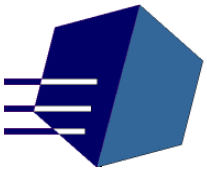
Appendix D

Leachate model report



CONSULTING EARTH SCIENTISTS

MOD 6 – LEACHATE GENERATION MODEL

GENESIS LANDFILL AND RECYCLING FACILITY

PREPARED FOR DIAL-A-DUMP INDUSTRIES PTY LTD

CES DOCUMENT REFERENCE: CES170514-EMM-AC

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TABLE OF CONTENTS

1 INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was commissioned by Dial-A-Dump Industries Pty Ltd (DADI) (the client) to provide an updated leachate generation model for the Genesis Landfill and Recycling Facility (the Site), to support the Major Project Approval No. 06_139 Modification 6 (Mod 6) application to modify the landfill cap and to change the operating hours for all activities within the facility. The change in operating hours will change the leachate generation profile over the filling period of the site, due to increased filling rates and increased volumes of irrigation water being used for dust suppression.

2 OBJECTIVES

The objective of the leachate model is to estimate the amount leachate generated at the site under the proposed Mod 6 operating conditions. To assess the amount of leachate generated at the site, CES has completed the following work:

- Reviewed available information pertaining to leachate management provided by DADI;
- Reviewed the existing site water balance assessment produced by CES (CES Document Reference: CES161004-ECS-AD);
- Conducted a back analysis of leachate generation using the information from the above water balance assessment;
- Development of a landfill filling and leachate generation model for the site under the proposed operating conditions, being the removal of the 700,000 tonne per annum landfilling limit, using the outputs from the Mod 6 water balance assessment (CES Document Reference CES170514-EMM-AB); and,
- Preparation of this report assessing leachate generation under the proposed Mod 6 operating conditions.

3 BACKGROUND INFORMATION

3.1 SITE LOCATION AND DESCRIPTION

The Genesis Landfill and Recycling Facility is located at Eastern Creek, NSW and is surrounded by a mix of commercial, open space, infrastructure (M4 motorway) and industrial developments.

The facility currently operates under two different Environmental Protection Licenses (EPL) issued by the NSW EPA, licence numbers 13426 and 20121.

3.2 LANDFILL HISTORY

The predominant feature at the site is a breccia quarry, formerly known as the Pioneer Quarry, where it is understood that extractive operations started in the 1950s. The quarry reached the end of its economic life and all quarrying activities at the site ceased in September 2006, although the open cut quarry void remains.

3.3 LANDFILL GEOMETRY

The landfill geometry information was reported in the *Leachate Collection System, Concept Design* (ERM, August 2008) as:

The open cut elliptical void is approximately 430 metres (m) x 700 m and up to 150 m in depth. The surface area is approximately 288,000 m^2 at ground surface and 12,000 m^2 at the base.

The landfill geometry used in this report is based upon that estimated from the site water balance assessment (CES161004-ECS-AD). Pertinent dimensions to this leachate generation model are:

Table 1: Estimated Landfill Areas

Dimension	**Estimated area (m^2)**
Total Landfill Catchment Area	472,000
Operating area of landfill (as at September 2016)	73,000
Area of 8 ML stormwater pond	5,525

3.3.1 Walls of Void

Benches of approximately 7 to 8 m in width exist along the sides of the void. The upper part of the quarry is excavated through unconsolidated sediments including clays and weathered shales and therefore has lower angled slopes. A spiral access road around 20 m in width around the edge of the void descends to the quarry base. Stormwater drains control run-off on the access road.

3.3.2 Base of void

A rectangular level area (-57m above Australian Height Datum (AHD) forms the base of the former void. A raised area (approximately 8m higher) is present to the east of the rectangular base. The base is fairly flat and drains to a sump from which groundwater ingress and run off is currently pumped. These areas have been entirely covered with landfill material.

The current base of the void is at approximately -10 m AHD and is approximately 10m lower than the 8 ML stormwater dam located in the western portion. The active filling area is in the eastern portion of the pit.

