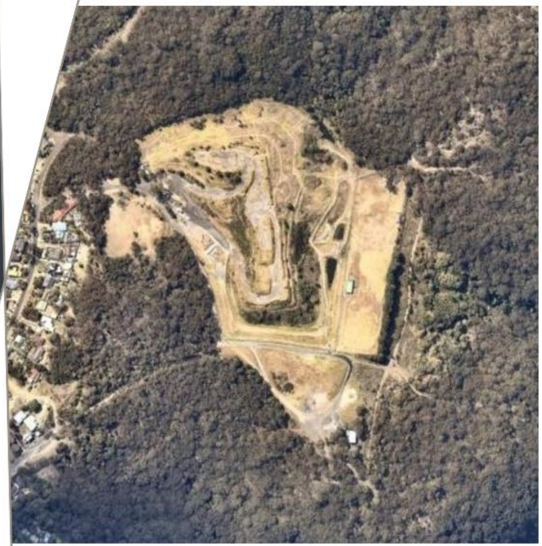
Helensburgh Landfill Annual Report 2018-2019



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1 Introduction

1.1 Background

Wollongong City Council (WCC) owns and operates the Helensburgh Landfill (the site), which is located in Nixon Place, Helensburgh NSW. The site ceased operation in 2012 and no longer receives waste with site activities limited to maintenance, upkeep and environmental monitoring. The site is situated at the north eastern periphery of the township of Helensburgh and is located approximately 300 metres to the east of the Helensburgh Railway station. The site is legally identified as Lots 621 and 915 DP 752033 with the site boundary illustrated on **Figure 1** in **Appendix A**.

WCC holds Environmental Protection Licence (EPL) Number 5861 issued by the NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997* (POEO Act). The licence authorises the scheduled activity of waste disposal (application to land) at the site with no limit on the scale of the activity.

A *Landfill Environmental Management Plan* (LEMP) was prepared in 2008 (GHD 2008) on behalf of WCC to ensure that environmental compliance is maintained throughout site operations and following closure. The management measures provided in the LEMP were developed in consideration of the *NSW Environmental Guidelines: Solid Waste Landfills (*EPA, 1996*)* and also addressed the monitoring and reporting requirements of EPL 5861. The NSW *Environmental Guidelines: Solid Waste Landfills* (EPA 1996) were superseded in 2016 and replaced with the *Environmental Guidelines: Solid Waste Landfills, Second edition* (EPA, 2016). The site is in a maintenance and closure phase and, as such, a revised LEMP is not considered necessary in response to the updated *Environmental Guidelines* (EPA 2016).

1.2 Objectives

The objectives of this Annual Report are to provide the EPA with the following:

> A summary of pollution monitoring data gathered during the reporting period of the 29^{th} of May 2018 to the 28^{th} of May 2019.

> Interpretation of monitoring data to assess the environmental performance of the site for compliance with conditions of the EPL.

1.3 Scope

1.3.1 Fieldwork

To meet the objectives of the Annual Report, the following scope of works was undertaken during the reporting period in accordance with the requirement of the EPL:

> Surface gas monitoring at areas where intermediate or final cover has been placed;

> Subsurface gas monitoring of seven landfill gas monitoring wells;

> Collection of surface water samples at three surface water monitoring points;

> Collection of groundwater from eight existing groundwater monitoring wells; and

> Monitoring of trade wastewater at one sampling point located at the pre-treatment discharge.

1.3.2 Reporting

Section 6 (R1) of EPL 5861 states that an Annual Return and an Annual Report must be prepared by the licence holder.

In accordance with Section 6 (R1.8) of the EPL, this Annual Report provides an assessment of environmental performance relevant to the licence conditions including:

> Tabulated results of all monitoring data required to be collected by this licence;

> A graphical presentation of data from at least the last three years in order to show variability and/or trends;

> An analysis and interpretation of all monitoring data;

- An analysis of, and response to, any complaints received;
- Identification of any deficiencies in environmental performance identified by the monitoring data, trends or incidents, and of remedial action taken, or proposed to be taken to address these deficiencies; and
- Recommendations on improving the environmental performance of the facility.

This report has been prepared in accordance with the reporting conditions provided in Section 6 of the EPL and in consideration of the *Environmental Guidelines: Solid Waste Landfills, Second edition* (EPA, 2016) *Requirements for publishing pollution monitoring data* (EPA, 2013).

2 Site Setting

2.1 Site History

The LEMP (GHD, 2008) provides the following information in relation to the historical site use:

> *Prior to establishment of waste disposal operations, the site was vacant bushland.*
> *In the initial years the site operated as a "trench and fill" operation, with a significant amount of waste burned within the trenches.*
> *It is understood that from the 1960's until approximately the early 1990's, the site operated as a sanitary depot accepting mainly nightsoil and putrescible wastes. Limited environmental controls were in-place at this time. The site continued to accept these types of waste until 1991, when putrescible waste ceased to be accepted at the site.*
> *Since 1991 the site has only been permitted by Wollongong City Council to accept "Class 2" style wastes e.g. furniture, wood, paper, plastics etc.*
> *Following completion of the "trench and fill" operations, landfilling operations shifted to "land raise" operations which involved the construction of a small hill created from the deposited waste materials. Filling operations constituted "land raising", which overtip previously landfilled waste in the site's central southern area.*
> *Material used for daily covering of the waste was obtained from a combination of clean fill materials delivered to the site.*
> *Wollongong City Council ordered two "Landfill Lids", to reduce daily cover requirements at this site by approximately 50%. Landfill Lids were used as alternative daily cover and are comprised of a portable rigid steel frame with a tarpaulin attachment.*

2.2 Topography and Drainage

The site is situated on the upper slopes of a hill on the north eastern most outskirts of the suburb of Helensburgh. The gradient of the site slopes towards the north and east in the direction of the adjoining Garrawarra State Conservation Area. The final form of the landfill is mounded with a slight to moderate radial grade in all directions toward the site boundary.

An elevation profile was created utilising an aerial image, taken on the 16th of September 2018, from Nearmap which shows that the lowest elevations of the site are located in the eastern portion with an approximate relative level (RL) of 190 m Australian Height Datum (AHD). The highest elevations are located at the centre of the site at the location of the former waste deposition area with an approximate RL of 210 m AHD.

Approximate surface contours are shown on **Figure 2** of **Appendix A**.

2.3 Soil and Geology

The site is situated within the Sydney Basin and sits atop the Illawarra Escarpment. The natural geology beneath the site is part of the Cumberland Sub-Group of the Illawarra Coal Measures, which are Permian in age. A review of the *1:100,000 geological map 'Wollongong-Port Hacking'* (Department of Mineral Resources, 1985) situates the site on Hawkesbury Sandstone, which is characterised by medium to coarse grained quartz sandstone with very minor shale and laminate lenses, which is generally consistent with soil observations noted during a previous intrusive investigation completed by GHD in 2008.

Test pitting completed by GHD (2008) as part of the LEMP suggests that the near surface natural geology of the area is as follows:

> Orange brown clayey Sand overlying;
> Orange mottled clayey Sand overlying;
> White clay Sand with red mottled Laterite (Ironstone) with clay Sand overlying;
> White loosely cemented Sandstone (assumed to be regional bedrock).

GHD noted that the thickness of residual soil was between 2.5 m and 4 m before bedrock was encountered. According to WCC, areas of the site that were historically used for deposition of waste have been capped with virgin excavated natural material (VENM), a material type as defined by the NSW EPA, with a nominal thickness of 0.3 m. However, earthworks at the site since closure showed a capping thickness up to 3.0 m.

2.4 Hydrogeology

2.4.1 Groundwater

Groundwater monitoring data has been collected from the site since September 1996. Historical gauging of groundwater levels indicates that the local aquifer typically ranges from 1.5 m to 4.5 m below ground level (mbgl). Based on trend graphs located in **Appendix D**, shallowest groundwater is generally located to the south of the site with more northern wells regularly gauged with a standing water level (SWL) 2.5 m to 3 m deeper than those in the south. Groundwater is inferred to flow in a north to easterly direction towards the Hacking River.

A groundwater bore search included in the LEMP (GHD 2008) indicates the presence of five registered groundwater wells within a 5 km radius of the site. The registered uses of these bores are for domestic stock purposes.

2.4.2 Surface Water

The LEMP (GHD 2008) identified a spring beneath the site, which is understood to feed surface water to a stream east of the site that discharges to the Hacking River, located approximately 400 metres to the southeast.

All surface water runoff from the landfill is collected by a water collection system around the perimeter of the site that drains to three stormwater ponds located along the eastern boundary of the site.

2.5 Climate

Climate data for the site was obtained from the nearby Bellambi Bureau of Meteorology (BOM) Weather Station (ID 068228) and the Lucas Heights ANSTO Station (ID 066078) to provide indicative climate conditions. The Bellambi Weather Station is located approximately 20 km south of the site at the base of the escarpment and the Lucas Heights weather station is located 16 km north of the site. The data from both stations are considered a reliable representation of the site conditions during the reporting period.

The key climatic data from the Bellambi weather station is summarised in **Table 2-1**.

Table 2-1 Climatic Data – Bellambi Weather Station

	2018						2019					
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)	18.8	1.6	29.4	54.6	129.2	100.6	103.0	68.2	89.2	187.0	53.2	7.2
Mean max temperature (°C)	17.0	18.6	17.9	19.0	19.3	22.7	24.1	25.7	24.8	24.8	22.7	21.0
Mean min temperature (°C)	10.3	9.9	10.0	11.0	14.1	15.7	18.2	20.5	18.6	18.5	16.0	13.5
Mean 9am wind speed (km/h)	18	14	19	17	19	19	14	13	16	15	12	16
Mean 3pm wind speed (km/h)	22	19	24	25	27	25	19	19	25	23	18	19
Mean 9am relative humidity (%)	67	49	51	61	77	66	78	82	73	74	68	57
Mean 3pm relative humidity (%)	61	44	47	59	75	68	73	78	66	65	68	55

Long-term averages for the Bellambi weather station are shown in **Table 2-2** and have been included for comparative purposes.

Table 2-2 Long Term Averages – Bellambi Weather Station

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	129.2	73.3	90.8	54.4	73.5	96.9	74.9	80.7	134.6	124.6	95.4	80.3
Mean max temperature (°C)[1]	17.6	17.1	18	20.2	21.6	22.3	24	25	24.9	24.1	22.3	19.9
Mean min temperature (°C)[1]	11.1	10.1	10.5	12.4	14.1	15.8	17.6	19.1	19.2	18.2	15.7	13.1
Mean 9am wind speed (km/h) [2]	17	16.7	17.7	18.1	18.2	18.7	17.5	17	15.9	15	16.1	15.8
Mean 3pm wind speed (km/h)[2]	21	20.7	23.6	24.8	24.7	24.6	25.4	24.5	23.9	23.7	22	20.9
Mean 9am relative humidity (%)[2]	63	60	56	59	62	72	71	72	74	70	67	61
Mean 3pm relative humidity (%)[2]	59	56	54	61	64	70	69	72	74	70	67	61

[1] Data recorded from 1997 – 2019

[2] Data recorded from 1997 – 2010

Long-term averages for the Lucas Heights Weather station are shown in **Table 2-3** below and have been included for comparative purposes.

Table 2-3 Long Term Averages – Lucas Heights Weather Station

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	105.0	53.1	69.8	50.5	70.4	91.3	77.6	95.6	104.2	119.6	91.6	75.6
Mean max temperature (°C)[2]	16.2	15.8	17.2	19.5	21.6	23.4	25.7	25.9	26.0	24.7	22.3	18.9
Mean min temperature (°C)[2]	8.2	6.6	7.4	9.4	11.9	13.7	15.9	17.4	17.6	16.1	13.3	10.1
Mean 9am wind speed (km/h)[2]	8.5	8.3	9.9	9.5	9.8	9.4	8.9	8.5	7.9	7.4	7.3	7.7
Mean 3pm wind speed (km/h)[2]	9.8	10.5	12.6	13.2	13.1	14.1	14.9	13.7	12.5	11.1	10.4	9.3
Mean 9am relative humidity (%)[2]	73	68	65	63	64	66	67	72	74	73	70	72
Mean 3pm relative humidity (%)[2]	61	52	51	52	57	57	57	62	63	63	58	58

[1] Data recorded from 1958 – 2019

[2] Data recorded from 1962 – 1982

The climate data shows relatively dry weather during the reporting period compared to the long term averages. The winter months were particularly dry as was early spring, with almost no rainfall recorded in the month of September.

The average maximum and minimum temperatures were generally similar to the long term averages. Mean wind speeds were similar with long-term trends, and humidity was lower than long-term trends indicating a dry year which correlates with the low rainfall.

3 Field Investigations

3.1 Fieldwork Methodology

The subsections below describe the frequency of monitoring, the monitoring methods, monitoring locations and analytes for surface gas, subsurface gas, stormwater, leachate and groundwater. The fieldwork methodologies implemented during the reporting period were developed in consideration of the guidance provided in the NSW EPA *Environmental Guidelines: Solid waste landfills (second edition)* (EPA 2016).

The final quarterly monitoring round was completed on the 31st May 2019 outside the reporting period closure on the 29th May 2019. Results from this round have been included as part of this report and assessment, however recommendations include ensuring that sampling rounds are timed in future years to align with the reporting period.

3.1.1 Surface Gas

Surface gas monitoring was completed during the reporting period to assess for potential surface emissions of landfill gasses (LFG) emanating from the landfill areas at the site. The purpose of the surface gas monitoring is to demonstrate that the cover material effectively controls the emission of landfill gas. The fieldwork methodology for surface gas monitoring is summarised below in **Table 3-1**. The location of each surface gas monitoring location is shown on **Figure 3** of **Appendix A**.

Table 3-1 Surface Gas Monitoring Methodology

Activity	Description
Frequency of Monitoring	Surface gas monitoring for methane was completed monthly during the reporting period in accordance with Section 5 (M2.2) of EPL 5861.
Monitoring Method	Methane was measured by a third party contractor, ALS Environmental, using an Inspectra Laser Gas Detector. The instrument used to measure methane concentrations was calibrated prior to each monitoring event. Surface gas monitoring was achieved by testing the atmosphere approximately 5 centimetres above the ground surface in areas with intermediate or final cover where wastes have been placed. The monitoring was completed on calm days (winds below 10km/hr) and in transects with an approximate spacings of 25 m.
Monitoring Locations	Surface gas monitoring for methane was undertaken at the following locations: ▪ Point 3: areas where intermediate or final cover has been placed i.e. transects A, B, C, E, F, G, H, I, J, K, L, M, N, O and P ▪ Weighbridge Office ▪ Nixon Place and Halls Road fence lines: transect Q

3.1.2 Subsurface Gas

Subsurface gas monitoring was completed during the reporting period to assess for potential offsite migration. The fieldwork methodology for subsurface gas monitoring is summarised below in **Table 3-2**. The location of each subsurface gas monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-2 Subsurface Gas Monitoring Methodology

Activity	Description
Frequency of Monitoring	Subsurface gas monitoring for methane was completed annually during the reporting period in accordance with Section 5 (M2.2) of EPL 5861.
Monitoring Method	Subsurface gas monitoring was measured by a third party contractor, ALS Environmental, using an Inspectra Laser Gas Detector. The instrument used to measure methane concentrations was calibrated prior to each monitoring event. Subsurface gas monitoring was achieved by testing the methane concentration in seven landfill gas monitoring wells (listed below) that are situated around the northern, eastern and southern perimeters of the landfill. The contents of each well was sampled and analysed prior to potential dilution by air.
Monitoring Locations	Subsurface gas monitoring for methane was undertaken at landfill gas monitoring wells, Point 4, Point 17, Point 18, Point 19, Point 20 and Point 21.

3.1.3 Stormwater

Stormwater monitoring was scheduled to be completed during the reporting period to detect excess sediment loads in stormwater leaving the site and/or cross-contamination of stormwater with landfill leachate.

The fieldwork methodology for stormwater monitoring is summarised below in **Table 3-3**. The location of stormwater monitoring locations is shown on **Figure 2** of **Appendix A**.

Table 3-3 Stormwater Monitoring Methodology

Activity	Description
Frequency of Monitoring	Stormwater sampling was scheduled to be completed daily during any discharge in accordance with Section 5 (M2.3) of EPL 5861, however, stormwater monitoring was not undertaken during the reporting since overflows of the stormwater pond did not occur.
Monitoring Method	N/A
Monitoring Locations	Had an overflow from the stormwater pond occurred a water sample would have been collected from the following monitoring point in accordance with Section 5 (M2.3) of EPL 5861: ▪ 1 (overflow from stormwater pond)
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each stormwater sample would have been scheduled to be analysed for: ▪ pH ▪ Total suspended solids (TSS)

3.1.4 Leachate

Leachate monitoring was completed periodically during the reporting period to provide data on the composition, height levels and volumes of leachate produced by the site, and to record details about any irregular discharges or overflows of leachate from the site. The fieldwork methodology for leachate monitoring is summarised below in **Table 3-4**. Leachate monitoring locations are shown on **Figure 2** of **Appendix A**.

Table 3-4 Leachate Monitoring Methodology

Activity	Description
Frequency of Monitoring	Leachate sampling was completed quarterly to assess electrical conductivity and annually to assess the remainder of parameters / contaminants (listed below) in accordance with Section 5 (M2.3) of EPL 5861.
Monitoring Method	Leachate monitoring was completed by a third party contractor, ALS Environmental. Grab samples of water were collected using a scoop at the nominated sampling point (summarised below). The instrument used to measure water quality parameters was calibrated prior to each monitoring event.
Monitoring Locations	A leachate sample was collected from the Monitoring Point 2 (leachate pond) in accordance with Section 5 (M2.3) of EPL 5861.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each leachate sample collected during the annual monitoring event was analysed for: ▪ Alkalinity ▪ Aluminium ▪ Arsenic ▪ Barium ▪ Benzene ▪ Cadmium ▪ Calcium ▪ Chloride ▪ Chromium (hexavalent) ▪ Chromium (total) ▪ Cobalt ▪ Copper ▪ Ethylbenzene ▪ Nitrate ▪ Nitrite ▪ Nitrogen (ammonia) ▪ Organochlorine pesticides (OCP) ▪ Organophosphate pesticides (OPP) ▪ pH ▪ Phosphorous (total) ▪ Polycyclic aromatic hydrocarbons (PAH) ▪ Potassium ▪ Sodium ▪ Sulfate ▪ Toluene ▪ TSS

Activity	Description
	▪ Fluoride ▪ Lead ▪ Magnesium ▪ Manganese ▪ Mercury ▪ Total organic carbon (TOC) ▪ Total petroleum hydrocarbons (TPH) ▪ Total phenolics ▪ Total suspended solids (TSS) In accordance with Section 5 (M2.3) of EPL 5861, each leachate sample collected during the quarterly monitoring event was analysed for electrical conductivity.

3.1.5 Surface Water

Surface water monitoring was completed periodically during the reporting period to verify that offsite surface water bodies were not being impacted by leachate or by sediment-laden stormwater from the landfill. The fieldwork methodology for surface water monitoring is summarised below in **Table 3-5**. Stormwater monitoring locations are shown on **Figure 2** of **Appendix A**.

Table 3-5 Surface Water Monitoring Methodology

Activity	Description
Frequency of Monitoring	Surface water sampling was completed quarterly in accordance with Section 5 (M2.3) of EPL 5861.
Monitoring Method	Surface water monitoring was completed by a third party contractor, ALS Environmental. Grab samples of water were collected using a scoop at the nominated sampling point (summarised below). The instrument used to measure water quality parameters was calibrated prior to each monitoring event.
Monitoring Locations	A surface water sample was collected from Monitoring Point 8 (pony club) in accordance with Section 5 (M2.3) of EPL 5861.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each sample was analysed for: ▪ Conductivity ▪ Dissolved oxygen ▪ Faecal coliforms ▪ Nitrogen (ammonia) ▪ pH ▪ Potassium ▪ Redox potential ▪ Total dissolved solids ▪ Total organic carbon

3.1.6 Groundwater

Groundwater monitoring was completed periodically during the reporting period to track groundwater quality with time and evaluate interactions with leachate and potential contaminants. The fieldwork methodology for groundwater monitoring is summarised below in **Table 3-6**. Groundwater monitoring locations are shown on **Figure 2** of **Appendix A**.

Table 3-6 Groundwater Monitoring Methodology

Activity	Description
Frequency of Monitoring	Groundwater monitoring was completed on a quarterly basis during the reporting period in accordance with Section 5 (2.3) of EPL 5861.
Monitoring Method	Groundwater was sampled by a third party contractor, ALS Environmental, using bailer technique. A pre-calibrated water quality meter used to measure groundwater quality parameters during monitor well purging. The collected groundwater samples were submitted to ALS Environmental for analysis of contaminants and parameters of interest (summarised below). Ground water levels were recorded before purging.
Monitoring Locations	Groundwater bores monitored during the reporting period included Point 5, Point 6, Point 7, Point 12, Point 13, Point 14, Point 15 and Point 16.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 groundwater monitoring points were analysed for: Annually ▪ Metals (aluminium, arsenic, barium, cadmium, chromium (hexavalent and Quarterly ▪ Alkalinity

Activity	Description	
	total), cobalt (Point 5, 6 and 7 only), copper, lead, manganese, mercury, zinc) ▪ Benzene, toluene, ethylbenzene, xylene (BTEX) ▪ Fluoride ▪ Nitrate and nitrite ▪ OCP ▪ OPP ▪ PAH ▪ TPH ▪ Total phenolics	▪ Calcium, magnesium, potassium, sodium, chloride, sulfate ▪ pH and conductivity ▪ Standing water level ▪ TDS ▪ TOC ▪ Nitrogen (ammonia)

3.1.7 Trade Wastewater

Monitoring of trade wastewater was completed periodically during the reporting period to confirm that water quality parameters of discharge were within the acceptable criteria. Discharge of trade waste to sewer was undertaken by Council in accordance with the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water 2017) (the *Consent*). The fieldwork methodology for trade wastewater monitoring is summarised below in **Table 3-7**. The trade waste monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-7 Trade Wastewater Monitoring Methodology

Activity	Description
Frequency	Trade wastewater sampling was undertaken on the 23 July 2018 and approximately every 2 months thereafter. If trade wastewater was not discharged on the scheduled day, then the sample was taken on the next day that trade wastewater was discharged. The reading of the flowmeter was obtained at the commencement and conclusion of each sampling event. Discrete samples were collected and tested for pH at the start and finish of each sample day.
Monitoring Method	Trade wastewater was sampled by a third party contractor, ALS Environmental. Composite samples were collected over a 24 hour period using a Composite Auto-sampler, and pre and post monitoring samples were collected in the form of grab samples. The probe used to measure water quality parameters was calibrated prior to each monitoring event and the trade wastewater samples collected were submitted to ALS Environmental for analysis of parameters of interest (summarised below).
Monitoring Locations	In accordance with the *Consent* (Sydney Water, 2017) monitoring of trade wastewater was undertaken at a sampling point located at the pre-treatment discharge, excluding domestic sewage and prior to the point of connection to the Sewer. The specific monitoring location is shown on **Figure 2** of **Appendix A**.
Analytes	Composite samples were submitted to ALS Environmental for analysis of the following: ▪ Nitrogen (ammonia) ▪ Suspended solids; ▪ Total dissolved solids; and ▪ Iron. Discrete samples were tested on site for pH and temperature using a calibrated water quality meter. Additionally the volume of wastewater discharged was obtained from the total flow reading presented on the flowmeter system.
Aesthetic Assessment	During sampling the sampler recorded the following aesthetic properties in accordance with the *Consent* (Sydney Water, 2017): ▪ Temperature; ▪ Colour; ▪ pH; ▪ Fibrous materials; ▪ Gross solids; and ▪ Flammability.

4 Data Quality Objectives

The NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)*, which is endorsed by the NSW EPA under s105 of the *Contaminated Land Management Act 1997*, requires that Data Quality Objectives (DQOs) are to be adopted for all assessment and remediation programs. The DQO process as adopted by the NSW EPA is described within US EPA (2000) *Guidance for the Data Quality Objectives Process and Data Quality Objectives Process for Hazardous Waste Site Investigations*.

4.1 Data Quality Objectives

The DQO process has been used to establish a systematic planning approach to setting the type, quantity and quality of data required for making decisions based on the environmental condition of the site. The DQO process involves the following seven steps detailed in **Table 4-1**.

Table 4-1 Data Quality Objectives

Activity	Description
Step 1: State the Problem	An Annual Report is required as a condition of EPL 5861 to assess the environmental performance of the site during the 2018/2019 reporting period. The Annual Report will summarise the type, concentrations, and extent of potential contamination / parameters in the matrices sampled including landfill gas (surface and subsurface), leachate, surface water and groundwater.
Step 2: Identify the decision / goal of the study	The NSW EPA requires an Annual Report to confirm if the environmental performance of the site meets the licence conditions and regulatory obligations of EPL 5861.
Step 3: Identify the information inputs	The primary inputs to the decisions described above are: Assessment of landfill gas, leachate, surface water and groundwater in accordance with direction of Section 5 (Monitoring and Recording Conditions) of EPL 5861. Assessment of management procedures for waste tyres. Laboratory analysis of samples for the contaminants and parameters of interest defined in Section 5 of EPL 5861. Assessment of analytical results against applicable performance criteria and Section 3 (Limit Conditions) of EPL 5861. Review of complaints recorded during the reporting period that relate to odour originating from the site. Aesthetic observations material encountered during sampling. Assessment of the suitability of the analytical data obtained, against the Data Quality Indicators (DQIs) outlined below.
Step 4: Define the boundaries of the study	The study site is located at Nixon Place, Helensburgh NSW. The lateral extent of the study is the site boundaries, as shown on Figure 2 of Appendix A. The vertical extent of the study extends into the landfill gas and groundwater monitoring wells installed during previous investigations. The temporal boundaries of the study are from the 29th of May 2018 to the 29th of May 2019 (i.e. the reporting period).
Step 5: Develop the analytical approach	The decision rules for the Annual Report include: The sampling points, contaminants and parameters of interest, frequency of sampling and sampling method will meet the requirements EPL 5861. Samples requiring laboratory analysis will be analysed at National Association of Testing Authorities (NATA) accredited laboratory. Laboratory QA/QC results will indicate reliability and representativeness of the data set. Laboratory Limits of Reporting (LORs) will be below the applicable guideline criteria for the analysed contaminants and parameters of interest, where possible. Applicable guideline criteria will be sourced from EPL 5861 and other NSW EPA endorsed guidelines (as necessary). If the concentration of a contaminant or parameter of interest is outside of the acceptable limit additional works may be required to assess the potential risk.

