Tir John (Phase 1) 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) Limited) on behalf of Enovert South Limited who manage the Tir John Phase 1 landfill on behalf of The City and County of Swansea. Cory Environmental (Gloucestershire) Limited (Cory) were contracted by The City and County of Swansea to manage the Site. Cory was subsequently rebranded as Enovert South Limited in January 2018. This report provides a review of the environmental monitoring carried out at the closed portion of the Tir John Landfill Site by Enovert during 2023.

Tir John Landfill Site comprises an area of approximately 36ha and is situated North of Fabian Way, Port Tennant, Swansea, at National Grid Reference (NGR) SS695936. The Site is located 3km from Swansea and approximately 1km from the coast. The Site comprises two separate Permitted areas, an older landfill referred to as Phase 1 and the adjoining operational Phase 2. Phases 1 and 2 are separated by a high voltage electricity transmission line and the associated standoff distance for which passes through the Site.

Phase 2 forms the eastern area of the Site, incorporating Cells 5 to 17; and is operating as a non-hazardous landfill. The Permit for the operational site (Phase 2) was transferred in full to Cory Environmental (Gloucestershire) Limited on 30/09/2015. However, Phase 1 remains the responsibility of The City and County of Swansea, although daily management has been sub-contracted to Enovert.

The original planning permission for the Site was issued in 1985. Waste Management Licence SWW14L was issued later in the same year. This also included permission for the development of Cells 5-14 of Phase 2. This Waste Management Licence was formally converted to EAWML 34011 on the 05/11/1996 on the transfer of ownership from Swansea City Council to Swansea City Waste Disposal Company Limited. The Permit was transferred back to the City and County of Swansea in February 2014, again with no modification to management.

The Environment Agency issued a permit variation, reference EPR/JP3395FD/V003, for Phase 1 on 15/03/2013. Phase 1 is currently regulated under Permit Number EPR/JB3597TN/V002 following the issue of a further variation by Natural Resources Wales (NRW) on 15/08/18. This landfill no longer accepts waste and following the submission of an amended closure report in November 2019 is now progressing towards definitive closure.

1.2 Site History

The Site was constructed within an area which was originally part of the Crymlyn Bog, believed to have been used for seasonal grazing prior to the 18th century. 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. Former coal drifts commonly surround 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 150m to the north.

The closed site is located within the footprint of a former power station which was constructed between 1932 and 1935. The power station used sea water as a coolant during the operation of this power plant. The power station was originally a coal fired station and then converted to oil during the 1960s until closure in the 1970s. However, large quantities of Pulverised Fuel Ash (PFA) from the original operational phase were deposited within the Crymlyn Bog to the

east of the power station platform. A PFA platform continued to be constructed from imported PFA until the mid-1980s.

There was also a short phase of landfilling with inert waste that extends to the east of the site (under the footprint of Cells 16 and 17 of the operational site) used as a fill to create a platform above the Crymlyn Bog. Waste disposal then continued until the 1980s for a wide inventory of wastes including domestic and other mixed wastes. This terminated when the disposal operations were granted planning permission.

Phase 1 was operated for the permanent disposal of municipal, degradable commercial and industrial, inert, metal and scrap-metals, within engineered containment cells, between 1985 and the early 1990s after which operations transferred to Phase 2.

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 with an easterly and south-easterly gradient towards the coast. There is a groundwater mound located at the spring monitored at GWD023, on the valley slopes at the western boundary of the closed site, which discharges into the PFA and alluvium that underlie the Site.

1.4 Site Engineering

The Site is fully capped and landscaping of the Site was completed in 2019. The Phase 1 basal engineering comprises an early Geosynthetic Clay Liner (GCL) and a basal drainage blanket. Phase 1 was built above the platform constructed to support the original power station and there are additional layers of PFA and crushed concrete underlying the phase.

It is considered likely that the historical engineering works associated with the power station and placement of the PFA has increased the compaction of the in-situ peats and the low permeability clay of the alluvium.

A Hydrogeological Risk Assessment (HRA) review was produced for the Site in September 2021.

1.5 Environmental Monitoring

Schedule 4 of the permit (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. Details are from the holistic site and are not specific to the closed site.

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 operational site (Phase 2) data

This Site is closed and there is no remaining void space. A site survey is attached as Drawing Ref. TJ87 which illustrates settlement data collected for the site in 2023.

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 Perimeter Gas

The closed site has a series of eight perimeter gas monitoring points along the southern and western boundaries (Table 3). The eastern and northern flanks are continuous with the operational landfill.

Table 3 Perimeter Ground Gas Summary 2023

Location	Methane			Carbon Dioxide		Oxygen		Balance	
	Avg	Max	Limit	Avg	Max	Avg	Max	Avg	Max
	%v/v								
TIRGP001	0.0	0.1	20.7	0.2	0.8	20.2	21.3	79.6	81.9
TIRGP002	0.0	0.1	1.0	0.2	0.7	20.8	22.0	79.0	79.7
TIRGP003	0.0	0.1	1.0	5.2	9.1	12.3	18.1	82.5	87.6
TIRGP004	0.0	0.1	1.0	1.1	2.4	19.5	20.9	79.5	81.4
TIRGP005	0.0	0.1	1.0	1.5	7.7	18.9	21.6	79.6	82.6
TIRGP006	0.0	0.1	1.0	0.9	3.1	20.1	21.2	79.0	79.5
TIRGP007	0.0	0.1	1.0	0.4	0.8	20.5	20.9	79.1	79.7
TIRGP008	0.6	6.9	2.5	2.9	9.9	18.0	21.1	78.5	79.8

Shaded cells indicate methane above permit limit.
Note: TIRGP series identified as LFG1 – LFG8 on monitoring point drawings.

The Site is located within the Crymlyn Bog, a lowland peaty fen that contains a biologically active soil bacterial 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 localised marsh areas), seasonal and weather dependent transitions.

The data demonstrates that there are three ground gas profile types around the perimeter of the closed Tir John landfill site. These profiles can be summarised as

- ground gas approximating to atmospheric concentrations, with an absence of methane;
- a ground gas enriched in carbon dioxide and significantly depleted in methane compared to landfill gas (TIRGP008); and
- a marsh gas or mine gas profile, where the methane: carbon dioxide ratio is enriched compared to expected for landfill gas (TIRGP008).

Permit limits are set for methane in all perimeter gas wells. The methane limits at TIRGP01 and TIRGP08 are a recognition that natural sources of methane within the vicinity of Tir John landfill site were identified during the preparation of the site's permit. Both mine gas associated with the Coal Measures strata and marsh gas generation associated with saturated horizons within the Crymlyn Bog should be expected. Similarly, the absence of carbon dioxide limits within the permit is a recognition that aerobic microbial activity can also occur within unsaturated zones.

Figure 1 Ground Gas Profile TIRGP008

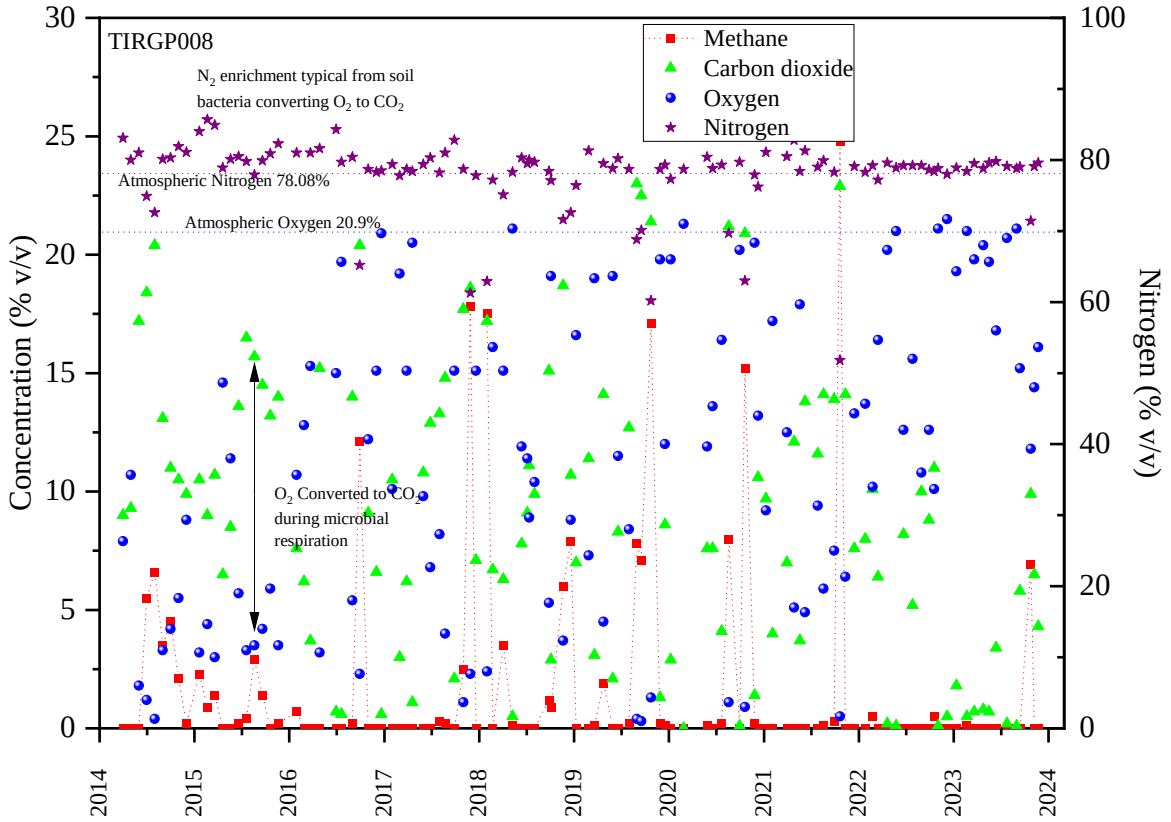
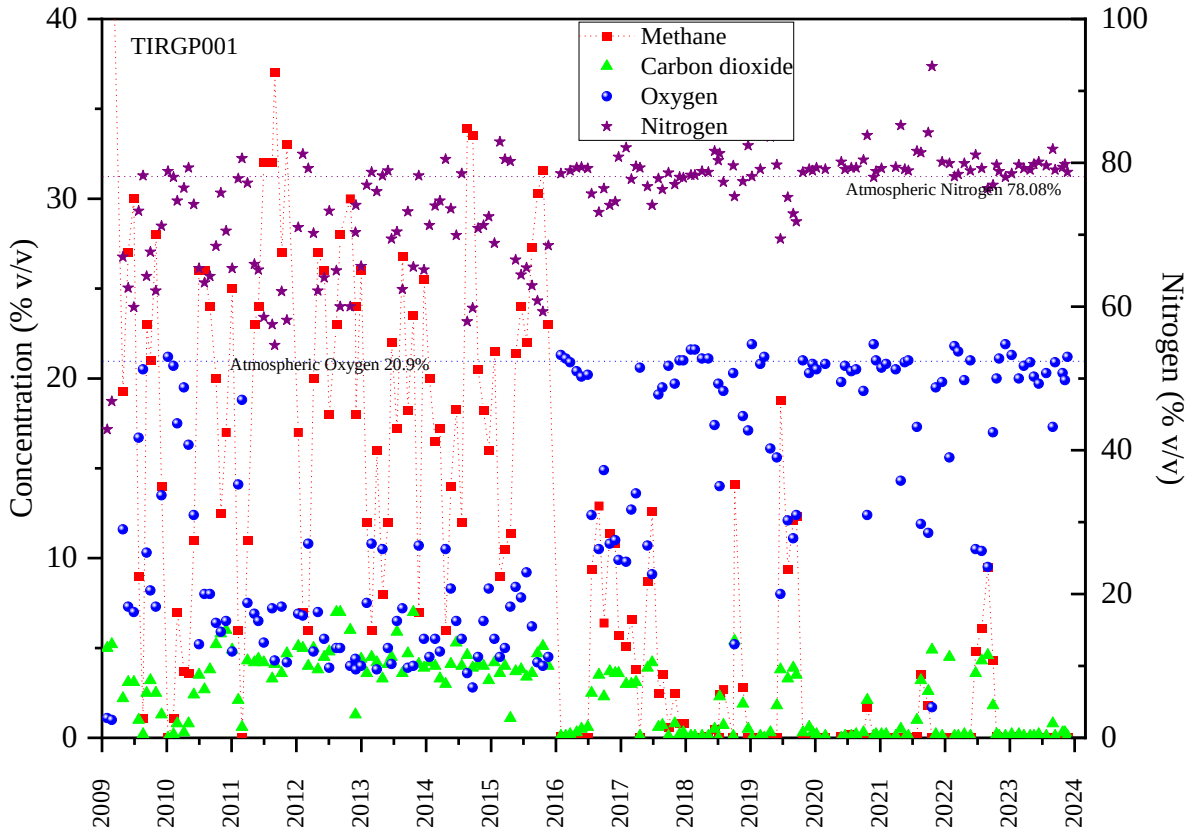


Figure 2 Ground Gas Profile TIRGP001



During 2023 the permit limits for methane were exceeded at only the perimeter monitoring location TIRGP008. This reading is consistent with previous seasonal patterns of methane in TIRGP008 during autumnal and winter periods, which had not been observed during 2022 (Figure 1).

Negligible methane was observed at TIRGP001 during 2023, representing a continued decline; indeed, concentrations in this monitoring point were overall lower than in any previous year since at least 2009. Prior to this TIRGP001 exhibited regular seasonal increases in methane from ~5% v/v to approximately 30% v/v.

TIRGP003 has continued to display a ground gas profile consistent with aerobic respiration conditions as reported at this monitoring location since 2016. The change in pattern at TIRGP003 appears to shortly precede the commencement of capping works in 2016. These engineering and preceding preparatory works could have contributed to changes in ground conditions which may have triggered the change in ground gas biochemical regime to aerobic respiration conditions, or that the well was blocked or flooded for a period, giving atmospheric results, and then subsequently remediated.

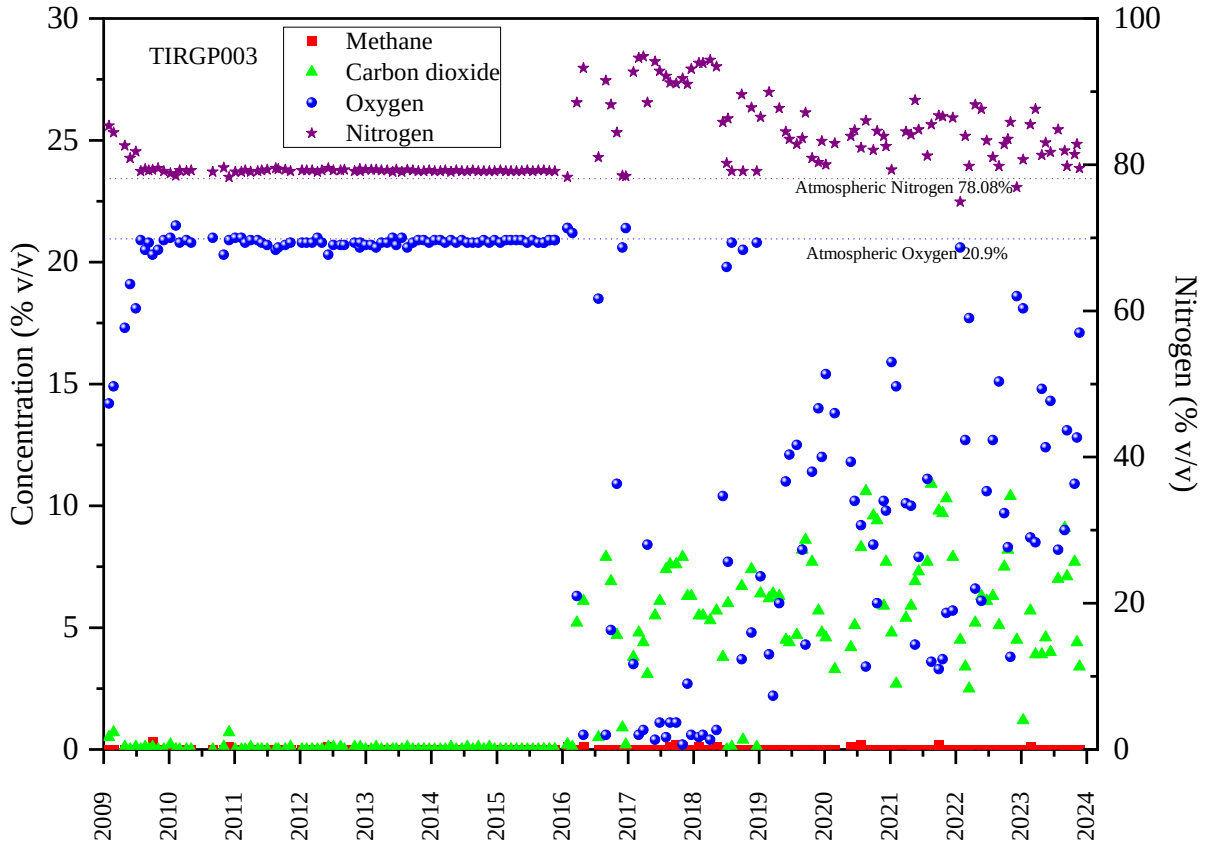
The relationship between ground gases in TIRGP003 can be described as natural soil microbial respiration which involves the consumption of oxygen in the soil by soil microbes and vegetation roots along with other anaerobic processes and its conversion to carbon dioxide:

$$O2 + C \rightarrow CO2$$

During this process, some of the carbon dioxide is lost to soil moisture and biological uptake and thus to equalise the pressure there is the continued ingress of air into the sub-surface, which also sustains the process by replenishing oxygen availability. As oxygen is continually consumed by microbial respiration, nitrogen in the soil becomes enriched above atmospheric concentrations.

