Tir John (Phase 2) Landfill

Annual Monitoring Review January - December 2023

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1 Introduction

1.1 Report Objectives

This report has been prepared by Ayesa (Byrne Looby Partners (UK) Ltd) on behalf of Enovert South Limited (Enovert) for the Tir John Phase 2 Landfill. The report provides a review of the environmental monitoring carried out for the Phase 2 portion of the Tir John Landfill Site by Enovert, the site operator, during 2023.

Tir John Landfill Site comprises an area of approximately 36 ha and is situated North of Fabian Way, Port Tennant, Swansea, at National Grid Reference (NGR) SS695936. The Site is located 3 km from Swansea and approximately 1 km from the coast. The Site comprises two separate permitted areas, an older landfill referred to as Phase 1 and the adjoining operational area, Phase 2. Phases 1 and 2 are separated by a high voltage electricity transmission line (and the associated standoff distance) that passes through the combined site. The closed and restored Phase 1 area remains the responsibility of the City and County of Swansea, although daily management has been contracted to Enovert.

This report reviews Phase 2 which comprises the Cells 5 to 17 areas. The original Waste Management Licence SWW14L included permission for the development of Phase 2 as Cells 5 - 14. Following a change to the regulatory framework an application for a PPC Permit was made by Swansea City Waste Disposal Limited in 2004 to enable continued operations within Cells 5 - 14 as well as the development for Cells 15 - 17. The permit was subsequently issued as TP3935LA/A001 in 2007 after a successful appeal. Subsequent variations to the permit were made in 2007, 2012, and 2013.

Swansea City Waste Disposal Ltd applied to transfer the permit to the City and County of Swansea at which point an updated permit was issued as EPR/LP3935EY on the 20/10/2013. There has been a subsequent transfer of the permit to Cory Environmental (Gloucestershire) Ltd and the permit was re-issued as EPR/VP3935AT on 30/09/2015. The permit was varied in February 2018 to change the operator and permit holder to Enovert South Ltd, and varied again in April 2019 to make minor technical amendments and was issued as EPR/VP3935AT/V004. The most recent variation, EPR/VP3935AT/V007, was completed in November 2021 to add 15 European Waste Catalogue (EWC) codes to the permit.

1.2 Site History

The Site was constructed within an area which was originally part of the Crymlyn Bog. Prior to the 18th century, the bog was seasonally grazed. The north to south Glan-y-Wern canal was constructed to facilitate coal mining within the area and the exploitation of coal seams within the valley. There are a series of former coal drifts in the vicinity of the Site, one of which coincides with a depression and forms a spring on the western boundary of the closed site. There is a similar feature 150 m to the north.

A coal fired power station was constructed on the footprint of Phase 1, resulted in the generation of large quantities of Pulverised Fuel Ash (PFA). This ash was deposited as a platform above the Crymlyn Bog to the east of the power station platform. The PFA platform continued to be extended until the mid-1980s and forms the subgrade beneath the footprint of Phase 2 Cells 5 to 15.

In parallel to the later stages of PFA disposal, there was also the disposal of inert waste in the east of the Site area (under the footprint of Cells 16 and 17 of Phase 2). These disposal operations gradually expanded to also include domestic and other non-hazardous wastes from 1979 until the waste management operations were formalised and regulated under the 1985 planning permission which formally authorised the Phase 1 landfill.

Landfilling operations have been undertaken at the site since 1953 in unlined cells and prior to that PFA had, since 1935, been deposited. There has therefore been 50 years of disposal within the permitted area prior to the construction of the first containment cell. Phase 1 was operated between 1985 and the early 1990s for the permanent disposal of municipal, degradable commercial and industrial, inert wastes, within engineered containment cells. Operations then transferred to Phase 2. However, the previously deposited inert wastes below Cells 5 to 15 were largely removed prior to cell formation and it is known that when the baling machinery was not operating in Phase 1, other wastes were deposited over the footprint of Cell 16 and Cell17 areas, i.e. the current and permitted future operational cells and remain in place.

Consequently, there are wastes deposited outside of (which pre-date) the footprint of the permitted landfills' engineered containment and which lies directly above organic rich sediments.

1.3 Site Setting

The Site is located within the Crymlyn Bog, a lowland peaty fen which was the former estuary of the River Clydach and the River Neath. The historically placed PFA is present below much of the waste in Phase 1 where it was pushed out into the bog and overlies the natural superficial alluvial deposits, comprising interbedded peat, clay, silt, sand and gravel layers. The Carboniferous South Wales Lower Coal Measures Formation underlies the alluvium and forms the sides of the valley to the west of the Site.

Topographically the ground falls from over 80 mAOD to the west of the Site to ~10 mAOD within the Crymlyn Bog. The local hydrogeology is controlled by springs along the western edge of the valley, which discharge into the Crymlyn Bog. The spring water contributes to the easterly and south-easterly gradient towards the coast. The springs, including the GDW023 spring forms localised groundwater mounds from the valley slopes at the western boundary of the closed site. This spring discharges into the PFA and alluvium that underlie the Site.

It is considered likely that the placement of the PFA has increased the compaction of the in-situ peats (i.e. the original bog sediments) and the low permeability alluvial clay.

1.4 Site Engineering

PFA underlies the Phase 2 Cells 5 – 15 area, with other wastes also underlying the Cell 16 – 17 footprint (Cells 1 - 4 are part of Phase 1 and are discussed separately). Consequently, there are wastes deposited outside of (and pre-dating) the footprint of the permitted landfills' engineered containment. These ash and waste materials lay directly above organic rich sediments. Regulatory and best practice engineering changes have driven the evolution of the Phase 2 containment and leachate management design over the operational life of the Site.

The earliest Phase 2 cells (Cells 5 - 11) are lined with a Geosynthetic Clay Liner (GCL) with an overlying 300 mm stone drainage blanket. The GCL was placed directly above a shaped PFA formation layer.

For Cells 12 - 14, a rock fill was placed above the PFA to raise the base of the landfill to achieve the desired elevation. The rock fill was overlain by a geotextile to separate the rock fill from a 100 mm gritstone formation layer to a 300 mm thick Bentonite Enriched Sand (BES) artificial geological barrier. Cells 12 - 14 are then lined with an artificial Geosynthetic Clay Liner (GCL). Leachate is collected via a 300 mm quarry gritstone fines drainage layer above the GCL.

Cell 15 construction includes a 300 mm thick 20-40 mm gravel drainage layer, with inset drainage pipes above a HDPE liner. There is a leak detection layer above the 500 mm BES artificial geological barrier, which was placed above a 4 m formation layer constructed from imported quarry overburden. Prior to the installation of artificial geological barriers at Cell 16, a groundwater monitoring and control system was installed.

Phase 2 Cells 5, 10, 11, 13 and 14 have been permanently capped with a LLDPE geomembrane. Cells 6 - 8 have a GCL cap, whilst Cells 9 and 12, which abut the operational Cell 16 area have a temporary cap. Cell 15 was capped with GCL during 2021. Cell 16 finished tipping on 29 September 2023 and is awaiting capping and restoration. During 2022 the lower flank of Cell 16 was capped with GCL to connect to Cell 15 and Cell 8. These works continued into 2023.

1.5 Site Activities

Disposal of non-hazardous wastes took place in Cell 16 during 2023, with tipping finished on 29 September. Disposal operations began in Cell 16 in March 2019 as a continuation of the Cell 15 operations.

Enovert's Operating Procedures (SHE-OP-01 – Waste Acceptance and Control) ensure that wastes are assessed against the relevant permit conditions and waste acceptance procedures prior to being authorised for disposal at the landfill. Each load of waste accepted is inspected visually at the Site. Contaminated land, filter cakes and restoration soils have validation samples taken and sent for laboratory analysis. Waste acceptance test results are compared against the Site permit conditions to confirm waste description/basic characterisation and acceptability for disposal.

During 2023, compliance testing was undertaken on 298 samples, with only three failures of the acceptance criteria. An investigation was undertaken for each failure, with acceptance only resumed where further evaluation of the data and / or additional testing could demonstrate the acceptance framework could be met.

The most recent Hydrogeological Risk Assessment Review was undertaken in July 2018 (TerraConsult Report 10127-R08).

1.6 Environmental Monitoring

Schedule 4 of the permit (Tables S4.2 and 4.3) requires that specific performance parameters are reported. These tables are reproduced below as Table 1 and Table 2. Reported details are for both Phases 1 and 2.

Table 1 Annual Production / Treatment

Table S4.3 Performance Parameters			
Parameter	Frequency of assessment	Annual total	Unit
Potable water used	Annually	2,414	m^3/yr
Energy used (including for leachate treatment)	Annually	131	MWh of electricity
Non-potable water used	Annually	0	m^3/yr

Table 2 Performance Parameters

Table S4.2: Annual production/treatment	
Leachate: Disposed of off-site; Disposed of to any onsite effluent treatment plant;	**Cubic metres/year** 109,620m^3/yr (from entire site) -
Surface water and/or Groundwater: Disposed of off site; Disposed of to any onsite effluent treatment plant	**Cubic metres/year** 127,934m^3/yr (from entire site) -
Landfill gas: combustion in flares; combustion in gas engines; Other methods of gas utilisation	**Normalised cubic metres/year** 1,072,500m^3/yr (from entire site) 2,068,970m^3/yr (from entire site) Nil

Note: Quantities are cumulative volumes including closed site (Phase 1) data

There is no further remaining void space at the Site, with tipping having ceased on 29 September 2023. Settlement figures for 2023 are illustrated on Drawing TJ87.

2 Monitoring Schedule

Enovert South Limited staff carried out environmental monitoring during 2023 at the locations shown on Drawing TJ87 in accordance with the site's Environmental Permit.

3 Gas Monitoring

3.1 In-Waste Gas

3.1.1 Gas Utilisation

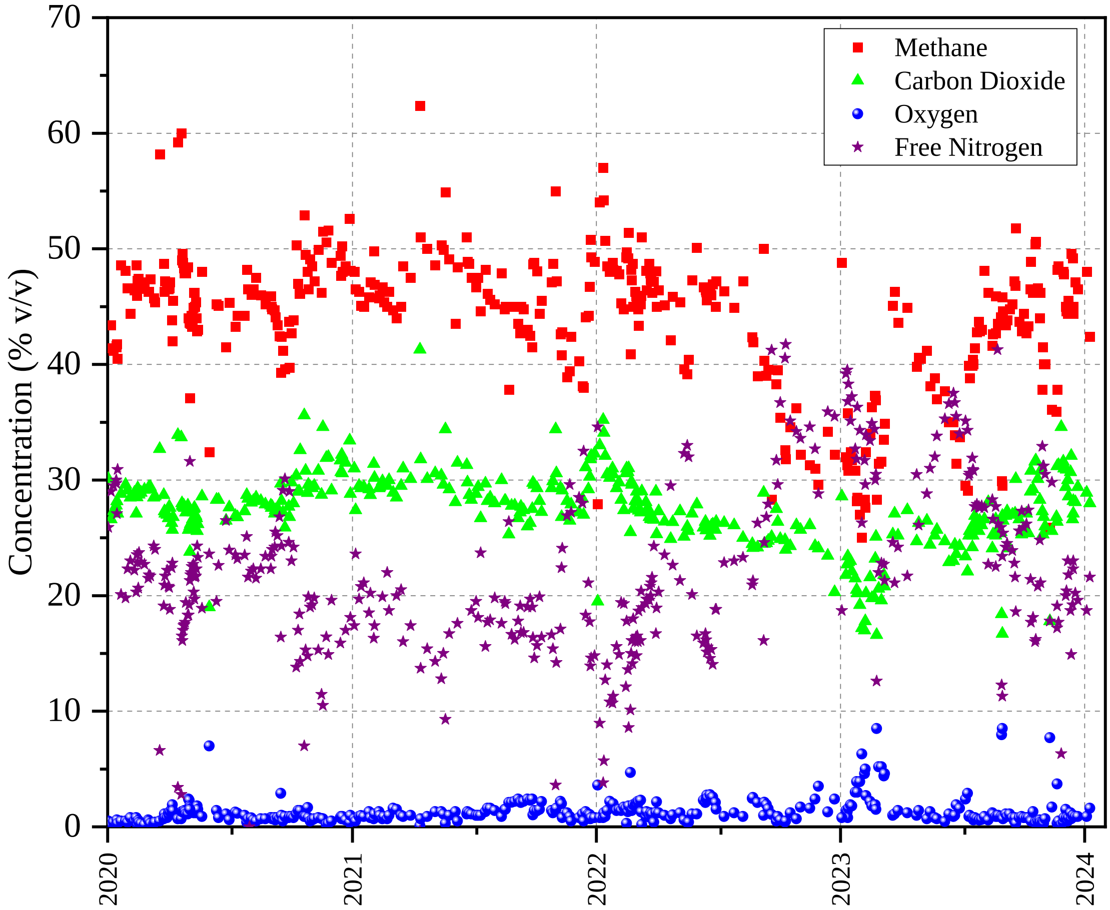
Landfill gas must be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and, to the extent possible, used. The Landfill Directive (99/31/EC) requires that wherever landfill gas cannot be utilised, then it must be flared. Landfill gas at Tir John landfill has in recent years been managed via combustion, principally used to generate renewable energy through a Jenbacher 312 Spark Ignition Engine with a capacity of 150 – 650 m^3/hr.

During 2022 the gas engine failed, and landfill gas was therefore treated through the on-site flare whilst a replacement was acquired. Gas to engines resumed in 2023, resulting in 66% of all gas being used via combustion. The on-site flare is in place as a contingency measure for when the engine is down or being serviced and has sufficient capacity (100 – 1,000 m^3/hr) to treat all landfill gas produced at the Site. Following an extended lead time, the engine was replaced in January 2023 with another Jenbacher 312 Spark Ignition Engine.

Gas yields decreased at the site during 2023 to an average of 359 m^3/hr, with around a third of the landfill gas sent to the flare and the other two thirds sent to the engine.

During 2022, the gas quality at the gas compound declined (reduction in methane and increase in nitrogen) due to the additional contribution from Cell 16 and increased abstraction (Figure 1). This decline continued into the early part of 2023, before gas quality improved for a short time in late March. Through to June there was another reduction in gas quality, however for the second half of the year gas quality has been back to levels since from 2020 through to the end of 2022, due to the development of methanogenic conditions within the youngest cells and the further extension of the cap at the Site.

Figure 1 Gas Quality at the Gas Management Compound



3.1.2 Gas Collection System

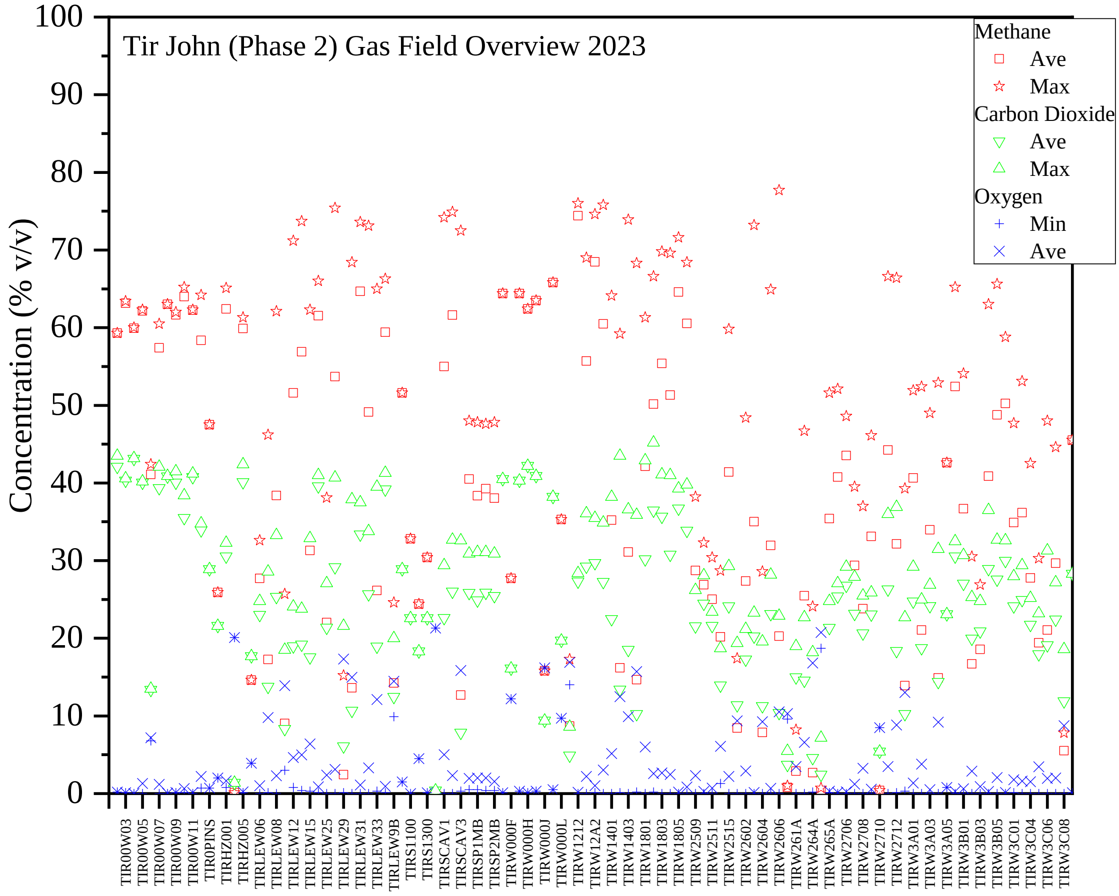
Gas quality and pressure measurements are carried out at the Site whilst the system is being balanced to optimise gas collection, prevent emissions and minimise the potential for oxygen ingress into the Site. The Tir John landfill gas (Figure 2) is typically a mixture of 40 - 70% methane with 20 - 40% carbon dioxide and typically negligible oxygen.

Carbon monoxide was consistently reported below 100 ppm throughout 2023 with a maximum of 29 ppm reported. Dräger-tubes have previously been used by Enovert and have demonstrated that there are often false positives reported by the gas analysers used to complete the routine monitoring.

Hydrogen sulphide levels were consistent with that expected for non-hazardous landfill cells and was reported at a maximum of 1,286 ppm during 2023. There were no odour complaints and hydrogen sulphide has remained negligible within the perimeter monitoring wells throughout 2023. Furthermore, site staff are required to carry personal gas alarms at the site for their own protection. No further assessment is therefore considered necessary.

Occasional elevated oxygen levels in excess of 5%v/v were identified at some in-waste wells during 2023 (Appendix B), with a high of 22.2%v/v recorded. Where identified, initial investigative steps taken to reduce the elevated concentrations of oxygen are to re-balance the affected well and any surrounding wells. If required, repairs are also made to pipework and seals.

Figure 2 In-Waste Landfill Gas Quality



3.2 Surface Emissions

Surface emission surveys were undertaken in September 2023. The survey was carried out to determine gas concentrations directly above the capped and temporary capped surfaces at the Site. Enovert uses a data logging system with GPS to allow the direct transfer of the FID route surveyed to site plans and hence identify areas of the cap which may require remediation. Discrete features, such as abstraction wells and transfer pipework were also surveyed.

The survey was carried out according to the objectives of Environment Agency guidance LFTGN07. Section 2.7 of LFTGN07[1] states that "*providing subsequent annual walkover surveys of that area demonstrate the surface concentration limits in air are less than 100 parts per million by volume (ppmv) immediately above the surface on the main zones of the cap and less than 1,000ppmv close to any discrete feature, you do not need to carry out subsequent flux box measurements to quantify emissions*".

[1] Environment Agency (2010) Guidance on monitoring landfill gas surface emissions. LFTGN07 v2 2010

The survey demonstrates that there is generally good gas control at the site with low emissions (i.e. <10ppm) occurring across the majority of the surveyed area. Emissions in the range 100–499 ppm were identified adjacent to discrete features such as leachate chambers in the north-east of the Site. Given that the higher readings observed occurred adjacent to a discrete feature they are not considered to be significant, and no further actions are required.

More significant emissions in the 100 to >1,000 ppm were identified above the operational areas of the Site which is consistent with these areas being uncapped.

3.3 Perimeter Gas

Ground gas was monitored at 11 perimeter locations surrounding Phase 2 in 2023. A summary of the data collected is provided within Table 3.

The Site is located within the Crymlyn Bog, a lowland peaty fen that contains a biologically active soil microbial community. As a consequence of the site's location, the background soil biogeochemistry is complex and subject to a number of influences including temperature, soil saturation (including marsh areas) and seasonal or weather dependent transitions. This is further complicated by the historical placement of wastes prior to the construction of the containment cells.

Table 3 Perimeter Ground Gas Summary 2023

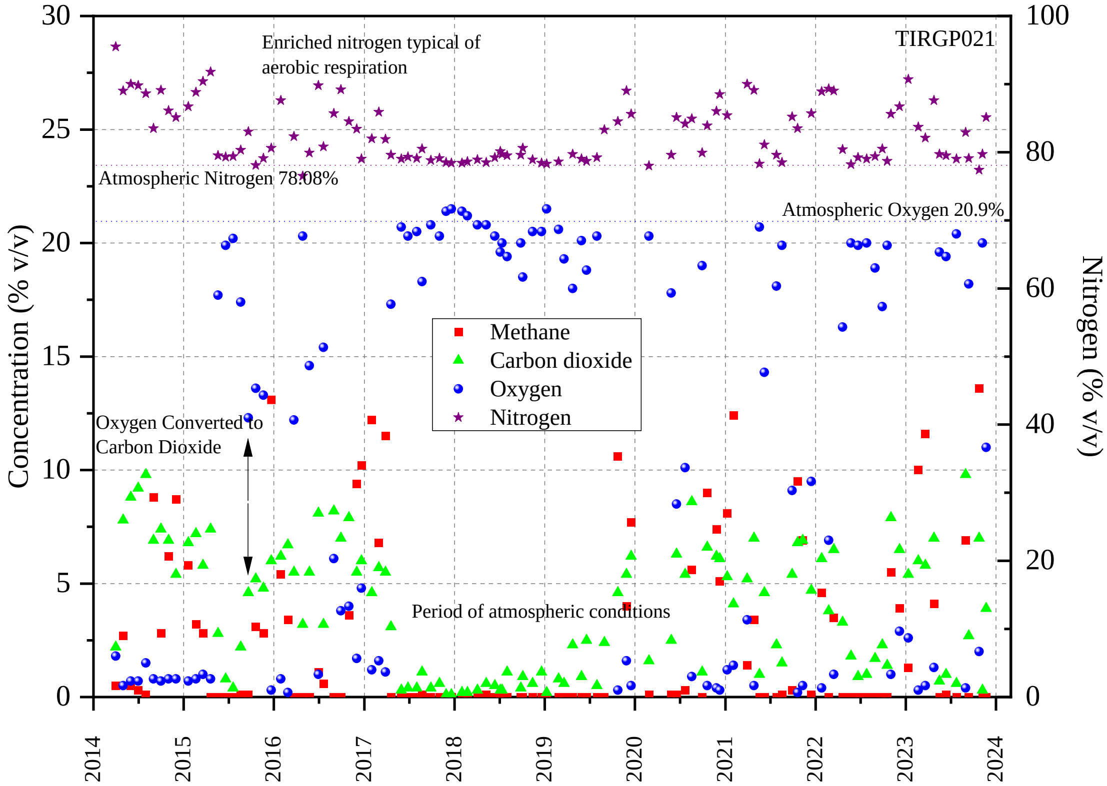
Location	Methane		Carbon Dioxide		Oxygen	
	Ave	Max	Ave	Max	Ave	Max
	%v/v		%v/v		%v/v	
TIRGP013	0.0	0.1	0.4	1.8	20.3	20.8
TIRGP014	0.0	0.1	5.3	9.9	14.2	20.8
TIRGP015	0.0	0.1	5.9	9.2	13.0	16.6
TIRGP016	0.0	0.1	9.0	12.3	9.6	13.8
TIRGP017	0.0	0.1	2.9	4.4	17.4	19.2
TIRGP018	0.0	0.1	5.0	10.2	15.1	20.8
TIRGP019	0.0	0.1	3.6	7.6	17.8	20.7
TIRGP020	0.0	0.3	5.5	9.6	12.9	20.1
TIRGP021	4.0	13.6	4.2	9.8	9.6	20.4
TIRGP022	0.0	0.2	0.7	1.9	19.5	21.4
TIRGP023	0.0	0.1	3.1	11.9	14.8	21.1

Shaded Cells indicate methane above 1% v/v.

Methane is typically negligible within perimeter monitoring wells with the exception of TIRGP021 located in the south-eastern corner of the Site, adjacent to Cell 6. During 2023 methane was recorded at a maximum of 13.6 %v/v in October. The reported data is consistent with the historical dataset for this location (Figure 3).

Methane in TIRGP021 follows a seasonal pattern with elevated concentrations observed in the wetter winter months. A maximum methane concentration of 10.6 %v/v was recorded in October 2019, and this was followed by a maximum of 9 %v/v in October 2020, 12.4 %v/v in February 2021 and 5.5 %v/v in November 2022. These spikes with the ground gas profile may be attributable to conditions conducive to anaerobic respiration under optimal seasonal moisture and temperature ground conditions. It is noted that the highest methane concentration in 2023 coincided with a notably wet period, following on from Storm Babet and an especially wet October in the UK which was the wettest in at least the past 25 years[2].

Figure 3 Ground Gas Profile TIRGP021



Although there is the cyclic observation of methane and carbon dioxide at TIRGP021, the ground gas profile (Figure 3) demonstrates that the atmospheric gases are not purged from the ground when methane is present. The observation of nitrogen enrichment is consistent with natural processes; the most likely of which is microbial respiration resulting in a direct conversion of oxygen to carbon dioxide. In this process nitrogen is replenished from air ingress into the soil to replace the respired oxygen and hence is enriched compared to the atmosphere. It is considered likely that as methane continues to be observed during periods of seasonally higher groundwater recharge, then ground conditions were perhaps not favourable to such an in-situ regime during autumn 2017 and 2018, allowing greater free exchange of atmospheric gases into the ground.

Methane was recorded at or below 0.3 %v/v at all other monitoring points during 2023.

Carbon dioxide is typically in the 2.5 %v/v to ~15 %v/v range at the perimeter monitoring locations (Figure 4). The majority of perimeter monitoring locations (TIRGP013 – 020) have a ground gas profile consistent with aerobic respiration, i.e. nitrogen enrichment along with oxygen conversion to carbon dioxide (Figure 5).

[2] https://www.gov.uk/government/publications/water-situation-national-monthly-reports-for-england-2023/water-situation-october-2023-summary

Figure 4 Perimeter Carbon Dioxide Summary

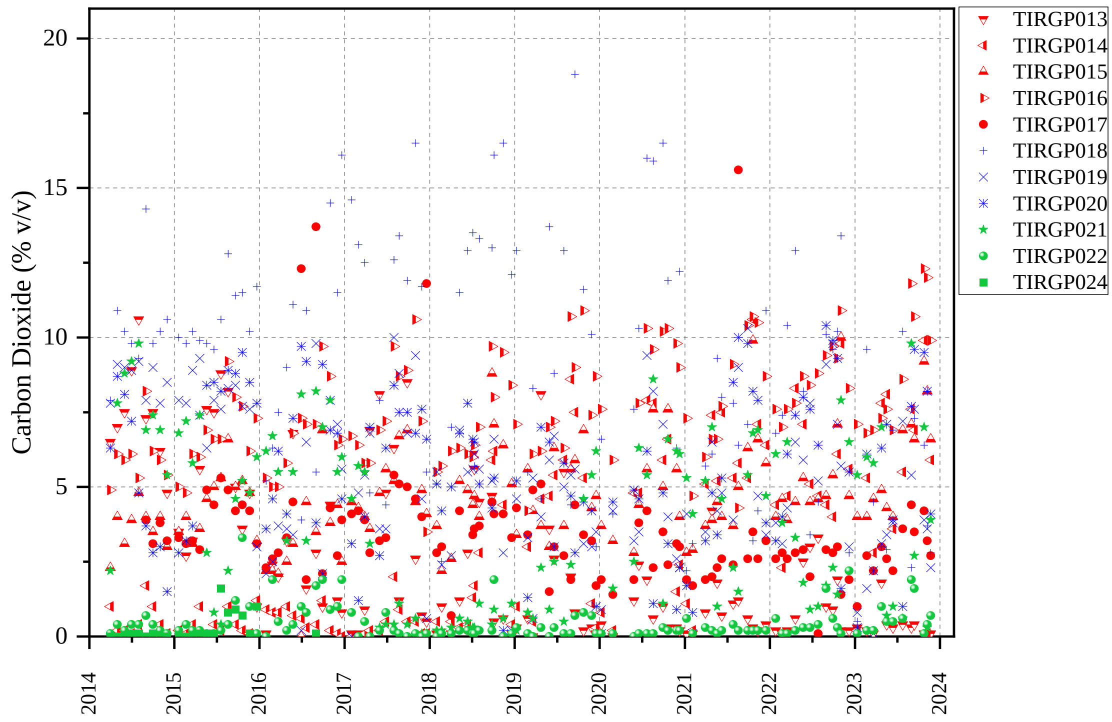


Figure 5 TIRGP015 Ground Gas Profile

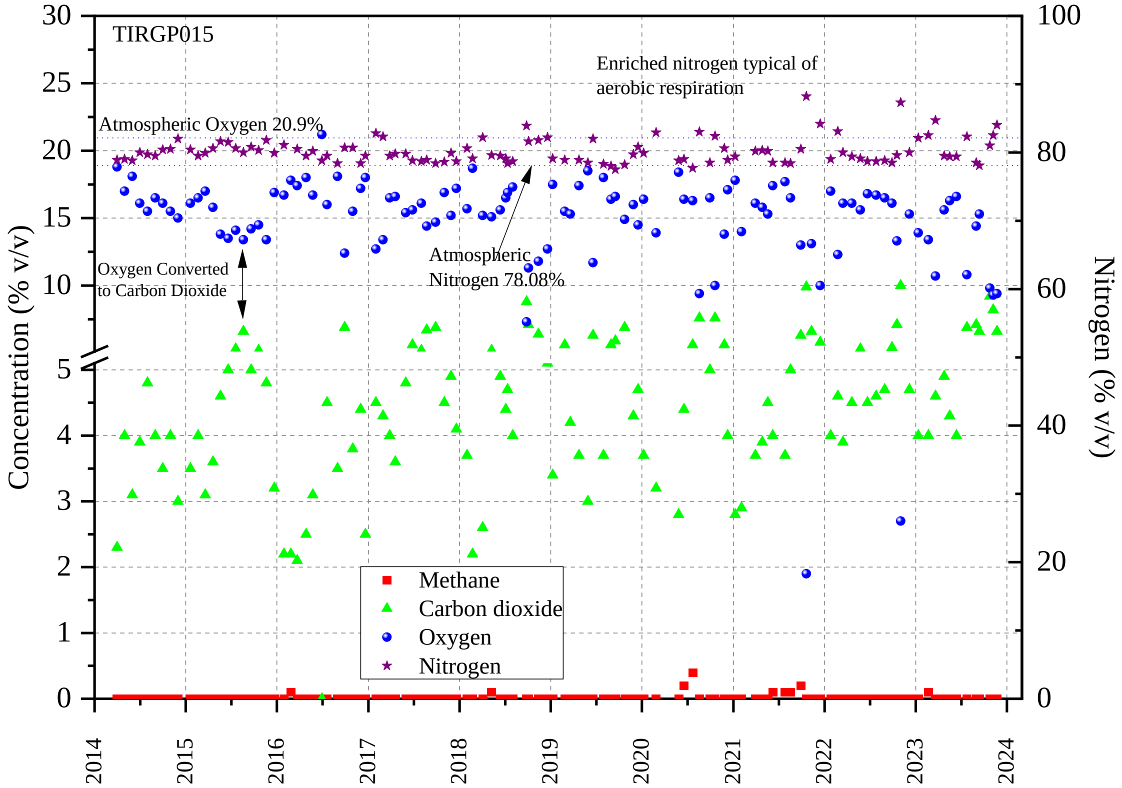
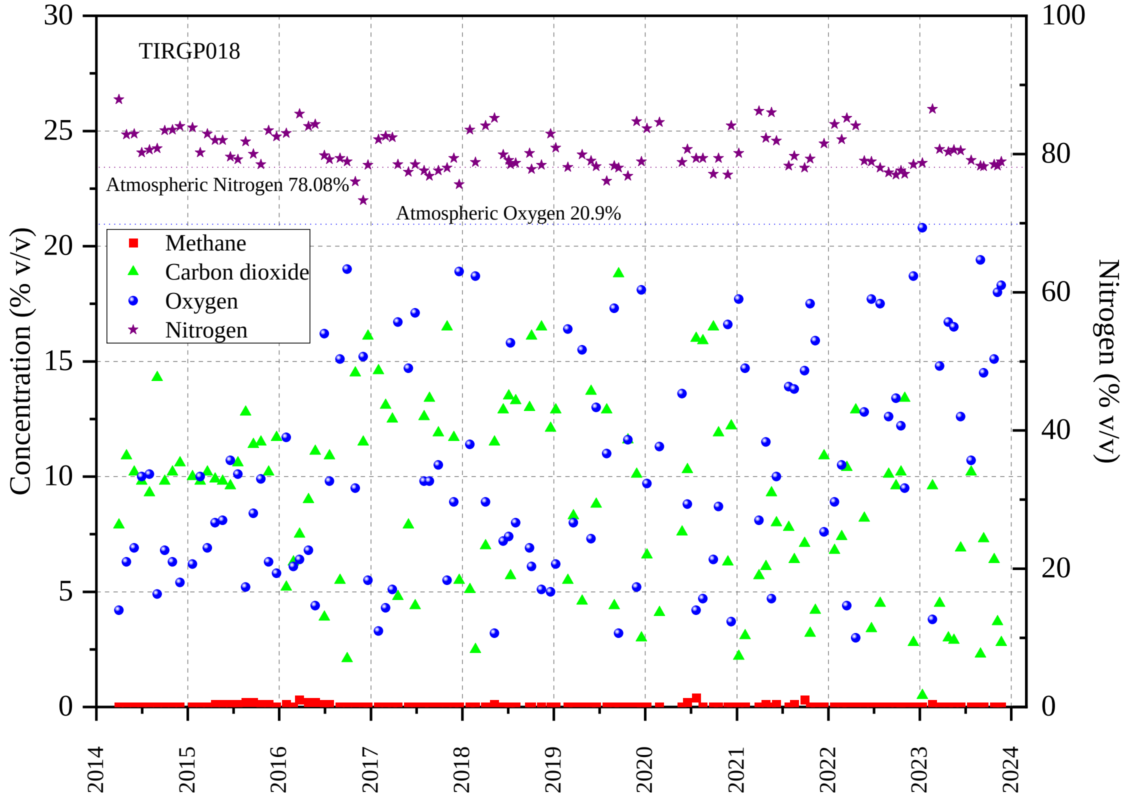


Figure 6 TIRGP018 Ground Gas Profile



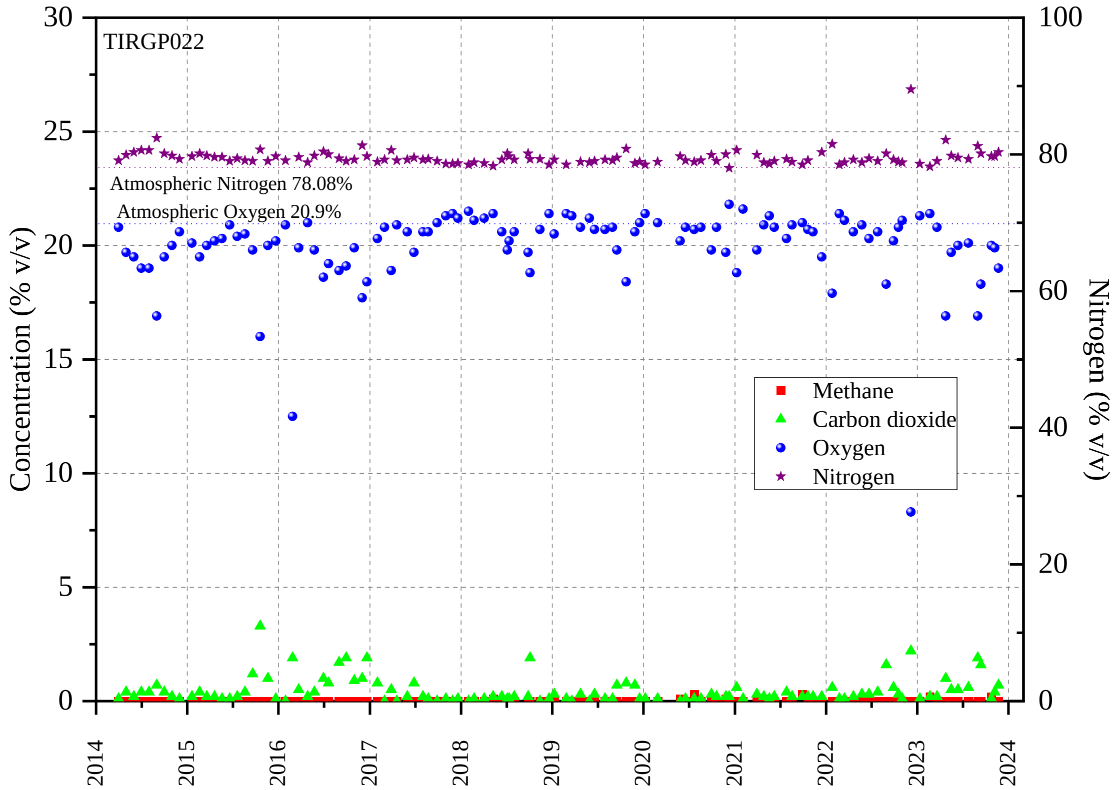
TIRGP018 (Figure 6) has a generally higher baseline carbon dioxide content (at 10 – 19 %v/v) than the other locations and follows a cyclical trend which has continued throughout 2023. The reported data at TIRGP018 is within the historic range and there are no increasing trends in carbon dioxide or methane. Carbon dioxide in 2023 was typically below 10 %v/v. TIRGP016 also has an average carbon dioxide concentration, 9.0 %v/v in 2023, however there is less fluctuation in the data range at this location compared to TIRGP018. Carbon dioxide is typically observed in the 5-10 %v/v range in TIRGP016.

