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

Annual environmental monitoring report for 2022

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1 Introduction

The Environmental Permit (EP) 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 2.1). 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 is currently permitted to accept inert waste, however it stopped accepting waste at the end of October 2018 as filling is complete. In-waste gas monitoring wells (GF01-GF11) were installed from May-June 2021. The Site is now fully restored, and a Closure Plan was submitted to Natural Resources Wales (NRW) for review (Stantec, 2021a) in September 2021. NRW have provided comments which CEMEX are addressing. Once the Closure Plan has been approved an application will be made to put the Site into formal aftercare.

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.

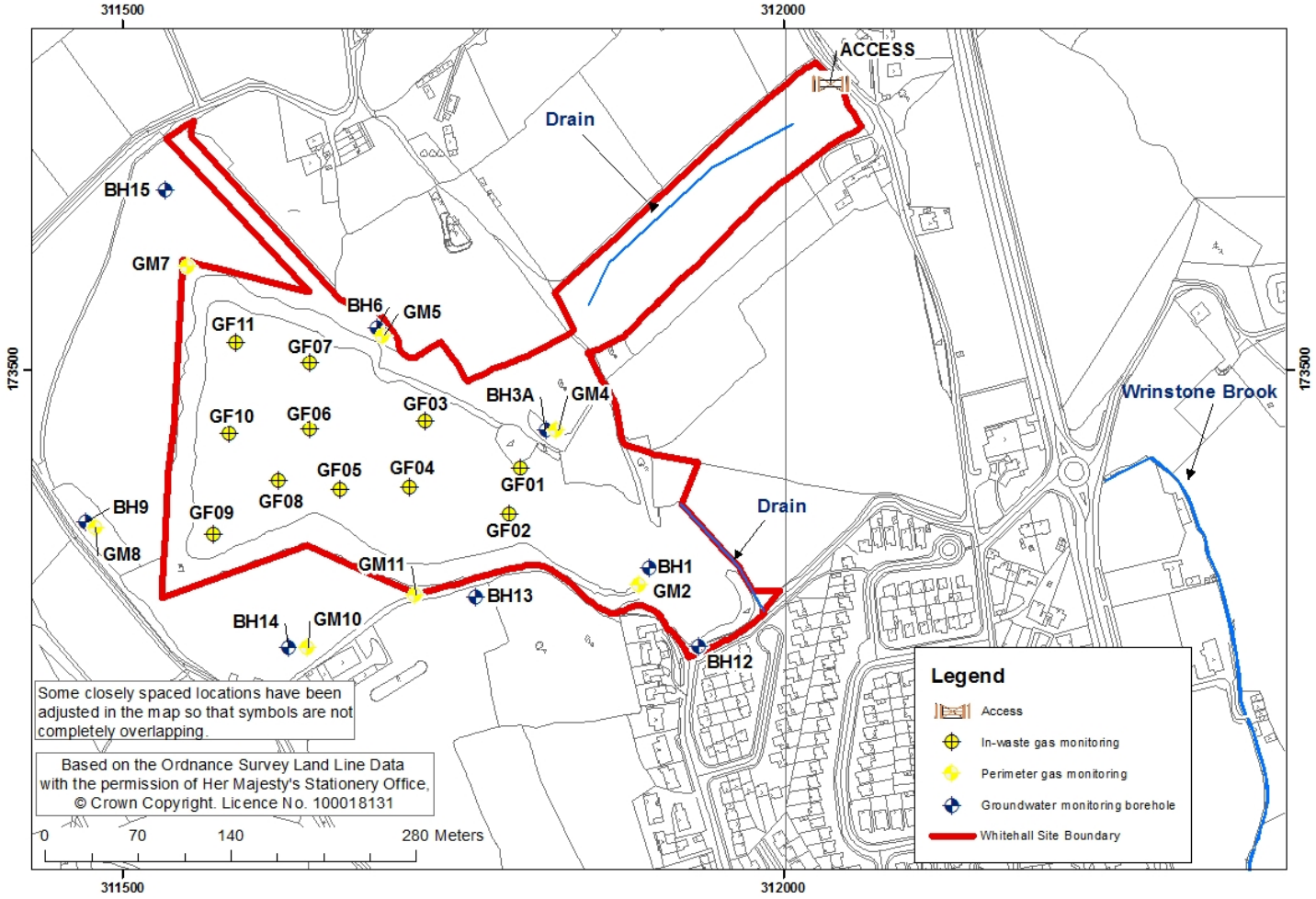
Waste was first accepted at Whitehall Landfill in November 1998. The Site formally operated under Waste Management Licence Number WM130189. Under this WML, the site was licensed to accept solid inert wastes including soils (topsoil, sub-soil and overburden), brickwork, stone, concrete, sand (excluding 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. Following transition to an Environmental Permit in 2006 the range of wastes that could be accepted was restricted to inert waste as defined by the Landfill Regulations.

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.

Figure 2.1 Site location plan



3 Review of Monitoring Data

Schedule 4 of the EP 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 2022. The locations of the monitoring points are shown on Figure 2.1.

3.1 Gas Monitoring

3.1.1 In-waste Gas Monitoring

11 in-waste boreholes were drilled in May and June 2021, and monitoring commenced in July 2021. These have been monitored monthly as specified in the EP and detailed in Table 3.1.

Monitoring requirements for the in-waste gas wells are detailed in the Closure Plan (Stantec, 2021a). Whilst not formally adopted within the permit, the data obtained from these wells is presented in this section for information.

Appendix A presents all in-waste gas concentrations collected during 2022. The January 2022 monitoring round was undertaken slightly late on 02/02/2022 with the February monitoring round on the 24/02/2022.

Table 3.1 Monitoring requirements at in waste boreholes.

Monitoring Locations	Parameter	Frequency
GF1-GF11	Methane	Monthly
	Carbon dioxide	
	Oxygen	
	Atmospheric Pressure	
	Differential Pressure	
	Flow Rate	

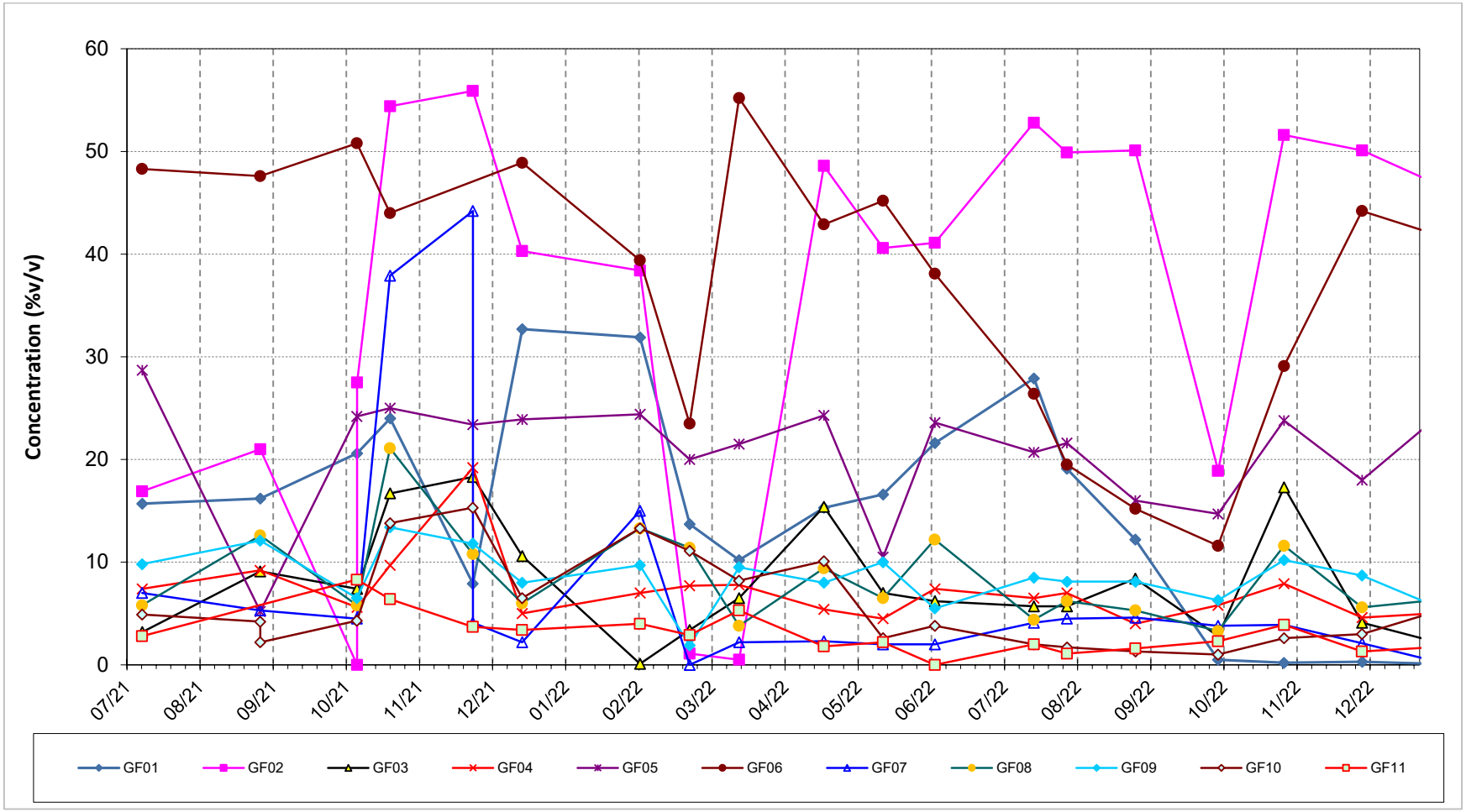
Methane varies between 0 %v/v in GF07 and GF11 and 55.2 %v/v in GF06 (Figure 3.1). However, most concentrations remain below 30 %v/v, except at GF06 and GF02 where results regularly exceed 40 %v/v. The locations with the highest carbon dioxide concentrations have the lowest methane concentrations and vice versa. There are no obvious temporal trends in the data.

Carbon dioxide concentrations are presented in Figure 3.2. Carbon dioxide concentrations are highest in GF11, with concentrations reaching 5.9 %v/v. Carbon dioxide is lowest in GF06 with most results less than 1 %v/v. There is a slight increasing trend in GF11, further time series data will indicate whether this is a seasonal trend. There are no other visible trends.

Flow rates are presented in Figure 3.3 with rates varying between -0.5 l/h at GF03 to 1.8 l/h at GF08. Flow rates are similar at all locations which show the same variations throughout the year with occasional exceptions. For example, at GF08 in February where flow rates continue to increase whereas the remaining flow rates are decreasing.