3.4 GEOLOGY AND HYDROGEOLOGY

A full review of the geology and hydrogeology of the site is set out in *Groundwater Assessment* (ERM, July 2008). The key features that relate to the collection of leachate are:

- the surficial geology comprises clay and weathered shales to a depth of approximately 32 m below ground level (bgl). Intact (Bringelly) shales predominate below the weathered shales down to depths approximating 146 m bgl. The Hawkesbury Sandstone is likely to be located approximately 20 m below the base of the quarry;
- there is an intermittent shallow perched groundwater system located around the quarry within the fill, clay and weathered shale. Permeabilities of these deposits range from $1.46E^{-3}$ m/day to 0.25 m/day. Based on the very isolated seepage observed from the clay and weathered shales exposed on the pit walls, this system is not in significant hydraulic contact with the quarry. This suggests that, provided leachate levels within the pit are kept below the base of the shallow aquifer system, leachate migration into this system is unlikely to occur. The water quality of this aquifer is considered to be poor and of limited human and environmental value; and
- there is a deeper regional groundwater system located within the shale deposits. The permeability of this shale has been calculated to be very low (1.75E-6 m/day to 8.7E-6 m/day). The elevation of this water table is likely to be in excess of 24 m AHD, which approximates 82 m above the original pit base. This indicates a strong inward hydraulic

gradient and suggests that the bulk formation hydraulic properties (including fracturing) of the surrounding geology are low. Given the low permeabilities of the geology surrounding the pit there is unlikely to be significant hydraulic contact between the quarry pit and the underlying Hawkesbury Sandstone. Overall, seepage from regional groundwater system into the quarry pit was estimated to approximate 2 m^3/day. The water quality of this aquifer is considered to be poor and of limited human and environmental value.

3.5 PROJECT APPROVAL

The current Project Approval (06_0139) provides for:

- A waste recovery facility including a MPC and greenwaste area. It is noted that the facility is not currently operating a greenwaste activities;
- Rehabilitation of the quarry void via a Class 2 (non-putrescible) landfill;
- Total throughput of up to 2 million tonnes of materials at the site per calendar year;
- Landfilling of up to 700,000 tonnes of non-putrescible waste (including asbestos);
- Stockpiling of up to 50 tonnes of tyres on site at any one time; and
- Stockpiling of up to 20,000 tonnes of greenwaste on site at any one time.

Although not all of the approved modifications are strictly relevant to the leachate modelling, the following modifications to the above original consent have been approved and included in this report for completeness:

3.5.1 Modification 1

Modification 1 (MOD 1 granted by the Minister on 30 September 2010) approved the following components:

- Electrically powered conveyor and chute;
- Postponed commencement of construction;
- Two way traffic on Fourth Avenue;
- Concrete bay walls within the greenwaste processing area; and
- Relocation of the wheelwash.

3.5.2 Modification 2

Modification 2 (MOD 2 granted by the Minister on 9 November 2010) comprised a correction to the land description details of the project Approval. The corrected reference to the land being Lots 1, 2, 3 and 4 in DP 1145808.

3.5.3 Modification 3

Modification 3 (MOD 3 granted by the Minister on 5 December 2011) approved the following components:

- Revised final landform level of the fill pad at Area D;
- Operational landform levels and site stormwater design;
- Internal office and external amenities to the Weighbridge;
- New amenities building;
- New amenities building associated with the spotter stations;
- New administrative/office building;
- New amenities at the tarp stand area;
- Approval for the use and relocation of the vehicle turning bay which works have already been carried out; and
- Voluntary planning agreement.

3.5.4 Modification 4

Modification 4 (MOD 4 granted by the Minister on 14 December 2013) approved the following components:

- Extended operating hours for the MPC allowing it to be operated during the hours of 6am to 10pm Monday to Friday, and 6am to 4pm Weekends and Public Holidays; and
- Modifications to the noise levels in Table 4, which provided that the Proponent would not exceed 36 LAeq (15 minute) dB(A) during the day and 35 LAeq (15 minute) dB(A) during the evening and Morning Shoulder.

3.5.5 Modification 5

Modification 5 (MOD 5 granted by the Minister on 17 March 2016) approved the following components:

- Allow construction of a Pre-Sort Enclosure in accordance with the plans submitted with the modification application.

3.6 MODIFICATION 6

3.6.1 Current Operations Conditions

The Proponent currently operates as follows:

Table 2 – Current Genesis Landfill and Recycling Facility Operation Hours (Table 5, Condition 39, Schedule 3, Project Approval (06_0139) as amended by MOD 4.

