Silent Valley Waste Services Limited

Silent Valley Landfill

2018 Annual Monitoring Report

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1 Introduction

This 2018 Annual Monitoring Report presents the surface water, groundwater, landfill gas and leachate results for the monitoring undertaken in the period January to December 2018 in accordance with the Silent Valley Environmental Permit (Permit no. MP3835SV, Ref. [1]) and the Aftercare Phase Environmental and Infrastructure Monitoring Program (Ref. [4]).

A total of seven groundwater wells, seventeen surface water locations, fifteen gas monitoring wells and nine leachate monitoring wells/drain outfalls have been monitored during this period. The assessment of the monitoring results against relevant screening criteria is also presented.

The data has been collected as referenced in Schedule 3 of the Consolidated Permit (Ref. [1]).

This report makes reference to the 2017 Annual Monitoring Report (Ref. [2]) and the 2018 First, Second and Third Quarterly Monitoring Reports (Ref. [14, 15 & 16]).

2 The Site

2.1 Site Location and Description

The site is currently occupied by Silent Valley Landfill and is located at National Grid Reference SO185 071, as shown on **Figure 1**.

The landfill area is bounded by steep valley sides to the west, north and east. The Cwm Merddog Nature Reserve, which is a designated SSSI site, is located to the south. The Nant Merddog stream runs down the valley and to the south of the site. Where the landfill is present, it has been diverted into a pipeline that passes to the east of the landfill.

Access to the landfill site is via a minor road which ascends the hillside from the village of Waun Lwyd, Cwm, Ebbw Vale.

The site lies in a partially infilled valley at a level of between 300m AOD and 420m AOD. The landfilled waste rises from the southern toe in a mound with an approximate maximum elevation of 405m AOD. The southern toe line of the landfill crosses the valley with levels ranging approximately from 310m AOD to 360m AOD and gradients of between 1 in 4 and 1 in 2.

No waste has been accepted at the landfill since August 2011.

The earthworks for the capping of the Phase 1 Landfill, that was found to not have a Landfill Directive compliant capping, was completed in September 2015. The capping is preventing infiltration into the Phase 1 landfill and consequently is expected to achieve a reduction in leachate production within the landfill (refer to **Appendix A**).

2.2 Summary of cut-off and Monitoring systems

As part of the engineered mitigation measures pursuant to conditions included in the Permit for the site (Ref.[1]), a groundwater cut-off has been implemented by installing a line of pumping wells at the southern toe of the landfill to prevent the migration of any leachate-impacted groundwater downstream of landfill.

Phase 1 of this scheme was carried out in 2005 with the installation of eleven trial pumping and two monitoring wells. Phase 2 works were carried out between November 2006 and February 2007 and the pumping system was installed and commissioned in October 2007.

The system has been maintained and improved since October 2007, with the installation of an automatic water level monitoring system in 2009 and the addition of a stand-by compressor in 2010. Replacement pumps and low-draw pumps were also installed in a number of wells in early 2009.

In November 2009, new leachate monitoring wells were installed following a series of pumping tests at three locations. Between June and July 2010, further works have been undertaken to install additional monitoring and pumping wells and to replace one monitoring well.

Details of these improvement works are provided in **Appendix A**.

On-going non-compliance with regards to the non-hazardous species of ammoniacal nitrogen and chloride at one of the compliance wells, GW9, has been identified, as discussed in previous monitoring reports. Investigation works have been undertaken to address this and are presented in the issued report (Ref. [3]) and summarised in **Appendix A**. These works included a walkover of the area downstream of the site within the SSSI, with the relevant permissions of the NRW, to investigate the presence and quality of potential groundwater breakouts and streams inputting to the Nant Merddog. The walkover identified two break-outs and a monitoring regime has since been implemented at sampling locations SW1 to SW10 (refer to Section 3.3.1) with the objective to sample and analyse these waters for the presence of landfill leachate species. A full year of monitoring has been completed in January 2015 and the findings of this monitoring are presented and discussed in an updated issue version of the GW9 report, originally submitted to NRW in September 2013 and issued in May 2015 (Ref. [3]). Monitoring of the outbreak locations has now been included within the permit requirements until further review.

3 Monitoring Regime

The monitoring regime is undertaken in accordance with the Aftercare Phase Environmental and Infrastructure Monitoring Program (Ref. [4]) which has been summarised within the following sections. Refer to Figure 2 for monitoring locations.

3.1 Rainfall

Rainfall is measured at intervals of 0.5hrs daily, and measurements are used in the assessment of leachate and groundwater monitoring results.

3.2 Leachate

Monitoring of leachate for both leachate quality and leachate levels (to confirm leachate heads) is undertaken in accordance with sections S3.1 and S3.7 of the Consolidated Permit (Ref. [1]).

3.2.1 Monitoring locations and frequency of monitoring

The following locations are monitored:

- Monitoring wells LC1A, LC2A, LC4A, LC5A, for leachate quality and leachate levels:
  - LC1A is located within Cell 1 of the landfill, on the eastern flank of the valley, in an area where the final level was completed by 1996;
  - LC2A is located in Cell 2, on the northern flank of the landfill. This well is near to the base of the old valley bottom. Leachate in this area may be slightly diluted by groundwater ingress but this is not considered as significant as that present at the landfill toe. The waste in this area was placed around the year 2000;
  - LC4A is located in Cell 4, on the north-western flank of the landfill, in refuse waste placed around 2002. Similarly, to LC1A, this well is located away from the valley 'drain';
  - LC5A is located in Cell 5, on the western flank of the landfill. Waste in this area was last placed in August 2011;
- Monitoring wells L1A and L1B, for leachate quality and L1A, L1B and L1 for leachate levels (leachate levels from these wells are no longer considered in the assessment of leachate head – see Section 3.2.2 below);
- Leachate drain outfalls LP3A and LP4 feeding into a concrete holding leachate lagoon at the toe of the landfill, for leachate quality only. LP4 directly outfalls into the lagoon including the leachate pumped directly from Cell 5. LP3A monitors the combined leachate from several pipes/drains, which is collected in a sump and then pumped to the lagoon from where it is discharged to the foul sewer. The following flows are monitored from LP3A:
    - LP1: BSC outfall pipe at the toe of the landfill;

- LP2: Armco outfall pipe at the toe of the landfill;
- LP2A: combined outfall from LP2 and other groundwater (weep hole) inputs from LP3, LP5, LP6 and LP7.

LP1 and LP2A are also monitored individually in addition to the monitoring locations agreed in the Permit (Ref. [1]). The results from these are discussed as part of the results obtained from LP3A.

The locations of the monitoring wells and leachate lagoons are presented on **Figure 2**.

Monitoring for leachate quality is undertaken quarterly in LC1A, LC2A, LC4A, LC5A, L1A, L1B, LP3A and LP4 for the determinand suite included in Table 6 and Table 7 of the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]), as required by the Permit (Ref. [1]). A hazardous substance suite is to be carried out every four years in LC1A, LC2A, LC4A, LC5A, L1A, L1B, LP3A and LP4 if there is an increase in contamination, as per the Permit (Ref. [1]).

Monitoring for leachate levels at LC1A, LC2A, LC4A, LC5A, L1A, L1B and L1 are undertaken **quarterly** with levels from L1A, L1B and L1 not used in the leachate head assessment. L1 is consistently recorded dry.

3.2.2 Compliance criteria

Assessment limits have been set for leachate head and composition as agreed in the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]) and in the Hydrogeological Risk Assessment (Ref. [5]). These are summarised in Tables 3.1 and 3.2 below.

3.2.2.1 Leachate head

As noted in Table 3.1, it is required that the monthly average leachate head level above the base of the landfill in LC1A, LC2A, LC4A and LC5A is less than 3m. The average leachate head compliance value was derived from the Hydrogeological Risk Assessment (Ref. [5]) undertaken in 2004, when limited leachate monitoring results were available and it was necessary to assume a probability density function for modelling the leachate head. The 3m head is considered the maximum head at which the landfill would be acting as if a liner had been placed at the bottom of the landfill in the 1980s.

Table 3.1: Leachate Assessment Limits

Measurement	Assessment limit	Assessment Test
Leachate Head/Level	Maximum head assumed in risk assessment (3m)	Mean leachate head measured in wells as set out in the Permit, exceeds assessment limit on three consecutive surveys.
Leachate Composition	Maximum concentration assumed in risk assessment	Mean concentration from wells in waste mass exceeds assessment limit on three consecutive surveys.

3.2.2.2 Leachate quality

Assessment limits for the contaminants for leachate quality, listed in Table 3.2, have also been set out in the Hydrogeological Risk Assessment (Ref. [5]), based on data from leachate wells L1, L1A and L1B.

Leachate quality is assessed from leachate wells L1A, L1B, LC1A, LC2A, LC4A and LC5A. Assessment of leachate quality is also undertaken in LP3A and LP4 but the results are not included in the assessment. For monitoring leachate quality, a reduced suite of contaminants is tested for on a quarterly basis as per the permit [1]. The revised suite of contaminants tested are present below:

- Manganese (mg/l)
- Mercury (mg/l)
- Nickel (mg/l)
- Zinc (mg/l)
- pH (pH units)
- Conductivity (uS/cm)
- Alkalinity as $CaCO_3$ (mg/l)
- Ammoniacal Nitrogen (mg/l)
- Chloride (mg/l)
- Sulphate (mg/l)
- Redox Potential (mV)
- Total Organic Carbon (TOC) (mg/l)
- Dissolved Oxygen (DO) (mg/l)
- Suspended Solids (mg/l)
- Dissolved Solids (mg/l)

The assessment limits are compared with the calculated mean contaminant concentrations from the monitoring wells in waste the mass. If the mean concentrations from wells in the waste mass exceed the assessment levels on three consecutive surveys, contingency actions will be triggered, as described in the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]) and summarised in Table 3.3.

Table 3.2 Leachate Acceptable Maximum Concentrations AMCs (from Ref. [8])

Contaminant	Acceptable Maximum Concentration AMCs (mg/l)
NH_3	526
Chloride	1408
Sulphate	999
Nickel	0.0681
Zinc	1.38/
Mercury	0.56 µg/l

Table 3.3: Leachate Monitoring Contingency Actions (from Ref. [8])

Contingency Action	Response Time
Report to NRW including initial assessment of possible causes	1 month
Report to NRW on re-appraisal of risk to groundwater and surface water and options for corrective measures	3 months
If risks are acceptable revise assessment criteria as appropriate. Continue monitoring. If risks are not acceptable implement agreed corrective actions (i.e. increase monitoring and frequency as agreed with the NRW)	6 months

3.3 Surface Water

Surface water sampling of the Nant Merddog is undertaken in accordance with the sampling protocols defined in the Aftercare Phase Environmental and Infrastructure Monitoring Program Report (Ref. [4]).

3.3.1 Monitoring locations and frequency of monitoring

Monitoring of surface water quality is currently being undertaken at the locations listed in Table 3.4 in order to identify any adverse impact resulting from escape of leachate from the landfill, particularly in relation to the Nant Merddog.

Monitoring point locations are marked on **Figure 2** and **Figure 3**.

Table 3.4: Surface Water Monitoring Locations

Monitoring Point		Location
Upstream locations	SWU	On the Nant Merddog, north (upstream) of landfill
	SW2AI	On drainage ditch system on northern perimeter of landfill. The ditch intercepts surface water run-off from the area north of the landfill and discharges to the Nant Merddog
	SWW4	On drainage ditch system north of the landfill, at point where the northern perimeter ditch system joins the eastern perimeter ditch system
	SWW1	On ditch system north-west of the landfill
	SWW2	On ditch system north-west of the landfill
Downstream locations	SWD	On the Nant Merddog, approximately 70m downstream of the landfill (15m downstream of the point where the diverted stream joins its original course).
	SWD1	On the Nant Merddog, approximately 300m downstream of SWD
	SW1, SW2, SW3, SW9 and SW10	A stream, feeding into the Nant Merddog some 190m downstream of SWD issuing on the eastern slope of the valley
	SW4, SW5, SW6	A potential groundwater out-break, feeding into the Nant Merddog some 155m downstream of SWD issuing on the eastern slope of the valley
	SW7	Nant Merddog immediately downstream of the above confluence
	SW8	Nant Merddog immediately downstream of the above stream confluence

Surface water sampling locations SW1 to SW10 have been set up and monitored since December 2013 following the recommendations made in the Arup 2011 report on investigations into the western flank of the cut-off system (Ref. [6]) and a walkover through the SSSI south of the landfill in November 2013. The monitoring regime was implemented in order to confirm the presence of landfill leachate species in these groundwater breakouts and the impact to the Nant Merddog.

The regime for surface water monitoring is in accordance to the requirements of the Permit (Ref. [1]), as follows:

- **quarterly** monitoring for locations SWD and SWD1;
- **six-monthly** monitoring for locations SWU, SWW1, SWW2, SW2AI, SWW4;
- **monthly** monitoring of the surface water monitoring locations SW1 to SW10.

3.3.2 Compliance criteria

The compliance criteria for surface water quality are the Environmental Quality Standards (EQS) which are appropriate for the Nant Merddog for all contaminants for which these are available, as defined in Table 13 of the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]).

The following suite of contaminants are tested for on a monthly basis for SW1 to SW10, as per the permit [1].

- Ammoniacal Nitrogen (mg/l)
- Chloride (mg/l)
- Mercury (mg/l)

The following suite of contaminants are tested for on a quarterly basis for SWD and SWD1 and six-monthly basis for SWU, SWW1, SWW2, SW2AI and SWW4, as per the permit [1], with the addition of calcium which is required for determining the bioavailable metal concentration, as described below.

- Manganese (mg/l)
- Mercury (mg/l)
- Nickel (mg/l)
- Zinc (mg/l)
- pH (pH units)
- Conductivity (uS/cm)
- Alkalinity as $CaCO_3$ (mg/l)
- Calcium (mg/l)
- Ammoniacal Nitrogen (mg/l)
- Chloride (mg/l)
- Sulphate (mg/l)
- Redox Potential (mV)
- Total Organic Carbon, filtered (TOC) (mg/l)
- Dissolved Oxygen (DO) (mg/l)
- Suspended Solids (mg/l)

Previously, site specific EQS values for freshwater had been derived, for nickel, manganese and zinc, based on the annual average concentration of water hardness in the Nant Merddog, downstream of the landfill. The Water Framework Directive [Ref12] has subsequently been updated with a number of the EQS compliance criteria no longer relying on hardness values. Instead, for a number of heavy metal species the EQSs are now based on the bioavailable concentrations which are derived from the recorded dissolved concentrations.

The bioavailability of a metal depends on a number of physico-chemical factors which govern both metal behaviour and the interactions of the toxic forms of the metals with a biological receptor. The Water Framework Directive – United Kingdom Technical Advisory Group (WFD-UKTAG) have developed a model known as the “Metal Bioavailability Assessment Tool (M-BAT) [Ref 13] which predicts the bioavailable concentration from dissolved concentrations.

To calculate the bioavailable concentration of the specific metals, calcium (Ca) and dissolved organic carbon (DOC) levels need to be obtained and input into the M-BAT tool along with pH and the recorded dissolved metal concentrations.

All compliance criteria values, including the updated heavy metals, are set out in **Table 3.5**.

Table 3.5: Compliance Criteria for the Nant Merddog

Contaminant	EQS (µg/l)	Notes
Ammoniacal Nitrogen (unionised)	15	EQS
Sulphate	400 mg/l	EQS
Chloride	250 mg/l	EQS
Nickel (Dissolved)	4	EQS
Zinc (Total)	13.7*	EQS
Mercury (Total)	1	EQS
Manganese	123	EQS

Notes:

* This level is based on the standard EQS value 10.9ug/l plus the Ambient Background Concentration (AMC) of the River Taff of 2.8ug/l [Ref. (12)].

3.3.3 Contingency Actions

As discussed in the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]), background water quality monitoring upstream of the landfill indicates that concentrations of some determinands may exceed the compliance criteria in some cases. The assessment of breaches of compliance criteria therefore includes an assessment of background levels. Such breaches may be acceptable in cases where they result from background levels. No Assessment Levels are set, but assessment is made by monitoring the data for trends of increasing contaminant concentrations.

If a significant trend of increasing contaminant concentration is identified, then the following contingency actions and timescales should be followed.

Table 3.6: Surface Water Monitoring Contingency Actions (from Ref. [8])

Contingency Action	Response Time
Advise NRW with initial assessment of possible causes e.g. unusual activities, leachate discharges etc.	1 month
Report to NRW on re-appraisal of risk to the Nant Merddog and report on monitoring since the increasing trend was identified.	3 months
If risks are acceptable continued monitoring and assessment will be undertaken with three monthly reporting and risk re-appraisal concerning the contaminants of concern until such time as no continued potentially unacceptable risk is considered to exist.	6 months

Contingency Action	Response Time
If risks are unacceptable agreed corrective measures will be implemented (i.e. increase monitoring location points and increase frequency as agreed with the NRW)	

If there is a particular incident that may result in surface water pollution additional monitoring will be agreed with the NRW.

3.4 Groundwater

Monitoring of groundwater is undertaken in accordance with Table S3.9 of the Permit (Ref. [1]), the Environment Agency guidance on groundwater monitoring (Ref. [7]) and in line with the monitoring schedule agreed with the NRW, as discussed in the 2010 Annual Monitoring Report (Ref. [8]).

3.4.1 Monitoring locations and frequency of monitoring

The following locations are currently monitored on a quarterly basis:

- Monitoring wells GW3A and GW4, located upstream of the landfill (referred to as ‘upstream wells’);
- Monitoring wells GW6, GW7, GW9, GW10, and GW12, located downstream of the landfill (referred to as ‘downstream wells’ or ‘compliance wells’);

GW11A can no longer be monitored as the location was covered during the construction of the Waste Transfer Station. It is proposed to replace this well in the near future. The locations of the monitoring wells are presented on Figure 2.

For details of previous monitoring undertaken at the site, refer to **Appendix B**.

3.4.2 Compliance criteria

Control and Trigger Levels have been developed for those contaminants addressed in the Hydrogeological Risk Assessment (Ref. [5]) as shown in **Table 3.6**. These contaminants cover a range of substances indicative of landfill leachate contamination which are potentially harmful to downstream groundwater and to the aquatic environment of the Nant Merddog.

The Control Levels allow the identification of any unexpected or adverse trends in the monitoring data and should be treated as an early warning system to enable investigative or corrective measures to be implemented, particularly where Trigger Levels might be breached.

Trigger Levels are specific compliance levels, or regulatory standards. They are defined as criteria at which significant adverse environmental effects and/or breaches of legislation have occurred. Such effects would be consistent with the groundwater having been polluted.

As discussed in the Hydrogeological Risk Assessment Supplementary Revision (Ref. [9]), during routine reviews of the groundwater monitoring results, it was noted that for certain contaminants (e.g. mercury, zinc and manganese), background concentrations measured upstream of the landfill in groundwater and surface water exceeded the applied Control and Trigger Levels (or in the case of manganese, the corresponding EQS), particularly following high rainfall events. As a result, a review of the background levels and their likely origin was undertaken and revised Control and Trigger Levels (or in the case of manganese, assessment level) were proposed and agreed with the Environment Agency, as presented in Table 3.7. The HRA for the site is currently being reviewed and revised in the context of a review of the background levels monitored since the HRA was undertaken.

Table 3.7: Groundwater Control and Trigger Levels (and Assessment Level for manganese)

Determinand	Control Levels (mg/l)		Trigger Level (mg/l)
	A	B	
Ammoniacal Nitrogen	0.8*	0.9*	1.0*
Chloride	210*	230*	250*
Mercury	0.0001**	0.00015**	0.0002**
Nickel	0.03*	0.04*	0.05*
Sulphate	300*	350*	400*
Zinc	0.02**	0.035**	0.05**
Manganese	-	-	1.0**

Notes:

* From Hydrogeological Risk Assessment (Ref. [8]).

** From Hydrogeological Risk Assessment Supplementary Revision (Ref. [9]) and Groundwater Monitoring: Trigger Levels report (Ref. [10]).

3.4.3 Contingency Actions

If the Control or Trigger levels are exceeded on three consecutive monitoring rounds, contingency actions will be triggered, as described in the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]) and summarised in Table 3.8.

Table 3.8: Groundwater Monitoring Contingency Actions (from Ref. [8])

Contingency Action	Response Time
Advise NRW with initial assessment of possible causes e.g. unusual activities.	1 month
Report to NRW on re-appraisal of risks to the Nant Merddog based on risk assessment review and Nant Merddog monitoring and further groundwater monitoring subsequent to breach.	3 months
If risks are acceptable the assessment criteria may be re-evaluated. If monitoring shows concentrations to have fallen back to below the control/trigger levels no further action may be necessary.	6 months
If risks are unacceptable agreed corrective measures will be implemented. The corrective measures if required and appropriate may include additional monitoring (frequency and location).	

If there is a particular incident that may result in groundwater pollution additional monitoring will be agreed with the NRW.

3.5 Landfill Gas

Landfill gas monitoring is carried out in accordance with the requirements of the Permit (Ref. [1]).

3.5.1 Monitoring locations and frequency of monitoring

The following locations are monitored for landfill gas (methane and carbon dioxide):

- GWM1 to GMW10;
- GMW12 to GMW14;
- GMW17 and GMW18.

These wells are located around the site perimeter, as shown on **Figure 2**.

The original well GMW1 was damaged at some point in the past and was replaced with GAS01 in February 2007. For ease of reference, this well is now referred to as GMW1.

3.5.2 Compliance criteria

Control and Trigger Levels for landfill gas have been established by Golder Associates (Ref. [10]).

For each monitored well, up to three monitoring points (valves) have been installed at different depths. Trigger and Control Levels have therefore been set for each monitoring point, where appropriate.

Currently, no Control and Trigger Levels are set for GMW1, GMW8, GMW9, GMW10, GMW17 and GMW18. Boreholes GMW8, 9 and 10 are located within 20m of the waste mass, in conflict with the Environment Agency's guidance on landfill gas management (Ref. [11]), which recommends perimeter wells be located at a distance greater than 20m from the boundary of the waste. To overcome this, additional wells (GWM12, 13, 14, 17 and 18) were installed at a greater distance from the landfill boundary, and Trigger Levels derived for GWM12, GWM13 and GMW14. Monitoring at GMW1, GMW17 and GMW18 is now required by the Permit (Ref. [1]), however there are still no Control and Trigger Levels for these locations.

As stated by Golder Associates (Ref. [10]), single exceedances need no immediate action. However, ongoing exceedances require informing the relevant people and organisation and appropriate measures of identification and solutions identified.

4 Monitoring Results

4.1 Rainfall

Measured rainfall data is illustrated in **Appendix C**, **Figures C1** to **C3**.

Figure C1 shows daily rainfall totals for the period January 2013 to September 2018 and highlights the dates when samples have been taken for analysis from the downstream compliance wells GW6, GW7, GW9, GW10, and GW12.

Figure C2 shows monthly rainfall totals for the same period in 2018, with monthly leachate head average data for 2016 and 2017 for comparison, as further discussed in Section 4.2.2.

Figure C3 shows monthly rainfall from July 2010 to September 2018.

4.1.1 Fourth Quarter Summary

December recorded the highest monthly rainfall of the quarter with 124.7mm, and the highest daily rainfall total was in October with 42.2mm. October recorded the lowest monthly rainfall with 81.6mm. The values recorded this quarter are generally typical for this time of year and similar rainfall was recorded in previous years (refer to previous monitoring reports).

4.1.2 Annual Summary

The combined total for the year of 2018 is 924.2mm, which is below the long-term average for the region of 1260mm (Ref [9]) and the lowest annual recorded rainfall since 2011.

March recorded the highest month of rainfall during 2018 with a level of 130.1mm recorded, previous data shows March as a relatively wet month. January, November and December also recorded rainfall levels over 100mm with the remaining months all recording levels below 100mm. The lowest rainfall was recorded in June with a level of 4.1mm, this is the lowest value recorded since rainfall monitoring began in 2008.

The middle two quarters of 2018 were drier than 2017 with the other two quarters recording higher rainfall levels. During 2018 there has not been a large storm event which can happen mid-winter when higher rainfall is usually recorded, therefore 2018 has recorded quite a dry year.

4.2 Leachate

4.2.1 Leachate Quality Monitoring

Leachate quality monitoring results from within the waste body and from leachate standpipes are presented in **Appendix D**, **Table D1** and include contaminant concentration averages and Acceptable Maximum Concentrations (AMCs) for mercury, nickel, zinc, ammoniacal nitrogen, chloride and sulphate. For the respective AMCs refer to **Table 3.2**.

In accordance with the Permit requirements, the leachate quality monitoring has been undertaken quarterly since March 2015. Leachate well LC1A continues to be unsampled due to lack of leachate present. Samples were obtained from L1A, L1B, LC2A, LC4A and LC5A.

<u>Fourth quarter summary</u>

With the exception of ammoniacal nitrogen and nickel, the average values for the monitored contaminants from the fourth quarter were below the AMC values. The highest recorded result for ammoniacal nitrogen was recorded in well LC5A with a value of 2110mg/l, above last quarter's value of 2010mg/l and the second highest recorded during the year. This has resulted in the average value of ammoniacal nitrogen being 804.48mg/l which is above the AMC of 526mg/l and the highest recorded since April 2017. The highest recorded result for nickel was also recorded in well LC5A with a value of 0.296mg/l, above last quarter's value of 0.163mg/l and the highest recorded in 2018. The average value of nickel was recorded as 0.089mg/l which is above the AMC of 0.0681mg/l and the highest since monitoring began.

<u>Annual summary</u>

The average values for the monitored contaminants have been recorded below their respective AMC's throughout 2018 with the exception of ammoniacal nitrogen and nickel. The average value of ammoniacal nitrogen had been steadily increasing throughout 2016 and 2017, hitting a high of 854mg/l in April 2017 proceeding to a low of 593.36mg/l in October 2017. However, the levels have continued increased throughout 2018 with October recording the highest with an AMC of 804.48mg/l.

Ammoniacal nitrogen levels continue to be recorded below level of detection in the downstream compliance wells, and the level recorded inG are showing a decreasing trend, although remain above the screening criteria.

The continuing high levels of ammoniacal nitrogen recorded will be reviewed within the current Hydrogeological Risk Assessment and reviewed in the context of the proposed investigations into LC5A.

For the respective AMCs refer to **Table 3.2**.

It should be noted that mercury has been consistently recorded below the laboratory analytical detection limit of 0.01µg/l in all the analysed samples and has been a continuing trend since 2013. Consequently, the monitored concentrations of mercury have not only been below the Acceptable Maximum Concentration (refer to **Table 3.2**), but also below the Trigger Level set for the groundwater compliance wells (see **Table 3.6**).

4.2.2 Leachate Level Monitoring

Field monitoring readings report the depths to leachate from the top of each well casing. The leachate head for each well is calculated as follows:

The leachate level (mAOD) is calculated by subtracting the depth to leachate (m) from the well head elevation (mAOD). The leachate level (mAOD) is then subtracted from the base of landfill level (mAOD).

The well height and ground level elevations were re-surveyed in 2015 in accordance with the requirements of the permit [Ref.1]. Leachate levels monitoring results are presented in **Appendix D**, **Table D2.**

The quarterly average leachate head was calculated for October with an average leachate head level of 2.84m recorded, within the 3m limit stipulated in the Permit (Ref. [1]).

The quarterly leachate head averages have been increasing since 2013 and even during dry periods the leachate head has continued to remain higher than pre-2013. Figure C2, Appendix C, shows the monthly rainfall plotted against the leachate head averages. Since the Cell 5 capping was completed in November 2011 and later the Phase 1- completed in September 2015, the leachate head levels within LC5A have not decreased as would have been expected but have actually increased, specifically since July 2016. This quarter's leachate head levels have recorded a slight increase from last quarter's but still remains below the 3m limit.

As discussed in the Annual Monitoring report for 2017 (Ref. [2]), the quarterly leachate head has showed a continuous rising trend since 2013. However, the average leachate head per year has decreased this year, the first time since it started increasing year on year since 2013, as detailed in Table 4.1 below.

Table 4.1: Annual Average Leachate Head

Year	Average Leachate Head	Maximum Leachate Head
2013	1.01m	2.45m
2014	1.14m	3.95m
2015	1.81m	4.96m
2016	2.54m	4.83m
2017	2.70m	5.09m
2018	2.58m	5.36m

Within the fourth quarter of 2018 the maximum leachate head was recorded at 5.36m in LC5A, which is a 0.56m increase from the previous quarter and the highest recorded during 2018. The average leachate head has been recorded as 2.84m which has risen slightly from last quarter which recorded 2.66m and is following an increasing trend through 2018. This increase in leachate head in LC5A has occurred following an extended dry spell of weather which had seen a decrease in the groundwater levels within all the compliance wells during the summer months.

All the average leachate head values recorded are still below the 3m limit as per the Permit (Ref[1]). The graph in Figure C2 shows the sudden increase of leachate head in January 2016. This is a result of applying the revised survey data (survey date from May 2015) in the calculations.

