

Caulmert Limited

Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council Waste Management Services

Annual Monitoring Review 2020

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DRAWINGS

11375aRev1 Brookhill 09-12-2020 Environmental Monitoring Plan
and 2020 Topographical site survey

APPENDICES

- Appendix 1:** Perimeter Landfill Gas Monitoring Summary Table, Landfill Gas Time-Series Graphs,
In Waste Gas Monitoring Summary Table, Surface Emissions Report
- Appendix 2:** Leachate Level and Quality Summary Tables and Time-Series Graphs
- Appendix 3:** Groundwater Level and Quality Summary Tables and Time-Series Graphs
- Appendix 4:** Surface Water Quality Summary Table and Time-Series Graphs
- Appendix 5:** Deposited Dust Monitoring results

1.0 INTRODUCTION

1.1 Background

- 1.1.1 This report has been compiled in compliance with the Environmental Permit (EP) Number AP3739KS for Brookhill Landfill Site, which requires that an annual review of the monitoring data collected at the site be carried out. The data reviewed in this report was collected from 1st January 2020 to 31st December 2020.
- 1.1.2 This report records the monitoring data for landfill gas, leachate, groundwater, surface water and dust, and discusses this data in relation to emission limits set in the EP. It also reports on fugitive emissions as performance parameters.
- 1.1.3 Previous monitoring data collected between the 1st of January 2009 and the 31st of December 2019 has also been included in the visual representation of the data as requested by Natural Resources Wales. This allows recent data to be viewed in the context of longer-term trends.

1.2 Site Location and Surrounding Land-use

- 1.2.1 Brookhill Landfill Site is located approximately 1.5 km north of Buckley, Flintshire, North Wales at NGR SJ278656. The site is accessed via the Pinfold Industrial Estate, Pinfold Lane, which is located off the A494 Mold to Ewloe Road.
- 1.2.2 The site is bound to the east by a wooded, disused railway leading to open grassland. Agricultural land lies to the west of the site. The Pinfold Industrial Estate and a number of residential properties (on the outskirts of Buckley, approximately 400 m away) are situated to the south of the site. A restored refuse tip (Ewloe Barn Landfill) lies to the north of the site. It is currently used for rough grassland leading to open grazing land and some woodland.
- 1.2.3 Brookhill Landfill Site has been developed in a former quarry, which was worked for Buckley Fireclay and the siltstones and mudstones beneath the Fireclay (known as the Warrant) for use in the manufacturing of bricks and tiles.
- 1.2.4 In 1997, in preparation for the engineering of the landfill site, further Fireclay was removed together with a quantity of coal in the quarry base under agreement with the Coal Authority.
- 1.2.5 Brookhill Landfill Site started accepting waste in 1999. The wastes permitted at the site were stipulated within the site permit. The general waste streams which were permitted at the site through its history can be summarised as:
- Domestic food and organic wastes – approximately 60%
 - Non-hazardous industrial wastes, (including plastic, paper, cardboard, wood, stone and sand, etc) – approximately 40%
 - Most special wastes (allowed until June 2004).

- 1.2.6 The special wastes which were tipped at the site were accepted pre-June 2004 (under the WML for the site). Therefore, they would have been deposited predominantly within Cell 1, and the lower parts of Cells 2, 3 and 4. It is likely that none of the waste tipped in Cells 5 and 6 contains any 'special waste' waste streams.
- 1.2.7 The site ceased accepting waste in late 2007. The final capping and restoration phases were undertaken during 2010.

2.0 ENVIRONMENTAL CONTEXT

2.1 Geology

- 2.1.1 Brookhill Landfill is situated within the Buckley Formation part of the Middle Coal Measures. Strata visible in the quarry walls prior to waste emplacement consist of the Warrant siltstone, overlain with the mudstone of the Buckley Fireclay, overlain with Buckley Fireclay Sandstones. The strata generally dip approximately 15° to the north east exposing the youngest beds of Buckley Formation in the eastern quarry wall prior to infilling. On a regional scale the quarry is situated within a faulted block with the major faults located 70 m to the west and 180 m to the east of the site.
- 2.1.2 Prior to filling, the Warrant could be seen exposed on the western face of the quarry and beneath the Fireclay to the north. The Warrant is described as consisting of highly weathered grey mudstones and moderately weathered red-brown siltstones with extremely closely-spaced fractures and discontinuities.
- 2.1.3 Buckley Fireclay could be seen to the north of the site prior to infilling. The strata can be divided up into the upper and lower Fireclays, which are separated by a thinly bedded layer of sandstone and basal black clay/mudstone. The Buckley Fireclays are described as being dark red-brown, thinly and thickly laminated highly weathered mudstones. The Buckley Fireclay sandstone interbedded with the mudstones and exposed at the quarry face prior to landfilling is orange-brown, fine to medium grained, thinly to thickly bedded, jointed with some joints infilled with clay, others exhibiting some seepage flow.
- 2.1.4 The site lies above several coal seams at depths between 100 m (16 mAOD) to 370 m beneath the site, forming part of the Middle and Lower Coal Measures. A thin coal seam, at the base of the Buckley Fireclay approximately 0.5m thick, has been worked in the centre of the site.
- 2.1.5 The 1:50,000 BGS geological map of the area shows that the drift geology consists in general of Boulder Clay/Glacial Till above the solid geology. However, in the area of the site itself, no drift deposits are present.

2.2 Hydrogeology

- 2.2.1 Accounts of visual inspections made of the quarry walls prior to landfilling report water seepages from the siltstones in the Warrant and from joints within the Buckley Fireclay Sandstone. Some seepage has also been observed through discontinuous i.e. intervening sandstone in the Fireclay strata.
- 2.2.2 The groundwater regime around the site is described in the revised Hydrogeological Risk Assessment (2008), and was updated in the Brookhill Landfill Hydrogeological Review (2014) prepared by RukHydro Ltd for Natural Resources Wales.

2.3 Hydrology

- 2.3.1 Topographic falls and corresponding surface water flows are in a north-easterly direction, towards Wepre Brook, approximately 2 km from the site boundary. The Brook runs into the River Dee which is approximately 5 km from the site.
- 2.3.2 During and following wet weather periods, surface water run-off to the south and west of the site is channelled around the western site perimeter before flowing overland to the Wepre Brook.

3.0 LANDFILL GAS

3.1 Monitoring regime

- 3.1.1 The in-waste gas field at Brookhill is monitored on a regular basis, and the gas wells are regulated to balance the gas field to ensure that the gas plant is supplied with landfill gas of high calorific content and low oxygen concentration. A summary table of the in-waste data is included in Appendix 1.
- 3.1.2 Routine landfill gas monitoring around the site perimeter is carried out on a weekly basis at boreholes BH1, BH3-BH21 and BH23-BH25. Methane, carbon dioxide, oxygen, relative pressure and atmospheric pressure were recorded on each visit.
- 3.1.3 Perimeter borehole locations are shown on Drawing 3031-CAU-XX-XX-DR-O-1802. Appendix 1 contains a landfill gas monitoring data summary table. Methane and carbon dioxide data from all boreholes is also displayed in time-series graphs in Appendix 1. The time-series graphs show methane and carbon dioxide concentrations in the perimeter boreholes recorded between January 2009 and December 2020. The perimeter landfill gas data obtained during the review period was compared with the EP limits.

3.2 In waste Boreholes

- 3.2.1 The gas field at Brookhill is monitored and balanced on a regular basis. Methane, carbon dioxide, oxygen, balance, relative pressure, hydrogen sulphide and carbon monoxide were recorded on each visit. In accordance with Condition 4.2.2 of the EP for the site, monitoring data for the in waste boreholes is submitted to the NRW monthly. Quarterly results are listed and discussed in quarterly reviews for the site. Here, the data collected between the 1st January 2020 and 31st December 2020 is summarised in Appendix 1.
- 3.2.2 Methane concentration was on average 49.42 %, varying between 0% (at GV 23) and 77% (at GV 22). The average methane concentration increased slightly when compared to the previous review (46.46 %). This suggests the improvements within the gas extraction system (removal of leachate from the gas wells) has been beneficial in terms of landfill gas management.
- 3.2.3 Concentrations of carbon dioxide ranged from 0.7 % within LC5 to 45.3 % within GV0A. The average site concentration of carbon dioxide increased slightly from 30.37 % (2019) to 32.63 % during 2020.
- 3.2.4 Oxygen concentrations within the in-waste boreholes ranged from 0.0 % to 22 %. On average the total oxygen concentration across the site was 2.25 %, a slight decrease compared to the previous reviews annual average of 2.6 %. Wells with potential air ingress are shown in table 3.1 below.

Table 3.1: Wells with potential Air ingress

Monitoring Point	Series	O2 %			% above 5%
		Min	Max	Average	
GV06	GV Wells	8	15.3	12.87	100%
GV08	GV Wells	5.6	18.7	12.61	100%
GV13	GV Wells	2.2	16.3	8.45	71%
GV17	GV Wells	0.5	7.3	2.91	25%
GV22	GV Wells	0	6.6	1.27	14%
GV23	GV Wells	0.1	17.6	6.46	36%
GV24	GV Wells	0	11.2	1.21	9%
GV301	GV Wells	0.4	14.3	9.67	67%
GV33	GV Wells	0.1	7.3	1.55	7%
GV38	GV Wells	0	18.9	6.16	44%
GV42	GV Wells	9.4	18.1	13.18	100%
GW34	Other Wells	0.6	14	2.86	10%
LC1B	LC Wells	7.2	7.6	7.4	100%
LC2B	LC Wells	0.6	17.1	6.6	43%
LC3	LC Wells	0.2	20	10.01	75%
LC4	LC Wells	0	18.8	6.47	33%
LC4B	LC Wells	1.1	20.3	11.94	71%
LC5	LC Wells	0.1	16.3	4.14	29%
LC6	LC Wells	0	15.5	5.49	44%
R1	R Wells	0	14.7	1.6	5%
R2B	R Wells	0	16	8.37	67%
R3	R Wells	6.1	9.6	8.06	100%
R4B	R Wells	0	16.1	3.19	19%
R5	R Wells	6.6	6.9	6.75	100%
R6B	R Wells	0	22	5.42	23%

3.3 Trace Gas Monitoring

3.3.1 Annual trace gas monitoring was carried out by Envirodan Air Quality and Environmental Consultants on 15th of December 2020 (see report included in Appendix 1). The sample point was described as 'Inlet Line to Utilisation Plant'. The ambient temperature was 5.3°C and the atmospheric pressure, 999 mbar.

3.3.2 Bulk landfill gas was sampled for methane, carbon dioxide and oxygen and was reported to contain the following concentrations (similar to the results in 2019):

- Methane 43.2 % v/v
- Carbon dioxide 29.4 % v/v
- Oxygen 4.7 % v/v

3.3.3 Laboratory analysis was undertaken for components identified in Table 1.1 of the Environment Agency document 'Guidance for Monitoring Trace Gas Components in Landfill Gas (LFTGN 04).

- 3.3.4 Of the 29 trace gases, 13 were detected. These were *vinyl chloride*, Chloroethane, *furan*, 1,1-dichloroethene, dimethyl sulphide, carbon disulphide, *1,1 dichloroethane*, *1,2 dichloroethane*, Benzene, trichloroethylene, toluene, styrene and hydrogen sulphide (see report included in Appendix 1). This is a decrease in the previous year where 15 trace gasses were detected.

3.4 Engine and Flare Emission Monitoring

- 3.4.1 Monitoring of the emissions from the landfill gas engine was carried out on the 15th of December 2020. The engine exhaust was sampled for oxides of nitrogen (as NO₂), carbon monoxide (CO), volatile organic compounds (VOCs as carbon), moisture and oxygen in accordance with the requirements in Table S4.2 in the EP.
- 3.4.2 Concentrations of NO₂ for the engine exceeded the compliance limit for the engine (500 mg(N)m⁻³) with a concentration of 516 ±24 mg(N)m⁻³. Concentrations of CO and VOCs were below the respective emission limits for the engine. The NO_x result on the engine was reported above the permit limits, but is within the overall uncertainties as detailed in LFTGN08, and is therefore considered as being compliant.
- 3.4.3 Concentrations of NO₂, CO and VOCs were all below their respective emissions limits within the Flare.

3.5 Perimeter Boreholes

Methane

- 3.5.1 As with the previous review, all perimeter gas boreholes had methane concentrations below their respective EP limits during 2020.
- 3.5.2 Methane concentrations have remained below 1.0 % in all locations except BH8 and BH9. Average concentrations ranged from 0.0 % in BH4, BH19 and BH20 to 7.39 % in BH9 during 2020.
- 3.5.3 Methane concentrations in BH8 and BH9 remained below their compliance limits with maximum concentrations of 21.1 % and 17 % respectively. Average concentrations within BH9 decreased from 9.11 % (2019) to 7.39 % (2020) when compared to the previous annual review. Average methane concentrations within BH8 remained similar to the previous review.

Carbon Dioxide

- 3.5.4 Carbon Dioxide was detected in all perimeter boreholes but remained below the relevant EP limits throughout the review period with the exception of BH6. Concentrations within BH6 exceeded the compliance limit of 1.5 % once with a maximum concentration of 2.3 % during September.

- 3.5.5 Concentrations throughout the site fluctuated during the review period. These fluctuations were not accompanied by increase in methane concentrations at those locations except for BH8 and BH9. It's therefore unlikely to reflect lateral emissions of landfill gas from the site. Ongoing monitoring will continue to be reviewed in accordance with the permit, and these trends will be reassessed.
- 3.5.6 Average concentrations across the site ranged from 0.3 % in BH20 to 4.91 % in BH9. No overall increases in CO₂ were noted in any other boreholes around the site.

4.0 LEACHATE

4.1 Introduction

4.1.1 Leachate levels at leachate chambers LC1B, LC2B, LC4B and LC6B are recorded monthly. During a meeting with Natural Resources Wales on the 16th of April 2013, it was agreed that leachate levels within LC3 and LC5 should no longer be reported, as it is not possible for them to be dipped to the base of the well. They have therefore been excluded from the data analysis within this report.

4.1.2 Leachate levels were also recorded at six retrofitted remote leachate monitoring points, named R1 – R6, at monthly intervals throughout the review period.

4.1.3 During June and July 2020, the leachate wells LW1 and LW6 were installed as detailed in the CQA Report 3448-CAU-XX-XX-RP-V-0307-A0-C1. Samples from these wells are included in the December analysis below.

4.1.4 Additionally, in line with the EP, samples from these chambers were sampled and analysed quarterly for the range of determinants listed below.

Alkalinity, pH, ammoniacal nitrogen, calcium, chloride, magnesium, potassium, sodium, sulphate, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC) and Total Oxidised Nitrogen (TON).

4.1.5 Samples collected from the leachate chambers in December 2020 were also analysed for the annual suite below:

Cyanide, metals – cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc, mineral oils, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), phenoxy acid herbicides, combined pesticides/herbicides and misc. organics.

4.1.6 Well locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.

4.2 Leachate Levels

4.2.1 Leachate levels were recorded monthly during the review period. Graphs and tables displaying leachate head (in metres above cell base) can be found in Appendix 2. The leachate levels in metres above Ordnance Datum (mAOD) were also compared to the groundwater levels in the nearest groundwater monitoring boreholes to assess hydraulic containment during the review period. The graphs are included in Appendix 2.

4.2.2 Table S4.1 in the EP requires that leachate levels must not exceed 2 m above the base of Cells 1 and 6, and 3 m above the cell base of Cells 2-5.

4.2.3 Pumped leachate levels recorded during this review period are summarised in Table 1 below. As discussed with NRW, 'pumped' leachate levels are recorded after pumps are switched off

for up to 4 hours before a dip is obtained. During 2020, 'rest' levels of leachate were recorded, which reflect the head of leachate after 48 hours of recovery (which has been demonstrated to be sufficient amount of time for leachate head to rebound to rest level, in accordance with report number 3448-VAU-XX-XX-RP-V-9107.A0-C1. The rest leachate levels are reported in relation to the compliance limits in Table 2 and plotted in Appendix 2.

- 4.2.4 As rest levels of leachate are now being obtained, compliance is assessed and reported against those. Pumped leachate levels are provided for completeness, and to provide additional information regarding the efficiency of the leachate management strategy at the site.

Leachate Wells

- 4.2.5 As can be seen in Table 4.1, pumped leachate levels were consistent throughout 2020, often close to the base of the respective wells, indicating that leachate extraction is optimised.

Table 4.1: Leachate Pumped Levels (levels above the EP limit are highlighted in orange)

Landfill Cell	Monitoring Point	Pumped Leachate Level (mAOD)			Compliance Limit (mAOD)
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	119.17	119.26	119.22	119
	BK R1	118.75	119.49	118.95	
Cell 2	BK LC 2B	115.17	115.28	115.23	117
	BK R2	116.73	116.82	116.77	
Cell 3	BK R3*	111.59	111.72	111.67	113.37
Cell 4	BK LC 4B*	114.68	114.79	114.74	115
	BK R4	115.36	115.44	115.42	115.6
Cell 5	BK R5	116.66	116.76	116.70	115.91
Cell 6	BK LC 6B	123.57	123.64	123.61	122
	BK R6	122.01	122.20	122.09	122.24

- 4.2.6 Leachate **rest levels** are tabulated in Table 4.2 in relation to the relevant compliance limits. The recorded rest levels were similar over the review period, indicating that the current leachate extraction strategy at the site continues to be efficient in managing leachate head to levels close to the compliance limits. On average both LC2B and well R3 have recorded rest leachate levels below its compliance limits during 2020. It is noted that in wells which exceed the compliance limit, the amount they exceed by is slowing decreasing over time in the majority of the wells. This is likely as a result of the ongoing extraction of leachate from gas wells at the site¹.

¹ Caulmert Ltd, February 2019; Document reference 3448-CAU-XX-XX-RP-V-9107-A0-C1: Brookhill Improvement Actions; Trial of Leachate Extraction from Gas Wells – Interpretative report.

Table 4.2: Rest Leachate Levels (mAOD) (exceedances of the EP limit are shown in yellow)

Landfill Cell	Monitoring Point	Rest Leachate Level (mAOD)			Compliance Limit (mAOD)
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	119.77	120.34	119.99	119
	BK R1	119.18	120.24	119.54	
Cell 2	BK LC 2B	116.19	116.56	116.40	117
	BK R2	117.57	118.21	117.86	
Cell 3	BK R3*	112.40	112.96	112.64	113.37
Cell 4	BK LC 4B*	115.38	116.23	115.79	115
	BK R4	116.02	116.38	116.23	115.6
Cell 5	BK R5	117.54	118.44	117.89	115.91
Cell 6	BK LC 6B	124.41	124.89	124.63	122
	BK R6	122.91	123.61	123.27	122.24

4.2.7 Graphs shown in Appendix 3 relate the reported leachate levels to the surrounding groundwater level. For all cells operated on the principle of hydraulic containment (Cells 2-6), all of the reported pumped leachate levels represent conditions of hydraulic containment throughout the review period.

4.2.8 The protocols for obtaining leachate levels that can be considered representative for the site, hydrogeological risks posed by the site, and how leachate is managed are currently under review, in discussion with NRW and will be formalised in the HRA review and updated leachate management plan for the site.

Gas Wells

4.2.9 As indicated in interpretive report 3448-CAU-XX-XX-RP-V-91071, a brief update and review of the progress of the leachate extraction trial is to be included in the quarterly and annual reports.

4.2.10 The counters for the pumps in well GV36, GV45 and GV48 recorded increases during this review period, while the remaining counters did not change, although this is reported as counter malfunction while the pumps remain operational. The pump counter readings for these three wells in total increased by 2,292,628 counts from the previous year's final reading on the 17th of December 2019. This is equivalent to ~917.05 m³ of leachate based on the capacity of the pumps (0.4 L per count) installed in those wells. This would be equivalent to ~2751.15 m³ for all GV wells if pumps within all 9 GV wells are pumping at a rate equivalent to the average of the three wells listed above.

4.2.11 Leachate head continues to be well maintained (Appendix 2, Graph 4), with levels remaining stable throughout the review period and similar to the previous review period. The levels have remained low, while extraction remained sustainable, suggesting steady state conditions.

- 4.2.12 The extraction in individual areas as well as from the gas-well system as a whole will continue to be reviewed in relation to leachate dynamics and ongoing leachate management strategy for the site.

4.3 Leachate Quality

- 4.3.1 A summary of the leachate quarterly quality analysis from 2020 is shown in Table 2 in Appendix 2 along with graphs showing trends in leachate quality between January 2009 and December 2020.

- 4.3.2 All leachate monitoring locations were sampled quarterly for the following parameters:

alkalinity, ammoniacal nitrogen, biological oxygen demand (BOD), calcium, chloride, chemical oxygen demand (COD), magnesium, total organic carbon (TOC), pH, potassium, sodium, sulphate and total oxidised nitrogen (TON).

Plus, the following annual hazardous substances screen during December:

Inorganics (total and free cyanide), Filtered metals (cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc), Mineral oils (C10 – C40), Semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), combined pesticides / herbicides and miscellaneous organics .

- 4.3.3 Average ammoniacal nitrogen concentration in the leachate across the site increased every year between 2009 and 2012. In 2009 the average was 1863 mg/l, and it reached 2775 mg/l in 2012. This is likely to represent the peak leachate strength. Concentrations appeared to plateau between 2014 and 2018 with average ammoniacal nitrogen concentrations of 2205 mg/l, 2008 mg/l, 2301 mg/l, 1988 mg/l and 1816 mg/l respectively. The overall average ammoniacal nitrogen concentration for the site as a whole increased in 2020 (2563.7 mg/l) compared to 2019 (1847.05 mg/l).
- 4.3.4 The average chloride concentration in the leachate in 2020 was 2806.5 mg/L, an increase compared to the averages of the previous reviews 2307 mg/l (2019) and 2005.8 mg/l (2018). This is lower than the peak chloride concentration recorded in 2011 (3464 mg/l) and is consistent with an interpretation of leachate strength decreasing since 2011-2012.
- 4.3.5 Yearly averages of calcium have continued the decreasing trend seen since 2012. Concentrations of magnesium and TON have remained relatively stable with the exception of LC4B which showed a decreasing trend in TON. Average sulphate concentrations increase within all leachate wells with the exception of LC4B when compared to the previous review. Overall, average sulfate concentrations at the site increased from 89.7 mg/l (2019) to 101.2 mg/l (2020). Average site concentrations of COD, potassium, sodium also increased when

compared to 2019. Average pH concentrations for the site have remained similar to the previous review at 8.01.

Annual Suite

- 4.3.6 During December the annual monitoring suite was carried out. Cyanide (total) concentrations were detected within all leached wells except LC1B. Total Cyanide concentrations ranged from 0.06 mg/L (LW1) to 0.15 mg/L (LW6). Of the 60 Semivolatile organic compounds, one was detected in LC3 and LC5, two were detected in LC6 and three were detected within LW6.
- 4.3.7 The number of volatile organic compounds (66 in total) detected ranged from 6 in LW1 to 12 in LC4B. Concentrations of benzene, dibromofluoromethane, m,p Xylene, o-Xylene and Toluene were detected at all monitoring locations.
- 4.3.8 No Combined Pesticides / Herbicides or miscellaneous organics were detected within the leachate monitoring locations.
- 4.3.9 No mercury was detected in LC2b, LC3, LW1 and LW6. Concentrations within the remaining locations ranged from 0.000014 mg/L (LC4B) to 0.000035 mg/L (LC5).

4.4 Emissions to sewer

- 4.4.1 The leachate treatment plant at the site accepts leachate from Brookhill and the nearby Standard landfill site. The treated effluent is discharged to public sewer and is thereby subject to a trade effluent agreement (discharge consent, DC).
- 4.4.2 The treated leachate discharge (Final Discharge, FD) is monitored on a monthly basis for:

ammoniacal nitrogen, chromium, chemical oxygen demand (COD), copper, lead, nickel, pH, suspended solids and zinc.

Ammoniacal Nitrogen

- 5.4.1 The ammoniacal nitrogen discharge consent limit (50 mg/l) was exceeded during 2020, with a maximum concentration of 1640 mg/l recorded on the 29th of September. An annual average of 328.98 mg/l was calculated for 2020, an increase compared to the previous reviews 8.6 mg/l (2019). This is currently under investigation due to potential sampling or laboratory error. The findings of the investigation will be sent to NRW as soon as possible.

Chemical Oxygen Demand (COD)

- 5.4.2 COD concentrations exceeded the discharge consent limit of 2000 mg/l twice in 2020. Exceedances were noted at 2710 mg/l during December respectively. An annual average of

1403 mg/l was recorded for 2020, an increase compared to the previous year's average of 1034 mg/l.

Suspended Solids

- 5.4.3 The suspended solids discharge consent limit (500 mg/l) was exceeded in August, September and October with concentrations of 2460 mg/l, 1640 mg/l and 1360 mg/l respectively. An average suspended solids concentration of 699.4 mg/l was also above the consent limit. The recorded average suspended solids concentration represents an increase when compared to the previous year's average of 531.2 mg/l.

5.0 GROUNDWATER

5.1 Introduction

5.1.1 During the review period groundwater levels were recorded on a monthly basis in groundwater monitoring boreholes GW1, GW2A, GW3A, GW4, GW5A, GW6, GW7 and GW8 (also referred to as GW1-GW8 for chemical analysis). Levels were also recorded in GW1A (also referred to as GW1.1), and in two piezometers, which are located at shallower horizons at GW4 and GW6 and are referred to as GW4.1 and GW6.1 respectively. Borehole locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.

5.1.2 Samples for chemical analysis were taken monthly from the 8 groundwater monitoring boreholes GW1 – GW8 and analysed for a range of determinants listed below:

ammoniacal nitrogen, chloride, dissolved oxygen, electrical conductivity and pH

5.1.3 All groundwater monitoring boreholes are also sampled quarterly for the following parameters:

alkalinity, cadmium, calcium, chemical oxygen demand (COD), chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, sulphate, total organic carbon (TOC), total oxidised nitrogen (TON) and zinc.

Plus, the following annual hazardous substances screen:

gasoline range organics (GRO) (C4 – C10), gasoline range organics (GRO) (C10-C12), benzene, toluene, ethyl benzene, m-& p-xylenes, o-xylenes, total xylenes, BTEX and MTBE.

5.2 Groundwater Levels

5.2.1 Groundwater levels were recorded monthly during the review period. The seasonal trend noted in the previous annual reviews is also evident in 2020, with seasonal decrease from March to September and highest levels being recorded in the winter months. When averaged for the year, groundwater levels in most boreholes were comparable to those in 2019 except for GW6.1 and GW6 and GW8. Groundwater levels increased by 1.96 m and 1.55 m within GW6 and GW6.1 respectively when compared to the previous review. Conversely, groundwater levels within GW8 decrease by 1.32 m when compared to the previous reviews average (117.8 mAOD)

5.2.2 Groundwater levels within GW8 were lower than those previously recorded during the past 7.5 years. Ground water levels within GW8 continued to 112.76 mAOD during August. Groundwater levels appear to have rebounded during the final half of the review period, however, are approximately 1 m below those recorded in the previous year (2019).

5.3 Groundwater Quality

5.3.1 Monthly groundwater sampling was undertaken at groundwater points GW1-GW8, as per the schedule outlined above. In May samples were analysed for the quarterly suite, and in December for the annual hazardous substances screen. Tables 1 and 2 in Appendix 3 summarise monthly and quarterly monitoring data from 2020. Time-series graphs for all parameters between 2009 and 2019 are also included in Appendix 3.

5.3.2 GW2A, GW3A and GW4 have EP limits for ammoniacal nitrogen, chloride, nickel, zinc, total xylenes and toluene, as these boreholes are regarded as being down-gradient of the site. The groundwater regime around the site has been under discussions during recent years, and revised EP limits have been discussed. For the purpose of this report, the current EP limits have been used.

Ammoniacal Nitrogen

5.3.3 The groundwater EP limit for ammoniacal nitrogen (1.7 mg/l) was exceeded in GW2A, GW3A and GW4 during 2020. Concentrations increased significantly during the final quarter within GW2A, GW3A and GW4.

5.3.4 As in the previous year, concentrations were highest in GW3A, where ammoniacal nitrogen was on average 37.23 mg/L, an increase compared to the average during 2019 (17.54 mg/L). The maximum concentration recorded there was 75.4 mg/L, reported in December. This was a significant increase compared to the maximum in the previous review (41.7 mg/L). However. It should be noted this is below the maximum recorded at this locations during 2018 (124 mg/l).

5.3.5 Concentrations in GW4 were on average 16.7 mg/L, higher than the 2019 average of 6.6 mg/L. Concentrations in GW2A also increased compared to 2019 with an average of 21.6 mg/l and remained below maximum historical average of 31.64 mg/l in 2014.

5.3.6 Average concentrations within the remaining groundwater boreholes ranged between 0.49 mg/l in GW5 and 15.97 mg/l in GW8.

5.3.7 It should be noted that the source of the ammoniacal nitrogen is unlikely to be leachate as there is very little correlation with chloride during 2020 (Figure 5.1). Also, it should be noted there are none of the hazardous substance that would be expected if the source was leachate (see 5.3.15). It is also unlikely that this has any relation to the increase in treated leachate ammoniacal nitrogen concentrations as the discharge from the treatment plant occurs on the opposite side of the site, at a significant distance to these monitoring locations.

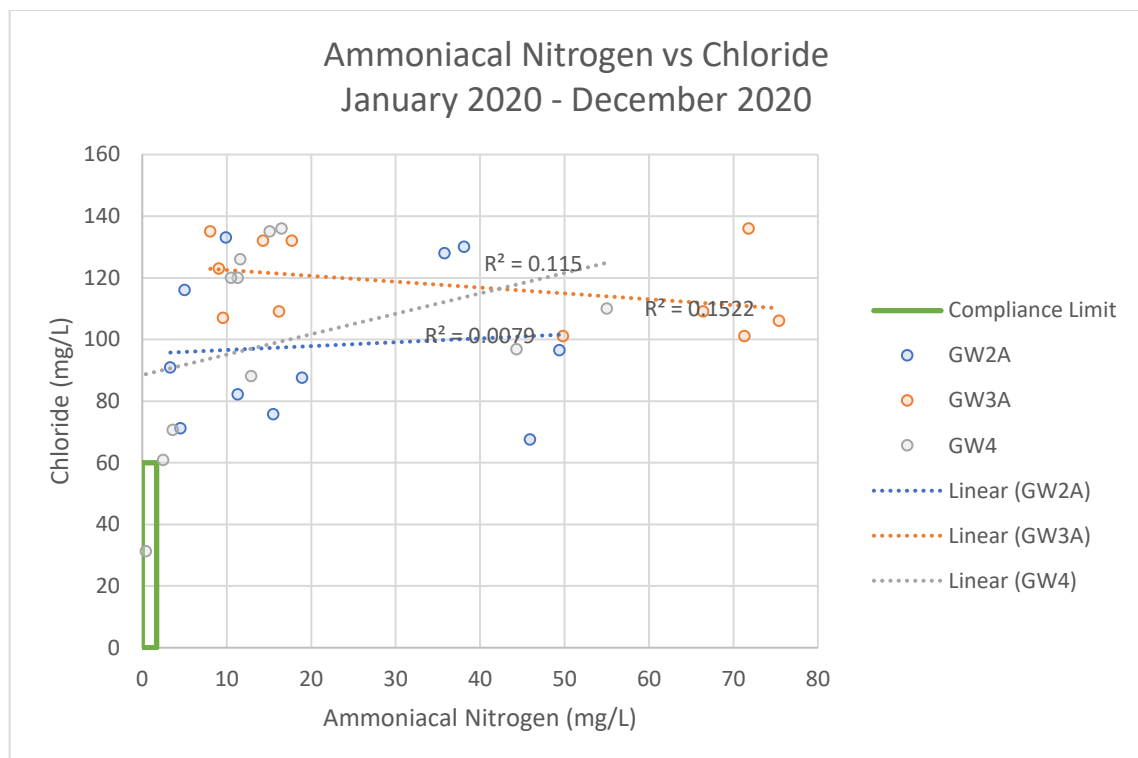


Figure 5.1: Ammoniacal nitrogen vs Chloride

Chloride

5.3.8 As in the past 4 Annual Reviews, the chloride EP limit (60 mg/l) was exceeded in GW2A and GW3A throughout 2020. At GW4 concentrations also exceeded the EP limit throughout the review with the exception of December where concentrations were below the EP limit (31.3 mg/L). For these boreholes, highest chloride concentrations were detected in GW3A and GW4, both with a maximum of 136 mg/L, a decrease from the previous year's maximum concentration of 170 mg/l (2019). GW3A also had the highest average concentration at 117.4 mg/L.

5.3.9 In GW1, GW1.1, GW5, GW6, GW7 and GW8 the average chloride concentrations were 83.8 mg/l, 135.35 mg/l, 92.59 mg/l, 45.85 mg/l, 127.2 mg/l and 113.4 mg/l respectively. This is a slight improvement compared to the previous review where concentrations within these locations ranged from 78.46 mg/l (GW1) to 198.76 (GW1.1).

Nickel

5.3.10 The compliance limit for nickel (0.15 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2020. The graph in Appendix 3 shows that nickel concentrations in these locations have been below the trigger level since July 2010.

Zinc

- 5.3.11 Similarly, to the previous years, the compliance limit for zinc (0.254 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2020. A graph in Appendix 3 shows that this trigger level was not exceeded on any occasion between January 2009 and December 2020.

Toluene

- 5.3.12 Toluene was below the compliance limit all locations throughout 2020. Concentrations remained below 0.001 mg/l, maintaining the improvement in groundwater quality noted in the previous annual review (2019).

Xylenes

- 5.3.13 No xylenes were detected in boreholes GW2A, GW3A and GW4, or any of the other groundwater monitoring points between January 2009 and December 2020.

Benzene

- 5.3.14 As in the past three reviews, no benzene was detected at any location on any monitoring visit in 2020.

Annual Suite

- 5.3.15 During December, the Annual monitoring round was carried out. No semi-volatile compounds, volatile organic compounds, Combined Pesticides / Herbicides or Miscellaneous Organics were detected at the groundwater monitoring locations. This further illustrates that the concentrations of ammoniacal nitrogen and chloride detected in the perimeter boreholes is unlikely to have originated from the landfill. Several key leachate indicator species, analysed in this annual suite would typically be detected in the event of a leachate outbreak.

6.0 SURFACE WATER

6.1 Introduction

- 6.1.1 Surface water samples are routinely taken from three locations; SW2, P2 and P4 which are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.
- 6.1.2 Water flows in a northerly direction alongside the outside perimeter fence of the western boundary of the site and accumulates in a pond at SW2 before slowly seeping through a man-made underground bypass drain which runs along the outside of the site towards the northern boundary. P2 is a pond to the west, which collects surface water run-off from the landfill. P4 is located in a field to the north west of the site, beyond landfill gas monitoring borehole BH10.
- 6.1.3 No samples have been collected from SW2 or P2 during this review period.
- 6.1.4 Surface water samples are analysed on a monthly basis for:
ammoniacal nitrogen, chloride, chemical oxygen demand (COD), pH and total suspended solids.
- 6.1.5 In the EP, Table S4.3 requires that only location P2 be controlled by chemical quality limits. As agreed with NRW, water in P2 is only sampled when there is the likelihood of an overflow to the discharge point².
- 6.1.6 A table displaying a summary of the laboratory analysis of the surface water samples from P4 collected during 2020 is presented in Appendix 4. Time-series graphs for all parameters between January 2009 and December 2020 are also included in Appendix 4.

6.2 Surface Water Quality

Ammoniacal Nitrogen

- 6.2.1 The average ammoniacal nitrogen concentration in P4 in 2020 was 0.35 mg/l, a decrease compared to the 2019 average of 3.09 mg/l.

Chemical Oxygen Demand (COD)

- 6.2.2 COD in P4 ranged between 66.3 mg/l and 192 mg/l. Concentrations were similar to the previous review (2019) where COD concentrations ranged from 65 mg/L to 121 mg/L.

Chloride

- 6.2.3 Concentrations varied between 23.3 mg/L and 35.4 mg/L in P4. Concentrations continued to decrease when compared to the previous review where concentrations ranged from 26.9 mg/l and 52 mg/l.

² E-mail correspondence, 14.07.2014, Alison Soper (NRW) to Phil Mulhall (FCC).

pH

- 6.2.4 pH has remained between 5 and 9 in all locations since January 2009. Average pH concentrations within P4 during 2020 were 7.88, a slight decrease compared to 2019 (7.94).

Suspended Solids

- 6.2.5 The average concentration within P4 was 53.93 mg/l during 2020. An increase since 2019 where the average suspended solid concentration was 20.73 mg/l. It should be noted that concentrations remained significantly below the historic maxima of 166.83 mg/l (2009).

7.0 FUGITIVE EMISSIONS

7.1 Introduction

- 7.1.1 Fugitive emissions to air are interpreted as fugitive gas emissions which might be escaping through the capped and uncapped areas of the site and dust releases from the site. Additionally, fugitive emissions of substances to water and sewer and their minimisation are considered.

7.2 Fugitive emissions to air

- 7.2.1 A surface emissions survey, consisting of a full site FID walkover was conducted on the 11th August by Caulmert Ltd. The gas extraction engine and flare were not operational during the walkover survey. As such, this monitoring was carried out under a worst case scenario where no landfill gas extraction was taking place.
- 7.2.2 In total, 40 point source emissions were detected during the 2020 FID survey. The highest concentrations are summarised in Table 3.2 below and detailed in the Surface Emissions Monitoring Report 4403-CAU-XX-XX-RP-V-0304.A0-C1, submitted separately to NRW.

Table 3.2: Summary of highest concentration PSEs

PSE	ID/Location	Methane Concentration (ppm)	Source of Emission
1	R6	>10,000	tefen valve
2	R6B	>10,000	well head, top plate
7	GV47	>10,000	base of well
9	GV45	>10,000	base of well
10	GV03	>10,000	inside chamber
14	GV44	>10,000	base of well
15	GV07	>10,000	well head, top plate
18	LC1B	>10,000	well head, top plate & fittings (500 ppm from flexi-pipe in ground near well base)
21	LC1	>10,000	well head, top plate & fittings
22	GV10	>10,000	base of gas connection line from new LW1
23	manifold	>10,000	monitoring tap for LC1B connection at manifold
24	LC3	>10,000	inside chamber
25	GV28	>10,000	base of well
26	GV37	>10,000	base of well
28	LC4	>10,000	well head, top plate
29	R4B	>10,000	tefen valve
30	LC4B	>10,000	well head top plate, fittings and flexible boot (dry rotted & cracked)
32	GV46	>10,000	well head; LC extraction top fittings
34	LC2B	>10,000	well head top fittings
38	LC5	>10,000	well head top fittings
40	GV33	>10,000	inside chamber

- 7.2.3 This was increase compared to the previous surface emissions monitoring survey in August 2019, where 5 emissions were recorded. Of the 40 emissions recorded in this survey, 21 were at the maximum level of detection (>10,000 ppm). This is an increase compared to the

previous review (2019) which recorded 2-point source emissions at the maximum limit of detection.

- 7.2.4 All of the detected emissions were from marked leachate or gas extraction wells, with no emissions detected from surface locations. No vegetation die-back was observed on the site.
- 7.2.5 Remediation of the identified point source emissions identified in the report was carried out by the Operator, and a follow up surface emissions survey is scheduled for early 2021 to verify the effectiveness of the improvements.

7.3 Particulates Monitoring

- 7.3.1 Quarterly dust monitoring was undertaken at the site, as required by the EP. Four monitoring rounds were completed during this review period, in March, June, September and December. Table 3 below shows the gross dust depositional rates.

Table 3: Results from dust monitoring at Brookhill

Period	Mar-20	Jun-20	Sep-20	Dec-20	EP Limit
Dust Concentration (mg/m²/day)					
Location 1: Site perimeter	<7.06	24.49	26.27	17.77	200
Location 2: Industrial estate	7.34	9.03	<7.48	139.65	200
Location 3: Oaks farm	10.80	24.7	15.27	103.55	200

- 7.3.2 All monitoring results were significantly below the Permit level. This is consistent with the results obtained last year.

7.4 Fugitive emissions to water and sewer

- 7.4.1 Fugitive emissions of substances to water or sewer were controlled by the site ensuring, that all monitored parameters in treated leachate were below the site EP limits and that leachate levels were kept as low as possible. Groundwater, surface water and any discharges to sewer were monitored for more parameters than required by the EP. The additional parameters analysed are discussed above in the relevant sections of this report.
- 7.4.2 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant was similar to that in 2019. The concentrations of parameters in surface water were similar or improved to those recorded in the previous review period.

8.0 ANNUAL PRODUCTION/TREATMENT**8.1 Introduction**

- 8.1.1 Annual production/treatment at Brookhill during the period January to December 2020 is reported in accordance with the EP for the site. Table S5.2 in the EP variation YP3835MJ (May 2008) has been reproduced and is presented as Table 4 below.

Table 4: Annual Production/Treatment

Annual production/treatment	
Leachate:	Cubic metres/year:
Disposed of offsite:	0
Disposed of to any onsite effluent treatment plant:	20,636
Recirculated into the waste mass.	0
Surface water and/or groundwater:	Cubic metres/year:
Disposed of offsite:	0
Disposed of to any onsite effluent treatment plant.	0
Landfill gas:	Normalised cubic metres/year:
Combustion in flares:	135,500
Combustion in gas engines:	2,084,500
Other methods of gas utilisation.	0

9.0 PERFORMANCE PARAMETERS

9.1 Introduction

- 9.1.1 The performance parameters at Brookhill for the period of January 2020 to end of 2020 were not available at the time of the completion of the report (*). When they become available, they will be forwarded separately to NRW as per the format of Table 5 below, which is a reproduction of Table S5.3 in the EP variation YP3835MJ (May 2008).

Table 5: Performance Parameters

Parameter	Frequency of assessment	Annual total	Unit
Energy Used (including for leachate treatment)	Annually	*	MWh of Electricity

- 9.1.2 It should be noted that typically the usage of energy at the site represents ~10% of the amount of energy exported at the same time.

10.0 TOPOGRAPHICAL SURVEY

10.1 Introduction

- 10.1.1 The latest topographical survey for the site was conducted on the 19th December 2020 (survey number 11375aRev1Brookhill) and is appended for reference. Using this survey, and the survey completed in May 2019, an estimate of the settlement was made. The difference between the two surveys was approximately 3070 m³.

11.0 SUMMARY

11.1 Landfill gas

- 11.1.1 Landfill gas in most in-waste boreholes was of good quality for utilisation, with average methane concentration of 49.42 % across the site. Of the 15 new gas extraction wells installed at the site in September/October 2015, GV35 – GV49 the majority are performing well and have a high concentration of methane and low oxygen with the exception of GV38 and GV42 which show potential air ingress. Potential air ingress has been identified in 25 wells across the site.
- 11.1.2 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 15th of December. Of the 29 trace gases, 13 were detected, a slight decrease compared to 2019 (when 15 were reported. see report included in Appendix 1).
- 11.1.3 Monitoring of the emissions from the landfill gas engine was carried out on the 15th of December 2020. The reported concentrations of NO₂ exceeded the engine emissions limit, but within the overall uncertainties detailed in LFTGN08, and therefore it is considered to represent a compliant result
- 11.1.4 Landfill gas concentration were monitored in perimeter monitoring boreholes around the site on a weekly basis. None of the monitored perimeter gas boreholes were in breach of their respective methane compliance limits during 2020. Similarly, carbon dioxide concentrations were below their respective EP limits at all locations with the exception of BH6 which exceeded its compliance limit once.

11.2 Leachate

- 11.2.1 Leachate head levels were below the EP limits throughout the year in LC2B and R3. Comparison between the reported leachate levels and the surrounding groundwater levels suggests that despite the noted exceedances, leachate levels in the hydraulically contained cells remained below the surrounding groundwater, maintaining hydraulic containment. The protocols for establishing representative leachate levels for the site, and the leachate management strategies are currently under review in discussion with NRW.
- 11.2.2 Leachate samples were analysed quarterly. Leachate quality in LC1B - LC6B during this review period was similar to that of the past four reviews (2016 to 2019). Average ammoniacal nitrogen concentration across the leachate wells increased but remained well below the historical maxima, which is consistent with the interpretation of peak leachate strength having been reached in 2011/2012 and leachate strength now decreasing.
- 11.2.3 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant improved through 2020 with the exception of ammoniacal nitrogen and suspended solid concentrations. However, it should be noted that suspended solid concentrations remained below historical maxima which reflects the

improvements made to the operation and infrastructure of the plant in 2016. The isolated, high ammoniacal nitrogen concentration detected in the final discharge in September 2020 is currently under investigation and is potentially a sampling or lab error.

11.3 Groundwater

- 11.3.1 Groundwater level results indicate a general seasonal decrease in water level within groundwater monitoring points from March to September, before a steady increase through the remainder of 2020. Groundwater levels overall remained similar to those in 2019 except for GW6.1, GW6 and GW8 Groundwater levels increased within GW6 and GW6.1, conversely, groundwater levels decreased within GW8.
- 11.3.2 Groundwater levels within GW8 were lower than those previously recorded during the past 7.5 years. Groundwater levels appear to have rebounded during the final half of the review period, however, are approximately 1 m below those recorded in the previous year (2019).
- 11.3.3 The EP limit for ammoniacal nitrogen of 1.7 mg/l was exceeded in locations GW2A, GW3A and on occasion at GW4 during 2019. Concentrations remained below historic maxima for the site and followed a similar pattern of seasonal variation.
- 11.3.4 The chloride EP limit (60 mg/l) was exceeded in GW2A, GW3A and GW4 during 2020. At GW4, chloride concentrations were below the EP limit during December were as GW2 and GW3A consistently breached the EP limit.
- 11.3.5 Zinc and Nickel concentrations remained below the trigger limits in GW2A, GW3 and GW4 throughout 2020. As previously noted, no xylenes, toluene or mercury were detected in any of the samples.
- 11.3.6 During the Annual suite, no semi-volatile compounds, volatile organic compounds, Combined Pesticides / Herbicides or Miscellaneous Organics were detected at the groundwater monitoring locations.

11.4 Surface Water

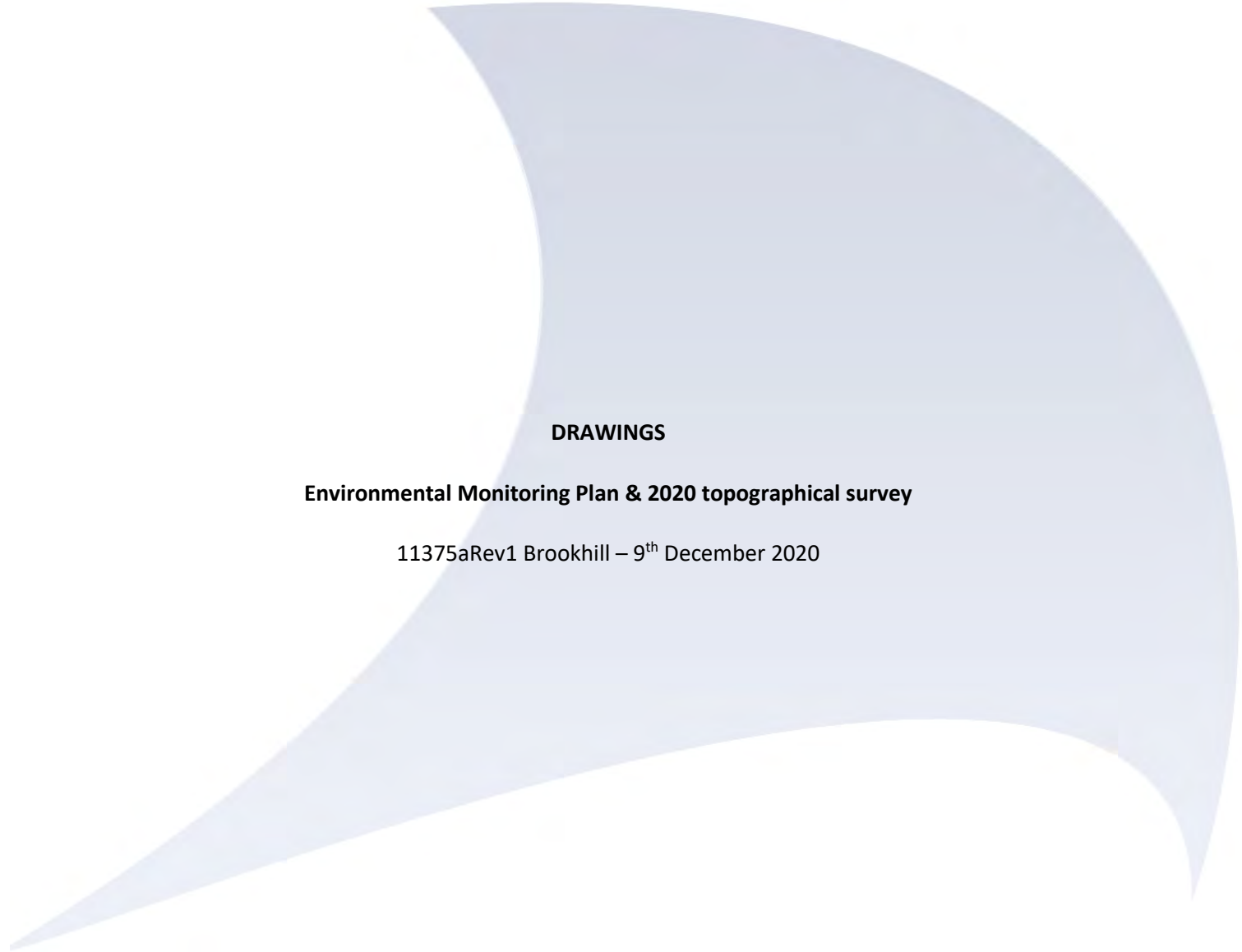
- 11.4.1 No water quality data was reported at SW2 or P2. The surface water quality parameters within P4 were similar to those detected during 2019, with the exception of ammoniacal nitrogen. Average ammoniacal nitrogen concentrations decrease by an order of magnitude compared to 2019.

