

18 September 2019

620.13429-L02-v0.1

Arcadis Australia Pacific Ltd Pty  
Level 16, 580 George St  
Sydney NSW 2000

**Attention: Sean Fishwick**

Dear Sean

## **Response to RFI Shoalhaven Landfill Stage 4 extension**

As requested, please find below SLR's response to the request for additional information issued by the NSW Environment Protection Agency and the Department of Planning and Environment in relation to the Soil, Water and Leachate Management Assessment prepared by SLR (ref. 610.15781-R04-v1.0.doc, dated 19 December 2018) for the proposed Stage 4 extension of Shoalhaven Landfill in Nowra.

### Further Information Request:

1. The Soil, Water and Leachate Management Assessment states that water balances have been completed in relation to surface water management and leachate management. While these water balances have been summarised in the document, neither water balance has been provided in its entirety. As such, the EPA cannot verify the adequacy of the proposed stormwater dams, the existing leachate dam or the proposed leachate irrigation area. It is recommended that the applicant provide a full copy of both water balances, including all calculations and assumptions used, as well as appropriate justifications for the sizing of the proposed management structures. Reference should be made to Sections 2 and 3 of the EPA's Environmental Guidelines: Solid Waste Landfills 2016.

### *SLR Response:*

A full copy of both water balances, including all calculations and assumptions used is provided in **Attachment A**.

### Further Information Request:

2. Further, a review of historical leachate quality data suggests that leachate in the existing leachate dam is potentially diluted with either stormwater or groundwater. This is based on the relatively low concentrations of analytes typically associated with landfill leachate. The proponent should consider this and provide an explanation of any dilution effects and of any associated implications for the water balances.

SLR Response:

### Review of Leachate Quality Data

The original leachate data submitted, dated 2015 – 2016 is summarised below and is a summary of the leachate quality encountered in the leachate dam and pump house. It is noted that some of the potential indicators of leachate i.e. TOC, TSS, ammonia and nitrate, are relatively low when compared to levels generally encountered in landfill leachate.

**Table 1 2015-2016 leachate data**

Analyte	Range Encountered	Trigger Value
Salinity	1740-1840mg/L	1500mg/L
pH	7.2-8.0	6.5-8.0
TSS	<LOR – 5mg/L	50mg/L
Phosphorus	0.4-0.42mg/L	0.05mg/L
Phosphate	0.15-0.16mg/L	0.02mg/L
Ammonia	42.1-43.1mg/L	2.57mg/L
Nitrate	0.04-0.05mg/L	0.7mg/L
TOC	43-43.7mg/L	-
TPH C10-C36	0.24-0.27mg/L	0.6mg/L
Aluminium	0.21mg/L	0.055mg/L

Source: Annual Environmental Monitoring Results October 2014 – October 2015, West Nowra Recycling and Waste Facility (ENRS, 2015).

Bold indicates range encountered is greater than the Trigger Value

Trigger Values – Australian and New Zealand Guidelines for Fresh and Marine Water, 95% Level of Species Protection in Fresh Waters (ANZECC, 2014)

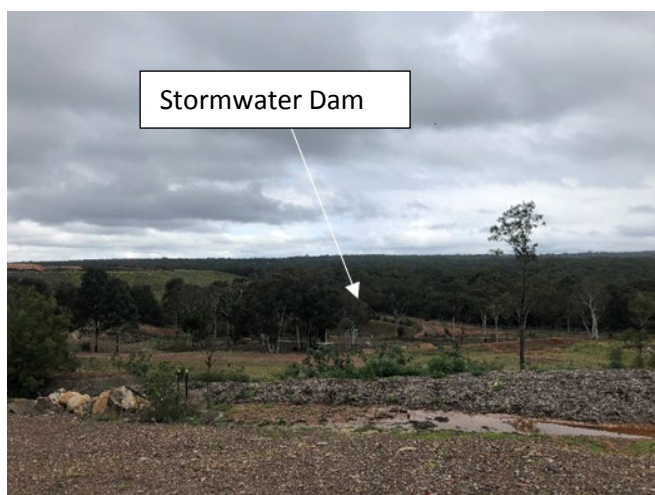
SLR undertook a comparison of leachate data collected from the leachate pit/pump station (Leach PH) located in Stage 3 with the leachate data collected from the downgradient leachate dam (LD1) to determine whether there is any evidence of dilution occurring in the leachate dam. The data reviewed by SLR was sourced from the West Nowra Recycling and Waste Facility – Annual Environmental Monitoring Report 2017-2018 prepared by Environmental and Natural Resource Solutions (ENRS). A summary of the data (2015 – 2018) collected from the two leachate locations is provided in Attachment B. The data indicates that concentrations of analytes that are considered general indicators of leachate are higher in the downgradient leachate dam than that encountered in the leachate pit/pump house during both the 2017 and 2018 monitoring events indicating dilution is not occurring in the leachate dam. During the 2016 monitoring event however the opposite is evident and the levels in the leachate dam were lower than the upgradient pit indicating potential dilution of the dam. A review of Bureau of Meteorology (BOM) recorded data identifies an above average rainfall was received in the Nowra region in 2015 (2016 sampling was conducted in February) (Source: [http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p\\_nccObsCode=139&p\\_display\\_type=dataFile&p\\_startYear=&p\\_c=&p\\_stn\\_num=068072](http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=068072)). This may have contributed to a greater quantity of direct rainfall entering the leachate dam and potentially leading to the apparent dilution captured during the 2016 monitoring event.

The concentration levels of the potential leachate indicators are still relatively low in the 2017 – 2018 monitoring events however the data does not suggest this is due to dilution occurring within the leachate dam, as the leachate closer to the source had significantly lower concentrations.

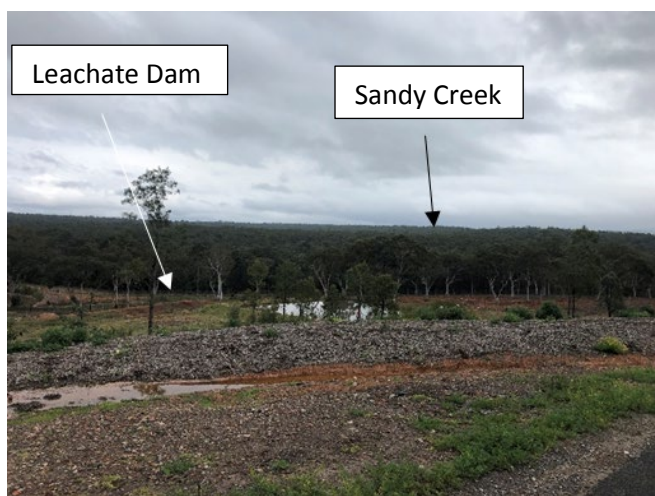
## Site Inspection

A site inspection was conducted by SLR on the leachate dam at the West Nowra Recycling and Waste Facility on Thursday 19th September 2019. The visit was conducted in the presence of Peter Windley, the Waste Depot Supervisor. The purpose of the site inspection was to identify any potential pathways for stormwater run-off to enter the leachate dam. Rainfall events occurred during the week of the 16th September 2019, with a cumulative rainfall of 80mm at the site on Wednesday 18th September. Some scattered rain occurred on the day of the site inspection. No inspection was conducted on the Leachate Pit and pump station in Stage 3.

The leachate dam is located on Stage 2 of the facility, situated west to the irrigation area and around 250m east to Sandy Creek. The leachate is currently pumped from the active landfill area – Stage 3 (250m to 400m south of the leachate dam) using three pumps. Leachate collected from Stage 2 is driven into the leachate dam using gravity mains (**Figure 1** and **Figure 2**). A first flush dam and a stormwater dam are located to the south-east and north of the leachate dam respectively. These dams collect the stormwater runoff generated up gradient of the leachate dam.



**Figure 1** Stormwater Reservoir (View from Stage 1) – West Direction



**Figure 2** Leachate Dam (View from Stage 1) - west direction

There is a high earth embankment around the entire leachate dam which isolates all sources of stormwater run-off from entering the dam (**Figure 3**). Stormwater is also diverted around the leachate dam via open grass channels and culverts pipes (**Figure 4** and **Figure 5**). This stormwater system is covered with vegetation (low grasses, shrubs) with scattered high trees (eucalyptus) which assist in reducing peak flows and sediment discharge. No stormwater pathways that have the potential to convey stormwater run-off into the leachate dam were identified during the inspection.



**Figure 3** Leachate Dam showing earth embankment – west direction



**Figure 4** Stormwater diversion drain along the eastern side of leachate dam (south west direction)



**Figure 5 Stormwater diversion drain along north eastern side of leachate dam (north west direction) – stormwater evident in drain due to wet weather condition**

A discharge point was observed at the low point of the leachate dam (northern end). Anecdotal evidence provided by Peter Windley indicated the leachate dam has overflowed once in the last five years. On-site operational structures (no flow barriers) have been installed to reduce the discharge of the leachate. The barriers shown in **Figure 6** reduce and slow down any potential leachate that may overflow, while an embankment at the end of the discharge point stops the leachate and isolate it from the stormwater system (**Figure 7**).



**Figure 6 Leachate Dam (low end point) with the discharge point and associated operational structures to stop overflow (west direction)**



**Figure 7** Embankment to stop leachate overflow

The irrigation area and unlined landfill areas (Stage 1 - complete) are both up gradient of the leachate dam (**Figure 8**). Stormwater run-off flows west and down gradient in direction of the leachate dam. A concrete slope conveys the stormwater run-off from the higher grounds to a stormwater pipe toward the low gradient slope between the leachate dam and the stormwater dam (**Figure 9**). The velocity of the run-off is reduced with in-built block of rocks along the concrete slope, to reduce erosion and sediment discharge (**Figure 10**). At all times the stormwater run-off is isolated from the leachate dam catchment using embankments, overland relief, stormwater pipes and open channels (**Figure 11**).



**Figure 8** Irrigation Area Stage 1- Higher Grounds – south west direction



**Figure 9 Stormwater System collecting run-off from the higher ground of Stage 1 and diverting past the leachate dam embankment – east direction**



**Figure 10 Slope Channel with in-built rocks to reduce speed of run off from Stage 1 – north east direction**

The stormwater run-off is discharged from site downgradient of the leachate dam in the direction of Sandy creek. The discharge point area is a low gradient slope covered with grass, trees and wood chips. This natural surface environment seeks to maximise vegetation filtering and infiltration of water into the ground, improving the final discharge quality.



**Figure 11 Stormwater discharge area - diversion of stormwater near the stormwater dam – north west direction**



**Figure 12 Stormwater pathways flowing from Stage 1 toward Sandy Creek (in between the stormwater dam and leachate dam)**

In conclusion the site inspection indicated there is an efficient and safe drainage system that collects, conveys and discharges stormwater away from the leachate dam catchment. The drainage system components include open grass channels, overload reliefs, culverts and stormwater pipes to divert stormwater downgradient to the leachate dam. Two reservoirs collect rainfall and stormwater run-off (first flush dam) which help to reduce run-off peak flow. Vegetation takes an integral part of the drainage system to prevent on-site erosion but also to maximize the infiltration of water into the ground reducing direct recharge to Sandy Creek.

In case of high rainfall events, on site structures are installed to reduce and potentially stop the progression of leachate that may overflow like earth embankments and no flow barriers.

Wet conditions during the inspection helped to identify that no major ponding areas formed into the stormwater drainage after consecutive days of rain. The stormwater is flowing well with no structures blocking the water flow. The stormwater drainage system appears to be well maintained and is checked daily by operators.

No pathways were identified that could conduct stormwater run-off directly into the leachate dam.

### **Assessment of Groundwater In-Flow Potential**

A geotechnical investigation of the existing leachate dam clay base liner conducted by GHD in 2018 determined the clay base liner of the leachate dam was suitable to act as a liner. As can be seen in the below extract from the GHD report, it was determined the existing liner was suitable to contain leachate. It could therefore be inferred the liner would also be suitable to prevent in-flow.