The maximum leachate levels have been recorded at LC5A which since 2013 has been showing a strong increasing trend. The leachate heads recorded in the remaining wells are stable with only well LC5A driving the increase in average head. Wells located in the Phase 1 cell, specifically LC1A have recorded low levels of leachate, generally lower than those recorded during 2017, with not enough to collect samples for testing.

Although the monthly average level for all the wells remains below the required 3.0m, the average level in well LC5A has shown an increase this quarter, therefore it is still considered that there is a general increasing trend in the average leachate head and there is still the potential to reach the 3m limit in the future. Investigations are proposed to be undertaken into the possible causes of the leachate head increase, these include well pump testing and the potential replacement of LC5A, however the increase shown this quarter should be closely monitored.

No significant variations of the leachate heads have been observed in the remaining leachate wells, with the monitored levels of L1, LC1A, LC2A and LC4A generally comparable to the 2017 levels.

4.3 Surface Water

4.3.1 Surface Water Quality Monitoring

The surface water quality monitoring results are presented in **Appendix D**, **Tables D3** and **D4**, and graphically in **Appendix C**, **Figure C4**.

Commentaries are provided for upstream and downstream monitoring points in the Nant Merddog, including locations SW1 to SW10 located downstream of the landfill, as discussed below.

4.3.1.1 SWU, SW2A1, SWW4, SWW1 and SWW2 (upstream of the landfill)

In accordance with the Permit requirements, these locations are monitored on a six-monthly basis, as set out in Section 3.

<u>Fourth quarter summary</u>

Mercury and ammoniacal nitrogen were recorded below the limit of detection at all locations and unionised ammoniacal nitrogen was recorded well below the assessment criteria at all locations.

Manganese was recorded below level of detection in SWU and SWW2. In SW2AI, SWW4 and SWW1 the concentrations were 0.0107mg/l, 0.0084mg/l and 0.0133mg/l respectively, well below the EQS freshwater value of 0.123mg/l.

Nickel was recorded below level of detection in SWU, SWW1 and SWW4. Nickel concentrations have been recorded above the EQS value of 0.004mg/l in SW2AI and SWW2, however at much lower concentrations than those recorded in the second quarter. The nickel results are based on filtered concentrations whereas the EQS assessment is based on the bioavailable concentrations of the metal. Using the M-BAT tool, as detailed in Section 3.3.2, the bioavailable results range from 0.0042mg/l in SW2AI to 0.0046mg/l in SWW2, still above the assessment criteria but by a very small margin. These have shown a significant decrease from earlier in the year.

Zinc was recorded below level of detection in SWU, SWW1, SWW2 and SWW4. In SW2A1 the concentration of zinc was 0.083mg/l, above the EQS level of 0.0137mg/l and higher than April's result which was below level of detection. The bioavailable concentration was recorded as 0.02mg/l which is only slightly above the EQS freshwater value. This is the first exceedance at this location since October 2017 when a level of 0.06mg/l was recorded.

Chloride concentrations have continued to be reported below the applied EQS level of 250mg/l and were recorded between 4.9mg/l in SWU and 11.10mg/l in SW2AI. Sulphate concentration of 419.0mg/l was recorded in SW2AI, exceeding the EQS freshwater value for the first time since April 2017 and the highest recorded since April 2013 when the same level was recorded. The remaining levels were generally below the EQS freshwater level with values of between 20.2mg/l and 393.0mg/l.

Annual summary

Ammoniacal nitrogen levels have remained below the laboratory detection level of 0.41mg/l since 2014 and the unionised concentrations were all recorded below the screening level of 0.015mg/l throughout 2018.

Chloride concentrations have continued to be recorded below their respective EQS freshwater screening levels. A single elevated level of sulphate was recorded in SW2AI, the first time since April 2017.

Elevated bioavailable levels of nickel have been recorded above the EQS freshwater screening criteria throughout 2018, recording particularly high levels at the beginning of the year. These levels reduced considerably in October 2018 suggesting that the earlier elevated levels were an anomaly.

Bioavailable zinc was recorded slightly above the EQS criteria in SW2AI. Zinc has historically been recorded above level of detection at the location.

4.3.1.2 SWD and SWD1 (downstream of the landfill)

A full suite of determinands is analysed on downstream samples SWD and SWD1 on a quarterly basis, as discussed in **Section 3.3.1**.

Fourth quarter summary

Ammoniacal nitrogen has remained below the measured level of detection of 0.41mg/l in both locations. Unionised ammoniacal nitrogen was recorded well below the assessment criteria at SWD and SWD1.

Chloride concentrations were reported well below the applied EQS level with values recorded as 6.6mg/l at SWD and 11.4mg/l at SWD1. Sulphate concentrations have decreased since the last quarter and still recording well below the EQS freshwater level with values of 94.5mg/l and 97.6mg/l at SWD and SWD1 respectively.

Nickel concentrations have been recorded below level of detection in SWD. There has been a slight increase from the last quarter in SWD1 with a bioavailable level of 0.0153mg/l recorded.

Zinc concentrations in the fourth quarter have been recorded below level of detection, significantly lower than last quarter's results which were the first exceedances recorded in either location since October 2015, and are likely to be an anomaly.

Mercury and manganese were all detected at concentrations well below the applied EQS values at both SWD and SWD1.

Annual summary

Ammoniacal nitrogen levels have continued to remain below the laboratory detection level of 0.41mg/l and have done since 2014. The majority of the unionised concentrations were recorded below the screening level of 0.015mg/l with the exception of January when a level of 0.021mg/l was recorded and July when a level of 0.0191mg/l.

Chloride and sulphate concentrations have continued to be recorded below their respective EQS freshwater screening levels.

All results for manganese were recorded below the EQS freshwater screening levels in 2018 with the majority of results recorded below their respective levels of detection.

Nickel levels in SWD have continued to record below level of detection during 2018, with the exception of April where a level of 0.0416mg/l was recorded. Due to the subsequent drop in level the following quarter this was deemed to be an anomaly and not indicative of any long term issue or trend. Nickel levels in SWD1 followed a similar pattern to SWD, however in the fourth quarter the levels increased above the screening criteria. The levels of nickel within these surface water locations should be monitored closely during 2019 as there have been some fluctuations recorded throughout 2018.

Zinc levels have been recorded below level of detection throughout 2018 with the exception of July. Both SWD and SWD1 recorded levels above the Freshwater EQS level during the third quarter, however these were subsequently recorded below level of detection in the fourth quarter. It should be noted that zinc levels have been recorded below level of detection within the majority of groundwater monitoring wells in the last two quarters, a possible decreasing trend emerging, which is mirrored in the Nant Merddog.

4.3.1.3 SW1 to SW10 (downstream of the landfill)

Surface water sampling of the groundwater break outs at SW1 to SW10 has been carried out since December 2013 on a monthly basis, comprising rounds of sampling for testing of ammoniacal nitrogen, chloride and mercury. Samples were collected from the majority of locations from January to December 2018 with the exception of the following due to the locations being recorded as dry, in particular during an extended spell of dry weather during the summer months.

- SW9 in February.
- SW1, 2, 3, 5, 6, 9 and 10 in June.
- SW1, 2, 3, 5, 6, 9 and 10 in July.
- SW1, 2, 3, 9 and 10 in August.
- SW1, 2 and 10 in September.
- SW2 and 9 in October.

Fourth quarter summary

During the reporting period, ammoniacal nitrogen was measured below the laboratory detection limit of 0.41mg/l at all monitored locations during October and November and the majority of locations in December. Concentrations of ammoniacal nitrogen above the level of detection were recorded in SW4 and SW5, 2.26mg/l and 1.33mg/l respectively, however these are located within tributaries and not the Nant Merdogg itself. The last level recorded above <0.41mg/l was in SW1 in February with a concentration of 0.5mg/l.

Mercury was recorded below the laboratory detection limit at all monitored locations.

Chloride was measured well below the EQS limit during the fourth quarter with levels fluctuating between the highest point of 54.6mg/l in SW4 in December and the lowest point of 6.4mg/l in SW8 in November. SW4 recorded the highest concentrations of chloride in all three months.

These break outs are from the same groundwater body as that monitored by GW9 and therefore it is considered that currently the non-compliance at GW9 continues to show no discernible impact on the Nant Merddog.

Annual summary

Ammoniacal nitrogen was recorded below the level of detection throughout 2018 with the exception SW4, SW5 and SW6 in December with 2.26mg/l, 1.33mg/l and 0.87mg/l respectively, recorded. Ammonia levels have decreased in GW9 and SW1 is the first monitoring point of the surface water monitoring locations with this and subsequent locations SW2 and SW3 showing no signs of impact. The elevated levels in the following downstream locations are the first elevations recorded since February 2016 with no identifiable source. This should be verified during the first quarter of 2019.

Chloride levels remain below the freshwater EQS level of 250mg/l throughout the year with the highest level of 129mg/l recorded in SW4 in July. The levels are fairly consistent at each location with little variation on impact from landfill.

Mercury levels have continued to remain below the level of detection since May 2014, with the exception of June and September 2018 where very low levels were recorded above level of detection but below 1ug/l.

4.4 Groundwater

4.4.1 Groundwater Quality Monitoring

Groundwater quality monitoring results are presented in graphical format in **Appendix C**, **Figures C6** and **C7** and in tabular format in **Appendix D**, **Table D5.** In the table, exceedances of the compliance criteria are highlighted using a colour-coded legend.

Chloride and ammoniacal nitrogen are the two main indicators of groundwater contamination by landfill leachate at the site. Chloride, in particular, is not attenuated in the groundwater by processes other than dilution and would be expected to be present wherever leachate contamination occurs.

Commentaries are provided for both upstream and downstream compliance wells. As reported in previous monitoring reports, the results from the latter have been compiled in relation to the different sandstone strata in which they are installed, i.e. S1, S2 and S3.

The groundwater quality monitoring results for the fourth quarter are detailed in the following sub-sections along with an annual review of the results.

4.4.1.1 Upstream Groundwater wells GW3A and GW4

GW3A and GW4 monitor the sandstone strata classified as S3-East, and GW11A had been installed in the sandstone strata classified as S2-West. Well GW11A is no longer sampled as the well was lost during the construction of the Waste Transfer Station. This well is due to be replaced in the forthcoming ground investigation works that are currently being procured.

<u>Fourth quarter summary</u>

During the fourth quarter of 2018, ammoniacal nitrogen concentrations continue to be measured below the laboratory limit of detection of 0.41mg/l in both GW3A and GW4.

Chloride has continued to be measured at below the control and trigger levels at concentrations of 8.7mg/l for GW3A and 9.1mg/l for GW4. Both results have increased since last quarter but remain well below the screening criteria.

Mercury was recorded as 0.10ug/l in GW4, below the trigger level. In GW3A, a concentration of 0.32ug/l has been recorded above the trigger level of 0.2ug/l. This level is higher than the concentration of 0.218ug/l recorded last quarter, but lower than the concentration in the second quarter, which was the highest recorded level since May 2014. On review of past results, mercury occasionally exceeds the screening criteria applied to the downstream groundwater, followed by a drop-in level to below LOD, indicating that these are temporary fluctuations associated with the environment outside of the influence of the landfill.

Manganese concentrations continue to be elevated in GW4, recording a level of 1.47mg/l, above the set criteria for the landfill. This has increased from last quarter's level of 1.20mg/l but still remains lower than concentrations recorded in 2017.

Nickel has continued to be recorded well below the assessment criteria in both GW3A and GW4, with a slight decrease recorded in GW4 from the previous quarter.

Zinc has been recorded below level of detection, <0.018mg/l in both GW3A and GW4. The levels of zinc over the past year have been showing a decrease in concentration.

In the upstream wells, sulphate concentrations were recorded at 66.4mg/l in GW4 and 124.0mg/l in GW3A. These values are well below the assessment criteria.

Annual summary

Ammoniacal nitrogen, chloride and nickel levels have been recorded below the assessment criteria applied to the landfill throughout 2018. Elevations of Mercury have been recorded in GW3A, a trend which has occurred in past results.

Elevated levels of zinc in both upstream groundwater and surface water have been recorded since mid-2010, however the final quarter of 2018 shows the concentrations have reduced below the limit of detection. This suggests the zinc source has reduced which is likely from a source other than the landfill.

Manganese concentrations continue to be above the Trigger Levels in GW4. As with zinc, the source of manganese is considered to be from an offsite source such as mine drainage which is considered to be impacting the groundwater in the locale of the landfill.

Sulphate concentrations remain below the assessment criteria throughout 2018.

4.4.1.2 Downstream Groundwater well GW10

GW10 has been installed in the sandstone strata classified as S3-East.

Fourth quarter summary

Ammoniacal nitrogen was measured below the assessment criteria with a level of 0.453mg/l recorded. This is a slight increase compared to the previous quarter, which was the first time the concentration had been recorded above the level of detection, <0.41mg/l, since February 2016.

Zinc has been recorded below the level of detection of <0.0180mg/l, the second time in a row since January 2015. On review of this quarter's zinc concentrations, all groundwater wells have recorded a decreased level of zinc.

Mercury concentrations were measured below the level of detection of <0.1ug/l in October, well below the assessment criteria.

Nickel concentrations continue to be recorded below the assessment criteria with a level of 0.0107mg/l recorded. This has increased a little from last quarter but does not exceed the second quarter result of 0.0251mg/l which was the highest recorded level since March 2009.

Manganese concentrations have been recorded above the Assessment Level of 1mg/l, with a level of 5.63mg/l recorded in October, the second consecutive quarter with the last exceedance recorded in February 2016. This is also the highest recorded concentration since October 2015.

Chloride and sulphate were measured at low concentrations of 13.5mg/l and 75.1mg/l respectively, a slight increase for the sulphate on last quarter's levels but both still well below the assessment criteria.

Annual summary

Ammoniacal nitrogen, mercury, nickel and chloride levels have been recorded below the assessment criteria throughout 2018.

Manganese concentrations increased above the 1mg/l Assessment Level in the second half of 2018. These are the highest levels since October 2015. Concentrations of manganese higher than the Assessment Level have been recorded upstream of the landfill in GW4. Consequently, the source of manganese is considered to be from an offsite source such as mine drainage which is considered to be impacting the groundwater in the locale of the landfill.

Elevated levels of zinc in both upstream groundwater and surface water have been recorded since mid-2010, however the second half of 2018 shows the concentrations have reduced below the limit of detection in GW10. The upstream wells also show a decreasing trend, which corroborates the assumption that zinc levels up and downstream of the landfill are linked and a consequence of the wider environment.

Sulphate concentrations remain below the assessment criteria throughout 2018.

4.4.1.3 Downstream Groundwater well GW9

GW9 has been installed in the sandstone strata classified as S2-East.

Fourth quarter summary

GW9 continues to be non-compliant for ammoniacal nitrogen in relation to the Trigger Level of 1mg/l (refer to previous monitoring reports, Reference [2]). Investigation works to address this have been undertaken in 2014 and are presented in a separate report (Reference [6]).

The ammoniacal nitrogen concentration was above the trigger level with a concentration of 3.88mg/l recorded, a decrease from the previous quarter's result of 5.98mg/l. The levels were showing a continued decreasing trend prior to January's results, with last October (2017) recording the lowest value since August 2011, which is considered likely due to completion of the capping to Phase 1. There have been occasional variations where infrequent single increases have occurred, similar to the second quarter of 2018, but the final quarter's result suggests that this decreasing trend is continued.

The mercury concentration was recorded as 0.016ug/l, lower than the level of 0.035ug/l from last quarter and much lower than the assessment level.

Zinc has been recorded below the level of detection of <0.0180mg/l, the second time in a row since October 2016. On review of this quarter's zinc concentrations, all groundwater wells have recorded a decreased level of zinc. Since April 2017, a decreasing pattern seems to be emerging, except for a slight increase in April 2018.

Nickel concentrations continue to be recorded below the assessment criteria. The level of 0.0038ug/l recorded this quarter is slightly lower than last quarter.

Manganese remains below the assessment level of 1.0mg/l with a level of 0.557mg/l recorded. This is a slight increase from the previous quarter.

The chloride concentration for July was 29.6mg/l, which is lower than last quarters result of 89.7mg/l and still well below the control and Trigger Levels.

Annual summary

The trigger level for ammoniacal nitrogen has continued to be exceeded throughout 2018. However, the concentrations have continued to show a significant decreasing trend since January 2016, with the exception of April 2018.

Elevated levels of zinc in both upstream groundwater and surface water have been recorded since mid-2010, however the second half of 2018 shows the concentrations have reduced below the limit of detection. The upstream wells also show this decreasing trend, which indicates the zinc source has reduced. GW9 should continue to be closely monitored in 2019 to ascertain that concentrations are reducing and remain low.

Manganese concentrations have been recorded above the freshwater EQS level during 2018 but below the assessment level of 1.0mg/l. Manganese concentrations should be closely monitored during 2019 as elevated background manganese concentrations have been observed in the upstream groundwater wells during the reporting period.

Mercury concentrations continue to be recorded below the assessment level throughout 2018. Chloride and sulphate levels continue to record below the assessment criteria throughout the year.

4.4.1.4 Downstream Groundwater well GW12

GW12 has been installed in the sandstone strata classified as S2-West.

Fourth quarter summary

The concentration of ammoniacal nitrogen has continued to be below level of detection of <0.41mg/l and has been since July 2016.

Mercury has been recorded as 0.393ug/l, which is greater than the trigger level and an increase from last quarter's result of <0.01ug/l, which was the lowest recorded since October 2016. Mercury concentrations have fluctuated over the past couple of years in this well, with the last highest reading of 0.92ug/l recorded in January 2017, therefore these levels should be closely monitored during 2019.

Zinc has been recorded below the level of detection of <0.0180mg/l, the second time in a row since December 2015. On review of this quarter's zinc concentrations, all groundwater wells have recorded a decreased level of zinc. Since January 2017, a decreasing pattern seems to be emerging, except for a slight increase in October 2017.

Nickel concentrations continue to be recorded below the assessment criteria. The level of 0.0090ug/l recorded this quarter is significantly lower than last quarter.

A sulphate level of 464mg/l has been recorded which is above the Trigger Level of 400mg/l for the first time since April 2017. Consistently levels have been recorded above 300mg/l since 2013, but this is significantly higher than those exceeding the control levels. The next quarter's results should confirm if this is a consistent increase or an infrequent elevation.

Manganese has been reported below the assessment criteria this quarter with a level of 0.0089mg/l recorded, a slight decrease from last quarter.

Annual summary

Ammoniacal nitrogen levels in 2018 have been recorded below level of detection and has remained <0.41mg/l since April 2016.

Mercury results have fluctuated throughout 2018. Results were below the detection level of 0.1ug/l in the first and third quarter but above trigger levels in the second and fourth quarter, 0.393ug/l and 0.236ug/l, respectively. It should be noted that leachate quality testing did not detect mercury, therefore elevated mercury in the groundwater is not considered to originate from the landfill.

Elevated levels of zinc in both upstream groundwater and surface water have been recorded since mid-2010, however the second half of 2018 shows the concentrations have reduced below the limit of detection. The upstream wells also show this decreasing trend, which indicates the zinc source has reduced. GW12 should continue to be closely monitored in 2019 to ascertain that concentrations are reducing and remain low.

Manganese concentrations have been recorded above the freshwater EQS level during 2018 but below the assessment level of 1.0mg/l. Manganese concentrations should be closely monitored during 2019 as elevated background manganese concentrations have been observed in the upstream groundwater wells during the reporting period.

Sulphate was recorded above the EQS freshwater value (400mg/l) with a value of 464mg/l in October. Control Level B (350mg/l) was exceeded in both January and April and Control Level A (300mg/l) was exceeded in July 2018. The sulphate levels have been fluctuating since April 2016 but remained at a high level this year.

An increasing trend of sulphate concentration at GW12 could be shown by looking at the yearly average sulphate concentrations in 2014, 149.2mg/l which rose to 222.9mg/l in 2015 and 369.2mg/l in 2016. However, the average dropped to 313.75mg/l in 2017 before rising again this year to 380.5mg/l. The levels of sulphate are generally below the trigger and control levels and therefore do not warrant concern at the he moment. Sulphate levels should be reviewed and monitored closely in 2019.

4.4.1.5 Downstream Groundwater wells GW6 and GW7

GW6 and GW7 have been installed in the centre of the valley in the sandstone strata classified as S1.

Fourth quarter summary

Ammoniacal nitrogen concentrations were recorded below the analytical detection limit in both GW6 and GW7. In the previous quarter GW6 recorded a level of 1.53mg/l, above the trigger level of 1.0mg/l but this has reduced again to the consistent level of <0.41mg/l in the final quarter.

Sulphates were measured within compliance levels in both wells, with 93.1mg/l recorded at GW6 and 108mg/l at GW7, both slightly elevated on the previous quarter.

Mercury concentrations are both well below the trigger and control levels and have been recorded as 0.03ug/l in GW6 and <0.01ug/l in GW7.

Manganese concentrations in GW6 were recorded below the assessment level of 1.0mg/l but have increased to 0.4230mg/l compared to 0.0868mg/l in the previous quarter. The manganese level in GW7 has been recorded as 2.76mg/l, above the assessment level of 1.0mg/l. This has increased from the last quarter which had a concentration of 2.13mg/l. Manganese has been recorded above the assessment level since July 2017, fluctuating between 1.0mg/l and 2.76mg/l, with the exception of April 2018. Historically manganese is known to fluctuate within this well, and it is considered that the concentrations are also impacted by the upstream groundwater.

Nickel and chloride has continued to record well below assessment criteria in both wells.

In GW7 zinc has been recorded below the level of detection of <0.018mg/l, this is a significant decrease from the past quarter result of 0.0710 which exceeded the trigger level. Zinc was measured below level of detection, <0.018mg/l in GW6 which is consistent with the majority of results over the past two years. On review of this quarter's zinc concentrations, all groundwater wells have recorded a decreased level of zinc. Overall, a decreasing pattern seems to be emerging.

Annual summary

Ammoniacal nitrogen concentrations have mostly remained below the trigger and control levels throughout 2018 in both wells, with the exception of one elevation of 1.53mg/l in GW6 during July. This is the first time a breach of the ammoniacal nitrogen assessment criteria has occurred since October 2011 when a level of 0.93mg/l was recorded above the control levels and is also the highest level recorded since April 2009 when a level of 3.1mg/l was recorded. The infrequent elevated levels recorded over the entire monitoring period suggest that this is unlikely to be a sign of a consistent increase in ammoniacal concentration within well GW6.

Sulphate, Nickel, Mercury and Chloride concentrations have remained below compliance levels all year.

No exceedances of manganese were recorded in GW6, a continuing trend from 2016. Manganese concentrations were recorded in GW7 below level of detection during the third quarter but above the EQS freshwater level (0.03mg/l) in January, July and October in which the highest level of 2.76mg/l was recorded. Elevated background manganese concentrations have been observed at similar levels at the upstream groundwater well GW4, suggesting a source of manganese other than the landfill.

GW6 shows a reduction in zinc to below detectable levels in the final half of 2018. The upstream wells also show this decreasing trend, which indicates the zinc source has reduced. GW7 exceeded the trigger level in July 2018 with a level of 0.071mg/l, with the remaining levels recorded below the level of detection. GW7 should continue to be closely monitored in 2019 to ascertain that concentrations are reducing and remain low.

4.4.2 Groundwater Levels Monitoring

Groundwater levels have been monitored on a quarterly basis in the compliance wells GW6, GW7, GW9, GW10 and GW12, as discussed in **Section 3.4**. Groundwater levels have also been monitored in the upstream wells GW3A and GW4. The monitoring results are illustrated graphically in **Appendix C**, **Figure C8**.

The table below summarises the groundwater level changes in each well.

Table 4.2: Groundwater level changes

Well	GW Level (m) January	GW Level (m) April	GW Level (m) July	GW Level (m) October
GW3A	30.07	30.07	29.94	30.07
GW4	10.57	10.95	12.02	11.20
GW6	5.22	5.17	6.42	5.58
GW7	2.21	2.22	3.58	2.34
GW9	16.78	16.84	17.44	16.98
GW10	7.55	7.61	7.83	7.66
GW12	7.67	7.74	8.10	7.80

During the first two quarters the water levels remained fairly consistent with a slight decrease noted in the majority of the wells. The third quarter, in July, recorded a significant drop in groundwater levels which is likely due to the drier Autumn season experienced this year. The last quarter has shown an increase in groundwater levels compared to the previous quarter, likely due to the return of wet weather.

4.5 Landfill Gas

4.5.1 Landfill Gas Quality Monitoring

The landfill gas monitoring results are presented in **Appendix D**, **Table D6** for the period January to December 2018. The results are discussed in detail in the sub-sections below for both monitored gases (methane and carbon dioxide).

Access to GMW14 is restricted due to its location being within a cattle quarantine paddock. Monitoring of this well has been limited since March 2014, with no readings undertaken this year.

The recommendation of repositioning GMW14 as discussed in previous monitoring reports remains valid due to access difficulties (Ref. [2]) and is currently being pursued. Considering the recorded concentrations to date, monitoring of landfill gas in GMW14 should be undertaken on a regular basis and contingency actions implemented, if necessary.

4.5.1.1 Methane

<u>Fourth quarter summary</u>

During the fourth quarter methane concentrations were recorded below the respective Control and Trigger Levels in all monitoring locations where assessment levels have been set, with levels recorded between 0% and 0.1%.

In GMW10 the levels of methane increased in all valves during October with levels ranging from 12.8% in the yellow valve and 18.2% in the red valve. This is an increase from last quarter where all three months recorded very low levels. However, November and December dropped, with levels in the red, yellow and white valves recording 0.0%. These levels have significantly dropped from those recorded in September and the first and second quarters and are the lowest recorded levels since February 2017.

Elevated levels of methane continue to be measured in monitoring wells GMW1, GMW8 and GMW9 (yellow valve), where the maximum recorded concentrations in this reporting period for GMW1 were 31.9% in October decreasing to 3.6% in December and 7.4% for GWM8 in December and 36.9% for GWM9 in November.

As discussed in **Section 3.5.1**, GMW8, 9 and 10 are located within 20m of the waste mass, where elevated methane concentrations are anticipated.

Methane was not detected in GMW17 or GMW18 during the fourth quarter. GMW18 could not be monitored in October due to the presence of cattle. No Control or Trigger Levels are available.

<u>Annual summary</u>

Throughout 2018 methane levels have remained below the respective Control and Trigger Levels (where available) in all monitoring locations.

GMW1 has recorded low methane levels in the red and white valves throughout 2018. The low levels correspond to those recorded during 2017. In the yellow valve, the levels are much higher with the highest level of 36.2% recorded in August. However, these levels are similar to those recorded in 2017, with a slightly higher peak in comparison with the 32.8% recorded in September 2017.

High levels of methane were detected in all three valves of GMW10 throughout the year with the exception of November and December when 0% methane was recorded. The levels recorded in the red and white valves are overall much lower than those recorded in 2017, particularly within the last 6 months. In GMW9 the elevated levels recorded in the yellow valve have generally been recorded lower throughout the 2018 compared to 2017, although still above 30%. This typically corresponds to low or very low concentrations being measured in the well's red and white valves. This continues to be observed in this reporting period. For both of these, no Control/Trigger Levels are available.

Elevated levels of methane continue to be measured in the monitoring well GMW8 (yellow valve) during 2018. The highest levels were recorded in the fourth quarter with 8.1% recorded in April. The concentrations generally fluctuate throughout the year with 7.4% recorded in December and the lowest concentration of 3.4% recorded in March. The levels recorded during 2018 fluctuate similar to 2017 with a peak in Spring and again in Winter.

As discussed in **Section 3.5.1**, GMW8, 9 and 10 are located within 20m of the waste mass, where elevated methane concentrations are anticipated.

Very low or no levels of methane were detected in GMW17 and GMW18, where Control or Trigger Levels are also not available.

4.5.1.2 Carbon Dioxide

Fourth quarter summary

Carbon dioxide concentrations were recorded below the respective Control and Trigger Levels, where available, in the majority of monitoring locations with the exception of GMW2, GMW5 and GMW6.

The control level of 1% in the red valve of GMW2 was exceeded in September, with a value of 1.2% recorded. However, levels recorded in November and December were both below the control level.

Levels of carbon dioxide were recorded above the trigger level in the yellow valve of GMW5 during all three months with levels ranging from 4.4% to 4.5%, continuing from the previous quarter in which the yellow valve exceeded the trigger level for the first time since monitoring began. Levels were also exceeded in the white valve during the months of October and December with levels of 4.6% and 4.8% recorded, similar to levels recorded in the previous quarter.

GMW6 recorded elevated levels of carbon dioxide in the red valve above the Control and Trigger Levels during October with a concentration of 5.1%, similar to those recorded in the previous quarter. The levels dropped to below the Trigger and Control Levels in November and December, the first time since April 2018.

Elevated levels of carbon dioxide also continue to be measured in GMW1, GMW8, GMW9, GMW10, GMW17 and GMW18. However, no Control/Trigger Levels have been derived for these locations which are in close proximity to the waste mass. Gas monitoring will continue in accordance with the agreed programme and the relevant Permit conditions.