Activity	Day	Time
Construction	Monday – Friday	07:00am to 18:00pm
	Saturday	08:00am to 16:00pm
	Sunday and Public Holidays	Not Approved
Operation	Monday – Friday	07:00am to 18:00pm
	Weekend and Public Holidays	08:00am to 16:00pm
MPC	Monday – Friday	06:00am to 22:00pm
	Weekend and Public Holiday	06:00am to 16:00pm

Clause 39a of the Project Approval states:

- *Operating hours of the conveyor and chute system are to be restricted to the facility's operational hours (and not times governing the Operation of the MPC as above) and as defined in condition 39 of Schedule 3.*

The maximum mass of material applied to land if 700,000tpa, with a maximum limit of material received at the facility of 2Mtpa.

3.6.2 Proposed Modification to Operating Conditions

The proponent proposes to amend the Existing Table 5 of Condition 39 (as set out above and amended by Modification 4).

Table 3 – Proposed Changes to Table 5, Condition 39

Activity	Sub-activity	Days	Hours
Construction		Monday-Friday	6am-6pm
		Saturday	8am-4pm
		Sunday and public holidays	nil
MPC and PSE	Receive Materials	Monday to Sunday	24 Hours
	Operations	Monday to Sunday	24 Hours
SMA	Receive Materials	Monday to Sunday	24 Hours
	Crushing and Screening	Monday to Sunday	6:00am to 6:00pm
Landfill	Receive Materials by truck	Monday to Sunday	5am-9pm

	Convey waste from MPC to landfill via chute	Monday to Sunday	24 Hours
Maintenance			
MPC, PSE and landfill	Repair machinery	Monday to Sunday	24 Hours
SMA	Cleaning and machinery repairs	Monday to Sunday	24 Hours
Chute	Clearing of blockages and general repairs	Monday to Sunday	24 Hours

The landfilling limit of 700,000tpa is removed. The 2Mtpa limit on material received at the facility is unchanged by this modification.

3.7 *INFILLING PROCEDURE AND LANDFILL LEACHATE GENERATION*

It is understood that the currently achieved infilling rate of the landfill is approximately 500,000tpa (estimated to be 295,000 m^3/year).

In 2008 ERM developed a leachate model for the site. The key data relevant to this document are summarized as follows:

- The design of the infilling system will allow separation of surface water run-off from the sides of the landfill from the rain falling directly onto the landfill waste and infiltrating to become leachate. This will significantly reduce the volume of leachate generated;
  However, it should be noted that the separated rainwater that is pumped/discharged to the pit stormwater dam and the surface dams (including the tanks underneath the Materials Processing Centre (MPC) is used for irrigation/dust suppression of the waste area. As a result, this water may generate leachate.
- ERM conservatively estimated the volumes of surface water and leachate generated within the landfill. Based on this, leachate generated is anticipated to range between 45 and 872 m^3/day, with an average of 241 m^3/day;
- As a result, ERM estimated that in order to maintain groundwater elevations at acceptable levels within the landfill, pumping rates from the landfill will be required to range between 250 m^3/day and 500 m^3/day;
- ERM stated that provided that pumping rates do not fall below 241 m^3/day, the landfill will be able to be used as a storage facility during times of high rainfall. This pumping rate

allowed a constant flow rate to be achieved from the leachate collection system and would negate the need for surface storage capacity for leachate pumped from the landfill;

- At the completion of the landfill and subsequent capping, leachate generation is likely to fall below 90 m^3/day. Due to the potentially poor ability of the regional groundwater system to absorb this volume of leachate there is potential for leachate elevations to eventually rise above the regional groundwater elevation and begin recharging the shallow perched groundwater system. Post landfill monitoring will help to quantify this process, however, there is potential for ongoing pumping to be required to prevent impact to receptors in potential hydraulic contact with the landfill.

3.8 BASECASE WATER BALANCE

In 2016 CES prepared a water balance (CES document reference CES161004-ECS-AD) for the site to assess the measured leachate extraction rates with the expected water inflows and outflows. For the purpose of this leachate generation model, the water balance has been modified such that the data reflects actual operating conditions at the site. The following assumptions were used in preparation of the water balance:

- Total leachate generating landfill footprint area = 288,000 m^2;
- Initial base of operating landfill footprint area = 73,000 m^2 (as at September 2016);
- Total footprint area of 8 ML stormwater pond = 5,525 m^2;
- Assume 10% of rainfall on the sidewalls interacts with landfill waste; 90% is collected by stormwater systems, adsorbed, or evaporated.
- Irrigation volumes of; 10,260 m^3/year water cart irrigation, 113,763m^3/year water cannon irrigation volume, 31,026 m^3/year sprinkler volume, for a total leachate volume from irrigation of 21,707 m^3/year, assuming 14% of irrigation waters interacts with waste in the landfill pit. The 14% assumption has been based upon a reconciliation of leachate production against the 2016 water balance (CES document reference CES161004-ECS-AD).
- The estimated flow rate of groundwater into the landfill is reported by ERM as 2 m^3/day (730 m^3/yr).
- Evaporation of 1.3091 m/year (Bureau of Metrology).
- 90th percentile rainfall of 1.1782m/year (Bureau of Metrology).

