Upper Lachlan Shire Council

Feasibility Study

Crookwell Landfill

June 2015

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1. Introduction

1.1 Background

The Upper Lachlan Shire Council (Council) is currently assessing the potential and feasibility of upgrading two Council managed landfill sites:

- Crookwell Landfill (located south of Crookwell)
- Gunning Landfill (located west of Gunning)

The upgraded facilities would be expected to meet the requirements of the New South Wales Environment Protection Authority (NSW EPA) and provide for the landfill needs of the Upper Lachlan Community well into the future.

Recently, the NSW EPA has issued a number of non-compliances for the Crookwell Landfill. In response, Council has entered into a Pollution Reduction Program (PRP) with the NSW EPA for the site. As part of the PRP, the NSW EPA attached Condition U1 to the site EPL which requires a landfill capacity investigation to be completed for the site.

The Gunning Landfill is unlicensed and is not subject to a PRP but is being investigated Council as part of the overall future landfill needs.

1.2 Purpose

The purpose of this report is to assess the potential for and feasibility of upgrading the Crookwell Landfill. At a minimum, the upgrade needs to meet the requirements stated in the NSW EPA Environmental Guidelines: Solids Waste Landfills (1996) and address the PRP requirements included in Section 8 of the Environmental Protection Licence (EPL) No. 6054.

GHD note that at the time this report has been prepared, the NSW EPA has released a draft second edition of the Environmental Guidelines: Solid Waste Landfill. In preparing this report GHD have considered the relevant requirements in the draft second edition. However, once this guideline is officially released, Council should review the advice contained in this report and against any new or revised requirements stated in the finalised guidelines.

The potential for and feasibility of upgrading Gunning Landfill is discussed in a separate report prepared by GHD as part of this engagement (2015).

1.3 Scope of works

The scope of works included:

- Desktop review of the historical site operations (Section 2.6)
- Summary of observations from the site visit (Section 2.12)
- Outline of performance of existing infrastructure, based on site visit observations and preliminary desktop studies (Section 3.2)
- Desktop assessment of feasibility of construction of additional landfill cells (Section 3.4)
- Desktop review of site soils and use for landfilling operations (Section 3.5)
- Preparation of a conceptual 3D model and plan of final landform for the site (Section 3.4)
- Preparation of conceptual 3D model and plan of future landfill cells (Section 3.4)
- Estimation of the remaining capacity of the site (Section 3.4)

- Estimation of the volume of cover and capping materials which will be required to support any future operations (Section 3.4)
- Estimation of the costs of undertaking required upgrades to existing site infrastructure (order of magnitude for assessment of options only) (Section 4.3)
- Estimation of the costs of preparing new landfill cells (order of magnitude for assessment of options only) (Section 4.3)
- Estimation of the costs of undertaking remaining capping work (order of magnitude for assessment of options only) (Section 4.3)
- Outline of additional investigation works or studies (Section 0)

1.4 Reliance

In preparation of this report, GHD has referenced the following documents. GHD has prepared this report on the basis of information provided by others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD have received the following information from Council:

- Crookwell data survey, 2011 - 2012
- Letter from John Bell (Council) to Julian Thompson (NSW EPA) dated 22 June 2010 titled RE: Crookwell Landfill Facility – Environment Protection Licence Number 6054
- Groundwater monitoring results 2001 - 2013
- 816F Landfill Compactor data sheet
- AAMHatch 2005 Crookwell tip mapping and contours (.dxf)
- Yearly waste data report for Crookwell Landfill, reporting period 1 July 2009 to 30 June 2010
- Yearly waste data report for Crookwell Landfill, reporting period 1 July 2010 to 30 June 2011
- Yearly waste data report for Crookwell Landfill, reporting period 1 July 2011 to 30 June 2012
- Yearly waste data report for Crookwell Landfill, reporting period 1 July 2012 to 30 June 2013
- Yearly waste data report for Crookwell Landfill, reporting period 1 July 2013 to 30 June 2014
- Annual return for licence number 6054, reporting period 20 June 2013 to 19 June 2014
- Annual return for licence number 6054, reporting period 20 June 2010 to 19 June 2011
- LandTeam June 2009, Detail survey Crookwell Waste Management Site (.dwg and .pdf)
- Aerial photography for Crookwell Landfill, dated 28 January 2015
- LandTeam February 2015, Detail survey Crookwell Waste Management Site (.dwg and .pdf)

The following technical reports provide by Council were reviewed:

- CMPS&F Pty Ltd, 1998. Landfill Environmental Management Plan for Crookwell Waste Depot
- Egis Consulting, 1999. Report on hydrological investigation of the Crookwell landfill
- Hawley et al, 2006a. Waste strategy: background report – Upper Lachlan Shire Council
- Hawley et al, 2006b. Waste strategy summary – Upper Lachlan Shire Council
- Upper Lachlan waste strategy review

GHD have also relied upon the following publicly available documents:

- Australian Bureau of Statistics, 2014. National Regional Profile: Upper Lachlan Shire
- Australian Bureau of Statistics, 2011. 2011 Census QuickStats: Crookwell
- Environmental Protection Licence (EPL) 6054, version date 10 April 2015
- NSW EPA, 1996. Environmental Guidelines: Solids Waste Landfills (the NSW Landfill Guidelines 1996)

As part of this engagement, GHD has also prepared a separate report for Gunning Landfill. This report should be read in conjunction with:

- GHD, 2015. Feasibility study – Gunning Landfill

1.5 Limitations

This report has been prepared by GHD for Upper Lachlan Shire Council and may only be used and relied on by Upper Lachlan Shire Council for the purpose agreed between GHD and the Upper Lachlan Shire Council as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Upper Lachlan Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described within this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Upper Lachlan Shire Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost estimate set out in section 4.2 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of providing an indication of the magnitude of cost required for the upgrade of the site and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

2. Site characteristics

2.1 Overview

The Upper Lachlan Shire consists on various towns and areas with a total population of approximately 7,500 (ABS, 2014). Crookwell has a population of approximately 2,500 (ABS, 2011).

The Upper Lachlan Shire is currently serviced by the following Council managed waste management facilities (Hawley et al, 2006a):

- Crookwell landfill
- Gunning landfill
- Collector landfill
- Bigga landfill
- Tuena landfill
- Taralga Waste transfer station

Crookwell landfill receives the majority of the waste generated from the Upper Lachlan Shire. It is the only licenced facility within the Upper Lachlan Shire and is fully managed by Council.

2.2 Site location and description

Crookwell Landfill is located on Grabben Gullen Road, Crookwell, approximately 3.5 km south-west from the township of Crookwell. Figure 1 shows the location of Crookwell landfill with regard to the township of Crookwell. The land on which the Crookwell landfill is located is approximately 7.7 ha in area.

Figure 1 Locality

2.3 Site history

The Crookwell landfill has been in operation since the 1960s, accepting and landfilling solid waste generated within Crookwell and the surrounding region. The site was issued a waste management licence in September 1997 and is classified as a Class 1 Solid Waste Landfill. A site specific landfill environmental management plan (LEMP) was prepared for the site (CPMS&F, 1998).

According to the LEMP, an area method style of landfilling (refer Figure 2) has traditionally been employed at the site as opposed to trench or gully method (refer Figure 3). However, some trench landfill was used for certain special waste such as for animal carcasses.

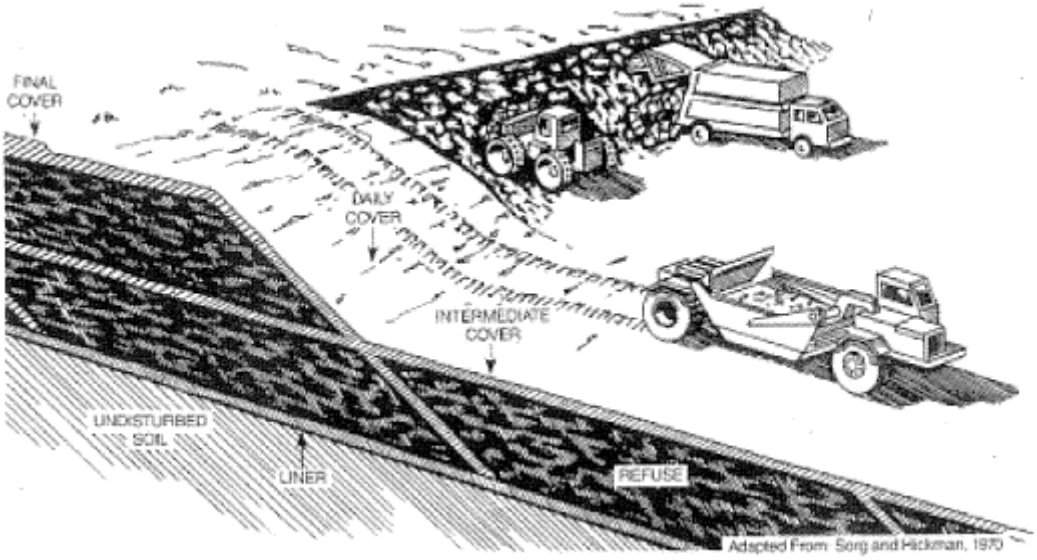
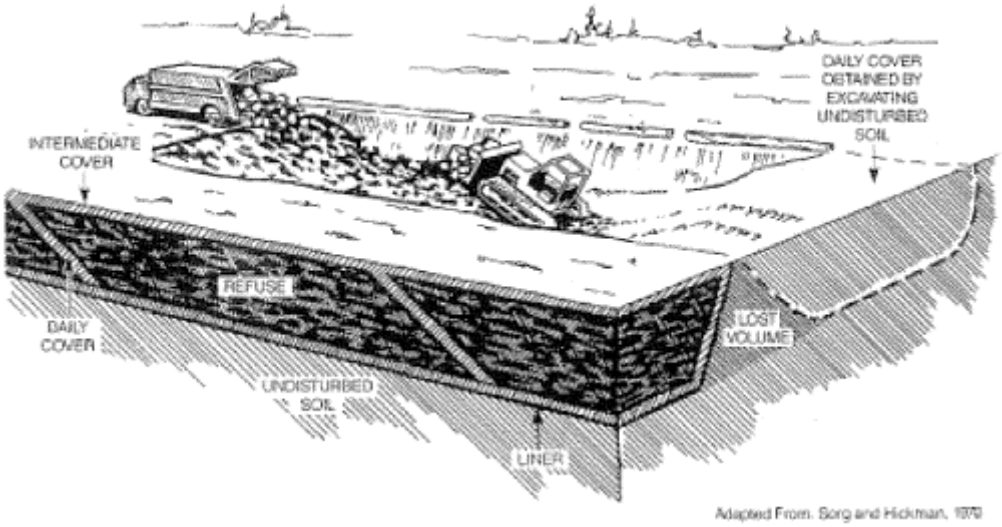


Figure 2 Area method of landfilling [1]



[1] Figure adopted from Sorg, T. and H. L. Hickman. 1970. Sanitary Landfill Facts. U. S. Department of Health Education and Welfare, Bureau of Solid Waste Management, Report No. SW-4ts.

Figure 3 Trench method of landfilling [2]

2.4 Waste composition

Crookwell landfill is licenced to accept both putrescible and non-putrescible waste, as well as asbestos and waste tyres. Wastes deposed of at the site include (CPMS&F, 1998):

- Municipal solid waste
- Commercial and industrial waste
- Construction and demolition waste
- Agricultural wastes
- Special waste including:
  - Animal carcasses
  - Stabilised biosolids
  - Asbestos

Crookwell Landfill also receives recyclables including metal, batteries, green waste, glass, cardboard and mattress. These are transported off site to contractors including Remondis and One Steel for processing and recovery.

