# HYDROGEOLOGICAL RISK ASSESSMENT REVIEW

## HENDY QUARRY
## SCHOOL RD
## MISKIN
## PONTYCLUN
## CF72 8PG

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***HYDROGEOLOGICAL RISK ASSESSMENT REVIEW***
***HENDY QUARRY, SCHOOL RD, MISKIN, PONTYCLUN, CF72 8PG***

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**HENDY QUARRY,
SCHOOL RD,
MISKIN,
PONTYCLUN**

**HYDROGEOLOGICAL RISK ASSESSMENT REVIEW**

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# 1.0 INTRODUCTION

## 1.1 Scope & Background

1.1.1 Sirius Environmental Limited ('Sirius') has been commissioned by Tarmac Limited ('Tarmac') to undertake a 6 year review of the Hydrogeological Risk Assessment for Hendy Quarry Landfill Site, Miskin, Pontyclun.

1.1.2 This report presents the results of a Hydrogeological Risk Assessment review (HRA review) for Hendy Quarry Landfill Site, Miskin, Pontyclun.

1.1.3 The original HRA was prepared in 2000 to support the installation's PPC permit application, which was issued in 2002 and subsequently varied in 2005. Subsequent HRA reviews have been undertaken in 2009, 2014 and 2017.

1.1.4 The current guidance requires the hydrogeological risk assessment to be reviewed every six years. This HRA Review consists of a review of the conceptual site model and the parameters used in the 2017 HRAR. This review is undertaken in consideration of all the information collected since the previous review was undertaken. Where any parameters are no longer appropriate the model is revised accordingly.

## 1.2 Site Setting

1.2.1 Hendy Quarry Landfill extends over an area of 8 hectares and is located approximately 500m east of Miskin and 2km south of Llantrisant, Rhondda Cynon Taff, at NGR ST 054 811. Landfilling commenced in September/October 2002.

1.2.2 The landfill is located adjacent to the village of Miskin to the west and the A4119 to the east. To the north lies agricultural land punctuated by commercial and industrial buildings. To the south and east – over the A4119 – lies agricultural land. A railway and the M4 motorway lie ~600m to the south beyond the agricultural land.

1.2.3 The topography in the vicinity of the site is undulating, with rolling hills. The site is built atop one of the hills and once beyond the edge of the site, falls away in all directions.

1.2.4 The boundary of the entire landfill site is securely fenced, with main access to the landfill via the quarry entrance road off the B4264. The site is kept closed and locked during non-operational hours and whenever the site is un-manned.

1.2.5 There are 67 Ancient Woodland sites within 2km of the landfill site, 14 historic landfills and 2 Sites of Special Scientific Interest (SSSI). The nearest sites which may be affected by groundwater level and quality are an Ancient Semi Natural Woodland immediately southeast of the site, a Restored Ancient Woodland ~250m southwest of the site, and Restored Ancient Woodland ~300m south of the site. The northern end of the Ely Valley Site of Special Scientific Interest (SSSI) lies ~250m to the south-southwest. Brofiscin Quarry, Groes-Faen SSSI lies ~1.25km to the east of the site.

1.2.6 The main surface water feature present in the vicinity of the site is the River Ely, which flows in a southeasterly direction and passes within 350m of the southwestern site boundary. A number of tributary streams drain the land southeast of the site, flow to the west and confluence with the River Ely.

1.2.7 There are 22No. licenced surface water discharges are located within 2km of the site. There are 5No. that discharge into streams upgradient of the site are of greatest concern as they may present a source of potential contamination.

1.2.8 The site is not located within a Flood Zone where the risk for flooding is greater than 0.1%.

1.2.9 The site is underlain by dolomitised limestone and dolomite of the Friars Point Limestone Formation and the ooidal limestone of the Gully Oolite Formation. There are no superficial deposits at the site.

1.2.10 The limestone formations are a principal aquifer with a medium-high to high rating for groundwater vulnerability. However, there are no licensed groundwater abstractions in the vicinity of the site. The inferred groundwater flow direction beneath the site, based on monitoring data is towards the southwest.

1.2.11 The site is not within a Source Protection Zone. This is defined by the Environment Agency as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

1.2.12 Two faults are shown to traverse through the site on the BGS 1:50,000 geological map. One fault trends in a north to south direction, the other in a northwest to southeast direction. It is likely that the faults meet ~100m south of the site.

1.2.13 It is proposed that the site will be restored to grassland, mixed woodland and open cliff faces for bird nesting.

## 2.0 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL REVIEW

### 2.1 Source

2.1.1 Inert waste was placed directly in the base of the quarry, as was industry practise at the time. There are no records available to confirm if an engineered geological barrier has historically been placed at the site. All future areas of waste deposit will require the placement of a geological barrier in accordance with the Environmental Permitting Regulations. The conceptual model for the site assumes that the geological barrier is absent across the base of the current waste footprint. Wastes were last imported to the site in October 2017.

Leachate Management

2.1.2 Only low risk inert waste is permitted to be deposited within the landfill facility. No leachate management is therefore required for the site.

Leachate Quality

2.1.3 Inert waste was first accepted into the site in September/October 2002 (BCL 2009). A permit was granted for the site in 2002 under the transitional arrangements of the Landfill Directive. Under the transitional arrangements, there was no requirement for leachate infrastructure to be installed, neither is there any requirement to collect leachate for inert sites under the LFD.

2.1.4 The Landfill Directive (LFD) definition of inert waste is:

> *"Waste that does not undergo any significant physical, chemical, or biological transformations. It will not dissolve or otherwise physically or chemically react, biodegrade, or adversely affect other matter with which it comes into contact in a way likely to give way to environmental pollution of harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater."*

2.1.5 As such, the total leachability and pollutant content of the wastes, and the ecotoxicity of the leachate must be insignificant and in particular not endanger the quality of groundwater.

2.1.6 The primary pollution control mechanism for the site is via pre-acceptance checks to ensure only inert wastes are deposited at the site. These checks require the waste producer to fully characterise the waste ahead of delivery to the site. Characterisation will include a full understanding of the source site, together with basic characterisation testing in accordance with the standard Waste Acceptance Criteria (WAC), as a minimum.

Off-site sources of contamination

2.1.7 There is potential for contamination of groundwater from off-site sources, particularly historical landfill sites and permitted water discharges respectively.

2.1.8 The water discharge site of primary concern are:

- Fuel and power production plant operated by Maxibrite Limited at Mwyndy Industrial Estate, 0.5 km to the north of Hendy Quarry,

2.1.9 The historical landfills of primary concern are:

- Tynewydd Farm Landfill (operated by Glen Harry Haulage Limited), which accepts construction, demolition and dredging waste.
- Llwynpennau Farm Landfill
- Bute Quarry, 250 m to the WNW
- Bute Cottages Quarry, 300 m to the north
- Brofiscin Quarry, 1.25 km to the east of the Site. Between 1965-70, this quarry was used as a disposal site for industrial and chemical waste. The wastes included toxic substances such as solvents, heavy metals, polychlorinated biphenyls (PCBs) and dioxins.

2.1.10 There is a high potential for poor quality groundwater to be present, as two of these former landfill sites are up-gradient of Hendy Landfill Site.

## 2.2 Pathways

2.2.1 The conceptual model for the site remains largely unaltered to the one produced in the 2009 HRAR and reviewed in 2017. In this section we will update any information to the most recent standards and terminology, along with presenting the data gathered since the previous HRAR.

Geology

2.2.2 The underlying shallow geology has previously been summarised and here is consolidated into the sequence in **Table 1**. The nomenclature has been changed since the 2017 review and the updated table reflects these changes.

2.2.3 In general, the Site geology consists of the limestones and dolomites of the Black Rock Limestone Subgroup. These overlie sandstones and mudstones belonging to the Old Red Sandstone Supergroup.

2.2.4 The Site is located on the northern limb of the Cardiff-Cowbridge anticline. On a regional scale, bedding dips steeply to the north northwest; at the Site, the limestone beds dip at 30-35 degrees to the north.

2.2.5 The quarry works strata of the Black Rock Limestone Group. The structure of the anticline is such that older rocks outcrop to the south of the Site, younger strata to the north.

2.2.6 Faults within the Lower Carboniferous Limestone Series predominantly exhibit a north-northwest to south-southeast trend. The major joint direction is similarly oriented, a second joint set is aligned east-northeast – west-southwest and a third joint set coincides with bedding orientation. Further geotechnical consideration and information is presented in the Hendy Quarry Development Plan 10A (*Doc Ref.: H74-10-D-002).*

2.2.7 Some karstification has occurred within the quarry; discontinuities have been widened and infilled with clays, silts and sands. Open karst features are limited to the uppermost quarry faces, generally less than 5m below pre-quarrying ground level.

**Table 1: Solid Geological Sequence at Hendy Quarry Landfill Site adapted from the BGS Lexicon of Named Rock Units**

| Super-group | Group | Sub-group | Formation | Lithology | Likely thickness | Hydro-geological Character |
|---|---|---|---|---|---|---|
| *Carboniferous Limestone Supergroup* | *Pembroke Limestone Group* | | High Tor Limestone Formation | Mid grey, predominantly thick-bedded, fine- to coarse-grained, burrowed, skeletal packstones, with thin beds and partings of shaly dolomite mudstone and siltstone. Some thin-bedded dark grey bituminous skeletal packstones interbedded with thin argillaceous wackestones and mudstones. Coarse, locally cross bedded, peloidal/skeletal/oolitic packstones/grainstones developed in lower and upper parts in northern sections.. | 133m in west/central Vale of Glamorgan. | |
| | | | Caswell Bay Mudstone Formation | Thinly interbedded grey and green grey peloidal and bioclastic micrites, wackestones and packstones, and cryptalgal laminites. Dolomitisation is locally common; on the southeast and east crop of the South Wales Coalfield and in the Chepstow area, the formation is predominantly dolomitised | 15m on the south crop of the South Wales Coalfield | Principal Moderately productive aquifer. Massive karstic limestone aquifer with rapid response to rainfall. Yields highly variable from dry to 40 L/s. |
| | | | Gully Oolite Formation | Medium- to thick-bedded, pale grey, oolitic grainstone with subordinate beds of fine-grained skeletal packstones. Cross-laminated and cross-bedded, some burrowing. Locally dolomitized, especially on the southeast and east crop of the South Wales Coalfield and in the Chepstow area. A palaeokarstic surface overlain by a green/red mudstone/clay palaeosol caps the Formation. | 19m on the southeast crop of the South Wales Coalfield. | |
| | *Avon Group* | *Black Rock Limestone Subgroup* | Friars Point Limestone Formation | Thin- to thick-bedded, dark grey to black, foetid, fine- to coarse-grained skeletal [mainly crinoid] packstones with subordinate thin beds of shaly argillaceous skeletal packstones and mudstone. Widespread burrowing and a lack of tractional structures characterises all but the lowermost part of the formation. The upper part of the formation is dolomitised in the south, while along the southern and eastern crop of the South Wales Coalfield the entire Formation is dolomitised. Formation deposited in a mid-ramp environment. | 76m on the south crop of the South Wales Coalfield. | |
| | | | Brofiscin Oolite Formation | Pale to purplish grey, thick-bedded to massive, cross-bedded, ooidal grainstone. On the southeast and east crop of the South Wales Coalfield the formation is dolomitized. Deposited as an ooid shoal. | 17m in the north of the Vale of Glamorgan | |
| | | | Barry Harbour Limestone Formation | Thin- to medium-bedded, dark grey, coarse- to fine-grained, commonly graded, skeletal [predominantly crinoidal, with subordinate brachiopods] packstones, either stacked or separated by thin beds | 32m on the south crop of the South Wales Coalfield. | |

| Super-group | Group | Sub-group | Formation | Lithology | Likely thickness | Hydro-geological Character |
|---|---|---|---|---|---|---|
| | | | | and partings of calcareous mudstone. In the northwest of the Vale of Glamorgan, thin beds of ooid grainstone are present in the uppermost part of the Formation. Along the southeast and east crop of the South Wales Coalfield, the Formation is predominantly dolomitized; the upper part comprising very fine- to fine-grained, pale to dark grey, partly laminated and cross laminated dolomitised packstones with sparse fossiliferous lenses that are locally silicified. | | |
| | | | Cwmyniscoy Mudstone Formation | Interbedded grey mudstones and thin- to medium-bedded skeletal packstones deposited in a mid-shelf environment. | 60m in the south of the Vale of Glamorgan, thinning northwards to 10m on the north crop of the South Wales Coalfield [Abergavenny]. | Secondary A |
| | | | Castell Coch Limestone Formation | Grey, locally reddened, medium- to thick-bedded, cross-bedded, oolitic and skeletal grainstones deposited as part of a barrier complex. Thin units of grey mudstone, calcite mudstone and calcisiltite are locally present in the uppermost part of the Formation and represent back barrier peritidal deposits. | 30m on the north crop of the South Wales Coalfield [Abergavenny], thinning southwards to 9m in the south of the Vale of Glamorgan.] | Principal Moderately productive aquifer. |
| | | | Tongwynlais Formation | Lower part comprises thin- to thick-bedded skeletal, peloidal, ooidal and sandy grainstones and packstones with subordinate grey mudstones, calcite mudstones, calcretes and ironstones. Upper part comprises thin- to medium-bedded skeletal packstones and grey mudstones. | Up to 50m in the south of the Vale of Glamorgan, thinning northwards to a feather edge in the Risca area on the east crop of the South Wales Coalfield. | Secondary A |
| ***Old Red Sandstone Supergroup*** | ***Brecon Beacons Group*** | ***Portishead Subgroup*** | Cwrt-yr-Ala Formation | Thinly interbedded quartzitic sandstones, siltstones and mudstones with subordinate thick commonly pebbly sandstone units | 15m to 73m | Secondary A aquifer. Largely mudstone and siltstone |

| Super-group | Group | Sub-group | Formation | Lithology | Likely thickness | Hydro-geological Character |
|---|---|---|---|---|---|---|
| | ***Daugleddau Group*** | ***Cosheston Subgroup*** | Brownstones Formation | Red, brown and purple fluvial sandstones with red mudstone interbeds. | To 1200m | sequence with occasional sandstone yielding only small amounts of groundwater |
| | | ***Milford Haven Subgroup*** | Llanishen Conglomerate Formation | Red sandstones, siltstones and mudstones with beds of pebbly sandstone and conglomerate | About 137 to 150 m. | |

Hydrogeology

2.2.8 The Carboniferous Limestone is classed as a major aquifer in England and Wales. It possesses significant secondary porosity due to joints and fractures. The flow within the fractures dominates the groundwater flow regime. The rock matrix has a very low permeability; therefore, the aquifer can exhibit a great deal of variability in its hydrogeological characteristics across even short distances.

2.2.9 The site sits within the formations of the Black Rock Limestone Subgroup. To the south lies the Cwmyniscoy Mudstone Formation, which - although listed as a Secondary A aquifer - behaves as an aquitard to the waters within the Black Rock Limestone Subgroup. This is demonstrated by the two boreholes along the southern boundary of the site. These boreholes have much higher groundwater elevations than those in the more permeable limestone subgroup. Both the lower permeability and the hydraulic gradient high groundwater levels create prevents groundwater flow to the south.

2.2.10 The rates of water that the quarry soakaway is able to sequester supports the idea of high transmissivity values being present at the site. The discharge limit (to soakaway) is 750m$^3$ /day, however in the assessment of run-off , ESI (2014)[1] stated that volumes of up to 8,031m$^3$ /day have been discharged.

Groundwater Flow

2.2.11 Until June 2021 a total of 10No. monitoring boreholes were routinely used to monitor groundwater levels around the periphery of the Hendy Quarry Landfill. However, from June 2021 groundwater level monitoring was only carried out on 4 boreholes – PZ02-08, PZ03-08, PZ07-08 and PZ08-08. The latter two of these were redrilled in 2021 and designated PZ07-08R and PZ08-08R. Monitoring continued in the replacement boreholes from June 2021. Monitoring data for these installations is presented in tabulated and graphical form in **Appendix 1.** A comparative summary of groundwater levels recorded in the 2016 review of the HRA against the levels monitored since June 2016 to date is presented in **Table 2** and a groundwater hydrograph are presented in **Appendix 1**. Groundwater contours are presented in **Drawing No. TA1066/04/02.**

2.2.12 Groundwater levels within the other boreholes continue to indicate a consistent groundwater gradient from the east to the west, with boreholes to the east of the sump (up-gradient wells PZ02/08 and PZ03/08) continuing to display a higher seasonal variation compared to those to the west of the sump.

**Table 2: Comparative summary of monitored groundwater levels around Hendy LFS (2013-2024)**

| BH Ref. | 2013-2017 | | | | January 2017-2024 | | | |
|---|---|---|---|---|---|---|---|---|
| | Groundwater Elevation (mAOD) | | | Range (m) | Groundwater Elevation (mAOD) | | | Range (m) |
| | *Min* | *Mean* | *Max* | | *Min* | *Mean* | *Max* | |
| BH0B | 43.98 | 45.26 | 46.33 | 2.35 | 34.48 | 44.76 | 46.92 | 12.44 |
| BH0H | 43.48 | 44.57 | 46.70 | 3.22 | 42.64 | 44.63 | 46.53 | 3.89 |
| BH0X | 45.07 | 45.95 | 47.29 | 2.22 | 44.00 | 46.06 | 48.57 | 4.57 |
| BH0Y | 53.24 | 54.37 | 55.49 | 2.25 | - | - | - | - |
| PZ01-08 | 42.34 | 49.06 | 55.27 | 12.93 | 45.06 | 47.04 | 49.37 | 4.31 |
| PZ02-08 | 47.74 | 50.93 | 58.62 | 10.88 | 43.59 | 49.62 | 62.16 | 18.57 |
| PZ03-08 | 47.73 | 50.75 | 55.94 | 8.21 | 41.96 | 49.8 | 57.2* | 15.24 |
| PZ05-08 | 62.61 | 64.33 | 66.82 | 4.21 | 55.88 | 64.33 | 66.88 | 11.00 |

[1] *ESI, Dec 2014, Hendy Quarry – Assessment of runoff, Ref 62847TN1*

| BH Ref. | 2013-2017 | | | | January 2017-2024 | | | |
|---|---|---|---|---|---|---|---|---|
| | Groundwater Elevation (mAOD) | | | Range (m) | Groundwater Elevation (mAOD) | | | Range (m) |
| | *Min* | *Mean* | *Max* | | *Min* | *Mean* | *Max* | |
| PZ06-08 | 55.50 | 57.46 | 61.87 | 6.37 | 55.21 | 58.13 | 62.21 | 7.00 |
| PZ07-08 | 44.25 | 45.65 | 47.17 | 2.92 | 43.24 | 45.83 | 47.18 | 3.945 |
| PZ07-08R | - | - | - | - | 37.52 | 43.9* | 56.62 | 19.10 |
| PZ08-08 | 41.59 | 43.87 | 46.35 | 4.76 | 42.21 | 44.44 | 46.42 | 4.213 |
| PZ08-08R | - | - | - | - | 39.65 | 44.13 | 54.26 | 14.61 |
| * Suspected erroneous results removed and statistics adjusted accordingly<br>Boreholes BH0B, BH0H, BH0X, PZ01-08, PZ05-08, PZ06-08 ceased monitoring in June 2021 | | | | | | | | |

## 2.3 Receptors

2.3.1 The primary receptor to the landfill activity continue to be groundwater within the underlying and surrounding Carboniferous Limestone Aquifer. This aquifer is classified as a Principal Aquifer which indicates that these rocks have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

2.3.2 The Carboniferous Limestone Aquifer ultimately discharges to the River Ely, along which a SSSI is located along a stretch of the Ely Valley.

2.3.3 There are several licensed abstractions and private water supplies registered within 2km of the site. None of these are located downgradient of the site relative to the direction of groundwater flow and therefore continue to be disregarded are potential receptors to the landfill activity.

2.3.4 Based on current regulatory requirements, the relevant compliance point for hazardous substances and non-hazardous pollutants is within groundwater in the Dinantian aquifer at the downgradient boundary of the site.

Groundwater Quality

2.3.5 The graphs and statistics assume that all results recorded at less than the laboratory detection limit are at the limit of detection to enable them to be displayed and conservatively included in the statistics.

2.3.6 For the purpose of this review the boreholes can be categorised by their position relative to the gradient of groundwater flow. Specifically, the groundwater monitoring boreholes can be divided into 3 groups, up-gradient, cross-gradient and down-gradient. These are summarised in **Table 3.**

**Table 3: Groundwater monitoring borehole groupings**

| BH Group | BH ID |
|---|---|
| Up-Gradient | PZ02-08, PZ03-08, |
| Down-Gradient | PZ07-08, PZ08-08, Sump, Discharge |

A comparative summary of monitored groundwater quality for the 2009 to 2017 and 2017 to 2024 review periods is presented in **Table 4**. Full groundwater quality monitoring data for the 2017 to 2024 review period is presented in **Appendix 2**.