TIRGP18, TIRGP16 and the adjacent monitoring points (GP17 and GP19) are installed physically lower than the base of the permitted landfill site. Therefore, as any migrating landfill gas from the adjacent cells would vent above ground level at TIRGP016 – 18 the ground gas patterns are unlikely to be derived from the Phase 2 landfill.

The monitoring points TIRGP013-20 along the northern section of the site were identified within the 2011 Hydrogeological risk assessment to be located within or directly adjacent to historical inert wastes as well as the Crymlyn Bog. Both regimes could support the types of biological respiration resulting in the observed carbon dioxide and hence explain the monitoring programme observations.

TIRGP22 has a different ground gas profile to the other locations, more closely reflecting atmospheric conditions (Figure 7). TIRGP22 has historically only contained the occasional isolated carbon dioxide peaks in excess of 2 %v/v, displaying a dampened seasonal trend, with otherwise negligible carbon dioxide. Whilst there were more detections of carbon dioxide in 2023, all readings remained below 2 %v/v.

Figure 7 TIRGP022 Ground Gas Profile



3.4 Summary

Methane was negligible in the perimeter monitoring network during 2023 with the exception of TIRGP021, where methane re-occurred over 1 %v/v, reaching 13.6 %v/v in October in response to notably wet weather. Methane has historically routinely been detected during the wetter months at TIRGP021, before depleting in late spring. Carbon dioxide in excess of 5 %v/v was observed almost ubiquitously around the perimeter of the Site.

Neither the methane nor the carbon dioxide is considered to be related to the permitted landfill operations. It is not known if the seasonally observed methane at TIRGP021 a consequence of a biogenic source is influenced by changing moisture conditions resulting in marsh gas generation, or even historical waste disposal activities. The permitted landfill is a land raise constructed above the surrounding modified and natural topography. Consequently, the ground gas monitoring points are located physically below the base of the landfill site and more likely influenced by the Crymlyn Bog and the historical disposal activities than the permitted Phase 2 landfill.

Carbon dioxide at the majority of the monitoring points was elevated above that expected for free draining open granular soils and is associated with a depletion in oxygen in combination with nitrogen enrichment. This is consistent with natural processes, most likely to be sub-surface microbial aerobic respiration, and concentrations are consistent with expectations for a biologically active soil, such as within a peat bog. Notwithstanding this, similar processes could also occur where there is organic matter within the made ground outside of the engineered containment cells.

4 Water Environmental Monitoring

4.1 Leachate

4.1.1 Leachate Levels

A vertical abstraction system was installed during 2017-2018. Previously leachate was managed passively via a gravity drainage system. Leachate continues to be removed from the Site and discharged to sewer.

During 2023, the majority of the site's leachate has been at less than 4 m above the base (Figure 8), an environmentally insignificant level for a site benefiting from an engineered liner. There are some areas where leachate heights are in the 5 – 8 m range however this is within the range modelled as part of the 2018 HRAR.

Leachate elevation at the majority of locations remained consistent with previous years and within the range ~10 – 17 mAOD (Figure 9). TIRLEW31 and TIRLEW32 have continued to be stable throughout 2023 following on from the capping of Cell 15 undertaken in 2020. TIRLEW15A was drilled as a replacement for TIRLEW15 in September 2023. The well features c. 19.2 m of slotted casing, and it is likely that the dips of 27.1 and 28.2 mAOD in November and December are due to perched moisture entering the well higher up and activating the dip meter. The well was drilled with a barrel auger and encountered 20 m of dry waste and only 2.73 m of wet waste.

Figure 8 Leachate Height

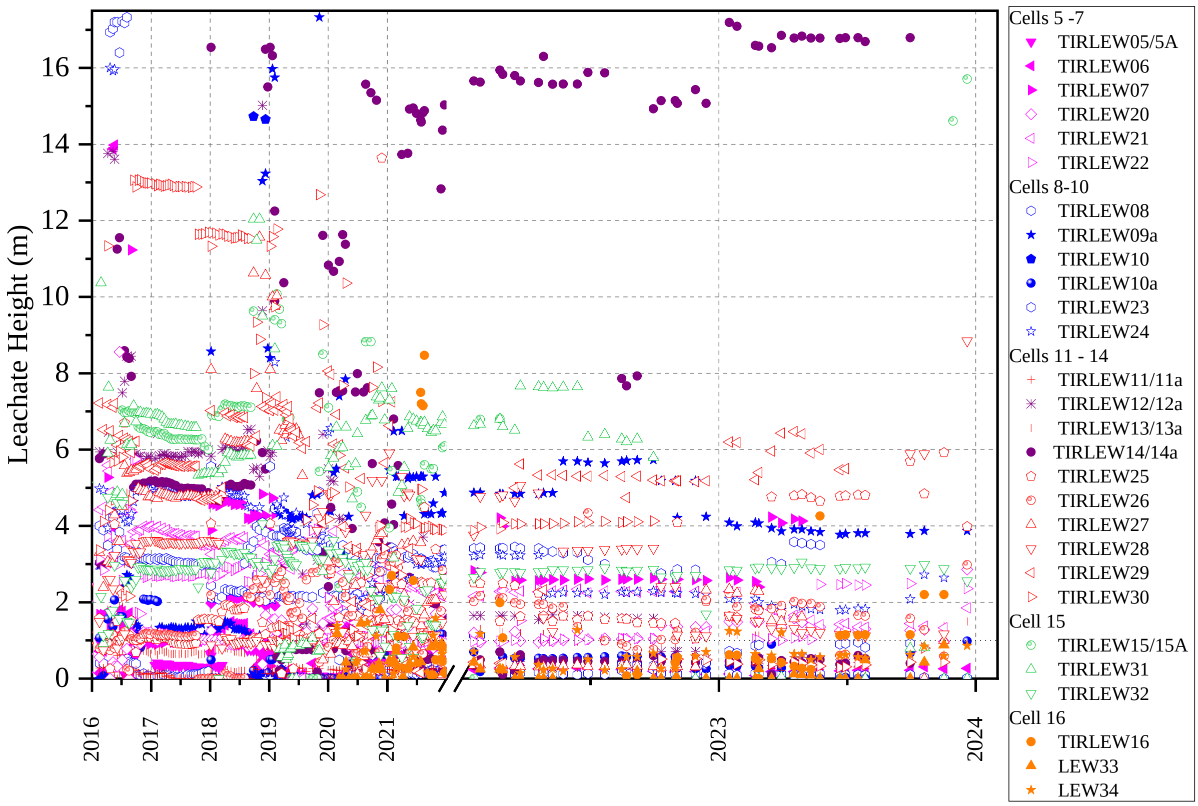
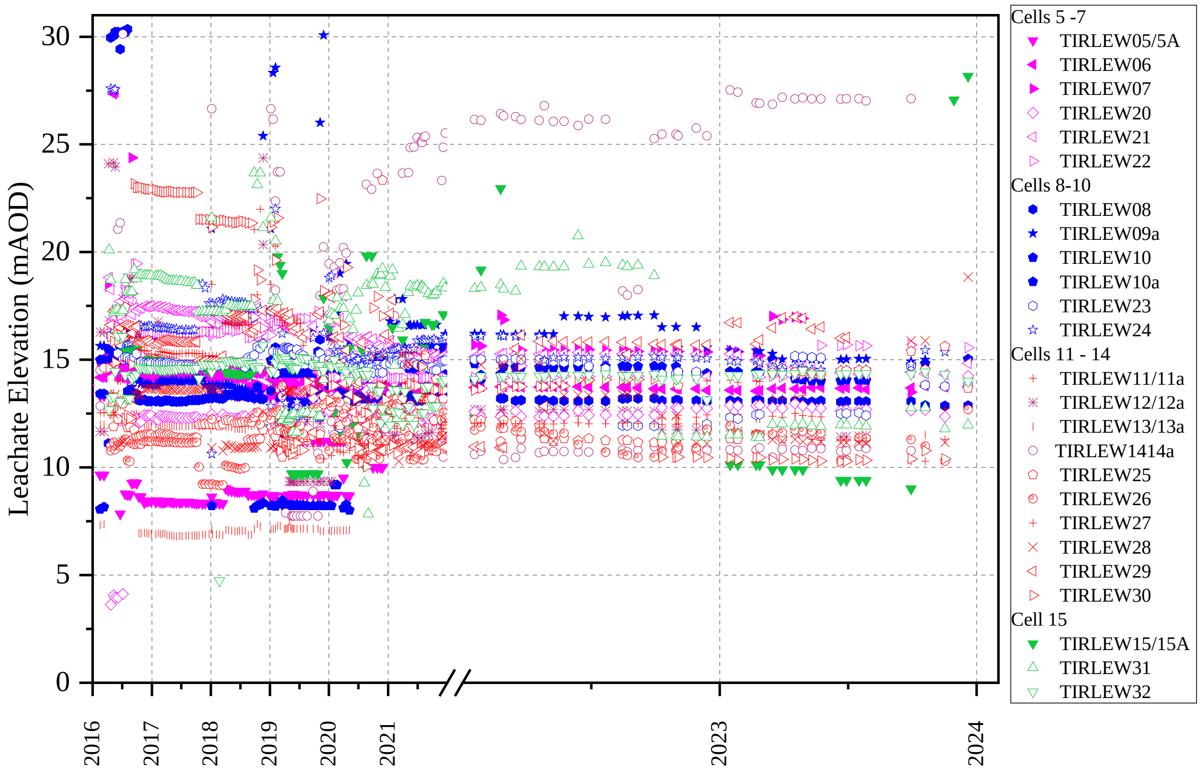


Figure 9 Leachate Elevation (mAOD)



The reported data at TIRLEW14 continues to be significantly elevated compared to the rest of the Site. This monitoring point was blocked by a jelly-like substance, sometimes referred to in the industry as “black goo". The data appears to be representative of a perched layer of moisture above the blockage. The Operator is trialling methods of clearing the blockage, such as the application of bleach; this work is ongoing.

The leachate volume within the site is monitored in two locations for the majority of cells and one location in the smaller cells (Drawing TJ87).

4.2 Leachate Quality

The leachate at Tir John Phase 2 comprises of an ammoniacal-N and potassium rich sodium-bicarbonate-chloride solution with organic components. The strongest leachate (i.e. the highest ammoniacal-N) is present within the youngest cells, i.e. Cell 16, Cell 15 and Cell 12 which neighbour the recently operational area (Table 4). There is a depleted leachate in the older cells with reducing ammoniacal-N and Chloride (Cells 5-7 and Cells 8-10). Due to the reducing strength of the older cells leachate, there is generally a reducing source term in this area of the Site and the pollution potential from Cells 5-7 is declining.

Table 4 Leachate Matrix Constituents 2023

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	Na	K	Cl
			µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Cells 5-7									
LEW05A	25/05/2023	Dry - reported sludge at bottom of well.							
LEW22	25/10/2023	Dry - reported sludge at bottom of well.							
Cells 8-10									
LEW23	25/05/2023	7.2	2700	45	300	14	290	96	300
LEW23	25/10/2023	7.2	3500	19	500	22	370	-	430
LEW25	25/05/2023	7.4	7500	600	610	15	650	230	860
LEW25	25/10/2023	7.3	4300	270	350	56	300	-	420
Cells 11, 13 and 14									
LEW26	23/05/2023	7.1	1500	3.7	78	2.9	120	44	120
LEW26	25/10/2023	7.2	1300	9.2	90	5.2	120	-	95
LEW28	23/05/2023	8.1	1600	0.015	240	4.5	150	50	210
LEW28	25/10/2023	8.1	480	0.026	110	1.5	17	-	17
LEW29	25/05/2023	7.6	4800	370	430	9.5	410	200	420
LEW29	25/10/2023	7.5	4800	310	440	20	340	-	350
Cells 12 and 15									
LEW12a	25/05/2023	8	17000	1600	2200	210	1500	340	2200
LEW12a	25/10/2023	7.9	16000	1800	2500	120	1600	-	2000
LEW31	25/05/2023	7.8	21000	1900	4800	190	1700	650	2500
LEW31	07/11/2023	7.7	17000	1800	4200	150	1700	-	2500
Cell 16									
LEW16	25/10/2023	7.9	16000	1600	5300	2900	2000	-	2100

The priority metal and metalloids are also typical of a non-hazardous leachate (Table 5). Mercury continues to remain below detection limits during 2023. Arsenic was reported at 0.0036 – 0.063 mg/l and typically remained below the EQS of 0.05 mg/l throughout 2023 (two samples, from Cells 12 and 15 in May, were slightly above the EQS).

Cadmium is typically reported below the limit of detection with the exception of LEW23, LEW26, LEW28 and LEW29. On all subsequent monitoring visits (with the exception of the 0.21 µg/l reading in LEW26 as it was late in the year) cadmium had returned to at or below the limit of detection of 0.02 µg/l.

Copper was found in negligible quantities across the monitoring locations, whilst zinc and lead were reported at higher and more variable concentrations. Lead was reported in the 0.0002 - 0.01 mg/l range while zinc is in the 0.0004 - 0.63 mg/l range, both being consistent with data from previous years.

Table 5 Leachate Priority Metals 2023

Sample Point	Date	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
		µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Cells 5-7									
LEW05A	25/05/2023	Dry - reported sludge at bottom of well.							
LEW22	25/10/2023	Dry - reported sludge at bottom of well.							
Cells 8-10									
LEW23	25/05/2023	0.07	< 0.005	0.0058	0.0038	0.017	0.0045	< 0.0002	0.018
	25/10/2023	0.02	-	-	-	-	0.025	0.0018	-
LEW25	25/05/2023	< 0.02	< 0.005	0.016	0.0022	0.068	0.0134	0.0012	0.023
	25/10/2023	< 0.02	-	-	-	-	0.005	< 0.0002	-
Cells 11, 13 and 14									
LEW26	23/05/2023	< 0.02	< 0.005	0.0012	0.0089	0.015	0.0439	< 0.0002	0.019
	25/10/2023	0.21	-	-	-	-	0.0834	0.0003	-
LEW28	23/05/2023	0.08	< 0.005	0.0026	0.06	0.028	0.0373	0.0005	0.0036
	25/10/2023	< 0.02	-	-	-	-	0.0116	0.001	-
LEW29	25/05/2023	0.02	< 0.005	0.0068	0.0044	0.024	0.0236	0.0003	0.014
	25/10/2023	< 0.02	-	-	-	-	0.0048	< 0.0002	-
Cells 12 and 15									
LEW12a	25/05/2023	< 0.08	< 0.5	0.066	0.14	0.14	0.63	0.01	0.063
	25/10/2023	< 0.08	-	-	-	-	0.016	0.001	-
LEW31	25/05/2023	< 0.08	< 0.5	0.24	0.011	0.25	0.14	< 0.001	0.056
	07/11/2023	< 0.08	-	-	-	-	< 0.0004	< 0.001	-
Cell 16									
LEW16	25/10/2023	< 0.08	-	-	-	-	0.037	< 0.001	-

A hazardous substances screen was carried out in May and October 2023 (Table 6). The non-hazardous herbicide mecoprop was identified the most frequently within the leachate, in the 0.05-52 µg/l range (lower than in 2022) whilst the herbicide dichlorprop was reported at lower concentrations, between 0.19 µg/l and 1.2 µg/l. In contrast to 2022, phenols were only identified as present within Cells 12, 15 and 16 (last year phenols were identified in all of the landfill cells). The older cells contain lower phenol concentrations than younger cells.

Polyaromatic hydrocarbons (PAHs) were observed in the younger cells but were absent from the older cells. Most detections came from well LEW12a. Where reported, PAHs typically remained below the leachate screening level of 10 µg/l and are therefore insignificant within the leachate.

The BTEX substances are volatile and are primarily removed via the landfill gas system, although a proportion does dissolve into solution. Consequently, these are continually formed throughout the stabilisation phase of all organic matter in the presence of moisture. Concentrations of these BTEX substances can be high in young wastes, however, once microbial processes commence their presence within leachates is usually limited as they are readily degradable. Previously, the only significant concentrations were reported in Cell16 (LEW16) which was the last operational cell as a presence is associated with fresh wastes. In 2023, however, leachate in this well was not sampled for organic or hazardous substances due to the presence of a "black goo" blockage in the well, limiting the volume of sample that could be collected.

Table 6 Identified Leachate Organic Substances

Sample Point	Date	Ethylbenzene	Toluene	m,p Xylene	o-xylene	1,2,4-Trimethylbenzene	Naphthalene	p-isopropyltoluene	Pentachlorophenol	Phenol	Dichlorprop	Mecoprop	indeno(1,2,3-cd)pyrene	benzo(a)pyrene	benzo(b)fluoranthene	benzo(ghi)perylene	benzo(k)fluoranthene
		µg/l															
Cells 5-7																	
LEW05A	25/05/2023	Dry - reported sludge at bottom of well.															
LEW22	25/10/2023	Dry - reported sludge at bottom of well.															
Cells 8-10																	
LEW23	25/05/2023	< 3	< 3	< 3	< 3	< 3	< 0.01	< 3	< 0.05	< 10	< 0.02	0.78	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW23	25/10/2023	-	-	-	-	< 3	-	-	-	< 10	< 0.02	0.3	-	< 0.01	-	-	-
LEW25	25/05/2023	< 3	< 3	< 3	< 3	< 3	< 0.01	< 3	< 0.05	< 10	0.19	52	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW25	25/10/2023	-	-	-	-	< 3	-	-	-	< 10	< 0.02	14	-	< 0.01	-	-	-
Cells 11, 13 and 14																	
LEW26	23/05/2023	< 3	< 3	< 3	< 3	< 3	< 0.01	< 3	< 0.05	< 10	< 0.02	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW26	25/10/2023	-	-	-	-	< 3	-	-	-	< 10	< 0.02	0.05	-	< 0.01	-	-	-
LEW28	23/05/2023	< 3	< 3	< 3	< 3	< 3	< 0.01	< 3	< 0.05	< 10	< 0.02	0.13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW28	25/10/2023	-	-	-	-	< 3	-	-	-	< 10	< 0.02	< 0.02	-	< 0.01	-	-	-
LEW29	25/05/2023	< 3	< 3	< 3	< 3	< 3	< 0.01	< 3	< 0.05	< 10	< 0.02	4.6	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW29	25/10/2023	-	-	-	-	< 3	-	-	-	< 10	< 0.02	4.7	-	< 0.01	-	-	-
Cells 12 and 15																	
LEW12a	25/05/2023	< 3	< 3	< 3	< 3	< 3	2.58	< 3	< 0.05	15	1.2	42	0.57	0.71	0.98	0.89	0.4
LEW12a	25/10/2023	-	-	-	-	< 3	-	-	-	46	< 0.02	26	-	< 0.01	-	-	-
LEW31	25/05/2023	< 3	10.4	6.4	5.4	< 3	6.75	6.3	< 0.05	15	< 0.02	23	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LEW31	07/11/2023	-	-	-	-	6.7	-	-	-	-	< 0.02	13	-	< 0.01	-	-	-
Cell 16																	
LEW16	25/10/2023	-	-	-	-	< 3	-	-	-	460	< 0.02	1.6	-	< 0.01	-	-	-

Note: detections highlighted in orange.

4.3 Groundwater

Groundwater monitoring is carried out in the bedrock, the *in-situ* superficial deposits and the waste / PFA platform beneath the waste. Groundwater monitoring was undertaken on a quarterly basis during 2023.

4.3.1 Groundwater Levels

Groundwater elevation during 2023 was consistent with the seasonal trends observed in previous years (Figure 10). GDW14 and GDW15 have continued to remain low compared to data prior to 2017, which is likely to be an artefact of groundwater abstraction for the Cell 16 underdrainage programme.

GDW14 and GDW15 are located at the interface of the Cell 16 extension area at the east of the Site. Groundwater elevation has been artificially reduced from 5.8 - 6.2 mAOD in 2015 to ~5 - 5.4 mAOD in 2017 – 2023 (Figure 11). The likelihood is that this is a product of the management of the groundwater via controls designed to induce a minimum unsaturated zone beneath Cell 16 (and also Cell 15 extension) to allow attenuation before entering the saturated horizon. This dewatering sphere of influence is also apparent in adjacent monitoring points. GWD16 and GWD17 which are located to the south-east of Cell 16 and the undeveloped Cell 17 are at the fringes of the dewatering sphere of influence.

Figure 10 Groundwater Elevation

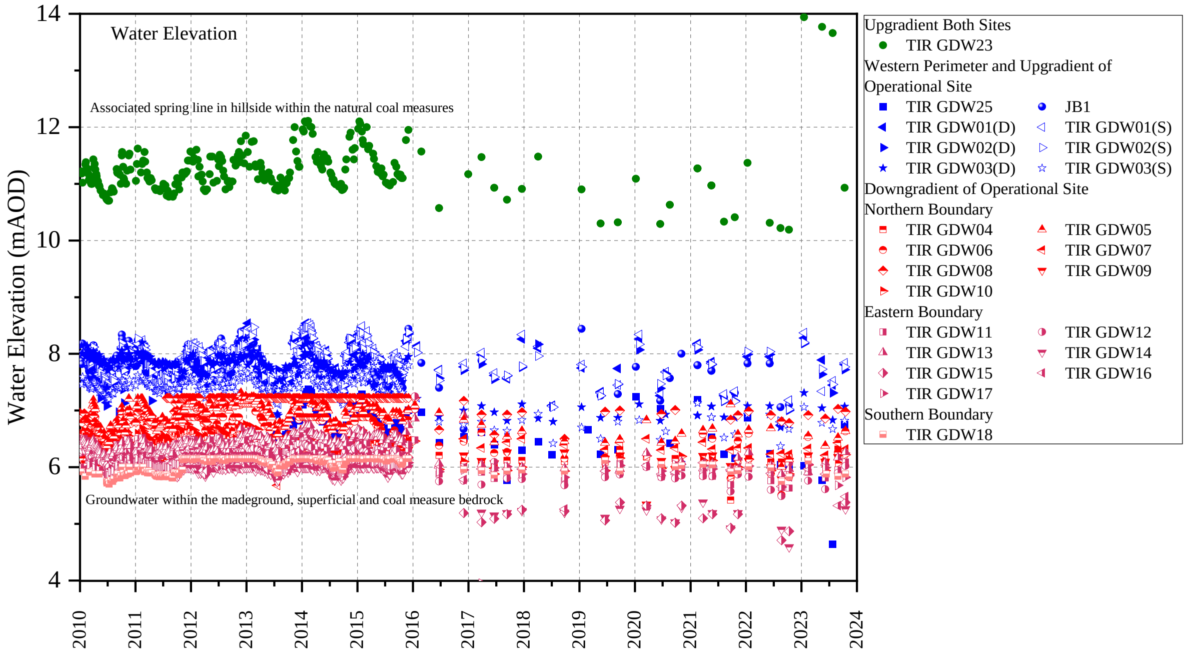
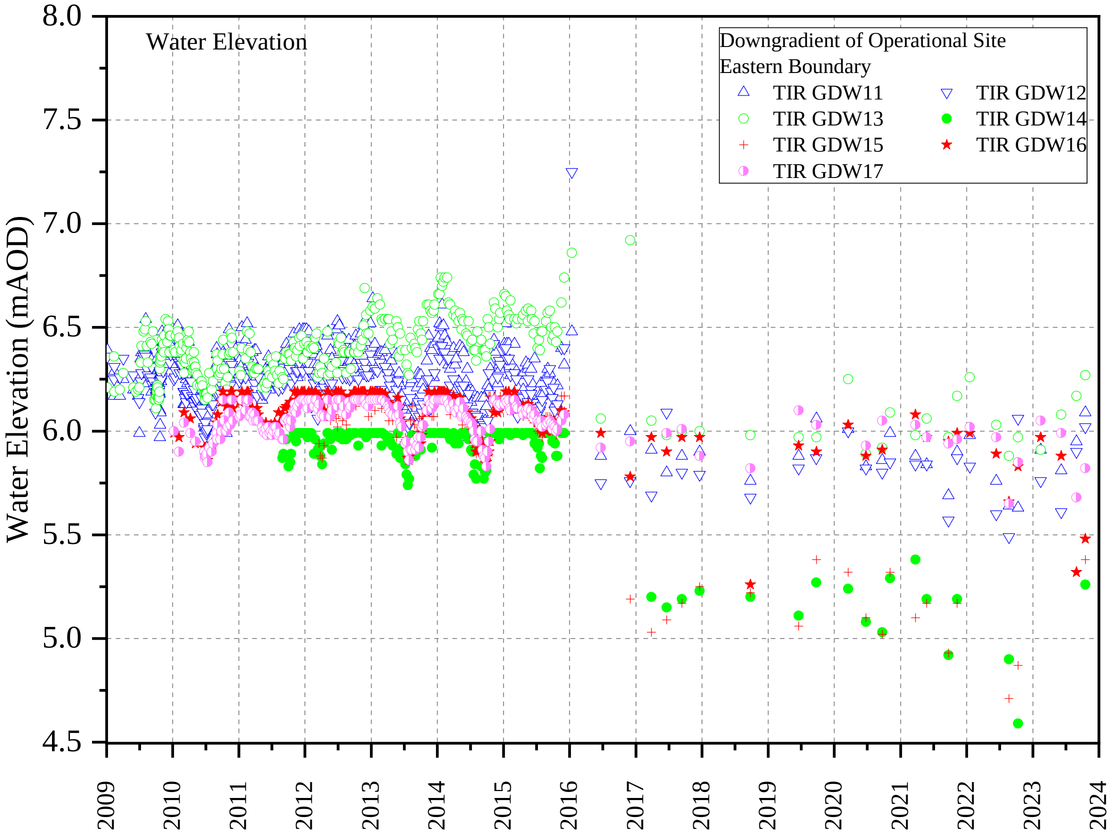


Figure 11 Groundwater Elevation (Eastern Boundary)



A seasonal fluctuation can be observed in the upgradient GDW23 (to the west of Phase 1) and the upgradient locations to the north and west of Phase 2 in the valley feature between the operational and closed phases. The seasonal trends are dampened within the deeper response zone of dual depth monitoring points, as well as on the north, east and south perimeter of the operational site as the groundwater becomes influenced by the groundwater within the bog and the PFA platform.

Groundwater recharge is dominated by springs on the valley slopes to the west of the closed Phase 1 landfill (e.g. GDW23) where groundwater levels are typically between 10.2 mAOD in the summer low and 12.1 mAOD in the winter high. However, in 2023 for the first seven months of the year water levels were between 13.6 and 14 mAOD, before returning to within the normal range in October with a reading of 10.9 mAOD. There is then an easterly fall in groundwater height coincident with the fall of topography from the valley slopes into the superficial alluvial sediment valley fill.

4.3.2 Groundwater quality

Monitoring is carried out for matrix substances (Table 7) and 'typical' leachate indicator substances including ammoniacal-N and chloride. The groundwater is a calcium-bicarbonate solution with secondary sulphate, sodium, potassium and chloride. Additional time series plots for each location are presented in the appendices.

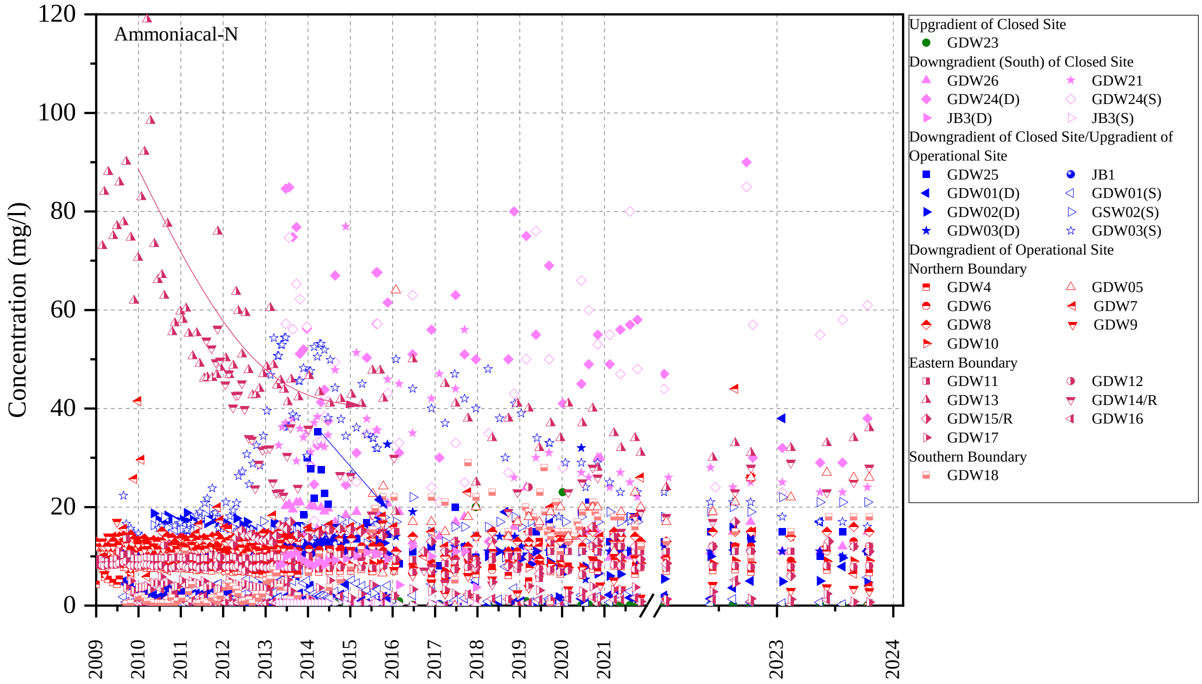
Table 7 Groundwater Matrix Summary (Average 2023)

Location	pH	NH_4-N	Ca	Mg	Na	K	Cl	SO_4
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
GDW01(D)	8.0	17.0	65	33	50	31	39	10
GDW01(S)	8.6	2.2	19	20	42	19	21	83
GDW02(D)	6.9	7.1	163	37	36	23	33	71
GDW02(S)	7.0	23.9	353	76	198	55	175	114
GDW03(D)	6.6	12.0	41	20	20	4	25	1
GDW03(S)	7.6	18.9	117	19	20	17	27	3
GDW04	5.9	7.4	9	5	21	6	29	3
GDW05	7.3	27.2	69	72	280	43	26	3
GDW06	6.5	11.8	68	15	39	10	32	2
GDW07	6.8	10.5	660	73	41	24	64	1710
GDW08	7.0	15.8	170	23	52	14	25	5
GDW09	7.1	3.6	270	110	81	20	67	84
GDW10	7.2	9.6	150	19	34	11	30	2
GDW11	6.8	12.4	150	22	58	10	71	2
GDW12	7.5	8.4	70	68	17	35	22	1
GDW13	6.9	35.6	150	53	96	31	130	3
GDW16	6.2	0.7	29	10	35	7	44	3
GDW17	6.5	1.7	95	23	88	11	173	65
GDW18	7.9	18.4	170	38	80	33	99	39

Table 8 Permit Limit Comparison

Location	NH_4-N			Cl		
	Mean	Max	Limit	Mean	Max	Limit
GDW01(D)	17.0	38	-	39	43	-
GDW01(S)	2.2	7.3	-	21	22	-
GDW02(D)	7.1	13	-	33	45	-
GDW02(S)	23.9	28	-	175	180	-
GDW03(D)	12.0	14	-	25	26	-
GDW03(S)	18.9	22	-	27	29	-
GDW04	7.4	9.2	12	29	31	100
GDW05	27.2	35	25	26	27	100
GDW06	11.8	14	16	32	46	100
GDW07	10.5	16	15	64	92	250
GDW08	15.8	19	20	25	29	100
GDW09	3.6	4.8	16	67	82	100
GDW10	9.6	12	15	30	32	100
GDW11	12.4	15	15	71	76	100
GDW12	8.4	10	12	22	23	100
GDW13	35.6	43	-	130	130	-
GDW16	0.7	1.6	4	44	46	100
GDW17	1.7	3.1	10	173	200	300
GDW18	18.4	23	5	99	110	300

Figure 12 Groundwater Ammoniacal-N



Ammoniacal-N has remained relatively stable during 2023 and consistent with the historical dataset in the majority of monitoring locations (Figure 12). However, it is noted that concentrations in 13 of the 19 locations have on average increased in 2023. The largest average increase was in GDW01(D), which rose by 14 mg/l on average compared to the previous year, although this is heavily skewed by a result of 38 mg/l in January, after which concentrations dropped to 17 mg/l in May and further still to 7.9 mg/l in July. The general increase across most wells is modest and is not indicative of an adverse trend as can be seen by the data shown in Figure 12.

Ammoniacal-N in GDW07 has followed a pattern of a generally consistent fluctuation between 10 and 20 mg/l, interspersed with higher short term reported concentrations in the 25 – 45mg/l range. These elevated spikes were most prominent in the 2009 – 2012 period and reoccurred in 2021 and 2022, before dropping back below 15 mg/l in 2023 (Figure 13). There is no correlation with increasing chloride as would be expected if leachate seepage or spillage had occurred.

During 2023 the permit limit was exceeded on three occasions in GDW05 in June, August and October, at 35 mg/l, 26 mg/l and 26 mg/l respectively (see summary in Table 8). In GDW18, the permit limit was exceeded on all four sampling visits in 2023, at 15 mg/l, 23 mg/l, 18 mg/l and 18 mg/l respectively. There was also one exceedance in GDW07 in June at 16 mg/l.

With regard to the limit at GDW07, it is considered likely that the permit limit exceedance is a result of an incomplete understanding of this background fluctuation, with the limit based on to narrow a dataset.