2.5 Waste quantity

The licenced maximum allowable waste receival is 7,000 tonnes per annum.

Findings from review of the yearly waste data reports are summarised in

Table 1. As there is no weighbridge installed on site these tonnages are based on vehicle counts. Data suggests that less than 3,000 tonnes of waste is received annually, and that this trend has remained relatively steady over the past 4 years. Of the waste received, around 2,850 tonnes is landfilled annually.

Table 1 Waste quantities

Financial Year Ending (FYE)	Waste quantities (tonnes)			Total received (tonnes)	Materials transported offsite for recovery (tonnes)	Total waste landfilled (tonnes)
	Municipal	C&I	C&D			
2010 / 11	2,649 [3]	26	285 [4]	2,960	77	2,882
2011 / 12	2,375 [5]	27	362 [6]	3,116	68	3,048
2012 / 13	2,621	27	325 [7]	2,972	242	2,730
2013 / 14	2,725	28	283 [8]	3,036	233	2,803

[2] Figure adopted from Song, T. and H. L. Hickman. 1970. Sanitary Landfill Facts. U. S. Department of Health Education and Welfare, Bureau of Solid Waste Management, Report No. SW-4ts

[3] Including 343 tonnes of municipal waste from Taralga Transfer Station

[4] Including 67 tonnes of VENM

[5] Including 352 tonnes of municipal waste from Taralga Transfer Station

[6] Including 69 tonnes of VENM

[7] Including 50 tonnes of VENM

[8] Including 52 tonnes of VENM

Average	**2,593**	**27**	**314**	**3,021**	**155**	**2,866**

2.6 Site operations

The site is currently open to Upper Lachlan Shire residents between Friday to Monday, 10:00 am to 4:00 pm. Council also runs weekly collection services for Grabben Gullen, Laggan, Binda and Crookwell (Hawley et al, 2006a).

Crookwell landfill is fenced on all sides with a lockable gate at the entrance located off Grabben Gullen Road. The site office is located at the centre of the site accessed by sealed bitumen road from the site entrance.

The active tipping face is located on the eastern side of the landfill and accessed by gravel tracks. A landfill compactor (CAT, 816F) is located on site and shared between Crookwell and Gunning landfill. The landfill is managed by two council staff that also run the collection services.

Green waste, metal waste and other recyclable materials are separated and stockpiled on site prior to being transported offsite for processing. Virgin Excavated Natural Materials (VENM) [(9)] is stockpiled and reused on site.

2.7 Topography

The waste depot is situated on the western flank of the Crookwell River valley, approximately 2 km upstream of Crookwell, and 2.5 km west of the river. The elevation of the site ranges between 990 mAHD and 1000 mAHD. (CPMS&F, 1998)

Landfilling has disturbed the natural topography which would have comprised gently sloping land falling towards the middle of the site and east toward the Crookwell River.

The surface created by the landfilling operations varies in shape and slope. A slope analysis of the latest survey received (LandTeam, 2015) has been undertaken using a 3D modelling package (12D model, version 11). It was noted that the eastern and western batters were over steepened and exceeded slopes of 1(V):3(H), with parts of the batter having slopes steeper than 1(V):2(H).

2.8 Climate

Mean daily maximum temperatures in Crookwell range from 26.5 °C in January to 9.5 °C in July. Mean daily minimum temperatures range from 10.7 °C in January to -0.1 °C in July. Rainfall is evenly distributed throughout the year, ranging from an average of 54 mm in February to 90 mm in August. The annual average rainfall in Crookwell is 853 mm. Table 2 provides a summary of climate statistics at Crookwell[10].

Table 2 Average monthly climate data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	26.5	25.9	23.6	18.4	13.9	10.3	9.5	11.0	14.7	18.3	21.4	25.0	18.2
Mean minimum temperature (°C)	10.7	10.7	8.8	5.0	2.3	0.6	-0.4	0.3	2.1	4.6	6.7	9.0	5.0
Mean monthly rainfall (mm)	69.6	54.3	58.0	58.5	66.1	89.3	84.3	89.5	75.0	76.9	65.1	66.6	852.7

[9] It is unclear whether testing is undertaken in order to classify the material as VENM material

[10] Bureau of Meteorology – Crookwell post office (070025), accessed 21 May 2015. Crookwell post office BOM site is approximately 3.5 km away from Crookwell landfill

Mean daily evaporation [11] (mm)	6.3	5.2	4.0	2.5	1.6	1.1	1.2	1.9	2.8	3.9	5.0	6.0	1257.4
Mean monthly evaporation [12] (mm)	195.3	145.6	124	75	49.6	33	37.2	57	86.8	117	155	180	1257.4

2.9 Hydrology

Landfilling has disturbed the topography which comprised gently sloping land which drained to an intermittent water course running through the middle of the site, flowing east toward the Crookwell River. The Crookwell River is approximately 2.5 km from the site and flows in a north westerly direction, joining the Lachlan River some 40 km north west of Crookwell (CPMS&F, 1998).

Grabben Gullen Road, on the western edge of the site, breaks the original landform resulting in the site being the head of the catchment of the intermittent water course (CPMS&F, 1998).

Stormwater runoff from the site is directed via a series of catch drains, bunds, and a leachate / stormwater storage dam to the lowest point on the site, located on the eastern edge of the site. Discharge off site flows via an intermittent watercourse in an easterly direction toward the Crookwell River (CPMS&F, 1998).

2.10 Geology

2.10.1 Regional geology

The 1:250,000 geological map for Goulburn (sheet SI 55-12, 1968) shows that the site is underlain by sediments of an undifferentiated sequence of Ordovician age. The sediments are of an intermediate-deep marine origin, which have undergone low-grade metamorphism. The rocks consist of black and grey slate and phyllite with greyish to olive, muddy, fine to medium quartzose sandstone. The sandstone frequently exhibits graded bedding and may be classed as a subgreywacke. The sequence is of an unknown thickness. The Crookwell area also is identified by the presence of basalt and dolerite extrusive igneous rocks that are also found in the central Lachlan valley (CPMS&F, 1998).

Soils on the site are low permeability weathered slates and clays. The soil profile is in the order of 0.1 to 2.5 m thick across the site and is likely to have been formed in-situ from alluvial-colluvial material derived from the parent rock. There is evidence of highly variable drainage characteristics of the soils on site. Soils directly beneath the site can be generally classified as Taralga Soil Landscapes. Taralga Soil Landscapes are associated with weathering of basalt plateau: to produce a range of 'Chocolate soils'. The soils are moderately deep brown or reddish brown duplex or gradationally textured soils. The subsoil is highly pedal with a light to medium clay texture. Soil reaction is acid. These soils form on the side slopes of the basalt plateau and valley fill areas. The main processes are moderate leaching and weathering under well-drained conditions with removal of salts Devonian sediments wherever they occur in conjunction with foot slopes - and valley floors. Soils are formed in-situ from alluvial-colluvial material derived from the parent rock (CPMS&F, 1998).

2.10.2 Local geology

Seven test pits were dug at the site as part of the preparation of the LEMP (CPMS&F, 1998). The test pit logs suggest that the site is situated above weathered slate at approximately 0.7 –

[11] Bureau of Meteorology – Goulburn TAFE (070263), accessed 21 May 2015. Crookwell post office BOM site does not have evaporation data available. Goulburn TAFE BOM site is approximately 40 km away from Crookwell landfill

[12] Mean daily evaporation multiplied by days in month

2 m below surface level. Approximately 0.3 – 1.5 m of clay and sand could be found above the slate and a thin (0.1 m) layer of top soil was encountered in certain areas.

2.11 Hydrogeology

The site investigation undertaken by CPMS&F (1998) identified two water bearing zones underneath the site. The first water bearing zone to be a shallow, impermanent zone in the soil profile. This system is only present in permeable soils (approximately 2 to 3 m thick) and can be regarded as a type of perched aquifer. The groundwater was located at depths ranging between 0.3 m and 1.8 m. Groundwater may be perched on ironstone bands within the soil horizon. Water from this zone may leak into the underlying bedrock water bearing zone, or discharge down gradient of the site and under some conditions, is likely to dry out completely. Rainfall recharge may re-saturate the perched aquifer at irregular intervals (CPMS&F, 1998).

The second and more significant water bearing zone is thought to be in a fractured rock aquifer representing the bedrock beneath the soil profile at a much deeper depth. It is thought that groundwater is transported through the rock mass via interconnected fractures and joints. The likely primary flow direction is towards the east based on site topography. The Department of Land and Water Conservation have classified the hydrogeological province around Goulburn as one that has a low potential for groundwater movement (CPMS&F, 1998).

There is a reference to a fractured water bearing zone at 41 m depth in a bore located 800m from the site. The flow direction was likely to be strongly controlled by topography and ground water flow must be directed towards the east due to the topographic slope down towards the Crookwell River (CPMS&F, 1998).

2.12 Site walkover

GHD conducted a site walkover of the site in the presence of Council and the NSW EPA on 28 April 2015.

The following key observations were noted:

- The pond area is not well defined and found to be quite boggy
- Access roads to the site office and stockpiles are in good condition
- Windblown litter to the adjacent site was evident and revision of the existing site operations and ongoing management is required
- There is a lack of cover material at the site and particularly the tipping face
- The existing tipping area, located at the northern end of the site, is very large and is contributing to the litter problem at the site and likely causing excess leachate generation. Optimisation of the operation of the tipping face is required to reduce the size and maximise airspace utilisation
- The eastern batter has been over steepened due to uncontrolled waste placement and waste is exposed from the batter. The batter will need to be cut back to a stable, maintainable slope and rehabilitated
- Odour was not noted during the site visit

3. Site evaluation

The NSW EPA requested an assessment to be undertaken at Crookwell landfill. In particular, condition U1 of the site's EPL requires a Landfill Capacity Investigation to be undertaken at the site. The follow sections provide GHD's response to the specific enquires listed on the site's EPL.

3.1 Investigate and report on the extent of current waste disposal (volume and area) on Lot 1 DP 332252 and the state of any cover and/or capping material present at the premises

3.1.1 Existing waste disposal

Upon conducting the site walkover and review of the available documents including the site LEMP and the available site surveys, the indicative extent of the current landfilled areas at Crookwell Landfill is approximately 3.5 ha as shown on sketch SK001 contained in Appendix A.

GHD note that minor areas of landfilling extend outside the northern lot boundary into the adjacent road reserve by approximately 5 m. Review of the LEMP further suggests that minor trench landfill operations may have occurred in the past outside the bulk landfill area for special waste such as animal carcasses and pump station waste.

A review of the site survey indicates there is approximately 135,000 m^3 of waste. This was calculated using a 3D modelling package (12D model, version 11) and assuming no excavation has been undertaken at the site. This volume of waste also only applies to the bulk waste mass and does not include any waste filled in trenches (such as the animal carcasses disposal trench) outside the bulk waste footprint, as depicted on sketch SK001 in Appendix A.

3.1.2 Cover/capping material

Onsite observations confirm that there is a lack of cover material over large parts of the site and particularly across the tipping face.

A review of the recent yearly waste data reports suggests that approximately 3,000 tonnes per annum of waste is accepted at Crookwell Landfill of which approximately 2,850 tonnes is landfilled (refer Section 2.4). Of the 2,850 tonnes per annum of waste that is landfilled approximately 60 tonnes, or approximately 2%, could be identified as VENM, This material would likely be suitable for daily waste covering. However GHD note that, depending on efficiency of operations and type of daily cover (soil or alternative), between 10 to 30% (or 280 to 850 tonnes per annum) of suitable material is required as operational material (cover and bund construction). As such investigations of alternative sources of operational material, via either suitable incoming waste or off-site, are required. Council could consider processing existing recyclables and C&D materials (such as crushing brick, concrete) to be used as operational material.

