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DUNCRAIG
WA 6023



22 December 2025

Department of Water and Environmental Regulation
Locked Bag 10
JOONDALUP DC
WA 6919

Sent via email to "info@dwer.wa.gov.au"

Attention: [REDACTED]

Subject: Millar Road landfill – Works Approval WTBA/2025/1 - Request For Information - Response

Dear [REDACTED],

Further to your request for information, dated 3 December 2025, **Table 1 – Response to Request for Information** provides the Proponent's responses:

Table 1 – Response to Request for Information

<p>Relevant Part of Application Form and Information Required</p>	<p>Rationale</p>	<p>Proponent's Response</p>
<p>Proposed leachate ponds stability assessment is required to support the application. The assessment should use site specific data and avoid the use of assumptions where possible and include leachate management contingencies, given the increased stability risks and liner failure.</p>	<p>No information has been provided relating to the stability of the proposed leachate ponds. Installing leachate ponds on top of existing landfill cells presents several critical stability and engineering challenges. Beyond the immediate concerns of liner integrity and settlement, other key stability issues that should be carefully evaluated include but are not limited to:</p> <p>Geotechnical Stability of the Capped Landfill</p> <ul style="list-style-type: none"> • Slope Stability: The added weight of the leachate pond could destabilize side slopes, especially given the landfill has steep batters and the cap is thin. • Bearing Capacity: The underlying waste and capping layers may not have sufficient strength to support the pond, leading to differential settlement or even failure. • Subsurface Heterogeneity: Waste composition and compaction vary, which can lead to uneven support and localized instability. 	<p>The following design aspects have been incorporated to ensure that the proposed development does not negatively impact the stability of the landfill slopes:</p> <ul style="list-style-type: none"> • The leachate ponds have been positioned a minimum of 10 m away from the edge of the landfill capped batters. • The ponds are only 3 m high and a maximum liquid operating level of 2.5 m results in a low uniformly distributed load on the top of the landfill surface. <p>A stability assessment of the impact of the proposed leachate ponds has been undertaken, which clearly demonstrates that the ponds will not impact the overall stability of the landfill or the existing capping layer.</p> <p>Attachment No. 1 – Stability Assessment provides the outcome of the landfill stability assessment.</p> <p>With the shallow leachate ponds, the additional bearing pressure on top of the landfill is minimal (equivalent to approximately 4 m of additional waste height). This will have no negative impact on the underlying waste mass, as putrescible landfills of this type can be developed with significantly greater waste heights, with no negative impact on the underlying waste. Cell 12 and Cell 13 commencing landfilling in March 2010 and April 2011 respectively and being completed by October 2013; hence, by the time the first leachate pond is developed in 2026, the underlying waste mass will be between 12 to 15 years old.</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
		<p>During this period, all of the immediate, primary and secondary settlement would have occurred, with only the residual settlement continuing (Xie and Xue June 2023). Typically, residual settlement occurs at an extremely slow rate in comparison to the earlier landfill settlement mechanisms. Hence, with the additional weight of the leachate ponds, there will be minimal, if any impact on waste settlement future landfill settlement. In addition, it is only differential settlement that is of potential concern on landfill surfaces. With minimal anticipated residual waste settlement, there will be insignificant differential waste settlement and hence, the leachate ponds or the underlying landfill capping system will not be impacted by settlement.</p> <p>The heterogeneity of the waste type within municipal landfills and the potential impact on waste settlement is mitigated by the fact that the landfill is developed in thin layers of typically 0.5 m thick; hence, on a daily basis, the mixed waste types are blended and spread across the landfill surface to form a general homogeneous waste mass, albeit comprising of a wide range of waste types. This blending and spreading results in the waste mass typically settling at a uniform rate, with the vast majority of any differential settlement occurring during the operational life of the landfill cell and hence, the void created by the differential settlement is filled in by subsequent waste lifts above.</p> <p>In the extreme event, if there is any noticeable differential settlement of the leachate ponds, this will be detected by the difference in pond perimeter bund levels when the ponds is full, (at 0.5 m freeboard). There will be portions of the perimeter</p>

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		<p>bund that will have greater than 0.5 m freeboard. From an operational point of view, this can be easily managed, by simply maintaining the 0.5 m freeboard from the lowest level of the perimeter bund (the portion that has settled the most). The only negative impact will be the slightly reduced pond storage volume. If the pond perimeter bund difference becomes significant, the lower portions of the perimeter bund can easily be increased in height to achieve the original pond storage capacity.</p>
	<p><i>Hydraulic and Seepage Concerns</i></p> <ul style="list-style-type: none"> • <i>Increased Hydraulic Load: A pond introduces a significant hydraulic head, which can drive leachate or water through the cap or sidewalls, potentially breaching containment systems.</i> • <i>Seepage-Induced Instability: Water infiltration can reduce shear strength of the capping soils and waste, increasing the risk of slope failure or internal erosion.</i> 	<p>The landfill capping system has a 1.5 m thick sand layer (growing medium) on top of the capping synthetic liner. This is a free-draining high permeable layer that releases accumulated rainwater rapidly and hence, does not build up hydraulic pressure on the cap liner. In addition, the proposed lined leachate ponds will intercept the rainfall and hence, significantly reduce the volume of water seeping into the growing medium. There will be no seepage-induced instability, as the leachate ponds will effectively reduce the water infiltration into the capping growing medium; hence, in reality, there will be a reduced possibility that the growing medium will saturate resulting in reduced shear risk. In addition, the leachate ponds are proposed to be constructed on the top of the landfill cells, where there is a 1 in 50 slope on the capped surface, hence, slope failure and internal erosion is not a consideration.</p>
	<p><i>Gas Generation and Pressure</i></p> <ul style="list-style-type: none"> • <i>Landfill Gas Migration: The pond may inhibit gas venting, increasing pressure beneath the cap and</i> 	<p>With the waste mass below the leachate ponds being 12 to 15 years old, the concentration of methane in the landfill gas has decreased significantly resulting in lower volumes of gas being</p>