Figure 13 Groundwater Matrix Chemistry GDW07

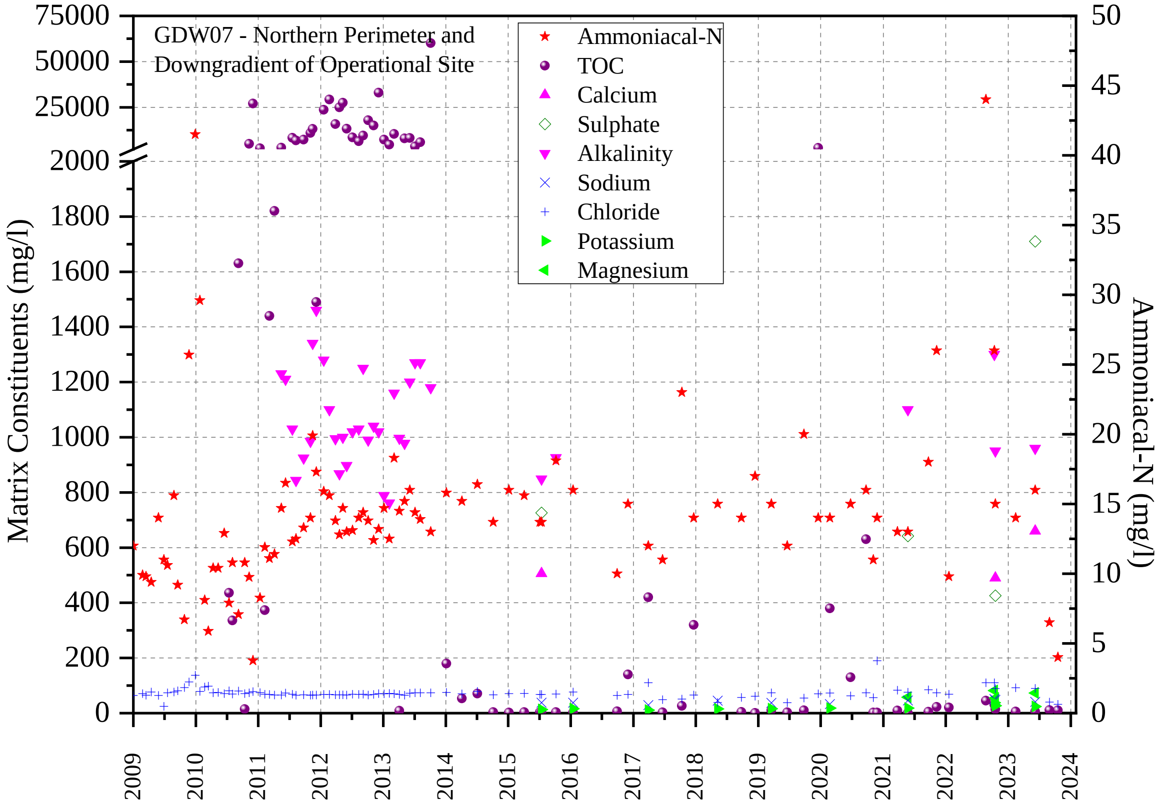
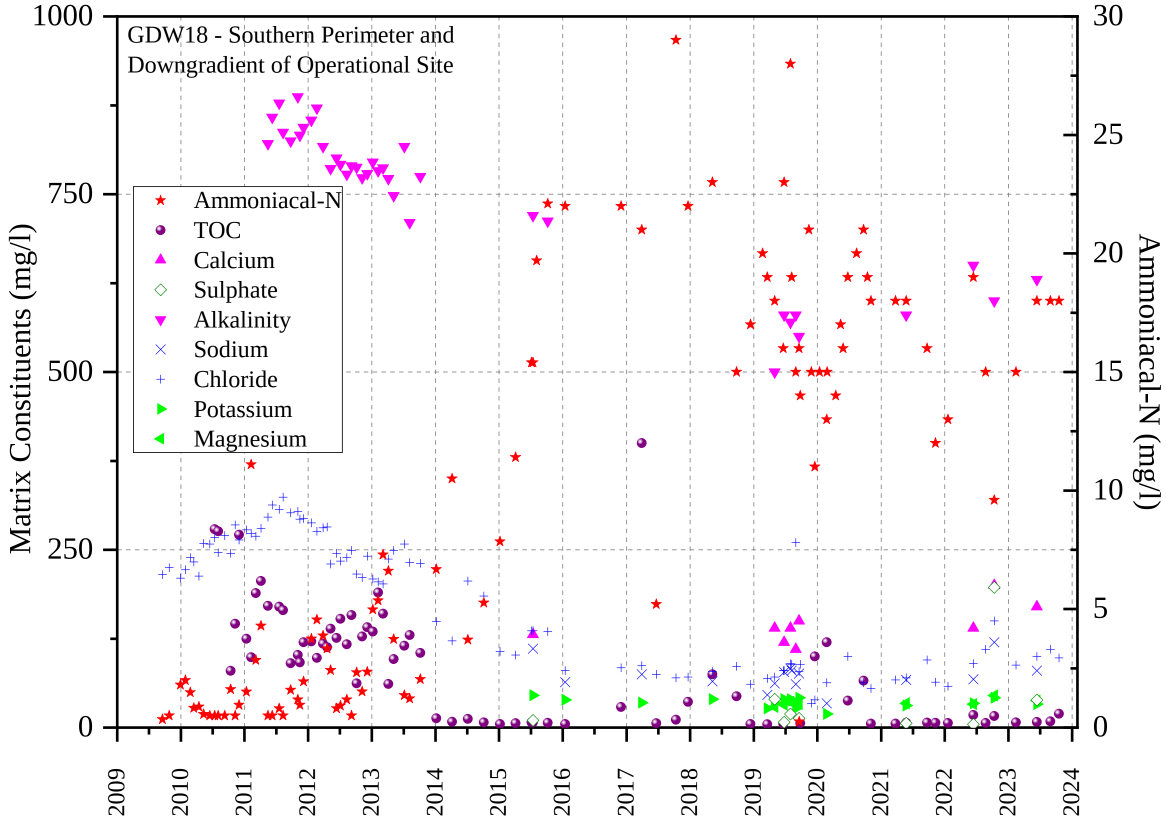


Figure 14 Groundwater Matrix Chemistry GDW18



There is a step change in ammoniacal-N at GDW18 which occurred in 2015-2016 when levels increased from ~5 mg/l to ~25 mg/l in 2016 before stabilising at this range during the following years, with the occasional outlier (Figure 14). However, in parallel to the increase in ammoniacal-N, chloride, alkalinity and COD all followed a depleting profile. Such a pattern is inconsistent with a continued outbreak or leakage of a non-hazardous landfill leachate.

The profile however more akin to that expected from waters originating in the Crymlyn Bog, rather than the Phase 2 leachates. Concentrations during 2023 were comparable to those for the previous c. nine years.

Ammoniacal-N in GDW09 had previously reached a peak of 26 mg/l in October 2022, but during 2023 the maximum concentration was 4.8 mg/l in June 2023. Historically ammoniacal-N has remained below 18 mg/l and from 2016-2021 was reported in the 0.9-10 mg/l range.

Ammoniacal-N at GDW05 has followed a multiyear fluctuating pattern between 15 and 30 mg/l. However, within this pattern occasional lower (5-10 mg/l) and higher (~65 mg/l) data has been observed as isolated points. During 2023, ammoniacal-N followed the general pattern, albeit the final three samples from the year were all above the permit limit, the latter two only just so at 26 mg/l. Chloride however at 25-30 mg/l is environmentally negligible and definitively indicative that there is not a Phase 2 landfill leachate influence in the groundwater at GDW05 (Figure 15).

Figure 15 Groundwater Matrix Chemistry GDW05

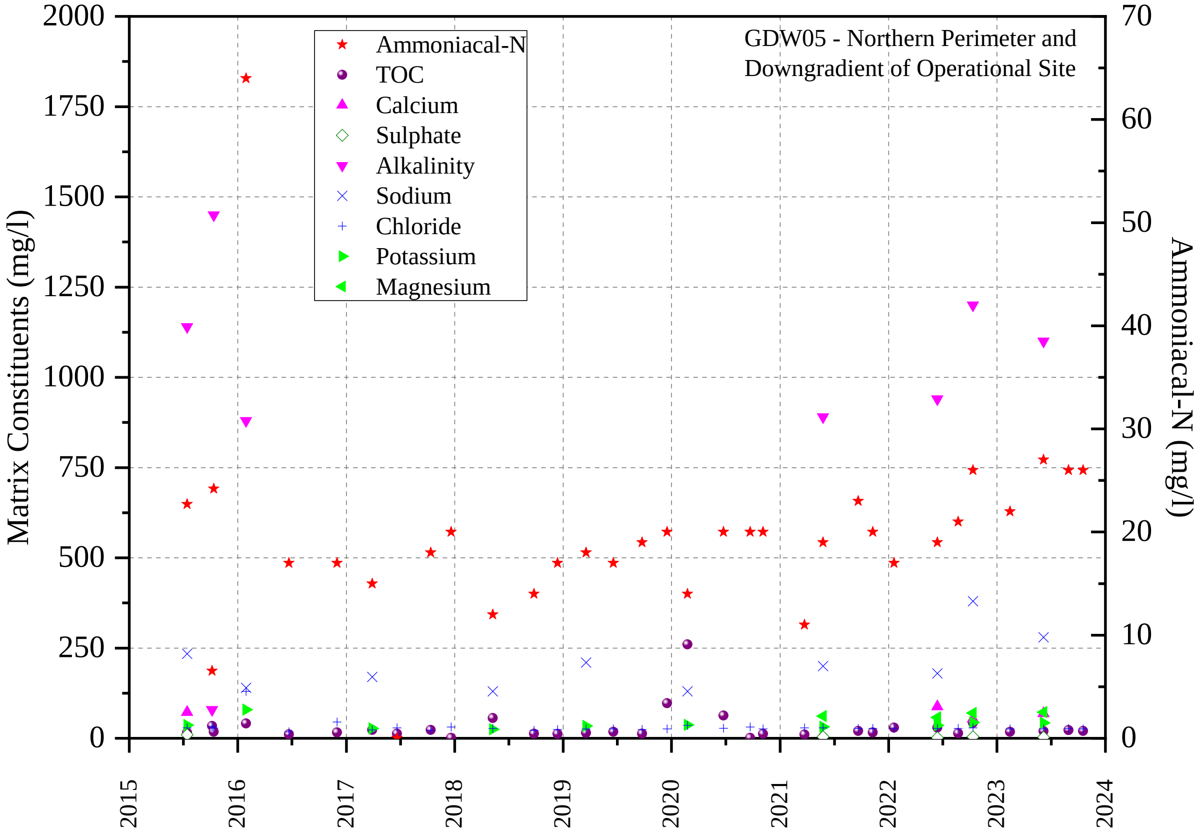


Figure 16 Groundwater Matrix Chemistry GDW01(D)

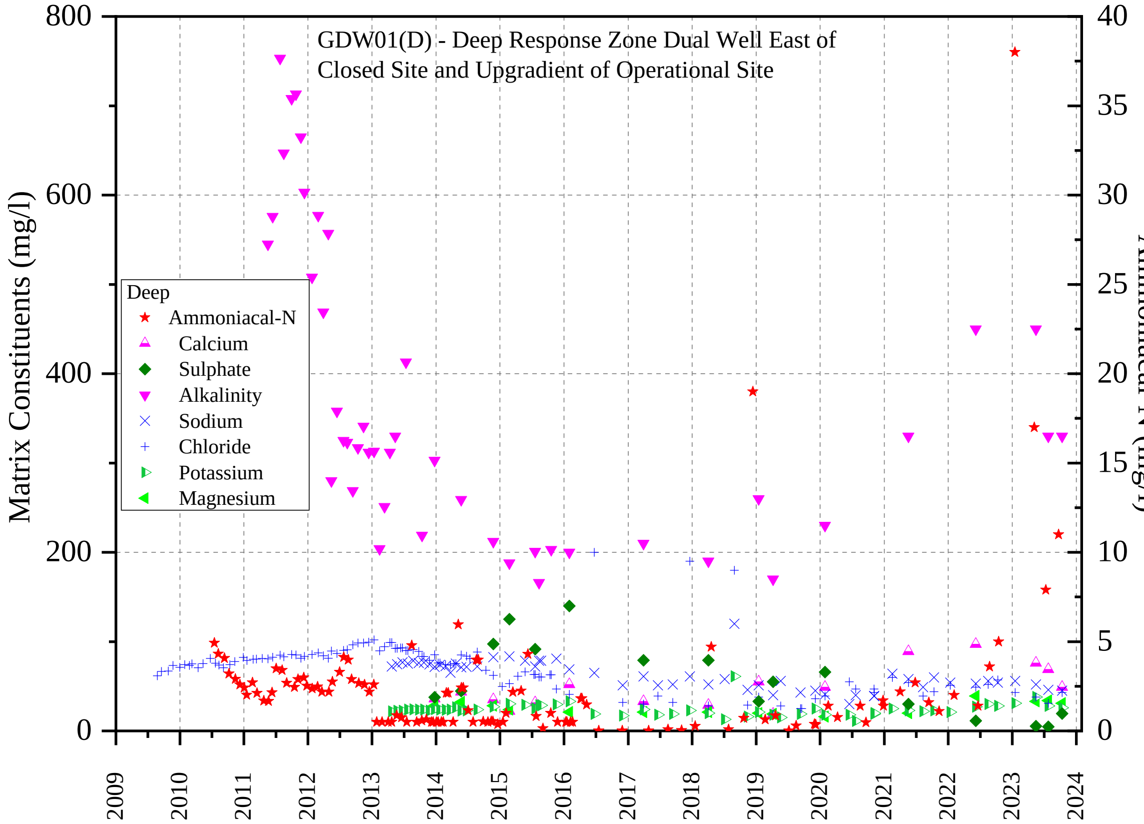
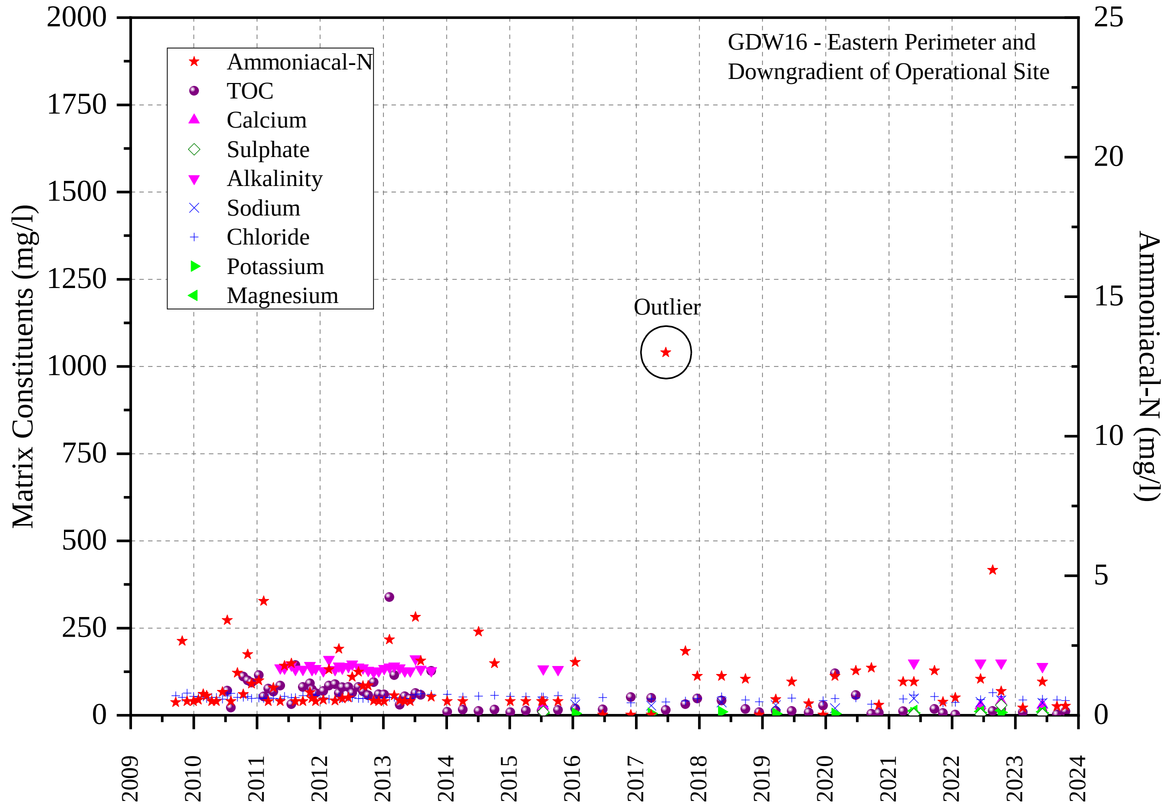


Figure 17 Groundwater Matrix Chemistry GDW16

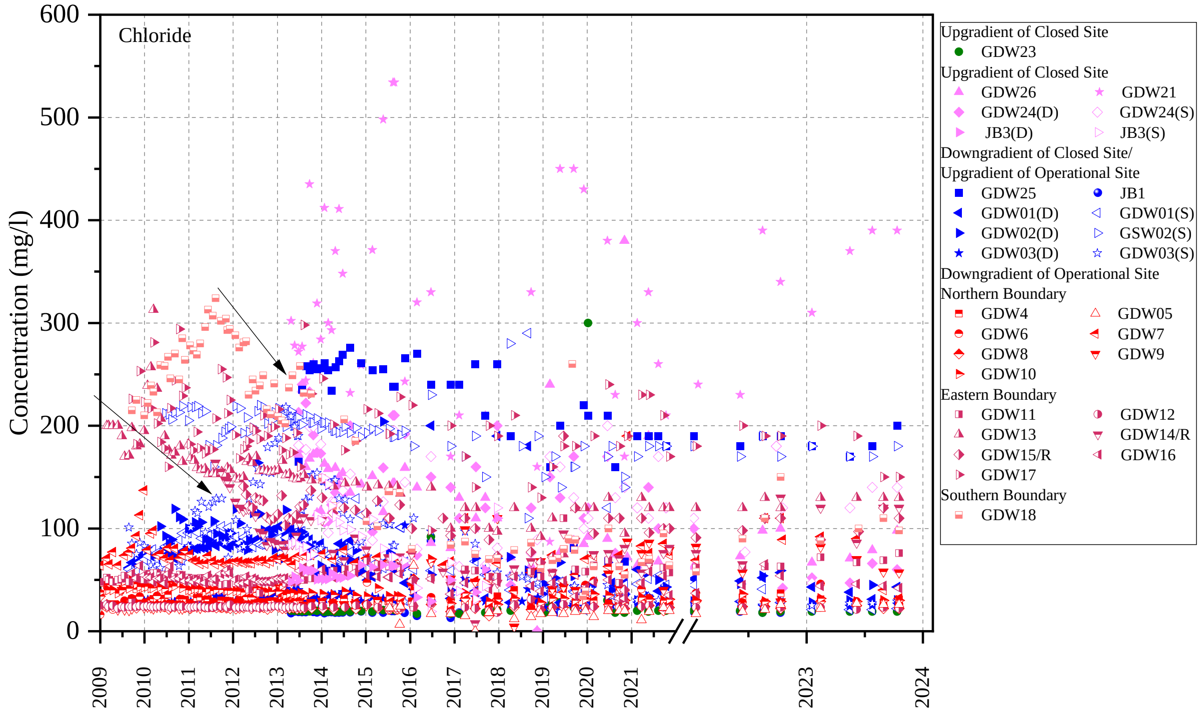


During 2023, there was an isolated increase in upgradient ammoniacal nitrogen in GDW01(D), which reached 38 mg/l in January (Figure 16). Concentrations then more than halved and dropped back down for the rest of the year. It is noted that this is not a Permit Limit location. Chloride at GDW01(D) remained stable and averaged at 39 mg/l during the year.

At GDW16 ammoniacal-N was consistent with previously reported concentrations, <0.0015-1.7 mg/l for the 2018-2021 period (Figure 17) following a previously reported isolated spike in 2022. Chloride at GDW16 remained stable and within the 42-46 mg/l range through the year.

Chloride has been reported below 250 mg/l (the Drinking Water Standard) at the Phase 2 site (Figure 18) and has not exceeded any of the (respective 100 mg/l, 250 mg/l and 300 mg/l) Permit Limits throughout the 2023 monitoring period (Table 8).

Figure 18 Groundwater Chloride



4.3.3 Priority Metals

The groundwater priority metals are summarised in Table 10. There were no exceedances of the Permit Limits specified in Table 9. Mercury and arsenic are hazardous substances. Mercury is typically reported below the limit of detection, <0.005µg/l, with only one sample (in GDW01(S)) being detected, at 0.006 µg/l, significantly below the DWS of 1 µg/l.

Arsenic is environmentally insignificant in the groundwater and is consistently reported below the 50 µg/l Environmental Quality Standard (EQS) with the exception of GDW01(S), as in previous years, where arsenic was observed at 72 µg/l and is most likely from the PFA host material.

Table 9 Groundwater Permit Limits

Table S3.5 Trigger levels for emissions into groundwater and monitoring requirements				
Monitoring point reference	**Parameter**	**Limit (including unit)**	**Reference Period**	**Monitoring frequency**
GDW4, GDW5, GDW6, GDW7, GDW8, GDW9, GDW10, GDW11, GDW12, GDW14, GDW15, GDW16, GDW17, GDW18	Atrazine	0.03 µg/l	Spot Sample	Quarterly
	Benzo(a)pyrene	1 µg/l		
	Cadmium	1 µg/l		
	Cis-1,2-dichlorethene	1 µg/l		
	Dichlorprop	0.05 µg/l		
	Reactive Phosphorus	0.05 mg/l		
	Tributyl Phosphate	0.02 µg/l		
	Zinc	75 µg/l		

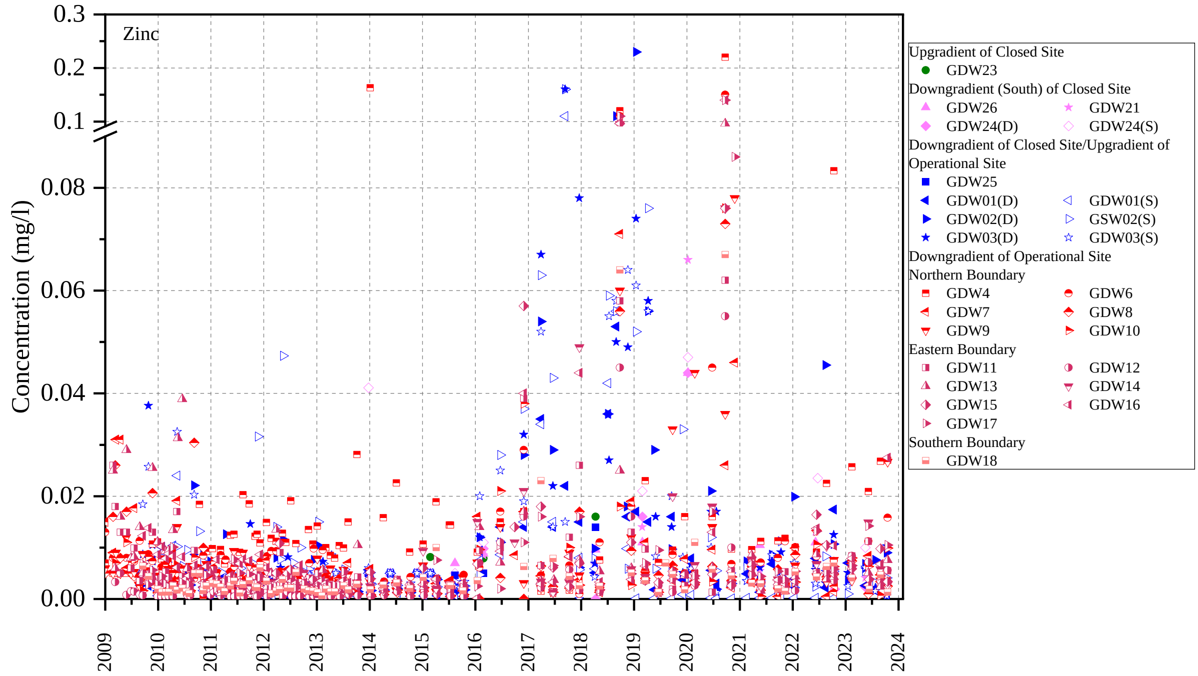
Table 10 Groundwater Priority Metal Summary (Max 2023)

Location	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
	mg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
GDW01(D)	0.3	410	0.05	<0.005	0.0004	0.005	0.0013	0.007	<0.0002	33
GDW01(S)	0.3	37	0.05	0.006	0.0006	0.001	0.0007	0.008	<0.0002	72
GDW02(D)	0.1	4200	0.03	<0.005	0.0004	0.003	0.0014	0.009	<0.0002	20
GDW02(S)	0.4	1500	<0.02	<0.005	0.0006	0.002	0.0007	0.005	<0.0002	2
GDW03(D)	0.2	810	0.03	<0.005	<0.0002	0.003	0.0012	0.010	<0.0002	1
GDW03(S)	0.2	1700	<0.02	<0.005	0.0003	0.003	0.0010	0.006	<0.0002	4
GDW04	-	110	0.10	<0.005	0.0009	0.008	0.0055	0.027	0.0016	18
GDW05	-	250	<0.02	<0.005	0.0014	0.003	0.0019	0.018	<0.0002	19
GDW06	-	170	0.05	<0.005	0.0004	0.002	0.0019	0.016	0.0014	6
GDW07	-	1100	<0.02	<0.005	0.0009	0.008	0.0028	0.008	0.0002	9
GDW08	-	870	<0.02	<0.005	0.0004	0.003	0.0027	0.007	<0.0002	5
GDW09	-	630	0.04	<0.005	0.0002	0.002	0.0082	0.027	0.0003	46
GDW10	-	450	<0.02	<0.005	0.0003	0.007	0.0018	0.010	<0.0002	5
GDW11	-	1200	<0.02	<0.005	0.0002	0.003	0.0018	0.011	<0.0002	2
GDW12	-	530	<0.02	<0.005	0.0006	0.006	0.0019	0.008	<0.0002	7
GDW13	-	1600	<0.02	<0.005	0.0003	0.003	0.0010	0.008	<0.0002	4
GDW14 R	-	-	0.03	<0.005	0.0009	0.011	0.0024	0.019	<0.0002	6
GDW15 R	-	-	<0.02	<0.005	0.0010	0.005	0.0029	0.010	<0.0002	5
GDW16	-	280	<0.02	<0.005	0.0005	0.004	0.0036	0.028	<0.0002	3
GDW17	-	1500	<0.02	<0.005	0.0007	0.004	0.0064	0.014	0.0009	6
GDW18	-	1000	<0.02	<0.005	0.0009	0.003	0.0025	0.005	<0.0002	10

Lead was reported largely at or below the limit of detection – the highest concentration was 0.0016 mg/l in GDW04. In any case, all samples were below the DWS of 0.01 mg/l throughout 2023. Cadmium continued to be consistently reported below the permit limit of 1 µg/l during 2023 and remained in the 0.02 - 0.1 µg/l range (Table 10).

Copper was reported in the 0.0005-0.011 mg/l range which is significantly below the DWS of 2 mg/l. Chromium was reported at a similar level to copper, in the 0.0002-0.0014 mg/l range which is environmentally insignificant and below the DWS of 0.05 mg/l. Nickel is similarly low to negligible.

Figure 19 Groundwater Zinc



Zinc remained below the 0.075 mg/l permit limit at all locations (Figure 19), having reported an exceedance at GDW04 in the year previous.

4.3.4 Phosphate Substances

Groundwater phosphate is monitored in accordance with the environmental permit for both the inorganic phosphate species and as the organo-complex tributyl phosphate. Tributyl phosphate was not identified within the groundwater during 2023 and was consistently reported below the limit of detection of <0.1 µg/l. This is consistent with the historical dataset for this substance.

The Operator changed laboratories during 2021 and the new accredited laboratory are unable to achieve a limit of detection (LOD) of less than the permitted limit using accredited analytical methods. Whilst the LOD is above the permit limit of 0.02 µg/l there is no indication that a significant change in the groundwater geochemistry has occurred during 2023. Tributyl phosphate is also significantly below the Annual Average Environmental Quality Standard of 50 µg/l. It is noted that there is no specified Minimum Reporting Value (MRV) for this substance and the current LOD is considered to be acceptable.

Reactive phosphorus (also known as orthophosphate) was reported above the 0.05 mg/l permit limit at several locations during 2023 (Table 11). The most significant exceedances were reported towards the north of the site at GDW05, GDW07 and GDW08, as well as GDW18 in the south-east.

Within GDW05, GDW07 and GDW08, orthophosphate was above the limit of detection throughout the year. The maximum concentration in both GDW05 and GDW07 was noted to be lower than those in 2022, even though all samples reported detections. In GDW08 there was only one detection in 2022, but ubiquitous detection in 2023, with a maximum concentration of 2.1 mg/l.

The LOD for orthophosphate is above the permit limit of 0.05 mg/l as accredited laboratory are unable to achieve a limit of detection (LOD) of less than the permitted limit using accredited analytical methods.

The most likely source of groundwater phosphates is from the PFA that was placed under and around the Site prior to the development of Phase 2. Consequently, an exceedance of the current permit limits in their current format does not indicate that the Phase 2 landfill has influenced the surrounding environment.

Table 11 Groundwater Orthophosphate Summary

Location	Orthophosphate (mg/l)			
	Q1	Q2	Q3	Q4
GDW01(D)	2.6	0.45	0.97	0.41
GDW01(S)	0.34	0.39	0.31	0.92
GDW02(D)	< 0.062	< 0.062	< 0.062	< 0.062
GDW02(S)	0.27	0.15	0.33	< 0.062
GDW03(D)	< 0.062	< 0.062	< 0.062	< 0.062
GDW03(S)	0.092	< 0.062	0.32	< 0.062
Permit Limit	**0.05**			
GDW04	< 0.062	0.2	< 0.062	< 0.062
GDW05	0.13	3.7	1.4	0.52
GDW06	< 0.062	< 0.062	< 0.062	0.16
GDW07	1.9	0.75	0.69	0.42
GDW08	0.16	0.21	2.1	0.15
GDW09	< 0.062	0.93	0.73	< 0.062
GDW10	< 0.062	< 0.062	0.073	< 0.062
GDW11	< 0.062	< 0.062	< 0.062	< 0.062
GDW12	< 0.062	< 0.062	< 0.062	< 0.062
GDW13	< 0.062	< 0.062	0.092	< 0.062
GDW14 R	< 0.062	0.35	< 0.062	< 0.062
GDW15 R	< 0.062	< 0.062	< 0.062	< 0.062
GDW16	< 0.062	< 0.062	< 0.062	< 0.062
GDW17	< 0.062	< 0.062	< 0.062	< 0.062
GDW18	< 0.062	0.17	0.16	0.077

4.3.5 Organic Screen including Hazardous Substances

A hazardous substances suite was carried out in June 2023. No hazardous substances were reported in the majority of monitoring locations with the exception of GDW07 (Table 12). Triphenyltin was reported at a low concentration in this monitoring location. However, it has not been identified in the leachate. Triphenyltin is a banned fungicide meaning that is it unexpected in the groundwater.

Table 12 Substances Present over the Limit of Detection

Substance	Units	GDW07	GDW01(D)
		07/06/2023	26/07/2023
Herbicides & Pesticides			
Triphenyltin (chloride)	µg/l	0.015	-
PAHs			
Benzo(a)pyrene	µg/l	-	0.08

Permit limits have been set for specific organic substances within the groundwater including Atrazine, Benzo(a)pyrene, Dichlorprop and Cis-1,2-dichloroethene. These substances are monitored quarterly and, where detected, were recorded below their respective permit limits throughout 2023. It is noted that the limit of detection for Atrazine and Cis-1,2-dichloroethene exceed the permit limits as the low levels are undetectable by UKAS accredited methods of analysis. In any case, even at the slightly higher LODs, these substances were not detected.

It is noted that benzo(a)pyrene was detected in upgradient monitoring location GDW01(D) at 0.08 µg/l in July, however this has not borne out any detections in any other monitoring wells.

4.4 Environmental Transects

To understand the background 'baseline' data of the Crymlyn Bog sampling, additional monitoring points have been installed along three transects which extend perpendicular to the Phase 2 Tir John Landfill Site into the bog. Transects EMT2, EMT6 & EMT7 are to the east of Cell 16, the southeast of the future Cell 7 and to the north of Cell 13 respectively.

The Environmental Monitoring Transects (EMTs) comprise a series of monitoring points at 2 m, 4 m, 8 m, 16 m, 32 m, and 64 m intervals, each of which has a shallow (1 m) and deep (2 m) response zone. The data from the annual screen, 02/03/2023, is presented in Table 13.

Table 13 Transect Water Quality

Sample Point	pH	NH4-N	Cl	SO_4	DOC	BOD	Ca	NO_3	Orthophosphate as PO_4	P
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
TIR ETM2 (1a)	7	19	71	17.9	11.6	6.7	110	0.26	< 0.062	0.88
TIR ETM2 (1b)	7.1	66	87	12.1	16.2	12	130	0.31	4.3	2.6
TIR ETM2 (2a)	7	22	98	8.44	11.3	15	130	0.11	< 0.062	0.076
TIR ETM2 (2b)	7.1	32	110	8.01	14.9	3.2	150	0.2	< 0.062	0.29
TIR ETM2 (3a)	7.1	12	69	23.8	7.39	4.3	130	0.22	< 0.062	0.11
TIR ETM2 (3b)	6.4	9.2	120	11.1	92.5	8.1	12	2.32	0.5	1.1
TIR ETM2 (4a)	7	12	71	15.7	17.9	290	130	0.22	0.56	0.31
TIR ETM2 (4b)	6.7	4.1	78	10.1	54.2	9.5	6.1	1.21	0.16	0.12
TIR ETM2 (5a)	7	4.4	64	28.2	8.81	5.1	110	0.19	< 0.062	0.063
TIR ETM2 (5b)	6.7	8.5	46	57.2	17.7	16	67	0.26	5.9	2
TIR ETM2 (6a)	6	0.74	32	83.9	15.8	10	40	0.24	< 0.062	0.082
TIR ETM2 (6b)	6.4	0.32	42	440	8.04	5.9	160	0.22	0.35	0.75
TIR ETM6 (1a)	7	0.2	51	30.3	1.59	1.4	97	0.05	< 0.062	0.92
TIR ETM6 (1b)	6.2	7.6	140	4.08	19.2	9.3	21	0.29	3.5	3.3
TIR ETM6 (2a)	6.4	0.16	44	4.36	1.05	2.4	47	0.2	< 0.062	0.31
TIR ETM6 (2b)	6.2	2.4	130	3.49	13.2	3.1	24	0.24	0.19	0.41
TIR ETM6 (3a)	6.8	1.6	46	12.3	4.83	6.8	77	0.13	< 0.062	0.23
TIR ETM6 (3b)	5.9	0.42	120	3.04	15.2	2.7	9.3	0.2	< 0.062	0.27
TIR ETM6 (4a)	6.1	0.26	65	10.5	1.01	2.9	39	0.08	< 0.062	0.36
TIR ETM6 (4b)	6.1	0.2	77	5.16	28.2	5.5	9.4	0.34	0.2	0.19
TIR ETM6 (5a)	6	0.8	60	1.78	3.92	6.1	36	0.07	< 0.062	0.68
TIR ETM6 (5b)	5	0.029	130	2.93	24	3	6.4	0.26	< 0.062	0.036
TIR ETM6 (6a)	6.2	0.055	32	3.96	10.8	2.8	21	0.39	< 0.062	0.14

Sample Point	pH	NH4-N	Cl	SO_4	DOC	BOD	Ca	NO_3	Orthophosphate as PO_4	P
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
TIR ETM6 (6b)	6.4	0.03	31	4.66	9.26	1.4	38	0.15	0.11	0.54
TIR ETM7 (1a)	6.7	0.14	19	2.06	12.2	4.3	22	0.54	< 0.062	0.95
TIR ETM7 (1b)	7.3	120	18	8.29	15.1	130	34	0.24	27	15
TIR ETM7 (2a)	6.5	0.34	18	2.76	12.4	3.3	31	0.6	< 0.062	0.98
TIR ETM7 (2b)	7.4	0.84	12	8.8	6.69	9.9	29	0.39	< 0.062	1.4
TIR ETM7 (3a)	6.5	2.1	19	3.21	10.2	9.9	29	0.31	< 0.062	2.1
TIR ETM7 (3b)	7.4	2.3	53	1.22	1.78	3.8	97	0.32	< 0.062	1.4
TIR ETM7 (4a)	6.7	0.11	19	1.11	2.26	2.1	34	0.13	< 0.062	0.39
TIR ETM7 (4b)	7.3	0.58	120	0.994	2.01	3.3	220	0.19	< 0.062	1
TIR ETM7 (5a)	6.8	0.045	51	0.931	2.61	3.1	55	0.16	0.15	0.2
TIR ETM7 (5b)	7.4	0.43	190	0.514	1.72	2.7	190	0.25	< 0.062	0.63
TIR ETM7 (6a)	6.7	0.13	22	0.867	1.81	2.6	28	0.08	< 0.062	0.98
TIR ETM7 (6b)	6.7	58	110	0.213	12.9	450	140	0.09	< 0.062	0.73

The data obtained for 2023 was broadly similar to that obtained in previous years. The data are demonstrative of a complex relationship whereby the nutrients ammoniacal-N and phosphorus are present as a series of elevated pockets where in-situ conditions must dominate rather than a progressively migrating leachate dispersion plume. This relation is further complicated as for EMT2, and potentially EMT6, the groundwater drawdown induces a hydraulic gradient from the bog towards the Cell 16 perimeter.

Chloride across the transects was typically in the similar range and distribution with depth and distance from the site at EMT2 (Figure 20), EMT6 (Figure 21) and EMT7 (Figure 22).