*“The Work as Executed (WAE) drawings show a Geosynthetic Clay Liner (GCL) was placed over the floor and walls of the leachate dam and that a select material was placed over the GCL to a thickness of at least 300mm. Testing of the select material for permeability indicates that the material has a high clay content with a hydraulic conductivity ( $k$ ) of at least  $4 \times 10^{-10}$  m/sec. When combined with a GCL having a typical  $k$  of  $1.9 \times 10^{-11}$  m/sec, we are satisfied that the permeability of the clay liner and GCL provides a barrier at least equivalent to a 1,000 mm thick compacted clay liner with  $k$  of less than  $1 \times 10^{-9}$  m/sec. In relation to our site observations of the general integrity of the leachate dam, the dam walls and floor exhibit no evidence of erosion or deformation that would influence the performance of the dam to contain leachate. We note also, as a further indicator of the integrity of the leachate dam liner, that testing of groundwater samples taken from monitoring points downstream of the leachate dam have not revealed any evidence of leakage of leachate from the dam” (GHD, 2018).*

It should be noted the exact depth of groundwater below the leachate pond is unknown but given the depth to water table collected from the downgradient groundwater wells it is estimated to be approximately 29.4 – 30.5mAHD (source: 2017-2018 ENRS data). Topographical data sourced from Geoscience Australia ELVIS LiDAR (Elevation Information System) indicates the depth of the leachate pond (which is known to be approximately 3.8m deep) is encountered at approximately 29.5mAHD. Given the proximity of the groundwater to the base of the leachate pond there is the possibility that hydraulic pressures could result in buckling/cracking of the clay liner, however site observations by GHD during periods when the pond levels were low did not identify any evidence of liner impact and the groundwater quality monitored downgradient does not show any evidence of leachate leakage, indicating the liner is intact.

In relation to whether there is evidence of groundwater inflow in quantities significant enough to impact water balance calculations, significant groundwater inflow would be expected to be evident in a stable leachate pond water table level (no fluctuations of height due to constant groundwater inflow). The water table level in the leachate pond has not been monitored, however photographic evidence (**Figure 13**) observed during the GHD leachate dam liner investigation and the SLR site inspection, indicates the leachate pond water table levels appear to be fluctuating and not stabilised by groundwater inflow.



**Figure 13 Water table levels in Leachate Dam**

Yours sincerely



SARAH KILL  
Principal Consultant

Checked/  
Authorised by: JP

# Attachment A

# Type F/D Sediment Dam Design - 90% rainfall

Settlement Zone Management Period  
 Sediment Zone Management Period  
 Disturbance Period

5 days
12 months
>3 years

<b>Dam 1</b>	
Design Storm (90%ile, 5 day)	
CALCULATIONS BASED ON PAGE J-4 OF BLUE BOOK APP J	
Basin Volume = Settling Zone Volume + Sediment Zone Volume	
<b>SETTLING ZONE VOLUME</b>	
Disturbed Runoff Coefficient (Cv) =	0.79 Table F2 of Blue Book, assuming type D hydrologic group, and rainfall 61-80mm
Clean Water Catch Runoff Coefficient (CCv) =	0.3 Best estimate of undisturbed area
Disturbed Area (A) (ha) =	2.993 Disturbed Area
Clean Water Area (CA) (ha) =	0 Clean Catchment
Rainfall (y%ile,Xday) (R) (mm) =	67 Table 6.3a of Blue Book (Kangaroo Valley, 5 day, 90%ile)
Settling Zone Volume (m <sup>3</sup> ) = 10 x (Cv x A x R + CCv x CA x R)	
Settling Zone Volume (m <sup>3</sup> ) =	<b>1,584</b>
<b>SEDIMENT ZONE VOLUME (12 month soil loss as calculated by RUSLE)</b>	
Area (A) (ha) =	2.993 Disturbed Area
Erosion control practice factor (P) =	1 Table A-2 of Blue Book, Assuming the area is generally rough and uneven
Rainfall erosivity factor (R) =	4500 App B Blue Book.
Soil erodibility factor (K) =	0.05 blue book default value Table A1 Blue Book. Weighted average of LS factors (6.551ha, 1%, 150m and 3.154ha, 30%,
Slope length/gradient factor (LS) =	1.88 30m)
Ground cover and management factor (C) =	1 Figure A-5 Blue Book, mostly disturbed, very limited grass cover.
Sediment Zone Volume (m <sup>3</sup> ) = A x (R x K x LS x P x C)/1.3	
Sediment Zone Volume (m <sup>3</sup> ) =	<b>974</b>
<b>50% of Settling Zone</b>	<b>792</b>
<b>BASIN VOLUME (Total Required Capacity) - Based on RUSLE</b>	
Total Required Capacity (m <sup>3</sup> ) = Settling Zone Volume + Sediment Zone Volume	
Total Required Capacity (m <sup>3</sup> ) =	<b>2,376</b>

## Type F/D Sediment Dam Design - 90% rainfall

Settlement Zone Management Period  
 Sediment Zone Management Period  
 Disturbance Period

5 days
12 months
>3 years

<b>Dam 2</b>	
Design Storm (90%ile, 5 day)	
CALCULATIONS BASED ON PAGE J-4 OF BLUE BOOK APP J	
Basin Volume = Settling Zone Volume + Sediment Zone Volume	
<b>SETTLING ZONE VOLUME</b>	
Disturbed Runoff Coefficient (Cv) =	0.79 Table F2 of Blue Book, assuming type D hydrologic group, and rainfall 61-80mm
Clean Water Catch Runoff Coefficient (CCv) =	0.3 Best estimate of undisturbed area
Disturbed Area (A) (ha) =	6.543 Disturbed Area
Clean Water Area (CA) (ha) =	0 Clean Catchment
Rainfall (y%ile,Xday) (R) (mm) =	67 Table 6.3a of Blue Book (Kangaroo Valley, 5 day, 90%ile)
Settling Zone Volume (m <sup>3</sup> ) = $10 \times (Cv \times A \times R + CCv \times CA \times R)$	
Settling Zone Volume (m <sup>3</sup> ) =	<b>3,463</b>
<b>SEDIMENT ZONE VOLUME (12 month soil loss as calculated by RUSLE)</b>	
Area (A) (ha) =	6.543 Disturbed Area
Erosion control practice factor (P) =	1 Table A-2 of Blue Book, Assuming the area is generally rough and uneven
Rainfall erosivity factor (R) =	4500 App B Blue Book.
Soil erodibility factor (K) =	0.05 blue book default value Table A1 Blue Book: Weighted average of LS factors (6.551ha, 1%, 150m and 3.154ha, 30%,
Slope length/gradient factor (LS) =	1.88 30m)
Ground cover and management factor (C) =	1 Figure A-5 Blue Book, mostly disturbed, very limited grass cover.
Sediment Zone Volume (m <sup>3</sup> ) = $A \times (R \times K \times LS \times P \times C) / 1.3$	
Sediment Zone Volume (m <sup>3</sup> ) =	<b>2,129</b>
<b>50% of Settling Zone</b>	<b>1,732</b>
<b>BASIN VOLUME (Total Required Capacity) - Based on RUSLE</b>	
Total Required Capacity (m <sup>3</sup> ) = Settling Zone Volume + Sediment Zone Volume	
Total Required Capacity (m <sup>3</sup> ) =	<b>5,195</b>



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## 2 Leachate Generation

### 2.1 Existing Site Data

Council provided leachate generation data from Landfill Stages 1 - 3 (2013 - 2014) for potential use within the Site leachate generation water balance. Council also notes that no data was available for landfill Stages 1 and 2 (old unlicensed areas, and prior to any record keeping). Several months within the historical data set were noted to be missing with other years not available.

It is considered that due to the historical and incomplete nature of the site leachate generation data, estimates of leachate produced by Stages 1 – 3 should instead be determined by the use of the Hydrologic Evaluation of Landfill Performance (HELP) computer program.

### 2.2 HELP Input Parameters

HELP input parameters developed for the Site leachate generation assessment is included within **Appendix A**.

### 2.3 Stage 1 - 3 Leachate Generation Summary

For the purposes of leachate generation modelling the HELP model conservatively incorporates 90<sup>th</sup> percentile annual rainfall volumes from historically wetter years. The monthly infiltration percentage rates are in accordance with associated capping arrangements (detailed within **Table 11**) and the monthly rainfall.

Where areas have been temporarily capped, an infiltration rate of 25 – 30% is typically attained and infiltration rates in restored (final capping areas) are typically in the range of 2 – 10% (Environmental Protection Agency, 2000).

Estimated leachate generation produced by Stages 1 – 3 is detailed Table 2.

**Table 2 Leachate Generation Summary – Stages 1 - 3**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Total (m <sup>3</sup> )
	Monthly Precipitation (mm)	63.5	81.5	83.4	96.0	87.3	70.5	98.5	121.5	138.3	108.0	106.8	115.6	1170.9
<b>Stage 1 Closure Area</b>	Leakage (mm)	3.24	3.2	3.1	3.24	3.12	3.19	3.21	2.9	3.26	3.15	3.28	3.19	
	Monthly Infiltration Percentage (%)	4.8%	3.0%	3.2%	2.8%	2.6%	3.6%	2.3%	1.6%	1.7%	2.0%	2.4%	1.8%	
	Leachate Production (m <sup>3</sup> )	92.34	91.2	88.35	92.34	88.92	90.915	91.485	82.65	92.91	89.775	93.48	90.915	1,085.28
<b>Stage 2 Closure Area</b>	Leakage (mm)	1.3	0.93	1.66	1.36	0.9	0.46	0.73	0.73	1.08	1.17	1.78	1.36	
	Monthly Infiltration Percentage (%)	2.0%	1.1%	2.0%	1.4%	1.0%	0.7%	0.7%	0.6%	0.8%	1.1%	1.7%	1.2%	
	Leachate Production (m <sup>3</sup> )	115.7	82.77	147.74	121.04	80.1	40.94	64.97	64.97	96.12	104.13	158.42	121.04	1,197.9
<b>Stage 3 Closure Area</b>	Leakage (mm)	1.03	1.04	1.52	1.43	1.02	0.66	0.8	0.69	0.86	1.01	1.37	1.23	
	Monthly Infiltration Percentage (%)	1.6%	1.3%	1.8%	1.5%	1.2%	0.9%	0.8%	0.6%	0.6%	0.9%	1.3%	1.1%	
	Leachate Production (m <sup>3</sup> )	91.67	92.56	135.28	127.27	90.78	58.74	71.2	61.41	76.54	89.89	121.93	109.47	1,126.7
<b>Stage 3 Operational Area</b>	Leakage (mm)	26.5	23.1	20.2	23.1	25.7	27.9	27.2	25.6	28.5	26	26.6	27.1	
	Monthly Infiltration Percentage (%)	41.73%	28.34%	24.22%	24.06%	29.44%	39.57%	27.61%	21.07%	20.61%	24.07%	24.91%	23.44%	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Total (m <sup>3</sup> )
Leachate Production (m <sup>3</sup> )	212	184.8	161.6	184.8	205.6	223.2	217.6	204.8	228	208	212.8	216.8	2460
<b>Estimated Monthly Stage 1 -3 leachate production (m<sup>3</sup>)</b>	511.7	451.3	533.0	525.5	465.4	413.8	445.3	413.8	493.6	491.8	586.6	538.2	5869.96

## 2.4 Stage 4 Leachate Generation Summary

The monthly infiltration percentage rates vary in accordance with associated capping arrangements (detailed within [Table 11](#)) and the associated monthly rainfall. Estimated leachate generation produced by Stage 4 is detailed in Table 3.

**Table 3 Leachate Generation Summary – Stage 4**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Total (m <sup>3</sup> )	
Precipitation (mm)	63.5	81.5	83.4	96.0	87.3	70.5	98.5	121.5	138.3	108.0	106.8	115.6		
<b>Closure 8.9 Ha</b>	Leakage (mm)	4.75	4.73	4.57	4.72	4.54	4.65	4.63	4.23	4.68	4.55	4.75	4.6	
	Monthly Infiltration Percentage (%)	7.5%	5.8%	5.5%	4.9%	5.2%	6.6%	4.7%	3.5%	3.4%	4.2%	4.4%	4.0%	
	Leachate Production (m <sup>3</sup> )	422.75	420.97	406.73	420.08	404.06	413.85	412.07	376.47	416.52	404.95	422.75	409.4	4930.6
<b>Operational 0.8 Ha</b>	Leakage (mm)	26.5	23.1	20.2	23.1	25.7	27.9	27.2	25.6	28.5	26	26.6	27.1	
	Monthly Infiltration Percentage (%)	41.73%	28.34%	24.22%	24.06%	29.44%	39.57%	27.61%	21.07%	20.61%	24.07%	24.91%	23.44%	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Total (m <sup>3</sup> )
Leachate Production (m <sup>3</sup> )	212	184.8	161.6	184.8	205.6	223.2	217.6	204.8	228	208	212.8	216.8	2460
<b>Stage 4 monthly leachate production (m<sup>3</sup>)</b>	634.75	605.77	568.33	604.88	609.66	637.05	629.67	581.27	644.52	612.95	635.55	626.2	7390.6

### 3 Leachate Management Options

A summary of feasible leachate management options including typical advantages and disadvantages are listed within Table 4.

