

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

Annual environmental monitoring report for 2019

Contents

1	Introduction.....	1
2	Site Description and History	2
3	Review of Monitoring Data	4
3.1	Landfill Gas Monitoring.....	4
3.2	Groundwater Monitoring.....	7
3.2.1	Groundwater Levels.....	7
3.2.2	Groundwater Quality.....	10
4	Other Reporting Requirements	17
4.1	Production and Treatment	17
4.2	Contamination/Decontamination.....	17
4.3	Topographical Survey.....	17
4.4	Compliance Testing and Other Details.....	17
5	Summary.....	18
6	References.....	19

Figures

Figure 1	Site location plan	3
Figure 2	Stable carbon dioxide concentrations in 2019	5
Figure 3	Historical stable carbon dioxide concentrations	6
Figure 4	Groundwater elevation during 2019	8
Figure 5	Historical groundwater elevation (2010-2019).....	9
Figure 6	Ammoniacal nitrogen in groundwater at boreholes with compliance limits.....	12
Figure 7	Potassium concentrations in groundwater at boreholes with compliance limits (downgradient).....	13
Figure 8	Potassium concentrations in groundwater at boreholes without compliance limits (upgradient).....	14

Tables

Table 1	Monitoring requirements and compliance limits for landfill gas monitoring in perimeter boreholes.....	4
Table 2	Groundwater monitoring requirements	7
Table 3	Groundwater quality compliance limits	10
Table 4	Statistical summary of groundwater compliance parameters in 2019	11
Table 5	Statistical summary of groundwater quality in 2019.....	15

Appendices

Appendix A	Landfill Gas Monitoring Data
Appendix B	Groundwater Level Monitoring Data
Appendix C	Groundwater Quality Monitoring Data
Appendix D	Topographical Survey

1 Introduction

The Environmental Permit for Whitehall Landfill (the 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 Description and History

The Site covers an area of 5.2 ha and lies to the northwest of Wenvoe, approximately six miles southwest of Cardiff City Centre, South Glamorgan, at NGR 311700 173450. It is currently permitted to accept inert waste, however it stopped accepting waste at the end of October 2018 as filling is complete. 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.

The landfill occupies a former 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 Waste Regulatory Authority, 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 this 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 in total they made up no more than 1% by volume of any one load. These included plaster, wood, wood products, cardboard and paper products.

The principal waste streams that arrived at Whitehall Quarry were all of construction and demolition waste, originating from various districts within Wales. The Site is certified to the environmental management standard ISO 14001:2015.

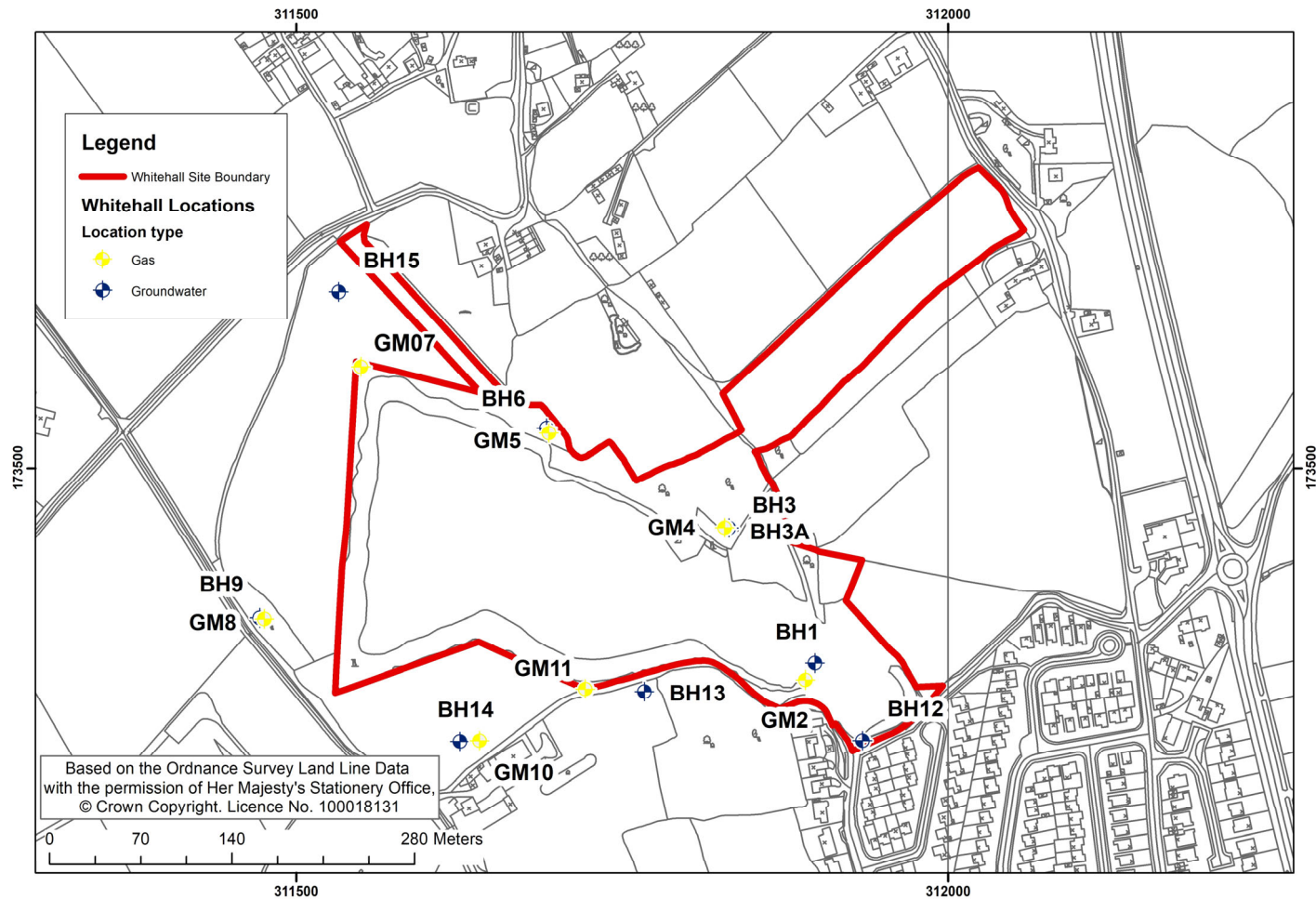
There are three closed landfills situated to the north, up-gradient of Whitehall Quarry. The most northerly of these, Greenwood Quarry, located approximately 500 m from Whitehall Quarry (Drawing ESID 2, ESI/Arup (2005)), was licensed to receive inert and semi-inert material (Wildgust, 1998. Lafferty,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

Whitehall Landfill

Annual environmental monitoring report for 2019

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 2019. The locations of the monitoring points are shown on Figure 1.

3.1 Landfill Gas Monitoring

Landfill gas has been monitored in seven perimeter gas monitoring boreholes on a monthly frequency in accordance with the requirements specified in the permit. The monitoring requirements and compliance limits are given in Table 1. The location of these boreholes is shown on Figure 1.

Appendix A presents all gas monitoring data collected at these locations during 2019.

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 again 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.

