CEMEX UK Materials Limited
Whitehall Landfill
Permit number: MP3036SS
Variation number: LP3630MR

Annual environmental monitoring report for 2017

Contents

Figures

Tables

Appendices

1 Introduction

The Environmental Permit for Whitehall Landfill site, no. MP3036SS, issued by the Environment Agency on 17 March 2006, specifies under condition 4.2.1 that:

"A report or reports on the performance of the activities over the previous year shall be submitted to the Agency by 31 January (or other date agreed in writing by the Agency) each year. The report(s) shall include as a minimum:

(a) a review of the results of the monitoring and assessment carried out in accordance with this permit against the relevant assumptions, parameters and results in the risk assessments submitted in relation to this installation and any agreed amendments thereto;

(b) where the operator's management system encompasses annual improvement targets, a summary report of the previous year's progress against such targets;

(c) the annual production/treatment set you in schedule 5 table S5.2

(d) details of any contamination or decontamination of the site which has occurred

(e) the topographical surveys required by condition 3.6.3 other than those submitted as part of a CQA validation report;

(f) the volumetric difference (reported in cubic metres) between the most recent topographical survey and the previous annual topographical survey i.e. the additional volume of the landfill void that is occupied by waste;

(g) an assessment of the settlement behaviour of the landfill body based on the difference between the most recent topographical survey and previous annual topographical survey for the areas of the landfill which did not receive waste between the surveys;

(h) a calculation of the remaining capacity (reported in cubic metres) derived from the pre-settlement contours and the most recent topographical survey;

(i) a summary of the WAC compliance testing undertaken in the period"

This report is presented in compliance with this condition.

The installation is a landfill site and associated infrastructure, for disposal of inert waste. The Site covers an area of 5.2 ha and lies in a closed limestone quarry to the northwest of Wenvoe, approximately six miles southwest of Cardiff City Centre, South Glamorgan, at NGR 311700 173450.

The Site is surrounded by fields and woodland to the north and woodland to the east (Figure 1). To the west of the site are fields crossed by footpaths and containing a small pond. The southern part of the site is mostly bounded by fields and a track, with woodland towards the eastern part. The south eastern tip of the site is bounded by the houses and gardens along Walston Road in Walston which is at the north western edge of Wenvoe.

2 Site History

The landfill occupies a limestone quarry that was operational from around 1930 until 1976. After cessation of operations the Site lay dormant for 20 years. In 1984 a planning application for disposal of inert waste was approved. Following this, in 1996, a Waste Management Licence was granted (by the WRA, the Vale of Glamorgan Borough Council at the time) and landfill operations at the site began.

Waste was first accepted at Whitehall Landfill in November 1998. The Site formally operated under Waste Management Licence Number WM130189. Under the WML, the site was licensed to accept solid inert wastes including soils (top soil, sub-soil and overburden), brickwork, stone, concrete, sand (excluding foundry sand), cement, plastics, glass and fired pottery/ceramics. Certain other materials could also be accepted into the landfill provided that together they made up no more than 1% by volume of any one load. These included plaster, wood, wood products and cardboard and paper products.

The principal waste streams arriving at Whitehall Quarry are all of construction and demolition waste, originating from various districts within Wales.

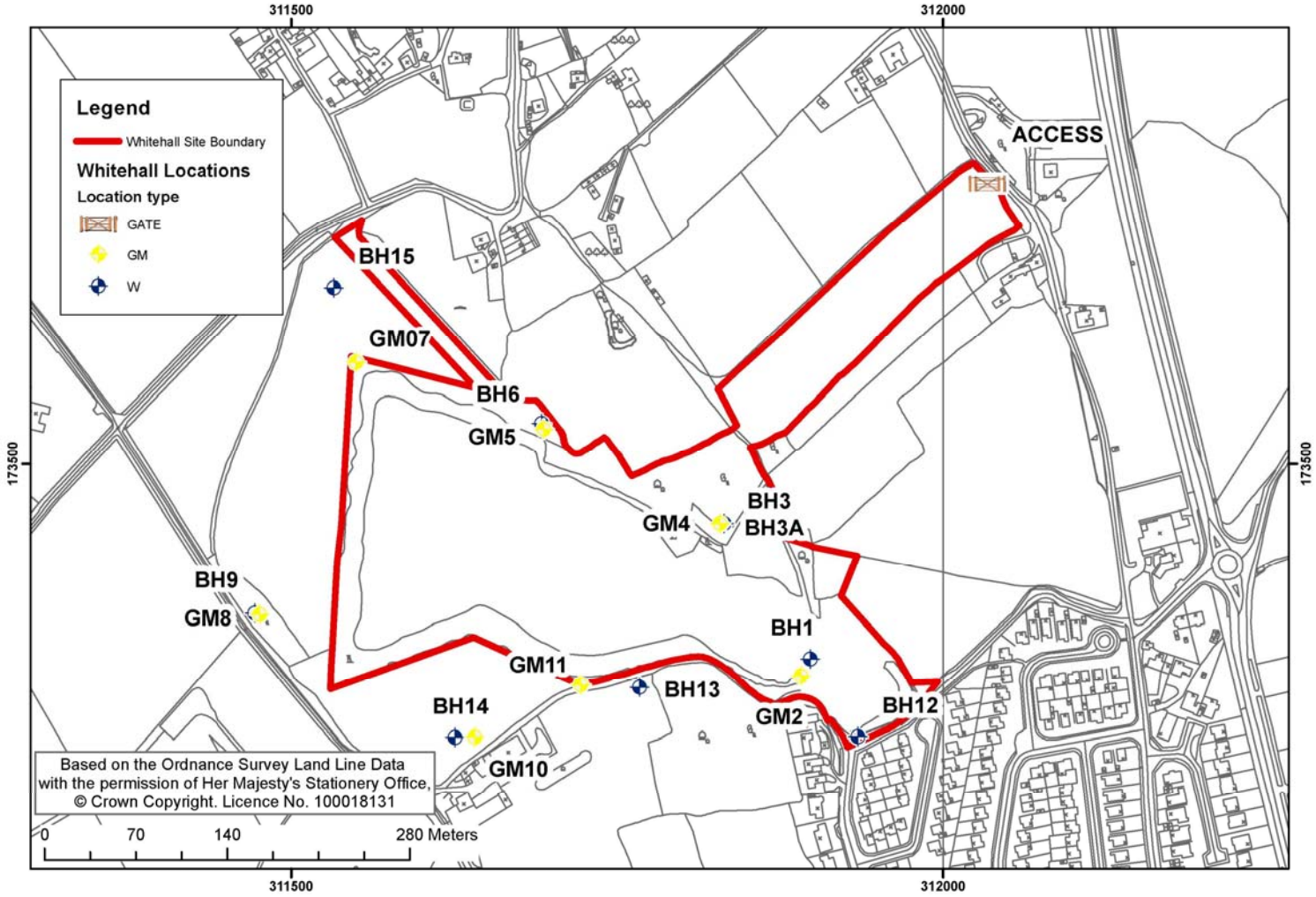
There are three closed landfills situated to the north, up gradient of Whitehall Quarry. The most northerly of these, Greenwood Quarry, located approximately 500 m from Whitehall Quarry (Drawing ESID 2, ESI/Arup (2005)), was licensed to receive inert and semi-inert material (Wildgust, 1998. Lafferty, 1998). Operations ceased in 1988. Greenwood Old Quarry lies immediately south of this and was licensed to accept solid non-toxic wastes although Wildgust (1998) and Lafferty (1998) suggest that material outside this classification was also accepted.

The most southerly of these sites, Blue Pool, located approximately 130 m from Whitehall Quarry (Drawing ESID 2, ESI/Arup (2005)), accepted solid non-toxic wastes and asbestos. Again Wildgust (1998) and Lafferty (1998) suggest other materials were disposed of at this site.

The Site covers an area of 5.2 ha and lies in a closed limestone quarry to the northwest of Wenvoe, approximately six miles southwest of Cardiff City Centre, South Glamorgan, at NGR 311700 173450. It is permitted to accept inert waste. The site is surrounded by fields and woodland to the north and woodland to the east (Figure 1). To the west of the Site are fields crossed by footpaths and containing a small pond. The southern part of the site is mostly bounded by fields and a track, with woodland towards the eastern part. The south eastern tip of the Site is bounded by the houses and gardens along Wallston Road in Wallston which is at the north western edge of Wenvoe.

Whitehall landfill is certified to the environmental management standard ISO 14001:2015.

Figure 1 Site location plan



3 Review of Monitoring Data

Schedule 4 of the site Permit specifies that monitoring of landfill gas and groundwater level and quality is required to assess any potential impact of the landfill on the surrounding environment. The following sections review the data collected from January to the end of the calendar year in December 2017. The locations of the monitoring points are shown on Figure 1.

3.1 Landfill Gas Monitoring

Landfill gas has been monitored for selected parameters in seven perimeter gas monitoring boreholes on a monthly frequency, with the exception of GM7, in accordance with the requirements specified in the variation notice. The location of these boreholes is shown on Figure 1.

Appendix A presents all gas monitoring data collected at these locations during 2017.

One of the stipulated gas monitoring locations, GM7, was lost in 2007. It was replaced by BH15 and gas monitoring had been undertaken at this location (with some interruptions for accessibility issues) since December 2007 until March 2017 when GM7 was located and monitoring resumed.

