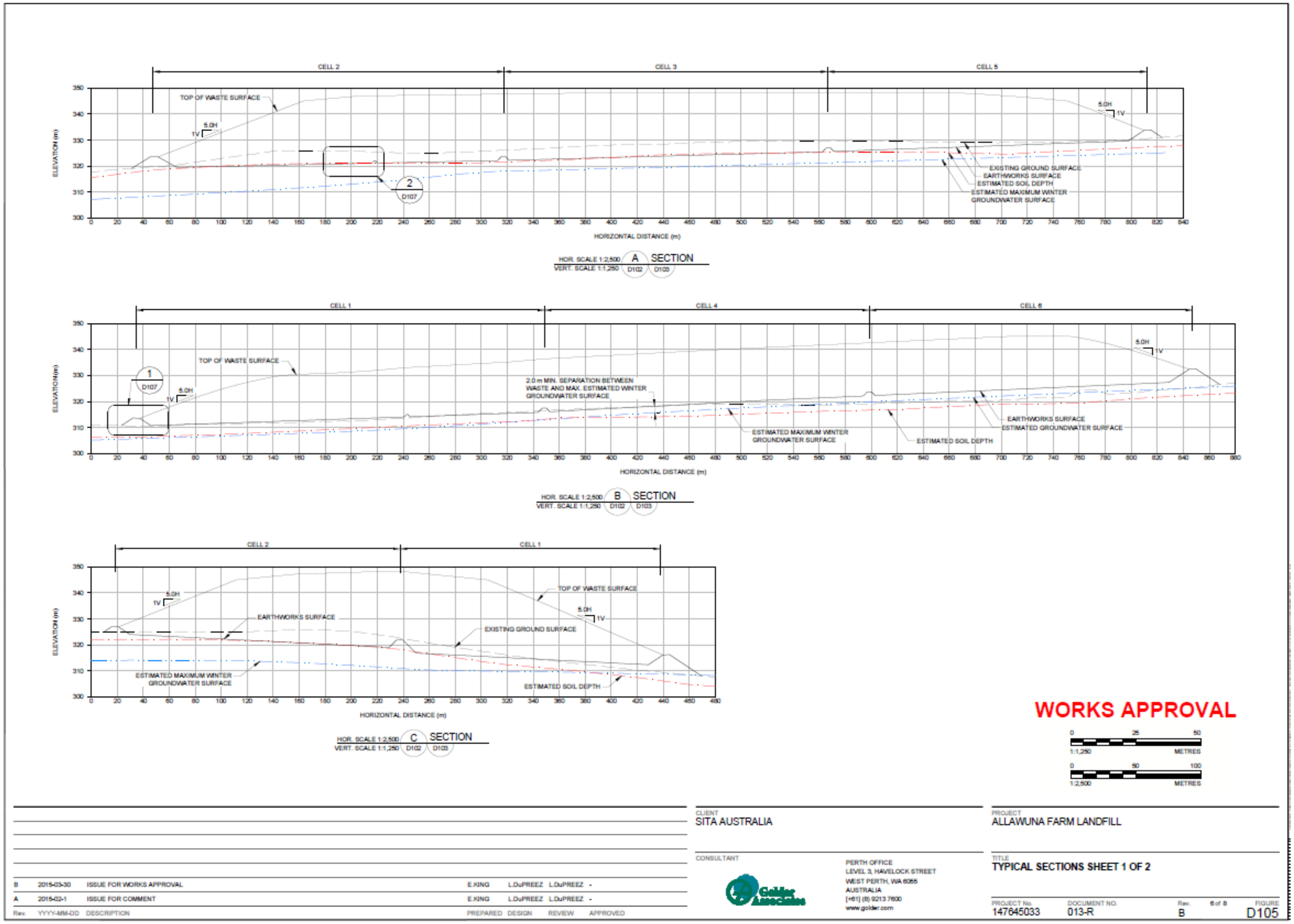

CELL 2
CELL 3
CELL 5
TOP OF WASTE SURFACE
EXISTING GROUND SURFACE
EARTHWORKS SURFACE
ESTIMATED SOIL DEPTH
ESTIMATED MAXIMUM WINTER GROUNDWATER SURFACE
HORIZONTAL DISTANCE (m)
ELEVATION (m)
A SECTION
CELL 1
CELL 4
CELL 6
2.0 m MIN. SEPARATION BETWEEN WASTE AND MAX. ESTIMATED WINTER GROUNDWATER SURFACE
ESTIMATED GROUNDWATER SURFACE
B SECTION
C SECTION
WORKS APPROVAL
METRES
CLIENT
SITA AUSTRALIA
PROJECT
ALLAWUNA FARM LANDFILL
CONSULTANT
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
www.golder.com
TITLE
TYPICAL SECTIONS SHEET 1 OF 2
PROJECT No.
147645033
DOCUMENT NO.
013-R
Rev.
B
FIGURE
D105
ISSUE FOR WORKS APPROVAL
ISSUE FOR COMMENT