Activity	Description
Step 6: Specify performance or acceptance criteria	To ensure the results obtained are accurate and reliable, sampling and analysis was undertaken in accordance with the guidance provided in EPL 5861. DQIs are used to assess the reliability of field procedures and analytical results. In particular, the DQIs within NSW EPA (2017) are used to document and quantify compliance. DQIs are described below, and are presented in Table 4-2, below: Completeness – A measure of the amount of useable data (expressed as %) from a data collection activity. Comparability – The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event. Representativeness – The confidence (expressed qualitatively) that data are representative of each media present on the site. Precision – A quantitative measure of the variability (or reproducibility) of data. Accuracy (bias) – A quantitative measure of the closeness of reported data to the true value.
Step 7: Develop the Plan for Obtaining Data	Sampling and Analysis has been undertaken in compliance with EPL 5861 by qualified technical staff with analysis completed by a NATA accredited Laboratory. Results are discussed within this report.

4.2 Data Quality Indicators

The following DQIs referenced in Step 6 in **Table 4-1**, have been adopted in accordance with the NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)*. The DQIs outlined in **Table 4-2** assist with decisions regarding the contamination status of the site, including the quality of the laboratory data obtained.

Table 4-2 Summary of Data Quality Indicators

Data Quality Indicator	Frequency	Data Acceptance Criteria
Completeness		
Field documentation correct	Each sampling event	All samples
Suitably qualified and experience sampler	Each sampling event	All samples
Appropriate lab methods and limits of reporting (LORs)	Each sampling event	All samples
Chain of custodies (COCs) completed appropriately	Each sampling event	All samples
Compliance with all sample holding times	All samples	All samples
Comparability		
Consistent standard operating procedures for collection of each sample. Samples should be collected, preserved and handled in a consistent manner	All samples	All samples
Experienced sampler	All samples	All samples
Climatic conditions (temperature, rain, wind etc) recorded and influence on samples quantified (if required)	All samples	All samples
Consistent analytical methods, laboratories and units	All samples	All samples
Representativeness		
Sampling technique appropriate for each media and analytes (appropriate collection, handling and storage)	All samples	All Samples

Data Quality Indicator	Frequency	Data Acceptance Criteria
Samples homogenous	All samples	All Samples
Detection of laboratory artefacts, e.g. contamination blanks	-	Laboratory artefacts detected and assessed
Samples extracted and analysed within holding times	All samples	All samples
Precision		
Laboratory duplicates	1 per 20 samples	<20% RPD Result > 20 × LOR <50% RPD Result 10-20 × LOR No Limit RPD Result <10 × LOR
Accuracy (Bias)		
Surrogate spikes	All organic samples	50-150%
Matrix spikes	1 per 20 samples	70-130%
Laboratory control samples	1 per 20 samples	70-130%
Method blanks	1 per 20 samples	<LOR

5 Performance Criteria

Environmental monitoring data gathered during the reporting period was screened against the applicable criteria for each sample type / matrix as summarised below.

5.1 Surface Gas

The results of surface gas monitoring were screened against the criteria provided in the *Environmental Guidelines* (EPA 2016). Specifically, the threshold level for closer investigation and potential action was detection of 500 parts per million of methane at any point of the landfill service.

5.2 Subsurface Gas

The results of subsurface gas monitoring were screened against the criteria provided in the *Environmental Guidelines* (EPA 2016). Specifically, the threshold levels for further investigation and corrective action were detection of methane at concentrations above 1% (v/v) and carbon dioxide at concentrations of 1.5% (v/v) above established natural background levels.

5.3 Water

5.3.1 Stormwater

In accordance with Section 3 (L2.5) of EPL 5861, the performance criteria for stormwater was no discharge of contaminated stormwater (stormwater that exceeds the limits of pH and total suspended solids) under dry weather conditions or storm events that are less than a 5 day, 75th percentile. The license defines a 5 day, 75th percentile rainfall event as a rainfall depth of 35.6 mm over any consecutive 5 day period.

5.3.2 Leachate Discharge

In accordance with Section 3 (L2.7) of EPL 5861, the limit for leachate was no discharge of leachate to waters under dry weather conditions or storm event(s) of less than 1:25 year, 24 hour recurrence interval. The license defines a 1:25 year, 24 hour duration rainfall event as a rainfall depth of 306 millimetres over any consecutive 24 hour period.

The performance criteria adopted for leachate discharges was based on records held by Council regarding the timing and nature of leachate discharges during the reporting period. Comparison was made to adopted surface and groundwater criteria below to provide an initial screening level.

5.3.3 Surface Water and Groundwater

The selected performance criteria for surface water and groundwater samples was based on the recommendations of the *Environmental Guidelines* (EPA 2016) and in consideration of the land use, site setting and the plausible interactions between potential contaminants and human and environmental receptors. A conceptual site model is provided in **Section 8.7** that further discusses these interactions.

The *Environmental Guidelines* (EPA 2016) recommends screening groundwater analytical results against the *National Environment Protection (Assessment of Site Contamination) Measure* (National Environment Protection Council, 2013), specifically:

> Schedule B1, Table 1C Groundwater Investigation Levels, which summarises trigger values from:

  - *Australian Water Quality Guidelines* (ANZECC 2000) for the 95% protection level trigger values which apply to ecosystems that are slightly to moderately disturbed with a moderate conservation value.
  - *Australian Drinking Water Guidelines* (National Health and Medical Research Council and the Natural Resource Management Ministerial Council, 2011, updated 2014) (ADWG). Whilst it is unlikely that surface and groundwater from the site are going to be consumed directly, the drinking water guidelines have been adopted as a conservative assessment of direct contact scenarios.

    NOTE: The ANZG (2018) notes the following with regards to the recently issued 2018 guidelines:

    "Several errors and inconsistencies in the toxicant DGVs database have been identified, and a process is underway to review and correct the information. In the meantime, it is advised that DGV search results are checked against Table 3.4.1 and Section 8.3.7 of the ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality to ensure accuracy."

As a result of:

- The above recommendation to default to the previous guidelines in the event of a discrepancy; and
- The recommendation to use the NEPM (2013) / ANZECC (2000) guidelines within the *NSW EPA Solid Waste Landfill Guidelines* (2016) and EPL 5861.

The NEPM (2013) / ANZECC (2000) guidelines have been relied upon as the assessment criteria in the preparation of this report.

Assessment of water physical characteristics was based on the *Australian Water Quality Guidelines* (ANZECC 2000) South East Australia Lowland River Physical Characteristics. This provides indicative threshold values for the suitability of site surface waters for discharge into nearby surface water systems.

5.3.4 Trade Wastewater

Trade wastewater analytical results were screened against the criteria provided in the *Consent* (Sydney Water, 2017). The *Consent* provides criteria for a variety of parameters for the long term average daily mass (LTADM) and the maximum daily mass (MDM).

In addition to analytical performance criteria the *Consent* provides limits for aesthetic properties of trade wastewater including temperature, colour, pH, fibrous materials, gross solids and flammability.

5.4 Odour

In accordance with Section 8 (E1.3) of EPL 5861 offensive odour must not emit beyond the boundary of the premises. The performance criteria adopted for potential offensive odour emissions was occurrences (if any) of complaints from members of the public relating to odour.

6 Results

Monitoring results gathered during the reporting period are provided in the data tables in **Appendix B** and are summarised in the relevant subsections below. Laboratory certificates of analysis and quality reports have not been appended to this report due to the large number of files, however, they can be provided upon request.

6.1 Gas

6.1.1 Surface Gas

The highest reported concentration of methane in surface gas was 10.1 ppm measured at transact K during the August 2018 monitoring event. This is well below the threshold level for further investigation and corrective action of 500 ppm.

Surface gas monitoring results from the reporting period are summarised in **Table 6** of **Appendix B**.

6.1.2 Subsurface Gas

No methane was recorded within subsurface gas monitoring wells above 0.1% v/v threshold value in any monitoring location. Therefore, all subsurface gas monitoring results were below the threshold level for further investigation and corrective action of 1% v/v.

All monitoring points with the exception of Point 4 (LFGMB1) were not sampled during the November 2018 monitoring event.

Subsurface gas samples were also measured for carbon dioxide concentrations as part of the monitoring regime though this is not a requirement of EPL 5861. All locations returned results above the threshold for further investigation of 1.5% (v/v) for all monitoring rounds during the reporting period. The highest continuous and peak results were from Point 18 with 22% (v/v) continuous and 22.3% (v/v) peak on 20 February 2019.

Subsurface gas monitoring results from the reporting period are summarised in **Table 5** of **Appendix B.**

6.2 Surface water

Sampling was attempted from the stormwater retention basin on site during all quarterly monitoring rounds but only contained water during the November 2018 and May 2019 events. During both events, minor exceedances of SE Australia Lowland River Physical Characteristics were identified for nitrogen (ammonia) and pH. Surface water monitoring results from the reporting period are summarised in **Table 4** of **Appendix B** with the following notable results presented in **Table 6-1**:

Table 6-1 Surface water guideline exceedances

			Dissolved Oxygen Saturation #1 (% Saturation)	pH
ANZECC 2000 SE Australia Lowland River Physical Characteristics			0.02	6.5-8.0
ANZECC 2000 Fresh Water (95%)			0.99	
EPA Designation	Locations ID	Sample Date		
8	Stormwater adj. to Pony Club	30/11/2018	0.02	8.0
		30/05/2019	0.09	8.2

6.3 Leachate

No uncontrolled off site discharges of leachate occurred during the reporting period under dry or wet weather. Samples were collected from the leachate pond quarterly for electrical conductivity analysis and annually for a broader suite of analytes. With the exception of copper and zinc during the annual suite all results were below the laboratory LOR or adopted guideline levels for site waters.

Leachate monitoring results from the reporting period are summarised in **Table 3** of **Appendix B.**

6.4 Groundwater

6.4.1 Groundwater Levels

Groundwater levels measured at the site during the reporting period are summarised in **Table 1** of **Appendix B** and ranged from 2.48 m below ground level (bgl) in groundwater monitoring Point 12 (LGMB1) on 30 November 2018 to 7.86 metres bgl in groundwater monitoring point 7 (BH4) on 15 August 2018. Locations 13 (LGMB2) and 15 (LGB4) were reported as dry during the 15 August 2018 monitoring round.

6.4.2 Laboratory Results

Measured exceedances against guideline criteria were identified for metals and nitrogen (ammonia) and are summarised in **Table 6-2** below. It is noted that the ANZECC Guidelines apply to the point at which groundwater discharges to a surface water body. The closest surface water body is Hacking River located approximately 400 metres south east of the site. Additionally, as stated above, groundwater is not used for drinking water purposes at or near the site which makes these screening values conservative. All metal results were recorded as total rather than dissolved metals. Interference between acid preservatives and sediment collected within sample containers may have resulted in higher recorded metals than exist dissolved and mobile within the water column.

Table 6-2 Groundwater guideline exceedances

			Cadmium	Copper	Lead	Manganese	Zinc	Nitrogen (ammonia)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		LOR	**0.01**	**0.001**	**0.001**	**0.001**	**0.001**	**0.005**
		ADWG 2015 Health	**0.002**	**2**	**0.01**	**0.5**		
		ANZECC 2000 Fresh Water (95%)	0.0002	0.0014	0.0034	1.9	0.008	
Metals Hardness Modified Trigger Values (HMTV)		**Moderate (60-119 mg/L as $CaCO_3$)**	0.00054		0.0136		0.02	
EPA Designation	Locations ID	Sample Date						
5	BH1	15/08/2018	0.0004	0.004	**0.012**	**0.691**	0.033	1.16
		31/05/2019						0.9
7	BH4	15/08/2018		0.007	0.008		**0.056**	
16	BH5	15/08/2018		**11**	0.008		0.052	
6	BH6	15/08/2018	0.0006	0.055	**0.024**		0.044	
12	LGMB1	15/08/2018	0.0002	0.012	**0.011**		0.118	
14	LGMB3	15/08/2018		0.01	0.008		0.033	

The analytes listed in **Table 6-3** were reported with results at the laboratory limits of reporting (LOR) however the LOR is greater than at least one of the guideline criteria. As noted above, the adopted criteria are conservative within the current site scenario as waters are not intended for use as drinking waters as intended with the ADWG (2015) criteria; and are not being assessed at the point of discharge to the environment as intended with ANZECC (2000) Freshwater criteria. As a result, for these analytes and criteria it is not possible to make a statement of the quality of the groundwater or potential for impacts to receptors as a result of unidentified exceedances. However, it is unlikely that any analyte concentrations below the identified LOR will have a deleterious impact on receptors.

Table 6-3 Groundwater analytes with results above criteria levels

Analyte	LOR
Hexavalent Chromium	0.01 mg/L
Aldrin + Dieldrin	0.5 µg/L
Chlordane	0.5 µg/L
DDT	2 µg/L

Analyte	LOR
Endrin	0.5 µg/L
g-BHC (Lindane)	0.5 µg/L
Heptachlor	0.5 µg/L
Azinophos methyl	0.5 µg/L
Chlorpyrifos	0.5 µg/L
Diazinon	0.5 µg/L
Dimethoate	0.5 µg/L
Malathion	0.5 µg/L
Methyl parathion	2 µg/L
Parathion	2 µg/L
Anthracene	1 µg/L
Benzo(a)pyrene	0.5 µg/L

6.5 Trade Wastewater

A summary of trade wastewater monitoring is provided below and tabulated in **Table 4** of **Appendix B**.

Trade wastewater monitoring was undertaken six times during the reporting period. The results of monitoring showed that on each occasion volume discharge, total dissolved solids, suspended solids, ammonia as N, biochemical oxygen demand and temperature were within the acceptable criteria provided in the *Consent* (Sydney Water, 2017).

pH was measured during each sampling event with a single non-conformance during the 12 September 2018 event (pH 6.7) against Sydney Water criteria (pH 7.0-10.0).

6.6 Odour

No complaints were recorded with relation to odour leaving the premises.

7 Quality Assurance / Quality Control

A detailed overview of the QA/QC program including internal laboratory QA/QC is included in **Appendix C**. A summary of the results of the QA/QC performance are included in the following sections.

7.1 Laboratory QA/QC

The selected analytical laboratory, ALS Environmental, undertake internal QA/QC procedures which include the analysis of method blanks, internal duplicate samples, laboratory control samples, matrix spikes and surrogate recovery. Additionally, laboratory QA/QC measures include receipt, logging, storage, preservation, holding time and analysis of samples within the method specified.

A review of the laboratory QA/QC procedures indicates that laboratory QA/QC procedures were within specified ranges for all samples with the exception of those summarised in **Table C-2, Appendix C**.

Samples were received and stored appropriately and all samples were analysed within the specified holding time.

7.2 Data Useability

The data validation process of laboratory QA/QC data indicates that the reported analytical results are representative of the conditions at the sample locations and that the analytical data can be relied upon for the purpose of the Annual Report for EPL 5861.

8 Discussion

The data and information gathered during the reporting period is discussed below in consideration of the performance criteria. In addition, and in accordance with Section 6 (R1.8) of EPL 5862, historical laboratory results have been tabulated and presented in graphical format that compares data from at least three years (where available).

Trend graphs are provided in **Appendix D** and summarised below. Where there is insufficient data to establish trends (i.e. results predominately below LOR), then no trend graph has been prepared.

8.1 Surface Gas

Surface gas monitoring completed during the reporting period did not identify surface methane concentrations that exceeded the threshold level. As such, non-conformances of the EPL did not occur during the reporting period with respect to surface gas emissions.

8.2 Subsurface Gas

Subsurface gas monitoring completed during the reporting period did not identify subsurface methane at concentrations that exceeded the threshold level. As such, non-conformances of the EPL did not occur during the reporting period with respect to subsurface gas.

Subsurface carbon dioxide (CO_2) levels were found to generally exceed the threshold criteria within Environmental Guidelines: Solid Waste Landfills (NSW EPA, 2016). While not required to be assessed under the EPL, it is recommended that WCC consider the potential for impacts of these elevated levels.

8.3 Stormwater

No uncontrolled releases of contaminated stormwater occurred during the reporting period under dry weather or storm events. As such non-conformances of the EPL did not occur with respect to releases of stormwater.

8.4 Surface Water

pH and nitrogen (ammonia) levels in minor exceedance of the *Lowland River Physical Characteristics* (ANZECC, 2000) were identified when samples could be collected from the sample location. pH results are below the average of recent results, but are part of a long term trend of increasing pH. The source or cause of this increase cannot be determined from results at this time. Nitrogen (ammonia) results are well below historical results and form part of a decreasing trend for this analyte.

The above noted exceedances are not considered to be significant or require action at this stage however potential causes of increasing pH should be considered and identified. These factors are further discussed in the recommendations in **Section 8.9**.

8.4.1 Trend Analysis

A series of graphs showing trends in stormwater contaminant and parameter levels are provided in **Appendix D** and are discussed below.

All analytes appear to show some degree of seasonality likely the result of rainfall variability and resulting dilution or concentration of the measured parameters. With the exception of an increasing trend in pH and recent spikes in redox potential, the measured parameters generally sit within long term ‘normal’ bands or show a decreasing trend away from threshold criteria where available.

8.5 Groundwater

8.5.1 Groundwater Levels

Interpretation of groundwater levels across the site from the reporting period indicate that the inferred groundwater flow direction is in a easterly direction towards the Hacking River and is shown on **Figure 2** of **Appendix A**. Shallowest groundwater is generally located to the south of the site with more northern wells regularly gauged with a standing water level (SWL) 2.5 m to 3 m deeper than those in the south.

8.5.1.1 Trend Analysis

A series of graphs showing groundwater level trends are provided in **Appendix D** and is discussed below.

A review of trend results show SWL has a seasonal variability which is potentially driven by rainfall. Within this variability, there appears to be a trend towards decreasing SWL. There is insufficient data at this stage to determine whether this is potentially the result of recent drought conditions producing reduced rainfall and lower groundwater levels or another cause.

8.5.2 Laboratory Results

Exceedances of guideline criteria were noted across the site for cadmium, copper, lead, manganese, zinc and in one location for nitrogen(ammonia)

The source of the exceedances is difficult to determine, however are most likely naturally occurring. The metal results for the current sampling period correlate with the long-term average observed in the sampling locations over the historically available data. The absence of impacts from any other contaminant indicators (i.e. hydrocarbons, pH, etc) and the long term average analyte results across the site suggest that there is a strong impact from the site geology. Reduced groundwater levels at the time of sampling has also potentially caused a slightly higher concentration of analytes in some locations.

Further to the above, groundwater samples were analysed for total metals. The potential for interference of between acid sample preservatives and sediment increasing results for some metals cannot be completely eliminated at this stage.

Nitrogen (ammonia) levels above guideline levels were identified at Point 5 (BH1). Point 14 (LGMB3) also reported higher levels, though just below guidelines. Both locations are adjacent to bushland east of the site while Point 13 (LGMB2) located between Points 5 and 14 returned results consistent with the rest of the site. As well construction details are not available at this time, it is not possible to identify whether this difference in results is due to well construction, different targeted aquifers or other reasons.

Due to the low level of the identified exceedances and in the absence of any other indicators of impact, the potential for offsite environmental impacts from the groundwater guideline exceedances is considered low in the absence of a clearly identified source-pathway-receptor linkages.

8.5.2.1 Trend Analysis

A trend graph and discussion has not been provided for analytes with insufficient data to be able to establish a trend due to low numbers of results above laboratory LOR.

A series of graphs showing trends in groundwater contaminant and parameter levels are provided in **Appendix D** and are discussed below.

The trend graphs from the annual groundwater monitoring event shows that contaminant and parameter concentrations have remained steady and relatively consistent with prior monitoring results. The overall trend of reduced groundwater level appears to correlate with a minor increase in the concentration of some analytes.

Nitrogen (ammonia) appears to show the greatest historical variability in Point 5 and 14. There may be some seasonality to these results, however that is not clear based on currently available data. The recent identification of exceedances in these locations is considered consistent with this variability, however does not appear to indicate a source.

8.6 Trade Wastewater

No trade wastewater was discharged into the sewer network from the site, however periodic testing of the groundwater for comparison against criteria outlined within the Consent (Sydney Water 2017) identified only one non-conformance during the reporting period. As no water was discharged to the sewer during the reporting period the Consent (Sydney Water 2017), conditions were not breached.

8.7 Conceptual Site Model

Generally, a conceptual site model (CSM) provides an assessment of the fate and transport of contaminants of potential concern (CoPC) relative to site specific subsurface conditions with regard to their potential risk to human health and the environment. The CSM takes into account site-specific factors including:

> Source(s) of contamination;

> Identification of CoPC associated with past (and present) source(s);

> Vertical, lateral and temporal distribution of CoPC;

> Site specific lithologic information including soil type(s), depth to groundwater, effective porosity, and groundwater flow velocity; and

> Actual or potential receptors considering both current and future land use both for the site and adjacent properties, and any sensitive ecological receptors.

> The CSM culminates in establishing the source to pathway to receptor linkages.

Based on the results discussed in this report a CSM has been developed and is outlined below in **Table 8-1**. Additional details are included in the sections that follow as necessary.

Table 8-1 Conceptual Site Model

CSM Element	Description
Contaminant Sources	Known contaminant sources at the site include: ▪ Historical use for disposal of sanitary waste including 'nightsoil' as well as putrescible waste from the 1960s to 1991. From 1991 putrescible waste ceased to be accepted at the site and the permitted waste was limited to "Class 2" style wastes such as furniture, wood paper, plastics (GHD, 2008). ▪ Leachate resulting from degradation of buried waste and interaction with groundwater. ▪ Landfill gases generated from the degradation of buried waste.
Site Current and Future Use	The site is a closed landfill that historically received waste from Wollongong City Council local government area. There is no known future use of the site.
Site Geology	The site lies within the Sydney Basin above the Illawarra Escarpment, and is part of the Cumberland Sub-Group of the Illawarra Coal Measures, which are Permian in age. Review of the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Mineral Resources, 1985) situates the site on Hawkesbury Sandstone – Medium to coarse grained quartz sandstone with very minor shale and laminate lenses, which is consistent with soil samples. Test pitting completed by GHD (2008) as part of the LEMP suggests that the near surface natural geology of the area is as follows. ▪ Orange Brown Clay Sand overlying; ▪ Orange Mottled Clay Sand overlying; ▪ White Clay Sand with Red Mottled Laterite (Ironstone) Clay Sand overlying; ▪ White Loosely Cemented Sandstone (assumed to be regional bedrock).
Site Hydrology and Hydrogeology	The closest surface water body to the site is Hacking River 400 m south-east of the site at the closest point and is the natural receiving body for the surrounding area. Site topography slopes radially away from the landfill mound with natural underlying structures sloping away towards the north, east and south down to the Hacking River. The site topography appears to be reflected in underlying natural strata which have the strongest influence on groundwater flow direction towards the east.
CoPCs	The CoPCs listed in EPL 5861 include heavy metals (aluminium, arsenic, barium, cadmium, chromium (hexavalent and total), cobalt, copper, lead, manganese, mercury, zinc), polycyclic aromatic hydrocarbon, total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes, naphthalene, organochlorine pesticides, organophosphate pesticides and phenolics. In addition to CoPC the EPL identifies potentially hazardous landfill gasses including methane and carbon dioxide.

CSM Element	Description
Extent of Impacts	The extent of potential contamination would primarily be located immediately below and down gradient of the tip face. Monitoring undertaken during the reporting period indicates that contaminants above the adopted criteria are limited to heavy metals and ammonia in leachate and groundwater. Other CoPCs were not reported above the laboratory limit of response or the adopted criteria. Methane was detected during the reporting period atop the current and previous tip face (surface gas) and subsurface, however, the concentrations were below the threshold level for further investigation and corrective action.
Potential Human Receptors	Potential human receptors include: ▪ Trespassers who illegally access the site; ▪ Contractors undertaking site maintenance including mowing, landscaping and fence repairs; ▪ Contractors undertaking scheduled environmental monitoring (surface water, groundwater and landfill gas); and ▪ Individuals working or living within close proximity to the site.
Potential Ecological Receptors	Potential ecological receptors include: ▪ Tributaries to the Hacking River and Wilsons Creek, located to the south east and north, respectively; ▪ The Garrawarra State Conservation Area located immediately north and east of the site boundary; ▪ Groundwater under the site being impacted as a result of the vertical migration of contaminants from leachate and buried waste; and ▪ Flora and fauna on the site interacting with contaminants in the soils including birds scavenging and nesting at the site.
Potential Contaminant Pathways	Potential contaminant pathways include: ▪ Dermal contact with contaminated materials including soil, waste and hazardous building materials during maintenance and potential earthworks; ▪ Dermal contact with contaminated media including surface water, groundwater and leachate during environmental monitoring; ▪ Inhalation of hazardous landfill gases emanating from buried waste and leachate; ▪ Inhalation of volatile contaminants and/or asbestos fibres; ▪ Ingestion of contaminant impacted materials including soil, waste and hazardous building materials; ▪ Potential contaminant uptake by vegetation; and ▪ Potential ingestion of contaminant impacted fresh produce (fruit and vegetables) grown down gradient of the site.

8.7.2 Data Gaps and Uncertainties

The assessment of potential contamination at the site was based on a site inspection and review of available historical reports and information. As such, the lateral and vertical extent of potential contamination in soil is unknown.

As noted in **Section 6.4.2** a number of analytes (see **Table 6-3**) were reported by the laboratory with LORs above applicable assessment criteria, at this stage it is not possible to make a statement in regard to exceedances and analyte impacts on receptors.

No field sampling sheets, in particular purging records and sampling notes have been supplied. As sampling was undertaken by a third party (ALS Environmental) it limits our capacity to make a statement on the impact of sampling approach on recorded results.

8.8 Conclusions

Based on the monitoring undertaken during the reporting period, Cardno has reached the following conclusions:

> Council implemented an environmental monitoring program during the 2017/2018 reporting period that satisfied the conditions and requirements of EPL 5861 and the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water, 2017).

> Water contained in stormwater and leachate ponds was managed such that uncontrolled releases of contaminated water did not occur during the reporting period.

> Monitoring results show that surface and subsurface hazardous ground gases were not present at concentrations that exceed the adopted performance criteria. Carbon dioxide, which is not required to be monitored as part of the EPL 5862, was monitored incidentally as part of the subsurface gas assessment and was recorded at levels in exceedance of adopted performance criteria for all locations in all monitoring rounds.

