# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

## PERMIT BV7311IE

## 2019 Annual Review of Environmental Monitoring

*Report Number 1965r1v1d0220*

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# Executive Summary

Since December 2004, Tata Steel (UK) Limited (Tata) has operated the Morfa Non-Hazardous Landfill (MNHL) in accordance with an Environmental Permit. Each year, an annual review report is required by the Permit. This report covers the period to the end of December 2019 and evaluates the leachate, groundwater, surface water, gas and dust data collected since 2005. A recent topographic survey of the site is also presented.

The landfill is designed upon the containment principle. Pollutants are kept within the wastes by surrounding the wastes with barriers that are virtually impermeable to water, liquids and ultimately gases. The landfill is currently being constructed as a series of cells; one currently accepts wastes with a possibility of producing landfill gas and the other accepting wastes with a low gassing potential. Within each cell, leachate produced by the action of rainfall infiltrating and leaching the wastes is managed by extraction and then treatment in the main steelworks. Until 2016, this management programme maintained the leachate at low levels and below Permit control levels. Since 2016 these levels have persistently breached the Permit criteria and the landfill is operating outside of the original design parameters and Permit conditions. In response, Tata initially increased the tankering of leachate and in 2019 completed the installation of a float-controlled pumping system to enable leachate removal 24/7. This system became operational in October 2019 and is now starting to reduce leachate levels.

Leachate chemistry is currently characterised by strongly alkaline pH and elevated concentrations of chloride, considered to be due to the combined leaching of slag wastes (source of alkalinity) and filter cake (source of chloride). Other parameters are currently present at low concentrations. Leachate from the unlined upgradient Morfa Closed Landfill is continuing to influence groundwater quality. As the closed landfill was finally fully restored in 2013 this influence has started to decline as rainfall can no longer infiltrate and leach the unlined waste. At this stage, there is no clear discernible evidence that the active MNHL is influencing groundwater quality.

# 1 INTRODUCTION

Tata Steel (UK) Limited (Tata) operates the Morfa Non-Hazardous Landfill (MNHL) in accordance with Environmental Permit No. BV7311Ie dated 17 December 2004. Since this time the Permit has undergone Variation on two occasions. The latest Variation Notice number is GP3430MH.

The Permit applies to only part of the original Morfa Landfill waste management site, with approximately 40% being closed upon the commencement of MNHL and Morfa Hazardous Landfill (MHL). The closed part of the site is referred to as Morfa Closed Landfill (MCL). The location of MNHL and its position relative to key site features including MNHL and MCL is shown on Figure 1 and Figure 2.

Tata submits a report to Natural Resources Wales (NRW) on a three-monthly basis which compares the monitoring results for landfill gas, leachate, surface and groundwater against the relevant emission limits, assessment limits, control levels and compliance limits specified in the permit. Permit Condition 4.2 requires that a further summary review of all monitoring data is produced on an annual basis. This report is the annual monitoring report for MNHL for the period January–December 2019 as required by Permit condition 4.2. This report also includes scale plans from the annual topographic survey, as required by the Permit.

The environmental monitoring commenced in 2005. This report has been compiled and completed by Geotechnology Ltd (Geotechnology) to provide an independent review of the monitoring data collected. Previous annual reports have also been prepared by Geotechnology.

Separate annual monitoring reports describing the monitoring undertaken at MHL and MCL have also been compiled by Geotechnology.

The Permit was eight years old in December 2012 which prompted a review of the initial Hydrogeological Risk Assessment (HRA). The review is provided in Geotechnology report 1177r1v1d0712 and follows the first review in report 711r1v1d0908. Geotechnology has recently completed a review of the HRA (Geotechnology report 1739r1v1d1217) but understands that NRW has not yet provided feedback. The next HRA should be scheduled for 2024 as Geotechnology understands that they are now on a six-year review cycle.

# 2 SITE DESCRIPTION AND ENVIRONMENTAL SETTING

The Morfa Site has been extensively investigated in support of landfill development. Since the issue of Environmental Permits (EPs) Tata Steel has maintained an extensive monitoring network that includes air quality monitoring, recording and investigating any visual or amenity issues, groundwater and surface water monitoring, landfill gas and landfill settlement. The information gathered to date is used in the following sections to describe the current site setting.

Based on the findings to date, a conceptual site model has been developed. This is illustrated in Figure 3 with each element discussed further below.

## 2.1 Location

The centre of the site is located at National Grid Reference SS781 838, as shown on Figure 1. The site currently comprises a mixture of casually over-tipped land, landfills constructed in accordance with the current Landfill Directive since 2004 (MNHL and MHL), the unlined but capped MCL, partially excavated sand dunes and pristine dune fields.

The site was granted planning consent for sand extraction and waste disposal in 1973 and has been used in part for these purposes since. The planning boundary covers a large area (as shown on Figure 2), though restrictions within the conditions required a stand-off to be observed between the landfill site and the River Kenfig to the south and Margam Sands to the west. Tata Steel also adopted a voluntary stand-off between the development of MNHL and MHL and Margam Moors, which was designated a SSSI in 1984, 11 years after planning consent for the landfill had been granted.

The site occupies a coastal location, adjacent to the dune system behind Margam Sands. The ground is generally flat with only 2 metres of relief between 6m and 8m AOD, though the western edge of the development encroaches into the dune system, where elevation rises to 14m AOD. The western edge of the site is the coastal dune field over its entire length and is roughly parallel to the beach which lies 75 metres further to the west. The southern edge of the site is occupied by MCL with the eastern edge following the fence line at the western edge of Margam Moors. The central part of the site is occupied by the current MNHL while the northwestern corner is occupied by MHL. The northern edge of the site is defined by a disused access track crossing from the coast road to the edge of the moors. These key features are illustrated in Figure 4.

The site is remote and located at the southern end of the Port Talbot steel plant. It is surrounded by land entirely owned by the company. The adjacent Margam Moors as far as the railway line to the east is owned by Tata Steel (UK) Ltd as is the site as far south as the River Kenfig. KNNR is located to the south of the River Kenfig and is bound by the southern bank of the River Kenfig.

There are no inhabited buildings within 1.9km and the nearest industrial buildings are close to 1km from the site. There are no public roads within 1km of the site and the adjacent beach is also under the private ownership of Tata Steel (UK) Ltd. There are no services crossing the site. One public footpath crosses the moors close to the site.

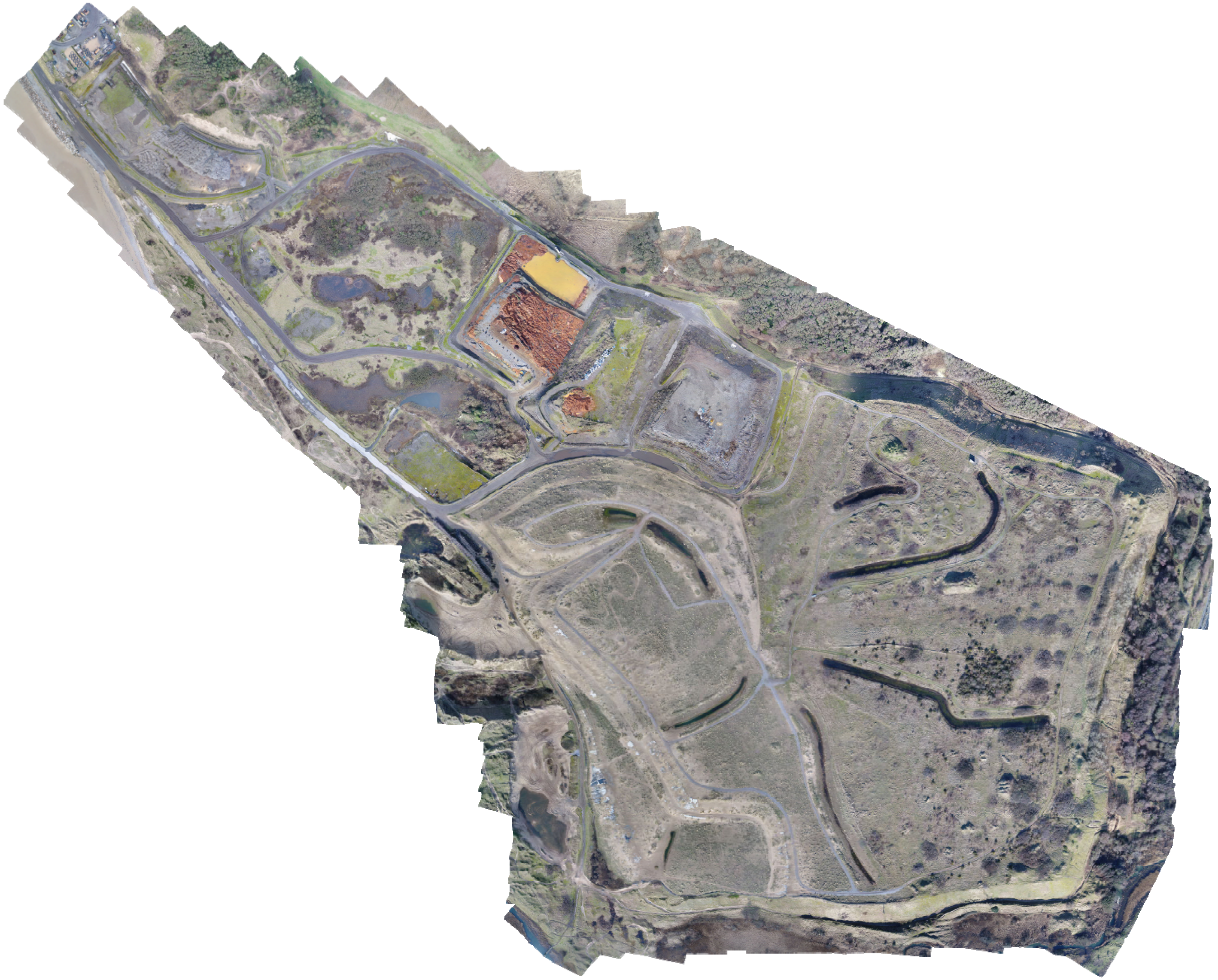


**Plate 2-1 Aerial view west over site (taken January 2018). Note recently restored areas on MCL**

The site lies in an area of great ecological interest. Some 40m to the south of MCL, on the opposite side of the River Kenfig is the Kenfig National Nature Reserve, a SAC. The site shares a common boundary to the east with the Margam Moors which has also been granted statutory protection by its SSSI designation.

The principal watercourse in the area is the River Kenfig, which drains a catchment to the east of the site. The water quality of the river is routinely monitored by the Environment Agency. Both chemical and biological indicators are used to classify the quality of the river water and the water course. The Kenfig flows to the south of the site, where it breaks the confines of its river valley to spread into a coastal wetland that gives rise in part to the ecological interest of the area. The wetland extends across the entire southern boundary of the closed landfill site, until the river discharges over a pebble bank onto Margam Sands. The pebble bank represents the highest point to which normal tides flow.

Margam moors is a flat, poorly drained moorland which has been artificially managed over many centuries with a ditch or reen system. Precipitation is slow to run-off and the poor vegetation cover supports a small livestock rearing effort. The moors are characterised by the deep man-made reed filled ditches which allow the moors to drain water northwards where it is collected and pumped into the steel plant to be used as process water.

## 2.2 Geology

Much of the site is underlain by an irregular sheet of wind-blown sand which extends from the ground surface down to an organic/alluvial clay layer. The sand deposit is typically several metres thick, though this locally increases due to sand dune topography. Being wind-blown, the dune sand is poorly graded, with a very uniform grain size throughout. The sand has blown inland from Margam Beach which lies to the west. Locally, the wind-blown sand is overlain by made ground comprising steel making wastes. The small woodland patches along the base of the northeastern flank of the site appear to be dune migration barriers and mark the extent of the blown sand.

Underlying the wind-blown sand at every trial pit and borehole, except those along the southern boundary, is an organic and alluvial clay layer of up to 2.8m thickness. The alluvial clay layer is continuous with the clays found at the surface on the adjacent Margam Moors and therefore this layer represents the moorland surface prior to the deposition of the wind-blown sands.

An examination of the reduced elevation of the clay layer has revealed that it is not completely flat, as it falls from 4.1m AOD at Borehole 14 to 3.2m in Borehole 2, adjacent to Margam Moors. Further, the upper surface of the clay aquitard has been found to have a broad shallow valley or trough running centrally through the site from south to north. Sufficient density of ground investigation data has allowed this feature to be identified and it explains the occurrence of contaminated groundwater emanating from MCL as a springline near SW3/SW2.

Ground investigation works in the southern part of the site has revealed that the clay layer is absent alongside the River Kenfig. The precise line along which it terminates is not known, though this line is considered to lie between Boreholes 14 and 10 and 9 and 16 (see Figure 4 and Figure 5). It is considered most likely that the River Kenfig, in its meandering past has eroded the clay layer, resulting in the sequence of strata seen in Boreholes 16, 15 and 10, where wind-blown sand directly overlies estuarine alluvium.

Throughout the area, the clay layer overlies an estuarine alluvium sequence, comprising principally dirty sands with shell fragments. Locally, finer lenses are seen and on occasions the upper surface of the estuarine fines layer supports a thin organic layer. In the extreme north of the site the estuarine fines dominate the sequence, with the upper 10m of the stratum comprising sandy silt and clays. Locally, within the estuarine deposits, gravels and even cobbles are noted occurring in bands, with one of these traceable between Boreholes 14 and 15.

The estuarine sands overlie glacial gravels at depth, which have been encountered in nearby deep boreholes. None of the investigation boreholes drilled at the site has continued sufficiently deep to intersect these strata. The glacial gravels, which also crop out beneath the seaward edge of the coastal barrier dunes extend inland for some distance. Coal Measures Bedrock underlies the glacial gravels at a depth of approximately 26m at the nearby Newlands Colliery.

## 2.3 Meteorology

Meteorological data is recorded by two site weather stations. One is located on top of the weighbridge office and the other is in the sub-contractors yard. Information is also routinely obtained from Natural Resources Wales stations located at Margam and at the Tata Steel Works site. The site typically receives approximately 1000mm rainfall per annum and the prevailing wind direction is southwesterly.

In recent years the on-site weather stations have not been fully functional and so for this report a daily rainfall record has been purchased from NRW.

## 2.4 Air Quality

Air quality at the site is routinely monitored by the Tata Steel Environment Department. Monitoring currently comprises:

- Deposition gauges which collect dust (and rainfall) via a bowl which drains into a bottle at four locations. These instruments record the total amount of dust fallen.
- Flexible poles fitted with 'sticky pads' at 5 sites. As the pads collect airborne dust from 360 degrees dust deposition direction can be evaluated. These were installed November 2005.

Independent quarterly asbestos fibre monitoring is also undertaken at four positions around MHL.

The Morfa Landfill site is not in an Air Quality Management Area.

During 2016, Tata moved the analysis of deposited dust from the BOS labs to the TDC Harbourside laboratory. Tata was aware that the change in laboratory had resulted in a step change in the data and following evaluation Geotechnology understands that this is due to a more sensitive technique being utilised at the accredited laboratory.

## 2.5 Hydrogeology

Ground investigation boreholes and trial pits excavated around the site have been used to obtain basic groundwater data, including groundwater levels and strata permeabilities.

During the investigation works it was apparent that the site is underlain by two water bodies. The first has been encountered throughout the site at shallow depth and lies within the wind-blown sand. This shallow water body sits above the alluvial clay sequence and drilling into the clay has been seen repeatedly to seal off water inflows from this "shallow aquifer".

When the clay layer is breached by drilling works and the underlying estuarine sand sequence is struck, groundwater rises in the drill casing to a different (and normally lower), height than the shallow aquifer. Continued drilling into the estuarine sand sequence maintains a uniform water level, indicating that there is no stratification within the "deep aquifer". The sequence of upper and lower aquifer observed in drilling works has been confirmed to be consistent across the site, except for a strip adjacent to the River Kenfig, where the clay layer separating the aquifer is absent. However, even in this area, shallow piezometers and boreholes reveal a head differential with the wells placed into the lower aquifer indicating stratification of the water body here too.

### 2.5.1 Shallow Aquifer

The shallow aquifer is the wind-blown sand deposit with vertical downward percolation eliminated or restricted by the presence of the underlying clay. Permeability tests have been undertaken (rising head tests) and these reveal a variation in permeability ranging from $2 \times 10^{-3}ms^{-1}$ to $5 \times 10^{-5}ms^{-1}$, with an average permeability of $2.3 \times 10^{-4}ms^{-1}$. Due to the sand deposits limited thickness the aquifer is thin, with perched water depths typically around 2 to 3 metres, extending from close to ground surface down to the underlying clay layer.

The position of each monitoring point has been established with a differential GPS instrument so that the spatial location of the data can be mapped. This has allowed groundwater surfaces to be constructed onto a base plan of the site.

An examination of the shallow groundwater surface shows that it is typically domed, with a concentric series of groundwater elevation contours centred on the highest elevation close to the centre of the site (see Figure 6). Groundwater flows in response to head loss and accordingly flow lines will be normal to the contours, radiating outward from the central dome. This radial flow pattern is considered to be a response to groundwater recharge in the shallow aquifer, which has very limited extent, following almost exactly the footprint of the site. Clearly, shallow groundwater flow from beneath the Morfa site would be expected toward Margam Moors, Margam Beach, the River Kenfig and the railway sidings.

In Section 2.2, the dune sand was noted to have limited extent, petering out along the site's boundary with Margam Moors. The moorland, which lies directly on the clay layer, is continuous with the clay underlying the dune sand and therefore the presence of a spring-line where the groundwater surface meets the edge of the sand deposit is not unexpected. A significant spring-line 40m from the northeast edge of the boundary along Margam Moors can be seen on the ground and this strip of wet ground supports a fen habitat which has been protected by SSSI status.

To the west of the site, the shallow aquifer discharges into Margam Beach in the inter-tidal zone. It is difficult to see the spring-line under conditions other than dry periods with spring tides but a linear seepage line at an elevation of 2.5m is present.

The shallow aquifer may or may not have localised areas where it is in continuity with the underlying deep aquifer. At every point where an investigation borehole has been drilled sufficiently deep, the presence of the underlying clay layer has been confirmed. It is likely, therefore, that the clay aquitard is either complete or near complete.

Ground investigation data has revealed that the ground alongside the Kenfig and along the southern part of the existing site comprises wind-blown sand over estuarine sands. The clay layer, characteristic of a large part of the existing site and the entire PPC permit boundary, is absent. This absence, most likely due to river erosion as described earlier, has prevented the clear separation between the upper and lower aquifers. However, there is a permeability contrast between the wind-blown sand aquifer and the underlying estuarine sands and this causes stratification within the groundwater. Greater heads in the shallow groundwater indicates that recharge from the shallow aquifer is active, explaining the difference in chemistry between shallow and deep groundwater along this edge.

Water quality in the shallow aquifer is variably impacted due to seepage from the unlined MCL. Shallow groundwater quality is poorest in the northeast (Margam Moors) downgradient flow zone of MCL where hazardous substances and elevated concentrations of non-hazardous pollutants have been historically found e.g. BH18–20 on Figure 4. When this shallow groundwater eventually discharges along the fringe with the Margam Moors as a springline (SW3 and SW2) it has had an observable ecological impact due to its alkaline mineralised load. Capping of MCL is intended to improve groundwater quality along this fringe line by recharging the system with clean surface water runoff. In topographically low areas secondary precipitates have accumulated where shallow groundwater interacts with the atmosphere. NRW has previously approved the covering of these areas to prevent direct access.

### 2.5.2 Deep Aquifer

Beneath the alluvial clay layer, the estuarine sands are saturated and piezometric levels are higher than the base of the clay. The water in the lower aquifer is therefore confined by the clay layer. Using data from the monitoring boreholes it has been possible to produce a map of the piezometric surface in the area surrounding the site. The piezometric surface plan of the deep aquifer is included in Figure 7.

Rising head permeability tests have been undertaken in many of the boreholes and these reveal that the lower aquifer is of lower permeability than the upper aquifer, with permeabilities ranging from $5.2 \times 10^{-4} ms^{-1}$ to $1.5 \times 10^{-7} ms^{-1}$. This is consistent with descriptions of the lower aquifer stratum as being silty sand.

Locally, thicker deposits of estuarine fines are found interbedded with the sands, with one principal fines stratum shown on the geological sections. At the northern edge of MHL, Boreholes 26 and 27 intersected a sequence dominated by silts and clays, with sand occurring as a minor constituent. Permeabilities here are expected to be accordingly smaller.

Typical deep groundwater piezometric levels are indicated on Figure 7 and the plan shows a pattern of decreasing head towards the north and west. There is no element of a radial pattern to the contours as seen in the overlying shallow groundwater, but rather a uniform loss of head from the east towards the west. Recharge to the deep aquifer takes place at some distance to the east of the site, where the sand and gravel deposits form undulating farmland in the Cornelly/Pyle/Margam district. Groundwater migrating seaward from this higher ground passes beneath the industrial areas (where it has been utilised for water resources), beneath the railway and then beneath the site.

An examination of Figure 7 shows that the deep groundwater surface is at the same level as the River Kenfig at the southern boundary of the site, strongly indicating a degree of interaction with the surface water. In this area drilling has also revealed that the clay aquitard is absent, with the wind-blown sand aquifer directly overlying the estuarine sequence.

The chemistry of the deep aquifer is generally far less contaminated with slag source pollutants than the upper aquifer. Most monitoring results show lower pH, lower alkalinity and lower calcium levels. Generally, water quality in the lower aquifer is like or better than the overlying shallow aquifer. However, the lower aquifer is contaminated with other pollutants, with ammoniacal nitrogen and nitrate in greater concentration than the shallow aquifer. The chemical profiles are evidence of pollution from various sources, MCL is the source of pollutants for the shallow aquifer, whilst industrial and farmland to the east is the source for the deep aquifer. Where water quality of the upper aquifer is good (i.e. little contamination with Ca, pH and alkalinity) the lower aquifer beneath is also low in these pollutants. Where the upper aquifer can be seen to be affected, the lower aquifer remains less so. This supports the observation that the clay aquitard provides effective separation of the two water bodies over much of the site.

### 2.5.3 Conceptual Hydrogeological Models

As the intrusive investigation programme has evolved and further monitoring data gathered, Geotechnology has developed and refined a conceptual hydrogeological model of the site that summarises the current level of understanding of the geology beneath the site and groundwater flow. The flow of water through the ground is a direct result of the geometry of the strata beneath and around the site and the physical properties of each stratum.

Due to the shallow trough in the clay aquitard between MCL and MHL, two conceptual models have been developed. One describes the shallow aquifer on the southern side of the trough around MCL and MNHL and one for the northern side of the trough around MHL. In both models the deep groundwater generally moves to the north and west, being recharged off-site in the surrounding industrial and agricultural areas.

In both conceptual models there is a degree of radial flow within the shallow aquifer. In the northern conceptual model, shallow groundwater moves towards Margam Moors and Margam beach. In the southern conceptual model, the radial component results in most of flow in the shallow aquifer moving toward the Margam Moors with a small contribution flowing towards the Kenfig, although the hydraulic gradient in this area is shallow and subject to sporadic reversal.

Flow to both the Moors and Kenfig is contaminated due to the leaching of wastes from MCL. As the dominant flow path is towards the Margam Moors this results in a concentration of pollution along the springline where the shallow aquifer discharges. This area is typically characterised by alkaline groundwater and precipitates can be found in topographically low areas. Leaching and dispersion of precipitates from this area is also impacting on surface water in Margam Moors.

Along the fringe with the River Kenfig, groundwater is found to be mineralised near MCL. However, the River Kenfig shows no evidence of any impact related to MCL. This is primarily considered to be due to the flat gradients along this fringe limiting advective transport from MCL to the Kenfig and dilution within the Kenfig. Waterlevels in the River Kenfig are higher than those in Margam Moors.

The monitoring conducted to date shows that there is no impact related to either MHL or MNHL. Shallow groundwater is currently polluted due to leaching of wastes deposited at MCL, whilst deep groundwater is polluted due largely to off-site recharge with a small contribution from MCL.

## 2.6 Hydrology

The site is surrounded by a sand dune field and there are no surface water courses within the site, or at its immediate perimeter. Surface water features near the site comprise the River Kenfig to the south, the Margam Moors ditch system to the north and the Bristol Channel to the west. A small number of isolated ponds are found on the low-lying area to the north of MCL in an area that will be developed as part of MNHL.

The flat lying moors have been managed for centuries for agricultural production by draining the clay soils using a deep network of ditches. The configuration of ditches has been developed to address local ground conditions. The ditches are at their densest along the southern and western edge of the moors where there is a need to drain surface water originating from the pronounced springline. All the ditches feed into the Mother Ditch which flows northward to a single gauged collection point. From here the entire flow of water is abstracted into the works for use as process water. The pumping is carried out after the water discharges over a weir and therefore pumping cannot affect water levels in the ditches.

The River Kenfig drains a small catchment to the east of the site to the sea at Margam Beach. This is the principal watercourse in the area and separates the site from Kenfig National Nature Reserve which is bound by the southern bank of the Kenfig. The river has a 95-percentile low flow of 950 litres/sec. The river is monitored routinely by Natural Resources Wales. Based on 36 measurements made in 2007, the upstream and downstream river stretches were chemically classified by the Agency as Grade B, with low levels of phosphorous but moderately elevated nitrates. The biology of the river stretches is classified as Grade E. The chemical and biological scale used by the Agency runs from A to F (very good to bad). The lack of deterioration in the quality of the River Kenfig demonstrated by the Agency is backed up by the routine monitoring of the River Kenfig undertaken by Tata Steel.

## 2.7 Ecological Setting

Two sites of ecological importance lie near the site:

- Kenfig National Nature Reserve (KNNR)
- Margam Moors SSSI

### 2.7.1 Kenfig National Nature Reserve

The northern boundary of Kenfig National Nature Reserve (KNNR) follows the southern bank of Kenfig River which flows to within 40m of the southern edge of MCL, as shown on Figure 4.

KNNR is a Special Area of Conservation (SAC), designated because of the following features:

Habitats of community interest whose conservation requires the designation of Special Areas of Conservation; these are included on Annex I of the European Communities Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora:

1. Fixed dunes with herbaceous vegetation (grey dunes).
2. Dunes with *Salix repens* subsp. *argentea* (*Salicion arenarae*).
3. Humid dune slacks.
4. Atlantic salt meadows (*Glauco-puccinellietalia maritimae*).
5. Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.

Animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation; these are included on Annex II of the European Communities Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora:

1. Fen orchid Liparis loeselii
2. Petalwort Petalophyllum ralfsii

KNNR is also included under the following United Kingdom designations:

- Sites of Special Scientific Interest (United Kingdom)
- National Nature Reserves (United Kingdom).

It supports populations of Nationally Rare and Nationally Scarce non-vascular plants including Petalwort, *Amblystegium serpens* var. *satinum, Campylium polygamum, Drepanocladus lycopodioides, D. sendtneri, Moerckia hibernica* and *Chara aspera*. Populations of Nationally Rare vascular plants include Fen Orchid, Sea Stock *Matthiola sinuata*, Long-stalked Orache *Atriplex longipes,* Maiden Pink *Dianthus deltoides,* Green-flowered Helleborine *Epipactis phyllanthes,* Variegated Horsetail*,* Portland Spurge *Euphorbia portlandica,* Sea Spurge *E. paralias, Euphrasia rostkoviana* and Hutchinsia *Hornungia petraea*. Several Nationally Scarce species of vascular plant have also been recorded. In addition, the site also supports a rich assemblage of Nationally Rare and Nationally Scarce invertebrate species. The exceptional wetness of the Kenfig dune system is of national significance and the hydrological regime appears perfectly natural. Although the KNNR groundwater system is thought to be mainly rain-fed, there is the possibility that groundwater inflow from underlying/neighbouring carbonate aquifers also plays a role.

Relevant factors which are known to influence the features at Kenfig and which are likely to influence dunes elsewhere locally include over-stabilisation, with the extent of bare sand having declined from c. 40% in 1946 to c. 2% at Kenfig at present; the virtual cessation of grazing by rabbits (through myxomatosis) and a decline in livestock grazing. Shoreline retreat, preventing the formation of strandline and fore dune communities, has long been a problem at Kenfig with only a small section of the shoreline up to 300m south of the mouth of the River Kenfig showing localised signs of accretion.

### 2.7.2 Margam Moors SSSI Description

The western part of Margam Moors lies within 40m of the active MNHL and is shown on Figure 4. Margam Moors is a Site of Special Scientific Interest (SSSI) designated because of the following features:

The mosaic of drainage ditches provides the main interest of the moors and it is principally for this feature that the site was designated as a Site of Special Scientific Interest (SSSI). In a Welsh context only the extensive Wentlooge Levels support a similar assemblage of habitats and species.

Important bird species that have been lost through habitat loss and possibly changes in management include White-fronted Goose *Anser albifrons* (a winter visitor) and Yellow Wagtail *Motacilla flava* (a summer visitor).

The site does still support numerous species of high conservation value including aquatic plants such as Frogbit *Hydrocharis morsus-ranae*, Flowering Rush *Butomus umbellatus*, Cyperus Sedge *Carex pseudocyperus*, Brown Sedge *C. disticha*, Unbranched Bur-reed *Sparganium emersum* and Arrowhead *Sagittaria sagittifolia*. In addition to the plants a rich assemblage of scarce aquatic invertebrates is also known to be present in the moors. Continuous management is required to prevent Common Reed *Phragmites australis* from shading out some of the more sensitive species.

Marginal habitats of significance include areas of species-rich mesotrophic marsh. These result from seepage of water from the base of the dunes and support a characteristic suite of species, often with substantial quantities of Yellow Flag *Iris pseudaTata Steel*, Meadowsweet *Filipendula ulmaria*, Water Mint *Mentha aquatica*, Ragged Robin *Lychnis flos-cuculi* and Lesser Spearwort *Ranunculus flammula*.

Areas of semi-improved grassland can be found to be in a less favourable condition and uncommon species are known to have been recorded in the past, e.g. Green-winged Orchid *Orchis morio*, Common Twayblade *Listera ovata* and Cowslip *Primula veris*, were either not recorded at all or were very scarce. An area of dense birch/sallow scrub occurs in the very south of the site. Biodiversity Action Plan species associated with the pastures and ditches include Shrill Carder Bee *Bombus sylvarum*, Brown-banded Carder Bee *B. humilis*, Brown Hare *Lepus europaeus*, Skylark *Alauda arvensis* and Reed Bunting *Emberiza schoeniclus*. The Kingfisher, a schedule 1 species protected under the Wildlife and Countryside Act has also been recorded in the past (Gillham, 1976).

# 3 REGULATORY FRAMEWORK

## 3.1 Background

The Permit defines the regulatory emission limits that must be met at MNHL. These include leachate limit levels, emission limits to air for particulates and landfill gas, emission limits for surface water and Compliance Limits for emissions into groundwater. Since the issue of the Permit these have changed on several occasions. To ensure these changes can be traced they are documented in Appendix 1.

The following sections summarise the Assessment Criteria used since January 2013.

New criteria were proposed in the 2017 annual review but as NRW has not formally commented upon these, Tata has continued to implement those presented below. Despite being implemented for many years, NRW has recently queried the criteria below following a recent Permit Variation (Variation EPR/BV7311IE/V006). Geotechnology understand that this aspect is to be clarified with NRW shortly. To inform this discussion, a short note is added to each section below. This note is underlined for easy reference.

## 3.2 Applicable Assessment Criteria

### 3.2.1 Emissions to Air

The limits for emission to air are reproduced in Table 3-1.

**Table 3-1 Particulate matter emission limits into air**

| Parameters and frequency of monitoring | Emission Limit | Designation of Monitoring Points | Note |
|---|---|---|---|
| Gross dust depositional rate – Quarterly | 200 $mg/m^2/day$* | D15, D16, D17, D18 and D19 | *50% correction factor applied (as outlined by Tata letter (ref:Landfill_003) dated 28 September 2007) |

The limit should only be applied to 50% of the total dust deposition. Therefore, the actual total dust deposition allowed before the emission limit is exceeded is 400 $mg/m^2/day$.

<u>The above criteria agree with those set out in the recent Permit Variation.</u>

### 3.2.2 Surface Water Control Levels

The surface water control levels are set out in Table 3-2.

**Table 3-2 Assessment Levels for Surface Water**

| | SW2 and SW4 | |
|---|---|---|
| **Parameter** | **Assessment level 1 (AL1)** | **Assessment level 2 (AL2)** |
| Cadmium | 0.1 | |
| Copper | 25 | 28 |
| Mercury | 0.1 | |
| Chloride | 200 | 250 |
| Ammonia | 2.75 | 3 |
| Alkalinity | 350 | 400 |
| Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l. | | |

The above criteria are not included in the recent Permit Variation as they relate to surface water control levels.

### 3.2.3 Groundwater Compliance Limits

The groundwater Compliance Limits and Control Levels (CL) are summarised in Table 3-3.

**Table 3-3 Groundwater Trigger and Control Levels**

| Parameter | BH3 (shallow aquifer) | | | BH4 (shallow aquifer) | | | BH6 (shallow aquifer) | | |
|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | CL1 | CL2 | Trigger Level | CL1 | CL2 | Trigger Level |
| Cadmium | - | 0.1 | | - | 0.1 | | - | 0.1 | |
| Mercury | - | 0.1 | | - | 0.1 | | - | 0.1 | |
| Chloride | | 100 | 250 | | 100 | 250 | | 100 | 250 |
| Ammonia | 8 | 10 | 12 | 2 | 3 | 4 | 14 | 16 | 18 |
| Alkalinity | 2400 | 2700 | 3000 | 650 | 700 | 750 | 1200 | 1300 | 1400 |
| | | | | | | | | | |
| | BH11 (shallow aquifer) | | | BH12 (shallow aquifer) | | | BH13 (shallow aquifer) | | |
| | CL1 | CL2 | Trigger Level | CL1 | CL2 | Trigger Level | CL1 | CL2 | Trigger Level |
| Cadmium | - | 0.1 | | - | 0.1 | | - | 0.1 | |
| Mercury | - | 0.1 | | - | 0.1 | | - | 0.1 | |
| Chloride | 100 | 200 | | 100 | 200 | | 100 | 200 | |
| Ammonia | 0.88 | 1.1 | | 0.44 | 0.52 | | 1.8 | 2.1 | |
| Alkalinity | 556 | 657 | | 284 | 335 | | 738 | 872 | |
| | | | | | | | | | |
| | BH14 (shallow aquifer) | | | BH30 (shallow aquifer) | | | | | |
| | CL1 | CL2 | Trigger Level | CL1 | CL2 | Trigger Level | | | |
| Cadmium | - | 0.1 | | | 0.1 | | | | |
| Mercury | - | 0.1 | | | 0.1 | | | | |
| Chloride | 100 | 200 | | | 100 | 250 | | | |
| Ammonia | 10.9 | 12.9 | | 2 | 3 | 4 | | | |
| Alkalinity | 178 | 211 | | 650 | 700 | 750 | | | |
| Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l.<br><br>These Assessment Criteria will also apply to future replacement boreholes for these positions although the situation will be reviewed at the time. | | | | | | | | | |

The above criteria are different to those included in the recent Permit Variation. These criteria are summarised in Table 3-4.

**Table 3-4 Permit Groundwater Trigger Levels**

| Parameter | BH3S | BH4S | BH6S | BH11S | BH12S | BH13S | BH14S |
|---|---|---|---|---|---|---|---|
| **Cadmium** | 1.1 | 0.88 | 2.86 | 0.55 | 1.1 | 1.1 | 3.41 |
| **Copper** | 6.5 | 6.5 | 14.3 | 6.5 | 13 | 7 | 6.5 |
| **Mercury** | 0.11 | 0.33 | 0.11 | 0.22 | 0.11 | 0.11 | 0.11 |
| **Ammonia** | 11.739 | 3.12 | 17.42 | 1.1 | 0.52 | 2.08 | 12.87 |
| **Alkalinity** | 2938 | 748.8 | 1443 | 656.5 | 335.4 | 872.3 | 210.6 |

### 3.2.4 Leachate Control Levels

The leachate assessment levels are summarised in Table 3-5.

**Table 3-5 Leachate Control Levels**

| Leachate Point | Ammoniacal nitrogen | Cl | As |
|---|---|---|---|
| **Unit** | **mg/l** | **mg/l** | **mg/l** |
| **Control levels** | 70 | 70000 | 3 |

The above criteria are not included in the recent Permit Variation as they relate to assessment levels.

### 3.2.5 Leachate Level Limits

The head of leachate shall not be permitted to exceed 1 metre above the base of any leachate monitoring point at any time throughout the operational or aftercare phases. This is set out in the current Permit.

As noted in the previous annual review, this limit has been breached and, in response, Tata has designed and constructed a new leachate control system that enables continuous leachate pumping 24hrs/day. As part of the ongoing commissioning phase the pump float controls are being established to ensure that leachate levels are controlled and below the trigger levels in the long-term. It is anticipated that during the Spring and Summer of 2020 the leachate levels will be brought down sufficiently to provide storage capacity for subsequent winter periods and to avoid elevated leachate levels recurring.

### 3.2.6 External Gas Monitoring Compliance Limits

The Compliance Limits are summarised in Table 3-6.

**Table 3-6 Perimeter Compliance Limits and Assessment Levels**

| Perimeter gas position | Methane Compliance Limit | Carbon Dioxide Assessment level |
|---|---|---|
| GA7 | 2 | 3.5 |
| GA16 | 3.6 | 3.4 |

These levels differ to those in the recent Permit Variation. These are reproduced in Table 3-7.

**Table 3-7 Permit Compliance Limits and Assessment Levels**

| Perimeter gas position | Methane Limit | Carbon Dioxide Limit |
|---|---|---|
| GA7 – GA15 | 1 | 1.5 |
| GA16 | 6 | 2 |

### 3.2.7 Internal Landfill Gas Compliance Limits

Compliance Limits are not established for the internal landfill gas monitoring wells during operation. Once a cell is capped, the average methane flux and total methane emission will need to be measured and compared to permissible emission rates stipulated in the Permit.

## 3.3 Assessment against Permit Criteria

The focus of this annual summary report is to evaluate the data collected against the applicable Assessment Criteria. To enable rapid and efficient data evaluation, time series graphs have been generated where applicable. These are presented in Appendices 2 to 8. Spatial summaries of key parameters are provided in Appendix 9.

Time series graphs have been plotted for most parameters where Compliance Limit and Control levels apply and where sufficient data is available for graphical plotting. Any agreed changes to the relevant Assessment Criteria are included where applicable. Time series plots of other key parameters are also presented in the relevant appendices. Where possible, the scale of the y-axis has been standardised on each graph for the same parameter from different monitoring locations to facilitate rapid comparison of the data.

## 3.4 Hydrogeological Risk Assessment Criteria

One of the objectives of the HRA review undertaken every 6 years is to ensure that the computer simulations used as part of the design of the landfill do not become detached from the reality of landfill construction and operation. Therefore, in addition to evaluating the data against the assessment criteria set out in the Permit, Geotechnology also uses the preparation of the annual report as an opportunity to compare the actual leachate chemistry with that modelled as part of the most recent HRA. The model input parameters against which the leachate chemistry is compared are summarised in Table 3-7. These were not modified as part of the recent HRA review as the assessment concluded that they are still protective of the controlled water environment.

**Table 3-8 Modelled leachate inventory**

| LandSim Parameter | Ammonia | Arsenic | Chloride |
|---|---|---|---|
| | mg/l | mg/l | mg/l |
| **Minimum Value** | 0.05 | 0.005 | 1000 |
| **Most Likely Value** | 10 | 0.3 | 10000 |
| **Maximum Value** | 50 | 3 | 61000 |
| **PDF Used** | Triangular | Triangular | Log Triangular |

# 4 MONITORING NETWORK

## 4.1 Monitoring Programme

### 4.1.1 Monitoring Completed

The full monitoring network available to Tata for all the landfills is shown in Figure 4. From this network the infrastructure used for the assessment of MNHL is summarised in Table 4-1. The table also summarises the key features of the current monitoring programme. Table 4-2 indicates the monitoring suites implemented.

<u>The main differences with this programme and that set out in the recent Permit Variation is that monthly gas monitoring is included in the Permit and the analytical schedules are different</u>.

**Table 4-1 2018 Monitoring Schedule**

| | Lab analysis | Surface water samples | Quarterly Groundwater samples | Annual Groundwater Samples | Monthly water levels | Leachate chemistry | Quarterly Gas |
|---|---|---|---|---|---|---|---|
| **Q1 (Jan-Mar)** | Indicator suite | SW1 – SW15, Ponds 1 - 7 | BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A | | SW gauges 1,2,4,5,6 Piezometers BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A Any other sampled groundwater wells | L1, L6, L7, L8, | GA1, GA2, GA7–GA16 W1–W16 **<u>(Monthly in Permit)</u>** |
| **Q2 (Apr-Jun)** | Indicator suite/ Characterisation suite alternated every year | SW1 – SW15, Ponds 1 - 7 | BH1, BH2, BH10S, BH11S, BH12S, BH13S, BH14S, BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A, | BH2D, BH10D, BH11D, BH12D, BH13D, BH14D BH3D, BH4D, BH6D, BH17D, BH18D, BH19D, BH20D | SW gauges 1,2,4,5,6 Piezometers BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A Any other sampled groundwater wells | L1, L6, L7, L8, | GA1, GA2, GA7–GA16 W1–W16 |
| **Q3 (Jul-Sep)** | Indicator suite | SW1 – SW15, Ponds 1 - 7 | BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A | | SW gauges 1,2,4,5,6 Piezometers BH3S, BH4S, BH6S, BH17S, BH18S,90 BH19S, BH20S, BH30, GWT3A Any other sampled groundwater wells | L1, L6, L7, L8, | GA1, GA2, GA7–GA16 W1–W16 |
| **Q4 (Oct-Dec)** | Indicator suite/ Characterisation suite alternated every year | SW1 – SW15, Ponds 1 - 7 | BH1, BH2S, BH10S, BH11S, BH12S, BH13S, BH14S, BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A | | SW gauges 1,2,4,5,6 Piezometers BH3S, BH4S, BH6S, BH17S, BH18S, BH19S, BH20S, BH30, GWT3A Any other sampled groundwater wells | L1, L6, L7, L8, | GA1, GA2, GA7–GA16 W1–W16 |

**Table 4-2 Current Analytical Monitoring Programme**

| Frequency | Indicator Suite<br>Quarterly<br>(Q1, Q2, Q3, Q4) | Characterisation suite*<br>Annually<br>(alternated each year between Q2 and Q4) |
|---|---|---|
| Analysis | pH, Electrical Conductivity, alkalinity, Calcium, Chloride, Chemical Oxygen Demand, Total Organic Carbon, Ammoniacal Nitrogen, Nitrate, Nitrite, Phosphorous, Phosphate, Arsenic | In addition to indicator suite: Sodium, Potassium, Magnesium, Sulphate, Boron, Total Chromium, Copper, Iron, Lead, Vanadium, Zinc, Cadmium, Mercury, VOC and SVOC |
| *Other parameters may be added depending upon any changes to the types of waste landfilled and review of results from preceding indicator suite | | |

## 4.2 Integrity of Monitoring Infrastructure

Each time samples are collected by Geotechnology, the monitoring infrastructure is inspected. The landfill operator also inspects parts of the monitoring infrastructure during more routine site checks.

### 4.2.1 Landfill Leachate Monitoring Infrastructure

The landfill leachate infrastructure is performing well. Dedicated pumps were provided for the purging and sampling of each sump to prevent cross contamination but samples are now retrieved using a sampling container connected to a length of rope.

### 4.2.2 Groundwater Monitoring Infrastructure

The integrity of the groundwater monitoring network is inspected monthly. The monitoring infrastructure continues to perform well although vandalism is sometimes a problem. Routine maintenance and repairs are rapidly undertaken by the contractor commissioned by Tata to manage the landfill. The routine clearance of vegetation is however required to ensure safe and full access to the whole monitoring network.

### 4.2.3 Shallow Piezometer Monitoring Network

A series of shallow piezometers have been manually installed into the shallow aquifer along the boundary with Margam Moors, as shown on Figure 2. These have been routinely monitored since 2006. This aspect of the monitoring network requires improvement and would benefit from routine vegetation clearance and measures to reduce the opportunity of livestock damaging piezometers on the edge of Margam Moors.

### 4.2.4 Surface Water Monitoring Network

The integrity, access and safety of each of the surface monitoring locations are inspected monthly. Installation of hand/rope rails would aid in the safe recovery of surface water samples as would routine vegetation clearance. Dense vegetation is preventing routine safe access.

### 4.2.5 External Gas Monitoring Infrastructure

The integrity of the external gas monitoring wells is inspected monthly.
Several minor repairs are required to the headworks which have rusted and broken at several positions.

### 4.2.6 Internal Gas Monitoring Infrastructure

The integrity of the internal gas monitoring wells in bio-cells A and B is inspected monthly. There are no problems with this aspect of the monitoring network although the vents, which are open to the atmosphere, are not designed for monitoring. Consequently, the data being gathered is influenced by atmospheric processes and dilution. Some monitoring points in the bio-cell are also difficult / impossible to safely access due to dense growth of buddleia and because the bales are sometimes separated by large gaps. Consequently, not all wells can be routinely safely accessed.

**Plate 4-1 Gaps between bales in bio cell**

### 4.2.7 Dust Monitoring Infrastructure

Dust monitoring is undertaken by Tata Environment Department. Up until 2011, dust monitoring comprised two types of monitoring:

- Deposition gauges which collect dust (and rainfall) via a bowl which drains into a bottle at four locations. These instruments record the total amount of dust fallen.
- Flexible poles fitted with 'sticky pads' at 5 sites. As the pads collect airborne dust from 360 degrees, the direction from which dust has deposited can be determined. These were installed November 2005.

Since 2011, only the deposition gauges have been used. The five dust monitoring positions (D15 – D19) are indicated on Figure 4. The 'sticky pad' poles were not used in 2011 as this aspect of the monitoring is not a Permit requirement and is now only considered by Tata during the implementation of contingency actions, documented in the Dust Management Plan for the site.

## 4.3 Actions required

Based on recent observations of the available monitoring network, the following items require address to ensure that high quality data continues to be collected:

- Many of the borehole headworks require repair due to corrosion to enable them to be closed. Specifically, BH1, BH2, BH3, BH4, BH6, BH9, BH10, BH12, BH15, BH16, BH17, BH18 and BH19 require improvement.
- Vegetation near several sampling points requires routine clearance to enable continual safe access throughout the year
- Site weather stations should be routinely maintained to ensure they continue to operate satisfactorily
- Hand rails should be installed at several surface water monitoring positions

Depending upon discussions with NRW, the monitoring programme and assessment levels may also need to be reviewed.

# 5 ANALYTICAL TESTWORK

## 5.1 Laboratory Selection

All aspects of the analytical and monitoring programme are directly managed by Tata Environment Department. Under the direction of the Environment Department, Geotechnology and the analytical laboratory undertake several aspects of the sampling and analysis. These include surface water, groundwater and leachate samples for laboratory analysis, measurement of groundwater and surface water levels and the on-site monitoring of landfill and ground gas. The landfill operator (Darlow Lloyd and Sons Ltd) undertake the routine leachate level monitoring required by the Permit. Tata Environmental Department undertakes all other monitoring aspects. All analysis is undertaken by TDC at the Harbourside laboratory, Port Talbot.

# 6 SITE ACTIVITY

## 6.1 Waste Treatment Centre

Since 2007, Tata has operated a waste treatment centre that comprises recycling, screening, sorting and bailing facilities, together with areas for the storage of processed and unprocessed materials prior to recovery. The facility mostly treats general wastes comprising plastics, paper, timber, glass, brick and concrete. Consequently, these wastes are largely diverted from landfill. This facility is located to the northwest of the active landfill cells of MNHL, as shown on Figure 4.

## 6.2 Construction of MNHL

Since issue of the Permit, four cells have been constructed; two biodegradable cells used for the deposition of wastes with a gassing potential and two cells for the deposition of non-hazardous waste without a significant gassing potential. A current topographic plan of the cells, as required by Permit condition 3.6.3 is provided in Figure 8. This is based on a topographic survey completed on 30 January 2018. Table 6-1 provides a summary of the cells constructed to date.

**Table 6-1 Landfill Cell Details**

| Cell Name | Leachate Sump | Waste Types | Operational Status |
|---|---|---|---|
| Cell 1 | L7 | Non-hazardous non-biodegradable | Full, non-active & awaiting capping |
| Cell 2 | L8 | | Active but approaching capacity |
| Bio Cell A | L1 | Non-hazardous biodegradable | Full, non-active & awaiting capping |
| Bio Cell B | L6 | | Active (close to capacity) |

Each cell of MNHL is designed upon the containment principle. Pollutants are kept within the wastes by surrounding the wastes with barriers that are virtually impermeable to water, liquids and gases. The landfill is currently being constructed as a series of cells, each measuring some 200m x 115m. The Engineered Barrier System (EBS) of each cell comprises Bentonite Enhanced Sand (BES) overlain by a High-Density Polyethylene (HDPE) liner. Above the EBS is a leachate collection system. A cross section of the key landfill engineering systems is provided in Figure 9.

To limit leachate generation each cell should be progressively capped once it is full of waste.

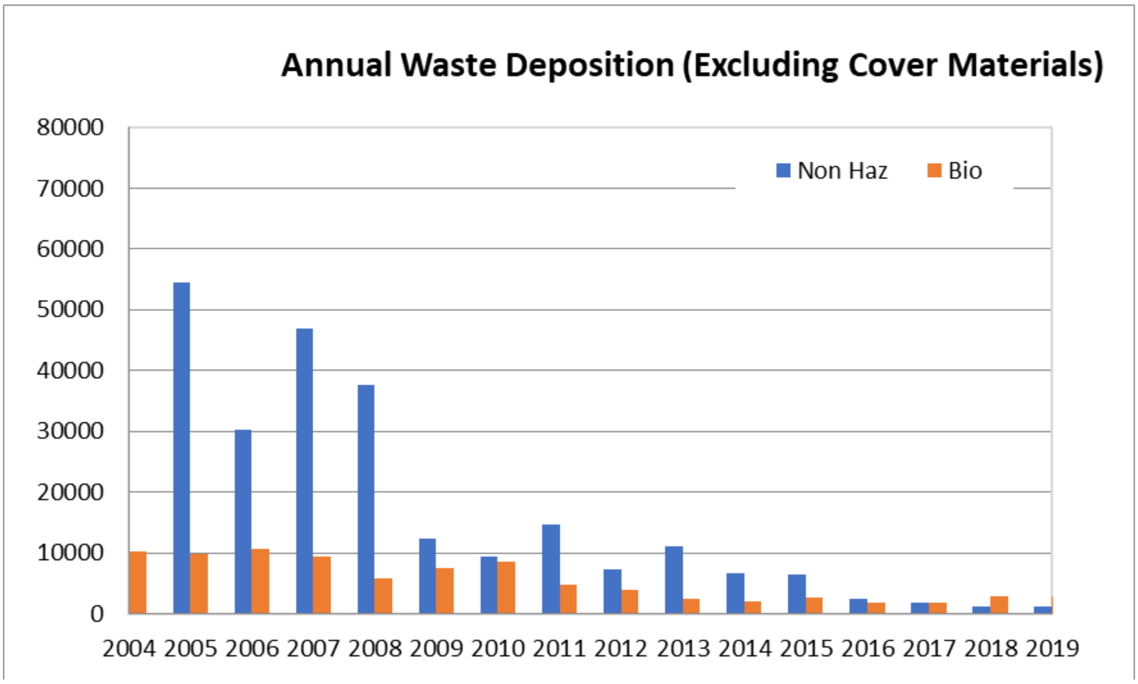
## 6.3 Sand Extraction

Restoration of MCL was completed in 2013. Following completion, there was no immediate demand for sand. However, since this time parts of the restored cap of MCL have been subject to wind erosion as the self-seeding vegetation is yet to take hold. Therefore, approximately 5000 tonnes has been excavated from Borrow Pit 1, as part of aftercare maintenance. Further extraction is envisaged as set out in the ROMP phasing plans (see Geotechnology report 1914r1v1d0819).

## 6.4 Landfilling at MNHL

### 6.4.1 Waste from Steelworks

A summary of the waste types and tonnages deposited at the landfill as recorded by the landfill operator is regularly submitted to NRW in accordance with the Permit requirements. A full graphical record of waste deposition is presented in Appendix 10 and a summary below. The mass of waste being landfilled is declining, as shown in the chart below.




During 2006, part of the filter cake from the unlined Storage Bays located on MCL started to be deposited within Cell 1 of MNHL. Any leachate contained within or produced by this material would report to landfill sump L7. Leachate from similar material that has been historically landfilled in the upgradient unlined MCL is already impacting groundwater upgradient and down gradient of MNHL.

Since October 2008, hot mill sludge (HMS) filter cake generated by the steelworks has been landfilled in Bio Cell B. This process has subsequently continued at a rate of approximately 500 - 700 tonnes/month. In accordance with Improvement Condition 1 of the Variation Notice this prompted the monthly monitoring of Benzo(a)pyrene (BaP) on samples collected from sump L6. In September 2010 this data was reviewed by Geotechnology to establish whether BaP control levels were required (see report 993r1v1d0910). As the data showed that BaP was not detected in the leachate, control levels were not considered to provide additional environmental protection. Benzo(a)pyrene has continued to be present in leachate below the analytical detection limit.

**Plate 6-1 View North over MNHL Cell 2. Note dominance of iron rich filter cake**

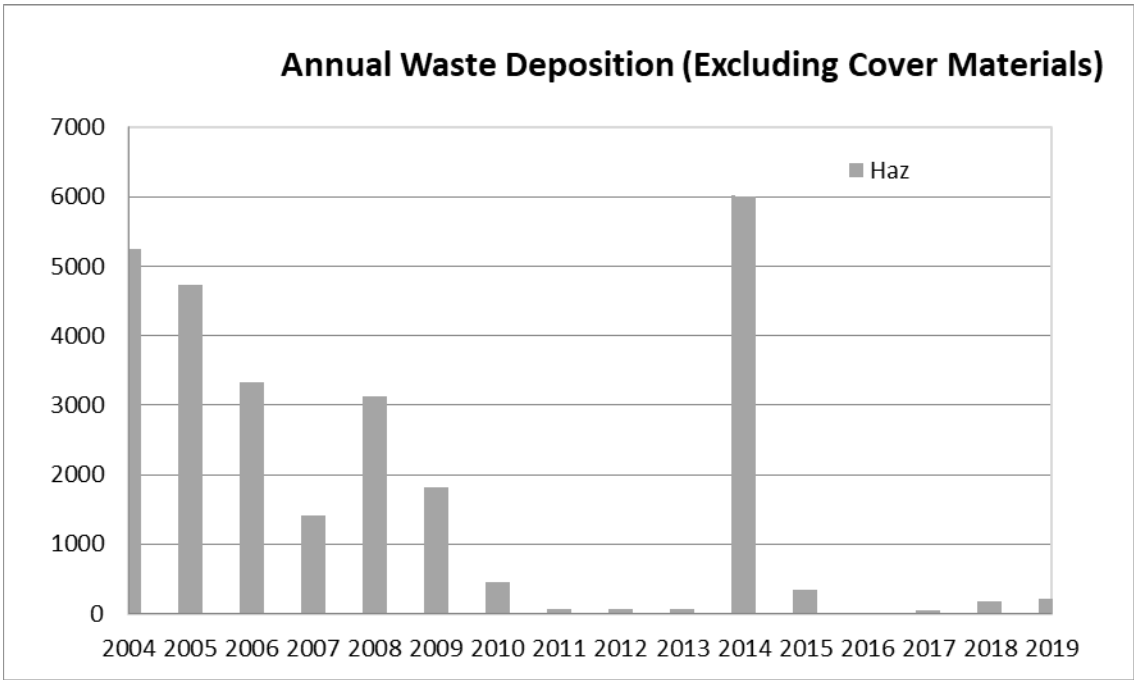
### 6.4.2 Third Party Waste Storage

The Tata landfills are only permitted to accept wastes generated by the company. However, during 2011 an exceptional emergency event occurred following which Tata was approached to assist. The unit contained an estimated 5000t of tyre fluff from the treatment of shredded tyres. During the days immediately following the fire, the Fire Rescue Service (FRS) discovered that the fire could not be readily extinguished using conventional firefighting techniques. A crust was forming on the surface of the material, limiting the effectiveness of the cooling water so the mass kept burning. Using expertise from elsewhere in the country a means of extinguishing the burning waste was developed: a quenching technique that involved mechanically placing excavated masses of the burning material into large water filled skips. This proved to be the only means of extinguishing the fire.

After quenching large volumes, the extinguished material required immediate removal as there was no space at the fire site. Following a request by the multi-agency task force coordinating the response to the incident, Tata agreed to the use of Cell 2 of MNHL for the temporary storage of the waste. On 25 June Tata started to accept waste into Cell 2 of MNHL. This process continued until 20 July 2011. This waste was moved from Cell 2 of MNHL into Cell 2 MHL in March 2014. This work was inspected by NRW at the time and a Construction Quality Assurance (CQA) report produced by Geotechnology following the works (see Geotechnology report 1327r1v1d0314).

## 6.5 Construction of Morfa Hazardous Landfill

Two cells have been constructed at MHL. Cell 2 was completed in August 2012. This new cell received the fire waste from Cell 2 of MNHL in March 2014. The declining rate of landfilling at the hazardous landfill is shown below.




## 6.6 Progressive Restoration

Progressive restoration of each cell should occur once it has been filled. This will limit leachate generation and enable better environmental control. At this stage, none of the cells at either MNHL or MHL have been restored. Once restoration does take place the landform will be the same as that described in Section 6.7 for the restored adjacent closed landfill.

## 6.7 Leachate Management

As shown in Figure 10, leachate collection facilities are provided above the geological barrier and artificially established barrier to allow leachate to flow quickly under gravity toward an engineered collection sump. Leachate levels are regularly monitored in the sump and as shown by the graphs in Appendix 2 have regularly exceeded 0.75m above the concrete slab in the winter periods in 2013, 2014 and 2015. Since 2016, the leachate levels have consistently breached the compliance 1.0m level. Only Bio Cell B (L6) levels have been below 1.0m during this this period. This aspect is further discussed in Section 8.

Until 2019, leachate was collected from the sump by vacuum pumps and tankered away from the landfill using $10m^3$ or $15m^3$ road-going tankers. These tankers took the leachate to the Tata wastewater treatment facility at the steel works. This system has now been replaced by a fixed pumped system, discharging directly into the works via a holding / balancing tank facility.

The new system involves pumping leachate from all cells at MNHL and MHL (currently five cells). There are three individual leachate pipe runs, one for the two MNHL bio-cell sumps, one for the two non-hazardous cell sumps and one for the MHL cell sump. The pumping at each cell can be float controlled to ensure that leachate heads are within permitted trigger and maximum limits.

The three individual pipe runs discharge initially into a holding/balancing tank located on the permitted Waste Transfer Station hardstanding (concreted) area near to the DLS offices. The balance tank is also float controlled and combines all leachates for further pumping into the end discharge sump within the main works, located at Morfa Coke Ovens, Gas Holder Deep Sump. Flowmeters are located at each sump location, and at the balance tank, to record individual and cumulative leachate outflows. The use of flowmeters will provide a check on the potential for leakage from any of the three pipes entering the balance tank.

The installation of the leachate pipework system was carried out in accordance with the principles of the Construction Quality Assurance (CQA) Plan and Specification (Geotechnology report 1486r1v2d0917). Validation was documented in Geotechnology report 1486r2v1d0719. A plan of the as-built system is reproduced in Figure 10.

## 6.8 Restoration of Morfa Closed Landfill (MCL)

Phased restoration of unlined MCL was undertaken between 2004 and 2013. The restoration involved the placement of site won dune sand over the plateau and parts of the re-profiled slopes. Below the sand, the restoration scheme involved placement of geomembranes which, in combination, provide gas and surface water management as well as providing barriers to precipitation ingress and gas egress. The sympathetic restoration also involves the placement of sand on top of the geomembranes, creating dune morphology like the surrounding land.

**Plate 6-2 Typical restoration profile on surface of MCL**

During 2012 and 2013, restoration included the short-term recovery of materials to be used in the steel making process as the topography was re-profiled. During this phase, waste which had remained undisturbed for several decades was exposed. Such wastes will therefore have been temporarily susceptible to weathering and leaching prior to them being capped. Seepage infiltrating to groundwater in these areas would be expected to pass beneath and around MNHL as MCL is hydraulically upgradient of MNHL.

### 6.8.1 Recharge Trench

The sand restoration layer that has been placed on MCL will permit infiltration to the underlying drainage composite, where it will be directed to percolate toward collector ponds. Overflow pipes from the ponds then transport the water into stilling chambers before flowing out into a series of ditches excavated into the natural sand along the boundary with Margam moors. Currently, part of the recharge trench system adjacent to MCL is complete with most of captured rainfall now being directed under gravity towards the boundary with Margam Moors near BH17, towards the River Kenfig near to BH15 and to the south near BH10. Cells of MNHL which are no longer active should be being progressively capped to enable similar restoration.

The accumulation of secondary precipitation in localised areas along the boundary of the site with Margam Moors is well documented. These have formed due to near surface interactions between shallow groundwater that is impacted by leachate from the unlined MCL and the atmosphere. Precipitates and poor-quality groundwater are present throughout this area but become visible in topographically low areas, where groundwater may be sometimes exposed. Wider dispersion and leaching of these previously accumulated precipitates and groundwater has been previously observed in response to changes in shallow groundwater levels. NRW has approved the covering of these areas with site won sand to limit direct access.

**Plate 6-3 Accumulation of secondary precipitates adjacent to MCL (between BH17 and P12)**

### 6.8.2 Hot Mill Sludge Storage Bays

As part of the capping of MCL, the historic deposits of Hot Mill Sludge (HMS) were first stabilised and then capped.

## 6.9 Summary of Landfilling and Restoration Activity

The timeline of landfill construction and operation is summarised in Table 6-2.

**Table 6-2 Summary of site activity to date**

| Activity | Start | Finish |
|---|---|---|
| Construction of MNHL Cell 1 | 1 June 2004 | 19 October 2004 |
| Construction of MHL Cell 1 | 1 June 2004 | 19 October 2004 |
| Restoration of MCL | September 2004 | 8 June 2013 |
| Construction of MNHL Bio Cell A | 14 June 2004 | 8 September 2004 |
| Construction and operation of waste treatment centre | 5 December 2006 | Ongoing |
| Construction of MNHL Bio Cell B | August 2007 | 13 October 2007 |
| Construction of MNHL Cell 2 | 6 May 2008 | 31 July 2009 |
| Landfilling of HMS filter cake in MNHL Bio Cell 2 | 28 October 2008 | Ongoing |
| Construction of MHL Cell 2 | October 2011 | Ongoing |
| Temporary storage of fire waste | 25 June 2011 | 14 March 2014 |
| Construction of recharge trench sections A & B | 30 Aug 2012 | 12 Oct 2012 |
| Connection of recharge trenches to ponds and commissioning of system | Ongoing | (partly completed during 2016 but damaged due to vandalism) |
| Installation and operation of new leachate pumping system | 2018 | October 2019 |

# 7 TOPOGRAPHIC SURVEY AND LANDFILL VOID SPACE

Condition 3.6.3 of the Permit requires an annual topographic survey to be completed.

## 7.1 Topographic Survey

A topographic survey of the operational landfill cells was carried out on 17 December 2018 and a repeat survey on 10 January 2020. Following data acquisition, the digital data was imported into a digital terrain model for each of the cells to calculate the available void space.

Since 2013 the surveys have been completed using an unmanned aerial vehicle (UAV) with survey control established using a GPS land-based GR-3 system. The UAV data is then used together with ground control points to create a digital terrain model. This method of surveying collects data points at significantly closer intervals than methods previously used and is therefore able to create a more detailed topographic model, as shown in Figure 8.

## 7.2 Remaining Void Space

Based on a comparison of the topographic levels observed at the end of 2018 and those from the most recent survey in January 2020, an assessment of void space available in each active cell has been made. This is summarized in Table 7-1.

Tata has recently been planning for the imminent loss of biodegradable waste cell capacity. The approach will first involve recovering materials from cell 1 and then extending the biodegradable cell lining systems into the new void thereby extending the capacity of the biodegradable waste cell. This work will be completed by mid-2020.

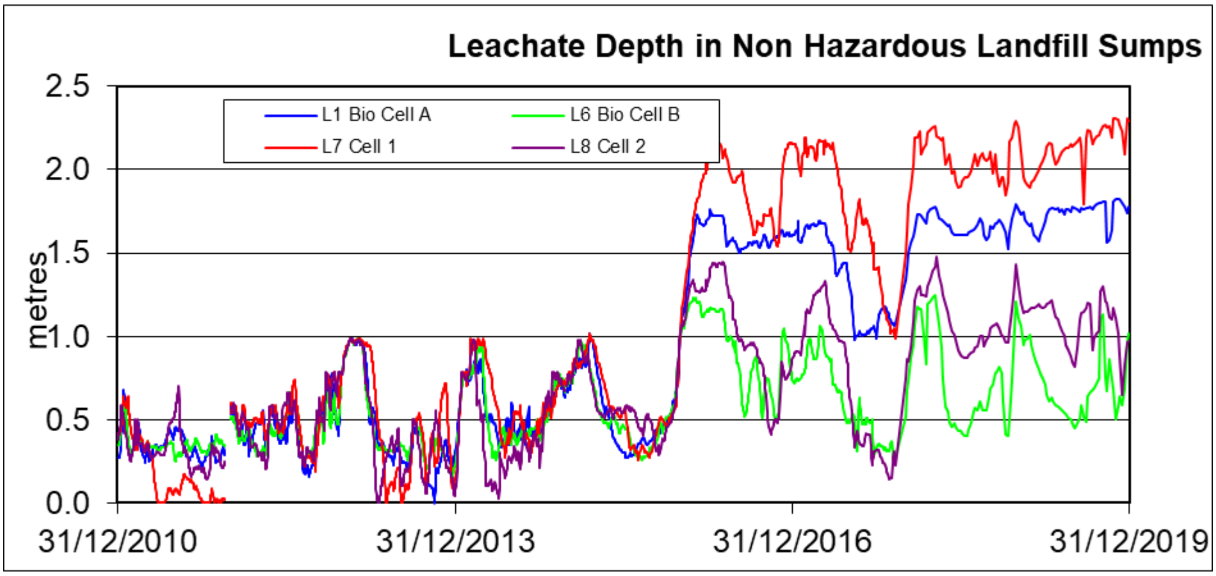
**Table 7-1 Volume Remaining in Active Landfill Cells**

| Volumes ($m^3$) | Biodegradable Cell A | Biodegradable cell B | Non-Hazardous Cell 1 | Non-Hazardous Cell 2 |
|---|---|---|---|---|
| **Total** | 78833.52 | 93067.88 | 202455.57 | 208340.25 |
| **Used 2019** | 81548.79 | 91243.68 | 192793.05 | 62308.78 |
| **Available 2020** | -2715.27 | 1824.20 | 9662.52 | 146031.47 |
| **% Available Space** | -3.44 | 1.96 | 4.77 | 70.09 |

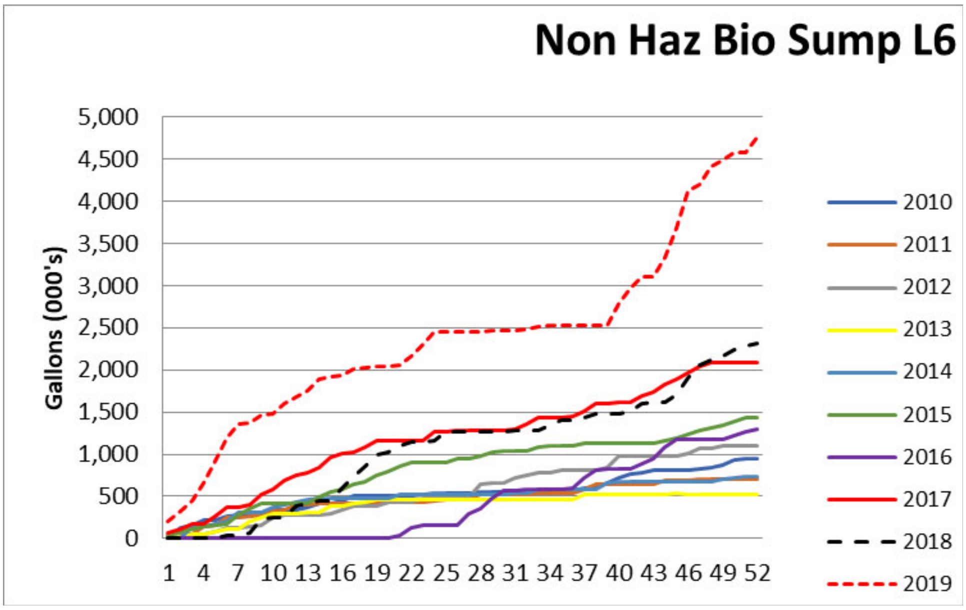
# 8 LEACHATE

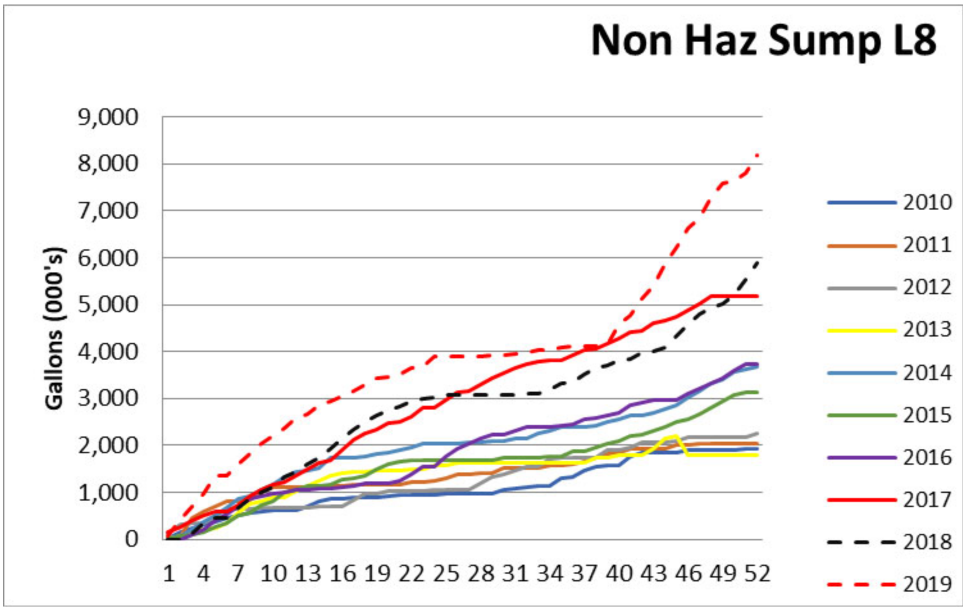
## 8.1 Leachate Level and Volumes

Based on the monitoring results provided by the landfill operator, the variation of leachate levels above the base of the sump is fully illustrated in Appendix 2 and summarised below. The monitoring reveals that leachate levels have regularly exceeded 0.75m above the concrete slab in the winter periods of 2013, 2014 and 2015. Since 2016, the leachate levels have regularly breached the compliance 1.0m level which means that this aspect has not been in accordance with the Permit requirements. Tata has previously informed NRW of this situation and installed a new leachate pumping system.




The impact of the newly installed leachate management system on leachate levels is most evident by reviewing the fall in leachate levels at L6 and L8 sumps during the winter of 2019. This has been achieved by a step change in the volume of leachate extracted, as revealed by the comparison of data for the past nine years presented in Appendix 2 and shown below.





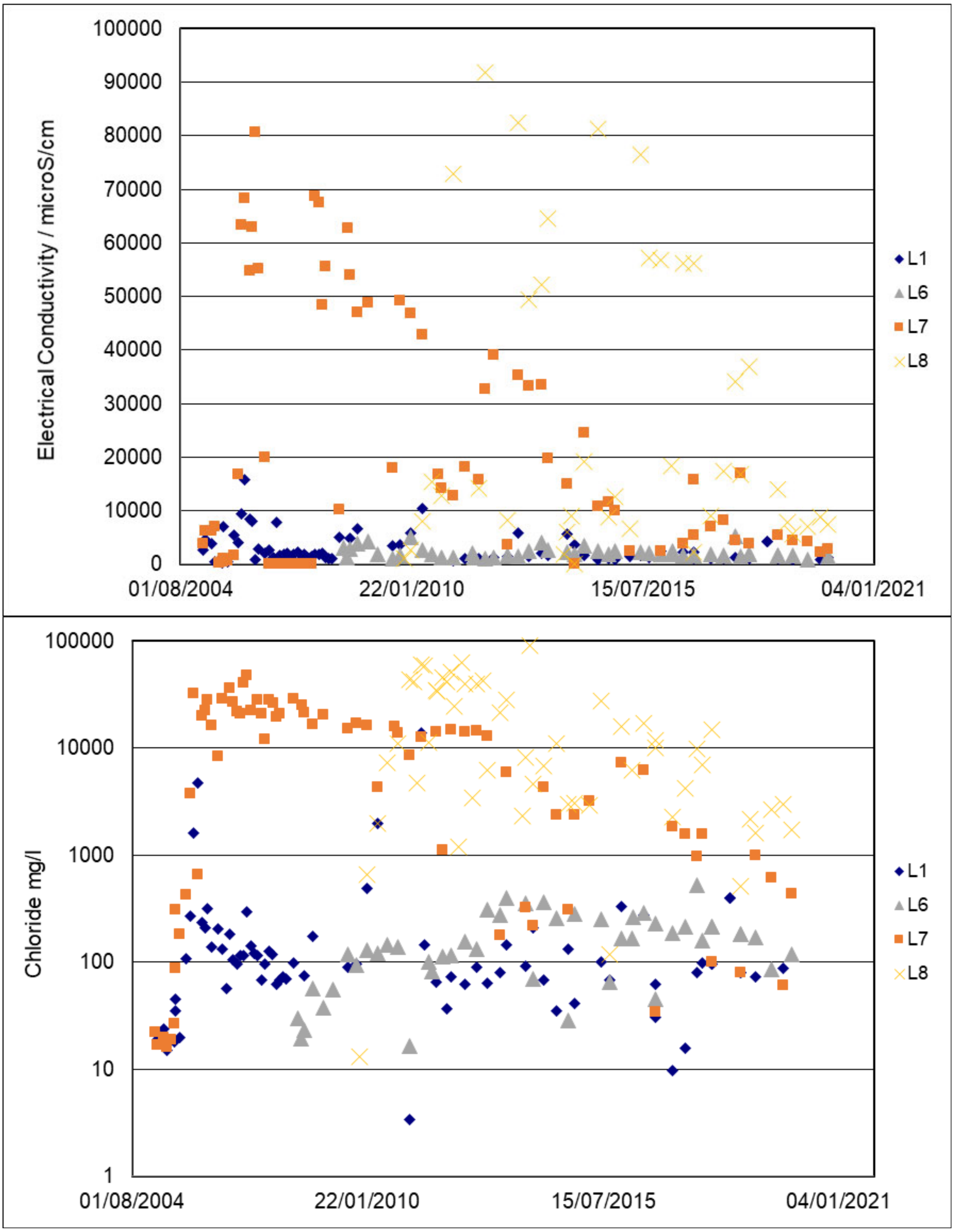

## 8.2 Leachate Chemistry

Each landfill cell is monitored at a separate landfill sump. Leachate samples L1 and L6 are in the sumps in Bio Cells A and B and L7 and L8 in Cell 1 and Cell 2 respectively. In each cell the daily cover used to encapsulate the wastes comprises slag.

### 8.2.1 Non-Volatile Species

Analysis of the leachate samples to date has revealed that it is typically dominated by a highly characteristic signature comprising elevated pH, calcium and alkalinity and low sulphate. This signature is strongest in the leachate in Cells 1 and 2 (sumps L7 and L8). The hydrochemistry of the leachate is illustrated in the graphs included in Appendix 3.

As noted previously, the leachate has continued to become more dilute during 2018 and 2019 with the electrical conductivity declining, most likely because of dilution due to high rainfall and rising leachate levels. The lower mineralisation is characterised by lower levels of ammonia, calcium, alkalinity and most notably chloride (see charts below of selected chemistry).




Filter cake (EWC code 11 01 10) has been placed into Cells 1 and 2 (with leachate draining to sumps L7 and L8) at a rate of approximately 500 - 800t/month since the start of monitoring. Produced by the lime neutralisation of acidic ferrous chloride and pickling solutions at the cold mill effluent treatment plant, the waste principally comprises iron oxyhydroxide chloride phases, calcium chloride, iron chloride and mixed oxides. Within the landfill, the soluble components of the waste are leached by infiltration. This process is suspected to be the source of the elevated levels of chloride and calcium. As the waste becomes buried and less oxygenated, the oxyhydroxide iron phases may also start to undergo changes. Some may start to age and crystallise, forming more stable iron oxide phases and some may undergo reductive dissolution in anaerobic conditions that may be present in parts of the landfill. This latter process could potentially release iron into the leachate along with other trace metals adsorbed to the iron precipitates.

**Plate 8-1 Cell 2 leachate sump L8. Note staining due to iron.**

This latter process was previously considered to be occurring within Cell 2 at L8, as iron significantly increased in concentration from <1mg/l to over 1000 mg/l during the latter part of 2012 and was elevated on several occasions during 2013. At the same time, the leachate sampled at sump L8 was found to be green in colour and the laboratory measured pH variable over a relatively brief time i.e. dropping from over pH 11 to pH 4 and then returning to pH 11 within 12 weeks (see chart below). Similar patterns were observed during 2014, 2015 and 2016. During 2017 no such patterns were observed but in 2018, very acidic pH levels were sometime reported but iron levels remained low. The pH variations may be a consequence of the acid / neutralising components of the waste. In 2019. These variations were less pronounced.

Nitrogen and phosphorous species are not typically persistently detected within the leachate.

Hazardous substances such as mercury, lead and cadmium are rarely found and only at very low concentrations. Many non-hazardous pollutants are also either not detected above the analytical detection levels or present at very low levels, some of which are comparable to or below current Environmental Quality Standards. The mobility of most of these substances is being limited by the elevated pH although substances capable of forming oxyanions, such as vanadium, are more frequently detected.

### 8.2.2 Volatile Species

Due to the nature of the waste streams very low levels of hydrocarbons, volatile organic compounds (VOCs) and semi VOCs have been detected to date. No substances have been detected in the recent years.

## 8.3 Evaluation against Control Levels and LandSim Criteria

Table 8-1 provides a comparison of recent leachate chemistry with the leachate inventory used in the most recent HRA and the Permit Control Levels. This demonstrates that the most recent leachate chemistry is comparable to the lower end of the Probability Density Functions (PDFs) used to describe the leachate inventory in the most recent HRA and is below the Permit control levels.

**Table 8-1 Evaluation of Leachate Chemistry**

| | Ammonia | Arsenic | Chloride |
|---|---|---|---|
| | mg/l | mg/l | mg/l |
| **LandSim PDF*** | Triangular (0.05, 10, 50) | Triangular (0.005, 0.3, 3) | Log Triangular (1000, 10000, 61000) |
| **Permit control Levels** | 70 | 3 | 70000 |
| **Leachate chemistry 2012** | | | |
| Maximum 2012 Leachate chemistry (L1, L6, L7, L8) | 54.3 | 0.57 | 62900 |
| **Leachate chemistry 2013** | | | |
| Maximum 2013 Leachate chemistry (L1, L6, L7, L8) | 14.7 | 0.54 | 91000 |
| **Leachate chemistry 2014** | | | |
| Maximum 2014 Leachate chemistry (L1, L6, L7, L8) | 5.1 | 0.26 | 11000 |
| **Leachate chemistry 2015** | | | |
| Maximum 2015 Leachate chemistry (L1, L6, L7, L8) | 11.3 | 0.22 | 27400 |
| **Leachate chemistry 2016** | | | |
| Maximum 2016 Leachate chemistry (L1, L6, L7, L8) | 7.3 | 0.38 | 17215 |
| **Leachate chemistry 2017** | | | |
| Maximum 2017 Leachate chemistry (L1, L6, L7, L8) | 2.55 | 0.006 | 9815 |
| **Leachate chemistry 2018** | | | |
| Maximum 2018 Leachate chemistry (L1, L6, L7, L8) | 2.15 | 0.004 | 2160 |
| **Leachate chemistry 2019** | | | |
| Maximum 2019 Leachate chemistry (L1, L6, L7, L8) | 1.19 | 1.09 | 3010 |
| *PDF – Probability Density Function used to describe statistical distribution of parameter. Triangular and Log Triangular are the PDFs used in most recent HRA. Values in parenthesis are minimum, most likely and maximum values used in LandSim model | | | |

## 8.4 Contingency Actions Taken

Tata and the landfill operator have pro-actively engaged with NRW regarding the plans to reduce the elevated leachate levels. This included the implementation of increased pumping in the short-term and construction of a dedicated leachate pumping system that became operational October 2019.

Progressive restoration of each cell should also be undertaken.

# 9 GROUNDWATER

## 9.1 Groundwater Level and Flow

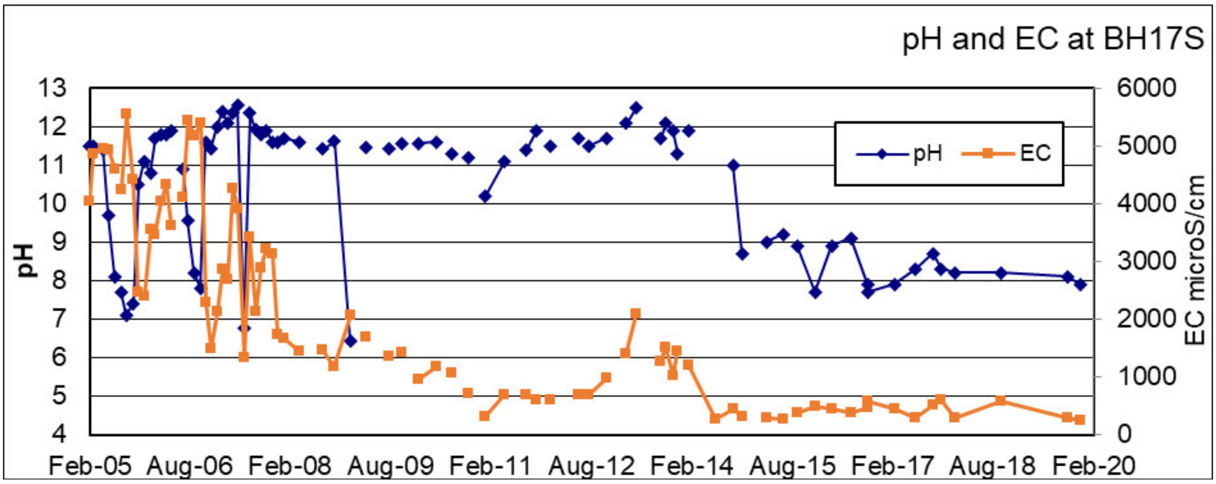
Groundwater levels in the shallow and deep aquifer are presented in Appendix 4 and Figures 11 and 12. The patterns of groundwater flow encountered during 2019 are very similar to those observed previously.

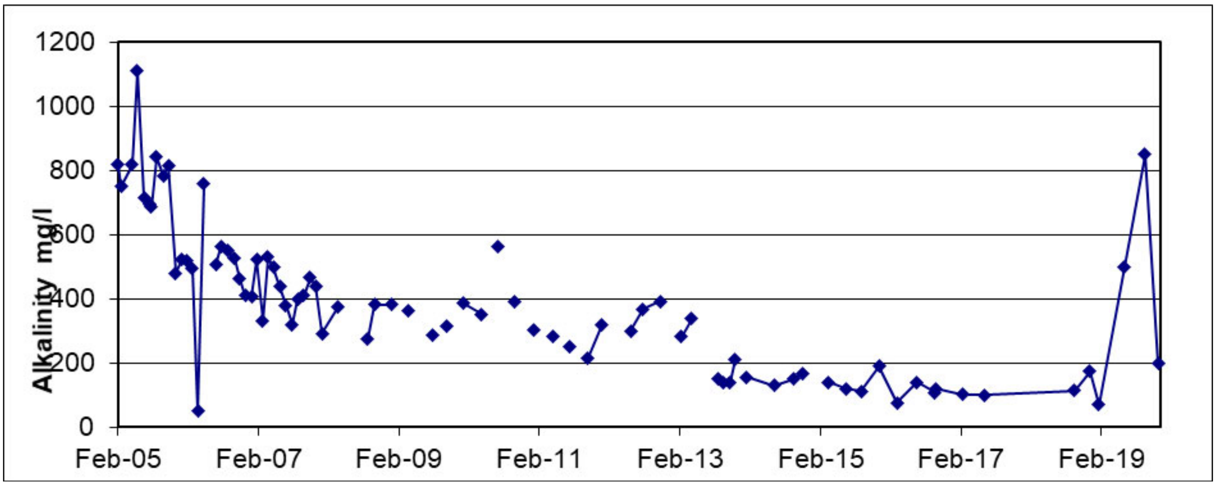
## 9.2 Groundwater Chemistry

### 9.2.1 Shallow Aquifer

The latest monitoring results are very similar to those observed previously with temporal variations illustrated in Appendix 5. Also included in Appendix 9 are spatial plots highlighting several key parameters.

The monitoring programme continues to confirm the diminishing impact of leachate from the adjacent unlined but capped MCL on groundwater directly upgradient of MNHL. Over the past few years, upgradient groundwater along the northern boundary of MCL has shown a sustained decrease in mineralisation, suggesting an overall change and improvement in water quality, most likely due to capping. This is most obvious at monitoring positions BH17S-BH20S which are directly upgradient of MNHL and downgradient of MCL. More recently, similar changes have started to be observed to the south of MCL. At these positions, there have been sustained decreases in the concentration of several parameters including pH Electrical Conductivity, ammonia, chloride, calcium, alkalinity and Chemical Oxygen Demand (COD) in the shallow aquifer as shown by the time series charts in Appendix 5 and selected charts below. With time, the water quality is likely to become less alkaline as less slag-based waste is exposed. As the water quality changes, trace metals may potentially become slightly more mobile and this may explain some of the impersistent variations in trace metal concentrations e.g. arsenic spike at BH30 in 2019.






In the shallow aquifer downgradient of the active cells, samples of groundwater have for some time revealed relatively short-term increases in alkalinity. These are considered to be related to the leaching of alkaline components from MCL, other areas of unlined waste and variations in shallow groundwater levels. Short–term variations in the concentration of ammonia and calcium may also be due to the same processes. There is no evidence to suggest seepage from MNHL is the cause as chloride, a key indicator of leachate is not sustainably increased. Groundwater quality downgradient of MNHL, along the boundary with Margam Moors SSSI (BH3, BH30, BH4 and BH6) is like the upgradient chemistry observed at GWT3A and BH17S – BH20S. At BH30 and BH4, the groundwater is less mineralised than groundwater to the west at BH3 and to the east at BH6. This may be indicative of variations in shallow groundwater quality caused by the occurrence of the springline to the west and historical seepage from MCL to the east.

### 9.2.2 Deep Aquifer

This is the seventh annual report since the introduction of the reduced monitoring schedule for the deep aquifer. Samples are now only collected annually.

The data suggests that there has been minor change in deep groundwater chemistry and that the reduced monitoring programme is not hampering understanding of the site conditions.

## 9.3 Assessment against Permit Compliance Limits and EQS

The graphs presented in Appendix 5 reveal temporal trends and compare the data with the control and trigger levels. These reveal that there have been breaches of control levels and trigger levels but none of these have been persistent (see Tables 9-1 and 9-2 for summary). The breaches are not considered indicative of leachate from MNHL.

## Table 9-1 Evaluation of Groundwater Data against Trigger Levels in 2017

| BH3 (shallow aquifer) | | | | | Comment | | BH4 (shallow aquifer) | | | | Comment | | BH6 (shallow aquifer) | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | | CL1 | CL2 | Trigger Level | Max | | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | <0.10 | | | - | 0.1 | | <0.10 | | | - | 0.1 | | <0.10 | |
| Mercury | - | 0.1 | | 1.73 | Increased concentration in Q2. | | - | 0.1 | | 1.48 | Increased concentration in Q2. | | - | 0.1 | | <0.10 | |
| Chloride | | 100 | 250 | 68.4 | | | | 100 | 250 | 48.5 | | | | 100 | | 32.84 | |
| Ammonia | 8 | 10 | 12 | 1.94 | | | 2 | 3 | 4 | 2.01 | | | 14 | 16 | | 0.70 | |
| Alkalinity | 2400 | 2700 | 3000 | 427.5 | | | 650 | 700 | 750 | 245 | | | 1200 | 1300 | | 535 | |

| BH11 (shallow aquifer) | | | | | Comment | | BH12 (shallow aquifer) | | | | Comment | | BH13 (shallow aquifer) | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | | CL1 | CL2 | Trigger Level | Max | | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | <0.10 | | | - | 0.1 | | | | | - | 0.1 | | <0.10 | |
| Mercury | - | 0.1 | | <0.10 | | | - | 0.1 | | | | | - | 0.1 | | <0.10 | |
| Chloride | 100 | 200 | | 68.56 | | | 100 | 200 | | 46.331 | | | 100 | 200 | | 32.56 | |
| Ammonia | 0.88 | 1.1 | | 0.425 | | | 0.44 | 0.52 | | <0.05 | | | 1.8 | 2.1 | | 0.70 | |
| Alkalinity | 556 | 657 | | 202.5 | | | 284 | 335 | | 75 | | | 738 | 872 | | 202.5 | |

| BH14 (shallow aquifer) | | | | | Comment | | BH30 (shallow aquifer) | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | 0.26 | Increased concentration in Q2. | | | 0.1 | | <0.10 | |
| Mercury | - | 0.1 | | 3.77 | Increased concentration in Q2. | | | 0.1 | | 0.28 | Increased concentration in Q2. |
| Chloride | 100 | 200 | | 38.56 | | | | 100 | 250 | 58.79 | |
| Ammonia | 10.9 | 12.9 | | 0 | | | 2 | 3 | 4 | 0.425 | |
| Alkalinity | 178 | 211 | | 232.5 | | | 650 | 700 | 750 | 358.75 | |

Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l.