3.2 Investigate and report on the condition and function of any landfill infrastructure currently present or installed at the site

Table 3 provides a list and evaluation of the landfill infrastructure observed at the site walkover.

Table 3 Evaluation of the landfill infrastructure

Landfill infrastructure	Condition	Assessment
Stormwater collection system	No formalised infrastructure is in place to collect onsite stormwater. Water currently flows in accordance with the topography. A pond area is identified at the site's eastern boundary. Stormwater ponding was observed in some landfill areas. Clean stormwater collected over the administration area currently drains away from the landfill	To improve environmental performance, the site should aim to separate 'clean' stormwater and stormwater that has come into contact with the waste mass. Bunds should be constructed around the active tipping face and other waste areas to prevent contamination of 'clean' stormwater. Low lying and flat areas over covered landfilled waste should be graded to allow surface water runoff. The gravel access tracks likely allow some stormwater to infiltrate into the landfill waste mass. Water should diverted from these areas where possible. Construction of a formal stormwater pond should be considered to provide for stormwater treatment and cover materials.
Leachate barrier	It is understood that the historically landfilled areas are unlined. Review of historical survey data and the site LEMP suggests that the current waste placement is occurring over areas which have been previously filled.	It is not practical to retrofit a basal liner for the existing landfilled areas. Cell liners should be considered for any future cells in accordance with the NSW Landfill Guidelines 1996 and any subsequent revisions of the Landfill Guidelines. Existing site geology would not be sufficient to provide the expected level of environmental protection.
Leachate collection system	There is currently no leachate collection system.	Leachate collection and conveyance systems should be included as part of the design of any new cells.
Leachate dam (monitoring point 1 as per EPL licence number 6054)	The area for the leachate dam labelled on the licence has been filled in with waste and could not be accessed. Available records from Council suggest that monitoring ceased at the leachate dam from 2006.	The EPL should be updated to reflect latest operations.
Sediment dam (monitoring point 2 as per EPL licence number	During the site walkover, it was observed that the pond area was not clearly defined and the general area was observed to be boggy.	The current pond area should be formalised. This should consist of bunding and lining with low permeability material to better contain the leachate. Rather than 'sediment pond', as currently labelled on

Landfill infrastructure	Condition	Assessment
6054)	This corresponds with the findings reported in the 2013 / 2014 annual return where it was observed that there was no water in the dam that could be sampled.	the licence, this pond could be upgraded and used as a leachate pond by providing suitable lining (refer Appendix A SK005). Climate data for the area suggests that annual evaporation rates exceed annual rainfall however this is seasonal. The leachate dam should be designed and located in an open area not shaded by vegetation to maximise evaporation.
Sediment dam on eastern property (monitoring point 3 as per EPL licence number 6054)	This monitoring location was not visited during the site visit.	Review of Council records between 2001 and 2015 suggests that water quality at the dam is considered within acceptable range and does not suggest leachate contamination. A formal review of the monitoring system should be undertaken to determine whether this is a suitable monitoring location.
Groundwater monitoring bores (monitoring points 4 to 8 as per EPL licence number 6054)	Groundwater monitoring bores are installed around the site and are continually being monitored by Council, with the exception of MW 3 which was damaged by earthworks.	Review of Council records between 2001 and 2015 suggests that groundwater quality at MW4S (elevated levels of nitrate) is influenced by leachate generated on site. This is not surprising due to the location of the well (downgradient of groundwater flows). Capping of completed areas and formalisation of the leachate dam is expected to improve the situation. A formal review of the monitoring system should be undertaken to determine whether the current monitoring locations are suitable. The currently damaged well should be replaced.
Leachate treatment / disposal system	There is currently no formalised leachate treatment or disposal system. The leachate dam offers some disposal via evaporation.	The current pond area should be formalised as described above. Depending of the level of collection in the future, Council may investigate other options of leachate treatment / disposal such as tankering off-site.
Gas management	There is currently no formalised gas management system on site.	If new cells are constructed, a formalised gas management system (such as gas extraction bores) would be required. Currently, the landfill is located away from residential receptors. A landfill gas risk assessment would be required if new

Landfill infrastructure	Condition	Assessment
		properties are to be developed adjacent the landfill footprint.
Asbestos pit	Asbestos has been historically accepted at the site. Council informed GHD that areas of asbestos filling are recorded and known. Council staff are trained in asbestos awareness and management.	Continue to designate specific area for asbestos waste disposal. Continue to provide training for landfill operators regarding working with asbestos waste. For any future works that require cutting back waste, an asbestos management plan should be prepared and implemented during the works.
Dead animal pit	Animal carcasses have been historically landfilled at the site in trenches. Review of the LEMP suggests animal carcasses trench exist to the south of the landfill waste mass. During the site walkover, animal carcass was observed in trenches to the north-west of the active tipping face. The trench was not covered and it was not clear whether the trench was designated for disposal of animal carcasses.	Designate specific area (trench) for disposal of animal carcasses. Cover the trenches with soil daily.
Green waste stockpile	Green waste stockpile is located south of the active tipping face	Maintain the size of the stockpile and engage contractor to remove green waste periodically Surface water to be diverted around green waste stockpile area,
Recyclable areas	Stockpiles of recyclables are located in different parts of the landfilled areas above the waste mass. A site shed is provided opposite the site office for residents to separate the recyclables	Maintain the size of the stockpiles and engage contractor to remove the recyclables periodically Surface water to be diverted around recyclables stockpile areas
Operational stockpile area	Stockpiles are located on the landfill waste mass.	Review of waste quantities received on site (Table 1) suggests that stockpiled materials are transported off site for recovery.
Weighbridge	There is currently no weighbridge installed on site.	If Council continues to use Crookwell Landfill and plans on extension of the landfill, Council should consider installation of a weighbridge to better track material inflow and outflow.
Administration	Administration area is currently located on	The administration area would need to be

Landfill infrastructure	Condition	Assessment
area / building	the landfill waste mass	relocated for the future works
Site fencing and security	The site is fenced along all sides, with the side adjacent to Grabben Gullen Road screened by trees.	While GHD did not walk along the entire boundary area during the site visit, it was observed that majority of the fence was in good condition.

3.3 Investigate and report on the likely cost to cap the existing landfill with a minimum 500 mm sealing layer of clay with a permeability less than k = 1 x 10^{-9} m/s and a vegetation layer of 150 mm of topsoil

It is understood that it would be difficult to obtain suitable low permeability clay in the immediate area[13]. In addition, the proposed vegetation layer profile (150 mm of topsoil) is unlikely to provide sufficient protection of the compacted clay layer from desiccation or provide sufficient rooting depth for the long-term viability of vegetation. Considering the regional nature of the landfill and the age of the waste, it is suggested that the final cover layer be revised to maintain the existing final cap thickness of 650 mm but the 500 mm depth of compacted clay be replaced with 500 mm layer of subsoil overlaying a geosynthetic clay liner (GCL). This would allow Council to a much more flexible specification of vegetation and subsoil while still providing for a low-permeability cap with adequate protection from desiccation and root penetration. The revised final cap profile would consist of (from top to bottom):

- Revegetation layer of local grasses and small shrubs
- Minimum 150 mm layer of topsoil (sourced locally)
- Minimum 500 mm layer of subsoil (sourced locally)
- Geosynthetic clay liner (proprietary product comprising a layer of natural sodium bentonite powder of uniform thickness and consistency, reinforced by needle-punching and thermal locking to fully integrate the cover and carrier geotextiles)
- Prepared subgrade (engineered waste/existing cover material)

The above capping configuration is shown on SK005 in Appendix A.

The cap would, at a minimum, be installed over the entire existing landfill surface area, which is estimated to be 34,000 m^2. This would equate to a requirement of:

- 34,000 m^2 of revegetation
- 5,100 m^3 of topsoil
- 17,000 m^3 of subsoil
- 34,000 m^2 of geosynthetic clay liner

The subgrade would be sourced from incoming waste materials but would likely require between 5,000 to 10,000 m^3 of material. The cap construction would be staged over the remaining life of the landfill as suitable material is identified and sourced.

An estimate of the cost of installing the above at today's rates is included in Section 4.2.

[13] Council to undertake additional local investigations to confirm.

3.4 Investigate and report on any areas of Lot 1 DP 332252 which have not been landfilled with waste in terms of their suitability for future landfill (soil type, soil permeability and groundwater properties) and the potential available airspace

The geology, hydrogeology and topography, as discussed in Section 2.10, would provide a sound base for future development of a leachate barrier and collection system, would allow for a suitable surface water management system and provide suitable separation from the primary water bearing zone beneath the site (Section 2.11). As such the remainder of the site is likely to be suitable for extension of the landfill footprint though further site specific investigations to confirm the desktop assessment undertaken in this report.

To investigate the potential available airspace of the site, GHD have considered three final landform options:

- Option 1 - Continue filling of the site within existing waste footprint
- Option 2 - Continue filling of the site with conservative extension
- Option 3 – Filling with maximised footprint area

3.4.1 Existing waste surface

Prior to development of the final landforms, GHD reviewed the existing waste footprint and the slopes. The current waste surface has an approximate maximum level of 997 mAHD.

As mentioned in section 2.7, GHD undertook a slope analysis of the latest survey received (LandTeam, 2015) using a 3D modelling package (12D model, version 11). It was noted that the eastern and western batters were over steepened and exceeded slopes of 1(V):3(H); with parts of the batter having slopes steeper than 1(V):2(H).

Results of the slope analysis of the existing landform undertaken are shown in Figure 4. Table 4 shows the colours adopted for the slope assessment and GHD's assessment of the slopes.

Table 4 Slope analysis of existing landform

Slope range, 1 (V) : X (H)	Colour	Assessment
Less than 3	Yellow	Considered too steep
3 to 4	Orange	Not preferred due to maintenance issue
4 to 20	Green	Preferred
Greater than 20	Red	Considered too flat

