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RED INDUSTRIES LTD

WALLEYS QUARRY LANDFILL SITE

ENVIRONMENTAL PERMIT VARIATION APPLICATION 2018

REVIEW OF HYDROGEOLOGICAL RISK ASSESSMENT

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Prepared for

Red Industries Limited

Prepared by

Egniol Environmental Ltd.
Llys Onnen
Ffordd y Llyn
Parc Menai
Bangor
GWYNEDD
LL57 4DF

Document Review

Version No.	Date of Review	Prepared By	Reviewed By	Approved By
1.0	07/12/2018	D Wolstencroft	N Riding	
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1. INTRODUCTION

1.1 Application Context

Red Industries Ltd (hereafter referred to as the 'Operator') own and operate Walleys Quarry, a non-hazardous landfill site. The company was issued an Environmental Permit (ref EPR/DP3734DC) to operate the landfill, in November 2016.

Walleys Quarry Landfill Site (hereafter referred to as the 'Site') is located in Silverdale, Newcastle under Lyme, Staffordshire, at National Grid Reference SJ831460. The Site is permitted to accept a variety of non-hazardous wastes, such as MRF residual waste, commercial, industrial and inert waste materials. The Operator is also permitted to accept stable non-reactive hazardous waste in the form of asbestos containing material, however no such hazardous waste is accepted at the Site.

By making this permit variation application the Operator proposes to increase the annual waste inputs at this site from 250,000 tonnes to 300,000 tonnes.

This proposal will not require a need to increase the overall landfill void capacity or the site footprint. There will be also no changes in the waste types which are already permitted for disposal at the Site.

2. REVIEW OF LATEST HYDROGEOLOGICAL RISK ASSESSMENT

2.1 Background

Condition 3.1.5 of the current permit for the site requires that a review of the Hydrogeological Risk Assessment (HRA) is undertaken every 6 years. The last review was undertaken in March 2011 by Caulmert Limited for the then owners of the site Tarmac.

The Operator has initiated the 2018 HRA Review which is currently being prepared by Egniol Environmental Limited, and which is planned to be completed in January 2019.

In order to fit in with the timescales required for this variation application it is the 2011 HRA Review that has been reviewed in relation to the proposed increase to the landfill waste input from 250,000 to 300,000 tonnes/annum.

2.2 Review

The advice received from the Environment Agency (EA) via the Pre-application Request (EPR/DP3734DC/V002) process was that a revised HRA would be required to be submitted as supporting information to the permit variation application. After checking via e-mail that the EA had not misunderstood the basis of the application, the following clarification was received from Francis Nwafar at the EA;

"Although your proposal is to increase the annual throughput and not the volume, we need to be satisfied that the proposed increase in waste input will not compromise the design of the landfill and the 'assumptions' that underline the design."

It is on this basis that we have reviewed the 2011 HRA Review, checking the conceptual model and the assumptions made therein.

The conceptual model, namely sources, pathways and receptors assumed in the 2011 HRA Review does not change for the proposed increase in annual throughput of waste.

From review of the 2011 HRA Review it is evident that the risks were assessed using the EA hydraulic containment spreadsheet, as was the original HRA for the site.

The rate at which waste is input into the site is not considered as part of the modelling undertaken using the EA hydraulic containment spreadsheet.

On this basis the risks assessed in the 2011 HRA Review are not altered by the rate at which waste is input into the site.

2.3 Conclusion

The proposed increase in waste input will not compromise the design of the landfill and the 'assumptions' that underline the design.

This review of the 2011 HRA Review should suffice as supporting information to the variation application to increase the annual waste inputs at the site from 250,000 tonnes to 300,000 tonnes.

The Operator has initiated the 2018 HRA Review which is currently being prepared by Egniol Environmental Limited, and which is planned to be completed in January 2019.

Appendix 1

Hydrogeological Risk Assessment Review March 2011

WALLEYS LANDFILL SITE

HYDROGEOLOGICAL RISK ASSESSMENT REVIEW MARCH 2011

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1. INTRODUCTION

1.1 Lafarge Aggregates Ltd (Lafarge) operates Walleys Quarry landfill under Permit no. BR9677. On their behalf, Egniol Consulting submitted to the Environment Agency (EA) in December 2008 a hydrogeological risk assessment (HRA) for the landfill to support increasing the permitted leachate depth during the operational phase of the landfill from 1m to 2m.