Based on the information above, the Water Balance Summary has been estimated and is reproduced in Table 4.

Table 4: Leachate Volume Summary

Source		Volume (m^3/yr)
V_1	Net Rainfall on waste in landfill pit	+126,509
V_2	Net Irrigation on waste in landfill pit	+21,707
V_3	Seepage from groundwater	+730
	Total Estimated Water Inputs	+161,927
V_4	Evaporation from Landfill pit with current waste deposit at -10 mAHD	-88,332
	Net Water Balance (m^3/yr)	**+60,614**
V_5	Leachate pumped out from landfill pit	-61,485

This water balance conducted between 30/09/2015 and 1/10/2016 has been included in this report as the basis of the back analysis exercise. Note that this water balance differs from the Mod 6 water balance assessment (CES document reference CES170514-EMM-AB), which provides an assessment of the water balance under the Mod 6 conditions, and has been utilised in the leachate model below.

4 LEACHATE MODELLING

4.1 BACK ANALYSIS

A back-analysis of leachate generation has been conducted utilising the water balance information presented in Table 4. The back-analysis which has been conducted reconciles the theoretical modelled leachate generation with observed leachate generation from the site. This model validation improves the confidence in the results from the Mod 6 projection leachate model. The leachate generation model was run over a period of 100 years, and the median volume of leachate generated was calculated for the initial landfill geometry (that is to say, the geometry which was used in the formation of the water balance presented above), calculated. The subsurface inflow parameter for the vertical percolation layer (waste) was varied such that the average annual volume of leachate collected was approximately equal to V_5, measured leachate pumped out from the landfill pit. This was calculated to be 0.10cm/day/m^2. This inflow accounts for V_2 net irrigation on waste in landfill pit. Details of the hydrogeological model are discussed in in Section 3.7.1.

Table 5: Leachate Generation Back Analysis

Model	Leachate collection volume (m^2)
Recorded Leachate Extraction (01/10/15 to 30/09/2016)	61,485

Back Analysis (irrigation of 0.10cm/day/m^2)	62,408[(1)]

[(1)]Median over 100 year period using synthetic weather model.

Groundwater seepage into the pit of an estimated volume of 2m^3/day was added separately to the calculated leachate generation (ERM, 2008).

Based on the results of the Mod 6 water balance, the expected irrigation water use on the landfill pit is 26,753m^3/year. This represents a 23% increase of the base case, and therefore an irrigation rate of 0.123cm/day/m^2 has been adopted for use in the leachate generation model for Mod 6.

4.1.1 Hydrogeological Model

The Hydrological Evaluation of Landfill Performance (HELP) model developed by the United States Environment Protection Agency (USEPA) Risk Reduction Engineering Laboratory was used to provide estimates of leachate generation rates for the completed landfill profile at the site.

The HELP model is a quasi-two-dimensional, unsaturated zone hydrological model. The model was developed by the USEPA to assist in predicting landfill hydrologic processes and testing the effectiveness of landfill designs. The model provides information on the percolation of water through the landfill profile, changes in the volume of water stored in each landfill component and the predicted quantity of water moving out of a landfill.

The landfill profile modelled in the hydrological simulations using HELP comprises the following components:

- Vertical percolation layers (Waste);
- Lateral Drainage layers (Gravel);
- Barrier soil (Clay).

Vertical water movement is modelled through the landfill cap, waste, and barrier layers. The following layer properties have been considered in the HELP model:

- Porosity.
- Field capacity.
- Wilting point (relevant for layers used as a growing medium).
- Saturated hydraulic conductivity.
- Subsurface inflow (irrigation and groundwater inflow may be crudely incorporated using this property).
- Initial moisture content.

Landfill water-balance modelling using the HELP model has been carried out in the following sequence:

1. Construct a conceptual model of the landfill in the form of a HELP profile.
2. Select climatic locations for weather data.
3. Nominate a time frame for modelling.
4. Evaluate the results of each model run.
5. Modify the profile as required and re-run the model.

It is important to note that the HELP model provides only broad-scale estimates of leachate generation, which can vary considerably from field conditions. As such, results should be regarded as coarse estimates only.