Figure 20 EMT2 Chloride

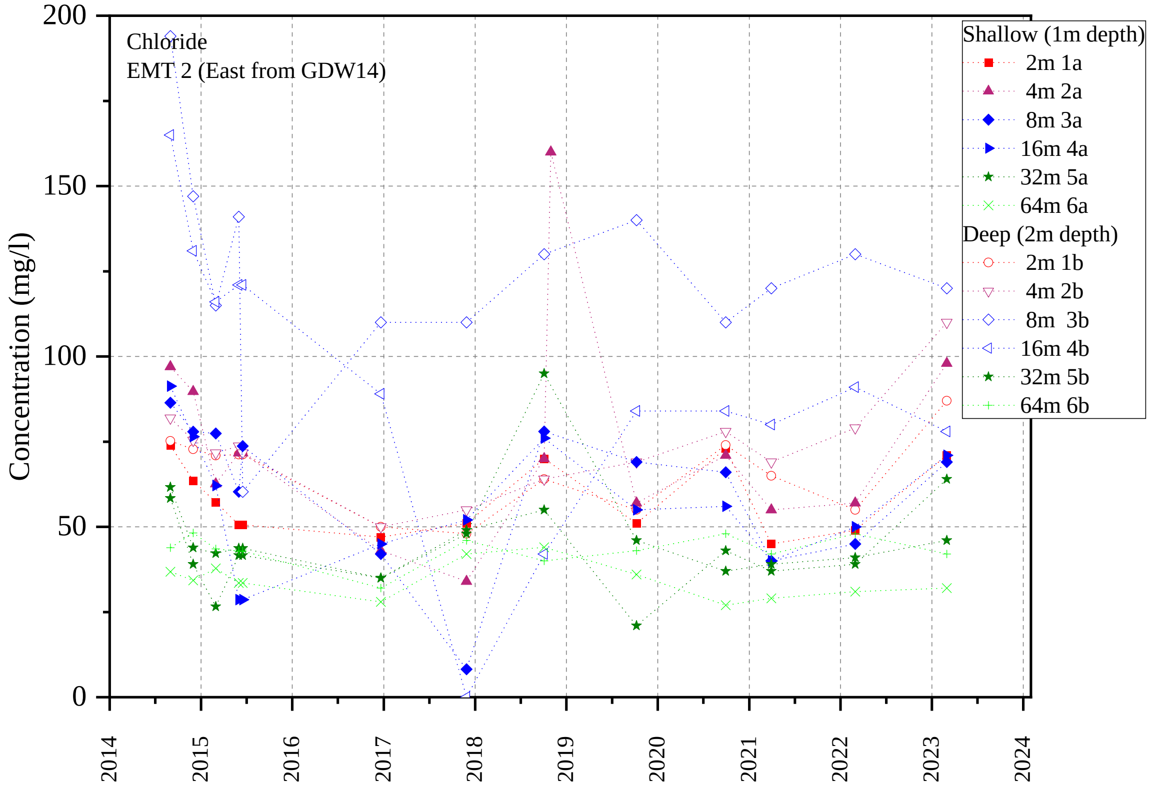


Figure 21 EMT6 Chloride

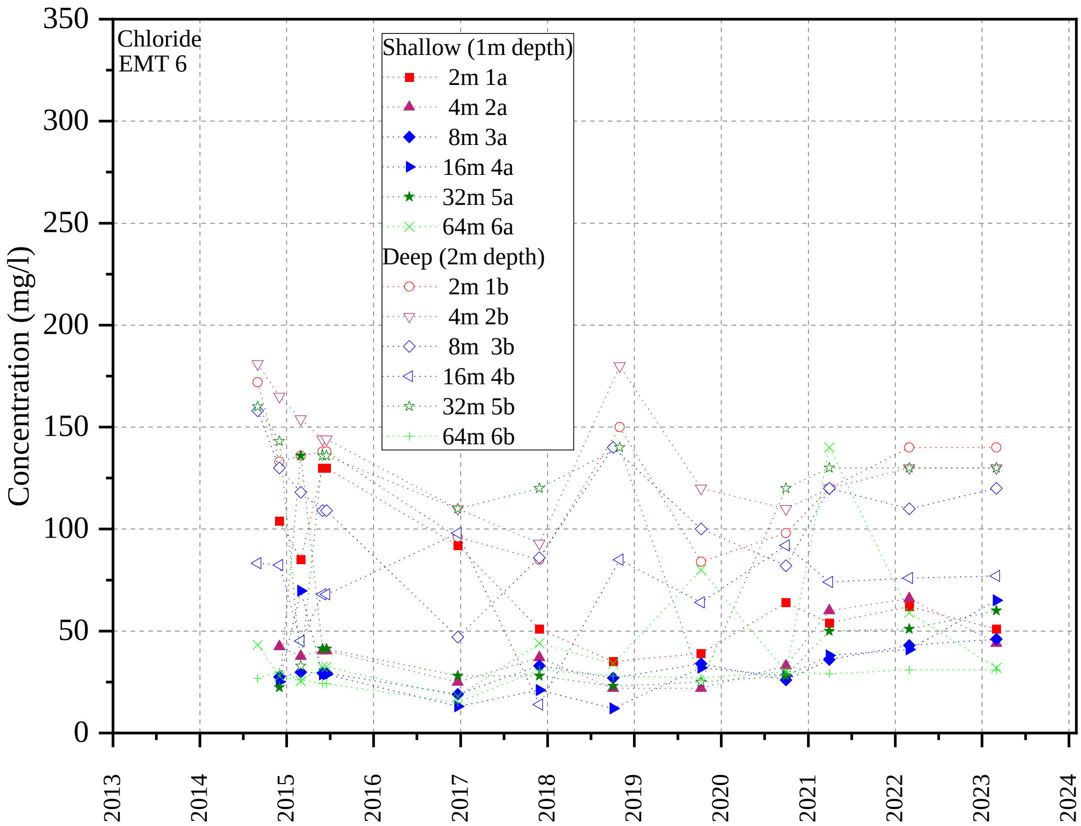
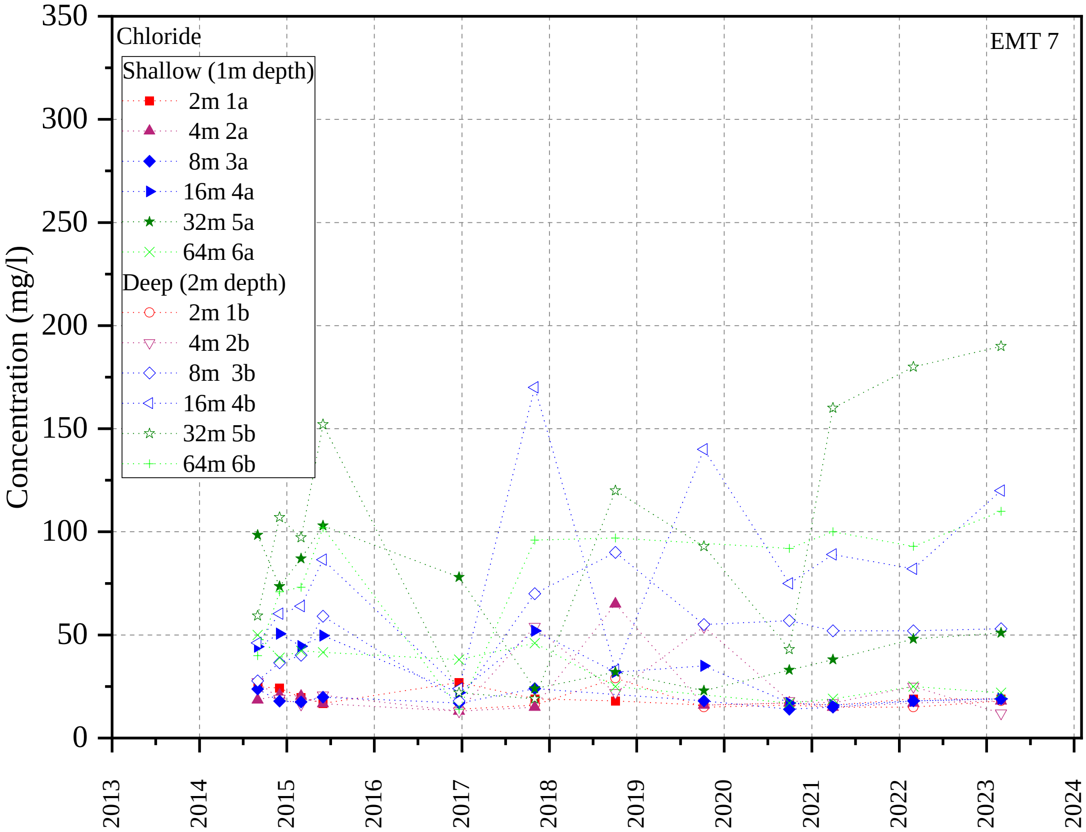


Figure 22 EMT7 Chloride



Ammoniacal-N is frequently reported at its highest concentration in the mid-distance or most distant monitoring points from the Site in EMT7 to the north of the Site. To the southeast EMT2 and EMT6 typically report the highest concentrations closest to the Site. There are also no particular time series relationships or link between chloride and ammoniacal-N which would be expected for a leachate influence as displayed in Figure 20 to Figure 25.

At EMT 2 there was a significantly elevated ammoniacal-N reading of 85 mg/l in 2022 at the 6b location, which is 64 m from the Site, but which did not recur in 2023 (Figure 23). The highest ammoniacal nitrogen concentration in EMT 2 was 66 mg/l at the 1b location.

A similar trend in ammoniacal-N is reported in EMT6 with decreasing concentrations with distance from the Site. Consequently, ammoniacal-N is considered to be restricted to the outer edges of the bog at the southern edge of the Made Ground. However, the inverse relationship between chloride and distance from the Site is not as pronounced at EMT6 compared to EMT2.

There are several contributing processes of which in-situ biological activity within the Crymlyn Bog is a key factor. Although the PFA and other historical wastes which pre-date the Phase 2 Landfill could potentially contribute nutrients and stimulate biological processes within the bog there does not appear to be a constant flux from the historical wastes into the adjacent bog. Neither is there an apparent influence from the Phase 2 leachate.

The data is indicative of a groundwater regime primarily influenced by localised conditions of each monitoring point and any relationship with the landfill and the historical operations is limited.

Figure 23 EMT2 Ammoniacal-N

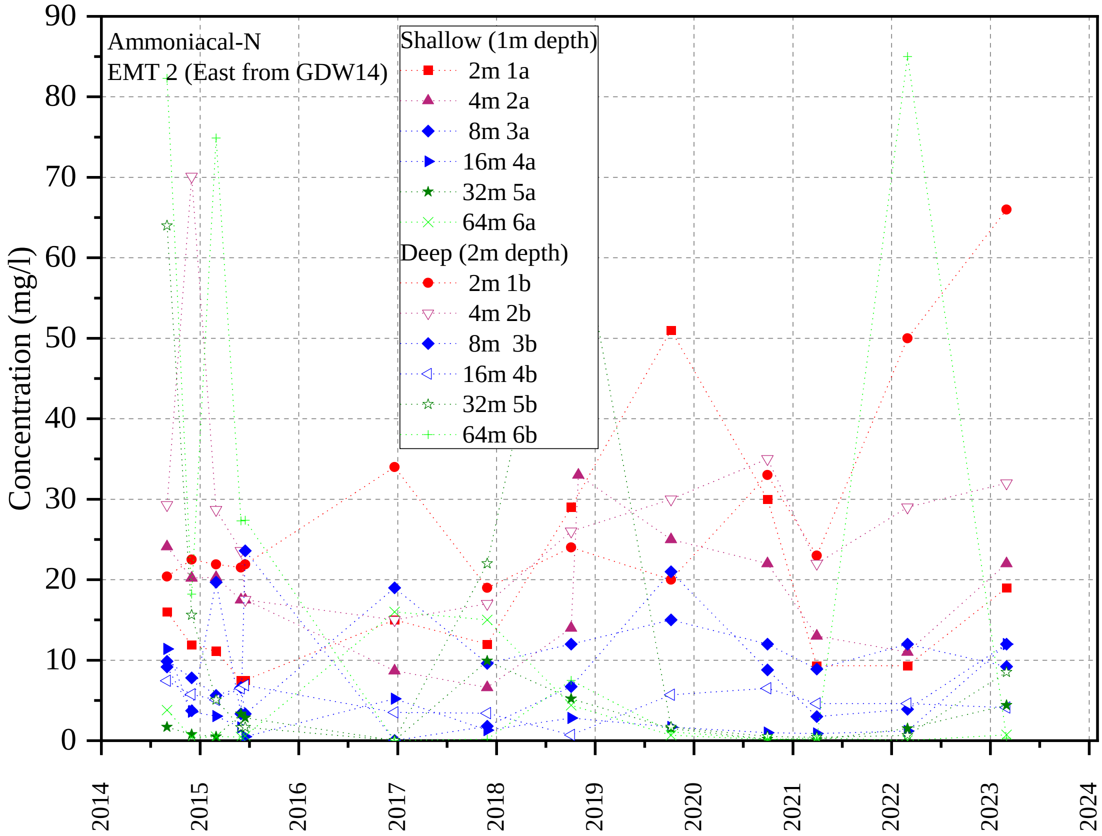


Figure 24 EMT6 Ammoniacal-N

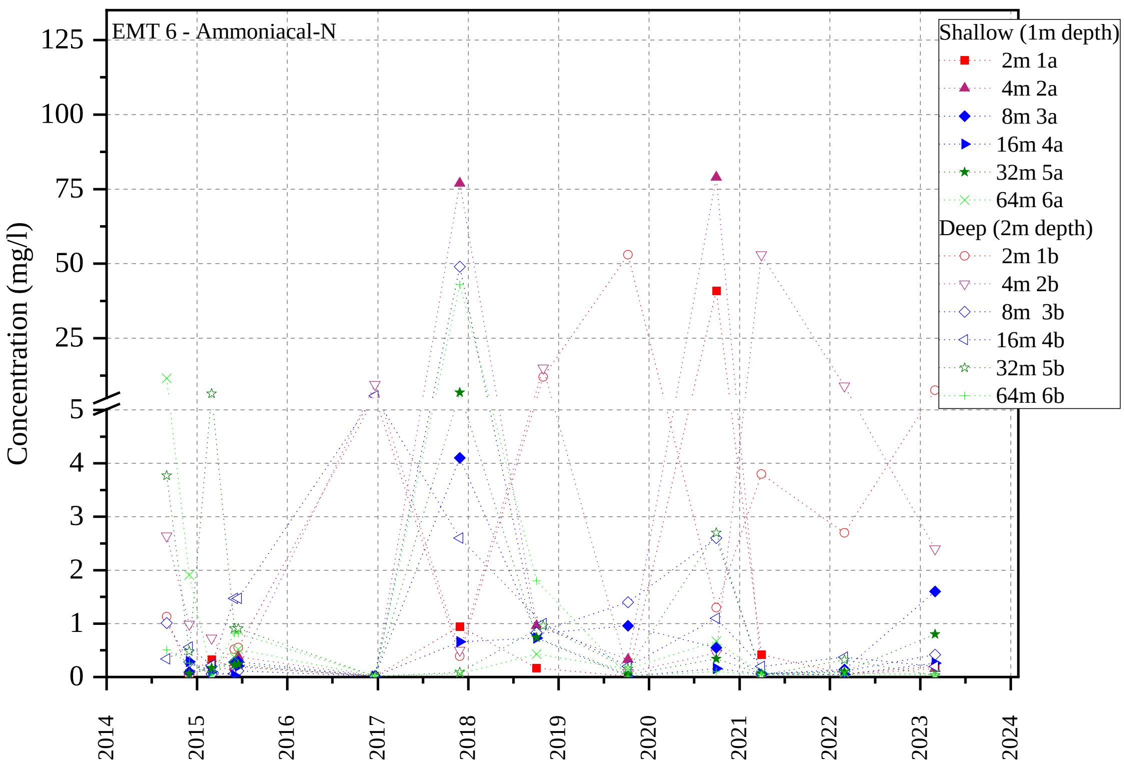
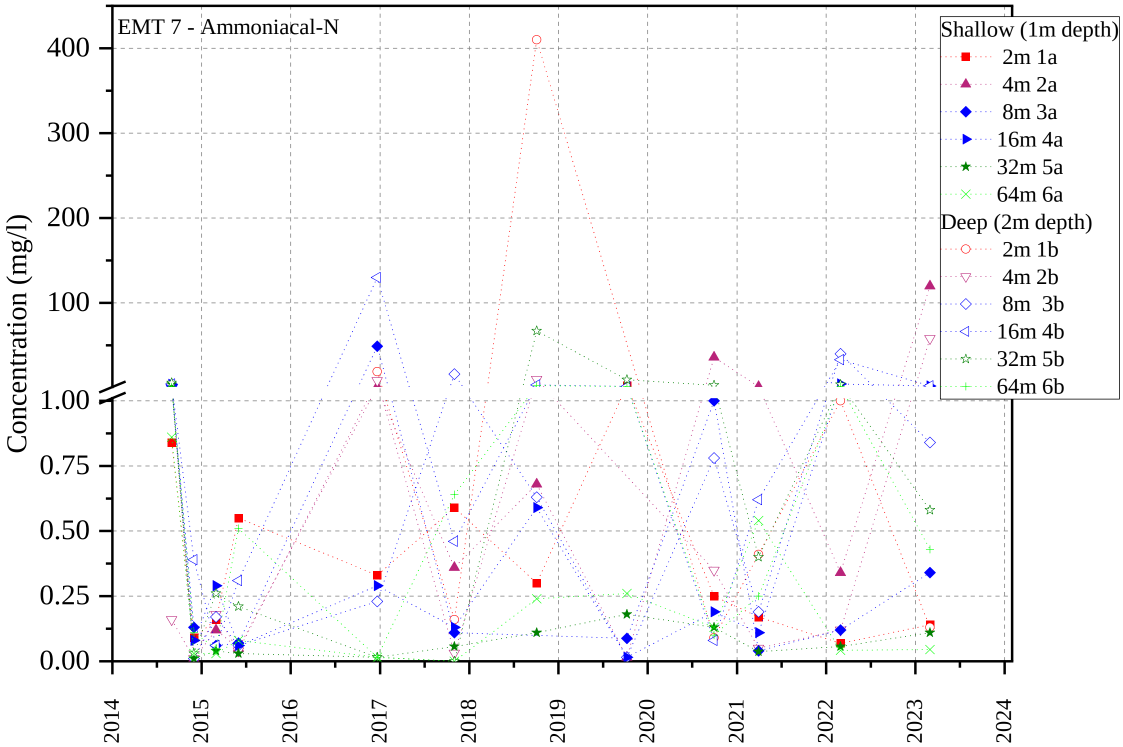


Figure 25 EMT7 Ammoniacal-N



4.5 Boreholes GDW16A and GDW16B

A condition of the continuation of the landfill into Cell 16, was the implementation of a Perimeter Control System (PCS) as a means to manage pore pressures and monitor the effects of the new landfill above an area of historic wastes in order to alleviate the potential for a historic leachate to be displaced into the bog when the cell area is loaded.

Groundwater monitoring was originally undertaken at the PCS monitoring points whilst construction works were undertaken in mid-2018. These were replaced by the Cell 16 PCS BH16A and PCS BH16B, as located at the edge of Cell 16 as shown on Figure 26 as permanent monitoring points, with data available from December 2019.

PCS BH16A and PCS BH16B are located at an increasing distance from the edge of Cell 16, but within the ring of Perimeter monitoring points. They are in close proximity to Perimeter monitoring point GDW13 and provide a closer surveillance location to PCS (mid) and therefore can act as a surveillance point for migrating leachate influenced groundwater prior to entering the bog.

PCS BH16A & 16B were monitored on a monthly basis throughout 2021 and a quarterly basis thereafter. The data collected demonstrates that ammoniacal-N (Figure 27) and chloride (Figure 28) are consistent with that of the surrounding monitoring points and within the bog along Environmental Monitoring Transect EMT2, after the data “settled”, after for example, the depletion phase data apparent for GDW13 between 2009 and 2015. In 2023 there has been an increase in chloride in PCS BH16B, but data is overall still within the expected range.

Figure 26 Groundwater Monitoring Points Adjacent to PCS BH16A & PCS BH16B

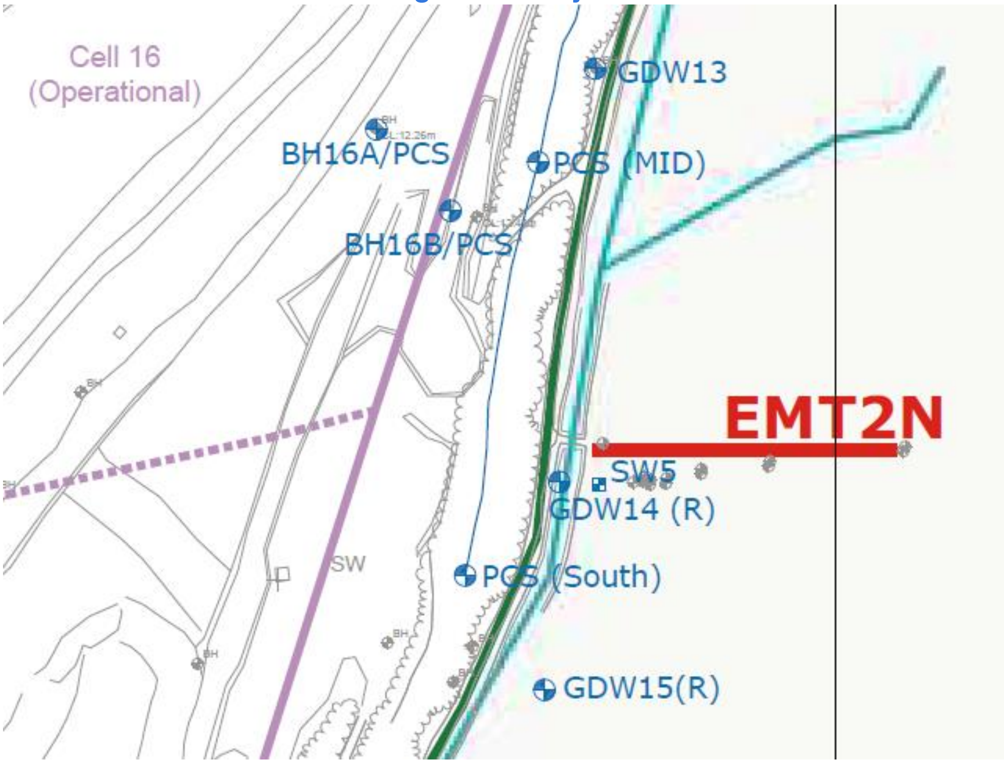


Figure 27 Edge of Cell 16 Groundwater Ammoniacal-N (2009 – 2023)

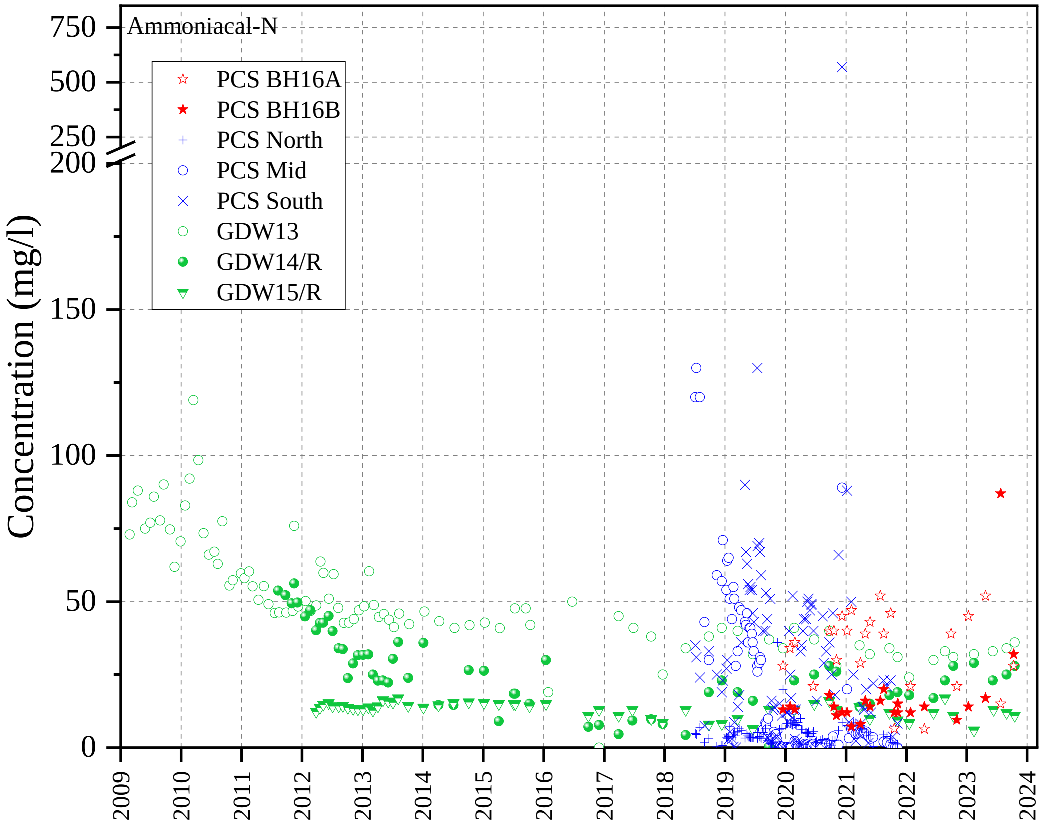
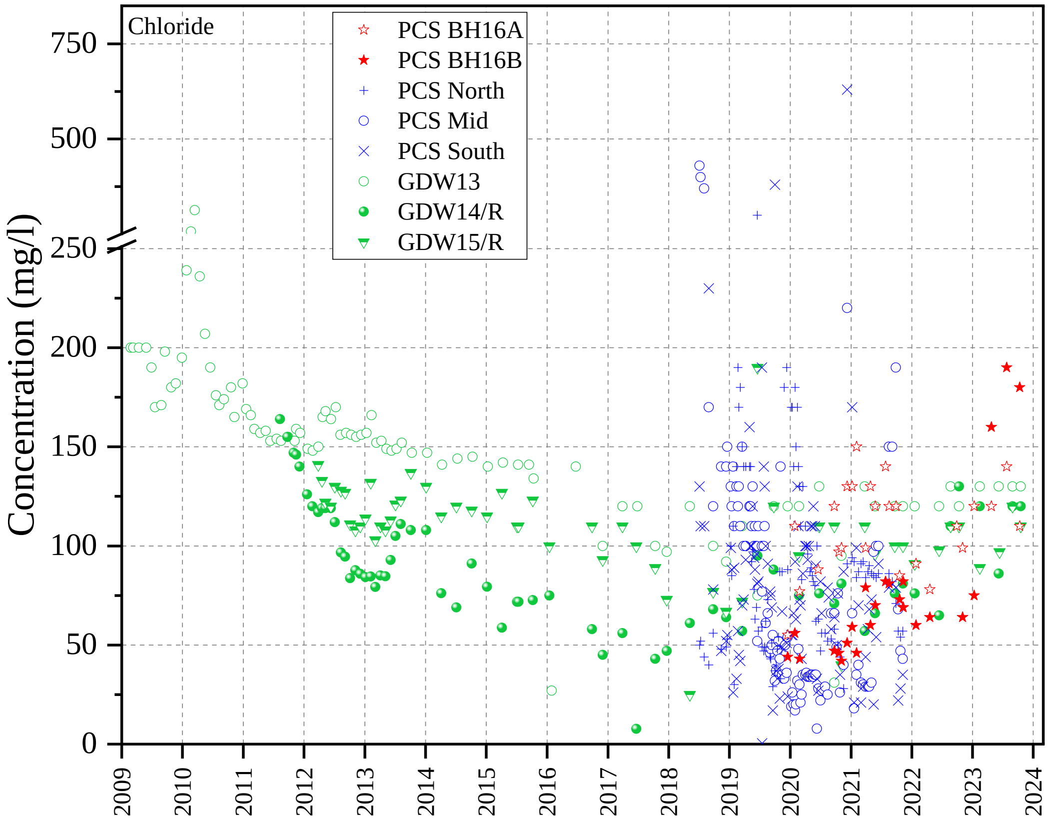


Figure 28 Edge of Cell 16 Groundwater Chloride (2009 – 2023)



The data profiles for the original PCS series followed the same depletion profile for that of GDW13, GDW14 /14R and GDW15 / 15R observed from 2009 to 2015, was also observed at the PCS series locations during 2018 and 2019, before stabilising at the same range as is being observed for all of the monitoring points between GDW13 and GDW15/15R, and at EMT2.

The data is superficially suggestive that there is a concentration gradient from PCS BH16A to PCS BH16B (Figure 29 and Figure 30), whereby maximum ammoniacal-N and chloride are at

- 52 mg/l to 32 mg/l ammoniacal-N;
- Previously, 150 mg/l reducing to 82 mg/l chloride. However, the 2023 data shows this to no longer be the case, with PCS BH16B now recording higher chloride than PCS BH16A on three of the four monitoring visits in the past year.

The indications of a previous concentration gradient are however considered as misleading given the historical trends and patterns, as there is not a continuous reducing gradient to the next ring of monitoring points at GDW13 – GDW15R as well as EMT2. The data is instead illustrative of the natural variation in the system as well as the propensity for localised concentrations. It is in that respect that the PCS BH16A & 16B data is as reflective of a gradient from external to the Site as to one from internal to the Site.

At this time the full extent of the actual fluctuation is unknown, however, as Figure 27 and Figure 28 illustrate 52 mg/l ammoniacal-N and 150 mg/l chloride are not necessarily maximum concentrations which could be observed. However, given the locations of GDW13, GDW14R and GDW15R, it is considered that specific BH16A & BH16B Permit Limits are not required, as a compliance function is already provided for in the permit by GDW13 – GDW15R. Nevertheless, Action Levels could be applied at 60 mg/l ammoniacal-N and 220 mg/l chloride, as 15% above present background.

Figure 29 Edge of Cell 16 Recent Groundwater Ammoniacal-N

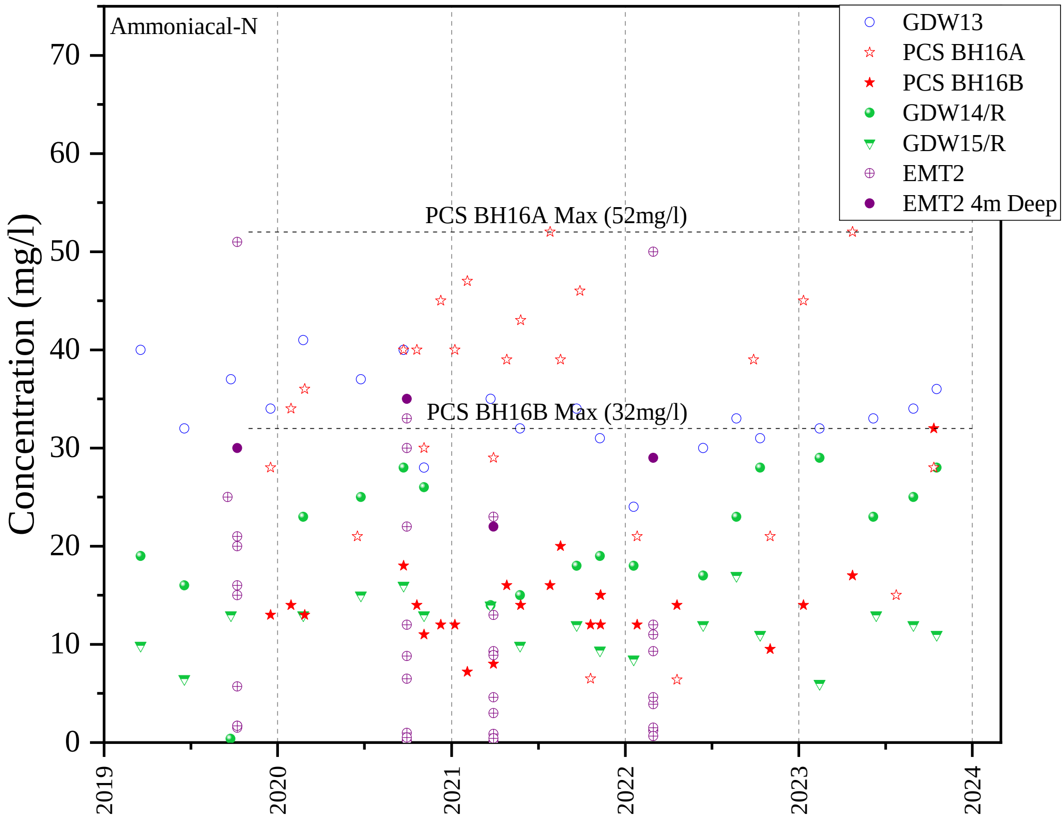
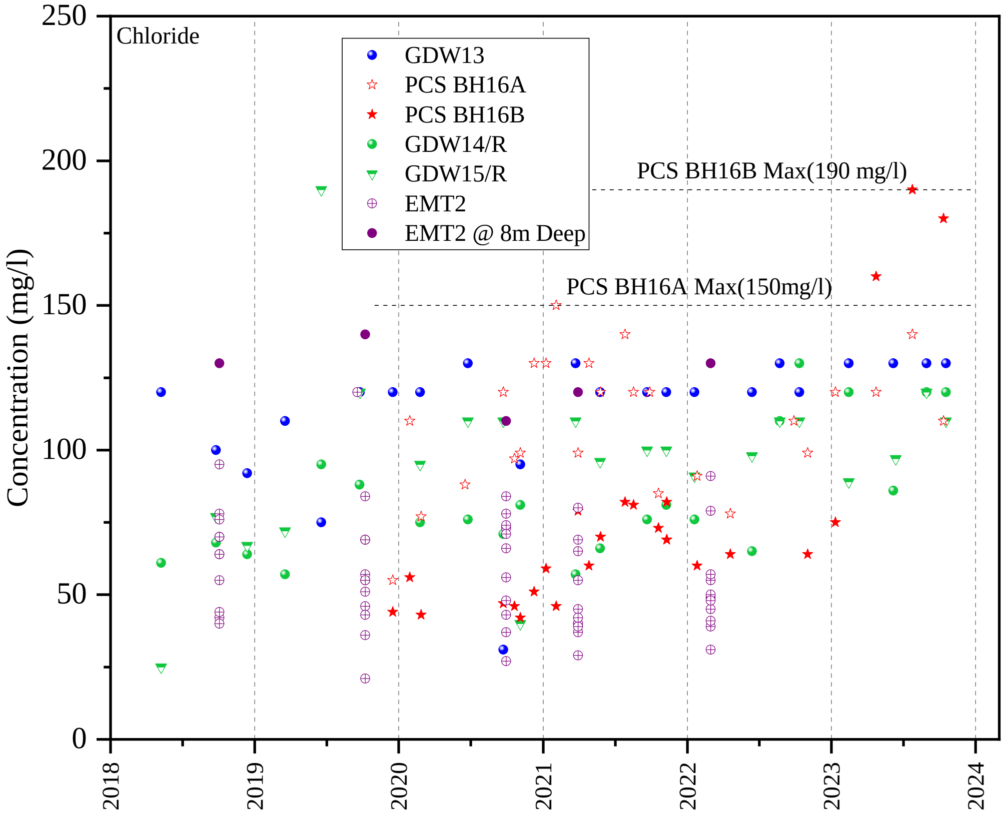


Figure 30 Edge of Cell 16 Recent Groundwater Chloride



4.6 Groundwater Summary

Groundwater elevation is responsive to seasonal recharge patterns. This response is strongest in the westerly upgradient and upslope locations. The effect decreases in the deeper response zone of paired monitoring points and the downgradient perimeter boreholes as the groundwater joins the water levels of the bog and within the PFA platform.

Ammoniacal-N and chloride are present within the groundwater. Neither substance appears to be related to the Phase 2 landfill leachate. The source of these parameters is considered to be in-situ and will include the pre-Phase 2 deposited materials including the beneath the Site and the adjacent organic rich sediments. These are estuarine in origin, therefore elevated chloride and ammoniacal-N is to be expected. In addition to the estuarine sediments, groundwater is recharged via springs emanating from Coal Measures; consequently, redox cycling of some substances is to be expected. This results in a groundwater chemistry that can be characterised as a series of localised biogeochemical systems. There is no indication of an influence from the Phase 2 landfill on groundwater chemistry.

4.7 Surface Water

Surface water drainage is collected in perimeter interception channels and drains which transfer the surface run-off to flow attenuation lagoons. This flow attenuated surface water is then discharged from the lagoon via a low energy pumped multi-outlet trickle head system to the Crymlyn Bog to the south of the Site.

During storm periods, when the surface water system and flow balancing lagoons are inundated, excess water travels via weirs into a connecting perimeter catchment channel, known as 'The Ditch' which transfers surface water to the southeast of the Site. The Ditch surrounds the downgradient perimeter of the Phase 2 site and is unlined. Consequently, The Ditch is in continuity with groundwater within the Crymlyn Bog and generally acts as a seepage channel. The Ditch terminates in the south-east corner of the landfill site where any remaining flow in the channel dissipates into the Crymlyn Bog.

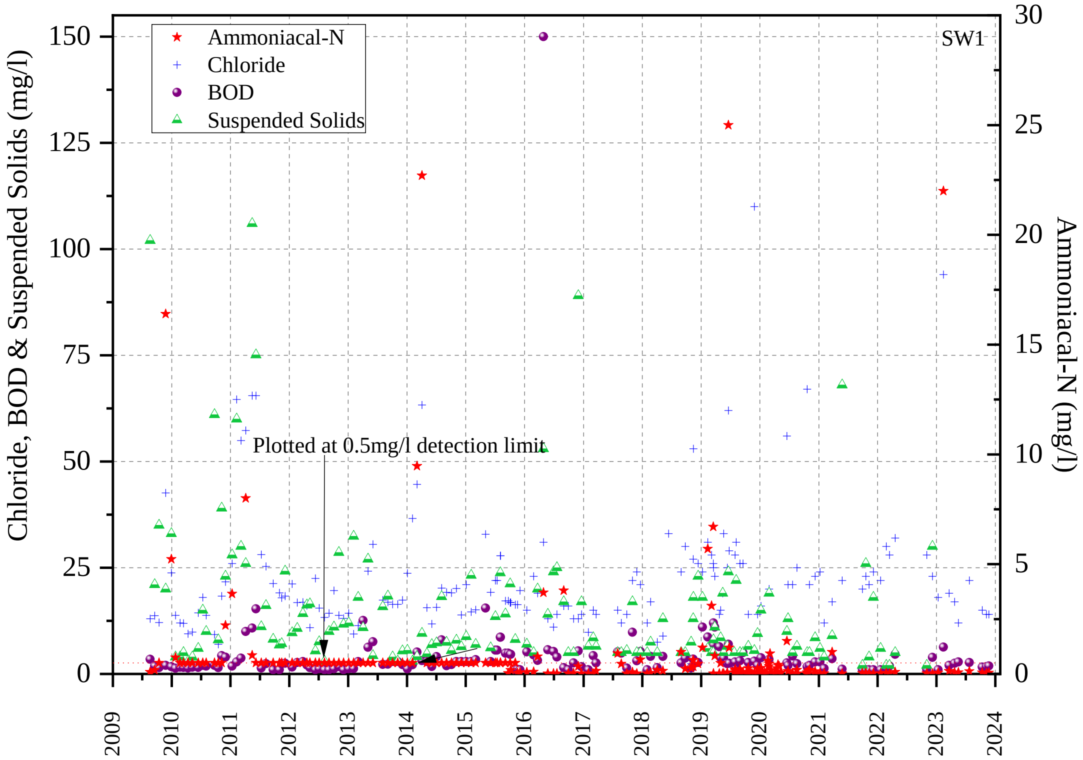
However, surface water within the lagoon has been maintained at a low level and no storm event has ever exceeded the weir height.