1.2 The HRA proposed leachate levels at 2m above the landfill base in cells 1 and 2 which was an increase of 1m above the permitted levels (1 m above the base). The principal reasons for this proposal were:

- The slope of the base of Cell 1 is very steep and consequently with a 1m leachate head, the footprint covers a very small area of the cell, approximately 1,000m^2, which is one sixth of the total.

- Leachate from Cell 1 is extracted by a sidewall riser. Due to the sidewall geometry and the current alignment of the riser, the riser will have to have a bend built into it as it is extended up the sidewall above 110mAOD. This has resulted in concerns about long term problems associated with lowering and raising the leachate pump.

- A breach has been created in the inter-cell bund between Cells 1 and 2. The aim of the breach was to facilitate the long term leachate management from the site by allowing the leachate to migrate from Cell 1 to Cell 2 to be abstracted from the vertical leachate tower in cell 2.

- The 3m thick basal lining extends to a height of 2m above the base level at the external boundary of the landfill cells. An increased leachate head of 2m will still lie within the basal lining.

1.3 The EA responded to the HRA by email on 18th November 2009. Caulmert Limited (CL) was appointed by Lafarge to review the EA response and a meeting was subsequently held on site on 22nd March 2010. The main issues and actions arising from the meeting were:

- the landfill leachate source term was to be updated to incorporate the latest analyses;
- analyses to include 1m thick sidewall lining;
- analyses to use specified, minimum, maximum and most likely permeabilities for the lining clay;
- CL to send current laboratory detection limits to EA due to concerns the current minimum reporting values could not be achieved by commercial laboratories.

1.4 Following the meeting the base of the landfill has been completed with the construction of the base to cell 4 during 2010 and landfill commenced in the cell in November 2010. A groundwater control system was installed beneath the lining to cell 4. All the groundwater drains installed around the landfill drain to a rockfilled sump beneath the cell. The groundwater is then abstracted by submersible groundwater pumps installed in 630DN

HDPE sidewall riser pipes. The groundwater is pumped to a high level settlement lagoon before it is discharged under gravity off site via the polishing lagoon. There are two pumps, one duty and one standby. The pumps are computer controlled to maintain a water level beneath the base of the landfill at 79mAOD. The system is fully automated and there is near continuous recording of system functions including discharge rate and groundwater level. In case of loss of external electrical power a standby diesel powered generator has been linked into the control system to automatically start if power is cut off for more than 2 minutes.

1.5 The original monitoring points installed in cell 1 soon became blocked and failed as the waste was raised and these were replaced in April 2010 with retro-drilled wells installed to intercept target pads. The tops of the two target pads have levels of 81.3mAOD and 81.85mAOD, respectively. The base of the cell is at 80mAOD and with a Permit leachate head of 1m the leachate level will be out of compliance if detected in the monitoring points.

1.6 This report presents an update of the HRA modelling of the operational phase of the landfill, or short term condition, comprising an update of leachate and groundwater quality data, generic hydrogeological analysis and subsequent assessment. Finally, recommendations are made regarding increasing the leachate compliance level to 83mAOD in cells 1 and 2 and incorporating the groundwater pumped discharge in the groundwater surveillance regime.

2. REVIEW OF CONCEPTUAL MODEL

2.1 Sources

Landfill Containment

2.1.1 The landfill containment comprises a 1m clay lining on the 1 in 3 sidewalls with a 3m thick basal clay lining. The 3m thick basal lining extends to height of 2m above the liner level at the external sidewall of each cell. Hence, the top leading edge of the 3m basal lining is at least 2m above the top of lining at the leachate collection point due to the basal falls to the collection point.

2.1.2 The 80m x 70m basal lining to cell 1 falls diagonally across the cell at initially 1 in 10 and flattening to around 1 in 30 towards the sidewall riser leachate extraction point with a lowest top of basal liner level of 80mAOD. The leading edge of the 3m thick 2m high sidewall has a low level of 83.24mAOD around the riser intake.

2.1.3 The 45m(avg) x 40m(avg) basal lining to cell 2 rises at an average of 1 in 50 from a level of 81mAOD at the leachate collection point such that the leading edge of the 3m thick 2m high sidewall has a level in the range 83.12mAOD to 83.28mAOD.