This inter-relationship between atmospheric gases is shown in Figure 3. The cyclic trends observed within the data set are likely a result of favourable conditions for respiration resulting in periods of increased biological activity and greater carbon dioxide production. It is noted that reported concentrations for the production of carbon dioxide in the ground as a result of an active biological system (soil respiration) can reach in excess of 13%v/v[1] [2].

Figure 3 Ground Gas Profile TIRGP003



Ground gas profiles for TIRGP001, TIRPGP002, TIRPGP004, TIRPGP005, TIRPGP006 and TIRPGP007 continue to demonstrate no influence from landfill sources (whilst TIRGP003 and TIRGP008 have separate, non-landfill influences). Methane was not present above the instrument limit of detection in these monitoring locations during 2023. Carbon dioxide was

[1] Amundson, R.G. and E.A. Davidson, Carbon and nitrogenous gases in the soil atmosphere, *J. Geochem. Explor*., 38, 13-41, 1990.

[2] Wood, B.D., C.K. Keller, and D.L. Johnstone, In situ measurement of microbial activity and controls on microbial CO_2 production in the unsaturated zone, *Water Resour. Res., 29*, 647–659, 1993.

observed in the 0-10% v/v range at these monitoring points during 2023 and is consistent with expectations for naturally biologically active soil conditions.

3.2 Gas Field

Landfill gas flow rates have depleted to the extent that there is insufficient landfill gas being generated to require abstraction from the majority of the installed abstraction infrastructure to yield a constant supply. Consequently, extraction is carried out in a proportional manner to the risk posed by the site and the declining source term. Abstracted landfill gas continues to support the generation of electricity at the shared Phase 2 gas utilisation plant. Perimeter gas monitoring confirms that gas migration at the site is not occurring.

3.3 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 use 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[3]. Section 2.7 of LFTGN07 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*".

The survey demonstrates that there is good gas control at the Site with low emissions (i.e. <10 ppm) occurring across all of the Phase 1 area. Previously, in 2022, emissions in the range 100–499 ppm were identified adjacent gas well W1304. However, such readings were not identified during the 2023 survey. No further action is required.

3.4 Summary

The ground gas composition was monitored in eight perimeter wells during 2023. There is an atmospheric composition in the majority of locations, with the occasional identification of carbon dioxide, consistent with in-situ microbial respiration. There are only two monitoring points (TIRGP008 and TIRGP003) which exhibit different ground gas systems.

4 Water Monitoring

4.1 Leachate

Leachate within Phase 1 is managed by a gravity drained system. The leachate from both sites is then discharged to sewer. The leachate volume discharged is not differentiated between the two site areas.

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

Leachate Levels

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). However, the landfill is actually one continuous hydraulic cell. A number of the monitoring points are retro drilled, with the most recently installed points HMW4, HMW5 and HMW8 installed and re-instated into the monitoring schedule in January 2020 following the completion of capping and restoration works (and denoted by an 'R' suffix on the monitoring point names). Consequently, these points were installed with an offset from the base of the site and by definition they are not in continuity with the original basal drainage layer.

As the Site has been fully capped with low permeability material since 2019 further stabilisation of leachate levels is expected to continue. Seasonal trends have dampened in the majority of monitoring points since the completion of capping at the site. Cell 3 continues to show some seasonal variation in leachate elevation, however as the reported leachate is above groundwater elevations then groundwater ingress is not suspected as a contributing factor.

Figure 4 Leachate Level

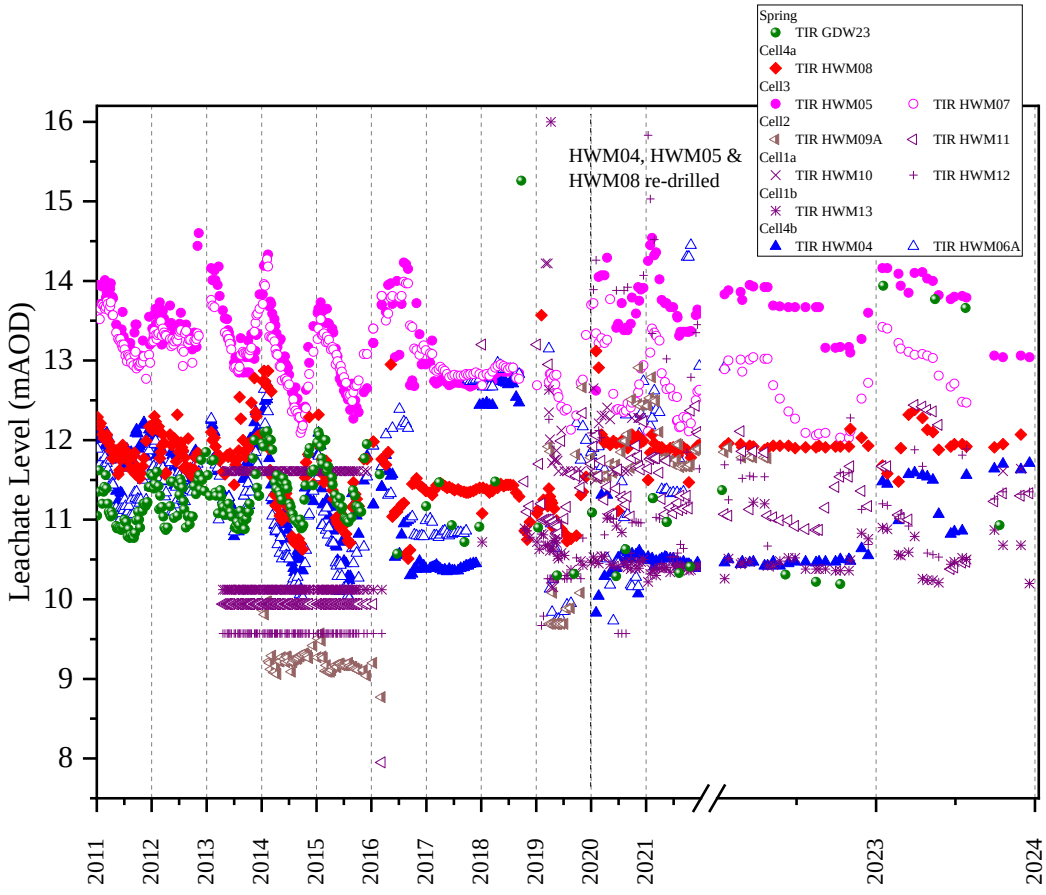
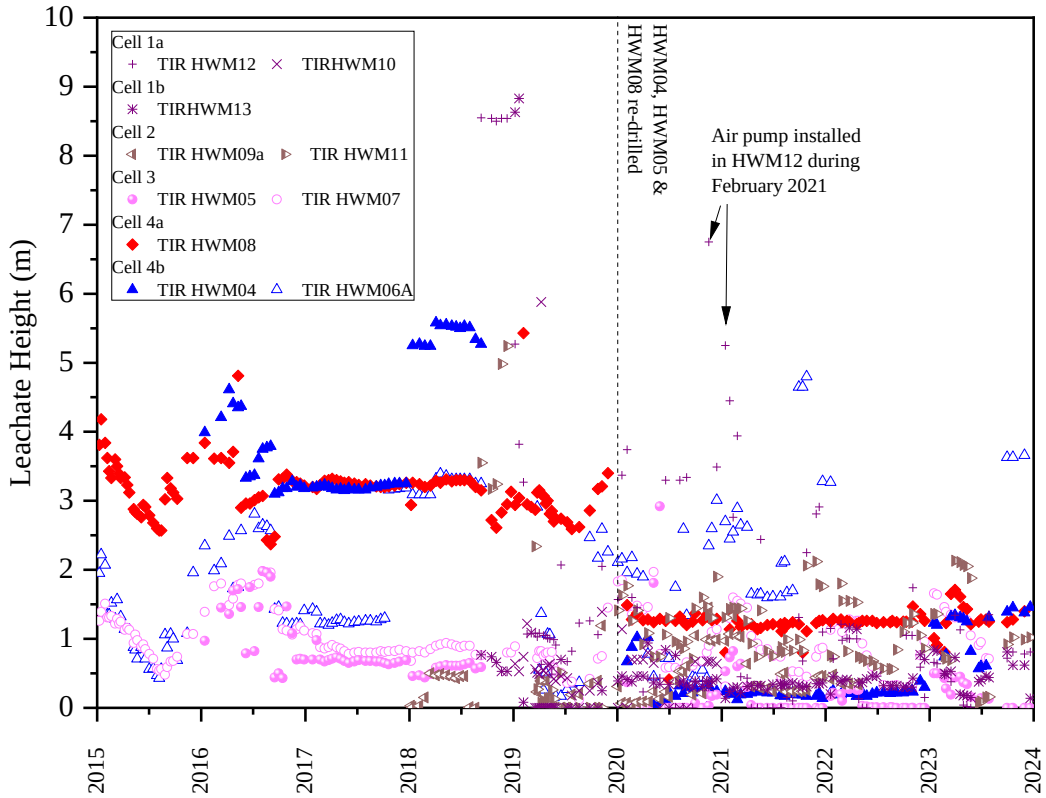


Figure 5 Leachate Height Above Plumbed Base



The leachate elevation is consistent with the hydraulic response towards the passive leachate collection system which drains leachate from an elevation of 10 – 11 mAOD into a central receiving lagoon, which is below the base of the landfill (with an invert height of ~9 mAOD) before discharge to sewer. The overall volume of leachate within the Site is expected to progressively decline as excess moisture within the waste mass is lost through the gravity drainage system.

4.2 Leachate Quality

Leachate within the Site is transitioning from a sodium-chloride bicarbonate solution with significant ammonium and potassium typical of non-hazardous leachates, to one where the majority of the sodium chloride and ammonium content has become significantly depleted (Table 4) (Figure 6 and Figure 7). The leachate appears to have depleted to less than 5% of that expected from methanogenic conditions within a municipal landfill, i.e. typical ammoniacal-N concentrations are <50 mg/l compared to typical methanogenic leachates at >1,000 mg/l ammoniacal-N. This depletion is not unexpected given the age of the waste.

Compared to recent years, leachate ammoniacal nitrogen has decreased further, with the maximum concentration being 68 mg/l in HWM07 and all other samples being <20 mg/l.

Chloride increased in Cells 1-2, driven by a rise in HWM13, but concentrations decreased in Cells 3, 4a and 4b.

Table 4 Leachate Matrix Constituents 2023

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alk
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
HWM04A	23/05/2023	6.9	1,600	8	140	8	31.2	200	35	65	26	68	42.4	940
	07/11/2023	6.7	1,400	6.9	65	7.5	27.6	220	38	65	22	40	112	720
HWM07	23/05/2023	7	2,200	68	320	250	21.5	150	35	66	35	96	30.1	1,200
HWM08A	23/05/2023	7	1,600	16	120	25	18.7	170	36	120	15	38	70.4	970
	25/10/2023	6.8	1,400	7.8	120	7.2	14	220	38	76	16	19	100	780
HWM11	25/10/2023	7	1,300	5.1	400	35	35.5	230	23	54	20	44	221	540
HWM12	23/05/2023	7.4	1,400	9.1	290	67	24.3	220	24	54	20	40	112	780
	25/10/2023	7.5	1,500	0.21	80	5.1	17.1	320	35	43	17	22	299	660
HWM13	23/05/2023	7.5	3,800	13	370	21	30.5	470	130	510	120	570	1,170	760
	25/10/2023	7.1	3,900	17	110	5.5	46.9	360	130	390	160	470	863	1,000

