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Tir John (Phase 1) Landfill

Annual Monitoring Review January-December 2022

Enovert South Limited

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Contents

1 Introduction

1.1 Background

This report has been prepared by Byrne Looby Partners (UK) Ltd (ByrneLooby) 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 2022.

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 issued in 1985 was converted to Waste Management Licence SWW14L 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 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 80mAOD to the west of the site to ~10mAOD 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 1and 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	167	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** 65,461m^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** 71,813m^3/yr (from entire site) -
Landfill gas: combustion in flares; combustion in gas engines; Other methods of gas utilisation	**Normalised cubic metres/year** 4,350,000m^3/yr (from entire site) Nil 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. TJ76 which illustrates settlement data collected for the site in 2022.

2 Monitoring Schedule

Enovert South Limited staff carried out environmental monitoring during 2022 at the locations shown on Drawing TJ74 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 2022

Location	Methane			Carbon dioxide		Oxygen		Balance	
	Ave	Max	Limit	Ave	Max	Ave	Max	Ave	Max
	%v/v								
TIRGP001	2.1	9.5	**20.7**	1.6	4.6	17.5	21.9	78.8	81.1
TIRGP002	0.0	0.0	**1.0**	2.1	5.7	18.6	22.0	79.4	82.0
TIRGP003	0.0	0.0	**1.0**	5.8	10.4	11.9	20.6	82.3	88.2
TIRGP004	0.0	0.0	**1.0**	1.0	4.7	19.8	21.9	79.2	82.4
TIRGP005	0.0	0.0	**1.0**	1.2	3.9	19.7	21.7	79.1	79.9
TIRGP006	0.0	0.0	**1.0**	1.1	3.7	19.8	21.6	79.1	84.0
TIRGP007	0.0	0.0	**1.0**	0.5	1.0	20.7	21.2	78.9	79.6
TIRGP008	0.1	0.5	**2.5**	5.7	11.0	15.5	21.5	78.7	79.6

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 (TIRGP001).

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.

During 2022 the permit limits for methane were not exceeded at any of the perimeter monitoring locations. Furthermore, the seasonal pattern of methane in TIRGP008 during autumnal and winter periods was not observed during 2022 (Figure 1).

Figure 1 – Ground Gas Profile TIRGP008

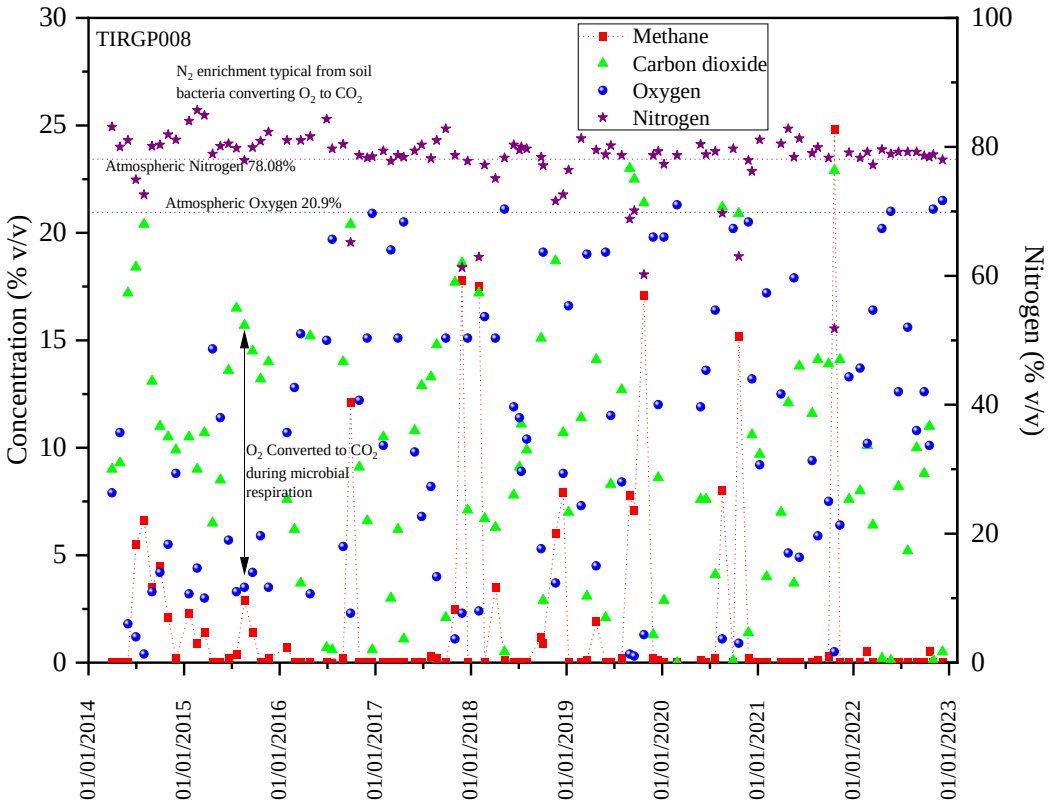
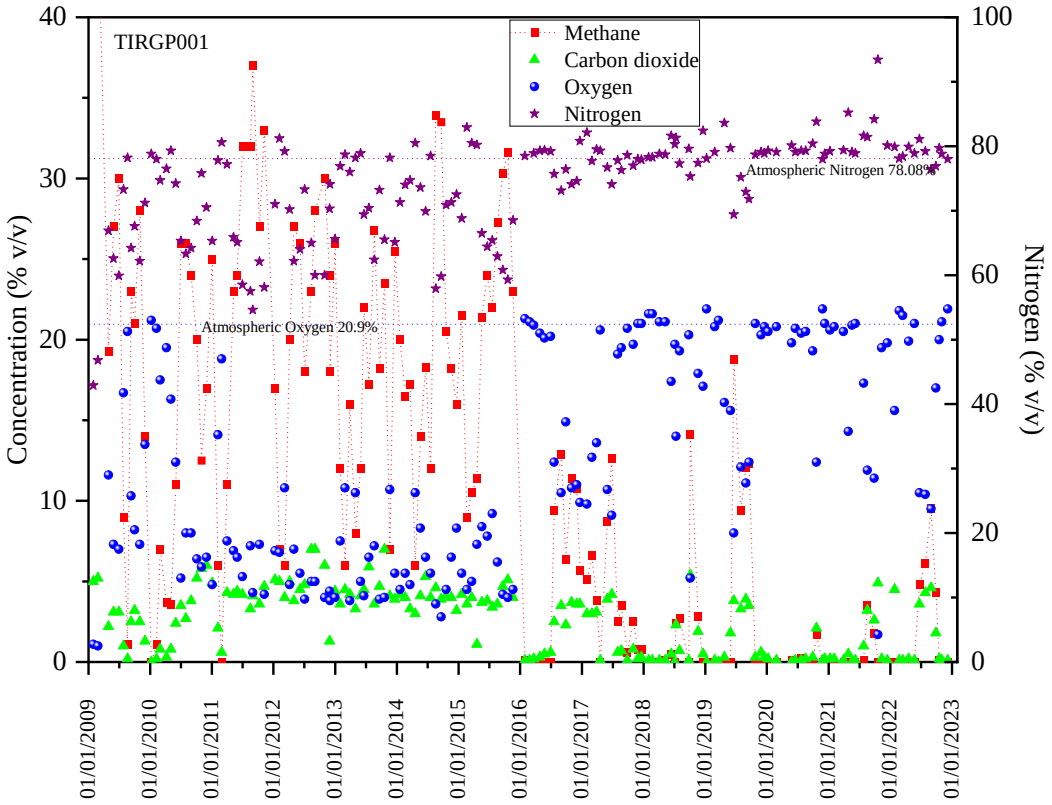


Figure 2 – Ground Gas Profile TIRGP001



Methane continued to be observed at TIRGP001 during 2022 with methane reaching a peak of 9.5%v/v during August which is consistent with the more recently established pattern since 2016. 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.

The relationship between ground gases in TIRGP003 can be describes 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:

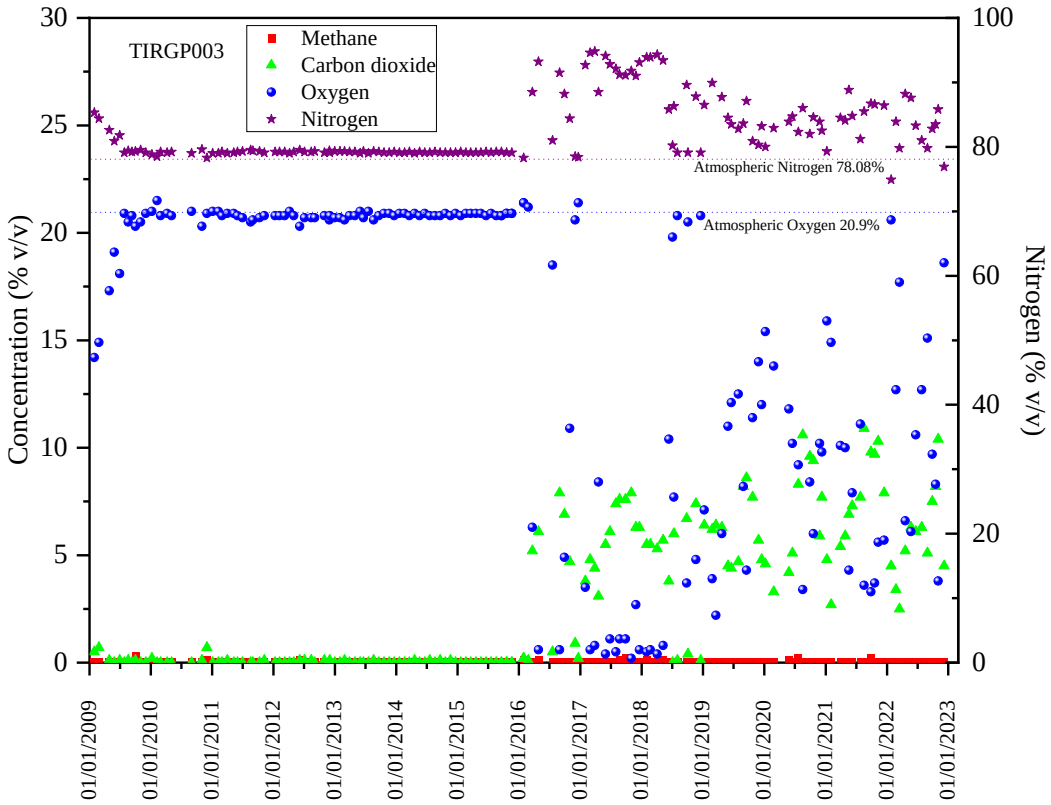
$$O_2 + C \rightarrow CO_2$$

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].

[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.

Figure 3 – Ground Gas Profile TIRGP003



Ground gas profiles for TIRPGP002, TIRPGP004, TIRPGP005, TIRPGP006 and TIRPGP007 demonstrate no influence from landfill sources. Methane was not present in these monitoring locations during 2022. Carbon dioxide was observed in the 0-10%v/v range at these monitoring points during 2022 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 continuous 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 December 2022. 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 generally good gas control at the site with low emissions (*i.e.* <10ppm) occurring across the majority of the Phase 1 area. Emissions in the range 100–499ppm were identified adjacent gas well W1304. 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.

3.4 Summary

The ground gas composition was monitored in eight perimeter wells during 2022. 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 TIRGP001) 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.

4.1.1 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 TJ74). 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. 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

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

seasonal variation in leachate elevation, however as the reported leachate is above groundwater elevations then groundwater ingress is not suspected as a contributing factor.

Leachate monitoring point HWM06A (Cell 4b) is reported to have become blocked during 2021 and has not been monitored during 2022. The City and County of Swansea in collaboration with Enovert are working to identify and implement a programme of remedial works.

Figure 4 – Leachate and Groundwater Level

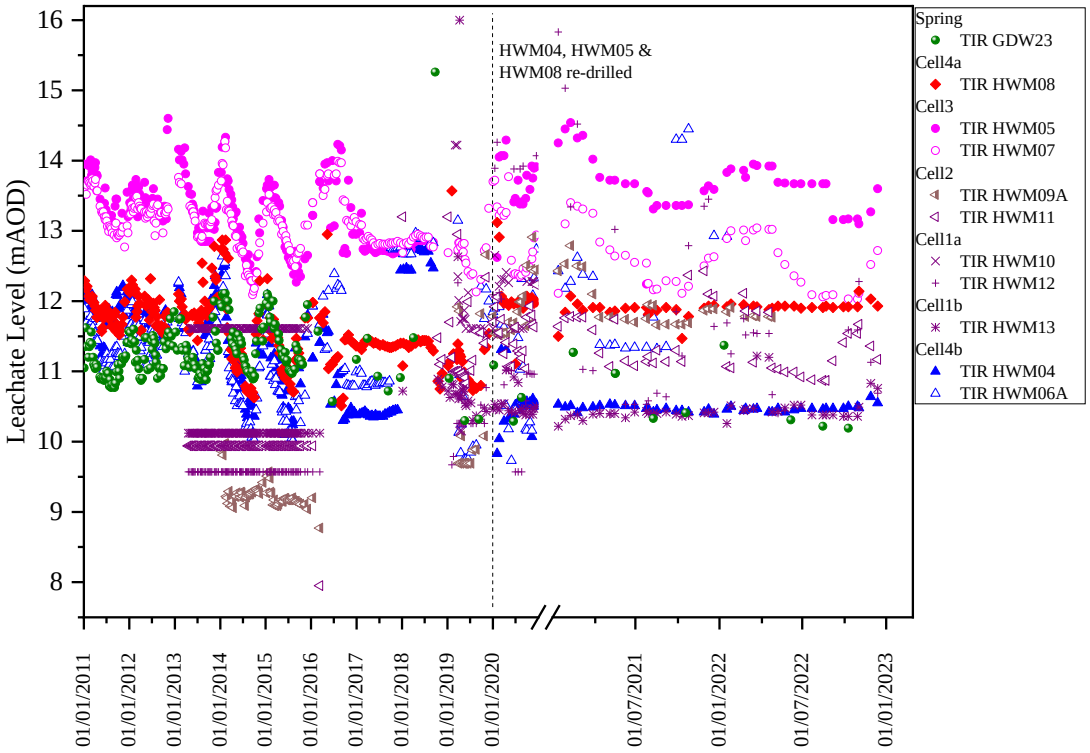
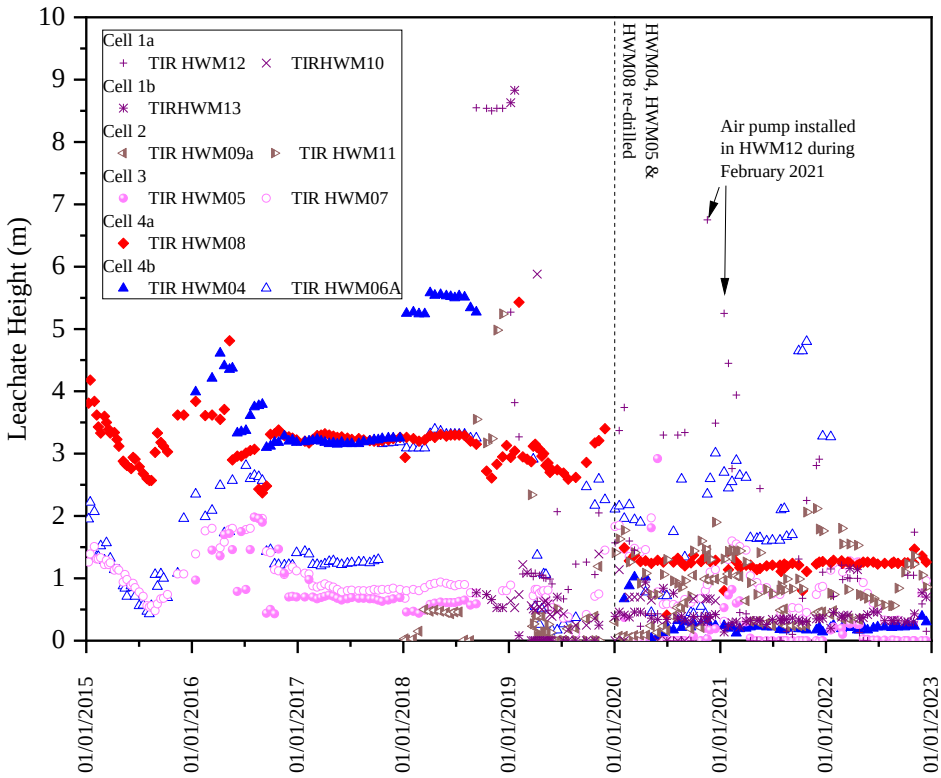


Figure 5 – Leachate Height Above Plumbed Base



The leachate elevation is consistent with the hydraulic response towards the passive leachate collection system which drains leachate from an elevation of 10 - 11mAOD into a central receiving lagoon, which is below the base of the landfill (with an invert height of ~9mAOD) 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 approximately 10% of that expected from methanogenic conditions within a municipal landfill, *i.e.* typical ammoniacal-N concentrations are <90mg/l compared to typical methanogenic leachates at >1,000mg/l ammoniacal-N. This depletion is not unexpected given the age of the waste.