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	<p><i>potentially causing uplift, cracking and/or create an explosive environment beneath the liner.</i></p> <ul style="list-style-type: none"> <i>Interaction with Gas Collection Systems: Existing infrastructure may be compromised or require redesign to accommodate the leachate ponds.</i> 	<p>extracted. Over time, this decrease/lower gas volumes will continue.</p> <p>Prior to the construction of the leachate ponds, any gas wells that are still active, will be extended to the outside perimeter of the ponds so that any gas can continue to be extracted. This will ensure that there is no increase of pressure beneath the landfill cap. In the event that there is increased pressure below the landfill cap liner, the weight of the leachate pond will prevent the cap liner from lifting.</p> <p>The top of the landfill has a comprehensive synthetic lining system (GCL/LLDPE) that significantly contains the landfill gas within the waste mass (to enable it to be extracted), resulting in minimal fugitive landfill gas emissions. In addition, with the thick layer of permeable sand over the synthetic capping liner, any landfill gas will oxidize within the soil layer or rapidly disperse through the sand layer and naturally vent beyond the pond liner.</p> <p>This matter has been addressed above.</p>
	<p><i>Settlement and Differential Movement</i></p> <ul style="list-style-type: none"> <i>Ongoing Waste Settlement: The leachate ponds may exacerbate differential settlement of the waste mass, leading to liner damage or loss of containment. This is of concern given that landfilling and capping ceased in 2019.</i> <i>Localized Loading: Concentrated loads from pond embankments or equipment could cause uneven deformation.</i> 	
	<p><i>Liner System Compatibility</i></p>	<p>The cap liner consists of a comprehensive lining system incorporating a GCL and geomembrane. This type of lining is used in the base of most lined landfills and as such, has an</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
	<ul style="list-style-type: none"> • <i>Capping Integrity: The existing cap may not be designed to support a pond liner system, especially if it lacks a geomembrane or drainage layer.</i> • <i>Pond Liner Stability: The interface between the pond liner and the landfill cap must be stable under wet conditions and resist sliding.</i> 	<p>ability to withstand substantial vertical loading (+50 m of waste). As described above, differential settlement is not anticipated to be a significant issue and hence, there will be minimal strain imposed onto the capping liner. In addition, the geomembrane utilised in the landfill capping system is an LLDPE, which is specifically designed/formulated to accommodate differential settlement (high elongation strength) if it should occur.</p> <p>The leachate pond is not installed directly on the landfill capping synthetic liner. There is the 1.5 m sandy growing medium between the two synthetic liners. The friction interface within the non-cohesive sandy soil, its high permeability, the gentle grade on top of the capped landfill and the fact that the pond liner will reduce saturation in the interface layer will ensure that there are no stability issues with the proposed leachate ponds.</p>
	<p><i>Structural and Operational Risks</i></p> <ul style="list-style-type: none"> • <i>Embankment Stability: Embankment design must account for landfill foundation variability.</i> • <i>Access and Maintenance: Heavy equipment access for pond maintenance could damage the cap or induce instability.</i> 	<p>The leachate pond perimeter embankments are low structures, at a maximum of 3 m high, with a top width of 3 m and internal and external batters of 1 (V) in 2 (H). This is a stable configuration, in particular with only having a pond maximum operation depth of 2.5 m and an overflow level of 3.0 m.</p> <p>As described above, there is not anticipated to be any negative impact from the minimal remaining settlement within the landfill waste mass; hence, in combination with the low gradient of the landfill cap, the landfill foundation provides a stable base on which to construct the ponds.</p> <p>There is a minimum 10 m wide strip between the ponds and the edge of the sloping capped landfill. This provides adequate space for access and maintenance of the leachate ponds.</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
<p>Leachate ponds sizing Further justification for leachate pond sizing is required, in line with the requirement that leachate balance be modelled over at least two consecutive 90th percentile wet years to ensure that the leachate system has sufficient capacity to deal with all the leachate generated over the operational life of the landfill.</p>	<p>The leachate generation modelling assessment has chosen to ignore the two consecutive 90th percentile leachate generation scenario. The purpose of a leachate balance assessment is to demonstrate that the leachate containment system will be able to operate in a satisfactory manner throughout all weather events during the facility's ongoing operations. The Delegated Officer considers that larger, or additional leachate ponds may be required to manage current and future leachate generation rates in line with the outcomes of the leachate generation modelling assessment.</p>	<p>The cap synthetic liner is covered by a 1.5 m thick soil layer (growing medium), which will protect the cap synthetic liner from damage.</p> <p>As can be seen by the HELP modelling, in a normal (mean) year, the modelling predicts 2 x 22,075 m³ or 44,150 m³ of leachate generation over a two-year period, while the two consecutive years of 90th percentile weather results in 120,380 m³ of leachate generation. This represents a 273% increase in leachate generation. It is not feasible to develop leachate pond capacity for this extreme level of hypothetical leachate generation. Consequently, the Proponent has looked at mechanisms to reduce leachate generation such that more intense rainfall weather patterns can be managed with a realistic sized leachate management infrastructure.</p> <p>To this end, the Proponent is currently developing a solution to improve the capping of the western landfill (a future Licence Amendment Application), which is the landfill area that generated by far the vast majority of the leachate on site. Once the western landfill has been recapped, then the leachate generation within the western landfill will be minimal, and hence, the proposed leachate ponds will be able to cater for two consecutive 90th percentile weather patterns.</p> <p>The current leachate pond development proposal uses up all of the most suitable long-term available area on site for pond development. This will provide the Proponent with additional leachate management capacity to manage unseasonable weather patterns; however, not two consecutive 90th percentile</p>

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Leachate assessment (empty at end of summer)	<p>The Delegated Officer notes operational controls would be required to manage leachate generation through consecutive average rainfall years, including the requirement to ensure that leachate ponds are empty prior to each winter period.</p> <p>All available historical images have been reviewed and it has been determined that leachate ponds at the premises have never been in an empty state since construction, dating back to 1995.</p> <p>The impact of recycling leachate across the landfill cells requires further consideration, including:</p> <ul style="list-style-type: none"> • The impact upon the leachate generation rates assessed within the leachate generation modelling assessment (leachate generation modelling) 	<p>rainfall year based on current forecast leachate generation levels.</p> <p>The development of the additional leachate pond capacity will provide the Proponent with increased ability to manage leachate, and along with other active leachate management efforts, will substantially reduce the volume of legacy leachate on site while the solutions for the recapping of the western landfill are finalised, approved by the DWER and then constructed. Thereafter, the new leachate ponds will be the only leachate ponds remaining on site, as the existing ponds will be removed as part of the recapping of the western landfill. The HELP modelling demonstrates that, with good leachate management operations, the proposed three new leachate ponds will be able to manage two consecutive 90th percentile wet years.</p>
		<p>The leachate ponds have historically never been empty because the site has predominantly relied on surface evaporation from the ponds to reduce the volume of leachate on site. The HELP modelling and water balance clearly demonstrates that simply relying on pond surface evaporation does not get rid of sufficient leachate out of the system; hence, there is a need to implement additional leachate management methods to significantly increase the volume of leachate removed from the system. This is demonstrated by the fact that, over time, the site has progressively accumulated more and more legacy leachate. The site is now at a stage where it needs to take dramatic action to remedy the situation.</p>