Compliance limits for stable methane and carbon dioxide of 1 % v/v and 6 % v/v respectively have been derived to provide threshold criteria and allow quantitative assessment of any potential harmful emissions from the landfill.

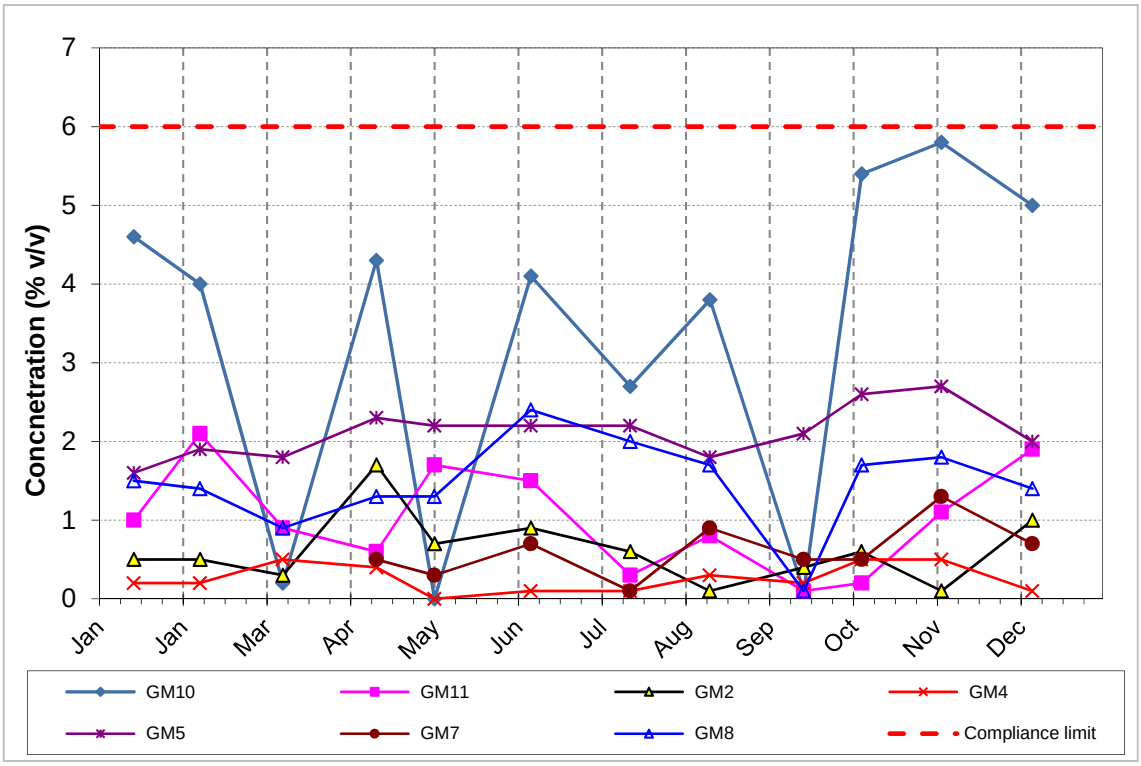
Methane has not been detected throughout the monitoring period in 2017, except in May and October when it was detected at 0.1 % v/v at all monitored locations. There have been no exceedances of the compliance limit.

Table 1 Compliance limits for landfill gas monitoring in perimeter boreholes

	Compliance Limit % v/v	
Monitoring Locations	**Carbon Dioxide**	**Methane**
GM2	6	1
GM4	6	1
GM5	6	1
GM7	6	1
GM8	6	1
CM10	6	1
CM11	6	1

Stable carbon dioxide concentrations between January and December 2017 are compared to the 6% v/v compliance limit at the required gas monitoring locations in Figure 2 below.

Figure 2 Stable carbon dioxide concentrations in 2017



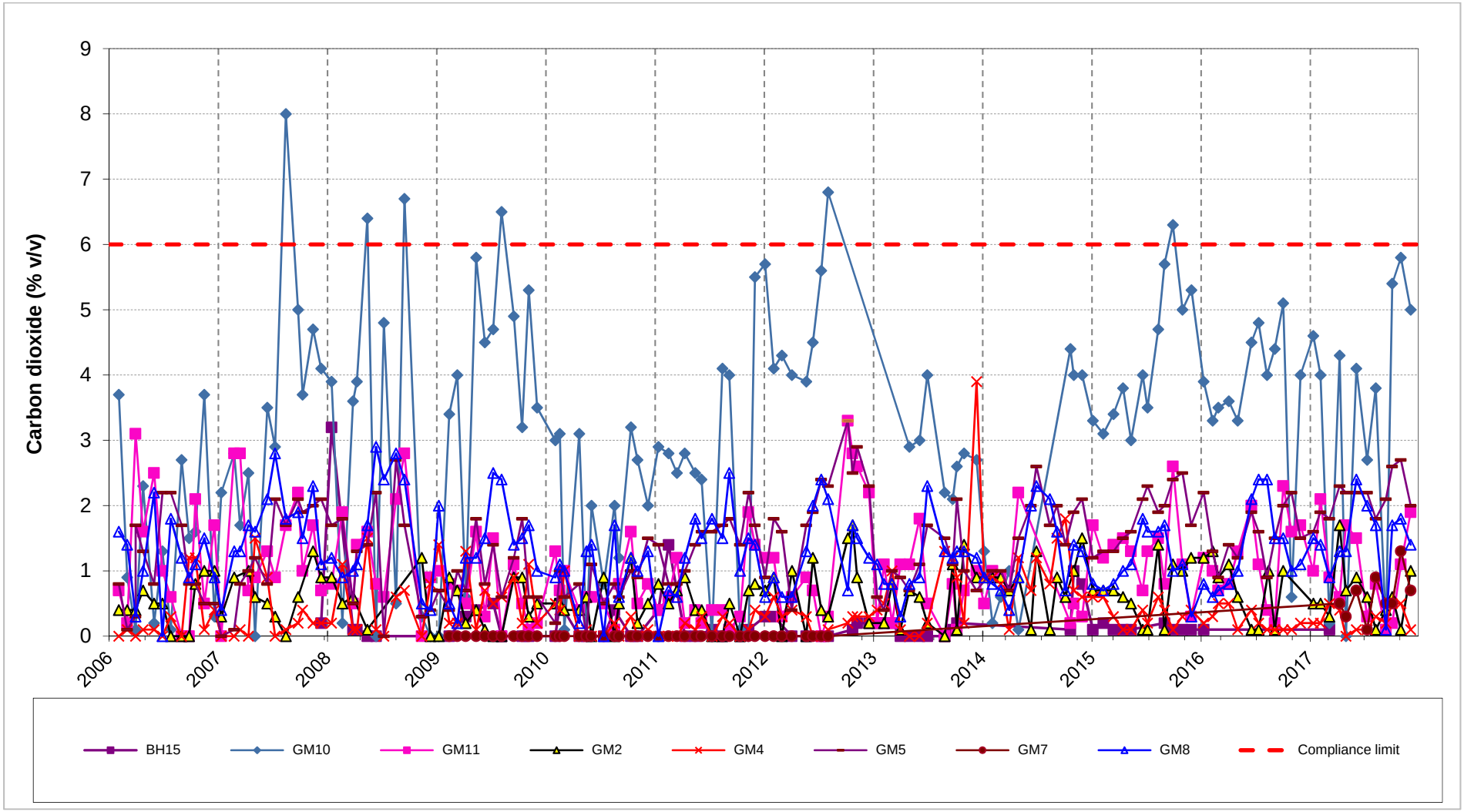
The carbon dioxide compliance limit was not exceeded on any occasion during 2017; however, GM10 came close to the limit during October to December. The majority of monitoring locations showed concentrations below 3 % v/v. Historically carbon dioxide concentrations have always been highest in GM10 and this continued to be the case in 2017, with a maximum reading of 5.8 % v/v.

As with previous years, there are no apparent short term trends in the data and concentrations are variable over the year at all monitoring points. Variations tend to correlate from one borehole to another, and are presumably related to variations in barometric pressure.

GM7 was not monitored for gas between January and March as it had previously been lost. The monitoring schedule was updated for 2017 and saw monitoring recommence in April 2017.

Historical stable carbon dioxide concentrations from early 2006 onwards are presented in Figure 3. The data show that concentrations of carbon dioxide were similar in 2017 to those in 2016 and previous years.

Figure 3 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the Permit requires groundwater quality to be monitored at four down-gradient site perimeter boreholes, BH1, BH12, BH13 and BH14, which have compliance limits set, as well as at five up-gradient boreholes BH3, BH3A, BH6, BH9 and BH15, which do not have any compliance limits, for the parameters listed in Table S4.4 of the permit (and summarised in Table 2). These locations were sampled on a quarterly and annual frequency for relevant determinands during 2017. The locations of the monitoring boreholes are shown on Figure 1.

Table 2 Groundwater monitoring requirements

Borehole	Parameter	Frequency
BH1, BH3, BH3A, BH6, BH9, BH12, BH13, BH14, BH15	Water level, pH, EC, NH4-N, Cl-, SO4, Alk, TON, TOC, Na, K, Ca, Mg, Fe	Quarterly[1]
	Mn, Cd, Cr, Cu, Ni, Pb, Zn, Naphthalene	Annually

[1] Frequency reduced from monthly to quarterly in mid-2015.