Table 4 – Leachate Matrix Constituents 2022

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
HWM07	20/04/2022	6.9	2100	150.0	750	110	49	120	33	82	68	110	19	1200
	18/10/2022	6.9	1700	12.0	1900	8	22	150	35	360	23	81	109	980
HWM08A	20/04/2022	6.9	1500	23.0	13000	170	25	110	30	230	23	89	8	1100
	18/10/2022	7.2	1800	0.1	670	25	40	570	100	190	28	120	1130	560
HWM11	18/10/2022	7.3	1400	2.9	120	8	22	460	53	100	27	69	752	490
HWM12	20/04/2022	7.3	1200	0.4	670	5	24	270	29	59	17	52	327	690
	18/10/2022	7.1	2100	2.2	420	30	31	590	57	110	30	72	810	680
HWM13	20/04/2022	7.3	2400	81.0	670	19	30	190	110	220	120	420	197	1200
	18/10/2022	7.4	3200	85.0	430	28	37	210	140	260	170	410	112	1400

Figure 6- - Leachate Ammoniacal-N

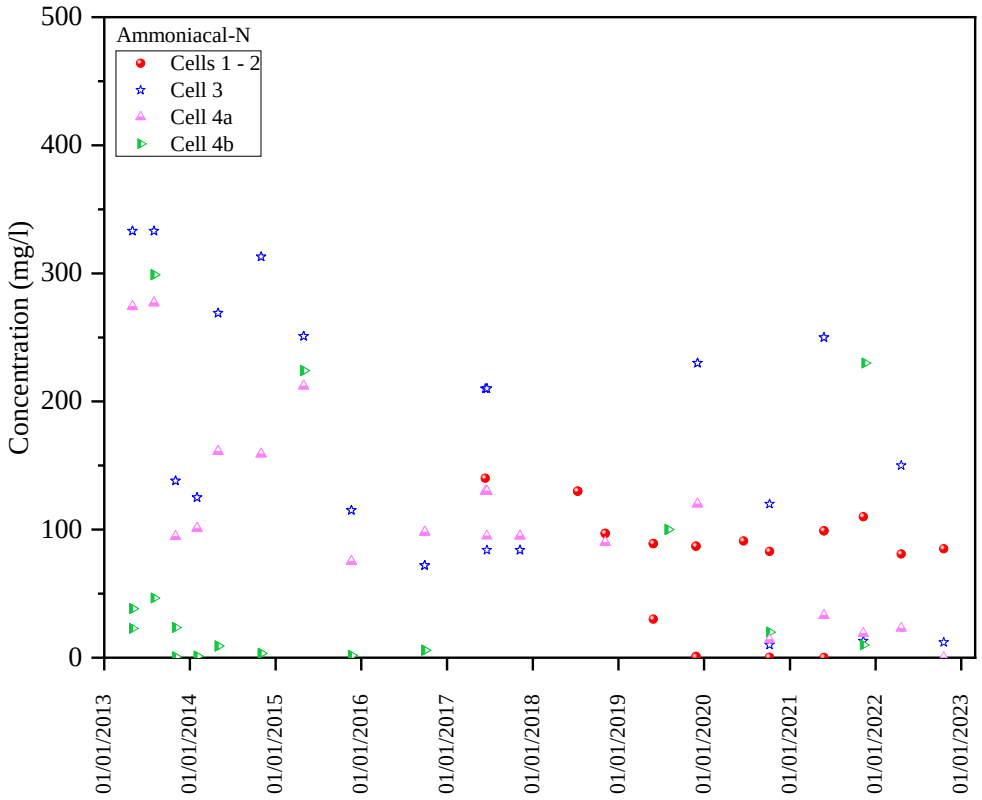
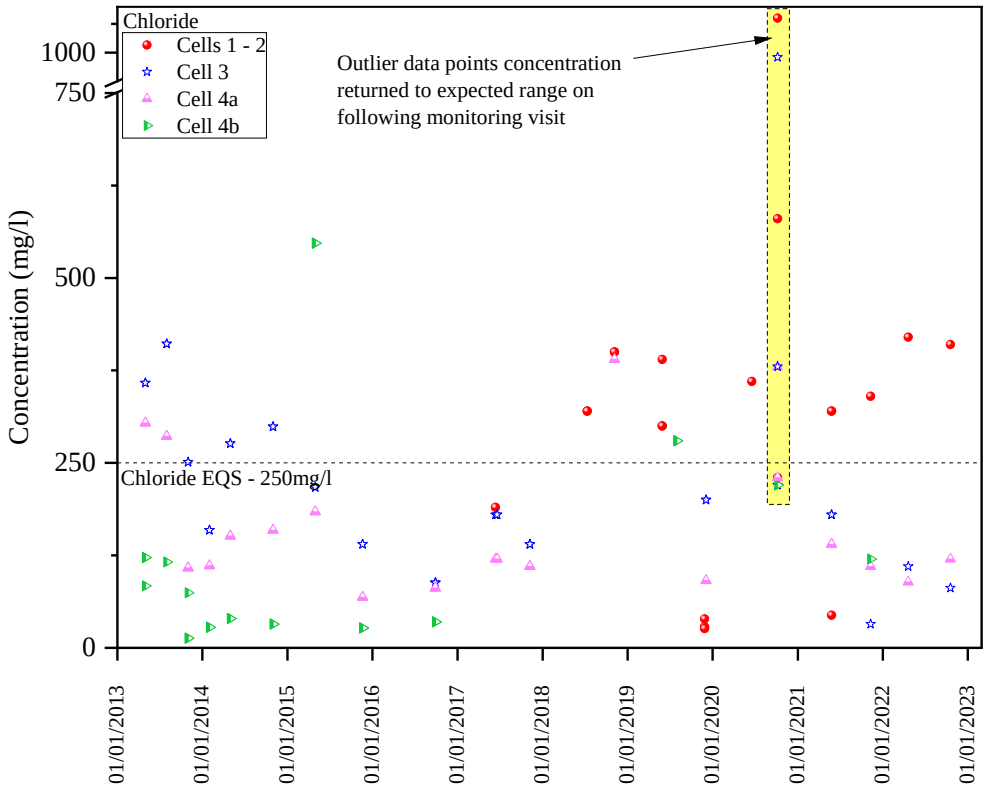


Figure 7 – Leachate Chloride

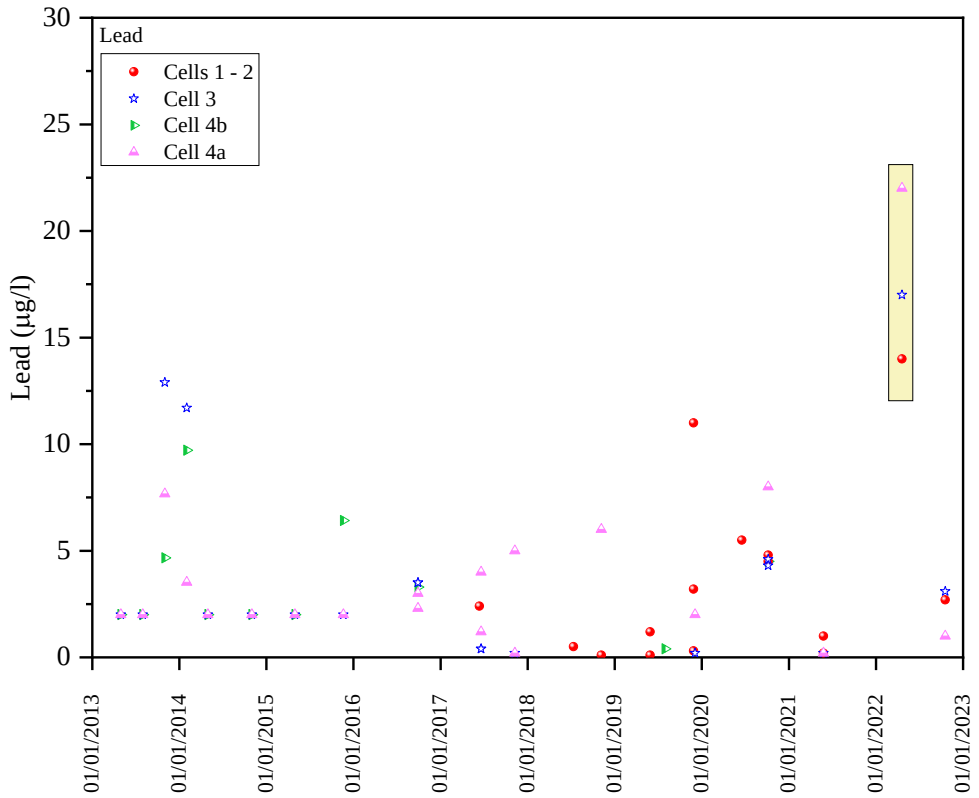


Leachate metals are also typical of a non-hazardous leachate (Table 5). Mercury is routinely below or approximating to the 0.1µg/l to <0.05µg/l detection limits and over an order of magnitude below the 1µg/l mercury Drinking Water Standard.

Cadmium is elevated in several locations compared to previous years with HWM08A being the highest with 10µg/l of cadmium reported in April 2022. This subsequently decreased to 0.02µg/l in October, *i.e.* the detection limit and consistent with historical data. Such a short term peak is consistent with a laboratory error and interference. Cadmium is otherwise below the 5µg/l DWS and consistent with the EQS for the site's setting (*i.e.* at a water hardness of 200mg/l).

There was also an anomaly in the lead data (Figure 8). Lead is reported artificially high for all of the locations in the April suite of data in the 0.014 – 0.022mg/l range before returning to the expected <0.01mg/l range in the following sampling visit. Such a pattern for the April sampling visit is consistent with a laboratory / reporting bias, presenting unrepresentative results, when in both cases (cadmium and lead) neither substance presents an actual risk to the environment.

Figure 8 – Leachate Lead



Chromium and copper were reported at environmentally negligible quantities across the monitoring locations with zinc at 0.002-0.08mg/l range for zinc.

Arsenic follows a historical pattern of a localised bias at Cell 1 (and at HWM13 in particular) and low concentrations elsewhere. Arsenic is however of no significance in this setting as firstly, arsenic within the leachate has depleted to at or below the 50µg/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 2022

Sample Point	Date	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
		mg/l	mg/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
HWM07	20/04/2022	0.8	0.5	0.74	< 0.005	0.006	0.002	0.030	0.034	0.017	0.004
	18/10/2022	0.1	0.6	0.03	< 0.05	0.002	0.004	0.014	0.009	0.003	0.004
HWM08A	20/04/2022	5.4	0.9	10.00	< 0.005	0.005	< 0.0007	0.040	0.084	0.022	<0.001
	18/10/2022	0.2	0.8	0.02	< 0.05	< 0.0002	0.017	0.008	0.002	0.001	0.004
HWM11	18/10/2022	0.0	0.3	< 0.02	< 0.05	< 0.0002	0.005	0.011	0.006	< 0.0002	0.002
HWM12	20/04/2022	0.2	0.2	0.24	0.01	0.004	0.006	0.030	0.032	0.019	0.023
	18/10/2022	0.2	1.2	0.05	< 0.05	0.001	0.001	0.005	0.013	0.001	0.006
HWM13	20/04/2022	0.3	1.0	0.27	< 0.005	0.003	0.007	0.040	0.024	0.014	0.025
	18/10/2022	0.2	1.0	0.10	< 0.05	0.002	< 0.0005	0.015	0.012	0.003	0.056

Shaded cell indicates suspected anomalous data

Table 6 – Identified Organic Substances within Leachate

Sample Point	Date	Mecoprop	Phenol
		ug/l	
TIR HWM07	20/04/2022	1.9	10.0
TIR HWM07	18/10/2022	0.1	< 1
TIR HWM08A	20/04/2022	< 0.02	15.0
TIR HWM08A	18/10/2022	< 0.02	< 1
TIR HWM11	18/10/2022	0.1	< 1
TIR HWM12	20/04/2022	< 0.02	4.2
TIR HWM12	18/10/2022	0.1	2.8
TIR HWM13	20/04/2022	0.7	3.2
TIR HWM13	18/10/2022	1.1	< 1

Shaded cells indicate value above limit of detection

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 – 1.9µg/l, which is insignificant in comparison to the 18µg/l EQS, the relevant water quality standard for a marsh/surface water pond type environmental setting regime.

Phenol (non-hazardous) was reported between 3.2µg/l and 15µg/l however, has not been reported as present for Tir John Phase 1 since 2016. AT the majority of monitoring locations phenol was reported below the EQS. Where reported above the EQS of 7.7µg/l, at HMW07 and HMW08A, phenol is not persistent and reported below the limit of detection on the following monitoring visit, meaning the results are environmentally insignificant.

4.3 Groundwater

4.3.1 Groundwater Levels

Groundwater elevations during 2022 were 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 11mAOD and 13mAOD.

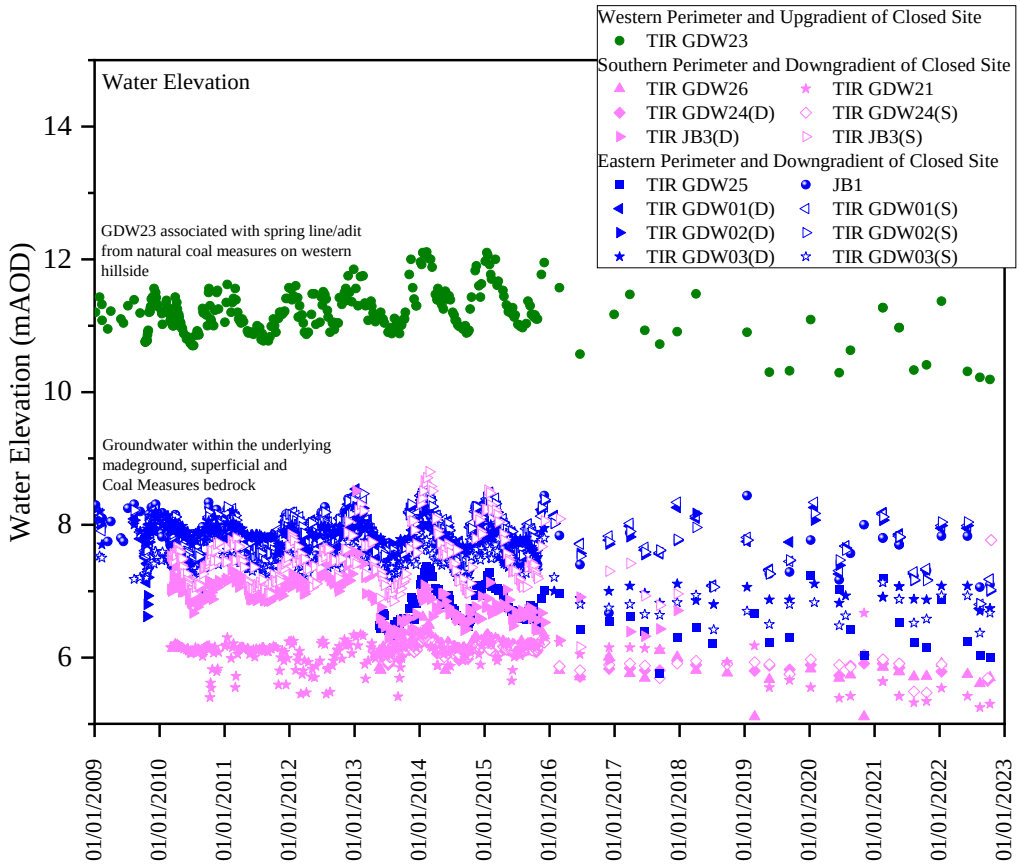
Groundwater levels within the Made Ground (PFA) and wider Crymlyn Bog also exhibit seasonal variation and are generally between ~6.5 and 9mAOD and ~5.5 – 6mAOD respectively (Figure 9).

The groundwater seasonal patterns are consistent with expectations, except for a single location where anomalous elevations were reported for both response zones at GDW24 during October 2022 when both the deep and shallow monitoring location were reported at 7.77mAOD (a depth of

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

2.14m). This was caused due to the borehole being buried then subsequently remediated which caused a blockage in the well due to ingress of soil. This monitoring point is currently under review.