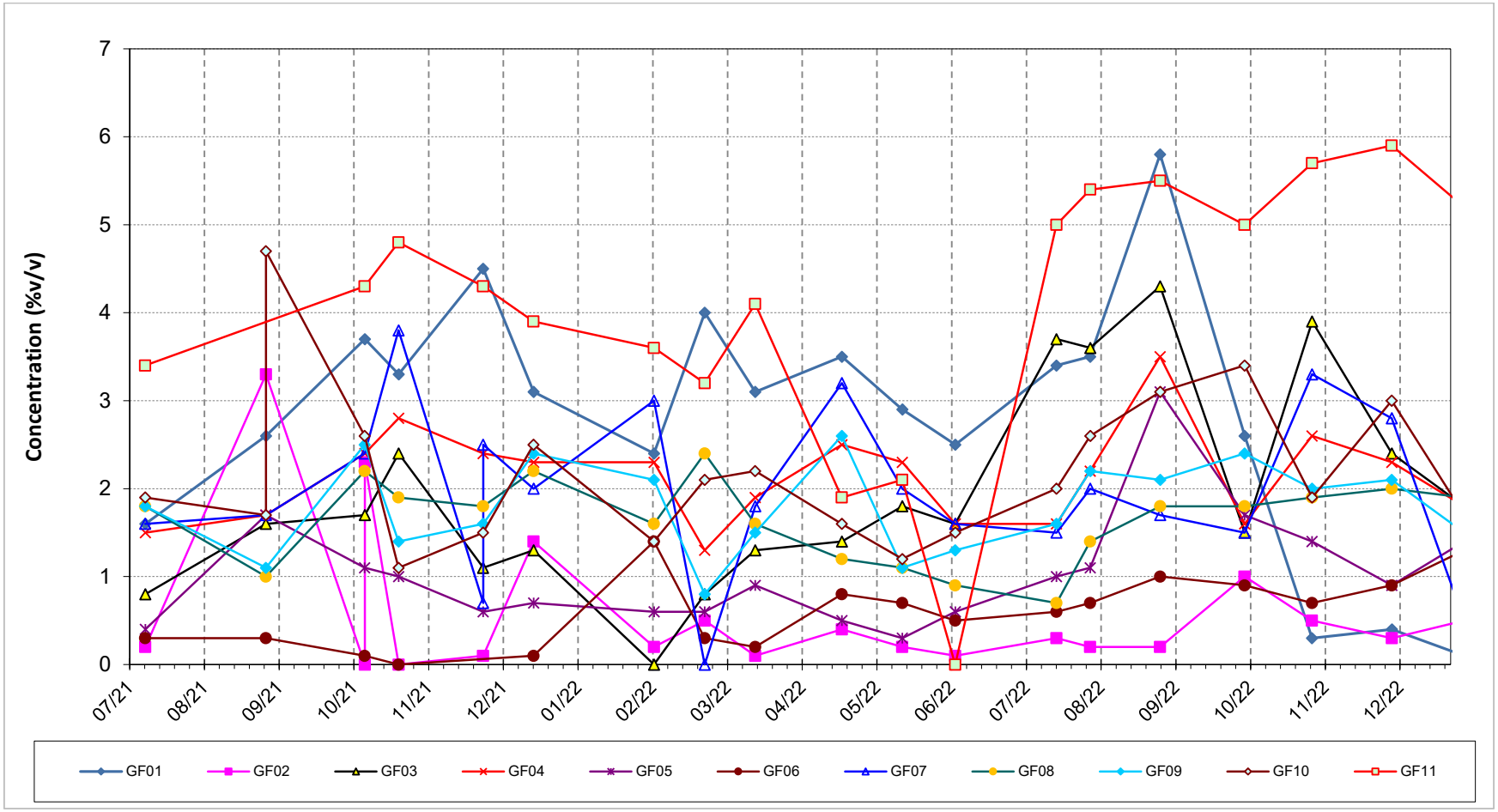
There are no increasing or decreasing trends throughout the year, and with no historical data to compare to, no historical trends can be established.

Figure 3.1 In-waste stable methane concentrations since boreholes were drilled (July 2021)



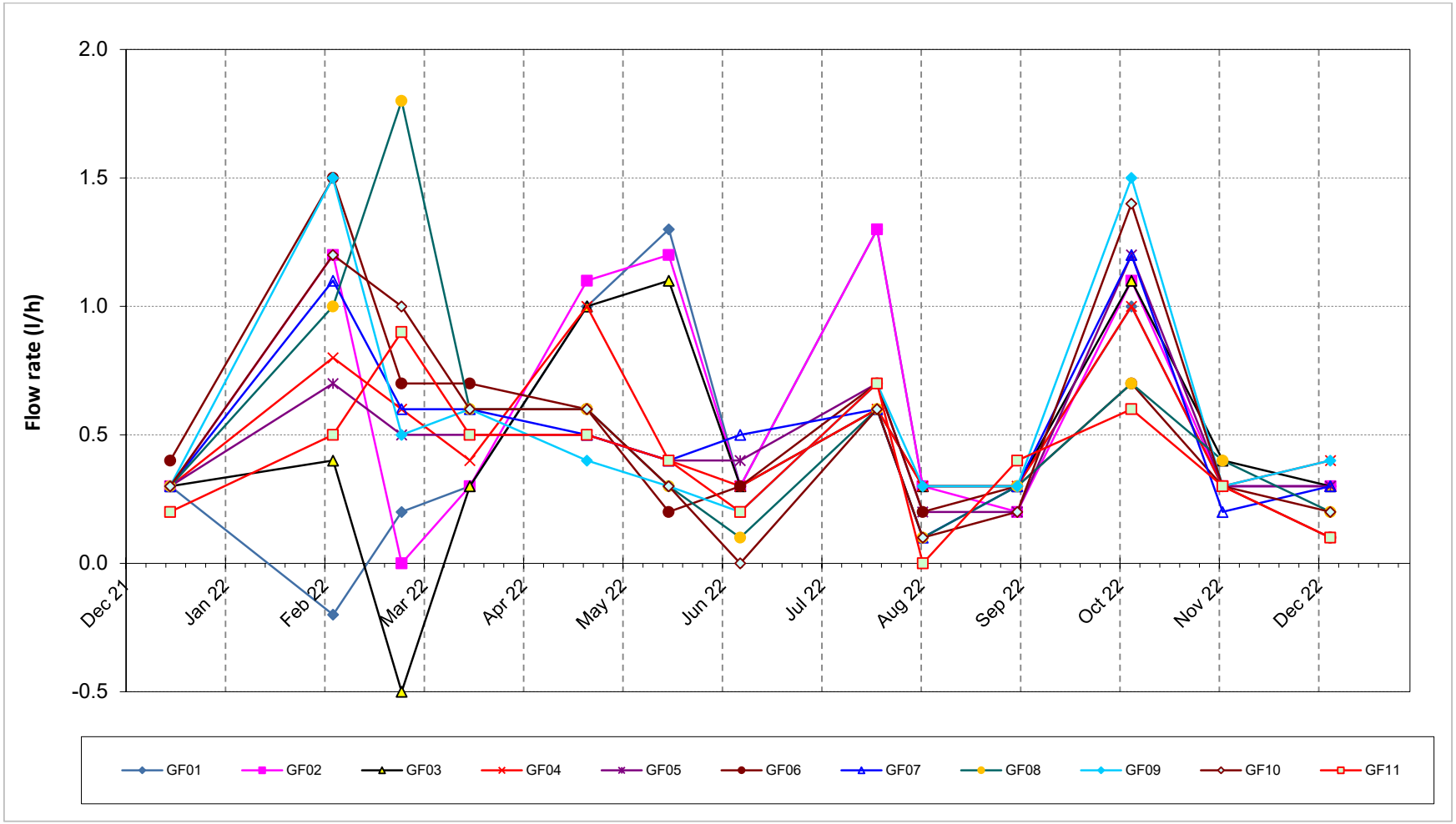
Note: The January 2022 monitoring round was undertaken on the 03/02/2022

Figure 3.2 In waste carbon dioxide concentrations in since boreholes were drilled (July 2021)



Note: The January 2022 monitoring round was undertaken on the 03/02/2022

Figure 3.3 Flow rate in gas boreholes since December 2021 (first reading taken)



3.1.2 Perimeter 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 EP. The monitoring requirements and compliance limits are given in Table 3.2

Appendix B presents all perimeter gas monitoring data collected during 2022.

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 due to 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. These are presented in Table 3.2

Table 3.2 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

Methane has been detected at 23 of the 83 occasions at low levels between 0.1 %v/v and 0.6 %v/v in March, September, October, and November, as presented in Table 3.3. These detections occurred at all the locations over the course of the year. There have been no exceedances of the compliance limit.

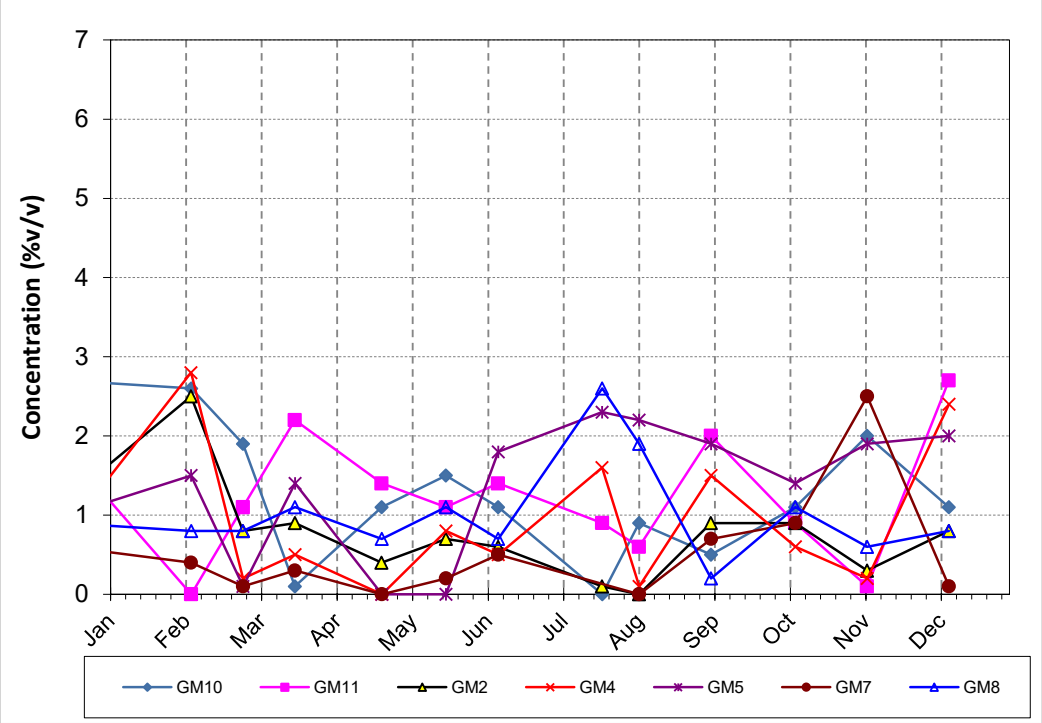
Table 3.3 Location of methane detections

Location	Date of detection	Reading (%v/v)
GM10	17/03/22	0.5
	05/10/22	0.1
	03/11/22	0.2
GM11	17/03/22	0.5
	05/10/22	0.1
	03/11/22	0.2
GM2	17/03/22	0.5
	05/10/22	0.1
	03/11/22	0.2
GM4	17/03/22	0.6
	01/09/22	0.1
	03/11/22	0.2
GM5	17/03/22	0.5
	01/09/22	0.1
	05/10/22	0.1

Location	Date of detection	Reading (%v/v)
	03/11/22	0.2
GM7	17/03/22	0.5
	01/09/22	0.1
	05/10/22	0.1
	03/11/22	0.2
GM8	17/03/22	0.5
	05/10/22	0.1
	03/11/22	0.2

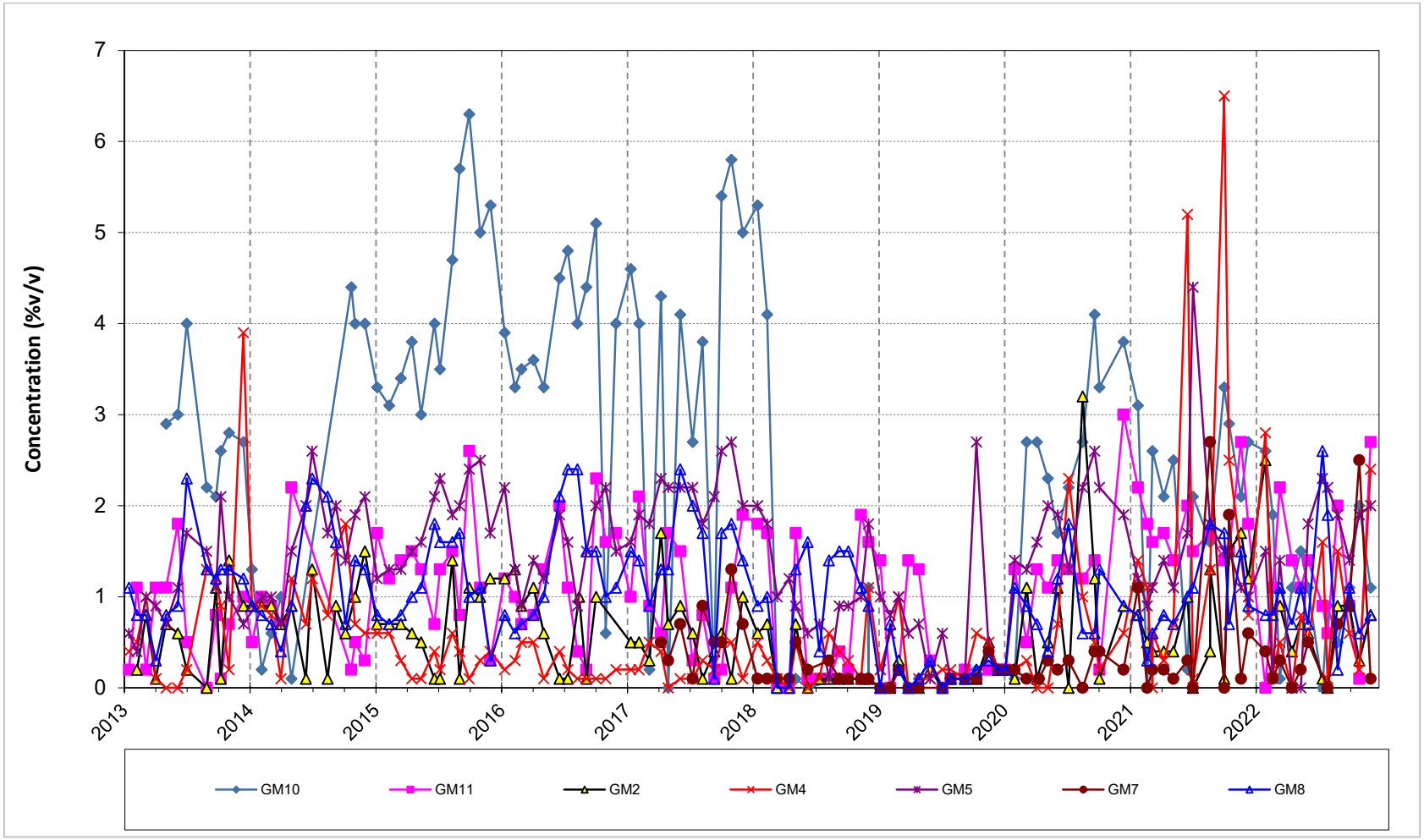
The carbon dioxide compliance limit was not exceeded during the reporting period, with all concentrations below 3 %v/v (Figure 3.4). There are no increasing trends in the data with concentrations generally lower than in previous years (Figure 3.5). There are decreasing trends at GM10 since September 2020 and GM2 since February 2022. All remaining locations data are similar to the previous years. Concentrations increased steadily from 2019 to 2021 when very low concentrations were recorded. Concentrations have slightly decreased during the reporting period, but are higher than the low levels in 2019, with data similar to that of 2015.