Two additional gas pumping wells were drilled in the vicinity of GMW1 in February 2015 in the hope that it would reduce the levels of carbon dioxide. However, the levels recorded during this quarter are similar to those recorded prior to the installation of the additional wells. The wells are still under extraction and are intermittently pumped.

Annual summary

In GMW2 the trigger level of 1.5% was exceeded in July in the red valve with a recorded level of 1.6%. The last recorded trigger level exceedance was in August 2017 with 1.7%. The control level of 1% in the red valve of GMW2 was also exceeded from August to October with a maximum level of 1.5% recorded. This is similar to 2017 with higher recordings during the summer months.

The trigger level of 2.67% was exceeded in the yellow valve of GMW3, with a value of 3.4% recorded in June. This if the first exceedance since July 2014 where a level of 5.8% was recorded.

The trigger level of 4.8% in the GMW5 white valve was exceeded in January and February with levels of 5.8% and 5.0%, respectively. The control level of 4.3% was exceeded from August to December with a maximum of 4.8% recorded in December. The white valve exceedances are similar to 2016 and 2017 with exceedances recorded in the January and February and the latter part of 2016 and 2017. In GMW5 the trigger level of 4.1% in the yellow valve was exceeded from July to December with a maximum of 4.5% recorded. The control level was exceeded with 3.7% in both March and May. These are the first exceedances that have been recorded in the yellow valve since monitoring began.

The red valve trigger level of 4.3% was exceeded in GMW6 throughout May to October and in February with a maximum recorded level of 5.6% in July and September. The control level was exceeded in June with a reading of 3.9%. These exceedances are of a similar level to those recorded in the last half of 2017. However, levels have dropped to below the Trigger and Control Levels in November and December this year, the first time since June 2017.

In GMW7 there was a control level exceedance in both the yellow and white valve during August. However, no exceedances have been recorded in other months throughout the year.

The yellow valve trigger level for GMW13 was exceeded in both February and August 2018 with a maximum value of 6.6%. The control level was exceeded from April – July and again in September with a maximum level of 5.9%. Similar exceedances have been observed in GMW13 in the past, since it continues to exhibit levels above the Trigger Level of 6%. GMW13 is located on the north-western flank of the valley, outside the waste mass. It is considered likely that this well is detecting ground gas concentrations from the local bedrock geology and marsh land in the vicinity of the well.

No readings were taken for GMW14 this year as it was inaccessible.

The levels recorded in GMW1 ranged from 0.1% in August to 5.1% in July in the red valve, 1.3% in December to 11.3% in September in the yellow valve, and 0.0% in March and April to 4.1% in January in the white valve. No Trigger Levels have been set for this location as not required by the permit [1].

Elevated levels of carbon dioxide continue to be recorded in GMW8 and GMW9. No Control/Trigger Levels have been derived for these locations. In GMW8 the highest reading in the reporting period were measured in February at 14.2% in the yellow valve, while at GMW9 a level of 20.1% was recorded in February in the yellow valve. The carbon dioxide concentrations measured in GWM9 are higher than those measured within any of the gas monitoring wells, a trend continuing from 2014. Elevated carbon dioxide concentrations in the yellow valve in GMW9 were recorded since August 2013, when levels rose to 31.6% and remained above 20% for the remainder of the year. In the first half of 2013, carbon dioxide was recorded between 0 and 3.3%.

The carbon dioxide levels in GMW10 have varied throughout the year. Levels above 9% have been recorded in the red, yellow and white valves from January to June with the maximum of 13.8% recorded in June. Recorded levels then reduce throughout the second half of the year with a slight rise in all valves in October. However, no control or Trigger Levels have been derived for this monitoring location.

The highest 2018 recorded carbon dioxide level in GMW17 was 6.6% in the yellow valve in February, which is slightly lower than the peak level last year. Readings were not taken in October for GMW18, but readings have been taken the rest of the year. A high of 3.3% was recorded in the yellow valve in March and 7.1% in the white valve in January. No Trigger Levels have been set for this location as they are not required by the permit [1].

Gas monitoring will continue in accordance with the agreed programme and the relevant Permit conditions.

5 Conclusions

The monitoring regime has been undertaken in accordance with the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]) with monitoring and testing done in accordance with the Permit (Ref. [1]). The following section concludes the assessments for leachate, surface water, groundwater and landfill gas.

5.1 Leachate

5.1.1 Leachate Quality

The majority of the determinands tested recorded average concentrations well below their respective AMC values except for ammoniacal nitrogen and nickel.

The average value of ammoniacal nitrogen was recorded above the AMC value of 526mg/l during 2018, with a maximum level of 804.48mg/l recorded in October and a minimum level of 610.78mg/l recorded in July. Review of the year's readings indicates that exceedances were recorded throughout 2018, occurring due to LC5A continuing to record high results up to 3 times greater than the next highest reading. However, on a comparison to 2017 the first three quarters were lower in 2018 with only the fourth quarter exceeding the level recorded during the same month the previous year. In accordance with the Aftercare Phase Environmental and Infrastructure Monitoring Program report (Ref. [4]) and summarised in Table 3.3., the contingency plan is to be implemented after three consecutive exceedances have been recorded. The continuing high levels of ammoniacal nitrogen recorded and the significance of well LC5A being the only well monitoring cell 5 will be reviewed within the current Hydrogeological Risk Assessment, however, the results should continue to be closely monitored in 2019.

5.1.2 Leachate Head Monitoring

The quarterly average leachate heads were calculated at between 2.35m and 2.84 across 2018, within the 3m limit stipulated in the Permit (Ref. [1]). However, an increasing trend in leachate head has been continually recorded in LC5A, with the leachate level steadily rising from 2013 to date with leachate head levels reaching 5.36m in October 2018. The average level is continuing to increase and therefore has the potential to reach the 3m limit within the near future. It is therefore proposed to undertake pumping tests within well LC5A with the possibility of installing a second well within Cell 5 which will help to correlate the leachate head level across the cell. This should help determine whether well LC5A is performing efficiently or whether the leachate head levels are due to an issue within this well.

The leachate head recorded in the remaining wells has remained stable with all maximum leachate values recorded in LC5A.

The wells located in the Phase 1 cell, specifically LC1A have recorded low levels of leachate with not enough to collect samples for testing and well L1 has consistently been recorded as dry.

A topographical survey at the location of each leachate monitoring well along with the re-measurement of the current heights of each well's casing in relation to the current ground level was undertaken in 2015 in order to verify any potential settlement or change to the wells arrangement. These levels have been adopted in to the leachate head calculations from 2016 onwards. Monitoring of leachate will continue in accordance with the agreed programme and the relevant Permit conditions.

5.2 Surface Water

The monitoring results for surface water generally indicate that the majority of the determinants are recorded at less than the detectable limit levels at both upstream and downstream monitoring locations, and the evidence indicates that there is currently no discernible impact on surface water receptors by the landfill.

5.2.1 SWU, SW2AI, SWW1, SWW2 and SWW4

Monitoring of these upstream locations is conducted six-monthly as per the permit [1].

The measured concentrations of ammoniacal nitrogen, unionised ammoniacal nitrogen and chloride were all within the set EQS values (or below the laboratory detection limit in the case of ammoniacal nitrogen) in the upstream section of the landfill, throughout 2018. A single elevated level of zinc and sulphate were recorded in SW2AI in October. Nickel was recorded above the EQS criteria in all surface water locations in April, however the levels recorded in October were considerably lower suggesting that the earlier elevated levels were an anomaly. A slight exceedance was recorded in SW2AI and SWW2, marginally above the 0.004mg/l criteria with levels recorded as 0.0042mg/l and 0.0046mg/l respectively.

5.2.2 SWD and SWD1

The surface water results for the monitoring points located downstream of the landfill indicate no significant environmental impact on this receptor. Ammoniacal nitrogen, mercury, manganese and chloride measured below their respective Freshwater EQS.

Nickel was recorded above the EQS value of 0.004mg/l in SWD and SWD1 in July and in SWD1 in October. Zinc was recorded above the EQS value of 0.0137mg/l in both locations during the third quarter, the first exceedance of the assessment criteria since October 2015. However, these dropped to below level of detection in the fourth quarter monitoring, suggesting that this is a possible anomaly.

Concentrations of sulphate are showing a general decreasing trend throughout 2018 with a slight increase in the third quarter but the concentrations are still well below the EQS freshwater level with a highest value of 138.0mg/l being recorded at SWD1 in July 2018. Low levels of sulphate have been detected in the groundwater upstream wells during the reporting period, therefore suggesting a source of sulphate other than the landfill.

5.2.3 SW1 – SW10

Monitoring of these downstream locations is still conducted monthly as per the amended permit [1]. Sampling could not be undertaken at locations SW1, SW2, SW3, SW5, SW6, SW9 and SW10 on a number of occasions throughout 2018 due to being recorded as dry.

Ammoniacal nitrogen concentrations were recorded in the downstream locations SW4, SW5 and SW6 above the detection level in December during the fourth quarter, with a maximum of 2.26mg/l recorded in SW4 with all remaining levels recorded below level of detection. Ammoniacal nitrogen levels recorded in GW9 were lower with the upstream locations showing no impact from this well on the surface water. The levels at these locations should be reviewed during the first quarter of 2019 to clarify if this is an anomaly or if further investigation is required.

Mercury levels were recorded below the limit of detection at all monitoring locations during 2018 with the exception of the months of June and September where very low levels were recorded in SW3 and SW4, although well below the EQS freshwater level.

Chloride levels remained well below the EQS freshwater concentration level of 250mg/l with a maximum of 129.0mg/l recorded in SW4 in July. This shows that the pumps are effective at stopping the leachate, which has high levels of chloride, from leaching into the Nant Merddog downstream of the landfill.

The results indicate that the continuing non-compliance at GW9, which is showing a decreasing trend, is not having a discernible environmental impact on the Nant Merddog downstream of the landfill.

5.3 Groundwater

The background groundwater quality monitoring continues to record elevated levels of mercury, zinc, sulphates and manganese suggesting other sources than the landfill for these determinants.

5.3.1 Upstream Wells

The upstream wells GW3A and GW4 continued to show slightly elevated levels of zinc during the first two quarters, however the levels during the last two quarters were recorded below the assessment criteria for the first time since November 2012.

Manganese has been recorded in GW4 above the assessment level throughout 2018.

Mercury has generally been recorded below the detection limit in GW4 and the first quarter for GW3. Mercury levels have been recorded above the trigger level, which is applied to the downstream groundwater, throughout the rest of 2018. Fluctuations in mercury levels have occurred in the past followed by a drop in level to below LOD. This suggests these are temporary fluctuations associated with the environment outside of the influence of the landfill.

These elevated concentrations upstream suggest there are sources other than the landfill for these determinands. This is likely to be from steel works waste deposited to the north of the landfill and old mine workings in the area which are likely to be the source of the elevated levels of zinc. Manganese is also a typical contaminant of mine drainage, which is considered to be impacting the groundwater in the locale of the landfill.

5.3.2 Downstream Wells / Compliance Wells

The results from the compliance wells indicate that generally the pumping system at the toe of the landfill is continuing to successfully control the potential egress of leachate from the landfill. No issues associated with pump failure within the cut-off system have been recorded during 2018.

Generally, the elevated concentrations of manganese and zinc observed in the downstream wells are likely to reflect background concentrations. This is because zinc and manganese concentrations are low in the leachate testing therefore indicating a different source from the landfill.

5.3.2.1 Compliance well GW10

In GW10, nickel and mercury have remained below the assessment criteria throughout 2018.

Manganese has been recorded above the assessment level in the last two quarters, first time since February 2016. With the exception of zinc, no other contaminants have been recorded above their respective assessment criteria suggesting this may be an anomaly or has originated from an off-site source.

Zinc has dropped to below the trigger level during the last two quarters of 2018, suggesting a decreasing trend emerging. Concentrations of zinc have also been recorded much lower in the upstream wells and in the majority of the compliance wells.

5.3.2.2 Compliance well GW9

GW9 is continuing to be non-compliant with ammoniacal nitrogen reported above the Trigger Level. Monitoring results have been showing a general decreasing trend since 2012, with the exception of limited occasions which are considered to be associated with seasonal variations and periods of persistent elevated rainfall. On completion of the Phase 1 capping in September 2015 the levels of ammoniacal nitrogen significantly decreased. There was a slight increase in January 2016, however the level of ammoniacal nitrogen has continued to decrease throughout 2016, 2017. The results in 2018 started showing a slight increase in January but throughout the year the results suggest that the decreasing trend is continuing. Therefore, concentrations of ammoniacal nitrogen should be closely monitored throughout 2019 to determine if there is a continuing decreasing trend.

The monitoring of the downstream environmental impact of the non-compliance at GW9 (sampling and analysis of the Nant Merddog and identified stream and break outs in the SSSI) is currently on-going. The available monitoring results to date show that the concentrations of ammoniacal nitrogen and chloride are not detectable in these streams, and no discernible impact on the Nant Merddog has been shown. As discussed in the updated GW9 report (Ref. [6]), it is considered that the on-going non-compliance at GW9 is due to the heavily fractured stratum in that locale that prevents the pumping system from intercepting all leachate-impacted groundwater. The current course of action is to undertake a further twelve months of monitoring of the surface water breakout locations followed by a further review of GW9.

Zinc was monitored in GW9 at concentrations above the Control Level B in January, above Control Level A in April and below level of detection in July and October. These results are showing a decreasing trend through 2018. The levels should be monitored closely in 2019 to confirm this decreasing trend.

Manganese concentrations have been recorded below the assessment level of 1.0mg/l throughout 2018. Manganese concentrations should be closely monitored during 2019, however elevated background manganese concentrations have been observed in the upstream groundwater wells during the reporting period, suggesting a source of manganese other than the landfill.

Mercury, chloride and sulphate levels continue to record below the assessment criteria.

5.3.2.3 Compliance well GW12

Groundwater contained within the sandstone strata S2-west is monitored by GW12. The ammoniacal nitrogen concentrations have continued to record below level of detection throughout the year. The last result recorded above level of detection was in April 2016 where the result was above the Control Level A value.

Mercury was recorded above the trigger level in April and December. The levels of mercury are shown to fluctuate over the past year. The leachate quality testing did not detect elevated levels of mercury, therefore the elevated mercury in the groundwater is not considered to originate from the landfill. However, levels of mercury should still be closely monitored during 2019.

Sulphate levels have historically been recorded as elevated since 2015, although fluctuating above and below the assessment criteria throughout 2016 and 2017. Sulphate levels were recorded above the Control Level A in the first three quarter's and exceeding the trigger level in December. The elevated levels do not seem to have a direct correlation with elevated rainfall or increase in water level. Elevated levels of sulphate are also not recorded in any other monitoring well. There has been an increasing trend in the yearly average concentrations, with the exception of the 2017 yearly average showing a decrease. Although the sulphate results have shown to be above the assessment criteria it is only by a very small margin and therefore the annual average may still show a declining trend. The sulphate results should be monitored closely during 2019 to assess whether the results continue to fluctuate and if the yearly average is declining or beginning to increase.

Nickel and manganese have continued to be below all assessment criteria.

Zinc continued to exceed the trigger level during the first two quarter's of 2018, although decreasing from 2017. The final two quarter's recorded less than the detection limit for the first time since December 2015. Therefore, zinc should be monitored closely in 2019 to determine if there is a decreasing trend present. As previously mentioned, zinc concentrations have also been found to be decreasing in the upstream wells and other compliance wells.

5.3.2.4 Wells GW6 and GW7

Elevated levels of zinc continued to be recorded within sandstone strata S1, monitored by GW6, in January and in GW7 in July. However, the remaining quarter's recorded levels at less than level of detection. The upstream wells also show this decreasing trend, which indicates the zinc source has reduced. Levels should continue to be closely monitored in 2019 to ascertain that concentrations are reducing and remain low.

Manganese concentrations continue to be recorded above assessment level in GW7 with a maximum concentration of 2.76mg/l recorded in December, coinciding with similar levels recorded in December 2017. Elevated background manganese concentrations have been observed at similar levels at the upstream groundwater well GW4, suggesting a source of manganese other than the landfill.

No concentrations of mercury, nickel, ammoniacal nitrogen, chloride or sulphate have been recorded in either well above the assessment criteria.

5.4 Landfill Gas

The gas monitoring results showed compliance with the set Control and Trigger Levels in the majority of gas monitoring locations.

5.4.1 Methane

Methane concentrations continue to be recorded below the respective Control and Trigger Levels (where available) in all monitoring locations.

Elevated levels of methane continue to be measured in monitoring wells GMW1, GMW8 and GMW9 in the yellow valve and GMW10 in all three valves with the exception of November and December where 0.0% was recorded. However, no Control/Trigger Levels are available for these locations. No methane was detected in GMW17 and 0.1% was detected in GMW18, where Control or Trigger Levels are also not available.

5.4.2 Carbon dioxide

Carbon dioxide levels in GMW13 were recorded above the Control and/or Trigger Levels in the yellow valve for the majority of 2018, recording below the assessment criteria in October, November and December. This well is considered to be impacted by the presence of marshland and bedrock geology on which this is located. The levels should be closely monitored in 2019 to see if they continue to show a decreasing trend.

Elevated concentrations of carbon dioxide were recorded in the red valve of GMW2 in July, August, September and October, above the trigger and control levels. This is the first exceedance recorded in this well since July 2014. However, these dropped below the trigger and control levels at the end of 2018.

GMW3 recorded a single elevation in June, thought to be an anomaly.

Concentrations of carbon dioxide in the yellow valve of GMW5 were recorded above the trigger level during July to December and above the control level in March and May. The levels recorded in the white valve have also been recorded above the trigger level in January and February and above the control level in August, September, October and December.

GMW6 has recorded elevated levels of carbon dioxide in February, May, July, August, September and October in exceedance of the Trigger Levels and above the control level in June in the red valve. These exceedances were recorded in similar months as ones in GWM2, GMW5 and GMW13. However, levels have dropped to below the Trigger and Control Levels in November and December.

Slight exceedances were recorded above the control level in GMW7 in August in the yellow and white valves.

Monitoring in GMW14 continues to have accessibility issues due to its location within a cattle quarantine paddock. The required monitoring frequency cannot currently be sustained due to its current location. It is currently proposed to install a new monitoring well in close proximity to the current location, within the Permit requirements.

Elevated levels of carbon dioxide continue to be measured in GMW1, GMW8, GMW9, GMW10, GMW17 and GMW18. However, no Control/Trigger Levels have been derived for these locations as they are in close proximity to the waste mass. Gas monitoring will continue in accordance with the agreed programme and the relevant Permit conditions.

In order to mitigate the elevated levels of carbon dioxide previously recorded in GMW1, two additional gas pumping wells were drilled in its vicinity in February 2015. However, the elevated levels recorded during this quarter are similar to those recorded prior to the installation of the additional pumping wells. This suggests the additional pumping is not reducing the carbon dioxide in GMW1. This will be considered during the site wide review.

Gas monitoring will continue in accordance with the agreed programme and the relevant Permit conditions.

5.5 Summary

The monitoring data and interpretation produced in this report has identified issues relating to contaminant levels recorded above the screening criteria within the leachate, groundwater, and surface waters. However, none of the highlighted issues are having a discernible impact on the surrounding environment and the landfill continues to generally comply with the requirements of the permit.

References

[1] Environment Agency, Silent Valley Landfill Site, Pollution Prevention and Control (England and Wales) Regulations 2000, Landfill (England and Wales) Regulations 2002, Permit number MP3835SV, November 2005, Permit amended as of 04/03/16.

[2] Arup, Silent Valley Landfill, 2017 Annual Monitoring Report, 31st January 2018.

[3] Arup, Silent Valley Landfill, Interim GW9 and Nant Merddog W, Issue May 2015.

[4] Arup, Silent Valley Landfill, Aftercare Phase Environmental and Infrastructure Monitoring Program, Issue June 2013.

[5] Arup, Silent Valley Landfill, Hydrogeological Risk Assessment, document reference 04/6363, November 2004.

[6] Arup, Silent Valley Landfill, Investigation in to the Western Flank of the Cut-off System. Compliance Well GW9 and GW10, document reference 115825, August 2011.

[7] Environment Agency, Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water, report reference LFTGN02, June 2014.

[8] Arup, Silent Valley Landfill, 2010 Annual Monitoring Report, document reference 11/7956, February 2011.

[9] Arup, Silent Valley Landfill, Hydrogeological Risk Assessment (Supplementary Revision May 2009), document reference 09/7543, June 2009.

[10] Golder Associates, Establishment of Trigger Levels at Silent Valley landfill site, letter report dated 21 December 2006.

[11] Environment Agency, Guidance on the management of landfill gas, document reference LFTGN03, June 2014.

[12] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

[13] Water Framework Directive - United Kingdom Technical Advisory Group (WFD-UKTAG), "Metal Bioavailability Assessment Tool (M-BAT)," 2014.

[14] Arup, Silent Valley Landfill, 2018 First Quarter Monitoring Report, 30th April 2018.

[15] Arup, Silent Valley Landfill, 2018 Second Quarter Monitoring Report, 27th July 2018.

[16] Arup, Silent Valley Landfill, 2018 Third Quarter Monitoring Report, 30th October 2018.

Figures

A4

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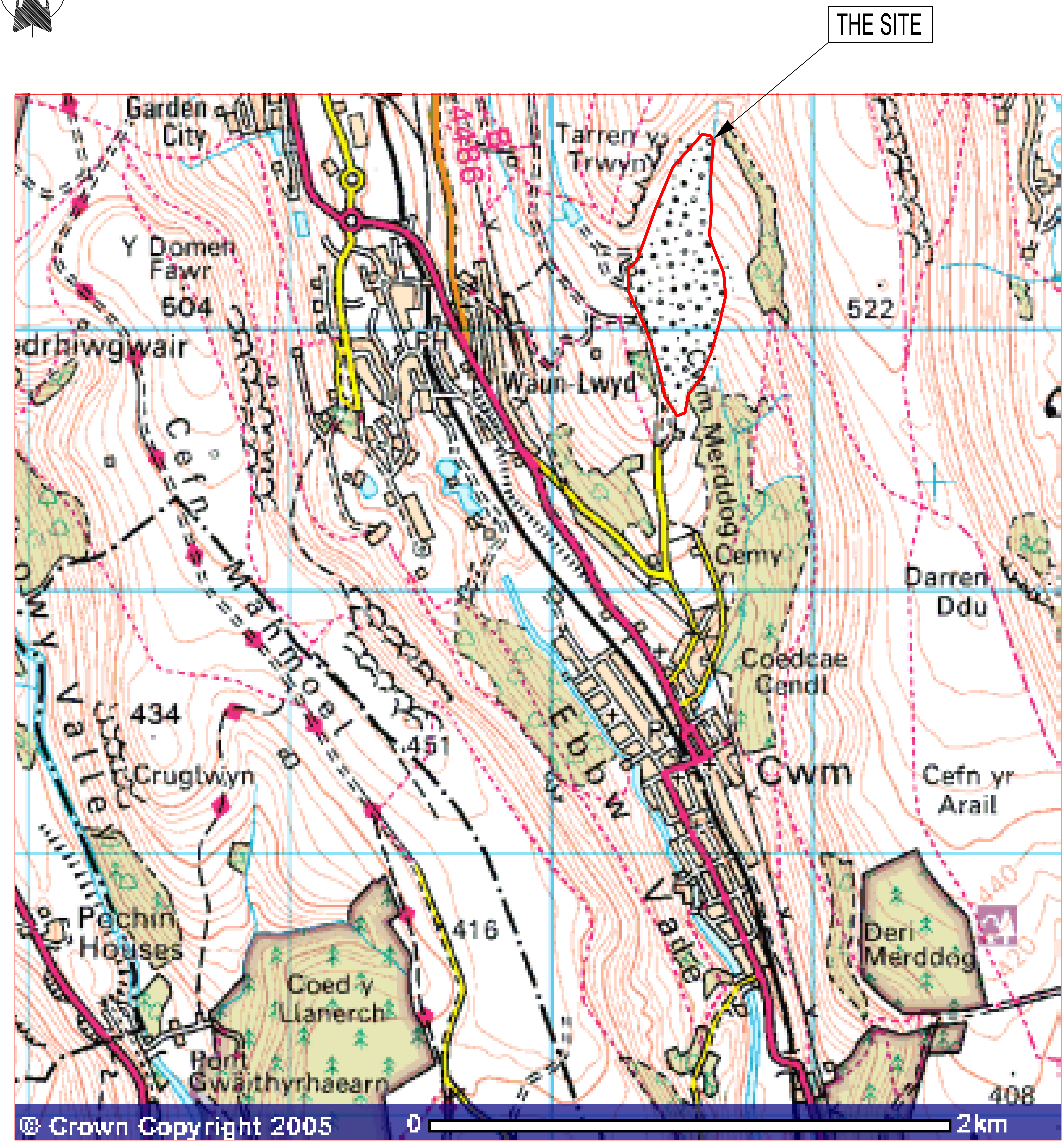
Job Title
Silent Valley Landfill

Drawing Title
Site Location

Scale at A4	N.T.S
Plot ID	zfigure1.dgn
Drawing Status	Information

Job No	Drawing No	Issue
115825	Figure 1	I0

I0	02/05/07	RP		
	Issued For Information			



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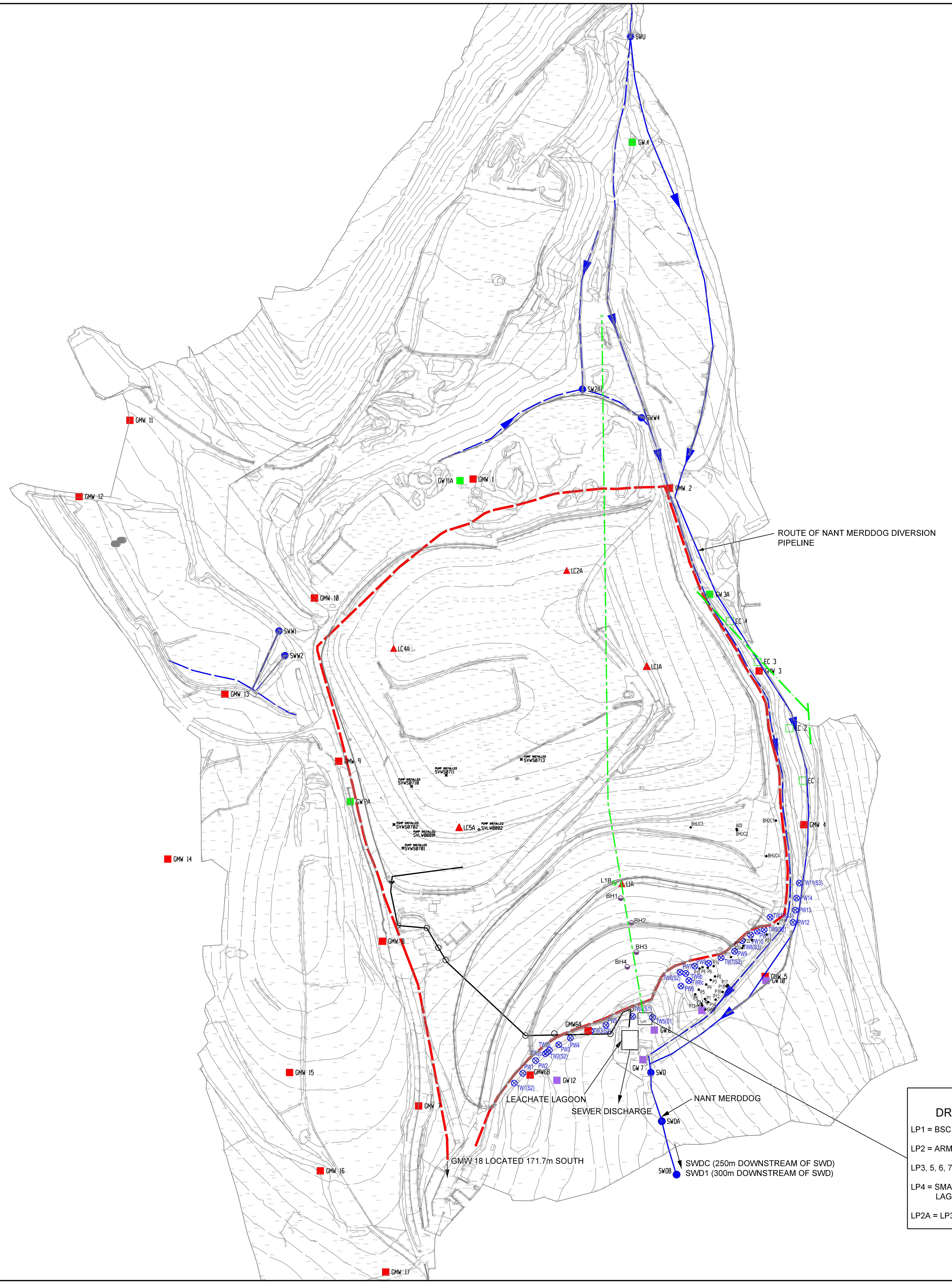