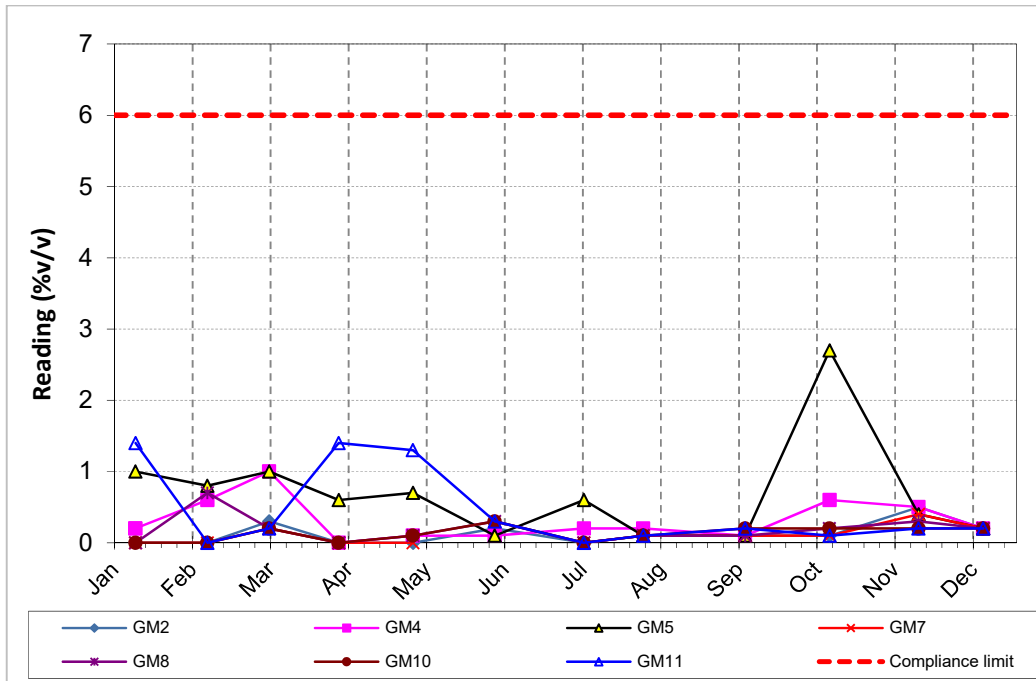
Methane has not been detected throughout the monitoring period in 2019, except on four occasions at GM2, GM4 and GM7 (all at 0.1% v/v in April) and at GM8 at 0.1% v/v in October. There have been no exceedances of the compliance limit.

Table 1 Monitoring requirements and compliance limits for landfill gas monitoring in perimeter boreholes

Monitoring Locations	Parameter	Frequency	Compliance limit (% v/v)
GM2, GM4, GM5, GM7, GM8, GM10, GM11	Methane	Monthly	1
	Carbon dioxide		6

Stable carbon dioxide concentrations between January and December 2019 are compared to the 6% v/v compliance limit at the required gas monitoring locations in Figure 2 below.

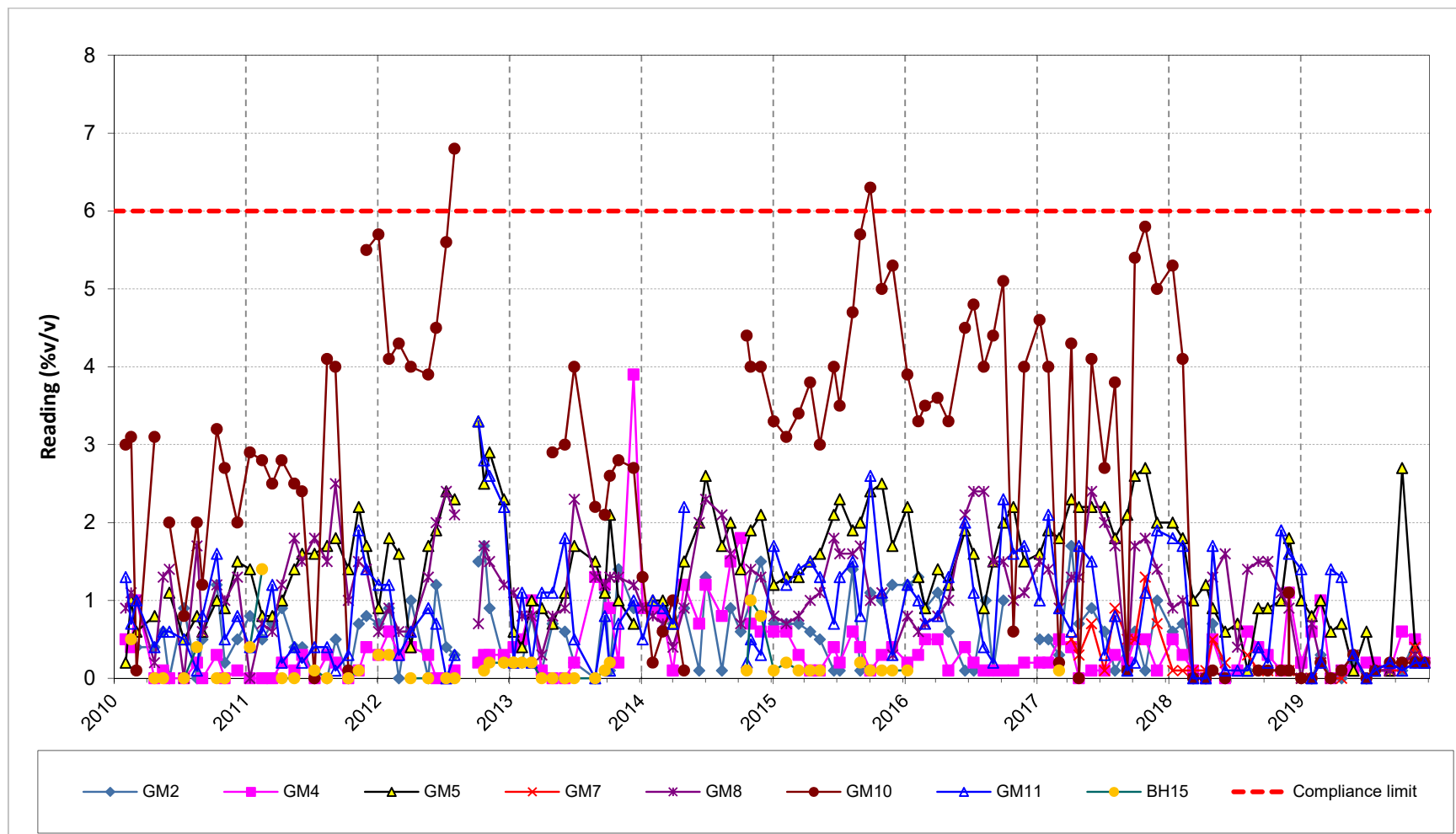
Figure 2 Stable carbon dioxide concentrations in 2019



The carbon dioxide compliance limit was not exceeded on any occasion during 2019. The majority of monitoring locations showed concentrations below 2% v/v, except for one reading of 2.7% v/v at GM5 in October. In general, before 2018, concentrations of carbon dioxide were higher, particularly at GM10, where concentration often came close to or exceeded the 6% v/v compliance limit. Historical carbon dioxide concentrations are presented in Figure 3.

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.

