

9 October 2019

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Arcadis Australia Pacific Pty Ltd
Level 5
141 Walker Street
NORTH SYDNEY NSW 2060

Attention: Sean Fishwick

Dear Sean

Shoalhaven Response to Submission Groundwater Elevation Review

Shoalhaven City Council (SCC) are proposing to extend the existing landfill operation at the West Nowra Recycling and Waste Facility (the Facility) at Flatrock Road, Mundamia, NSW. As part of the development approval process an environmental impact assessment (EIS) was prepared and submitted to the New South Wales Environmental Protection Agency (NSW EPA). This letter report is a response to groundwater related issues raised by NSW EPA following their review of the EIS.

1 Groundwater Issue

It is proposed in the EIS that the landfill cell excavation depth will not come within 100mm of the average depth to groundwater, with the base of the landfill cell floor (top of leachate drainage layer) greater than two metres above the average groundwater table. This specification is based on EPA Victoria Best Practice Environmental Management (BPEM) – Siting, design, operation and rehabilitation of landfills (Victorian Guidelines) (EPA Victoria, 2014). The NSW EPA require a response to confirm that there is a sufficient buffer distance between the proposed landfill design cell floor elevation and the average groundwater elevation across the site.

2 Groundwater Elevation Review

To determine average groundwater elevations at the site and understand if seasonal fluctuations exist, a review of all site monitoring data has been undertaken. The review included:

- compilation of water level data for all monitoring bores assessed as targeting the water table aquifer;
- review of water level data in conjunction with rainfall data for the area to determine if seasonal fluctuations exist, and if so determine the magnitude of these fluctuations;
- calculation of summary statistics for groundwater elevations, i.e. maximum, minimum and average groundwater elevations; and
- establishment of groundwater buffer distance based on the findings of the review.

2.1 Data Inputs

SLR have been provided groundwater level monitoring data to assist with the groundwater response to submission. **Table 1** provides a summary of the data reviewed with the locations of all bores from which the data is sourced presented in **Figure 1**. The monitoring data for bores located in Stage 1 to 3 has been included as **Appendix A**. Logger data from the bores located in Stage 4 has not been included in this report due to the large number of records taken. This data can be made available on request.

Table 1 Groundwater Elevation Data Source Summary

Data Source	Monitoring Bore IDs	Landfill Stage Area	Monitoring Date Range
Environment & Natural Resource Solutions (ENRS), 2018, Annual Environmental Monitoring Results 2017-2018, ENRS00047.3: Table 6: Quarterly water quality monitoring results.	BH1, BH2, BH3, BH4, BH5, BH6, BH7, BH10, BH11, BH12, BH13, BH14, BH16, BH17, BH18, BH19, BH20, BH21, BH22, BH23	Stage 1 to Stage 3	November 2014 to August 2018 (note water levels not measured in all bores measured during each monitoring event)
ALS Environmental Certificate of Analysis report EW1900555 (supplied by Shoalhaven City Council)	BH3, BH4, BH6, BH7, BH13, BH14, BH16, BH17, BH20, BH22	Stage 1 to Stage 3	February 2019
ENRS datalogger data (supplied by Shoalhaven City Council)	GW1, GW1a, GW2, GW3, GW4, GW5	Proposed Stage 4	01/06/2016 to 16/07/2019

2.2 Results

Summary statistics for groundwater elevations measured in bores located around the landfill Stage 1 to Stage 3 and within the proposed landfill Stage 4 are presented in **Table 2**. It should be noted that the logger data shows multiple significant drawdown events in bores GW1 and GW4 over the monitoring period. It is believed that the larger drawdown events are likely to represent the abstraction of groundwater from the bores for sampling purposes, with the smaller events representing the removal of the logger to enable the downloading of the level data. A decline in water levels is also observed in all monitoring bores between 20 December 2018 and 17 January 2019. This decline is due to a faulty barometric logger used to compensate the groundwater elevation data. The data representing the artificial drawdown and faulty barometric logger has therefore been omitted for the generation of the following water level summary statistics to prevent a false representation of groundwater elevations for the site.