> Some elevated metals were present in leachate samples collected from the leachate pond, however, this is not considered unusual in the context of the historical site use as a landfill. Leachate was contained on site within the pond and as such the concentrations are not considered a significant risk to human or environmental receptors.

> The surface water sample collected from Point 8 (pony club) recorded a pH of slightly elevated pH and nitrogen(ammonia) level against ANZECC (2000) SE Australia Lowland River Guidelines. The low level of the exceedances and the absence of other potential contaminant or concerning water quality indicators within this sample mean it is not considered an environmental concern but should be monitored to ensure ongoing minimal environmental impact.

> Metals were detected above the performance criteria in groundwater at numerous monitoring wells, however, samples were submitted for analysis of total metals and therefore the elevated concentrations may be due to the presence of sediments. Overall the absence of other indicators such as hydrocarbons, pH, etc and the long term average of the analyte results suggests that there is no or limited impact from the landfill on these results. It should also be noted that the adopted criteria are conservative within the current site scenario as waters are not intended for use as drinking waters as intended with the ADWG (2015) criteria and are not being assessed at the point of discharge to the environment as intended with ANZECC (2000) Freshwater criteria.

Future monitoring events should also assess dissolved concentrations of metals to determine if elevated metals are attributed to sediment or if they exist in dissolved phase, as discussed below in **Section 8.9.**

> The source of elevated nitrogen (ammonia) levels in Point 5 is difficult to determine but is consistent with historical variability of this analyte in this location and at Point 14.

> No complaints were received from the public relating to offensive odours originating from the site during the reporting period.

8.9 Recommendations

Based on the monitoring undertaken during the reporting period the following actions are recommended:

> The potentially lowering groundwater levels on the site should be regularly assessed to determine impacts on both analysis concentrations and the ability to continue monitoring of the site based on retrievable well volumes during sampling events. In the absence of well construction data it is not possible to make comment around the latter at this time.

> The laboratory limit of response was above the adopted screening criteria for several analytes including PAHs, OCPs and OPPs. Future analysis of these analytes should be undertaken with an LOR below the applicable guideline levels to allow for effective assessment of the impacts to on and offsite receptors.

> Historically water samples have been submitted for laboratory analysis of total heavy metals in accordance with EPL 5861. Water samples should also be analysed for dissolved metals (i.e. filtered) to determine if elevated metals are attributed to sediment or if they exist in dissolved phase.

> Subsurface carbon dioxide results should be assessed to determine impacts on landfill gas management for the site. The assessment should consider whether these results are typical for a landfill of this composition and stage of life and whether additional measures should be put in place to manage measured gas levels.

- Regular sampling event timing should be reviewed to ensure it aligns with the reporting period within EPL5861. Four quarterly events are to be completed with the May 29 (Yr 1) to May 28 (Yr 2) monitoring window in future campaigns.

9 References

ANZECC (2000), Australian Water Quality Guidelines, 2000

Australian Standards (1999), AS 4482.2-1999 Guide to the Sampling and Investigation of Potentially Contaminated Soil - Volatile Substances, 1999

GHD (2008), Landfill Environmental Management Plan, Helensburgh Landfill, 2008

NEPC (2013), National Environment Protection (Assessment of Site Contamination) Measure, 2013

NHMRC (2014), Australian Drinking Water Guidelines, 2014)

NSW EPA (1996), NSW Environmental Guidelines: Solid Waste Landfills, 1996

NSW EPA (2013), Requirements for publishing pollution monitoring data, 2013

NSW EPA (2015), Asbestos and Waste Tyre Guidelines, 2015

NSW EPA (2016), Environmental Guidelines: Solid Waste Landfills (Second Edition), 2016

NSW EPA (2017), Guidelines for the NSW Site Auditor Scheme (3rd Edition), 2017

NSW DPI (1985), 1:100,000 geological map Wollongong-Port Hacking, 1985

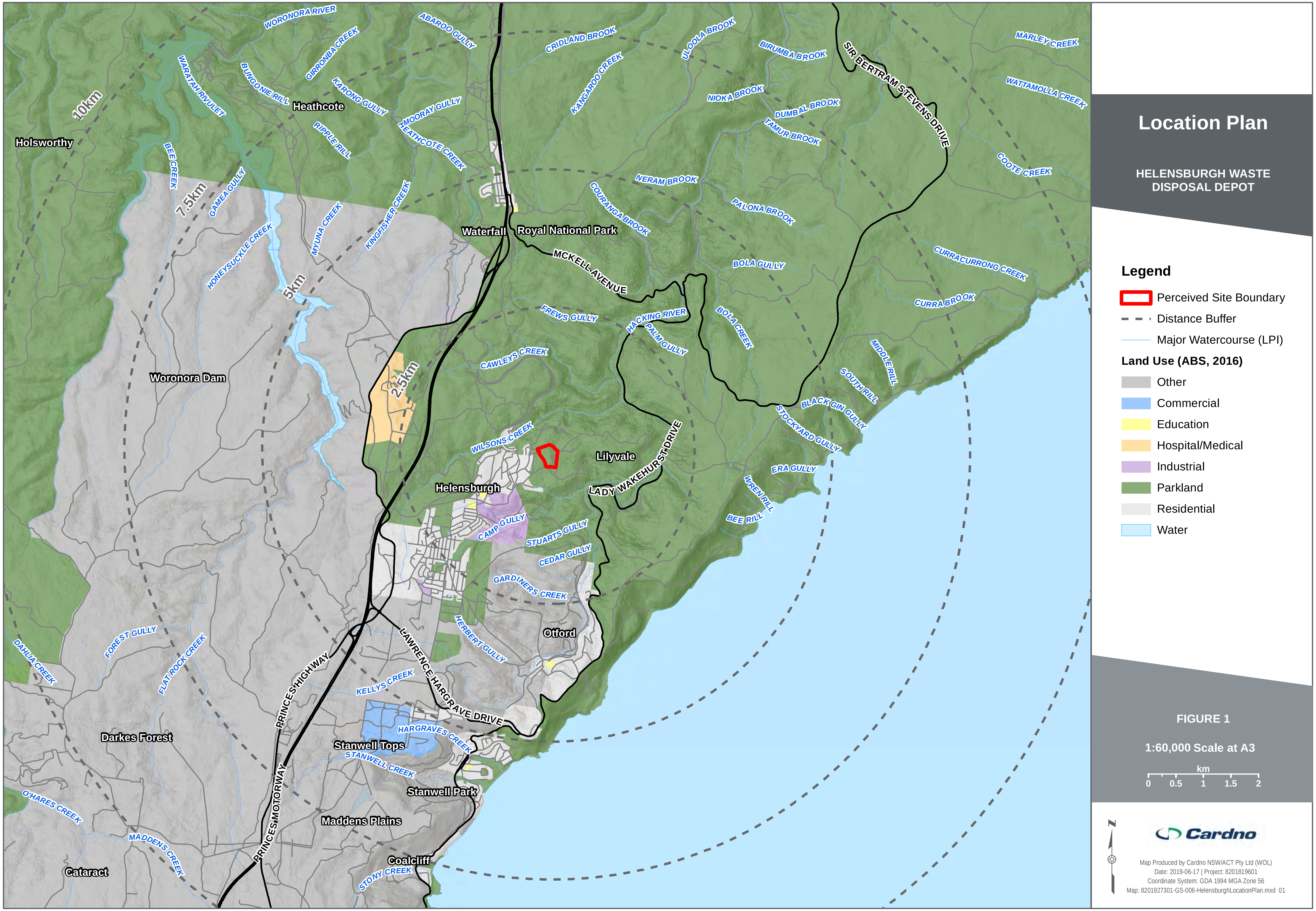
Sydney Water (2017), Consent to Discharge Industrial Trade Wastewater, 2017

US EPA (2000), Guidance for the Data Quality Objectives Process and Data Quality Objectives Process for Hazardous Waste Site Investigations, 2000

APPENDIX

A

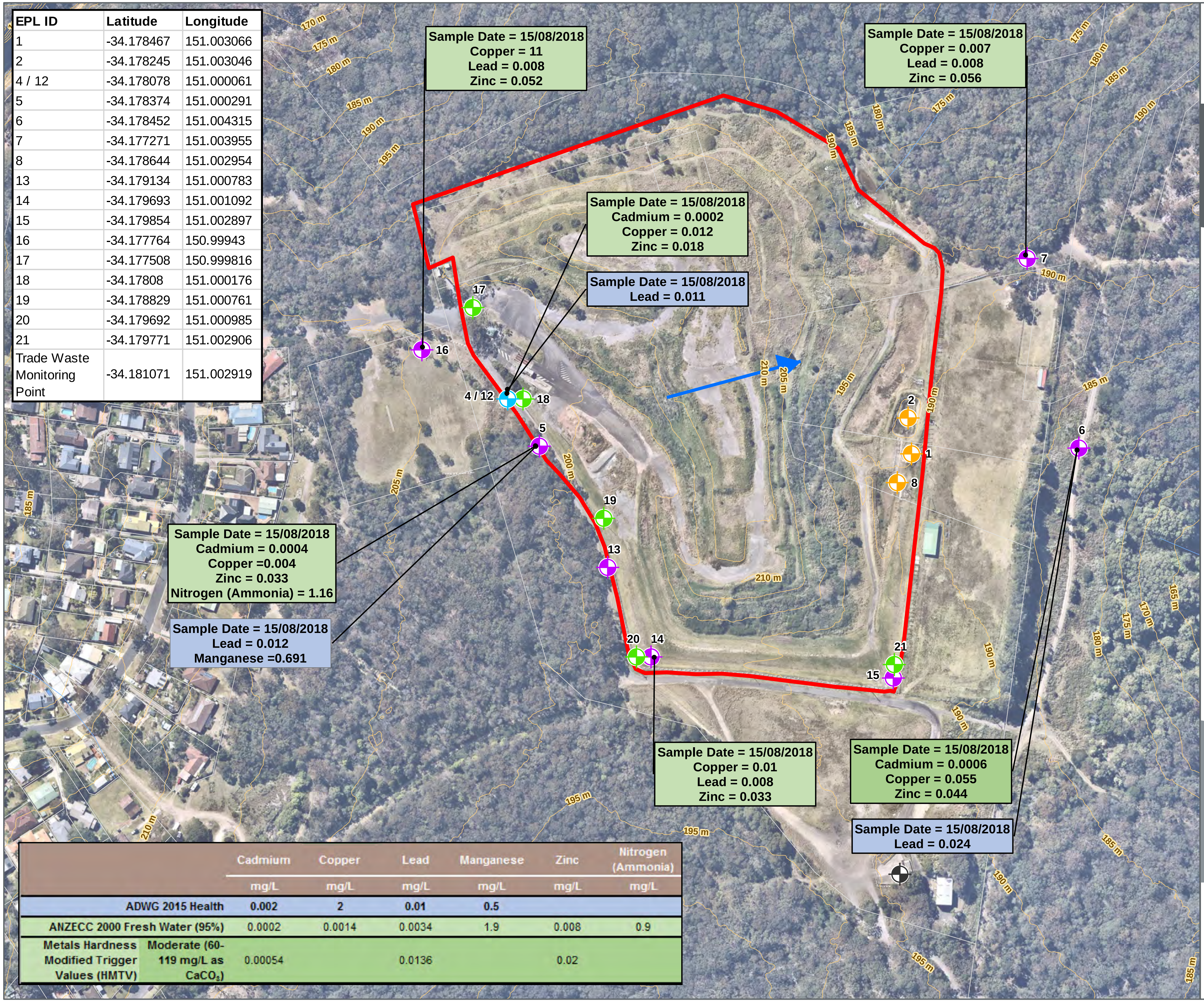
SITE FIGURES



Location Plan
HELENSBURGH WASTE DISPOSAL DEPOT
Legend
Perceived Site Boundary
Distance Buffer
Major Watercourse (LPI)
Land Use (ABS, 2016)
Other
Commercial
Education
Hospital/Medical
Industrial
Parkland
Residential
Water
FIGURE 1
1:60,000 Scale at A3
km
0 0.5 1 1.5 2
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-06-17 | Project: 8201819601
Coordinate System: GDA 1994 MGA Zone 56
Map: 8201927301-GS-006-HelensburghLocationPlan.mxd 01
Holsworthy
Heathcote
Waterfall
Royal National Park
Woronora Dam
Helensburgh
Lilyvale
Otford
Darkes Forest
Stanwell Tops
Stanwell Park
Maddens Plains
Coalcliff
Cataract
10km
7.5km
5km
2.5km
MCKELL AVENUE
SIR BERTRAM STEVENS DRIVE
LADY WAKEHURST DRIVE
LAWRENCE HARGRAVE DRIVE
PRINCES HIGHWAY
PRINCES MOTORWAY
HACKING RIVER
WORONORA RIVER

Monitoring Site Locations

HELENSBURGH WASTE DISPOSAL DEPOT



EPL ID	Latitude	Longitude
1	-34.178467	151.003066
2	-34.178245	151.003046
4 / 12	-34.178078	151.000061
5	-34.178374	151.000291
6	-34.178452	151.004315
7	-34.177271	151.003955
8	-34.178644	151.002954
13	-34.179134	151.000783
14	-34.179693	151.001092
15	-34.179854	151.002897
16	-34.177764	150.99943
17	-34.177508	150.999816
18	-34.17808	151.000176
19	-34.178829	151.000761
20	-34.179692	151.000985
21	-34.179771	151.002906
Trade Waste Monitoring Point	-34.181071	151.002919

		Cadmium	Copper	Lead	Manganese	Zinc	Nitrogen (Ammonia)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2015 Health		0.002	2	0.01	0.5		
ANZECC 2000 Fresh Water (95%)		0.0002	0.0014	0.0034	1.9	0.008	0.9
Metals Hardness Modified Trigger Values (HMTV)	Moderate (60-119 mg/L as $CaCO_3$)	0.00054		0.0136		0.02	

Legend

- Perceived Site Boundary
- Dual (Landfill Gas and Ground Water Monitoring)
- Gas Monitoring Only
- Ground Water Monitoring Only
- Surface Water Monitoring Only
- Trade Waste Monitoring Point
- Inferred Groundwater Flow Direction
- Watercourse (LPI)
- 5m Contours (LPI LiDAR, 2013)
- Cadastre (DFSI-SS, 2018)

FIGURE 2

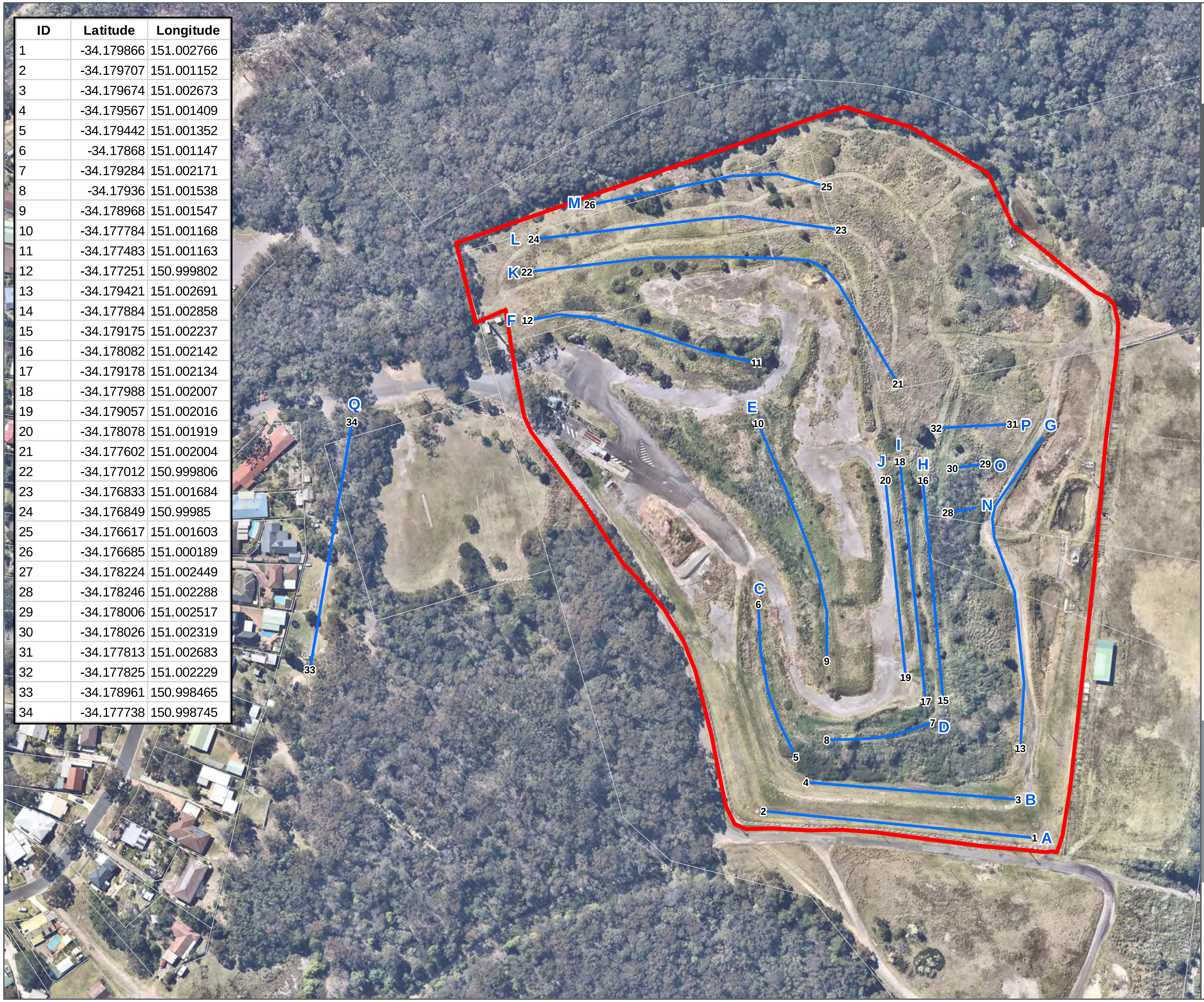
1:2,500 Scale at A3

m
0 20 40 60 80

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-06-24 | Project: 820189601
Coordinate System: GDA 1994 MGA Zone 56
Map: 8201927301-GS-007-HelensburghMonitoringLocations.mxd 01
Aerial imagery supplied by nearmap (September, 2018)

ID	Latitude	Longitude
1	-34.179866	151.002766
2	-34.179707	151.001152
3	-34.179674	151.002673
4	-34.179567	151.001409
5	-34.179442	151.001352
6	-34.17868	151.001147
7	-34.179284	151.002171
8	-34.17936	151.001538
9	-34.178968	151.001547
10	-34.177784	151.001168
11	-34.177483	151.001163
12	-34.177251	150.999802
13	-34.179421	151.002691
14	-34.177884	151.002858
15	-34.179175	151.002237
16	-34.178082	151.002142
17	-34.179178	151.002134
18	-34.177988	151.002007
19	-34.179057	151.002016
20	-34.178078	151.001919
21	-34.177602	151.002004
22	-34.177012	150.999806
23	-34.176833	151.001684
24	-34.176849	150.99985
25	-34.176617	151.001603
26	-34.176685	151.000189
27	-34.178224	151.002449
28	-34.178246	151.002288
29	-34.178006	151.002517
30	-34.178026	151.002319
31	-34.177813	151.002683
32	-34.177825	151.002229
33	-34.178961	150.998465
34	-34.177738	150.998745



Surface Gas Monitoring Locations

HELENSBURGH WASTE DISPOSAL DEPOT

Legend

- Perceived Site Boundary
- Surface Gas Monitoring Transect
- Cadastre (DFSI-SS, 2018)

FIGURE 3

1:2,000 Scale at A3

m
0 20 40 60 80

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-06-17 | Project: 820189601
Coordinate System: GDA 1994 MGA Zone 56
Map: 8201927301-GS-008-HelensburghGasMonitoringLocations.mxd 01
Aerial imagery supplied by nearmap (September, 2018)

APPENDIX

B

RESULTS SUMMARY TABLES

				Metals												BT		
			Standing Water Level	Aluminium	Arsenic	Barium	Cadmium	Chromium (Hexavalent)	Chromium (Total)	Cobalt	Copper	Lead	Manganese	Mercury	Zinc	Benzene	Ethyl Benzene	Toluene
			m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L
		LOR	-	0.01	0.001	0.001	0.0001	0.01	0.0001	0.001	0.001	0.001	0.001	0.0001	0.005	1	2	2
		ADWG 2015 Health			**0.01**	**2**	**0.002**	**0.05**			**2**	**0.01**	**0.5**	**0.001**		**1**	**300**	**800**
		ANZECC 2000 Fresh Water (95%)		0.055#4	0.013#2		0.0002	0.001	0.0033#5	0.0028#5	0.0014	0.0034	1.9	0.0006	0.008	950		
Metals Hardness Modified Trigger Values (HMTV)#6		**Moderate (60-119 mg/L as $CaCO_3$)**					0.00054		0.00825			0.0136			0.02			
EPA Designation	Locations ID	Sample Date																
5	BH1	15/08/2018	5.29	0.87	0.001	0.045	0.0004	*< 0.01*	0.001	0.008	0.004	**0.012**	**0.691**	< 0.0001	0.033	< 1	< 2	< 2
		30/11/2018	4.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	4.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	4.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	BH4	15/08/2018	7.86	2.92	< 0.001	0.038	< 0.0001	*< 0.01*	0.003	0.008	0.007	0.008	0.254	< 0.0001	0.056	< 1	< 2	< 2
		30/11/2018	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	6.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	6.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	BH5	15/08/2018	6.31	2.62	< 0.001	0.022	< 0.0001	*< 0.01*	0.008	0.007	0.11	0.008	0.268	< 0.0001	0.052	< 1	< 2	< 2
		30/11/2018	4.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	5.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	6.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	BH6	15/08/2018	4.64	14	0.006	0.236	0.0006	*< 0.01*	0.076	0.033	0.055	**0.024**	0.252	< 0.0001	0.044	< 1	< 2	< 2
		30/11/2018	3.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	4.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	LGMB1	15/08/2018	2.91	5.55	0.003	0.031	0.0002	*< 0.01*	0.005	< 0.001	0.012	**0.011**	0.022	< 0.0001	0.118	< 1	< 2	< 2
		30/11/2018	2.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	3.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	3.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	LGMB2	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	4.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	4.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	LGMB3	15/08/2018	4.74	3.72	0.001	0.012	< 0.0001	*< 0.01*	0.006	0.004	0.01	0.008	0.018	< 0.0001	0.033	< 1	< 2	< 2
		30/11/2018	3.24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	4.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	4.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	LGMB4	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	4.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	4.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	5.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

			EX			OCPs						OPPs						
			(m & p) Xylene	(o) Xylene	Total Xylene	Aldrin + Dieldrin	Chlordane	DDT	Endrin	g-BHC (Lindane)	Heptachlor	Azinophos methyl	Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Diazinon	Dichlorvos
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
		LOR	2	2	2	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		ADWG 2015 Health			**600**	**0.3**	**2**	**9**		**10**	**0.3**	**30**	**10**	**0.5**	**2**	**10**	**4**	**5**
		ANZECC 2000 Fresh Water (95%)	200#1	350			0.08	0.01	0.02	0.2	0.09	0.02				0.01	0.01	
Metals Hardness Modified Trigger Values (HMTV)#6		**Moderate (60-119 mg/L as $CaCO_3$)**																
EPA Designation	Locations ID	Sample Date																
5	BH1	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	BH4	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	BH5	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	BH6	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	LGMB1	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	LGMB2	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	LGMB3	15/08/2018	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	LGMB4	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

									Pesticides			PAHs				Hydrocarbons		
			Dimethoate	Ethion	Fenthion	Malathion	Methyl parathion	Monocrotophos	Fenamiphos	Parathion	Pirimphos-ethyl	Anthracene	Benzo(a)pyrene	Naphthalene	Polycyclic Aromatic Hydrocarbons (Total)	Total Phenolics	Total Petroleum Hydrocarbons	Alkalinity (as Calcium Carbonate)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L
		LOR	0.5	0.5	0.5	0.5	2	2	0.5	2	0.5	1	0.5	1	1	0.05	50	1
		ADWG 2015 Health	**7**	**4**	**7**	**70**	**0.7**	**2**	**0.5**	**20**	**0.5**		**0.01**					
		ANZECC 2000 Fresh Water (95%)	0.15			0.05				0.004		0.4		16		0.32#3		
Metals Hardness Modified Trigger Values (HMTV)#6		**Moderate (60-119 mg/L as $CaCO_3$)**																
EPA Designation	Locations ID	Sample Date																
5	BH1	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	35
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33
7	BH4	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	1
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 1
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
16	BH5	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	< 1
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 1
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 1
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1
6	BH6	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	102
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	198
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	87
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126
12	LGMB1	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	18
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
13	LGMB2	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
14	LGMB3	15/08/2018	*< 0.5*	< 0.5	< 0.5	*< 0.5*	< 2	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1	< 0.05	< 50	12
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
15	LGMB4	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