Figure D4

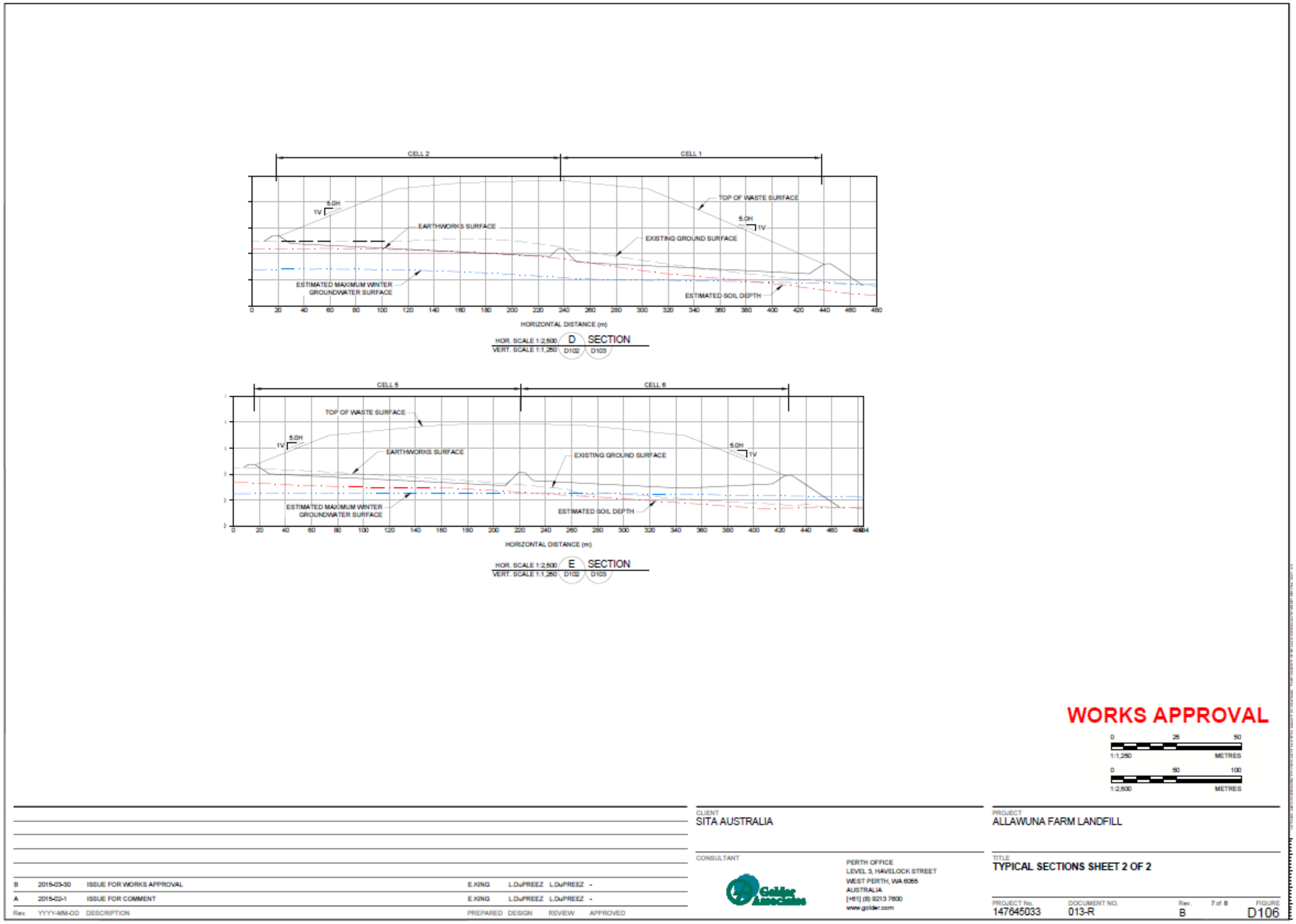
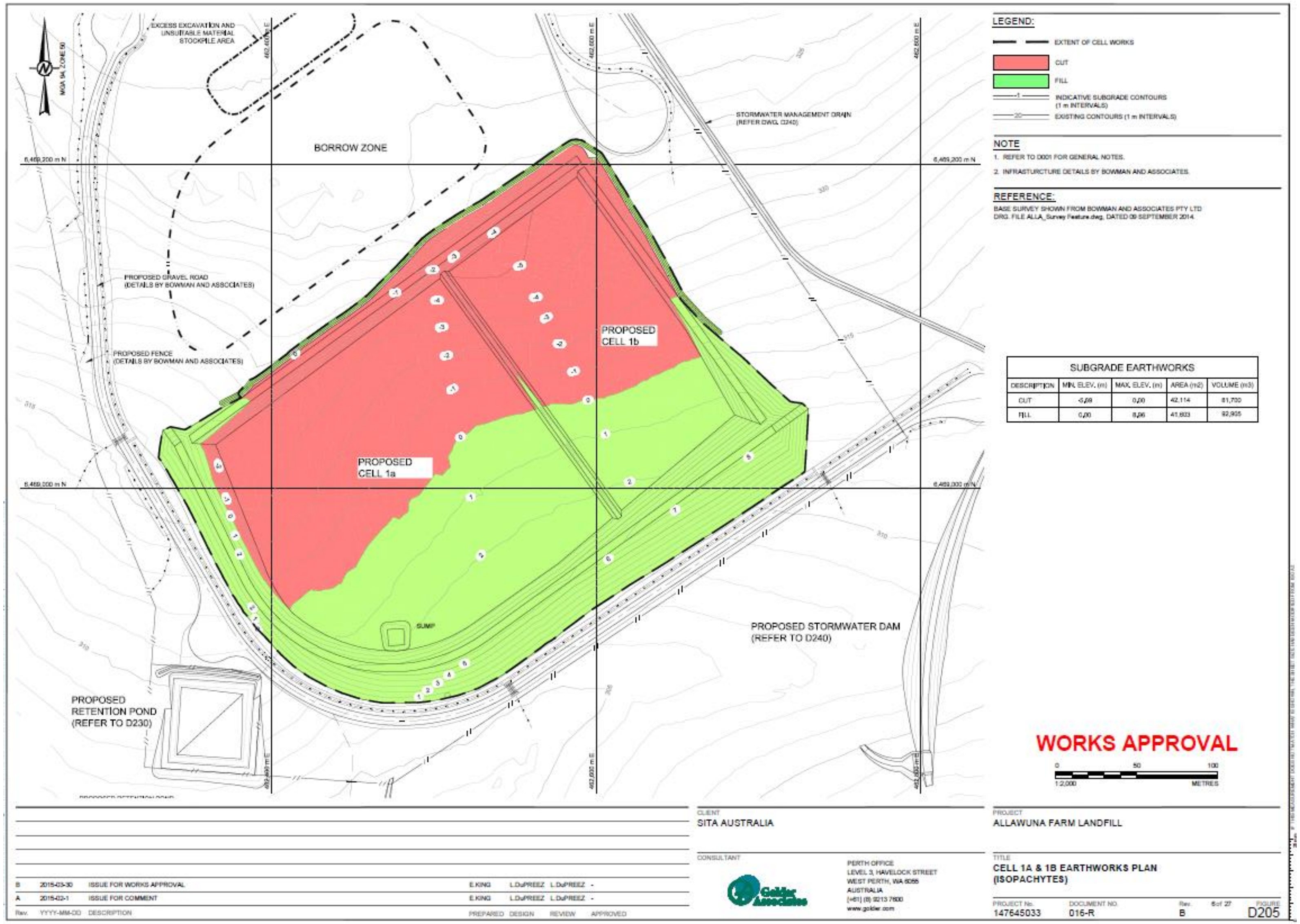

CELL 2
CELL 1
TOP OF WASTE SURFACE
EARTHWORKS SURFACE
EXISTING GROUND SURFACE
ESTIMATED MAXIMUM WINTER GROUNDWATER SURFACE
ESTIMATED SOIL DEPTH
HORIZONTAL DISTANCE (m)
D SECTION
CELL 5
CELL 6
E SECTION
WORKS APPROVAL
CLIENT
SITA AUSTRALIA
PROJECT
ALLAWUNA FARM LANDFILL
TITLE
TYPICAL SECTIONS SHEET 2 OF 2
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
B 2015-03-30 ISSUE FOR WORKS APPROVAL
A 2015-02-1 ISSUE FOR COMMENT
PROJECT No. 147645033
DOCUMENT NO. 013-R
Rev. B
FIGURE D106

Figure D5



EXCESS EXCAVATION AND UNSUITABLE MATERIAL STOCKPILE AREA
BORROW ZONE
STORMWATER MANAGEMENT DRAIN (REFER DWG. D240)
PROPOSED GRAVEL ROAD (DETAILS BY BOWMAN AND ASSOCIATES)
PROPOSED FENCE (DETAILS BY BOWMAN AND ASSOCIATES)
PROPOSED CELL 1b
PROPOSED CELL 1a
SUMP
PROPOSED STORMWATER DAM (REFER TO D240)
PROPOSED RETENTION POND (REFER TO D230)
6,469,200 m N
6,469,000 m N
LEGEND:
EXTENT OF CELL WORKS
CUT
FILL
INDICATIVE SUBGRADE CONTOURS (1 m INTERVALS)
EXISTING CONTOURS (1 m INTERVALS)
NOTE
1. REFER TO D001 FOR GENERAL NOTES.
2. INFRASTURCTURE DETAILS BY BOWMAN AND ASSOCIATES.
REFERENCE:
BASE SURVEY SHOWN FROM BOWMAN AND ASSOCIATES PTY LTD
DRG. FILE ALLA_Survey Feature.dwg, DATED 09 SEPTEMBER 2014.
SUBGRADE EARTHWORKS
DESCRIPTION | MIN. ELEV. (m) | MAX. ELEV. (m) | AREA (m2) | VOLUME (m3)
CUT | -5,09 | 0,00 | 42,114 | 81,700
FILL | 0,00 | 8,96 | 41,803 | 92,905
WORKS APPROVAL
0 50 100
1:2,000 METRES
B 2015-03-30 ISSUE FOR WORKS APPROVAL E.KING L.DuPREEZ L.DuPREEZ -
A 2015-02-1 ISSUE FOR COMMENT E.KING L.DuPREEZ L.DuPREEZ -
Rev. YYYY-MM-DD DESCRIPTION PREPARED DESIGN REVIEW APPROVED
CLIENT
SITA AUSTRALIA
CONSULTANT
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
[+61] (8) 9213 7600
www.golder.com
PROJECT
ALLAWUNA FARM LANDFILL
TITLE
CELL 1A & 1B EARTHWORKS PLAN (ISOPACHYTES)
PROJECT No. 147645033
DOCUMENT NO. 016-R
Rev. B
6 of 27
FIGURE D205