Figure 3 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the Permit requires monitoring of groundwater quality at four down-gradient site perimeter boreholes, BH1, BH12, BH13 and BH14, which have compliance limits set, and at five up-gradient boreholes BH3, BH3A, BH6, BH9 and BH15, which do not have any compliance limits. The required parameters are 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 2019. 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, Electrical conductivity, Ammoniacal Nitrogen as N, Chloride, Sulphate as SO ₄ , Alkalinity, TON, TOC, Sodium, Potassium, Calcium, Magnesium, Iron	Quarterly ¹
	Manganese, Cadmium, Chromium, Copper, Nickel, Lead, Zinc, 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. The current compliance limits are given in Table 3.

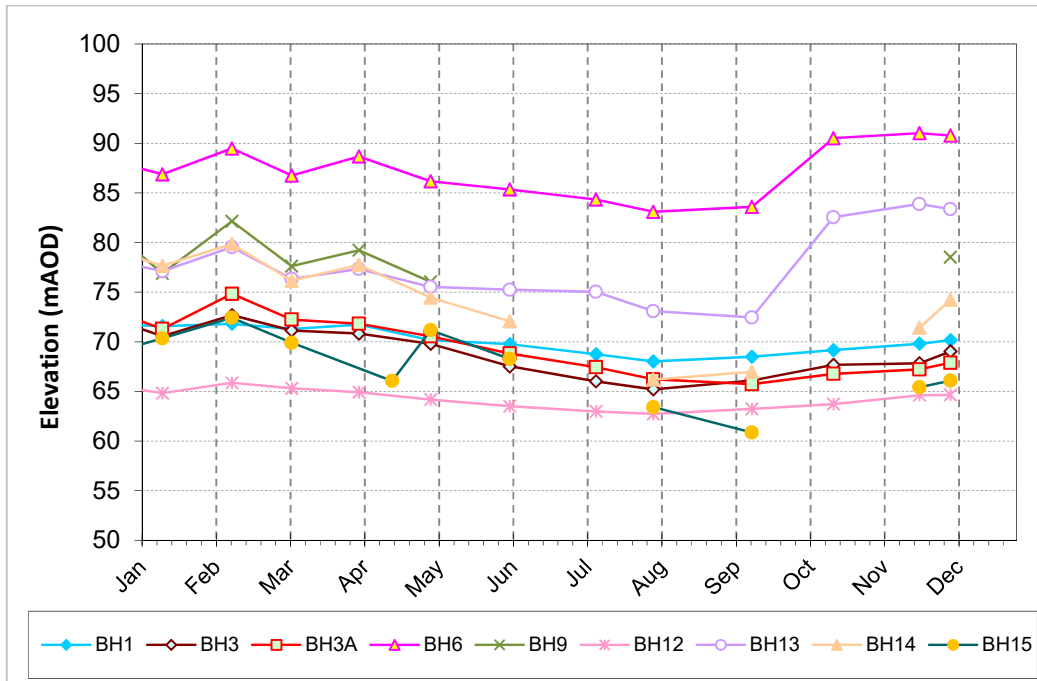
3.2.1 Groundwater Levels

Monthly groundwater level data collected during 2019 are presented in Figure 4

There are three boreholes that had periods with no monitoring data during 2019: BH9, BH14 and BH15. BH9 was dry from June to November. Both BH14 and BH15 were inaccessible in July and October due to overgrowth of vegetation.

In 2019, groundwater levels show a decline from February to August/September and then a rise to the end of the year. This increase is most marked at BH6 and BH13 where the increase from September to October is 6.9 and 10.1 m respectively. Groundwater levels were highest at BH6, with a maximum of 91.0 mAOD in November. Groundwater levels were generally lowest at BH12, except in September when levels at BH15 dropped below those at BH12 for one month at 60.9 mAOD.

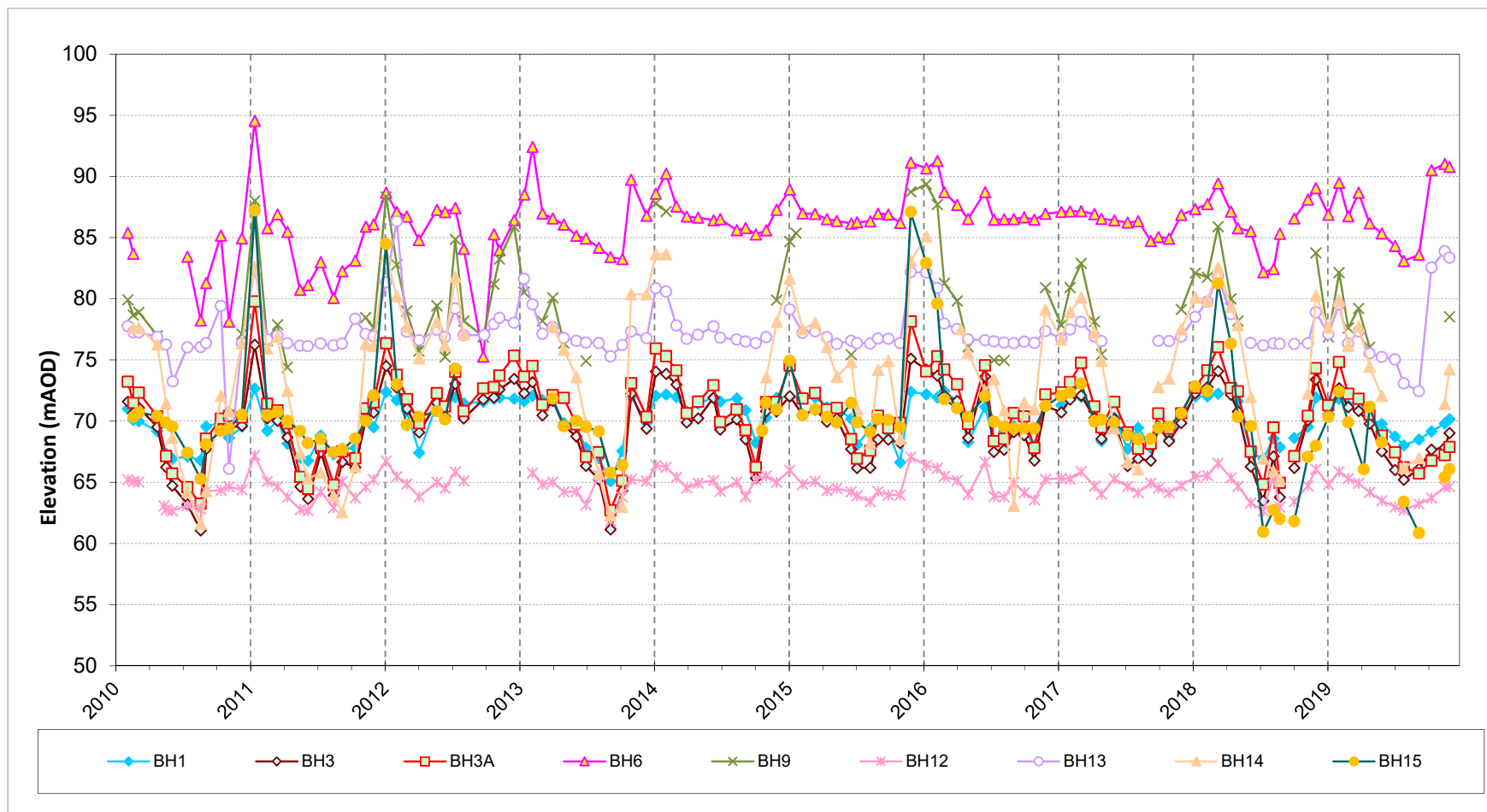
Figure 4 Groundwater elevation during 2019



Historical observed groundwater levels for the past decade for all monitoring locations are shown in Figure 5. Overall the groundwater levels match with the historical trends. The groundwater levels monitored in BH3 and BH3A exhibit a similar trend to BH1, but with greater variation. The remaining monitoring locations all exhibit similar fluctuation timings, with differing degrees of variation. BH12 shows smaller amplitudes than the other wells. BH13 previously showed smaller amplitudes of changes, in line with BH12, however it shows a large amplitude change in October 2019.