			Inorganics										Physical Characteristics		
			Calcium	Magnesium	Potassium	Sodium	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Nitrogen (Ammonia)	Total Dissolved Solids	Total Organic Carbon	pH
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH
		LOR	1	1	1	1	1	0.1	1	0.01	0.01	0.01	1	1	0.01
		ADWG 2015 Health						**1.5**	**500**	**50**	**3**				
		ANZECC 2000 Fresh Water (95%)								7.2		0.9			
Metals Hardness Modified Trigger Values (HMTV)[#6]		**Moderate (60-119 mg/L as $CaCO_3$)**													
EPA Designation	Locations ID	Sample Date													
5	BH1	15/08/2018	22	18	1	58	120	< 0.1	60	0.04	< 0.01	1.16	279	4	5.9
		30/11/2018	29	24	< 1	76	176	-	110	-	-	0.18	426	2	5.1
		20/02/2019	17	14	1	68	108	-	85	-	-	0.06	272	4	5.2
		31/05/2019	18	17	1	68	133	-	67	-	-	0.9	345	3	5.8
7	BH4	15/08/2018	1	5	2	80	60	< 0.1	90	0.78	< 0.01	0.3	266	3	4.5
		30/11/2018	1	5	1	87	72	-	92	-	-	0.09	308	< 1	4.5
		20/02/2019	1	5	1	93	85	-	98	-	-	0.17	308	4	4.5
		31/05/2019	< 1	6	1	94	78	-	103	-	-	0.04	266	5	5
16	BH5	15/08/2018	3	4	1	23	32	< 0.1	16	0.27	< 0.01	0.02	125	< 1	4.6
		30/11/2018	5	5	2	28	43	-	24	-	-	0.04	108	1	4.6
		20/02/2019	5	6	1	25	42	-	27	-	-	0.01	107	< 1	4.6
		31/05/2019	4	5	2	24	39	-	17	-	-	0.02	108	< 1	4.7
6	BH6	15/08/2018	32	16	5	25	26	< 0.1	38	0.11	< 0.01	0.02	314	8	6.4
		30/11/2018	48	25	6	20	22	-	29	-	-	0.05	364	15	6.7
		20/02/2019	26	14	5	27	34	-	27	-	-	0.01	309	11	6
		31/05/2019	38	21	8	22	26	-	16	-	-	0.08	374	14	6.5
12	LGMB1	15/08/2018	10	7	< 1	34	16	< 0.1	83	0.11	< 0.01	0.04	164	6	5.4
		30/11/2018	19	8	1	27	19	-	58	-	-	0.03	138	2	5.8
		20/02/2019	6	6	< 1	33	18	-	74	-	-	0.02	171	4	5.1
		31/05/2019	7	6	3	30	16	-	69	-	-	0.08	140	7	5.3
13	LGMB2	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	17	7	5	11	15	-	24	-	-	0.04	238	3	5.5
		20/02/2019	24	10	7	13	20	-	30	-	-	0.03	570	9	5.4
		31/05/2019	22	10	8	12	16	-	24	-	-	0.06	372	11	5.3
14	LGMB3	15/08/2018	8	5	4	28	38	< 0.1	12	1.71	< 0.01	0.82	139	2	5.3
		30/11/2018	9	4	5	12	19	-	18	-	-	0.29	134	< 1	5.5
		20/02/2019	8	4	4	17	29	-	16	-	-	0.54	152	3	5.2
		31/05/2019	9	5	4	15	24	-	14	-	-	0.35	93	2	5.8
15	LGMB4	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	11	4	29	11	16	-	50	-	-	0.04	164	3	5.2
		20/02/2019	14	6	28	11	17	-	64	-	-	0.04	212	5	5.3
		31/05/2019	14	6	27	10	17	-	65	-	-	0.02	165	4	5.2

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

Results Table 2: Stormwater Results
2018-2019 Reporting Period

	Conductivity	Dissolved Oxygen	Faecal Coliforms	Nitrogen (Ammonia)	Potassium	Redox potential	Total Dissolved Solids	Total Organic Carbon	pH
	µS/cm	mg/L	CFU/100mL	mg/L	mg/L	mV	mg/L	mg/L	pH
LOR	1	0.01	1	0.01	1	0.1	10	1	0.1
ADWG 2015 Health									
ANZECC 2000 Fresh Water (95%)				0.9					
ANZECC 2000 SE Australia Lowland River Physical Characteristics	125-2200			0.02					6.5-8.0

EPA Designation	Locations ID	Sample Date	Conductivity	Dissolved Oxygen	Faecal Coliforms	Nitrogen (Ammonia)	Potassium	Redox potential	Total Dissolved Solids	Total Organic Carbon	pH
8	Stormwater adj. to Pony Club	15/08/2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/11/2018	253	7.56	85	0.02	10	160	185	10	8
		20/02/2019	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
		30/05/2019	610	9.59	72	0.06	16	244	401	16	8.2

			Metals												BTEX						OCPs			
			Aluminium	Arsenic	Barium	Cadmium	Chromium (Hexavalent)	Chromium (Total)	Cobalt	Copper	Lead	Manganese	Mercury	Zinc	Benzene	Ethyl Benzene	Toluene	(m & p) Xylene	(o) Xylene	Total Xylene	Aldrin + Dieldrin	Chlordane	DDT	Endrin
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
		LOR	0.01	0.001	0.001	0.0001	0.01	0.0001	0.001	0.001	0.001	0.001	0.001	0.005	1	2	2	2	2	2	0.5	0.5	2	0.5
		ADWG 2015 Health		**0.01**	**2**	**0.002**	**0.05**			**2**	**0.01**	**0.5**	**0.001**		**1**	**300**	**800**			**600**	**0.3**	**2**	**9**	
		ANZECC 2000 Fresh Water (95%)	0.055#4	0.013#2		0.0002	0.001	0.0033#5	0.0028#5	0.0014	0.0034	1.9	0.0006	0.008	950			200#1	350			0.08	0.01	0.02
Metals Hardness Modified Trigger Values (HMTV)#6		**Extremely Hard (>240 mg/L as $CaCO_3$)**				0.002		0.02772			0.09078			0.072										
EPA Designation	Locations ID	Sample Date																						
2	Leachate Pond	15/08/2018	0.35	0.004	0.224	< 0.0001	*< 0.01*	0.001	0.001	0.038	0.002	0.139	< 0.0001	0.105	< 1	< 2	< 2	< 2	< 2	< 2	*< 0.5*	*< 0.5*	*< 2*	*< 0.5*
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

					OPPs													Pesticides			PAHs			
			g-BHC (Lindane)	Heptachlor	Azinophos methyl	Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenthion	Malathion	Methyl parathion	Monocrotophos	Fenamiphos	Parathion	Pirimphos-ethyl	Anthracene	Benzo(a)pyrene	Naphthalene	Polycyclic Aromatic Hydrocarbons (Total)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	2	0.5	2	0.5	1	0.5	1	1
ADWG 2015 Health			**10**	**0.3**	**30**	**10**	**0.5**	**2**	**10**	**4**	**5**	**7**	**4**	**7**	**70**	**0.7**	**2**	**0.5**	**20**	**0.5**		**0.01**		
ANZECC 2000 Fresh Water (95%)			0.2	0.09	0.02				0.01	0.01		0.15			0.05				0.004		0.4		16	
Metals Hardness Modified Trigger Values (HMTV)[#6]	**Extremely Hard (>240 mg/L as $CaCO_3$)**																							
EPA Designation	Locations ID	Sample Date																						
2	Leachate Pond	15/08/2018	*< 0.5*	*< 0.5*	*< 0.5*	< 0.5	< 0.5	< 0.5	*< 0.5*	*< 0.5*	< 0.5	*< 0.5*	< 0.5	< 0.5	*< 0.5*	*< 2*	< 2	< 0.5	*< 2*	< 0.5	*< 1*	*< 0.5*	< 1	< 1
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

			Hydrocarbons		Inorganics											Physical Characteristics			
			Total Phenolics	Total Petroleum Hydrocarbons	Alkalinity (as Calcium Carbonate)	Calcium	Magnesium	Potassium	Sodium	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Nitrogen (Ammonia)	Total Dissolved Solids	Total Organic Carbon	Electrical Conductivity	pH
			mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µS/cm	pH
		LOR	0.05	50	1	1	1	1	1	1	0.1	1	0.01	0.01	0.01	1	1	1	0.01
		ADWG 2015 Health									**1.5**	**500**	**50**	**3**					
		ANZECC 2000 Fresh Water (95%)	0.32#3										7.2		0.9				
Metals Hardness Modified Trigger Values (HMTV)#6		**Extremely Hard (>240 mg/L as $CaCO_3$)**																	
EPA Designation	Locations ID	Sample Date																	
2	Leachate Pond	15/08/2018	< 0.05	< 50	253	102	30	18	40	32	< 0.1	153	0.89	< 0.01	0.08	545	11	843	7.4
		30/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	718	-
		20/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	632	-
		31/05/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	607	-

#1 As (p) Xylene
#2 As As(V)
#3 As Phenol
#4 For pH>6.5
#5 Low Reliability Trigger Value, See ANZECC 2000, Section 8.3.7
#6 Values derived utilising factors within Table 3.4.4, ANZECC 2000
Italics LOR above applicable guidelines

	Discharge Measurements			Grab Samples							Maximum Daily Mass			
	Meter Reading (start)	Meter Reading (finish)	Volume Dishcharged	Discrete Start pH (start)	Ammonia as N	Suspended Solids (SS)	Total Dissolved Solids	Iron	pH Finish	Temperature.	Ammonia	Suspended Solids	Total Dissolved Solids	Iron
	L	L	L	pH unit	mg/L	mg/L	mg/L	mg/L	pH unit	°C	kg/day	kg/day	kg/day	kg/day
Acceptance Standard			50kL / day	7.0-10.0	100	600	10,000	50	7.0-10.0	< 38				
MDM											4	12	104	2
LTADM											0.6	0.62	19.5	0.3

Location	Date														
Trade Waste Discharge Point	23/07/2018	34968.93	34968.93	0.00	NC	0.5	26	514	14.5	7.8	12	0.0000005	0.0005140	0.0000145	0.0000005
	12/09/2018	34974.51	34974.57	0.06	NC	0.8	16	656	2.46	6.7	17	0.0000008	0.0006560	0.0000025	0.0000008
	12/11/2018	34979.50	34979.61	0.11	NC	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	-	-	-	-
	14/01/2019	34986.27	34986.27	0.00	NC	5.9	7	408	0.31	7.3	24	0.0000059	0.0004080	0.0000003	0.0000059
	15/03/2019	34993.75	34993.75	0.00	NC	14.3	86	767	34.8	7.1	22	0.0000143	0.0007670	0.0000348	0.0000143
	8/05/2019	34999.80	34999.80	0.00	NC	1.4	13	384	2.28	7.4	18	0.0000014	0.0003840	0.0000023	0.0000014
	2018/2019 LTADM	-	-	-	-	-	-	-	-	-	-	0.0000046	0.0005458	0.0000109	0.0000046

MDM Maximum Daily Mass — Equal to the average daily concentration (mg/L) multiplied by the total discharge (kL) and converted to kilograms

LTADM Long Term Average Daily Mass — Arithmetic average of all daily mass discharges

	CH4	CH4 Peak	CO2	CO2 peak	SWL
	% v/v	% v/v	% v/v	% v/v	m
NSW EPA (2016) Solid Waste Landfills	1 % v/v	1 % v/v	1.5 % v/v	1.5 % v/v	

EPA Designation	Location ID	Date					
4	LFGMB1	15/08/2018	< 0.1	< 0.1	4.2	4.2	3.16
		26/11/2018	< 0.1	< 0.1	4.2	0.7	2.48
		20/02/2019	< 0.1	< 0.1	10.8	11	3.18
		7/05/2019	0	0	9.4	10.6	2.24
17	LGB5	15/08/2018	< 0.1	< 0.1	5.5	5.5	Dry
		26/11/2018	-	-	-	-	-
		20/02/2019	< 0.1	< 0.1	9.3	9	Dry
		7/05/2019	0	0	9.9	10.3	Dry
18	LGB6	15/08/2018	< 0.1	< 0.1	17.5	17.5	Dry
		26/11/2018	-	-	-	-	-
		20/02/2019	< 0.1	< 0.1	22	22.3	Dry
		7/05/2019	0	0	20.5	20.9	4.08
19	LGB7	15/08/2018	< 0.1	< 0.1	3.3	4.4	Dry
		26/11/2018	-	-	-	-	-
		20/02/2019	< 0.1	< 0.1	11.1	11.1	5
		7/05/2019	0	0	8.2	8.2	5.05
20	LGB8	15/08/2018	< 0.1	< 0.1	5.1	5.1	4.85
		26/11/2018	-	-	-	-	-
		20/02/2019	< 0.1	< 0.1	6.3	6.3	4.15
		7/05/2019	0	0	5.6	5.6	3.6
21	LGB9	15/08/2018	< 0.1	< 0.1	6.5	6.5	Dry
		26/11/2018	-	-	-	-	-
		20/02/2019	< 0.1	< 0.1	13.9	13.9	Dry
		7/05/2019	0	0	7.7	7.7	Dry

					CH_4
					ppm
NSW EPA (2016) Solid Waste Landfills, Surface Emissions					500
		Location (MGA 56)			
Transect	Sample Point	Northing	Easting	Sample Date	
A	1	6216110	315781	15/08/2018	1.0
	2	6216112	315798	15/08/2018	1.0
	3	6216111	315811	15/08/2018	1.2
	4	6216110	315826	15/08/2018	0.9
	5	6216108	315843	15/08/2018	1.0
	6	6216106	315865	15/08/2018	0.9
	7	6216104	315887	15/08/2018	1.2
	8	6216101	315911	15/08/2018	1.7
	9	6216096	315940	15/08/2018	2.1
B	1	6216118	315936	15/08/2018	1.8
	2	6216115	315918	15/08/2018	2.0
	3	6216115	315897	15/08/2018	1.8
	4	6216116	315873	15/08/2018	1.6
	5	6216117	315852	15/08/2018	2.0
	6	6216118	315830	15/08/2018	1.9
	7	6216119	315817	15/08/2018	1.8
	8	6216120	315805	15/08/2018	2.1
C	1	6216122	315804	15/08/2018	1.7
	2	6216130	315792	15/08/2018	1.8
	3	6216144	315786	15/08/2018	2.0
	4	6216162	315779	15/08/2018	1.3
	5	6216179	315773	15/08/2018	1.1
	6	6216200	315769	15/08/2018	1.3
	7	6216219	315770	15/08/2018	1.2
D	1	6216163	315874	15/08/2018	1.2
	2	6216163	315865	15/08/2018	1.5
	3	6216160	315856	15/08/2018	1.3
	4	6216159	315844	15/08/2018	1.3
	5	6216160	315829	15/08/2018	1.2
	6	6216161	315818	15/08/2018	1.1
E	1	6216238	315792	15/08/2018	1.4
	2	6216224	315797	15/08/2018	1.1
	3	6216205	315801	15/08/2018	1.3
	4	6216189	315804	15/08/2018	1.4
	5	6216176	315816	15/08/2018	1.5
	6	6216173	315833	15/08/2018	1.2
F	1	6216379	315657	15/08/2018	1.3
	2	6216386	315371	15/08/2018	1.4
	3	6216388	315686	15/08/2018	1.3
	4	6216387	315699	15/08/2018	1.4
	5	6216382	315714	15/08/2018	1.2
	6	6216375	315728	15/08/2018	1.1
	7	6216370	315747	15/08/2018	1.4
	8	6216367	315762	15/08/2018	1.2
	9	6216367	315782	15/08/2018	1.2

					CH_4
					ppm
NSW EPA (2016) Solid Waste Landfills, Surface Emissions					500
		Location (MGA 56)			
Transect	Sample Point	Northing	Easting	Sample Date	
G	1	6216145	315932	15/08/2018	1.3
	2	6216176	315932	15/08/2018	1.5
	3	6216219	315927	15/08/2018	1.6
	4	6216248	315921	15/08/2018	1.3
	5	6216275	315911	15/08/2018	1.3
	6	6216301	315924	15/08/2018	1.5
	7	6216324	315939	15/08/2018	1.2
	8	6216345	315946	15/08/2018	0.9
	9	6216369	315950	15/08/2018	1.3
H	1	6216168	315889	15/08/2018	1.2
	2	6216180	315887	15/08/2018	1.3
	3	6216219	315886	15/08/2018	1.4
	4	6216242	315884	15/08/2018	1.3
	5	6216262	315883	15/08/2018	1.2
I	1	6216337	315886	15/08/2018	2.0
	2	6216318	315879	15/08/2018	2.8
	3	3216300	315875	15/08/2018	2.6
	4	6216281	315873	15/08/2018	2.6
	5	6216265	315872	15/08/2018	2.3
	6	6216242	315873	15/08/2018	1.8
	7	6216219	315880	15/08/2018	1.5
	8	6216197	315883	15/08/2018	1.4
	9	6216177	315883	15/08/2018	1.2
J	1	6216185	315860	15/08/2018	1.6
	2	6216211	315858	15/08/2018	1.8
	3	6216230	315858	15/08/2018	1.8
	4	6216243	315858	15/08/2018	2.5
	5	6216255	315858	15/08/2018	2.3
	6	6216272	315755	15/08/2018	3.0
	7	6216292	315852	15/08/2018	2.3
	8	6216309	315847	15/08/2018	2.0
	9	6216331	315847	15/08/2018	2.0
	10	6216345	315847	15/08/2018	2.0
	11	6216361	315847	15/08/2018	2.0
	12	6216381	315841	15/08/2018	2.0
	13	6216401	315836	15/08/2018	1.7
	14	6216412	315831	15/08/2018	2.0
	1	6216397	315643	15/08/2018	1.8
	2	6216406	315658	15/08/2018	1.9
	3	6216414	315679	15/08/2018	2.3
	4	6216422	315699	15/08/2018	1.5
	5	6216426	315717	15/08/2018	1.6
	6	6216428	315736	15/08/2018	1.9
	7	6216429	315756	15/08/2018	1.4

					CH_4
					ppm
NSW EPA (2016) Solid Waste Landfills, Surface Emissions					500
		Location (MGA 56)			
Transect	Sample Point	Northing	Easting	Sample Date	
K	8	6216431	315776	15/08/2018	1.3
	9	6216434	315800	15/08/2018	1.3
	10	6216436	315821	15/08/2018	1.6
	11	6216431	315836	15/08/2018	2.0
	12	6216418	315848	15/08/2018	2.7
	13	6216400	315858	15/08/2018	10.1
	14	6216382	315858	15/08/2018	1.6
	15	6216362	315857	15/08/2018	1.4
L	1	6216384	315876	15/08/2018	1.7
	2	6216407	315877	15/08/2018	1.7
	3	6216432	315874	15/08/2018	1.3
	4	6216450	315860	15/08/2018	1.0
	5	6216463	315841	15/08/2018	1.5
	6	6216464	315820	15/08/2018	1.5
	7	6216457	315801	15/08/2018	1.3
	8	6216450	315780	15/08/2018	1.2
	9	6216448	315759	15/08/2018	1.0
	10	6216441	315728	15/08/2018	0.9
	11	6216434	315700	15/08/2018	1.1
	12	6216429	315676	15/08/2018	1.1
M	1	6216429	315634	15/08/2018	1.3
	2	6216438	315651	15/08/2018	1.6
	3	6216445	315667	15/08/2018	1.5
	4	6216451	315682	15/08/2018	1.5
	5	6216458	315706	15/08/2018	1.3
	6	6216466	315733	15/08/2018	1.3
	7	6216475	315766	15/08/2018	1.2
	8	6216487	315799	15/08/2018	1.3
	9	6216487	315834	15/08/2018	1.6
	10	6216487	315859	15/08/2018	1.4
	11	6216476	315882	15/08/2018	1.9
	12	6216463	315899	15/08/2018	1.9
N	1	6216345	315924	15/08/2018	1.6
	2	6216321	315911	15/08/2018	1.3
	3	6216324	315898	15/08/2018	1.2
O	1	6216345	315900	15/08/2018	1.1
	2	6216344	315907	15/08/2018	1.1
	3	6216343	315913	15/08/2018	1.1
	4	6216341	315923	15/08/2018	1.2
	5	6216339	315930	15/08/2018	1.2
	6	6216337	315937	15/08/2018	1.2
	7	6216332	315946	15/08/2018	1.7
	1	6216366	315865	15/08/2018	1.5
	2	6216372	315874	15/08/2018	1.3

					CH_4
					ppm
NSW EPA (2016) Solid Waste Landfills, Surface Emissions					500
		Location (MGA 56)			
Transect	Sample Point	Northing	Easting	Sample Date	
P	3	6216375	315885	15/08/2018	1.5
	4	6216376	315896	15/08/2018	1.4
	5	6216374	315908	15/08/2018	1.3
	6	6216373	315917	15/08/2018	1.2
	7	6216372	315929	15/08/2018	1.3
	8	6216370	315946	15/08/2018	1.2
	9	6216364	315969	15/08/2018	1.6
Q	No Access, Overgrown				
81 Halls Rd fenceline adjoining landfill	1	6216133	315445	15/08/2018	2.0
79 Halls Rd fenceline adjoining landfill	2	6216114	315452	15/08/2018	1.9
77 Halls Rd fenceline adjoining landfill	3	-	-	15/08/2018	1.8
75 Halls Rd fenceline adjoining landfill	4	6216050	315438	15/08/2018	1.8
69 Halls Rd fenceline adjoining landfill	5	6216001	315429	15/08/2018	1.8
1 Nixon Pl fenceline adjoining landfill	6	6216140	315412	15/08/2018	1.9

APPENDIX

C

LABORATORY QA/QC ASSESSMENT

Quality Assurance/Quality Control (QA/QC) procedures were implemented to ensure the precision accuracy, representativeness, completeness and comparability of all data gathered. The QA/QC procedures included:

- Equipment calibration to ensure field measurements obtained are accurate;
- Equipment decontamination to prevent cross contamination;
- The completion of a field form for each monitoring point;
- Use of appropriate measures (i.e. gloves) to prevent cross contamination;
- Appropriate sample identification;
- Correct sample preservation;
- Sample transport with Chain of Custody (CoC) documentation; and
- Laboratory analysis in accordance with NATA accredited methods.

Table C-1 details the QA/QC procedures and sample collection details undertaken during monitoring and sample collection. **Table C-2** summarises the number of QA/QC samples collected during this investigation. CoC, Sample Receipt Notifications (SRNs), laboratory certificates and Interpretive QA/QC Reports can be provided upon request. These documents are typically appended to the report but due to the quantity of documents they have been omitted.

Table C1: Field QAQC Method Validation

Requirement	Yes/No	Comments
Equipment calibration	Yes	Each field instrument was calibrated prior to use. Calibration certificates can be provided by ALS Environmental upon request.
Equipment decontamination	Yes	Decontamination of sampling equipment (interface probe) was undertaken by washing with phosphate free detergent (Decon 90) followed by a rinse with potable water.
Sampling and monitoring documentation	Yes	Water sampling and gas monitoring was documented by ALS Environmental during each sampling event. Copies of sampling and monitoring documentation can be provided upon request.
Sample collection	Yes	Samples were collected using laboratory provided sampling containers and a clean pair of gloves was used for each new sampling point to limit the potential for cross-contamination.
Sample identification	Yes	All samples were marked with a unique identifier including the sampling point and date.
Sample preservation	Yes	Following collection water samples were placed in an esky that contained bricks. Samples were kept chilled from sample collection until laboratory receipt.
COC documentation	Yes	A COC form was completed by ALS Environmental detailing the sample identification, collection date, sampler and laboratory analysis required. COC forms and SRN can be provided upon request. The SRN indicates that the samples were received at the laboratory intact and chilled and within the required holding times.
NATA accredited methods	Yes	ALS Environmental are a NATA accredited laboratory for the required analysis, which was completed in accordance with NATA accredited methods.

Laboratory QC and QCI Report Summary

The laboratory selected to undertake laboratory testing, ALS Environmental, is NATA accredited for the analysis required. ALS Environmental undertook internal QA/QC measures to demonstrate the suitability of the data. The laboratory is required to undertake and report internal laboratory Quality Control procedures for all chemical analysis undertaken, including:

- Laboratory duplicate sample analysis at the rate of one duplicate analysis per ten samples;
- Method blank at the rate of one method blank analysis per 20 samples;
- Laboratory control sample at the rate of one laboratory control sample analysis per 20 samples; and

> Spike recovery analysis at the rate of one spike recovery analysis per 20 samples.

Compliance with the internal laboratory QA/QC requirements is provided within the QC and QCI reports provided by ALS Environmental, which can be provided upon request and are discussed below.

The QC and QCI reports received from ALS Environmental highlight outliers of QA/QC standards including holding time breaches and internal QC results. Review of the QC and QCI documentation provided by ALS Environmental indicates that several outliers existed which are summarised below in **Table C-2**.

Table C-2: Laboratory QA/QC Outlier Summary

Report	Outlier Type	Analyte	Justification
EW1802601	Matrix Spike	Metals	No matrix spikes analysed, target percentage 5%
EW1803269	Matrix Spike	Sulfate as SO_4	MS recovery not determined, background level greater than or equal to 4x spike level
		Chloride	
		Ammonia as N	
EW1803270	Matrix Spike	PAH/Phenols	No matrix spikes analysed, target percentage 10%
		Pesticides	No matrix spikes analysed, target percentage 8%
		TRH Semi-volatile fraction	No matrix spikes analysed, target percentage 10%
	Laboratory Duplicates	PAH/Phenols	No laboratory duplicates analysed, target percentage 10%
		Pesticides	No laboratory duplicates analysed, target percentage 8%
		TRH Semi-volatile fraction	No laboratory duplicates analysed, target percentage 10%
EW1803271	No QA/QC outliers		
EW1803272	Matrix Spike	Nitrite as N	Recovery less than lower data quality objective
		PAH/Phenols	No matrix spikes analysed, target percentage 10%
		Pesticides	No matrix spikes analysed, target percentage 8%
		TRH Semi-volatile fraction	No matrix spikes analysed, target percentage 10%
	Laboratory Duplicates	PAH/Phenols	No laboratory duplicates analysed, target percentage 10%
		Pesticides	No laboratory duplicates analysed, target percentage 8%
		TRH Semi-volatile fraction	No laboratory duplicates analysed, target percentage 10%
EW1803680	Matrix Spike	Metals	No matrix spikes analysed, target percentage 5%
EW1804670	No QA/QC outliers		
EW1804930	No QA/QC outliers		
EW1804931	No QA/QC outliers		
EW1804932	Method blank	Total Dissolved Solids	Method blanks analysed below target frequency of 5%
EW1900069	Matrix Spike	Metals	No matrix spikes analysed, target percentage 5%
EW1900709	Matrix Spike	Sulfate as SO_4	MS recovery not determined, background level greater than or equal to 4x spike level
		Ammonia as N	

Report	Outlier Type	Analyte	Justification
EW1900710	No QA/QC outliers		
EW1900711	No QA/QC outliers		
EW1901095	Matrix Spike	Metals	No matrix spikes analysed, target percentage 5%
EW1902014	Matrix Spike	Metals	No matrix spikes analysed, target percentage 5%
EW1902313	No QA/QC outliers		
EW1902315	Matrix Spike	Sulfate as SO4	MS recovery not determined, background level greater than or equal to 4x spike level
EW1902317	No QA/QC outliers		

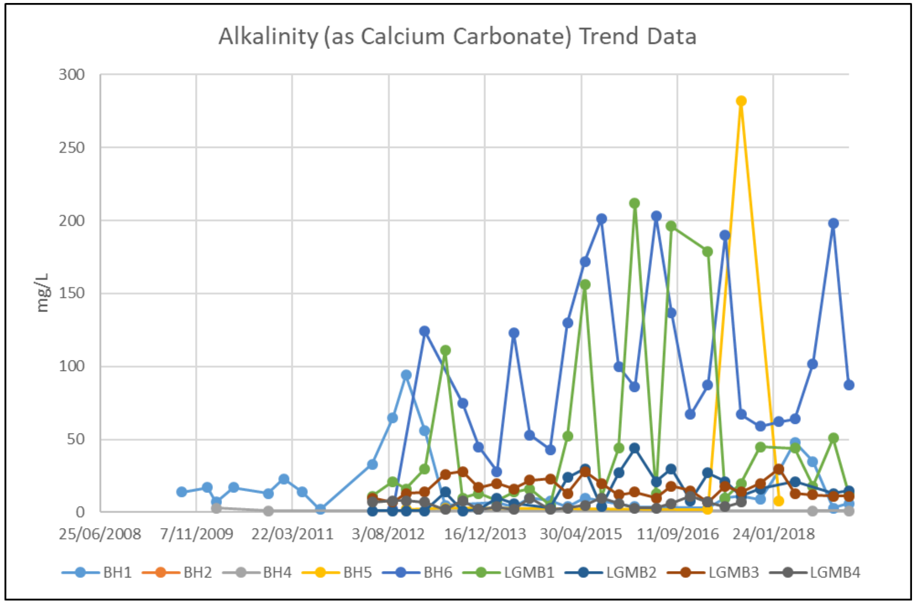
Cardno concludes that the data reported by ALS Environmental as presented in this Annual Report is suitable for interpretative to assess the environmental performance and compliance with EPL 5861.