The landfill modelled using HELP is presented in Table 6.

Table 6: Water Balance Modelled Landfill Profile

Layer Number	Layer Type	Thickness (m)	Porosity	Field Capacity	Saturated Hydraulic Conductivity[1]	Sub-surface Inflow (mm/d)	Leachate Re-circulated (%) Collected
1	General Solid Waste	100(3)	0.671	0.292	$1.0x10^{-3}$	0.10(2)	0
2	Aggregate Drainage Layer (gravel)	0.3	0.397	0.032	0.3	0	0
3	Barrier Soil (Compacted Clay)	1.0	0.427	0.418	$8.64x10^{-4}$	0	0

(1) Saturated hydraulic conductivity expressed in units of cm s^{-1}, consistent with HELP model input. For example, permeability of 10^{-8} m s^{-1} is equivalent to 10^{-6} cm s^{-1}.
(2) Determined through iteration to approximate leachate collection data.
(3) This value was varied between 15 and 100m, with a difference in leachate generation of approximately 1.1% calculated. This difference is considered insignificant and as such the effect of variable waste thickness has not been included in the model.

A synthetic weather generator has been incorporated into the HELP model. Data for Sydney Airport meteorological station has been used in the modelling exercise. The HELP model was run on a yearly timescale for 100 years.

4.2 CONCLUSION AND MODIFICATION 6 PROJECTION

The following assumptions and changes have been made for the leachate generation model under the Modification 6 operating conditions:

- Irrigation volumes are increased by 23% as a result of additional dust suppression requirements, and
- Landfilling rate is increased as a result of additional allowable time for waste delivery and removal of the landfilling limit of 700,000tpa.

A landfilling model has been prepared to assist with calculation of the leachate volumes. The average annual leachate collection of the HELP model has been applied to the area of the landfill base, with the addition of leachate being generated from the pit walls at a rate of 10% of the annual precipitation. The landfilling model assumes the pit to be filled at an even rate, with the pit being approximated to be a truncated cone. Two scenarios under the Modification 6 operating conditions have been considered in this assessment; the maximum case where the 2Mpta received is all landfilled, and a 50% increase over the currently realised filling rate.

The parameters varied in the models are presented in Table 7.

Table 7: Leachate model scenarios

	Landfilling rate (m^3/year)	**Landfilling rate (tpa)**	**Irrigation rate (cm/day/m^2)**
Base case	295,000	472,000	0.100
Modification 6 – 50% increase over existing filling rate	442,500	708,000	0.123
Modification 6 – 2Mtpa	1,250,000	2,000,000	0.123

The estimated leachate generation, compared to the base case estimation is presented in Figure 1 below.