Review of the logger data shows that between 01 June 2016 and 16 July 2019 groundwater elevations in the monitored bores ranged from 38.21mAHD (GW2a) to 42.33mAHD (GW1). The highest groundwater elevations were consistently recorded in GW1 (located in the southwest corner of the proposed Stage 4 cell) over this period, with an average elevation of 41.95mAHD recorded within the bore.

Between January 2016 and March 2018 the lowest groundwater elevations were generally recorded in monitoring bores GW4 and GW5 located in the north and northeast of the cell. After March 2018 the lowest elevations were recorded in GW2 in the southeast of the cell. GW2a (located next to GW2) recorded the lowest average groundwater elevation of 38.53 mAHD. It should be noted that except for between 21 March 2017 and 05 October 2017, GW2a was reported as dry over the monitoring period.

Rainfall cumulative deviation from the mean (CDFM) data has been calculated from daily rainfall measurements recorded at Australian Bureau of Meteorology (BoM) station 68213 (Nowra Boat Shed (Shoalhaven River)) located approximately 5km east of the site. Comparison of groundwater levels with the CDFM can provide an indication on whether the groundwater is responsive to changes in climatic trends, e.g. groundwater levels increase in wetter than normal conditions and decrease in drier than normal conditions. **Figure 2** shows the Stage 4 extension monitoring bore water level data plotted against the CDFM. Review of the data shows that groundwater levels were relatively stable up until September 2017, after which they gradually decline. Review of the CDFM show that conditions were wetter than normal up until April 2017 after which they were drier than normal. The stable groundwater levels over the wetter monitoring period and gradual declining levels over the drier monitoring period show that the response to rainfall is minimal.