Figure 9 – Groundwater Elevation (2009-2022)



4.3.2 Groundwater Quality

As discussed in historical environmental monitoring reviews and the recent 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 presented in Table 8. The data collected during 2022 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 2022)

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	6.8	308	0.04	58	2	25	18	18	4	19	45
TIR JB1	7.6	338	0.16	106	9	37	23	13	4	19	14
GDW03(D)	6.3	485	11.25	175	13	40	22	23	5	26	2
GDW03(S)	7.3	775	21.50	47	7	120	19	30	22	28	5
South of Site											
GDW24(D)	7.0	1500	55.67	256	7	150	34	106	65	107	53
GDW24(S)	6.9	1575	52.50	208	16	150	38	117	63	122	186
GDW26	7.0	963	13.25	45	6	95	24	97	38	84	5
GDW21	6.8	1425	25.75	408	14	59	35	223	45	300	41
East (Between Phase 1&2)											
GDW01(D)	7.4	748	3.00	2270	51	97	39	54	27	52	11
GDW01(S)	8.4	465	0.87	1275	51	27	15	53	23	36	92
GDW02(D)	6.8	965	10.10	155	27	170	40	54	24	47	8
GDW02(S)	6.9	1925	19.00	189	43	400	86	230	56	178	69
GDW25	7.1	2325	14.50	2143	20	480	180	225	62	188	516

Table 8 – Ammoniacal-N Permit Limit Comparison

Location	GDW21	GDW24(D)	GDW24(S)	GDW26
Limit	**51**	**85**	**75**	**25**
12/01/2022		47	44	10
26/01/2022	26			
07/06/2022	28			11
22/06/2022			24	
16/08/2022	24			15
28/09/2022		90	85	
11/10/2022	25			17
18/10/2022		30	57	

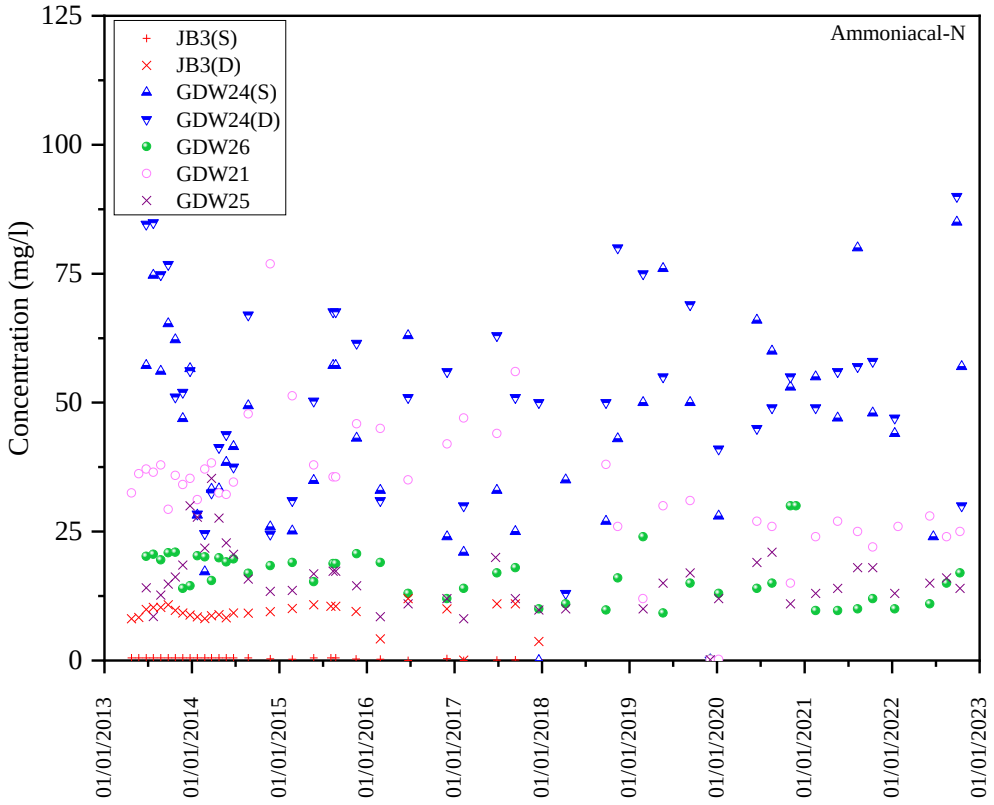
Shaded cells exceed the permit limit

The monitoring programme has demonstrated that ammoniacal-N is elevated around the site and this includes the 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 local baseline conditions rather than a landfill influence. As discussed within the 2021 HRAR[4], ammoniacal-N appears to decrease with distance from the site.

Permit limits for ammoniacal-N are set at these downgradient monitoring points and these were generally not exceeded during 2022 with the exception of GW24(S)/(D) during September 2022

where ammoniacal-N was reported in excess of the respective Permit limits at 90mg/l in GDW24(D) and 85mg/l at GDW24(S). This is most likely due to the damage sustained to the well as mentioned above. During the subsequent monitoring visit ammoniacal-N had returned to below the permit limits. The data reported at GDW24 is typically consistent with the historical dataset.

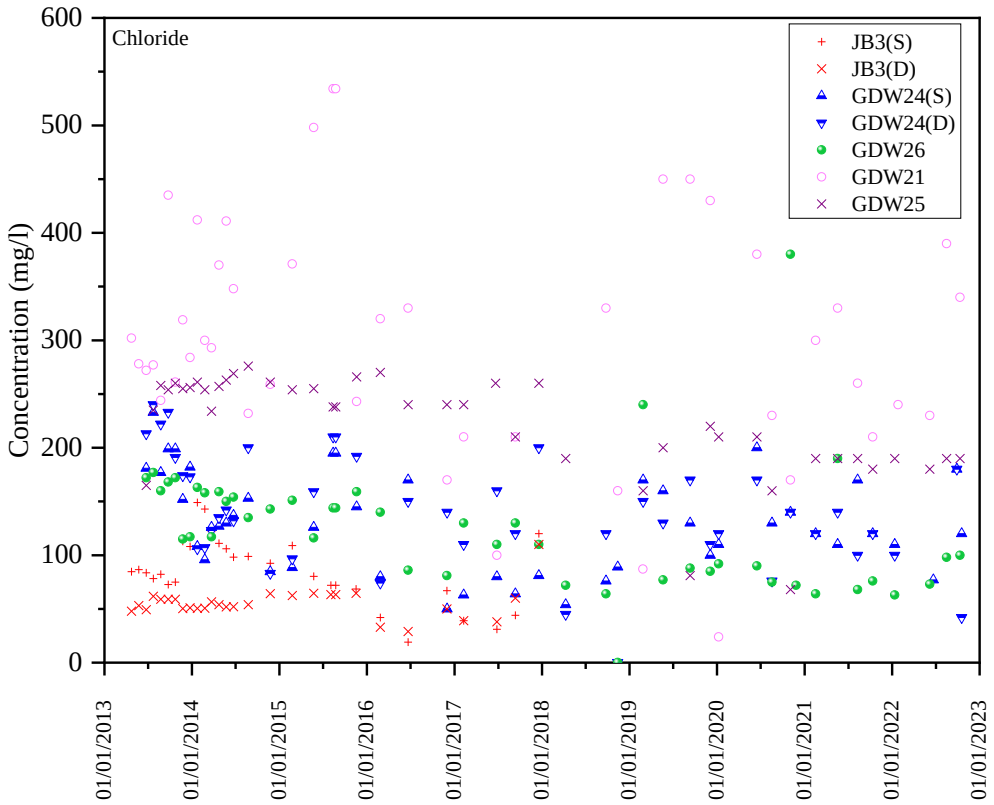
Figure 10- Ammoniacal-N to the South of Phase 1



Chloride is typically reported below the 250mg/l DWS and these trends have continued during 2022. The exception to this is at GDW21 where chloride is more variable oscillating within the range 170mg/l to 450mg/ (Figure 11). However, chloride appears to follow a similar trend to ammoniacal-N of increasing concentration with distance from the edge of the landfill site (Figure 11). Furthermore, chloride concentrations within the leachate are typically below that reported at GDW21 and therefore must be associated with a non-landfill source.

Sulphate has reduced at a number of locations and was previously reported in excess of chloride at GDW02(D), GDW02(S), GDW25 and GDW26. Presently sulphate is reported at similar but typically lower concentrations that groundwater chloride with the exception of GW25 where the average sulphate remains elevated above 500mg/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 11- 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 notable concentrations present in GW24 at 0.01µg/l which is significantly below the 1µg/l DWS. Cadmium was reported in the 0.02 - 0.07µg/l range which is within the typically reported range for the site.

Lead is reported below or approximating the limit of detection during 2022 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 0.001 - 0.004mg/l range with zinc reported at a slightly higher range of 0.002-0.02mg/l. Nickle was negligible within the groundwater and typically oscillated around the limit of detection at <0.0005mg/l.

Arsenic is typically in the 1-10µg/l range except for at GW01(S & D) where arsenic was reported averaging 36µg/l and is most likely an artefact of the PFA host material. However, as the reported arsenic at GW01 is between the EQS of 50µg/l and for all locations except GW01(S) below the DWS of 10µg/l, there is no environmental significance to the data.

Table 9 – Groundwater Priority Metal Summary (Average 2022)

Sample Point	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	mg/l
North & West										
GDW23	0.04	3.18	0.07	<0.005				0.007		0.0003
TIR JB1	0.02	0.11	0.02	<0.005				0.002		0.0008
GDW03(D)	0.21	0.76	0.02	<0.005	0.0010	0.0018	0.0006	0.006	<0.0002	0.0009
GDW03(S)	0.05	1.73	0.02	<0.005	0.0010	0.0012	0.0006	0.005	0.0003	0.0018
South of Site										
GDW21	0.17	0.25	0.02	<0.005				0.013		0.0024
GDW24(D)	0.08	0.53	0.02	0.011				0.002		0.0090
GDW24(S)	2.12	0.68	0.02	0.011				0.024		0.0048
GDW26	0.07	0.54	0.02	<0.005				0.011		0.0008
East (Between Phase 1&2)										
GDW01(D)	0.05	0.58	0.03	<0.005	0.0008	0.0015	<0.0005	0.008	<0.0002	0.0083
GDW01(S)	0.03	0.06	0.02	0.009	0.0006	0.0007	<0.0005	0.004	<0.0002	0.0363
GDW02(D)	0.05	3.88	0.04	<0.005	0.0012	0.0015	0.0007	0.021	<0.0002	0.0040
GDW02(S)	0.30	0.67	0.02	<0.005	0.0025	0.0040	0.0009	0.005	<0.0002	0.0017
GDW25	0.03	0.37	0.02	0.005				0.007		0.0051

A hazardous substances suite was carried out in June 2022. No hazardous substances were reported in the majority of monitoring locations with the exception of a single substance (triphenyltin) at GDW2(S) and GDW3(D) at 0.08µg/l and 0.03µg/l respectively (Table 10).

Triphenyltin has not been identified in the leachate in either landfill or historically within the groundwater. Given the low chloride in the groundwater it is considered that the reported concentrations are aspirational reporting of a substance which is not actually present in the groundwater due to the presence of either the Phase 1 or the Phase 2 landfills

Table 10 – Substances Present over the Limit of Detection

Substance	Units	TIRGDW 2 (S)	TIRGDW 3 (D)
		07/06/2022	
Herbicides & Pesticides			
Triphenyltin (chloride)	µg/l	0.082	0.031

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 2m, 4m, 8m, 16m, 32m, and 64m intervals, each of which has a shallow (1m) and deep (2m) response zone. The data from the annual screen is presented in Table 11.

Table 11 – Closed Transect Water Quality

Sample Point	Date	pH	NH_4-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
ETM1 (1a)	01/03/2022	7.3	36.00	120	2	8	5	95	0.15	< 0.062	0.85
ETM1 (1b)	01/03/2022	7.5	21.00	190	5	7	3	98	0.11	< 0.062	3.80
ETM1 (2a)	01/03/2022	7	27.00	160	4	24	5	100	0.12	0.07	0.40
ETM1 (2b)	01/03/2022	7.2	14.00	110	2	2	3	77	0.13	< 0.062	2.30
ETM1 (3a)	01/03/2022	7.2	18.00	110	4	23	5	120	0.11	< 0.062	3.00
ETM1 (4a)	01/03/2022	7.4	5.10	79	4	16	6	120	0.11	0.13	2.90
ETM1 (4b)	01/03/2022	7.1	2.30	270	2	2	4	240	0.12	< 0.062	2.00
ETM1 (5a)	01/03/2022	7.4	0.24	83	4	1	5	140	0.09	< 0.062	0.78
ETM1 (5b)	01/03/2022	7.3	24.00	350	7	44	26	49	0.29	9.90	3.80
ETM1 (6a)	01/03/2022	7.3	0.04	100	2	1	7	130	0.12	< 0.062	1.10
ETM1 (6a)	20/04/2022	6.8					12	110			
ETM1 (6a)	27/07/2022	6.9					13	130			
ETM1 (6a)	12/10/2022	7.1					16	120			
ETM1 (6b)	01/03/2022	7.3	1.70	440	4	3	28	110	0.26	0.34	0.51
ETM1 (6b)	20/04/2022	6.8					30	96			
ETM1 (6b)	27/07/2022	6.8					35	98			
ETM1 (6b)	12/10/2022	7					35	110			
ETM5 (1a)	01/03/2022	7.3	37.00	86	2	< 1	3	110	0.07	< 0.062	1.40
ETM5 (1b)	01/03/2022	7.5	23.00	79	2	8	3	52	0.06	0.54	4.90
ETM5 (2a)	01/03/2022	7.2	29.00	99	2	26	7	130	0.06	0.35	2.70
ETM5 (2b)	01/03/2022	7.4	35.00	160	5	26	3	100	3.93	0.13	6.20
ETM5 (3a)	01/03/2022	7.2	20.00	92	3	6	6	110	0.11	0.10	1.20
ETM5 (3b)	01/03/2022	7	3.00	210	2	38	4	220	0.13	< 0.062	1.30
ETM5 (4a)	01/03/2022	6.9	1.60	130	3	3	6	190	0.12	< 0.062	2.00
ETM5 (4b)	01/03/2022	7.5	0.09	520	5	3	34	200	0.25	< 0.062	0.15
ETM5 (5a)	01/03/2022	7	0.62	160	2	3	8	170	0.06	< 0.062	0.87
ETM5 (5b)	01/03/2022	7.3	1.20	260	4	8	23	150	0.13	0.40	0.48
ETM5 (6a)	01/03/2022	6.4	< 0.015	210	4	5	23	33	0.15	< 0.062	0.14
ETM5 (6a)	20/04/2022	6.3					23	28			
ETM5 (6a)	27/07/2022	6.4					21	31			
ETM5 (6a)	12/10/2022	6.9					23	82			
ETM5 (6b)	01/03/2022	5.6	< 0.015	290	4	1	28	19	0.23	< 0.062	0.06
ETM5 (6b)	20/04/2022	5.6					26	16			
ETM5 (6b)	27/07/2022	5.5					27	15			
ETM5 (6b)	12/10/2022	6.4					27	50			

Ammoniacal-N in EMT1 is typically lower in the deeper response zone and decreases with distance from the site boundary for both the shallow and deep installations (Figure 13). Conversely, the measured chloride increases with distance from the site boundary (Figure 12), at both the deep installations, *i.e.* the concentration increases towards the coast, where saline intrusion can be reasonably expected to occur.

Figure 12 – Transect EMT1 Chloride

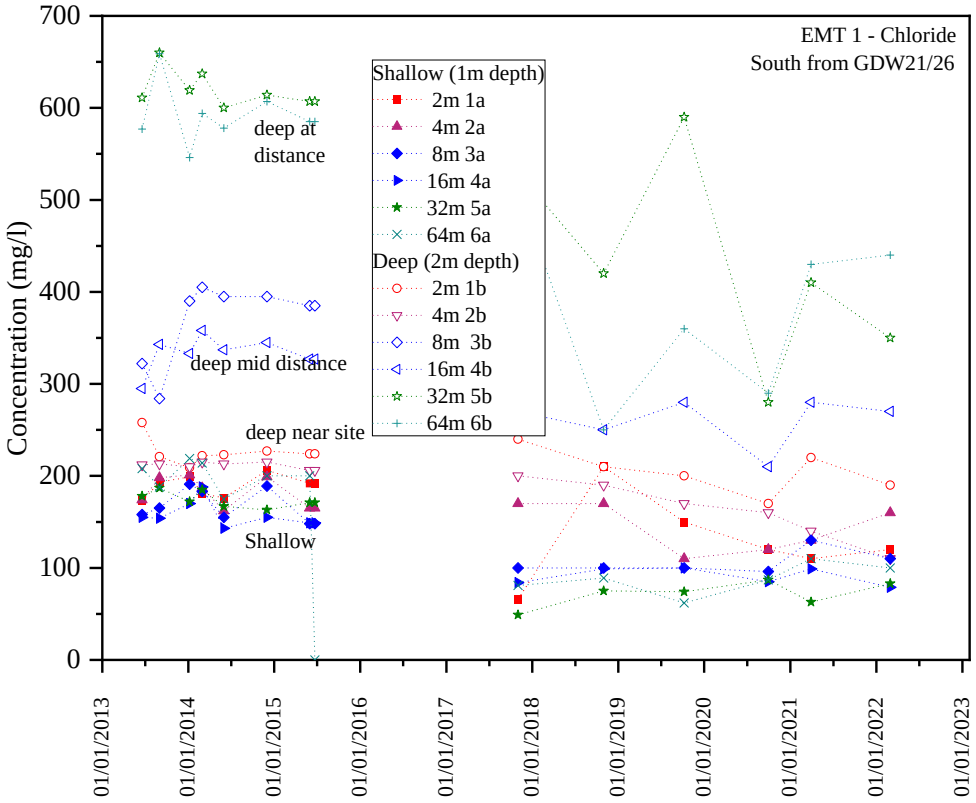
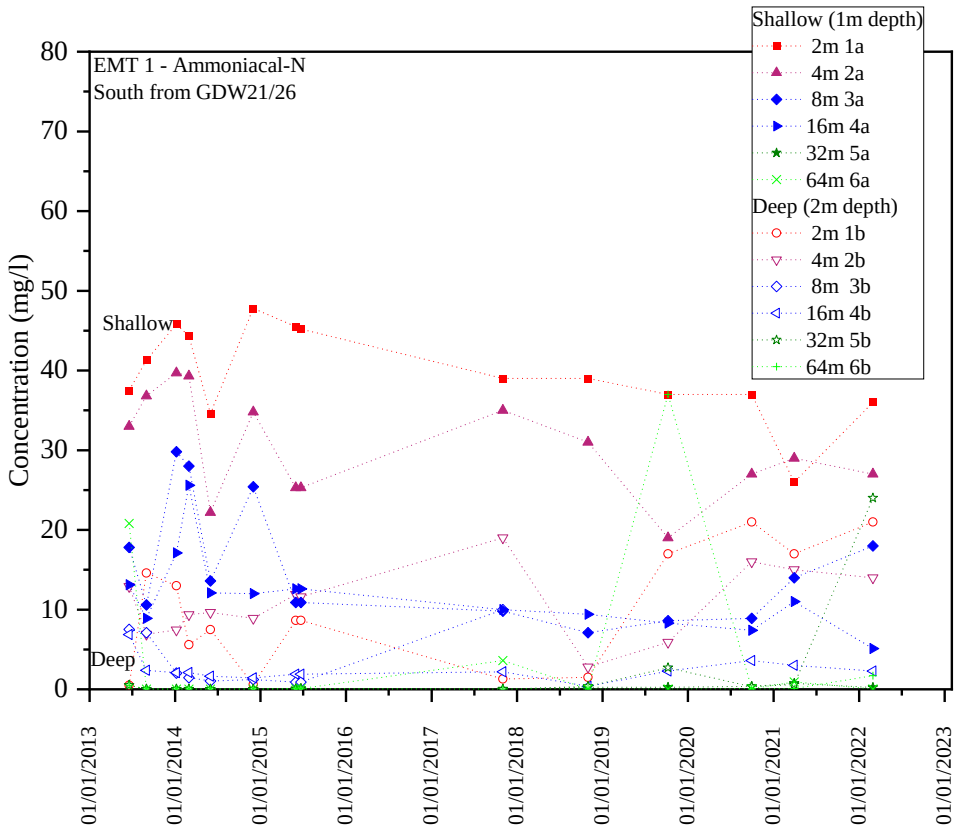


Figure 13 – Transect EMT1 Ammoniacal-N



A similar trend in ammoniacal-N is reported in EMT5 with decreasing concentrations with distance from the site (Figure 15). 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 EMT5 compared to EMT1. The highest chloride concentrations in EMT5 are observed at depth in the 16m shallow monitoring point (Figure 14).