Figure 6 Leachate Ammoniacal Nitrogen

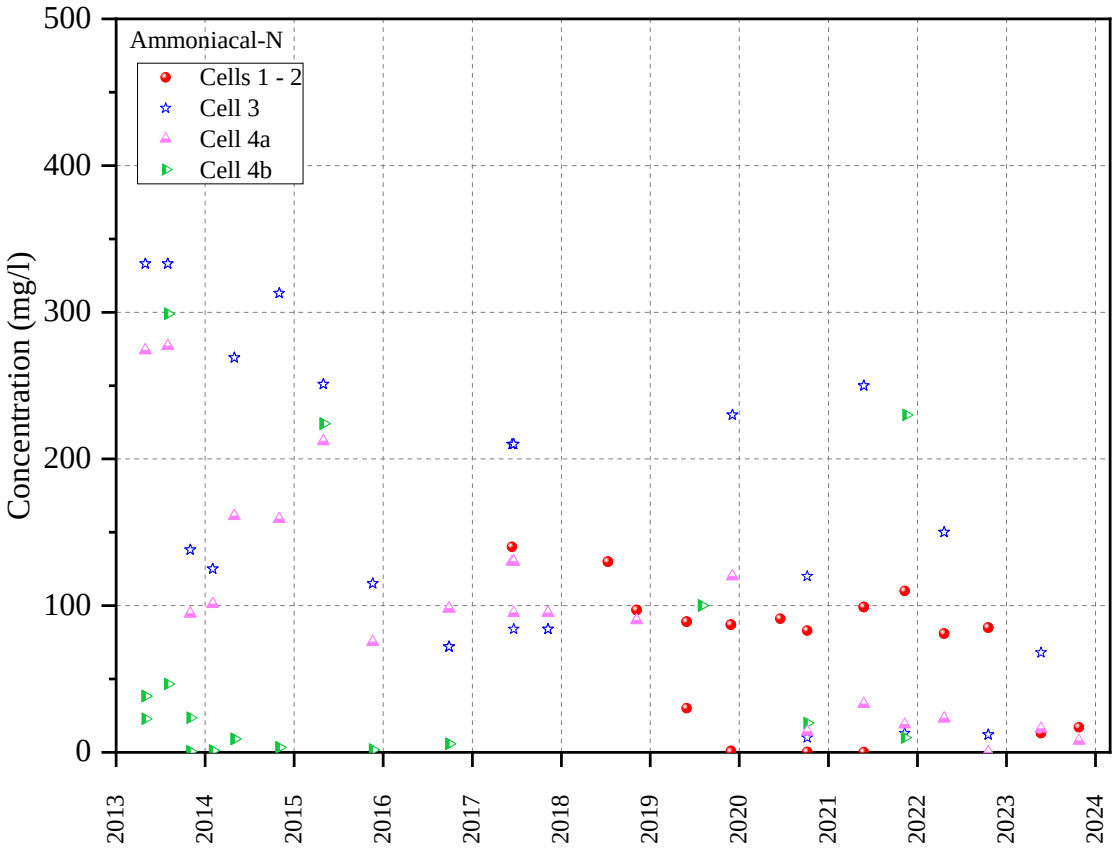


Figure 7 Leachate Chloride

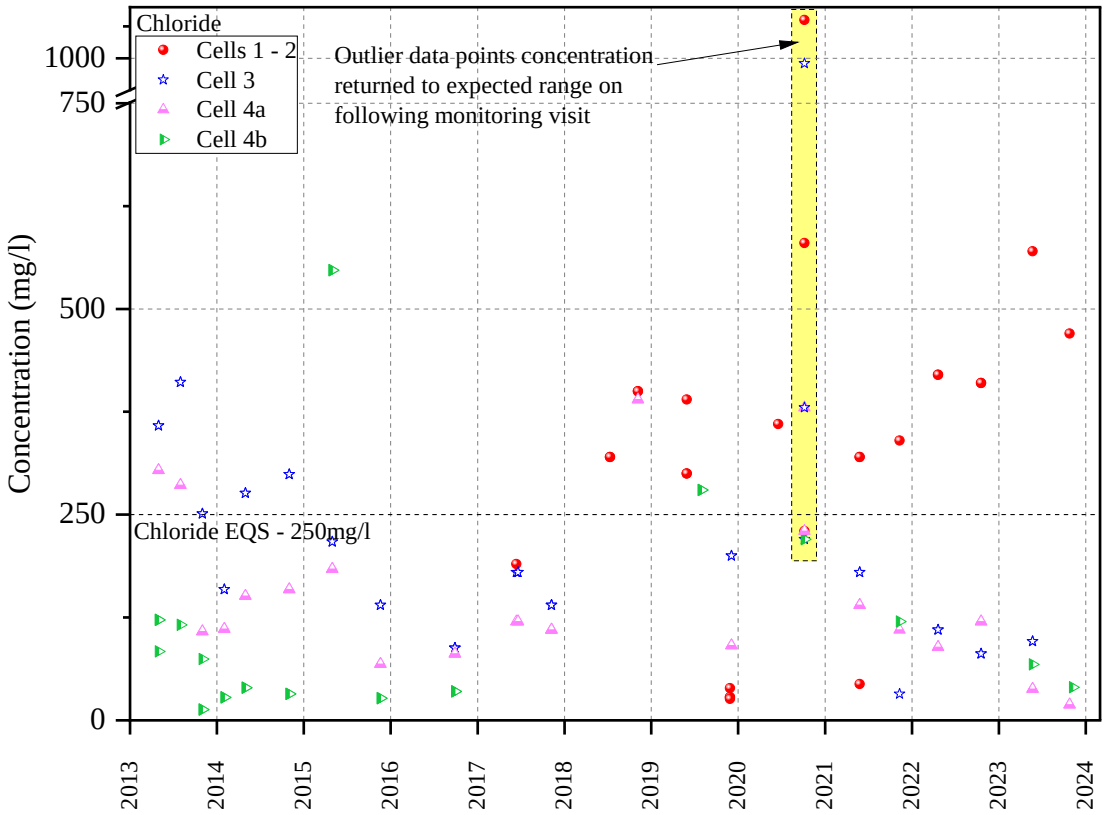
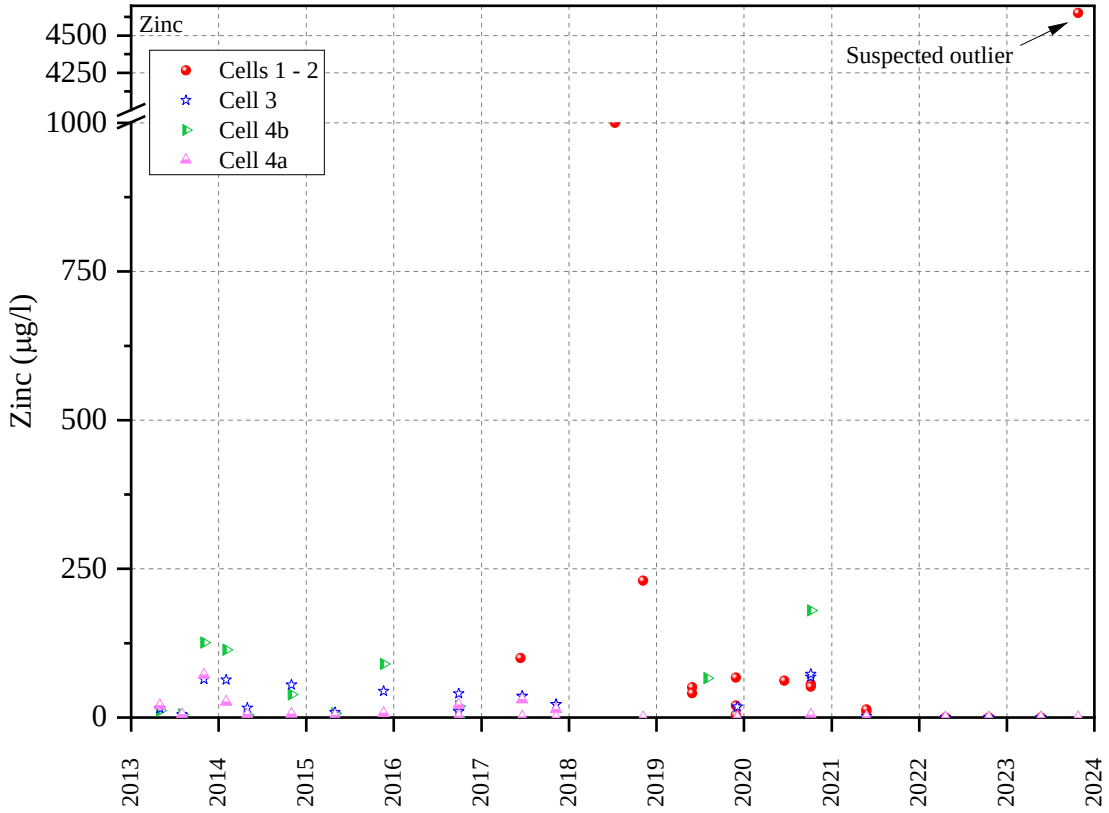


Figure 8 Leachate Zinc



Leachate metals are also typical of a non-hazardous leachate (Table 5). Mercury is routinely below or approximating to the 0.1 µg/l to <0.05 µg/l detection limits and generally over an order of magnitude below the 1 µg/l mercury Drinking Water Standard. There were four detections in 2023, compared to one in the previous year.

Cadmium concentrations are lower than in 2022. The highest concentration was 0.9 µg/l in October in HWM13. This is possibly an erroneous result, and will be checked against the subsequent sample, when possible, as a short-term peak would be consistent with a laboratory error and interference. Cadmium is otherwise below the 5 µg/l DWS and consistent with the EQS for the site's setting (i.e. at a water hardness of 200 mg/l).

Whilst lead data for 2023 did not report any anomalies as in 2022 (Figure 9) there was one anomalous data point for zinc in TIRHWM13. The result of 4.65 mg/l is more than four times the previous high concentration in 2018, which was itself attributed to likely particulates incorporated within the sample being included in the reported results, rather than a fundamental change in leachate chemistry. Two other samples, 24.8 µg/l in HWM12 in October and 46.8 µg/l in HWM13 in May, demonstrated environmentally negligible concentrations.

Figure 9 Leachate Lead

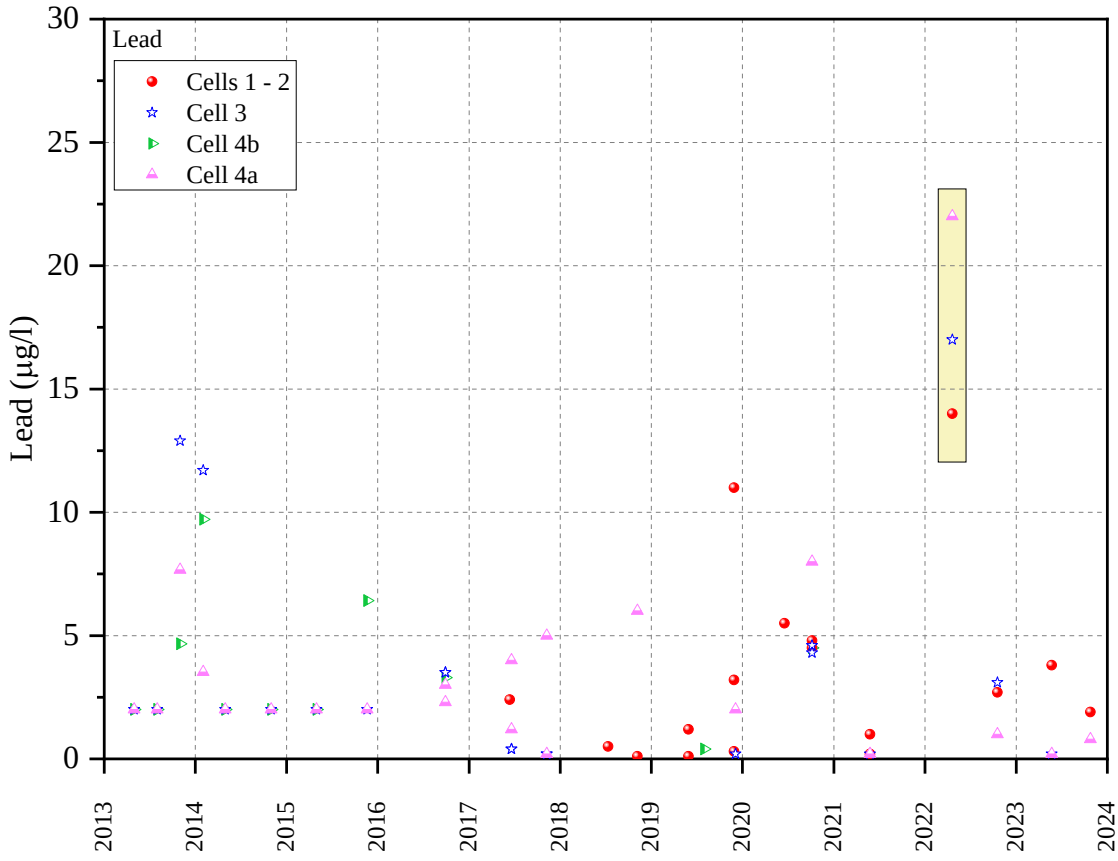
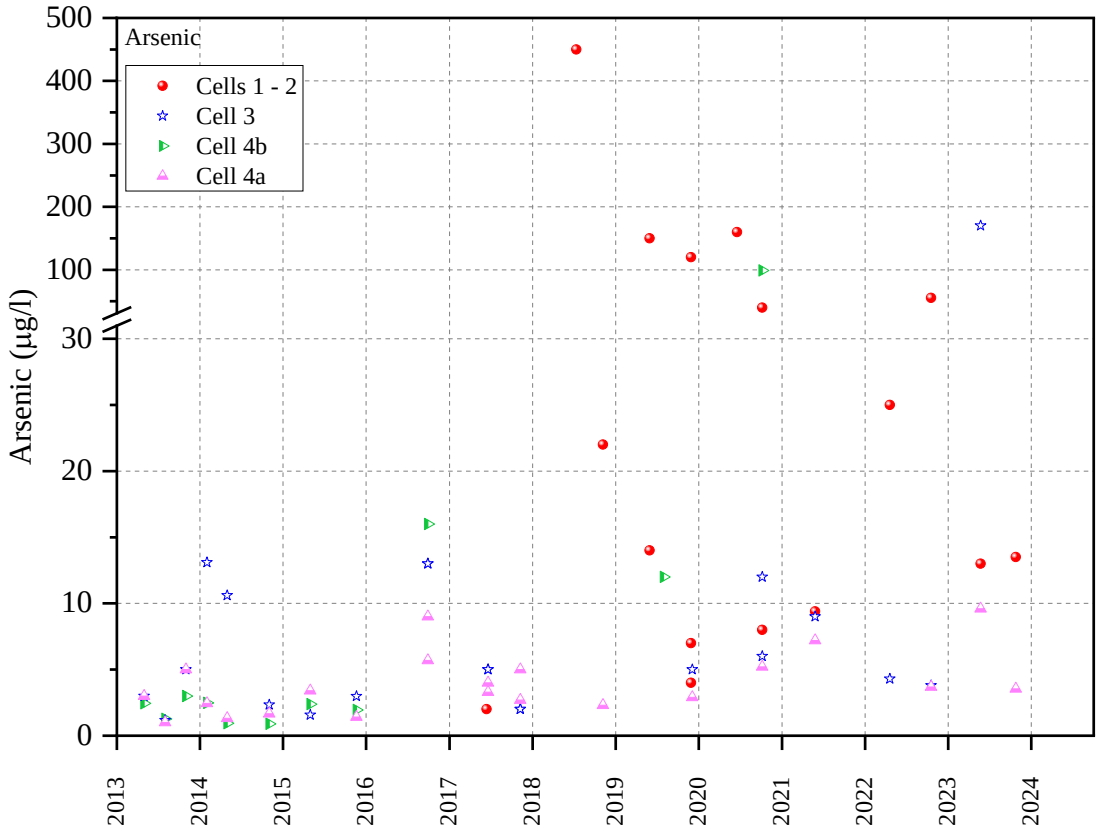


Figure 10 Leachate Arsenic



Chromium and copper were reported at environmentally negligible quantities across the monitoring locations.

Arsenic has historically followed pattern of a localised bias at Cell 1 (and at HWM13 in particular) and low concentrations elsewhere. This continued to be the case in 2023, although there was an isolated sample in Cell 3 in May which was higher than previously. This was the only sample obtained from this location (TIRHWM07) analysed for arsenic in 2023. Arsenic is however of no significance in this setting as firstly, arsenic within the leachate has mostly depleted to at or below the 50 µg/l EQS, even in the localised Cell 1 area. Further to this, the Site is constructed on a former residual ash platform constructed using the coal PFA residue from the adjacent former coal power station. Given that arsenic is a known secondary component of coal, it is unsurprising that arsenic is present in the youngest cell and will also be present in significant quantities outside of the Site. Given these factors there can be no additional risk presented to the environment from arsenic in this site setting.

Table 5 Leachate Priority Metals 2023

Sample Point	Date	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
		mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
HWM04A	23/05/2023	0.26	2.20	<0.02	0.0084	0.9	3.9	3.3	4.0	<0.2	14
	07/11/2023	1.2	1.90	<0.02	<0.05	0.5	1.0	2.1	4.3	<0.2	3.2
HWM07	23/05/2023	0.37	0.24	0.02	<0.05	1.1	1.8	5.3	3.5	<0.2	170
HWM08A	23/05/2023	2.4	1.70	0.03	<0.005	1.5	<0.5	3.1	1.9	0.2	9.6
	25/10/2023	0.31	0.88	<0.02	0.0056	0.8	1.6	5.5	12.1	0.8	3.6
HWM11	25/10/2023	2.6	0.44	<0.02	<0.005	0.2	1.5	5.6	6.9	<0.2	3.1
HWM12	23/05/2023	0.61	0.20	0.09	0.0502	0.9	2.4	5.3	7.7	2.5	15
	25/10/2023	0.046	0.11	<0.02	<0.05	0.3	5.1	3.5	24.8	<0.2	8.2
HWM13	23/05/2023	0.043	1.70	0.04	<0.05	1.1	2.6	26	46.8	3.8	13
	25/10/2023	0.054	2.00	0.9	0.0103	0.6	11	29	4,651	1.9	13.5

Shaded cell indicates suspected anomalous data.

Table 6 Identified Organic Substances within Leachate

Sample point	Date	Mecoprop
		µg/l
HWM04A	23/05/2023	0.13
HWM07	23/05/2023	1.8
HWM08A	23/05/2023	0.1
HWM12	23/05/2023	0.55
HWM13	23/05/2023	0.62

No specific hazardous organic substances were identified as being present in the leachate above their specific detection limits (Table 6). The non-hazardous herbicide mecoprop was identified at 0.1 – 1.8 µg/l, which is insignificant in comparison to the 18 µg/l EQS, the relevant water quality standard for a marsh/surface water pond type environmental setting regime.

No other specific organic substances were identified within leachate in 2023.

4.3 Groundwater

4.3.1 Groundwater Elevation

Groundwater elevation during 2023 was largely consistent with the historic dataset. Groundwater levels and flow direction are discussed in detail within the 2021 Hydrogeological Risk Assessment Review (HRAR)[4].

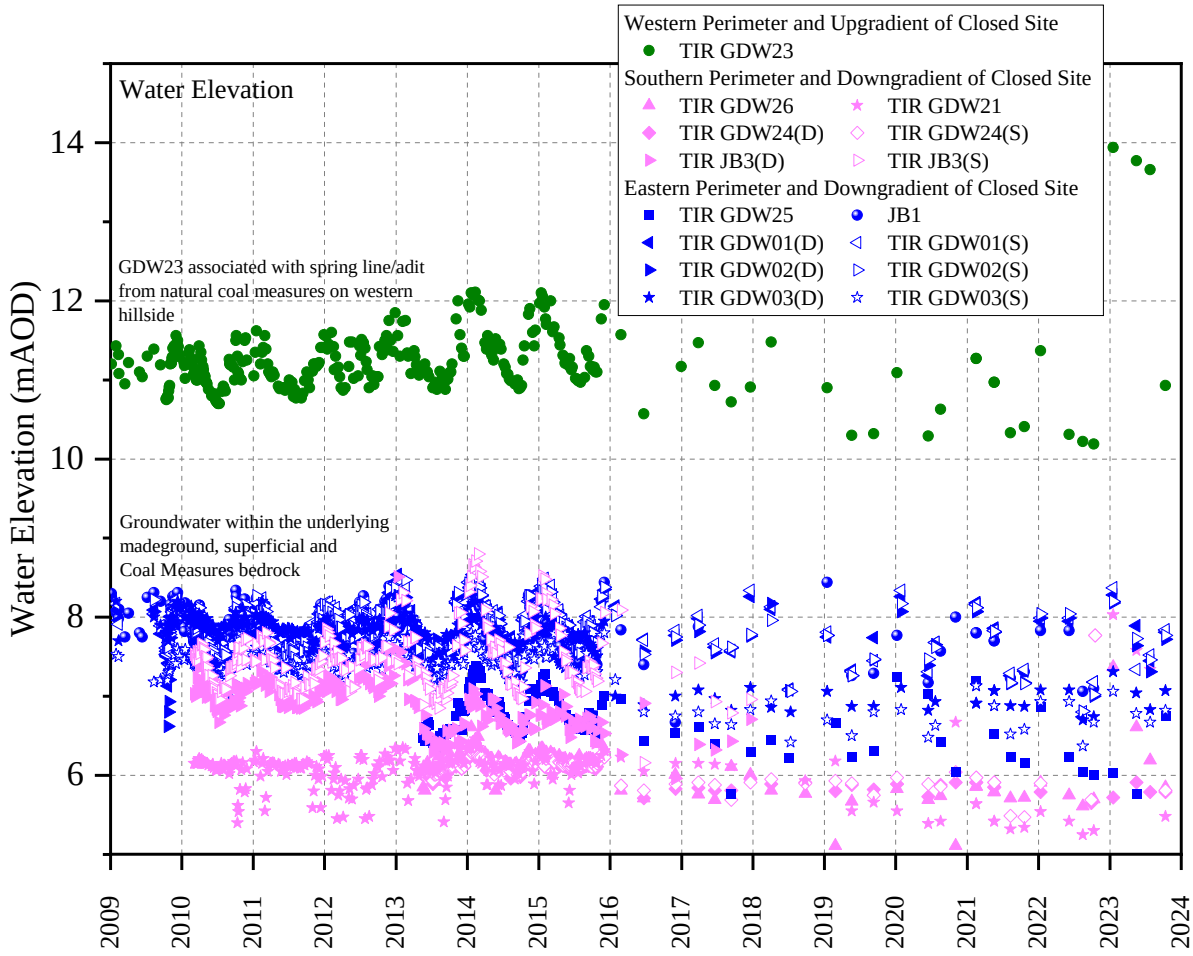
GDW23 is located in the vicinity of a spring which has formed where a permeable / water bearing unit underlain by an interbedded impermeable clay unit has intersected the topography. Notwithstanding the presence of springs on the hillside above GDW23, water levels in the bedrock at the western edge of Cell 3 fluctuate seasonally typically between 10 mAOD and 13 mAOD. During the first part of year, groundwater levels in GDW23 rose to their highest level within the past 14 years, however by October levels were back to just under 11 mAOD, which is considered to be within the normal range.