Control levels and compliance limits were updated for selected locations following the 2016 HRA review (ESI, 2016). These changes were agreed with NRW via letter and email dated 15 July 2016.

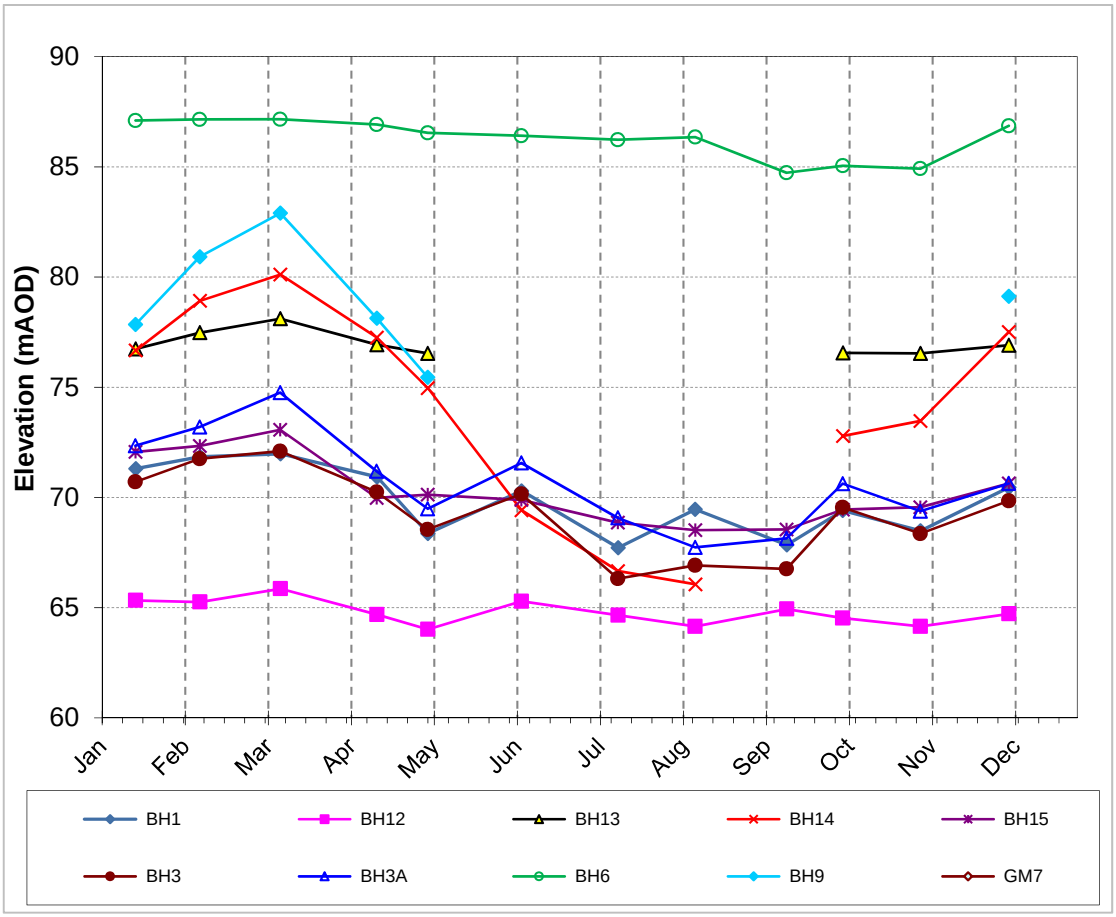
3.2.1 Groundwater Levels

Figure 4 presents the groundwater level data collected during 2017.

There are three boreholes that had months with no monitoring during 2017, these included BH13, BH14 and BH9. BH13 was not dipped between June and September due to being inaccessible from overgrown grass. BH14 was not dipped in September as the location was also inaccessible. Finally, BH9 was recorded as dry between June and November; hence no water levels were taken. In the previous annual report (CEMEX, 2016) it was noted that BH9 was blocked towards the end of the year and that the dip probe cannot pass to the full depth of the installed well. This was established following a camera survey carried out in May 2015, at which time a second minor blockage was also removed. Therefore, it is only possible to monitor this well under high groundwater level conditions.

In general, groundwater elevation during 2017 showed little change from the previous year (shown in Figure 5). Water levels showed seasonal trends as were slightly higher during January, especially in BH9 and BH14, and dropped to lower levels during the summer months of July and August but were mainly consistent throughout the year. BH6 recorded the lowest water level since 2013.

Figure 4 Groundwater elevation during 2017

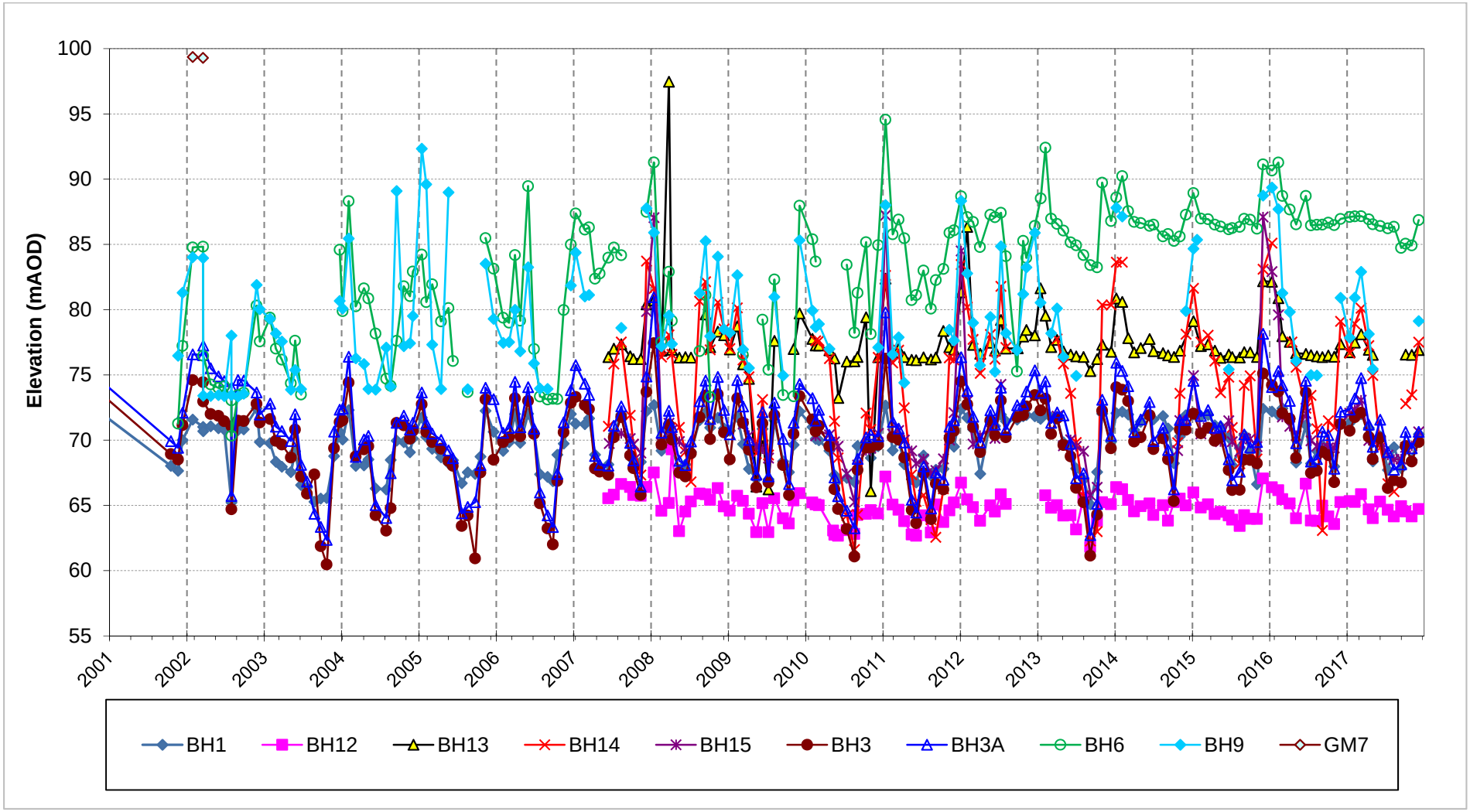


Historical observed water levels for all monitoring locations are shown in Figure 5. The groundwater levels monitored in BH3 and BH3A exhibit a similar trend to BH1, but with greater variation. However, during the current monitoring period the variation has decreased with very similar water levels being recorded at all three locations. The remaining monitoring locations all exhibit similar fluctuation timings, with varying degrees of variation. BH12 and BH13 follow the most similar trend with the least variation and BH6 and BH9 follow a similar trend but with greater variation.

Groundwater levels are generally more variable to the south-west where, historically, the variation in groundwater level is markedly greater in BH14, which continued to be the case during 2017. BH9 also showed a large variation in groundwater levels, although this borehole once again featured only a partial dataset during 2017 due to it being blocked.