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	<p>assessment indicates that 100% of carted leachate would be evaporated). This may not be achievable in a real life scenario;</p> <ul style="list-style-type: none"> • If liquid accumulates unevenly, it can create perched layers and destabilize side slopes. • Added moisture can reactivate anaerobic microbes, increasing methane and CO2 production; and • Any proposed monitoring. e.g. Leachate head monitoring within all cells. <p>This information is required to undertake a risk assessment of the application</p>	<p>A few years ago, the site put in significant effort to run a water cart for the majority of the summer period, anecdotally up to 8 water carts per day. During this period, the leachate levels in the landfill sumps and ponds were reduced substantially, demonstrating that, with intense effort, it is possible to manage all leachate on site with the current four leachate ponds. However, the intensity of effort needs to be maintained for every summer period.</p> <p>This leachate pond development proposal will provide additional pond surface area and storage capacity, that along with water cart utilisation, should enable the site legacy leachate volume to be significantly reduce while the Proponent progresses with the recapping of the western landfill.</p> <p>The proposed additional leachate management infrastructure gives the proponent the ability to improve the site leachate management and also transition through the recapping of the western landfill.</p> <p>"Leachate recycling" or water cart utilisation is not about saturating the landfill surface such that, in time, the leachate eventually seeps down to the leachate sump. It is about spraying a thin layer of approximately 10 mm of leachate over available areas of the landfill during dry periods such that the sprayed leachate is able to evaporate from the landfill surface during the day and not seep into the waste mass. With the Perth long dry summers, it is possible to spray an area a couple of time per day without over-saturating the landfill surface. Ultimately, it is better to over-saturate the landfill surface than under-saturate the surface, as this ensures that the maximum</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
<p>Bulk green waste stormwater ponds Further information is required in order to assess proposed green waste processing area stormwater ponds. Including:</p> <ul style="list-style-type: none"> • Impact of irrigation of leachate to Cells 8 and Cell 10; and • The provision of an updated water balance assessment for the green waste storage area using the assumptions contained within Appendix B of the 	<p>The Delegated Officer notes that the application proposes the reuse of leachate for the irrigation of the adjacent Cell 8 and Cell 10. The leachate generation modelling assessment indicates that the western portion of the landfill is the most significant contributor to leachate generation at the Site. The inclusion of the irrigation to the surface of Cells 8 and 10 will only exacerbate leachate generation rates in this area, especially if applied during or after rainfall as proposed. In addition, these irrigation volumes have not been included in the leachate generation modelling assessment.</p> <p>The Delegated Officer notes that the calculations used in the water balance assessment are based upon the assumption that the ponds are empty prior to all rainfall events. This is not a realistic modelling scenario.</p>	<p>daily evaporation is achieved, albeit with some wasted effort in over-saturating the surface.</p> <p>With regards to uneven accumulation, perched layers, destabilisation, reactivation of anaerobic microbes and landfill gas generation etc. this is only relevant to leachate recycling (reinjection) within the landfill. As described above, the water cart utilisation does not result in any/much seepage of leachate into the waste mass.</p> <p>The spraying of leachate on the landfill surface will not impact on the saturation level within the landfill and hence, there is no additional leachate head monitoring requirements. The Proponent currently monitors the level of the leachate in all landfill sumps, this activity will continue.</p>
		<p>The spraying of the uncontaminated surface water runoff from the green waste area will only be sprayed on the adjacent east and south facing side batters of the capped Cell 8 and 10. These areas were recently capped with at coated GCL liner and are at a typical batter of 1 in 3.5. The capped area is significantly large in comparison to the volume of the stormwater sumps such that there will only be occasional watering of the batters, not saturation of the growing medium. The batters have well established vegetation cover that will consume the water through evapotranspiration and strip any nutrients that may be present in the surface water runoff. This area of the western landfill is a minor contributor to the leachate generation (refer Table 12, line 2); hence, the minor volume of additional irrigation will not have a material impact, if any, on the overall leachate generation on site.</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
<p><i>Guideline: Better Practice Organics Recycling.</i></p>	<p><i>Additionally, the assumption that 50% of precipitation falling on to the hardstand area will reach the stormwater ponds appears to be less than documented values. Green waste with a 30% moisture content will have the capacity to absorb an additional 10% of rainfall (40% total moisture capacity). The Guideline: Better Practice Organics Recycling uses conservative assumptions in this water balance assessment, including that 100% of precipitation to the catchment area is converted to runoff into the leachate pond (i.e. runoff coefficient of 1) and negligible seepage occurs from the leachate pond. The purpose of a water balance is to demonstrate that the leachate containment system will be able to operate in a satisfactory manner throughout the seasons and during the facility's ongoing operations.</i></p>	<p>The green waste area is not a composting operation. The facility has been sized such that there is not sufficient space to accumulate a large volume of green waste for an extended period; hence, the green waste will need to be moved off site on a regular basis. Consequently, there will be no composting of the organic matter and hence, the surface water runoff will not be highly contaminated with biodegrading organic material. Provided the green waste hardstand area is maintained such that there is no ponding on the limestone surface, then the green waste will not stagnate in the surface water, and the surface water runoff will have a low contamination level and hence, can be sprayed onto the Cell 8 and 10 batters within a few days after a rainfall event. The stormwater pond will be maintained empty.</p> <p>As described in the Application Supporting Documentation, Section 8.5, based on 100% surface water runoff, the two ponds have the capacity to cater for a 244 mm rainfall event (488 mm at 50% runoff). A 1 in 100 year, 7-day rainfall event results in 212 mm of rainfall; hence, the green waste area stormwater ponds can cater for the worst-case scenario rainfall event, with 100% runoff and still have 15% additional capacity. With the facility being operated as a single rainfall event system, whereby the ponds are pumped out within a few days of each rainfall event, a month-on-month water balance is not relevant.</p>
<p><i>Stormwater management Provide further controls for the prevention of stormwater becoming</i></p>	<p><i>The applicant states that stormwater from the small goods drop-off area, bulk drop-off areas, and waste transfer station will be managed via soakwells and stormwater collection sumps. The</i></p>	<p>The waste materials in the small goods drop off area will be contained within bins, covered areas or under tarps. The inert</p>

Relevant Part of Application Form and Information Required	Rationale	Proponent's Response
<p>contaminated prior to disposal to ground via soakwells and stormwater collection sumps.</p>	<p>Delegated Officer notes that stormwater that comes in contact with waste has the potential to become contaminated and cause environmental impacts. This information is required to undertake a risk assessment of the application</p>	<p>area and scrap metal area do not contain waste material that will result in contaminated surface water runoff. The green waste drop off area is for daily drop off activities and the accumulated green waste will be relocated to the new bulk green waste area within 24 hours (maximum 48 hours) of being dropped off. In addition, the drop off area is well graded to prevent ponding and hence stagnation of surface water. This will prevent the surface water from getting contaminated such that it will result in environmental harm. The community waste transfer station will also be operated with a fast turnover of waste being transferred to the landfill. Typically, the waste will be transferred multiple times per day; hence, the vast majority of the waste will be moved to landfill within a few hours of being dropped off. Only on the rare occasion will there be waste left within the transfer station overnight. Also, all residents in the Metropolitan area have a kerbside collection for putrescible waste and the vast majority of the waste received at the transfer station is bulk waste, hence, there is minimal waste that will generate contaminated surface water runoff. Based on the rapid removal of waste material from the drop-off area, there is minimal possibility that the surface water runoff will be contaminated to a degree that will result in environmental harm.</p>

Should you have further queries, please do not hesitate to contact the undersigned.

Yours Sincerely



Attachment No. 1 – Stability Assessment

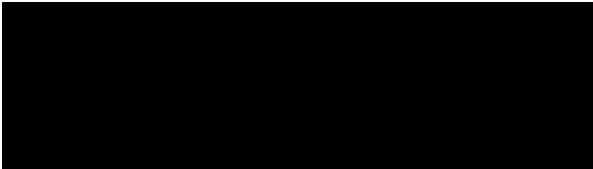
Attachment No. 1 – Stability Assessment

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Project: WA004-25-002LTR

10 December 2025



Dear [REDACTED],

Re: Cell 12 to 15 Leachate Pond Stability Assessment

1. Introduction

1.1. Purpose

BEC WA Pty Ltd, trading as BEC-IWP (BEC-IWP), has been engaged by IW Projects on behalf of the City of Rockingham to undertake a stability analysis of the proposed leachate ponds to be constructed atop Cells 12 to 15 at the Millar Road Landfill. The Site is located at 204 Millar Road West, Baldivis WA 6171.

This letter provides a summary of the stability assessment outcomes addressing the queries and stability concerns raised by the Department of Water and Environmental Regulation (DWER), following their review of the leachate pond design.

1.2. Background

IW Projects and BEC-IWP completed the detailed HELP modelling and water balance assessment for the Site. The assessment identified the need for additional leachate storage capacity to support the ongoing operational life of the facility. In response, IW Projects designed the proposed leachate ponds to accommodate the modelled leachate generation volumes.

2. Stability Assessment

2.1. Background

Golder previously completed infiltration and stability assessments for Cells 12 to 15 at Millar Road Landfill. The previous stability assessments (Golder, 2014) and (Golder, 2015) evaluated the veneer stability of the then-proposed capping system, which was subsequently revised and reassessed with outcomes summarised in (Golder, 2018a). Following materials testing completed in August 2018, as part of construction quality assurance, the tested interface friction angle was found to be lower than the assumed interface friction angle in the stability assessment. Hence, the assessment was revised using the tested interface friction angle and outcomes documented in (Golder, 2018b)



In these previous assessments, the analysis focused on identifying the 'critical interface' within the capping profile, defined as the interface between the compacted final cover and the uncompacted growing medium. This critical interface comprised the coated GCL and cushion geotextile layers, which were modelled as a single interface using shear strength parameters governing the lowest friction angle and adhesion within the system, and later the actual tested interface friction angle. The stability assessments found that the original design capping configuration did not meet the minimum factor of safety (FoS) for the static and pseudo-static loading conditions without amendments.

The outcome of these assessments and subsequent discussions between the designer (IW Projects), City of Rockingham, WML Consulting, and Golder resulted in the design being amended to remove the lower cushion geotextile. For the sections where the lower cushion geotextile had already been installed on site they were removed in accordance with Figure 1 to increase the FoS to meet the minimum requirements.