## Table 9-2 Evaluation of Groundwater Data against Trigger Levels in 2018

| BH3 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | | |
| Chloride | | 100 | 250 | | |
| Ammonia | 8 | 10 | 12 | | |
| Alkalinity | 2400 | 2700 | 3000 | | |

| BH4 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | 0.1 | Detected September only |
| Chloride | | 100 | 250 | | |
| Ammonia | 2 | 3 | 4 | 9.44 | Detected December only |
| Alkalinity | 650 | 700 | 750 | | |

| BH6 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | | |
| Chloride | | 100 | 250 | | |
| Ammonia | 14 | 16 | 18 | | |
| Alkalinity | 1200 | 1300 | 1400 | | |

| BH11 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | | |
| Chloride | 100 | 200 | | | |
| Ammonia | 0.88 | 1.1 | | | |
| Alkalinity | 556 | 657 | | | |

| BH12 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | | |
| Chloride | 100 | 200 | | | |
| Ammonia | 0.44 | 0.52 | | 7.29 | Detected December only |
| Alkalinity | 284 | 335 | | | |

| BH13 (shallow aquifer) 2016 | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | 0.3 | Detected September only |
| Chloride | 100 | 200 | | | |
| Ammonia | 1.8 | 2.1 | | | |
| Alkalinity | 738 | 872 | | | |

| BH14 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | - | 0.1 | | | |
| Mercury | - | 0.1 | | | |
| Chloride | 100 | 200 | | | |
| Ammonia | 10.9 | 12.9 | | | |
| Alkalinity | 178 | 211 | | 230 | Detected Jan and Dec only |

| BH30 (shallow aquifer) | CL1 | CL2 | Trigger Level | Max | Comment |
|---|---|---|---|---|---|
| Cadmium | | 0.1 | | | |
| Mercury | | 0.1 | | | |
| Chloride | | 100 | 250 | 266 | Detected December only |
| Ammonia | 2 | 3 | 4 | | |
| Alkalinity | 650 | 700 | 750 | | |

Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l.

## Table 9-3 Evaluation of Groundwater Data against Trigger Levels in 2019

| | BH3 (shallow aquifer) | | | | Comment | BH4 (shallow aquifer) | | | | Comment | BH6 (shallow aquifer) | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | CL1 | CL2 | Trigger Level | Max | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | <0.15 | | - | 0.1 | | <0.15 | | - | 0.1 | | 0.4 | Increased in June. |
| Mercury | - | 0.1 | | 0.2 | CL breached in June and July (0.3). | - | 0.1 | | 0.2 | Increased in June. <0.1 in July. | - | 0.1 | | <0.1 | |
| Chloride | | 100 | 250 | 55.1 | | | 100 | 250 | 92.8 | | | 100 | 250 | 32.47 | |
| Ammonia | 8 | 10 | 12 | 4.2 | | 2 | 3 | 4 | 5.59 | Increased in June. <0.05 in July. | 14 | 16 | 18 | 5.3 | |
| Alkalinity | 2400 | 2700 | 3000 | 370 | | 650 | 700 | 750 | 174 | | 1200 | 1300 | 1400 | 550 | |

| | BH11 (shallow aquifer) | | | | Comment | BH12 (shallow aquifer) | | | | Comment | BH13 (shallow aquifer) 2016 | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | CL1 | CL2 | Trigger Level | Max | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | <0.15 | | - | 0.1 | | | | - | 0.1 | | <0.15 | |
| Mercury | - | 0.1 | | <0.1 | | - | 0.1 | | | | - | 0.1 | | <0.1 | |
| Chloride | 100 | 200 | | 86.4 | | 100 | 200 | | 60.6 | | 100 | 200 | | 90.1 | |
| Ammonia | 0.88 | 1.1 | | 0.05 | | 0.44 | 0.52 | | <0.05 | | 1.8 | 2.1 | | 0.05 | |
| Alkalinity | 556 | 657 | | 220 | | 284 | 335 | | 148 | | 738 | 872 | | 240 | |

| | BH14 (shallow aquifer) | | | | Comment | BH30 (shallow aquifer) | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | CL1 | CL2 | Trigger Level | Max | | CL1 | CL2 | Trigger Level | Max | |
| Cadmium | - | 0.1 | | <0.15 | | | 0.1 | | <0.15 | |
| Mercury | - | 0.1 | | <0.1 | | | 0.1 | | 0.1 | 0.1 in June, <0.1 in July |
| Chloride | 100 | 200 | | 47.13 | | | 100 | 250 | 95.7 | |
| Ammonia | 10.9 | 12.9 | | 0.45 | | 2 | 3 | 4 | 0.88 | |
| Alkalinity | 178 | 211 | | 250 | CL increased in June but not in subsequent months. | 650 | 700 | 750 | 370 | |

Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l.

## 9.4 Contingency Actions Taken

Where necessary, Tata implemented additional monitoring, but no further contingency actions were required. Improvements have been made regarding the timing of any additional sampling and further improvements are planned.

# 10 SURFACE WATER LEVELS

The results of the surface water monitoring are presented in Appendix 5 and Appendix 6. Spatial variations in selected water chemistry are also provided in Appendix 7.

## 10.1 Assessment against Permit Control Levels

Surface water immediately northeast of MHL on Margam Moors is already known to be significantly impacted by seepage from MCL, as there is a well-developed highly alkaline springline.

Due to the low risk that MNHL directly poses to surface water under active management control and the historical impact of seepage from MCL, there are no Permit Compliance Limits for surface water. Instead, there are two assessment levels (AL1 and AL2). An evaluation of the 2018 and 2019 datasets against these levels is presented in Table 8-1. This analysis reveals no persistent breaches in the last two years.

**Table 10-1 Comparison of surface water quality with assessment levels**

| | SW2 and SW4 | | 2018 | 2019 |
|---|---|---|---|---|
| **Parameter** | **Assessment level 1 (AL1)** | **Assessment level 2 (AL2)** | **Max** | **Max** |
| Cadmium | 0.1 | | <0.1 | <0.15 |
| Copper | 25 | 28 | 0.9 | <0.2 |
| Mercury | 0.1 | | <0.1 | 0.2 (SW4 June)<br><0.1 in July |
| Chloride | 200 | 250 | 81.4 | 93 |
| Ammonia | 2.75 | 3 | <0.05 | 0.113 |
| Alkalinity | 350 | 400 | 240 | 200 |
| Cadmium, copper and mercury reported as µg/l. Alkalinity reported as mg/l $CaCO_3$. Ammonia reported as mg/l. | | | | |

Over the past four years, elevated alkalinity has been observed at SW4, particularly during the period May-November. As this monitoring position is upstream of the landfill, the changes are not related to processes occurring at the landfill.

Other surface water sample locations immediately downstream of the landfill (SW13 and SW14) do not show such variations and the chemistry observed during recent years is consistent. SW14 is not currently accessible due to dense vegetation.

Sample SW15 is taken from pooled water (because of the ground surface intersecting shallow groundwater) to the north of the landfill. This position is close to a slag hardstanding used for vehicle storage and maintenance. The water chemistry observed at this position has also remained relatively consistent, like that at SW13 and SW14, although the alkalinity concentration has been variable since 2015. The cause of these variations is unclear but could be related to variations in pool water level resulting in exposure and subsequent flushing of made ground dominated by slag.

## 10.2 Contingency Actions Taken

No contingency actions were required.

# 11 DUST

Tata has been routinely monitoring dust around the Morfa landfills for many years. A review of recent data has lead Tata to question the environmental benefit of monitoring at the continued frequency. A full description of the work that has led to this position was set out in the 2017 annual report for MNHL (see Geotechnology report 1761r1v1d0218). Tata has previously requested that NRW considers the results and the cessation or reduction of monitoring. Geotechnology understands that Tata has not yet received formal feedback.

## 11.1 Assessment against Permit Control Levels

The relative locations of the dust monitoring points are as follows:

- D15 is located at the northern end of the site near the offices and close to the coal stockyards.
- D16 is in the middle of Margam Moors north of MNHL.
- D17 is located east of MNHL near the old landfill bordering the SSSI.
- D18 is located to the southeast of MNHL near the old landfill and rail sidings.
- D19 is located to the west of site near to the beach and road.

The results from the depositional dust monitoring undertaken in 2019 are summarised in Appendix 9. The results are broadly similar to those observed in previous years with elevated levels of particulates found to be highly soluble with low or no detectable iron and elevated carbon. This suggests that the particulates are not coal (given the solubility) but more likely marine or plant matter in origin.

## 11.2 Contingency Actions Taken

No specific contingency actions have been taken by Tata. The landfill operator routinely deploys a bowser to spray water on all landfill haul roads to minimise the generation of dust in accordance with the air quality management plan for the landfill. The data demonstrates that dust from the landfill cells is not an issue of significant concern.

# 12 LANDFILL GAS

## 12.1 Internal Monitoring

Internal landfill gas chemistry can be measured at GA1, GA2 and W1 – W8 within Bio Cell A and W9 – W16 in Bio Cell B. Due to the fixed height of the gas wells they can only be safely monitored when the waste level surrounding the well is sufficiently high and stable.

Until 2011, the monitoring had failed to detect more than 1.6% carbon dioxide or methane and 33 ppm carbon monoxide. In March 2011, this pattern changed with landfill gas containing up to 61% methane and 48% carbon dioxide detected at GA1 and GA2 in Bio Cell A. The occurrence was, however, short-lived and localised. No other gas wells detected such levels and all subsequent measurements at GA1 and GA2 have failed to detect methane and carbon dioxide above 2%. In Bio Cell B, methane has never exceeded 0.6% and carbon dioxide 5.7% with the highest concentrations typically found at W10 and W11. Some of this data is presented in Appendix 8.

As the waste is not capped in either bio-cell, the gas is free to vent to the atmosphere and these measurements should only be considered indicative.

## 12.2 External Monitoring

External landfill gas is monitored around the northern (GA7, GA15 & GA16), eastern (GA8, GA9 & GA10) and southern (GA11 & GA12) boundaries of the bio cell (see Figure 4).

Along the southern and eastern boundaries, ground gas has been infrequently detected. Since 2014, methane has not been detected and carbon dioxide has not been detected above 0.2%. Low levels (<10 ppm) of carbon monoxide and hydrogen sulphide have been infrequently detected.

Historically, the situation has been different along the northern boundary as ground gas has been detected along this boundary for several years, most notably at GA16 but more recently at GA7. In response, the compliance limits for GA16 were increased following an evaluation of the likely ground gas sources that concluded that the landfill was not the source of the gas. At no point since 2012 have the monitoring results breached the compliance limits at GA15 or GA16. At no point since 2012 has the concentration of methane or carbon dioxide exceeded 0.3%. Low levels (<10 ppm) of carbon monoxide and hydrogen sulphide have been infrequently found. On 14 March 2017 a reading of 193ppm hydrogen sulphide was detected. A repeat of the measurement at the time failed to detect any hydrogen sulphide. Such elevated levels have never been detected at any monitoring location and all monitoring since March 2017 has failed to detect hydrogen sulphide above 2ppm at any position.

## 12.3 Contingency Actions Taken

No contingency actions were required.

# 13 2017 REPORT RECOMMNEDATIONS

In the 2017 annual review a series of new control and trigger levels were proposed alongside modifications to the analytical and monitoring programme. Geotechnology understands that NRW is still reviewing the report and recommendations. As only verbal agreement has been provided to Tata the modifications have not been fully implemented.

# 14 SUMMARY AND RECOMMENDATIONS

## 14.1 Evaluation and Summary

At MNHL there will always be difficulty in determining influences on groundwater as both the shallow and deep aquifers have been impacted to varying degrees by seepage from unlined areas of waste and other off-site sources. Additionally, as the construction of the landfill was subject to CQA during construction and this included a leak location survey, the volume of leakage that is predicted by the LandSim model is small. Identifying seepage from the landfill is not, therefore, straightforward given variations and similarities between the leachate and upgradient groundwater and the low volume predicted to leak.

There is, however, one key tracer and this is currently chloride. Although the current concentration of chloride has reduced in the leachate sumps it remains above most levels observed in groundwater and surface water. Based on the hydrochemical monitoring data collected to date there is no evidence to suggest that the landfill is not behaving as initially predicted and the identified receptors remain protected from impacts related to MNHL. Leachate levels have, however, been elevated above the control levels for many months and this does require action utilising the new leachate umping system. As cells cease to operate, progressive restoration should also be taking place as this limits the amount of leachate requiring management, potentially reduces the mineralised content requiring treatment and reduces the potential flux of contaminants.

## 14.2 Environmental Protection

The initial risk assessments, completed as part of the Permit Application, clearly demonstrated the potential for the landfill to emit non-hazardous pollutants to groundwater and potentially surface water. There was also the potential that the landfill would generate dust during landfilling activity and associated vehicular movements and earthworks. Landfill gas is not likely to be associated with the industrial components of the waste, but the generation of small amounts could not be wholly discounted, particularly within the biodegradable cell.

To ensure that the landfill performs at least as well as predicted throughout the lifespan of the Permit, a monitoring programme was put in place to evaluate the leachate source concentrations, leachate head, groundwater flow, surface water chemistry, gas generation and dust deposition. Based on the monitoring data reviewed to date, there is no evidence to suggest that the landfill is not behaving as initially predicted and the identified receptors remain protected. However, the persistent increased leachate levels do require assessment and careful management.

## 14.3 Regulatory Framework

In January 2013, a new set of control levels and compliance limits were established. Since this time additional data has been gathered and the HRA has been recently reviewed. Based on the currently available information Geotechnology suggested revised control levels and compliance limits focussed on arsenic and chloride in the 2017 annual review. Tata should gain approval from NRW before applying the suggested amendments. Discussions also need to be held with NRW to agree a way forward regarding issues that have arisen since the issue of the recent Permit Variation in December 2019.

## 14.4 Monitoring

A new testing schedule and monitoring programme was suggested for leachate, groundwater, surface water and dust in the 2017 annual review. Tata should gain approval from NRW before applying the suggested amendments.

Tata has also previously requested that NRW considers the benefit of continued monitoring of dust.

## 14.5 Actions Required

The annual report has identified several items requiring action:

- Continued implementation of measures to reduce leachate levels as soon as practical
- Many of the borehole headworks require repair due to corrosion to enable them to be closed. Specifically, BH1, BH2, BH3, BH4, BH6, BH9, BH10, BH12, BH15, BH16, BH17, BH18 and BH19 require improvement.
- Vegetation near several sampling points requires routine clearance to enable continual safe access.
- Site weather stations should be routinely maintained to ensure they continue to operate satisfactorily.

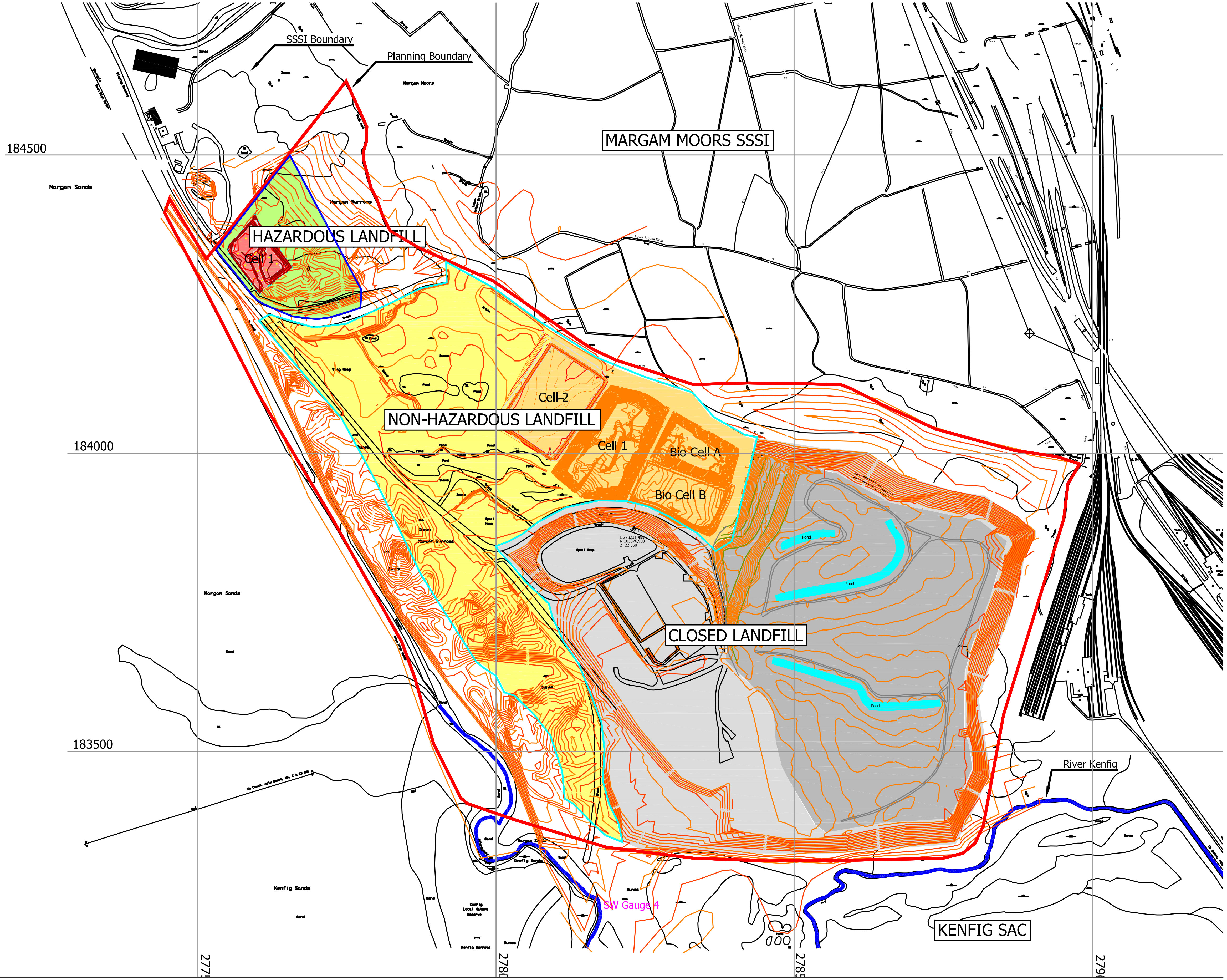
## Figure 1  Site Location Plan

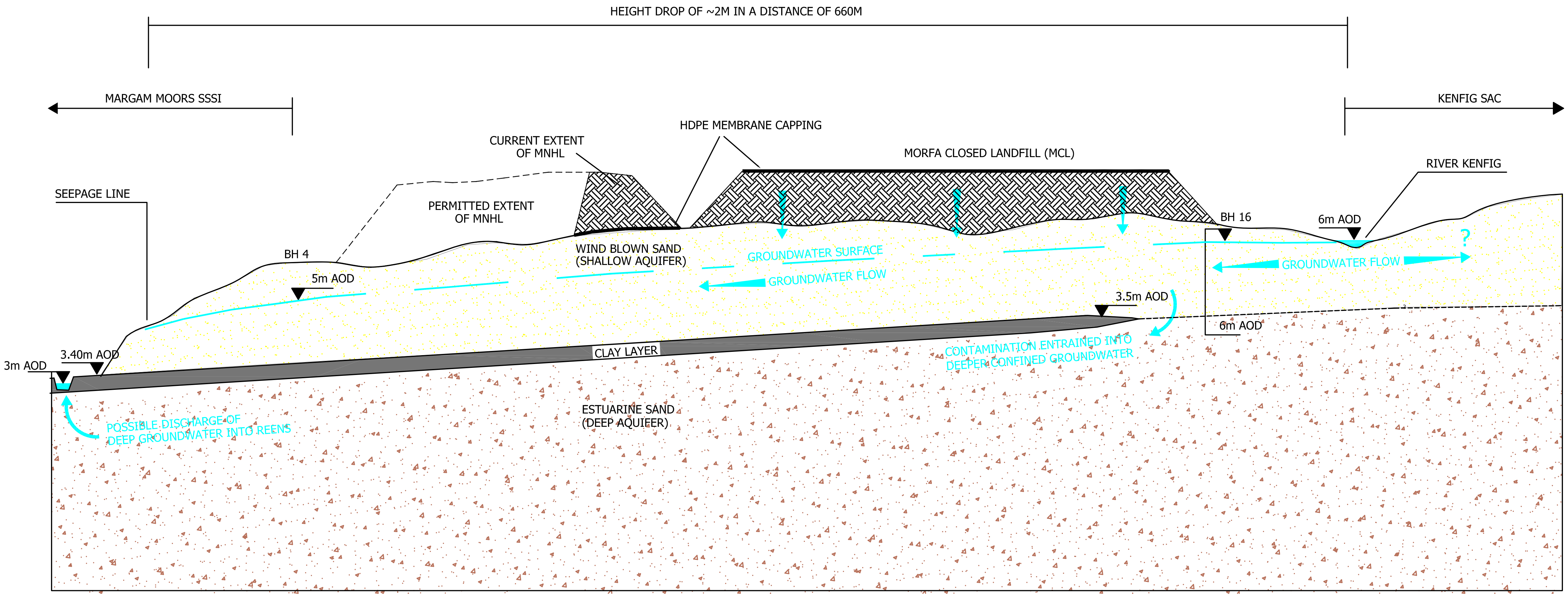

Reproduced from the Ordnance Survey Land Ranger Map
with the permission of The Controller of Her Majesty's Stationery Office

## Figure 2  Detailed Site Plan Showing Planning and Permit Boundaries

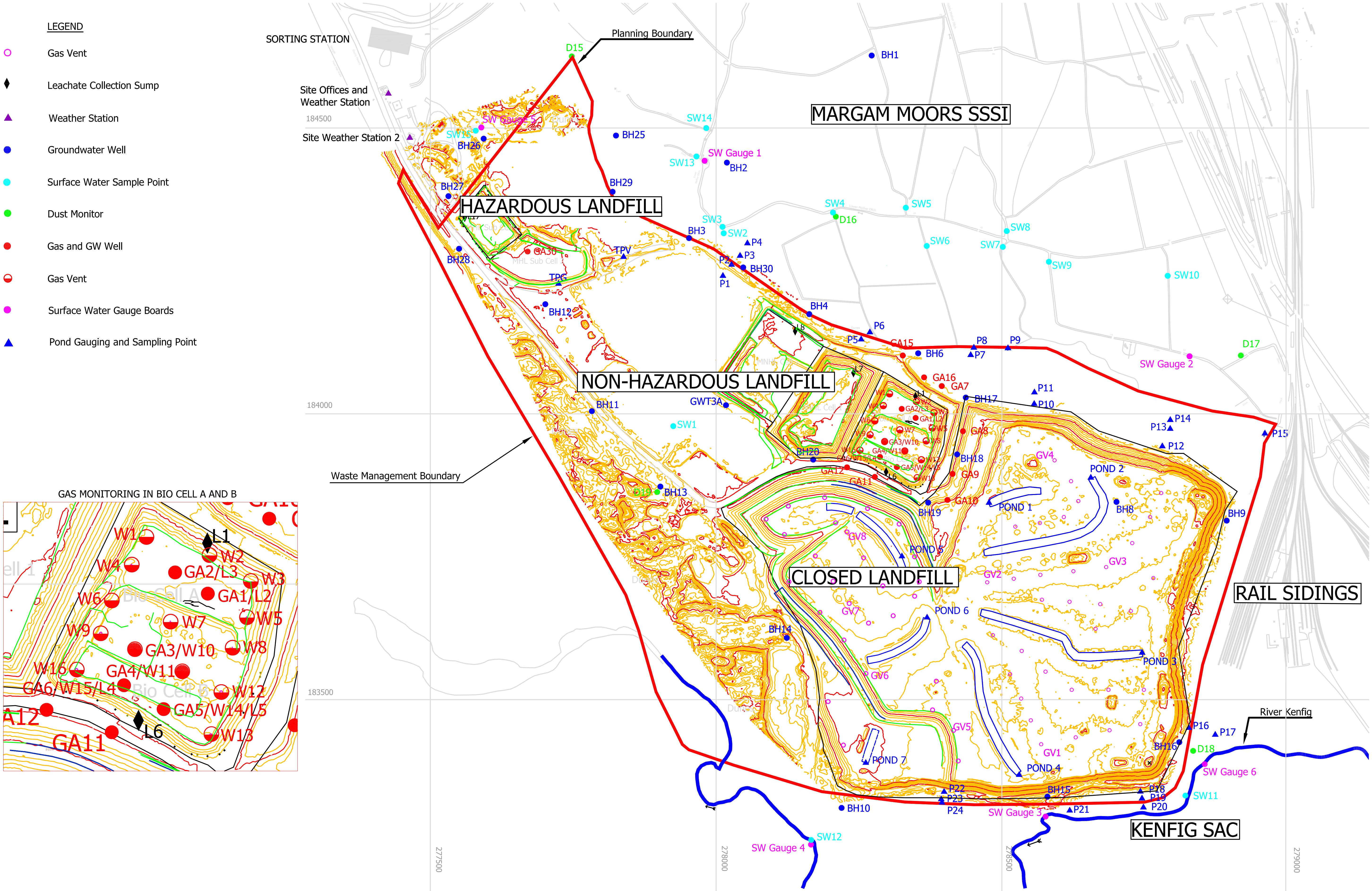
LEGEND:

- Undeveloped Part of MHL
- Developed Part of MHL
- Developed Part of MNHL
- Undeveloped Part of MNHL
- Restored Part of MCL
- Unrestored Part of MCL
- 1973 Planning Permission Boundary

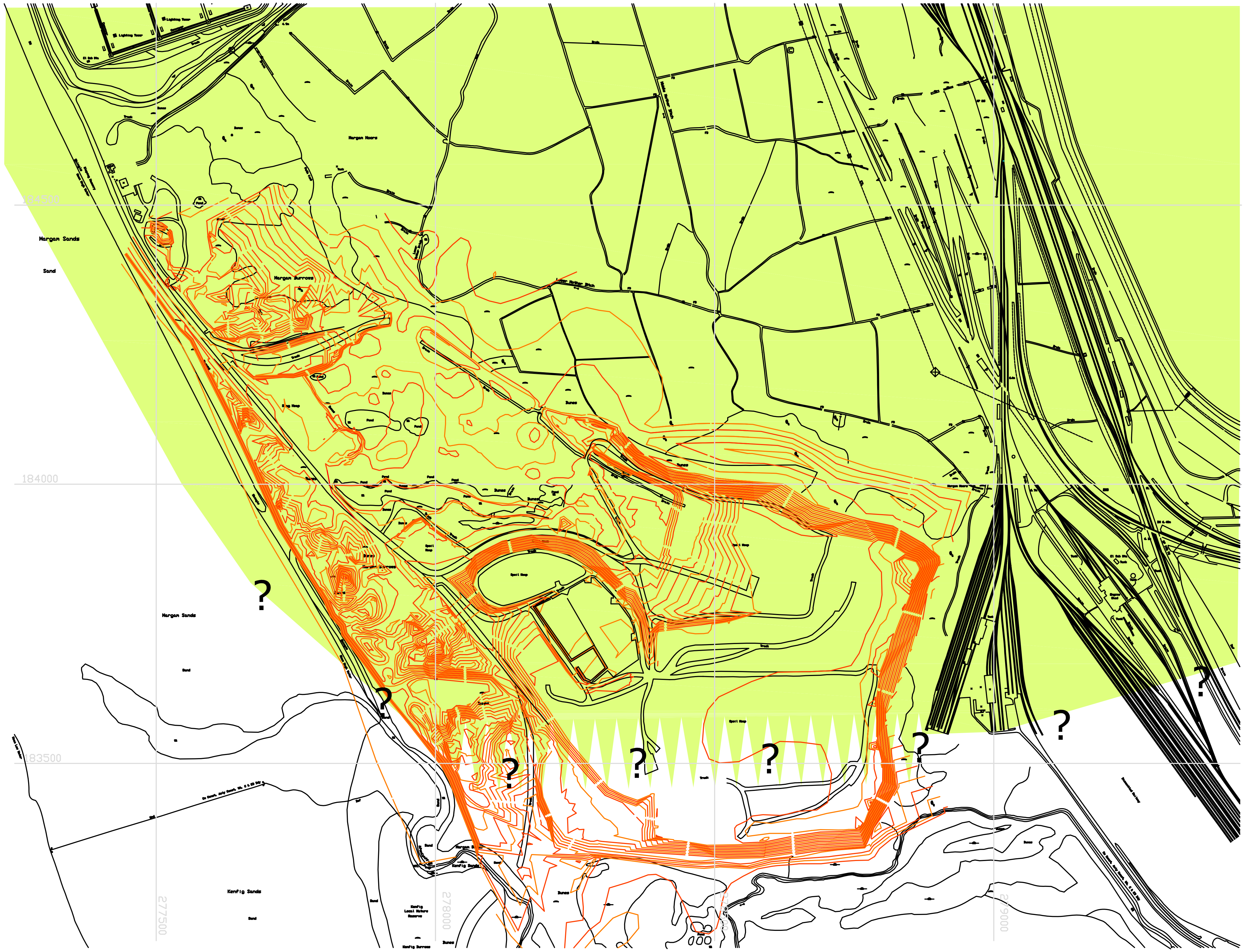



HEIGHT DROP OF ~2M IN A DISTANCE OF 660M
MARGAM MOORS SSSI
KENFIG SAC
HDPE MEMBRANE CAPPING
CURRENT EXTENT OF MNHL
MORFA CLOSED LANDFILL (MCL)
RIVER KENFIG
SEEPAGE LINE
PERMITTED EXTENT OF MNHL
BH 16
6m AOD
BH 4
WIND BLOWN SAND (SHALLOW AQUIFER)
GROUNDWATER SURFACE
?
5m AOD
GROUNDWATER FLOW
GROUNDWATER FLOW
3.5m AOD
6m AOD
3.40m AOD
3m AOD
CLAY LAYER
CONTAMINATION ENTRAINED INTO DEEPER CONFINED GROUNDWATER
ESTUARINE SAND (DEEP AQUIFER)
POSSIBLE DISCHARGE OF DEEP GROUNDWATER INTO REENS

## Figure 4 Available Monitoring Network



## Figure 5 Extent of Clay Layer



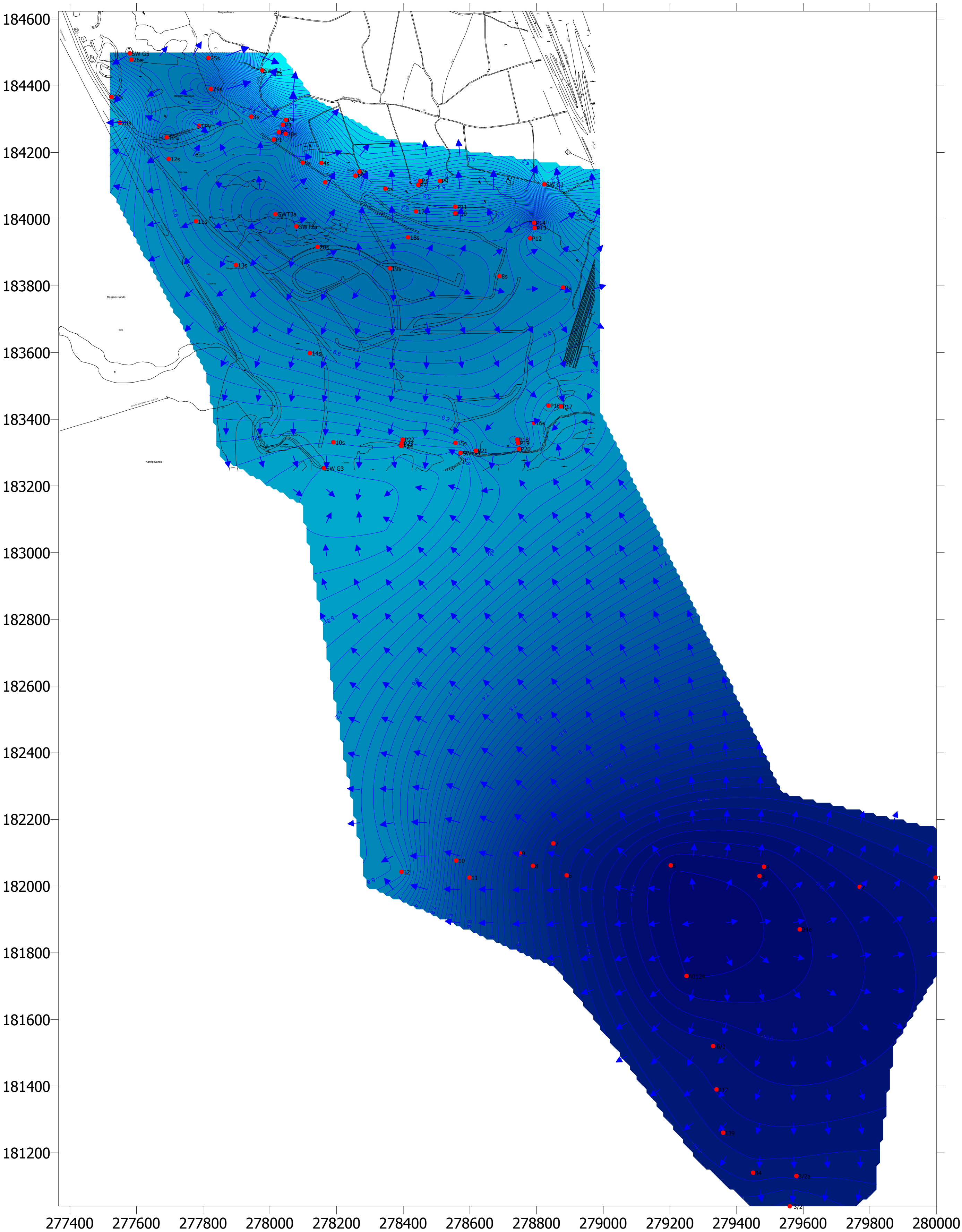


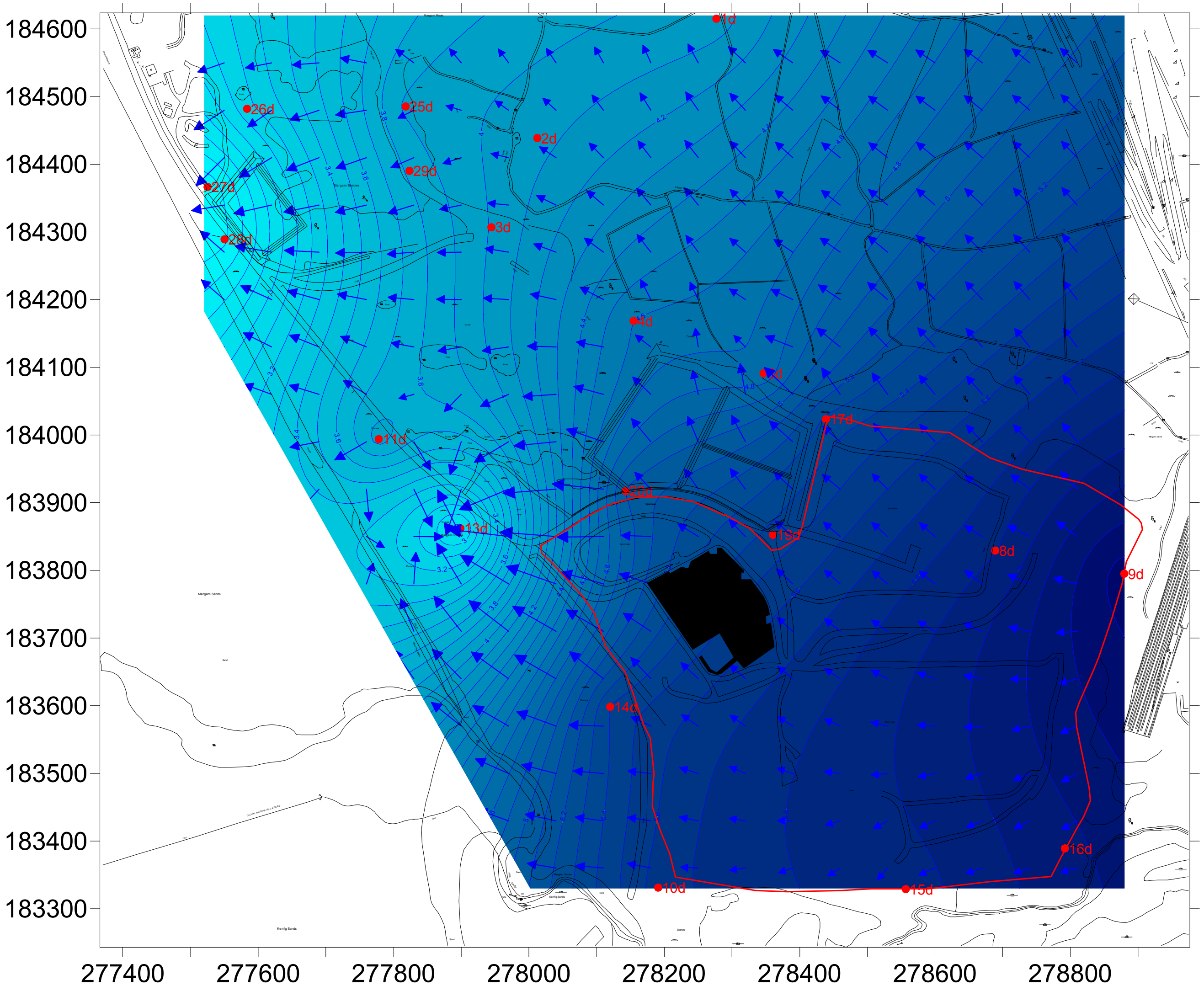

**Figure 6 Typical Contour Plan of Piezometric Surface in Shallow Aquifer**

Revision 0

1965r1v1d0220 Figure 6

Scale 1:1250

## Figure 7  Typical Contour Plan of Piezometric Surface in Deep Aquifer



Drawing Number 1965/8

Legend

Prominent Contour (5m)

Normal Contour (1m)

Notes

Digital survey model generated using Pix4D image processing software.

Imagery acquired by DJI Phantom 4 pro RTK photogrammetry survey on 10 January 2020.

Survey control installed using Topcon Hiper SR dGPS Network Rover.

| Rev | Date | Status/Ammendments |
|---|---|---|

CLIENT

TATA STEEL UK LIMITED

PROJECT

MORFA NON-HAZARDOUS LANDFILL
2019 ANNUAL REVIEW OF
ENVIRONMENTAL MONITORING

TITLE

CURRENT TOPOGRAPHIC
PLAN OF LANDFILL CELLS

| DRAWING NUMBER | REVISION |
|---|---|
| 1965/8 | 0 |

| DATE | DRAWN | CHECKED | SCALE AT A3 |
|---|---|---|---|
| 01.20 | KJT | DRAFT | 1:1250 |

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Aberdulais, Neath
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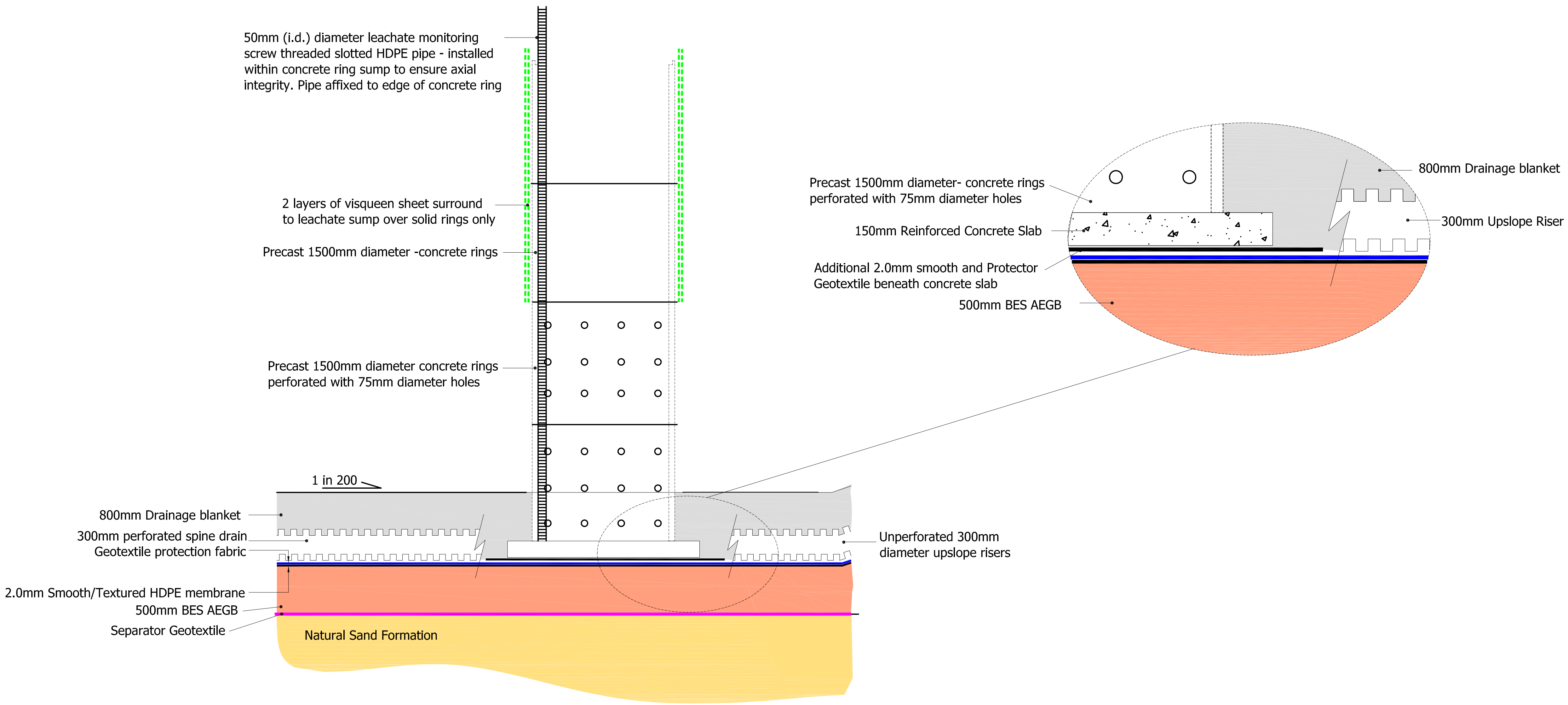
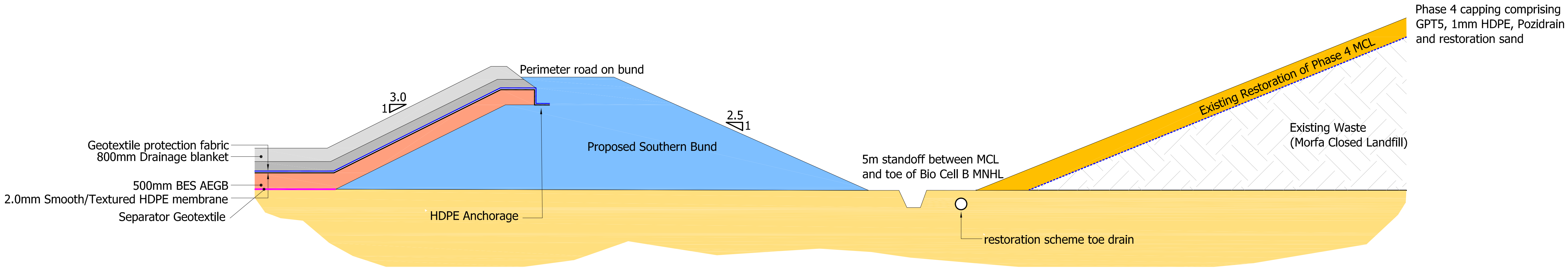
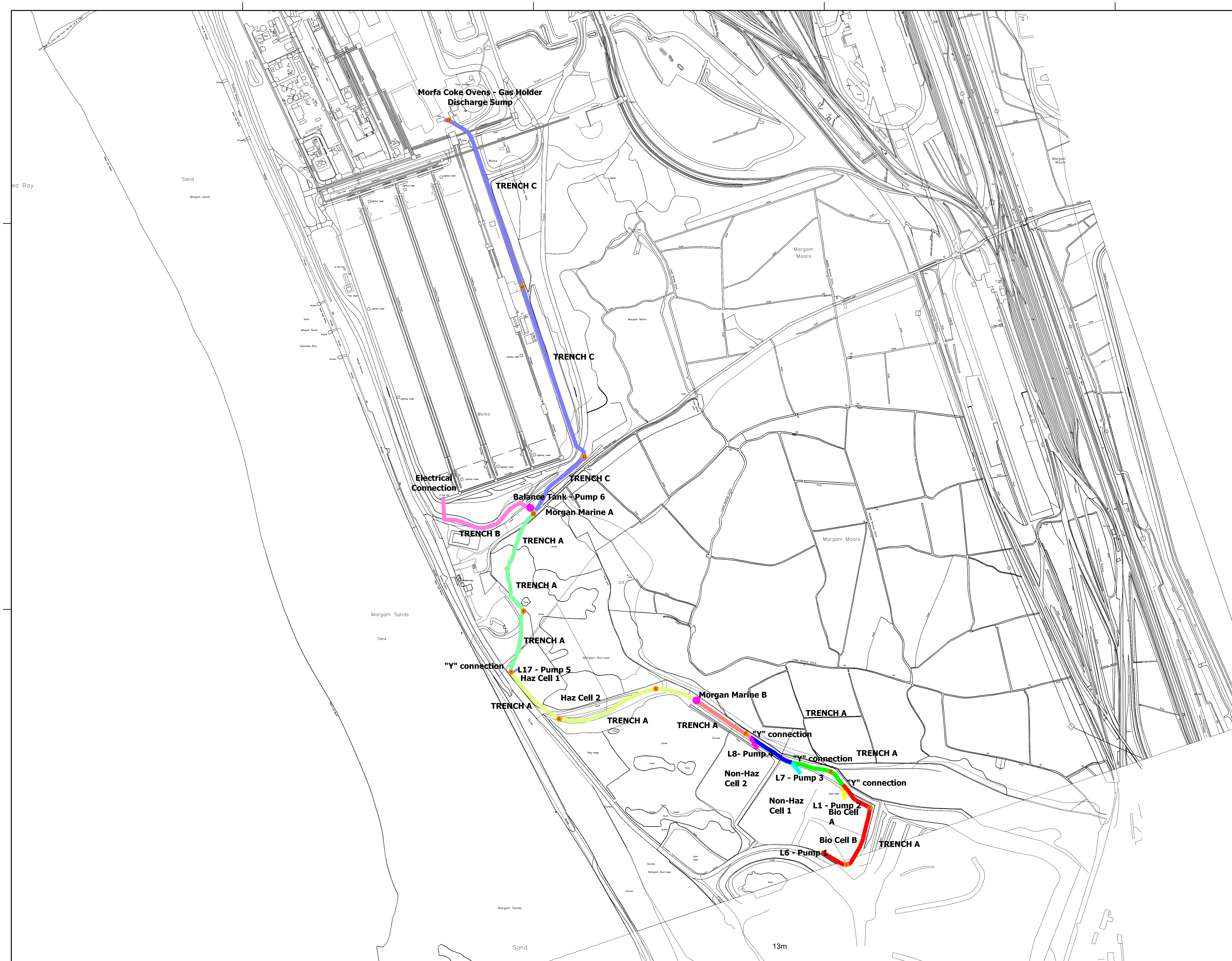
GEO TECHNOLOGY

## Figure 9 Cross Sections of Key Landfill Engineering Systems






**Drawing Number 1965 Figure 10**

**Legend**

- L6 Sump Number
- Survey Check Point (see Table 7-1)
- Location of Electrical Control Panel - Morgan Marine A or B
- Chainage A
- Chainage B
- Chainage C
- Chainage D
- Chainage E
- Chainage F
- Chainage G
- Chainage H
- Chainage I
- Chainage J
- Chainage K
- Chainage L

**NOTE**

| Rev | Date | Status/Ammendments |
|---|---|---|

CLIENT
**TATA STEEL (UK) Ltd.**

PROJECT
**MORFA NON-HAZARDOUS LANDFILL 2019 ANNUAL REVIEW OF ENVIRONMENTAL MONITORING**

TITLE
**LEACHATE COLLECTION SYSTEM**

| DRAWING NUMBER | REVISION | | |
|---|---|---|---|
| 1965/10 | FINAL | | |
| SCALE AT A1 | DATE | DRAWN | CHECKED |
| 1:4000 | 2.19 | AJ/KT | |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# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

# PERMIT BV7311IE

## 2019 Annual Review of Environmental Monitoring

## Appendix 1
## Record of Permit Update

*Report Number 1965r1v1d0220*

**Record of Permit Update**

**This summary is intended to signpost the reader to reports and correspondence related to changes to the monitoring programme that have occurred since Permit issue.**

- Subsequent to the issue of the Permit, Geotechnology presented a revised set of Assessment Criteria for groundwater, surface water and leachate in accordance with the Permit Improvement Conditions. These revised Assessment Criteria were initially presented by Geotechnology following a review of the Hydrogeological Risk Assessment (HRA) (see Geotechnology report 403.1/1/1006 Review of Hydrogeological Risk Assessment) after commencement of landfilling. These criteria were further updated following feedback from NRW in Geotechnology letter 403/reviewHRA/lt1/BR/kp (dated 17 January 2007) to the Agency and also in the 2006 annual monitoring report (see Geotechnology report 528.1/0/0307).
- During 2007, NRW commented upon the revised criteria presented in the 2006 annual report and after slight modification, a revised set of Assessment Criteria for groundwater and surface water were agreed (see Geotechnology correspondence 244Permit_lt1/BR/kp and NRW correspondence dated 30 April 2007 and 7 June 2007 (ref: BV7311IE)).
- The 2006 annual monitoring report also indicated that dust levels regularly exceeded the Permit limit of 100 $mg/m^2/day$ and that the generation of dust was not solely related to landfilling activities according to Tata. On 28 September 2007, Tata submitted a request to NRW that suggested apportioning 50% of the measured dust to the landfill with a limit value of 200 $mg/m^2/day$ and the other 50% allocated to other activities at the works and natural deposition.
- Further minor operational changes to the Permit were requested by Tata on 13 June 2008 (Tata reference LANDFILLPPC_017). The request related to leachate control levels, surface water assessment levels, dust levels and Compliance Limits at external gas well GA16. These changes were prompted by the 2007 annual monitoring report (see Geotechnology report 620.1/0/0108), a meeting with the NRW on 10 June 2008 and NRW Compliance Assessment Reports 01718 and 01770. In response, NRW agreed the minor changes to the Permit in a letter dated 30 July 2008. For clarity, this letter summarised the changes and the applicable assessment criteria.
- As part of a Permit Variation Notice (Variation Notice No. GP3430MH) an Improvement Programme required Tata to undertake a review of copper trigger levels. Geotechnology undertook this assessment at the request of Tata (see Geotechnology report 990r1v1d0610 dated June 2010) and NRW has reviewed and accepted the new groundwater copper trigger levels. The NRW review and acceptance is set out in Compliance Assessment Report 03451 issued 25 November 2010.
- As part of the 2011 annual review (Geotechnology report 1130r1v1d0412) new assessment levels for carbon monoxide and compliance levels for methane were derived in accordance with The Industry Code of Practice (ICOP) guidance.
- As part of the 2012 HRA review, new assessment levels were presented for leachate, groundwater and surface water (see Geotechnology report 1177r1v1d0712). These were also consolidated in a letter to NRW from Tata on 4 February 2013. Given the acceptance of these new levels towards the end of 2012, Tata only started implementing the use of these new control and compliance levels in January 2013.
- In the 2017 annual review a series of new control and trigger levels were proposed alongside modifications to the analytical and monitoring programme. These were verbally agreed by NRW at a Technical Working Party meeting but Tata has yet to receive written confirmation from NRW.

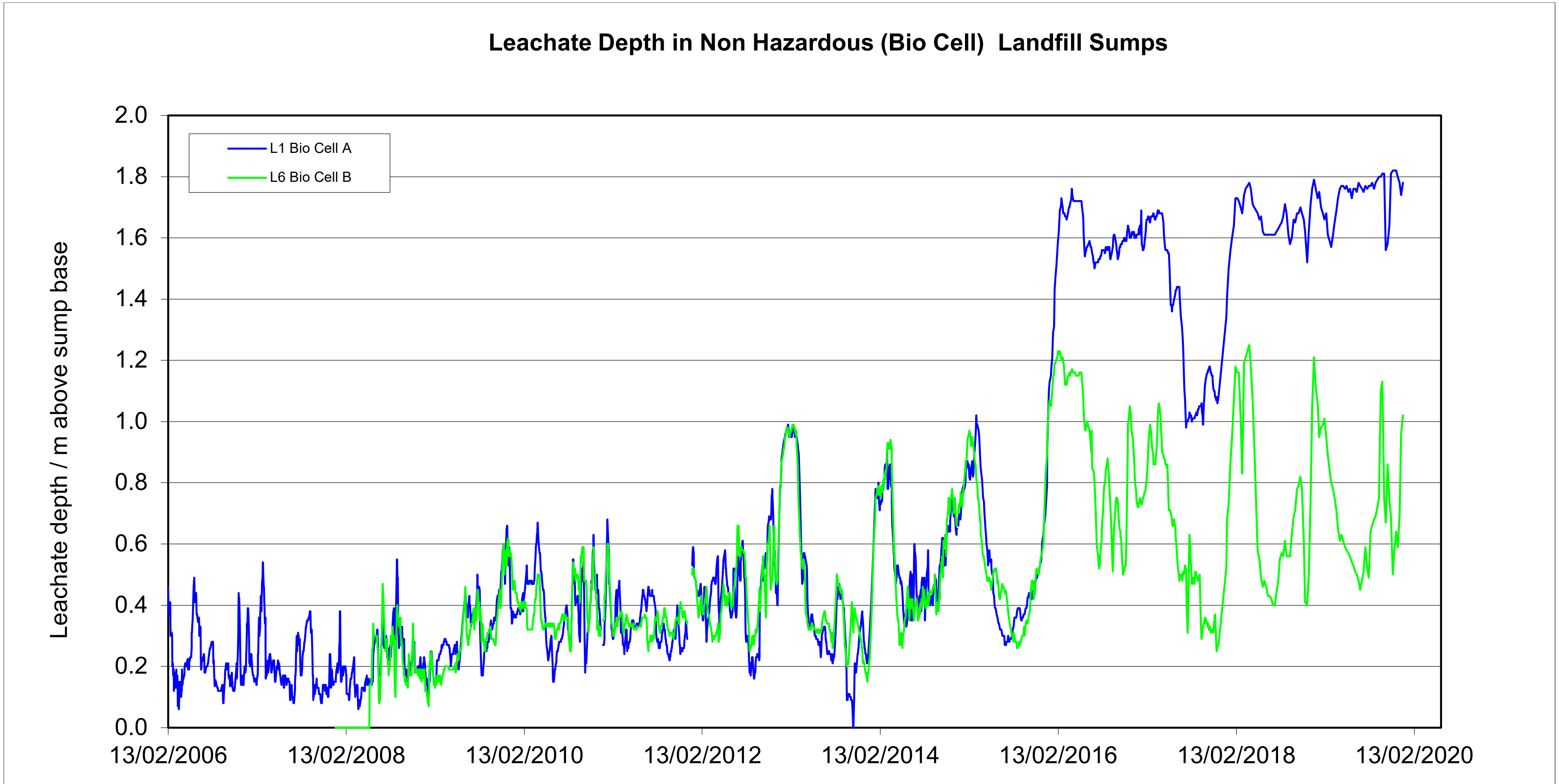
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

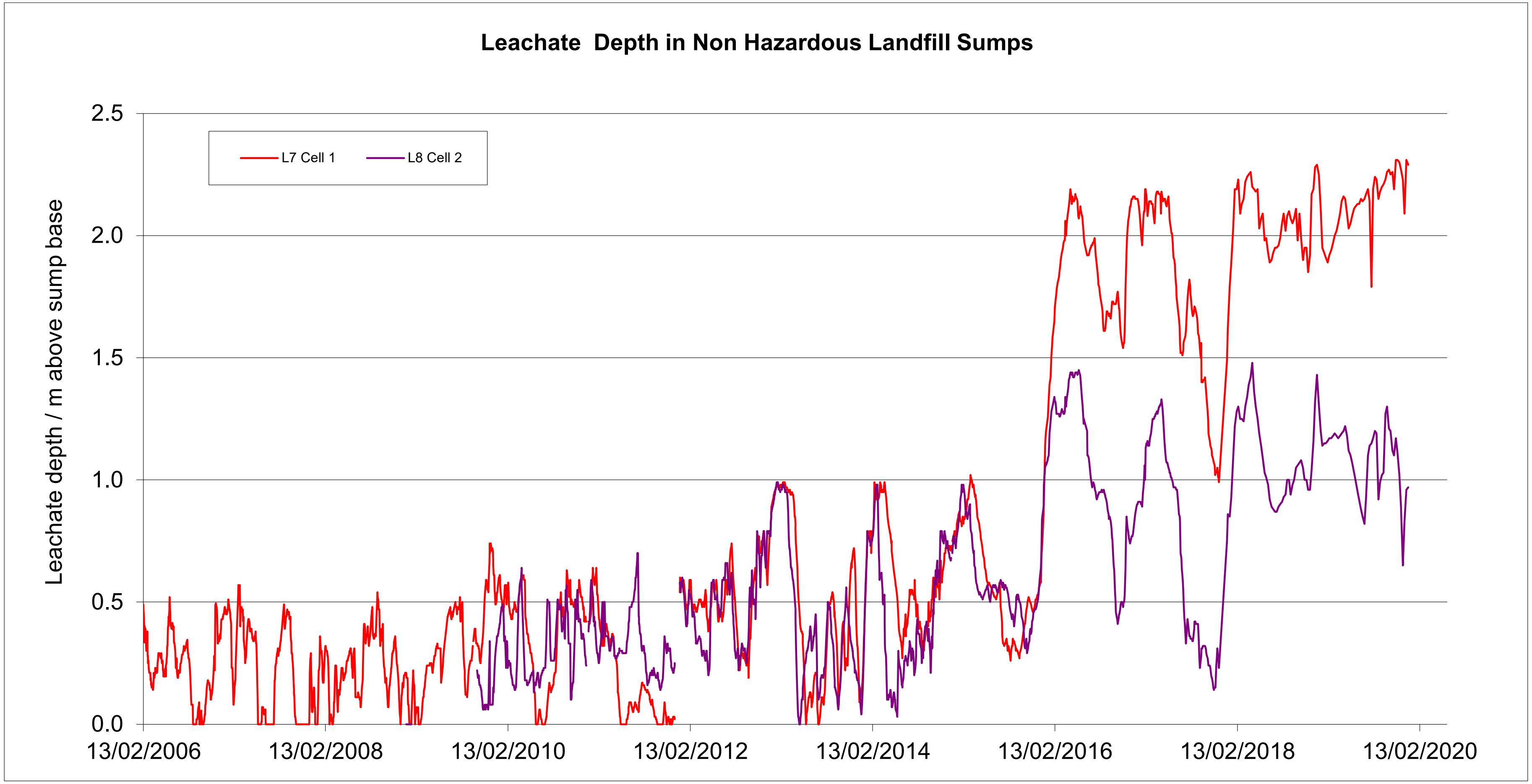
# PERMIT BV7311IE

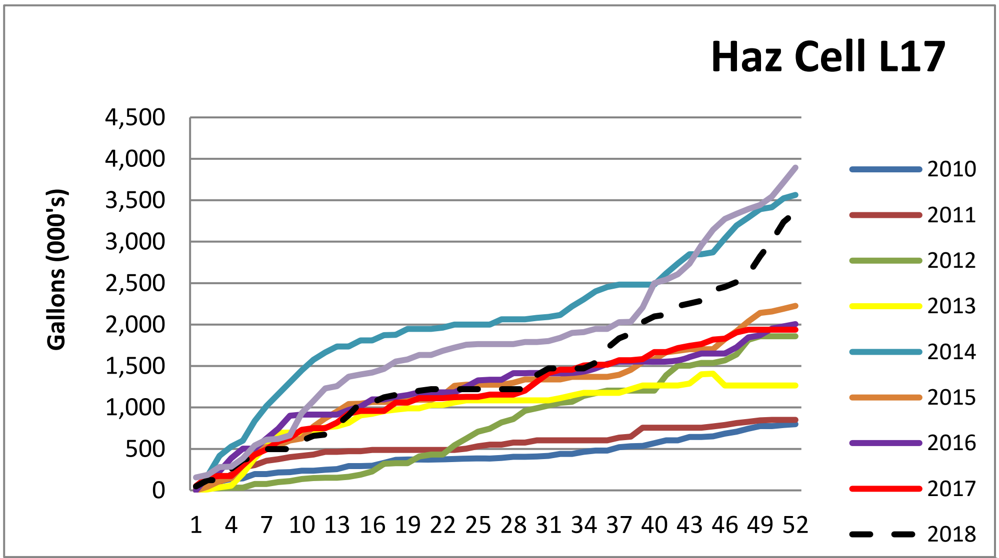
## 2019 Annual Review of Environmental Monitoring

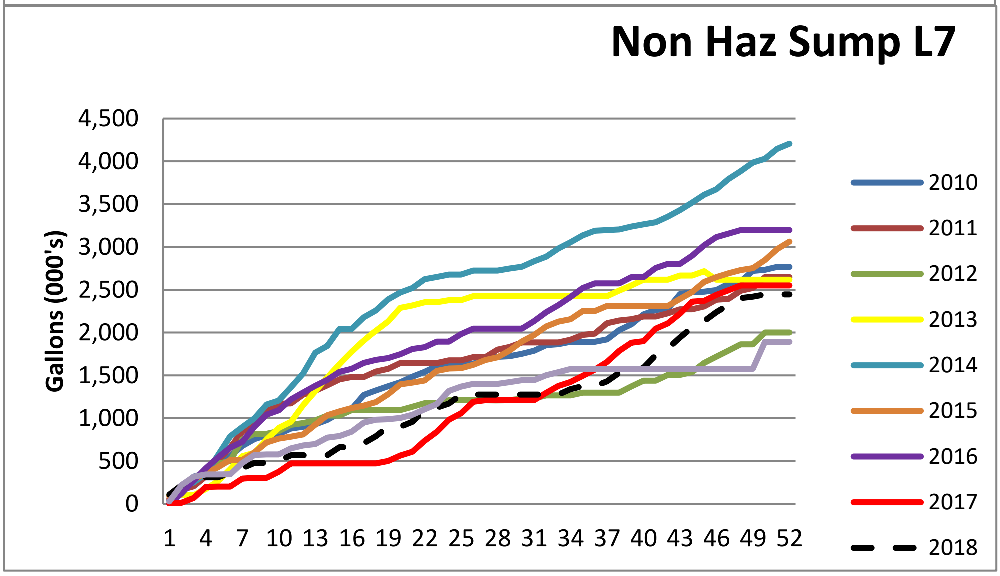
## Appendix 2
## Temporal Variation of Leachate Levels and Leachate Pumping Volumes

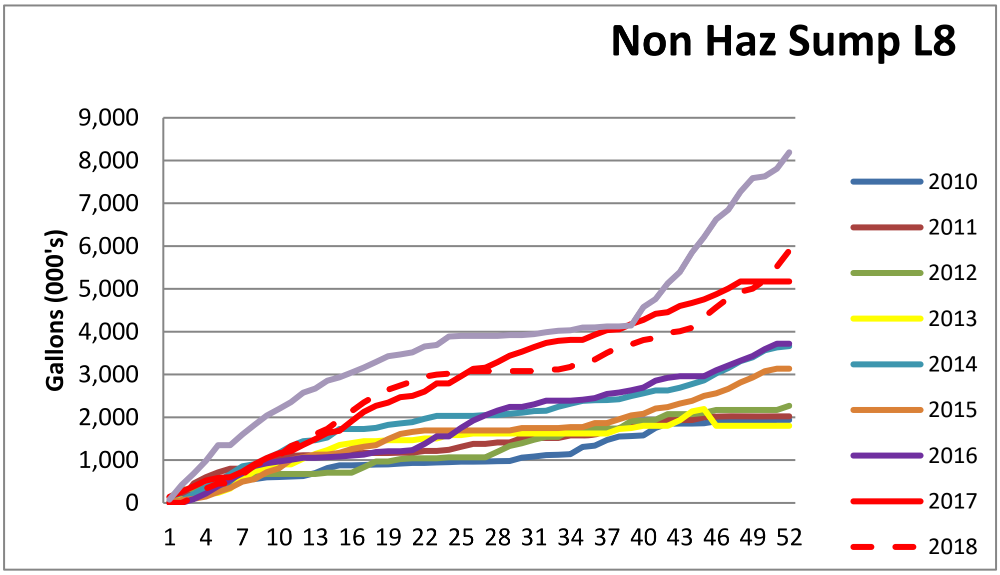
*Report Number 1965r1v1d0220*

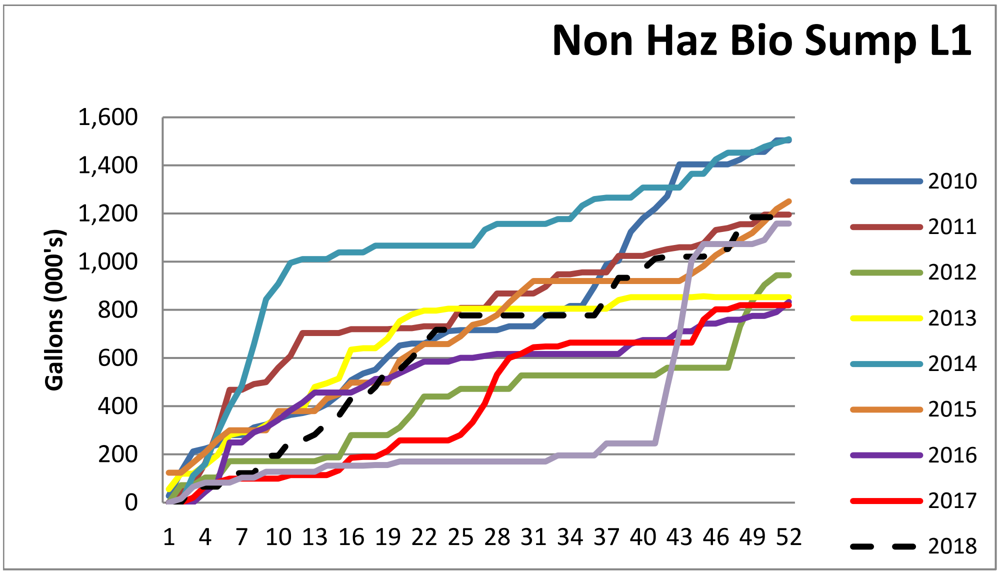

Leachate Depth in Non Hazardous (Bio Cell) Landfill Sumps
L1 Bio Cell A
L6 Bio Cell B
Leachate depth / m above sump base
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
13/02/2006
13/02/2008
13/02/2010
13/02/2012
13/02/2014
13/02/2016
13/02/2018
13/02/2020

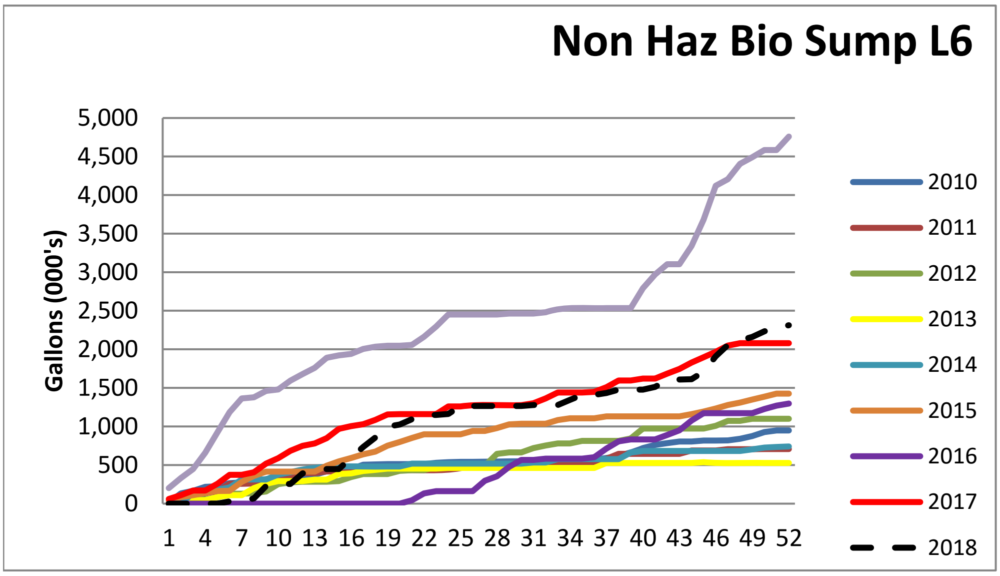

Leachate Depth in Non Hazardous Landfill Sumps
L7 Cell 1
L8 Cell 2
Leachate depth / m above sump base
2.5
2.0
1.5
1.0
0.5
0.0
13/02/2006
13/02/2008
13/02/2010
13/02/2012
13/02/2014
13/02/2016
13/02/2018
13/02/2020


Haz Cell L17
Gallons (000's)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
2010
2011
2012
2013
2014
2015
2016
2017
2018


Non Haz Sump L7
Gallons (000's)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
2010
2011
2012
2013
2014
2015
2016
2017
2018


Non Haz Sump L8
Gallons (000's)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
2010
2011
2012
2013
2014
2015
2016
2017
2018


Non Haz Bio Sump L1
Gallons (000's)
0
200
400
600
800
1,000
1,200
1,400
1,600
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
2010
2011
2012
2013
2014
2015
2016
2017
2018


Non Haz Bio Sump L6
Gallons (000's)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
2010
2011
2012
2013
2014
2015
2016
2017
2018

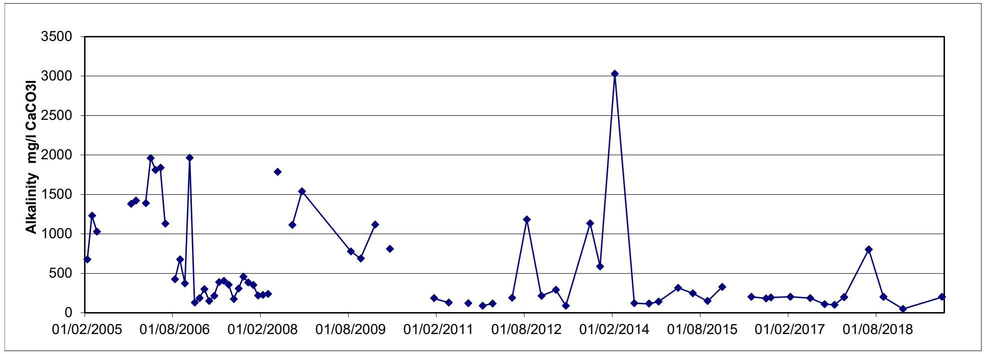
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

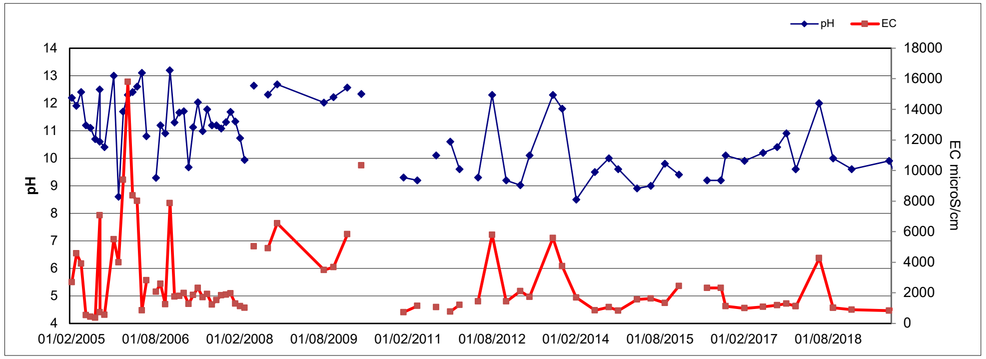
## PERMIT BV7311IE

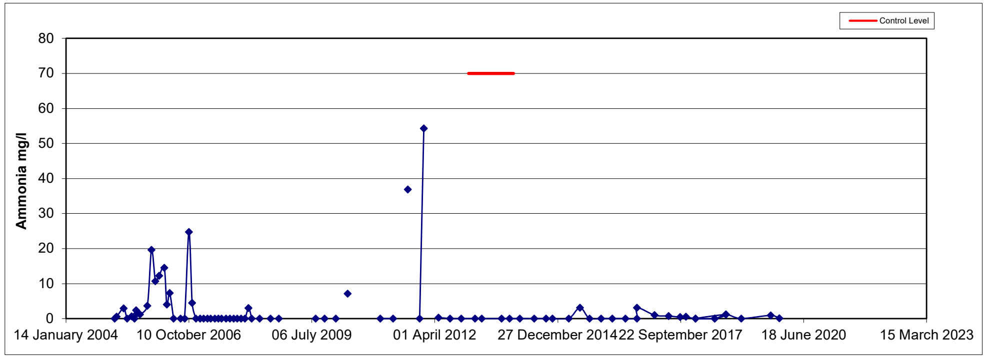
## 2019 Annual Review of Environmental Monitoring

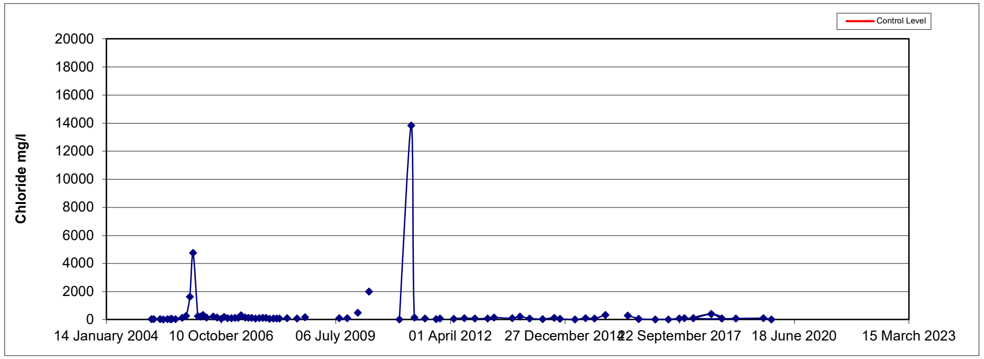
## Appendix 3
## Temporal Variation of Leachate Chemistry

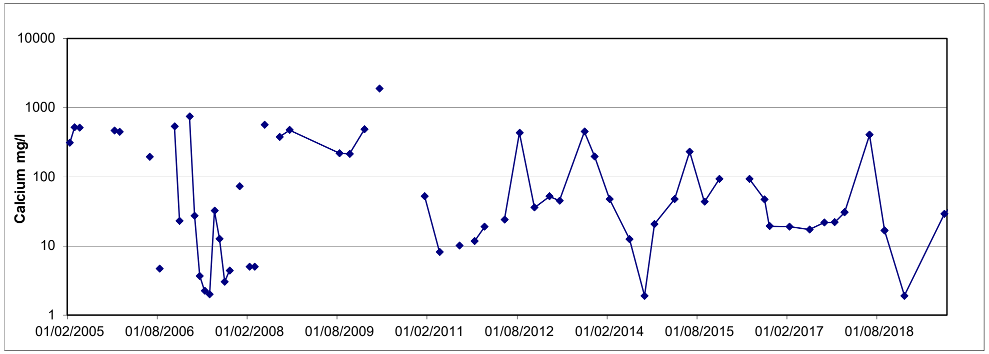
*Report Number 1965r1v1d0220*

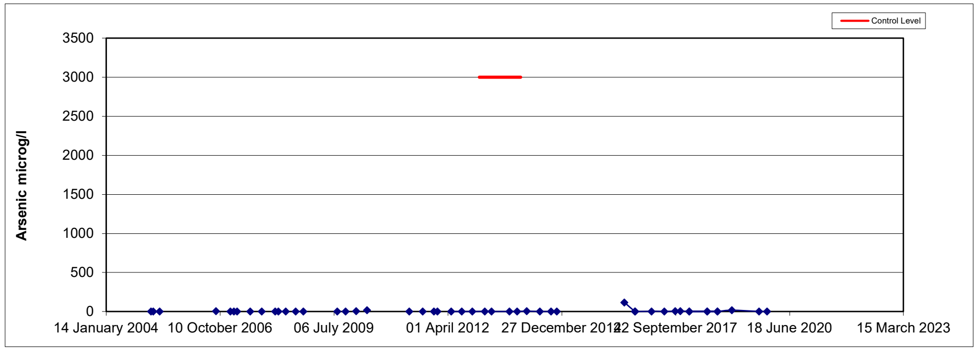

Alkalinity mg/l CaCO3l
3500
3000
2500
2000
1500
1000
500
0
01/02/2005
01/08/2006
01/02/2008
01/08/2009
01/02/2011
01/08/2012
01/02/2014
01/08/2015
01/02/2017
01/08/2018

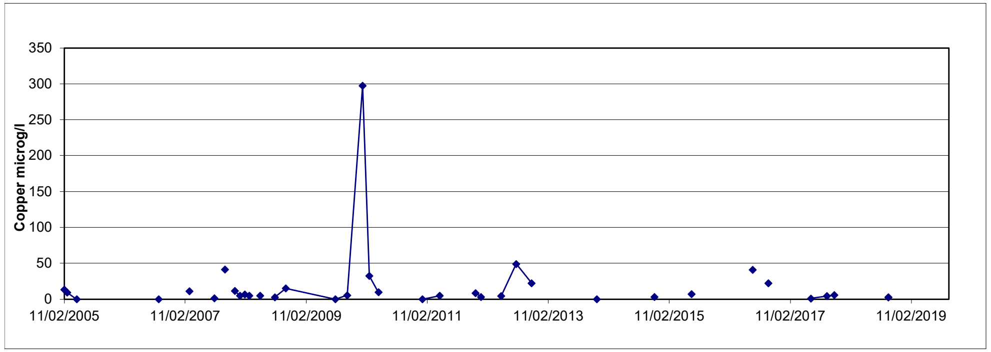

pH
EC
pH
EC microS/cm
14
13
12
11
10
9
8
7
6
5
4
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
01/02/2005
01/08/2006
01/02/2008
01/08/2009
01/02/2011
01/08/2012
01/02/2014
01/08/2015
01/02/2017
01/08/2018

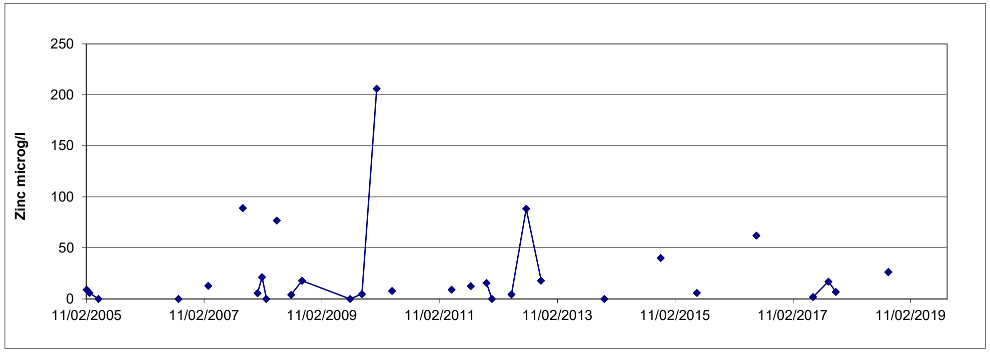

Control Level
Ammonia mg/l
80
70
60
50
40
30
20
10
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

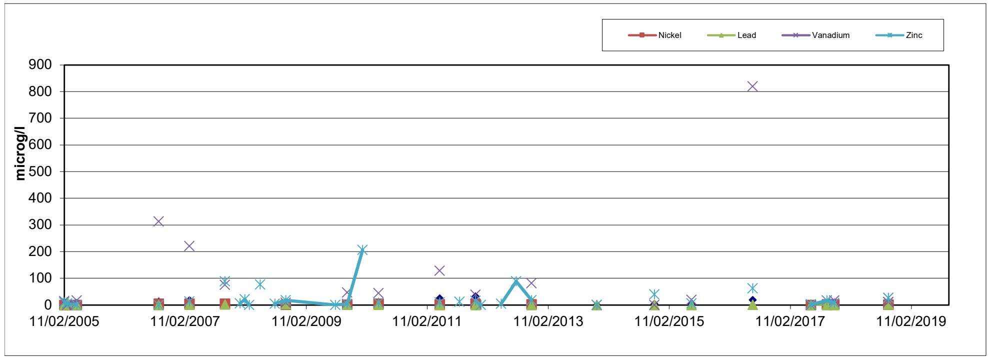

Control Level
Chloride mg/l
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

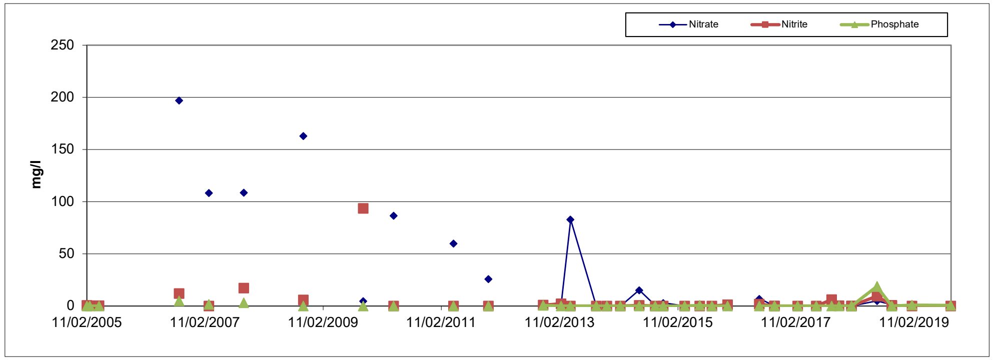

Calcium mg/l
10000
1000
100
10
1
01/02/2005
01/08/2006
01/02/2008
01/08/2009
01/02/2011
01/08/2012
01/02/2014
01/08/2015
01/02/2017
01/08/2018

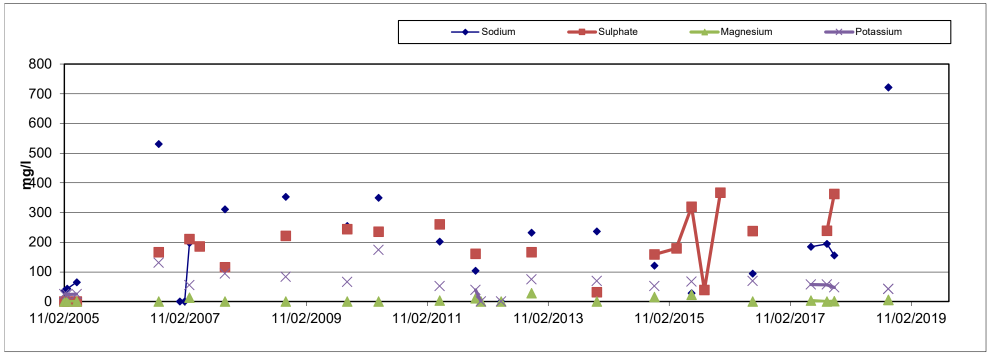

Control Level
Arsenic microg/l
3500
3000
2500
2000
1500
1000
500
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023


Copper microg/l
350
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


Zinc microg/l
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


Nickel
Lead
Vanadium
Zinc
microg/l
900
800
700
600
500
400
300
200
100
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


Nitrate
Nitrite
Phosphate
mg/l
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


Sodium
Sulphate
Magnesium
Potassium
mg/l
800
700
600
500
400
300
200
100
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

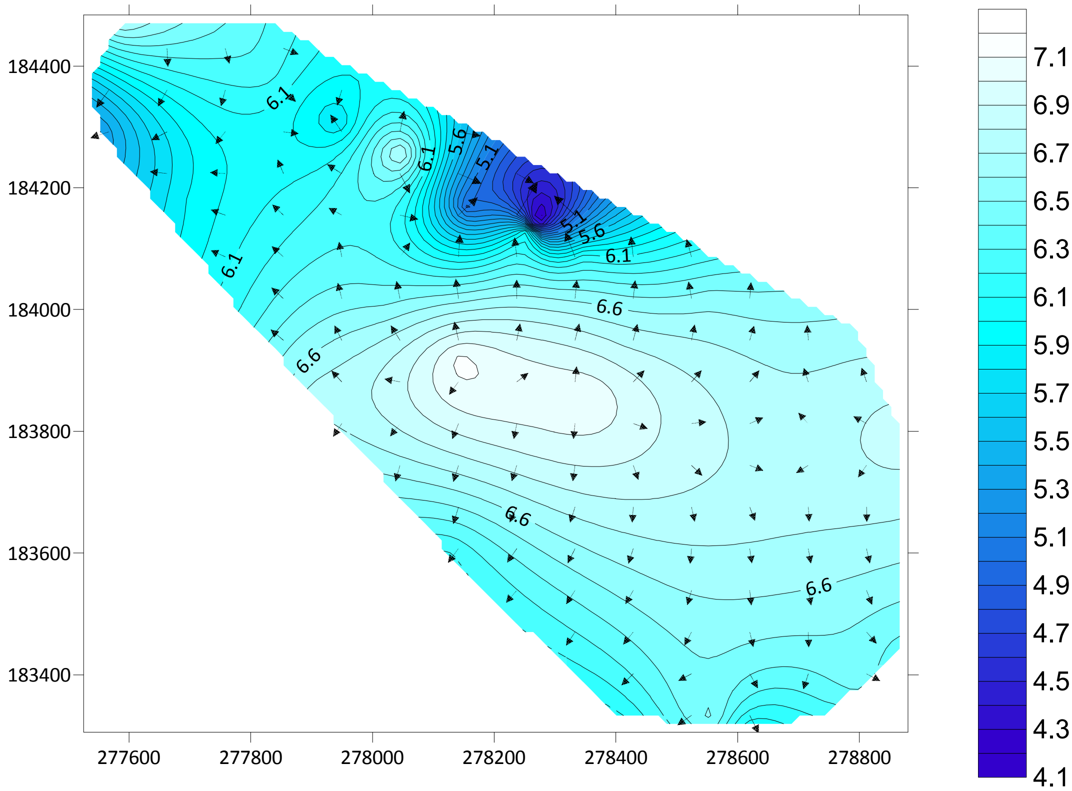
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

## PERMIT BV7311IE

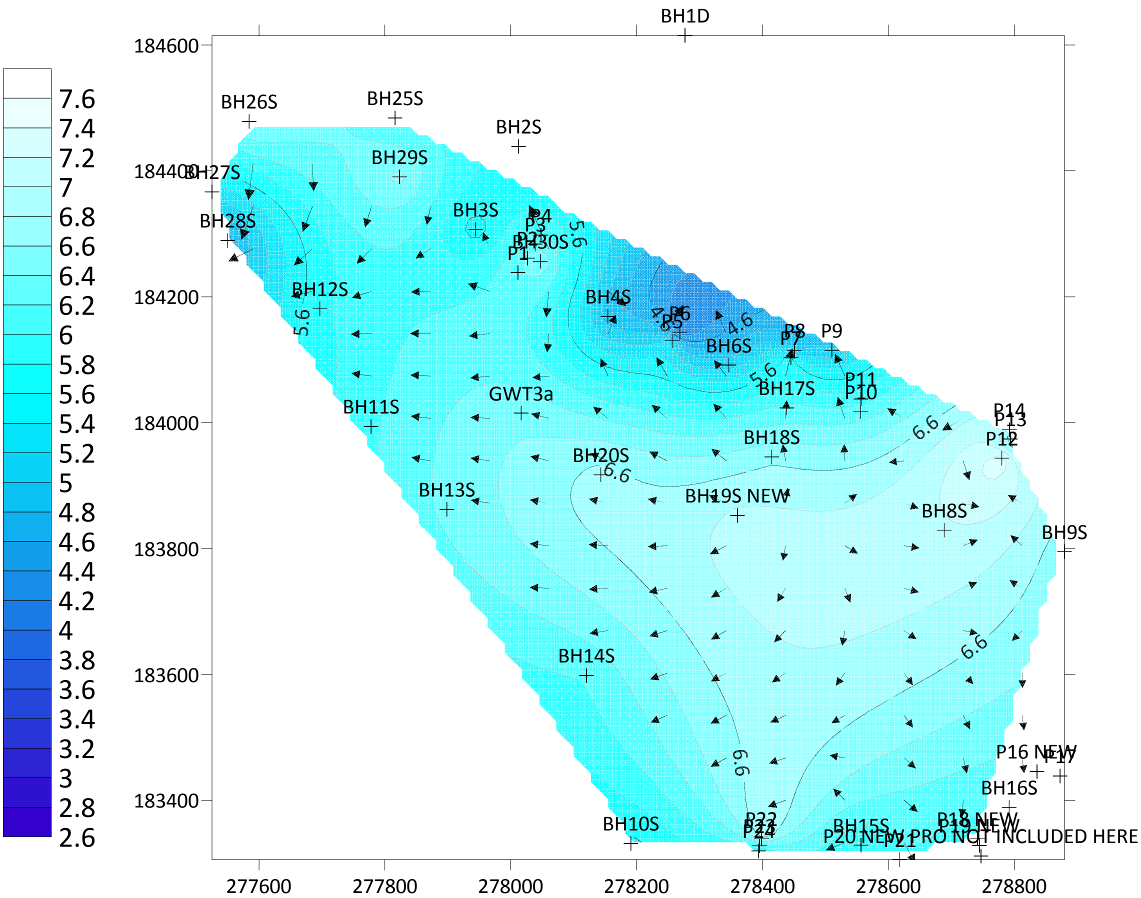
## 2019 Annual Review of Environmental Monitoring