Figure D6

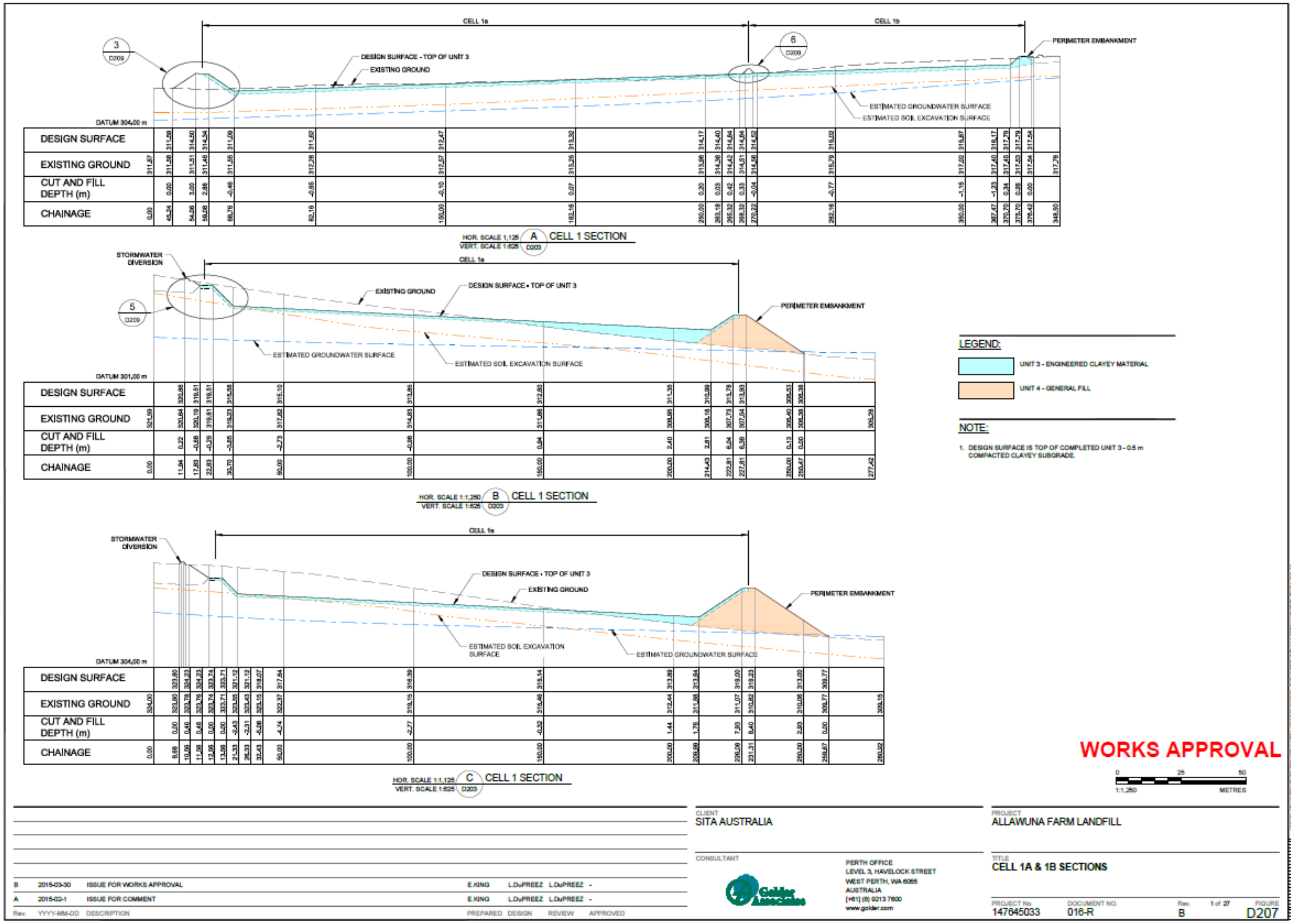

CELL 1a
CELL 1b
PERIMETER EMBANKMENT
DESIGN SURFACE - TOP OF UNIT 3
EXISTING GROUND
ESTIMATED GROUNDWATER SURFACE
ESTIMATED SOIL EXCAVATION SURFACE
DESIGN SURFACE
EXISTING GROUND
CUT AND FILL DEPTH (m)
CHAINAGE
A CELL 1 SECTION
STORMWATER DIVERSION
B CELL 1 SECTION
C CELL 1 SECTION
LEGEND:
UNIT 3 - ENGINEERED CLAYEY MATERIAL
UNIT 4 - GENERAL FILL
NOTE:
1. DESIGN SURFACE IS TOP OF COMPLETED UNIT 3 - 0.5 m COMPACTED CLAYEY SUBGRADE.
WORKS APPROVAL
METRES
B 2015-03-30 ISSUE FOR WORKS APPROVAL
A 2015-02-1 ISSUE FOR COMMENT
CLIENT
SITA AUSTRALIA
PROJECT
ALLAWUNA FARM LANDFILL
CONSULTANT
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
TITLE
CELL 1A & 1B SECTIONS
PROJECT No. 147645033
DOCUMENT NO. 016-R
Rev. B
FIGURE D207