It should be noted that re-circulation is not considered a feasible leachate reduction option within this assessment, as once the absorptive capacity within the waste mass is reached, no source reduction of leachate is achieved.

**Table 4 Leachate Management Option Summary**

Option	Option Description	Advantages	Disadvantages
1	Leachate Storage Pond	<p><b>Simple</b> – A storage pond provides a relatively simple and effective method of managing leachate</p> <p><b>Storage</b> - A leachate storage pond can be utilised in conjunction with other alternate leachate treatment methods such as physico-chemical treatment or thermal treatment.</p>	<p><b>Cost</b> - Ponds are required to be lined to the equivalent performance standard as the landfill and are subject to the same landfill construction approvals and auditing requirements.</p> <p><b>Odour</b> - If leachate ponds become anaerobic, or where odour is particularly critical due to surrounding sensitive land uses, leachate odours can become an issue. Where odour is an actual or potential issue, then the leachate pond may need to be covered or mechanically aerated. Other associated leachate measures such as irrigation will provide some source reduction, lowering the amount of leachate stored in the leachate storage pond, but should not be relied upon to reduce odour issues.</p> <p><b>Pond size</b> – Large storage pond is necessary to ensure sufficient sizing in accordance with best practice NSW EPA requirements.</p>
2	Reverse Osmosis (RO) Plant – leachate treatment	<p><b>Leachate reduction</b> – Can achieve moderate reduction in leachate for the site estimated at ~60%, dependant on leachate quality.</p>	<p><b>Cost</b> – High capital expenditure and potentially requiring a separate approval from EPA.</p> <p><b>Power</b> –High power consumption for operation</p> <p><b>Maintenance</b> –Involves regular on-going maintenance</p> <p><b>Leachate concentrate</b> – Moderate levels of by-product volumes of leachate concentrate produced (~40%)</p> <p><b>Not a standalone system</b> - Must be utilised in conjunction with other leachate management measures, such as leachate pond storage</p>
3	Direct Evaporation Treatment System - Leachate is evaporated by the combustion of landfill gas.	<p><b>Leachate reduction</b> - High reduction in leachate feed volume ~90%. Leachate treatment rate of 35m<sup>3</sup>/day.</p>	<p><b>Maintenance</b> – Maintenance required, albeit minimal.</p> <p><b>Not a standalone system</b> - Must be utilised in conjunction with other leachate management measures, such as leachate pond storage.</p>

Option	Option Description	Advantages	Disadvantages
	Leachate combustion machines can either be portable or placed in fixed locations for long-term service. The system can be operated on a variety of fuels – natural gas, methane, propane, fuel oil or waste oil.	<p><b>Leachate concentrate</b> – Low by-product levels of leachate concentrate produced (~10%)</p> <p><b>Operational Area</b> – Minimal space requirements in comparison to other infrastructure, i.e. in comparison to an additional leachate storage pond</p>	<p><b>Landfill gas use</b> –Consumption of landfill gas (180 m<sup>3</sup>/hr of LFG consumption for 35m<sup>3</sup>/day of leachate reduction)</p> <p><b>Leachate concentrate</b> – Further management measures may be required to deal with the high strength leachate concentrate.</p> <p><b>Moderate Cost</b> – Moderate capital expenditure (~ \$0.5M). Cost effective in comparison to an RO plant</p>
4	Surface irrigation of leachate over suitable areas at the landfill	<p><b>Cost effective</b> – Low construction and installation cost in comparison to other treatment systems.</p> <p><b>Leachate reduction</b> - Moderate levels of leachate reduction.</p> <p>Source reduction – Surface irrigation increases the level of evapotranspiration.</p>	<p><b>Moderate application rate</b>- The irrigation application rate must not exceed the capacity of the land to absorb the nutrient, salt, organic and hydraulic loadings supplied by the leachate. It must not compromise any future use of the land or productivity of the soil. The application rate must minimise runoff. It should not cause spray drift of leachate.</p> <p><b>Must be utilised in conjunction with other measures</b> - Occupiers must have contingency measures in place, should irrigation become unviable for any reason. This must include one or more of the other options discussed in this section, such as a leachate dam.</p> <p><b>Effectiveness</b> - Spray irrigation over the active landfill surface may not be as effective in distributing the leachate throughout the waste mass in comparison to re-injection. It may also pose risks of increased odour impacts, surface runoff, and spray drift.</p>
5	Solar system in conjunction with an RO Treatment Plant	<p><b>Leachate reduction</b> – High levels of leachate reduction achievable, leachate treatment rate of up to 100m<sup>3</sup>/day.</p>	<p><b>Cost</b> – High capital expenditure for Reverse Osmosis Plant and potentially requiring a separate approval from EPA.</p> <p><b>Power</b> –Moderate to high power consumption for operation</p> <p><b>Maintenance</b> –Involves regular on-going maintenance of filtration units</p> <p><b>Leachate concentrate</b> – Moderate levels of by-product volumes of leachate concentrate produced (~20-40%)</p> <p><b>Not a standalone system</b> - Must be utilised in conjunction with other leachate management measures, such as leachate pond storage</p>

Option	Option Description	Advantages	Disadvantages
6	Leachate Storage Tank	<p><b>Simple</b> – A storage tank provides a relatively simple and effective method of managing leachate</p> <p><b>Storage</b> - A leachate storage pond can be utilised in conjunction with other alternate leachate treatment methods such as physico-chemical treatment or thermal treatment.</p>	<p><b>Cost</b> – High capital expenditure required for the installation of suitably sized storage tanks.</p> <p><b>Bundling</b> - Tanks and associated connection points must be surrounded by a bund with a capacity of at least 110% of the tanks.</p> <p><b>No Evaporation</b> – If the storage tank is enclosed, no evaporation (source reduction) will occur.</p>
7	Discharge to public sewer	<p><b>Low impact</b> – Sewer discharge typically has a low environmental impact for the landfill operation and does not have the same odour issues typically associated with leachate pond storage or irrigation.</p>	<p><b>Approval</b> - requires the approval of the local sewerage authority and a Trade Waste Agreement, which may impose restrictions on the quality of leachate permitted to be discharged</p> <p><b>Location</b> – Assessment of feasibility required</p> <p><b>Cost</b> – Connection costs and sewer discharge rates may make sewer discharge unfeasible.</p> <p><b>Treatment</b> - Sewer discharge and treatment at the wastewater treatment plant can encounter issues if the leachate contains high levels of contaminants.</p>

### 3.1 Leachate Management Recommendations

The performance rating for each criterion is determined as detailed within [Table 5](#). Each leachate management option is rated using an Ordinal scale: 5 (*Excellent*) to 0 (*Very Poor*). Each criterion is weighted evenly in this brief analysis.

**Table 5 Leachate Management Multi-Criteria Analysis**

Option	Option Description	Criteria				Total Score
		Leachate Reduction	Capital Expenditure	On-going Maintenance	Energy Consumption	
1	Leachate Storage Pond	2	25	4	4	12
2	Reverse Osmosis (RO) Plant – leachate treatment	3	1	2	1	7
3	Direct Evaporation Treatment System - Leachate is evaporated by the combustion of landfill gas	4	2	4	3	13
4	Surface irrigation of treated leachate on suitable areas of the landfill subject to salinity management	3	4	4	4	15

Option		Criteria				Total Score
		Leachate Reduction	Capital Expenditure	On-going Maintenance	Energy Consumption	
5	Solar system in conjunction with an RO Treatment Plant	5	21	2	2	110
6	Leachate Storage tank	1	2	4	5	12
7	Discharge to public sewer	4	1	4	3	12

Based upon **Table 5**, it is recommended that the following leachate management measures are given further consideration in conjunction with Option 1 within a Site Water Balance:

- Option 4 - Construction of an Irrigation System (Constructed on-top of Cell 2)
- Option 3 - Direct Evaporation Treatment System - Evaporation by the combustion of landfill gas

## 4 Water Balance

A water balance is developed for the analysis of alternate leachate management scenarios at the Site. In accordance with NSW EPA Environmental Guidelines: Solid Waste Landfills, the water balance was conducted over a period of two consecutive wet years (90<sup>th</sup> percentile) to ensure that the proposed system has sufficient capacity to deal with all leachate generated during both the operational and closure periods of the landfill.

The site water balance considers the following scenarios, as described in Table 6.

**Table 6: Scenario Summary**

Scenario	Scenario Detail
1	Utilisation of the existing leachate storage pond (Option 1) and the construction of an irrigation system on the crest of Stage 2 (Option 4).
2	Utilisation of the existing leachate storage pond (Option 1) and the use of a direct evaporation treatment system (Option 3).

### 4.1 Design Parameters

The design parameters appropriate for this water balance assessment as defined within Section 2.3 of the NSW EPA Environmental Guidelines: Solid Waste Landfills, are summarised within **Table 7**.

**Table 7 Water balance design parameters**

Item	Requirement
General	Collected leachate must be stored in appropriately sized dams or tanks and disposed of so as not to cause environmental harm. There must be sufficient leachate disposal capacity to prevent the build-up of leachate and an increase in the risks of water pollution and offensive odours.
Water balance requirement	The model should account for all predicted leachate inputs and outputs from the leachate management system. The model should be run by using monthly time intervals, and it should estimate the changes in the cumulative volume with each month. The maximum cumulative volume may not be reached until many months into the landfill's operation.
Water balance duration	In deciding on any of the above management options, a water balance should be modelled over <u>at least two consecutive wet years</u> (90 <sup>th</sup> percentile) to ensure that the proposed system has sufficient capacity to deal with all leachate generated over the operational life of the landfill.
Pan Coefficient	The evaporation from the leachate dam should be estimated by using a pan coefficient of 70%.
Storage	The dam must have a freeboard that can accept rainfall directly on the dam from a 24hour rainfall event with a 1-in-25-year average recurrence interval without overflowing.

## 4.2 Water Balance Scenarios

### 4.2.1 Scenario 1: Option 1 (Existing Leachate Storage Pond) and Option 4 (Proposed Irrigation Area over Stage 2)

An existing water balance is developed for Stages 1 – 4 to determine the sufficiency of the existing leachate storage pond and the construction of an irrigation system on the crown of Stage 2 to accommodate two consecutive wet years (90<sup>th</sup> percentile rainfall) and predicted leachate generation from Stages 1 - 4.

Parameters for the Scenario 1 water balance are provided within [Table 8](#).

**Table 8 Scenario 1 Water Balance Parameters**

Scenario	Purpose	Assumptions
1	Determine the sufficiency of the existing leachate management system to accommodate two consecutive wet years (90 <sup>th</sup> percentile rainfall) and predicted leachate generation from Stages 1 – 4.	<ol style="list-style-type: none"> <li>Leachate management by the use of the existing leachate storage pond and a revised irrigation system constructed on Stage 2 (ie Option 1 and Option 4).</li> <li>Irrigation system is able to dispose of 730mm/m<sup>2</sup> over the irrigation area per year at a rate of (851 m<sup>3</sup>/month).</li> <li>The clay cap where the irrigation system is proposed for Cell 2 requires removal and is to be re-instated with 1400mm depth of silty sand and 200mm of topsoil to allow for infiltration.</li> </ol>

Input parameters for Scenario 1 are provided within [Table 9](#).

**Table 9 Water Balance Inputs**

Inputs												
	January	February	March	April	May	June	July	August	September	October	November	December
<b>Average Rainfall</b>	396	719	339	343	178	427	322	265	249	376	316	403
<b>90th Percentile Rainfall</b>	427	547	560	645	586	474	662	816	929	726	717	777
<b>Leachate from cell (m<sup>3</sup>)</b>	1151	1064	1109	1139	1082	1056	1080	999	1142	1110	1228	1171
Outputs												
<b>Dam Evap (m<sup>3</sup>)</b>	908	724	642	483	376	316	358	488	604	749	800	953
<b>Irrigation Use (m<sup>3</sup>/month)</b>	852	852	852	852	852	852	852	852	852	852	852	852

### 4.2.1.1 Preliminary Irrigation Area Sizing

The irrigation area was iteratively sized in accordance with the findings of the SEEP/W model. The irrigation modelling determined 730mm of leachate per m<sup>2</sup> can be applied over the irrigation area. The irrigation system to be constructed Stage 2 is required to be at least 14,000 m<sup>2</sup> in size. The findings of the preliminary irrigation modelling and conceptual sizing of the disposal area are included in **Appendix B**. The water balance (average and 90<sup>th</sup> percentile rainfall events) for Scenario 1 is depicted within **Figure 1**.