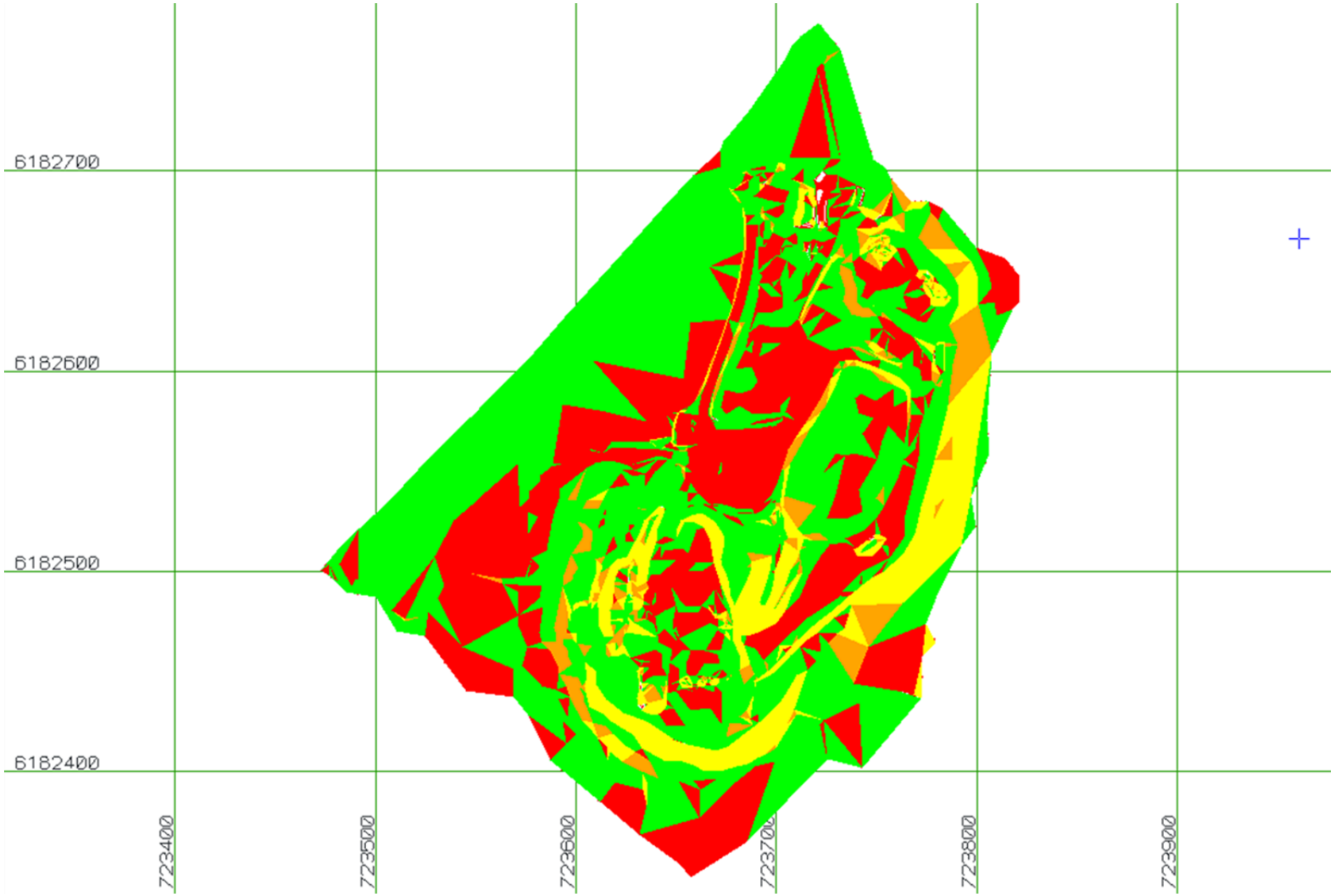


Figure 4 Slope analysis of existing landform

Erosion and Sediment Control

Maintaining slopes between 1(V):20(H) and 1(V):4(H) is essential for erosion and sediment control, allowing the capping layer to be effectively maintained whilst promoting stormwater runoff. Generally, slopes flatter than 1(V):20(H) have high risk of promoting excessive ponding which leads to excess infiltration through the cap resulting in the generation of large, undesirable quantities of leachate.

Maintaining a batter slope greater than 1(V):4(H) has the potential to promote issues associated with slope stability and may result in failure of the final cap through veneer failure of the capping materials.

Accordingly, GHD has undertaken the detailed design in accordance with a maximum and minimum slope of 1(V):4(H) and 1(V):20(H) respectively.

Encroachment considerations

The waste footprint may require to be trimmed at the northern boundary to keep the waste within the lot boundary. Parts of the waste footprint along the eastern boundary also need to be trimmed to increase the distance from the current fence for the installation of the cap.

3.4.2 Option 1 - Continue filling of the site within existing waste footprint

This option allows for continue filling of the site within the existing waste footprint to reach a certain height (approximately 996 mAHD). This allows continued operation of the site without expansion of the waste footprint (hence construction of lined cells).

The final landform provides a surface which has 1(V) in 4(H) batters and a top platform with a fall of at least 5%. Based on the current survey (February 2015) this surface provides an additional capacity of approximately 19,000 m^3 (taking into account relocation of waste in order to reduce the existing slopes). Assuming an airspace utilisation rate of 650 – 850 kg/m^3 (per Landfill guidelines and considering the use of compactor onsite) and a landfilling rate of 2,850 tonnes per annum (per

Table 1), there is approximately 4 -5 years of capacity provided by this final waste surface.

The final landform for this option is shown in SK002 in Appendix A

3.4.3 Option 2 - Continue filling of the site with conservative extension

This option allows for continue filling of the site with conservative expansion to reach a certain height (approximately 998 mAHD). This final landform has a smaller landfill footprint than the final landform proposed in the LEMP (Appendix B) and mostly continues landfilling on the existing disturbed area to form a shape that would allow preferential stormwater management whilst producing a natural mound.

The final landform provides a surface which has 1(V) in 4(H) batters and a top platform with a fall of at least 5%. Based on the current survey (February 2015) this surface provides an additional capacity of approximately 76,000 m^3 (taking into account relocation of waste in order to reduce the existing slopes). Assuming an airspace utilisation rate of 650 – 850 kg/m^3 (per Landfill guidelines and considering the use of compactor onsite) and a landfilling rate of 2,850 tonnes per annum (per

Table 1), there is approximately 17 - 23 years of capacity provided by this final waste surface.

It would require the development of new lined landfill cells covering approximately 39,600 m^2 compared to the current 32,900 m^2 (extra 6700 m^2). This area would require:

- Grading and preparation as a subgrade for the liner system
- Installation of a leachate barrier layer and associated protection layers
- Installation of leachate collection system including extraction system

It is noted that the increased landfill footprint area and the provision of barrier and drainage systems may require an upgrade to the leachate pond.

This final landform would be the site capping area to 40,500 m^2 compared to the current 33,700 m^2.

It is noted that the footprint assumed here is smaller than the footprint of the proposed final landform proposed in the LEMP (Appendix B) and mostly continues landfilling on existing disturbed area to form a shape that would promote shedding of water and produce a natural mound. Additionally, some minor excavation works within the proposed cell areas, which may be required to provide a suitable surface for the installation of any future lining and leachate collection system, may provide a small amount of additional capacity.

The final landform for this option is shown in SK003 in Appendix A

3.4.4 Option 3 - Filling with maximised footprint area

This option proposes filling of the site to a footprint similar to the footprint proposed in the LEMP (Appendix B).

The final landform provides a surface which has 1(V) in 4(H) batters and a top platform with a fall of at least 5%. Based on the current survey (February 2015) this surface provides an additional capacity of approximately 149,700 m^3 (taking into account relocation of waste in order to reduce the existing slopes). Assuming an airspace utilisation rate of 650 – 850 kg/m^3 (per Landfill guidelines and considering the use of compactor onsite) and a landfilling rate of 2,850 tonnes per annum (per

Table 1), there is approximately 34 - 44 years of capacity provided by this final waste surface.

The final landform for this option is shown in SK004 in Appendix A

3.5 Investigate and report on the available landfill cover resource that is VENM at the site and identify how much of it could reasonably be extracted

Landfill cover is very limited at the site. Currently, landfill cover is sourced from soil material received at the site from local agricultural excavations (i.e. excavation of new dams on farms). Landfill cover is also sourced from bulk earthworks and roadworks in the Shire, as well as major civil works (i.e. windfarm constructions) from private construction companies.

Review of the yearly waste data reports suggests Crookwell Landfill receives approximately 50 to 70 tonnes of VENM from C&D sources per year. These materials should be stockpiled on site for use as cover. The incoming waste stream should be continuously monitored for materials which would be appropriate for daily cover.

It is understood that there is no plan to develop a borrow source on-site. This decision is supported by historical test pitting which has shown a limited depth of soils (Section 2.10.2) and the potential erosion and sediment control issues which a borrow pit may introduce. Minor earthworks may be required in developing future landfill areas and upgrading the pond area, and these may generate small amounts of soil material which should be stockpiled for onsite use.

It is also recommended that Council review their cover usage procedures to include stripping any existing cover from the surface before additional waste is placed above so that it can be reused at the end of the day. Minimisation of the area of active tipping will also assist in stretching the existing limited supply.

Council could also investigate the use of Alternative Daily Cover (ADC) on site as an alternative cover source.

3.5.1 Cover gain through different options

Council could potentially gain cover if the landfill footprint is expanded (option 2 and option 3). Based on results from local test pits (refer section 2.10.2), an estimated 0.1 m layer of top soil and 1.5 meters of VENM could be recovered and used as cover material on site.

Option 2 (6,850 m^2 expansion) would provide approximately 685 m^3 of top soil and 10275 m^3 of VENM material which could be used as daily cover or the subsoil layer in the final cap. Assuming a bulk density of 1.76 tonnes / m^3, this corresponds to approximately 1,200 tonnes of top soil and 18,000 tonnes of ENM material.

Option 3 (12,300 m^2 expansion) would provide approximately 1230 m^3 of top soil and 18450 m^3 of VENM material which could be used as daily cover or the subsoil layer in the final cap. Assuming a bulk density of 1.76 tonnes / m^3, this corresponds to approximately 2,100 tonnes of top soil and 32,400 tonnes of VENM material.

As discussed in section 3.1.2, between 10 to 30% (or 280 to 850 tonnes per annum) of suitable material is required as operational material (cover and bund construction). Table 5 shows the VENM gain compared against the likely amount of cover material required.

Table 5 Preliminary excavated material balance

Option	Additional airspace (m^3)	Waste capacity (tonnes)[14]	Cover required (tonnes)[15]	Subsoil required (tonnes)[16]	Stockpiled ENM (tonnes)	Balance (tonnes) [17]
1	19,000	12,350 – 16,150	1,235 – 4,845	28,645	0	29,880 to 33,490 deficit
2	76,000	49,400 – 64,600	4,940 – 19,380	35,640	18,000	22,580 to 37,020 deficit
3	149,700	97,305 – 127,245	9,730 – 38,170	80,960	32,400	58,290 to 86,730 deficit

3.6 Provide a concept design for additional landfill cell(s) which could be constructed in virgin ground at the site in accordance with "EPA Environmental Guidelines: Solid Waste Landfills (1996)" including an estimate of construction cost

The extent of the proposed additional cell areas is illustrated on SK003 and SK004 (Appendix A). Typical details for the cells are illustrated on SK005 (Appendix A).

[14] Assuming an airspace utilisation rate of 650 – 850 kg/m3 (per Landfill guidelines and considering the use of compactor onsite)

[15] 10 to 30%

[16] Area multiplied by 0.5 m of top soil (as per proposed capping profile), converted to tonnes assuming 1.76 tonnes / m^3

[17] Stockpiled ENM - (Cover required + subsoil required)

The additional cells would be developed by:

- Undertaking minor earthworks as required to provide a suitable subgrade surface, graded to a low point and perimeter containment bunds
- Installing a leachate barrier system on the base, with appropriate protection layers
- Installing a leachate collection system and extraction point

GHD consider that the EPA benchmark technique liner system of 900 mm of compacted clay would not be appropriate for this site as clay materials are not locally available. GHD would propose an alternative equivalent system consisting of a geosynthetic clay liner and overlying confining protection soil layer.

The costs associated with these works are discussed in Section 4.2.