Orthophosphate is generally reported at the detectable limit in the majority of monitoring points along the EMT5 transect with 0.54mg/l in EMT5(1b) being the highest concentration observed during the 2022 monitoring of EMT5.

The highest concentration of orthophosphate observed in EMT1 during 2022 was 9.9mg/l at EMT1(5b). This is significantly elevated from previous years and is 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.

Figure 14 – Transect EMT5 Chloride

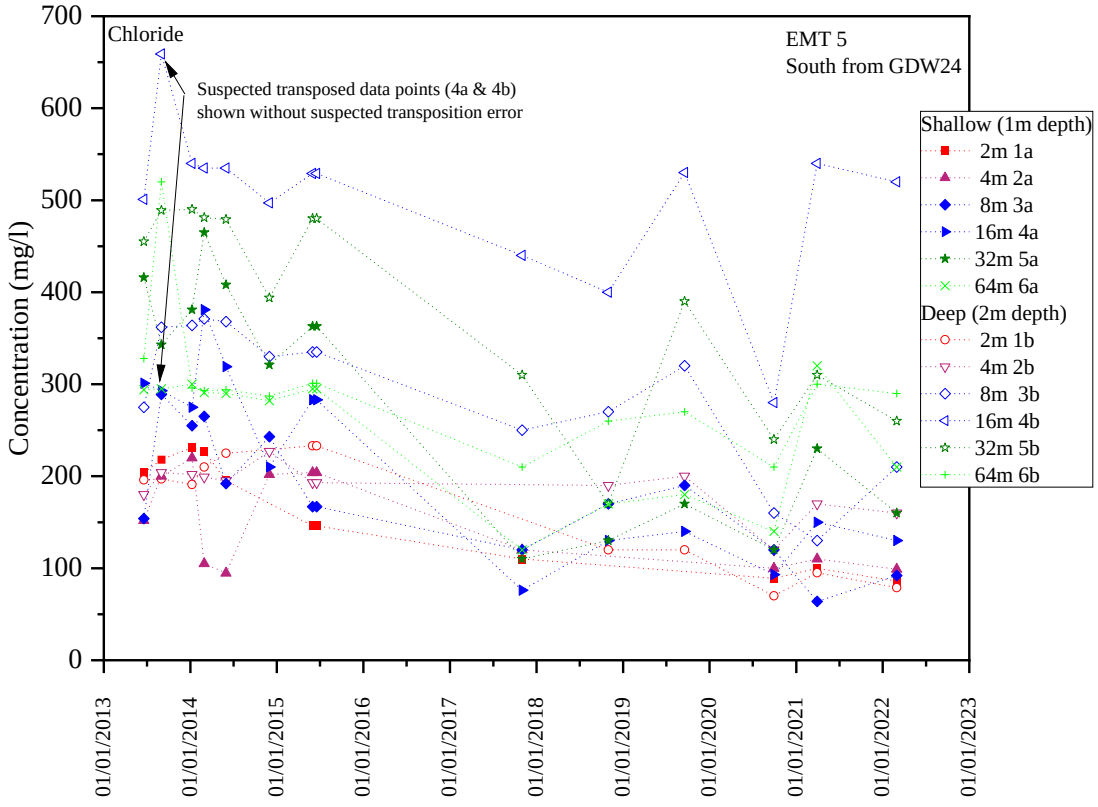
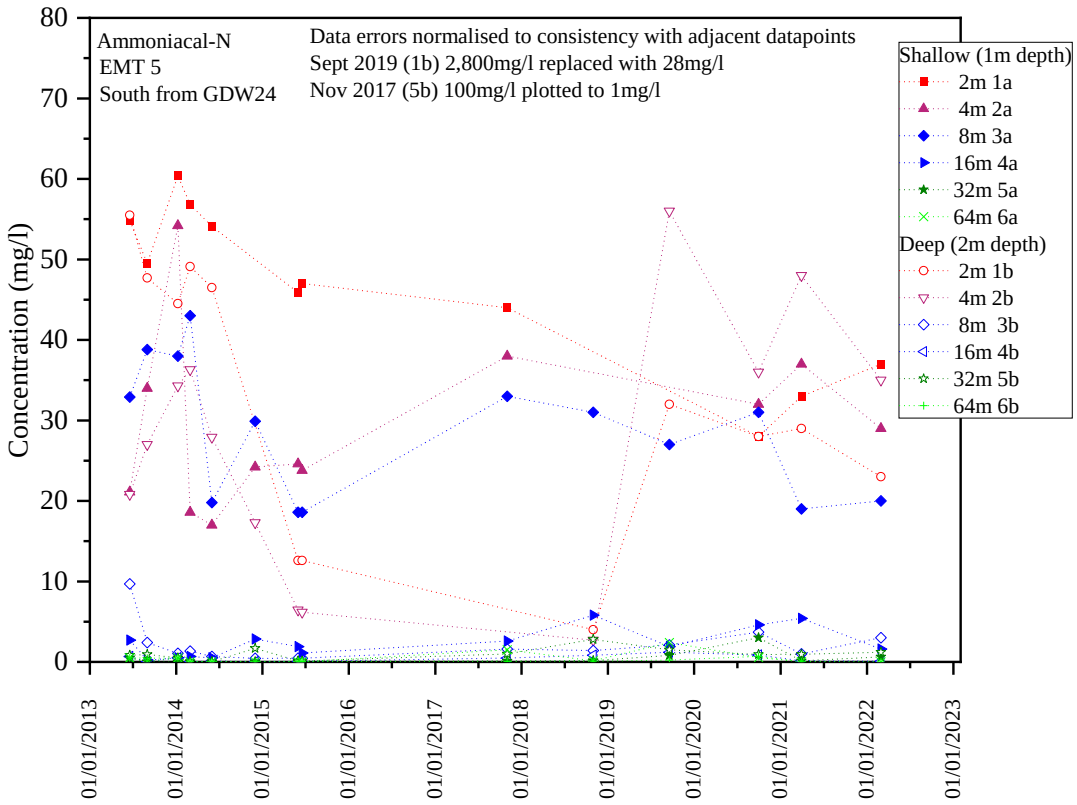


Figure 15 – Transect EMT5 Ammoniacal-N



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 Phased 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-N concentrations and therefore even if there are any future seepages, these would not be discernible on the existing background system.

Elevated ammoniacal-N 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-N typically decreases with distance from the site, however, any suspicion of a direct association with the landfill is disabused by the chloride data which demonstrates that chloride decreases with proximity to the site within

EMT5. It is also possible that the ammoniacal-N 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 two complaints received at the Tir John landfill during 2022, both regarding overgrown vegetation and shrubs into neighbouring properties, which were subsequently cut back

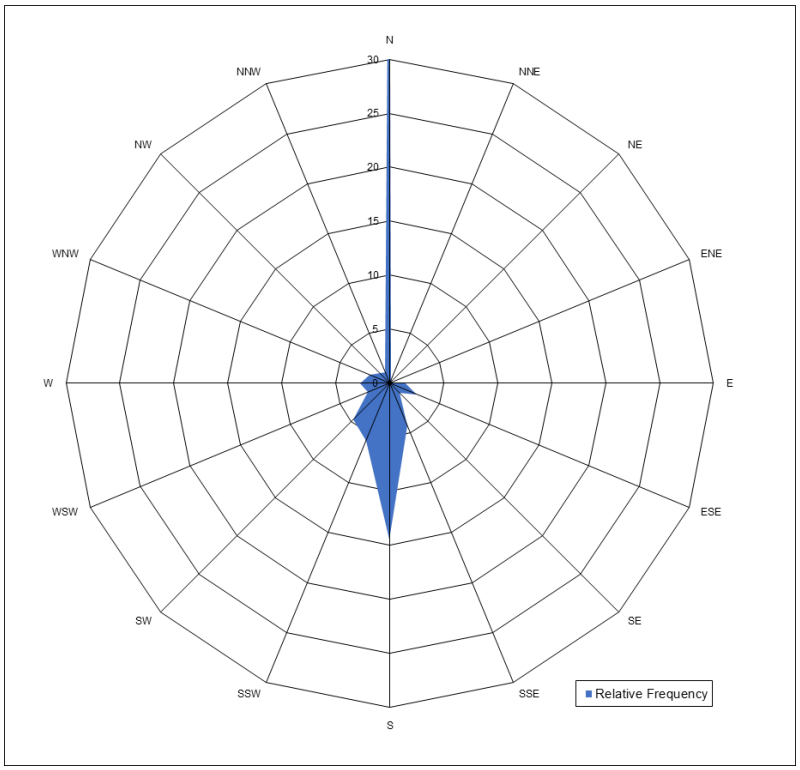
5.2 Weather Data

Given the close association of potential nuisance emissions to weather conditions, the weather monitoring data are summarised in Table 12. 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 2021 to 2022 saw uncharacteristically low rainfall, this seems to have been a data collection error, the rain gauge was replaced which has since resulted in more usual data being collected.

Table 12 – Rainfall and Temperature Summary

Month	Temperature (2022)			Rainfall						
	Min	Max	Ave	2016	2017	2018	2019	2020	2021	2022
	°C			mm / month						
January	-2	7	14	49	79	144	78	105	184	9
February	0	9	15	104	70	51	62	202	104	2
March	1	10	19	106	113	135	99	67	53	8
April	-1	11	21	71	28	62	68	38	15	45
May	6	14	21	91	15	47	28	12	156	58
June	7	16	26	112	74	36	73	144	29	73
July	9	18	33	48	13	130	35	91	73	30
August	9	19	32	103	65	31	140	159	5	41
September	5	16	23	131	143		164	40	22	69
October	5	15	21	54	52	17	194	205	29	145
November	2	12	18	99	83	125	142	96	4	238
December	-5	6	14	49	121	117	180	199	2	137
			Total	**1,016**	**854**	**895**	**1,263**	**1356**	**674**	**854**

Figure 16 – Wind Rose Diagram 2022



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-N. However, there are no increasing trends and concentrations in 2022 were typically reported below Permit limits.

Although there has been localised, and temporary exceedances of groundwater Permit Limits, these can either be attributed to flawed data reporting or are within the historical expectations for the site. Thus, 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 Landfill Site
Perimeter Gas Summary January - December 2022

Location	Methane			Carbon dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure			CH4/CO2		
	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	2.1	9.5	0.1	1.6	4.6	9.5	17.5	21.9	76.4	78.8	81.1	0.0	0.2	1.0	0.0	1.0	3.0	1003	1018	1034	-8.5	-0.1	5.8	0.0	0.6	2.4
TIRGP002	0.0	0.0	0.0	0.1	2.1	5.7	13.8	18.6	22.0	77.9	79.4	82.0	0.0	0.1	1.0	0.0	1.1	3.0	1004	1019	1035	-137.4	-22.0	0.5	0.0	0.0	0.0
TIRGP003	0.0	0.0	0.0	2.5	5.8	10.4	3.8	11.9	20.6	74.9	82.3	88.2	0.0	0.1	1.0	0.0	1.1	3.0	1005	1019	1035	-140.0	-11.6	0.4	0.0	0.0	0.0
TIRGP004	0.0	0.0	0.0	0.1	1.0	4.7	12.9	19.8	21.9	77.6	79.2	82.4	0.0	0.1	1.0	0.0	0.9	3.0	1004	1019	1035	-0.7	0.0	0.4	0.0	0.0	0.0
TIRGP005	0.0	0.0	0.0	0.2	1.2	3.9	16.5	19.7	21.7	78.0	79.1	79.9	0.0	0.2	1.0	0.0	1.1	3.0	1004	1019	1035	-0.3	0.0	0.3	0.0	0.0	0.0
TIRGP006	0.0	0.0	0.0	0.1	1.1	3.7	12.3	19.8	21.6	77.6	79.1	84.0	0.0	0.0	0.0	0.0	0.8	3.0	1004	1018	1034	-0.4	0.0	0.3	0.0	0.0	0.0
TIRGP007	0.0	0.0	0.0	0.1	0.5	1.0	19.9	20.7	21.2	78.5	78.9	79.6	0.0	0.1	1.0	0.0	0.8	3.0	1004	1019	1034	-0.4	0.0	0.3	0.0	0.0	0.0
TIRGP008	0.0	0.1	0.5	0.1	5.7	11.0	10.1	15.5	21.5	77.2	78.7	79.6	0.0	0.0	0.0	0.0	0.8	3.0	1004	1018	1034	-0.3	0.0	0.3	0.0	0.0	0.1