11.5 Fugitive emissions to air

- 11.5.1 Fugitive emissions to air were monitored by way of an FID Walkover survey, completed in August 2020. The report 4403-CAU-XX-XX-RP-V-0304.A0-C1 has been submitted separately.

11.6 Dust

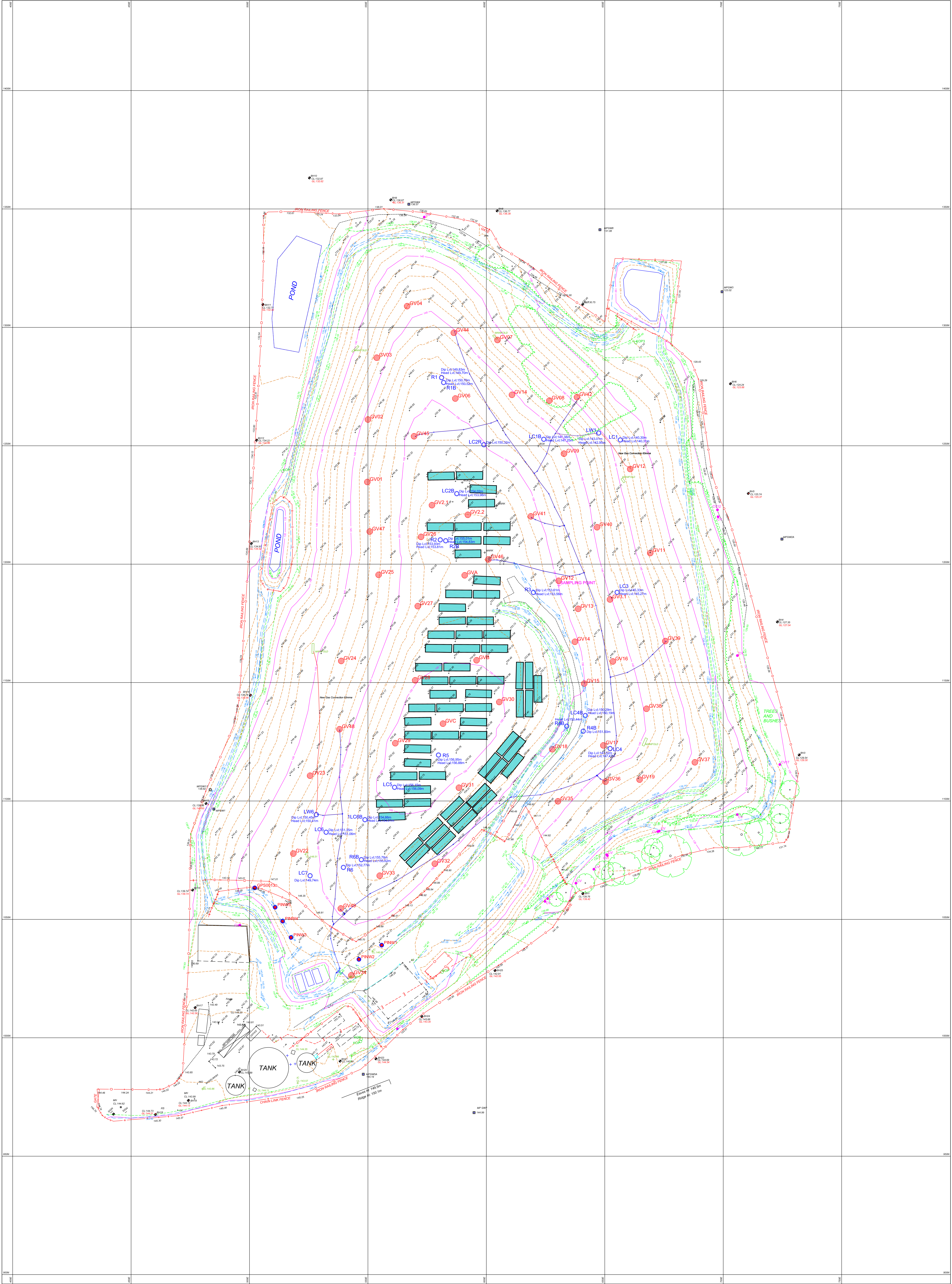
11.6.1 Dust monitoring results show that dust emissions were very low and significantly below the compliance limit of 200 mg/m²/day throughout the review period.



DRAWINGS

Environmental Monitoring Plan & 2020 topographical survey

11375aRev1 Brookhill – 9th December 2020



SITE

Brookhill
Landfill Site

PROJECT

Site Survey
(18-05-2020)

SCALE

1:500 @ A0

DRAWING DATE

03/02/2021

DRAWING No.

11375a Rev.1

CLIENT


Sir y Fflint
Flintshire
COUNTY COUNCIL
English Cymraeg

Levels Relate To : SITE DATUM

Co-ordinates : SITE GRID

 LC5
 GV31
 PIN6

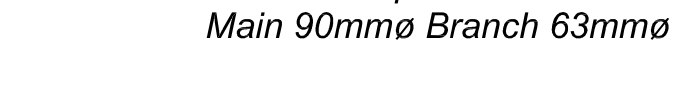

Leachate Well

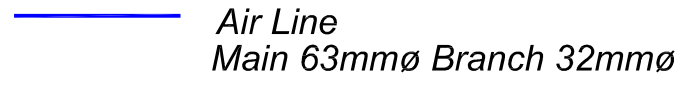
Gas Vent Switched On

Pin Gas Ven

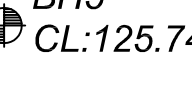
Solar Panel

 Leachate Pipe
Main 90mm Branch 63mm

 Air Line
Main 63mm Branch 32mm

 Gas Line
Main 63mm

 BH5
CL:125.74

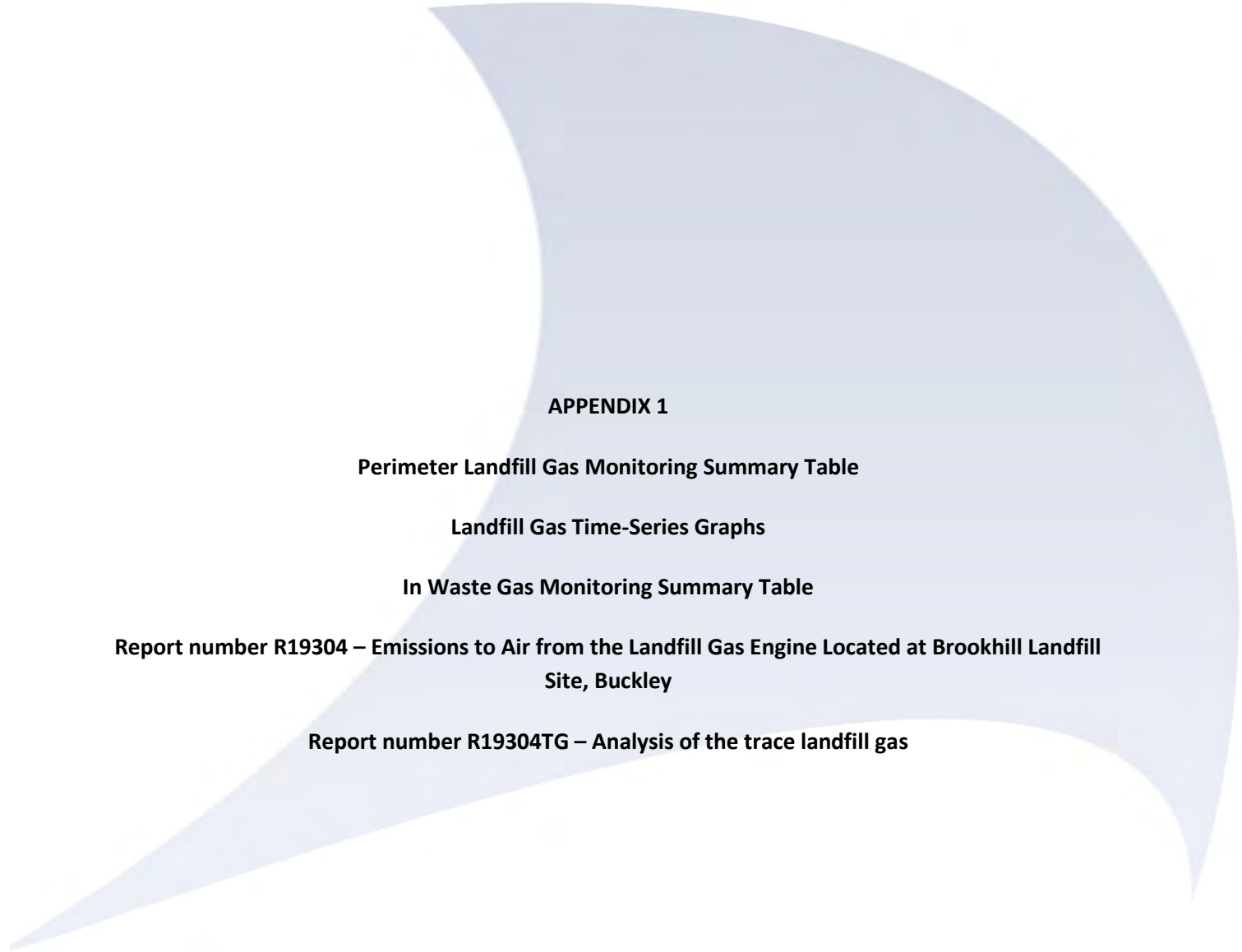
 MPGW2A

Borehole

Ground Water Monitoring Point


www.stafsurv.com

Vernon Court yard, Main Road, Sudbury, Derbyshire, DE5 5HS
T: 01283 584500 F: 01284 584844 E: info@stafsurv.com



APPENDIX 1

Perimeter Landfill Gas Monitoring Summary Table

Landfill Gas Time-Series Graphs

In Waste Gas Monitoring Summary Table

**Report number R19304 – Emissions to Air from the Landfill Gas Engine Located at Brookhill Landfill
Site, Buckley**

Report number R19304TG – Analysis of the trace landfill gas

APPENDIX 1 – LANDFILL GAS
Table 1: In-Waste Landfill Gas

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
G010MA	Min	44.5	31	0.3	0	0
	Max	58.8	39.9	2.1	3	0
	Average	53.11	35.68	1.15	0.77	0
	Count	13	13	13	13	13
G010MB	Min	40.3	29.8	0.3	0	0
	Max	57.9	42.2	2.7	2	0
	Average	49.6	35.3	1.52	0.92	0
	Count	12	12	12	12	12
G01MDA	Min	45.9	32.1	0.2	0	0
	Max	58.1	39.6	1.8	2	0
	Average	53.53	36.28	0.84	0.67	0
	Count	12	12	12	12	12
G01MDB	Min	42.2	31	0.2	0	0
	Max	57.9	43.6	2.4	3	0
	Average	51.39	35.85	1.24	1.33	0
	Count	15	15	15	15	15
GV01	Min	51.2	32.8	0	0	0
	Max	65.3	39.2	1.2	2	0
	Average	59.55	35.26	0.68	0.62	0
	Count	8	8	8	8	8
GV03	Min	59.4	30	0	0	0
	Max	69.8	35.9	1.5	6	0
	Average	66.46	33.66	0.43	0.78	0
	Count	9	9	9	9	9
GV04	Min	25	21.6	0.1	0	0
	Max	67.3	34.7	3.7	1	0
	Average	45.79	30.1	0.88	0.12	0
	Count	16	16	16	16	16
GV06	Min	24.5	12.9	8	3	0
	Max	35.1	20.5	15.3	5	0
	Average	28.03	15.43	12.87	4.33	0
	Count	3	3	3	3	3
GV07	Min	28.7	24	0	0	0
	Max	72.4	36.3	4.1	2	0
	Average	56.24	28.28	1.47	0.33	0
	Count	18	18	17	18	18
GV08	Min	2.5	4.5	5.6	4	0
	Max	36.9	21.8	18.7	11	0
	Average	15.96	12.06	12.61	7.4	0
	Count	10	10	10	10	10

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
GV09	Min	38.4	27.4	0	0	0
	Max	65.7	36.6	2.7	4	0
	Average	54.81	31.46	0.54	0.82	0
	Count	17	17	17	17	17
GV0A	Min	59.1	39.5	0	1	0
	Max	60.3	45.3	0.2	3	1
	Average	59.54	42.21	0.06	2	0.12
	Count	8	8	8	8	8
GV0B	Min	45.4	36.2	0.1	0	0
	Max	66.4	40.1	1	1	2
	Average	54.62	38.35	0.45	0.5	0.5
	Count	4	4	4	4	4
GV0C	Min	57	39.5	0	1	0
	Max	64.4	44.7	1.1	4	2
	Average	59.79	42	0.42	2	0.25
	Count	8	8	8	8	8
GV10	Min	37.8	22.7	0	0	0
	Max	64.6	31.2	0.7	0	0
	Average	54.91	27.96	0.25	0	0
	Count	13	13	13	13	13
GV11	Min	33	23.7	0	0	0
	Max	68.5	38.9	1.2	2	0
	Average	48.14	30.26	0.39	0.29	0
	Count	14	14	14	14	14
GV12	Min	50.9	41.7	0.3	1	0
	Max	61.1	42.5	0.5	1	2
	Average	54.3	42.23	0.37	1	0.67
	Count	3	3	3	3	3
GV13	Min	0.9	6.7	2.2	0	0
	Max	48.4	33.2	16.3	2	0
	Average	23.45	19.81	8.45	0.86	0
	Count	14	14	14	14	14
GV14	Min	52.6	37.2	0	0	0
	Max	61.6	42.7	1.2	3	1
	Average	57.6	40.11	0.29	1.94	0.12
	Count	16	16	16	16	16
GV15	Min	53.6	37.2	0.1	0	0
	Max	61.3	44.2	1.5	3	1
	Average	57.8	40.65	0.54	2	0.08
	Count	12	12	12	12	12
GV16	Min	38.5	32.5	0	0	0
	Max	60.8	42.7	1	4	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Average	54.58	37.41	0.39	1.84	0
	Count	19	19	19	19	19
GV17	Min	27.7	23.2	0.5	0	0
	Max	61.3	38.9	7.3	21	2
	Average	38.78	30.42	2.91	5	0.38
	Count	8	8	8	8	8
GV18	Min	54.7	39.4	0	0	0
	Max	60.6	45.1	1.2	5	0
	Average	58.12	42.46	0.21	2.75	0
	Count	12	12	12	12	12
GV21	Min	64.5	34.9	0.3	1	0
	Max	65	35.4	0.4	1	0
	Average	64.75	35.15	0.35	1	0
	Count	2	2	2	2	2
GV22	Min	57.4	23.3	0	0	0
	Max	78.1	37.3	6.6	0	0
	Average	67.54	32.06	1.27	0	0
	Count	7	7	7	7	7
GV23	Min	0	3.7	0.1	0	0
	Max	64.8	40.9	17.6	1	0
	Average	35.72	25.74	6.46	0.09	0
	Count	11	11	11	11	11
GV24	Min	2.2	8.3	0	0	0
	Max	65.4	43.9	11.2	3	0
	Average	56.55	36.62	1.21	0.64	0
	Count	11	11	11	11	11
GV25	Min	32.8	23.6	0	0	0
	Max	63.1	41.4	4.7	2	0
	Average	47.67	34.18	0.66	0.38	0
	Count	13	13	13	13	13
GV26	Min	33.6	19.3	0.1	0	0
	Max	63.3	41.9	3.8	19	3
	Average	55.58	36.69	0.83	2.08	0.23
	Count	13	13	13	13	13
GV27	Min	51	38	0	0	0
	Max	62.2	45.2	0.7	3	2
	Average	59.05	41.68	0.27	1.46	0.15
	Count	13	13	13	13	13
GV28	Min	55.9	35.9	0	0	0
	Max	62.8	45.2	1.4	4	0
	Average	59.07	41.15	0.23	1.87	0
	Count	15	15	15	15	15

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
GV29	Min	54.1	36.3	0	0	0
	Max	65.4	42.5	1.7	4	0
	Average	59.24	39.39	0.38	1.33	0
	Count	12	12	12	12	12
GV30	Min	54.9	38.7	0.1	1	0
	Max	64	39.9	0.7	3	0
	Average	59.35	39.32	0.32	2.17	0
	Count	6	6	6	6	6
GV301	Min	18.5	14.5	0.4	0	0
	Max	65.6	36	14.3	1	0
	Average	34.2	21.67	9.67	0.33	0
	Count	3	3	3	3	3
GV31	Min	47.2	32.9	0.1	0	0
	Max	64.9	42	0.8	2	0
	Average	58.7	38.89	0.48	0.7	0
	Count	10	10	10	10	10
GV32	Min	48	34.9	0.2	1	0
	Max	67.7	44	3.7	3	1
	Average	57.94	39.83	1.31	1.71	0.14
	Count	7	7	7	7	7
GV33	Min	32.3	23.2	0.1	0	0
	Max	62.1	42.5	7.3	3	0
	Average	48.46	35.46	1.55	0.79	0
	Count	14	14	14	14	14
GV35	Min	43	34	0	0	0
	Max	63.1	44.6	1.9	1	0
	Average	56.53	39.16	0.46	0.45	0
	Count	20	20	20	20	20
GV36	Min	20.1	25.8	0	0	0
	Max	63	34.7	1.6	1	0
	Average	38.26	30.13	0.58	0.19	0
	Count	21	21	21	21	21
GV37	Min	27.6	25.6	0	0	0
	Max	68.8	42.1	2	3	0
	Average	48.56	30.02	1.03	0.26	0
	Count	23	23	23	23	23
GV38	Min	0.4	2.3	0	0	0
	Max	63.1	36	18.9	3	0
	Average	35.12	23.11	6.16	0.72	0
	Count	18	18	18	18	18
GV39	Min	45.9	26.2	0	0	0
	Max	67.2	43.2	2.1	6	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Average	58.76	32.52	0.68	1.05	0
	Count	20	20	20	20	20
GV40	Min	38.9	28.8	0	0	0
	Max	66	38.4	1.1	3	0
	Average	53.18	32.62	0.31	0.53	0
	Count	19	19	19	19	19
GV41	Min	49.7	34.1	0	0	0
	Max	65.7	41.6	0.9	3	0
	Average	59.38	38.36	0.29	0.92	0
	Count	13	13	13	13	13
GV42	Min	1.4	4.1	9.4	0	0
	Max	24.3	11.1	18.1	1	0
	Average	11.88	7.44	13.18	0.4	0
	Count	5	5	5	5	5
GV43	Min	40.6	27.8	0	0	0
	Max	65.3	38.2	1.9	3	0
	Average	55.76	33.93	0.32	0.4	0
	Count	20	20	20	20	20
GV44	Min	11.2	17.4	0.1	0	0
	Max	67.2	38.8	2.9	2	0
	Average	46.11	29.62	1.11	0.29	0
	Count	17	17	17	17	17
GV45	Min	36.5	25.5	0	0	0
	Max	65.9	40.7	3.3	30	0
	Average	51.87	33.97	0.61	2.2	0
	Count	15	15	15	15	15
GV46	Min	30.6	24.2	0	0	0
	Max	60.9	44	4.7	64	0
	Average	53.92	38.96	0.67	7.1	0
	Count	21	21	21	21	21
GV47	Min	36.6	32.9	0	0	0
	Max	61.3	40.7	1	1	1
	Average	57.25	38.37	0.45	0.18	0.18
	Count	11	11	11	11	11
GV48	Min	51.7	32.7	0	0	0
	Max	65.8	42.5	3.5	1	0
	Average	57.79	38.06	0.51	0.4	0
	Count	10	10	10	10	10
GV49	Min	25.2	22.3	0	0	0
	Max	63.4	41.8	1.4	2	0
	Average	51.81	34.34	0.48	0.33	0
	Count	18	18	18	18	18

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
GW34	Min	2.3	13.3	0.6	0	0
	Max	61.8	33.3	14	3	0
	Average	29.51	21.85	2.86	0.7	0
	Count	10	10	10	10	10
LC1B	Min	22.7	19.3	7.2	0	0
	Max	33.5	21	7.6	1	0
	Average	29.12	20.03	7.4	0.33	0
	Count	6	6	6	6	6
LC2B	Min	17.7	13.7	0.6	0	0
	Max	63.7	38	17.1	3	0
	Average	41.06	27.98	6.6	0.33	0
	Count	21	21	21	21	21
LC2R	Min	41.7	31.1	0	0	0
	Max	66.9	37.4	1.7	1	0
	Average	56.81	34.05	0.32	0.12	0
	Count	17	17	17	17	17
LC3	Min	1.6	4.1	0.2	0	0
	Max	54.6	36.8	20	1	0
	Average	24.31	17.62	10.01	0.25	0
	Count	8	8	8	8	8
LC4	Min	0.2	3.4	0	0	0
	Max	64.6	40.3	18.8	24	20
	Average	39.63	26.46	6.47	5.5	2.17
	Count	18	18	18	18	18
LC4B	Min	0.2	2.6	1.1	0	0
	Max	54.8	42.6	20.3	5	0
	Average	16.19	15.92	11.94	2.79	0
	Count	14	14	14	14	14
LC5	Min	0.2	0.7	0.1	0	0
	Max	67.8	44.7	16.3	4	1
	Average	45.91	31.96	4.14	1.33	0.17
	Count	24	24	24	24	24
LC6	Min	2.4	6	0	0	0
	Max	66.6	38.8	15.5	3	0
	Average	39.98	27.27	5.49	0.78	0
	Count	18	18	18	18	18
LC6B	Min	49.4	32.4	0	0	0
	Max	60.1	42.4	1.1	3	0
	Average	56.83	39.28	0.61	0.82	0
	Count	11	11	11	11	11
M010MA	Min	48	36.4	0.1	1	0
	Max	60.6	43	1.1	4	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Average	56.78	40.06	0.28	2.17	0
	Count	12	12	12	12	12
M010MB	Min	48.1	36.3	0.1	0	0
	Max	61	43.8	1.1	5	0
	Average	56.76	40.39	0.27	2	0
	Count	12	12	12	12	12
M050MA	Min	54.9	36.3	0.2	0	0
	Max	55.8	36.8	0.2	0	0
	Average	55.35	36.55	0.2	0	0
	Count	2	2	2	2	2
M050MB	Min	51.8	35.2	0.2	0	0
	Max	55.3	41.4	0.3	0	0
	Average	52.8	38.42	0.25	0	0
	Count	4	4	4	4	4
PRG041	Min	53.6	40.9	0	1	0
	Max	53.6	40.9	0	1	0
	Average	53.6	40.9	0	1	0
	Count	2	2	2	2	2
PRG046	Min	47.5	40.3	0.4	1	0
	Max	47.5	40.3	0.4	1	0
	Average	47.5	40.3	0.4	1	0
	Count	2	2	2	2	2
PRL005	Min	60.2	29.6	0.6	0	0
	Max	60.8	30	0.7	0	0
	Average	60.5	29.8	0.65	0	0
	Count	2	2	2	2	2
R1	Min	0.6	4.7	0	0	0
	Max	67.3	36.8	14.7	6	0
	Average	58.08	32.9	1.6	0.85	0
	Count	20	20	20	20	20
R1B	Min	58.3	28.8	0.2	0	0
	Max	66.8	38.4	2.4	2	0
	Average	63.12	32.92	0.97	0.83	0
	Count	6	6	6	6	6
R2B	Min	0.3	8.6	0	1	0
	Max	41.3	28.1	16	15	0
	Average	8.42	15.13	8.37	8.17	0
	Count	6	6	6	6	6
R3	Min	8.8	14.6	6.1	0	0
	Max	44.2	25	9.6	0	0
	Average	29.76	20.34	8.06	0	0
	Count	5	5	5	5	5

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
R4B	Min	0.2	2.8	0	0	0
	Max	58.2	42	16.1	2	0
	Average	44.04	31.45	3.19	1.5	0
	Count	16	16	16	16	16
R5	Min	39.1	32.9	6.6	2	0
	Max	39.4	33.6	6.9	2	0
	Average	39.25	33.25	6.75	2	0
	Count	4	4	4	4	4
R6B	Min	0.1	5.8	0	0	0
	Max	60	44.8	22	5	0
	Average	43.93	30.2	5.42	1.38	0
	Count	13	13	13	13	13

APPENDIX 1 – LANDFILL GAS
Table 2: Perimeter Landfill Gas (% v/v)

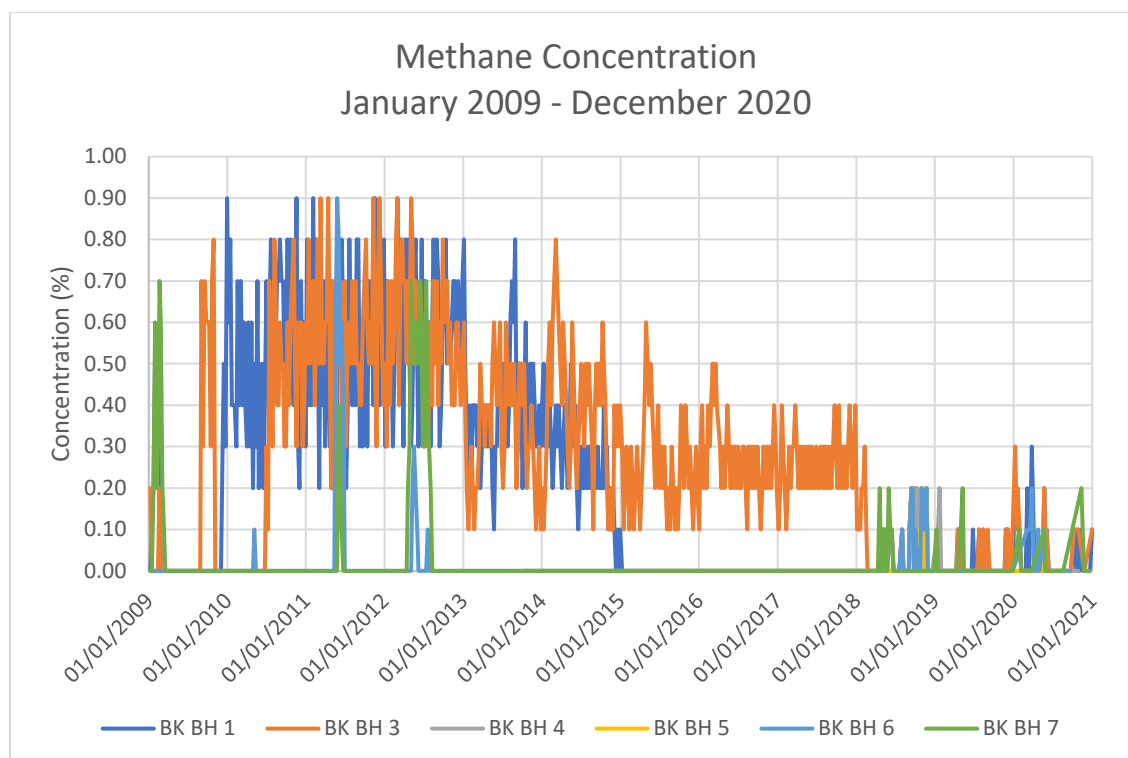
Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
BK BH 1	Min	0	1	0	8.8
	Average	0.3		1.9	
	Max	0.04		0.61	
	Count	51		51	
BK BH 3	Min	0	1	0	3.1
	Average	0.3		2.9	
	Max	0.04		1.25	
	Count	37		37	
BK BH 4	Min	0	1	0.1	5.1
	Average	0.1		3.6	
	Max	0		1.4	
	Count	22		22	
BK BH 5	Min	0	1	0	1.5
	Average	0.1		1.4	
	Max	0.01		0.46	
	Count	18		18	
BK BH 6	Min	0	1	0.1	1.5
	Average	0.2		2.3	
	Max	0.02		0.64	
	Count	26		26	
BK BH 7	Min	0	1	0	10
	Average	0.2		1.6	
	Max	0.02		0.45	
	Count	29		29	
BK BH 8	Min	0	32.2	0	3.6
	Average	21.1		3.5	
	Max	5.85		2.83	
	Count	51		51	
BK BH 9	Min	0.3	29.6	0.5	10.4
	Average	17		9.8	
	Max	7.39		4.91	
	Count	51		51	
BK BH 10	Min	0	1	0.6	3.9
	Average	0.2		1.8	
	Max	0.03		1.29	
	Count	30		30	
BK BH 11	Min	0	1	0.2	6.5
	Average	0.3		5.1	
	Max	0.04		1.73	
	Count	51		51	
BK BH 12	Min	0	1	0.1	6.6
	Average	0.1		5.8	
	Max	0.02		2.23	
	Count	49		49	
BK BH 13	Min	0	1	0	9.4
	Average	0.3		2.9	

APPENDIX 1 – LANDFILL GAS

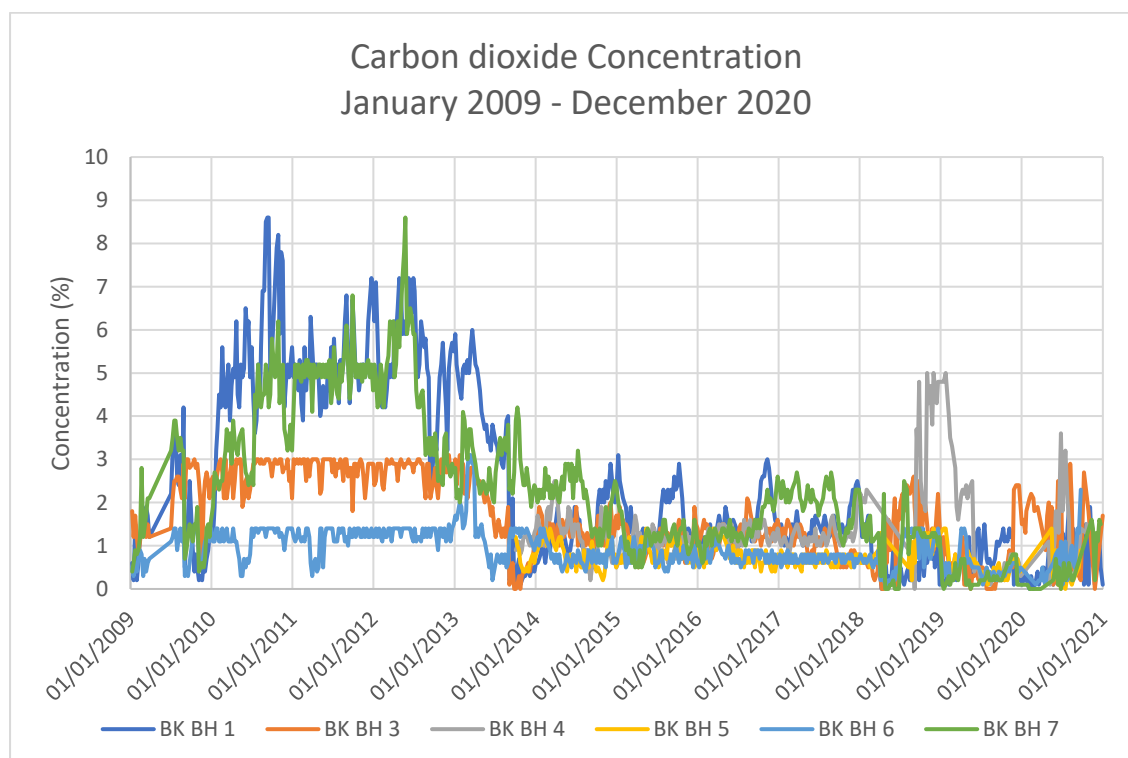
Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
	Max	0.02		0.8	
	Count	37		37	
BK BH 14	Min	0	1	0	3.5
	Average	0.2		1.4	
	Max	0.02		0.39	
	Count	51		51	
BK BH 15	Min	0	1	0	17.6
	Average	0.2		1.9	
	Max	0.03		0.67	
	Count	51		51	
BK BH 16	Min	0	1	0.1	11.4
	Average	0.6		1.9	
	Max	0.11		0.41	
	Count	13		13	
BK BH 17	Min	0	1	0	12.9
	Average	0.2		3.8	
	Max	0.03		0.76	
	Count	51		51	
BK BH 18A	Min	0	3.5	0	10
	Average	0.5		5.4	
	Max	0.03		1.73	
	Count	51		51	
BK BH 19	Min	0	1	0	11.2
	Average	0.1		2.6	
	Max	0		0.68	
	Count	21		21	
BK BH 20	Min	0	1	0.2	-
	Average	0		0.4	
	Max	0		0.3	
	Count	11		11	
BK BH 21	Min	0	1	0	11.4
	Average	0.1		4.3	
	Max	0.01		1.2	
	Count	36		36	
BK BH 23	Count	0	1	0.1	7.3
	Min	0.1		6.5	
	Average	0.02		2.56	
	Max	51		51	
BK BH 24	Count	0	1	0	1.5
	Min	0.1		1.1	
	Average	0.02		0.36	
	Max	51		51	
BK BH 25	Count	0	1	0.1	9.9
	Min	0.1		4.4	
	Average	0.02		1.13	
	Max	50		50	

APPENDIX 1 – LANDFILL GAS

Graph 1a: Perimeter Landfill Gas - Methane concentration in BH1, BH3, BH4, BH5, BH6 and BH7

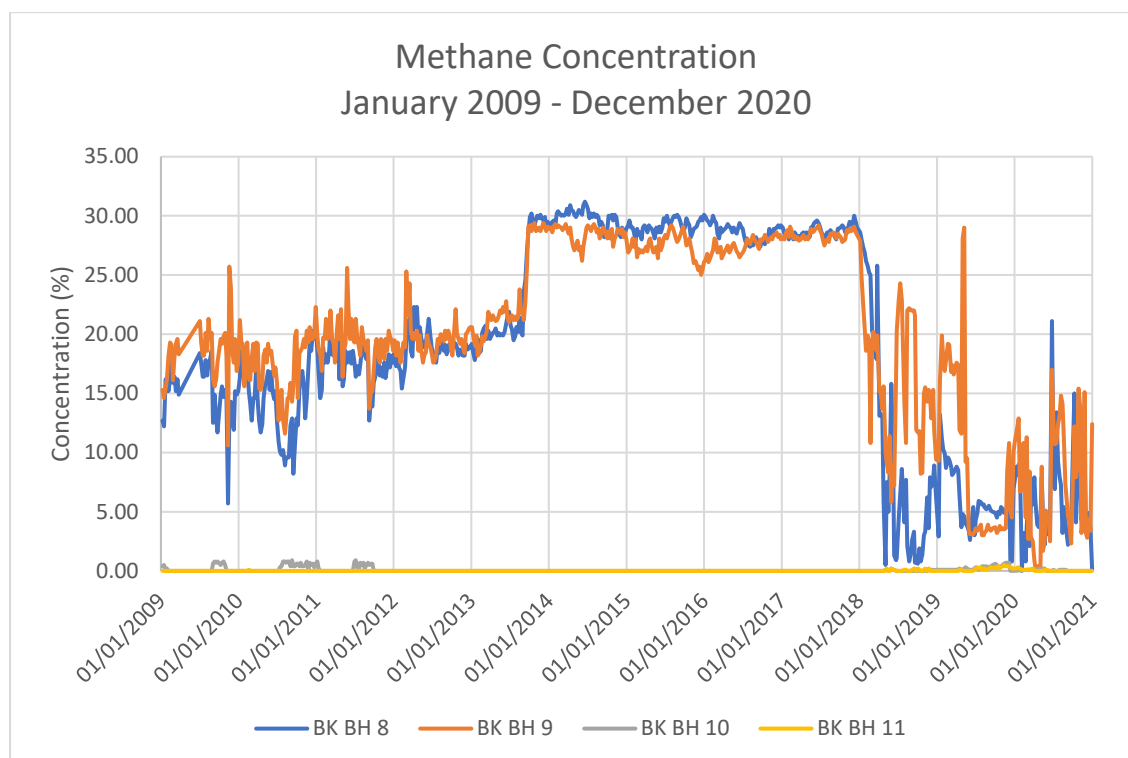


Graph 1b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH1, BH3, BH4, BH5, BH6 and BH7

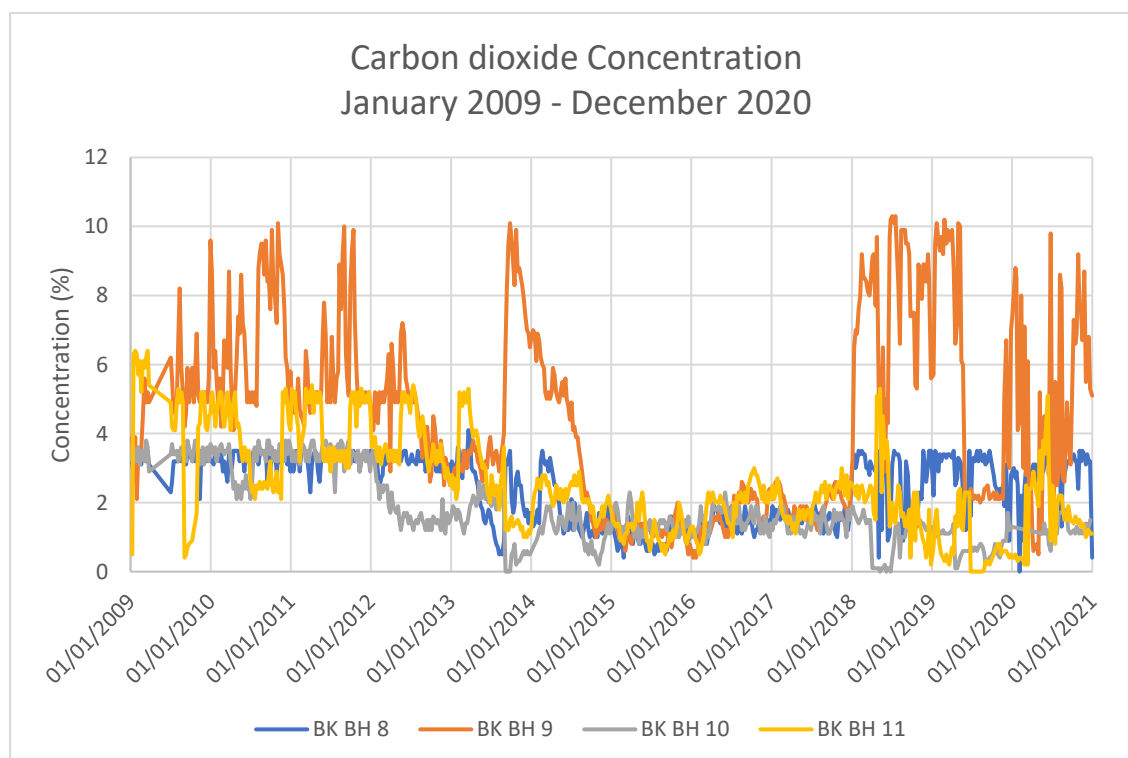


APPENDIX 1 – LANDFILL GAS

Graph 2a: Perimeter Landfill Gas - Methane concentration in BH08, BH09, BH10 and BH11

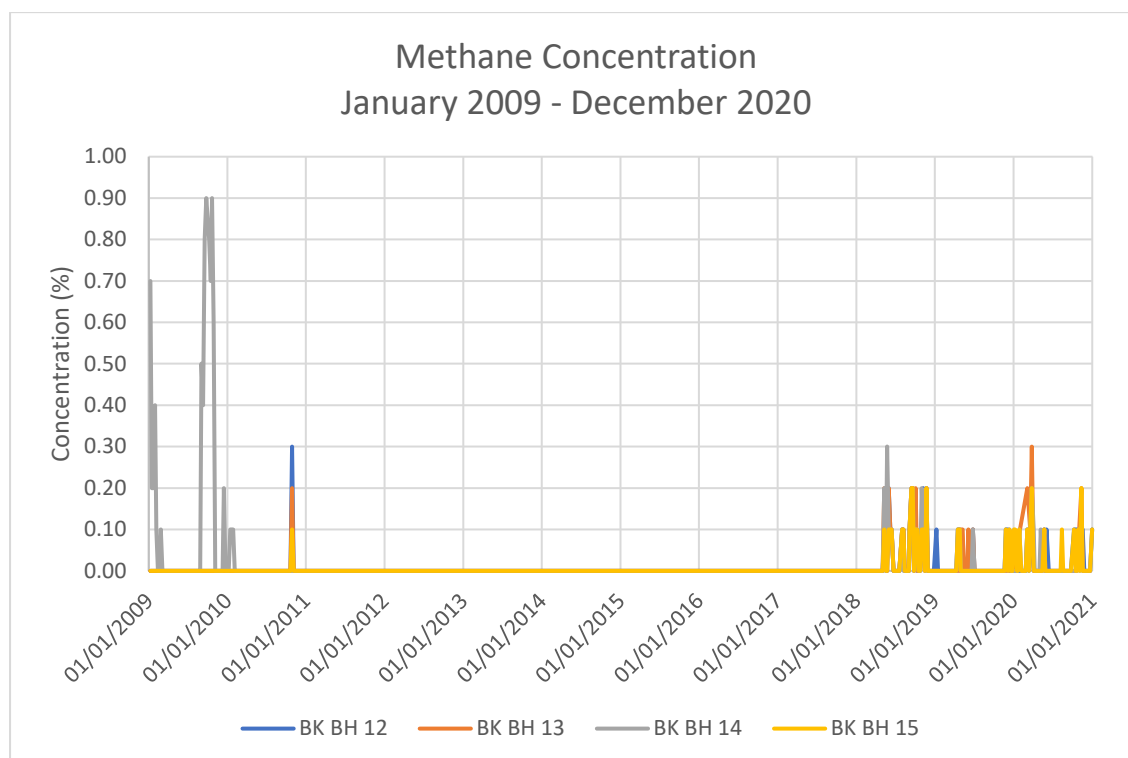


Graph 2b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH08, BH09, BH10 and BH11

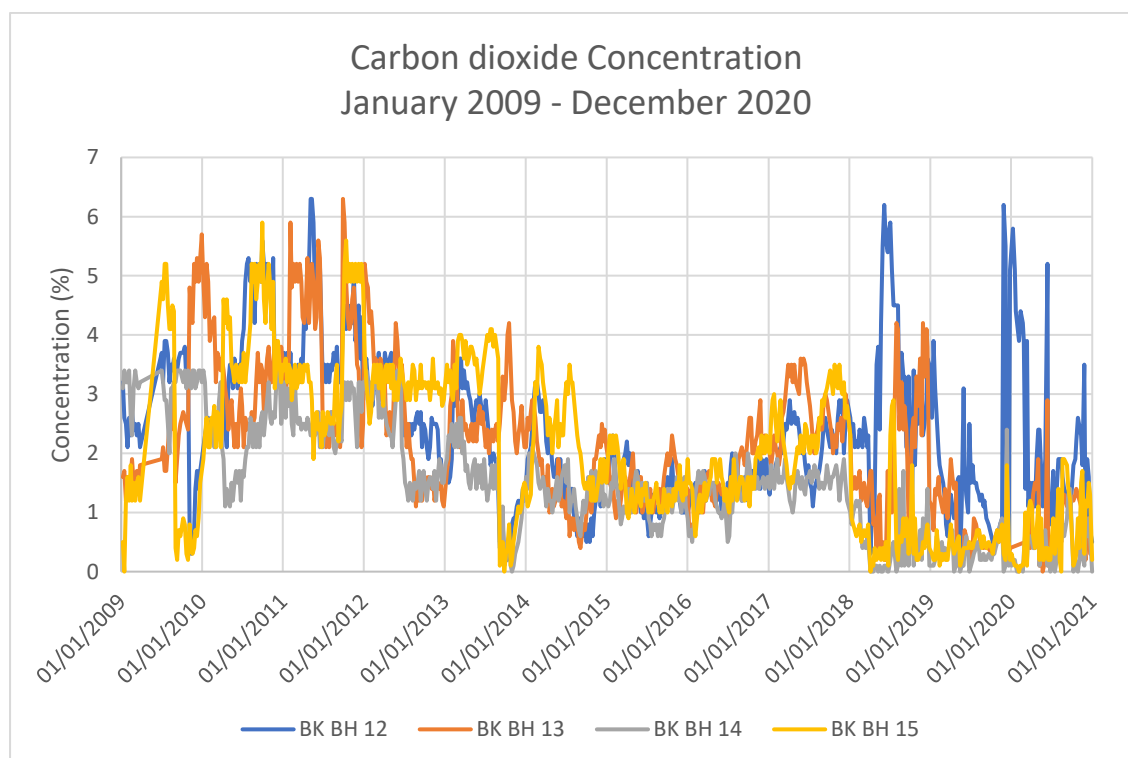


APPENDIX 1 – LANDFILL GAS

Graph 3a: Perimeter Landfill Gas - Methane concentration in BH12, BH13, BH14 and BH15

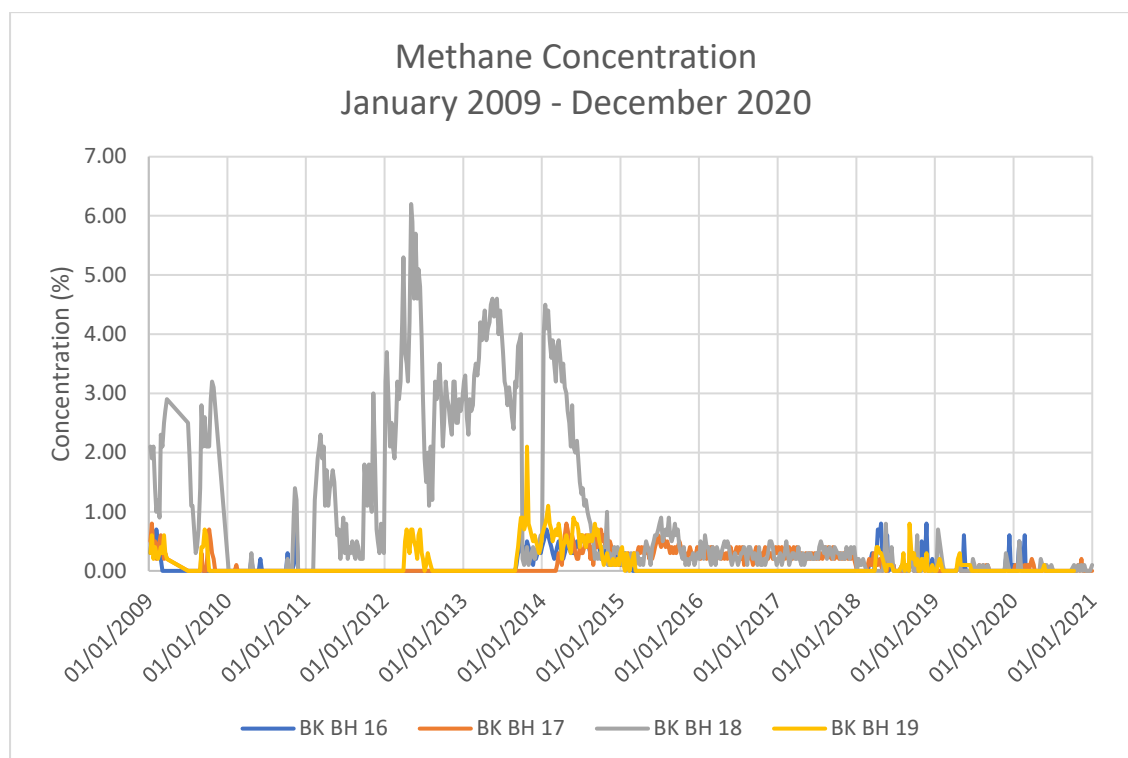


Graph 3b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH12, BH13, BH14 and BH15