4. Proposed future works

4.1 Improvements to existing operations

The following works are proposed to improve existing operations:

- Formalise the existing stormwater management system by:
  - Preparing a stormwater management plan
  - Provide bunds around active tipping face, waste and stockpile areas to prevent contamination of 'clean' stormwater
  - Plan and install stormwater infrastructure including catch drains and detention basin
- Formalise the leachate management system
  - Preparing a leachate management plan
  - Line the existing leachate pond
  - Construct a toe drain around the landfill to collect and convey leachate to the leachate pond
  - Dispose of collected leachate by evaporation and/or recirculation during dry years, tanker off-site during wet years
- Clearly define waste disposal areas by:
  - Minimising the tipping area
  - Defining areas for special waste such as animal carcasses and asbestos
  - Training staff regarding working with asbestos
  - Controlling active tipping face by construction of bunds using engineered waste
  - Developing a landfill filling plan
- Undertake a gas risk assessment
- Undertake a survey annually
- Stockpile VENM and other suitable materials received on site to be used as cover material
- Investigate use of alternative daily cover and improvement of current cover soil usage
- Cap and revegetate as soon as possible after filling

In addition, Council should also remediate existing over steepend eastern and western batter areas and maintain future waste slopes between 1(V):20(H) and 1(V):4(H). Slopes within this range will improve erosion and sediment control, allow for better maintenance of the capping layer and promotes stormwater runoff , in turn reducing leachate generation.

4.2 Upgrade of Crookwell Landfill

The continued development of the site should be considered in three stages:

- Essential works – required to improve existing environmental performance of the site, including capping of areas which have already reached final waste heights
- Existing future works – costs associated progressive capping of the existing landfilled areas as they reach proposed landform heights and
- Potential expansion works – costs associated with development and closure of proposed new cell(s)

4.3 Capital expenditure

A capital expenditure (CAPEX) cost estimate for each stage has been prepared based on GHD experience and is contained in Appendix C and summarised in Table 6. This cost estimate is provided for the purpose of providing an indication of the likely **magnitude of cost** required for the continued development of the site. Further feasibility studies, concept and detailed design works are required to confirm these costs.

4.3.1 Inherent and contingent risk

Risk workshops dedicated to the formation of a risk register for the purpose of conducting a probabilistic risk assessment were not carried out by GHD. Subsequently, contingencies were calculated in the following manner (derived by reference to industry standards):

- An assessment of inherent risk has been made by GHD based on assumptions applied during the estimation process and the likely accuracy of measured and rated items included to form the base estimate. An inherent risk allowance of 5-15% (dependent on the line item) has been applied for this estimate based on the level of accuracy; and
- Project contingency has been calculated at a % mark-up on the base estimate. Contingency is an allowance for unforeseen items not covered in the base estimate. Contingency is a function of the level of assumptions made for the estimate and the level of accuracy of the estimate. A contingency allowance of 30% has been applied for this estimate to consider overall project risk.

4.3.2 Estimate reliance

This estimate has been prepared on pre-concept design and project information and is reliant and fundamental assumptions which have yet to be proven by further project development. As such all aspects of the project are considered highly variable and subject to change. The level of confidence to be expected is in the order of +/-40%. We note that the level of estimate reliance is generally a function of design definition and will increase as the project matures toward contract formation.

4.3.3 Exclusions

The following items have been excluded from the cost estimate:

- Project financing costs and insurance
- Council procurement and tender service costs
- Council project management
- Council's contingency (funding set aside to cover for unexpected adjustments, fundamental scope changes, etc)
- Escalation
- Discounting
- Staging of landfill cells and infrastructure
- Ongoing operation, management and maintenance costs for the site
- Ongoing monitoring
- Landfill gas management, if required
- Leachate disposal costs
- Post-closure management and maintenance

- Any additional EPA requirements

4.3.4 Assumptions

The following assumptions have been made in preparing the cost estimate:

- The extent of the works are as indicated on the conceptual site sketches
- The quantities are high level estimates only based on limited topographical data. Minimal 3D modelling has been undertaken
- Unit Rates include materials, labour and equipment
- Depth to rippable rock assumed to be below the cells
- No provision for changes in legislation, third-party litigation or corrective actions resulting in remediation has been allowed for
- No allowance for bulking, wastage, over excavation and tolerances has been made as the earthworks quantities are high level estimates only
- No allowance for geosynthetic overlaps or seams as the geosynthetic quantities are high level estimates only
- Leachate will be treated and disposed of on-site (no sewer connection / rising main would be required)
- No groundwater collection system would be required
- An allowance of 20% has been included for Contractor indirect costs and design

4.3.5 Costing tables

Table 6 to Table 8 shows the estimated costs for each option. Details are contained in Appendix C.

Table 6 Indicative CAPEX cost for site development works (Option 1)

Works	Cost ($)
Essential works	
Formalise existing leachate dam area pond area	$44,000
Stormwater management works	$31,000
Stormwater pond	$32,000
Remediation of existing batters	$430,000
Capping of completed landfill areas (eastern and western batters)	$521,000
Sub-total	$1,058,000
Contingency (50%)	$1,587,000
Existing future works	
Surface water management plan	$15,000
Leachate management plan	$15,000
Gas management plan	$15,000
Remaining capping works	$372,000
Cell lining works	$31,000
Stormwater management works	$4,000
Relocation of existing site infrastructure	$25,000
Sub-total	$477,000
Contingency (50%)	$716,000
Total	$2,303,000
Indicative cost per m^3 of airspace remaining	$121 / m^3

Table 7 Indicative CAPEX cost for site development works (Option 2)

Works	Cost ($)
Essential works	
Formalise existing leachate dam area pond area	$44,000
Stormwater management works	$31,000
Stormwater pond	$32,000
Remediation of existing batters	$430,000
Capping of completed landfill areas (eastern and western batters)	$521,000
Sub-total	$1,058,000
Contingency (50%)	$1,587,000
Existing future works	
Surface water management plan	$15,000
Leachate management plan	$15,000
Gas management plan	$15,000
Remaining capping works	$517,000
Cell lining works	$636,000
Stormwater management works	$10,000
Relocation of existing site infrastructure	$25,000
Sub-total	$1,233,000
Contingency (50%)	$1,850,000
Total	$3,437,000
Indicative cost per m^3 of airspace remaining	$45 / m^3

Table 8 Indicative CAPEX cost for site development works (Option 3)

Works	Cost ($)
Essential works	
Formalise existing leachate dam area pond area	$44,000
Stormwater management works	$31,000
Stormwater pond	$32,000
Remediation of existing batters	$280,000
Capping of completed landfill areas (eastern and western batters)	$521,000
Sub-total	$908,000
Contingency (50%)	$1,362,000
Existing future works	
Surface water management plan	$15,000
Leachate management plan	$15,000
Gas management plan	$15,000
Remaining capping works	$634,000
Cell lining works	$1,118,000
Stormwater management works	$14,000
Relocation of existing site infrastructure	$25,000
Sub-total	$1,836,000
Contingency (50%)	$2,754,000
Total	$4,116,000
Indicative cost per m^3 of airspace remaining	$27 / m^3

5. Conclusion, recommendation and implementation

5.1 Conclusion

5.1.1 Options

GHD has undertaken a feasibility assessment of upgrade Crookwell Landfill based on desktop review of available information and site visit. This also addresses the PRP requirements included in Section 8 of the EPL No. 6054 to undertake a landfill capacity investigation.

GHD has considered three options for the final landform of the site:

- Option 1 – Close the landfill as soon as practicable and shape the waste with minor filling within existing waste footprint (approximately 4-5 years of capacity remaining).
- Option 2 – Continue filling of the site with conservative extension that just takes up the existing disturbed and stockpile areas (approximately 17 - 23 years of capacity remaining)
- Option 3 – Filling with maximised footprint area, as per the PRP suggestion and in general accordance with the existing existing site LEMP (approximately 34 - 44 years of capacity remaining)

The assessment concluded that the site is workable and, pending an assessment of financial suitability by Council, all 3 options are viable potentially providing to 44 years of landfilling capacity (option 3).

5.1.2 Essential works

A series of essential works were identified in order to remediate the landfill regardless of what option is chosen. These works include:

- Remediation of existing over-steepened batter on the eastern and western site boundary. This would involve trimming of the existing landfill toe and capping works; and
- Formalisation of water management at the site, including formalisation of leachate dam and stormwater infrastructure.

The main challenge identified for the site is the lack of cover materials. Currently the site receives approximately 2% VENM material which could be used as cover material. Depending on efficiency of operations and type of daily cover, between 10 to 30% of suitable material would be required as operational material. Sufficient cover material would assist in mitigating issues currently challenging the site such as windblown litter and pests.

5.1.3 Capital cost estimate

Order of magnitude capital costs are provided for the three options. These costs are indicative only and could possibly be reduced if Council undertakes the works using available resources (staff and equipment).

- Option 1 – Close the landfill as soon as practicable and shape the waste with minor filling within existing waste footprint had a cost of approximately $2.3 million which equates to a cost per cubic metre of airspace gained of $121.
- Option 2 – Continue filling of the site with conservative extension that just takes up the existing disturbed and stockpile areas had a cost of approximately $3.4 million which equates to a cost per cubic metre of airspace gained of $45.

- Option 3 – Filling with maximised footprint area, as per the PRP suggestion and in general accordance with the existing existing site LEMP had a cost of approximately $4.1 million which equates to a cost per cubic metre of airspace gained of $27.

Early planning and staging of the remediation works would allow Council to spread out the cost over the life of the facility, with Council setting aside funds for the progressive rehabilitation and after care of the site after the initial remediation works.

5.1.4 Way forward

Council should compare the costs provided against the costs for closing the site and sending the waste to other disposal facilities. The true costs (including cost of essential works and social cost) should be considered when making the assessment.

Should Councils assessment indicate that filling of the site should continue it is considered that Option's 2 and 3 would better provide for future needs of the Upper Lachlan Shire. They also provide opportunity for reclamation of cover material through excavation of local dams that would be used for surface water and leachate management.

Option 1, with an estimated of 4 to 5 years of landfill capacity would be inadequate in meeting the long term needs of the Upper Lachlan Shire. When considering the costs for the essential works to remediate the site, this option is also not considered cost effective.

5.2 Recommendations

It is recommended that Council undertake an assessment to compare the costs provided against the costs for closing the site and sending the waste to other disposal facilities. The true costs (including cost of essential works and social cost) should be considered when making the assessment.

Should Councils assessment indicate that filling of the site should continue it is considered that Option's 2 and 3 would better provide for future needs of the Upper Lachlan Shire. They also provide opportunity for reclamation of cover material through excavation of local dams that would be used for surface water and leachate management. Council should seek agreement from the NSW EPA regarding the proposed Works contained in this report are suitable to ensure the costs calculated are practical. Early planning is critical to provide guidance for staged remediation of the site and to optimise the cost spread.

An indicative implementation plan is provided in Section 5.3 for Option 3.

5.3 Implementation plan

Should Councils assessment indicate that filling of the site should continue GHD recommend that Council prioritise works which will provide the most immediate environmental improvements, followed by those which further investigate the concepts developed in this feasibility study. This is summarised in Table 9 (Option 3 shown).

Additional works will be required to be added to this plan based on the results of the existing items. The plan should be provided to NSW EPA in response to the current licence conditions.