2.1.4 The leachate drainage blanket in both cells extends up the full height of the 3m thick 2m high sidewall.

2.1.5 The breach between the two cells was formed in early 2008 at a location where the top of liner level on the cell 1 side of the bund was around 80.2mAOD and 81.2mAOD on the cell 2 side of the bund.

2.1.4 The base of cell 4 which was completed in November 2010 abuts and is elevated above cell 2 with a minimum level of 84.3mAOD at the junction between them. The leachate drainage blanket in cell 4 is connected to that in cell 2 via the aggregate surround to the two leachate monitoring points in cell 2. There is no dividing inter-cell bund and there is the potential for leachate to drain into cell 2 from cell 4.

Leachate Levels

2.1.5 Two monitoring points were installed on the lining of cell 1 with top of liner levels of around 80.3mAOD (LS01) and 81.3mAOD (LS02). Initial recording of leachate levels indicated small heads in LS01, typically 0.2m, indicating a leachate head of 0.6m above the lowest top of liner. There were no recorded leachate heads in LS02 due to its higher level.

2.1.6 As the waste level was raised in cell 1 during the construction of cell 2 there were increasing problems with the stability of the monitoring points due to movement causing blockages and ultimately their failure. They were subsequently replacement with retro-drilled monitoring points designated LS01A and LS02A and installed onto target pads. The top of liner levels at the location of theses points has been estimated at 80.1mAOD (LS01A) and

80.25mAOD (LS02A). Both points are closer to the lowest point of the liner and the breach in the inter-cell bund.

2.1.7 Two monitoring points were installed on the base of cell 2 and designated LS03 and LS05 with top of liner levels of 81.3mAOD and 81.8mAOD, respectively. The leachate collection point was designated LS04.

2.1.8 The recorded leachate levels in cells 1 and 2 for 2009 and 2010 are shown in Figure 1 and the base data from 2007 onwards is enclosed in Appendix 1. The following main points can be observed:

i) There was a gradual rise in the leachate level in cell 2 throughout 2009 reaching 83mAOD. During the first 9 months of 2010 leachate levels were at or below this level. During September 2010 onwards there is a significant variation in recorded leachate levels. During the construction of cell 4, and after placement of the leachate drainage blanket, there were periods of very heavy rainfall and this resulted in occasional large volumes of surface water discharging from the exposed base of cell 4 into the leachate drainage blanket of cell 2. Much of this leachate was subsequently pumped directly to a temporary storage tank for subsequent disposal off-site.

ii) The recorded leachate levels in the monitoring points LS03 and LS05 are generally in good agreement but are slightly above, around 0.2m, those recorded in the collection point LS04. In theory they should all be the same and it is considered the difference is due to recording tolerances following the raising of LS04 as the waste level was raised.

iii) The recorded levels in cell 1 in the replacement monitoring points show considerable variation during the latter part of 2010 and this is symptomatic of the variation in leachate levels in cell 2 possibly due to leachate flowing through the breach from cell 2 into cell 1.

All the leachate in cells 1 and 2 was abstracted via the pump in the cell 1 sidewall riser and some of the variations in level from mid-2010 onwards have in part been caused by ongoing operational problems with the pump resulting in frequent failure requiring pump maintenance and replacement.

2.1.9 Due to the small area covered by a 1m leachate head in cell 1 (leachate level 81mAOD) experience is showing that it is difficult to manage and collect the leachate.

2.1.10 A leachate level of 83mAOD does not go above above the top of the 2m high 3m thick sidewall and there is a small freeboard. A level of 83mAOD is equivalent to a 2m leachate head in cell 2 and a 3m leachate head in cell 1

Leachate Source Term

2.1.11 A spreadsheet summary of updated leachate quality data to the end of 2010 is enclosed in Appendix 2 and indicates that the leachate quality is similar to that used within the HRA. The data includes analyses of samples recovered from wells within the landfill and also those collected from the leachate collection tank. The ammoniacal nitrogen concentrations are slightly higher and consequently the models described later have been amended to reflect this. The maximum ammoniacal nitrogen concentration recorded was 829mg/l and the source term has been extended to 850mg/l to allow for further maturing of the leachate.

2.1.12 A full suite of hazardous contaminants has been undertaken annually on recovered leachate samples. Detailed results of analyses for 2009 and 2010 are enclosed in Appendix 2. The HRA summarised hazardous substances which had concentrations above the laboratory detection limits and this table is updated in Table 1 below to include the data from 2009 and 2010.