Groundwater levels within the Made Ground (PFA) and wider Crymlyn Bog also exhibit seasonal variation and are generally between ~6.5 and 9 mAOD and ~5.5 – 6 mAOD respectively (Figure 11).

[4] TerraConsult Limited (2021) Tir John (Closed) Landfill. Hydrogeological Risk Assessment Review. Ref. 10686-R01

The groundwater seasonal patterns are consistent with expectations, except for the aforementioned GDW23.

Figure 11 Groundwater elevation (2009 – 2023)



4.3.2 Groundwater Quality

As discussed in historical environmental monitoring reviews and the 2021 HRAR, interpreting the groundwater quality monitoring data with respect to identifying a potential landfill influence is complicated.

The Site is located on a biologically active peat bog (i.e. organic rich under anaerobic conditions) whilst the power station also used seawater as a coolant. Consequently, there is an expectation that ammoniacal-N, COD and chloride, three primary leachate indicators, are elevated within the local groundwater system. This is further complicated by the significant quantities of PFA deposited below and adjacent to the site, which is likely to result in elevated potassium and other salts including phosphates, in addition to metals. Therefore, the groundwater cannot be compared directly to a potable water supply with respect to the primary water quality constituents usually considered when assessing water quality.

Matrix substances and 'typical' leachate indicator substances are summarised in Table 7. A comparison with Permit Limits is presented in Table 8. The data collected during 2023 is consistent with the historical dataset and no significant trends have been identified.

However, the key observation is that the groundwater composition, and in particular the off-site transects into the bog appear to contain significantly greater ammoniacal-N and chloride than is present within the Phase 1 landfill. As such, given the extent that the Phase 1 landfill has depleted in leachate strength, a continuing or future influence of the landfill cannot be inferred from the dataset.

Table 7 Groundwater Matrix Summary (Average 2023)

Location	pH	EC	NH_4-N	COD	BOD	Ca	Mg	Na	K	Cl	SO_4
		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
North & West											
GDW23	6.7	325	0.10	32	1.1	27.0	21.0	18.5	4.0	19.0	68.9
TIR JB1	7.5	345	1.49	18	8.3	34.0	24.0	15.8	4.9	18.5	12.6
GDW03(D)	6.6	508	12.00	99	12.8	41.0	20.3	20.0	4.2	25.0	1.1
GDW03(S)	7.6	760	18.86	49	8.3	116.7	19.0	19.5	16.5	27.0	2.8
South of Site											
GDW24(D)	7.7	1065	32.00	115	5.4	100.0	29.0	58.3	53.5	56.3	138.0
GDW24(S)	6.9	1550	49.25	50	3.3	130.0	42.0	105.0	57.3	111.8	67.9
GDW26	6.9	918	12.25	321	22.7	76.0	26.0	81.3	33.0	78.8	3.2
GDW21	6.5	1575	23.75	94	5.9	60.0	39.0	220.0	39.5	365.0	18.7
East (Between Phase 1&2)											
GDW01(D)	8.0	798	16.99	9775	69.5	64.7	32.7	49.8	30.8	38.8	9.8
GDW01(S)	8.6	395	2.22	1014	8.4	19.0	19.7	42.3	19.3	21.3	83.1
GDW02(D)	6.9	1040	7.10	66	18.9	163.3	37.0	36.0	23.0	33.3	70.9
GDW02(S)	7.0	2325	23.86	596	13.2	353.3	76.3	197.5	54.5	175.0	114.2
GDW25	7.1	2550	12.75	2260	11.7	360.0	130.0	215.0	56.3	182.5	603.0

Table 8 Ammoniacal Nitrogen Permit Limit Comparison

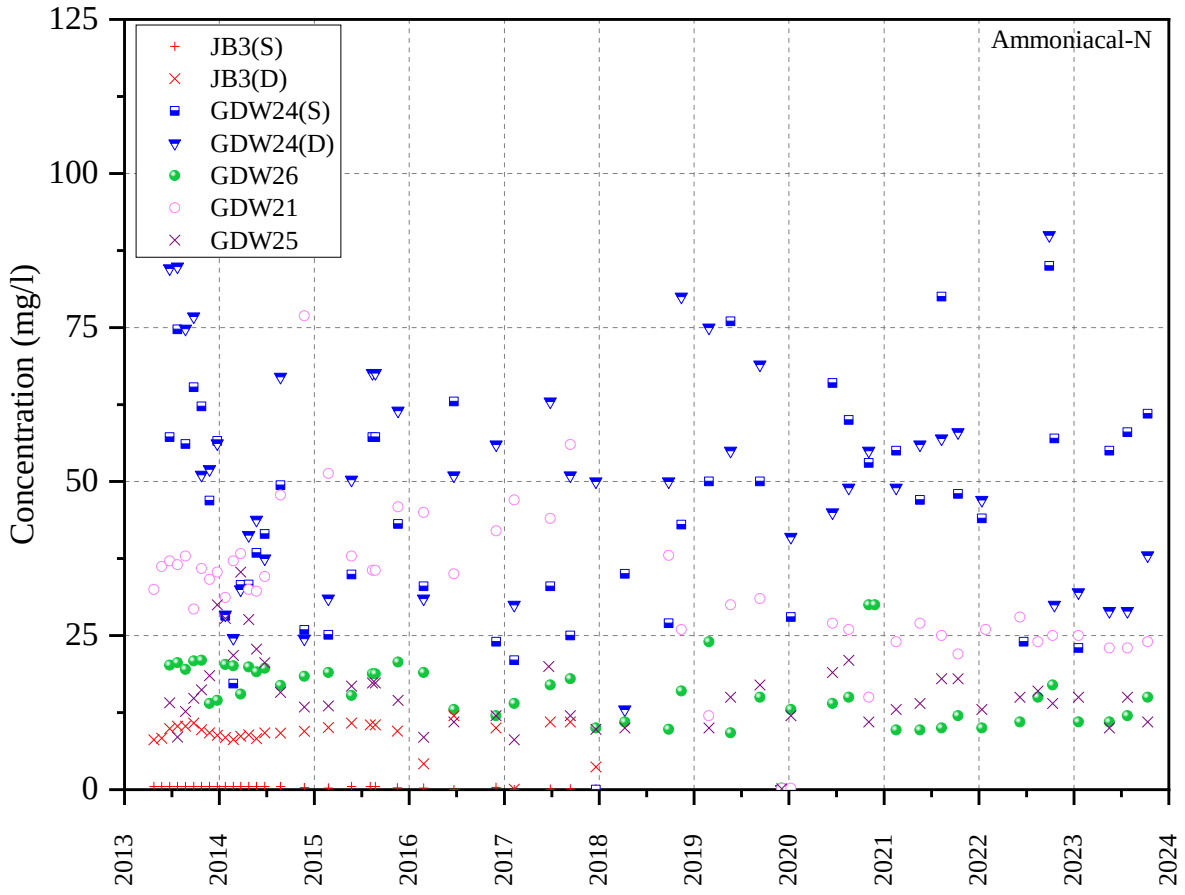
Location	GDW21	GDW24(D)	GDW24(S)	GDW26
Limit	**51**	**85**	**75**	**25**
18/01/23	18	32	23	11
16/05/23	17			
17/05/23		29	55	11
26/07/23	17	29	58	12
12/10/23	16	38	61	15

The monitoring programme has previously demonstrated that ammoniacal-N is elevated around the Site, and this includes monitoring points on the southern perimeter of the closed site where monitoring commenced during 2013 (GDW24(S)/(D), GDW21 and GDW26). However, this is considered to be a reflection of baseline conditions rather than a landfill influence. As discussed within the 2021 HRAR[5], ammoniacal-N appears to increase with distance from the Site.

[5] TerraConsult Limited (2021) Tir John (Closed) Landfill. Hydrogeological Risk Assessment Review. Ref. 10686-R01

Permit limits for ammoniacal-N are set at these downgradient monitoring points and these were not exceeded during 2023. The maximum concentration in downgradient permit limit locations was 61 mg/l in GDW24(S) in October, 14 mg/l below the permit limit.

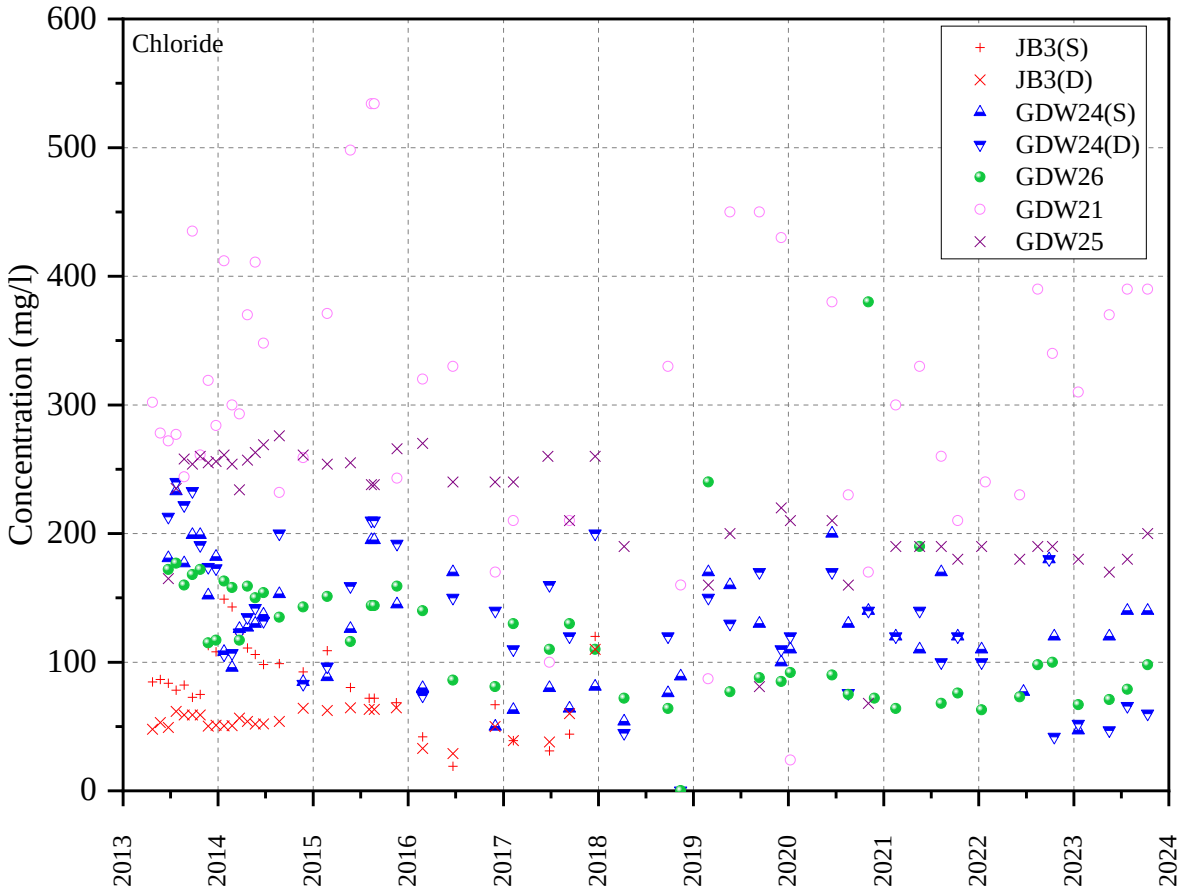
Figure 12 Ammoniacal-N to the South of Phase 1



Chloride is typically reported below the 250mg/l DWS and these trends have largely continued in 2023 (Figure 13). Concentrations in GDW21 were the highest, reaching 390 mg/l in July and October. This is consistent with previous years, when similar or sometimes higher concentrations have been recorded. Chloride within this well typically oscillates between 160 mg/l and 450 mg/l. Chloride appears to follow a similar trend to ammoniacal-N of increasing concentration with distance from the edge of the landfill site. Furthermore, chloride concentrations within the leachate are typically below that reported at GDW21 and therefore must be associated with a non-landfill source.

Sulphate concentrations are broadly in line with previous years, having slightly reduced over the past decade, with slightly lower concentrations than chloride. The exception is GDW25, where the sulphate concentration remains above 600 mg/l. The sulphate is considered to be a product of the host materials due to the methanogenic nature of the Site and is therefore most likely to be a consequence of the PFA and independent of the landfills.

Figure 13 Chloride to the South of Phase 1



The hazardous metal mercury is typically reported below the limit of detection to the north, west and east of the Site with the only detection in 2023 being in GDW23, albeit at the limit of detection. Thus, all data are significantly below the 1 µg/l DWS.

Cadmium was reported in the 0.02 - 0.03 µg/l range which is within the typically reported range for the site.

Lead was reported below the limit of detection during 2023 and is consistent with the historical dataset. Lead is not considered to be environmentally significant within the groundwater.

Chromium and copper were observed in the 0.0002 - 0.002 mg/l range, which is lower than in the previous year, with zinc reported at a slightly higher range of 0.001 to 0.01 mg/l. Nickel was negligible within the groundwater and was typically observed close to the limit of detection of <0.0005 mg/l.

Arsenic was typically in the 0.3-15 µg/l range, except for at GDW01(S) where arsenic was reported averaging 60 µg/l. As stated in the 2023 report, this is most likely an artefact of the PFA host material. Although the reported arsenic at GDW01(S) is above the EQS of 50 µg/l, for all other locations concentrations are below the DWS of 10 µg/l and as such there is no environmental significance to the data.

Table 9 Groundwater Priority Metal Summary (Average 2023)

Location	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
	mg/l	mg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
North & West										
GDW23	0.048	4800	0.03	0.005	-	-	-	0.006	-	0.34
TIR JB1	0.161	155	<0.02	<0.005	-	-	-	0.001	-	1.31
GDW03(D)	0.073	755	0.02	<0.005	0.0002	0.0019	0.0009	0.006	<0.0002	0.63
GDW03(S)	0.098	1550	<0.02	<0.005	0.0002	0.0012	0.0009	0.003	<0.0002	2.72
South of Site										
GDW24(D)	0.025	273	0.02	<0.005	-	-	-	0.002	-	11.19
GDW24(S)	0.278	593	0.02	<0.005	-	-	-	0.010	-	4.58
GDW26	1.466	593	<0.02	<0.005	-	-	-	0.004	-	5.28
GDW21	2.680	375	0.03	<0.005	-	-	-	0.004	-	2.29
East (Between Phase 1&2)										
GDW01(D)	0.081	235	0.03	<0.005	0.0003	0.0017	0.0008	0.003	<0.0002	14.67
GDW01(S)	0.089	27	0.03	<0.005	0.0003	0.0006	0.0006	0.003	<0.0002	60.10
GDW02(D)	0.049	3250	0.03	<0.005	0.0003	0.0011	0.0012	0.007	<0.0002	10.46
GDW02(S)	0.270	1050	<0.02	<0.005	0.0003	0.0010	0.0006	0.003	<0.0002	1.70
GDW25	0.027	413	<0.02	<0.005	-	-	-	0.007	-	4.91

A hazardous substances suite was carried out in May 2023. No hazardous substances were reported in any monitoring points.

4.4 Environmental Transects

There are two monitoring transects which extend into the Crymlyn Bog from the southern edge of the closed site. The transects 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 is presented in Table 10.

Ammoniacal nitrogen is typically lower in the deeper response zone and decreases with distance from the Site boundary for both the shallow and deep installations (Figure 15). A continued decline in concentrations is evident in the 2023 data.

Conversely, the measured chloride increases with distance from the Site boundary (Figure 14) at the deep installations, i.e. the concentration increases towards the coast, where saline intrusion can be reasonably expected to occur.

A similar trend in ammoniacal nitrogen is reported in EMT5, with decreasing concentrations with distance from the Site (Figure 17) and a continued temporal decrease in 2023. Consequently, ammoniacal nitrogen is 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 EMT5 compared to EMT1. The highest chloride concentrations in EMT5 continue to be observed at depth in the 16 m shallow monitoring point (Figure 16).