## Appendix 4
## Temporal Variation of Groundwater Levels

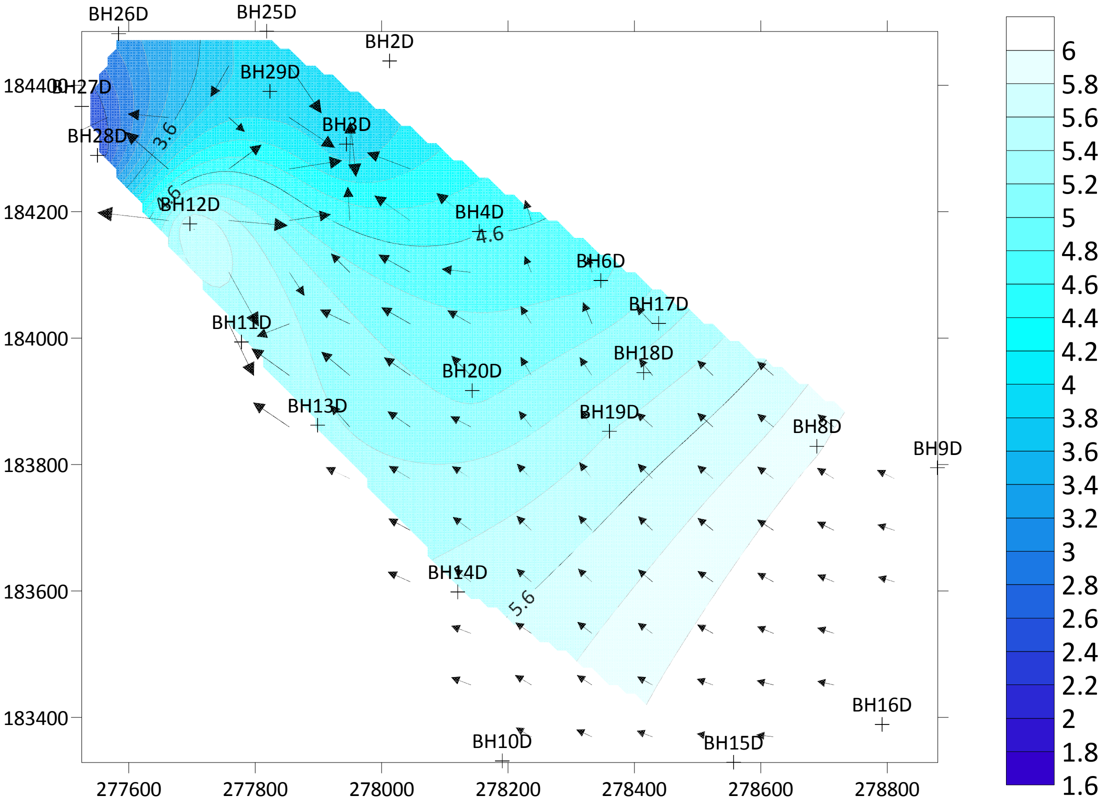
*Report Number 1965r1v1d0220*



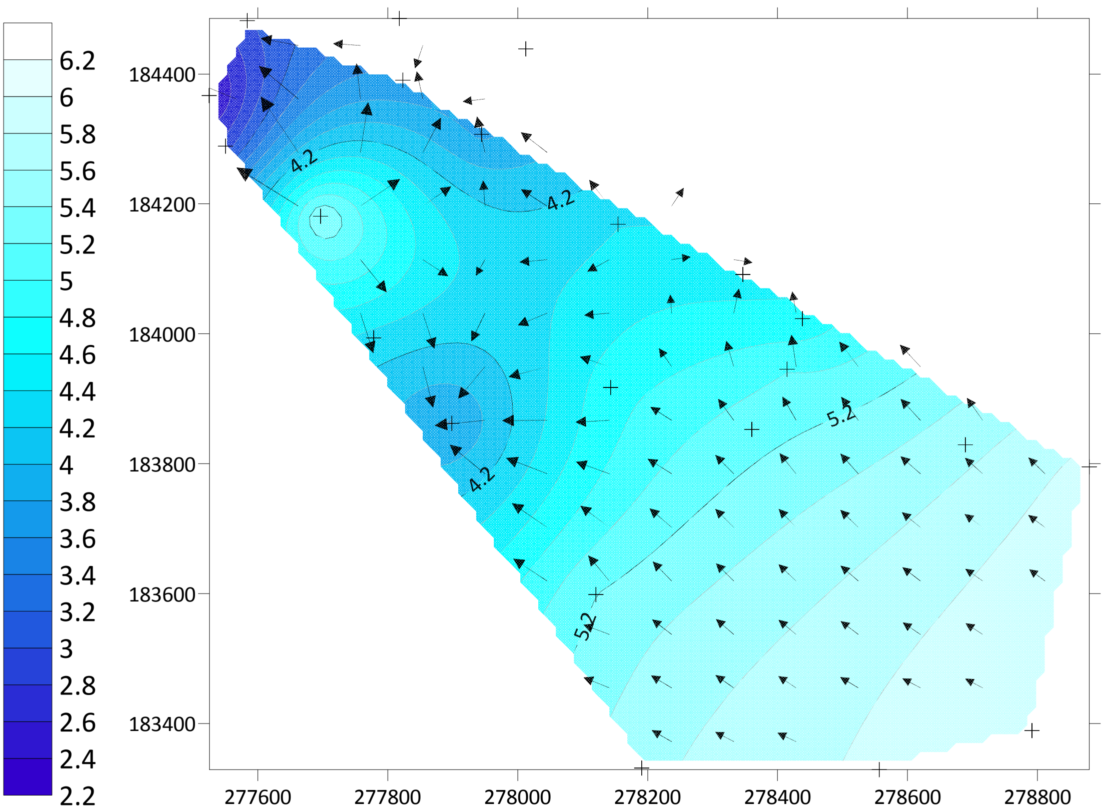

**Shallow Groundwater Contours, December2018**



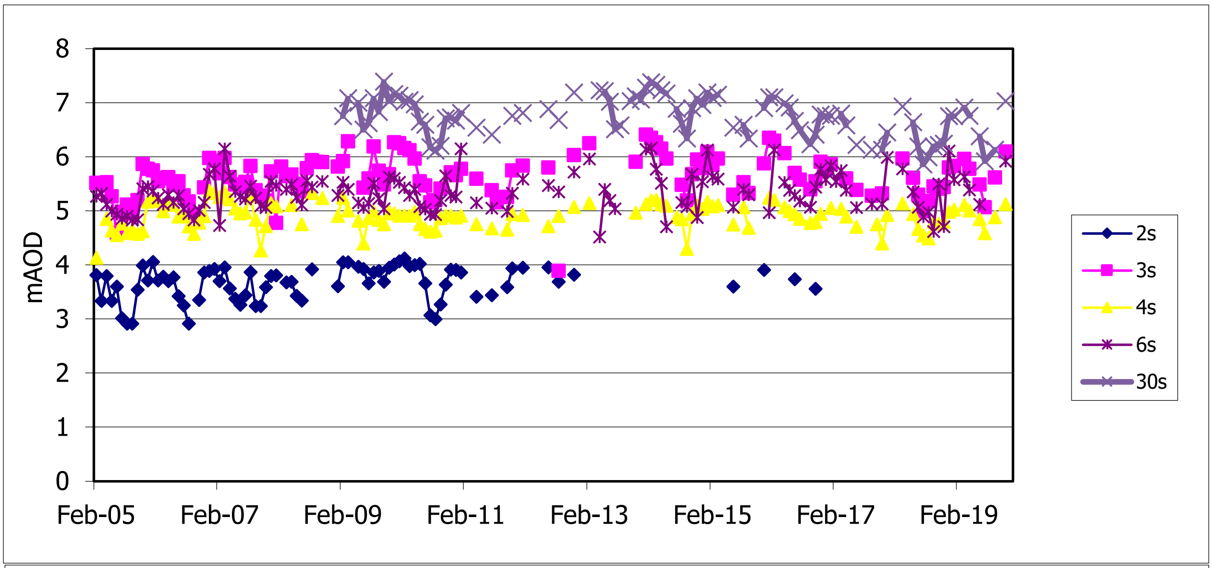

**Shallow Groundwater Contours, June 2019**

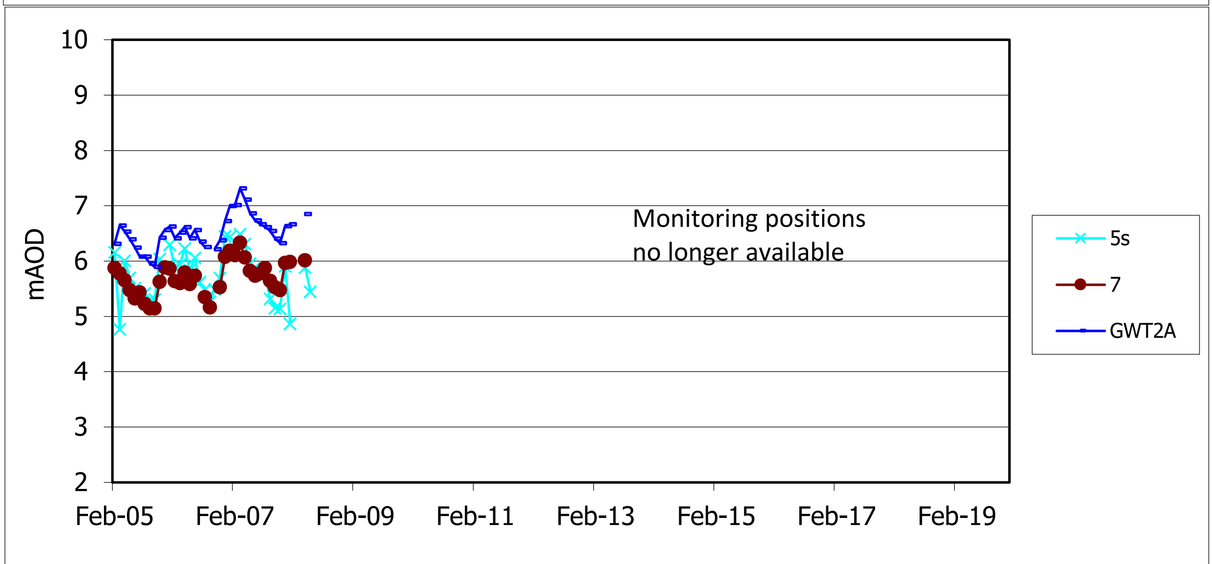


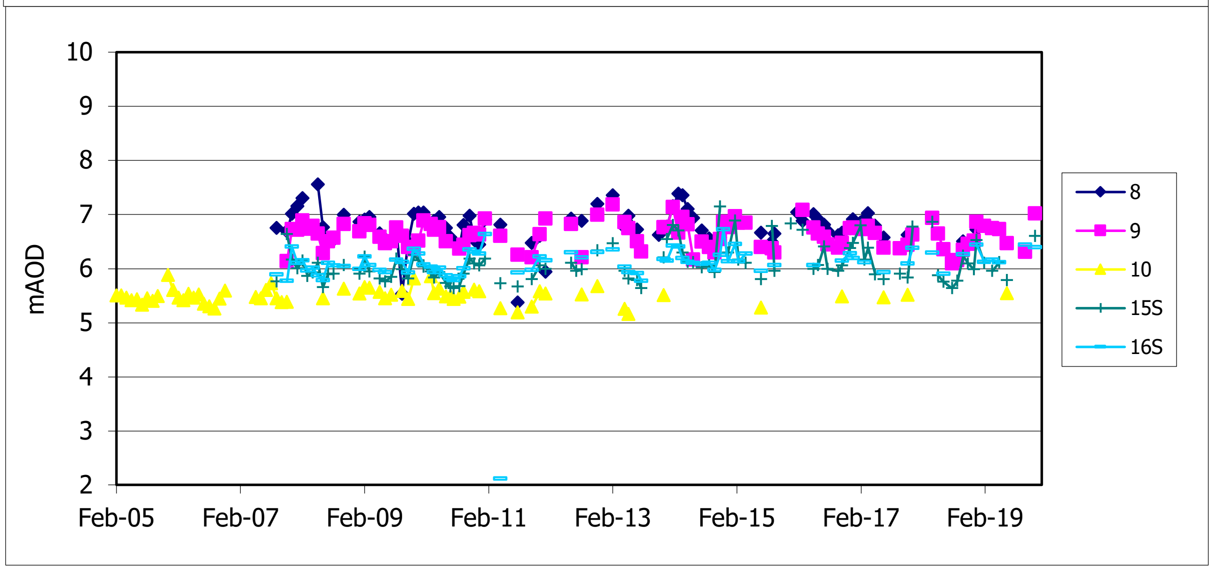

**Deep Groundwater Levels, December 2018**

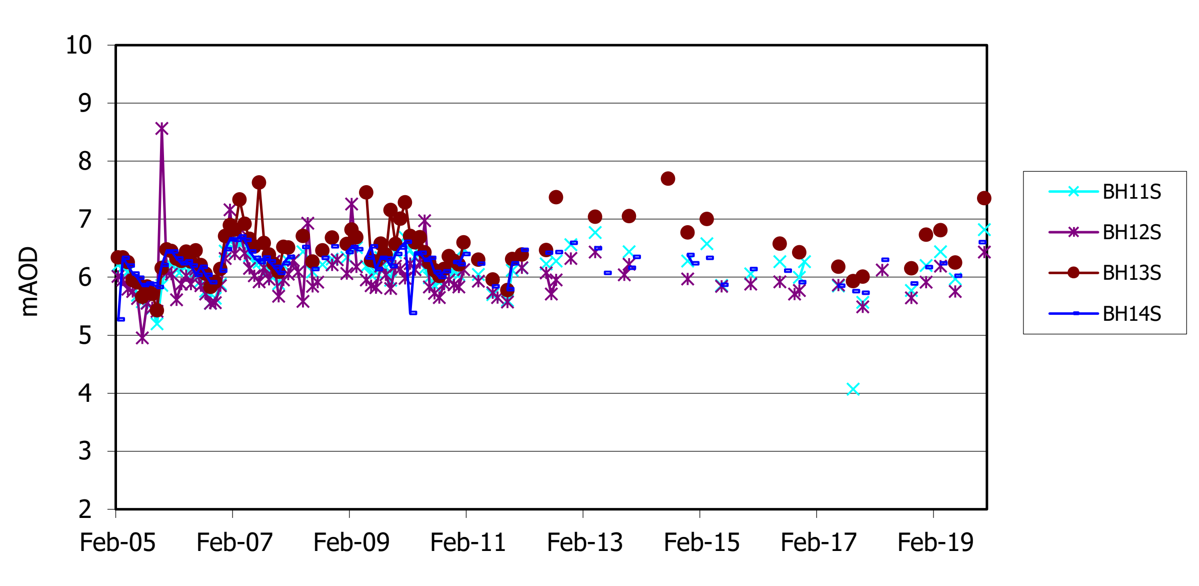


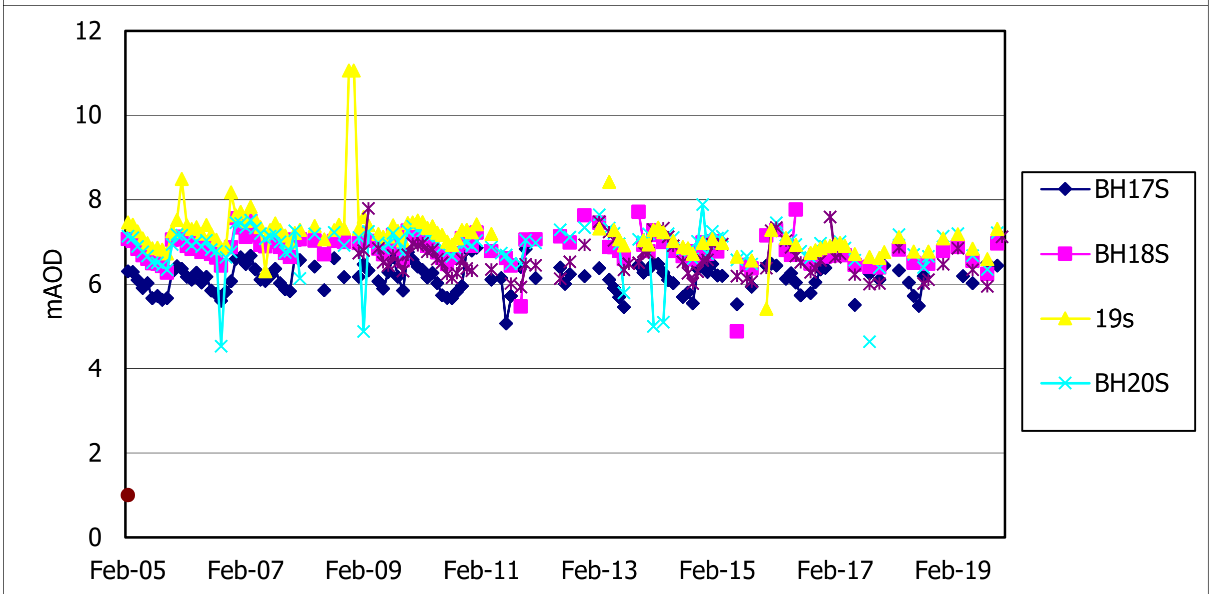

**Deep Groundwater Levels, June 2019**

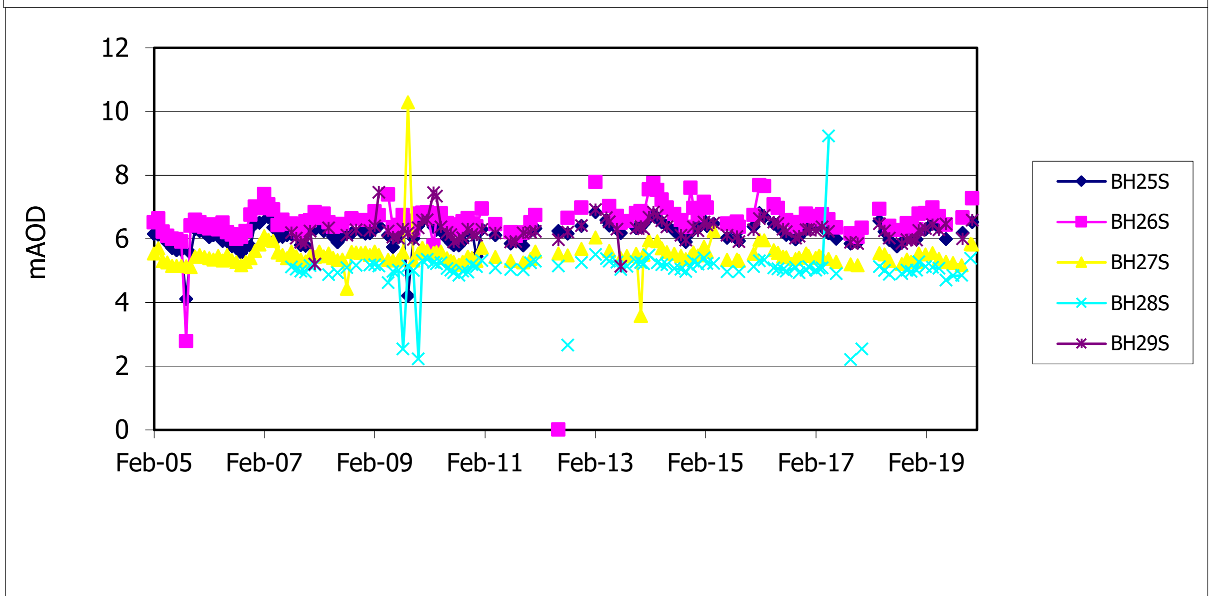

mAOD
8
7
6
5
4
3
2
1
0
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
2s
3s
4s
6s
30s

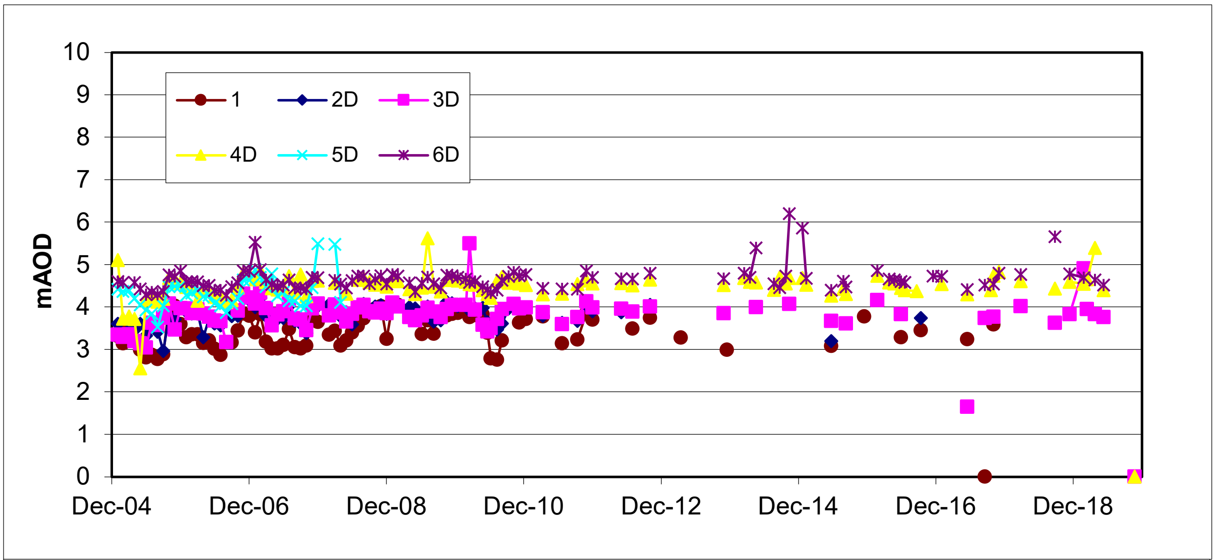

mAOD
10
9
8
7
6
5
4
3
2
Monitoring positions
no longer available
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
5s
7
GWT2A

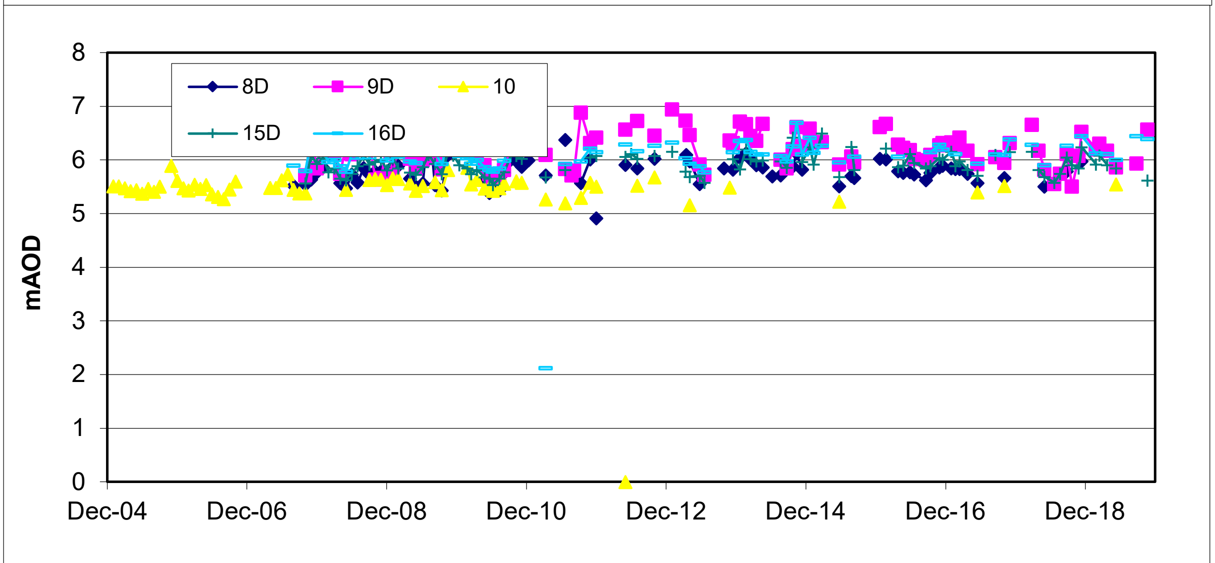

mAOD
10
9
8
7
6
5
4
3
2
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
8
9
10
15S
16S

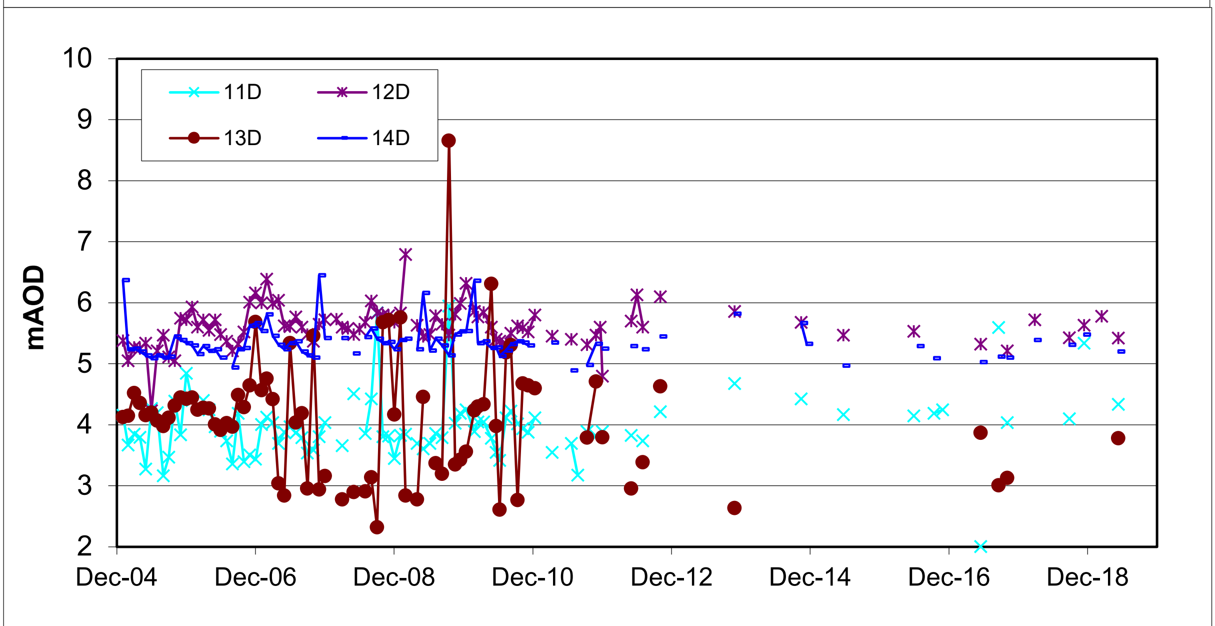

10
9
8
7
6
5
4
3
2
mAOD
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
BH11S
BH12S
BH13S
BH14S

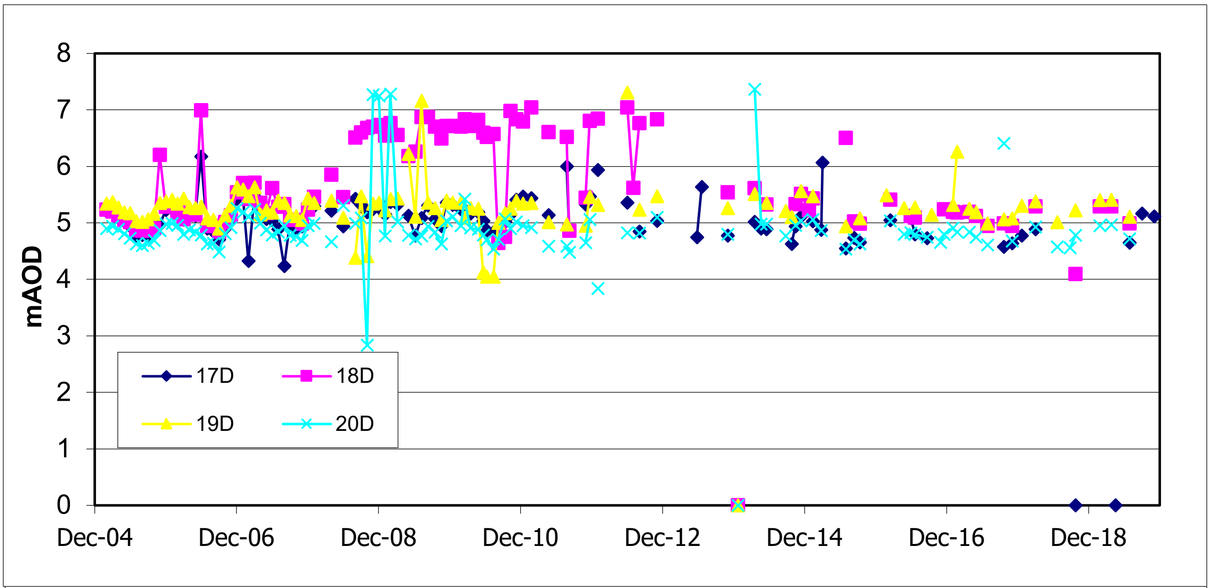

12
10
8
6
4
2
0
mAOD
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
BH17S
BH18S
19s
BH20S

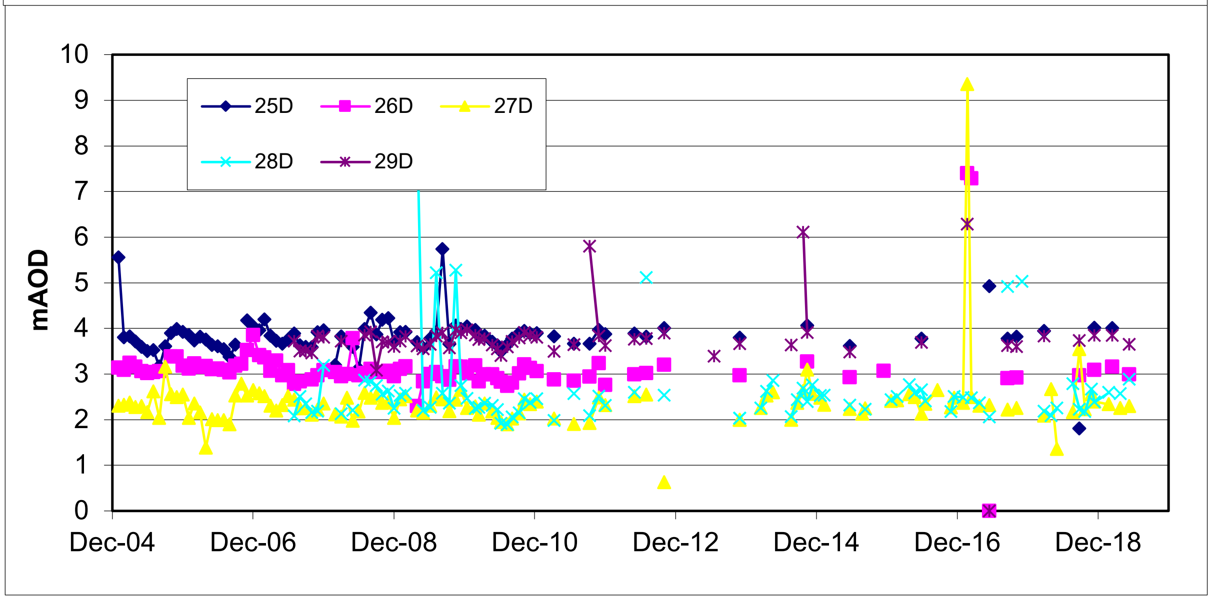

12
10
8
6
4
2
0
mAOD
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
BH25S
BH26S
BH27S
BH28S
BH29S

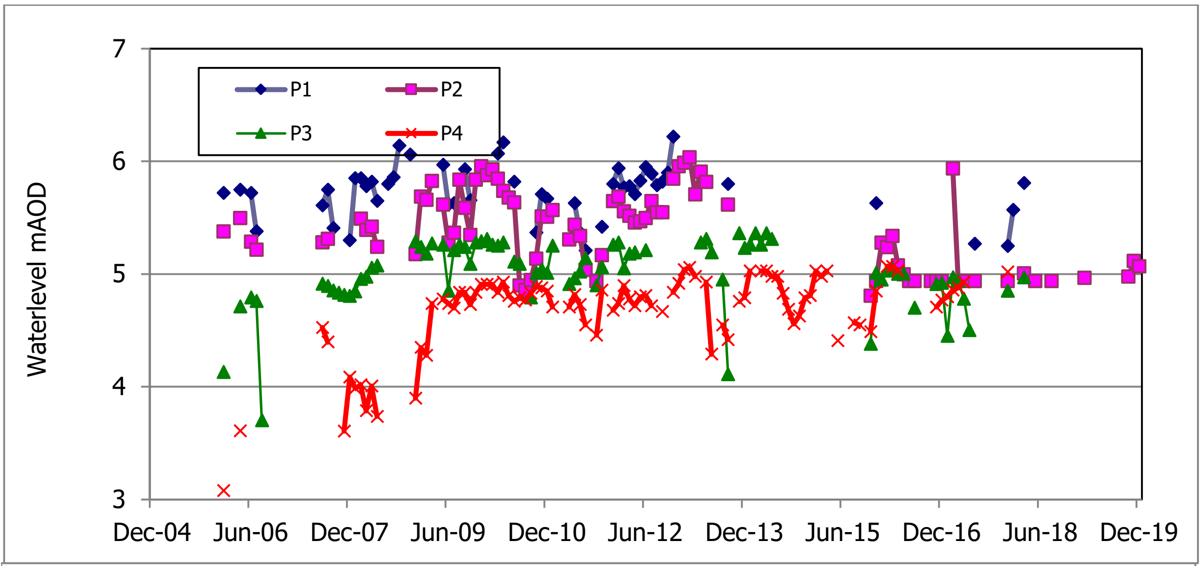

mAOD
10
9
8
7
6
5
4
3
2
1
0
1
2D
3D
4D
5D
6D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18

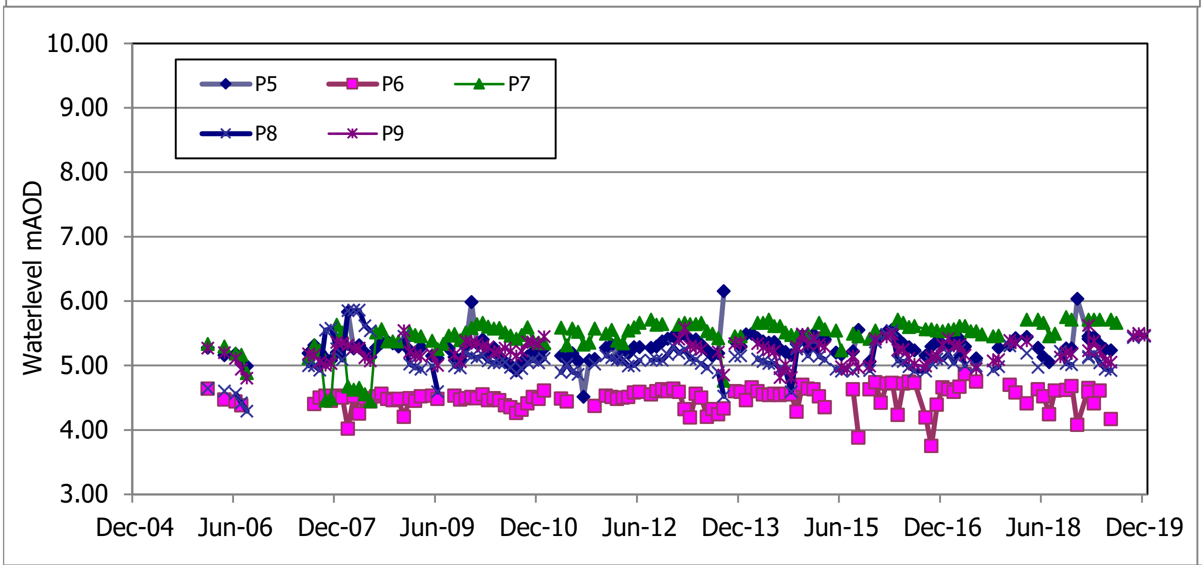

mAOD
8
7
6
5
4
3
2
1
0
8D
9D
10
15D
16D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18

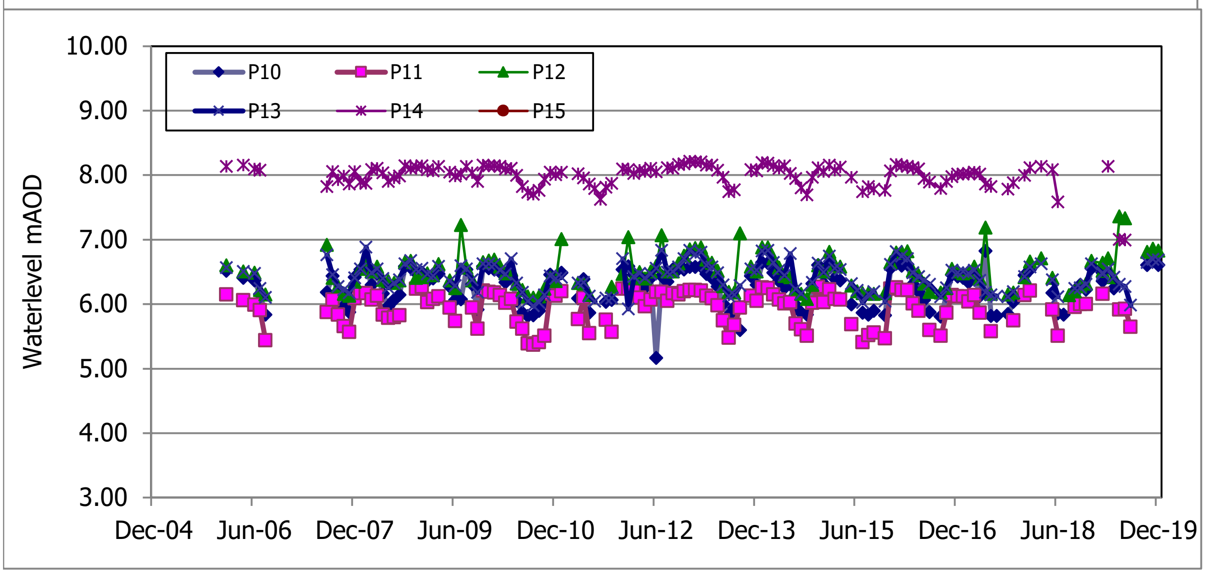

mAOD
10
9
8
7
6
5
4
3
2
11D
12D
13D
14D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18

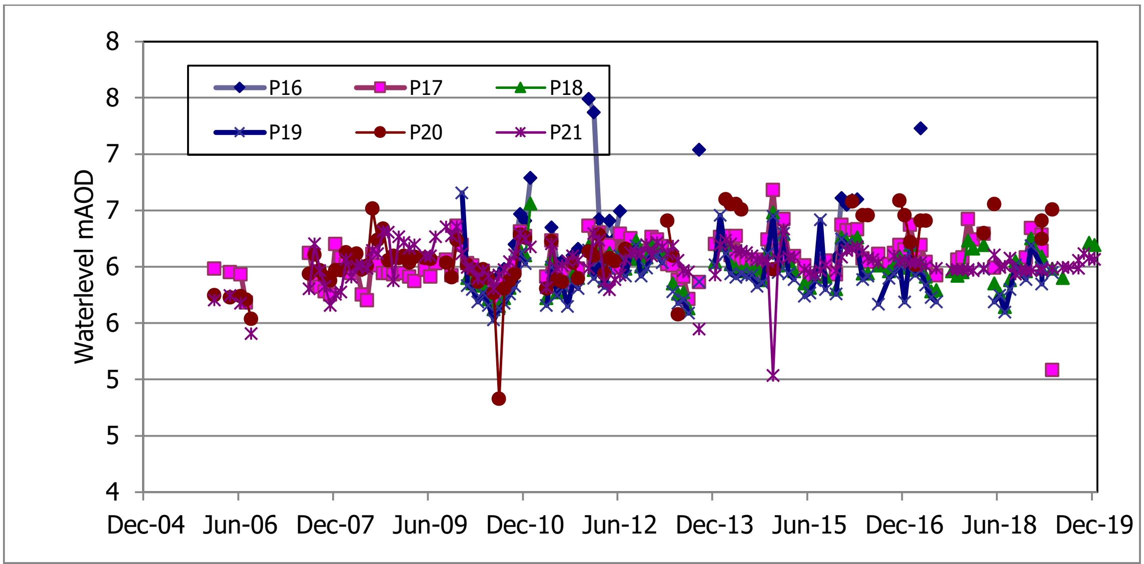

8
7
6
5
4
3
2
1
0
mAOD
17D
18D
19D
20D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18

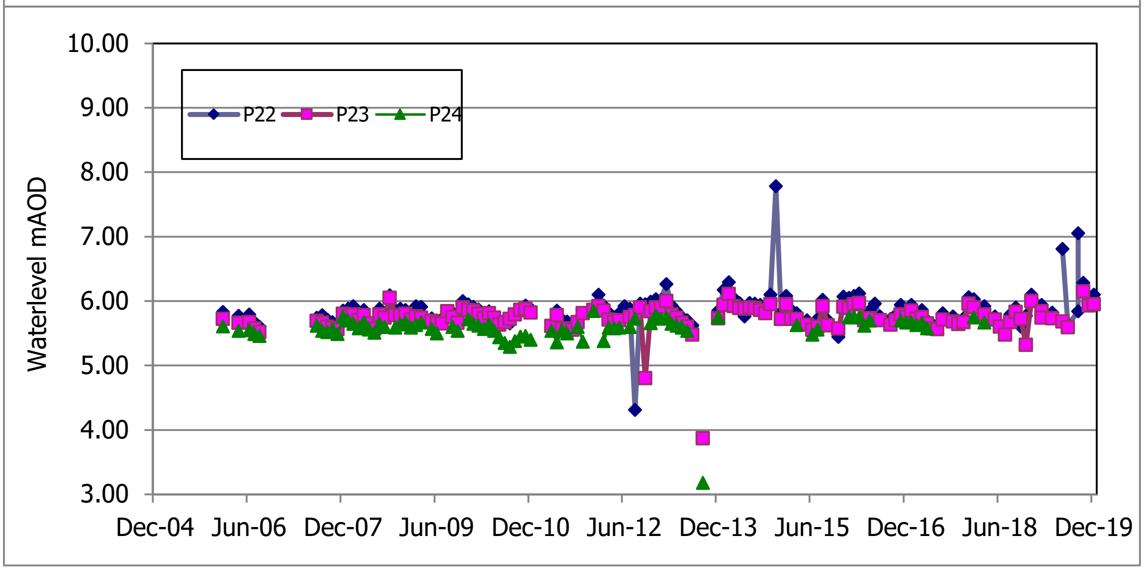

10
9
8
7
6
5
4
3
2
1
0
mAOD
25D
26D
27D
28D
29D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18

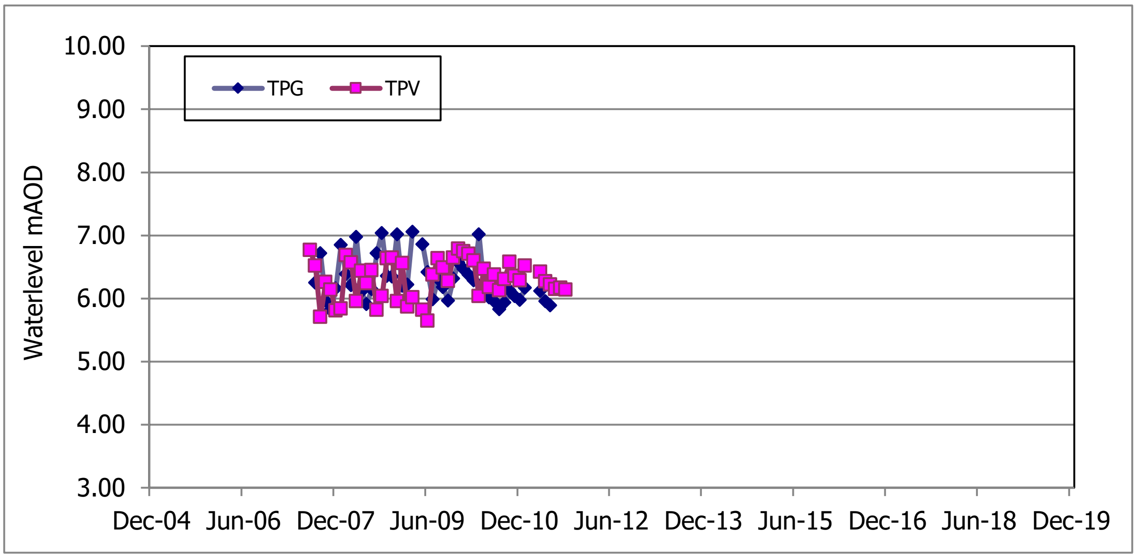

Waterlevel mAOD
7
6
5
4
3
P1
P2
P3
P4
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19


Waterlevel mAOD
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
P5
P6
P7
P8
P9
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19


Waterlevel mAOD
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
P10
P11
P12
P13
P14
P15
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19


8
8
7
7
6
6
5
5
4
Waterlevel mAOD
P16
P17
P18
P19
P20
P21
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19


10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
Waterlevel mAOD
P22
P23
P24
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19


10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
Waterlevel mAOD
TPG
TPV
Dec-04
Jun-06
Dec-07
Jun-09
Dec-10
Jun-12
Dec-13
Jun-15
Dec-16
Jun-18
Dec-19

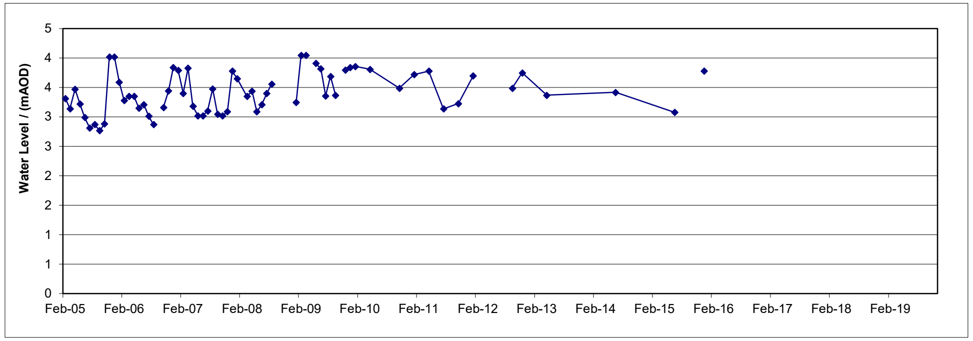
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

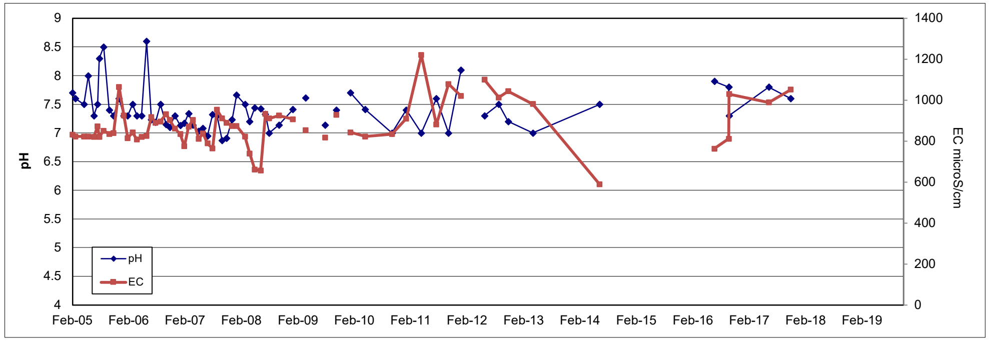
## PERMIT BV7311IE

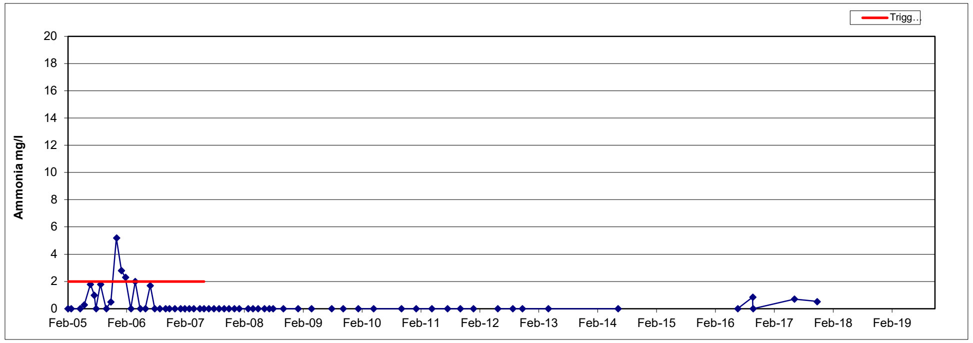
## 2019 Annual Review of Environmental Monitoring

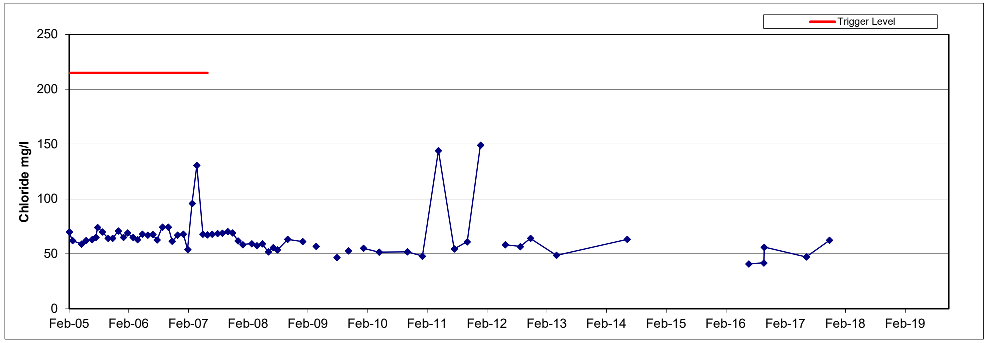
## Appendix 5
## Temporal Variation of Groundwater Chemistry

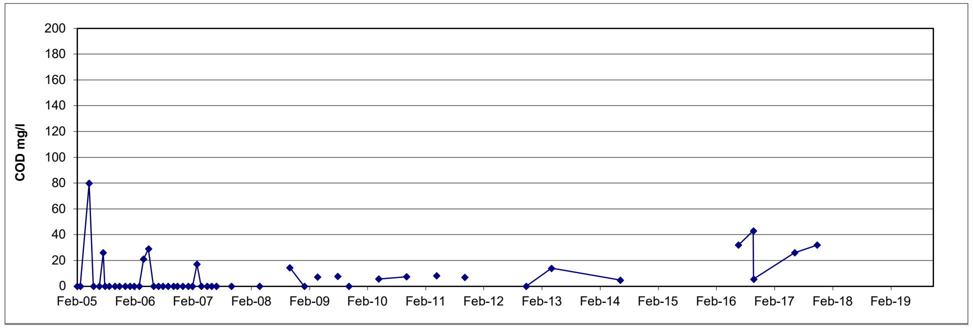
*Report Number 1965r1v1d0220*

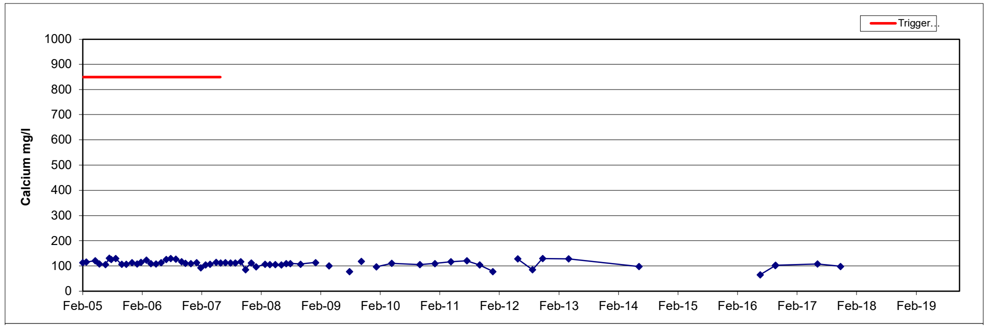

Water Level / (mAOD)
0
1
1
2
2
3
3
4
4
5
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

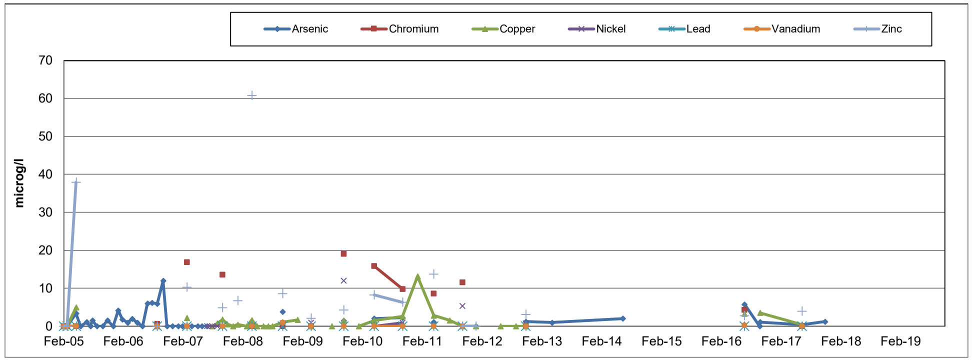

pH
EC microS/cm
pH
EC
4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9
0 200 400 600 800 1000 1200 1400
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

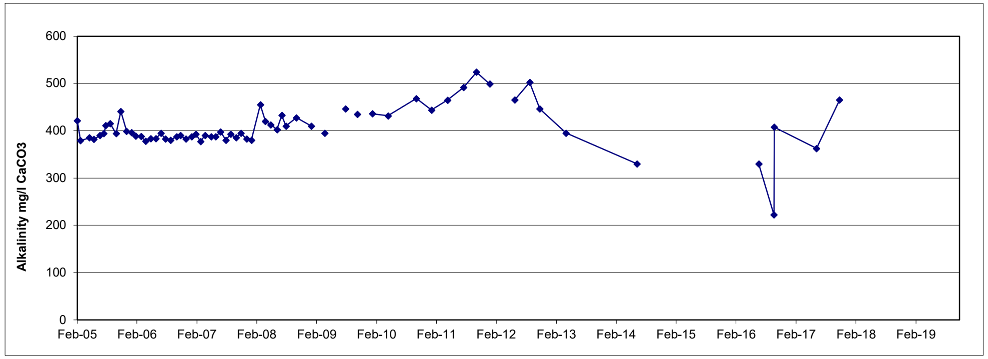

Trigg...
Ammonia mg/l
0 2 4 6 8 10 12 14 16 18 20
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

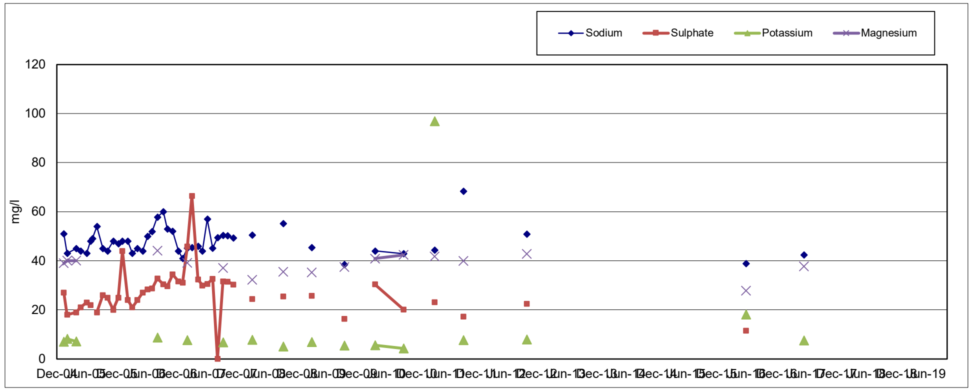

Trigger Level
Chloride mg/l
0 50 100 150 200 250
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

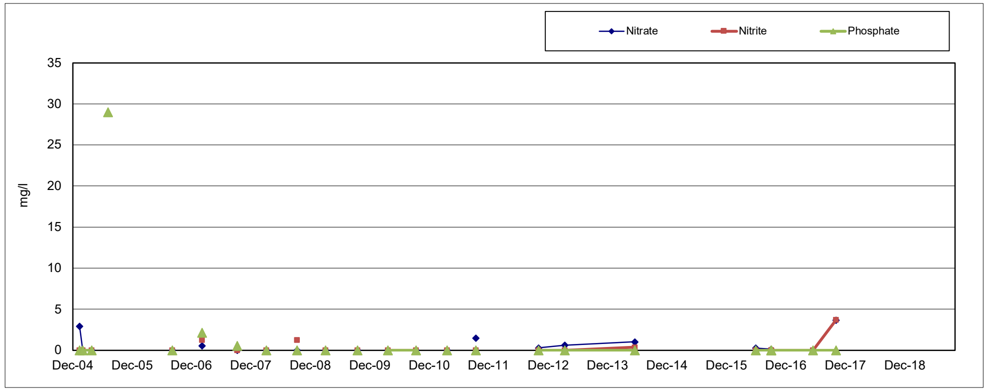

COD mg/l
0 20 40 60 80 100 120 140 160 180 200
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

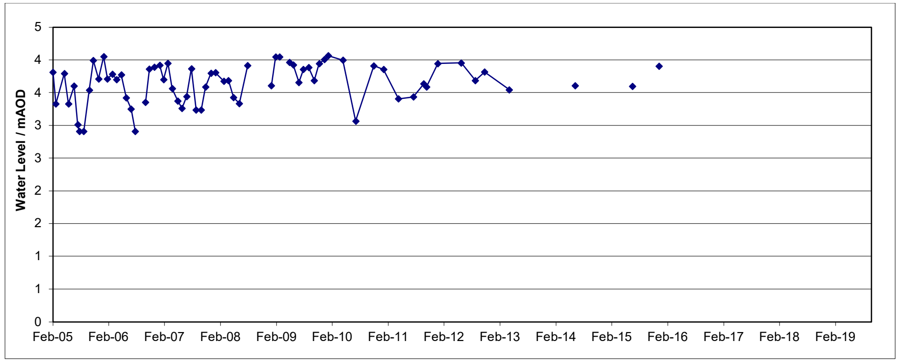

Trigger...
Calcium mg/l
0 100 200 300 400 500 600 700 800 900 1000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

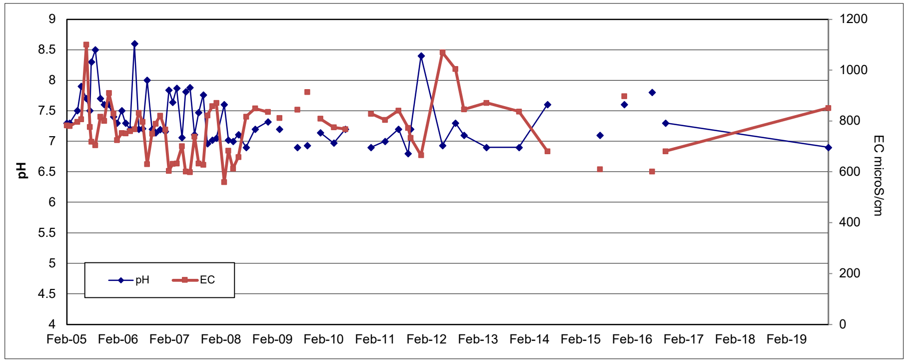

Arsenic
Chromium
Copper
Nickel
Lead
Vanadium
Zinc
microg/l
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

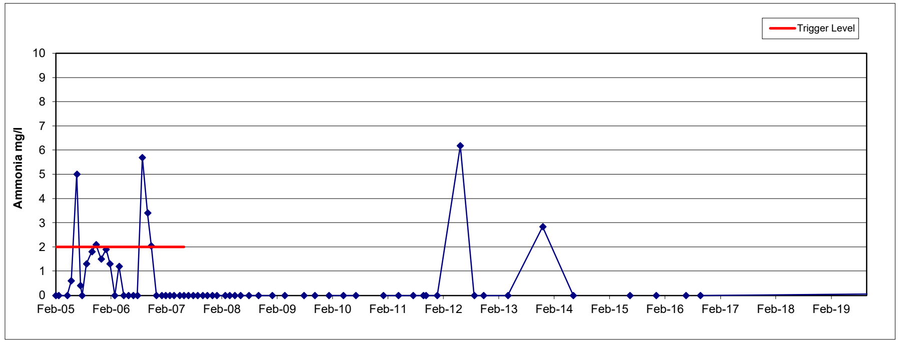

Alkalinity mg/l CaCO3
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

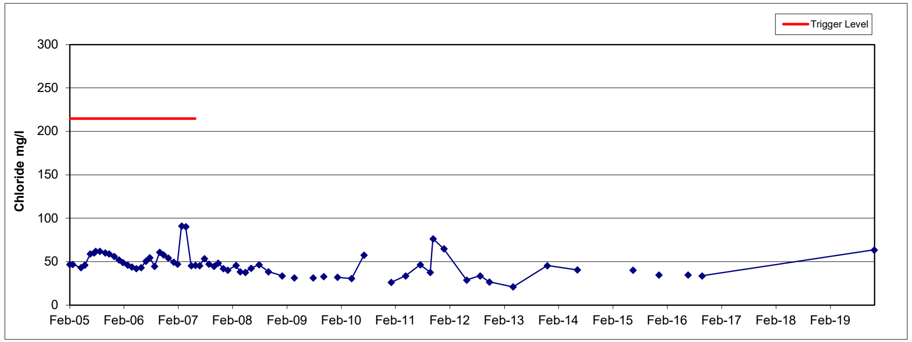

Sodium
Sulphate
Potassium
Magnesium
mg/l
120
100
80
60
40
20
0

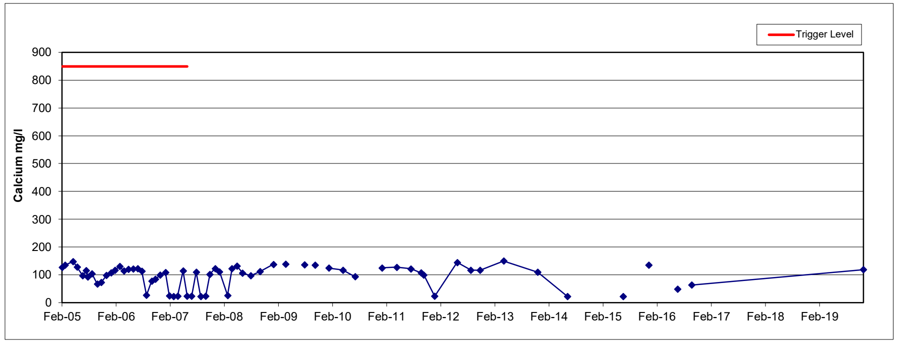

Nitrate
Nitrite
Phosphate
mg/l
35
30
25
20
15
10
5
0
Dec-04 Dec-05 Dec-06 Dec-07 Dec-08 Dec-09 Dec-10 Dec-11 Dec-12 Dec-13 Dec-14 Dec-15 Dec-16 Dec-17 Dec-18

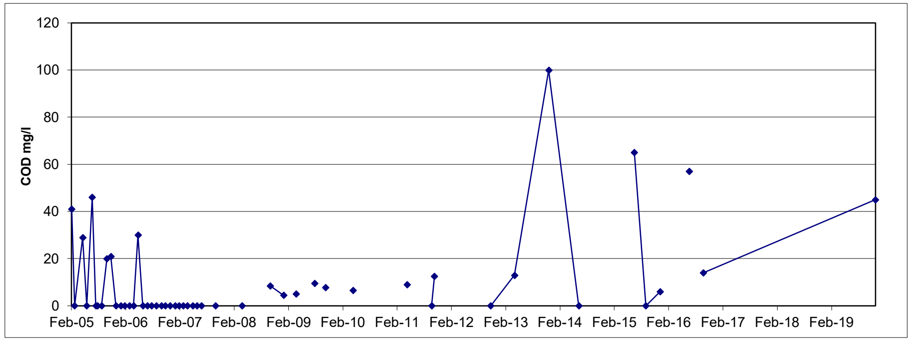

Water Level / mAOD
0
1
1
2
2
3
3
4
4
5
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

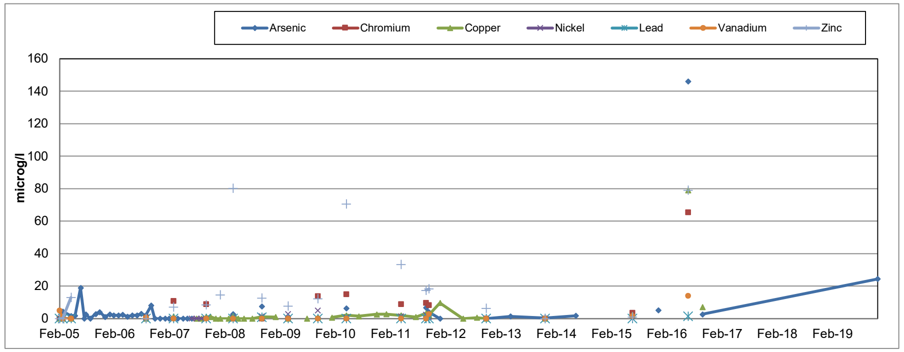

pH
EC microS/cm
pH
EC
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

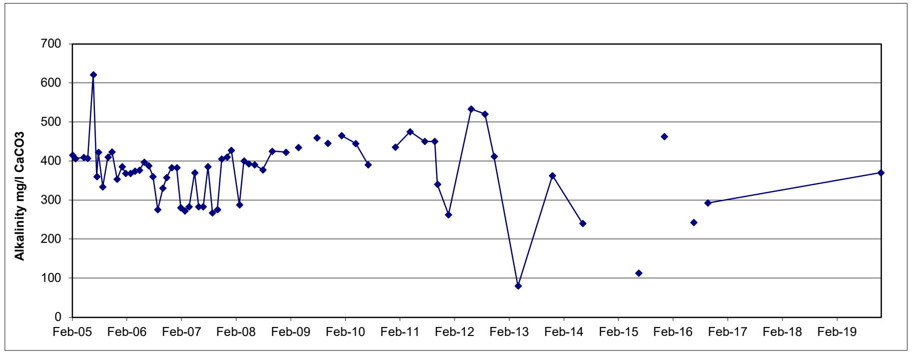

Trigger Level
Ammonia mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

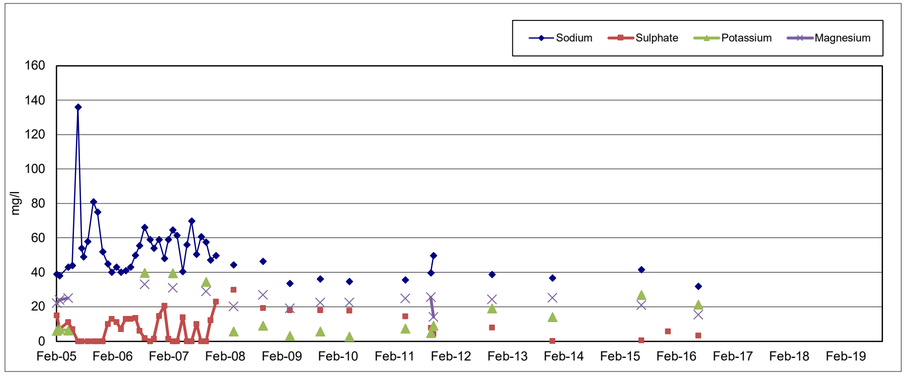

Trigger Level
Chloride mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

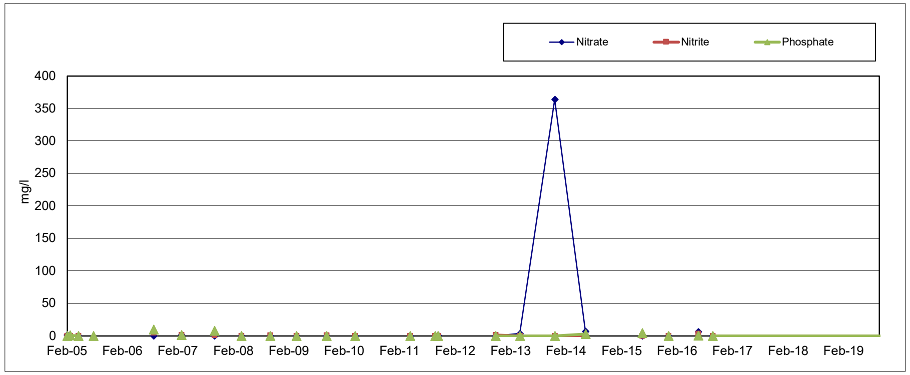

Trigger Level
Calcium mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

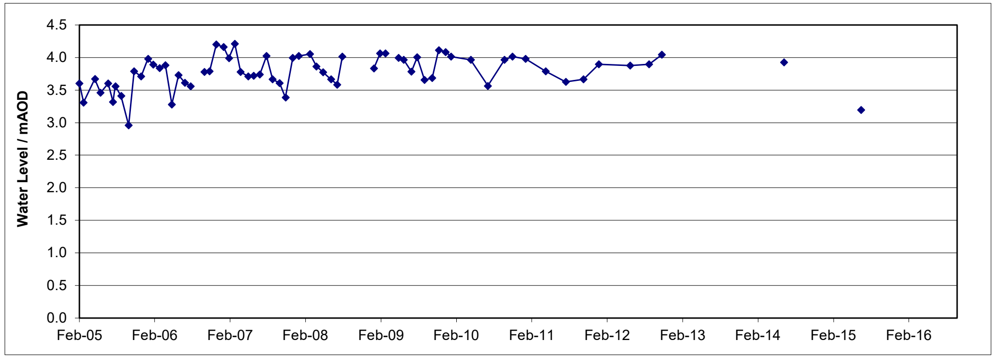

COD mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

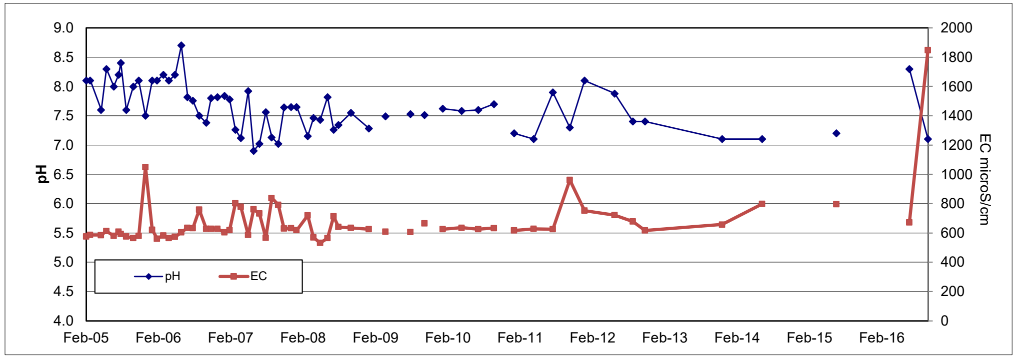

Arsenic
Chromium
Copper
Nickel
Lead
Vanadium
Zinc
microg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

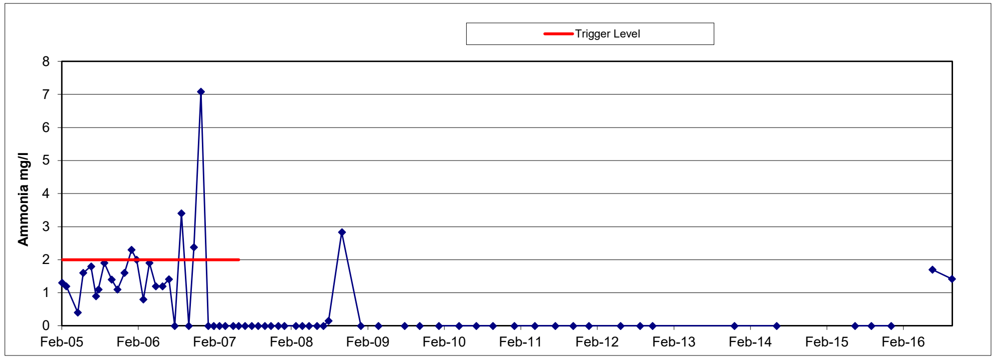

Alkalinity mg/l CaCO3
700
600
500
400
300
200
100
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

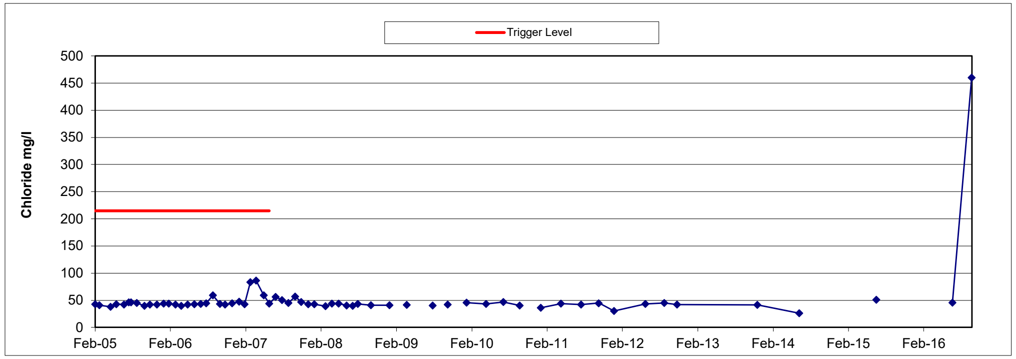

Sodium
Sulphate
Potassium
Magnesium
mg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

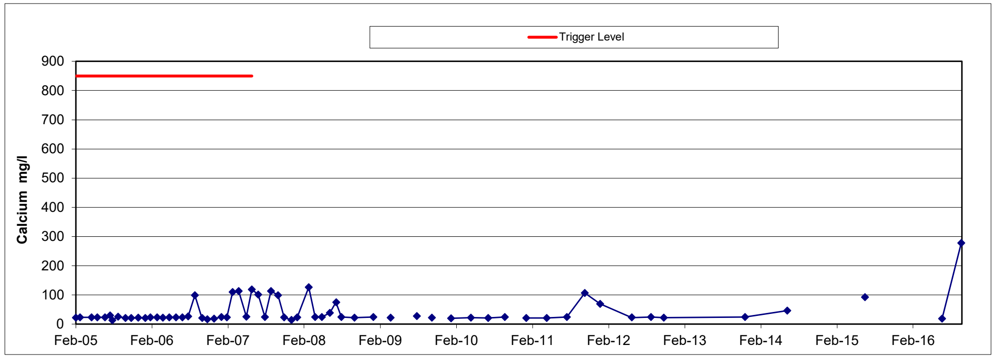

Nitrate
Nitrite
Phosphate
mg/l
400
350
300
250
200
150
100
50
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

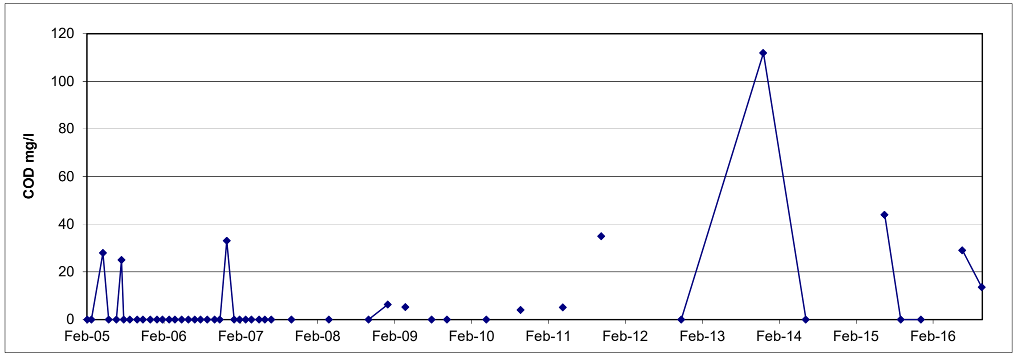

Water Level / mAOD
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

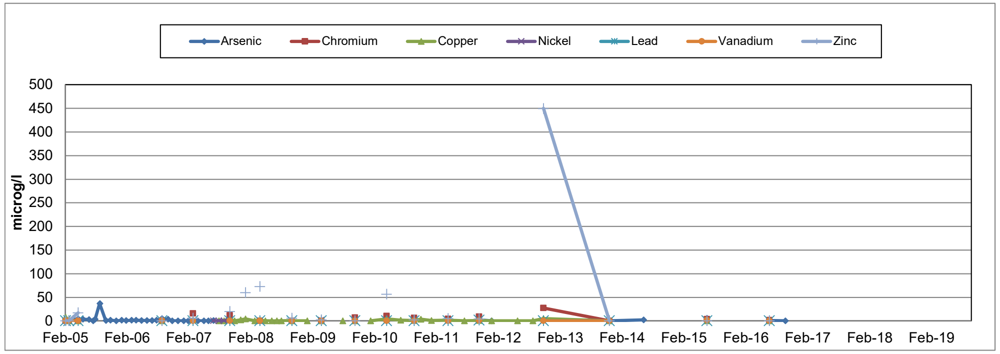

pH
EC microS/cm
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
2000
1800
1600
1400
1200
1000
800
600
400
200
0
pH
EC
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

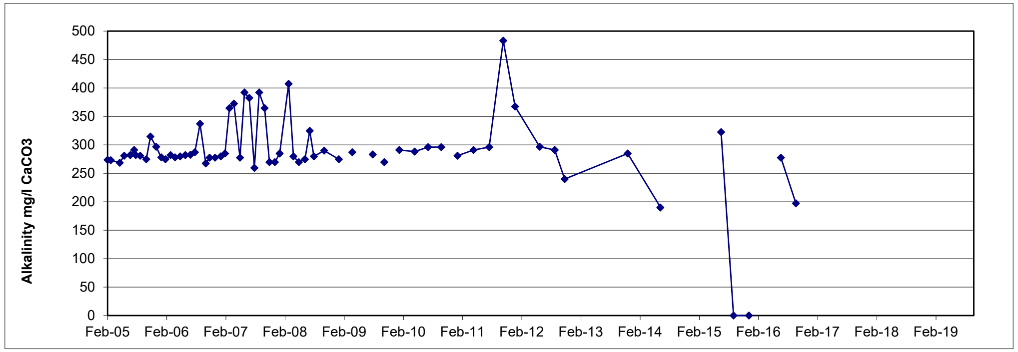

Trigger Level
Ammonia mg/l
8
7
6
5
4
3
2
1
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

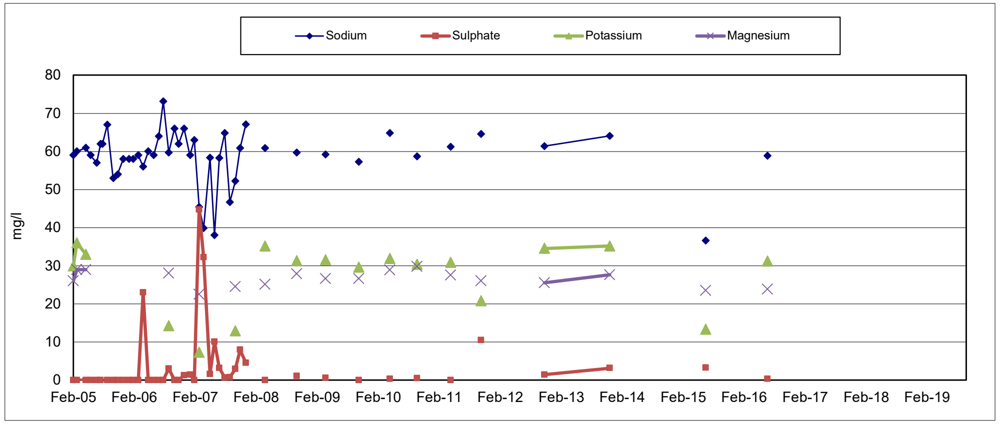

Trigger Level
Chloride mg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

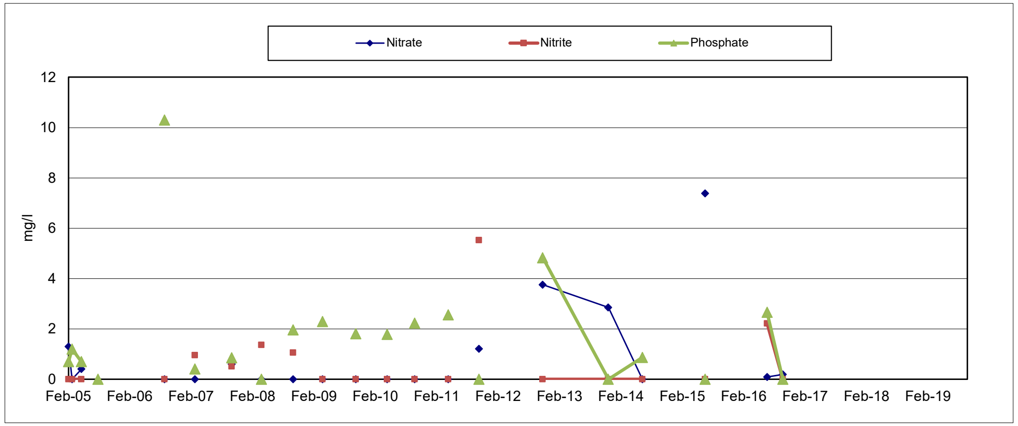

Trigger Level
Calcium mg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

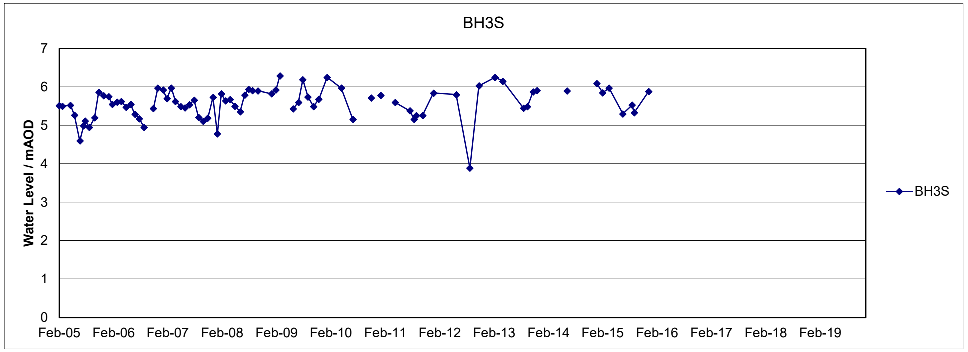

COD mg/l
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16

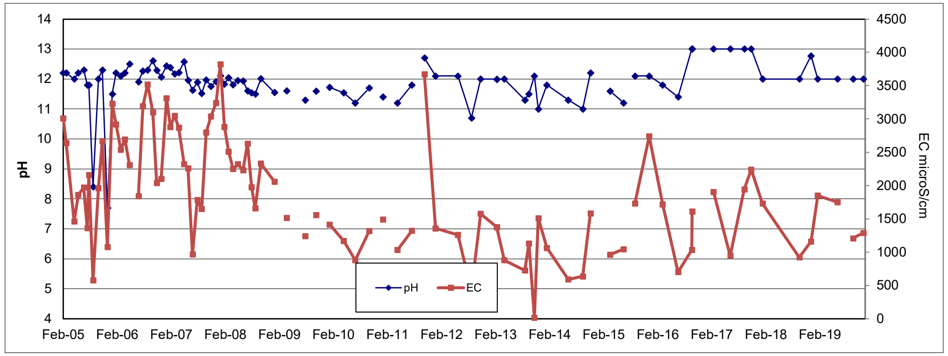

Arsenic
Chromium
Copper
Nickel
Lead
Vanadium
Zinc
microg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

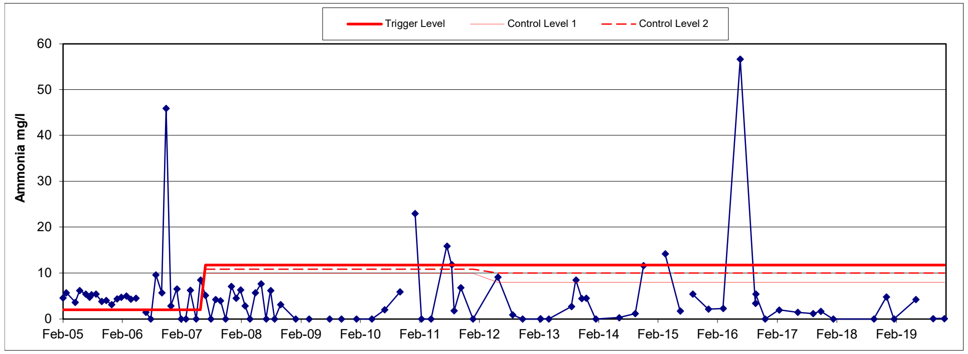

Alkalinity mg/l CaCO3
500
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

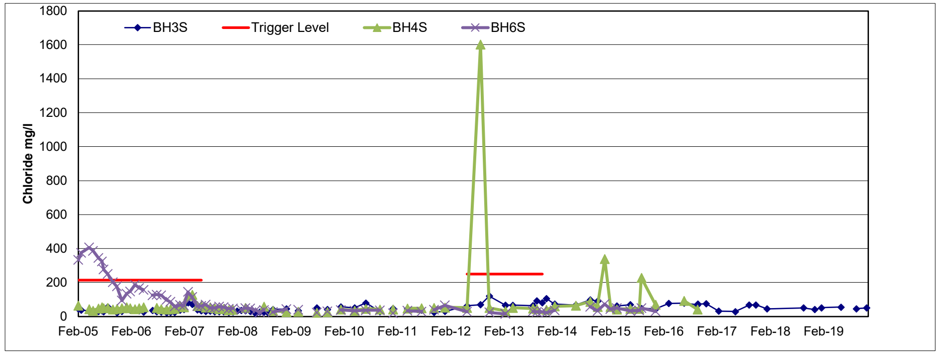

Sodium
Sulphate
Potassium
Magnesium
mg/l
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

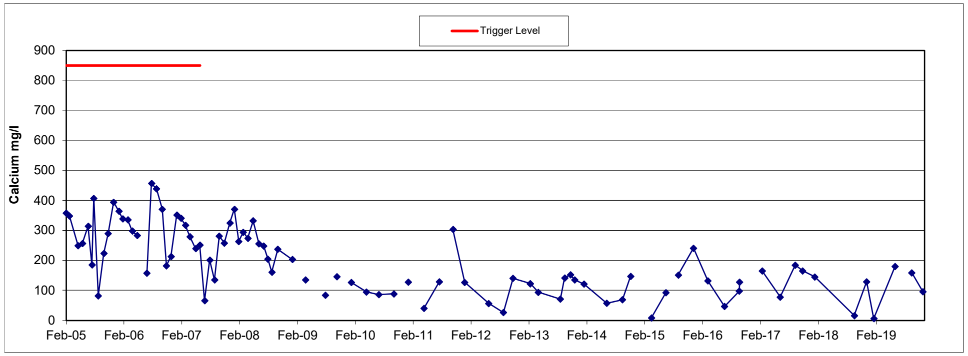

Nitrate
Nitrite
Phosphate
mg/l
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

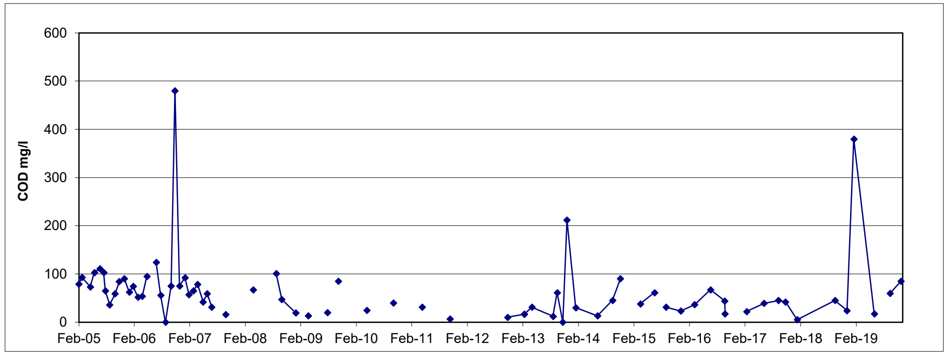

BH3S
Water Level / mAOD
0 1 2 3 4 5 6 7
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19
BH3S

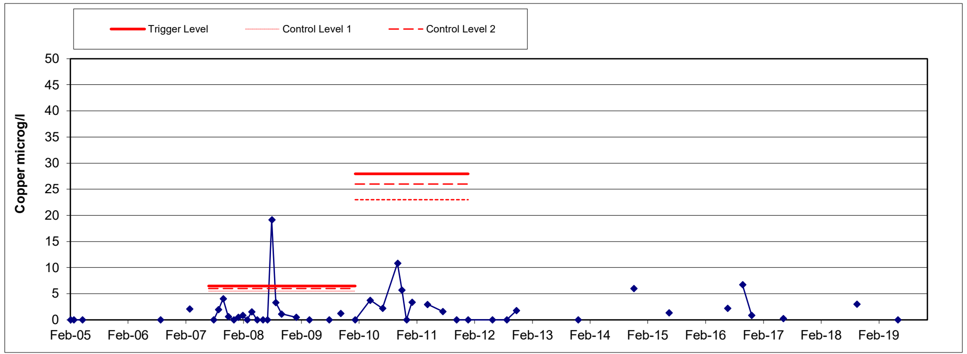

pH
4 5 6 7 8 9 10 11 12 13 14
EC microS/cm
0 500 1000 1500 2000 2500 3000 3500 4000 4500
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19
pH
EC

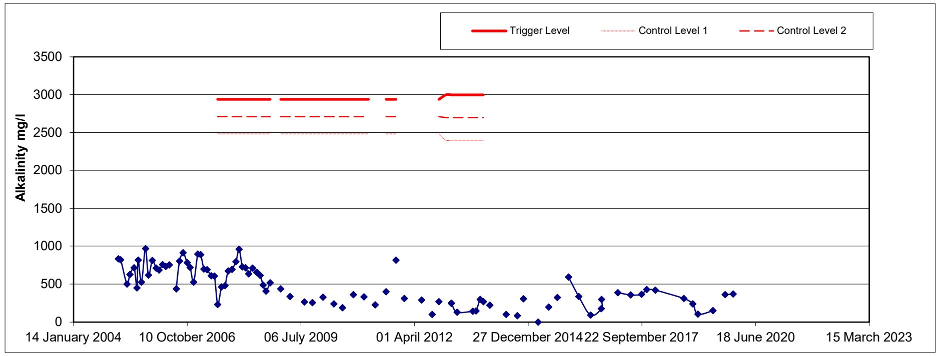

Trigger Level
Control Level 1
Control Level 2
Ammonia mg/l
0 10 20 30 40 50 60
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

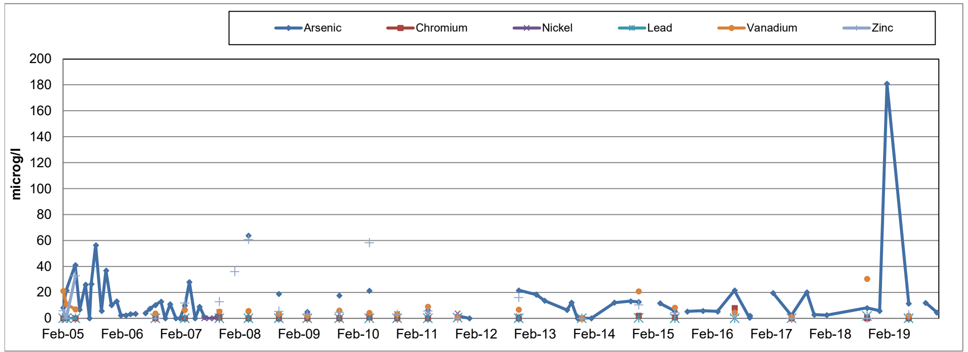

BH3S
Trigger Level
BH4S
BH6S
Chloride mg/l
0 200 400 600 800 1000 1200 1400 1600 1800
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