LEGEND

EC 1	EASTERN CUT-OFF MONITORING WELLS
GMW5	GAS MONITORING POINTS
GW10	COMPLAINCE POINT GROUND WATER WELLS
GW4	GROUND WATER MONITORING WELLS
SW1	SURFACE WATER SAMPLING POINTS
LC1	LEACHATE MONITORING WELLS
	SURFACE WATER DITCHES
	EXTENT OF LANDFILLED WASTE
TWs & PWs	PUMPING WELL CUT OFF SYSTEM

LEACHATE
DRAIN OUTFALLS

LP1 = BSC PIPE

LP2 = ARMCO PIPE

LP3, 5, 6, 7 = OTHER OUTLET PIPES

LP4 = SMALL DIRECT INPUT TO THE LAGOON

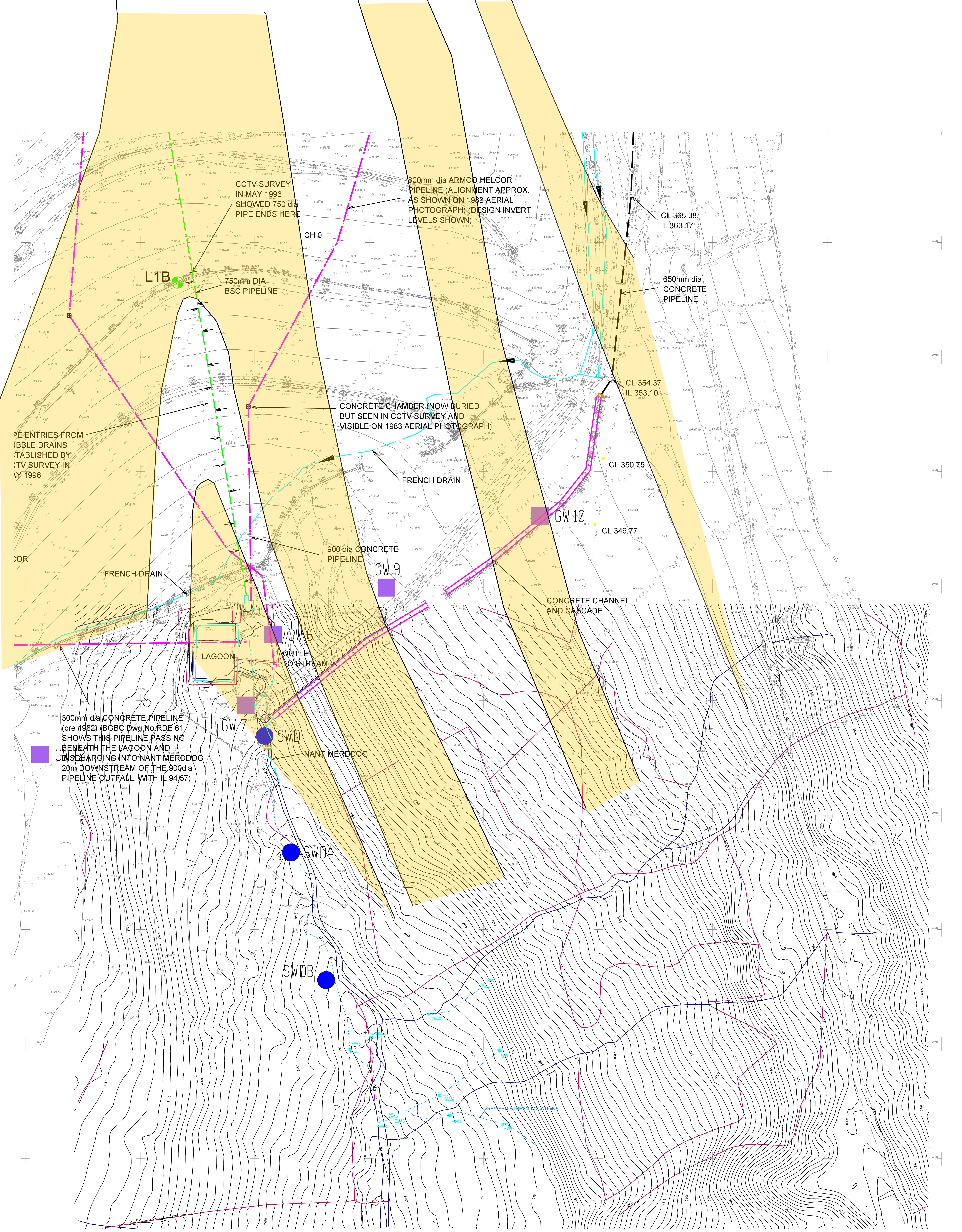
LP2A = LP3 + LP5 + LP6 + LP7

SCALE 1:2500 @ A1

SILENT VALLEY LANDFILL
SITE PLAN
ENVIRONMENTAL MONITORING

115825-00 FIGURE **2**

J:\115000\115825-00\4 Internal Project Data\4-30 Drawings\4-33 Civil\Figure 2 Site_Plan_Env_Monitor_Prog.dgn



CCTV SURVEY
IN MAY 1996
SHOWED 750 dia
PIPE ENDS HERE
800mm dia ARMCO HELCOR
PIPELINE (ALIGNMENT APPROX.
AS SHOWN ON 1983 AERIAL
PHOTOGRAPH) (DESIGN INVERT
LEVELS SHOWN)
CH 0
CL 365.38
IL 363.17
L1B
750mm DIA
BSC PIPELINE
650mm dia
CONCRETE
PIPELINE
CL 354.37
IL 353.10
CONCRETE CHAMBER (NOW BURIED
BUT SEEN IN CCTV SURVEY AND
VISIBLE ON 1983 AERIAL PHOTOGRAPH)
PE ENTRIES FROM
JBBLE DRAINS
STABLISHED BY
CTV SURVEY IN
AY 1996
FRENCH DRAIN
CL 350.75
GW 10
CL 346.77
COR
900 dia CONCRETE
PIPELINE
GW 9
FRENCH DRAIN
CONCRETE CHANNEL
AND CASCADE
GW 6
OUTLET
TO STREAM
LAGOON
GW 7
SWD
300mm dia CONCRETE PIPELINE
(pre 1982) (BGBC Dwg No RDE 61
SHOWS THIS PIPELINE PASSING
BENEATH THE LAGOON AND
DISCHARGING INTO NANT MERDDOG
20m DOWNSTREAM OF THE 900dia
PIPELINE OUTFALL, WITH IL 94.57)
NANT MERDDOG
SWDA
SWDB
REVISED STREAM LOCATIONS

Appendix A

Details of cut-off and monitoring systems

A1 Pumping cut-off system and monitoring

The following is a summary of the activities that have taken place at the site in relation to the pumping and monitoring system since its installation in 2007.

2007 **October:** The pumping system became operational.

2008 **November/December:** A programme of inspection and maintenance was undertaken to check the level and performance of each well and pump following the findings of the January to September 2008 interim report, which indicated that the cut-off system operated less efficiently post high rainfall events, with concentrations within the compliance wells temporarily increasing. A number of wells were found to be silting up and required cleaning. Details are presented in the Annual Monitoring Report 2008.

2009 **January:** The majority of wells were successfully cleaned. The base of wells TW2, TW7, PW4 and PW10 were found to be above the depth shown on the logs. Deeper replacement wells were installed at TW2, TW6 and TW7, (called TW2A, TW6A and TW7A), construction details as shown in the sketch at the end of this Appendix;

February: Low-draw pumps were installed to improve the situation at PW4, PW7, PW10 and PW14;

March: Existing pumps were replaced with more robust pumps, to cope with silting and iron hydroxide deposition;

April: Pumping from these replacement wells commenced;

November/December: The pumps in wells TW2A and TW6A were overwhelmed during periods of very heavy rainfall, producing impacts in the compliance wells downstream, at GW9 and GW12 and monthly average leachate heads often in excess of permitted values. There was concern that the monitored heads may have been influenced by perched leachate bodies, the monitoring wells having been constructed with slag gravel response zones extending through the body of the landfill. As a result, two more pumping wells were installed alongside each of wells TW2A and TW6A, with the aim that these wells would provide support to the existing wells and prevent further migration of leachate. Pumping tests and the installation of new leachate monitoring wells at the locations of LC1, LC2 and LC4 (LC1A, LC2A and LC4A) were undertaken to obtain additional information on the leachate heads. The new wells were installed with 3m long response zones in contact with the base of the landfill and isolated from potential perched leachate bodies higher up within the landfill mass. As such, they are representative for measuring the hydrostatic head of leachate that acts on the base of the landfill and potentially drives leakage. The wells have consistently indicated leachate heads that are much lower than those measured previously in the corresponding former monitoring wells LC1, LC2 and LC4. This is considered strong evidence that the average leachate heads derived previously were influenced by perched leachate bodies.

2010 **February:** Wells TW2B, TW2C, TW6B and TW6C were installed alongside wells TW2A and TW6A. The monitoring results indicate there has been an improvement of water quality in GW12 in relation to ammoniacal nitrogen and chloride (i.e. in TW2A, only one exceedance of the compliance limit for ammoniacal nitrogen and no exceedances for chloride were recorded since the installation of the new pumps). However, this improvement was not replicated at GW9 downstream of TW6A, B and C. Extensive investigations including sampling and laboratory analyses have been undertaken to confirm the source of the leachate species encountered in GW9 and measures to address this issue have been undertaken (see Reference [8]). The investigations identified an uncapped plateau area on the eastern flank of the landfill and concluded that one of the sources of the leachate monitored in GW9 may be groundwater infiltrating into the waste body from this uncapped area and flowing towards GW9 within fractured mudstone and sandstone layers, in line with the geological and hydrogeological model also presented in the report. Part of the leachate body in the uncapped waste was also considered to be flowing towards a gabion mattress-lined ditch located on the eastern flank of the landfill. This leachate was found to be diluted by the surface waters flowing in the ditch and potentially by groundwater from the valley sides, and was also considered likely to be impacting GW9. The capping of the eastern plateau was completed in August 2011 (see below).

June/July: A replacement monitoring well LC5A was drilled adjacent to LC5. A back-up compressor has been installed to provide support to the compressor currently in use at Silent Valley.

August: The new leachate well, LC5A, was commissioned and subsequently monitored in accordance with the quarterly monitoring regime.

2011 Leachate pumping was temporarily ceased due to bio-fouling of the pumps and wells. The pumping was shortly after reinstated using gas extraction wells and the pumping continues to date.

August: The capping of the eastern plateau was completed. Since its installation, the levels of ammoniacal nitrogen and chloride in GW10 were observed to have significantly reduced towards the end of 2011; however, these continued to be above the compliance level in GW9 and further sampling was recommended to monitor the trend.

2012: No specific maintenance or upgrades on the monitoring infrastructure were required or undertaken in 2012.

2013 **March to July:** The pump in PW12, which pumps from sandstone strata S3, was found to be not working. Following a number of maintenance works, the pump was still found to be failing. On reinstatement of the electronic groundwater monitoring system in July (see further details below), it was evident that the pump in this location was continuing to have issues. The pump was consequently changed in August and the groundwater levels within the well have since returned to the required level. Maintenance issues were also recorded in the eastern section of the cut-off system, wells between April and September 2013 in TW10.

December: Although there is no current evidence to suggest issues with the efficacy of the BSC pipe located in the southern flank of Phase 1 landfill, SVWS commissioned the installation of four additional leachate monitoring wells (BH1 to BH4) along the alignment of the BSC pipe in December. The objective is for these boreholes to be monitored to confirm both the nature and level of leachate within the Phase 1 area and any long-term trends in leachate level (note that monitoring has temporarily ceased due to the works undertaken for the capping of Phase 1 landfill – see following sentence). During the installation of these wells, observations indicated that the capping of Phase 1 landfill was not typical of a low permeability capping system and further investigations, including the excavation of 19no shallow trial pits, confirmed that the existing capping was likely to not be preventing infiltration of rainwater. SVWS are currently undertaking works to improve the capping of the Phase 1 area in order to achieve a reduction in the leachate production and achieve regulatory compliance (see below).

2014 **July:** Earthworks for the installation of the capping system in Phase 1 landfill commenced. A combination of cut and fill is used to slacken the existing landfill slope angles to a maximum gradient of 1V:2.5H to achieve a stable angle for the capping system.

July to September: Further issues were identified within the eastern section of the cut-off system, particularly in TW11, and also in TW10 and PW14, all installed within the Sandstone S3 stratum. Pump failure was recorded in TW11 from July the 7th till September the 4th. After a number of attempts, the pump was finally retrieved and further delay in a pump reinstatement was caused by the delivery of required replacement parts. In addition, pumps installed in TW10 and PW14 repeatedly failed after service, however are now fully operational.

2015 **January:** capping of Phase 1 landfill is ongoing, with the earthworks largely complete. In addition to the new capping, improvements are also being made to both the surface water drainage and the leachate drain at the toe of the landfill. A new access track has also been constructed across the landfill to provide access for construction and future maintenance.

A1.1 Electronic Monitoring System

Since April/May 2009, the water levels within the pumping wells have been continuously monitored using electronic devices installed within the wells, so-called 'divers'. These send water level data at a specified frequency directly to an office-based computer, allowing continuous remote monitoring of the efficiency of the cut-off system. This has enabled immediate investigation and remedial actions to be taken when the water level within any well has risen unacceptably or abnormally.

In March 2013, however, problems have occurred with some of the modems, devices collecting data and sending this information to the office-based computer. During the repair period, the efficiency of parts of the pumping system was monitored manually. The modems have been successfully reinstalled in July 2013 and no further issues have been recorded since then.

A1.2 Future maintenance and reinforcement

The pumping well cut-off system is considered to be both robust and flexible. There is considerable redundancy in its design, both in terms of the spacing of the wells and the capacity of the pumps. The system can be easily modified or augmented by the addition of new wells as necessary (as has already taken place in 2008, 2009 and early 2010). In addition to this, the electronic monitoring system, together with routine on-going maintenance of the wells and pumps and provision of replacement pumps, enables corrective actions to be taken in advance of any acute problem that could have an adverse impact on the local groundwater environment. It is clear that for the significant majority of the site, the pumping system is preventing the impact of leachate species from within the body of the waste (or discharge zone as per the Groundwater Regulations 2009 incorporated into EPN2012) on the groundwater. Where there is the one non-compliance, GW9, Silent Valley has undertaken extensive investigations and works (References [7] and [8]).

Appendix B

Previous Site Monitoring

B1 Groundwater Monitoring

There are eight monitoring wells located upstream of the landfill site, where background groundwater quality monitoring has been carried out. These are GW2A, GW3A, GW4, GW11A and EC1 to EC4. Of these, GW2A, EC3 and EC4 were frequently dry and therefore a sample could not always be collected. The EC wells were installed in April 2008 as part of the initial feasibility study into an eastern pumping cut-off system and were included into routine monitoring in October 2008 until June 2010.

B2 Surface Water Monitoring

Locations S1 to S6 and SW2AO (see table below) were monitored from October 2008 to April 2010 to check the background quality of groundwater emerging from the eastern hillside, to supplement existing information and particularly identify any trends associated with the passage of water through abandoned mine workings and associated mudstone/seat- earth strata. Each of the monitoring locations comprised a perennial stream originating from groundwater issues.

Table B1: Former surface water monitoring locations

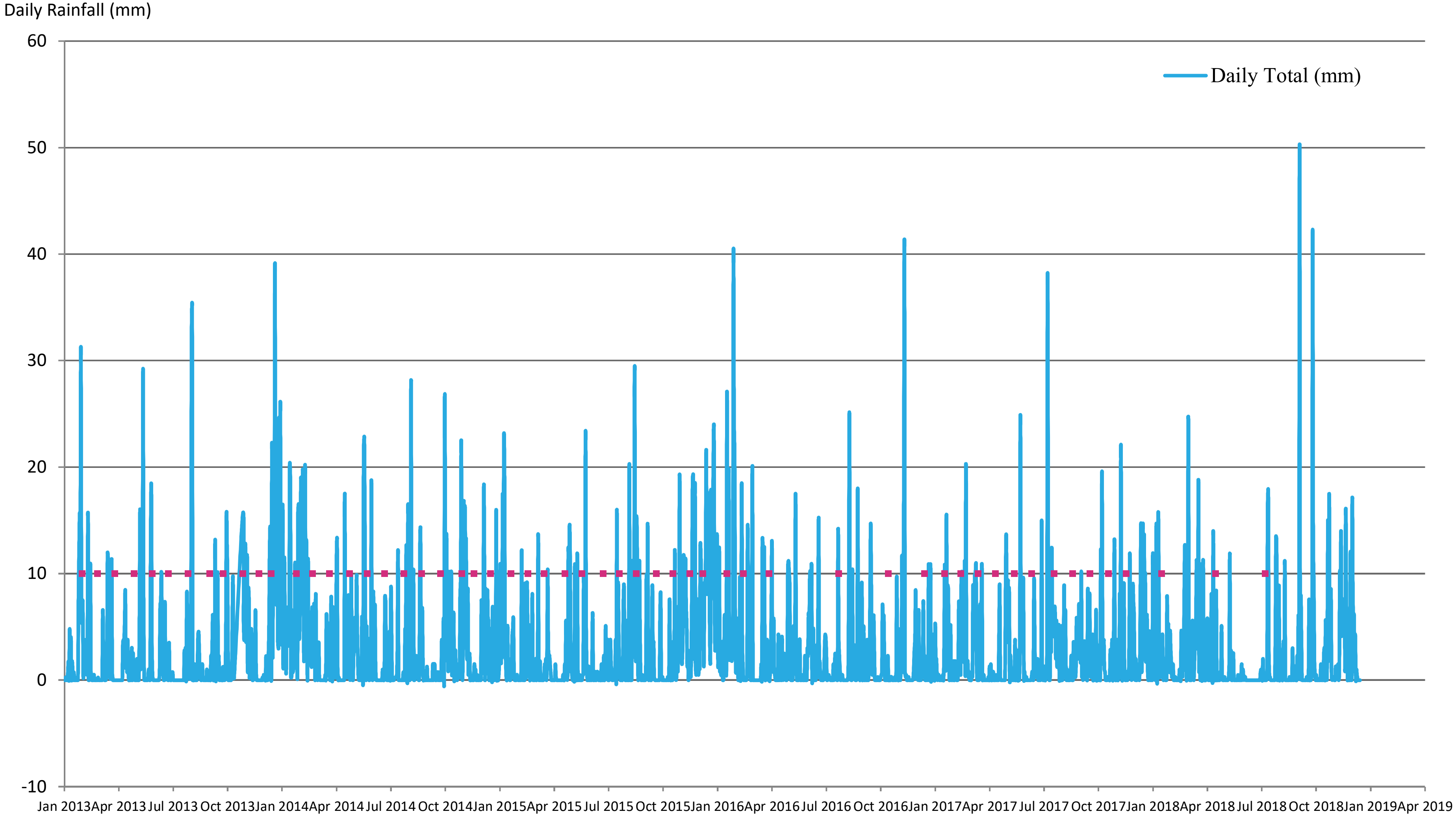
Monitoring Point	Location
S1	A stream, located 20m east of the landfill; approximately 100m north of the recorded landslide; emerging from the backfill of a former opencast site.
S2	A stream, located 20m east of the landfill; 100m south of S1, emerging from within the recorded landslide.
S3	A stream, located 350m downstream of the point where the diverted Nant Merddog joins its original course; the sampling point S3 is located approximately 150m upstream of the confluence with the Nant Merddog; the stream originates from issues downhill of the Old Tramway Path.
S4	A stream, located 650m south-east of the landfill, issuing from the foot of a cliff above the Old Tramway Path; the sampling point S4 is located approximately 10-20m above the path.
S5	A stream, located 70m south of S4; the stream crosses the pathway; the sampling point is located directly downstream of the path.
S6	A stream, located just outside the fence perimeter, the sampling point is located some 20m south of compliance well GW10.
SW2AO	Aqua-pipe outfall discharging to Nant Merddog (pipe buried beneath landfill in north-south direction) – sampling point abandoned, pipe is collapsed and collecting leachate from landfill, and was subsequently diverted into the leachate lagoon sump.

Between February and April 2010, water hardness in the Nant Merddog was undertaken in monthly rounds in order to select appropriate hardness dependant EQS levels. Previously, hardness data used was for the River Ebbw Fawr at the confluence of the Nant Big and the Nant Merddog.

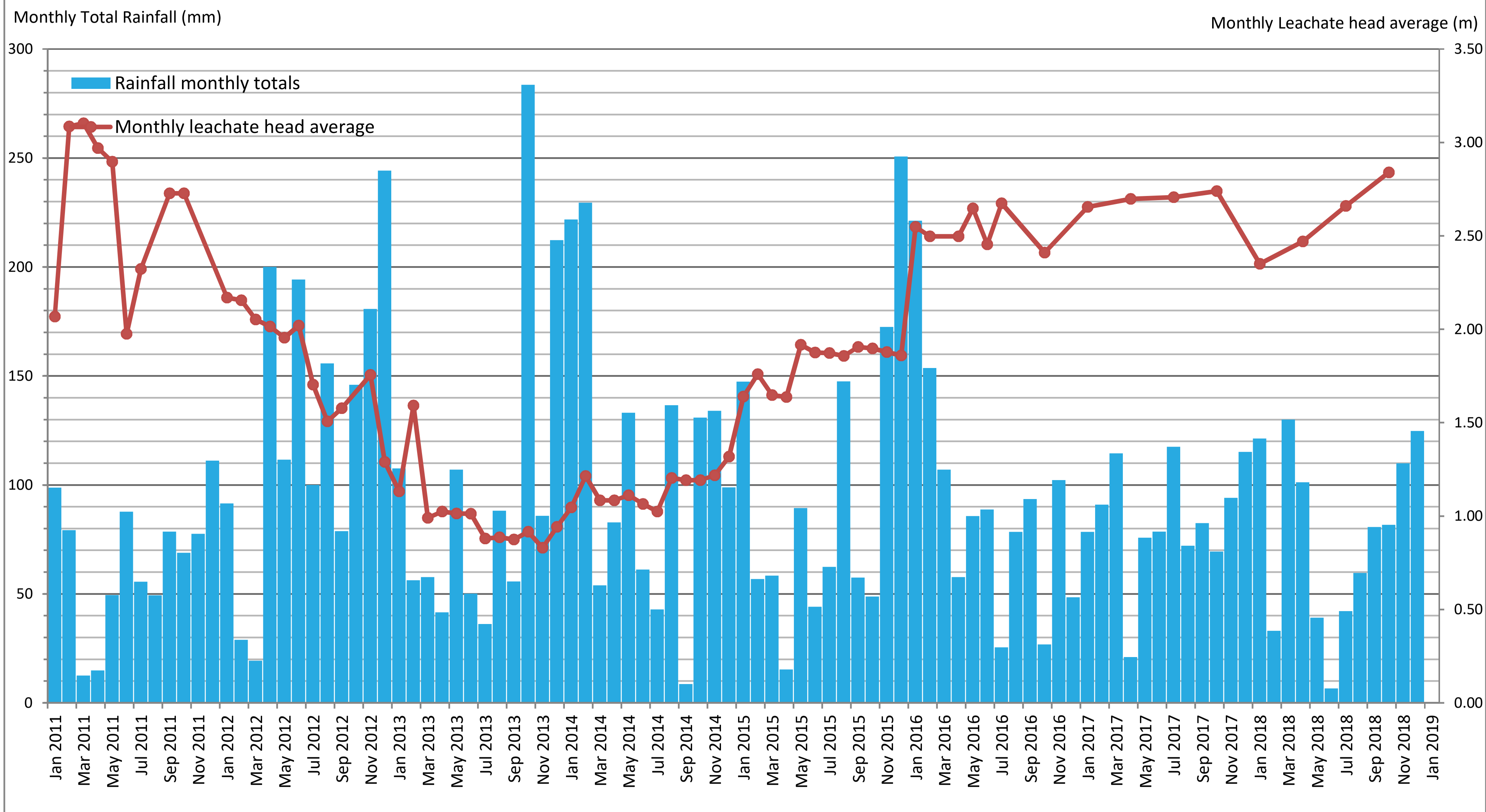
Appendix C

Monitoring Results - Graphs

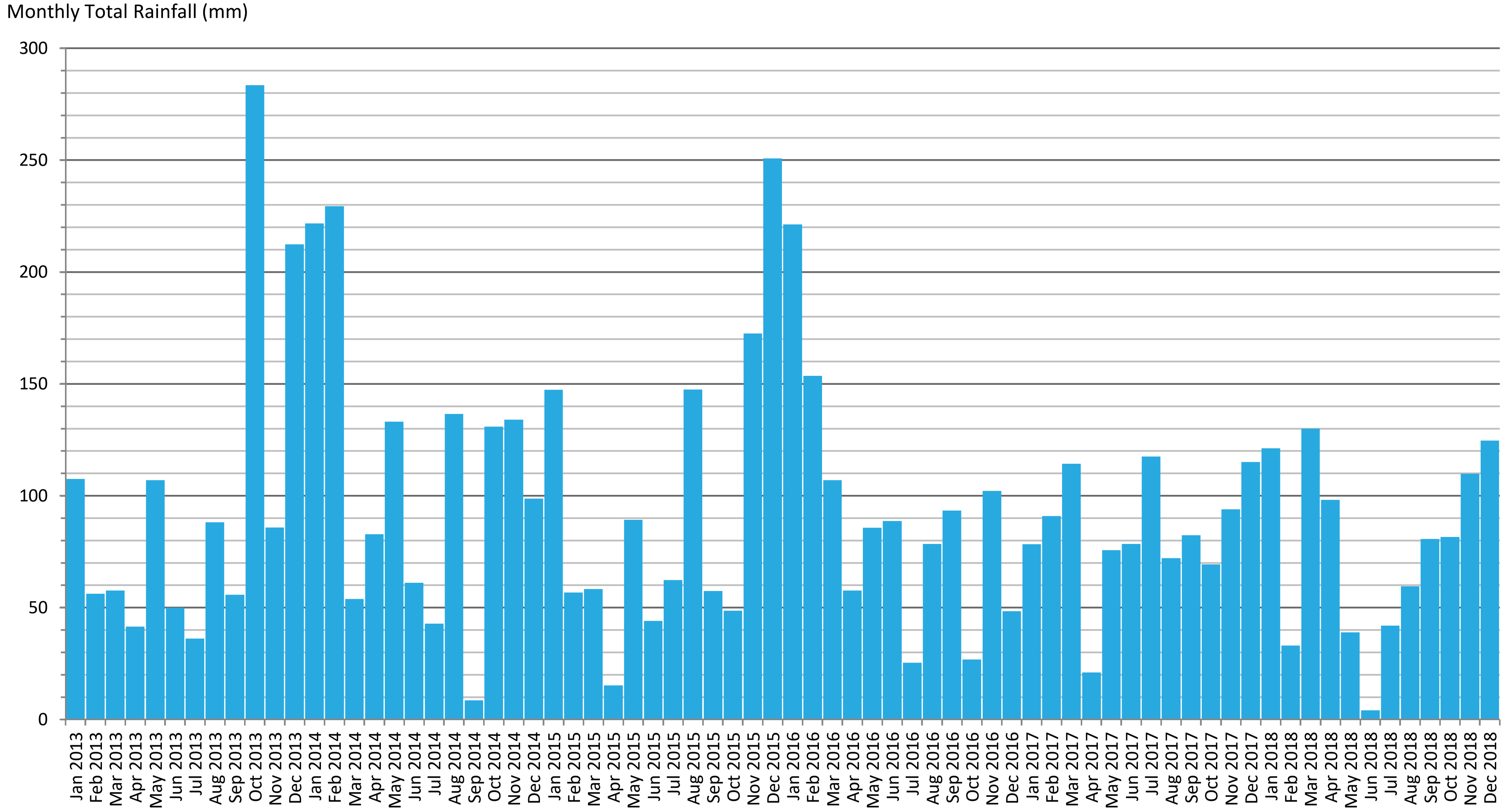
Appendix C
Figure C1
Daily rainfall totals and sampling events (January 2013 - December 2018)



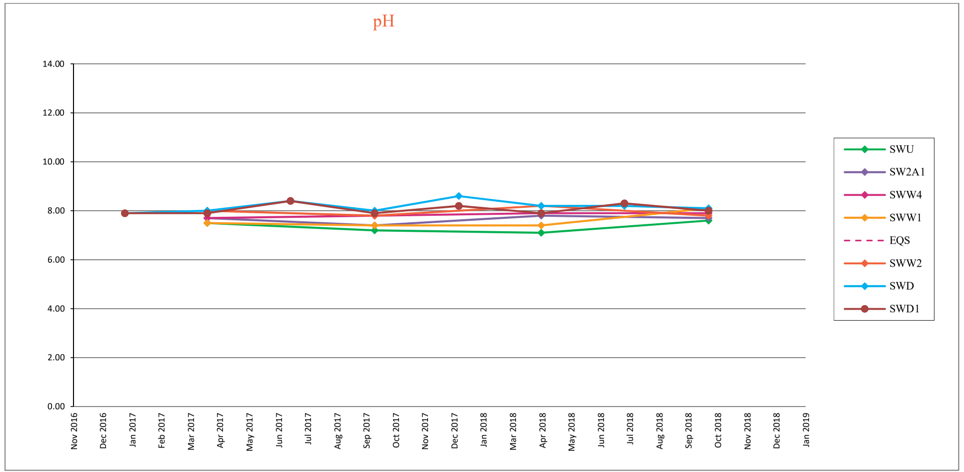
Appendix C
Figure C2
Monthly rainfall totals (January 2013 - December 2018)