Table 14 Surface Water Quality Summary 2023

Sample Point	NH4-N		BOD		Cl		Susp. Solids	
	mg/l							
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Permit Limit SW1	0.5		20				40	
SW1	2.5	22.0	2.5	6.3	25	94	10	40
SW2	3.1	3.9	4.7	25.0	31	40	6	16
SW3	0.5	6.0	1.2	2.3	22	57	4	17
SW4	18.8	29.0	5.9	14.0	82	120	17	63

There was one Permit Limit exceedance during 2023 at SW1, which occurred in February at 22 mg/l (Figure 31). However, there were no further exceedances on any of the subsequent monthly monitoring visits, and the March sample recorded just 0.13 mg/l.

Figure 31 SW1 Surface Water Permit Limit Substances



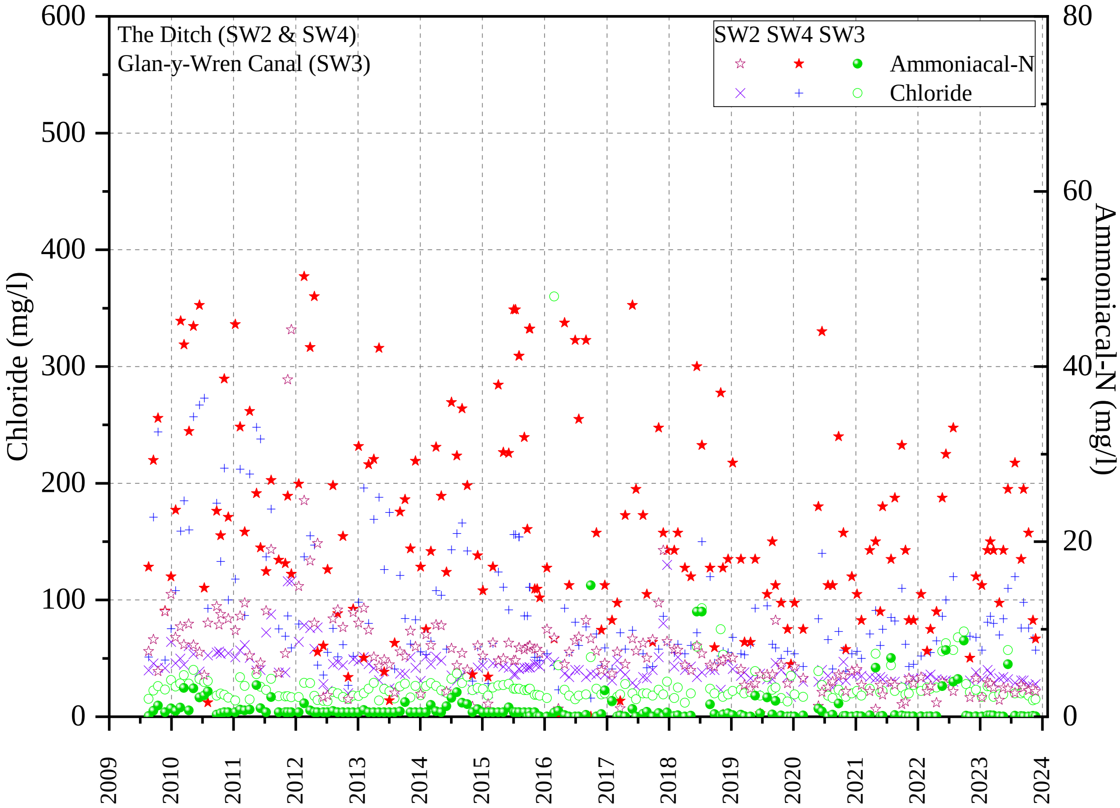
The Glan-y-Wern canal (SW3) is considered as representative of an essentially static water body, which can contain stagnant water conditions and is generally isolated from the surrounding water systems, albeit that there will be some continuity with the bog pore water particularly during high recharge periods.

The Ditch (SW2 and SW4) is, however, more complex. Chloride remained below its DWS of 250 mg/l at SW2 and SW4 (Figure 32) and has remained stable at both points since 2016. Ammoniacal-N, however, is elevated and has historically fluctuated between <5 mg/l and 50 mg/l at SW4. This trend has continued through 2023.

There is a general declining trend of ammoniacal-N at the SW2 monitoring point with 2023 concentrations been recorded in the 1.9 – 3.9 mg/l range. Previously ammoniacal-N has been observed in the 5 - 10 mg/l range at SW2.

Ammoniacal-N variability within the Ditch is likely to be due to a greater hydraulic continuity with the anoxic conditions within the Crymlyn Bog in the downstream sampling location (SW4) compared to the upstream location (SW2).

Figure 32 Surface water Ammoniacal-N and Chloride



The priority metals are at low to negligible concentrations within the surface water. Lead was reported below or approximating the limit of detection as was chromium, both in the <0.0002-0.0006 mg/l range. Copper and nickel were at 1.1 – 3.5 µg/l with zinc reported in the 1.7 – 9.8 µg/l range.

Table 15 Surface Water Priority Metals Summary

Sample Point	Date	Fe	Mn	Cd	Cr	Cu	Ni	Zn	Pb
		mg/l	mg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SW1	12/10/2023	0.011	0.78	< 0.02	0.0003	0.0028	0.0006	0.0075	< 0.0002
SW2	12/10/2023	0.015	37	< 0.02	< 0.0002	0.0054	0.0035	0.0017	< 0.0002
SW3	12/10/2023	0.2	3.3	< 0.02	0.0002	0.0052	0.0023	0.0098	< 0.0002
SW4	12/10/2023	0.096	960	< 0.02	0.0006	0.0011	0.0028	0.0059	< 0.0002

5 Amenity

5.1 Complaints

The Operator's complaints procedure is compliant to the relevant clauses of ISO14001 and involves the capture and implementation of immediate corrective action for every complaint. There are processes that review the effectiveness of the corrective action and if necessary, further preventative action is undertaken to prevent reoccurrence of the complaint.

There were no complaints received at the Tir John landfill during 2023.

5.2 Weather Data

Given the close association of potential nuisance emissions to weather conditions, the weather monitoring data are summarised in Table 16 and wind data in Figure 33.

Temperature ranges were consistent with expectations for the sites location and total rainfall was consistent with that previously observed in 2017 and 2018, albeit that the Winter months of early 2022 saw uncharacteristically low rainfall.

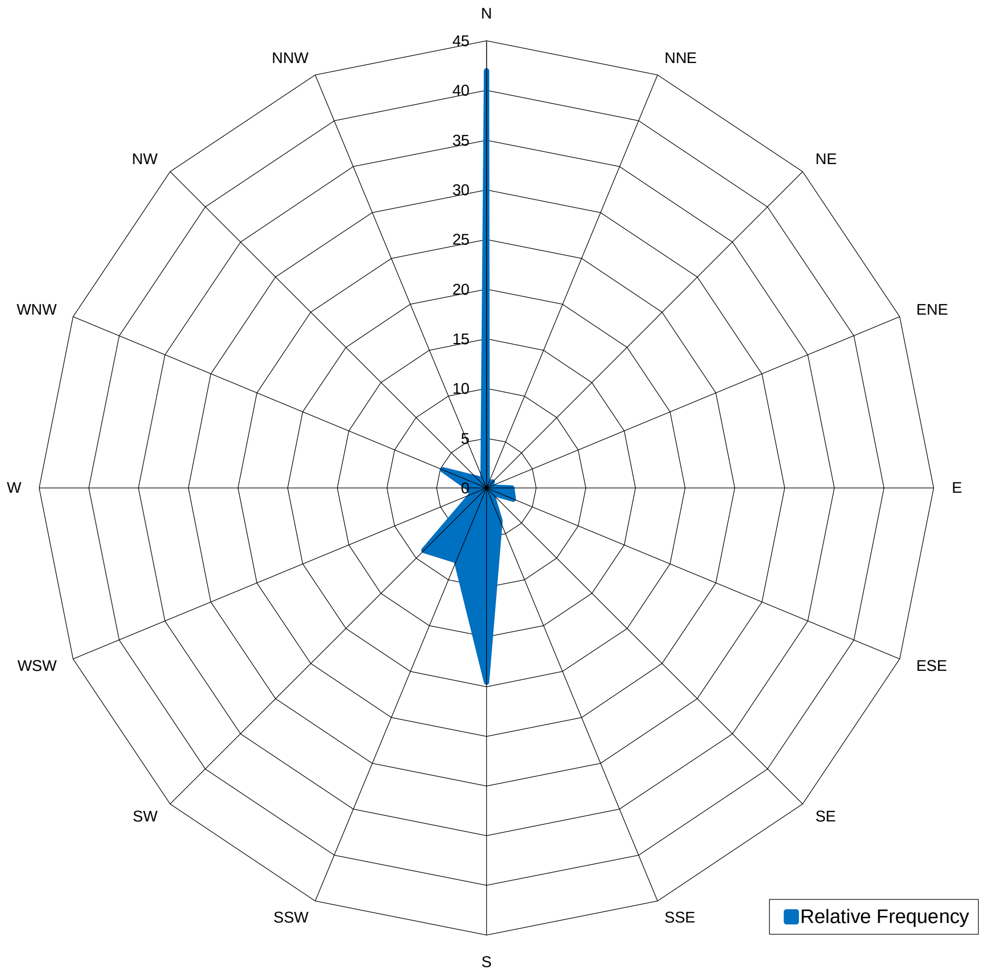
There have been issues with the rainfall data towards the end of 2023, meaning that the dataset is not complete.

Table 16 Rainfall and Temperature Summary

Month	Temperature (2023)			Rainfall							
	Min	Max	Ave	2016	2017	2018	2019	2020	2021	2022	2023
	°C			mm / month							
January	-2	13	7.2	49	79	144	78	105	184	9	147
February	-2	14	8.2	104	70	51	62	202	104	2	23
March×	1	14	8.6	106	113	135	99	67	53	8	108
April×	4	16	11.0	71	28	62	68	38	15	45	25
May×	8	19	13.2	91	15	47	28	12	156	58	1
June	No data			112	74	36	73	144	29	73	23
July				48	13	130	35	91	73	30	110
August				103	65	31	140	159	5	41	14
September×	6	28	16.4	131	143		164	40	22	69	23
October×	Insufficient data			54	52	17	194	205	29	145	27
November	No data			99	83	125	142	96	4	238	1*
December×	Insufficient data			49	121	117	180	199	2	137	0*
			Total	**1,016**	**854**	**895**	**1,263**	**1356**	**674**	**854**	**502**

** Suspect data, as no rain was recorded after 1 November.*
× Incomplete data.

Figure 33 Wind Rose Diagram 2023



6 Summary

Landfilling operations have been undertaken at the Site since 1953 in unlined cells and prior to that PFA had been deposited since 1935. There has therefore been 50 years of disposal within the permitted area prior to the construction of the first containment cell. The current phase of operations commenced in the 1990s.

The Site is located within a former river estuary cut into the South Wales Coal Measures, which was subsequently infilled by silts, clays, sands and peat deposits to form fenland conditions (The Crymlyn Bog).

There is no evidence of landfill gas migration from the Phase 2 of the Tir John landfill site. Similarly, there is no indication that there are ongoing leachate seepages or spillages to groundwater or surface water even though leachate is locally elevated within the Site.

A Hydrogeological Risk Assessment (HRA) Review for the Tir John Phase 2 landfill was undertaken during 2018. This review demonstrated that the landfill was not causing a discernible impact on the hydrogeological system. This conclusion continues to be validated by the monitoring data collected to-date. The HRA review recommended a revision to the monitoring schedules to reduce the list of specific substances incorporated within the permit schedule, to a suite more appropriate to the actual leachate inventory.

The groundwater quality is poor for a potable water supply. For example, ammoniacal-N is relatively high. However, this is due to the background influences which dominate the groundwater chemistry. This is likely to include leaching from the PFA, biological activity within the organic rich host sediments, which is contributing to anaerobic and anoxic conditions as well as potential long term minor influences from historical wastes outside of the containment cells and groundwater recharge from the Coal Measures.

It is unlikely that the presence of waste within the engineered containment cells is exerting a discernible environmental impact.

Appendix A – Perimeter Gas Monitoring Data

Tir John Phase 2 Landfill Site
Perimeter Gas Summary January - December 2023

Location	Methane			Carbon Dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric Pressure			Relative Pressure			CH_4/CO_2		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v			%v/v			%v/v			%v/v			ppm			ppm			mb			mb			ratio		
TIRGP013	0.0	0.0	0.1	0.1	0.4	1.8	19.6	20.3	20.8	78.6	79.3	79.8	0.0	0.0	0.0	0.0	0.2	2.0	996	1,016	1,033	-0.3	-0.1	0.3	0.0	0.0	0.5
TIRGP014	0.0	0.0	0.1	0.1	5.3	9.9	7.4	14.2	20.8	78.1	80.5	84.3	0.0	0.0	0.0	0.0	0.2	2.0	999	1,016	1,033	-0.3	0.0	0.2	0.0	0.0	0.0
TIRGP015	0.0	0.0	0.1	4.0	5.9	9.2	9.3	13.0	16.6	78.1	81.2	84.7	0.0	0.0	0.0	0.0	0.1	1.0	998	1,016	1,033	-0.2	0.0	0.3	0.0	0.0	0.0
TIRGP016	0.0	0.0	0.1	6.8	9.0	12.3	5.7	9.6	13.8	77.6	81.4	85.7	0.0	0.0	0.0	0.0	0.2	1.0	998	1,016	1,033	-0.3	0.0	0.2	0.0	0.0	0.0
TIRGP017	0.0	0.0	0.1	1.0	2.9	4.4	15.3	17.4	19.2	78.4	79.6	80.6	0.0	0.0	0.0	0.0	0.1	1.0	998	1,016	1,033	-0.2	0.0	0.4	0.0	0.0	0.0
TIRGP018	0.0	0.0	0.1	0.5	5.0	10.2	3.8	15.1	20.8	78.2	79.9	86.5	0.0	0.1	1.0	0.0	0.1	1.0	998	1,016	1,033	-0.3	0.0	0.2	0.0	0.0	0.0
TIRGP019	0.0	0.0	0.1	0.1	3.6	7.6	13.3	17.8	20.7	76.8	78.6	79.5	0.0	0.3	3.0	0.0	0.2	1.0	998	1,016	1,032	-0.3	0.0	0.2	0.0	0.0	0.1
TIRGP020	0.0	0.0	0.3	0.3	5.5	9.6	8.5	12.9	20.1	78.9	81.6	85.1	0.0	0.1	1.0	0.0	0.3	2.0	998	1,016	1,032	-0.1	0.0	0.3	0.0	0.0	0.3
TIRGP021	0.0	4.0	13.6	0.3	4.2	9.8	0.3	9.6	20.4	77.4	82.2	90.7	0.0	0.0	0.0	0.0	0.3	1.0	998	1,016	1,032	-0.6	0.0	0.4	0.0	0.6	2.0
TIRGP022	0.0	0.0	0.2	0.1	0.7	1.9	16.9	19.5	21.4	78.2	79.8	82.1	0.0	0.0	0.0	0.0	0.5	2.0	998	1,016	1,032	-0.6	0.3	1.7	0.0	0.3	2.0
TIRGP023	0.0	0.0	0.1	0.1	3.1	11.9	0.7	14.8	21.1	77.4	82.0	90.7	0.0	0.0	0.0	0.0	0.5	2.0	998	1,016	1,032	-0.3	0.0	0.3	0.0	0.0	0.0

Appendix B – Gas Management Field Summary

Tir John Landfill Site

In-Waste Gas Summary January - December 2023

Location	Methane			Carbon Dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v																		mb					
TIR00W01	59.3	59.3	59.3	40.7	42.1	43.5	0.2	0.2	0.2	0.0	0.0	0.0	12.0	15.0	18.0	5.0	7.0	9.0	1003	1014	1024	-12.7	-9.9	-7.1
TIR00W03	62.9	63.2	63.4	40.0	40.3	40.6	0.1	0.1	0.1	0.0	0.0	0.0	9.0	12.0	15.0	2.0	16.0	30.0	1004	1016	1027	-16.9	-13.4	-9.9
TIR00W04	59.8	59.9	60.0	43.0	43.1	43.2	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	14.0	9.0	10.0	11.0	1004	1004	1004	-15.3	-13.7	-12.1
TIR00W05	62.0	62.2	62.3	39.9	40.1	40.2	0.0	1.3	2.6	0.0	0.0	0.0	13.0	15.5	18.0	4.0	6.0	8.0	1004	1016	1027	0.7	0.9	1.2
TIR00W06	39.8	41.1	42.4	13.2	13.4	13.5	6.8	7.2	7.6	37.6	38.4	39.1	14.0	16.5	19.0	3.0	4.0	5.0	1004	1016	1027	-0.9	-0.6	-0.3
TIR00W07	54.3	57.4	60.5	36.6	39.4	42.1	0.0	1.2	2.4	0.0	3.4	6.7	9.0	11.0	13.0	1.0	2.0	3.0	1003	1015	1027	-14.5	-11.9	-9.2
TIR00W08	63.0	63.0	63.0	40.8	40.9	40.9	0.0	0.1	0.1	0.0	0.0	0.0	17.0	17.0	17.0	15.0	15.5	16.0	1004	1004	1004	-22.8	-22.0	-21.2
TIR00W09	61.3	61.7	62.0	38.6	40.1	41.5	0.1	0.2	0.2	0.0	0.0	0.0	6.0	8.0	10.0	1.0	5.5	10.0	1003	1014	1025	-0.3	0.1	0.5
TIR00W10	62.8	64.0	65.2	32.6	35.5	38.4	0.1	0.7	1.2	0.0	1.7	3.4	10.0	13.0	16.0	16.0	37.5	59.0	1004	1015	1025	-0.9	-0.2	0.5
TIR00W11	62.2	62.3	62.3	40.3	40.8	41.2	0.0	0.2	0.3	0.0	0.0	0.0	5.0	8.0	11.0	0.0	3.5	7.0	1005	1017	1028	4.9	5.0	5.1
TIR00W12	52.5	58.4	64.2	33.0	33.9	34.8	0.7	2.2	3.7	0.3	5.6	10.8	6.0	7.0	8.0	0.0	0.5	1.0	1004	1016	1027	1.0	2.5	4.1
TIR0PINS	47.5	47.5	47.5	28.9	28.9	28.9	0.7	0.7	0.7	22.9	22.9	22.9	2.0	2.0	2.0	1.0	1.0	1.0	1004	1004	1004	-41.3	-41.3	-41.3
TIRHWM06	25.9	25.9	25.9	21.6	21.6	21.6	2.0	2.0	2.0	50.5	50.5	50.5	4.0	4.0	4.0	0.0	0.0	0.0	1018	1018	1018	-0.3	-0.3	-0.3
TIRHZ001	59.7	62.4	65.1	28.8	30.6	32.3	0.8	1.7	2.5	1.8	5.4	9.0	6.0	10.5	15.0	1.0	1.5	2.0	1015	1015	1015	-5.0	-2.4	0.3
TIRHZ004	0.1	0.1	0.1	1.4	1.4	1.4	20.1	20.1	20.1	78.4	78.4	78.4	3.0	3.0	3.0	0.0	0.0	0.0	1005	1005	1005	0.1	0.1	0.1
TIRHZ005	58.0	59.9	61.3	37.1	40.1	42.4	0.1	0.2	0.8	0.0	0.2	0.8	5.0	8.4	11.0	0.0	57.6	278.0	1005	1012	1017	-54.6	-21.3	1.0
TIRHZ006	14.6	14.6	14.6	17.7	17.7	17.7	3.9	3.9	3.9	54.6	54.6	54.6	3.0	3.0	3.0	1.0	1.0	1.0	1006	1006	1006	-6.4	-6.4	-6.4
TIRLEW06	20.9	27.7	32.6	19.0	23.0	24.8	0.0	1.0	3.0	42.1	48.2	57.0	0.0	1.7	6.0	0.0	2.0	21.0	999	1014	1033	-0.9	-0.1	0.9
TIRLEW07	0.0	17.3	46.2	1.8	13.8	28.6	0.1	9.8	20.5	23.8	59.2	87.0	0.0	0.5	1.0	0.0	0.0	0.0	997	1011	1026	-1.1	0.1	1.4
TIRLEW08	0.0	38.4	62.1	1.8	25.3	33.3	0.0	2.3	20.9	4.6	34.0	77.2	0.0	4.5	19.0	0.0	2.4	11.0	999	1013	1031	-3.4	-0.3	1.2
TIRLEW10	0.0	9.0	25.7	1.5	8.3	18.5	3.0	13.9	20.6	49.5	68.8	79.1	0.0	0.7	2.0	0.0	0.3	3.0	997	1012	1030	-6.6	-0.9	0.6
TIRLEW12	8.4	51.6	71.2	6.5	19.0	24.1	0.8	4.6	17.4	3.8	24.8	67.7	2.0	5.5	16.0	0.0	1.2	3.0	998	1010	1027	-5.0	-0.8	2.1
TIRLEW14	12.8	56.9	73.7	4.8	19.2	23.8	0.4	5.0	17.3	2.7	18.9	65.1	0.0	1.9	3.0	0.0	0.6	3.0	998	1013	1030	-2.4	-0.3	0.6
TIRLEW15	0.3	31.3	62.3	2.2	17.6	32.9	0.3	6.4	12.5	4.5	44.8	85.0	1.0	2.0	3.0	0.0	1.0	2.0	1005	1008	1011	0.1	0.2	0.3
TIRLEW16	57.1	61.5	66.0	38.5	39.6	41.0	0.1	0.9	1.7	0.0	0.7	2.0	11.0	12.7	15.0	5.0	16.0	25.0	1004	1013	1027	0.1	0.3	0.5
TIRLEW25	0.6	22.0	38.1	8.1	21.4	27.1	0.0	2.4	15.1	36.0	54.2	83.6	0.0	0.7	1.0	0.0	1.7	7.0	997	1012	1031	-2.0	-0.3	1.0
TIRLEW27	1.3	53.7	75.4	3.6	29.1	40.7	0.0	3.1	18.6	0.0	18.0	76.5	0.0	2.4	5.0	0.0	13.3	90.0	1005	1014	1028	-0.3	0.1	0.7
TIRLEW29	0.0	2.4	15.2	0.2	6.1	21.6	0.1	17.3	21.4	63.1	74.2	78.6	0.0	1.5	4.0	0.0	0.3	2.0	999	1013	1030	-0.8	-0.2	0.3
TIRLEW30	0.0	13.6	68.4	0.4	10.7	37.9	0.0	15.0	21.3	0.0	61.1	78.3	0.0	1.7	5.0	0.0	5.1	56.0	1005	1014	1028	-0.7	0.1	0.4
TIRLEW31	34.4	64.7	73.6	20.4	33.4	37.5	0.0	1.1	9.6	0.0	4.3	35.6	0.0	2.8	5.0	0.0	10.5	84.0	1004	1012	1028	-28.5	2.5	62.7
TIRLEW32	0.8	49.1	73.1	3.8	25.7	33.8	0.0	3.3	13.7	0.0	22.7	82.4	0.0	3.0	8.0	0.0	3.5	21.0	1005	1015	1029	-56.7	-9.0	3.3
TIRLEW33	0.8	26.2	65.0	4.3	18.9	39.5	0.3	12.1	18.9	0.0	44.0	76.6	1.0	6.8	10.0	4.0	326.8	1286.0	1004	1012	1025	-0.2	0.3	0.6
TIRLEW34	51.6	59.4	66.3	37.2	39.2	41.3	0.1	0.9	2.8	0.0	2.1	8.4	10.0	11.5	14.0	6.0	9.3	11.0	1005	1017	1026	-7.9	-2.3	4.3
TIRLEW9B	9.1	14.3	24.6	6.2	12.5	20.0	9.9	14.5	17.6	46.9	58.8	65.0	1.0	2.3	4.0	0.0	2.8	7.0	1003	1013	1027	-2.1	-0.6	-0.1
TIRPINWS	51.6	51.6	51.6	28.9	28.9	28.9	1.5	1.5	1.5	18.0	18.0	18.0	1.0	1.0	1.0	0.0	0.0	0.0	1012	1012	1012	-71.0	-71.0	-71.0
TIRS1100	32.8	32.8	32.8	22.6	22.6	22.6	0.0	0.0	0.0	44.6	44.6	44.6	1.0	1.0	1.0	0.0	0.0	0.0	1013	1013	1013	-52.6	-52.6	-52.6
TIRS1200	24.4	24.4	24.4	18.3	18.3	18.3	4.5	4.5	4.5	52.8	52.8	52.8	1.0	1.0	1.0	0.0	0.0	0.0	1013	1013	1013	-71.7	-71.7	-71.7
TIRS1300	30.4	30.4	30.4	22.6	22.6	22.6	0.1	0.1	0.1	46.9	46.9	46.9	1.0	1.0	1.0	0.0	0.0	0.0	1013	1013	1013	-71.9	-71.9	-71.9
TIRS1400	0.0	0.0	0.0	0.4	0.4	0.4	21.3	21.3	21.3	78.3	78.3	78.3	0.0	0.0	0.0	0.0	0.0	0.0	1005	1005	1005	0.0	0.0	0.0
TIRSCAV1	5.4	55.0	74.2	5.0	22.6	29.4	0.0	5.0	18.6	0.0	18.0	71.0	0.0	2.2	5.0	0.0	2.4	16.0	1007	1016	1030	-72.7	-32.7	6.8
TIRSCAV2	1.2	61.6	74.9	6.6	26.0	32.7	0.0	2.3	18.7	0.0	11.4	73.5	1.0	2.2	4.0	0.0	2.5	25.0	1007	1015	1030	-74.0	-27.4	1.3
TIRSCAV3	0.0	12.7	72.5	0.1	7.8	32.6	0.3	15.8	21.7	0.0	64.1	78.3	0.0	1.5	4.0	0.0	0.8	6.0	999	1014	1030	-1.5	-0.2	0.5
TIRSP1MA	21.4	40.5	48.0	13.8	25.8	30.9	0.5	2.0	12.1	20.9	31.7	52.7	0.0	3.4	7.0	0.0	3.7	21.0	1007	1015	1032	-98.6	-47.8	-15.7
TIRSP1MB	19.0	38.4	47.8	13.5	24.9	31.1	0.5	2.0	8.8	20.6	34.8	58.7	0.0	1.4	6.0	0.0	1.3	13.0	998	1013	1035	-99.3	-63.2	-21.2
TIRSP2MA	21.6	39.3	47.6	13.5	25.9	31.1	0.4	2.0	12.3	20.5	32.9	52.6	0.0	3.0	7.0	0.0	5.2	20.0	1008	1016	1032	8.0	89.9	162.0
TIRSP2MB	30.5	38.1	47.8	21.2	25.5	30.9	0.4	1.6	3.3	20.9	34.9	45.6	0.0	1.8	6.0	0.0	1.8	21.0	997	1014	1035	6.1	70.1	155.7
TIRW000E	64.4	64.4	64.4	40.5	40.5	40.5	0.1	0.1	0.1	0.0	0.0	0.0	12.0	12.0	12.0	3.0	3.0	3.0	1008	1008	1008	1.1	1.1	1.1
TIRW000F	27.7	27.7	27.7	16.1	16.1	16.1	12.2	12.2	12.2	44.0	44.0	44.0	7.0	7.0	7.0	15.0	15.0	15.0	1009	1009	1009	0.9	0.9	0.9
TIRW000G	64.4	64.4	64.4	40.3	40.3	40.3	0.3	0.3	0.3	0.0	0.0	0.0	12.0	12.0	12.0	9.0	9.0	9.0	1008	1008	1008	0.8	0.8	0.8

Location	Methane			Carbon Dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v																		mb					
TIRW000H	62.4	62.4	62.4	42.2	42.2	42.2	0.1	0.1	0.1	0.0	0.0	0.0	17.0	17.0	17.0	5.0	5.0	5.0	1008	1008	1008	2.5	2.5	2.5
TIRW000I	63.5	63.5	63.5	40.9	40.9	40.9	0.3	0.3	0.3	0.0	0.0	0.0	7.0	7.0	7.0	0.0	0.0	0.0	1009	1009	1009	0.3	0.3	0.3
TIRW000J	15.8	15.8	15.8	9.4	9.4	9.4	16.2	16.2	16.2	58.6	58.6	58.6	4.0	4.0	4.0	43.0	43.0	43.0	1009	1009	1009	0.5	0.5	0.5
TIRW000K	65.8	65.8	65.8	38.2	38.2	38.2	0.5	0.5	0.5	0.0	0.0	0.0	5.0	5.0	5.0	0.0	0.0	0.0	1009	1009	1009	3.4	3.4	3.4
TIRW000L	35.3	35.3	35.3	19.7	19.7	19.7	9.7	9.7	9.7	35.3	35.3	35.3	4.0	4.0	4.0	0.0	0.0	0.0	1009	1009	1009	-0.1	-0.1	-0.1
TIRW1211	0.1	8.7	17.3	1.2	4.9	8.6	14.0	16.9	19.8	60.1	69.5	78.9	1.0	2.0	3.0	0.0	0.5	1.0	1005	1009	1012	-0.2	-0.1	0.1
TIRW1212	71.8	74.4	76.0	25.6	27.3	28.4	0.0	0.2	0.4	0.0	0.3	1.5	1.0	3.2	5.0	0.0	11.0	32.0	1006	1014	1029	-66.2	-18.6	0.7
TIRW12A1	7.8	55.7	69.0	4.8	29.2	36.1	0.0	2.2	16.8	0.0	13.8	70.6	0.0	3.9	29.0	0.0	6.5	30.0	1005	1014	1029	-68.8	-31.1	1.1
TIRW12A2	54.7	68.5	74.6	25.7	29.7	35.5	0.1	1.0	3.8	0.0	3.1	15.8	0.0	3.1	7.0	0.0	5.5	30.0	1005	1015	1029	-76.0	-35.3	0.3
TIRW12A3	0.2	60.5	75.8	1.1	27.3	34.9	0.0	3.0	21.9	0.0	10.5	76.8	0.0	2.5	7.0	0.0	1.2	7.0	1006	1016	1030	-44.1	-13.2	17.0
TIRW1401	0.2	35.2	64.1	1.0	22.5	38.2	0.0	5.1	18.6	0.0	37.5	83.0	1.0	2.6	4.0	0.0	3.2	13.0	1005	1014	1026	-12.5	-4.2	0.2
TIRW1402	0.1	16.2	59.2	0.8	13.4	43.5	0.1	12.5	20.9	0.0	58.6	81.0	1.0	2.0	3.0	0.0	2.8	9.0	1005	1015	1027	-70.3	-17.5	0.2
TIRW1403	0.0	31.1	73.9	0.6	18.5	36.6	0.0	9.9	21.2	0.0	49.1	78.2	0.0	2.1	5.0	0.0	4.9	26.0	1005	1012	1027	-0.4	38.2	228.4
TIRW1404	0.0	14.7	68.3	0.5	10.3	35.9	0.2	15.7	21.3	0.0	60.2	80.2	0.0	1.6	4.0	0.0	1.2	6.0	1005	1013	1027	-64.8	-13.3	0.2
TIRW1801	0.1	42.1	61.3	1.9	30.2	42.9	0.0	6.0	20.8	0.0	22.5	76.6	0.0	3.8	7.0	0.0	7.1	67.0	1004	1013	1028	-47.1	8.2	118.9
TIRW1802	1.4	50.1	66.6	4.0	36.4	45.2	0.2	2.6	17.9	0.0	12.2	76.7	0.0	3.5	7.0	0.0	7.0	61.0	1004	1012	1028	-69.6	-20.9	23.6
TIRW1803	0.6	55.4	69.8	8.4	35.7	41.1	0.0	2.7	18.9	0.0	8.0	72.2	0.0	3.4	7.0	0.0	7.1	70.0	1004	1013	1028	-70.3	32.7	200.1
TIRW1804	0.8	51.3	69.6	4.0	30.8	41.0	0.0	2.5	11.7	0.0	19.2	83.5	1.0	4.0	9.0	0.0	9.3	79.0	1004	1014	1028	-68.6	-24.6	22.2
TIRW1805	60.7	64.6	71.6	33.2	36.7	39.3	0.0	0.2	0.8	0.0	0.5	4.1	1.0	3.5	7.0	0.0	5.8	55.0	1004	1013	1028	-58.8	-19.4	54.0
TIRW1806	41.7	60.5	68.4	23.6	33.8	39.8	0.0	0.9	7.2	0.0	5.7	27.5	1.0	2.8	6.0	0.0	1.5	7.0	1005	1014	1028	-57.6	-12.2	0.9
TIRW2509	12.3	28.7	38.2	12.5	21.6	26.2	0.0	2.3	10.6	37.7	47.4	64.6	0.0	0.5	1.0	0.0	0.9	12.0	999	1012	1031	-3.0	-0.3	1.0
TIRW2510	19.0	26.9	32.3	22.4	24.5	28.1	0.0	0.3	1.0	39.6	48.4	57.0	0.0	0.6	2.0	0.0	0.1	1.0	997	1013	1032	-1.2	-0.1	0.9
TIRW2511	20.8	25.0	30.4	16.9	21.6	23.4	0.0	0.7	4.0	46.3	52.6	59.3	0.0	0.6	1.0	0.0	2.4	20.0	997	1012	1027	-1.4	-0.4	0.9
TIRW2512	2.7	20.2	28.7	1.7	13.9	18.7	1.3	6.1	19.3	51.3	59.6	75.3	1.0	1.6	2.0	0.0	0.2	1.0	1005	1012	1018	-0.7	0.5	3.0
TIRW2515	0.3	41.4	59.8	6.3	24.1	29.3	0.0	2.2	17.9	12.0	32.2	75.5	0.0	2.0	6.0	0.0	2.9	20.0	1004	1013	1030	-34.1	-11.1	0.6
TIRW2601	0.1	8.4	17.4	0.1	11.4	19.4	0.0	9.4	21.5	62.4	70.8	78.2	0.0	1.2	3.0	0.0	0.6	3.0	1005	1013	1029	-0.9	-0.1	1.3
TIRW2602	1.3	27.4	48.4	1.7	17.3	21.2	0.0	2.9	18.8	33.1	52.4	77.9	0.0	0.9	3.0	0.0	0.5	3.0	997	1013	1030	-3.9	-0.8	0.8
TIRW2603	18.3	35.0	73.2	18.2	20.2	23.3	0.0	0.1	0.9	5.3	44.4	61.6	0.0	1.4	4.0	0.0	2.0	21.0	995	1012	1030	-8.7	-3.8	0.1
TIRW2604	0.6	7.9	28.6	3.4	11.3	19.6	0.0	9.3	19.8	51.9	71.6	78.4	0.0	1.0	2.0	0.0	0.5	2.0	997	1011	1030	-72.9	-6.3	0.2
TIRW2605	5.0	32.0	64.9	17.2	23.1	28.2	0.0	0.7	2.9	7.9	44.2	75.0	0.0	1.6	5.0	0.0	0.4	3.0	997	1014	1030	-5.1	-1.4	0.3
TIRW2606	0.2	20.3	77.7	2.3	10.4	22.9	0.0	10.5	19.1	0.0	58.9	87.1	0.0	0.8	2.0	0.0	0.5	2.0	999	1012	1030	-4.7	-0.9	0.5
TIRW2607	0.6	0.8	1.0	1.9	3.7	5.5	9.6	10.3	11.0	82.9	85.2	87.5	0.0	0.0	0.0	0.0	1.0	2.0	1011	1020	1029	-0.2	0.0	0.2
TIRW261A	0.2	2.9	8.2	6.3	15.0	19.0	0.0	3.5	12.8	72.8	78.6	84.5	1.0	1.4	3.0	0.0	0.4	2.0	1005	1012	1027	-0.7	0.2	1.2
TIRW263A	0.7	25.5	46.7	1.9	14.5	22.7	0.0	6.6	21.3	30.5	53.4	76.6	0.0	1.3	4.0	0.0	3.0	20.0	999	1013	1030	-16.6	-9.0	2.8
TIRW264A	0.0	2.7	24.1	1.2	4.6	18.2	0.2	16.8	20.3	57.5	75.9	80.0	0.0	1.3	3.0	0.0	0.7	3.0	1005	1015	1030	-1.4	-0.2	0.3
TIRW264B	0.0	0.2	0.7	0.1	2.4	7.2	18.7	20.7	22.2	71.9	76.6	78.3	0.0	1.0	3.0	0.0	0.4	3.0	997	1012	1030	-9.8	-1.3	2.5
TIRW265A	22.5	35.4	51.6	17.3	21.4	24.8	0.1	0.3	0.9	23.5	42.9	59.5	0.0	1.2	4.0	0.0	1.4	15.0	999	1014	1030	-31.4	-10.8	-3.3
TIRW2705	25.2	40.7	52.1	22.8	25.4	27.1	0.0	0.1	0.4	21.1	33.7	49.5	0.0	0.5	2.0	0.0	0.9	11.0	999	1013	1031	-26.3	-3.1	1.0
TIRW2706	30.1	43.5	48.6	23.3	26.8	29.2	0.0	0.2	0.8	22.2	29.5	46.4	0.0	1.2	2.0	0.0	2.5	23.0	997	1011	1027	-30.2	-11.6	-6.3
TIRW2707	0.7	29.4	39.5	6.5	23.2	27.9	0.0	1.2	14.0	33.9	46.2	78.8	0.0	0.6	2.0	0.0	1.4	18.0	999	1014	1032	-1.1	-0.4	0.6
TIRW2708	0.2	23.8	37.0	4.2	20.6	25.5	0.0	3.3	21.0	37.0	52.3	74.6	0.0	0.7	1.0	0.0	0.1	1.0	997	1013	1032	-3.2	-0.4	0.4
TIRW2709	15.9	33.1	46.1	15.4	23.1	25.9	0.0	0.6	6.9	29.2	43.2	61.8	0.0	0.5	2.0	0.0	1.0	13.0	997	1012	1031	-2.8	-1.2	0.6
TIRW2710	0.4	0.4	0.4	5.4	5.4	5.4	8.5	8.5	8.5	85.7	85.7	85.7	1.0	1.0	1.0	0.0	0.0	0.0	1027	1027	1027	0.3	0.3	0.3
TIRW2711	0.2	44.2	66.6	0.3	26.3	36.0	0.0	3.5	20.6	0.0	26.2	86.2	0.0	2.6	5.0	0.0	10.3	95.0	1004	1014	1030	-1.6	-0.1	0.8
TIRW2712	0.3	32.1	66.4	0.4	18.4	36.9	0.1	8.8	21.0	0.0	41.0	77.9	0.0	2.1	5.0	0.0	1.2	5.0	1005	1012	1025	-0.8	0.0	1.3
TIRW2713	0.1	13.9	39.3	0.1	10.2	22.7	0.3	13.0	21.0	33.8	62.9	81.0	0.0	1.4	4.0	0.0	1.0	4.0	1005	1013	1029	-7.2	-0.9	1.1
TIRW3A01	0.8	40.6	51.9	3.4	24.7	29.2	0.0	1.4	9.9	18.3	33.2	85.9	0.0	1.5	3.0	0.0	4.9	34.0	998	1010	1029	-16.0	-5.9	0.1
TIRW3A02	1.1	21.1	52.4	1.5	18.7	25.0	0.0	3.8	20.9	24.0	56.4	76.5	0.0	1.5	3.0	0.0	2.4	16.0	996	1012	1029	-2.5	-0.8	0.6
TIRW3A03	10.1	34.0	49.0	21.0	24.1	26.9	0.0	0.5	5.1	24.1	41.4	67.8	0.0	1.4	3.0	0.0	2.6	15.0	998	1011	1029	-3.2	-0.8	1.3
TIRW3A04	0.2	14.9	52.9	2.5	14.4	31.5	0.0	9.2	22.1	15.1	61.5	85.7	0.0	1.2	3.0	0.0	1.4	13.0	997	1012	1029	-1.0	-0.1	1.3
TIRW3A05	42.6	42.6	42.6	23.1	23.1	23.1	0.8	0.8	0.8	33.5	33.5	33.5	2.0	2.0	2.0	0.0	0.0	0.0	1013	1013	1013	-3.2	-3.2	-3.2
TIRW3A06	41.0	52.4	65.2	28.2	30.5	32.5	0.0	0.3	1.1	2.5	16.6	30.7	0.0	1.7	4.0	0.0	4.2	27.0	1004	1012	1029	-23.7	-10.3	0.1