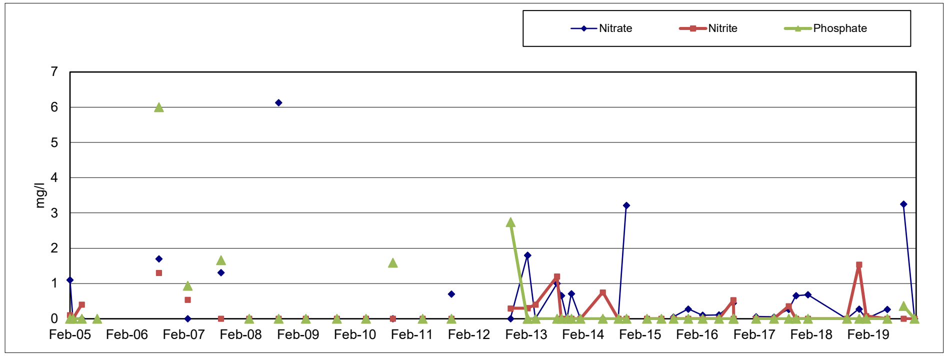

Trigger Level
Calcium mg/l
0 100 200 300 400 500 600 700 800 900
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

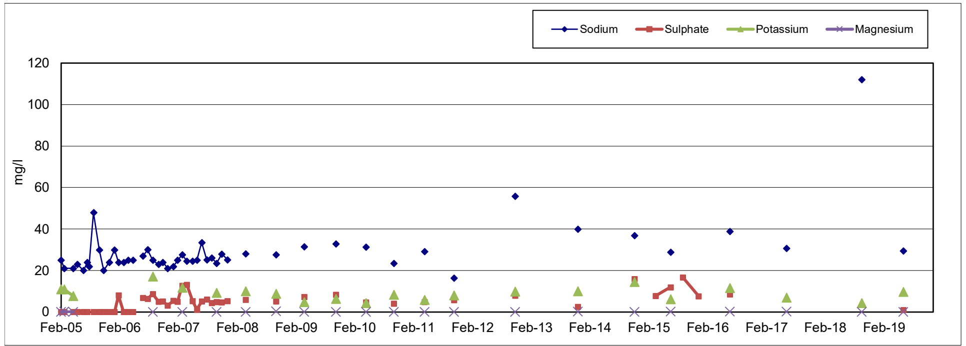

COD mg/l
0 100 200 300 400 500 600
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

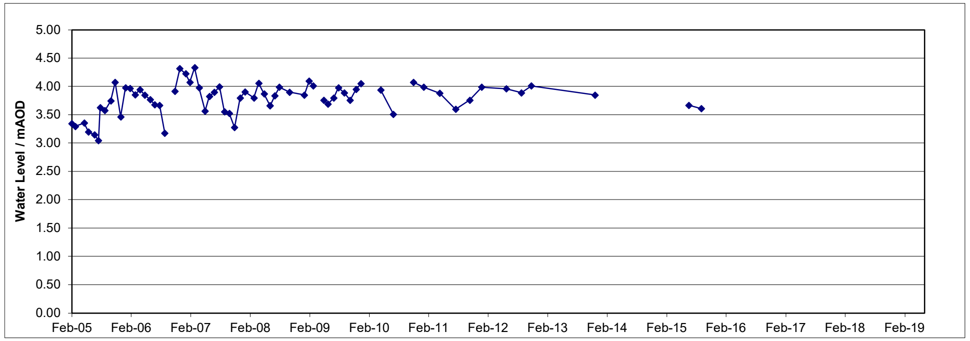

Trigger Level
Control Level 1
Control Level 2
Copper microg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

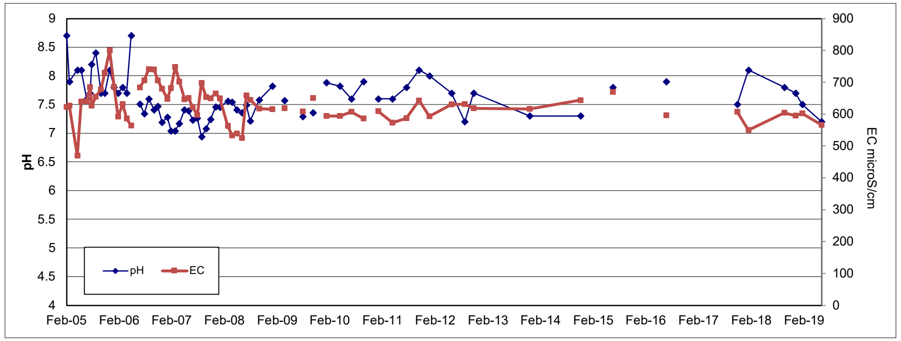

Trigger Level
Control Level 1
Control Level 2
Alkalinity mg/l
14 January 2004 10 October 2006 06 July 2009 01 April 2012 27 December 2014 22 September 2017 18 June 2020 15 March 2023

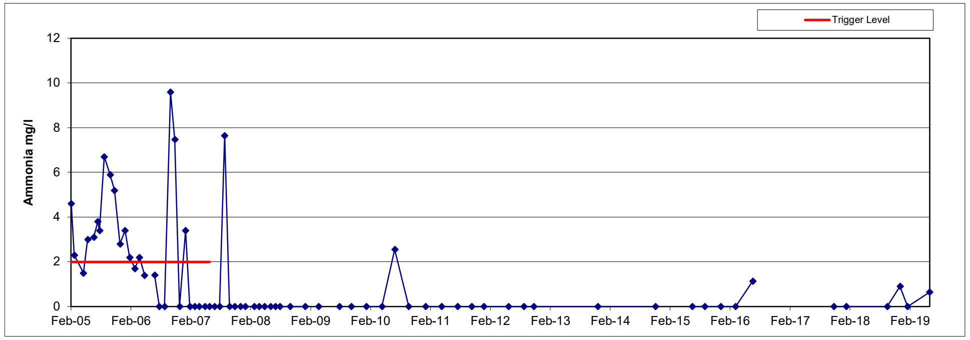

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

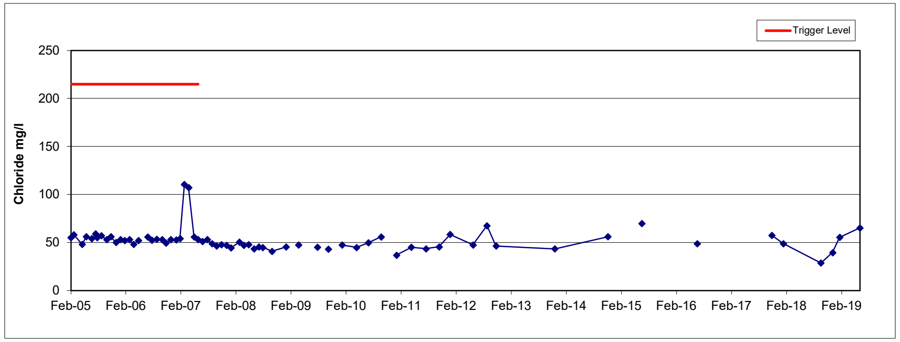

Nitrate
Nitrite
Phosphate
mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

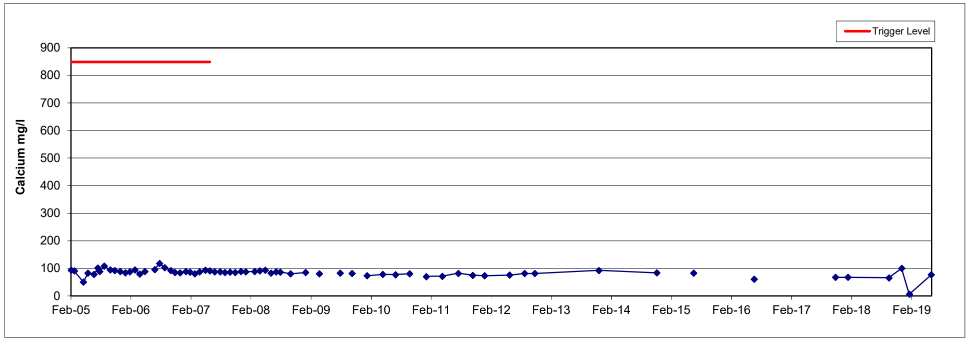

Sodium
Sulphate
Potassium
Magnesium
mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

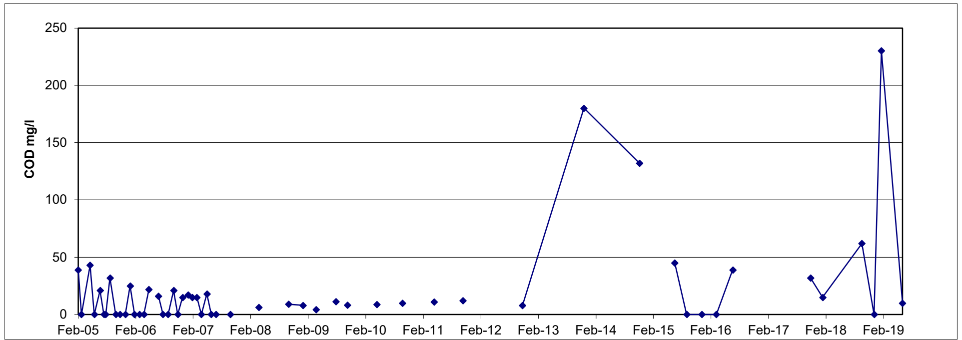

Water Level / mAOD
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

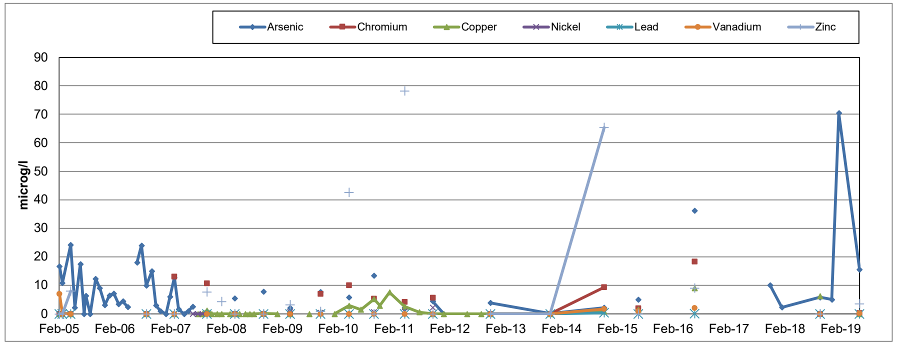

pH
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
EC microS/cm
900
800
700
600
500
400
300
200
100
0
pH
EC
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

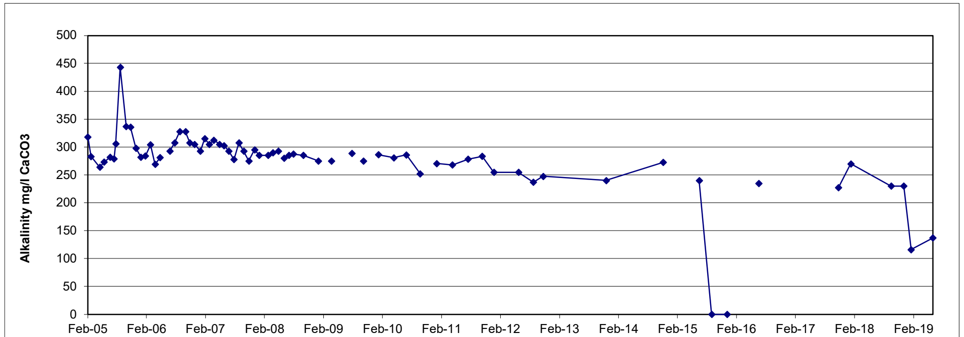

Trigger Level
Ammonia mg/l
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

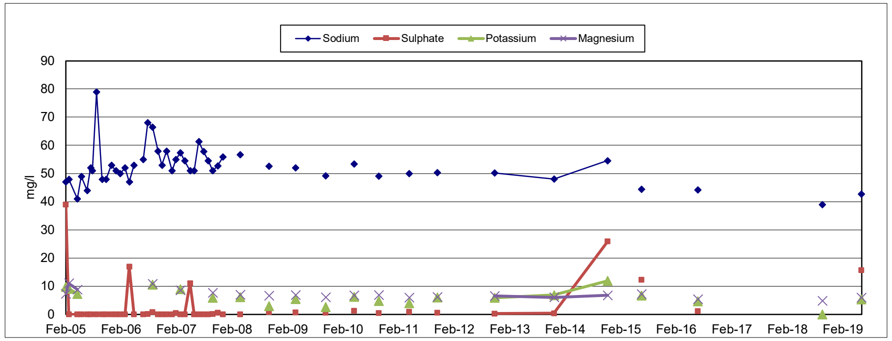

Trigger Level
Chloride mg/l
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

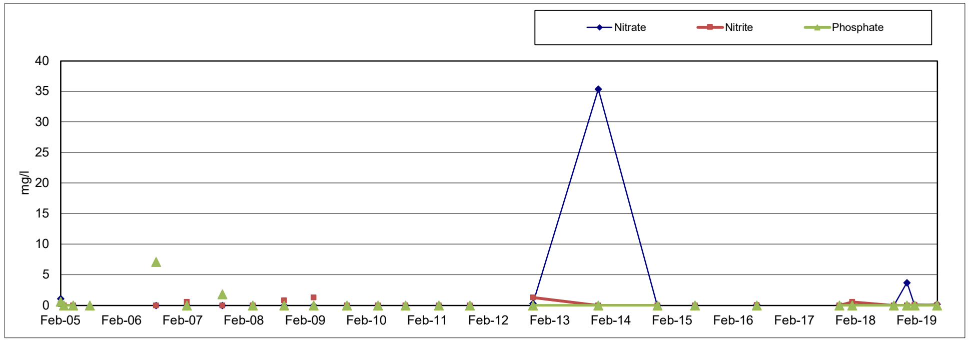

Trigger Level
Calcium mg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

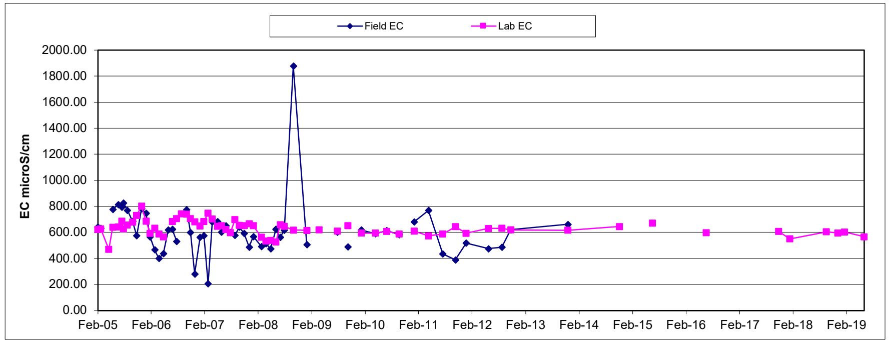

COD mg/l
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

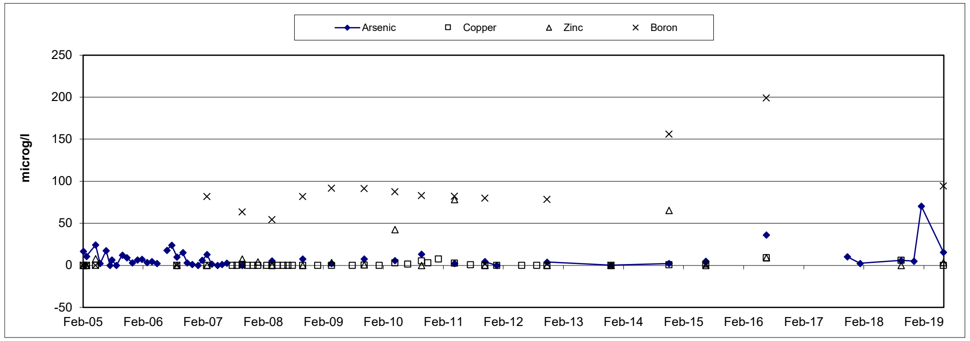

Arsenic Chromium Copper Nickel Lead Vanadium Zinc
microg/l
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

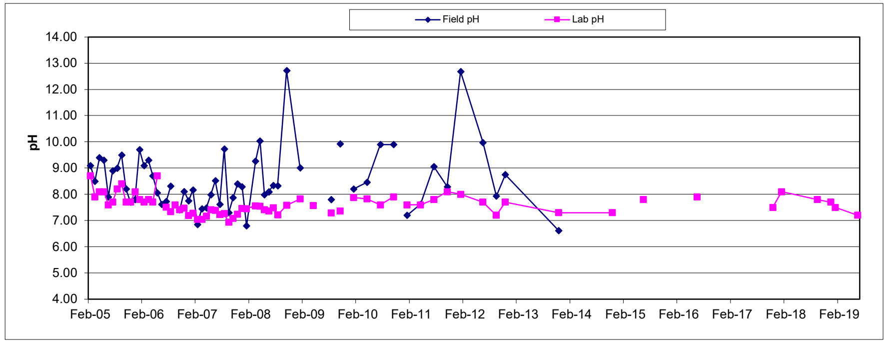

Alkalinity mg/l CaCO3
500
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

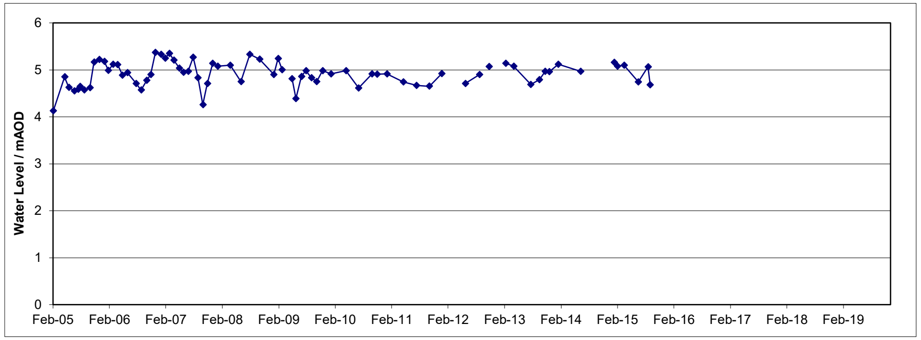

Sodium Sulphate Potassium Magnesium
mg/l
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

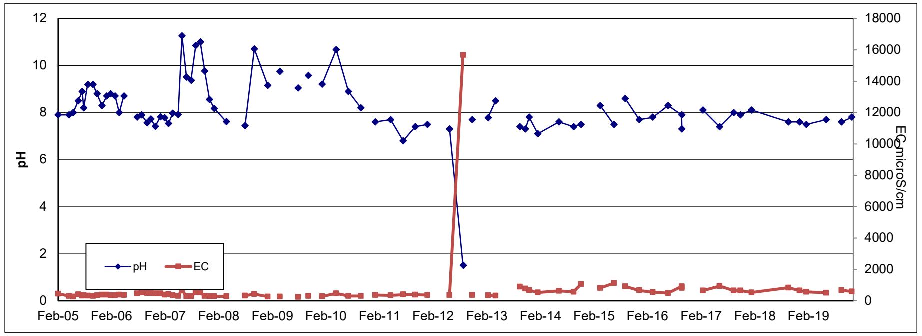

Nitrate
Nitrite
Phosphate
mg/l
40
35
30
25
20
15
10
5
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

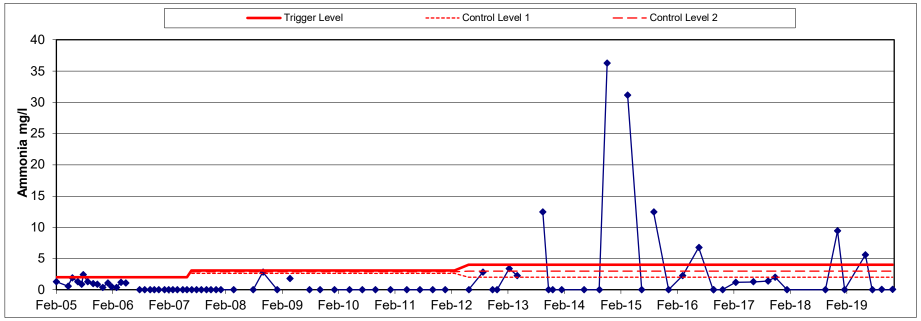

Field EC
Lab EC
EC microS/cm
2000.00
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

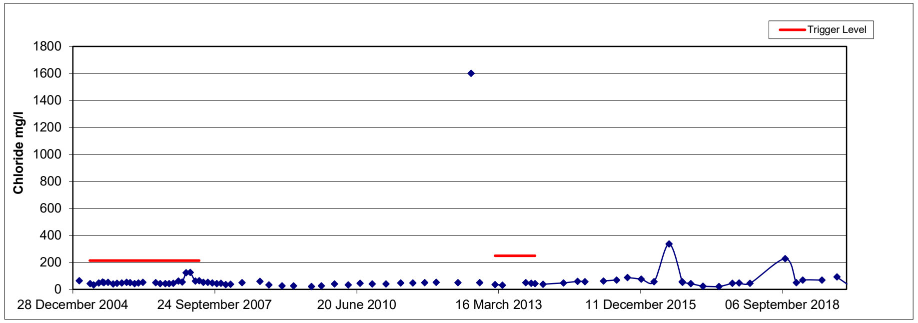

Arsenic
Copper
Zinc
Boron
microg/l
250
200
150
100
50
0
-50
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

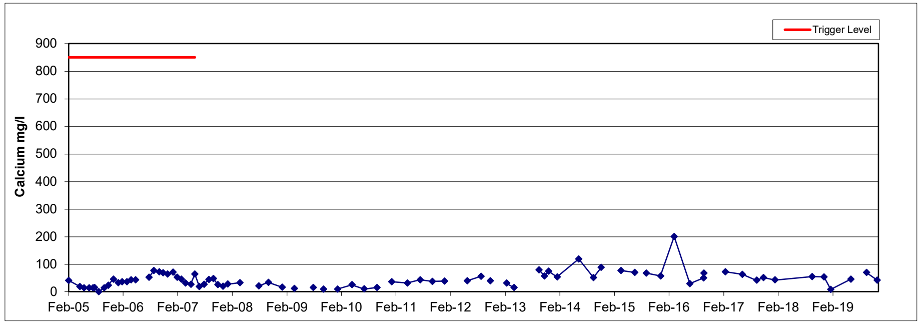

Field pH
Lab pH
pH
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

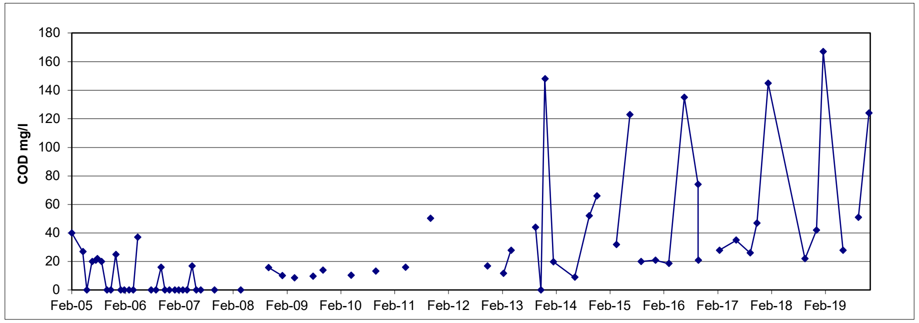

Water Level / mAOD
0
1
2
3
4
5
6
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

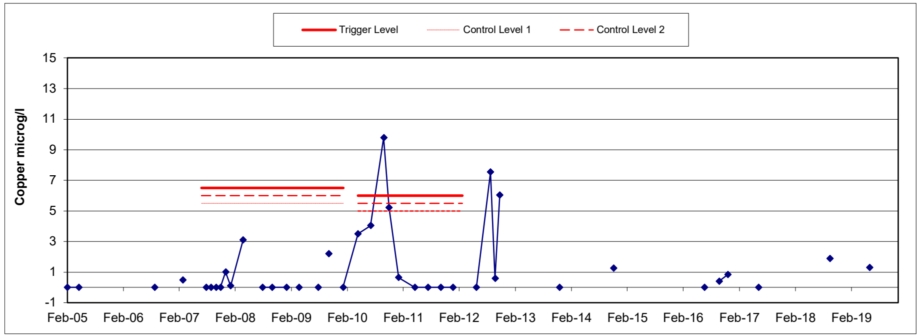

pH
EC microS/cm
pH
EC
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

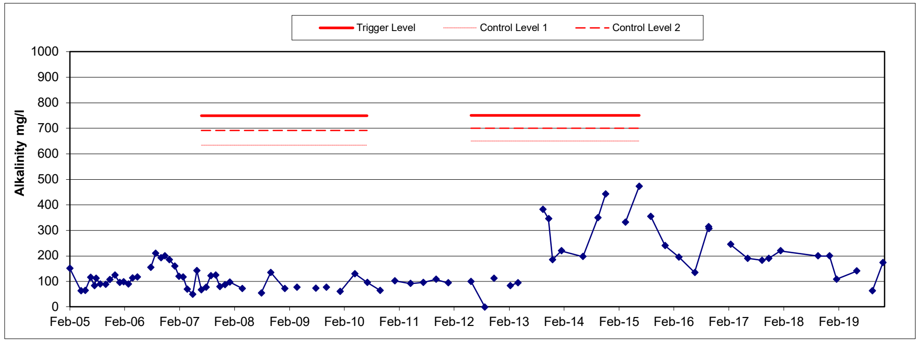

Trigger Level
Control Level 1
Control Level 2
Ammonia mg/l
0
5
10
15
20
25
30
35
40
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

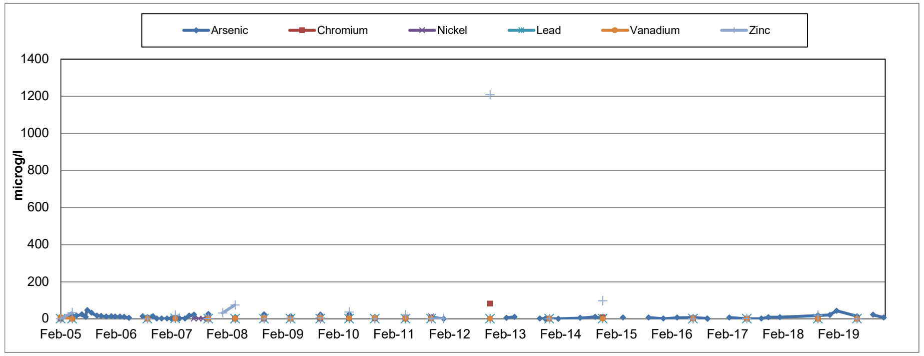

Trigger Level
Chloride mg/l
0
200
400
600
800
1000
1200
1400
1600
1800
28 December 2004 24 September 2007 20 June 2010 16 March 2013 11 December 2015 06 September 2018

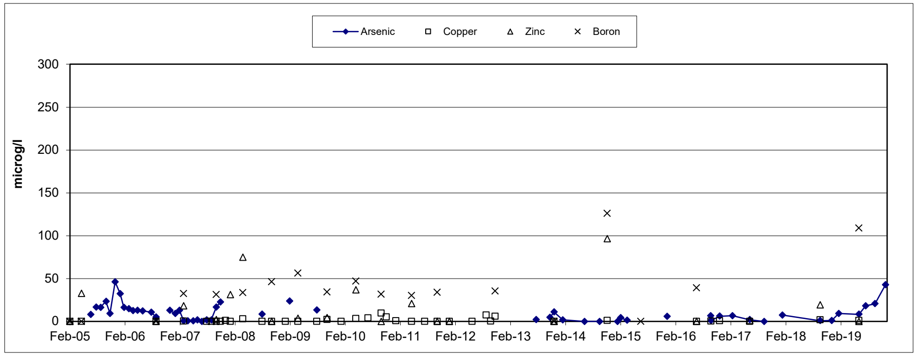

Trigger Level
Calcium mg/l
0
100
200
300
400
500
600
700
800
900
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

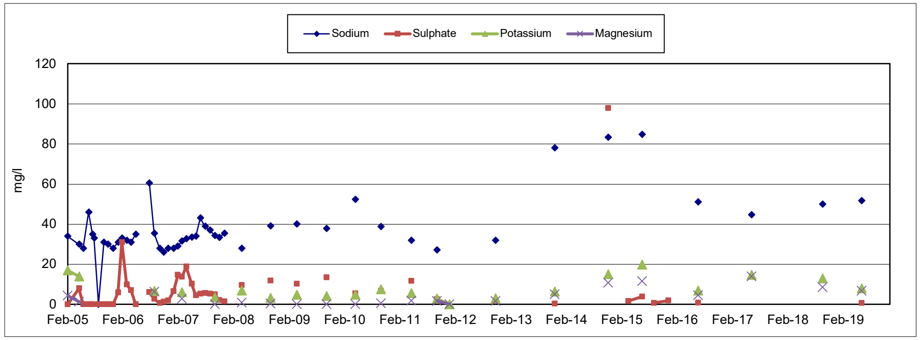

COD mg/l
0
20
40
60
80
100
120
140
160
180
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

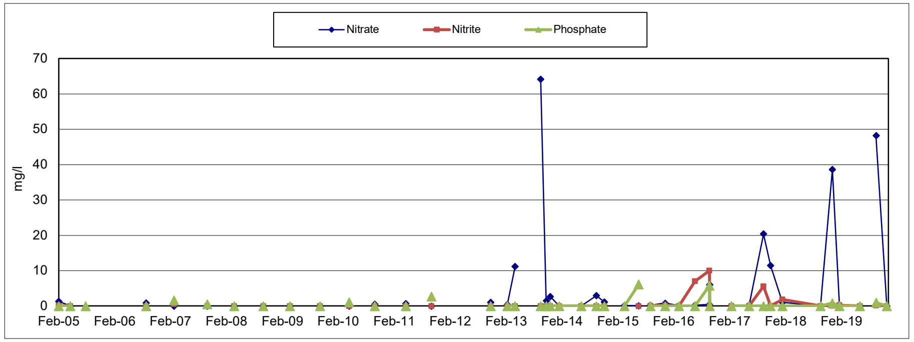

Trigger Level
Control Level 1
Control Level 2
Copper microg/l
15
13
11
9
7
5
3
1
-1
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

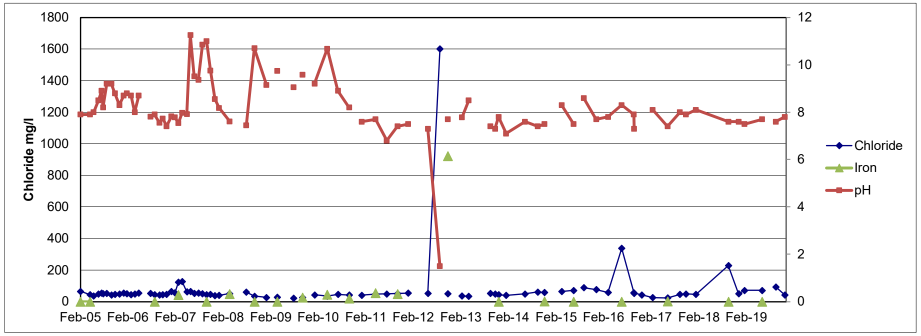

Trigger Level
Control Level 1
Control Level 2
Alkalinity mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

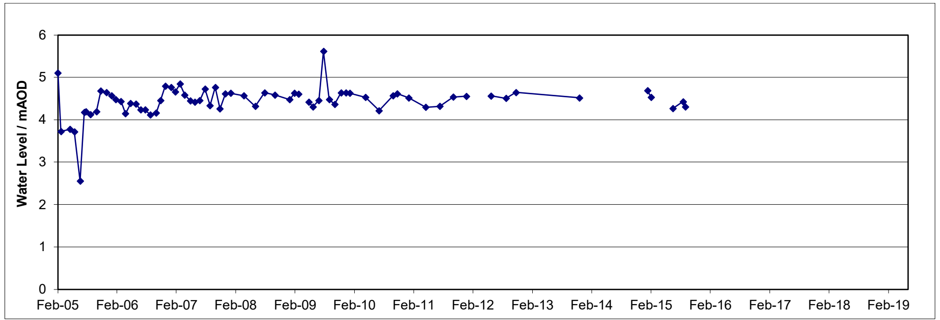

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
1400
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

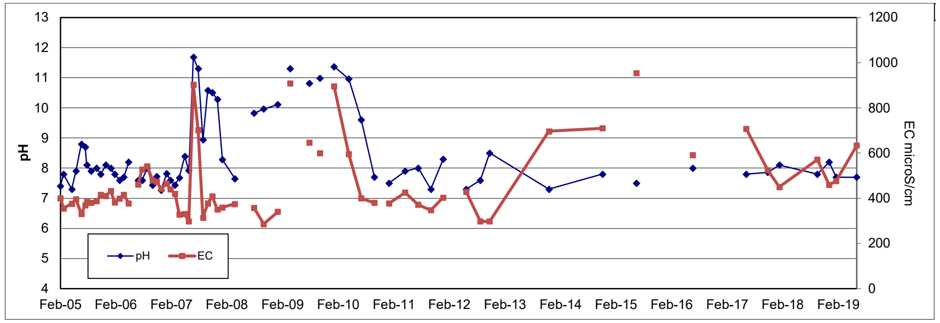

Arsenic
Copper
Zinc
Boron
microg/l
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

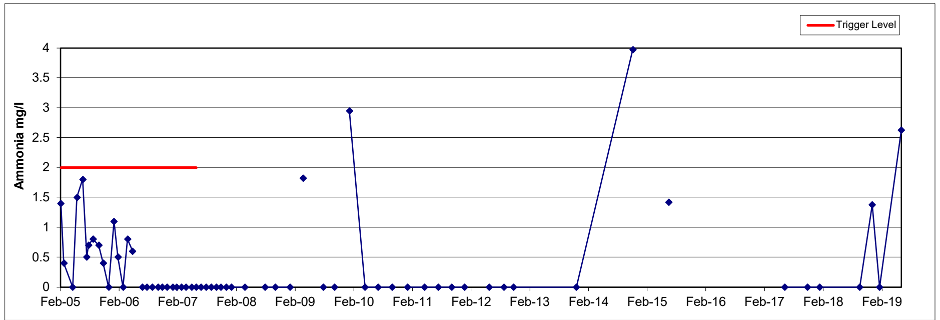

Sodium
Sulphate
Potassium
Magnesium
mg/l
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

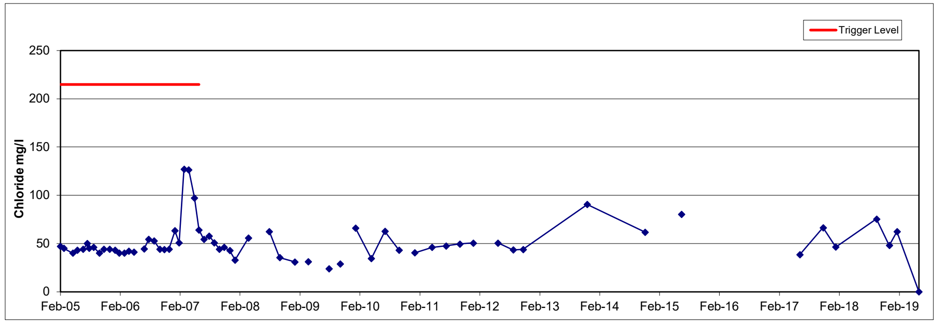

Nitrate
Nitrite
Phosphate
mg/l
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

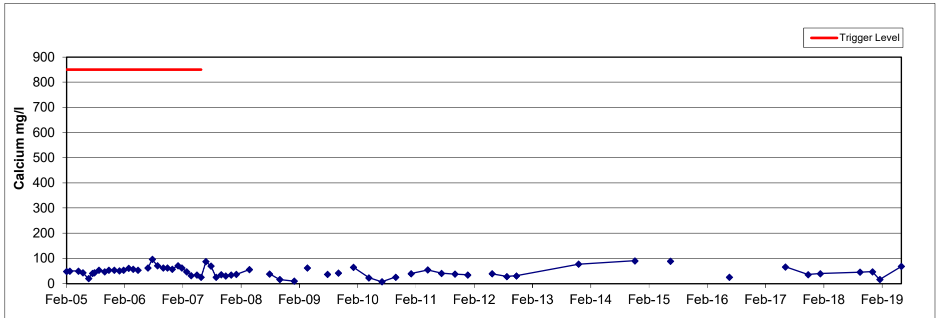

Chloride mg/l
1800
1600
1400
1200
1000
800
600
400
200
0
12
10
8
6
4
2
0
Chloride
Iron
pH
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

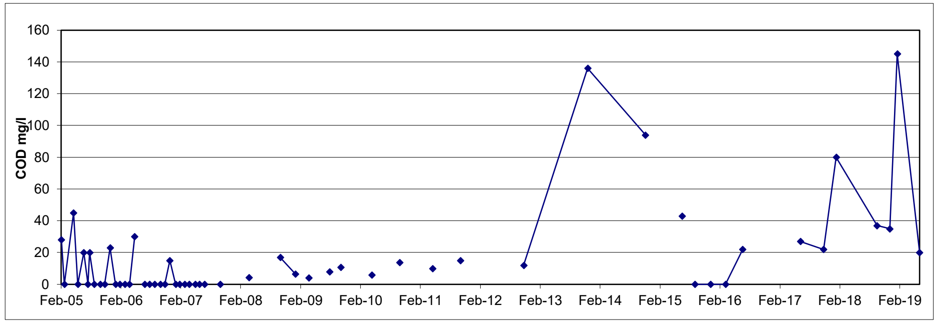

Water Level / mAOD
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

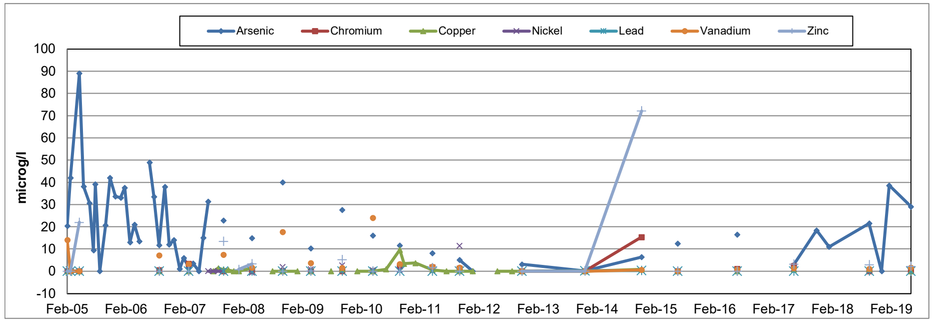

pH
EC microS/cm
pH
EC
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

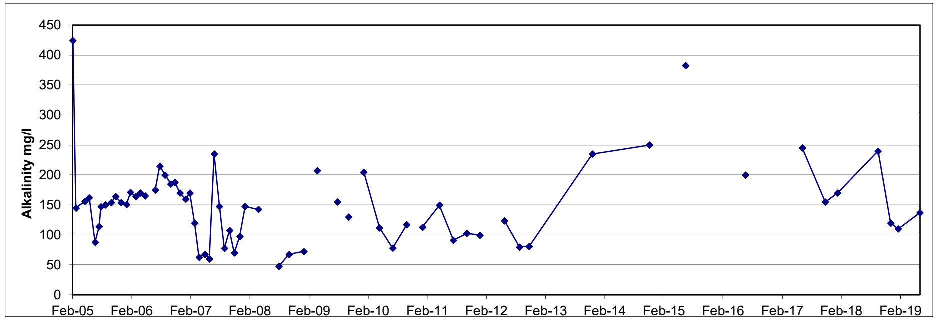

Trigger Level
Ammonia mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

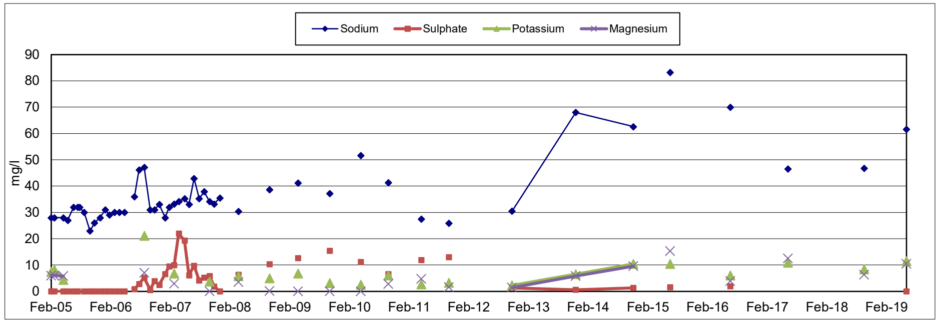

Trigger Level
Chloride mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

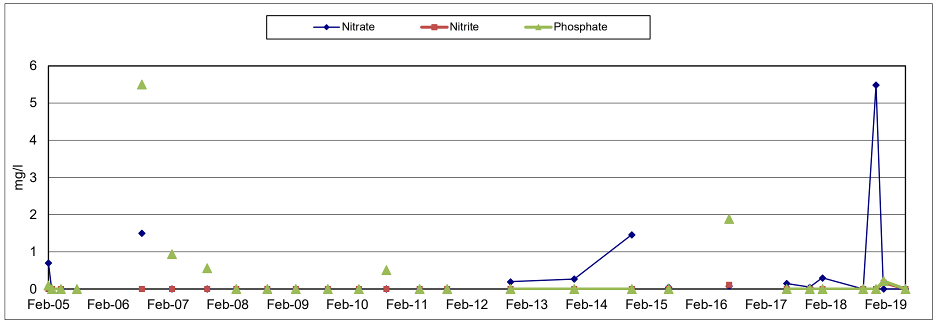

Trigger Level
Calcium mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

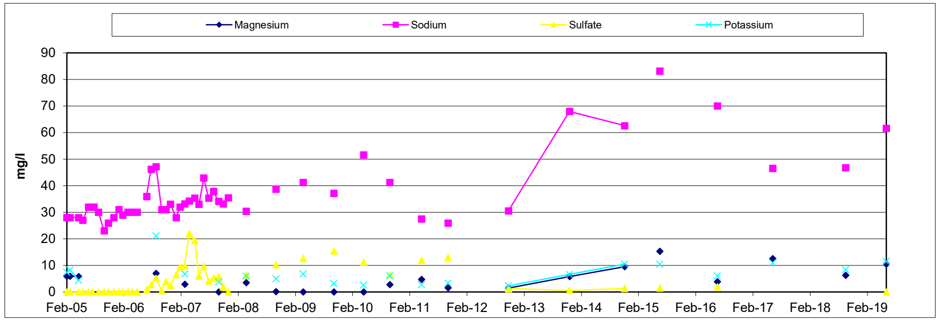

COD mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

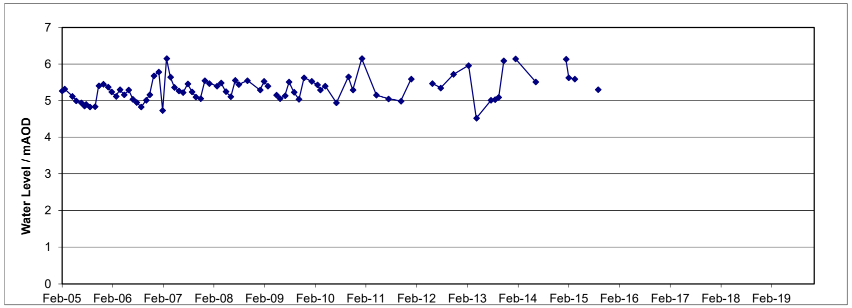

Arsenic
Chromium
Copper
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
-10
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

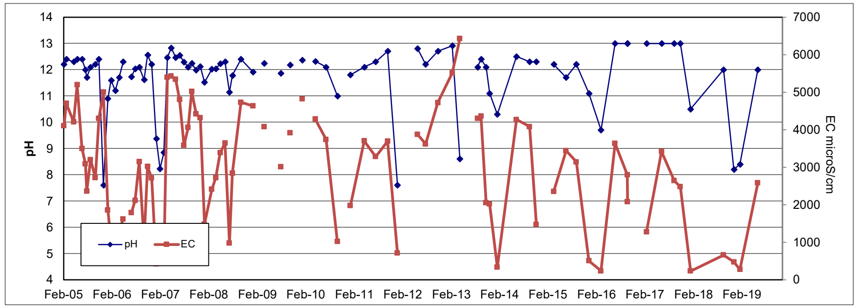

Alkalinity mg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

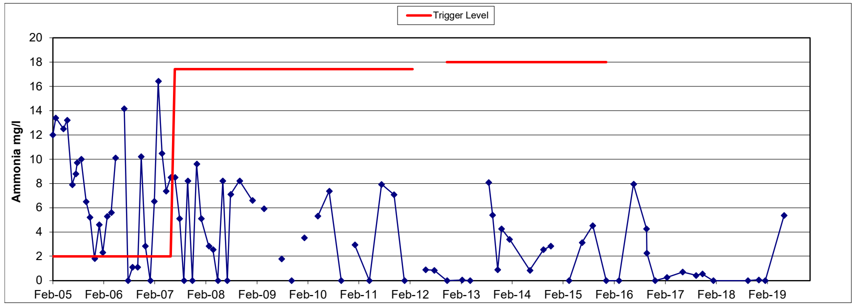

Sodium
Sulphate
Potassium
Magnesium
mg/l
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

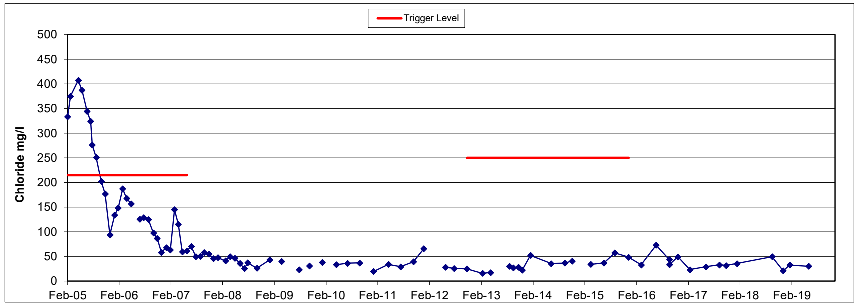

Nitrate
Nitrite
Phosphate
mg/l
6
5
4
3
2
1
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

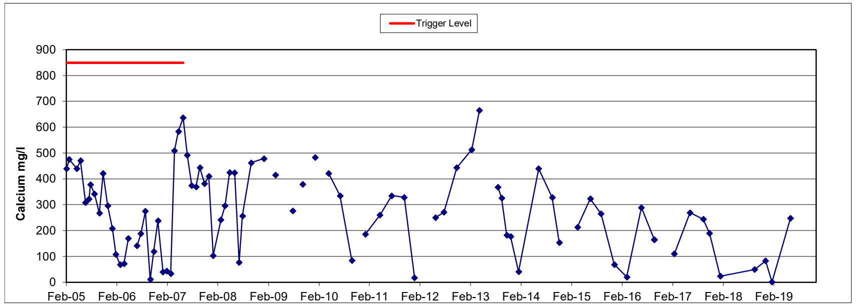

Magnesium
Sodium
Sulfate
Potassium
mg/l
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

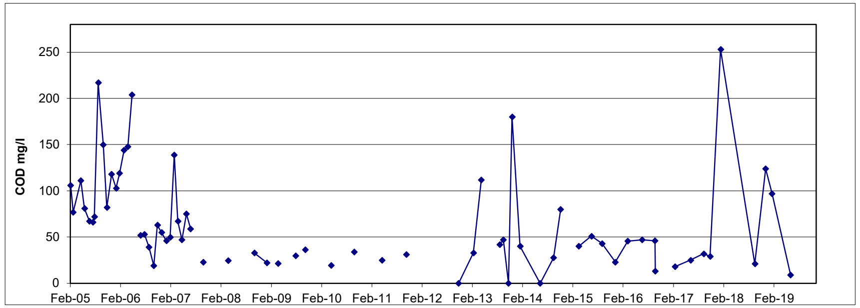

Water Level / mAOD
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

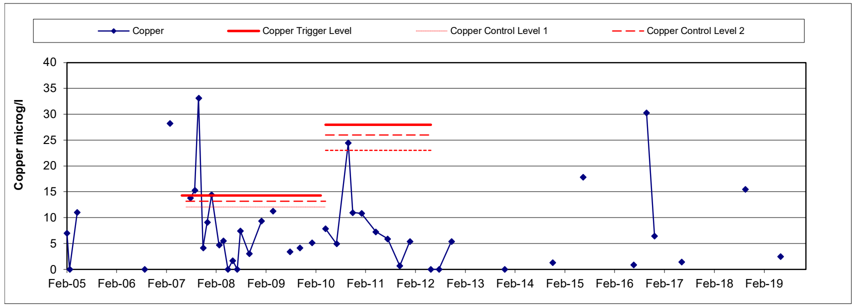

pH
EC microS/cm
pH
EC

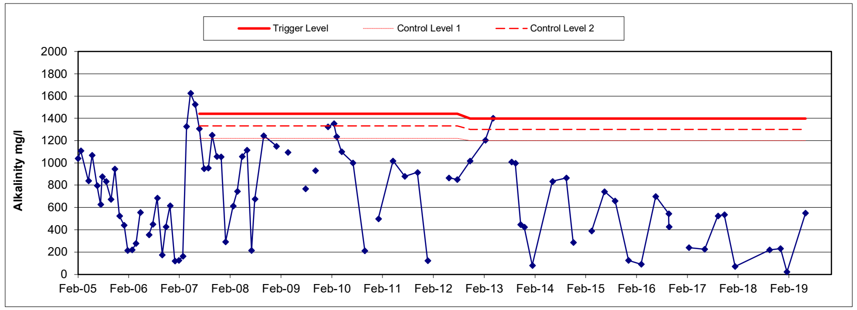

Trigger Level
Ammonia mg/l

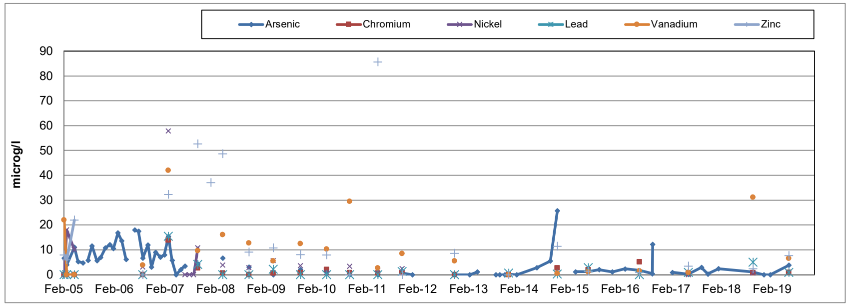

Trigger Level
Chloride mg/l

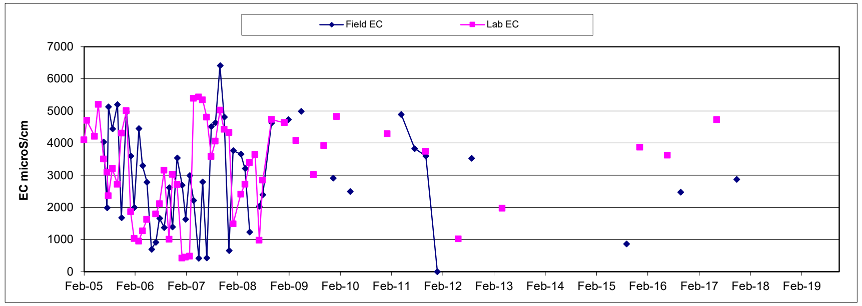

Trigger Level
Calcium mg/l

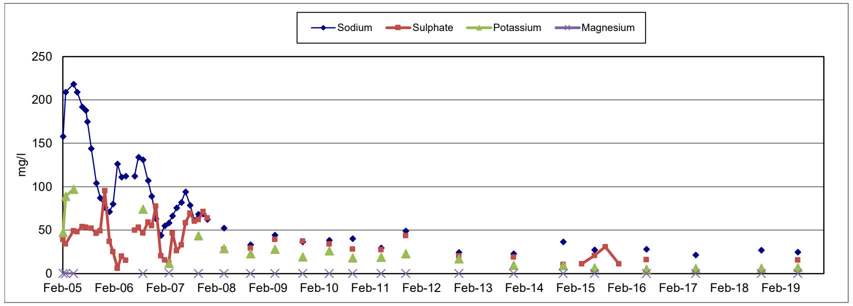

COD mg/l

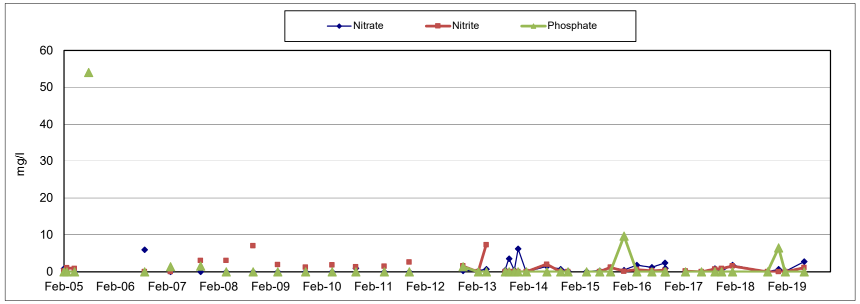

Copper
Copper Trigger Level
Copper Control Level 1
Copper Control Level 2
Copper microg/l
0
5
10
15
20
25
30
35
40
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

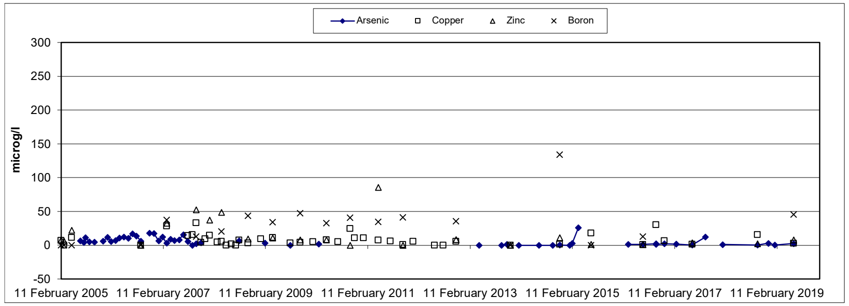

Trigger Level
Control Level 1
Control Level 2
Alkalinity mg/l
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

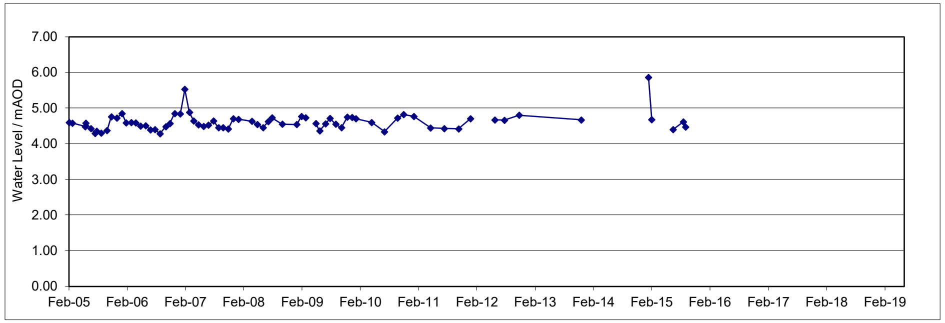

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
0
10
20
30
40
50
60
70
80
90
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

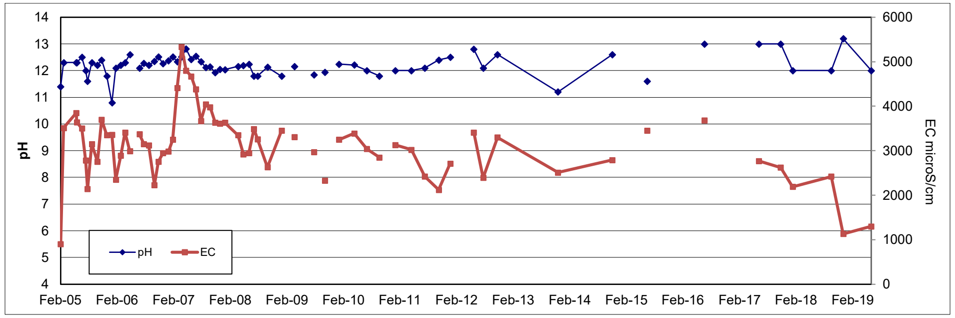

Field EC
Lab EC
EC microS/cm
0
1000
2000
3000
4000
5000
6000
7000
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

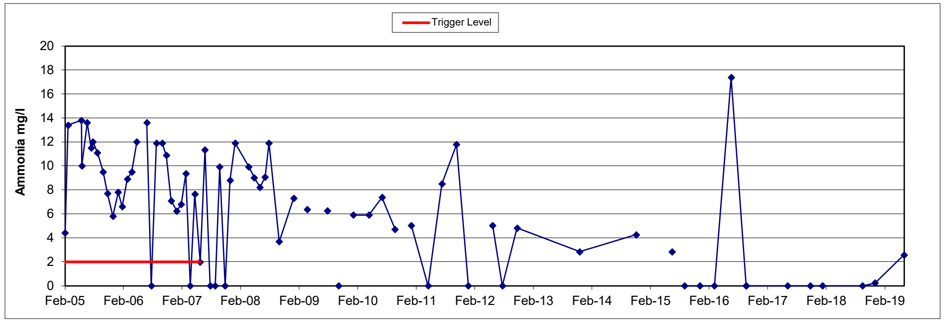

Sodium
Sulphate
Potassium
Magnesium
mg/l
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

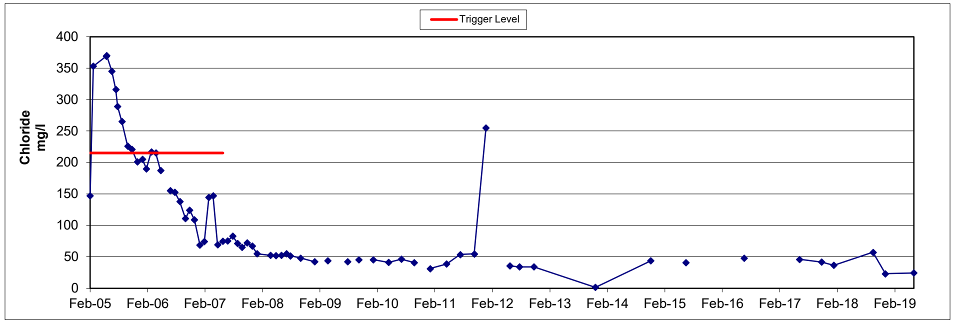

Nitrate
Nitrite
Phosphate
mg/l
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

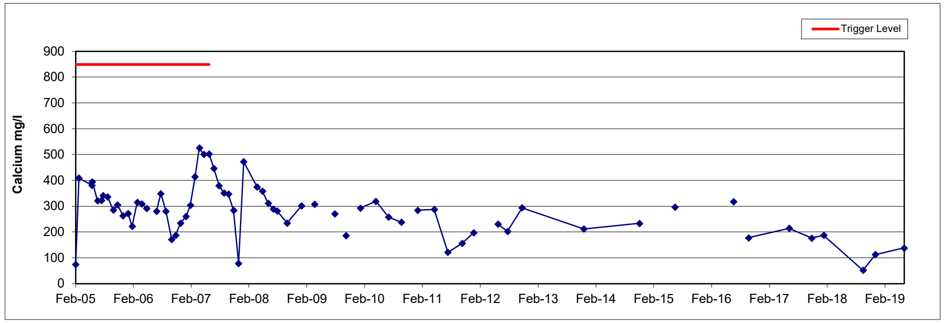

Arsenic
Copper
Zinc
Boron
microg/l
300
250
200
150
100
50
0
-50
11 February 2005 11 February 2007 11 February 2009 11 February 2011 11 February 2013 11 February 2015 11 February 2017 11 February 2019

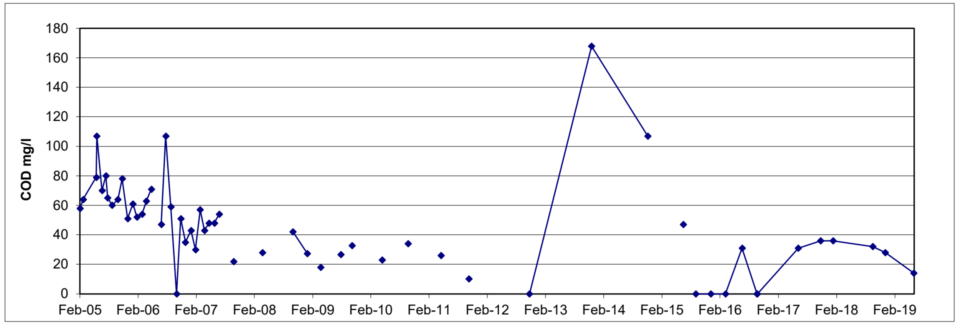

Water Level / mAOD
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

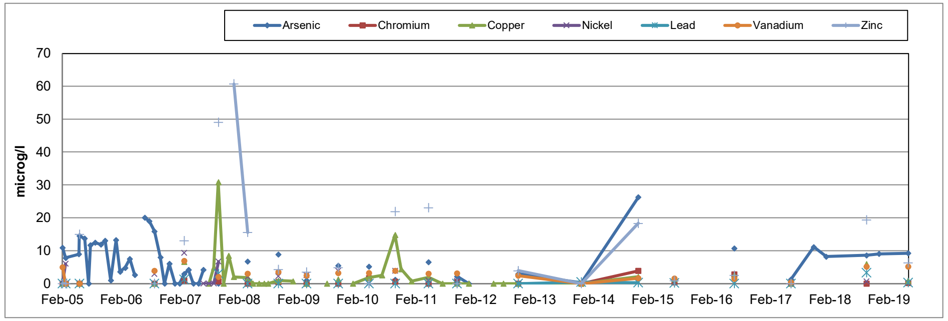

pH
EC microS/cm
pH
EC
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

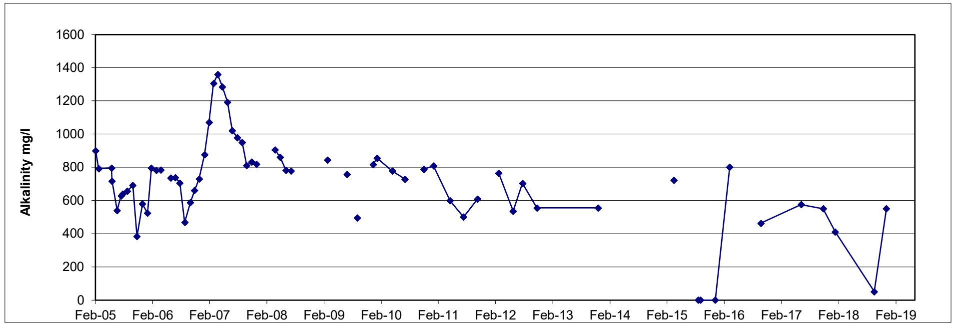

Trigger Level
Ammonia mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

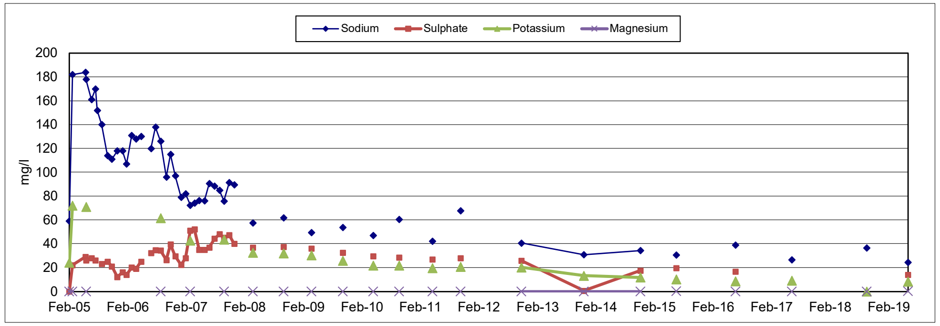

Trigger Level
Chloride mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

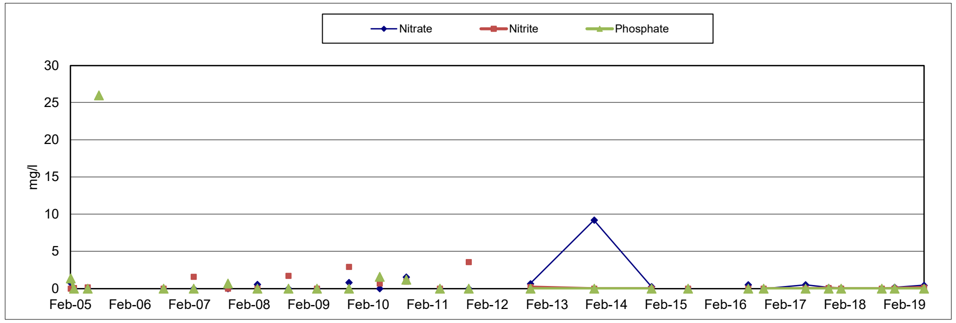

Trigger Level
Calcium mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

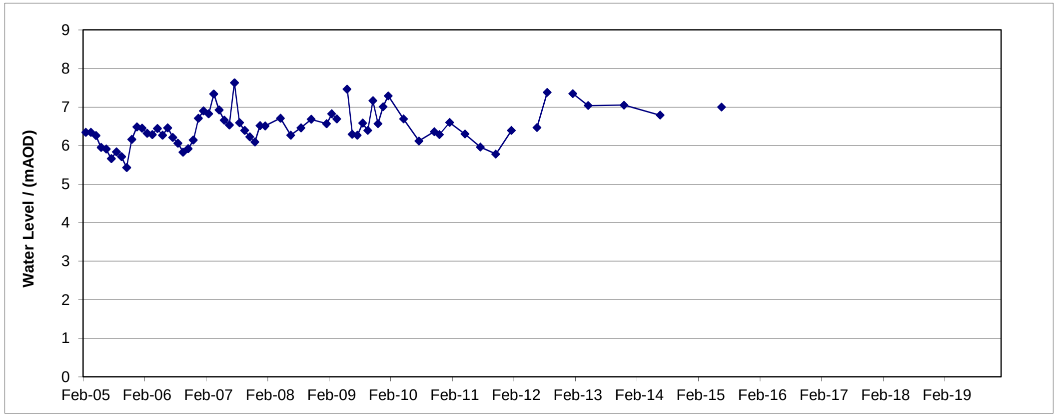

COD mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

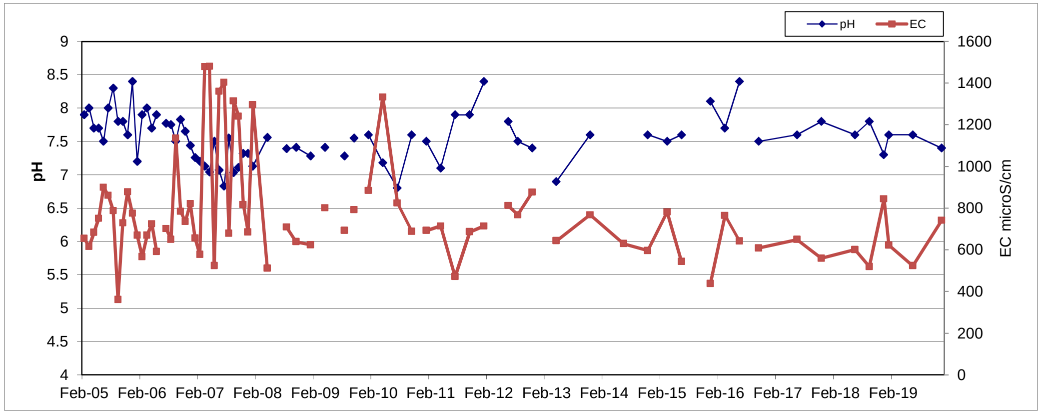

Arsenic
Chromium
Copper
Nickel
Lead
Vanadium
Zinc
microg/l
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

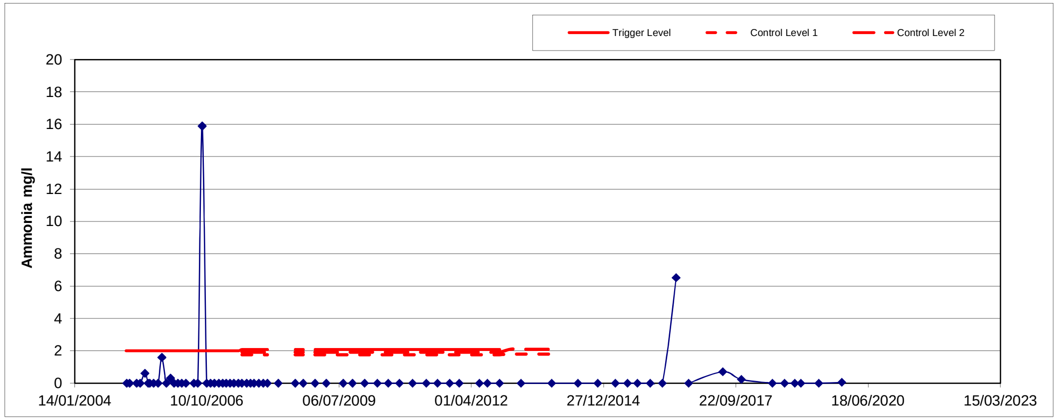

Alkalinity mg/l
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

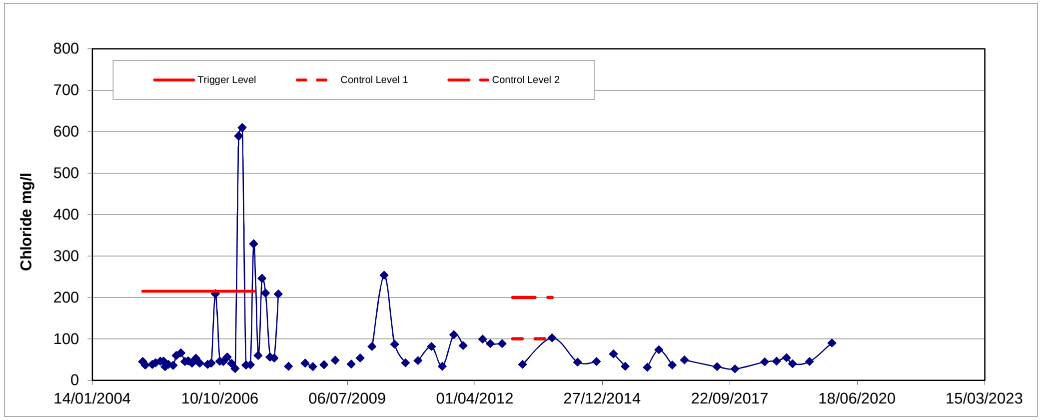

Sodium
Sulphate
Potassium
Magnesium
mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

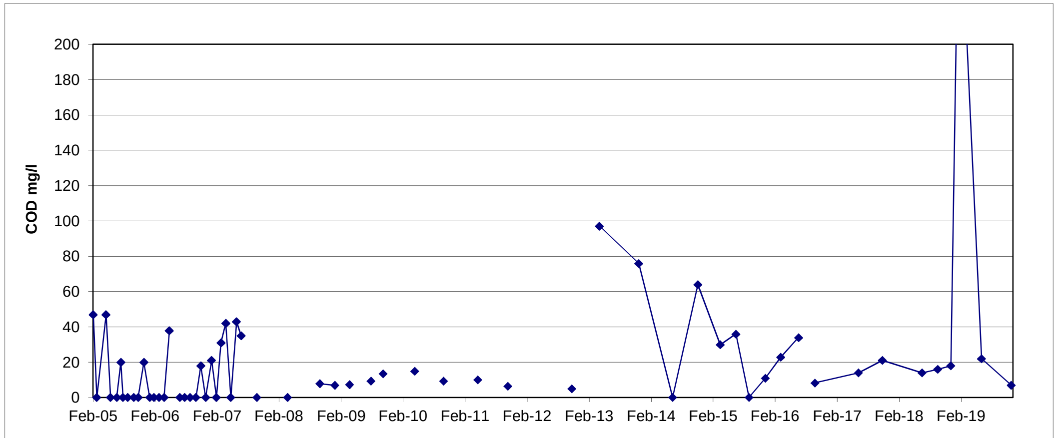

Nitrate
Nitrite
Phosphate
mg/l
30
25
20
15
10
5
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

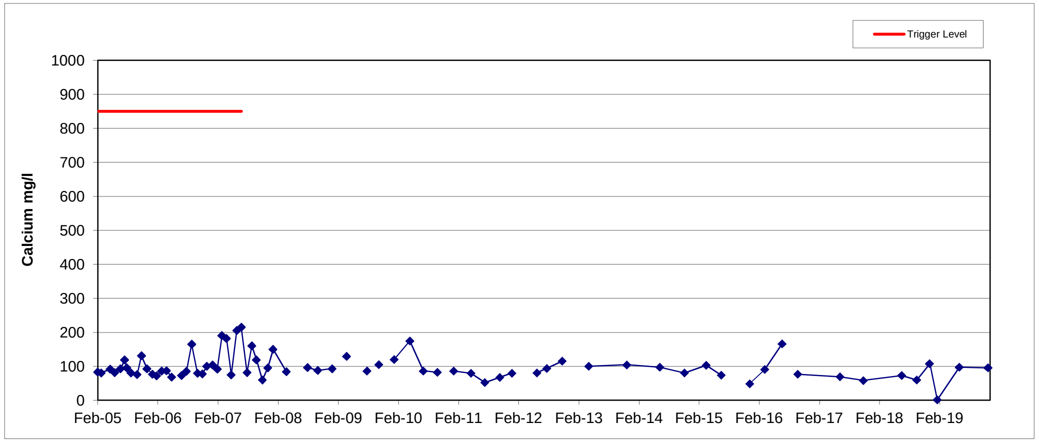

Water Level / (mAOD)
0
1
2
3
4
5
6
7
8
9
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

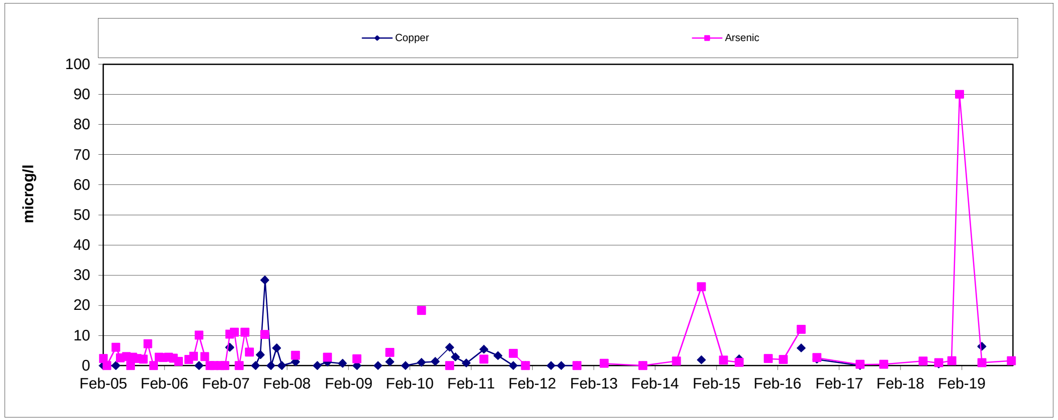

pH
EC
pH
EC microS/cm
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
0
200
400
600
800
1000
1200
1400
1600
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

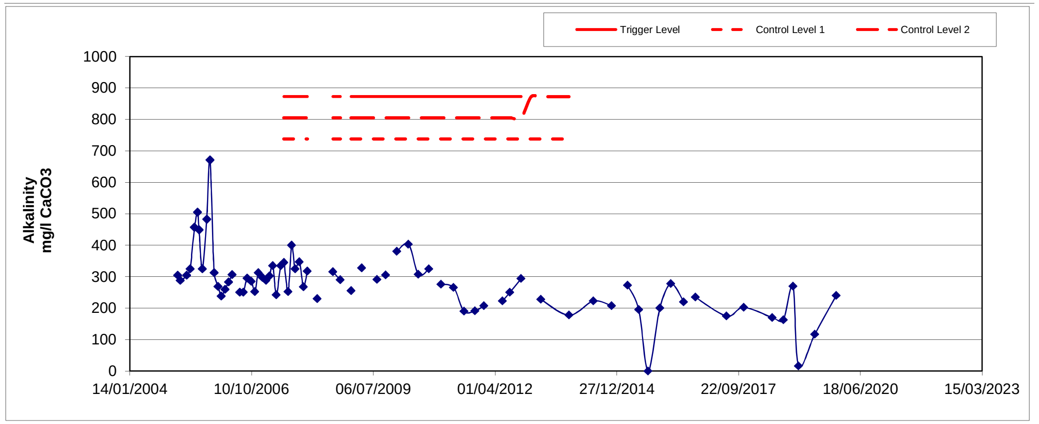

Trigger Level
Control Level 1
Control Level 2
Ammonia mg/l
0
2
4
6
8
10
12
14
16
18
20
14/01/2004 10/10/2006 06/07/2009 01/04/2012 27/12/2014 22/09/2017 18/06/2020 15/03/2023

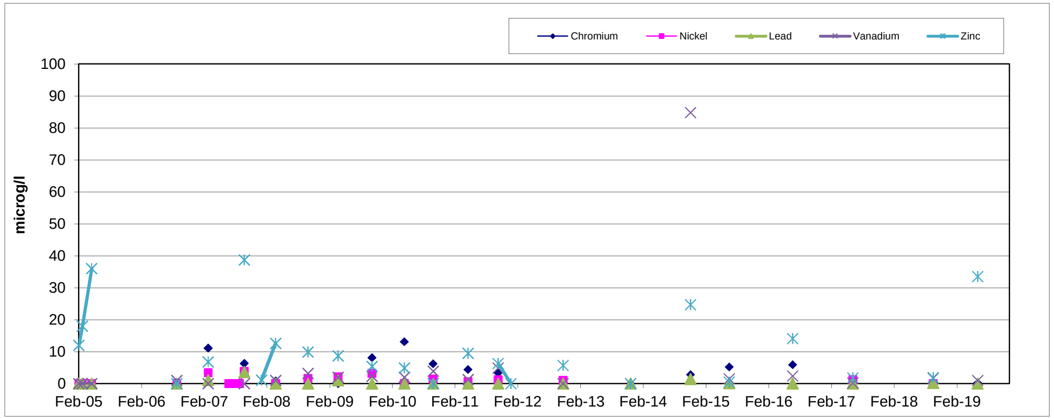

Trigger Level
Control Level 1
Control Level 2
Chloride mg/l
0
100
200
300
400
500
600
700
800
14/01/2004 10/10/2006 06/07/2009 01/04/2012 27/12/2014 22/09/2017 18/06/2020 15/03/2023

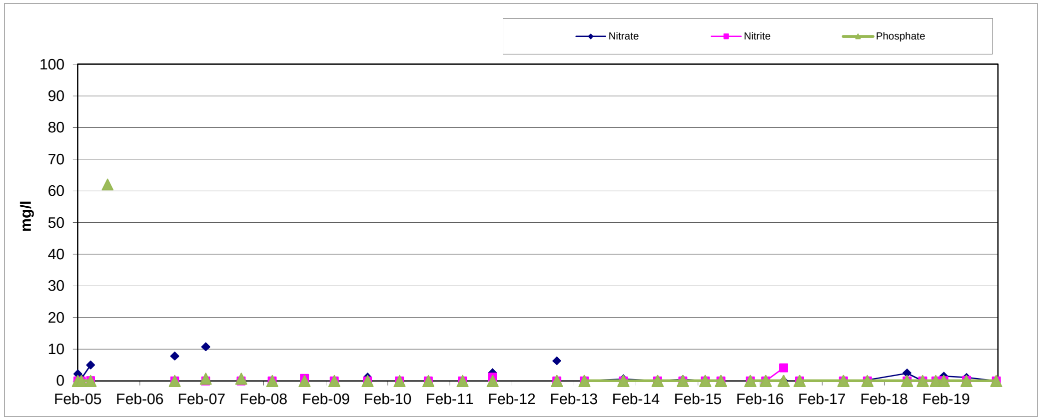

COD mg/l
0
20
40
60
80
100
120
140
160
180
200
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

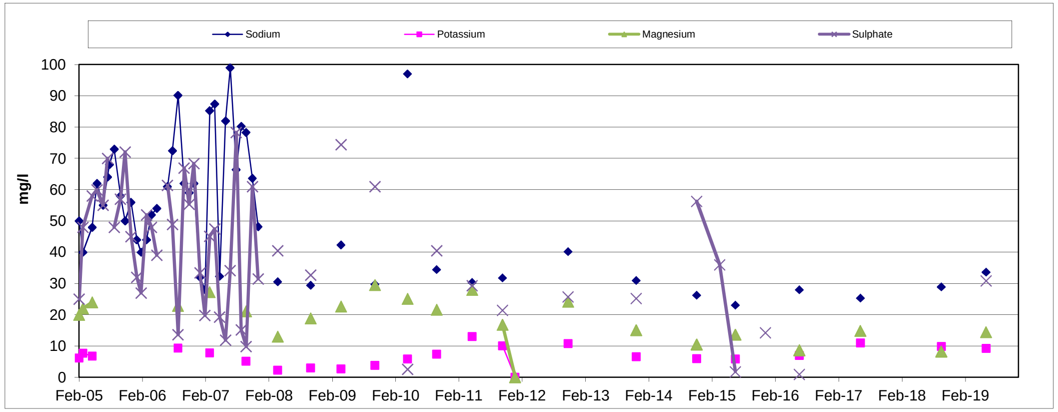

Trigger Level
Calcium mg/l
0
100
200
300
400
500
600
700
800
900
1000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

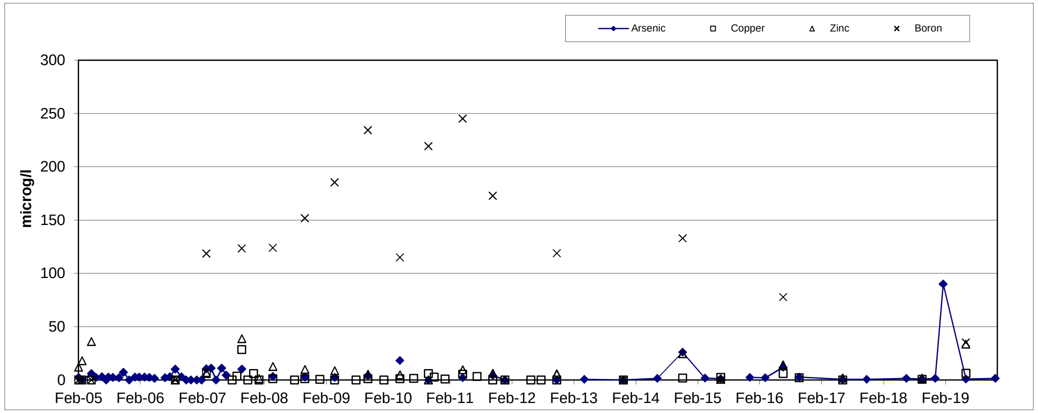

Copper
Arsenic
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

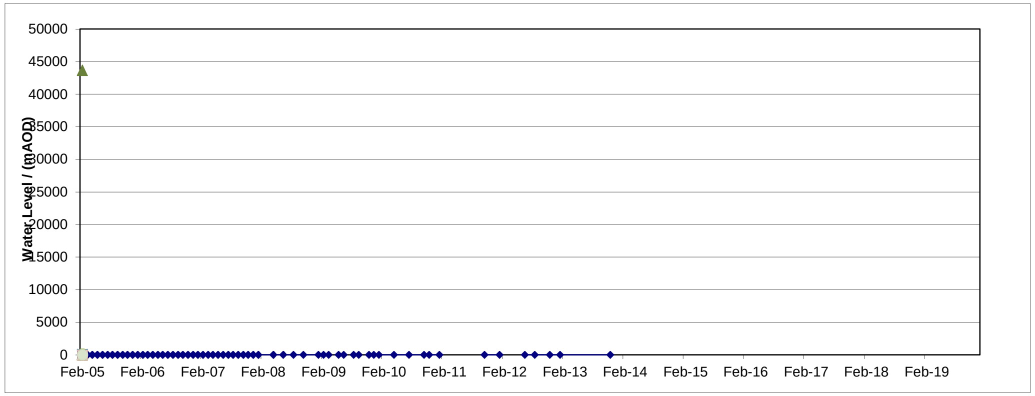

Trigger Level
Control Level 1
Control Level 2
Alkalinity
mg/l CaCO3
1000
900
800
700
600
500
400
300
200
100
0
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

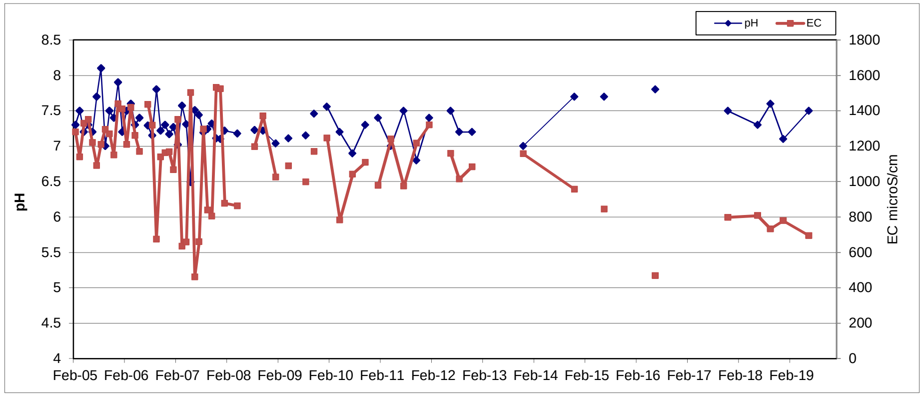

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

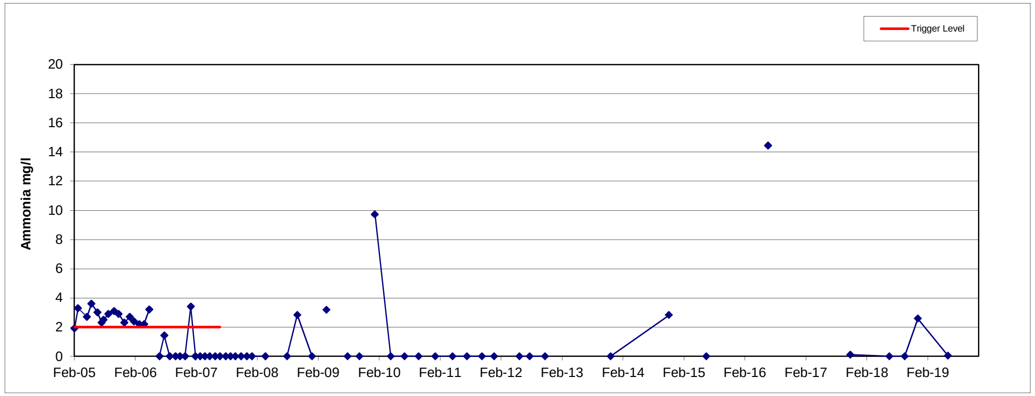

Nitrate
Nitrite
Phosphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

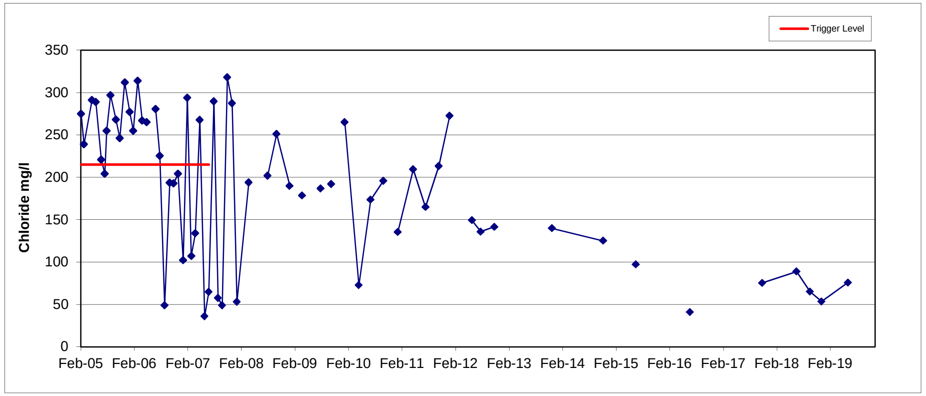

Sodium
Potassium
Magnesium
Sulphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

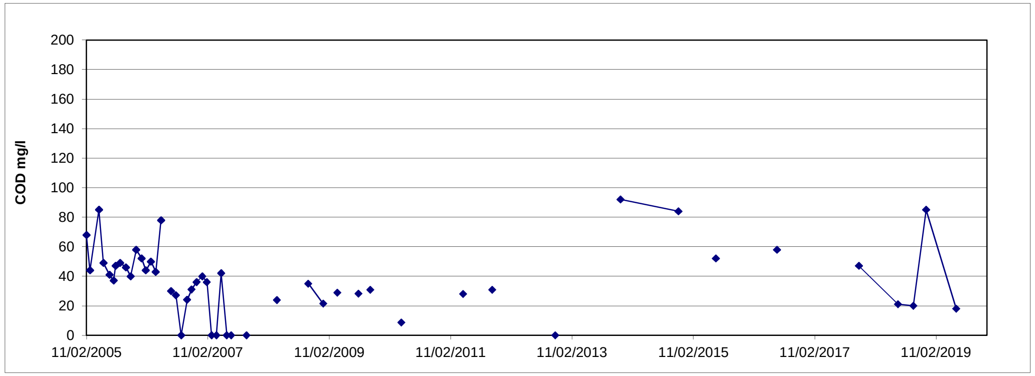

Arsenic
Copper
Zinc
Boron
microg/l
300
250
200
150
100
50
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