Table 9 Implementation plan (Option 3)

Task	Timeframe (financial year)	Indicative costs [18]
Prepare surface water, leachate and gas management plans and undertake detailed design of batter remediation [19]	2015 /16	$132,000
Undertake remediation of existing batters Undertake stormwater management works and construction of stormwater pond Formalise existing leachate pond area	2016/17	$741,000
Cap completed landfill areas including remediated batters	2017/18	$782,000
Staged landfill development and remediation works in accordance with amended LEMP.	2018/19 to 2048/49 – 2058/59	Approximately $540,000 every 6 to 8 years for 30 to 40 years (i.e. 5 stages, total $2.7 million)

[18] Subject to assumptions noted in section 4.3, considering costs for Option 3 and includes contingency

[19] Assume detailed design of batter remediation costs is equivalent to 10% of capital works cost (i.e. $43,000)

Appendices

Appendix A - Sketches

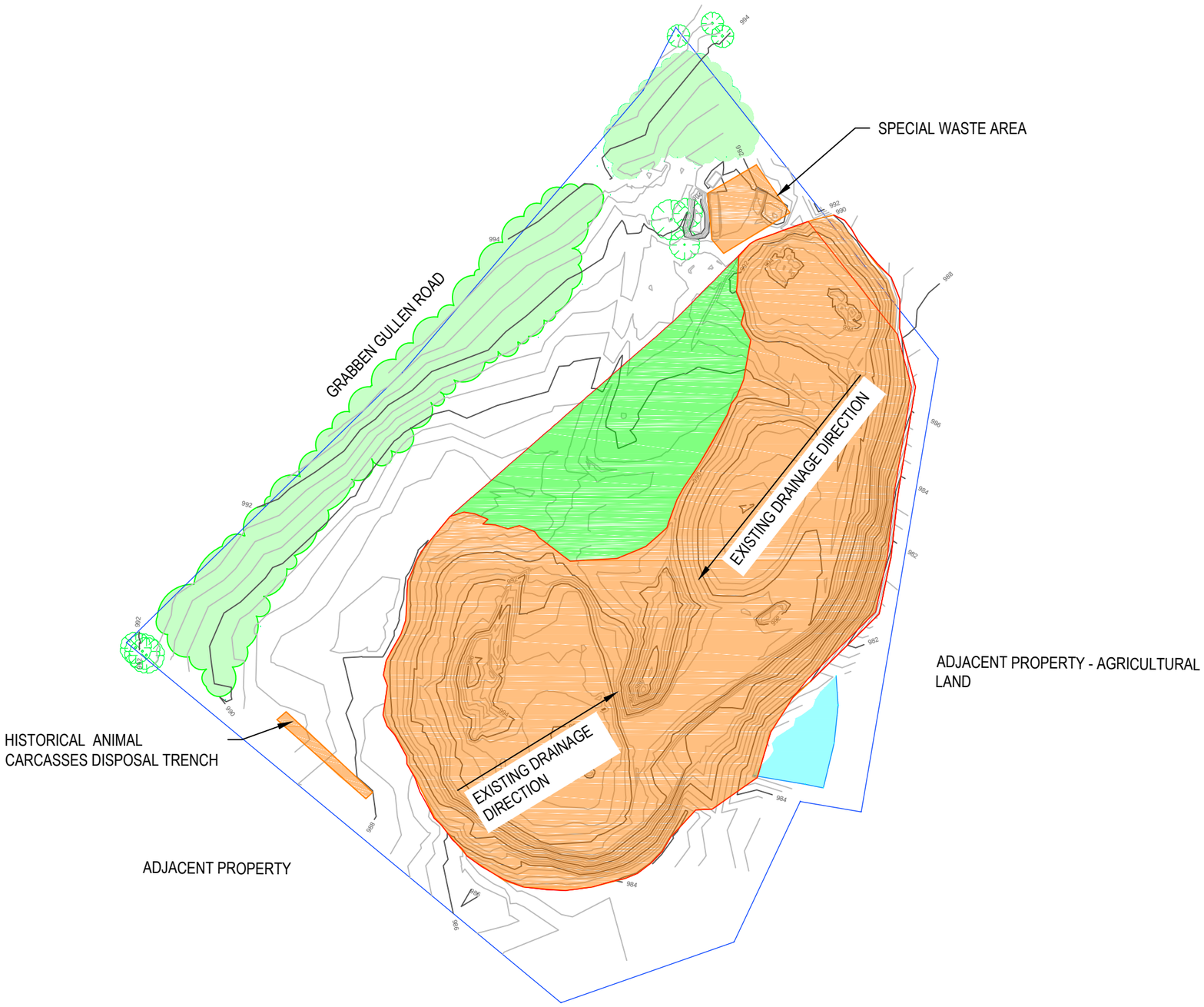
SK001 – EXISTING SITE AREA

SK002 – FINAL WASTE SURFACE – OPTION 1

SK003 – FINAL WASTE SURFACE – OPTION 2

SK004 – FINAL WASTE SURFACE – OPTION 3

SK005 – TYPICAL DETAILS



N

LEGEND

- SITE BOUNDARY
- EXISTING SURFACE
- EXISTING TREES
- EXISTING POND AREA
- EXISTING LANDFILLED AREA
- EXISTING HARDSTAND AREA

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	FOR DISCUSSION		09.06.15

UPPER LACHLAND SHIRE COUNCIL
CROOKWELL LANDFILL
EXISTING SITE AREA

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scale	1:2000 for A3	job no.	21-24492
date	MAY 2015	rev no.	A

approved (PD) SK001

SURVEY PROVIDED BY COUNCIL AND DATED FEB 2015

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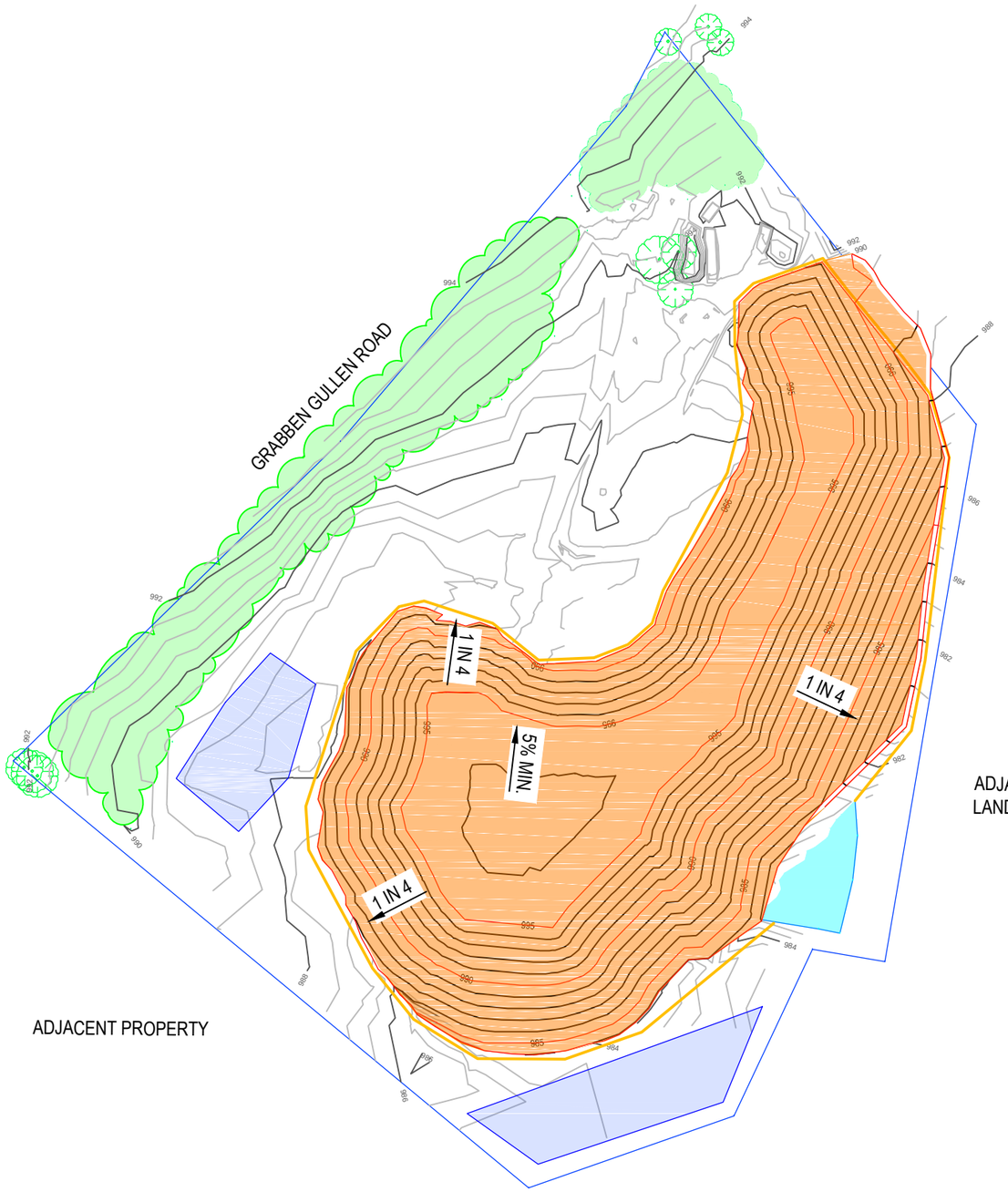

N

LEGEND

- SITE BOUDNARY
- EXISTING SURFACE
- EXISTING TREES
- EXISTING POND AREA
- TOE OF WASTE
- PROPOSED WASTE LEVELS
- PROPOSED TOE DRAIN FOR LEACHATE INTERCEPTION
- POSSIBLE LOCATIONS FOR NEW STORMWATER PONDS
- EXISTING LANDFILLED AREA

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

WASTE RELOCATION REQUIRED	21,500 m³
TOTAL CAPACITY PROVIDED	40,500 m³
WASTE CAPACITY REMAINING	19,000 m³
FINAL LANDFORM CAP AREA	33,700 m²

SURVEY PROVIDED BY COUNCIL AND DATED FEB 2015

PRELIMINARY

rev	description	app'd	date
A	FOR DISCUSSION		09.06.15

UPPER LACHLAND SHIRE COUNCIL
CROOKWELL LANDFILL

FINAL WASTE SURFACE OPTION 1

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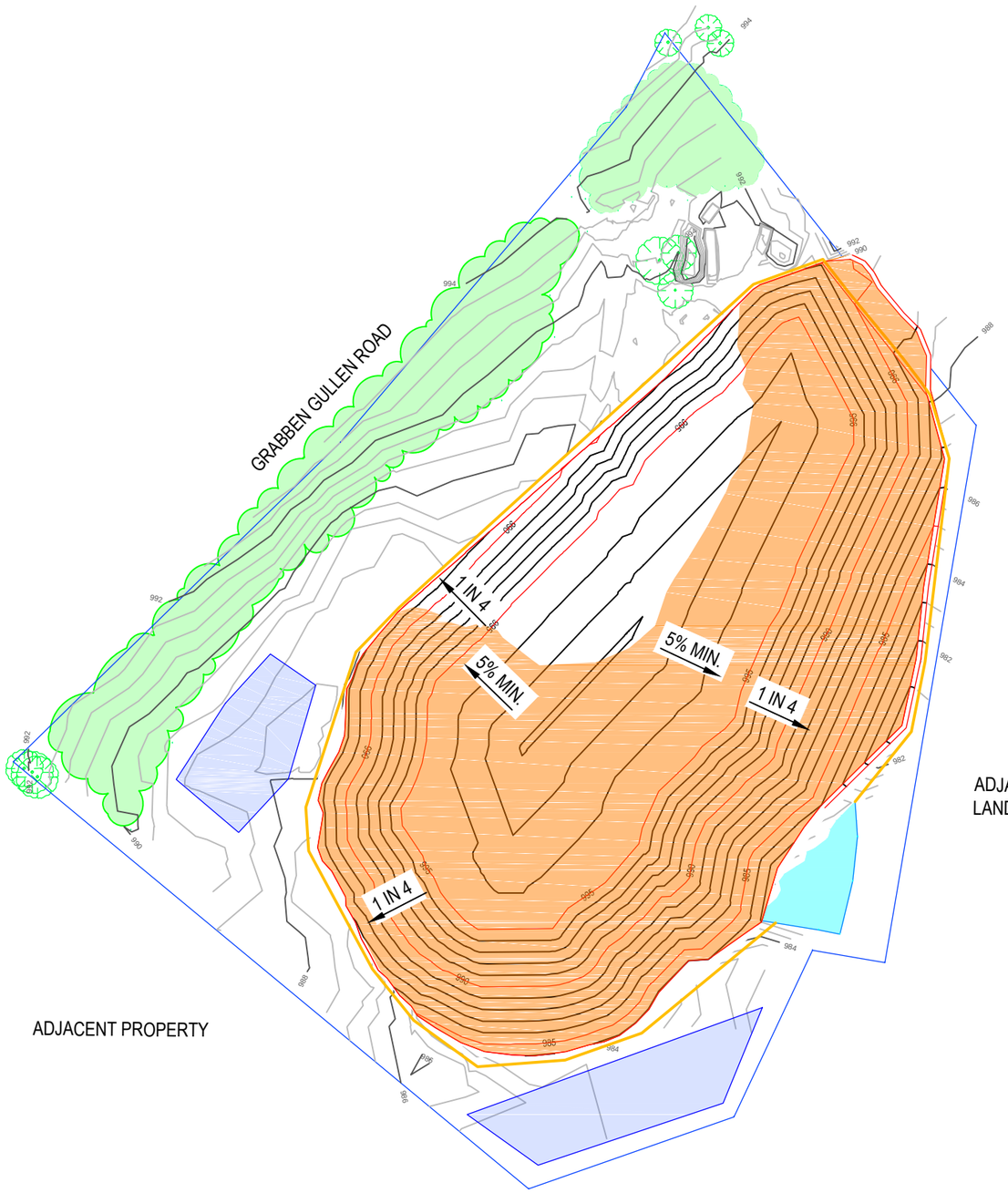
scale 1:2000 for A3 job no. 21-24492
date JUNE 2015 rev no. A