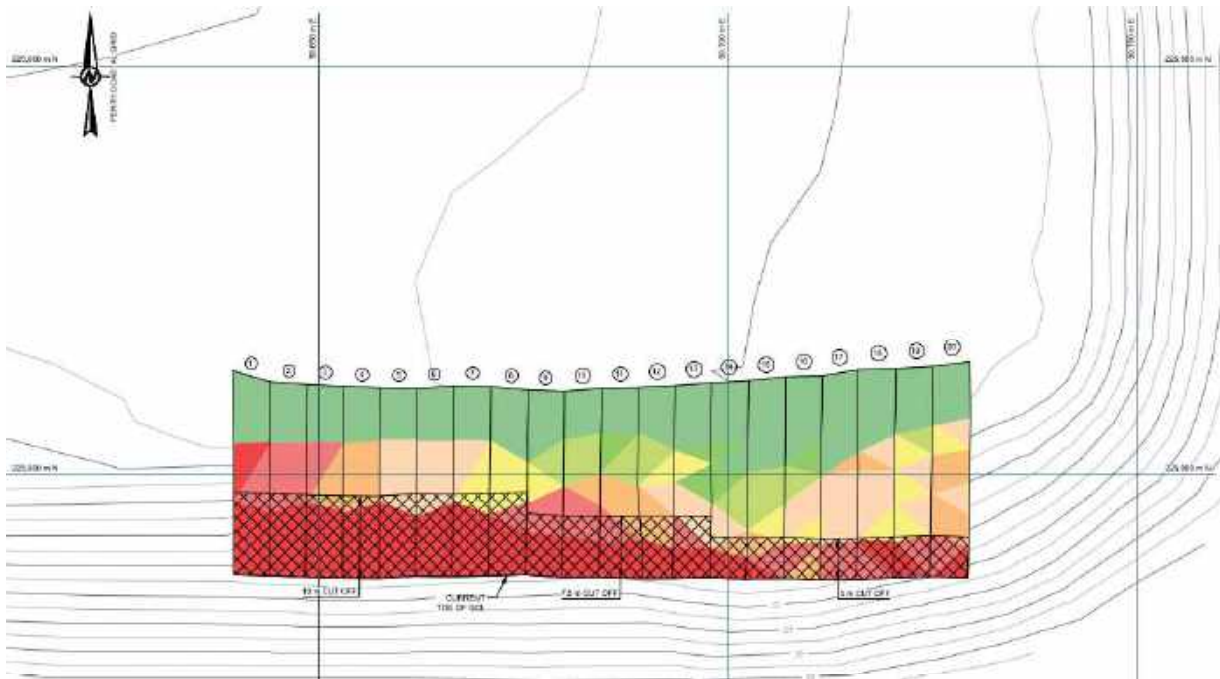


Figure 1: GCL and lower cushion geotextile cut off plan view

2.2. Approach

Building on the assessments completed by Golder between 2014 and 2018, the current stability assessment evaluates the potential influence of the proposed leachate ponds on both veneer stability and global stability of the landfill side slopes.

A stability assessment was undertaken to assess the effect the construction of the proposed leachate ponds will have (if any) on the veneer and global stability of the landfill cell composite liner and landfill side slopes as a result of the added weighting/forces brought on by the ponds.

2.3. Analysis Method

To assess the leachate ponds' effect on stability, a two-dimensional limit-equilibrium slope-stability analysis was undertaken using SLIDE v9.0 (Rocscience). All sections were analysed using the Morgenstern-Price method, which employs a method-of-slices formulation and satisfies both force equilibrium and moment equilibrium for each slice. The analyses were carried out using non-circular failure mechanisms under static and pseudo-static loading conditions. All assessments were carried out with optimisation to assess the likely critical failure surface. Localised sloughing along the slope surface were ignored and only failure surfaces with a minimum depth of 0.5 m were considered.

2.4. Model Section

The critical sections remain the same as identified in (Golder, 2018b) with an additional cross section (section C), these are shown in Figure 2.

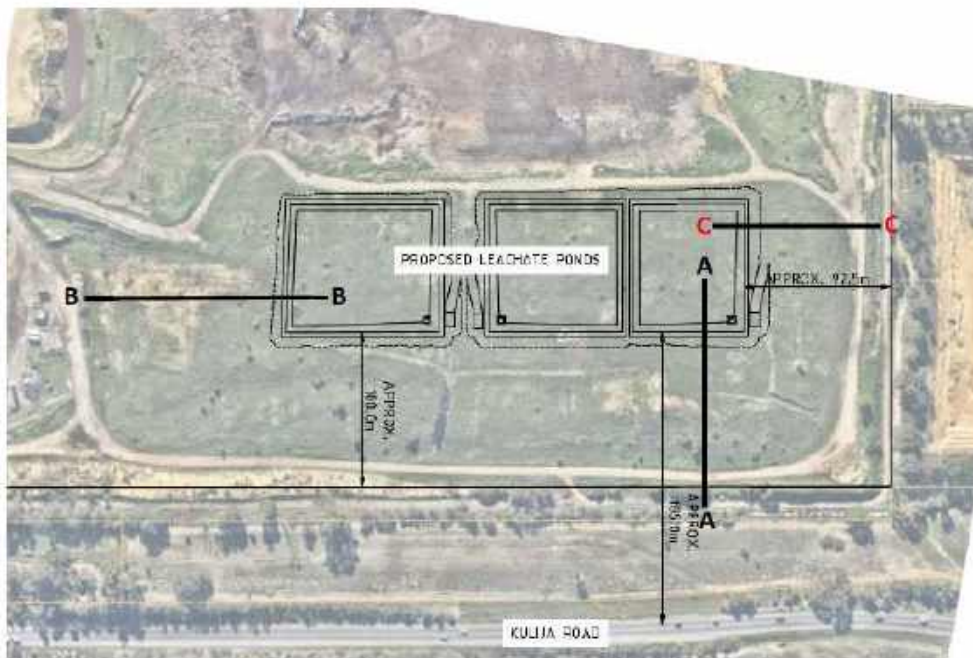


Figure 2: Proposed leachate pond layout and stability cross sections

A “critical area” on a slope is typically the zone where the combination of slope geometry, material properties, pore pressures, and loading conditions produces the lowest FoS. This generally corresponds to the steepest and longest section of the slope, as these geometries tend to exhibit higher failure potential. Accordingly, the sections have been selected as follows:

- Section A represents the critical area where the underlying capping constitutes the original design. As can be seen from Figure 1, the lower cushion geotextile is only present within Section A.
- Section B represent the critical area where the underlying capping constitutes the revised capping design.



- Section C represents the critical area with similar slope geometry to Section A but with the revised capping design.

2.5. Cases Analysed and Minimum Factor of Safety

Consistent with the Golder assessments a minimum target FoS of 1.5 for static conditions and 1.1 for pseudo-static (seismic) loading conditions has been adopted. These values reflect the use of conservative material parameters and align with FoS criteria recommended by the Australian National Committee on Large Dams (ANCOLD), as well as other published guidance for urban embankment dams. In the absence of a dedicated regulatory standard for landfill slope stability in Australia, ANCOLD guidance represents the most appropriate benchmark for managing geotechnical risk.

The analyses represent normal operating conditions, with no additional surcharge loads applied to the landfill crest or outer side slopes. A separate short-term static case incorporating a conservative 300 mm head on the liner was also assessed to simulate elevated pore pressures during intense rainfall or temporary ponding conditions. Seismic loading has been incorporated using an unfactored peak ground acceleration (PGA) of 0.04 g (Golder, 2018b). The cases analysed and minimum factors of safety are shown in Table 1.

Table 1 – Cases Analysed and minimum FoS

Case	Loading Condition	Minimum FoS
1	Long-term, Static, No phreatic surface above liner	1.5
2	Short-term, Static, 300 mm head above liner	1.2 – 1.3
3	Pseudo-static (seismic), no phreatic surface above liner	1.1

2.6. Material Parameters

Material parameters adopted are consistent with the previous stability assessments to enable a direct comparison and to isolate the influence of the proposed leachate ponds on overall stability.