Figure D7

Government of **Western Australia**
Department of **Environment Regulation**

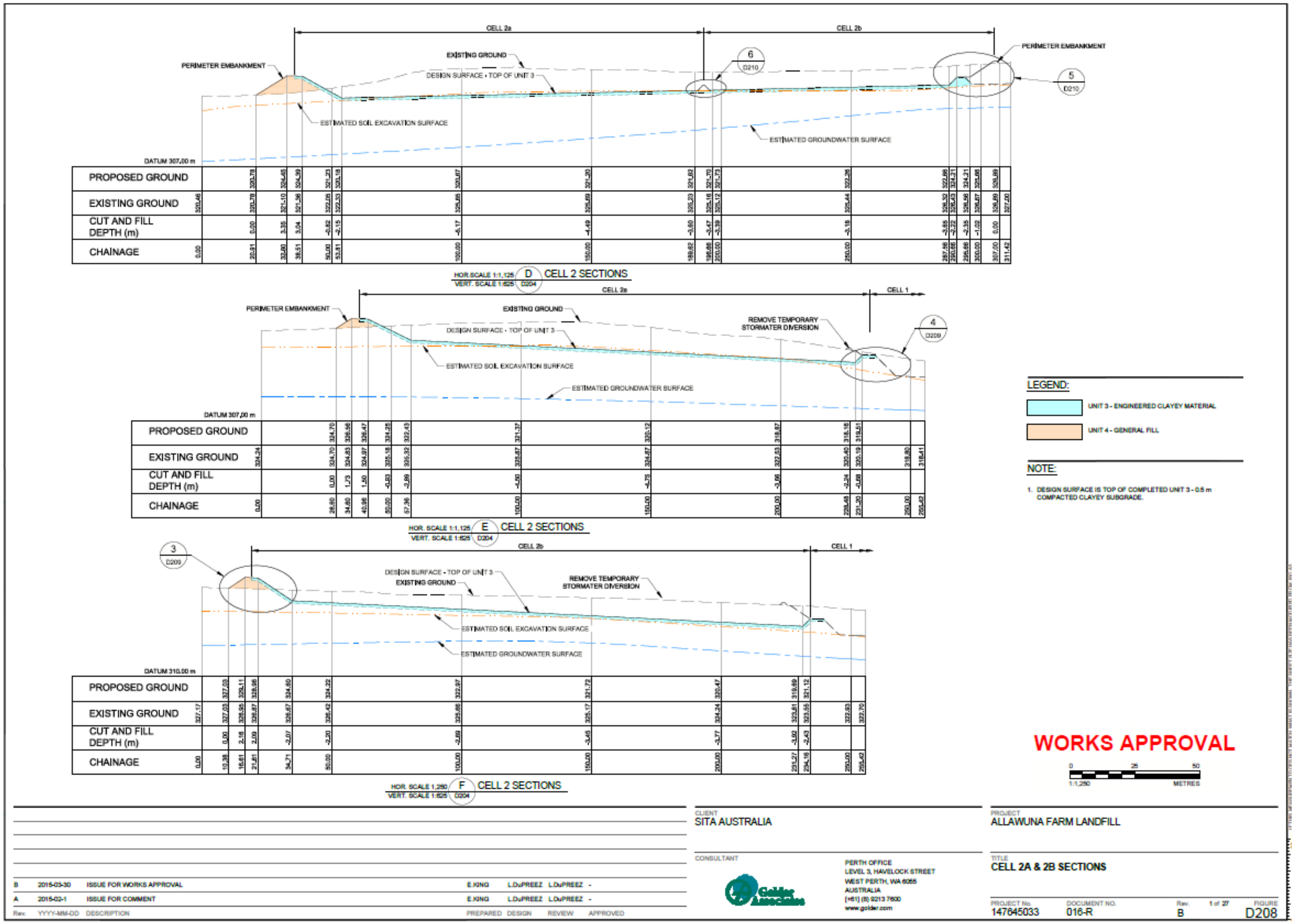
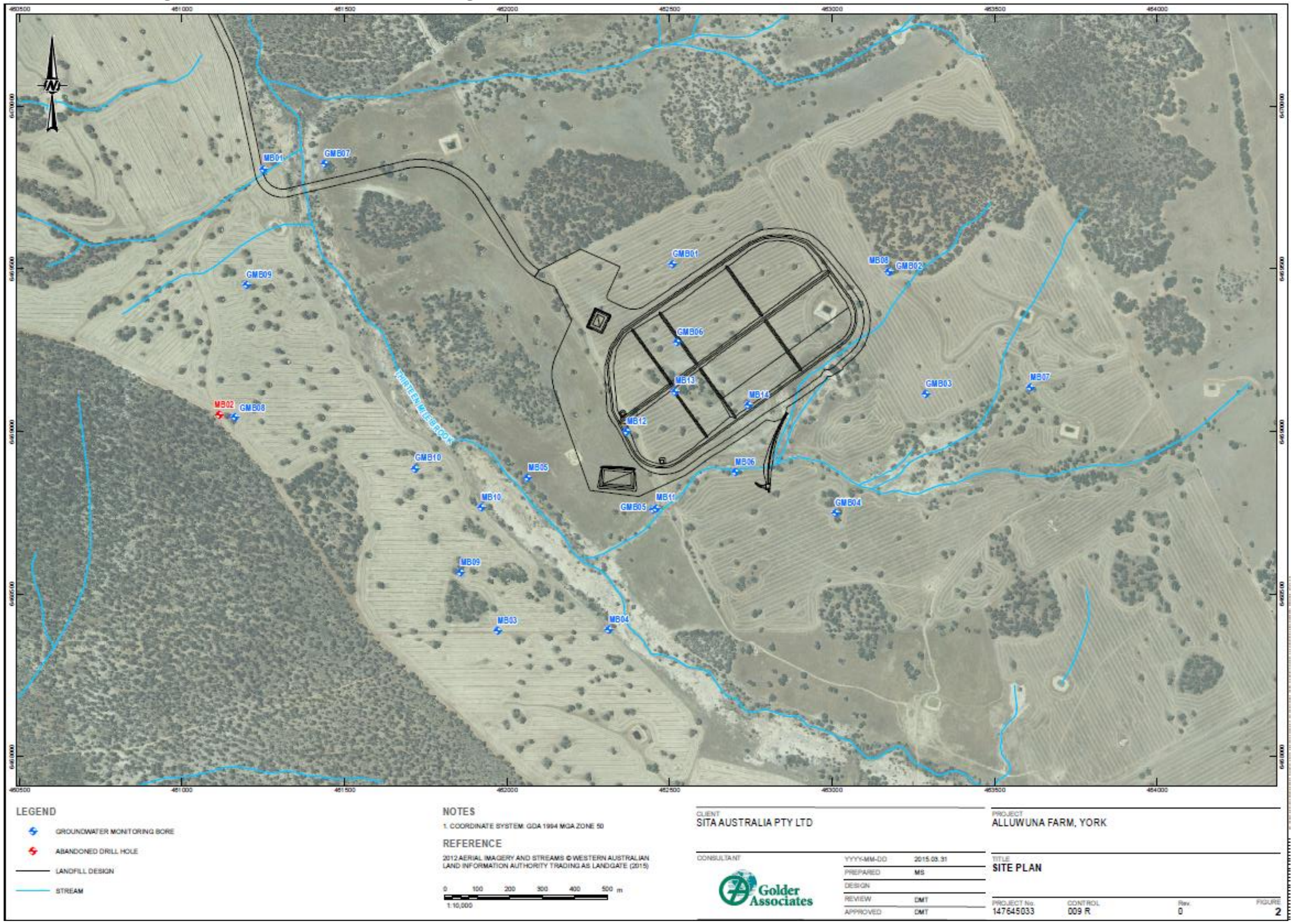


Figure D8

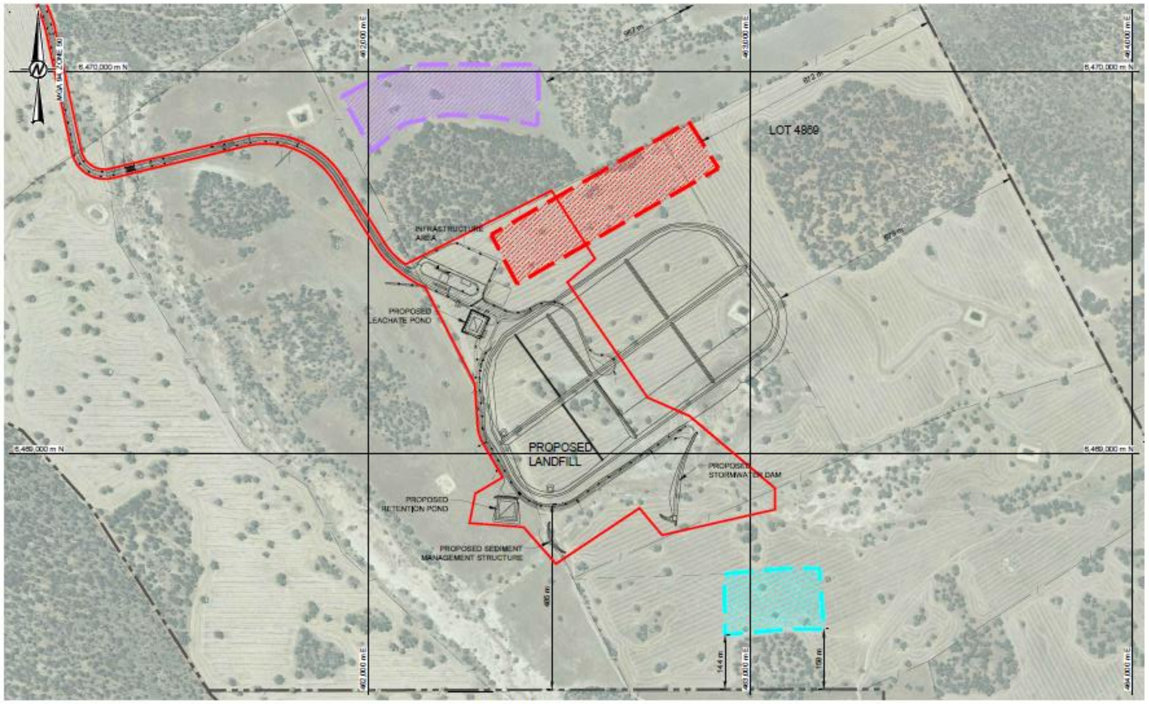
Appendix E

Location of groundwater monitoring bores

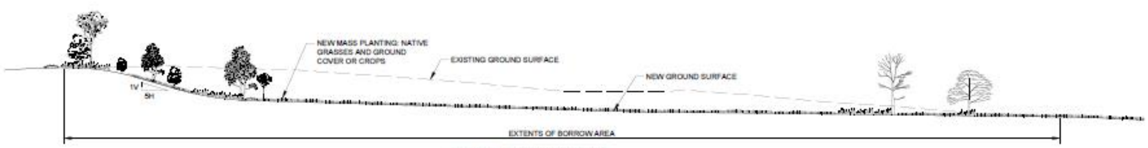


Appendix F

Location of proposed Borrow Areas



LAYOUT PLAN
SCALE 1:10,000 m



TYPICAL BORROW SECTION
SCALE 1:1,250 m

LEGEND:

- BORROW AREA 1
- BORROW AREA 2
- BORROW AREA 3
- WORKS APPROVAL AREA
- CADASTRAL BOUNDARY
- EXISTING FENCE

NOTE:

1. REFER TO D001 FOR GENERAL NOTES.

REFERENCE:

BASE MAP SHOWN FROM BOWMAN AND ASSOCIATES PTY LTD DRG. FILE "FULL SIZED AERIAL PHOTO.jpg"

BORROW AREAS			
DESCRIPTION	VOLUMES (m^3)	AREA (ha)	AVERAGE DEPTH (m)
AREA 1	420000	8.8	4.8
AREA 2	320000	7.2	4.3
AREA 3	180000	4.0	4.2

WORKS APPROVAL

0 250 500
1:10,000 METRES

Rev.	YYYY-MM-DD	DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED
B	2015-03-30	ISSUE FOR WORKS APPROVAL	E.KING	L.DuPREEZ	L.DuPREEZ	-
A	2015-02-1	ISSUE FOR COMMENT	E.KING	L.DuPREEZ	L.DuPREEZ	-

CLIENT
SITA AUSTRALIA

CONSULTANT
Golder Associates
PERTH OFFICE
LEVEL 3, HAVELOCK STREET
WEST PERTH, WA 6005
AUSTRALIA
[+61] (8) 9213 7600
www.golder.com