Figure 3.4 Stable carbon dioxide concentrations in 2022



Note: The January 2022 monitoring round was undertaken on the 03/02/2022

Figure 3.5 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the EP requires monitoring of groundwater quality at four down-gradient 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 EP and are summarised in Table 3.4. These locations were sampled on a quarterly and annual frequency for relevant determinands during 2022. The locations of the monitoring boreholes are shown on Figure 2.1. The January monitoring round was conducted on 02/02/2022.

We note that BH3 and BH3A are located very close to each other. The Closure Plan (Stantec, 2021a) recommends that BH3 is removed from the monitoring network. Since the Closure Plan hasn't been accepted, BH3 data is still being monitored.

Table 3.4 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 SO4, 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.

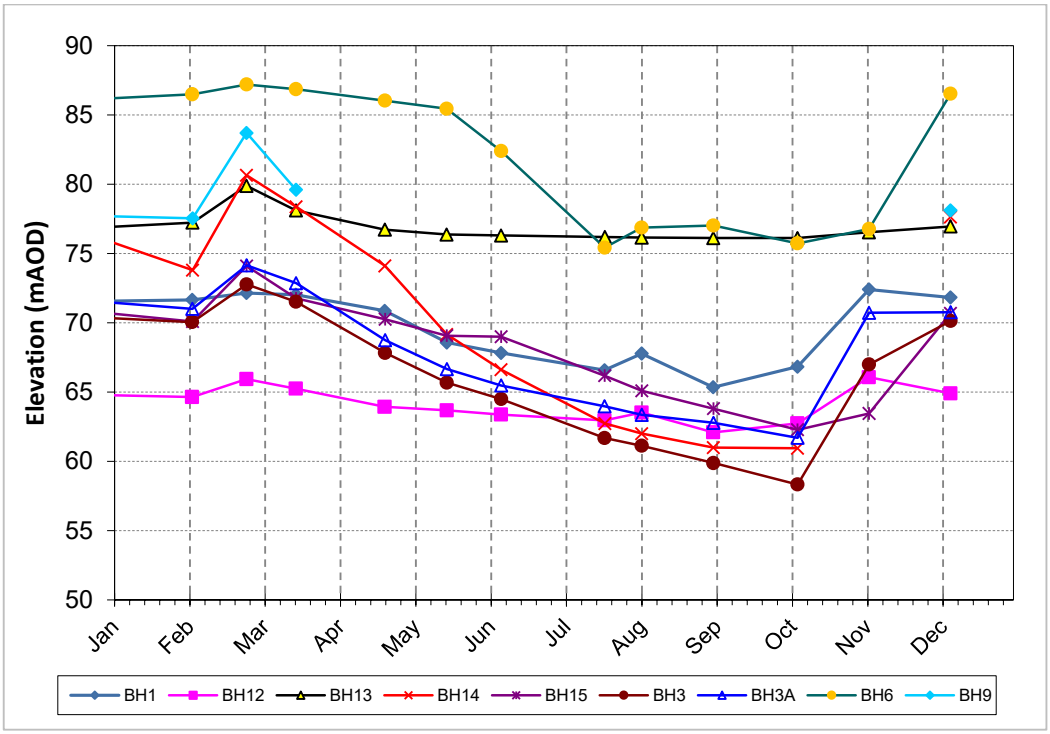
3.2.1 Groundwater Levels

Monthly groundwater level data collected during 2022 are presented in Figure 3.6. The full dataset for 2022 is presented in Appendix C.

BH09 was dry from March to December so no groundwater levels were recorded.

In 2022, groundwater levels reached their maximum in February, before decreasing at all locations until September. There was a sharp rise in levels at most locations from October to December following heavy rainfall. The highest levels are typically at BH06, BH09 and BH13 which are located in the north, south and south of the Site respectively. Measurements in September and October are lower than in previous years with levels at BH3 and BH14 recording the lowest levels in the last decade (Figure 3.7). Levels at most of the other locations during these months were also amongst the lowest in the last decade.

Figure 3.6 Groundwater elevation during 2022

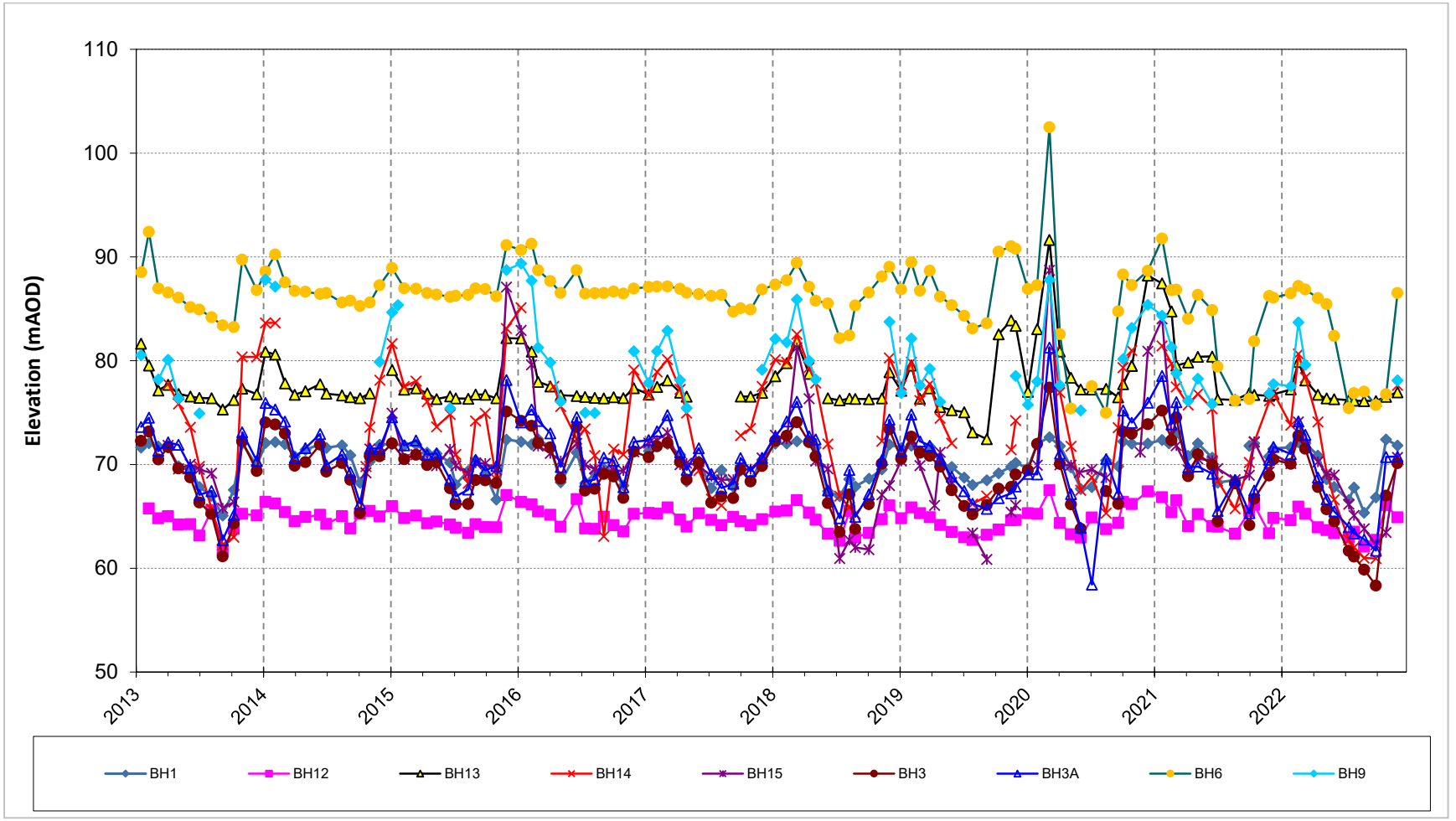


Note: The January 2022 monitoring round was undertaken on the 03/02/2022

Historical observed groundwater levels for the past decade for all monitoring locations are shown in Figure 3.7. Overall, the groundwater levels are generally consistent with historical trends, with slightly lower levels in September and October, probably due to the dry summer. The groundwater elevation at all monitoring locations exhibits similar fluctuation timings (higher during the winter and lower during the summer), with differing degrees of variation. BH12 shows smaller amplitudes than the other wells. There were lower groundwater levels at BH6 from 2020 to 2022 compared to the period 2012 to 2019. There were eleven readings below 80 mAOD from 2020 to 2022 (altogether) and there were no readings below 82 mAOD from 2012 to 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 2022 although matched by some other locations (BH06, BH03A).

Figure 3.7 Historical groundwater elevation (2013-2022)



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 3.4.

The quarterly dataset for 2022 is presented in Appendix D.

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 3.5 below details the compliance limits applied to the appropriate groundwater quality determinands at the required locations.

The compliance limit for potassium at BH12 was updated in the revised 2019 annual report (Cemex, 2020) to reflect the increase in concentrations due to a potassium-rich plume originating upgradient of the landfill (Cemex, 2016). A new compliance limit of 24.7 mg/l was calculated (included in Table 3.5) as well as a control limit of 19.7 mg/l. There are no compliance limits specified for up-gradient boreholes BH3, BH3A, BH6, BH9 or BH15.

Table 3.5 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	24.7	0.05
BH13, BH14	0.39	250	200	12	0.05

A statistical summary of general groundwater quality for all determinands that are monitored at the Site is presented in Table 3.6. Determinands have been compared to the UK Drinking Water Standards (UK DWS) for reference.

Groundwater quality at the Site is generally good, with concentrations above the UK DWS only recorded during 2022 for sulphate, iron, manganese and ammoniacal nitrogen. There was only one result above the manganese UKDWS of 0.05 mg/l at BH3A in April with a concentration of 0.085 mg/l. Three iron results are above the UKDWS of 0.2 mg/l equating to 11.5 % of the samples. Similarly, two sulphate results exceed the UKDWS of 250 mg/l however these are just 7.7 % of the results and seven ammoniacal nitrogen results exceeded the UKDWS equating to 26.9 % of samples.