Figure A. 1 – Perimeter Gas Monitoring Point TIRGP001

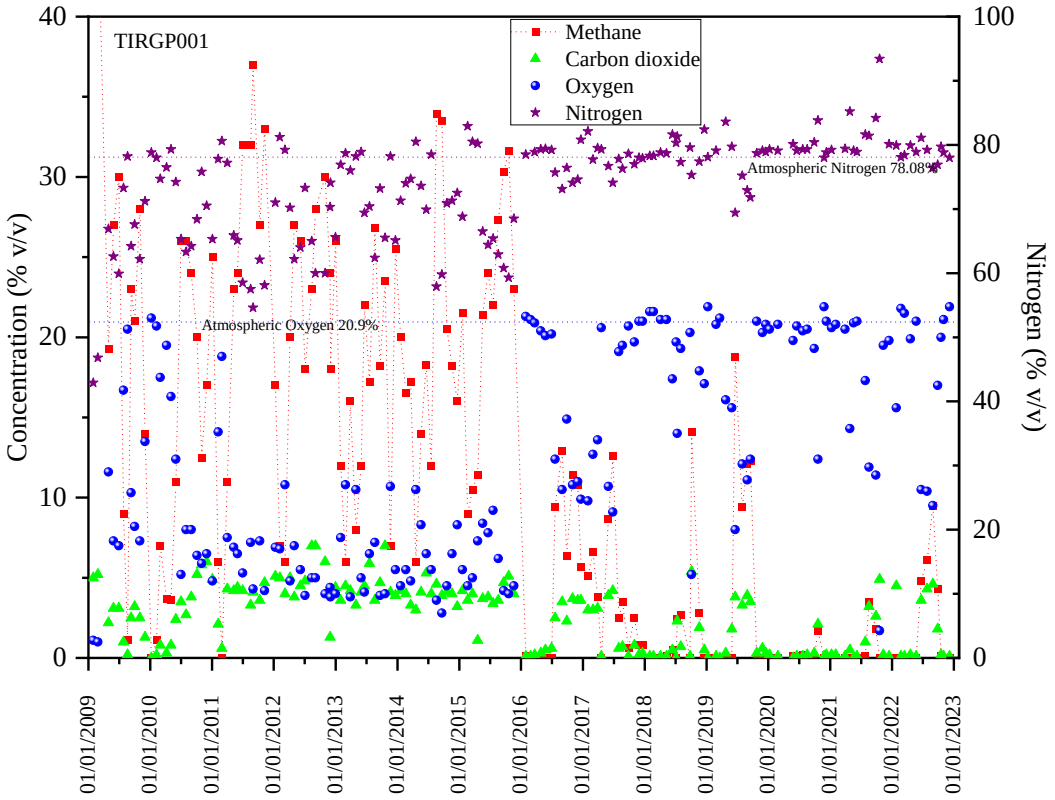


Figure A. 2 – Perimeter Gas Monitoring Point TIRGP002

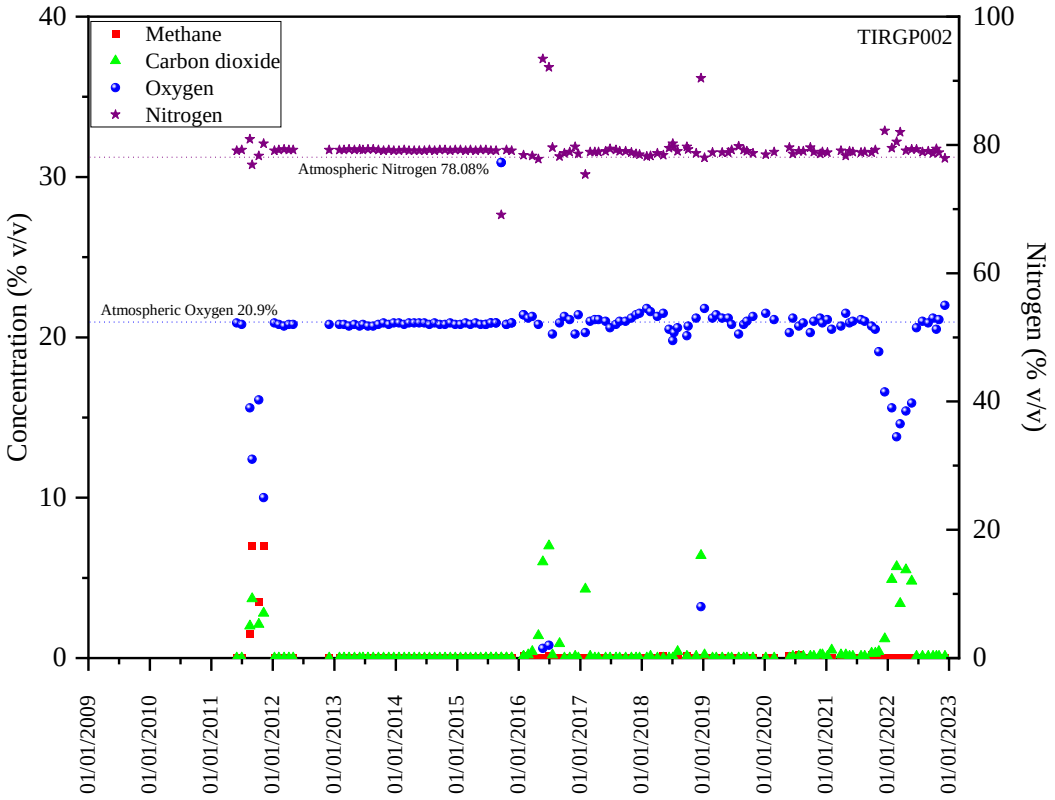


Figure A. 3 – Perimeter Gas Monitoring Point TIRGP003

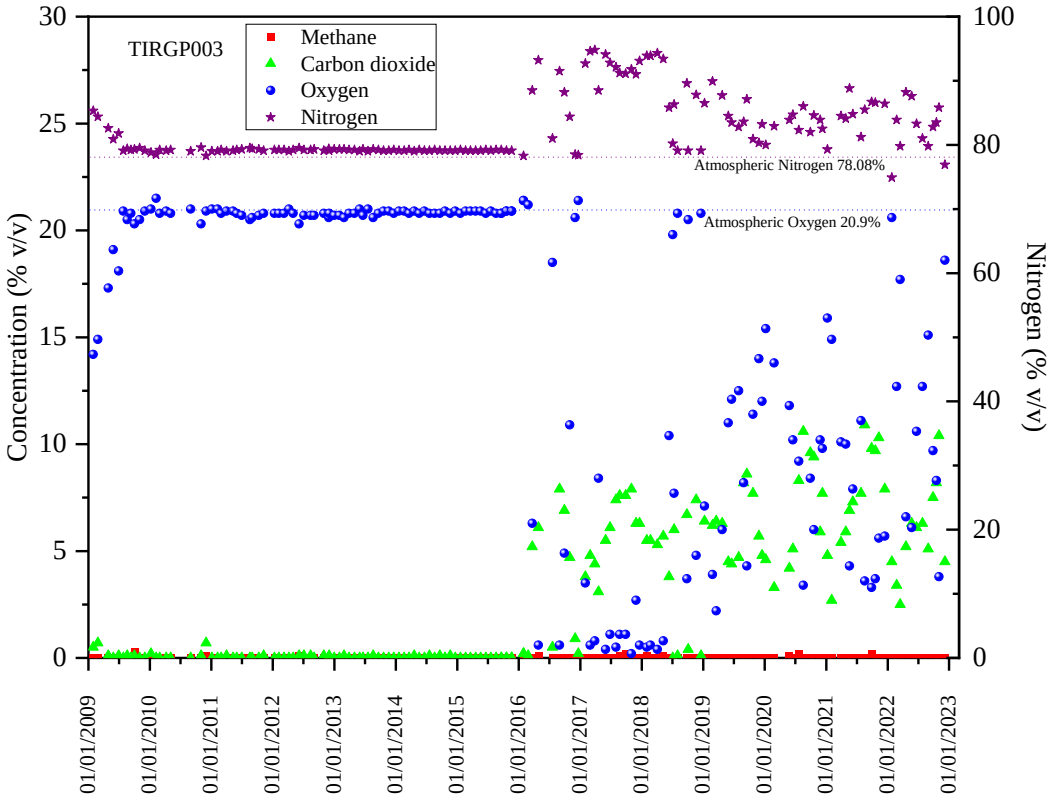


Figure A. 4 - Perimeter Gas Monitoring Point TIRGP004

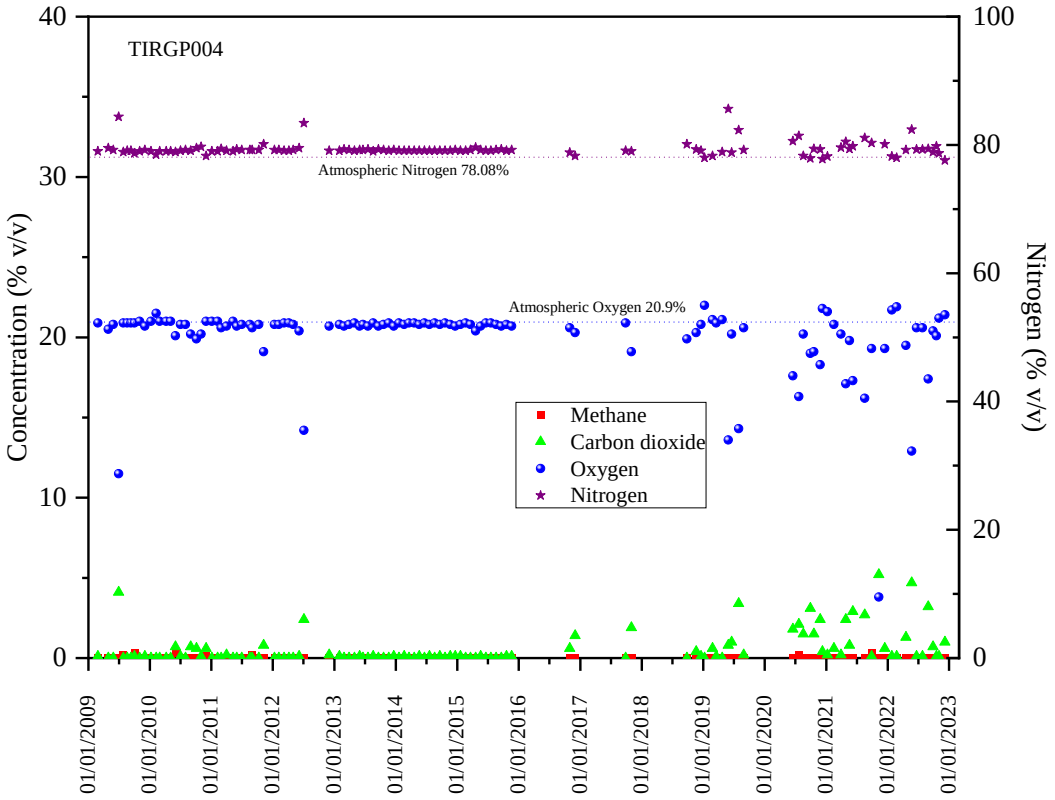


Figure A. 5 - Perimeter Gas Monitoring Point TIRGP005

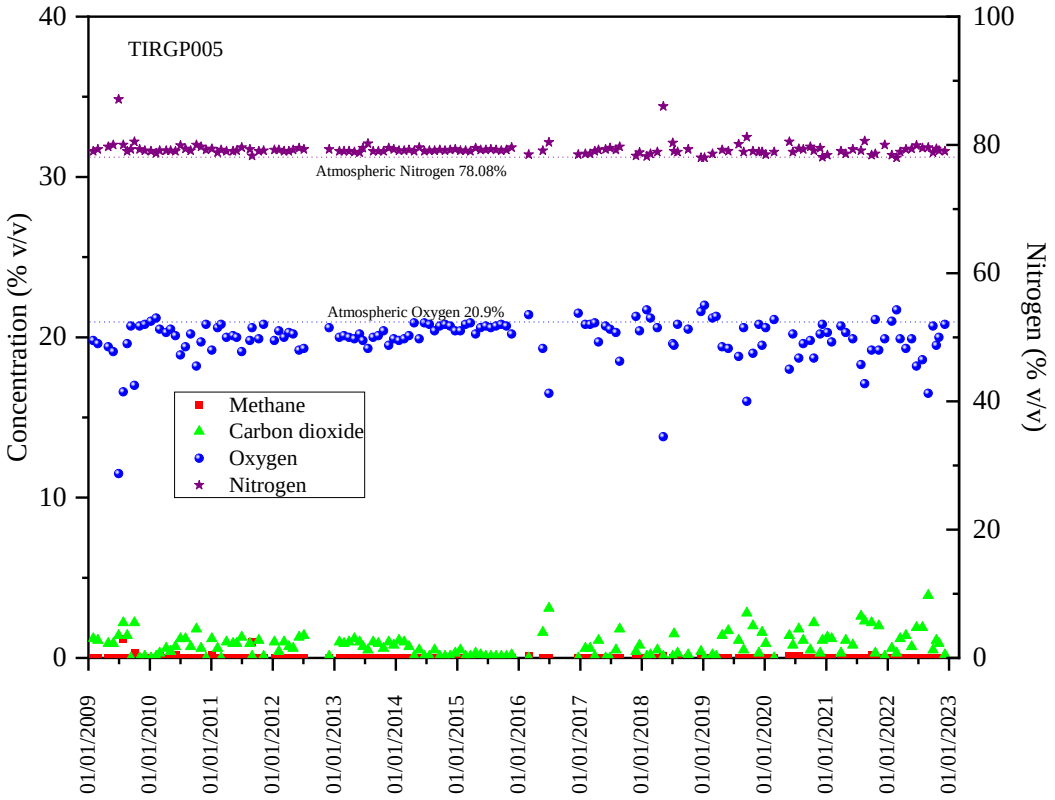


Figure A. 6 - Perimeter Gas Monitoring Point TIRGP006

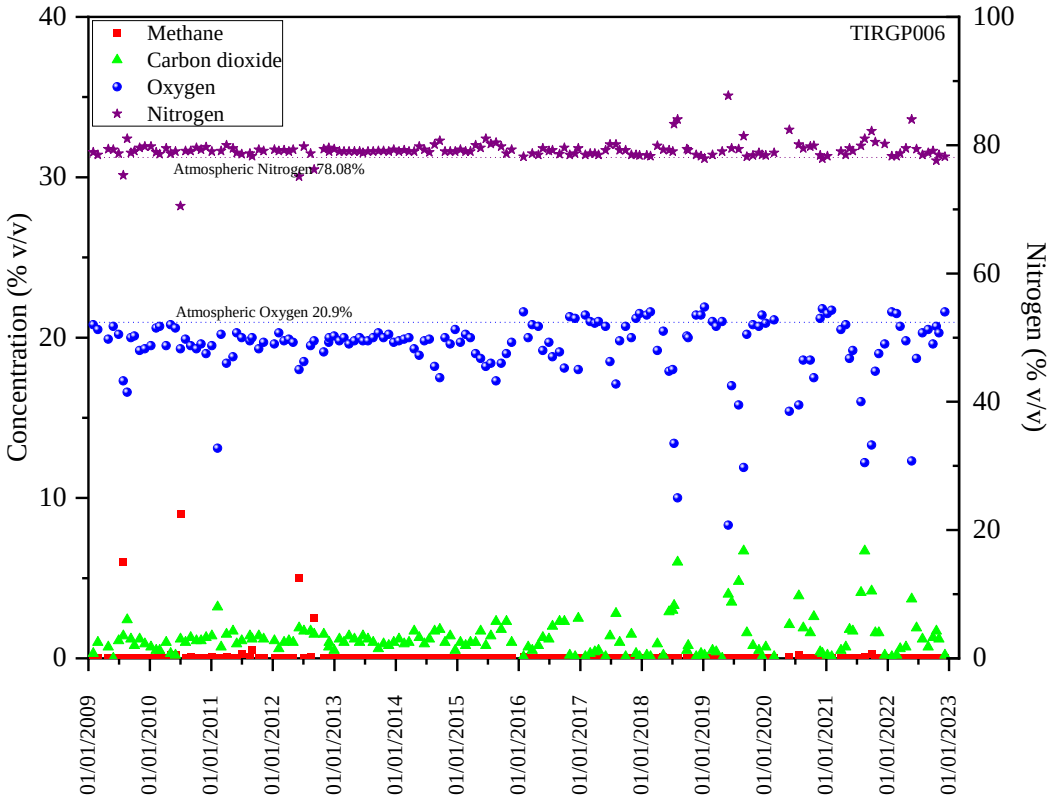


Figure A. 7 - Perimeter Gas Monitoring Point TIRGP007

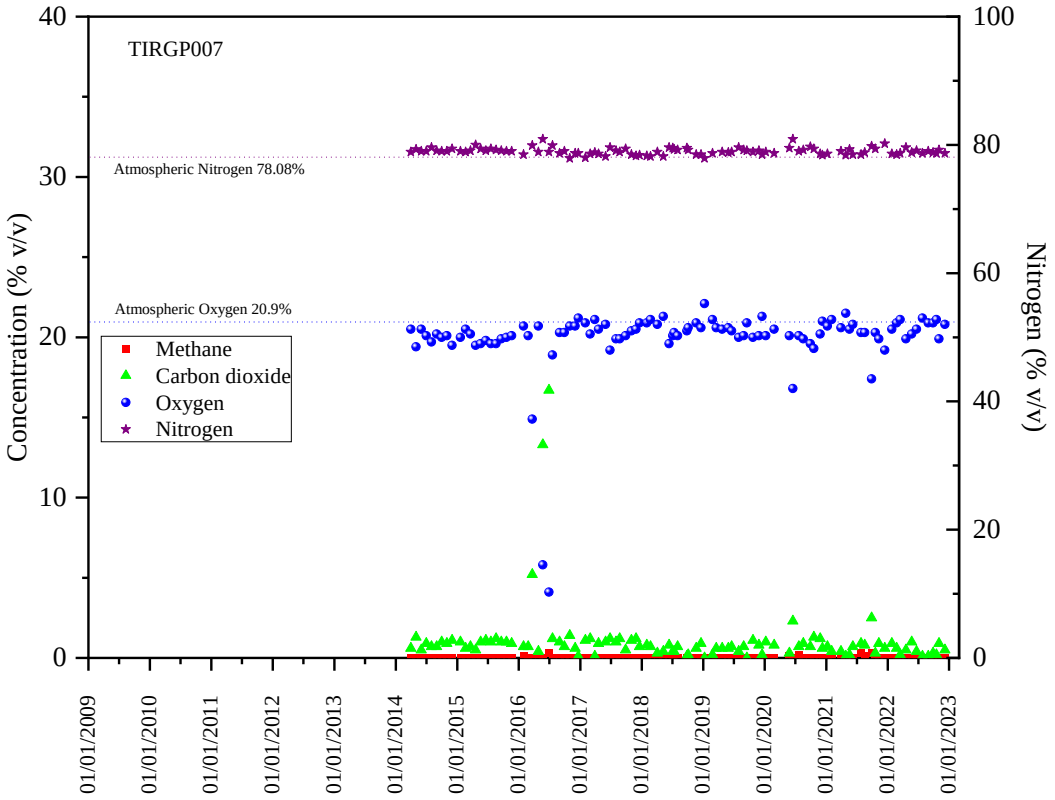
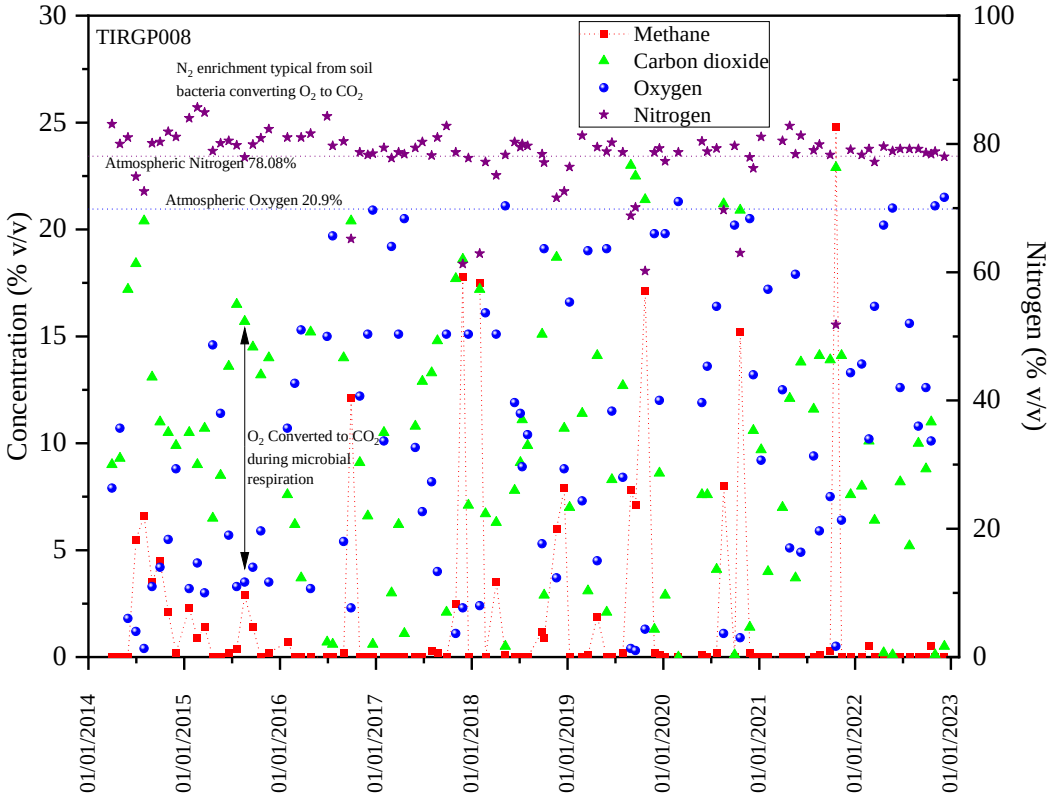