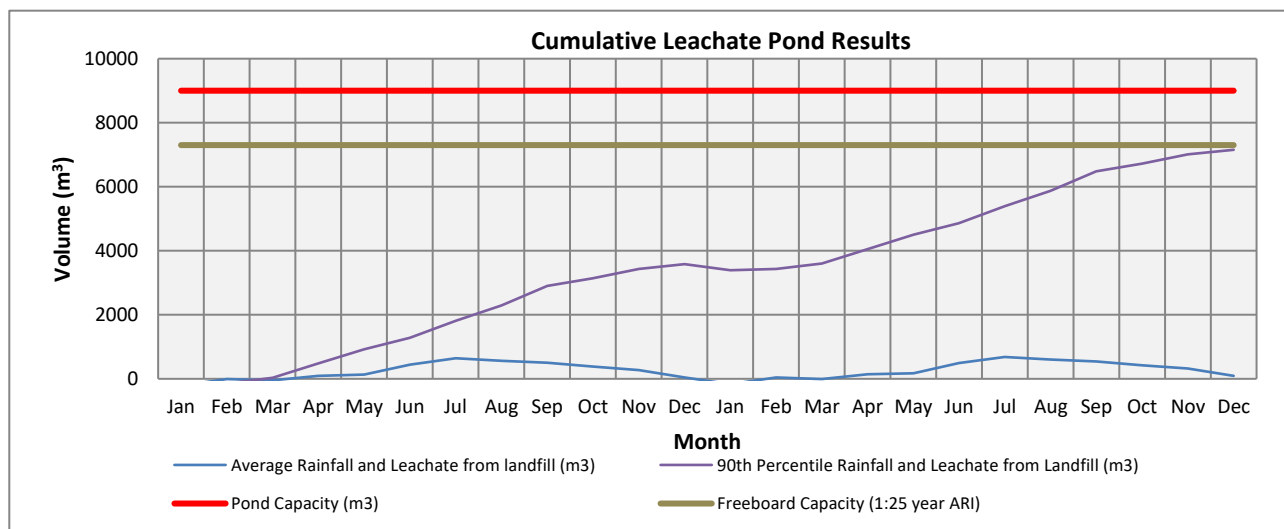


Figure 1 Scenario 1 Results

As shown in **Figure 1**, the water balance for Scenario 1 confirms sufficient capacity of the current leachate storage pond to accommodate two consecutive 90<sup>th</sup> percentile rainfall years and leachate generated by Stages 1-4 if a new irrigation area of 14,000m<sup>2</sup> is constructed

### 4.2.2 Scenario 2 Option 1 (Existing Leachate Storage Pond) and Option 3 (Direct Evaporation Treatment System)

As included within **Table 6**, a water balance is developed for Stages 1 - 4 including the use of the existing leachate storage pond and a direct evaporation treatment system. Parameters and assumptions used for the Scenario 2 water balance is provided within **Table 10**.

Table 10 Scenario 2 Water Balance Parameters

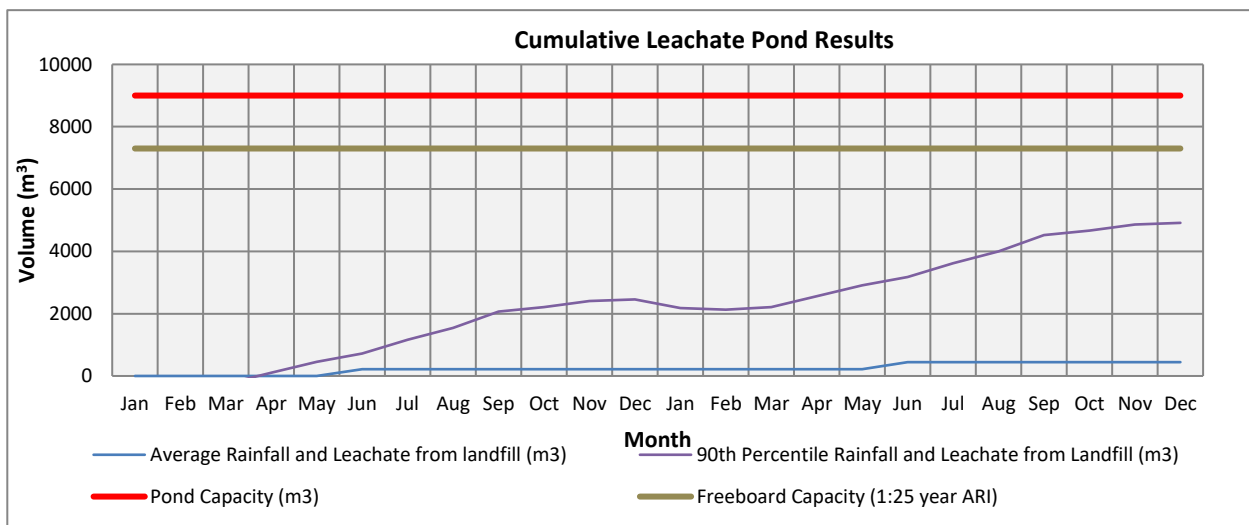
Scenario	Purpose	Assumptions
2	Determine if the evaporation treatment system in conjunction with the existing leachate storage pond is able to accommodate two consecutive wet years (90 <sup>th</sup> percentile rainfall) and leachate generation from Stages 1 - 4.	<ol style="list-style-type: none"> <li>Leachate management by the use of the existing leachate storage pond (Option 1) and a Direct Evaporation Treatment System (Option 3)- Evaporation of leachate by the combustion of landfill gas is included within this scenario. The evaporation rate of removal is 35m<sup>3</sup>/day.</li> <li>Disposal via irrigation not required in this scenario</li> </ol>

Input parameters for Scenario 1 are provided within [Table 11](#).

**Table 11 Water Balance Inputs**

Inputs												
	January	February	March	April	May	June	July	August	September	October	November	December
Average Rainfall	396	719	339	343	178	427	322	265	249	376	316	403
90th Percentile Rainfall	427	547	560	645	586	474	662	816	929	726	717	777
Leachate from cell (m <sup>3</sup> )	1151	1064	1109	1139	1082	1056	1080	999	1142	1110	1228	1171
Outputs												
Dam Evap (m <sup>3</sup> )	908	724	642	483	376	316	358	488	604	749	800	953
Direct Evaporation Treatment System (m <sup>3</sup> /month)	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050

Leachate generation for average and 90<sup>th</sup> percentile rainfall events for Stages 1 - 4 is depicted within [Figure 2](#).



**Figure 2: Scenario 2 Results**

In this scenario, leachate generated by Stages 1 - 4 would be sufficiently dealt with via the direct evaporation treatment system and existing leachate storage pond.

## 5 Recommendation

Preliminary water balance modelling indicates that leachate volumes produced by Stages 1-4 is able to be managed by one of the following scenarios, as described in Table 12.

**Table 12 Leachate Management Recommendations**

Scenario	Description	Notes
1	<p>Construction of an irrigation system on top of Cell 2.</p> <p>The irrigation system is to be utilised in conjunction with the existing leachate storage pond.</p>	<p>The clay cap where the irrigation system is proposed for Cell 2 will require removal and is to be re-instated with 1400mm of silty sand and 200mm of topsoil.</p> <p>The irrigation disposal area is required to be at least 14,000m<sup>2</sup> in size with a maximum annual leachate application rate of 730mm/m<sup>2</sup> at a rate of 851 m<sup>3</sup>/month over the irrigation area per year. Refer to Appendix B for proposed irrigation area preliminary assessment and concept design.</p>
2	<p>Installation of a direct evaporation treatment system The evaporation system is to be utilised in conjunction with the existing leachate storage pond.</p>	<p>Evaporation treatment is recommended as an alternate leachate management measure to provide high levels of leachate source reduction and low levels of leachate concentrate.</p>

## 6 Bibliography

Environmental Protection Agency. (2000). *Landfill Manuals: Landfill Site Design*.

NSW EPA. (2016). Environmental Guidelines: Solid Waste Landfills.

SLR Consulting. (2017). West Nowra Recycling and Waste Facility Proposed Stage 4 Landfill Extension Concept Design Report.

SLR Consulting. (2017). West Nowra Recycling and Waste Facility Proposed Stage 4 Landfill Extension Soil, Water and Leachate Assessment.

## APPENDIX A

### HELP INPUT PARAMETERS

## HELP Input Parameters

A water balance was conducted over a period of two consecutive wet years (90<sup>th</sup> percentile) as recommended within the NSW EPA landfill guidelines, to ensure that the proposed system has sufficient capacity to deal with all leachate generated during both the operational and closure periods of the landfill.

The following section contains the input parameters used within the Hydrological Evaluation of Landfill Performance (HELP) model.

### Capping Arrangements

The capping arrangements for Stages 1 – 4 for the purposes of HELP generation modelling are detailed within Table 13.

**Table 13 Capping arrangements**

Stage	Estimated Landfilled Area (ha)	Barrier Arrangement	Reference
1	9.5	Stage 1 Landfill is assumed to be covered with a compacted clay liner 600mm thick with a permeability of $10^{-9}$ m/s. Note: It is understood that Stage 1 landfilling occurred prior to regulatory licensing requirements, in unlined trenches. A combination of gravel and concrete drains discharge leachate to the existing leachate dam. It is estimated 30% of leachate produced is captured by the retro-fitted leachate system and discharged into the existing leachate storage pond.	Shoalhaven City Council (12 <sup>th</sup> /10/18)
2	8.2	Stage 2 is assumed to be covered with a compacted clay liner with a permeability of $10^{-9}$ m/s and a geomembrane of $10^{-11}$ m/s.	
3	10	Stage 3 lining is a combination of clay lining and synthetic lining. For the purposes of this assessment, it is assumed the barrier layer comprises a permeability of $10^{-9}$ m/s.	
	0.8	300mm intermediate cover soils assumed to be a compacted liner with a permeability of $10^{-6}$ m/s.	
4	9.7	A seal bearing surface 300mm thick A sealing layer comprising: A 2mm low density polyethylene flexible membrane (i.e. LDPE) or approved alternative; and A Geosynthetic Clay Liner; A 1,000 mm revegetation layer	West Nowra Recycling and Waste Facility Proposed Stage 4 Landfill Extension Concept Design Report (SLR, 2017)
	0.8	300mm intermediate cover soils	

### Climate Data

Climate data for the model was obtained from SILO (Scientific Information for Land Owners) which contains a database of historical climate records for Australia, hosted by the Science Delivery Division of the Department of Science, Information Technology and Innovation. SILO contains Australian climate data from 1889 to the present date of this assessment. SILO datasets are constructed from observational records provided by the

Bureau of Meteorology. SILO was utilized to process the raw data, which may contain missing values, to derive a dataset for the Site which is both spatially and temporally complete.

SILO data was obtained for, maximum and minimum temperature, pan evaporation, vapor pressure, and relative humidity at the times of maximum and minimum temperature.

### Rainfall

A data set of over 25 years was obtained for this assessment, including solar radiation, daily rainfall and average temperature.

### Evaporative zone depth

The evaporative zone depth is the maximum depth from which water may be removed by evapotranspiration. The value specified influences the storage of water near the surface and therefore directly affects the computations for evapotranspiration and runoff. Where surface vegetation is present, the evaporative depth should at least equal the expected average depth of root penetration. The depth specified should be characteristic of the maximum depth to which the moisture changes near the surface due to drying over the course of a year, typically occurring during peak evaporative demand or when peak quantity of vegetation is present. It is assumed that the evaporative zone depth for the purpose of this assessment is 10 cm.

### Maximum leaf area index

Leaf area index (LAI) is defined as the dimensionless ratio of the leaf area of actively transpiring vegetation to the nominal surface area of the land on which the vegetation is growing. The LAI for this assessment is 1.0 (poor stand of grass, utilised for the operational landfilled areas) and 3.5 (good stand of grass, utilised for the closed/rehabilitated landfilled areas).

### Growing Season

The growing season input parameter influences the evapotranspiration rate within the HELP model. The start of the growing season is based on mean daily temperature and plant species. Typically, the start of the growing season for grasses is the Julian date (day of the year) when the normal mean daily temperature rises above 10 to 13 degrees Celsius. For the purpose of this assessment, the growing season is considered to be year-round.