**Table 4: Groundwater Quality Summary Review**

| Determinand | Statistic | Discharge | | PZ02-08 | | PZ03-08 | | PZ07-08 | | PZ07-08R | PZ08-08 | | PZ08-08R | Sump |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2017-2024 |
| Alkalinity (mg/l) | Min | - | 215 | 108 | 130 | 124 | 178 | 279 | - | 106 | 222 | 290 | 150 | 110 |
| | Average | - | 276.0 | 265.0 | 169.6 | 312.0 | 310.9 | 279.0 | 430 | 308.7 | 406.0 | 315.0 | 323.7 | 176.9 |
| | Max | - | 325 | 1470 | 356 | 546 | 354 | 279 | - | 588 | 1230 | 340 | 466 | 270 |
| Ammoniacal Nitrogen (mg/l) | Min | 0.27 | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | 0.01 | - | <0.01 | 0.01 | 0.05 | <0.01 | <0.01 |
| | Average | 0.35 | 0.019 | 0.21 | 0.038 | 0.26 | 0.044 | 0.22 | 0.36 | 0.014 | 0.23 | 1.663 | 0.014 | 0.089 |
| | Max | 0.41 | 0.05 | 0.41 | 0.44 | 1.40 | 0.31 | 0.30 | - | 0.05 | 1.10 | 8.60 | 0.08 | 0.26 |
| Cadmium (mg/l) | Min | 0.0006 | <0.00002 | 0.00002 | <0.00002 | 0.0001 | <0.00002 | 0.0001 | - | <0.00002 | 0.0001 | <0.00002 | <0.00002 | <0.00002 |
| | Average | - | 0.000027 | 0.001 | 0.000032 | 0.0017 | 0.000391 | 0.0006 | 0.00009 | 0.00004 | 0.00190 | 0.000027 | 0.000052 | 0.000029 |
| | Max | 0.0006 | 0.00009 | 0.0084 | 0.00029 | 0.0131 | 0.00065 | 0.0012 | - | 0.00015 | 0.0060 | 0.00004 | 0.00036 | 0.00010 |
| Calcium (mg/l) | Min | 77 | 80 | 45 | 44 | 8 | 65 | 109 | - | 38 | 7 | 92 | 56 | 38 |
| | Average | 89.0 | 96.0 | 111.0 | 63.8 | 106.0 | 94.3 | 150.0 | 120.0 | 96.0 | 230.0 | 98.8 | 109.8 | 66.8 |
| | Max | 98 | 105 | 1010 | 110 | 174 | 128 | 214 | - | 125 | 1280 | 110 | 150 | 93 |
| Chloride (mg/l) | Min | 29.5 | 16 | 3 | 7 | 4 | 7 | 20 | - | 3 | 10 | 39 | 4 | 15 |
| | Average | 36.0 | 24.2 | 37.0 | 24.8 | 73.0 | 56.5 | 38.0 | 53.0 | 23.4 | 41.0 | 42.2 | 25.9 | 33.4 |
| | Max | 42.2 | 31 | 136 | 79 | 131 | 100 | 50 | - | 46 | 57 | 47 | 35 | 71 |
| Chromium (mg/l) | Min | 0.002 | <0.001 | 0.001 | <0.001 | 0.001 | <0.001 | 0.001 | - | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 |
| | Average | - | 0.0011 | 0.0030 | 0.0010 | 0.0040 | 0.0011 | 0.0040 | <0.001 | 0.0011 | 0.0100 | 0.0010 | 0.0011 | 0.0011 |
| | Max | 0.0020 | 0.002 | 0.0090 | 0.002 | 0.0100 | 0.003 | 0.0070 | - | 0.002 | 0.0370 | 0.001 | 0.003 | 0.002 |
| Copper (mg/l) | Min | 0.0090 | <0.001 | 0.0010 | <0.0005 | 0.0010 | 0.0009 | 0.0020 | - | <0.001 | 0.0010 | <0.0005 | <0.001 | <0.001 |
| | Average | 0.0090 | 0.001 | 0.0120 | 0.001 | 0.0270 | 0.002 | 0.0200 | 0.0009 | 0.001 | 0.0290 | 0.001 | 0.001 | 0.002 |
| | Max | 0.009 | 0.002 | 0.065 | 0.004 | 0.206 | 0.010 | 0.048 | - | 0.003 | 0.144 | 0.002 | 0.003 | 0.003 |
| Dissolved Oxygen (mg O2/l) | Min | 3 | 7 | 0.1 | 8 | 0.5 | 6 | 4.8 | - | 5 | 2.4 | 6 | 3 | 5 |
| | Average | 6.90 | 10.79 | 6.30 | 10.26 | 5.40 | 9.63 | 6.70 | 8.9 | 9.68 | 5.10 | 7.88 | 9.93 | 9.89 |
| | Max | 10.3 | 12.4 | 11.3 | 12.6 | 9.9 | 12.5 | 8.2 | - | 12.7 | 9.4 | 9.7 | 12.5 | 12.6 |

| Determinand | Statistic | Discharge | | PZ02-08 | | PZ03-08 | | PZ07-08 | | PZ07-08R | PZ08-08 | | PZ08-08R | Sump |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2017-2024 |
| Electrical conductivity (us/cm) | Min | 558 | 500 | 241 | 310 | 312 | 370 | 666 | - | 241 | 601 | 760 | 322 | 334 |
| | Average | 694.0 | 619.7 | 342.0 | 414.5 | 776.0 | 756.6 | 666.0 | 910 | 655.5 | 724.0 | 800.0 | 721.6 | 540.8 |
| | Max | 884 | 741 | 699 | 844 | 950 | 970 | 666 | - | 794 | 885 | 900 | 926 | 830 |
| Iron (mg/l) | Min | 0.23 | <0.01 | 0.01 | <0.005 | 0.01 | <0.005 | 0.01 | - | <0.01 | 0.01 | <0.005 | <0.01 | <0.005 |
| | Average | 0.570 | 0.011 | 3.020 | 1.582 | 2.240 | 4.064 | 3.350 | <0.005 | 0.011 | 6.850 | 3.840 | 0.010 | 0.033 |
| | Max | 1.36 | 0.02 | 16.10 | 72 | 5.20 | 170 | 9.22 | - | 0.05 | 24.70 | 23 | 0.02 | 0.17 |
| Magnesium (mg/l) | Min | 21 | 19 | 6 | 5 | 2 | 9 | 33 | - | 6 | 2 | 28 | 8 | 12 |
| | Average | 24.0 | 24.5 | 35.0 | 9.3 | 37.0 | 29.7 | 45.0 | 39 | 29.9 | 59.0 | 31.7 | 31.1 | 20.8 |
| | Max | 28 | 30 | 437 | 34 | 115 | 40 | 70 | - | 38 | 271 | 34 | 46 | 32 |
| Manganese (mg/l) | Min | 0.044 | <0.002 | 0.002 | <0.001 | 0.002 | <0.001 | 0.044 | - | <0.002 | 0.002 | <0.001 | <0.002 | 0.001 |
| | Average | 0.080 | 0.009 | 0.400 | 0.116 | 0.300 | 0.242 | 0.830 | <0.001 | 0.053 | 1.800 | 1.231 | 0.016 | 0.024 |
| | Max | 0.16 | 0.031 | 6.36 | 5 | 1.04 | 10 | 1.92 | - | 0.672 | 15.70 | 7 | 0.285 | 0.256 |
| Naphthalene (ug/l) | Min | 0.01 | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | 0.01 | - | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 |
| | Average | 0.010 | <0.01 | 0.080 | 0.025 | 0.080 | 0.025 | 0.010 | <0.01 | 0.012 | 0.070 | 0.150 | 0.023 | 0.032 |
| | Max | 0.02 | <0.01 | 2 | 0.45 | 2 | 0.50 | 0.02 | - | 0.1 | 2 | 0.81 | 0.41 | 0.33 |
| Nickel (mg/l) | Min | 0.003 | <0.001 | 0.001 | <0.001 | 0.001 | <0.001 | 0.003 | - | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 |
| | Average | 0.004 | 0.0010 | 0.008 | 0.0010 | 0.006 | 0.0011 | 0.007 | 0.001 | 0.0011 | 0.015 | 0.0012 | 0.0011 | 0.0012 |
| | Max | 0.006 | 0.001 | 0.062 | 0.001 | 0.014 | 0.003 | 0.016 | - | 0.003 | 0.056 | 0.002 | 0.002 | 0.002 |
| PAH (ug/l) | Min | 0.000 | - | 0.010 | <0.01 | 0.010 | <0.01 | 0.010 | - | 0.01 | - | <0.01 | - | 0.02 |
| | Average | 0.003 | - | 0.110 | 0.066 | 0.050 | 0.068 | 0.090 | <0.01 | 0.07 | - | 0.348 | - | 0.18 |
| | Max | 0.01 | - | 1.72 | 0.510 | 0.17 | 0.53 | 0.32 | - | 0.24 | - | 2.0 | - | 0.59 |
| Total USEPA16) PAH (ug/l) | Min | - | <0.16 | - | <0.16 | - | <0.16 | - | - | <0.16 | - | <0.16 | - | <0.16 |
| | Average | - | <0.16 | - | 0.16 | - | <0.16 | - | - | 0.17 | - | 0.17 | - | 0.18 |
| | Max | - | 1.1 | - | 0.18 | - | 0.17 | - | - | 0.25 | - | 0.23 | - | 0.33 |
| pH (liquid) (pH units) | Min | 7.5 | 7.4 | 7.3 | 7.3 | 6.7 | 7.2 | 7.4 | 7.7 | 7.1 | 7.1 | 7.8 | 7.2 | 7.4 |
| | Average | 8.02 | 7.70 | 8.00 | 7.78 | 7.80 | 7.64 | 7.90 | 7.67 | 7.51 | 7.75 | 7.89 | 7.47 | 7.93 |

| Determinand | Statistic | Discharge | | PZ02-08 | | PZ03-08 | | PZ07-08 | | PZ07-08R | PZ08-08 | | PZ08-08R | Sump |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2009-2017 | 2017-2024 | 2017-2024 | 2017-2024 |
| | Max | 8.7 | 8.1 | 8.8 | 8.6 | 8.5 | 8.1 | 8.3 | 7.7 | 8.6 | 8.8 | 8.0 | 8.2 | 8.3 |
| Potassium (mg/l) | Min | 3.8 | 3 | 0.5 | 0.42 | 0.8 | <1 | 2.4 | 3 | <1 | 1.0 | 1.6 | <1 | 2 |
| | Average | 5.0 | 3.7 | 1.7 | 1.1 | 2.4 | 2.1 | 2.9 | 3.0 | 3.0 | 2.9 | 2.9 | 3.2 | 3.6 |
| | Max | 6.2 | 4 | 4.3 | 4 | 3.6 | 5 | 3.5 | 3 | 4 | 5.8 | 4 | 6 | 7 |
| Sodium (mg/l) | Min | 16 | 10 | 5 | 5 | 4 | 4 | 11 | 25 | 2 | 7 | 21 | 2 | 9 |
| | Average | 21 | 14.9 | 19 | 14.2 | 41 | 35.0 | 17 | 25.0 | 14.4 | 22 | 25.3 | 17.8 | 19.2 |
| | Max | 24 | 18 | 65 | 44 | 72 | 68 | 22 | 25 | 22 | 41 | 29 | 27 | 33 |
| Sulphate (mg/l) | Min | 52.5 | 26.0 | 4.3 | <3 | 8.0 | <3 | 0.0 | 08.0 | 09.0 | 9.6 | 28.0 | 09.0 | 20.0 |
| | Average | 81.7 | 37.4 | 12.8 | 10.7 | 12.5 | 17.0 | - | 08.0 | 35.8 | 53.0 | 56.5 | 44.6 | 52.7 |
| | Max | 110.0 | 50.0 | 45.6 | 84.0 | 16.4 | 160.0 | 10.7 | 08.0 | 54.0 | 117.0 | 96.0 | 105.0 | 150.0 |
| Total Organic Carbon (mg/l) | Min | 2.6 | 1.31 | 0.07 | 0.20 | 0.55 | 0.28 | 0.7 | 14 | 0.57 | 0.7 | 5 | 0.63 | 2.34 |
| | Average | 4.10 | 2.82 | 1.32 | 2.66 | 1.78 | 3.63 | 1.08 | 14.00 | 2.03 | 2.34 | 8.50 | 2.80 | 6.96 |
| | Max | 5.6 | 4 | 7 | 14 | 9 | 18 | 1.72 | 14 | 7.2 | 11 | 11 | 9.2 | 16 |
| TPH (mg/l) | Min | - | <0.01 | - | <0.01 | - | <0.002 | - | - | - | - | <0.002 | - | <0.01 |
| | Average | - | <0.3 | - | <0.3 | - | <0.3 | - | 0.11 | - | - | 0.07 | - | <0.3 |
| | Max | - | <0.3 | - | <0.3 | - | <0.3 | - | - | - | - | 0.19 | - | <0.3 |
| Total TPH >C8-C40 (Aromatic) (mg/l) | Min | 0.03 | <0.01 | 0.02 | <0.01 | 0.02 | <0.01 | 0.01 | - | <0.01 | 0.02 | - | <0.01 | <0.01 |
| | Average | 0.06 | 0.024 | 0.02 | 0.027 | 0.03 | 0.026 | 0.07 | - | 0.03 | 0.04 | - | 0.045 | 0.023 |
| | Max | 0.16 | 0.090 | 0.11 | 0.11 | 0.05 | 0.15 | 0.23 | - | 0.10 | 0.14 | - | 0.44 | 0.08 |
| TPH (mg/l) | Min | - | <0.01 | - | <0.01 | - | <0.002 | - | - | - | - | <0.002 | - | <0.01 |
| | Average | - | <0.3 | - | <0.3 | - | <0.3 | - | 0.11 | - | - | 0.07 | - | <0.3 |
| | Max | - | <0.3 | - | <0.3 | - | <0.3 | - | - | - | - | 0.19 | - | <0.3 |

2.3.7 The trigger levels for groundwater quality are laid out in Table S4.2 Environmental Permit EPR/KP3795FU. These have been reproduced in Table 5 below for convenience.

**Table 5: Groundwater trigger limits**

| Monitoring point | Parameter | Limit (units) |
|---|---|---|
| PZ07-08<br>PZ08-08 | Chloride | 150 mg/litre |
| | Ammoniacal Nitrogen | 0.5 mg/litre |
| | Sulphate | 200 mg/litre |
| | Nickel | 0.034 mg/litre[a] |
| | Cadmium | 1 µg/litre |
| | Naphthalene | 10 µg/litre |

[a] – *reduce trigger limit agreed under 2017 HRAR*

2.3.8 The following sections will discuss any notable or anomalous significant trends and events observed in the groundwater quality data.

2.3.9 In the 2017 HRAR, the results of metals comprised a mixed analysis of total and dissolved concentrations. following this review, analytical methods have focussed on the dissolved fractions only.

*Alkalinity*

2.3.10 The alkalinity of water within upgradient borehole PZ03/08 and downgradient boreholes PZ07/08R and PZ08/08R are fairly consistent, generally fluctuating between ~250mg/l and ~390mg/l, with short lived reductions to as low as ~100mg/l recorded during 2023 and 2024 in down-gradient boreholes. There is a suggestion of a reducing concentration trend observed in each of these three boreholes from 2022 to 2024.

2.3.11 The alkalinity of groundwater at PZ02/08 is significantly lower, with concentration ranging between ~130mg/l and ~200mg/l, with and increasing trend evidence from 2017 to 2024. The concentration within PZ02-08 are more closely related to the concentrations recorded in the quarry sump which would suggest the influence of a surface water source close to this borehole position.

*Calcium & Magnesium*

2.3.12 Calcium and magnesium concentrations trends mirror those exhibited by alkalinity. Calcium and magnesium concentrations in PZ03/08, PZ07/08R and PZ08/08R typically range between 80mg/l and 150mg/l and ~25 to ~40mg/l respectively, compared to a typically range of ~40mg/l to ~80mg/l for calcium and ~5mg/l and ~15mg/in for magnesium in PZ02/08. For boreholes PZ03/08, PZ07/08R and PZ08/08R the average Ca:Mg ratio equates to ~3:1, compared to an average ratio of ~7:1 at PZ02/08.

*Cadmium*

2.3.13 The greatest cadmium concentrations are recorded in the up-gradient PZ03/08 with concentration typically between ~0.2mg/l and ~0.5mg/l from 2017 to 2021, with a wider concentration range of ~0.05µg/l and 0.65µg/l exhibited from 2021 onwards. Concentration in all other boreholes and were typically below 0.1µg/l. Well below the compliance limit of 1µg/l.

*Chloride*

2.3.14 With the exception of PZ03-08, chloride concentrations in all other boreholes have been generally recorded concentrations below 50mg/l. In PZ03-08,

chloride concentrations continued the increasing trend observed in the 2017 HRAR, peaking at 100mg/l in 2018/2019, followed by a reduction to ~50mg/l in 2020 and another rise in concentration to ~80mg/l in 2022, following which a further sharp reduction to below 50mg/l has been observed. These concentrations trends mirror concentration trends observed for sodium which would suggest that the source of the increased chloride is the application and runoff of road salt along the A4119 trunk road located to the immediate east of the quarry, although no clear seasonality of the trends can the identified from the data.

*Chromium*

2.3.15 Concentrations of chromium have been below the limit of detection of 0.001mg/l except for readings up to 0.003mg/l on 5 occasions. One of these detections occurred in 2018 in the Quarry Sump, and the remainder of the detections occurred in 2022 and 2023 in PZ07-08R and PZ08-08R.

*Copper*

2.3.16 Copper concentrations have been stable close to or at the limit of detection of 0.001mg/l, measuring below 0.004mg/l excepting two high readings of 0.0051mg/l and 0.0095mg/l at borehole PZ03-08 in 2017 and 2018 respectively.

*Sodium*

2.3.17 With the exception of PZ03-08, sodium concentrations are typically recorded less than 30mg/l, with a reducing concentration trends recorded from 2022.

2.3.18 As mentioned previously, sodium concentrations trends in PZ03-08 correlate with those trends observed for chloride, with peaks of ~70mg/l and ~50mg/l observed in 2018/2019 and 2022 respectively, with each peak followed by reduction to below 35mg/l. This was observed in previous reporting periods and was explained by road salt run-off from the adjacent A4116 highway.

*Ammoniacal Nitrogen*

2.3.19 One exceedance of the trigger level occurred on 04/10/2018 in PZ08-08, where the recorded concentration was 0.9mg/l. From 2020 onwards, concentrations reduced significantly, with concentrations largely recorded below 0.1mg/l.

*Lead*

2.3.20 With the exception of PZ03-08 and PZ07-07R, lead concentration were recorded at below 0.001mg/l. At PZ03-08 lead was largely and frequently detected at concentrations of up to ~0.007 mg/l, with a concentration increasing above 0.003mg/l from October 2019 onwards. Occasional detections, typically up to ~0.005mg/l, were recorded in PZ07-08R following its installation in 2021.

*Sulphate*

2.3.21 Sulphate concentrations in the up-gradient boreholes are largely recorded below 15mg/l, with greater concentrations recorded in down-gradient boreholes. Concentrations in PZ07-08R fluctuated between ~10mg/l and ~50mg/l (with a reducing trends), whilst concentrations at PZ08-08R fluctuated between ~10mg/l and ~100mg/l, mirroring the concentration range recorded pre-2020 in PZ08-08. From 2021, sulphate concentrations recorded at the sump mirror the range recorded at PZ07/08R. All concentration recorded we below the trigger level of 200mg/l.

2.3.22 The concentrations are similar in value to the previous reporting period. No exceedances were recorded in the most recent period.

*Total Oxidised Nitrogen (TON)*

2.3.23 The general trend of the TON concentrations continues as in the previous reporting period. A generally stable, low concentration that has occasional spikes which quickly return to the baseline. The concentrations in PZ03-08 were slightly elevated through 2022.

*Zinc*

2.3.24 All boreholes except PZ03-08 record low concentrations of zinc, typically less than 0.01mg/l. Borehole PZ03-08 recorded an average concentration of 0.08mg/l. This is considerably higher than the other boreholes except for two instances where high zinc anomalies occurred in PZ07-08R and PZ08-08R in June 2021 and December 2022. PZ03-08 also his a much higher variability and is erratic, changing by a high proportion of its entire range month by month in some cases.

*Organic Species (Polycyclic aromatic hydrocarbon (PAH), Total petroleum hydrocarbons (TPH) and Naphthalene*

2.3.25 The general trend of the organic species concentrations continues as in the previous reporting period. Concentration are generally low and stable with very occasional spikes which quickly return to the baseline. The notable spikes occurred in January 2019, October 2022 and December 2023, all in down-gradient boreholes.

2.3.26 Naphthalene continues to be detected in upgradient and down-gradient boreholes with no increase observed.

Environmental Assessment Levels (EALs)

2.3.27 The priority contaminants selected under previous reviews of the HRA were based on likely potential contaminants associated with contaminated soils and topsoil within rogue loads. These priority contaminants remain valid for consideration of the risk to groundwater. A review of the EAL selected in 2017 against the latest monitored baseline groundwater quality is presented in **Table 6.**

**Table 6: Environmental Assessment Level Review**

| Parameter | Quality standard | | Standard | Up Gradient groundwater 95%ile 2017 Review | Up Gradient groundwater 95%ile 2017-2024 | Selected EAL |
|---|---|---|---|---|---|---|
| | AA | MAC | | | | |
| Ammoniacal Nitrogen mg/l | | 0.5 | Water supply regulations | 0.41^ | 0.23 | 0.5 |
| Naphthalene ug/l | 2 | 130 | EQS (WFD) | 0.035 | 0.03# | 2 |
| Nickel ug/l | 4 (bio) | 32 | EQS (WFD) | 14 | 2 | 20 |
| Cadmium ug/l | 0.25* | 1.5* | EQS (WFD) | 3.4# | 0.6 | 1 |
| Chloride mg/l | | 250 | EQS (WFD) & Water supply regulations 2016 | 128 | 100 | 150 |
| Sulphate mg/l | 400 | | EQS (WFD) | 26 | 13# | 75 |

Notes: ^ 95%ile values is the same as the laboratory detection limit.
*Average alkalinity for up gradient locations is 268 mg/l CaCO3. Standard selected on this basis
# - anomalous data points removed from calculation of 95%ile

## 2.4 Conceptual Site Model Review Summary

2.4.1 The results of a review of the conceptual site model can be summarised as:-

- Permitted waste codes have been added in 2019 and 2023, but no waste has been accepted at the site since the codes were added.
- There has been no change in the pathways associated with the site. Groundwater levels are stable and a geological barrier will be installed in all new areas providing additional protection.
- No significant deterioration of ground or surface water quality has been observed in any boreholes located up-, cross and down-gradient of the landfill since 2017.
- No change in the receptors

2.4.2 Based on the review of the conceptual site model there is no requirement to review the risk assessment is required.