Table 1: Hazardous Substances - Leachate Quality Analysis*

Parameter	Units	26/7/07	21/8/08	17/6/09	5/7/10
Toluene	µg/l	5.3	577	389	108
Dichlobenil	µg/l	284		75	
Dichlorprop	µg/l	11.3		5.14	
Dichloromethane	µg/l	416			
Ethyl Benzene	µg/l	5.6		92	50
o-xylene	µg/l	9.3		53.6	52
m,p-xylene	µg/l	86.4		155	151
Mecoprop	µg/l	36.2	10.6	7.01	43.3
MTBE	µg/l	372	123	120	27.6

* Concentrations recorded above the laboratory detection limits

2.1.13 On the basis of the above it is not proposed to amend the selected priority compounds to be modelled. It is noted that currently there is no discernable concentrations of tributyltin within the leachate at Walleys, however, it is considered reasonable that it may be detected as the leachate matures.

2.1.14 The modelled source term is summarised in Table 2.

Table 2 – Modelled Source Term

Priority Compound	Units	Leachate Quality to December 2010			Modelled Values
		Min	Most likely	Max	mg/l
Ammoniacal Nitrogen	mg/l	24.6	352	850	850
Chloride	mg/l	361	1221	3650	3650
Mercury	mg/l	<0.0001	N/A	0.0001	0.0001
Nickel	mg/l	0.025	0.035	0.27	0.27
Tributyltin	mg/l	<0.0001	N/A	0.0001	0.0001
Phenol	mg/l	1.52		4.91	4.91
Xylene	mg/l	0.041		0.21	0.21
Mecoprop	mg/l	0.01		0.14	0.14

2.2 Pathways

2.2.1 The focus of this report is on the operational phase of the landfill when the groundwater level is artificially kept below the base of the landfill, the so called short term condition. For this scenario the pathway is the landfill lining.

2.2.2 The permeability data from the conformance testing of the basal lining clay to cell 2 was been collated in the HRA into a single dataset for statistical analysis. The permeability results were significantly better than the maximum specified value of 1.0 x 10^{-9} m/s. The data showed a very narrow spread of values between 7.2 x 10^{-11}m/s to 1.6 x 10^{-10}m/s. Permeability data from the placement of the lining clay to the base of cell 4 during 2010 also showed a very narrow spread over the range 9.7 x 10^{-11}m/s to 1.1 x 10^{-10}m/s for clays from the same source as cell 2.

2.2.3 The generic spreadsheet models are deterministic and therefore analyses have been carried out for the minimum, most likely and maximum permeability. The minimum value is set at the minimum permeability recorded, 7.2 x 10^{-11}m/s, with the maximum permeability set at the maximum recorded, 1.6 x 10^{-10} m/s. The most likely value is 1.0 x 10^{-10} m/s which is the maximum of the bin range with the most occurrences within it and is therefore a conservative assessment. A detailed discussion of the model scenarios is presented in Section 3.

2.3 Receptors

2.3.1 For the short term condition the receptor is the groundwater beneath the site and the point of discharge has been taken to be the base of the landfill lining.

2.3.2 The results of analyses of groundwater collected from monitoring boreholes on 5th July 2010 have been compared with the results of monitoring for the period 2001 to 2008 and this has shown there has not been any significant change in groundwater quality. A spreadsheet summary of the data is enclosed in Appendix 3 and the concentrations of the priority contaminants are summarised in Table 3.

Table 3 – Summary of Concentrations of Priority Contaminants in Groundwater

Priority Contaminant	Min	Avg	Max	Compliance Limit (Permit Trigger Concentration)
Ammoniacal Nitrogen (mg/l)	<0.3	0.8	9.3	
Chloride (mg/l)	4	37.52	170	
Nickel (mg/l)	<0.005	0.11	2.15	
Phenol (mg/l)	<0.1	<0.1	<0.1	>0.0005
Mercury (mg/l)	<0.0001	0.00025	0.0005	>0.0001
Tributyltin (mg/l)	<0.00002	<0.00002	<0.00002	>0.0005
Xylene (mg/l)	<0.0002	0.00028	0.00031	>0.003
Mecoprop (mg/l)	<0.00004	0.00063	0.0016	>0.0001

It is of interest to note the concentrations of mecoprop at times before landfill operations commenced in 2007 exceed the permit compliance (trigger) limit. Similarly, some concentrations of mercury exceeded the compliant limit but these were recorded in samples all recovered on the same day, 4th December 2001, soon after groundwater sampling commenced. On all other dates the recorded mercury concentration was <0.0001mg/l. There were also concentrations of mecoprop in excess of the current EA MRV (see Table 4).