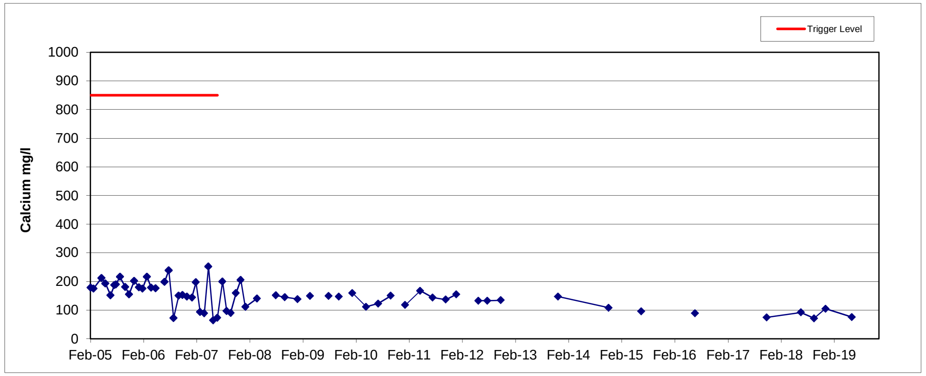

Water Level / (mAOD)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

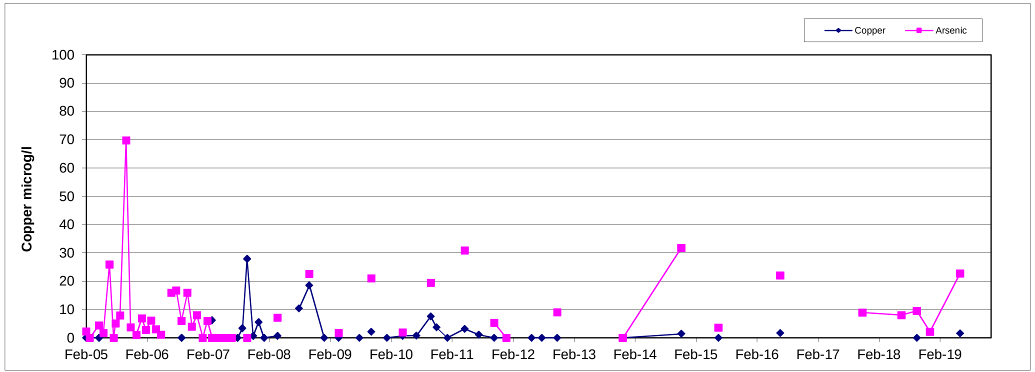

pH
EC
pH
EC microS/cm
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

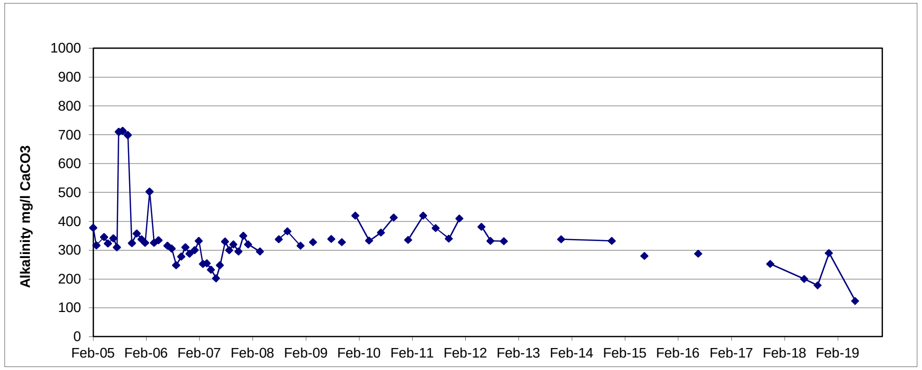

Trigger Level
Ammonia mg/l
20
18
16
14
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

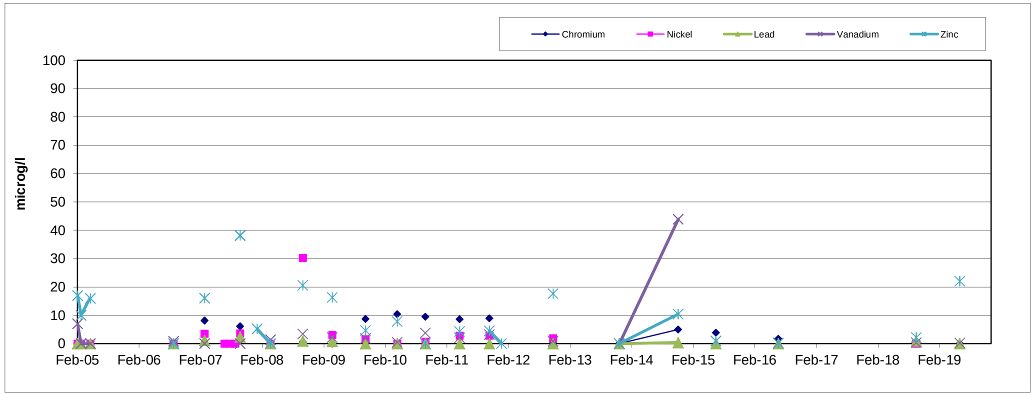

Trigger Level
Chloride mg/l
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

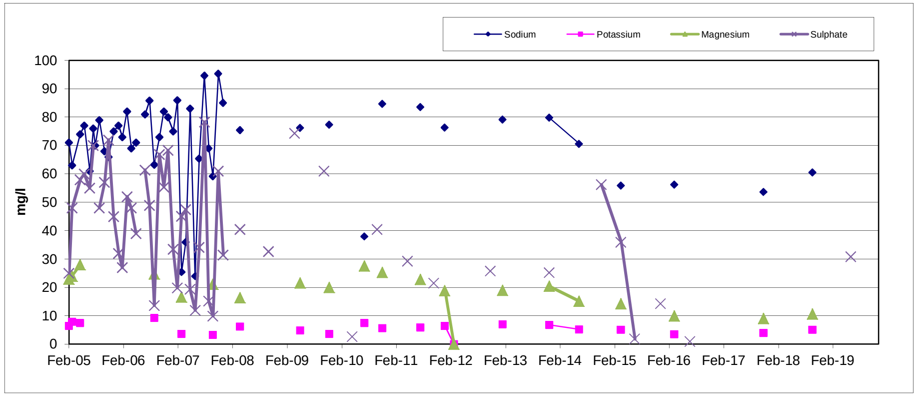

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
11/02/2005 11/02/2007 11/02/2009 11/02/2011 11/02/2013 11/02/2015 11/02/2017 11/02/2019

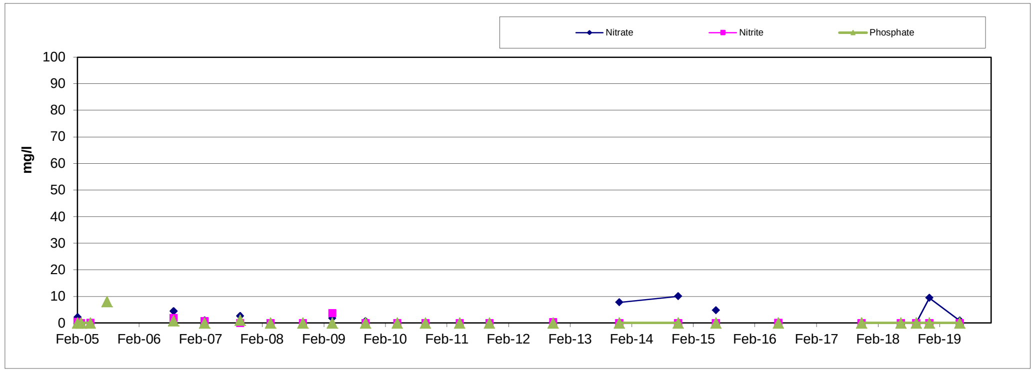

Trigger Level
Calcium mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

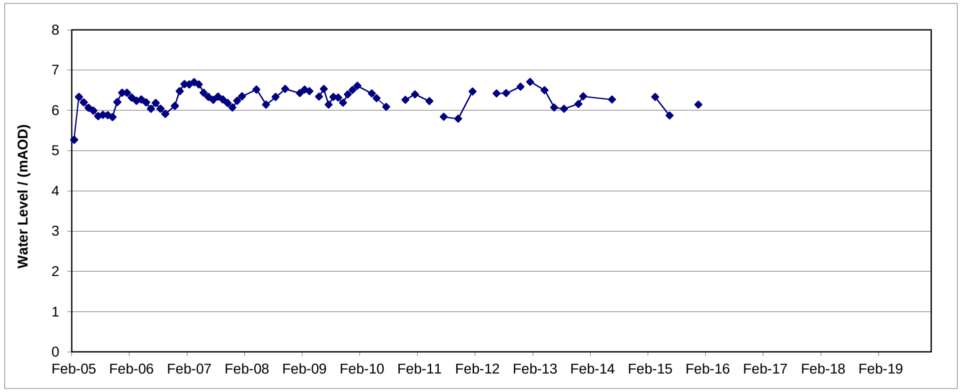

Copper
Arsenic
Copper microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

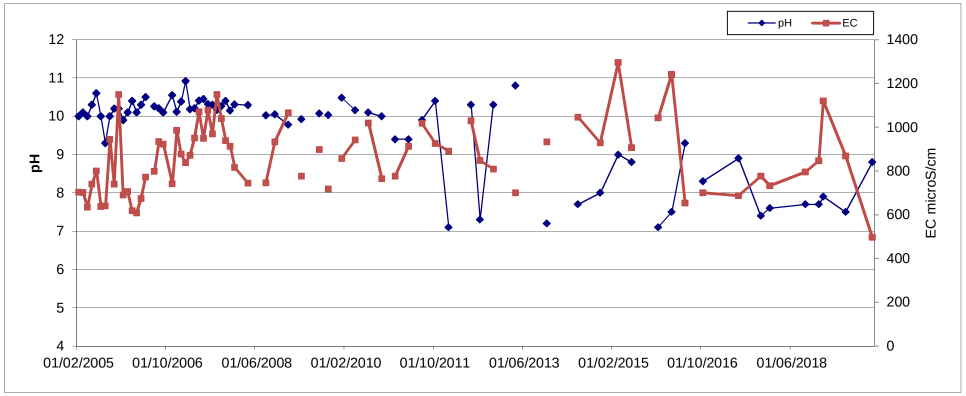

Alkalinity mg/l CaCO3
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

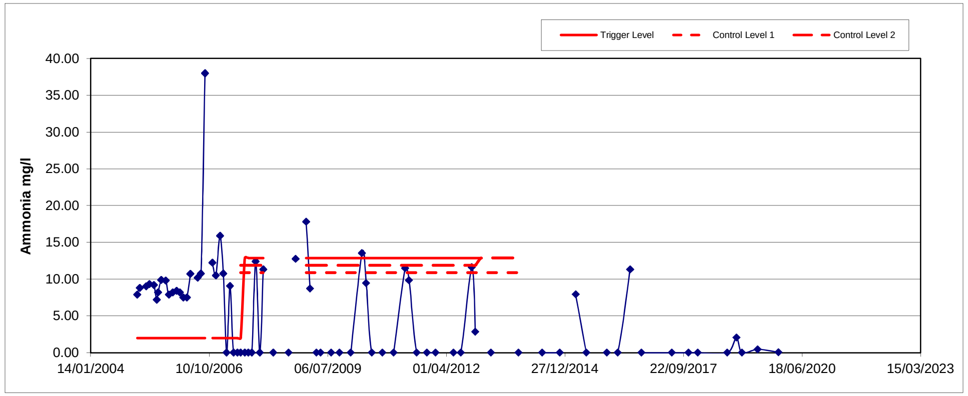

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

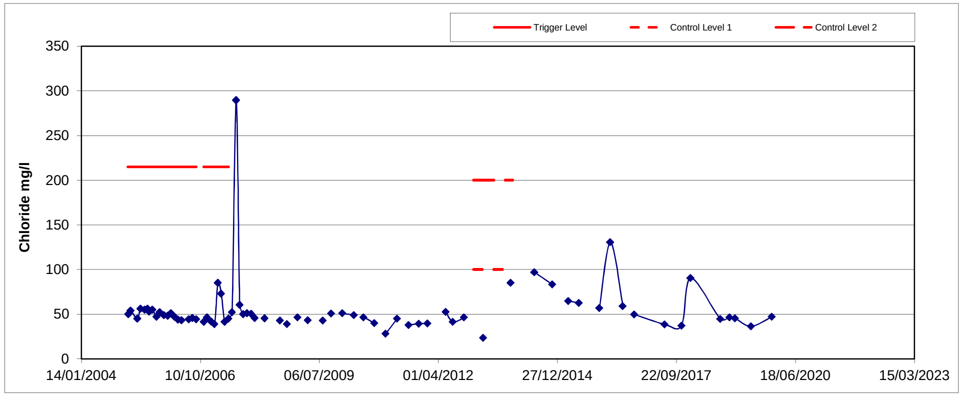

Sodium
Potassium
Magnesium
Sulphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

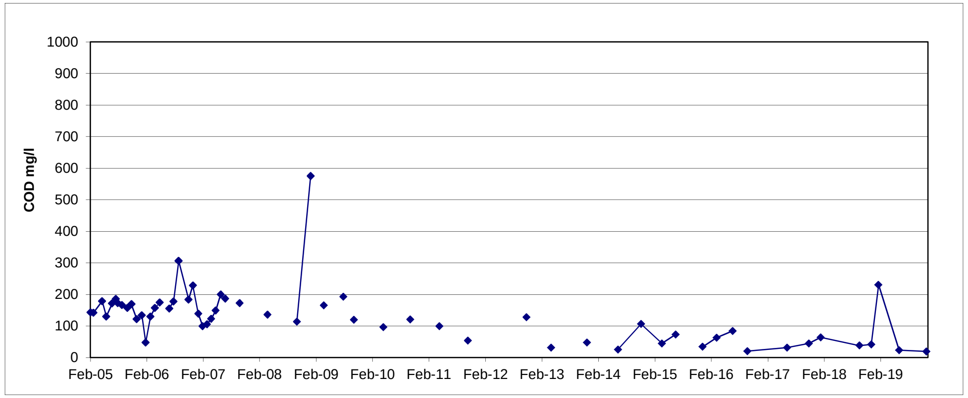

Nitrate
Nitrite
Phosphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

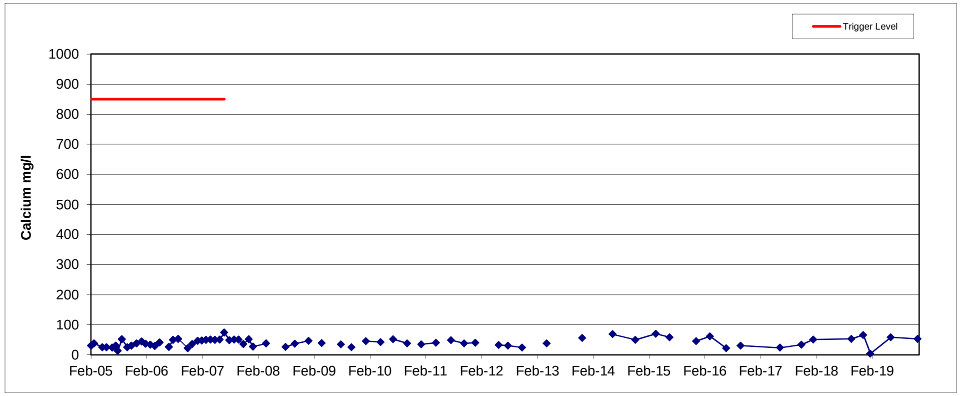

Water Level / (mAOD)
0
1
2
3
4
5
6
7
8
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

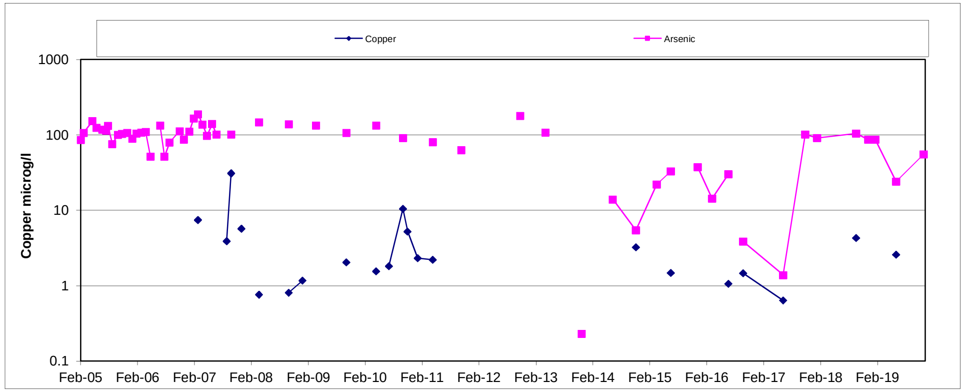

pH
EC
pH
EC microS/cm
01/02/2005
01/10/2006
01/06/2008
01/02/2010
01/10/2011
01/06/2013
01/02/2015
01/10/2016
01/06/2018

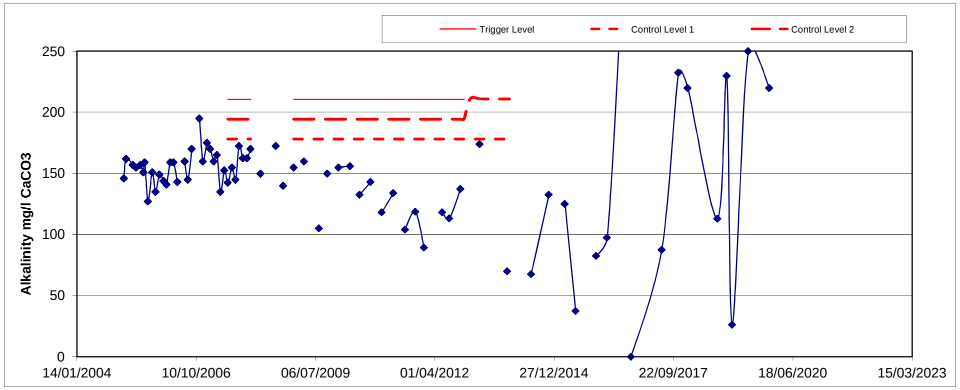

Trigger Level
Control Level 1
Control Level 2
Ammonia mg/l
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

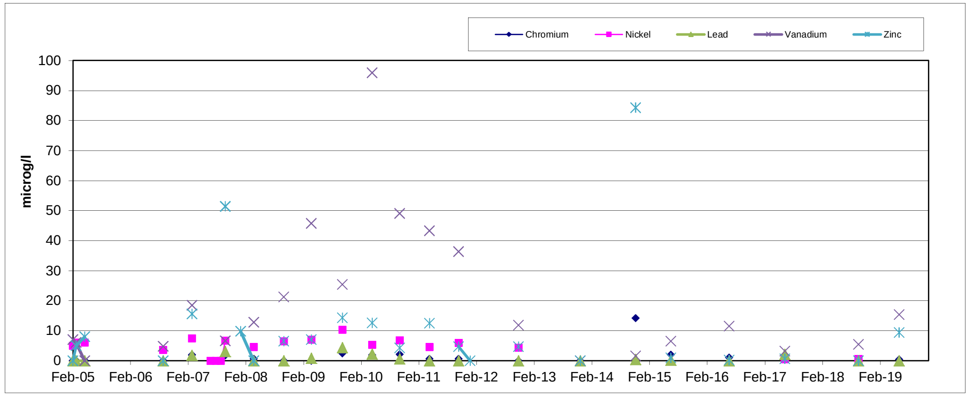

Trigger Level
Control Level 1
Control Level 2
Chloride mg/l
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

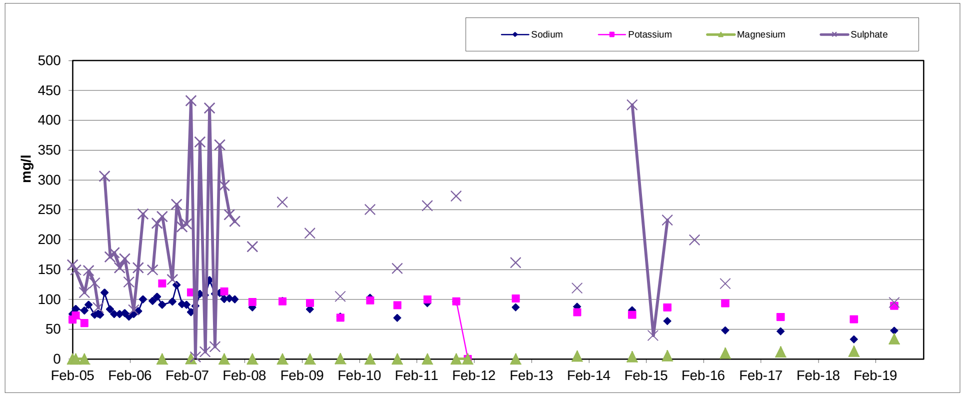

COD mg/l
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

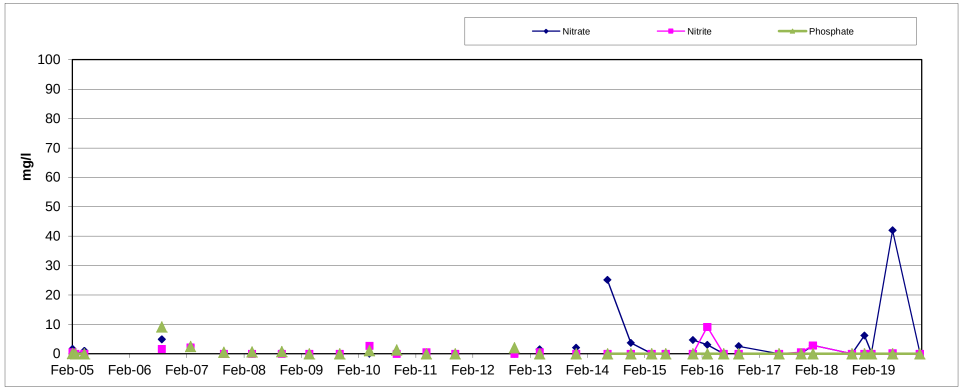

Trigger Level
Calcium mg/l
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

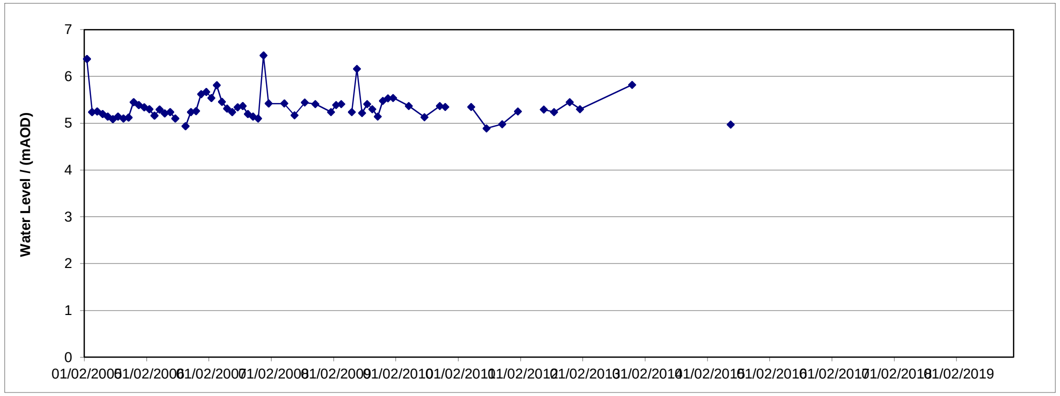

Copper
Arsenic
Copper microg/l
1000
100
10
1
0.1
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

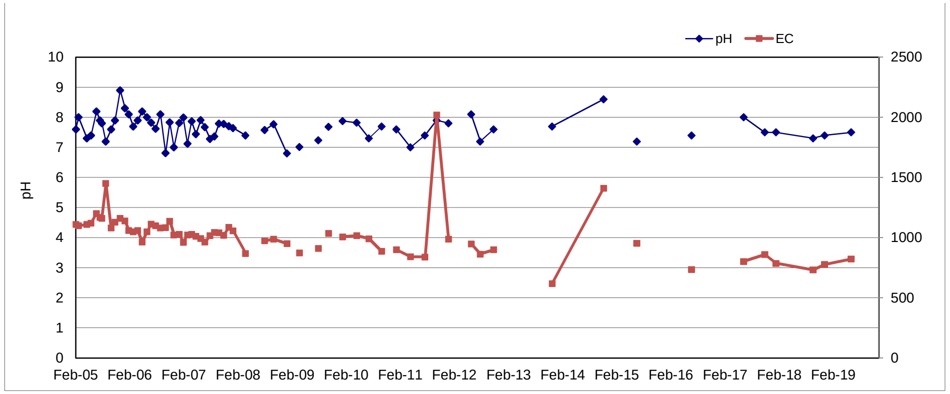

Trigger Level
Control Level 1
Control Level 2
Alkalinity mg/l CaCO3
250
200
150
100
50
0
14/01/2004 10/10/2006 06/07/2009 01/04/2012 27/12/2014 22/09/2017 18/06/2020 15/03/2023

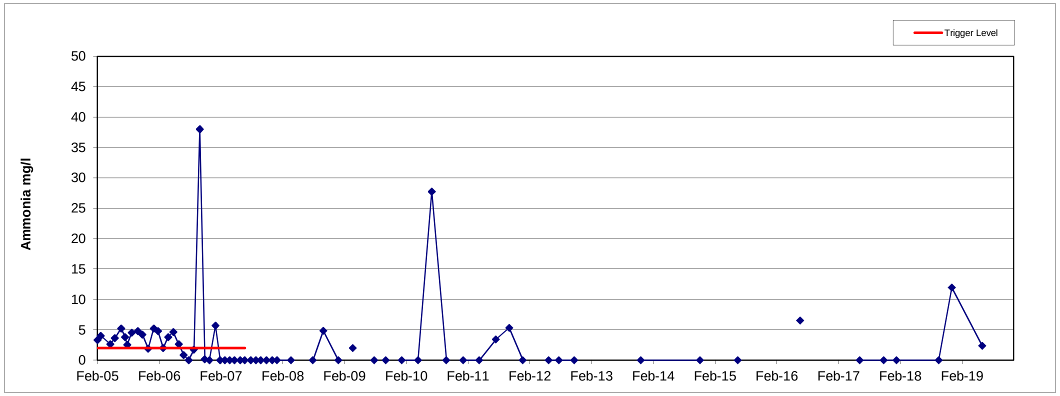

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100 90 80 70 60 50 40 30 20 10 0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

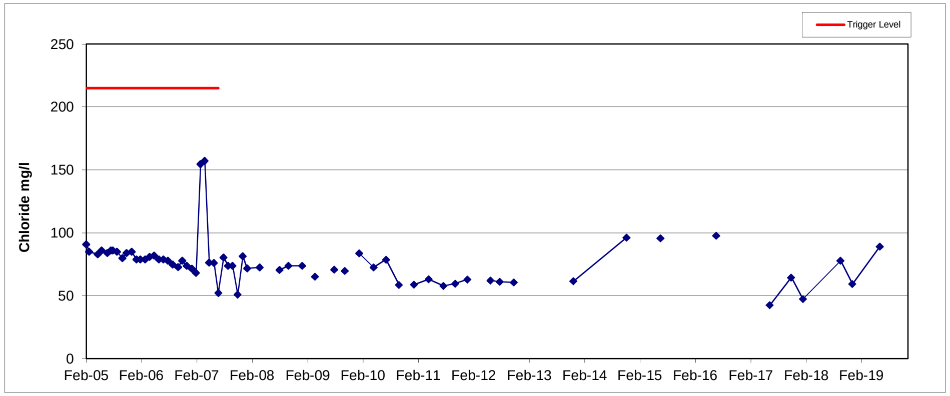

Sodium
Potassium
Magnesium
Sulphate
mg/l
500 450 400 350 300 250 200 150 100 50 0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

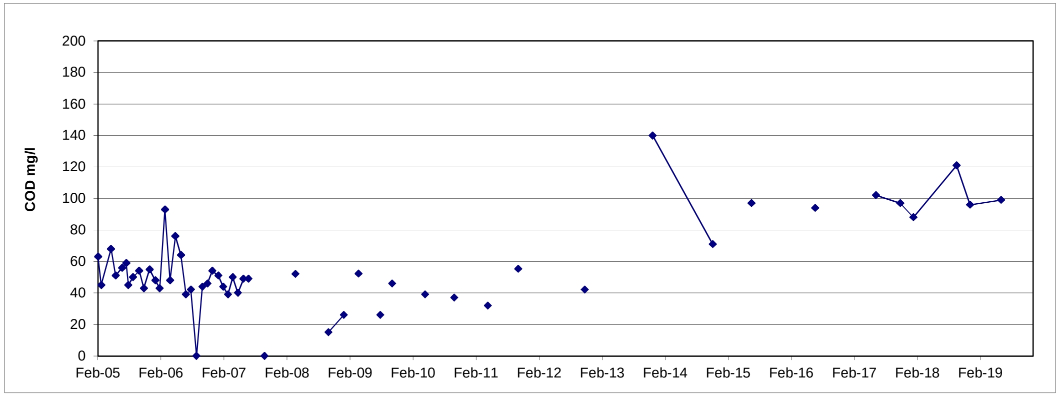

Nitrate
Nitrite
Phosphate
mg/l
100 90 80 70 60 50 40 30 20 10 0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

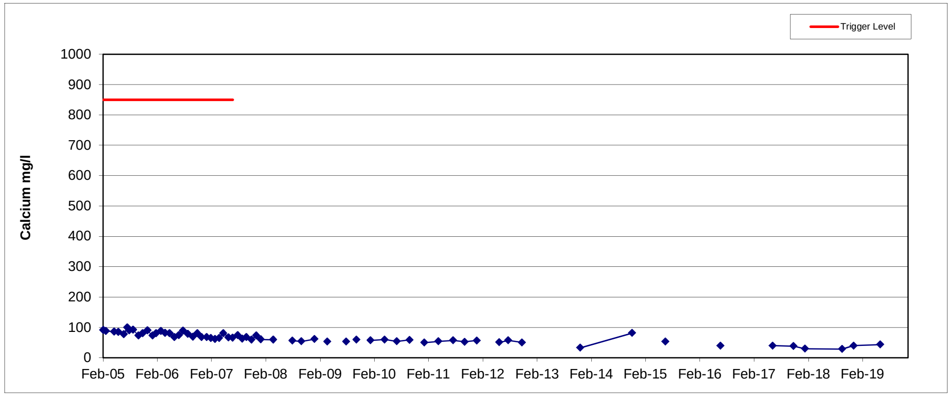

Water Level / (mAOD)
01/02/2005
01/02/2006
01/02/2007
01/02/2008
01/02/2009
01/02/2010
01/02/2011
01/02/2012
01/02/2013
01/02/2014
01/02/2015
01/02/2016
01/02/2017
01/02/2018
01/02/2019

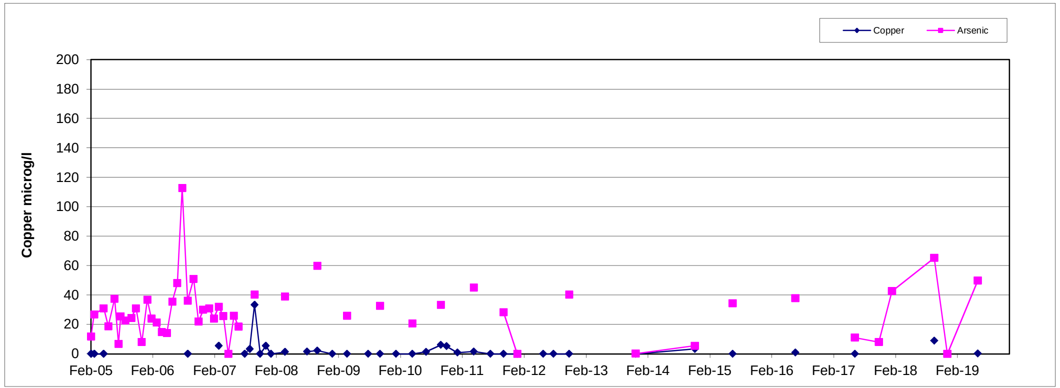

pH
EC
pH
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

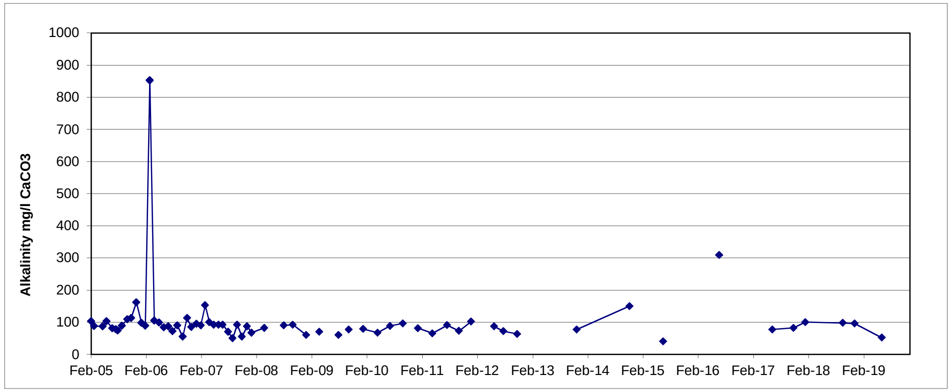

Trigger Level
Ammonia mg/l

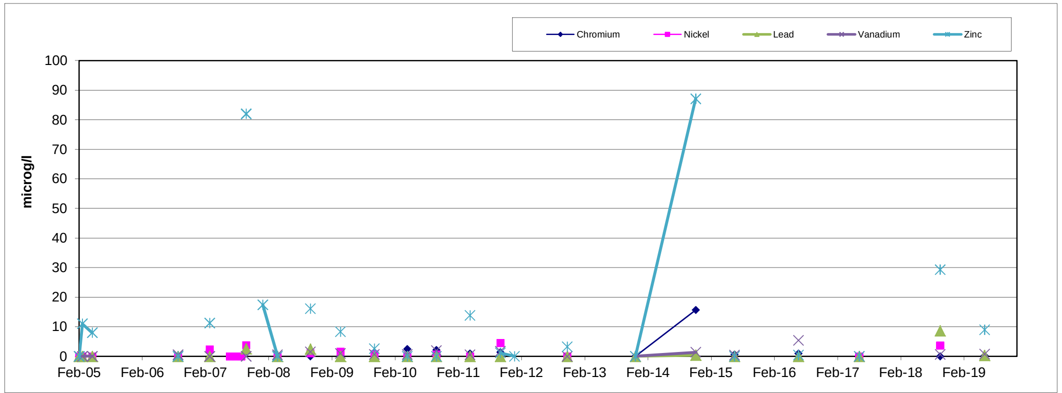

Trigger Level
Chloride mg/l

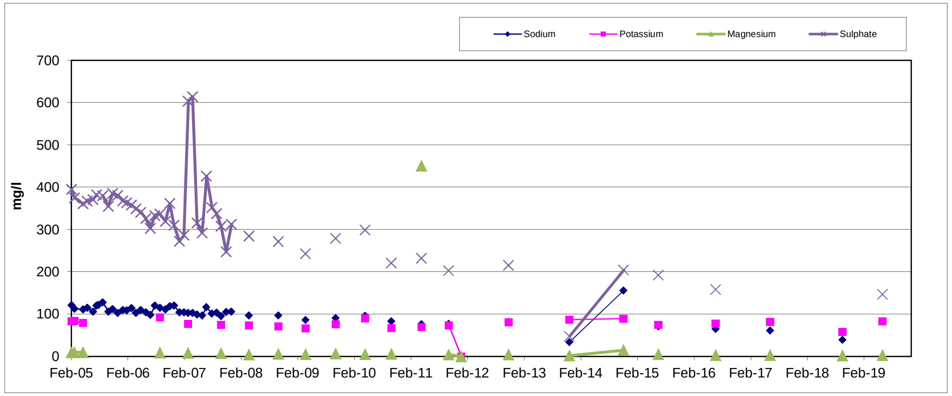

COD mg/l

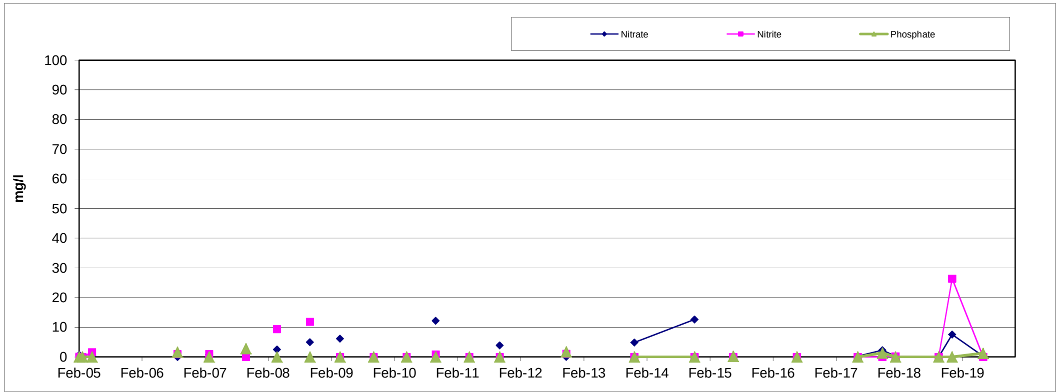

Trigger Level
Calcium mg/l

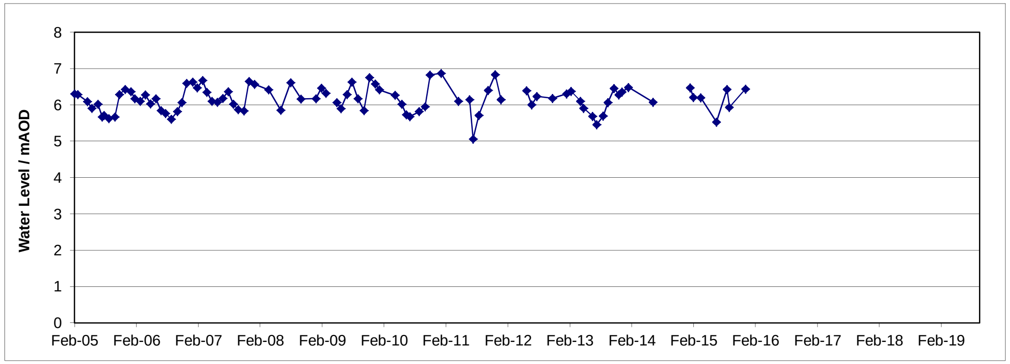

Copper
Arsenic
Copper microg/l
0
20
40
60
80
100
120
140
160
180
200
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

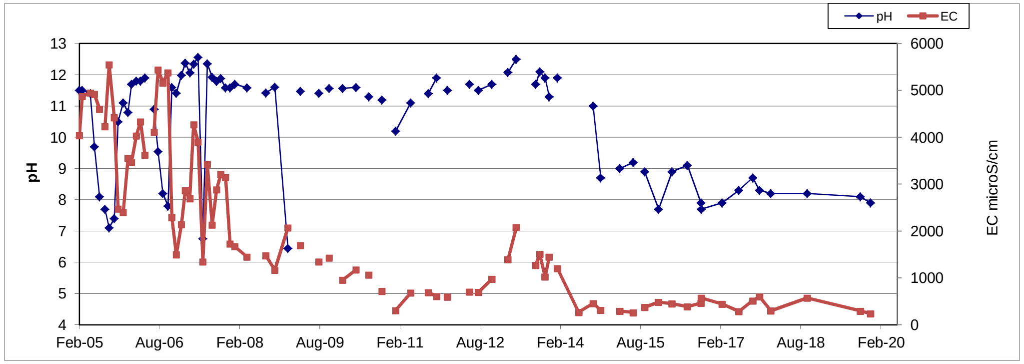

Alkalinity mg/l CaCO3
0
100
200
300
400
500
600
700
800
900
1000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

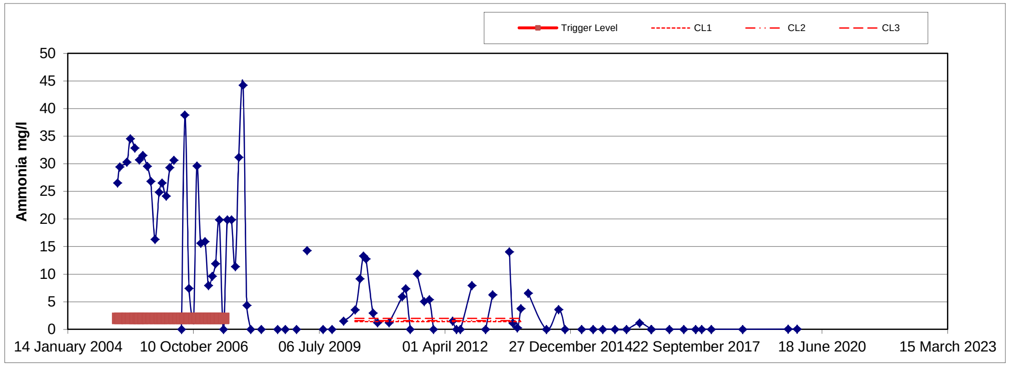

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
0
10
20
30
40
50
60
70
80
90
100
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

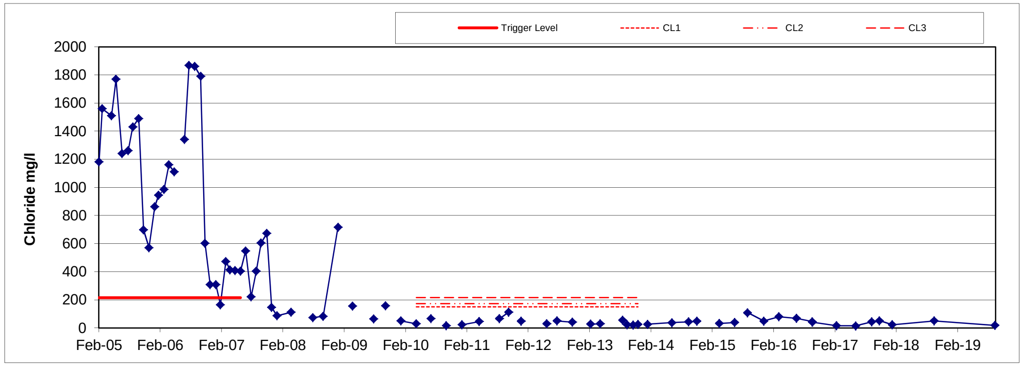

Sodium
Potassium
Magnesium
Sulphate
mg/l
0
100
200
300
400
500
600
700
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

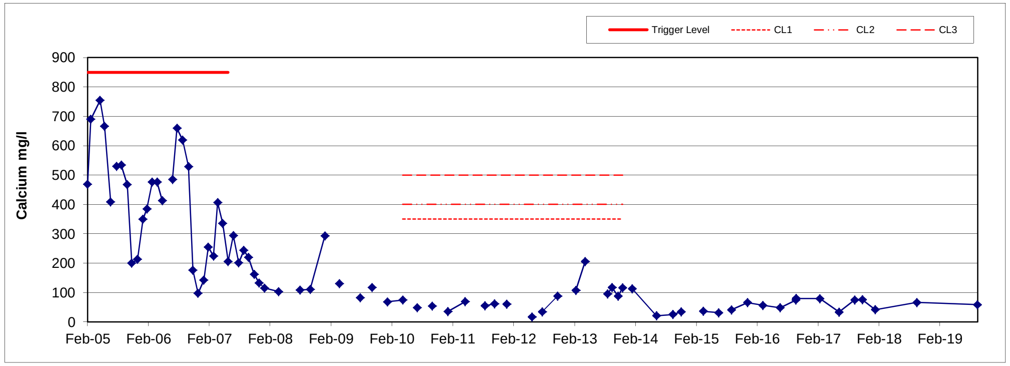

Nitrate
Nitrite
Phosphate
mg/l
0
10
20
30
40
50
60
70
80
90
100
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

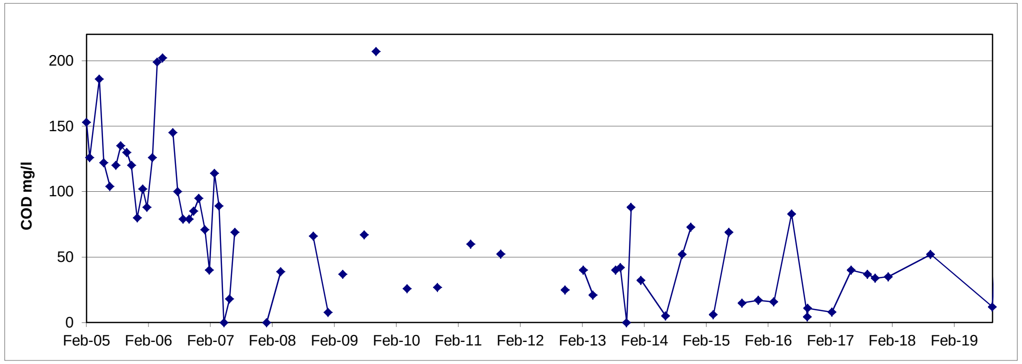

Water Level / mAOD
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

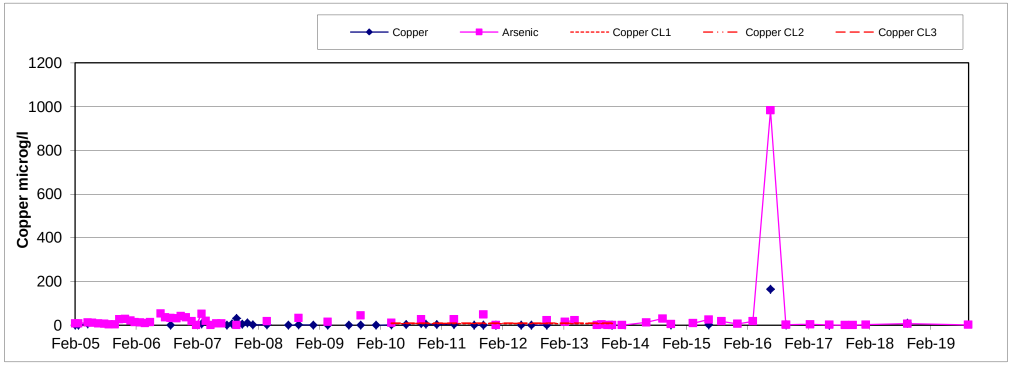

pH
EC
EC microS/cm
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18
Feb-20

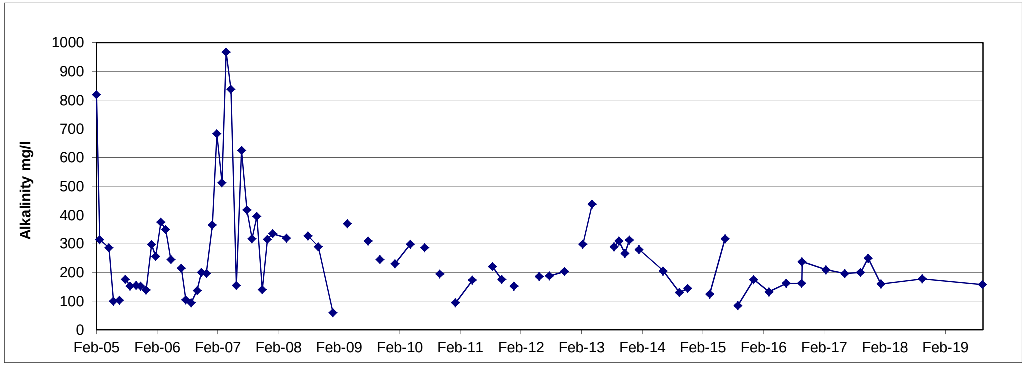

Trigger Level
CL1
CL2
CL3
Ammonia mg/l
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

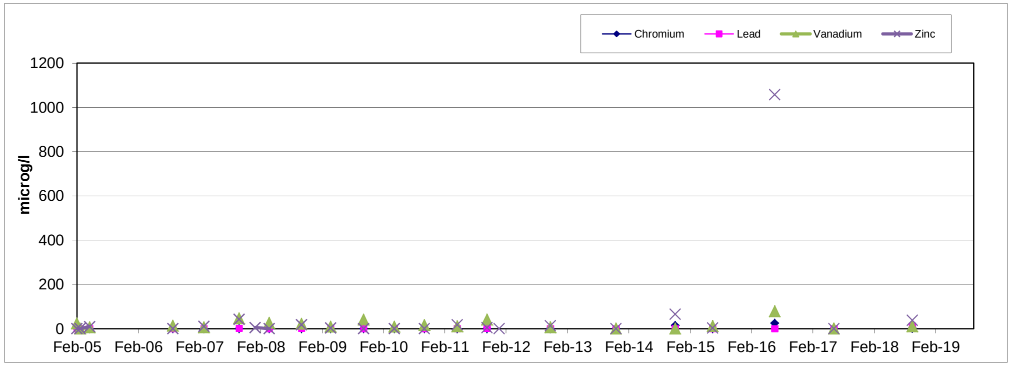

Trigger Level
CL1
CL2
CL3
Chloride mg/l
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

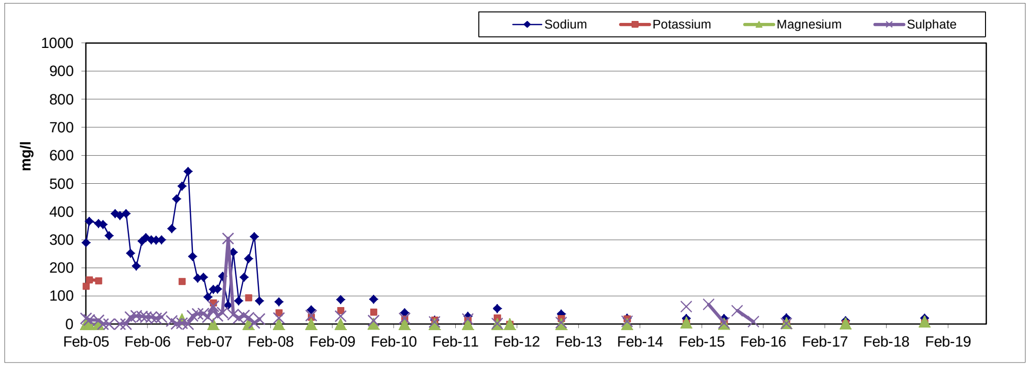

Trigger Level
CL1
CL2
CL3
Calcium mg/l
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

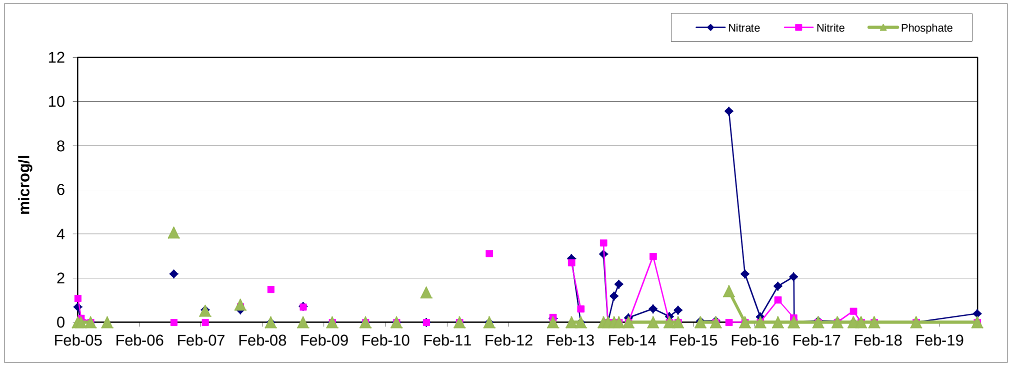

COD mg/l
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

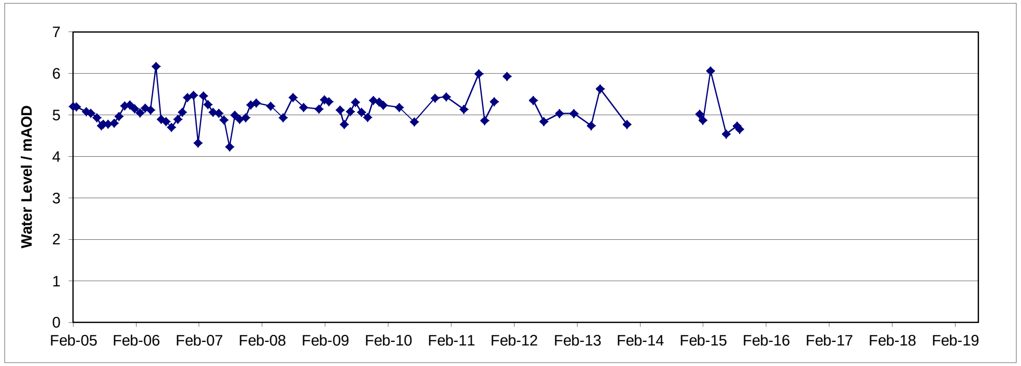

Copper
Arsenic
Copper CL1
Copper CL2
Copper CL3
Copper microg/l
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

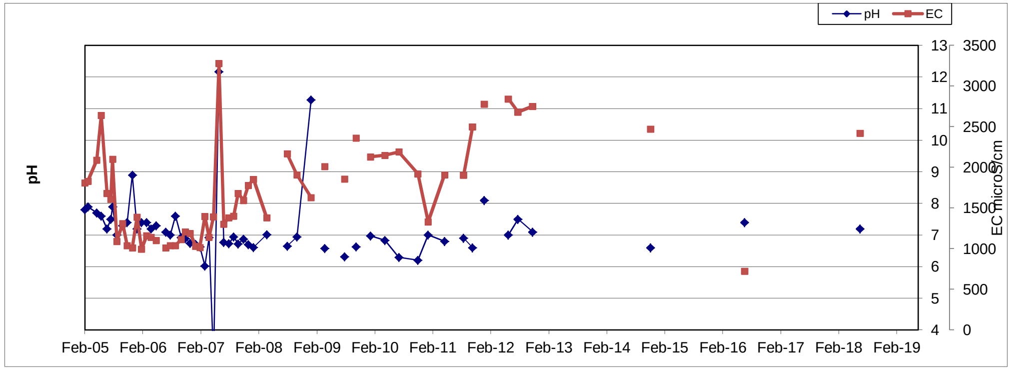

Alkalinity mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

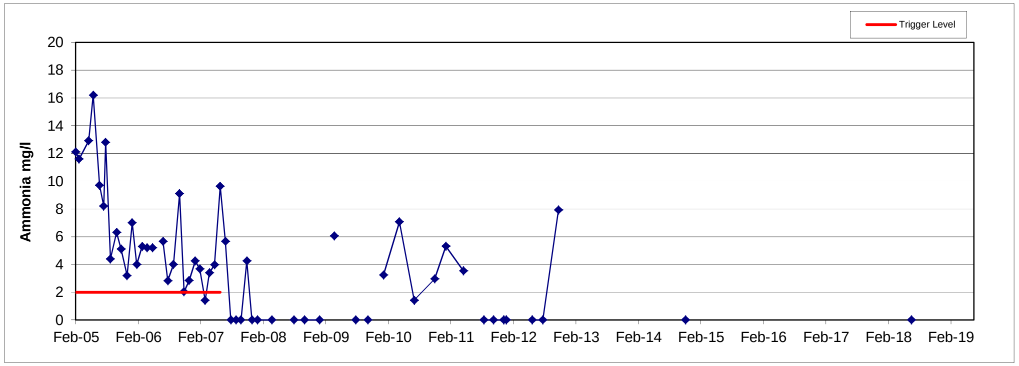

Chromium
Lead
Vanadium
Zinc
microg/l
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

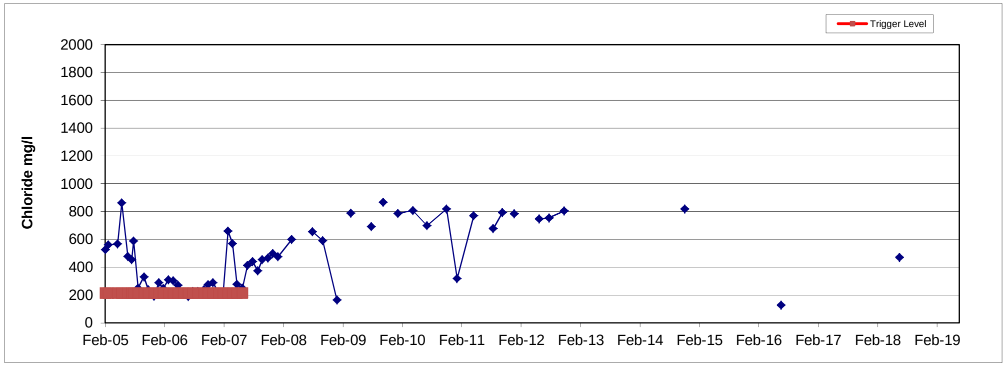

Sodium
Potassium
Magnesium
Sulphate
mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

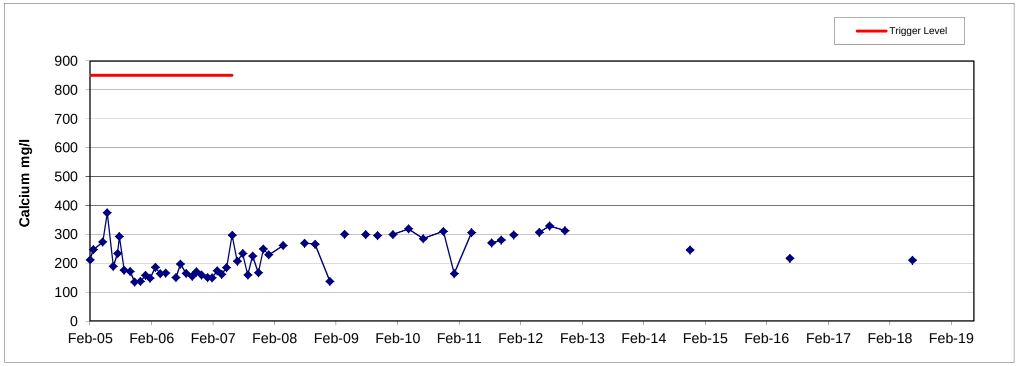

Nitrate
Nitrite
Phosphate
microg/l
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

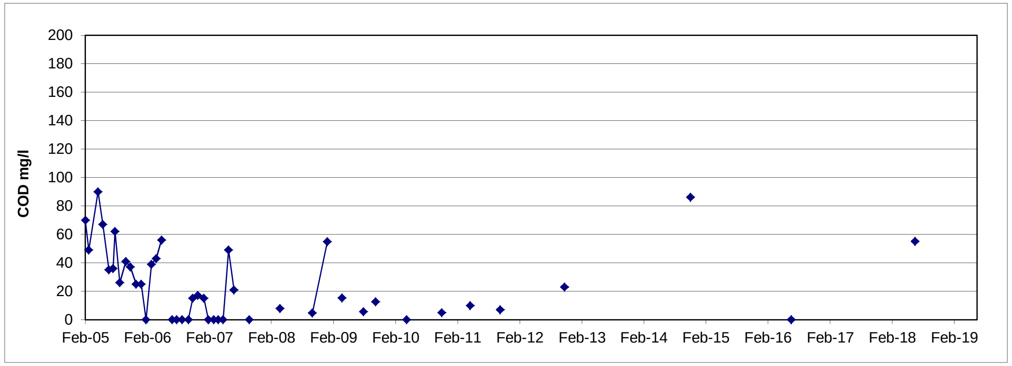

Water Level / mAOD
0
1
2
3
4
5
6
7
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

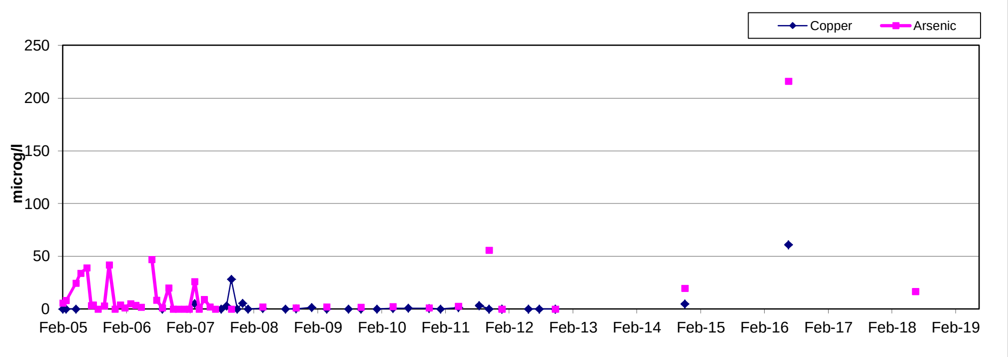

pH
EC
pH
4 5 6 7 8 9 10 11 12 13
ECmicroS/cm
0 500 1000 1500 2000 2500 3000 3500
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

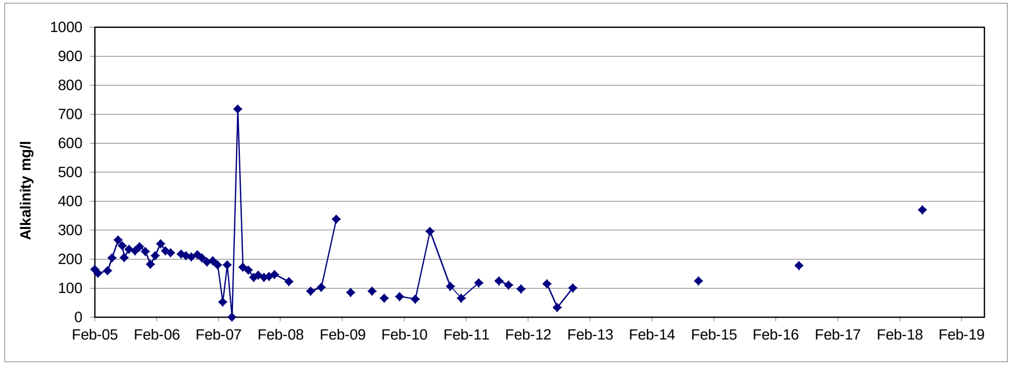

Trigger Level
Ammonia mg/l
0 2 4 6 8 10 12 14 16 18 20
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

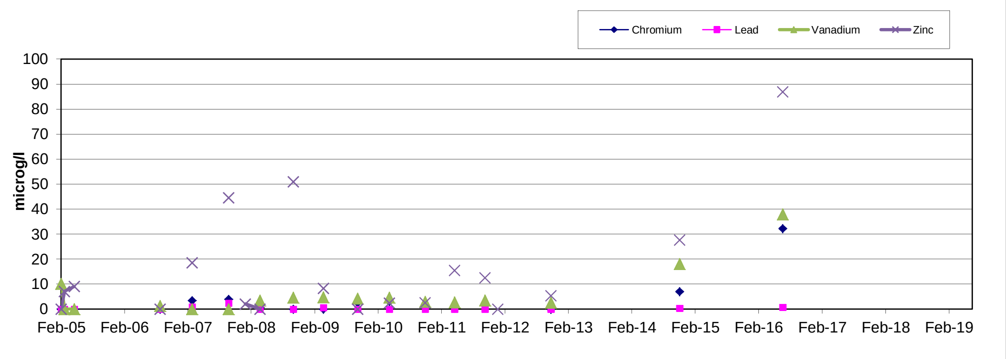

Trigger Level
Chloride mg/l
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

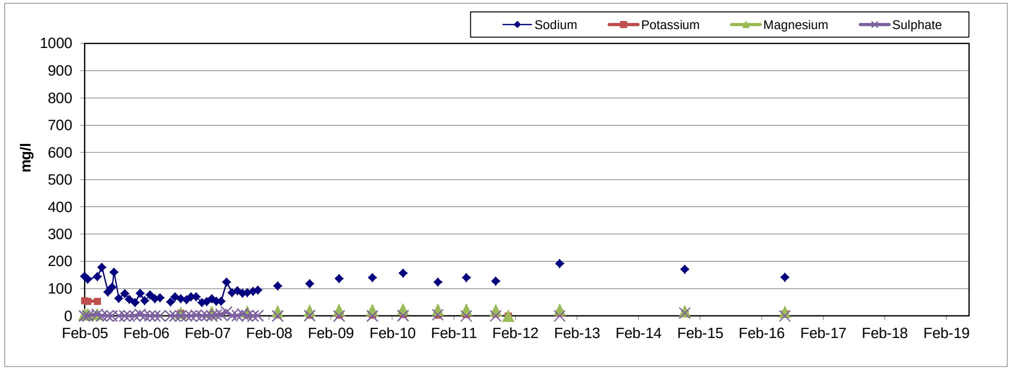

Trigger Level
Calcium mg/l
0 100 200 300 400 500 600 700 800 900
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

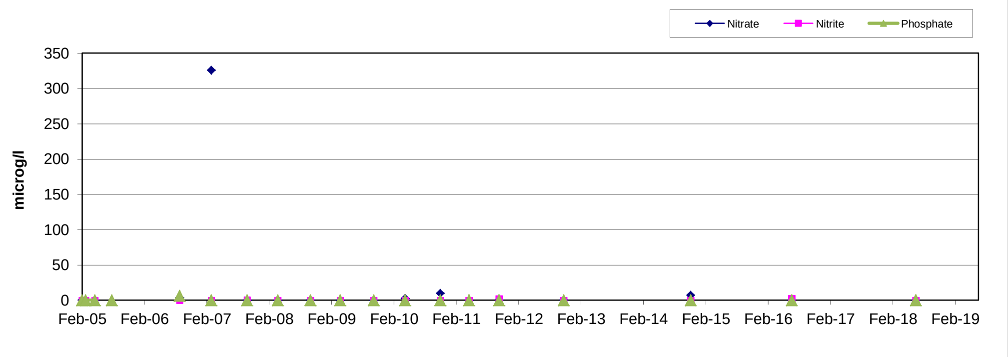

COD mg/l
0 20 40 60 80 100 120 140 160 180 200
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

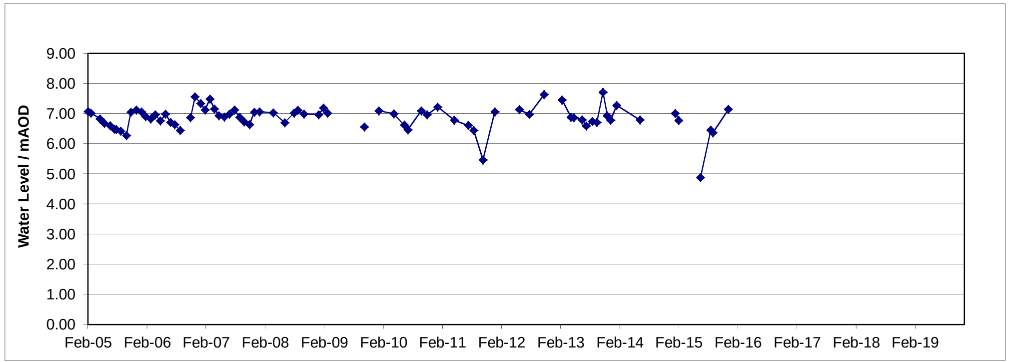

Copper
Arsenic
microg/l
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

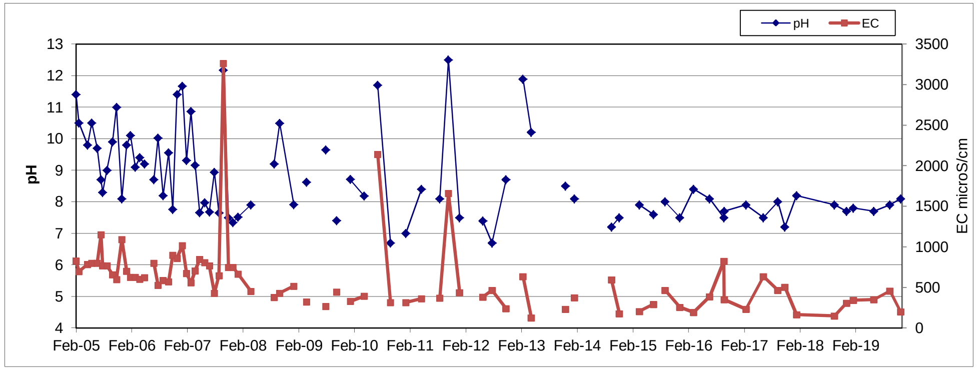

Alkalinity mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

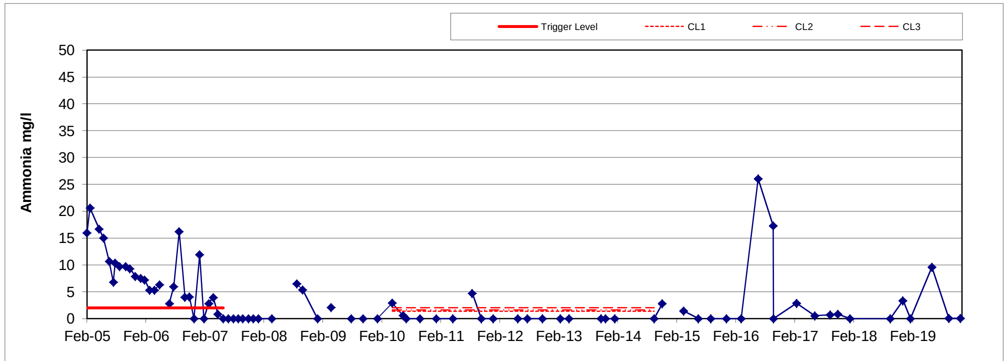

Chromium
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

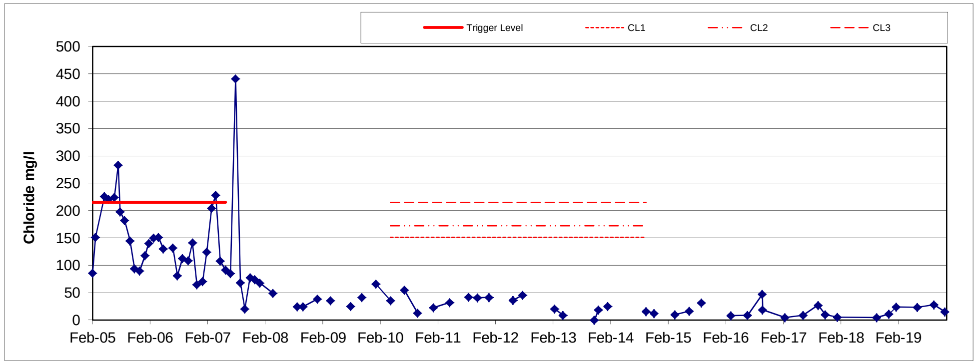

Sodium
Potassium
Magnesium
Sulphate
mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

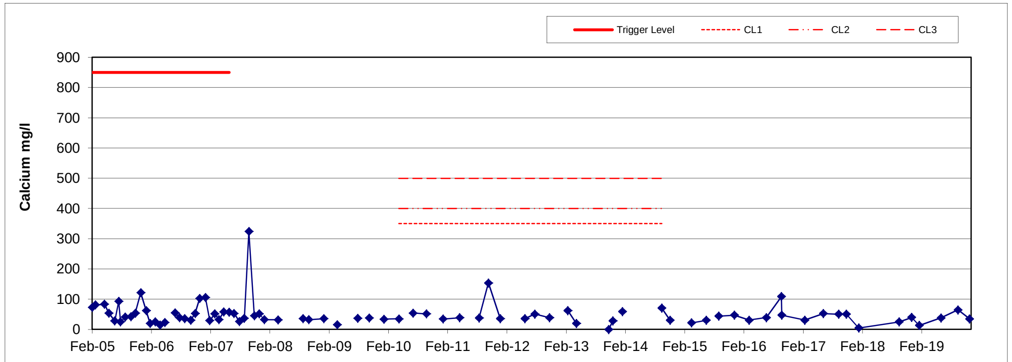

Nitrate
Nitrite
Phosphate
microg/l
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

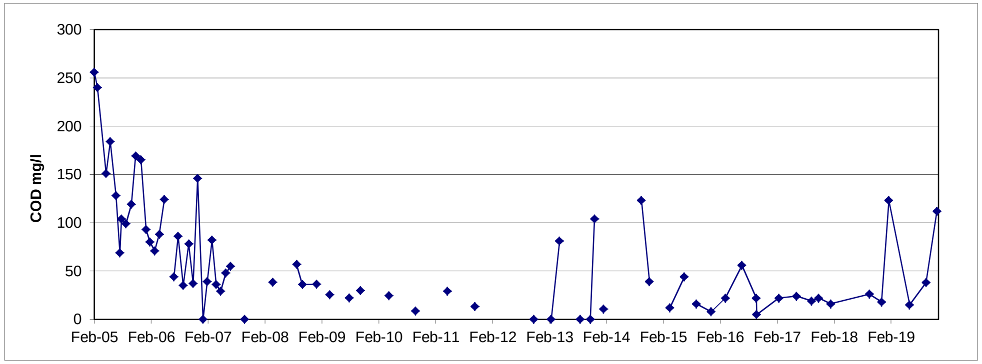

Water Level / mAOD
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

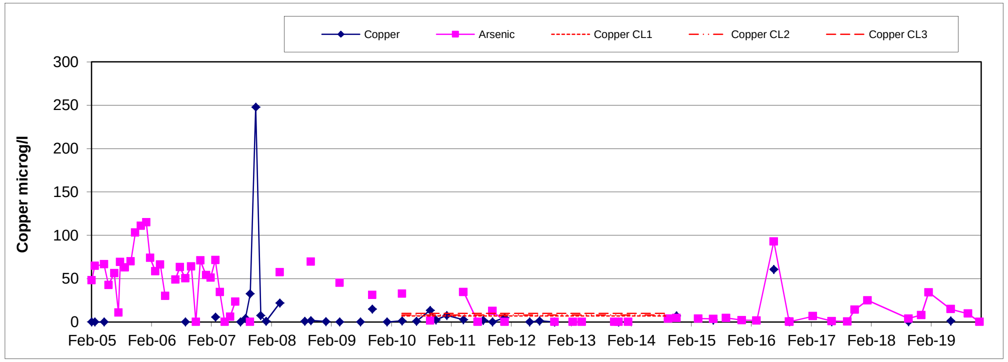

pH
EC
13
12
11
10
9
8
7
6
5
4
3500
3000
2500
2000
1500
1000
500
0
EC microS/cm
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

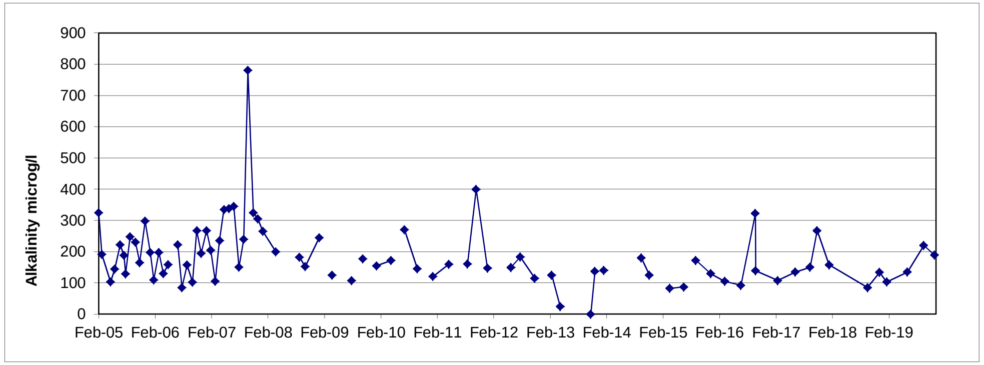

Trigger Level
CL1
CL2
CL3
Ammonia mg/l
50
45
40
35
30
25
20
15
10
5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

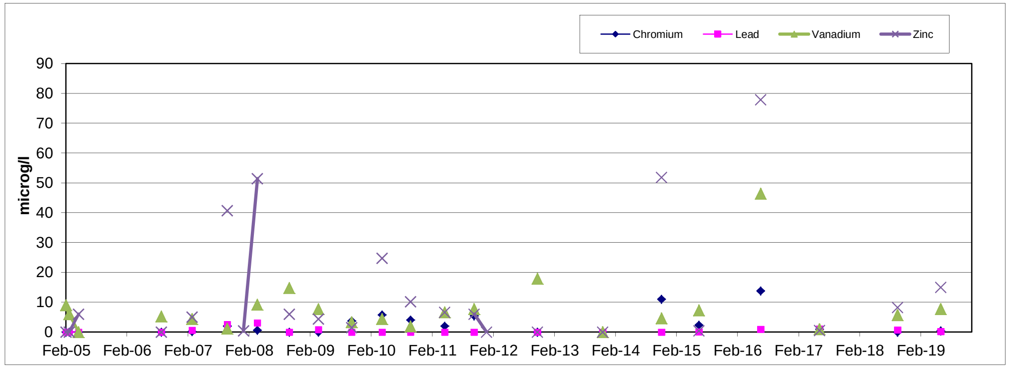

Trigger Level
CL1
CL2
CL3
Chloride mg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

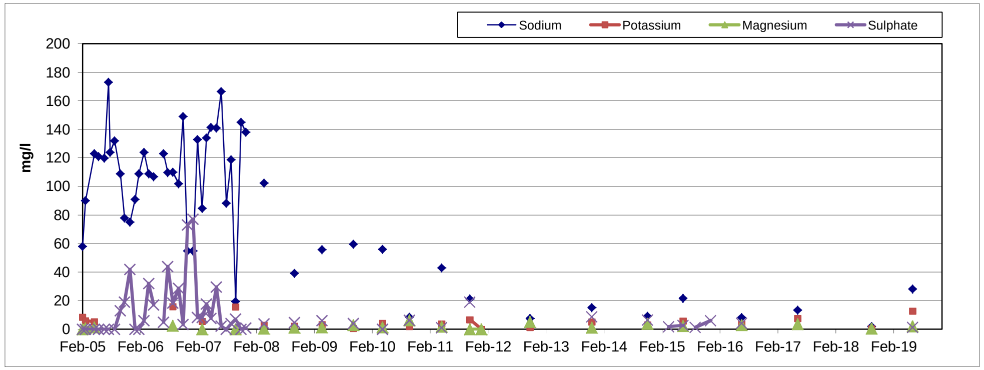

Trigger Level
CL1
CL2
CL3
Calcium mg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

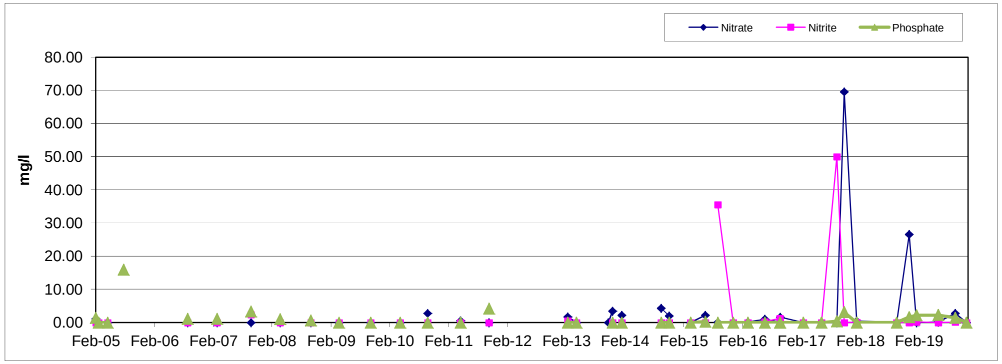

COD mg/l
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

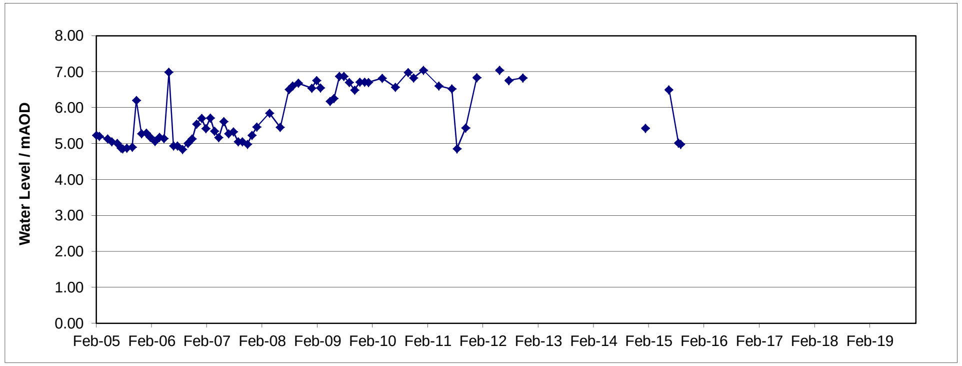

Copper
Arsenic
Copper CL1
Copper CL2
Copper CL3
Copper microg/l
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

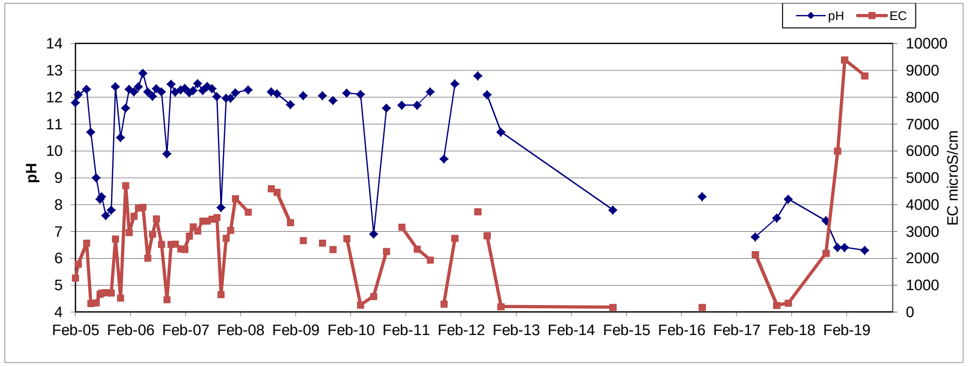

Alkalinity microg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

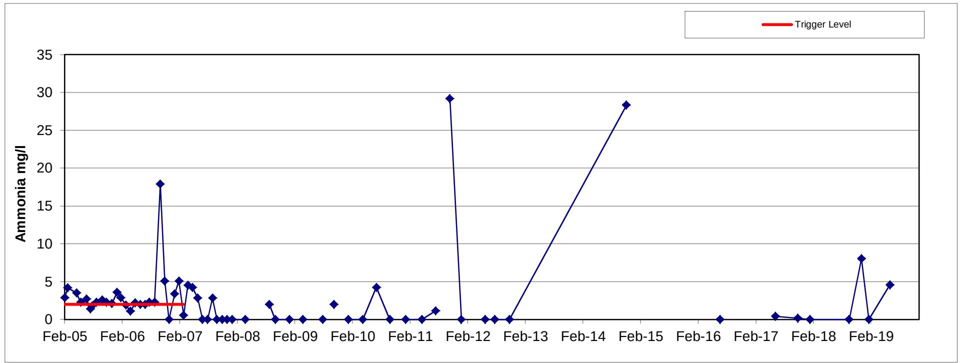

Chromium
Lead
Vanadium
Zinc
microg/l
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

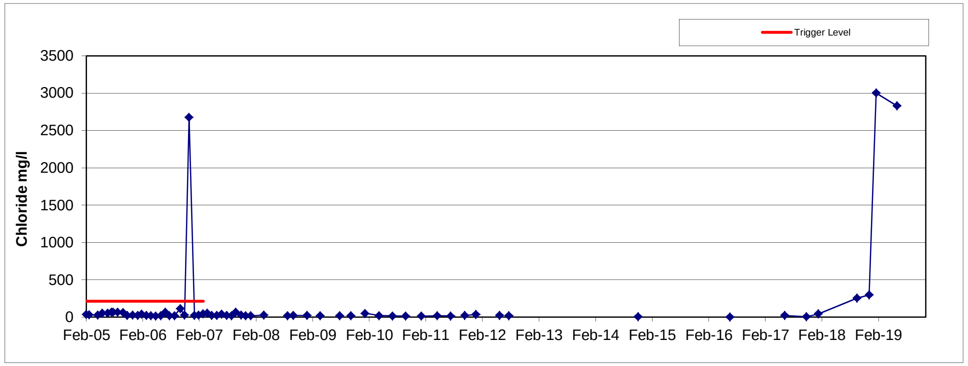

Sodium
Potassium
Magnesium
Sulphate
mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

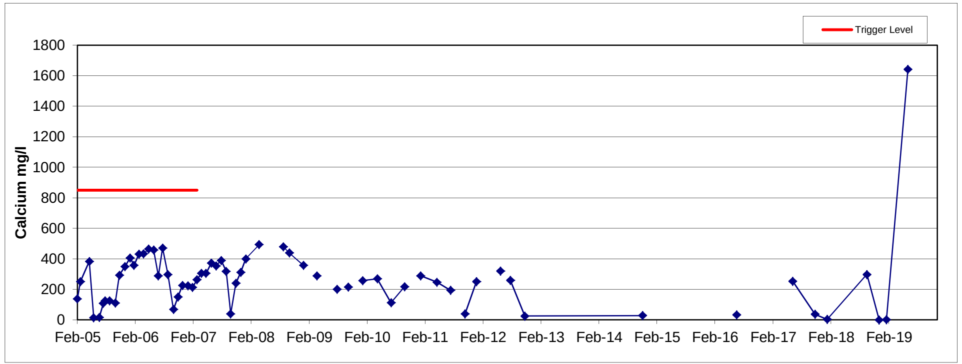

Nitrate
Nitrite
Phosphate
mg/l
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

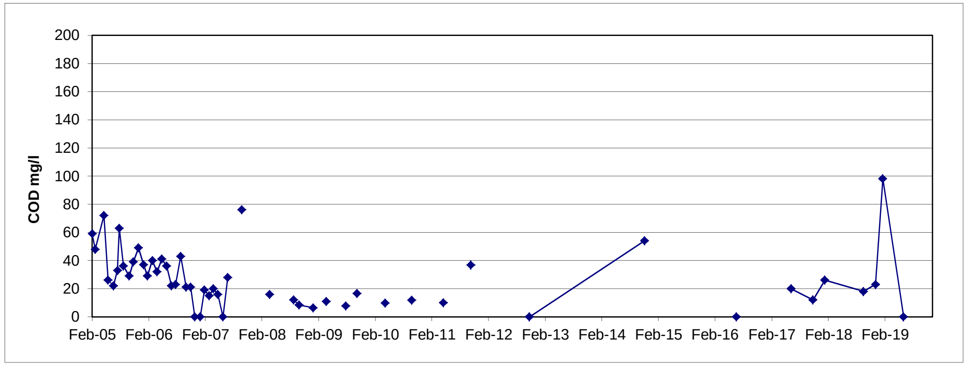

Water Level / mAOD
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

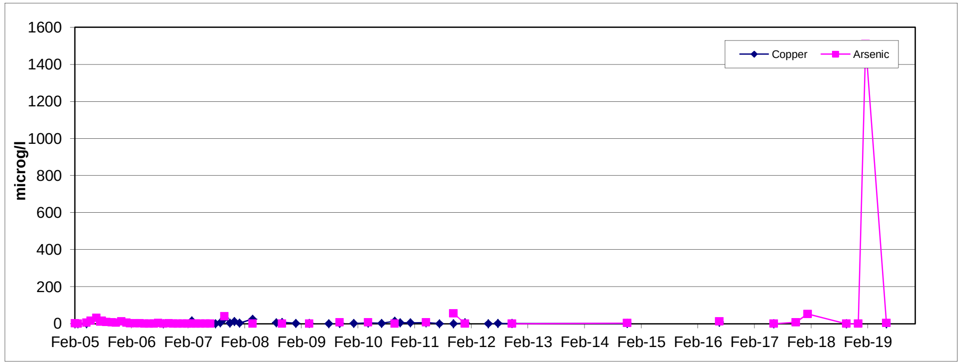

pH
EC
pH
EC microS/cm
14
13
12
11
10
9
8
7
6
5
4
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Trigger Level
Ammonia mg/l
35
30
25
20
15
10
5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

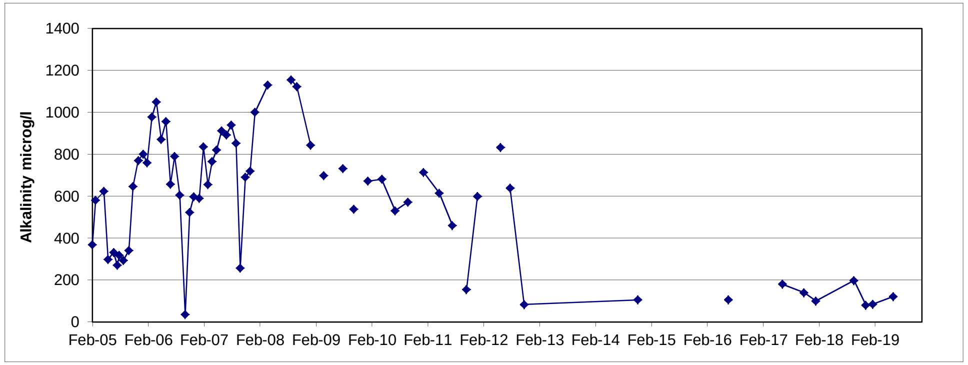

Trigger Level
Chloride mg/l
3500
3000
2500
2000
1500
1000
500
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Trigger Level
Calcium mg/l
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

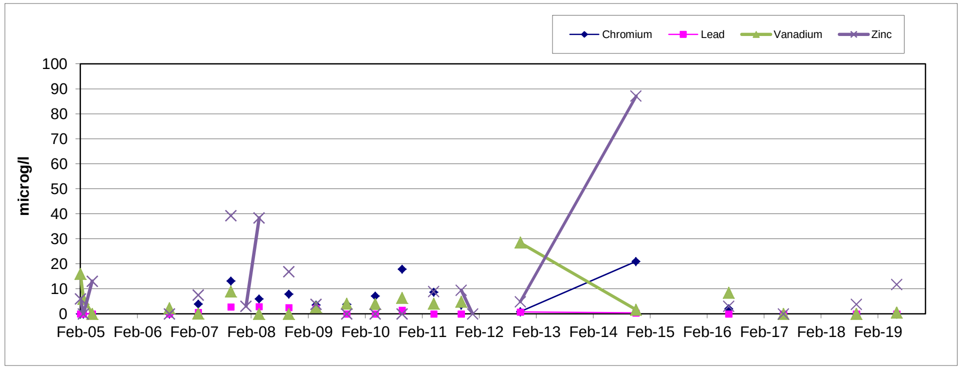

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19



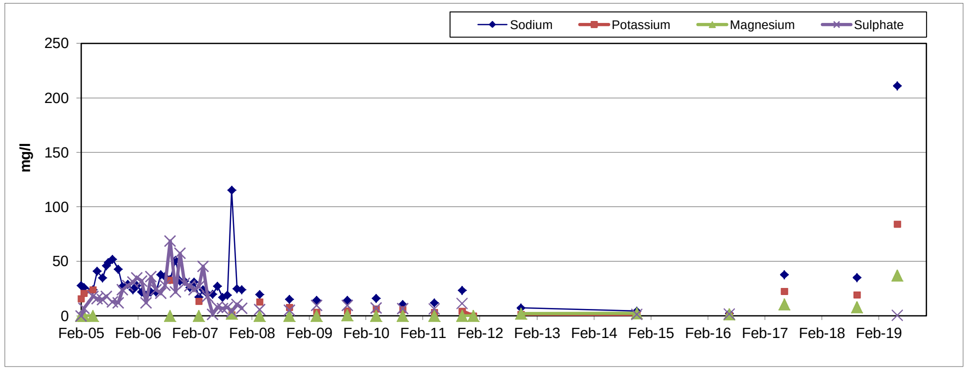
Copper
Arsenic
microg/l
1600
1400
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