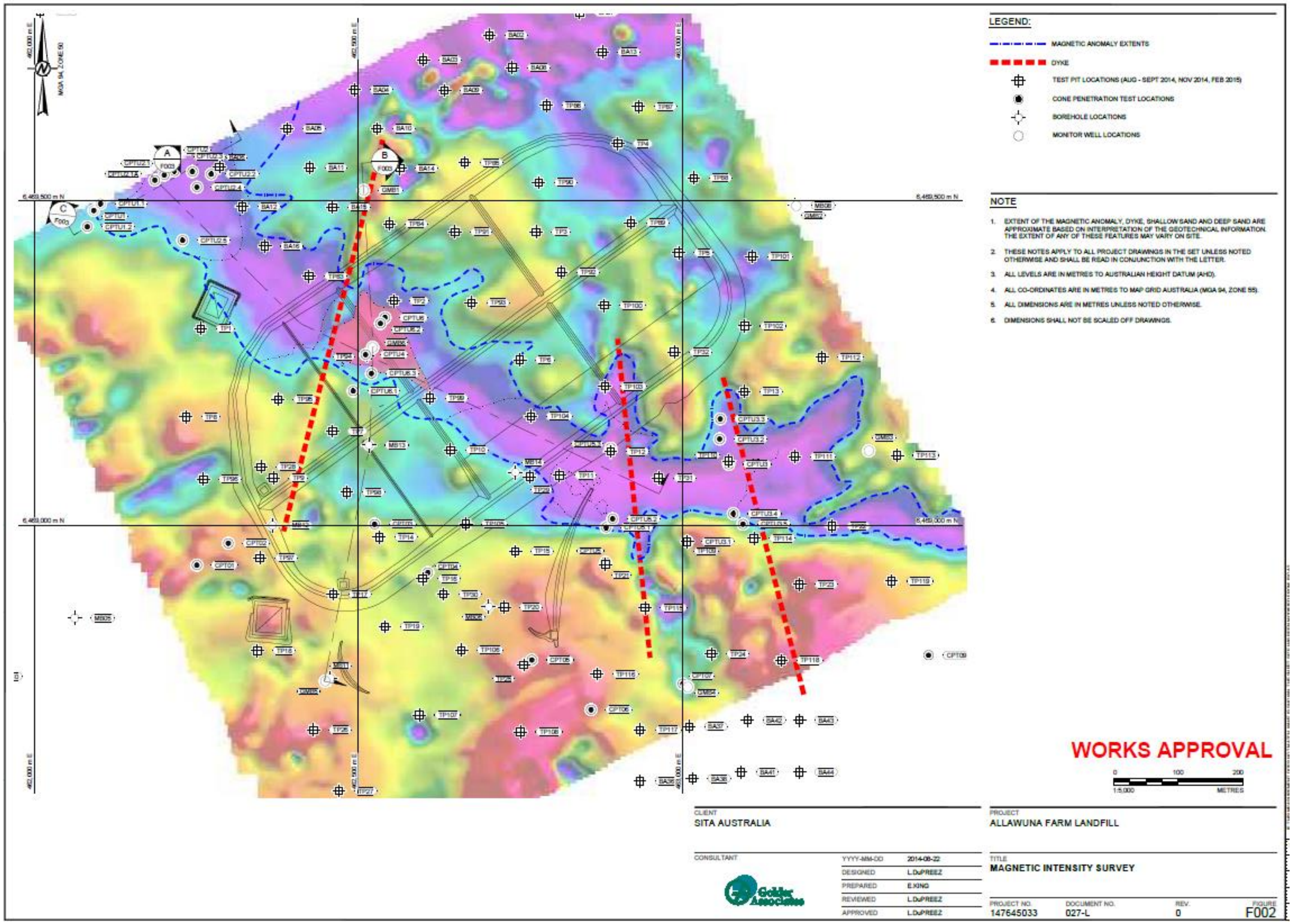
PROJECT
ALLAWUNA FARM LANDFILL

TITLE
BORROW AREA PLAN

PROJECT No. 147645033 | DOCUMENT NO. 013-R | Rev. B | 8 of 8 | FIGURE D104

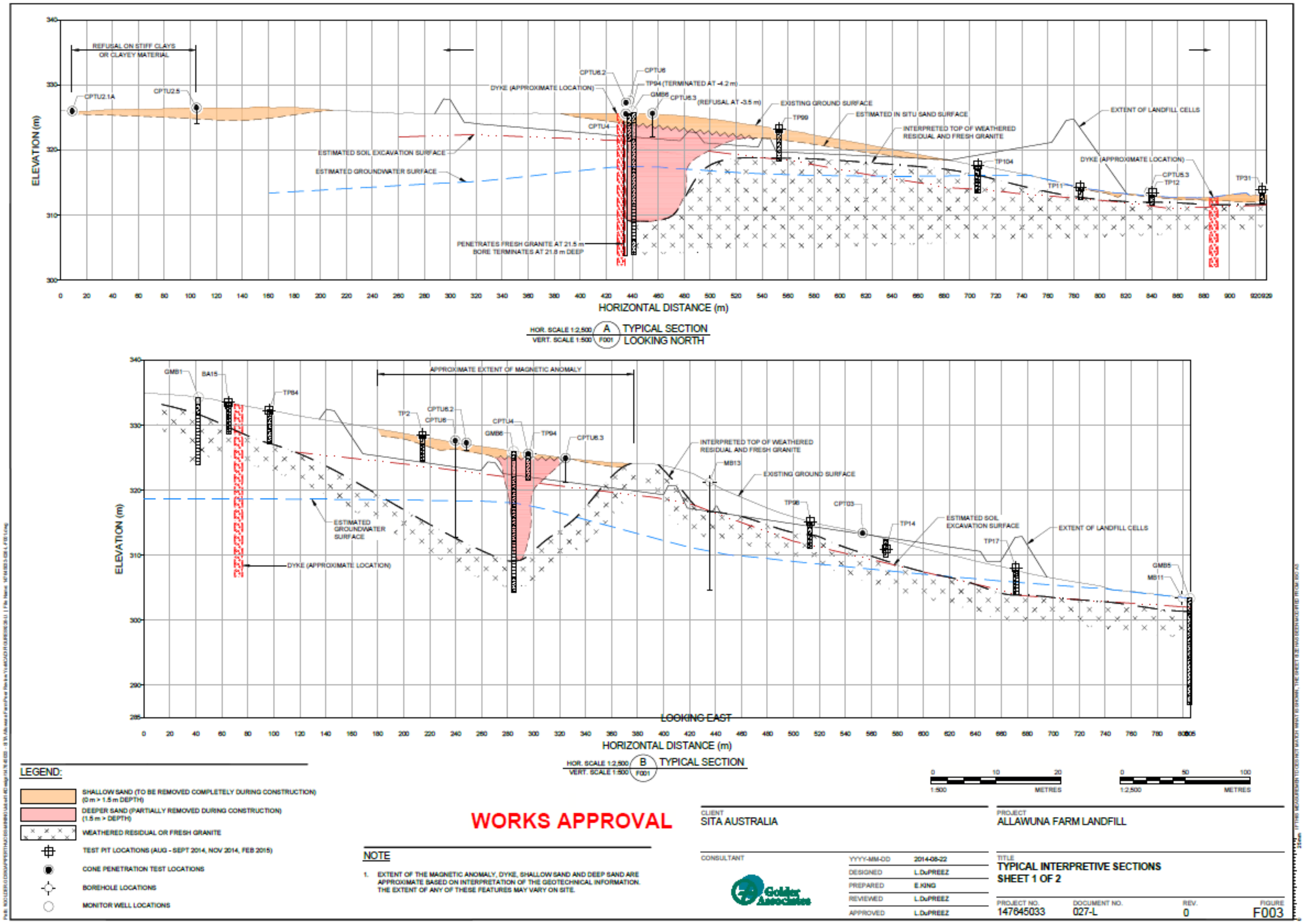
Appendix G

Cone penetrometer locations including the locations of cross-sections depicted in Appendix H



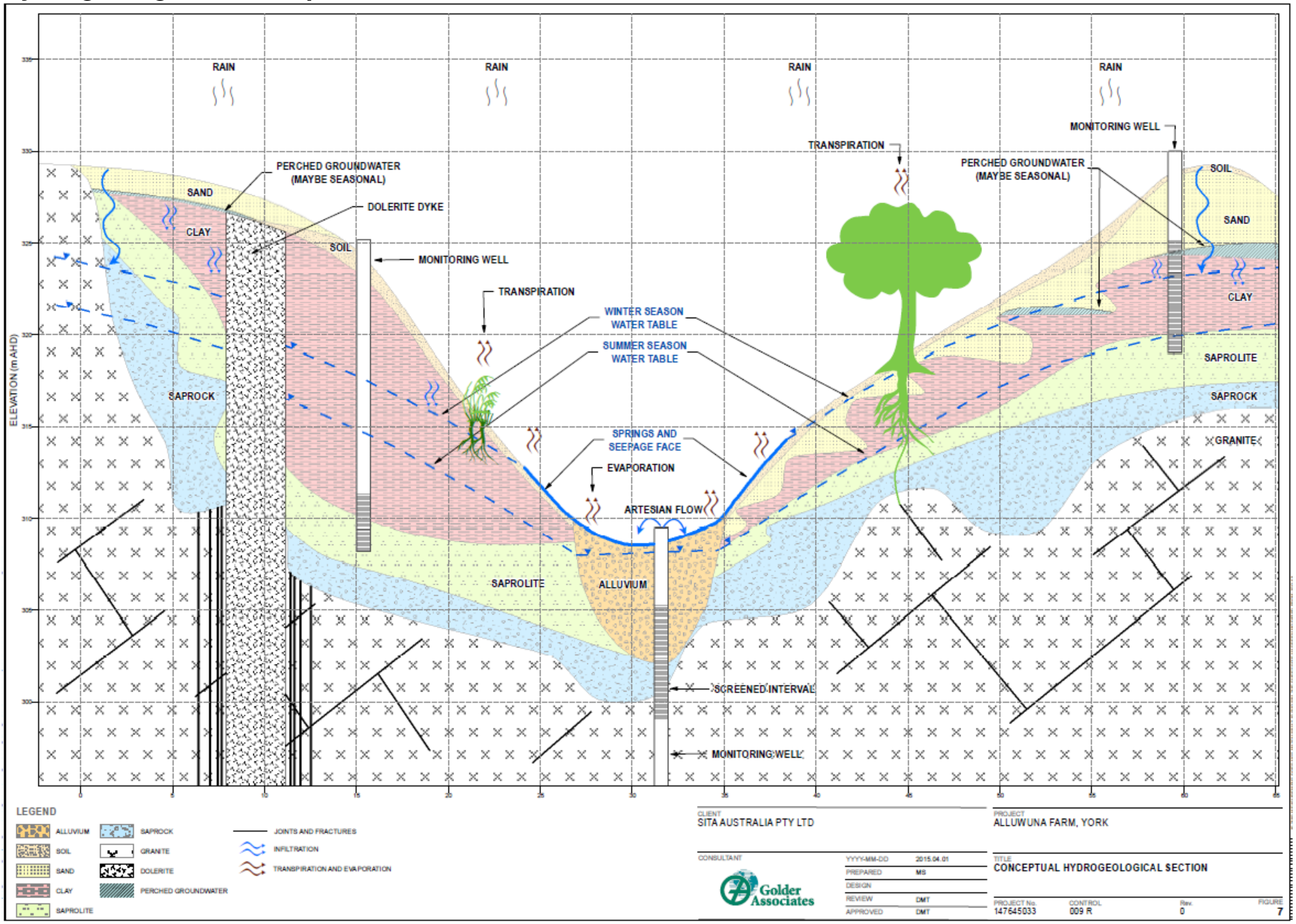
Government of **Western Australia**
Department of **Environment Regulation**