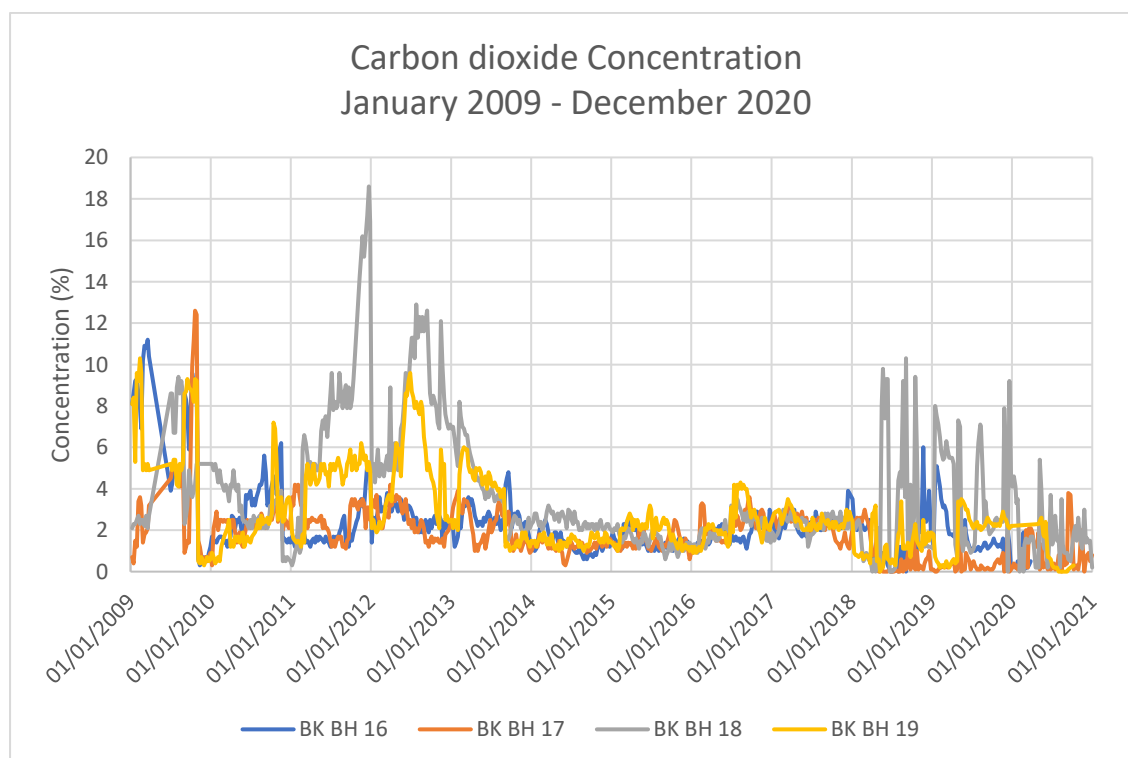


APPENDIX 1 – LANDFILL GAS

Graph 4a: Perimeter Landfill Gas - Methane concentration in BH16, BH17, BH18 and BH19

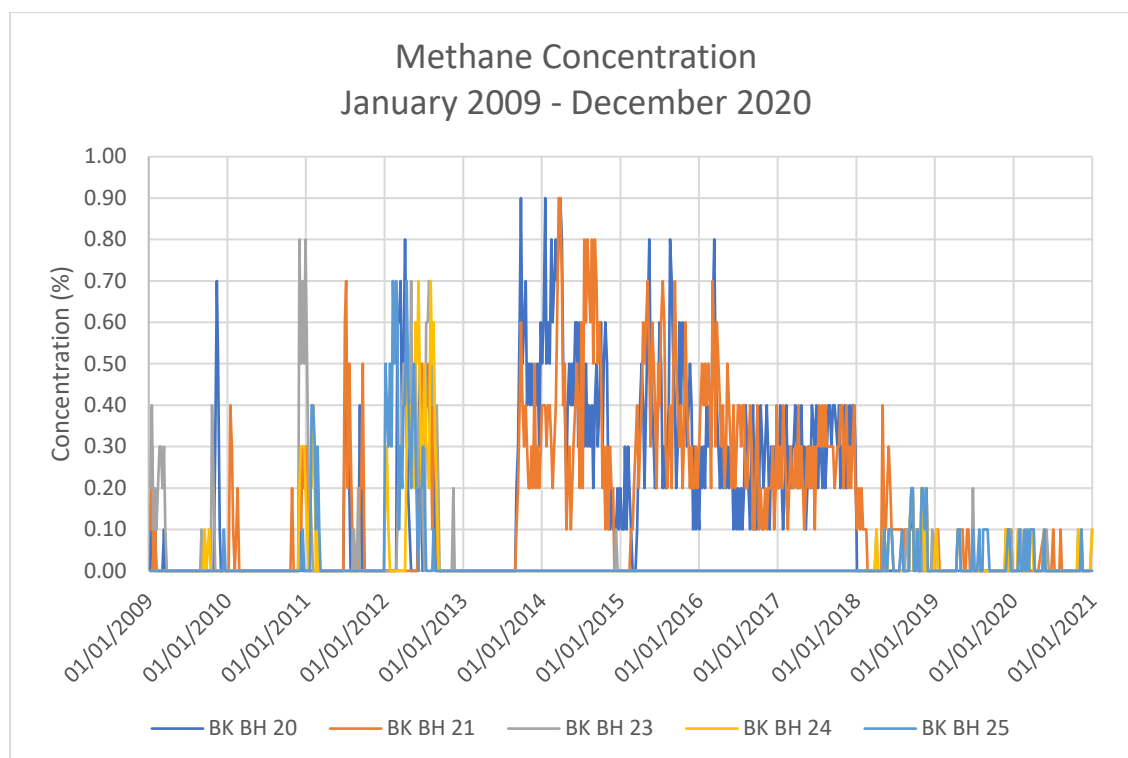


Graph 4b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH16, BH17, BH18 and BH19

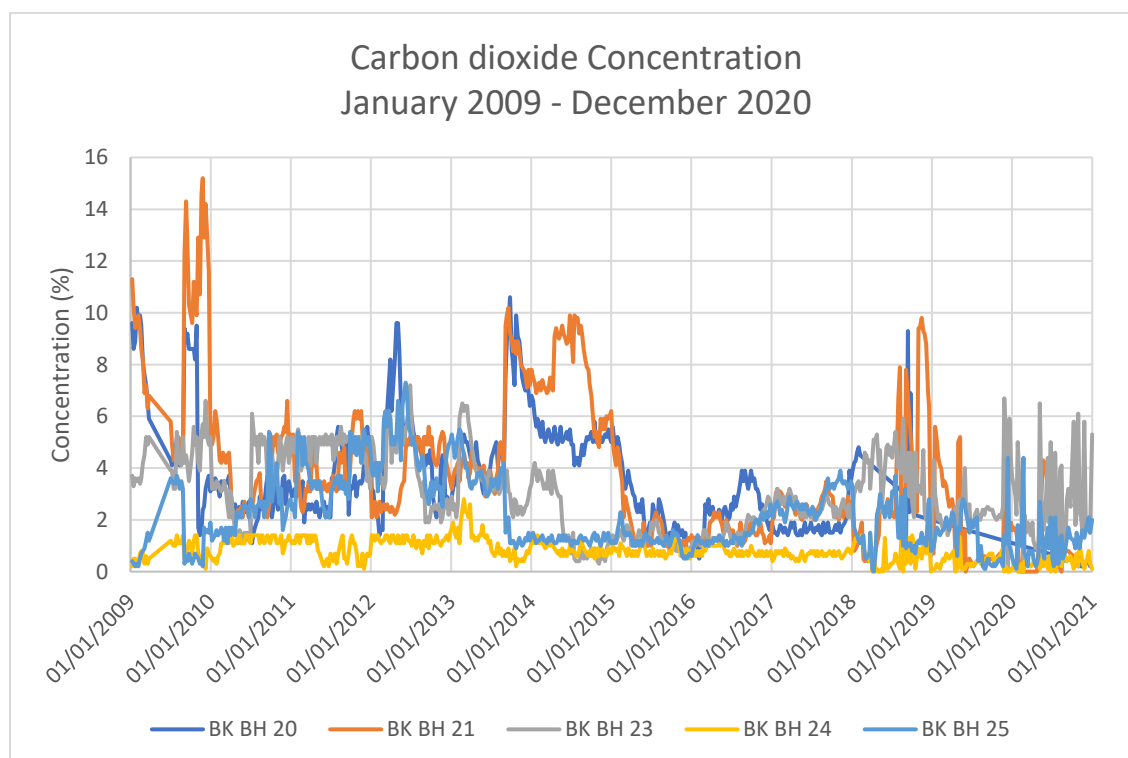


APPENDIX 1 – LANDFILL GAS

Graph 5a: Perimeter Landfill Gas - Methane concentration in BH20, BH21, BH23, BH24 and BH25



Graph 5b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH20, BH21 and BH23 - BH25



**Report for the Periodic Monitoring of Emissions to Air from the Landfill
Gas Engine and Flare Stack Located at Brookhill Landfill Site, Buckley.**

Part 1: Executive Summary

Permit Number: BV7273 (YP3835MJ)

Operator: Flintshire County Council

Installation: Brookhill Landfill Site (Engine and Flare)



4251

Monitoring dates: 15th December 2020

Job Number: **R20534**

Version: 1

Address: **Flintshire County Council**

Brookhill Landfill Site

Brookhill Way, Pinfold Industrial Estate

Flintshire, CH7 3PL

Monitoring Organisation: **EnviroDat Ltd.**

Address: Cutbush Commercial

Cutbush Lane East

Reading

RG2 9AF

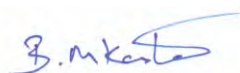
Date of Report: 15th January 2021

Report Approved By: Bruce Kester

MCERTS Registration Number: MM03 190 (Level II, TE1, 2, 3 & 4)

Function: Technical Manager (Team Leader)

Signed:



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Notes to Report.

- a). EnviroDat Ltd, Report Template V12.
- b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.
- c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

PART 1: EXECUTIVE SUMMARY

1.1 Monitoring Objectives

Flintshire County Council operates a landfill gas engine and a flare stack at its facility located at Brookhill Landfill site. This combustion plant has the potential to pollute the atmosphere. Consequently, these processes are subject to regulation and periodic environmental monitoring is necessary under this regulation.

Methane is produced as a by-product of the decomposition of organic waste that is buried within the site (methanogenesis). This methane is extracted and pumped through inert piping to the engine or flare for combustion, the scale of which is dictated according to local engineering, operational requirements and methanogenic rate. The flare is designed to operate when excess gas is produced or for periods of engine maintenance.

EnviroDat Limited was requested to undertake a monitoring campaign on the engine stack. This work forms part of the annual compliance test.

The pollutants monitored within the engine emissions, as required under permit BV7273, are summarised below:

Substances to be monitored	Emission Point Identification	
	Engine Stack	Flare Stack
Oxides of Nitrogen (NO _x as NO ₂)	✓	✓
Carbon Monoxide (CO)	✓	✓
Total Volatile Organic Compounds (VOCs)	✓	✓
Moisture (for correction)	✓	✓
Oxygen (O ₂ for correction)	✓	✓
Special requirements	None requested	

1.2 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Estimate of Uncertainty (2σ at 95% confidence)	Units	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method (see note below)	Operating Status
Engine Stack	Oxides of Nitrogen (as NO ₂)	500	516	±24	mg(N)m ⁻³	101.3 kPa, 273K, dry gas, 5% O ₂	15/12/20	08:59-09:59	BS EN 14792	A	At 100% capacity
	Carbon Monoxide	1400	616	±41	mg(N)m ⁻³				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	1000	725	±33	mg(N)m ⁻³				BS EN 12619	A	
	Moisture	-	9.1	n/a	%	101.3 kPa, 273K, dry gas			BS EN 14790	A	
	Oxygen	-	6.87	±0.38	%				BS EN 14789	A	

NOTE:

- A. EnviroDat Ltd MCerts/UKAS Accredited for sampling and analysis.
- B. EnviroDat Ltd MCerts/UKAS Accredited for sampling only, UKAS Accredited analysis conducted by sub-contract laboratory.
- C. EnviroDat Ltd UKAS Accredited for sampling only (further clarification is given in section 1.4). Analysis of this component is not UKAS Accredited.
- D. The method for sampling and analysis is not UKAS or MCerts Accredited, method follows documented in-house procedure (further clarification is given in section 1.4).
- E. The method for sampling is not UKAS or MCerts Accredited, UKAS Accredited analysis conducted by sub-contract laboratory.

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Estimate of Uncertainty (2σ at 95% confidence)	Units	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method (see note below)	Operating Status
Flare Stack	Oxides of Nitrogen (as NO ₂)	150	66	±3	mg(N)m ⁻³	101.3 kPa, 273K, dry gas, 3% O ₂	15/12/20	11:35-12:35	BS EN 14792	A	At 40% capacity
	Carbon Monoxide	50	51	±4	mg(N)m ⁻³				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	10	1.1	±0.3	mg(N)m ⁻³				BS EN 12619	A	
	Moisture	-	7.1	n/a	%	BS EN 14790			A		
	Oxygen	-	11.78	±0.55	%	BS EN 14789			A		

NOTE:

- A. EnviroDat Ltd MCerts/UKAS Accredited for sampling and analysis.
- B. EnviroDat Ltd MCerts/UKAS Accredited for sampling only, UKAS Accredited analysis conducted by sub-contract laboratory.
- C. EnviroDat Ltd UKAS Accredited for sampling only (further clarification is given in section 1.4). Analysis of this component is not UKAS Accredited.
- D. The method for sampling and analysis is not UKAS or MCerts Accredited, method follows documented in-house procedure (further clarification is given in section 1.4).
- E. The method for sampling is not UKAS or MCerts Accredited, UKAS Accredited analysis conducted by sub-contract laboratory.

1.3 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results			
								Substance	CEMS Results	Periodic Monitoring Results	Units
Engine	15/12/20	Combustion	Continuous	Landfill Gas	N/A	None	Producing 400kWe (100% MCR)	N/A	N/A	N/A	N/A
Flare	15/12/20	Combustion	As Demanded	Landfill Gas	N/A	None	At 40% MCR	N/A	N/A	N/A	N/A

1.4 Monitoring Deviations

Emission Point Reference	Substance Deviations	Monitoring Deviations	Other Relevant Issues
Engine	None	None	None
Flare	None	None	None

PART 2: SUPPORTING INFORMATION

2.1 Appendix I: General Information

2.1.1 Monitoring organisation staff details

Monitoring at Brookhill Landfill Site was conducted by the following EnviroDat Engineers:

Team Leader, Bruce Kester - MCERTs (Level II, TE1, 2,3 & 4)	MM03 190
Team Leader, Dean Kyle - MCERTs (Level II, TE3 & TE4)	MM12 1188

2.1.2 Monitoring method details

Parameter	Standard Reference Method/Alternative	EnviroDat Procedure	MCerts Accreditation
Oxides of Nitrogen (as NO ₂)	BS EN 14792	SP14792	MCerts
Carbon Monoxide (CO)	BS EN 15058	SP15058	MCerts
Volatile Organic Compounds (VOCs)	BS EN 12619	SP12619	MCerts
Moisture (H ₂ O)	BS EN 14790	SP14790	MCerts
Oxygen (O ₂)	BS EN 14789	SP14789	MCerts

2.1.3 Monitoring organisation equipment and gas check list references

EQUIPMENT			
Item	Reference	Calibration Due	PAT Due
Portable Gas Analyser	PGA#03	17-Aug-21	Oct-21
Flame Ionisation Detector Analyser	FID#01	11-Oct-21	Oct-21
Gas Conditioner	COND#05	17-Aug-21	Oct-21
NOx Converter	CONV#04	1-Jan-21	Oct-21

Digital Barometer	DB#30	7-May-21	-
Balance	BAL#05	31-Mar-21	-
Heated Filter Head	HFH#04	1-Jan-21	Oct-21
Heated Line	HL#1, 2, 3	1-Jan-21	-
Timepiece	TP#13	5-Aep-21	-
Data logger	DL#01	28-Dec-20	-
'Apex' Kit	APEX#01	Various	Oct-21
Dry Gas Meter ('Apex')	DGM#15	19-Aug-21	-
Timepiece	TP#06	19-Aug-21	-
Thermocouple ('Apex')	TC#05	19-Aug-21	-
Thermocouple Reader ('Apex')	TCR#08	19-Aug-21	-
Manometer ('Apex' Orange)	MAN#02	19-Aug-21	-
Manometer ('Apex' Red)	MAN#03	19-Aug-21	-
Thermocouple ('Apex' Dogleg Exit)	TC#21	26-Jul-21	-

GAS CYLINDERS			
	Certificate No.	Level (ppm)	Validity
'Zero' Gas (%)	VC2686487	99.9995%	N/A
Oxygen Span Gas (%)	VC8172860	8.02%	30-Jan-21
VOC Span Gas	VC8172860	596	30-Jan-21
Carbon Monoxide Span Gas	VC109017	1212	14-Apr-21
Nitric Oxide Span Gas	VC109017	257.8	14-Apr-21
VOC Span Gas	2035820	9.20	14-Apr-21
Oxygen Span Gas (%)	2035820	10.04%	15-Sep-21
Carbon Monoxide Span Gas	VC2394A	150.1	14-Apr-21
Nitric Oxide Span Gas	VC2384A	92.0	14-Apr-21

2.2 Appendix II: Emission Point Reference Data & Results

2.2.1 Photograph of Sampling Location on Engine and Flare



Engine sampled from 10mm turbo port within engine container on vertical section of approx. 0.2m diameter stack.



Flare sampled from top on vertical section of approx. 2.0m diameter stack.

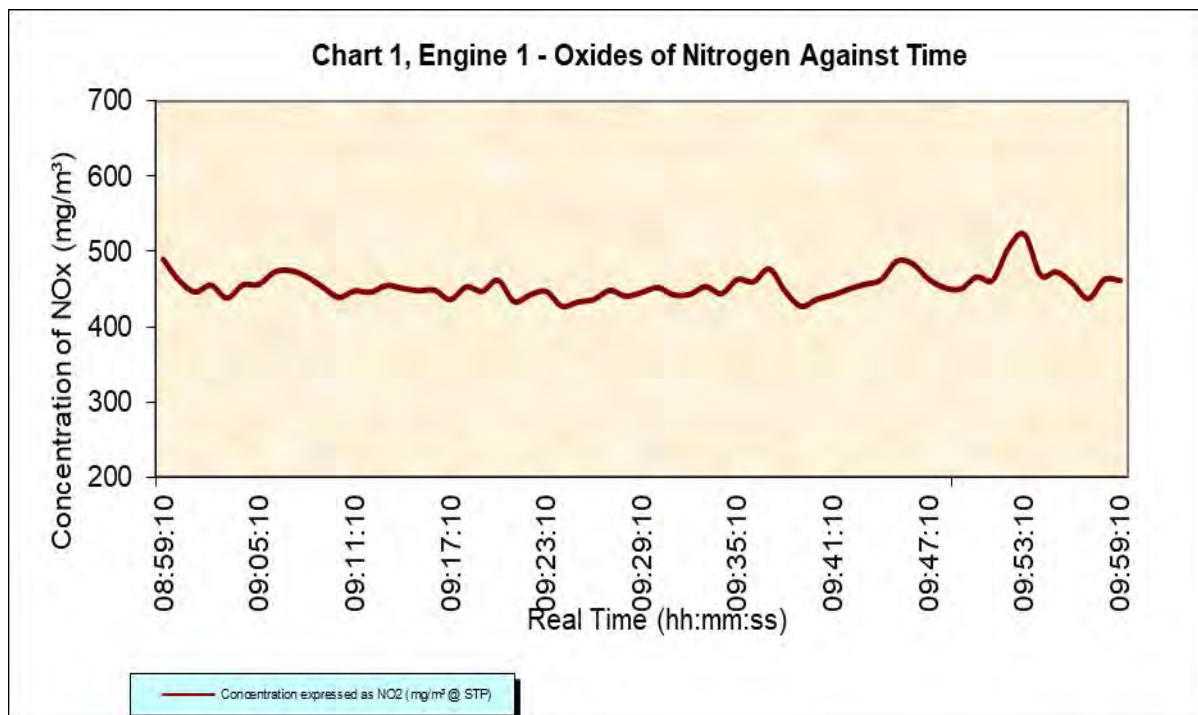
2.2.2 Homogeneity testing

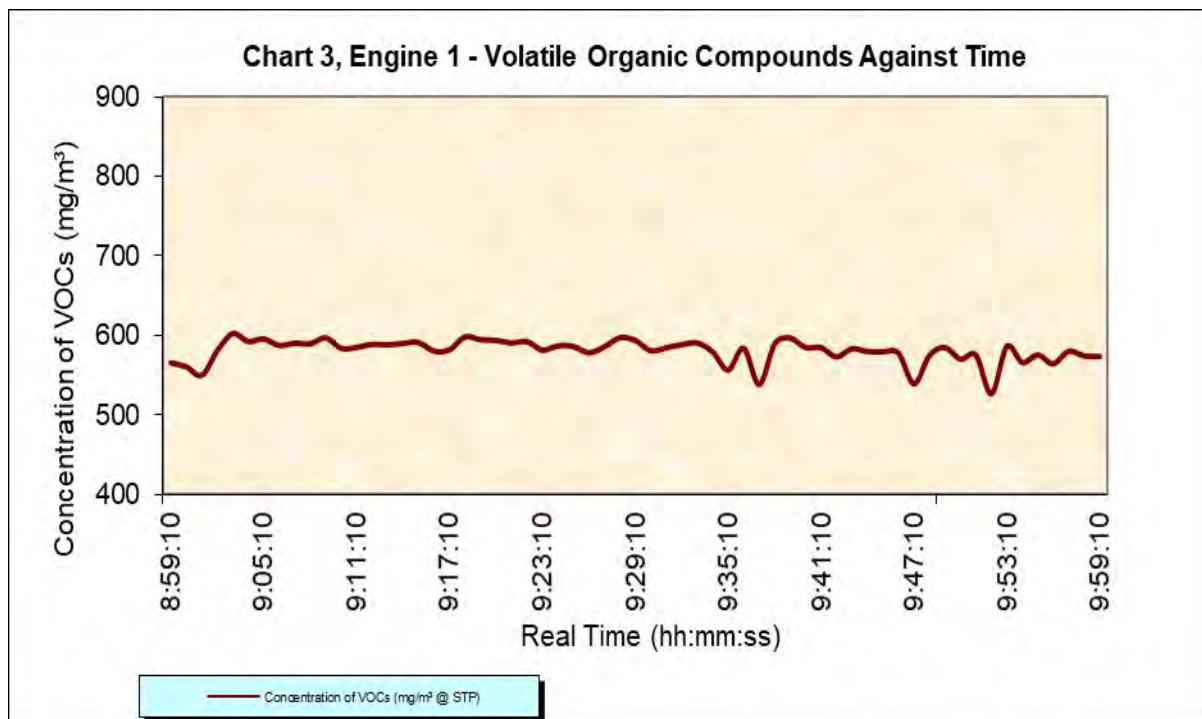
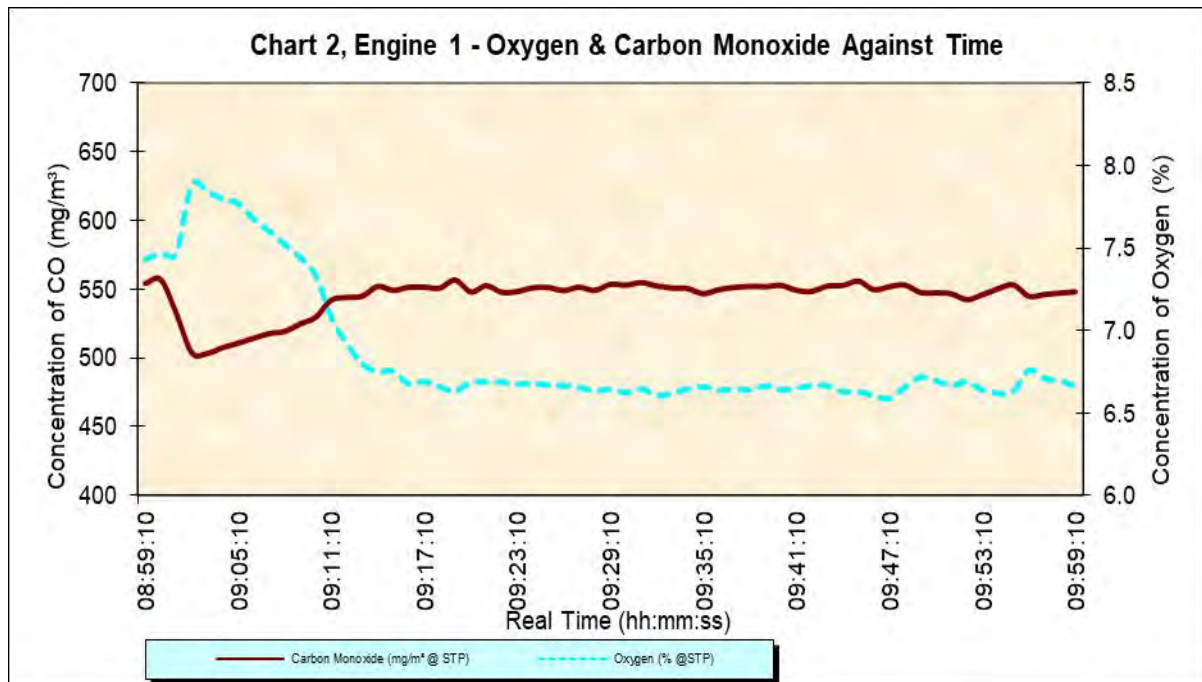
BS EN 15259 stipulates that the exhaust gases emitted from combustion processes are tested to ensure homogeneity and that a representative sample is obtained during the monitoring, subject to a number of caveats as elucidated in Environment Agency guidance MID15259. The details of the testing at each emission point are summarised below:

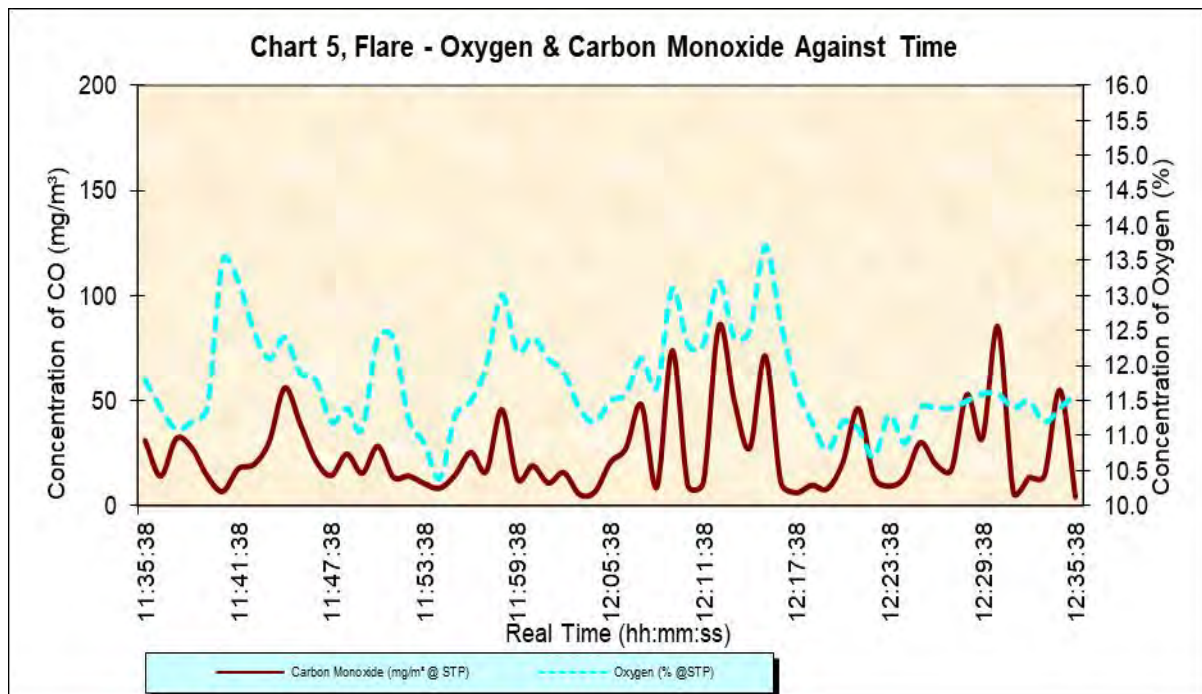
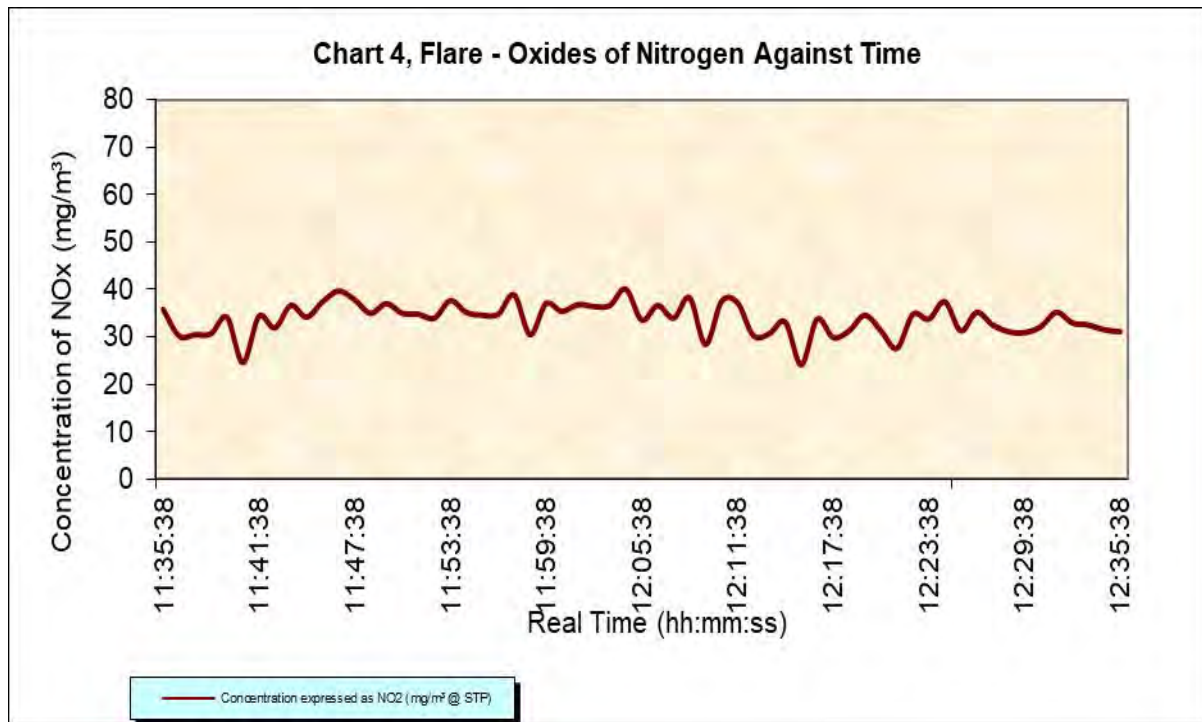
Stack	Result of Homogeneity Testing
Engine & Flare	N/A –homogeneity testing only required on stacks exceeding 1.13 m diameter, as specified in MID 15259. Homogeneity assumed & single point sampling acceptable. Homogeneity Testing on a live flare is deemed unsafe & cannot be completed

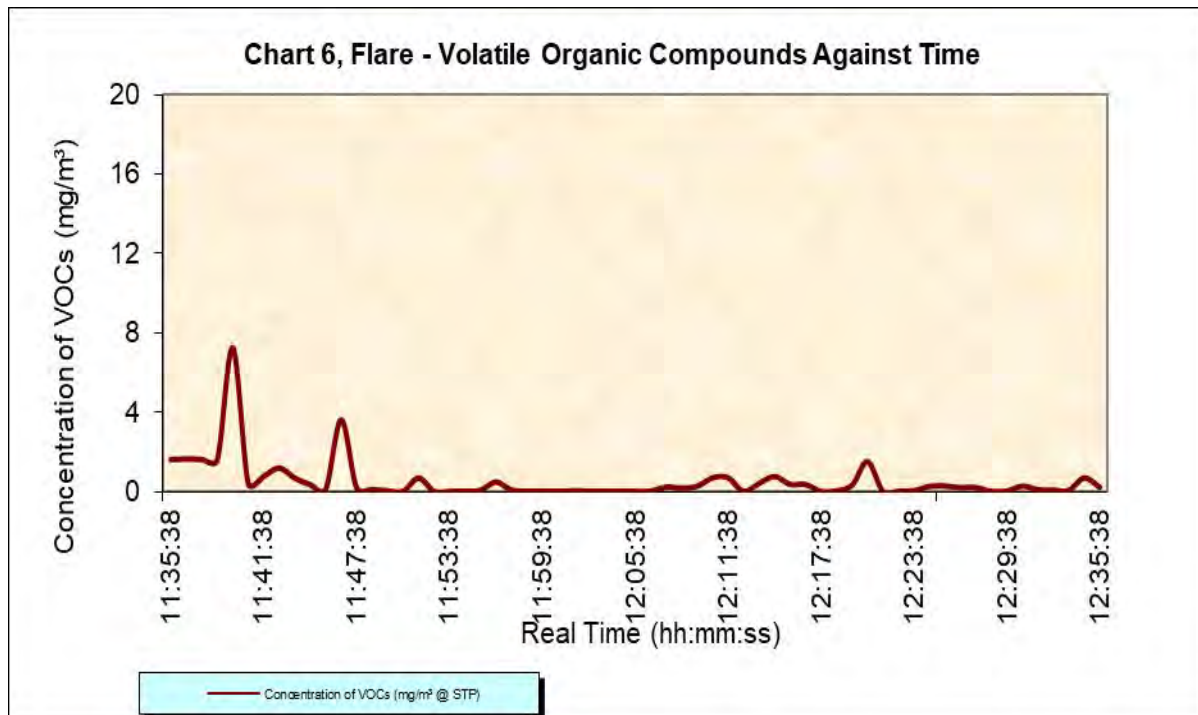
2.2.3 Gas analyser site measurements and calibrations

The data in the following Charts 1 - 6 and Tables 1 - 2 are expressed in mgm^{-3} @ STP and is uncorrected for O_2 . In Addition, VOC results are expressed as carbon equivalent. This data was subsequently converted to reference oxygen concentrations (Section 1.2) with the addition of moisture correction for VOCs. Calibration data is shown in Tables 3 – 4.







**Table 1 – Engine, Raw Data**

Time	Oxygen Dry gas (%)	VOC Wet gas (mgC/m³)	CO Dry Gas (mg/m³)	NO _x Dry Gas (mg/m³)	Comment
08:59:10	7.4	565.9	553.7	489.7	
09:00:10	7.5	560.9	556.6	461.6	
09:01:10	7.5	550.1	532.4	446.2	
09:02:10	7.9	581.1	504.2	455.4	
09:03:10	7.8	602.8	503.6	438.3	
09:04:10	7.8	592.7	507.8	455.5	
09:05:10	7.8	596.1	511.0	456.4	
09:06:10	7.7	587.6	514.5	473.0	
09:07:10	7.6	590.8	517.9	474.6	
09:08:10	7.5	589.8	519.4	466.6	
09:09:10	7.4	597.4	524.9	452.8	
09:10:10	7.3	584.2	529.6	439.3	
09:11:10	7.1	585.3	541.9	447.7	
09:12:10	6.9	589.2	543.7	445.8	
09:13:10	6.8	588.5	544.7	454.9	
09:14:10	6.8	590.5	551.7	451.2	
09:15:10	6.8	591.6	548.8	447.9	
09:16:10	6.7	580.7	551.1	448.8	
09:17:10	6.7	582.4	551.2	436.2	
09:18:10	6.7	598.7	550.6	453.1	
09:19:10	6.6	595.1	556.4	447.2	
09:20:10	6.7	594.2	547.7	461.7	

Time	Oxygen Dry gas (%)	VOC Wet gas (mgC/m ³)	CO Dry Gas (mg/m ³)	NO _x Dry Gas (mg/m ³)	Comment
09:21:10	6.7	590.9	552.3	433.6	
09:22:10	6.7	592.7	547.5	442.5	
09:23:10	6.7	581.8	548.1	447.1	
09:24:10	6.7	587.4	550.7	427.5	
09:25:10	6.7	586.6	551.0	433.0	
09:26:10	6.7	578.6	548.8	436.4	
09:27:10	6.7	586.0	551.2	448.4	
09:28:10	6.6	597.5	548.8	440.8	
09:29:10	6.6	594.2	553.2	445.7	
09:30:10	6.6	581.0	552.6	452.2	
09:31:10	6.6	584.8	554.5	442.4	
09:32:10	6.6	588.7	552.0	443.0	
09:33:10	6.6	590.9	550.5	453.5	
09:34:10	6.6	579.4	550.2	444.1	
09:35:10	6.7	556.7	546.5	462.8	
09:36:10	6.6	584.4	549.5	459.8	
09:37:10	6.6	538.6	551.0	476.8	
09:38:10	6.6	589.5	551.8	447.1	
09:39:10	6.7	597.2	551.5	427.2	
09:40:10	6.6	585.2	552.5	436.8	
09:41:10	6.7	585.0	549.0	442.3	
09:42:10	6.7	573.4	548.2	450.3	
09:43:10	6.7	583.7	552.0	456.5	
09:44:10	6.6	580.0	552.4	462.3	
09:45:10	6.6	579.9	555.6	487.2	
09:46:10	6.6	577.9	549.4	483.5	
09:47:10	6.6	539.4	551.5	463.0	
09:48:10	6.7	575.2	552.8	451.8	
09:49:10	6.7	585.3	547.4	450.3	
09:50:10	6.7	570.4	547.1	466.2	
09:51:10	6.7	575.7	546.4	462.3	
09:52:10	6.7	526.8	542.3	504.9	
09:53:10	6.6	586.6	545.8	522.4	
09:54:10	6.6	566.2	550.0	468.8	
09:55:10	6.6	575.8	552.8	472.9	
09:56:10	6.8	564.6	544.6	457.9	
09:57:10	6.7	580.5	545.9	437.6	
09:58:10	6.7	574.6	547.0	462.7	
09:59:10	6.7	573.8	547.9	461.5	

Table 2 – Flare, Raw Data

Time	Oxygen Dry gas (%)	VOC Wet gas (mgC/m ³)	CO Dry Gas (mg/m ³)	NO _x Dry Gas (mg/m ³)	Comment
11:35:38	11.8	1.6	31.0	35.7	
11:36:38	11.4	1.6	14.3	30.1	
11:37:38	11.1	1.6	32.0	30.4	
11:38:38	11.2	1.6	27.6	30.6	
11:39:38	11.4	7.3	14.3	34.1	
11:40:38	13.5	0.4	7.0	24.4	
11:41:38	13.2	0.8	17.8	34.3	
11:42:38	12.5	1.2	19.8	31.8	
11:43:38	12.1	0.7	30.6	36.6	
11:44:38	12.4	0.3	56.1	34.1	
11:45:38	11.9	0.1	39.1	37.4	
11:46:38	11.8	3.6	21.6	39.6	
11:47:38	11.2	0.2	14.5	37.8	
11:48:38	11.4	0.1	24.8	34.9	
11:49:38	11.1	0.0	15.6	37.0	
11:50:38	12.4	0.0	28.4	34.9	
11:51:38	12.4	0.7	13.8	34.7	
11:52:38	11.2	0.0	14.3	33.9	
11:53:38	10.9	0.0	10.8	37.6	
11:54:38	10.4	0.0	8.5	35.1	
11:55:38	11.3	0.1	14.9	34.5	
11:56:38	11.5	0.5	25.5	34.7	
11:57:38	12.0	0.1	16.5	38.8	
11:58:38	13.0	0.0	45.8	30.4	
11:59:38	12.2	0.0	13.0	37.0	
12:00:38	12.4	0.0	19.1	35.3	
12:01:38	12.1	0.0	11.0	36.8	
12:02:38	11.9	0.0	15.9	36.3	
12:03:38	11.4	0.0	5.6	36.6	
12:04:38	11.2	0.0	6.8	40.0	
12:05:38	11.5	0.0	20.8	33.5	
12:06:38	11.6	0.0	27.4	36.6	
12:07:38	12.1	0.2	48.1	33.9	
12:08:38	11.7	0.2	9.0	38.2	
12:09:38	13.1	0.3	73.8	28.3	
12:10:38	12.3	0.7	9.8	37.4	
12:11:38	12.3	0.7	11.1	37.2	
12:12:38	13.2	0.0	85.5	30.2	
12:13:38	12.4	0.4	49.9	30.6	
12:14:38	12.5	0.8	27.6	33.1	

Time	Oxygen Dry gas (%)	VOC Wet gas (mgC/m ³)	CO Dry Gas (mg/m ³)	NO _x Dry Gas (mg/m ³)	Comment
12:15:38	13.7	0.4	71.3	24.0	
12:16:38	12.6	0.4	11.3	33.7	
12:17:38	11.7	0.0	6.4	29.8	
12:18:38	11.2	0.0	9.9	31.2	
12:19:38	10.8	0.3	8.3	34.5	
12:20:38	11.2	1.5	20.8	31.2	
12:21:38	11.1	0.0	46.3	27.5	
12:22:38	10.7	0.0	13.8	34.7	
12:23:38	11.3	0.0	9.5	33.7	
12:24:38	10.9	0.3	13.8	37.4	
12:25:38	11.4	0.3	30.1	31.2	
12:26:38	11.4	0.2	19.8	35.1	
12:27:38	11.4	0.2	17.4	32.4	
12:28:38	11.5	0.0	52.9	31.0	
12:29:38	11.6	0.0	32.3	30.8	
12:30:38	11.6	0.3	85.0	32.0	
12:31:38	11.4	0.1	6.6	35.1	
12:32:38	11.5	0.1	13.5	32.9	
12:33:38	11.2	0.1	14.4	32.4	
12:34:38	11.4	0.7	55.0	31.4	
12:35:38	11.6	0.2	4.4	31.0	

Table 3 – Engine, Calibration Data

ANALYSER CALIBRATION DATA					
Pre Sampling Check					
		NO (ppm)	CO (ppm)	O ₂ (%)	VOC's (ppm)
Range		500	2000	25	1000
Zero Gas	Cylinder No.	VC2686487			Scrubbed Air
Span Gas	Cylinder No.	VC109017	VC109017	VC8172860	VC8172860
	Certified Value	257.8	1212	8.02	596
Zero Check	Value	0.4	2	0.01	1
<2 x repeatability (Yes/No)		YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	Value	0.9	1	0.02	2
	<2% of span	YES	YES	YES	YES
Span Gas	Value	257	1201	8.05	588
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	Value	1.6	3	-0.01	3
	Drift (%)	0.3	0.2	0.4	0.2
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required
Span Gas	Value	255.4	1203	8	585
	Drift (%)	0.9	0.0	0.2	0.7
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required

Table 4 – Flare, Calibration Data

ANALYSER CALIBRATION DATA					
Pre Sampling Check					
		NO (ppm)	CO (ppm)	O ₂ (%)	VOC's (ppm)
Range		100	200	25	10
Zero Gas	Cylinder No.	VC2686487			Scrubbed Air
Span Gas	Cylinder No.	VC2394A	VC2394A	2035820	2035820
	Certified Value	92	150.1	10.04	9.2
Zero Check	Value	0.4	0.2	-0.01	0.04
<2 x repeatability (Yes/No)		YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	Value	0.4	0.5	0	0.05
	<2% of span	YES	YES	YES	YES
Span Gas	Value	91.8	148.2	10.02	9.1
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	Value	0.3	0.9	-0.01	0.08
	Drift (%)	0.1	0.3	0.1	0.3
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required
Span Gas	Value	91.1	148.3	10	9.12
	Drift (%)	0.7	0.2	0.1	0.1
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required

2.3 Appendix III: Uncertainty Calculation

2.3.1 Engine Uncertainty Calculation

NOx - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	2.37
Drift	U_{odr}	8.55
volume or pressure flow dependence	U_{spres}	0.06
atmospheric pressure dependence	U_{apres}	0.59
ambient temperature dependence	U_{temp}	0.12
NH ₃ (20 mg/m ³)	U_{interf}	0.14
CO ₂ (15%)	-	0.02
H ₂ O (30%)	-	0.01
Error in logger voltage	-	0.50
Dependence on voltage	U_{volt}	0.03
Converter efficiency	U_{ceff}	2.10
losses in the line (leak)	U_{leak}	5.26
Uncertainty of calibration gas	U_{calib}	5.26

NOx Measurement uncertainty		Result	
Combined uncertainty		455.51	mg/m ³
Expanded uncertainty	$k = 2$	11.79	mg/m ³
Expanded uncertainty		23.59	mg/m ³
Uncertainty corrected to std conds		23.59	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	4.72 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	23.59 mg.m ⁻³ of result	

CO - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	5.77
Drift	U_{odr}	17.58
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	1.15
ambient temperature dependence	U_{temp}	0.00
CO ₂ (15%)	U_{interf}	0.00
N ₂ O (40mgm ³)	-	0.00
CH ₄ (57mgm ³)	-	0.00
H ₂ O (1%)	-	0.00
Dependence on voltage	U_{volt}	0.03
Error in Logger reading	-	2.00
losses in the line (leak)	U_{leak}	6.29
Uncertainty of calibration gas	U_{calib}	6.29

CO Measurement uncertainty		Result	
Combined uncertainty		544.39	mg/m ³
Expanded uncertainty	$k = 2$	20.66	mg/m ³
Expanded uncertainty		41.31	mg/m ³
Uncertainty corrected to std conds		41.31	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	2.95 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	41.31 mg.m ⁻³ of result	

VOC - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	3.74
Drift	U_{odr}	12.71
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	0.75
ambient temperature dependence	U_{temp}	0.00
NH ₃ (20 mg/m ³)	U_{interf}	0.00
CO ₂ (15%)	-	0.00
H ₂ O (30%)	-	0.00
Error on Logger voltage	-	1.00
Dependence on voltage	U_{volt}	0.03
losses in the line (leak)	U_{leak}	6.72
Uncertainty of calibration gas	U_{calib}	6.72

VOC Measurement uncertainty		Result	
Combined uncertainty		581.65	mg/m ³
Expanded uncertainty	$k = 2$	16.35	mg/m ³
Expanded uncertainty		32.70	mg/m ³
Uncertainty corrected to std conds		32.70	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	3.27 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	32.70 mg.m ⁻³ of result	

Oxygen - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.20
Standard deviation of repeatability at span level	U_{rs}	0.03
Lack of fit	U_{rf}	0.08
Drift	U_{odr}	0.11
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	0.01
ambient temperature dependence	U_{temp}	0.02
CO ₂ (15%)	-	0.00
NO _x (300)	-	0.06
NO ₂ (30)	-	0.00
dependence on voltage	U_{volt}	0.02
losses in the line (leak)	U_{leak}	0.08
Error in Logger voltage	-	0.03
Uncertainty of calibration gas	U_{calib}	0.08

O₂ Measurement uncertainty	Result	6.87	%vol
Combined uncertainty		0.19	%vol
% of value		2.77	%
Expanded uncertainty	expressed with a level of confidence of 95%	5.54 % of value	
Expanded uncertainty	expressed with a level of confidence of 95%	0.38 % vol	

2.3.2 Flare Uncertainty Calculations

NOx - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rf}	0.47
Drift	U_{odr}	1.38
volume or pressure flow dependence	U_{spres}	0.01
atmospheric pressure dependence	U_{apres}	0.00
ambient temperature dependence	U_{temp}	0.00
NH ₃ (20 mg/m ³)	U_{interf}	0.14
CO ₂ (15%)	-	0.02
H ₂ O (30%)	-	0.01
Error in logger voltage	-	0.10
Dependence on voltage	U_{volt}	0.03
Converter efficiency	U_{ceff}	0.16
losses in the line (leak)	U_{leak}	0.39
Uncertainty of calibration gas	U_{calib}	0.39

NOx Measurement uncertainty	Result	33.89	mg/m ³
Combined uncertainty		1.58	mg/m ³
Expanded uncertainty	k = 2	3.17	mg/m ³
Uncertainty corrected to std conds		3.17	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	2.11 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	3.17 mg.m⁻³ of result	

CO - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rf}	0.58
Drift	U_{odr}	1.59
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	0.00
ambient temperature dependence	U_{temp}	0.00
CO ₂ (15%)	U_{interf}	0.00
N ₂ O (40mgm ³)	-	0.00
CH ₄ (57mgm ³)	-	0.00
H ₂ O (1%)	-	0.00
Dependence on voltage	U_{volt}	0.03
Error in Logger reading	-	0.20
losses in the line (leak)	U_{leak}	0.30
Uncertainty of calibration gas	U_{calib}	0.30

CO Measurement uncertainty	Result	26.10	mg/m ³
Combined uncertainty		1.76	mg/m ³
Expanded uncertainty	k = 2	3.53	mg/m ³
Uncertainty corrected to std conds		3.53	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	7.05 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	3.53 mg.m⁻³ of result	

VOC - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	u_{r0}	0.80
Standard deviation of repeatability at span level	u_{rs}	0.10
Lack of fit	u_{rf}	0.04
Drift	u_{dr}	0.10
volume or pressure flow dependence	u_{spres}	0.00
atmospheric pressure dependence	u_{apres}	0.00
ambient temperature dependence	u_{temp}	0.00
NH ₃ (20 mg/m ³)	u_{interf}	0.00
CO ₂ (15%)	-	0.00
H ₂ O (30%)	-	0.00
Error on Logger voltage	-	0.01
Dependence on voltage	u_{volt}	0.03
losses in the line (leak)	u_{leak}	0.01
Uncertainty of calibration gas	u_{calib}	0.01

VOC Measurement uncertainty	Result	0.51	mg/m³
Combined uncertainty		0.15	mg/m ³
Expanded uncertainty	k = 2	0.30	mg/m ³
Uncertainty corrected to std conds		0.30	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%	3.00 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%	0.30 mg.m⁻³ of result	

Oxygen - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	u_{r0}	0.20
Standard deviation of repeatability at span level	u_{rs}	0.03
Lack of fit	u_{rf}	0.14
Drift	u_{dr}	0.13
volume or pressure flow dependence	u_{spres}	0.00
atmospheric pressure dependence	u_{apres}	0.00
ambient temperature dependence	u_{temp}	0.00
CO ₂ (15%)	-	0.00
NO(300)	-	0.06
NO ₂ (30)	-	0.00
dependence on voltage	u_{volt}	0.02
losses in the line (leak)	u_{leak}	0.14
Error in Logger voltage	-	0.03
Uncertainty of calibration gas	u_{calib}	0.14

O₂ Measurement uncertainty	Result	11.78	%vol
Combined uncertainty		0.28	%vol
% of value		2.35	%
Expanded uncertainty	expressed with a level of confidence of 95%	4.70 % of value	
Expanded uncertainty	expressed with a level of confidence of 95%	0.55 % vol	

2.4 Appendix IV: Moisture Calculations

Test No	T1
Date	15-12-20
pbar (mbar)	998
pbar (mmHg)	749
Nozzle Diameter (mm)	n/a
Temp of Meter (in)/(out) °C	8
DH _{ave} (mmH ₂ O)	10.0
DGM Cal Factor (Y)	0.9927

Site	Flintshire CC Brookhill AD Site
Stack	Engine
Job Number:	R20534
Site Team:	BK & DK
Data Entered By:	BK

Enter Data into coloured cells only

Start Volume Reading	356.5580	m³
End Volume Reading	357.1522	m³
Volume Sampled	0.5899	m³

Start time	08:59	hr:min
End time	09:59	hr:min
Total time	01:00	hr:min

IMPINGER	1	2	3	4	Initials of Analyst
Absorber Solution (Type):	H2O	H2O	KO	SILICA	
Sample No:	n/a	n/a	n/a	n/a	
Analysis Required:	n/a	n/a	n/a	n/a	
Initial Weight of Impingers plus absorber (g)	839.6	830.7	802.5	809.1	BK
Final Weight of Impingers plus absorber (g)	871.0	838.9	803.8	813.7	BK
Weight Gain (g)	31.4	8.2	1.3	4.6	

Total Weight Gain (1+2+3+4) (g)	45.5
---------------------------------	------

Gas Volume of water at 0°C and 101.3kPa (l)	56.65
Gas Meter volume at 0°C and 101.3kPa (l)	565.14

Moisture content of Gases (%)	9.1
-------------------------------	-----

Test No	T2
Date	15-12-20
pbar (mbar)	998
pbar (mmHg)	749
Nozzle Diameter (mm)	n/a
Temp of Meter (in)/(out) °C	9
DH _{ave} (mmH ₂ O)	10.0
DGM Cal Factor (Y)	0.9927

Site	Flintshire CC Brookhill AD Site
Stack	Flare
Job Number:	R20534
Site Team:	BK & DK
Data Entered By:	BK

Enter Data into coloured cells only

Start Volume Reading	357.1594	m³
End Volume Reading	357.7402	m³
Volume Sampled	0.5766	m³

Start time	11:35	hr:min
End time	12:35	hr:min
Total time	01:00	hr:min

IMPINGER	1	2	3	4	Initials of Analyst
Absorber Solution (Type):	H2O	H2O	KO	SILICA	
Sample No:	n/a	n/a	n/a	n/a	
Analysis Required:	n/a	n/a	n/a	n/a	
Initial Weight of Impingers plus absorber (g)	871.0	838.9	803.8	813.7	BK
Final Weight of Impingers plus absorber (g)	894.7	842.7	804.0	820.0	BK
Weight Gain (g)	23.7	3.8	0.2	6.3	

Total Weight Gain (1+2+3+4) (g)	34
---------------------------------	----

Gas Volume of water at 0°C and 101.3kPa (l)	42.33
Gas Meter volume at 0°C and 101.3kPa (l)	551.02

Moisture content of Gases (%)	7.1
-------------------------------	-----

**ANALYSIS OF THE
TRACE LANDFILL GAS**

AT

Brookhill Landfill Site

Brookhill Way
Pinfold Industrial Estate
Buckley, Flintshire
CH7 3PL

Commissioned by: Paul Murphy

Of

Flintshire County Council

Waste Management Service
Alltami Depot
Mold Road - Alltami, Flintshire
CH7 6LG

Date of Survey:

15th December 2020

Compiled By:

Bruce Kester
Technical Manager

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Technical Manager
MCerts Level II (TE1, 2, 3 & 4)

Signed: BMK

Dated: 15th January 2021

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1. INTRODUCTION
2. PLANT DESCRIPTION
3. SAMPLING PROCEDURES
4. RESULTS

APPENDICES:

APPENDIX A: Site Information & Preliminary Gas Measurements
APPENDIX B: Trace Gas Results
APPENDIX C: Trace Gas Chart
APPENDIX D: Siloxane Results

Notes to Report.