### Other Climate Data Inputs

Other climate data properties incorporated into the HELP model include the average yearly average wind speed is 12.4 km/hr and average relative humidity for the area is described within Table 14.

**Table 14 Average relative humidity**

Quarter	Average Relative Humidity (%)
First Quarter	66
Second Quarter	62.7
Third Quarter	55.3
Fourth Quarter	58.0

## APPENDIX B

### PRELIMINARY LEACHATE IRRIGATION AREA ASSESSMENT

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## Introduction

Arcadis has engaged SLR Consulting (SLR) to determine suitable leachate management options for the West Nowra Recycling and Waste Facility (the Facility) as a result of the proposed Stage 4 landfilling activities. As part of this scope of work a preliminary assessment of the volume of leachate that can be applied to the proposed irrigation area over the existing Stage 2 area has been carried out.

The purpose of the desk based irrigation assessment was to determine a preliminary sizing of the required on-site leachate irrigation area to adequately manage irrigation waters and to inform the concept design for the EIS stage of the proposed landfill extension. This assessment has not included any site specific investigations and does not cover detailed irrigation system design, which shall be carried out in the detailed design phase, once approval has been granted.

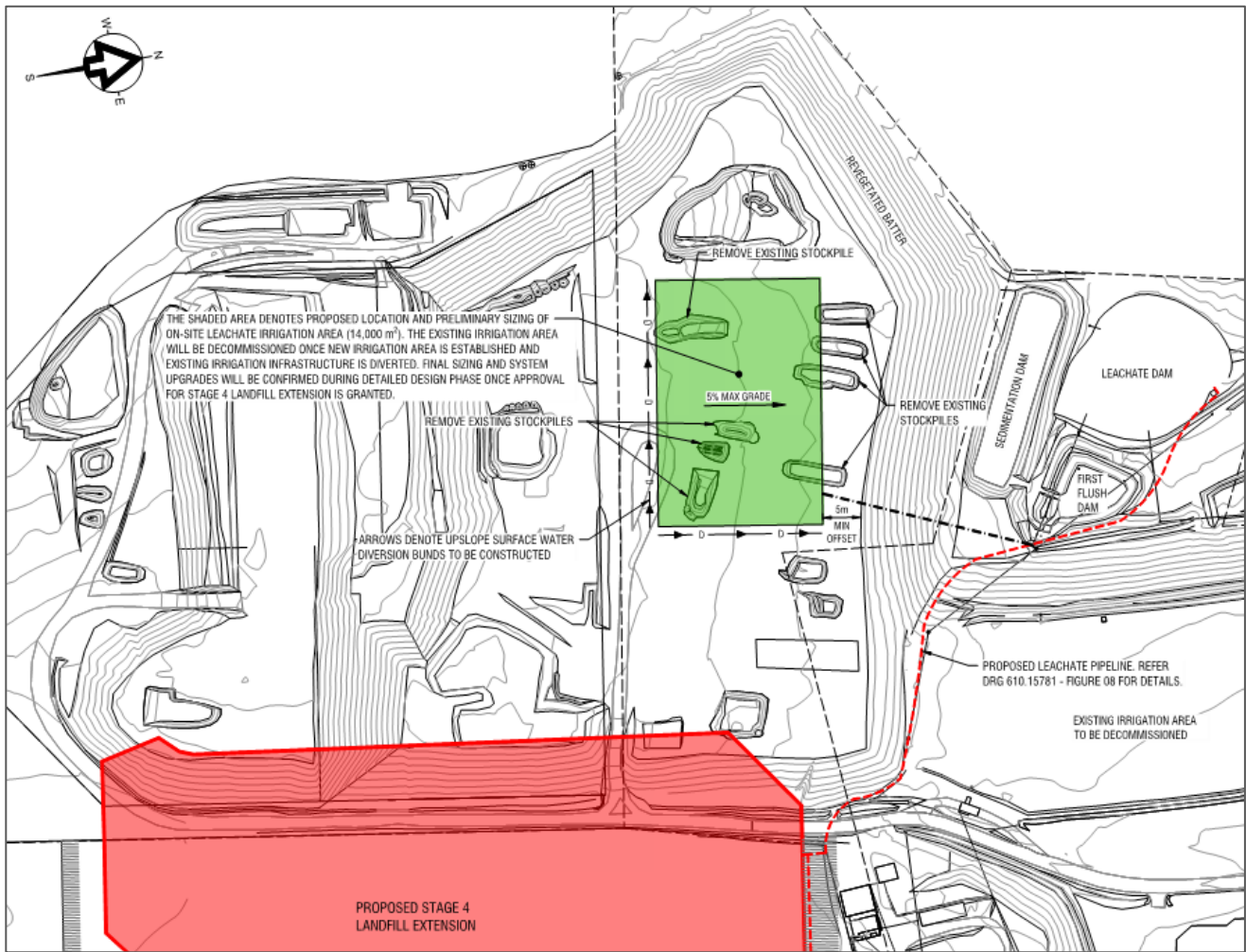
## Background

To assess the quantity of leachate that can be applied to an area without generating run-off a water balance of the soil system should be developed, which takes into consideration:

- Precipitation;
- Evapotranspiration;
- Surface runoff;
- Topography;
- Soil and vegetation characteristics; and
- Soil moisture storage.

The soil system is considered to be in balance when the precipitation entering the soil equals the amount leaving through evapotranspiration. In this case the irrigation volume will contribute to the water balance of the soil.

The area proposed to be utilised for irrigation is located in the central area of Stage 2, as shown in **Figure 3** below. This area was previously used for waste disposal and has a liner underlying the waste. The area has been capped with 200mm topsoil, 800mm silty sand, and 600mm clay.



**Figure 3 Proposed preliminary irrigation area**

**Climate**

Climate data for the model was obtained from SILO (Scientific Information for Land Owners) which contains a database of historical climate records for Australia, hosted by the Science Delivery Division of the Department of Science, Information Technology and Innovation. SILO contains Australian climate data from 1889 to the present date of this assessment. SILO datasets are constructed from observational records provided by the Bureau of Meteorology. SILO was utilized to process the raw data, which may contain missing values, to derive a dataset for the Site which is both spatially and temporally complete.

SILO data was obtained for, maximum and minimum temperature, pan evaporation, vapor pressure, and relative humidity at the times of maximum and minimum temperature. SILO provides daily climate values which are required for input into the modelling programme.

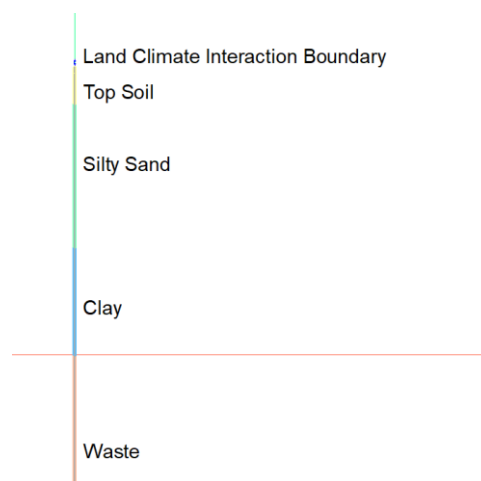
Data for humidity, temperature, and solar radiation were obtained from the BOM website, with different stations providing different data sets:

- Humidity data was calculated quarterly using monthly percentages obtained for Nowra RAN Air Station AWS station (068072);
- Temperature data was obtained for Ulladulla AWS station (069138); and
- Solar radiation was obtained for Nowra Boat Shed station (068213).

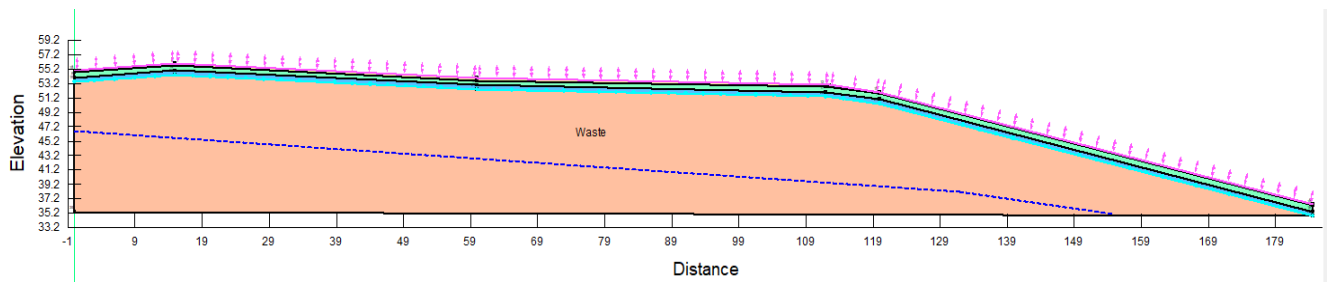
## Methodology

Geostudio is an integrated, multi-physics numerical analysis tool that has four components that simulate the flow of energy/mass. Geostudio SEEP/W coupled with thermal functionality has been utilised to simulate an average year of weather to the current layout of the Stage 2 capping profile. A 1D analysis of the soil profile can provide inputs to the evaporation potential of the system allowing for an estimate of additional loading to the system that can be undertaken. As this is a preliminary assessment to inform the concept design, no vegetation has been incorporated into this model, as it has been assumed that vegetation will not have been established at the outset of irrigation.

To ensure a conservative calculation of soil saturation potential prior to run off generation the profile utilised is shown in **Figure 2.2.1**. The current profile has an approximate slope of 3% and an approximate embankment slope of 23%. A land climate interaction boundary specifying the site specific climate data detailed in **Section 02**, has been applied to assess the evaporation potential of the soil system.



**Figure 4: 1 Dimensional Analysis of the Capping Evaporation Potential**



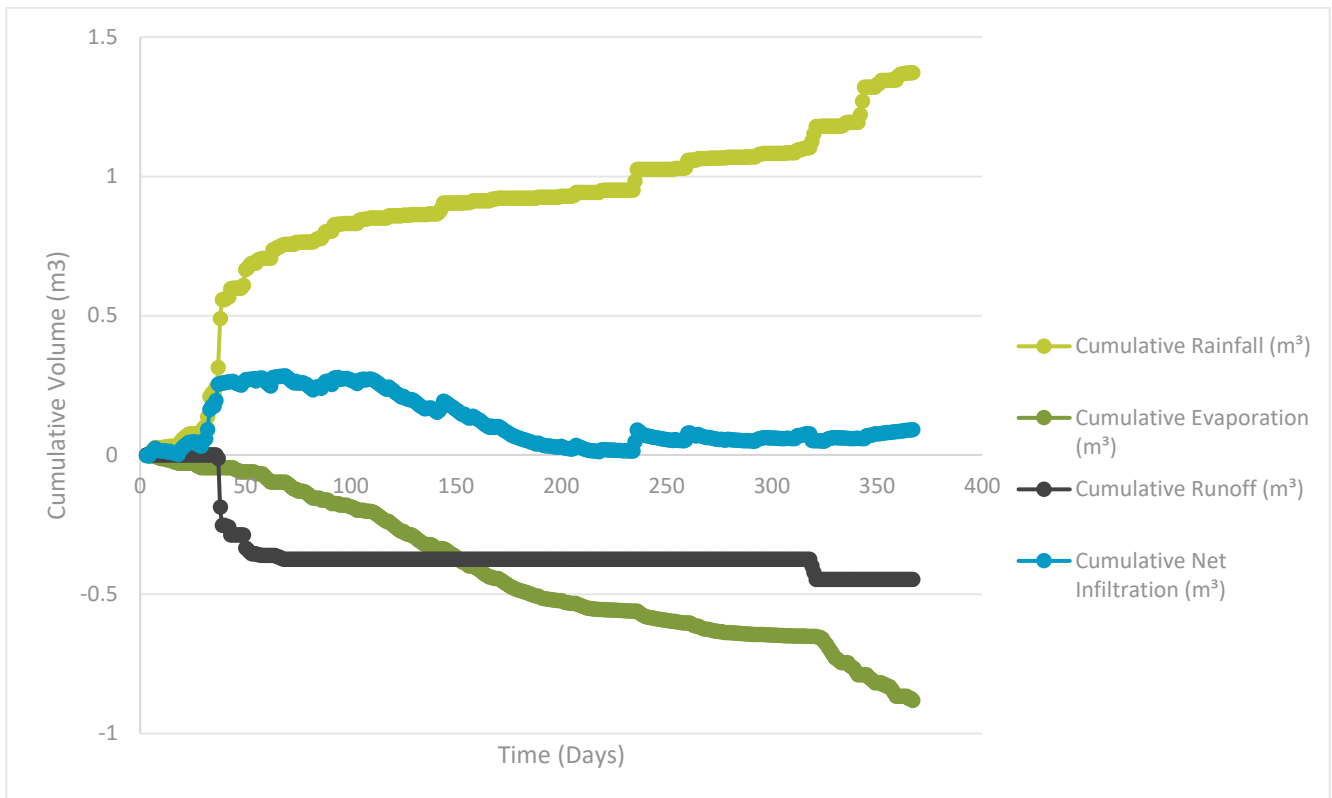
**Figure 2.2 Shoalhaven Stage 2 landform profile modelled**

It should be noted that site specific soil data for soil moisture curves were not provided and estimates established in literature have been used. Soil moisture curves provide the soil suction parameters of the model, which is the soils ability to retain water in an under unsaturated conditions. Confirmation of soil type and vegetation characteristics shall be carried out in the detail design phase.