Groundwater levels are generally more variable to the south-west where, historically, the variation in groundwater level is markedly greater in BH14, which has continued to be the case during 2019. BH14 had a maximum groundwater level of 79.9 mAOD and a minimum of 66.2 mAOD, a range of 13.7 m.

Figure 5 Historical groundwater elevation (2010-2019)



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) as outlined in Table 2.

The entire data set for 2019 is presented in Appendix C.

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

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

During 2019, there was a total of two compliance limit exceedances out of the 65 individual analyses carried out. There was one exceedance of ammoniacal nitrogen at BH13 in July with a concentration of 0.47 mg/l against the compliance limit of 0.39 mg/l – the first record of any concentration of ammoniacal nitrogen at this borehole. The other exceedance was at BH12 in July with a potassium concentration of 19.7 mg/l against a compliance limit of 18.6 mg/l. Schedule 6 notifications were submitted on both of these occasions.

Table 4 Statistical summary of groundwater compliance parameters in 2019

Determinand	No. of Results	Unit	Min	Max	Mean	95th Percentile	# > LOD	% > LOD	Limits		
									No. Exceeding	% Exceeding	Compliance limit
Ammoniacal Nitrogen as N	13	mg/l	<0.06	0.47	n.d.	0.206	1	7.7	1	7.7	0.39
Chloride	13	mg/l	7.2	177	56.7	140	13	100	0	0	250
Iron	13	mg/l	<0.025	0.055	n.d.	0.06	1	7.7	0	0	0.2
Naphthalene	13	µg/l	<0.01	<0.01	n.d.	n.d.	0	0	0	0	0.05
Potassium (BH1)	4	mg/l	10.5	14.6	12.6	14.4	4	100	0	0	27
Potassium (BH12)	4	mg/l	9.54	19.7	14.3	18.9	4	100	1	25	18.6
Potassium (BH13, BH14)	5	mg/l	0.79	4.3	2.41	4.05	5	100	0	0	12

Red indicates that the compliance limit was exceeded

Groundwater ammoniacal nitrogen concentrations for the last decade are presented in Figure 6. This shows that in the last ten years, the majority of samples at down-gradient boreholes are at or below the detection limit. There are a number of peaks in concentration up to a maximum of 0.92 mg/l at BH1 in 2016, although this was an isolated peak.

Potassium concentrations in groundwater during the last decade are presented in Figure 7 and Figure 8. Potassium concentrations have been slightly elevated at BH1, BH12 and BH13 since 2016. 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 8) but stabilised around 15 mg/l from 2013 before the lowest measured concentration was recorded in April 2018 at 12.7 mg/l. There was no monitoring of BH9 during 2019 as it was dry or there was insufficient water to obtain a sample. This issue was discussed previously in CEMEX (2016). Maximum potassium concentrations at BH3A (up-gradient) were higher in 2019 than in the last 5 years, however there were also two relatively low concentrations.

In the HRA Review (ESI, 2016) it was noted that the compliance limits were to be reviewed annually at BH1 and BH12. On the basis of the current data, it is recommended that the compliance limits are maintained at their current levels for 2020 and reviewed again in the annual report.

Iron was only detected once during the year at 55 µg/l. No readings exceeded the compliance limit.

There were no naphthalene exceedances during 2019 (see Table 4). 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 exceedances of the UK DWS only recorded during 2019 for ammoniacal nitrogen. Data for 2019 is in line with the historical dataset.

Figure 6 Ammoniacal nitrogen in groundwater at boreholes with compliance limits

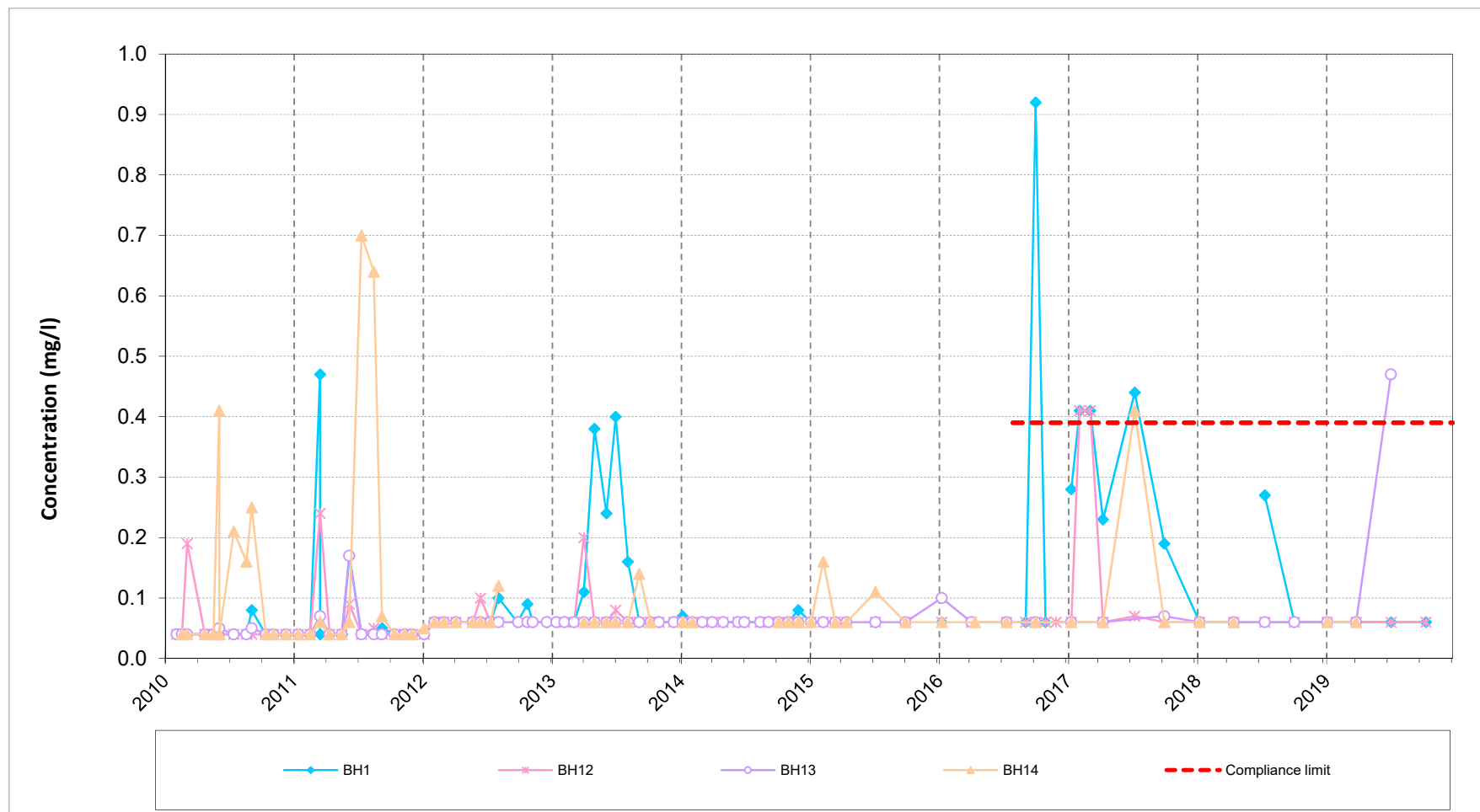


Figure 7 Potassium concentrations in groundwater at boreholes with compliance limits (downgradient)