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Table 3.6 Statistical summary of groundwater quality in 2022

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS No. Exceeding	UKDWS % Exceeding	UKDWS Action Level
Field / lab parameters														
pH	26	pH units	7.10	7.90	7.48	7.45	0.24	7.20	7.9	26	100	0	0	-
pH (Field)	26	pH units	7.04	10.70	7.86	7.70	0.76	7.05	8.5	26	100	0	0	-
Conductivity- Electrical (Field)	26	µS/cm	369	3110	1039	848	576	642	2149	26	100	0	0	-
Conductivity- Electrical 20deg	26	µS/cm	505	2300	843	658	453	562	1960	26	100	0	0	-
Major ions														
Alkalinity as CaCO3	26	mg/l	193	400	328	336	49	263	397	26	100	0	0	-
Calcium	26	mg/l	86.6	367	128	101	71.8	87.9	301	26	100	0	0	-
Chloride	26	mg/l	8	206	46	35.4	50	10.4	171	26	100	0	0	250
Magnesium	26	mg/l	12.4	42.3	28.4	31	8.37	13.6	40.4	26	100	0	0	-
Potassium	26	mg/l	0.8	28.1	7.02	3.25	7.66	0.955	24.3	26	100	0	0	-
Sodium	26	mg/l	5.26	187	31.3	17.3	45.9	6.53	144	26	100	0	0	200
Sulphate as SO4	26	mg/l	<4.4	823	115	30.9	215	5.48	651	25	96.2	2	7.692	250
Minor ions														
Cadmium	8	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.005
Chromium	8	mg/l	<0.002	<0.002	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.05
Copper	8	mg/l	<0.009	0.012	n.d.	n.d.	n.d.	n.d.	0.0096	1	12.5	0	0	2
Iron	26	mg/l	<0.025	10.1	0.64	n.d.	2.2	n.d.	4.23	6	23.1	3	11.54	0.2

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	No. Exceeding	% Exceeding	UKDWS Action Level
Lead	8	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.01
Manganese	8	mg/l	<0.007	0.085	0.031	0.026	0.028	n.d.	0.073	7	87.5	1	12.5	0.05
Nickel	8	mg/l	<0.003	0.005	n.d.	n.d.	n.d.	n.d.	0.004	1	12.5	0	0	0.02
Zinc	8	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	5.8	0.64	n.d.	1.39	n.d.	3.65	10	38.5	7	26.92	0.39
Nitrogen (total oxidised) as N	26	mg/l	<0.7	16.5	2.08	n.d.	3.42	n.d.	6.1	12	46.2	0	0	-
Landfill parameters														
TOC (filtered)	26	mg/l	1.8	55.7	9.92	4.8	13.9	2.53	46.2	26	100	0	0	-
PAHs														
Napthalene	26	mg/l	<1E-05	0.000146	0.0000278	n.d.	0.0000414	n.d.	0.000114	10	38.5	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.

There were nine exceedances of the compliance limits during 2022, an increase from one during the previous reporting period. The exceedances are shown below in Table 3.7

Table 3.7 Groundwater compliance limit exceedances

Location	Date	Determinand	Action level (mg/l)	Result (mg/l)
BH1	19/07/2022	Ammoniacal Nitrogen	0.39	0.52
BH12	19/07/2022	Ammoniacal Nitrogen	0.39	0.91
BH13	05/10/2022	Ammoniacal Nitrogen	0.39	5.8
BH1	19/07/2022	Napthalene	0.00005	0.000106
BH12	21/04/2022	Napthalene	0.00005	0.000057
BH12	05/10/2022	Napthalene	0.00005	0.0001
BH13	05/10/2022	Napthalene	0.00005	0.000116
BH13	05/10/2022	Iron	0.2	10.1
BH13	05/10/2022	Potassium	12	28.1

A statistical summary of groundwater quality compliance parameters is presented in Table 3.8. The data for potassium has been split over three rows, as there are separate compliance limits.

Groundwater ammoniacal nitrogen concentrations for the last decade are presented in Figure 3.8 and Figure 3.9. This shows that in the last ten years, the majority of samples at down-gradient boreholes are at or below the detection limit. Ammoniacal nitrogen is detected 10 times during the reporting period, 6 of which are in the downgradient boreholes. Ammoniacal nitrogen was detected four times at BH1, the first detections since 2018 and exceeded the compliance limit in July 2022 (0.52 mg/l). The remaining two detections at the downgradient boreholes are isolated peaks; concentration of 0.91 mg/l at BH12 in July and 5.8 mg/l at BH13 in October, both of these detections exceeded the compliance limit. Other detections are recorded at BH3 (between 0.46 mg/l and 2.1 mg/l in February, April and July) and BH15 (4.17 mg/l in October) during the reporting period, however there are no compliance limits for these as they are upgradient wells. As a result, the recent data maintains the same trends as the historical data with most results below the detection limit with occasional isolated peaks. The presence of these isolated peaks at up and down hydraulic gradient wells is suggestive that the landfill is not the source of the ammoniacal nitrogen.

Potassium concentrations in groundwater during the last decade are presented in Figure 3.10 and Figure 3.11. Potassium concentrations have been slightly elevated at BH13 since 2016 where concentrations have been gradually increasing. Previous elevated concentrations at BH1 have reduced back to levels before 2016. CEMEX (2016) suggested that a plume containing potassium had originated from up-hydraulic-gradient of the Site and is currently passing through it. The increasing trend at BH13 has led to the most recent sample in October exceeding the compliance limit recording 28.1 mg/l. This is much higher than the remaining measurements at this location and a similar spike at BH15 is observed, like the ammoniacal nitrogen results at these two locations. Historical potassium concentrations in BH9 (up-hydraulic-gradient) were higher (Figure 3.11) but stabilised around 15 mg/l from 2013 and in 2020 dropped to around 9 mg/l continuing into 2021. No sampling was carried out at BH9 during the current reporting period as it was dry or there was insufficient water to obtain a sample. This issue was discussed previously in CEMEX (2016). Most potassium results

show decreases through 2019-2020 with recent 2021 and 2022 data showing a slight concentration increase in BH1, BH12, BH13, and BH3A, however the results remain consistent with previous historical data.

In the HRA Review (Stantec, 2021) it was recommended that the compliance limits were reviewed annually at BH1 and BH12. On the basis of the current data, it is recommended that the compliance limits at BH1 and BH12 are maintained at their current levels for 2022 and reviewed again in the next annual report.

Historical iron concentrations are plotted on Figure 3.12. Iron concentrations peaked at 10.1 mg/l which is an exceedance of the compliance limit and occurred in October at BH13. All other results are consistent with previous years, in particular 2015.

There were four naphthalene exceedances during the reporting period (see Table 3.7). This is an increase from the previous reporting period where just one exceedance was recorded.

Five out of the nine compliance limit exceedances were in October 2022, these high results are corresponding with some of the lowest groundwater levels meaning that there is limited dilution within the wells. It is possible that whilst purging the wells, previously undisturbed sediment at the base may have been pulled up into the groundwater. As the water levels increased during the remainder of the year, there is more dilution and as such the concentrations of determinands has decreased. It is unlikely that the increase in concentrations is related to a change in behaviour at the landfill.

Table 3.8 Statistical summary of groundwater compliance parameters in 2022

														Compliance Limit
Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	No. Exceeding	% Exceeding	Action Level
Chloride	13	mg/l	8	203	48.83	38.1	51.58	9.08	125.3	13	100	0	0	250
Ammoniacal Nitrogen as N	13	mg/l	<0.06	5.8	0.62	n.d.	1.58	n.d.	2.87	6	46.15	3	23.08	0.39
Napthalene	13	mg/l	<1E-05	0.0001	0.00002	n.d.	0.00004	n.d.	0.0001	6	46.15	4	30.77	0.00005
Iron	13	mg/l	<0.025	10.1	0.80	n.d.	2.79	n.d.	4.15	3	23.08	1	7.69	0.2
Potassium (BH1)	4	mg/l	7.19	8.49	8.01	8.185	0.58	7.3175	8.47	4	100	0	0	27
Potassium (BH12)	3	mg/l	14.7	17.2	16.27	16.9	1.37	14.92	17.17	3	100	0	0	24.7
Potassium (BH13, BH14)	6	mg/l	0.8	28.1	6.48	2.87	10.65	0.8175	21.91	6	100	1	16.67	12

Figure 3.8 Historical ammoniacal nitrogen in groundwater at boreholes with compliance limits (downgradient)

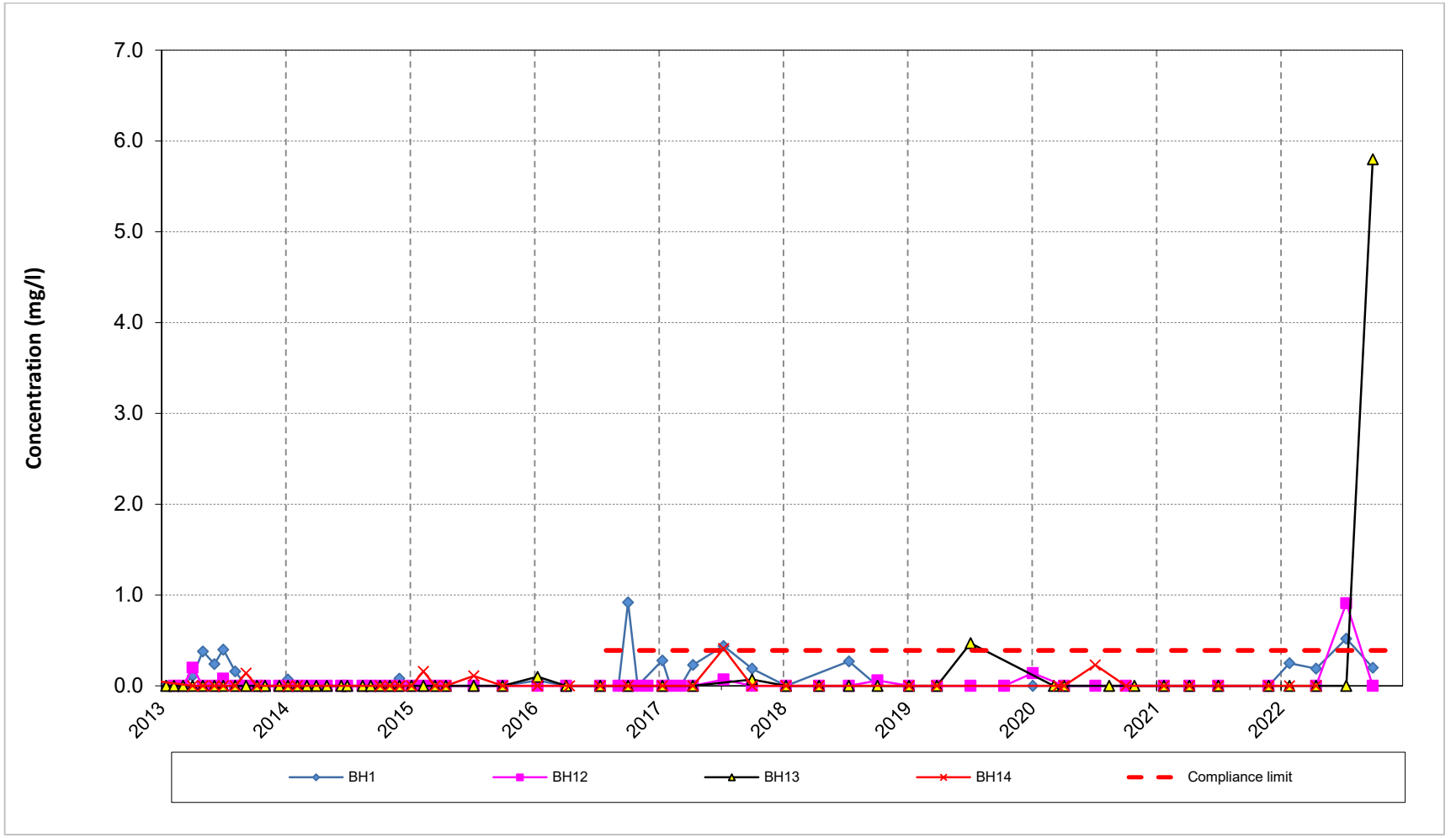


Figure 3.9 Historical ammoniacal nitrogen concentrations in groundwater at boreholes without compliance limits (upgradient)