Typical shear strength parameters for municipal solid waste (MSW) have been taken from published drained test data, including Koerner and Soong (2000), Eid, Stark, Evans & Sherry (1999), and Zekkos et al. (2015). These studies consistently report friction angles in the ranges of 20 to 35° and cohesion values between 0 and 20 kPa, with bulk unit weights between 7 and 12 kN/m³. The lower-bound design values from these reports have been used to inform this assessment.

A summary of the material parameters is provided in Table 2.



Table 2: Summary of material strength parameters

Material	Strength Parameters			Reference
	Unit Weight γ_m (kN/m ³)	Friction Angle ϕ' (degrees)	Cohesion c' (kPa)	
Uncompacted Growing Medium	18	27	0.0	(Golder, 2018a)
Compacted final cover (Sand)	17	35	0.0	
Interface Geotextile vs GCL (Nonwoven side)	18	10.8 / 16.6	0.0	
Interface Sand vs GCL (Nonwoven side)	18	34.9	3.6	
MSW*	10	25.0	5.0	(Koerner & Soong, 2000) (Eid, Stark, Evans, & Sherry, 1999) (Zekkos, 2015)

Note: * - Global stability assessment uses these material strength parameters. For the veneer stability, MSW was assigned infinite strength.

2.7. Stability Results

2.7.1. Veneer Stability

For the veneer stability assessment, the underlying waste mass has been assumed to provide sufficient support to the capping system. As is common practice for veneer analyses, the foundation materials beneath the liner have been assigned an effectively “infinite” strength (i.e., non-governing) so that only the critical liner and cover-soil interfaces control the calculated FoS.

A summary of the results is shown in Table 3.

Table 3: Summary of veneer stability results

Section	Minimum Factor of Safety		
	Case 1 (> 1.5)	Case 2 (>1.2-1.3)	Case 3 (>1.1)
Section A	2.08	1.86	1.77
Section B	2.01	1.73	1.72
Section C	1.66	1.66	1.47

The results indicate that the veneer stability is stable for all sections assessed and the leachate ponds have no measurable effect.



2.7.2. Global Stability

Global stability was also assessed for the three sections by modelling the landfill mass as a complete system, with all relevant material parameters applied. This approach identifies the critical failure surface that may develop when the entire slope behaves as a single, composite structure.

A summary of the results is shown in Table 4.

Table 4: Summary of global stability results

Section	Minimum Factor of Safety		
	Case 1 (> 1.5)	Case 2 (>1.2-1.3)	Case 3 (>1.1)
Section A	2.08	1.86	1.77
Section B	2.01	1.74	1.72
Section C	1.66	1.66	1.47

The results indicate that failures are confined within the uncompacted growing medium, hence the results are consistent with the

3. Discussion

The results of both the veneer and global stability assessments demonstrate that the performance of the capping system and landfill slopes is governed almost entirely by the properties of the uncompacted growing medium rather than by deeper layers or the underlying waste mass. This outcome is consistent with expectations for relatively shallow side slopes where the uppermost soil layer has the lowest friction angle in the material profile and therefore forms the most likely location for a translational slip to develop.

Veneer Stability

The veneer stability assessment confirms that all analysed sections achieve acceptable FoS under both static and pseudo-static loading conditions.

Importantly, the results are similar to the findings of Golder (2018b), who identified that the weakest interface in the original design was associated with the continuous geomembrane in Section A. In their assessment, the geomembrane-GCL interface, particularly where the geomembrane had not been cut back, exhibited the lowest interface friction angle and governed the veneer stability. Subsequently, under the revised design, where this lower-strength interface was removed (cut as per Figure 1), the controlling layer has shifted to the growing medium, resulting in an improvement in overall (global) stability. Had the original design been fully constructed without this modification, it is likely that the FoS would have fallen below the recommended thresholds.

The analysis also demonstrates that the presence of adjacent leachate ponds does not impose any measurable impact on veneer stability.



Global Stability

The global stability assessment further supports the conclusion that instability, where it occurs, is dominated by the shallow capping layer rather than the deeper waste mass or foundation soils. Across all sections, the identified critical slip surfaces remain confined within the uncompacted growing medium, indicating shallow translational failure modes rather than deep-seated rotational mechanisms.

The leachate pond bunds/embankments were also explicitly included in the global stability models. In all cases, the bunds remained stable, with factors of safety exceeding:

- 1.66 under static loading, and
- 1.47 under pseudo-static loading (seismic loading applied)

The presence of the ponds does not materially influence the governing failure mechanisms for either veneer stability or overall landfill stability. The applied 300 mm head on the liner represents a conservative short-term condition—such as intense rainfall or a hypothetical severe leakage scenario through the leachate pond liner into the uncompacted growing medium. Even under this elevated head condition, all assessed sections remained stable, indicating that the capping system and side slopes retain adequate factors of safety.

4. Closing

We trust this letter provides sufficient information to address the stability queries raised by DWER in relation to the Cells 12 to 15 leachate pond design at the Millar Road Landfill. For any queries or clarifications, please contact the undersigned.

Sincerely,

Gustav van Veyeren
Senior Civil and Environmental Engineer
0413 223 738 | Gustav.vanveyeren@beconsult.com

Attachment 1: Stability analysis results



5. References

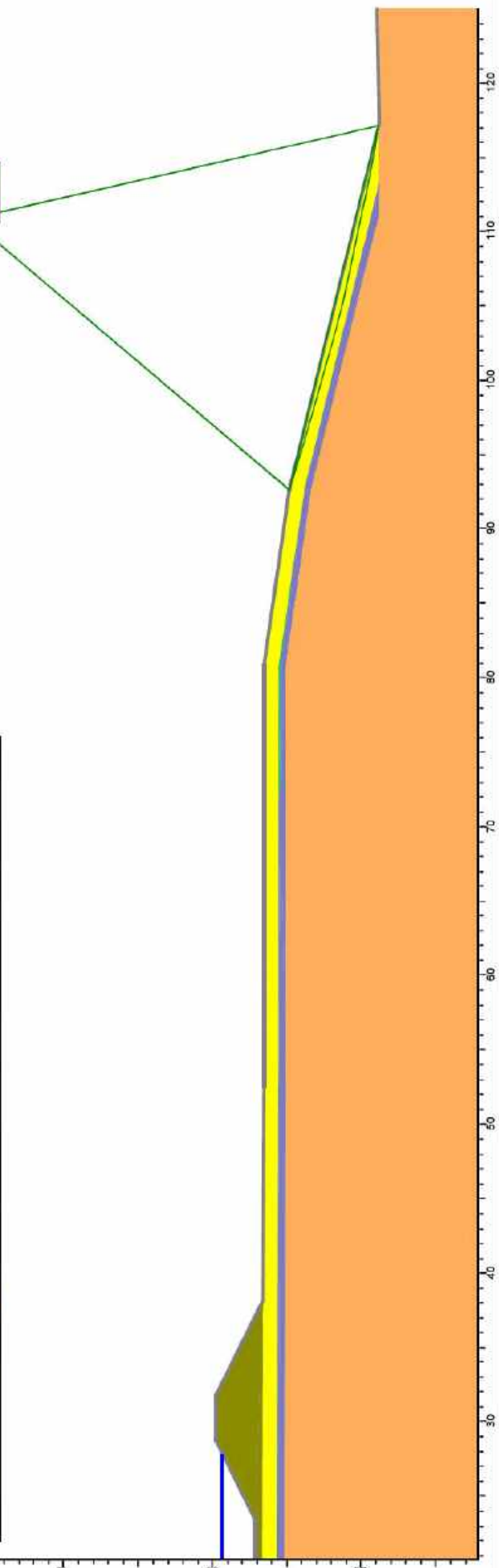
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- Golder. (2018a, June 20). 1898022-001-M-Rev2. *MILLAR ROAD LANDFILL – REVISED VENEER STABILITY AND INFILTRATION ASSESSMENT CELL 12 AND CELL 13 CAPPING WORKS*.
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ATTACHMENT 1
Stability analysis results