The range of water levels at the monitoring locations is typically under 6 m. The exceptions to this are BH9 and BH14, which record a 7 m and 14 m variation over the course of 2017 respectively. Such variations are common in limestone aquifers that have limited storage potential.

Figure 5 Historical groundwater elevation



3.2.2 Groundwater Quality

Groundwater quality monitoring has been conducted in accordance with conditions specified in Schedule 4 of the PPC Variation Notice (LP3630MR) for stipulated parameters on an approximate monthly or quarterly frequency, and for additional parameters on an annual basis.

The entire data set for 2017 is presented in Appendix C.

Determinands for which compliance limits have been set.

Compliance limits for selected groundwater quality parameters have been derived in order to quantitatively assess landfill performance. A review of defined compliance limits was conducted by CEMEX in 2008 and submitted to the Environment Agency, as the regulating authority at the time, which approved the revised levels. These came into effect in October 2008.

Compliance limits were subsequently revised as part of the 2016 HRA review (ESI, 2016) and these were agreed with NRW in July 2016. Table 3 below details the compliance limits applied to the appropriate groundwater quality determinands at the required locations. There are no compliance limits specified for up-gradient boreholes BH3, BH3A, BH6, BH9 or BH15.

Table 3 Groundwater quality compliance limits

Location	Compliance limit				
	Ammoniacal Nitrogen (mg/l)	Chloride (mg/l)	Iron as Fe (µg/l)	Potassium (mg/l)	Napthalene (µg/l)
BH1	0.39	250	200	27 (12)	0.05
BH12				18.6 (14.73)	
BH13				12	
BH14					

Note: Numbers in brackets refer to old compliance limit prior to 2016 HRA review.

A statistical summary of groundwater quality compliance parameters is presented in Table 4. The data for potassium have been split over three rows, as there are separate compliance limits.

During 2017 there were a total of two compliance limit exceedances out of 89 individual analyses carried out. The two exceedances were for ammoniacal nitrogen. Whilst there were few detections of ammoniacal nitrogen, the result of 0.44 mg/l in BH1 in July and 0.41 mg/l in BH14 in July were in exceedance of the compliance limit. Table 5 shows five results for ammoniacal nitrogen which were above the DWS, including two down-gradient boreholes but also BH3A and BH9 which are up-gradient. Figure 6 shows an elevated concentration was noted in BH3A of 2 mg/l, however, the majority of the results in BH3A and BH9 are between 0.4-0.6 mg/l which are similar to the BH1 and BH14 concentrations. Due to these results and the fact that slightly elevated concentrations were detected up-gradient, it is likely that the ammoniacal nitrogen is not associated with this Site.

Figure 6 Ammoniacal nitrogen during 2017

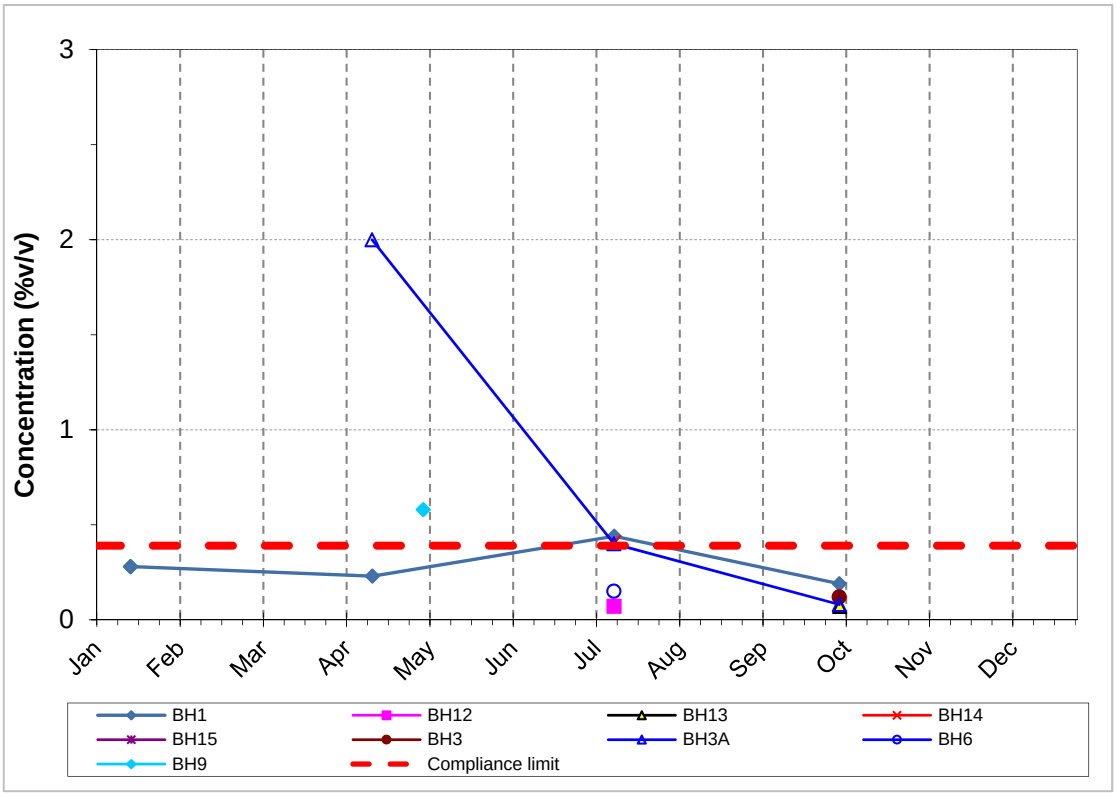


Table 4 Statistical summary of groundwater compliance parameters in 2017

Determinand	No. of Results	Unit	Min	Max	Mean	95th Percentile	# > LOD	% > LOD	Limits		
									No. Exceeding	% Exceeding	Action Level
Compliance parameters											
Ammoniacal Nitrogen as N	19	mg/l	<0.06	0.44	0.146	0.41	7	36.84	2	11	0.39
Chloride	15	mg/l	5.3	105	36.77	91.91	15	100	0	0	250
Iron	21	mg/l	<0.12	0.13	0.078	0.12	2	9.52	0	0	0.2
Napthalene	15	µg/l	<0.01	<0.02	0.007	0.013	0	0	-	-	0.05
Potassium (BH1)	6	mg/l	12.1	16.9	14.33	16.65	6	100	0	0	27
Potassium (BH13, 14)	7	mg/l	0.69	1.91	1.231	1.808	7	100	0	0	12
Potassium (BH12)	6	mg/l	7.85	18.6	13.33	18.03	6	100	-	-	18.6

Figure 7 shows groundwater chloride concentrations in 2017 – the maximum concentration was recorded in BH12 and was less than half the action level, reaching 105 mg/l in October. In general, concentrations were in line with the data from previous years, with a smaller peak in BH12 actually being recorded in 2017.