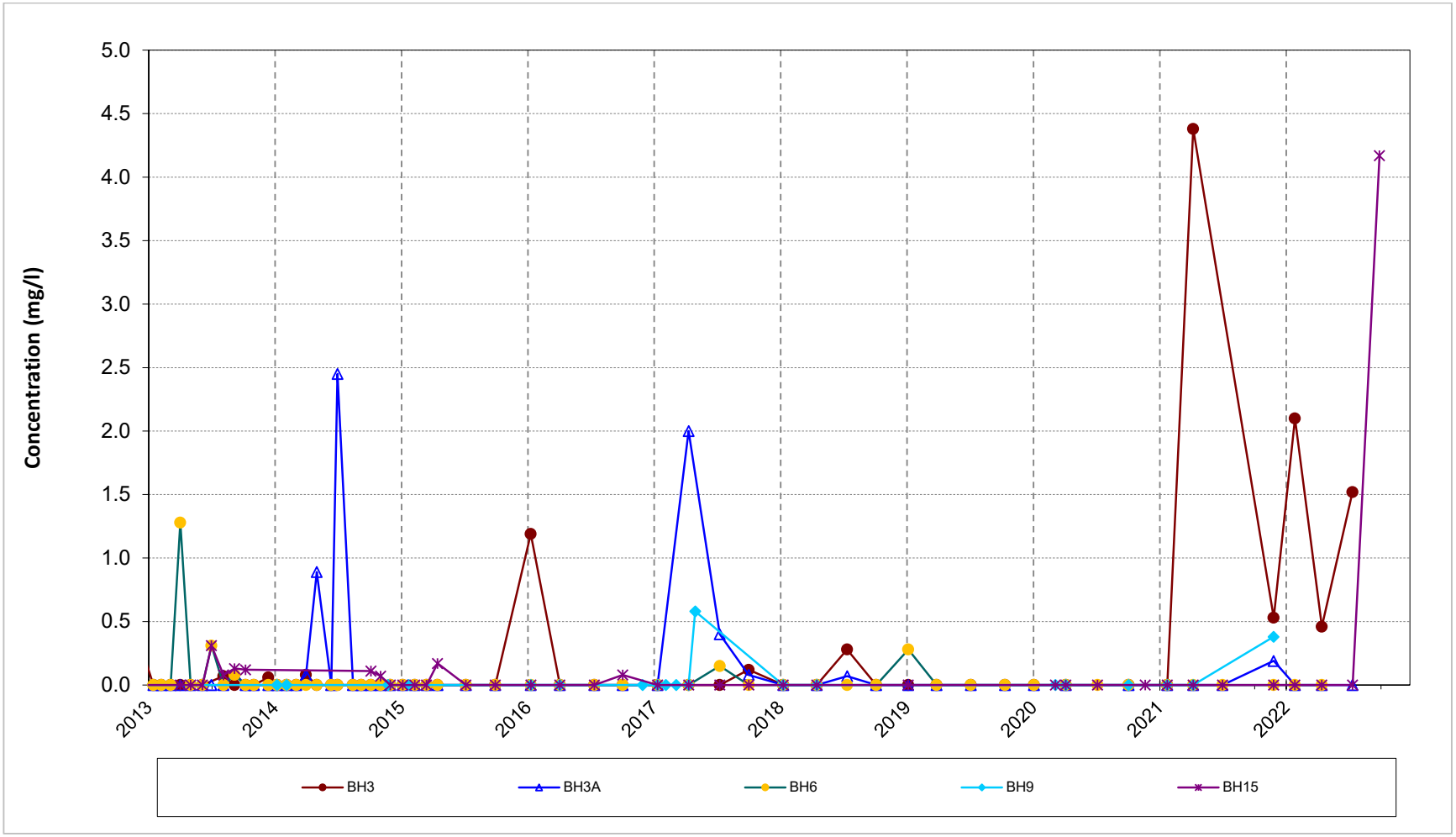


Figure 3.10 Historical potassium concentrations in groundwater at boreholes with compliance limits (downgradient)

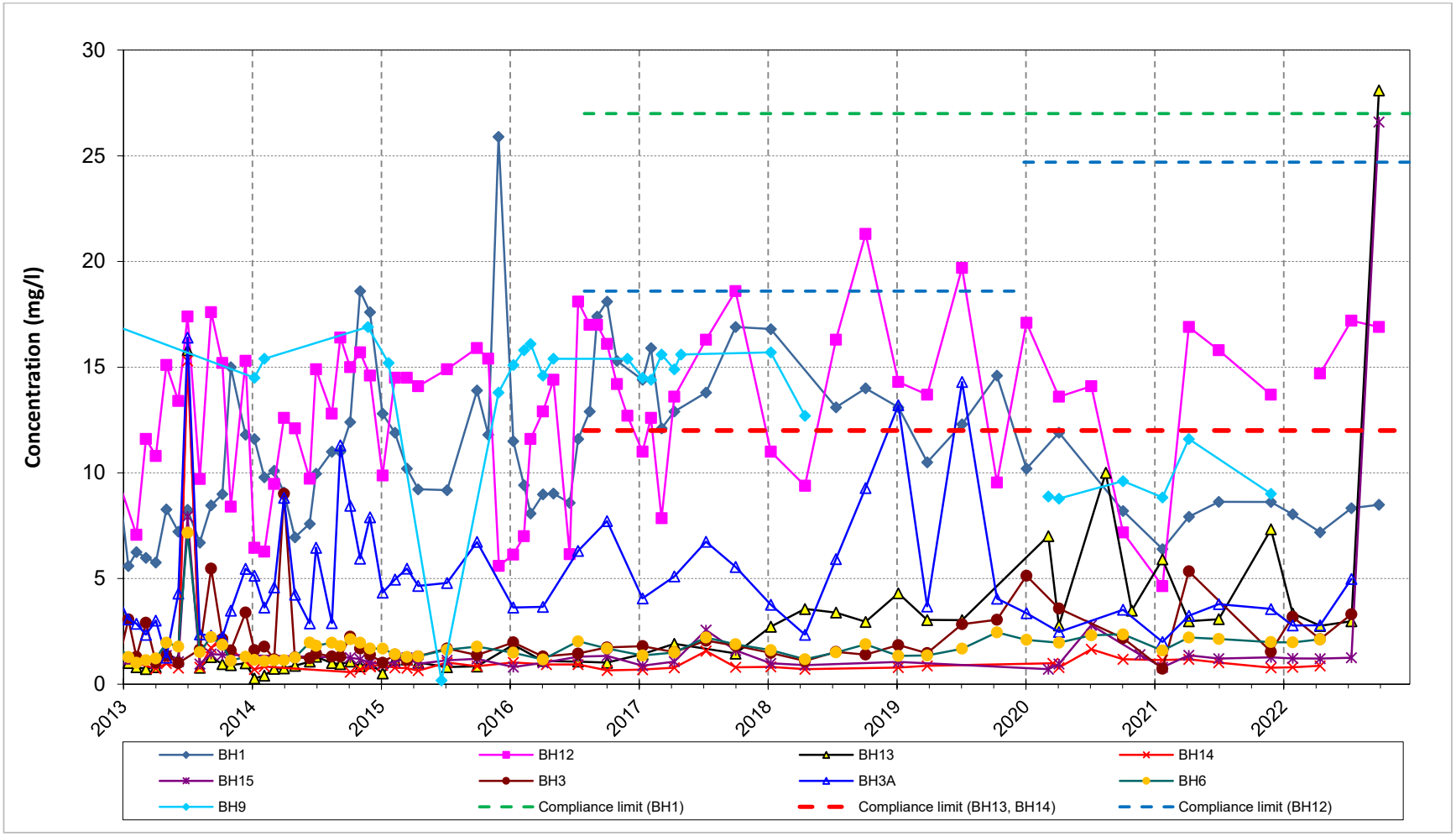


Figure 3.11 Historical potassium concentrations in groundwater at boreholes without compliance limits (upgradient)

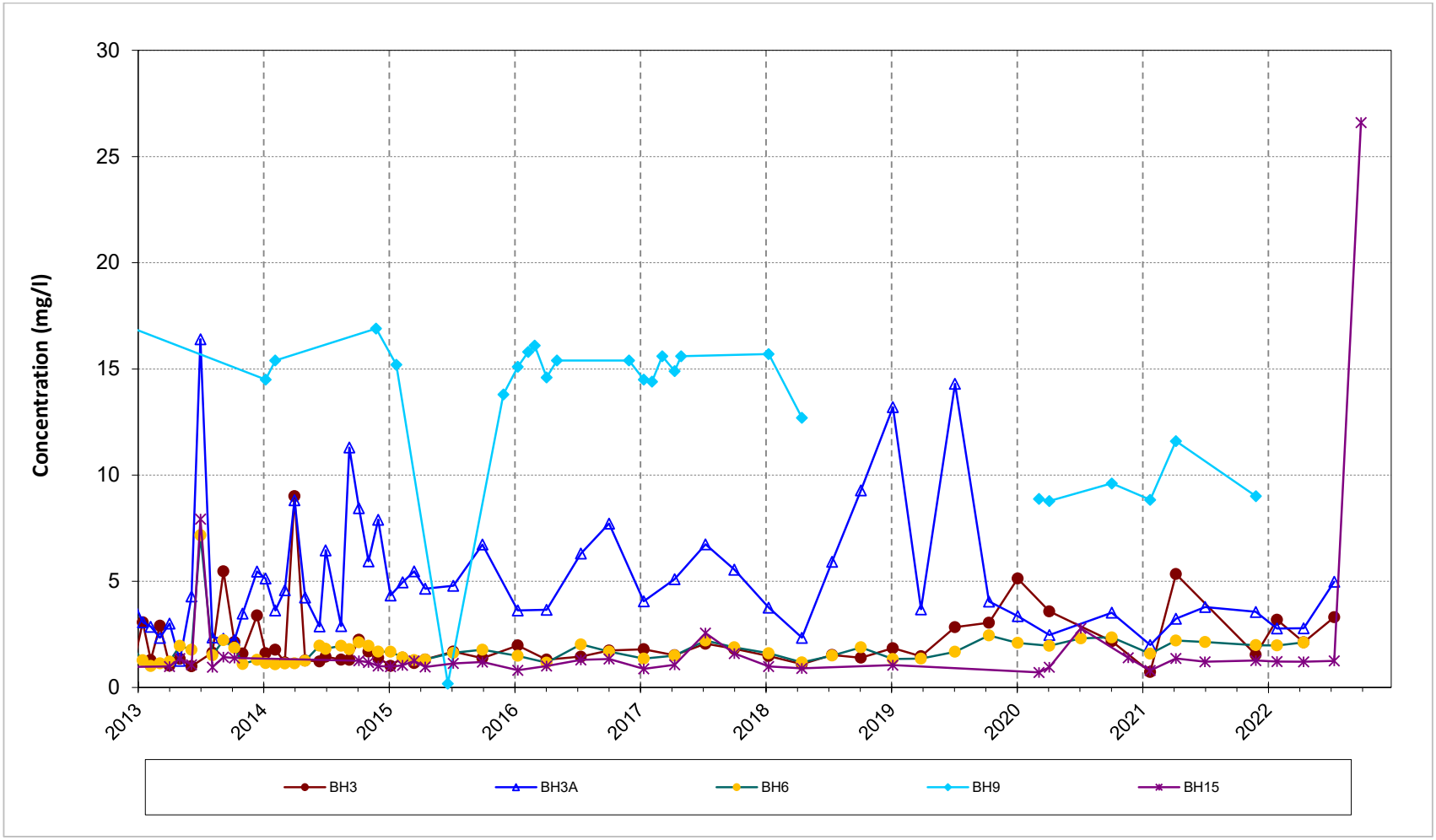
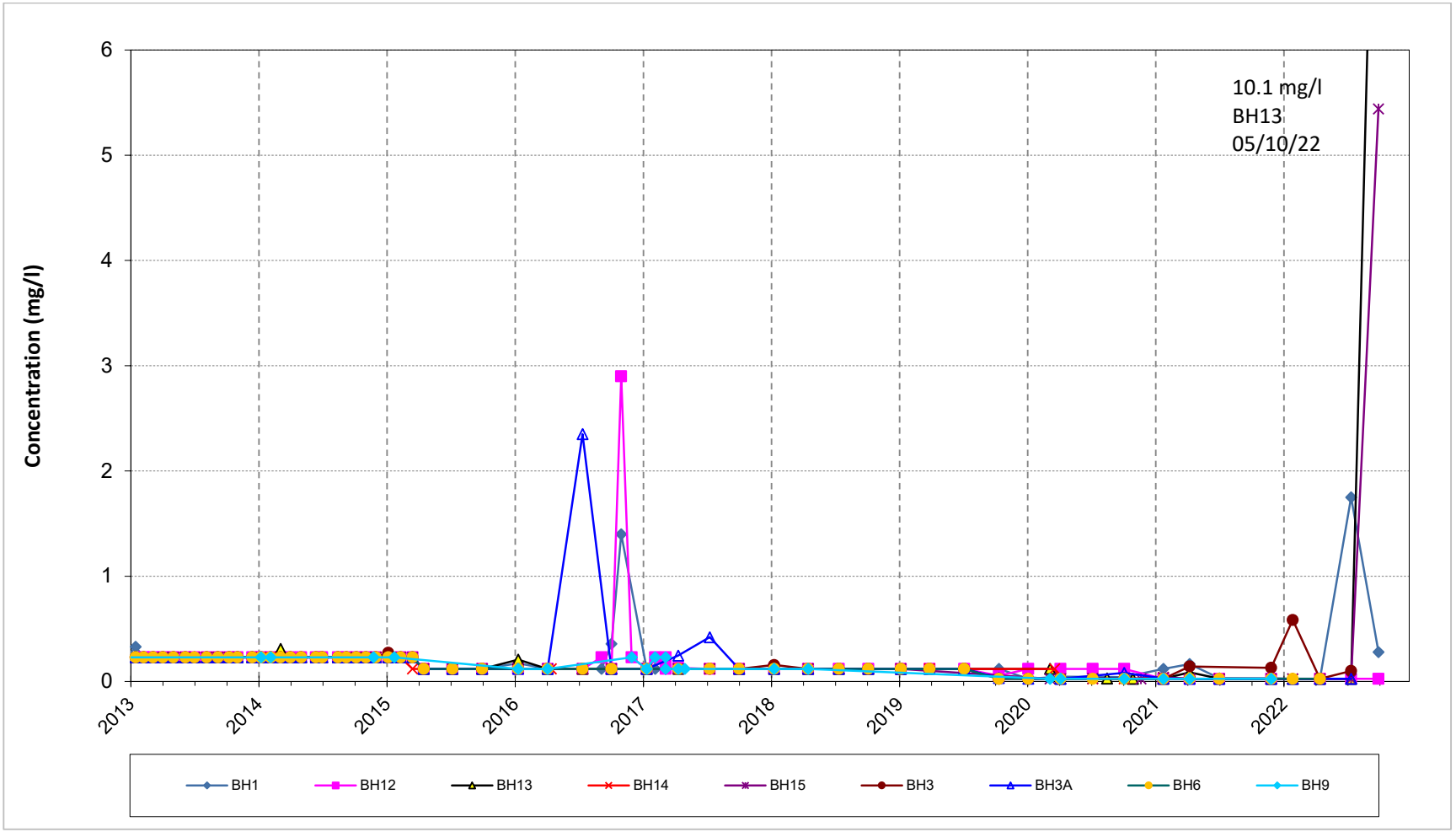