- a). EnviroDat Ltd, Report Template V10.
- b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.
- c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

1. INTRODUCTION

- 1.1 EnviroDat Limited was commissioned by Paul Murphy, on behalf of Flintshire County Council, to measure the trace gas and siloxane components from landfill gas located at Brookhill Landfill Site. Sampling was performed on the 15th December 2020.
- 1.2 The sampling was conducted in response to permit requirements (Permit No. BV7273/ YP3835MJ). Monitoring was conducted with reference to the Environment Agency document 'Guidance for Monitoring Trace Components in Landfill Gas' (LFTGN 04).

2. PLANT DESCRIPTION

- 2.1 Landfill gas is currently utilised by the engine plant. Samples of the fuel gas were taken from a feed system for trace gas analysis after the gas booster on the inlet to the engine.

3. SAMPLING PROCEDURES

- 3.1 Trace gas sampling was performed from the fuel gas inlet, with analysis for components identified in Table 1.1 of the EA LFTGN04 guidance note. General site information is presented in Appendix A.
- 3.2 Mixed bed, automated thermal desorption (ATD) tubes were used for sampling of the priority volatile organic species prior to analysis by gas chromatography with mass spectrometry (GC/MS), in accordance with EA recommendations and documented EnviroDat protocol, SPTGN04. The results are

presented in Appendix B. The analytical component of the work was conducted at Marchwood Scientific Services (MSS) Ltd.

- 3.3 The LFTGN04 designated 'priority' carbonyl components (i.e. methanal and ethanal) were sampled onto dinitrophenylhydrazine (DNPH) impregnated, silica gel sorbent tubes prior to analysis by high performance liquid chromatography (HPLC) incorporating an ultraviolet (UV) detection system, in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS.
- 3.4 Arsenic was sampled onto an activated charcoal sorbent tube prior to analysis by inductively coupled plasma/mass spectrometry (ICP/MS), in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS.
- 3.5 Hydrogen sulphide was sampled by Envirodat MCerts GA5000 analyser. The results are presented in Appendix B.
- 3.6 Siloxanes sampling was affected using EnviroDat Ltd. documented internal protocol SP SILOX. This involves passing a metered volume of the gas through solid sorbent material whereby the siloxane congeners are captured and concentrated to allow analysis by gas chromatography utilising mass spectrometric detection (GC/MS). The analysis was carried out at MSS and is UKAS accredited for sampling and analysis.

4. RESULTS

- 4.1 Preliminary measurements of the 'bulk gases' are given in Appendix A.
- 4.2 Measured concentrations of the EA 'priority' trace components for the landfill gas are given in Appendix B and shown graphically in Appendix C.
- 4.3 Measured concentrations of the siloxane components for the landfill gas are given in Appendix D.

APPENDIX A

Site Information & Preliminary Gas Measurements

TABLE A: Site Information & Preliminary Gas Measurements

Sample Position Details			
Date	15/12/20	Site	Brookhill LFS
Ambient Temperature	5.3°C	Atmospheric Pressure	999mbar
Monitoring Organisation (s)	EnviroDat Ltd	Analytical Laboratory	Marchwood Scientific Services Ltd
Location of Sampling Point	Inlet Line to Utilisation Plant	Area of Influence of collection system sampled	All capped areas of the site
Type of Sampling Point	Nipple & Tap	Temperature of gas	6.3°C, at sample flow meter
Vacuum on Sampling	None, Positive pressure	Type of waste	Domestic, Industrial, Commercial & Hazardous
		Age of Waste	-
Status of Gas System	Fully Operational, Steady State	Other	-
Parameter	Concentration	Units	Comments
Methane*	43.2	%	-
Carbon Dioxide*	29.4	%	-
Oxygen*	4.7	%	-
Nitrogen	22.7	%	Assumed to be balance of gas
Hydrogen Sulphide	34	ppmv	See Appendix B
Carbon Monoxide	-	ppmv	Not required

APPENDIX B

Trace Gas Results

TABLE B: Trace Gas Results

Trace Gases							
	Test Duration	Flow Rate	Flowmeter	Volume	Ambient T	Barometric P	Volume
	(min)	(ml/min)	CAL Factor	(l as sampled)	(°C)	(kPa)	(l @ STP)
Arsenic	60	200	0.9844	11.81	6	99.9	11.38
Aldehydes	20	200	1.022	4.09	6	99.9	3.94
VOC	6	50	1.0056	0.30	6	99.9	0.29

Compound	Mass of TG (ng)	LoD of TG (ng)	Concentration	Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
Arsenic (as As)		50	< 4	µg/m ³	-	N
Acetaldehyde (Ethanal)		100	< 25	µg/m ³	-	Y
Formaldehyde (Methanal)		100	< 25	µg/m ³	-	Y
Vinyl chloride	470	10	1617	µg/m ³	-	N
1,3-butadiene		10	< 34	µg/m ³	-	N
Methanethiol		50	< 172	µg/m ³	-	N
Chloroethane	42	10	144	µg/m ³	-	N
1-pentene		20	< 69	µg/m ³	-	N
1,4-epoxy-1,3-butadiene (Furan)	420	10	1445	µg/m ³	-	N
Ethanethiol		50	< 172	µg/m ³	-	N
1,1-dichloroethene	12	5	41	µg/m ³	-	N
Dimethyl sulphide	72	10	248	µg/m ³	-	N
Dichloromethane		10	< 34	µg/m ³	-	N
Carbon disulphide	660	10	2270	µg/m ³	-	N
1,2-dichloroethene (trans + cis)		10	< 34	µg/m ³	-	N
1,1-dichloroethane	90	5	310	µg/m ³	-	N
Propanethiol		40	< 138	µg/m ³	-	N
1,2-dichloroethane	6	5	21	µg/m ³	-	N
Carbon tetrachloride		5	< 17	µg/m ³	-	N
Benzene	2000	1	6879	µg/m ³	c	N
Trichloroethylene	21	5	72	µg/m ³	-	N
Butanethiol		40	< 138	µg/m ³	-	N
Dimethyl disulphide		10	< 34	µg/m ³	-	N
Toluene	1700	5	5847	µg/m ³	b	N
Butyric acid		10	< 34	µg/m ³	-	N
Ethyl butyrate		10	< 34	µg/m ³	-	N
2-Butoxyethanol		10	< 34	µg/m ³	-	N
Styrene	94	5	323	µg/m ³	-	N

Compound	Concentration of H ₂ S (%)	LoD of H ₂ S (%)	Concentration	Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
Hydrogen sulphide	0.0034	0.001	51727	µg/m ³	-	N

*H₂S value is equivalent to 34ppm

- (a) – Results have been blank corrected
(b) – Results should be considered a minimum due to detector saturation
(c) – Results should be viewed with caution due to being outside of the instrument calibration range

Reference to UKAS (final column) relates to the accreditation status of the analysis only, sampling is covered under EnviroDat Accreditation scope.

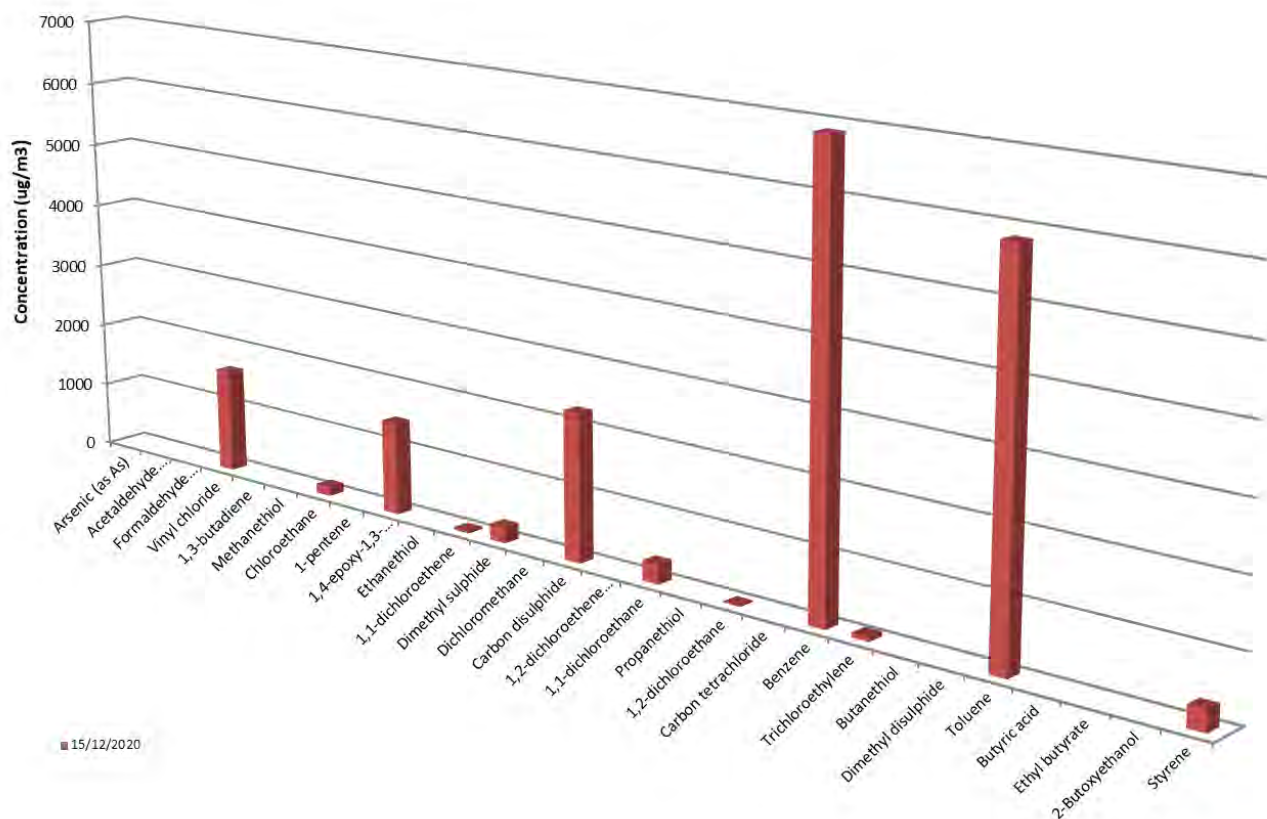
APPENDIX C

Trace Gas Chart

TABLE C: Trace Gas Chart

Priority Trace Components - Brookhill LFS - December 2020

NON DETECTED DATA PRESENTED AS BLANKS - HYDROGEN SULPHIDE RESULTS NOT SHOWN DUE TO RELATIVELY HIGH VALUES



APPENDIX D

Siloxane Results

TABLE D(i): Siloxane Results

Test No	T1
Date	15/12/2020
Site	Brookhill LFS
Stack	Fuel Gas Line
Reference Conditions - Oxygen (%)	n/a
- Temperature (°C)	0
- Pressure (kPa)	101.3
Job Number	R20534
Site Team	BK & DK
Test Conducted By	BK & DK
Data Entered By	BK & DK

Test Start Time	10:40
Test End Time	11:40
Test Duration (min)	60
Flowmeter Rate at Start (ml/min)	200
Flowmeter Rate at End (ml/min)	200
Mean Flowmeter Rate (ml/min)	200
Uncorrected Volume Sampled (l)	12.00

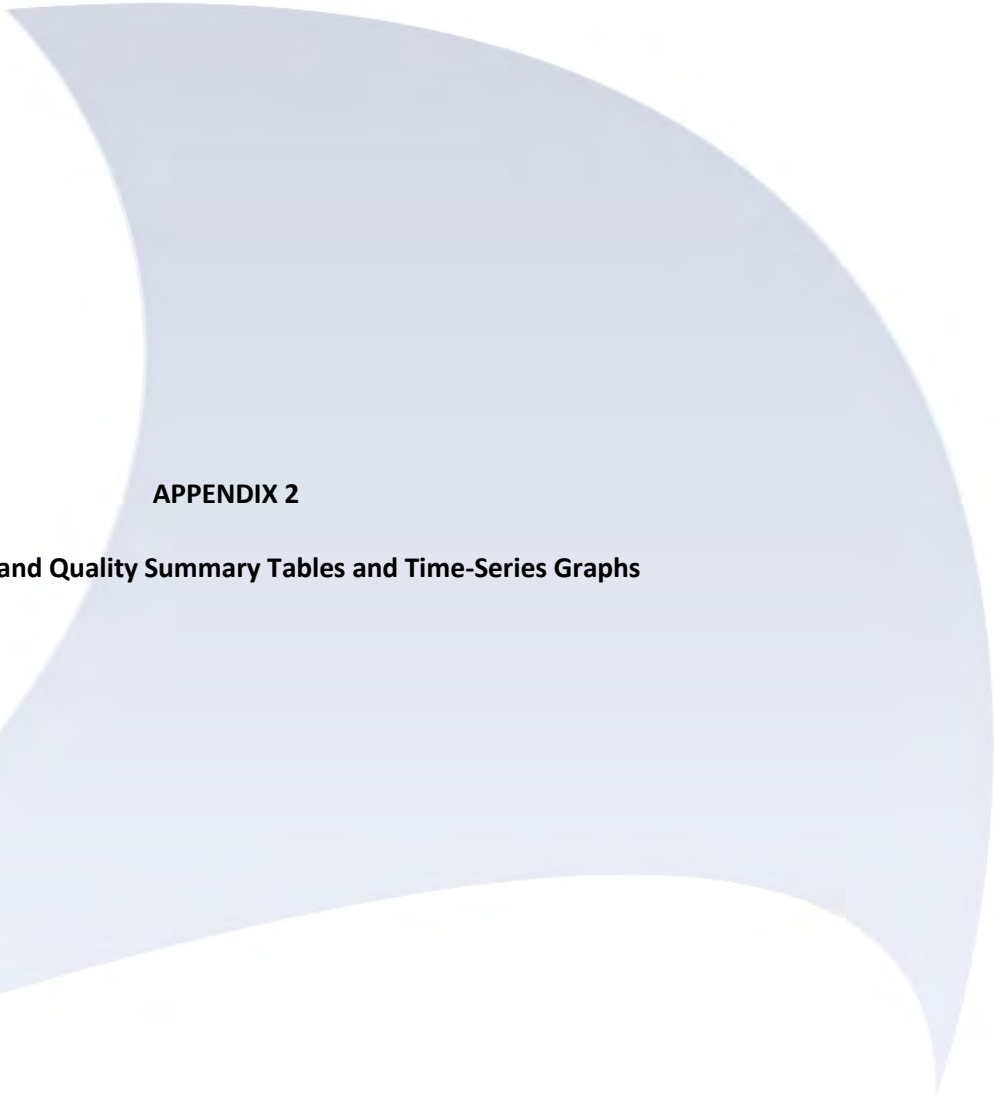
Barometric Pressure (kPa)	99.9
Ambient Temperature (°C)	6.3
Flowmeter Calibration Factor (f)	0.9844
Stack Oxygen Level (%)	n/a
Volume Sampled @ Reference Conditions	11.38

Primary Tube Reference Identification Number	7966571659
Security Tube Reference Identification Number	0
Blank Tube Reference Identification Numbers	0
Mass of Siloxane on Primary Tube (ug)	3240.3
Mass of Siloxane on Security Tube (ug)	5
Breakthrough (Reject if > 5%)	Accepted
Total Mass of Siloxane in Sample (ug)	3245.3

Siloxane Concentration (mg/m ³ @ STP and Ref O ₂)	285.08
--	--------

TABLE D(ii): Siloxane/Silicon Congener Breakdown

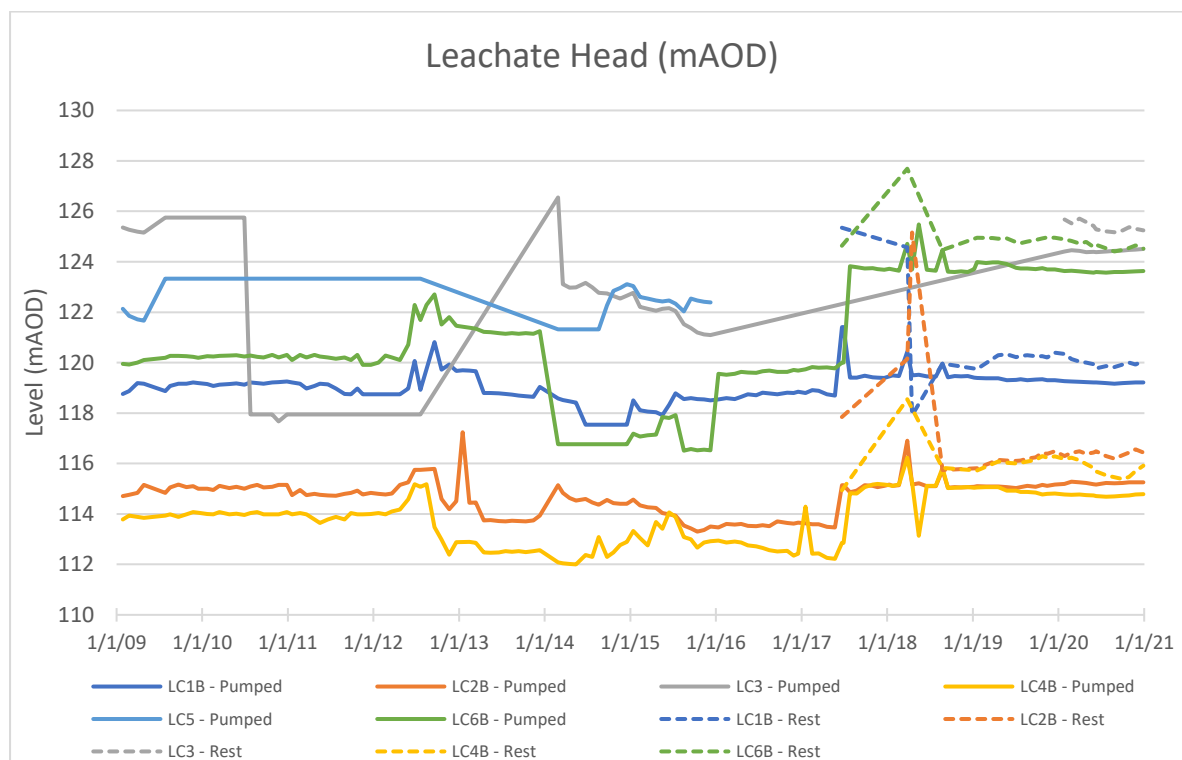
Siloxane	Siloxane Concentration (mg/m ³ @ STP)	Organic Silicon Concentration (mg/m ³ @ STP)
Decamethylcyclopentasiloxane	193.30	73.25
Decamethyltetrasiloxane	< 0.11	< 0.04
Hexamethylcyclotrisiloxane	0.14	0.05
Hexamethyldisiloxane	2.54	0.88
Octamethylcyclotetrasiloxane	85.25	32.30
Octamethyltrisiloxane	0.62	0.22
Dodecamethylcyclohexasiloxane	0.09	0.03
Dodecamethylpentasiloxane	< 3.03	< 1.11
Total Siloxane Concentration:	285.08	
Total Silicon Concentration:		107.89



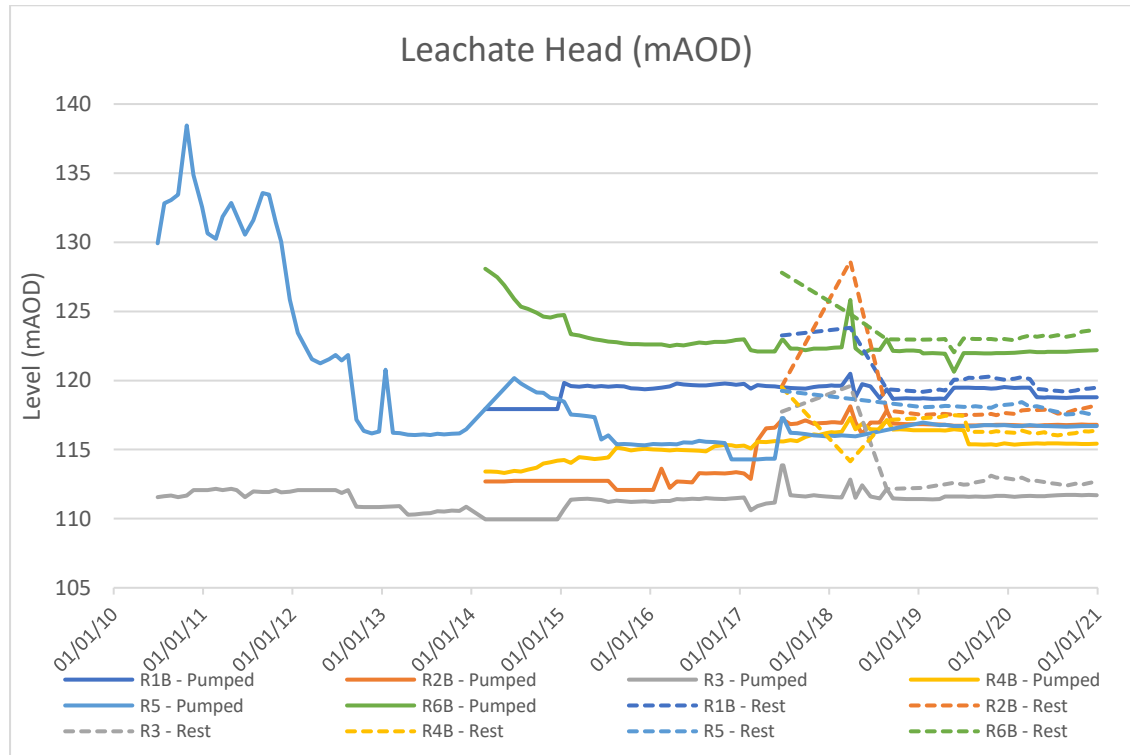
APPENDIX 2

Leachate Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 2 - LEACHATE

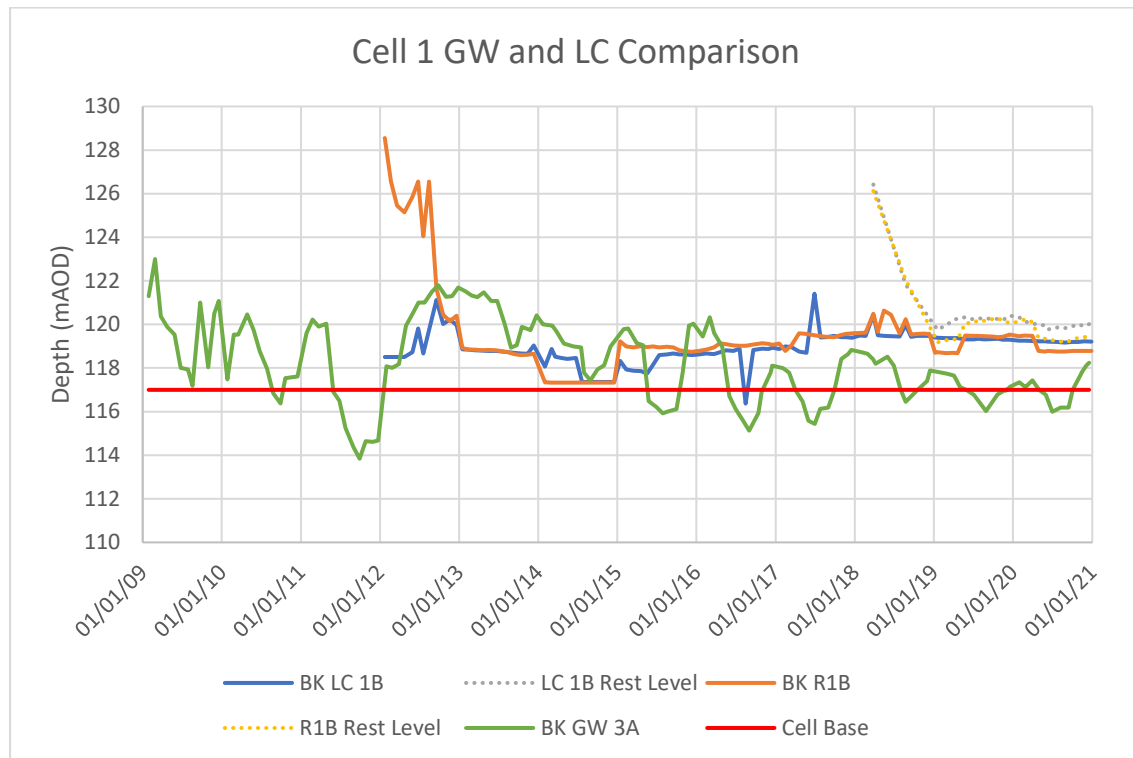


Graph 1: Leachate Levels as mAOD at LC Series Wells

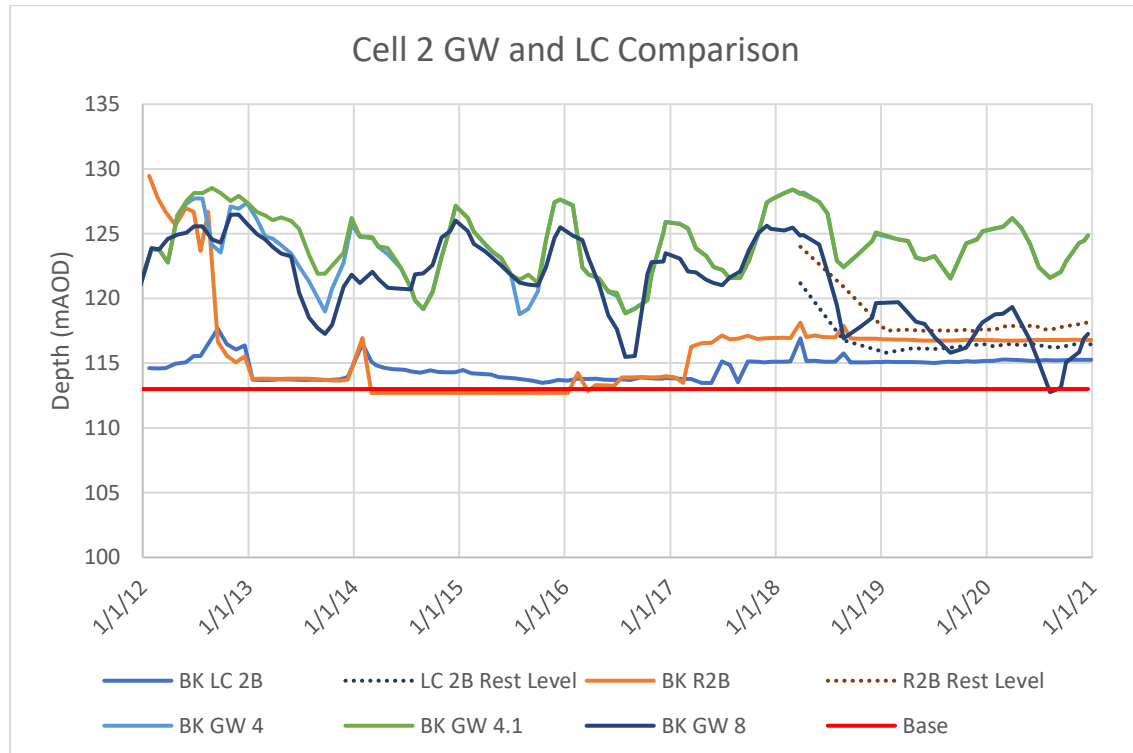


Graph 2: Leachate Levels as mAOD at Remote Leachate Monitoring Points

APPENDIX 2 - LEACHATE

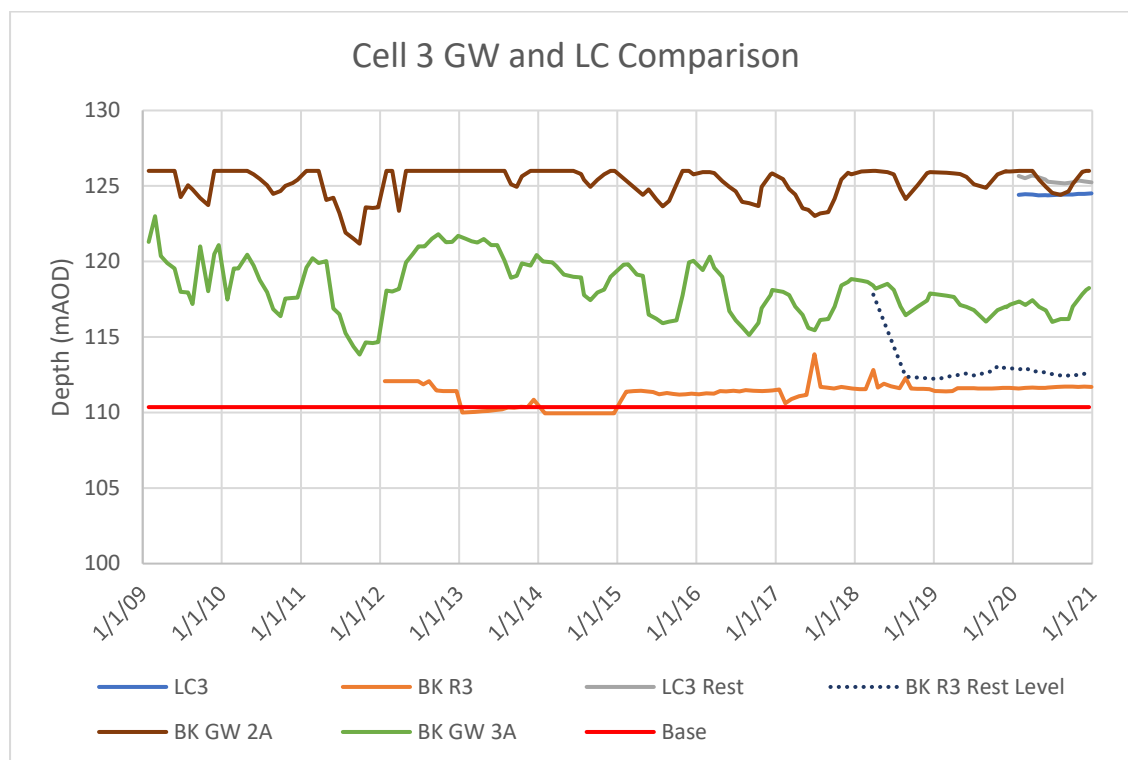


Graph 3: Groundwater and Leachate level comparison in Cell 1

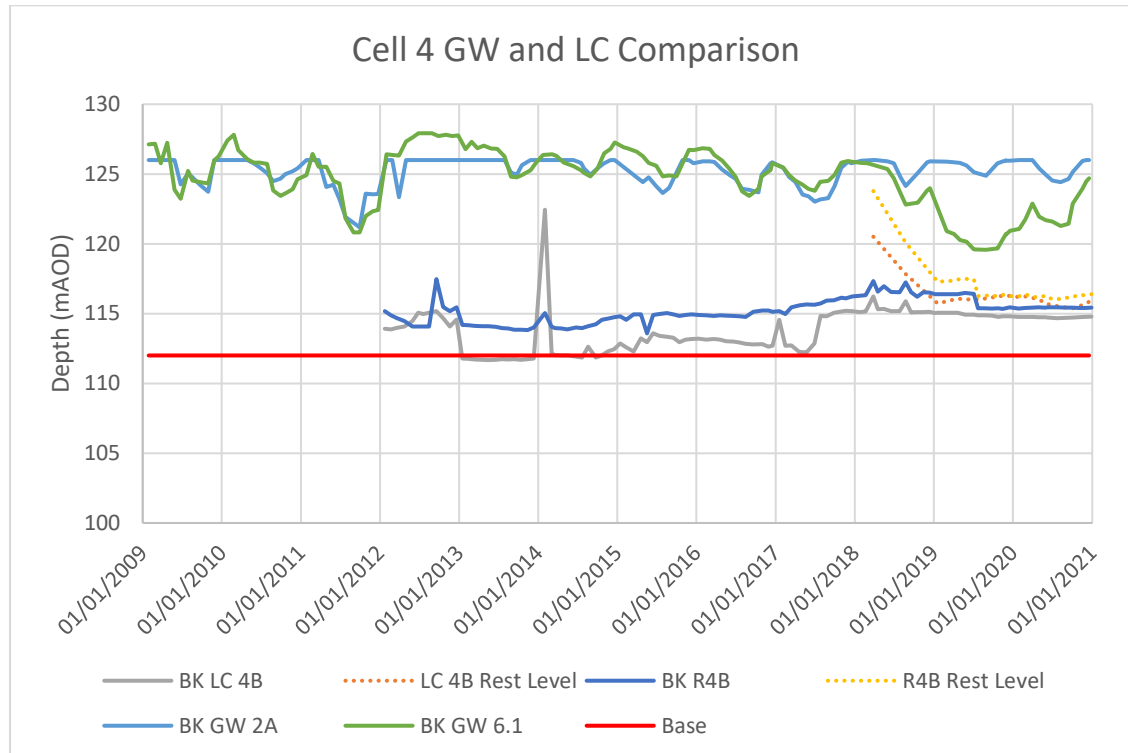


Graph 4: Groundwater and Leachate level comparison in Cell 2

APPENDIX 2 - LEACHATE

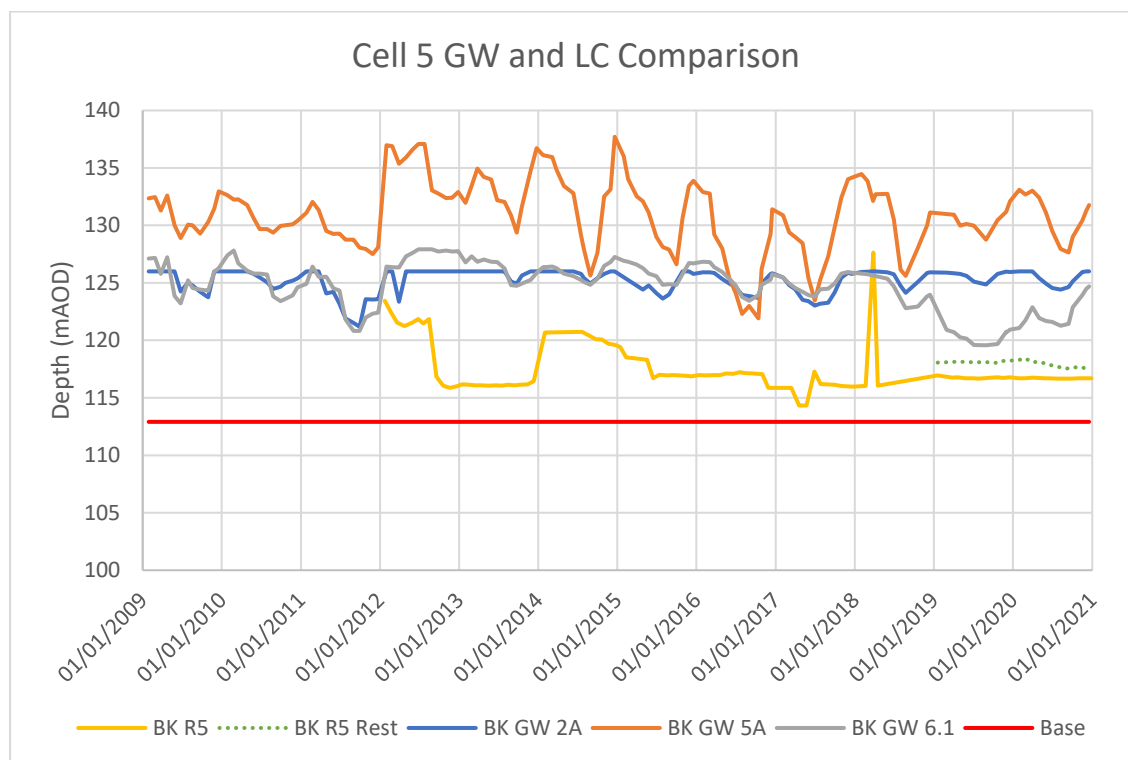


Graph 5: Groundwater and Leachate level comparison in Cell 3

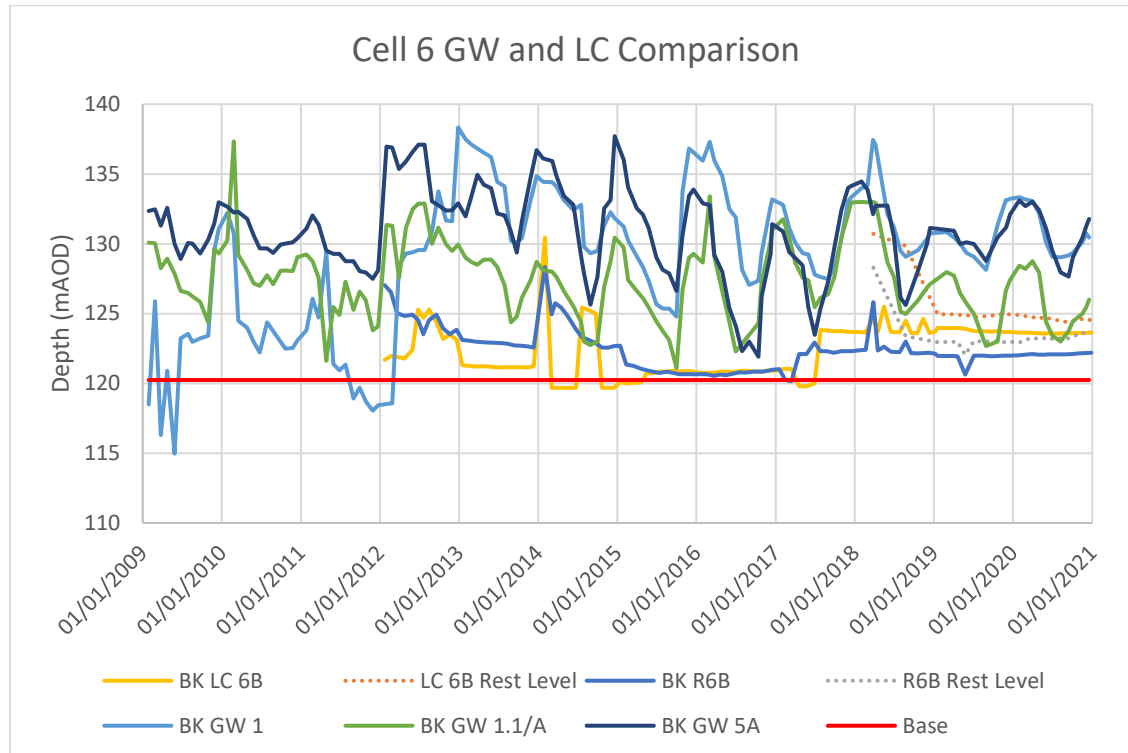


Graph 6: Groundwater and Leachate level comparison in Cell 4

APPENDIX 2 - LEACHATE

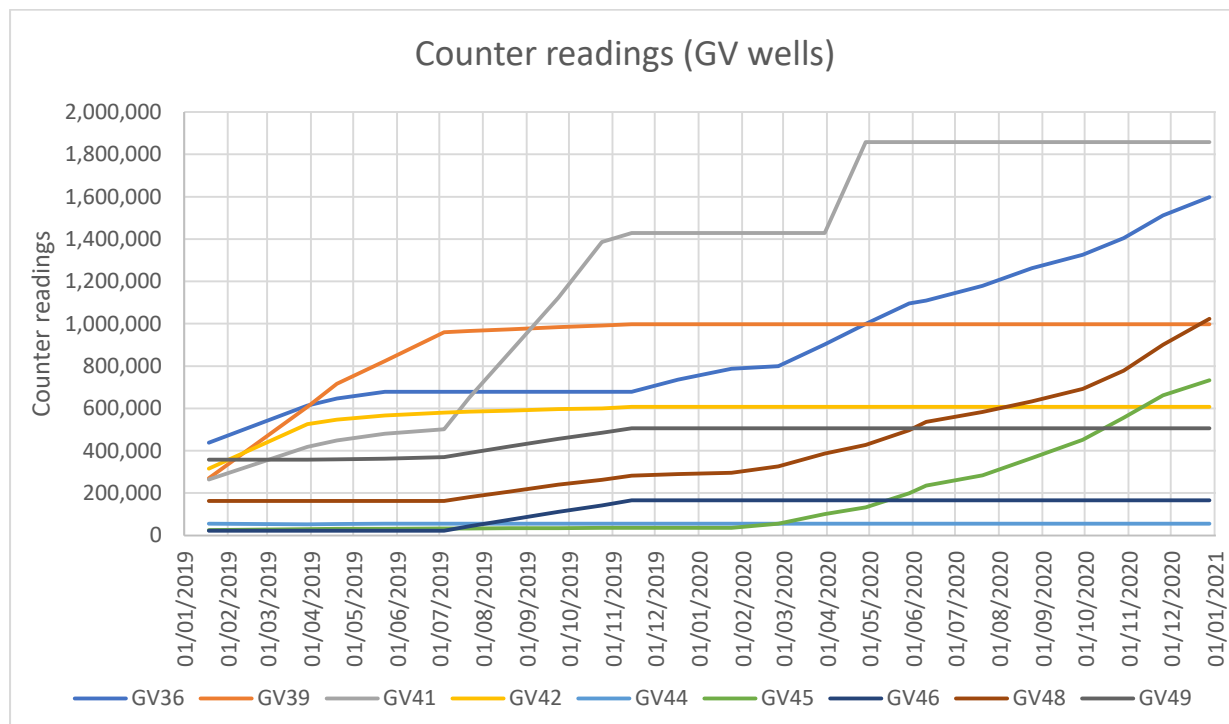


Graph 7: Groundwater and Leachate level comparison in Cell 5

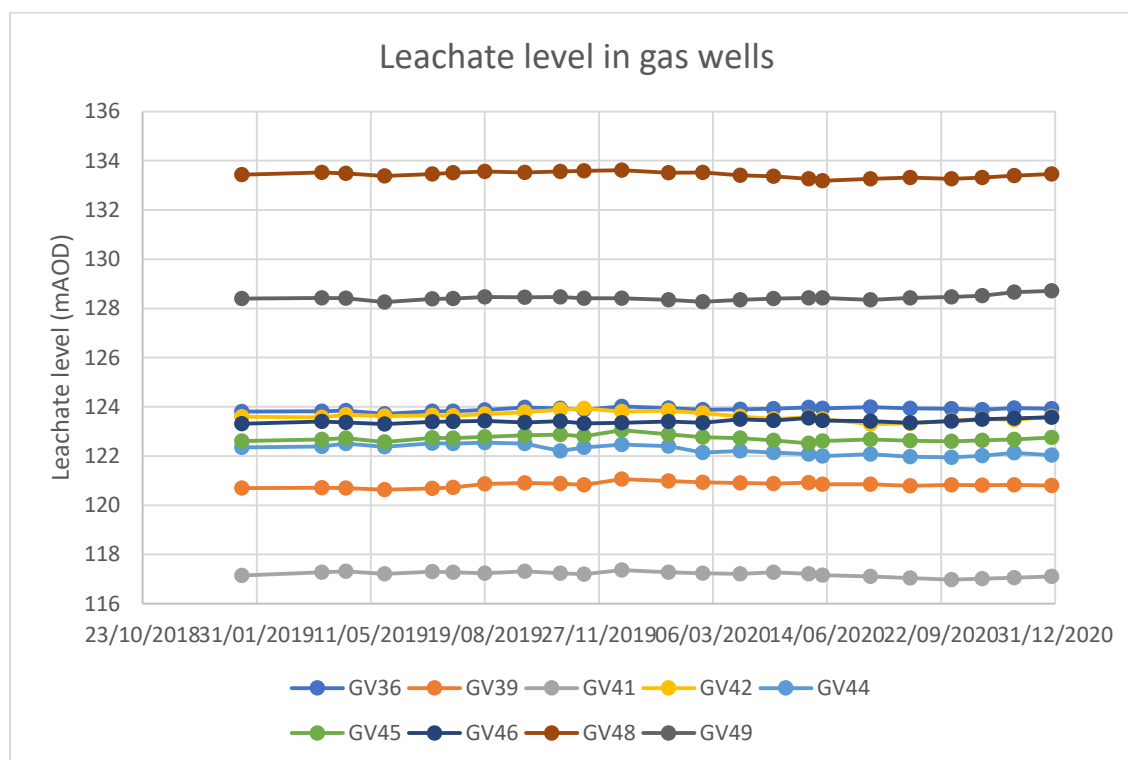


Graph 8: Groundwater and Leachate level comparison in Cell 6

APPENDIX 2 - LEACHATE



Graph 9: Pump Counter readings since commencement of the trial



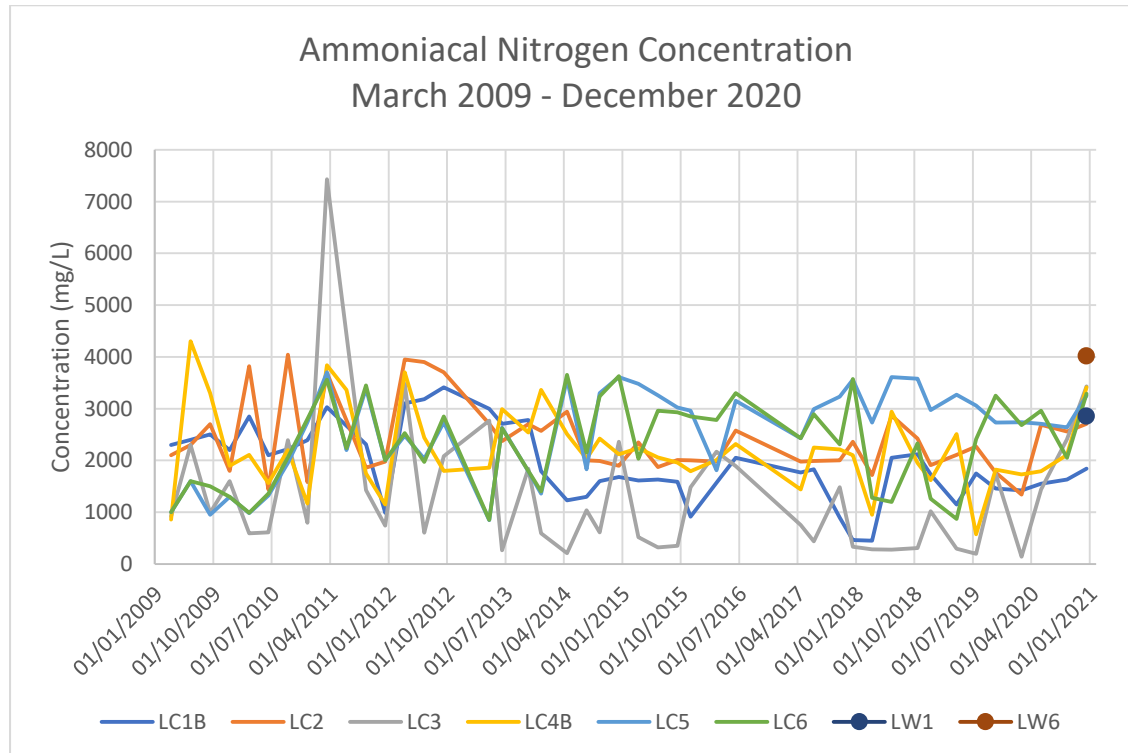
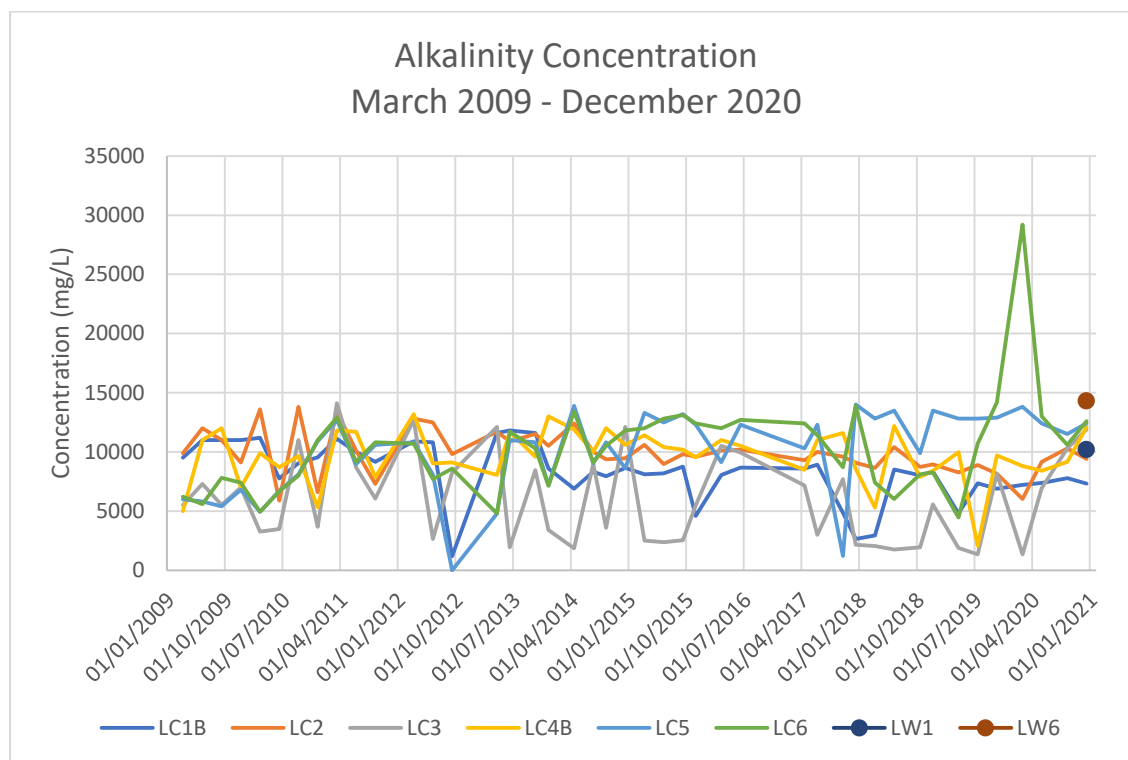
Graph 10: Leachate in GV wells at various stages throughout the trial