## 3.0 HYDROGEOLOGICAL RISK ASSESSMENT

### 3.1 Summary of previous Risk Assessment

3.1.1 The calculated dilution available with the limestone aquifer demonstrates that potential volume of leachate generated by the is very small in comparison to the flow within the aquifer beneath the base of the site. Accounting for the this dilution factors and a nominal contaminant loading indicates that there would be no unacceptable discharge at the point of groundwater emergence. This assessment is based on dilution within the aquifer only and no attenuation or dispersion has been considered. Consequently, the inert nature of the waste accepted at the site in accordance with article 2 of the LFD will not pose a risk to groundwater with respect to hazardous substances and non-hazardous pollutants.

### 3.2 Review of Technical Precautions

Capping

3.2.1 The waste comprises inert fill material and as such does not require a low permeability capping layer.

Lining System

3.2.2 A geological barrier will be placed in all new areas in accordance with the landfill Directive. The geological barrier is required to have a minimum thickness of 0.5m with a permeability equivalent to 1m at 1 x $10^{-7}$ m/s.

Leachate Management

3.2.3 Due to the inert nature of the waste, there is no requirement to collect and manage the leachate at the site.

Groundwater management

3.2.4 Groundwater abstraction from the quarry sump will continue until such time that the waste levels rise above that of the natural water table.

## 4.0 REQUISITE SURVEILLANCE REVIEW

### 4.1 Leachate Monitoring Schedule Review

Due to the nature of the waste, no leachate collection infrastructure is required at the site and no monitoring is required.

### 4.2 Groundwater Monitoring Schedule Review

4.2.1 No changes are proposed to the parameters and frequencies listed in in the groundwater monitoring schedule specified in Environmental Permit PP3738XM. All groundwater monitoring points are presented in **Drawing No. H074-00074-1.**

4.2.2 No changes are proposed to the Control Levels and Compliance/Trigger Limits previously derived in the 2017 HRA Review.

### 4.3 Surface Monitoring Schedule Review

4.3.1 There are no proposals to vary the permit at this time to revise the surface water monitoring and compliance limits specified in Table Series S4.1 to Environmental Permit PP3738XM.

# 5.0 CONCLUSION

## 5.1 Compliance with the Landfill Directive

5.1.1 The review has indicated that there has been no significant change in the conceptual model over the review period. The waste material permitted at the site remains inert waste as defined by the LFD and appropriate waste acceptance procedures are employed at the site. Therefore, under the LFD there is no requirement to collect leachate from the site, install an artificial sealing layer nor provide a low permeability cap to the site.

5.1.2 This report has demonstrated that the site remains in a high sensitivity setting with respect to the groundwater environment and that the assessment of accidents and consequences has indicated that there would be no discernible impact on the receptor.

5.1.3 Leachate, groundwater and surface water compliance and monitoring schedules have also been reviewed to ensure that adequate protection of ground water resources continues at the site. The site therefore continues to comply with the relevant requirements of the Landfill Directive.

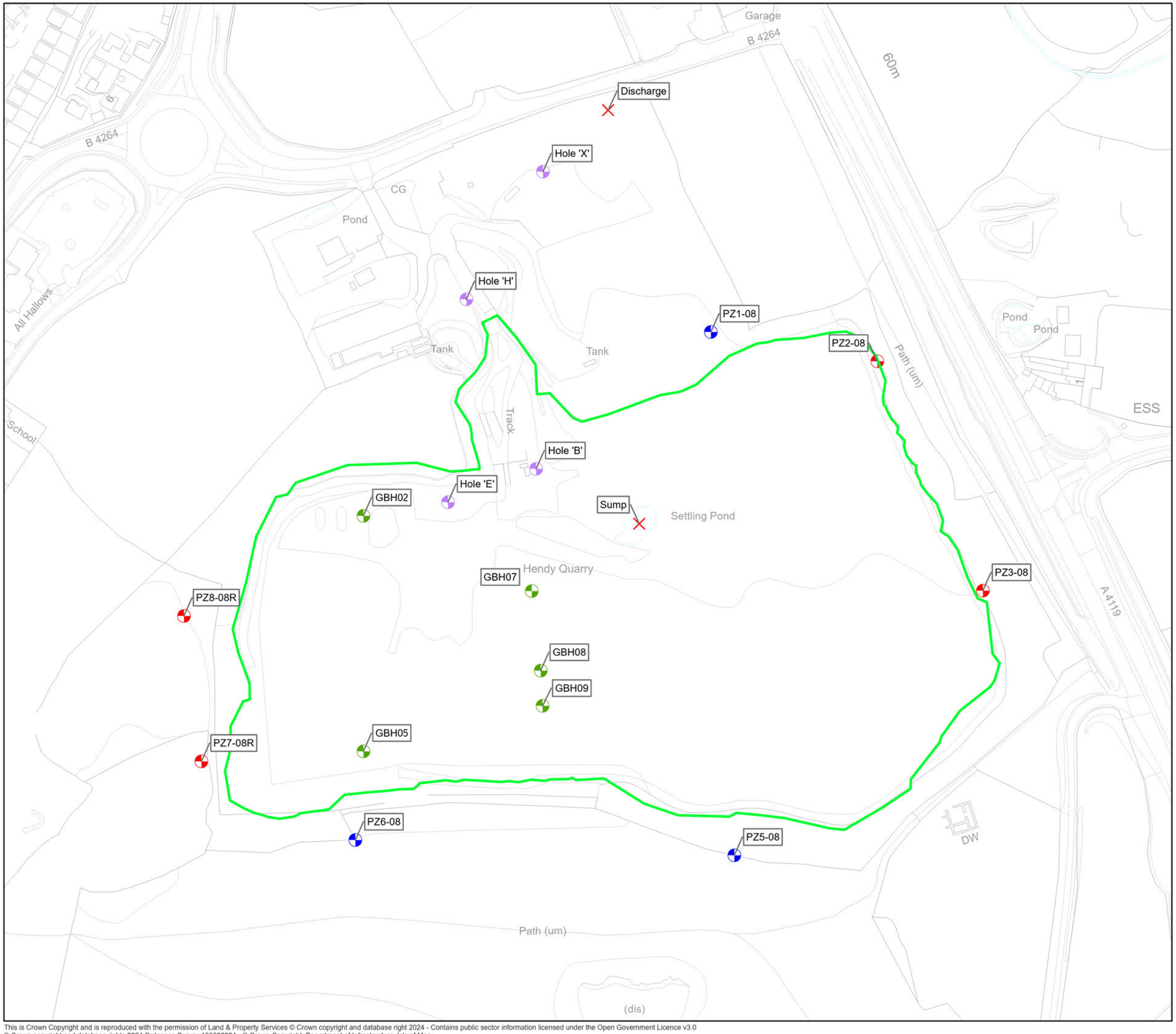
## 5.2 Compliance with Schedule 22 of the Environmental Permitting Regulations

5.2.1 In accordance with Schedule 22 of the Environmental Permitting Regulations 2016 (EPR) a review of the hydrogeological risk assessment for Hendy Landfill Site has been prepared.

5.2.2 The landfill continues to pose a potential hazard to groundwater quality, consequently it continues to fall within the scope of the Schedule 22 of the EPR.

5.2.3 Technical precautions will continue to be implemented to prevent the discernible discharge of pollutants to avoid pollution throughout the site's lifecycle. The site therefore continues to comply with the relevant requirements of the Schedule 22 of the EPR.


# Drawings




## Legend

- Permit Boundary
- Combined Gas / Groundwater monitoring points
- Internal Landfill Gas monitoring boreholes
- Landfill Gas Monitoring boreholes external to the body of waste
- Existing/Former boreholes at the site
- Surface water monitoring point

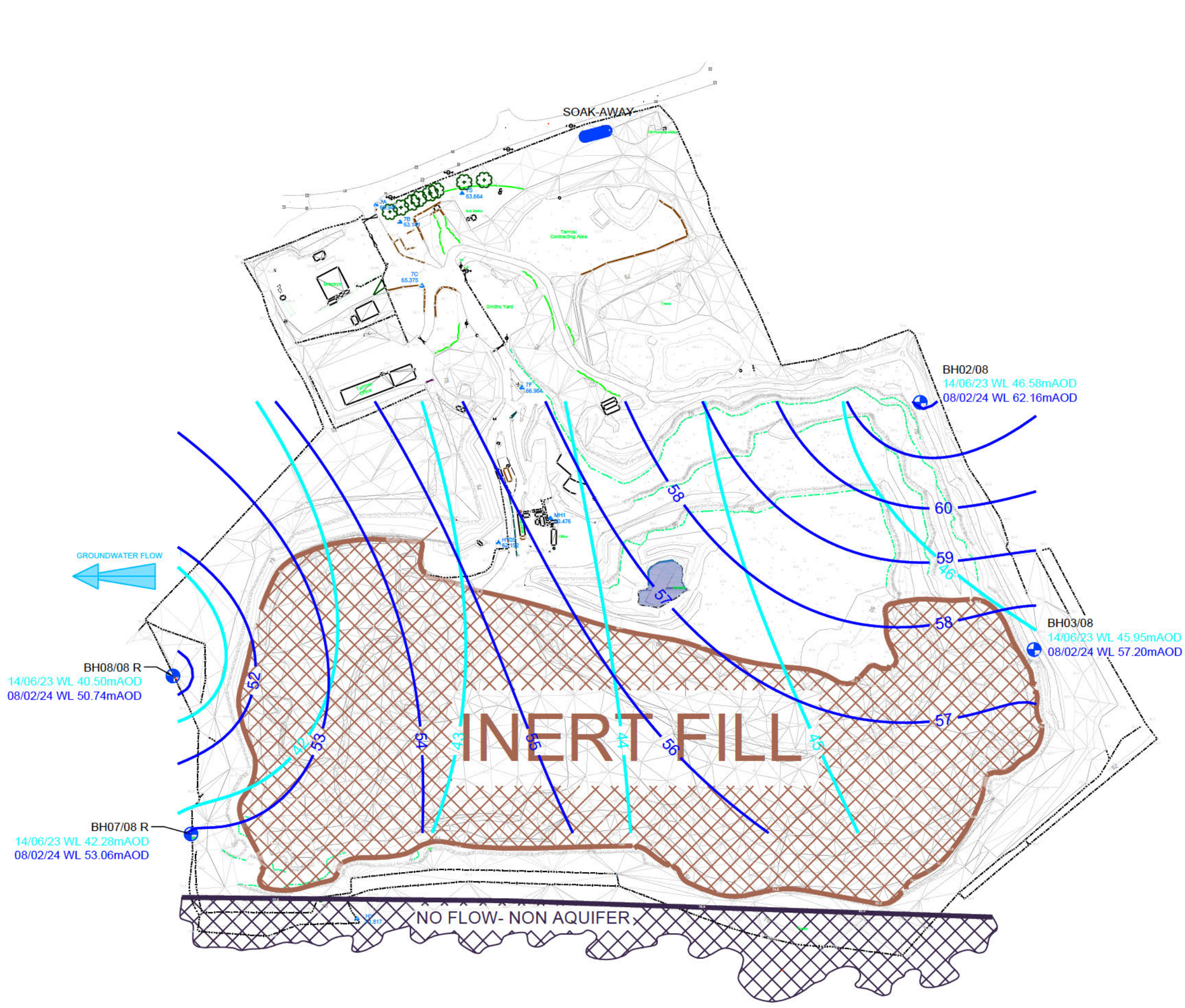
TARMAC
A CRH COMPANY

**Site Name:**
*H074 Hendy*

**Drawing Name:**
*Hendy Environmental Monitoring Point Plan*

| Drawn By: | Scale @ A3: |
|---|---|
| S Halliday | 1:2,500 |
| **Date:** | **Drawing No:** |
| 05/11/2024 | H074-00074-1 |

N






NOTES

## LEGEND

- PZ02/08 PERMIT BOREHOLE LOCATION
- SOAK AWAY
- Groundwater level contours 14/06/2023
- Groundwater level contours 08/02/2024

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|

CLIENT: TARMAC A CRH COMPANY

sirius Environmental
Suite 2, The Beacon Enterprise Centre, Dafen, Llanelli SA14 8LQ

JOB TITLE: Hendy Landfill Hydrogeological Risk Assessment Review

DRAWING TITLE: Groundwater Contour Plan

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| S.P | 03/12/2024 | D.T | 03/12/2024 |

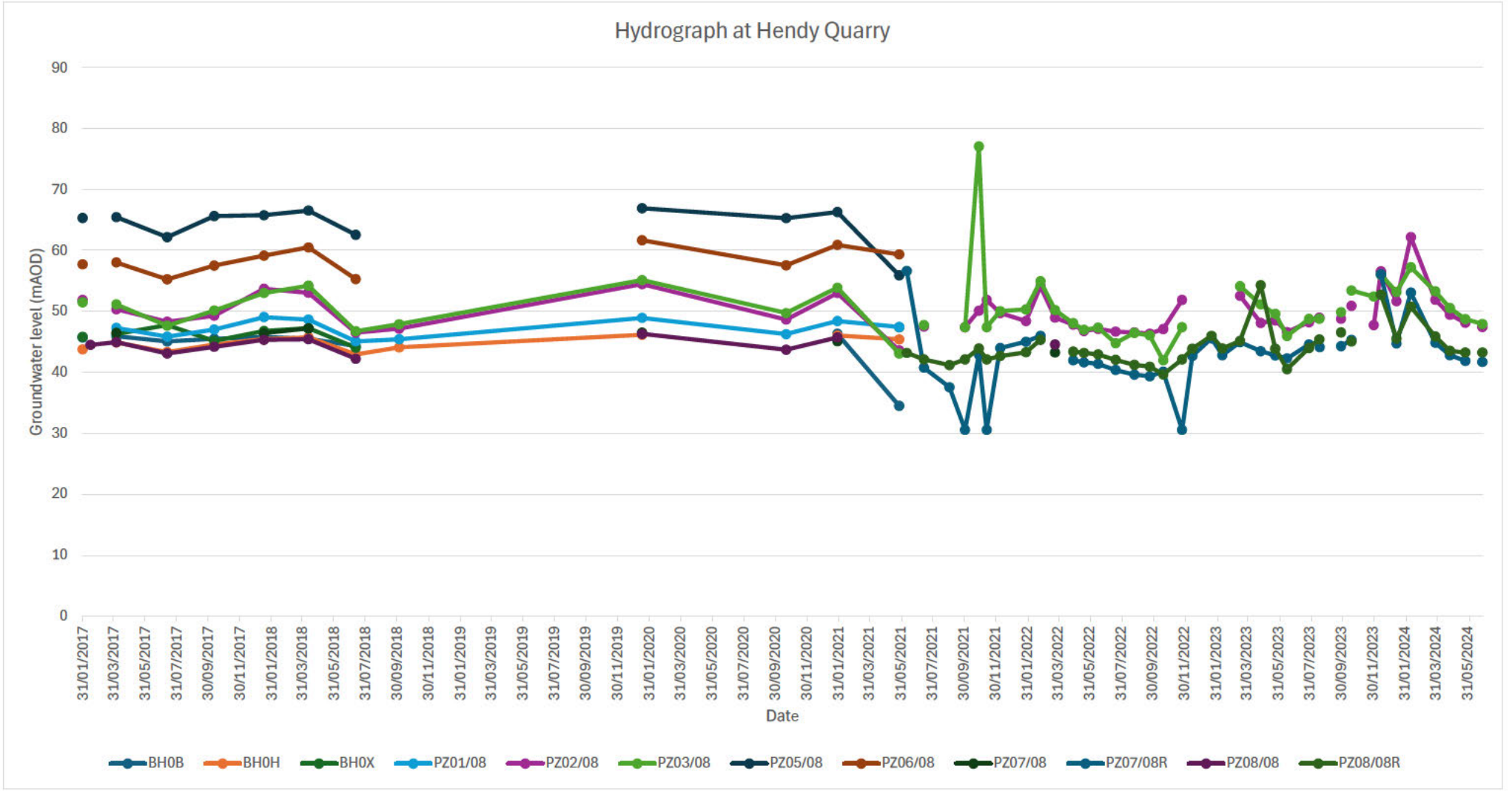
| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
| 1:2500 | A3 | TA1066/04/02 | 0 |

# APPENDIX 1

## Groundwater Level Data and Charts

Full dataset supplied in: TA1066/02/A1.R0 Hendy Water Levels

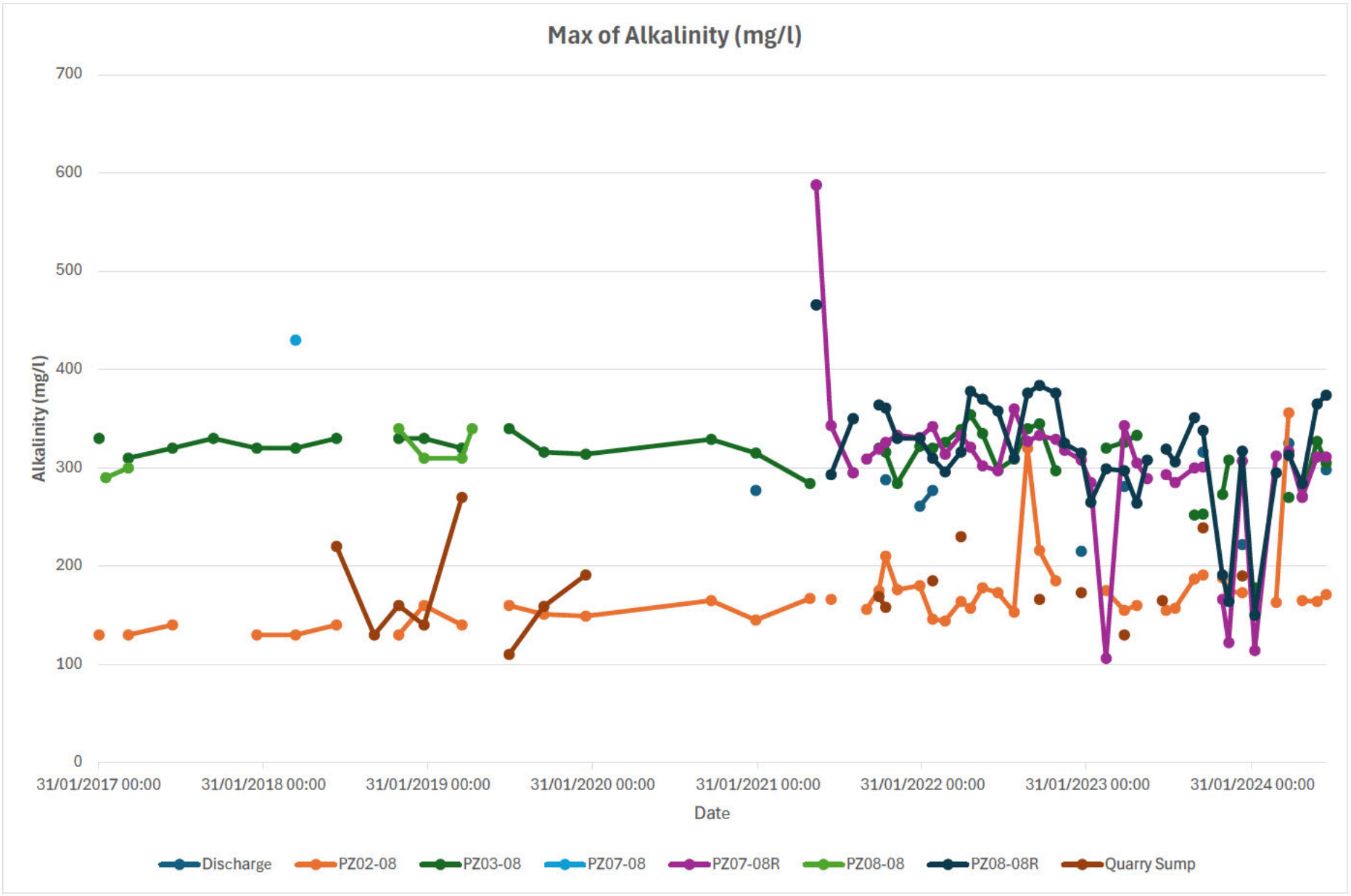
| Average of Water Level (m AOD) | Column Labels | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Row Labels | BH0B | BH0H | BH0X | PZ01/08 | PZ02/08 | PZ03/08 | PZ05/08 | PZ06/08 | PZ07/08 | PZ07/08R | PZ08/08 | PZ08/08R |
| 31/01/2017 00:00 | 45.68 | 43.77 | 45.81 | | 51.84 | 51.48 | 65.28 | 57.69 | | | | |
| 15/02/2017 00:00 | | | | | | | | | | | 44.47 | |
| 06/04/2017 00:00 | 45.89 | 44.90 | 46.24 | 47.28 | 50.33 | 51.11 | 65.44 | 57.99 | 46.44 | | 44.92 | |
| 13/07/2017 00:00 | 45.02 | 43.31 | 47.73 | 45.83 | 48.30 | 47.62 | 62.13 | 55.23 | | | 43.07 | |
| 12/10/2017 00:00 | 45.49 | 44.55 | 45.15 | 47.01 | 49.25 | 50.12 | 65.59 | 57.49 | | | 44.16 | |
| 16/01/2018 00:00 | 45.81 | 45.44 | 46.76 | 49.03 | 53.66 | 53.00 | 65.73 | 59.10 | 46.39 | | 45.31 | |
| 12/04/2018 00:00 | 45.47 | 45.71 | 47.22 | 48.63 | 53.03 | 54.21 | 66.50 | 60.45 | 47.18 | | 45.43 | |
| 12/07/2018 00:00 | 44.32 | 42.93 | 44.03 | 45.06 | 46.50 | 46.74 | 62.52 | 55.26 | | | 42.21 | |
| 04/10/2018 00:00 | | 44.06 | | 45.43 | 47.13 | 47.87 | | | | | | |
| 16/01/2020 00:00 | 46.29 | 46.14 | | 48.90 | 54.43 | 55.11 | 66.88 | 61.62 | 46.50 | | 46.29 | |
| 20/10/2020 00:00 | | | | 46.26 | 48.64 | 49.72 | 65.27 | 57.52 | | | 43.69 | |
| 27/01/2021 00:00 | 46.31 | 46.01 | | 48.38 | 53.00 | 53.84 | 66.26 | 60.86 | 45.08 | | 45.71 | |
| 26/05/2021 00:00 | 34.48 | 45.39 | 47.34 | 47.42 | 43.59 | 43.06 | 55.88 | 59.32 | | | | |
| 10/06/2021 00:00 | | | | | | | | | | 56.62 | | 43.19 |
| 13/07/2021 00:00 | | | | | 47.50 | 47.72 | | | | 40.74 | | 42.09 |
| 31/08/2021 00:00 | | | | | | | | | | 37.52 | | 41.18 |
| 30/09/2021 00:00 | | | | | 47.39 | 47.38 | | | | 30.56 | | 42.11 |
| 27/10/2021 00:00 | | | | | 50.09 | 77.01 | | | | 42.85 | | 43.90 |
| 11/11/2021 00:00 | | | | | 51.85 | 47.38 | | | | 30.56 | | 42.11 |
| 07/12/2021 00:00 | | | | | 49.71 | 50.01 | | | | 43.98 | | 42.66 |
| 26/01/2022 00:00 | | | | | 48.40 | 50.29 | | | | 44.99 | | 43.29 |
| 23/02/2022 00:00 | | | | | 54.05 | 54.91 | | | | 45.97 | | 45.33 |
| 23/03/2022 00:00 | | | | | 48.96 | 50.20 | | | 43.24 | | 44.54 | |
| 27/04/2022 00:00 | | | | | 47.79 | 48.06 | | | | 41.95 | | 43.39 |
| 18/05/2022 00:00 | | | | | 46.76 | 46.99 | | | | 41.62 | | 43.16 |
| 14/06/2022 00:00 | | | | | 47.12 | 47.31 | | | | 41.36 | | 42.94 |
| 18/07/2022 00:00 | | | | | 46.65 | 44.76 | | | | 40.36 | | 42.03 |
| 23/08/2022 00:00 | | | | | 46.54 | 46.46 | | | | 39.62 | | 41.20 |
| 22/09/2022 00:00 | | | | | 46.32 | 46.06 | | | | 39.34 | | 40.94 |
| 18/10/2022 00:00 | | | | | 47.09 | 41.96 | | | | 40.10 | | 39.65 |
| 23/11/2022 00:00 | | | | | 51.85 | 47.38 | | | | 30.56 | | 42.11 |
| 13/12/2022 00:00 | | | | | | | | | | 42.70 | | 43.86 |
| 19/01/2023 00:00 | | | | | | | | | | 45.54 | | 45.99 |
| 09/02/2023 00:00 | | | | | | | | | | 42.78 | | 43.90 |
| 15/03/2023 00:00 | | | | | 52.54 | 54.11 | | | | 44.95 | | 45.16 |
| 24/04/2023 00:00 | | | | | 48.09 | 51.12 | | | | 43.43 | | 54.26 |
| 22/05/2023 00:00 | | | | | 48.49 | 49.56 | | | | 42.76 | | 43.85 |
| 14/06/2023 00:00 | | | | | 46.58 | 45.95 | | | | 42.28 | | 40.50 |
| 26/07/2023 00:00 | | | | | 48.20 | 48.75 | | | | 44.54 | | 43.98 |
| 15/08/2023 00:00 | | | | | 48.93 | 48.79 | | | | | | 45.40 |
| 16/08/2023 00:00 | | | | | | | | | | 44.10 | | |
| 26/09/2023 13:02 | | | | | | 49.86 | | | | | | |
| 26/09/2023 13:09 | | | | | 48.77 | | | | | | | |
| 26/09/2023 13:43 | | | | | | | | | | | | 46.54 |
| 26/09/2023 14:11 | | | | | | | | | | 44.26 | | |
| 16/10/2023 00:00 | | | | | 50.87 | 53.39 | | | | 45.33 | | 45.03 |
| 28/11/2023 11:30 | | | | | | 52.41 | | | | | | |
| 28/11/2023 11:45 | | | | | 47.74 | | | | | | | |
| 12/12/2023 00:00 | | | | | 56.56 | 55.96 | | | | 56.07 | | 52.71 |
| 11/01/2024 00:00 | | | | | 51.63 | 53.16 | | | | 44.73 | | 45.53 |
| 08/02/2024 00:00 | | | | | 62.16 | 57.20 | | | | 53.06 | | 50.74 |
| 26/03/2024 00:00 | | | | | 51.89 | 53.26 | | | | 44.83 | | 45.87 |
| 23/04/2024 00:00 | | | | | 49.42 | 50.53 | | | | 42.79 | | 43.52 |
| 23/05/2024 00:00 | | | | | 48.13 | 48.72 | | | | 41.84 | | 43.23 |
| 25/06/2024 11:10 | | | | | | 47.92 | | | | | | |
| 25/06/2024 11:35 | | | | | 47.43 | | | | | | | |
| 25/06/2024 12:56 | | | | | | | | | | | | 43.24 |
| 25/06/2024 13:28 | | | | | | | | | | 41.69 | | |