2.3.3 The EAL's used in the HRA have been re-assessed in the light of changes to MRV's published by the EA and the fact that in respect of hazardous substances there must be no discernable discharge to groundwater. A summary of environmental standards is presented in Table 4.

Table 4 – Environmental Standards

Priority Contaminant	UK DWS	EQS	EA MRV	HRA Modelled EAL	Revised EAL
Ammoniacal Nitrogen (mg/l)	0.5			0.5	0.5
Chloride (mg/l)	250	250		250	250
Nickel (mg/l)	0.02	0.05-0.2		0.05	0.05
Phenol (mg/l)	0.5	0.03		0.03	0.03
Mercury (mg/l)	0.001	0.001	0.00001	0.0005	0.00001
Tributyltin (mg/l)		0.00002	0.000001	0.00005	0.000001
Xylene (mg/l)		0.03	0.003	0.05	0.003
Mecoprop (mg/l)	0.0001	0.02	0.00004	0.002	0.00004

The EAL's for the hazardous substances have been revised to the EA MRV. It should be noted these are predicted concentrations as the MRV's are generally above commercial laboratory reporting limits. Also, there are recorded concentrations of mecoprop in the groundwater which exceed the MRV. However, using the MRV for mecoprop allows for any future improvement in the natural background water quality.

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Numerical Modelling

3.1.1 The modelling approach has been chosen for consistency with respect to the approach adopted in the HRA. There are two modelling scenarios:

- a short term scenario where the groundwater levels are artificially depressed beneath the base of the site, and;
- a long term scenario where the groundwater levels have been allowed to rebound such that hydraulic containment conditions prevail at the site.

It is considered that the proposed change to the leachate control levels for the duration of the management period will not alter the long term scenario and therefore no further assessment of this scenario has been undertaken as part of this report.

3.1.2 The modelling approach is the same as that used in the HRA. The spreadsheet solves the Ogata-Banks 1-D equation for diffusive, dispersive and advective contaminant transport with retardation. The analysis is deterministic and separate models have been analysed for the range of parameters considered. The output from the spreadsheet gives the time required for the concentration at the receptor to reach the EAL. For the short term condition these times can then be compared with the operational period, 20 yrs, of the landfill.

3.1.3 The proposed maximum permitted leachate head in Cell 2 is 2m above the base of the cell. This equates to a leachate level of approximately 83 mAOD. Under these circumstances there is a pathway for leachate to flow into cell 1 through the inter-cell bund breach. If steady state conditions prevail, a two metre head in Cell 2 would equate to approximately a maximum 3m head in Cell 1 albeit it over a limited area due to the steep basal gradient. Therefore the models have also assessed the travel times of leachate to migrate through the lining should a 3m leachate head develop within Cell 1.

3.1.4 Advective flow down through the lining will be influenced by the hydraulic gradient. In the HRA the hydraulic gradient was calculated assuming the groundwater level was at the base of the 3m thick lining. Under the current situation with the groundwater beneath the landfill now controlled at 79.0mAOD hydraulic gradients will be reduced and this scenario has also been modelled. The calculated hydraulic gradients for the various scenarios are presented in Table 5.

Table 5 – Calculated Hydraulic Gradients

Cell	Top of Liner (mAOD)	Base of Liner (mAOD)	Leachate Head (m)	Hydraulic Gradient	
				Base of Liner	GWL
1	80	77	1	1.33	0.67
			2	1.67	1.00
			3	2.00	1.33
2	81	78	1	1.33	1.00
			2	1.67	1.33

It should be noted that analyses with the same liner thickness, permeability and hydraulic gradient will give the same results irrespective of the leachate head and the position of the groundwater table.

3.1.5 Models have also been analysed for transport through the 1m sidewall lining system. This condition will only occur if:

- Perched leachate develops adjacent to the side wall lining system.
- Leachate heads in the base of cells 1 and 2 go above the 2m high 3m thick sidewall sections of the liner.