APPENDIX 2 - LEACHATE

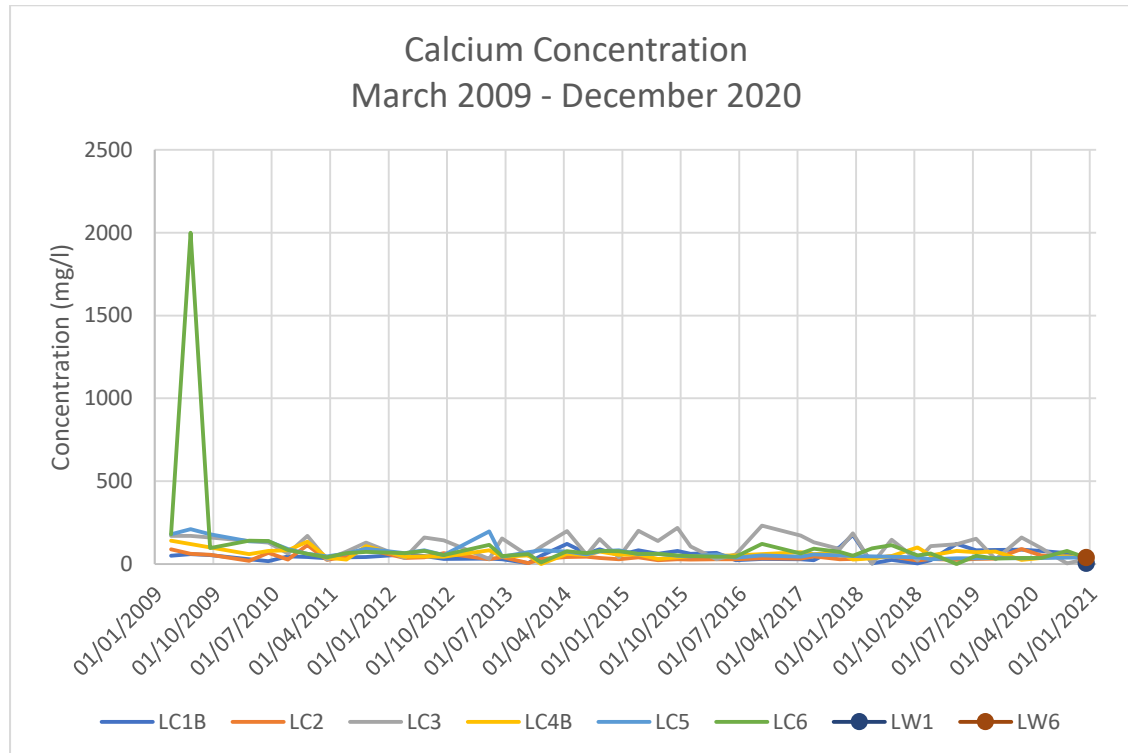
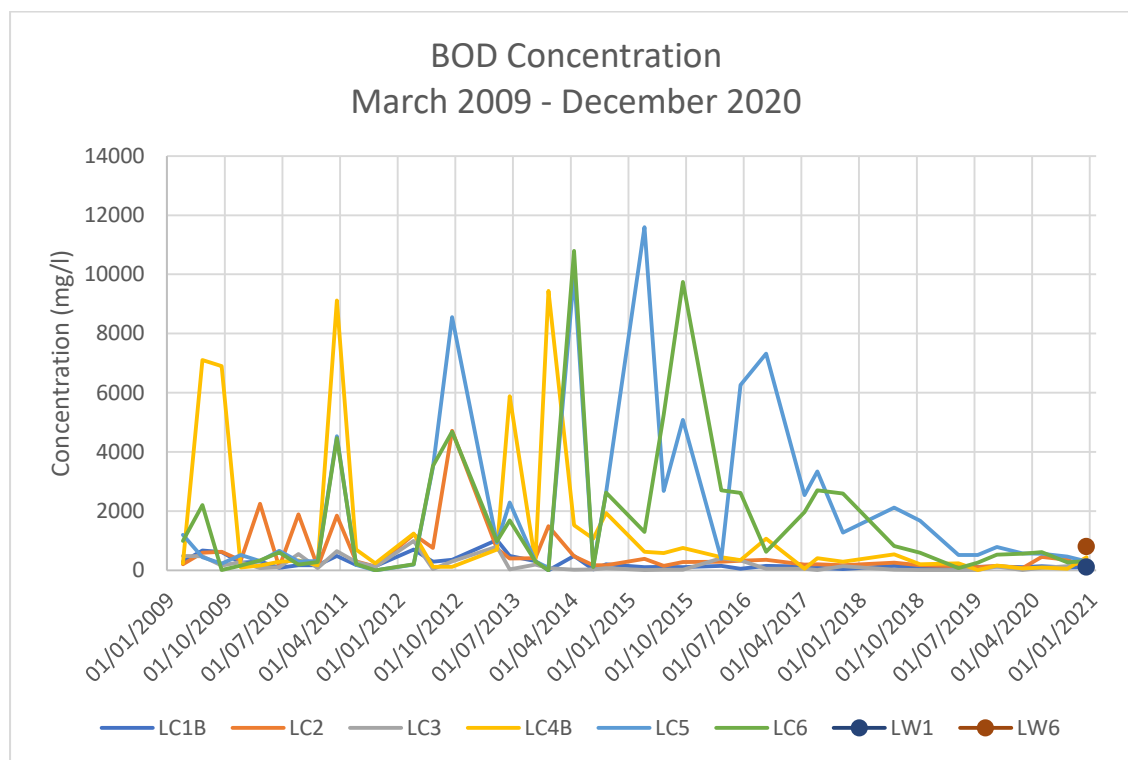
Table 2: Leachate Quality Summary - Quarterly Suite (all parameters are in mg/l)

	LC1B			LC2			LC3		
Sample Description	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity, Total as CaCO ₃	7200	7780	7417.5	6030	10300	8722.5	1330	11900	7620
Ammoniacal Nitrogen as N	1420	1840	1610	1340	2710	2325	139	3430	1854.75
BOD, Unfiltered	94.6	132	108.15	76.6	448	243.82	5.43	401	157.51
Calcium	18.3	87.1	62.5	39.1	90	56.32	3.63	159	72.58
Chloride	1830	2090	1952.5	1100	2690	2190	259	4560	2182.25
COD, unfiltered	1800	2170	2000	2180	4710	3462.5	129	4930	2572.25
Magnesium	24.1	113	83.9	51.7	101	75.28	38.7	116	63.32
Organic Carbon, Total	543	689	610.25	711	1620	1059.5	37.9	1600	797.22
pH	192	881	659.75	477	1020	814.5	97.3	875	631.08
Potassium	1560	1720	1645	798	3680	2037	213	2250	1413.25
Sodium	1.19	40	18.57	6.79	275	86.57	2	108	28.89
Sulphate	0.02	3	0.9	0.02	3	0.77	0.02	4.31	1.23
Total Oxidised Nitrogen as N	7.73	7.9	7.81	7.85	7.96	7.92	7.66	8.17	7.96
	LC4B			LC5			LC6		
Sample Description	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity, Total as CaCO ₃	11500	13800	12525	10600	29200	16350	10200	10200	10200
Ammoniacal Nitrogen as N	2640	3250	2835	2050	3290	2745	2860	2860	2860
BOD, Unfiltered	297	565	470	263	614	435.5	111	111	111
Calcium	33.8	40.6	37.3	36.1	78.5	46.72	4.58	4.58	4.58
Chloride	2640	3870	3282.5	3000	3970	3465	2330	2330	2330
COD, unfiltered	5480	6920	6135	3630	6710	5452.5	3110	3110	3110
Magnesium	65.8	78.4	70.42	64.3	75.4	68.7	34.3	34.3	34.3
Organic Carbon, Total	1350	2220	1855	1360	2140	1715	969	969	969
pH	8.09	8.28	8.19	8.01	8.55	8.27	8.04	8.04	8.04
Potassium	815	961	873.75	749	1060	883	1000	1000	1000
Sodium	2470	3200	2775	2360	2980	2637.5	1670	1670	1670
Sulphate	25.6	249	169.4	11.5	546	269.38	40	40	40
Total Oxidised Nitrogen as N	0.02	4.09	1.04	0.02	5.35	1.61	3.07	3.07	3.07

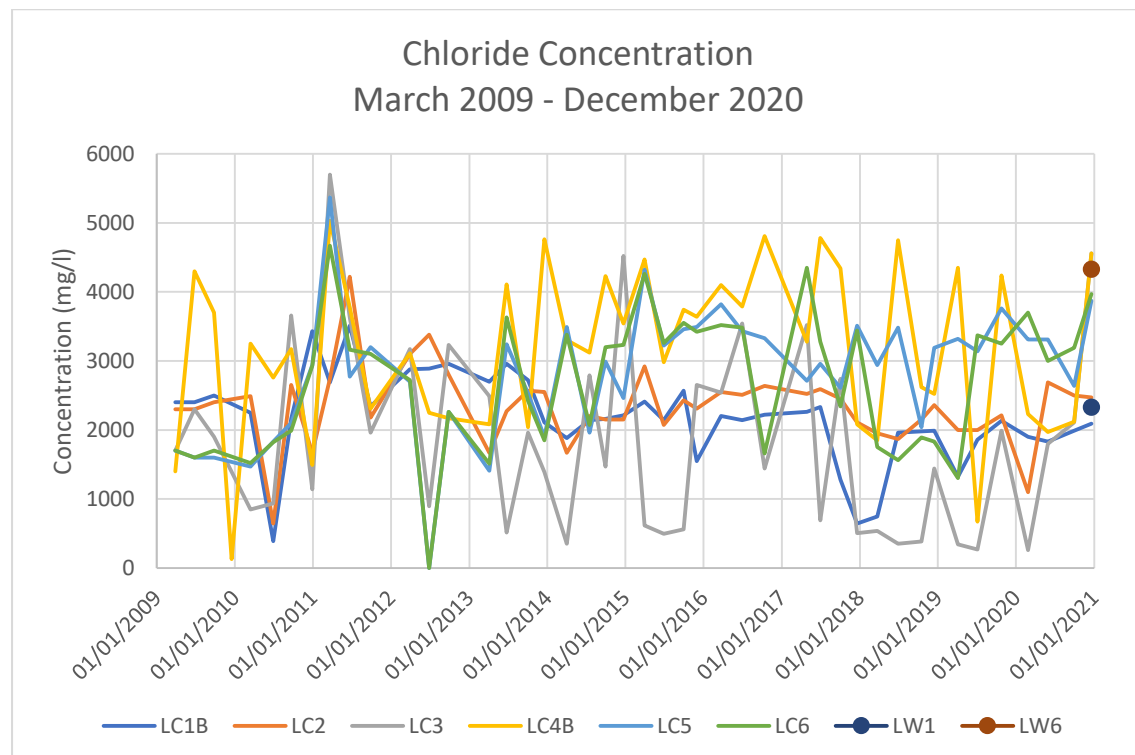
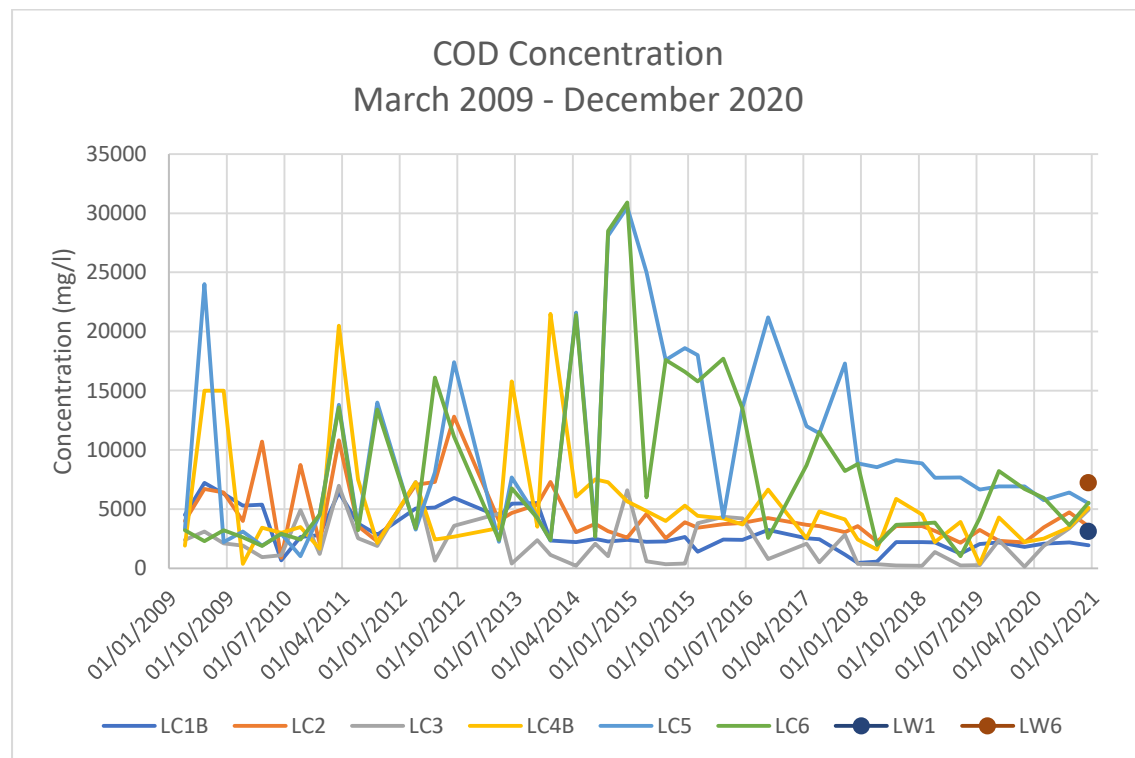
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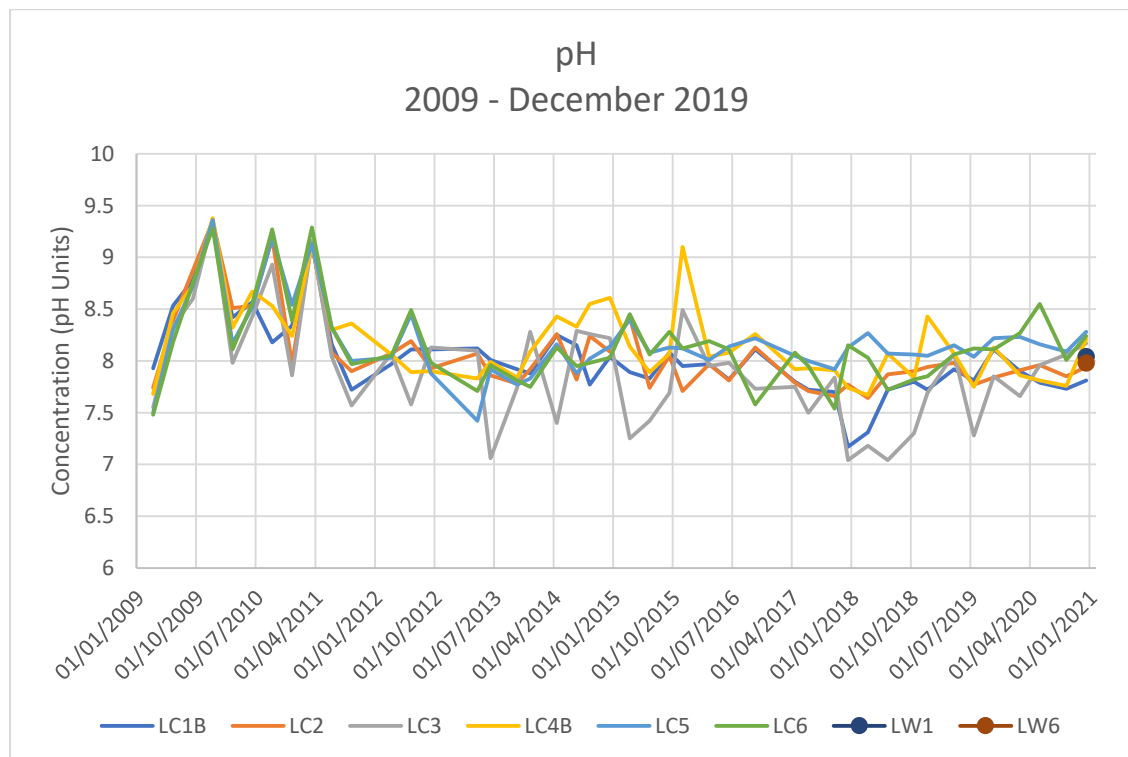
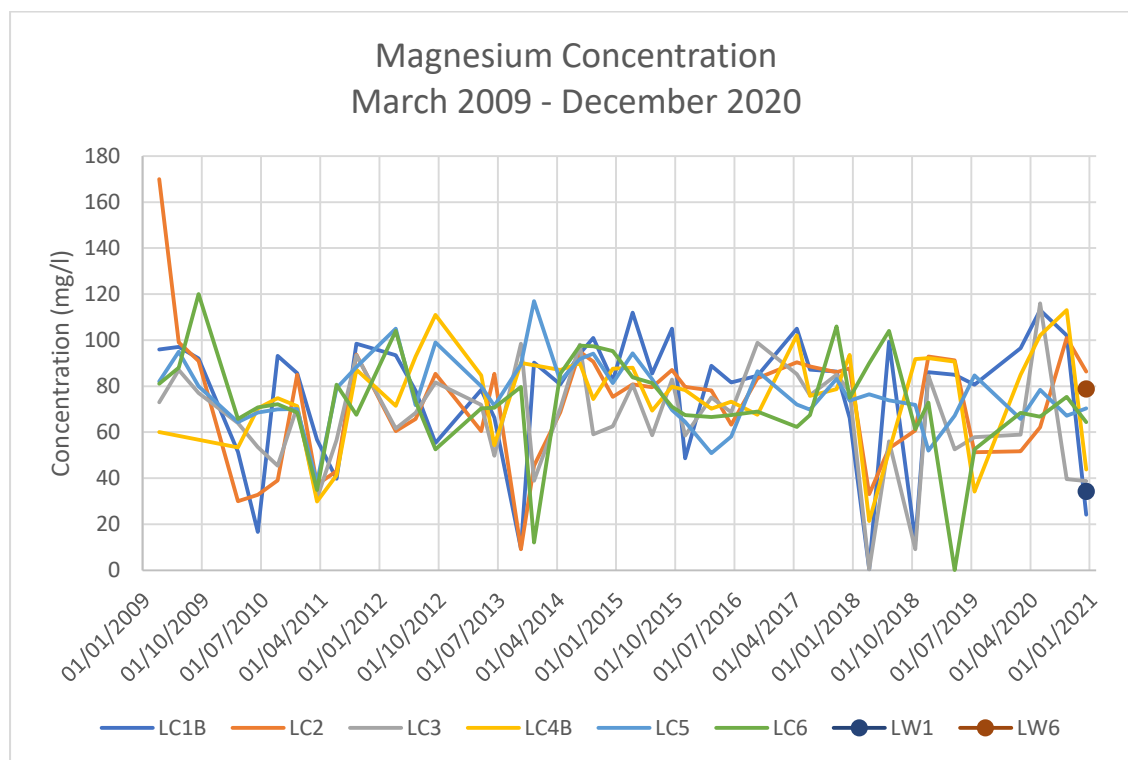
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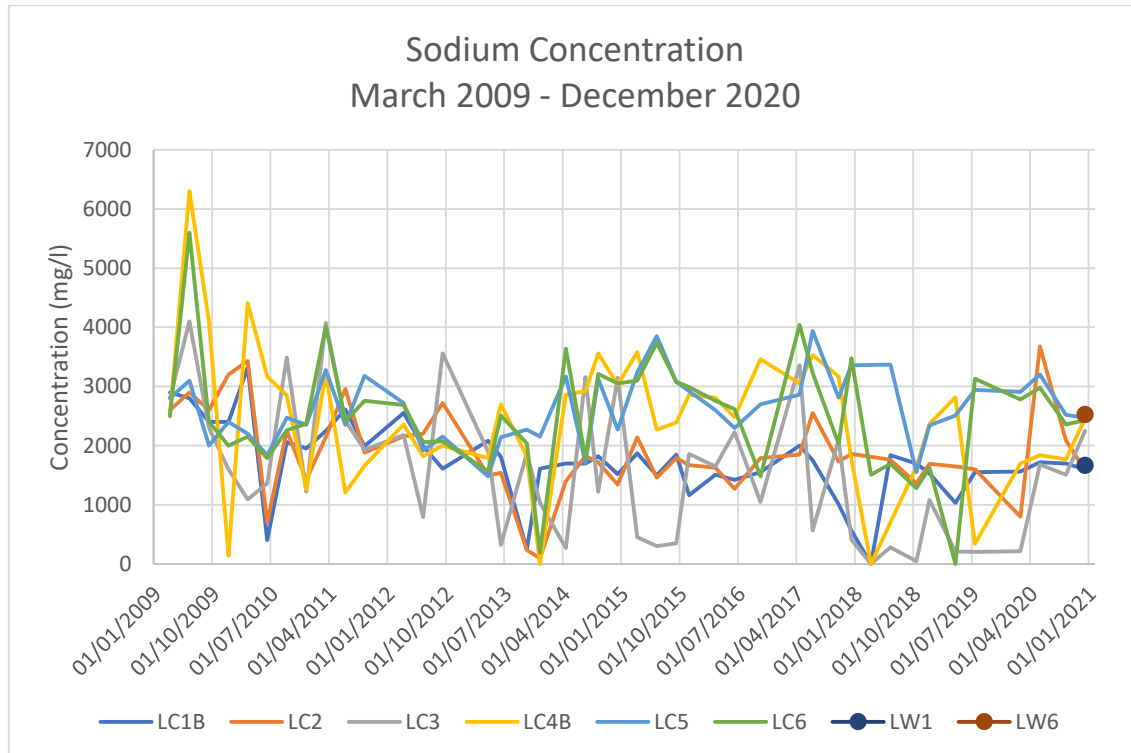
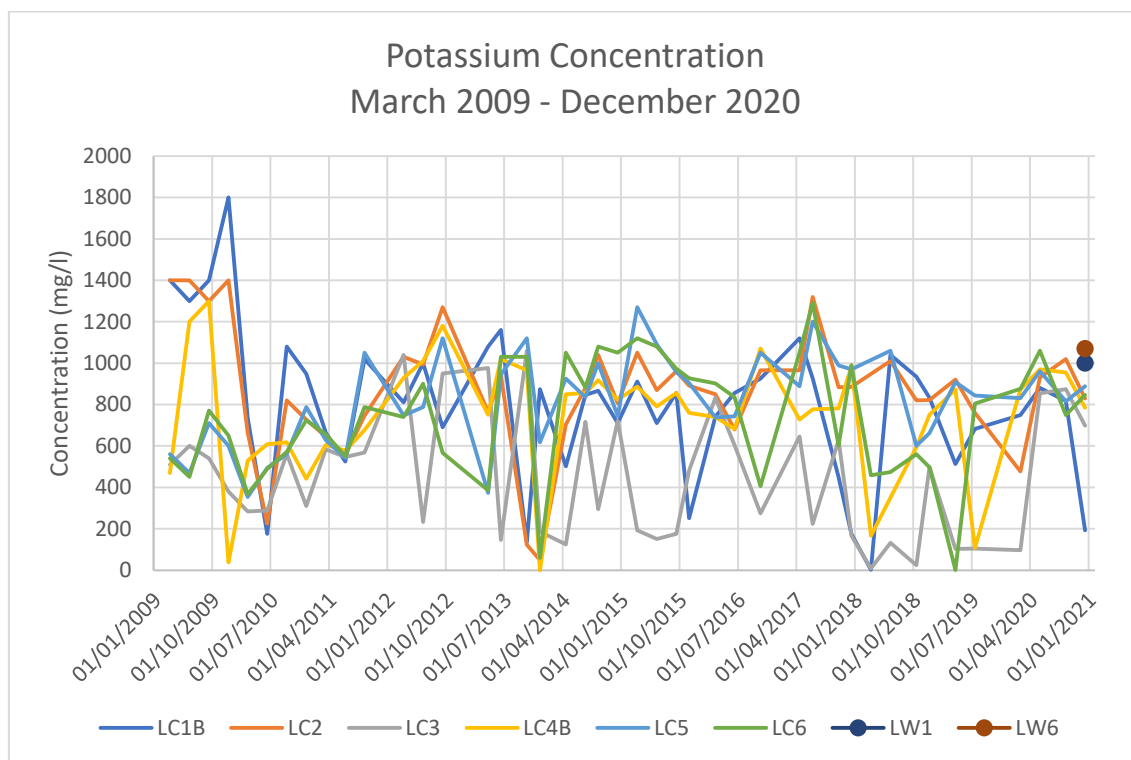
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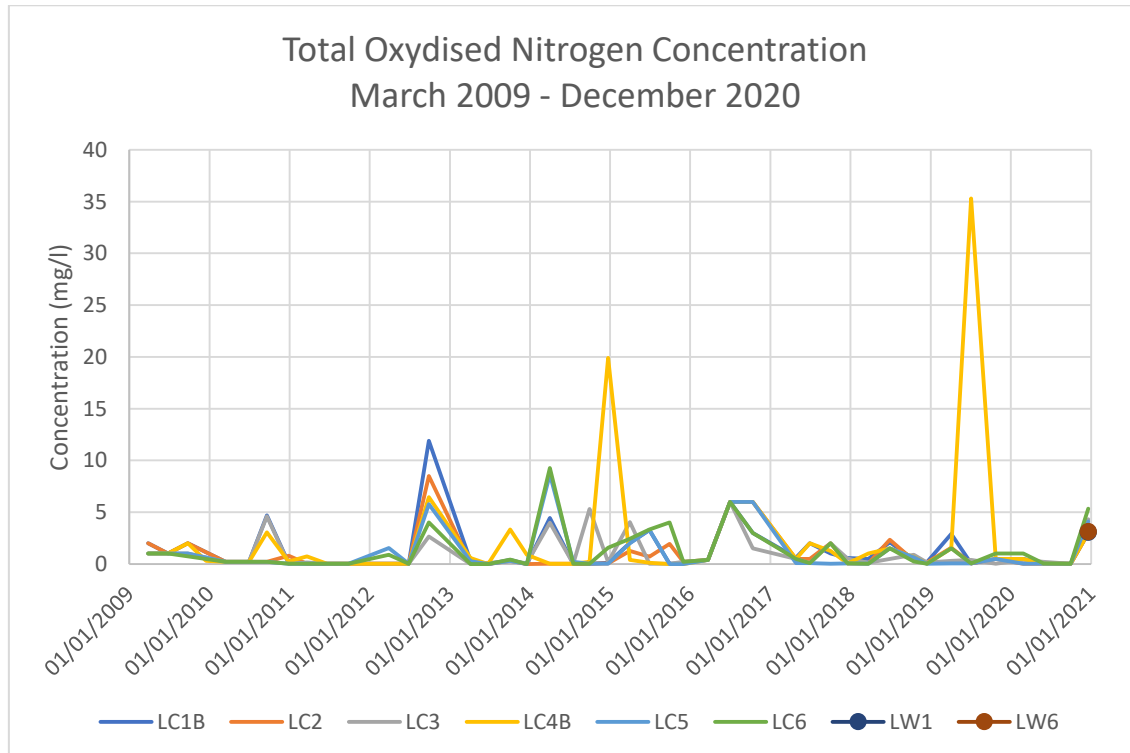
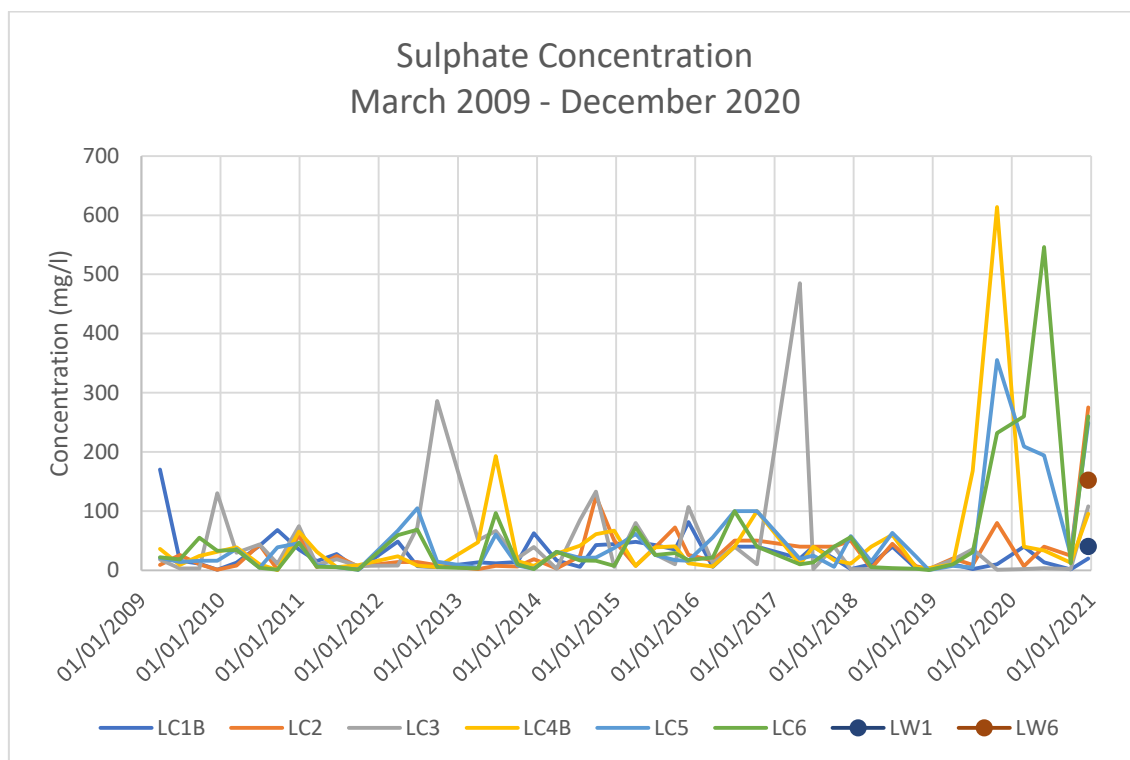
APPENDIX 2 – LEACHATE



APPENDIX 2 – LEACHATE



APPENDIX 2 – LEACHATE



APPENDIX 2 – LEACHATE

Table 3: Leachate Quality Summary - Annual Suite

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
Inorganics									
Cyanide, Free	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cyanide, Total	mg/l	<0.05	0.08	0.1	0.11	0.13	0.13	0.06	0.15
Filtered (Dissolved) Metals									
Cadmium (diss.filt)	mg/l	<0.00008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	0.000804
Chromium (diss.filt)	mg/l	0.0167	0.175	0.214	0.245	0.264	0.239	0.608	0.428
Copper (diss.filt)	mg/l	0.00199	0.00908	0.107	0.106	0.0153	0.0516	0.0404	0.231
Iron (Dis.Filt)	mg/l	1.48	12.4	5.5	6.38	6.2	5.4	8.06	17.8
Lead (diss.filt)	mg/l	0.000259	0.0043	0.00733	0.00829	0.00442	0.00535	0.00662	0.0361
Manganese (diss.filt)	mg/l	0.0467	0.259	0.108	0.123	0.22	0.197	0.0376	0.198
Mercury (diss.filt)	mg/l	0.000015	<0.00001	<0.00001	0.000014	0.000035	0.000021	<0.0001	<0.00001
Nickel (diss.filt)	mg/l	0.0711	0.405	0.197	0.23	0.357	0.362	0.439	0.678
Zinc (diss.filt)	mg/l	0.00733	0.131	0.217	0.248	0.174	0.211	0.103	1.42
Mineral Oil / Oils & Greases									
Mineral oil >C10 C40 (aq)	mg/l	0.312	0.525	3.92	2.99	0.489	0.483	0.755	1.54
Semi-Volatile Organic Compounds (SVOCs)									
1,2,4-Trichlorobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
1,2-Dichlorobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
1,3-Dichlorobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
1,4-Dichlorobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,4,5-Trichlorophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,4,6-Trichlorophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,4-Dichlorophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,4-Dimethylphenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,4-Dinitrotoluene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2,6-Dinitrotoluene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2-Chloronaphthalene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2-Chlorophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2-Methylnaphthalene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
2-Methylphenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	0.104
2-Nitroaniline (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05

APPENDIX 2 – LEACHATE

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
2-Nitrophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
3-Nitroaniline (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Bromophenylphenylether (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Chloro-3-methylphenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Chloroaniline (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Chlorophenylphenylether (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Methylphenol (aq)	mg/l	<0.02	<0.05	0.183	<0.1	<0.05	0.067	<0.1	0.851
4-Nitroaniline (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
4-Nitrophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Acenaphthene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Acenaphthylene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Anthracene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Azobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Benzo(a)anthracene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Benzo(a)pyrene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Benzo(b)fluoranthene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Benzo(g,h,i)perylene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Benzo(k)fluoranthene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
bis(2-Chloroethoxy)methane (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
bis(2-Chloroethyl)ether (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
bis(2-Ethylhexyl) phthalate (aq)	mg/l	<0.04	<0.1	<1	<1	0.118	0.117	<1	<0.1
Butylbenzyl phthalate (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Carbazole (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Chrysene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Dibenzo(a,h)anthracene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Dibenzofuran (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Diethyl phthalate (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Dimethyl phthalate (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Fluoranthene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Fluorene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Hexachlorobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Hexachlorobutadiene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Hexachlorocyclopentadiene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05

APPENDIX 2 – LEACHATE

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
Hexachloroethane (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Indeno(1,2,3-cd)pyrene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Isophorone (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Naphthalene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
n-Dibutyl phthalate (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
n-Dioctyl phthalate (aq)	mg/l	<0.1	<0.25	<0.5	<0.5	<0.25	<0.25	<0.5	<0.25
Nitrobenzene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
n-Nitroso-n-dipropylamine (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Pentachlorophenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Phenanthrene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Phenol (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	0.733
Pyrene (aq)	mg/l	<0.02	<0.05	<0.1	<0.1	<0.05	<0.05	<0.1	<0.05
Volatile Organic Compounds (VOCs)									
1,1,1,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1,2,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trimethylbenzene	mg/l	0.00732	0.00525	0.00945	0.0111	0.00455	0.00467	<0.001	0.00315
1,2-Dibromo-3-chloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromoethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene	mg/l	0.00206	0.00146	0.00233	0.00378	0.00105	<0.001	<0.001	<0.001
1,3-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 – LEACHATE

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
1,4-Dichlorobenzene	mg/l	0.00158	0.00102	0.00427	0.00434	0.00188	0.00196	<0.001	<0.001
2,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromofluorobenzene**	%	100	95.9	94.8	97.5	92	92.6	95.1	87.7
4-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-iso-Propyltoluene	mg/l	0.00202	<0.001	0.015	0.0132	0.00603	0.00659	0.00324	0.00261
Benzene	mg/l	0.00262	0.00128	0.00343	0.011	0.00282	0.00284	0.00207	0.00334
Bromobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromodichloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromoform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbon disulphide	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbontetrachloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	mg/l	0.00216	<0.001	<0.001	0.00974	<0.001	0.00195	<0.001	<0.001
Chloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	mg/l	<0.001	<0.001	0.0032	<0.001	0.00173	0.00172	<0.001	<0.001
cis-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromofluoromethane**	%	109	106	105	102	101	98.6	105	99.8
Dibromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorodifluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	mg/l	0.0126	0.00359	0.0119	0.0176	<0.001	0.0041	0.00467	0.0119
Hexachlorobutadiene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene	mg/l	<0.001	<0.001	<0.001	0.00105	<0.001	<0.001	<0.001	<0.001
m,p-Xylene	mg/l	0.0208	0.0212	0.0219	0.0237	0.0151	0.0164	0.00527	0.0207
Methyl tertiary butyl ether (MTBE)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene	mg/l	0.00359	0.00347	0.0171	0.0554	0.00885	0.00594	<0.001	<0.001
n-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
o-Xylene	mg/l	0.00861	0.00879	0.00984	0.0128	0.00713	0.00707	0.00186	0.00784

APPENDIX 2 – LEACHATE

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
Propylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
sec-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Styrene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Amyl methyl ether (TAME)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/l	0.0013	0.00366	0.0318	0.0143	0.00816	0.0147	0.00455	0.0204
Toluene-d8**	%	102	102	101	102	101	101	102	99.7
trans-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Combined Pesticides / Herbicides									
Aldrin	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
alpha-HCH	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Atrazine	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Azinphos ethyl	mg/l	<0.0001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0002
Azinphos methyl	mg/l	<0.0001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0002
beta-HCH	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Carbophenothion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Chlorfenvinphos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Chlorothalonil	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chlorpyrifos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Chlorpyrifos-methyl	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
cis-Chlordane	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Diazinon	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Dichlorvos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Dieldrin	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Dimethoate	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Disulfoton	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Endosulphan I	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Endosulphan II	mg/l	<0.0001	<0.0001	<0.00002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

APPENDIX 2 – LEACHATE

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
Endosulphan Sulphate	mg/l	<0.0003	<0.0003	<0.00002	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Endrin	mg/l	<0.0001	<0.0001	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ethion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Etrimphos	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fenitrothion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Fenthion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
gamma-HCH (Lindane)	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Heptachlor	mg/l	<0.0001	<0.0001	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Heptachlor epoxide	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Hexachlorobenzene	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Isodrin	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Malathion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Methyl Parathion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Mevinphos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
o,p'-DDD (TDE)	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
o,p'-DDE	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
o,p'-DDT	mg/l	<0.00015	<0.00015	<0.00001	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
p,p'-DDD (TDE)	mg/l	<0.0001	<0.0001	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
p,p'-DDE	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
p,p'-DDT	mg/l	<0.0002	<0.0002	<0.00001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
p,p'-Methoxychlor	mg/l	<0.0002	<0.0002	<0.00001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Parathion	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Pendimethalin	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Permethrin I	mg/l	<0.0001	<0.0001	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Permethrin II	mg/l	<0.0001	<0.0001	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Phosalone	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Pirimiphos-methyl	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Propetamphos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Quintozene (PCNB)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Simazine	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Tecnazene	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Telodrin	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
trans-Chlordane	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005

APPENDIX 2 – LEACHATE

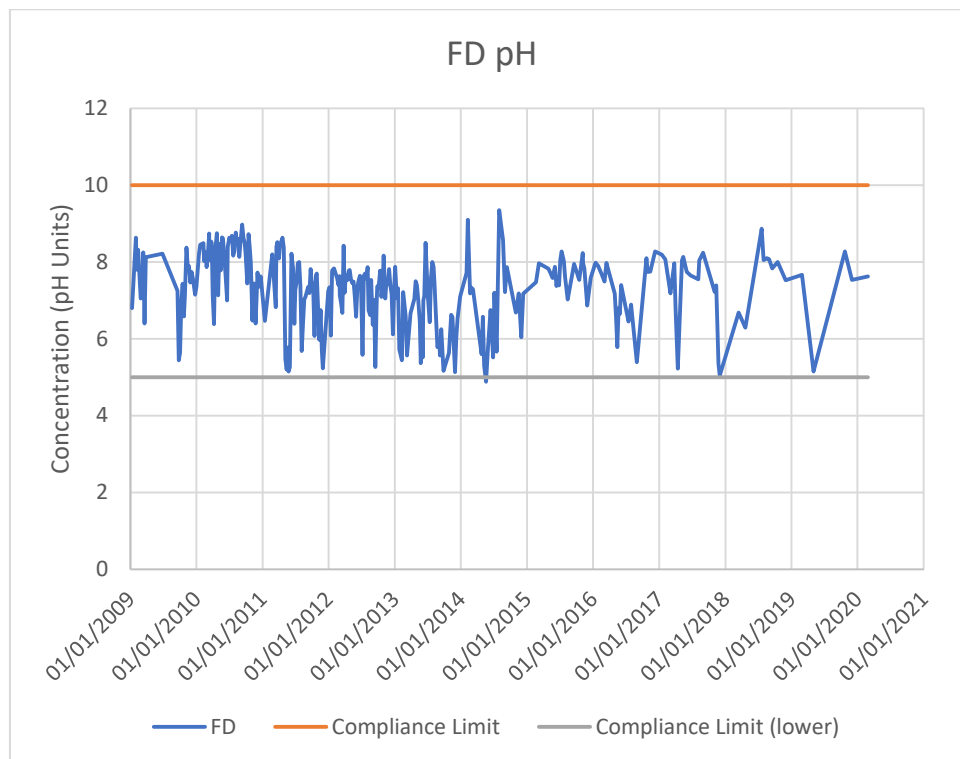
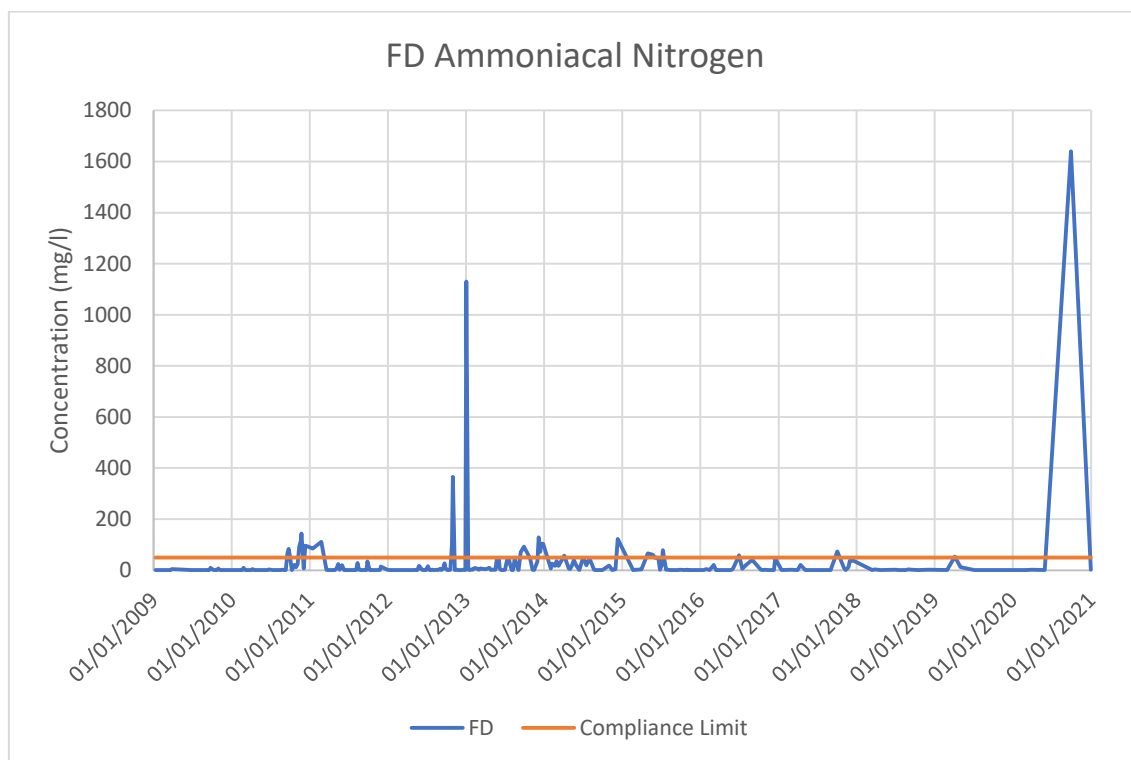
Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6	LW1	LW6
Date Sampled		18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020	18/12/2020
Triadimefon	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Triallate	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Triazophos	mg/l	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001
Trifluralin	mg/l	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Miscellaneous Organics									
Dibutyl tin	mg/l	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Surrogate	%	75.3	65	63.1	80.7	84.4	64.7	52.7	95.5
Tetrabutyl tin	mg/l	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Tributyl tin	mg/l	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006
Triphenyl tin	mg/l	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006