Table 10 Closed Transect Water Quality

Sample Point	Date	pH	NH4-N	Cl	SO_4	DOC	BOD	Ca	NO_3	Ortho-phosphate	P
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
ETM1 (1a)	21/03/2023	7.3	27	95	3.97	5.46	11	81	0.05	< 0.062	0.8
ETM1 (1b)	21/03/2023	7.4	17	170	3.27	1.56	18	89	0.11	< 0.062	0.74
ETM1 (2a)	21/03/2023	7	20	170	2.71	2.46	33	94	0.04	< 0.062	0.66
ETM1 (2b)	21/03/2023	7.1	13	120	2.26	3.23	6.1	81	0.16	0.18	3.8
ETM1 (3a)	21/03/2023	7	9.4	93	3.91	4	24	120	0.14	0.076	1.3
ETM1 (3b)	21/03/2023	Dry									
ETM1 (4a)	21/03/2023	6.9	3.7	73	3.72	4.28	12	120	0.08	< 0.062	0.92
ETM1 (4b)	21/03/2023	6.8	2.2	290	1.27	4.36	8.4	220	0.19	< 0.062	1.2
ETM1 (5a)	21/03/2023	6.9	0.62	74	2.27	3.77	10	120	0.15	0.3	0.58
ETM1 (5b)	21/03/2023	6.9	2.7	390	4.8	19.2	3.3	46	0.25	2.6	0.98
ETM1 (6a)	21/03/2023	7.6	0.062	65	2.9	5.05	4.5	150	0.25	< 0.062	2.7
ETM1 (6b)	21/03/2023	7.7	< 0.015	400	2.18	16.7	5.5	110	0.26	0.35	0.13
ETM5 (1a)	21/03/2023	7.9	24	53	2.17	3.81	12	110	0.09	< 0.062	2.2
ETM5 (1b)	21/03/2023	7.9	27	69	0.747	3.13	8.7	48	0.15	0.098	5.7
ETM5 (2a)	21/03/2023	7.4	26	87	5.29	4.98	24	150	0.07	< 0.062	1.7
ETM5 (2b)	21/03/2023	8.1	24	120	4.12	1.92	33	80	0.66	0.42	3.4
ETM5 (3a)	21/03/2023	7.8	20	68	6.09	3.53	1.5	100	0.11	< 0.062	0.75
ETM5 (3b)	21/03/2023	7.1	3.2	310	0.856	2.44	67	260	0.21	0.95	0.91
ETM5 (4a)	21/03/2023	7.1	1.5	110	2.22	5.9	1.1	160	0.22	0.45	0.79
ETM5 (4b)	21/03/2023	7.7	0.07	560	3.94	8.04	4.4	170	0.46	< 0.062	0.51
ETM5 (5a)	21/03/2023	7	0.11	170	1.71	30.3	2.7	170	0.13	0.23	2.2
ETM5 (5b)	21/03/2023	7.8	17	170	6.59	11.5	10	50	0.15	5.5	2.4
ETM5 (6a)	21/03/2023	7.1	0.17	210	3.32	18.5	12	38	0.22	0.16	0.14
ETM5 (6b)	21/03/2023	6.2	0.02	320	3.27	26.1	9	15	0.39	< 0.062	0.046

Orthophosphate (for which there is no Minimum Reporting Value[6]) is generally reported at or close to the detectable limit in the majority of monitoring points along the EMT5 transect with 2.6 mg/l in EMT1(5b) being the highest concentration observed during the 2023 monitoring of EMT5, this location once again having the highest concentration. There were 12 detections in 2023, compared with nine in 2022.

The highest concentration of orthophosphate observed in EMT1 during the previous year was 9.9 mg/l at EMT1(5b). Thus, concentrations have notably dropped from the previous high, which was considered to be an outlier. The orthophosphate does not appear to follow a specific trend of increasing or declining with distance from the Site along either of the transects, instead there is fluctuation throughout the depth and distance profiles.

[6] No MRV has been published via Natural Resources Wales, but the Environment Agency details are located at: https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values

Figure 14 Transect EMT1 Chloride

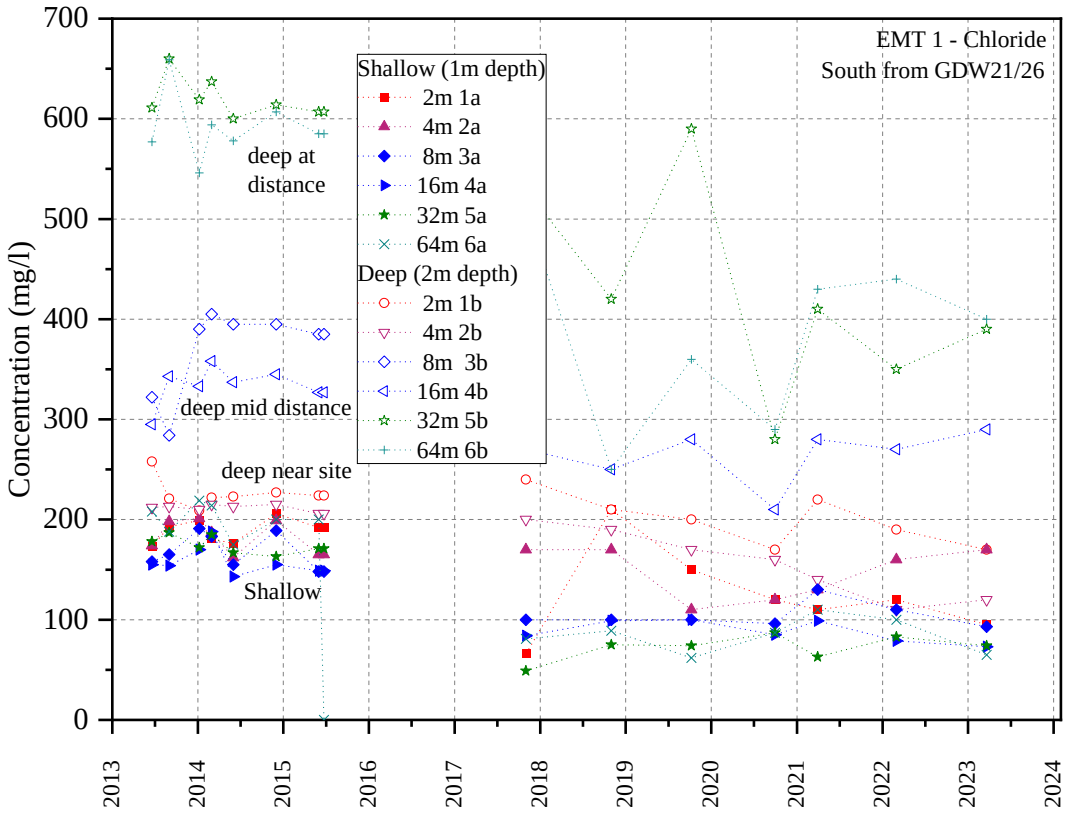


Figure 15 Transect EMT1 Ammoniacal-N

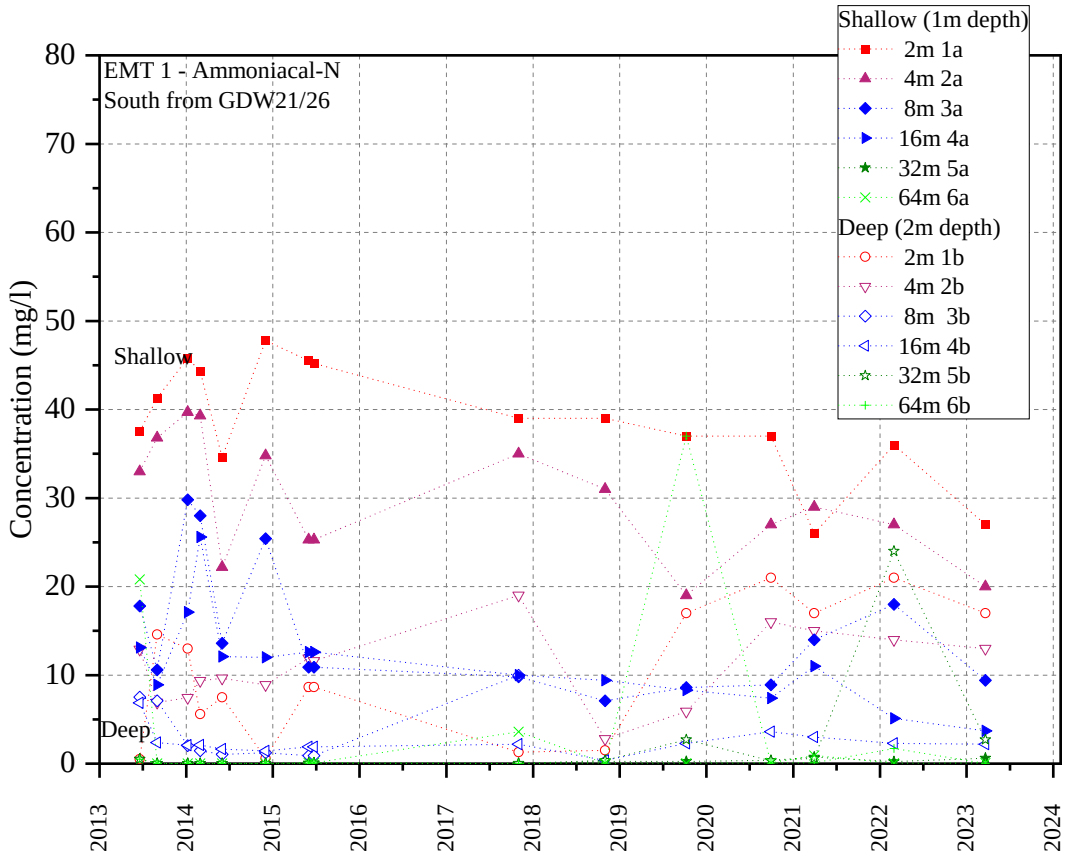


Figure 16 Transect EMT5 Chloride

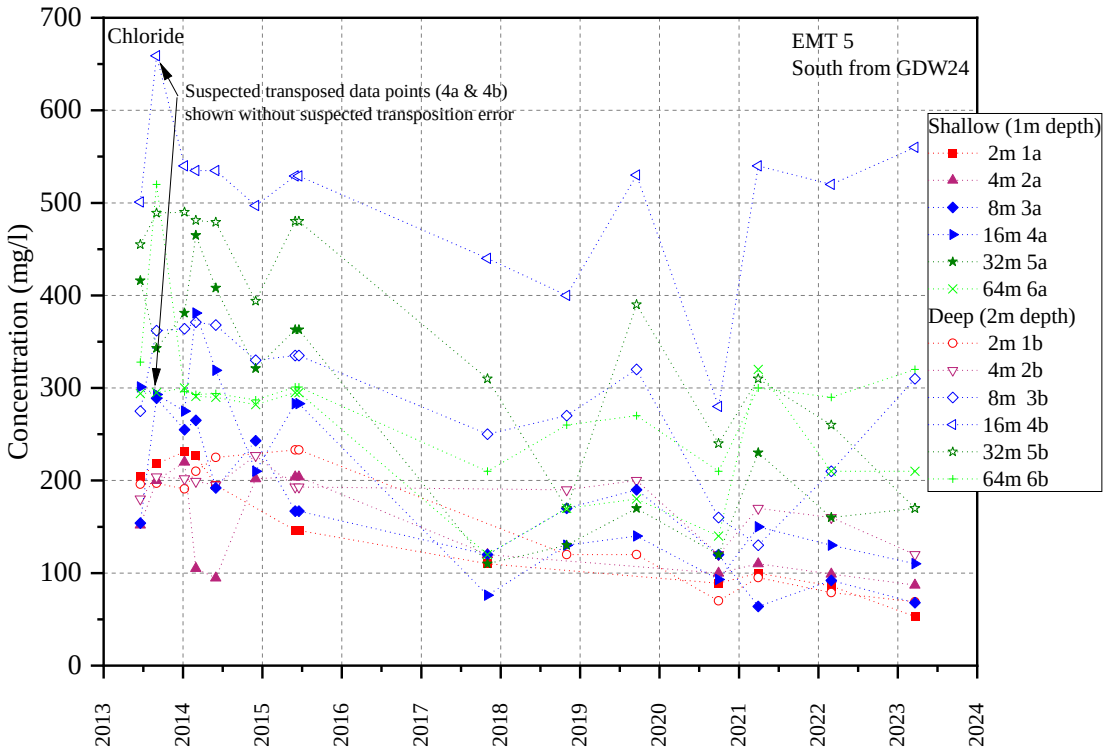
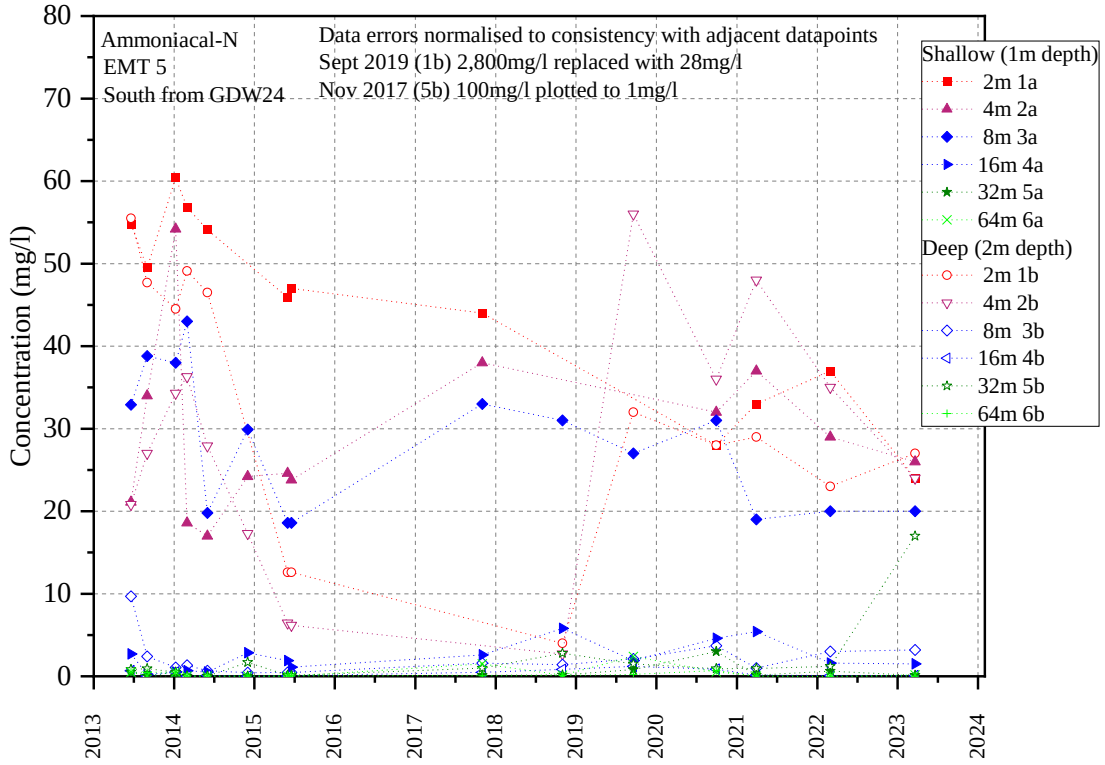


Figure 17 Transect EMT5 Ammoniacal-N



4.5 Groundwater Summary

The quality of the groundwater system has generally remained consistent with previous years. The groundwater elevation within the perimeter monitoring points follows a seasonal infiltration / evapotranspiration pattern, particularly in the east of the Site.

There are a number of influences on the groundwater quality, which include marine ingress, the legacy of seawater used as a power station coolant, the underlying PFA platform as well as the earliest phases of landfilling. What can be determined however, is that the Phase 1 landfill has depleted to the extent that the leachate strength is holistically lower than the concentrations observed for ammonium and chloride outside of the landfill. Consequently, there is no longer the potential for the Phase 1 landfill to affect off-site groundwater quality. The Phase 1 landfill leachate will continue to deplete in strength and chloride / ammoniacal nitrogen concentrations and therefore even if there are any future seepages, these would not be discernible on the existing background system.

Elevated ammoniacal nitrogen is not associated with chloride and can be attributed to high background levels from a number of sources including the underlying superficial peat deposits, the PFA platform and the mining history of the area.

Transects south of the Site in Crymlyn bog demonstrate that ammoniacal nitrogen typically decreases with distance from the Site. Any suspicion of a direct association with the landfill is countered by the chloride data, which demonstrates that chloride decreases with proximity to the Site within EMT5. It is also possible that the ammoniacal nitrogen could be a consequence of the organic rich natural host sediments, the disturbed ground, historical activities and the presence of the PFA. The PFA could also contribute to heavy metals, calcium, potassium, chloride, sodium and sulphates around the margins of the platform.

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 11. Temperature ranges, where available, were consistent with expectations for the site's location. However, incomplete temperature data was evident for half of the months, whilst no temperature data at all was collected in the summer months of June, July and August. Rainfall data was also suspect, in particular as no rain was recorded after 1 November 2023 (and only 1 mm was recorded in May 2023). Therefore, no comment is made comparing the 2023 rainfall data to previous years.

Table 11 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.

6 Summary

Tir John Phase 1 is a capped and actively managed landfill, which ceased to accept wastes over 20 years ago. The leachate composition is consistent with the site's age and is significantly depleted compared to that of a younger non-hazardous landfill. The leachate has depleted to the extent that it no longer contains environmentally significant components given this particular site setting. The leachate is managed passively under gravity.

Recommendations to amend the leachate monitoring programme were set out within the 2021 HRAR. However, given that the leachate strength has depleted to such an extent that chloride is largely below quality standards, and ammoniacal-N outside of the Site is frequently greater than within the Site, it is considered that leachate should continue to be passively managed following the current mechanism. Additional active leachate management is therefore no longer a priority, however, given the inter-linked co-managed Phase 2 site then there is security of management in the short and intermediate term to follow the continued stabilisation of the Site.

The monitoring programme at the Tir John Phase 1 Landfill site has demonstrated that landfill gas is being actively managed and that there is no evidence of uncontrolled sub-surface landfill gas migration or emissions to land. There are seasonal fluctuations in ground gas chemistry consistent with a healthy in-situ microbial respiration, as well as a mine gas / marsh gas signature.