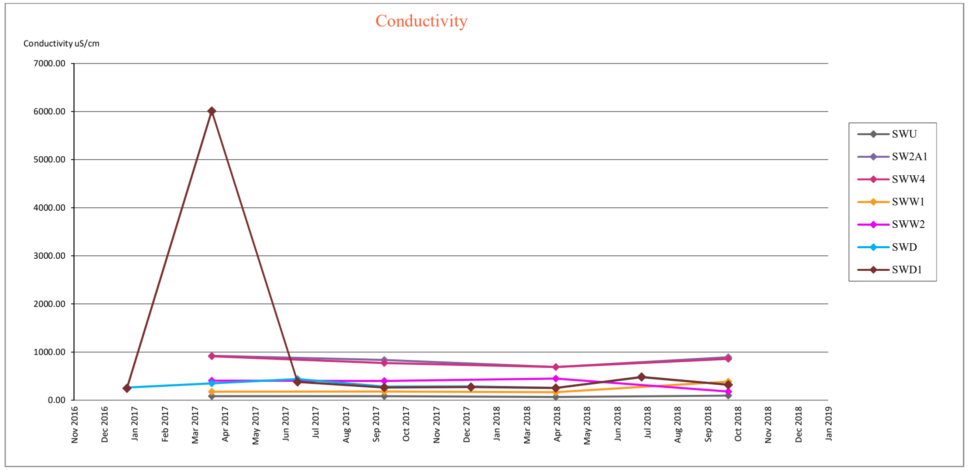


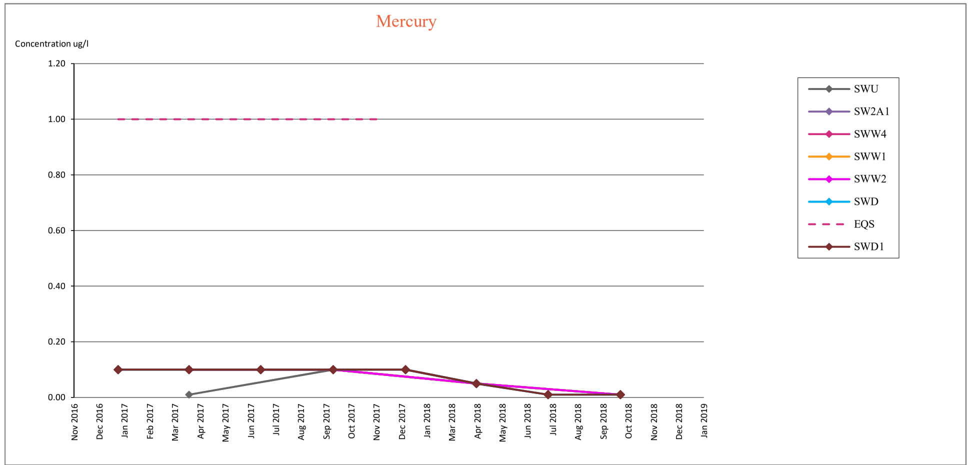
Appendix C
Figure C3
Monthly total rainfall (January 2013 - December 2018)

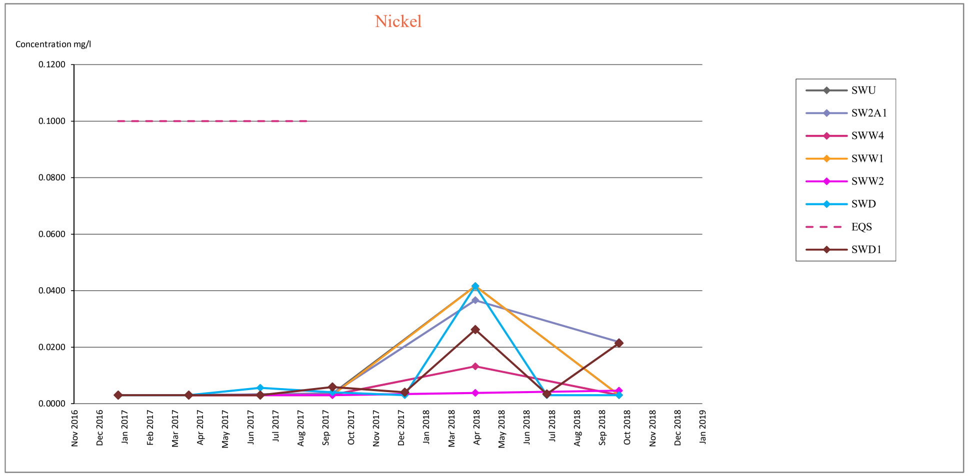


APPENDIX C
Figure C4
Surface water monitoring graphs

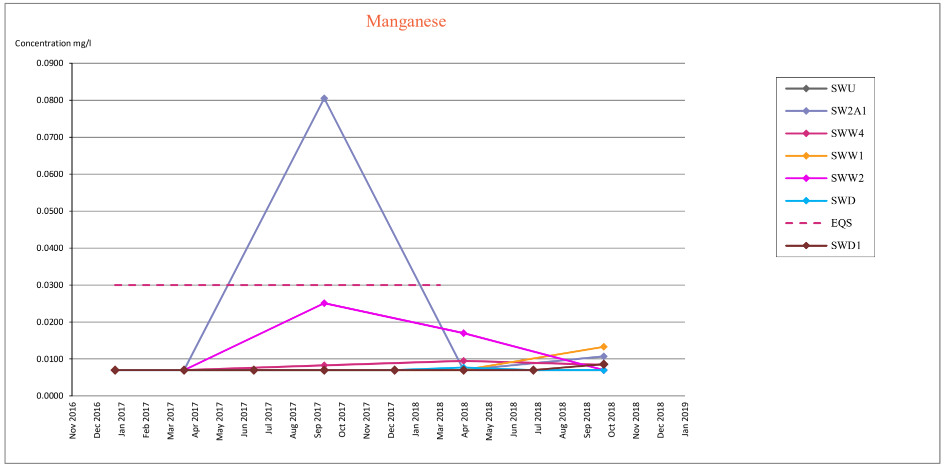


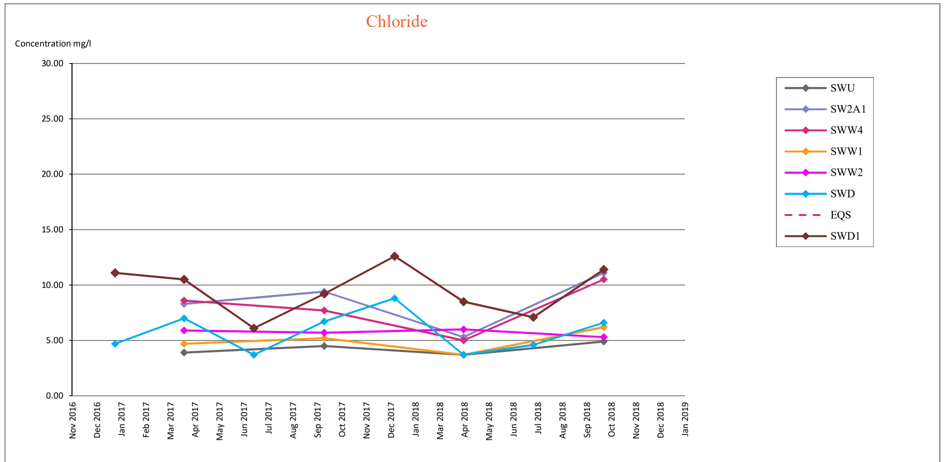


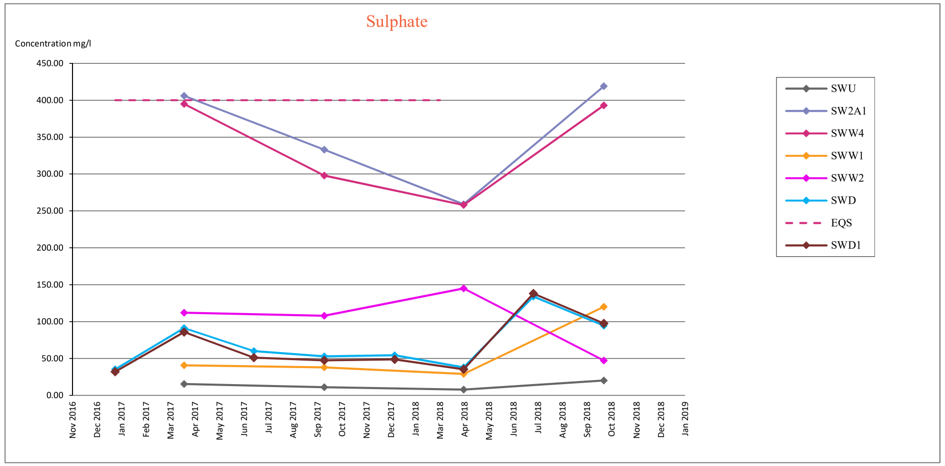




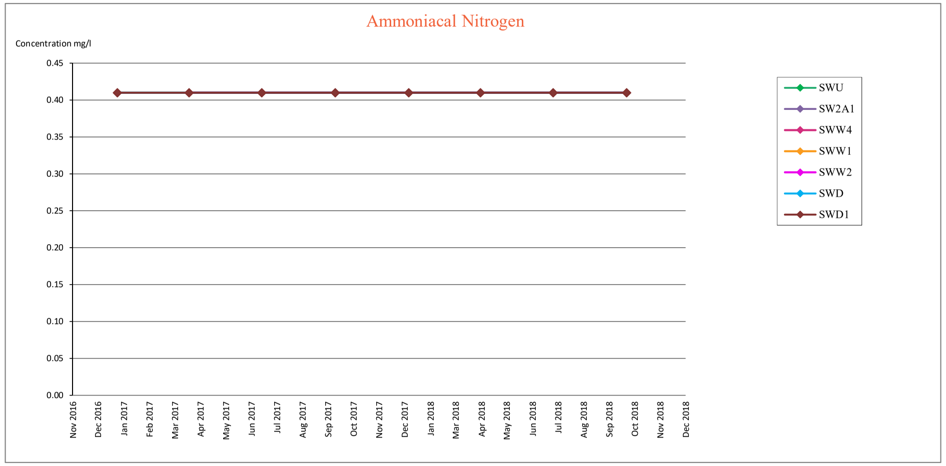
APPENDIX C
Figure C4
Surface water monitoring graphs

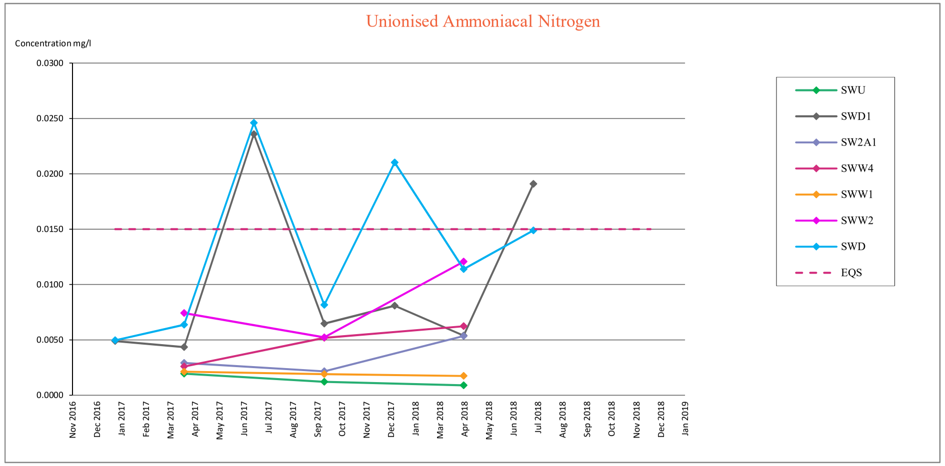




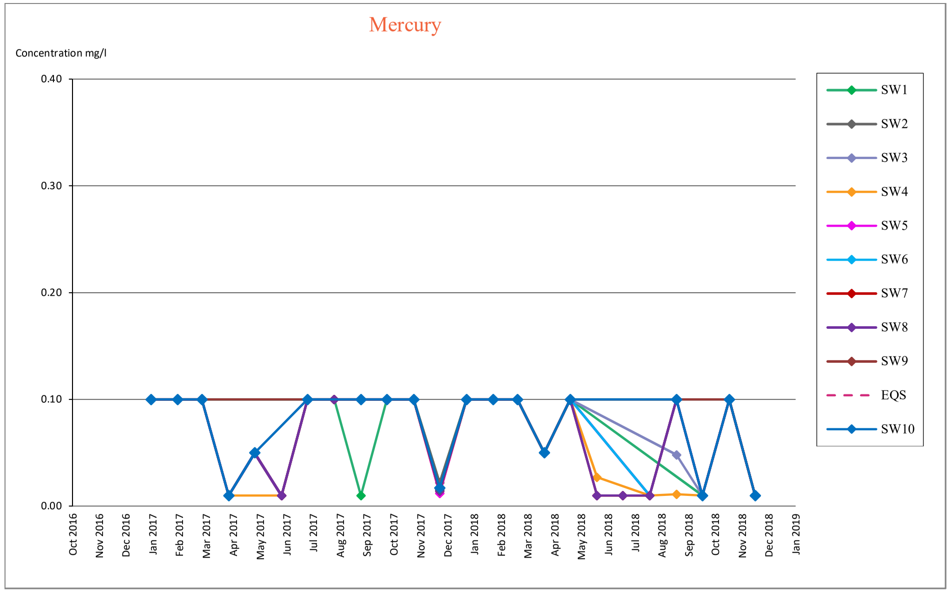


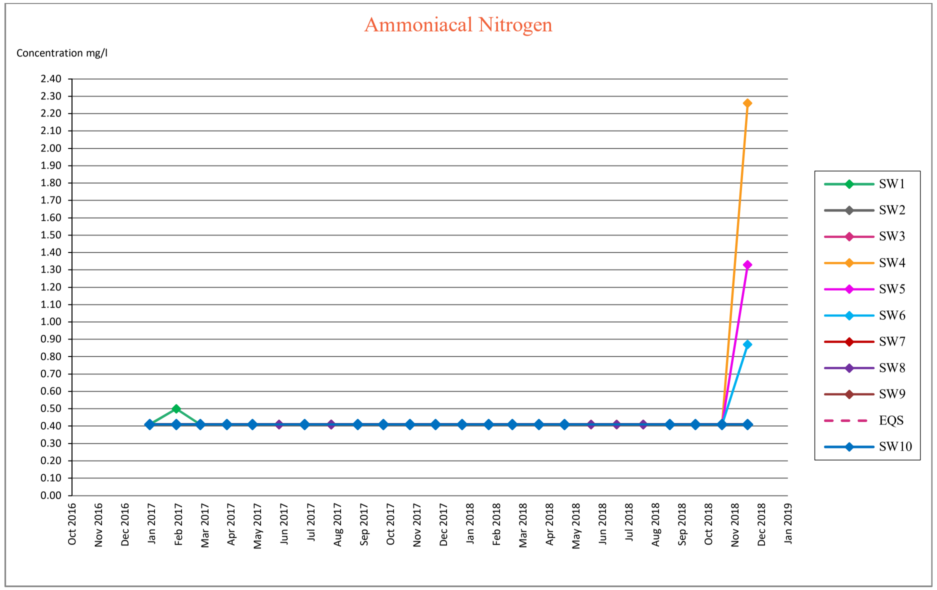
APPENDIX C
Figure C4
Surface water monitoring graphs

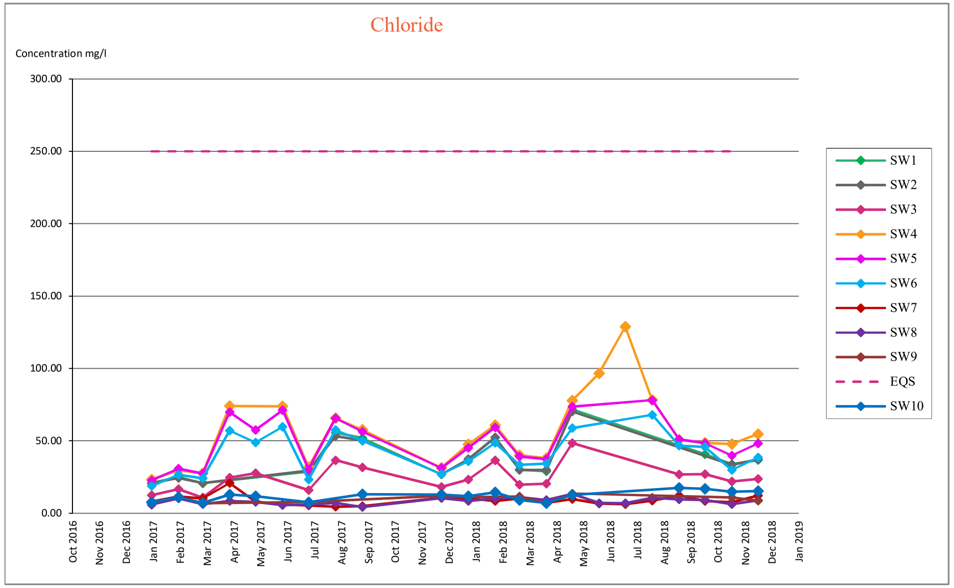




APPENDIX C
Figure C5
Surface water monitoring graphs (SW1 to SW10)

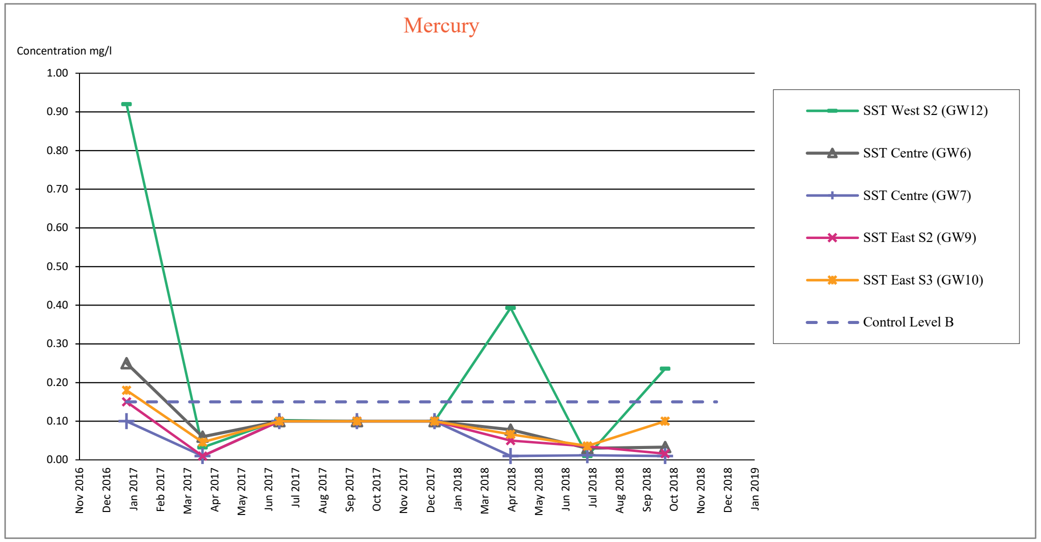


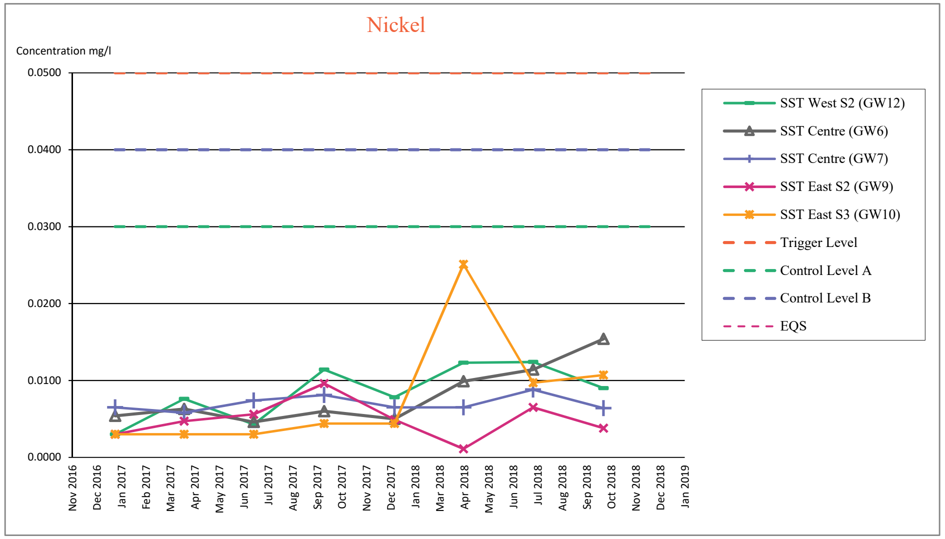


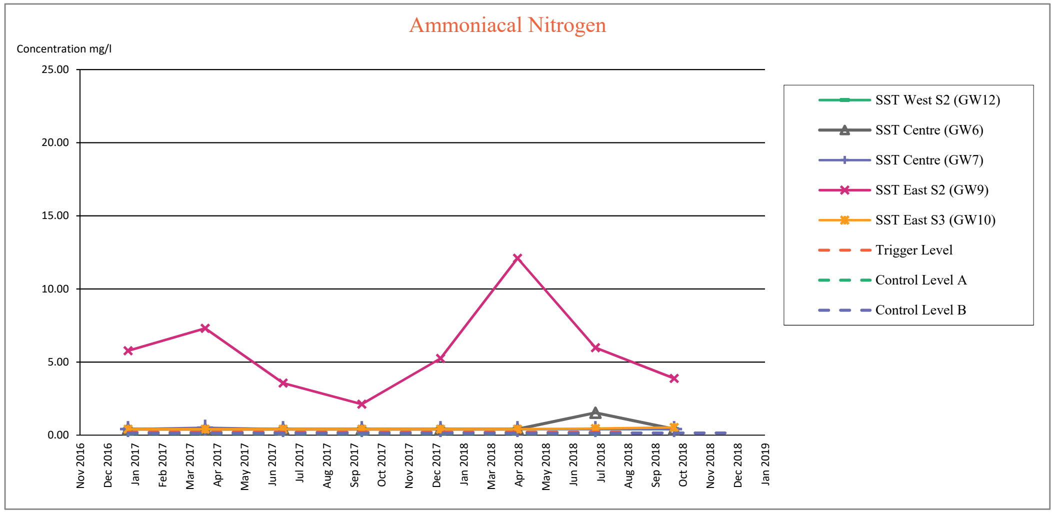


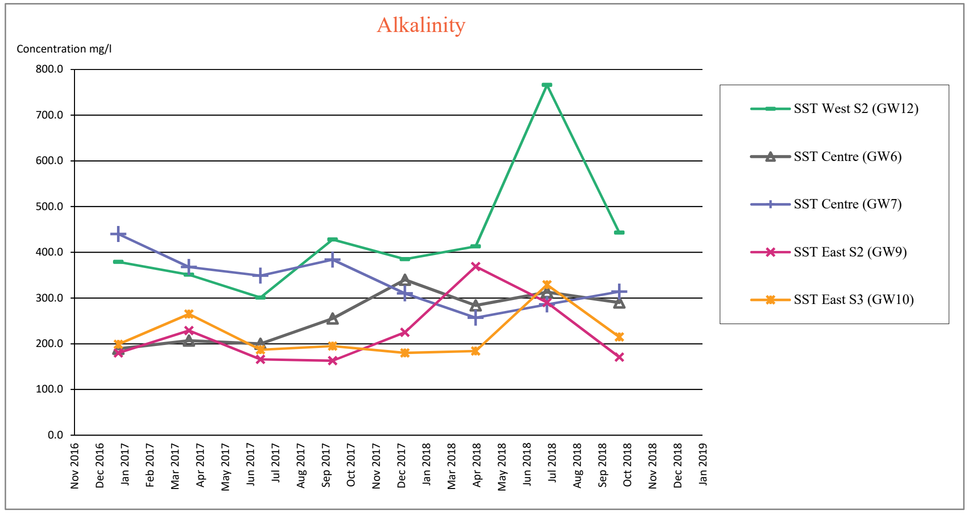
APPENDIX C
Figure C6
Groundwater quality monitoring results - Compliance wells graphs

Compliance wells graphs







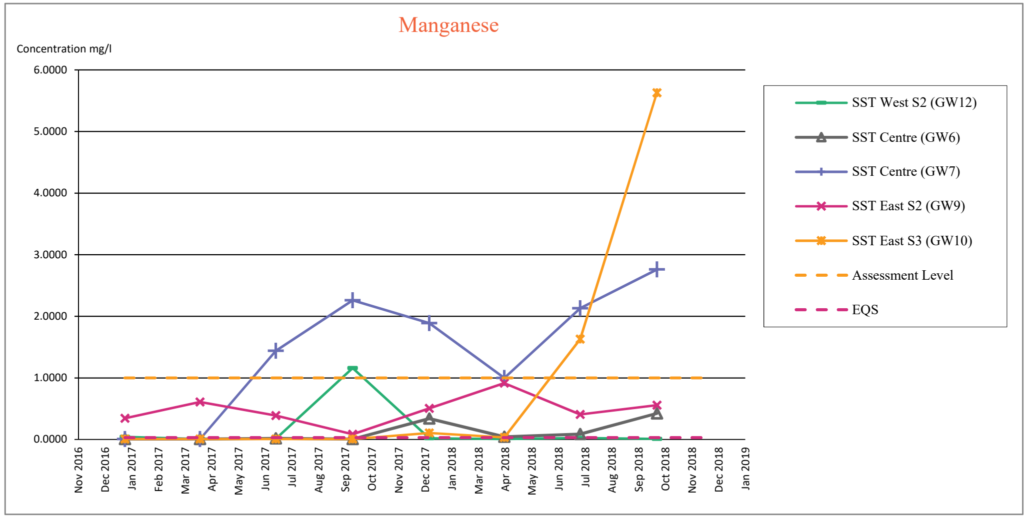


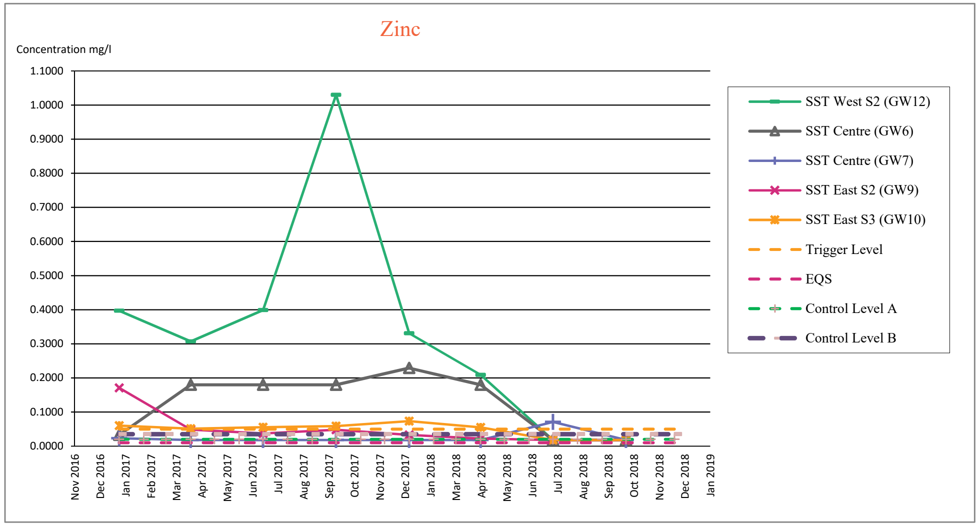
APPENDIX C

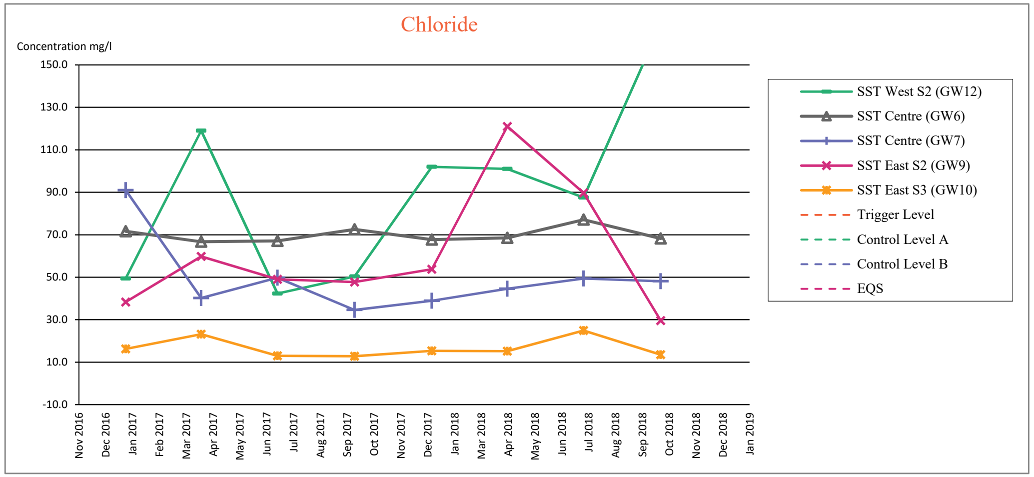
Figure C6

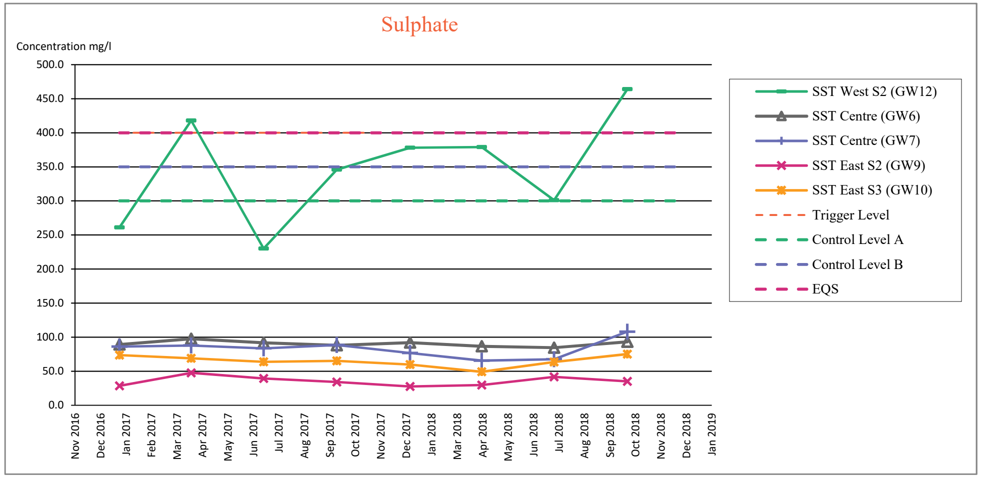
Groundwater quality monitoring results - Compliance wells graphs