Appendix H
Cross sections of liner geophysical feature



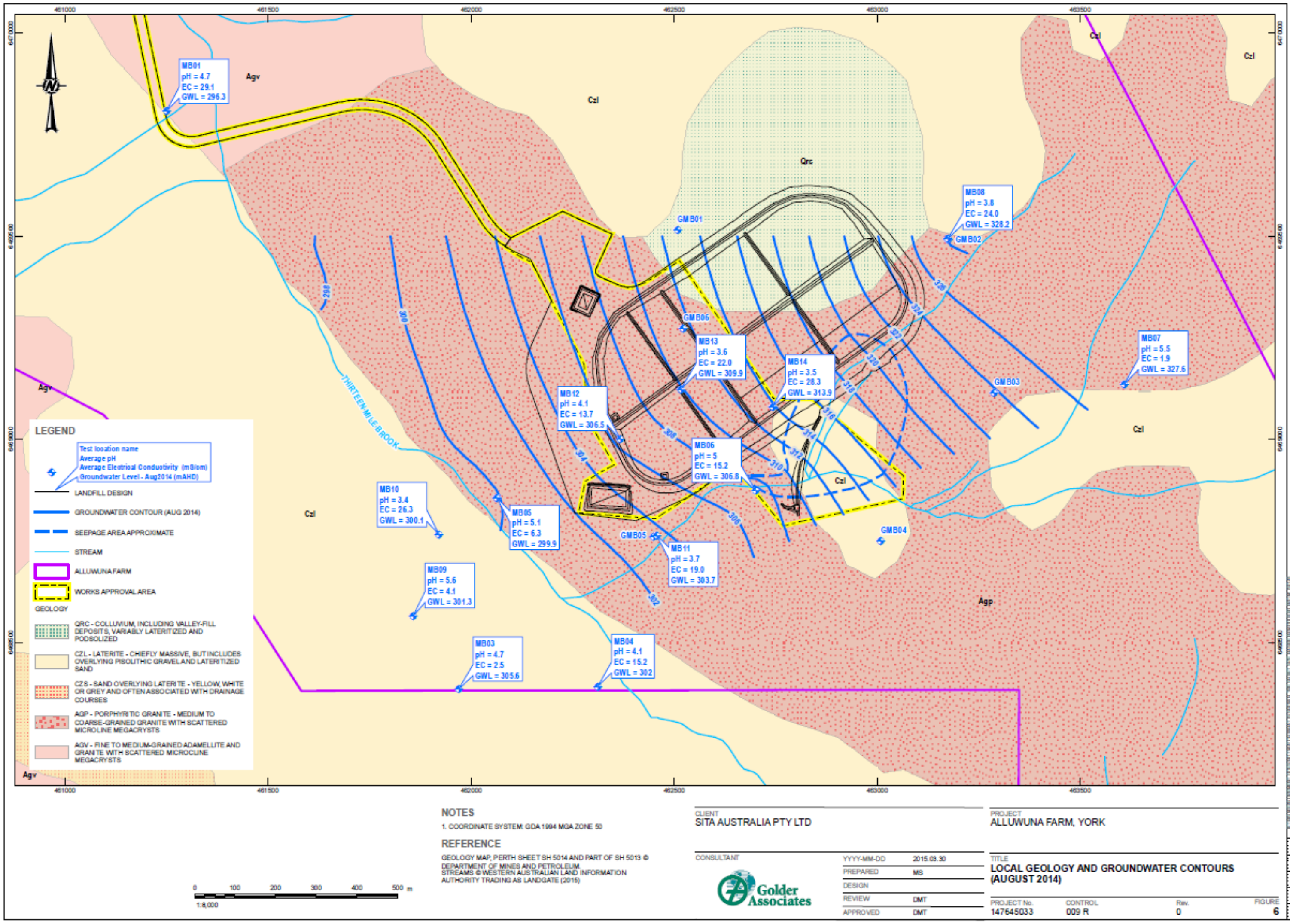
Appendix I

Hydrogeological Conceptual Site Model



Appendix J

Groundwater contours



Appendix K

Technical Memoranda from GHD Pty Ltd

29 May 2015

Lauren Fox
Licensing Officer - Waste Industries (South A)
Department of Environment Regulation
Locked Bag 33, Cloisters Square
PERTH WA 6850

Our ref: 61/32250 14899
Your ref: DER2015/000628

Dear Lauren

Allawuna Farm Landfill - Works Approval W5830:ALLAWUNA
Independent Stability Assessment

1 Introduction

GHD has been instructed by the Department of Environment Regulation (DER) to carry out an independent stability assessment for the proposed Allawuna Farm Class II landfill site, located approximately 20km west of the town of York, WA. GHD was instructed via email dated 18 May 2015.

2 Scope of work

The scope of work as identified in GHD's proposal letter dated 24 April 2015 is as follows. GHD will review documentation and information provided by the DER in terms of:

- Landfill geometry (i.e. ground model including leachate water levels and seismicity)
- Material parameters applied – soil / waste / other materials including geo-materials
- Slope stability approach / philosophy / FoS applied etc.
- Appropriateness of the method of analysis
- Review of the slope stability analysis in accordance with the requirements of DER's Brief

3 Available documentation

The following documentation has been made available to GHD:

1. Golder Associates (2015). Works Approval Application Supporting Documentation – Allawuna Landfill. Submitted to: Mr John Jones, SITA Australia. Report number 147645033-013-R-Rev0. March.

The works approval includes a total of 23 appendices (A to W) of which the following are considered of relevance to the stability assessment:

2. **Appendix A**: Allawuna Landfill Layout Plans and Sections
3. **Appendix B**: Allawuna Landfill Cell 1 and 2, Leachate Pond, Subsurface Drainage, Retention Pond and Stormwater Dam Construction Plans

GHD Pty Ltd ABN 39 008 488 373
57 Herbert St Artarmon NSW 2064 Locked Bag 2727 St Leonards NSW 1590 Australia
T 61 2 9462 4700 F 61 2 9462 4710 E atnmail@ghd.com W www.ghd.com

4. **Appendix D**: Golder Associates (2015). Allawuna Farm Landfill Development Geotechnical Investigations for Landfill Development. Submitted to: SITA Australia. Report number 147645033-008-R-Rev0. March.
5. **Appendix E:** Golder Associates (2015). Allawuna Farm Landfill Hydrogeological Site Characterisation Studies. Submitted to: SITA Australia. Report number 147645033-009-R-Rev0. March.
6. **Appendix F**: Golder Associates (2015). Stability Analysis and Liner System Integrity Assessment for Landfill Development. Submitted to: SITA Australia. Report number 147645033-012-R-Rev0. March.

4 Geotechnical review

4.1 Geotechnical model review

A number of geotechnical investigations have been undertaken by Golder as illustrated in Figure 4 of the Geotechnical Investigations Report (Appendix D). The investigations undertaken provide good spatial coverage of the site, both of the proposed landfill cells and the surrounding area including borrow areas. The majority of the exploratory holes within the landfill ultimate boundary consisted of shallow test pits, with around 50% of logs not recording bedrock. Four boreholes were drilled for hydrogeological monitoring (Appendix E), with limited geotechnical information provided within the logs.

The subsurface conditions are noted by Golder as representative of a typical latertic profile. Material encountered within 1m of the surface was typically granular and this was confirmed by the cone penetration testing (CPT) undertaken both within the proposed landfill footprint and the surrounding area. The dominant underlying material was noted to comprise stiff sandy clay.

GHD has undertaken a detailed review of individual test pit logs, which has highlighted some lateral variation in the near surface soils. The geotechnical parameters assigned to the in situ soil in Table 5 of the Stability Analysis Report (Appendix F) are consistent with a cohesive material. Material descriptions for test pits undertaken within the area of the proposed cell 2b suggest a more granular material, with TP94 encountering sand with only traces of silt and clay to its base at a depth of 4m. This has implications for stability analysis, particularly under seismic conditions (further detail provided with Section 4.2).

No rock mass properties have been quoted within the relevant reports appending the works approval (Appendices D and F), whether assumed or otherwise. Test pits and CPTs are not considered to be the most appropriate techniques for confirming bedrock and the exploratory holes undertaken may have refused on weathered material or boulders, i.e. rock head levels are not clear. Three of the hydrogeological boreholes (MB12, MB13 and MB14) did not encounter rock and were drilled to depths between 8 and 16m. Borehole GMB6 encountered granite at a depth of 21.5m.

CPTu6 undertaken within the area of the proposed cell 2b encountered soil strength materials up to a depth of 14.5m at which point it refused. This is not reflected in any of the geotechnical models presented despite acknowledgement by Golder of the variability in ground conditions in Section 6.2 of Appendix F, where the presence of colluvium and vertical fissures are discussed. The ground model definition is not clear in this area.

4.2 Global stability analysis review

A number of cases have been considered for stability analysis as described in the report presented as Appendix F of the works approval document. The analyses have been based on the proposed geometry of Sections B and C as indicated in Figure 1 within Appendix F, which are considered by Golder to represent the critical sections for global stability. It is noted that all reported minimum factors of safety (FoS) within Tables 6, 8 and 9 of Appendix F relate to analyses based on the geometry of Section C.

A range of groundwater conditions have been considered in the analyses and the assessment of horizontal seismic load coefficients has been carried out consistent with the method set out in AS1170.4.

The calculated minimum FoS' are above the required minimums for all cases with the exception of selected analyses under maximum credible earthquake (MCE) conditions. As discussed in Section 4.1, the geotechnical models adopted for stability analysis do not appear to consider the variability in soil depth as per the indicated ground conditions.

The strength parameters attributed to the waste as presented within Table 5 of Appendix F (φ' = 25° and c' = 5kPa) are considered lower bound based on published values as shown in Figure 1.