Location	Methane			Carbon Dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v																		mb					
TIRW3B01	22.0	36.7	54.1	17.4	27.0	30.7	0.0	0.6	7.9	15.3	35.6	54.3	0.0	1.0	2.0	0.0	1.9	24.0	997	1012	1027	-22.4	-7.6	0.2
TIRW3B02	8.7	16.7	30.5	10.4	20.0	25.3	0.0	2.9	16.0	43.2	60.4	70.0	0.0	1.2	3.0	0.0	2.4	19.0	1004	1012	1026	-1.6	-0.4	1.1
TIRW3B03	9.1	18.6	26.9	14.6	20.9	24.8	0.0	0.9	3.1	50.1	59.6	73.2	0.0	1.0	3.0	0.0	3.1	20.0	999	1009	1018	-2.7	-0.2	0.7
TIRW3B04	27.2	40.9	63.0	20.2	28.9	36.5	0.0	0.3	0.9	0.2	29.9	51.7	0.0	1.4	3.0	0.0	6.6	38.0	998	1012	1029	-61.7	-27.8	-0.9
TIRW3B05	0.7	48.8	65.6	2.7	27.6	32.7	0.0	2.1	20.9	3.4	21.6	75.7	1.0	1.8	3.0	0.0	1.8	18.0	1004	1013	1030	-13.8	-4.8	0.1
TIRW3B07	42.3	50.3	58.8	26.7	30.0	32.6	0.0	0.1	0.7	8.6	19.6	29.7	0.0	1.5	4.0	0.0	3.3	35.0	1003	1013	1030	-8.4	-4.9	0.1
TIRW3C01	4.9	34.9	47.7	5.8	24.1	28.0	0.1	1.8	17.6	24.8	39.2	71.7	0.0	1.5	6.0	0.0	1.0	8.0	998	1012	1030	-11.9	-3.1	0.4
TIRW3C03	0.2	36.2	53.1	2.0	24.9	29.4	0.0	1.6	20.2	17.7	37.3	77.6	0.0	1.9	6.0	0.0	4.1	30.0	1004	1013	1029	-41.6	-22.0	0.0
TIRW3C04	10.7	27.8	42.5	11.5	21.7	25.2	0.0	1.5	11.4	32.2	48.9	66.4	0.0	0.6	2.0	0.0	1.6	19.0	999	1014	1031	-2.7	-0.3	1.2
TIRW3C05	2.8	19.4	30.3	7.4	17.9	23.2	0.0	3.5	13.8	43.6	59.2	75.6	0.0	0.7	2.0	0.0	0.4	3.0	999	1012	1031	-4.3	-0.6	1.4
TIRW3C06	0.8	21.1	48.0	4.3	19.1	31.3	0.0	2.0	16.4	20.6	57.9	78.5	0.0	1.4	5.0	0.0	2.1	11.0	999	1014	1027	-13.9	-2.0	1.4
TIRW3C07	0.3	29.7	44.6	2.1	22.4	27.2	0.0	2.0	20.6	28.4	45.9	77.0	0.0	1.0	3.0	0.0	1.9	17.0	997	1010	1030	-37.1	-4.5	0.1
TIRW3C08	0.1	5.5	7.8	0.1	11.9	18.6	0.0	8.8	21.3	69.2	73.8	78.5	0.0	2.3	3.0	0.0	2.3	4.0	1006	1010	1014	-45.8	-20.6	0.4
TIRWELL1	45.5	45.5	45.5	28.3	28.3	28.3	0.1	0.1	0.1	26.1	26.1	26.1	2.0	2.0	2.0	33.0	33.0	33.0	1013	1013	1013	-6.6	-6.6	-6.6

Appendix C – Water Monitoring Data

Tir John Phase 2 Landfill Site
Leachate Quality Summary January - December 2023

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	Mg	Na	K	Cl	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LEW12a	25/05/2023	8	17000	1600.0	2200	210		1500	340	2200	< 0.08	< 0.5	0.066	0.14	0.140	0.630	0.01	0.0630
LEW12a	25/10/2023	7.9	16000	1800.0	2500	120		1600		2000	< 0.08					0.016	0.00	
LEW16	25/10/2023	7.9	16000	1600.0	5300	2900		2000		2100	< 0.08					0.037	< 0.001	
LEW23	25/05/2023	7.2	2700	45.0	300	14		290	96	300	0	< 0.005	0.0058	0.004	0.017	0.005	< 0.0002	0.0180
LEW23	25/10/2023	7.2	3500	19.0	500	22		370		430	0					0.025	0.00	
LEW25	25/05/2023	7.4	7500	600.0	610	15		650	230	860	< 0.02	< 0.005	0.016	0.002	0.068	0.013	0.00	0.0230
LEW25	25/10/2023	7.3	4300	270.0	350	56		300		420	< 0.02					0.005	< 0.0002	
LEW26	23/05/2023	7.1	1500	3.7	78	3		120	44	120	< 0.02	< 0.005	0.0012	0.009	0.015	0.044	< 0.0002	0.0019
LEW26	25/10/2023	7.2	1300	9.2	90	5		120		95	0					0.083	0.00	
LEW28	23/05/2023	8.1	1600	< 0.015	240	5		150	50	210	0	< 0.005	0.0026	0.060	0.028	0.037	0.00	0.0036
LEW28	25/10/2023	8.1	480	0.0	110	2		17		17	< 0.02					0.012	0.00	
LEW29	25/05/2023	7.6	4800	370.0	430	10		410	200	420	0	< 0.005	0.0068	0.004	0.024	0.024	0.00	0.0140
LEW29	25/10/2023	7.5	4800	310.0	440	20		340		350	< 0.02					0.005	< 0.0002	
LEW31	25/05/2023	7.8	21000	1900.0	4800	190		1700	650	2500	< 0.08	< 0.5	0.24	0.011	0.250	0.140	< 0.001	0.0560
LEW31	07/11/2023	7.7	17000	1800.0	4200	150		1700		2500	< 0.08					< 0.0004	< 0.001	

Tir John Phase 2 Landfill Site
Groundwater Quality Summary January - December 2023

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alkalinity	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As	MCPP
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l
GDW01(D)	18/01/2023	8.1	900	38.0	1300	110	46			56	31	43			0.01	410	< 0.02	< 0.005	< 0.0002	0.0007		0.007	< 0.0002	12.30	< 0.02
	16/05/2023	7.9	810	17.0	8800	12	1	76	33	52	38	38	5	450	0.28	200	0.05	< 0.005	0.0004	< 0.0005	0.0013	0.003	< 0.0002	5.63	< 0.02
	26/07/2023	7.8	790	7.9	15000	130	1	69	34	46	28	31	5	330	0.01	220	< 0.02	< 0.005	< 0.0002	0.0052	< 0.0005	0.002	< 0.0002	7.36	< 0.02
	12/10/2023	8.1	690	11.0	14000	26	2	49	31	45	26	43	20	330	0.03	110	< 0.02	< 0.005	< 0.0002	< 0.0005	0.0007	0.001	< 0.0002	33.40	< 0.02
GDW01(S)	18/01/2023	8.5	390	0.4	450	10	1			52	18	21			< 0.004	24	0.02	< 0.005	< 0.0002	< 0.0005		0.001	< 0.0002	72.00	< 0.02
	16/05/2023	8.6	400	0.7	4	2	1	21	21	38	22	21	62	170	0.03	37	0.05	< 0.005	0.0006	< 0.0005	0.0007	0.008	< 0.0002	61.60	< 0.02
	26/07/2023	8.7	380	0.3	2600	8	1	17	18	44	18	21	124	150	0.01	26	0.03	< 0.005	< 0.0002	0.0008	< 0.0005	0.001	< 0.0002	55.00	< 0.02
	12/10/2023	8.7	410	5.7	1000	14	2	19	20	35	19	22	63	160	0.31	21	0.02	0.006	< 0.0002	< 0.0005	< 0.0005	0.002	< 0.0002	51.80	< 0.02
GDW02(D)	18/01/2023	7.2	1000	4.9	12	4	3			34	24	28			0.01	2900	0.03	< 0.005	< 0.0002	0.0007		0.004	< 0.0002	1.61	< 0.02
	16/05/2023	6.7	1100	5.0	180	33	3	170	35	36	25	30	77	550	0.08	3000	0.03	< 0.005	0.0004	< 0.0005	0.0014	0.007	< 0.0002	19.90	< 0.02
	26/07/2023	6.9	960	9.7	30	4	5	150	41	46	20	45	21	590	0.09	4200	0.03	< 0.005	< 0.0002	0.0026	0.0014	0.008	< 0.0002	3.22	< 0.02
	12/10/2023	6.6	1100	4.7	41	34	5	170	35	28	23	30	115	500	0.02	2900	< 0.02	< 0.005	< 0.0002	< 0.0005	0.0009	0.009	< 0.0002	17.10	< 0.02
GDW02(S)	18/01/2023	7.0	2100	22.0	180	8	4			210	47	180			0.19	1500	< 0.02	< 0.005	< 0.0002	0.0008		0.001	< 0.0002	1.12	< 0.02
	16/05/2023	6.9	2600	21.0	38	11	6	370	75	210	57	170	138	1300	0.42	870	< 0.02	< 0.005	0.0006	< 0.0005	< 0.0005	0.005	< 0.0002	1.70	< 0.02
	26/07/2023	7.1	2100	21.0	65	14	10	310	88	190	63	170	105	1300	0.20	960	< 0.02	< 0.005	0.0002	0.0023	0.0007	0.003	< 0.0002	1.93	< 0.02
	12/10/2023	6.9	2500	21.0	2100	20	6	380	66	180	51	180	100	1300	0.27	870	< 0.02	< 0.005	0.0002	< 0.0005	< 0.0005	0.004	< 0.0002	2.04	< 0.02
GDW03(D)	18/01/2023	7.0	480	11.0	35	1	4			19	4	25			0.05	810	< 0.02	< 0.005	< 0.0002	0.0005		0.005	< 0.0002	0.47	< 0.02
	16/05/2023	6.5	540	11.0	140	20	6	40	24	27	7	24	2	240	0.03	810	< 0.02	< 0.005	< 0.0002	0.0007	0.0006	0.006	< 0.0002	0.50	< 0.02
	26/07/2023	6.5	460	10.0	120	2	8	44	16	15	3	25	1	230	0.07	660	0.03	< 0.005	< 0.0002	0.0034	0.0012	0.002	< 0.0002	0.51	< 0.02
	12/10/2023	6.3	550	11.0	100	28	5	39	21	19	4	26	1	250	0.15	740	< 0.02	< 0.005	< 0.0002	0.0031	0.001	0.010	< 0.0002	1.04	< 0.02
GDW03(S)	18/01/2023	8.0	740	18.0	13	3	3			18	17	25			0.04	1700	< 0.02	< 0.005	< 0.0002	0.0010		0.003	< 0.0002	3.72	< 0.02
	16/05/2023	7.3	780	17.0	18	10	4	110	21	25	18	27	2	430	0.22	1400	< 0.02	< 0.005	0.0003	0.0006	0.0009	0.006	< 0.0002	2.88	< 0.02
	26/07/2023	7.5	720	17.0	74	7	4	130	18	18	16	27	3	440	0.09	1600	< 0.02	< 0.005	< 0.0002	0.0027	0.001	0.002	< 0.0002	1.13	< 0.02
	12/10/2023	7.4	800	16.0	91	13	4	110	18	17	15	29	4	420	0.04	1500	< 0.02	< 0.005	< 0.0002	< 0.0005	0.0008	0.001	< 0.0002	3.13	< 0.02
GDW04	14/02/2023	5.9		7.0			34					31					0.07		0.0005	0.0072		0.026	0.001	10.10	< 0.02
	07/06/2023	5.8		7.2			36	9	5	21	6	26	3	75		110	0.1	< 0.005	0.0007	0.0082	0.0055	0.021	0.0014	13.00	< 0.02
	30/08/2023	5.7		7.1			53					28					0.07		0.0009	0.0066		0.027	0.0016	12.20	< 0.02
	18/10/2023	6.0		6.7			39					31					0.05		0.0009	0.0042		0.027	0.0012	17.70	< 0.02
GDW05	14/02/2023	7.1		22.0			18					26					< 0.02		0.0006	0.0009		0.002	< 0.0002	9.59	< 0.02
	07/06/2023	7.3		27.0			20	69	72	280	43	26	3	1100		250	< 0.02	< 0.005	0.0007	0.0034	0.0019	0.005	< 0.0002	9.32	< 0.02
	30/08/2023	7.3		26.0			23					27					< 0.02		0.0009	0.0025		0.003	< 0.0002	11.00	< 0.02
	18/10/2023	7.3		26.0			20					26					< 0.02		0.0014	0.0034		0.018	< 0.0002	18.90	< 0.02
GDW06	14/02/2023	6.6		9.1			10					46					< 0.02		< 0.0002	0.0010		0.008	< 0.0002	1.78	< 0.02
	07/06/2023	6.4		11.0			12	68	15	39	10	29	2	320		170	0.03	< 0.005	< 0.0002	0.0022	0.0019	0.011	< 0.0002	1.62	< 0.02
	30/08/2023	6.4		13.0			12					25					< 0.02		0.0002	0.0022		0.005	0.0014	1.88	< 0.02
	18/10/2023	6.4		12.0			17					26					0.05		0.0004	0.0020		0.016	< 0.0002	6.24	< 0.02
GDW07	14/02/2023	6.9		14.0			6					92					< 0.02		0.0003	0.0023		0.007	< 0.0002	2.37	< 0.02
	07/06/2023	6.9		12.0			6	660	73	41	24	90	1710	960		1100	< 0.02	< 0.005	0.0002	0.0014	0.0028	0.008	< 0.0002	9.04	< 0.02
	30/08/2023	6.7		6.5			11					40					< 0.02		0.0009	0.0083		0.005	0.0002	2.08	< 0.02
	18/10/2023	6.8		4.0			10					32					< 0.02		0.0006	0.0007		0.003	< 0.0002	2.72	< 0.02
GDW08	14/02/2023	7.0		14.0			11					29					< 0.02		0.0002	0.0006		0.007	< 0.0002	2.11	< 0.02
	07/06/2023	7.0		15.0			20	170	23	52	14	25	5	640		870	< 0.02	< 0.005	0.0003	0.0030	0.0027	0.001	< 0.0002	4.52	< 0.02
	30/08/2023	7.0		16.0			9					22					< 0.02		0.0003	0.0025		0.003	< 0.0002	4.46	< 0.02
	18/10/2023	7.0		15.0			19					22					< 0.02		0.0004	0.0010		0.003	< 0.0002	4.82	< 0.02
GDW09	14/02/2023	7.1		3.0			5					82					< 0.02		< 0.0002	< 0.0005		0.004	< 0.0002	45.50	< 0.02
	07/06/2023	7.2		3.7			78	270	110	81	20	70	84	1000		630	0.04	< 0.005	< 0.0002	0.0012	0.0082	0.007	0.0003	20.00	< 0.02
	30/08/2023	7.0		3.4			15					58					< 0.02		0.0002	0.0022		0.004	< 0.0002	16.80	< 0.02
	18/10/2023	7.0		2.9			5					57					< 0.02		0.0002	0.0018		0.027	0.0002	23.20	< 0.02
GDW10	14/02/2023	7.1		8.8			10					32					< 0.02		< 0.0002	0.0073		0.008	< 0.0002	3.17	< 0.02
	07/06/2023	7.2		9.0			7	150	19	34	11	29	2	530		450	< 0.02	< 0.005	0.0003	0.0033	0.0018	0.006	< 0.0002	1.97	< 0.02
	30/08/2023	7.3		9.0			8					30					< 0.02		< 0.0002	0.0021		0.001	< 0.0002	4.55	< 0.02
	18/10/2023	7.2		9.1			15					30					< 0.02		0.0003	0.0045		0.010	< 0.0002	2.71	< 0.02
GDW11	14/02/2023	6.8		11.0			9					72					< 0.02		< 0.0002	0.0005		0.008	< 0.0002	2.16	< 0.02
	07/06/2023	6.8		12.0			10	150	22	58	10	67	2	530		1200	< 0.02	< 0.005	< 0.0002	0.0024	0.0018	0.011	< 0.0002	1.83	< 0.02
	30/08/2023	6.8		12.0			10					69					< 0.02		< 0.0002	0.0032		0.003	< 0.0002	2.20	< 0.02
	18/10/2023	6.7		12.0			9					76					< 0.02		0.0002	0.0007		0.006	< 0.0002	2.33	0.06
GDW12	14/02/2023	7.4		7.9			7					23					< 0.02		0.0006	0.0033		0.008	< 0.0002	5.78	< 0.02
	07/06/2023	7.4		8.1			7	70	68	17	35	21	1	510		530	< 0.02	< 0.005	< 0.0002	0.0049	0.0019	0.007	< 0.0002	5.53	< 0.02
	30/08/2023	7.6		7.8			10					23					< 0.02		< 0.0002	0.0057		0.004	< 0.0002	7.13	< 0.02
	18/10/2023	7.7		8.0			15					22					< 0.02		< 0.0002	0.0015		0.006	< 0.0002	5.10	< 0.02

Tir John Phase 2 Landfill Site
Groundwater Quality Summary January - December 2023

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alkalinity	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As	MCPP
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l
GDW13	14/02/2023	6.9		32.0			8					130					< 0.02		0.0003	0.0006		0.005	< 0.0002	1.12	0.07
	07/06/2023	7.0		33.0			7	150	53	96	31	130	3	760		1600	< 0.02	< 0.005	< 0.0002	0.0029	0.001	0.005	< 0.0002	0.58	< 0.02
	30/08/2023	6.8		34.0			11					130					< 0.02		0.0002	0.0019		0.002	< 0.0002	3.83	0.05
	18/10/2023	7.0		36.0			8					130					< 0.02		0.0003	0.0015		0.008	< 0.0002	3.72	0.04
GDW16	14/02/2023	6.0		0.3			9					44					< 0.02		0.0004	0.0009		0.008	< 0.0002	3.01	< 0.02
	07/06/2023	6.3		1.2			10	29	10	35	7	46	3	140		280	< 0.02	< 0.005	0.0005	0.0043	0.0036	0.003	< 0.0002	1.62	< 0.02
	30/08/2023	6.1		0.3			2					44					< 0.02		0.0004	0.0034		0.007	< 0.0002	1.96	< 0.02
	18/10/2023	6.3		0.3			11					42					< 0.02		0.0003	0.0029		0.028	< 0.0002	3.29	< 0.02
GDW17	14/02/2023	6.4		1.3			12					200					< 0.02		0.0004	0.0025		0.007	0.0003	5.45	< 0.02
	07/06/2023	6.6		2.4			13	95	23	88	11	190	65	230		1500	< 0.02	< 0.005	0.0003	0.0025	0.0064	0.014	< 0.0002	2.74	< 0.02
	30/08/2023	6.5		0.8			27					150					< 0.02		0.0006	0.0034		0.005	0.0003	3.15	< 0.02
	18/10/2023	6.6		0.7			14					150					< 0.02		0.0007	0.0037		0.011	0.0009	5.87	< 0.02
GDW18	14/02/2023	7.2		15.0			7					88					< 0.02		0.0009	< 0.0005		0.004	< 0.0002	5.55	0.3
	13/06/2023	7.2		18.0			8	170	38	80	33	100	39	630		1000	< 0.02	< 0.005	0.0007	0.0009	0.0025	0.002	< 0.0002	3.76	0.31
	30/08/2023	7.3		18.0			9					110					< 0.02		0.0007	0.0032		0.005	< 0.0002	8.65	0.16
	18/10/2023	9.7		18.0			19					98					< 0.02		0.0007	0.0023		0.001	< 0.0002	9.64	0.15

Tir John Landfill Site
Surface Water Quality Summary January - December 2023

Sample Point	Date	pH	NH_4-N	COD	BOD	TOC	Na	K	Cl	SO_4	Alk	Fe	Mn	Cd	Cr	Cu	Ni	Zn	Pb	Susp. Solids
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SW1	11/01/2023	8.2	0.05	9	< 1	3			18											8
	14/02/2023	8.0	22.00	72	6	23			94											40
	21/03/2023	8.0	0.13	12	2	5			19											< 2
	24/04/2023	8.0	0.07	20	3	7			17											4
	17/05/2023	8.0	0.07	27	3	9			12											3
	25/07/2023	7.9	0.12	24	3	8			22											4
	12/10/2023	8.0	0.06	17	2	5	14	3.3	15	31.6	120	0.011	0.78	< 0.02	0.0003	0.0028	0.0006	0.0075	< 0.0002	3
	07/11/2023	8.0	0.03	9	2	4			14											5
	22/11/2023	8.0	0.05	7	2	5			14											22
SW2	11/01/2023	7.3	2.20	12	< 1	5			32											3
	14/02/2023	7.2	3.90	12	< 1	4			40											3
	02/03/2023	7.5	3.80	17	3	4			37											3
	21/03/2023	7.3	3.30	14	< 1	5			29											< 2
	24/04/2023	7.2	1.90	11	< 1	4			33											13
	17/05/2023	7.2	3.30	13	2	4			34											4
	13/06/2023	7.4	3.20	32	25	10			32											6
	25/07/2023	7.3	2.70	13	4	5			29											16
	30/08/2023	7.2	3.60	9	7	8			31											4
	13/09/2023	7.4	3.30	11	4	5	21		31											11
	12/10/2023	7.4	3.00	18	6	5	23	15.0	27	27	310	0.015	37	< 0.02	< 0.0002	0.0054	0.0035	0.0017	< 0.0002	4
	07/11/2023	7.3	3.20	6	3	4			26											4
	22/11/2023	7.4	2.90	10	4	13			28											5
SW3	11/01/2023	7.6	< 0.015	14	< 1	4			17											4
	14/02/2023	7.2	0.14	15	1	5			26											12
	02/03/2023	7.1	0.16	17	< 1	5			26											< 2
	21/03/2023	7.2	0.13	15	< 1	5			17											< 2
	24/04/2023	7.3	0.04	11	< 1	5			19											< 2
	17/05/2023	7.1	0.03	15	2	5			19											2
	13/06/2023	7.5	6.00	3	2	4			57											17
	25/07/2023	7.2	0.11	14	1	8			20											< 2
	30/08/2023	7.2	0.06	19	1	10			20											4
	13/09/2023	7.2	0.06	18	< 1	7	15		21											< 2
	12/10/2023	7.2	0.03	22	1	8	10	2.9	18	5	56	0.200	3.3	< 0.02	0.0002	0.0052	0.0023	0.0098	< 0.0002	< 2
	07/11/2023	7.3	0.08	11	< 1	5			14											2
	22/11/2023	7.3	0.05	12	< 1	5			15											< 2
SW4	11/01/2023	8.2	15.00	37	2	12			57											7
	14/02/2023	7.5	19.00	31	7	8			81											26
	02/03/2023	7.5	20.00	29	4	8			86											8
	21/03/2023	7.5	19.00	54	4	19			80											10
	24/04/2023	7.4	13.00	66	4	8			70											4
	17/05/2023	7.6	19.00	43	2	9			84											17
	13/06/2023	7.9	26.00	32	12	11			110											63
	25/07/2023	7.7	29.00	36	3	13			120											6
	30/08/2023	7.5	18.00	73	14	9			76											51
	13/09/2023	7.8	26.00	29	5	10	74		98											7
	12/10/2023	7.7	21.00	40	10	9	62	34.0	76	45	580	0.096	960	< 0.02	0.0006	0.0011	0.0028	0.0059	< 0.0002	15
	07/11/2023	7.5	11.00	23	8	9			67											7
	22/11/2023	7.4	8.90	21	2	17			57											6