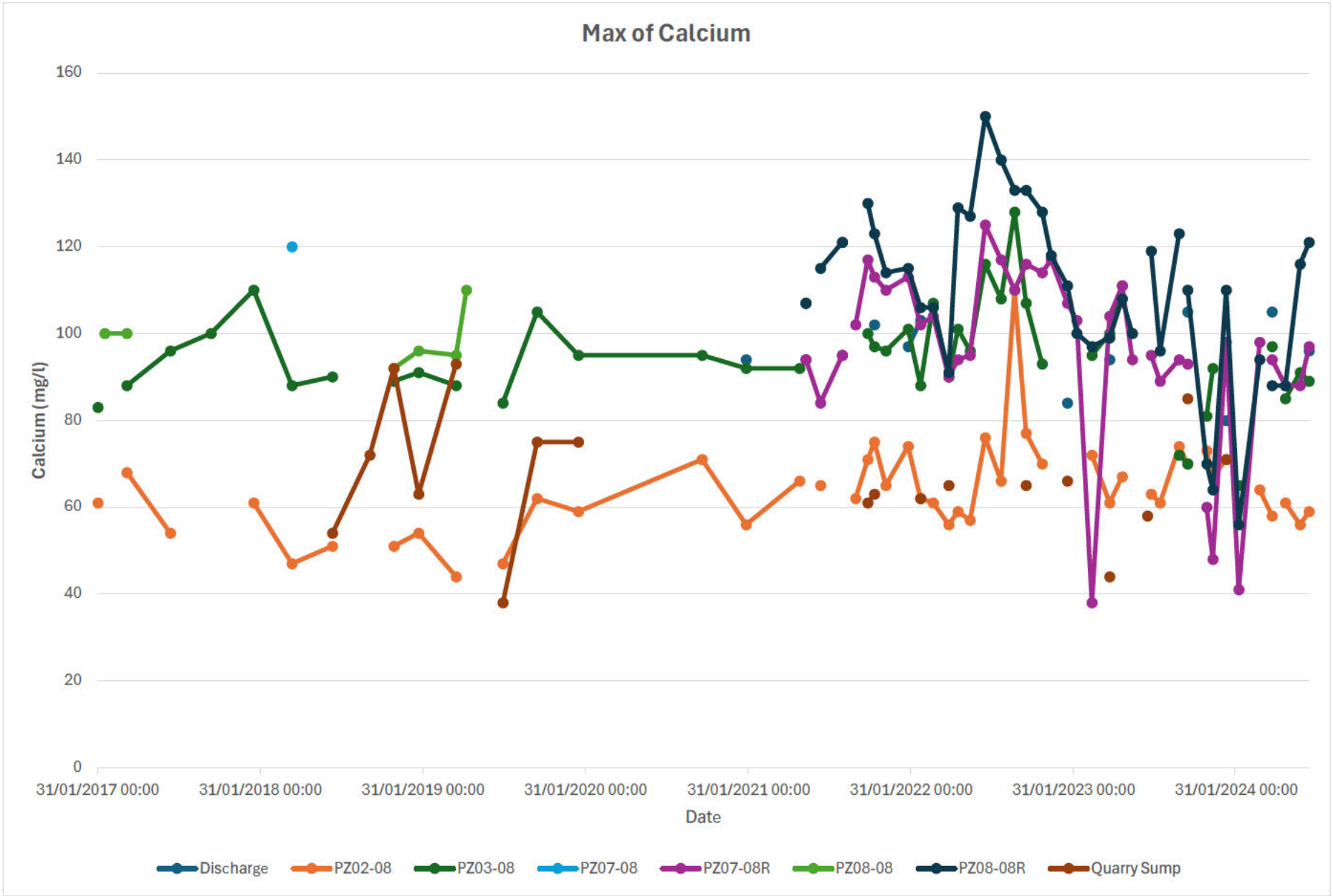

Hydrograph at Hendy Quarry
Groundwater level (mAOD)
90
80
70
60
50
40
30
20
10
0
31/01/2017
31/03/2017
31/05/2017
31/07/2017
30/09/2017
30/11/2017
31/01/2018
31/03/2018
31/05/2018
31/07/2018
30/09/2018
30/11/2018
31/01/2019
31/03/2019
31/05/2019
31/07/2019
30/09/2019
30/11/2019
31/01/2020
31/03/2020
31/05/2020
31/07/2020
30/09/2020
30/11/2020
31/01/2021
31/03/2021
31/05/2021
31/07/2021
30/09/2021
30/11/2021
31/01/2022
31/03/2022
31/05/2022
31/07/2022
30/09/2022
30/11/2022
31/01/2023
31/03/2023
31/05/2023
31/07/2023
30/09/2023
30/11/2023
31/01/2024
31/03/2024
31/05/2024
Date
BH0B
BH0H
BH0X
PZ01/08
PZ02/08
PZ03/08
PZ05/08
PZ06/08
PZ07/08
PZ07/08R
PZ08/08
PZ08/08R

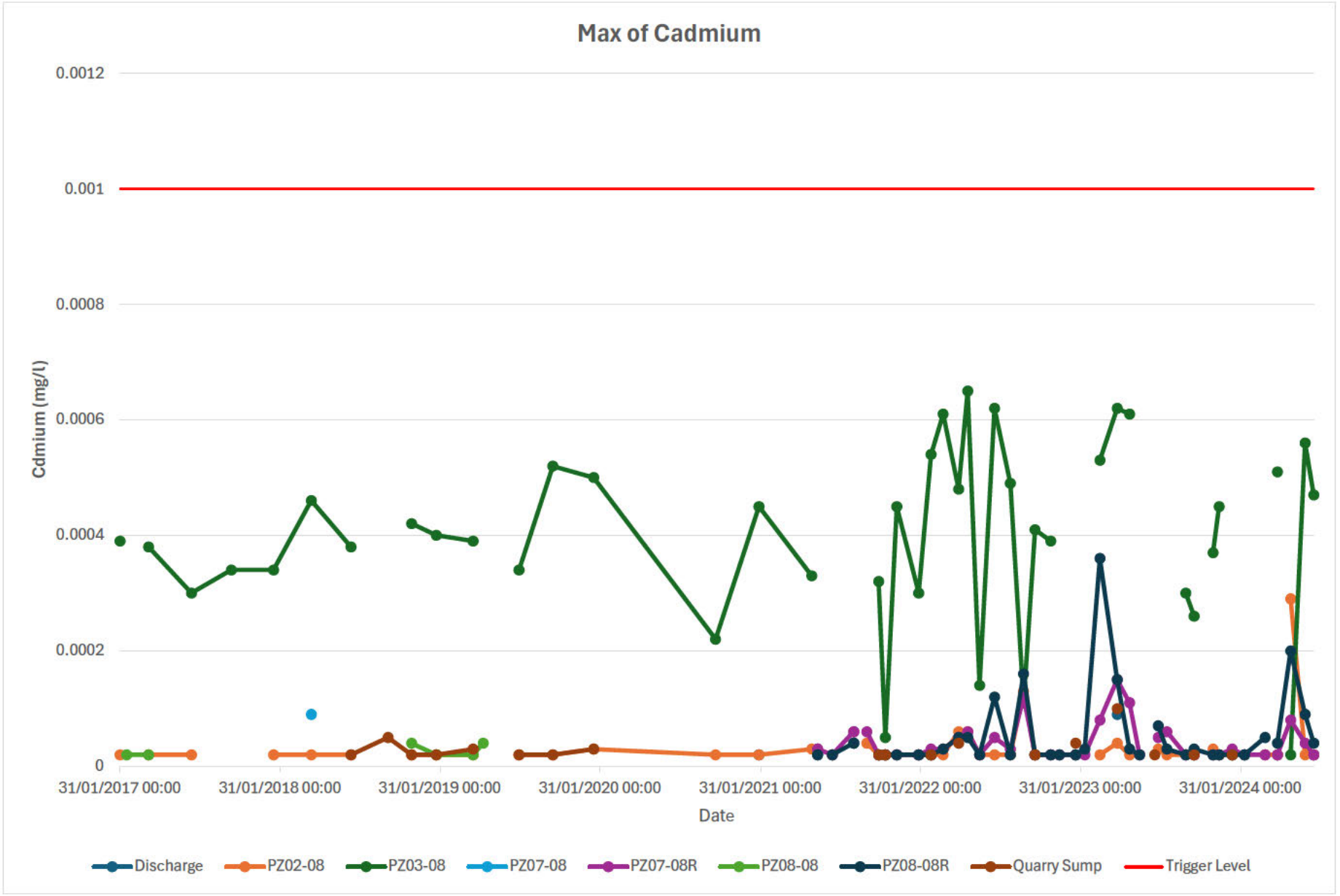
# APPENDIX 2

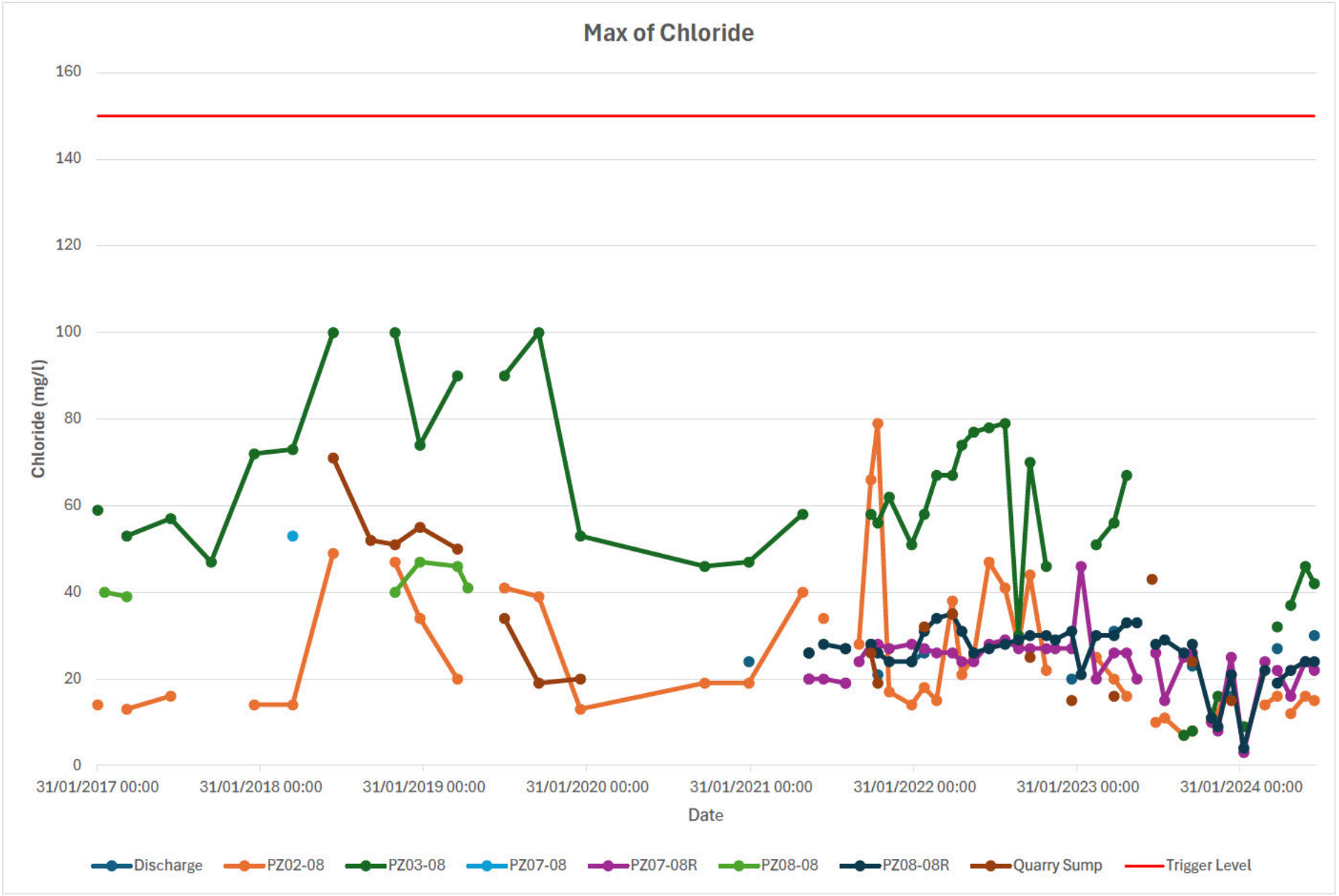
## Groundwater Quality Data and Charts

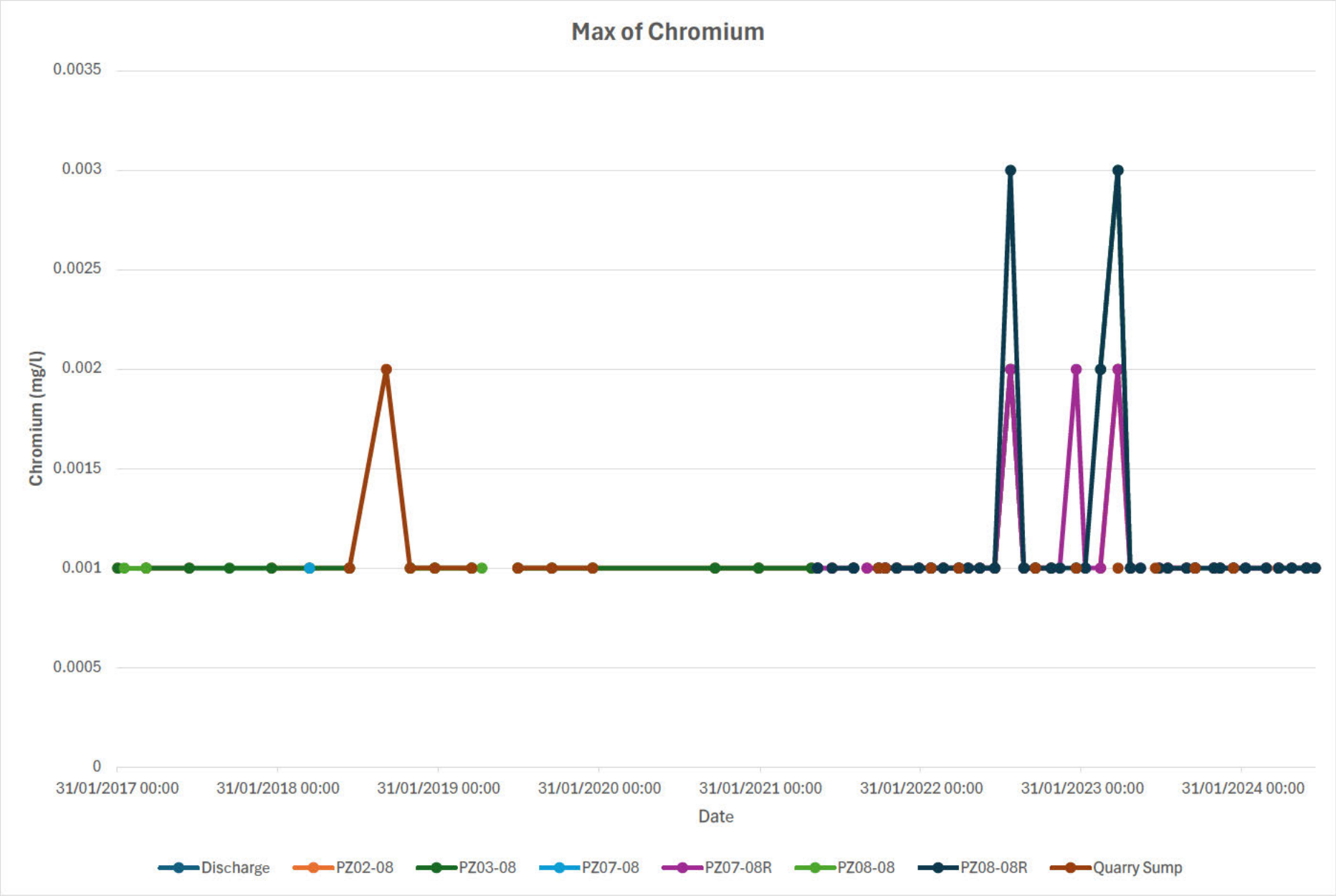
Full dataset supplied in: TA1066/02/A2.R0 Hendy Water Quality