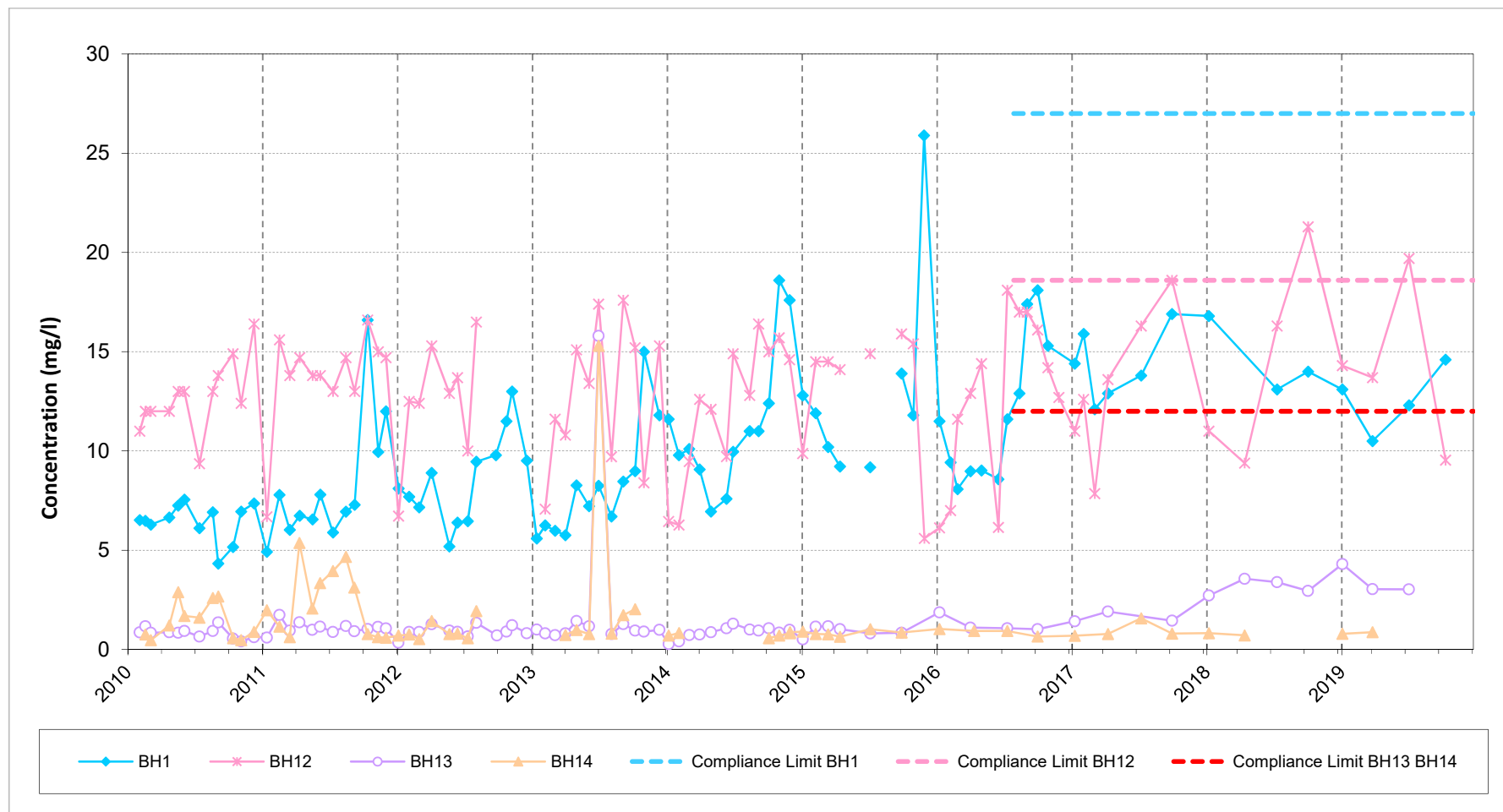
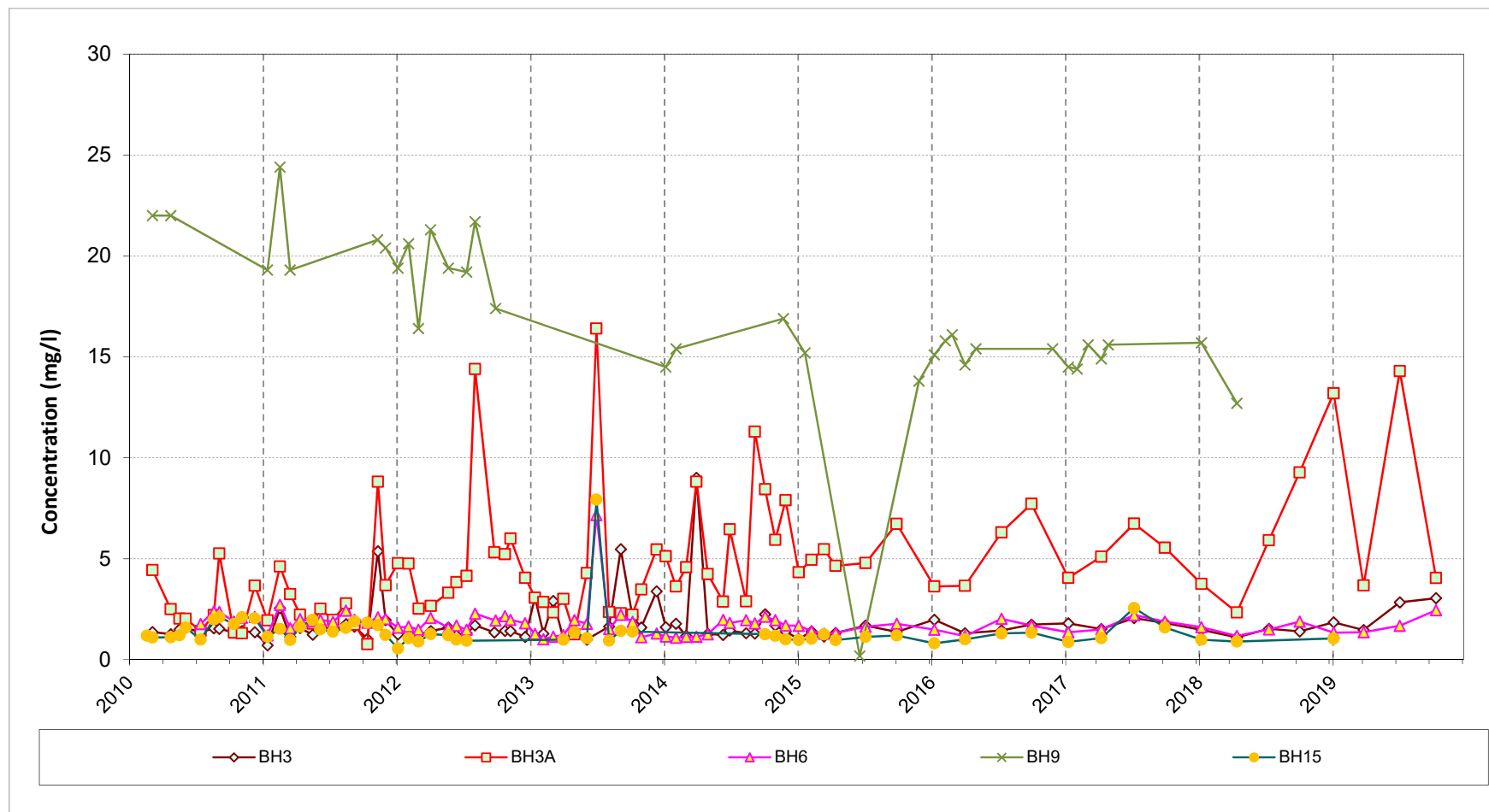