Figure C. 1 – Leachate Chloride

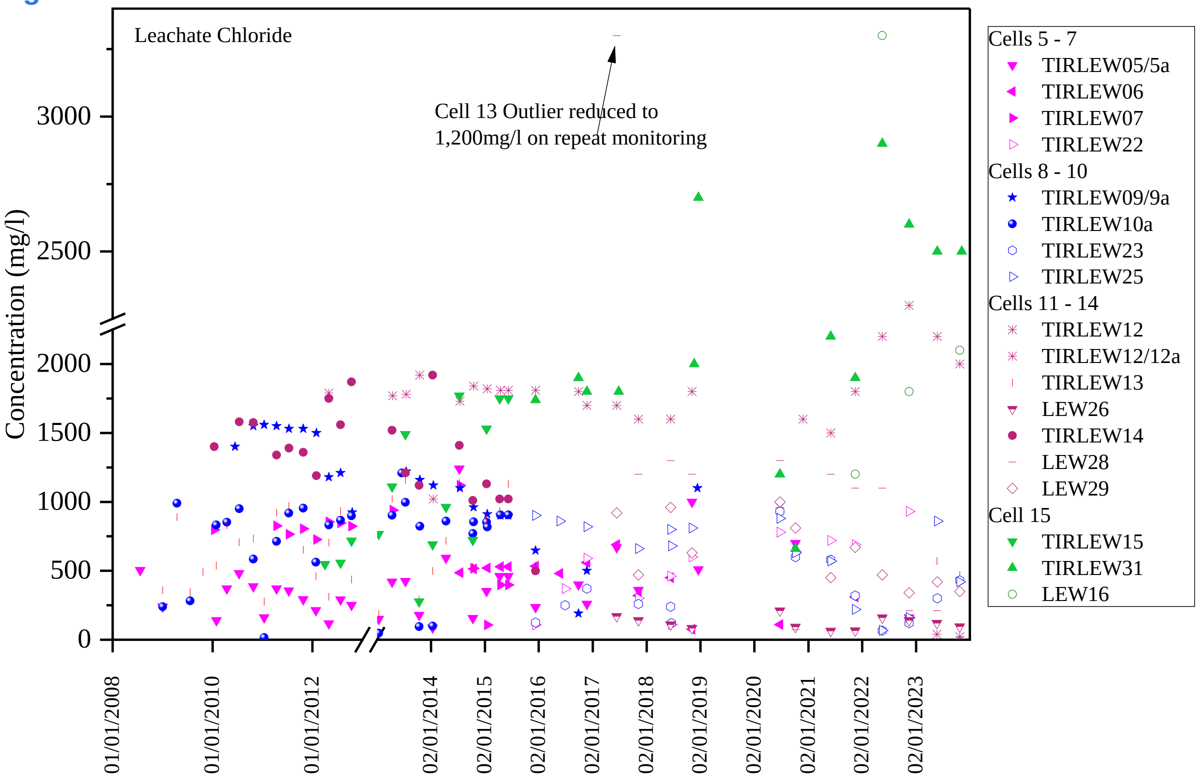


Figure C. 2 – Leachate Ammoniacal-N

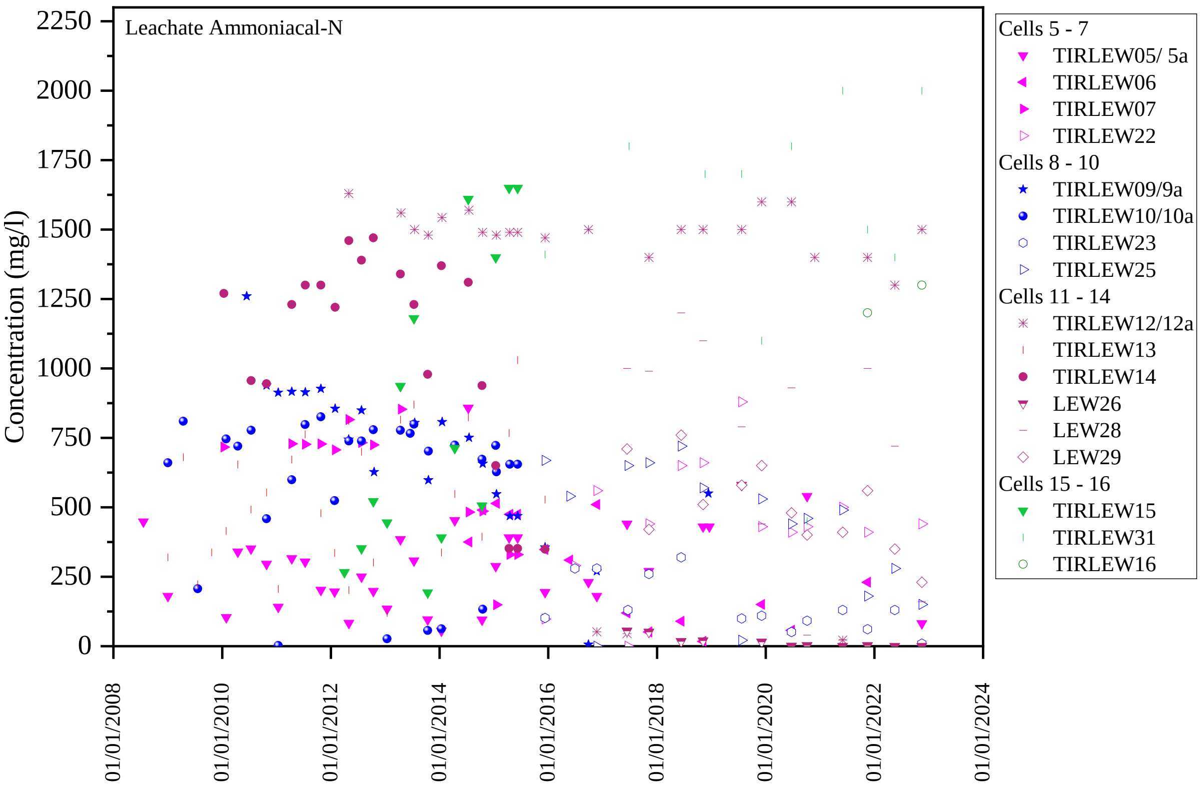


Figure C. 3 – Groundwater Monitoring Point GDW01D

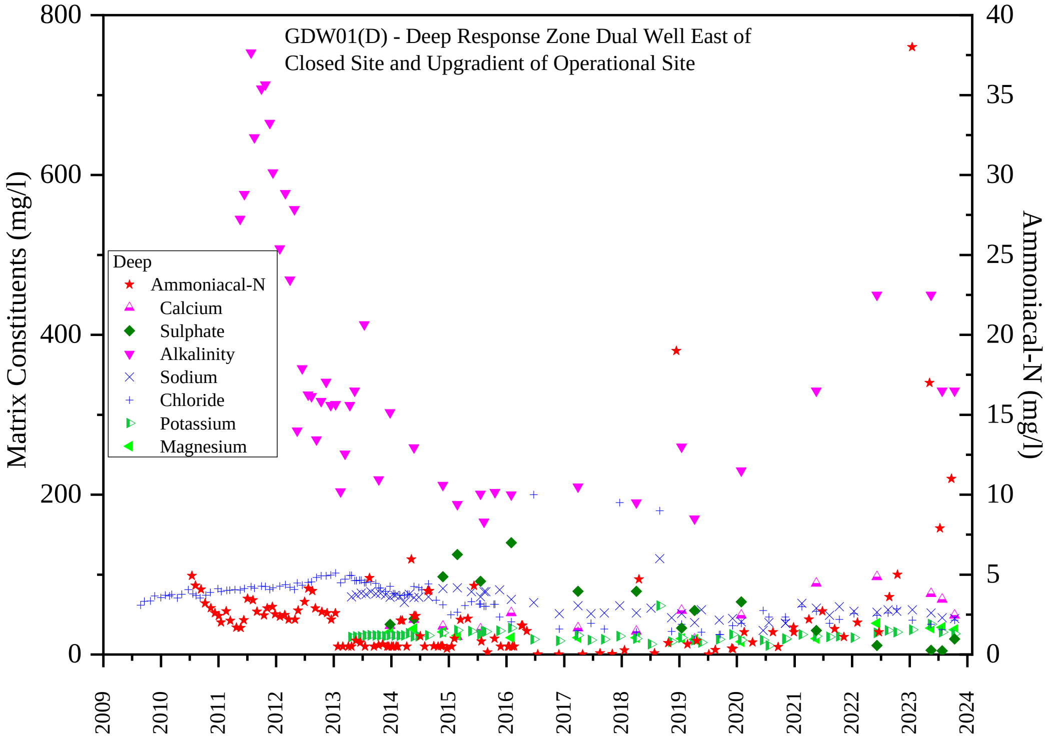


Figure B. 4 – Groundwater Monitoring Point GDW01S

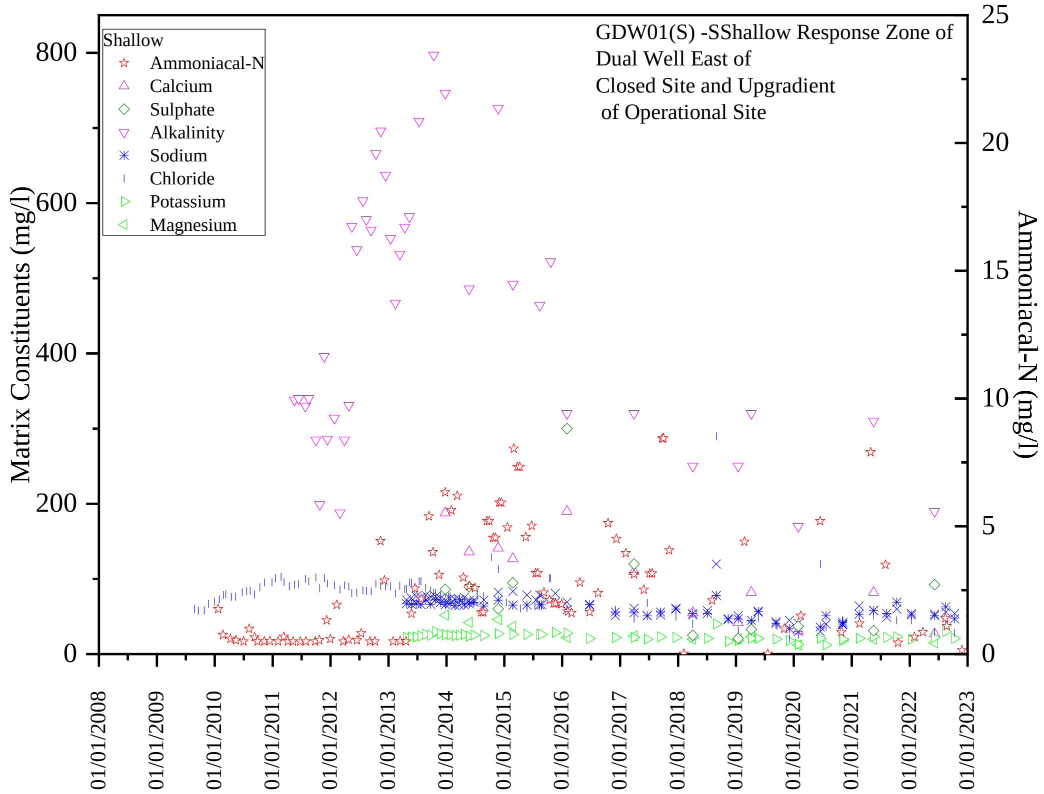


Figure C. 5 – Groundwater Monitoring Point GDW02D

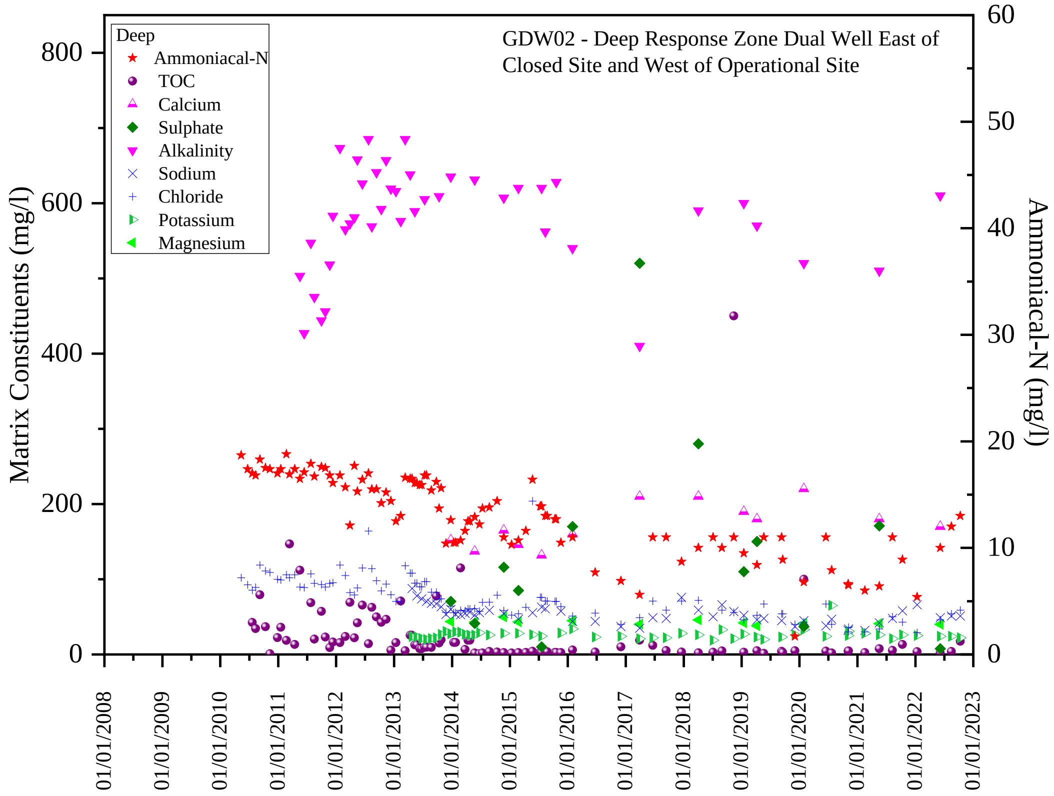


Figure C. 6 – Groundwater Monitoring Point GDW02S

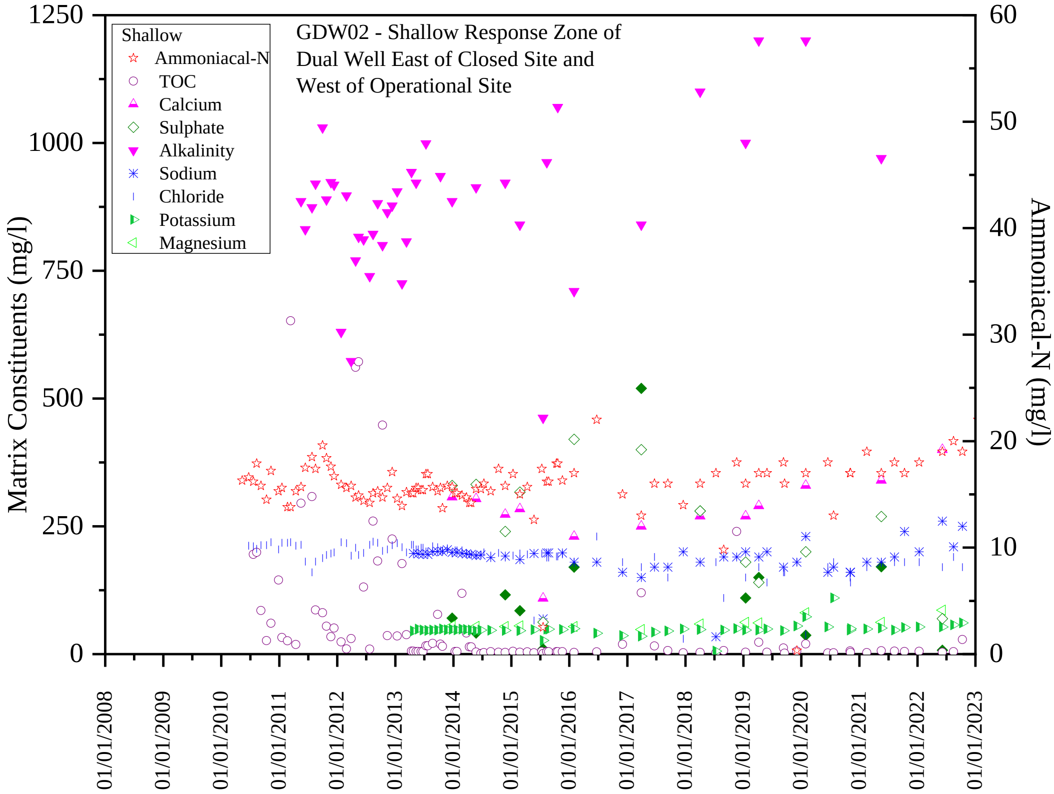


Figure C. 7 – Groundwater Monitoring Point GDW03

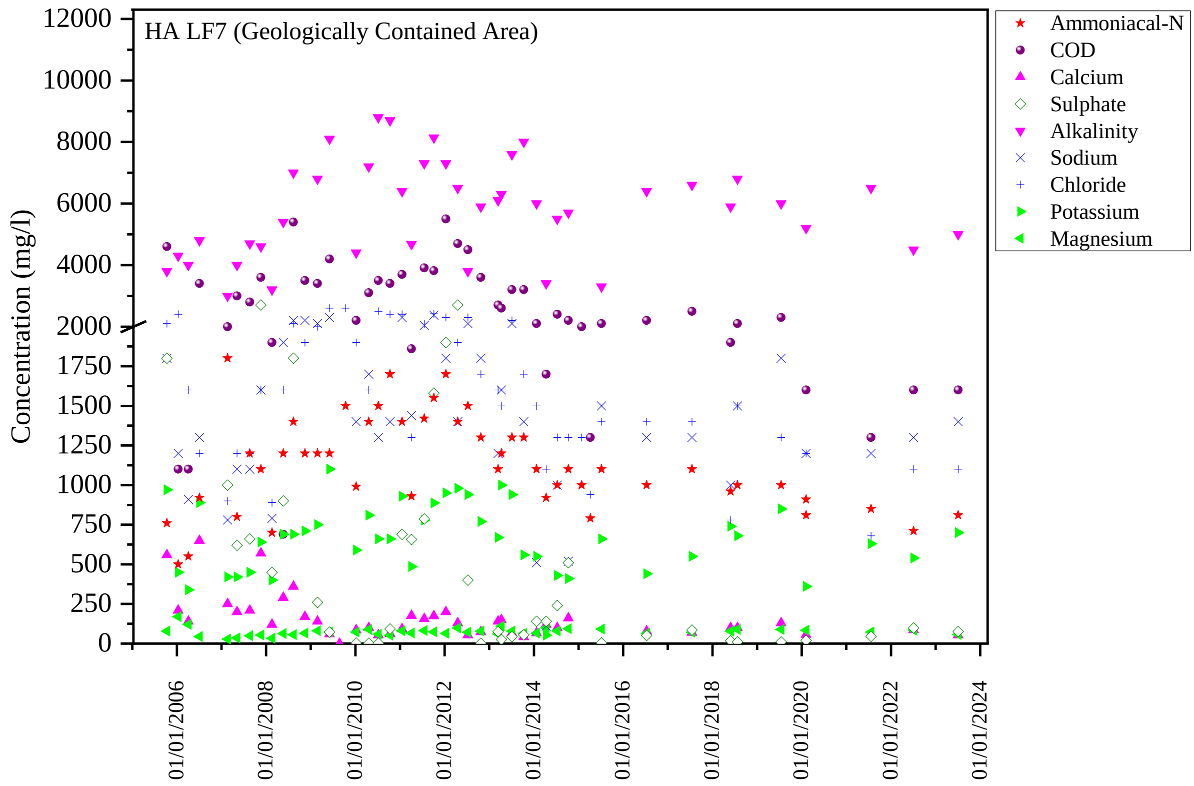


Figure C. 8 – Groundwater Monitoring Point GDW04

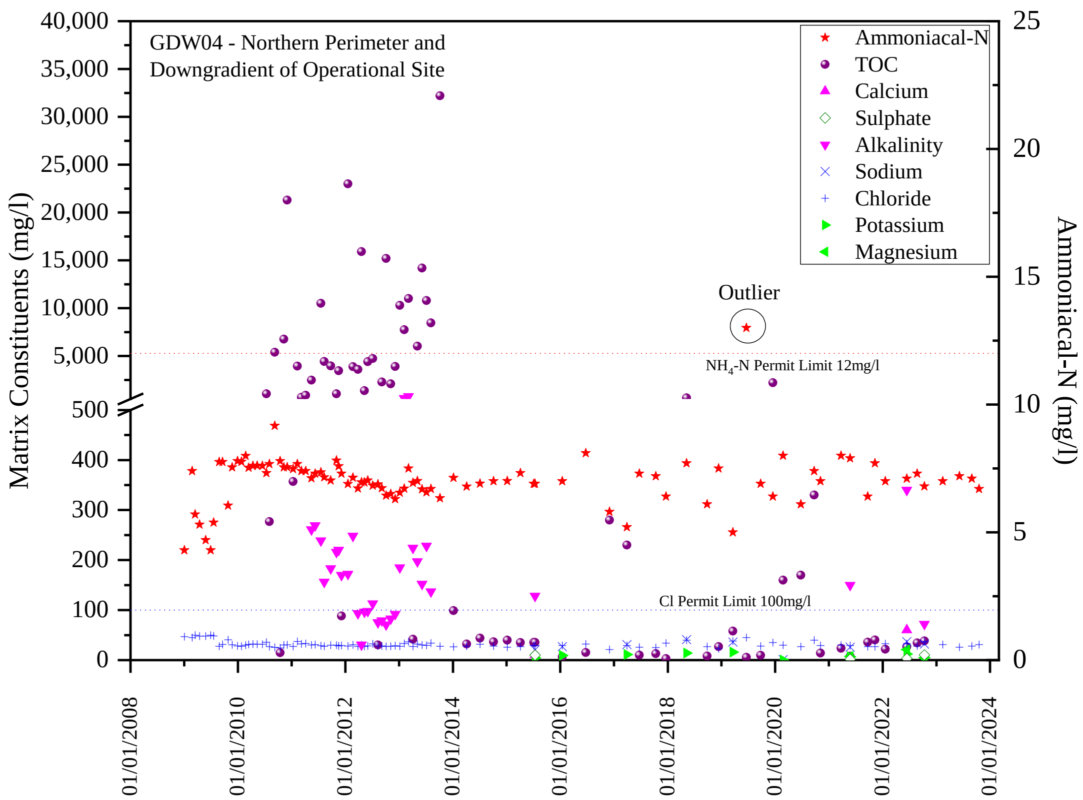


Figure C. 9 – Groundwater Monitoring Point GDW05

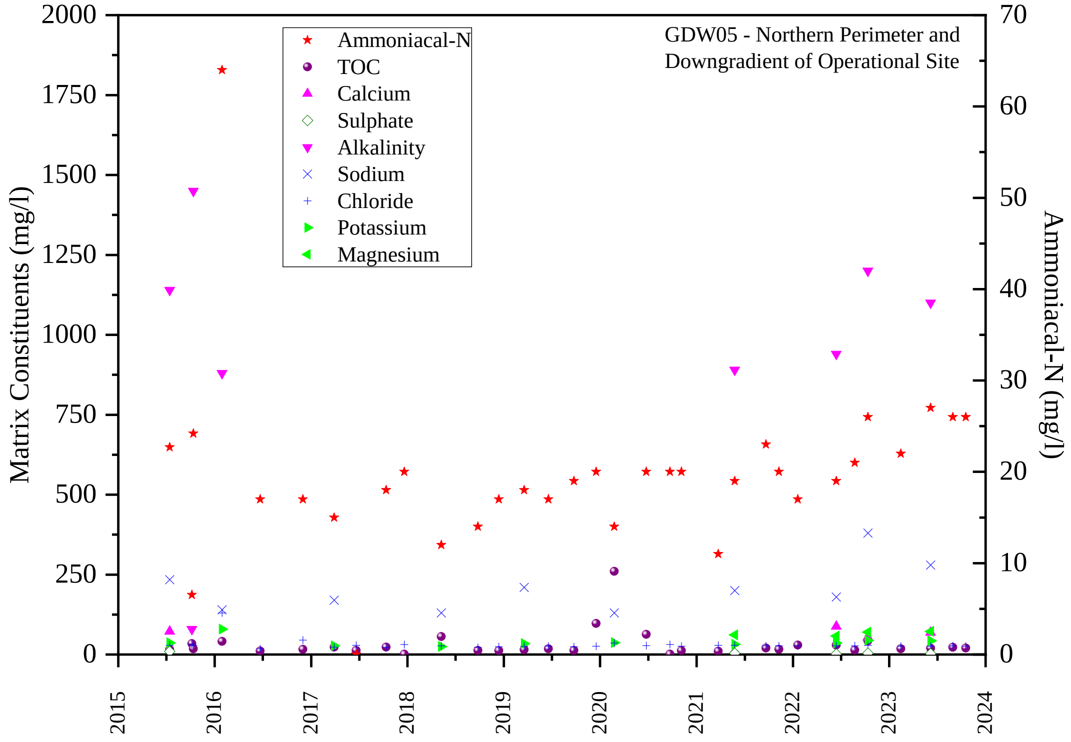


Figure C.10 – Groundwater Monitoring Point GDW06

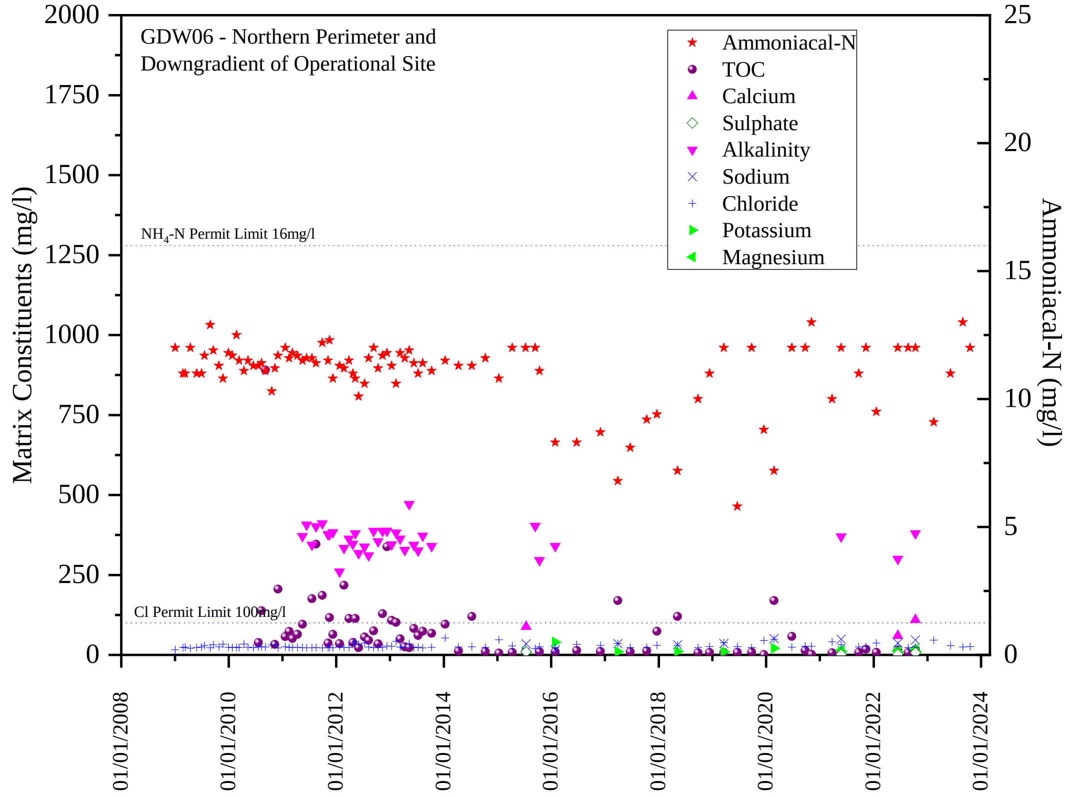


Figure C.11 – Groundwater Monitoring Point GDW07

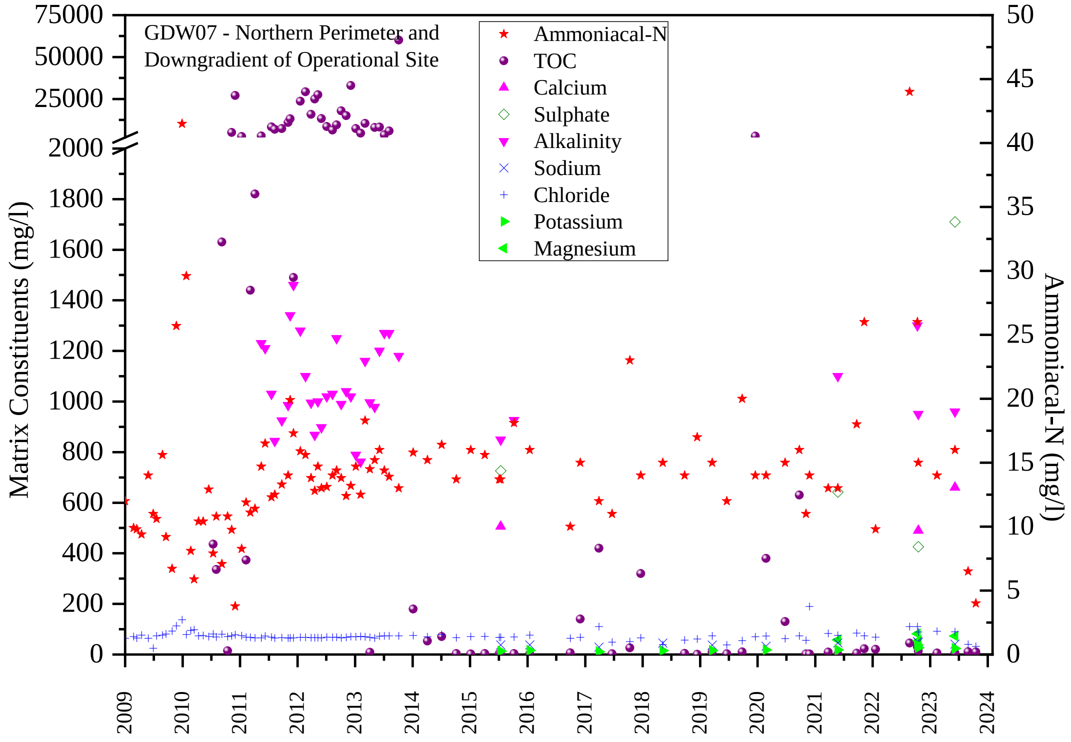


Figure C.12 – Groundwater Monitoring Point GDW08

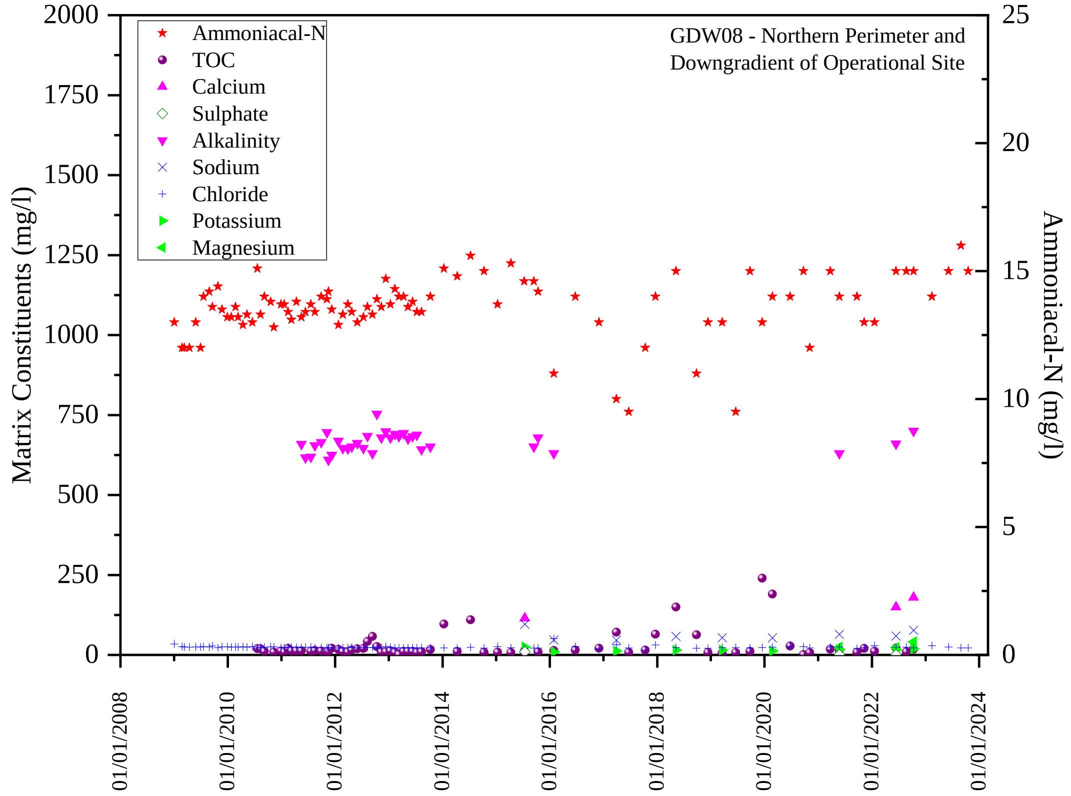


Figure C.13 – Groundwater Monitoring Point GDW09

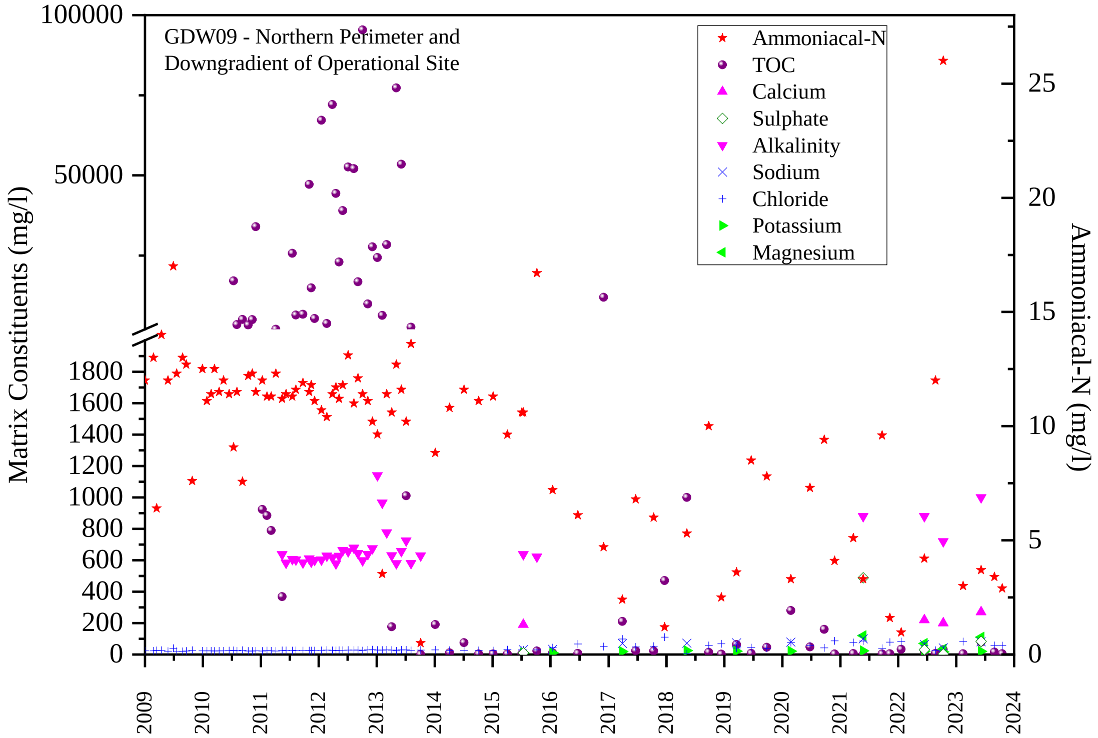


Figure C.14 – Groundwater Monitoring Point GDW10

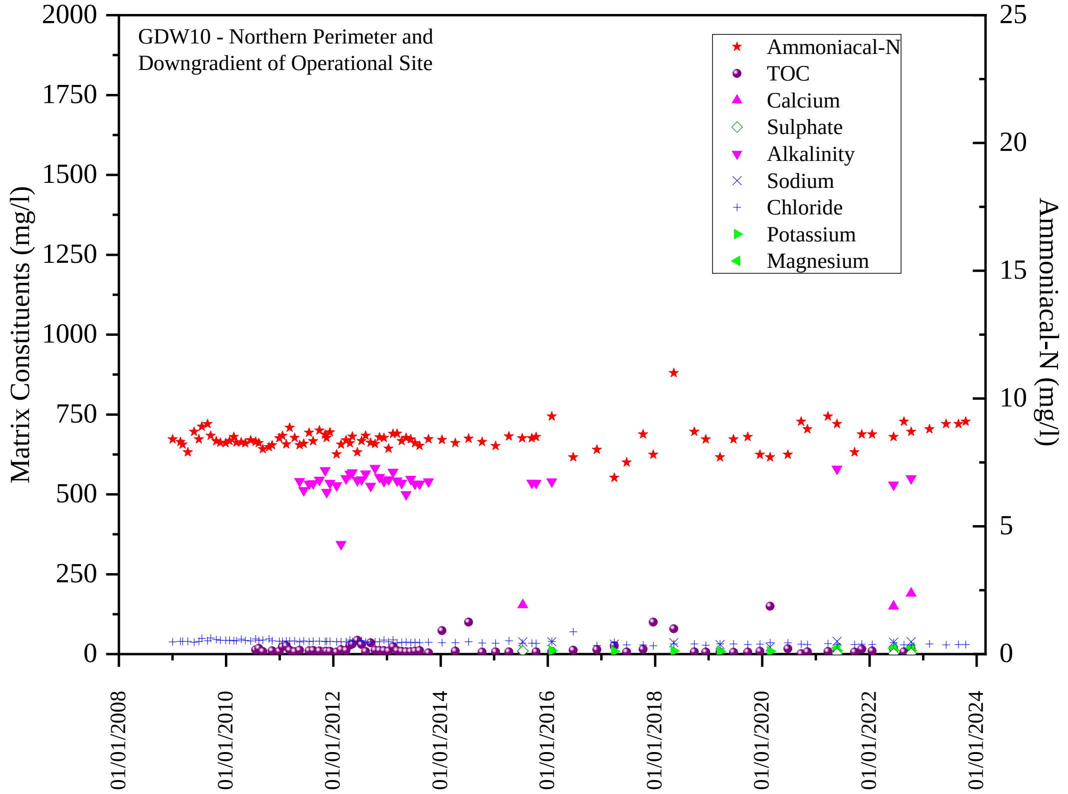


Figure C.15 – Groundwater Monitoring Point GDW11

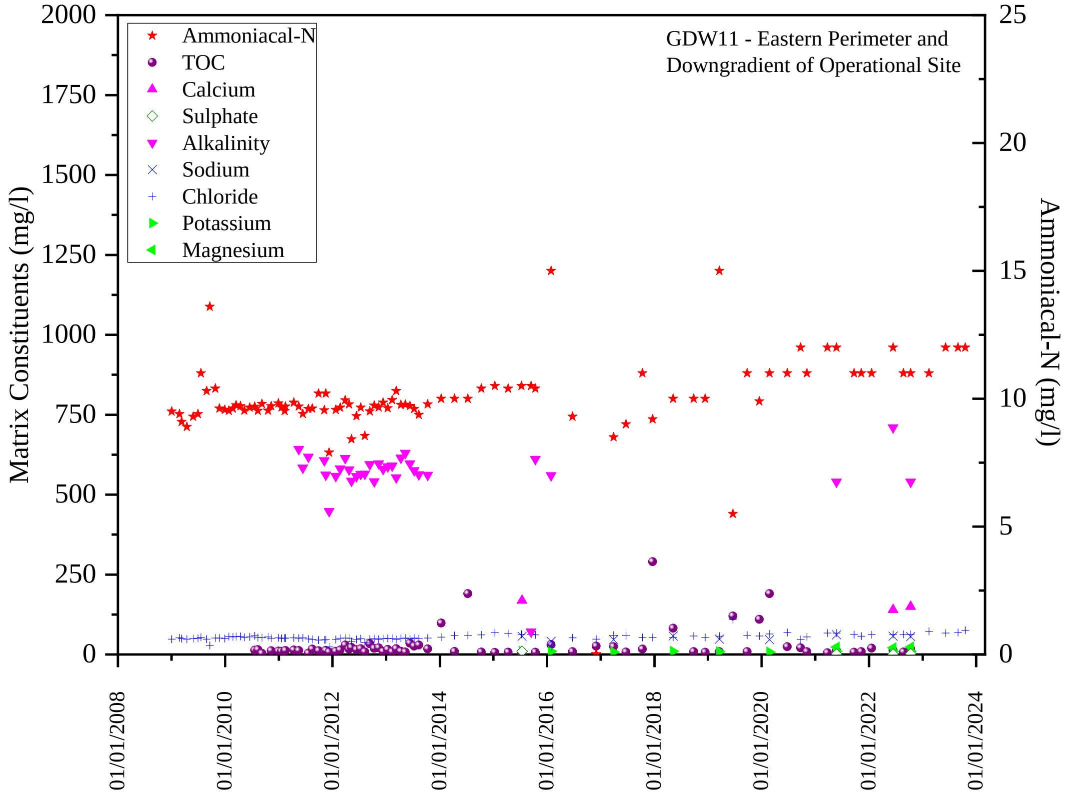


Figure C.16 – Groundwater Monitoring Point GDW12

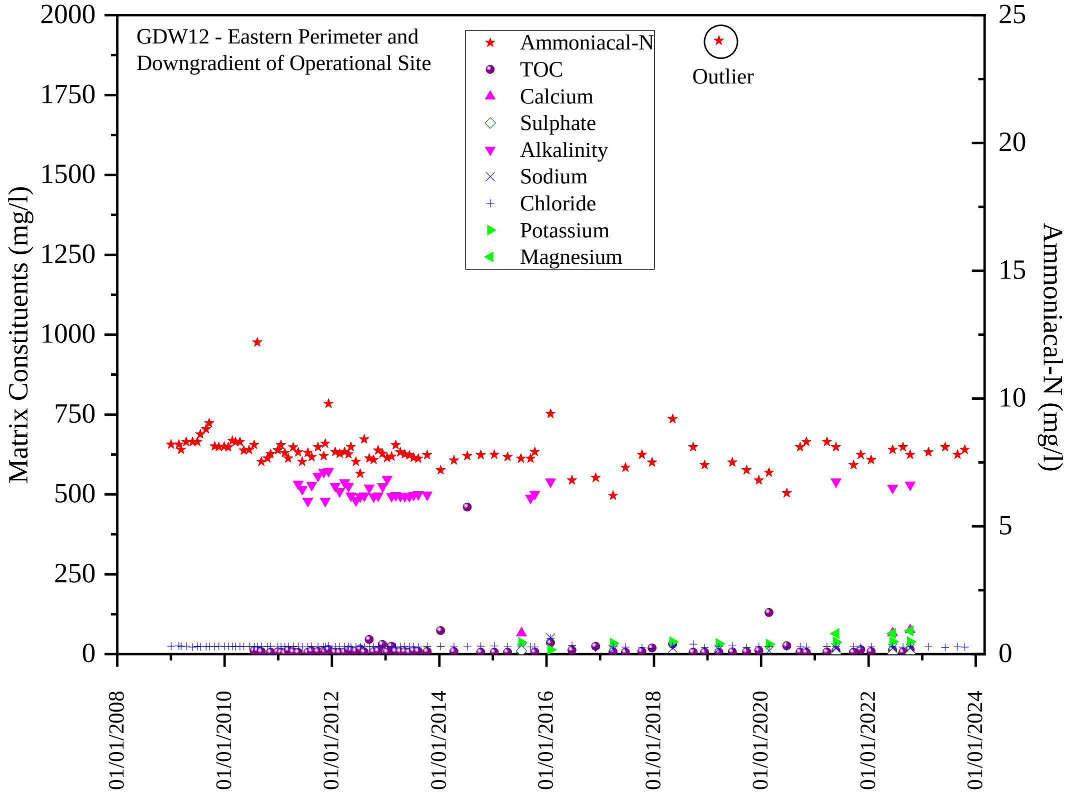


Figure C.17 – Groundwater Monitoring Point GDW13

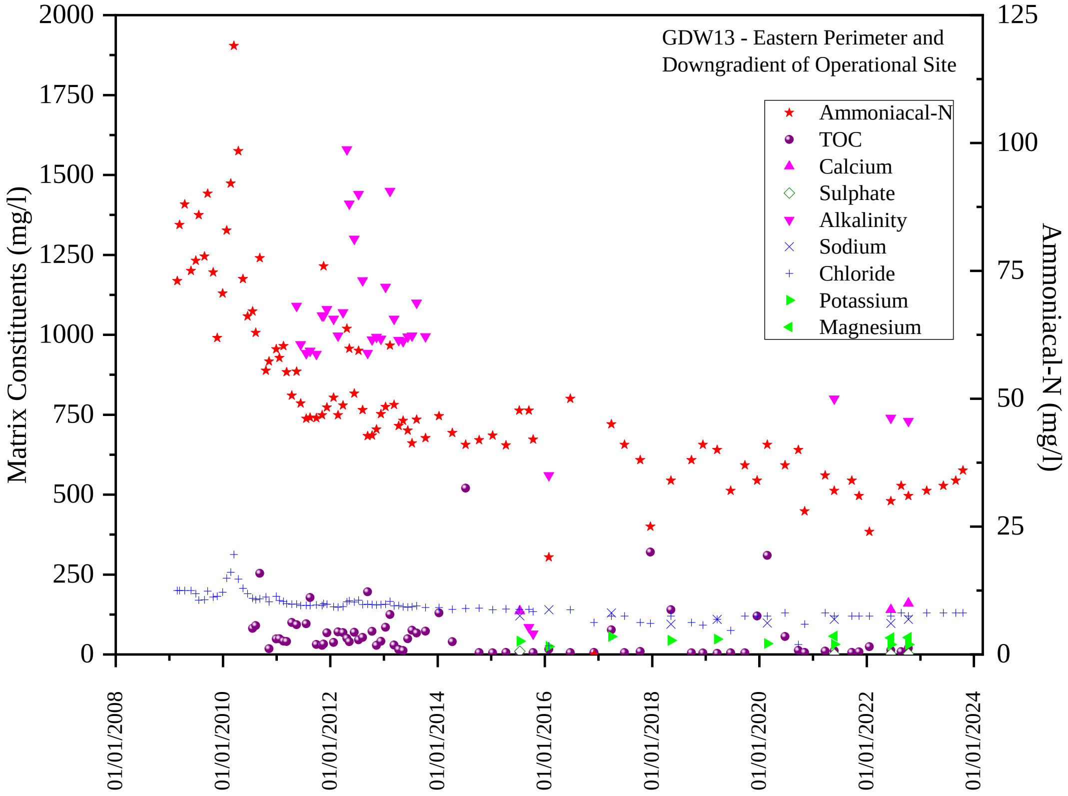


Figure C.18 – Groundwater Monitoring Point GDW14

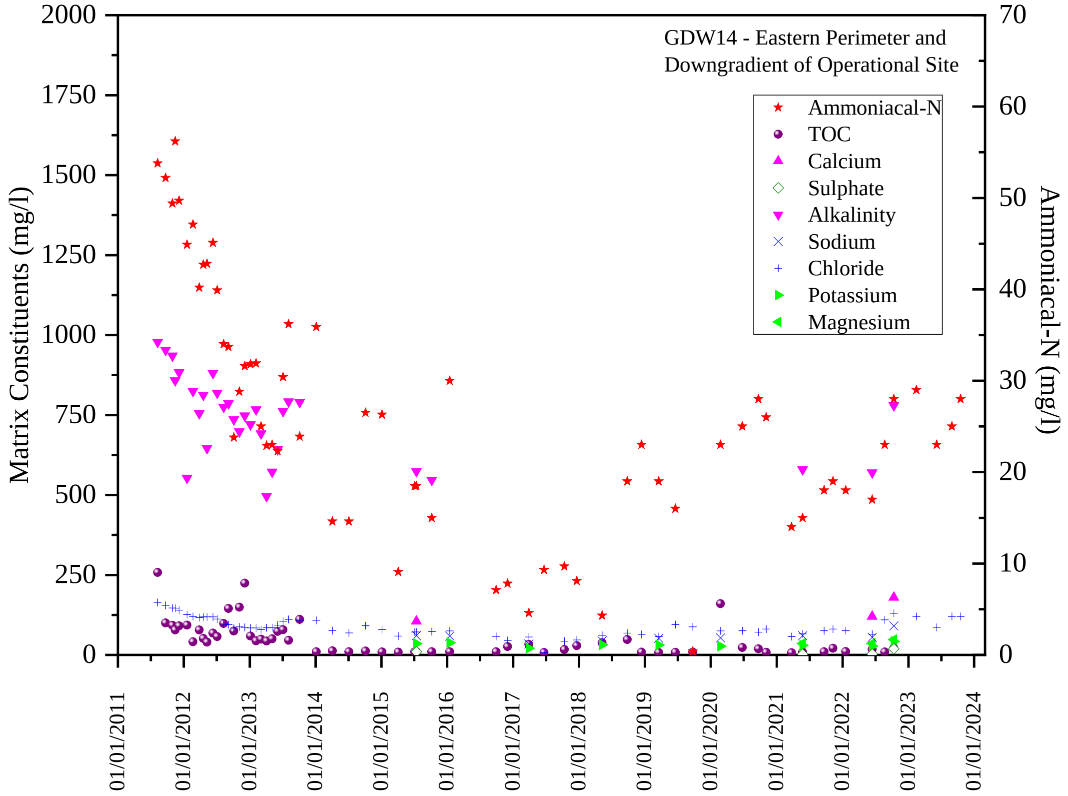


Figure C.19 – Groundwater Monitoring Point GDW15

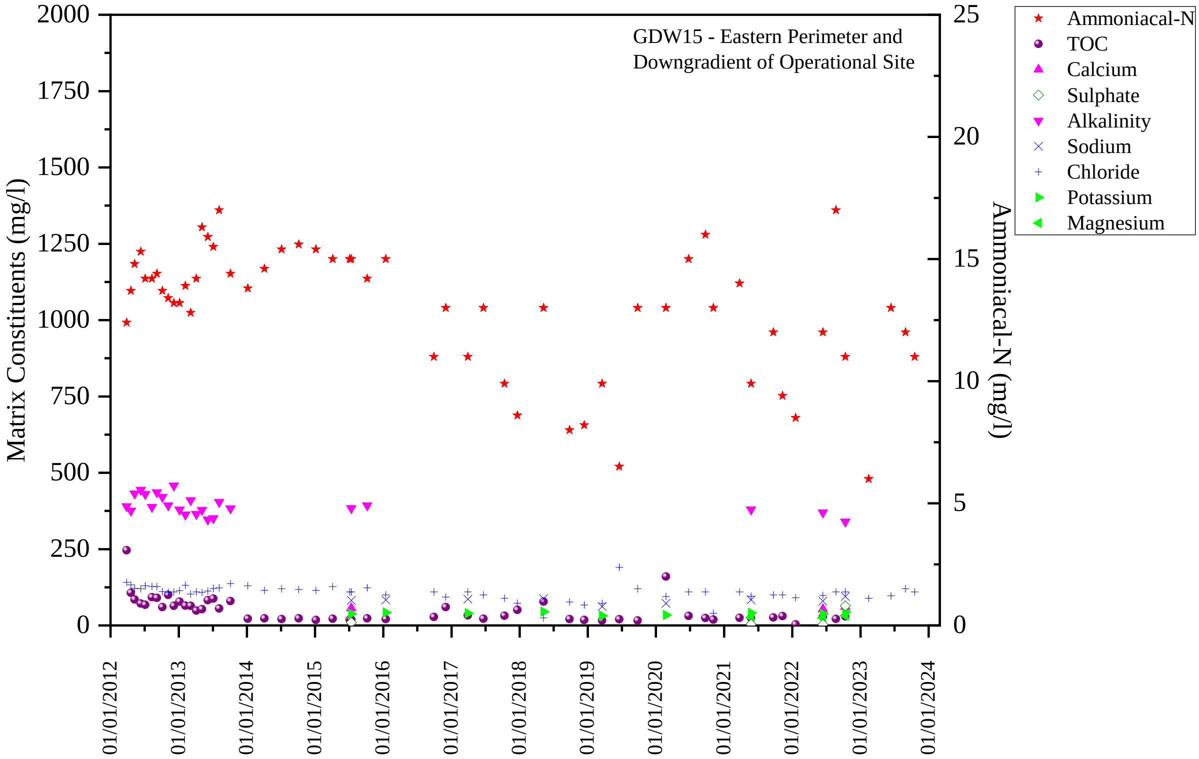


Figure C.20 – Groundwater Monitoring Point GDW16

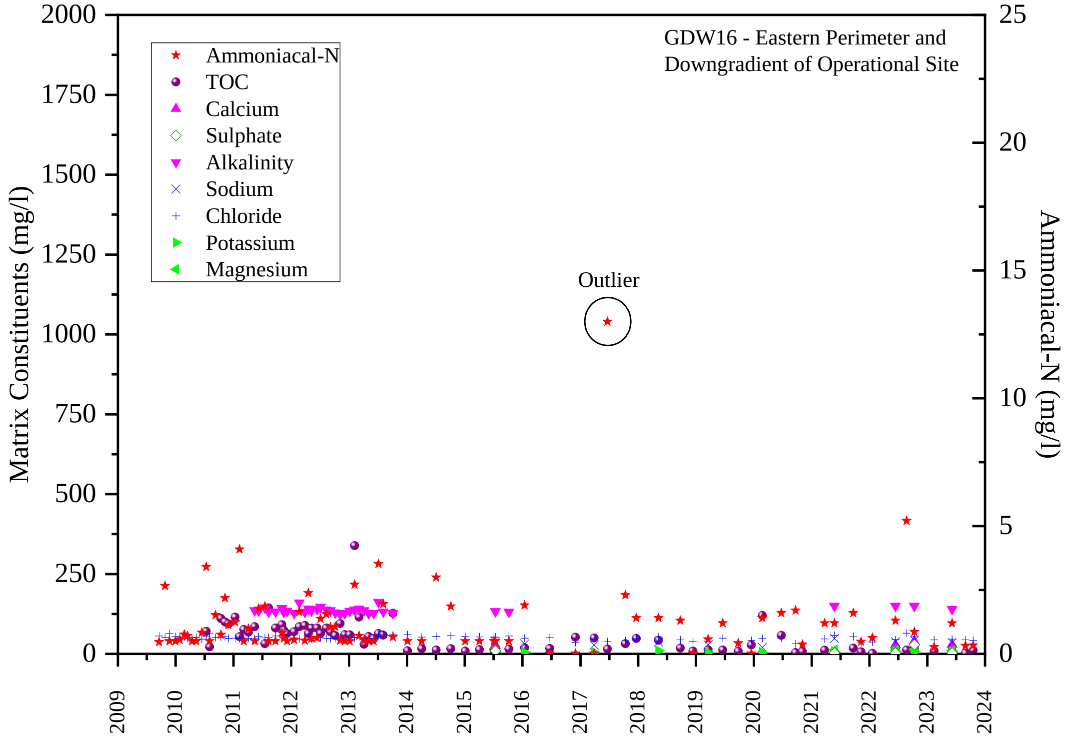


Figure C.21 – Groundwater Monitoring Point GDW17

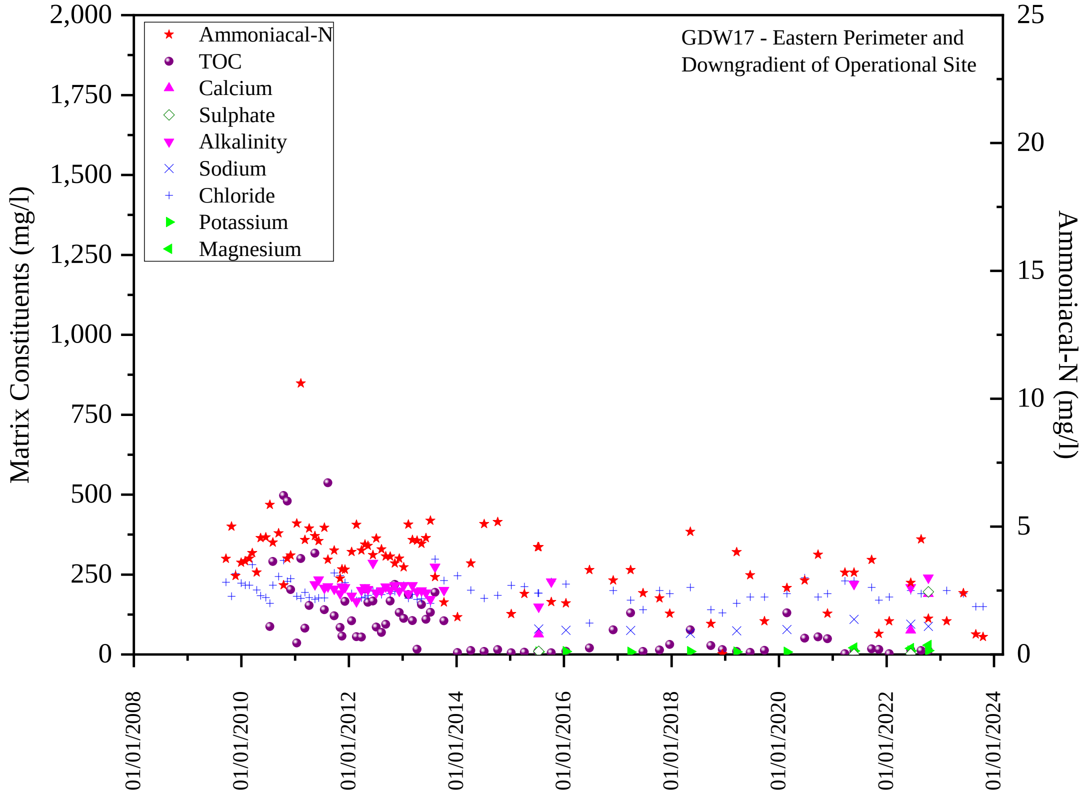


Figure C.22 – Groundwater Monitoring Point GDW18