APPENDIX 2 - LEACHATE

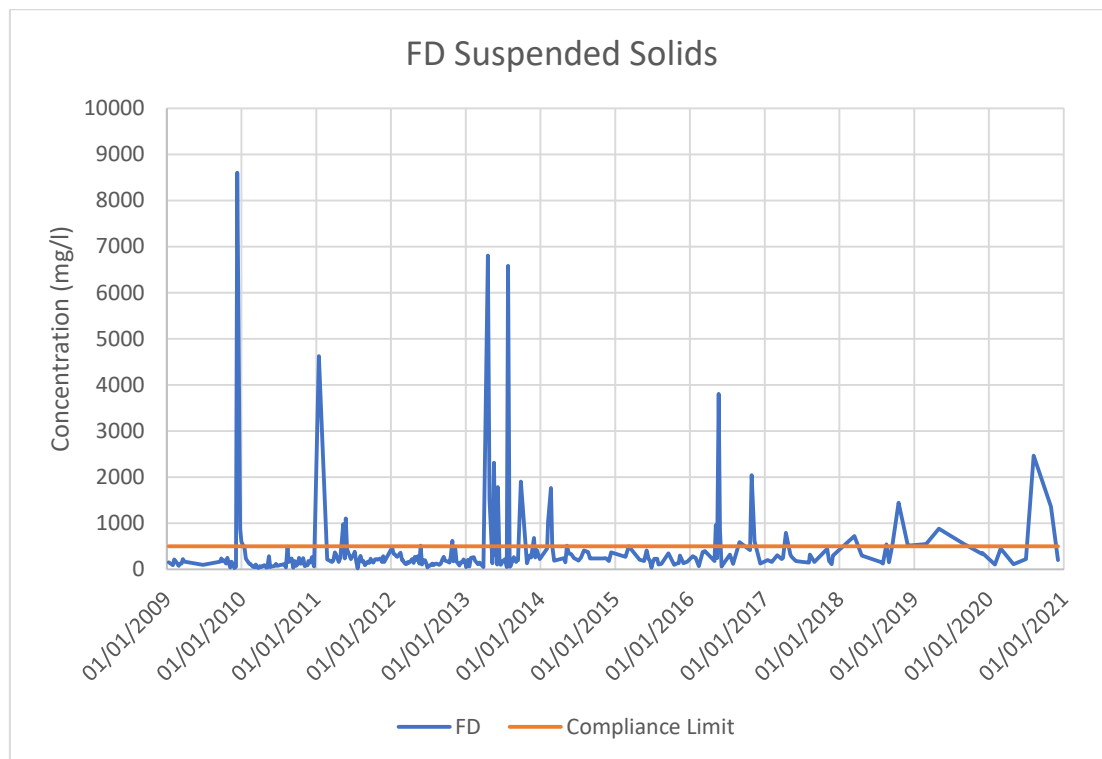
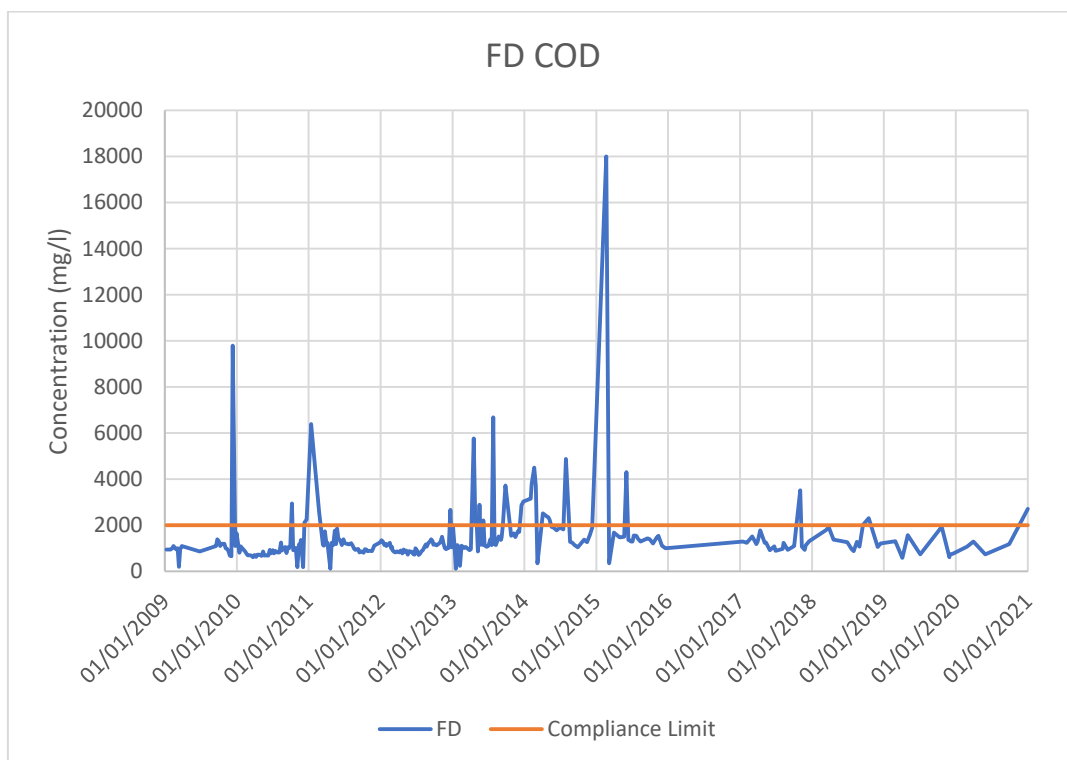
Table 4: Final Discharge Quality Summary

Parameter	Units	Compliance Limit	Min	Max	Average	Count
Alkalinity, Total as CaCO ₃	mg/L		263	830	554	5
Ammoniacal Nitrogen as N	mg/L	50	0.31	1640	328.982	5
BOD, unfiltered	mg/L		7.65	37.4	21.87	5
Chloride	mg/L		1270	3190	2354	5
Chromium	mg/L	2	0.0248	0.0606	0.0406	4
COD, unfiltered	mg/L	2000	747	2710	1403.4	5
Copper	mg/L	2	0.0316	0.0475	0.04122	4
Iron	mg/L		2.57	89.4	29.03	4
Lead	mg/L	2	0.00142	0.00603	0.002912	4
Nickel	mg/L	2	0.112	0.176	0.147	4
Nitrate as N	mg/L		634	634	634	1
Nitrite as N	mg/L		0.0374	108	21.80468	5
Nitrogen, Kjeldahl	mg/L		18.7	245	70.18	7
Nitrogen, Total	mg/L		616	616	616	1
Non Volatile Suspended Solids	mg/L		31.5	960	339.7	6
Organic Carbon, Total	mg/L		154	209	184.8	4
pH	pH Units	>5<10	7.62	7.62	7.62	1
Phosphate (Ortho as PO ₄)	mg/L		7.01	18.5	11.793	7
Sodium	mg/L		1560	2720	2245	4
Sulphate	mg/L		13.4	117	82.55	4
Suspended solids, Total	mg/L	500	98	2460	699.4	8
Total Organic Carbon, as C*	mg/L		206	206	206	1
Total Oxidised Nitrogen as N	mg/L		0.1	705	518.02	7
TPH / Oil & Greases	mg/L		2	24.3	11.6	4
Volatile Suspended Solids	mg/L		129	129	129	1
Zinc	mg/L	2	0.0646	0.194	0.1143	4

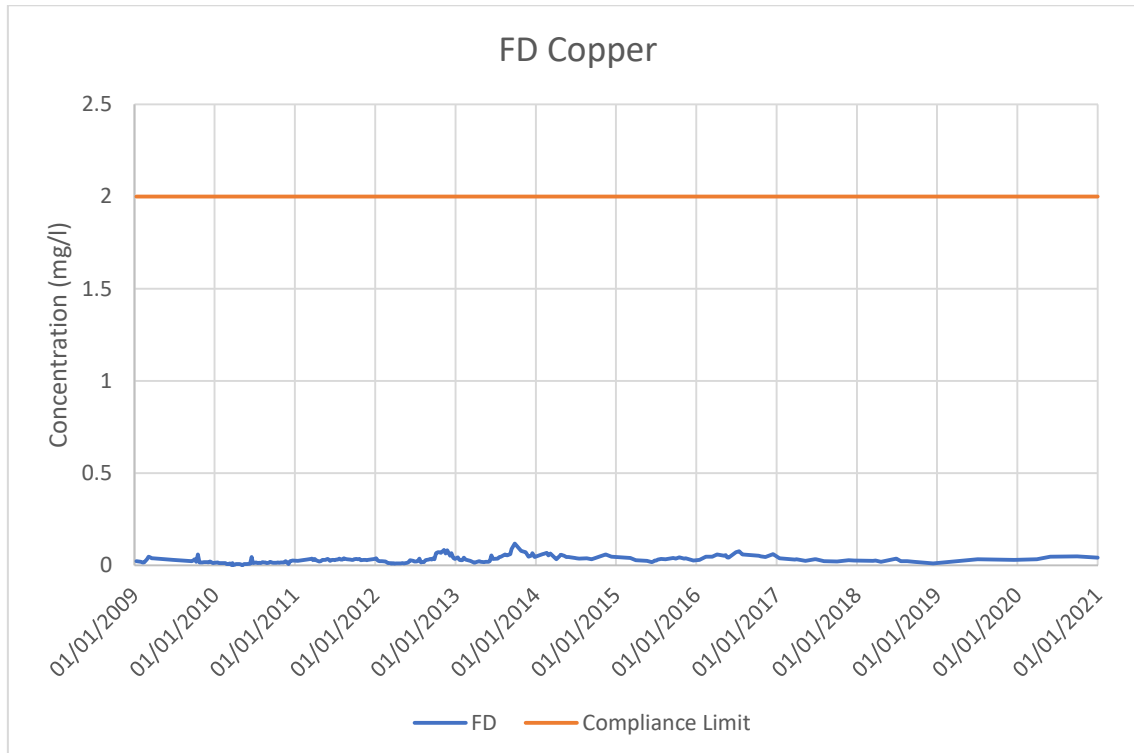
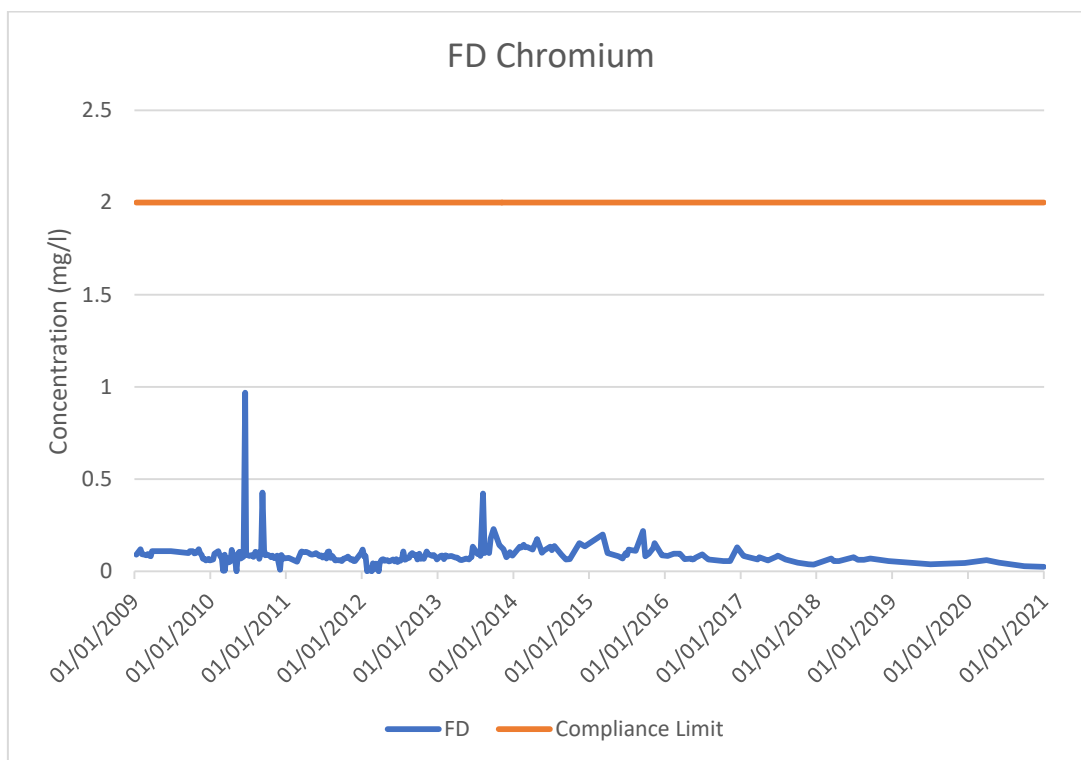
APPENDIX 2 - LEACHATE



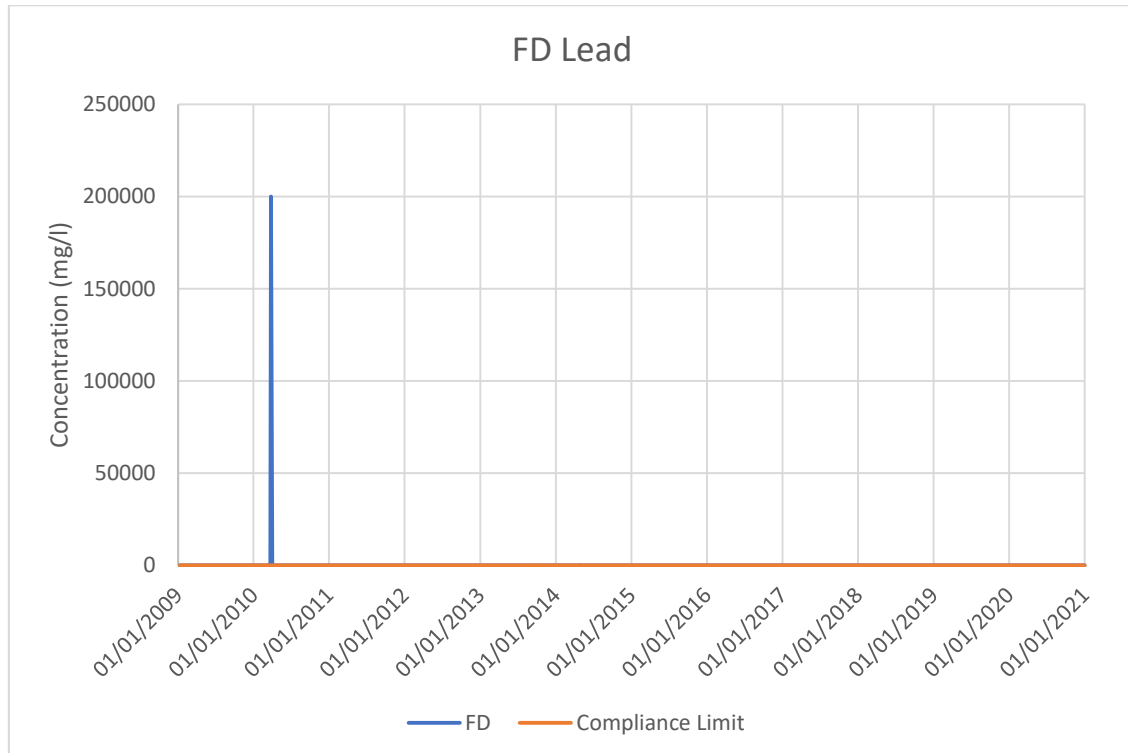
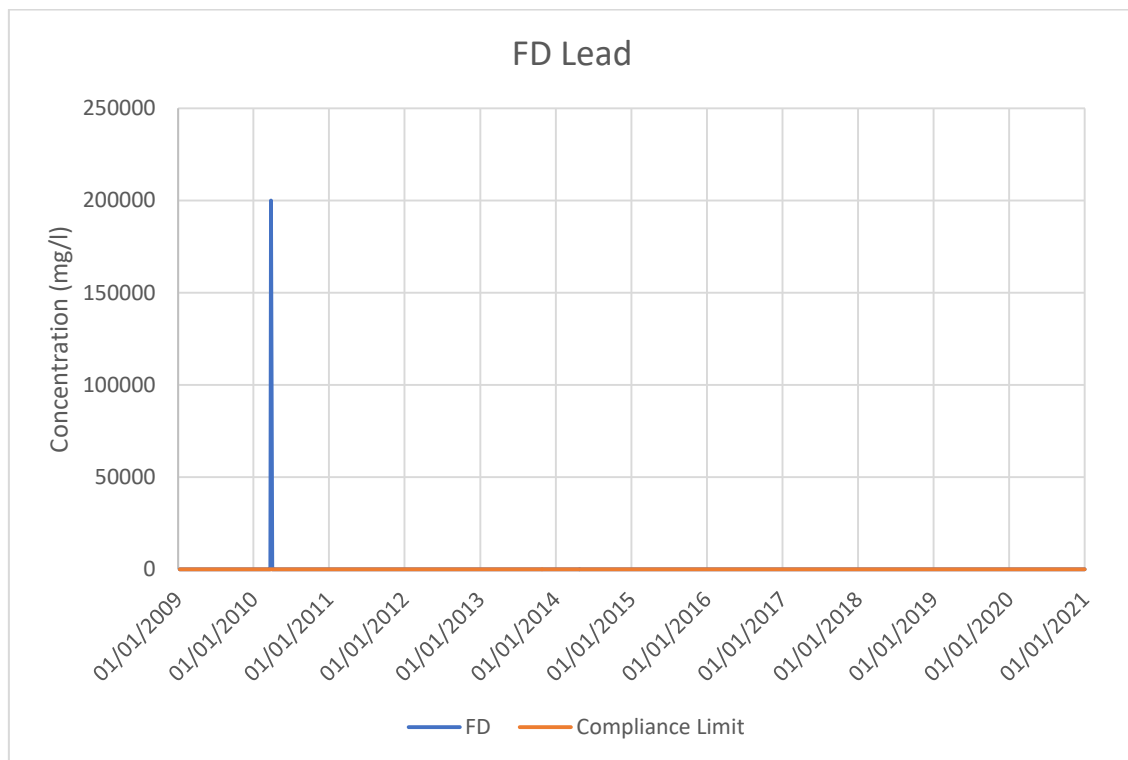
APPENDIX 2 - LEACHATE



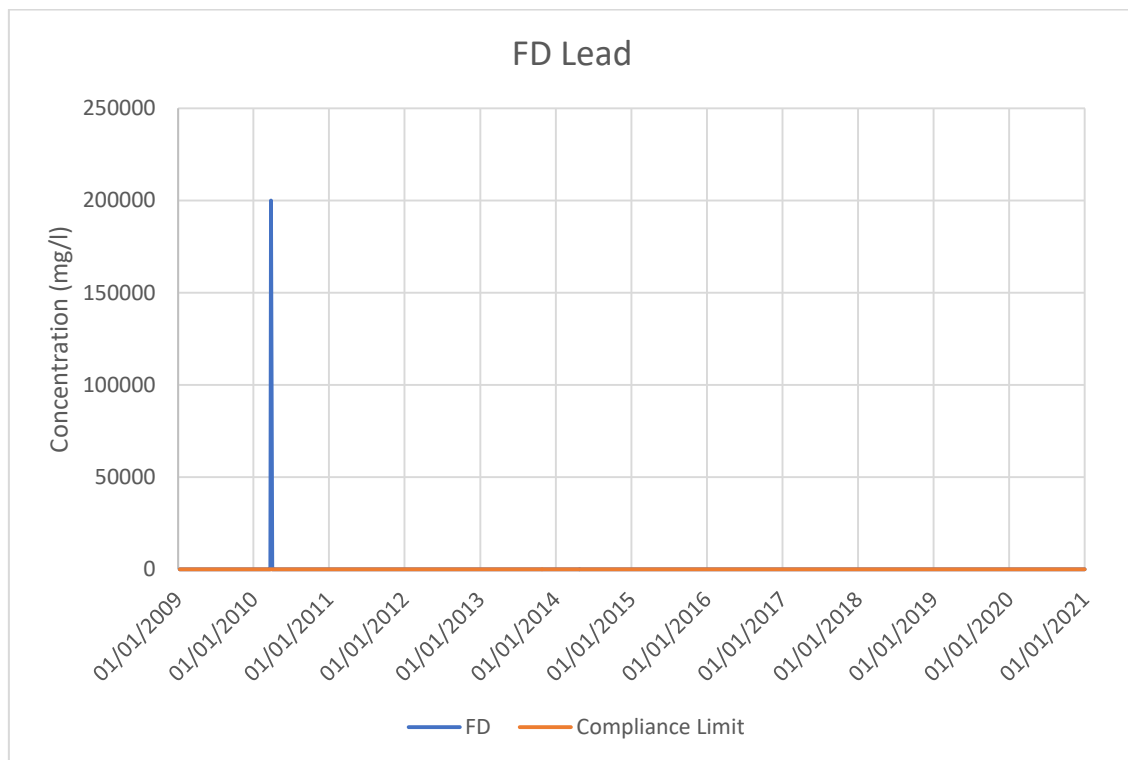
APPENDIX 2 - LEACHATE

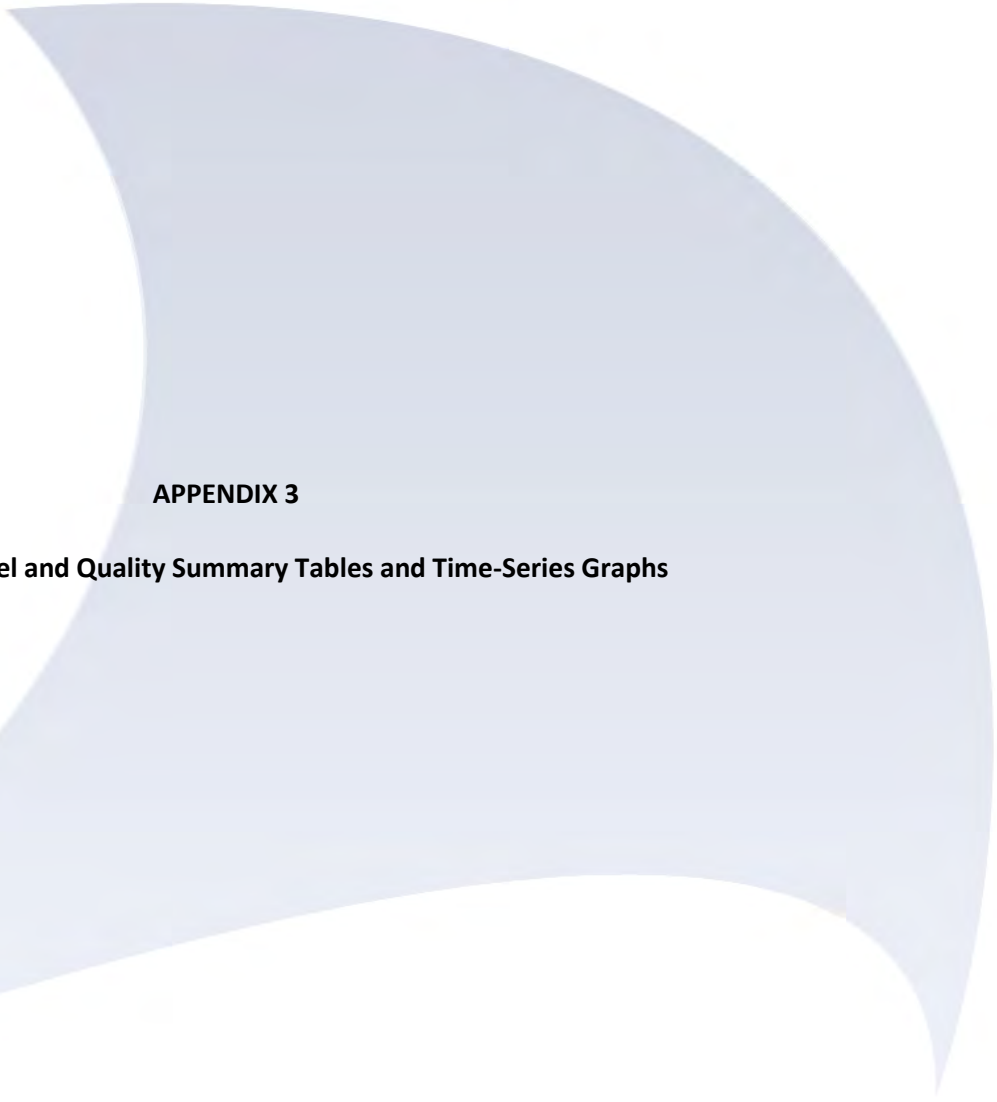


APPENDIX 2 - LEACHATE



APPENDIX 2 - LEACHATE

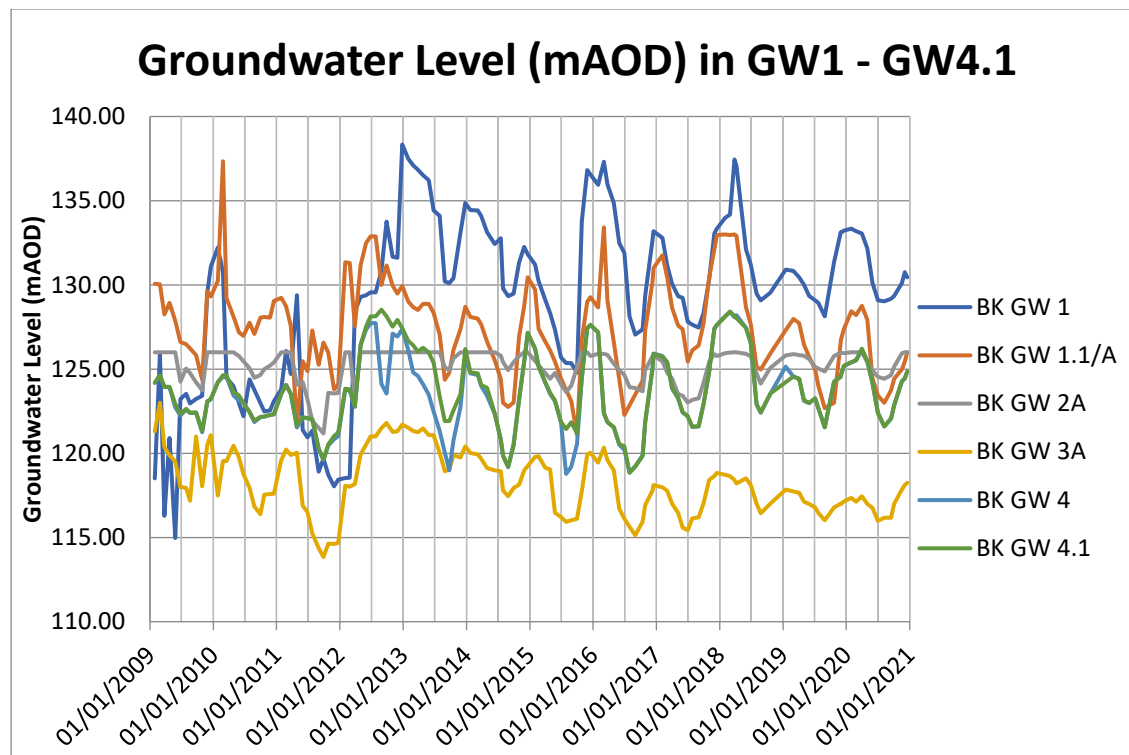




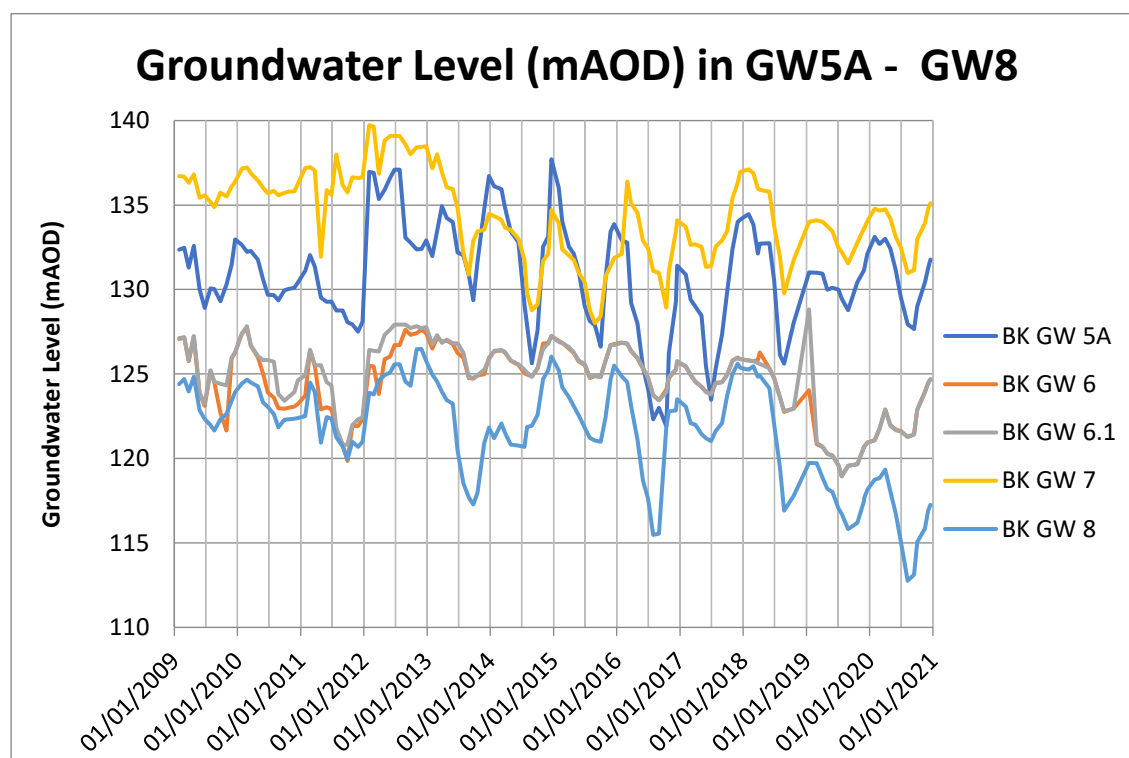
APPENDIX 3

Groundwater Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 3 - GROUNDWATER



Graph 1A: Groundwater level as metres above Ordnance Datum (2009-2020)



Graph 1B: Groundwater level as metres above Ordnance Datum (2009-2020)

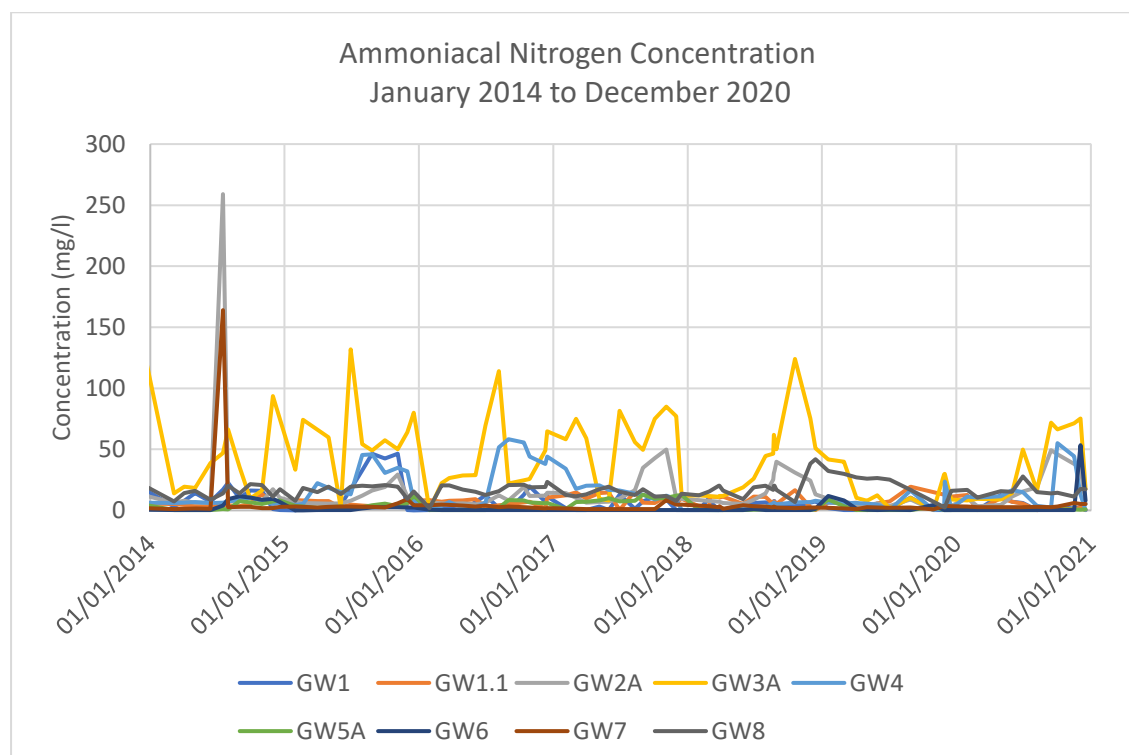
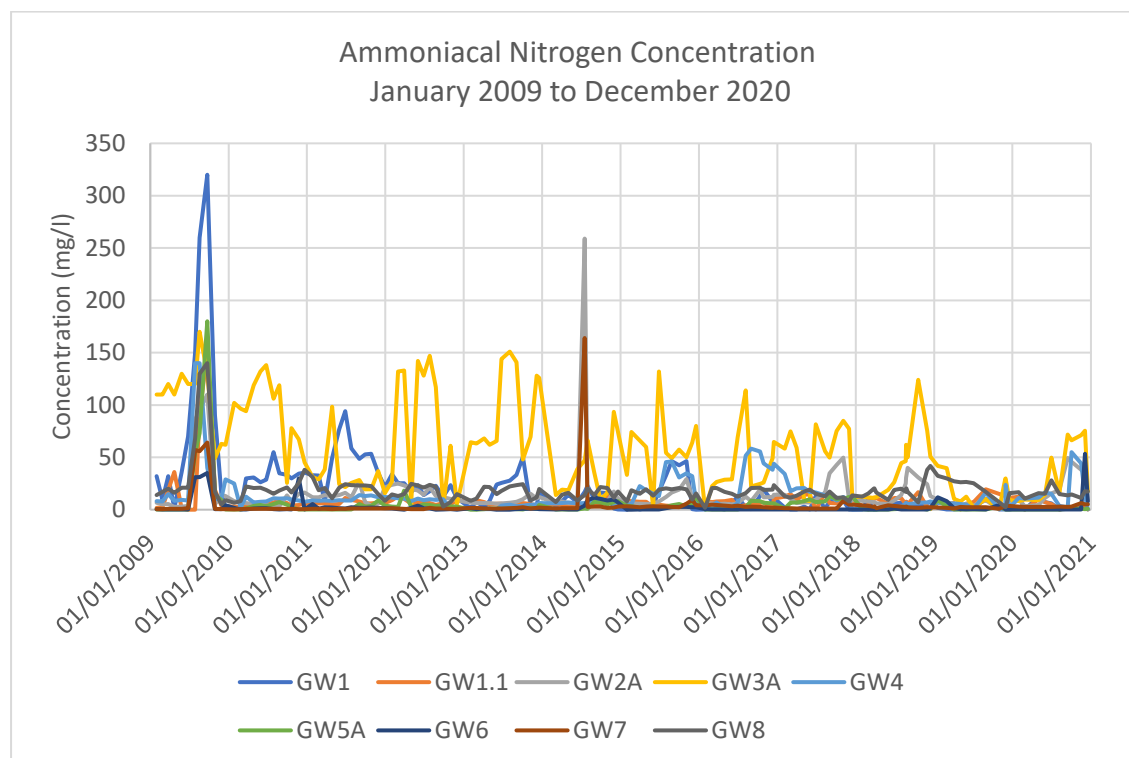
APPENDIX 3 - GROUNDWATER

Table 1: Groundwater Quality (Monthly) 2018

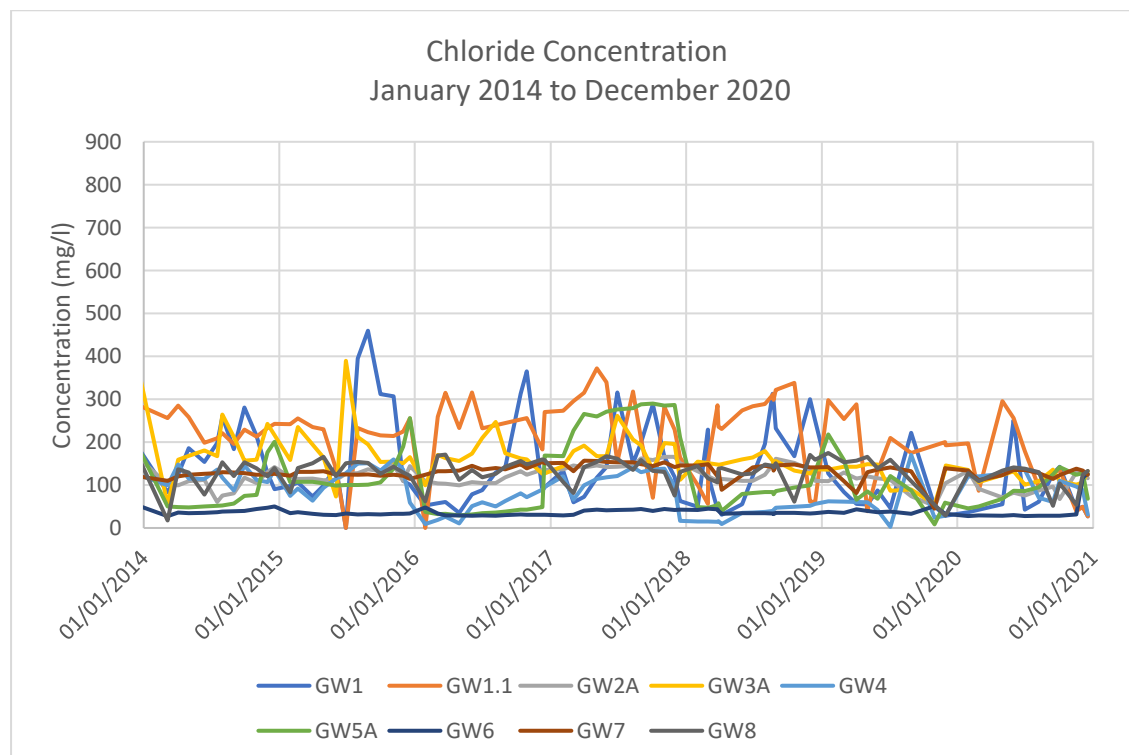
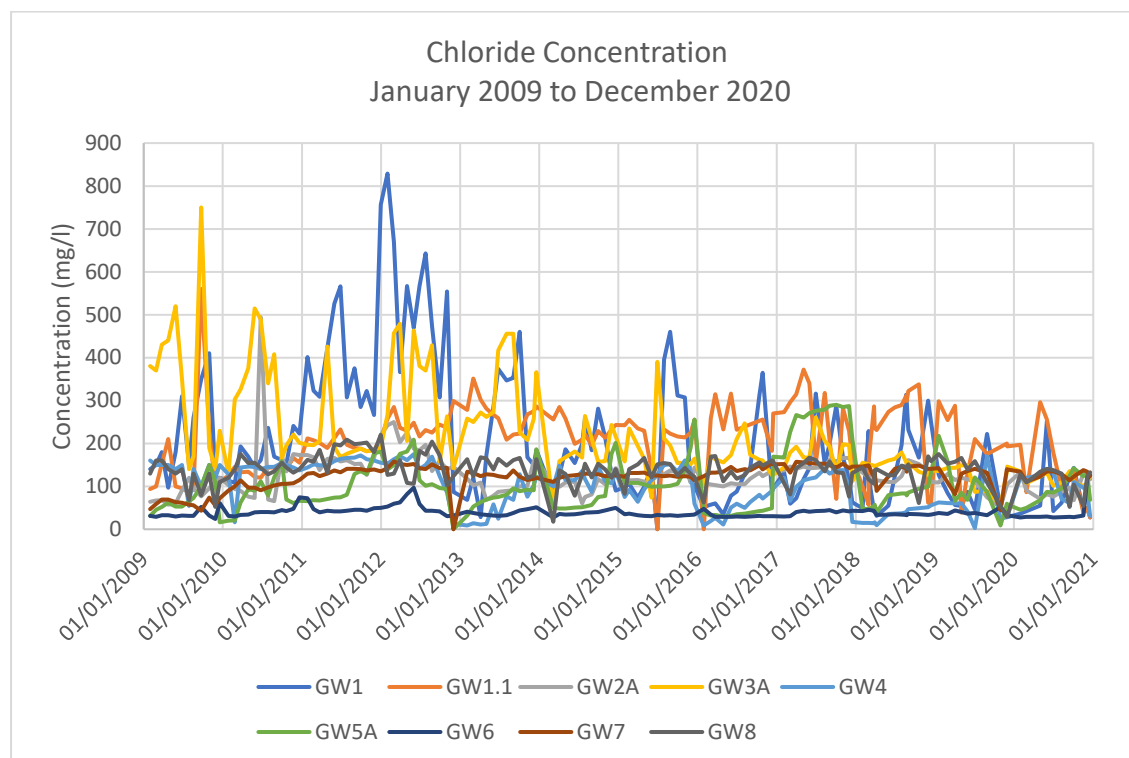
Sample Description	Limit (GW2A, GW3A, GW4)	GW1			GW1.1			GW2A			GW3A			GW4		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Ammoniacal Nitrogen	1.7	<0.2	12.50	3.27	<0.2	12.50	3.83	3.32	49.40	21.60	8.05	75.40	37.23	0.42	55.00	16.70
Chloride	60	27.30	252.00	83.80	27.40	296.00	135.35	67.50	133.00	98.05	101.00	136.00	117.40	31.30	136.00	99.52
Conductivity @ 20 deg.C	N/A	0.87	3.07	2.11	0.92	2.82	1.70	1.01	1.58	1.30	1.26	1.97	1.61	0.85	1.91	1.38
Dissolved Oxygen	N/A	<0.3	7.35	4.54	<0.3	9.06	4.81	<0.3	7.42	2.85	<0.3	7.45	3.55	<0.3	9.18	4.47
pH	N/A	6.16	7.86	7.18	6.31	7.66	7.00	6.99	7.62	7.26	6.69	7.53	7.00	6.48	8.12	7.10

Sample Description	GW5A			GW6			GW7			GW8		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Ammoniacal Nitrogen	<0.2	1.14	0.49	<0.2	53.40	5.77	2.52	6.18	3.52	10.60	27.90	15.97
Chloride	45.40	142.00	92.59	27.60	126.00	45.85	111.00	138.00	127.20	52.00	141.00	113.40
Conductivity @ 20 deg.C	0.57	1.24	0.93	0.69	1.59	0.90	0.63	0.69	0.67	0.70	1.38	1.17
Dissolved Oxygen	1.48	9.45	6.24	<0.3	8.20	5.18	0.74	8.22	3.81	0.38	7.97	4.03
pH	6.26	8.00	6.73	6.94	7.68	7.27	7.26	7.99	7.55	6.50	8.31	6.86

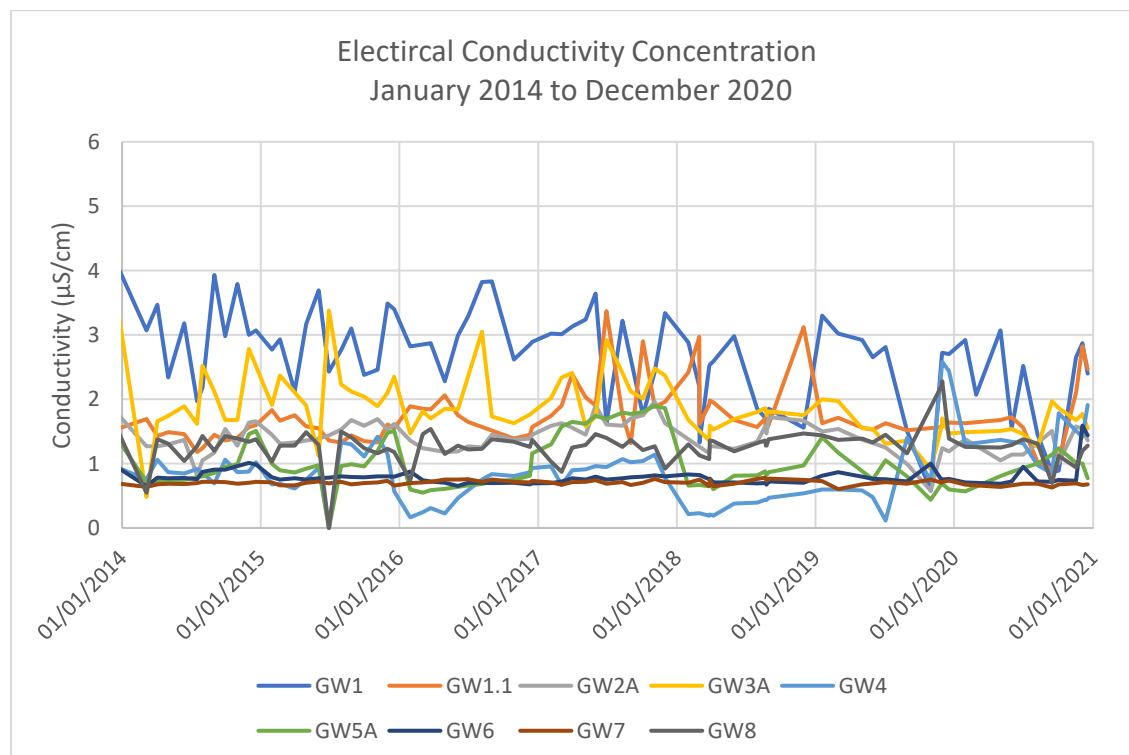
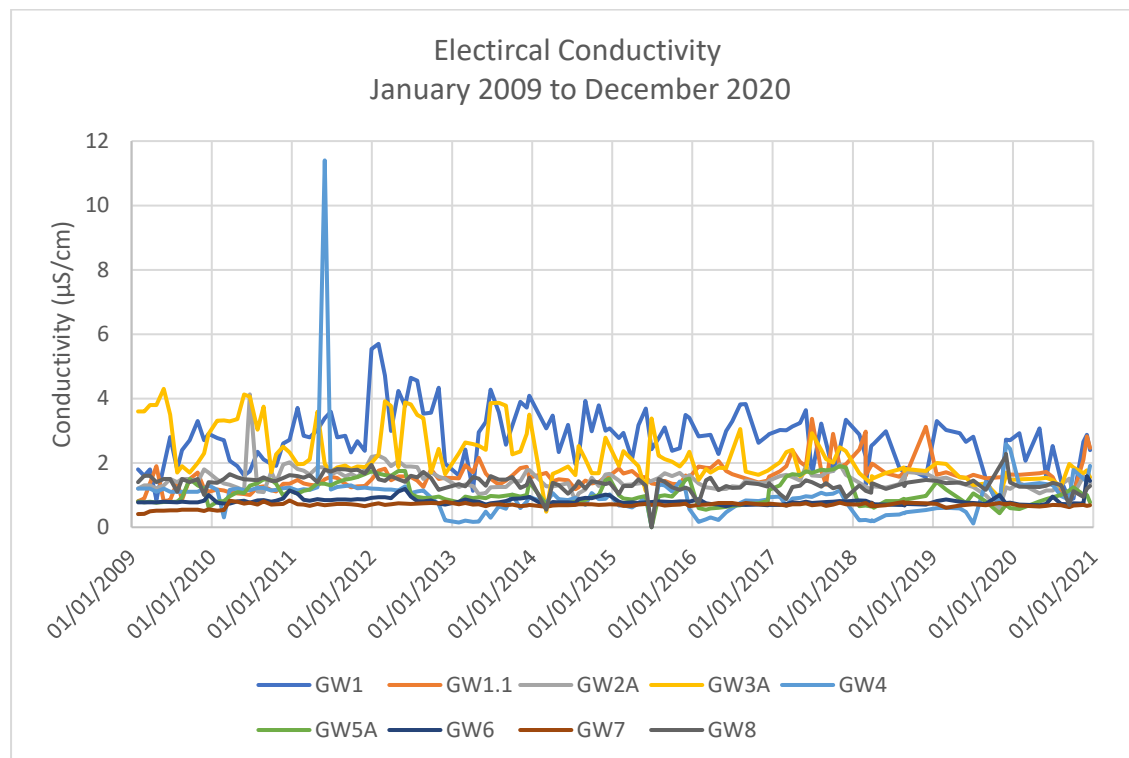
APPENDIX 3 - GROUNDWATER