Figure 3.12 Historical iron concentrations at all groundwater locations



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 2022.

CEMEX UK environmental management system sets targets to reduce energy, water and waste production on all sites, however as Whitehall is a closed inert site these figures are already zero so we do not have any improvement progress to report.

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 E. This shows contours in the most recent 2022 survey compared to those in the previous 2020 survey. No significant differential settlement is shown at the Site with the majority of changes within 15 cm.

4.4 Compliance Testing and Other Details

No waste has been accepted in 2022 since filling ceased in October 2018.

5 Summary

This review covers the period between January and December 2022 and reviews the landfill gas, groundwater level and groundwater quality dataset at the Site.

The review has shown the following:

- Eleven in waste gas wells were installed in May and June 2021 with data first recorded in July 2021. Methane varies from between 0 %v/v to 55.2 %v/v with carbon dioxide varying from 0 %v/v to 5.9 % v/v.
- 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 in perimeter boreholes. Methane was only detected 23 times out of 83 in 2022, all between 0.1 and 0.6 %v/v.
- Gas flow varies since December 2021 from -0.5 l/h to 1.8 l/h. Flow follows similar patterns at each location with peaks occurring every two to three months. No long term trends were established due to a lack of historical data.
- Carbon dioxide concentrations in perimeter boreholes did not exceed the compliance limit during the reporting period with all concentrations below 3 %v/v.
- Groundwater levels are slightly lower than in previous years and are amongst the lowest in the last decade in September and October. Groundwater levels generally decreased from February to October and subsequently increased sharply from November to December following heavy rainfall.
- Groundwater quality is generally good, with limited sulphate, manganese, iron, and ammoniacal nitrogen concentrations above the UKDWS.
- There were three exceedances of the compliance limits for ammoniacal nitrogen, four exceedances for napthalene and one exceedance each for iron and potassium during the quarterly monitoring rounds. These were recorded at BH1, BH12 and BH13 predominantly in October (five exceedances) but also once in April and three times in July. The high concentrations recorded during October are likely to be due to lower dilution in groundwater as groundwater levels were anomalously low. Since groundwater levels have recovered, concentrations have reduced. Thus, the elevated concentrations are not considered to be due to changes in landfill behaviour.

6 References

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Appendix A
In-waste Gas Monitoring Data

Appendix A Table 1 In waste gas monitoring data for 2022

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	FlowrateVol l/h	O2Stable %	Ground conditions
GF01	03/02/2022	1003	31.9	2.4	2.28	-0.2	3.3	Damp
GF01	24/02/2022	1001	13.7	4	1.74	0.2	5.6	Waterlogged
GF01	17/03/2022	1021	10.2	3.1	1.08	0.3	6.8	Waterlogged
GF01	22/04/2022	995	15.3	3.5	-0.1	1	5.7	Damp
GF01	17/05/2022	1003	16.6	2.9	-0.74	1.3	6.8	Damp
GF01	08/06/2022	995	21.6	2.5	-0.25	0.3	7.4	
GF01	20/07/2022	1004	27.9	3.4	-0.67	1.3	6	Dry
GF01	03/08/2022	1006	19.1	3.5	0.02	0.3	3.1	Damp
GF01	01/09/2022	1014	12.2	5.8	-0.07	0.3	1.9	Dry
GF01	06/10/2022	1016	0.5	2.6	2.6	1	11.3	Damp
GF01	03/11/2022	993	0.2	0.3	-0.51	0.3	20.6	Waterlogged
GF01	06/12/2022	1016	0.3	0.4	0.04	0.3	20.9	Damp
GF02	03/02/2022	1003	38.4	0.2	-16.01	1.2	7.9	Damp
GF02	24/02/2022	999	1.1	0.5	1.76	0	19.5	Waterlogged
GF02	17/03/2022	1020	0.5	0.1	0.06	0.3	21.1	Waterlogged
GF02	22/04/2022	994	48.6	0.4	-0.14	1.1	0.9	Damp
GF02	17/05/2022	1002	40.6	0.2	-0.65	1.2	4.7	Damp
GF02	08/06/2022	994	41.1	0.1	-0.17	0.3	4.6	
GF02	20/07/2022	1003	52.8	0.3	-0.65	1.3	0.3	Dry
GF02	03/08/2022	1006	49.9	0.2	0.39	0.3	0.4	Damp
GF02	01/09/2022	1012	50.1	0.2	0.05	0.2	0.5	Dry
GF02	06/10/2022	1015	18.9	1	0.43	1.1	7.8	Damp
GF02	03/11/2022	993	51.6	0.5	-0.34	0.3	0.6	Waterlogged
GF02	06/12/2022	1015	50.1	0.3	0.07	0.3	1	Damp
GF03	03/02/2022	1001	0.1	0	1.78	0.4	5.6	Damp
GF03	24/02/2022	999	3.4	0.8	2.03	-0.5	12.3	Waterlogged
GF03	17/03/2022	1019	6.5	1.3	0.09	0.3	4.1	Damp
GF03	22/04/2022	994	15.4	1.4	-0.02	1	3.9	Dry
GF03	17/05/2022	1001	7	1.8	-0.64	1.1	7.9	Damp
GF03	08/06/2022	993	6.2	1.6	-0.15	0.3	13.4	
GF03	20/07/2022	1003	5.7	3.7	-0.28	0.6	10.1	Dry
GF03	03/08/2022	1003	5.7	3.6	0.71	0.3	10.9	Y
GF03	01/09/2022	1011	8.4	4.3	-0.07	0.3	7.7	Dry
GF03	06/10/2022	1014	2.8	1.5	0.47	1.1	14.5	Damp
GF03	03/11/2022	990	17.3	3.9	-0.37	0.4	4	Damp
GF03	06/12/2022	1016	4.1	2.4	0.09	0.3	10.4	Damp
GF04	03/02/2022	1001	7	2.3	1.61	0.8	6.4	Damp
GF04	24/02/2022	998	7.7	1.3	1.76	0.6	6.5	Waterlogged
GF04	17/03/2022	1019	7.8	1.9	0.91	0.4	1.2	Damp
GF04	22/04/2022	993	5.4	2.5	-0.04	1	3.7	Dry
GF04	17/05/2022	1002	4.5	2.3	-0.31	0.4	1	Damp
GF04	08/06/2022	992	7.4	1.6	0.79	0.3	1.8	
GF04	20/07/2022	1002	6.5	1.6	-0.3	0.6	2.2	Dry
GF04	03/08/2022	1005	7	2.2	0.36	0.3	0.3	Y
GF04	01/09/2022	1012	4	3.5	0.2	0.3	0.9	Dry
GF04	06/10/2022	1013	5.8	1.6	0.83	1	2	Damp

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	FlowrateVol l/h	O2Stable %	Ground conditions
GF04	03/11/2022		7.9	2.6	-0.19	0.3	1.2	Damp
GF04	06/12/2022	1014	4.6	2.3	0.49	0.4	0.9	Damp
GF05	03/02/2022	1001	24.4	0.6	3.02	0.7	0.6	Damp
GF05	24/02/2022	998	20	0.6	1.78	0.5	7.2	Waterlogged
GF05	17/03/2022	1019	21.5	0.9	-0.13	0.5	1.3	Damp
GF05	22/04/2022	993	24.3	0.5	1.74	0.5	0.7	Damp
GF05	17/05/2022	1001	10.5	0.3	-0.38	0.4	11.7	Damp
GF05	08/06/2022	992	23.6	0.6	-29.75	0.4	0.5	
GF05	20/07/2022	1002	20.7	1	-0.12	0.7	1.4	Dry
GF05	03/08/2022	1004	21.6	1.1	0.81	0.2	0.3	Y
GF05	01/09/2022	1010	16	3.1	0.36	0.2	0.5	Dry
GF05	06/10/2022	1013	14.7	1.7	0.33	1.2	4.7	Damp
GF05	03/11/2022	989	23.8	1.4	-0.27	0.3	0.7	Damp
GF05	06/12/2022	1015	18	0.9	0.23	0.3	0.8	Damp
GF06	03/02/2022	1001	39.4	1.4	1.64	1.5	6.6	Damp
GF06	24/02/2022	997	23.5	0.3	1.7	0.7	11.8	Waterlogged
GF06	17/03/2022	1018	55.2	0.2	-0.07	0.7	1.4	Damp
GF06	22/04/2022	993	42.9	0.8	0.39	0.6	1.7	Damp
GF06	17/05/2022	1001	45.2	0.7	-0.24	0.2	1.9	Damp
GF06	08/06/2022	992	38.1	0.5	-0.05	0.3	4.2	
GF06	20/07/2022	1001	26.4	0.6	-0.23	0.7	0.5	Dry
GF06	03/08/2022	1003	19.5	0.7	0.81	0.2	0.3	Damp
GF06	01/09/2022	1009	15.2	1	0.36	0.3	0.4	Dry
GF06	06/10/2022	1014	11.6	0.9	0.58	0.7	4.5	Damp
GF06	03/11/2022	990	29.1	0.7	-0.32	0.3	0.8	Damp
GF06	06/12/2022	1014	44.2	0.9	0.79	0.1	1.2	Damp
GF07	03/02/2022	1001	15	3	1.63	1.1	0.7	Damp
GF07	24/02/2022	998	0	0	1.72	0.6	21.4	Waterlogged
GF07	17/03/2022	1018	2.2	1.8	0.14	0.6	4.3	Damp
GF07	22/04/2022	993	2.3	3.2	0.24	0.5	1	Dry
GF07	17/05/2022	1001	2	2	-0.36	0.4	4.5	Damp
GF07	08/06/2022	992	2	1.6	-0.11	0.5	7.2	
GF07	20/07/2022	1001	4.1	1.5	0.04	0.6	3.6	Dry
GF07	03/08/2022		4.5	2	0.88	0.1	0.6	Damp
GF07	01/09/2022	1009	4.6	1.7	0.22	0.3	2.5	Dry
GF07	06/10/2022	1013	3.8	1.5	0.91	1.2	4.2	Damp
GF07	03/11/2022	989	3.9	3.3	-0.56	0.2	0.5	Damp
GF07	06/12/2022	1014	2.1	2.8	0.35	0.3	0.4	Damp
GF08	03/02/2022	1001	13.3	1.6	2.43	1	0.7	Damp
GF08	24/02/2022	998	11.4	2.4	1.97	1.8	3.5	Waterlogged
GF08	17/03/2022	1019	3.8	1.6	-0.11	0.6	7	Waterlogged
GF08	22/04/2022	993	9.4	1.2	0.25	0.6	3.9	Dry
GF08	17/05/2022	1002	6.5	1.1	-0.24	0.3	3.9	Damp
GF08	08/06/2022	992	12.2	0.9	0.08	0.1	1.3	
GF08	20/07/2022	1002	4.4	0.7	-0.24	0.6	8.2	Dry
GF08	03/08/2022	1003	6.2	1.4	0.73	0.1	0.8	Damp
GF08	01/09/2022	1010	5.3	1.8	0.52	0.3	0.6	Dry
GF08	06/10/2022	1014	3.3	1.8	0.69	0.7	4.7	Damp
GF08	03/11/2022	989	11.6	1.9	-0.17	0.4	0.8	Damp
GF08	06/12/2022	1014	5.6	2	0.23	0.2	1.3	Damp