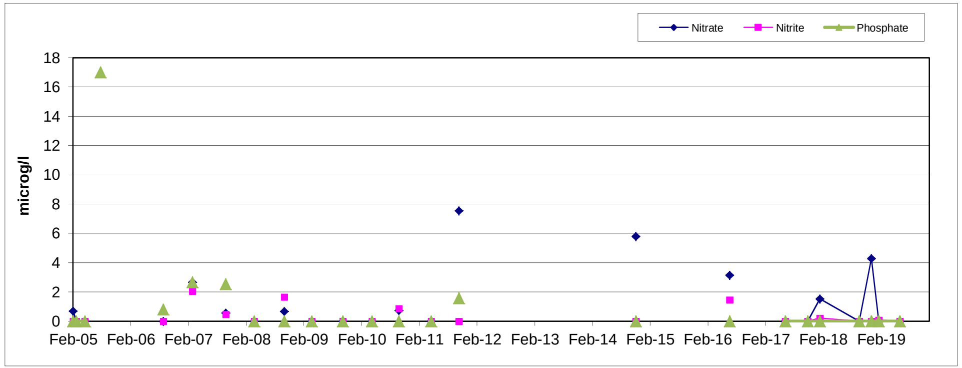
Alkalinity microg/l
1400
1200
1000
800
600
400
200
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

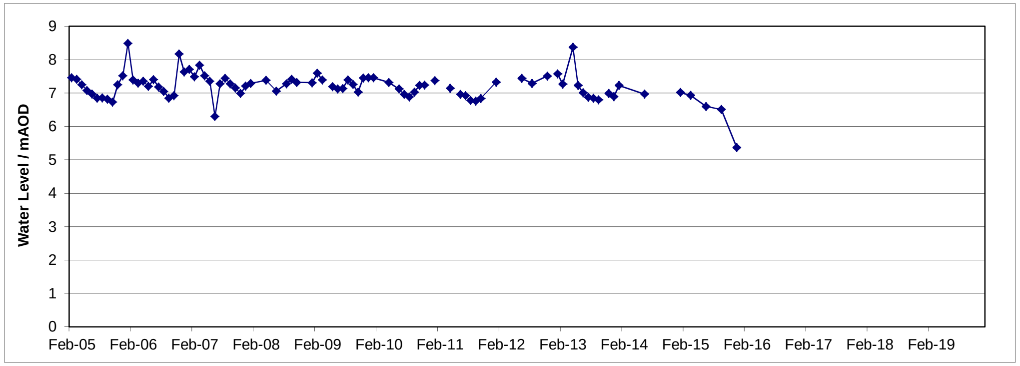
Chromium
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

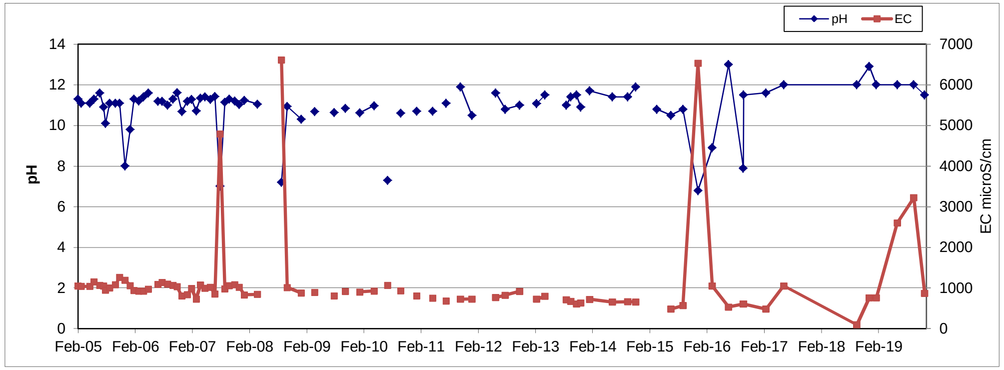



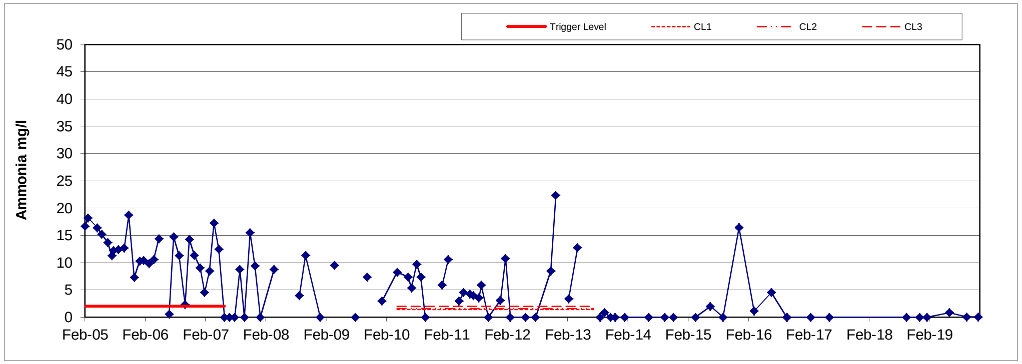
Sodium
Potassium
Magnesium
Sulphate
mg/l
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

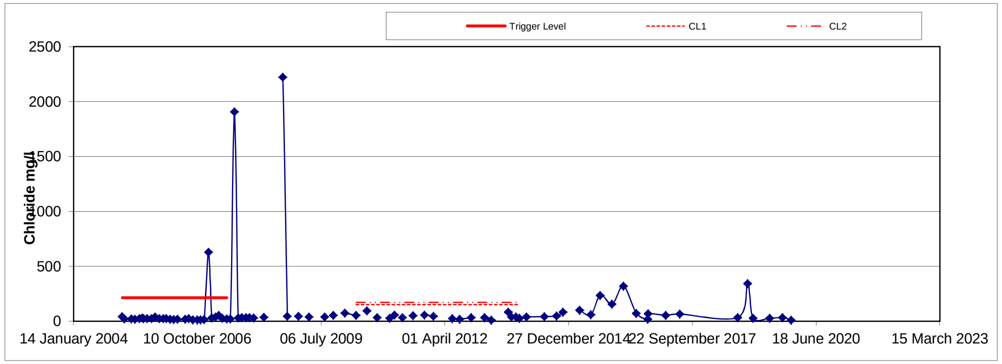



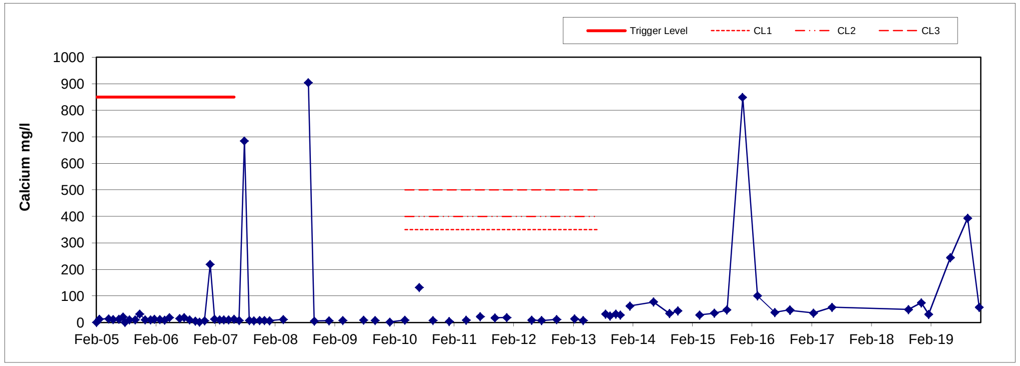
Nitrate
Nitrite
Phosphate
microg/l
18
16
14
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

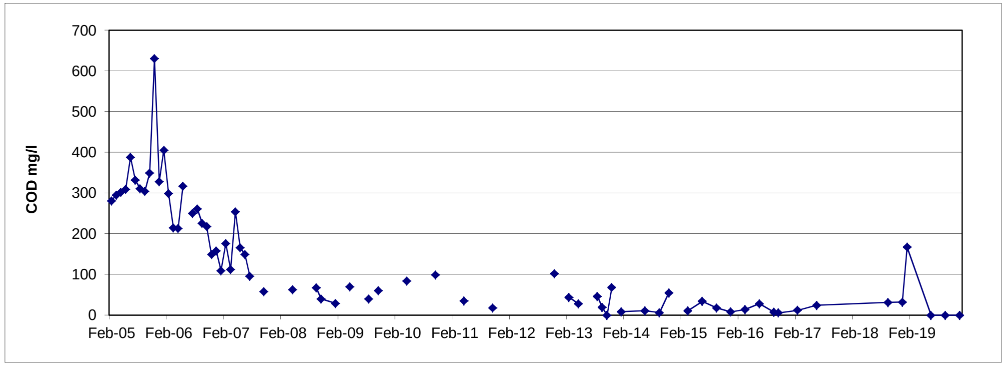

Water Level / mAOD
0
1
2
3
4
5
6
7
8
9
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

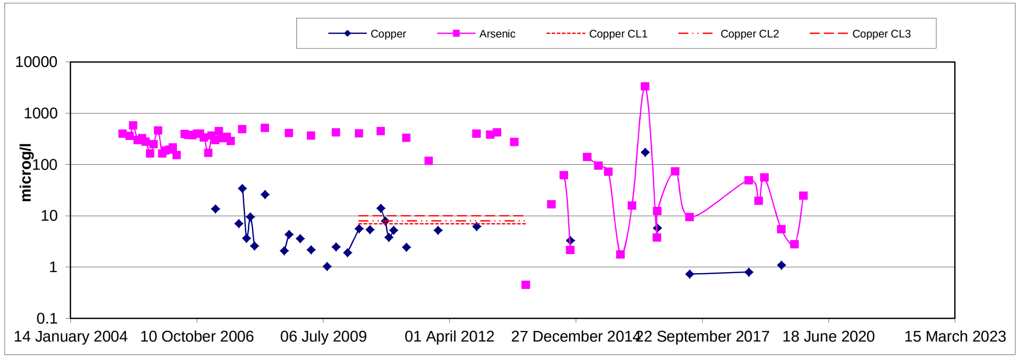

pH
EC
pH
EC microS/cm
0
2
4
6
8
10
12
14
0
1000
2000
3000
4000
5000
6000
7000
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

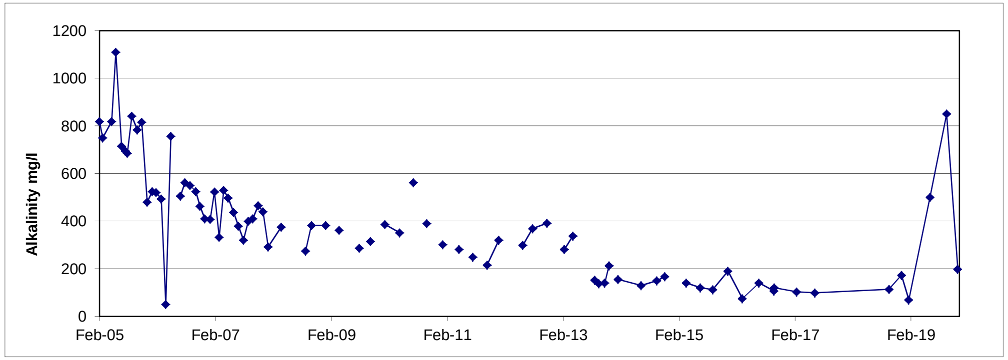

Trigger Level
CL1
CL2
CL3
Ammonia mg/l
0
5
10
15
20
25
30
35
40
45
50
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

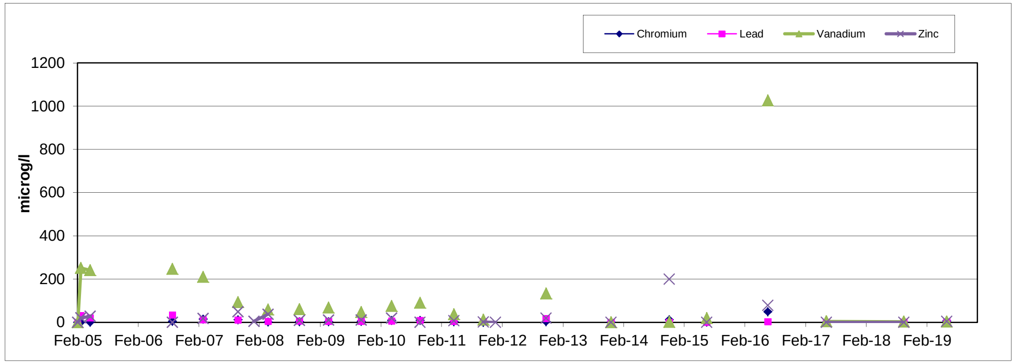

Trigger Level
CL1
CL2
Chloride mg/l
0
500
1000
1500
2000
2500
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

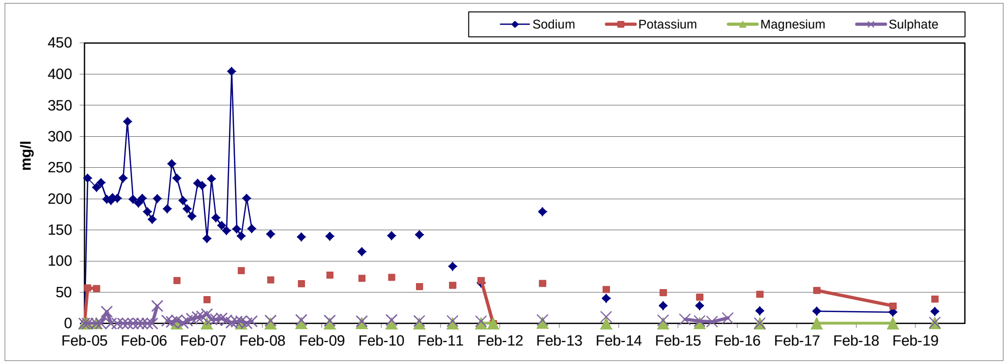

Trigger Level
CL1
CL2
CL3
Calcium mg/l
0
100
200
300
400
500
600
700
800
900
1000
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

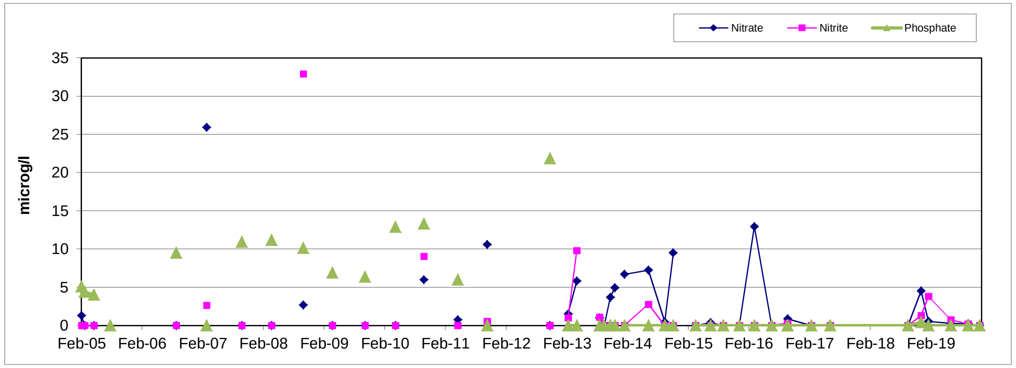

COD mg/l
0
100
200
300
400
500
600
700
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

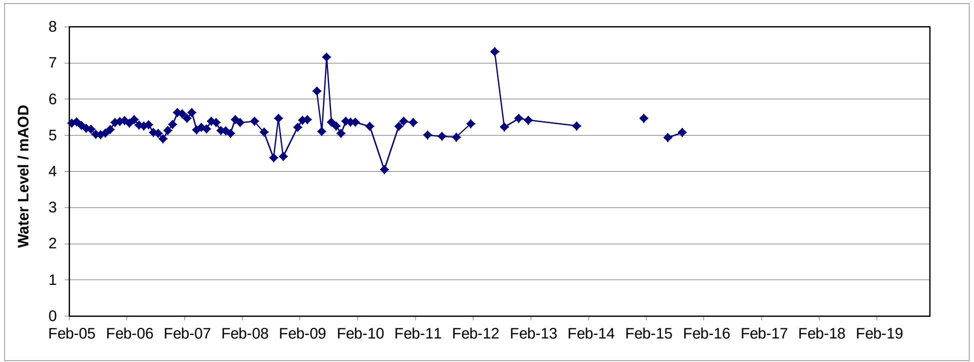

Copper
Arsenic
Copper CL1
Copper CL2
Copper CL3
microg/l
10000
1000
100
10
1
0.1
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

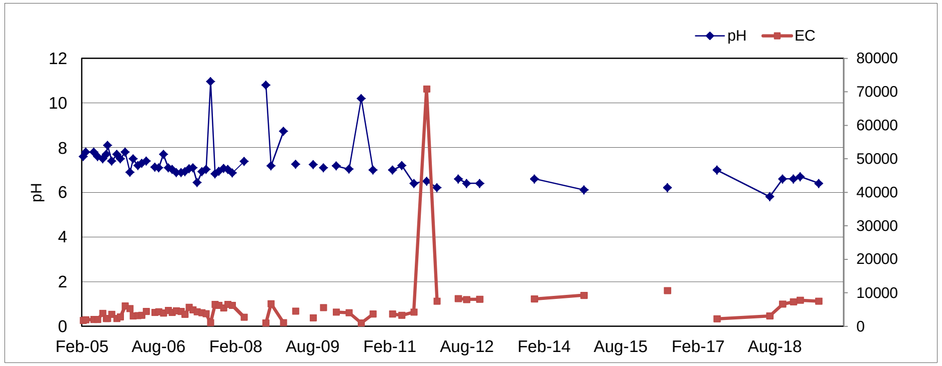

Alkalinity mg/l
1200
1000
800
600
400
200
0
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19

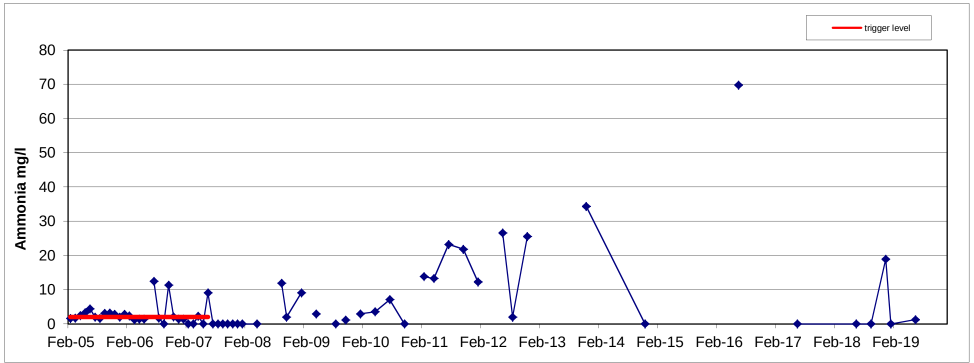

Chromium
Lead
Vanadium
Zinc
microg/l
1200
1000
800
600
400
200
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

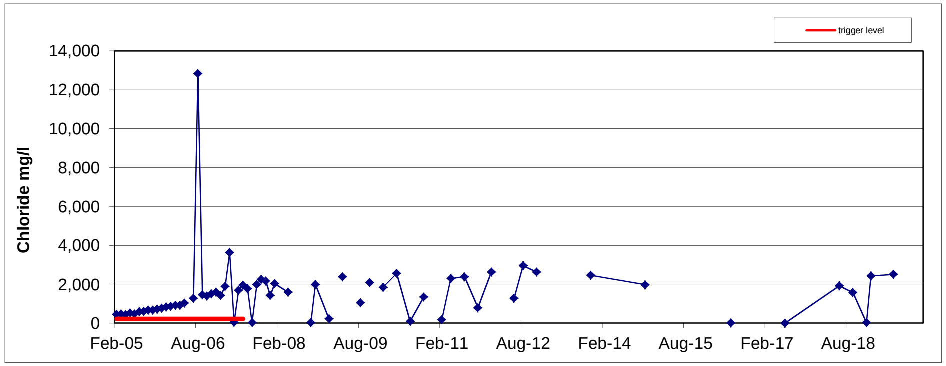

Sodium
Potassium
Magnesium
Sulphate
mg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

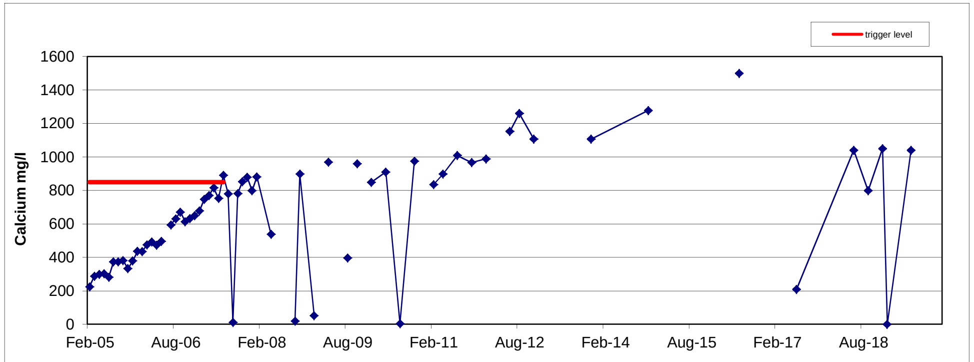

Nitrate
Nitrite
Phosphate
microg/l
35
30
25
20
15
10
5
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19

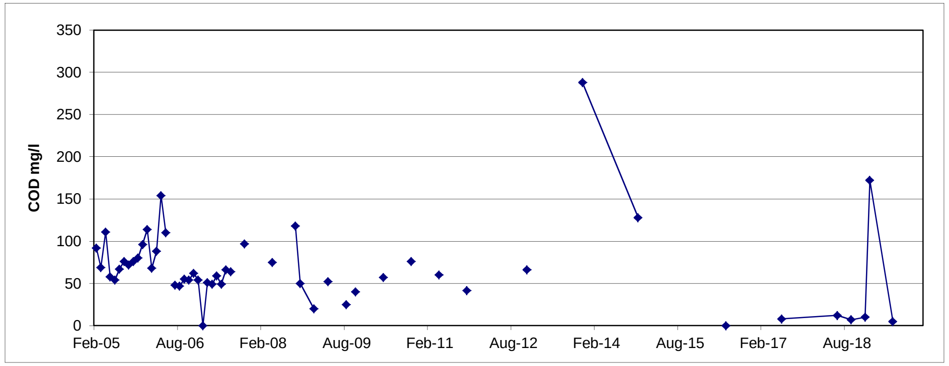

Water Level / mAOD
0
1
2
3
4
5
6
7
8
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

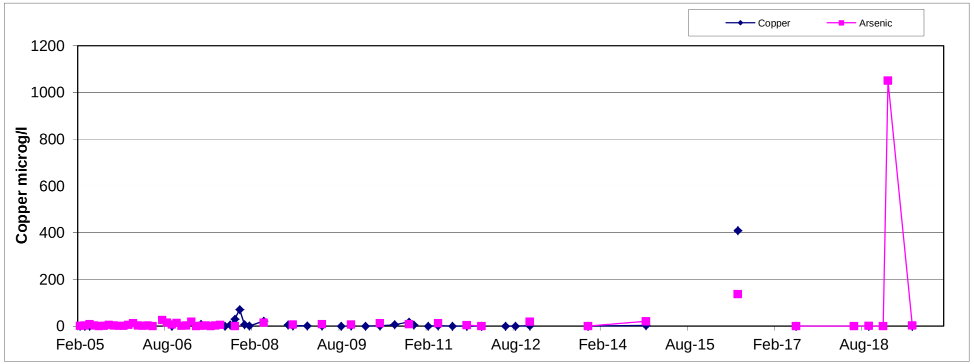

pH
EC
pH
0
2
4
6
8
10
12
0
10000
20000
30000
40000
50000
60000
70000
80000
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

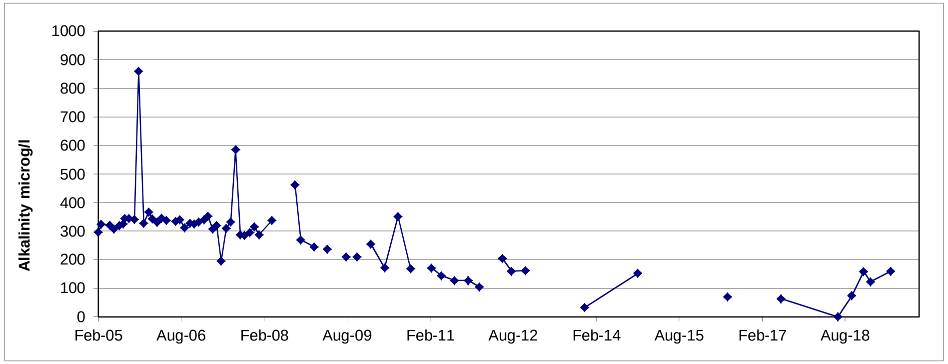

trigger level
Ammonia mg/l
0
10
20
30
40
50
60
70
80
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

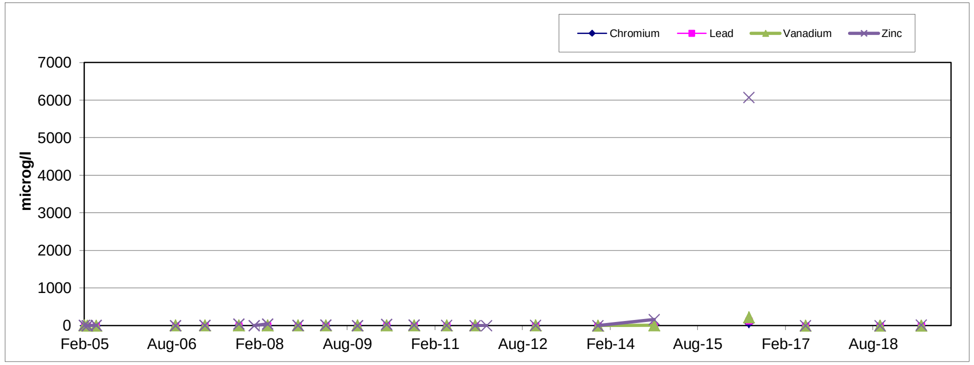

trigger level
Chloride mg/l
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

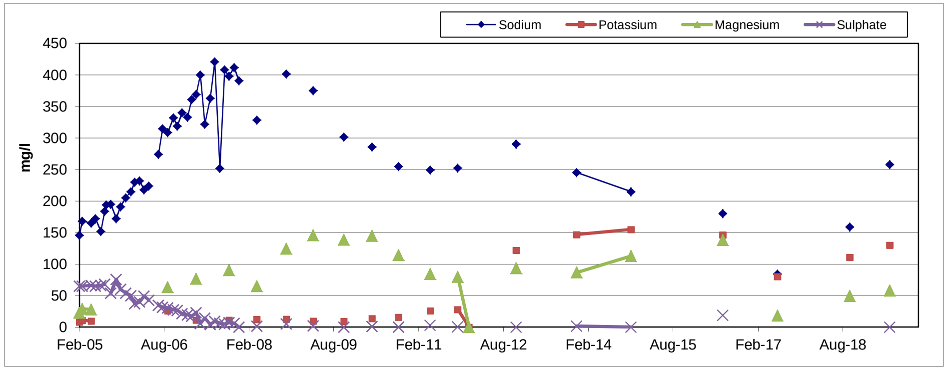

trigger level
Calcium mg/l
0
200
400
600
800
1000
1200
1400
1600
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

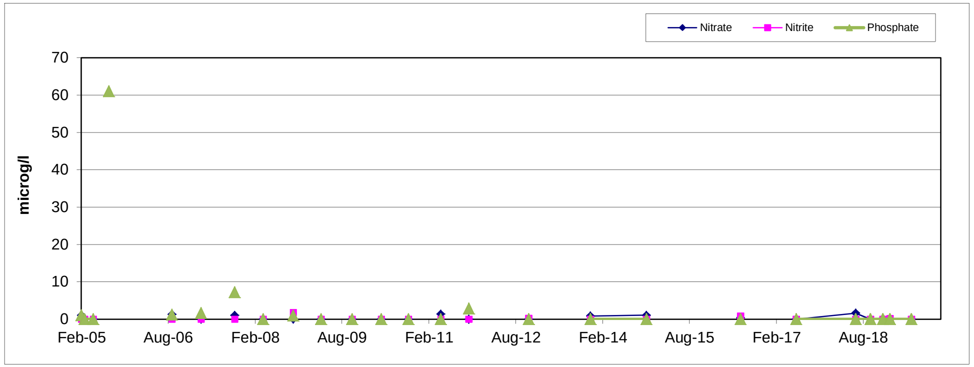

COD mg/l
0
50
100
150
200
250
300
350
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

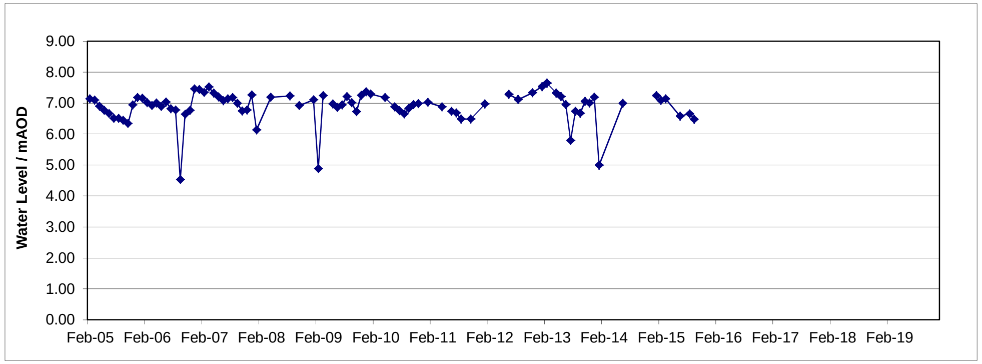

Copper
Arsenic
Copper microg/l
1200
1000
800
600
400
200
0
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18

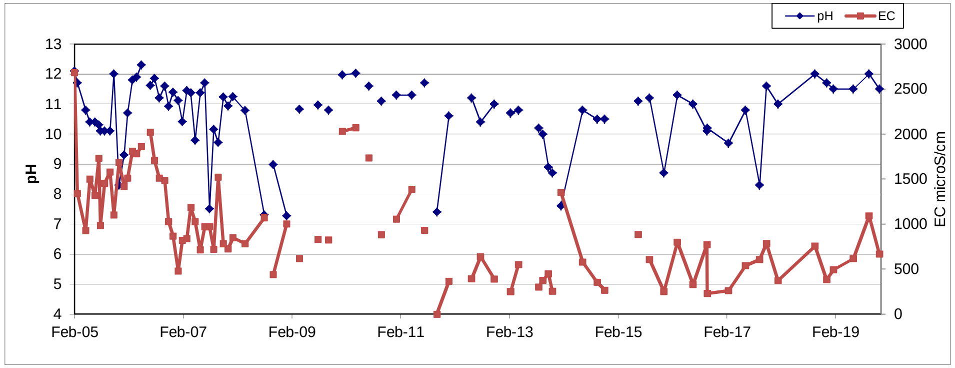

Alkalinity microg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18

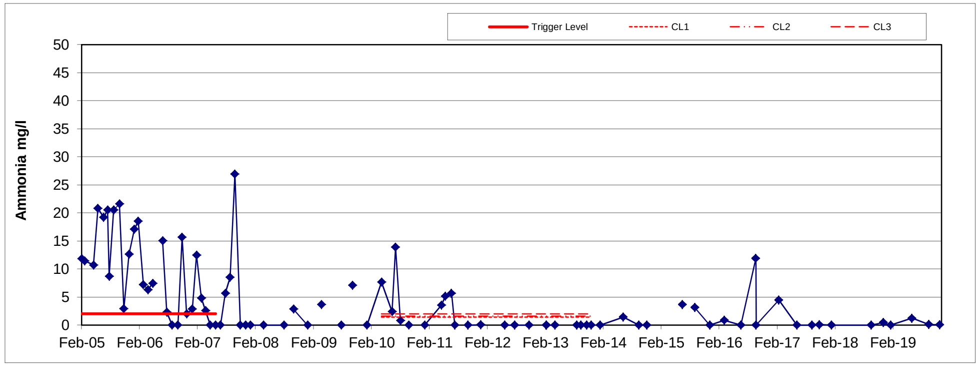

Chromium
Lead
Vanadium
Zinc
microg/l
7000
6000
5000
4000
3000
2000
1000
0
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18

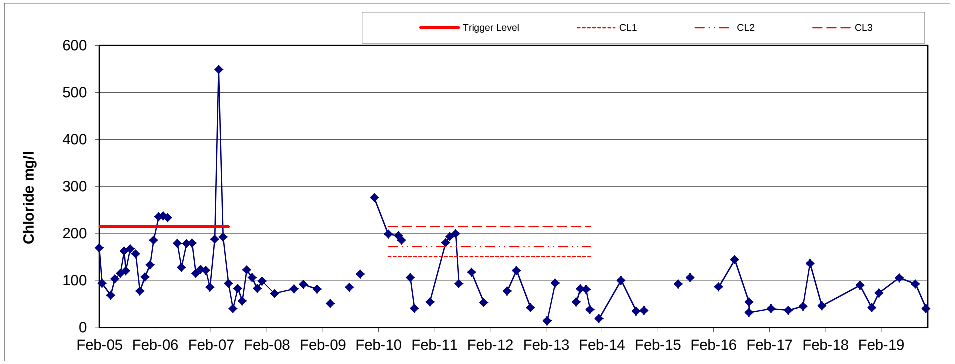

Sodium
Potassium
Magnesium
Sulphate
mg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18

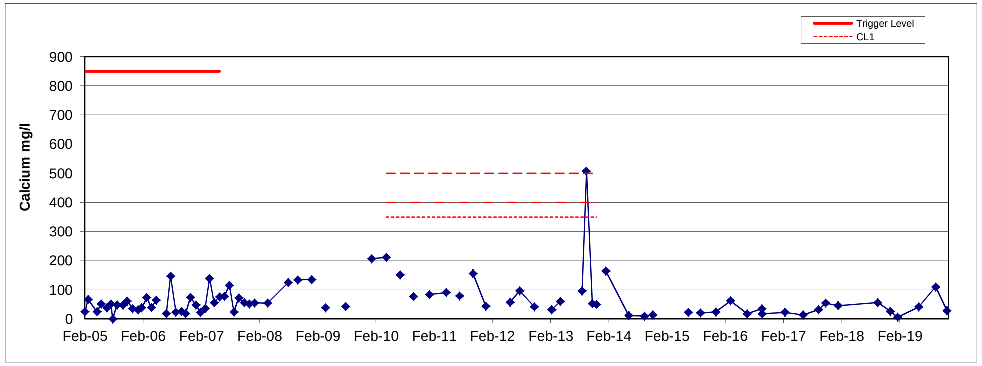

Nitrate
Nitrite
Phosphate
microg/l
70
60
50
40
30
20
10
0
Feb-05
Aug-06
Feb-08
Aug-09
Feb-11
Aug-12
Feb-14
Aug-15
Feb-17
Aug-18

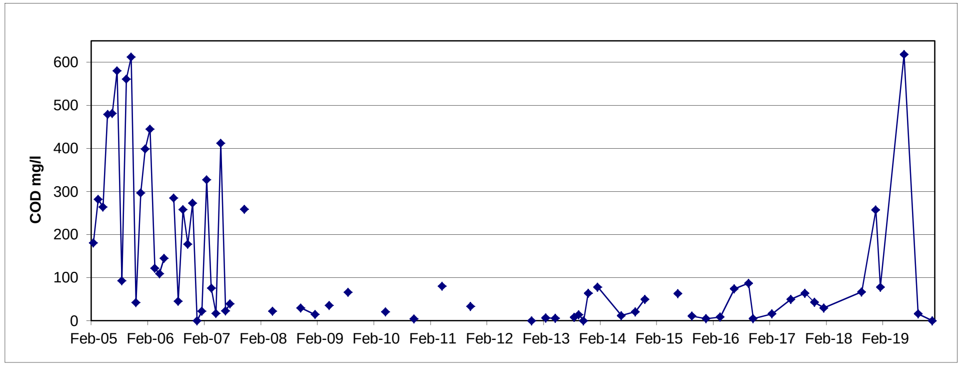

Water Level / mAOD
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

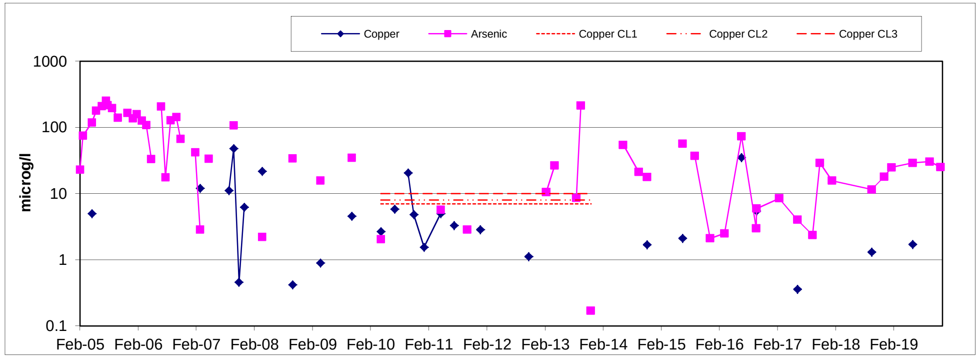

pH
EC
pH
EC microS/cm
13
12
11
10
9
8
7
6
5
4
3000
2500
2000
1500
1000
500
0
Feb-05 Feb-07 Feb-09 Feb-11 Feb-13 Feb-15 Feb-17 Feb-19

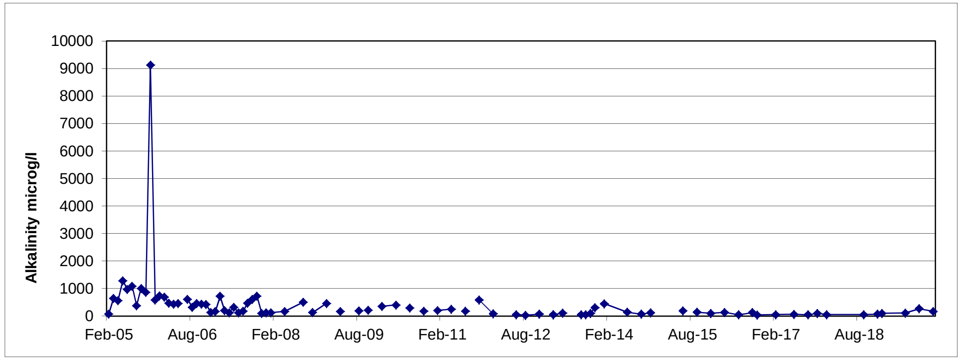

Trigger Level
CL1
CL2
CL3
Ammonia mg/l
50
45
40
35
30
25
20
15
10
5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

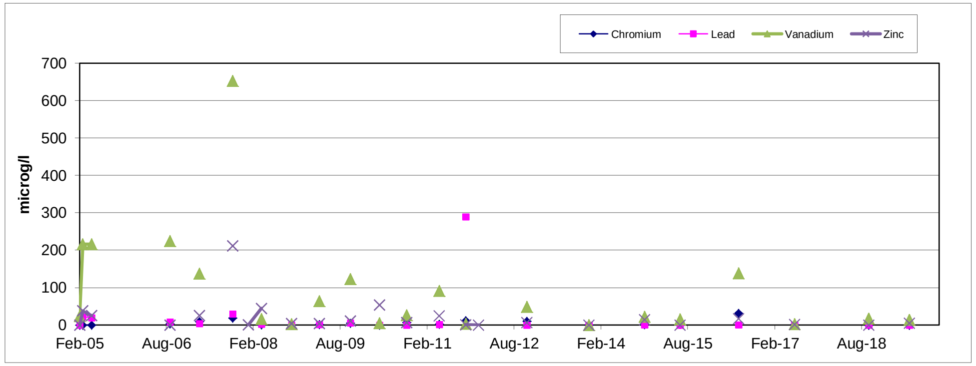

Trigger Level
CL1
CL2
CL3
Chloride mg/l
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

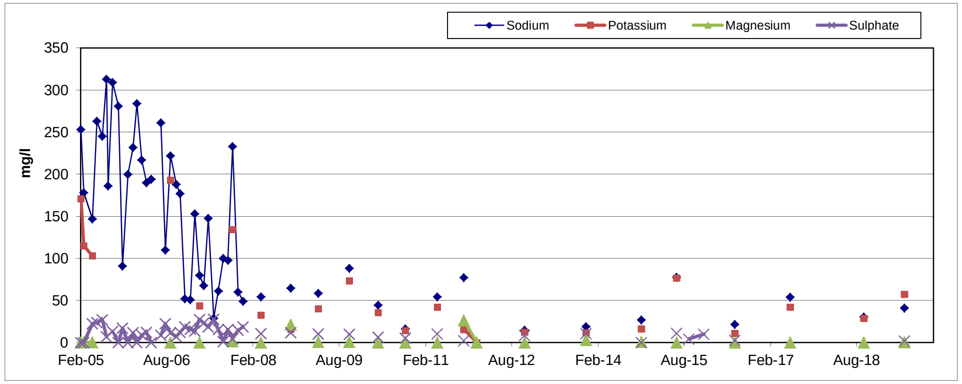

Trigger Level
CL1
Calcium mg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

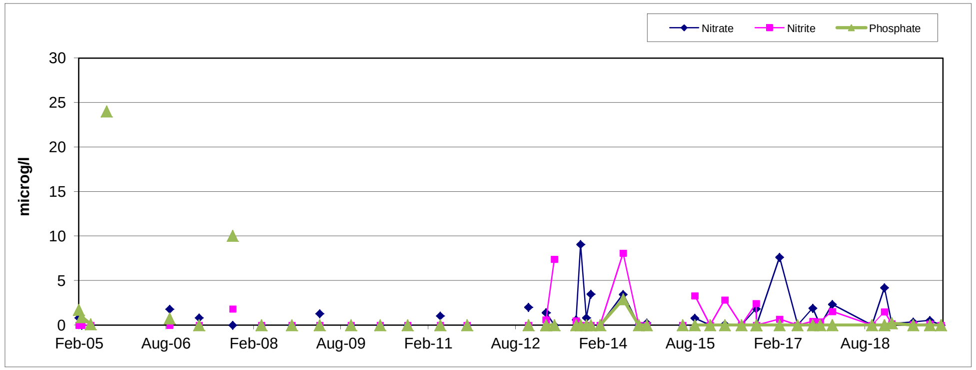

COD mg/l
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

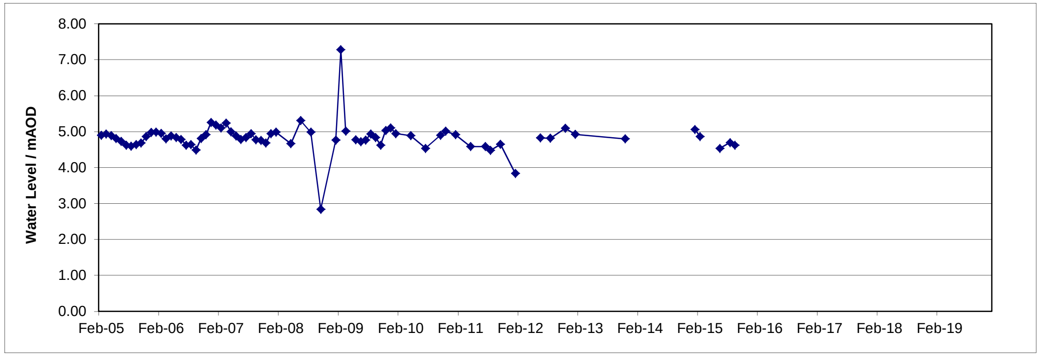

Copper
Arsenic
Copper CL1
Copper CL2
Copper CL3
1000
100
10
1
0.1
microg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

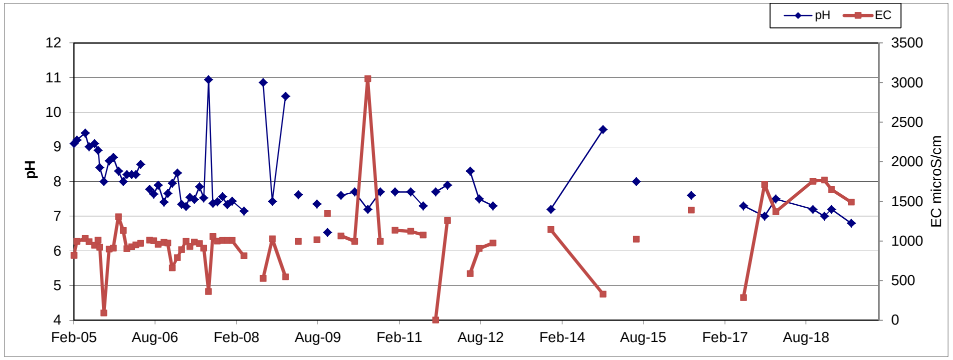

10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Alkalinity microg/l
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

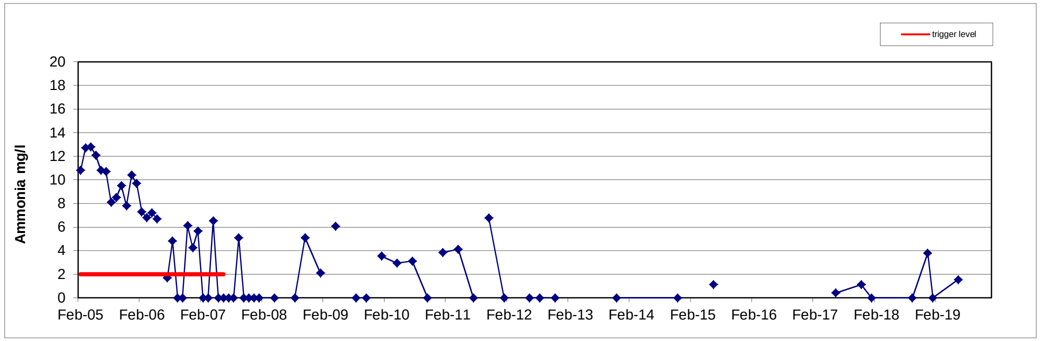

Chromium
Lead
Vanadium
Zinc
700
600
500
400
300
200
100
0
microg/l
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

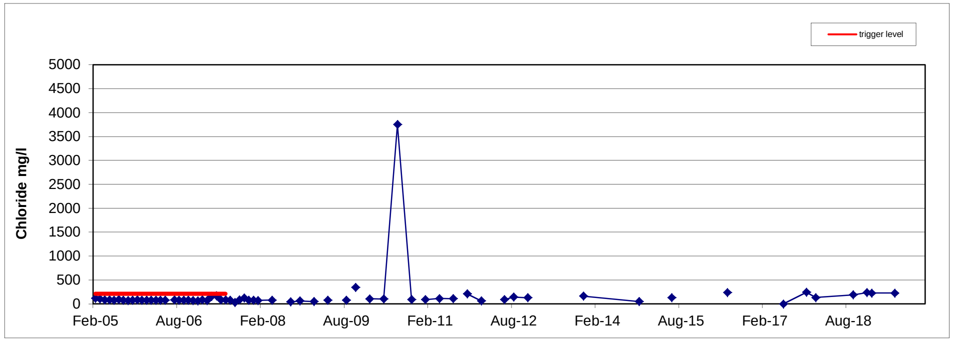

Sodium
Potassium
Magnesium
Sulphate
350
300
250
200
150
100
50
0
mg/l
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

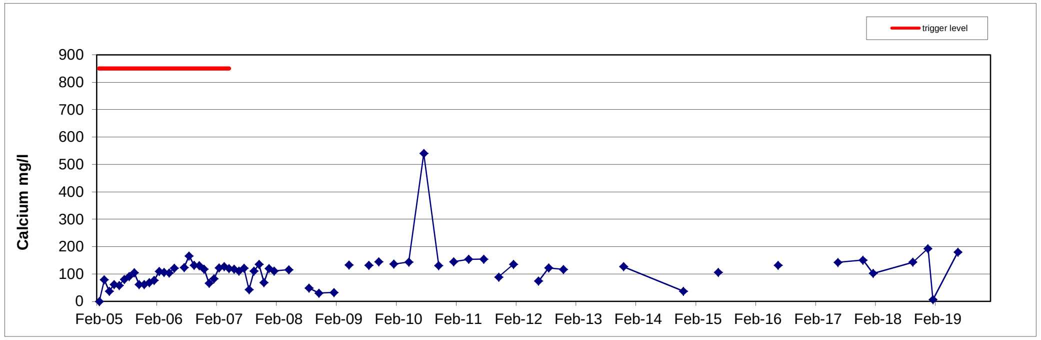

Nitrate
Nitrite
Phosphate
30
25
20
15
10
5
0
microg/l
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

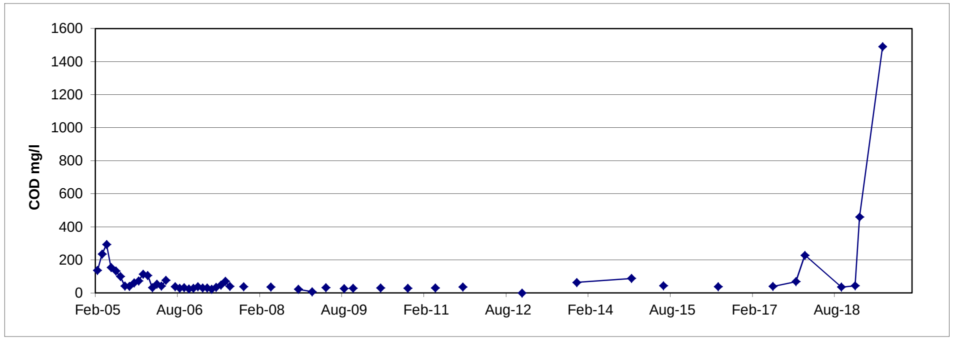

Water Level / mAOD
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

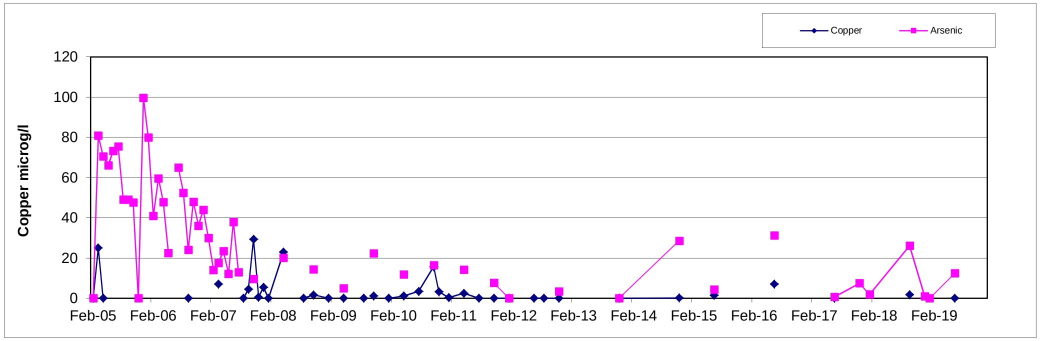

pH
EC
12
11
10
9
8
7
6
5
4
3500
3000
2500
2000
1500
1000
500
0
EC microS/cm
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

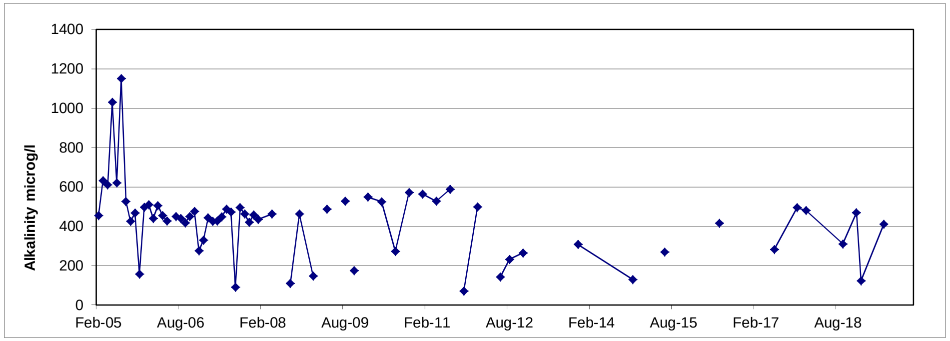

trigger level
Ammonia mg/l
20
18
16
14
12
10
8
6
4
2
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

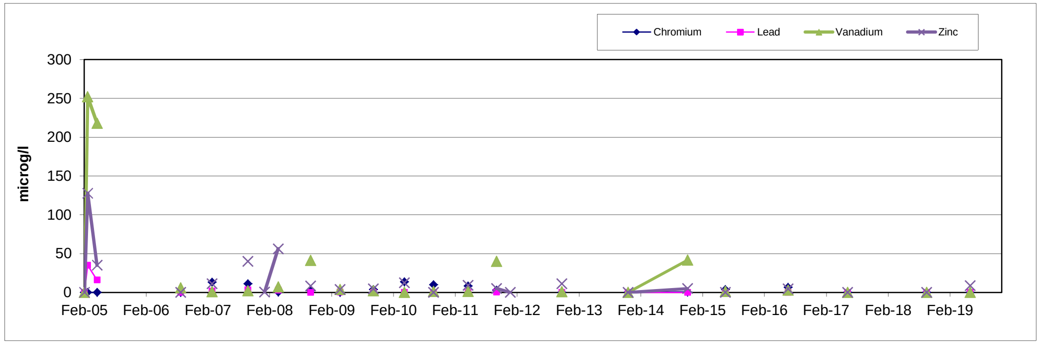

trigger level
Chloride mg/l
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

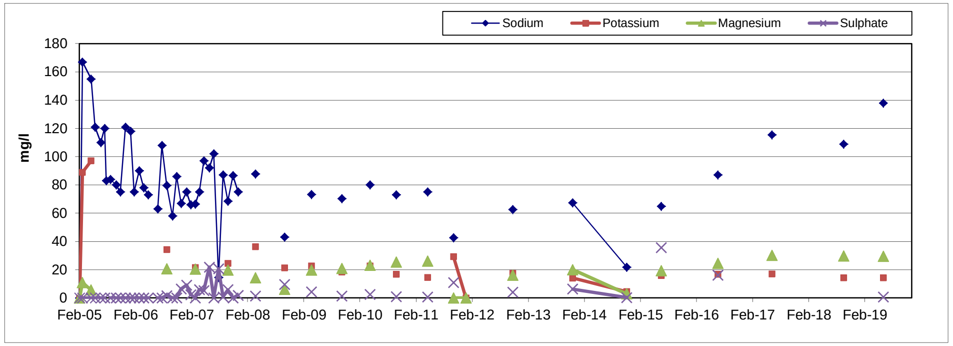

trigger level
Calcium mg/l
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

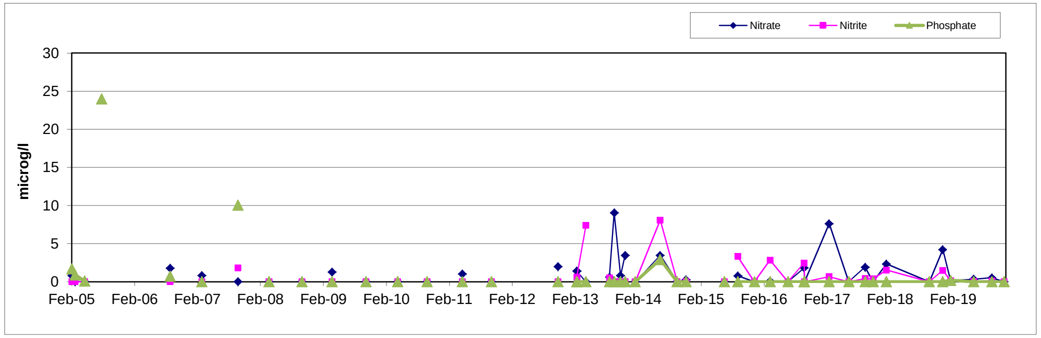

COD mg/l
1600
1400
1200
1000
800
600
400
200
0
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

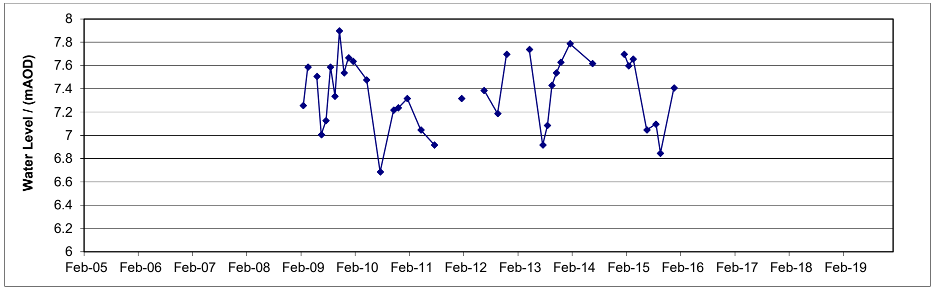

Copper
Arsenic
Copper microg/l
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

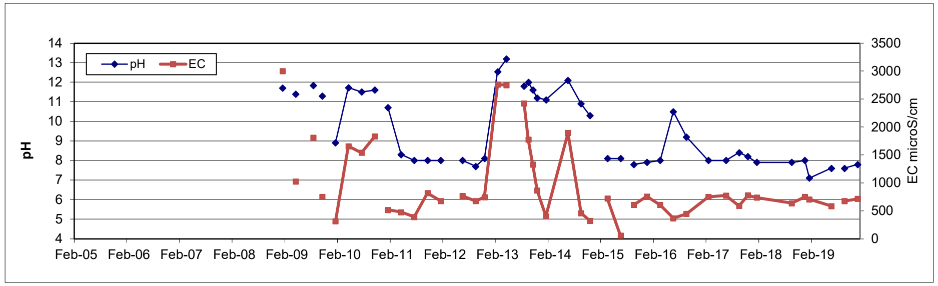

Alkalinity microg/l
1400
1200
1000
800
600
400
200
0
Feb-05 Aug-06 Feb-08 Aug-09 Feb-11 Aug-12 Feb-14 Aug-15 Feb-17 Aug-18

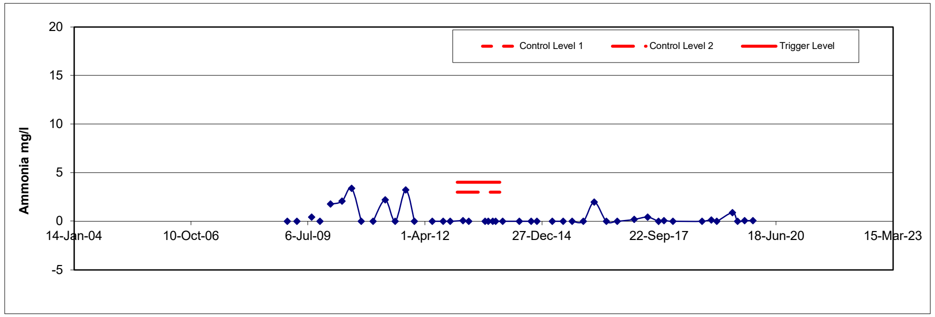

Chromium
Lead
Vanadium
Zinc
microg/l
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

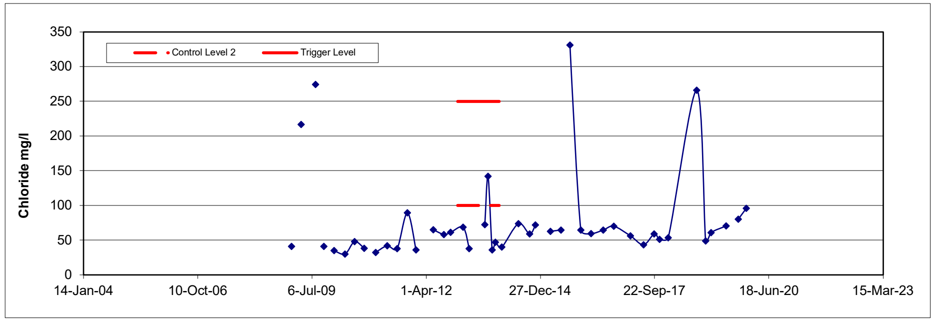

Sodium
Potassium
Magnesium
Sulphate
mg/l
180
160
140
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

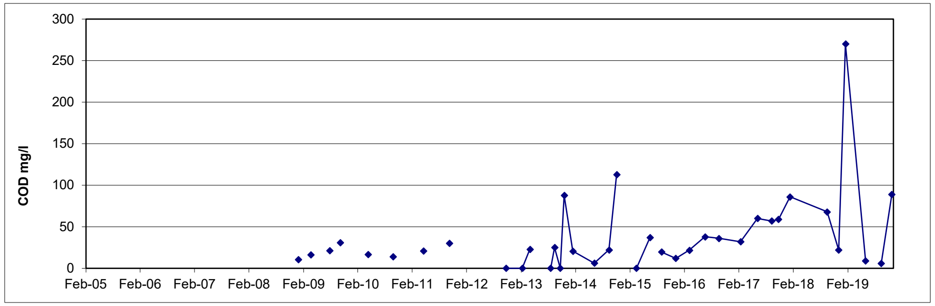

Nitrate
Nitrite
Phosphate
microg/l
30
25
20
15
10
5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

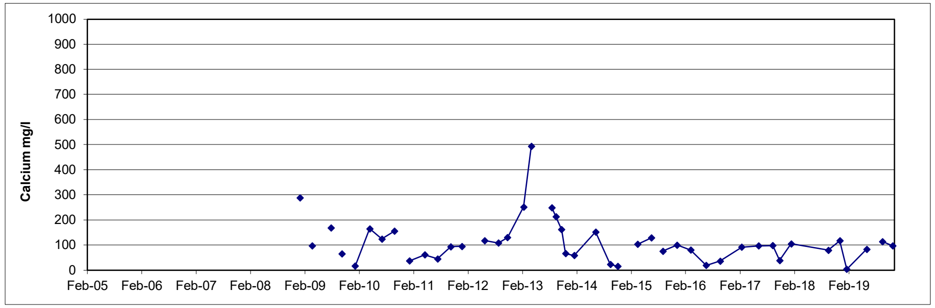

Water Level / (mAOD)
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

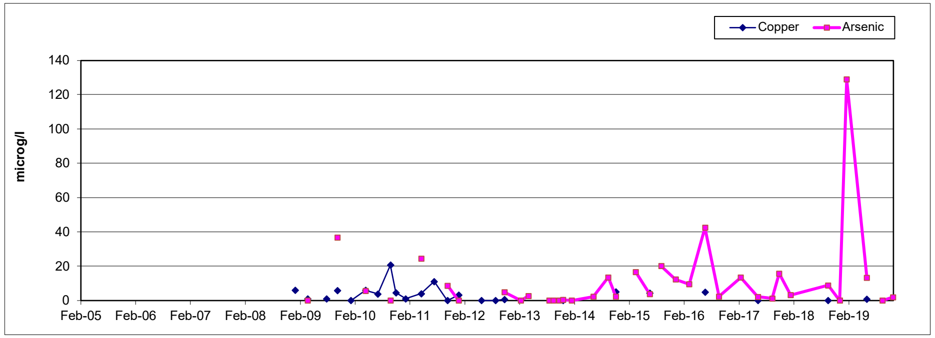

pH
EC
pH
EC microS/cm
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

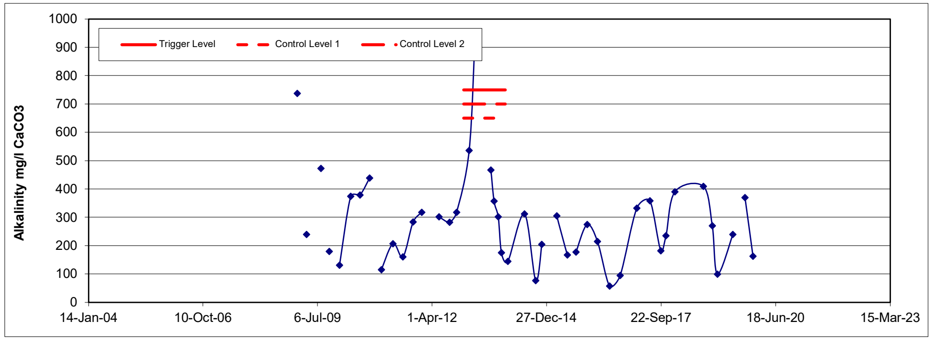

Ammonia mg/l
Control Level 1
Control Level 2
Trigger Level
14-Jan-04 10-Oct-06 6-Jul-09 1-Apr-12 27-Dec-14 22-Sep-17 18-Jun-20 15-Mar-23

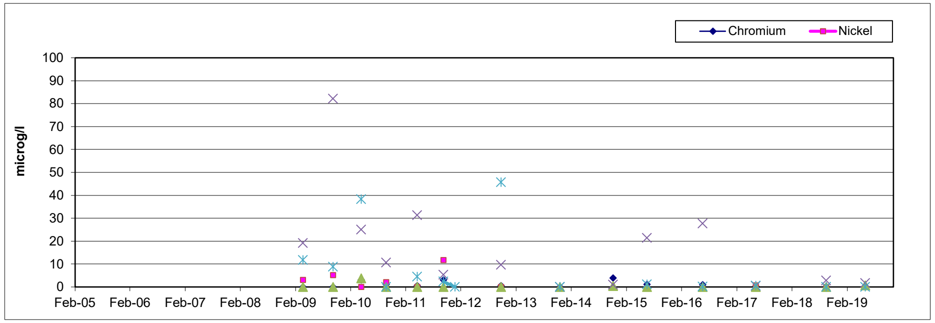

Chloride mg/l
Control Level 2
Trigger Level
14-Jan-04 10-Oct-06 6-Jul-09 1-Apr-12 27-Dec-14 22-Sep-17 18-Jun-20 15-Mar-23

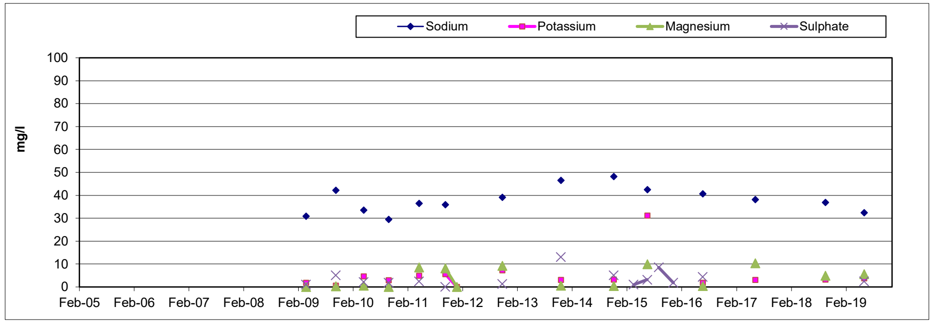

COD mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

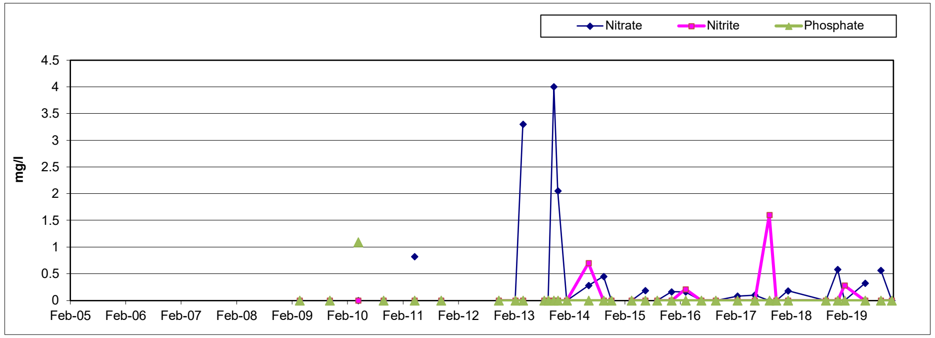

Calcium mg/l
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

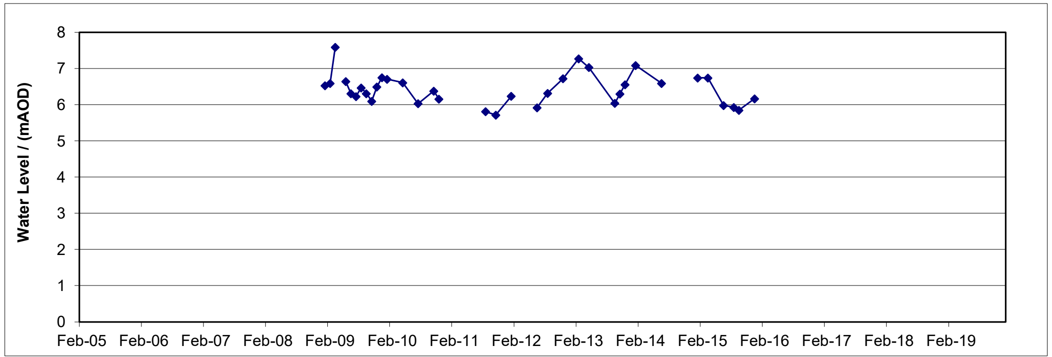

Copper
Arsenic
microg/l
140
120
100
80
60
40
20
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

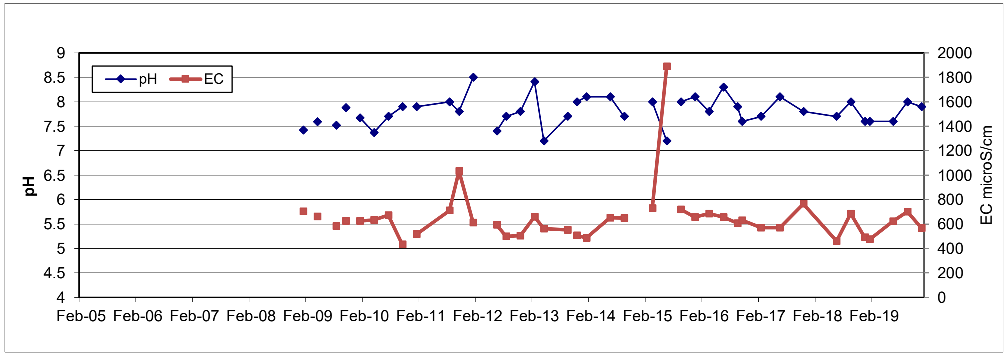

Trigger Level
Control Level 1
Control Level 2
Alkalinity mg/l CaCO3
1000
900
800
700
600
500
400
300
200
100
0
14-Jan-04 10-Oct-06 6-Jul-09 1-Apr-12 27-Dec-14 22-Sep-17 18-Jun-20 15-Mar-23

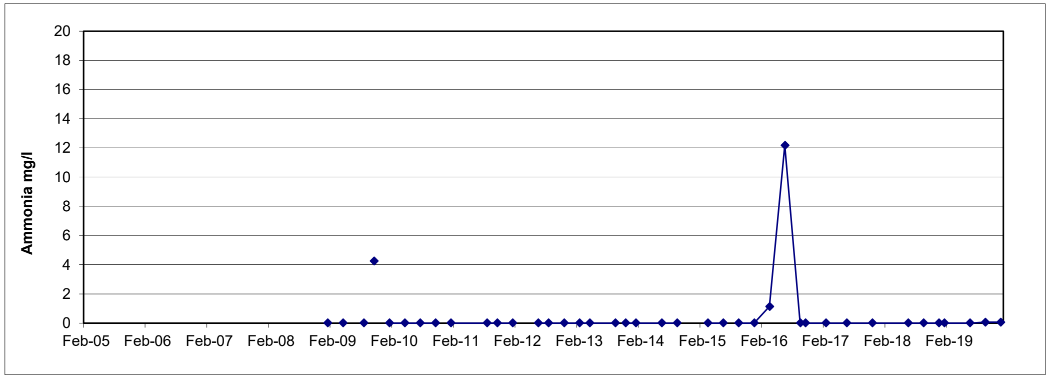

Chromium
Nickel
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

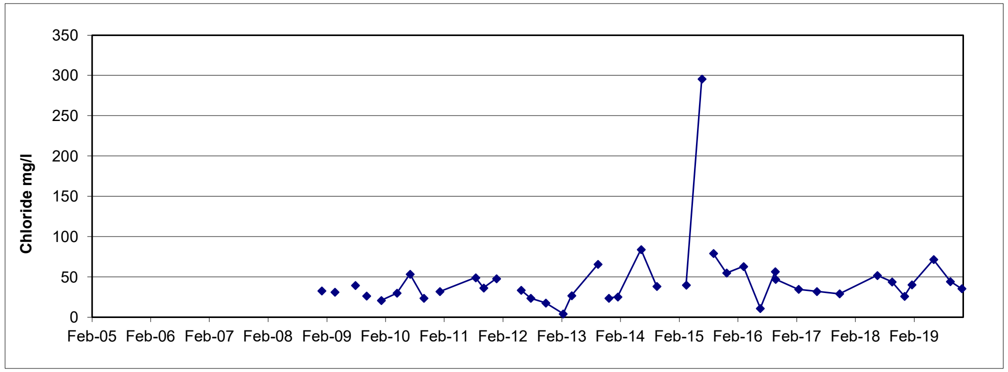

Sodium
Potassium
Magnesium
Sulphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

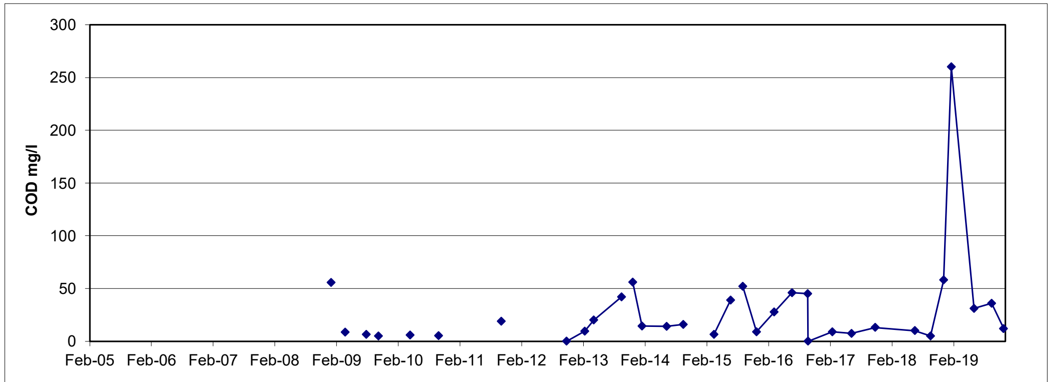

Nitrate
Nitrite
Phosphate
mg/l
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

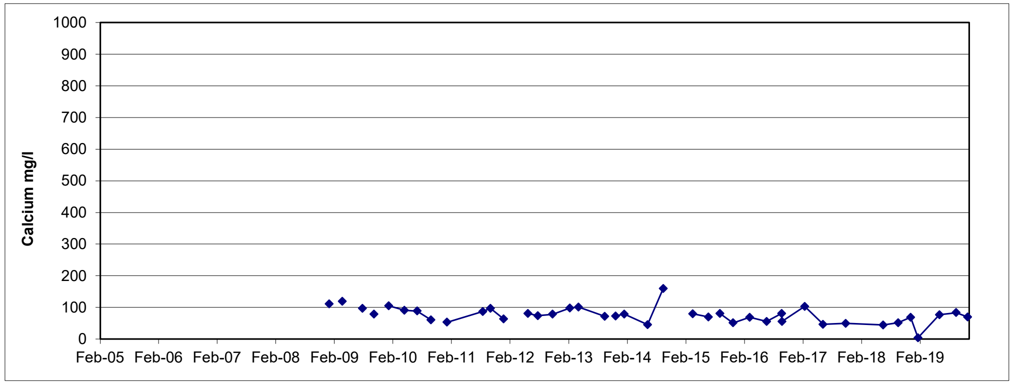

Water Level / (mAOD)
0
1
2
3
4
5
6
7
8
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

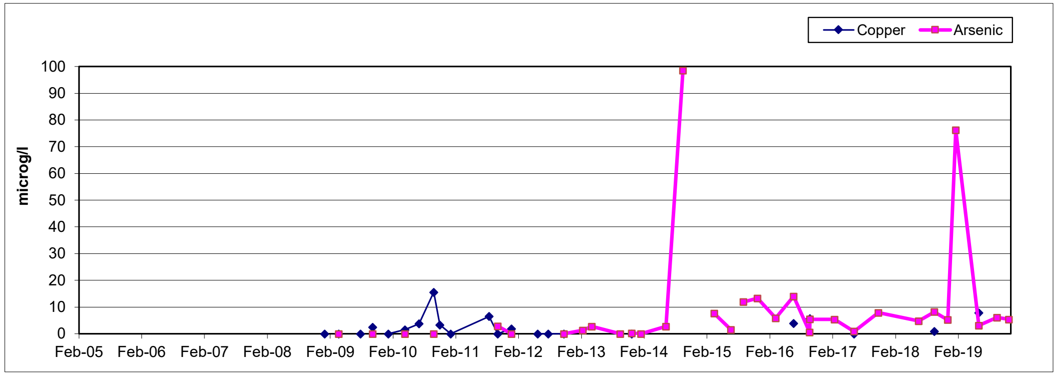

pH
EC
pH
EC microS/cm
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

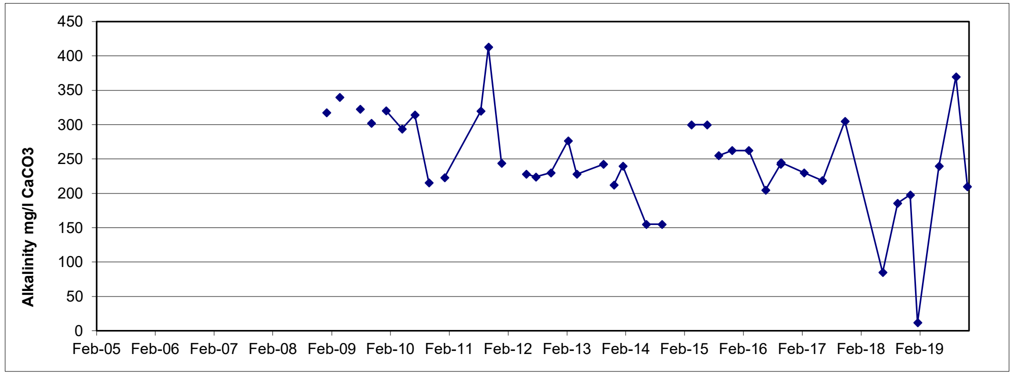

Ammonia mg/l
0
2
4
6
8
10
12
14
16
18
20
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

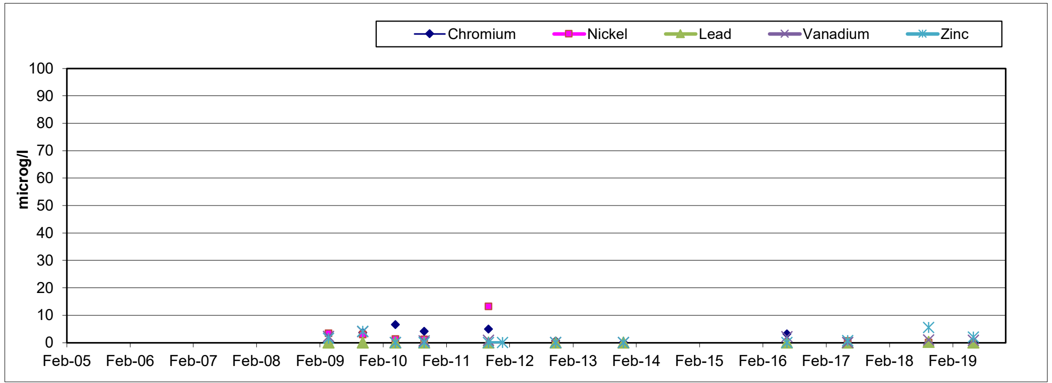

Chloride mg/l
0
50
100
150
200
250
300
350
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

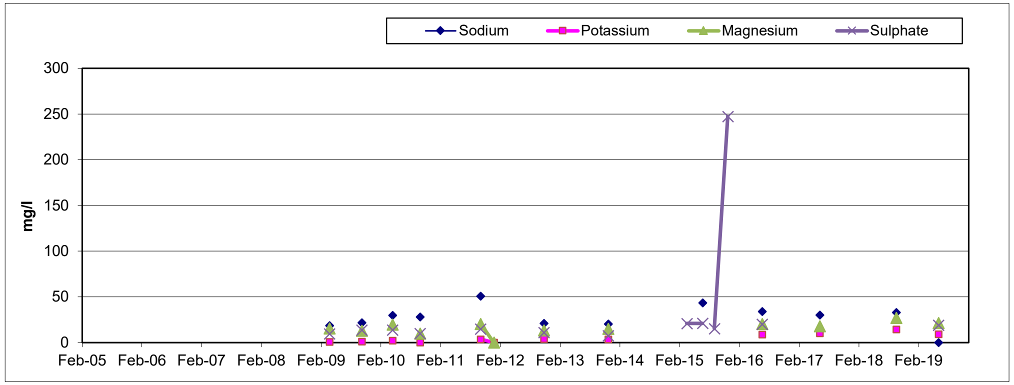

COD mg/l
0
50
100
150
200
250
300
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

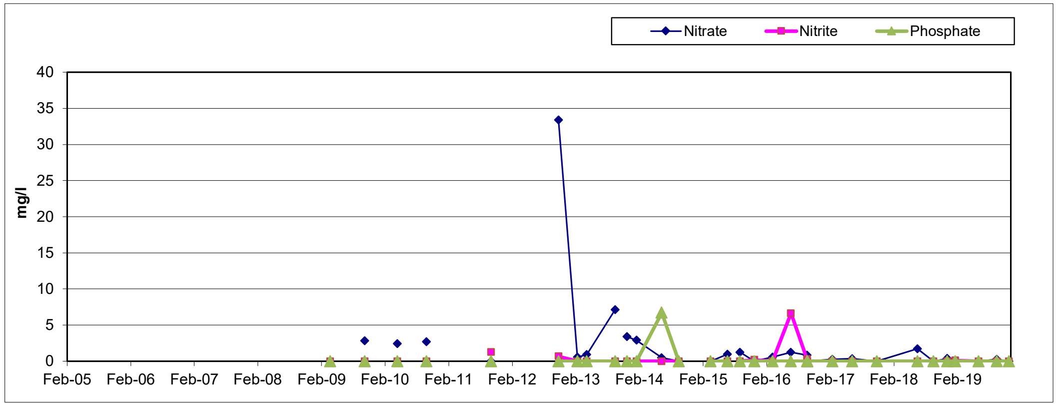

Calcium mg/l
0
100
200
300
400
500
600
700
800
900
1000
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Copper
Arsenic
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Alkalinity mg/l CaCO3
450
400
350
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Sodium
Potassium
Magnesium
Sulphate
mg/l
300
250
200
150
100
50
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19


Nitrate
Nitrite
Phosphate
mg/l
40
35
30
25
20
15
10
5
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17 Feb-18 Feb-19

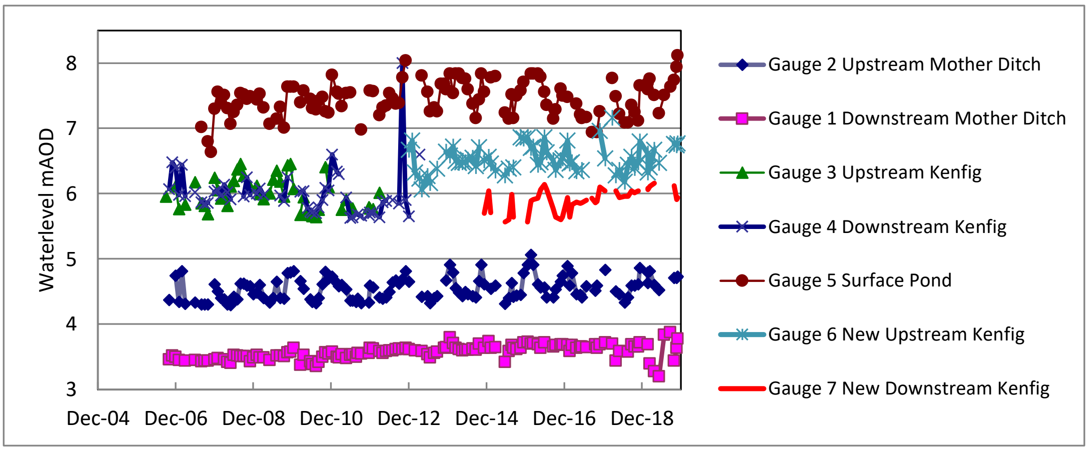
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

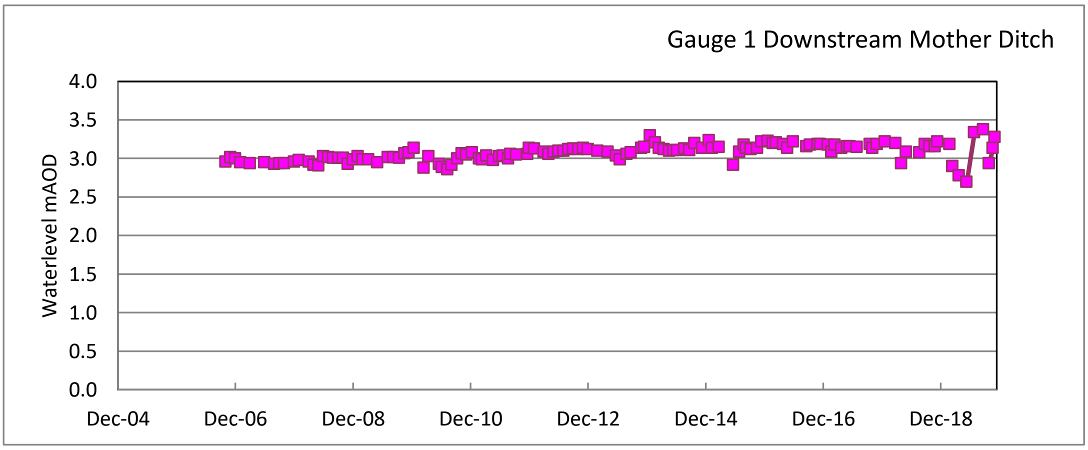
## PERMIT BV7311IE

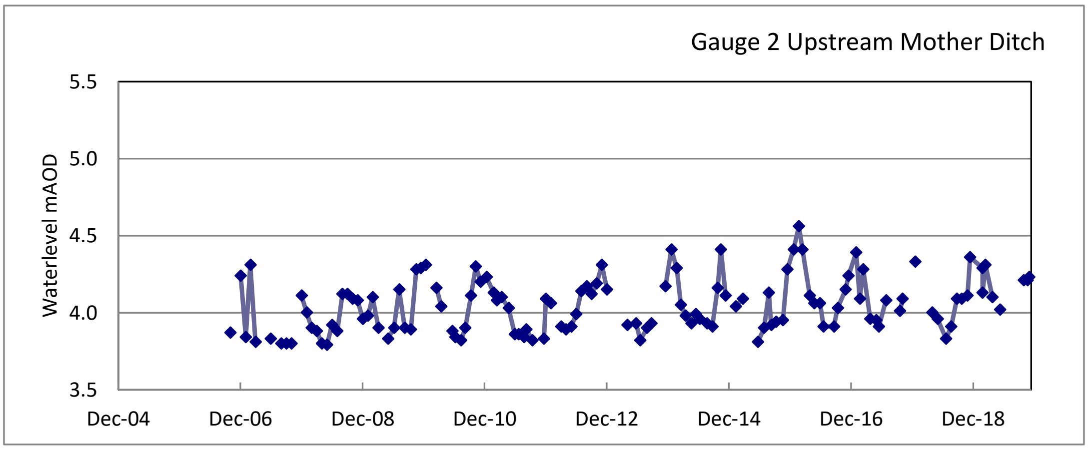
## 2019 Annual Review of Environmental Monitoring

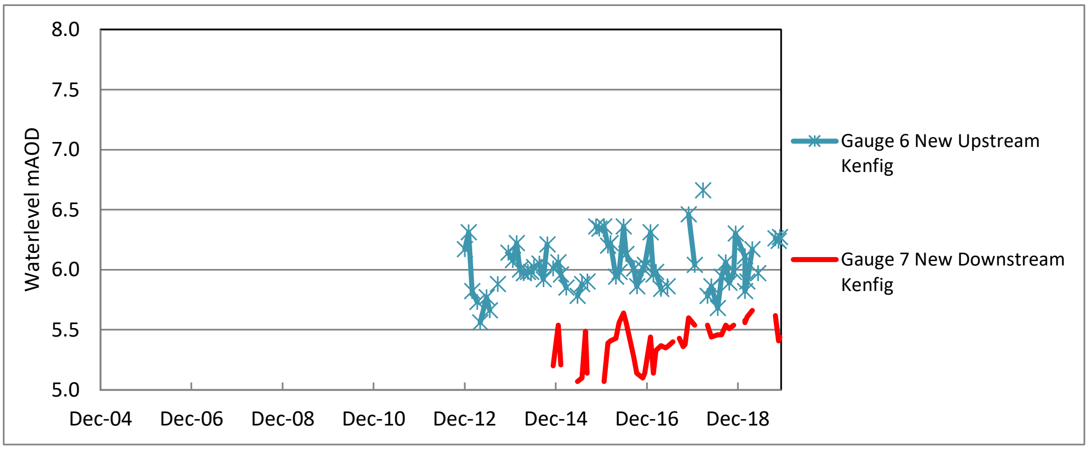
## Appendix 6
## Temporal Variation of Surface Water Chemistry