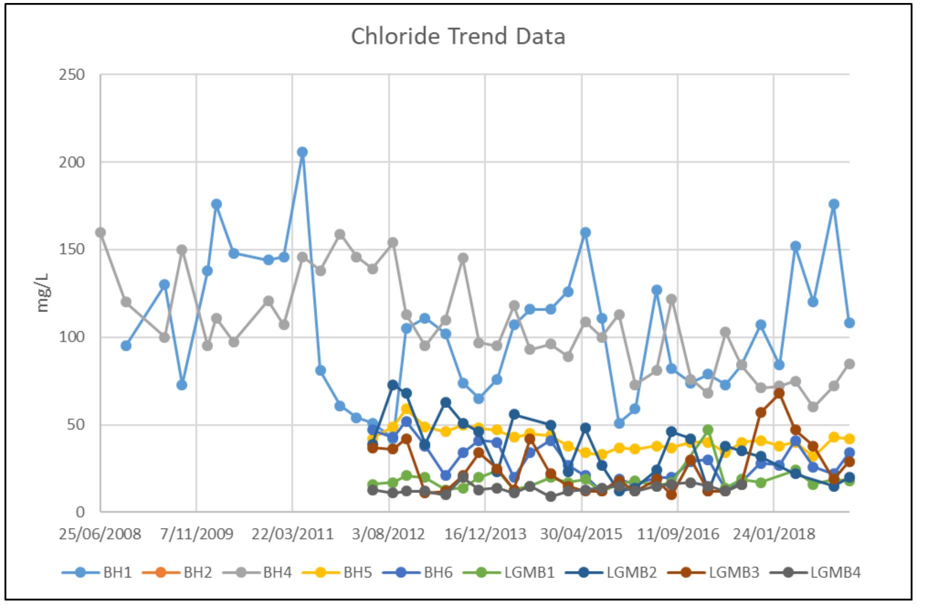
APPENDIX

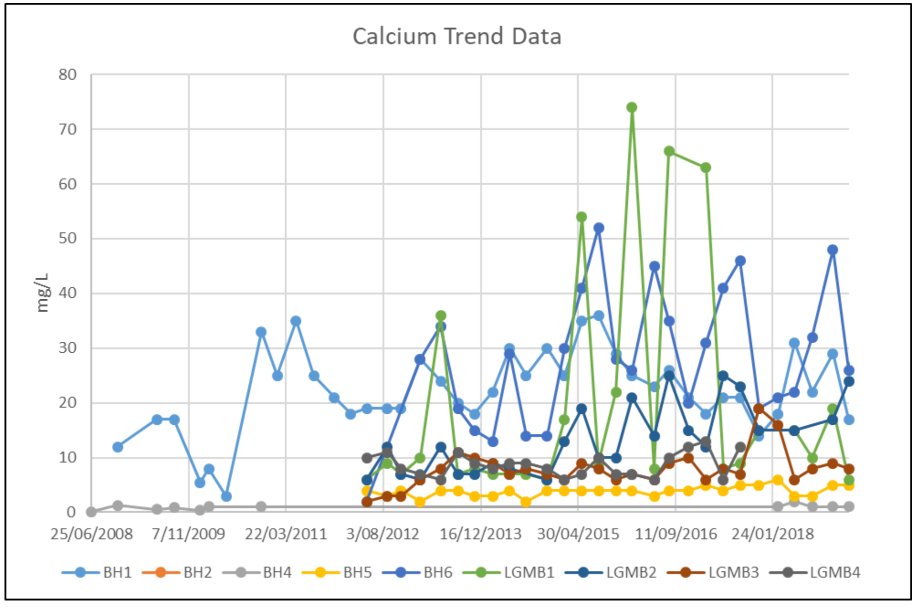
D

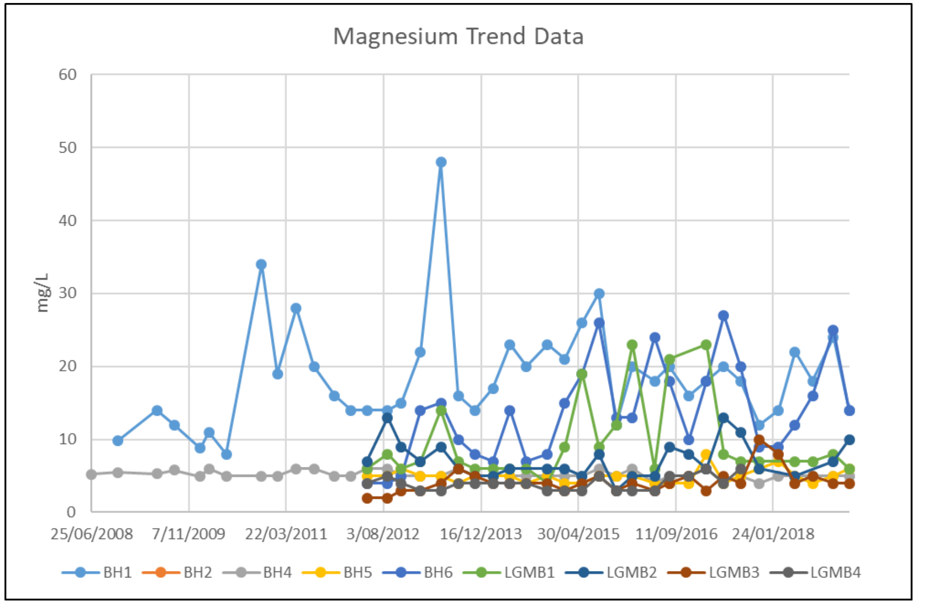
TREND GRAPHS

Helensburgh Groundwater Monitoring Results Graphs

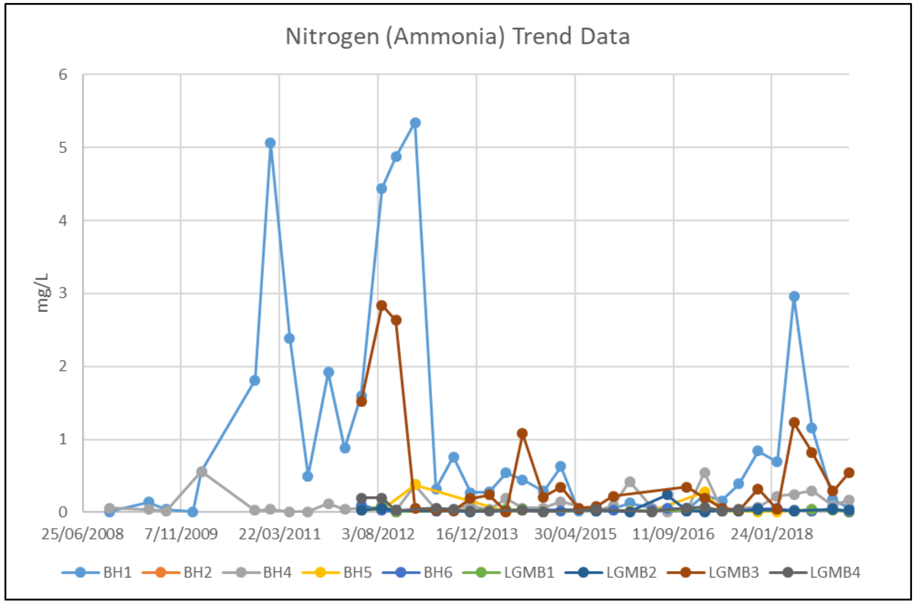


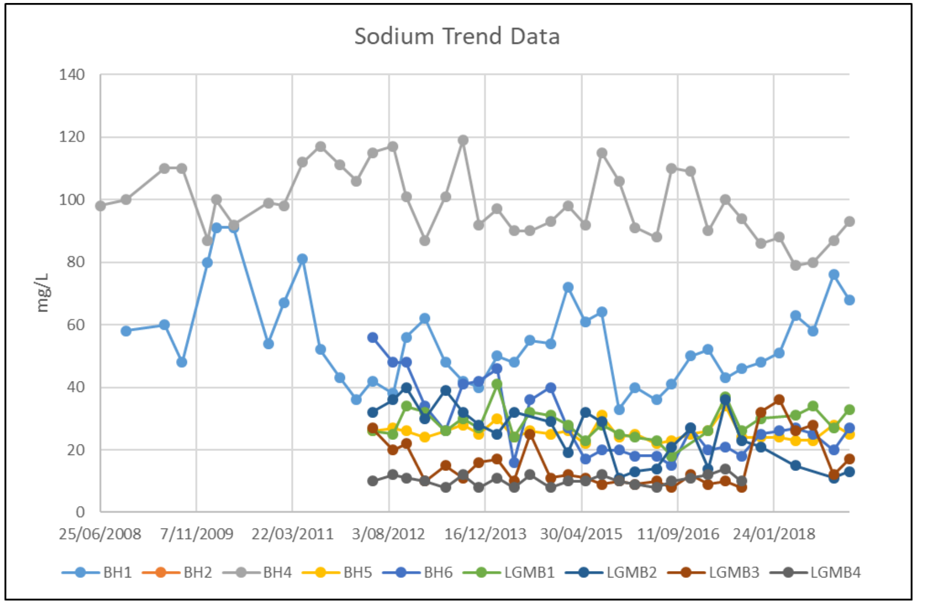


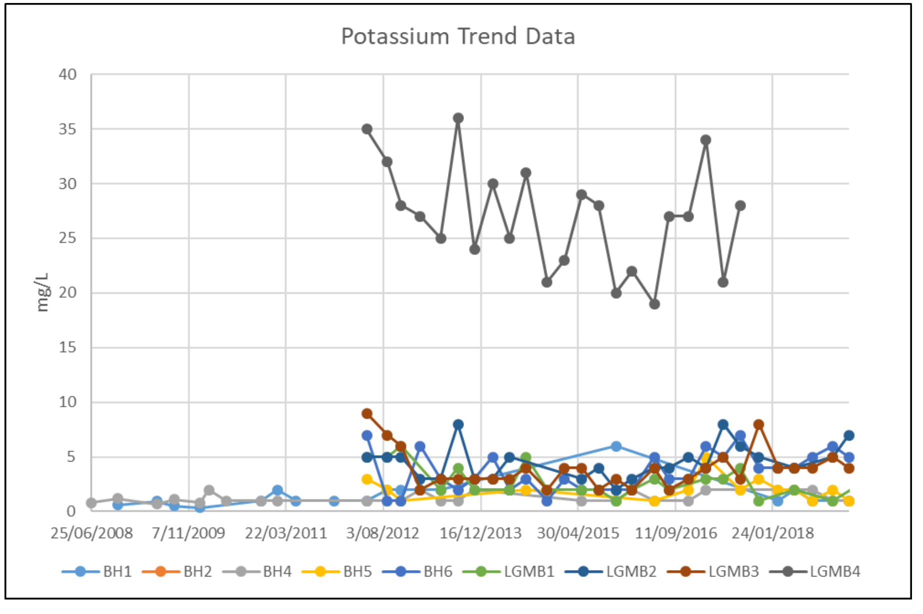


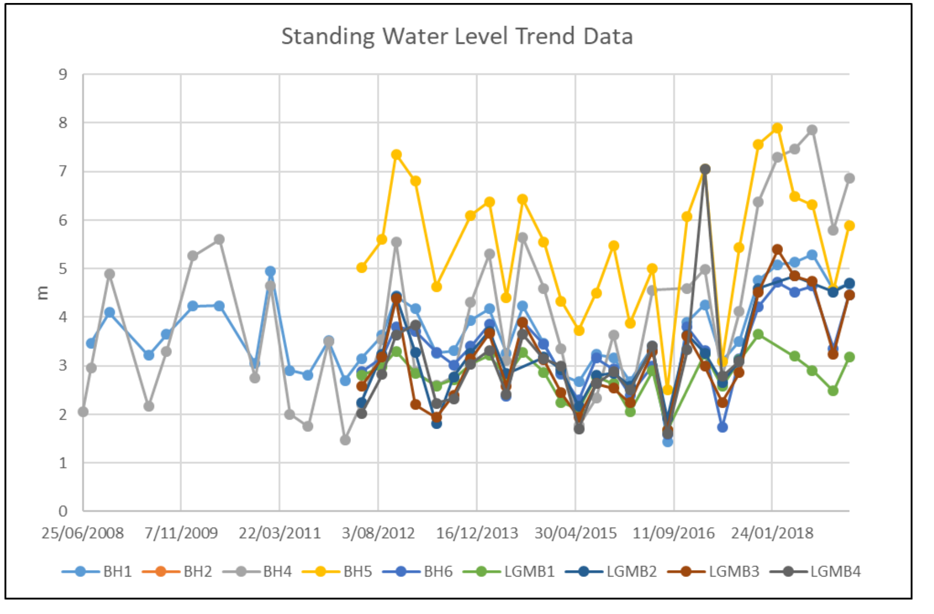


Helensburgh Groundwater Monitoring Results Graphs

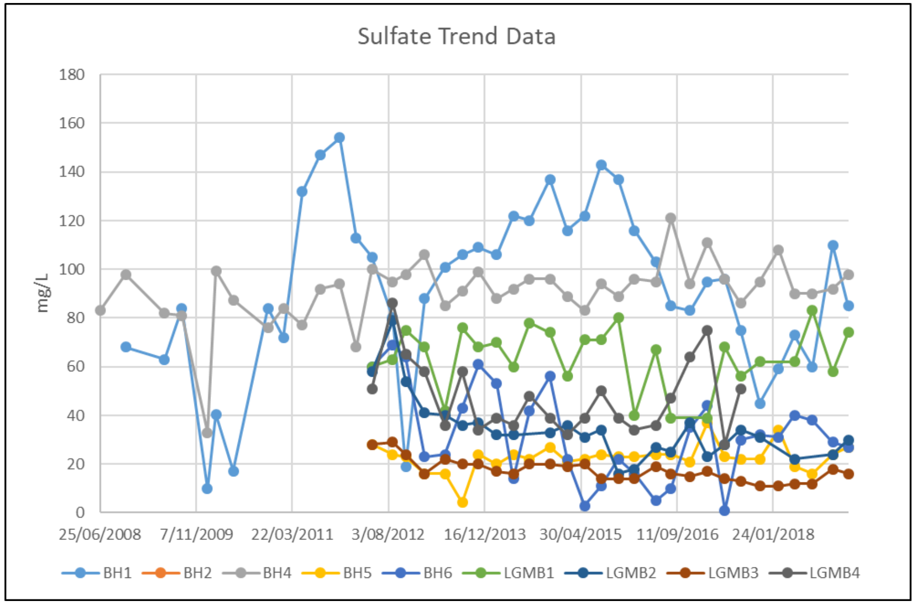


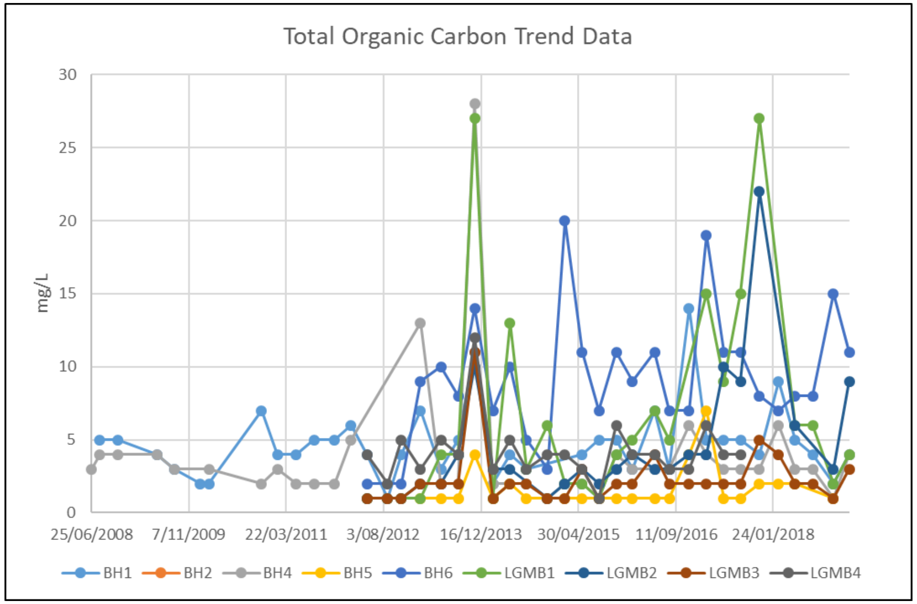


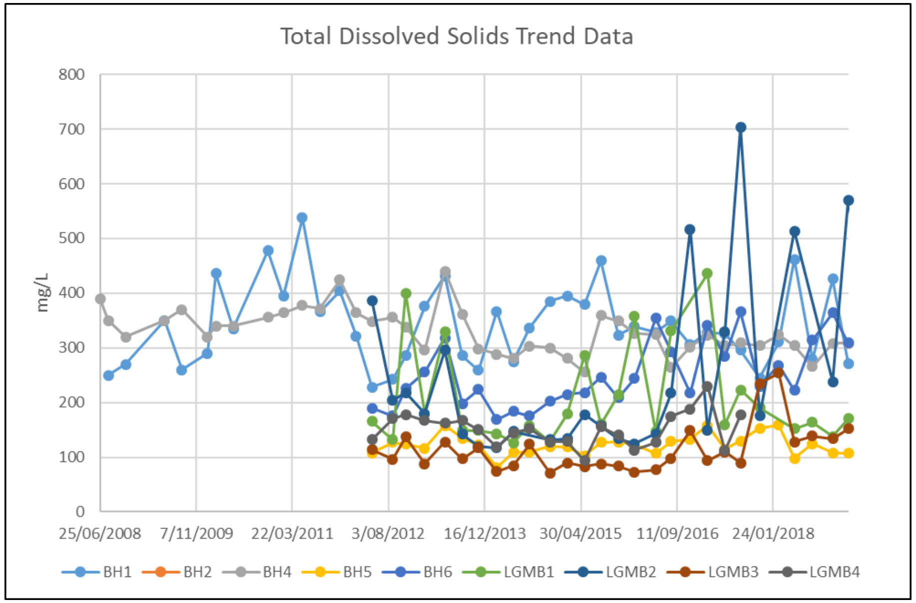


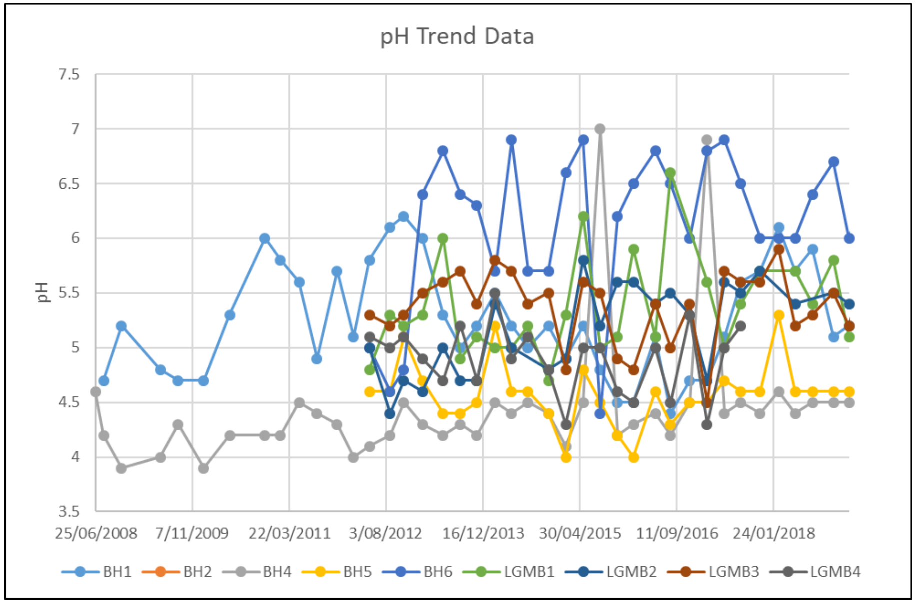


Helensburgh Groundwater Monitoring Results Graphs

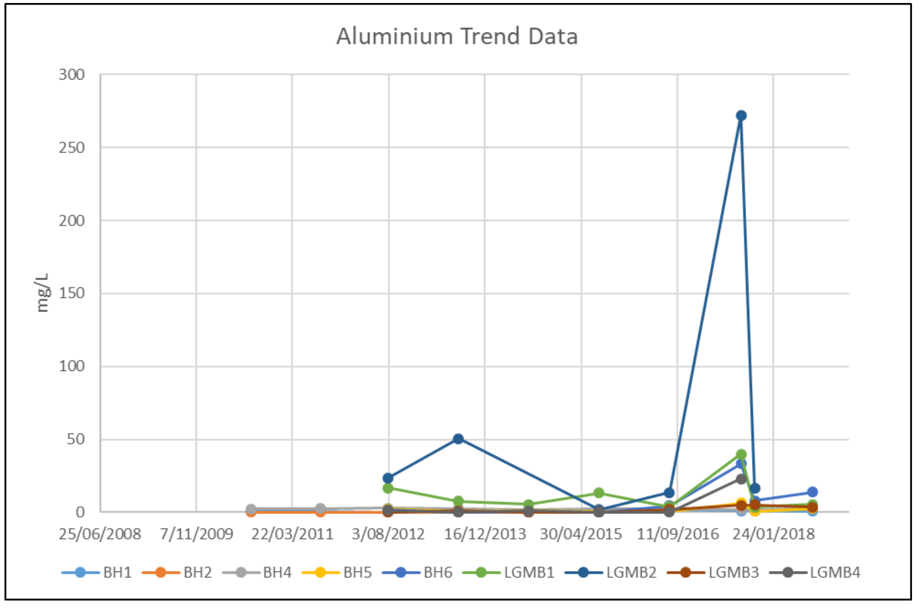


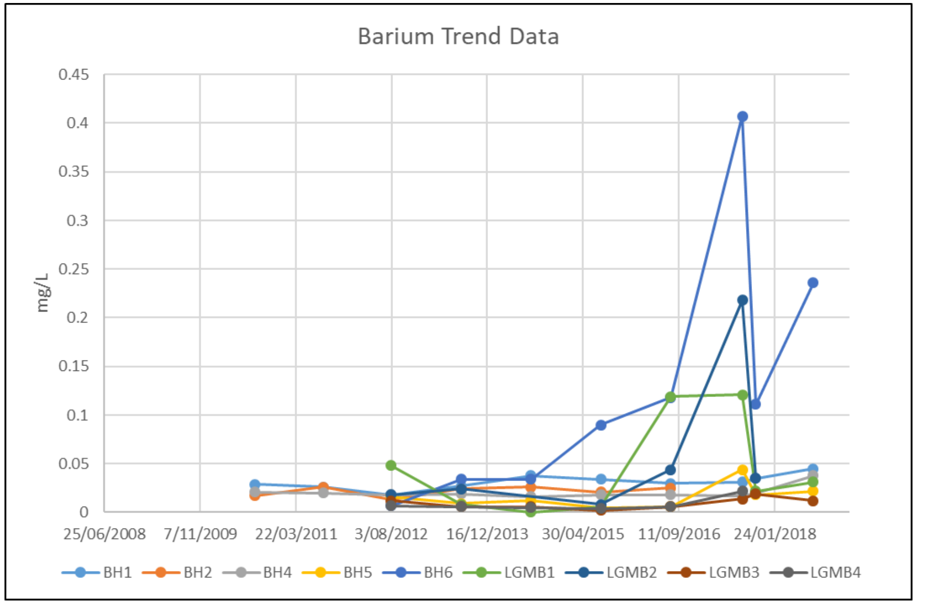


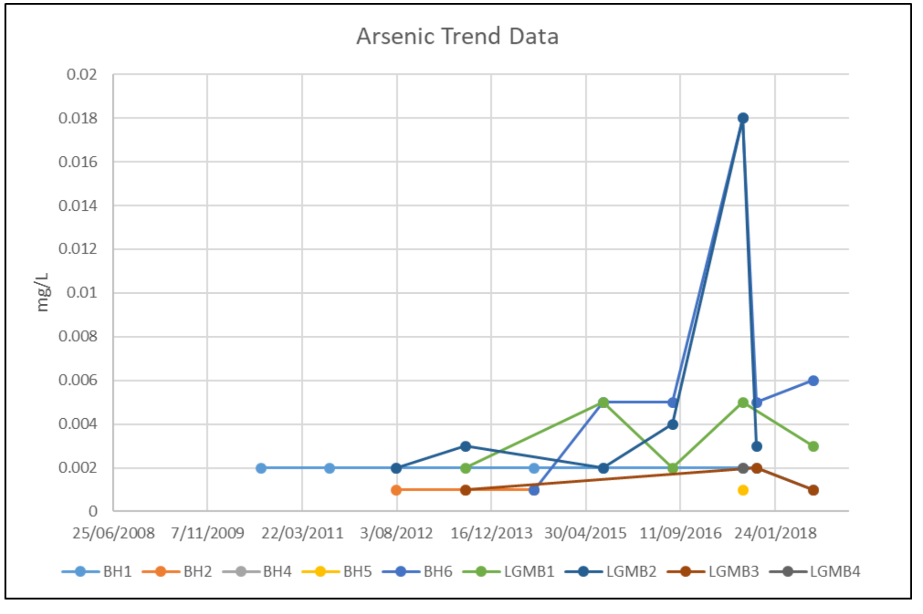


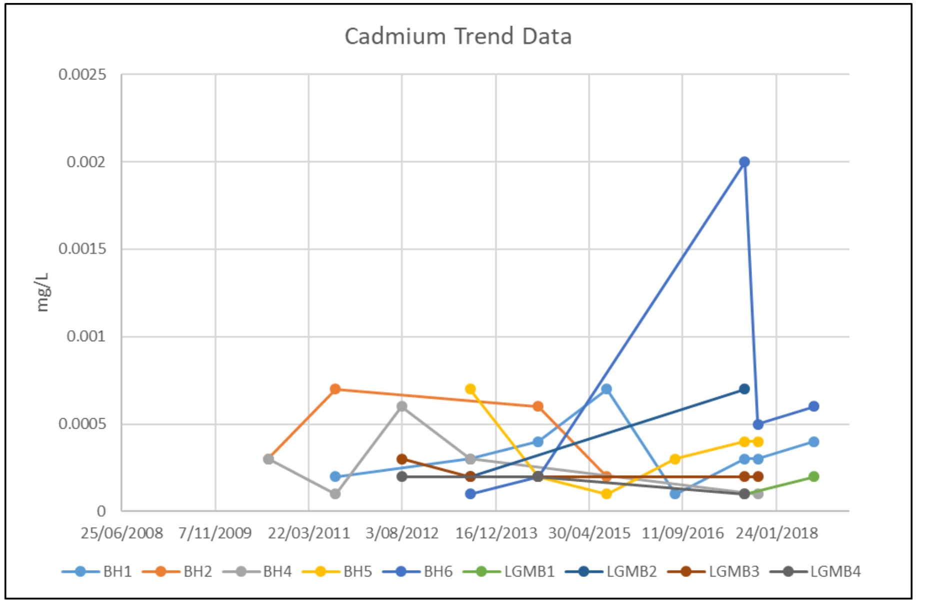