Figure A. 8 - Perimeter Gas Monitoring Point TIRGP008



Appendix B – Water Monitoring Data

BYRNELOOBY
AN aveso COMPANY

Tir John Phase 1 Landfill Site
Leachate Quality Summary January - December 2022

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	20/04/2022	6.9	2100	150.0	750	110	49	120	33	82	68	110	19	1200	0.8	0.5	0.74	< 0.005	0.006	0.002	0.03	0.034	0.017	0.004
	18/10/2022	6.9	1700	12.0	1900	8	22	150	35	360	23	81	109	980	0.1	0.6	0.03	< 0.05	0.002	0.004	0.01	0.009	0.003	0.004
HWM08A	20/04/2022	6.9	1500	23.0	13000	170	25	110	30	230	23	89	8	1100	5.4	0.9	10.00	< 0.005	0.005	< 0.0007	0.04	0.084	0.022	<0.001
	18/10/2022	7.2	1800	0.1	670	25	40	570	100	190	28	120	1130	560	0.2	0.8	0.02	< 0.05	< 0.0002	0.017	0.01	0.002	0.001	0.004
HWM11	18/10/2022	7.3	1400	2.9	120	8	22	460	53	100	27	69	752	490	0.0	0.3	< 0.02	< 0.05	< 0.0002	0.005	0.01	0.006	< 0.0002	0.002
HWM12	20/04/2022	7.3	1200	0.4	670	5	24	270	29	59	17	52	327	690	0.2	0.2	0.24	0.01	0.004	0.006	0.03	0.032	0.019	0.023
	18/10/2022	7.1	2100	2.2	420	30	31	590	57	110	30	72	810	680	0.2	1.2	0.05	< 0.05	0.001	0.001	0.01	0.013	0.001	0.006
HWM13	20/04/2022	7.3	2400	81.0	670	19	30	190	110	220	120	420	197	1200	0.3	1.0	0.27	< 0.005	0.003	0.007	0.04	0.024	0.014	0.025
	18/10/2022	7.4	3200	85.0	430	28	37	210	140	260	170	410	112	1400	0.2	1.0	0.10	< 0.05	0.002	< 0.0005	0.02	0.012	0.003	0.056

Figure B. 1- Leachate Chloride

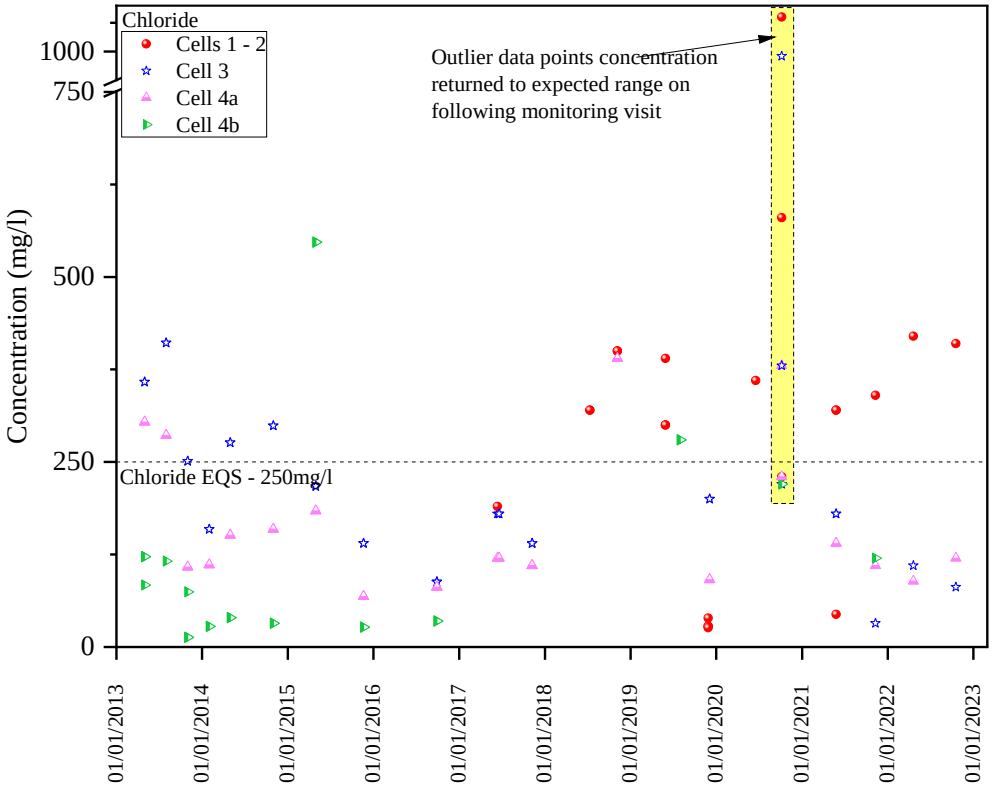
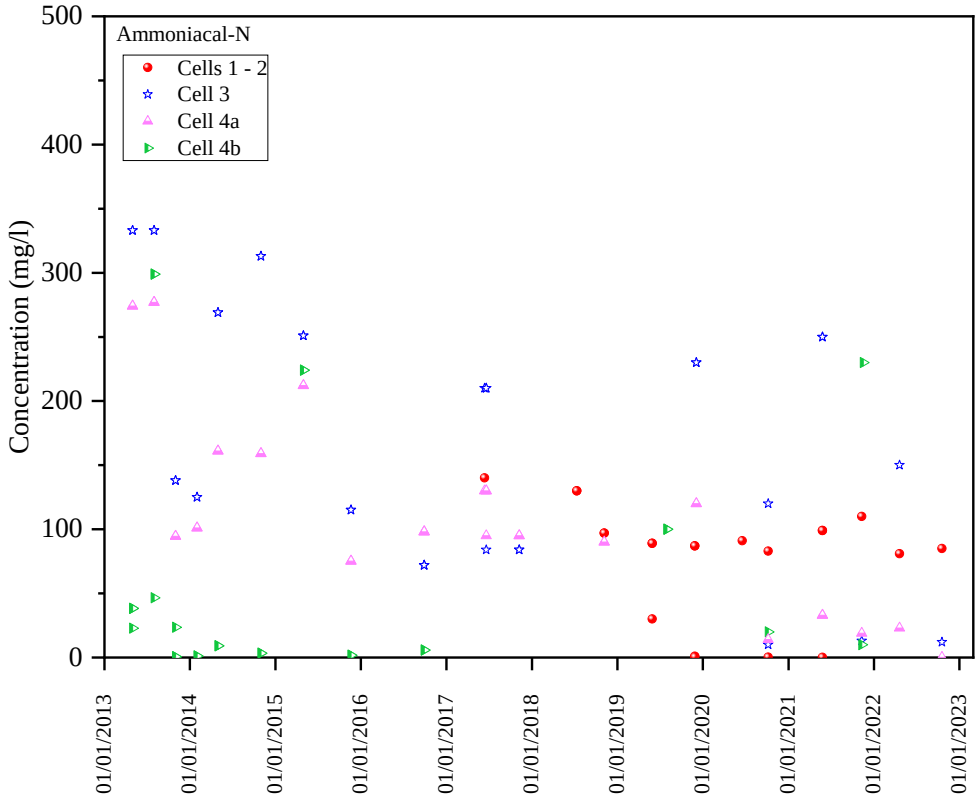


Figure B. 2- Leachate Ammoniacal-N



BYRNELOOBY
AN avesa COMPANY

Tir John Phase 1 Landfill Site
Groundwater Quality Summary January - December 2022

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	mg/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/l
GDW01(D)	12/01/2022	7.5	700	2.00	7300	4	2			54	21	51			0.01	0.34	0.02	< 0.005	0.0024	0.002		0.004	< 0.0002	0.0082	< 0.02
	07/06/2022	7.6	560	1.40	810	18	0	97	39	53	27	49	11	450	0.14	0.59	0.03	< 0.005	< 0.0002	0.001	< 0.0005	0.008	< 0.0002	0.0072	< 0.02
	16/08/2022	7.3	860	3.60	810	120	4			56	30	52			0.01	0.49	0.03	< 0.005	< 0.0002	0.003		0.002	0.0002	0.0113	< 0.02
	11/10/2022	7.2	870	5.00	160	62	16			54	28	57			0.05	0.89	< 0.02	< 0.005	< 0.0002	< 0.0005		0.017	< 0.0002	0.0065	< 0.02
GDW01(S)	12/01/2022	7.7	650	1.30	2800	5	2			52	20	45			0.02	0.16	0.03	< 0.005	0.0019	0.001		0.002	< 0.0002	0.0183	< 0.02
	07/06/2022	8.4	350	0.17	130	33	< 0.1	27	15	51	22	29	92	190	0.08	0.03	< 0.02	< 0.005	< 0.0002	< 0.0005	< 0.0005	0.001	< 0.0002	0.0553	< 0.02
	16/08/2022	8.4	460	1.30	1400	150	9			63	30	41			< 0.004	0.02	< 0.02	< 0.005	< 0.0002	< 0.0005		0.008	< 0.0002	0.0168	< 0.02
	11/10/2022	8.9	400	0.71	770	16	6			47	21	28			< 0.004	0.03	< 0.02	0.0227	< 0.0002	< 0.0005		0.004	< 0.0002	0.0549	< 0.02
GDW02(D)	12/01/2022	7.2	960	5.40	520	20	4			66	25	29			0.02	3.10	0.05	< 0.005	0.0043	0.001		0.020	< 0.0002	0.0107	< 0.02
	07/06/2022	6.6	700	10.00	47	42	2	170	40	49	24	46	8	610	0.09	4.40	< 0.02	< 0.005	< 0.0002	0.001	0.0007	0.007	< 0.0002	0.0032	< 0.02
	16/08/2022	6.6	1100	12.00	26	24	4			51	24	54			0.03	4.00	< 0.02	< 0.005	< 0.0002	0.002		0.046	< 0.0002	0.0005	< 0.02
	11/10/2022	6.6	1100	13.00	28	23	18			51	22	59			0.06	4.00	0.06	< 0.005	< 0.0002	0.002		0.011	< 0.0002	0.0016	< 0.02
GDW02(S)	12/01/2022	6.9	2100	18.00	430	8	5			200	53	180			0.10	0.74	< 0.02	< 0.005	0.0093	0.008		0.002	< 0.0002	0.0024	< 0.02
	07/06/2022	7.1	1200	19.00	54	46	4	400	86	260	53	170	69	1300	0.52	0.19	< 0.02	< 0.005	< 0.0002	0.004	0.0009	0.002	< 0.0002	0.0021	< 0.02
	16/08/2022	6.8	2400	20.00	170	71	5			210	57	190			0.26	0.86	< 0.02	< 0.005	< 0.0002	0.003		0.008	< 0.0002	0.0012	< 0.02
	11/10/2022	6.8	2000	19.00	100	49	29			250	61	170			0.34	0.89	< 0.02	< 0.005	< 0.0002	< 0.0005		0.005	< 0.0002	0.0009	< 0.02
GDW03(D)	12/01/2022	6.4	500	12.00	400	7	6			20	5	27			0.07	0.88	< 0.02	< 0.005	0.0032	0.003		0.002	< 0.0002	0.0007	< 0.02
	07/06/2022	6.3	470	11.00	58	9	3	40	22	22	4	27	2	240	0.52	0.76	< 0.02	< 0.005	< 0.0002	0.001	0.0006	0.006	< 0.0002	0.0004	< 0.02
	16/08/2022	6.2	480	11.00	51	24	4			25	5	24			0.19	0.75	< 0.02	< 0.005	< 0.0002	0.002		0.003	< 0.0002	0.0017	< 0.02
	11/10/2022	6.4	490	11.00	190	10	11			23	5	26			0.07	0.63	< 0.02	< 0.005	< 0.0002	0.001		0.013	< 0.0002	0.0006	< 0.02
GDW03(S)	12/01/2022	7.5	790	23.00	78	2	5			40	20	28			0.09	1.60	< 0.02	< 0.005	0.0032	0.001		0.007	0.0005	0.0036	< 0.02
	07/06/2022	7.2	620	21.00	11	10	3	120	19	25	21	28	5	470	0.09	1.90	< 0.02	< 0.005	< 0.0002	0.002	0.0006	0.003	< 0.0002	0.0013	< 0.02
	16/08/2022	7.2	850	21.00	36	14	4			28	24	25			0.02	1.80	< 0.02	< 0.005	< 0.0002	0.001		0.005	< 0.0002	0.0008	< 0.02
	11/10/2022	7.3	840	21.00	64	3	10			25	22	29			0.01	1.60	0.02	< 0.005	< 0.0002	0.001		0.006	< 0.0002	0.0017	< 0.02
GDW21	26/01/2022	7.5	1000	26.00	210	2	4			190	52	240			0.49	0.13		0.0061						0.0027	
	07/06/2022	6.7	1300	28.00	400	5	7	59	35	190	53	230	41	470	0.04	0.24	< 0.02	< 0.005				0.013		0.0024	< 0.02
	16/08/2022	6.4	1800	24.00	530	44	11			240	37	390			0.03	0.33		< 0.005						0.0025	
	11/10/2022	6.5	1600	25.00	490	4	21			270	38	340			0.11	0.31		< 0.005						0.0018	
GDW23	12/01/2022	6.9	310	0.08	64	< 1	1			15	3	20			0.04	2.20		< 0.005						0.0004	
	07/06/2022	7.0	290	< 0.015	76	< 1	< 0.1	25	18	16	4	20	45	100	0.08	2.30	0.07	< 0.005				0.007		0.0002	< 0.02
	16/08/2022	6.6	330	0.03	46	3	1			20	4	18			0.02	4.00		< 0.005						0.0002	
	11/10/2022	6.7	300	0.04	47	3	3			19	4	19			< 0.004	4.20		< 0.005						0.0002	
GDW24(D)	12/01/2022	6.9	1500	47.00	15	< 1	3			95	53	100			0.18	0.48		< 0.005						0.0019	
	28/09/2022	6.8	2000	90.00	660	16	4			170	91	180			0.04	0.77		0.0229						0.0210	
	18/10/2022	7.3	1000	30.00	92	3	3	150	34	53	50	42	53	610	0.02	0.34	< 0.02	< 0.005				0.002		0.0040	< 0.02
GDW24(S)	12/01/2022	6.9	1500	44.00	53	< 1	3			98	51	110			0.10	0.64		< 0.005						0.0036	
	22/06/2022	7.1	1300	24.00	58	7	2	150	38	80	49	77	186	490	0.49	0.65	0.02	< 0.005				0.024		0.0021	< 0.02
	28/09/2022	6.7	2000	85.00	430	50	4			180	89	180			7.80	0.82		0.029						0.0097	
	18/10/2022	6.8	1500	57.00	290	5	3			110	61	120			0.10	0.61		< 0.005						0.0040	
GDW25	12/01/2022	7.1	2500	13.00	4200	34	20			210	54	190			0.02	0.40		< 0.005						0.0051	
	07/06/2022	7.1	2100	15.00	2300	3	1	480	180	240	70	180	516	1500	0.03	0.33	0.02	< 0.005				0.007		0.0076	< 0.02
	16/08/2022	7.1	2600	16.00	770	20	3			220	59	190			0.01	0.42		< 0.005						0.0049	
	11/10/2022	7.1	2100	14.00	1300	24	24			230	63	190			0.03	0.34		< 0.005						0.0029	
GDW26	12/01/2022	7.0	840	10.00	29	1	2			75	29	63			0.06	0.46		< 0.005						0.0006	
	07/06/2022	7.0	810	11.00	18	2	< 0.1	95	24	93	36	73	5	500	0.08	0.54	< 0.02	< 0.005				0.011		0.0005	< 0.02
	16/08/2022	6.8	1200	15.00	44	6	3			110	43	98			0.03	0.64		< 0.005						0.0006	
	11/10/2022	7.2	1000	17.00	90	16	10			110	44	100			0.10	0.52		< 0.005						0.0016	
TIR JB1	12/01/2022	7.6	350	0.22	35	< 1	1			12	4	19			0.02	0.08		< 0.005						0.0004	
	07/06/2022	7.5	320	0.17	320	3	< 0.1	37	23	13	4	19	14	190	0.02	0.14	< 0.02	< 0.005				0.002		0.0012	< 0.02
	16/08/2022	7.5	360	0.16	36	30	1			14	4	18			0.04	0.13		< 0.005						0.0009	
	11/10/2022	7.6	320	0.10	31	2	4			14	4	18			0.01	0.11		< 0.005						0.0006	