## Results

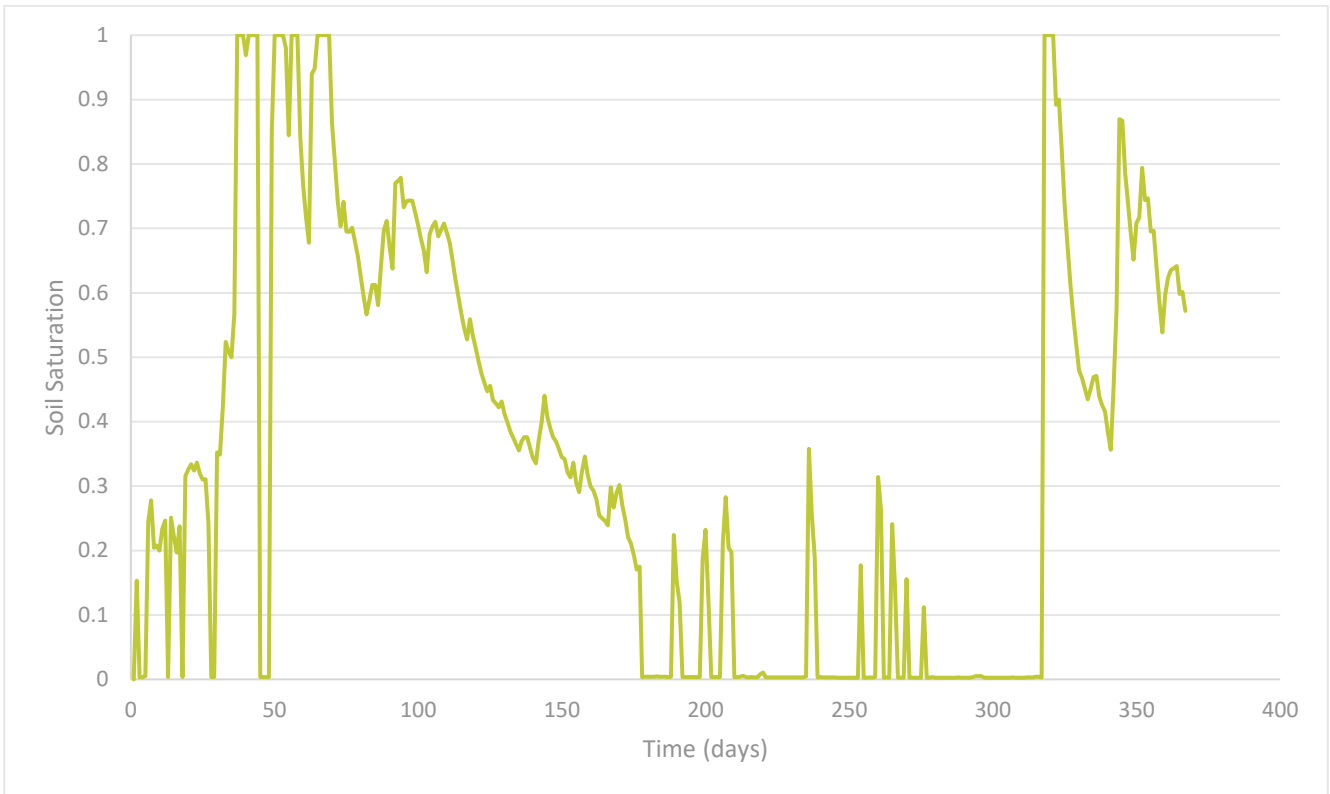
### 1D Soil Profile Analysis – Base Conditions

The cumulative runoff of the 1D soil column is indicative of the soil water balance, and whether the current system without additional irrigation would have any runoff generated. Based on the analysis the soil water balance the cumulative rainfall exceeds the cumulative evaporation; however, this does not mean that there is runoff generation as net percolation into the underlying soil layers contribute to the runoff potential and soil storage, **Figure 5**. Note that positive cumulative net infiltration is indicative of water moving into the soil and negative is indicative of water moving out of the soil.



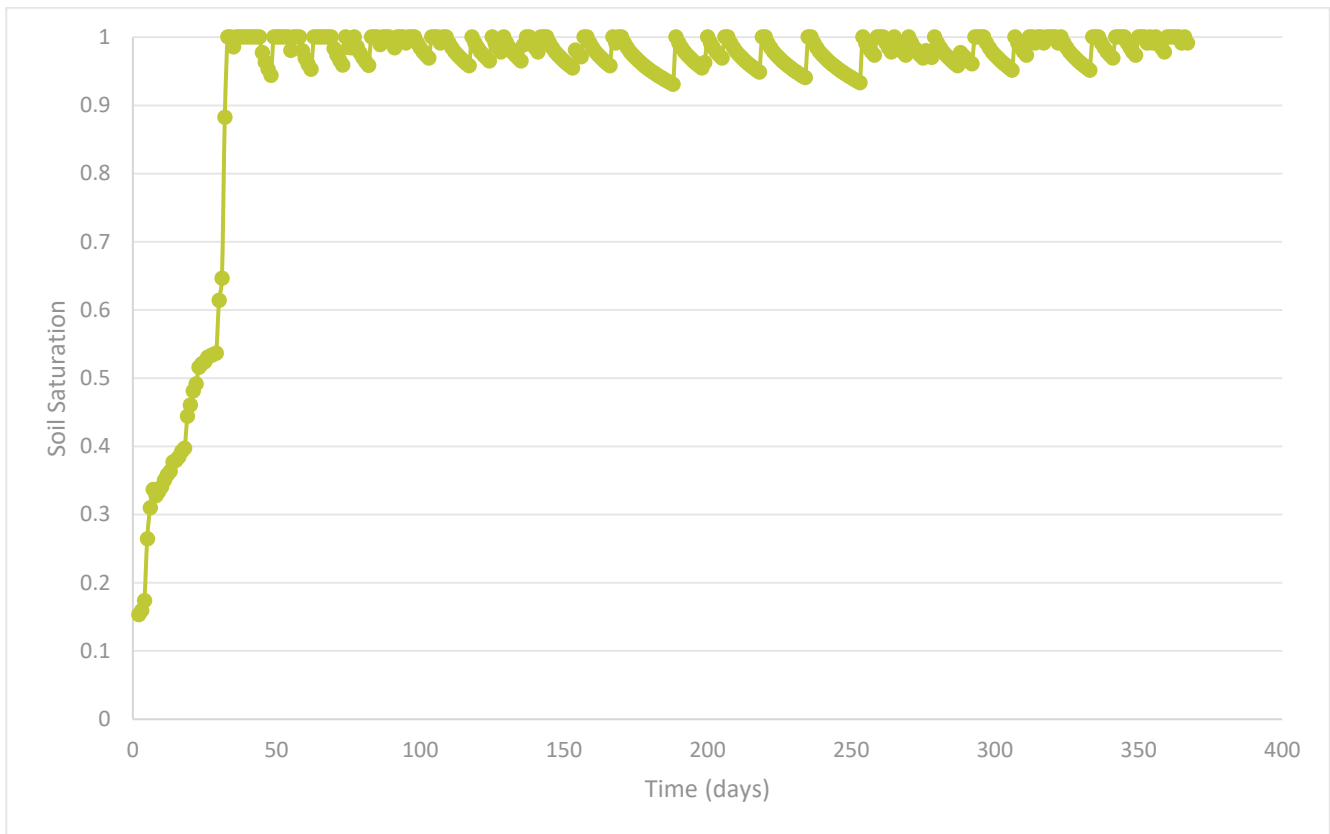
**Figure 5 Cumulative climate and infiltration rates**

The soil saturation degree is shown in **Figure 6** below. The soil saturation has been set at the top node of the analysis to determine when the system would generate runoff and be capable of taking additional leachate. As can be seen in the Figure 4, the system has periods where the soil is saturated and would generate some runoff as a result of rain exceeding the storage capacity and evaporation potential of the system. These instances are the result of rain events that are sustained over periods of 24 hours or greater.



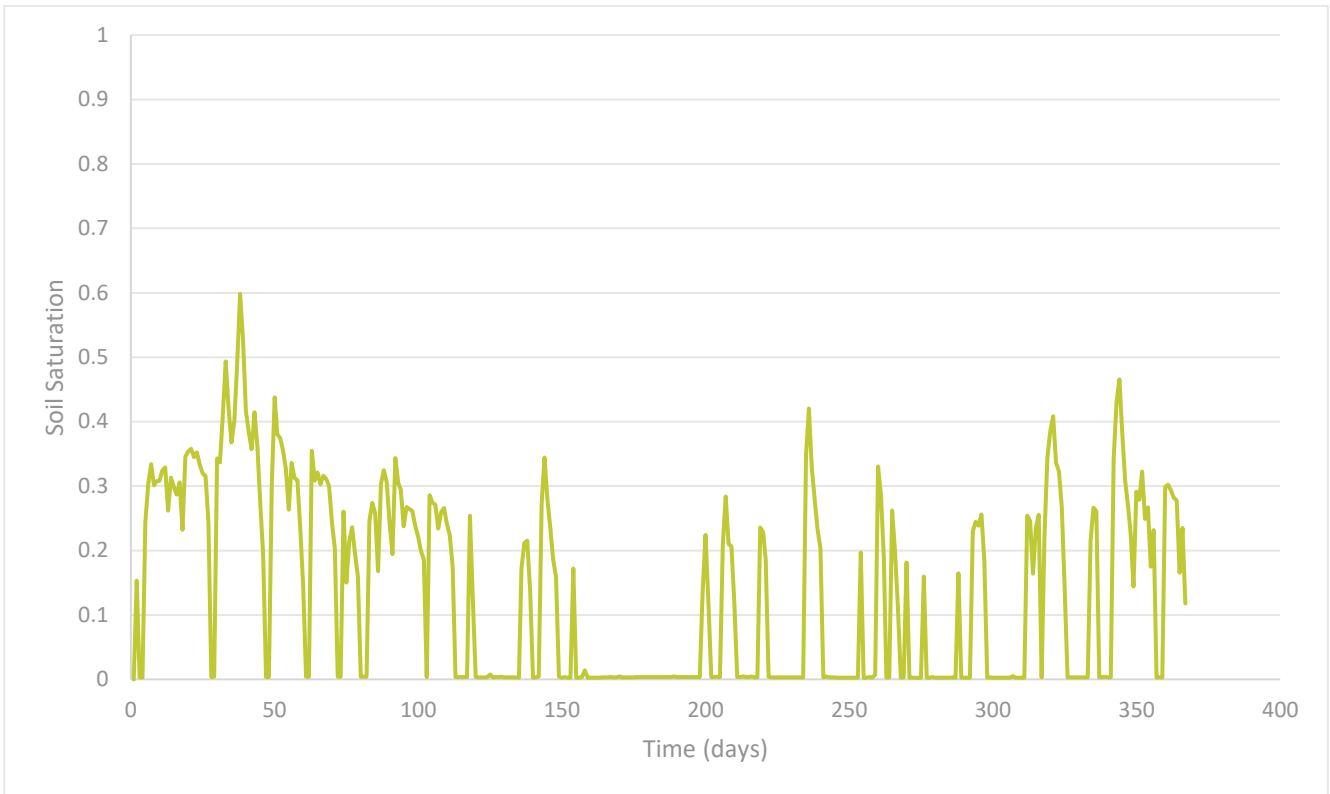
**Figure 6 Soil Saturation over modelling period of 365 days**

Application of leachate to the area at a rate 0.1mm per day over the course of the year, with days of precipitation excluded was modelled to assess the soil saturation with increased wetting. These results show that increasing the wetting of the soil horizon continually creates significantly greater soil saturation conditions, which are shown in **Figure 7**.