Figure 7 Groundwater chloride concentrations in 2017

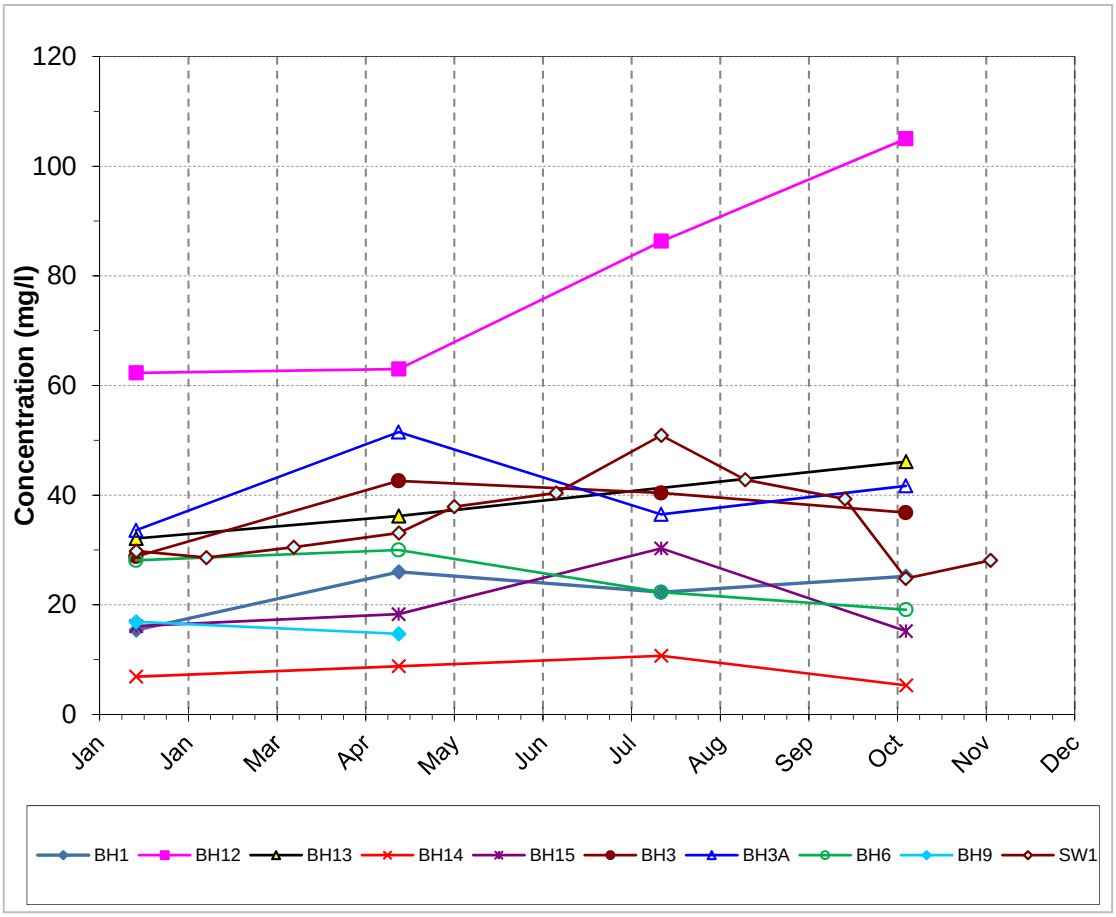
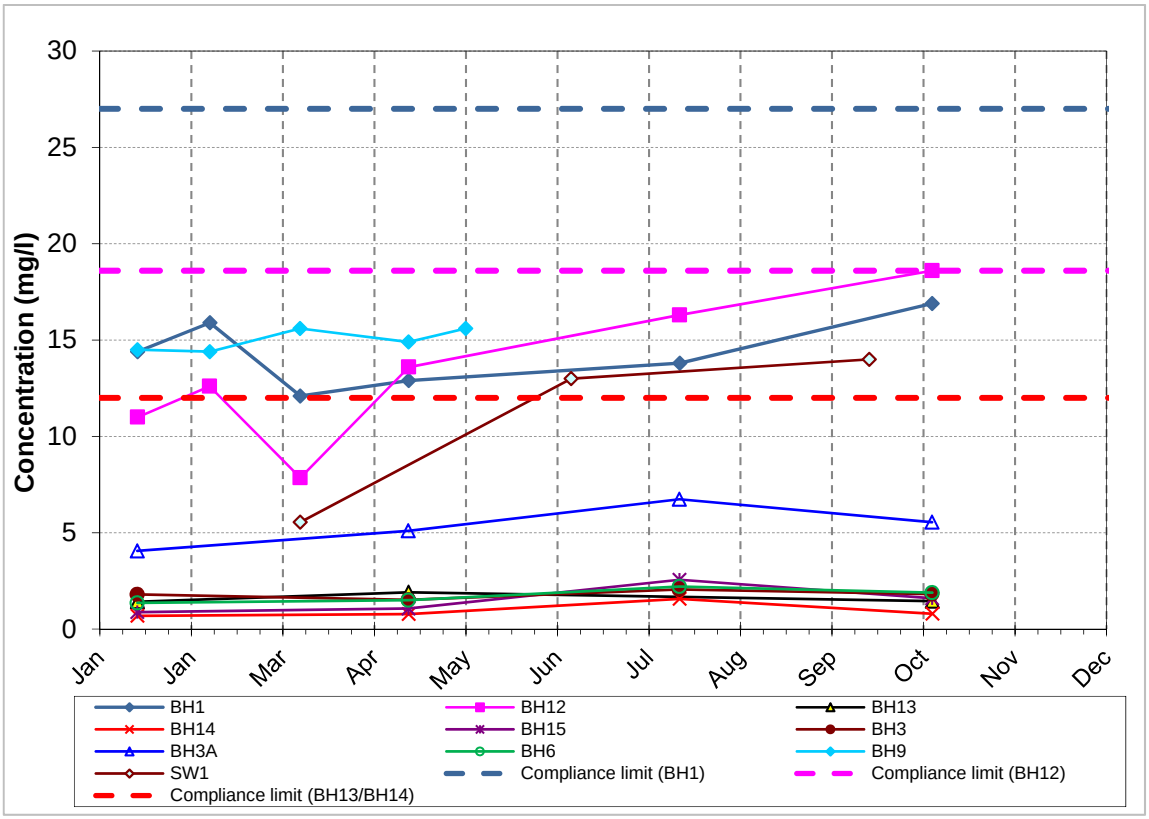


Figure 8 Groundwater potassium concentrations in 2017



Groundwater potassium concentrations during 2017 are presented in Figure 8. As reported in Table 4 there were no exceedances of any of the compliance limits. However, the highest concentration which was recorded in BH12 in October at 18.6 mg/l is at the compliance limit.

CEMEX (2016) suggested that a plume containing potassium had originated from up hydraulic gradient of the Site and is currently passing through it. Historical potassium concentrations in BH9 (up hydraulic gradient) were higher (Figure 9) but now appear to have stabilised around 15 mg/l. Concentrations at BH1 and BH12 (down hydraulic gradient) had been rising and are now either continuing to do so or have levelled off. BH12 concentrations appeared to have peaked at 18.1 mg/l in July 2016 and then declined. However, another peak at 18.6 mg/l was recorded in October 2017. This was the third successive increase in concentrations during 2017 – it is noted that concentrations have historically never increased on more than five consecutive occasions. The highest concentration at BH1 was 18.1 mg/l in October 2016.

Whilst the concentration at BH12 has not exceeded the compliance limit, it was reached in October 2017. Between January and May the concentrations were below the historical compliance limit, however between May and December this was exceeded as the concentration increased towards the new compliance limit. The compliance limit was changed in 2016 as mentioned previously in Section 3.2.

Routine sampling in BH9 was not performed after May 2017 due to the borehole being dry. This issue was discussed previously in CEMEX (2016). During a camera survey in May 2015 the borehole was found to have been blocked at two separate depths, preventing routine sampling. The blockage higher up in the borehole was removed, allowing samples to be obtained during winter when the groundwater elevation in the Limestone is higher and above the deeper blockage (which is at 25.4 m bgl).

During 2016 it was noted that the compliance limits were to be continually reviewed at BH1 and BH12 in order to decide on whether the compliance limits could be lowered. On the basis of the current data, it is recommended that the compliance limits are maintained at their current levels for 2018 and reviewed again in the 2018 annual report.

Iron was detected at low concentrations during the year, but no readings exceeded the compliance limit. The limit of detection was reduced to 120 µg/l in order to be able to determine whether exceedances were occurring through a different method in the laboratory.

There were no naphthalene exceedances during 2017 (see Table 4).

Other requisite determinants

A statistical summary of general groundwater quality at the site is presented in Table 5. Determinands have been compared to the UK Drinking Water Standards (UK DWS) for reference.

Groundwater quality at the Site is generally good, with a minor number of results occasionally recorded above the UK DWS during 2017 for calcium, sulphate, manganese and ammoniacal nitrogen.

The results for the major ions show only one calcium result (BH12) and 3 sulphate results (BH1 and BH3A) above the DWS. Iron and manganese are the only metals with results exceeding the DWS, with one manganese result in BH3A and 5 ammoniacal nitrogen results (BH3A, BH1, BH14 and BH9). Data for 2017 is in line with the historical dataset, with BH12 increasing in concentration for the majority of the determinands.

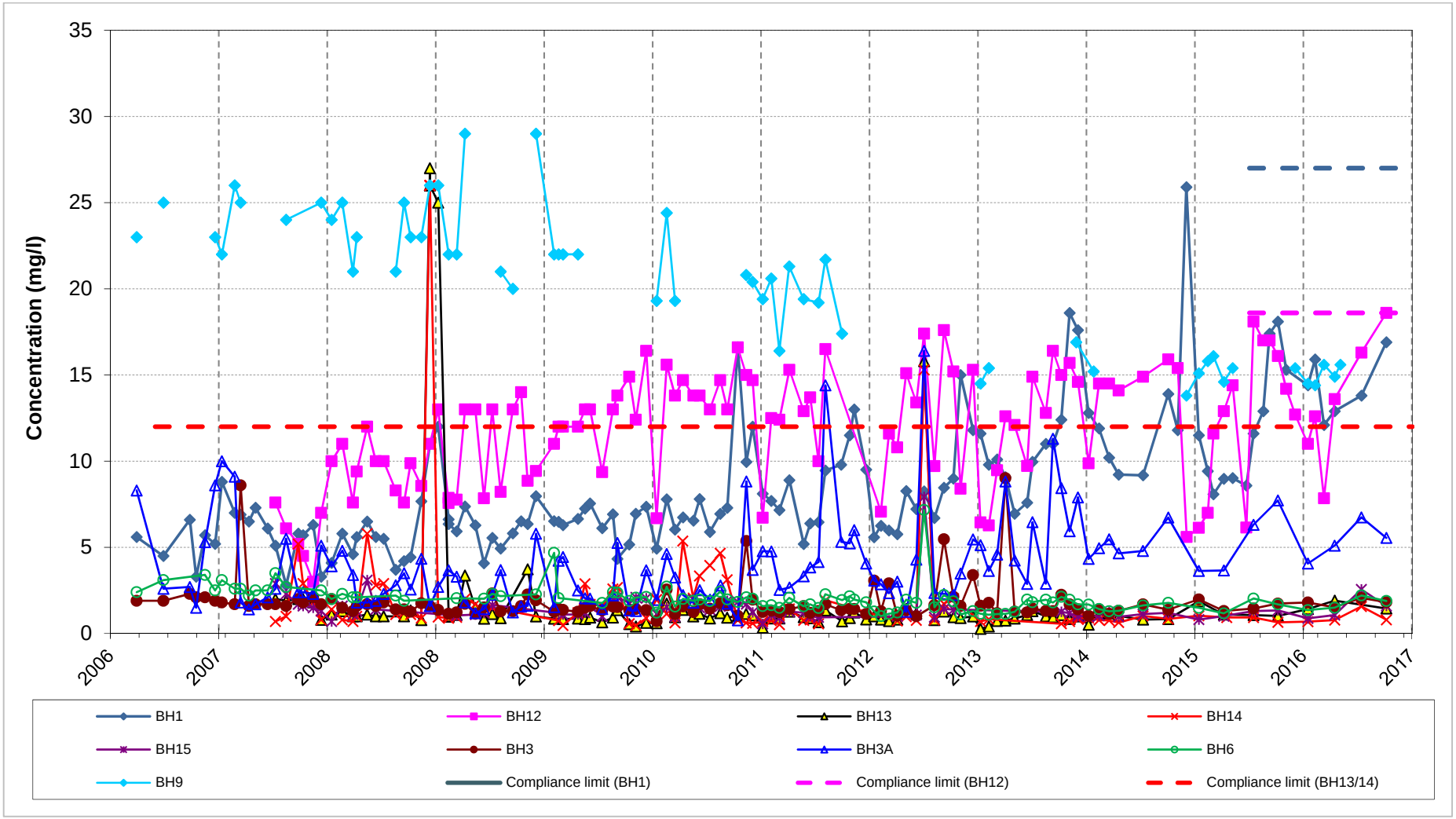
Table 5 Statistical summary of groundwater quality in 2017