approved (PD) SK002



N

LEGEND

- SITE BOUDNARY
- EXISTING SURFACE
- EXISTING TREES
- EXISTING POND AREA
- TOE OF WASTE
- PROPOSED WASTE LEVELS
- PROPOSED TOE DRAIN FOR LEACHATE INTERCEPTION
- POSSIBLE LOCATIONS FOR NEW STORMWATER PONDS
- EXISTING LANDFILLED AREA

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

WASTE RELOCATION REQUIRED	21,500 m³
TOTAL CAPACITY PROVIDED	97,500 m³
WASTE CAPACITY REMAINING	76,000 m³
FINAL LANDFORM CAP AREA	40,500 m²
EXTENSION AREA	6,850 m²

SURVEY PROVIDED BY COUNCIL AND DATED FEB 2015

PRELIMINARY

rev	description	app'd	date
A	FOR DISCUSSION		09.06.15

UPPER LACHLAND SHIRE COUNCIL
CROOKWELL LANDFILL

FINAL WASTE SURFACE OPTION 2

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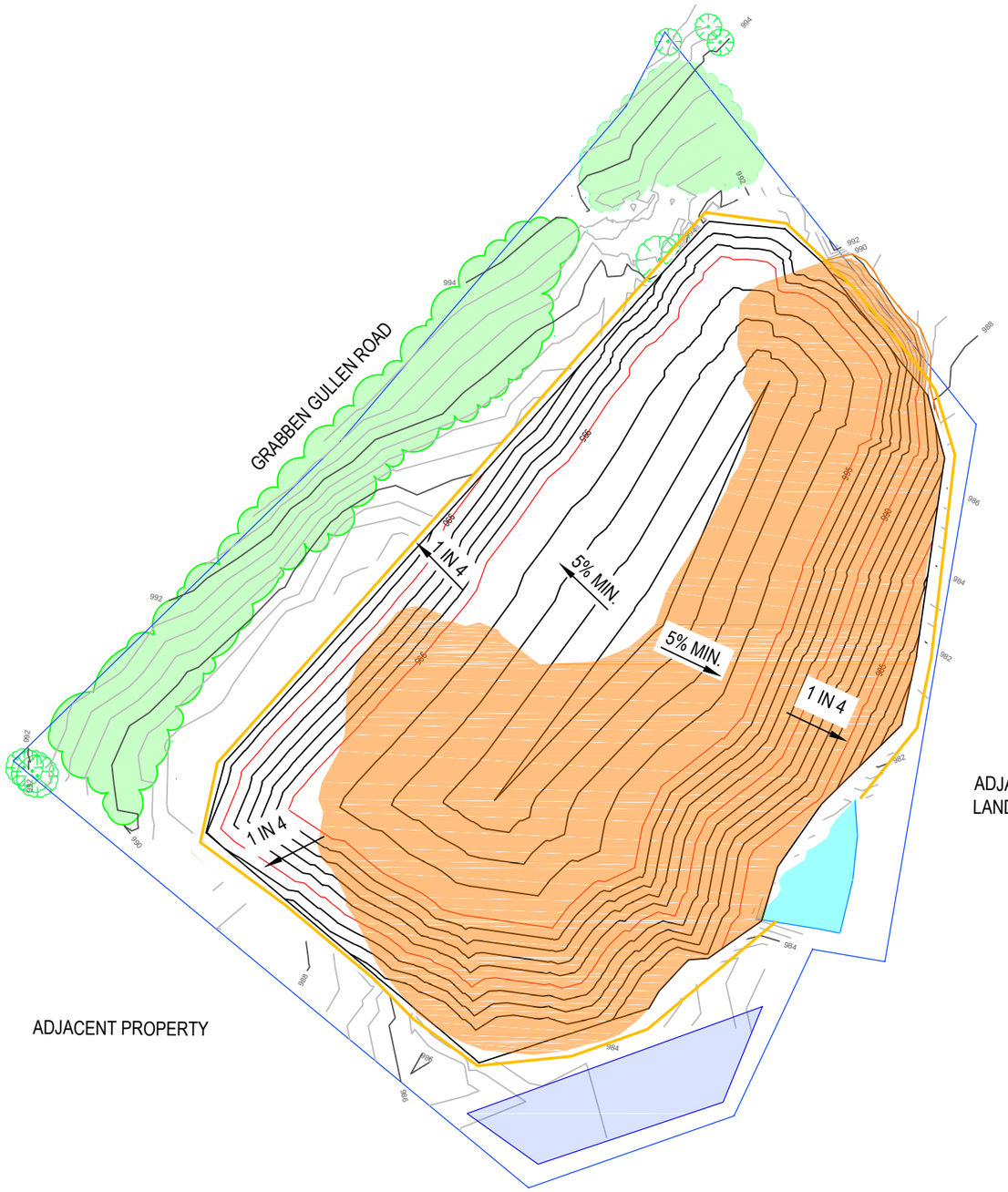
scale 1:2000 for A3 job no. 21-24492
date JUNE 2015 rev no. A

approved (PD) SK003



N

LEGEND

- SITE BOUDNARY
- EXISTING SURFACE
- EXISTING TREES
- EXISTING POND AREA
- TOE OF WASTE
- PROPOSED WASTE LEVELS
- PROPOSED TOE DRAIN FOR LEACHATE INTERCEPTION
- POSSIBLE LOCATIONS FOR NEW STORMWATER PONDS
- EXISTING LANDFILLED AREA

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

WASTE RELOCATION REQUIRED	14,000 m³
TOTAL CAPACITY PROVIDED	163,200 m³
WASTE CAPACITY REMAINING	149,700 m³
FINAL LANDFORM CAP AREA	46,000 m²
EXTENSION AREA	12,300 m²

SURVEY PROVIDED BY COUNCIL AND DATED FEB 2015

PRELIMINARY

rev	description	app'd	date
A	FOR DISCUSSION		09.06.15

UPPER LACHLAND SHIRE COUNCIL
CROOKWELL LANDFILL

FINAL WASTE SURFACE OPTION 3

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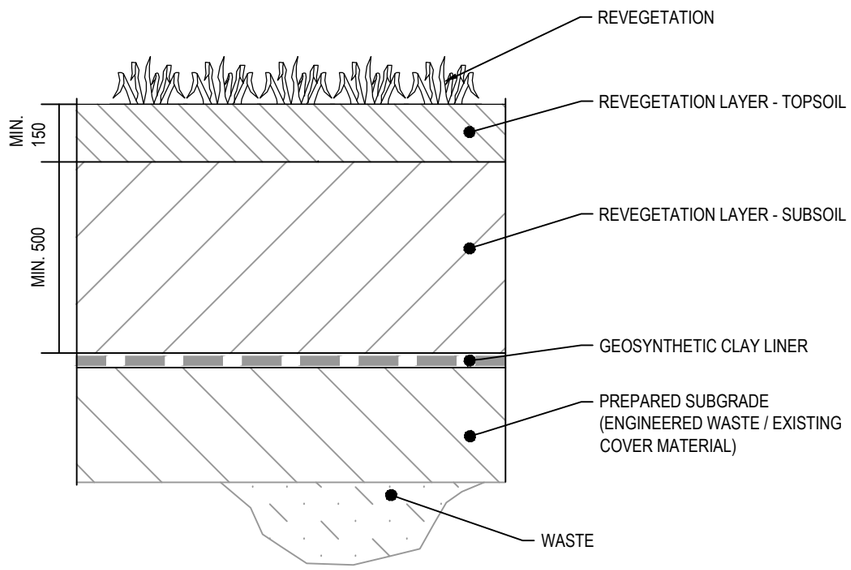
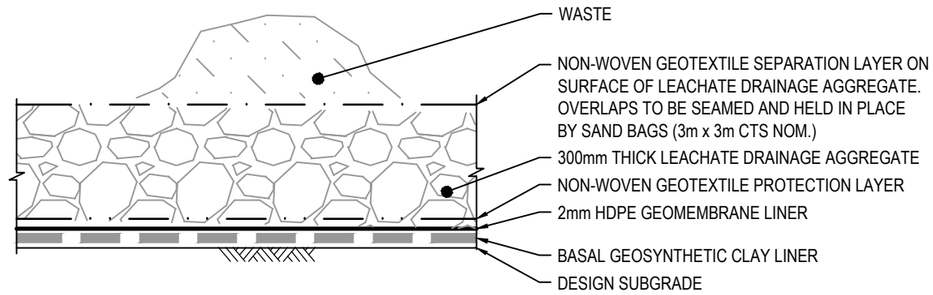
date JUNE 2015 rev no. A