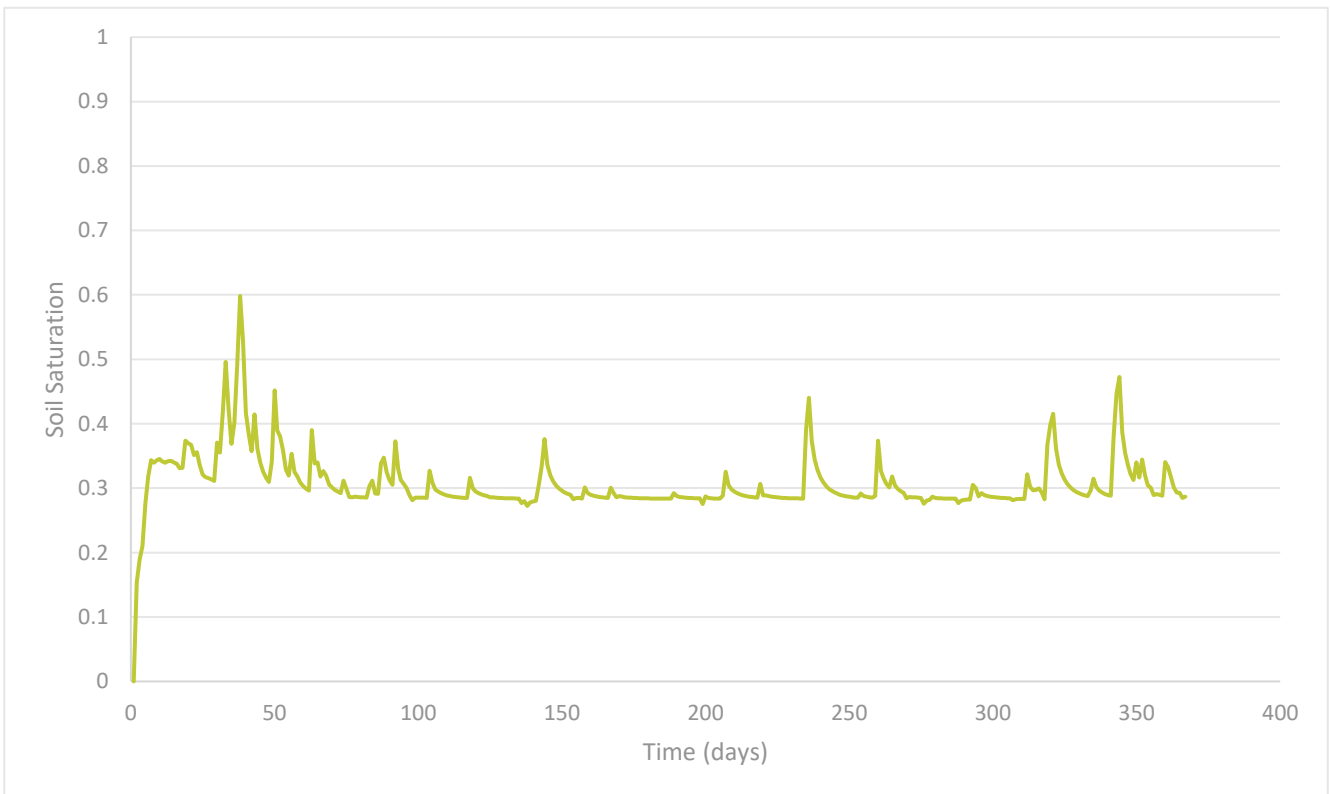


**Figure 7 Soil Saturation at 0.1mm leachate application to the 1D column**

The system was also modelled removing the clay liner component and replacing it with silty sand, the results of the degree of soil saturation running this simulation with just the environmental conditions are shown in **Figure 8** below. The simulation was also run with an application of 5mm of leachate applied to the area over each day that precipitation did not occur; these results are shown in **Figure 9** below. The results from the application of leachate at 2mm/day over 365 days show that run off is not likely to be generated.



**Figure 8 Degree of Soil Saturation with clay removed from capping system**



**Figure 9 Degree of Soil Saturation with clay removed and 2mm of leachate applied daily (except on days with rainfall)**

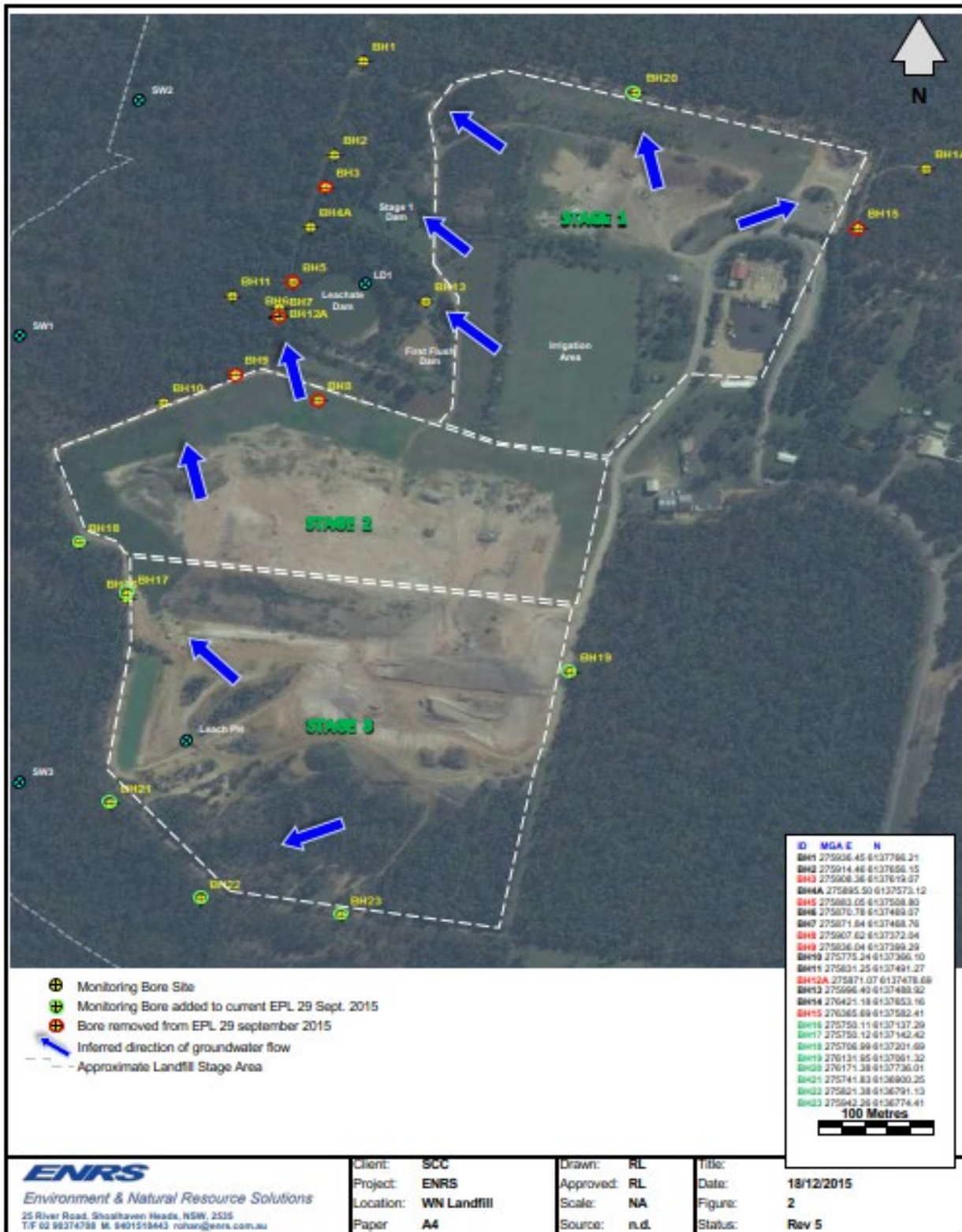
## Recommendations

Based on the modelling that was performed in Geostudio SEEP/W an accumulative application of 730mm of leachate over the selected irrigation area per year would be acceptable with the clay cap removed. It should be noted that leachate irrigation should be avoided on days that rainfall has occurred to reduce the potential for run-off. The irrigation area should be monitored to ensure the establishment of healthy flora and that the oversaturation of the ground is not an issue.

If the clay cap remains in place the area is unlikely to be able have leachate application without risk of leachate run off generation. Additionally, creating saturated soil conditions would result in difficult flora establishment.

Furthermore, it would be advisable that a buffer zone of 5m between the crest of the embankment and the irrigation zone be established and 0.5m bunding be placed on the downslope portions of the irrigation area. The bunding would prevent run-off leaving the area in the event that rainfall occurred on the same day that leachate irrigation had taken place.

## Attachment B



## Attachment C

TABLE 7: Annual Water Quality Monitoring Results (2017-2018)							
West Nowra Recycling and Waste Facility : EPL 5877							
Site No	Analyte	Units	ANZECC 2000 Freshwater (95% Species)	Nov-15	Feb-16	Feb-17	Feb-18
Leach PH	Alkalinity (CaCO3)	mg/L	-	727	3880	2	<1
Leach PH	Aluminium	mg/L	0.055	0.16	0.02	0.46	0.28
Leach PH	Ammonia as N	mg/L	0.9 (pH 8) - 2.57 (pH 6)	42.1	425	1.25	1.64
Leach PH	Arsenic	mg/L	0.024	0.004	0.007	0.002	<0.001
Leach PH	Barium	mg/L	-	0.025	0.266	0.018	0.032
Leach PH	Benzene	mg/L	0.95	<0.001	0.016	<1	<1
Leach PH	Bicarbonate	mg/L	-	727	3880	2	<1
Leach PH	Cadmium	mg/L	0.0002	<0.0001	<0.0001	0.0013	0.0004
Leach PH	Calcium	mg/L	-	41	480	14	18
Leach PH	Carbonate	mg/L	-	<1	<1	<1	<1
Leach PH	Chloride	mg/L	-	#N/A	NR	-	120
Leach PH	Hexavalent Chromium	mg/L	0.001	<0.01	<0.01	<0.01	<0.01
Leach PH	Total Chromium	mg/L	0.008 HMTV CrVI	0.004	0.051	<0.001	<0.001
Leach PH	Cobalt	mg/L	-	0.003	0.014	0.028	0.012
Leach PH	Conductivity	uS/cm	2200 max - 125 min	3260	9760	374	591
Leach PH	Copper	mg/L	0.0014	<0.001	<0.001	0.014	0.001
Leach PH	Ethyl- Benzene	mg/L	0.14 **	<0.002	0.393	<2	<2
Leach PH	Fluoride	mg/L	-	0.1	0.2	0.2	0.7
Leach PH	Lead	mg/L	0.0034	<0.001	<0.001	<0.001	<0.001
Leach PH	Magnesium	mg/L	-	104	304	8	12
Leach PH	Manganese	mg/L	1.9	0.22	2.85	0.521	0.464
Leach PH	Mercury	mg/L	0.0006	<0.0001	<0.0001	<0.0001	<0.0001
Leach PH	Nitrate	mg/L	0.7	0.04	<0.01	0.26	0.53
Leach PH	Nitrite	mg/L	-	0.05	0.02	0.07	<0.01
Leach PH	OCPS	mg/L	-	-	-	-	-
Leach PH	Aldrin	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	alpha-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	alpha-Endosulphan	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	beta-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	beta-Endosulphan	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Chlordane	mg/L	0.00008	<0.0005	<0.0005	<0.5	<0.5
Leach PH	cis-Chlordane	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	trans-Chlordane	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	DDD	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	DDE	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	DDT	mg/L	0.00001	<0.002	<0.002	<2.0	<2.0
Leach PH	delta-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Dieldrin	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Endosulphan Sulphate	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Endrin	mg/L	0.00002	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Endrin ketone	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Endrin Aldehyde	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	gamma-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Heptachlor	mg/L	0.00009	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Heptachlor Epoxide	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Hexachlorobenzene	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Lindane	mg/L	0.0002	#N/A	-	<0.5	<0.5
Leach PH	Methoxychlor	mg/L	-	<0.002	<0.002	<2.0	<2.0