Compliance wells graphs

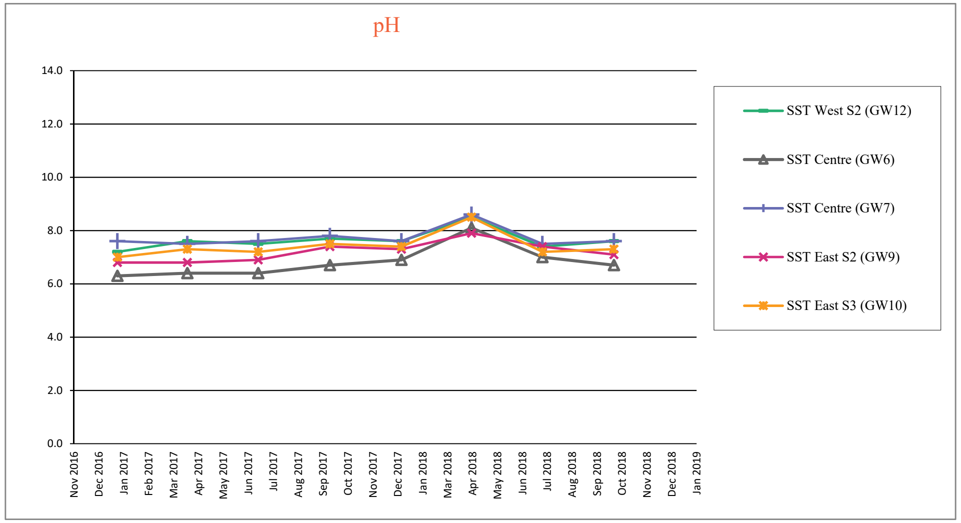




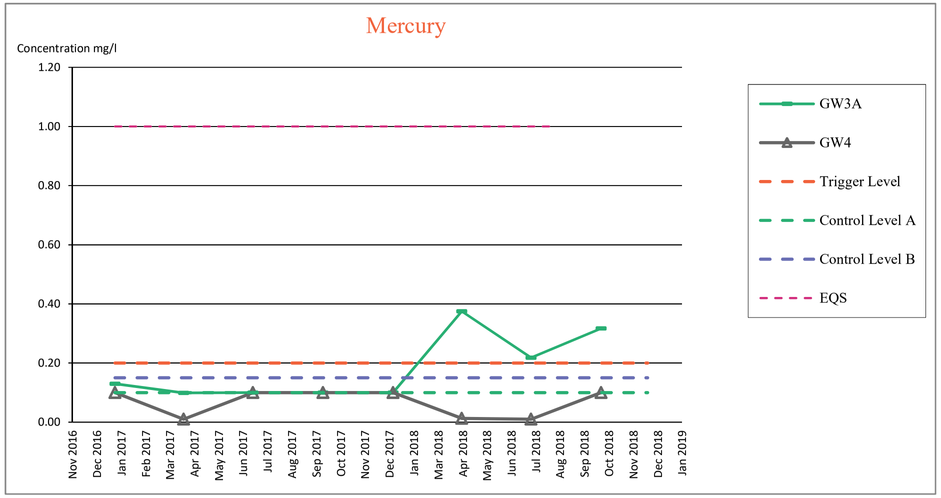


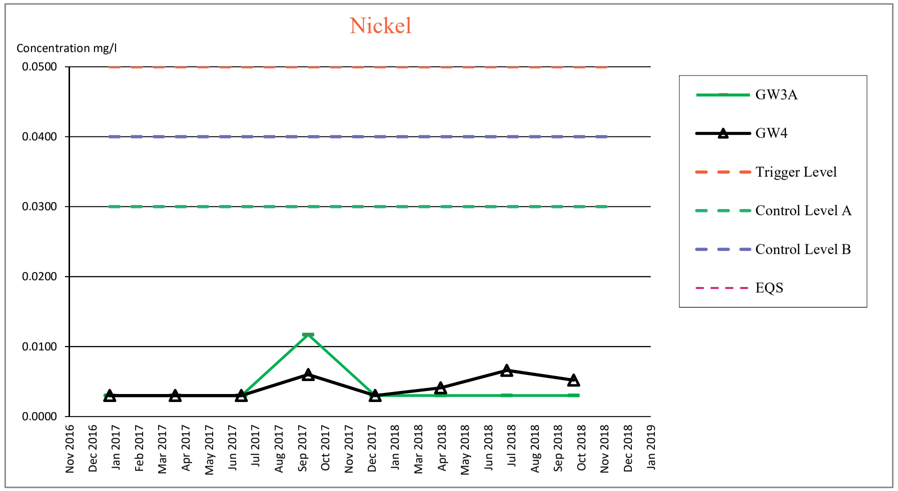


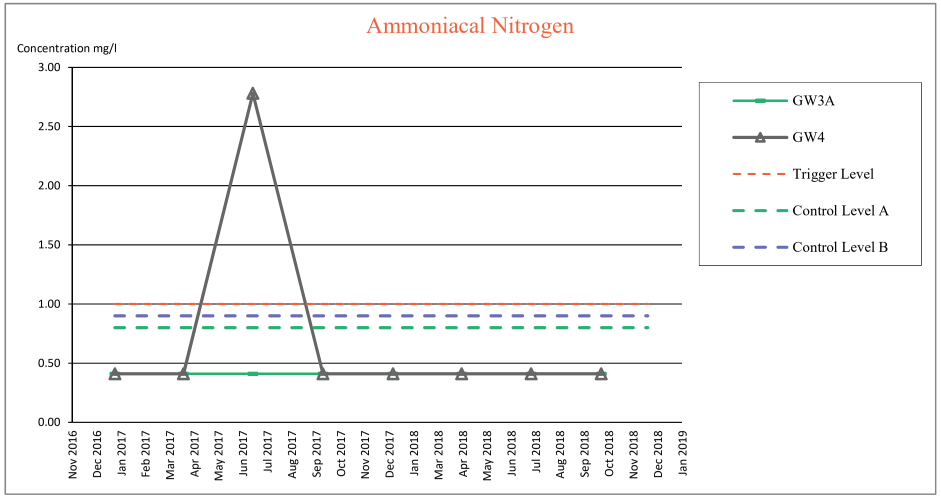
Compliance wells graphs

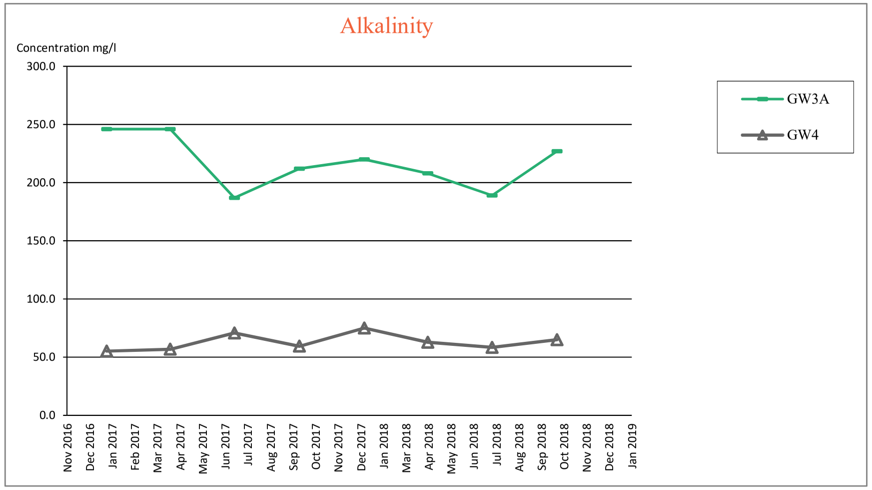


APPENDIX C
Figure C7
Groundwater quality monitoring results - Upstream wells graphs

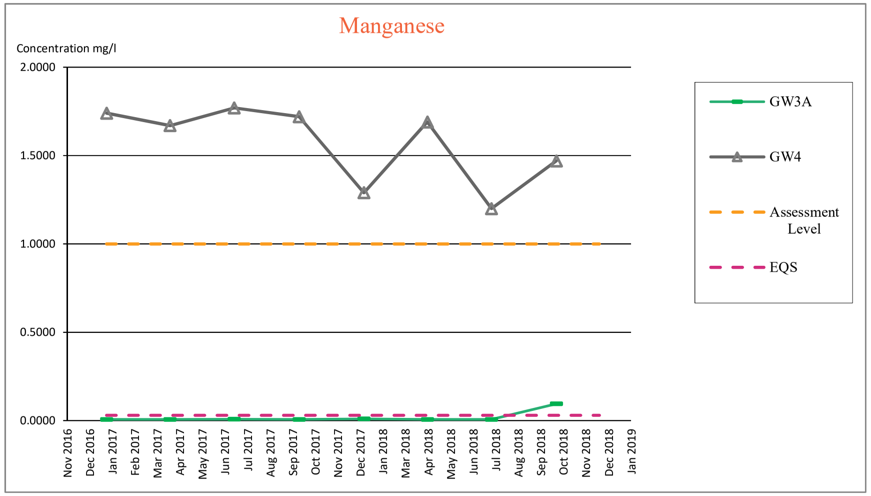


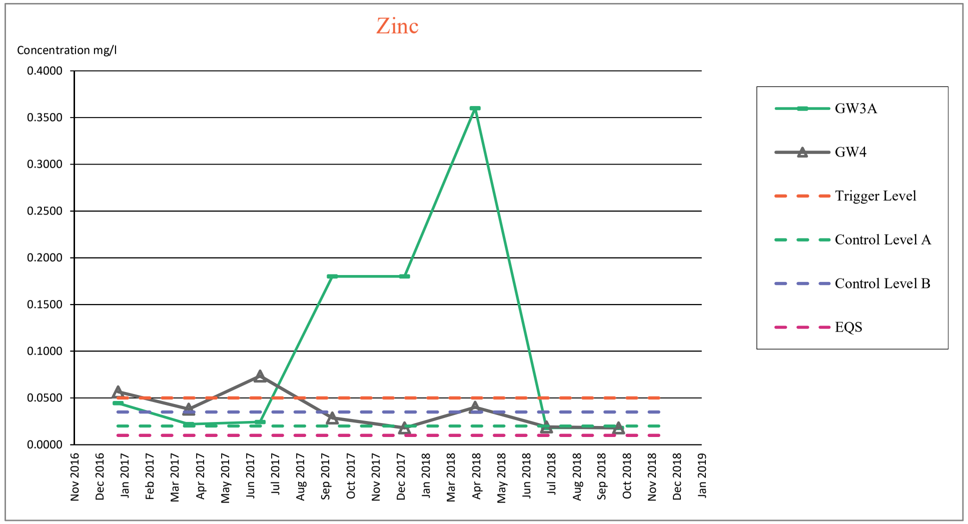


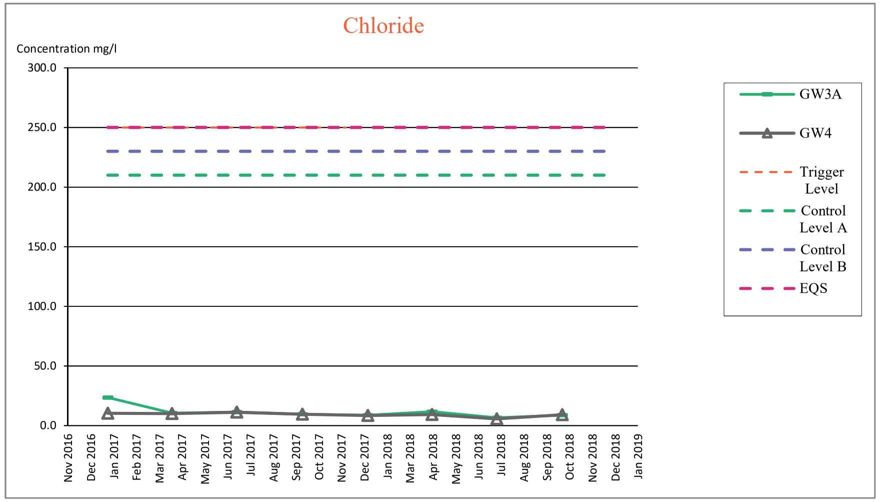


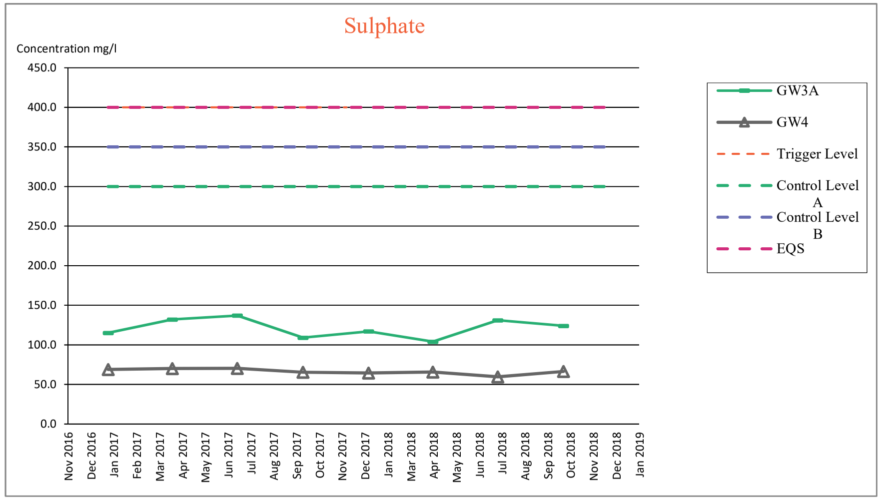


APPENDIX C
Figure C7
Groundwater quality monitoring results - Upstream wells graphs

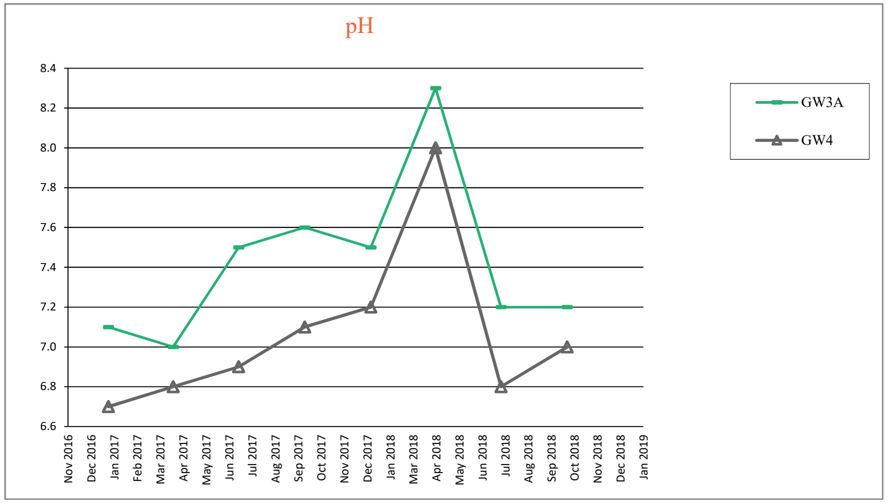




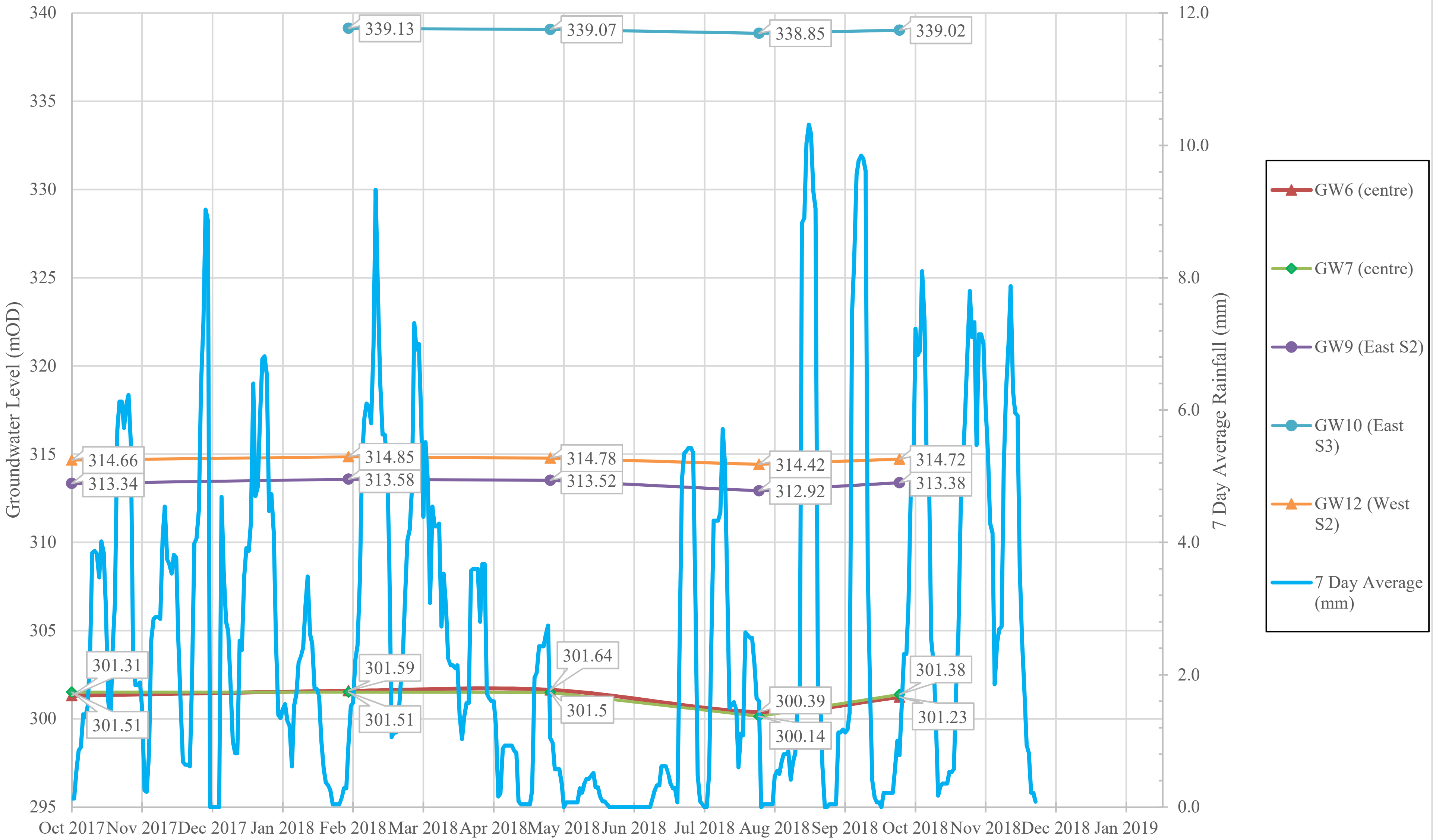




APPENDIX C
Figure C7
Groundwater quality monitoring results - Upstream wells graphs



Appendix C
Figure C8
Groundwater monitoring levels downstream of compliance wells



Appendix D

Monitoring Results - Tables

Appendix D
Table D1
Leachate Monitoring Results

January 2018												
LOCATION	**Units**	**L1A**	**L1B**	**LC1A**	**LC2A**	**LC4A**	**LC5A**	**Maximum concentration (mg/l)**	**Monthly Average (mg/l)**	**Acceptable Maximum Concentration (AMC) (mg/l)**	**LP3A**	**LP4**
Date Sampled	-							-	-	-		
Manganese in filtrate as Mn	mg/l	0.36	0.146	N/S	0.111	0.693	0.0948	**0.693**	**0.281**	--	0.104	0.279
Mercury, filt trace as Hg	mg/l	< 0.0001	< 0.0001	N/S	N/T*	N/T*	N/T*	< **0.00010**	< **0.00010**	**0.00056**	< 0.0001	< 0.0001
Nickel in filtrate as Ni	mg/l	0.0294	0.0235	N/S	0.0721	0.0082	0.165	**0.165**	**0.0596**	**0.0681**	0.0074	0.0086
Zinc, ultra-low filtered as Zn	mg/l	0.0204	0.022	N/S	2.02	1.54	0.165	**2.02**	**0.753**	**1.380**	0.0208	0.033
pH	pH Units	8	7.7	N/S	8.4	7.8	8.3	**8.40**	**8.040**	--	8	7.9
Conductivity- Electrical 20C	uS/cm	2150	2460	N/S	9400	4370	24000	**24000.0**	**8476.0**	--	1630	2080
Alkalinity as CaCO3	mg/l	1090	440	N/S	5380	2490	12800	**12800.0**	**4440.0**	--	360	550
Ammoniacal Nitrogen as N	mg/l	< 0.41	29	N/S	674	293	2100	**2100.0**	**619**	**526**	4.9	28.4
Chloride as Cl	mg/l	182	206	N/S	788	219	1900	**1900.0**	**659**	**1408**	138	153
Sulphate as SO4	mg/l	86.3	441	N/S	7.01	< 4.4	35.14	**441.0**	**115**	**999**	256	294
Redox Potential (see note 4)	mV	67	88	N/S	110	93	104	**110.0**	**92.4**	--	84	93
Total Suspended Solids	mg/l	1230	18	N/S	2990	2120	304	**2990.0**	**1332.4**		6	10
Solids, Total Dissolved 180 deg C	mg/l	1470	1650	N/S	4460	1900	10100	**10100.0**	**3916.0**		1100	1280
Dissolved Oxygen, Fixed	mg/l	< 0.5	2.3	N/S	< 0.5	< 0.5	< 0.5	**2.30**	**0.9**		6.1	4.4
TOC (filtered)	mg/l	16.1	27.8	N/S	272	60	1060	**1060.0**	**287.2**		15.7	17

Notes
1. < denotes 'less than'.
2. L1A,L1B, LC1A, LC2A,LC4A, LC5A: Wells in Waste.
3. -- denotes 'no acceptable maximum concentration available'.
4. The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis
5. LC5A is a replacement for LC5 well.
6. NS denotes 'not sampled.

Appendix D
Table D1
Leachate Monitoring Results

April 2018												
LOCATION	**Units**	**L1A**	**L1B**	**LC1A**	**LC2A**	**LC4A**	**LC5A**	**Maximum concentration (mg/l)**	**Average concentration (mg/l)**	**Acceptable Maximum Concentration (AMC) (mg/l)**	**LP3A**	**LP4**
Date Sampled	-									-		
Manganese in filtrate as Mn	mg/l	0.225	0.193	N/S	0.102	0.648	0.125	**0.6480**	**0.2586**	**--**	< 0.007	0.0533
Mercury, filt trace as Hg	mg/l	< 0.00001	<0.00001	N/S	< 0.0001	< 0.0001	< 0.0001	**0.0001**	**0.0001**	**0.00056**	< 0.00001	< 0.00001
Nickel in filtrate as Ni	mg/l	0.0384	0.0081	N/S	0.127	0.0188	0.171	**0.1710**	**0.0727**	**0.0681**	0.0056	0.0037
Zinc, ultra-low filtered as Zn	mg/l	0.225	0.0195	N/S	2.01	0.682	0.212	**2.010**	**0.630**	**1.380**	0.0433	0.0214
pH	pH Units	8	8	N/S	8.6	7.9	8.6	**8.60**	**8.2**	**--**	8.5	8.2
Conductivity- Electrical 20C	uS/cm	2190	1830	N/S	9380	4360	23100	**23100**	**8172**	**--**	1120	1030
Alkalinity as CaCO3	mg/l	999	383	N/S	5080	2380	15400	**15400**	**4848**	**--**	278	285
Ammoniacal Nitrogen as N	mg/l	6.6	16.8	N/S	684	298	2260	**2260.00**	**653.08**	**526**	1.63	42.6
Chloride as Cl	mg/l	190	123	N/S	767	214	1870	**1870**	**633**	**1408**	62.6	44.7
Sulphate as SO4	mg/l	92.5	426	N/S	21.4	11.1	94.7	**426**	**129.1**	**999**	123	86.6
Redox Potential (see note 4)	mV	43	49	N/S	118	19	27	**118**	**51.2**	**--**	97	101
Total Suspended Solids	mg/l	672	8	N/S	2600	1130	328	**2600**	**947.6**		15	12
Solids, Total Dissolved 180 deg (	mg/l	1500	1310	N/S	4280	1810	9810	**9810**	**3742.0**		625	462
Dissolved Oxygen, Fixed	mg/l	0.9	1.6	N/S	< 0.5	< 0.5	< 0.5	**2**	**0.8**		6.6	6.2
TOC (filtered)	mg/l	26.5	15.5	N/S	246	56	986	**986**	**266.0**		9.7	8

Notes
1. < denotes 'less than'.
2. L1A,L1B, LC1A, LC2A,LC4A, LC5A: Wells in Waste.
3. -- denotes 'no acceptable maximum concentration available'.
4. The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis
5. LC5A is a replacement for LC5 well.
6. NS denotes 'not sampled.
7. * denotes 'no result for filtered mercury analysis due to interference from sample matrix'.