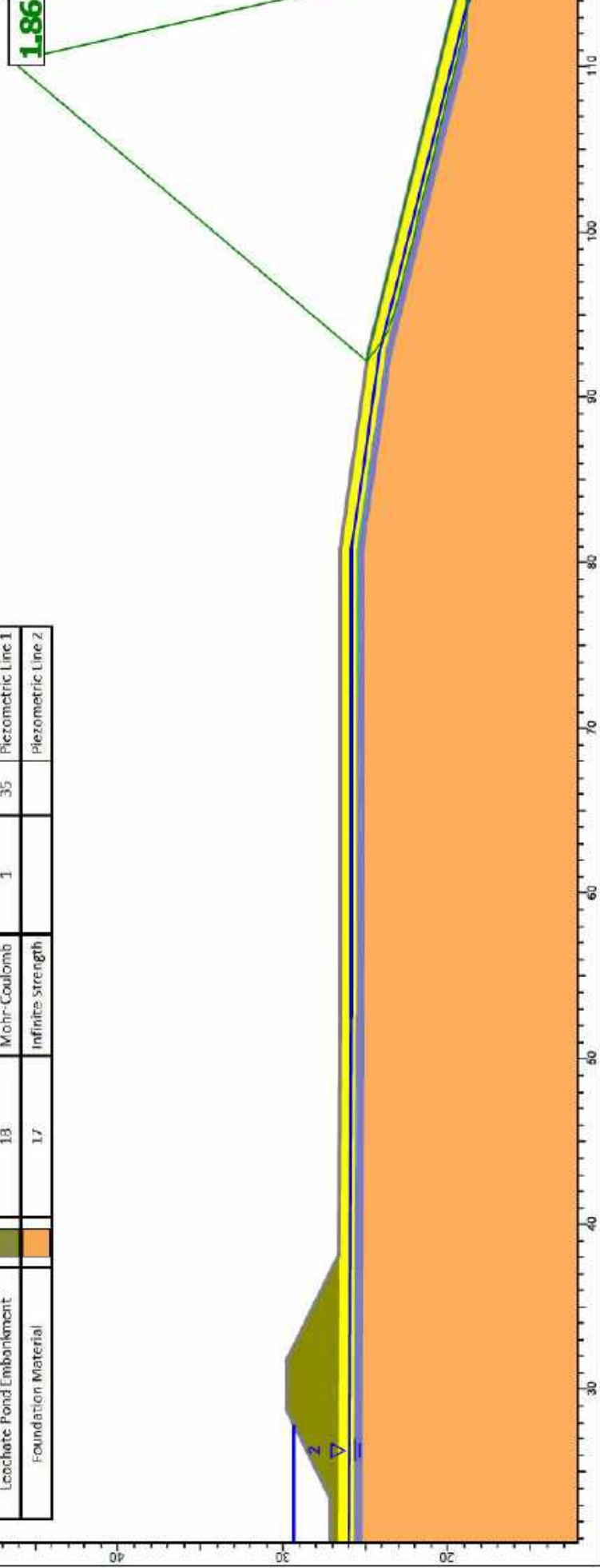
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Geotextile vs GCL (lower)	Green	18	Mohr-Coulomb	0	10.8	None
Interface Sand vs GCL	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Olive	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None


208



		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT	DATE	Long Term Static Section A	
DRAWN	GW		10-Dec-25	PROJECT NO.	WA004-25-002
CHECK	GW		10-Dec-25		
SCALE	NTS	A4			Figure A1

Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	Piezometric Line 2
Interface Geotextile vs GCL (lower)	Green	18	Mohr-Coulomb	0	10.8	Piezometric Line 2
Interface Sand vs GCL	Blue	18	Mohr-Coulomb	3.6	34.9	Piezometric Line 2
Leachate Pond Embankment	Olive	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			Piezometric Line 2

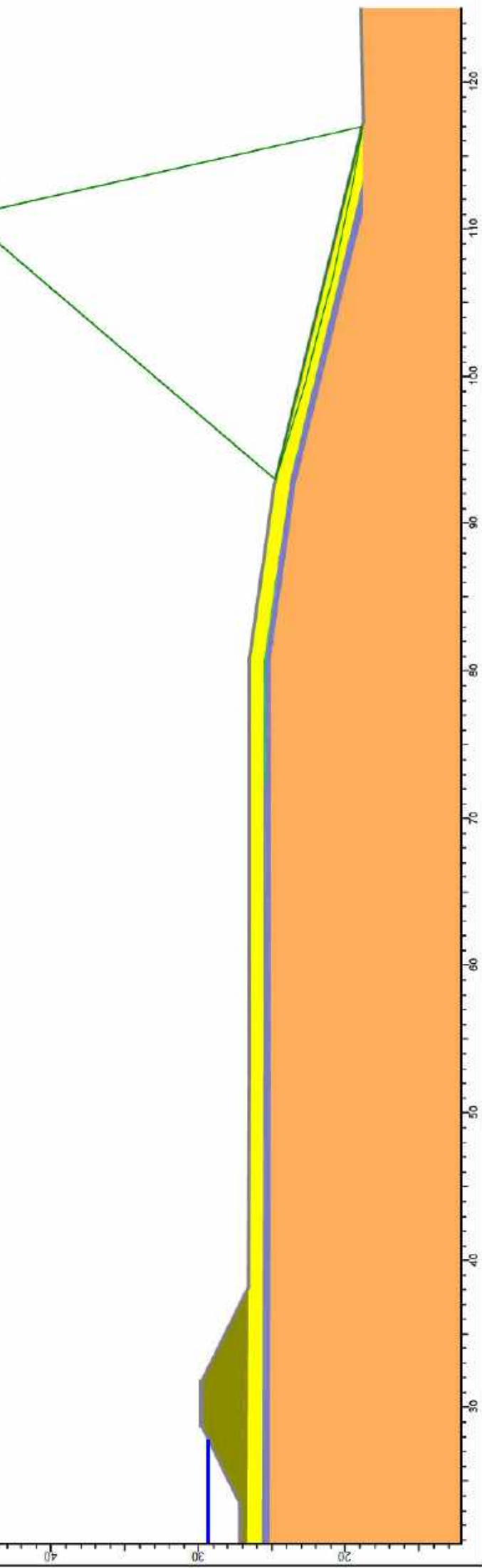



		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT		DATE	10-Dec-25
DRAWN	GW	CHECK	GW	DATE	10-Dec-25
SCALE	NTS	A4		PROJECT NO.	WA004-25-002
Short Term Static, 300mm head on Liner Section A					
				Figure A2	



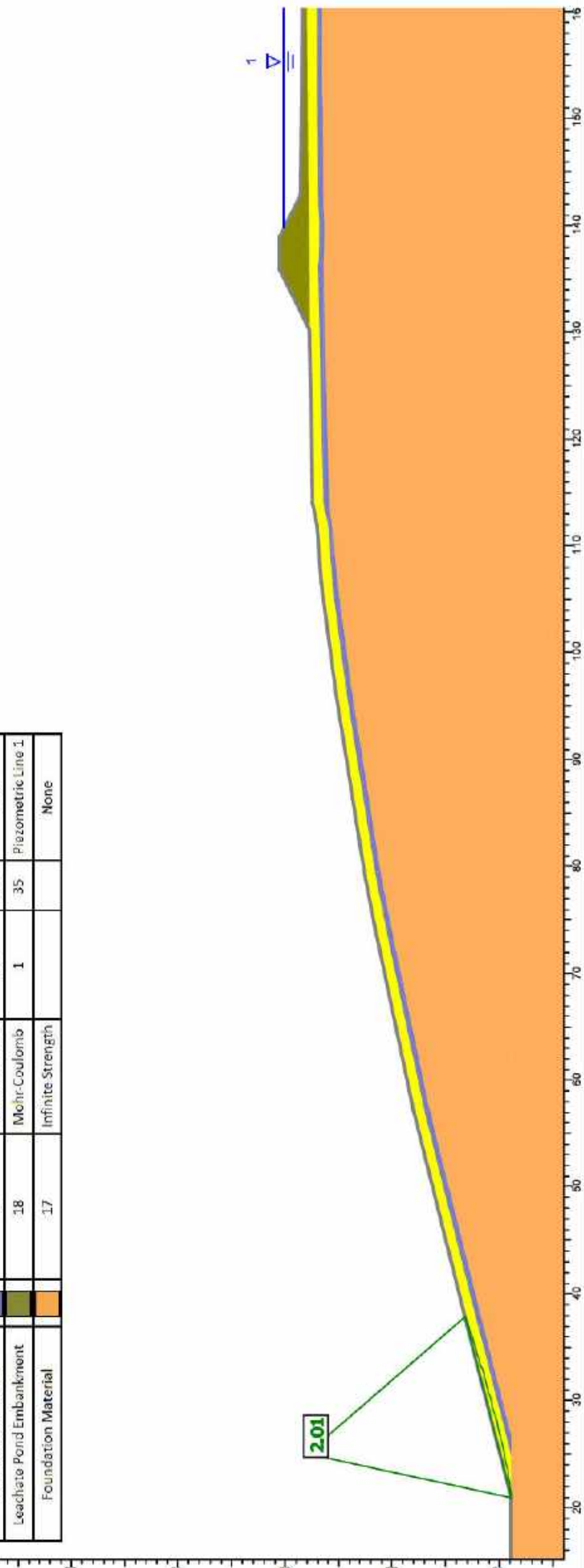
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Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Geotextile vs GCL (lower)	Green	18	Mohr-Coulomb	0	10.8	None
Interface Sand vs GCL	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Olive	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None