Figure B. 3 - Groundwater Monitoring Point GDW01D

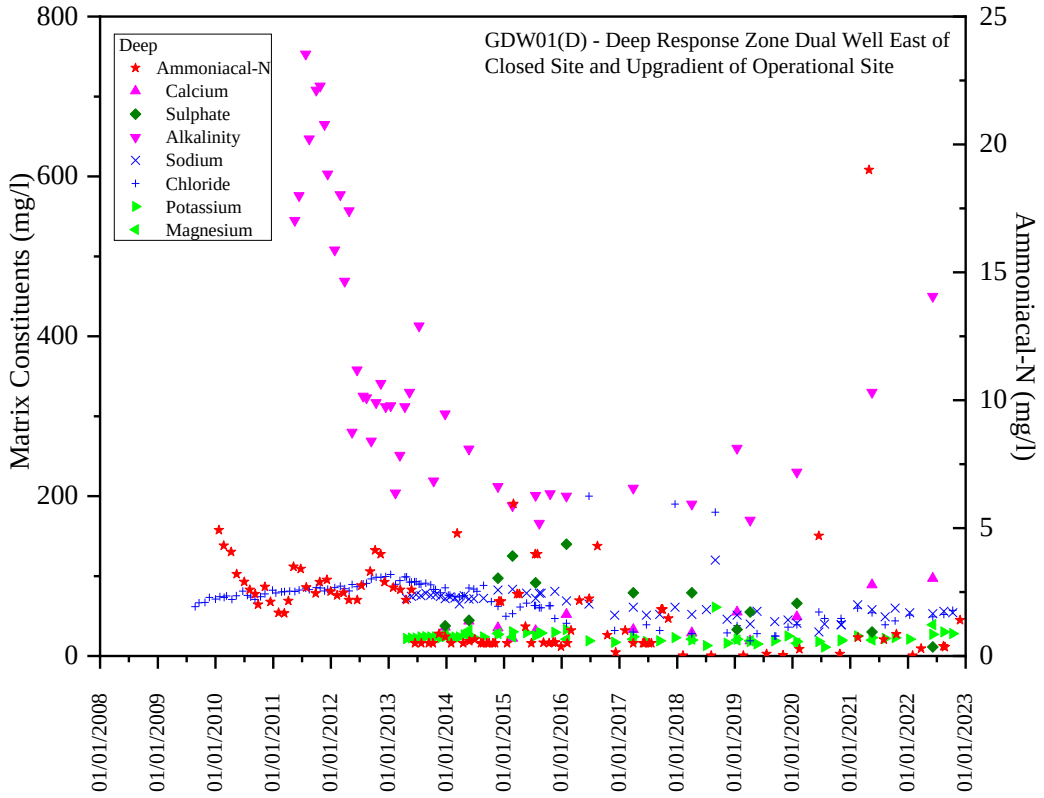


Figure B. 4 - Groundwater Monitoring Point GDW01S

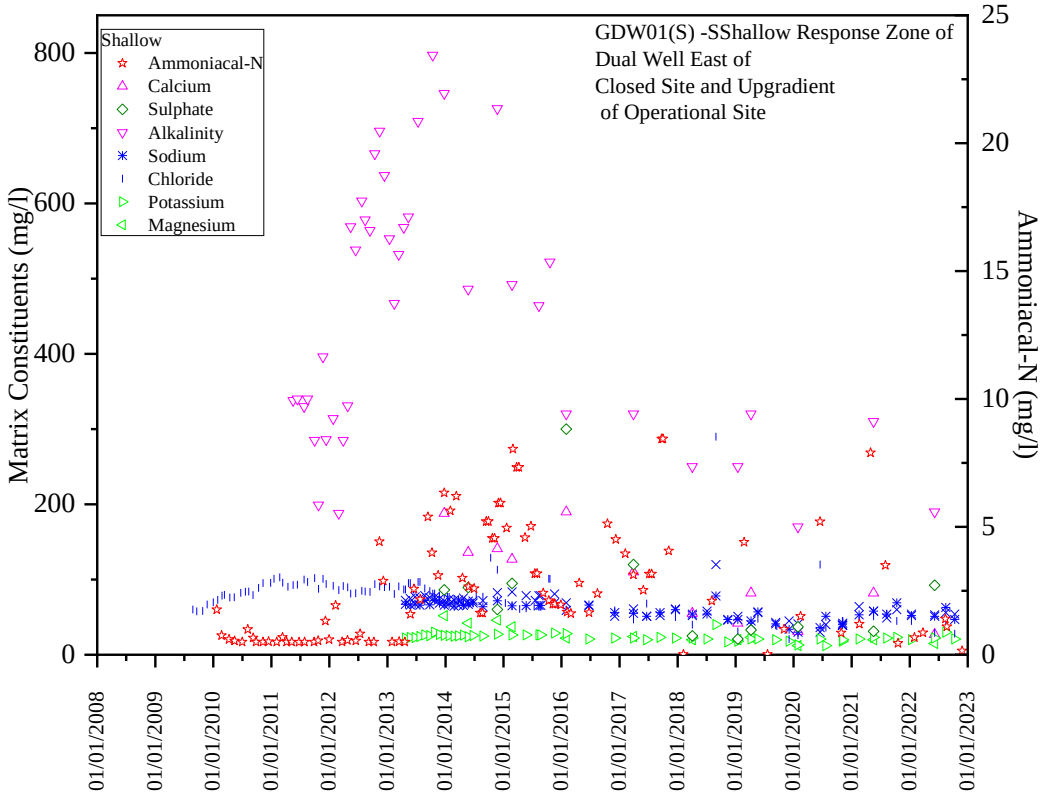


Figure B. 5 - Groundwater Monitoring Point GDW02D

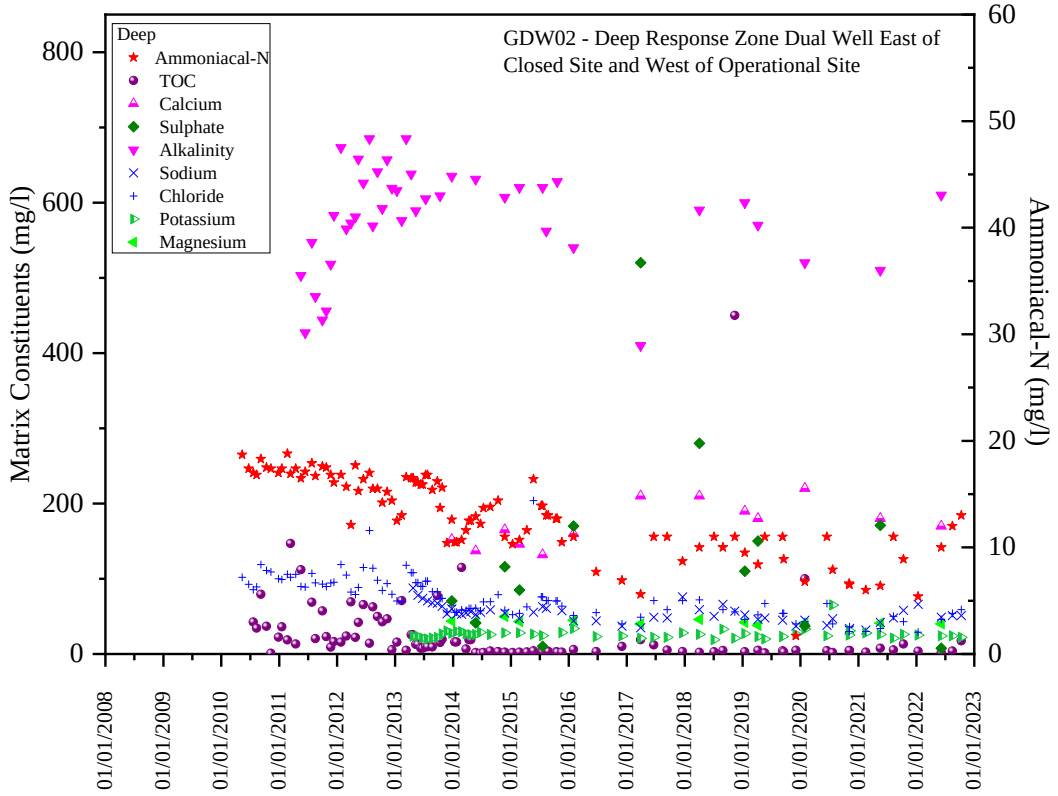


Figure B. 6 – Groundwater Monitoring Point GDW02S

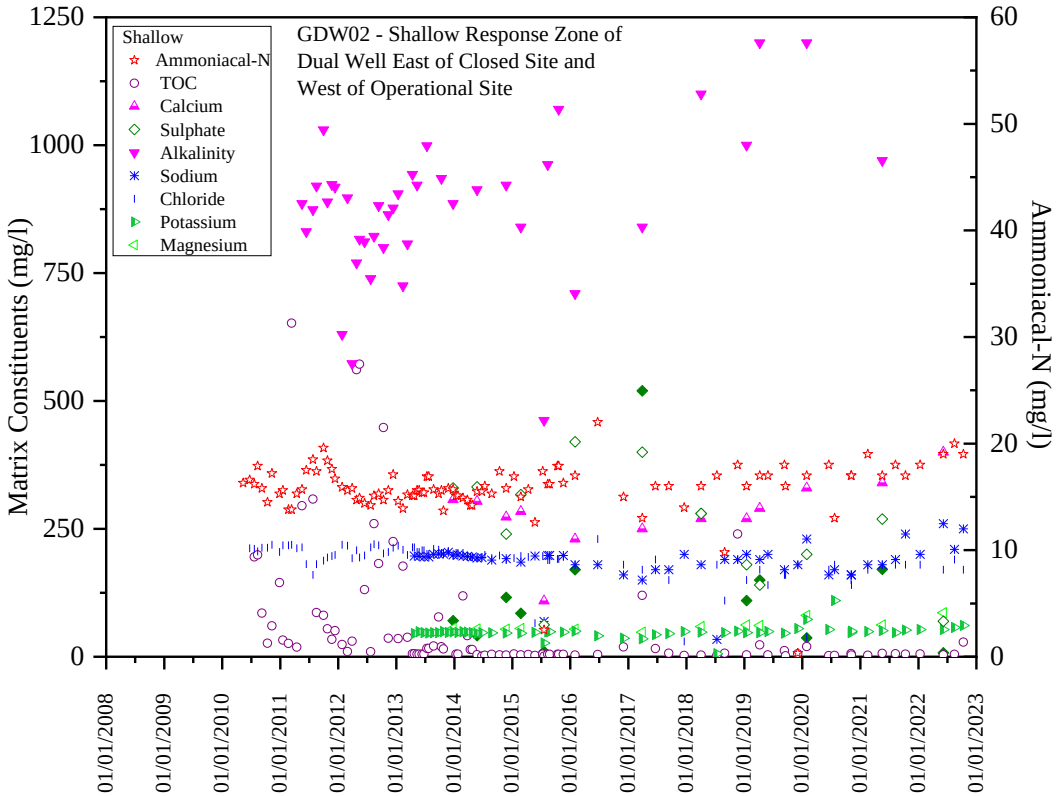


Figure B. 7 - Groundwater Monitoring Point GDW03

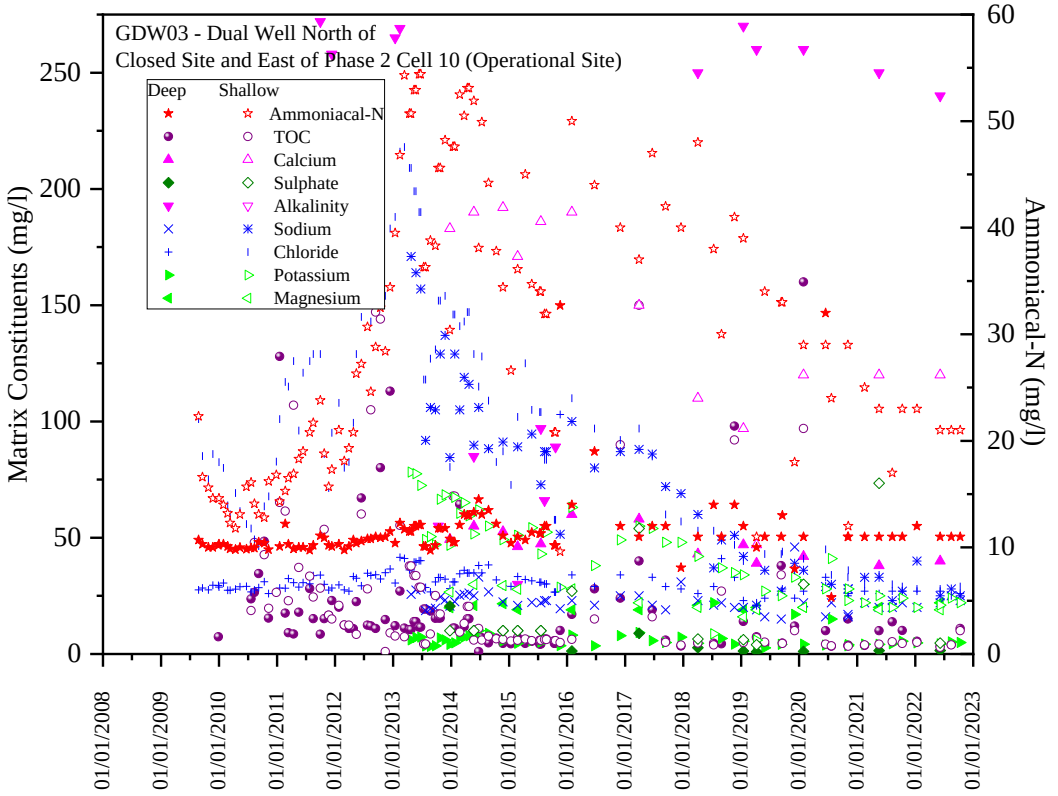


Figure B. 8 - Groundwater Monitoring Point GDW21

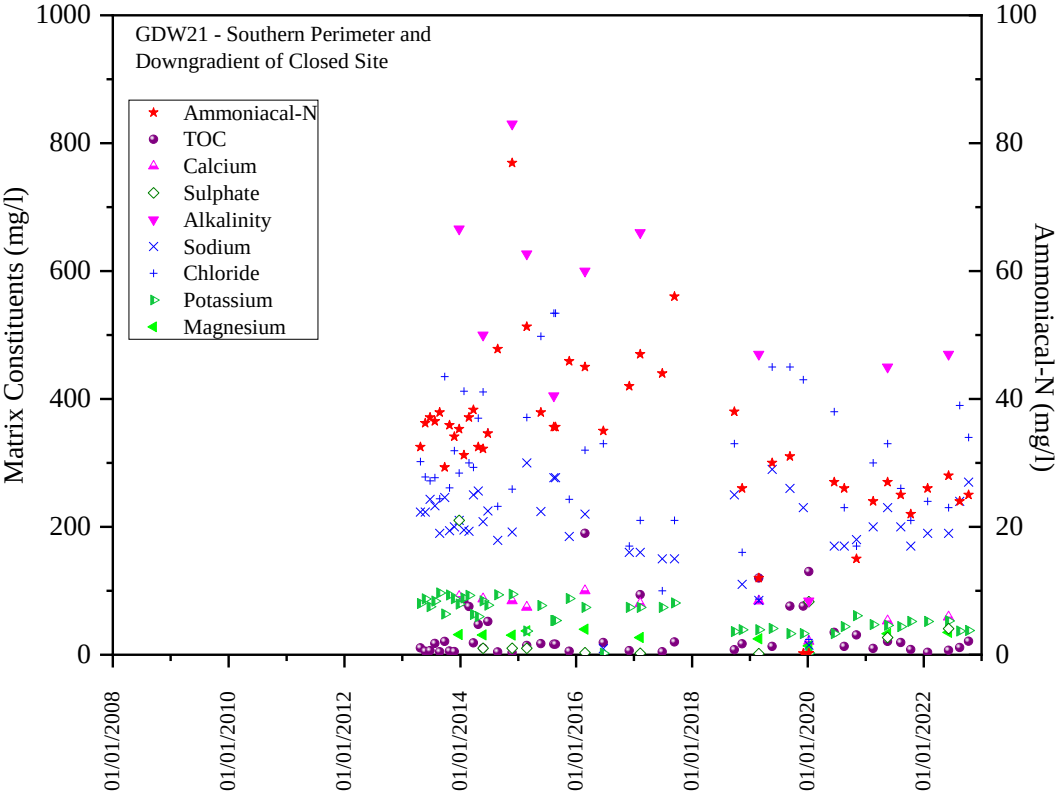


Figure B. 9 – Groundwater Monitoring Point GDW23

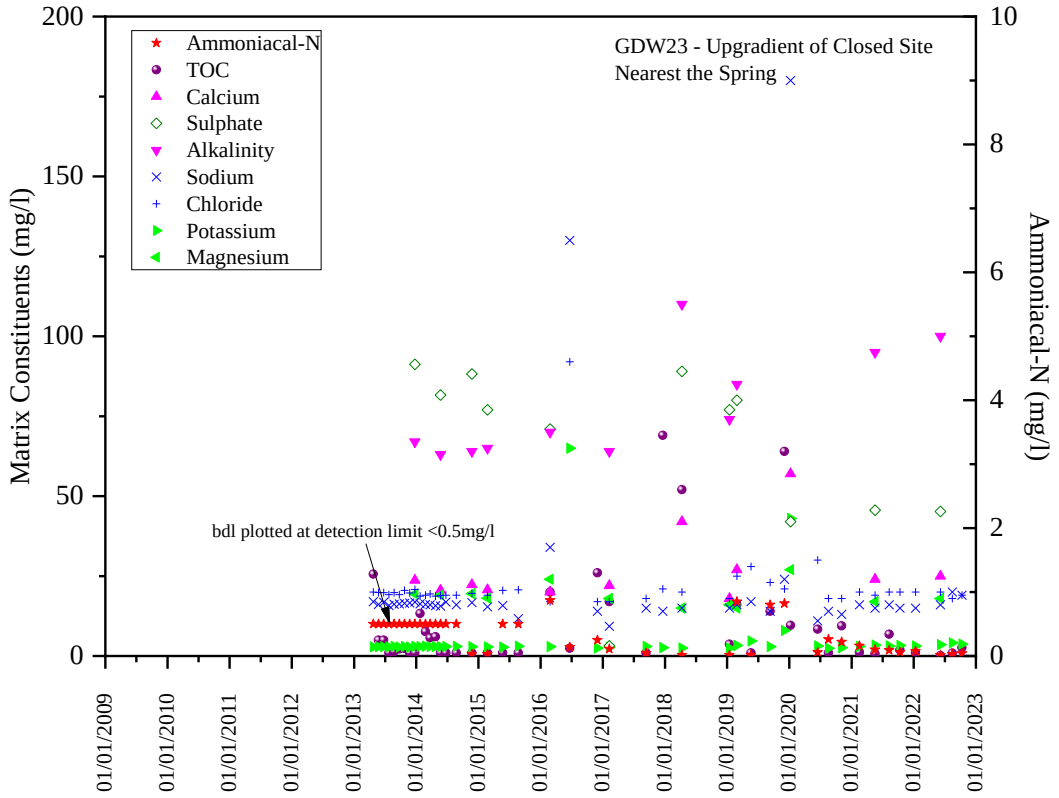


Figure B. 10 - Groundwater Monitoring Point GDW24

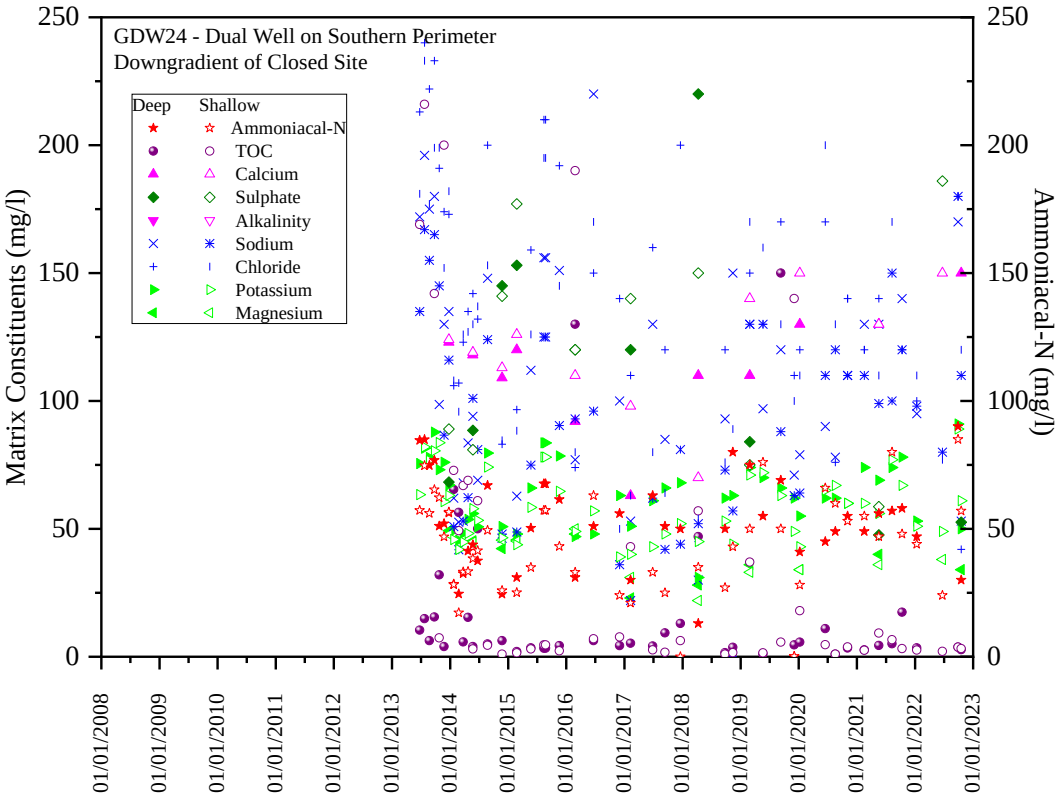


Figure B. 11 – Groundwater Monitoring Point GDW25

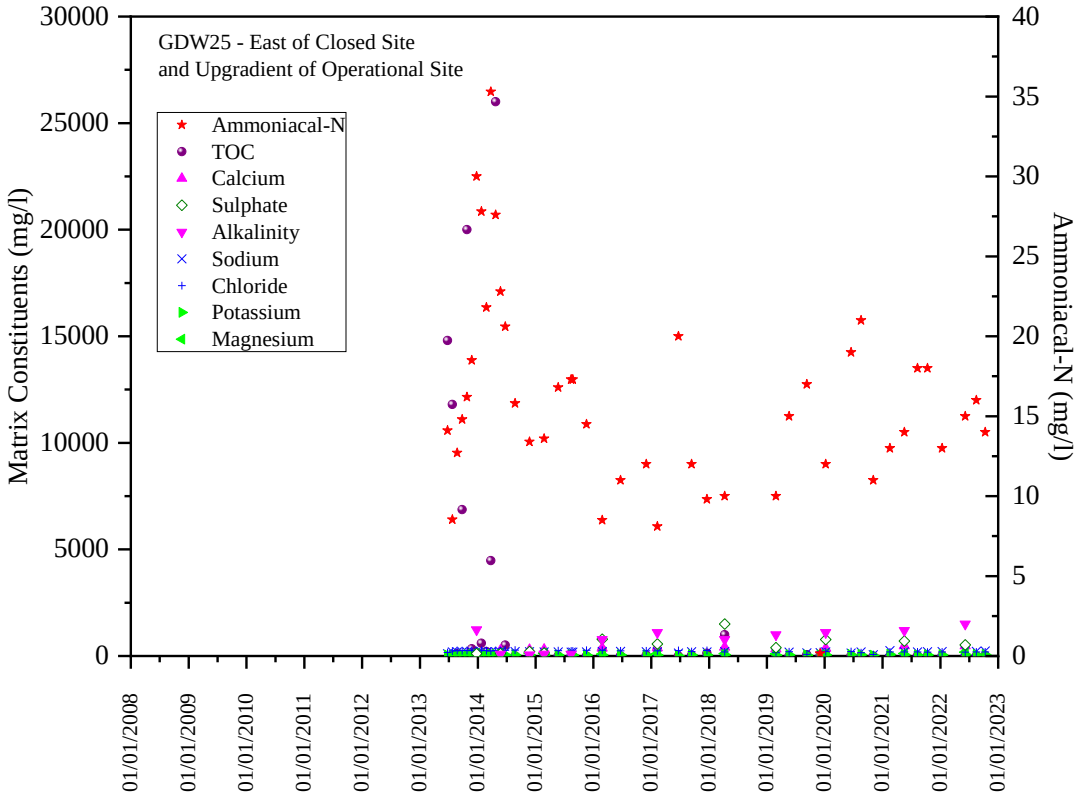
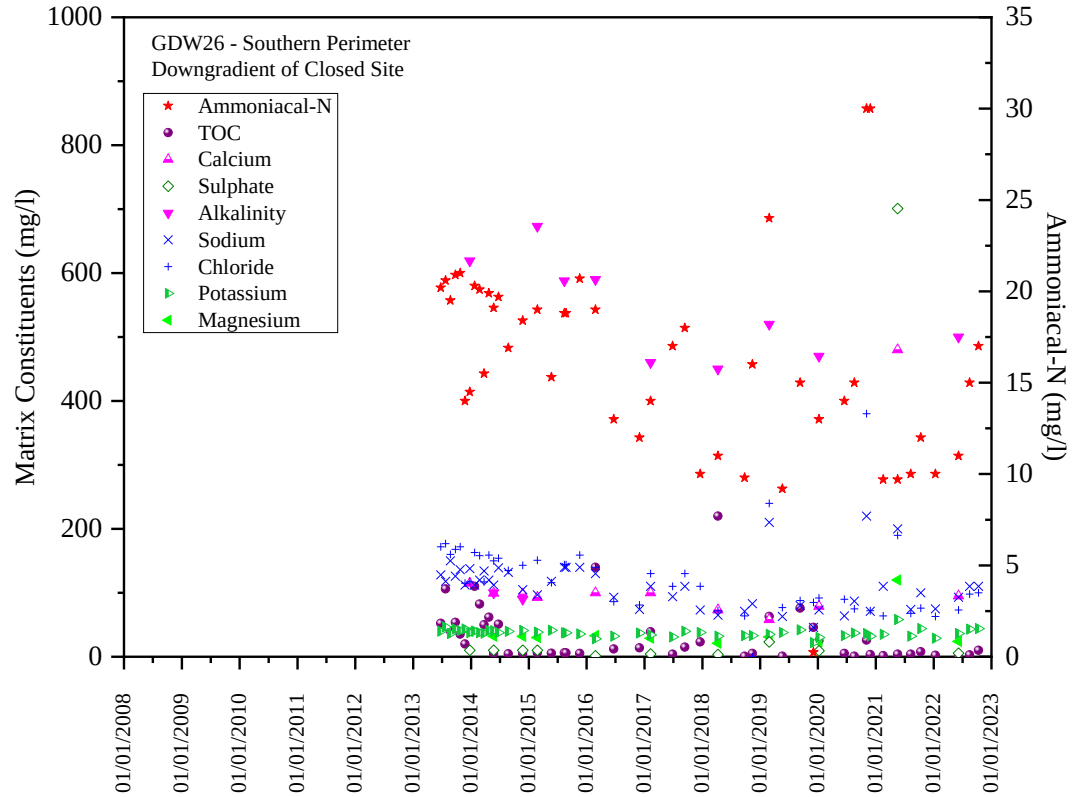


Figure B. 12 – Groundwater Monitoring Point GDW26



Appendix C – Drawing

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