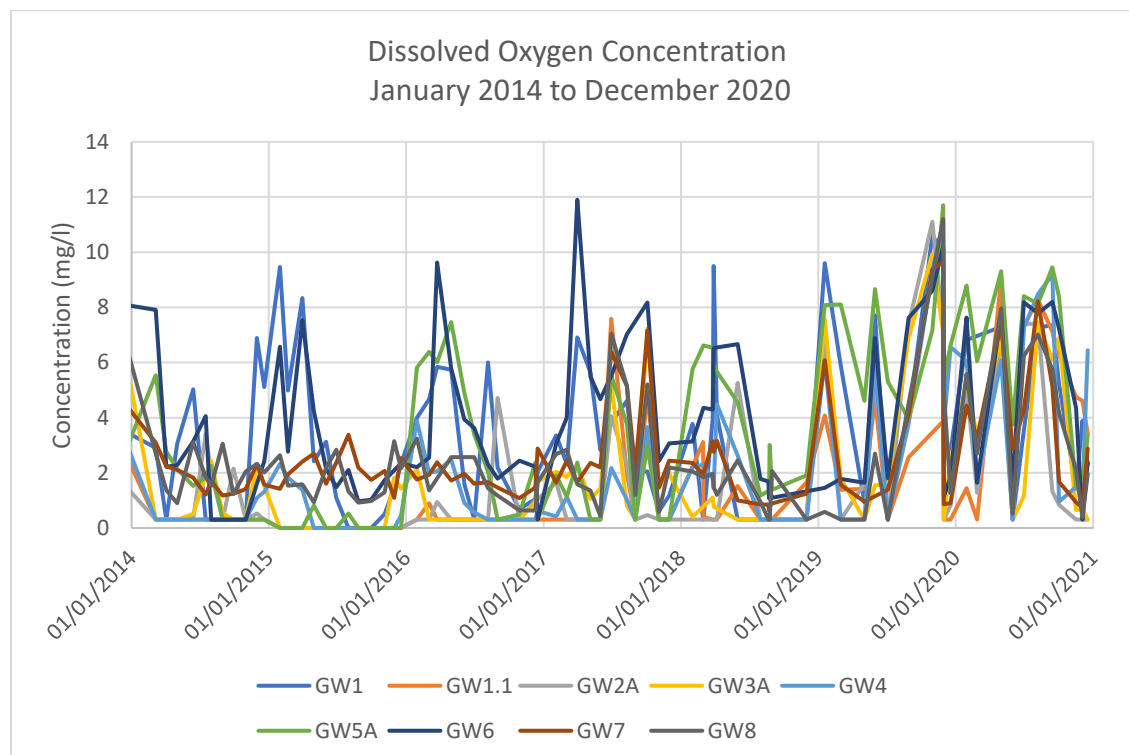
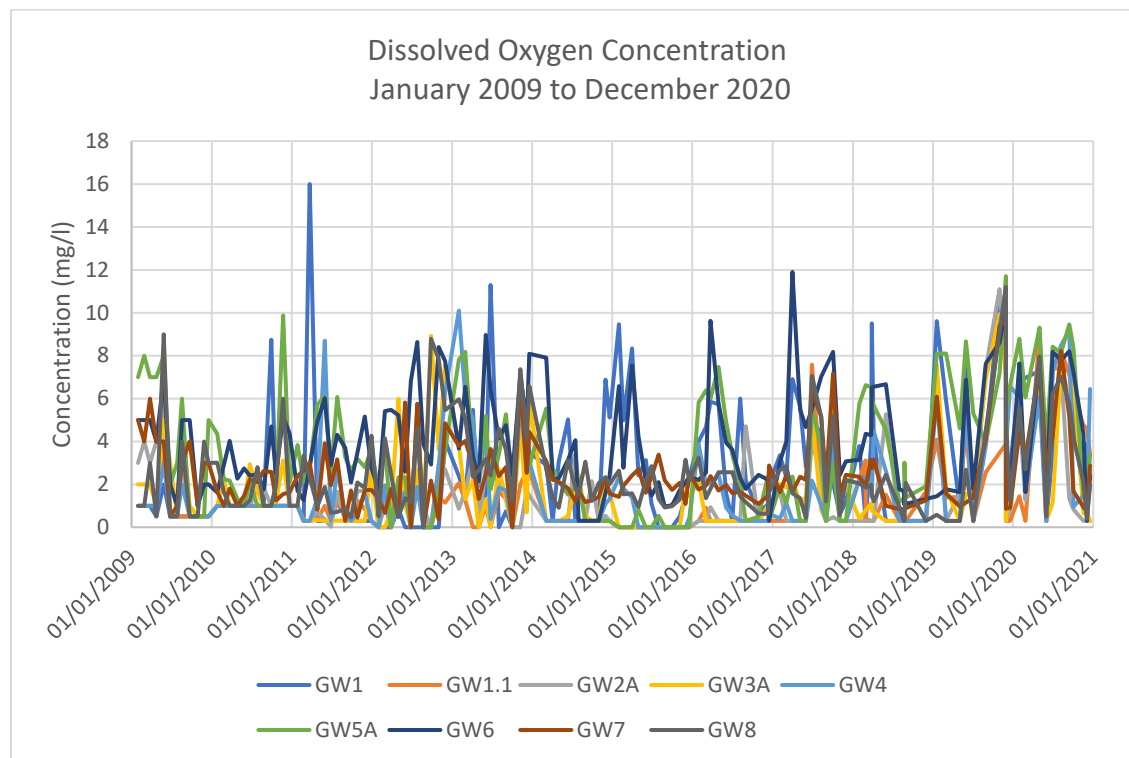
APPENDIX 3 - GROUNDWATER



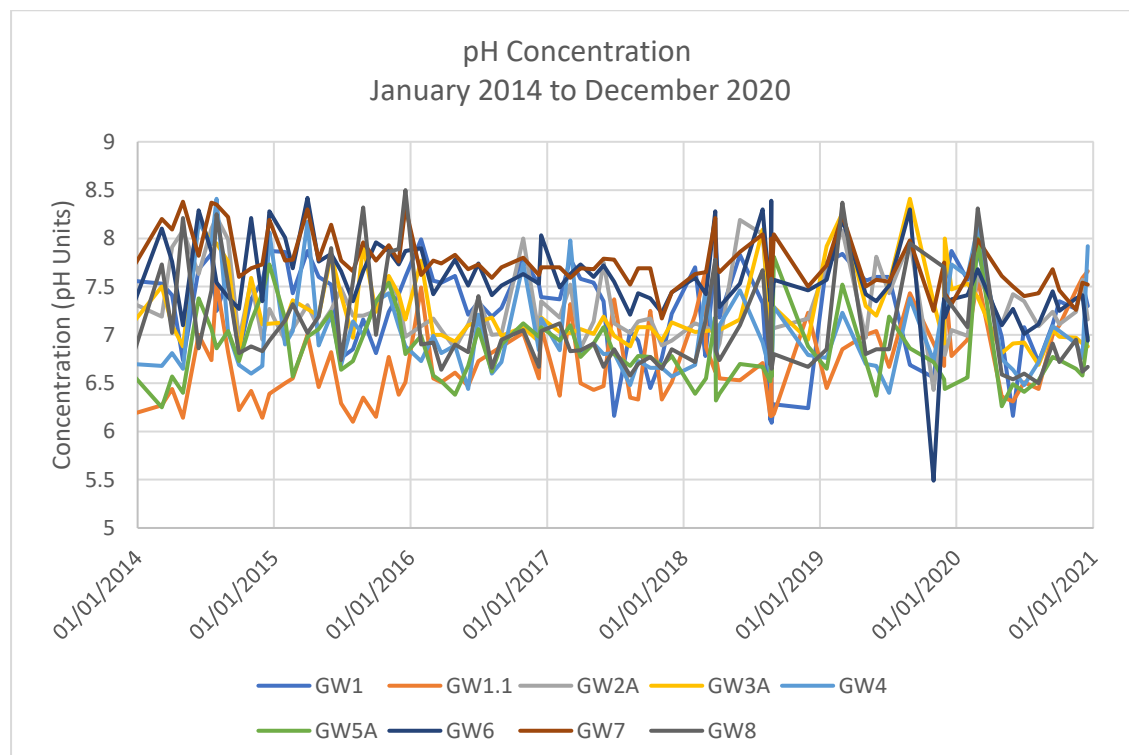
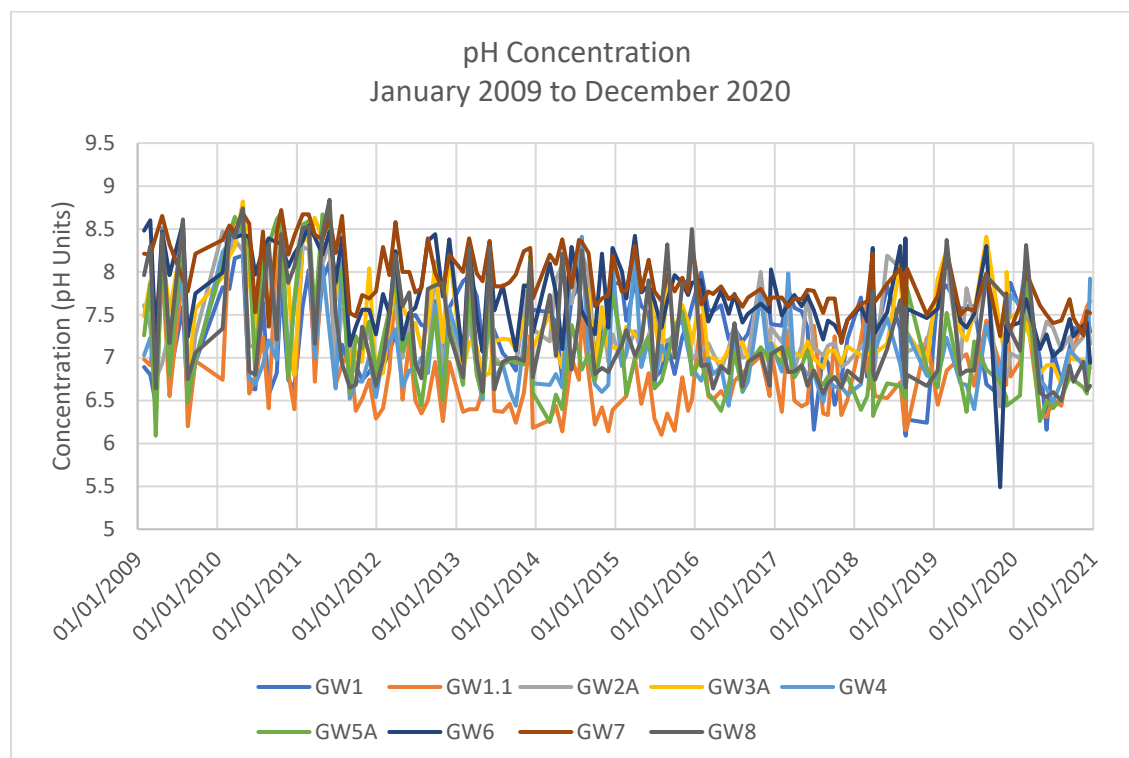
APPENDIX 3 - GROUNDWATER



APPENDIX 3 - GROUNDWATER



APPENDIX 3 - GROUNDWATER



APPENDIX 2 - GROUNDWATER

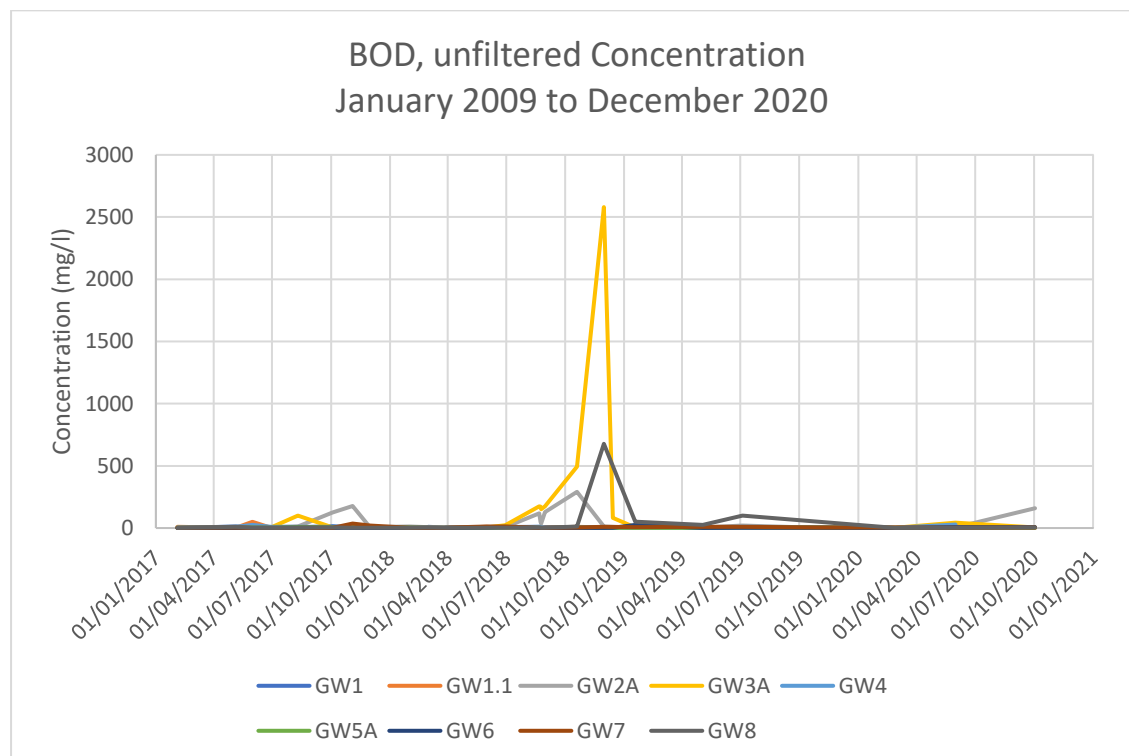
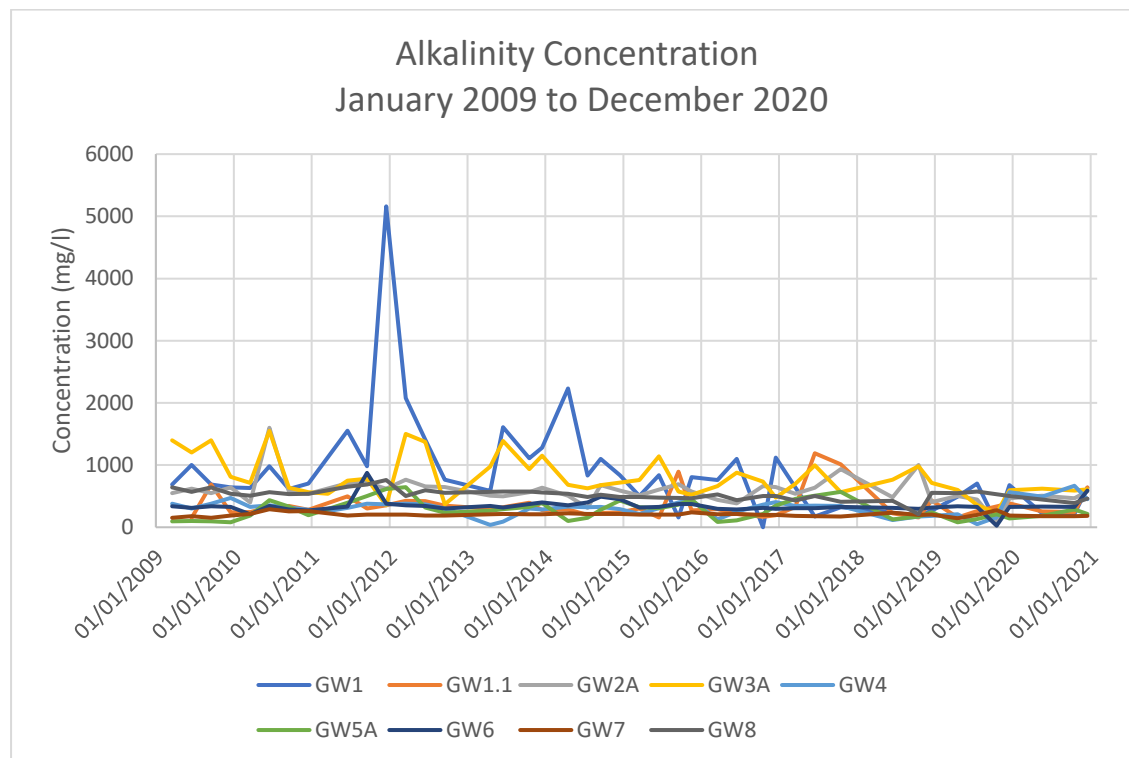
Table 2: Groundwater Quality (Quarterly)

Sample Description		GW1			GW1.1			GW2A			GW3A			GW4		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity (mg/l)		215	634	357.3	243	639	378.3	467	581	519.3	591	621	607.7	452	667	536.3
BOD, unfiltered (mg/l)		<1	5.76	3.6	2.38	20.5	8.433	3.3	158	55.05	<3	42.8	16.5	2.95	28.3	15.625
Cadmium (mg/l)		<0.00008	0.000194	0.000137	<0.00008	0.000208	0.000144	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.000087	0.0000835
Calcium (mg/l)		61.2	521	237.07	87.5	524	254.5	112	162	145	140	179	157	131	379	221
Chemical Oxygen Demand (COD) (mg/l)		29.2	150	105.73	18.7	314	194.23	36.4	203	128.47	75.4	224	147.47	77.4	146	111.47
Chromium (mg/l)		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.00286	0.0019
Copper (mg/l)		<0.0003	0.0111	0.0057	<0.0003	0.0122	0.00625	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.00617	0.00324
Iron (mg/l)		0.0371	26.2	13.11855	0.0385	24.4	12.21925	0.0347	7.68	3.85735	2.76	4.06	3.41	0.04	21.3	10.67
Lead (mg/l)		<0.0002	<0.0002	<0.0002	<0.0002	0.000209	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.000714	0.00046
Magnesium (mg/l)		31.4	61.4	45.77	34.2	64.8	48.3	26.3	43.5	37.47	50.1	65.8	56.27	42.8	48.4	45.9
Manganese (mg/l)		0.0614	7.14	3.6007	0.0694	8.21	4.1397	4.14	4.89	4.515	0.883	1.11	0.9965	0.0793	0.713	0.39615
Nickel (mg/l)	Limit							0.15			0.15			0.15		
	Values	0.00541	0.0264	0.015905	0.00539	0.0226	0.013995	0.0067	0.0141	0.0104	0.0194	0.0202	0.0198	0.00538	0.0245	0.01494
Potassium (mg/l)			19.3	102	48.1	22	106	50.1	22	34.9	29.7	26.5	55.4	37.97	39.5	87.8
Sodium (mg/l)			25.9	105	69.83	26.8	114	76.57	41.5	67.8	55.77	113	151	129	25.4	129
Toluene (mg/l)	Limit							0.004			0.004			0.004		
	Values	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Oxidised Nitrogen (TON) (mg/l)			<0.1	188	64.84	<0.1	188	65.57	0.0261	<0.3	0.14203	<0.1	7.27	2.64	<0.1	90.5
Zinc (mg/l)	Limit							0.254			0.254			0.254		
	Values	0.0141	0.0339	0.024	0.00642	0.0365	0.02146	0.00265	0.00289	0.00277	0.00563	0.00896	0.007295	0.00397	0.0173	0.010635
m,p-Xylene (mg/l)	Limit							0.011			0.011			0.011		
	Values	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

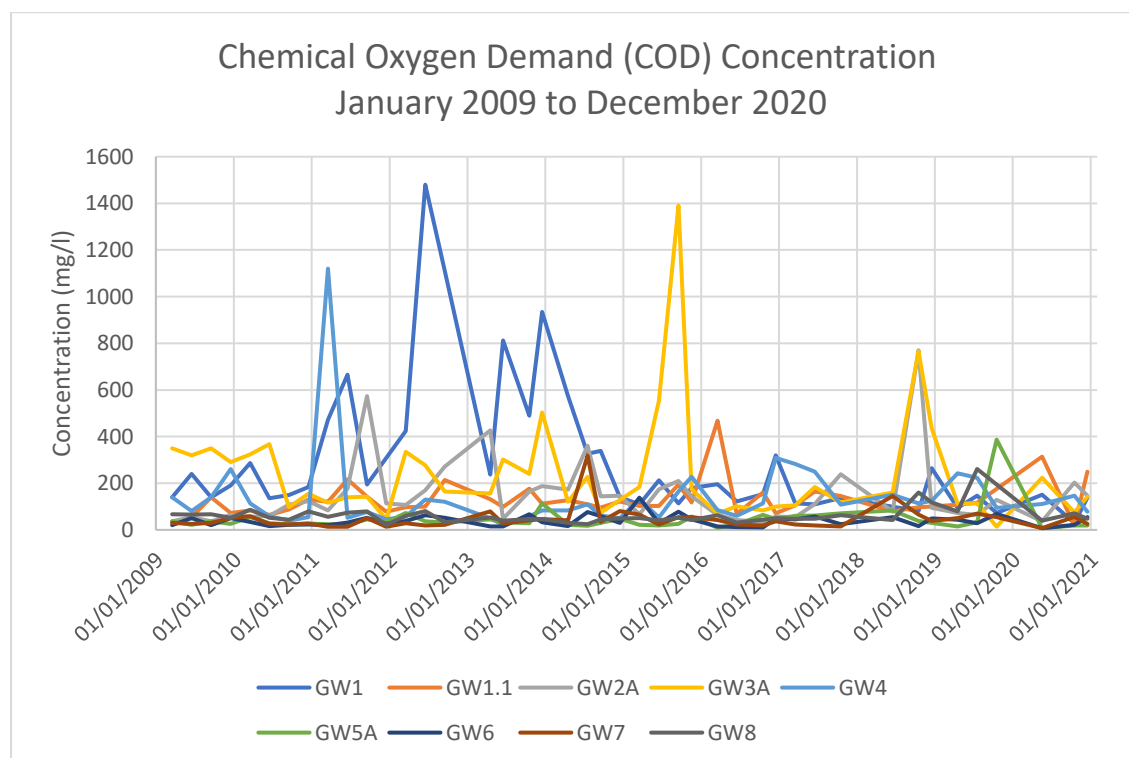
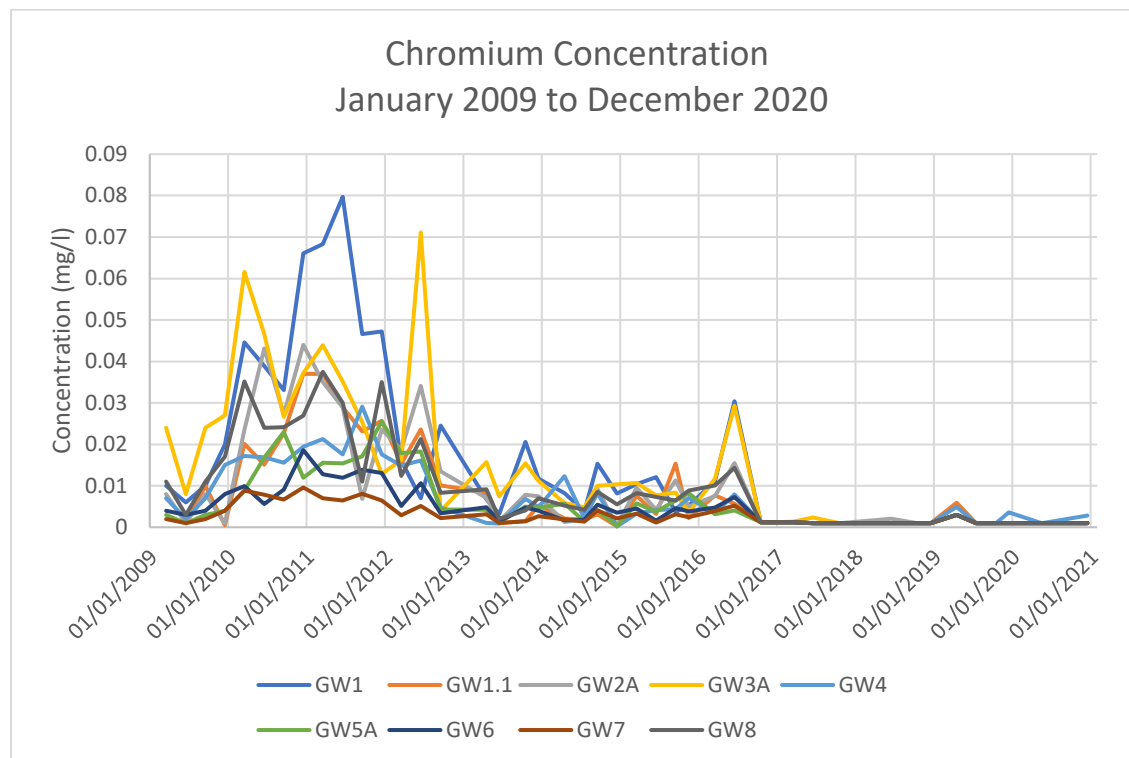
APPENDIX 2 - GROUNDWATER

Sample Description	GW5A			GW6			GW7			GW8		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity (mg/l)	185	284	227.3	327	590	417.3	176	183	179.7	391	460	432.3
BOD, unfiltered (mg/l)	<1	2.31	1.4	<1	8.29	5.5	3.01	4.78	3.74	<1	4.33	2.6
Cadmium (mg/l)	0.000117	0.00023	0.0001735	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
Calcium (mg/l)	67.9	133	106.63	104	158	125.3	18.8	22.7	20.63	91.1	121	104
Chemical Oxygen Demand (COD) (mg/l)	<7	19.3	15.1	<7	54.8	27.9	7.34	56	29.747	39.1	71.5	52.6
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/l)	0.00464	0.00476	0.0047	<0.0003	0.00176	0.00103	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Iron (mg/l)	<0.019	<0.019	<0.019	<0.019	5.3	2.6595	<0.019	0.0437	0.0314	0.121	0.732	0.4265
Lead (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	0.00112	0.00066	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Magnesium (mg/l)	19.2	38	27.3	34	49.6	40.4	27.2	36	30.57	33.1	45.9	38.83
Manganese (mg/l)	<0.003	0.197	0.1	0.766	3.03	1.898	0.107	0.136	0.1215	0.537	0.552	0.5445
Nickel (mg/l)	0.0187	0.0321	0.0254	0.00241	0.018	0.010205	0.00065	0.00084	0.000745	0.0223	0.0276	0.02495
Potassium (mg/l)	11.9	20.3	15.67	18.2	30.1	22.37	23.2	28.1	25.53	33.4	44.2	39.73
Sodium (mg/l)	52.9	106	81.07	20.1	101	47.7	62.9	81.7	70.23	97.2	127	109.4
Toluene (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Oxidised Nitrogen (TON) (mg/l)	6.62	32.8	17.84	<0.1	1.11	0.5	<0.1	1.14	0.55	<0.02	0.762	0.294
Zinc (mg/l)	0.0122	0.0295	0.02085	0.00227	0.0137	0.007985	0.00221	0.00554	0.003875	0.00848	0.00975	0.009115
m,p-Xylene (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

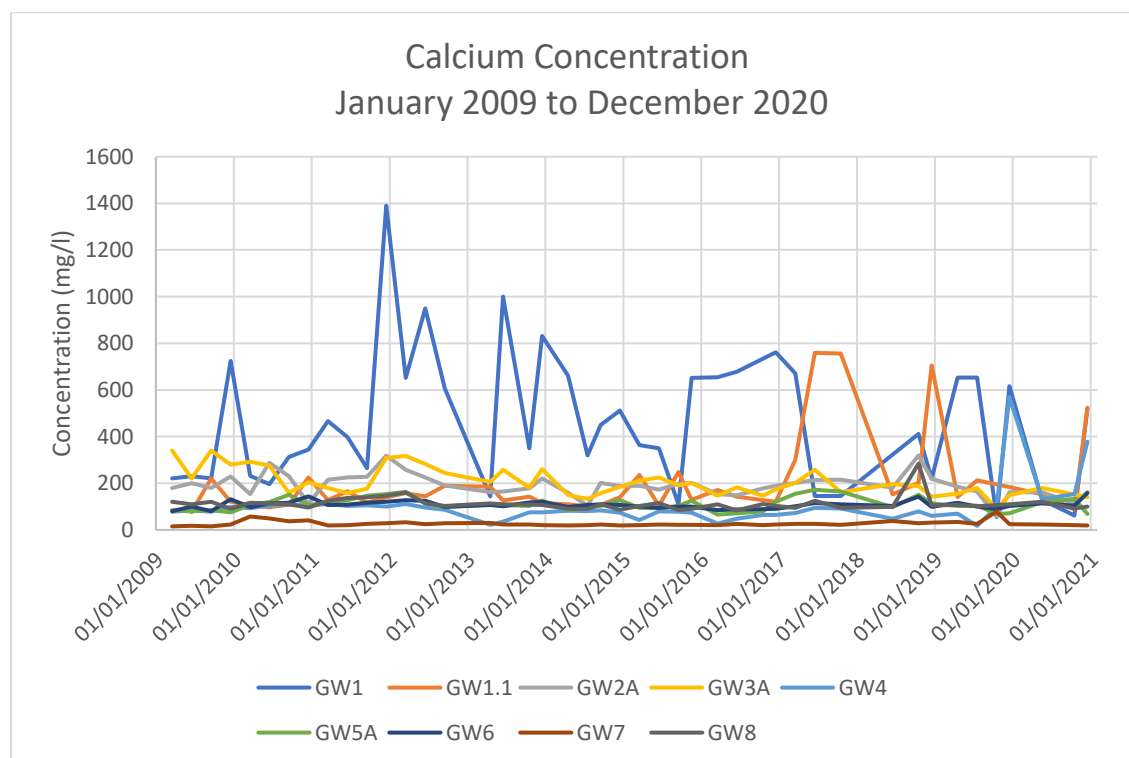
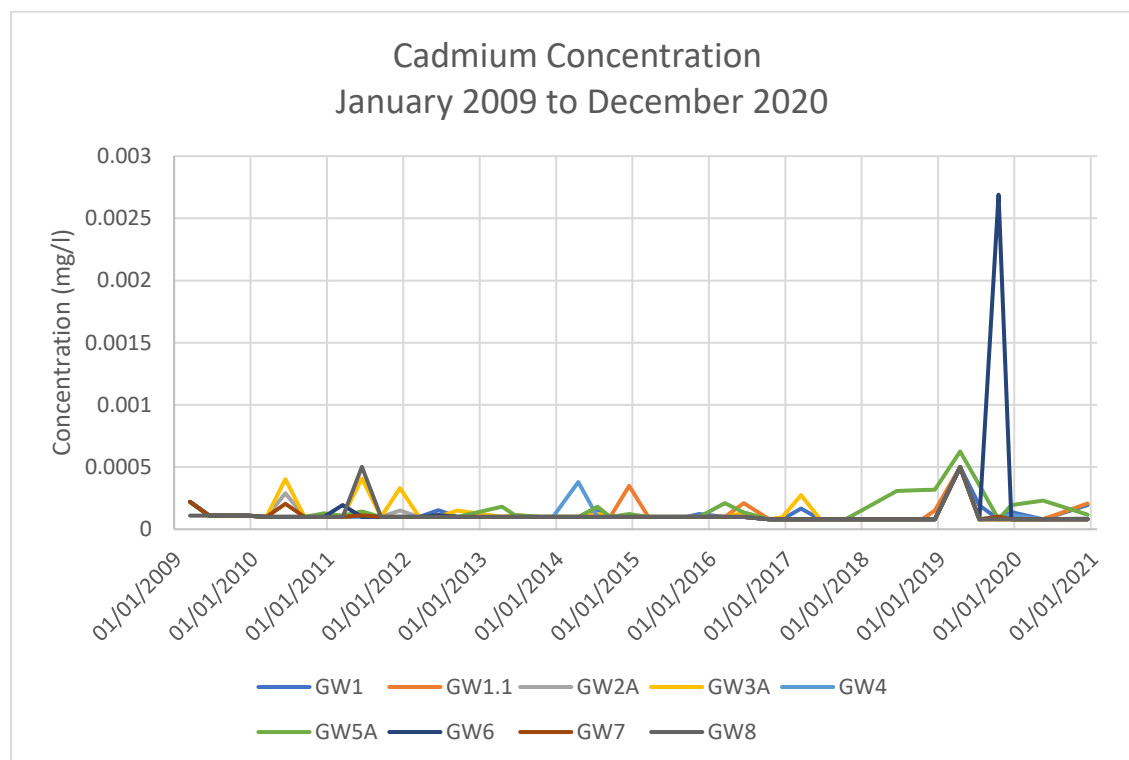
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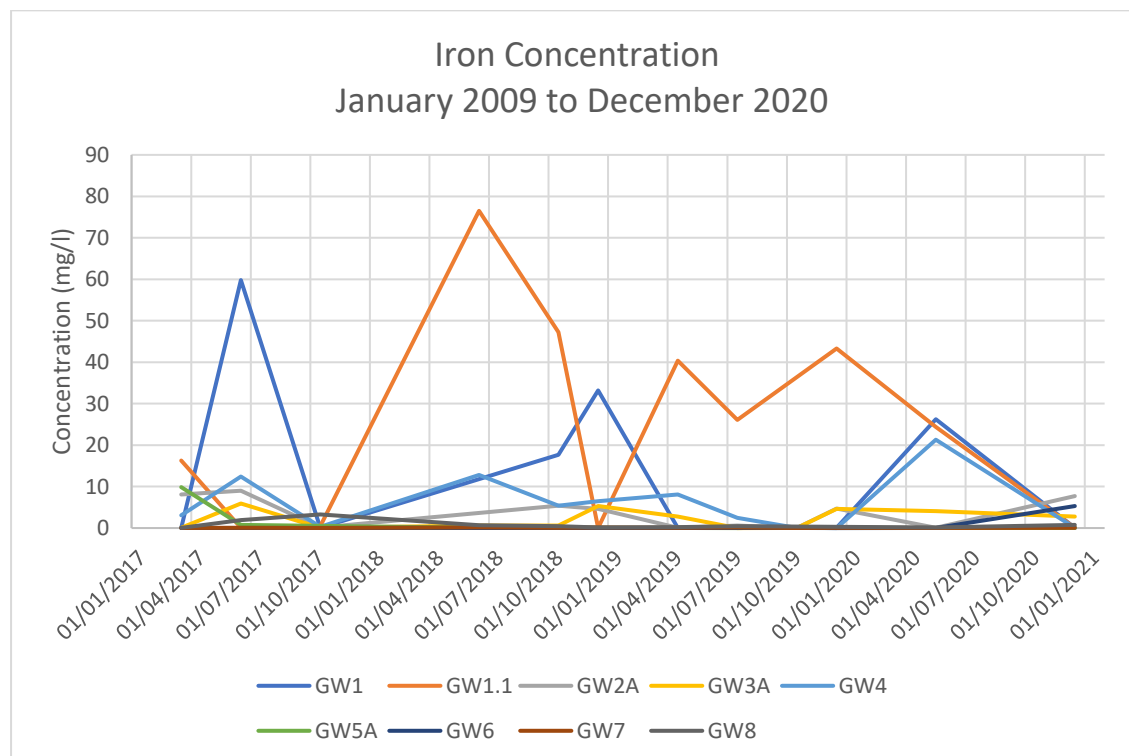
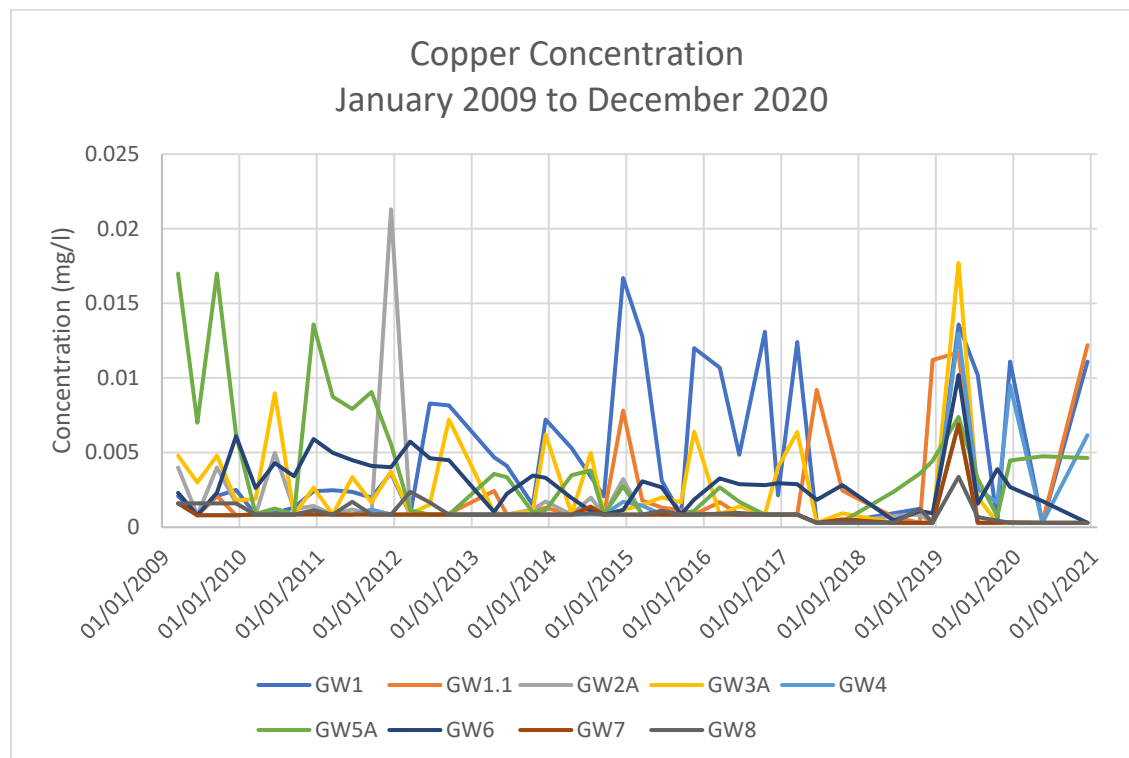
APPENDIX 3 - GROUNDWATER



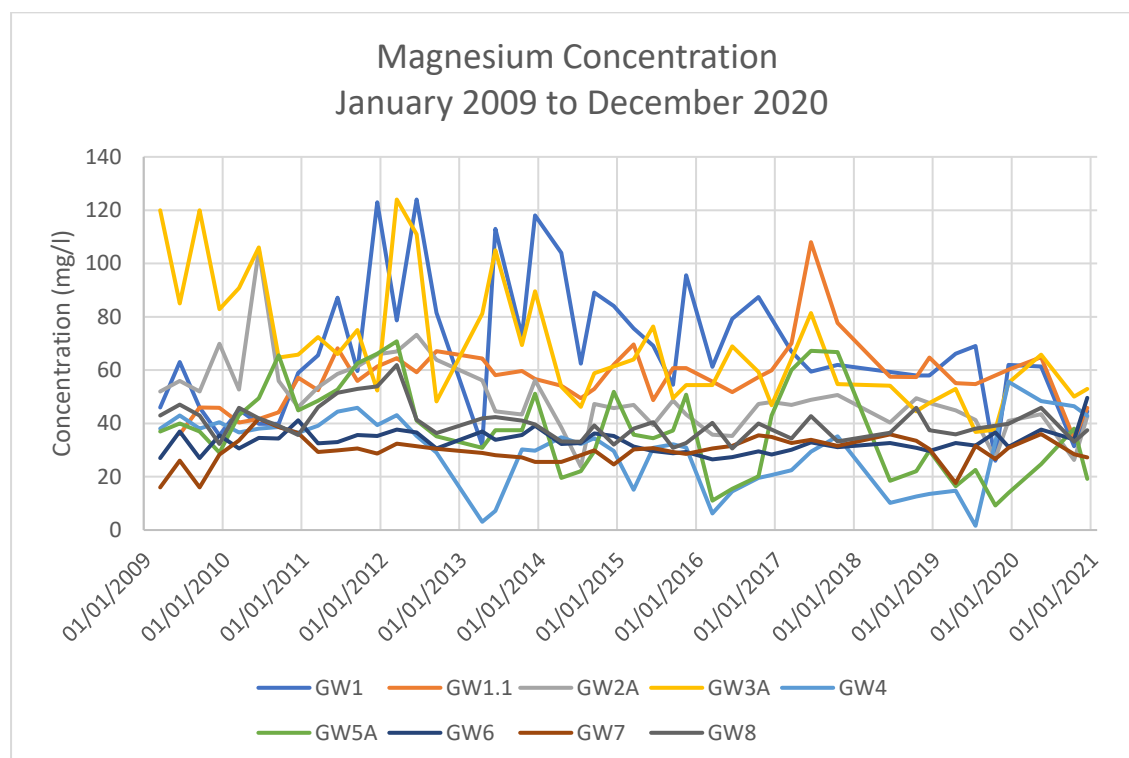
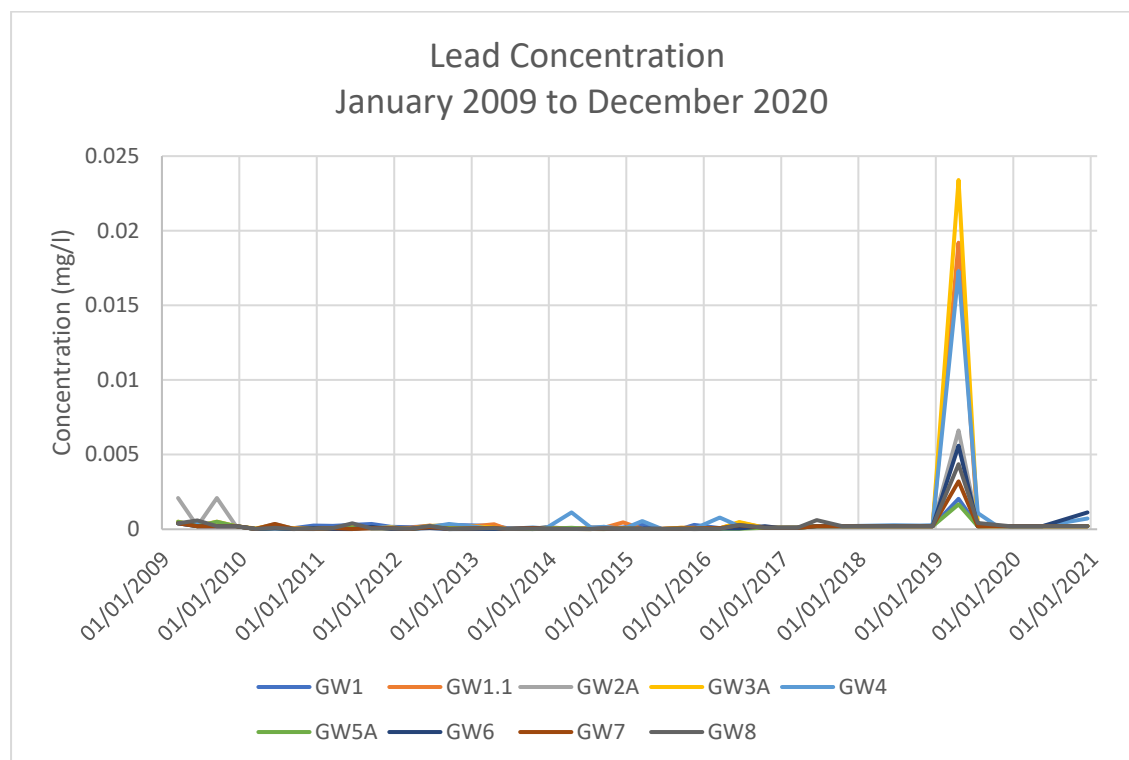
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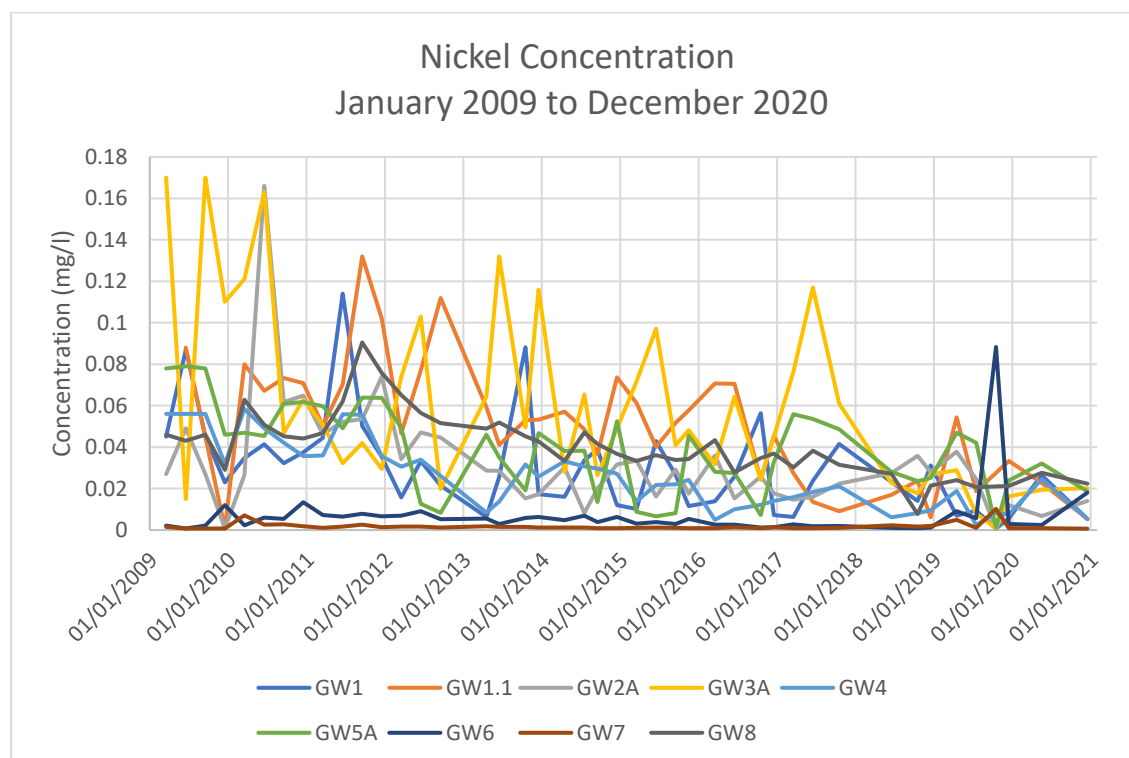
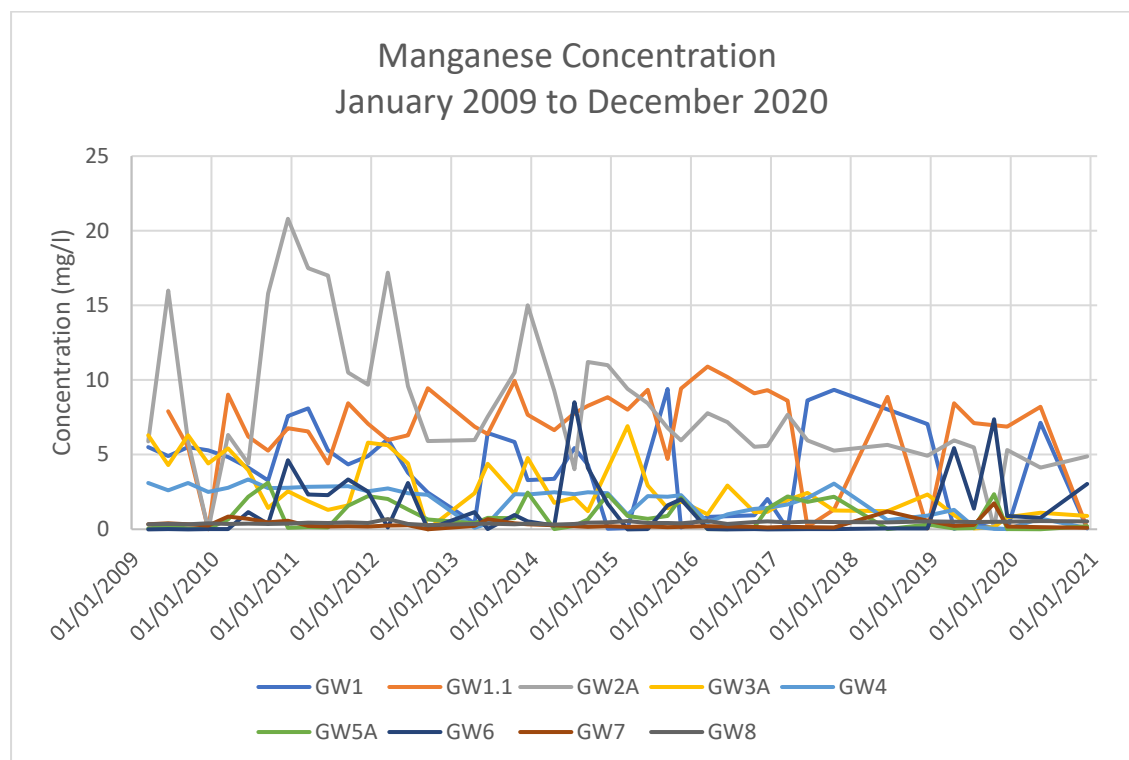
APPENDIX 3 - GROUNDWATER