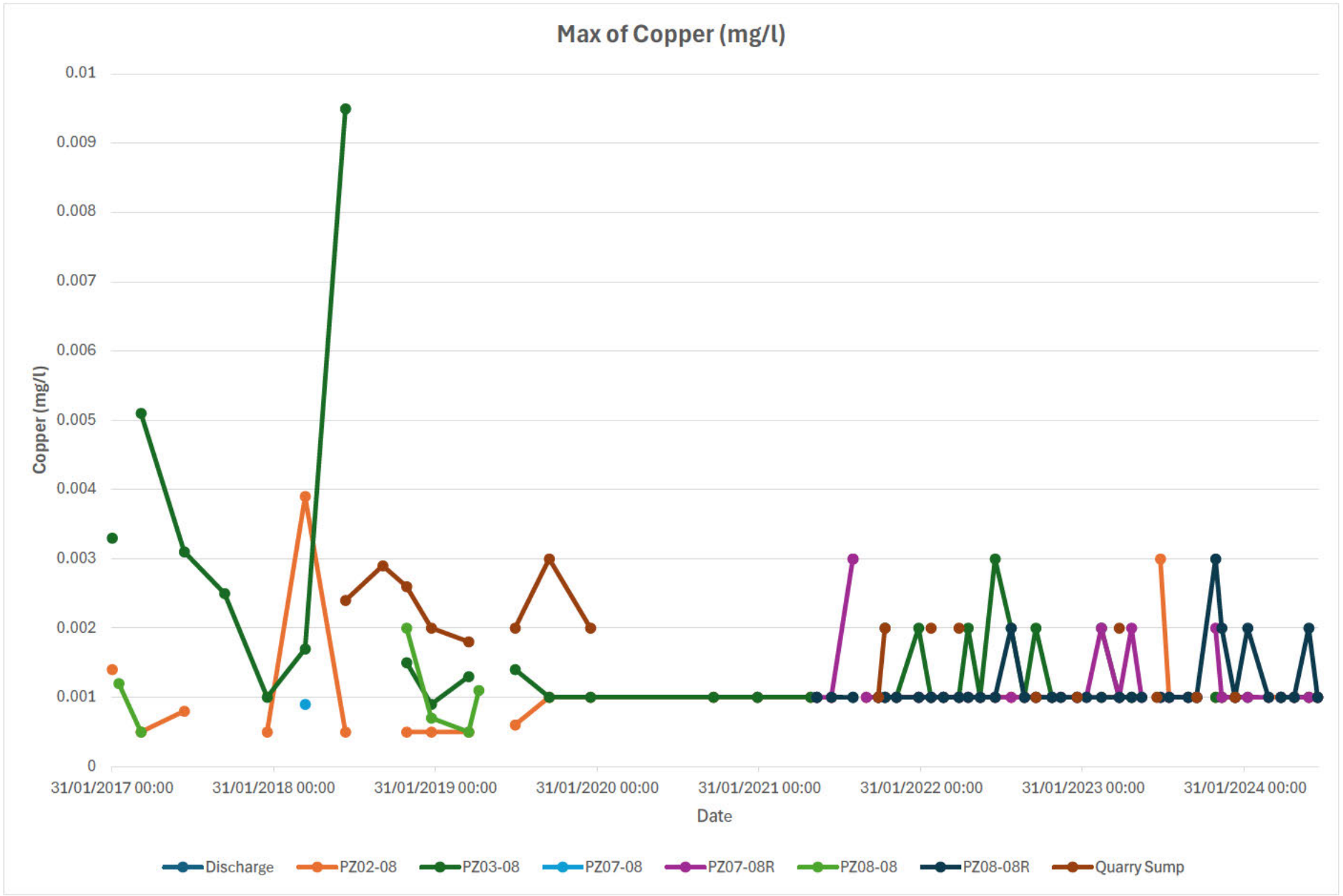

Max of Alkalinity (mg/l)
Alkalinity (mg/l)
700
600
500
400
300
200
100
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

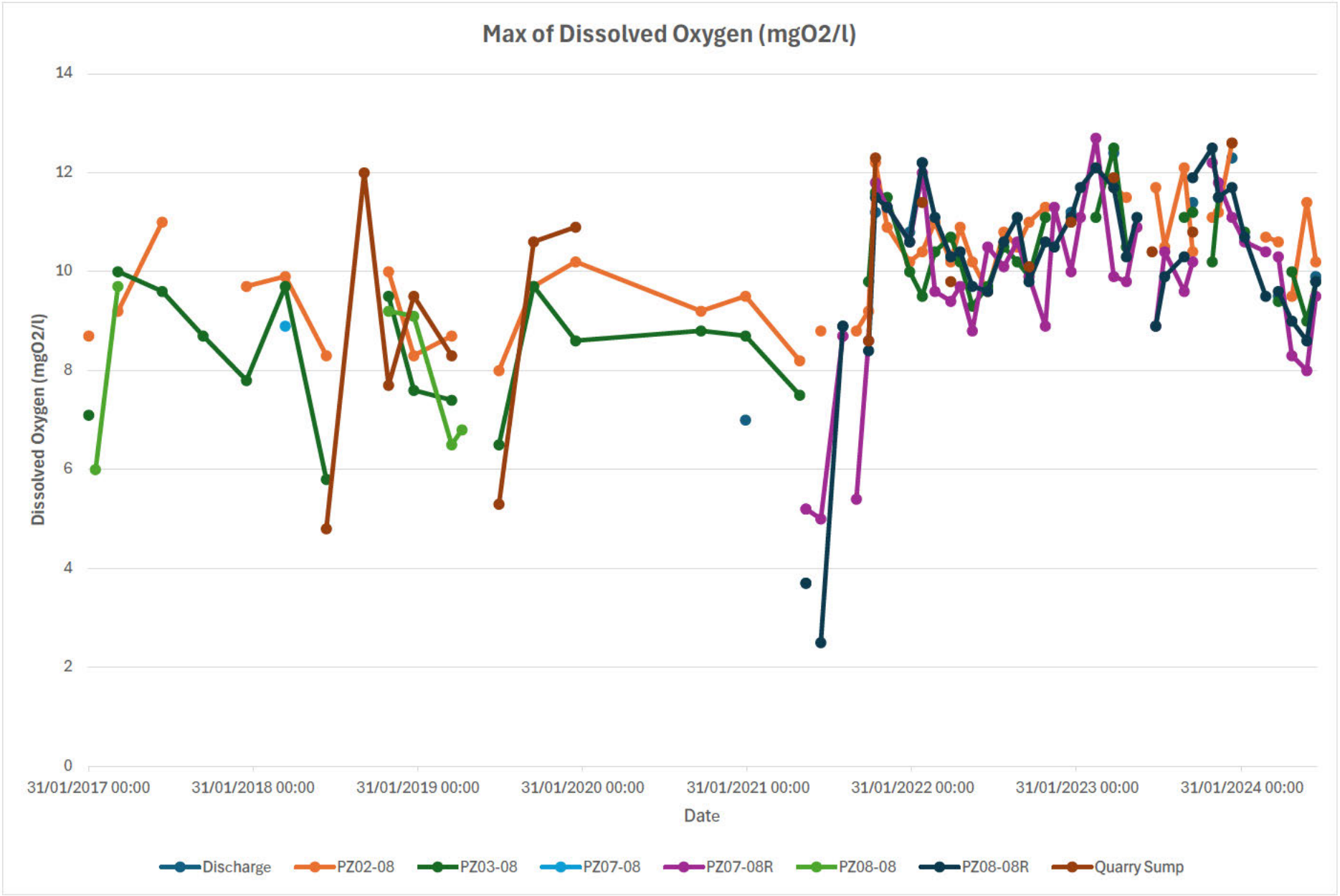

Max of Calcium
160
140
120
100
80
60
40
20
0
Calcium (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

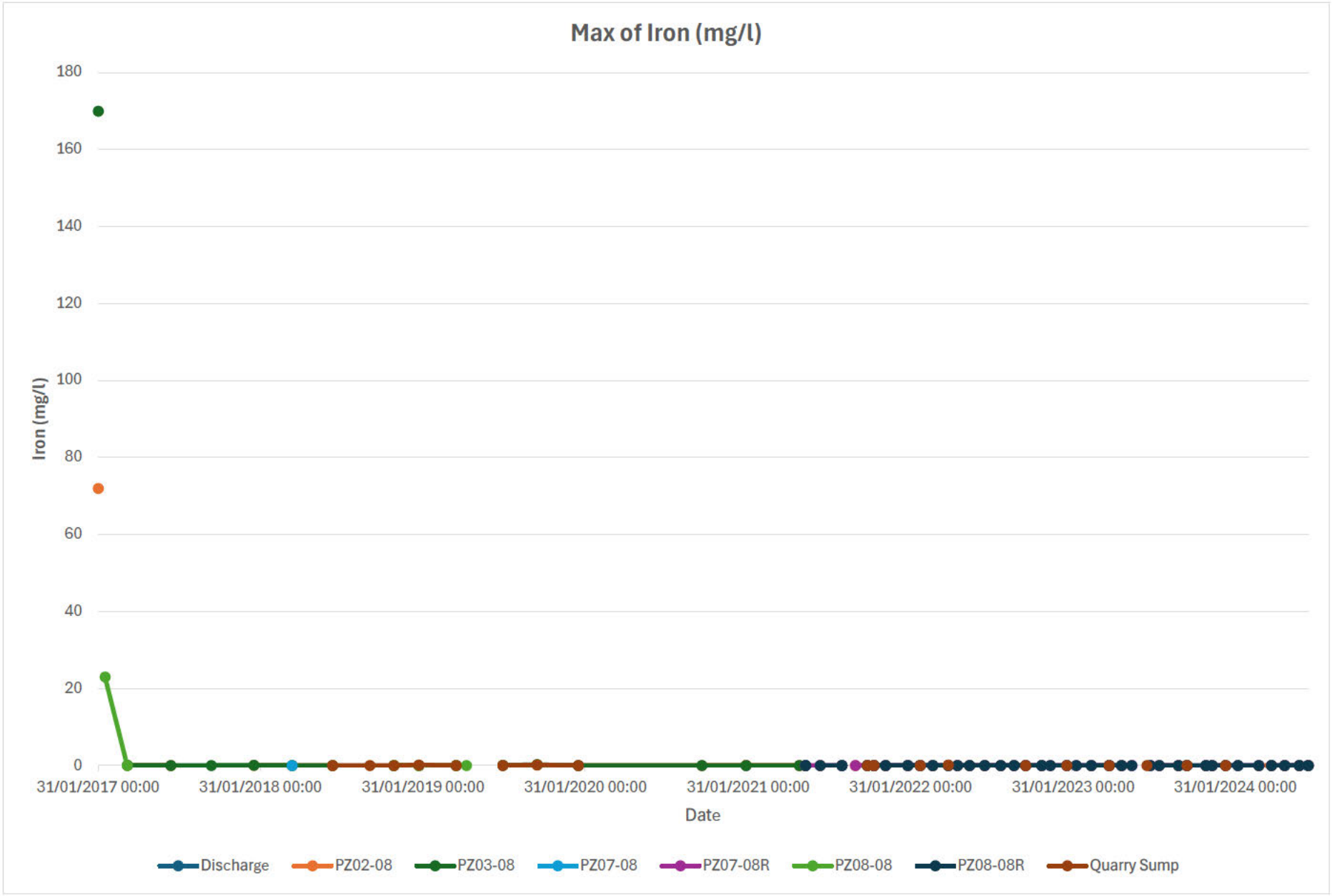

Max of Cadmium
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Cdmium (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

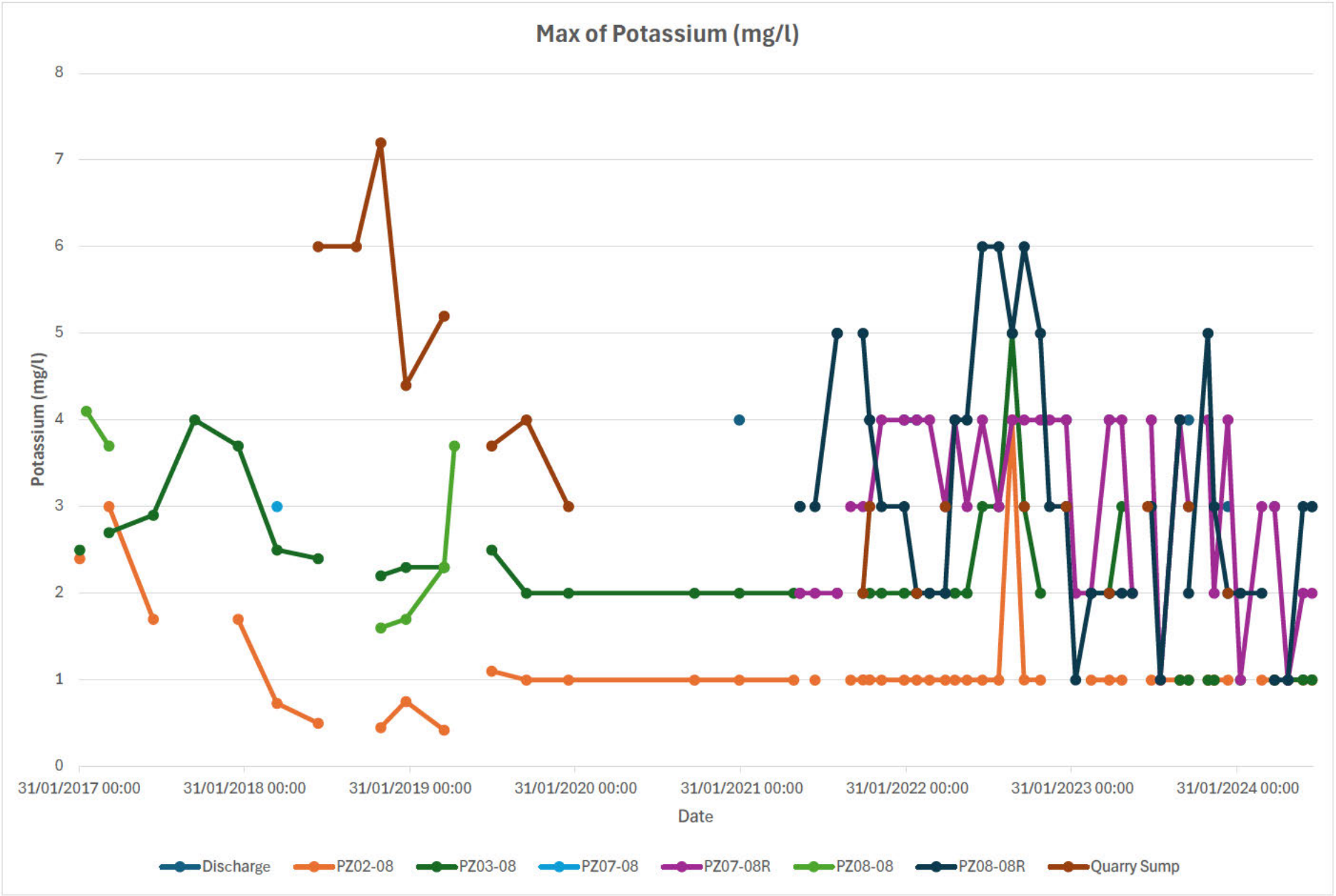

Max of Chloride
160
140
120
100
80
60
40
20
0
Chloride (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

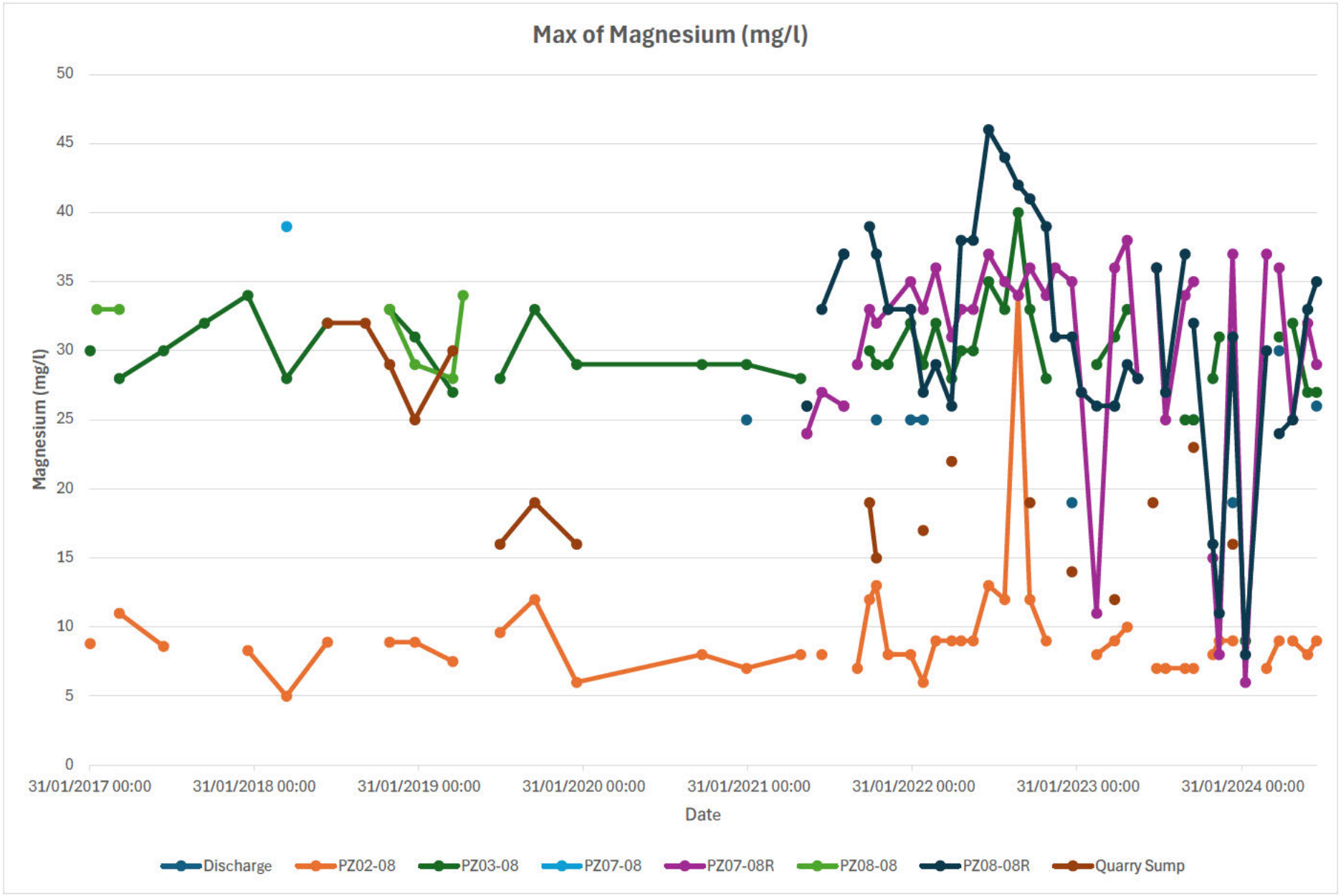

Max of Chromium
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Chromium (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

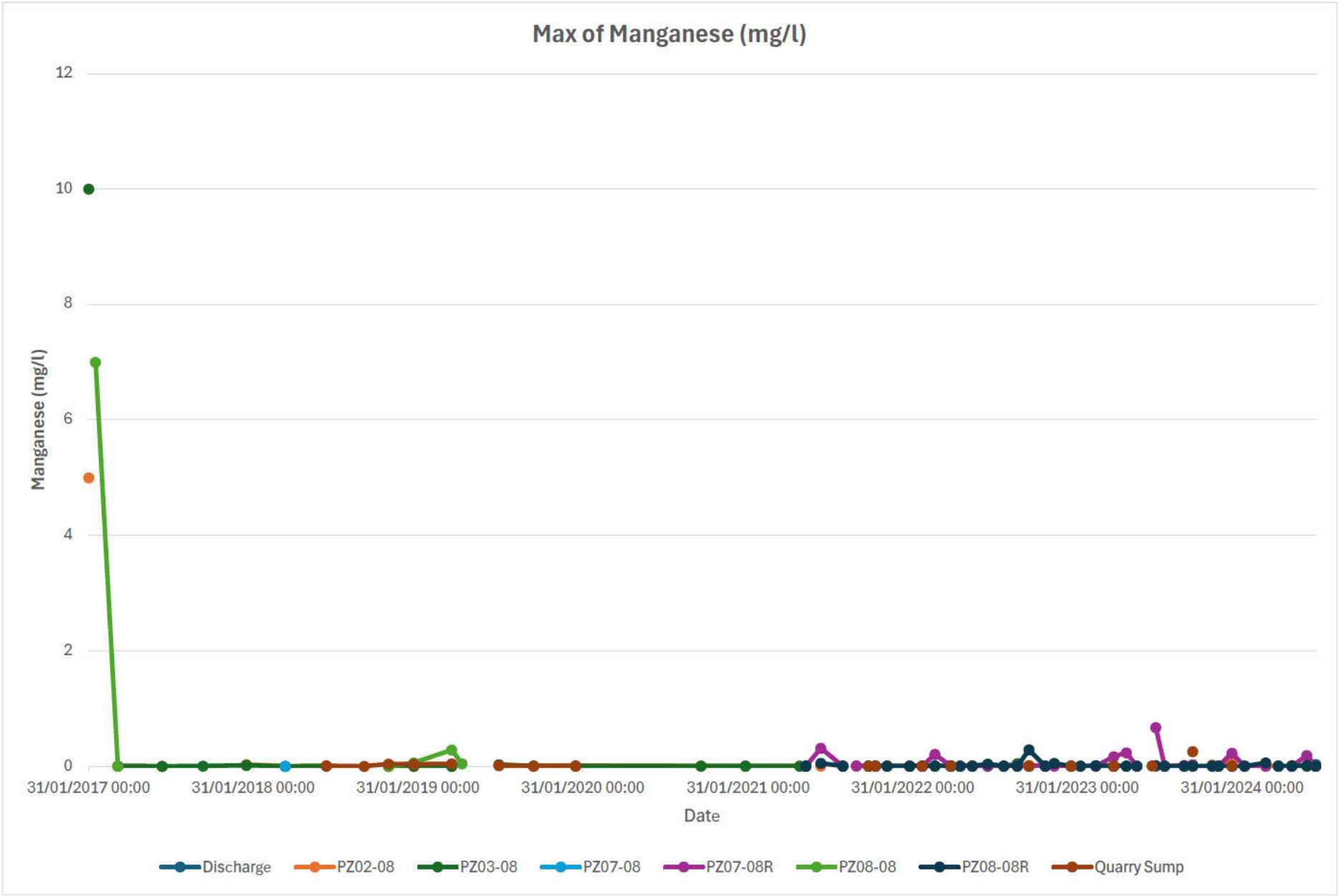

Max of Copper (mg/l)
Copper (mg/l)
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