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	FlowrateVol l/h	O2Stable %	Ground conditions
GF09	03/02/2022	1001	9.7	2.1	1.61	1.5	3.7	Damp
GF09	24/02/2022	997	1.9	0.8	2.08	0.5	14.9	Waterlogged
GF09	17/03/2022	1018	9.5	1.5	-0.11	0.6	0.6	Waterlogged
GF09	22/04/2022	994	8	2.6	0.49	0.4	3.1	Dry
GF09	17/05/2022	1002	10	1.1	-0.17	0.3	1.8	Damp
GF09	08/06/2022	992	5.5	1.3	-0.1	0.2	6.7	
GF09	20/07/2022	1002	8.5	1.6	-12.07	0.7	0.5	Dry
GF09	03/08/2022	1003	8.1	2.2	0.71	0.3	0.2	Damp
GF09	01/09/2022	1009	8.1	2.1	0.46	0.3	0.3	Dry
GF09	06/10/2022	1014	6.3	2.4	0.22	1.5	1.4	Damp
GF09	03/11/2022	990	10.2	2	-0.34	0.3	0.6	Damp
GF09	06/12/2022	1015	8.7	2.1	0.51	0.4	0.7	Damp
GF10	03/02/2022	1001	13.3	1.4	1.62	1.2	7.2	Damp
GF10	24/02/2022	997	11.1	2.1	1.79	1	5.2	Waterlogged
GF10	17/03/2022	1018	8.2	2.2	-0.11	0.6	0.6	Waterlogged
GF10	22/04/2022	994	10.1	1.6	0.37	0.6	2.7	Dry
GF10	17/05/2022	1002	2.6	1.2	-0.18	0.3	7	Damp
GF10	08/06/2022	992	3.8	1.5	-0.03	0	4	
GF10	20/07/2022	1002	2	2	-0.19	0.6	1.9	Dry
GF10	03/08/2022	1003	1.7	2.6	0.8	0.1	0.8	Damp
GF10	01/09/2022	1010	1.3	3.1	0.44	0.2	1.1	Dry
GF10	06/10/2022	1013	1	3.4	0.12	1.4	3.1	Damp
GF10	03/11/2022	989	2.6	1.9	-0.25	0.3	0.7	Damp
GF10	06/12/2022	1015	3	3	0.77	0.2	1.5	Damp
GF11	03/02/2022	1001	4	3.6	1.58	0.5	1.5	Damp
GF11	24/02/2022	997	2.9	3.2	2.25	0.9	5.3	Waterlogged
GF11	17/03/2022	1018	5.3	4.1	-0.12	0.5	0.6	Waterlogged
GF11	22/04/2022	994	1.8	1.9	0.3	0.5	11.5	Dry
GF11	17/05/2022	1001	2.2	2.1	-6.87	0.4	9.1	Damp
GF11	08/06/2022	992	0	0	-0.06	0.2	20.6	
GF11	20/07/2022	1001	2	5	-0.22	0.7	2	Dry
GF11	03/08/2022	1003	1.1	5.4	1.34	0	1	Damp
GF11	01/09/2022	1009	1.6	5.5	0.86	0.4	1.3	Dry
GF11	06/10/2022	1014	2.3	5	0.65	0.6	2.3	Damp
GF11	03/11/2022	989	3.9	5.7	-0.12	0.3	1	Damp
GF11	06/12/2022	1015	1.3	5.9	0.23	0.1	1.6	Damp

Appendix B
Perimeter Gas Monitoring Data

Appendix A Table 2 Gas monitoring data for 2022

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	FlowrateVol l/h	O2Stable %	Ground conditions
GM10	03/02/2022	1001	0	2.6	1.65	0.4	19	Damp
GM10	24/02/2022	997	0	1.9	1.95	0.3	5.1	Waterlogged
GM10	17/03/2022	1019	0.5	0.1	-0.13	0.4	21.3	Damp
GM10	21/04/2022	998	0	1.1	-0.05	0.2	19.2	Damp
GM10	17/05/2022	1003	0	1.5	0.26	0.3	19.1	Damp
GM10	07/06/2022	998	0	1.1	0.04	0.2	19.6	Damp
GM10	19/07/2022	1001	0	0	1.44	-0.2	21.1	Dry
GM10	03/08/2022	999	0	0.9	-0.57	1.3	19.9	Damp
GM10	01/09/2022	1007	0	0.5	0.44	0.6	20.3	Dry
GM10	05/10/2022	995	0.1	1.1	0.58	0.4	19.3	Damp
GM10	03/11/2022	987	0.2	2	0.54	0.8	19.1	Waterlogged
GM10	06/12/2022	1016	0	1.1	2.52	0.3	20.4	Damp
GM11	03/02/2022	1001	0	0	1.65	0.3	21.2	Damp
GM11	24/02/2022	997	0	1.1	4.77	0.6	21	Waterlogged
GM11	17/03/2022	1019	0.5	2.2	-0.3	0.8	18.8	Damp
GM11	21/04/2022	998	0	1.4	-0.04	0.3	18.5	Damp
GM11	17/05/2022	1003	0	1.1	0.05	0.3	19.5	Damp
GM11	07/06/2022	998	0	1.4	0	0.3	19	Damp
GM11	19/07/2022	1001	0	0.9	2.01	-0.1	19.8	Dry
GM11	03/08/2022	1000	0	0.6	0.42	1.1	20.1	Damp
GM11	01/09/2022	1007	0	2	0.5	0.6	19	Dry
GM11	05/10/2022	995	0.1	0.9	0.51	0.4	19.4	Damp
GM11	03/11/2022	987	0.2	0.1	0.55	0.7	20.8	Damp
GM11	06/12/2022	1016	0	2.7	1.09	0.3	19.6	Damp
GM2	03/02/2022	1007	0	2.5	-7.09		17.7	Damp
GM2	24/02/2022	1000	0	0.8	7.61	0.6	21.3	Damp
GM2	17/03/2022	1023	0.5	0.9	-0.12	0.5	20.8	Damp
GM2	21/04/2022	1003	0	0.4	0.4	0.3	20.4	Damp
GM2	17/05/2022	1007	0	0.7	0.04	0.6	19.5	Damp
GM2	07/06/2022	1003	0	0.6	-6.93	0.4	19.8	Damp
GM2	19/07/2022	1005	0	0.1	0.61	0.1	20.3	Dry
GM2	03/08/2022	1004	0	0	-0.01	0.4	20.5	Damp
GM2	01/09/2022	1011	0	0.9	2.2	0.6	19.8	Damp
GM2	05/10/2022	999	0.1	0.9	-9.1	0.8	19.3	Damp
GM2	03/11/2022	991	0.2	0.3	1.38	0.6	20.4	Damp
GM2	06/12/2022	1021	0	0.8	0.04	0.3	20.5	Damp
GM4	03/02/2022	1004	0	2.8	1.61	1.3	20.6	Damp
GM4	24/02/2022	1000	0	0.2	1.88	0.3	21.3	Damp
GM4	17/03/2022	1022	0.6	0.5	0.13	0.3	20.8	Damp
GM4	21/04/2022	997	0	0	-0.41		20.5	Damp
GM4	17/05/2022	1005	0	0.8	-0.04	0.3	19.8	Damp
GM4	07/06/2022	1001	0	0.5	-0.03	0	20.2	Damp
GM4	19/07/2022	1004	0	1.6	0	0	19.6	Dry
GM4	03/08/2022	1003	0	0.1	-0.25	0.3	20.4	Damp
GM4	01/09/2022	1009	0.1	1.5	0.37	0.4	19.3	Dry
GM4	05/10/2022	999	0	0.6	0.78	0.5	19.9	Damp
GM4	03/11/2022	989	0.2	0.2	0.52	0.7	20.7	Damp

Location	Date	Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	FlowrateVol l/h	O2Stable %	Ground conditions
GM4	06/12/2022	1015	0	2.4	-0.04	0.2	19	Damp
GM5	03/02/2022	1000	0	1.5	1.63	0.6	19.1	Damp
GM5	24/02/2022	997	0	0.1	1.85	0.3	21.6	Damp
GM5	17/03/2022	1018	0.5	1.4	0.05	0.3	18.5	Damp
GM5	21/04/2022	998	0	0	-0.02	0.2	20.8	Dry
GM5	17/05/2022	1003	0	0	-0.11	0.4	20.6	Damp
GM5	07/06/2022	997	0	1.8	-0.61	1.3	18	Damp
GM5	19/07/2022		0	2.3	1.1	0	18.8	Dry
GM5	03/08/2022	1000	0	2.2	1.84	0.3	18.8	Damp
GM5	01/09/2022	1006	0.1	1.9	0.46	0.6	19	Dry
GM5	05/10/2022	995	0.1	1.4	0.54	0.4	19.4	Damp
GM5	03/11/2022	986	0.2	1.9	1.09	1.1	18.8	Damp
GM5	06/12/2022	1015	0	2	0.05	0.3	17.4	Damp
GM7	03/02/2022	1000	0	0.4	1.62	1.4	18.2	Damp
GM7	24/02/2022	997	0	0.1	1.83	0.4	21.2	Damp
GM7	17/03/2022	1018	0.5	0.3	1.67	0.4	20.9	Damp
GM7	21/04/2022	997	0	0	-0.41	0.6	20.4	Dry
GM7	17/05/2022	1002	0	0.2	-0.45	1.2	20.4	Damp
GM7	07/06/2022	997	0	0.5	-0.17	0.7	19.8	Damp
GM7	19/07/2022	Inaccessible - overgrown						
GM7	03/08/2022	1000	0	0	-4.74	0.6	20.4	Damp
GM7	01/09/2022	1008	0.1	0.7	-0.13	1.1	19.4	Dry
GM7	05/10/2022	995	0.1	0.9	0.54	0.3	19.4	Damp
GM7	03/11/2022	986	0.2	2.5	0.44	1.1	20	Damp
GM7	06/12/2022	1014	0	0.1	0.7	-0.1	21.3	Damp
GM8	03/02/2022	1001	0	0.8	1.66	0.6	19.9	Damp
GM8	24/02/2022	997	0	0.8	1.67	0.3	21.1	Damp
GM8	17/03/2022	1019	0.5	1.1	-0.08	0.5	20.3	Damp
GM8	21/04/2022	998	0	0.7	-0.06	0.1	20.2	Damp
GM8	17/05/2022	1003	0	1.1	-0.02	0.4	19.4	Damp
GM8	07/06/2022	998	0	0.7	0.77	0.2	19.8	Damp
GM8	19/07/2022	1001	0	2.6	1.02	0	18.3	Dry
GM8	03/08/2022	999	0	1.9	-0.52	1.2	18.7	Damp
GM8	01/09/2022	1006	0	0.2	1.09	0.4	20.4	Dry
GM8	05/10/2022	994	0.1	1.1	1.24	0.8	19.2	Damp
GM8	03/11/2022	986	0.2	0.6	0.53	0.7	20	Damp
GM8	06/12/2022	1015	0	0.8	0.18	0.4	21	Damp

Appendix C
Groundwater Level Monitoring Data

Appendix B Table 1 Groundwater level data (mAOD) for 2022

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
02/02/2022	71.66	64.64	77.23	73.80	70.10	70.05	71.01	86.49	77.54
24/02/2022	72.15	65.94	79.88	80.65	74.10	72.77	74.15	87.19	83.7
16/03/2022	72.03	65.25	78.11	78.38	71.77	71.52	72.86	86.86	79.6
21/04/2022	70.86	63.94	76.72	74.11	70.26	67.83	68.75	86.03	Dry
16/05/2022	68.58	63.68	76.37	69.17	69.08	65.68	66.66	85.45	
07/06/2022	67.83	63.38	76.3	66.62	69.00	64.5	65.48	82.39	
19/07/2022	66.58	62.96	76.19	62.74	66.19	61.68	63.98	75.42	
03/08/2022	67.78	63.52	76.15	62.01	65.10	61.12	63.36	76.87	
01/09/2022	65.35	62.10	76.12	61.00	63.81	59.88	62.78	77.02	
05/10/2022	66.83	62.74	76.12	60.95	62.29	58.33	61.70	75.73	
03/11/2022	72.41	66.07	76.53	Dry	63.46	66.99	70.73	76.77	
06/12/2022	71.83	64.91	76.96	77.64	70.69	70.13	70.77	86.53	78.11