For this scenario the same liner parameters were used as for the 3m thick basal lining. The hydraulic gradient, 2.00, was calculated on the basis of a 1m leachate head with groundwater at the back of the lining. A second scenario was also assessed using a 0.5m head.

3.1.6 Due to the deterministic nature of the analyses the source term was assumed to remain constant.

3.2 Emissions to Groundwater

3.2.1 The results of the analyses are presented in terms of the time taken for each contaminant to reach its compliance level at the base of the lining. Eight analyses were carried out for the base, referenced 1 to 8. Analyses 7 and 8 were hydraulically equivalent to analyses 2 and 1 respectively and, as expected, produced identical data. Two analyses, referenced 9 and 10, were carried for the 1m thick sidewall. A summary of the calculated times is enclosed in Appendix 4 and copies of the spreadsheet output are also enclosed in Appendix 4.

Basal Emission

3.2.2 Analysis 1 assumed a 1m leachate head with the groundwater table at the base of the liner and a liner permeability of 1×10^{-9} m/s. This is equivalent to the conditions used in the Permit Application but with the revised source terms and compliance levels.

Hazardous Substances

3.2.3 The calculated times for tributyltin were found to be never less than 1,000 yrs and the data for these are not included in the summary table in the Appendix. Where blanks for other hazardous substances appear in the table this is also because the calculated times exceeded 1,000 yrs. The calculated time for mercury was found to be less than 1,000 yrs only for analysis 1 (685.8 yrs) and this contaminant will not be considered further.

3.2.4 The times calculated for Xylene were only less than 1,000 yrs for analyses carried out using the maximum permeability (3 no.) and these were greater than 500 yrs. The time for the Permit calculation was 132.1 yrs. On this basis this contaminant will not be considered further.

3.2.5 The time for mecoprop to reach its compliance level was 46 yrs for the Permit calculation. However, when the maximum, most likely and minimum permeabilities are used from the 'as built' data the calculated times all exceed 200 yrs and in one case, analysis 3 with minimum permeability, exceeds 1,000 yrs.

Comment

Increasing the leachate head to 3m above the 3m thick basal lining does not cause a threat to the emission of the modelled hazardous substances to groundwater for the operational phase of the landfill

Non-hazardous Substances

3.2.6 The calculated times for ammoniacal nitrogen all exceeded 100 yrs. The corresponding time for the Permit calculation was 26 yrs.

3.2.7 The calculated times for chloride, the least retarded contaminant, all exceeded 20 yrs. The corresponding time for the Permit calculation was 5.2 yrs. The modelled compliance level at the base of the lining was 250 mg/l. The background groundwater has recorded concentrations at the site boundary in the range 4 mg/l to 170 mg/l. Assuming these also apply beneath the landfill there is the chance of increased chloride concentrations.

3.2.8 The calculated rate of discharge from the analyses for a 3m leachate head with maximum permeability (1.6×10^{-10} m/s) for the lining is 0.03 l/m^2/d. The area of lining covered in cells 1 and 2 will be around 4,500m^2 giving an outflow of 135 l/d, or 0.006 m^3/hr. The groundwater pump controlling the groundwater level beneath the landfill discharges groundwater at a rate of around 18m^3/hr. Hence, it is unlikely there will be any discernable increase in chloride concentration in the pumped groundwater due to outward seepage from the base of the landfill.

3.2.8 The calculated times for phenol all exceeded 50 yrs. The corresponding time for the Permit calculation was 11.9 yrs.

Comment

Increasing the leachate head to 3m above the 3m thick basal lining does not cause a threat to the emission of the modelled non-hazardous substances to groundwater for the operational phase of the landfill.

Sidewall

3.2.9 Analyses 9 and 10 were carried out to investigate the times for the compliance levels to be reached via transmission through the 1m thick sidewall lining. The analyses were carried out assuming the groundwater was at the base of the lining with leachate heads of 1m (analysis 9) and 0.5m (analysis 10).

Hazardous Substances

3.2.10 The calculated times for tributyltin were found to be never less than 1,000 yrs and the data for these are not included in summary table in the Appendix. The calculated times for mercury were found to be less than 1,000 yrs only for analysis 9 (950.7 yrs). These contaminants will not be considered further.