Helensburgh Groundwater Monitoring Results Graphs

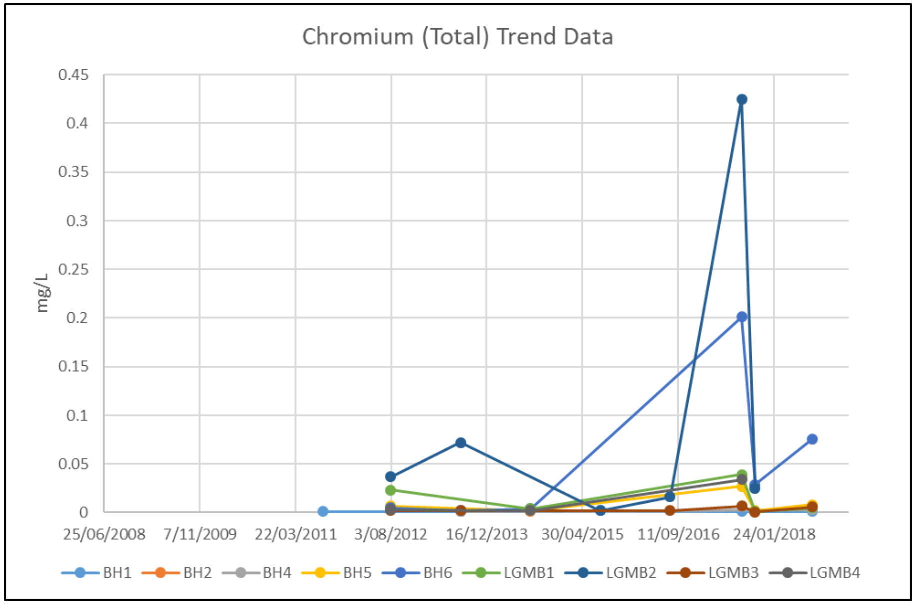


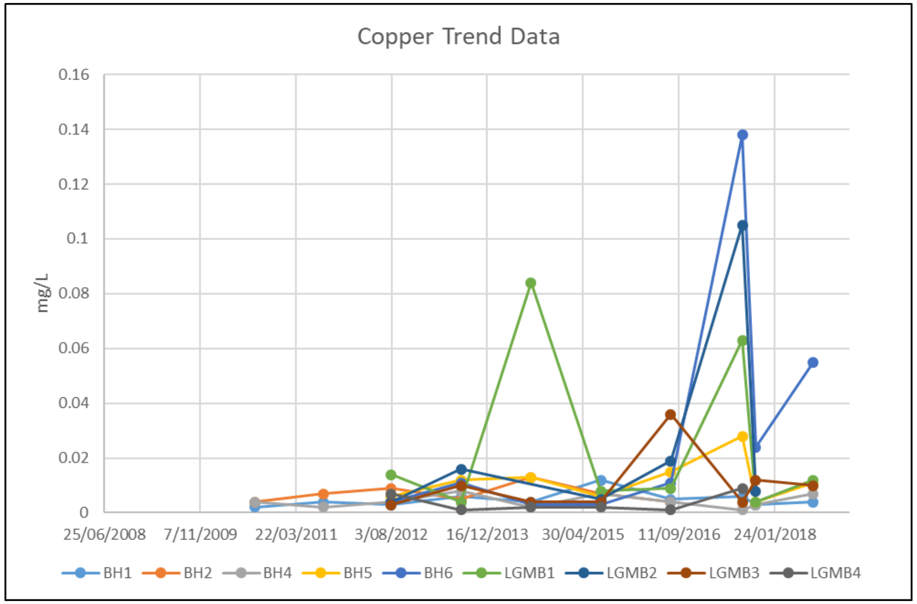


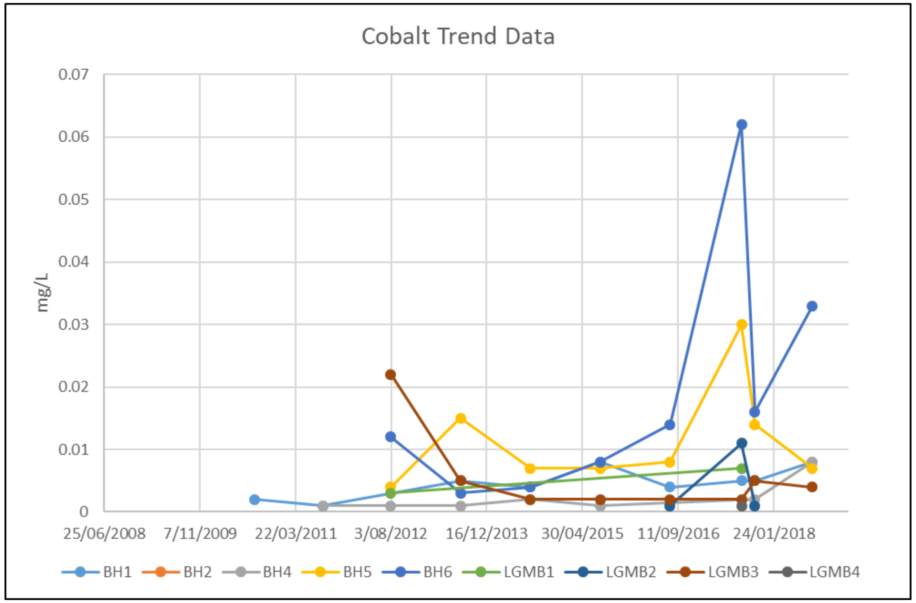


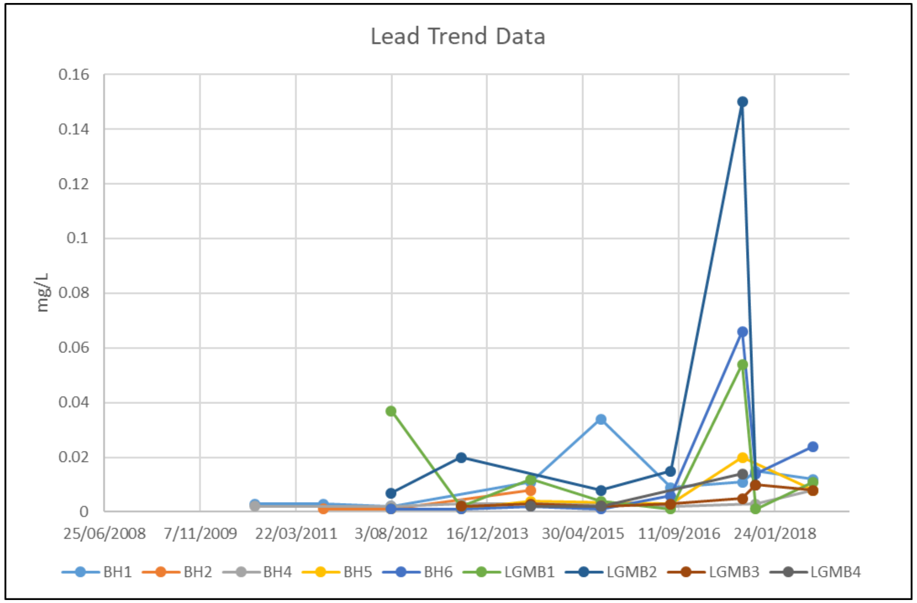


Helensburgh Groundwater Monitoring Results Graphs

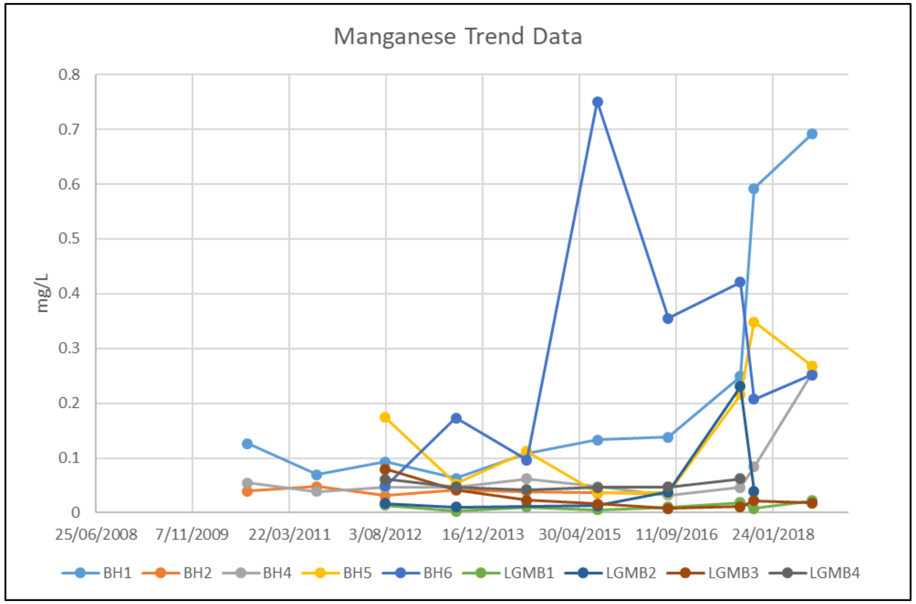


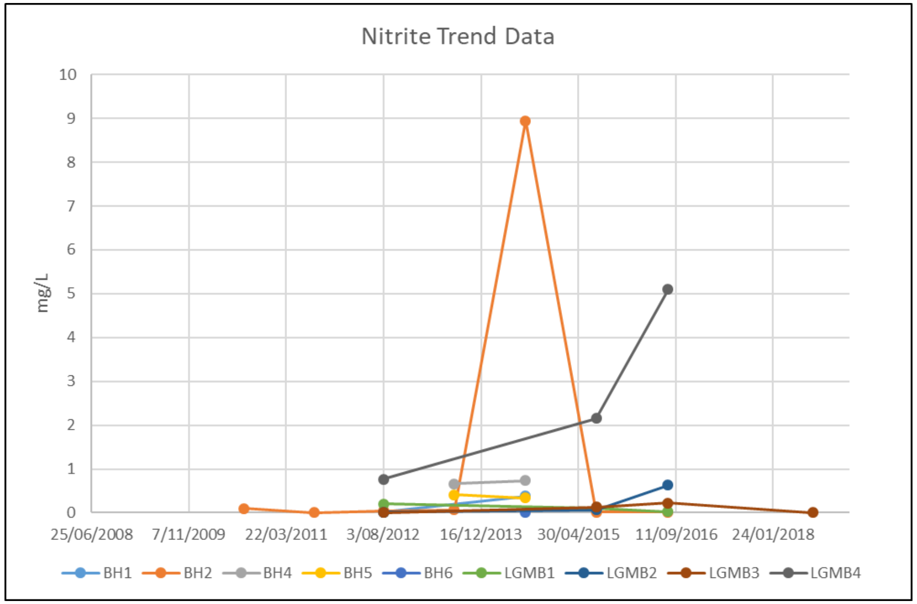


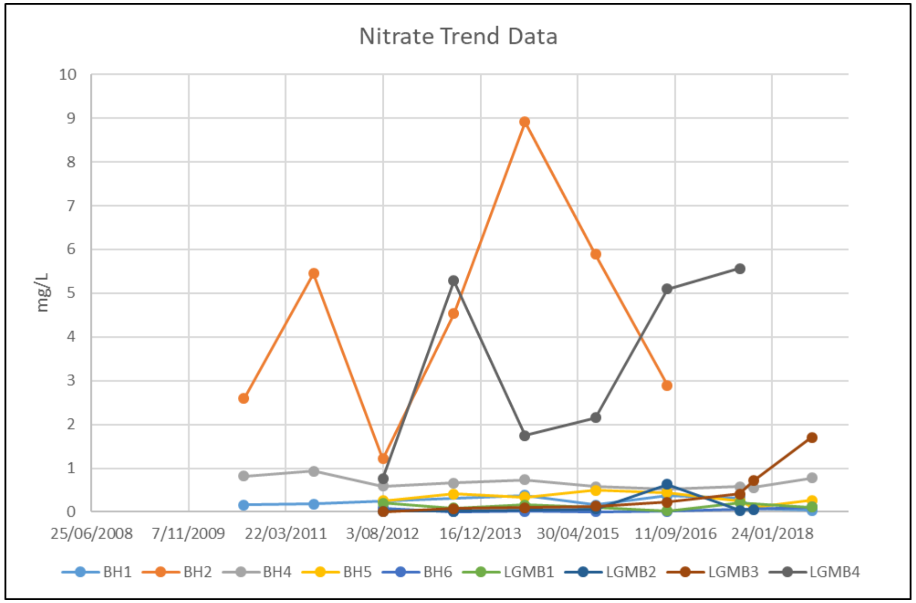


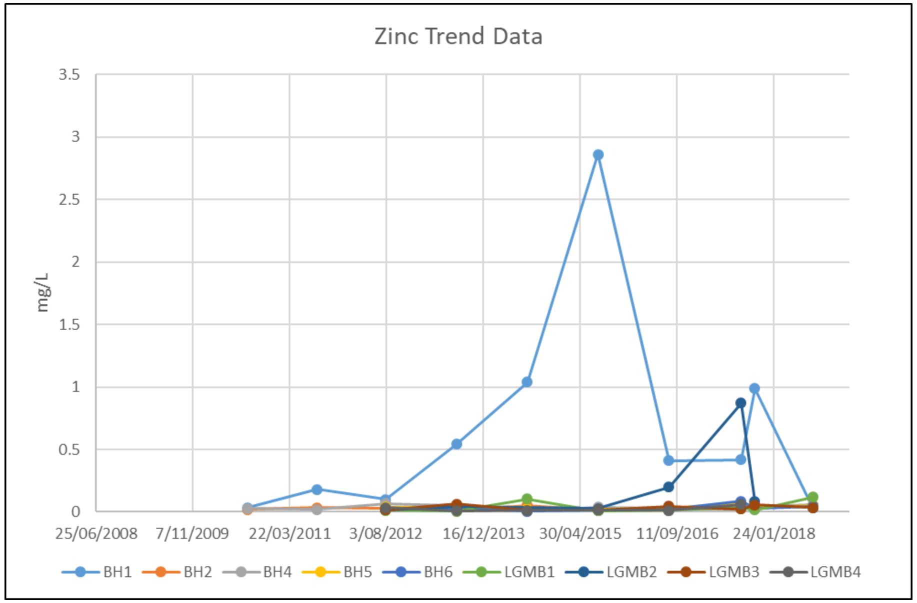


Helensburgh Groundwater Monitoring Results Graphs

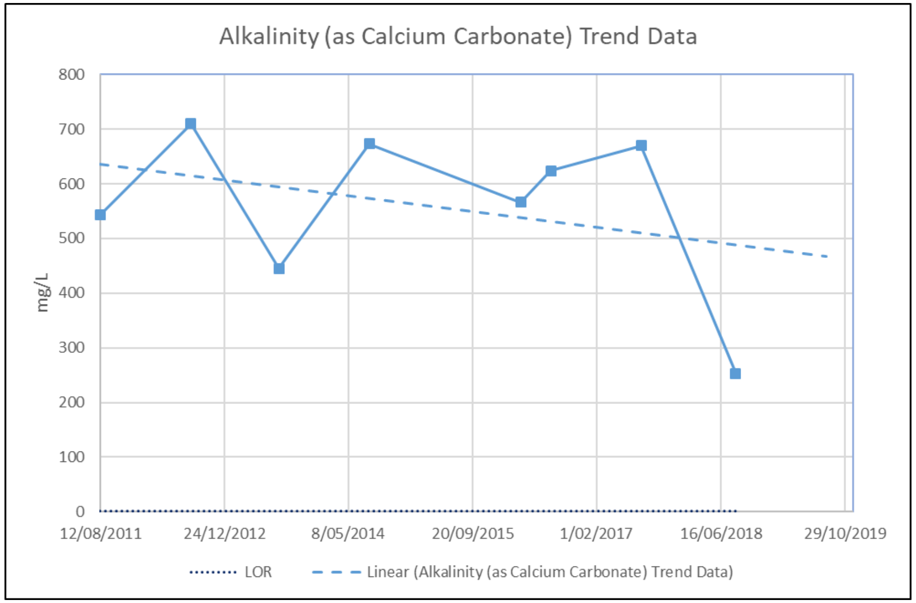


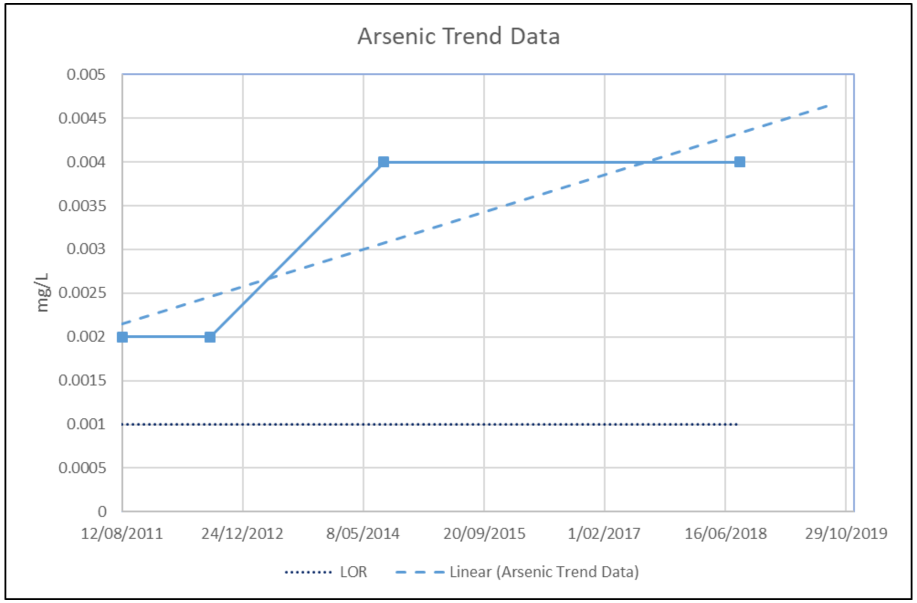


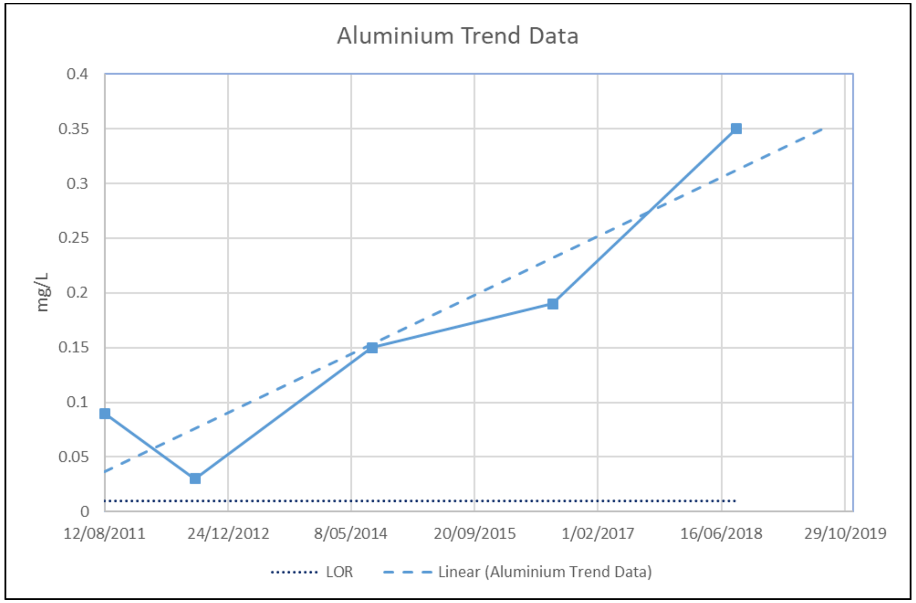


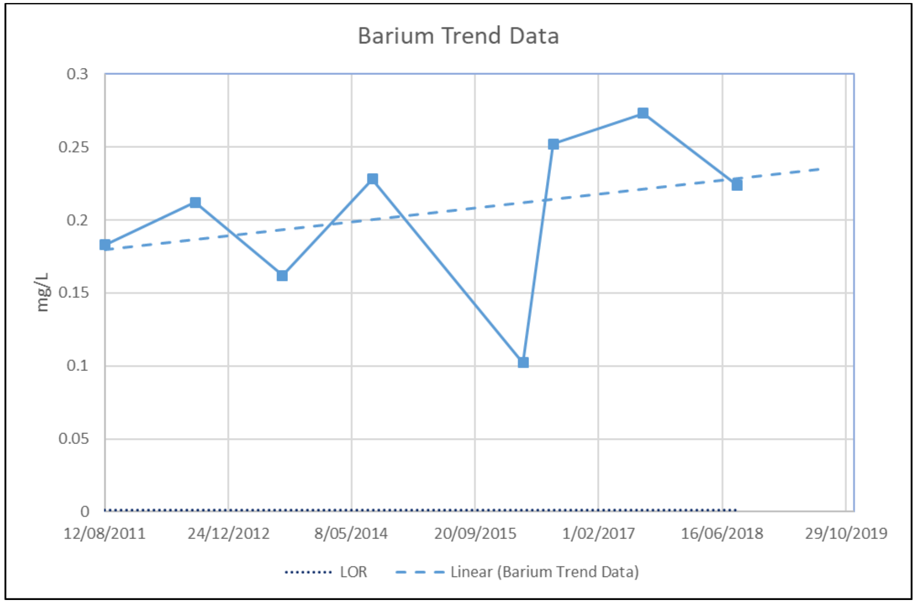


Helensburgh Leachate Monitoring Results Graphs









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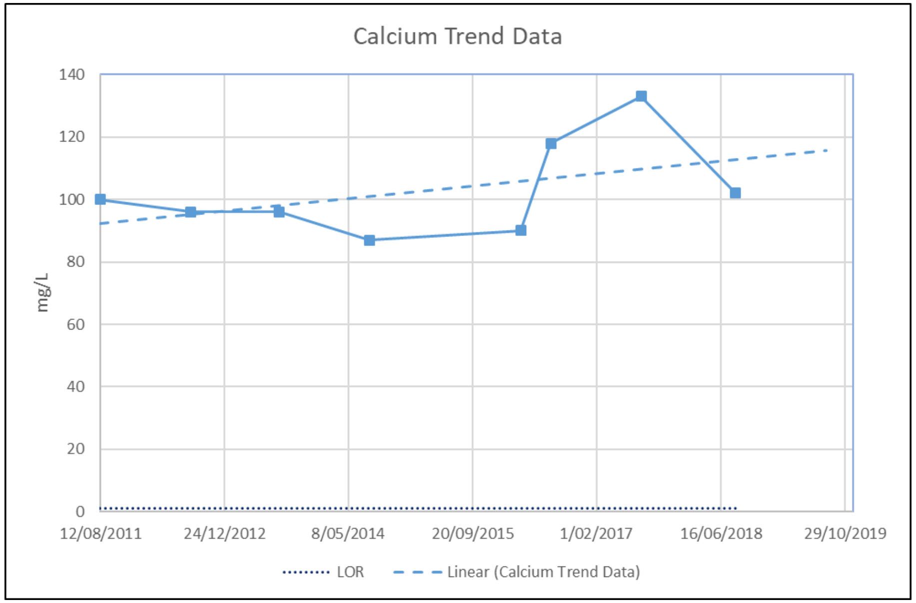