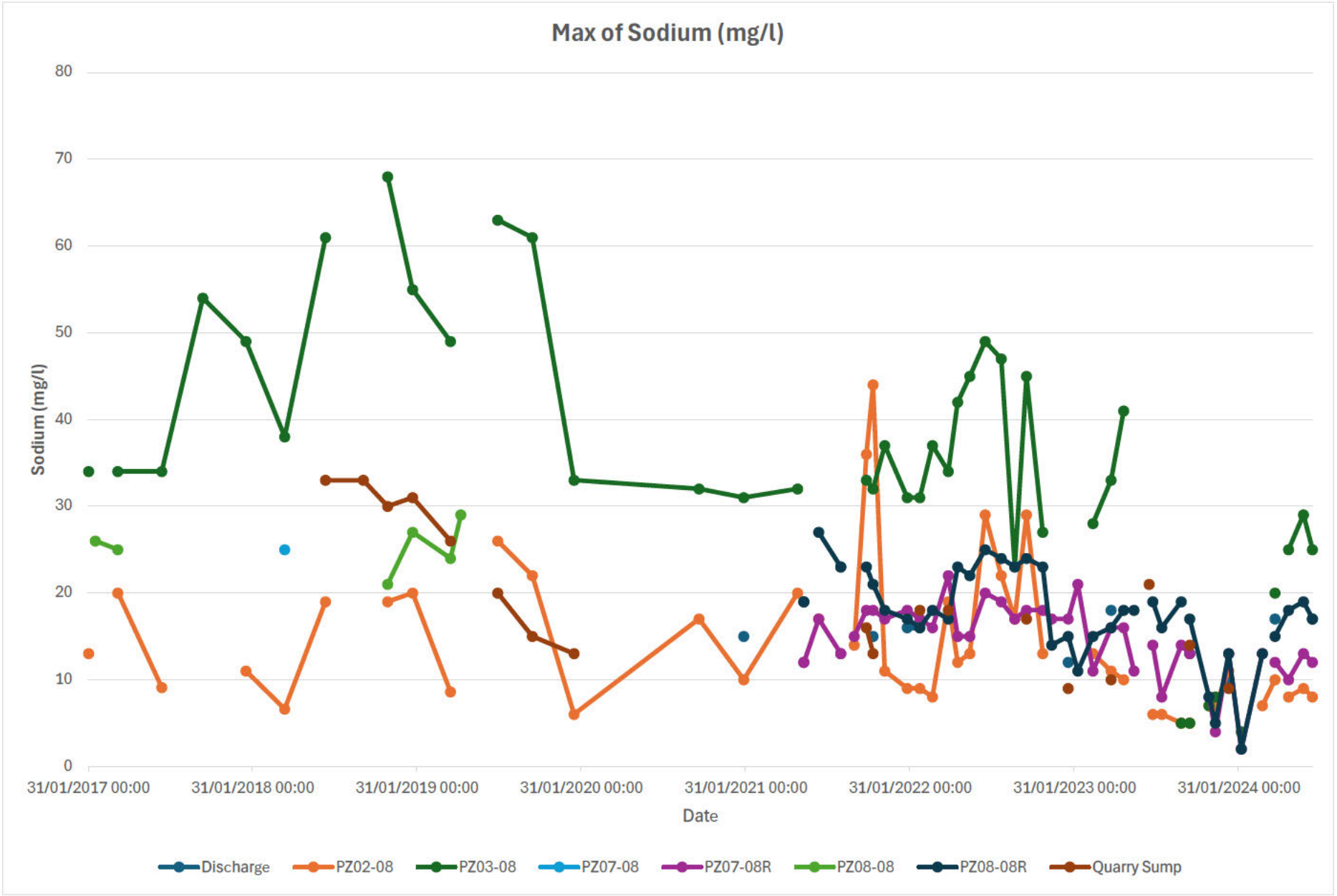

Max of Dissolved Oxygen (mgO2/l)
Dissolved Oxygen (mgO2/l)
14
12
10
8
6
4
2
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

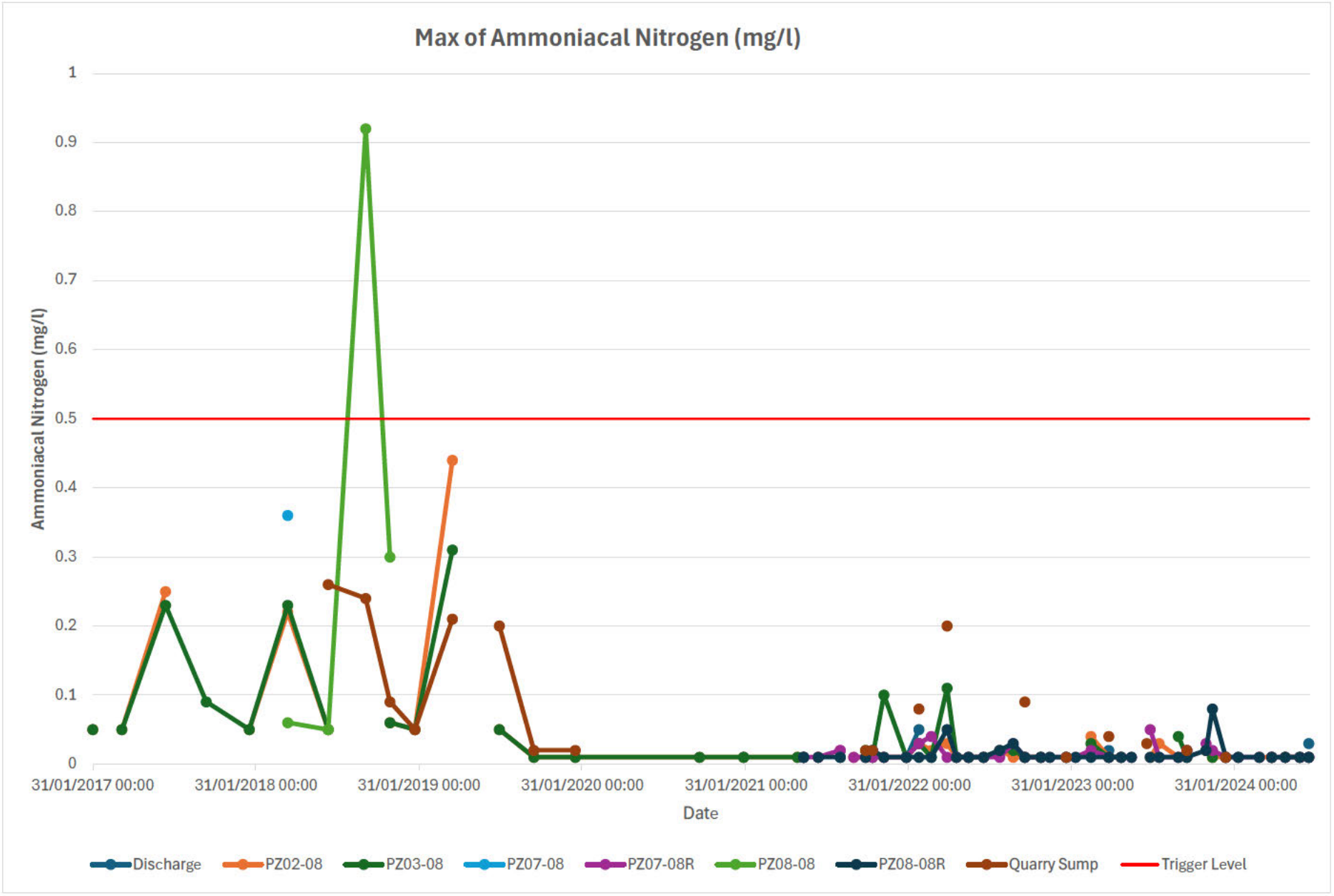

Max of Iron (mg/l)
180
160
140
120
100
80
60
40
20
0
Iron (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

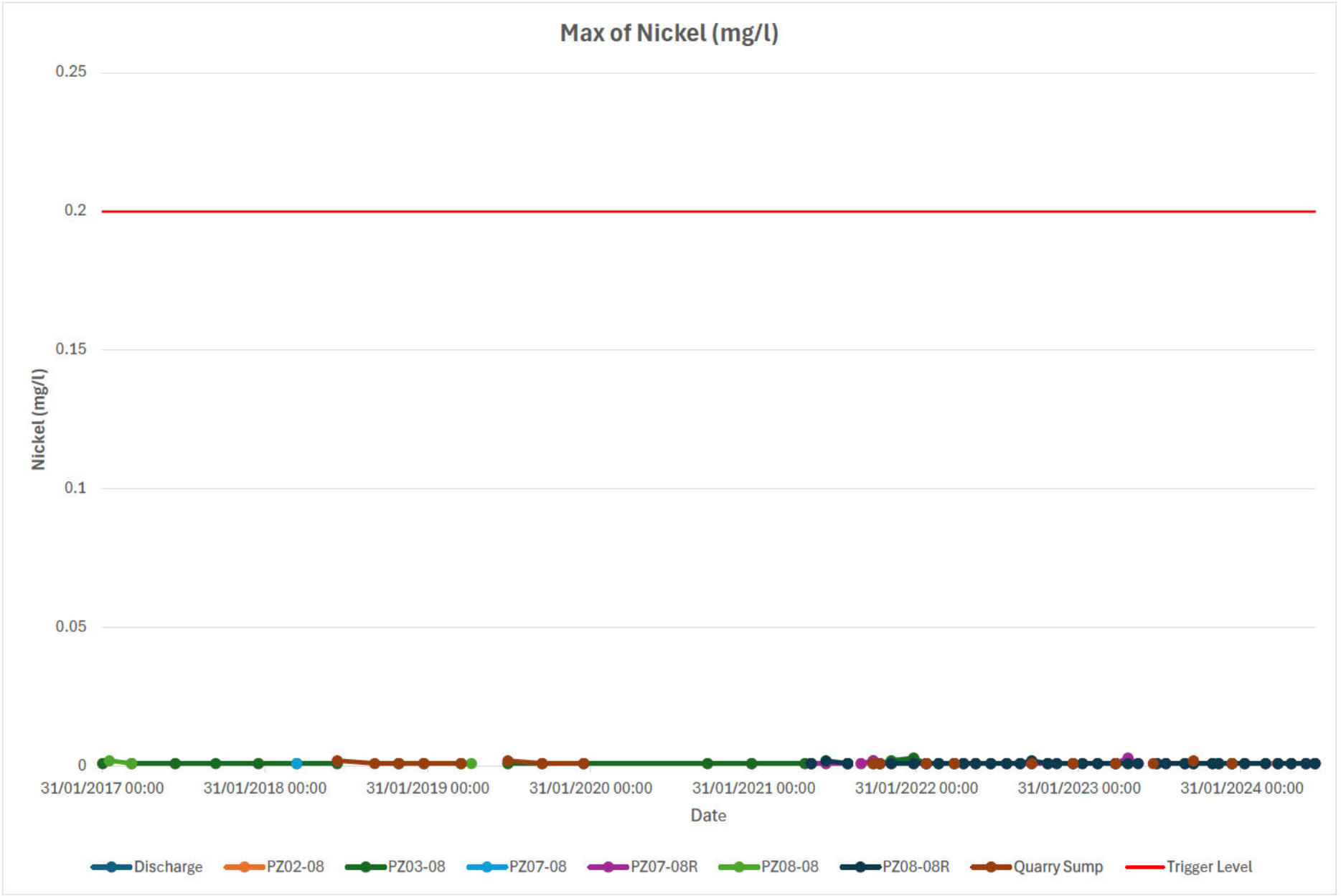

Max of Potassium (mg/l)
Potassium (mg/l)
8
7
6
5
4
3
2
1
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

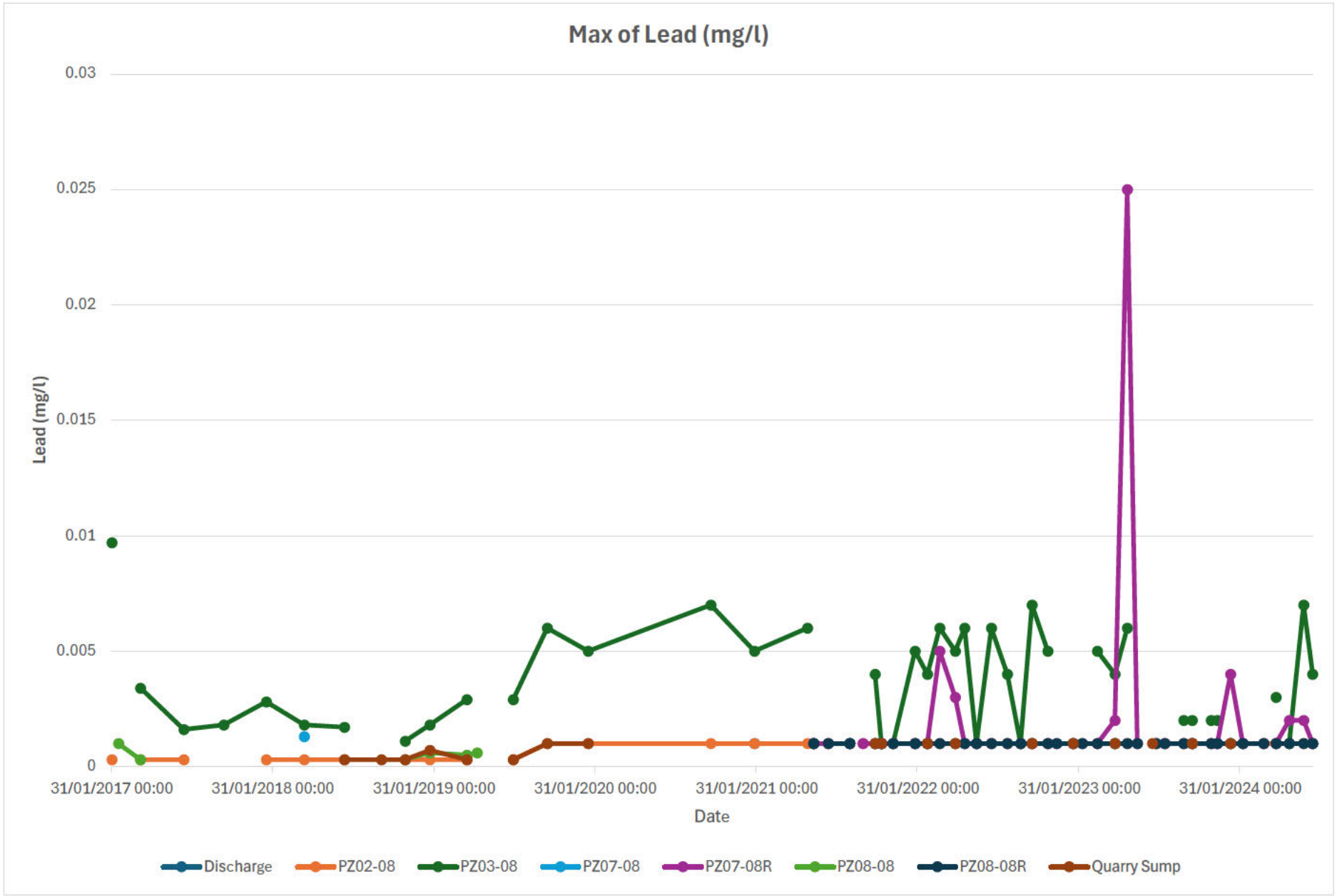

Max of Magnesium (mg/l)
Magnesium (mg/l)
50
45
40
35
30
25
20
15
10
5
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

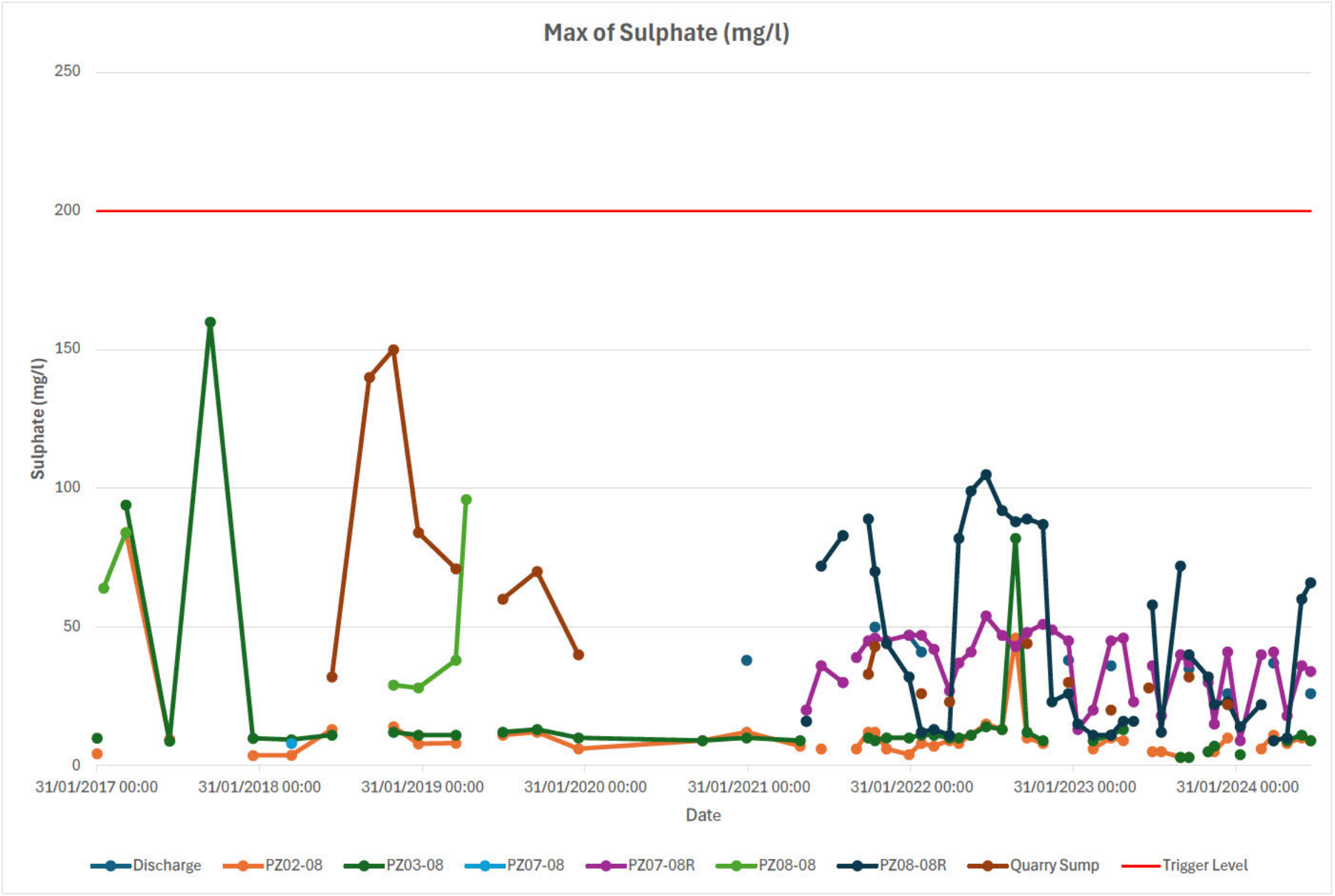

Max of Manganese (mg/l)
12
10
8
6
4
2
0
Manganese (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

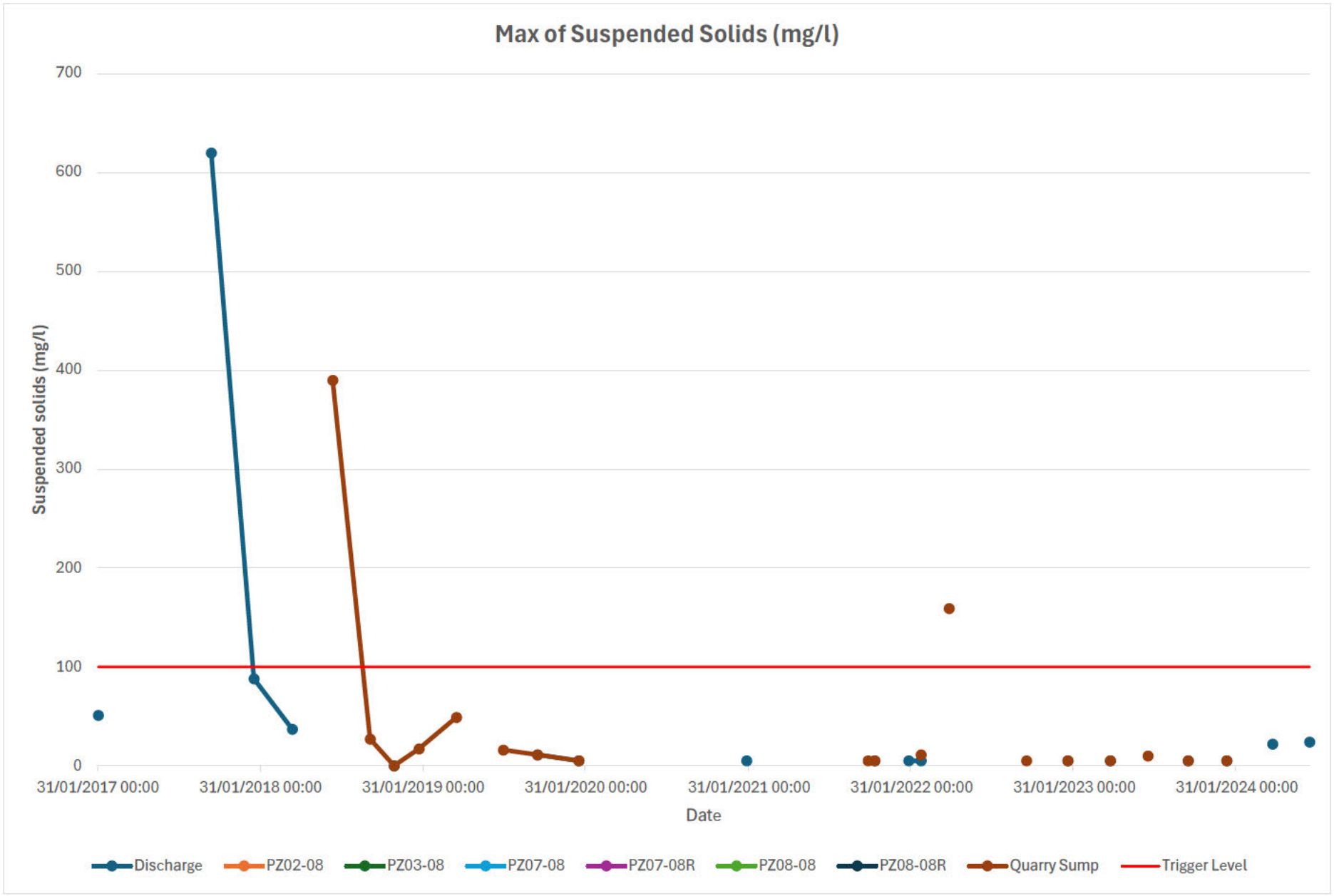

Max of Sodium (mg/l)
Sodium (mg/l)
80
70
60
50
40
30
20
10
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