3.2.11 The times calculated for Xylene were 183 yrs (analysis 9) and 243.7 yrs(analysis 10) assuming the maximum liner permeability. Hence, during the operational phase of the landfill should the leachate head rise above the 2m high 3m thick sidewall section for short periods it is unlikely there would be any risk of transmission to groundwater.

3.2.12 The times calculated for mecoprop exceeded 60 yrs. Hence, during the operational phase of the landfill should the leachate head rise above the 2m high 3m thick sidewall section for short periods it is unlikely there would be any risk of transmission to groundwater.

Comment

Increasing the leachate head at the base of the landfill may for short periods result in the leachate coming into contact with the 1m thick sidewall. However, it is considered for this scenario there is no significant risk of emission of hazardous substances to groundwater during the operational phase of the landfill.

Non-hazardous Substances

3.2.13 The calculated times for nickel all exceeded 1,000 yrs and this will not be considered further. The calculated times for ammoniacal nitrogen exceeded 35 yrs, those for chloride 7 yrs and phenol 16 yrs. For a 1m head acting across the 1m thick lining the calculated discharge rate is 0.03 $l/m^2/d$ for the maximum permeability (the same as that for discharge across the 3m thick lining under a 3m leachate head). The external length of the sidewall at the top of the base in cells 1 and 2 is 150m. Assuming a leachate contact head of 2m gives a contact area of around 1,000m^2 for a 1 in 3 slope. Hence, the discharge would be 30 l/d, or 0.001 m^3/hr, and as noted above for the base this is a very small volume compared to the background pumped groundwater discharge. It is unlikely therefore that emission of these substances will cause any discernable increase in the pumped groundwater during the operational phase of the landfill.

4. REQUISITE SURVEILLANCE

4.1 Leachate

4.1.1 On the basis of the assessment in this report it is not considered there is any requirement to vary the Permit in regard to the monitoring frequency, sampling or testing of leachate.

4.1.2 On the basis of the assessment in this report it is consider new control and compliance levels should be set for the leachate level in cells 1 and 2. A leachate control level of 82.5mAOD and a compliance level of 83.0 mAOD should be applied.

4.2 Groundwater

4.2.1 On the basis of the assessment in this report it is not considered there should be any requirement to vary the Permit in regard to monitoring frequency, sampling or testing in existing sampling points.

4.2.2 As the groundwater control system is fully operational,and controlling the groundwater level beneath the landfill, it is considered the operation of the system in regard to groundwater discharge rate and groundwater quality should be added to the Permit. Current EA guidance requires groundwater pumped from beneath a landfill as part of groundwater control measures should continue to be considered as groundwater even though it is no longer in contact with the ground.

5. CONCLUSIONS

5.1 Review of Technical Precautions

Leachate Head Control

5.1.1 The above review and additional modelling has indicated that the leachate levels may be increased to 2 m above the base of cell 2 without a significant increase in the risk of emission of hazardous substances to groundwater. This increase in leachate levels would facilitate leachate management for cells 1 and 2 given the uncertainty regarding the long term sustainability of the sidewall riser to cell 1..

5.1.2 It is therefore recommended that the leachate compliance level within the Permit are increased to allow a level of 83mOAD for Cells 1 and 2 corresponding to leachate heads of 3m and 2m, respectively.

Groundwater Management System

5.1.3 The groundwater management system is now fully operational and discharges groundwater to the settlement lagoon. The system is computer controlled and there is near continuous recording of the system functions including discharge rate and ground water level beneath the base of the landfill. It is recommended that:

i) The discharge and groundwater level data should be submitted to the EA on an annual basis during the operational phase of the landfill, and;

ii) The pumped discharge of groundwater into the settlement lagoon should become a permitted groundwater sampling location.

Figures

APPENDICES

Appendix 1	**Leachate Level Data**
Appendix 2	**Summary of Leachate Quality Data**
Appendix 3	**Summary of Groundwater Quality Data**
Appendix 4	**Model Results Summary and Spreadsheet Model Output Sheets**

Appendix 1

Leachate Level Data

Please refer to CD Copy

Appendix 2

Summary of Leachate Quality Data

Please refer to CD Copy

Appendix 3

Summary of Groundwater Quality Data

Please refer to CD Copy

Appendix 4

Model Results Summary and Spreadsheet Model Output Sheets

Please refer to CD Copy