												UKDWS	
Determinand	**No. of Results**	**Unit**	**Min**	**Max**	**Mean**	**Standard Deviation**	**5th Percentile**	**95th Percentile**	**# > LOD**	**% > LOD**	**No. Exceeding**	**% Exceeding**	**Action Level**
Field / lab parameters													
Conductivity – Electrical (Field)	36	µS/cm	222	1422	767	249	436	1256	36	100	0	0	-
Conductivity – Electrical 20deg	33	µS/cm	337	1540	738	235	564	1264	33	100	0	0	-
pH	33	pH	7.2	8.3	7.69	0.283	7.3	8.2	33	100	-	-	-
pH (Field)	36	pH	4.2	8.4	7.41	0.65	6.95	8.1	36	100	-	-	-
Major ions													
Alkalinity as CaCO3	33	mg/l	131	462	310	85.84	159	452.2	33	100	-	-	-
Calcium	33	mg/l	45	273	116	44.46	80.6	206	33	100	1	3	250
Chloride	33	mg/l	5.3	105	32.6	21.9	8.04	72.3	33	100	0	0	250
Magnesium	33	mg/l	6.3	40.5	27.1	9.178	13.42	39.8	33	100	0	0	50
Potassium	40	mg/l	0.69	18.6	7.28	6.32	0.80	16.3	40	100	-	-	-
Sodium	33	mg/l	3.09	64.6	16.97	13.85	5.15	46.3	33	100	0	0	200
Sulphate as SO4	33	mg/l	<4.4	525	76.64	120.7	2.2	319.8	29	87.9	3	9	250

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS No. Exceeding	UKDWS % Exceeding	UKDWS Action Level
Metals													
Cadmium	9	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.005
Chromium	9	mg/l	<0.002	<0.002	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.05
Copper	9	mg/l	<0.009	<0.009	n.d.	n.d.	n.d.	n.d.	0	0	0	0	2
Iron	43	mg/l	<0.12	0.421	n.d.	n.d.	n.d.	0.128	4	9.3	2	5	0.2
Lead	9	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.025
Manganese	9	mg/l	<0.007	1.4	0.168	0.46	n.d.	0.86	5	55.6	1	11	0.05
Nickel	9	mg/l	0.003	0.016	0.0058	0.004	0.003	0.012	9	100	0	0	0.02
Zinc	9	mg/l	<0.018	<0.018	0.009	0	0.009	0.009	0	0	0	0	5
Nitrogen species													
Ammoniacal Nitrogen as N	40	mg/l	<0.06	2	0.173	0.327	n.d.	0.447	13	32.5	5	13	0.39
Nitrate as N	9	mg/l	<0.7	6.6	1.91	2.362	n.d.	6.04	4	44.4	0	0	11
Nitrogen (total oxidised) as N	33	mg/l	<0.7	10.6	2.41	2.37	0.4	6.42	24	72.7	-	-	-
Other parameters													
BOD + ATU (5 day)													
Naphthalene	33	µg/l	<0.01	0.012	0.0064	0.003	0.005	0.011	2	6.06	-	-	-
TOC	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: if significant number of results exceed action limit row is coloured as follows: 10 – 25% pale red, 25 – 50% darker red, >50% dark red. n.d. statistic not determinable. Mean statistics for non-detects are calculated at half the limit of detection.

Figure 9 Historical groundwater potassium concentrations



4 Other Reporting Requirements

4.1 Production and Treatment

Schedule 5 Table S5.2 requires the operator to report the annual production and treatment of surface water and or groundwater that has been disposed of off-site and or disposed to any effluent treatment plant.

No surface water or groundwater has been taken off site or disposed of to any effluent treatment plant, thus no return is reported for 2017.

4.2 Contamination/Decontamination

There has been no contamination or decontamination of the site within the reporting period.

4.3 Topographical Survey

An up to date topographical survey is included in Appendix D.

4.4 Compliance Testing and Other Details

In 2017 an estimated 49,000 m^3 was tipped at the site. The remaining reported capacity is 45,000 m^3.

All waste accepted on the site were from CEMEX Approved List (as detailed in the PPC Application document WHL IPPC Volume 2, Site Operation Plan). Therefore no waste characterisation was required or undertaken.

5 Summary

The review covers the period between January and December 2017 and reviews the landfill gas, groundwater level and groundwater quality dataset at the Site.

The review has shown the following:

- Landfill gas has been monitored on an approximately monthly basis in seven perimeter gas boreholes in accordance with the requirements specified in the variation notice.
- Borehole GM7 was lost in 2007 and so was replaced by BH15 where gas monitoring was undertaken since December 2007 until March 2017. GM7 was then relocated and monitoring has resumed at this location from April 2017.
- There have been no exceedances of the compliance limit for methane and was only detected in May and October at 0.1 %v/v at all monitored locations.
- Carbon dioxide concentrations did not exceed the 6 % v/v compliance limit during the year. The majority of monitoring locations recorded concentrations below 3 % v/v. Concentrations were highest in GM10, as in previous years, with a maximum concentration of 5.8 % v/v in November. Consistently high elevations were recorded from October to December above 5 % v/v.
- There were no significant changes in groundwater elevation during 2017. Water levels in March were the highest in the year which were similar values to the previous year. BH14 continued to display a great range in water levels throughout the year.
- Ammoniacal nitrogen was detected in 13 out of 43 samples during 2017. Breaches of the compliance limit occurred in just two out of 19 samples. These breaches of the compliance limit were in BH1 and BH14 with 0.44 mg/l in BH1 in July and 0.41 mg/l in BH14 in July, compared to a compliance limit of 0.39 mg/l. It is noted that following these results concentrations returned to below the limit of detection later in the year.
- Chloride concentrations did not exceed the compliance limit in 2017 for any of the down-gradient boreholes. There were no significant changes in the data set from that of previous years with readings still being below half the compliance limit.
- There were no exceedances of iron for the compliance limit locations, even with the lower 0.2 mg/l compliance limit for which CEMEX arranged for the laboratory to accommodate a lower limit of detection.
- There were no exceedances of the potassium compliance limit in 2017. However, BH12 concentrations reached the limit on one occasion before falling below it on the subsequent monitoring round. Concentrations in BH9 appear to have stabilised after a number of years where they were declining. BH1 and BH12 concentrations also appear to have reached a steady state, with similar concentrations to BH9 following a number of years of rising trends.

6 References

CEMEX, 2016. Whitehall Landfill: Annual Environmental Monitoring Report for 2016.

ESI/Arup, 2005. Whitehall Landfill Conceptual Model, ESID Report.

ESI, 2008. Whitehall control and trigger level review. Report reference: 6496h.

ESI, 2016. Whitehall Landfill: Six-year Hydrogeological Risk Assessment Review. Report reference: 60080ADR1.

Lafferty, F. 1998. Landfill Gas Monitoring and Risk Assessment at Whitehall Quarry. M.Sc. Thesis, Applied Environmental Geology, unpublished.

Natural Resources Wales [NRW], 2016. Letter from Gwyn Jones to Gillian Ratcliffe, Re: Whitehall Quarry Hydrogeological Risk Assessment, dated 10 June 2016.

Wildgust, N.A., 1998. Hydrogeological Risk Assessment, Whitehall Quarry Landfill, Wenvoe, South Wales. M.Sc. Thesis, Applied Environmental Geology, Dept. of Earth Sciences, University of Cardiff (Unpublished).