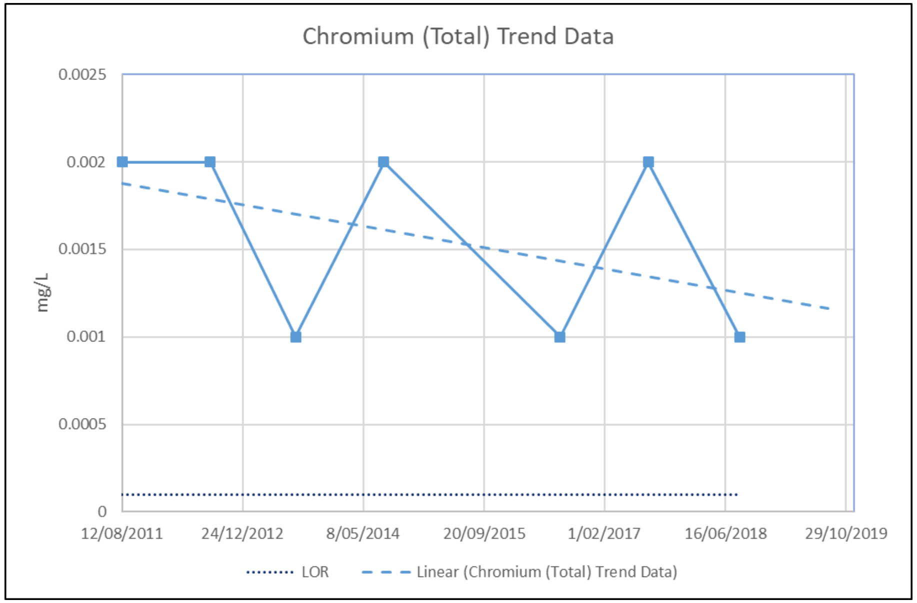

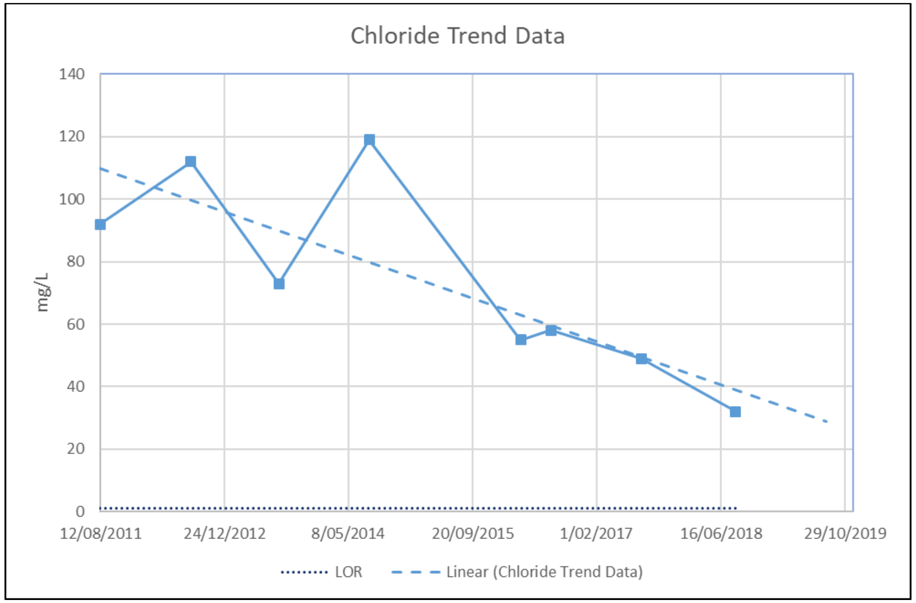

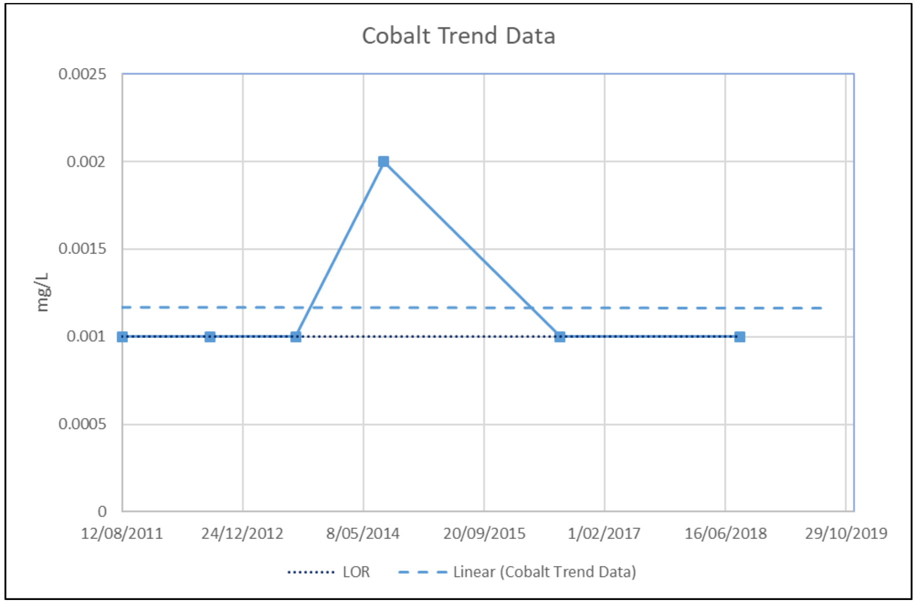

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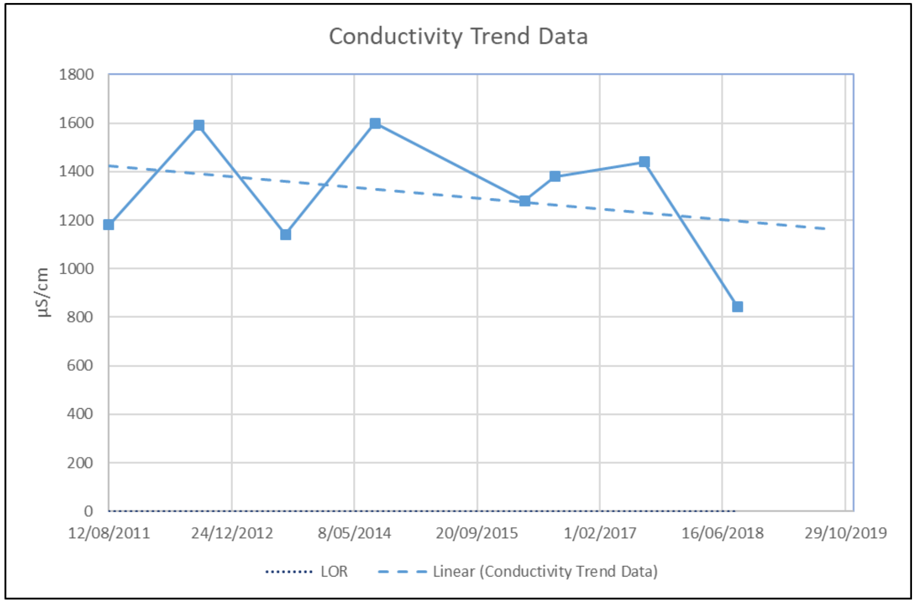

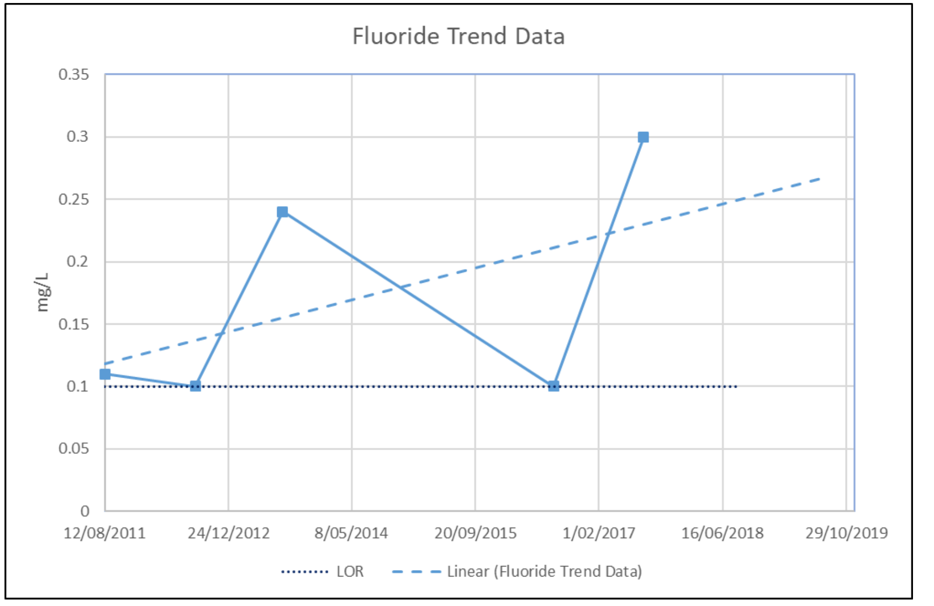

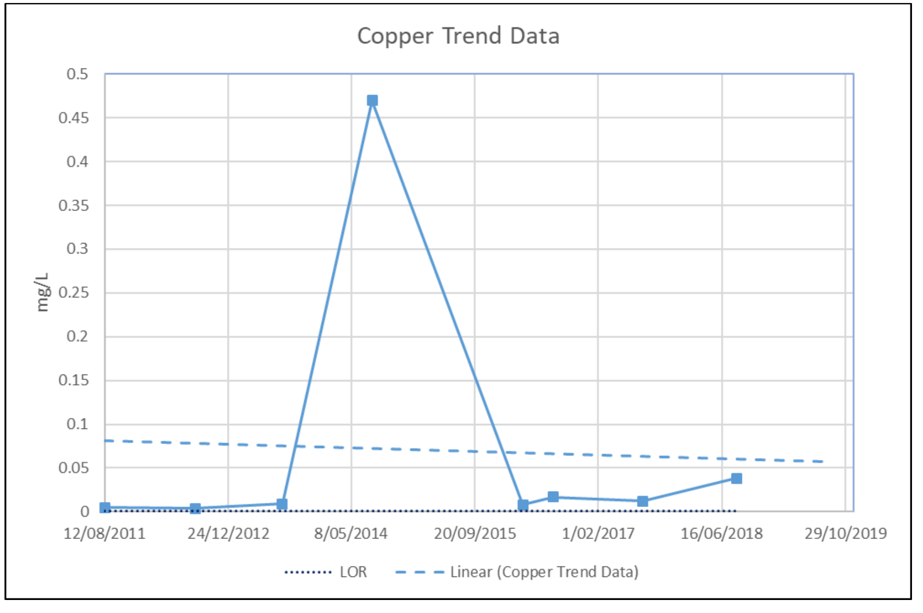

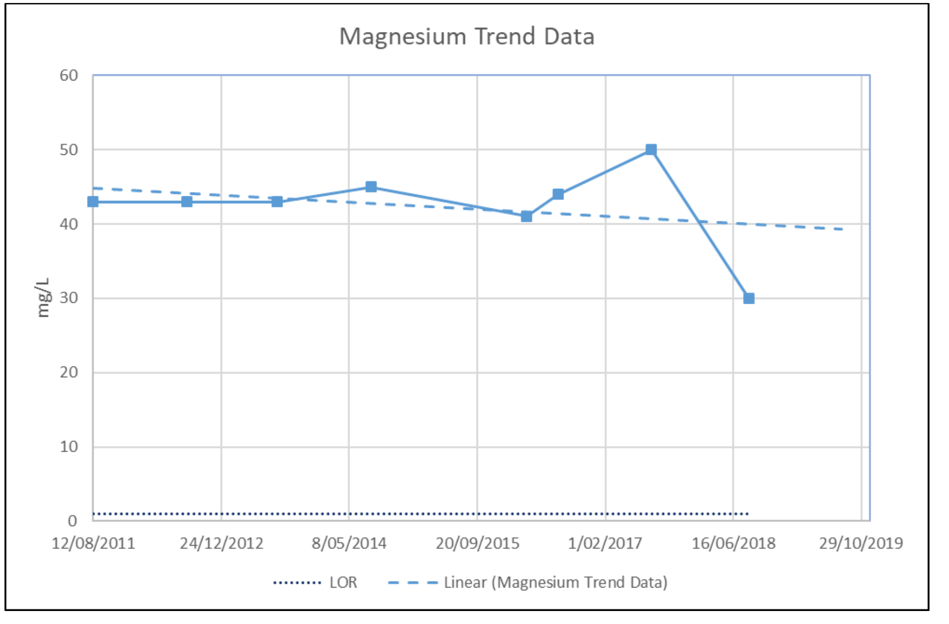

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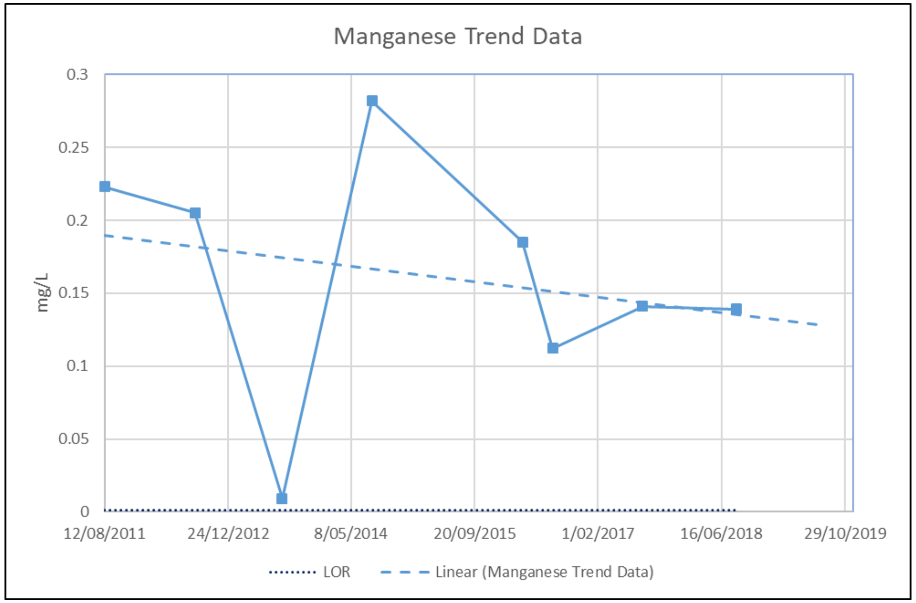

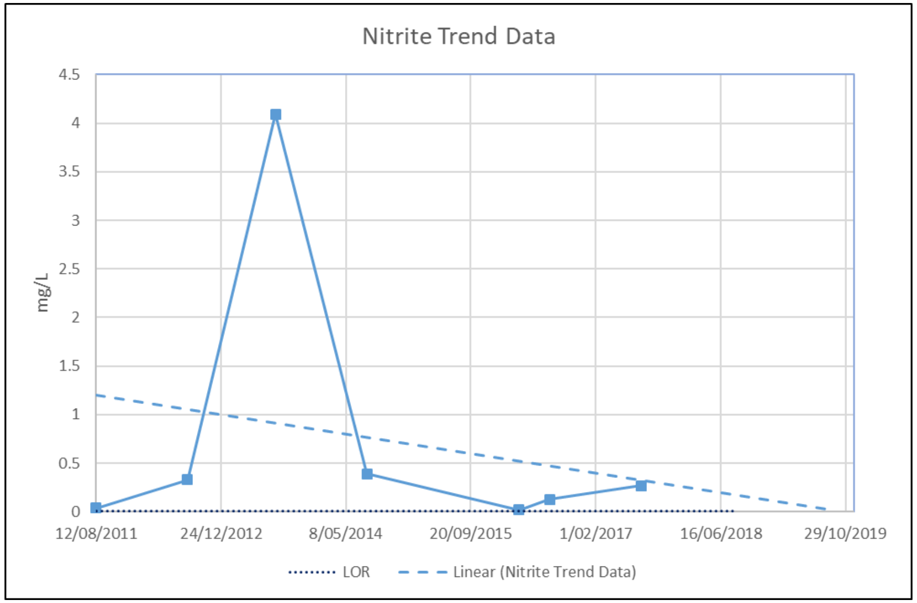

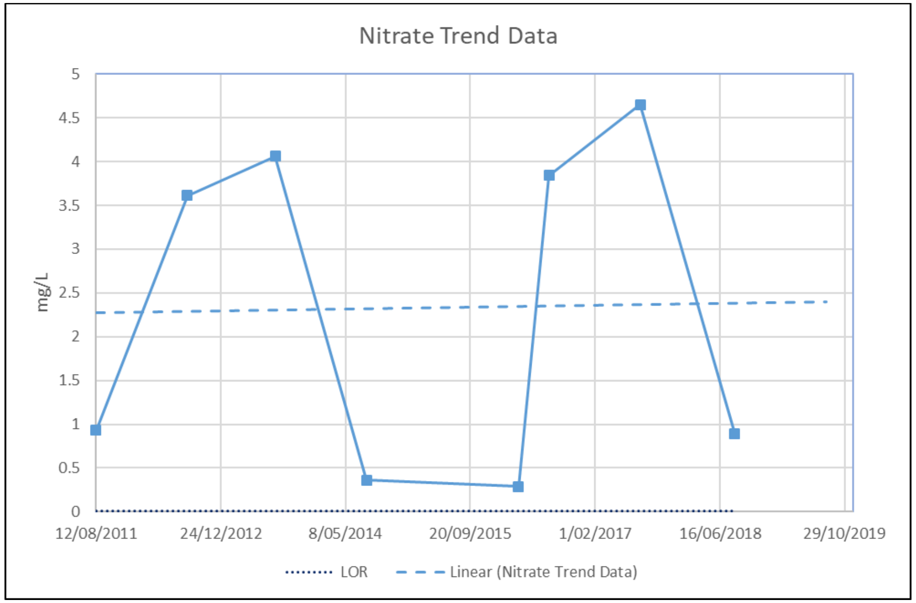

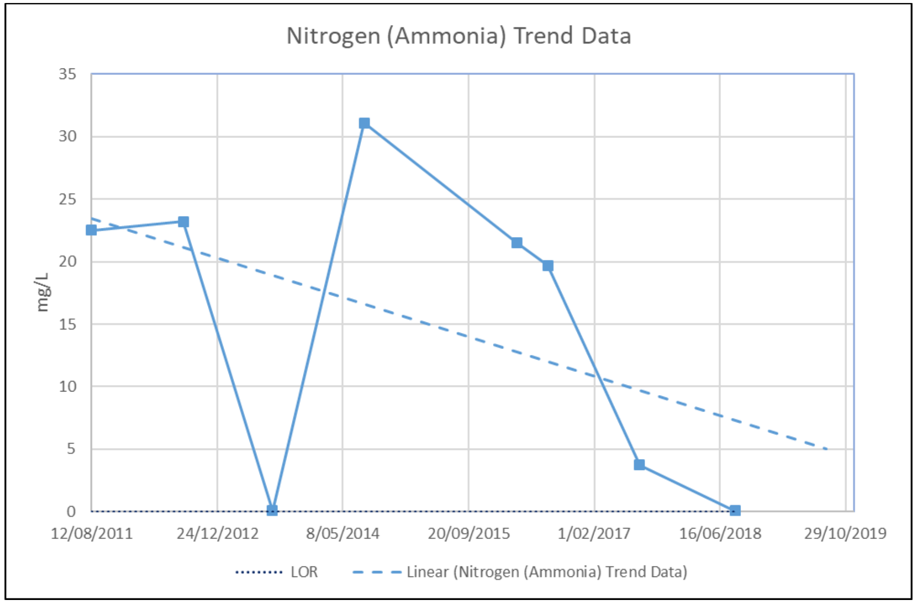

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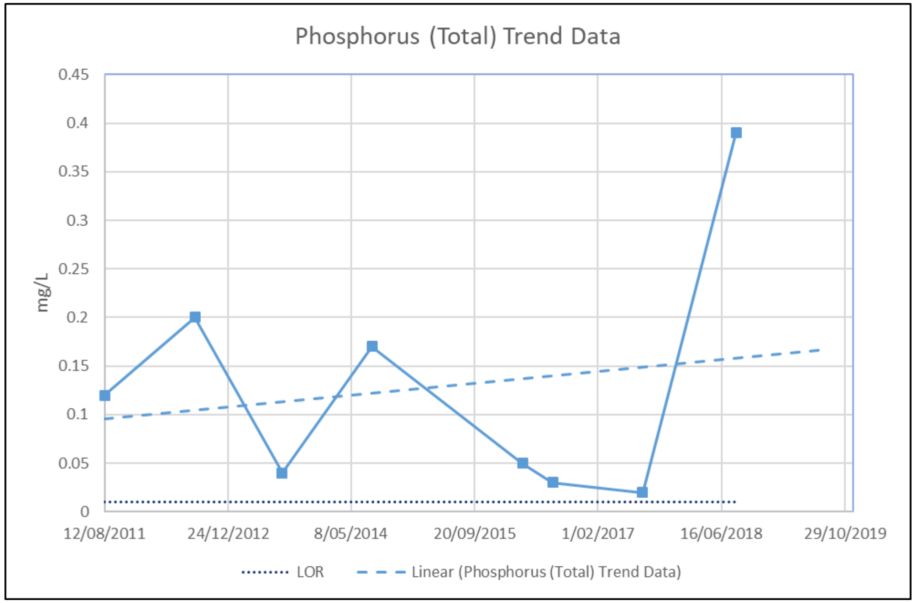
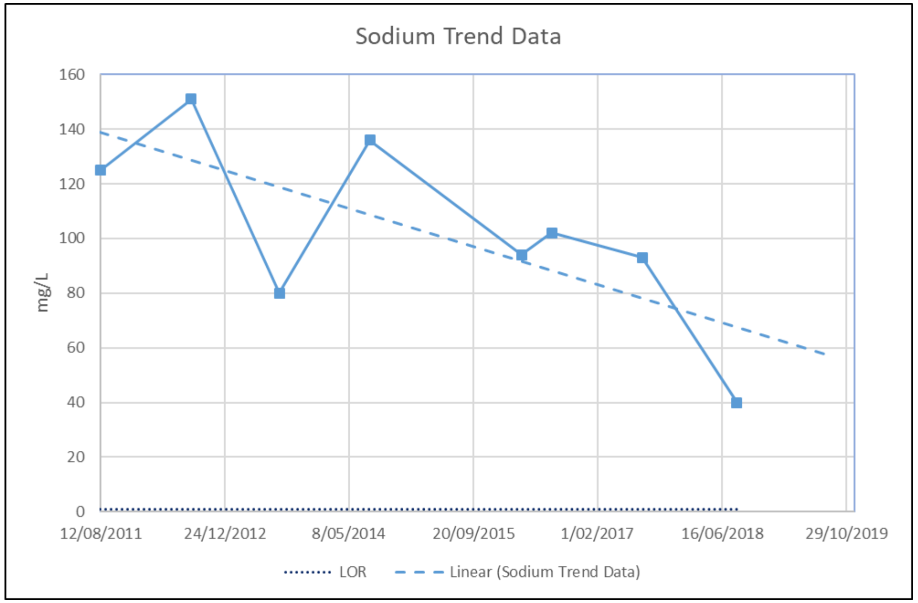
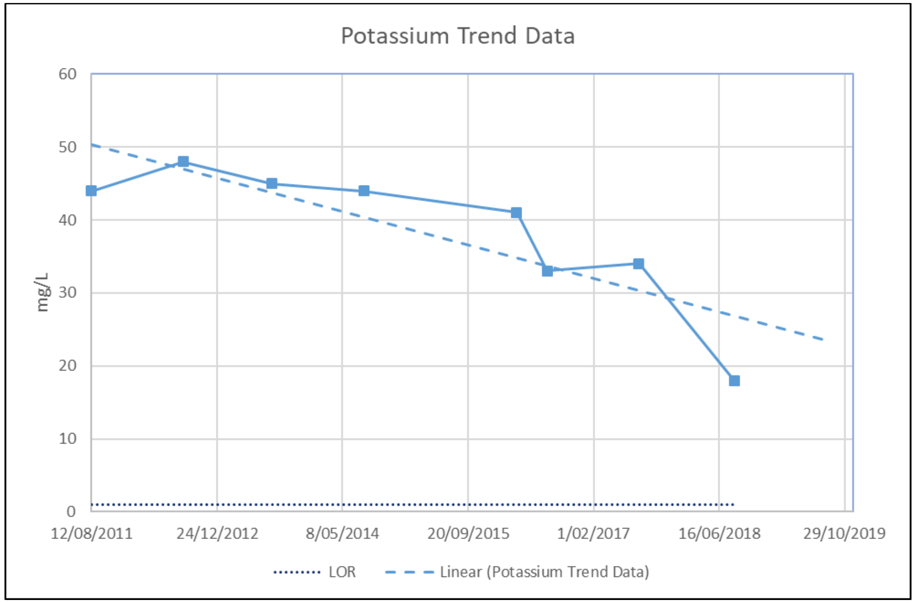
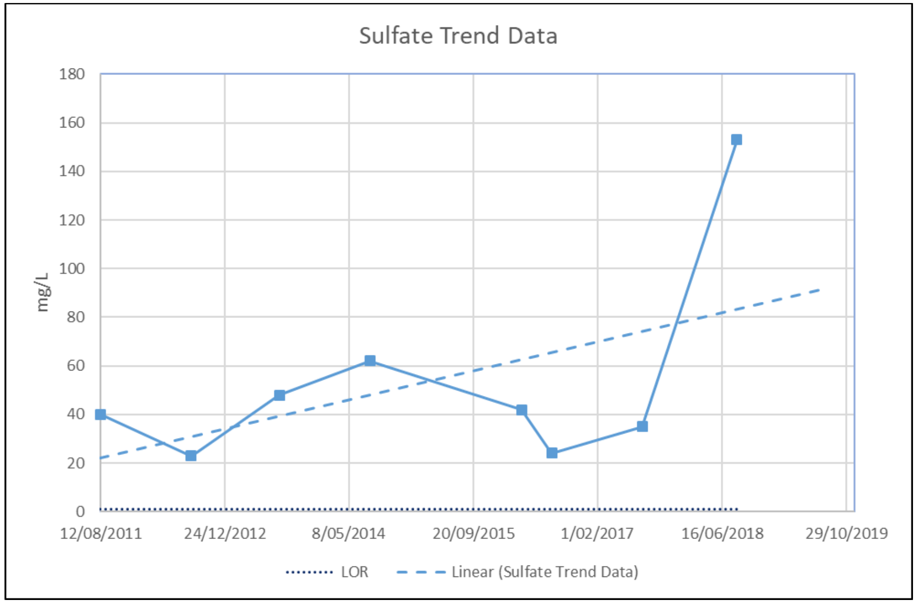
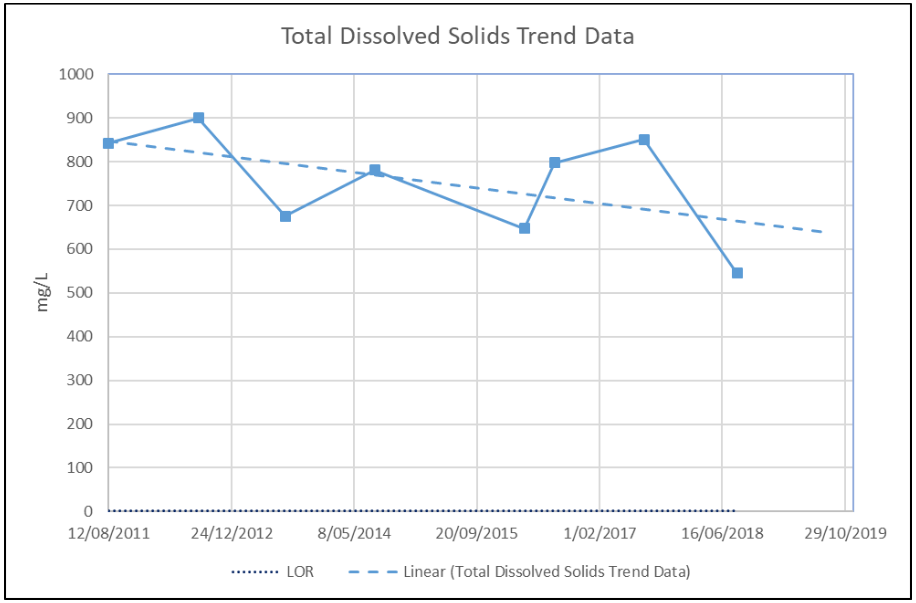