*Report Number 1965r1v1d0220*


Waterlevel mAOD
8
7
6
5
4
3
Dec-04 Dec-06 Dec-08 Dec-10 Dec-12 Dec-14 Dec-16 Dec-18
Gauge 2 Upstream Mother Ditch
Gauge 1 Downstream Mother Ditch
Gauge 3 Upstream Kenfig
Gauge 4 Downstream Kenfig
Gauge 5 Surface Pond
Gauge 6 New Upstream Kenfig
Gauge 7 New Downstream Kenfig


Gauge 1 Downstream Mother Ditch
Waterlevel mAOD
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Dec-04 Dec-06 Dec-08 Dec-10 Dec-12 Dec-14 Dec-16 Dec-18


Gauge 2 Upstream Mother Ditch
Waterlevel mAOD
5.5
5.0
4.5
4.0
3.5
Dec-04 Dec-06 Dec-08 Dec-10 Dec-12 Dec-14 Dec-16 Dec-18


Waterlevel mAOD
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Dec-04 Dec-06 Dec-08 Dec-10 Dec-12 Dec-14 Dec-16 Dec-18
Gauge 6 New Upstream Kenfig
Gauge 7 New Downstream Kenfig

**MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT**

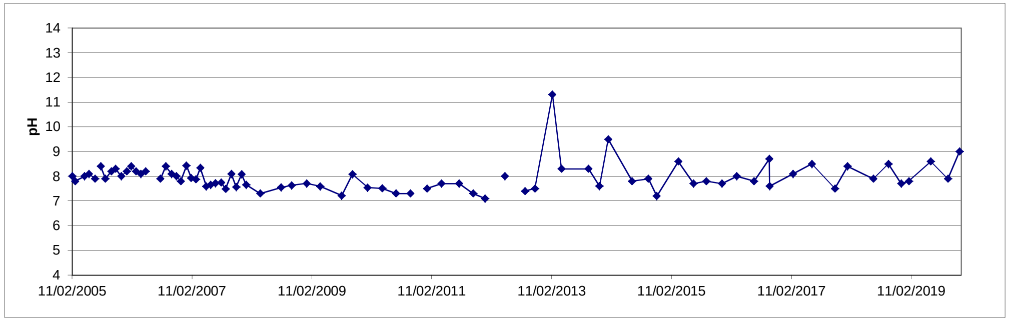
**PERMIT BV7311IE**

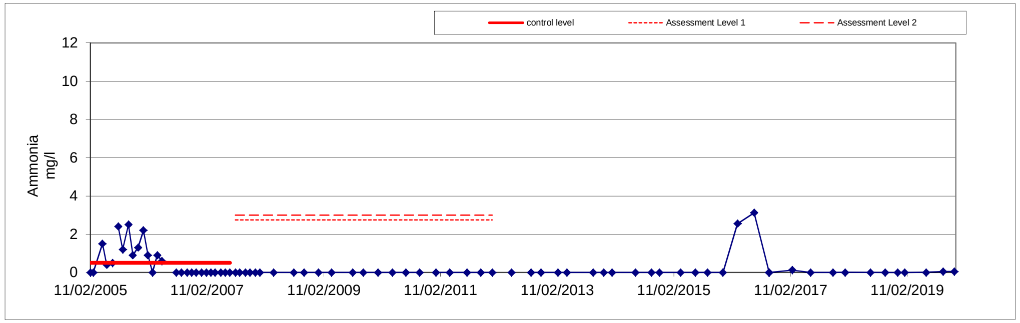
**2019 Annual Review of Environmental Monitoring**

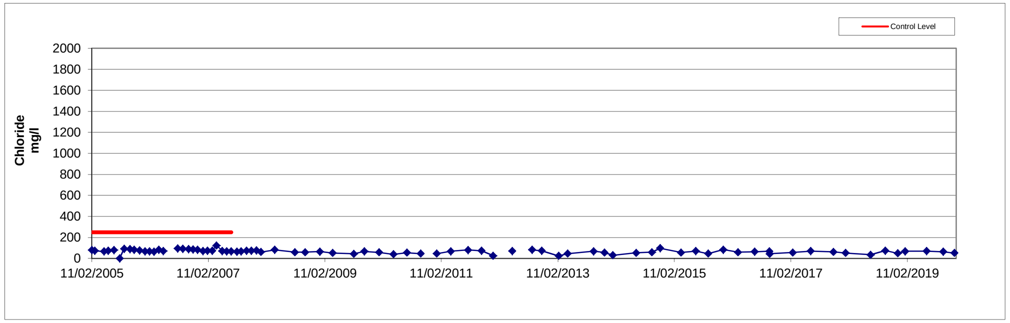
**Appendix 7**
**Temporal Variation of Surface Water Chemistry**
*Report Number 1965r1v1d0220*

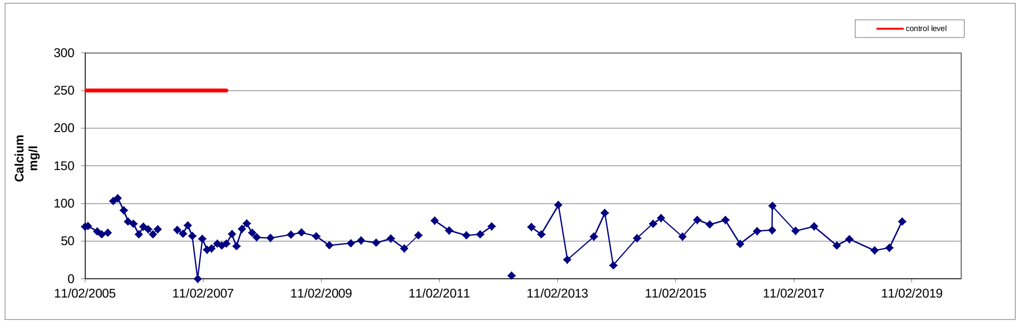
# Monitoring data for SW 1

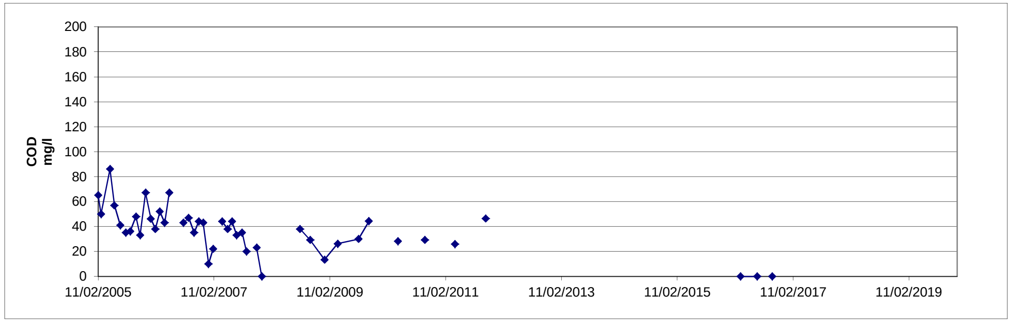


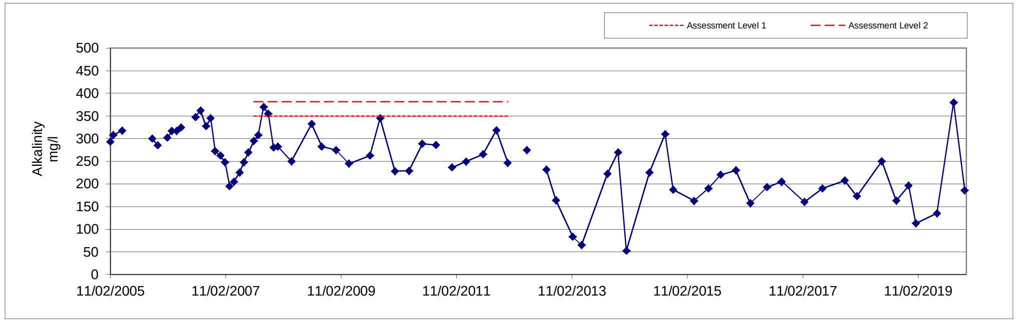


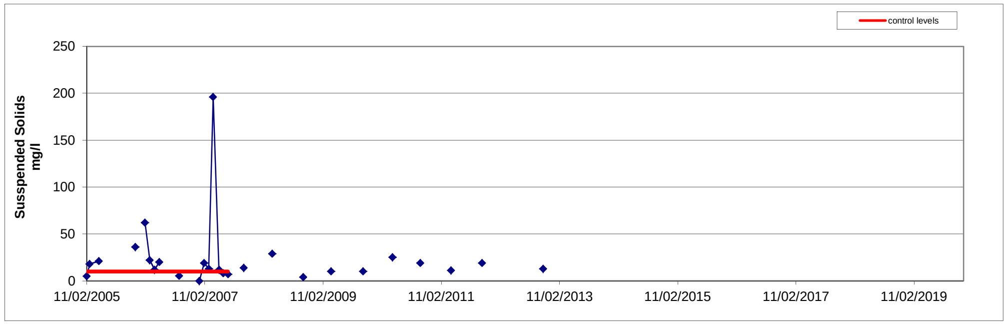



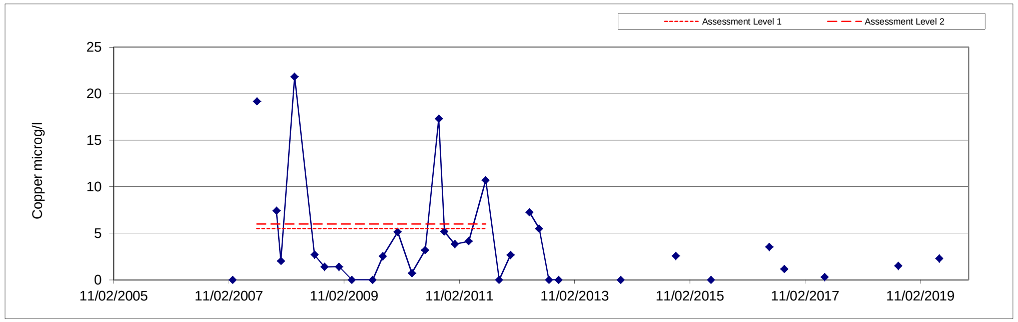



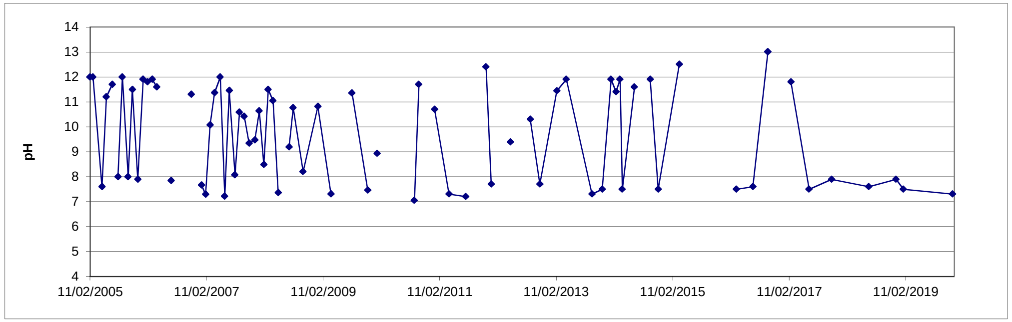



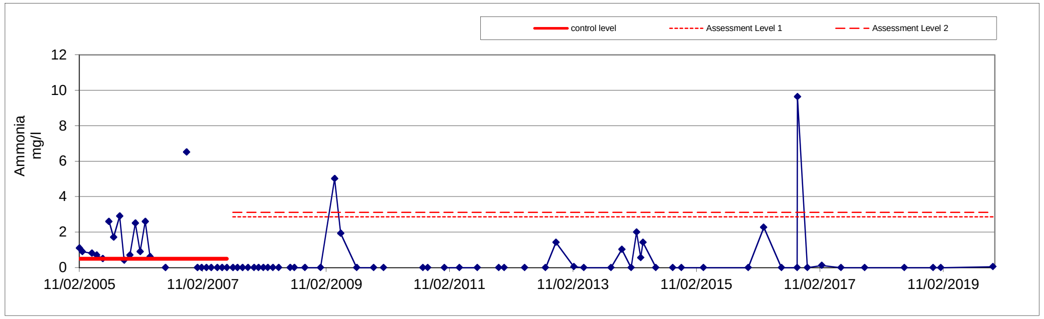



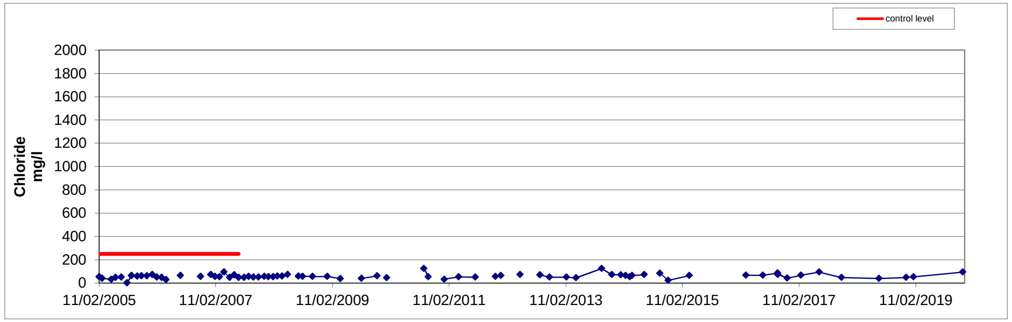



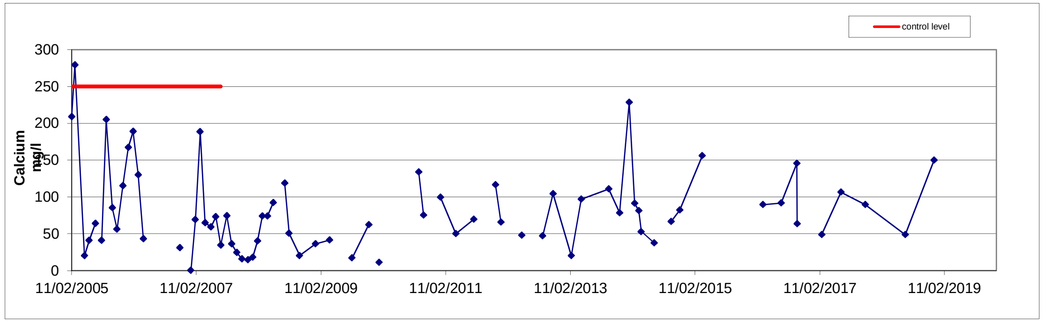



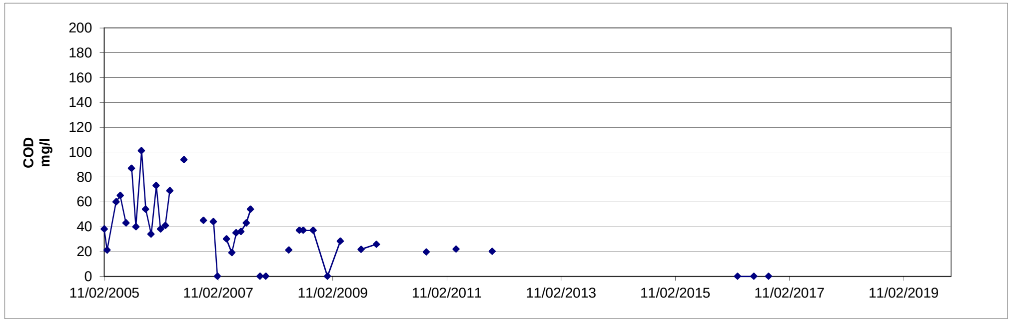



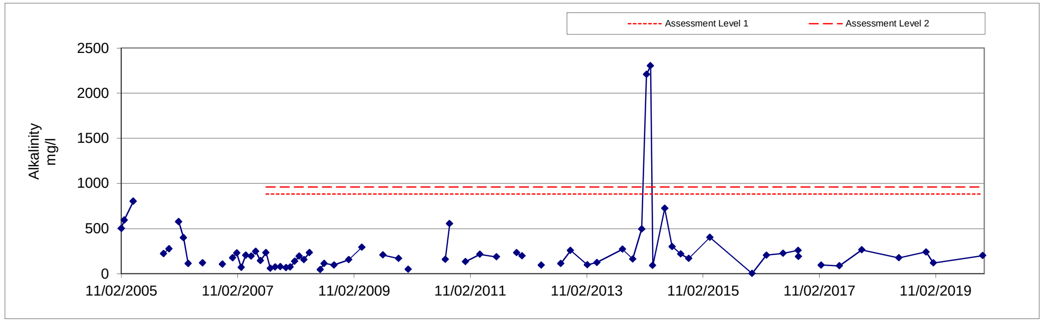

pH

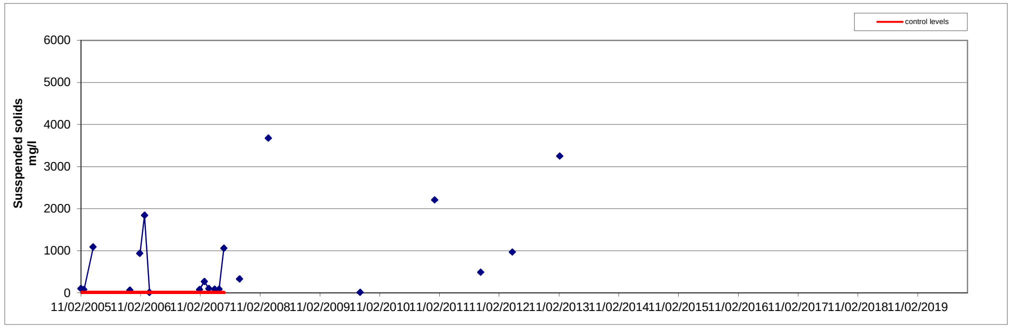

control level
Assessment Level 1
Assessment Level 2
Ammonia mg/l

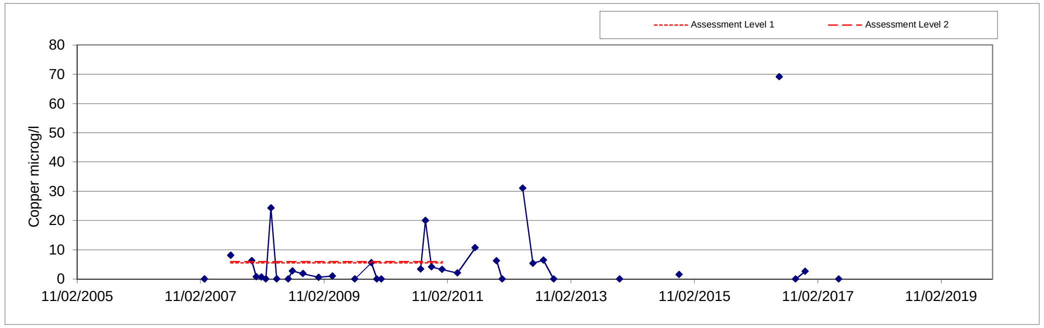

control level
Chloride mg/l

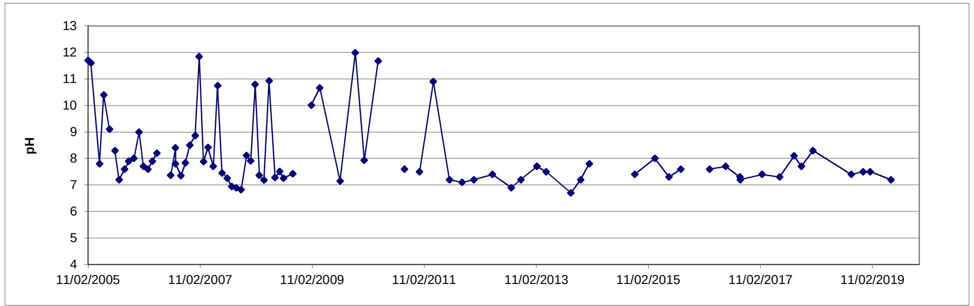

control level
Calcium mg/l

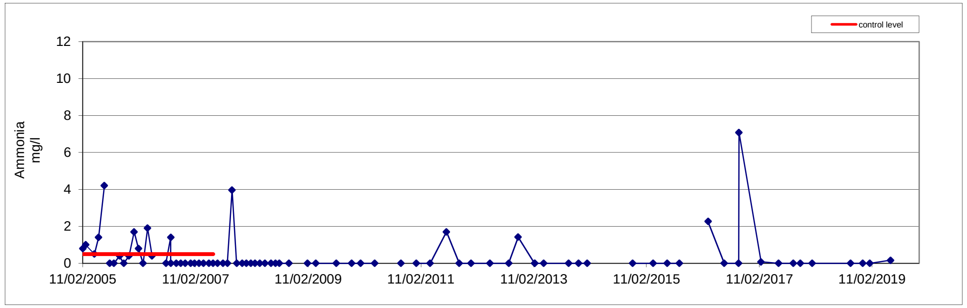

COD mg/l

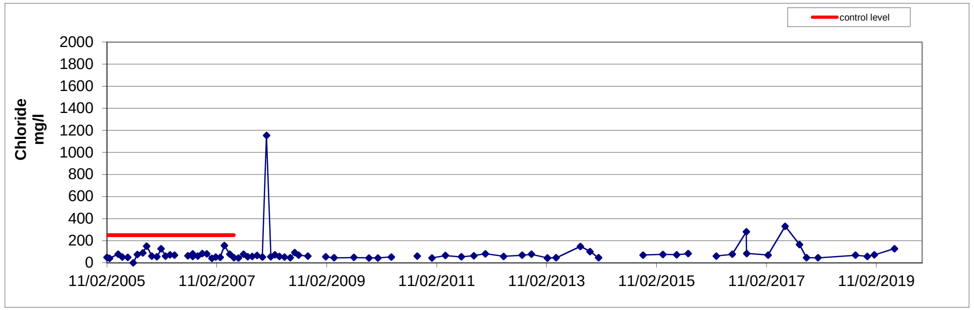

Assessment Level 1
Assessment Level 2
Alkalinity mg/l

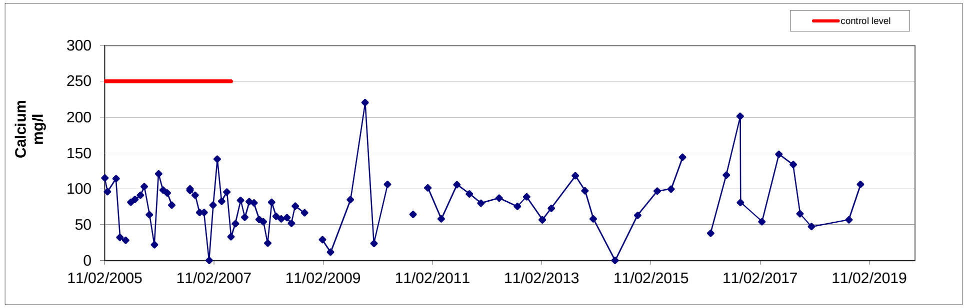

control levels
Susspended solids mg/l

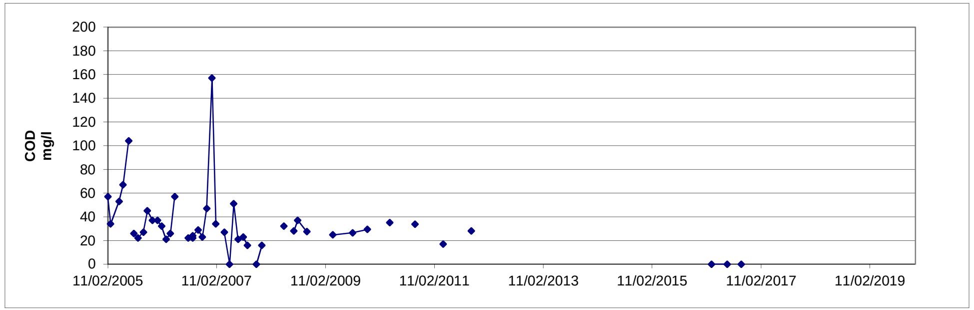

Assessment Level 1
Assessment Level 2
Copper microg/l

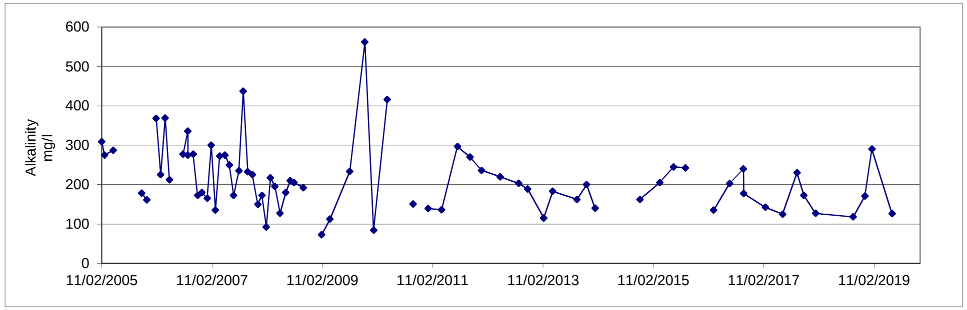

pH
13
12
11
10
9
8
7
6
5
4
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

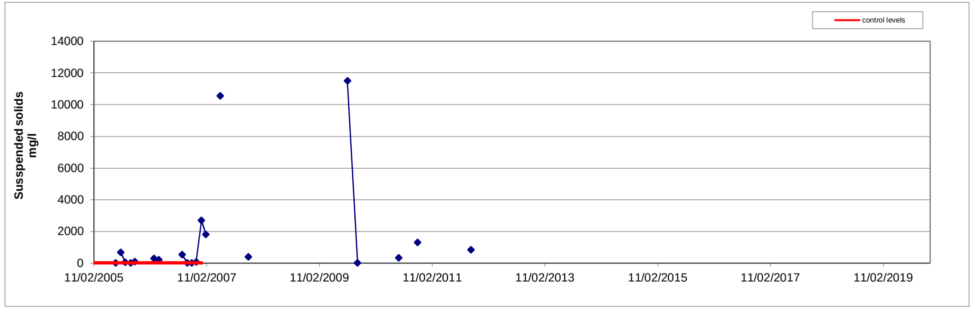

control level
Ammonia
mg/l
12
10
8
6
4
2
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

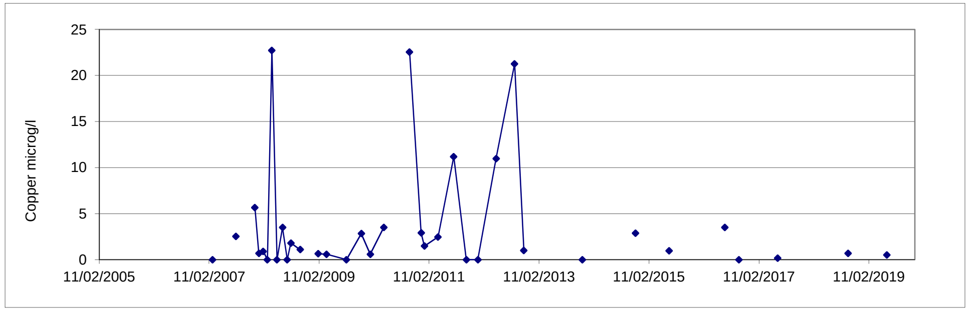

control level
Chloride
mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

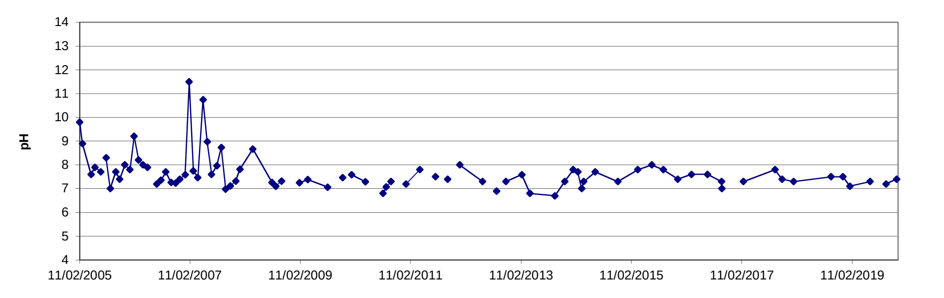

control level
Calcium
mg/l
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

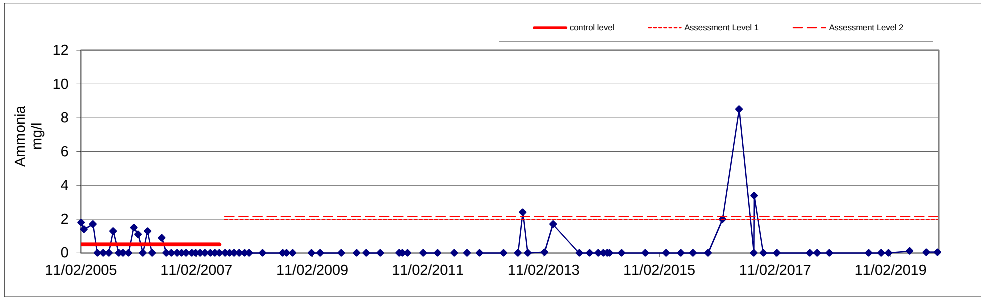

COD
mg/l
200
180
160
140
120
100
80
60
40
20
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

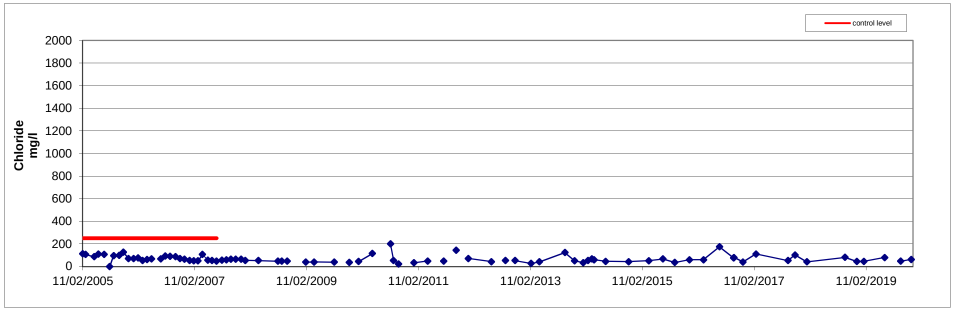

Alkalinity
mg/l
600
500
400
300
200
100
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

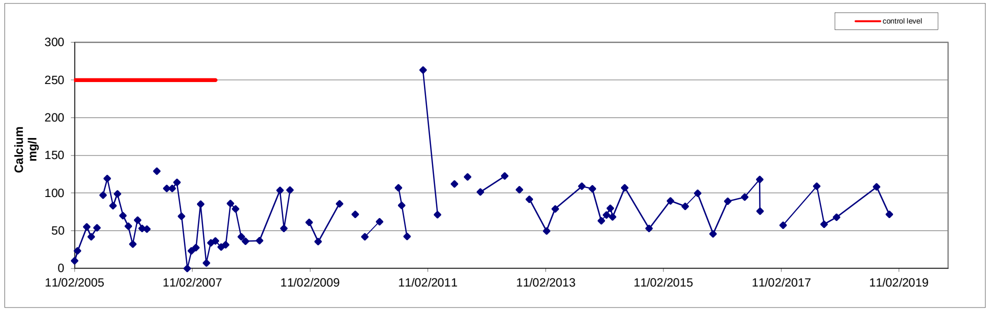

control levels
Susspended solids
mg/l
14000
12000
10000
8000
6000
4000
2000
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

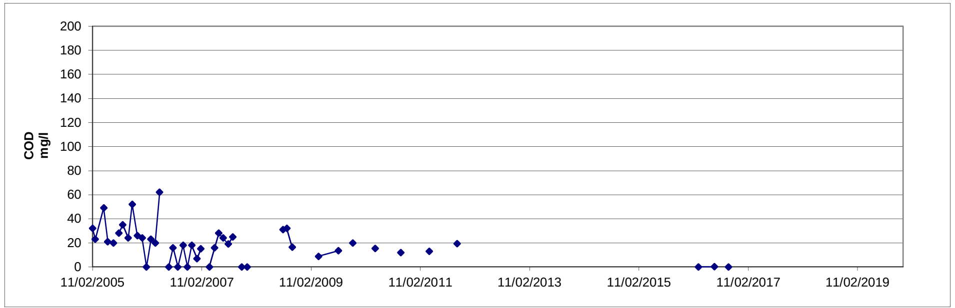

Copper microg/l
25
20
15
10
5
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

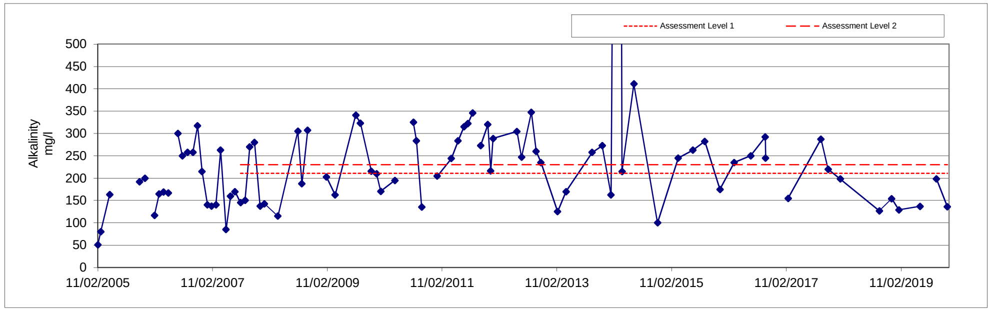

pH
4
5
6
7
8
9
10
11
12
13
14
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

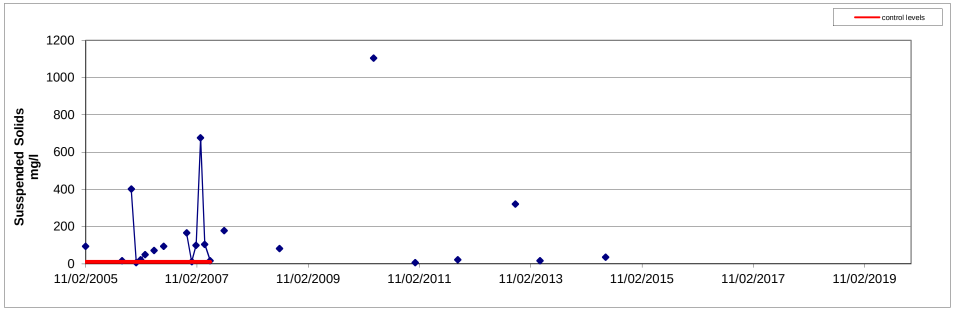

control level
Assessment Level 1
Assessment Level 2
Ammonia
mg/l
0
2
4
6
8
10
12
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

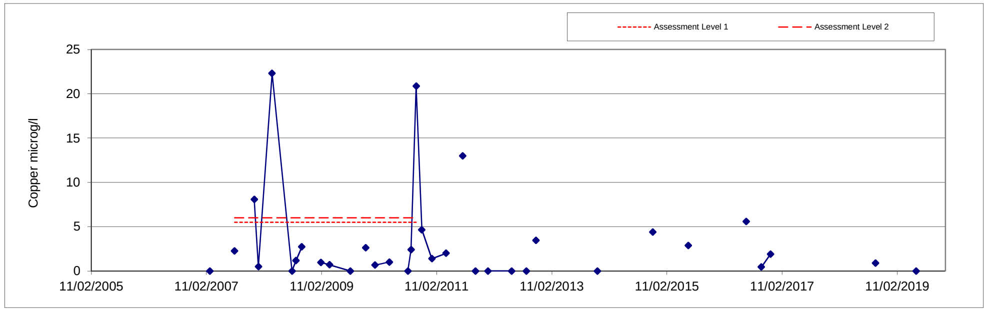

control level
Chloride
mg/l
0
200
400
600
800
1000
1200
1400
1600
1800
2000
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


control level
Calcium
mg/l
0
50
100
150
200
250
300
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


COD
mg/l
0
20
40
60
80
100
120
140
160
180
200
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019


Assessment Level 1
Assessment Level 2
Alkalinity
mg/l
0
50
100
150
200
250
300
350
400
450
500
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

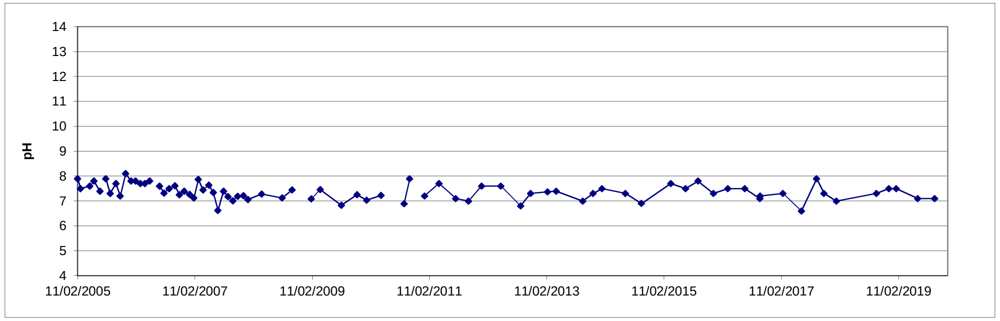

control levels
Susspended Solids
mg/l
0
200
400
600
800
1000
1200
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

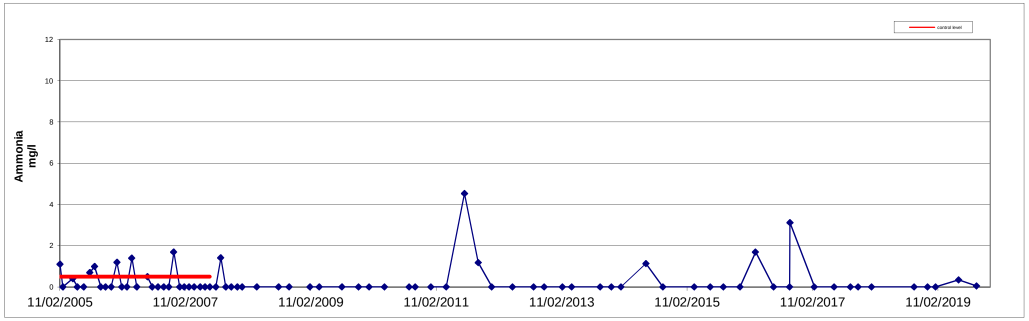

Assessment Level 1
Assessment Level 2
Copper microg/l
0
5
10
15
20
25
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

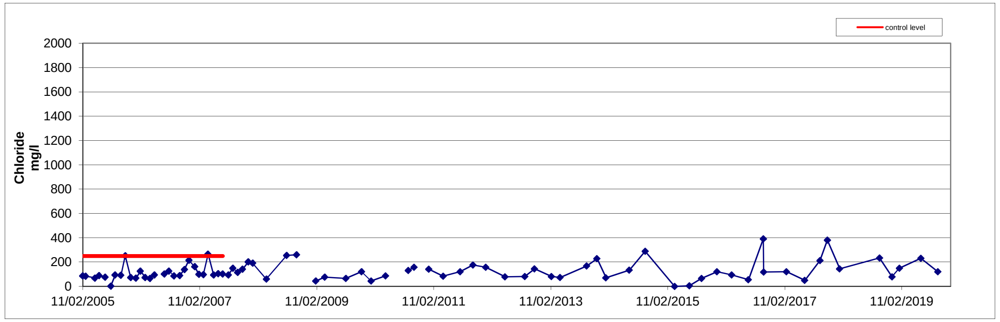
Morfa Landfill

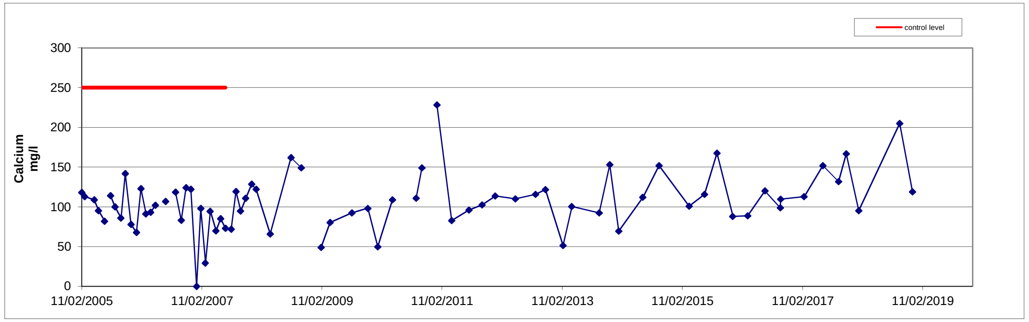
# Monitoring data for SW 5

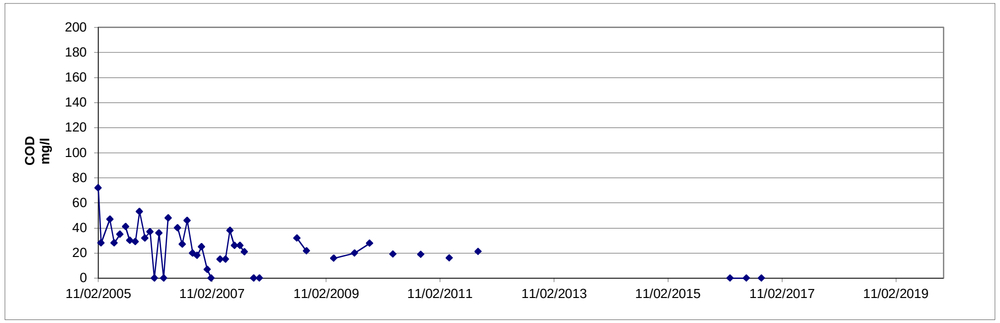
Tata Steel (UK) Ltd

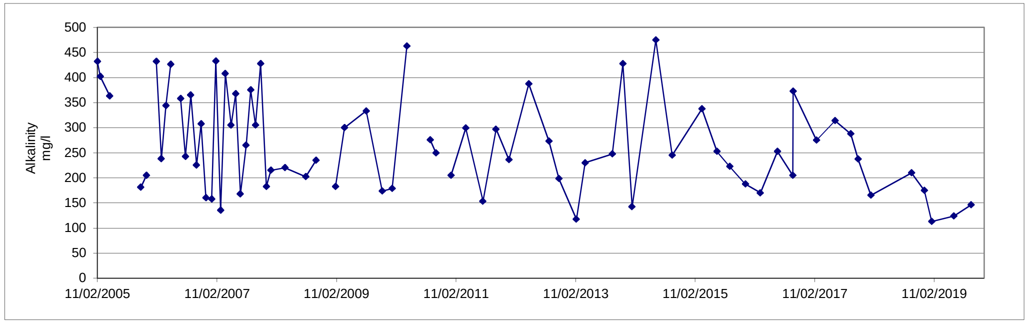


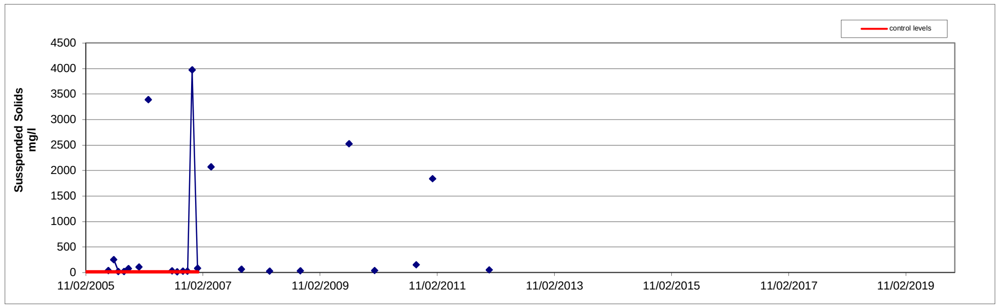



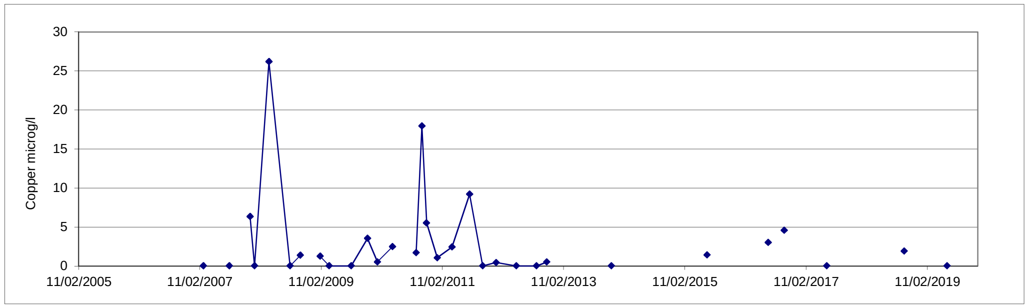



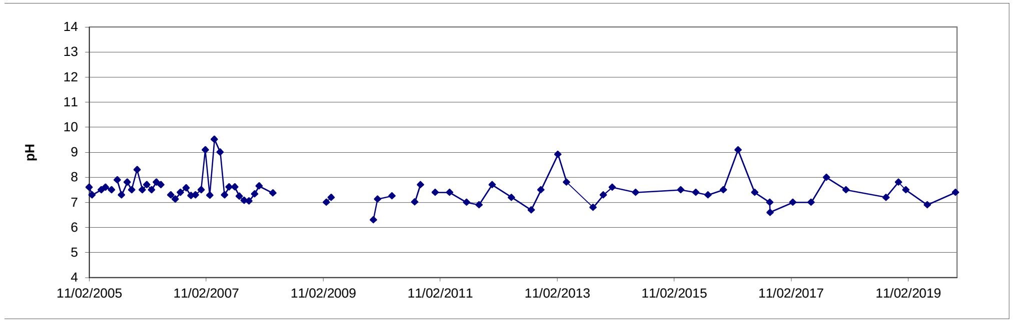



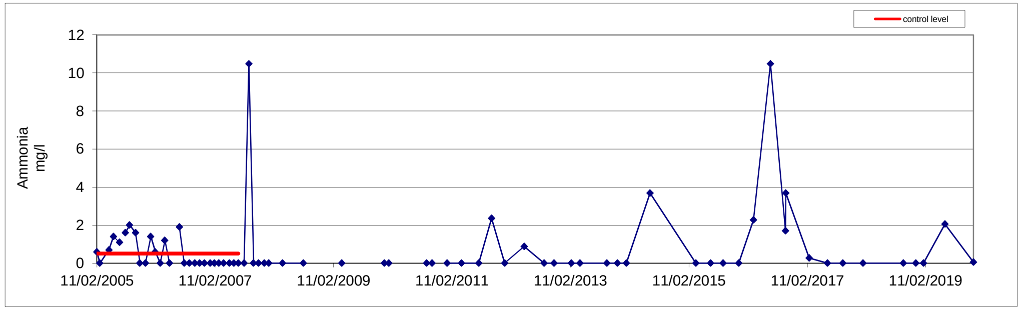



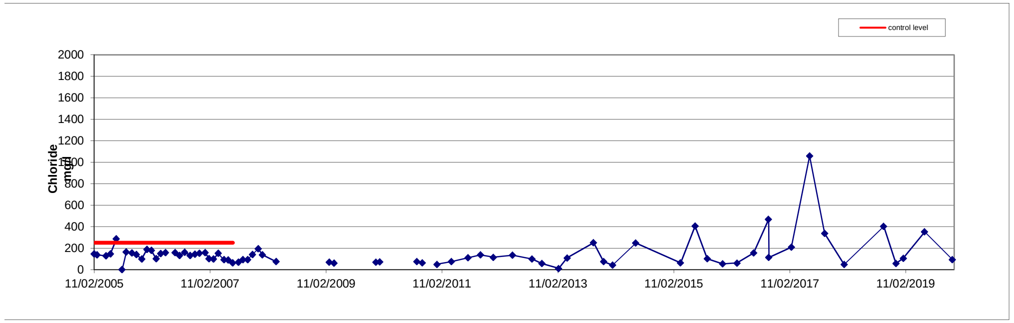



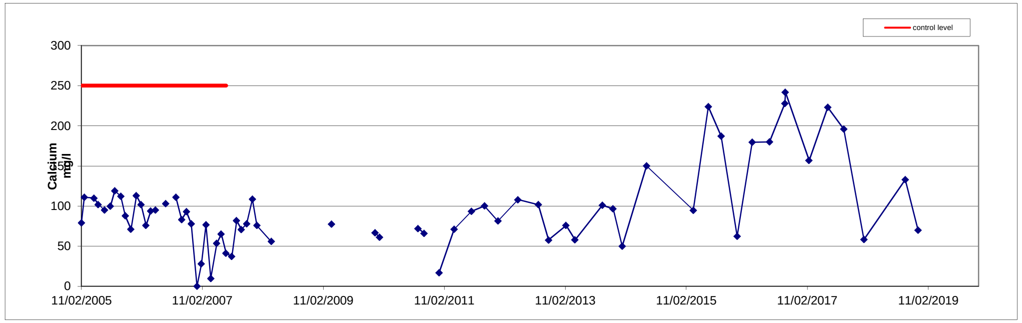



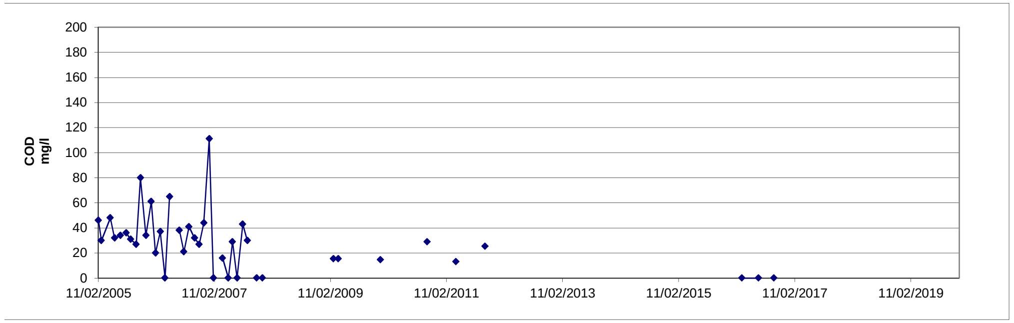



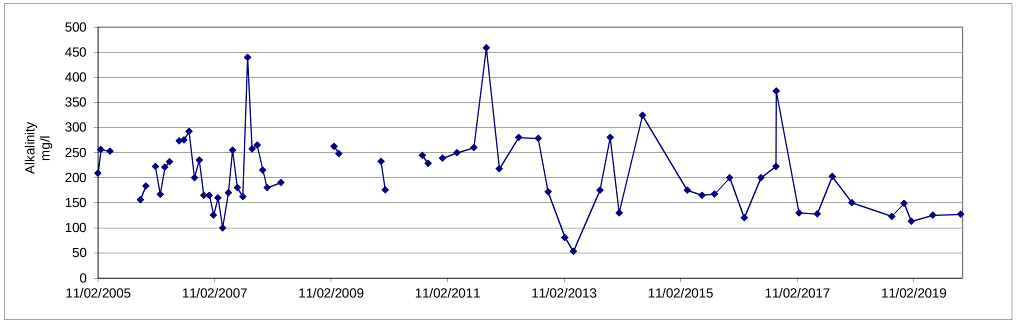

pH
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

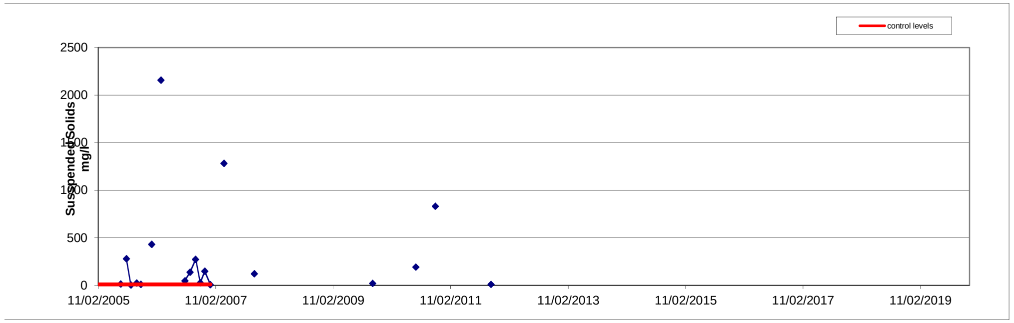

control level
Ammonia
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

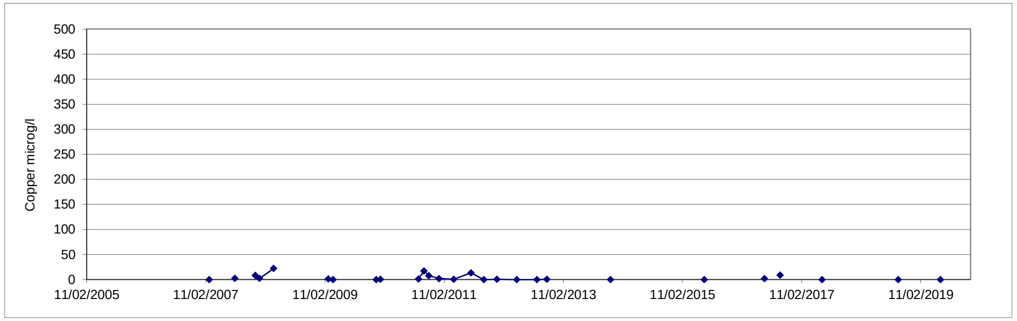

control level
Chloride
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

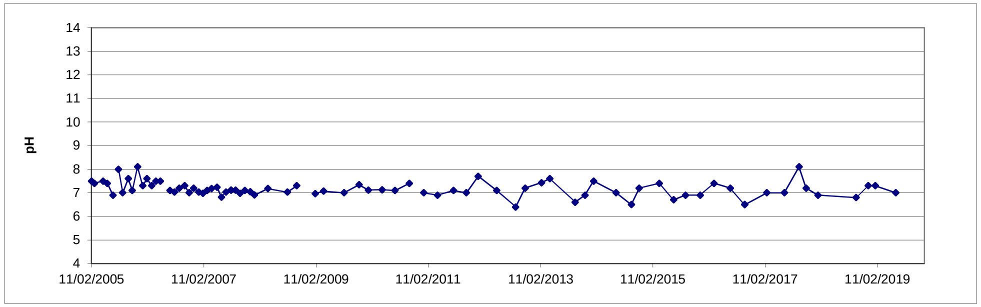

control level
Calcium
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

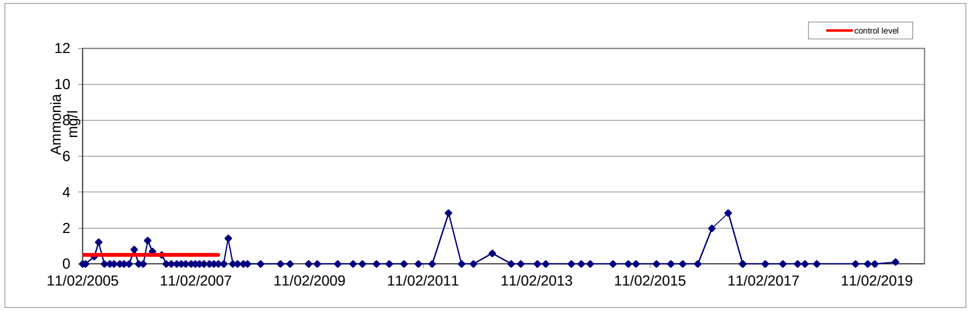

COD
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

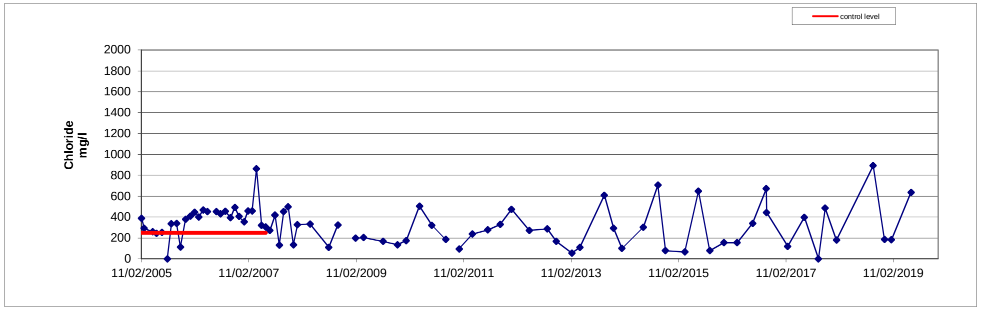

Alkalinity
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

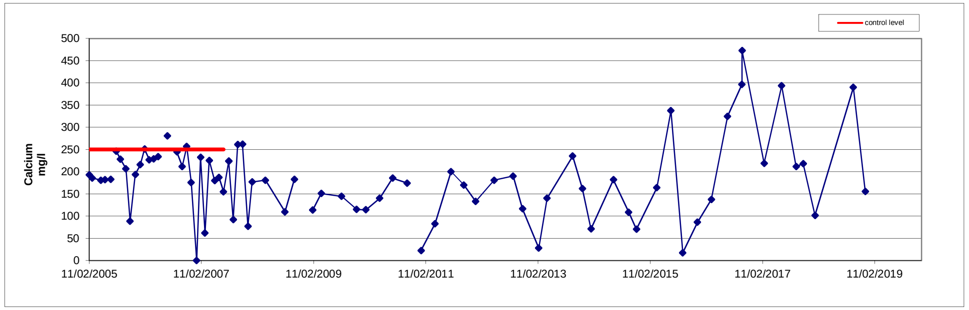

control levels
Suspended Solids
mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

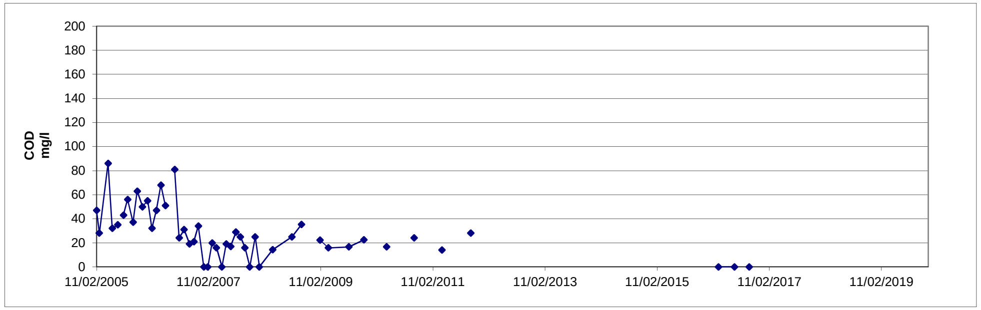

Copper microg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

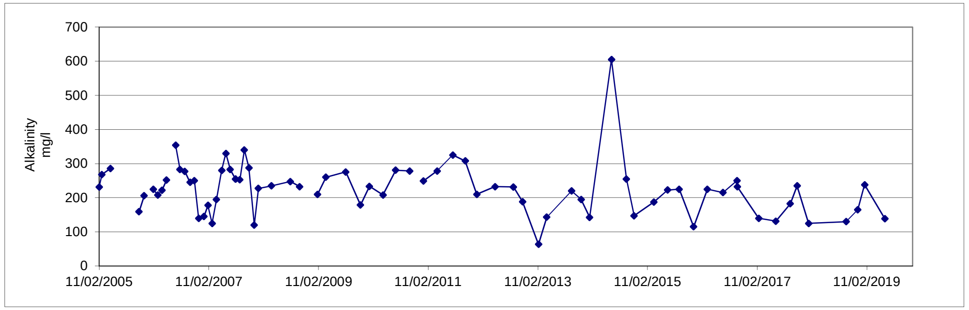

pH
14
13
12
11
10
9
8
7
6
5
4
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

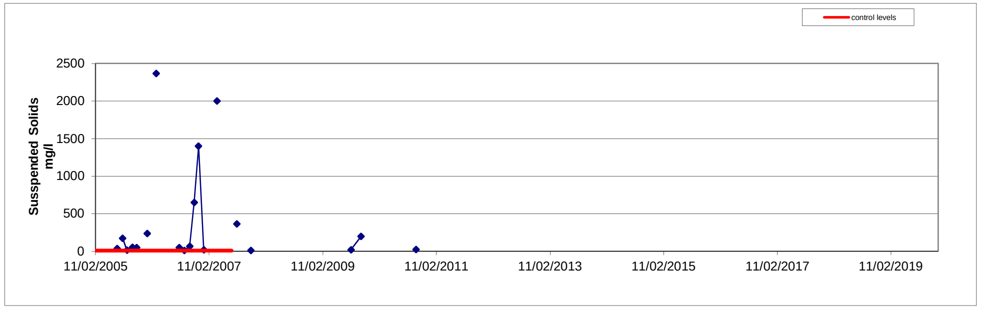

control level
Ammonia
mg/l
12
10
8
6
4
2
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

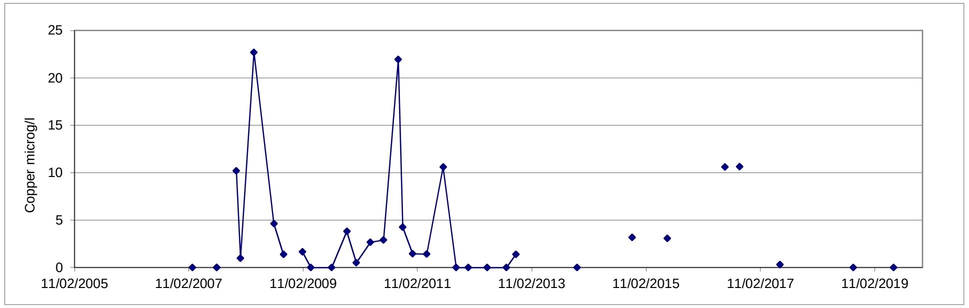

control level
Chloride
mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

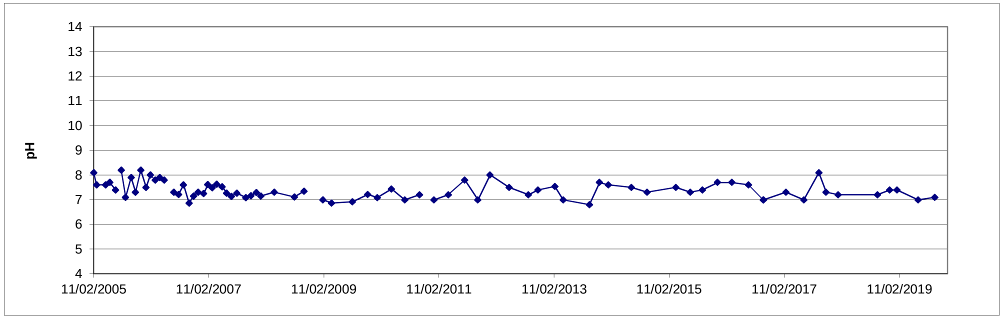

control level
Calcium
mg/l
500
450
400
350
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

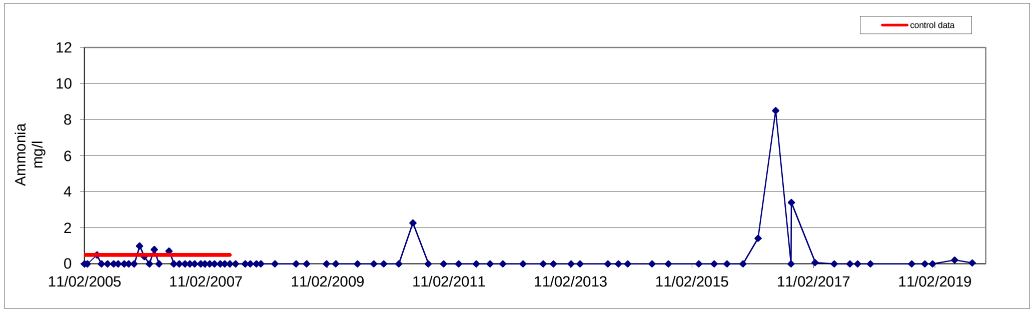

COD
mg/l
200
180
160
140
120
100
80
60
40
20
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

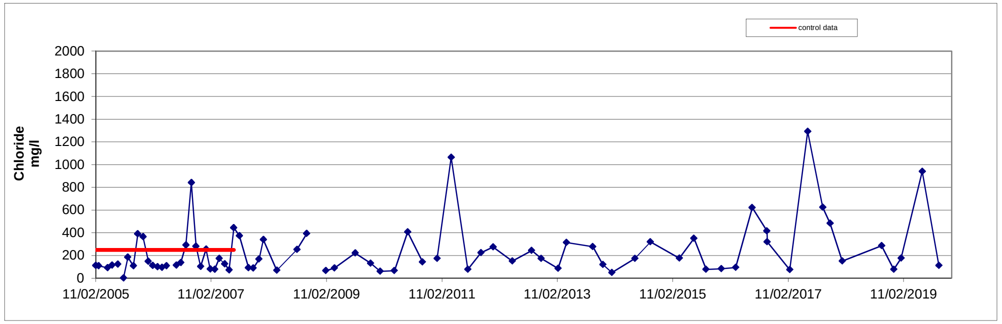

Alkalinity
mg/l
700
600
500
400
300
200
100
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

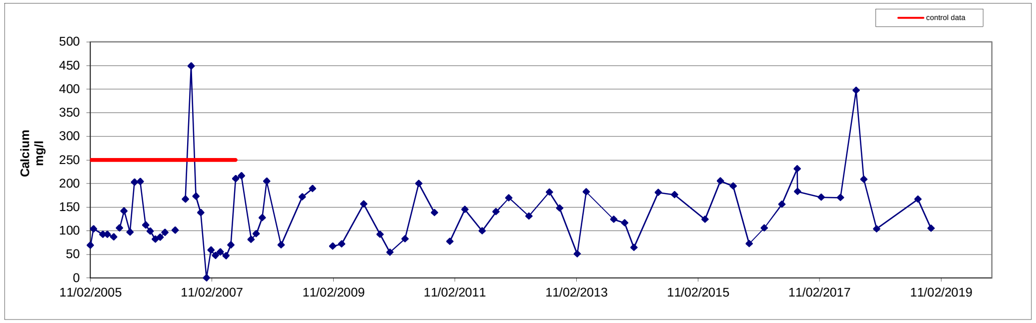

control levels
Susspended Solids
mg/l
2500
2000
1500
1000
500
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

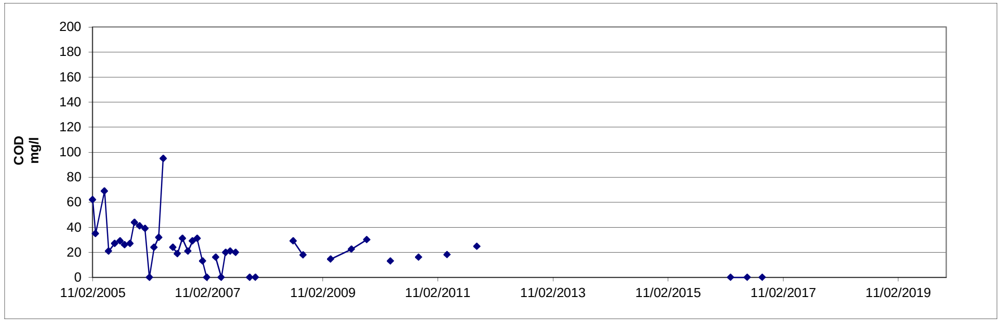

Copper microg/l
25
20
15
10
5
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

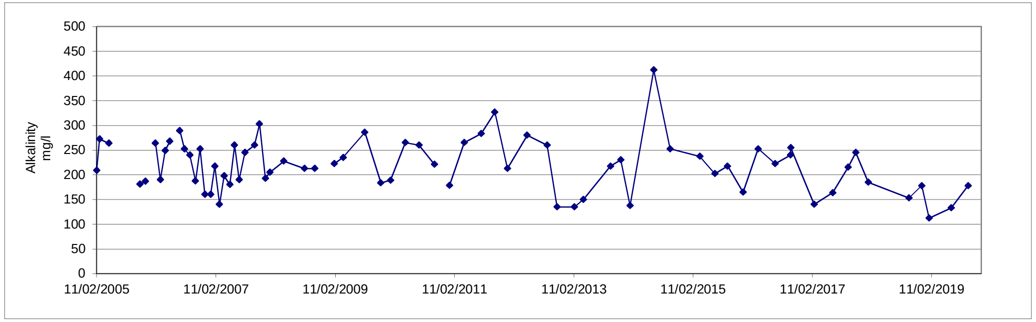

pH
14
13
12
11
10
9
8
7
6
5
4
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

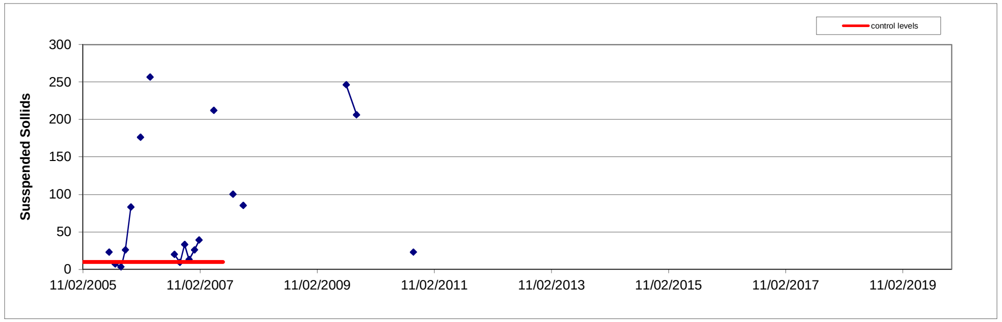

control data
Ammonia mg/l
12
10
8
6
4
2
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

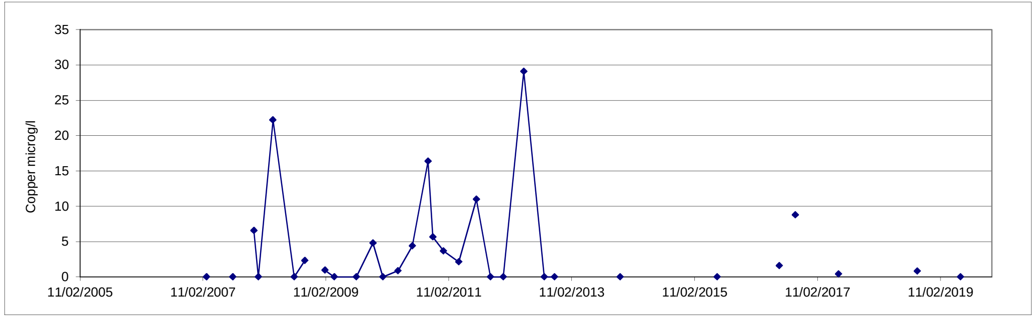

control data
Chloride mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

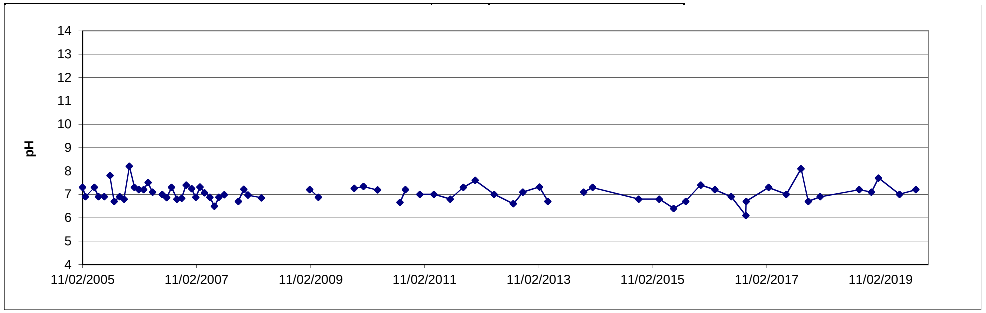

control data
Calcium mg/l
500
450
400
350
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

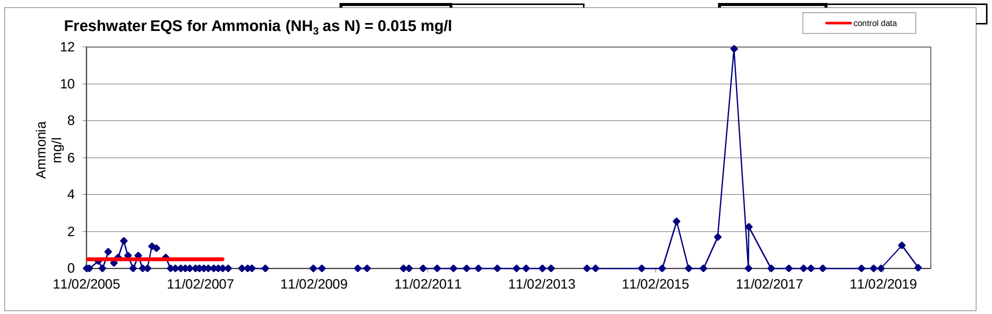

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

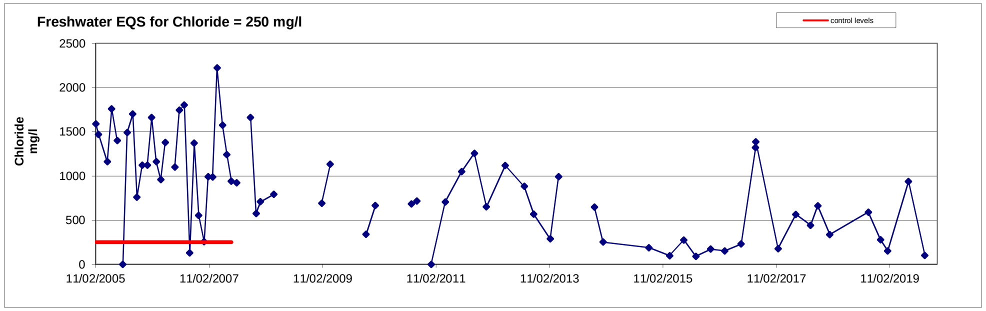

Alkalinity mg/l
500
450
400
350
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

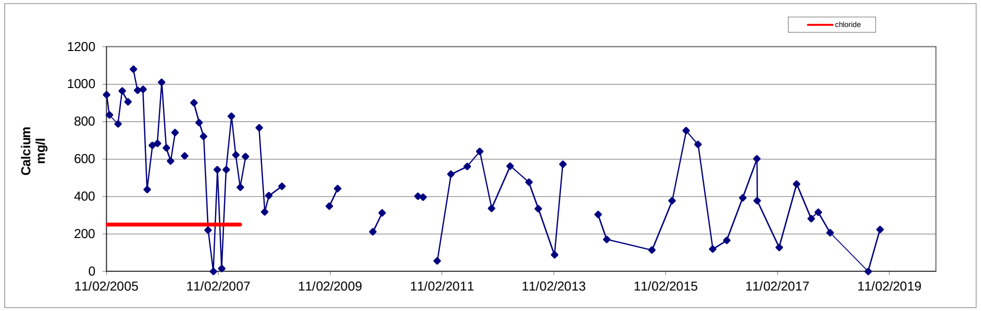

control levels
Susspended Sollids
300
250
200
150
100
50
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

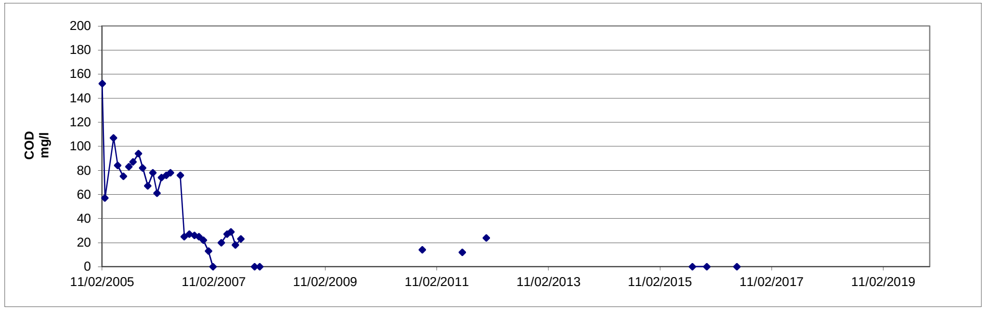

Copper microg/l
35
30
25
20
15
10
5
0
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

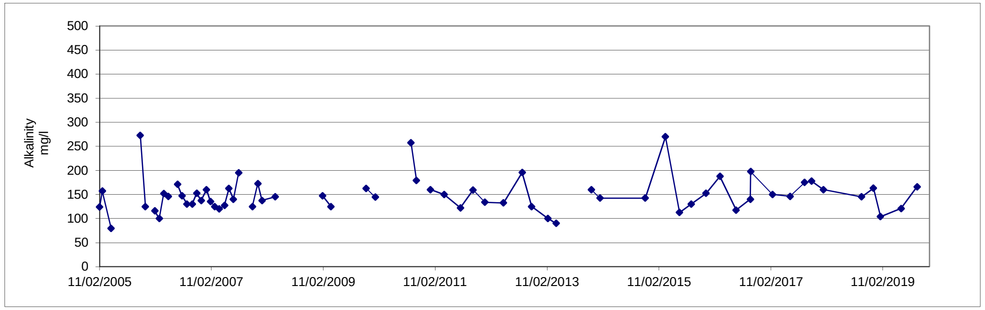

pH
14
13
12
11
10
9
8
7
6
5
4
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

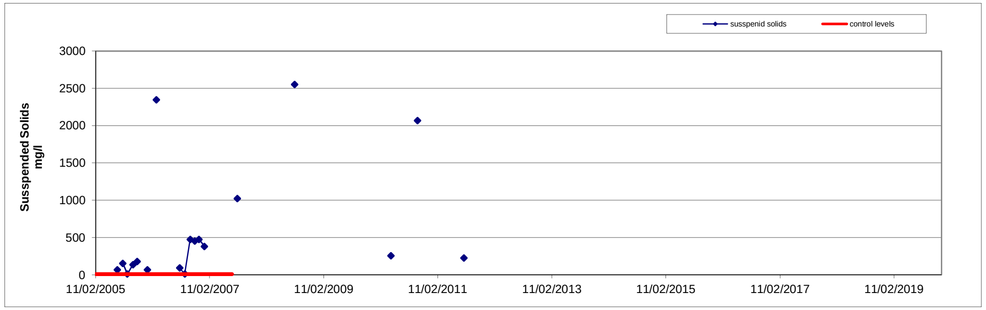

Freshwater EQS for Ammonia (NH3 as N) = 0.015 mg/l
control data
Ammonia mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

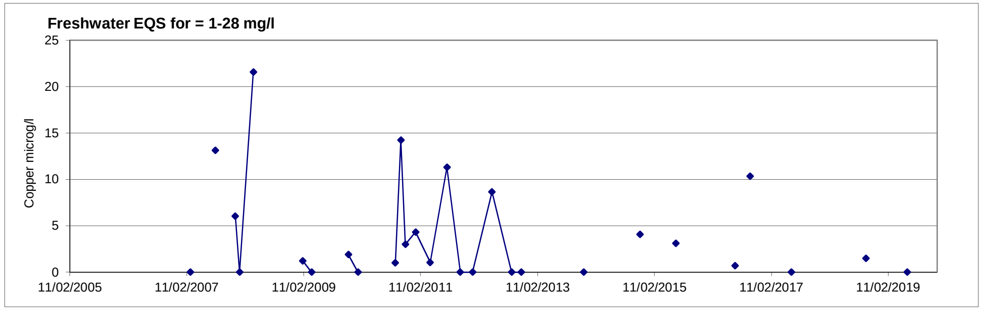

Freshwater EQS for Chloride = 250 mg/l
control levels
Chloride mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

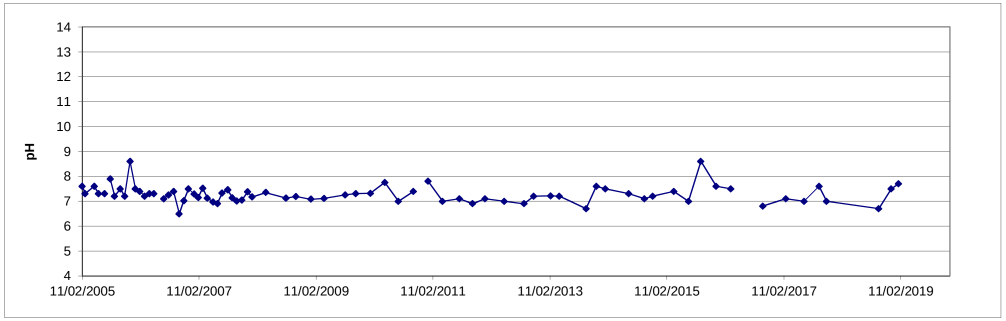

chloride
Calcium mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

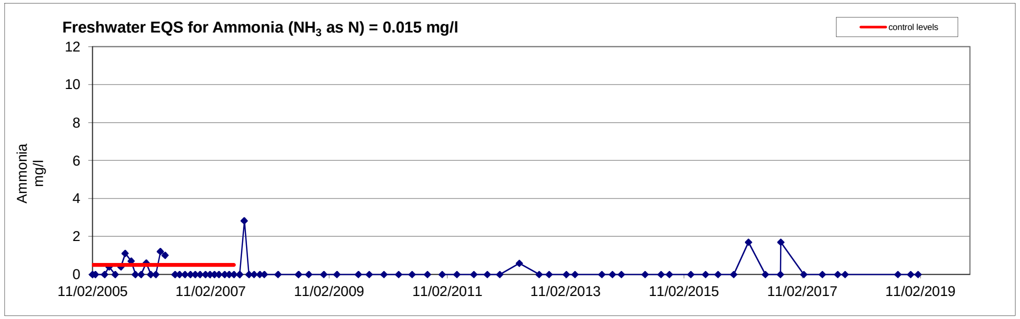

COD mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

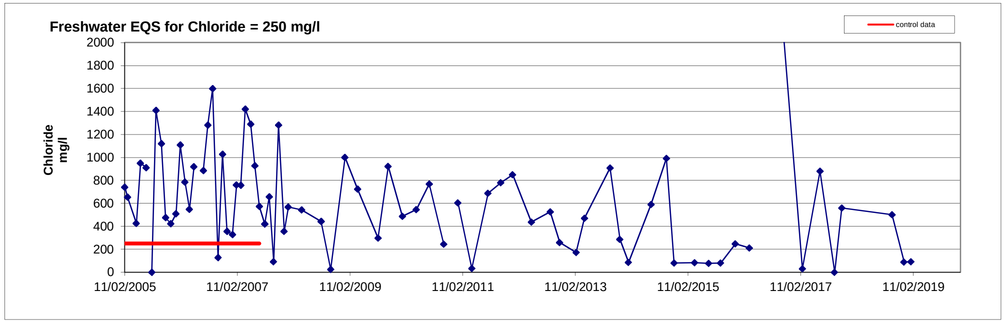

Alkalinity mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

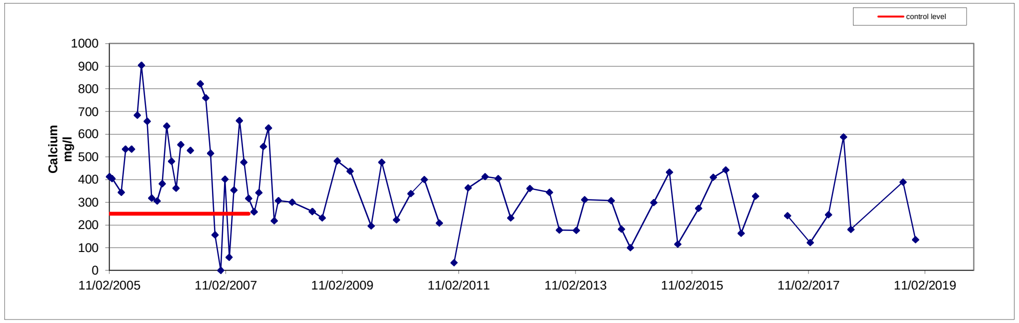

susspenid solids
control levels
Susspended Solids mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

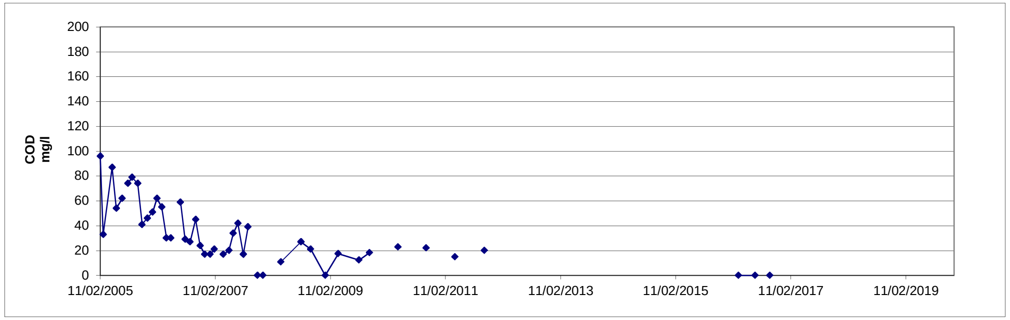

Freshwater EQS for = 1-28 mg/l
Copper microg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