Appendix A
Landfill Gas Monitoring Data

Appendix A Table 1 Gas monitoring data for 2017

Location	Date	Baro mb	CH4Peak % v/v	CH4Stable % v/v	CO2Peak % v/v	CO2Stable % v/v	DiffPress mb	O2Stable % v/v
BH15	08/03/2017	1000	0	0	0.1	0.1	-0.07	21.3
GM10	13/01/2017	1001	0	0	4.6	4.6	-1.24	15.4
GM10	06/02/2017	1003	0	0	4	4	-0.67	15.7
GM10	08/03/2017	1002	0	0	0.2	0.2	0.28	21.4
GM10	11/04/2017	1019	0	0	4.4	4.3	0.63	17.1
GM10	02/05/2017	1011	0.1	0.1	0.1	0	1.13	22.5
GM10	06/06/2017	988	0	0	4.1	4.1	0.91	17.9
GM10	12/07/2017	1008	0	0	2.7	2.7	0.65	18.6
GM10	10/08/2017	1017	0	0	3.8	3.8	0.1	15
GM10	13/09/2017	993	0	0	0.1	0.1	-0.07	20.7
GM10	04/10/2017	1013	0.1	0.1	5.4	5.4	0.07	12.3
GM10	02/11/2017	1007	0	0	5.8	5.8	0.31	12.3
GM10	05/12/2017	1026	0	0	5	5	0.33	16.4
GM11	13/01/2017	1001		0	1	1	-1.22	20.1
GM11	06/02/2017	1002	0	0	2.1	2.1	-0.83	18.9
GM11	08/03/2017	1001	0	0	0.9	0.9	0.76	20.7
GM11	11/04/2017	1019	0	0	0.6	0.6	7.69	20.8
GM11	02/05/2017	1010	0.1	0.1	1.7	1.7	5.96	21.1
GM11	06/06/2017	990	0	0	1.5	1.5	0.48	20.3
GM11	12/07/2017	1008	0	0	0.9	0.3	0.19	20
GM11	10/08/2017	1017	0	0	0.8	0.8	0.2	20.5
GM11	13/09/2017	994	0	0	0.1	0.1	-0.1	20.6
GM11	04/10/2017	1013	0.1	0.1	0.2	0.2	0.07	21.5
GM11	02/11/2017	1007	0	0	1.2	1.1	0.1	19.8
GM11	05/12/2017	1025	0	0	1.9	1.9	0.02	20.4
GM2	13/01/2017	1005		0	0.5	0.5	-1.58	20.1
GM2	06/02/2017	1006	0	0	0.5	0.5	-0.6	20.3
GM2	08/03/2017	1006	0	0	0.3	0.3	-0.16	20.5
GM2	11/04/2017	1022	0	0	1.7	1.7	0.12	20
GM2	02/05/2017	1014	0.1	0.1	0.7	0.7	0.62	21.8
GM2	06/06/2017	995	0	0	0.9	0.9	0.19	20.3

Location	Date	Baro mb	CH4Peak % v/v	CH4Stable % v/v	CO2Peak % v/v	CO2Stable % v/v	DiffPress mb	O2Stable % v/v
GM2	12/07/2017	1014	0	0	0.6	0.6	0.51	18.8
GM2	10/08/2017	1021	0	0	0.1	0.1	-0.31	21.3
GM2	13/09/2017	997	0	0	0.4	0.4	-0.43	20.6
GM2	04/10/2017	1019	0.1	0.1	0.7	0.6	-0.17	20.9
GM2	02/11/2017	1011	0	0	0.1	0.1	-0.12	21
GM2	05/12/2017	1029	0	0	1	1	-1.85	20.4
GM4	13/01/2017	1004		0	0.2	0.2	3.16	21
GM4	06/02/2017	1007	0	0	0.2	0.2	0.03	20.8
GM4	08/03/2017	1003	0	0	0.6	0.5	-1.26	19.6
GM4	11/04/2017	1022	0	0	0.4	0.4	0.15	20.5
GM4	02/05/2017		0	0	0.1	0	0.63	20.8
GM4	06/06/2017		0	0	0.1	0.1	0.24	19.2
GM4	12/07/2017	1009	0.1	0.1	0.1	0.1	-0.07	20.8
GM4	10/08/2017	1019	0	0	0.3	0.3	-0.39	20.7
GM4	13/09/2017	994	0	0	0.2	0.2	-0.27	20.4
GM4	04/10/2017	1016	0.1	0.1	0.5	0.5	-0.07	20.6
GM4	02/11/2017	1010	0.1	0	0.5	0.5	-0.07	20.4
GM4	05/12/2017	1029	0	0	0.1	0.1	-0.17	20.7
GM5	13/01/2017	1001	0	0	1.6	1.6	-1.05	19.5
GM5	06/02/2017	1004	0	0	1.9	1.9	0.02	19.4
GM5	08/03/2017	1000	0	0	1.8	1.8	0.16	18.5
GM5	11/04/2017	1018	0	0	2.3	2.3	0.22	17.5
GM5	02/05/2017	1011	0.1	0.1	2.2	2.2	0.81	19.1
GM5	06/06/2017	989	0	0	2.2	2.2	0.41	18.1
GM5	12/07/2017		0	0	2.2	2.2	0.05	19.3
GM5	10/08/2017	1018	0	0	1.8	1.8	-0.1	19.1
GM5	13/09/2017	992	0	0	2.1	2.1	-0.2	18.9
GM5	04/10/2017	1013	0.1	0.1	2.6	2.6	0.19	18.8
GM5	02/11/2017	1007	0	0	2.7	2.7	0.05	18.4
GM5	05/12/2017	1025	0	0	2	2	-0.1	19.1
GM7	11/04/2017	1018	0	0	0.5	0.5	0.51	20
GM7	02/05/2017	1010	0.1	0.1	0.4	0.3	1.76	21.8

Location	Date	Baro mb	CH4Peak % v/v	CH4Stable % v/v	CO2Peak % v/v	CO2Stable % v/v	DiffPress mb	O2Stable % v/v
GM7	06/06/2017	989	0	0	0.7	0.7	0.48	19.7
GM7	12/07/2017	1007	0	0	0.1	0.1	6.17	20.9
GM7	10/08/2017	1017	0	0	1	0.9	-0.15	20.2
GM7	13/09/2017	991	0	0	0.5	0.5	-0.1	20.4
GM7	04/10/2017	1012	0.1	0.1	0.5	0.5	-0.14	21.2
GM7	02/11/2017	1006	0	0	1.3	1.3	0.05	19.5
GM7	05/12/2017	1025	0	0	0.7	0.7	-0.05	18.9
GM8	13/01/2017	1000		0	1.5	1.5	-1.29	19
GM8	06/02/2017	1005	0	0	1.4	1.4	-0.33	20.3
GM8	08/03/2017	1002	0	0	0.9	0.9	0.12	19.9
GM8	11/04/2017	1019	0	0	1.3	1.3	0.43	19.5
GM8	02/05/2017	1010	0.1	0.1	1.3	1.3	0.72	21.2
GM8	06/06/2017	989	0	0	2.4	2.4	0.19	18.7
GM8	12/07/2017	1007	0	0	2	2	0.27	19.6
GM8	10/08/2017	1017	0	0	1.7	1.7	-0.12	20.1
GM8	13/09/2017	993	0	0	0.1	0.1	-0.51	21.7
GM8	04/10/2017	1013	0.1	0.1	1.7	1.7	0.03	20.3
GM8	02/11/2017	1007	0	0	1.8	1.8	0.02	19.8
GM8	05/12/2017	1026	0	0	1.4	1.4	-0.22	20.3

Appendix B
Groundwater Level Monitoring Data

Appendix B Table 1 Groundwater level data (mAOD) for 2017

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
13/01/2017	71.31	65.33	76.74	76.67	72.07	70.71	72.35	87.10	77.85
06/02/2017	71.85	65.26	77.48	78.92	72.34	71.76	73.20	87.15	80.92
08/03/2017	71.98	65.86	78.11	80.11	73.07	72.10	74.76	87.16	82.90
13/04/2017	70.93	64.69	76.93	77.25	69.98	70.25	71.19	86.92	78.13
02/05/2017	68.37	64.02	76.54	74.96	70.13	68.55	69.49	86.54	75.45
06/06/2017	70.30	65.29	[2]	69.42	69.89	70.16	71.57	86.41	[3]
12/07/2017	67.72	64.66	[2]	66.66	68.86	66.32	69.08	86.23	[3]
10/08/2017	69.46	64.15	[1]	66.06	68.52	66.92	67.74	86.35	[3]
13/09/2017	67.85	64.94	[2]	[2]	68.55	66.76	68.15	84.73	[3]
04/10/2017	69.41	64.53	76.56	72.79	69.45	69.55	70.63	85.05	[3]
02/11/2017	68.49	64.15	76.54	73.47	69.56	68.36	69.38	84.92	[3]
05/12/2017	70.46	64.72	76.91	77.51	70.64	69.85	70.64	86.86	79.13