Groundwater within the area is generally of poor quality with respect to ammoniacal nitrogen. However, there are no increasing trends and concentrations in 2023 were reported below Permit limits. The stable nature of the background chemistry is suggestive that a steady-state system has developed, which is not at risk from, or being influenced by the Phase 1 landfill.

Appendix A – Perimeter Gas Monitoring Data

Tir John Phase 1 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		
TIRGP001	0.0	0.0	0.1	0.1	0.2	0.8	17.3	20.2	21.3	78.5	79.6	81.9	0.0	0.0	0.0	0.0	1.0	2.0	997	1,016	1,031	-0.2	0.5	5.4	0.0	0.0	0.5
TIRGP002	0.0	0.0	0.1	0.1	0.2	0.7	19.9	20.8	22.0	77.8	79.0	79.7	0.0	0.0	0.0	0.0	0.8	2.0	998	1,017	1,032	-0.1	0.1	0.4	0.0	0.1	1.0
TIRGP003	0.0	0.0	0.1	1.2	5.2	9.1	8.2	12.3	18.1	79.5	82.5	87.6	0.0	0.0	0.0	0.0	0.9	2.0	998	1,016	1,032	-0.3	0.1	0.5	0.0	0.0	0.0
TIRGP004	0.0	0.0	0.1	0.1	1.1	2.4	16.2	19.5	20.9	78.4	79.5	81.4	0.0	0.1	1.0	0.0	0.8	2.0	998	1,016	1,032	-0.8	0.0	0.6	0.0	0.0	0.2
TIRGP005	0.0	0.0	0.1	0.0	1.5	7.7	9.7	18.9	21.6	78.3	79.6	82.6	0.0	0.0	0.0	0.0	0.8	2.0	999	1,016	1,032	-1.2	0.0	0.4	0.0	0.1	1.0
TIRGP006	0.0	0.0	0.1	0.2	0.9	3.1	18.2	20.1	21.2	78.6	79.0	79.5	0.0	0.1	1.0	0.0	0.5	2.0	998	1,016	1,032	-0.3	0.0	0.3	0.0	0.0	0.2
TIRGP007	0.0	0.0	0.1	0.1	0.4	0.8	19.8	20.5	20.9	78.4	79.1	79.7	0.0	0.0	0.0	0.0	0.4	2.0	998	1,016	1,032	-0.3	0.0	0.3	0.0	0.0	0.2
TIRGP008	0.0	0.6	6.9	0.1	2.9	9.9	11.8	18.0	21.1	71.4	78.5	79.8	0.0	0.0	0.0	0.0	0.4	2.0	998	1,016	1,032	-0.3	0.0	0.4	0.0	0.1	0.7