Appendix D
Table D1
Leachate Monitoring Results

July 2018												
LOCATION	**Units**	**L1A**	**L1B**	**LC1A**	**LC2A**	**LC4A**	**LC5A**	**Maximum concentration (mg/l)**	**Average concentration (mg/l)**	**Acceptable Maximum Concentration (AMC) (mg/l)**	**LP3A**	**LP4**
Date Sampled	-											
Manganese in filtrate as Mn	mg/l	0.163	0.311	N/S	0.125	0.57	0.159	**0.57**	**0.2656**	--	0.17	0.182
Mercury, filt trace as Hg	mg/l	0.000012	< 0.00001	N/S	< 0.00001	< 0.0002	< 0.0002	**0.0002**	**0.0000864**	**0.00056**	< 0.00001	< 0.00001
Nickel in filtrate as Ni	mg/l	0.0285	0.016	N/S	0.111	0.0152	0.163	**0.163**	**0.06674**	**0.0681**	0.0094	0.0077
Zinc, ultra-low filtered as Zn	mg/l	0.144	0.0353	N/S	3.4	1.83	0.294	**3.4**	**1.14066**	**1.380**	< 0.018	< 0.018
pH	pH Units	7.6	7.5	N/S	8.4	7.4	8.4	**8.4**	**7.86**	--	8.1	7.9
Conductivity- Electrical 20C	uS/cm	2530	2850	N/S	10200	4330	22800	**22800**	**8542**	--	2120	2190
Alkalinity as CaCO3	mg/l	1040	716	N/S	541	2400	594	**2400**	**1058.2**	--	480	938
Ammoniacal Nitrogen as N	mg/l	< 0.41	48.5	N/S	710	285	2010	**2010**	**610.782**	**526**	< 0.41	45.2
Chloride as Cl	mg/l	242	242	N/S	866	207	1870	**1870**	**685.4**	**1408**	214	185
Sulphate as SO4	mg/l	122	122	N/S	8.03	18.9	< 4.4	**122**	**55.066**	**999**	366	114
Redox Potential (see note 4)	mV	138	145	N/S	134	-59	-59	**145**	**59.8**	--	145	140
Total Suspended Solids	mg/l	284	18	N/S	1580	2860	296	**2860**	**1007.6**	--	5	5
Solids, Total Dissolved 180 deg (	mg/l	1650	4690	N/S	1930	1840	9480	**9480**	**3918**	--	1530	1330
Dissolved Oxygen, Fixed	mg/l	2	2	N/S	< 0.5	< 0.5	< 0.5	**2**	**1.1**	--	6.3	5.6
TOC (filtered)	mg/l	19	37.1	N/S	316	61.1	1430	**1430**	**372.64**	--	23.3	25.4

Notes
1. < denotes 'less than'.
2. L1A,L1B, LC1A, LC2A,LC4A, LC5A: Wells in Waste.
3. -- denotes 'no acceptable maximum concentration available'.
4. The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis
5. LC5A is a replacement for LC5 well.
6. NS denotes 'not sampled.
No monthly average leachate levels above Maximum Acceptable Concentration (MAC)

Appendix D
Table D1
Leachate Monitoring Results

October 2018												
LOCATION	**Units**	**L1A**	**L1B**	**LC1A**	**LC2A**	**LC4A**	**LC5A**	**Maximum concentration (mg/l)**	**Average concentration (mg/l)**	**Acceptable Maximum Concentration (AMC) (mg/l)**	**LP3A**	**LP4**
Date Sampled	-											
Manganese in filtrate as Mn	mg/l	0.262	0.202	N/S	0.116	0.736	0.184	0.736	0.3000	--	0.132	0.202
Mercury, filt trace as Hg	mg/l	< 0.0001	< 0.0001	N/S		< 0.00001	< 0.00001	0.000	0.0001	0.00056	< 0.00001	< 0.00001
Nickel in filtrate as Ni	mg/l	0.0314	0.0192	N/S	0.0852	0.0123	0.296	0.296	0.0888	0.0681	0.0115	0.00093
Zinc, ultra-low filtered as Zn	mg/l	1.01	0.0613	N/S	1.77	0.442	0.2	1.770	0.6967	1.38	< 0.018	0.0234
pH	pH Units	7.5	7.8	N/S	8.3	7.4	8.3	8.300	7.86	--	8.2	8.1
Conductivity- Electrical 20C	uS/cm	2530	3290	N/S	10500	4220	24000	24000	8908	--	2100	2220
Alkalinity as CaCO3	mg/l	1260	741	N/S	5670	2300	12800	12800	4554.2	--	420	701
Ammoniacal Nitrogen as N	mg/l	<0.41	76.9	N/S	747	284	2110	2110	804.475	526	0.99	20
Chloride as Cl	mg/l	247	348	N/S	920	211	1850	1850	715.2	1408	217	189
Sulphate as SO4	mg/l	50.9	444	N/S	<4.4	17.1	90.2	444	150.550	999	346	270
Redox Potential (see note 4)	mV	114	104	N/S	137	17	-97	137	55.0	--	115	113
Total Suspended Solids	mg/l	1910	76	N/S	2690	521	178	2690	1075.0		4	6
Solids, Total Dissolved 180 deg C	mg/l	1830	2290	N/S	5000	1880	8840	8840	3968		1620	1610
Dissolved Oxygen, Fixed	mg/l	< 0.5	2.4	N/S	< 0.5	< 0.5	< 0.5	2.4	0.88		< 0.5	< 0.5
TOC (filtered)	mg/l	25.4	77.5	N/S	309	54.5	1100	1100	313.3		21.1	19.7

Notes
1. < denotes 'less than'.
2. L1A,L1B, LC1A, LC2A,LC4A, LC5A: Wells in Waste.
3. -- denotes 'no acceptable maximum concentration available'.
4. The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis.
5. LC5A is a replacement for LC5 well.
6. NS denotes 'not sampled.
No monthly average leachate levels above Maximum Acceptable Concentration (MAC)

Appendix D
Table D2
Leachate Head Levels

Well	Parameter	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
LC1A	Elevation of base of landfill mAOD	357.62	N/S	N/S	357.62	N/S	N/S	357.62	N/S	N/S	357.62	N/S	N/S
	Elevation at top of casing mAOD	398.88	N/S	N/S	398.88	N/S	N/S	398.88	N/S	N/S	398.88	N/S	N/S
	Depth to leachate from top of casing (m)	40.40			40.39			40.41			40.41		
	Leachate elevation (mAOD)	358.48	N/S	N/S	358.49	N/S	N/S	358.47	N/S	N/S	358.47	N/S	N/S
	Calculated leachate head (m)	0.86	N/S	N/S	0.87	N/S	N/S	0.85	N/S	N/S	0.85	N/S	N/S
LC2A	Elevation of base of landfill mAOD	362.49	N/S	N/S	362.49	N/S	N/S	362.49	N/S	N/S	362.49	N/S	N/S
	Elevation at top of casing mAOD	401.26	N/S	N/S	401.26	N/S	N/S	401.26	N/S	N/S	401.26	N/S	N/S
	Depth to leachate from top of casing (m)	35.83			35.78			35.81			35.71		
	Leachate elevation (mAOD)	365.43	N/S	N/S	365.48	N/S	N/S	365.45	N/S	N/S	365.55	N/S	N/S
	Calculated leachate head (m)	2.94	N/S	N/S	2.99	N/S	N/S	2.96	N/S	N/S	3.06	N/S	N/S
LC4A	Elevation of base of landfill mAOD	372.27	N/S	N/S	372.27	N/S	N/S	372.27	N/S	N/S	372.27	N/S	N/S
	Elevation at top of casing mAOD	401.24	N/S	N/S	401.24	N/S	N/S	401.24	N/S	N/S	401.24	N/S	N/S
	Depth to leachate from top of casing (m)	26.92			26.92			26.94			26.90		
	Leachate elevation (mAOD)	374.32	N/S	N/S	374.32	N/S	N/S	374.30	N/S	N/S	374.34	N/S	N/S
	Calculated leachate head (m)	2.05	N/S	N/S	2.05	N/S	N/S	2.03	N/S	N/S	2.07	N/S	N/S
LC5A	Elevation of base of landfill mAOD	350.14	N/S	N/S	350.14	N/S	N/S	350.14	N/S	N/S	350.14	N/S	N/S
	Elevation at top of casing mAOD	380.98	N/S	N/S	380.98	N/S	N/S	380.98	N/S	N/S	380.98	N/S	N/S
	Depth to leachate from top of casing (m)	27.29			26.89			26.04			25.48		
	Leachate elevation (mAOD)	353.69	N/S	N/S	354.09	N/S	N/S	354.94	N/S	N/S	355.50	N/S	N/S
	Calculated leachate head (m)	3.55	N/S	N/S	3.95	N/S	N/S	4.80	N/S	N/S	5.36	N/S	N/S
L1	Casing height (mAOD)	356.80	N/S	N/S	356.80	N/S	N/S	356.80	N/S	N/S	356.80	N/S	N/S
	Leachate (mbgl)	-			-								
	Leachate (m AOD)	-	N/S	N/S	-	N/S	N/S	-	N/S	N/S	-	N/S	N/S
	Base of landfill (m AOD)	336.80	N/S	N/S	336.80	N/S	N/S	336.80	N/S	N/S	336.80	N/S	N/S
	Depth of well from top of casing (m)	21.03	N/S	N/S	21.03	N/S	N/S	21.01	N/S	N/S	21.04	N/S	N/S
	Base of well (m AOD)	336.80	N/S	N/S	336.80	N/S	N/S	335.79	N/S	N/S	335.76	N/S	N/S
	Calculated leachate head (m)	-	N/S	N/S	-	N/S	N/S	-	N/S	N/S	-	N/S	N/S
L1A*	Casing height (mAOD)	354.84	N/S	N/S	354.84	N/S	N/S	354.84	N/S	N/S	354.84	N/S	N/S
	Leachate (mbgl)	19.31			18.47			19.40			19.93		
	Leachate (m AOD)	335.53	N/S	N/S	336.37	N/S	N/S	335.44	N/S	N/S	334.91	N/S	N/S
	Base of landfill (m AOD)	316.64	N/S	N/S	316.64	N/S	N/S	316.64	N/S	N/S	316.64	N/S	N/S
	Depth of well from top of casing (m)	21.12	N/S	N/S	21.03	N/S	N/S	20.93	N/S	N/S	20.93	N/S	N/S
	Base of well (m AOD)	334.84	N/S	N/S	334.84	N/S	N/S	334.84	N/S	N/S	334.84	N/S	N/S
	Calculated leachate head (m)	18.89	N/S	N/S	19.73	N/S	N/S	18.80	N/S	N/S	18.27	N/S	N/S
L1B*	Casing height (mAOD)	354.34	N/S	N/S	354.34	N/S	N/S	354.34	N/S	N/S	354.34	N/S	N/S
	Leachate (mbgl)	24.60			25.04			25.88			24.94		
	Leachate (m AOD)	329.74	N/S	N/S	329.30	N/S	N/S	328.46	N/S	N/S	329.40	N/S	N/S
	Base of landfill (m AOD)	319.60	N/S	N/S	319.60	N/S	N/S	319.60	N/S	N/S	319.60	N/S	N/S
	Depth of well from top of casing (m)	35.50	N/S	N/S	35.50	N/S	N/S	35.50	N/S	N/S	20.93	N/S	N/S
	Base of well (m AOD)	319.34	N/S	N/S	319.34	N/S	N/S	319.34	N/S	N/S	319.34	N/S	N/S
	Calculated leachate head (m)	10.14	N/S	N/S	9.70	N/S	N/S	8.86	N/S	N/S	9.80	N/S	N/S

2018	Quarterly Leachate Head Averages (m)
January	2.35
February	N/S
March	N/S
April	2.47
May	N/S
June	N/S
July	2.66
August	N/S
September	N/S
October	2.84
November	N/S
December	N/S

Minimum monthly leachate head average

Maximum monthly leachate head average

Notes:

Top of casings were re-surveyed in 2015

1. LC1A top of casing is 1580mm above ground level.

2. LC2A top of casing is 846mm above GL.

3. LC4A top of casing is 1109mm above GL.

4. LC2A and LC4A reduced (protruding pipe length cut) on 23 Feb 10.

5. Levels in L1 were not measured due to well being dry.

* Well not included in monthly average.

** Cover level re-surveyed in September 2009.

Note: L1 is generally dry or with very little water in it.

Month	Location	Site	Date	Mercury, ultra-low total as Hg	Redox Potential	Manganese in filtrate as Mn	Nickel in filtrate as Ni	Bioavailable Ni	Zinc, ultra-low total as Zn	Bioavailable Zn	pH	Conductivity-Electrical 20C	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Unionised Ammoniacal Nitrogen **	Measured surface water	Chloride as Cl	Sulphate as SO4	Solids, Suspended	Dissolved oxygen	TOC (Filtered)	Calcium
				ug/l	mV	mg/l	mg/l	mg/l	mg/l	mg/l		uS/cm	mg/l	mg/l	mg/l	°C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Freshwater EQS**				1	-	0.123	0.004	0.004	0.0137	0.0137	-	-	-	-	0.015**	-	250	400	-	-	-	-
January	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	01/02/2018	< 0.10	47.00	< 0.0070	< 0.0030	-	< 0.0180	-	8.60	288.00	85.00	< 0.41	0.0210	5.8	8.80	54.40	4.00	11.10	1.00	35.1
		SWD1	01/02/2018	< 0.10	54.00	< 0.0070	0.0040	-	< 0.018	-	8.20	273.00	70.00	< 0.41	0.0081	4.9	12.60	48.90	3.00	11.10	1.20	30
February	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
March	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
April	Upstream of Landfill	SWU	03/05/2018	< 0.05	24.00	< 0.0070	0.0416	0.02895	< 0.018	-	7.10	66.20	11.20	< 0.41	0.0009	9.10	<3.7	7.90	4.00	11.30	<0.7	4.7
		SW2AI	03/05/2018	< 0.05	83.00	< 0.0070	0.0366	0.01076	< 0.018	-	7.80	689.00	91.20	< 0.41	0.0053	11.60	5.30	259	38.00	10.10	5.60	99.6
		SWW4	03/05/2018	< 0.05	85.00	0.0095	0.0132	0.00422	< 0.018	-	7.90	689.00	80.80	< 0.41	0.0062	10.60	5.00	258.00	6.00	11.30	5.60	91.3
	NW Ditch System	SWW1	03/05/2018	< 0.05	40.00	< 0.0070	0.0416	0.03261	< 0.018	-	7.40	166.00	33.60	< 0.41	0.0017	8.80	<3.7	29.10	3.00	10.60	<0.7	16.2
		SWW2	03/05/2018	< 0.05	64.00	0.0170	0.0038	0.00282	< 0.018	-	8.20	449.00	77.60	< 0.41	0.0121	10.40	6.00	145.00	1.00	12.60	<0.7	53.3
	Downstream of Landfill	SWD	03/05/2018	< 0.05	46.00	0.0077	0.0416	0.04160	< 0.018	-	8.20	256.00	82.40	< 0.41	0.0114	9.60	<3.7	37.90	1.00	9.70	1.50	35.5
		SWD1	03/05/2018	< 0.05	49.00	< 0.0070	0.0262	0.01921	< 0.018	-	7.90	252.00	69.60	< 0.41	0.0054	8.60	8.50	35.40	5.00	11.70	1.90	29.6
May	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
June	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
July	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	26/07/2018	< 0.01	-57	< 0.007	< 0.0030	-	0.080	0.054	8.20	476.00	126.0000	< 0.41	0.0149	13.30	4.60	134.00	118	<0.5	1.6	51.2
		SWD1	26/07/2018	< 0.01	-45	< 0.007	0.0034	-	0.111	0.072	8.30	482.00	115.0000	< 0.41	0.0191	13.70	7.10	138.00	8	<0.5	1.7	54.4
August	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
September	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
October	Upstream of Landfill	SWU	31/10/2018	< 0.01	-92	< 0.0070	< 0.0030	-	< 0.018	-	7.60	95.50	< 30	< 0.41	0.0027	8.40	4.90	20.20	2	9.6	<0.7	7.98
		SW2AI	31/10/2018	< 0.01	-1	0.0107	0.0218	-	0.083	0.0200	7.70	894.00	66	< 0.41	0.0029	6.60	11.10	419.00	12	9.6	10	144
		SWW4	31/10/2018	< 0.01	38	0.0084	< 0.0030	-	< 0.018	-	7.90	859.00	54	< 0.41	0.0039	4.10	10.50	393.00	2	9.9	9	128
	NW Ditch System	SWW1	31/10/2018	< 0.01	-15.00	0.0133	< 0.0030	-	< 0.018	-	8.10	386.00	87.00	< 0.41	0.0103	11.30	6.20	120.00	1	9.6	1.3	41.4
		SWW2	31/10/2018	< 0.01	-12.00	< 0.0070	0.0046	-	< 0.018	-	7.80	180.00	39.00	< 0.41	0.0045	9.30	5.30	47.20	<1	10.3	<0.7	18.5
	Downstream of Landfill	SWD	31/10/2018	< 0.01	-95.00	< 0.0070	< 0.0030	-	< 0.018	-	8.10	324.00	77.00	< 0.41	0.0081	8.00	6.60	94.50	2	10.5	1.3	43.5
		SWD1	31/10/2018	< 0.01	-82.00	0.0086	0.0214	0.0153	< 0.018	-	8.00	320.00	64.00	< 0.41	0.0055	5.70	11.40	97.60	<1	10.90	1.50	39.7
November	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
December	Upstream of Landfill	SWU	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SW2AI		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW4		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	NW Ditch System	SWW1	Six-monthly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWW2		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Downstream of Landfill	SWD	Quarterly	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
		SWD1		N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
Minimum				< 0.0100	-95.0	< 0.007	< 0.003		< 0.0180		7.1	66.2	11.20	< 0.41	0.0009	4.10	4.60	7.90	1.00	9.60	1.00	4.70
Maximum				< 0.1000	85.0	0.017	0.042		0.1110		8.6	894.0	126.00	< 0.41	0.02	13.70	12.60	419.00	118.00	12.60	10.00	144.00

Exceedance of EQS
Upstream of Nant Merddog
Downstream of Nant Merddog

Notes
1.The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis
2.N/S - Not analysed
3.Unionised ammoniacal nitrogen based on measured
4.Environmental Quality Standard EQS 1 for freshwater is derived to protect the most sensitive aquatic life.
5.NW Ditch - North Western (ditch system)

Appendix D
Table D4
Surface water monitoring SW1 to SW10

MONTH	LOCATION	DATE		Mercury, ultra-low total as Hg		Ammoniacal Nitrogen as N	Chloride as Cl
				ug/l		mg/l	mg/l
	Freshwater EQS			1		n/a	250
January	SW1	01/02/2017	<	0.10	<	0.41	21
	SW2	01/02/2017	<	0.10	<	0.41	20.8
	SW3	01/02/2017	<	0.10	<	0.41	12.6
	SW4	01/02/2017	<	0.10	<	0.41	23.4
	SW5	01/02/2017	<	0.10	<	0.41	22.7
	SW6	01/02/2017	<	0.10	<	0.41	18.9
	SW7	01/02/2017	<	0.10	<	0.41	8
	SW8	01/02/2017	<	0.10	<	0.41	6
	SW9	01/02/2017	<	0.10	<	0.41	7.2
	SW10	01/02/2017	<	0.10	<	0.41	7.7
February	SW1	02/03/2017	<	0.10		0.5	25.0
	SW2	02/03/2017	<	0.10	<	0.41	24.4
	SW3	02/03/2017	<	0.10	<	0.41	16.7
	SW4	02/03/2017	<	0.10	<	0.41	29.8
	SW5	02/03/2017	<	0.10	<	0.41	30.8
	SW6	02/03/2017	<	0.10	<	0.41	26.6
	SW7	02/03/2017	<	0.10	<	0.41	11.7
	SW8	02/03/2017	<	0.10	<	0.41	10.3
	SW9	02/03/2017	<	0.10	<	0.41	11.1
	SW10	02/03/2017	<	0.10	<	0.41	11.3
March	SW1	23/03/2017	<	0.10	<	0.41	20.80
	SW2	23/03/2017	<	0.10	<	0.41	21.00
	SW3	23/03/2017	<	0.10	<	0.41	10.90
	SW4	23/03/2017	<	0.10	<	0.41	27.80
	SW5	23/03/2017	<	0.10	<	0.41	27.50
	SW6	23/03/2017	<	0.10	<	0.41	24.20
	SW7	23/03/2017	<	0.10	<	0.41	10.20
	SW8	23/03/2017	<	0.10	<	0.41	6.30
	SW9	23/03/2017	<	0.10	<	0.41	6.90
	SW10	23/03/2017	<	0.10	<	0.41	7.20
April	SW1	03/05/2018	<	0.05	<	0.41	29.00
	SW2	03/05/2018	<	0.05	<	0.41	30.00
	SW3	03/05/2018	<	0.05	<	0.41	20.50
	SW4	03/05/2018	<	0.05	<	0.41	38.10
	SW5	03/05/2018	<	0.05	<	0.41	37.50
	SW6	03/05/2018	<	0.05	<	0.41	34.40
	SW7	03/05/2018	<	0.05	<	0.41	7.10
	SW8	03/05/2018	<	0.05	<	0.41	9.10
	SW9	03/05/2018	<	0.05	<	0.41	7.00
	SW10	03/05/2018	<	0.05	<	0.41	7.10
May	SW1	29/05/2018	<	0.10	<	0.41	71.70
	SW2	29/05/2018	<	0.10	<	0.41	70.30
	SW3	29/05/2018	<	0.10	<	0.41	48.50
	SW4	29/05/2018	<	0.10	<	0.41	77.80
	SW5	29/05/2018	<	0.10	<	0.41	73.80
	SW6	29/05/2018	<	0.10	<	0.41	58.80
	SW7	29/05/2018	<	0.10	<	0.41	9.80
	SW8	29/05/2018	<	0.10	<	0.41	13.40
	SW9	29/05/2018	<	0.10	<	0.41	13.70
	SW10	29/05/2018	<	0.10	<	0.41	12.80
June	SW1	28/06/2018		dry		dry	dry
	SW2	28/06/2018		dry		dry	dry
	SW3	28/06/2018		dry		dry	dry
	SW4	28/06/2018		0.027	<	0.41	96.60
	SW5	28/06/2018		dry		dry	dry
	SW6	28/06/2018		dry		dry	dry
	SW7	28/06/2018	<	0.01	<	0.41	6.80
	SW8	28/06/2018	<	0.01	<	0.41	7.10
	SW9	28/06/2018		dry		dry	dry
	SW10	28/06/2018		dry		dry	dry
July	SW1	26/07/2018		dry		dry	dry
	SW2	26/07/2018		dry		dry	dry
	SW3	26/07/2018		dry		dry	dry
	SW4	26/07/2018		Note 1	<	0.41	129
	SW5	26/07/2018		dry		dry	dry
	SW6	26/07/2018		dry		dry	dry
	SW7	26/07/2018	<	0.01	<	0.41	6.4
	SW8	26/07/2018	<	0.01	<	0.41	7
	SW9	26/07/2018		dry		dry	dry
	SW10	26/07/2018		dry		dry	dry
August	SW1	29/08/2018		dry		dry	dry
	SW2	29/08/2018		dry		dry	dry
	SW3	29/08/2018		dry		dry	dry
	SW4	29/08/2018	<	0.01	<	0.41	78.4
	SW5	29/08/2018	<	0.01	<	0.41	78.2
	SW6	29/08/2018	<	0.01	<	0.41	68
	SW7	29/08/2018	<	0.01	<	0.41	8.8
	SW8	29/08/2018	<	0.01	<	0.41	10.7
	SW9	29/08/2018		dry		dry	dry
	SW10	29/08/2018		dry		dry	dry

Appendix D
Table D4
Surface water monitoring SW1 to SW10

MONTH	LOCATION	DATE		Mercury, ultra-low total as Hg		Ammoniacal Nitrogen as N		Chloride as Cl
				ug/l		mg/l		mg/l
	Freshwater EQS			1		n/a		250
September	SW1	26/09/2018		dry		dry		dry
	SW2	26/09/2018		dry		dry		dry
	SW3	26/09/2018		0.048	<	0.41		26.9
	SW4	26/09/2018		0.011	<	0.41		50.8
	SW5	26/09/2018	<	0.100	<	0.41		51.2
	SW6	26/09/2018	<	0.100	<	0.41		46.8
	SW7	26/09/2018	<	0.100	<	0.41		13.3
	SW8	26/09/2018	<	0.100	<	0.41		9.6
	SW9	26/09/2018		dry		dry		dry
	SW10	26/09/2018	<	0.100	<	0.41		17.6
October	SW1	31/10/2018	<	0.01	<	0.41		40.7
	SW2	31/10/2018		dry		dry		dry
	SW3	31/10/2018	<	0.01	<	0.41		27.00
	SW4	31/10/2018	<	0.01	<	0.41		48.70
	SW5	31/10/2018	<	0.01	<	0.41		48.50
	SW6	31/10/2018	<	0.01	<	0.41		45.90
	SW7	31/10/2018	<	0.01	<	0.41		8.50
	SW8	31/10/2018	<	0.01	<	0.41		9.10
	SW9	31/10/2018		dry		dry		dry
	SW10	31/10/2018	<	0.01	<	0.41		16.9
November	SW1	28/11/2018	<	0.100	<	0.41		33.90
	SW2	28/11/2018	<	0.100	<	0.41		33.50
	SW3	28/11/2018	<	0.100	<	0.41		22.00
	SW4	28/11/2018	<	0.100	<	0.41		47.80
	SW5	28/11/2018	<	0.100	<	0.41		39.90
	SW6	28/11/2018	<	0.100	<	0.41		29.90
	SW7	28/11/2018	<	0.100	<	0.41		7.70
	SW8	28/11/2018	<	0.100	<	0.41		6.40
	SW9	28/11/2018	<	0.100	<	0.41		10.90
	SW10	28/11/2018	<	0.100	<	0.41		15.00
December	SW1	18/12/2018	<	0.01	<	0.41		36.90
	SW2	18/12/2018	<	0.01	<	0.41		37.30
	SW3	18/12/2018	<	0.01	<	0.41		23.80
	SW4	18/12/2018	<	0.01		2.26		54.60
	SW5	18/12/2018	<	0.01		1.33		48.40
	SW6	18/12/2018	<	0.01		0.87		38.60
	SW7	18/12/2018	<	0.01	<	0.41		12.20
	SW8	18/12/2018	<	0.01	<	0.41		8.90
	SW9	18/12/2018	<	0.01	<	0.41		8.70
	SW10	18/12/2018	<	0.01	<	0.41		15.40
Minimum			<	0.0100	<	0.41		6.00
Maximum				0.10		2.26		129.00
Count				95.00		96.00		96.00

Appendix D
Table D5
Groundwater monitoring results

Location	Month	Date	Test reference number	Redox Potential	Mercury, filtrate as Hg	Manganese in filtrate as Mn	Nickel in filtrate as Ni	Zinc, ultra-low filtered as Zn	pH	Electrical Conductivity 20C	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Unionised Ammoniacal Nitrogen ***	Measure water temperature	Chloride as Cl	Sulphate as SO4	Calcium	D.O. concentration	TOC (Filtered)
				mV	ug/l	mg/l	mg/l	mg/l	pH units	uS/cm	mg/l	mg/l	mg/l	°C	mg/l	mg/l	mg/l	mg/l	mg/l
Trigger Level					(0.2ª)		0.05	(0.05ª)	--	--	--	1	--	--	250	400	--	--	--
Control Level A					(0.1ªª)	--	0.03	(0.02ªª)	--	--	--	0.8	--	--	210	300	--	--	--
Control Level B					(0.15ªª)	--	0.04	(0.035ªª)	--	--	--	0.9	--	--	230	350	--	--	--
Assessment Level					--	(1.0ª)	--	--	--	--			--	--	--	--	--	--	--
UPSTREAM WELLS																			
SST East S3																			
	Jan-17	30/01/17	15849039	-63	0.13	< 0.0070	< 0.0030	0.0445	7.1	682.0	246.0	< 0.41	0.0012	12.6	23.5	115.0		6.7	2.8
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040348	97	0.099	< 0.0070	< 0.0030	0.0220	7.0	694.0	246.0	< 0.41	0.0009	12.4	10.4	132.0		5.2	2.0
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290503	-19	< 0.10	0.0084	< 0.0030	0.0243	7.5	573.0	187.0	< 0.41	0.0031	13.6	11.3	137.0		8.2	2.5
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530927	59	< 0.10	< 0.0070	0.0117	< 0.1800	7.6	602.0	212	< 0.41	0.0039	13.6	9.5	109		7	2.2
	Nov-17		Quarterly																
GW3A	Dec-17																		
	Jan-18	30/01/18	16812270	156	< 0.10	0.0101	< 0.0030	< 0.1800	7.5	605.0	220.0	< 0.41	0.0029	12.5	8.7	117.0	110.0	9.9	1.5
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084459	56	0.375	< 0.0070	< 0.0030	< 0.3600	8.3	593.0	208.0	< 0.41			11.7	104.0	128.0	10.7	1.5
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349963	103	0.218	< 0.0070	< 0.0030	< 0.0180	7.2	568.0	189.0	< 0.41			6.6	131.0	82.1	5.1	2.1
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637857	138	0.32	0.0951	< 0.003	< 0.0180	7.2	606.0	227	< 0.41			8.7	124	92.4	8.5	2.4
	Nov-18		Quarterly																
	Dec-18																		
	Jan-17	30/01/17	15849040	-61	< 0.10	1.7400	< 0.0030	0.0565	6.7	256.0	55.2	< 0.41	0.0004	9.1	10.3	68.8		4.1	< 0.7
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040349	91	< 0.01	1.6700	< 0.0030	0.0380	6.8	280.0	56.8	< 0.41	0.0004	9.1	10.1	70.0		4.1	< 0.7
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290504	-19	< 0.10	1.7700	< 0.0030	0.0735	6.9	291.0	70.8	2.78	0.0042	10.3	11.2	70.3		< 0.5	3.4
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530928	45	< 0.10	1.7200	0.0060	0.0286	7.1	267.0	59.4	< 0.41	0.0010	10.0	9.5	65.4		1.9	< 0.7
	Nov-17		Quarterly																
GW4	Dec-17																		
	Jan-18	30/01/18	16812271	147	< 0.10	1.2900	< 0.0030	< 0.0180	< 7.2	289.0	75.0	< 0.41	0.0011	9.2	8.4	64.4	13.0	4.3	< 0.7
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084460	55	0.01	1.6900	0.0041	0.0400	8.0	274.0	62.8	< 0.41			9.2	65.6	15.0	3.0	< 0.7
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349964	89	< 0.01	1.2000	0.0066	0.0190	6.8	247.0	58.4	< 0.41			5.6	59.6	22.6	2.4	< 0.7
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637858	125	< 0.10	1.4700	0.0052	< 0.0180	7.0	247.0	65.0	< 0.41			9.1	66.4	16	3.1	< 0.7
	Nov-18		Quarterly																
	Dec-18																		
DOWNSTREAM WELLS / COMPLIANCE WELLS																			
SST West S2																			
	Jan-17	30/01/17	15849046	-8	0.92	0.0448	< 0.0030	0.3970	7.2	1120.0	379.0	< 0.41	0.0017	14.8	49.4	261.0		11.1	4.8
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040355	164	0.032	< 0.0070	0.0076	0.3070	7.6	1790.0	351.0	< 0.41	0.0044	15.0	119.0	418.0		9.5	9.7
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290510	229	0.10	0.0113	0.0043	0.3990	7.5	1110.0	301.0	< 0.41	0.0036	15.4	42.3	230.0		10.0	4.3
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530934	91	< 0.10	1.1600	0.0114	1.0300	7.7	1340	428	< 0.41	0.0060	16.2	50.4	346		9.2	4.7
	Nov-17		Quarterly																
GW12	Dec-17																		
	Jan-18	30/01/18	16812277	185	< 0.10	0.0198	0.0078	0.3310	7.6	1760.0	385.0	< 0.41	0.0054	18.0	102.0	378.0	209.0	5.7	10.7
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084466	90	0.393	< 0.0070	0.0123	0.2090	8.5	1720.0	413.0	< 0.41			101.0	379.0	138.0	7.2	10.2
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349970	131	< 0.01	0.0250	0.0124	< 0.0180	7.4	1520.0	766.0	< 0.41			87.5	301.0	76.6	< 0.5	11.1
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637864	141	0.236	0.0089	0.0090	< 0.0180	7.6	2140	443	< 0.41			169	464	152	5.8	16.1
	Nov-18		Quarterly																
	Dec-18																		
SST Centre																			
	Jan-17	30/01/17	15849041	-30	0.25	< 0.0070	0.0054	0.0330	6.3	731.0	189.0	< 0.41	0.0002	12.2	71.6	89.1		4.4	3.9
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040350	102	0.06	< 0.0070	0.0063	< 0.1800	6.4	764.0	207.0	< 0.41	0.0002	12.0	66.7	97.5		4.4	3.7
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290505	25	< 0.10	0.0188	0.0046	< 0.1800	6.4	744.0	200.0	< 0.41	0.0002	12.7	67.1	91.7		5.4	3.6
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530929	69	< 0.10	< 0.0070	0.0060	< 0.1800	6.7	823	255	< 0.41	0.0005	12.7	72.5	87.9		3.4	3.3
	Nov-17		Quarterly																
GW6	Dec-17																		
	Jan-18	30/01/18	16812272	166	< 0.10	0.3390	0.0050	0.2290	6.9	930.0	340.0	0.41	0.0007	12.1	67.7	91.9	90.4	3.2	3.6