Figure 8 Potassium concentrations in groundwater at boreholes without compliance limits (upgradient)



Whitehall Landfill
Annual environmental monitoring report for 2019

Table 5 Statistical summary of groundwater quality in 2019

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	UKDWS				
										# > LOD	% > LOD	No. Exceeding	% Exceeding	Action Level
Field / lab parameters														
Conductivity- Electrical (Field)	24	µS/cm	3.27	3230	1306	1074	796	577	2884	24	100	0	0	-
Conductivity- Electrical 20deg	26	µS/cm	437	1390	782	607	302	477	1313	26	100	0	0	-
pH	26	pH	7	7.9	7.56	7.55	0.221	7.25	7.9	26	100	0	0	-
pH (Field)	25	pH	7.1	8.4	7.66	7.7	0.35	7.2	8.28	25	100	0	0	-
Major ions														
Alkalinity as CaCO3	26	mg/l	187	518	307	276	88.6	211	470	26	100	0	0	-
Calcium	26	mg/l	61.9	225	123	109	45.9	79.3	209	26	100	0	0	-
Chloride	26	mg/l	7.2	177	49.3	28.8	41.9	8.48	113	26	100	0	0	250
Magnesium	26	mg/l	11.5	74.4	29.5	25.6	16.7	12.1	65.3	26	100	0	0	-
Potassium	26	mg/l	0.79	19.7	6.62	3.37	5.87	0.915	14.5	26	100	0	0	-
Sodium	26	mg/l	6.05	56.8	20.4	14.5	13.8	6.68	45.3	26	100	0	0	200
Minor ions														
Cadmium	7	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.01
Chromium	7	mg/l	<0.002	<0.002	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.05
Copper	7	mg/l	<0.009	<0.009	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	2
Iron	26	mg/l	<0.025	0.055	n.d.	n.d.	n.d.	n.d.	0.06	2	7.7	0	0	0.2
Lead	7	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.01
Manganese	7	mg/l	<0.007	0.019	0.0103	0.008	0.0061	n.d.	0.0184	5	71	0	0	0.05
Nickel	7	mg/l	0.003	0.011	0.0053	0.004	0.0029	0.003	0.0098	7	100	0	0	0.02

Whitehall Landfill
Annual environmental monitoring report for 2019

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	UKDWS				
										# > LOD	% > LOD	No. Exceeding	% Exceeding	Action Level
Zinc	7	mg/l	<0.018	<0.018	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	-
Nitrogen species														
Ammoniacal Nitrogen as N	26	mg/l	<0.06	0.47	n.d.	n.d.	n.d.	n.d.	0.217	2	7.7	1	3.8	0.39
Nitrogen (total oxidised) as N	26	mg/l	<0.7	8.1	2.15	1.55	1.91	n.d.	4.78	18	69	0	0	-
Landfill parameters														
TOC (filtered)	26	mg/l	2.2	12.9	5.57	5.2	2.83	2.28	10.6	26	100	0	0	-
PAHs														
Naphthalene	26	mg/l	<1E-05	<1E-05	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	-
Other parameters														
D.O. concentration	6	mg/l	3.7	10.5	5.85	4.5	2.75	3.78	9.85	6	100	0	0	-

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.

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 2019.

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 2019 0 m³ was tipped at there is no remaining void.

5 Summary

The review covers the period between January and December 2019 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.
- There have been no exceedances of the compliance limit for methane, which was only detected four times in 2019.
- Carbon dioxide concentrations did not exceed the 6% v/v compliance limit during the year. The majority of monitoring locations recorded concentrations below 2% v/v. The maximum carbon dioxide concentration was at GM5 in October at 2.7%v/v. Carbon dioxide concentrations are generally lower than previous years, particularly at GM10.
- Groundwater levels stayed within typical ranges during 2019. There was a marked increase in groundwater levels particularly at BH6 and BH13 between September and October. Groundwater levels generally decreased from February to September and then increased to the end of the year.
- Ammoniacal nitrogen was only detected in 1 out of 26 samples during 2019 at 0.47 mg/l, which did exceed the compliance limit of 0.39 mg/l at BH13 in July.
- Chloride concentrations did not exceed the compliance limit in 2019 at any of the monitoring locations. There were no significant changes in the data set from that of previous years.
- There were no exceedances of the iron compliance limit for the compliance limit locations.
- There was one exceedance of the potassium compliance limit in 2019 at BH12 in July at 19.7 mg/l. Concentrations in BH1 appear to have reached a steady state, with similar concentrations to recent concentrations in BH9 following a number of years of rising trends.
- Groundwater quality is generally good, with ammoniacal nitrogen only present at concentrations higher than the UKDWS on one occasion.