TABLE 7: Annual Water Quality Monitoring Results (2017-2018) West Nowra Recycling and Waste Facility : EPL 5877							
Site No	Analyte	Units	ANZECC 2000 Freshwater (95% Species)	Nov-15	Feb-16	Feb-17	Feb-18
Leach PH	OPP's	mg/L					
Leach PH	Chlorpyrifos	mg/L	0.00001	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Diazinon	mg/L	0.00001	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Dichlorvos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Ethion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Fenthion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Malathion	mg/L	0.00005	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Parathion	mg/L	0.000004	<0.002	<0.002	<2.0	<2.0
Leach PH	Demeton-S-methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Monocrotophos	mg/L	-	<0.002	<0.002	<2.0	<2.0
Leach PH	Dimethoate	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Chlorpyrifos-methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Parathion-methyl	mg/L	-	<0.002	<0.002	<2.0	<2.0
Leach PH	Pirimphos-ethyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Bromophos-ethyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Fenamiphos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Prothiofos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Carbophenothion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Azinphos Methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Chlorfenvinphos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Phosphate	mg/L	0.02 FRP*	<b>0.16</b>	<b>1.02</b>	<0.01	<0.01
Leach PH	Total Phosphorus	mg/L	0.05	<b>0.4</b>	<b>2.16</b>	<b>0.01</b>	<b>0.1</b>
Leach PH	PAHs	mg/L					
Leach PH	Acenaphthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Acenaphthylene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Benzo(a)anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Benzo(a)pyrene	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
Leach PH	Benzo(b)&(k)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Benzo(b)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Benzo(k)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Benzo(g,h,i)perylene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Chrysene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Dibenzo(a,h)anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Fluorene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Indeno(1,2,3-c,d)pyrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Naphthalene	mg/L	0.016	<0.001	<b>0.0026</b>	<1.0	<1.0
Leach PH	PAH (total)	mg/L	-	<0.0005	<b>0.0026</b>	<0.5	<0.5
Leach PH	Phenanthrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	Pyrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
Leach PH	pH	pH units	8.0 - 6.5*	<b>7.5</b>	<b>7.1</b>	<b>5.7</b>	<b>4.3</b>
Leach PH	Potassium	mg/L	-	<b>97</b>	<b>297</b>	-	<b>5</b>
Leach PH	Sodium	mg/L	-	<b>394</b>	<b>730</b>	-	<b>60</b>
Leach PH	Sulphate	mg/L	-	<b>5</b>	<b>5</b>	<b>79</b>	<b>85</b>
Leach PH	Toluene	mg/L	0.3 0**	<0.002	<b>0.017</b>	<2	<2
Leach PH	Total Phenolics	mg/L	0.32	<0.05	<0.05	-	<0.05
Leach PH	Total Dissolved Solids	mg/L	1500 max - 85 min	<b>1840</b>	<b>4390</b>	<b>170</b>	<b>261</b>
Leach PH	Total Organic Carbon	mg/L	-	<b>43</b>	<b>116</b>	<b>6.8</b>	<b>2</b>
Leach PH	TPHs	mg/L	-				
Leach PH	C10-C14	mg/L	-	<0.05	<b>1</b>	<50	<50
Leach PH	C15-C28	mg/L	-	<b>0.27</b>	<b>1.61</b>	<100	<100
Leach PH	C29-C36	mg/L	-	<0.05	<0.05	<50	<50
Leach PH	C10-C36	mg/L	10 **	<b>0.27</b>	<b>2.61</b>	<50	<50
Leach PH	C6-C9	mg/L	7 (NEPM F1)	<0.02	<b>1.32</b>	<20	<20
Leach PH	Total Suspended Solids	mg/L	50 ****	<5	<b>40</b>	<5	<b>35</b>
Leach PH	Xylene	mg/L	0.35	<0.002	<b>0.105</b>	<2	<2
Leach PH	meta- & para-Xylene	mg/L	0.35	<0.002	<b>0.08</b>	<2	<2
Leach PH	ortho-Xylene	mg/L	0.35	<0.002	<b>0.025</b>	<2	<2
Leach PH	Zinc	mg/L	0.008	<0.005	<b>0.014</b>	<b>0.231</b>	<b>0.088</b>

**TABLE 7: Annual Water Quality Monitoring Results (2017-2018)**  
 West Nowra Recycling and Waste Facility : EPL 5877

Site No	Analyte	Units	ANZECC 2000 Freshwater (95% Species)	Nov-15	Feb-16	Feb-17	Feb-18
LD 1	OPP's	mg/L					
LD 1	Chlorpyrifos	mg/L	0.00001	<0.0005	<0.0005	<0.5	<0.5
LD 1	Diazinon	mg/L	0.00001	<0.0005	<0.0005	<0.5	<0.5
LD 1	Dichlorvos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Ethion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Fenthion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Malathion	mg/L	0.00005	<0.0005	<0.0005	<0.5	<0.5
LD 1	Parathion	mg/L	0.000004	<0.002	<0.003	<2.0	<2.0
LD 1	Demeton-S-methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Monocrotophos	mg/L	-	<0.002	<0.002	<2.0	<2.0
LD 1	Dimethoate	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Chlorpyrifos-methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Parathion-methyl	mg/L	-	<0.002	<0.002	<2.0	<2.0
LD 1	Pirimphos-ethyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Bromophos-ethyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Fenamiphos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Prothiofos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Carbophenothion	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Azinphos Methyl	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Chlorfenvinphos	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Phosphate	mg/L	0.02 FRP*	<b>0.15</b>	<b>1.15</b>	<b>0.03</b>	<b>0.02</b>
LD 1	PAHs	mg/L	0.05				
LD 1	Acenaphthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Acenaphthylene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Benzo(a)anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Benzo(a)pyrene	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Benzo(b)&(k)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Benzo(b)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Benzo(k)fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Benzo(g,h,i)perylene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Chrysene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Dibenzo(a,h)anthracene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Fluoranthene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Fluorene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Indeno(1,2,3-c,d)pyrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Naphthalene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	PAH (total)	mg/L	0.016	<0.0005	<0.0005	<0.5	<0.5
LD 1	Phenanthrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	Pyrene	mg/L	-	<0.001	<0.001	<1.0	<1.0
LD 1	pH	pH units	8.0 - 6.5*	<b>7.9</b>	<b>8.5</b>	<b>8.8</b>	<b>8.3</b>
LD 1	Potassium	mg/L	-	<b>97</b>	<b>104</b>	----	<b>86</b>
LD 1	Sodium	mg/L	-	<b>394</b>	<b>374</b>	----	<b>445</b>
LD 1	Sulphate	mg/L	-	<5	<b>8</b>	<b>23</b>	<b>22</b>
LD 1	Toluene	mg/L	0.3 0**	<0.002	<0.002	<2	<2
LD 1	Total Phenolics	mg/L	0.32	<0.05	<0.05	-	<0.05
LD 1	Total Dissolved Solids	mg/L	1500 max - 85 min	<b>1740</b>	<b>1510</b>	<b>716</b>	<b>1480</b>
LD 1	Total Organic Carbon	mg/L	-	<b>43.7</b>	<b>43</b>	<b>36.9</b>	<b>46</b>
LD 1	TPHs	mg/L	-				
LD 1	C10-C14	mg/L	-	<0.05	<0.05	<50	<50
LD 1	C15-C28	mg/L	-	<b>0.24</b>	<b>0.014</b>	<100	<100
LD 1	C29-C36	mg/L	-	<0.05	<0.05	<50	<50
LD 1	C10-C36	mg/L	10 **	<b>0.24</b>	<b>0.14</b>	<50	<50
LD 1	C6-C9	mg/L	7 (NEPM F1)	<0.02	<0.02	<20	<20
LD 1	Total Phosphorus	mg/L	0.05	<b>0.42</b>	<b>0.19</b>	<2	<b>0.74</b>
LD 1	Total Suspended Solids	mg/L	50 ****	<b>5</b>	<b>28</b>	<b>5</b>	<b>146</b>
LD 1	Xylene	mg/L	0.35	<0.002	<0.002	<2	<2
LD 1	meta- & para-Xylene	mg/L	0.35	<0.002	<0.002	<2	<2
LD 1	ortho-Xylene	mg/L	0.35	<0.002	<0.002	<2	<2
LD 1	Zinc	mg/L	0.008	<0.005	<0.005	<b>0.008</b>	<b>0.015</b>

Australian and New Zealand Environment and Conservation Council, Guidelines for Fresh and Marine Water Quality (ANZECC 2000)

\*ANZECC 2000 Trigger Levels for Fresh Water & Lowland Rivers (Table 3.3.2) in South East Australia

\*\*NSW DEC (1994) Guidelines for Assessing Service Station Sites - Threshold Concentrations for Aquatic Environments - Fresh Waters

\*\*\*NEPM 2013 Schedule B1 Guideline on Investigation Levels for Soil and Groundwater

\*\*\*\*ANZECC 2000 Trigger Levels for Lowland Rivers (Table 8.2.12) in New South Wales

FRP = Filterable Reactive Phosphate

Leach PH = Leachate Pump House

Values that exceed the EPL ANZECC guidelines are shaded:

TABLE 7: Annual Water Quality Monitoring Results (2017-2018) West Nowra Recycling and Waste Facility : EPL 5877							
Site No	Analyte	Units	ANZECC 2000 Freshwater (95% Species)	Nov-15	Feb-16	Feb-17	Feb-18
LD 1	Alkalinity (CaCO3)	mg/L	-	751	541	291	318
LD 1	Aluminium	mg/L	0.055	0.21	0.14	0.24	1.56
LD 1	Ammonia as N	mg/L	0.9 (pH 8) - 2.57 (pH 6)	43.1	13.4	15.7	2.57
LD 1	Arsenic	mg/L	0.024	0.004	0.003	0.003	0.004
LD 1	Barium	mg/L	-	0.026	0.022	0.033	0.078
LD 1	Benzene	mg/L	0.95	<0.001	<0.001	<1	<1
LD 1	Bicarbonate	mg/L	-	751	456	251	316
LD 1	Cadmium	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
LD 1	Calcium	mg/L	-	42	28	31	43
LD 1	Carbonate	mg/L	-	<1	85	40	2
LD 1	Chloride	mg/L	-	587	573	309	799
LD 1	Hexavalent Chromium	mg/L	0.001	<0.01	<0.01	<0.01	<0.01
LD 1	Total Chromium	mg/L	0.008 HMTV CrVI	0.003	0.003	0.004	0.004
LD 1	Cobalt	mg/L	-	0.002	0.002	0.002	0.001
LD 1	Conductivity	uS/cm	2200 max - 125 min	3240	2780	1500	2970
LD 1	Copper	mg/L	0.0014	<0.001	0.001	0.008	0.007
LD 1	Ethyl- Benzene	mg/L	0.14 **	<0.002	<0.002	<2	<2
LD 1	Fluoride	mg/L	-	0.2	0.1	0.2	1.2
LD 1	Lead	mg/L	0.0034	<0.001	<0.001	<0.001	0.004
LD 1	Magnesium	mg/L	-	104	89	31	51
LD 1	Manganese	mg/L	1.9	0.217	0.073	0.042	0.081
LD 1	Mercury	mg/L	0.0006	<0.0001	<0.0001	<0.0001	<0.0001
LD 1	Nitrate	mg/L	0.7	0.05	<0.01	0.15	0.17
LD 1	Nitrite	mg/L	-	0.09	2.51	0.29	0.2
LD 1	OCP's	mg/L	-	-	-	-	-
LD 1	Aldrin	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	alpha-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	alpha-Endosulphan	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	beta-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	beta-Endosulphan	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Chlordane	mg/L	0.00008	<0.0005	<0.0005	<0.5	<0.5
LD 1	cis-Chlordane	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	trans-Chlordane	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	DDD	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	DDE	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	DDT	mg/L	0.00001	<0.002	<0.002	<2.0	<2.0
LD 1	delta-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Dieldrin	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Endosulphan Sulphate	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Endrin	mg/L	0.00002	<0.0005	<0.0005	<0.5	<0.5
LD 1	Endrin ketone	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Endrin Aldehyde	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	gamma-BHC	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Heptachlor	mg/L	0.00009	<0.0005	<0.0005	<0.5	<0.5
LD 1	Heptachlor Epoxide	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Hexachlorobenzene	mg/L	-	<0.0005	<0.0005	<0.5	<0.5
LD 1	Lindane	mg/L	0.0002	#N/A	-	<0.5	<0.5
LD 1	Methoxychlor	mg/L	-	<0.002	<0.002	<2.0	<2.0