Appendix D
Table D5
Groundwater monitoring results

Location	Month	Date	Test reference number	Redox Potential	Mercury, filtrate as Hg	Manganese in filtrate as Mn	Nickel in filtrate as Ni	Zinc, ultra-low filtered as Zn	pH	Electrical Conductivity 20C	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Unionised Ammoniacal Nitrogen ***	Measure water temperature	Chloride as Cl	Sulphate as SO4	Calcium	D.O. concentration	TOC (Filtered)
				mV	ug/l	mg/l	mg/l	mg/l	pH units	uS/cm	mg/l	mg/l	mg/l	°C	mg/l	mg/l	mg/l	mg/l	mg/l
	Trigger Level				**(0.2[a])**		**0.05**	**(0.05[a])**	**--**	**--**	**--**	**1**	**--**	**--**	**250**	**400**	**--**	**--**	**--**
	Control Level A				**(0.1[aa])**	**--**	**0.03**	**(0.02[aa])**	**--**	**--**	**--**	**0.8**	**--**	**--**	**210**	**300**	**--**	**--**	**--**
	Control Level B				**(0.15[aa])**	**--**	**0.04**	**(0.035[aa])**	**--**	**--**	**--**	**0.9**	**--**	**--**	**230**	**350**	**--**	**--**	**--**
	Assessment Level				**--**	**(1.0[a])**	**--**	**--**	**--**	**--**			**--**	**--**	**--**	**--**	**--**	**--**	**--**
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084461	72	0.08	0.0440	0.0099	< 0.1800	8.1	881.0	284.0	< 0.41			68.5	86.6	75.2	5.0	3.5
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349965	110	0.03	0.0868	0.0114	< 0.0180	7.0	977.0	313.0	1.53			77.1	84.5	85.0	2.8	3.7
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637859	124	0.03	0.4230	0.0154	< 0.0180	6.7	801	290	< 0.41			68.2	93.1	51.3	4.6	5.7
	Nov-18		Quarterly																
	Dec-18																		

Appendix D
Table D5
Groundwater monitoring results

Location	Month	Date	Test reference number	Redox Potential	Mercury, filtrate as Hg	Manganese in filtrate as Mn	Nickel in filtrate as Ni	Zinc, ultra-low filtered as Zn	pH	Electrical Conductivity 20C	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Unionised Ammoniacal Nitrogen ***	Measure water temperature	Chloride as Cl	Sulphate as SO4	Calcium	D.O. concentration	TOC (Filtered)
				mV	ug/l	mg/l	mg/l	mg/l	pH units	uS/cm	mg/l	mg/l	mg/l	ºC	mg/l	mg/l	mg/l	mg/l	mg/l
Trigger Level					(0.2ª)		0.05	(0.05ª)	--	--	--	1	--	--	250	400	--	--	--
Control Level A					(0.1ªª)	--	0.03	(0.02ªª)	--	--	--	0.8	--	--	210	300	--	--	--
Control Level B					(0.15ªª)	--	0.04	(0.035ªª)	--	--	--	0.9	--	--	230	350	--	--	--
Assessment Level					--	(1.0ª)	--	--	--	--			--	--	--	--	--	--	--
GW7	Jan-17	30/01/17	15849042	-23	< 0.10	< 0.0070	0.0065	0.0233	7.6	1250.0	440.0	< 0.41	0.0032	10.8	91.0	86.1		3.2	13.0
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040351	157	< 0.01	< 0.0070	0.0058	< 0.0180	7.5	950.0	368.0	0.51	0.0032	10.8	40.2	87.8		3.3	7.1
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290506	38	< 0.10	1.4400	0.0074	< 0.0180	7.6	966.0	349.0	< 0.41	0.0034	11.8	49.8	83.5		3.4	7.4
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530930	89	< 0.10	2.2600	0.0081	< 0.0180	7.8	957.0	384	< 0.41	0.0055	12.0	34.6	88.5		4.1	7.7
	Nov-17		Quarterly																
	Dec-17																		
	Jan-18	30/01/18	16812273	173	< 0.10	1.8900	0.0065	< 0.0180	< 7.6	870.0	310.0	< 0.41	0.0031	10.4	38.9	76.7	69.0	3.0	5.0
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084462	87	< 0.01	1.0000	0.0065	< 0.0180	8.6	786.0	257.0	< 0.41			44.6	65.5	63.5	3.9	5.5
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349966	122	0.01	2.1300	0.0088	0.0710	7.5	837.0	286.0	< 0.41			49.4	67.5	84.9	2.8	5.8
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637860	133	< 0.01	2.7600	0.0064	< 0.0180	7.6	892.0	314	< 0.41			48.1	108	85.5	3.3	6.8
	Nov-18		Quarterly																
	Dec-18																		
GW14	Jan-18	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18																		
	May-18		Quarterly																
	Jun-18																		
	Jul-18																		
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18																		
	Nov-18		Quarterly																
	Dec-18																		
SST East S2																			
GW9	Jan-17	30/01/17	15849043	-24	0.15	0.3460	< 0.0030	0.1710	6.8	570.0	180.0	5.77	0.0081	12.4	38.3	28.4		3.3	4.9
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040352	152	< 0.01	0.6090	0.0047	0.0485	6.8	710.0	229.0	7.30	0.0105	12.7	59.8	47.6		2.5	4.5
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290507	28	< 0.10	0.3880	0.0056	0.0372	6.9	603.0	166.0	3.56	0.0063	12.5	49.0	39.3		4.2	3.9
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530931	75	< 0.10	0.0841	0.0096	0.0479	7.4	599.0	163.0	2.12	0.0121	12.8	47.7	34.1		6.2	4.6
	Nov-17		Quarterly																
	Dec-17																		
	Jan-18	30/01/18	16812274	166	< 0.10	0.5050	0.0049	0.0331	7.3	691.0	225.0	5.25	0.0218	11.6	53.8	27.6	38.8	3.4	5.2
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084463	86	0.05	0.9150	0.0011	0.0222	7.9	1190.0	369.0	12.10			121.0	29.7	74.6	3.0	14.0
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349967	121	0.035	0.4080	0.0065	< 0.0180	7.4	936.0	290.0	5.98			89.7	41.7	54.7	3.1	8.9
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637861	123	0.016	0.5570	0.0038	< 0.0180	7.1	477.0	171.0	3.88			29.6	35.1	30.5	2.9	3.9
	Nov-18		Quarterly																
	Dec-18																		
SST East S3																			
GW10	Jan-17	30/01/17	15849044	-29	0.18	< 0.0070	< 0.0030	0.0601	7.0	535.0	199.0	< 0.41	0.0008	10.2	16.2	73.5		7.2	5.4
	Feb-17		Quarterly																
	Mar-17																		
	Apr-17	24/04/17	16040353	156	0.046	< 0.0070	< 0.0030	0.0514	7.3	700.0	265.0	< 0.41	0.0015	9.6	23.2	69.0		7.4	6.5
	May-17		Quarterly																
	Jun-17																		
	Jul-17	01/08/17	16290508	7	< 0.10	0.0080	< 0.0030	0.0553	7.2	498.0	187.0	< 0.41	0.0013	10.8	13.0	63.8		7.5	4.5
	Aug-17		Quarterly																
	Sep-17																		
	Oct-17	24/10/17	16530932	61	< 0.10	< 0.0070	0.0044	0.0586	7.5	513.0	195.0	< 0.41	0.0028	12.1	12.8	65.2		7.3	4.2
	Nov-17		Quarterly																
	Dec-17																		
	Jan-18	30/01/18	16812275	158	< 0.10	0.1050	0.00440	0.0733	7.4	500.0	180.0	< 0.41	0.0020	10.5	15.3	59.8	55.9	10.0	4.2
	Feb-18		Quarterly																
	Mar-18																		
	Apr-18	01/05/18	17084464	54	0.066	0.0336	0.0251	0.0548	8.5	477.0	184.0	< 0.41	0.0223	9.7	15.2	49.1	53.0	8.6	4.2
	May-18		Quarterly																
	Jun-18																		
	Jul-18	24/07/18	17349968	112	0.036	1.6300	0.0097	< 0.0180	7.2	795.0	329.0	0.45			24.9	63.5	94.0	4.6	9.4
	Aug-18		Quarterly																
	Sep-18																		
	Oct-18	29/10/18	17637862	114	< 0.10	5.6300	0.0107	< 0.0180	7.3	530.0	215.0	0.53			13.5	75.1	67.7	5.8	6.1
	Nov-18		Quarterly																
	Dec-18																		

Exceedance of Control Level

Notes
* The redox potential was not measured on site and there is a possibility that it has changed between sampling and analysis{*/}
** Unionised ammoniacal nitrogen based on measured Temperature and pH; unionised ammoniacal nitrogen = total ammonia/$(1+10^{(10.055-(0.0324*Tc)-pH)})$, where TºC is measured water temperature.

Appendix D
Table D5
Groundwater monitoring results

Location	Month	Date	Test reference number	Redox Potential	Mercury, filtrate as Hg	Manganese in filtrate as Mn	Nickel in filtrate as Ni	Zinc, ultra-low filtered as Zn	pH	Electrical Conductivity 20C	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Unionised Ammoniacal Nitrogen ***	Measure water temperature	Chloride as Cl	Sulphate as SO4	Calcium	D.O. concentration	TOC (Filtered)
				mV	ug/l	mg/l	mg/l	mg/l	pH units	uS/cm	mg/l	mg/l	mg/l	ºC	mg/l	mg/l	mg/l	mg/l	mg/l
	Trigger Level				**(0.2ª)**		**0.05**	**(0.05ª)**	--	--	--	**1**	--	--	**250**	**400**	--	--	--
	Control Level A				**(0.1ªª)**	--	**0.03**	**(0.02ªª)**	--	--	--	**0.8**	--	--	**210**	**300**	--	--	--
	Control Level B				**(0.15ªª)**	--	**0.04**	**(0.035ªª)**	--	--	--	**0.9**	--	--	**230**	**350**	--	--	--
	Assessment Level				--	**(1.0ª)**	--	--	--	--			--	--	--	--	--	--	--

Exceedance of Trigger Level
Exceedance of freshwater EQS
Exceedance of Assessment Level

^ Ammonia result confirmed on duplicate analysis.
^^ Reporting limits raised for EH analysis due to sample matrix.
NM temperature not measured on site therefore 10ºC is applied for the unionised ammoniacal nitrogen calculation

Empty' denotes not enough water in well for sample

Appendix D
Table D6
Landfill Gas Monitoring Results

		METHANE (% by Volume)												CARBON DIOXIDE (% by Volume)								
Location	Valve	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
	Red Valve	0.1	0	water	0	0	0	0.1	0.1	0	0	0	0	0.1	0.8	water	0.2	0.5	0.9	1.6	1.1	1.5
	Yellow Valve	0	0	water	0	0	0	0.1	0.1	0.1	0	0	0	0	0.1	water	0	0	0.3	0.6	0.4	0.7
	White Valve	0	0	water	0	0	0	0.1	0.1	0	0.1	0	0	2.6	0.8	water	1.8	0	0	0	0	3.6
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
GMW2	Trigger Level Red	-	-	-	-	-	-	-	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
	Control Level Red	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
	Red Valve	0	0	0	0	0	0.2	0.1	0.1	0.1	0.1	0	0	6.2	5.3	6.1	5.7	5.1	5.3	2	2.5	2.6
	Yellow Valve	0	0	0.2	0	0	0.1	0.1	0.1	0.1	0.1	0	0	0.1	0.0	0.3	0.1	0.1	3.4	1.6	1.6	0.1
	White Valve	0.3	0	0.3	0.1	0	0.1	0.1	0.1	0.1	0.1	0.3	0	20.3	3.8	2.6	0.6	1.9	2.8	1.9	0.2	10.3
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
GMW3	Trigger Level Red	-	-	-	-	-	-	-	-	-	-	-	-	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	24.02	24.02	24.02	24.02	24.02	24.02	24.02	24.02	24.02
	Control Level Red	-	-	-	-	-	-	-	-	-	-	-	-	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
	Red Valve	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0.2	0.1	0.6	0.8	0.6	0.5
	Yellow Valve	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0.2	0	0.1	0.1	0.1	0	0.1	0	0.3
	White Valve	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0	0.1	0	0	0	0.4	0.6	1.2	0.3	0.4
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
GMW4	Trigger Level Red	-	-	-	-	-	-	-	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
	Control Level Red	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
	Red Valve	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0	6.1	5.9	5.9	5.5	5.9	5.3	6.2	5.9	6.2
	Yellow Valve	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0	3.6	2.6	3.7	3.4	3.7	3.4	4.3	4.3	4.4
	White Valve	0	0	0	0	0	0.1	0.1	0.1	0	0	0	0	5.8	5	3.2	2.5	1.8	1.9	4.1	4.4	4.7
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
GMW5	Trigger Level Red	-	-	-	-	-	-	-	-	-	-	-	-	8.48	8.48	8.48	8.48	8.48	8.48	8.48	8.48	8.48
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
	Control Level Red	-	-	-	-	-	-	-	-	-	-	-	-	7.98	7.98	7.98	7.98	7.98	7.98	7.98	7.98	7.98
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Red Valve	0	0	0	0	0	0	0.1	0	0	0	0	0	3.8	4.8	2.4	2.8	4.4	3.9	5.6	4.8	5.6

Appendix D
Table D6
Landfill Gas Monitoring Results

Location	Valve	METHANE (% by Volume) Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	CARBON DIOXIDE (% by Volume) Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
GMW6	Yellow Valve	0	0	0	0	0	0	0.1	0.1	0	0	0	0	2.2	2.1	2.4	2.5	0.9	0.6	1.8	2.9	2.9
	White Valve	0	0	0	0	0	0	0	0.1	0	0	0	0	1.9	1.6	0.9	1.2	1.5	1.1	1.4	1.4	1.4
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
	Trigger Level Red	-	-	-	-	-	-	-	-	-	-	-	-	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	5	5	5
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76
	Control Level Red	-	-	-	-	-	-	-	-	-	-	-	-	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26
GMW7	Yellow Valve	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0.7	0.5	0.2	1.3	0.4	0.3	0.9	1.5	1
	White Valve	0	0	flooded	0	0	0	0.1	0	0	0	0	0	0.6	0.6	flooded	1.3	0.4	0.4	0.9	1.6	1.1
	Trigger Levels	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
	Control Levels	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-
	Trigger Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
	Trigger Level White	-	-	-	-	-	-	-	-	-	-	-	-	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82
	Control Level Yellow	-	-	-	-	-	-	-	-	-	-	-	-	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Control Level White	-	-	-	-	-	-	-	-	-	-	-	-	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
GMW12	Red Valve	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0.1	0.2	1	0.6	0.1	0.6	0.4	0.7
	Yellow Valve	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0.2	0.2	0.9	0.6	0.1	0.6	0.3	0.7
	White Valve	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0.3	0.2	1	0.8	0.2	0.7	0.8	1.2
	Trigger Level Red	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	Trigger Level Yellow	1	1	1	1	1	1	1	1	1	1	1	1	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
	Trigger Level White	1	1	1	1	1	1	1	1	1	1	1	1	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Control Level Red	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	4	4	4	4	4	4	4	4	4
	Control Level Yellow	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Control Level White	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	5	5	5	5	5	5	5	5
GMW13	Red Valve	0	0	0	0	0	0	0	0.1	0	0	0	0	1.2	1.5	1.2	1.1	1.3	1.3	1.6	1.2	1.2
	Yellow Valve	0	0.1	0	0	0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	4.1	6.6	5.2	5.6	5.9	5.9	5.6	6.1	5.8
	White Valve	0	0	0	0	0	0	0.1	0	0	0	0	0	3.7	3.3	2.7	3.7	2.9	3	3.8	2.6	3.3
	Trigger Level Red	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
	Trigger Level Yellow	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	6	6	6	6	6	6	6	6	6
	Trigger Level White	1	1	1	1	1	1	1	1	1	1	1	1	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82
	Control Level Red	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
	Control Level Yellow	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Control Level White	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32
GMW14	Red Valve	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
	Yellow Valve	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
	White Valve	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
	Trigger Level Red	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Trigger Level Yellow	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
	Trigger Level White	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	Control Level Red	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1	1	1	1
	Control Level Yellow	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	Control Level White	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9

Appendix D
Table D6
Landfill Gas Monitoring Results

		METHANE (% by Volume)												CARBON DIOXIDE (% by Volume)								
Location	Valve	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
GMW1**	Red Valve	0.5	0.5	0.5	0.7	2.6	2.7	1.6	0.1	1.7	0.5	1.1	0.7	1.3	1.5	1.3	2.3	3.7	3.5	5.1	0.1	4.2
	Yellow Valve	11.7	10.8	11.3	9	23.8	29.1	20.2	36.2	34.8	31.9	13.2	3.6	4.1	6.2	4.2	6	5.6	8.3	10.7	11	11.3
	White Valve	11.8	10.9	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	4.1	1	0	0	1	0.1	1.2	0.1	1.4
GMW8*	Yellow Valve	6.7	4.3	3.4	8.1	7.9	4.3	4.9	3.7	3.6	3.9	5	7.4	13.4	14.2	10.6	12.2	11.5	6.4	12	11.9	12.3
	White Valve	0	0	0	0	0	0	0.1	0	0.1	0	0	0	5.8	6.1	5.1	4.3	4.7	2.4	5.2	5.4	5.5
GMW9*	Red Valve	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0.1	0	1.9	2.2	2.1	0.8	1.2	1.3	2	2	2
	Yellow Valve	41.2	40.5	40.6	36.8	32.6	29.3	27.2	28.3	31.1	34.5	36.9	36.2	16.6	20.1	16.9	15.8	15.7	16	17.4	17.2	17.1
	White Valve	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.3	4.5	0.3
GMW10*	Red Valve	52	41.3	49.3	46.6	41.8	14.9	0.1	0.1	0	18.2	0	0	10.3	13	9.6	9.9	11.1	13.8	3.4	3.7	2.5
	Yellow Valve	51.5	46.8	48.2	43.3	41.7	19.2	0.1	0.1	0	12.8	0	0	10.4	13.7	9.3	8.6	9.9	13	3.3	3.2	2.4
	White Valve	41.7	31.7	26.2	32.3	32.6	13.4	0.2	0	0.1	14.1	0	0	9.6	10.8	6.3	9.6	10.8	13.8	4.3	4.6	8.8
GMW17**	Red Valve	0	0	0	0	0	0	0	0	0	0	0	0	1.3	1.3	1.4	1.3	1.1	1	1.3	1.3	1.3
	Yellow Valve	0	0	0	0	0	0	0	0	0	0	0	0	6	6.6	5.3	5.4	5.3	5	3.4	6	5.7
	White Valve	0	0	0	0	0	0	0	0	0	0	0	0	5.1	4.6	4.3	4.7	1.9	1.8	3.4	3.2	2.8
GMW18**	Yellow Valve	0	0	0	0	0	0	0	0.1	0	nt	0	0	0.1	1.5	3.3	0.1	2.3	1.9	2.2	2.3	1.9
	White Valve	0	0	0	0	0	0	0	0	0	nt	0	0	7.1	6.9	9	8.5	6.9	4.9	4.2	5.4	6.6

Notes:
1. Water denotes 'water in well - reading abandoned'.
2. NT denotes 'reading not taken'.
3. NT in GMW14 is due to cattle quarantine paddock around well location.
4. Where the asterisc (*) is present, no trigger levels have been set, as high levels of methane and carbon dioxide gas are recorded. This is likely to be associated with the presence of bog/marshland.
5. Where two asteriscs (**) are present, no trigger levels have been set, as not require by the Permit (Reference [2]).

	Exceedance of Trigger
	Exceedance of Control

Appendix D
Table D6
Landfill Gas Monitoring Results

Location	Valve	Oct-18	Nov-18	Dec-18	Comments
GMW2	Red Valve	1.2	0.7	0.7	Red Valve, 25.5m depth
	Yellow Valve	0.4	0	0.1	Yellow Valve,14m depth
	White Valve	0	0	0	White Valve, 4m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Red	1.5	1.5	1.5	
	Trigger Level Yellow	4.3	4.3	4.3	
	Trigger Level White	12.1	12.1	12.1	
	Control Level Red	1	1	1	
	Control Level Yellow	3.8	3.8	3.8	
	Control Level White	11.6	11.6	11.6	
GMW3	Red Valve	2.1	3.1	2.6	Red Valve, 19m depth
	Yellow Valve	0.2	0.1	0.2	Yellow Valve,9m depth
	White Valve	0.1	17	0.2	White Valve, 3.5m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Red	7.3	7.3	7.3	
	Trigger Level Yellow	2.67	2.67	2.67	
	Trigger Level White	24.02	24.02	24.02	
	Control Level Red	6.8	6.8	6.8	
	Control Level Yellow	2.17	2.17	2.17	
	Control Level White	23.5	23.5	23.5	
GMW4	Red Valve	0.3	0.2	0.1	Red Valve, 30m depth
	Yellow Valve	0.1	0.4	0	Yellow Valve,20m depth
	White Valve	0.1	0	0	White Valve, 5m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Red	1.5	1.5	1.5	
	Trigger Level Yellow	4.3	4.3	4.3	
	Trigger Level White	12.1	12.1	12.1	
	Control Level Red	1	1	1	
	Control Level Yellow	3.8	3.8	3.8	
	Control Level White	11.6	11.6	11.6	
GMW5	Red Valve	6.2	6.4	5.9	Red Valve, 26.3m depth
	Yellow Valve	4.4	4.5	4.5	Yellow Valve,15m depth
	White Valve	4.6	4.3	4.8	White Valve, 5m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Red	8.48	8.48	8.48	
	Trigger Level Yellow	4.1	4.1	4.1	
	Trigger Level White	4.8	4.8	4.8	
	Control Level Red	7.98	7.98	7.98	
	Control Level Yellow	3.6	3.6	3.6	
	Control Level White	4.3	4.3	4.3	
	Red Valve	5.1	3.6	3.4	Red Valve, 26.3m depth

Appendix D
Table D6
Landfill Gas Monitoring Results

Location	Valve	Oct-18	Nov-18	Dec-18	Comments
GMW6	Yellow Valve	2.7	3.6	2.6	Yellow Valve,15m depth
	White Valve	1.4	1.3	1.8	White Valve, 5m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Red	4.3	4.3	4.3	
	Trigger Level Yellow	5	5	5	
	Trigger Level White	3.76	3.76	3.76	
	Control Level Red	3.8	3.8	3.8	
	Control Level Yellow	4.5	4.5	4.5	
	Control Level White	3.26	3.26	3.26	
GMW7	Yellow Valve	0.9	0.4	0.3	Yellow Valve,12 depth
	White Valve	1	0	0.3	White Valve, 5m depth
	Trigger Levels	-	-	-	
	Control Levels	-	-	-	
	Trigger Level Yellow	1.8	1.8	1.8	
	Trigger Level White	1.82	1.82	1.82	
	Control Level Yellow	1.3	1.3	1.3	
	Control Level White	1.32	1.32	1.32	
GMW12	Red Valve	0.3	0	0.2	Red Valve, 26.3m depth
	Yellow Valve	0.3	0	0.2	Yellow Valve,15m depth
	White Valve	1	0.1	0.3	White Valve, 5m depth
	Trigger Level Red	4.5	4.5	4.5	
	Trigger Level Yellow	2.9	2.9	2.9	
	Trigger Level White	5.5	5.5	5.5	
	Control Level Red	4	4	4	
	Control Level Yellow	2.4	2.4	2.4	
	Control Level White	5	5	5	
GMW13	Red Valve	1.3	1.5	1.3	Red Valve, 26.3m depth
	Yellow Valve	5.5	5.2	5	Yellow Valve,15m depth
	White Valve	0	3.6	3.8	White Valve, 5m depth
	Trigger Level Red	7.9	7.9	7.9	
	Trigger Level Yellow	6	6	6	
	Trigger Level White	5.82	5.82	5.82	
	Control Level Red	7.4	7.4	7.4	
	Control Level Yellow	5.5	5.5	5.5	
	Control Level White	5.32	5.32	5.32	
GMW14	Red Valve	nt	nt	nt	Red Valve, 26.3m depth
	Yellow Valve	nt	nt	nt	Yellow Valve,15m depth
	White Valve	nt	nt	nt	White Valve, 5m depth
	Trigger Level Red	1.5	1.5	1.5	
	Trigger Level Yellow	5.9	5.9	5.9	
	Trigger Level White	5.4	5.4	5.4	
	Control Level Red	1	1	1	
	Control Level Yellow	5.4	5.4	5.4	
	Control Level White	4.9	4.9	4.9	

Appendix D
Table D6
Landfill Gas Monitoring Results

Location	Valve	Oct-18	Nov-18	Dec-18	Comments
GMW1**	Red Valve	1.9	2.9	6.4	Red Valve, 23.5m depth
	Yellow Valve	4.9	6.8	1.3	Yellow Valve,14.7m depth
	White Valve	0.1	0.1	1	White Valve, 6.5m depth
GMW8*	Yellow Valve	12.4	12.3	11.6	Yellow Valve,17.5m depth
	White Valve	6.1	5.5	5.4	White Valve, 5.7m depth
GMW9*	Red Valve	2.1	2.3	2.2	Red Valve, 27m depth
	Yellow Valve	15.8	15.5	12.3	Yellow Valve,15m depth
	White Valve	0.2	0.2	0.2	White Valve, 8.5m depth
GMW10*	Red Valve	8.2	3	2.2	Red Valve, 19.5m depth
	Yellow Valve	7.4	2.7	2.2	Yellow Valve,15m depth
	White Valve	8.1	3.1	2.3	White Valve, 8m depth
GMW17**	Red Valve	1.4	1.6	1.6	Red Valve, 26.3m depth
	Yellow Valve	5.9	5.3	4.7	Yellow Valve,15m depth
	White Valve	2.9	6	5.2	White Valve, 5m depth
GMW18**	Yellow Valve	nt	2.4	0.1	Yellow Valve,12 depth
	White Valve	nt	7	6.9	White Valve, 5m depth

Notes:
1. Water denotes 'water in well - reading al
2. NT denotes 'reading not taken'.
3. NT in GMW14 is due to cattle quarantin
4. Where the asterisc (*) is present, no trigg
5. Where two asteriscs (**) are present, no

	Exceedance of Trigger
	Exceedance of Control