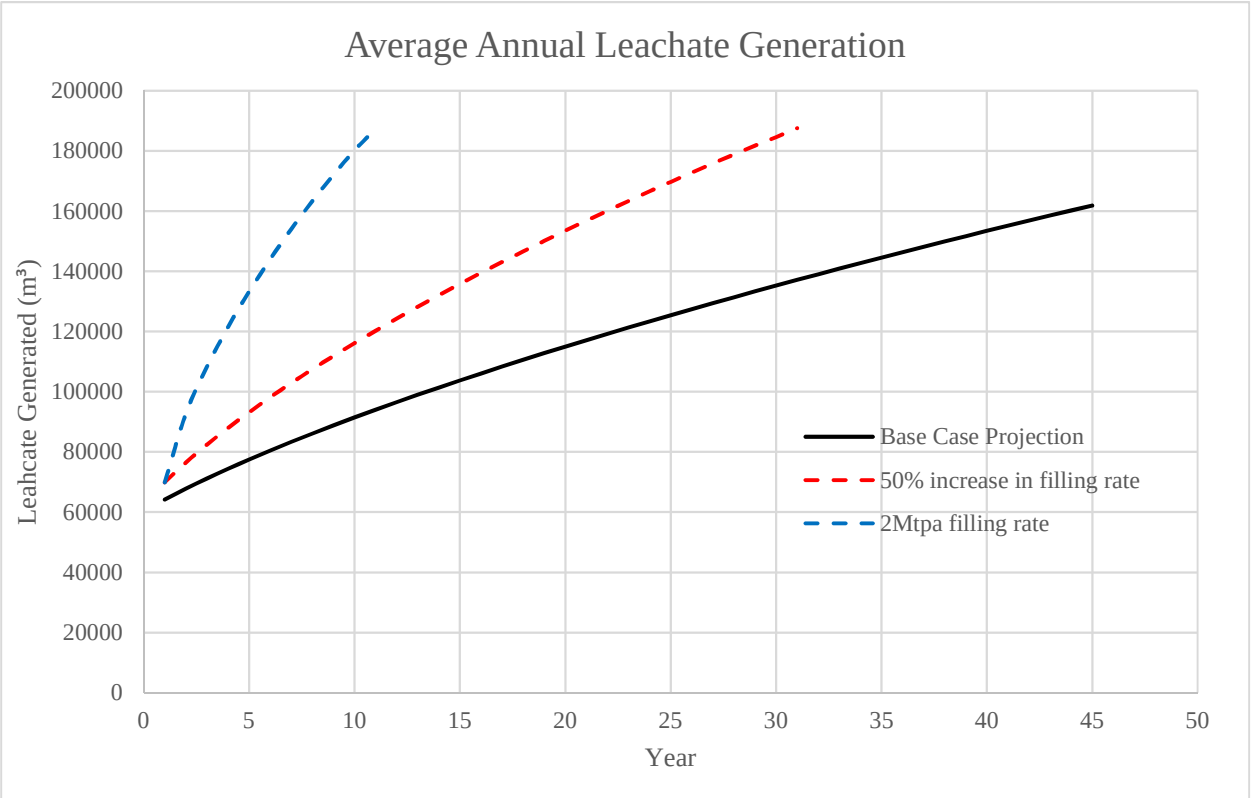

Figure 1: Estimated Leachate Generation

Figure 1 shows that initially Modification 6 results in approximately 9% additional leachate being generated over the base case, increasing to 15% at the time of landfill completion. Under the Mod 6 case, the average expected initial leachate extraction rate is 192m^3/day, increasing to 505m^3/day at the completion of landfilling.

It should be noted that leachate generation under this model is primarily a function of the height of waste in the landfill pit, and therefore the area where rainfall will interact with waste.

CES understands that Genesis has capacity for leachate treatment of approximately 219,000m^3/year via five Sequence batch reactors (SBRs), based on 7 to 9 hours treatment time. The leachate generation model using the Mod 6 conditions indicates the maximum annual leachate volume generated will be approximately 185,000m^3/year, which is less than the current leachate treatment activity. It is further understood that the Tradewaste Water Consent for treated leachate disposal has a maximum discharge of 650kL/day (237,250m^{3}m/year), which is greater than the expected maximum leachate generation volume.

During periods of prolonged or heavy rainfall, it could be expected that leachate generation rates exceed those reported here for a short time. CES understands that the leachate conveyance system has capacity to store excess leachate within the pit prior to treatment and discharge.

This model does not consider the effect of capping of the landfill once filling is complete, and the leachate generation estimate of the capped landfill previously reported in ERM (2008) is not affected by Mod 6.

CES understands that the leachate collection system has a designed capacity of 890m^3/day (324,850m^3/year) which is greater than the maximum expected leachate volume under the Mod 6 conditions.

5 REFERENCES

NSW Minister of Planning, Project Approval, Section 75J of the Environmental Planning and Assessment Act 1979, Schedule 1, Application No: 06_0139 (as modified)

NSW EPA, Environmental Protection Licence No. 13426.

Douglas Partners, Report on Soil, Water and Leachate Management Plan, Light Horse Business Centre, Eastern Creek, Project 46950, December 2011

ERM, Groundwater Assessment, Light Horse Business Centre, Eastern Creek, NSW, Australia,. Report: 0071234rp01_Final, August 2008

ERM, Leachate Collection System, Concept Design, ThaQuarry Pty Ltd. Report 0071234rp1v3, August 2008

IGGC 2007. Archbold Road, Eastern Creek: Groundwater and Salinity Assessment for Proposed Quarry Rehabilitation Project and Developable Land, Light Horse Business Centre, BJ07/Rp010RevE, May 2007 Update.

Consulting Earth Scientists, Water Balance Report, Genesis Landfill and Recycling Faculty, CES161004-ECS-AD dated 09 November 2016

Consulting Earth Scientists, Modification 6 Water Balance Report CES170514-EMM-AB dated 14 August 2017

DADI Group Pty Ltd, Environmental Management Strategy; Soil, Waste and Leachate Management Plan, Revised March 2017

DADI Group Pty Ltd, Environmental Management Strategy; Leachate Collection Conveyance and Management System, Revised 16 March 201