1.77



		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT	DATE	Pseudo-static (PGA 0.04g) Section A	
DRAWN	GW	10-Dec-25	PROJECT NO.	WA004-25-002	Figure A3
CHECK	GW	10-Dec-25	A4		
SCALE	NTS				

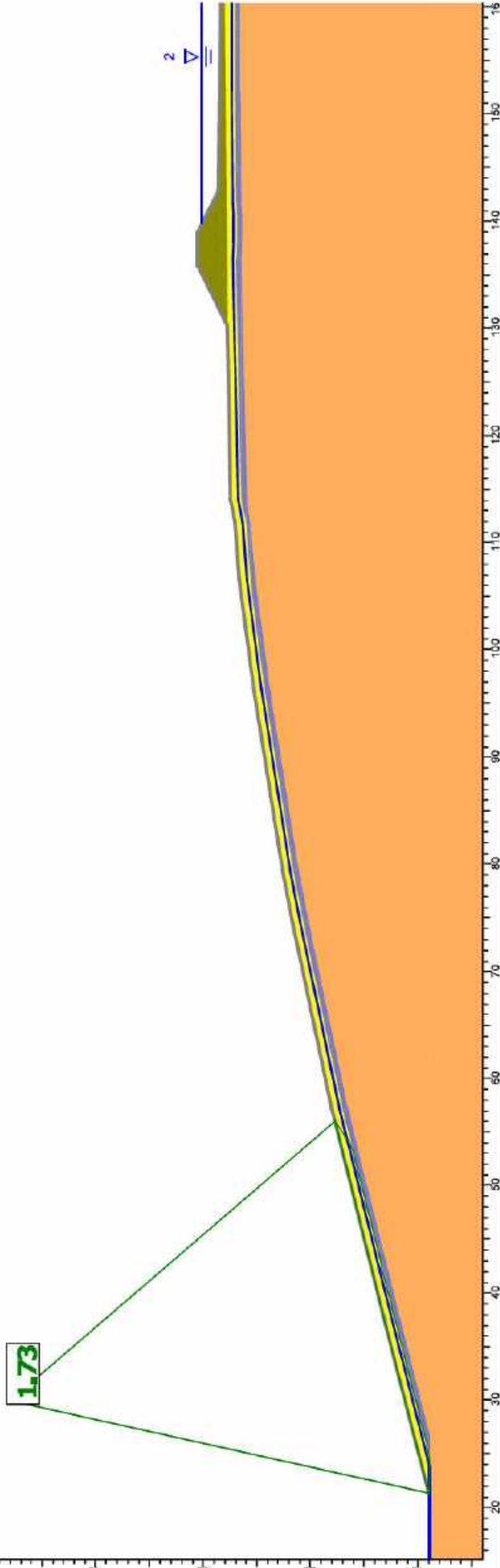
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Sand vs GCI	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None




		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond	
		CLIENT	GW	DATE	10-Dec-25	
DRAWN	GW	CHECK	GW	DATE	10-Dec-25	
SCALE	NTS	A4		PROJECT NO.	WA004-25-002	
				Long Term Static		Figure A4
				Section B		

Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	Piezometric Line 1
Interface Sand vs GCL	Blue	18	Mohr-Coulomb	3.6	34.9	Piezometric Line 1
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 2
Foundation Material	Orange	17	Infinite Strength			Piezometric Line 1

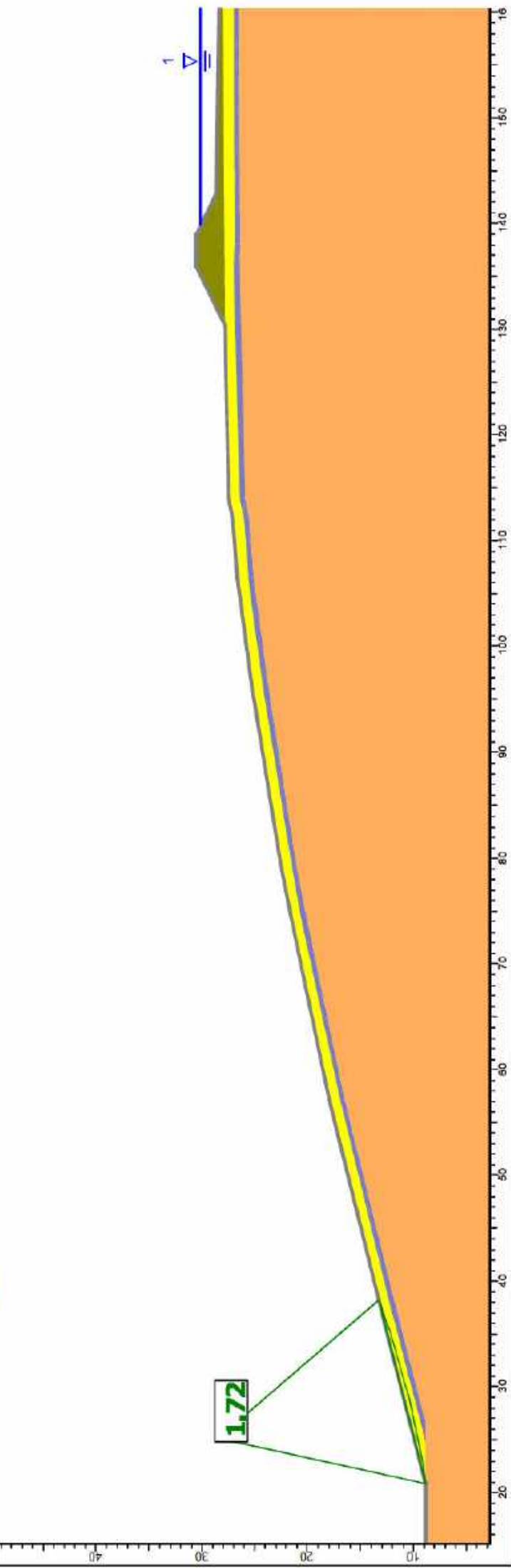
1.73




		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT	GW	DATE	10-Dec-25
DRAWN	GW	CHECK	GW	DATE	10-Dec-25
SCALE	NTS	A4	PROJECT NO.		WA004-25-002
Short Term Static, 300mm head on Liner					Figure A5
Section B					