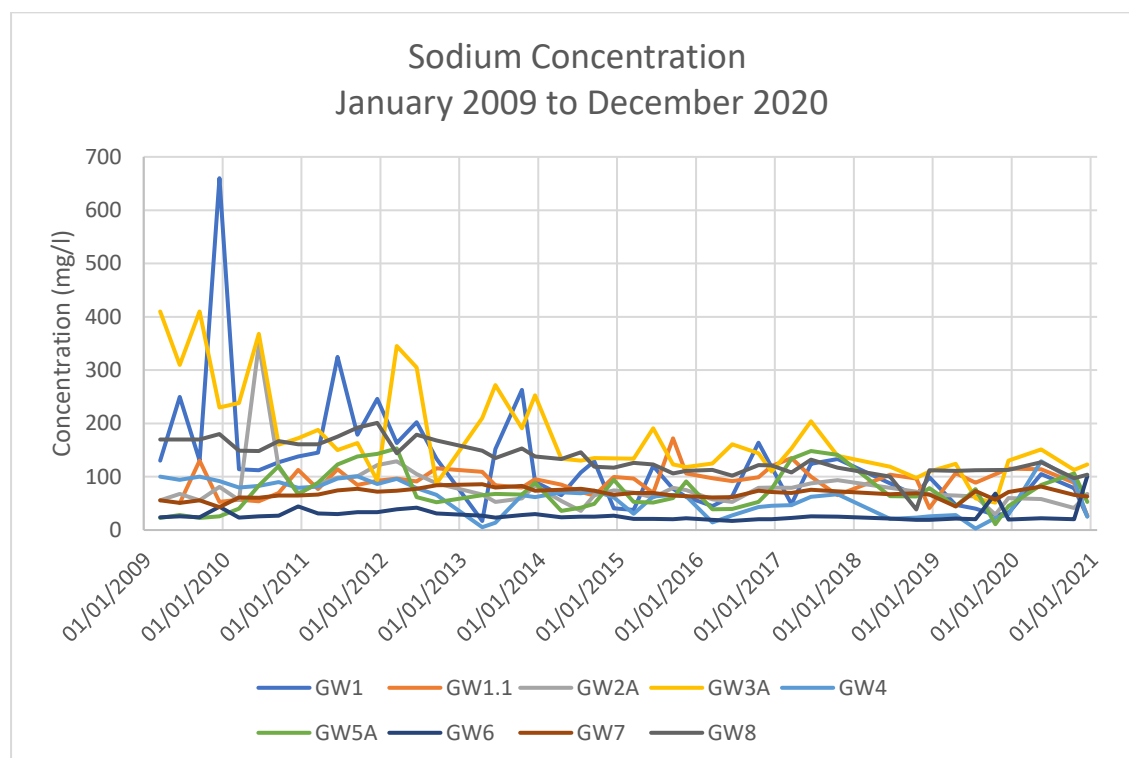
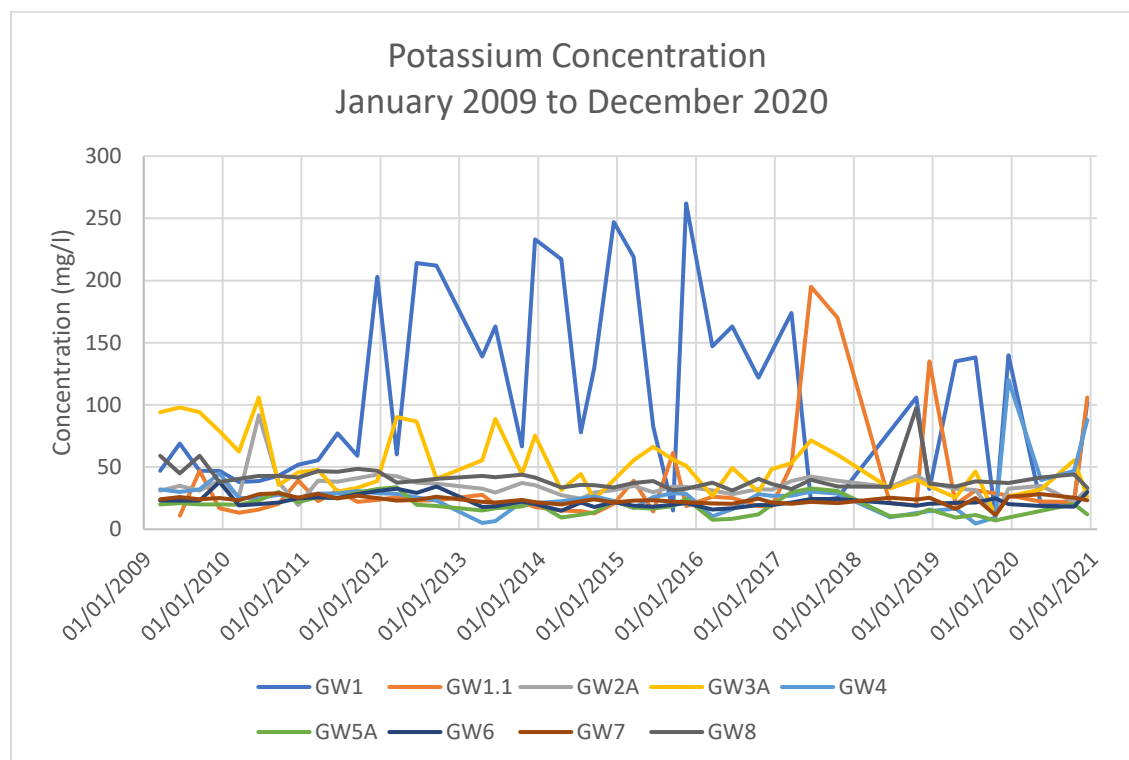
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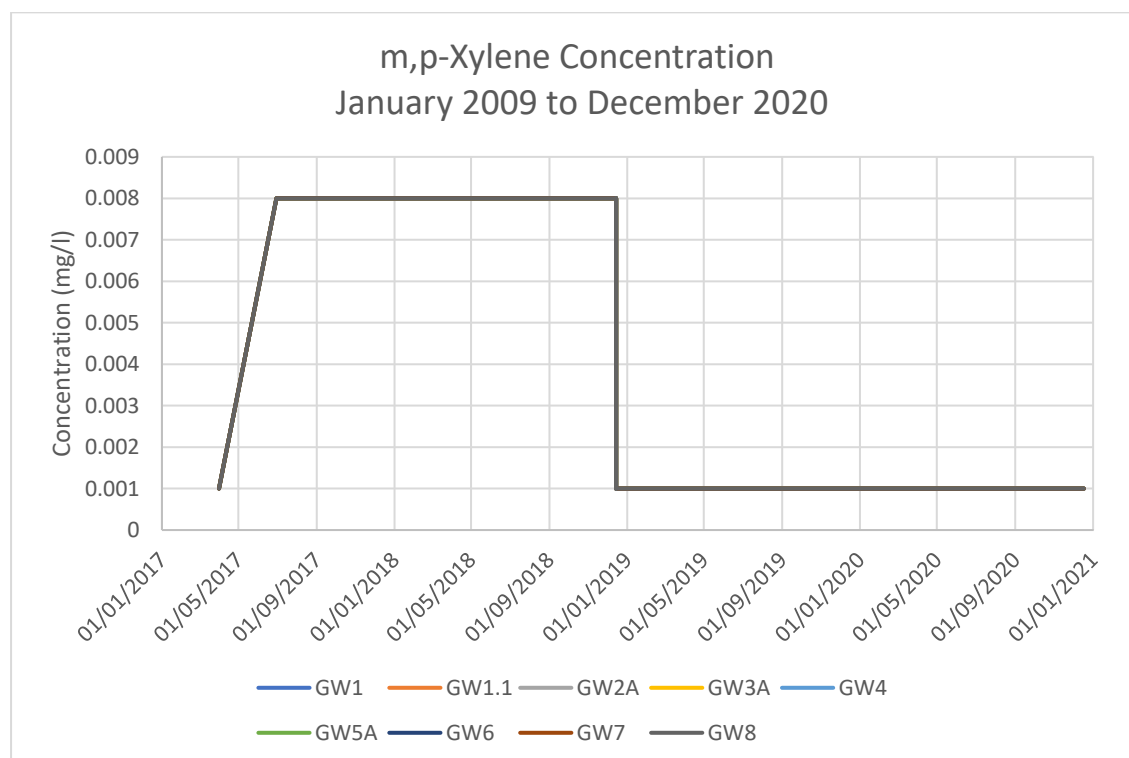
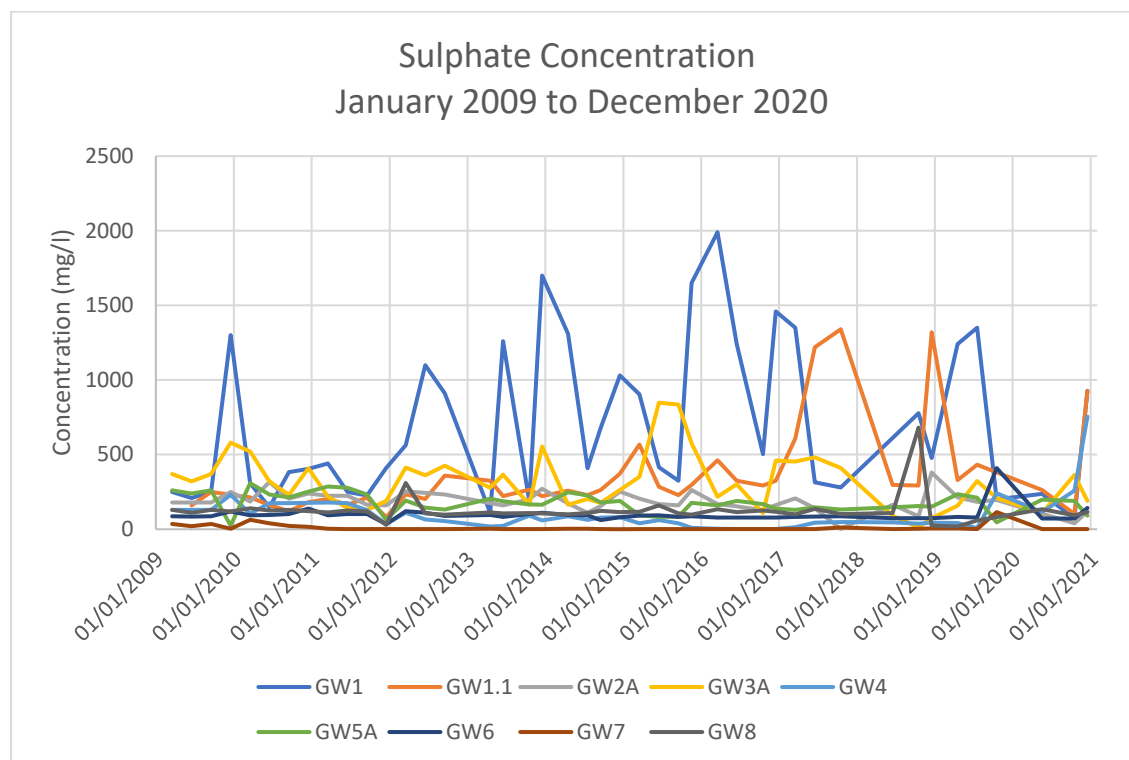
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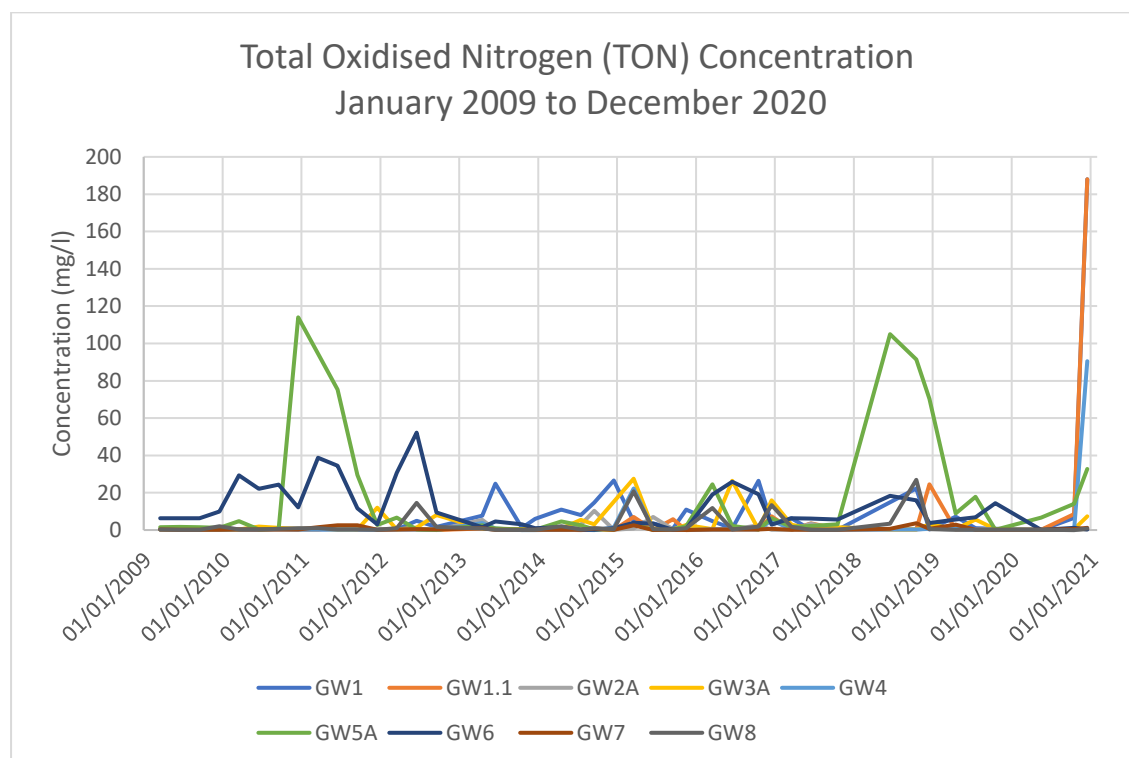
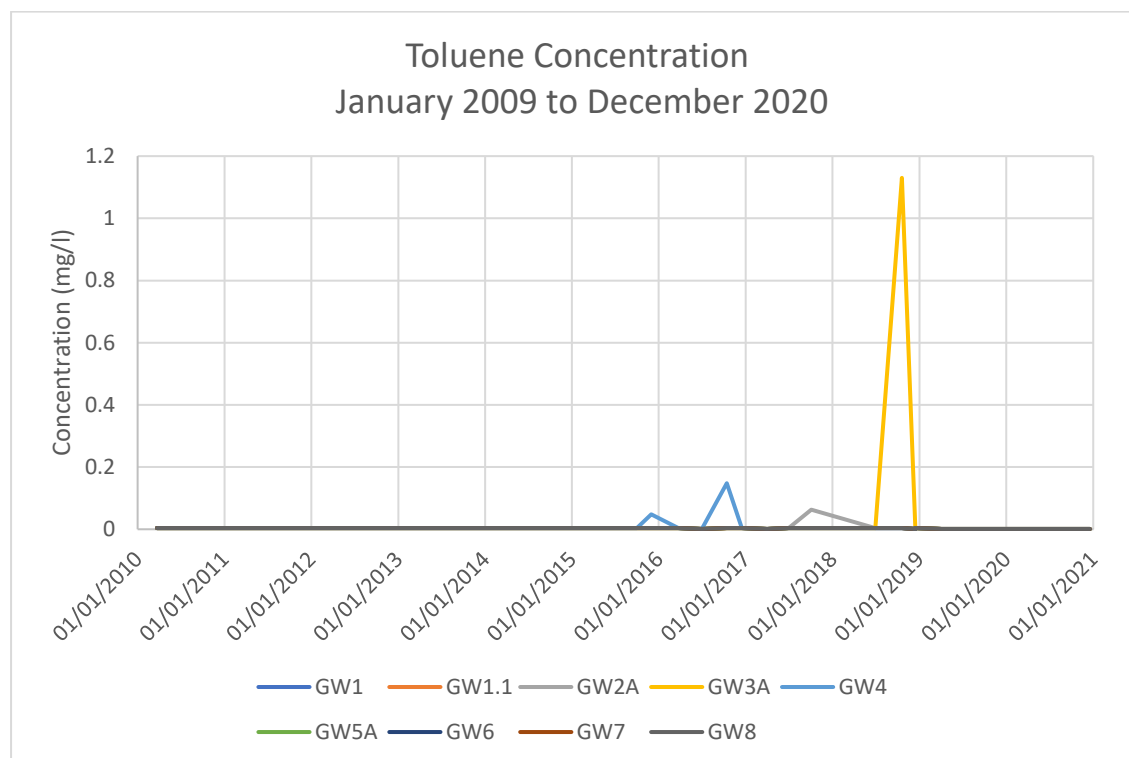
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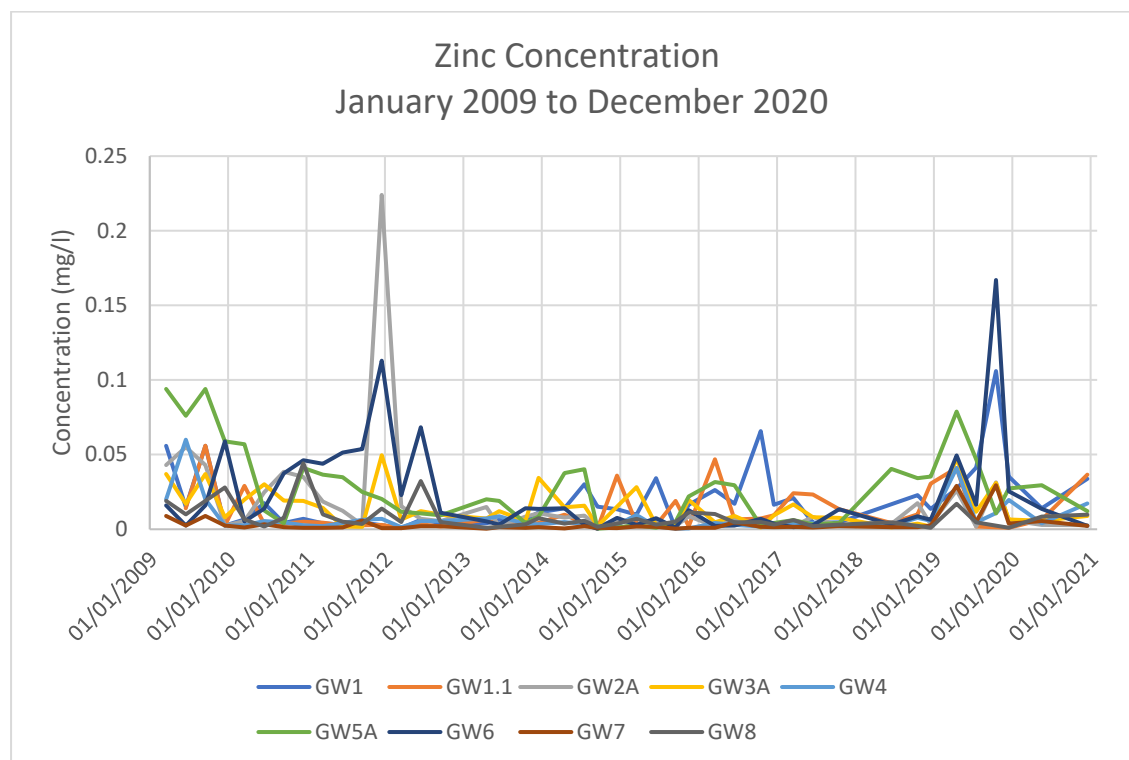
APPENDIX 3 - GROUNDWATER



APPENDIX 3 - GROUNDWATER



APPENDIX 3 - GROUNDWATER



APPENDIX 2 - GROUNDWATER**Table 3: Groundwater Quality (Hazardous Suite). Detected hazardous substances are highlighted**

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
Mineral Oil / Oils & Greases										
Mineral oil >C10 C40 (aq)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TPH Criteria Working Group (TPH CWG)										
Benzene	mg/l	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Ethylbenzene	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
m,p-Xylene	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
o-Xylene	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Sum of detected BTEX	mg/l	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028
Sum of detected Xylenes	mg/l	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Toluene	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Semi-Volatile Organic Compounds (SVOCs)										
1,2,4-Trichlorobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichlorobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,5-Trichlorophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,6-Trichlorophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dichlorophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dimethylphenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,6-Dinitrotoluene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chloronaphthalene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Methylnaphthalene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Methylphenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Nitroaniline (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Nitrophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3-Nitroaniline (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromophenylphenylether (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloro-3-methylphenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloroaniline (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
4-Chlorophenylphenylether (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Methylphenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Nitroaniline (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Nitrophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acenaphthene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acenaphthylene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Anthracene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Azobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(a)anthracene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(a)pyrene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(b)fluoranthene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(g,h,i)perylene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(k)fluoranthene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Chloroethoxy)methane (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Chloroethyl)ether (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Ethylhexyl) phthalate (aq)	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Butylbenzyl phthalate (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbazole (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chrysene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenzo(a,h)anthracene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenzofuran (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diethyl phthalate (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethyl phthalate (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluorene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobutadiene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorocyclopentadiene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachloroethane (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Indeno(1,2,3-cd)pyrene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Dibutyl phthalate (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
n-Dioctyl phthalate (aq)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrobenzene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Nitroso-n-dipropylamine (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pentachlorophenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenanthrene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenol (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pyrene (aq)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Organic Compounds (VOCs)										
1,1,1,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trimethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromo-3-chloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromoethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromofluorobenzene**	%	98.8	99.8	99.4	100	100	99.4	99.6	99.4	100
4-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
4-iso-Propyltoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromodichloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromoform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbon disulphide	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbontetrachloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromofluoromethane**	%	105	108	107	103	105	108	106	103	105
Dibromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorodifluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobutadiene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
m,p-Xylene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methyl tertiary butyl ether (MTBE)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
o-Xylene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Propylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
sec-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Styrene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Amyl methyl ether (TAME)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
Tetrachloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene-d8**	%	102	102	102	102	102	102	102	103	102
trans-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Combined Pesticides / Herbicides										
Aldrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
alpha-HCH	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Atrazine	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Azinphos ethyl	mg/l	<0.00002	<0.00002	<0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Azinphos methyl	mg/l	<0.00002	<0.00002	<0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
beta-HCH	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Carbophenothion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorfenvinphos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorothalonil	mg/l	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorpyrifos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorpyrifos-methyl	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
cis-Chlordane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Diazinon	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dichlorvos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dieldrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dimethoate	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Disulfoton	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan I	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan II	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Endosulphan Sulphate	mg/l	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006
Endrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Ethion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Etrimphos	mg/l	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Fenitrothion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
Fenthion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
gamma-HCH (Lindane)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Heptachlor	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Heptachlor epoxide	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Hexachlorobenzene	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Isodrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Malathion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Methyl Parathion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mevinphos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDD (TDE)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDE	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDT	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDD (TDE)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDE	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDT	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
p,p'-Methoxychlor	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Parathion	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Pendimethalin	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Permethrin I	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Permethrin II	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Phosalone	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Pirimiphos-methyl	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Propetamphos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Quintozone (PCNB)	mg/l	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Simazine	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Tecnazene	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Telodrin	mg/l	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
trans-Chlordane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triadimefon	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triallate	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triazophos	mg/l	<0.00001	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Trifluralin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Miscellaneous Organics										

APPENDIX 2 - GROUNDWATER

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020	17/12/2020
Dibutyl tin	mg/l	<0.000005	<0.0003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Surrogate	%	81.6	96.3	52.1	86.9	88.9	88.6	55.6	74.2	78.8
Tetrabutyl tin	mg/l	<0.000002	<0.00012	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tributyl tin	mg/l	<0.000001	<0.00006	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001
Triphenyl tin	mg/l	<0.000001	<0.00006	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001



APPENDIX 4

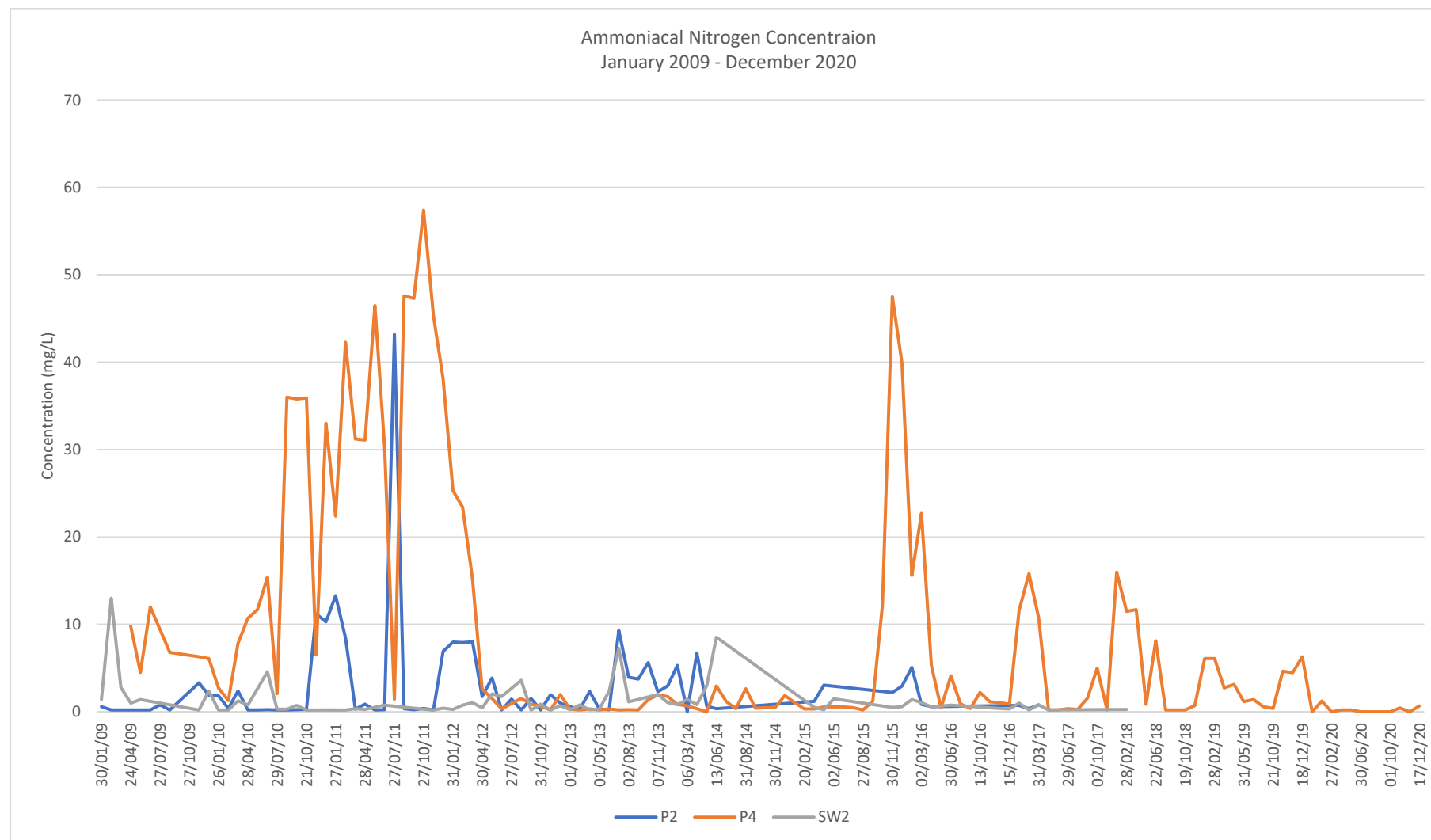
Surface Water Quality Summary Table and Time-Series Graphs

APPENDIX 4**Table 1: Monthly Surface Water Quality (2019)**

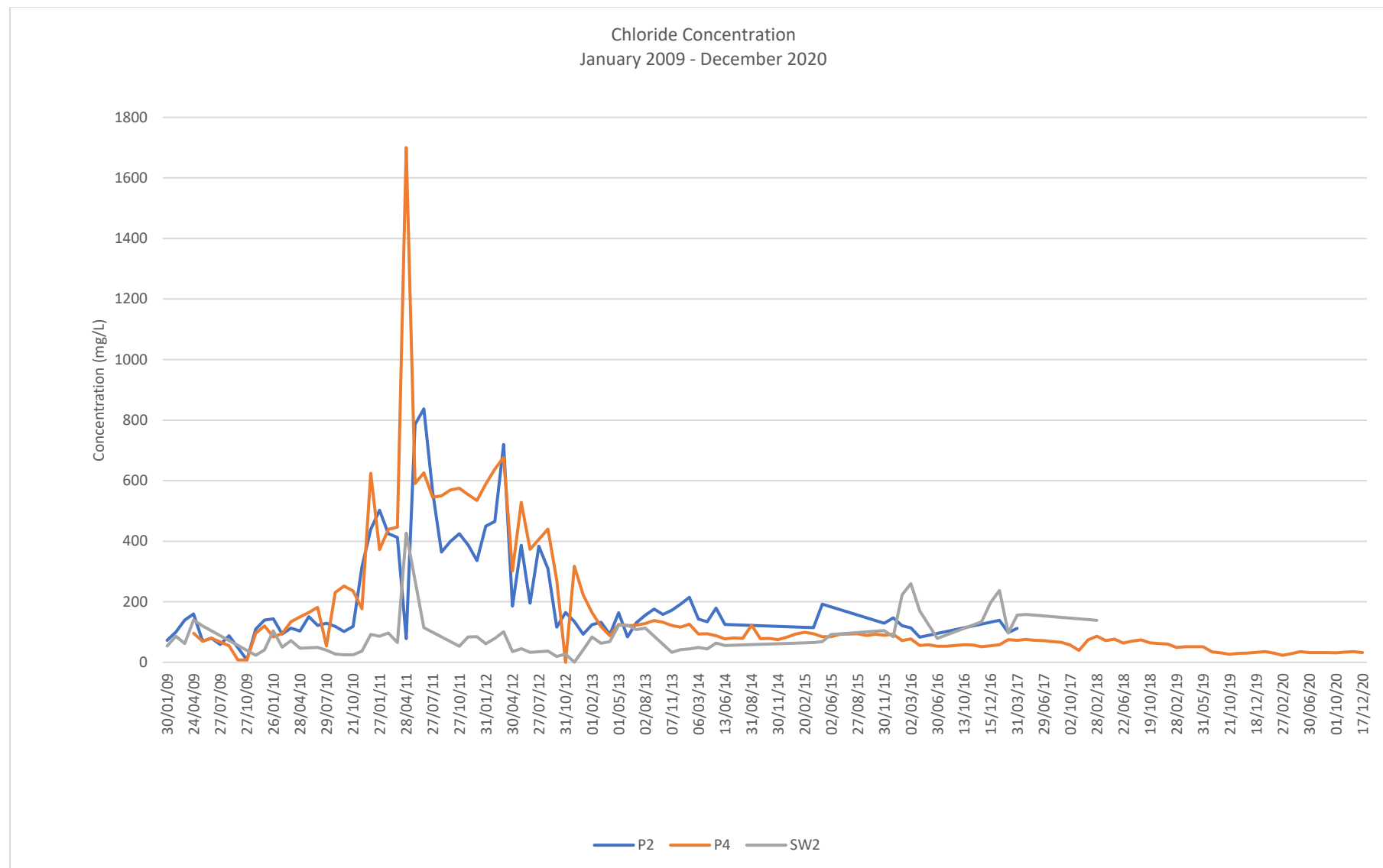
Location	Ammoniacal Nitrogen as NH			Chloride			COD, unfiltered			pH			Suspended solids, Total		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
P2 EP Limit	1.6			250			100			>6 < 9			100		
P4	<0.20	1.24	0.35	23.30	35.40	31.86	66.30	192.00	111.51	7.28	8.19	7.88	3.90	329.00	53.93

APPENDIX 4

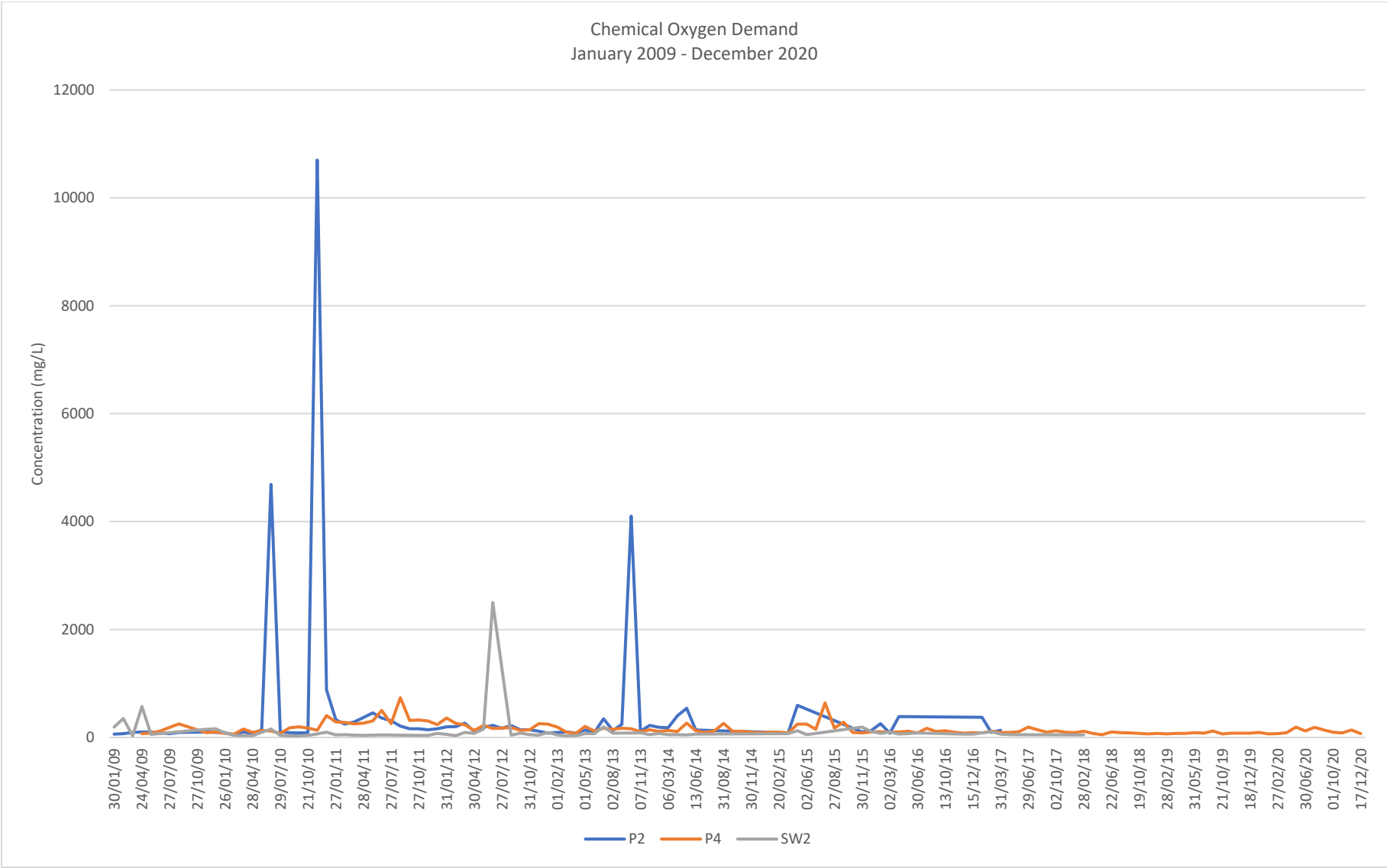
Time Series Graphs



APPENDIX 4

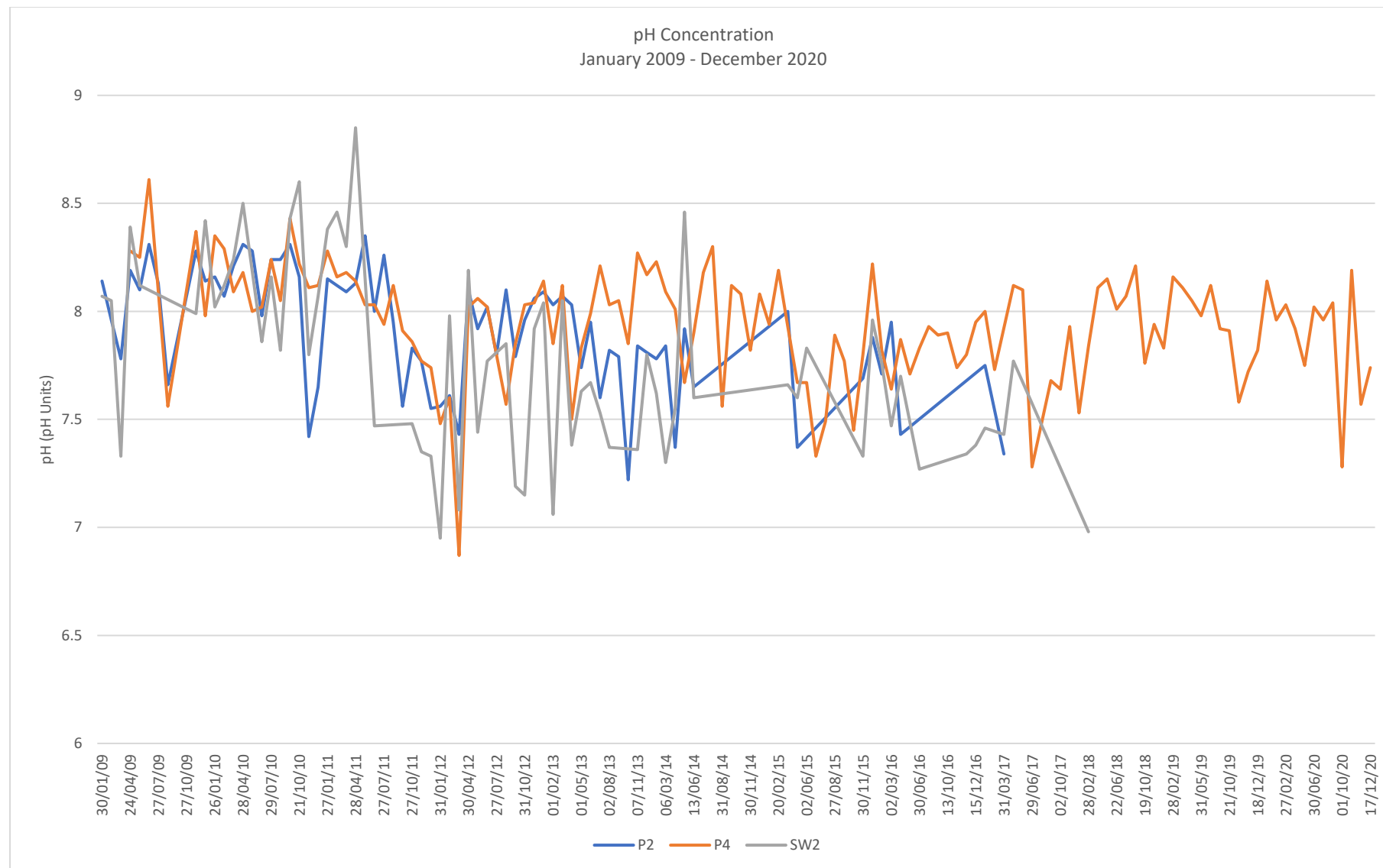


APPENDIX 4

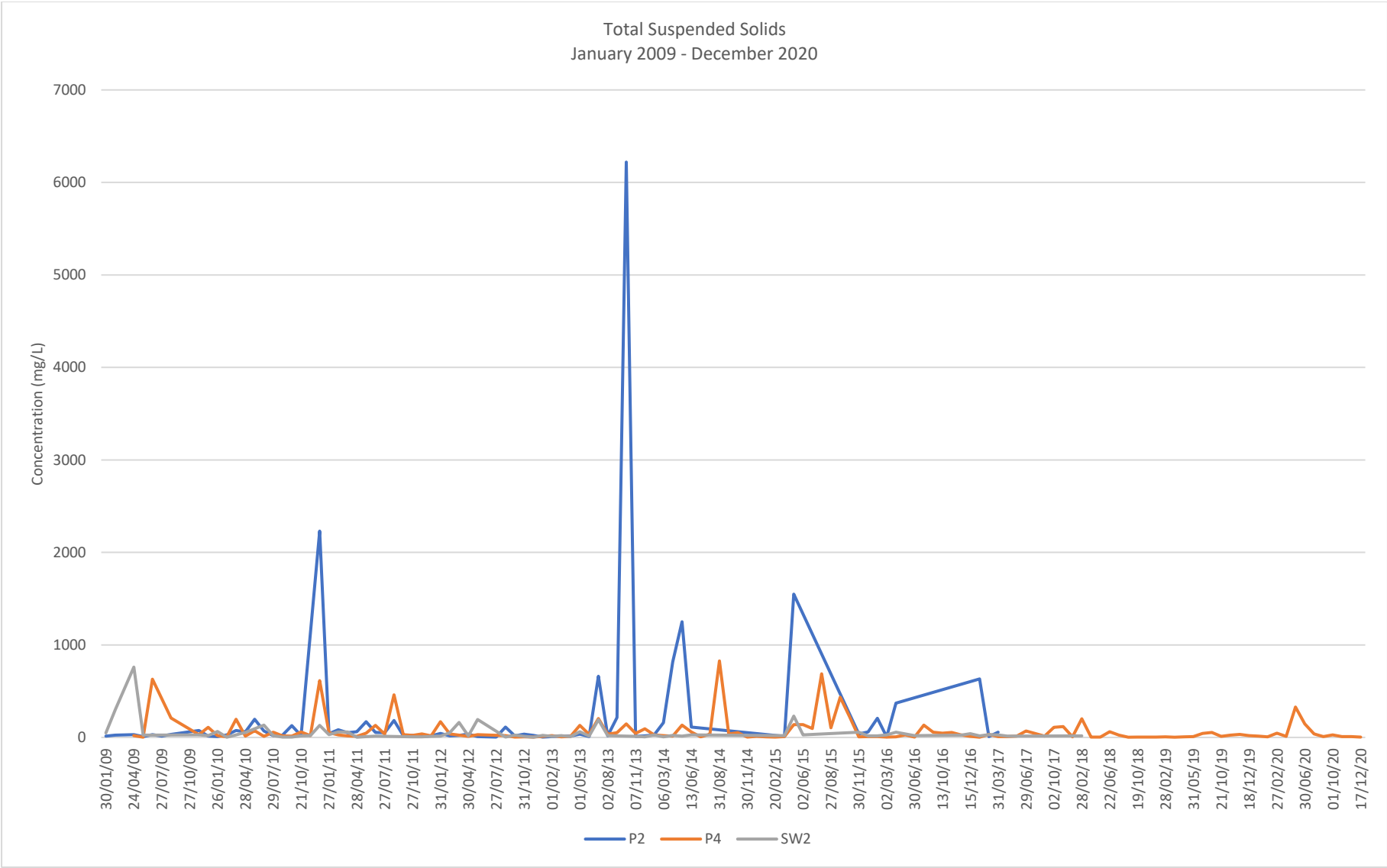


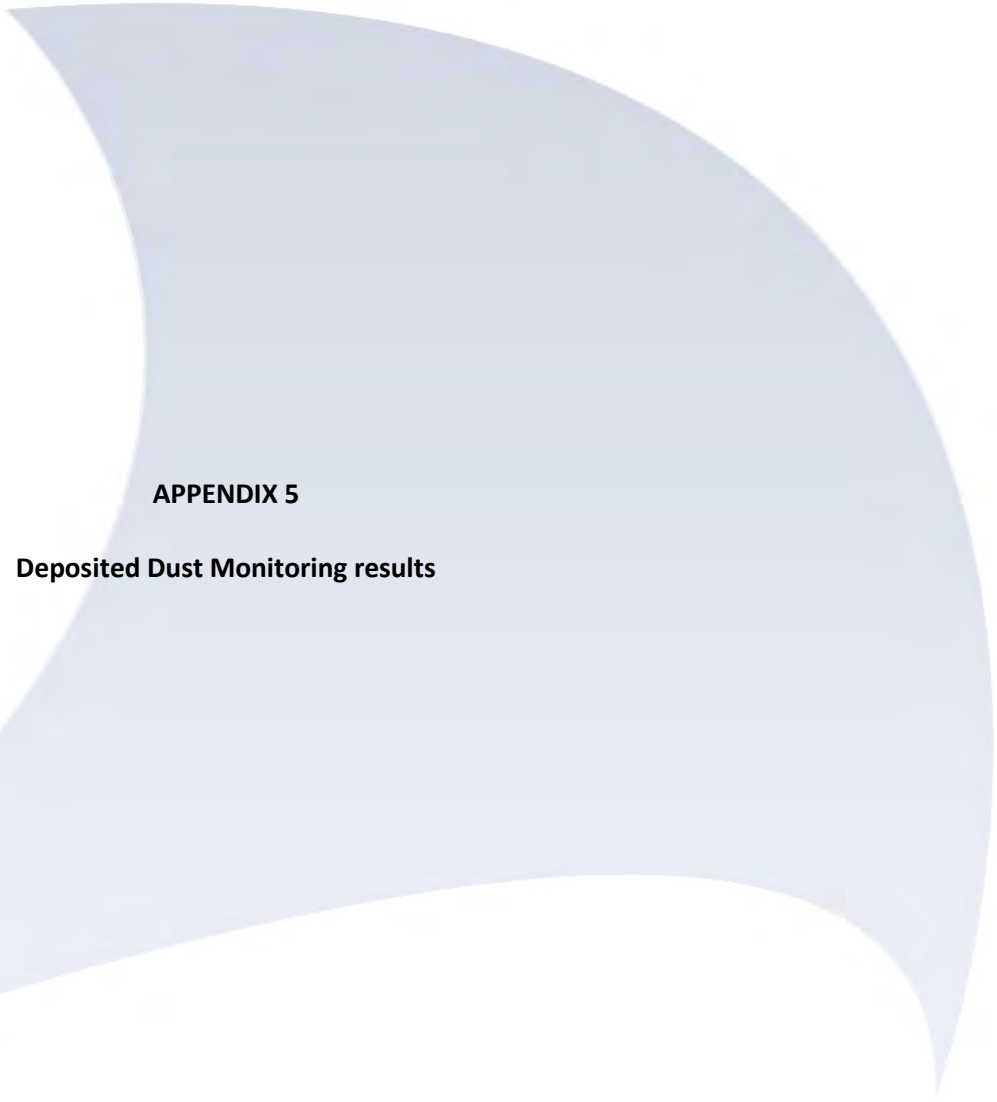
APPENDIX 4

APPENDIX 4



APPENDIX 4





APPENDIX 5

Deposited Dust Monitoring results

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge during the period of:

From: 04/03/2020 To: 08/04/2020
No. of days 35

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3



Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1	700	<10	<7.06
Location 2	720	10.4	7.34
Location 3	650	15.3	10.80

Comments:

► Dust analysis carried out by i2 analytical

Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge located near to electricity meter house.

Location 1: Site Operations - located opposite transfer pad

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm (near road)

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge during the period of:

From: 09/06/2020 To: 14/07/2020
No. of days 35

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3



Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1	4330	34.7	24.49
Location 2	4770	12.8	9.03
Location 3	3690	35	24.70

Comments:

► Dust analysis carried out by i2 analytical

Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge located near to electricity meter house.

Location 1: Site Operations - located opposite transfer pad

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm (near road)

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge during the period of:

From: 02/09/2020 To: 05/10/2020
No. of days 33

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3



Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1		35.1	26.27
Location 2		<10	<7.48
Location 3		20.4	15.27

Comments:

► Dust analysis carried out by i2 analytical

Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge located near to electricity meter house.

Location 1: Site Operations - located opposite transfer pad

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm (near road)

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge during the period of:

From: 09/12/2020 To: 04/01/2021
No. of days 26

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3



Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1	2800	18.7	17.77
Location 2	4750	147	139.65
Location 3	1780	109	103.55

Comments:

- Dust analysis carried out by i2 analytical
- Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge located near to electricity meter house.
- From personal conversation with site staff dust gauge at location 1 was knocked over for an unknown period of time.

Location 1: Site Operations - located opposite transfer pad

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm (near road)



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