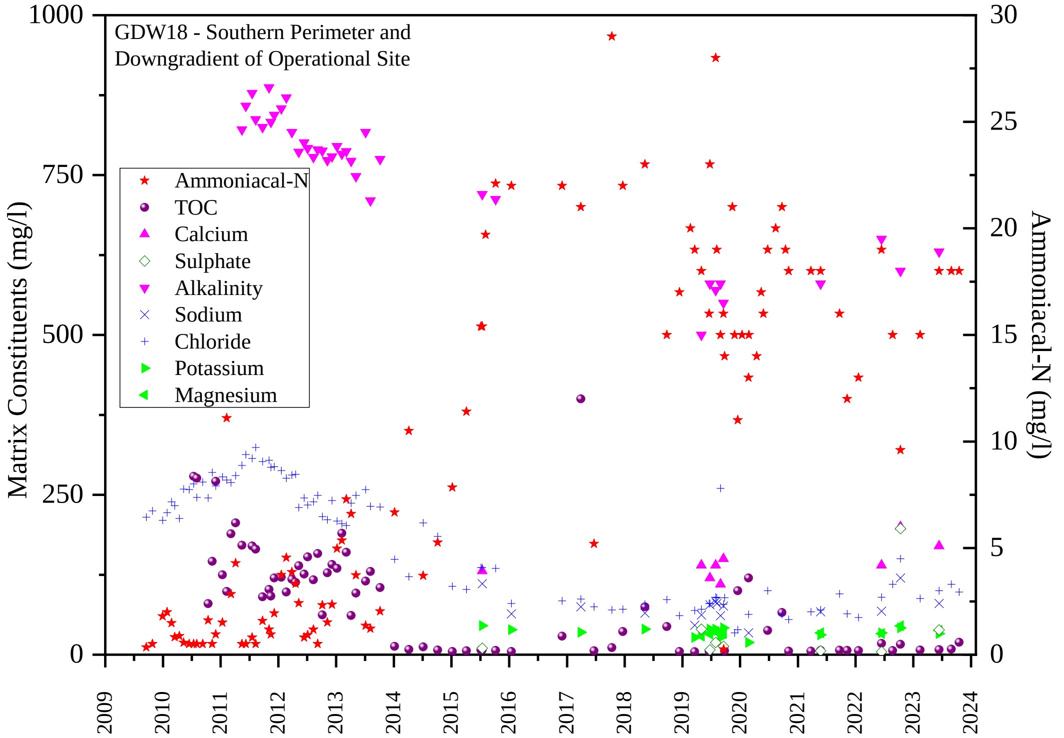


Figure C.23 – Groundwater Monitoring Point SW1

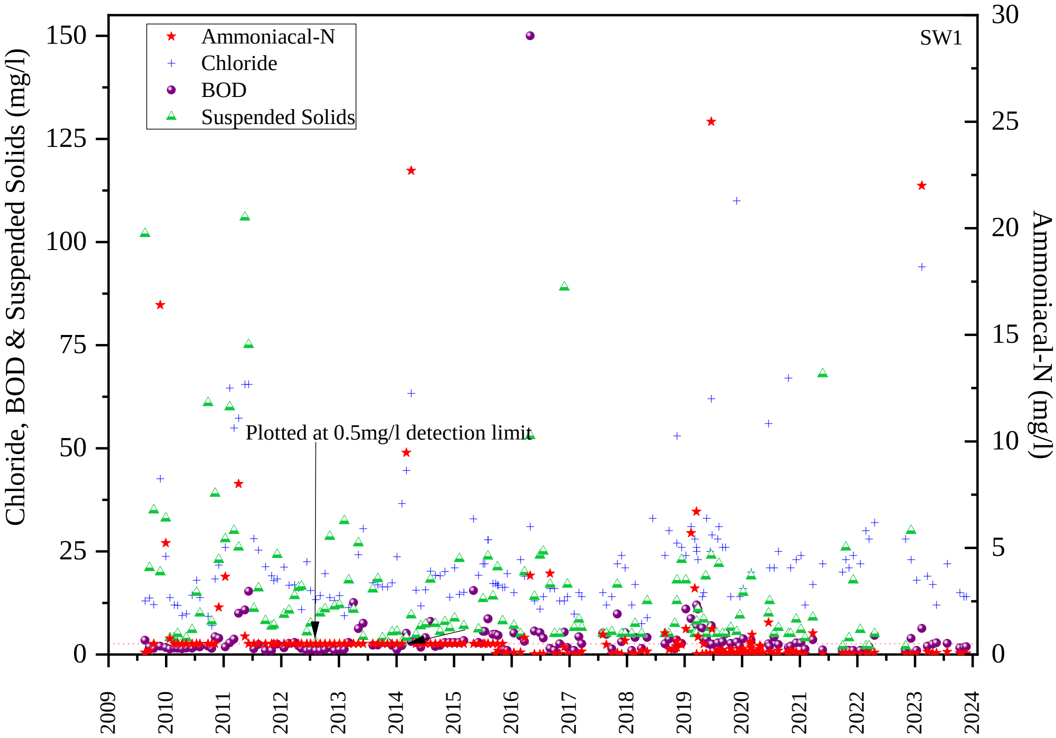


Figure C.24 – Groundwater Monitoring Point SW2

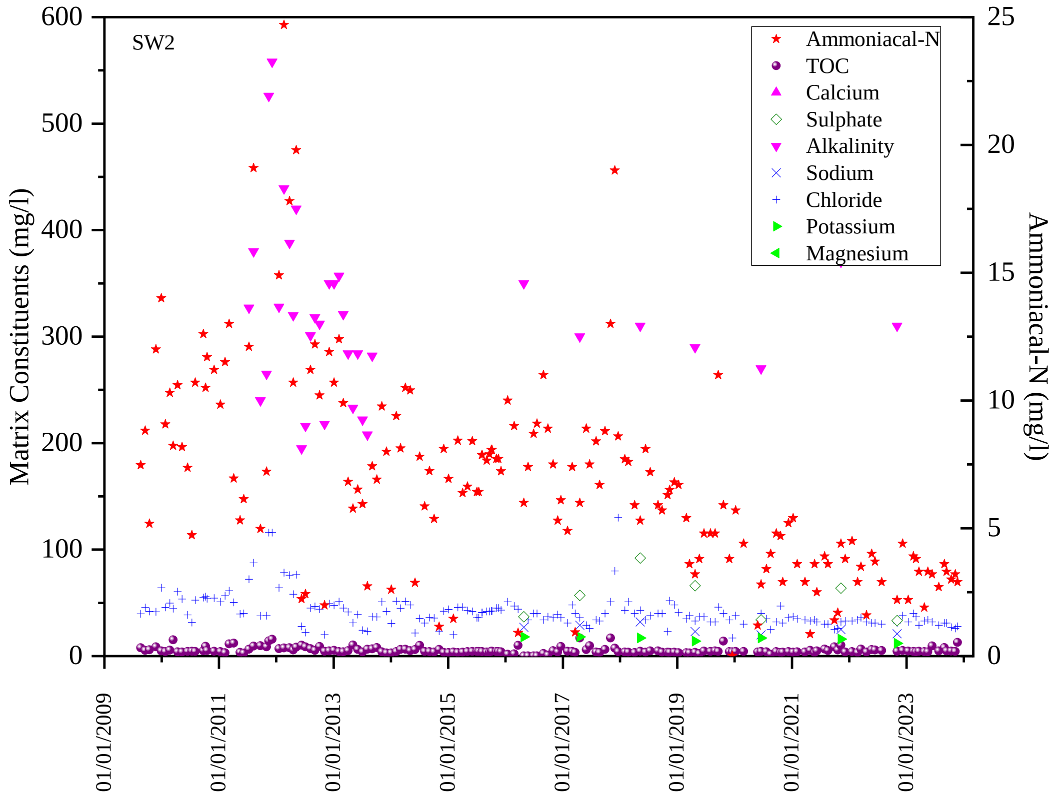


Figure C.25 – Groundwater Monitoring Point SW3

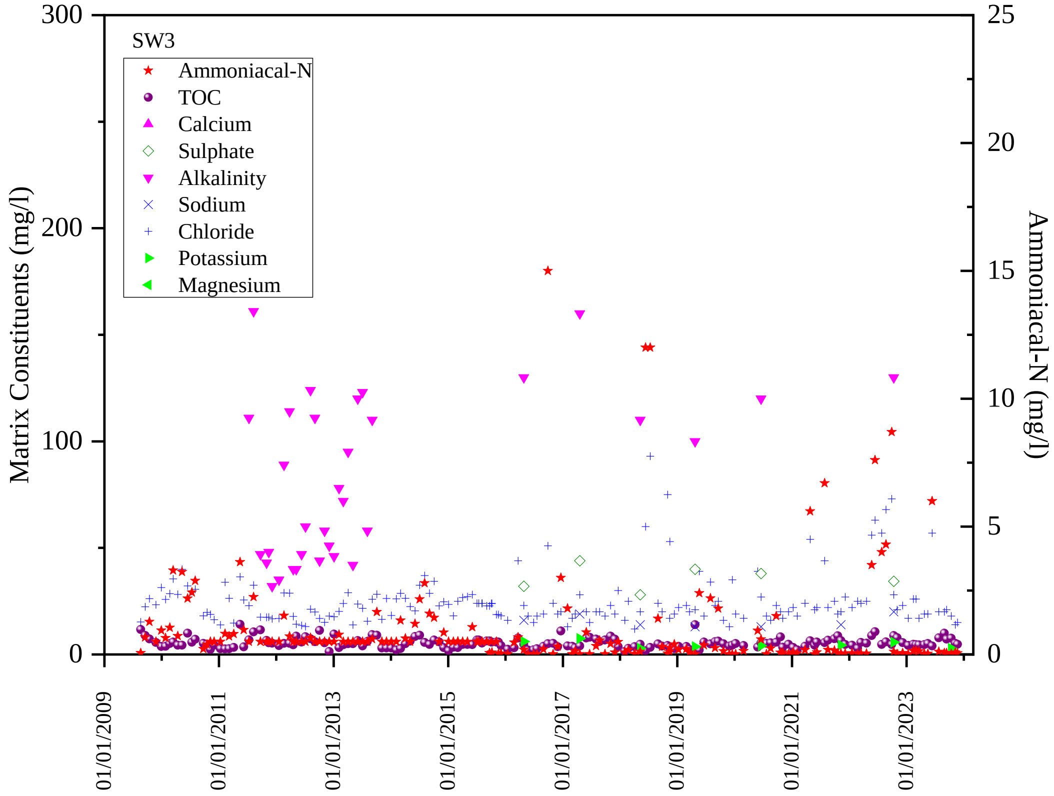
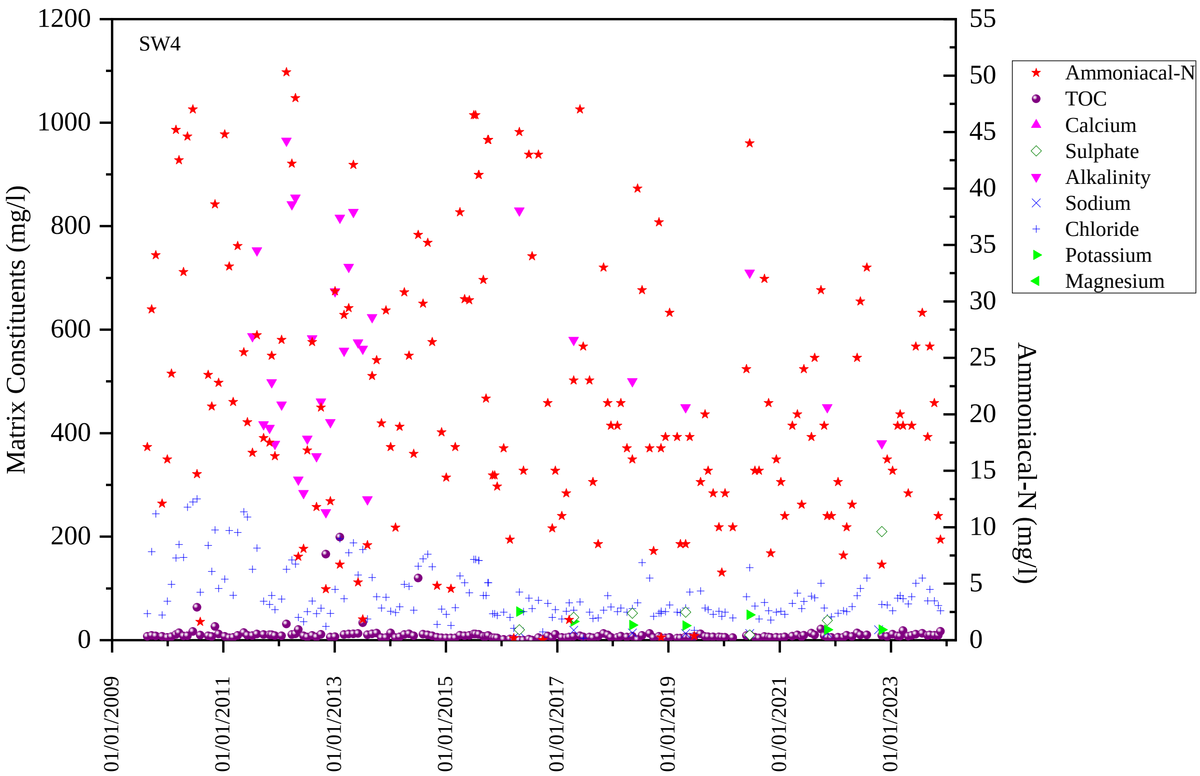
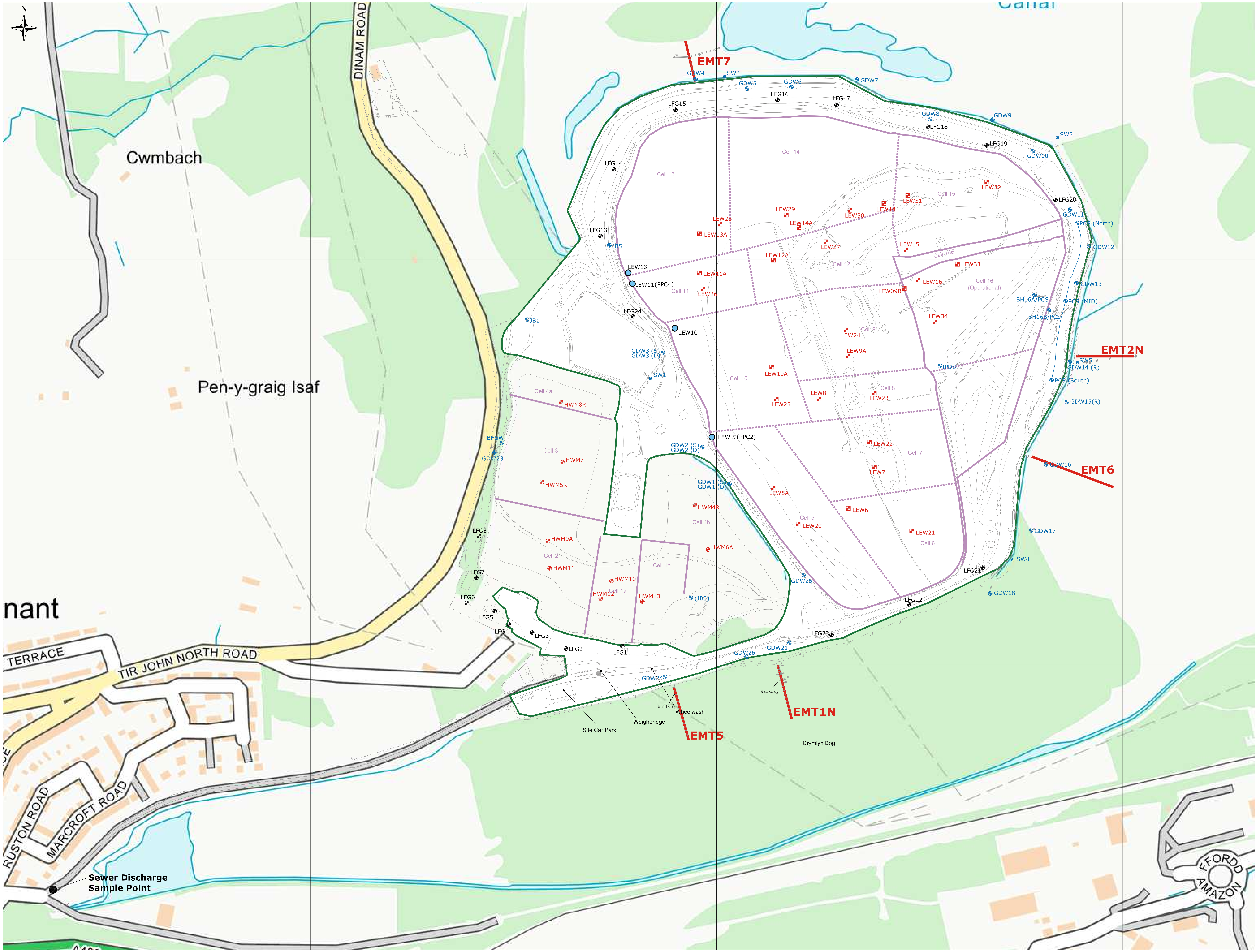


Figure C.26 – Groundwater Monitoring Point SW4



Drawings



Key

- Permit Boundary
- Leachate extraction sump
- Leachate monitoring well
- Surface water monitoring point
- Ground water monitoring borehole
- Gas monitoring borehole
- Drainage sump
- ( ) Not in use

Enovert

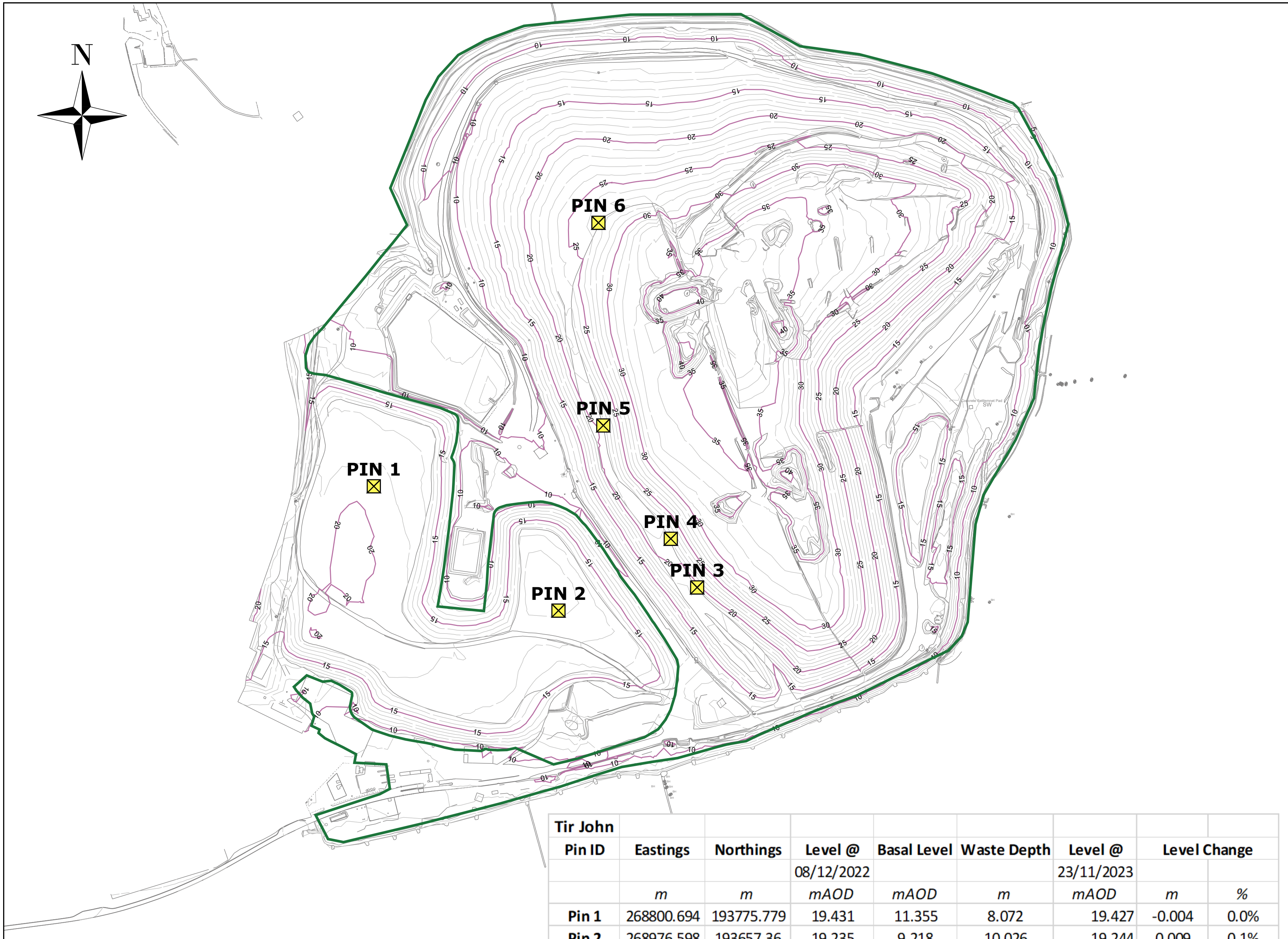
Units 3-5 Greyfriars Business Park,
Frank Foley Way, Stafford, ST16 2ST
Tel: 01785 251555

Site: TIR JOHN

Title: Environmental Monitoring Locations

Drawn:	Date:	Scale @A1:
TJG	13-1-23	1:2000

Drawing number: TJ74



Key

- Permit Boundary
- Settlement Monitoring Location
- 5m contour line
- 1m contour line

Tir John								
Pin ID	**Eastings**	**Northings**	**Level @**	**Basal Level**	**Waste Depth**	**Level @**	**Level Change**	
			08/12/2022			23/11/2023		
	m	*m*	*mAOD*	*mAOD*	*m*	*mAOD*	*m*	*%*
Pin 1	268800.694	193775.779	19.431	11.355	8.072	19.427	-0.004	0.0%
Pin 2	268976.598	193657.36	19.235	9.218	10.026	19.244	0.009	0.1%
Pin 3	269108.71	193679.429	19.14	10.663	8.427	19.090	-0.050	-0.6%
Pin 4	269083.601	193725.789	20.85	10.137	10.667	20.804	-0.046	-0.4%
Pin 5	269019.3	193833.71	20.123	10.405	9.646	20.051	-0.072	-0.7%
Pin 6	269014.656	194026.778	26.184	8.786	17.327	26.113	-0.071	-0.4%

Enovert
Units 3-5 Greyfriars Business Park,
Frank Foley Way, Stafford,
ST16 2ST
Tel: 01785 251555

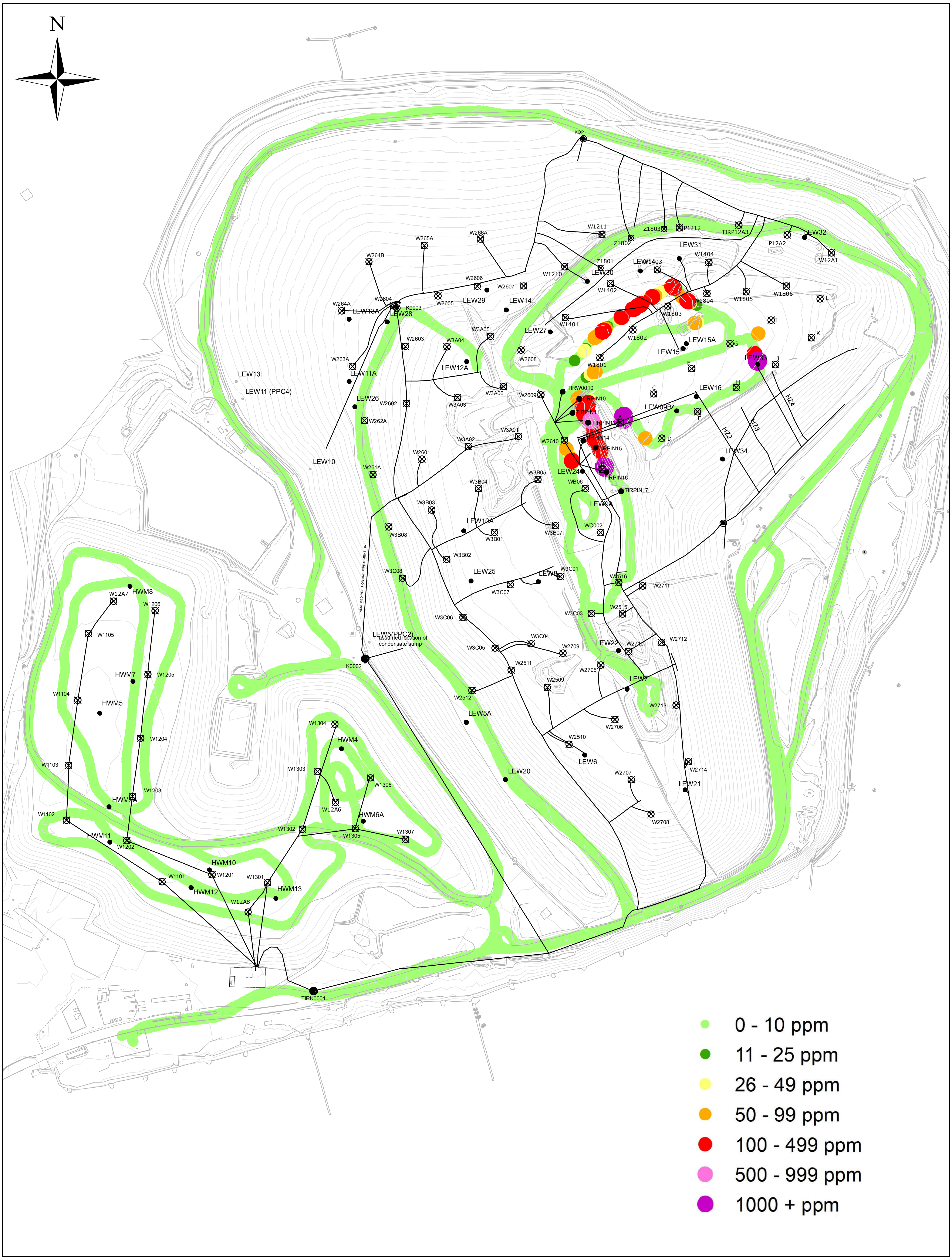
Revision: Details:

Site: **TIR JOHN**

Title: **Site Survey**

Drawn: TJG | Date: 5-2-24 | Scale @A4: 1:5000

Drawing number: **TJ87**



TIR JOHN
FID Survey Dated 28-9-23

1:2,500 @ A3

Enovert