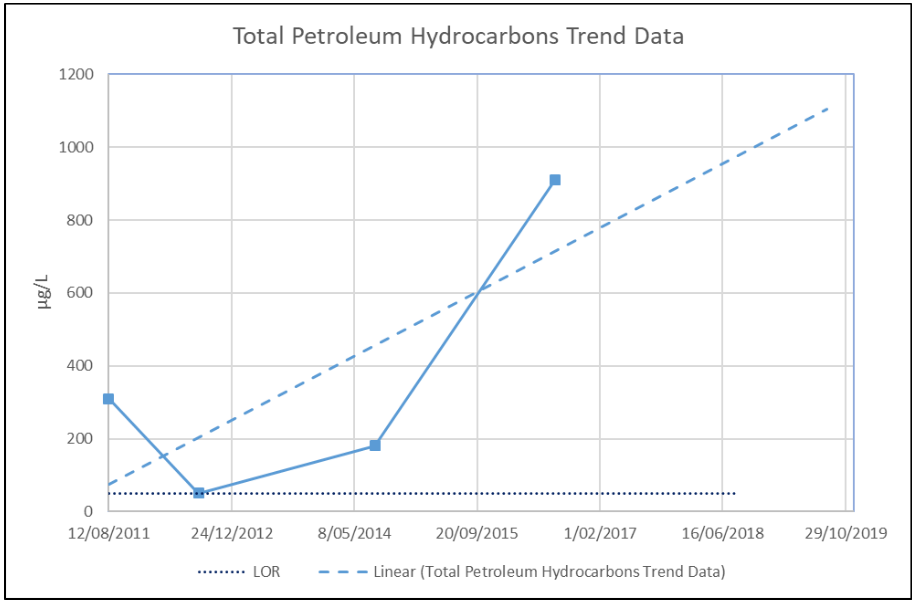


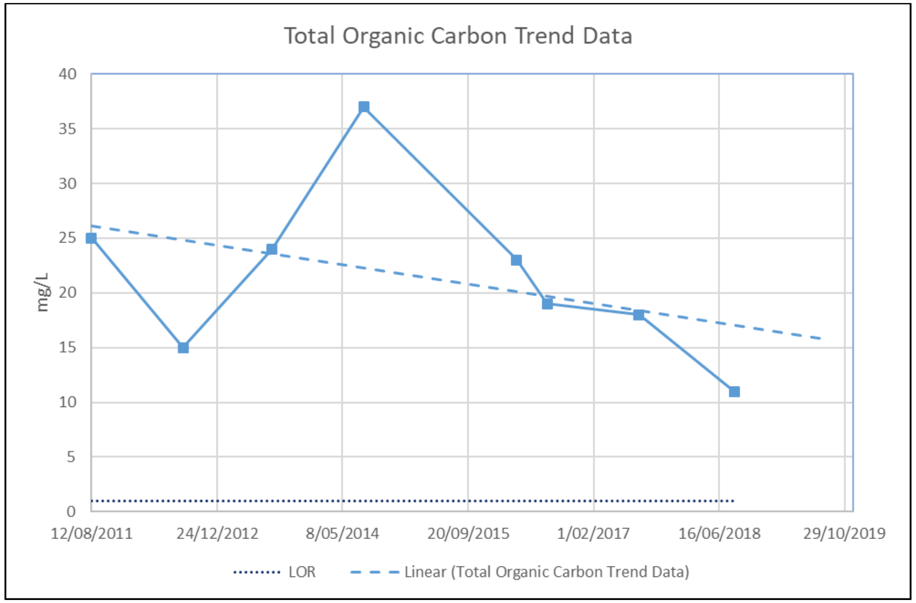


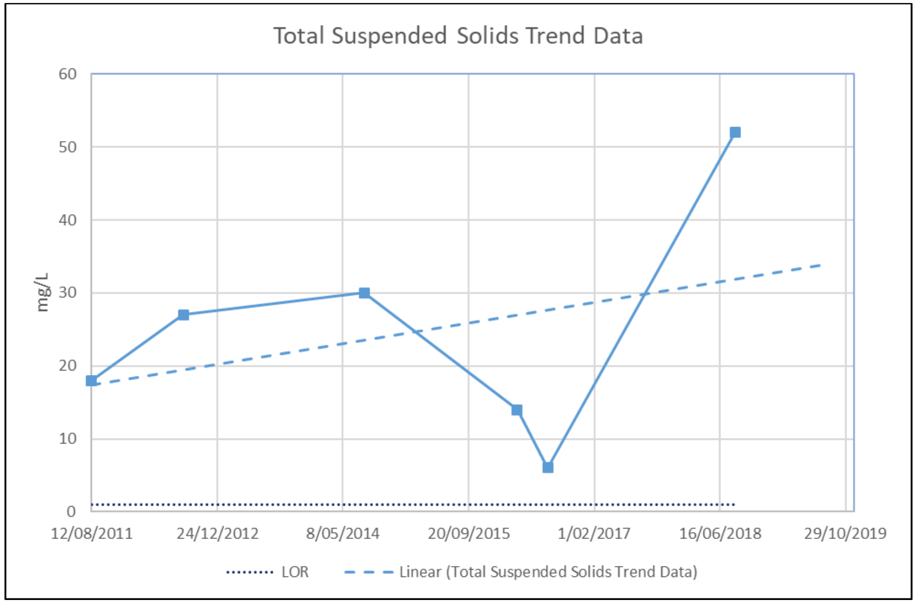


Helensburgh Leachate Monitoring Results Graphs

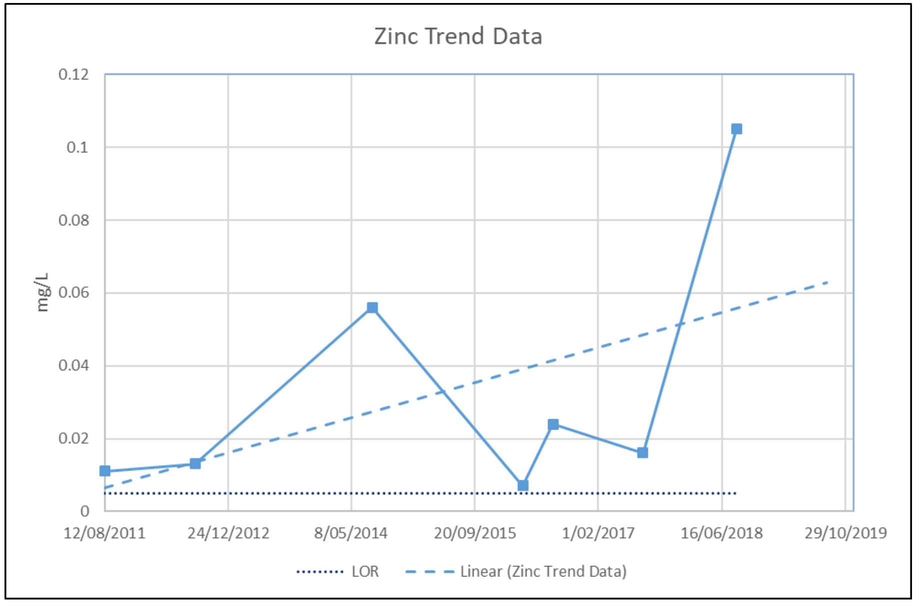


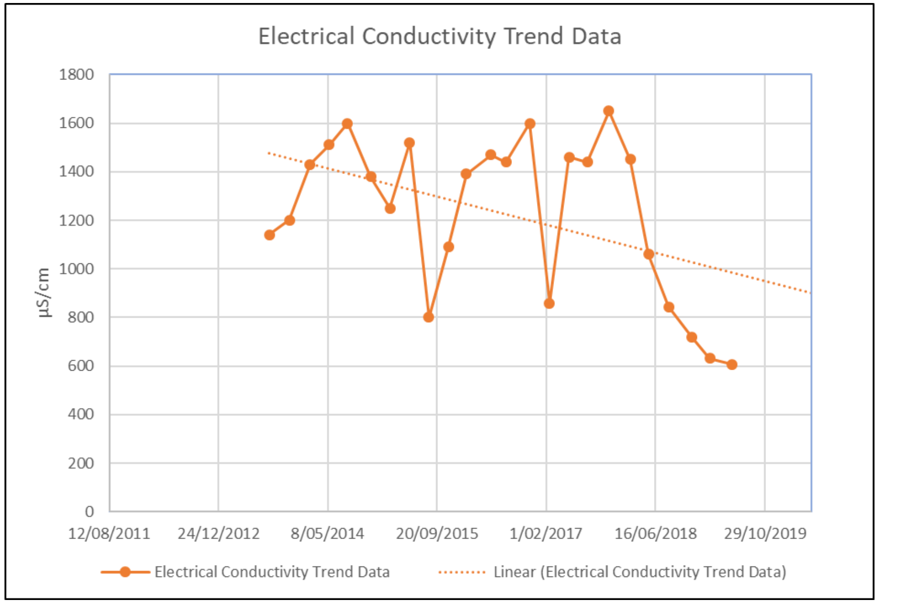


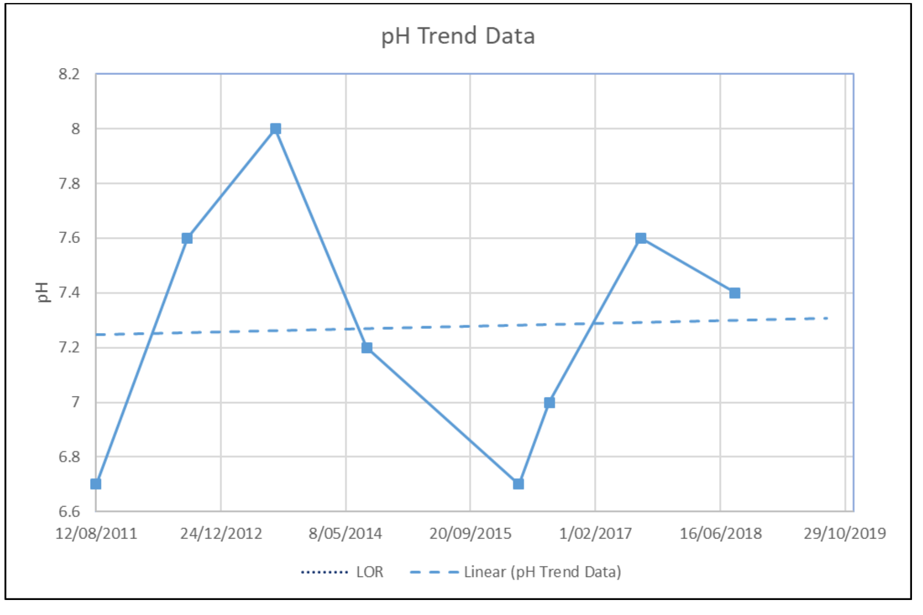




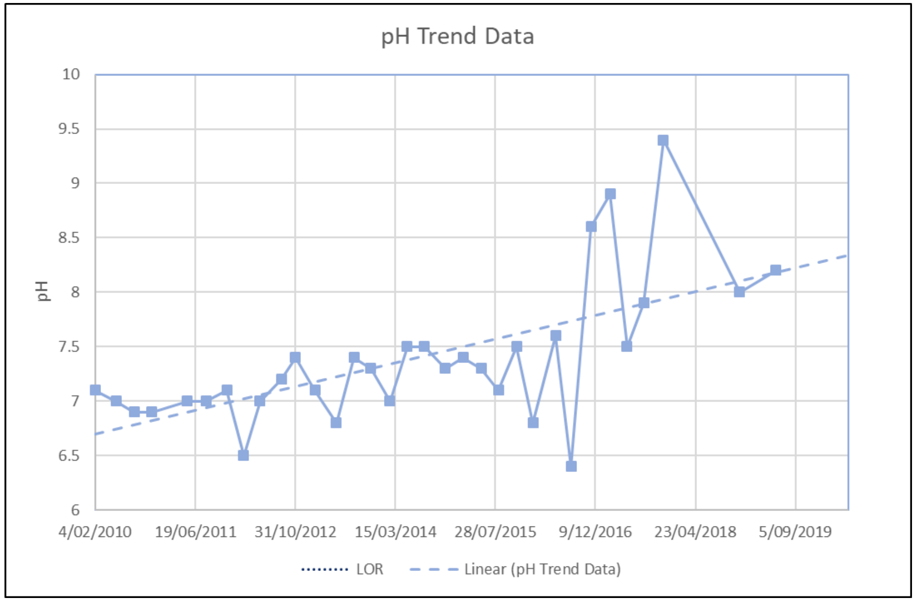
Helensburgh Leachate Monitoring Results Graphs

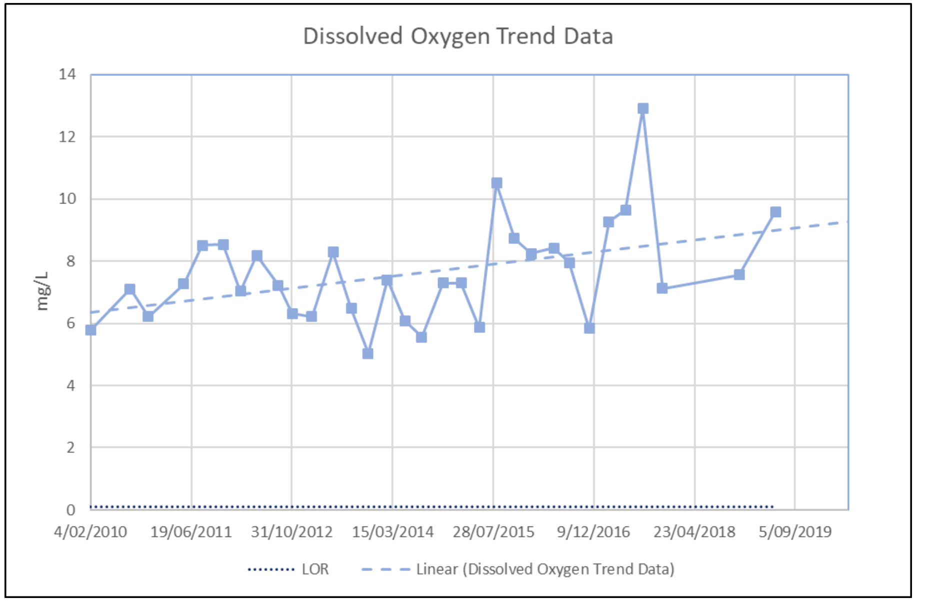


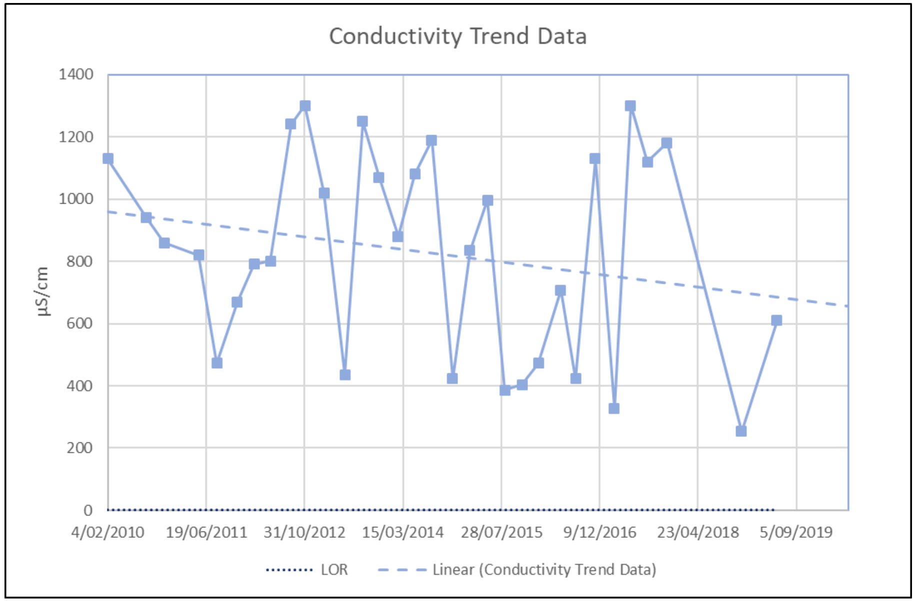


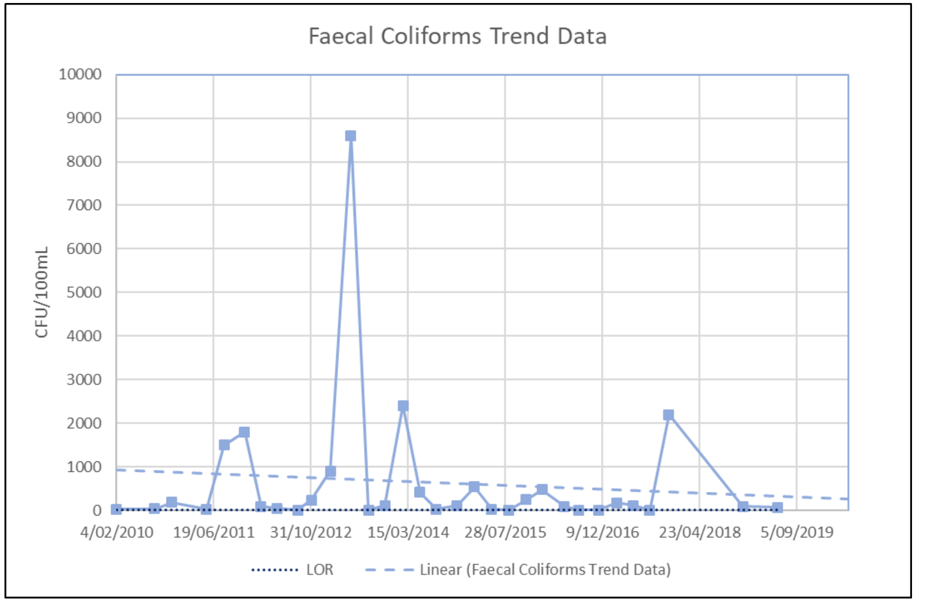


Helensburgh Surface water Monitoring Results Graphs

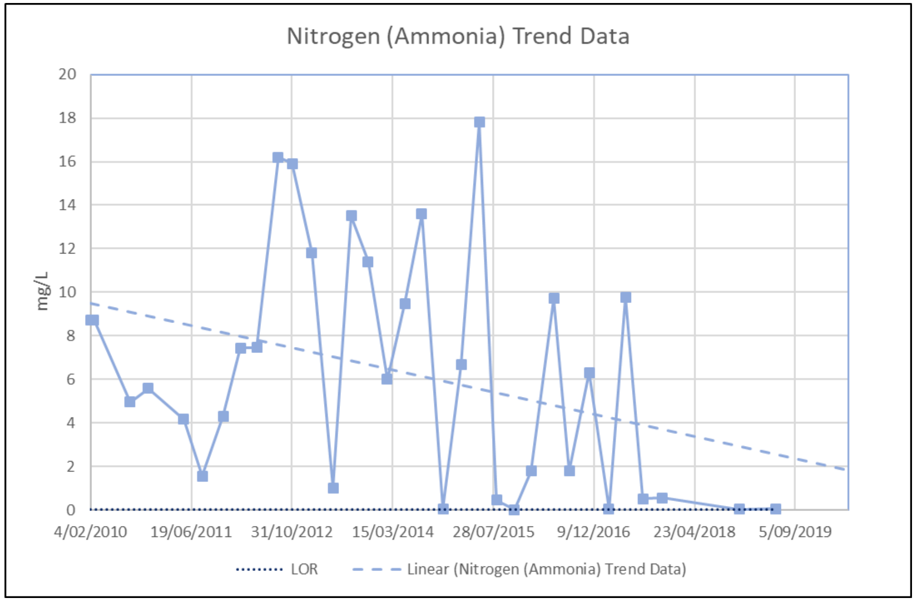


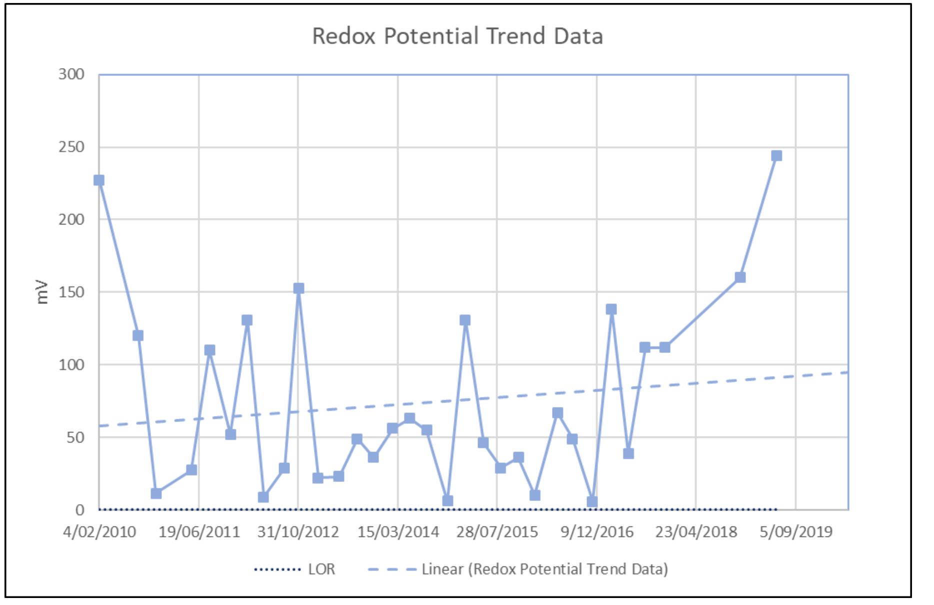


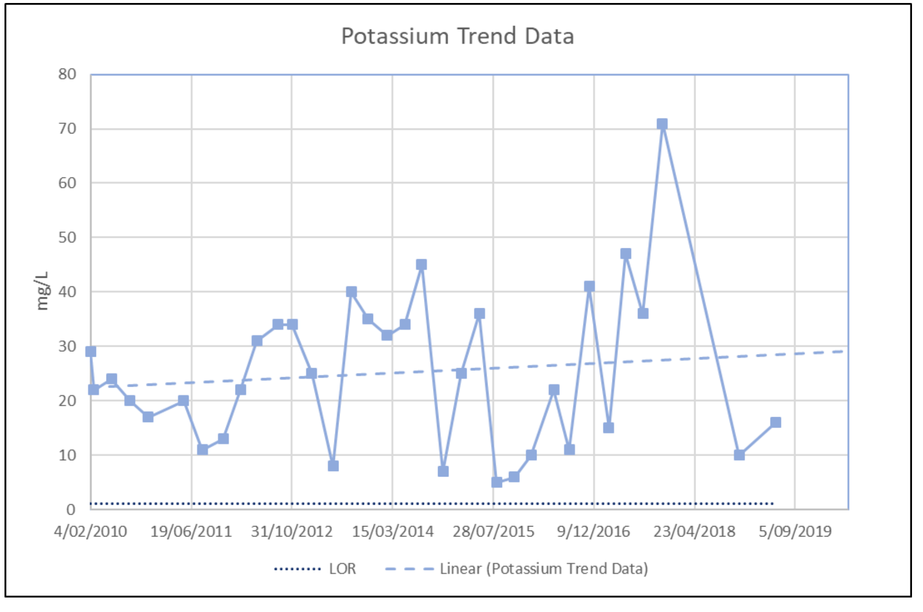


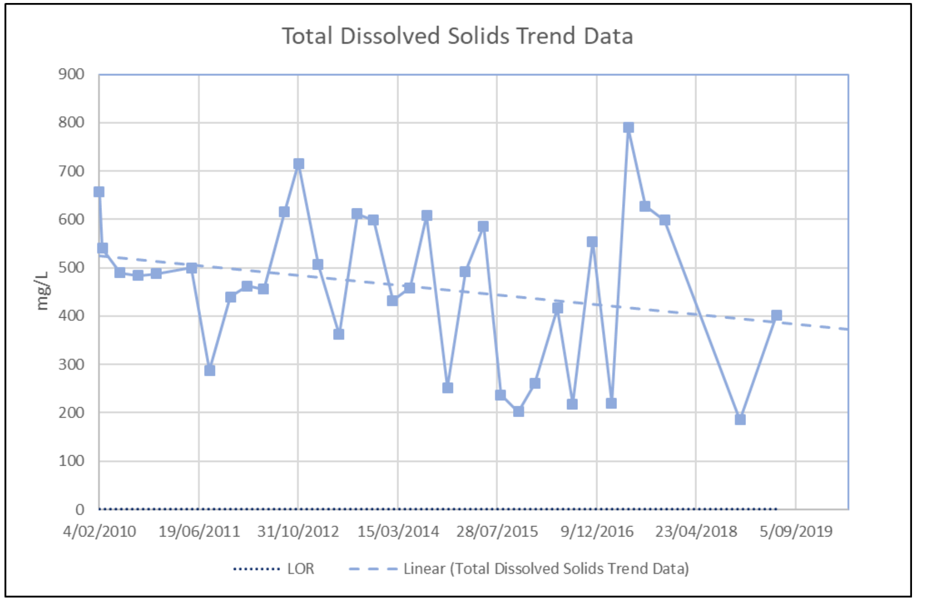


Helensburgh Surface water Monitoring Results Graphs









Helensburgh Surface water Monitoring Results Graphs