6 References

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

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

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 2019

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	O2Stable %
GM10	09/01/2019	1021	0	0	-0.13	21.1
GM10	07/02/2019	997	0	0	-0.15	20.8
GM10	04/03/2019	985	0	0.2	1.61	20.2
GM10	01/04/2019	1011	0	0	66.21	20.6
GM10	01/05/2019	1007	0	0.1	0.26	21.4
GM10	03/06/2019	1001	0	0.3	0.09	20.4
GM10	09/07/2019	1009	0	0	0.36	20.6
GM10	02/08/2019	1007	0	0.1	-0.4	20.5
GM10	12/09/2019	1021	0	0.2	-0.43	20.8
GM10	16/10/2019	992	0	0.2	-0.36	20.6
GM10	21/11/2019	989	0	0.2	-0.45	21.4
GM10	17/12/2019	995	0	0.2	-0.5	21.5
GM11	09/01/2019	1021	0	1.4	0.07	19.9
GM11	07/02/2019	997	0	0	0.65	20.7
GM11	04/03/2019	985	0	0.2	0.1	20.2
GM11	01/04/2019	1011	0	1.4	69.18	18.7
GM11	01/05/2019	1007	0	1.3	9.17	20.1
GM11	03/06/2019	1001	0	0.3	0.09	20.8
GM11	09/07/2019	1009	0	0	0.34	20.5
GM11	02/08/2019	1007	0	0.1	-0.36	20.5
GM11	12/09/2019	1020	0	0.2	-0.47	21
GM11	16/10/2019	993	0	0.1	-0.28	20.8
GM11	21/11/2019	988	0	0.2	-0.48	21.4
GM11	17/12/2019	995	0	0.2	-0.52	21.7
GM2	09/01/2019	1026	0	0	-43.2	20.9
GM2	07/02/2019	1002	0	0	0.01	20.6
GM2	04/03/2019	991	0	0.3	-0.26	20.9
GM2	01/04/2019	1012	0.1	0	66.5	21.3
GM2	01/05/2019	1011	0	0	0.03	21.6
GM2	03/06/2019	1006	0	0.2	0.02	21.2
GM2	09/07/2019	1014	0	0	-0.09	20.7
GM2	02/08/2019	1008	0	0.1	-0.21	20.3
GM2	12/09/2019	1023	0	0.1	0.17	21
GM2	16/10/2019	996	0	0.1	-0.4	21.2
GM2	21/11/2019	988	0	0.5	-0.43	21.4
GM2	17/12/2019	996	0	0.2	-0.21	21
GM4	09/01/2019	1024	0	0.2	-0.07 0.83	20.6
GM4	07/02/2019	1002	0	0.6	-0.01	20.4
GM4	04/03/2019	990	0	1	-0.22	20.4
GM4	01/04/2019	1010	0.1	0	66.64	21
GM4	01/05/2019	1006	0	0.1	0.05	21.6
GM4	03/06/2019	1006	0	0.1	0.07	21.3
GM4	09/07/2019	1013	0	0.2	-0.1	19.3
GM4	02/08/2019	1007	0	0.2	-0.24	20.3
GM4	12/09/2019	1021	0	0.1	-0.12	20.9

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	O2Stable %
GM4	16/10/2019	994	0	0.6	-0.36	21
GM4	21/11/2019	988	0	0.5	-0.47	21.4
GM4	17/12/2019	996	0	0.2	-0.29	21
GM5	09/01/2019	1021	0	1	-0.1	19.4
GM5	07/02/2019	996	0	0.8	-0.11	19.6
GM5	04/03/2019	985	0	1	-0.07	19.4
GM5	01/04/2019	1009	0	0.6	66.44	19.9
GM5	01/05/2019	1007	0	0.7	0.36	20.5
GM5	03/06/2019	1000	0	0.1	0.02	21.1
GM5	09/07/2019	1008	0	0.6	0.17	19.7
GM5	02/08/2019	1008	0	0.1	0.22	20.4
GM5	12/09/2019	1021	0	0.1	-0.41	20.9
GM5	16/10/2019	992	0	2.7	-0.14	17.5
GM5	21/11/2019	989	0	0.4	-0.26	21.4
GM5	17/12/2019	996	0	0.2	-0.38	21.3
GM7	09/01/2019	1021	0	0	-0.07	20.9
GM7	07/02/2019	997	0	0	-0.08	20.8
GM7	04/03/2019	985	0	0.2	-0.38	20.3
GM7	01/04/2019	1008	0.1	0	66.55	21.2
GM7	01/05/2019	1006	0	0	0.46	21.6
GM7	03/06/2019					
GM7	09/07/2019	1009	0	0	0.67	20.4
GM7	02/08/2019	1008	0	0.1		20.4
GM7	12/09/2019	1022	0	0.1	-0.21	20.9
GM7	16/10/2019	992	0	0.1	-0.28	21.3
GM7	21/11/2019	989	0	0.4	-0.22	21.4
GM7	17/12/2019	995	0	0.2		21.1
GM8	09/01/2019	1021	0	0	-0.12	21
GM8	07/02/2019	997	0	0.7	1.72	20.1
GM8	04/03/2019	985	0	0.2	-0.24	20.3
GM8	01/04/2019	1010	0	0	66.35	20.9
GM8	01/05/2019	1007	0	0.1	0.12	21.4
GM8	03/06/2019		0	0.3	0.03	20.9
GM8	09/07/2019	1009	0	0	0.07	20.5
GM8	02/08/2019	1007	0	0.1	-0.36	20.4
GM8	12/09/2019	1021	0	0.1	-0.43	20.8
GM8	16/10/2019	991	0.1	0.2	-0.28	21.5
GM8	21/11/2019	989	0	0.3	-0.5	21.4
GM8	17/12/2019	996	0	0.2	-0.43	21.4

Yellow cells indicate duplicate readings taken on this date

Blank cells indicate no data available

Appendix B

Groundwater Level Monitoring Data

Appendix B Table 1 Groundwater level data (mAOD) for 2019

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
09/01/2019	71.58	64.82	77.11	77.65	70.34	70.55	71.29	86.87	76.89
07/02/2019	71.82	65.87	79.54	79.85	72.41	72.68	74.83	89.48	82.14
04/03/2019	71.29	65.31	76.34	76.15	69.90	71.14	72.23	86.75	77.62
01/04/2019	71.73	64.92	77.34	77.75	a	70.83	71.82	88.67	79.22
15/04/2019					66.06				
01/05/2019	70.16	64.18	75.54	74.45	71.17	69.79	70.55	86.17	76.04
03/06/2019	69.76	63.50	75.24	72.06	68.27	67.52	68.82	85.35	b
09/07/2019	68.74	62.98	75.04	a	a	66.01	67.44	84.33	b
02/08/2019	68.02	62.73	73.09	66.19	63.41	65.21	66.22	83.10	b
12/09/2019	68.49	63.23	72.45	66.97	60.86	66.10	65.73	83.60	b
16/10/2019	69.16	63.72	82.55	a	a	67.67	66.77	90.51	b
21/11/2019	69.80	64.62	83.89	71.41	65.42	67.83	67.22	91.02	b
04/12/2019	70.16	64.65	83.36	74.23	66.08	69.03	67.89	90.78	78.53

a - Location inaccessible due to overgrowth of vegetation

b - Dry

Appendix C

Groundwater Quality Monitoring Data

Appendix C Table 1 Quarterly groundwater quality data for 2019

[illegible]