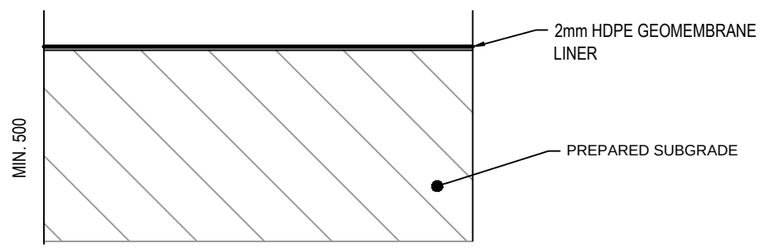
approved (PD) SK004



TYPICAL CAP DETAILS



TYPICAL BASAL LANDFILL BARRIER SYSTEM



TYPICAL POND LINING DETAIL

FOR DISCUSSION

rev	description	app'd	date
A	FOR DISCUSSION		09.06.15

UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
TYPICAL DETAILS

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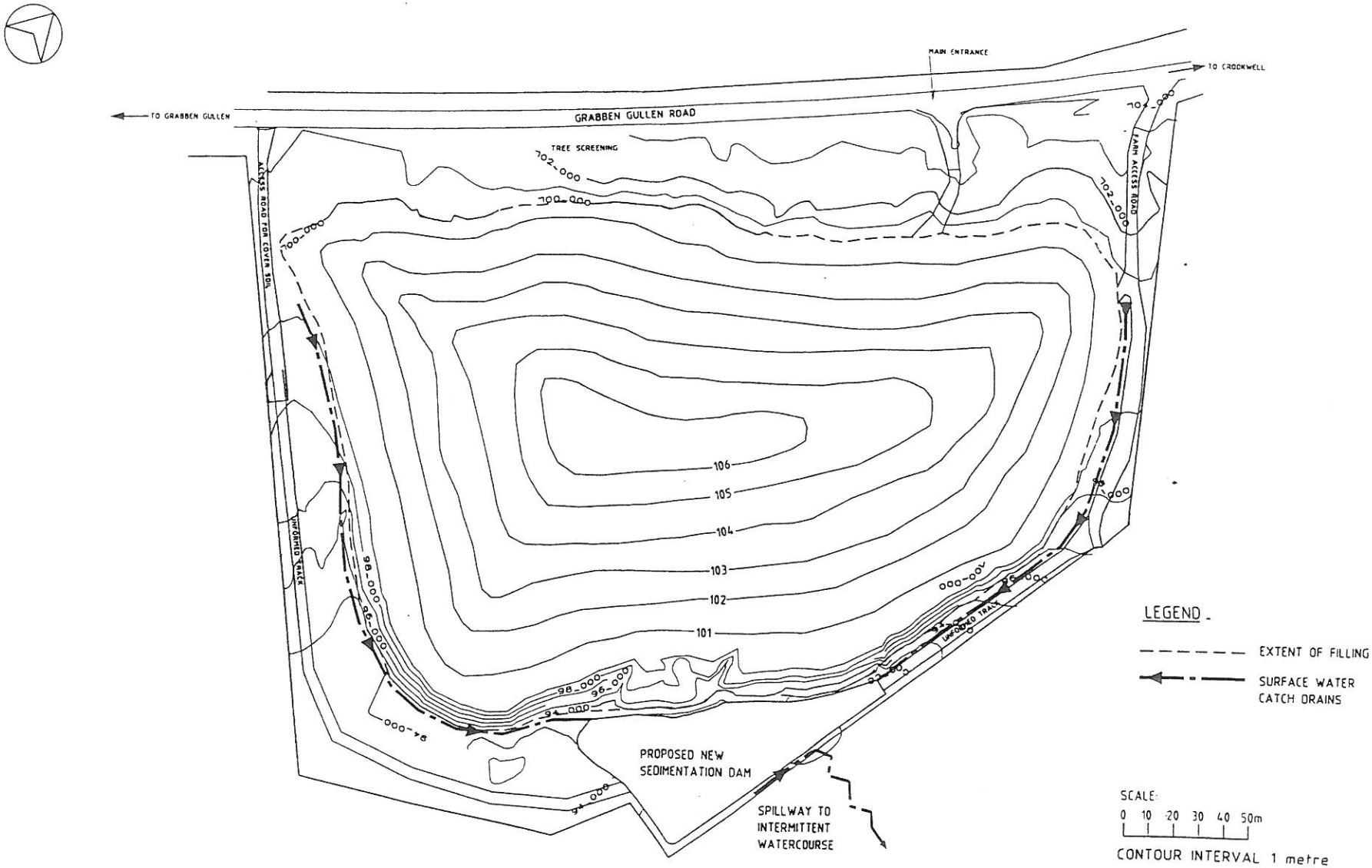
scale	NTS for A3	job no.	21-24492
date	JUNE 2015	rev no.	A

approved (PD) SK005

Appendix B - Proposed Final Landform (1998)

From existing LEMP (CMPS&F, 1998)

CROOKWELL SHIRE COUNCIL
CROOKWELL LANDFILL DEPOT – PROPOSED FINAL LANDFORM



REV 0
FILE VNZ0026- VN/5519
PLOT DATE 30.3.98

FIGURE 5

CMDS

Appendix C – Cost estimation for future works

Crookwell Landfill
Job Number: 21-24492

Date Prepared: 01/06/2015

Indicative cost estimate - Option 1 Minimal area

Reliance: Order of magnitude only

Works	Quantity	Units	Rate (indicative)	Cost ($, indicative)	Notes
Essential works					
Formalise existing leachate dam	1,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$ GMB liner - $20/m^2$	$ 44,000	Clearing, minor excavation, bunds, liner
Stormwater management works	33,700	m^2	Grades and cross fall - $2.38/m^2$ Excavation of toe drain - $15/m^3$	$ 31,000	Grading, drains and diversion bunds
Stormwater pond	2,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$	$ 32,000	Clearing, minor excavation, bunds, liner
Remediation of existing batters	21,500	m^3	Waste excavation - $20/m^3$	$ 430,000	Excavation and relocation of existing waste (possible asbestos contamination)
Capping of completed landfill areas (eastern and western batters)	19,500	m^2	Assume material imported Topsoil layer (150 mm) - $12/m^3$ Soil (500 mm) - 9/m^3 Vegetation - $2.34 /$m^2$ GCL - $15 / m^2 CQA x 2 Toe drain $60/m	$ 521,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Total				**$ 1,058,000**	
Contingency	50%			**$ 1,587,000**	Includes design, project management and contractor indirects
Existing future works					
Surface water management plan	1	unit	$15,000.00	$ 15,000	nominal
Leachate management plan	1	unit	$15,000.00	$ 15,000	nominal
Gas management plan	1	unit	$15,000.00	$ 15,000	nominal
Remaining capping works	14200	m^2	Assume material imported Topsoil layer (150 mm) - $12/$m^3$ Soil (500 mm) - 9/m^3 Vegetation - 2.34 /m^2 GCL - 15 / m^2 CQA x 2 Toe drain $60/m COA x 2	$ 372,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Cell lining works	0	m^2	Stripping and clearing - $0.65/m2 Excavation $15/m2 Grades and cross fall - $2.38/m2 GCL - $15/m2 GMB $ 20/m2 Drainage layer $30/m2 CQA x 3	$ 31,000	Subgrade, liner, aggregate, sump & pump
Stormwater management works	0	m^2	Grades and cross fall - $2.38/$m^2$ Excavation of toe drain - $15/$m^3$	$ 4,000	Grading, drains and diversion bunds
Relocation of existing site infrastructure	0		$25,000	$25,000	Move site shed. Construct new roads etc
Total				**$ 477,000**	
Contingency	50%			**$ 716,000**	Includes design, project management and contractor indirects

Crookwell Landfill
Job Number: 21-24492

Date Prepared: 01/06/2015

Indicative cost estimate - Option 2 Conservative expansion

Reliance: Order of magnitude only

Works	Quantity	Units	Rate (indicative)	Cost ($, indicative)	Notes
Essential works					
Formalise existing leachate dam	1,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$ GMB liner - $20/m^2$	$ 44,000	Clearing, minor excavation, bunds, liner
Stormwater management works	33,700	m^2	Grades and cross fall - $2.38/m^2$ Excavation of toe drain - $15/m^3$	$ 31,000	Grading, drains and diversion bunds
Stormwater pond	2,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$	$ 32,000	Clearing, minor excavation, bunds, liner
Remediation of existing batters	21,500	m^3	Waste excavation - $20/m^3$	$ 430,000	Excavation and relocation of existing waste (possible asbestos contamination)
Capping of completed landfill areas (eastern and western batters)	19,500	m^2	Assume material imported Topsoil layer (150 mm) - $12/m^3$ Soil (500 mm) - $9/m^3$ Vegetation - $2.34 /m^2$ GCL - $15 / m^2 CQA x 2 Toe drain $60/m	$ 521,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Total				**$ 1,058,000**	
Contingency	50%			**$ 1,587,000**	Includes design, project management and contractor indirects
Existing future works					
Surface water management plan	1	unit	$15,000.00	$ 15,000	nominal
Leachate management plan	1	unit	$15,000.00	$ 15,000	nominal
Gas management plan	1	unit	$15,000.00	$ 15,000	nominal
Remaining capping works	21000	m^2	Assume material imported Topsoil layer (150 mm) - $12/m^3$ Soil (500 mm) - 9/m^3 Vegetation - 2.34 /m^2 GCL - 15 / m^2 CQA x 2 Toe drain $60/m COA x 2	$ 517,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Cell lining works	6850	m^2	Stripping and clearing - $0.65/m2 Excavation $15/m2 Grades and cross fall - $2.38/m2 GCL - $15/m2 GMB $20/m2 Drainage layer $30/m2 CQA x 3	$ 636,000	Subgrade, liner, aggregate, sump & pump
Stormwater management works	6,800	m^2	Grades and cross fall - $2.38/$m^2$ Excavation of toe drain - $15/$m^3$	$ 10,000	Grading, drains and diversion bunds
Relocation of existing site infrastructure	1		$25,000	$25,000	Move site shed. Construct new roads etc
Total				**$ 1,233,000**	
Contingency	50%			**$ 1,850,000**	Includes design, project management and contractor indirects

Crookwell Landfill
Job Number: 21-24492

Date Prepared: 01/06/2015

Indicative cost estimate - Option 3 maximum area

Reliance: Order of magnitude only

Works	Quantity	Units	Rate (indicative)	Cost ($, indicative)	Notes
Essential works					
Formalise existing leachate dam	1,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$ GMB liner - $20/m^2$	$ 44,000	Clearing, minor excavation, bunds, liner
Stormwater management works	33,700	m^2	Grades and cross fall - $2.38/m^2$ Excavation of toe drain - $15/m^3$	$ 31,000	Grading, drains and diversion bunds
Stormwater pond	2,000	m^2	Stripping and clearing - $0.65/m^2$ Excavation - $15/m^3$	$ 32,000	Clearing, minor excavation, bunds, liner
Remediation of existing batters	14,000	m^3	Waste excavation - $20/m^3$	$ 280,000	Excavation and relocation of existing waste (possible asbestos contamination)
Capping of completed landfill areas (eastern and western batters)	19,500	m^2	Assume material imported Topsoil layer (150 mm) - $12/m^3$ Soil (500 mm) - $9/m^3$ Vegetation - $2.34 /$m^2$ GCL - $15 / m^2 CQA x 2 Toe drain $60/m	$ 521,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Total				**$ 908,000**	
Contingency	50%			**$ 1,362,000**	Includes design, project management and contractor indirects
Existing future works					
Surface water management plan	1	unit	$15,000.00	$ 15,000	nominal
Leachate management plan	1	unit	$15,000.00	$ 15,000	nominal
Gas management plan	1	unit	$15,000.00	$ 15,000	nominal
Remaining capping works	26500	m^2	Assume material imported Topsoil layer (150 mm) - $12/m^3$ Soil (500 mm) - 9/m^3 Vegetation - 2.34 /m^2 GCL - 15 / m^2 CQA x 2 Toe drain $60/m COA x 2	$ 634,000	Subgrade prep, subsoil, topsoil, grass, CQA costs
Cell lining works	12300	m^2	Stripping and clearing - $0.65/m2 Excavation $15/m2 Grades and cross fall - $2.38/m2 GCL - $15/m2 GMB $20/m2 Drainage layer $30/m2 CQA x 3	$ 1,118,000	Subgrade, liner, aggregate, sump & pump
Stormwater management works	12,300	m^2	Grades and cross fall - $2.38/$m^2$ Excavation of toe drain - $15/$m^3$	$ 14,000	Grading, drains and diversion bunds
Relocation of existing site infrastructure	1		$25,000	$25,000	Move site shed. Construct new roads etc
Total				**$ 1,836,000**	
Contingency	50%			**$ 2,754,000**	Includes design, project management and contractor indirects

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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