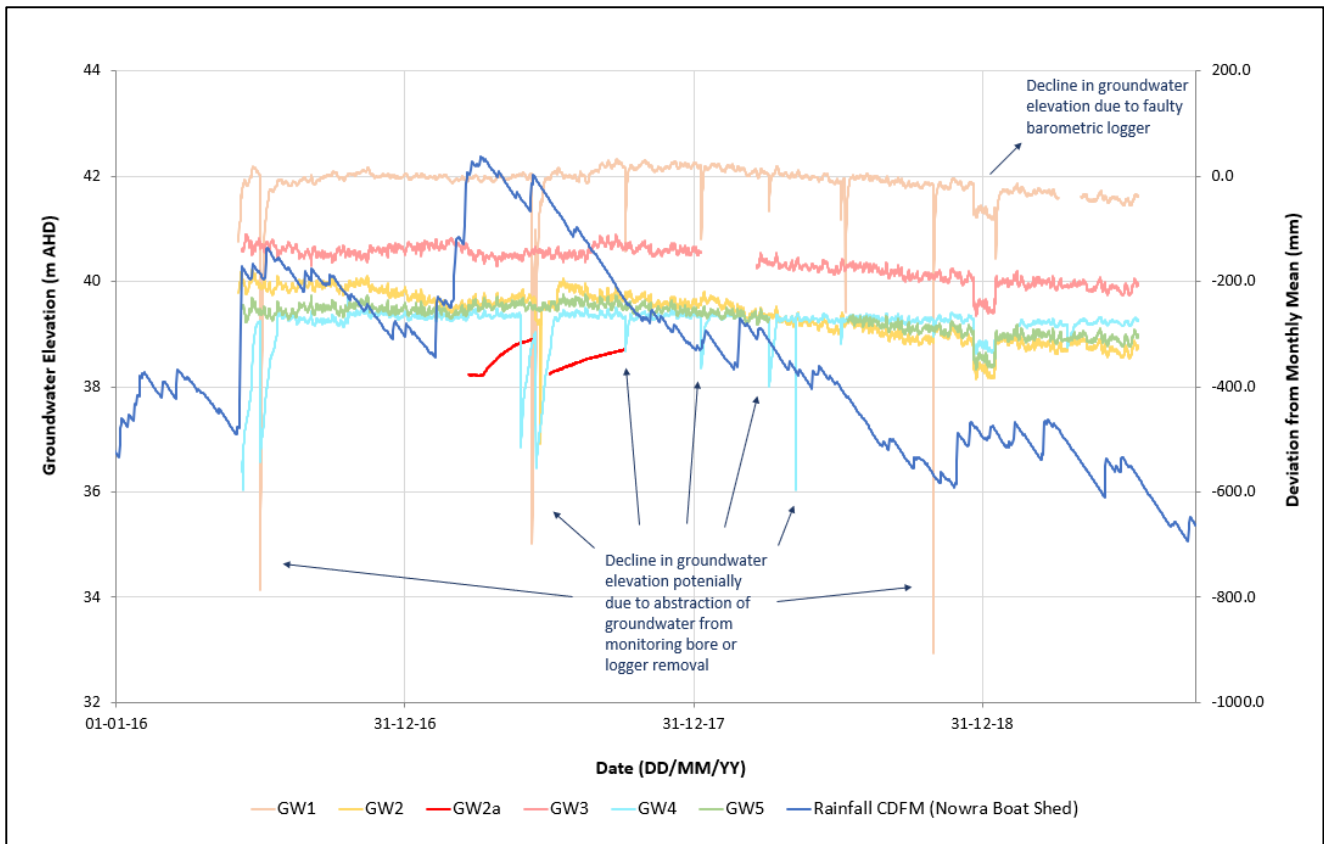
Figure 1 Monitoring Bore Location Plan



Table 2 Groundwater Elevation Summary Statistics

Bore ID	Date Range	Number of Records	Maximum Elevation (m AHD)	Minimum Elevation (m AHD)	Average Elevation (m AHD)	Standard Deviation
Manual Measurements presented in ENRS 2017/2018 Annual Report						
BH1	September 2015	1	32.4	32.4	32.4	0
BH2	September 2015 – February 2018	5	33.29	33.29	33.29	1.22
BH3	November 2014 - September 2015	4	33.7	33.7	33.7	1.39
BH4	November 2014 - February 2019	16	31.5	31.5	31.5	0.2
BH5	November 2014 - May 2015	3	28.8	28.8	28.8	0.17
BH6	November 2014 - February 2019	17	30.7	30.7	30.7	0.28
BH7		17	31	31	31	0.48
BH10	November 2014 - May 2018	15	39.1	39.1	39.1	1.57
BH11	September 2015	1	30.8	30.8	30.8	0
BH12	November 2014 - January 2015	4	34.1	34.1	34.1	1.72
BH13	November 2014 - February 2019	17	34.1	34.1	34.1	0.29
BH14		14	36.7	36.7	36.7	0.1
BH16		17	39.7	39.7	39.7	0.38
BH17		17	39.2	39.2	39.2	0.33
BH18	November 2014 - May 2018	7	36.4	36.4	36.4	0.2
BH19	September 2015	1	42.1	42.1	42.1	0
BH20	November 2014 - February 2019	16	37.4	37.4	37.4	0.41
Shoalhaven City Council Data Logger Records						
GW1	01/06/2016 – 16/07/2019	3966	42.33	41.44	41.95	0.18
GW1a		0 (Dry)	0.00	0.00	-	-
GW2		4438	40.22	38.54	39.41	0.41
GW2a		723	38.91	38.21 / Dry	38.53	0.20
GW3		4141	40.90	39.72	40.38	0.28
GW4		4001	39.72	38.62	39.28	0.12
GW5		4024	40.00	38.75	39.37	0.24

Figure 2 Groundwater Elevations against CDFM (Nowra Boat Shed)



3 Response to Groundwater Issue

Review of available data shows that between 2016 and 2019 the maximum average groundwater elevation was recorded in GW1 at 41.95m AHD. Continuous monitoring of groundwater elevations within bores installed within the proposed Stage 4 extension area shows that fluctuations in relation to climatic trends have been minimal, particularly in response to a wetter than average period in the first part of 2017. It is therefore unlikely that groundwater will rise above the maximum elevation recorded to date.