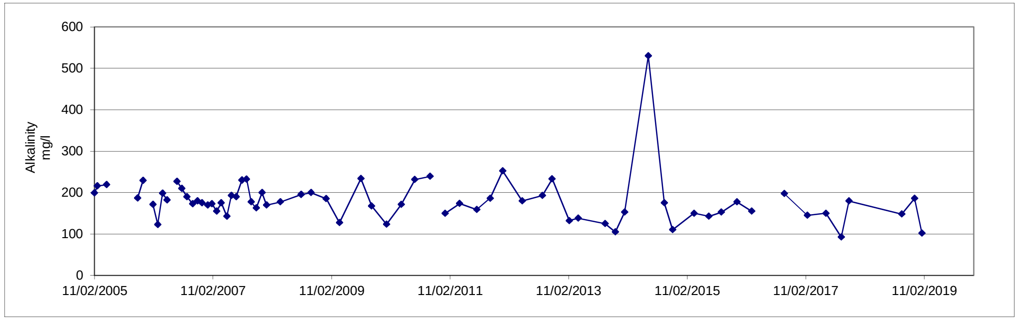


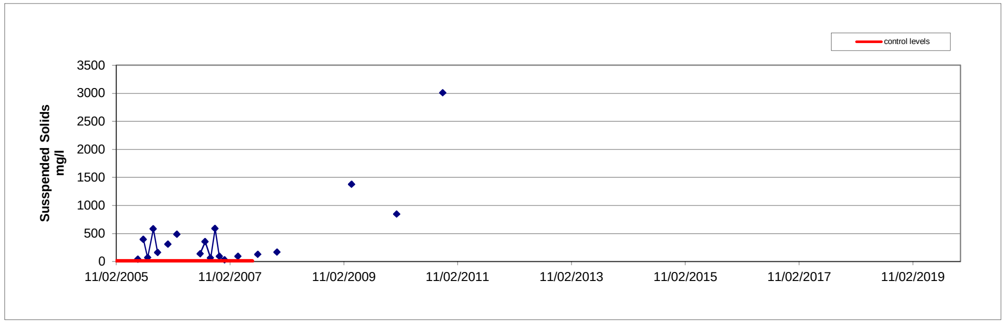


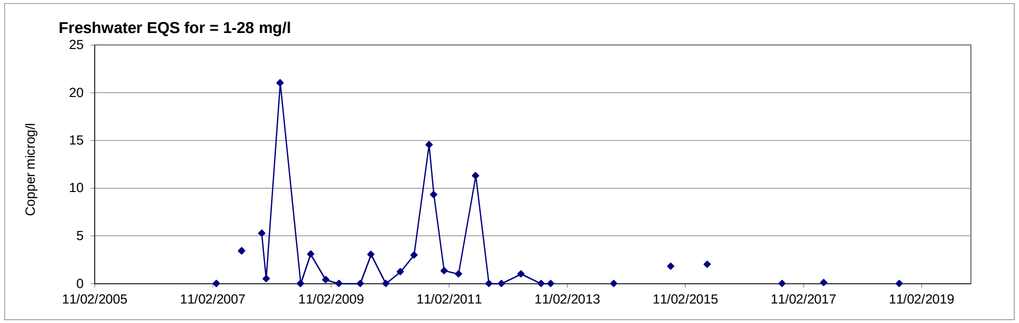




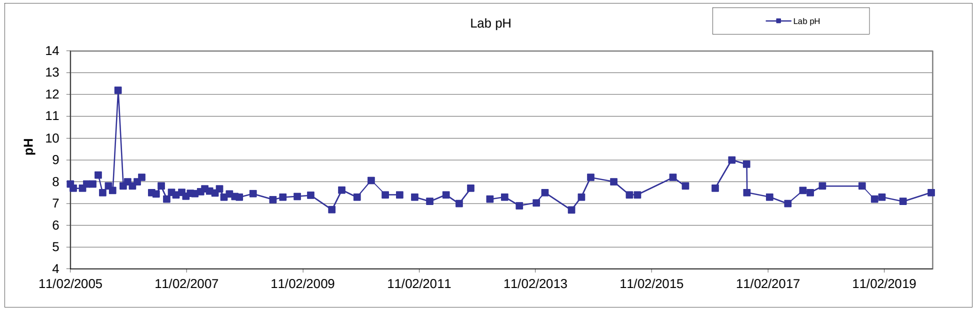


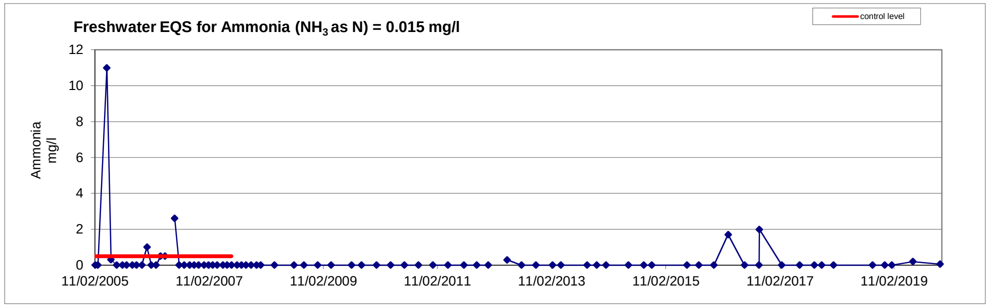


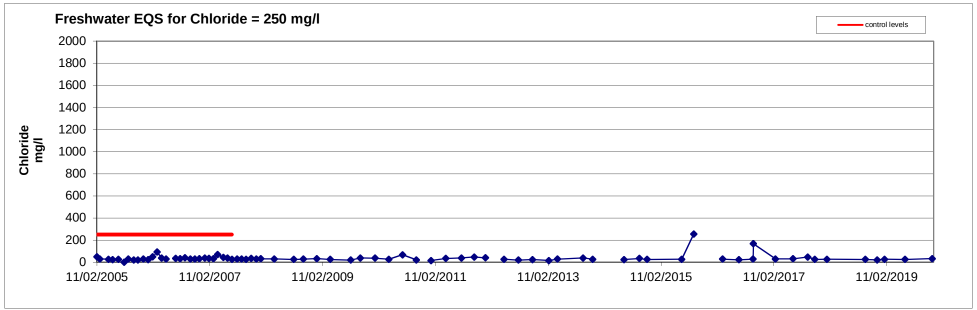


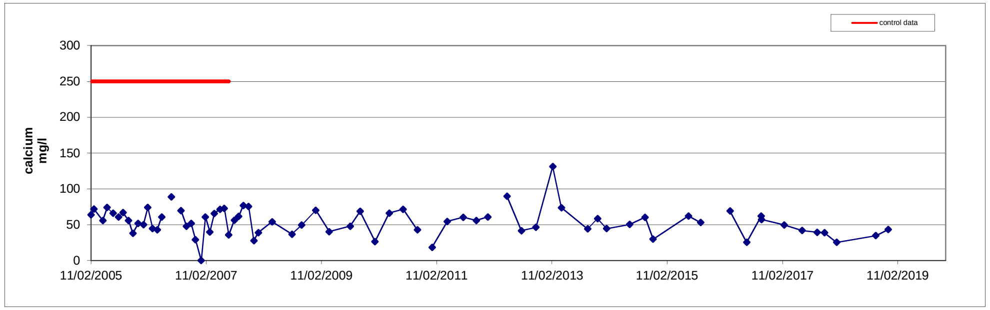


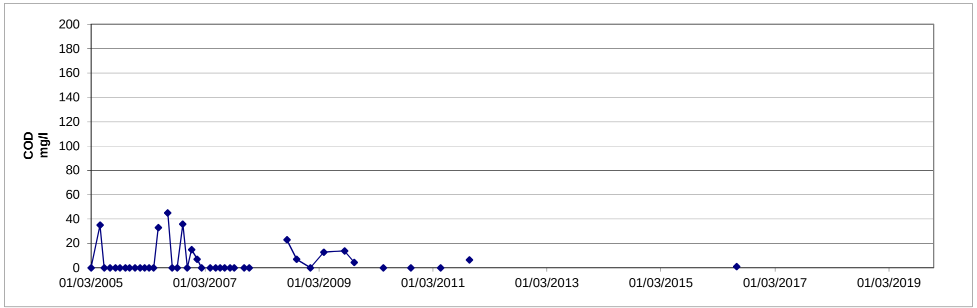
# Monitoring data for SW 11

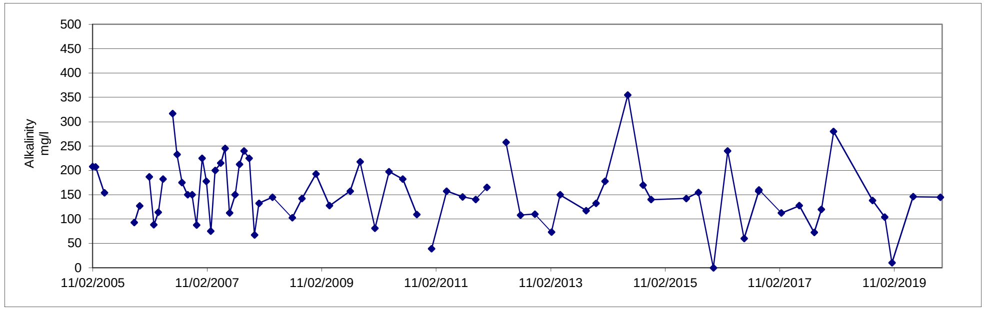


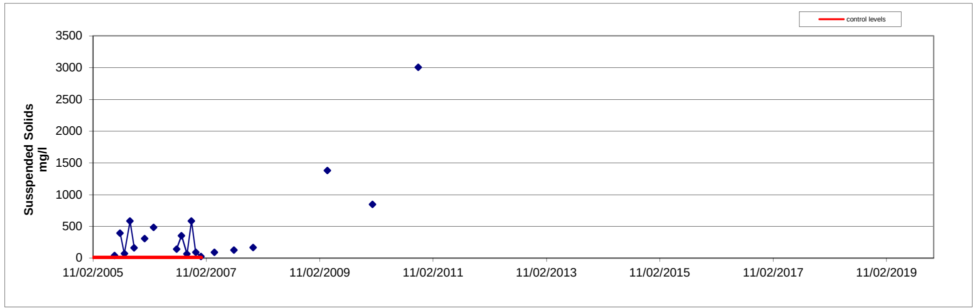



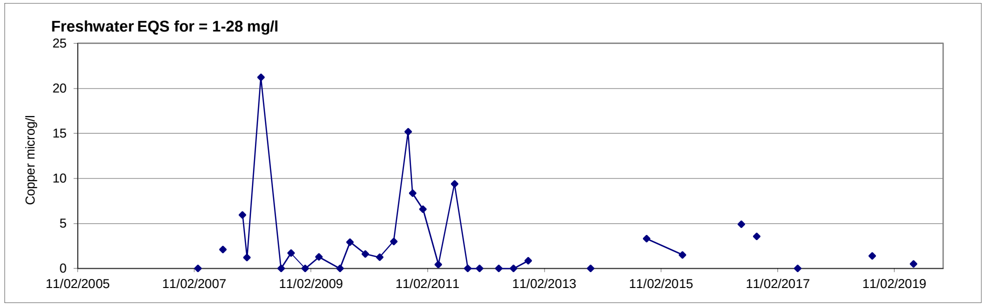



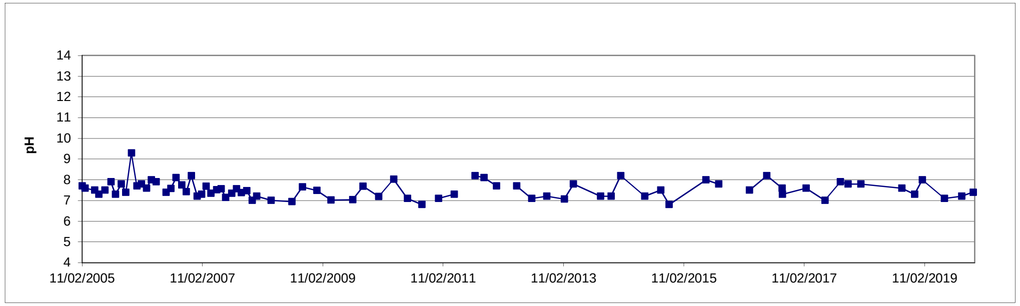



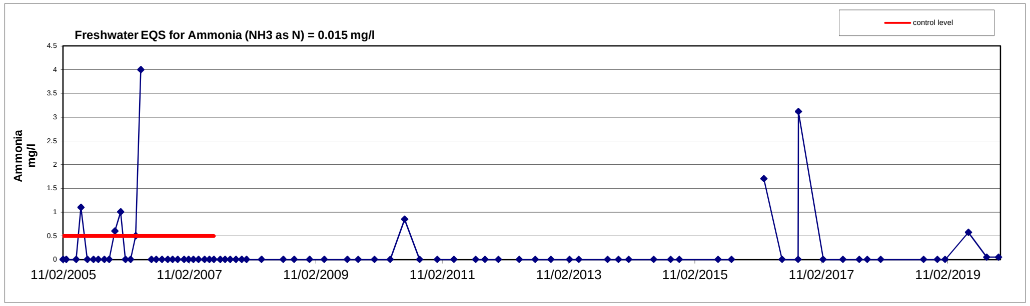



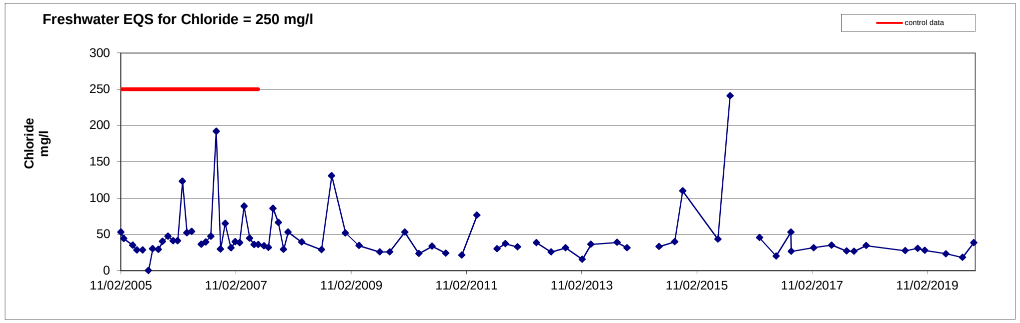



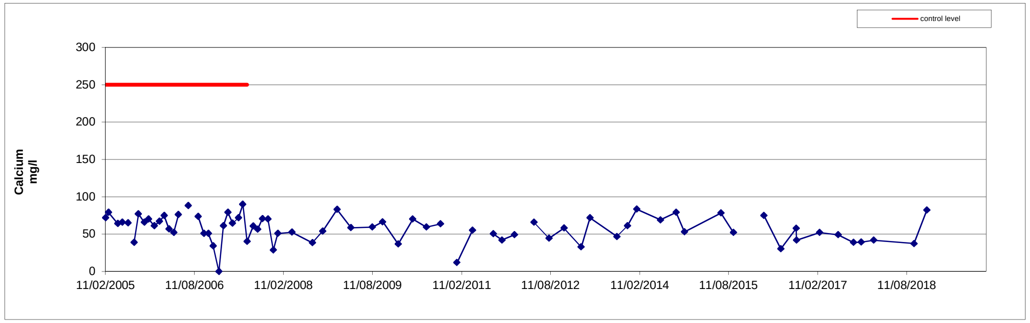



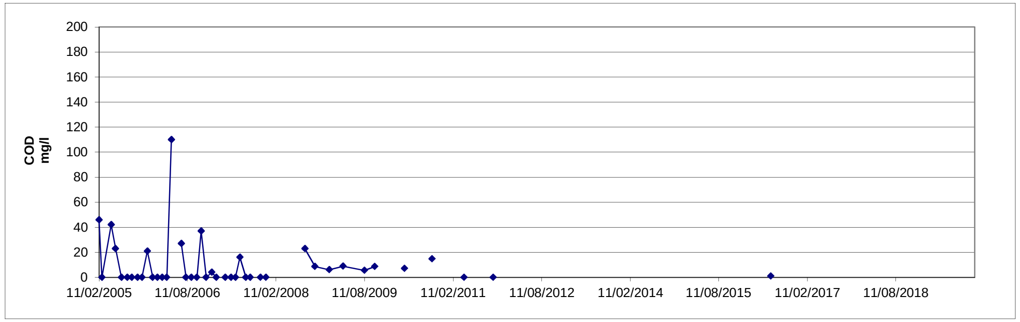



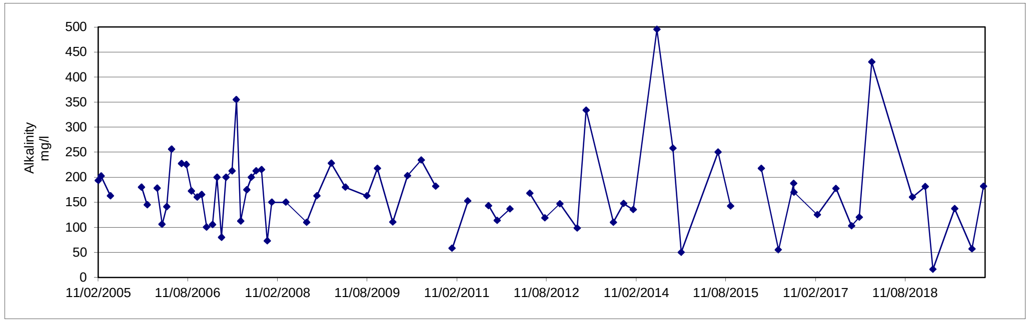

pH
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

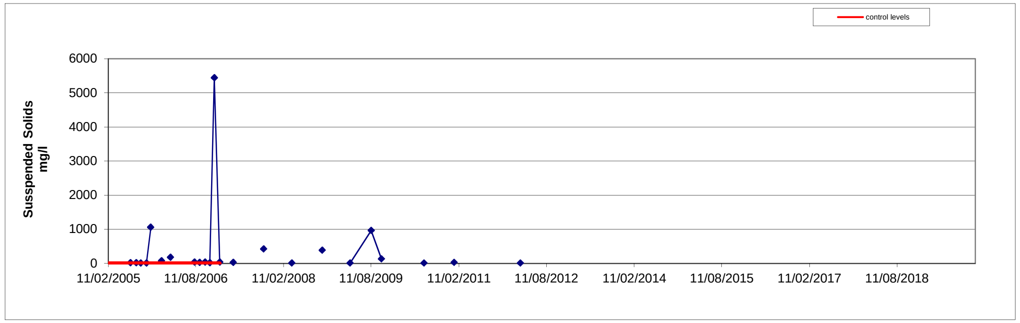

Freshwater EQS for Ammonia (NH3 as N) = 0.015 mg/l
control level
Ammonia mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

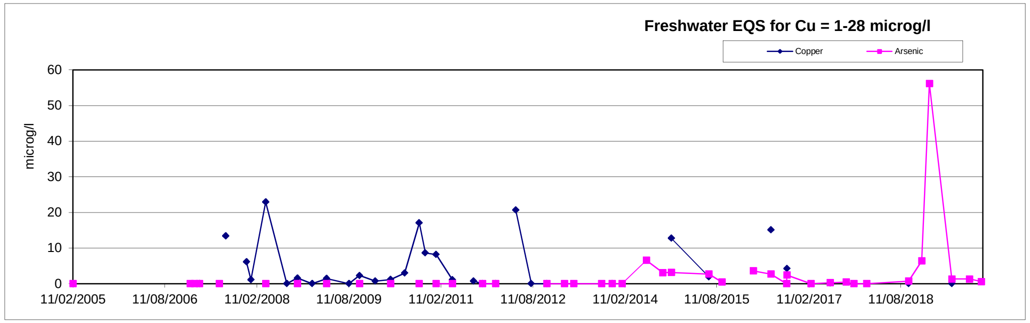

Freshwater EQS for Chloride = 250 mg/l
control data
Chloride mg/l
11/02/2005
11/02/2007
11/02/2009
11/02/2011
11/02/2013
11/02/2015
11/02/2017
11/02/2019

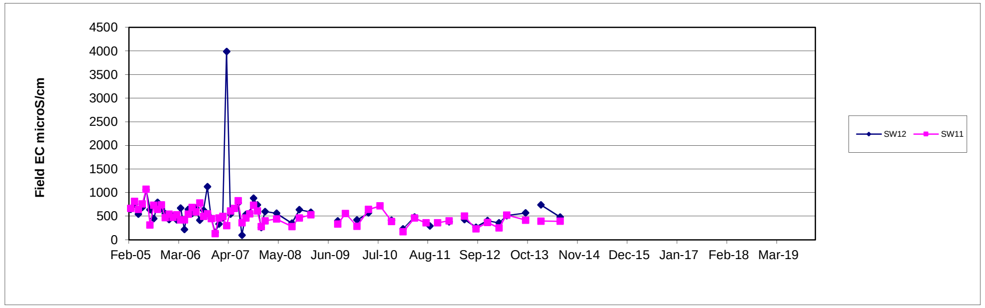

control level
Calcium mg/l
11/02/2005
11/08/2006
11/02/2008
11/08/2009
11/02/2011
11/08/2012
11/02/2014
11/08/2015
11/02/2017
11/08/2018

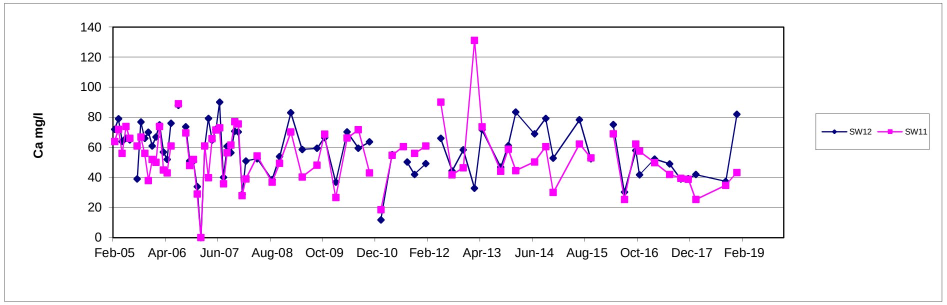

COD mg/l
11/02/2005
11/08/2006
11/02/2008
11/08/2009
11/02/2011
11/08/2012
11/02/2014
11/08/2015
11/02/2017
11/08/2018

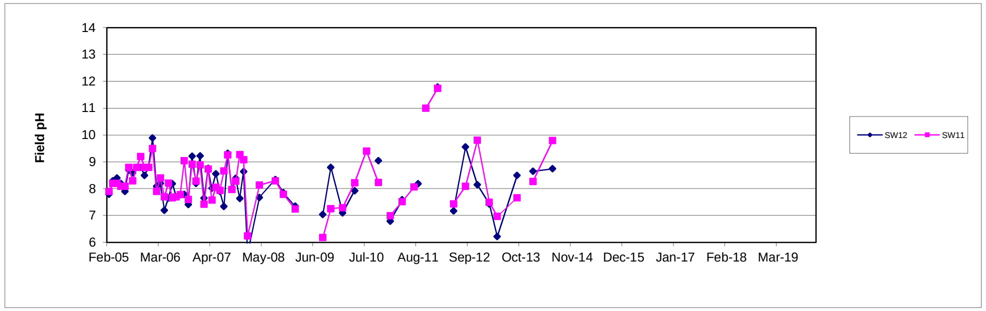

Alkalinity mg/l
11/02/2005
11/08/2006
11/02/2008
11/08/2009
11/02/2011
11/08/2012
11/02/2014
11/08/2015
11/02/2017
11/08/2018

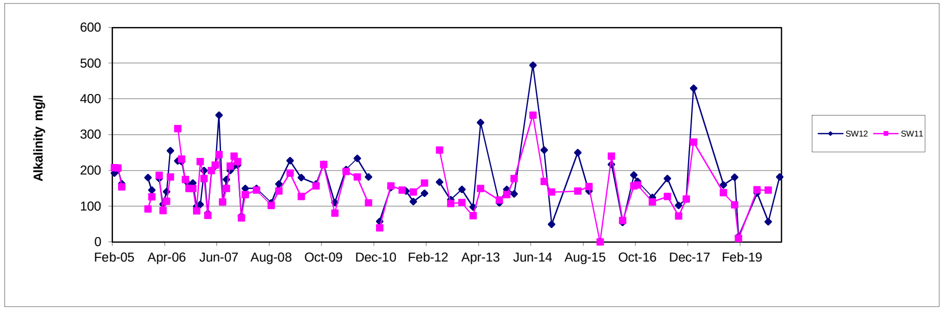

control levels
Susspended Solids mg/l
11/02/2005
11/08/2006
11/02/2008
11/08/2009
11/02/2011
11/08/2012
11/02/2014
11/08/2015
11/02/2017
11/08/2018

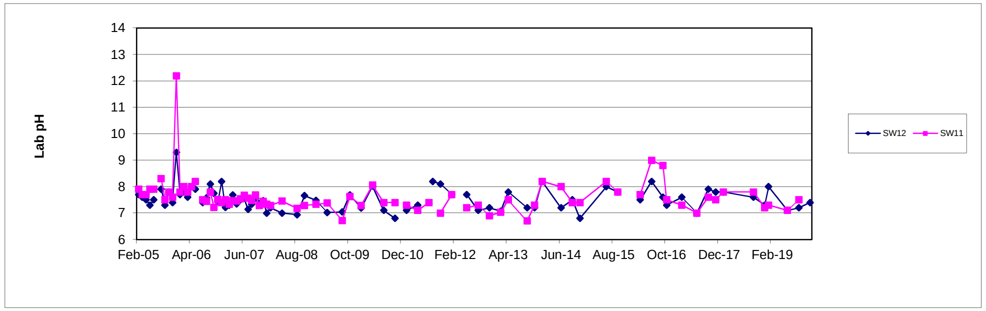

Freshwater EQS for Cu = 1-28 microg/l
Copper
Arsenic
microg/l
11/02/2005
11/08/2006
11/02/2008
11/08/2009
11/02/2011
11/08/2012
11/02/2014
11/08/2015
11/02/2017
11/08/2018

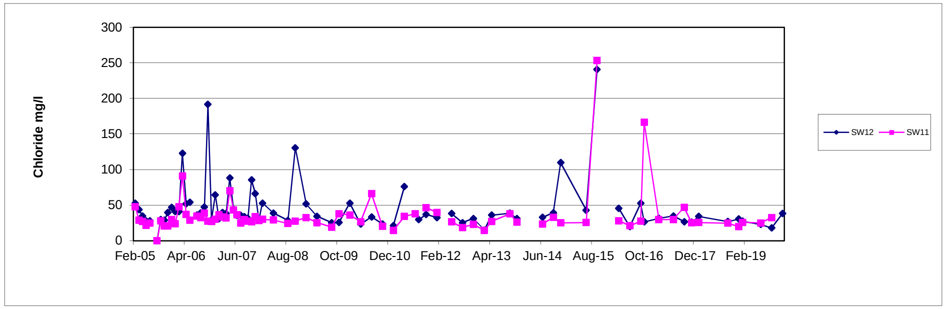

Field EC microS/cm
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Feb-05 Mar-06 Apr-07 May-08 Jun-09 Jul-10 Aug-11 Sep-12 Oct-13 Nov-14 Dec-15 Jan-17 Feb-18 Mar-19
SW12 SW11

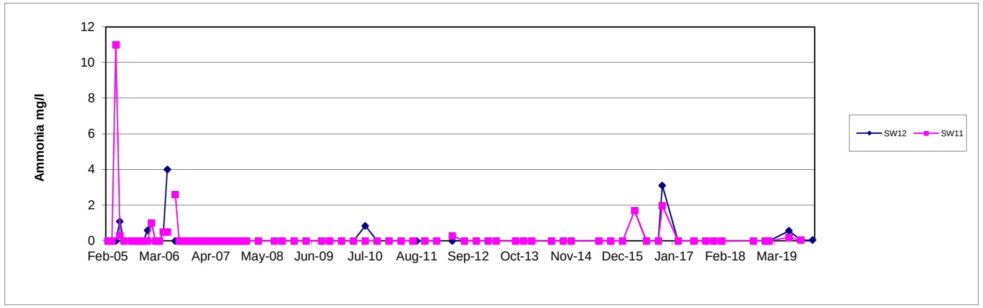

Ca mg/l
140
120
100
80
60
40
20
0
Feb-05 Apr-06 Jun-07 Aug-08 Oct-09 Dec-10 Feb-12 Apr-13 Jun-14 Aug-15 Oct-16 Dec-17 Feb-19
SW12 SW11

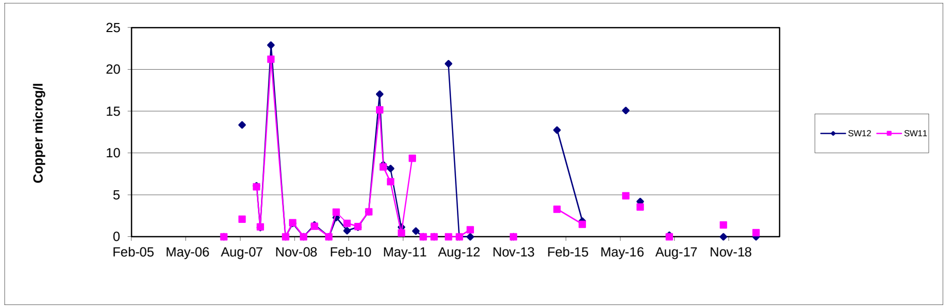

Field pH
14
13
12
11
10
9
8
7
6
Feb-05 Mar-06 Apr-07 May-08 Jun-09 Jul-10 Aug-11 Sep-12 Oct-13 Nov-14 Dec-15 Jan-17 Feb-18 Mar-19
SW12 SW11

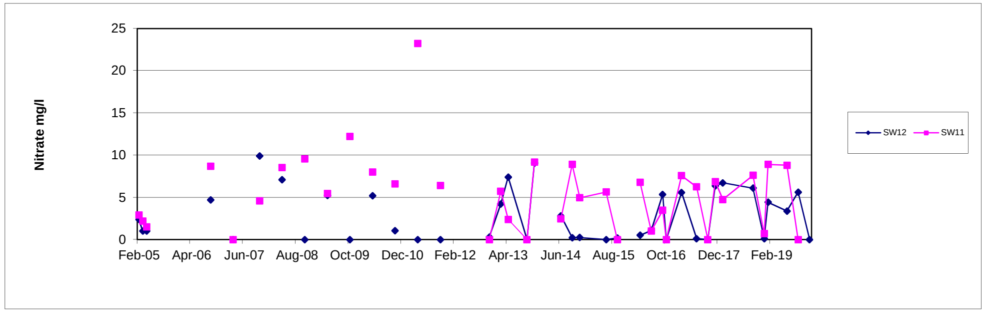

Alkalinity mg/l
600
500
400
300
200
100
0
Feb-05 Apr-06 Jun-07 Aug-08 Oct-09 Dec-10 Feb-12 Apr-13 Jun-14 Aug-15 Oct-16 Dec-17 Feb-19
SW12 SW11

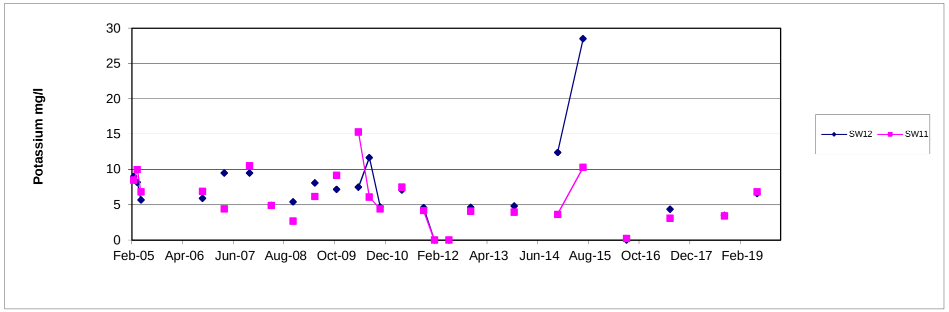

Lab pH
14
13
12
11
10
9
8
7
6
Feb-05 Apr-06 Jun-07 Aug-08 Oct-09 Dec-10 Feb-12 Apr-13 Jun-14 Aug-15 Oct-16 Dec-17 Feb-19
SW12 SW11

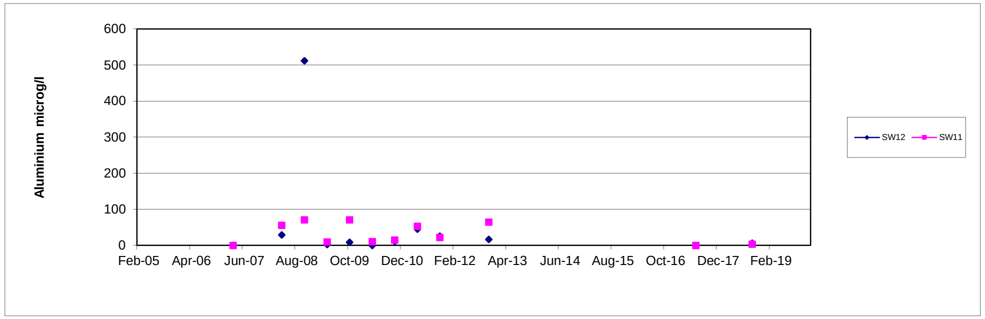

Chloride mg/l
300
250
200
150
100
50
0
Feb-05 Apr-06 Jun-07 Aug-08 Oct-09 Dec-10 Feb-12 Apr-13 Jun-14 Aug-15 Oct-16 Dec-17 Feb-19
SW12 SW11

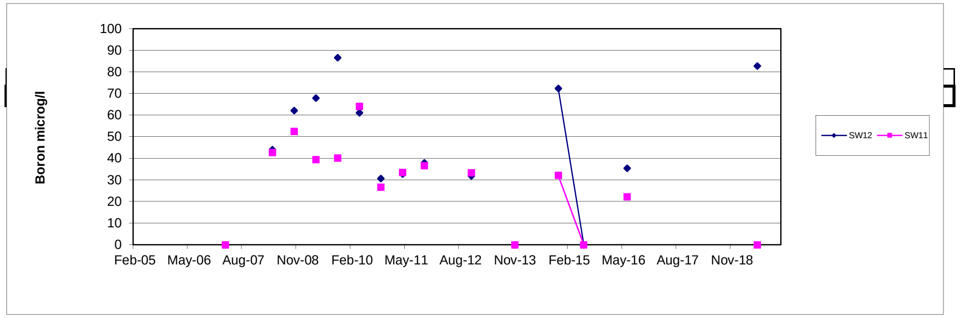

Ammonia mg/l
12
10
8
6
4
2
0
Feb-05 Mar-06 Apr-07 May-08 Jun-09 Jul-10 Aug-11 Sep-12 Oct-13 Nov-14 Dec-15 Jan-17 Feb-18 Mar-19
SW12 SW11

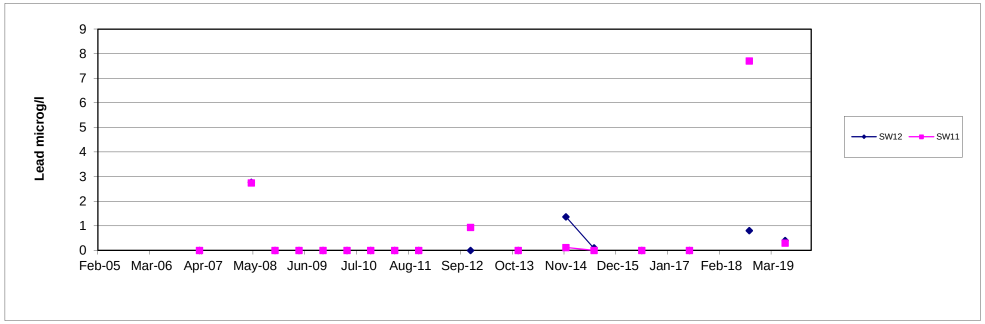

Copper microg/l
25
20
15
10
5
0
Feb-05 May-06 Aug-07 Nov-08 Feb-10 May-11 Aug-12 Nov-13 Feb-15 May-16 Aug-17 Nov-18
SW12 SW11

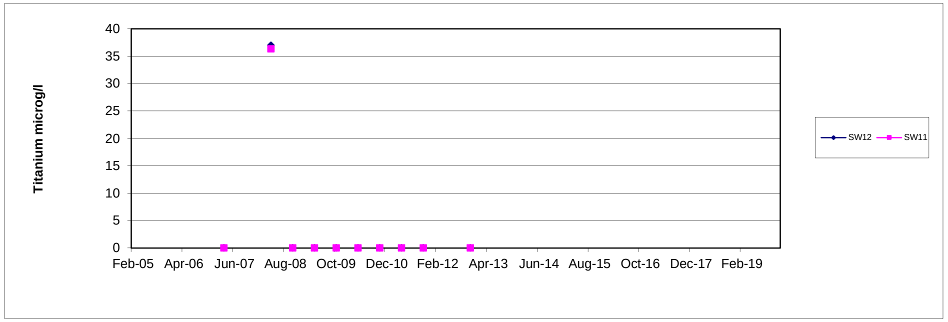

Nitrate mg/l
0
5
10
15
20
25
Feb-05
Apr-06
Jun-07
Aug-08
Oct-09
Dec-10
Feb-12
Apr-13
Jun-14
Aug-15
Oct-16
Dec-17
Feb-19
SW12
SW11


Potassium mg/l
0
5
10
15
20
25
30
Feb-05
Apr-06
Jun-07
Aug-08
Oct-09
Dec-10
Feb-12
Apr-13
Jun-14
Aug-15
Oct-16
Dec-17
Feb-19
SW12
SW11


Aluminium microg/l
0
100
200
300
400
500
600
Feb-05
Apr-06
Jun-07
Aug-08
Oct-09
Dec-10
Feb-12
Apr-13
Jun-14
Aug-15
Oct-16
Dec-17
Feb-19
SW12
SW11


Boron microg/l
0
10
20
30
40
50
60
70
80
90
100
Feb-05
May-06
Aug-07
Nov-08
Feb-10
May-11
Aug-12
Nov-13
Feb-15
May-16
Aug-17
Nov-18
SW12
SW11


Lead microg/l
0
1
2
3
4
5
6
7
8
9
Feb-05
Mar-06
Apr-07
May-08
Jun-09
Jul-10
Aug-11
Sep-12
Oct-13
Nov-14
Dec-15
Jan-17
Feb-18
Mar-19
SW12
SW11


Titanium microg/l
0
5
10
15
20
25
30
35
40
Feb-05
Apr-06
Jun-07
Aug-08
Oct-09
Dec-10
Feb-12
Apr-13
Jun-14
Aug-15
Oct-16
Dec-17
Feb-19
SW12
SW11

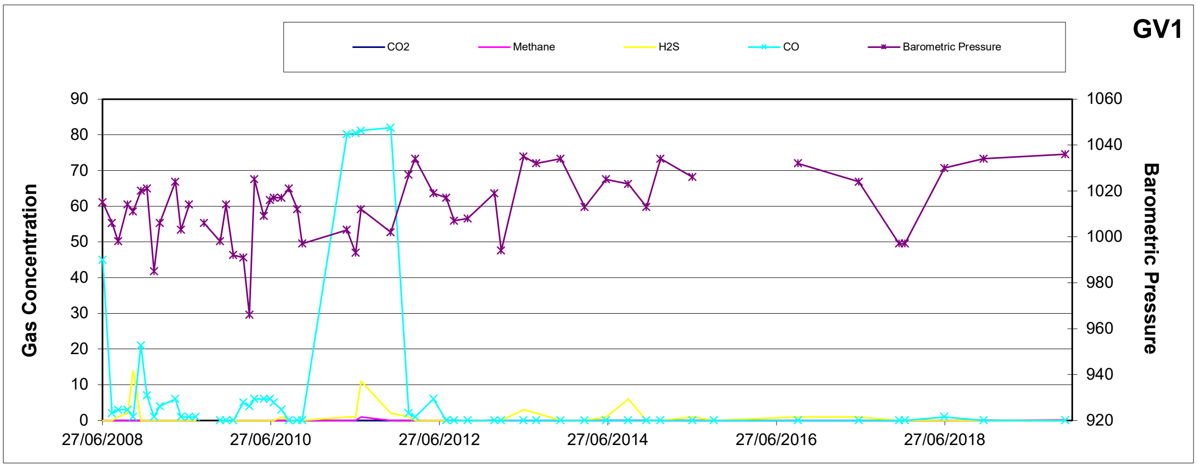
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

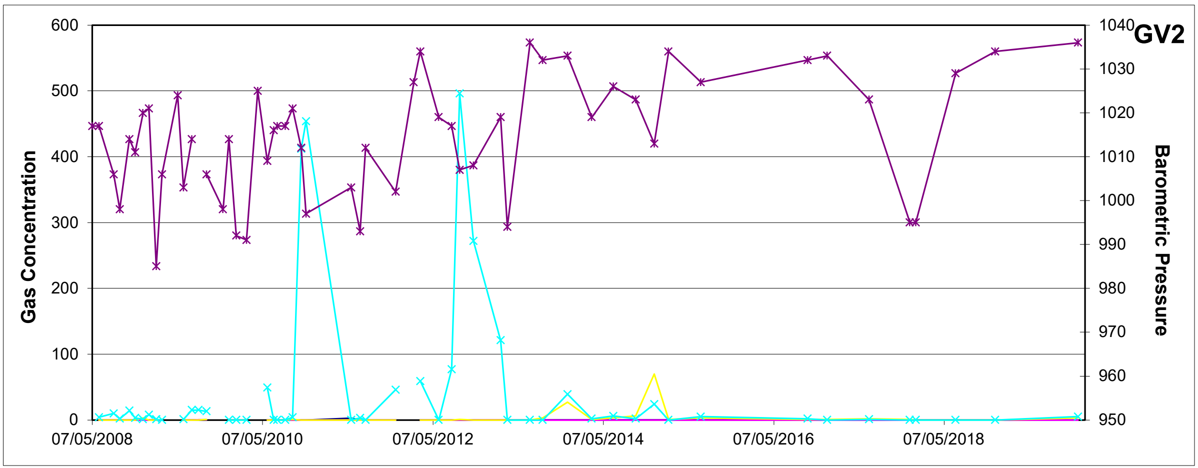
## PERMIT BV7311IE

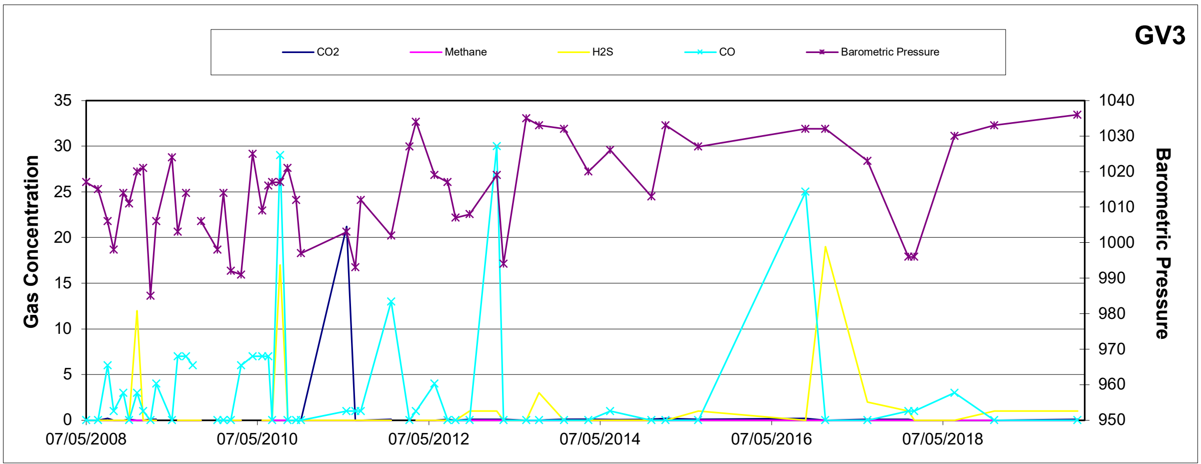
## 2019 Annual Review of Environmental Monitoring

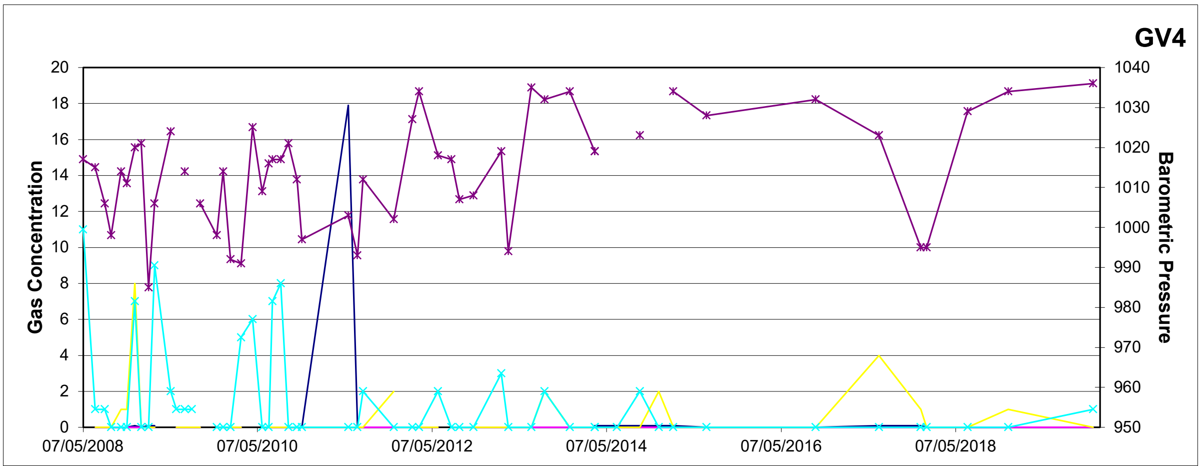
## Appendix 8
## Temporal Variation of Landfill Gas Chemistry

*Report Number 1965r1v1d0220*

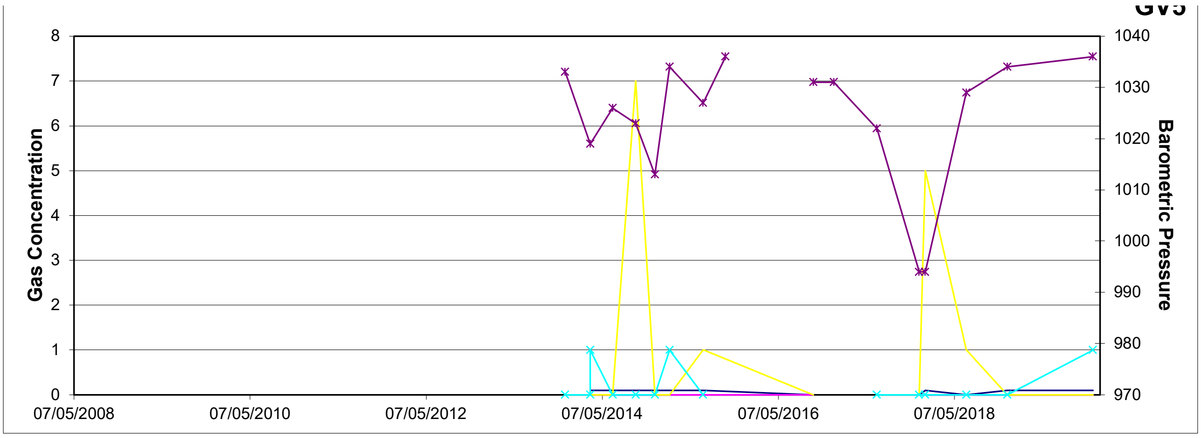

GV1
CO2
Methane
H2S
CO
Barometric Pressure
Gas Concentration
Barometric Pressure
0
10
20
30
40
50
60
70
80
90
920
940
960
980
1000
1020
1040
1060
27/06/2008
27/06/2010
27/06/2012
27/06/2014
27/06/2016
27/06/2018

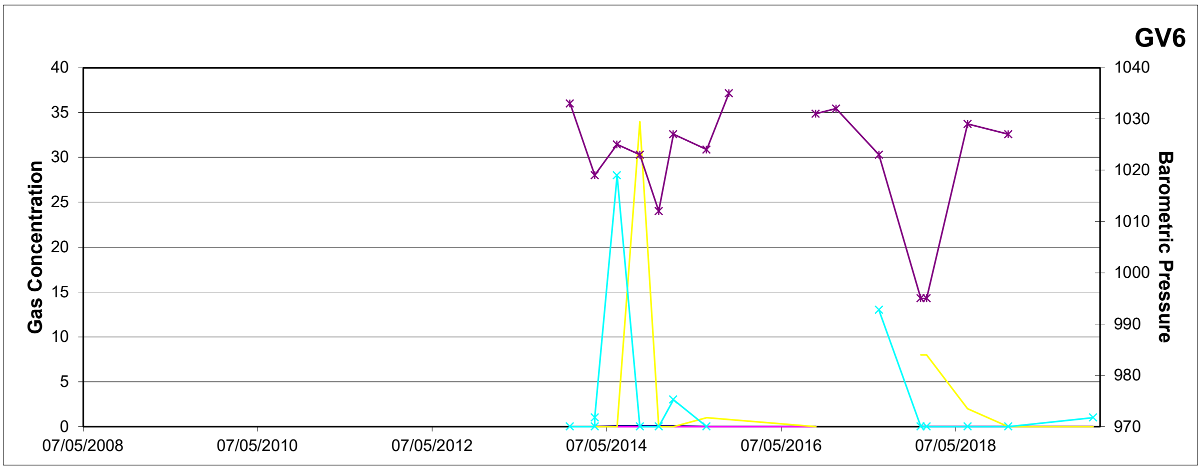

GV2
Gas Concentration
Barometric Pressure
0
100
200
300
400
500
600
950
960
970
980
990
1000
1010
1020
1030
1040
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018

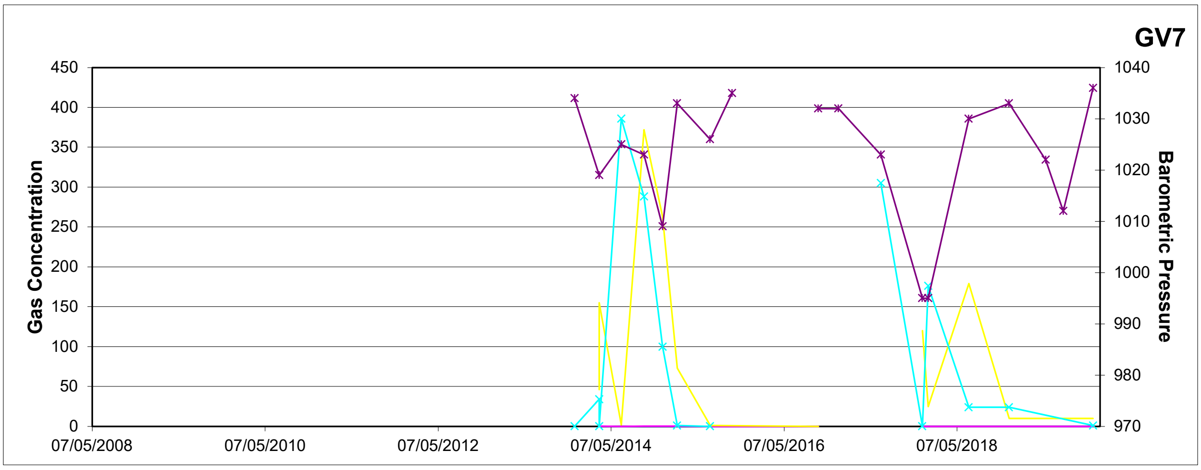

GV3
CO2
Methane
H2S
CO
Barometric Pressure
Gas Concentration
Barometric Pressure
0
5
10
15
20
25
30
35
950
960
970
980
990
1000
1010
1020
1030
1040
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018

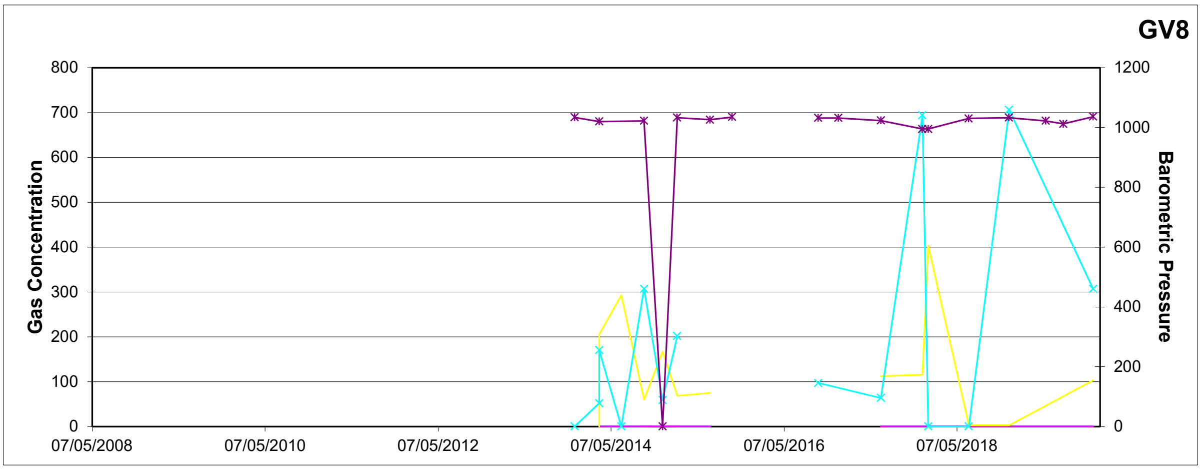

GV4
Gas Concentration
Barometric Pressure
0
2
4
6
8
10
12
14
16
18
20
950
960
970
980
990
1000
1010
1020
1030
1040
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018

GV5


GV5
Gas Concentration
Barometric Pressure
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018


GV6
Gas Concentration
Barometric Pressure
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018


GV7
Gas Concentration
Barometric Pressure
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018


GV8
Gas Concentration
Barometric Pressure
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018

# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

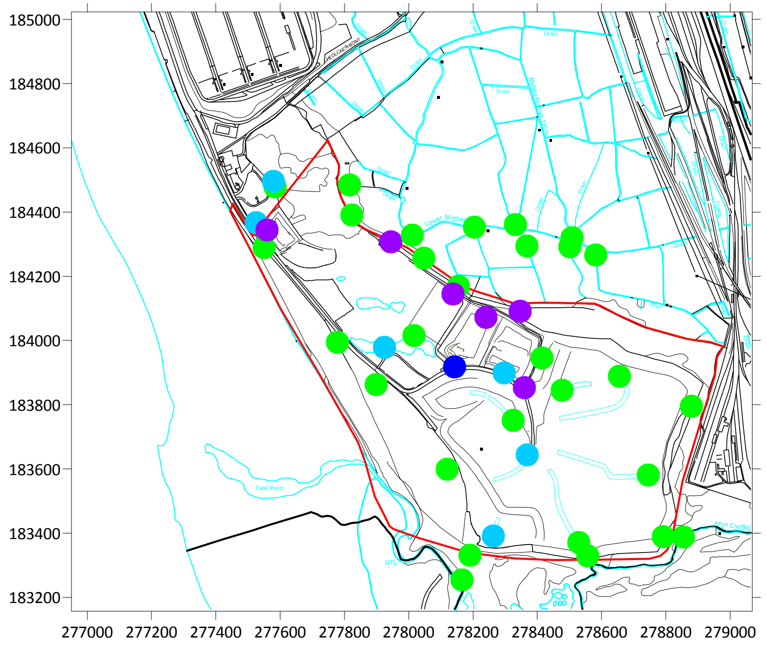
## PERMIT BV7311IE

## 2019 Annual Review of Environmental Monitoring

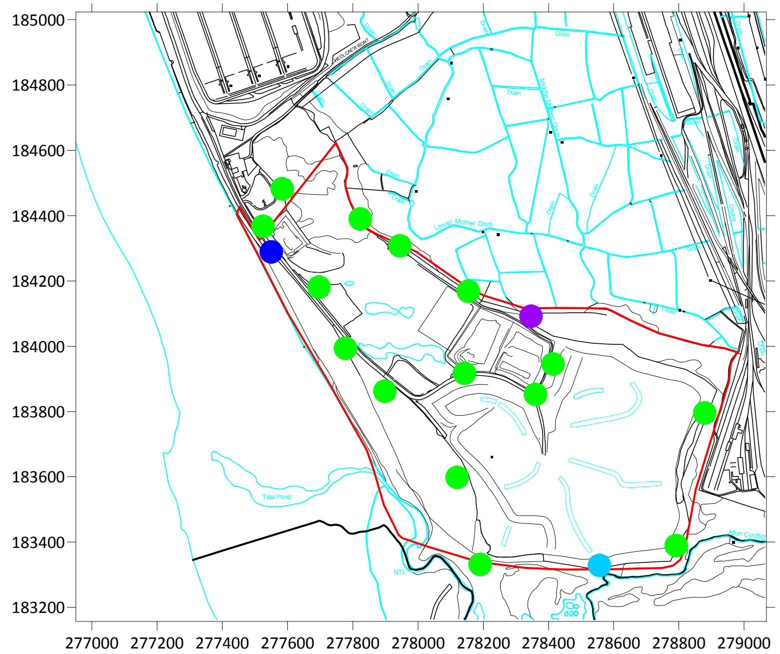
## Appendix 9
## Spatial Variation of Key Parameters

*Report Number 1965r1v1d0220*

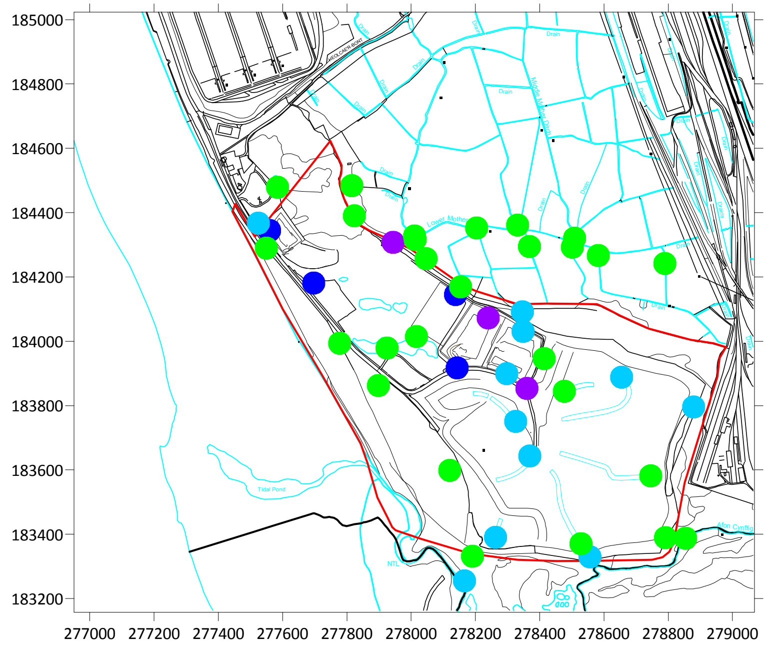
## pH in Groundwater, Leachate and Surface Water Chemistry



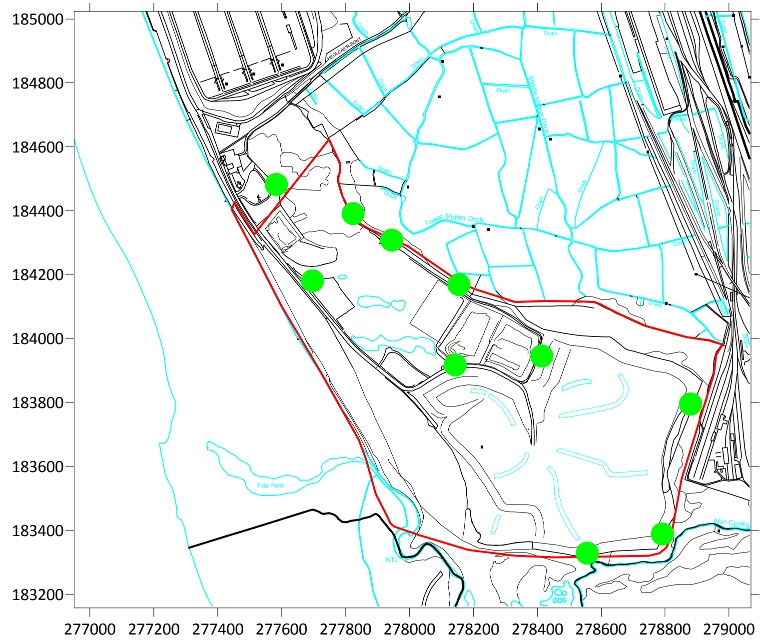

**June 2019 - Shallow GW, Leachate, Ponds and Surface Water**




**June 2017 - Deep Groundwater**

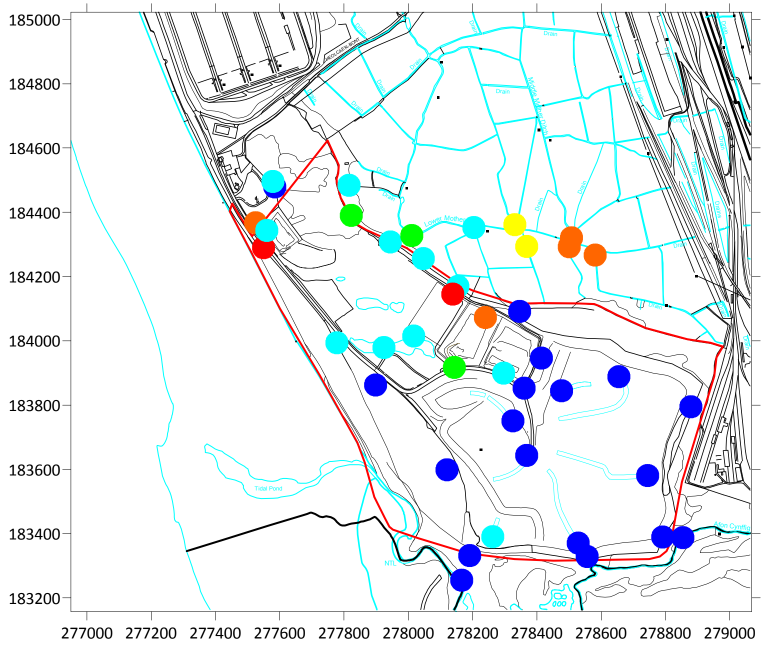



**Jan 2019 - Shallow GW, Leachate, Ponds and Surface Water**

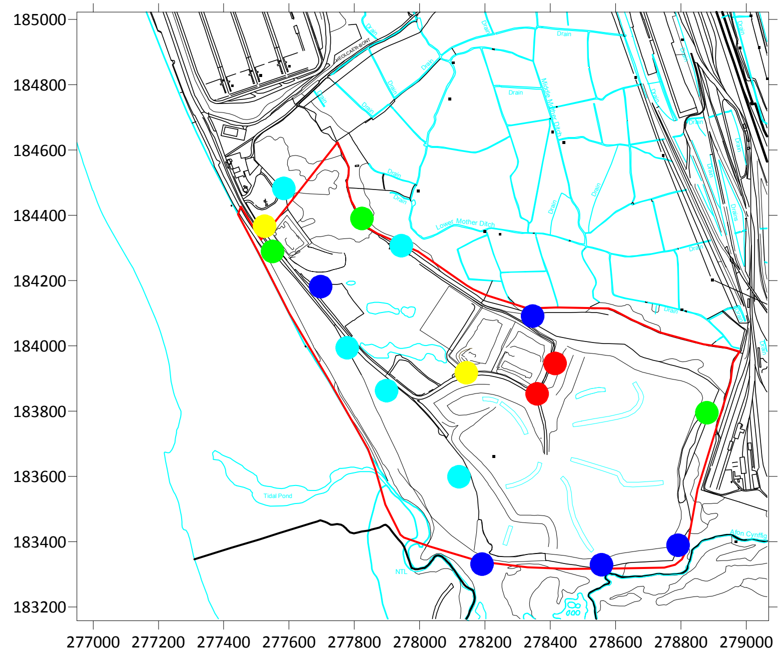



**Jan 2019 - Deep Groundwater**

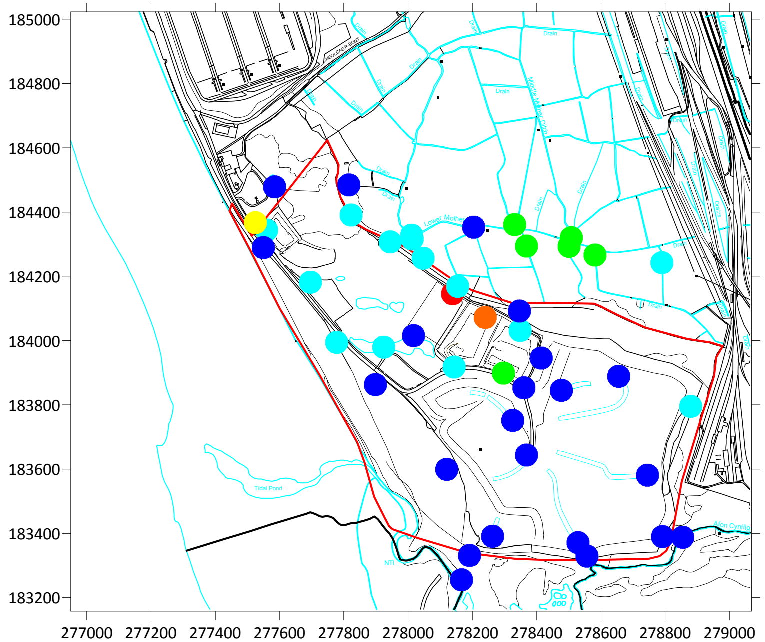
## Chloride in Groundwater, Leachate and Surface Water Chemistry



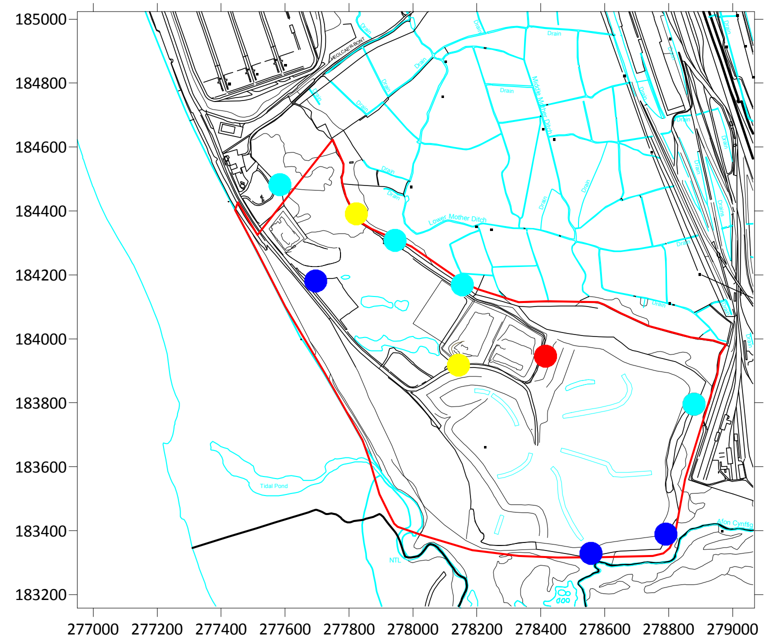

**June 2019 - Shallow GW, Leachate, Ponds and Surface Water**




**June 2019 - Deep Groundwater**

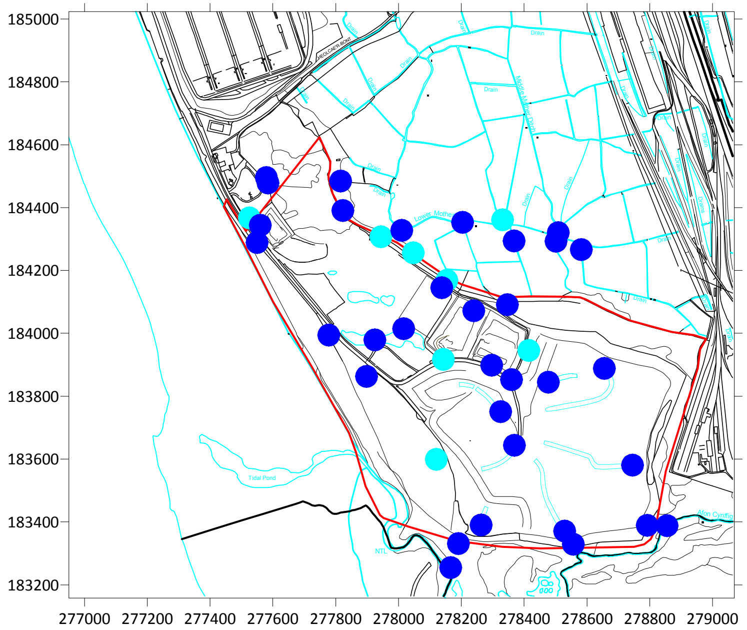



**Jan 2019 - Shallow GW, Leachate, Ponds and Surface Water**

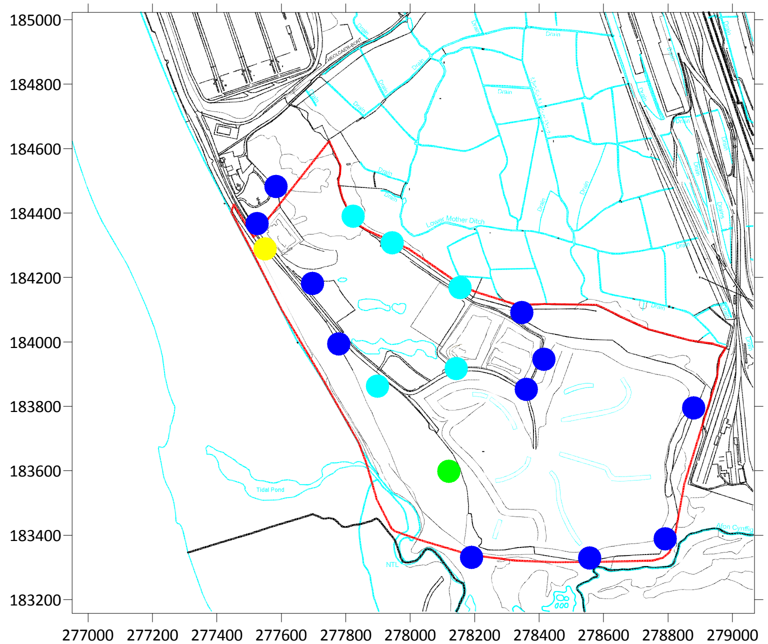



**Jan 2019 - Deep Groundwater**

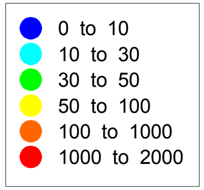
## Arsenic in Groundwater, Leachate and Surface Water

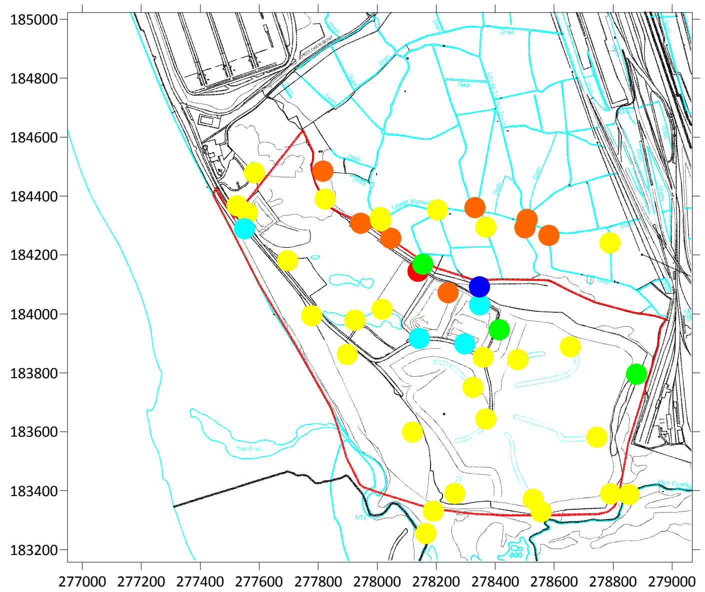



**June 2019 - Shallow GW, Leachate, Ponds and Surface Water**

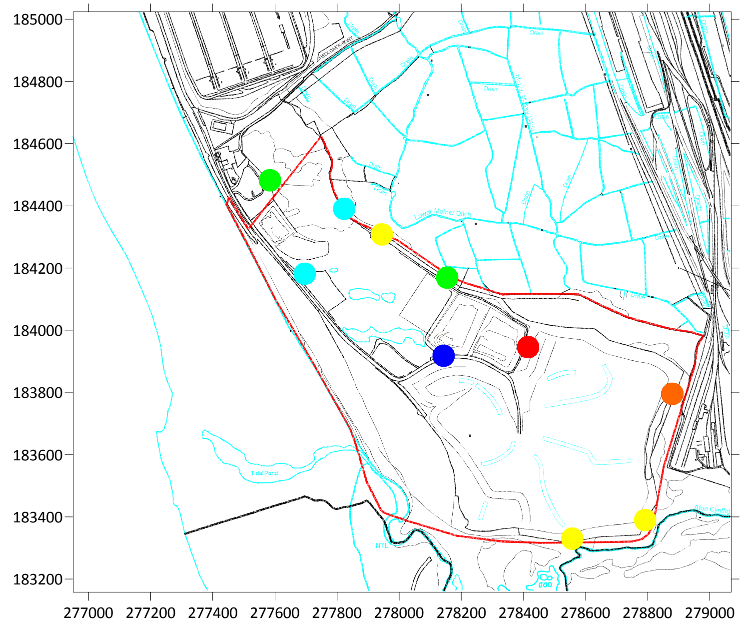



**June 2019 - Deep Groundwater**




**Jan 2019 - Shallow GW, Leachate, Ponds and Surface Water**




**Jan 2019 - Deep Groundwater**

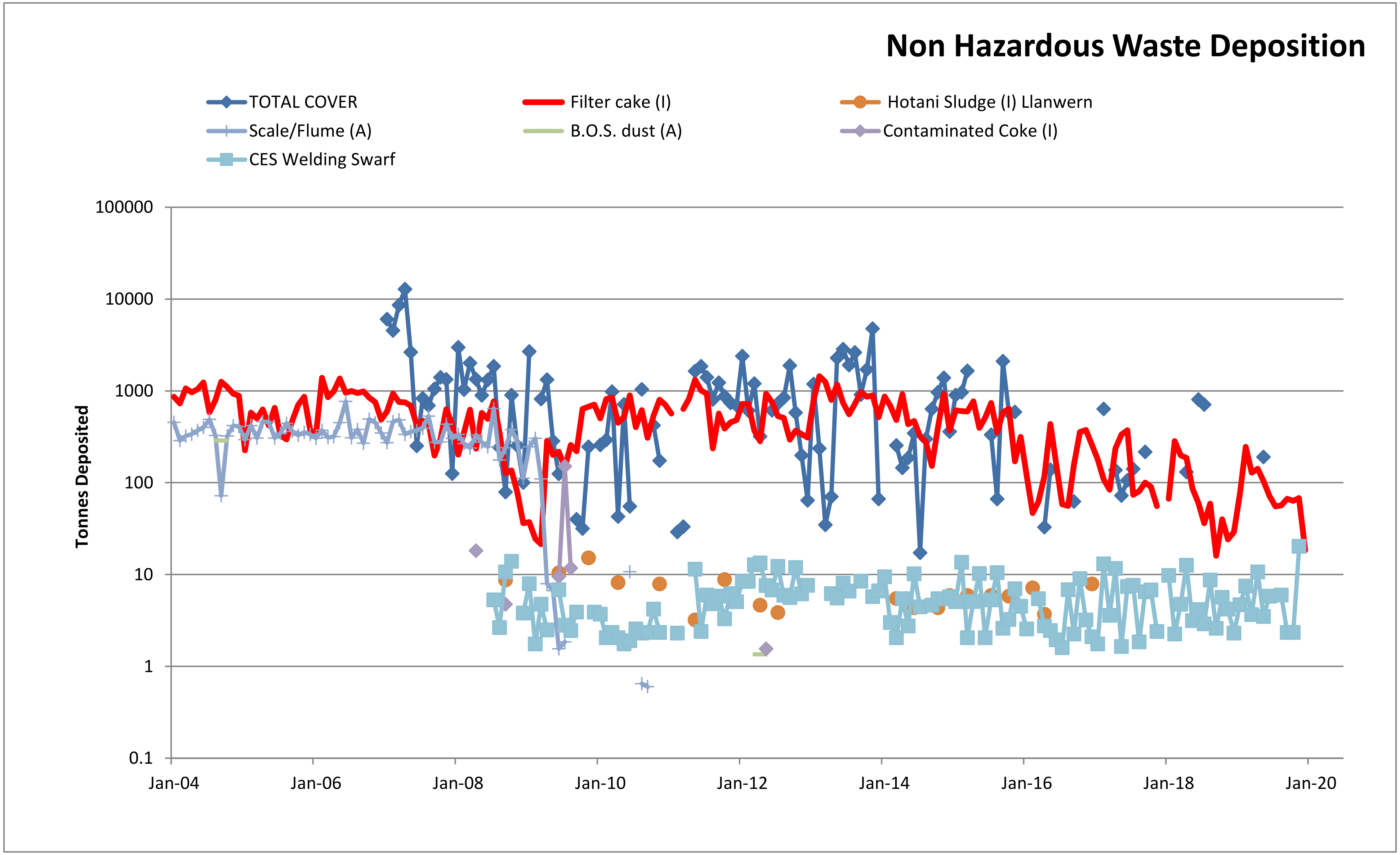
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

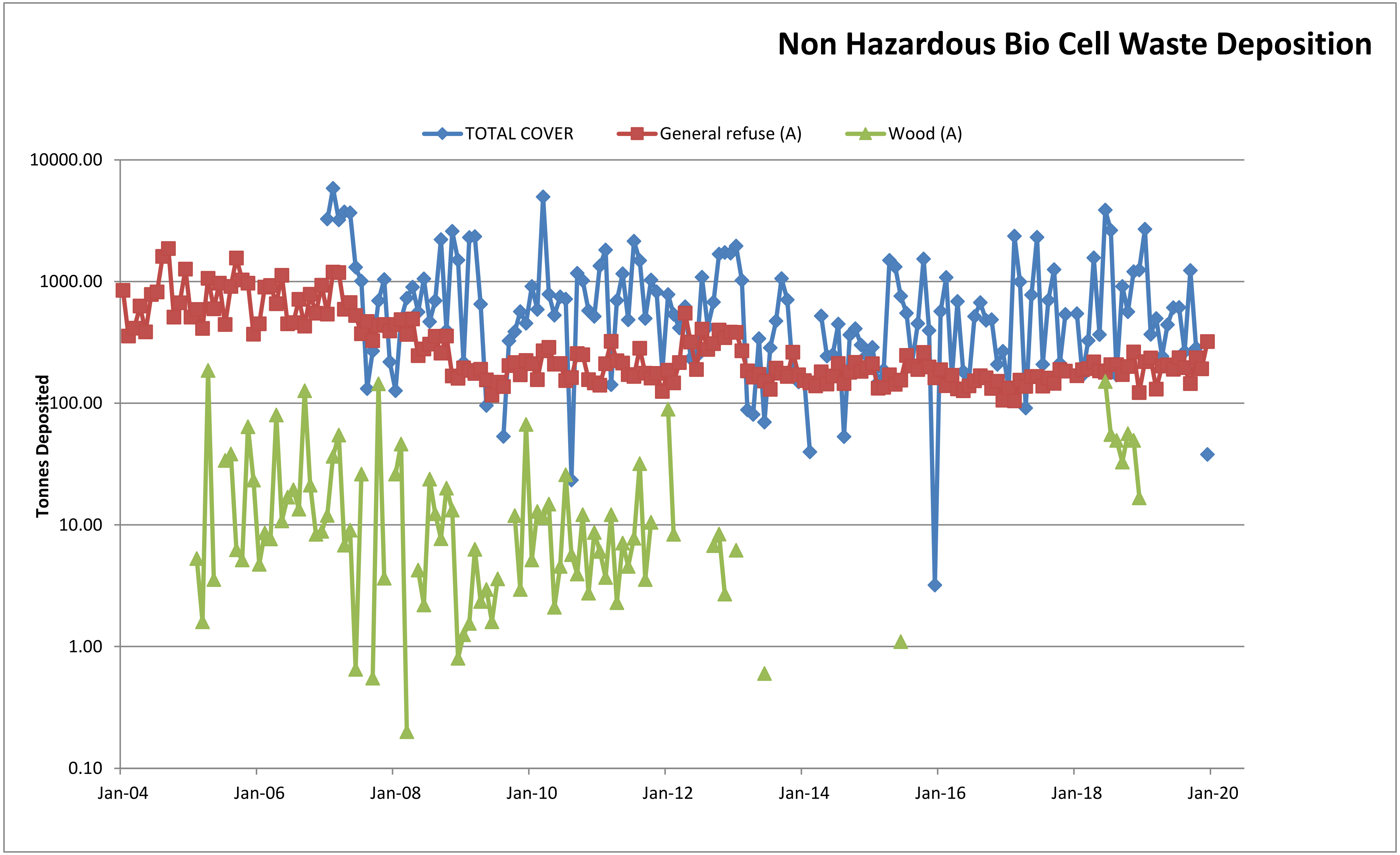
## PERMIT BV7311IE

## 2019 Annual Review of Environmental Monitoring

## Appendix 10
## Record of Landfilled Waste

*Report Number 1965r1v1d0220*


Non Hazardous Waste Deposition
TOTAL COVER
Filter cake (I)
Hotani Sludge (I) Llanwern
Scale/Flume (A)
B.O.S. dust (A)
Contaminated Coke (I)
CES Welding Swarf
Tonnes Deposited
100000
10000
1000
100
10
1
0.1
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20


Non Hazardous Bio Cell Waste Deposition
TOTAL COVER
General refuse (A)
Wood (A)
Tonnes Deposited
10000.00
1000.00
100.00
10.00
1.00
0.10
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20

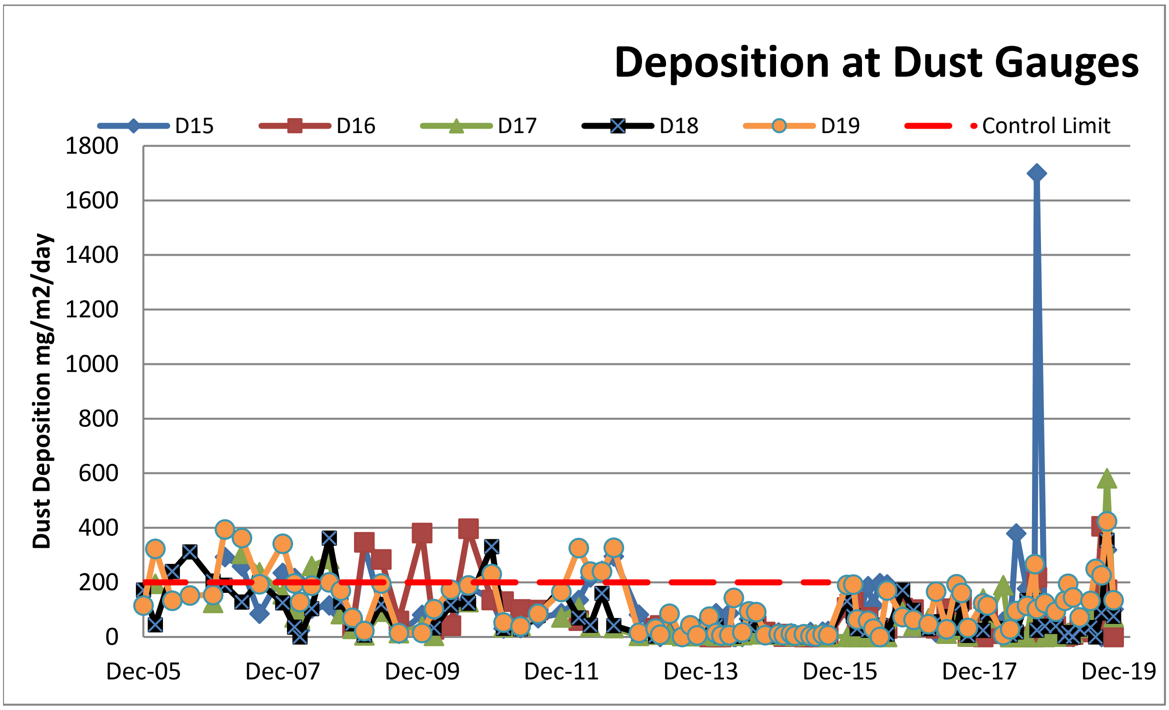
# MORFA NON-HAZARDOUS LANDFILL, PORT TALBOT

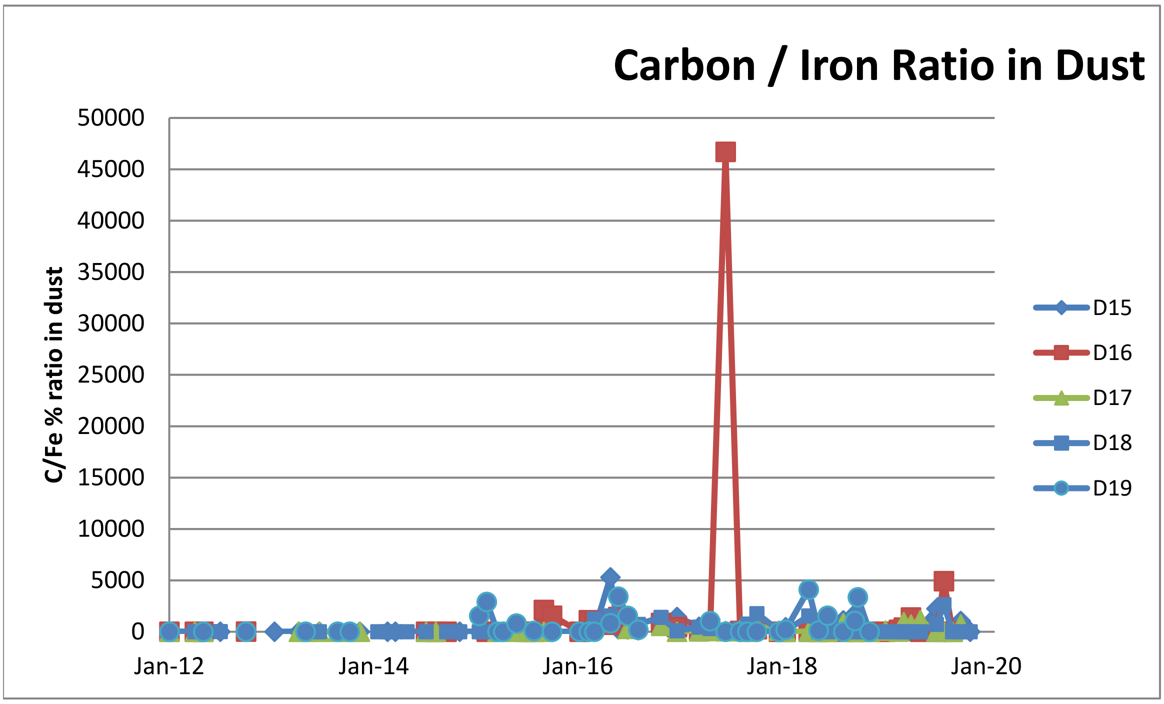
## PERMIT BV7311IE

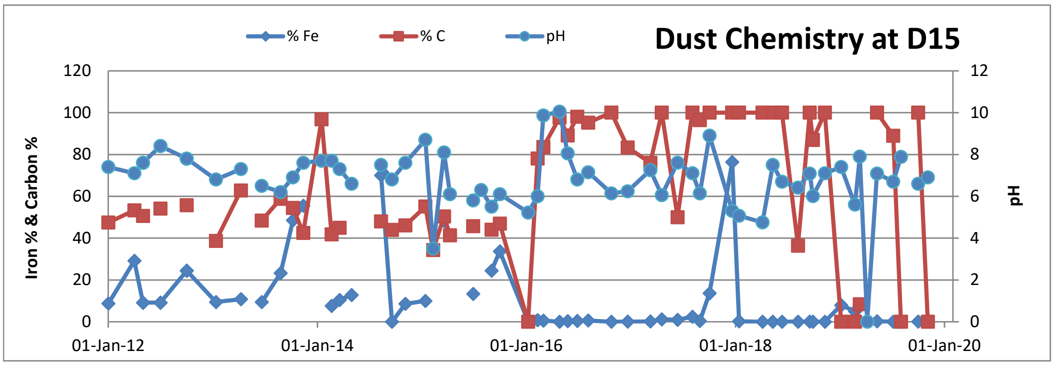
## 2019 Annual Review of Environmental Monitoring

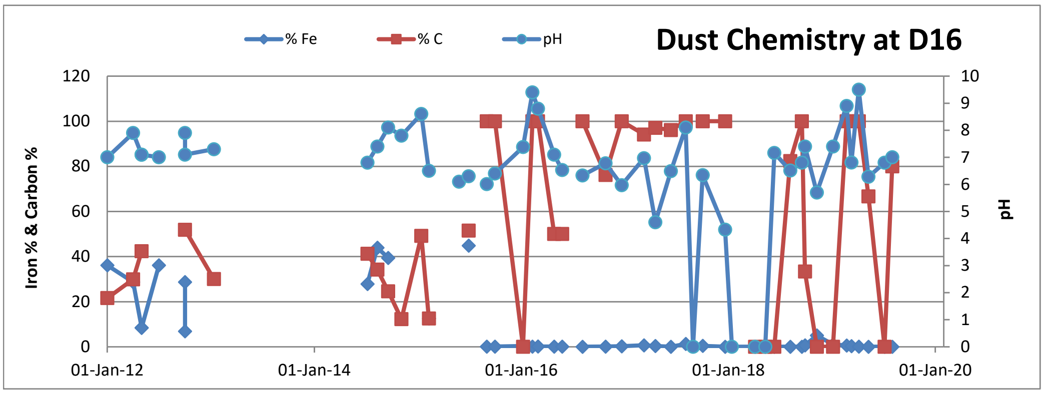
## Appendix 11
## Results from Dust Monitoring Gauges

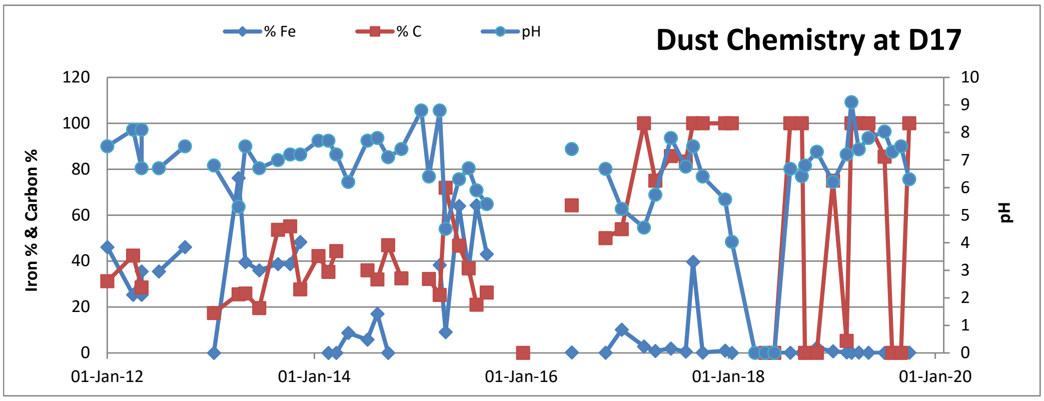
*Report Number 1965r1v1d0220*

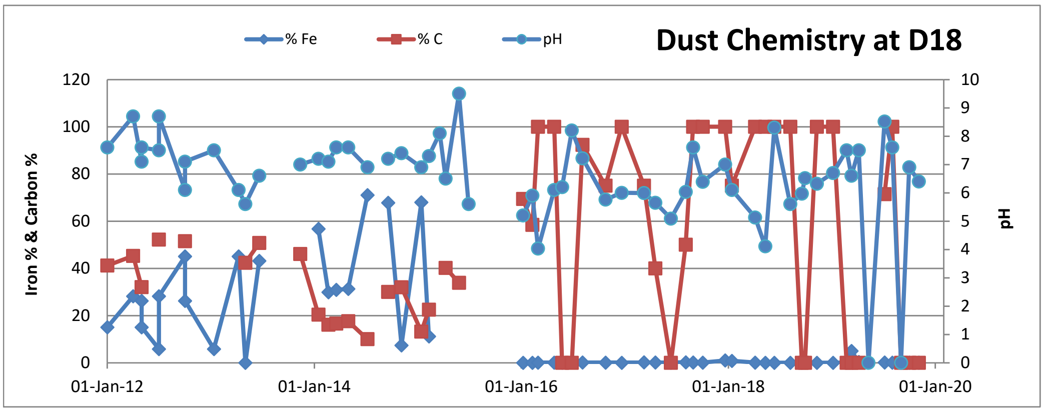

Deposition at Dust Gauges
D15
D16
D17
D18
D19
Control Limit
Dust Deposition mg/m2/day
1800
1600
1400
1200
1000
800
600
400
200
0
Dec-05
Dec-07
Dec-09
Dec-11
Dec-13
Dec-15
Dec-17
Dec-19

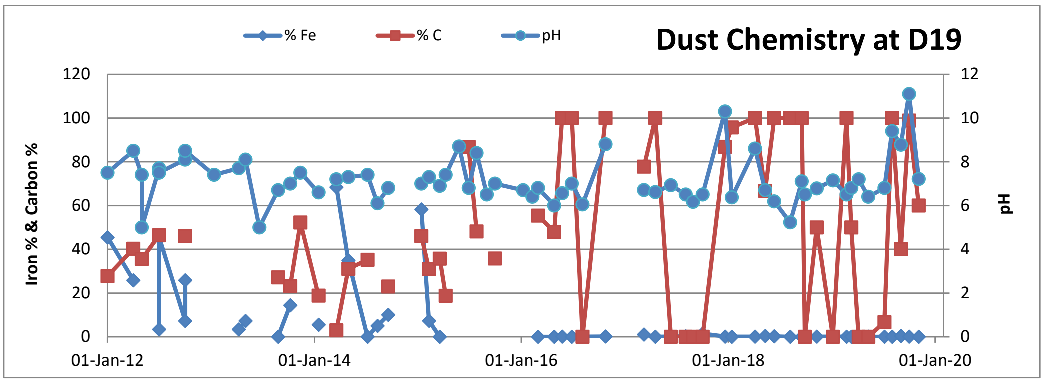

Carbon / Iron Ratio in Dust
C/Fe % ratio in dust
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
D15
D16
D17
D18
D19


% Fe
% C
pH
Dust Chemistry at D15
Iron % & Carbon %
pH
0
20
40
60
80
100
120
0
2
4
6
8
10
12
01-Jan-12
01-Jan-14
01-Jan-16
01-Jan-18
01-Jan-20


% Fe
% C
pH
Dust Chemistry at D16
Iron % & Carbon %
pH
0
20
40
60
80
100
120
0
1
2
3
4
5
6
7
8
9
10
01-Jan-12
01-Jan-14
01-Jan-16
01-Jan-18
01-Jan-20


% Fe
% C
pH
Dust Chemistry at D17
Iron % & Carbon %
pH
0
20
40
60
80
100
120
0
1
2
3
4
5
6
7
8
9
10
01-Jan-12
01-Jan-14
01-Jan-16
01-Jan-18
01-Jan-20


% Fe
% C
pH
Dust Chemistry at D18
Iron % & Carbon %
pH
0
20
40
60
80
100
120
0
1
2
3
4
5
6
7
8
9
10
01-Jan-12
01-Jan-14
01-Jan-16
01-Jan-18
01-Jan-20


% Fe
% C
pH
Dust Chemistry at D19
Iron % & Carbon %
pH
0
20
40
60
80
100
120
0
2
4
6
8
10
12
01-Jan-12
01-Jan-14
01-Jan-16
01-Jan-18
01-Jan-20

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