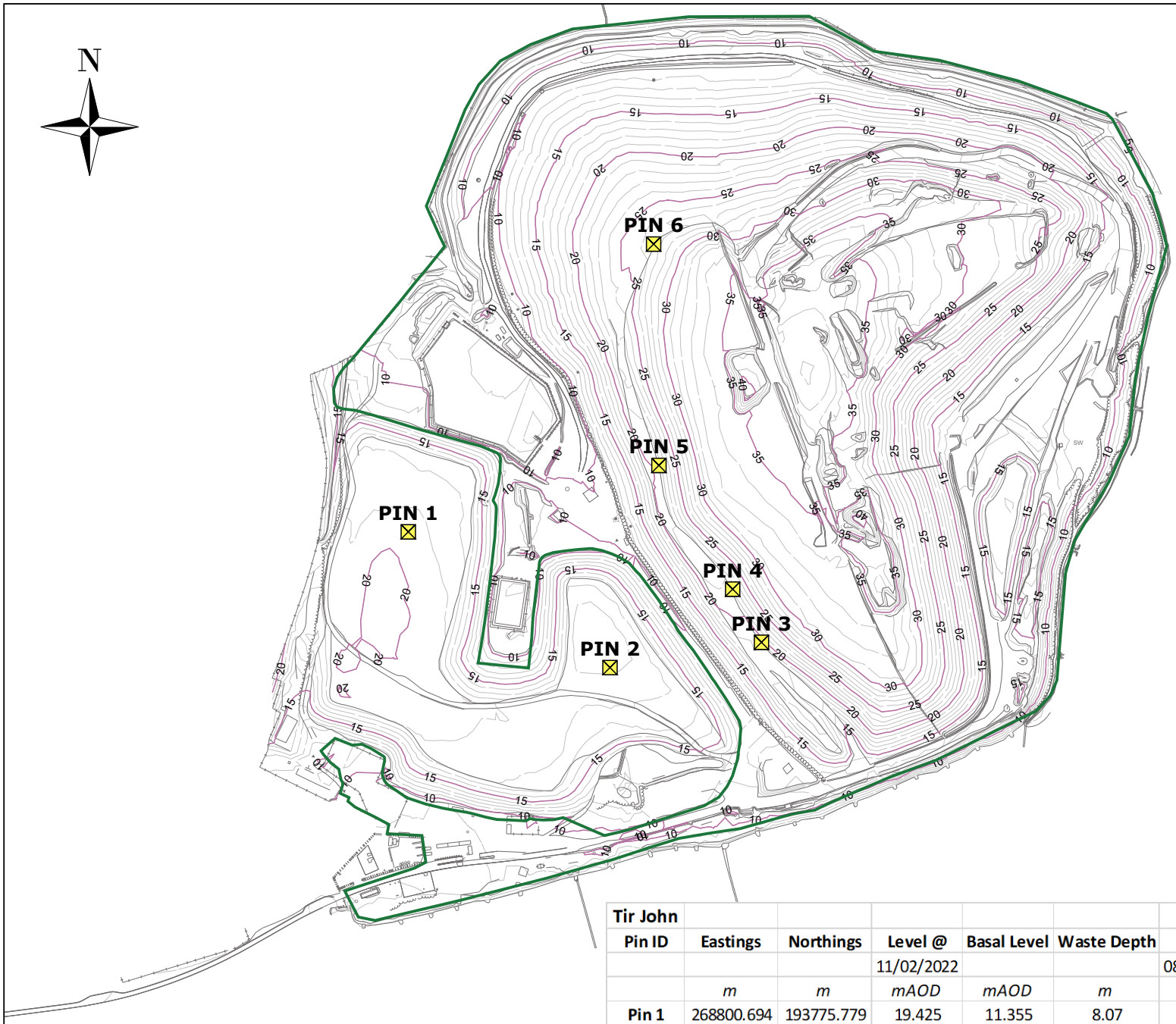
Revision:	Details:

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**	
			11/02/2022			08/12/2022		
	m	*m*	*mAOD*	*mAOD*	*m*	*mAOD*	*m*	*%*
Pin 1	268800.694	193775.779	19.425	11.355	8.07	19.431	0.006	0.1%
Pin 2	268976.598	193657.36	19.248	9.218	10.03	19.235	-0.013	-0.1%
Pin 3	269108.71	193679.429	19.096	10.663	8.433	19.14	0.044	0.5%
Pin 4	269083.601	193725.789	20.848	10.137	10.711	20.85	0.002	0.0%
Pin 5	269019.3	193833.71	20.137	10.405	9.732	20.123	-0.014	-0.1%
Pin 6	269014.656	194026.778	26.206	8.786	17.42	26.184	-0.022	-0.1%

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

Revision:	Details:

Site: **TIR JOHN**

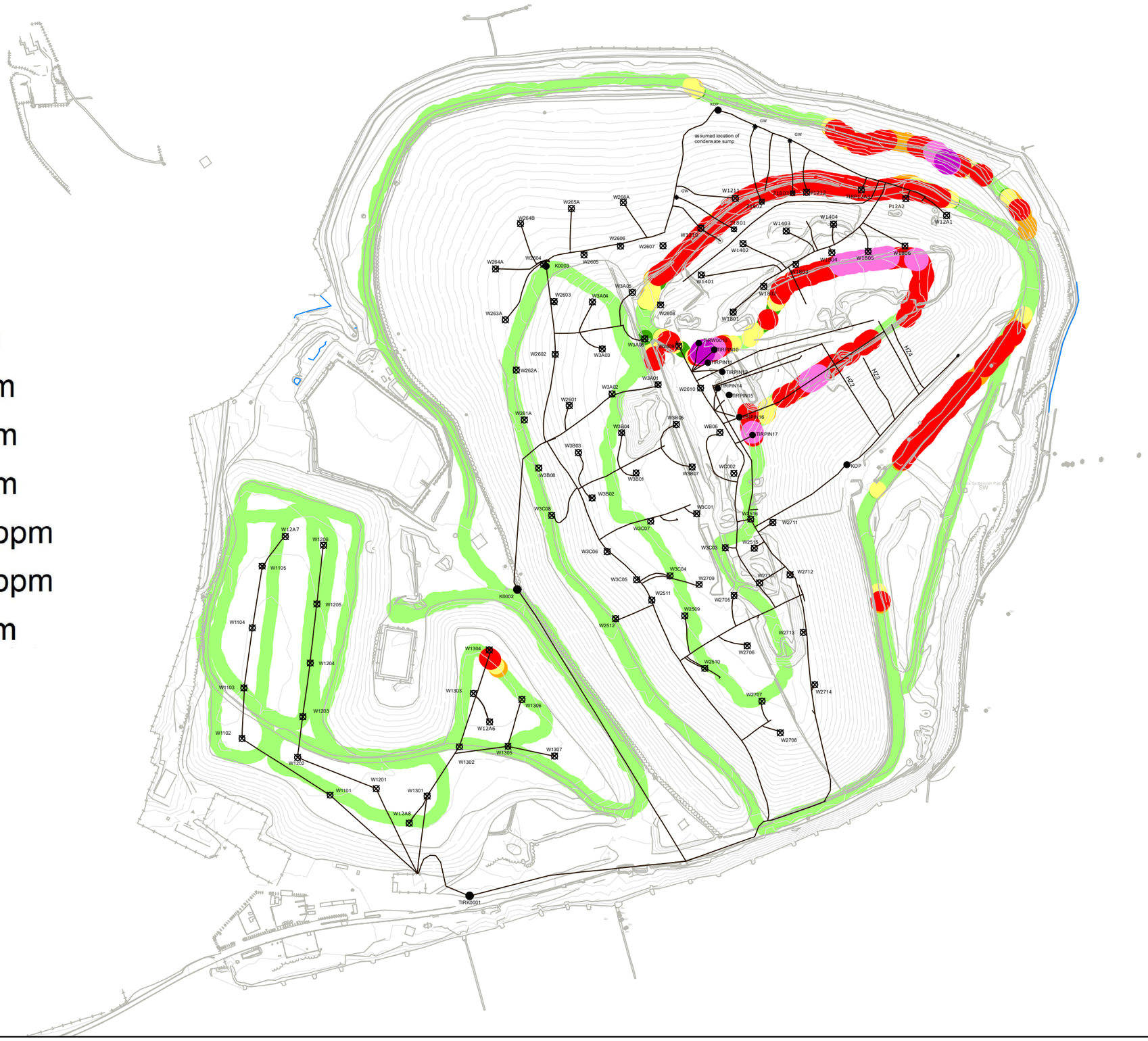
Title: **Site Survey**

Drawn	Date:	Scale @A4:
TJG	6-3-23	1:5000

Drawing number **TJ76**

N

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



1:3,500 @ A3

TIR JOHN
FID Survey Dated 21-12-22

Enovert

IRELAND | UK | UAE | BAHRAIN | KSA

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