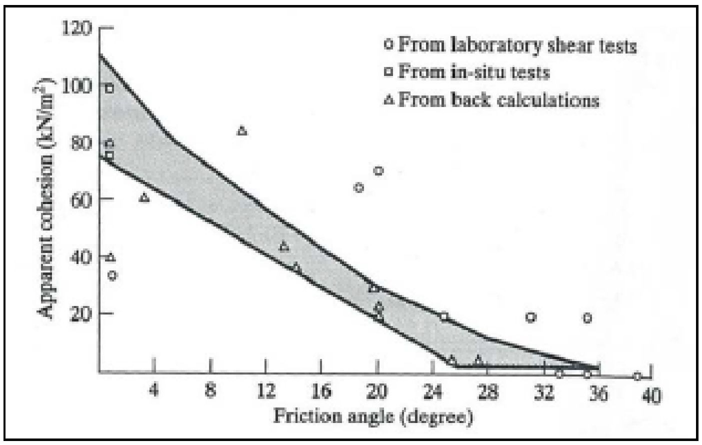


Figure 1 Summary of municpal solid waste strength data (based upon Singh and Murphy, ***1990, source ref.1)***

It is considered that increasing the effective cohesion of the waste material may result in the minimum FoS for waste stability under MCE conditions (Appendix F output Figure B8) increasing to from 0.95 above 1.0.

It is acknowledged that under static conditions critical slip surfaces are not likely to penetrate bedrock. Golder have modelled bedrock as a material "considered to have infinite strength" as stated in note 5 to Table 5 within Appendix F. With consideration to the likely variable weathering profile and confidence in true bedrock depth given the site investigations techniques adopted, this analytical approach is not considered appropriate for stability analysis under pseudo-seismic conditions.

4.3 Veneer stability analysis review

Stability analysis of the proposed capping arrangement has been undertaken based on the proposed geometry of Section A as indicated in Figure 1 within Appendix F. It is acknowledged that the input parameters are conservative and the inclusion of a textured LLDPE geomembrane to provide an acceptable FoS is considered acceptable.

5 Conclusion and recommendations

Following our review of the works approval document and accompanying appendices, some specific clarifications are required to demonstrate stability under all required scenarios as follows:

1. Reassessment of stratigraphic models for global stability analysis to consider and clearly identify the variable soil and potentially significant rock depths across the proposed landfill footprint;
2. Re-analysis of critical stability analyses (Figure C1, C2) with reduced effective cohesion to consider the presence of granular soils as encountered within selected test pits;
3. Sensitivity analysis of the strength parameters assigned to the waste under MCE conditions.

The stability of the capping system for the final landform is considered stable based on the veneer stability analysis undertaken and noting the specification of a textured rather than smooth LLDPE.

6 References

1. Qian, X, Koerner, R & Gray, D. (2001). *Geotechnical Aspects of Landfill Design and Construction.* Prentice Hall, Sydney

Written by:

Ben Dening
Senior Geotechnical Engineer

Reviewed by:

Dr Bryn Thomas
Senior Geotechnical Engineer

06 August 2015

Lauren Fox
Licensing Officer - Waste Industries (South A)
Department of Environment Regulation
Locked Bag 33, Cloisters Square
PERTH WA 6850

Our ref: 61/32250
14965
Your ref: DER2015/000628

Dear Lauren

Allawuna Farm Landfill - Works Approval W5830:ALLAWUNA
Independent Stability Assessment - Additional Information Review

1 Introduction

GHD were instructed by the Department of Environment Regulation (DER) via email dated 18 May 2015 to carry out an independent stability assessment for the proposed Allawuna Farm Class II landfill site, located approximately 20km west of the town of York, WA. The landfill design including stability analysis submitted for the Works Aproval Application (WAA) was prepared by Golder Associates Pty Ltd (Golder). The GHD independent stability assessment (ref. 61/32250 dated 29 May 2015) concluded that some specific clarifications were required to demonstrate stability under all scenarios.

2 Scope of work

The scope of work as identified in GHD's proposal letter dated 28 July 2015 is as follows. GHD will review additional documentation provided by the DER with consideration of the conclusions and recommendations provided within GHD's independent stability assessment (Ref. 61/32250), dated 29 May 2015. These recommendations are:

- Reassessment of stratigraphic models for global stability analysis to consider and clearly identify the variable soil and potentially significant rock depths across the proposed landfill footprint;
- Re-analysis of critical stability analyses with reduced effective cohesion to consider the presence of granular soils as encountered within selected test pits;
- Sensitivity analysis of the strength parameters assigned to the waste under MCE conditions.

3 Available documentation

In addition to the documentation provided for the independent stability assessment (and listed within Section 3 of that document). The following document has been made available to GHD:

- Golder Associates (2015). Addendum to the Allawuna Farm Landfill Works Approval Application (mky1ff) Landfill Stability. Submitted to: Mr John Jones, SITA Australia. Report number 147645033-025-M-RevA DRAFT. 14 July.

GHD Pty Ltd ABN 39 008 488 373
57 Herbert St Artarmon NSW 2064 Locked Bag 2727 St Leonards NSW 1590 Australia
T 61 2 9462 4700 F 61 2 9462 4710 E atnmail@ghd.com W www.ghd.com

4 Geotechnical review

The following sections provide our assessment of Golder's response dated 14 July 2015 to the recommendation and conclusions of GHD's independent stability assessment.

4.1 Reassessment of stratigraphic models

Section 3.1 of the Golder addendum stability report provides details of the updated stability analyses to consider the variable subgrade materials. The geotechnical parameters provided for in situ sand are acceptable, with adopted friction angle considered to be lower bound.

Golder considers that the critical failure mode is sliding along the proposed liner system. The minimum calculated factors of safety (FoS) remained unchanged for all cases, with the exception of output figures A3 and A4, where slight improvement was recorded.

As discussed in Section 4.1 of the GHD independent stability assessment, the adopted ground model stratigraphy in this area (cell 2) for Section C is not consistent with the available geotechnical information and the supplied design cross sections. The cut depth in this area is indicated to be less than 4m and none of the test pits undertaken within this area (TP2, TP83, TP84, TP91, BA14, BA15 and BA16) encountered rock. The nearest boreholes which were drilled for groundwater monitoring (GMB1 and GMB6) encountered rock at 10.35m (RL 323.94m) and 21.5m (RL304.11m) respectively. The dominant underlying material was noted to comprise stiff sandy clay as confirmed by cone penetration (CPT) testing, with localised zones of more granular material.

This is not considered to have a significant impact on these analyses, though this has not been checked through independent stability analysis by GHD. It is recommended that Golder Associates confirm this.

4.2 Reassessment of critical stability analysis to consider granular soils

Additional analyses were undertaken to consider the influence of granular materials within the embankment foundation for the critical sections (Section C). The details provided within Section 3.2 and Figures C1 and C2 of the addendum report indicate reduced calculated FoS' in comparison to the previous analyses of these sections, though they are above the required minimum values.

4.3 Waste sensitivity analysis

Golder have carried out a sensitivity analysis to the strength parameters adopted for the waste material and details of this are provided with Section 3.3 of the addendum report. A range of values has been adopted including increased cohesion which has resulted in a calculated FoS above 1.0 as suggested by GHD in the letter report dated 29 May 2015.

The values adopted in the Works Approval Application are acknowledged as being conservative as supported by Figure 1 in the addendum report. The additional stability analysis of the waste is therefore considered to be acceptable.

5 Conclusions and recommendations

1. Following our review of the additional information supplied by Golder Associates (Addendum dated 14 July 2015), GHD is satisfied that the operational landform design is considered to be stable.
2. The stratigraphic model for analysis of cell 2 (Section C) does not reflect the indicated ground conditions from the available geotechnical information, though based on the analysis presented in figures C1 and C2, the global stability of the landfill in this area is likely to be acceptable. Golder Associates should confirm this.
3. No additional stability monitoring is recommended for the landfill assuming that it is constructed in accordance with the design.

Written by:	Reviewed by:
Ben Dening	**Dr Bryn Thomas**
Senior Geotechnical Engineer	Senior Principal Geotechnical Engineer

Appendix L
Surface water diversion system