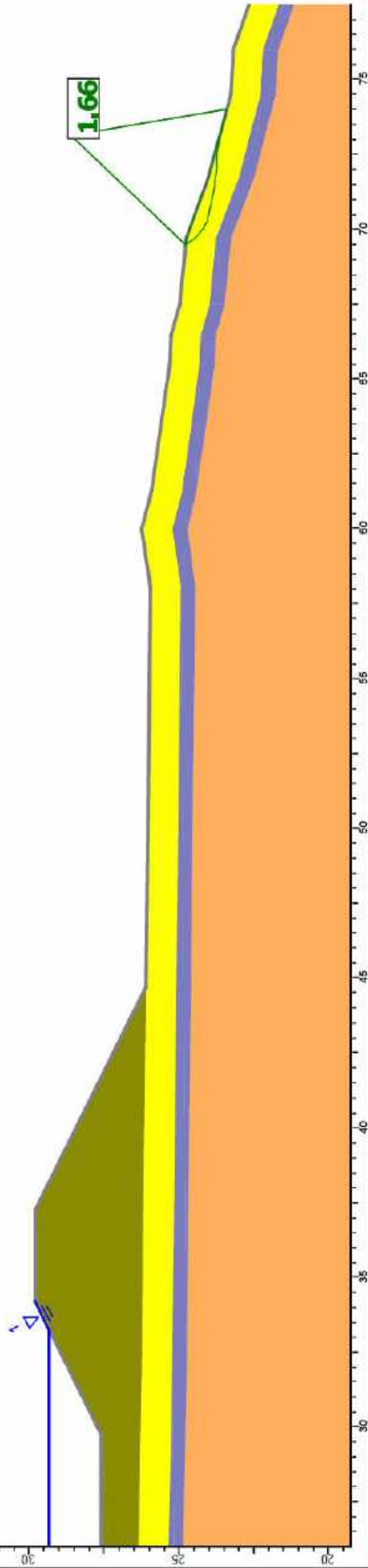



Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Sand vs GCI	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None



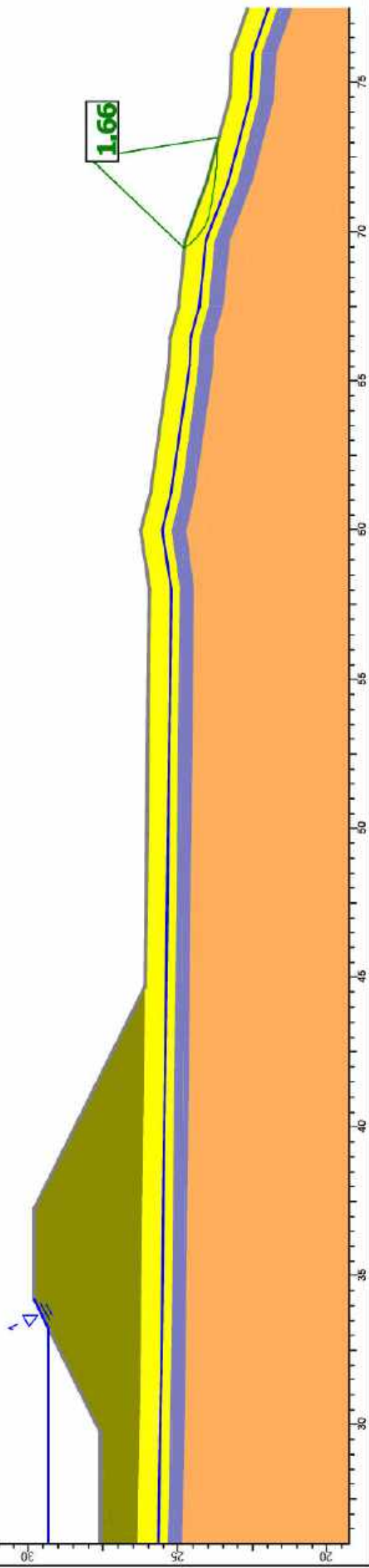
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		CLIENT		Pseudo-static (PGA 0.04g) Section B	
DRAWN	GW	DATE	10-Dec-25	PROJECT NO.	WA004-25-002
CHECK	GW	DATE	10-Dec-25		
SCALE	NTS		A4		Figure A6


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Sand vs GCI	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None



		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT		Long Term Static Section C	
DRAWN	GW	DATE	10-Dec-25	PROJECT NO.	WA004-25-002
CHECK	GW	DATE	10-Dec-25		
SCALE	NTS		A4		Figure A7

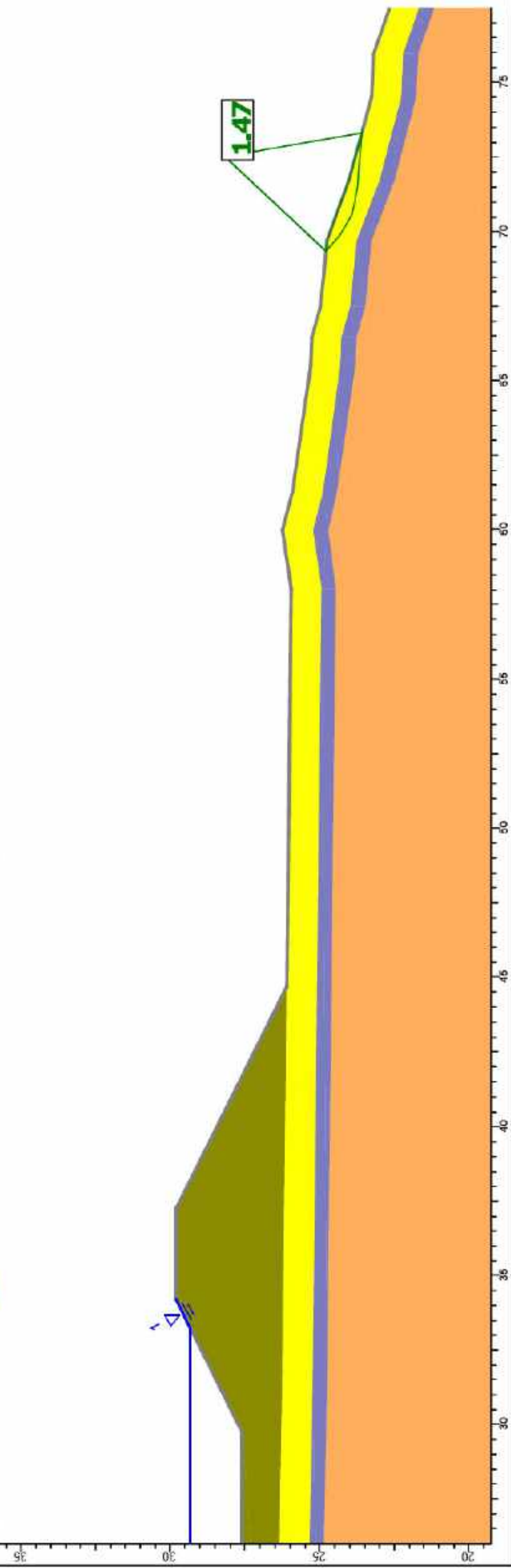
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	Piezometric Line 2
Interface Sand vs GCL	Blue	18	Mohr-Coulomb	3.6	34.9	Piezometric Line 2
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			Piezometric Line 2




		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT		DATE	10-Dec-25
DRAWN	GW	CHECK	GW	DATE	10-Dec-25
SCALE	NTS	A4		PROJECT NO.	WA004-25-002
Short Term Static, 300mm head on Liner					Figure A8
Section C					



Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Uncompacted Growing Medium	Yellow	18	Mohr-Coulomb	0	27	None
Interface Sand vs GCI	Blue	18	Mohr-Coulomb	3.6	34.9	None
Leachate Pond Embankment	Green	18	Mohr-Coulomb	1	35	Piezometric Line 1
Foundation Material	Orange	17	Infinite Strength			None



		CITY OF ROCKINGHAM		PROJECT	Millar Road Cell 12 Leachate Pond
		CLIENT		Pseudo-static (PGA 0.04g) Section C	
DRAWN	GW	DATE	10-Dec-25	PROJECT NO.	WA004-25-002
CHECK	GW	DATE	10-Dec-25		
SCALE	NTS		A4		Figure A8