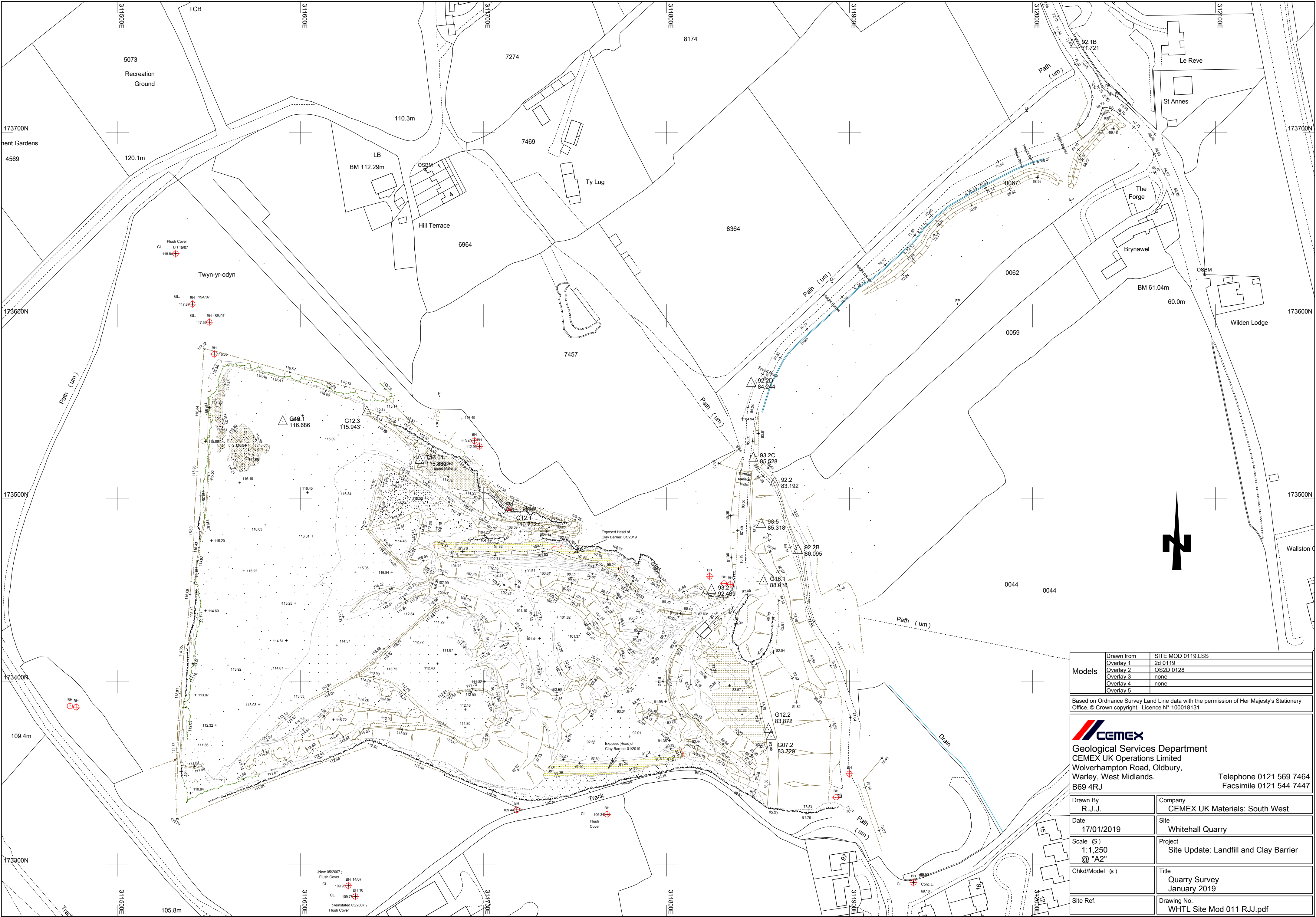
		Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Calcium	Chloride	Conductivity- Electrical 20deg	Conductivity- Electrical (Field)	Filtering det for STL	Ionic balance	Iron	Magnesium	Naphthalene	Nitrogen (total oxidised) as N	pH	pH (Field)	Potassium	Sodium	Sulphate as SO4	TOC (filtered)
Location	Date	mg/l	mg/l	mg/l	mg/l	µS/cm	µS/cm	µm	%	µg/l	mg/l	µg/l	mg/l	pH	pH	mg/l	mg/l	mg/l	mg/l
BH3	09/01/2019	230	<0.06	131	55.7	849	952	0.45	1.4	<120	32.3	<0.01	0.8	7.4	7.9	1.85	26.9	187	3.4
BH3	01/04/2019	248	<0.06	88.3	43.8	599	1092	0.45	2.1	<120	24.2	<0.01	<0.7	7.7	7.6	1.47	22.9	44.6	3
BH3	09/07/2019	279	<0.06	110	48.7	761	1695	0.45	-0.4	<120	28.1	<0.01	<0.7	7.5	7.4	2.84	23.4	97	2.8
BH3	16/10/2019	242	<0.06	84.1	28.1	570	792	0.45	-3.6	<25	19.4	<0.01	<0.7	7.9	7.1	3.05	14.9	66	5.4
BH3A	09/01/2019	269	<0.06	130	86.8	849	923	0.45	0.2	<120	30.8	<0.01	1.3	7.6	8.3	13.2	46.4	164	9.2
BH3A	01/04/2019	269	<0.06	82.6	55.1	606	1095	0.45	-1.6	<120	20.8	<0.01	<0.7	7.6	8.2	3.68	28.8	23.1	5.5
BH3A	09/07/2019	222	<0.06	207	99.8	1320	2950	0.45	-1.6	<120	40.3	<0.01	1.4	7.4	7.4	14.3	42.1	432	6.3
BH3A	16/10/2019	216	<0.06	61.9	29.4	437	3.27	0.45	-3.5	33	12.1	<0.01	<0.7	7.8	7.2	4.05	14	<4.4	12.9
BH6	09/01/2019	272	0.28	104	21	608	621	0.45	9.3	<120	21.3	<0.01	<0.7	7.6	7.9	1.34	11.2	8.7	2.2
BH6	01/04/2019	273	<0.06	94.6	19.8	510	924	0.45	5.1	<120	17.3	<0.01	<0.7	7.7	7.8	1.36	11.2	<4.4	2.5
BH6	09/07/2019	319	<0.06	93.7	22.4	603	1495	0.45	-1.2	<120	26.9	<0.01	3.4	7.9	7.4	1.68	9.51	13.4	3.8
BH6	16/10/2019	333	<0.06	109	20.3	593	819	0.45	1.4	<25	19.5	<0.01	<0.7	7.7	7.4	2.45	9.97	5	3.7
BH9	09/01/2019	Insufficient liquid to obtain a sample																	
BH9	01/04/2019	Insufficient liquid to obtain a sample																	
BH9	09/07/2019	Dry																	
BH9	16/10/2019	Dry																	

Appendix C Table 2 Annual groundwater quality data 2019

Location		Date	Cadmium µg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Manganese mg/l	Nickel mg/l	Zinc mg/l
BH1	01/04/2019		<0.6	<0.002	<0.009	<0.006	0.013	0.004	<0.018
BH12	01/04/2019		<0.6	<0.002	<0.009	<0.006	0.017	0.007	<0.018
BH13	01/04/2019		<0.6	<0.002	<0.009	<0.006	0.019	0.011	<0.018
BH14	01/04/2019		<0.6	<0.002	<0.009	<0.006	0.007	0.003	<0.018
BH15	01/04/2019	Location inaccessible due to overgrowth of vegetation							
BH3	01/04/2019		<0.6	<0.002	<0.009	<0.006	<0.007	0.003	<0.018
BH3A	01/04/2019		<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH6	01/04/2019		<0.6	<0.002	<0.009	<0.006	0.008	0.005	<0.018
BH9	01/04/2019	Insufficient liquid to obtain a sample							

Appendix D

Topographic Survey



Models	Drawn from	SITE MOD 0119.LSS
	Overlay 1	2d 0119
	Overlay 2	OS2D 0128
	Overlay 3	none
	Overlay 4	none

Based on Ordnance Survey Land Line data with the permission of Her Majesty's Stationary Office, © Crown copyright. Licence N° 100018131



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: South West
Date 17/01/2019	Site Whitehall Quarry
Scale (S) 1:1,250 @ "A2"	Project Site Update: Landfill and Clay Barrier
Chkd/Model (S)	Title Quarry Survey January 2019
Site Ref.	Drawing No. WHTL Site Mod 011 RJJ.pdf