Appendix B – Water Monitoring Data

Figure B. 1 – Leachate Chloride

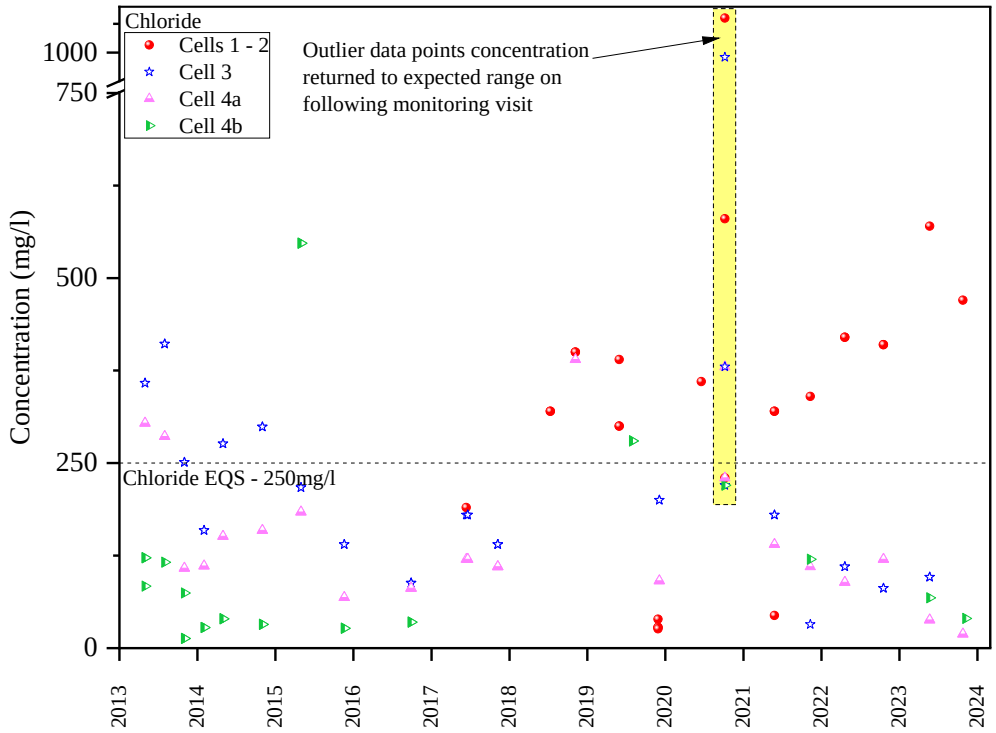


Figure B. 2 – Leachate Ammoniacal-N

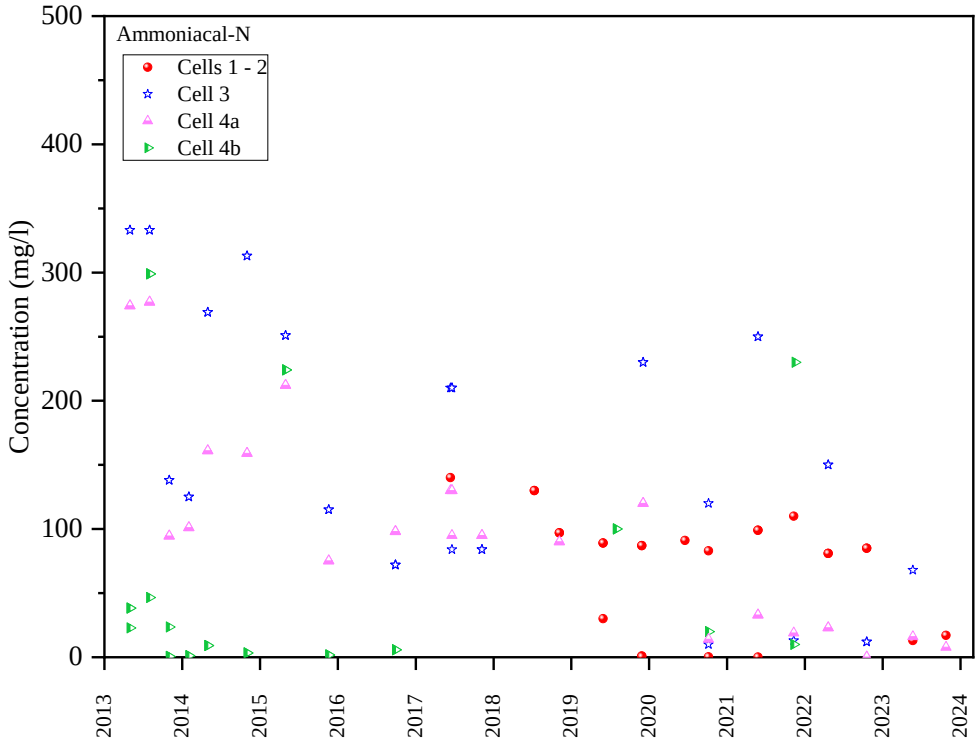


Figure B. 3 – Groundwater Monitoring Point GDW01D

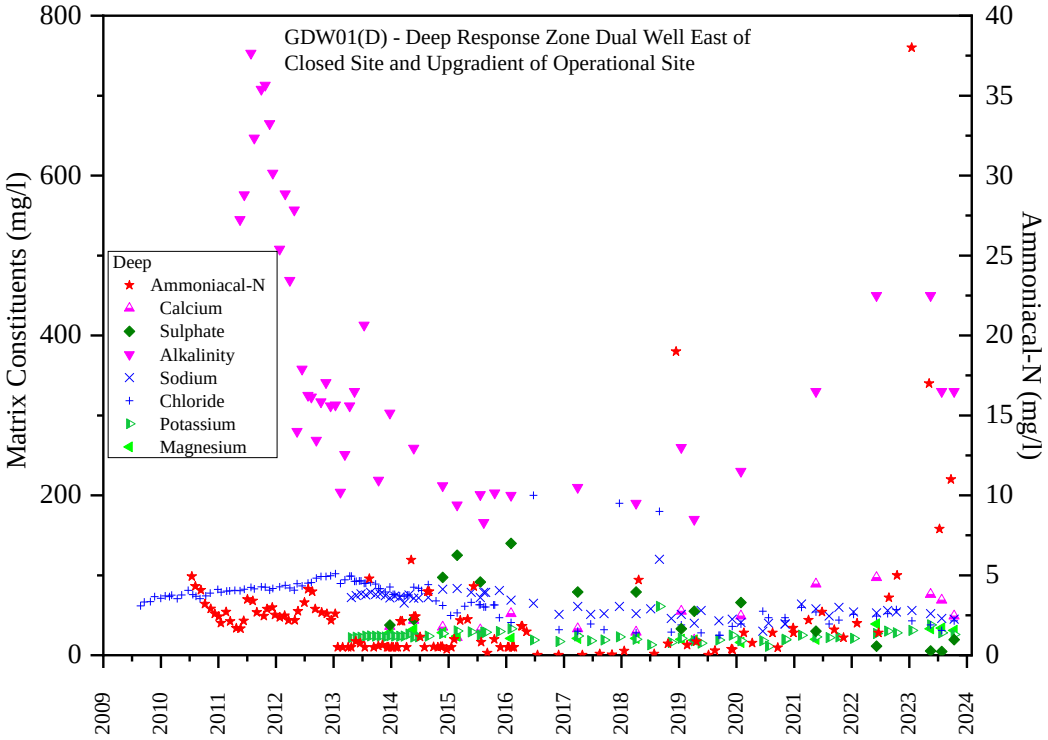


Figure B. 4 – Groundwater Monitoring Point GDW01S

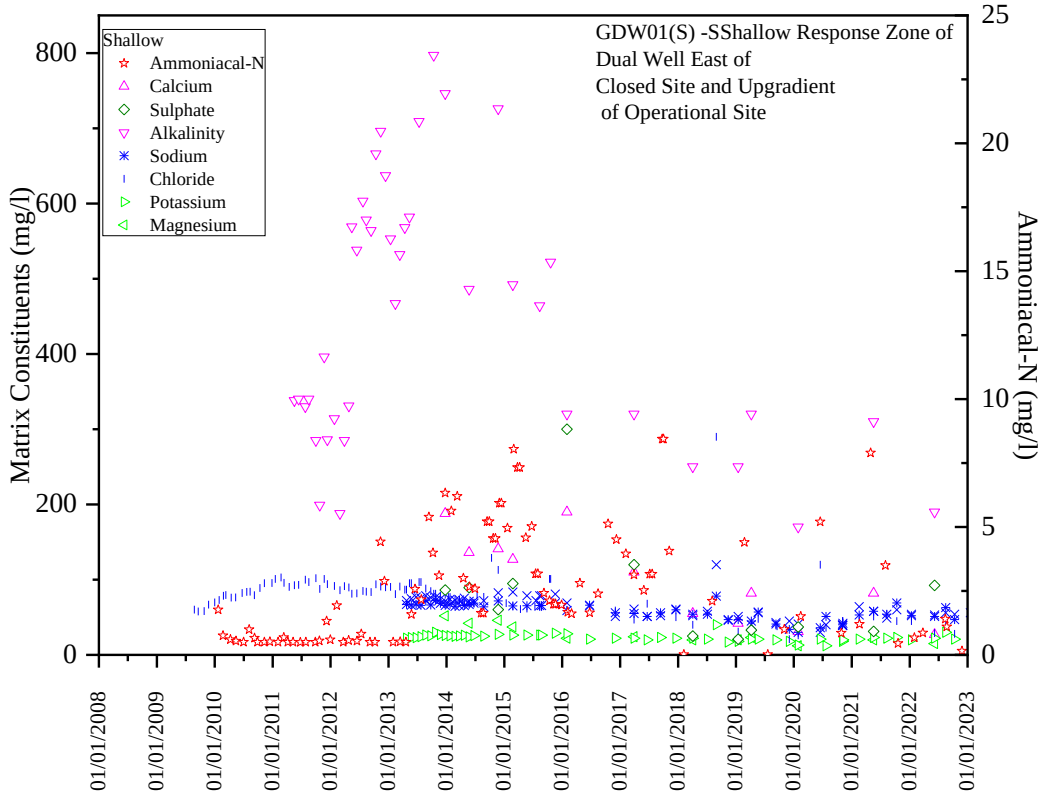


Figure B. 5 – Groundwater Monitoring Point GDW02D

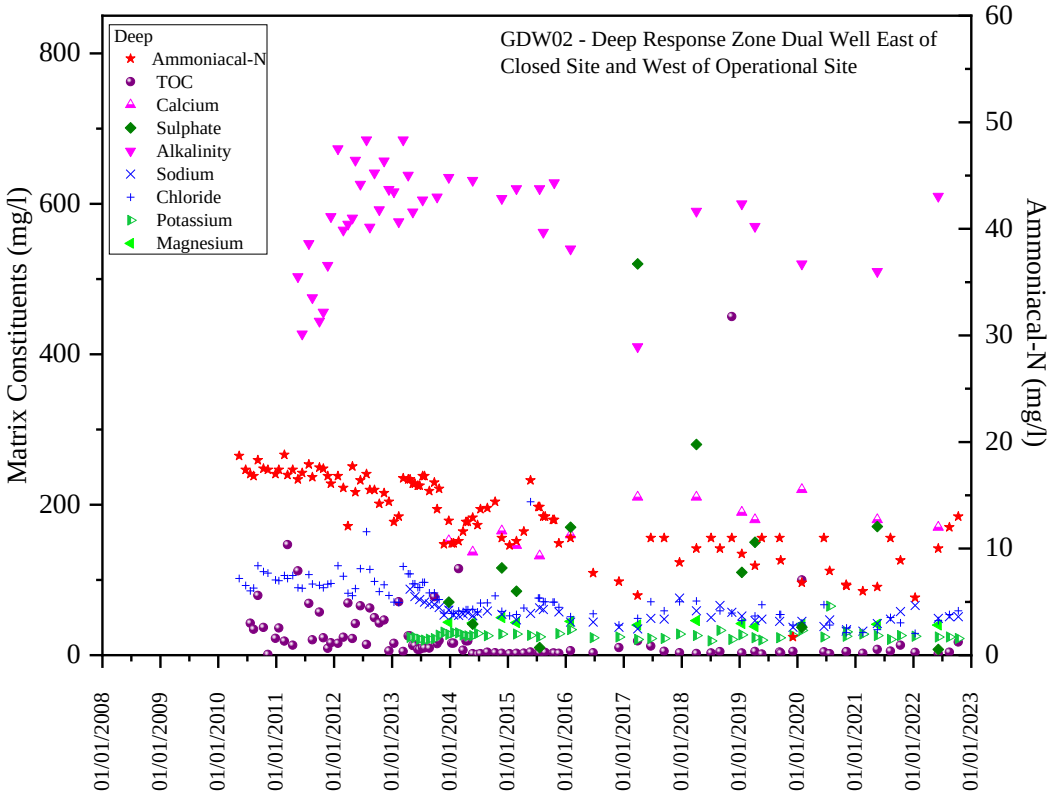


Figure B. 6 – Groundwater Monitoring Point GDW02S

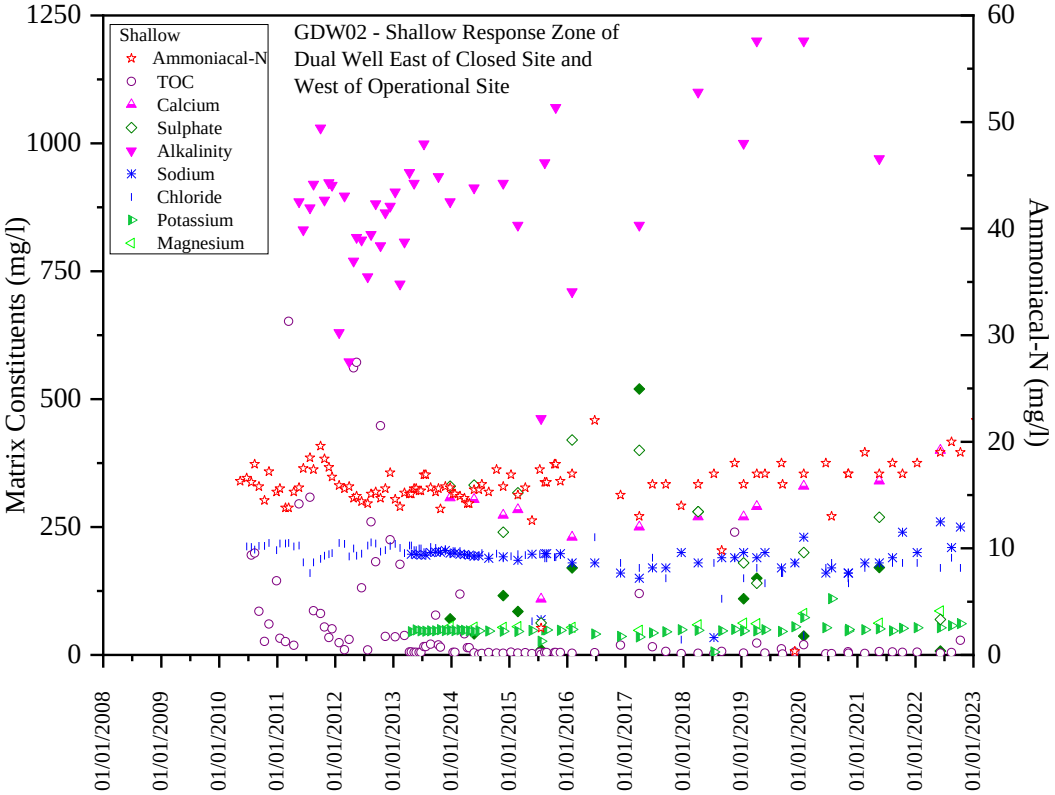


Figure B. 7 – Groundwater Monitoring Point GDW03

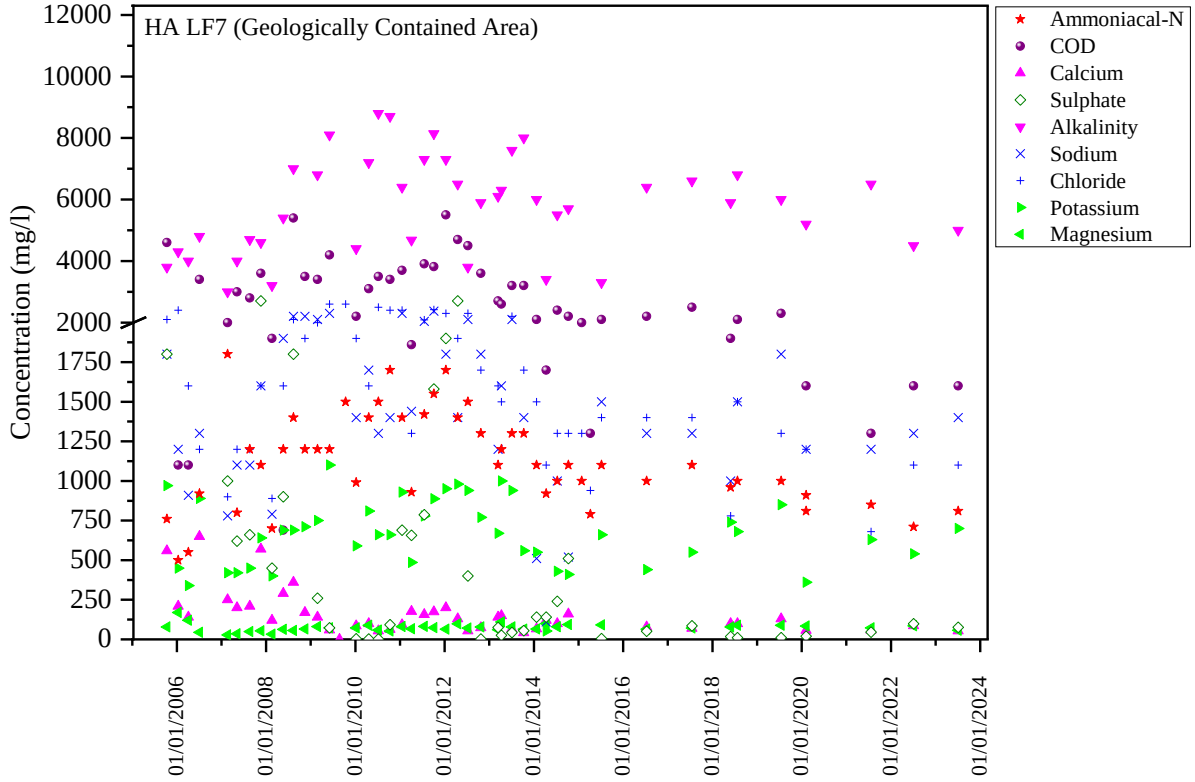


Figure B. 8 – Groundwater Monitoring Point GDW21

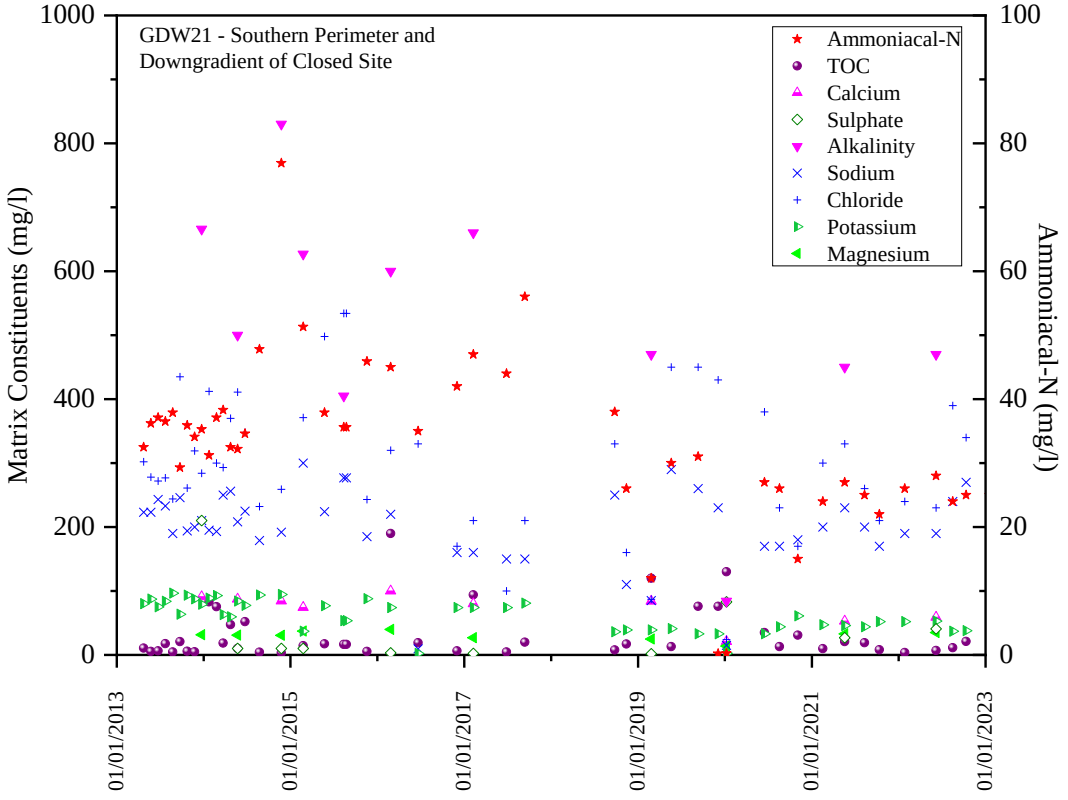


Figure B. 9 – Groundwater Monitoring Point GDW23

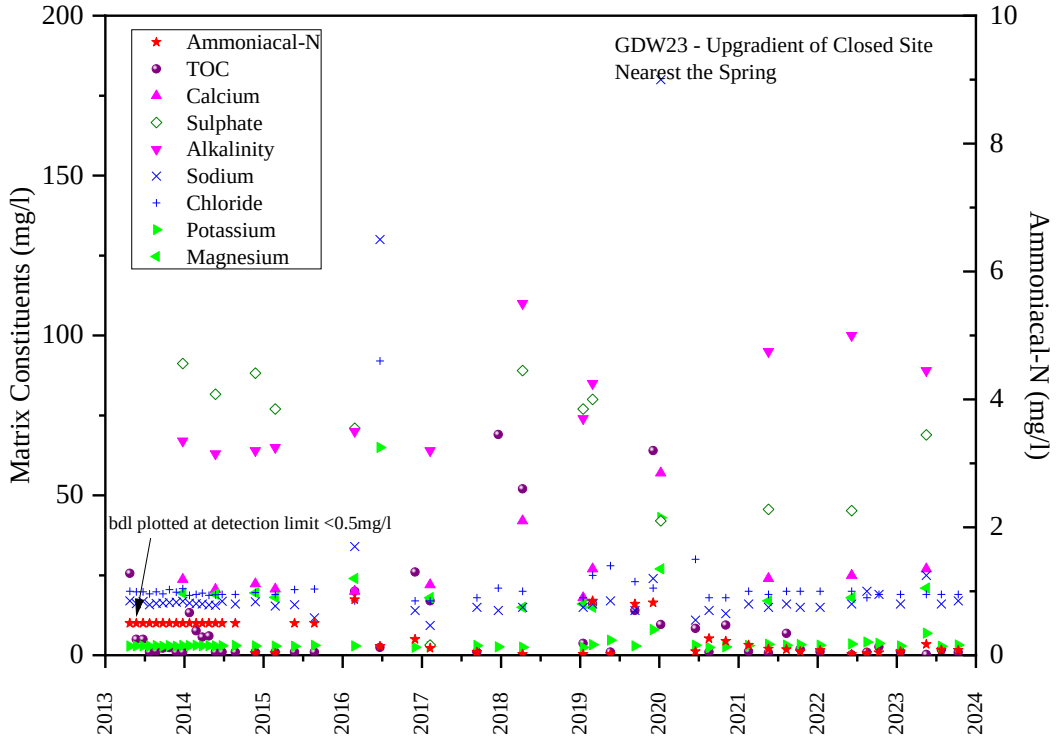


Figure B.10 – Groundwater Monitoring Point GDW24

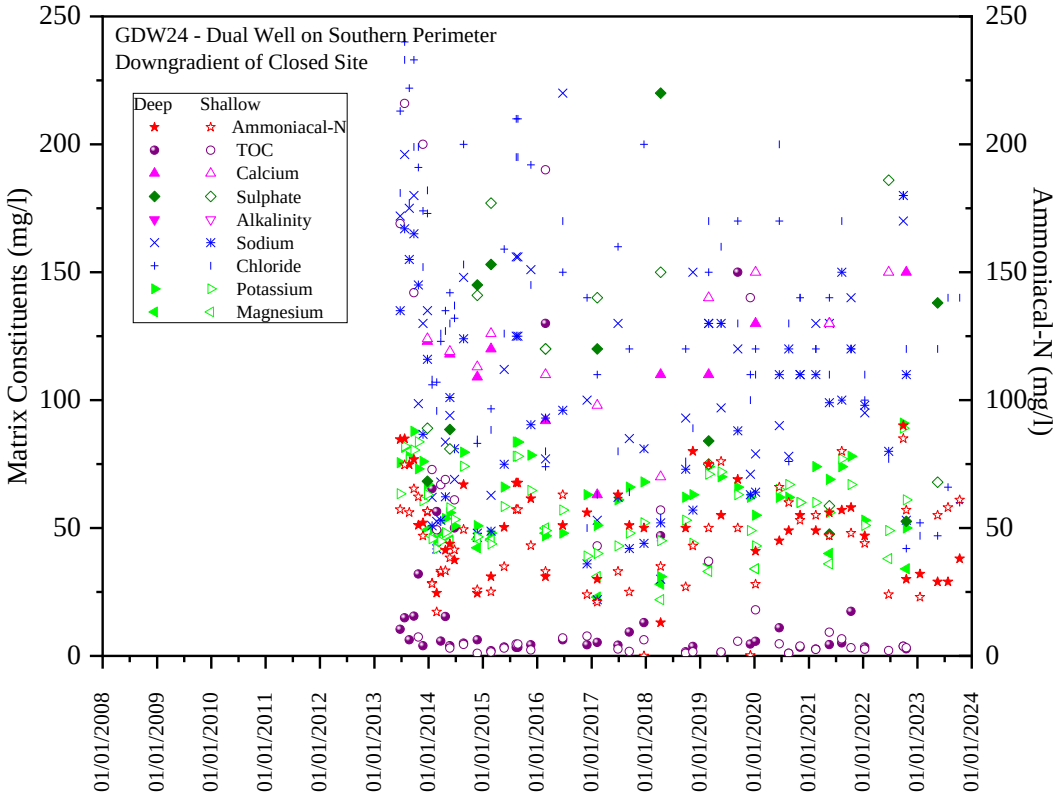


Figure B.11 – Groundwater Monitoring Point GDW25

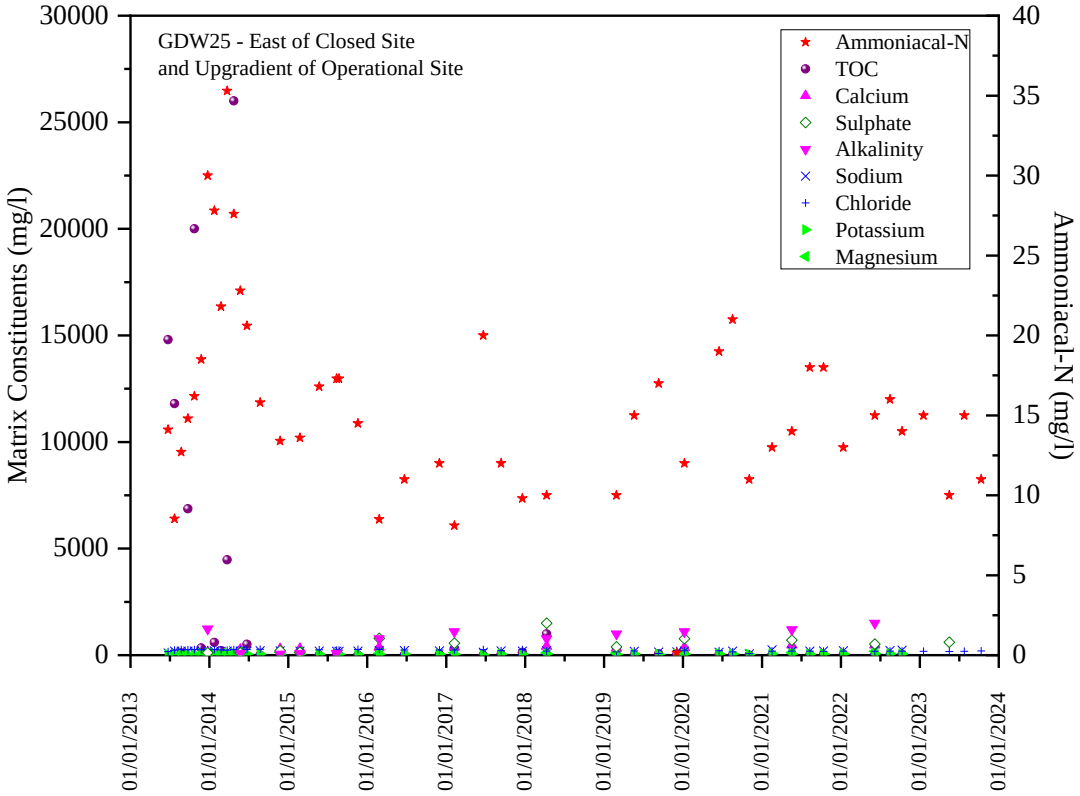
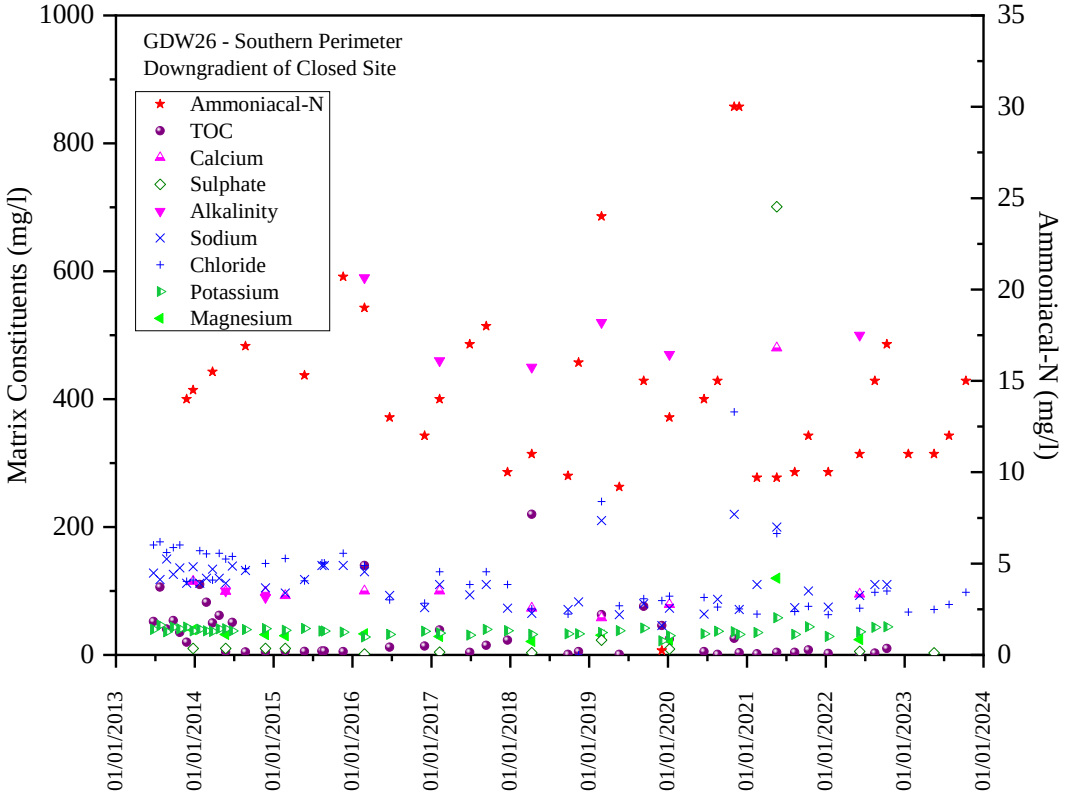