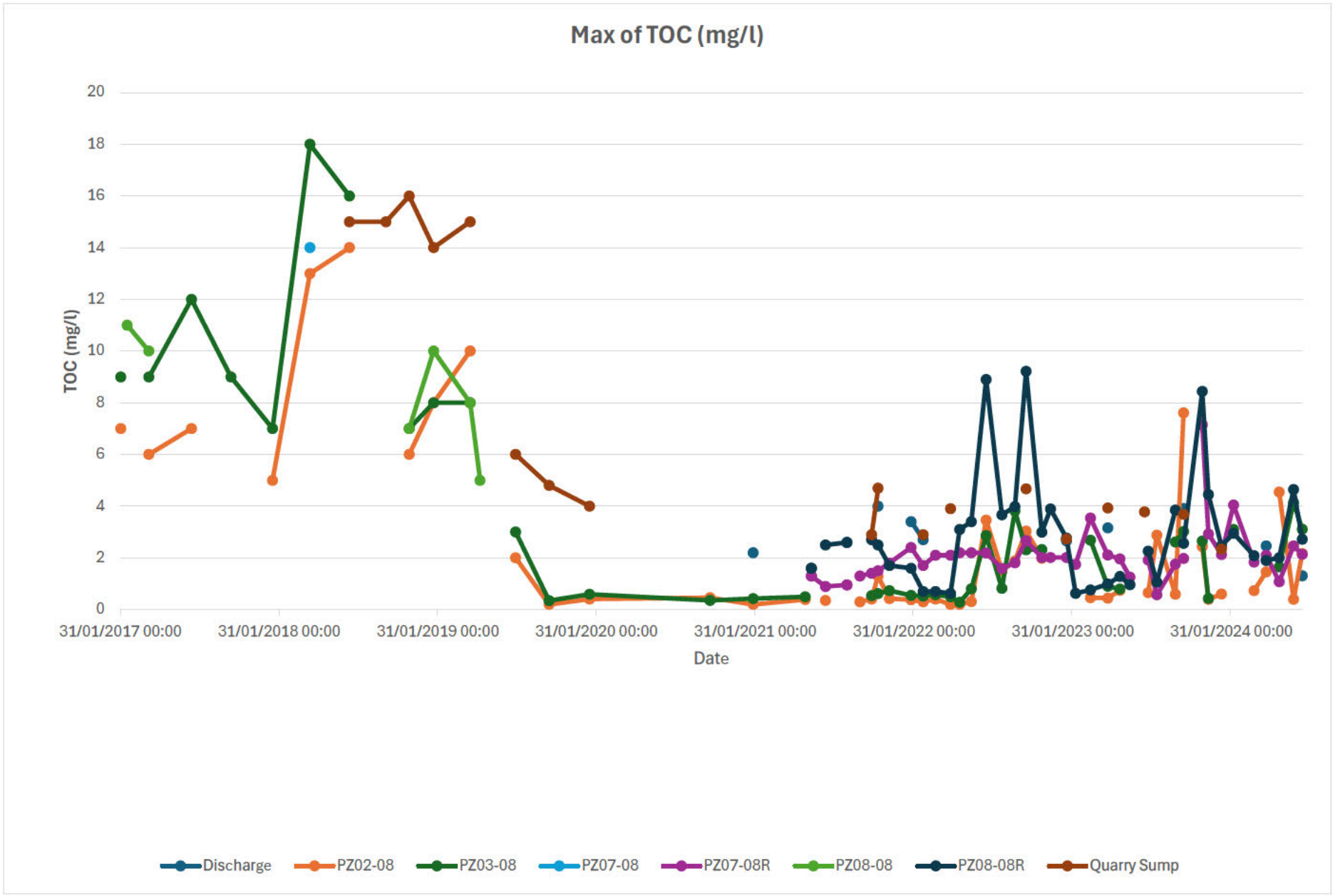

Max of Ammoniacal Nitrogen (mg/l)
Ammoniacal Nitrogen (mg/l)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

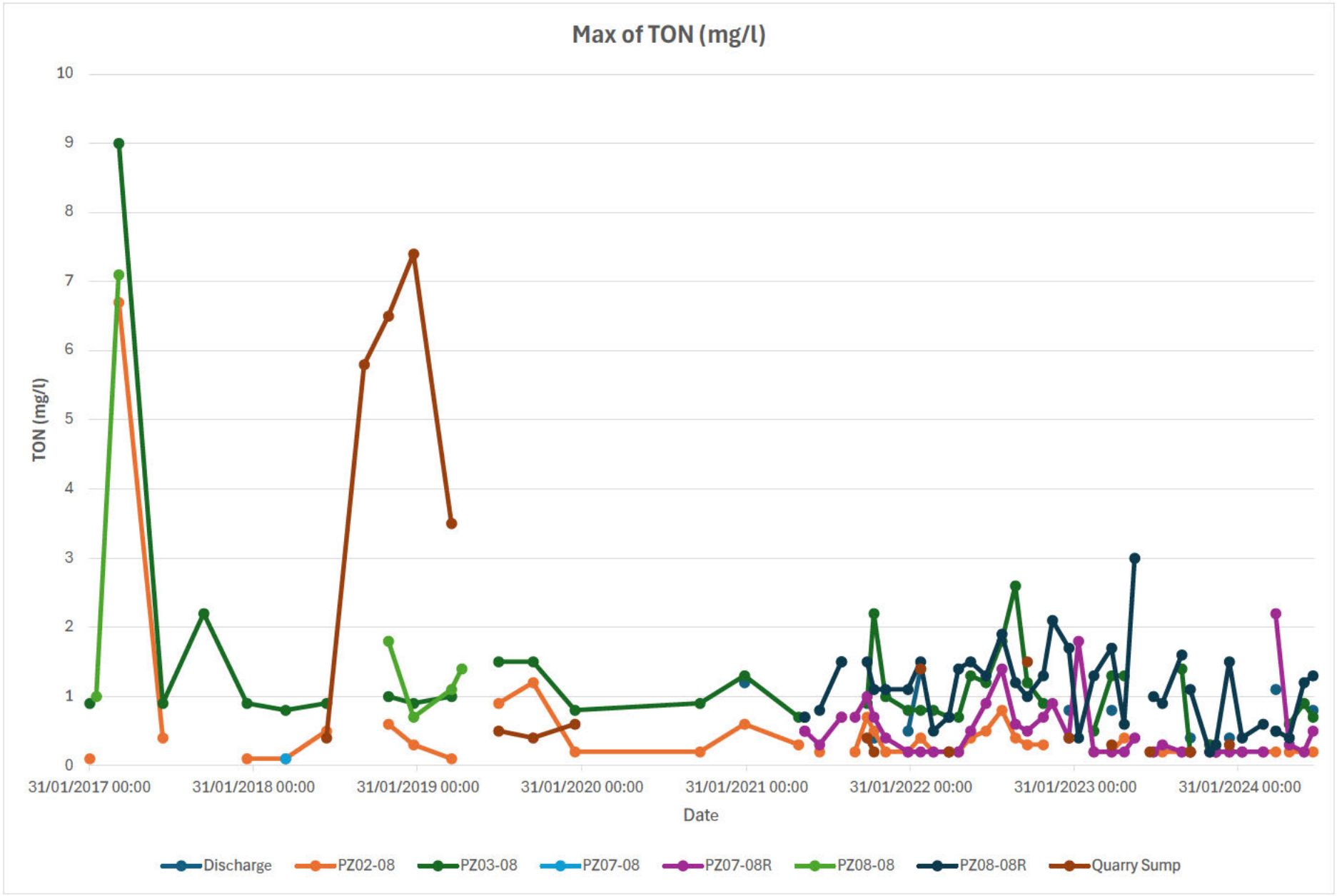

Max of Nickel (mg/l)
0.25
0.2
0.15
0.1
0.05
0
Nickel (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

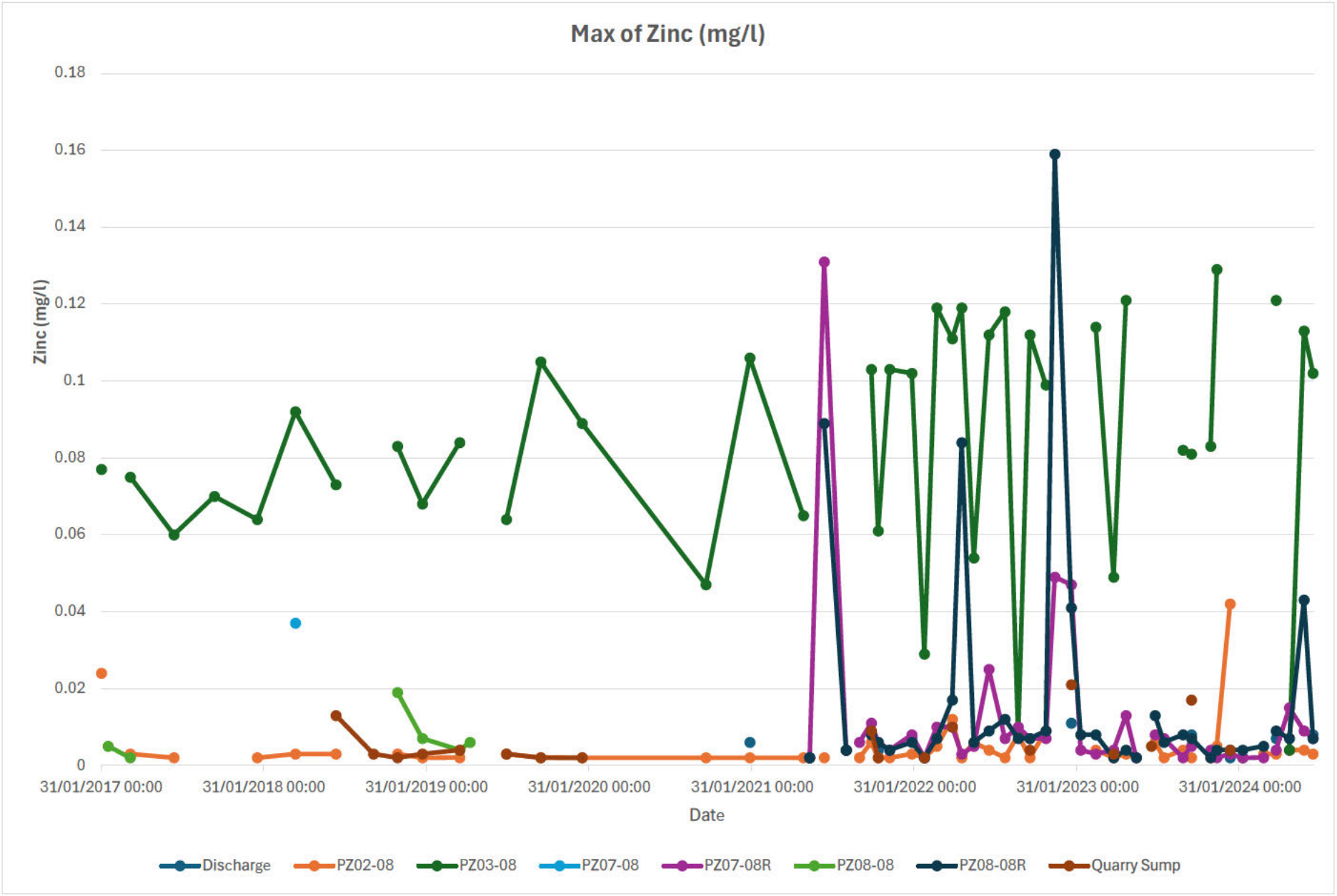

Max of Lead (mg/l)
0.03
0.025
0.02
0.015
0.01
0.005
0
Lead (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

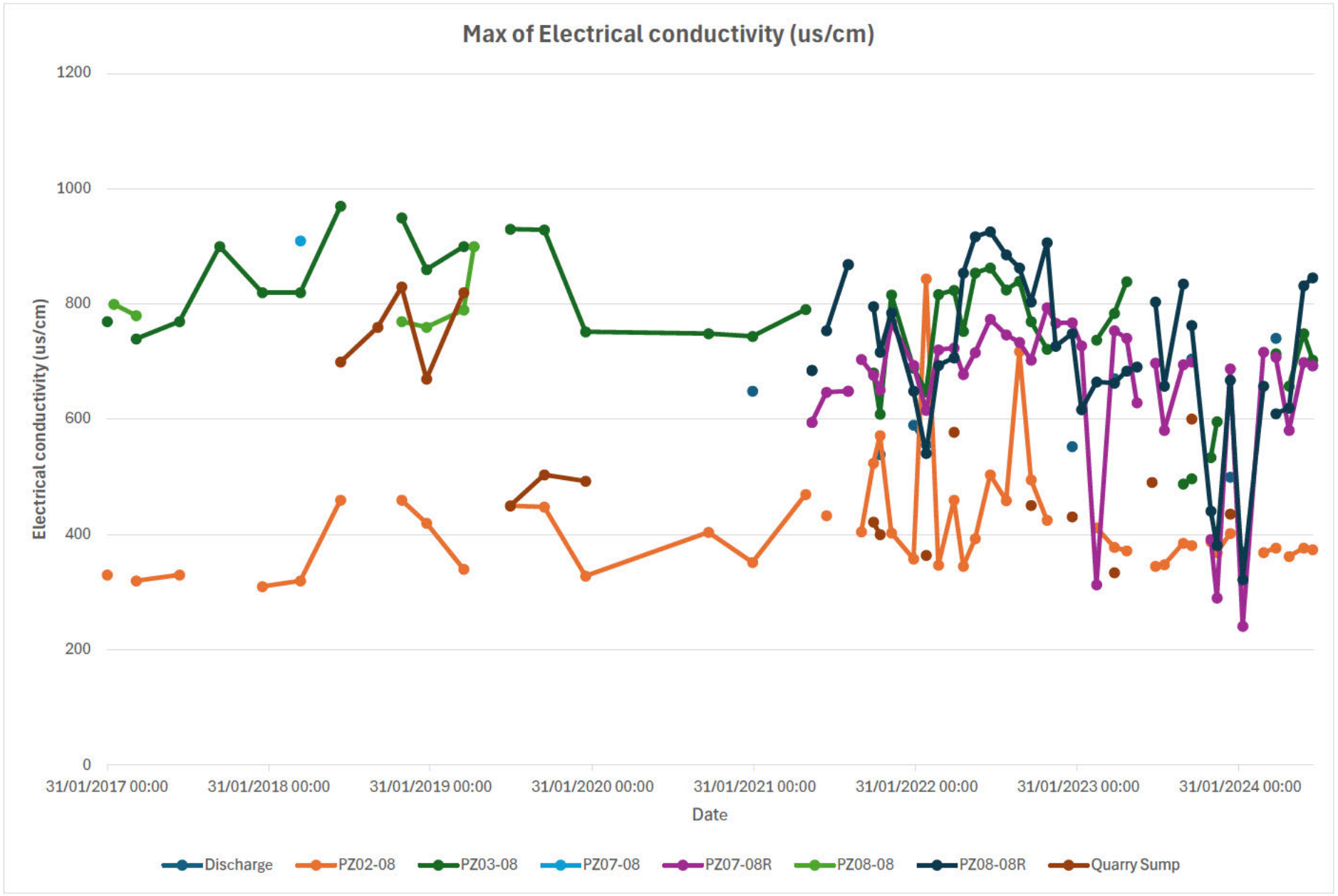

Max of Sulphate (mg/l)
250
200
150
100
50
0
Sulphate (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

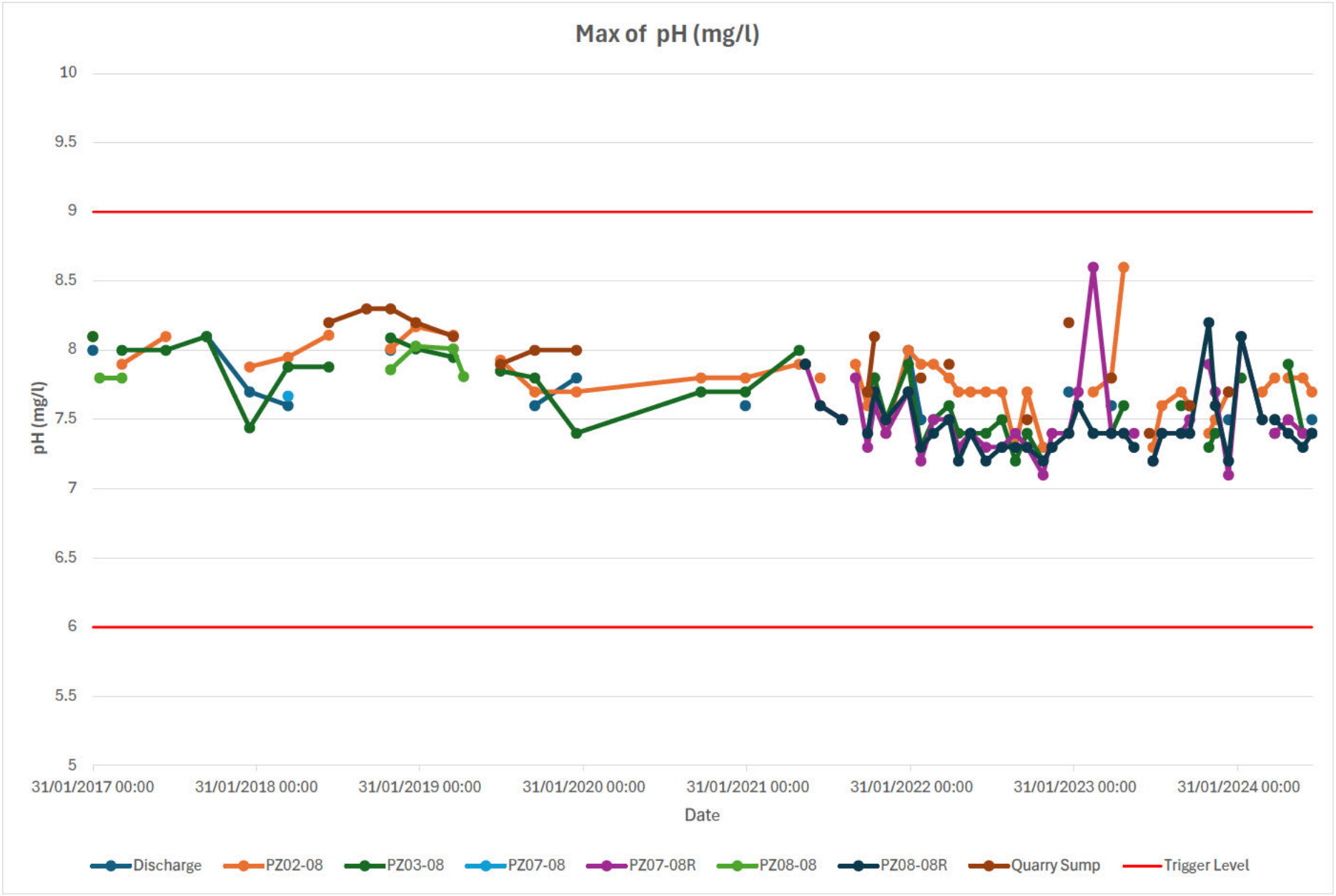

Max of Suspended Solids (mg/l)
700
600
500
400
300
200
100
0
Suspended solids (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

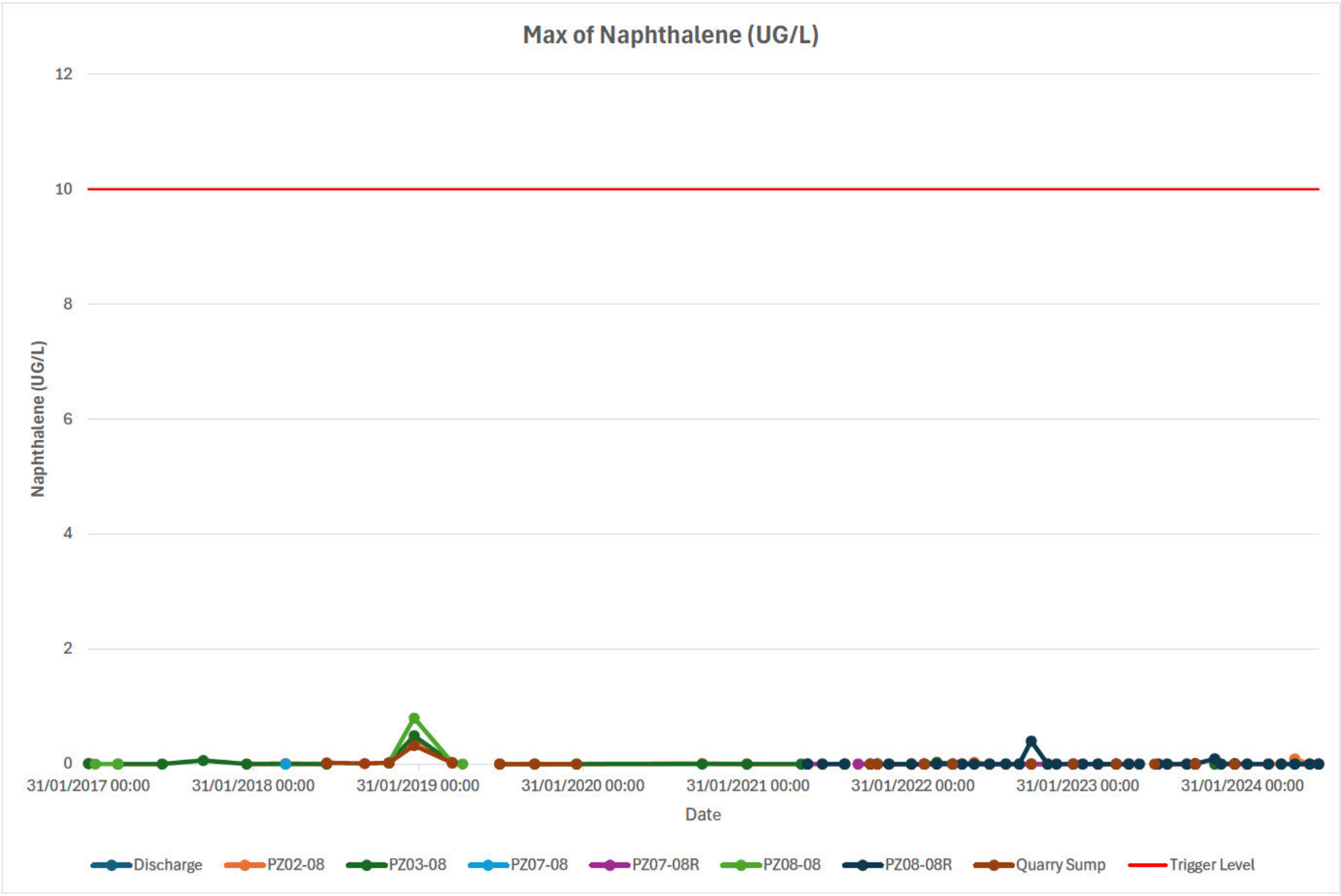

Max of TOC (mg/l)
TOC (mg/l)
20
18
16
14
12
10
8
6
4
2
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