Appendix D
Groundwater Quality Monitoring Data

Appendix D Table 1 Quarterly groundwater quality data for 2022

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity- Electrical 20deg µS/cm	Ionic balance %	Iron µg/l	Magnesium mg/l	Napthalene µg/l	Nitrogen (total oxidised) as N mg/l	pH pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	TOC (filtered) mg/l
BH1	02/02/2022	298	0.25	101	17	589	-3.1	<25	15.2	0.032	<0.7	7.6	8.04	10	46.2	10.1
BH1	21/04/2022	260	0.19	89.5	16.8	505	-1.8	<25	13.1	<0.01	<0.7	7.6	7.19	9.02	33.4	5.4
BH1	19/07/2022	271	0.52	98	20.2	608	-0.4	175	15.2	0.106	<0.7	7.2	8.33	11	45.3	7.7
BH1	05/10/2022	193	0.2	91.1	21.9	562	-2.1	28	12.4	0.022	16.5	7.3	8.49	12.3	46	13.1
BH12	02/02/2022	Borehole blocked														
BH12	21/04/2022	369	<0.06	175	61.6	1110	-0.4	<25	33.3	0.057	0.9	7.4	14.7	42.9	224	11.1
BH12	19/07/2022	383	0.91	176	73.5	1210	-0.2	<25	34.6	<0.01	<0.7	7.3	17.2	49.9	223	19.5
BH12	05/10/2022	394	<0.06	184	71	1130	1.6	<25	35.7	0.100	1	7.3	16.9	51.1	210	9
BH13	02/02/2022	337	<0.06	96.7	38.1	770	2.4	<25	40	<0.01	2.6	7.4	3.35	23.4	38.1	4
BH13	21/04/2022	382	<0.06	97.6	46.9	755	0.0	<25	42.3	<0.01	1.3	7.6	2.76	27.8	28	3.5
BH13	19/07/2022	367	<0.06	94.4	47	781	-0.1	<25	40.5	<0.01	1.1	7.3	2.98	27	27.9	3
BH13	05/10/2022	333	5.8	367	203	2210	2.4	10100	33.7	0.116	<0.7	7.4	28.1	187	794	55.7
BH14	02/02/2022	400	<0.06	109	8	650	-1.5	<25	30.7	<0.01	2.1	7.9	0.8	5.26	4.8	2.4
BH14	21/04/2022	398	<0.06	113	9.8	687	-0.4	<25	31.8	<0.01	2.9	7.7	0.87	6.72	9.7	4.4
BH14	19/07/2022	Insufficient liquid to obtain a sample														
BH14	05/10/2022															
BH15	02/02/2022	335	<0.06	103	19.2	650	0.6	<25	32.5	<0.01	5.3	7.6	1.22	10.4	28.1	3.8

Location	Date	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Calcium	Chloride	Conductivity- Electrical 20deg	Ionic balance	Iron	Magnesium	Napthalene	Nitrogen (total oxidised) as N	pH	Potassium	Sodium	Sulphate as SO4	TOC (filtered)
		mg/l	mg/l	mg/l	mg/l	µS/cm	%	µg/l	mg/l	µg/l	mg/l	pH units	mg/l	mg/l	mg/l	mg/l
BH15	21/04/2022	342	<0.06	102	16.9	657	-0.2	<25	32.6	<0.01	6.3	7.8	1.21	10.7	25.8	4.8
BH15	19/07/2022	342	<0.06	101	17.3	883	-0.2	<25	33.2	<0.01	5.5	7.3	1.25	9.67	25.8	1.8
BH15	05/10/2022	346	4.17	340	206	2300	-2.9	5440	31.6	0.146	<0.7	7.1	26.6	175	823	55.1
BH3	02/02/2022	315	2.1	96.9	39.6	640	1.0	585	21.7	<0.01	<0.7	7.2	3.19	16.2	<4.4	7.4
BH3	21/04/2022	286	0.46	88.6	45.3	615	-2.0	<25	21.2	0.0100	<0.7	7.8	2.13	18.3	16.3	4.5
BH3	19/07/2022	340	1.52	115	34.6	754	-0.2	101	28.5	<0.01	<0.7	7.2	3.31	18.8	65.6	4.2
BH3	05/10/2022	Insufficient liquid to obtain a sample														
BH3A	02/02/2022	282	<0.06	94.3	38.4	635	-2.1	<25	23.5	0.014	<0.7	7.9	2.78	21.1	59.2	4.9
BH3A	21/04/2022	299	<0.06	88.7	48.8	658	-1.3	<25	26.5	<0.01	<0.7	7.5	2.79	24.3	28.3	6.6
BH3A	19/07/2022	277	<0.06	124	36.1	813	-0.8	<25	30.9	0.039	<0.7	7.2	4.98	20.9	162	4.8
BH3A	05/10/2022	Insufficient liquid to obtain a sample														
BH6	02/02/2022	314	<0.06	87.6	23.5	562	-1.2	<25	26.7	<0.01	<0.7	7.6	1.98	9.05	12.1	3.8
BH6	21/04/2022	308	<0.06	86.6	22.2	571	1.7	<25	31	<0.01	<0.7	7.9	2.12	8.84	13.8	2.9
BH6	19/07/2022	Insufficient liquid to obtain a sample														
BH6	05/10/2022															
BH9	02/02/2022	347	<0.06	112	12	614	0.7	<25	20	<0.01	3	7.5	9.31	6.46	7.5	4.5
BH9	21/04/2022	Dry														
BH9	19/07/2022															
BH9	05/10/2022															

Appendix D Table 2 Annual groundwater quality data 2022

Location	Date	Cadmium µg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Manganese mg/l	Nickel mg/l	Zinc mg/l
BH1	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.046	<0.003	<0.018
BH12	21/04/2022	<0.6	<0.002	0.012	<0.006	<0.007	0.005	<0.018
BH13	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.021	<0.003	<0.018
BH14	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.03	<0.003	<0.018
BH15	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.008	<0.003	<0.018
BH3	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.05	<0.003	<0.018
BH3A	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.085	<0.003	<0.018
BH6	21/04/2022	<0.6	<0.002	<0.009	<0.006	0.007	<0.003	<0.018
BH9	21/04/2022	Dry						

Appendix E
Topographic Survey

311600E

311700E

311800E

11850E

173500N

173400N

7457

GM7
CL:116.65

BH6
CL:113.40
GL:112.69

GM5
CL:112.93
GL:112.34

GF11 (06/2021)
CL:117.31
GL:116.67

GF07 (06/2021)
CL:115.91
GL:115.27

GF10 (06/2021)
CL:115.90
GL:115.33

GF06 (06/2021)
CL:114.66
GL:113.90

GF03 (06/2021)
CL:104.09
GL:103.39

GF08 (06/2021)
CL:115.26
GL:114.56

GF04 (06/2021)
CL:106.51
GL:105.86

GF05 (06/2021)
CL:113.09
GL:112.36

GF09 (06/2021)
CL:113.30
GL:112.66

GF02 (06/2021)
CL:92.36
GL:91.67

GF01 (06/2021)
CL:89.86
GL:89.20

GM4
CL:92.53

BH3
CL:90.69

BH3A
CL:90.04

GM11 (06/2021)
CL:109.80
GL:109.40

BH13 (06/2021)
CL:106.71
GL:106.28

Ungraded
Tipped Material

Gate

'Cut' Drainage Grip

Stone Filled Grip

Exposed Head of
Clay Barrier:
Placed 10/07/2020

Exposed Head of
Clay Barrier: 01/2019

Speed Ramp

Path (um)

Stile

Stile

Tarmac
surface
ends

Track

peg

LVL

Survey Legend/Abbreviations

BH	Borehole	MKR	Marker Post
BOL	Bollard	MT	Mercury Telecom Cover
BS	Bike Stand	OHC	Overhead Cable
BT	British Telecoms Cover	OHP	Overhead Pipe
BW	Barbed Wire Fence	OSBM	Ordnance Survey Bench Mark
BWK	Brickwork	PB	Post Box
CATV	Cable TV Cover	PGM	Permanent Ground Marker
CB	Close Boarded Fence	PR	Post & Rail Fence
CCTV	Closed Circuit TV	PW	Post & Wire Fence
CHLK	Chainlink Fence	PWS	Post & Wire Stock Fence
CNPL	Chestnut Paling Fence	RE	Rodding Eye
CL	Cover Level	RG	Road Gully
CM	Cable Marker	RN	Road Name
CP	Catch Pit	RS	Road Sign
DIA	Diameter	Ret Wa	Retaining Wall
DK	Drop Kerb	RWP	Rain Water Pipe
EJB	Electricity Junction Box	SAP	Sapling
EP	Electricity Pole	SC	Stop Cock
ER	Earth Rod	SPR	Spread
FH	Fire Hydrant	SV	Stop Valve
FW	Foul Water	SVP	Soil Vent Pipe
G	Gully	SW	Storm Water
GP	Gate Post	TB	Telephone Box
GV	Gas Valve	TJB	Telephone Junction Box
HT	Height	TL	Traffic Light
IC	Inspection Cover	TP	Telephone Pole
IL	Invert Level	UTL	Unable To Lift
IR	Iron Railing Fence	UTT	Unable To Trace
KO	Kerb Outlet	VP	Vent Pipe
LB	Litter Bin	WM	Water Meter
LC	Lamp Column	WV	Water Valve
LP	Lamp Post		
MH	Manhole		

Trees

Ash (3 bole)
Dia:0.60
Spr:18.00
Ht: 14.50

5.090

Notes
1. Species, bole diameter, spread, no. of trunks & height values supplied only upon request. Values left out if not required.
2. If Required, No of trunks assumed to be one (in which case no entry) unless otherwise stated.
3. Bole, Spread and Height Dimensions in metres.

Generic Tree Species Abbreviations.

App	= Apple	Lim	= Lime
Ash	= Ash	Map	= Maple
Bee	= Beech	Oak	= Oak
Bir	= Birch	Pin	= Pine
CBee	= Copper Beech	Pop	= Poplar
Ced	= Cedar	Rho	= Rhododendron
Che	= Cherry	Row	= Rowan
Con	= Conifer	SPin	= Scots Pine
Eld	= Elder	SBir	= Silver Birch
Elm	= Elm	Spr	= Spruce
Fir	= Fir	Syc	= Sycamore
FMap	= Field Maple	Unk	= Unknown
Haz	= Hazel	Wal	= Walnut
Hol	= Holly	Wil	= Willow
Hor	= Horse Chesnut	Win	= Wingnut
Lau	= Laurel	Yew	= Yew
Lar	= Larch		
Ley	= Leylandii		

- Contours - Prominent (0.50m interval)
- Contours - Normal (0.10m interval)
- Contours - Minus Prominent (0.50m interval)
- Contours - Minus Normal (0.10m interval)

Notes

The plan location of all underground services shown are map indicative only. No attempt has been made to detect individual services. The completeness of the information shown can not be guaranteed. Do not scale off plan.

In the absence of evidence to the contrary, the routes of confirmed connections between inspection chambers has been assumed to be direct.

All Building Eave Levels are taken at base of fascia board unless otherwie stated.

This survey has been transformed to Ordnance Survey National Grid Reference System. All levels are reduced to Ordnance Survey datum.

Revision History

00	24/07/2020	Opening survey of completed restoration, undertaken to OSGB National Grid and Datum, via GPS derived techniques (by Cemex surveyor).
01	03/09/2020	Update (GSurv) to include constructed drainage grips.
02	04/03/2022	Full site settlement survey undertaken (10m grid).

gsurv
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Client
Cemex UK Materials Ltd

Project
Wenvoe Landfill Site. Old Port Road, Wenvoe. CF5 6AX

Title
Isopachyte Level Difference Plan Between Surveys - 24th July 2020 & as Surveyed 04th March 2022

Drawn By	Scale	Date
D Mildenhall	1:500 @A1	09/03/2020

Drawing No.	Rev.
dwg 22 615/002_0	00