[1] *- Location inaccessible – cannot get to the monitoring point.*

[2] *- Location could not be found.*

[3] *– Location dry.*

Appendix C
Groundwater Quality Monitoring Data

Appendix C Table 1 Quarterly groundwater quality data for 2017

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity-Electrical (Field) µS/cm	Conductivity-Electrical 20deg µS/cm	Iron µg/l	Magnesium mg/l	Naphthalene µg/l	Nitrogen (total oxidised) as N	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	TOC (filtered) mg/l
BH1	13/01/2017	138	0.28	45	15.4	458	337	120	6.3	<0.04	0.8	7.3	8.4	14.4	5.21	18.6	13
BH1	06/02/2017		<0.41			222		<230					7.2	15.9			
BH1	08/03/2017		<0.41					<120						12.1			
BH1	13/04/2017	221	0.23	95.5	26	606	583	<120	15.4	<0.02	<0.7	7.5	7.5	12.9	12.4	70.3	6.3
BH1	12/07/2017	218	0.44	86.2	22.3	580	597	<120	12.7	<0.02	2.8	8.1	8	13.8	12.3	69.5	9.7
BH1	04/10/2017	238	0.19	106	25.2	693	649	<120	17.3	<0.02	0.9	7.5	7.5	16.9	13.4	84.7	10.1
BH12	13/01/2017	332	<0.06	173	62.3	1422	1050	<120	29.5	<0.01	3	7.8	7.6	11	33.6	227	9.2
BH12	06/02/2017		<0.41			418		<230					7.1	12.6			
BH12	08/03/2017		<0.41					<120						7.85			
BH12	13/04/2017	358	<0.06	202	63	1211	1200	129	39.4	<0.01	2.1	7.4	7.7	13.6	41.7	287	5.6
BH12	12/07/2017	282	0.07	212	86.3	1098	1360	<120	38.1	<0.01	2.8	8.2		16.3	53.2	369	6.8
BH12	04/10/2017	258	<0.06	273	105	1390	1540	<120	39	<0.01	3.1	7.5	7.4	18.6	64.6	525	8.7
BH13	13/01/2017	354	<0.06	84.1	32.1	830	642	<120	36.3	<0.01	3.9	7.8	8.2	1.42	9.77	7.5	1.8
BH13	13/04/2017	323	<0.06	85.8	36.2	672	661	<120	35.7	<0.01	<0.7	7.6	4.2	1.91	11.1	10.3	1.5
BH13	12/07/2017																
BH13	04/10/2017	337	0.07	94.8	46.1	725	719	<120	40.5	<0.01	1	7.7	8	1.45	18.3	10.6	2
BH14	13/01/2017	462	<0.06	132	6.9	935	718	<120	31.3	<0.01	10.6	7.6	7.8	0.69	3.09	<4.4	1.6
BH14	13/04/2017	454	<0.06	133	8.8	808	785	<120	34.9	<0.01	5.2	7.2	7.3	0.78	5.16	<4.4	1.4
BH14	12/07/2017	448	0.41	131	10.7	735	817	<120	36.1	<0.01	6.3	8	7.4	1.57	6	<4.4	1.9
BH14	04/10/2017	451	<0.06	137	5.3	771	783	<120	35.9	<0.01	3.9	7.5	7.6	0.8	5.14	<4.4	1.9
BH15	13/01/2017	348	<0.06	107	16.1	807	610	<120	21.3	<0.01	4	7.6	7.5	0.88	8.28	11.8	1.8
BH15	13/04/2017	323	<0.06	111	18.3	661	628	<120	22.2	<0.01	1.3	7.4	7.1	1.07	9.32	13.1	1.8
BH15	12/07/2017	266	<0.06	90.4	30.3	561	600	<120	17.3	<0.01	2	8.1	7.2	2.56	16.8	14.5	2.9

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity-Electrical (Field) µS/cm	Conductivity-Electrical 20deg µS/cm	Iron µg/l	Magnesium mg/l	Naphthalene µg/l	Nitrogen (total oxidised) as N	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	TOC (filtered) mg/l
BH15	04/10/2017	323	<0.06	109	15.2	637	638	<120	23.2	<0.01	1.5	7.7	7.8	1.6	12.5	18.7	2.3
BH3	13/01/2017	318	<0.06	96.8	28.8	848	650	<120	23	<0.01	0.8	7.7	7.3	1.8	14.2	61.4	2.4
BH3	13/04/2017	226	<0.06	75.4	42.6	572	548	<120	20.4	<0.01	<0.7	7.7	7.2	1.52	17.4	19.4	1.7
BH3	12/07/2017	258	<0.06	97.3	40.4	609	660	<120	25.7	<0.01	0.8	8.2	7.2	2.06	20.1	47.1	1.5
BH3	04/10/2017	263	0.12	109	36.8	730	710	<120	28.8	0.0100	1.4	7.8	7.3	1.82	20.1	87.8	2.4
BH3A	13/01/2017	280	<0.06	85.7	33.6	970	605	<120	19.7	<0.01	<0.7	7.7	7.7	4.06	19.6	36.1	6.8
BH3A	13/04/2017	285	2	100	51.5	772	737	246	24.2	<0.02	<0.7	7.5	7.3	5.1	23.8	58.2	5.3
BH3A	12/07/2017	131	0.4	88.4	36.5	761	666	421	13.9	<0.01	2.3	8.3	7.6	6.74	24	166	3.6
BH3A	04/10/2017	173	0.08	127	41.7	872	820	<120	24.2	0.012	2.8	7.7	7	5.55	26.7	219	4.3
BH6	13/01/2017	332	<0.06	173	62.3	1422	1050	<120	29.5	<0.01	3	7.8	7.6	11	33.6	227	9.2
BH6	06/02/2017		<0.41			418		<230					7.1	12.6			
BH6	08/03/2017		<0.41					<120						7.85			
BH6	13/04/2017	358	<0.06	202	63	1211	1200	129	39.4	<0.01	2.1	7.4	7.7	13.6	41.7	287	5.6
BH9	13/01/2017	423	<0.06	135	16.9		693	<120	20.8	<0.01	5.9	7.3	7.6	14.5	7.85	4.6	2.8
BH9	06/02/2017		<0.41			442		<230					7.2	14.4			
BH9	08/03/2017		<0.41					<120						15.6			
BH9	13/04/2017	412	<0.06	141	14.7		817	<120	23.7	<0.01	6.6	7.4	7.5	14.9	7.71	8.3	2.3
BH9	02/05/2017		0.58			952		<120					6.8	15.6			
BH9	12/07/2017																
BH9	04/10/2017																

Appendix C Table 2 Annual groundwater quality data 2017

Location	Date	Cadmium µg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Manganese mg/l	Nickel mg/l	Zinc mg/l
BH1	13/04/2017	<0.6	<0.002	<0.009	<0.006	0.043	0.004	<0.018
BH12	13/04/2017	<0.6	<0.002	<0.009	<0.006	0.015	0.006	<0.018
BH13	13/04/2017	<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH14	13/04/2017	<0.6	<0.002	<0.009	<0.006	0.024	0.003	<0.018
BH15	13/04/2017	<0.6	<0.002	<0.009	<0.006	<0.007	0.005	<0.018
BH3	13/04/2017	<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH3A	13/04/2017	<0.6	<0.002	<0.009	<0.006	1.4	0.016	<0.018
BH6	13/04/2017	<0.6	<0.002	<0.009	<0.006	<0.007	0.005	<0.018
BH9	13/04/2017	<0.6	<0.002	<0.009	<0.006	0.012	0.005	<0.018

Appendix D
Topographical Survey

311600E 311700E 311800E 311900E 312000E 312100E 312200E

173700N 173600N 173500N 173400N 173300N

7274 7469 7457 8364 6964 0067 0062 0059 0044 0044

110.3m

LB
BM 112.29m

OSBM

Ty Lug

Hill Terrace

Twyn-yr-odyn

Flush Cover
CL. BH 15/07
118.84

GL. BH 15A/07
117.87

GL. BH 15B/07
117.59

BH TB.65

G12.3
115.865

12.01
115.882
Compacted Tipped Material

12.1
110.670

BH
113.40
112.93

BH
109.44

Track

Path (um)

92.2D
84.244

93.2C
85.528

92.2
83.192

93.5
85.318

92.2B
80.095

G16.1
88.018

93.2
92.409

G12.2
83.872

G07.2
83.729

A:
70.612

Path (um)

Drain

Path (um)

Path (um)

Le Reve

St Annes

The Forge

Brynawel

OSBM
BM 61.04m
60.0m

Wilden Lodge

PORT ROAD

Wallston Castle
(PH)

Shelter

Ty Gwenfo

GREAT

CLOSE

105.8m
Cattle Grid

(New 05/2007)
Flush Cover
CL. 109.99
BH 14/07

CL. 109.78
BH 10

(Reinstated 05/2007)
Flush Cover

CL. 106.34
BH
Flush Cover

BH 109.52
CL.
Conc.L.
69.18

Models		
	Drawn from	SITE MOD 070617.LSS
	Overlay 1	2D 0617
	Overlay 2	OS2D 0507
	Overlay 3	none
	Overlay 4	none
	Overlay 5	

CEMEX
Geological Services Department
CEMEX UK Operations Limited
Wolverhampton Road, Oldbury,
Warley, West Midlands.
B69 4RJ
Telephone 0121 569 7464
Facsimile 0121 544 7447

Drawn By: R.J.J.	Company: CEMEX UK Materials: Southh West
Date: 12/06/2017	Site: Whitehall Quarry
Scale(S): 1:1,250 @ "A2"	Project: Quarry Survey Update (Landfill)
Chkd/Model(s):	Title: Quarry Survey June 2017
Site Ref.	Drawing No.: WHTL Site MOD 0617 RJJ.pdf