Based on the data reviewed and in accordance with the Vic EPA BPEM guidance, the elevation of the landfill cell floor (top of the drainage layer) should not be constructed at less than 43.95m AHD which is 2m above the maximum average groundwater elevation recorded.

Yours sincerely



DUNCAN DAWSON
Senior Hydrogeologist

Checked/
Authorised by: DL

APPENDIX A

STAGE 1 TO 3 MONITORING BORE GROUNDWATER LEVEL RECORDS

Measurement Date	Groundwater Elevation (m AHD)																
	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH10	BH11	BH12	BH13	BH14	BH16	BH17	BH18	BH19	BH20
01-11-14	-	-	30.20	31.20	28.40	30.20	30.40	33.70	-	30.10	33.50	36.50	38.70	38.70	35.90	-	36.10
01-02-15	-	-	30.50	31.20	28.50	30.10	30.40	33.70	-	30.10	33.60	36.60	38.80	38.70	-	-	35.50
01-05-15	-	-	30.90	31.40	28.80	30.50	30.20	32.80	-	30.20	33.90	-	39.00	39.00	-	-	35.70
01-09-15	32.40	30.90	33.70	31.50	-	30.60	31.00	34.10	30.80	34.10	34.10	-	39.70	39.20	-	42.10	36.00
01-11-15	-	-	-	31.30	-	30.00	29.60	33.80	-	-	33.50	-	38.80	38.80	-	-	35.90
01-02-16	-	-	-	-	-	30.70	30.70	33.80	-	-	33.70	36.60	39.00	39.00	36.20	-	
01-05-16	-	-	-	30.90	-	29.50	29.20	33.70	-	-	32.90	36.40	38.70	38.70	-	-	35.90
01-08-16	-	-	-	31.50	-	30.30	30.60	32.60	-	-	33.80	36.70	39.00	39.00	-	-	35.80
01-11-16	-	30.00	-	31.10	-	30.20	30.30	32.50	-	-	33.40	36.30	38.80	38.70	36.00	-	35.80
01-02-17	-	30.10	-	30.80	-	30.40	30.30	32.30	-	-	33.40	36.40	38.70	38.60	35.80	-	35.80
01-05-17	-	-	-	31.30	-	30.20	30.50	32.60	-	-	33.60	36.40	38.90	38.80	35.90	-	35.70
01-08-17	-	-	-	31.50	-	30.20	30.40	39.10	-	-	33.60	36.50	38.90	38.90	35.90	-	37.40
01-11-17	-	-	-	31.30	-	30.10	29.70	33.10	-	-	33.40	36.40	38.10	38.00	-	-	35.90
01-02-18	-	33.29	-	31.26	-	30.28	29.40	33.05	-	-	33.14	36.43	37.96	37.94	-	-	36.20
01-05-18	-	-	-	31.30	-	30.10	29.80	33.10	-	-	33.20	36.40	38.50	38.50	36.40	-	36.20
01-08-18	-	-	-	31.10	-	29.70	30.00	-	-	-	33.10	36.50	38.30	38.30	-	-	36.00
Feb-19	-	30.40	-	31.40	-	30.30	30.60	-	-	-	33.40	36.50	38.80	38.70	-	-	35.70
Monitoring Events	1	5	4	16	3	17	17	15	1	4	17	14	17	17	7	1	16
Maximum	32.40	33.29	33.70	31.50	28.80	30.70	31.00	39.10	30.80	34.10	34.10	36.70	39.70	39.20	36.40	42.10	37.40
Minimum	32.40	33.29	33.70	31.50	28.80	30.70	31.00	39.10	30.80	34.10	34.10	36.70	39.70	39.20	36.40	42.10	37.40
Average	32.40	33.29	33.70	31.50	28.80	30.70	31.00	39.10	30.80	34.10	34.10	36.70	39.70	39.20	36.40	42.10	37.40
Standard Deviation	0.00	1.22	1.39	0.20	0.17	0.28	0.48	1.57	0.00	1.72	0.29	0.10	0.38	0.33	0.20	0.00	0.41