Figure B.12 – Groundwater Monitoring Point GDW26



Tir John Phase 1 Landfill Site
Leachate 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
			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	mg/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
HWM07	23/05/2023	7	2200	68.0	320	250	22	150	35	66	35	96	30	1200	0.4	0.2	0.02	< 0.005	0.001	0.002	0.005	0.004	< 0.0002	0.170
HWM08A	23/05/2023	7	1600	16.0	120	25	19	170	36	120	15	38	72	970	2.4	1.7	0.03	< 0.005	0.002	< 0.0005	0.003	0.002	0.000	0.010
	25/10/2023	6.8	1400	7.8	120	7	14	220	38	76	16	19	100	780	0.3	0.9	< 0.02	0.01	0.001	0.002	0.006	0.012	0.001	0.004
HWM11	25/10/2023	7	1300	5.1	400	35	36	230	23	54	20	44	221	540	2.6	0.4	< 0.02	< 0.005	0.000	0.002	0.006	0.007	< 0.0002	0.003
HWM12	23/05/2023	7.4	1400	9.1	290	67	24	220	24	54	20	40	112	780	0.6	0.2	0.09	0.05	0.001	0.002	0.005	0.008	0.003	0.015
	25/10/2023	7.5	1500	0.2	80	5	17	320	35	43	17	22	299	660	0.0	0.1	< 0.02	< 0.005	0.000	0.005	0.004	0.025	< 0.0002	0.008
HWM13	23/05/2023	7.5	3800	13.0	370	21	31	470	130	510	120	570	1170	760	0.0	1.7	0.04	< 0.005	0.001	0.003	0.026	0.047	0.004	0.013
	25/10/2023	7.1	3900	17.0	110	6	47	360	130	390	160	470	863	1000	0.1	2.0	0.90	0.01	0.001	0.011	0.029	4.651	0.002	0.135

Tir John Phase 1 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	38.00	1300	110	46			56	31	43			0.01	410	< 0.02	< 0.005	< 0.0002	0.001		0.007	< 0.0002	12.30	< 0.02
	16/05/2023	7.9	810	17.00	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	7.90	15000	130	1	69	34	46	28	31	5	330	0.01	220	< 0.02	< 0.005	< 0.0002	0.005	< 0.0005	0.002	< 0.0002	7.36	< 0.02
	12/10/2023	8.1	690	11.00	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	0.41	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	0.67	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	0.26	2600	8	1	17	18	44	18	21	124	150	0.01	26	0.03	< 0.005	< 0.0002	0.001	< 0.0005	0.001	< 0.0002	55.00	< 0.02
	12/10/2023	8.7	410	5.70	1000	14	2	19	20	35	19	22	63	160	0.31	21	0.02	0.0059	< 0.0002	< 0.0005	< 0.0005	0.002	< 0.0002	51.80	< 0.02
GDW02(D)	18/01/2023	7.2	1000	4.90	12	4	3			34	24	28			0.01	2900	0.03	< 0.005	< 0.0002	0.001		0.004	< 0.0002	1.61	< 0.02
	16/05/2023	6.7	1100	5.00	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	9.70	30	4	5	150	41	46	20	45	21	590	0.09	4200	0.03	< 0.005	< 0.0002	0.003	0.0014	0.008	< 0.0002	3.22	< 0.02
	12/10/2023	6.6	1100	4.70	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	22.00	180	8	4			210	47	180			0.19	1500	< 0.02	< 0.005	< 0.0002	0.001		0.001	< 0.0002	1.12	< 0.02
	16/05/2023	6.9	2600	21.00	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	21.00	65	14	10	310	88	190	63	170	105	1300	0.20	960	< 0.02	< 0.005	0.0002	0.002	0.0007	0.003	< 0.0002	1.93	< 0.02
	12/10/2023	6.9	2500	21.00	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	11.00	35	1	4			19	4	25			0.05	810	< 0.02	< 0.005	< 0.0002	0.001		0.005	< 0.0002	0.47	< 0.02
	16/05/2023	6.5	540	11.00	140	20	6	40	24	27	7	24	2	240	0.03	810	< 0.02	< 0.005	< 0.0002	0.001	0.0006	0.006	< 0.0002	0.50	< 0.02
	26/07/2023	6.5	460	10.00	120	2	8	44	16	15	3	25	1	230	0.07	660	0.03	< 0.005	< 0.0002	0.003	0.0012	0.002	< 0.0002	0.51	< 0.02
	12/10/2023	6.3	550	11.00	100	28	5	39	21	19	4	26	1	250	0.15	740	< 0.02	< 0.005	< 0.0002	0.003	0.001	0.010	< 0.0002	1.04	< 0.02
GDW03(S)	18/01/2023	8.0	740	18.00	13	3	3			18	17	25			0.04	1700	< 0.02	< 0.005	< 0.0002	0.001		0.003	< 0.0002	3.72	< 0.02
	16/05/2023	7.3	780	17.00	18	10	4	110	21	25	18	27	2	430	0.22	1400	< 0.02	< 0.005	0.0003	0.001	0.0009	0.006	< 0.0002	2.88	< 0.02
	26/07/2023	7.5	720	17.00	74	7	4	130	18	18	16	27	3	440	0.09	1600	< 0.02	< 0.005	< 0.0002	0.003	0.001	0.002	< 0.0002	1.13	< 0.02
	12/10/2023	7.4	800	16.00	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
GDW21	18/01/2023	6.6	1500	25.00	76	5	16			190	40	310			0.05	360		< 0.005						1.65	
	17/05/2023	6.5	1400	23.00	47	1	12	60	39	210	45	370	19	360	0.67	360	0.03	< 0.005				0.004		3.82	< 0.02
	26/07/2023	6.4	1700	23.00	63	2	18			220	33	390			5.30	420		< 0.005						2.48	
	12/10/2023	6.6	1700	24.00	190	16	13			260	40	390			4.70	360		< 0.005						1.20	
GDW23	18/01/2023	6.8	350	0.06	51	< 1	1			16	3	19			0.01	4300		< 0.005						< 0.15	
	17/05/2023	6.7	300	0.17	6	< 1	0	27	21	25	7	19	69	89	0.04	4600	0.03	< 0.005				0.006		0.39	< 0.02
	26/07/2023	6.6	330	0.09	62	< 1	2			16	3	19			0.03	6100		< 0.005						0.35	
	12/10/2023	6.8	320	0.08	7	1	1			17	3	19			0.11	4200		< 0.005						0.46	
GDW24(D)	18/01/2023	7.6	1100	32.00	120	2	3			54	55	52			0.01	370		< 0.005						4.86	
	17/05/2023	7.8	960	29.00	26	5	4	100	29	51	50	47	138	450	0.07	250	0.02	< 0.005				0.002		11.50	< 0.02
	26/07/2023	7.5	1100	29.00	55	3	2			61	50	66			0.01	240		< 0.005						9.79	
	12/10/2023	7.8	1100	38.00	260	11	4			67	59	60			0.01	230		< 0.005						18.60	
GDW24(S)	18/01/2023	7.0	1300	23.00	42	1	2			50	36	47			1.00	730		< 0.005						7.74	
	17/05/2023	6.8	1400	55.00	51	2	3	130	42	120	59	120	68	750	0.03	490	0.02	< 0.005				0.010		4.09	< 0.02
	26/07/2023	6.8	1800	58.00	50	4	3			120	63	140			0.08	620		< 0.005						4.03	
	12/10/2023	7.0	1700	61.00	58	5	3			130	71	140			0.01	530		< 0.005						2.44	
GDW25	18/01/2023	7.3	2300	15.00	3400	9	3			200	50	180			0.02	400		< 0.005						8.71	
	17/05/2023	6.9	2000	10.00	100	33	4	360	130	200	58	170	603	1100	0.05	450	< 0.02	< 0.005				0.007		4.57	< 0.02
	26/07/2023	7.1	2800	15.00	5500	4	4			200	47	180			0.02	560		< 0.005						2.38	
	12/10/2023	7.1	3100	11.00	40	2	3			260	70	200			0.02	240		< 0.005						3.99	
GDW26	18/01/2023	7.2	830	11.00	54	4	3			66	31	67			0.03	630		< 0.005						0.91	
	17/05/2023	6.8	880	11.00	120	11	3	76	26	79	33	71	3	440	0.51	540	< 0.02	< 0.005				0.004		2.91	< 0.02
	26/07/2023	6.9	960	12.00	450	12	4			85	35	79			0.02	630		< 0.005						8.62	
	12/10/2023	6.7	1000	15.00	660	64	9			95	33	98			5.30	570		< 0.005						8.68	
TIR JB1	18/01/2023	7.6	330	0.21	13	1	5			11	3	18			0.01	140		< 0.005						1.05	
	17/05/2023	7.5	340	0.55	5	2	1	34	24	26	9	19	13	190	0.25	250	< 0.02	< 0.005				0.001		2.58	< 0.02
	26/07/2023	7.5	320	0.09	22	2	1			12	3	18			0.01	71		< 0.005						0.47	
	12/10/2023	7.5	390	5.10	32	29	4			14	5	19			0.37	160		< 0.005						1.13	

Appendix C - Drawings

N

Cwmbach

Pen-y-graig Isaf

nant

DINAM ROAD

TIR JOHN NORTH ROAD

TERRACE

RUSTON ROAD

MARCROFT ROAD

A4230

Canal

EMT7

EMT2N

EMT6

EMT1N

EMT5

GDW4 SW2 GDW5 GDW6 GDW7 GDW8 GDW9 SW3 GDW10 GDW11 PCS (North) GDW12 GDW13 PCS (MID) GDW14 (R) PCS (South) GDW15(R) GDW16 GDW17 SW4 GDW18 GDW21 GDW23 GDW24 GDW25 GDW26

LFG15 LFG16 LFG17 LFG18 LFG19 LFG20 LFG14 LFG13 LFG24 LFG8 LFG7 LFG6 LFG5 LFG4 LFG3 LFG2 LFG1 LFG21 LFG22 LFG23

Cell 14 Cell 13 Cell 15 Cell 15E Cell 12 Cell 16 (Operational) Cell 11 Cell 9 Cell 10 Cell 8 Cell 4a Cell 3 Cell 7 Cell 4b Cell 5 Cell 6 Cell 2 Cell 1b Cell 1a

LEW32 LEW31 LEW29 LEW30 LEW14 LEW28 LEW14A LEW13A LEW27 LEW15 LEW12A LEW33 LEW13 LEW11A LEW11(PPC4) LEW26 LEW16 LEW09B BH16A/PCS BH16B/PCS LEW34 LEW24 LEW9A LEW10 LEW10A LEW8 LEW25 LEW23 LEW5 (PPC2) LEW22 LEW7 LEW5A LEW6 LEW20 LEW21

JB1 JB5 (JB3) SW1 SW5 IPDS BHSW HWM8R HWM7 HWM5R HWM4R HWM9A HWM6A HWM11 HWM10 HWM12 HWM13 GDW3 (S) GDW3 (D) GDW2 (S) GDW2 (D) GDW1 (S) GDW1 (D)

Site Car Park

Weighbridge

Wheelwash

Walkway

Walkway

Crymlyn Bog

Sewer Discharge Sample Point

AFFORD AMAZON

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

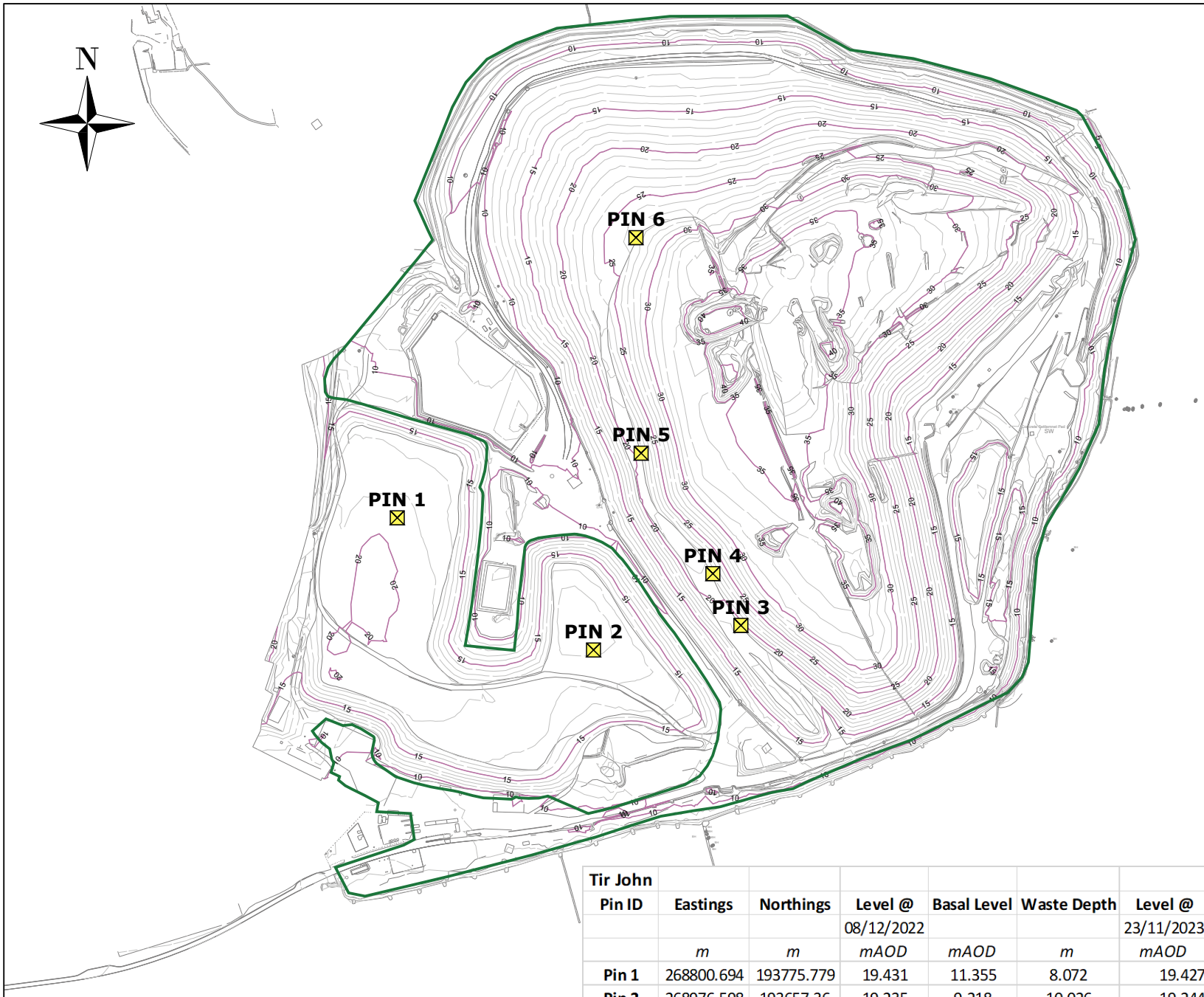
Revision:	Details:

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

Drawing number **TJ87**

N

KOP
W1211
Z1803
P1212
TIRP12A3
LEW32
P12A2
W12A1
Z1802
LEW31
W1404
W265A
W266A
W264B
Z1801
LEW14
W1403
W1210
LEW30
W2606
W2607
W1402
W1805
W1806
W2604
W2605
LEW29
LEW14
W1804
L
W264A
LEW13A
K0003
LEW28
W1803
I
W1401
W3A05
LEW27
W1802
K
W2603
W3A04
LEW15A
G
W263A
W2608
LEW15
W1801
LEW33
J
LEW13
LEW11A
LEW12A
F
LEW11 (PPC4)
W3A06
W2609
TIRW0010
C
LEW16
H
LEW26
W2602
W3A03
TIRPIN10
LEW09B
HZ4
W262A
TIRPIN11
A
TIRPIN12
J
HZ3
W3A01
TIRPIN14
W2610
D
HZ2
W3A02
TIRPIN15
LEW34
LEW10
W2601
W261A
B
LEW24
TIRPIN16
W3B05
W3B04
WB06
TIRPIN17
W3B03
LEW9A
LEW10A
WC002
W3B08
W3B01
W3B07
W3B02
W3C08
LEW25
W3C01
LEW8
W2516
W2711
W3C07
W2515
W3C03
W3C06
LEW5(PPC2)
assumed location of condensate sump
W3C04
W3C05
W2709
LEW22
W2710
W2712
K0002
W2511
W2705
W2509
LEW7
W2512
W2713
LEW5A
W2706
W1304
HWM4
W2510
W1303
W1306
LEW6
W2714
LEW20
W2707
LEW21
W12A6
HWM6A
W2708
W1302
W1305
W1307
HWM11
W1202
HWM10
W1101
W1201
W1301
HWM12
HWM13
W12A8
TIRK0001
HWM8
W12A7
W1206
W1105
HWM7
W1205
W1104
HWM5
W1204
W1103
W1203
HWM9A
W1102
ASSUMED POSITION AND PIPE DIMENSION

0 - 10 ppm
11 - 25 ppm
26 - 49 ppm
50 - 99 ppm
100 - 499 ppm
500 - 999 ppm
1000 + ppm

TIR JOHN
FID Survey Dated 28-9-23

1:2,500 @ A3

Enovert