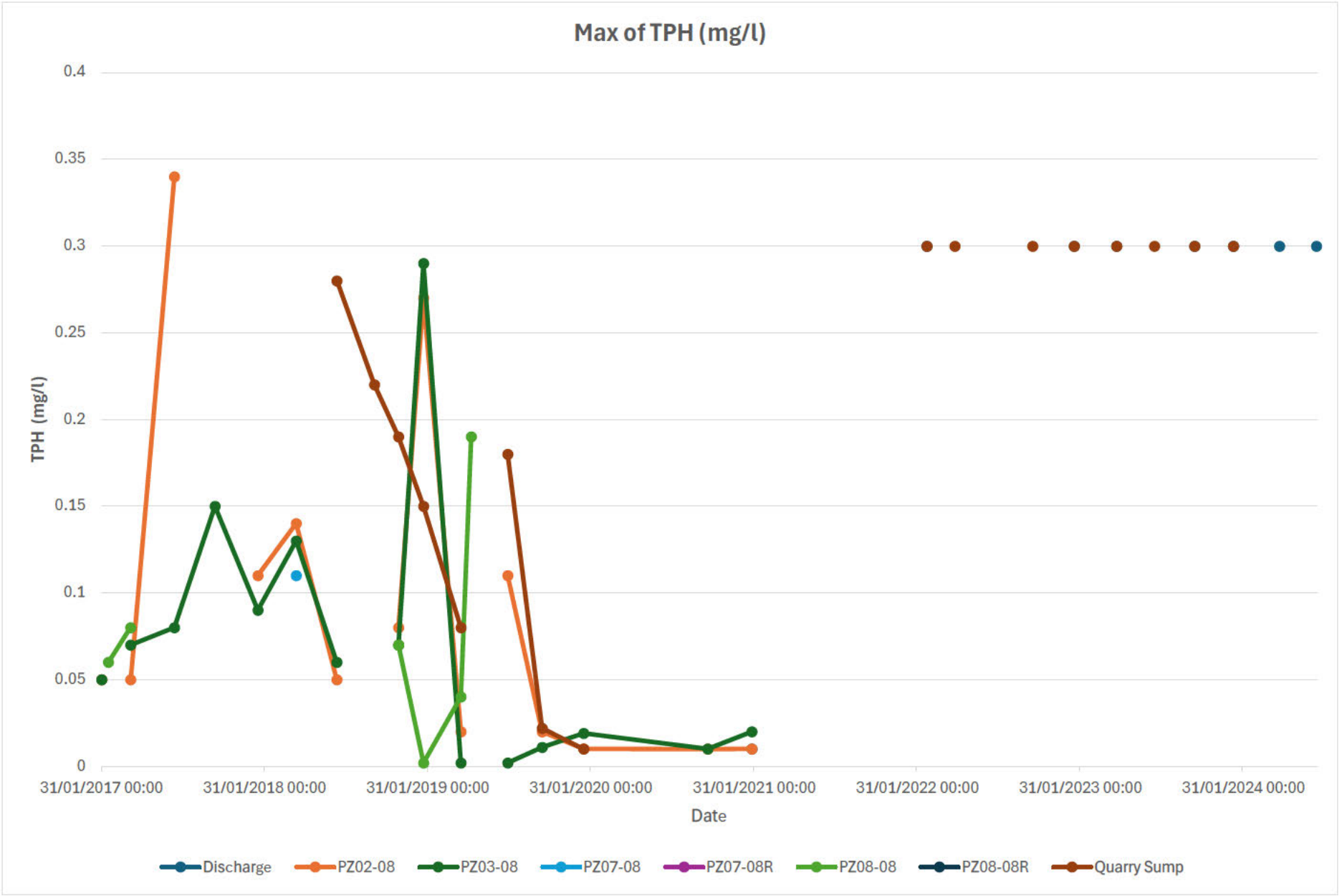

Max of TON (mg/l)
TON (mg/l)
10
9
8
7
6
5
4
3
2
1
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

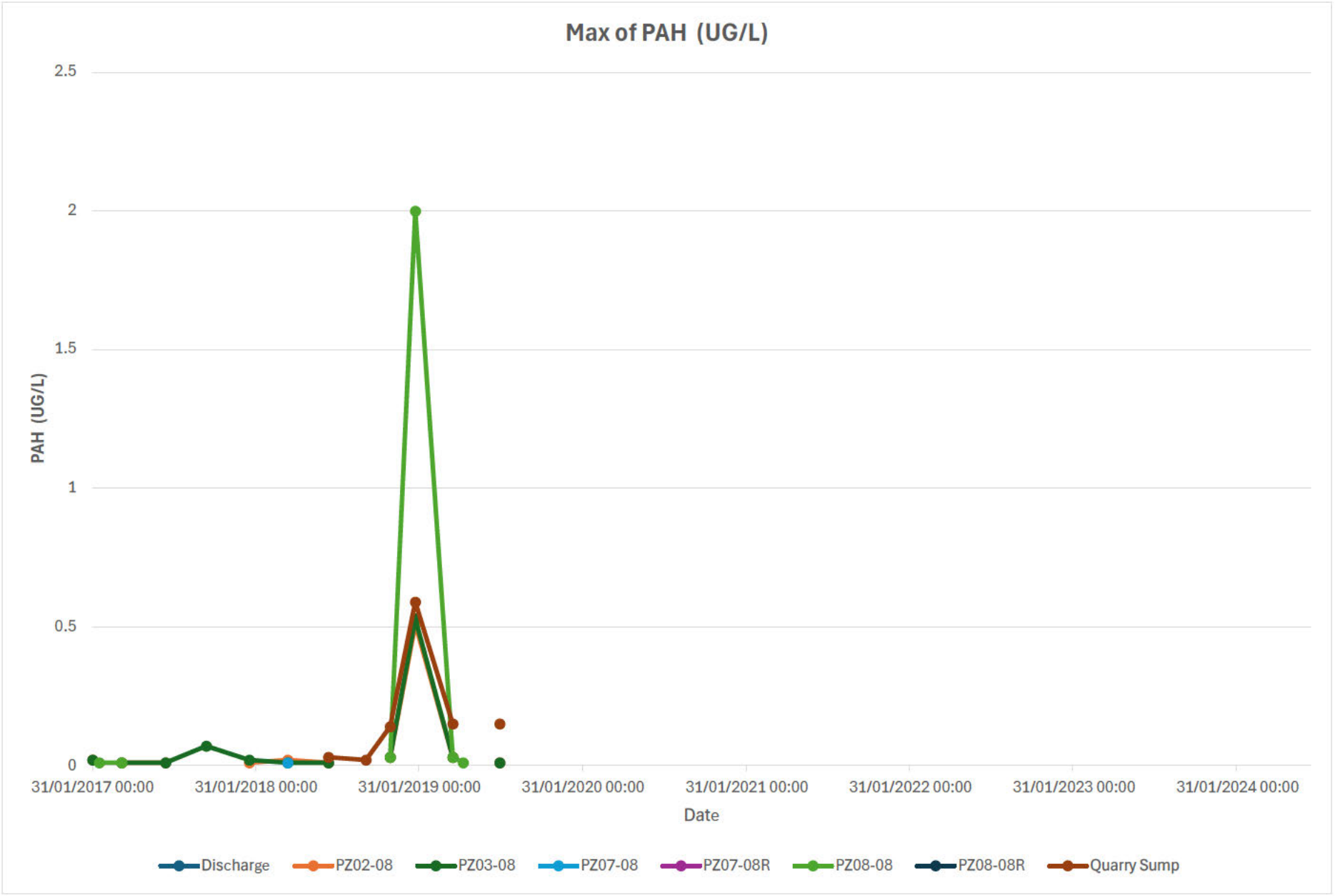

Max of Zinc (mg/l)
Zinc (mg/l)
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

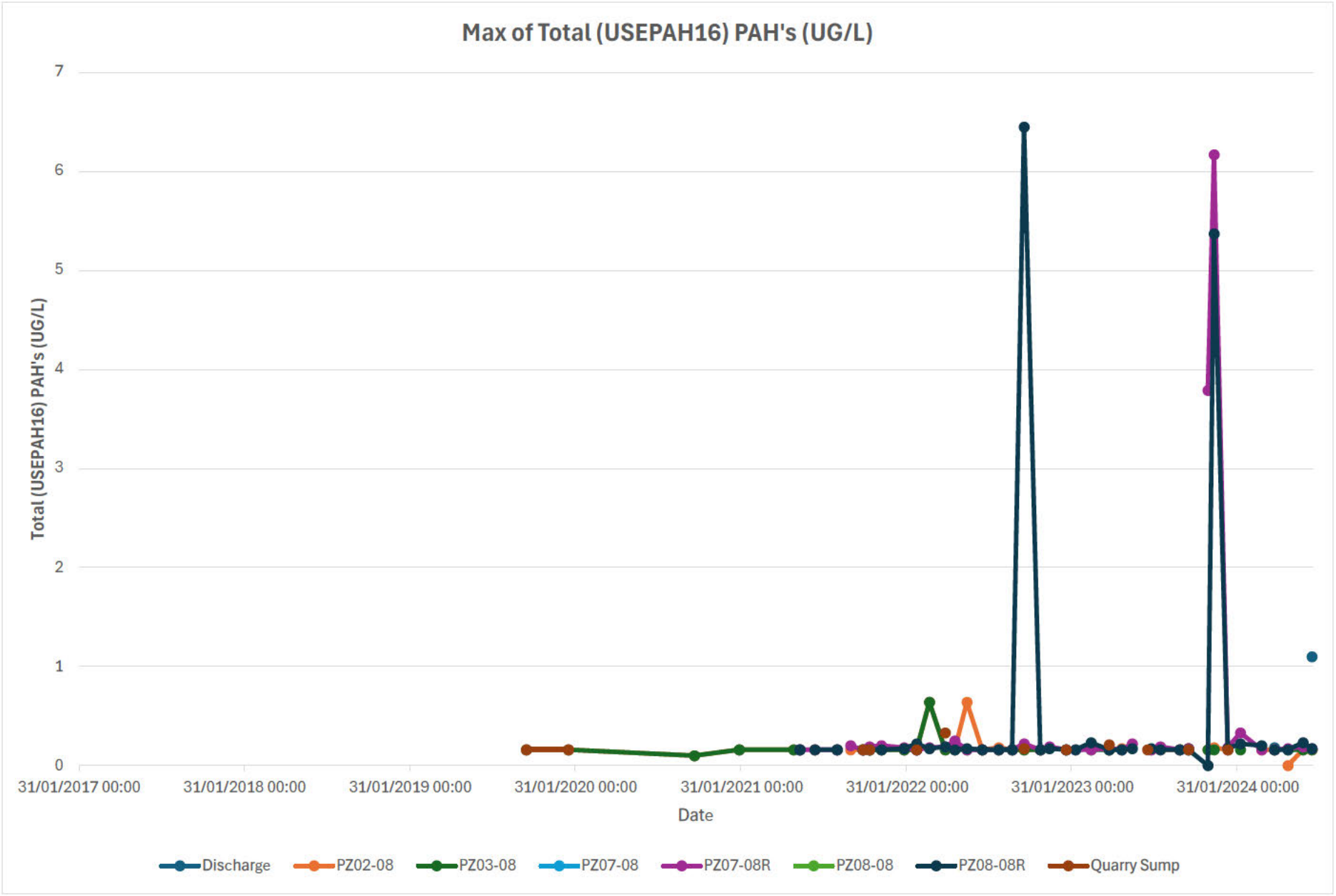

Max of Electrical conductivity (us/cm)
1200
1000
800
600
400
200
0
Electrical conductivity (us/cm)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump

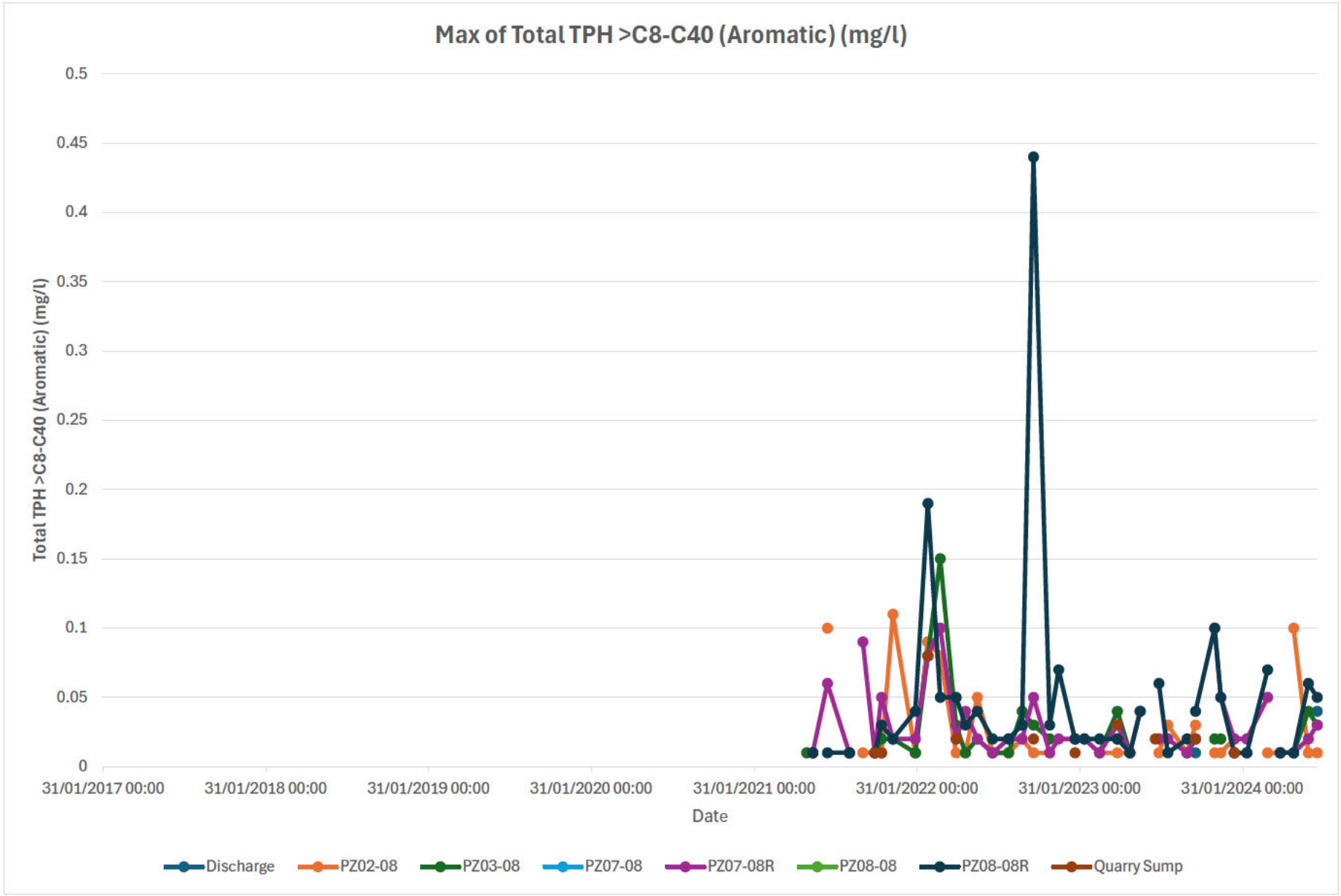

Max of pH (mg/l)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
pH (mg/l)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level

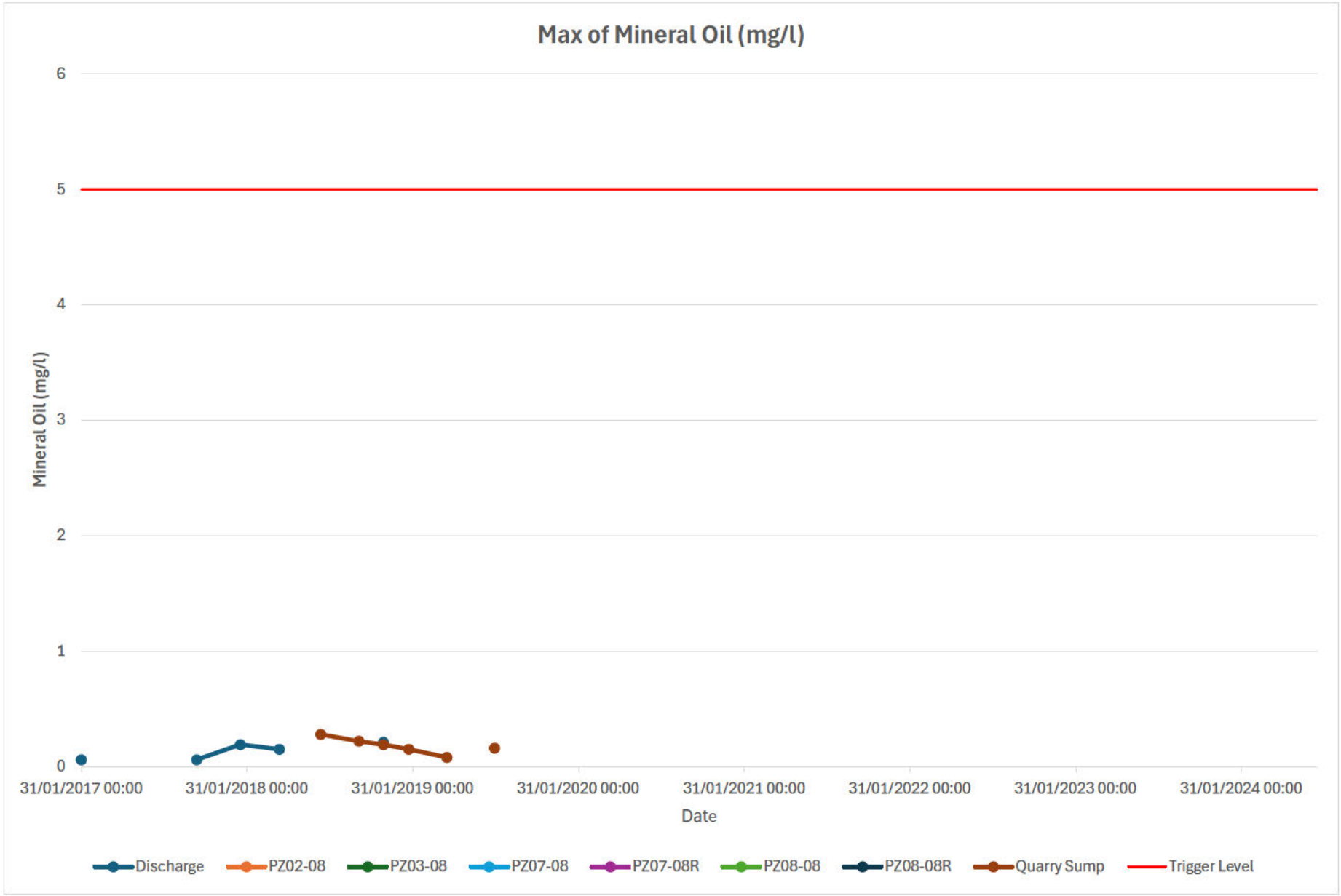

Max of Naphthalene (UG/L)
12
10
8
6
4
2
0
Naphthalene (UG/L)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level


Max of TPH (mg/l)
TPH (mg/l)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump


Max of PAH (UG/L)
2.5
2
1.5
1
0.5
0
PAH (UG/L)
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump


Max of Total (USEPAH16) PAH's (UG/L)
Total (USEPAH16) PAH's (UG/L)
7
6
5
4
3
2
1
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump


Max of Total TPH >C8-C40 (Aromatic) (mg/l)
Total TPH >C8-C40 (Aromatic) (mg/l)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump


Max of Mineral Oil (mg/l)
Mineral Oil (mg/l)
6
5
4
3
2
1
0
31/01/2017 00:00
31/01/2018 00:00
31/01/2019 00:00
31/01/2020 00:00
31/01/2021 00:00
31/01/2022 00:00
31/01/2023 00:00
31/01/2024 00:00
Date
Discharge
PZ02-08
PZ03-08
PZ07-08
PZ07-08R
PZ08-08
PZ08-08R
Quarry Sump
Trigger Level